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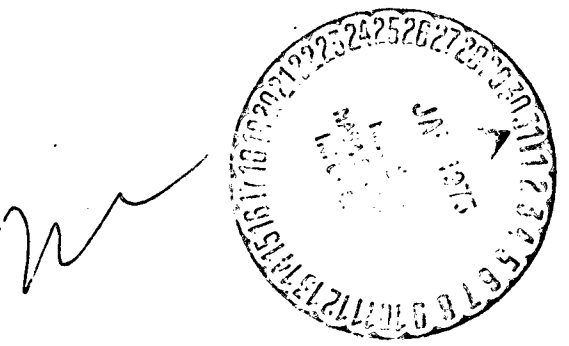
COMMUNICATION SYSTEMS PERFORMANCE AND COVERAGE ANALYSIS FOR APOLLO 10 (F TYPE MISSION)



INFORMATION SYSTEMS DIVISION

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

MSC INTERNAL NOTE NO. EB-R-69-5

PROJECT APOLLO

COMMUNICATION SYSTEMS PERFORMANCE AND COVERAGE ANALYSIS FOR APOLLO 10 (F TYPE MISSION)

By
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and
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APRIL 30, 1969

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NOMENCLATURE

A, B	noise spectral density constants
ACT	activation
ACQ	acquisition
AGC	automatic gain control
AGS	abort guidance subsystem
AM	amplitude modulation
AOS	acquisition of signal
APS	ascent propulsion system
ARIA	Apollo Ranging Instrumented Aircraft
BEP	bit error probability
BER	bit error rate
BET	best estimate of trajectory
BW_C	carrier loop noise bandwidth
BW_{IF}	IF noise bandwidth
BW_{PRN}	PRN ranging predetection noise bandwidth
BW_{TM}	telemetry predetection noise bandwidth
BW_V	voice predetection noise bandwidth
C	velocity of light
CDH	constant delta altitude
CDR	commander
CM	command module
CMC	command module computer
CMP	command module pilot
COAS	crew optical alignment
COMM	communications

CSI	colliptic sequence initiation maneuver
CSM	command service module
CTE	central timing equipment
DAP	digital autopilot
DFI	developmental flight instrumentation
DOI	descent orbit insertion
DPS	descent propulsion system
DSE	data storage equipment
DSIF	deep space instrumentation facility
EMU	extravehicular mobility unit
ETR	Eastern Test Range
EVA	extravehicular activity
EVT	extravehicular transfer
f	transmitted frequency
ΔF	peak frequency deviation
FM	frequency modulation
G_{GR}	gain of MSFN antenna
G_R	gain of receiving antenna
G_{TR}	gain of transmitting antenna
G_{SC}	gain of spacecraft antenna
GET	ground elapsed time
GMT	Greenwich mean time
HBR	high bit rate
HF	high frequency
HGA	high-gain antenna

IN	initiate
IMU	inertial measurement unit
IU	instrumentation unit
IVC	intervehicle communications
IVT	intravehicular transfer
JETT	jettison
K	Boltzman's constant
$L_{M/C}$	carrier modulation loss
$L_{M/PRN}$	PRN modulation loss
$L_{M/TM}$	telemetry modulation loss
$L_{M/V}$	voice modulation loss
L_P	pointing loss
L_{PZ}	polarization loss
L_R	receiver circuit loss
L_S	space loss
L_{SC}	spacecraft circuit loss
L_T	transmitter circuit loss
LBR	low bit rate
LHC	left-hand circular polarization
LLM	lunar landing mission
LM	lunar module
LMP	lunar module pilot
LOI	lunar orbit insertion
LOS	loss of signal

LPO	lunar parking orbit
LTA	LM test article
MCC	midcourse correction
MCC-H	Mission Control Center - Houston
M_{TM}	telemetry modulation index
M_V	voice modulation index
MET	mission elapsed time
MSFN	Manned Space Flight Network
MTVC	manual thrust vector control
n mi	nautical mile
P_C	carrier power
P_N	noise power
P_{PRN}	PRN channel power
P_R	total received power
P_{TM}	telemetry channel power
P_{TR}	transmitted power
P_V	voice channel power
PCM	pulse code modulation
PLSS	portable life support system
PM	phase modulation
PRN	pseudorandom noise
PTC	passive thermal control
RCS	reaction control system
RDP	radiation distribution plot

RF	radio frequency
RHC	right-hand circular polarization
RTC	real-time commands
SCS	stabilization control system
SLA	spacecraft LM adapter
SM	service module
SNR_{REQ}	required signal-to-noise ratio
SPS	service propulsion system
T&D	transposition and docking
TEC	transearth coast
TEI	transearth injection
TLC	translunar coast
TLI	translunar injection
TM	telemetry
TPF	terminal phase final
TPI	terminal phase initiation
TPM	terminal phase midcourse
TR	terminate
TRC	transponder ranging gain constant
TVC	thrust vector control
UDL	updata link
VHF	very high frequency
WI	word intelligibility
WRE	Weapons Research Establishment
WSMR	White Sands Missile Range

WTR	Western Test Range
ϕ_R	PRN phase deviation
θ, ϕ	spacecraft attitude angles with respect to ground station

1. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

As a result of the analysis performed in this report, the following conclusions and recommendations are made:

a) Except when specifically stated otherwise, (transposition and docking, lunar orbit, and reentry phases) the analysis presented in this report uses the operational trajectory for mission AS-505/CSM-106/LM-4, which assumes a nominal launch date of 18 May 1969. The analysis of launch and earth parking orbit phases is presented for three typical launch trajectory azimuths: 72, 90, and 108 degrees. A launch date other than 18 May 1969 will have a minor effect on predicted launch and earth parking orbit circuit margin performance. However, a change in launch date will affect subsequent phases of the mission. The 18 May 1969 trajectory data for the transposition and docking, lunar orbit, and reentry phases were not available at the time of publication. The predictions for these phases will be updated in an addendum. Should the trajectory change significantly, the predictions presented in this report and its addendum can be updated in near real time by means of the ISD/MSC computer aided analysis system.

b) During the transposition and docking phase, color television (TV) pictures of good quality can be provided using the CSM omni/85-foot MSFN antenna combination. CSM omni antenna A and the GDS 85-foot MSFN station are recommended during this time period. The CSM HGA (NBW)/85-foot MSFN antenna combination will provide good quality color TV pictures during color TV transmission periods from near-earth distances during translunar and transearth coast periods. The CSM HGA (NBW) antenna must be used with the GDS 210-foot antenna in order to obtain good quality color TV pictures during color TV transmission periods from near-lunar and lunar distances.

c) Saturn V mission data indicate that the total received power at MIL during the Saturn V launch phase is degraded by 40 to 50 dB as a result of flame effects during staging and approximately 1.5 seconds after interstage jettison. It is anticipated that degradation will be rapid enough to cause loss of receiver lock. Total received power will also be degraded by approximately 20 dB as a result of launch vehicle shadowing.

It is recommended that GBM be used as the primary S-band receiving site subsequent to 5-degree AOS at approximately 2 minutes after lift-off.

d) During the launch phase, CSM omni antenna B should be used for lift-off. Antenna D should be selected approximately 6 minutes after lift-off for the 72- and 90-degree launch azimuth and approximately 4 minutes after lift-off for the 108-degree launch azimuth. Selection of these antennas will provide positive margins for S-band communications during the entire launch phase. Station handover for the 72- and 90-degree launch should be MIL to GBM to BDA to VAN. Station handover for the 108-degree launch should be MIL to GBM to ANG.

e) CSM omni antenna D will provide goof communication coverage for all station passes of greater than 5 degrees elevation for the entire earth parking orbit phase except for the first pass over HTV for a 72-degree launch azimuth. Antenna C should be selected for this pass. Antenna D should be selected by ground command prior to TLI, and the spacecraft antenna switches should be set for subsequent ground command selection of antenna A for the CSM/S-IVB separation maneuver during the transposition and docking phase. Antenna A should be used from S-IVB/CSM separation until LM spring ejection at which time antenna B should be selected.

f) The CSM VHF/AM system will provide voice communications with positive circuit margins for all MSFN station passes during the launch and earth parking orbit phases. The LEFT CSM VHF antenna should be selected for these phases. The VHF/AM system should be used as the primary voice communication system during earth parking orbit for station passes below 5 degrees elevation. After CSM/S-IVB separation during the transposition and docking phase, the VHF/AM received carrier power at the MSFN stations will drop considerably below the 90-percent word intelligibility threshold and may not be usable.

g) Voice phasing interference can occur in the spacecraft when one crewman listens to both VHF and USB, simultaneously. It is recommended that, during the launch phase, one crewman listen to VHF and one to S-band, with volume control thumb wheels somewhat higher

than normal to override booster noise. It is also recommended that the USB uplink voice be turned down in the spacecraft during mission phases when the VHF voice is the primary mode of communication.

h) During most of translunar coast and transearth coast and all of lunar orbit, CSM downlink modes 1 (voice and 51.2-kbps telemetry) and 2 (voice, 51.2-kbps telemetry, and PRN) will not be available using the omni antennas with the 85-foot MSFN stations because of negative circuit margins. However, utilization of the GDS 210-foot antenna will provide positive margins for these modes with the CSM spacecraft omni antennas out to lunar distance. Downlink PM mode 15 (51.2 kbps telemetry and PRN) will be available on the omni antennas to approximately 145,000 miles from earth with the 85-foot MSFN station. It is recommended that reliance be made on low bit rate telemetry when omni antennas are used during the near lunar portions of these phases.

i) During the translunar coast and transearth coast crew rest PTC periods, it is recommended that CSM omni antennas be used with ground command switching instead of the CSM HGA whenever possible. This will lessen the possibilities of not being able to dump the contents of the DSE if difficulties are encountered in HGA reacquisition.

j) During translunar coast and transearth coast crew active PTC periods, it is recommended that the CSM omni antenna switching be accomplished by ground command or the crew be advised of the optimum switching frequency with respect to the MSFN receivers. If the crew performs the antenna switching on the basis of high head set noise levels, the received carrier power at the MSFN will usually fall below threshold levels prior to each antenna switch.

k) FM test data analysis indicates LM FM mode 9 (voice and telemetry) will be satisfactory with LM steerable/85-foot MSFN antenna combination at lunar distance. FM capability will also exist for the CSM using the HGA (NBW)/85-foot MSFN antenna combination. All standard CSM FM modes using the HGA (NBW)/85-foot MSFN antenna combination will have positive circuit margins at lunar distance. The CSM color TV mode, however, requires the use of the HGA (NBW)/210-foot antenna combination for satisfactory picture quality.

l) New phase lock loop FM demodulators will be used at 85-foot MSFN stations for Apollo 10 and subsequent missions. The demodulators have selectable two-sided loop bandwidths of either 3.6 MHz (narrow) or 10 MHz (wide). It is mandatory that the demodulators be configured correctly for the various CSM and LM FM modes for proper demodulation of the FM signals. Section 9 of this report contains the required configurations for the various CSM and LM FM modes.

m) Reacquisition of range code may be required following antenna switching operation during all mission phases.

n) Selection of backup voice and/or low bit rate telemetry in the LM disables the ranging channel. In order to provide a ranging capability when using the LM S-band inflight antennas, it is necessary to provide a special ranging only mode designated LM PM mode 11. Mode 11 is selected by setting the voice and PCM switches to the off position and by turning on the ranging channel. At lunar distance, LM PM mode 11 will have a positive circuit margin of approximately 4 dB when using the LM S-band inflight/85-foot MSFN antenna combination.

2. INTRODUCTION

This report predicts the communications coverage for selected phases of the Apollo 10 mission (AS-505/CSM-106/LM-4). The Apollo 10 mission will be the first lunar mission to include both CSM and LM operations. The mission consists of up to three earth parking orbits, a translunar coast, a lunar orbit period that includes approximately 31 revolutions and a LM descent orbit to 50,000 feet, a fast return transearth coast, and reentry. Communication predictions are provided for the major events and time periods listed in Table 4-1.

The analysis in this report is based on the operational trajectory for mission AS-505/CSM-106/LM-4. For trajectory simulation, launch was assumed to occur 18 May 1969 from launch complex 39B on a nominal launch azimuth of 72, 90, or 108 degrees from true North.

The report consists principally of a series of signal stength versus elapsed mission time plots for the MSFN, CSM, and LM receivers. The plots contain signal strength predictions for the spacecraft S-band and VHF/AM systems. The plots were produced by a computer program which combined the spacecraft trajectory, measured antenna patterns, transmitter and receiver performance characteristics, and system mathematical models to make a simulation of the communication system performance during the mission. The results are shown in Sections 5 through 11 of this report. When available, measured spacecraft parameters were used in the predictions; otherwise, worst case specified values were used. Worst case specified MSFN parameter values were also used. The antenna gain patterns were obtained from fractional or full-scale mockups of the CSM or LM and were made at the test facilities of the Space Electronics and Systems Division (SESD) at the Manned Spacecraft Center.

The receiver thresholds, keyholes, times of major events, 5-degree elevation look angles, and points of closest approach to the MSFN stations are indicated on each plot. The values for slant range between the spacecraft and the MSFN station and the MSFN antenna azimuth and elevation angles at the point of closest approach are printed on each plot.

The voice thresholds are defined as the values of received carrier power that will produce the required predetection signal-to-noise ratios for 90 percent and 70 percent word intelligibility (WI). The voice thresholds are indicated by a horizontal dashed line. Only the 90 percent WI voice threshold is shown on the VHF/AM received carrier power plots. The updata link threshold is defined as the value of received carrier power for a message rejection rate of 1 per 1000 or a bit error probability of 6.6×10^{-6}. The downlink telemetry thresholds are defined as the value of received carrier power which will produce bit error probabilities of 10^{-6} and 10^{-3} in the PCM telemetry output data. Telemetry thresholds are indicated by a tick mark in the right-hand margin. The carrier threshold for the S-band system is the required received carrier power for receiver lock. Thresholds for PRN ranging are not shown. In calculating threshold values for MSFN sites, it was assumed that all stations employ uncooled parametric amplifiers except Ascension, Carnarvon, Guam, Hawaii, Madrid, Canberra, and Goldstone, which have cooled parametric amplifiers.

Keyholes and terrain obstructions are indicated by the same dot pattern since both cause the same end result of antenna coverage limitation. The MSFN antenna keyhole results from limitations placed on the antenna motion. These limitations are imposed by a cam on the antenna which cuts off unified S-band transmitter radiation and disconnects the servo motors from the antenna when it is below 14 degrees in elevation and within ±14 degrees of the north-south axis of a 30-foot antenna and within ±14 degrees of the east-west axis of an 85-foot antenna. The above definition of keyhole applies to all MSFN S-band sites except Bermuda and Antigua where the elevation constraint has been reduced from 14 degrees to 6.6 degrees by modifying the antenna mount.

The times at which the CSM high-gain antenna scan warning limits, electrical scan limits, and mechanical limits are exceeded are indicated on the high-gain antenna plots as  ,  , and , respectively.

The 5-degree elevation look angles (5 DEG), spacecraft point of closest approach to a MSFN station (PCA), and times of major events are indicated by a vertical dashed line and mnemonic code at the top of the plot. Section 4 presents a list of mnemonics used to identify major events.

The report contains several appendixes which provide detailed information on the communication systems mathematical models, performance characteristics and capabilities, used in the preparation of this report. Detailed MSFN station AOS/LOS data and real-time operational aids information are also supplied in the appendixes. The real-time operational aids augment the communications coverage contained in the various sections of this report in that they may be used to derive useful PM and FM S-band modes at particular spacecraft ranges from a MSFN station during those mission phases (such as translunar and transearth coast phases) where coverage predictions are provided for only representative portions of the phase. The operational aids illustrate S-band modes slant-range capabilities (or range limitation) for various antenna combinations.

All RF coverage plots in this report are based on trajectory data for an 18 May launch date except the transposition and docking, lunar orbit, and reentry phases. Plots for these phases were generated from 17 May launch date trajectory data because 18 May trajectory data were not available at time of publication. Updated plots for these phases will be supplied in an addendum when the required trajectory data become available. Doppler shift plots will also be provided in an addendum when 18 May trajectory data for all mission phases become available.

3. MISSION COMMUNICATION OBJECTIVES

The communication objectives for the Apollo 10 mission include the demonstration of LM S-band communications with MSFN at lunar distances with both the omni and steerable antennas and the evaluation of the integrated communications necessary to support a lunar landing.

3.1 LM COMMUNICATIONS AT LUNAR DISTANCE

This mission will demonstrate at lunar distance LM/MSFN S-band communications via the steerable antenna. Test objectives include evaluation of manual and automatic acquisition performance and evaluation of tracking performance.

3.2 LM OMNI ANTENNAS AT LUNAR DISTANCE

The Apollo 10 mission will evaluate LM/MSFN S-band communications at lunar distance via the omni antennas using the 85-foot MSFN stations.

3.3 CSM HIGH-GAIN ANTENNA REFLECTIVITY

The CSM S-band spacecraft reflectivity with the CSM/LM docked will be assessed by using the CSM high-gain antenna in the narrow beam width, the medium beam width, and the wide beam width while communicating with 85-foot, with 30-foot cooled, and with 30-foot uncooled receiving antennas at selected ranges.

3.4 LM/CSM/MSFN VOICE AND TELEMETRY COMMUNICATIONS

The Apollo 10 mission will demonstrate the integrated communication systems of the CSM, the LM, and MSFN. Integrated communications test objectives will include the following:

a) Simultaneous voice communication between the LM and MSFN via S-band and between the LM and CSM via VHF

b) Voice conference communication between LM, MSFN, and CSM utilizing the LM S-band steerable antenna and the CSM high-gain antenna with MSFN acting as a voice relay

c) Voice conference communication between the LM, CSM, and MSFN using VHF voice communication between the LM and the CSM with the CSM providing voice relay to MSFN via S-band

d) Voice communication between the CSM, LM, and MSFN using VHF voice between the CSM and LM with the LM providing voice relay via S-band

e) Demonstrate the capability to transmit LM voice and low bit rate telemetry simultaneously to the CSM, to record the LM telemetry and voice data simultaneously in the CSM, and to dump the LM telemetry data and then the voice data to MSFN.

4. MISSION SUMMARY

4.1 MISSION TRAJECTORY

The analysis presented in this report assumes the Apollo 10 launch will occur 18 May 1969 from launch complex 39B on a nominal flight azimuth of 72, 90, or 108 degrees from true North. Computer plots provided for the transposition and docking, lunar orbit, and reentry phases are based on a 17 May launch date. Plots for these phases based on a 18 May launch date will be supplied in an addendum.

Table 4-1 lists the major events for a 72-degree launch azimuth, first injection opportunity mission profile. The launch vehicle will insert the spacecraft into a 100-nautical mile circular earth parking orbit. Translunar injection will be over the Pacific with ignition of the S-IVB stage occurring on the second revolution. The nominal injection will provide a free return to earth if lunar orbit insertion is not initiated.

Within 2 hours after translunar injection, the CSM will separate from the S-IVB, transpose, dock, and initiate ejection of the LM. Passive thermal control will be initiated after the first midcourse correction and will be maintained throughout the translunar coast except when other activities (such as midcourse corrections) require different attitudes.

The SPS will insert the spacecraft into a lunar orbit of approximately 60 by 170 nautical miles. After system checks are completed, the orbit will be circularized at approximately 60 nautical miles. Two astronauts will enter the LM and check out the LM for separation from the CSM. After separation, the LM will perform a simulated descent orbit insertion burn resulting in an orbit of approximately 60 by 8 nautical miles. After the descent orbit pericynthion has been reached, a DPS phasing burn will be performed to set up the LM active rendezvous. The LM RCS will be used for staging, and a simulated APS insertion burn will be performed. The LM will perform various rendezvous maneuvers that will bring it to a position below and behind the CSM. After LM active docking and crew transfer, the LM will be jettisoned. The LM APS engine will then be ignited again and burned to depletion.

Transearth injection will be accomplished with an SPS burn. The return flight time will be approximately 55 hours. During transearth coast, passive thermal control will be used, and midcourse corrections will be made if required.

Prior to atmospheric entry, the command module will be separated from the service module using the service module RCS. Splashdown will be in the Pacific 8 days after launch.

4.2 MSFN COVERAGE SUMMARY

Table 4-2 lists the geodetic locations and communications capabilities of the MSFN ground stations. A bar graph summary of the MSFN coverage for each mission time phase covered in this report is included in the section covering the mission phase. Table 4-3 lists ship locations for a 18 May 1969 launch.

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch

Event	Mnemonic	Time from Lift-off (Hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
Lift-off	LAUNCH	00:00:00	00:00:00:00	Launch and EPO
Staging	STGING	00:02:32	00:00:02:32	
First S-IVB ignition	IST-IG	00:08:45	00:00:08:45	
Earth orbit insertion	INSERT	00:11:21	00:00:11:21	
Translunar injection burn ignition (first opportunity)	1TLI-IG	02:33:33.19	00:02:33:33.19	
Translunar injection burn cutoff (first opportunity)	1TLI-CO	02:38:40.08	00:02:38:40.08	
CSM/S-IVB separation	SIVSEP	03:00:00	00:03:00:00	T and D
Television transmission (color)	CLR TV	03:00:00	00:03:00:00	
CSM/LM docking	DOCKNG	03:10:00	00:03:10:00	
LM spring ejection	LMEJET	04:06:00	00:04:06:00	
CSM/LM SPS evasive maneuver	EVADE	04:28:47	00:04:28:47	
S-IVB slingshot maneuver	2ND-IG	04:39:00	00:04:39:00	
First midcourse correction	MCC-1	11:33:00	00:11:33:00	TLC
Begin PTC mode	BEGPTC	12:05:00	00:12:05:00	
Begin 8-hr rest period	BEREST	13:00:00	00:13:00:00	
End rest period	ENREST	21:30:00	00:21:30:00	
End PTC mode	ENDPTC	24:45:00	01:00:45:00	
Second midcourse correction	MCC-2	26:30:00	01:02:30:00	
Begin high gain antenna operation	HGAOPS	26:50:00	01:02:50:00	
S-band reflectivity test	S-BAND	26:50:00	01:02:50:00	

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
Television transmission (color)	CLR TV	27:15:00	01:03:15:00	TLC
Begin PTC mode	BEGPTC	27:25:00	01:03:25:00	
Begin 9-hr rest period	BEREST	34:00:00	01:10:00:00	
End rest period	ENREST	43:00:00	01:19:00:00	
End PTC mode	ENDPTC	44:50:00	01:20:50:00	
Begin PTC mode	BEGPTC	45:15:00	01:21:15:00	
End PTC mode	ENDPTC	52:45:00	02:04:45:00	
Third midcourse correction	MCC-3	53:45:00	02:05:45:00	
Television transmission (color)	CLR TV	54:00:00	02:06:00:00	
Begin PTC mode	BEGPTC	54:20:00	02:06:20:00	
Begin 10-hr rest period	BEREST	58:00:00	02:10:00:00	
End rest period	ENREST	68:00:00	02:20:00:00	
End PTC mode	ENDPTC	69:35:00	02:21:35:00	
Fourth midcourse correction	MCC-4	70:45:00	02:22:45:00	
Television transmission (color)	CLR TV	72:20:00	03:00:20:00	
Lunar orbit insertion burn	LOI-1	75:45:00	03:03:45:00	LPO
Lunar orbit circularization burn	LOI-2	80:10:00	03:08:10:00	
Television transmission (color)	CLR TV	80:45:00	03:08:45:00	
LMP intravehicular transfer to LM	IVT-LM	81:50:00	03:09:50:00	
LMP intravehicular transfer to CSM	IVTCSM	83:45:00	03:11:45:00	

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
Begin 8-hr rest period	BEREST	84:45:00	03:12:45:00	LPO
End rest period	ENREST	92:15:00	03:20:15:00	
LMP intravehicular transfer to LM	IVT-LM	94:30:00	03:22:30:00	
CDR intravehicular transfer to LM	IVT-LM	94:55:00	03:22:55:00	
Secondary S-band T/R and power amplifier checks	SECCHK	95:05:00	03:23:05:00	
S-band steerable antenna checks	STEERA	95:10:00	03:23:10:00	
LMP intravehicular transfer to CSM	IVTCSM	95:15:00	03:23:15:00	
LMP intravehicular transfer to LM	IVT-LM	95:45:00	03:23:45:00	
Switch to S-band steerable antenna	SWSTEE	96:55:00	04:00:55:00	
Undock	UNDOCK	98:10:00	04:02:10:00	
Television transmission (color)	CLR TV	98:15:00	04:02:15:00	
CSM separation	CSMSEP	98:35:16	04:02:35:16	
Rendezvous radar (RR) and VHF ranging checks	RR/VHF	98:51:00	04:02:51:00	
Landing radar test	LDGRDR	99:25:00	04:03:25:00	
LM DPS descent orbit insertion burn	DPSDOI	99:33:59	04:03:33:59	
Initiate RR tracking	RR-ON	99:37:00	04:03:37:00	
Terminate RR tracking	RR-OFF	99:45:00	04:03:45:00	

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
LM descent orbit pericynthion	PERICN	100:31:13	04:04:31:13	LPO
LM DPS phasing burn	DPSPHA	100:46:21	04:04:46:21	
Initiate RR tracking and and VHF ranging	RR-ON	100:52:00	04:04:52:00	
Terminate RR tracking	RR-OFF	100:57:00	04:04:57:00	
Initiate RR tracking	RR-ON	101:15:00	04:05:15:00	
Terminate RR tracking	RR-OFF	101:26:00	04:05:26:00	
Initiate RR tracking	RR-ON	102:09:00	04:06:09:00	
Terminate RR tracking	RR-OFF	102:21:00	04:06:21:00	
LM RCS staging	RCSSTG	102:33:18	04:06:33:18	
LM APS insertion burn	LMNSRT	102:43:18	04:06:43:18	
Initiate RR tracking	RR-ON	103:01:00	04:07:01:00	
LM RCS CSI	LM-CSI	103:33:46	04:07:33:46	
LM RCS plane change	LM-PC	104:01:42	04:08:01:42	
LM RCS CDH	LM-CDH	104:31:44	04:08:31:44	
LM RCS TPI	LM-TPI	105:09:00	04:09:09:00	
First LM midcourse correction (RCS)	LMCC-1	105:24:00	04:09:24:00	
Second LM midcourse correction (RCS	LMCC-2	105:39:00	04:09:39:00	
LM TPF	LMTPF	105:48:00	04:09:48:00	
Rendezvous	RENDEZ	105:54:00	04:09:54:00	
LM active docking	LMDOCK	106:20:00	04:10:20:00	

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
CDR intravehicular transfer to CSM	IVTCSM	107:09:00	04:11:09:00	LPO
LMP intravehicular transfer to CSM	IVTCSM	107:24:00	04:11:24:00	
Jettison LM	JETTLM	108:09:23	04:12:09:23	
Television transmission (color)	CLR TV	108:35:00	04:12:35:00	
LM APS burn to depletion	LMAPSD	108:39:00	04:12:39:00	
Begin 9-hr rest period	BEREST	109:00:00	04:13:00:00	
End rest period	ENREST	118:00:00	04:22:00:00	
Begin landmark tracking (four revolutions)	BELDMK	121:00:00	05:01:00:00	
End landmark tracking	ENLDMK	128:00:00	05:08:00:00	
Begin 3 1/2-hr rest period	BEREST	128:40:00	05:08:40:00	
End rest period	ENREST	131:50:00	05:11:50:00	
Transearth injection burn	TEI	137:20:00	05:17:20:00	TEC
Television transmission (black and white)	B&W TV	137:45:00	05:17:45:00	
Begin PTC mode	BEGPTC	138:50:00	05:18:50:00	
Begin 5 1/2-hr rest period	BEREST	140:30:00	05:20:30:00	
End 5 1/2-hr rest period	ENREST	146:00:00	06:02:00:00	
End PTC mode	ENDPTC	150:20:00	06:06:20:00	
Fifth midcourse correction	MCC-5	152:20:00	06:08:20:00	
Television transmission (color)	CLR TV	152:35:00	06:08:35:00	

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
Begin PTC mode	BEGPTC	152:50:00	06:08:50:00	TEC
Begin 9-hr rest period	BEREST	154:00:00	06:10:00:00	
End rest period	ENREST	163:00:00	06:19:00:00	
End PTC mode	ENDPTC	164:53:00	06:20:53:00	
Begin PTC mode	BEGPTC	165:30:00	06:21:30:00	
End PTC mode	ENDPTC	167:13:00	06:23:13:00	
Begin PTC mode	BEGPTC	168:00:00	07:00:00:00	
End PTC mode	ENDPTC	171:03:00	07:03:03:00	
Begin PTC mode	BEGPTC	171:45:00	07:03:45:00	
End PTC mode	ENDPTC	174:15:00	07:06:15:00	
Sixth midcourse correction	MCC-6	176:50:00	07:08:50:00	
Begin PTC mode	BEGPTC	177:20:00	07:09:20:00	
Begin 8-hr rest period	BEREST	179:00:00	07:11:00:00	
End rest period	ENREST	186:00:00	07:18:00:00	
End PTC mode	ENDPTC	186:30:00	07:18:30:00	
Television transmission (color)	CLR TV	186:50:00	07:18:50:00	
Seventh midcourse correction	MCC-7	188:50:00	07:20:50:00	
CM/SM separation	SM SEP	191:35:00	07:23:35:00	
Entry interface	ENTRY	191:50:32	07:23:50:32	Reentry
Enter S-band blackout period	BLKOUT	191:50:58	07:23:50:58	
0.05 g	0.05 G	191:51:02	07:23:51:02	

Table 4-1. Sequence of Key Events for 72-Degree Launch Azimuth, 18 May 1968 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)	
Peak g	PEAK G	191:51:56	07:23:51:56	Reentry
Exit S-band blackout period	BLKOUT	191:53:58	07:23:53:58	
Drogue chute deployment	DROGUE	191:59:04	07:23:59:04	
Main chute deployment	MAIN	191:59:54	07:23:59:54	
Splashdown	SPLASH	192:04:47	08:00:04:47	

Table 4-2. MSFN Stations and Capabilities

Station and Designator		Coordinates[a] Geodetic[b] Latitude (deg)	Longitude[b] (deg)	Geodetic[c] Height (ft)	C-band[d] TKG	VHF Voice	VHF TLM	UHF COM	Unified S-band Voice	Unified S-band TLM	Unified S-band TKG, R&RR	Unified S-band Updata	Unified S-band TV Record	USB Type
Merritt Island	MIL	28.50827222	-80.69341666	32.81		X	X		X	X	X	X	X	30-ft dual
	MLA	28.42486194	-80.66440389	39.37	X									
Patrick AFB	PAT	28.22655278	-80.59929167	49.21	X									
Cape Kennedy	CNV	28.48176667	-80.57651389	45.93	X	X	X	X						
Grand Bahama	GBI	26.63634999	-78.26770833	39.37	X	X	X	X						
	GBM	26.63285833	-78.23766388	59.06					X	X	X	X	X	30-ft single
Grand Turk	GTK	21.46288889	-71.13211389	91.86	X			X						
Bermuda	BDA	32.35128611	-64.65518055	68.90	X	X	X	X	X	X	X	X	X	30-ft single[e]
Antigua	ANT	17.14403055	-61.79285833	190.29	X	X	X	X						
	ANG	17.01669166	-61.75268888	91.86					X	X	X	X	X	30-ft single[e]
Grand Canary	CYI	27.73999999	-15.60305555	131.23	X	X	X	X	X	X	X	X	X	30-ft single
Ascension	ASC	-07.97276111	-14.40169445	469.16	X	X	X							
	ACN	-07.95505555	-14.32757778	1843.83					X	X	X	X	X	30-ft dual[g]
Madrid	MAD	40.45535833	-04.16739445	2706.69					X	X	X	X	X	85-ft dual[g]
	MADX[f]	40.42865277	-04.24793888	2680.45					X	X	X	X	X	85-ft dual[h]
Pretoria	PRE	-25.94373333	28.35848889	5334.65	X									
Tananarive	TAN	-19.01805555	47.30444431	36.09	X	X	X							
Carnarvon	CRO	-24.90759166	113.72424722	190.29	X	X	X	X	X	X	X	X	X	30-ft dual[g]
Guam	GWM	13.30924444	144.73441389	416.67		X	X		X	X	X	X	X	30-ft dual[g]
Honeysuckle	HSK	-35.58473889	148.97657777	3766.40					X	X	X	X	X	85-ft dual[g]
Creek	HSKX[f]	-35.40223333	148.98005832	2208.00					X	X	X	X	X	85-ft dual[h]
Hawaii	HAW	22.12489722	-159.66498889	3772.97	X	X	X	X	X	X	X	X	X	30-ft dual[g]
Point Arguello	CAL	34.58290277	-120.56115000	2168.64	X	X								
Goldstone	GDS	35.34169444	-116.87328889	3166.01					X	X	X	X	X	85-ft dual[g]
	GDSX[f]	35.38966944	-116.84906110	3375.98					X	X	X	X	X	85-ft dual[h]
Guaymas	GYM	27.96320555	-110.72085000	62.34		X	X		X	X	X	X	X	30-ft single
White Sands	WHS	32.35822222	-106.36956389	4041.99	X									
Corpus Christi	TEX	27.65375000	-97.37846945	32.81		X	X	X	X	X	X	X	X	30-ft single

[a] Coordinates based on Fischer Earth Model of 1960

[b] Minus signs indicate south latitude or west longitude

[c] Geodetic height is the algebraic sum of the height above mean sea level and the geodial separation

[d] C-band tracking by skin reflections only

[e] These single sites have dual uplink capability

[f] JPL wing

[g] These S-band sites have cooled paramps

[h] These S-band sites have cooled masers

Table 4-3. Ship Locations

Ship and Designation	Major Equipment	Latitude* (deg)	Longitude* (deg)	Purpose
USNS Mercury (MER)	USB-30'	-32.00	131.00	Coverage for TLI
USNS Redstone (RED)	USB-30'	-14.00	145.50	Coverage for TLI
		-26.50	169.00	Coverage for reentry
USNS Vanguard (VAN)	USB-30'	25.00	-49.00	Coverage for insertion
USNS Huntsville (HTV)	USB-12'	-1.0	164.0	Coverage for TLI
		-17.5	-173.0	Coverage for reentry blackout

*Minus signs indicate south latitude or west longitude

5. LAUNCH

5.1 INTRODUCTION

The launch phase covers the period from lift-off through orbital insertion. Communications predictions and recommendations are provided for nominal launch azimuths of 72, 90, and 108 degrees for an 18 May 1968 launch.

The following communications recommendations are contained in this section:

a) One crewman listen to S-band voice only and one crewman listen to VHF/AM voice only.

b) Use S-band antenna B at lift-off. Select antenna D at approximately 6 minutes after lift-off on 72- and 90-degree launch azimuths and at approximately 4 minutes after lift-off on 108-degree launch azimuth.

c) Use GBM as primary S-band receiving site during staging.

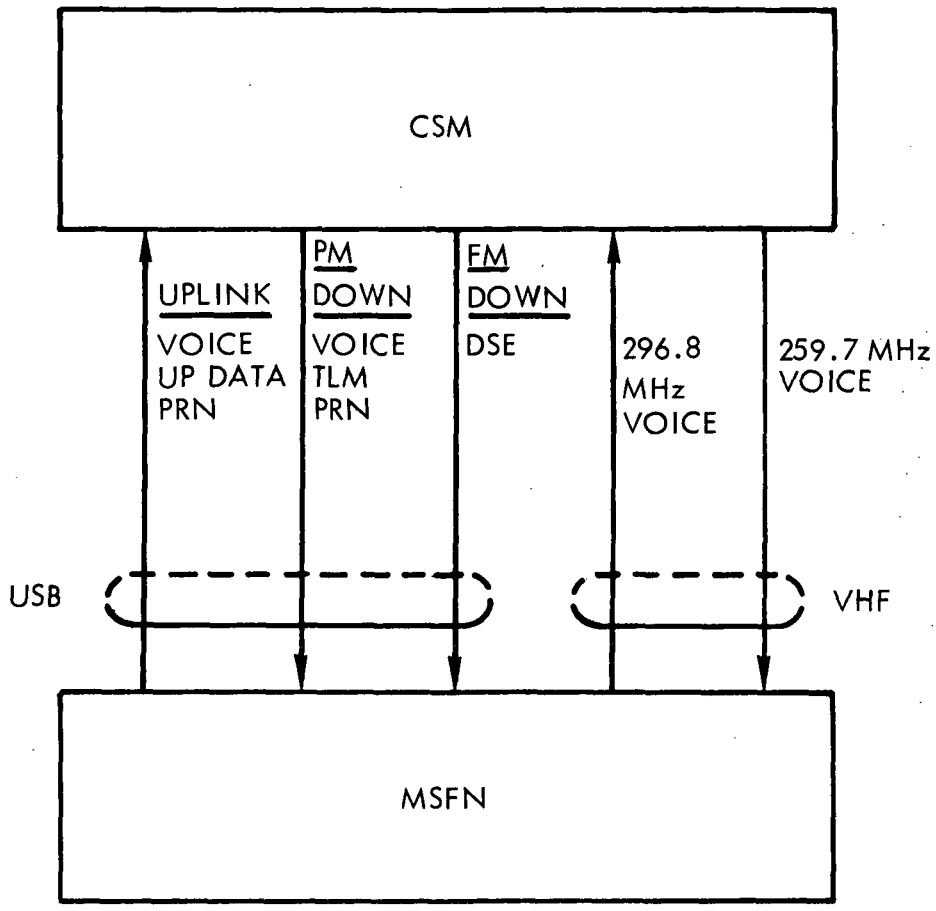
d) Use LEFT CSM VHF antenna for the entire launch phase.

e) Handover MIL to GBM to BDA to VAN on 72- and 90-degree launch azimuths. Handover from MIL to GBM to ANG on 108-degree launch azimuth

5.2 BASIC COMMUNICATION CONFIGURATION

The basic communication configuration to be used during the launch phase is shown in Figure 5-1. This configuration consists of both VHF/AM and S-band communications between the CSM and MSFN.

The S-band system will provide full PM uplink and downlink communications. Full uplink (PM mode 6) consists of voice, updata, and PRN ranging. Full downlink (PM mode 2) consists of voice, HBR telemetry, and PRN ranging. The S-band system FM downlink will also be available for playback of the contents of the data storage equipment (DSE) which will be in operation during the launch phase and may be dumped at a later time.



NOTES:
1. ALL AUDIO CENTERS HAVE VHF AND S-BAND VOLUMES UP
2. S-BAND SQUELCH ENABLED
3. VOICE TRANSMITTED SIMULTANEOUSLY ON S-BAND AND VHF
4. VHF DUPLEX B WILL BE SELECTED FOR LAUNCH OPERATIONS

Figure 5-1. Basic Communication Configuration for Launch Phase

The VHF/AM system will be operated in the Duplex B mode; i.e., uplink voice will be transmitted on 296.8 MHz, and downlink voice will be transmitted on 259.7 MHz.

Voice will be transmitted simultaneously on S-band and VHF/AM. All audio centers will have VHF/AM and S-band volumes turned up. In order to avoid voice phasing effects within the spacecraft, it is recommended that one crewman listen to S-band voice only and one crewman listen to VHF/AM voice only.

5.3 RF COVERAGE SUMMARY

A bar graph summary of RF communications coverage for the three launch azimuths is given in Figure 5-2. The bar graph shows AOS/LOS times, recommended spacecraft antenna selections, and recommended handover sequence. The spacecraft recommendations are based on the following criteria and in this order of precedence:

a) Antennas which provide the largest positive circuit margin (carrier power above the 70-percent WI voice threshold and 10^{-3} BEP telemetry threshold on S-band downlink and carrier power above 90-percent WI voice threshold on VHF/AM downlink).

b) Antennas which allow minimum spacecraft switching.

Computer plots of received carrier power versus elapsed time from lift-off (Figures 5-3 through 5-18), for the three launch azimuths are furnished for each station providing S-band or VHF/AM coverage. A plot is provided for each pair of diametrically opposite CSM S-band omnidirectional antennas (i.e., A and C, B and D) for both uplink and downlink signals. A plot is also provided for the two CSM VHF/AM scimitar antennas for both uplink and downlink signals. The letters L and R are used on the bar graphs and VHF/AM plots to designate the CSM VHF LEFT and RIGHT antennas. The plots are shown in the order of station coverage and the VHF/AM and S-band plots are grouped for each station. Section 2 presents a complete description of the RF coverage computer plots provided in this document.

Uplink mode 6 (PRN ranging, voice, and updata) and downlink mode 2 (PRN ranging, voice, and 51.2-kbps telemetry) were used for the S-band computer plots during the launch phase of the mission.

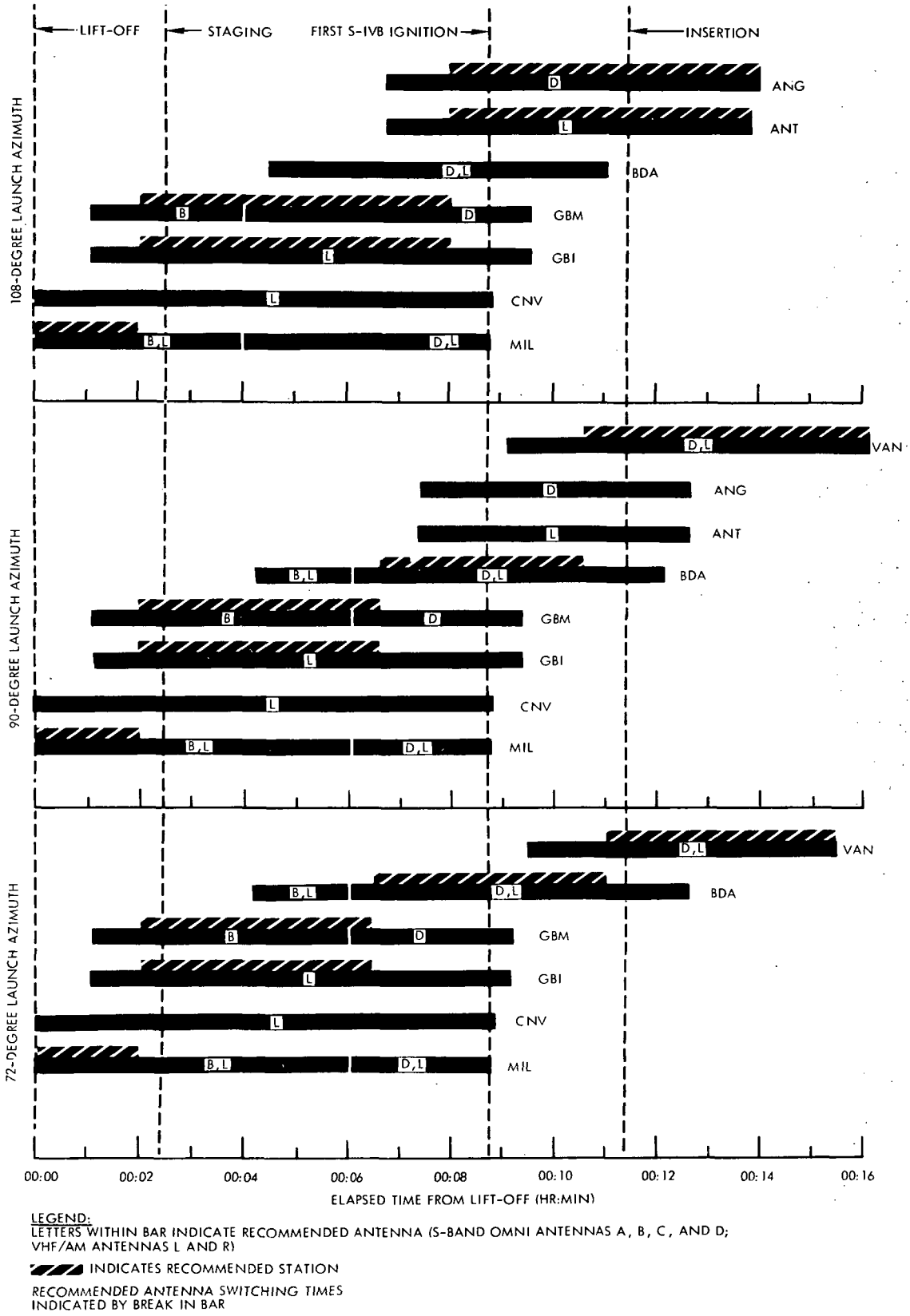


Figure 5-2. RF Coverage for Launch Phase

5.4 S-BAND PERFORMANCE

The S-band received carrier power versus elapsed time from lift-off plots for the three launch azimuths indicate that the received carrier power can be maintained above the 90 percent WI voice threshold and the 10^{-6} BEP telemetry by selecting the antennas shown in Figure 5-2.

A problem during the launch phase is the degradation of the received carrier power resulting from the flame attenuation during staging and approximately 1.5 seconds after interstage jettison. Flame attenuation occurs when the radio signal passes through the rocket engine plume and is attenuated by the ionization produced in the exhaust plume. Based on the postflight analysis of previous Saturn V flights, the maximum amount of degradation resulting from flame attenuation is expected to be approximately 40 to 50 dB, and it is anticipated to be rapid enough to cause loss of receiver lock.

Another problem is the degradation of received carrier power due to launch vehicle shadowing. Shadowing occurs when the MSFN to spacecraft line of sight falls within 7 degrees of the launch vehicle -X axis. The amount of degradation expected based on previous Saturn V flights is approximately 20 dB. Received carrier power levels on the computer plots do not reflect flame attenuation or shadowing. These areas are indicated by shading on the plots for the affected stations.

Flame attenuation and shadowing will affect the MIL station only; therefore, GBM is recommended as the primary S-band receiving site during staging. Handover from MIL to GBM should be attempted prior to staging. No antenna keyhole or terrain obstruction will be encountered during the launch phase.

5.4.1 72-Degree Launch Azimuth

S-band communication coverage for the 72-degree launch azimuth is provided by MIL, GBM, BDA, and VAN. Antenna selections for these stations are shown in Figure 5-2, and the received carrier power will be above voice and telemetry thresholds if the indicated antennas are selected.

During the launch countdown antenna C can be expected to exhibit pattern distortion due to close proximity to the white room. This pattern distortion is not reflected in the received carrier power plots. Antenna B should have the least pattern distortion due to launch tower proximity and will provide good communication coverage at lift-off; therefore, antenna B should be selected for the S-band coverage during launch countdown and at lift-off. Antenna D should be selected at approximately 6 minutes after lift-off and prior to handover from GBM to BDA. Antenna D will provide good communication coverage for the first S-IVB ignition. The selections of antennas B and D for a 72-degree launch azimuth have proven satisfactory on previous missions.

5.4.2 90-Degree Launch Azimuth

S-band communication coverage for the 90-degree launch azimuth is provided by MIL, GBM, BDA, ANG, and VAN. Antenna selections for these stations are shown in Figure 5-2.

Antenna B will provide good coverage for lift-off. It is recommended that antenna D be selected for BDA and subsequent stations. The handover and antenna switching should occur at the same time as for the 72-degree launch azimuth.

5.4.3 108-Degree Launch Azimuth

Communication coverage for a 108-degree launch azimuth is provided by MIL, GBM, BDA, and ANG. Antenna B will provide good communications coverage at lift-off. Antenna B exhibits considerable signal fluctuation on the received carrier power plot for GBM (Figure 5-16f) between 4 minutes and 6 minutes. Antenna D should, therefore, be selected at approximately 4 minutes after lift-off and used for remainder of launch and EPO phase.

Above threshold communication performance can be maintained by handover from MIL to GBM to ANG. In order to avoid terrain obstruction problems, handover from GBM to ANG should be initiated approximately 8 minutes after lift-off and before the look angle at GBM falls below 5 degrees.

5.5 VHF/AM PERFORMANCE

Figure 5-2 indicates the recommended VHF antenna selections for the stations covering the three launch azimuths. The carrier power will remain above the 90 percent voice word intelligibility threshold for the entire launch phase for all three launch azimuths. The LEFT CSM VHF antenna will provide the best coverage throughout the launch phase for the 72-, 90-, and 108-degree launch azimuths.

The VHF/AM signal levels at MIL and CNV will be affected by flame attenuation and shadowing during the launch phase.

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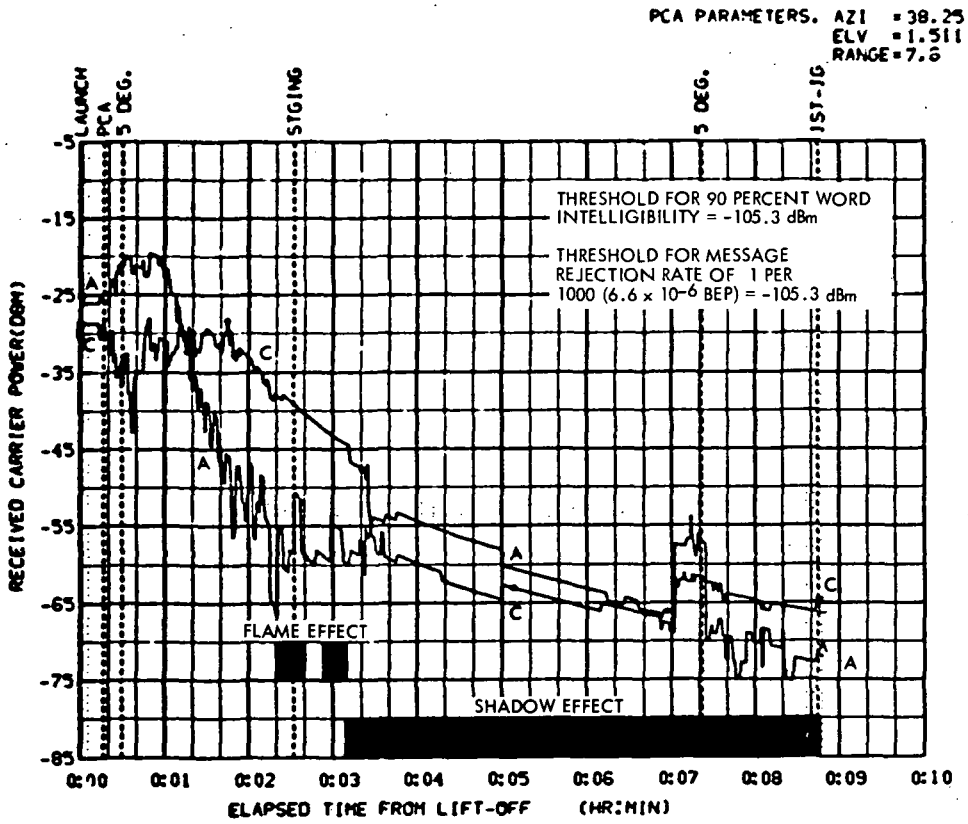


FIGURE 5-3a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

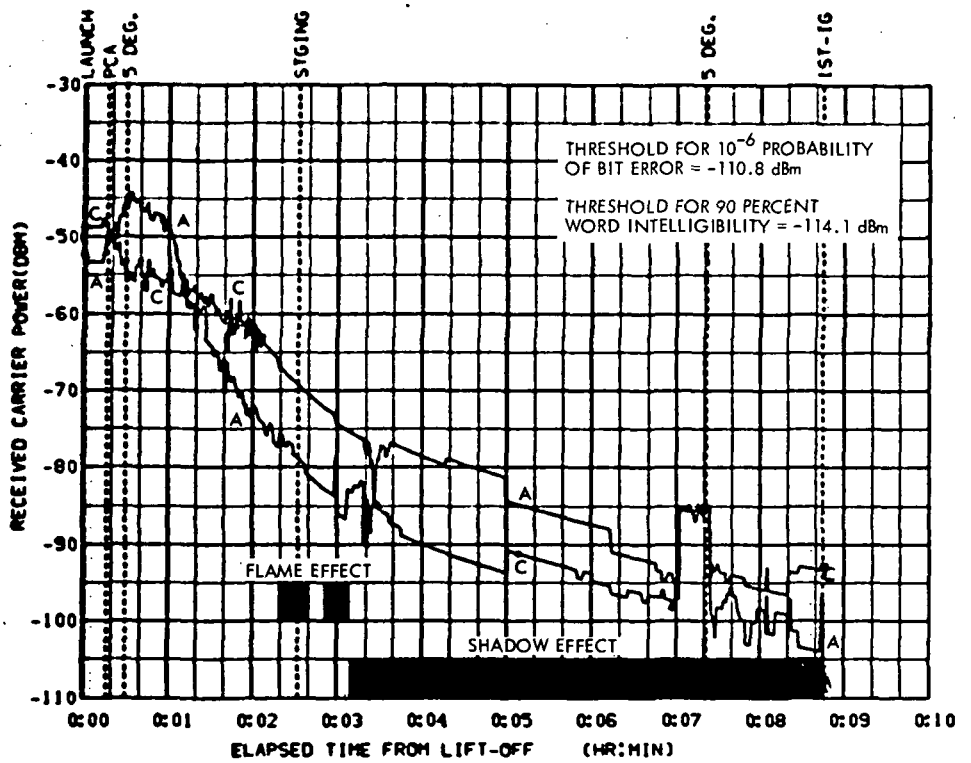


FIGURE 5-3b. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

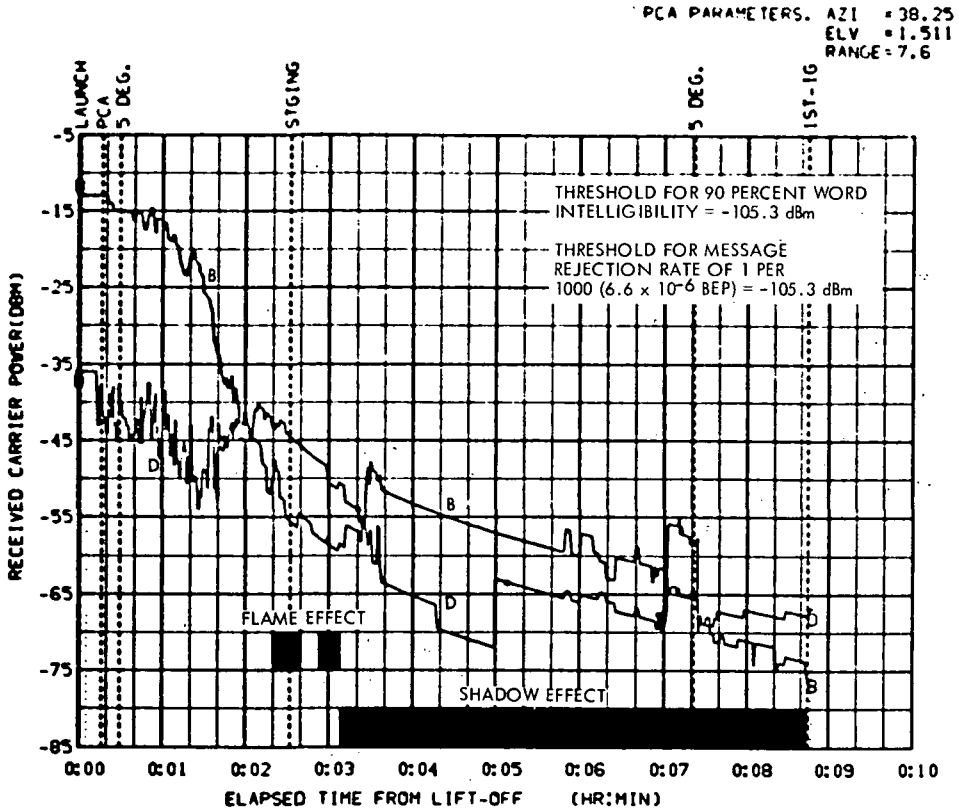


FIGURE 5-3c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

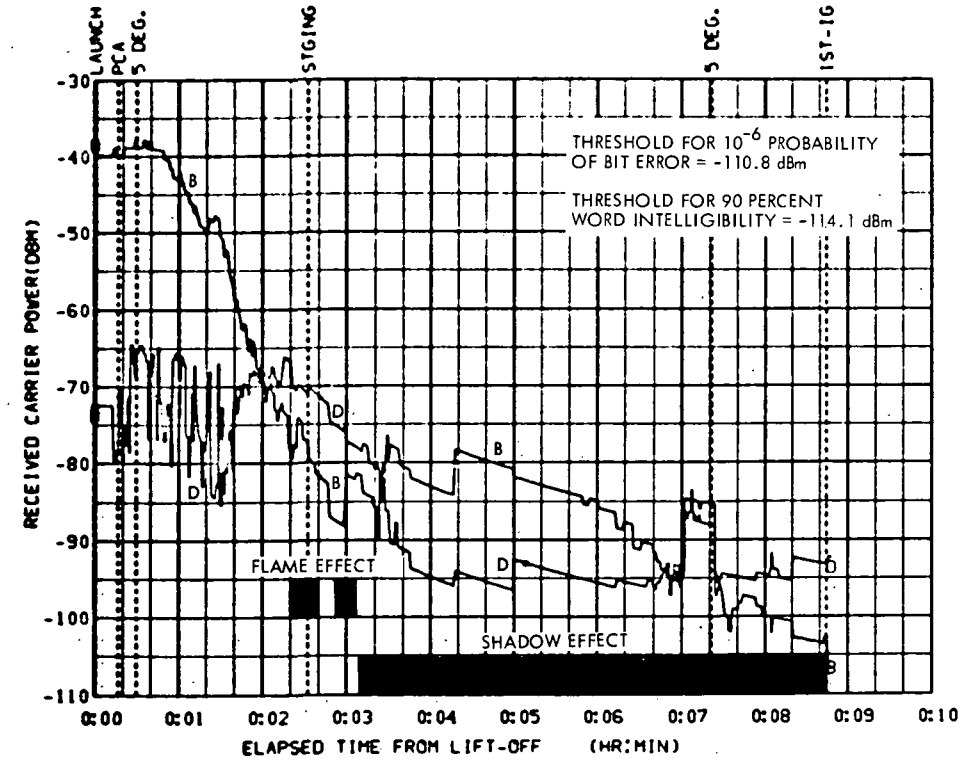


FIGURE 5-3d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

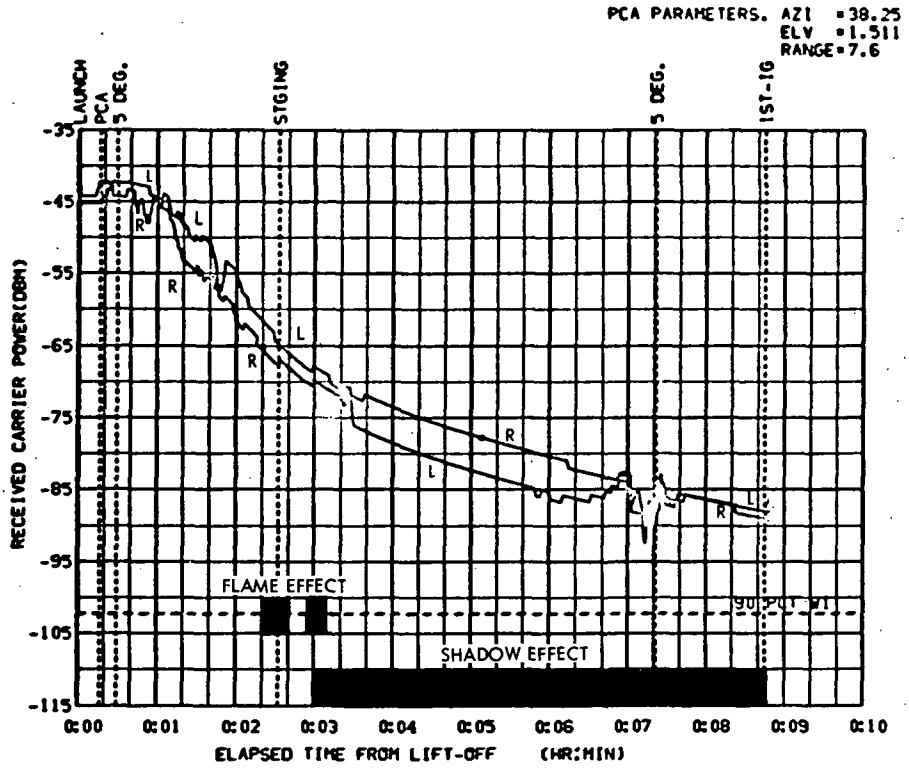


FIGURE 5-3e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

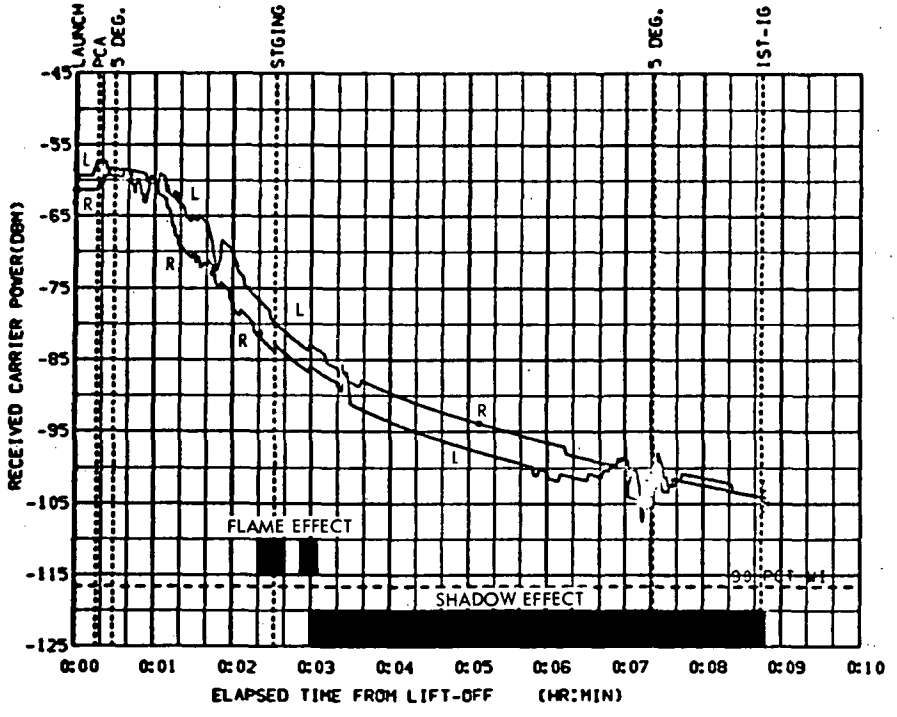


FIGURE 5-3f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

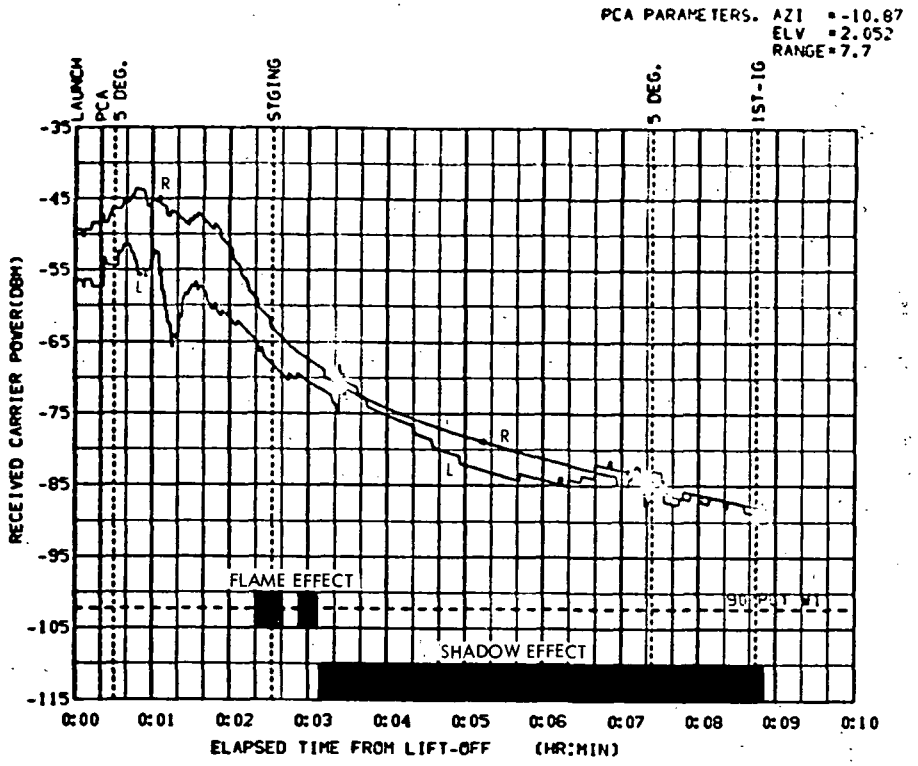


FIGURE 5-4a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

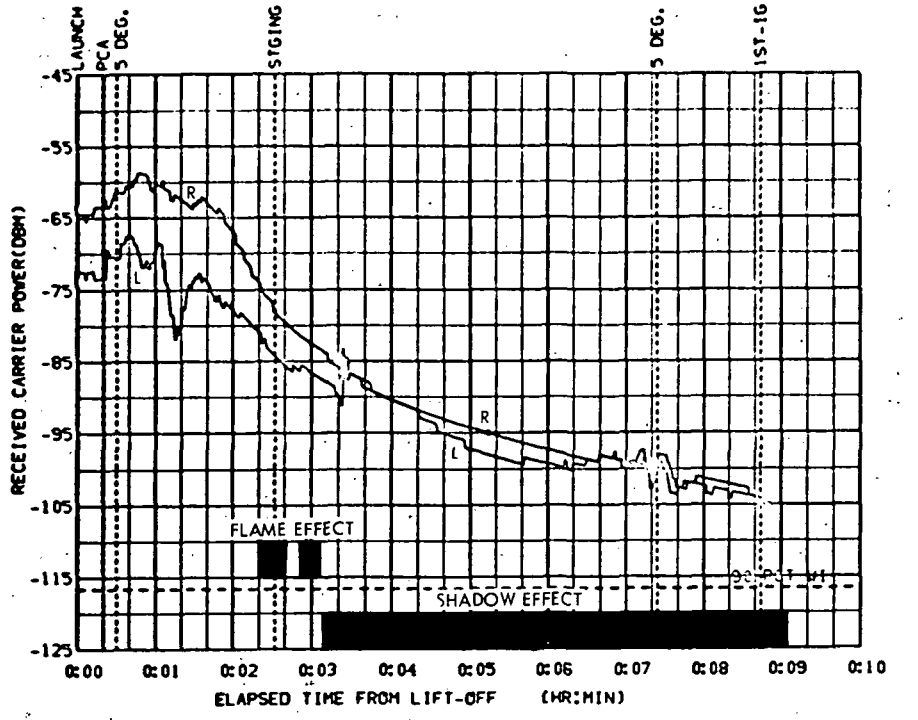


FIGURE 5-4b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

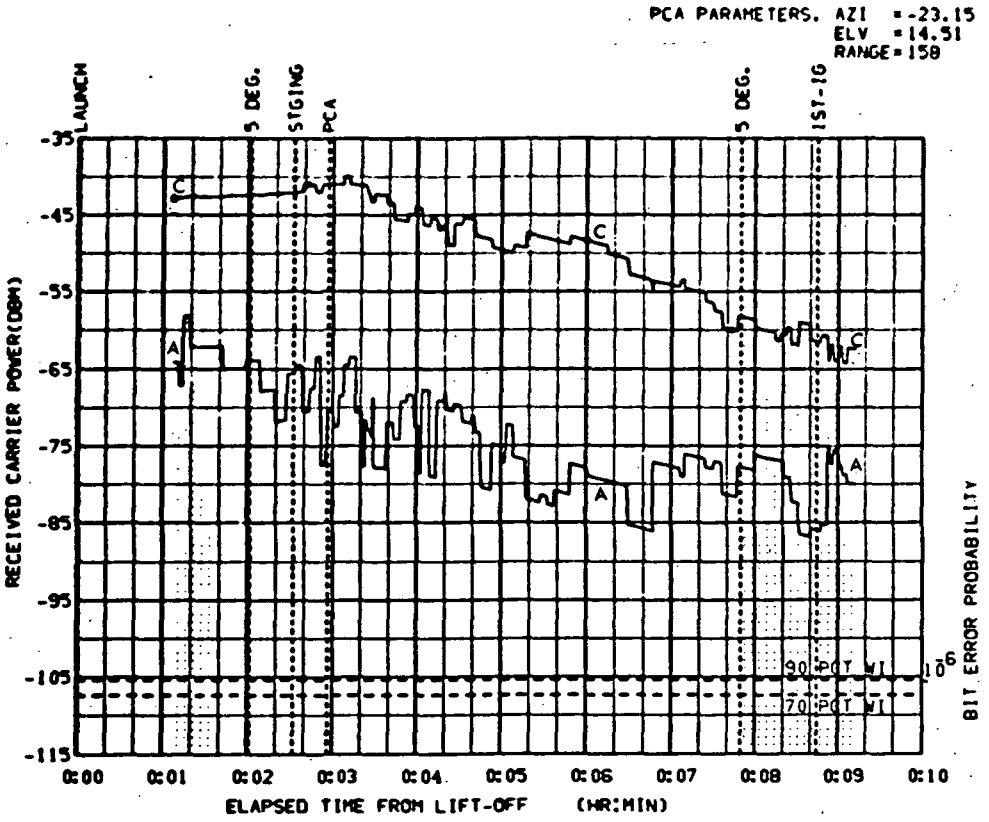


FIGURE 5-5a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

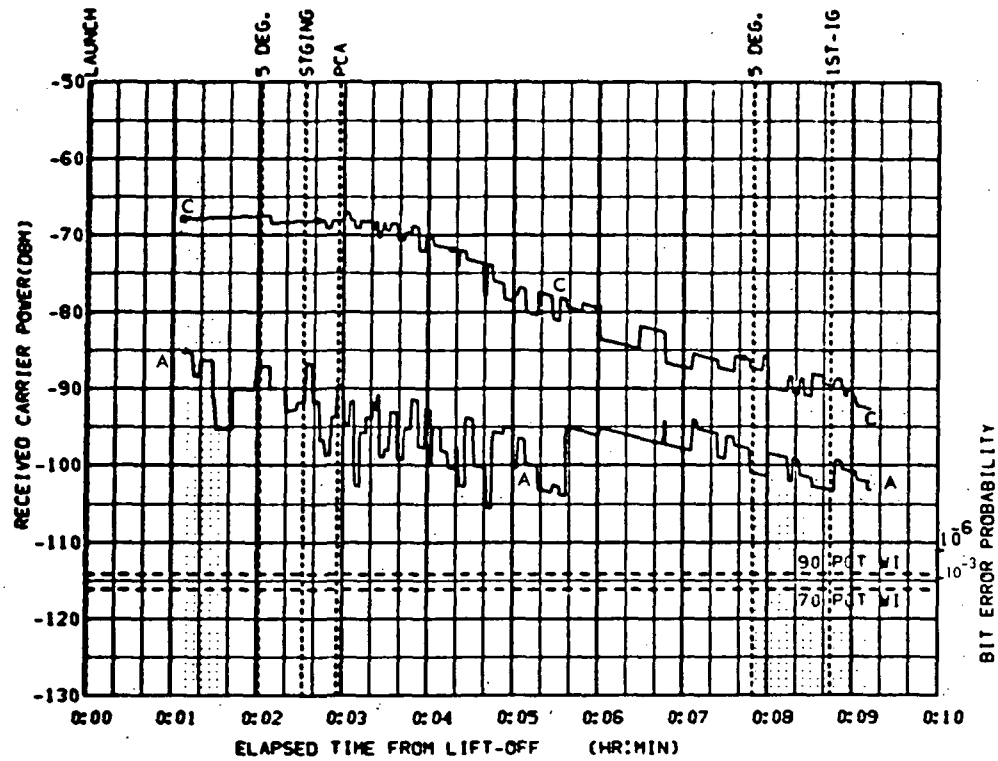


FIGURE 5-5b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

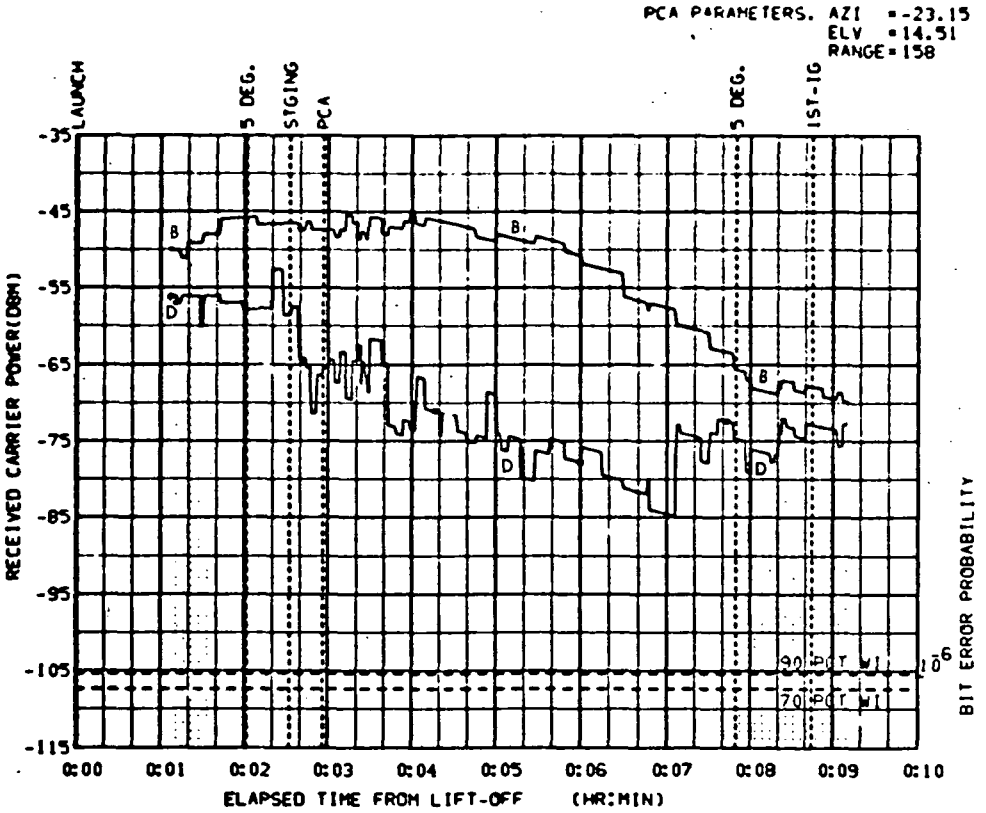


FIGURE 5-5c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

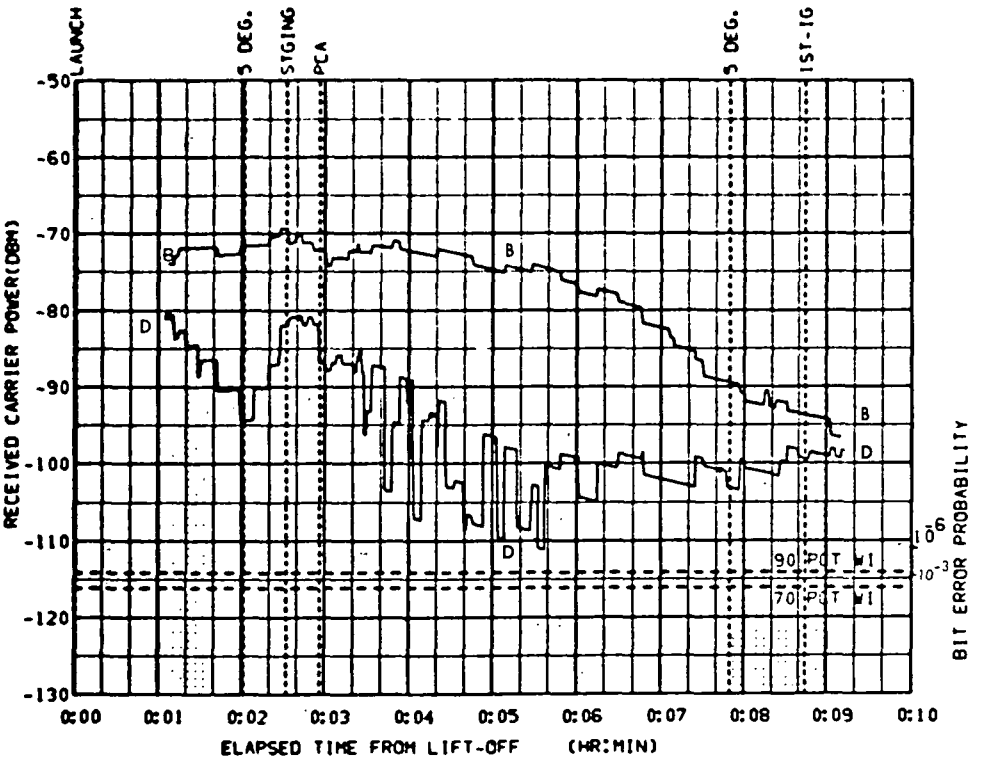


FIGURE 5-5d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

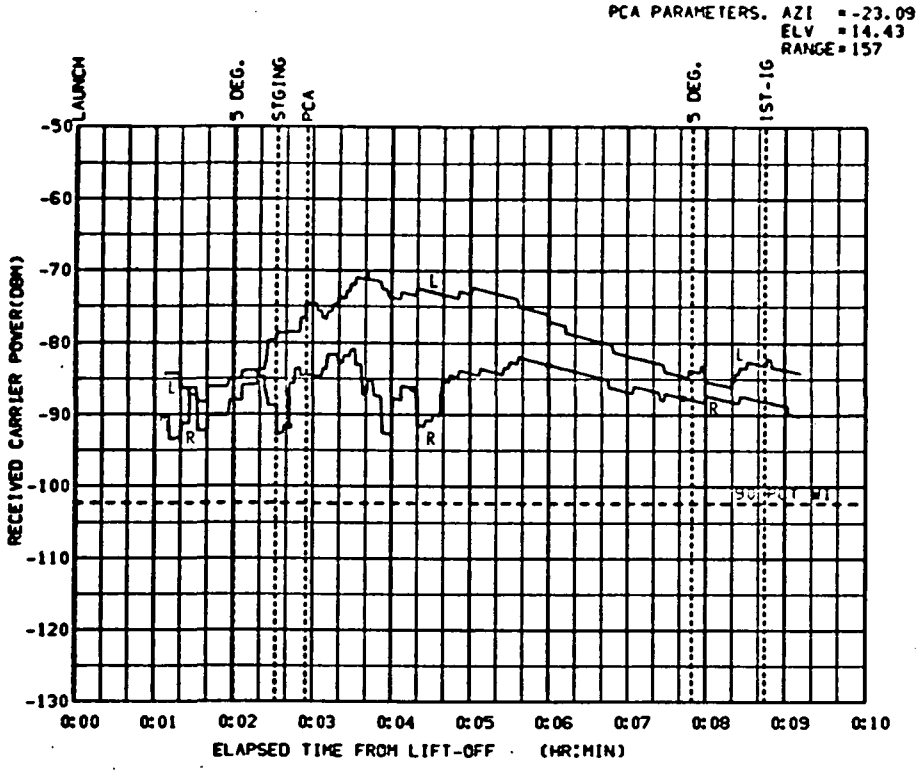


FIGURE 5-5e. 6BI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

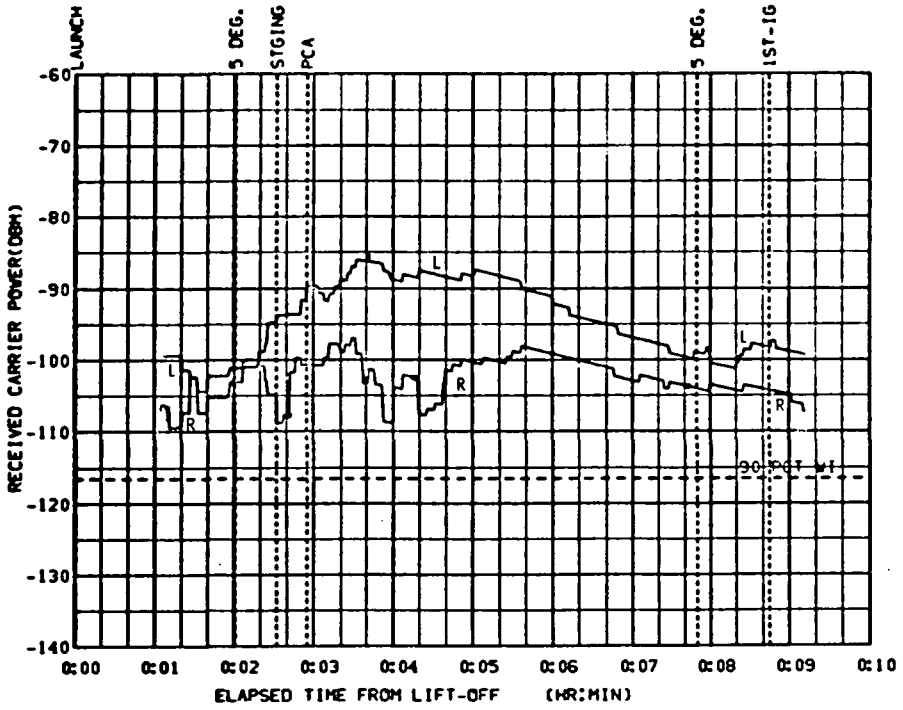


FIGURE 5-5f. 6BI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

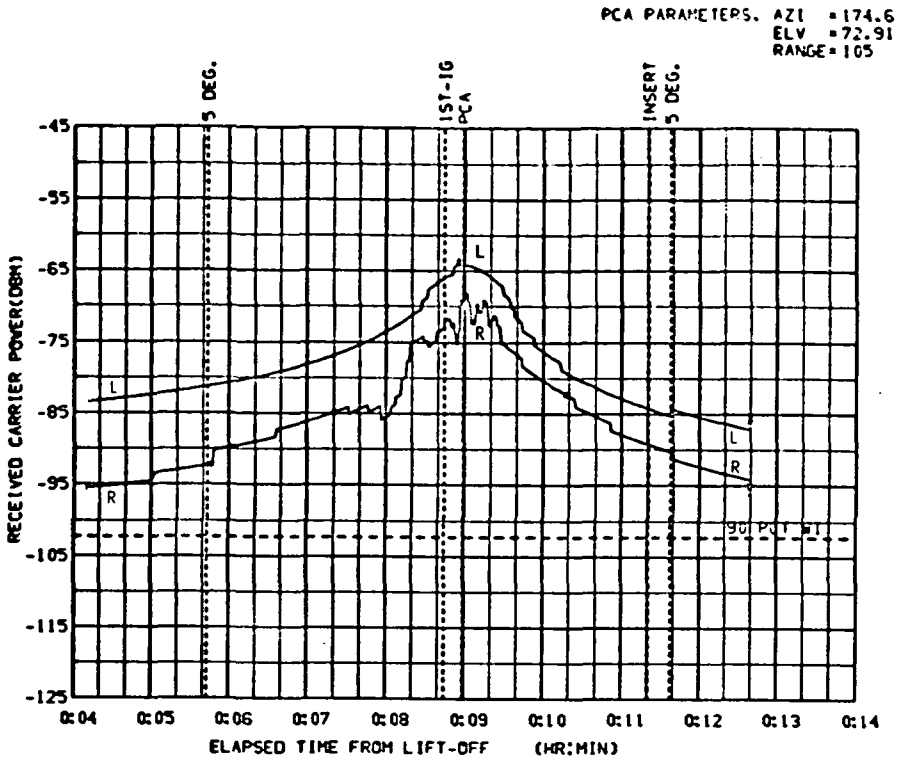


FIGURE 5-6a. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

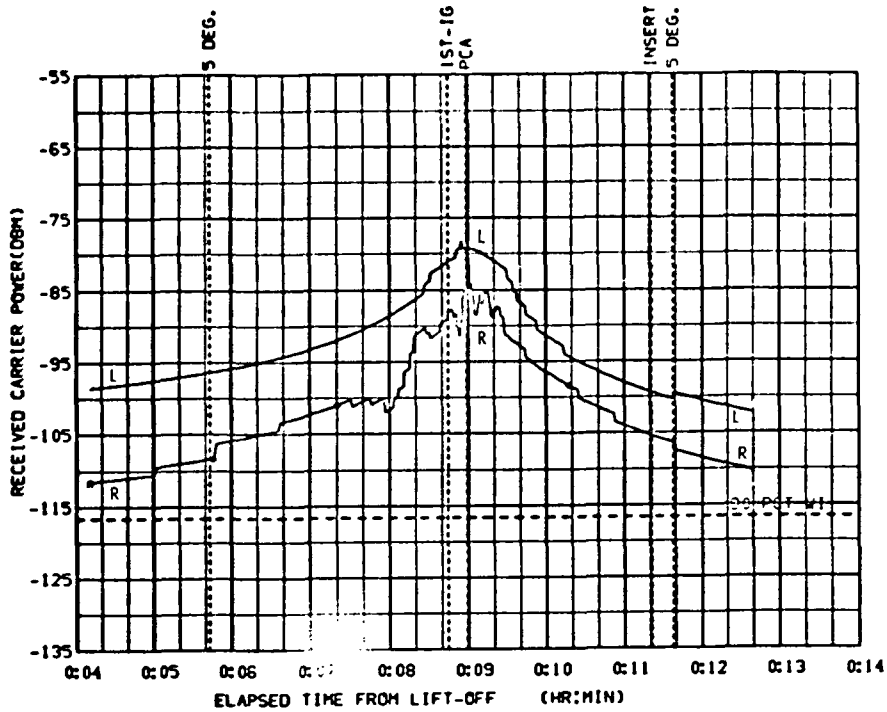


FIGURE 5-6b. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

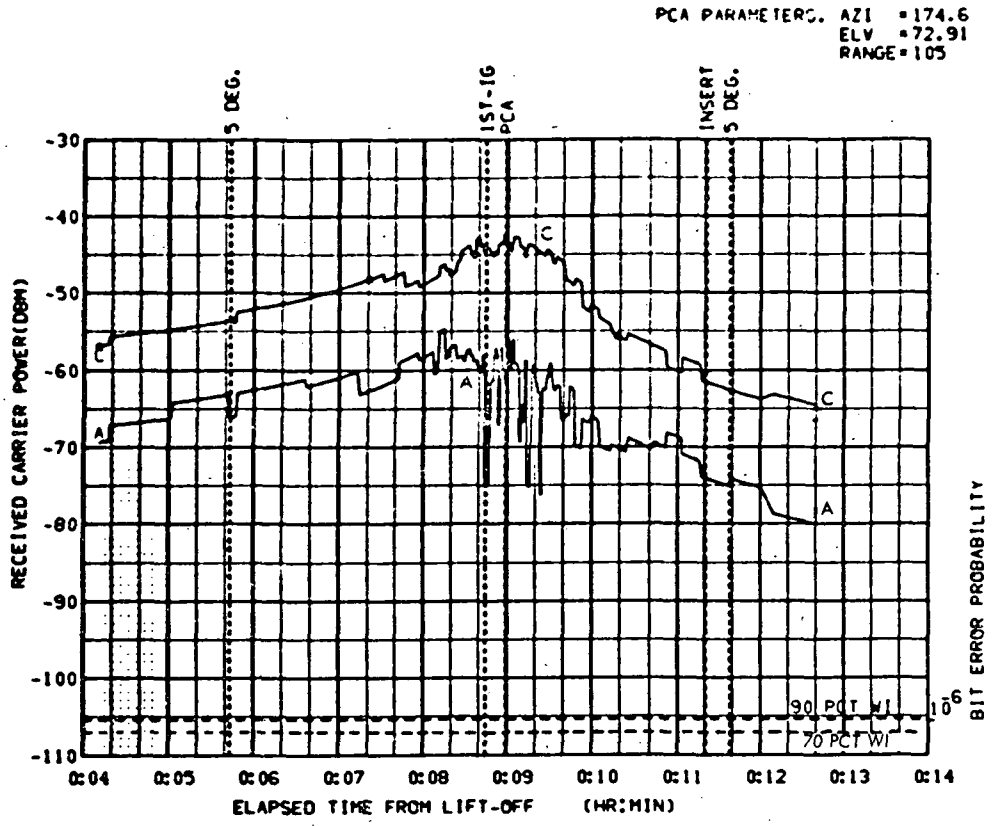


FIGURE 5-6c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

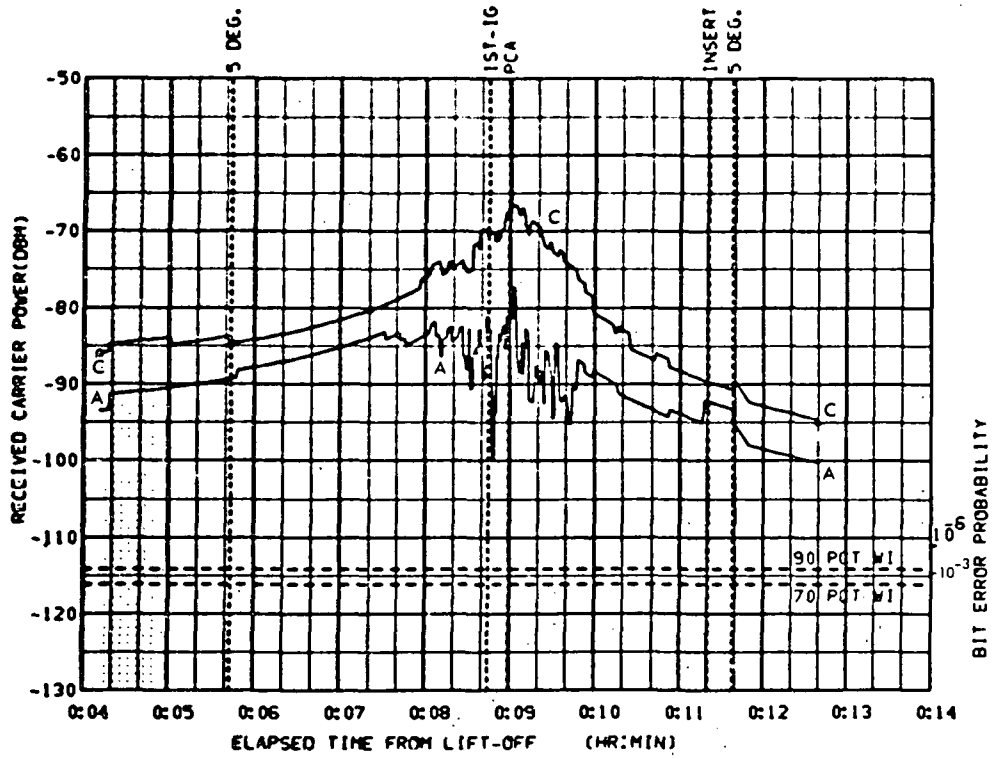


FIGURE 5-6d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

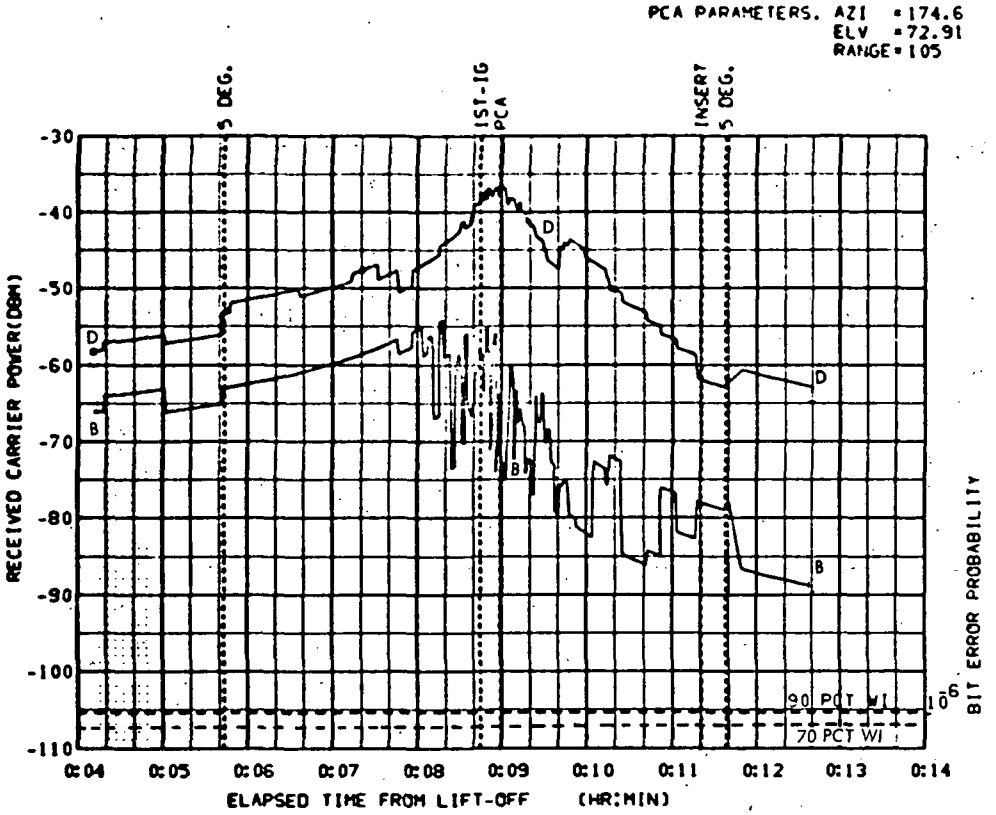


FIGURE 5-6e. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

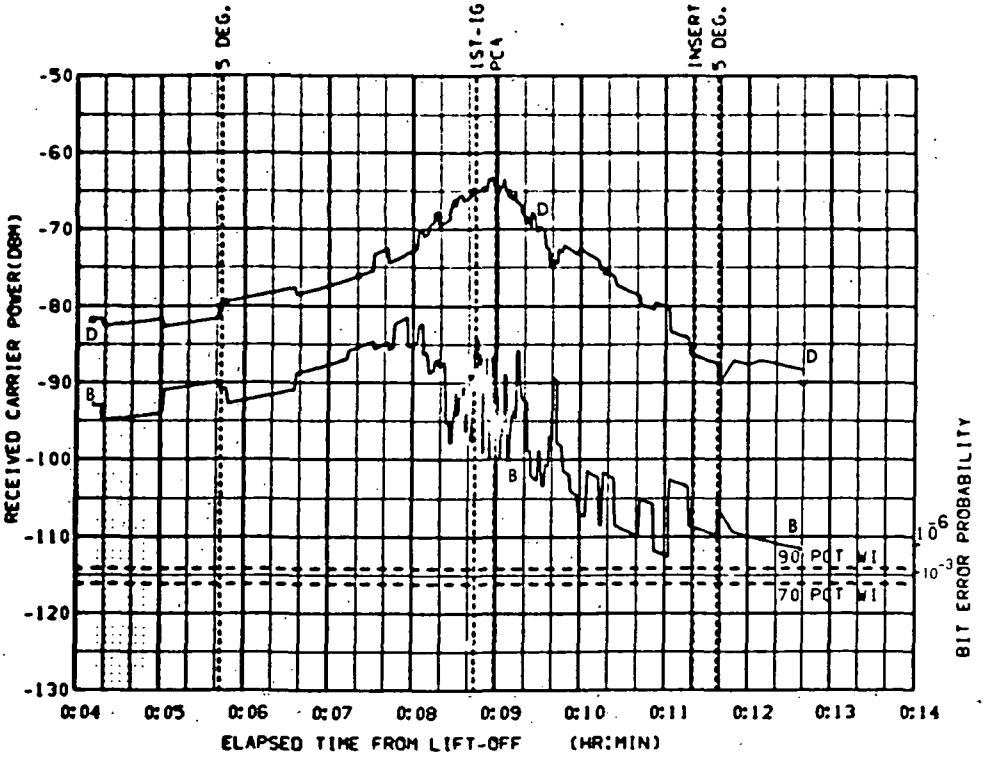


FIGURE 5-6f. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

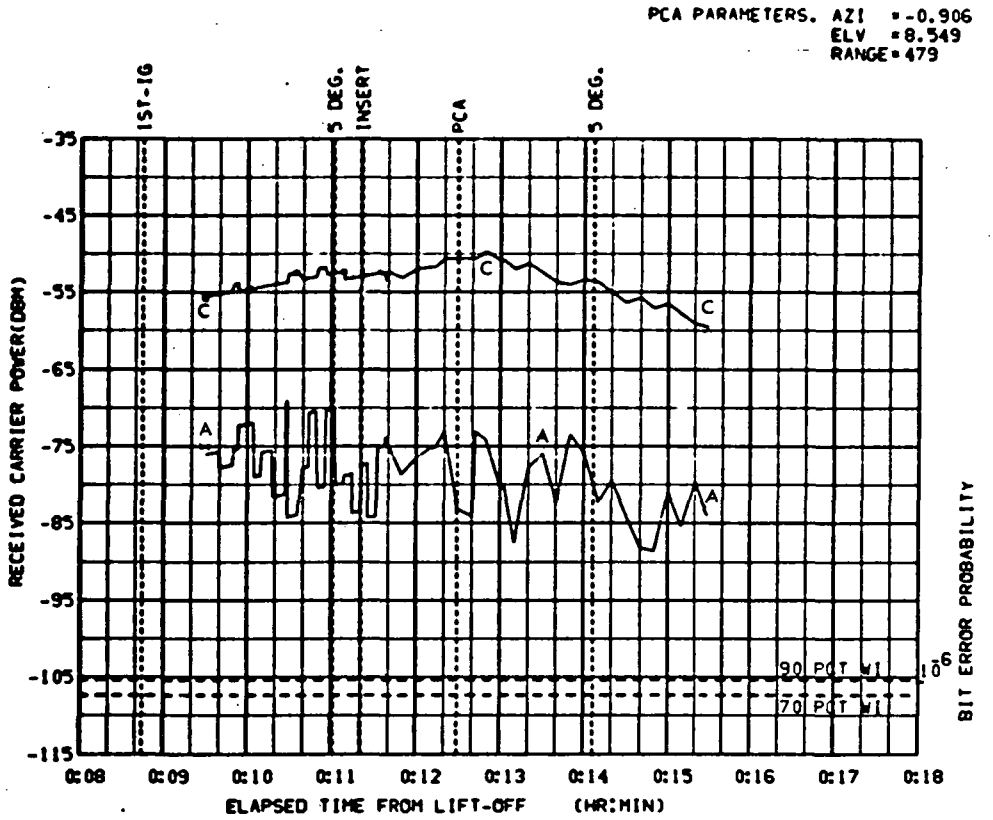


FIGURE 5-7a. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

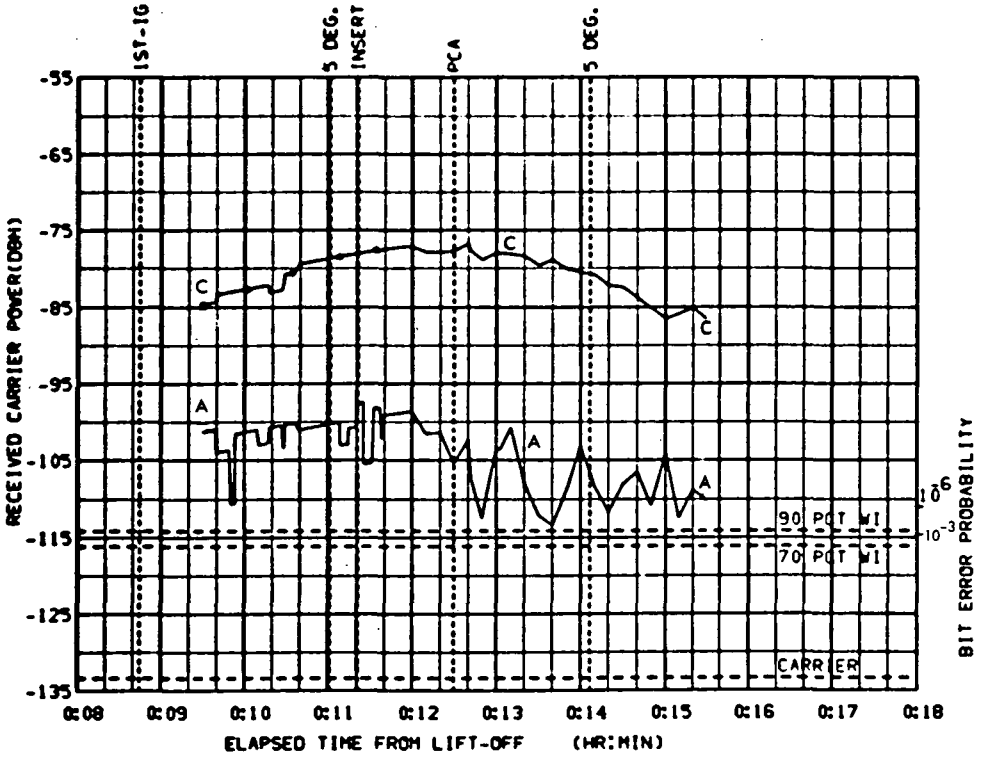


FIGURE 5-7b. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

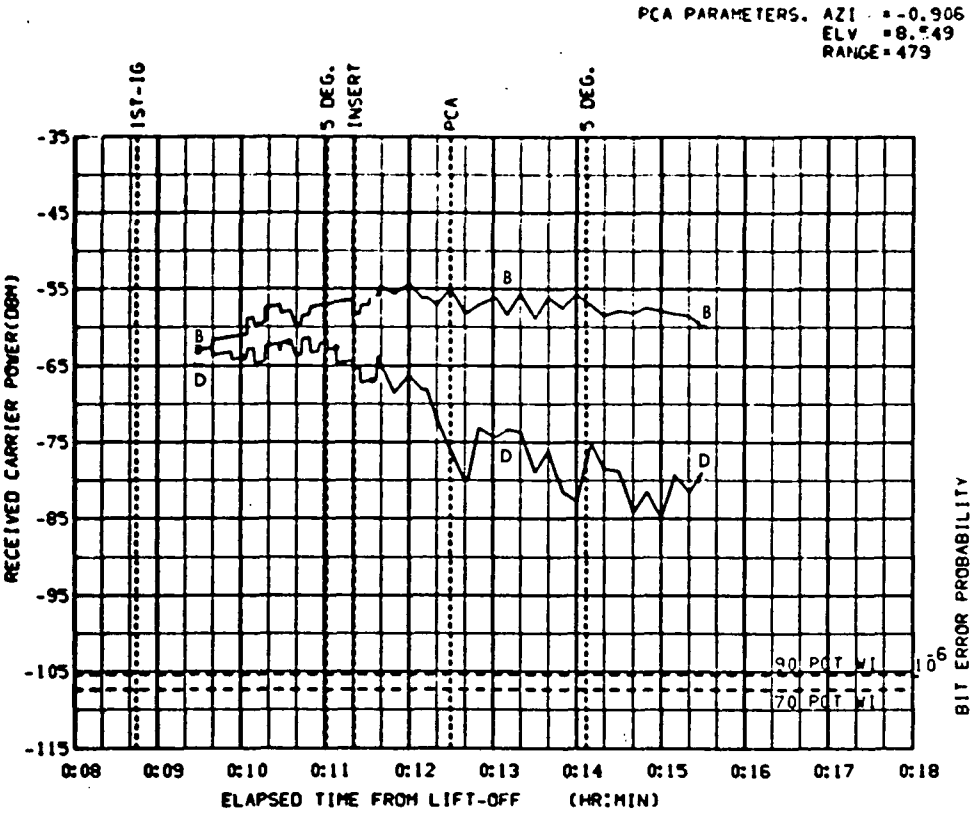


FIGURE 5-7c. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

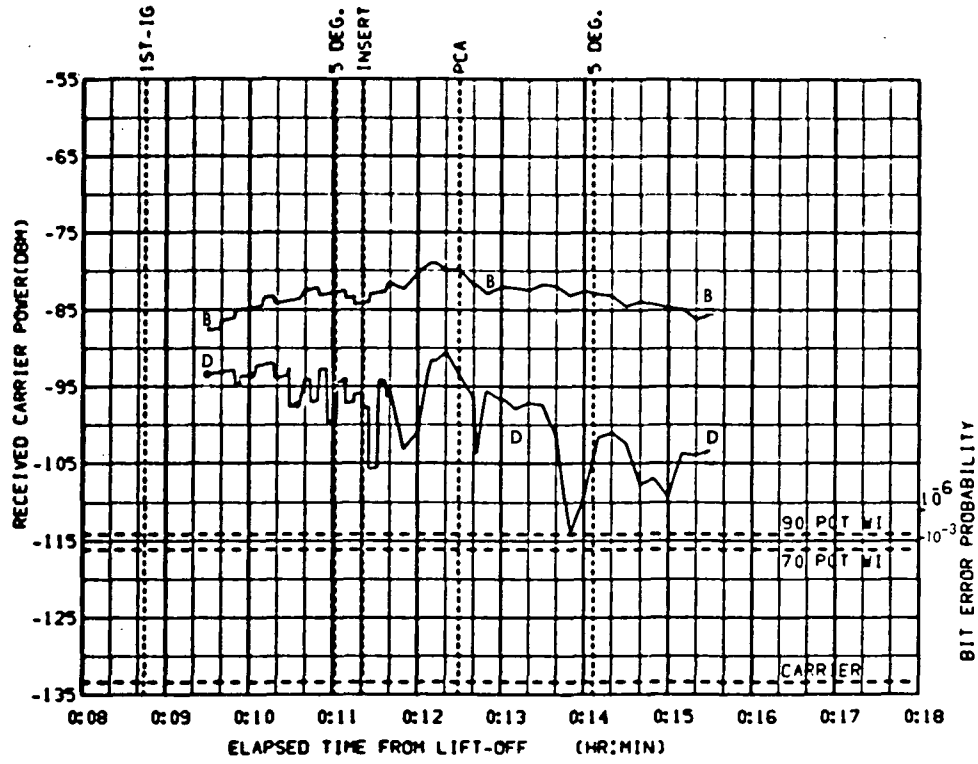


FIGURE 5-7d. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

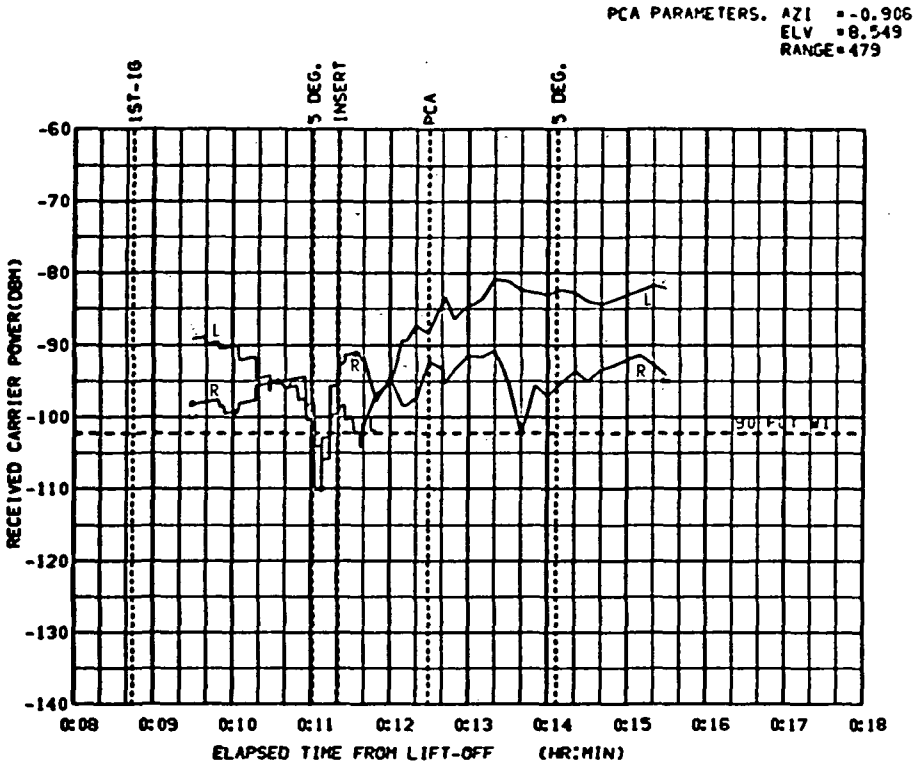


FIGURE 5-7e. VAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

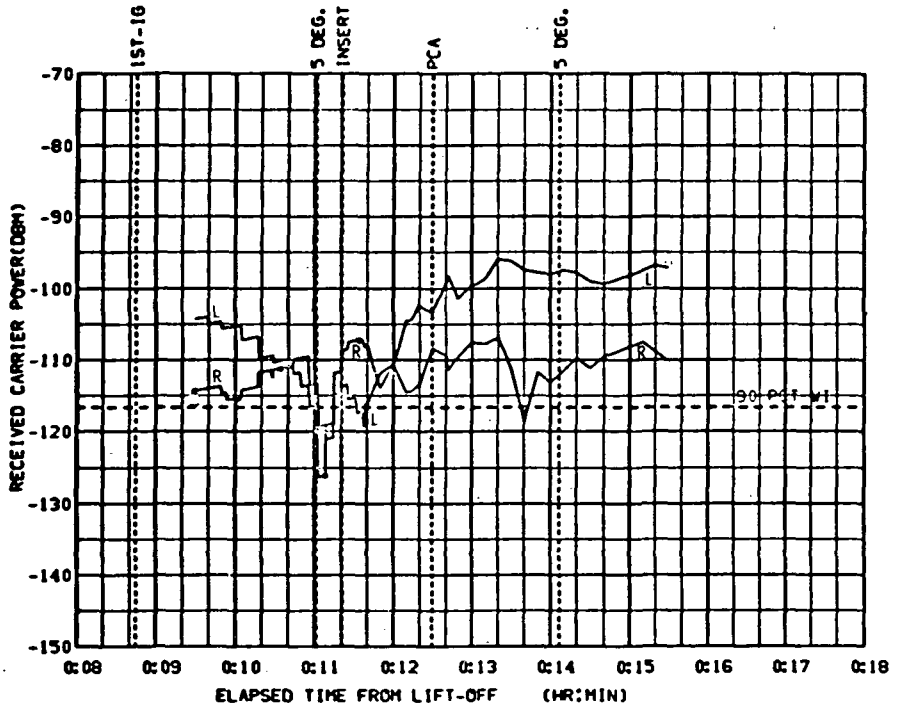


FIGURE 5-7f. VAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (72 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

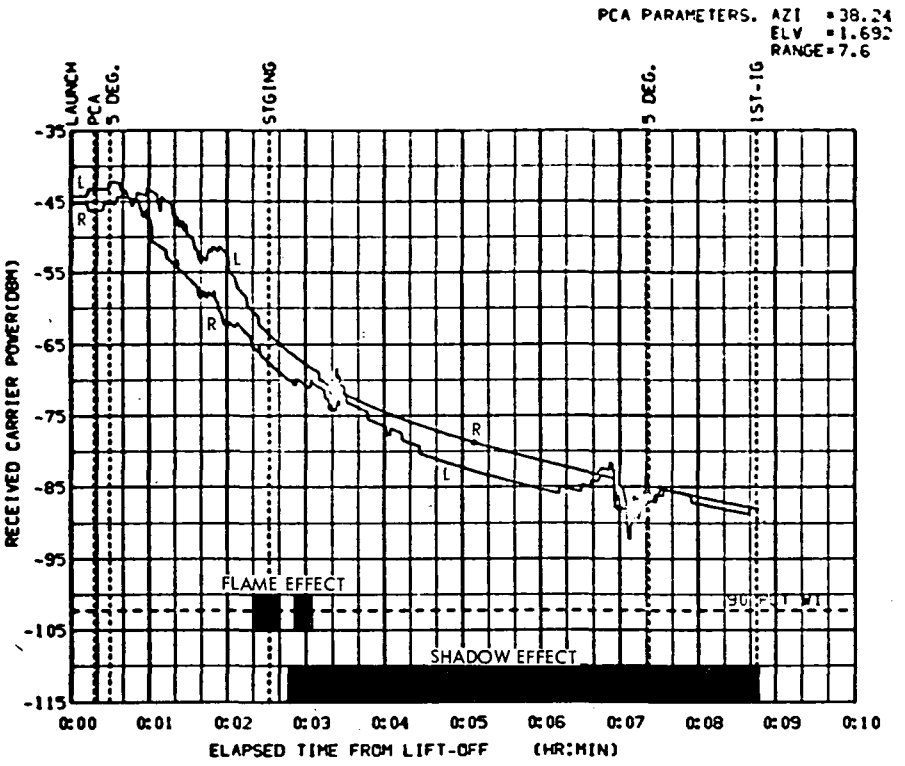


FIGURE 5-8a. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

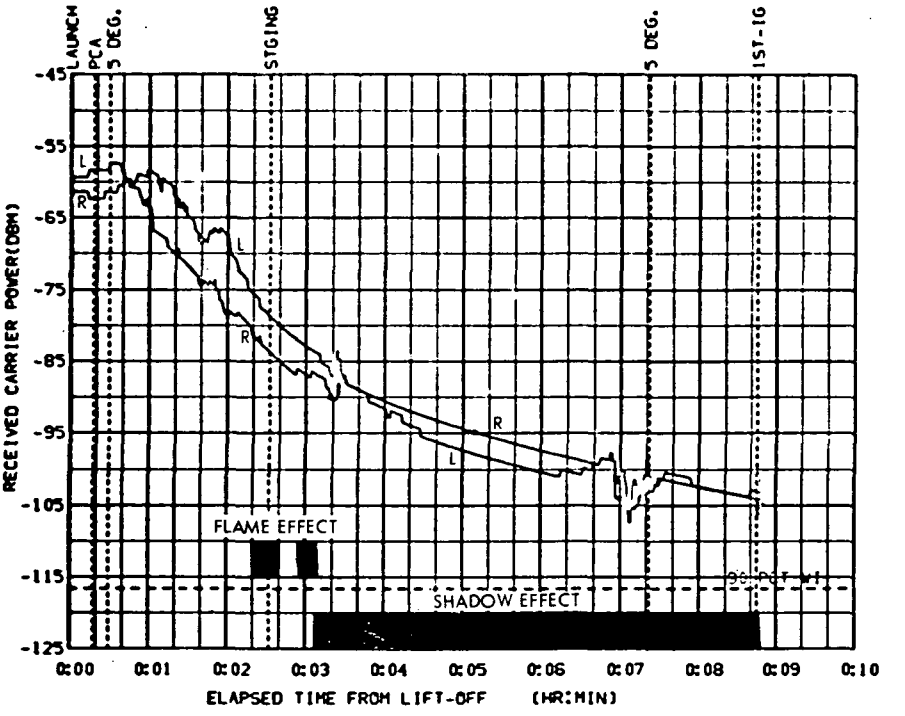


FIGURE 5-8b. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

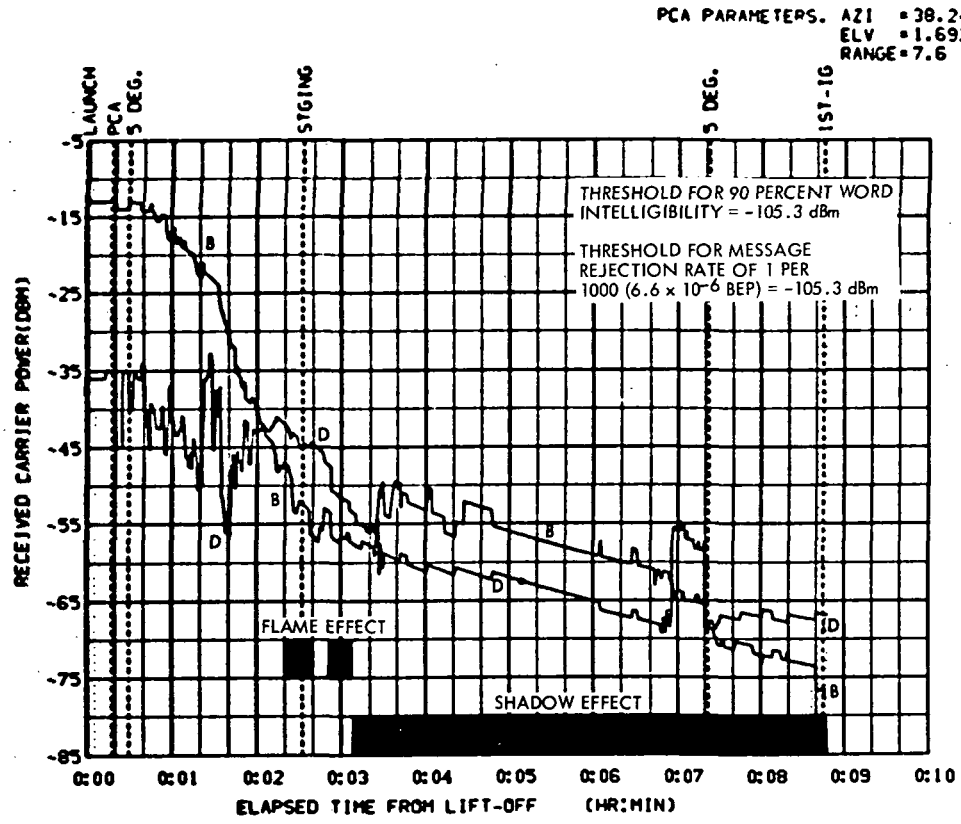


FIGURE 5-8c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

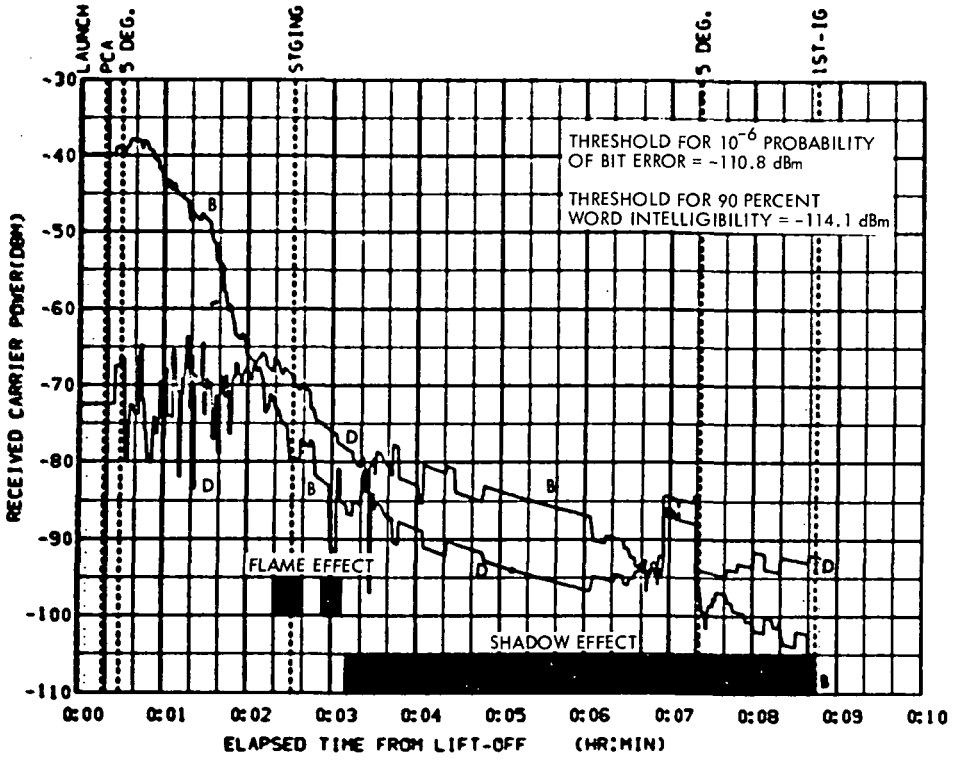


FIGURE 5-8d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

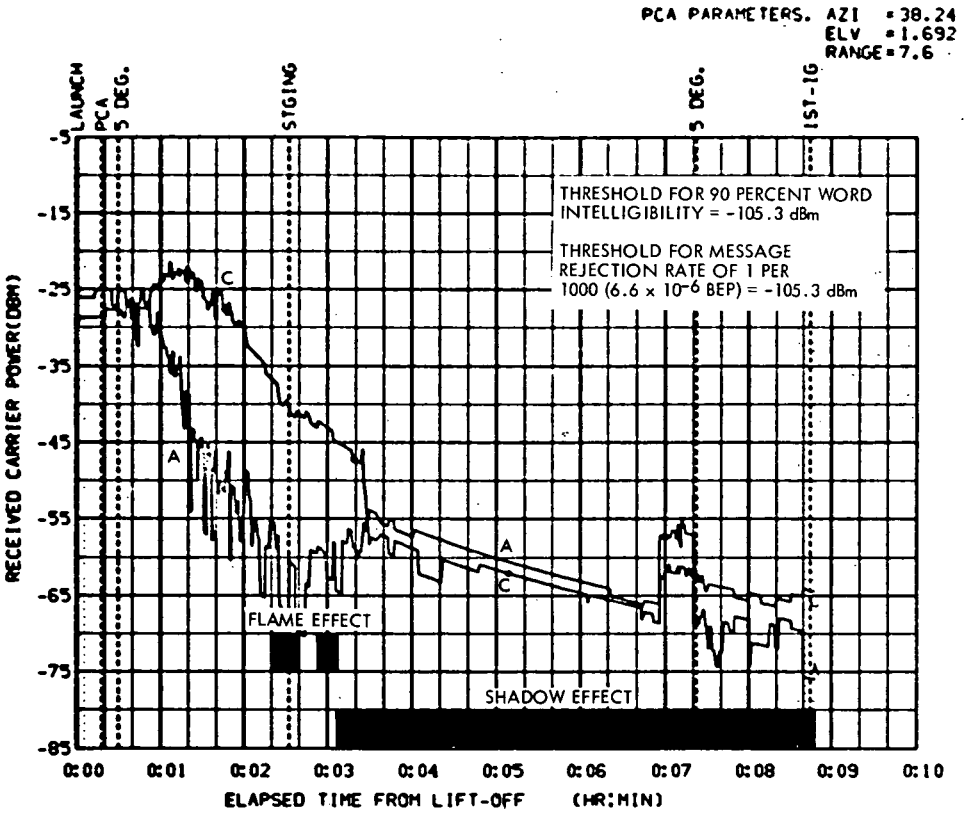


FIGURE 5-8e. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

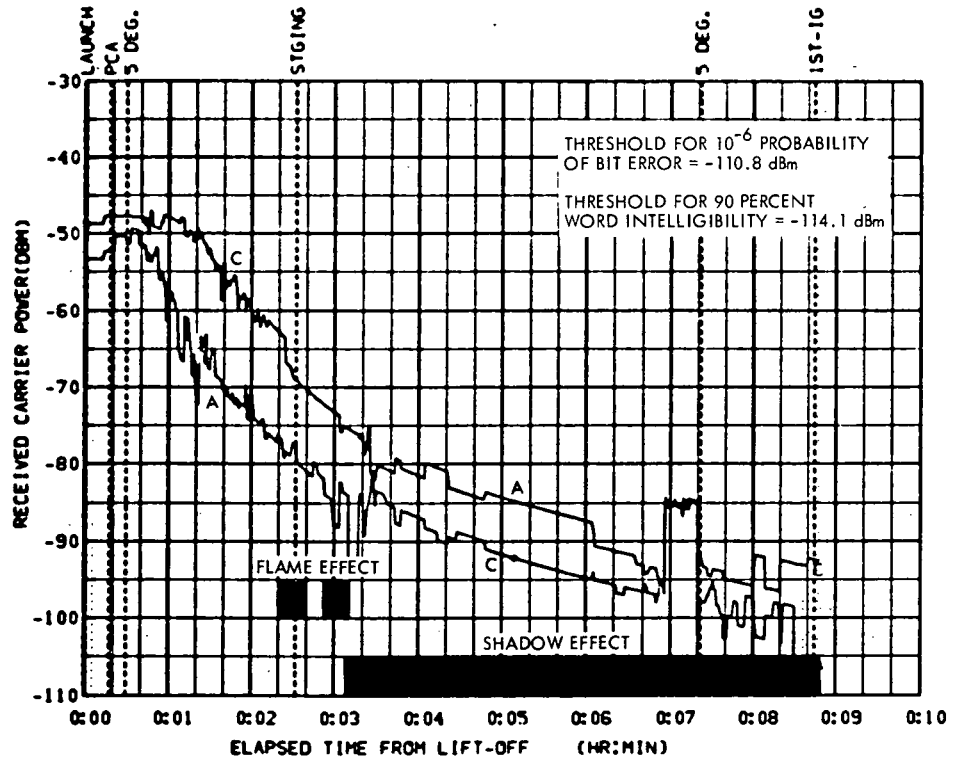


FIGURE 5-8f. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

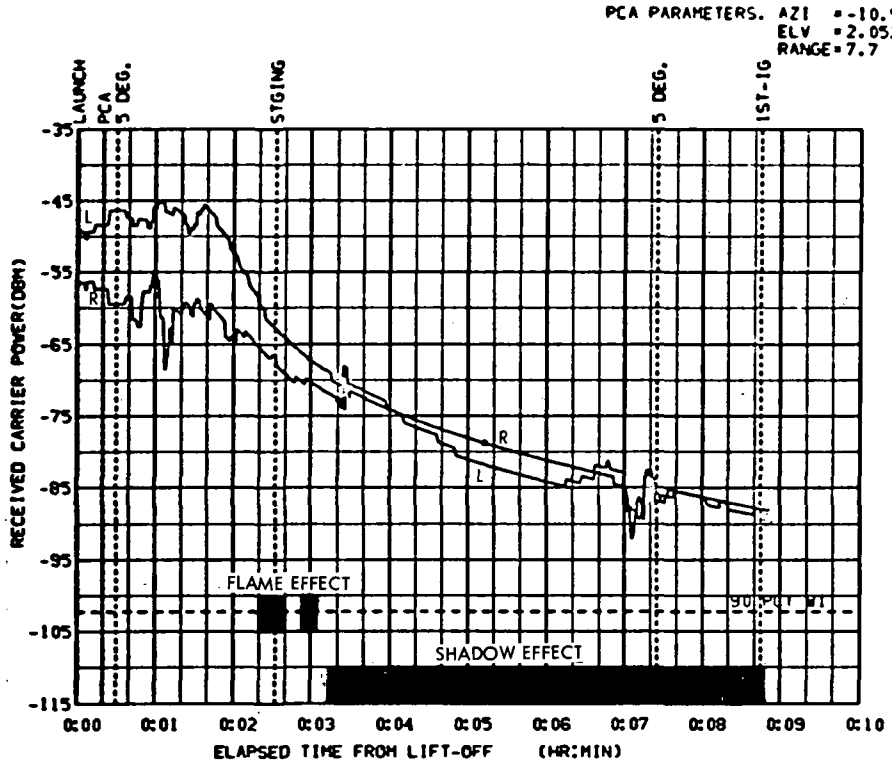


FIGURE 5-9a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

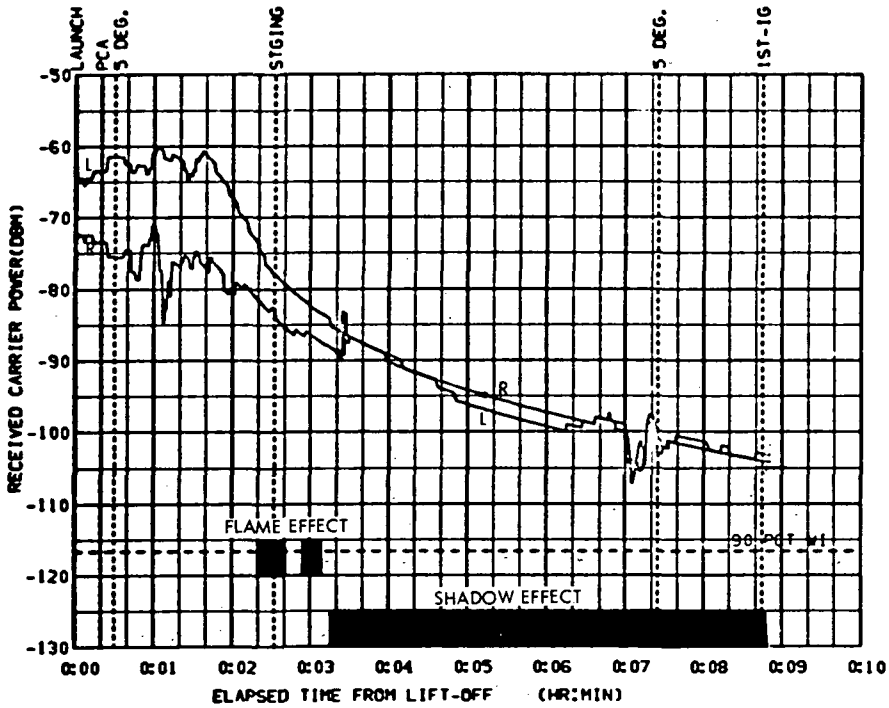


FIGURE 5-9b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

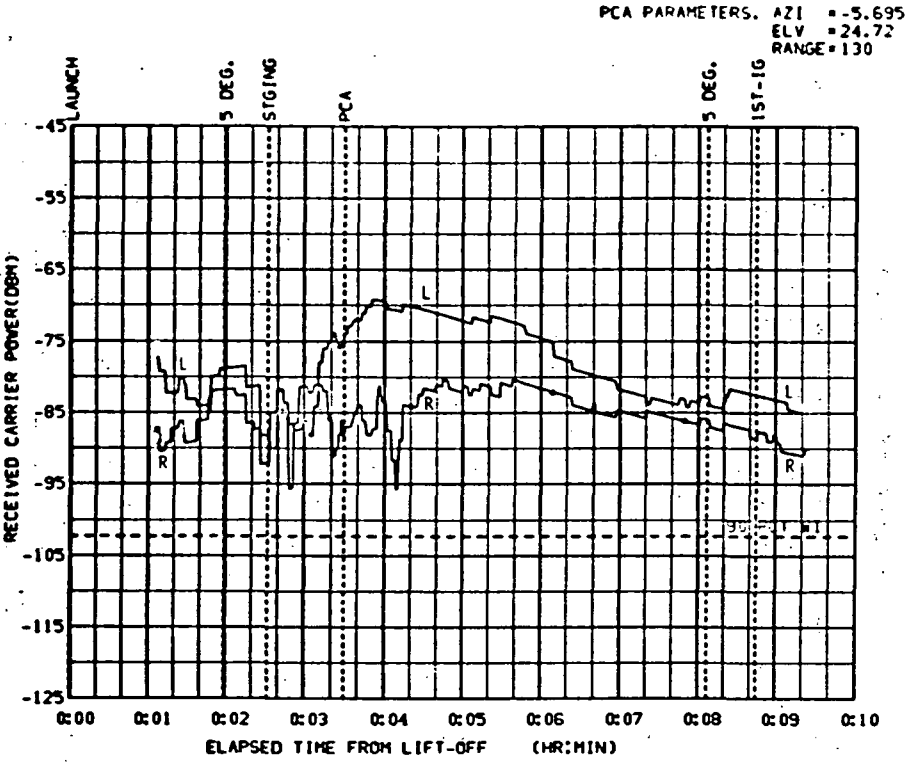


FIGURE 5-10a. 6BI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

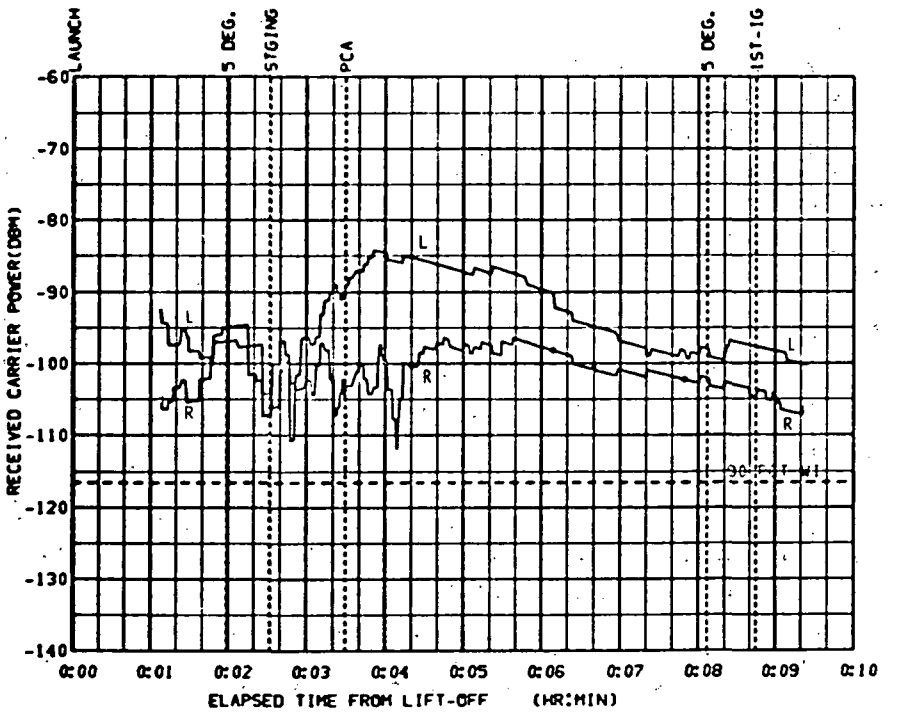


FIGURE 5-10b. 6BI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

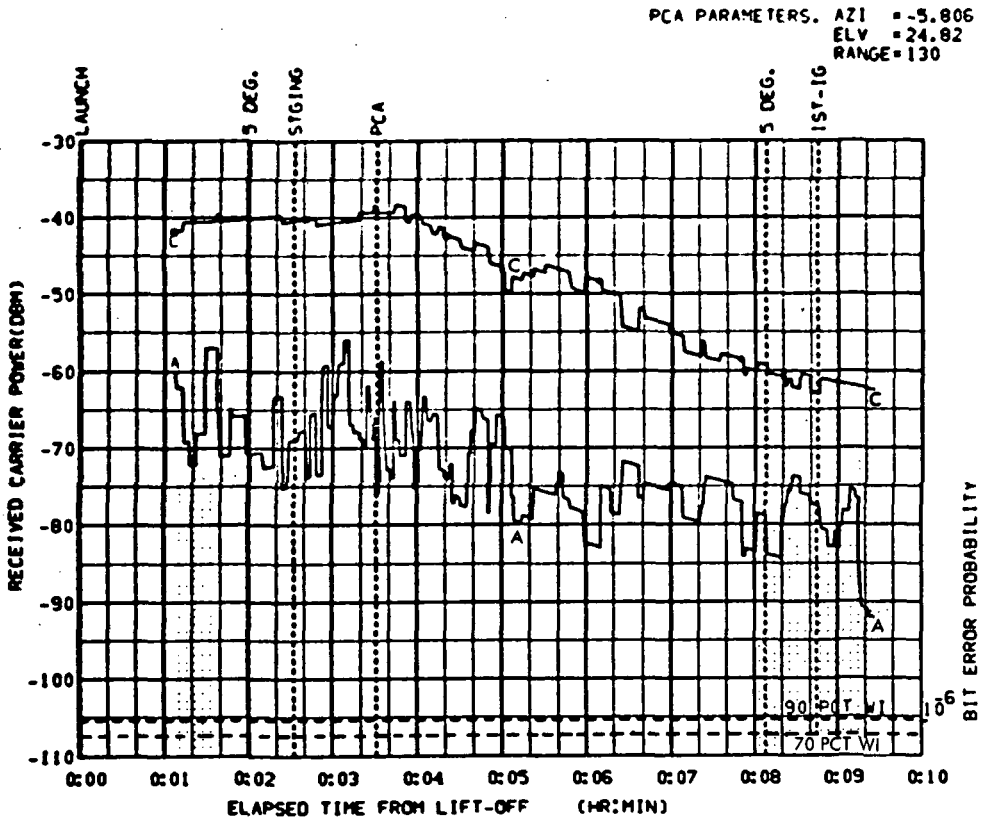


FIGURE 5-10c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

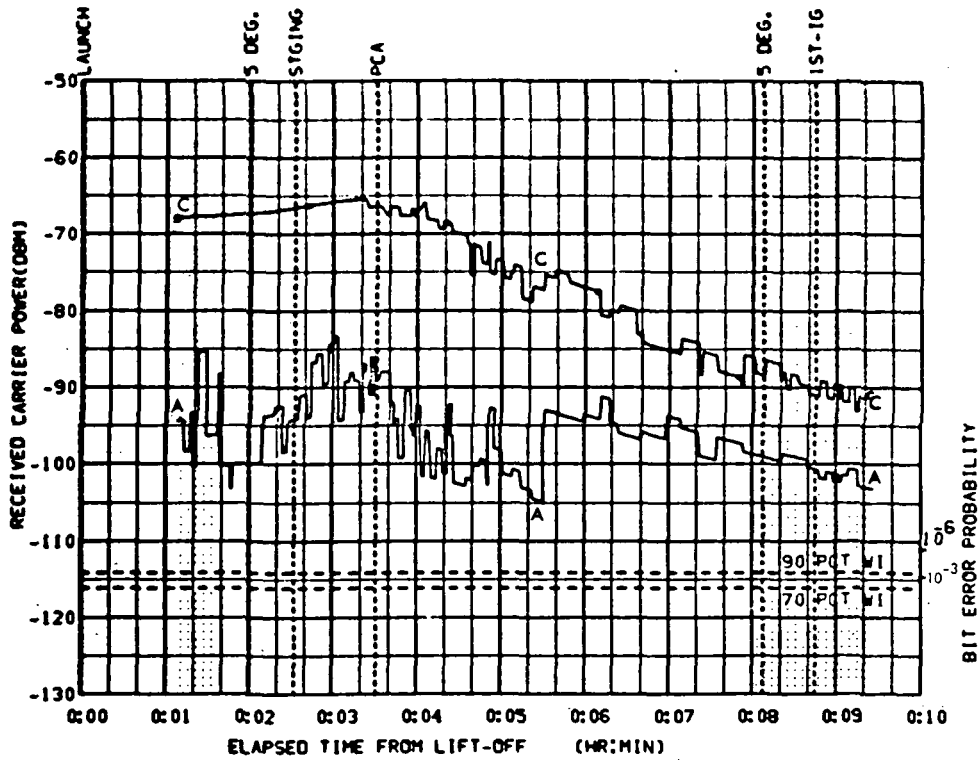


FIGURE 5-10d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

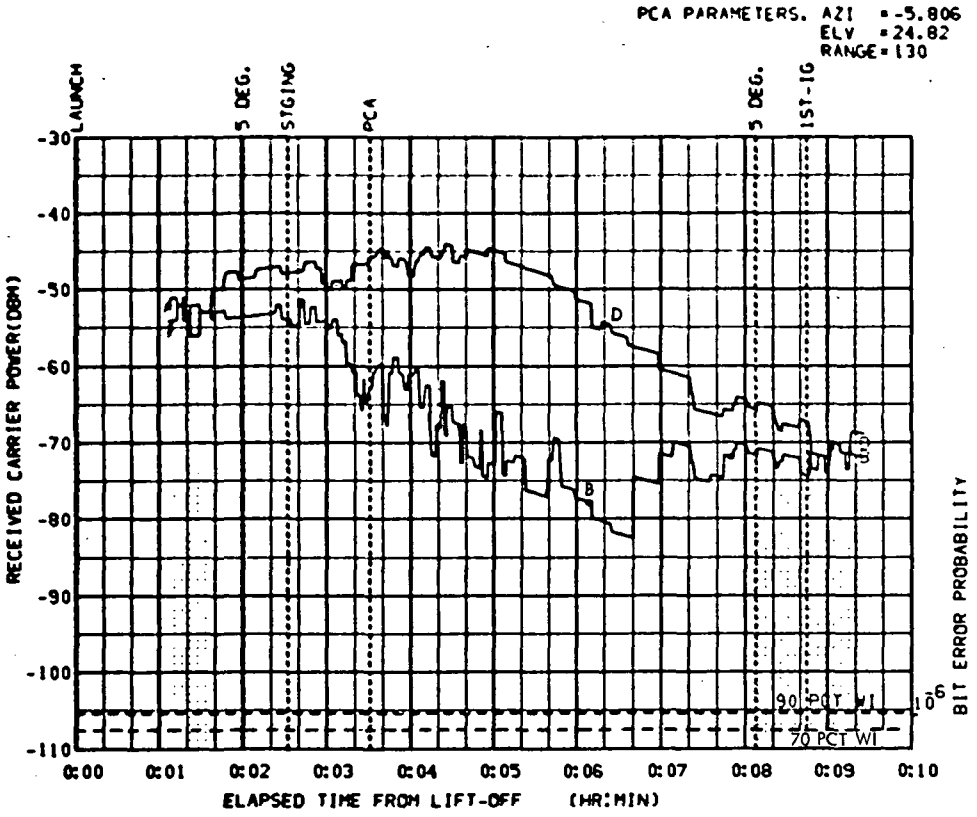


FIGURE 5-10e. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

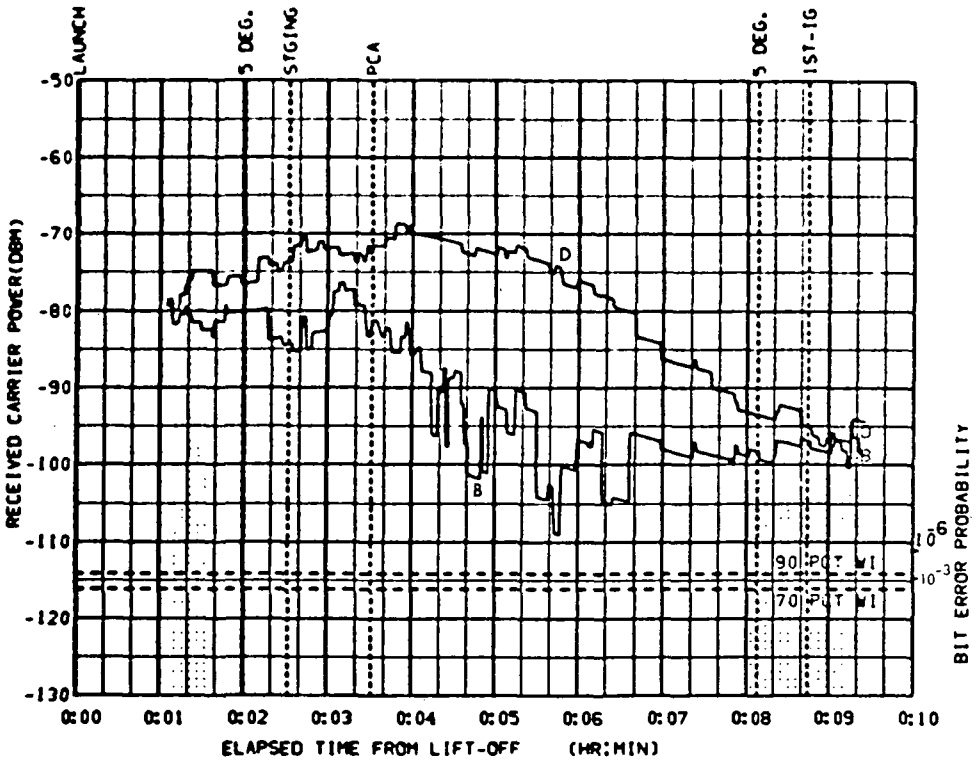


FIGURE 5-10f. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

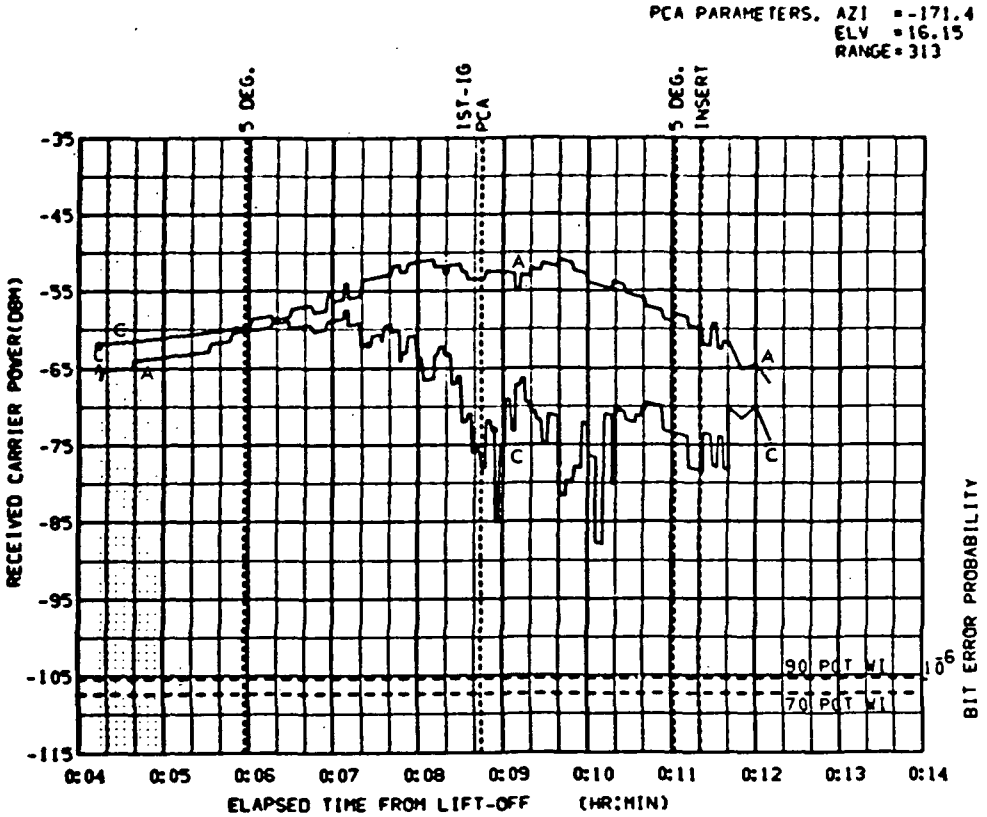


FIGURE 5-11a. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

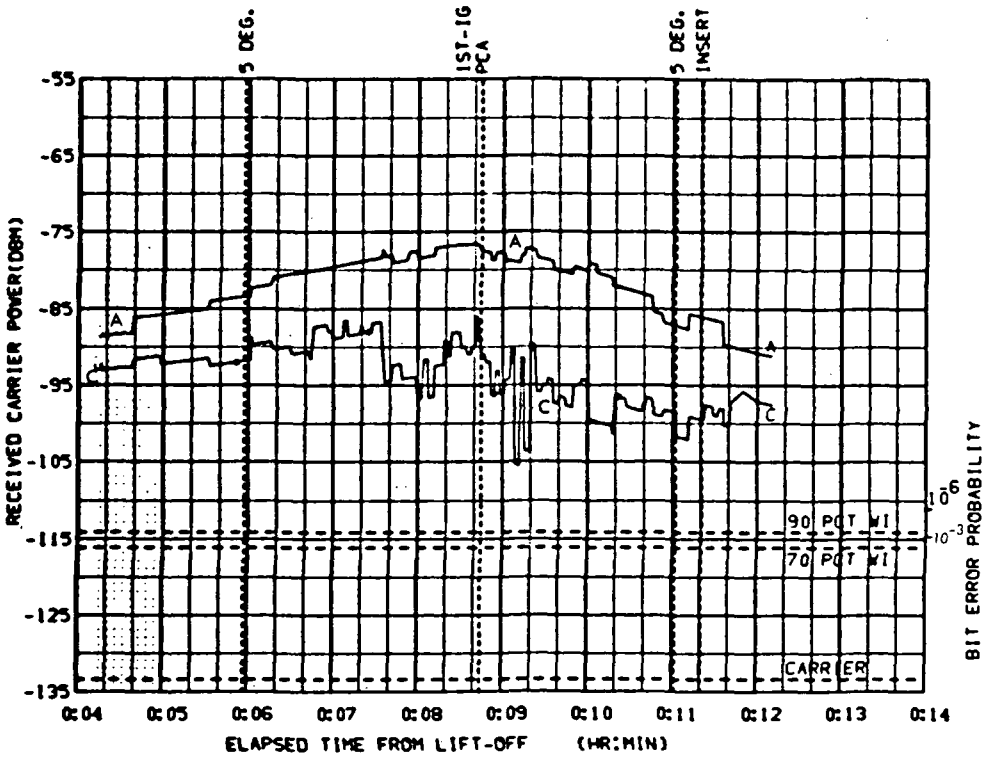


FIGURE 5-11b. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

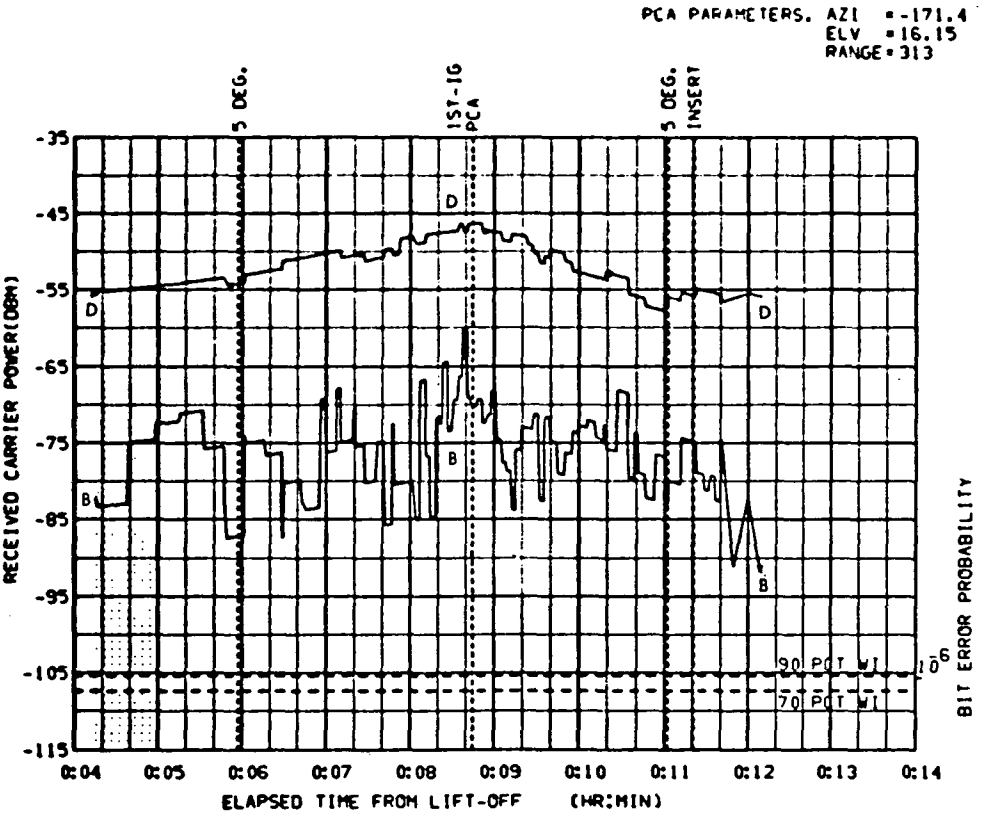


FIGURE 5-11c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

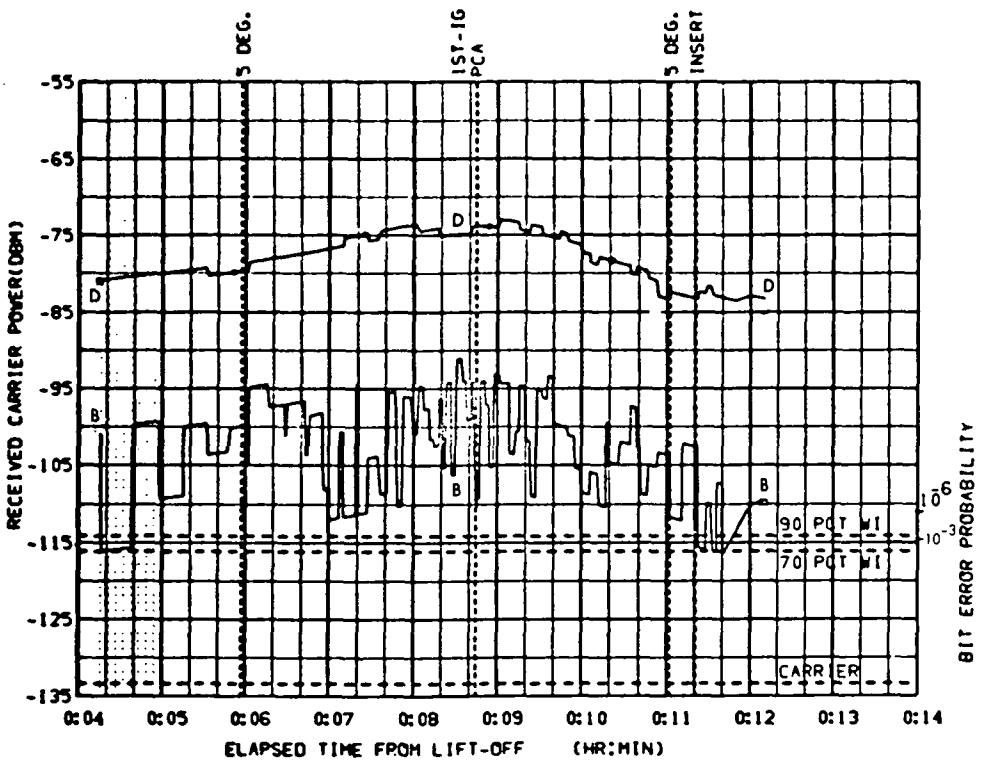


FIGURE 5-11d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

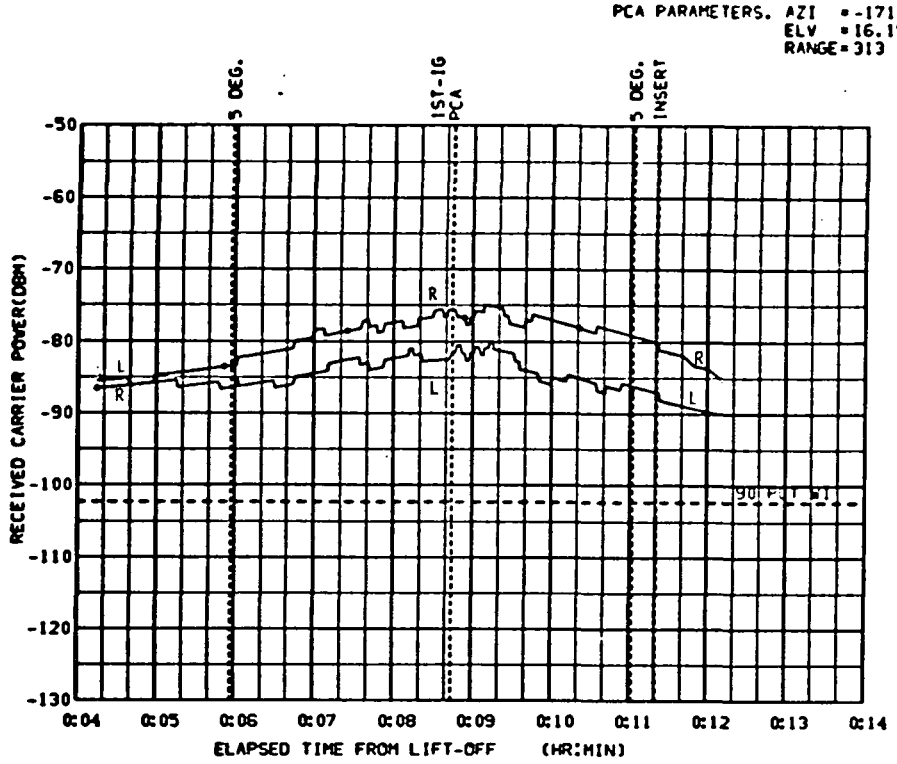


FIGURE 5-11e. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

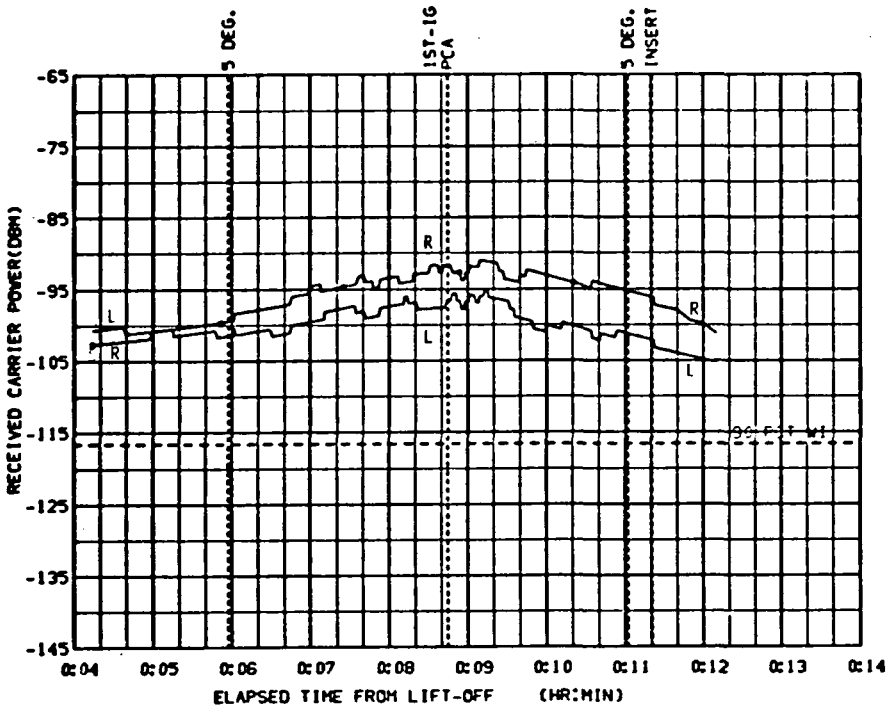


FIGURE 5-11f. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

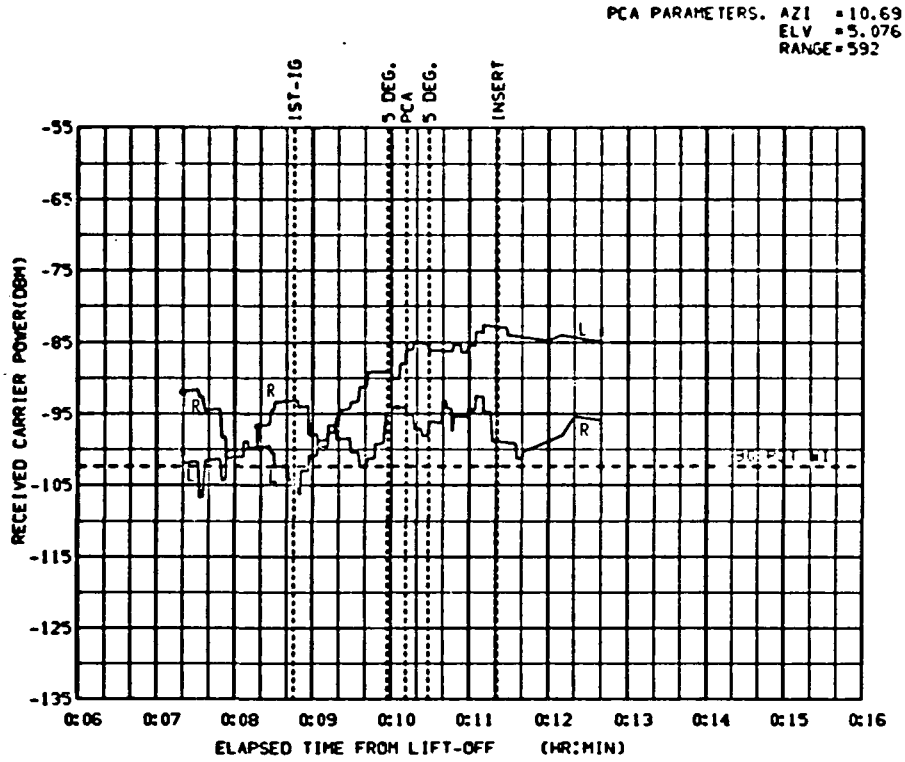


FIGURE 5-12a. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

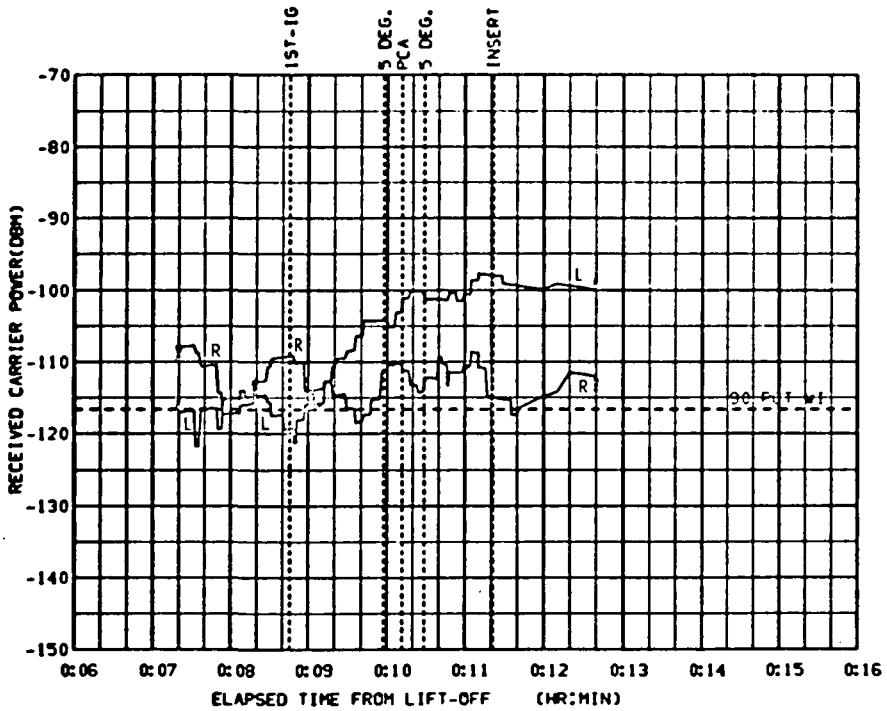


FIGURE 5-12b. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

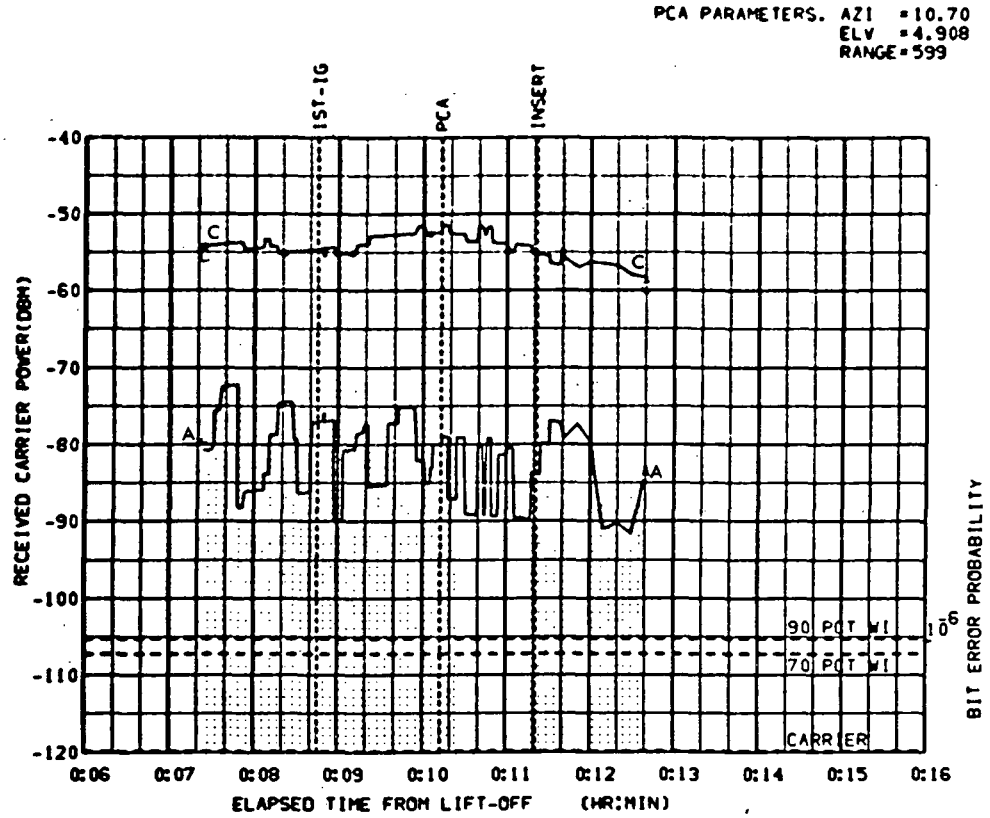


FIGURE 5-12c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

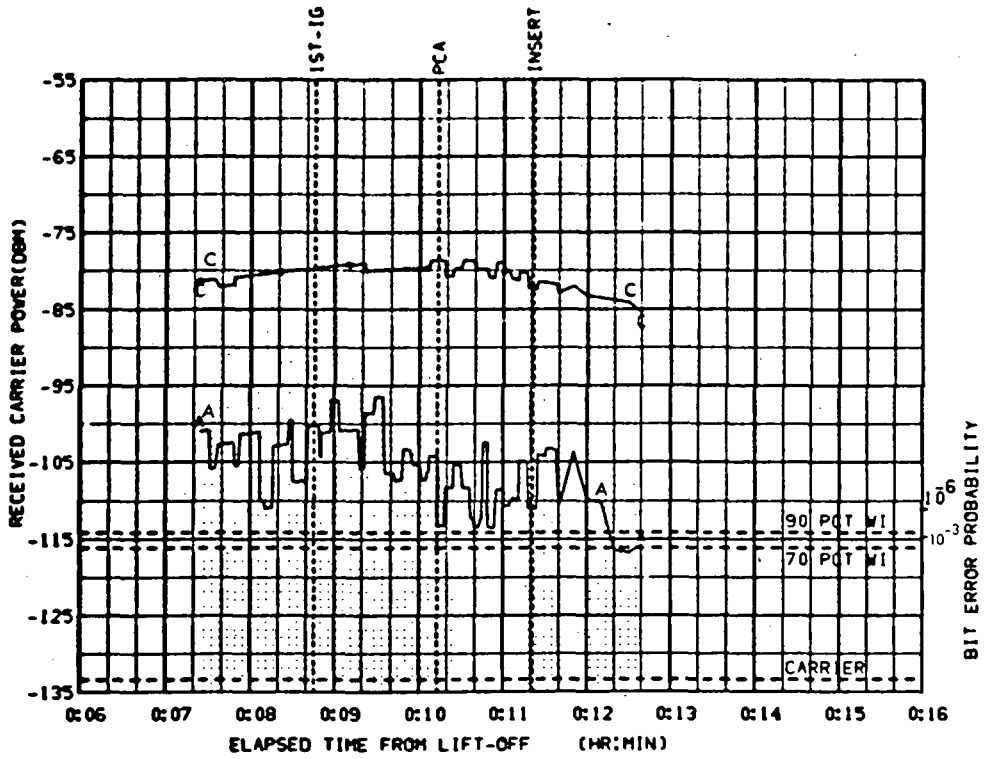


FIGURE 5-12d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

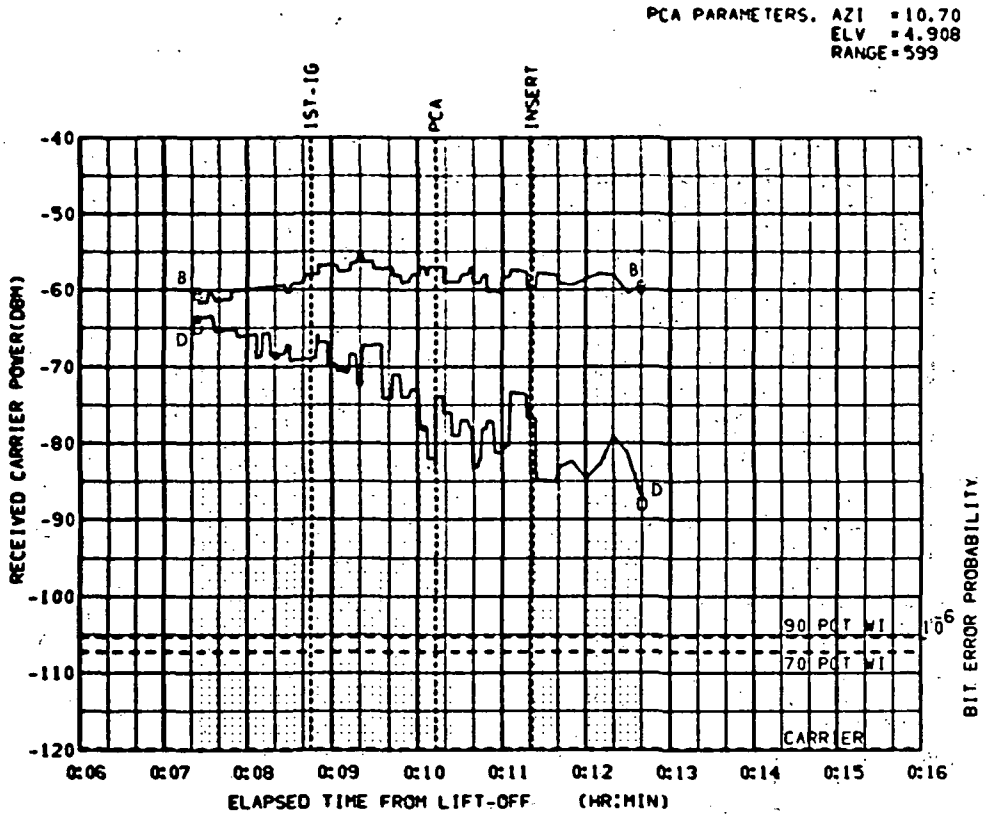


FIGURE 5-12e. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

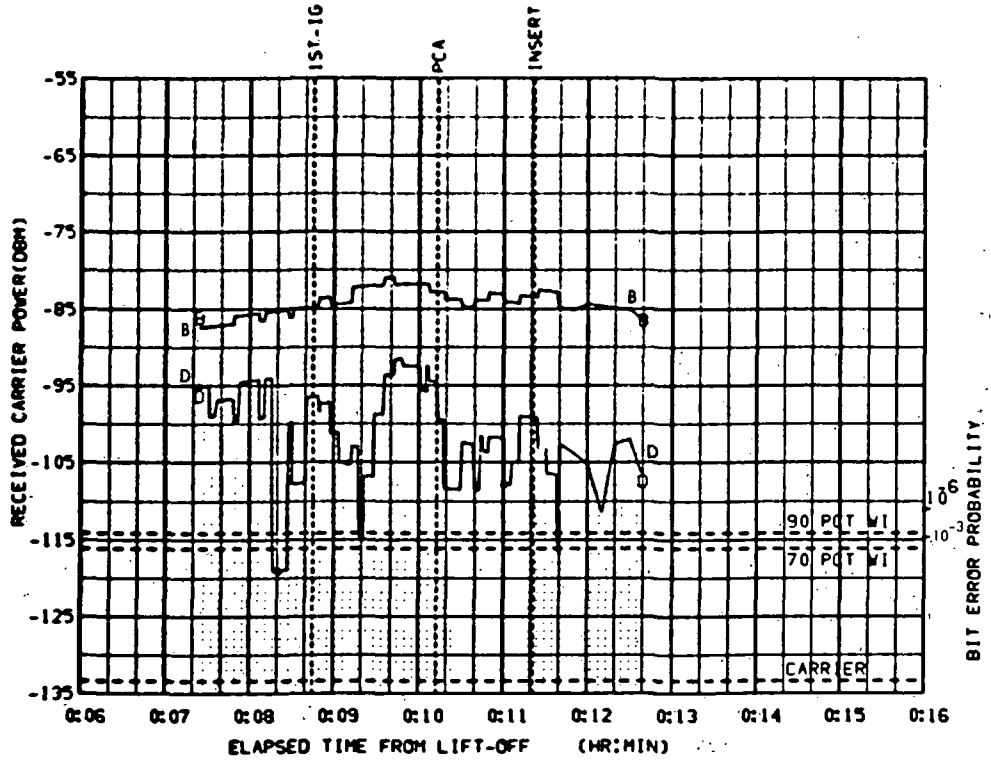


FIGURE 5-12f. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

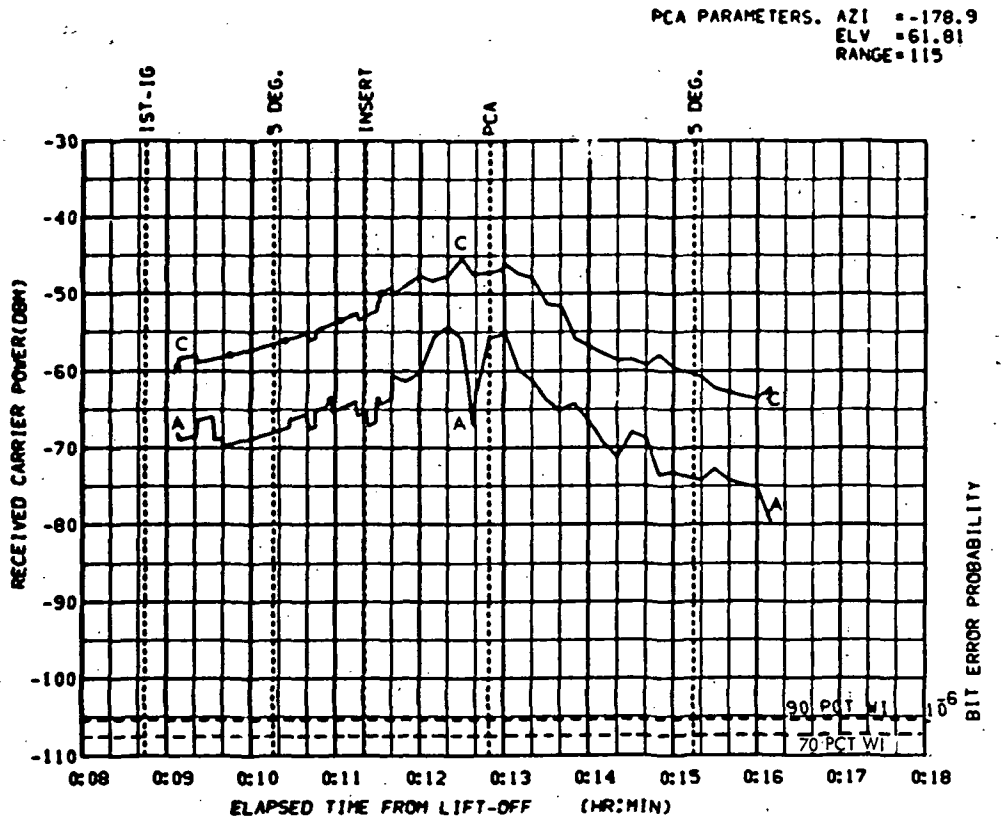


FIGURE 5-13a. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

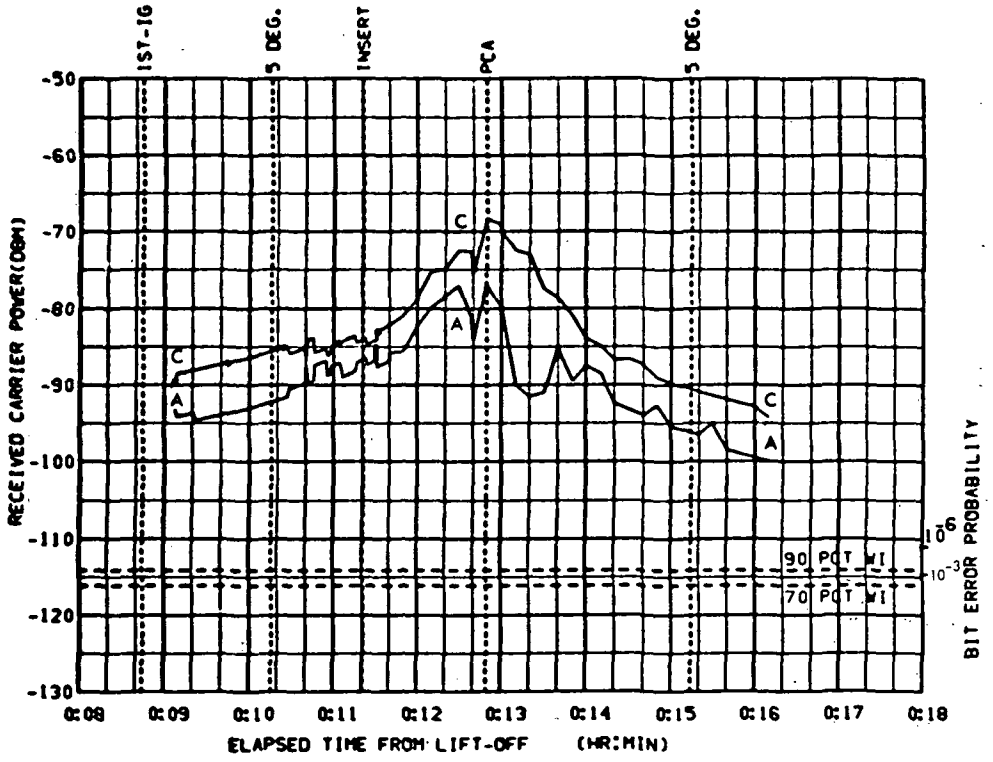


FIGURE 5-13b. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

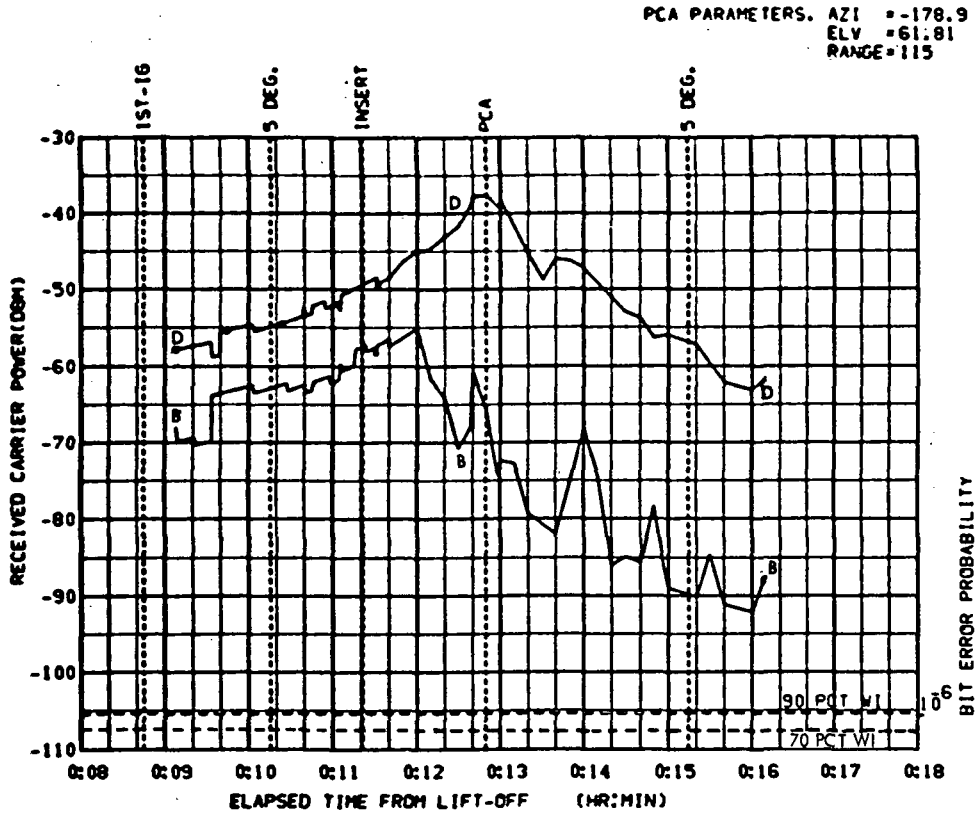


FIGURE 5-13c. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

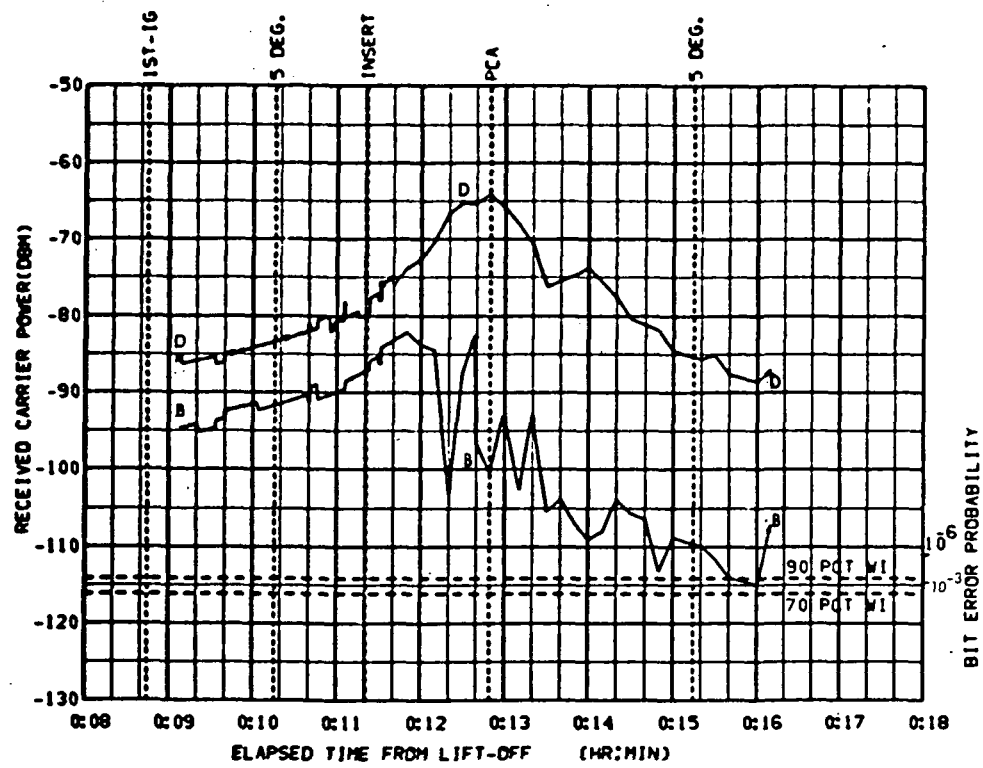


FIGURE 5-13d. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

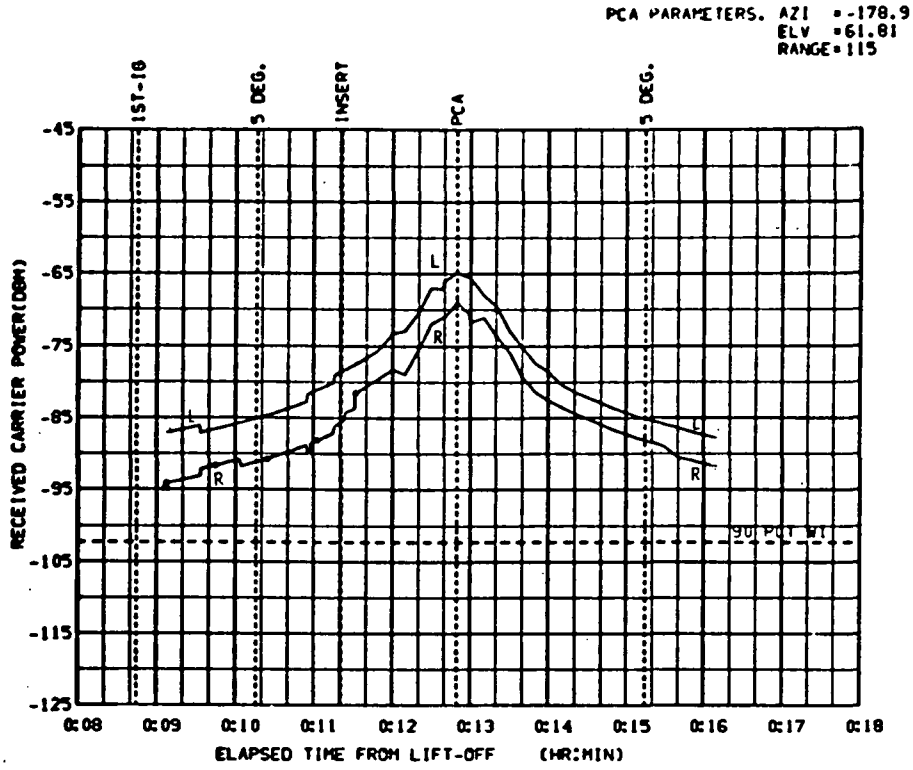


FIGURE 5-13e. VAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

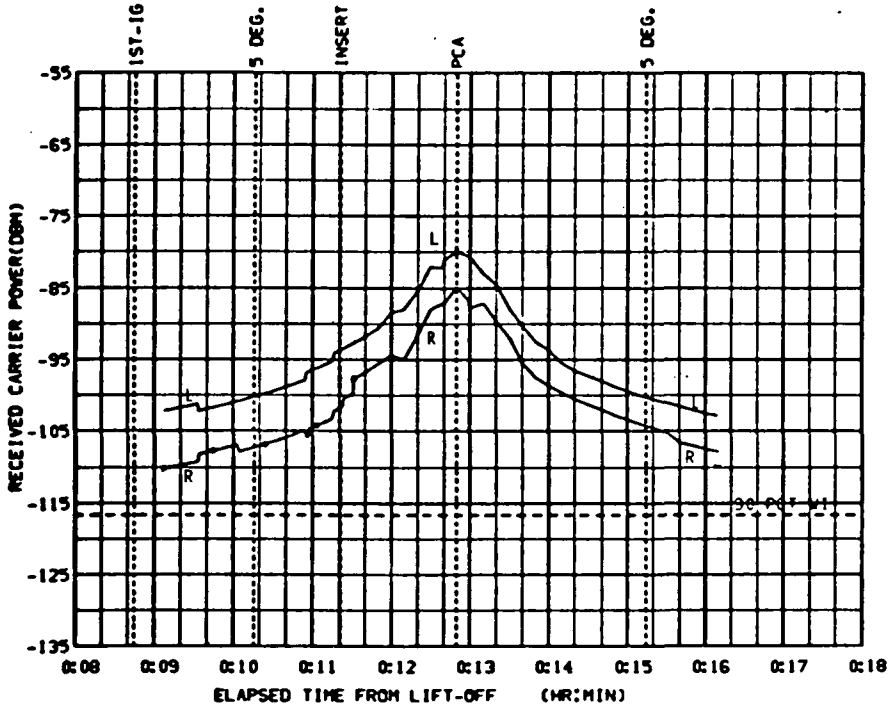


FIGURE 5-13f. VAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (90 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

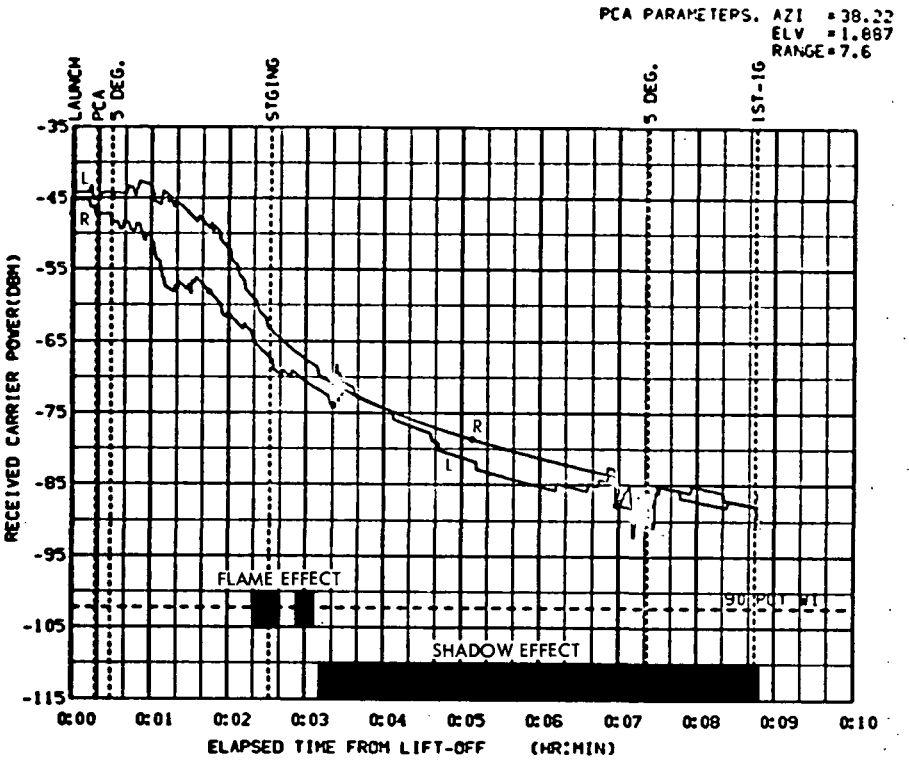


FIGURE 5-14a. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

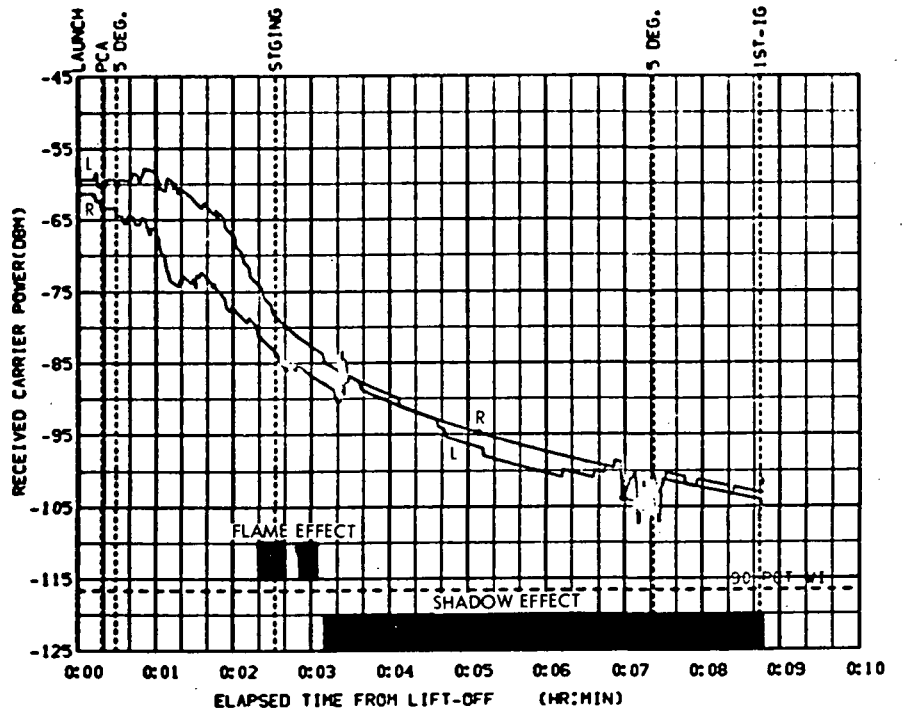


FIGURE 5-14b. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

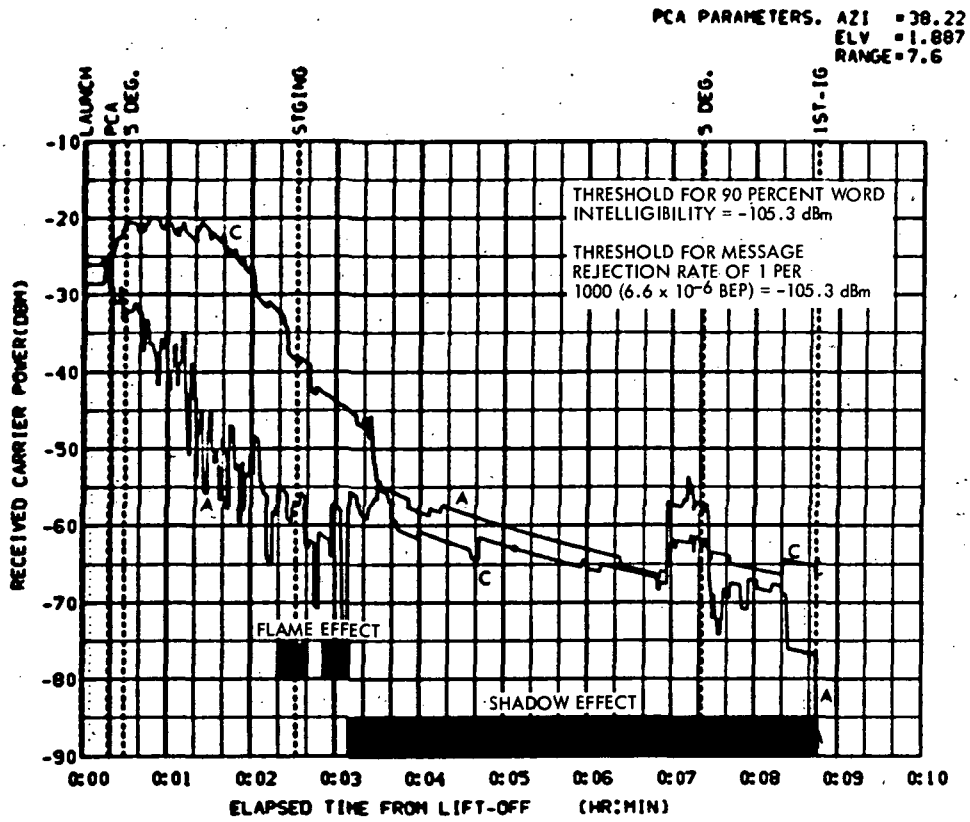


FIGURE 5-14c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

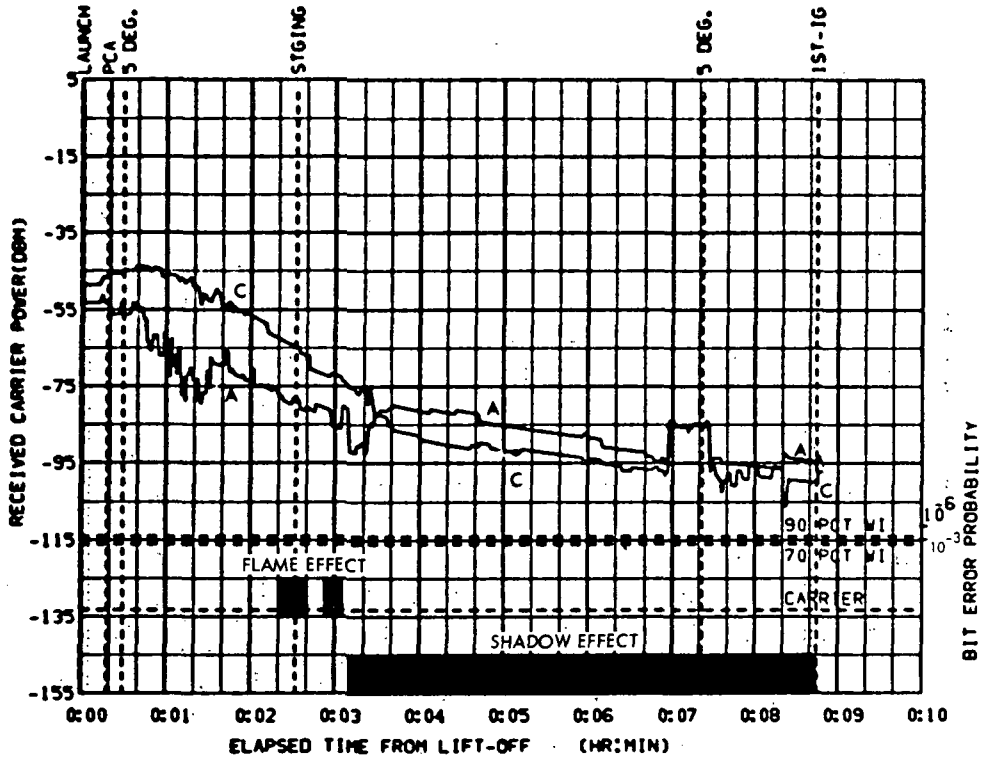


FIGURE 5-14d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

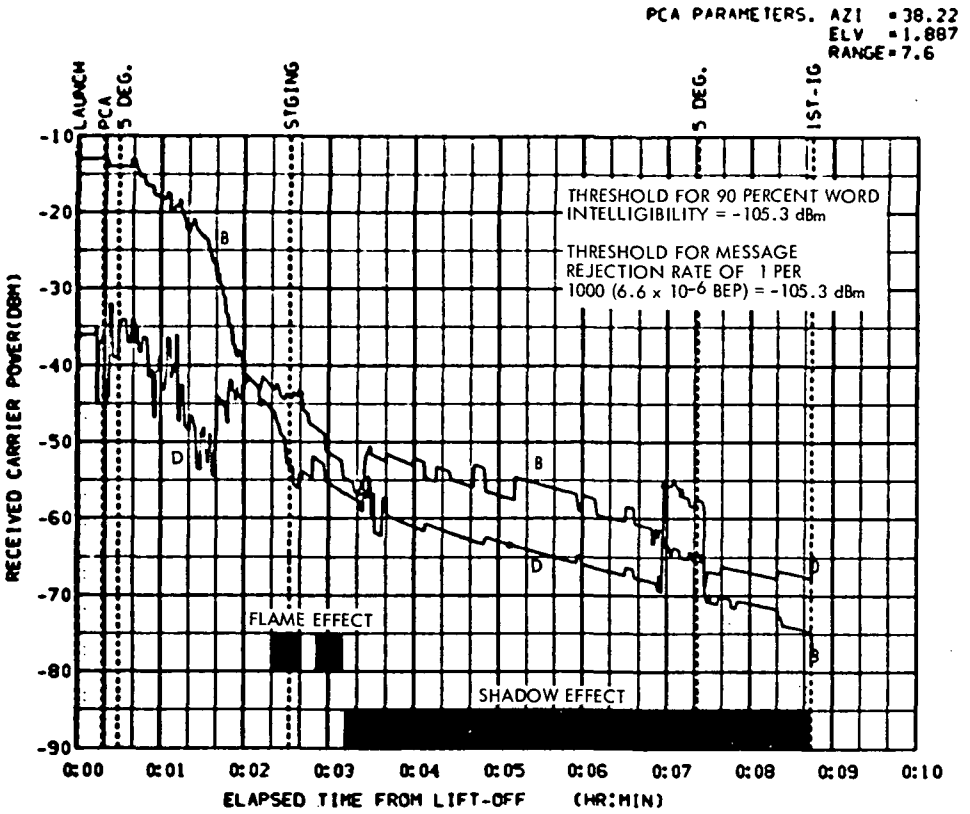


FIGURE 5-14e. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

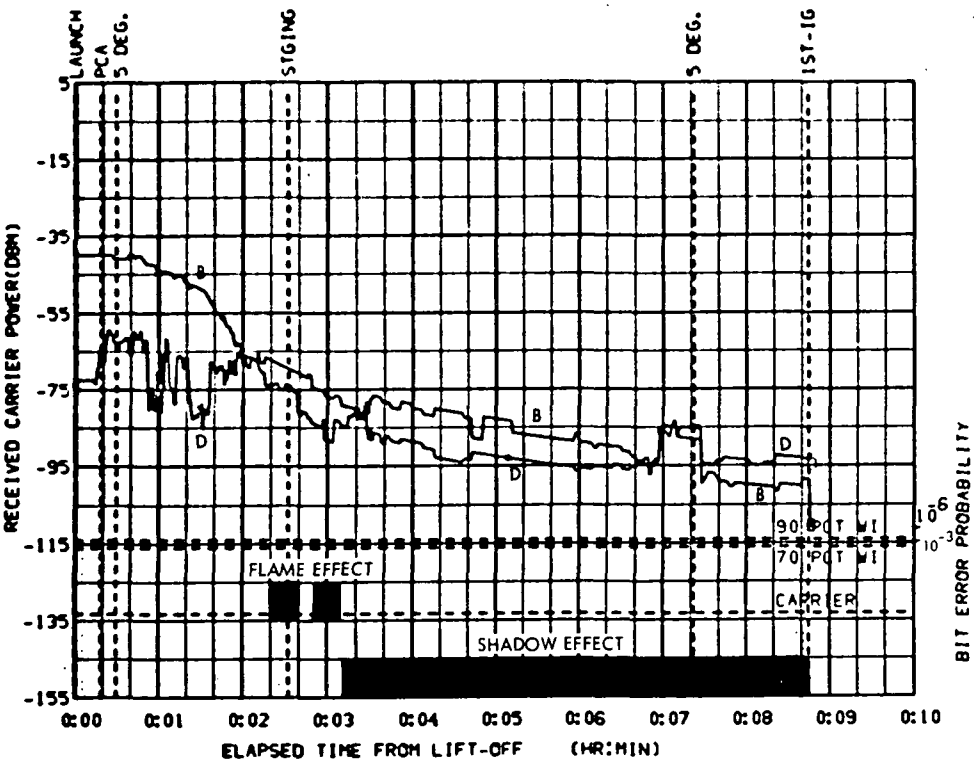


FIGURE 5-14f. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

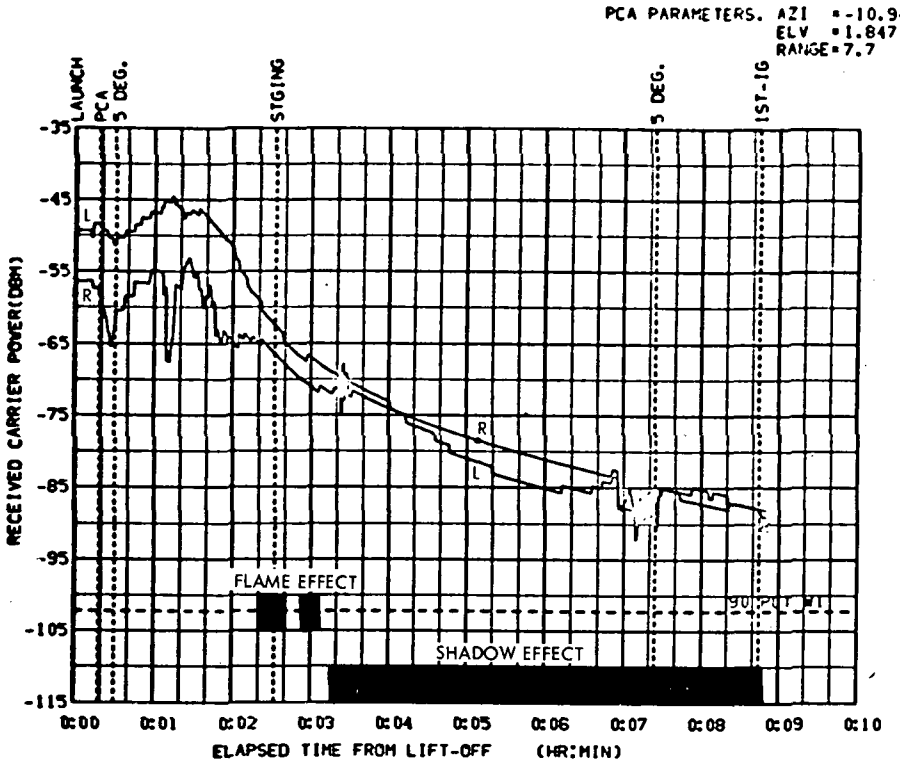


FIGURE 5-15a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

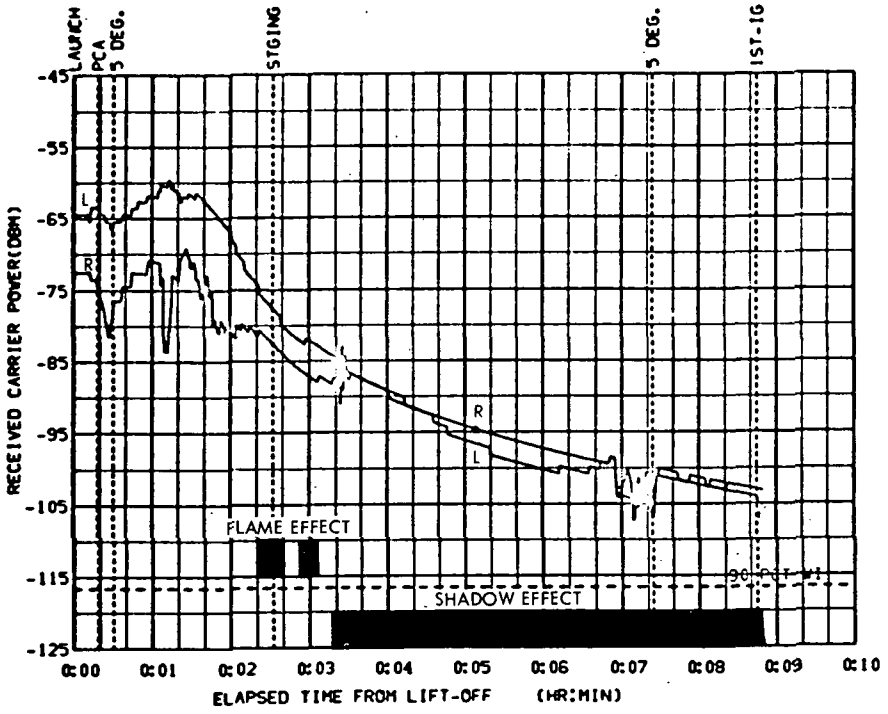


FIGURE 5-15b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

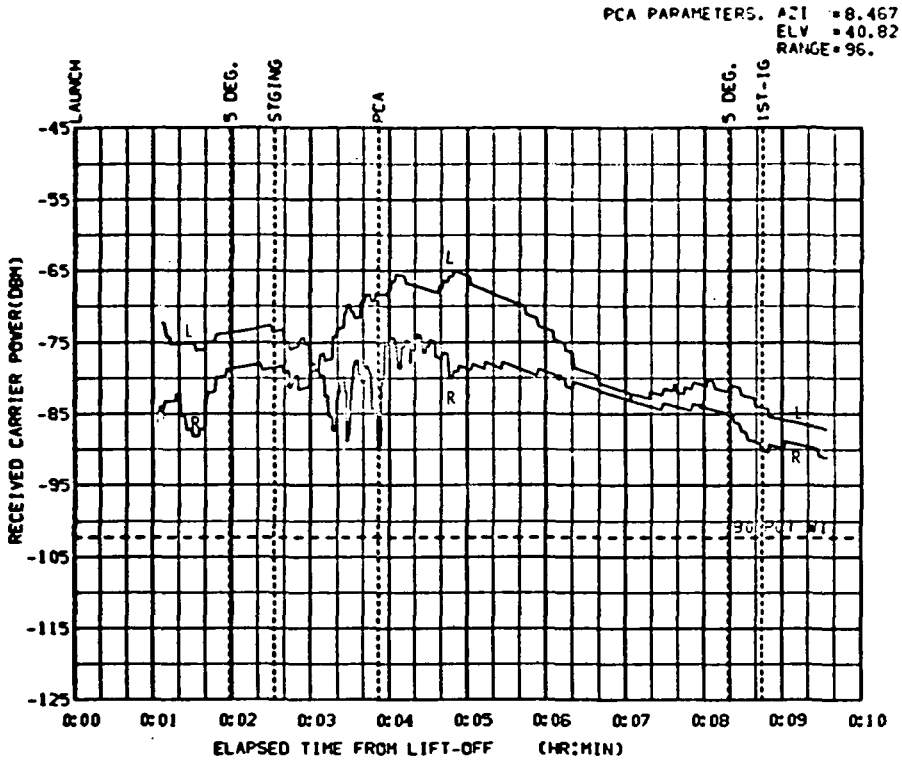


FIGURE 5-16a. 6BI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

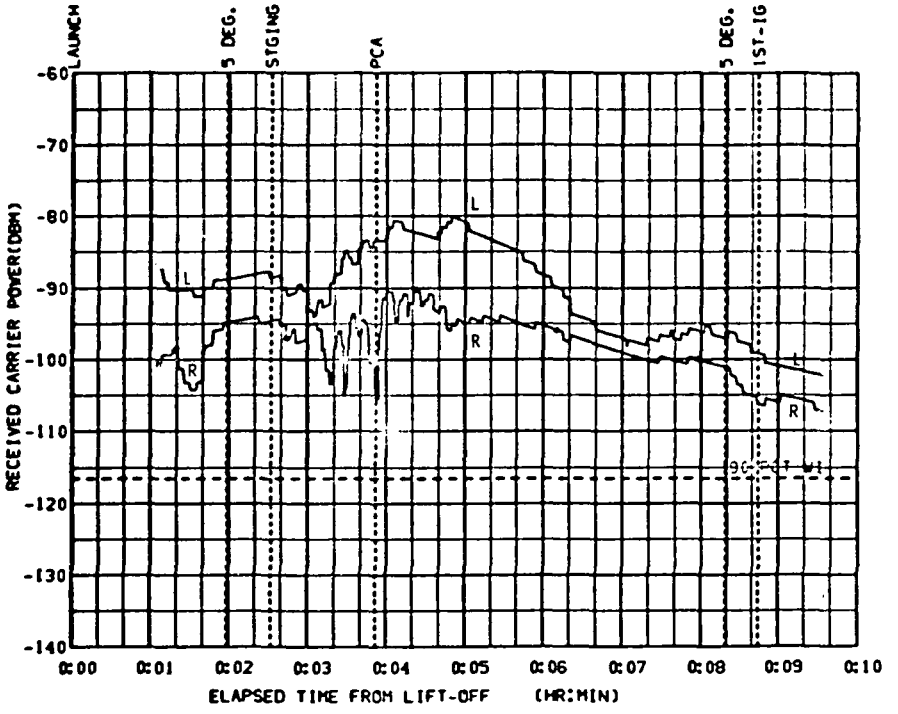


FIGURE 5-16b. 6BI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

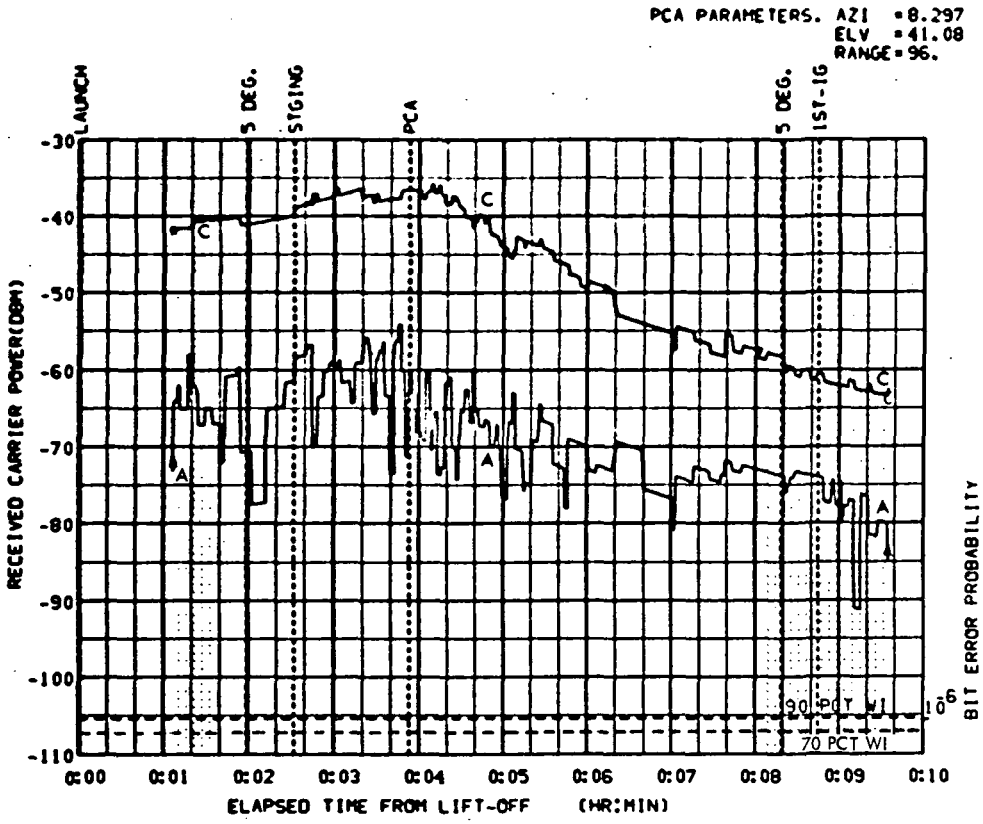


FIGURE 5-16c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

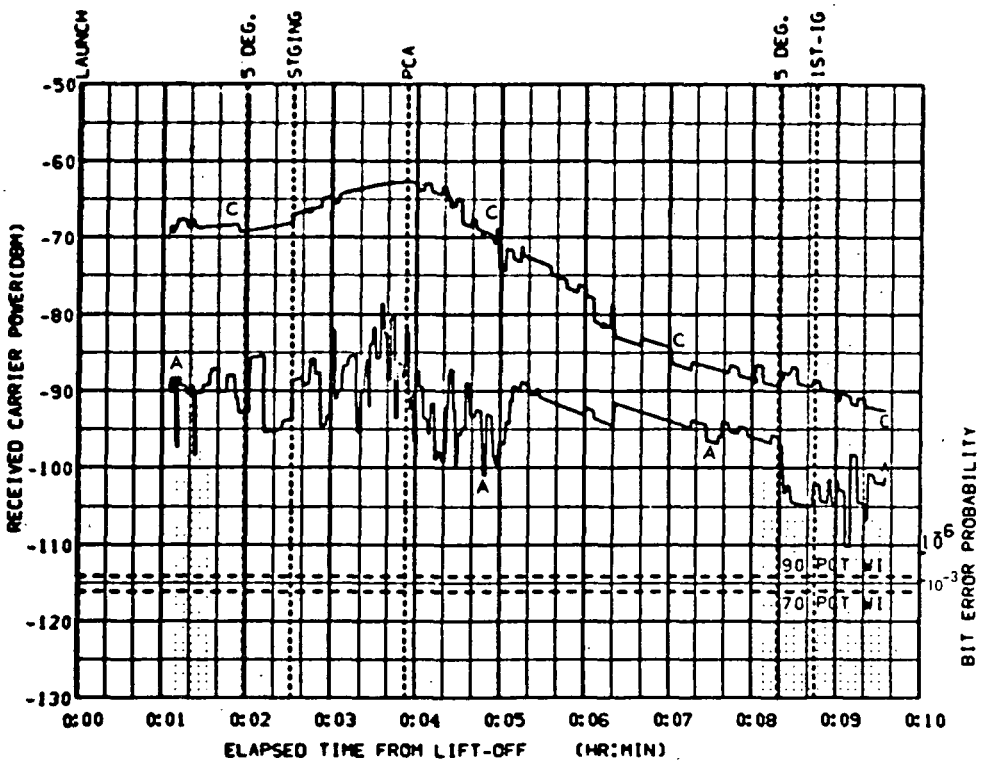


FIGURE 5-16d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

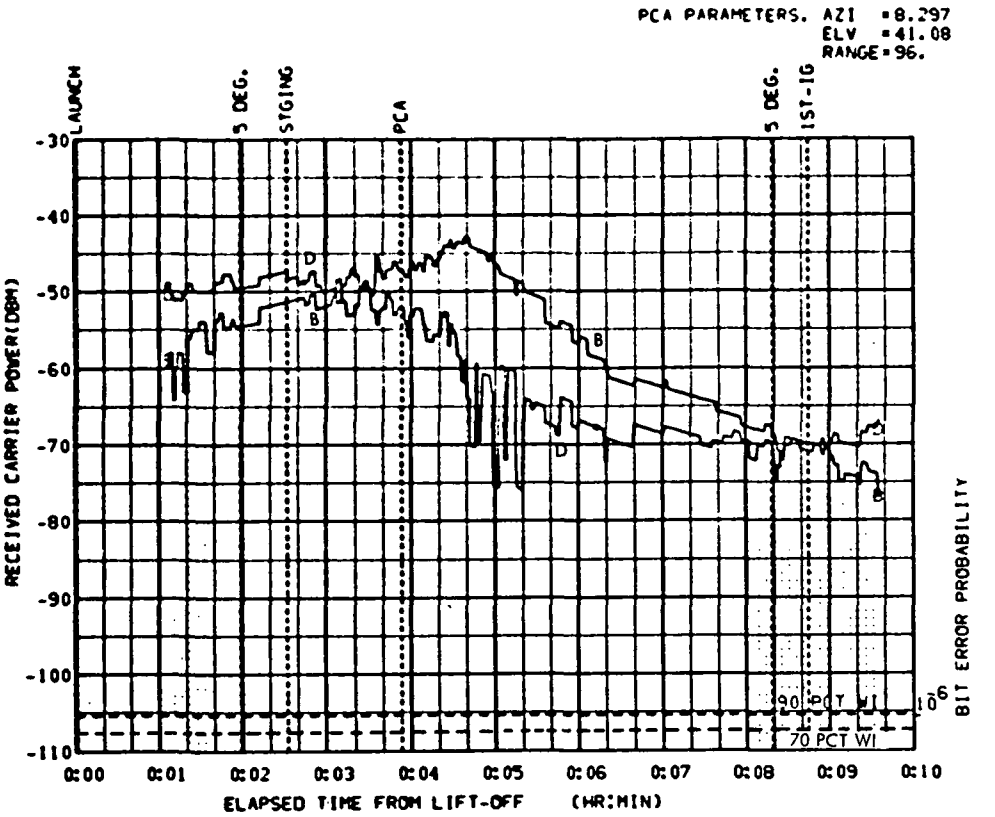


FIGURE 5-16e. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

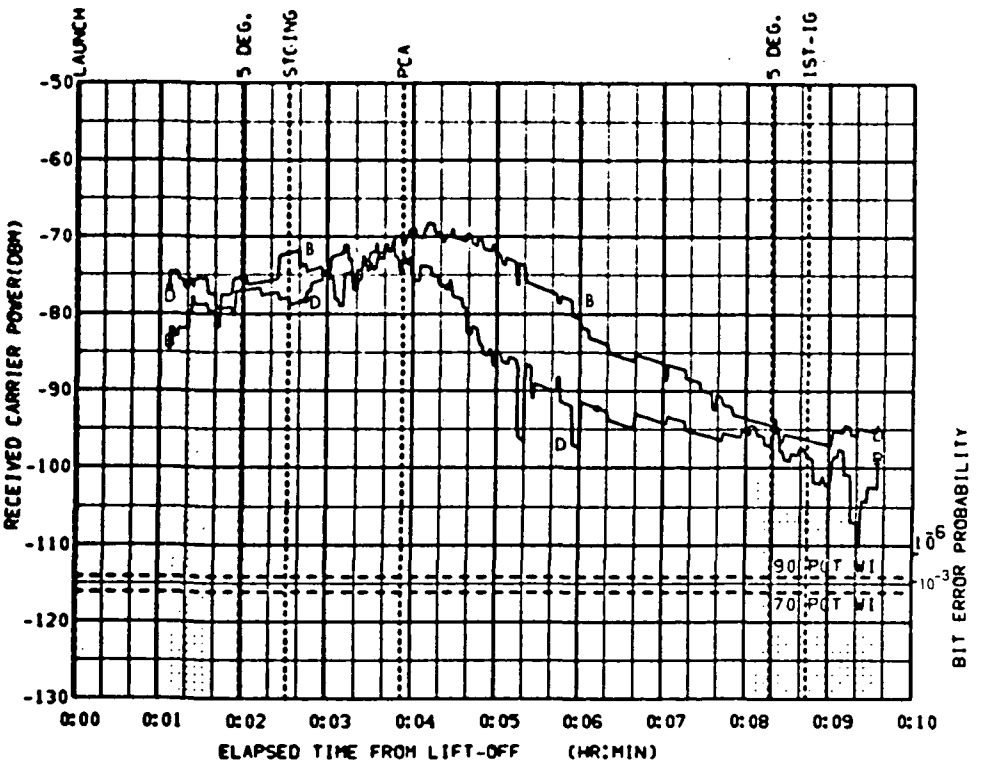


FIGURE 5-16f. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

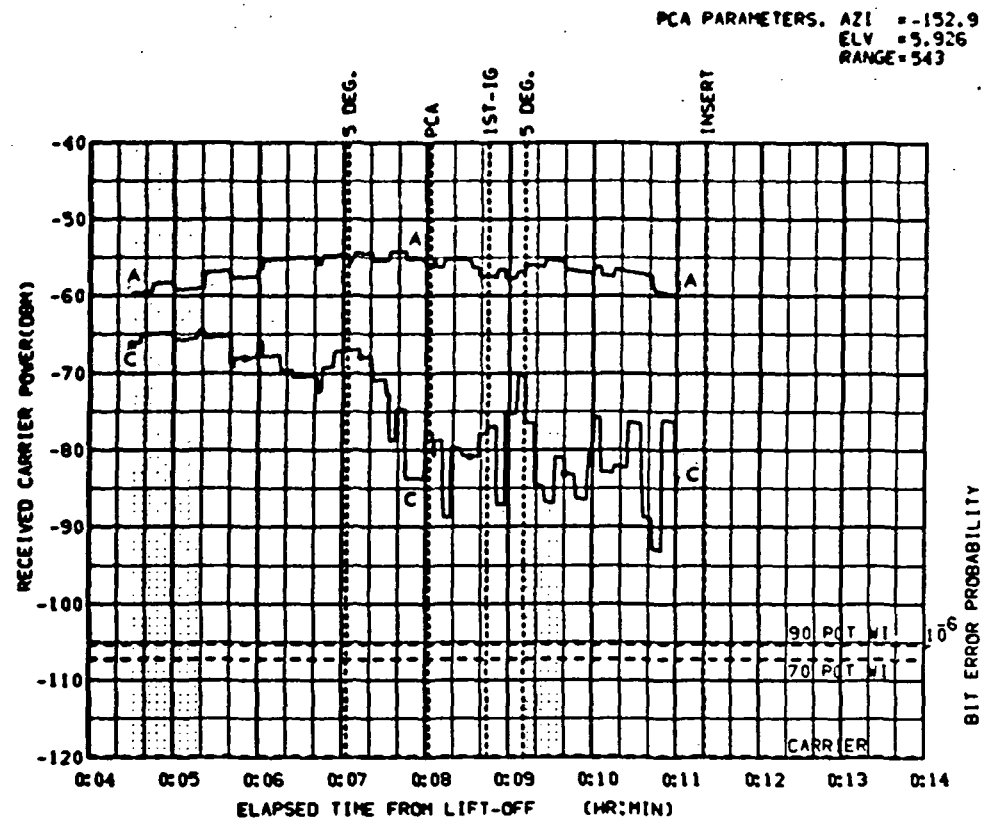


FIGURE 5-17a. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

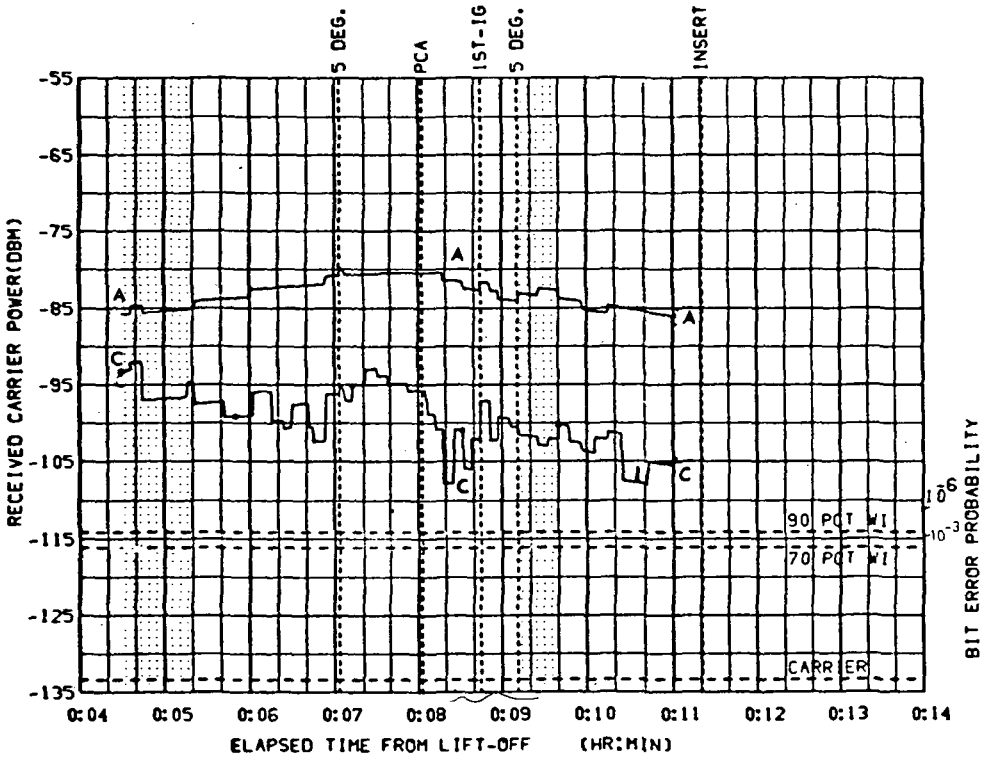


FIGURE 5-17b. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

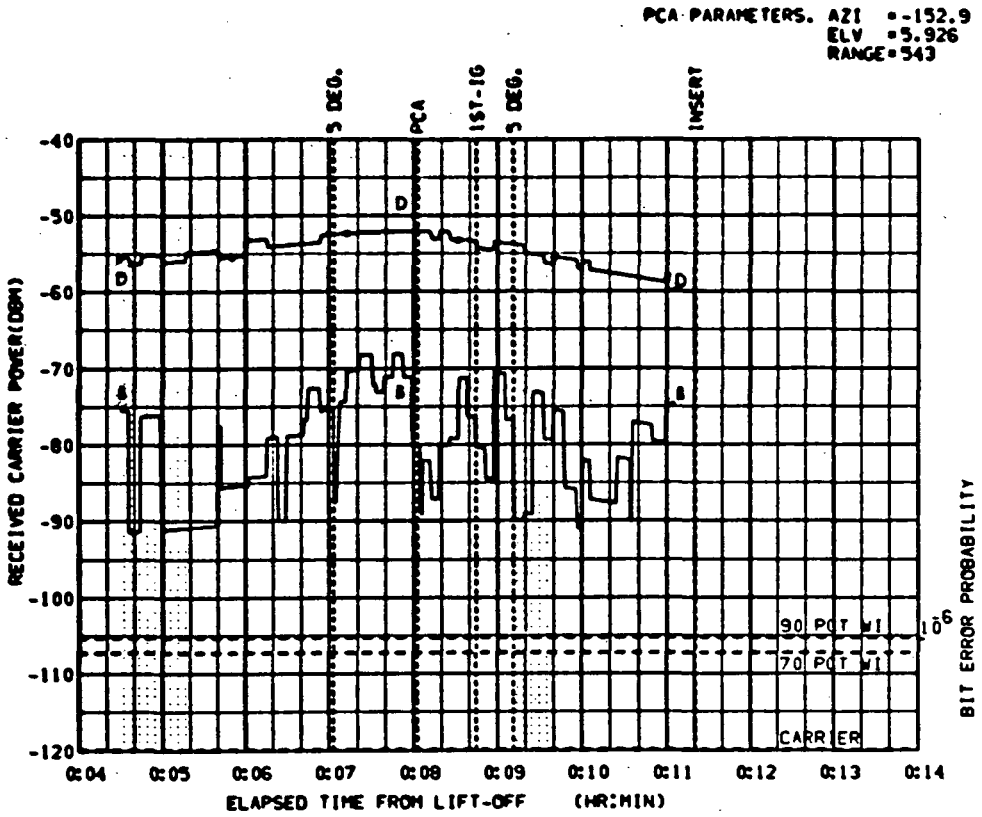


FIGURE 5-17c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

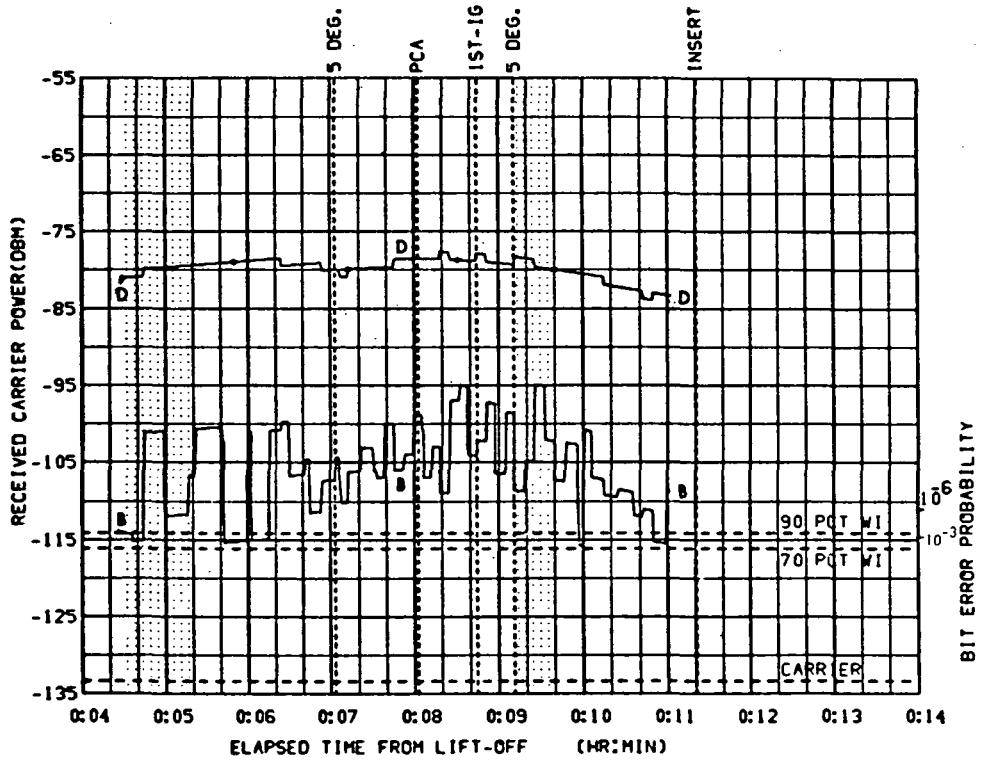


FIGURE 5-17d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

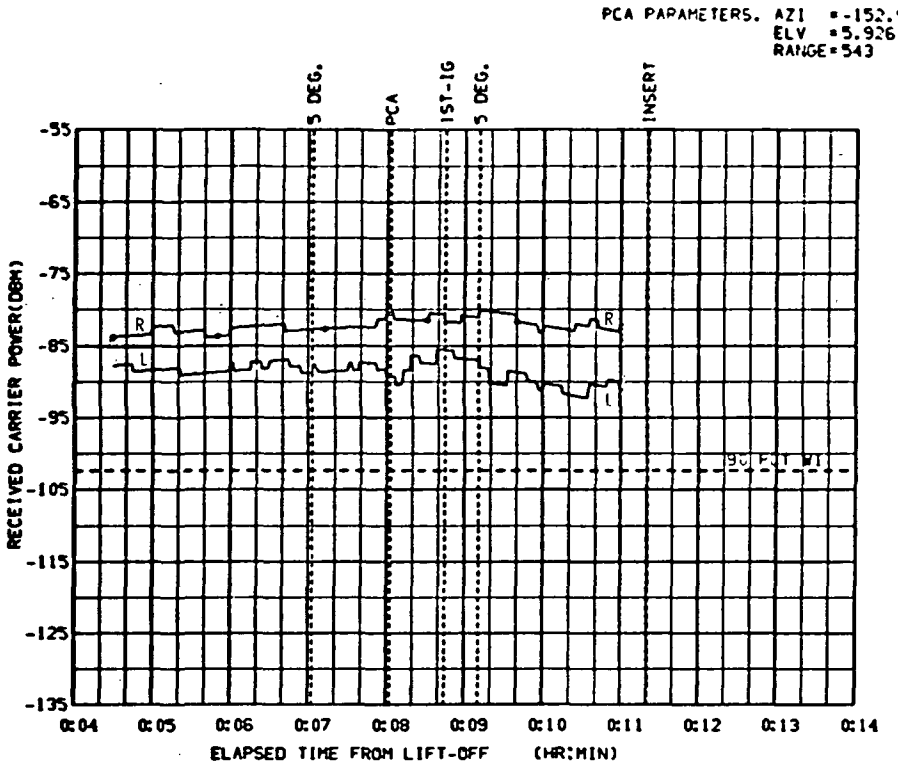


FIGURE 5-17e. BDA UPLINK, MSFN/CSM, VHF/AM, SM ANTENNAS CSM/S-IVB, LAUNCH (108 DEGREE), APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

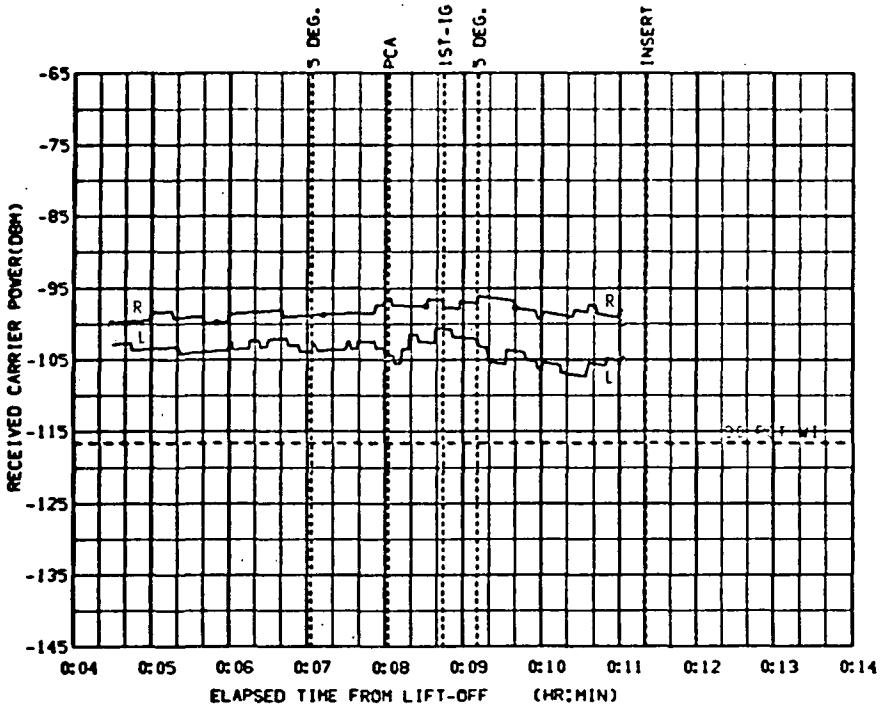


FIGURE 5-17f. BDA DOWNLINK, CSM/MSFN, VHF/AM, SM ANTENN CSM/S-IVB, LAUNCH (108 DEGREE), APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

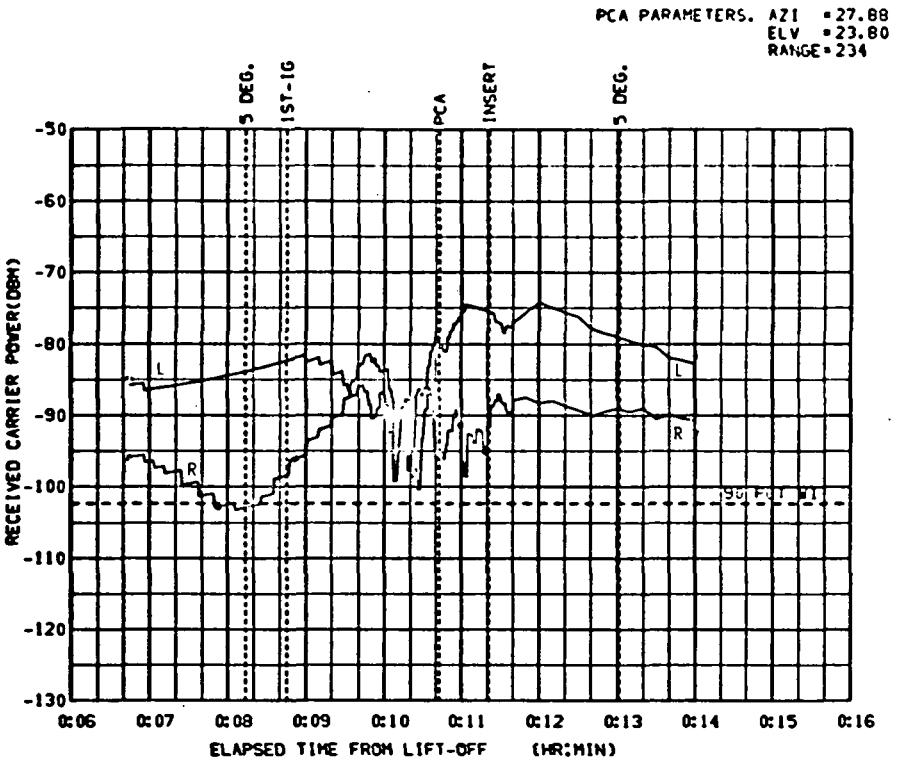


FIGURE 5-18a. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

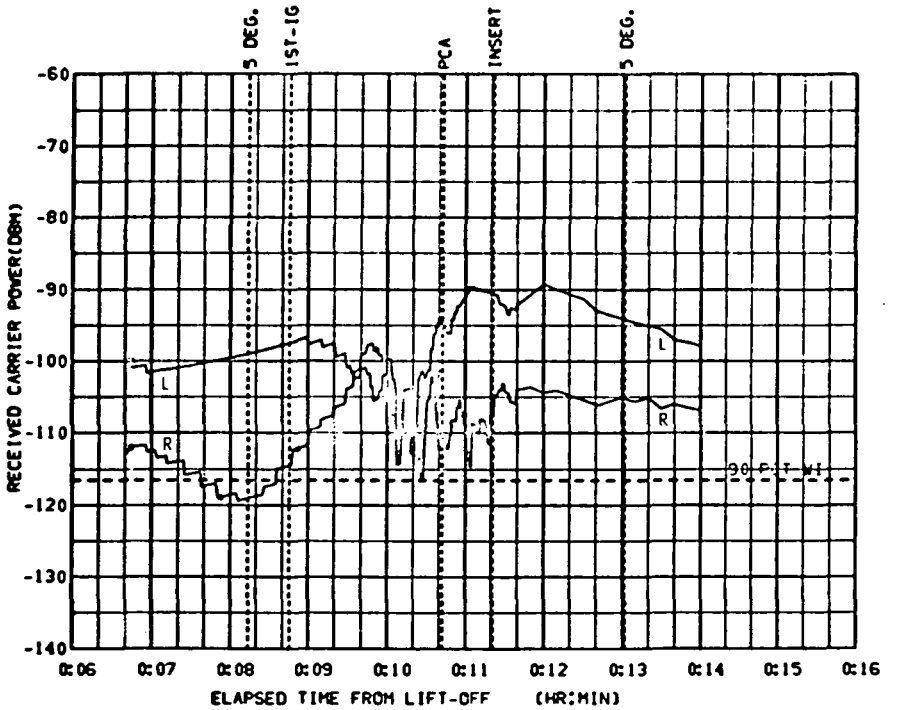


FIGURE 5-18b. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

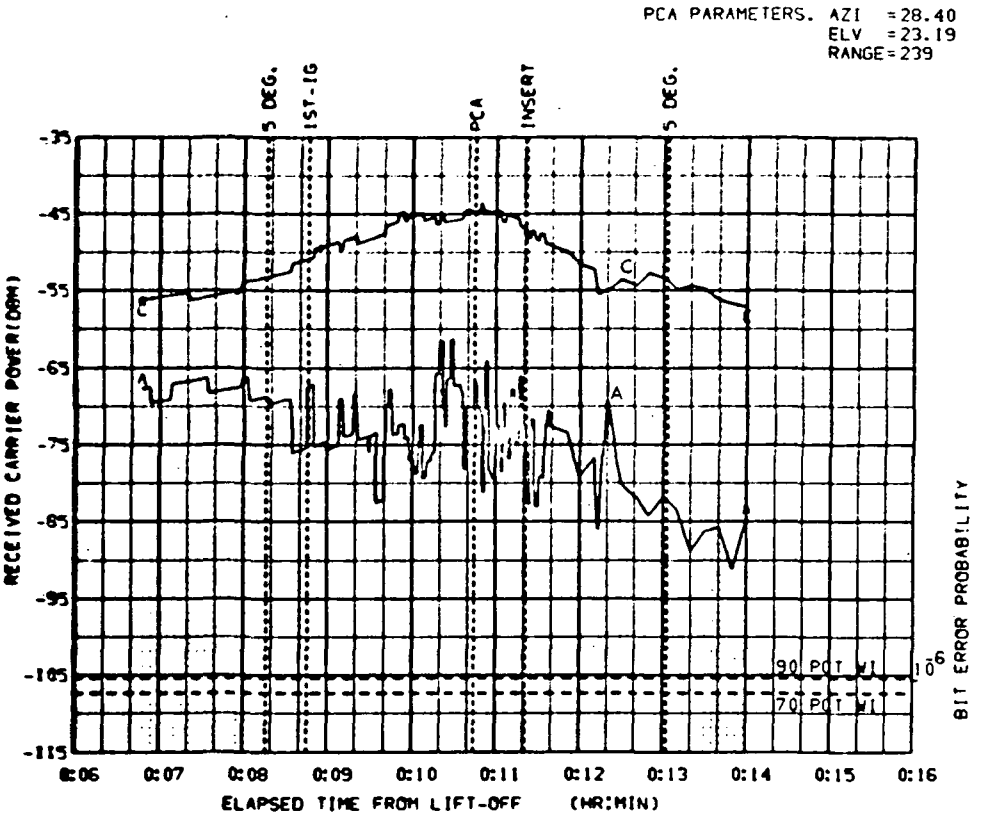


FIGURE 5-18c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

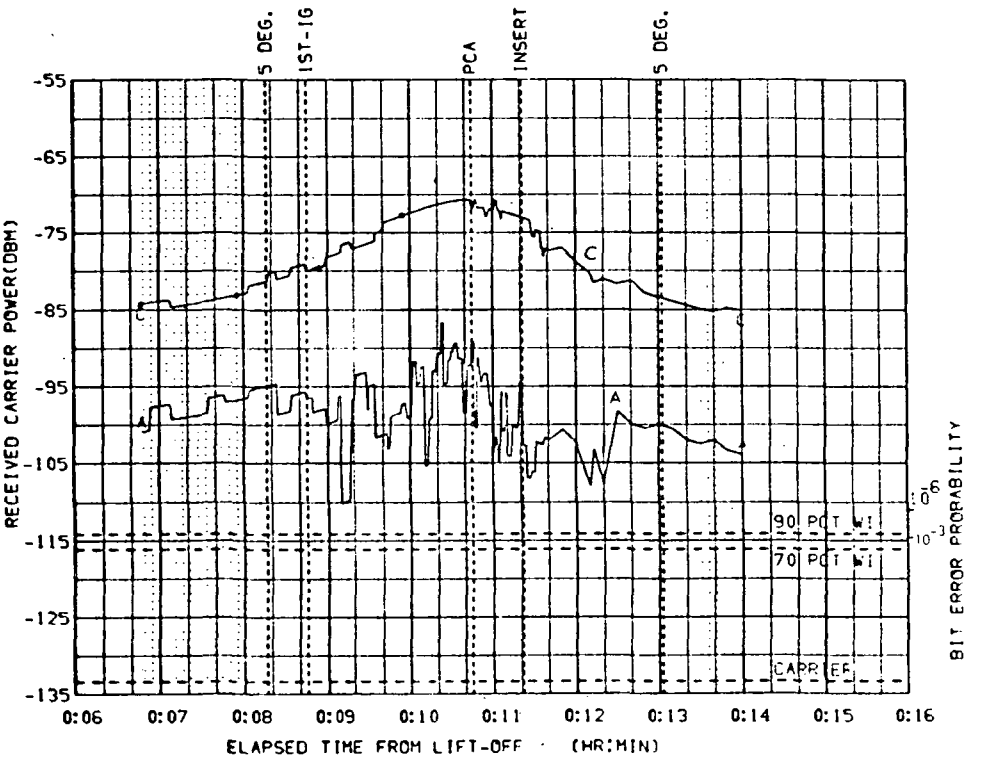


FIGURE 5-18d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

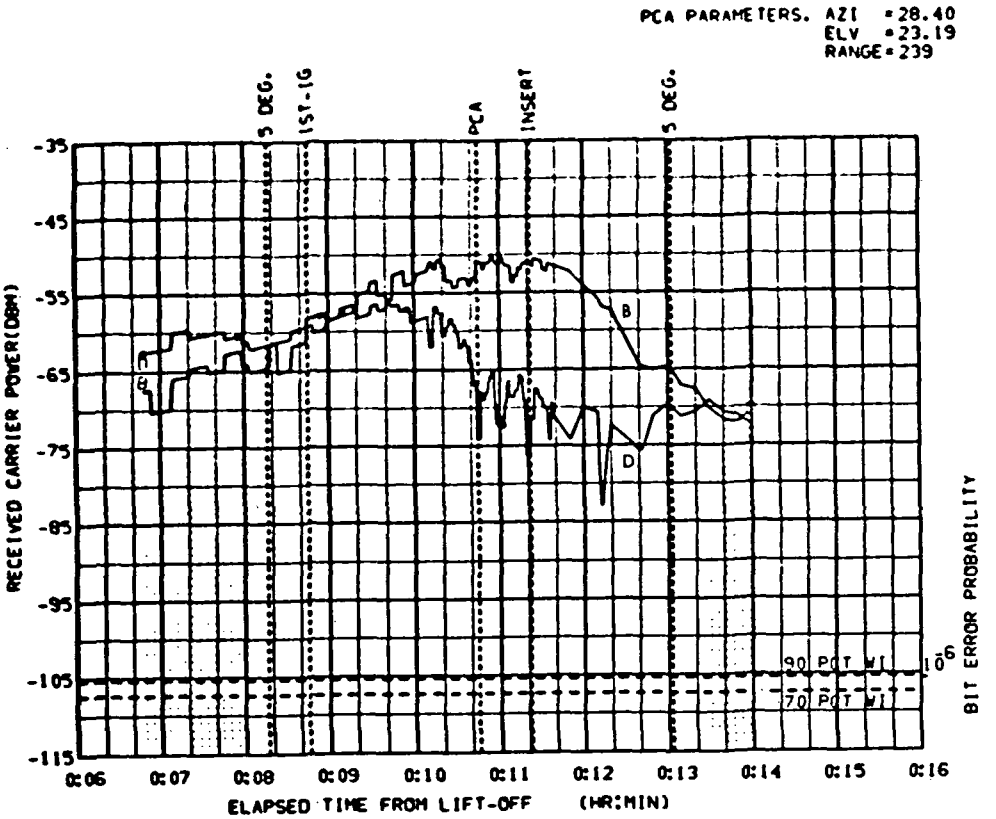


FIGURE 5-18e. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

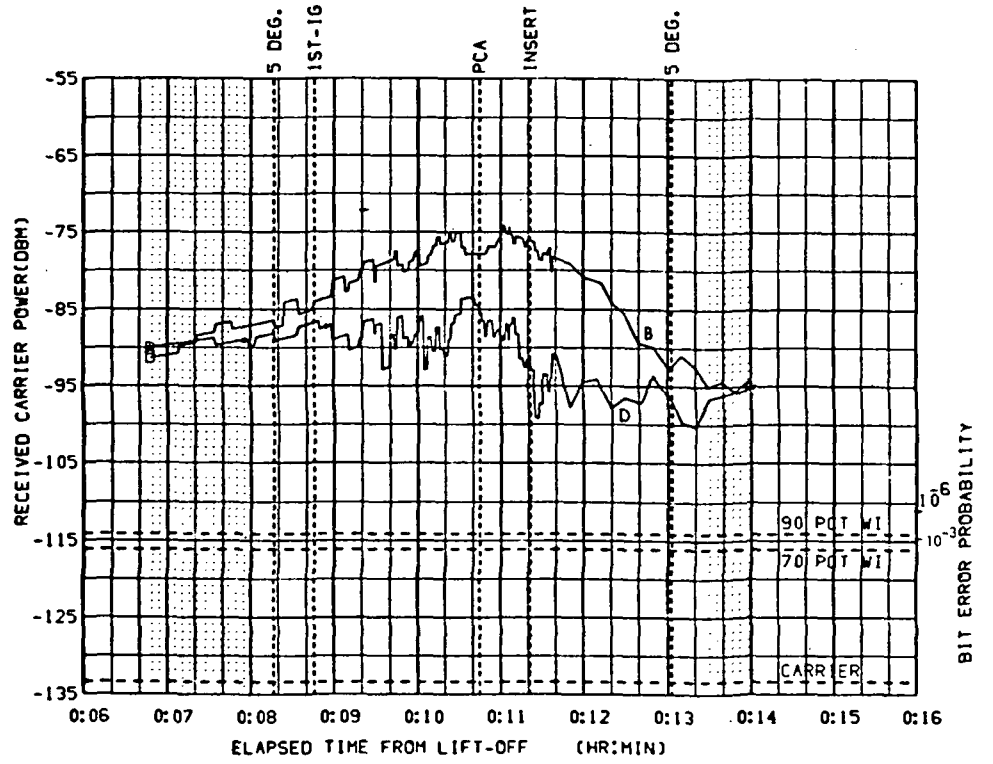


FIGURE 5-18f. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. LAUNCH (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

6. EARTH PARKING ORBIT

6.1 INTRODUCTION

The earth parking orbit phase (EPO) of the mission covers the time period from orbital insertion through three revolutions and includes the translunar injection burn (TLI) for two possible injection opportunities, occurring on the second and third revolutions, respectively. Communications analysis and recommendations are provided for three typical EPO trajectories resulting from 72-, 90-, and 108-degree launch azimuths on an 18 May 1969 launch.

The following communications recommendations are contained in this section:

a) Use CSM omni antenna D for the entire EPO phase except for the first pass over HTV on 72-degree launch azimuth when antenna C should be used.

b) Use the LEFT CSM VHF antenna for the entire EPO phase.

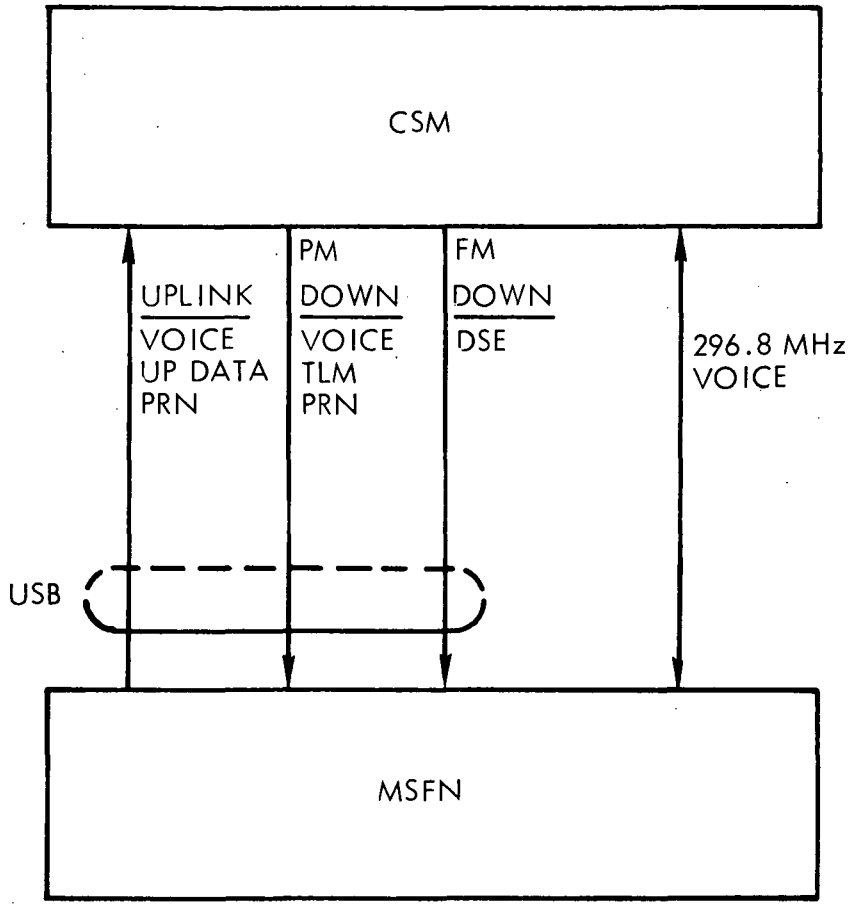
c) One crewman listen to S-band voice only and one crewman listen to VHF/AM voice only.

d) Initiate ground command of antenna D prior to TLI; then set CSM S BAND ANTENNA switches for selection of antenna A. Ground command antenna A at start of CSM/S-IVB separation maneuver (during T and D phase).

e) VHF/AM voice should be primary on all station passes when below 5-degree elevation.

6.2 BASIC COMMUNICATION CONFIGURATION

The basic communication configuration to be used during the EPO phase is shown in Figure 6-1. The communication configuration is the same as that used during the launch phase with the exception that the VHF/AM system will be used in the Simplex A mode; i.e., both uplink and downlink VHF/AM voice will be transmitted on a carrier frequency of 296.8 MHz. The DSE will be used to record CSM LBR telemetry during LOS periods. The contents of the DSE will be dumped during each pass over the U.S. and over CRO just prior to TLI.



NOTES:
1. ALL AUDIO CENTERS HAVE VHF AND S-BAND VOLUMES UP
2. S-BAND SQUELCH ENABLED
3. VOICE TRANSMITTED SIMULTANEOUSLY ON S-BAND AND VHF
4. VHF SIMPLEX A WILL BE SELECTED FOR EARTH ORBIT OPERATIONS

Figure 6-1. Basic Communication Configuration for Earth Parking Orbit.

Voice will be transmitted simultaneously on both the VHF/AM system and the S-band system. All audio centers will have the VHF/AM and S-band volumes turned up. In order to avoid voice-phasing problems within the spacecraft, it is recommended that one crewman listen to S-band voice only and one crewman listen to VHF/AM voice only.

6.3 RF COVERAGE SUMMARY

A bar graph summary of RF communications for the three EPO trajectories is given in Figures 6-2 through 6-4. The bar graphs show MSFN AOS/LOS times and recommended spacecraft antenna selections for each MSFN station. The spacecraft antenna recommendations are based on the following criteria and in this order of precedence:

a) Antennas which provide the largest positive circuit margin (carrier power above 70 percent WI voice threshold and 10^{-3} BEP telemetry threshold on S-band downlink and carrier power above 90 percent WI voice threshold on VHF/AM downlink)

b) Antennas which allow minimum spacecraft antenna switching

Computer plots of received carrier power versus elapsed time from lift-off (Figures 6-5 through 6-109) for the three EPO trajectories are furnished for each MSFN station providing S-band or VHF/AM coverage. The plots are presented in the orbital order of MSFN station coverage. A plot is provided for each pair of diametrically opposite CSM S-band omnidirectional antennas (i.e., A and C, B and D) for both uplink and downlink signals for each S-band station. A plot is also provided for the two CSM VHF scimitar antennas for both uplink and downlink signals for each VHF/AM station. The letters L and R are used on the bar graphs and the VHF/AM plots to designate the LEFT and RIGHT VHF antennas. (Section 2 presents a complete description of the computer plots.) The TLI burn times for the 72-, 90-, and 108-degree launch azimuths covered are listed in Table 6-1.

Uplink mode 6 (PRN ranging, voice, and updata) and downlink mode 2 (PRN ranging, voice, and 51.2-kbps telemetry) were used for the S-band computer plots for the EPO phase of the mission.

Table 6-1. Translunar Injection Burn Times

Launch Azimuth (deg)	Opportunity	TLI Ignition		TLI Cutoff	
		Time from Lift-off (hr:min:sec)	Plot Mnemonic	Time from Lift-off (hr:min:sec)	Plot Mnemonic
72	1	02:33:33.19	1TLIIG	02:38:40.08	1TLICO
72	2	04:01:41.7	2TLIIG	04:06:47.02	2TLICO
90	1	02:24:29.0	1TLIIG	02:29:37.5	1TLICO
90	2	03:52:39.77	2TLIIG	03:57:47.05	2TLICO
108	1	02:20:05.9	1TLIIG	02:25:13.27	1TLICO
108	2	03:48:09.17	2TLIIG	03:53:14.8	2TLICO

6.4 S-BAND PERFORMANCE

The S-band received carrier power versus elapsed time from lift-off plots for the three EPO trajectories indicate that the received carrier power can be maintained above the 90 percent WI voice threshold and the 10^{-6} BEP telemetry threshold by selecting the antennas shown in Figures 6-2 through 6-4.

The S-IVB will maintain a local horizontal attitude throughout the earth parking orbit phase except for an inertial hold of approximately 10 seconds immediately after EPO insertion. The local horizontal attitude will maintain the CSM -Z axis pointed downward along the local vertical (heads down); therefore, omni antennas C and D will provide the best communications. Antenna D will provide good communications for all stations for all three EPO trajectories with one exception which will be discussed in the analysis of the 72-degree launch azimuth EPO. Antenna D will also provide good communications after TLI and until shortly before CSM/S-IVB separation during the transposition and docking phase at which time antenna A must be selected. To simplify antenna switching during the EPO phase and transposition and docking maneuvers, it is recommended that (a) antenna D be selected by ground command during EPO; (b) S BAND ANTENNA switches S-40 and S-41 in the CSM be set to OMNI and OMNI A, respectively, prior to TLI; and (c) ground command antenna A at start of CSM/S-IVB separation maneuver (during T and D phase).

6.4.1 72-Degree Launch Azimuth

S-band communication coverage for the 72-degree launch azimuth EPO is provided by all USB stations except MAD and GWM. Above threshold signal levels can be maintained at all stations for the entire 72-degree launch azimuth EPO by selecting antenna D with the exception of the first pass over HTV at approximately 1 hour 9 minutes during which time antenna C should be used. Switching from antenna D to C should occur after loss of signal at HSK and prior to acquisition of signal at HTV.

Antenna D should be reselected prior to acquisition of signal at GYM and used for the remainder of the EPO phase and until CSM/S-IVB separation during the transposition and docking phase. Ground command for antenna D selection should be sent prior to TLI to allow the CSM S BAND ANTENNA switches to be set for the previously recommended automatic selection of antenna A at the start of the CSM/S-IVB separation maneuver (during T and D).

The coverage for the major part of S-IVB preignition sequence for the first opportunity TLI will be provided by CRO. MER will provide coverage for TLI ignition and a portion of the burn time. The remaining burn time and TLI cutoff will be covered by RED. Antenna D will provide good communications at each of these stations.

CRO will provide coverage for the final 2 minutes of the S-IVB preignition sequence for the second opportunity TLI ignition and most of the burn time. Limited coverage during the burn can also be provided by MER; however, the antenna elevation at MER will be below 5 degrees during the entire pass. The second opportunity TLI cutoff may not be adequately covered since 0-degree acquisition of signal at RED will not occur until approximately the same time as TLI cutoff.

Keyholes of less than 1 minute duration will limit coverage at CRO at approximately 55 minutes and at GBM at approximately 1 hour 39 minutes. A short duration keyhole will also be experienced at HAW at 2 hours 52 minutes if TLI does not occur on the first opportunity. Coverage will be limited by terrain obstruction at GDS on the first pass over the U.S.; however, GYM will provide the initial coverage over the U.S.

6.4.2 90-Degree Launch Azimuth

The 90-degree launch azimuth EPO will be covered by all stations except CYI, HTV, HSK, and MAD. The received carrier power can be maintained above the 90 percent WI voice threshold and the 10^{-6} BEP telemetry threshold during the entire 90-degree launch azimuth EPO phase by selecting antenna D.

No USB station will provide coverage for the first opportunity TLI ignition and during the S-IVB preignition sequence.* CRO will have 0-degree acquisition of signal approximately 50 seconds after TLI ignition and will provide coverage for the remainder of the burn including TLI cutoff. Coverage at CRO, however, will be subject to antenna keyhole limitations. Postburn coverage will be provided by RED. No USB station will provide coverage for the second opportunity TLI burn.*

A keyhole will occur at HAW at approximately 1 hour 19 minutes. If TLI does not occur on the first opportunity and a third revolution is required, keyholes will occur at MIL (approximately 3 hours 11 minutes), GBM (approximately 3 hours 13 minutes), ANG (approximately 3 hours 18 minutes), and ACN (approximately 3 hours 31 minutes).

6.4.3 108-Degree Launch Azimuth

S-band coverage for the 108-degree launch azimuth EPO is provided by MIL, GBM, BDA, ANG, ACN, CRO, GWM, HAW, GDS, GYM, and TEX. Selection of antenna D will provide received carrier levels above the 90 percent WI voice threshold and 10^{-6} BEP telemetry threshold for the entire 108-degree launch azimuth EPO.

The first opportunity TLI and S-IVB preignition sequence will not be covered by any MSFN ground station.* The last USB station to provide above 5-degree elevation coverage prior to the first opportunity TLI will be ANG, which will acquire at approximately 1 hour 41 minutes. ANG will experience coverage limitations caused by antenna keyhole at approximately 1 hour 44 minutes. ACN will acquire at approximately 1 hour 56 minutes 30 seconds and will remain below 5-degree elevation for the entire pass. There will be no S-band coverage by MSFN ground stations for the second opportunity TLI.* The last USB station to provide coverage prior to the second opportunity TLI will be TEX at approximately 3 hours 5 minutes. The maximum antenna elevation at TEX will be approximately 4.9 degrees, and coverage will be limited by terrain obstruction from 3 hours 8 minutes to LOS. (TAN will provide VHF/AM voice coverage during TLI ignition.)*

*ARIA are expected to provide TLI support.

Coverage will be limited by antenna keyhole at CRO (approximately 56 minutes), HAW (approximately 1 hour 20 minutes), MIL (approximately 1 hour 39 minutes), and GBM (approximately 1 hour 37 minutes). If TLI does not occur on the first opportunity, the communication coverage for the third revolution pass over HAW will be limited by keyhole and terrain obstruction.

6.5 VHF/AM PERFORMANCE

VHF antenna selections and AOS/LOS times for each MSFN station covering earth parking orbits for 72-, 90-, and 108-degree launch azimuths are shown in Figures 6-2 and 6-3.

The LEFT CSM VHF antenna (L) is recommended for each VHF/AM station covering the three EPO trajectories. The LEFT VHF antenna will drop momentarily to the 90 percent WI voice threshold over VAN at approximately 1 hour 45 minutes on the 72-degree launch azimuth EPO. The LEFT VHF antenna will momentarily drop slightly below the 90 percent WI voice threshold over MER (56 minutes), CRO (2 hours 27 minutes), and RED (2 hours 37 minutes) on the 90-degree launch azimuth EPO. The LEFT antenna will momentarily drop slightly below the voice threshold over CRO at approximately 54 minutes on the 108-degree launch azimuth EPO. The LEFT antenna, however, will provide the best overall coverage for the stations mentioned above.

VHF/AM communications system coverage for the first and second opportunity TLI burns will be provided by the same stations that provide S-band communication system coverage with additional VHF/AM coverage support provided by TAN. The VHF/AM communication system will usually provide adequate voice communication during the times when the S-band coverage is limited by low elevation. The initial voice contact at AOS will usually be through the VHF/AM system at low elevation angles. After S-band acquisition, the system providing the best voice communication performance will be used as the primary voice communication system. It is recommended that the VHF/AM system be primary on all station passes when below 5-degree elevation.

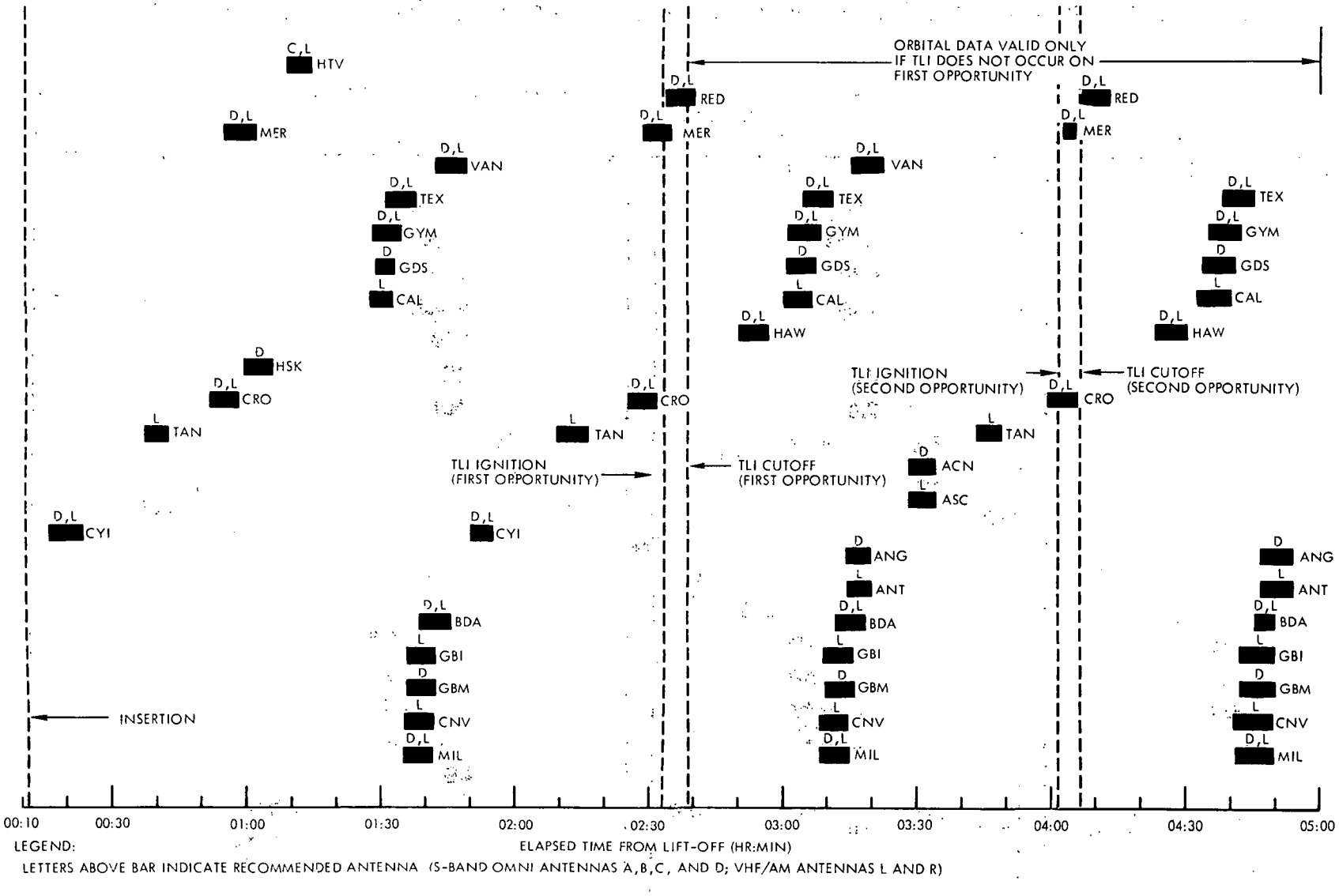


Figure 6-2. RF Coverage Summary for Earth Parking Orbit (72-Degree Launch Azimuth)

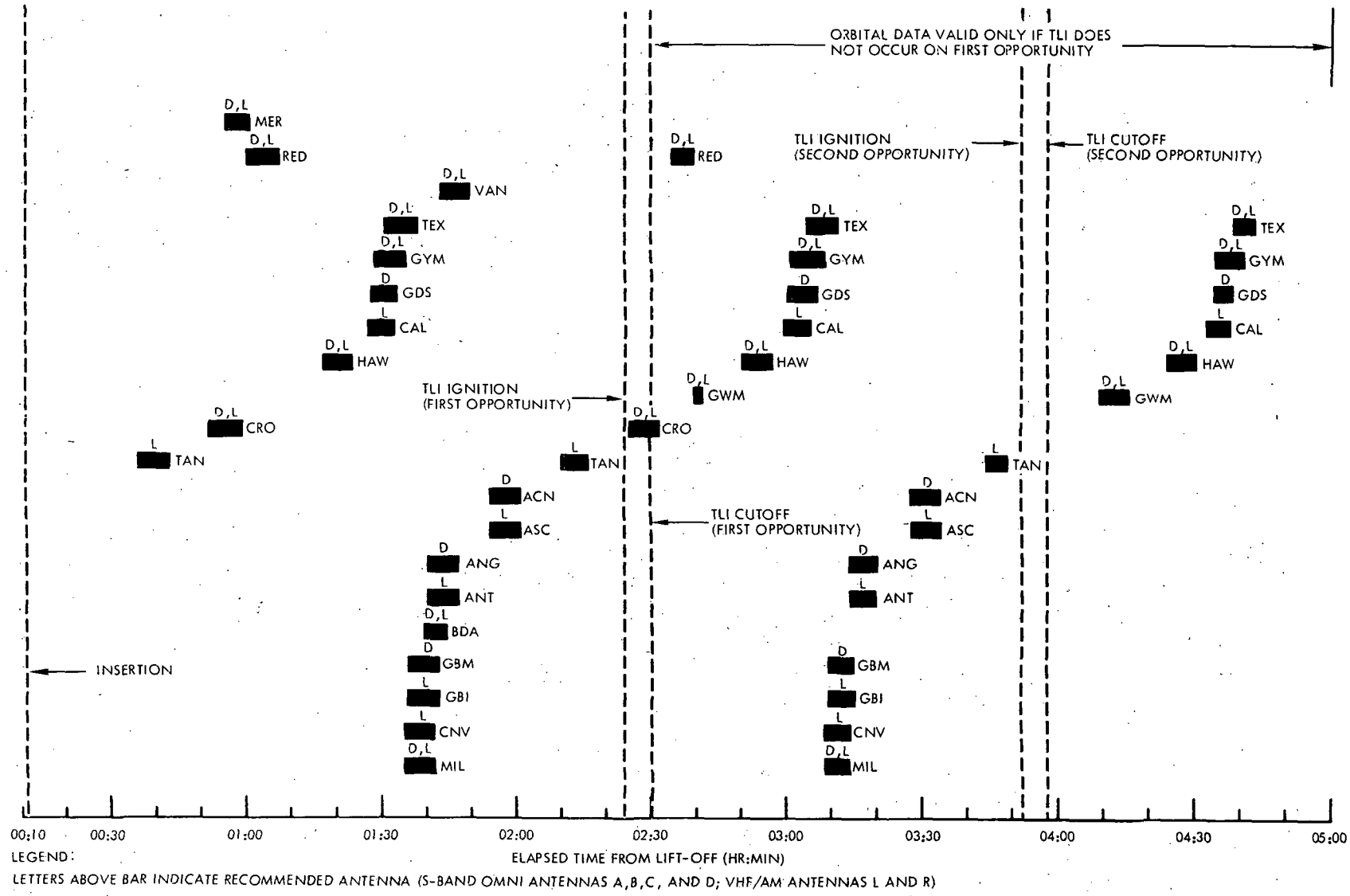


Figure 6-3. RF Coverage Summary for Earth Parking Orbit (90-Degree Launch Azimuth)

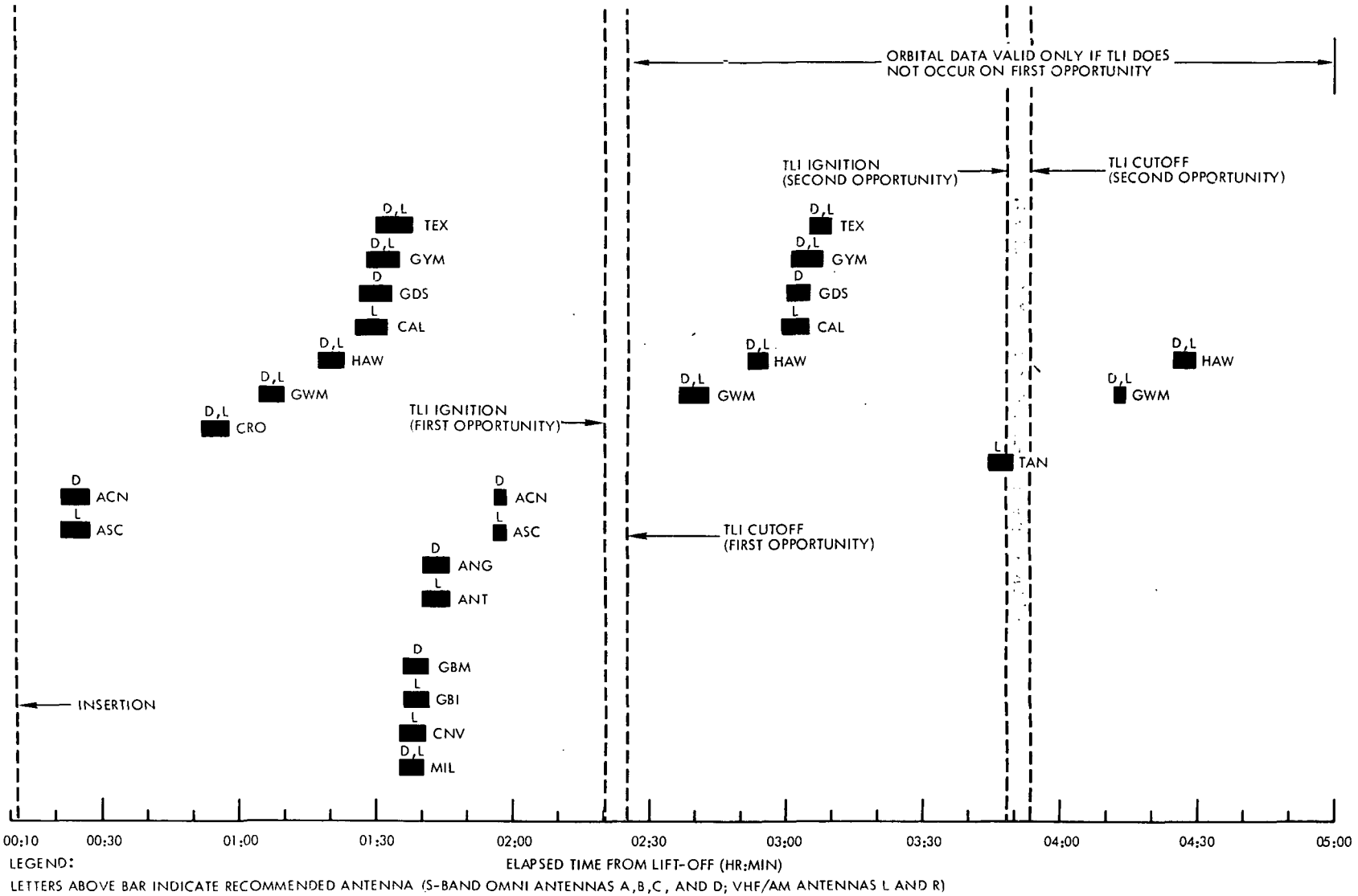


Figure 6-4. RF Coverage Summary for Earth Parking Orbit (108-Degree Launch Azimuth)

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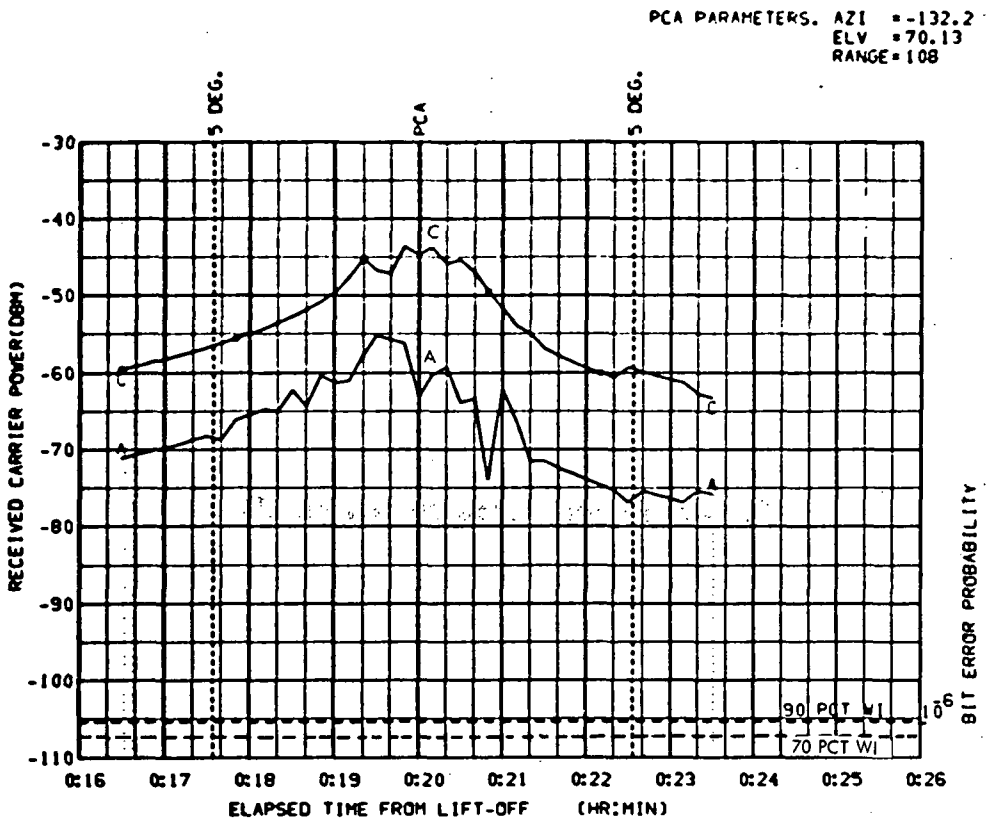

FIGURE 6-5a. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

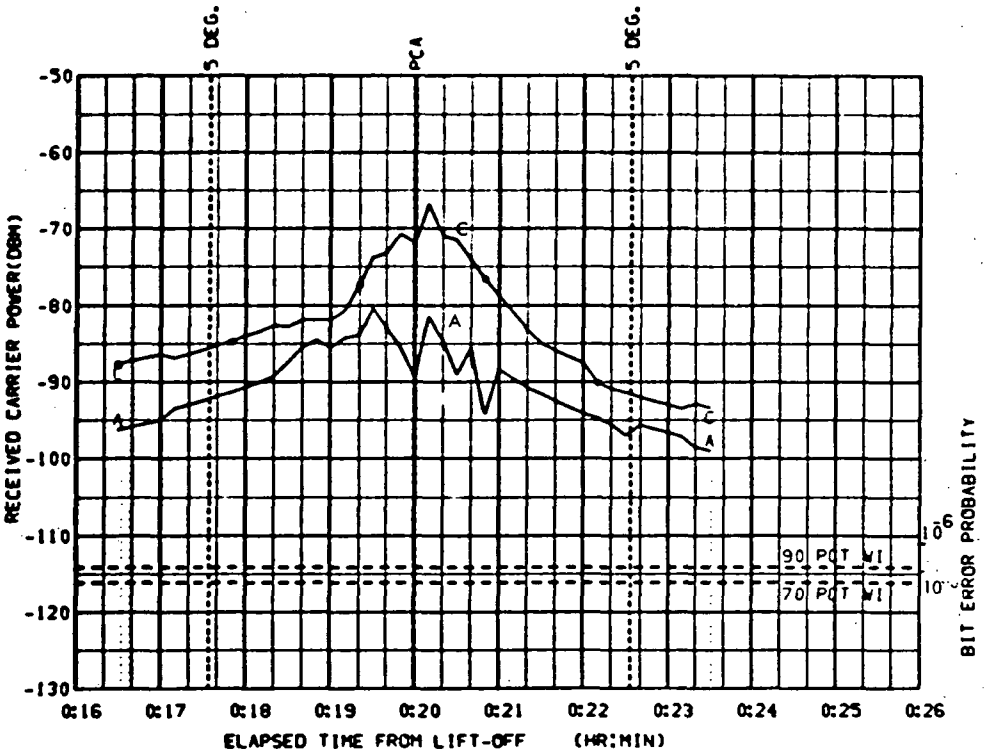

FIGURE 6-5b. CYI DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

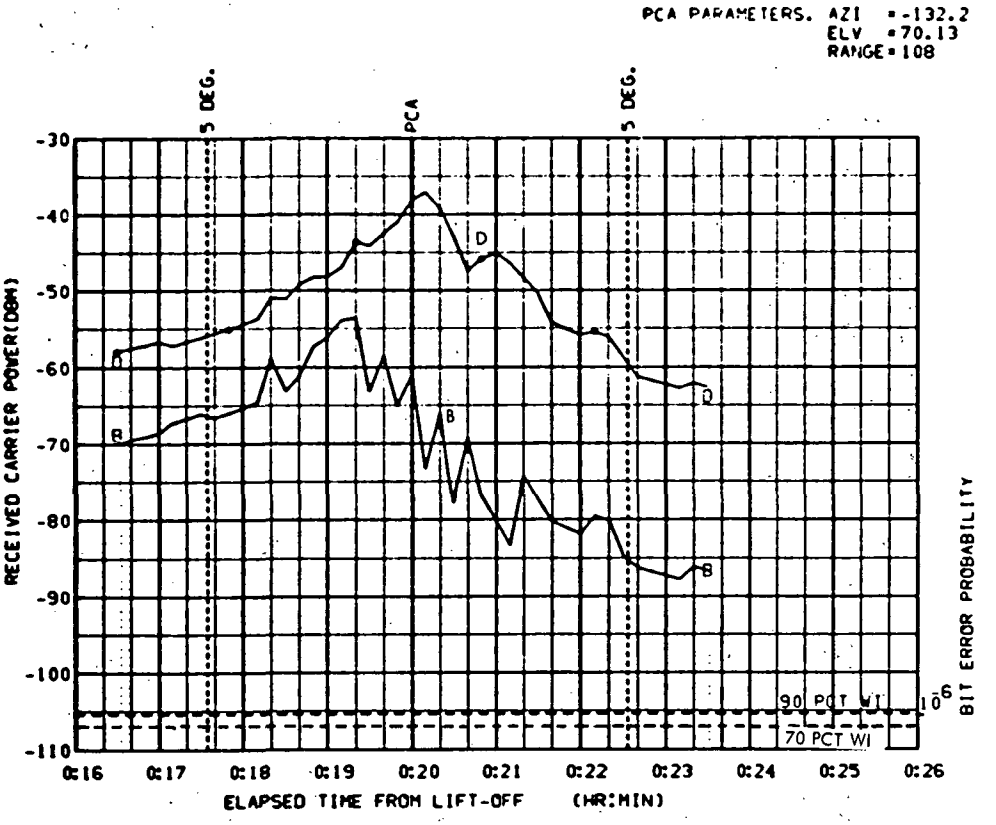

FIGURE 6-5c. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

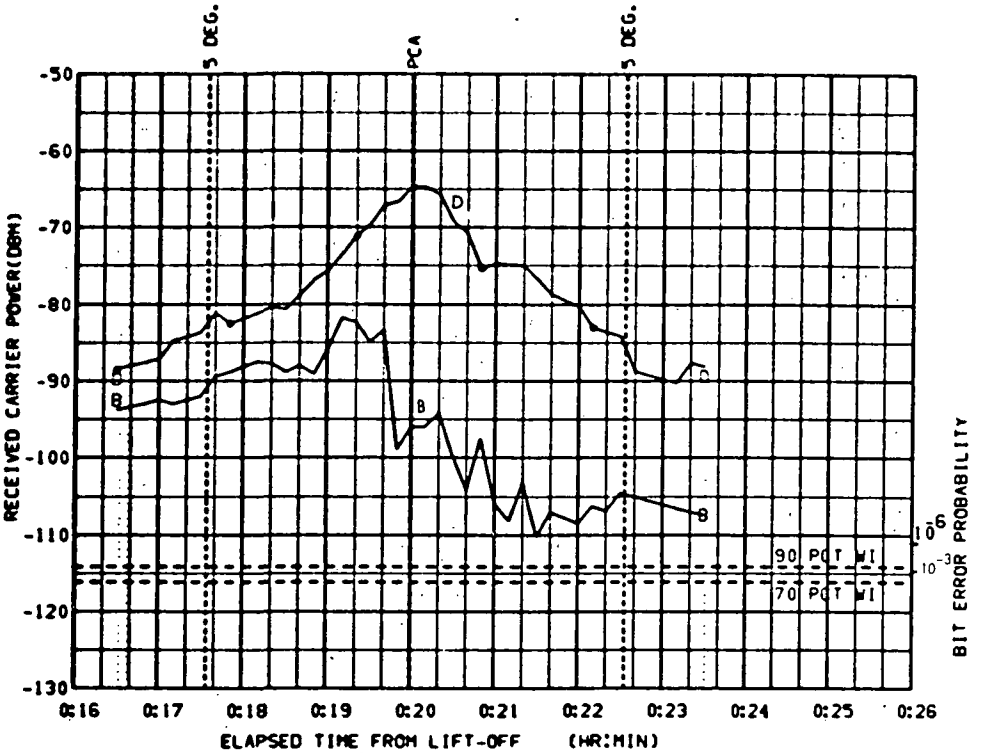

FIGURE 6-5d. CYI DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

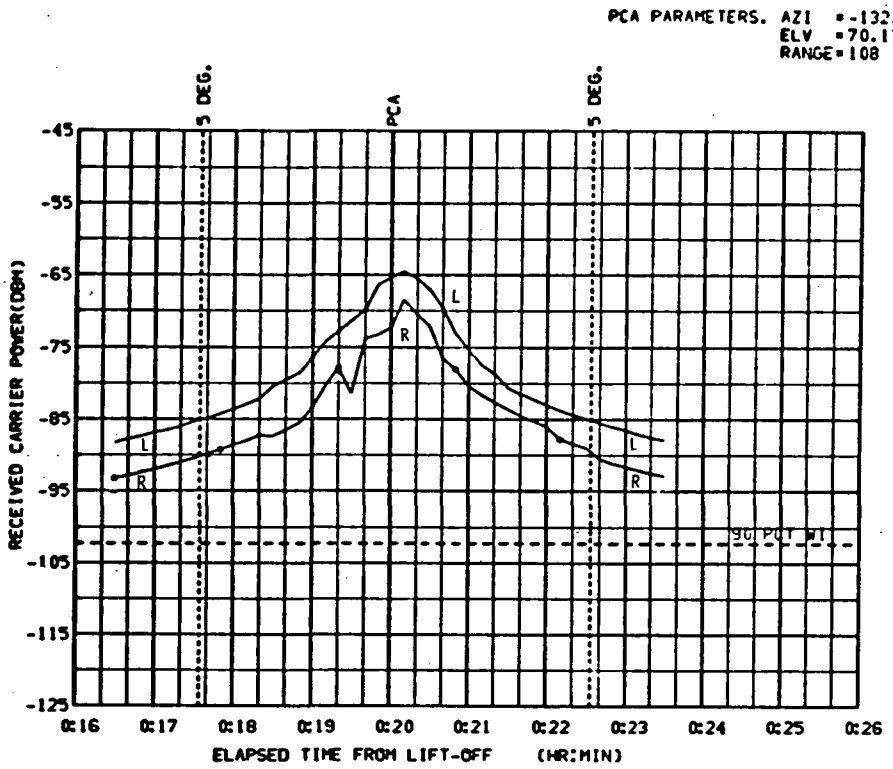

FIGURE 6-5e. CYI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

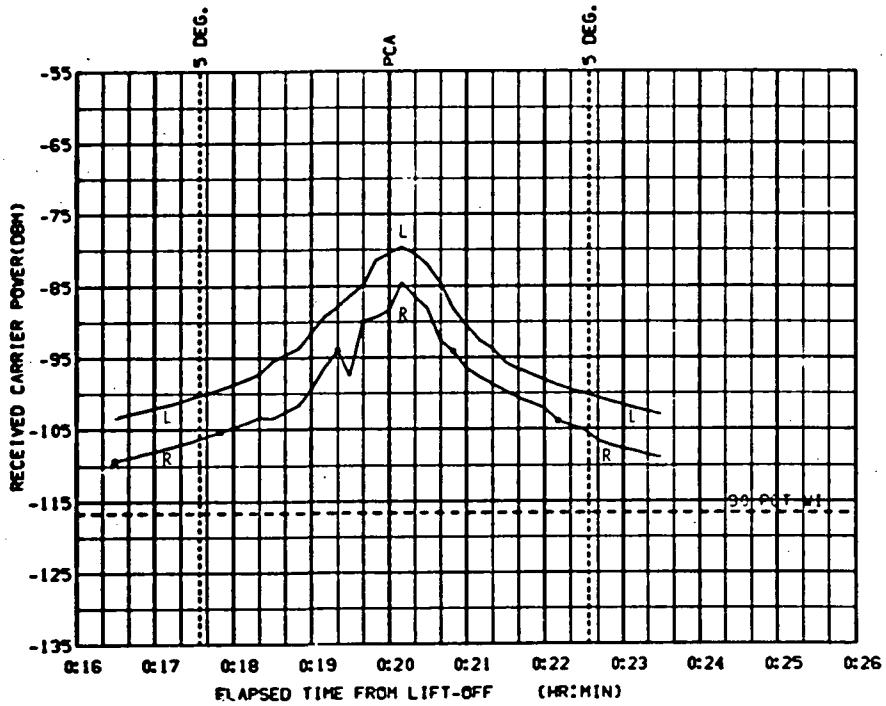

FIGURE 6-5f. CYI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

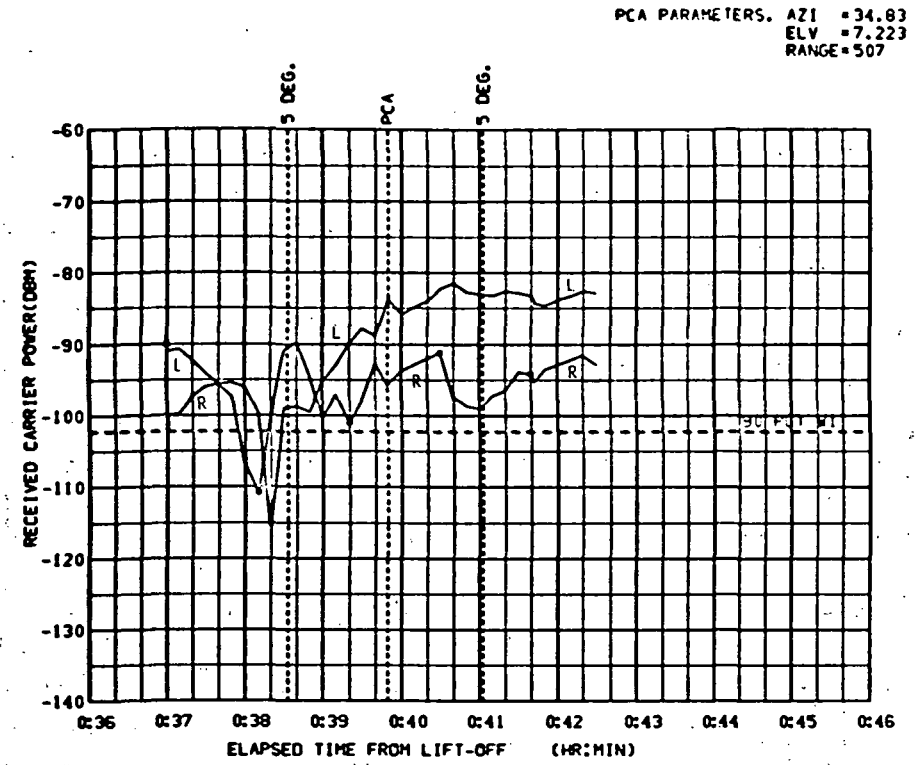

FIGURE 6-6a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

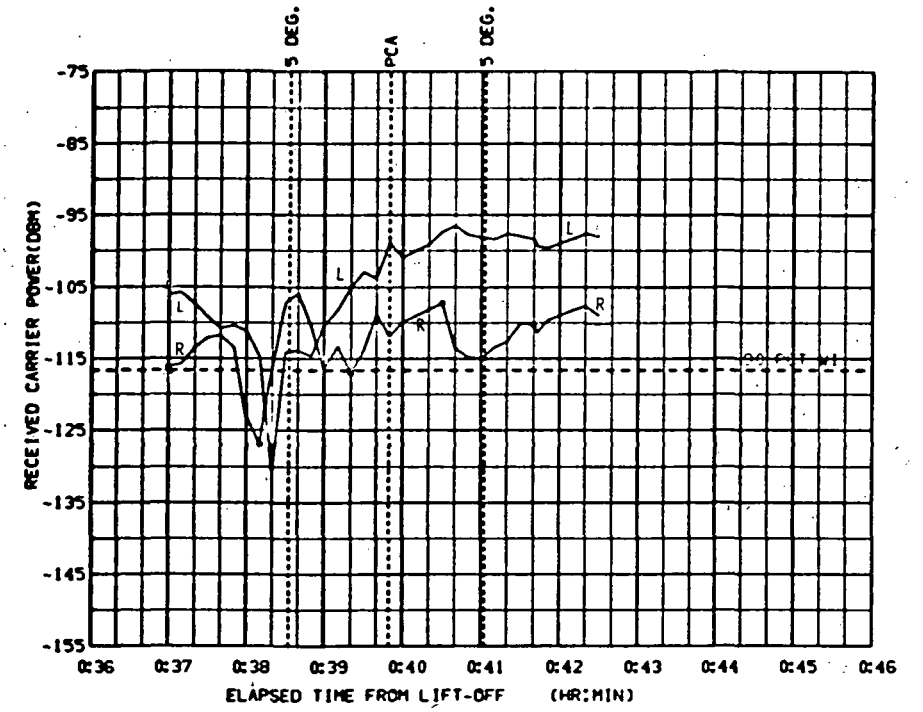

FIGURE 6-6b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

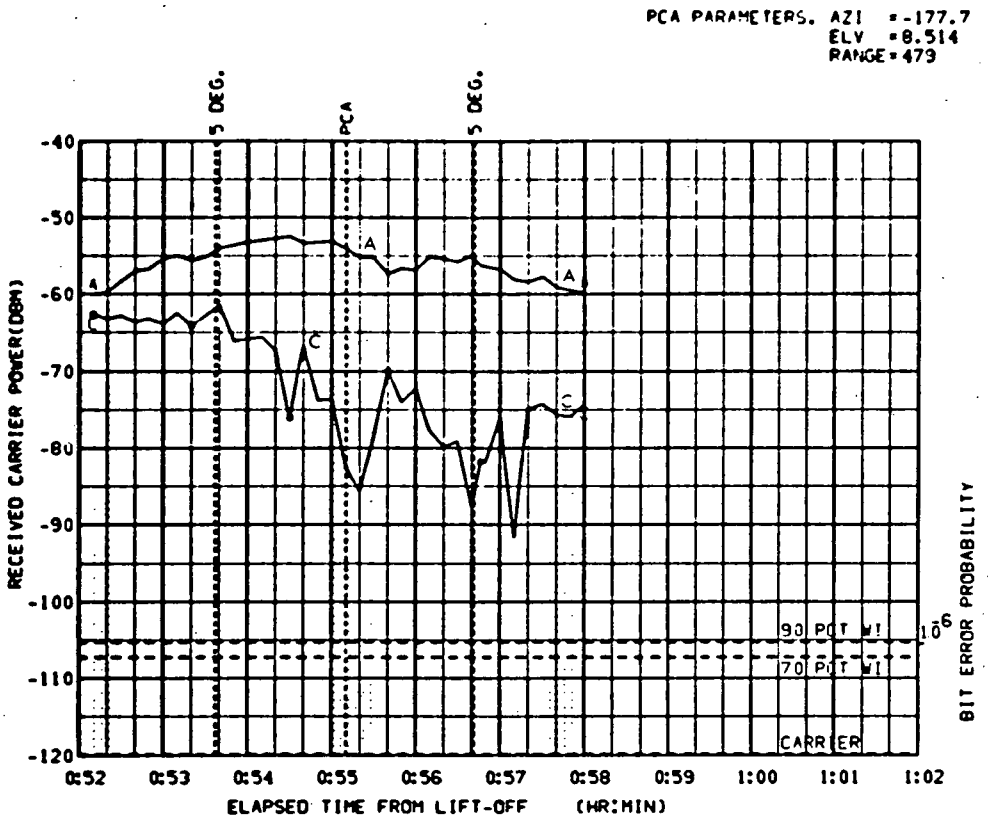

FIGURE 6-7a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

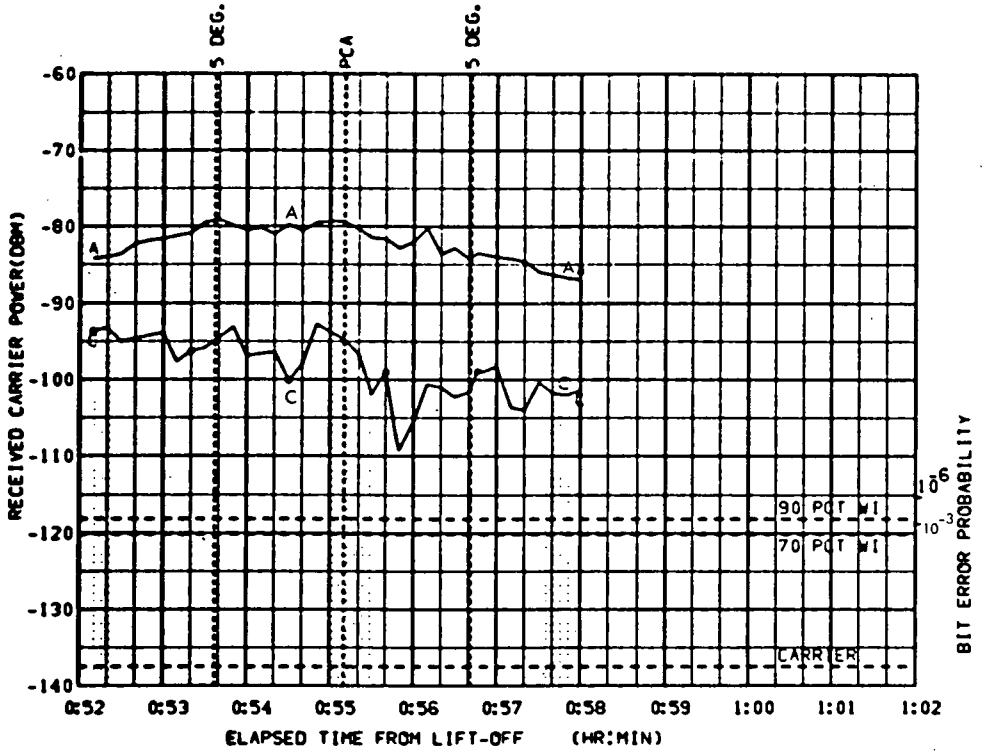

FIGURE 6-7b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

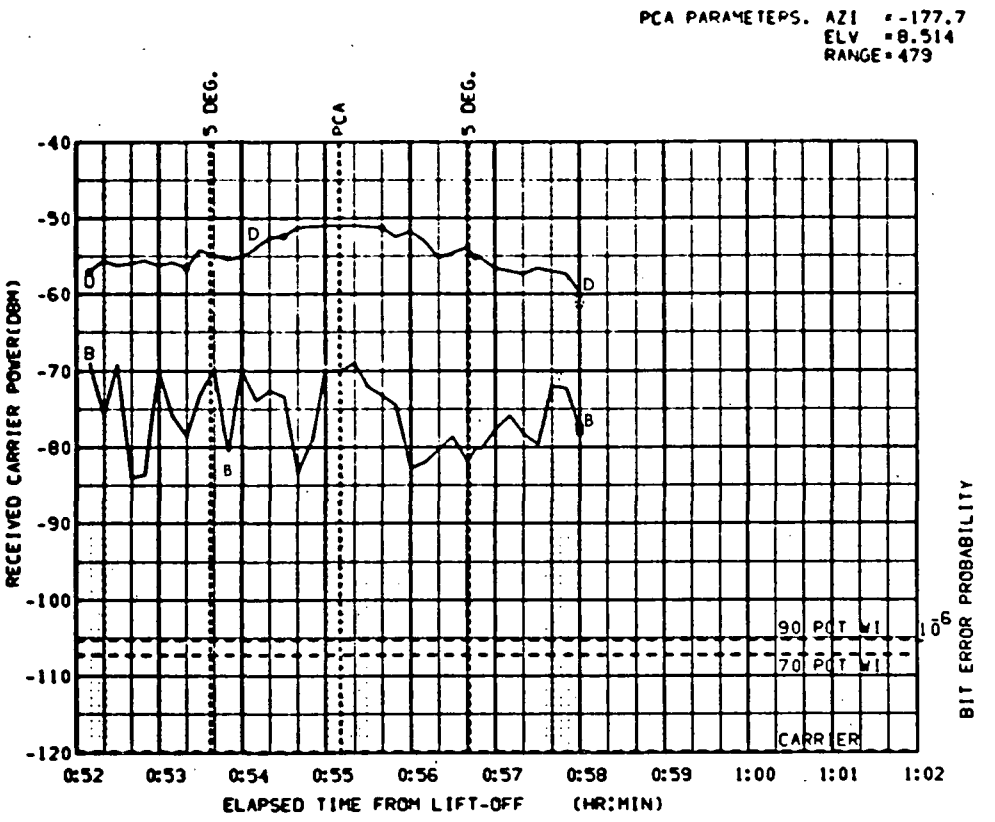

FIGURE 6-7c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

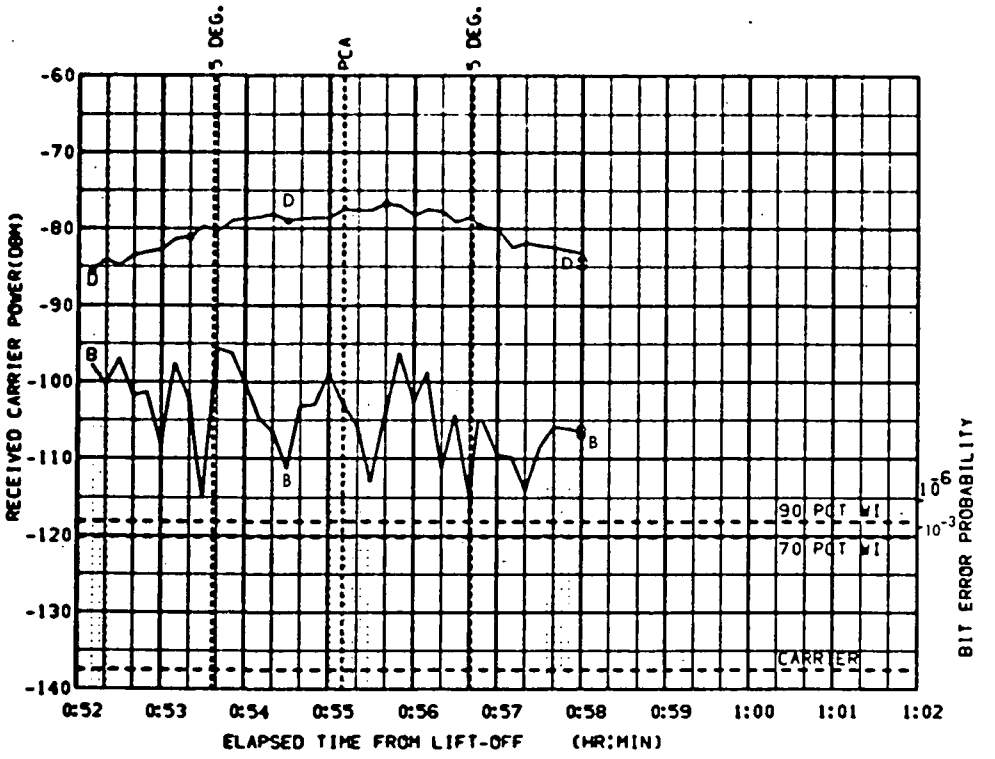

FIGURE 6-7d. CRO ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

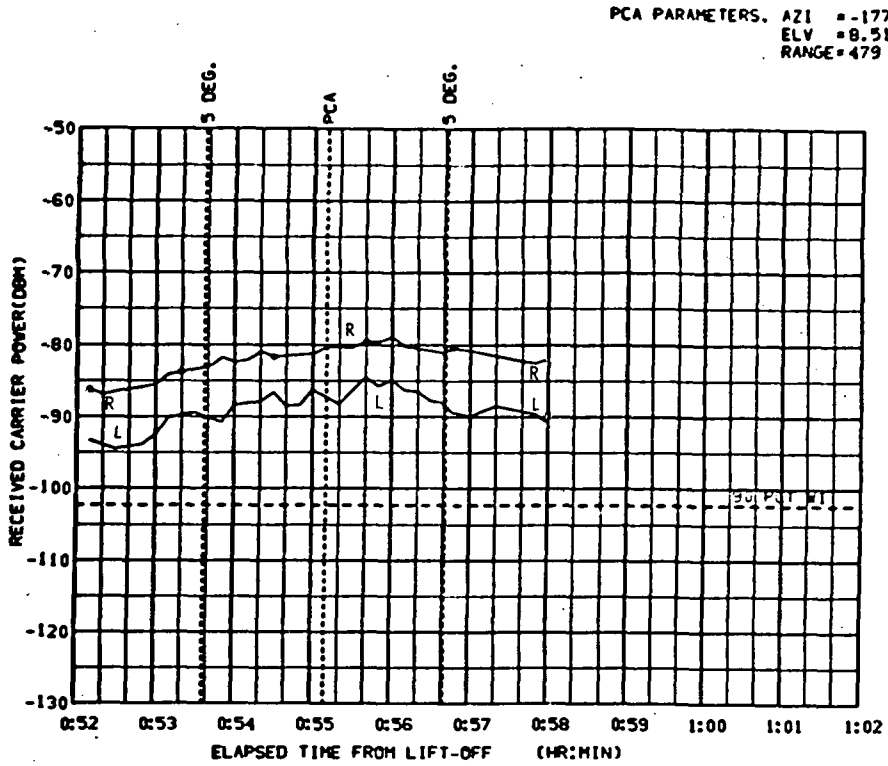

FIGURE 6-7e. CRO UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

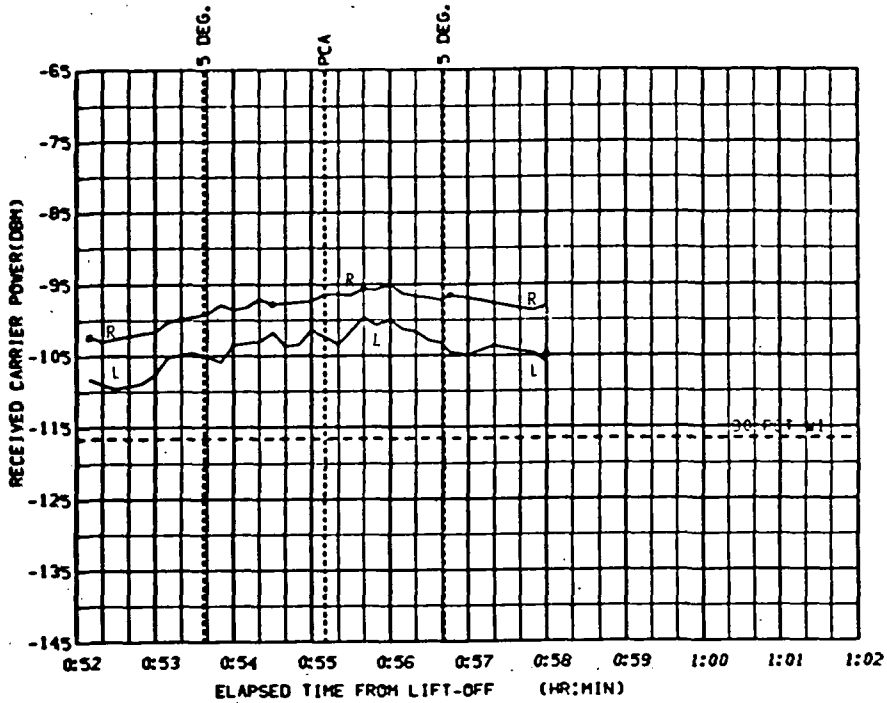

FIGURE 6-7f. CRO DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

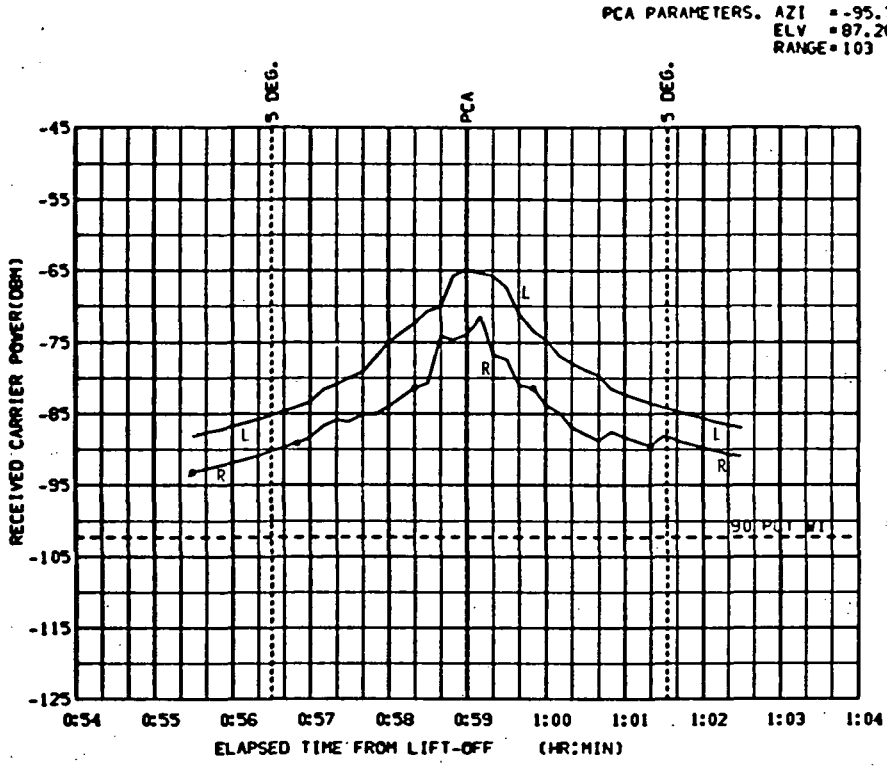

FIGURE 6-8a. MER UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

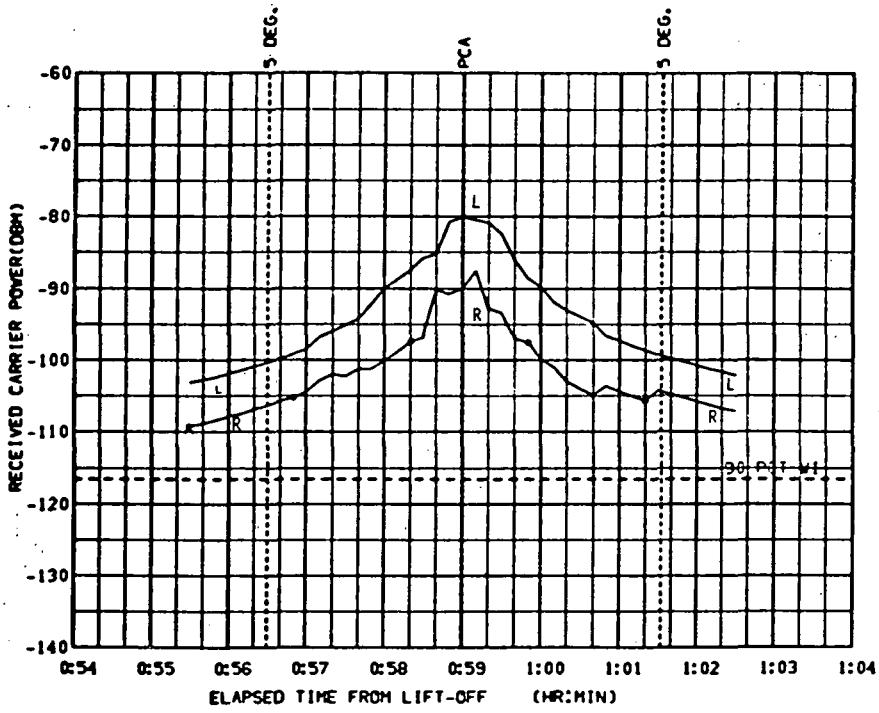

FIGURE 6-8b. MER DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

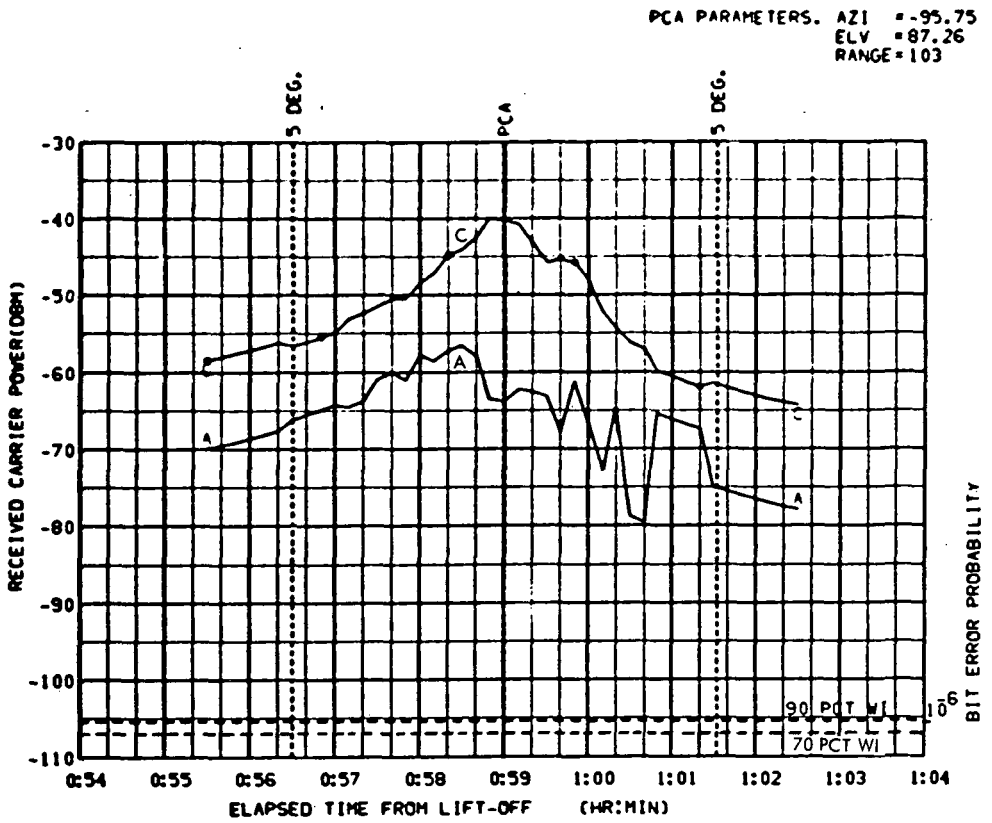

FIGURE 6-8c. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

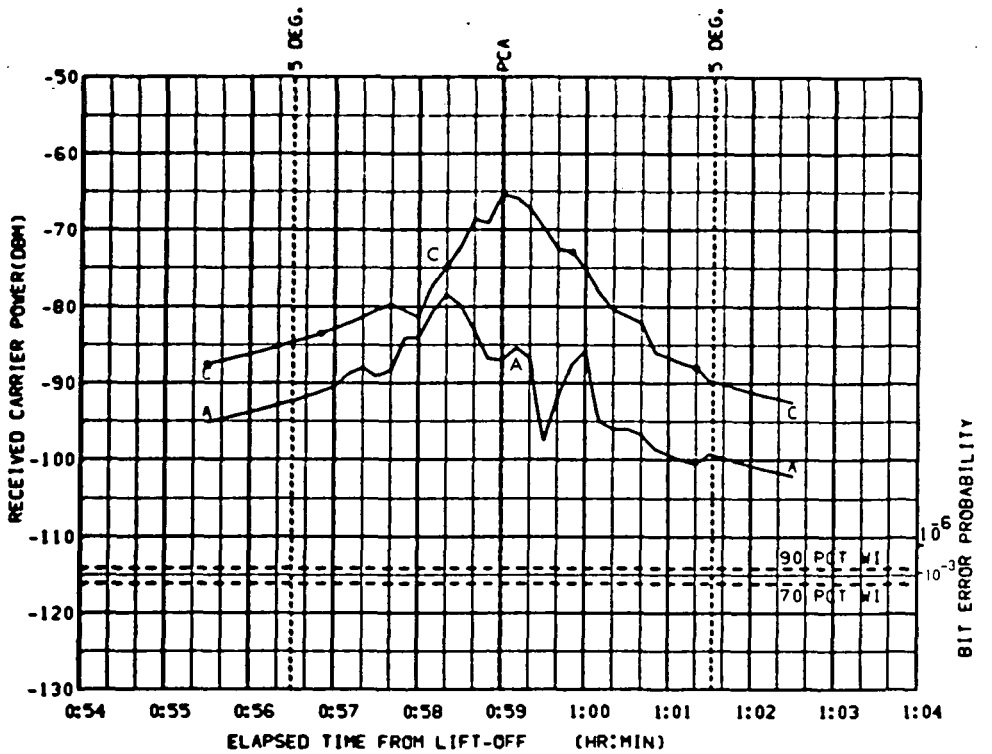

FIGURE 6-8d. MER ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

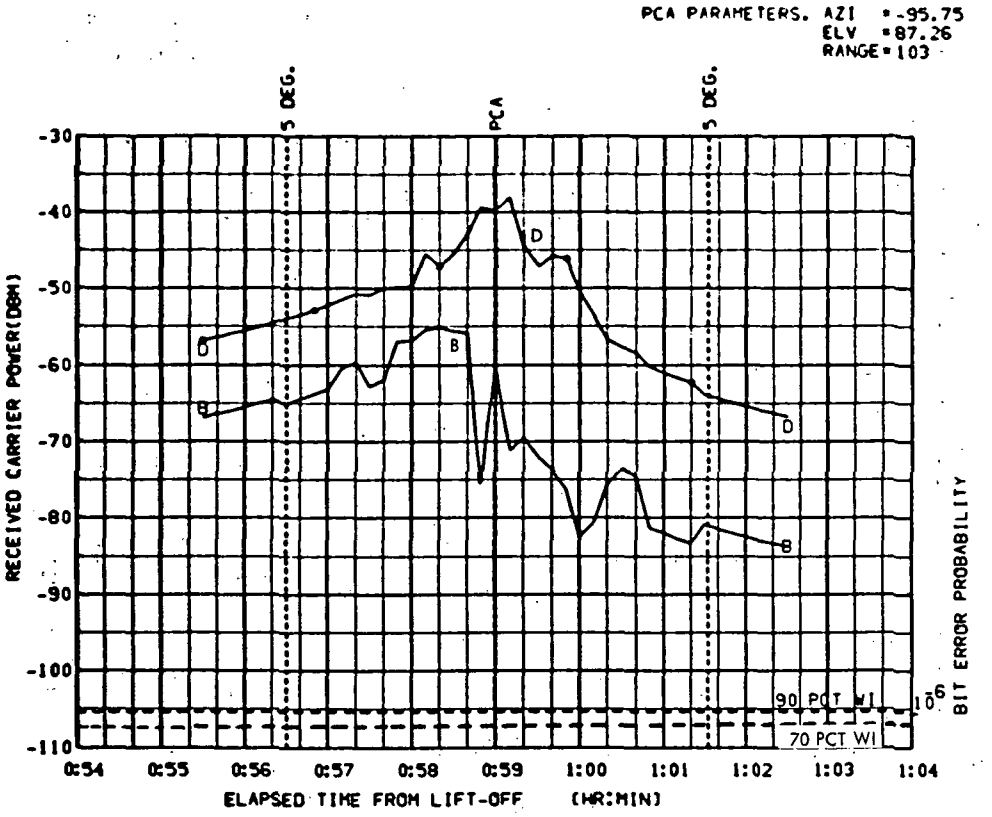

FIGURE 6-8e. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

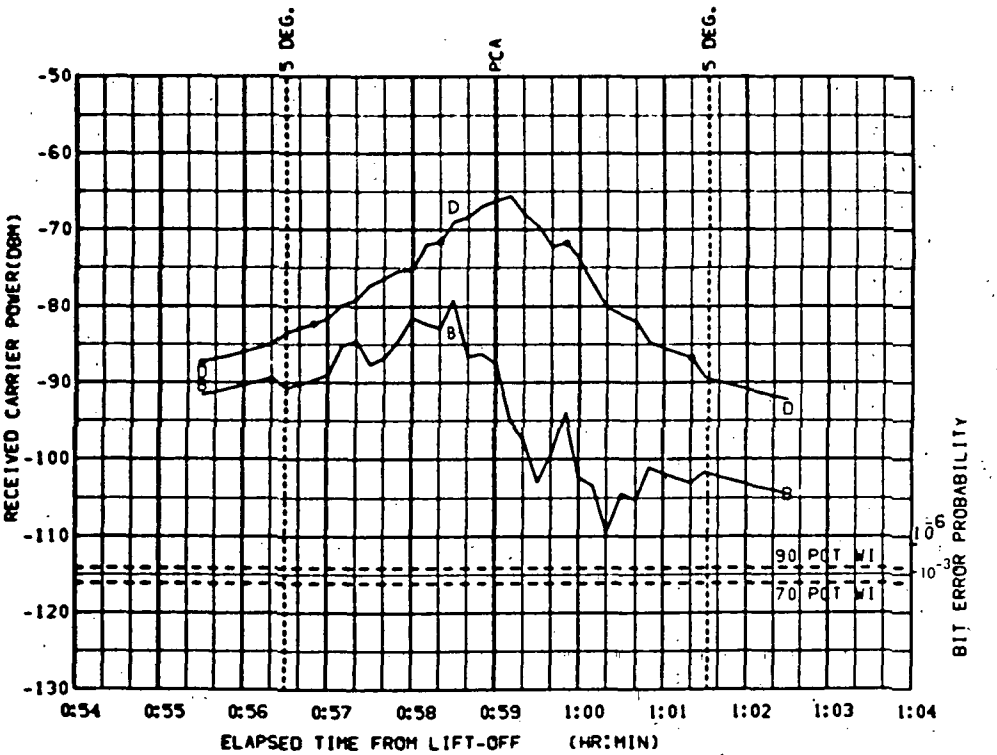

FIGURE 6-8f. MER DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

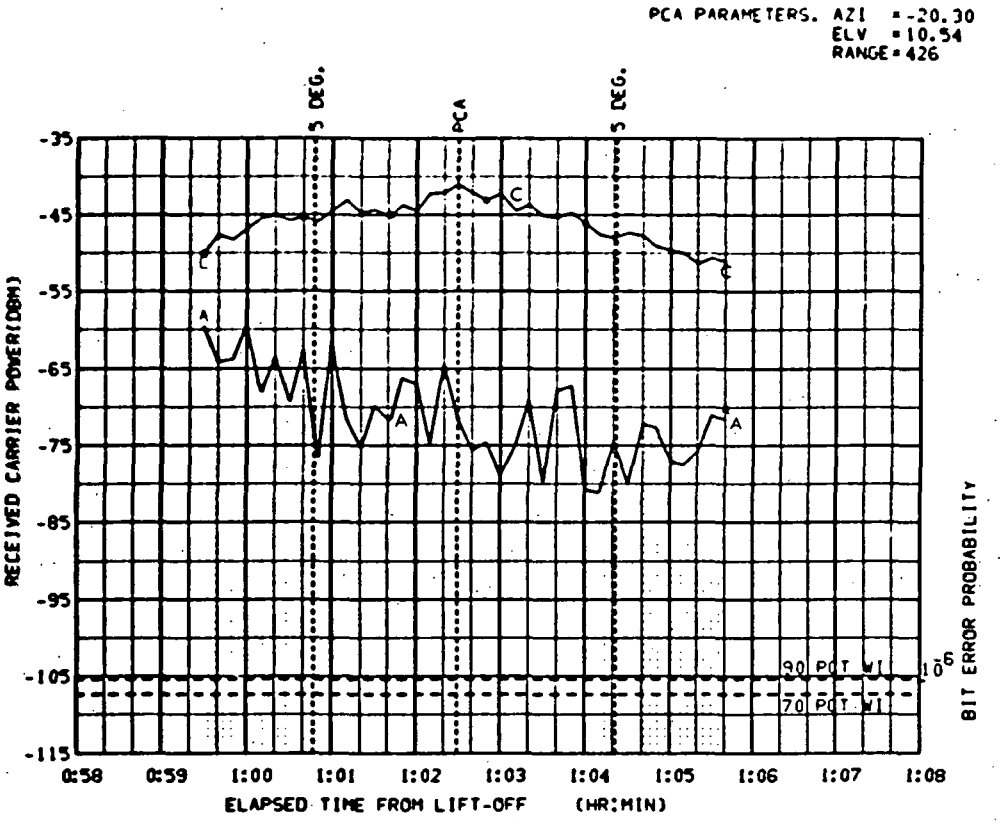

FIGURE 6-9a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

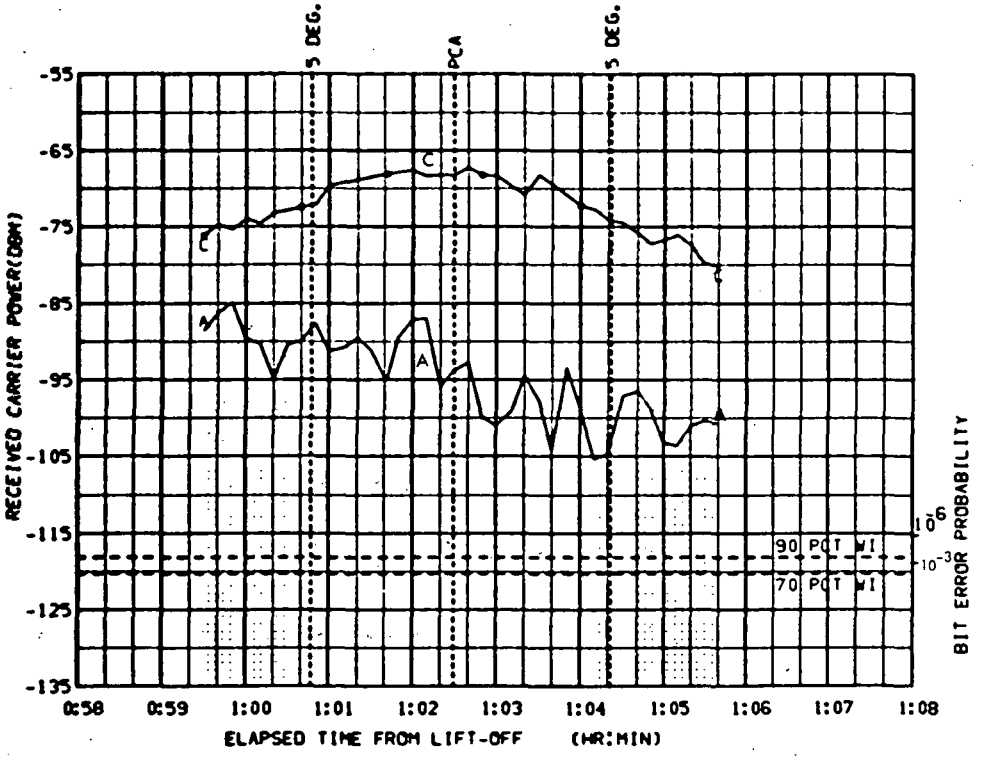

FIGURE 6-9b. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

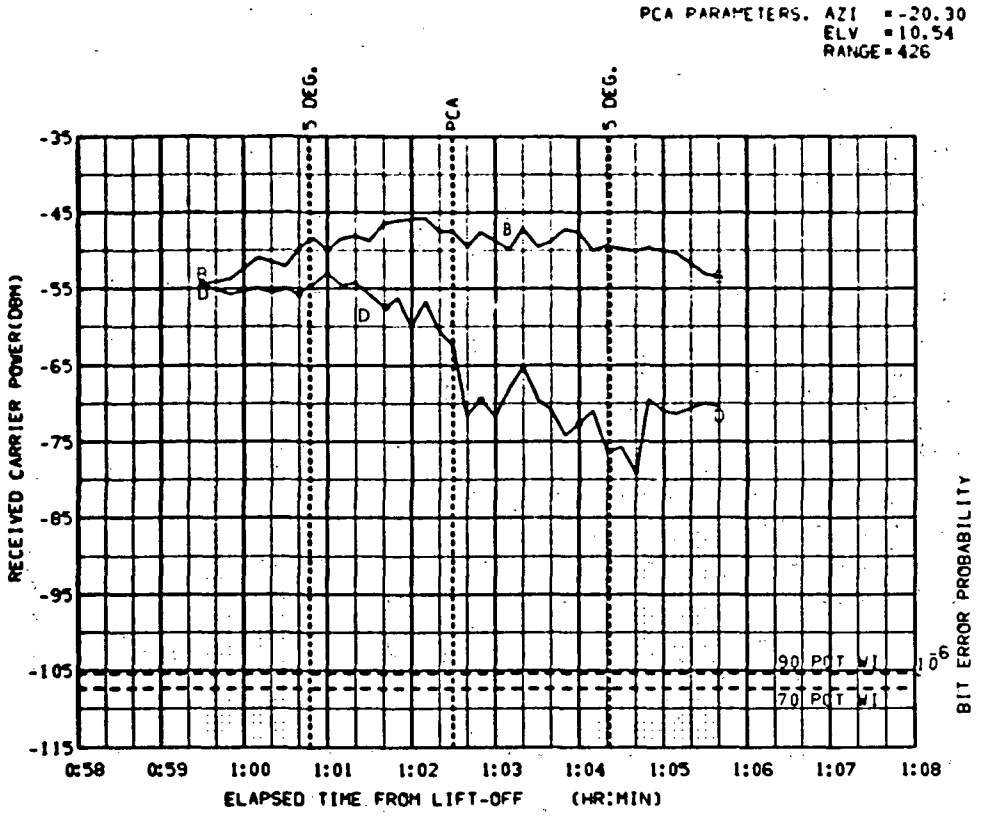

FIGURE 6-9c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

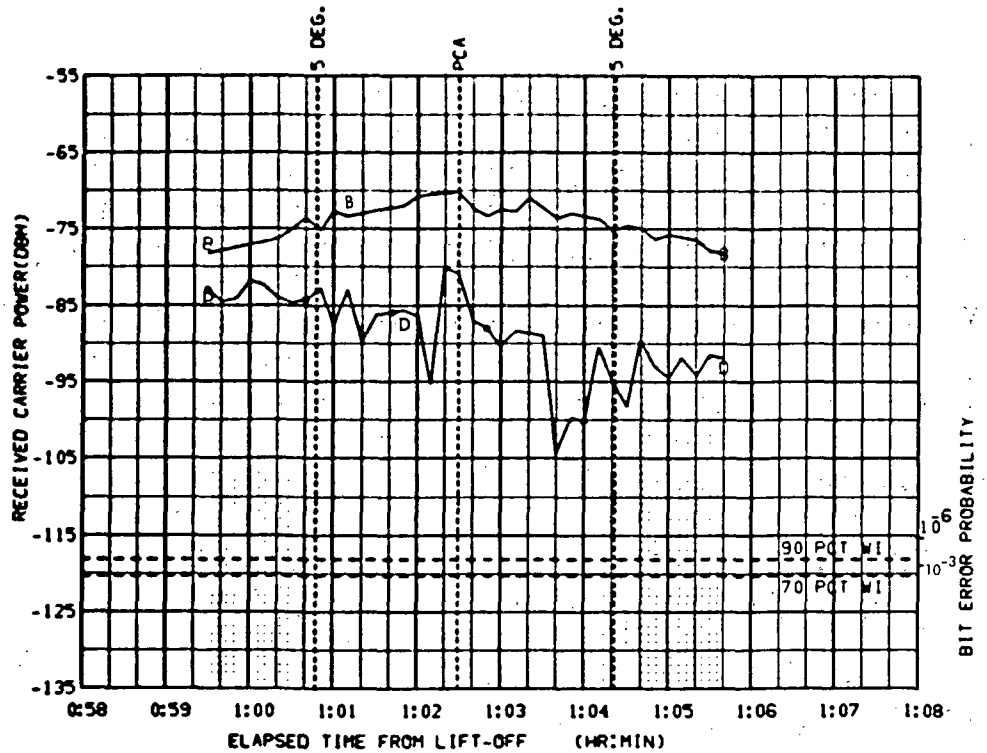

FIGURE 6-9d. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

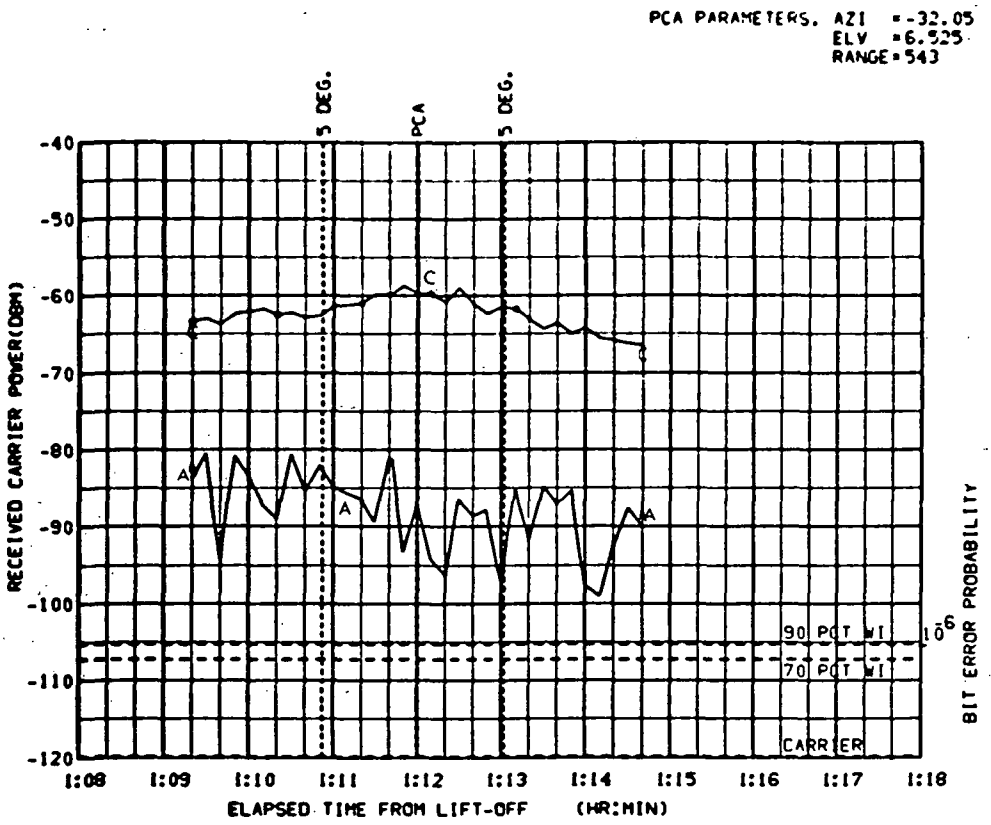

FIGURE 6-10a. MTV UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

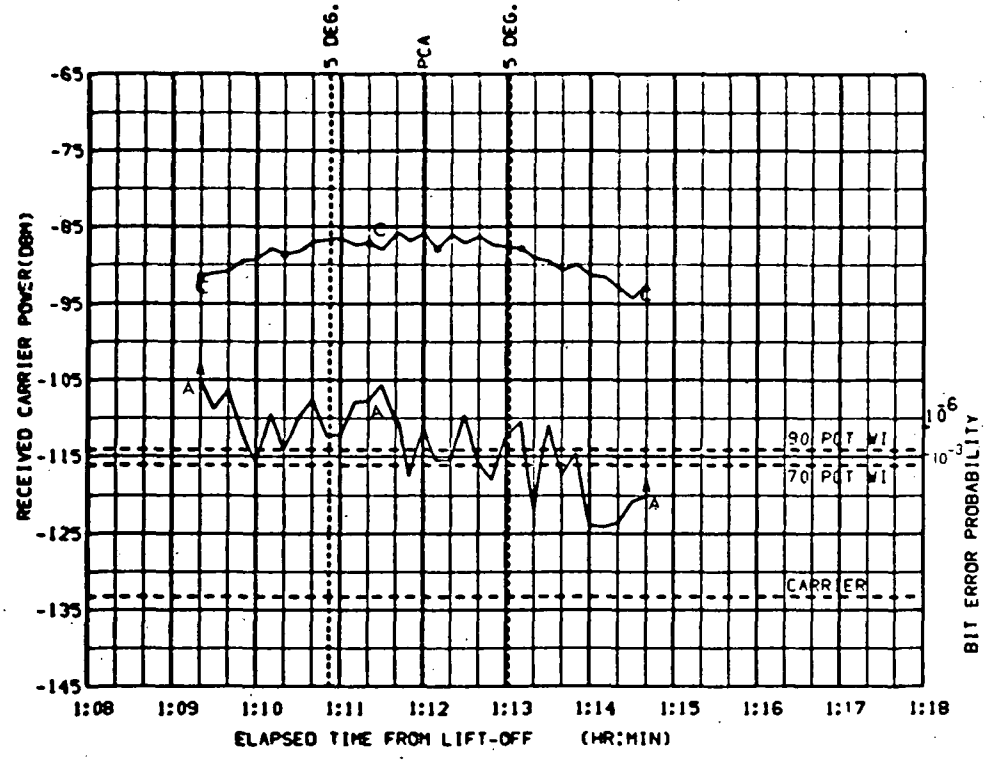

FIGURE 6-10b. MTV DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

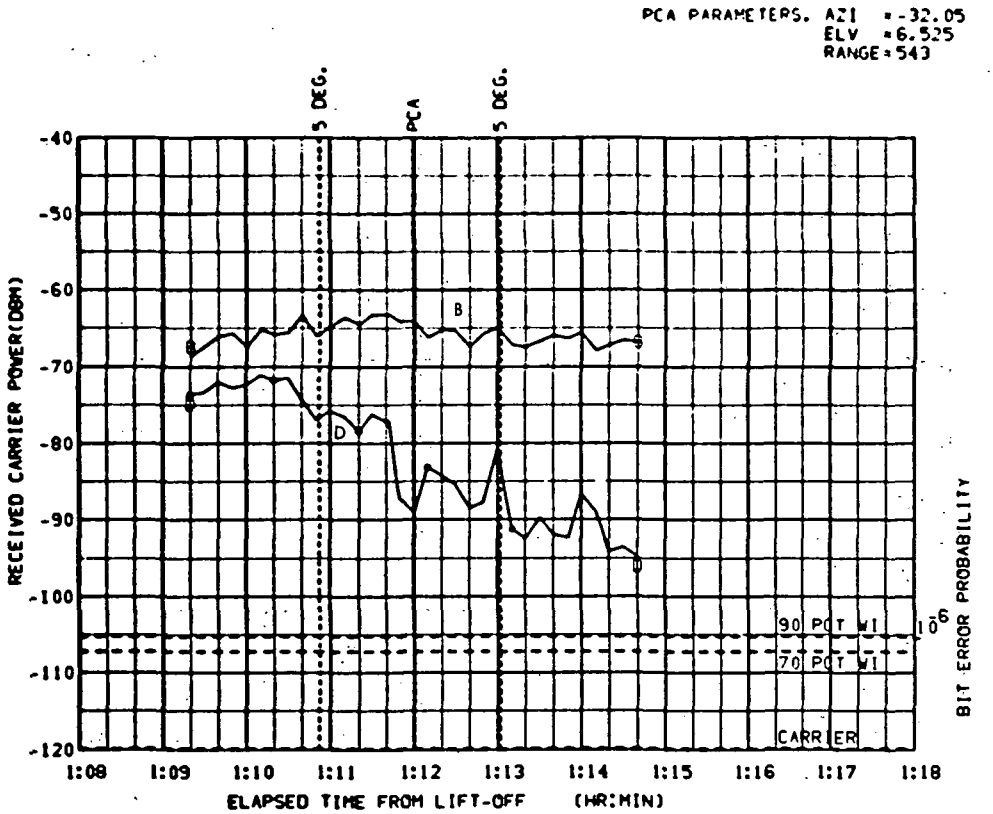

FIGURE 6-10c. HTV UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

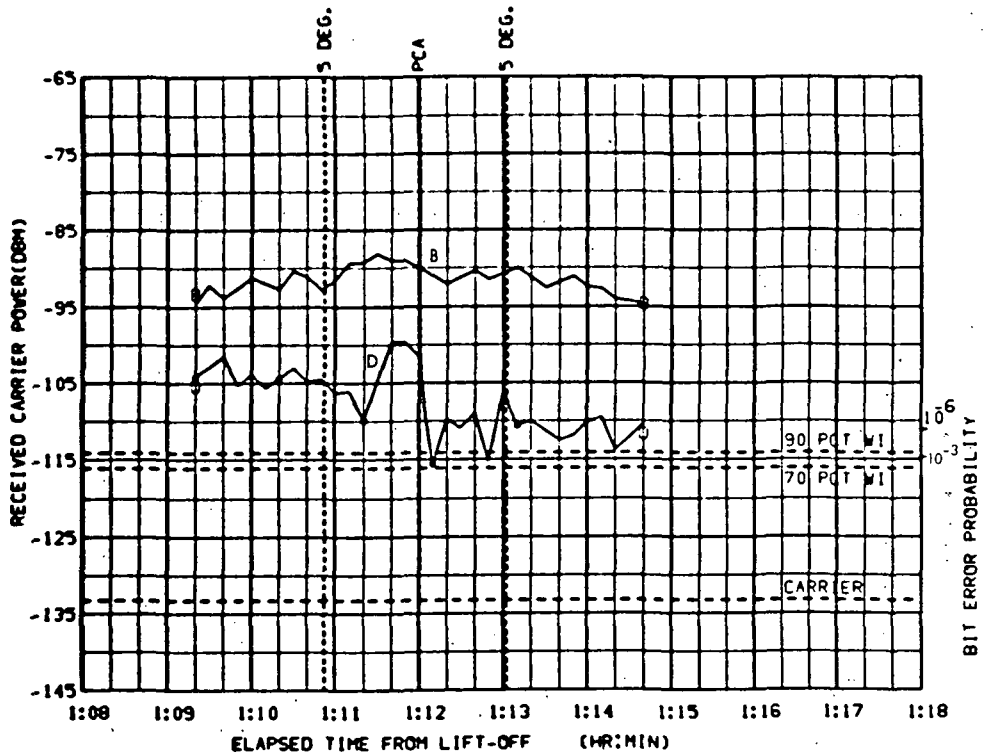

FIGURE 6-10d. HTV ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

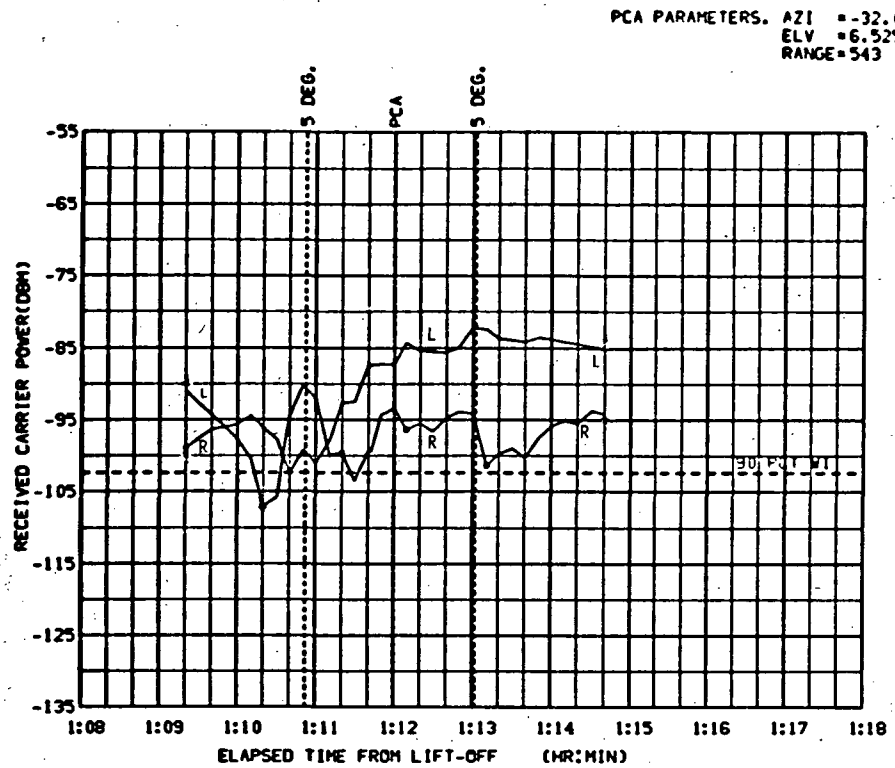

FIGURE 6-10e. HTV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

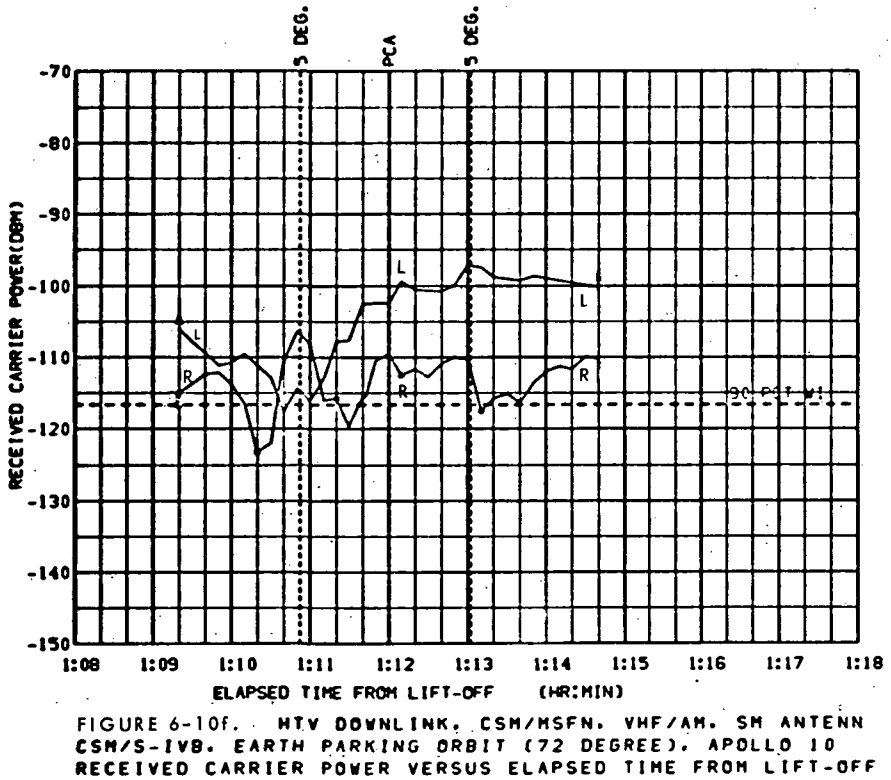

FIGURE 6-10f. HTV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =154.8
ELV =3.406
RANGE=677

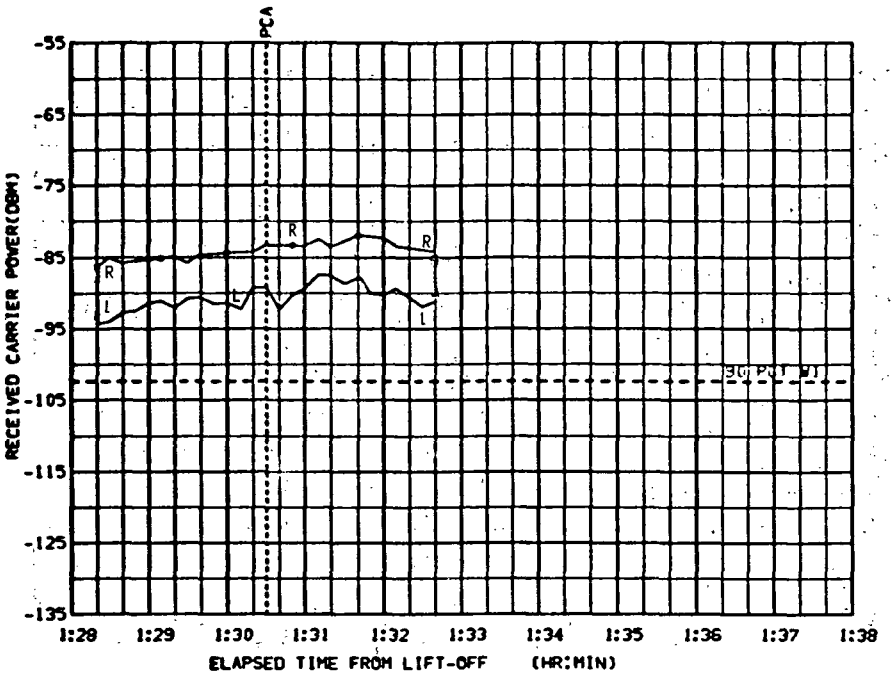

FIGURE 6-11a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

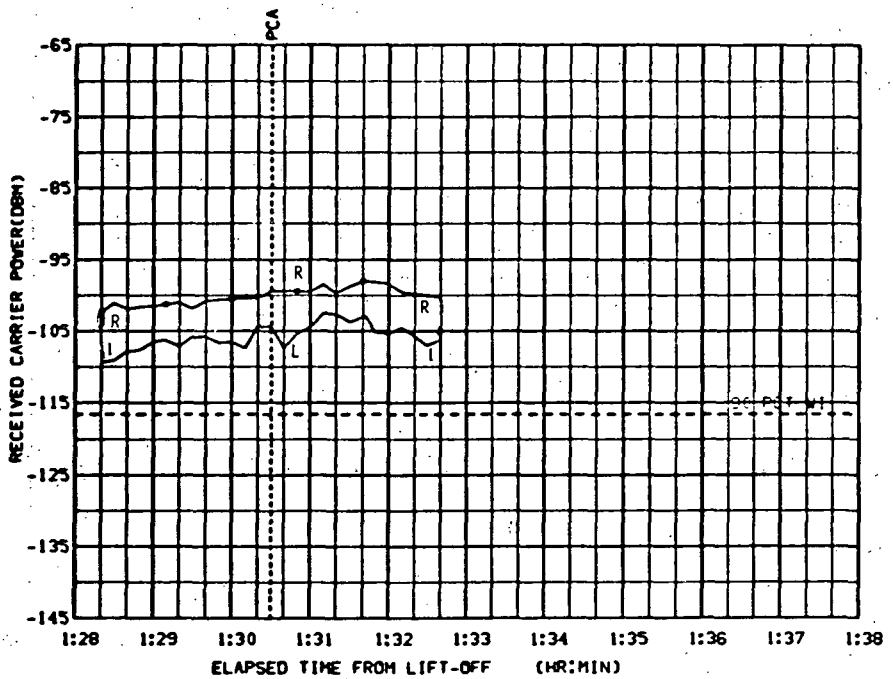

FIGURE 6-11b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =155.8
ELV =4.233
RANGE=641

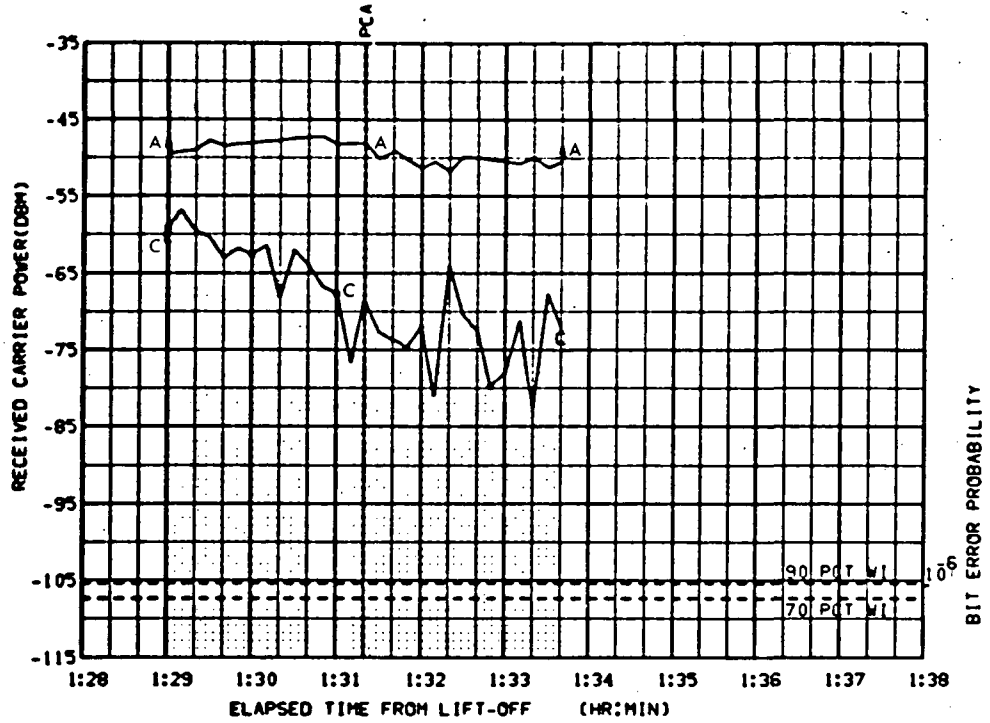

FIGURE 6-12a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

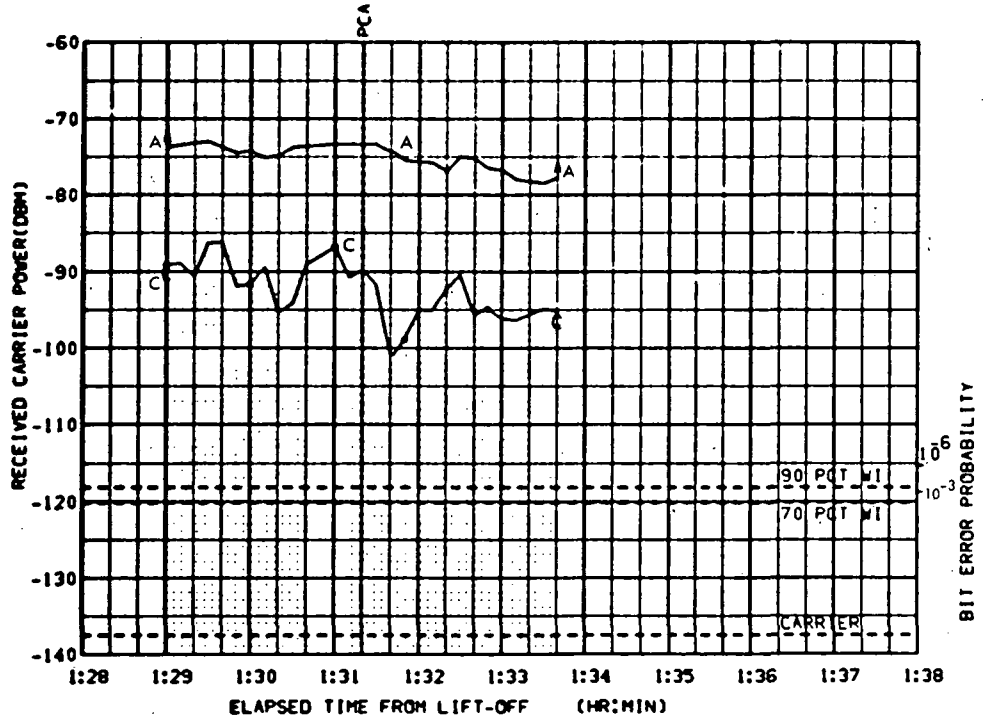

FIGURE 6-12b. GDS ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

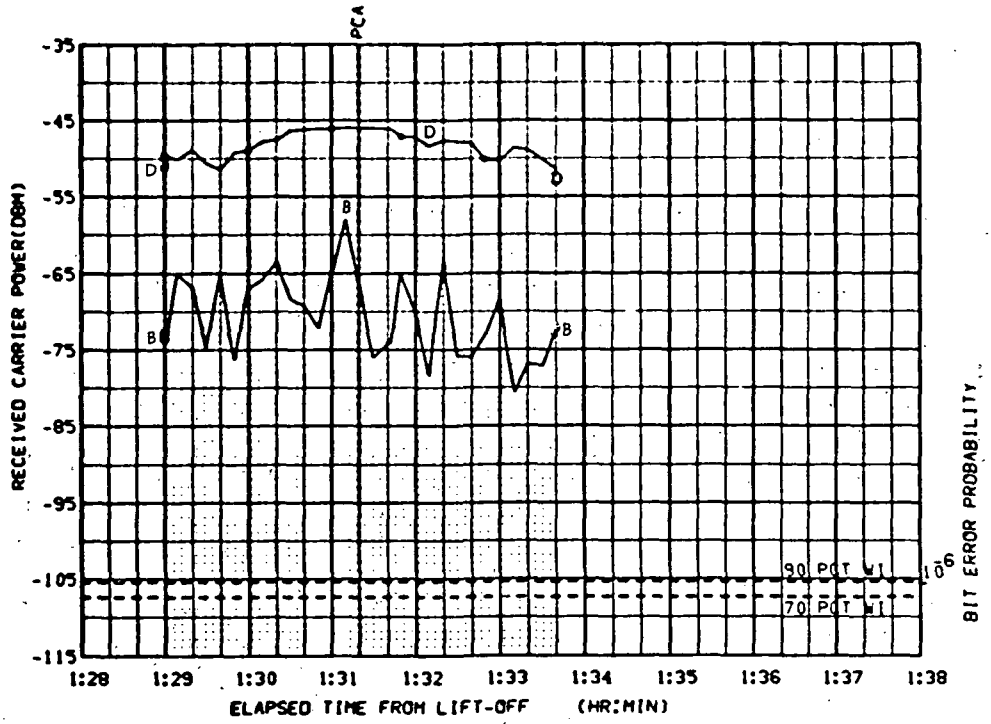

FIGURE 6-12c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

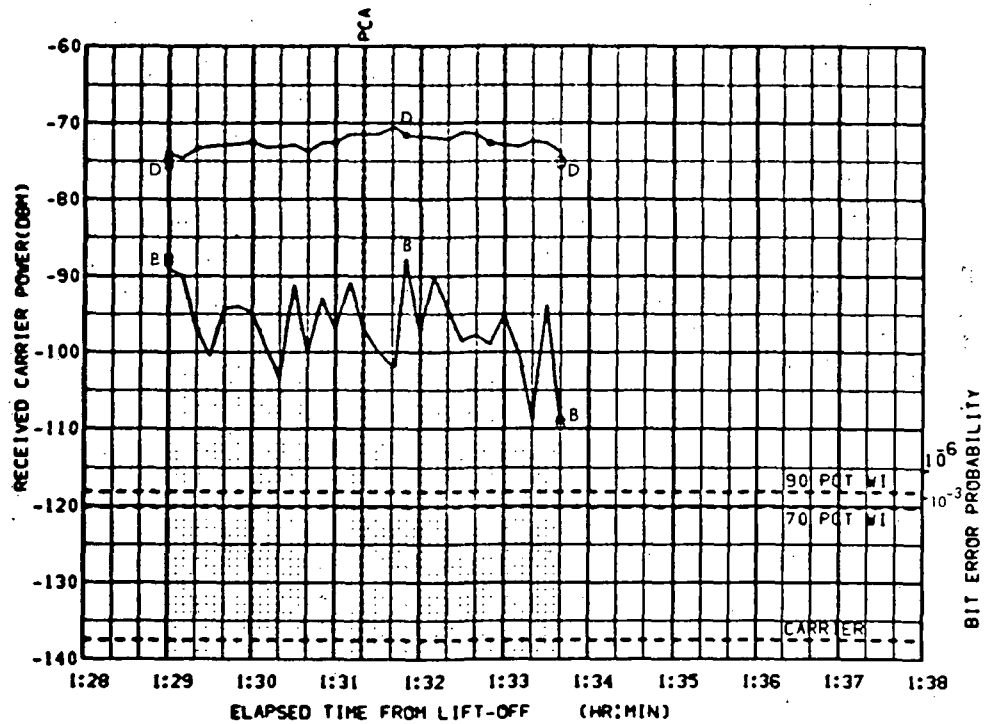

FIGURE 6-12d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

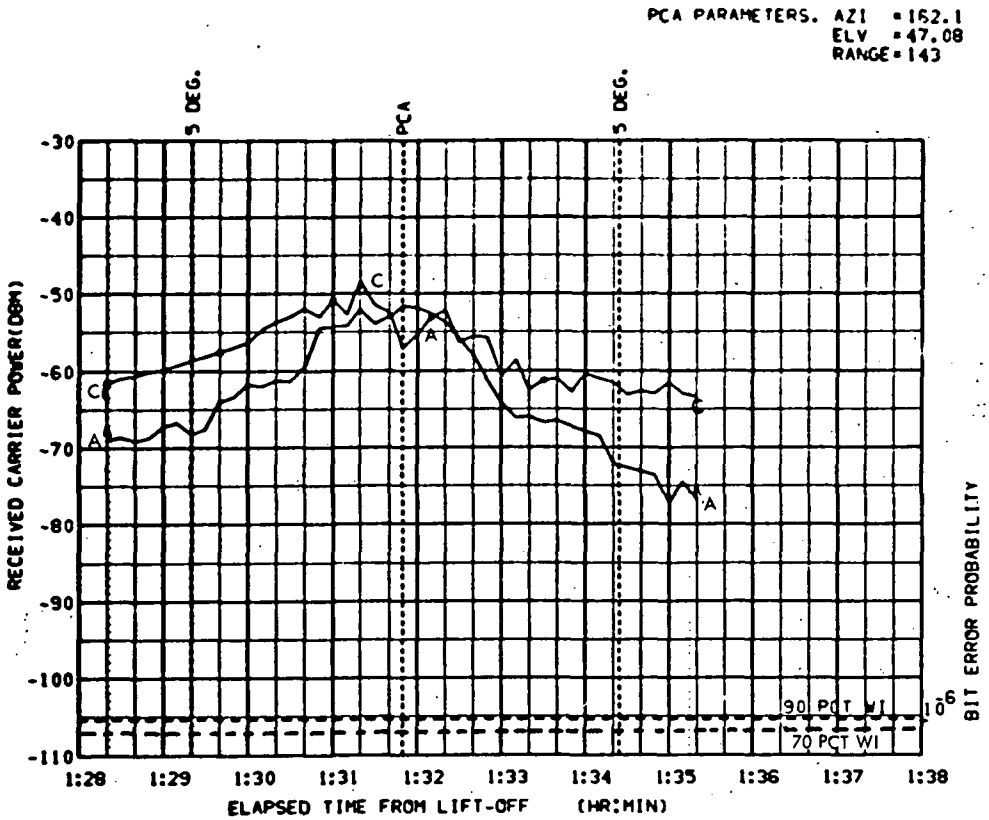

FIGURE 6-13a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

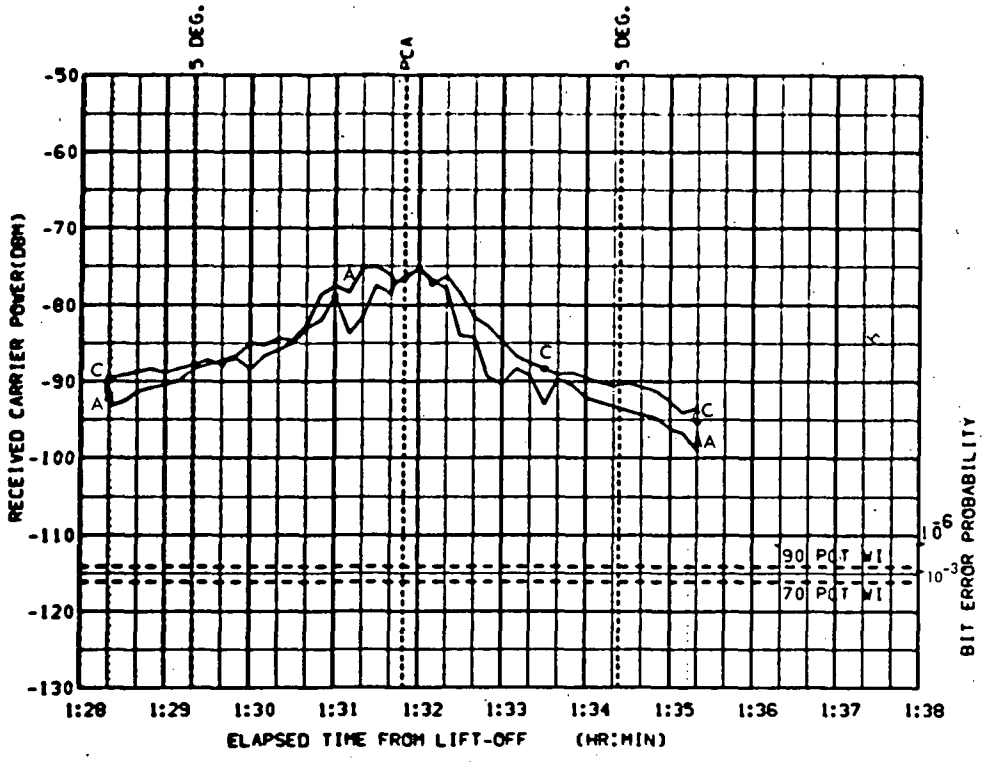

FIGURE 6-13b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

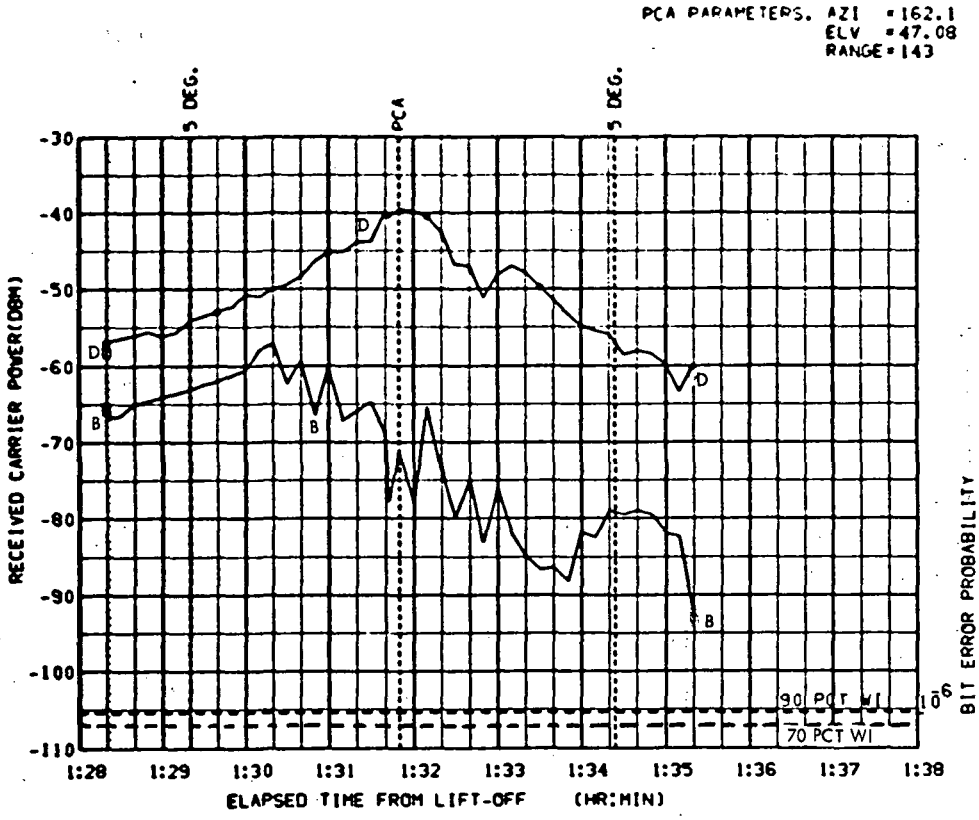

FIGURE 6-13c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

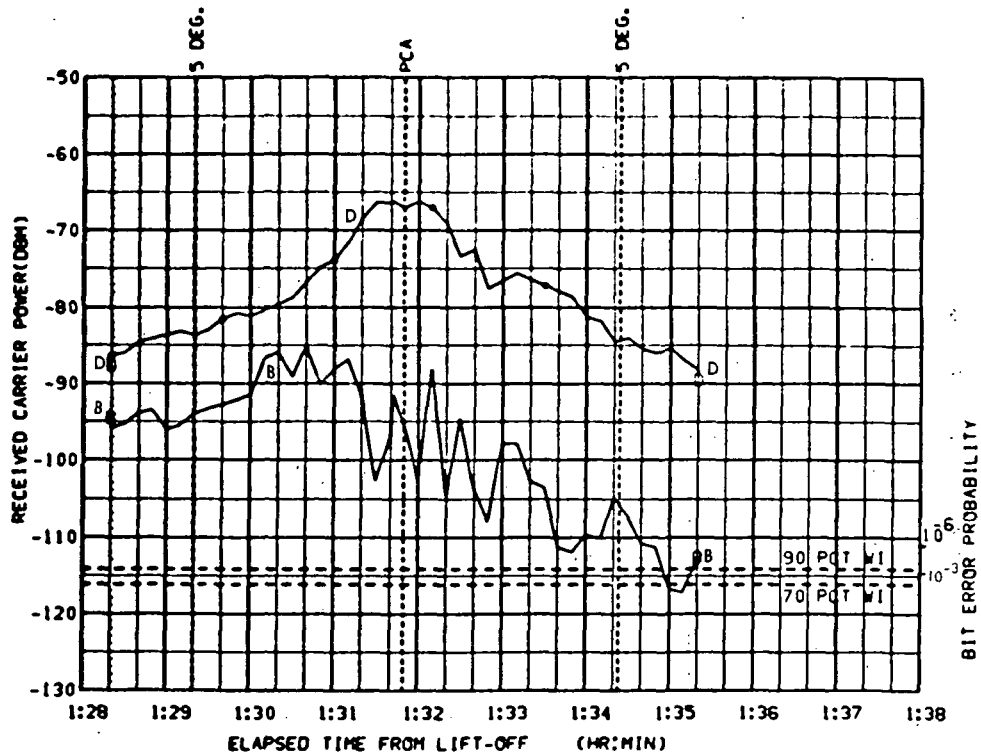

FIGURE 6-13d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

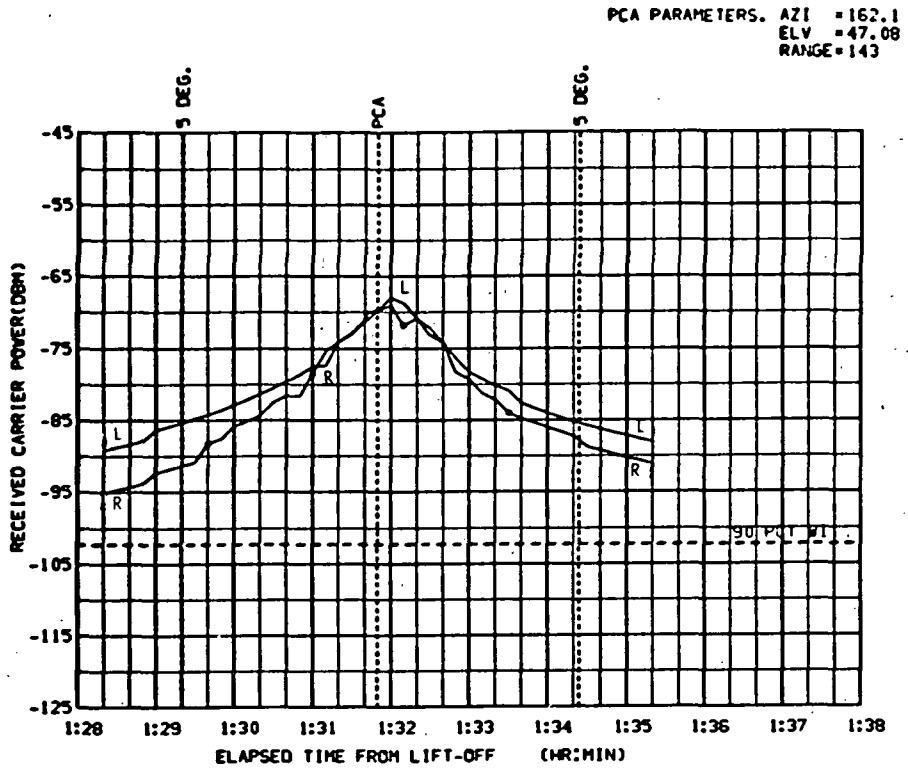

FIGURE 6-13e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

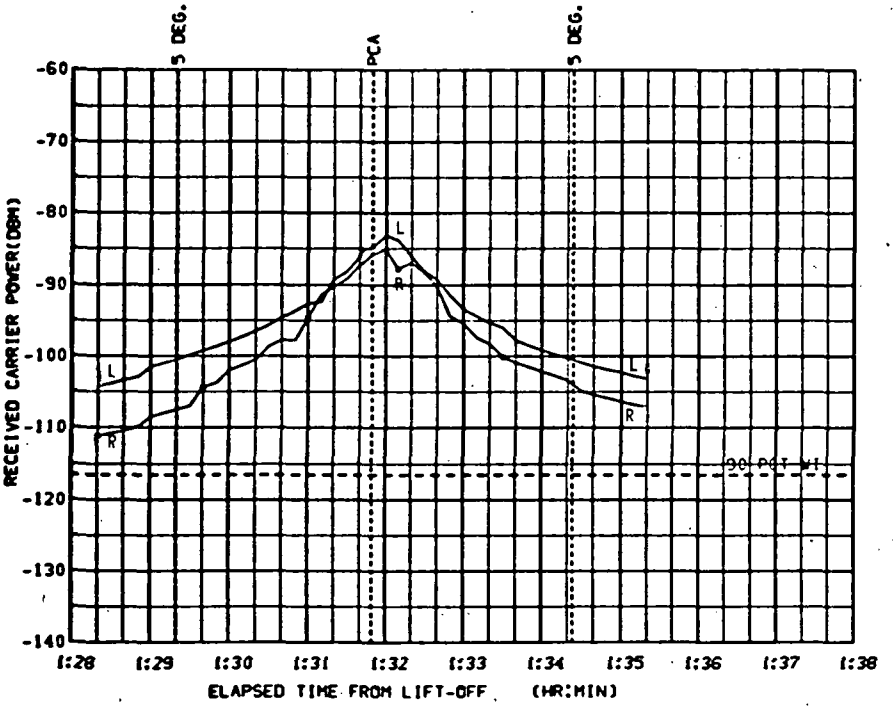

FIGURE 6-13f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

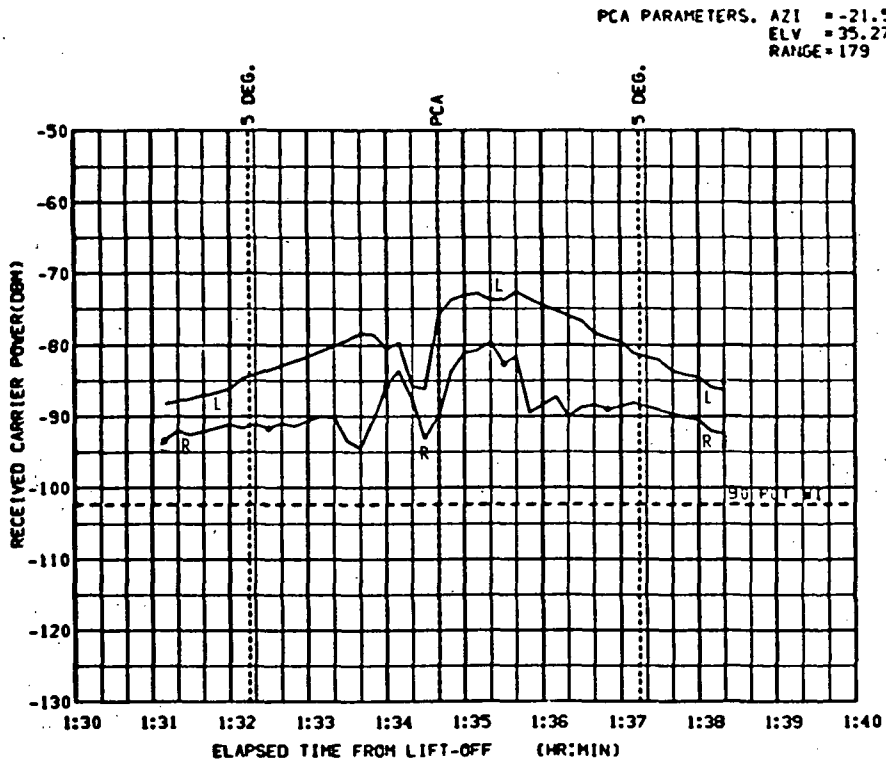

FIGURE 6-14a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

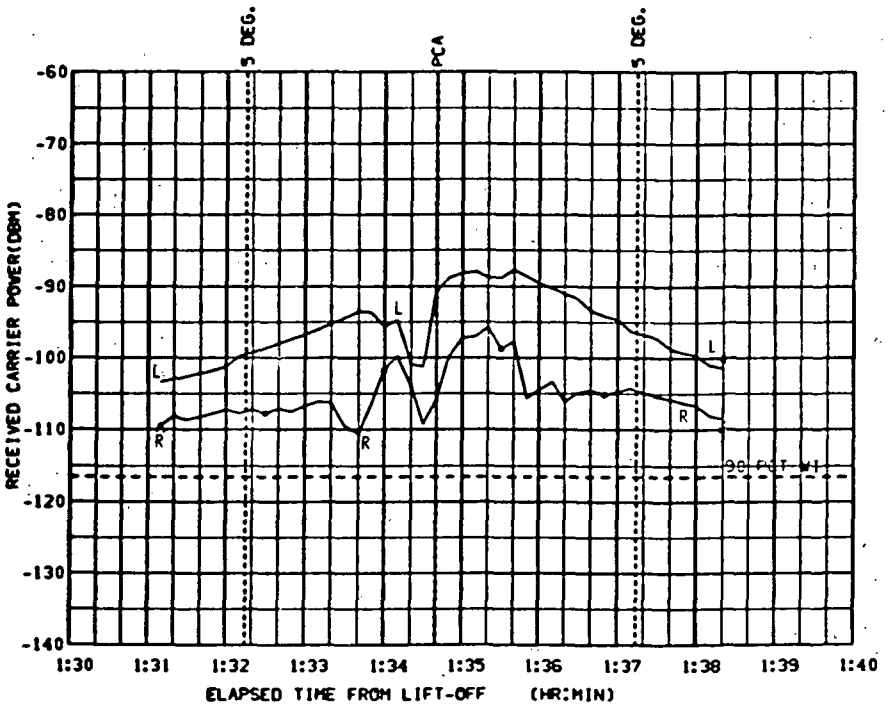

FIGURE 6-14b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

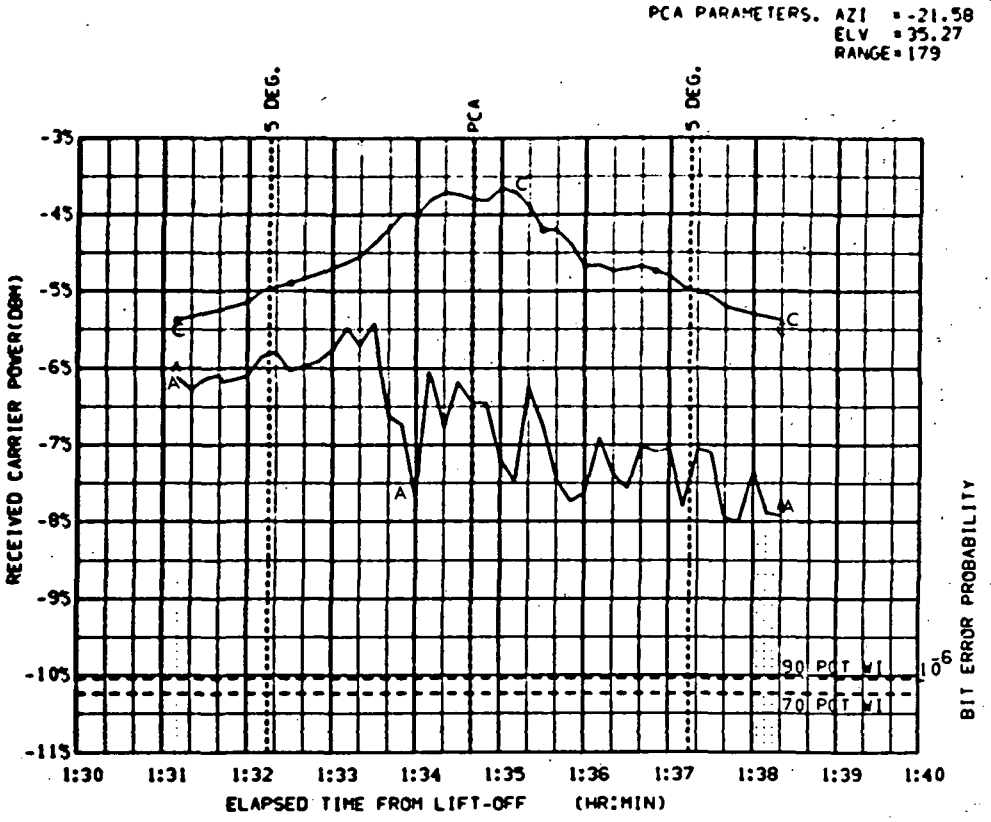

FIGURE 6-14c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

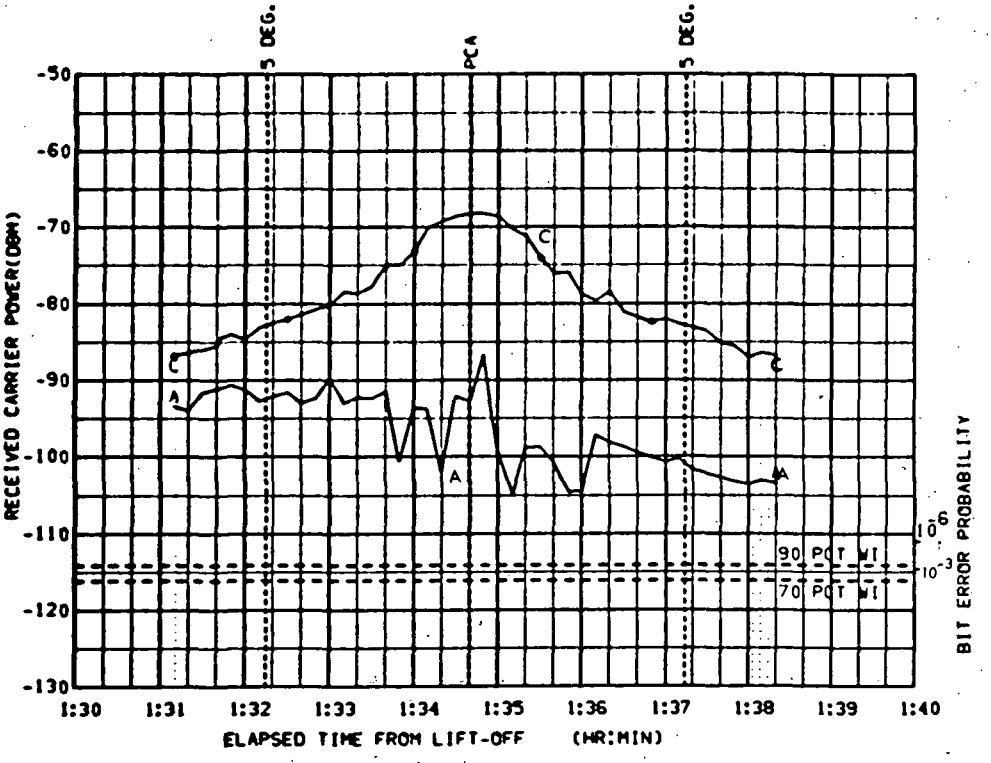

FIGURE 6-14d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

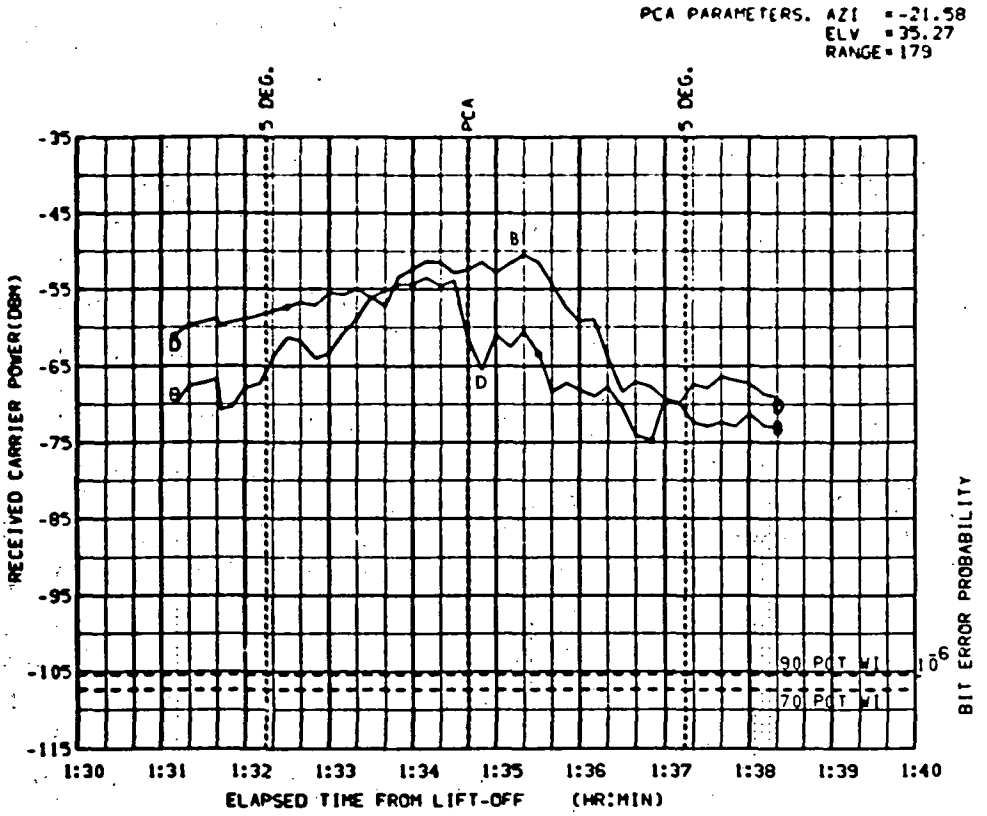

FIGURE 6-14e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

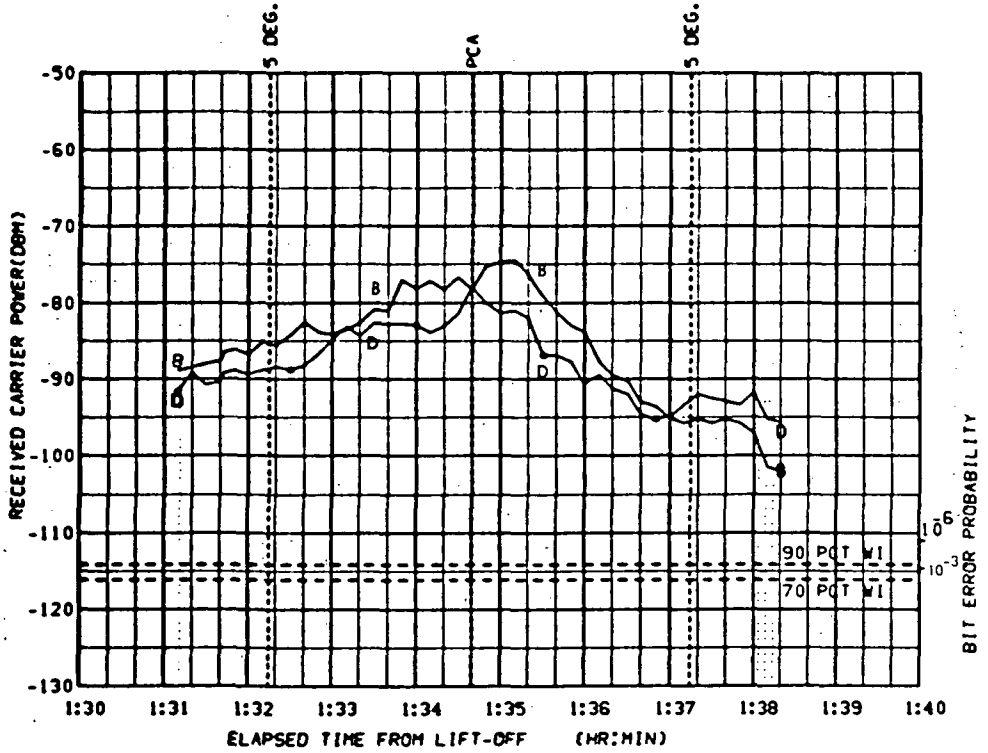

FIGURE 6-14f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

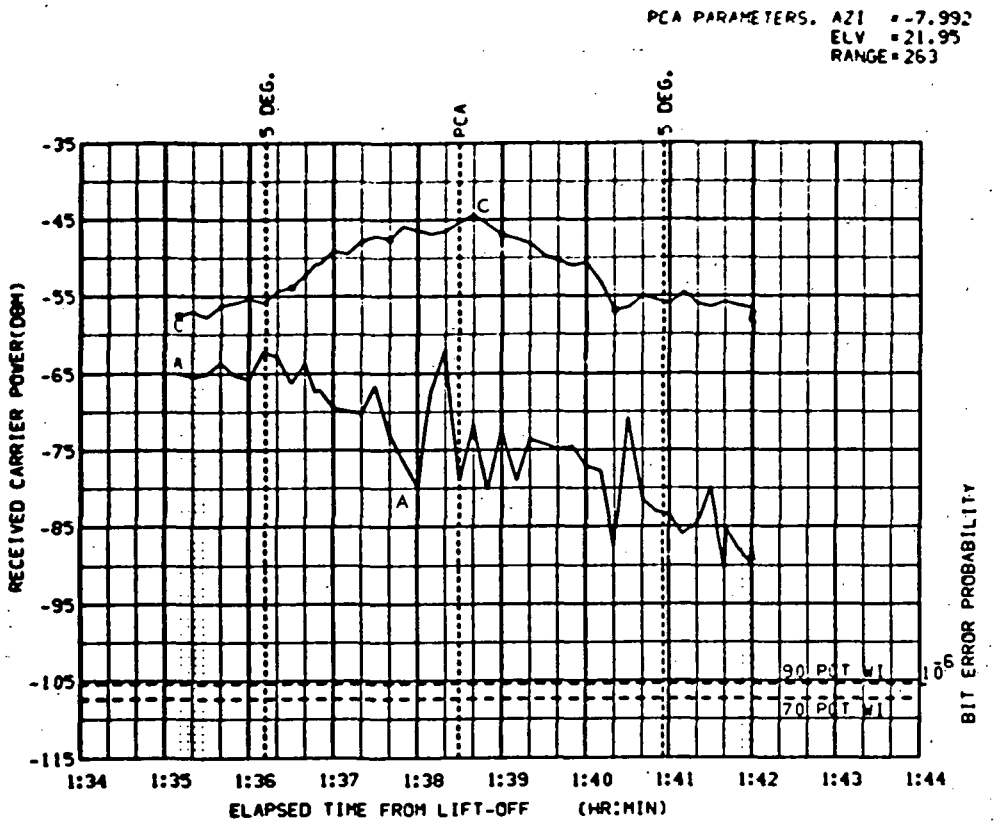

FIGURE 6-15a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

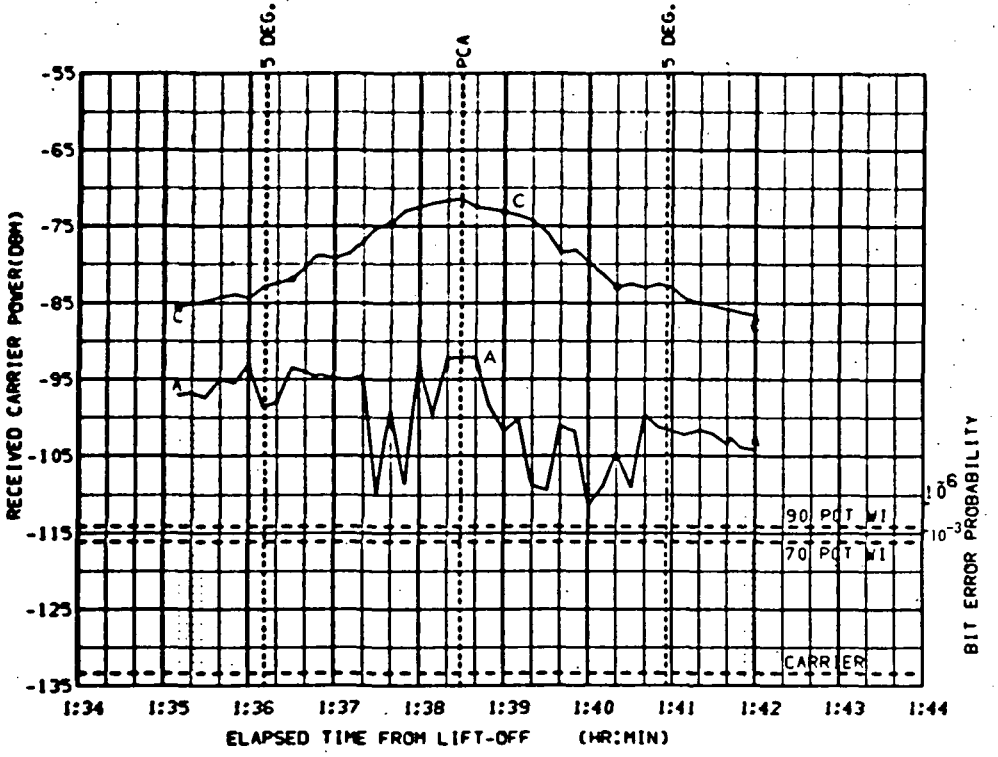

FIGURE 6-15b. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

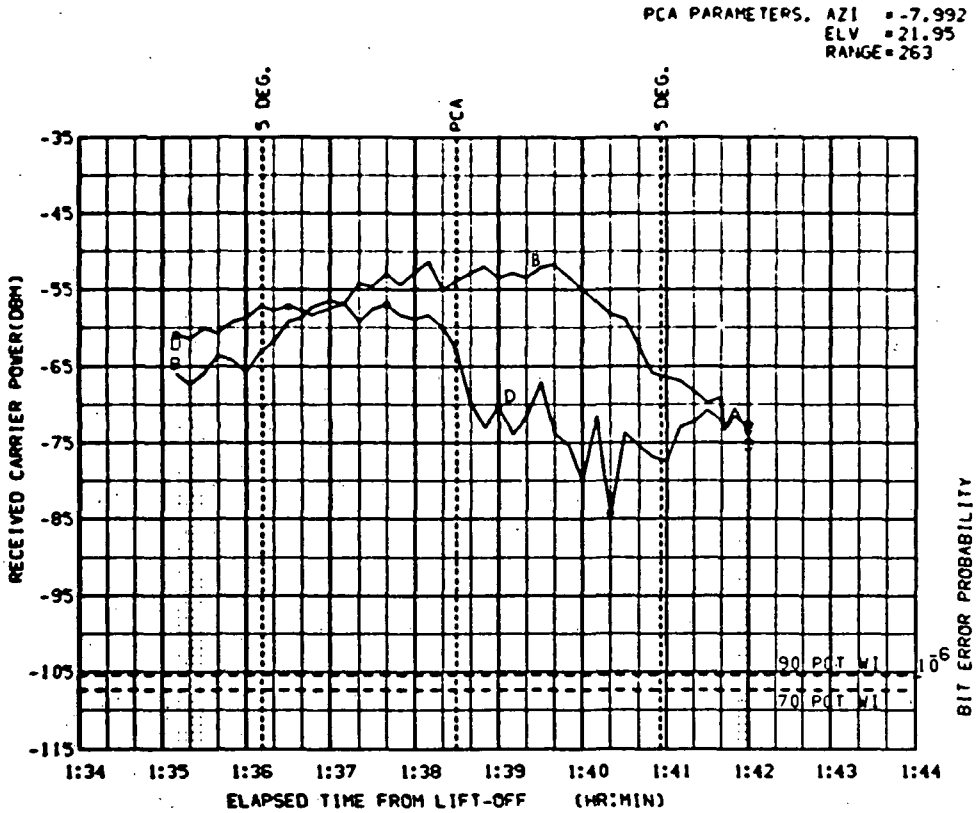

FIGURE 6-15c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

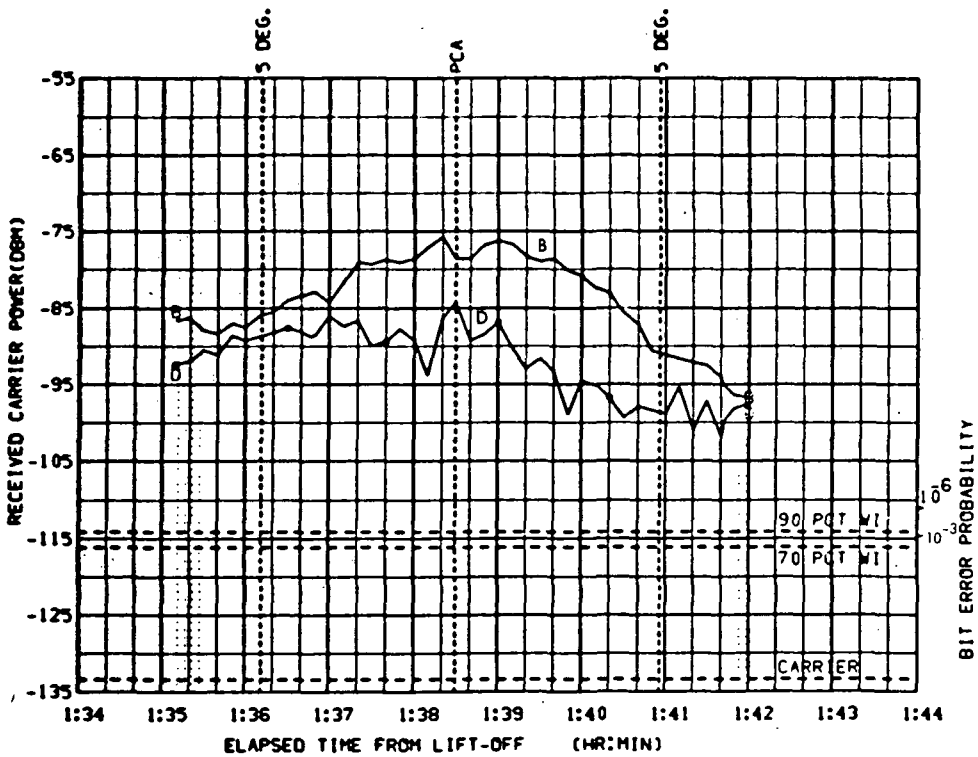

FIGURE 6-15d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

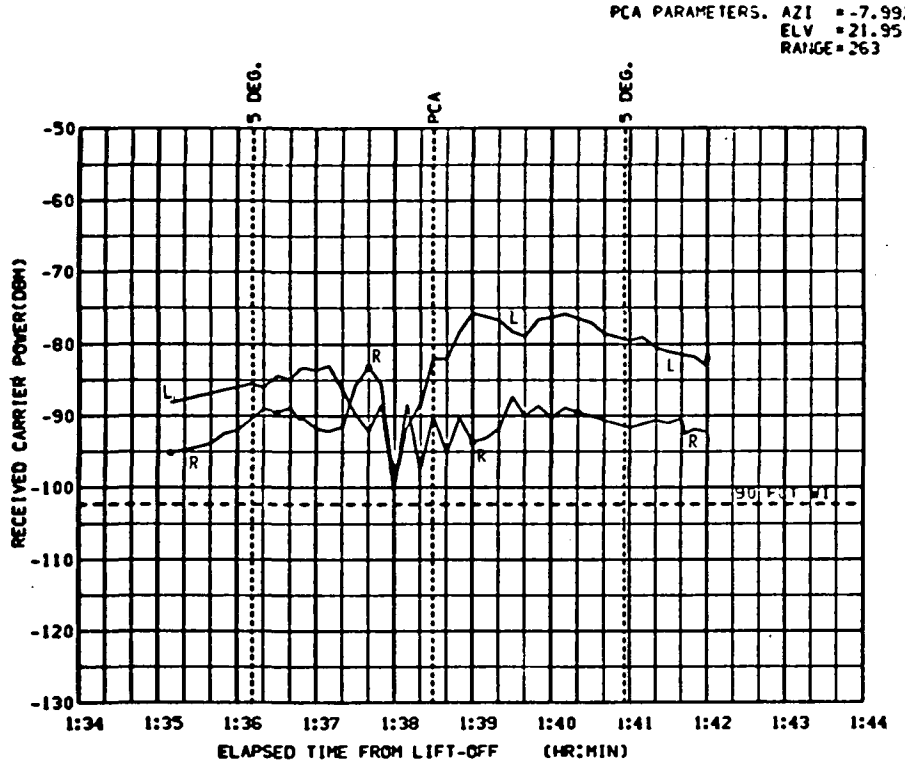

FIGURE 6-15e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

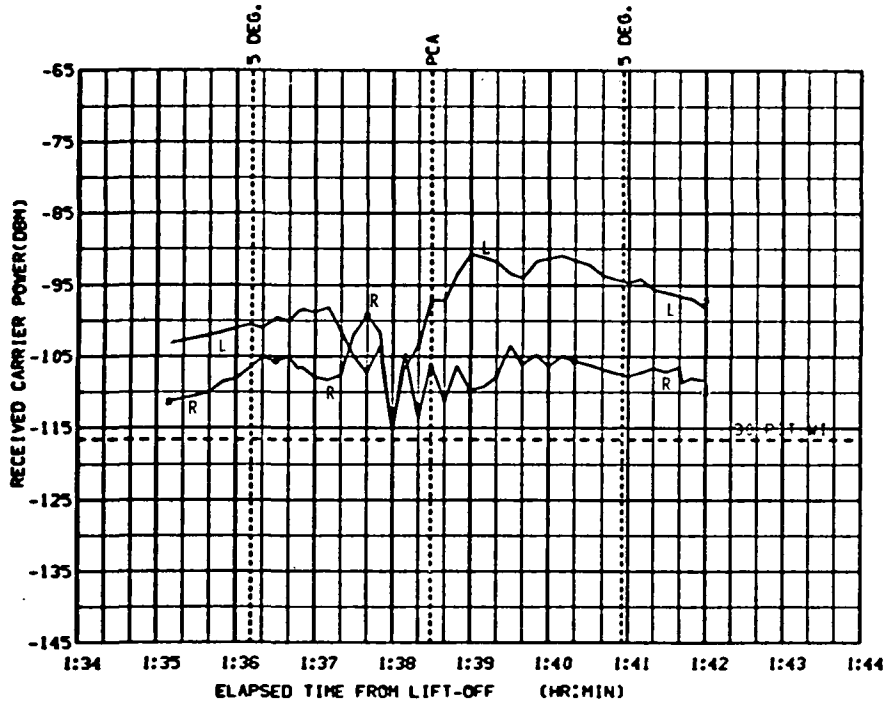

FIGURE 6-15f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

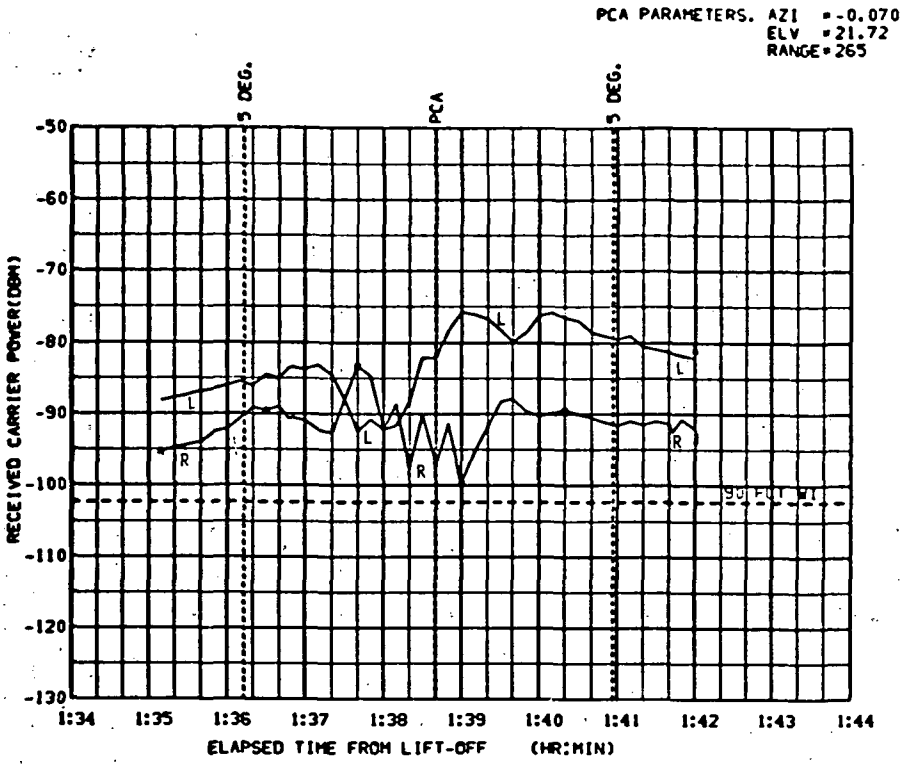

FIGURE 6-16a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

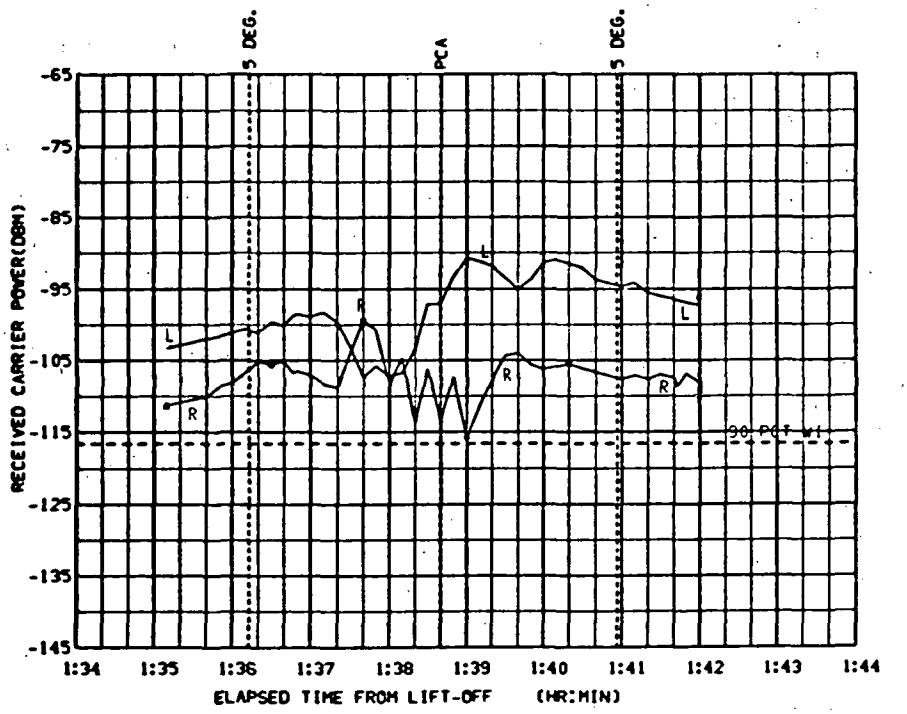

FIGURE 6-16b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

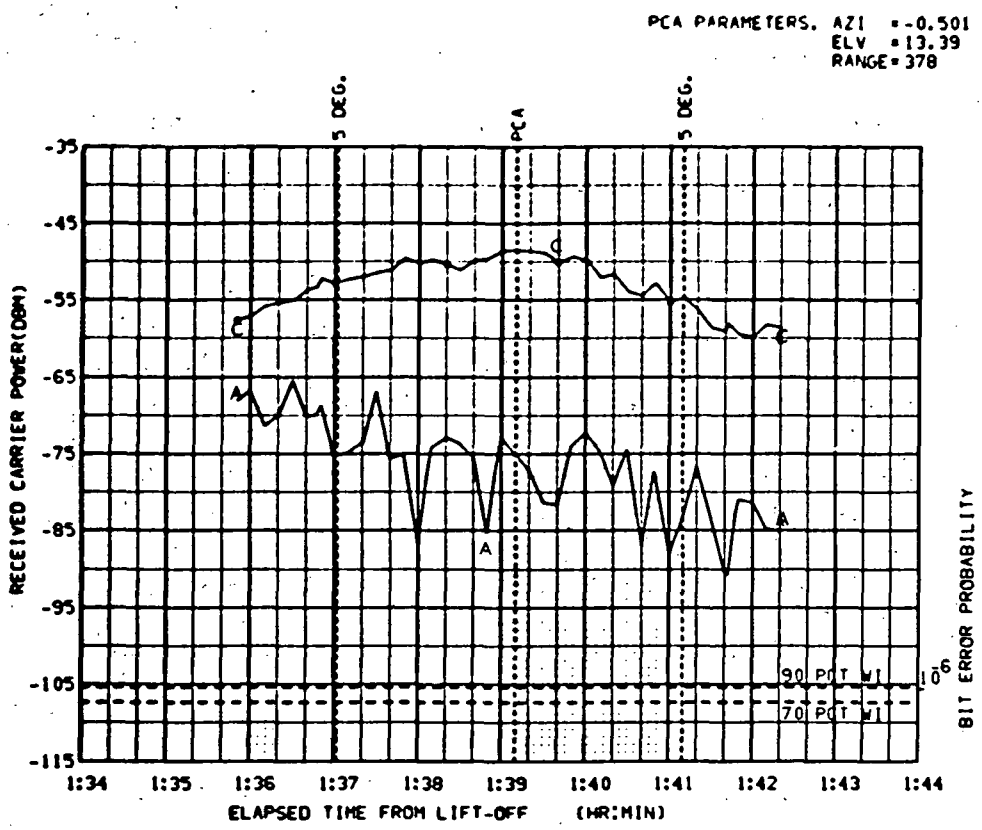

FIGURE 6-17a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

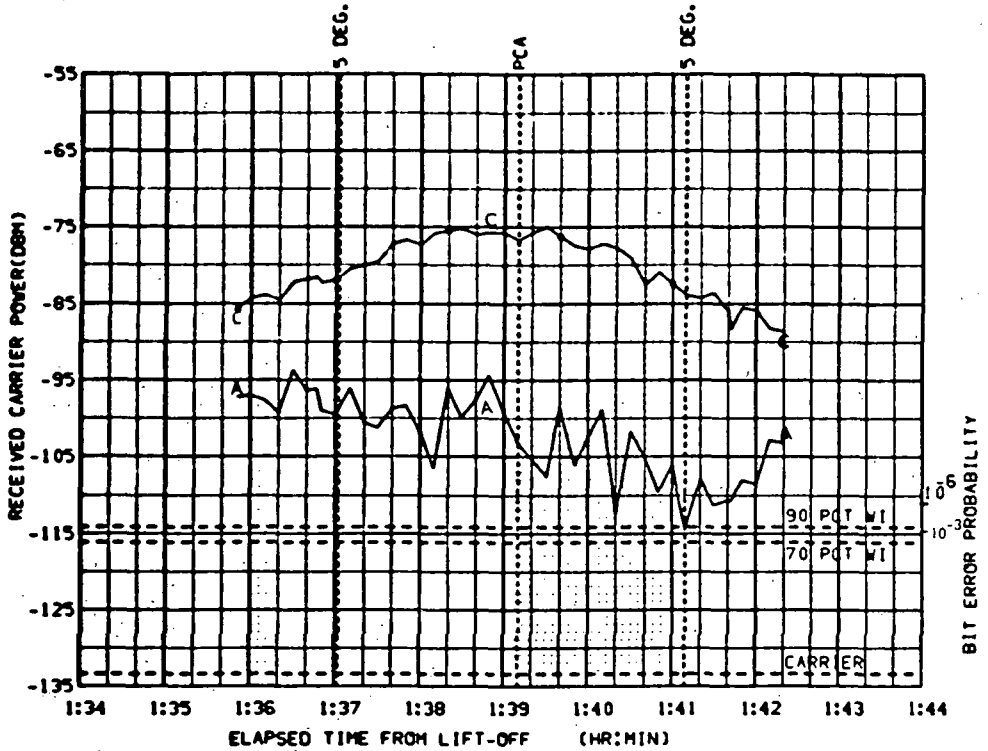

FIGURE 6-17b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

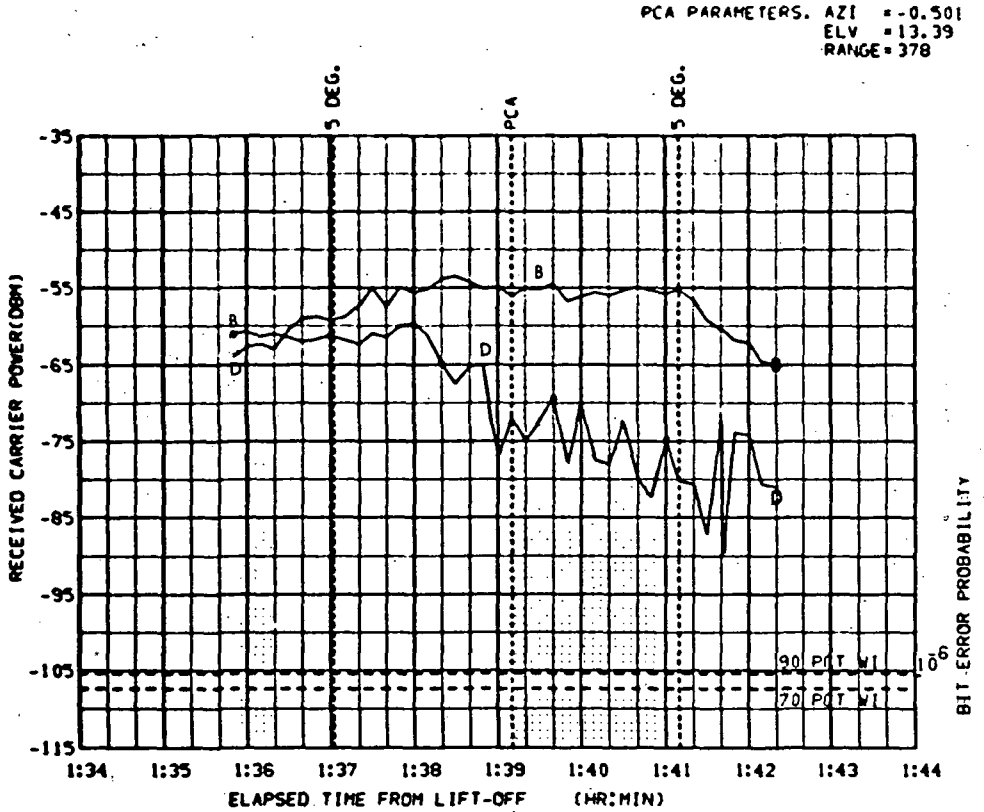

FIGURE 6-17c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

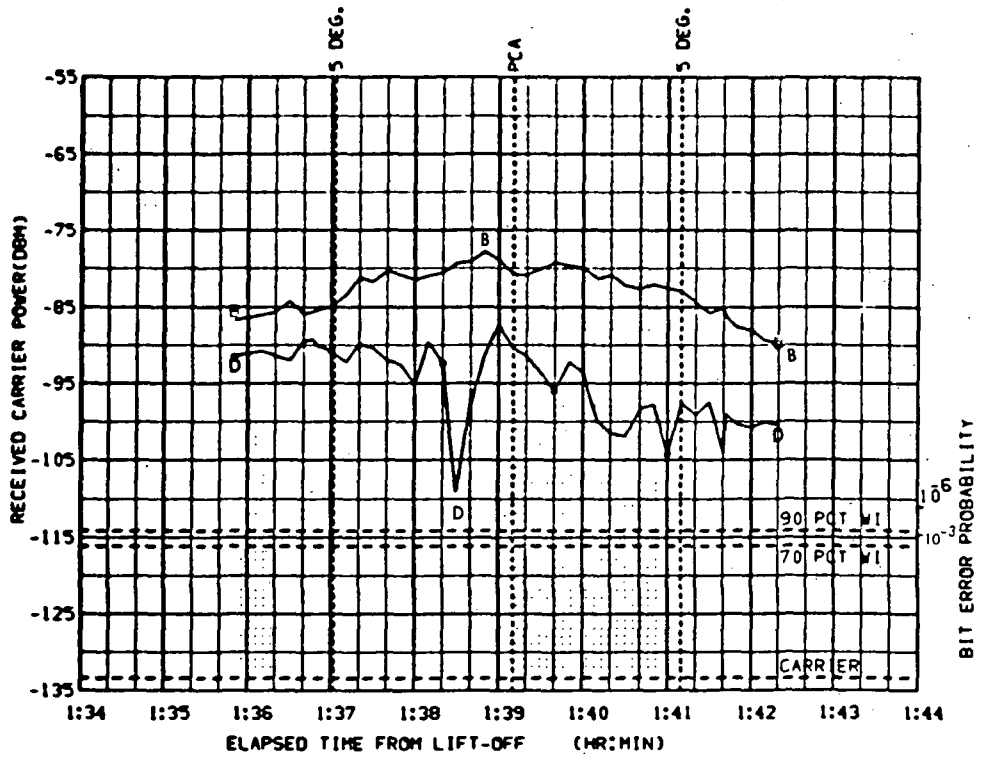

FIGURE 6-17d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

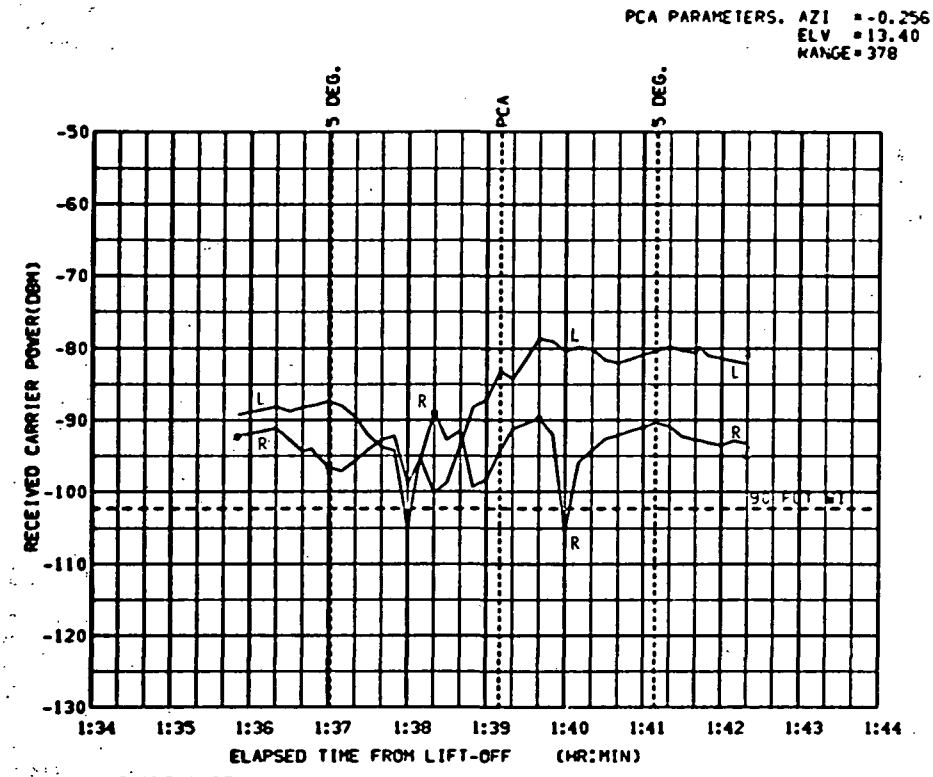

FIGURE 6-17e. GBI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

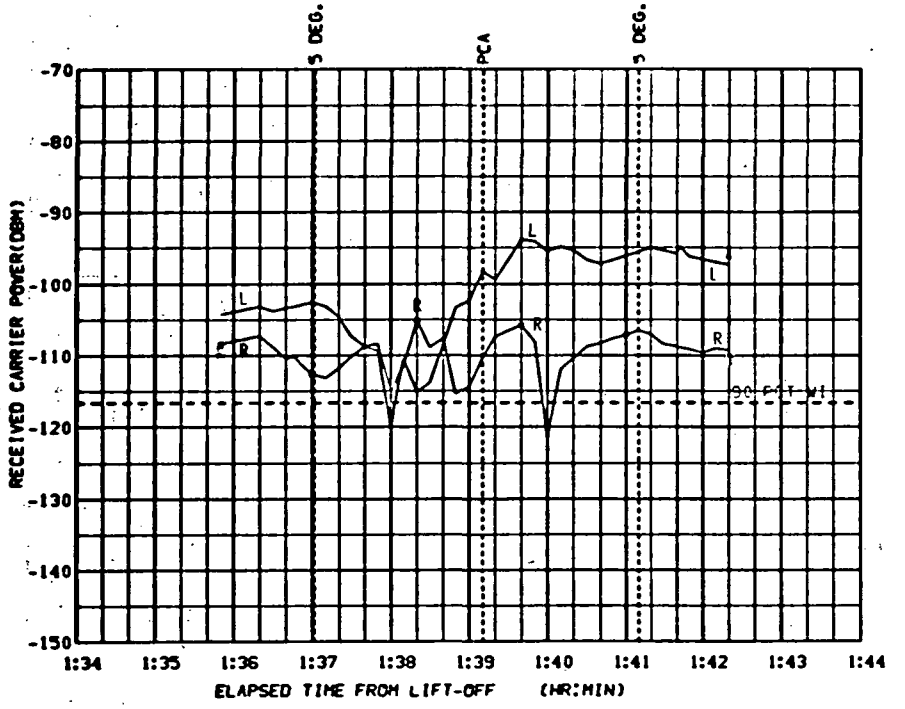

FIGURE 6-17f. GBI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

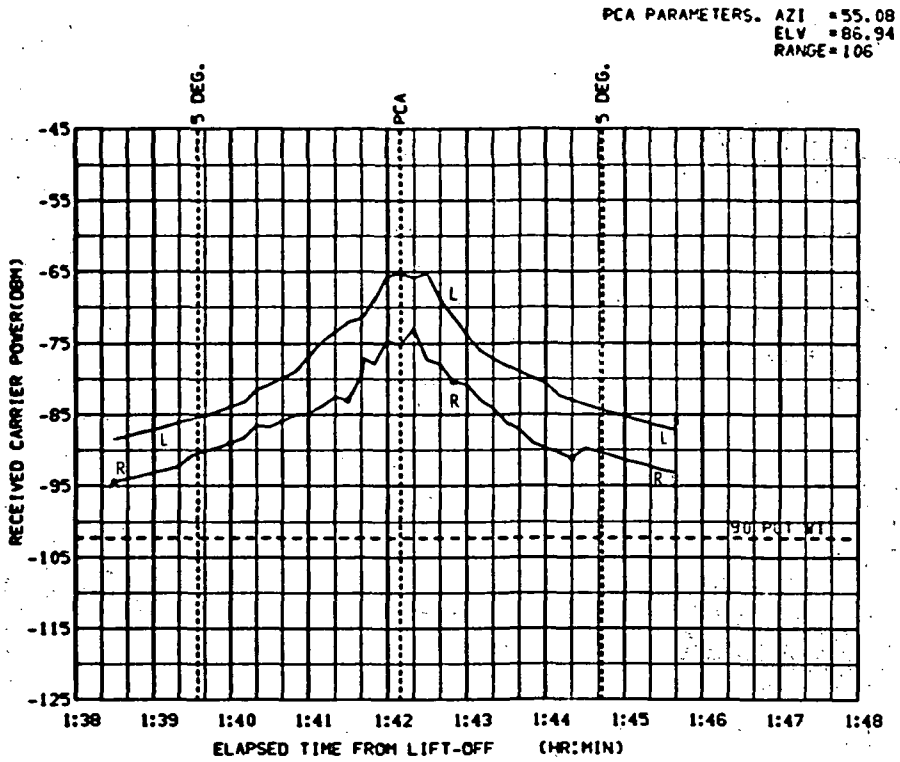

FIGURE 6-18a. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

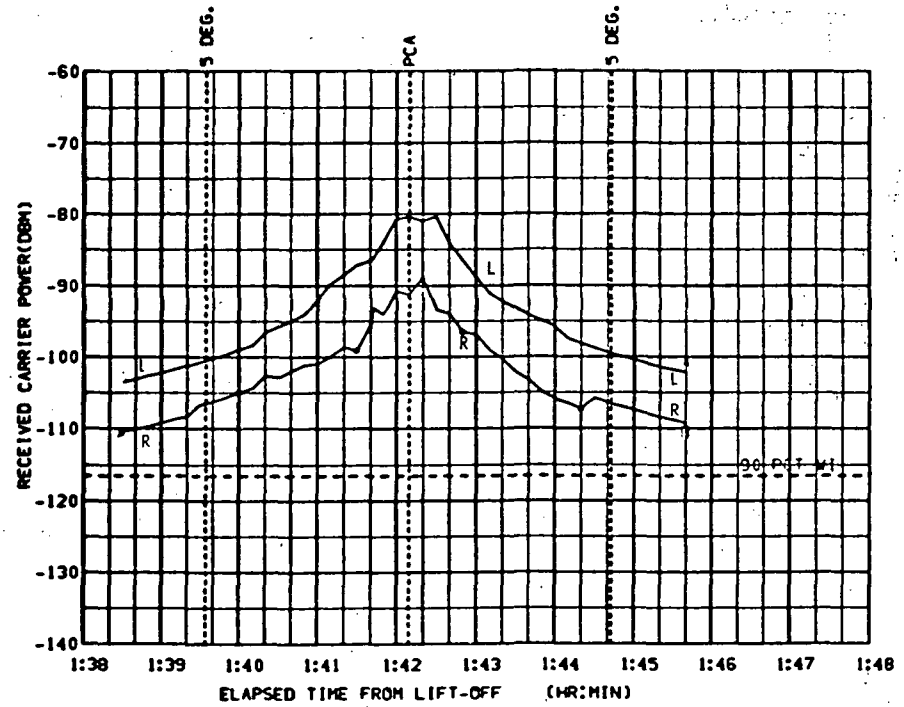

FIGURE 6-18b. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

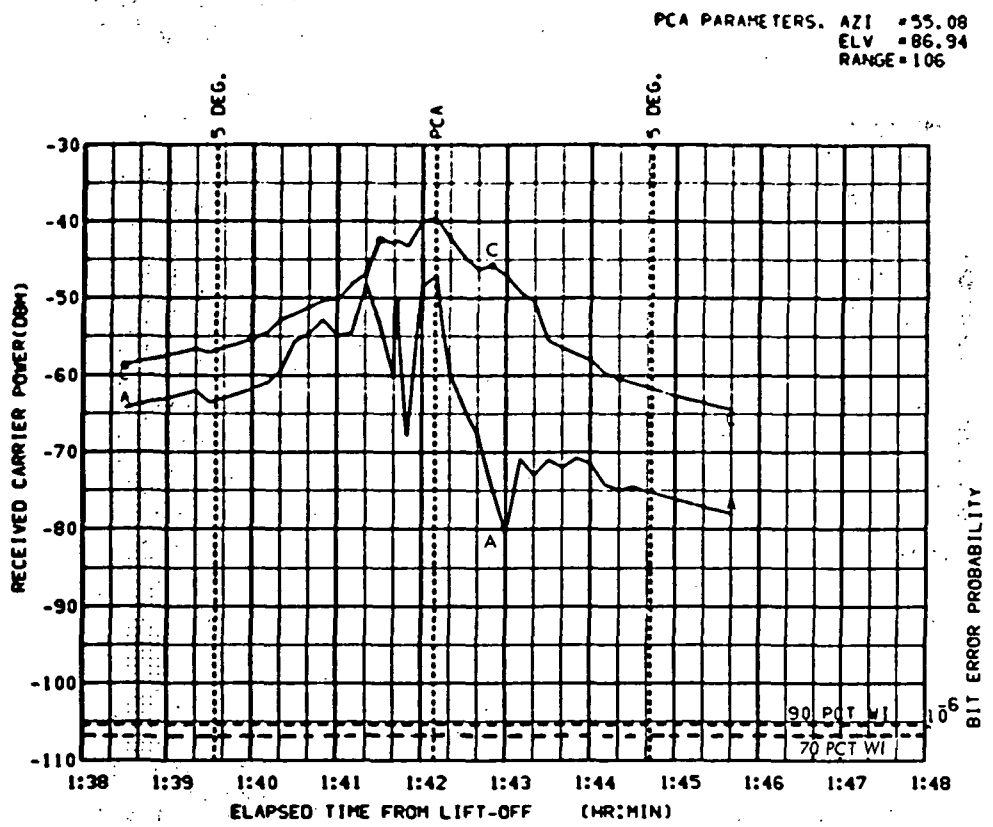

FIGURE 6-18c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

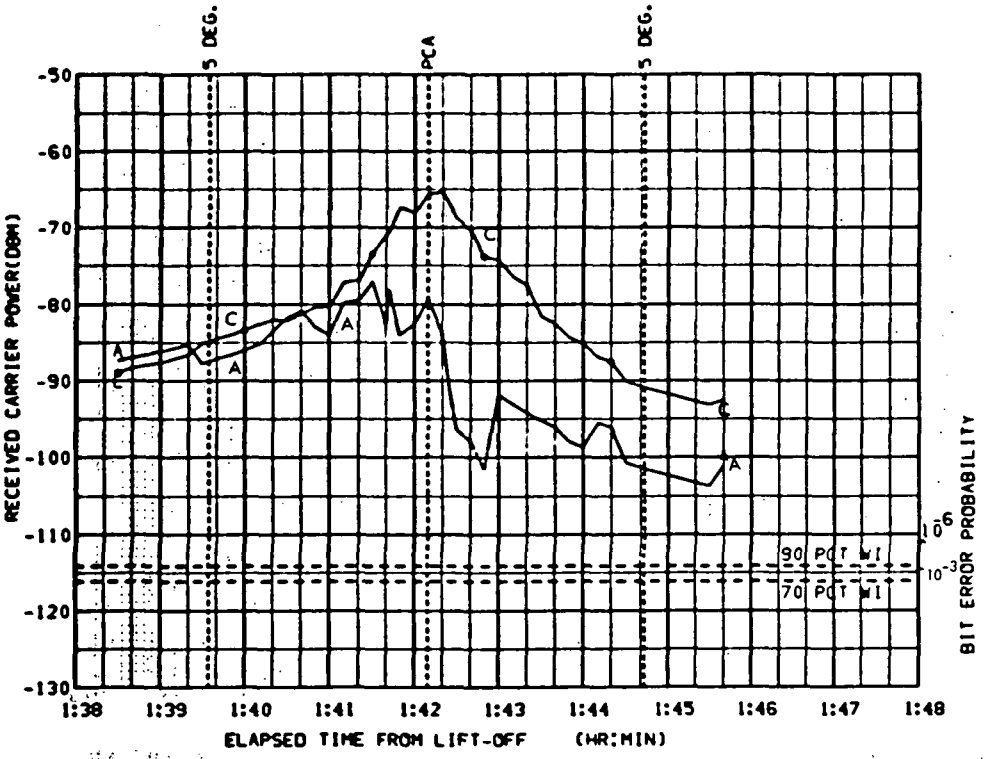

FIGURE 6-18d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

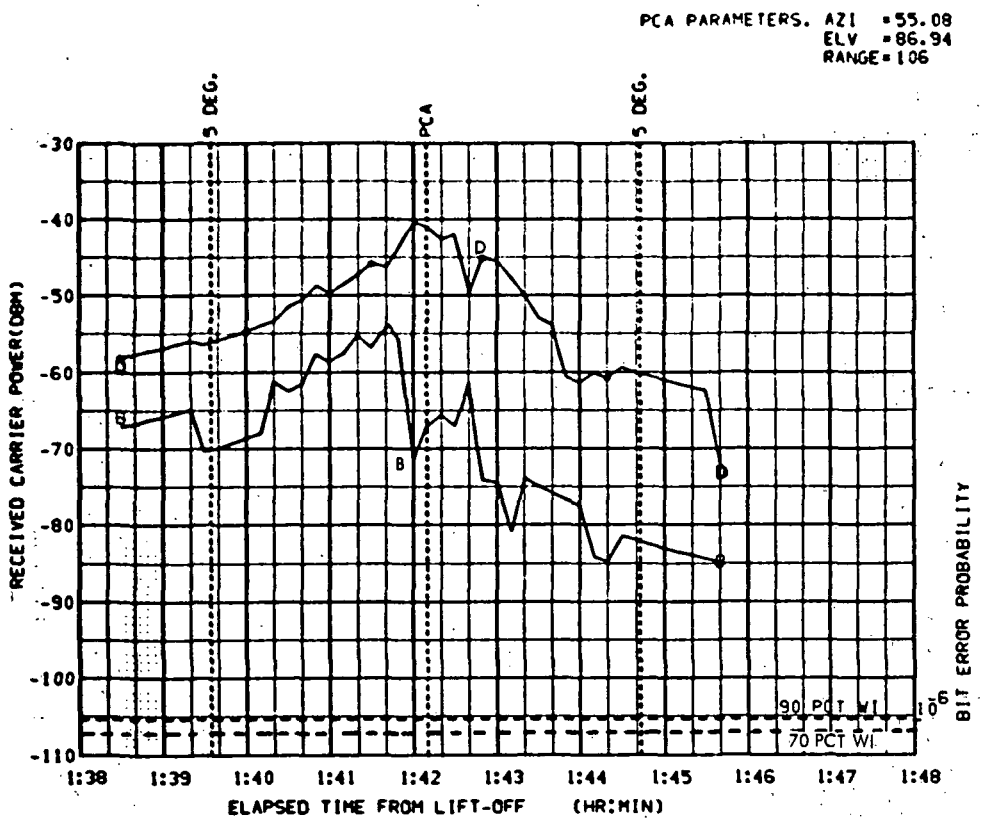

FIGURE 6-18e. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

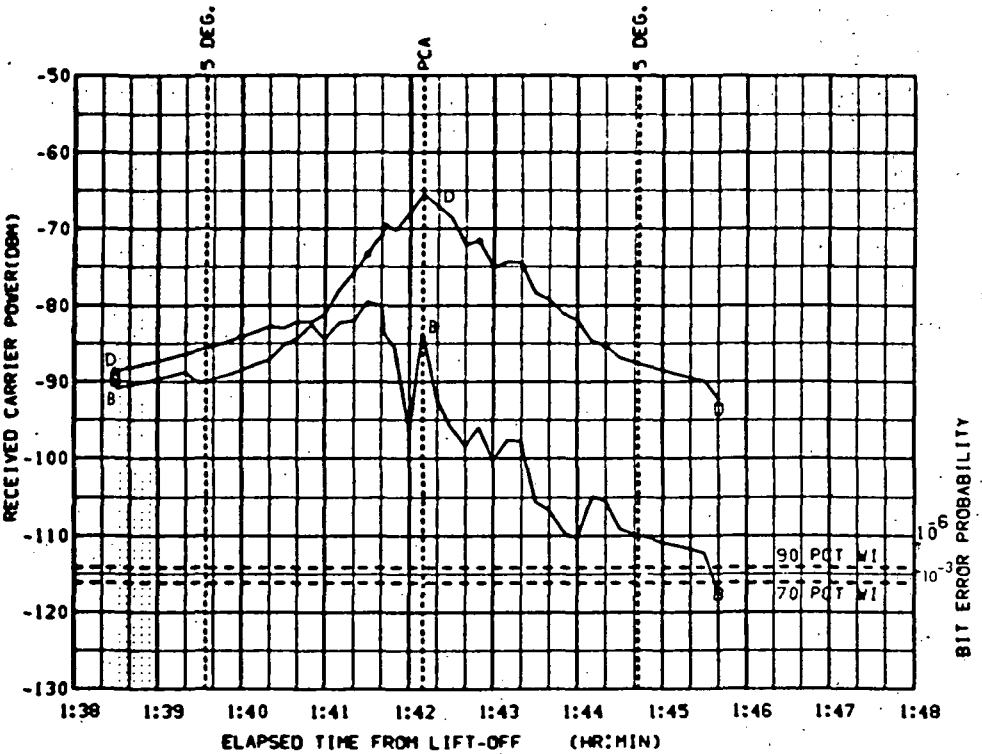

FIGURE 6-18f. BDA ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

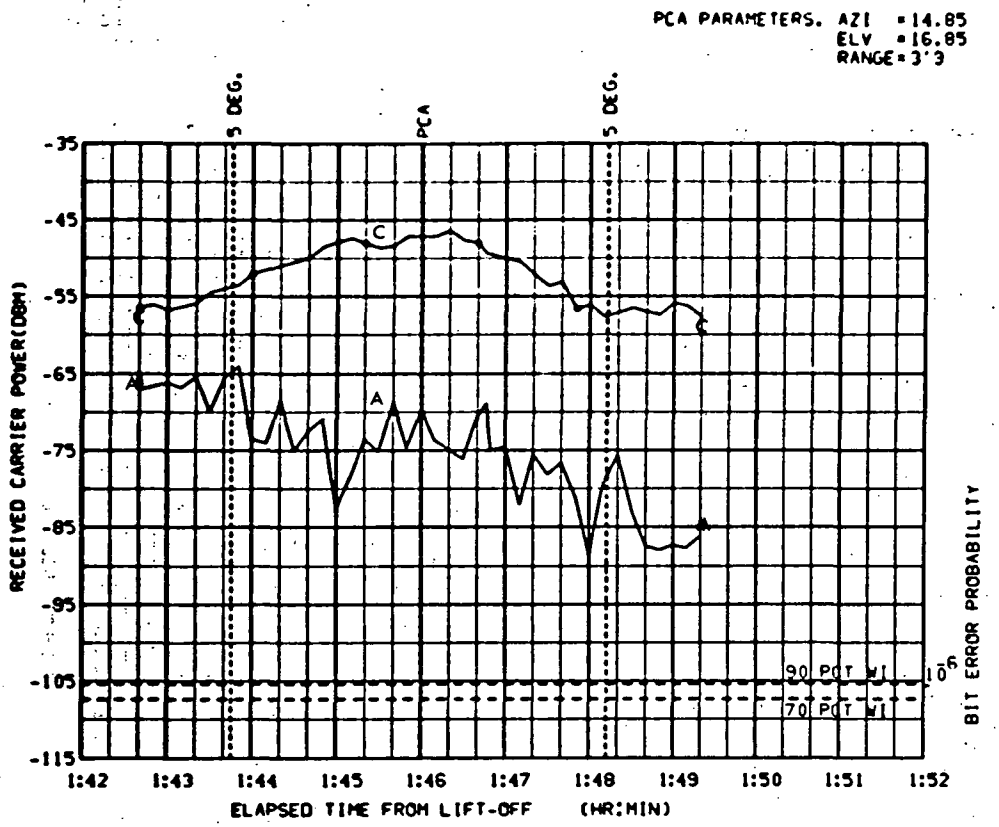

FIGURE 6-19a. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

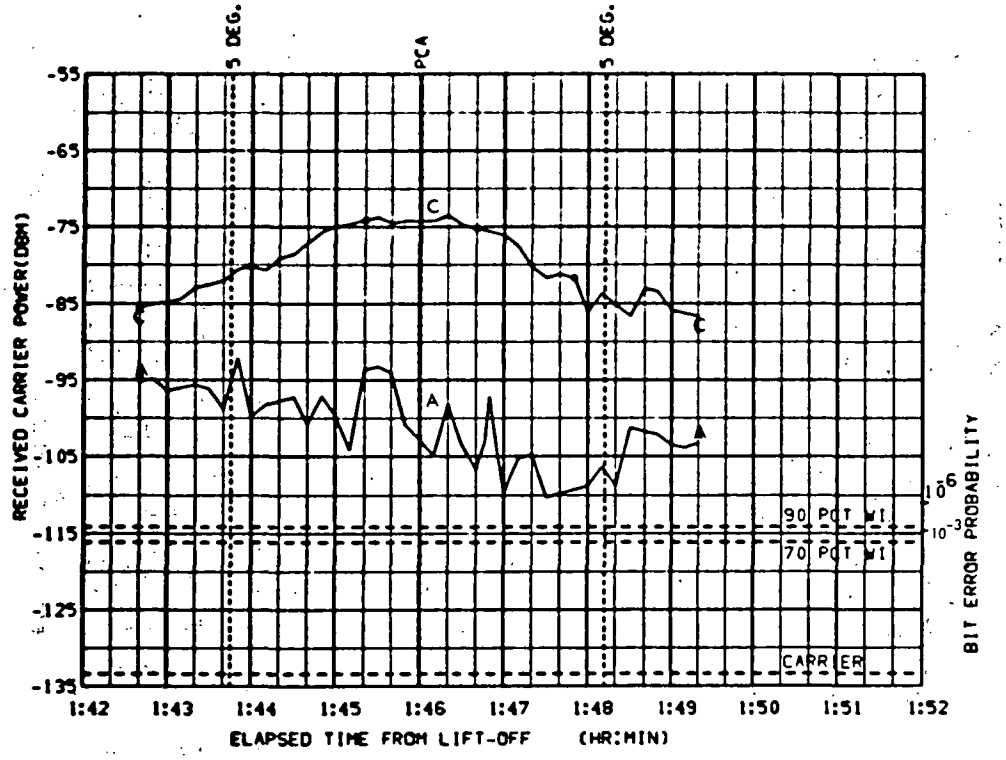

FIGURE 6-19b. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

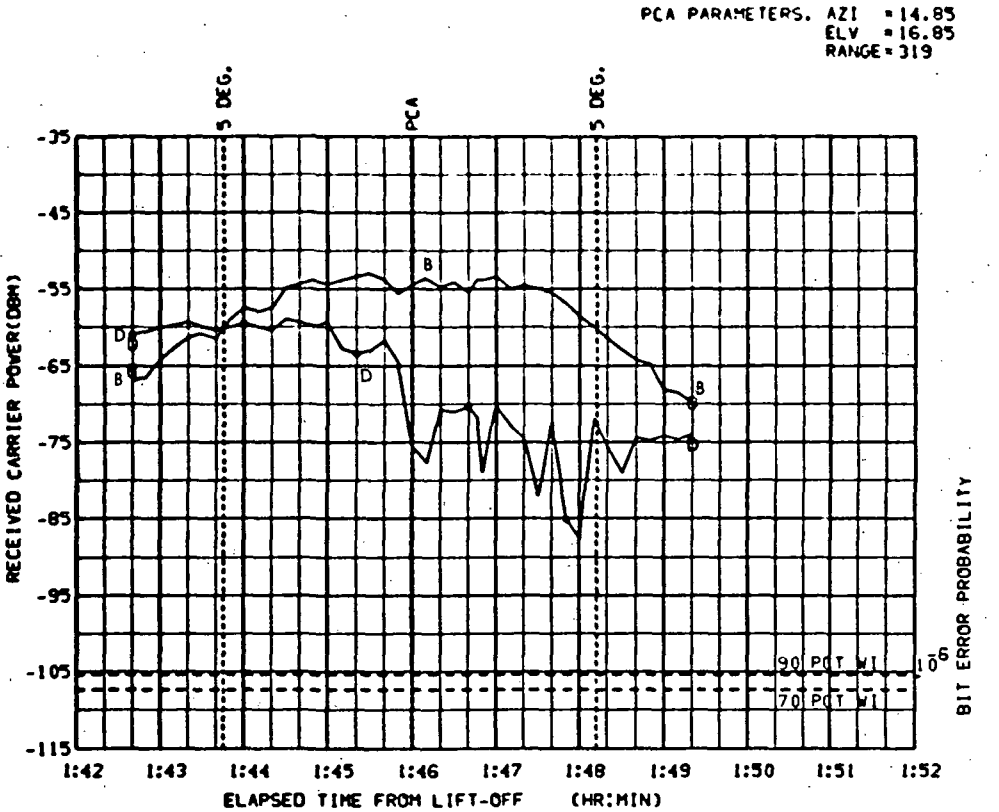

FIGURE 6-19c. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

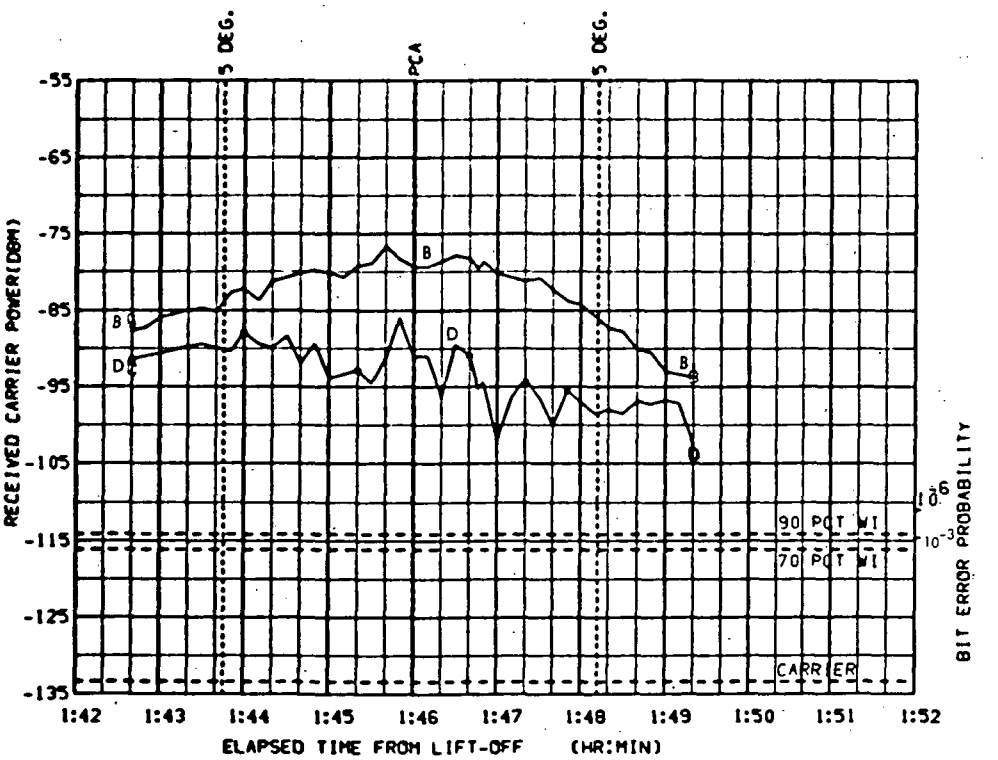

FIGURE 6-19d. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

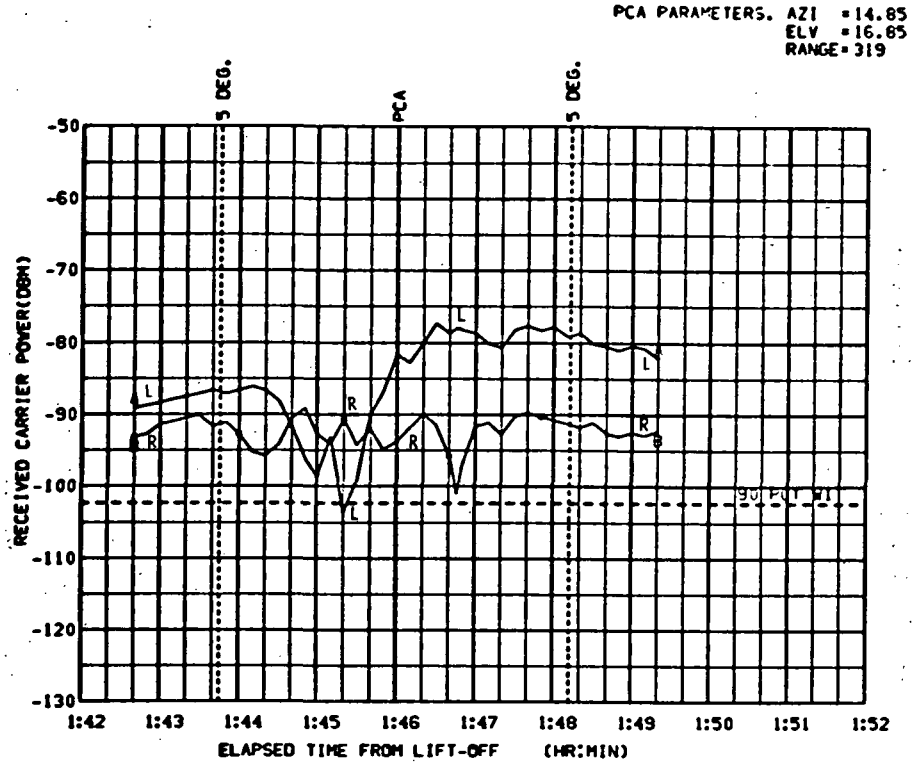

FIGURE 6-19e. VAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

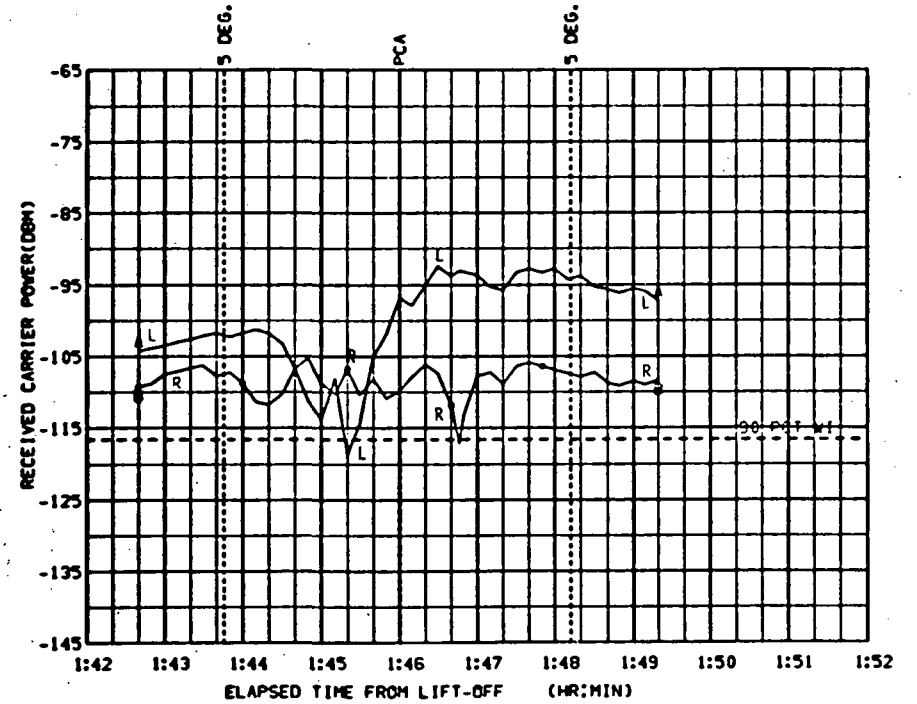

FIGURE 6-19f. VAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

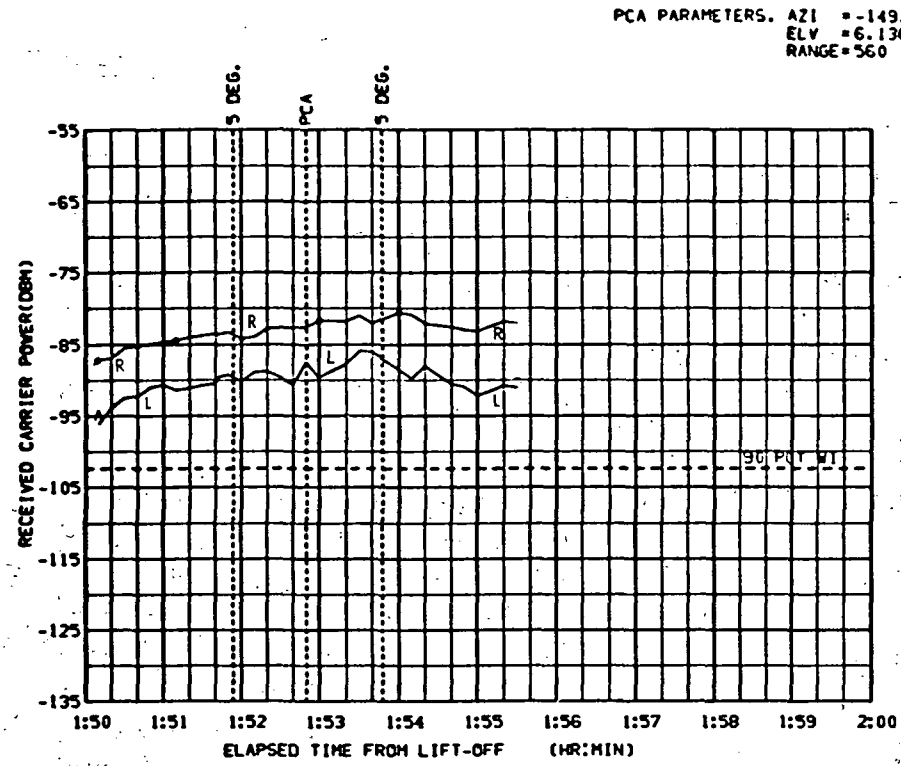

FIGURE 6-20a. CYI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

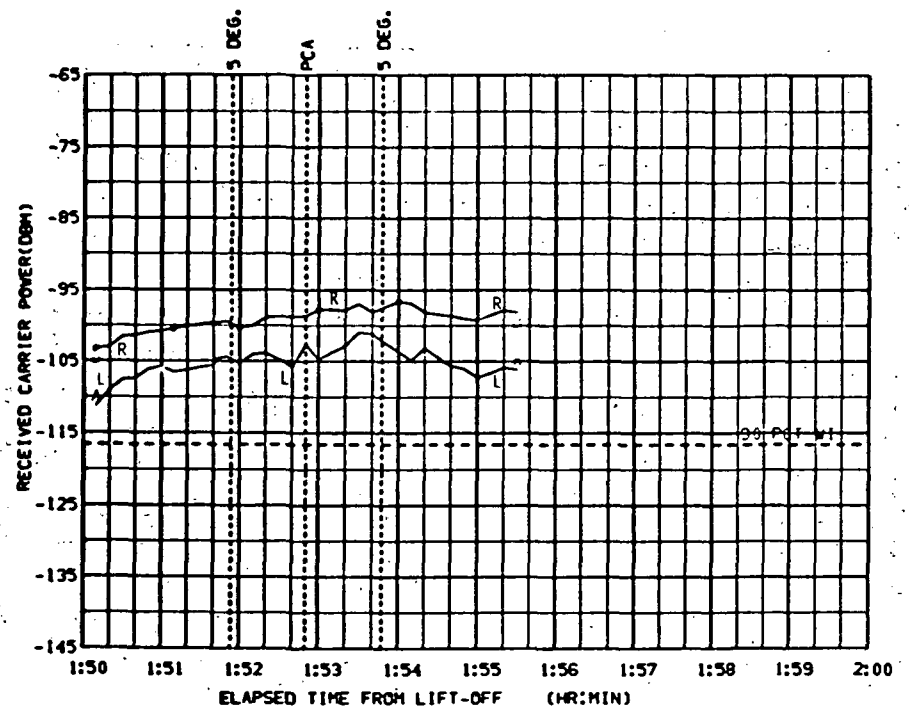

FIGURE 6-20b. CYI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

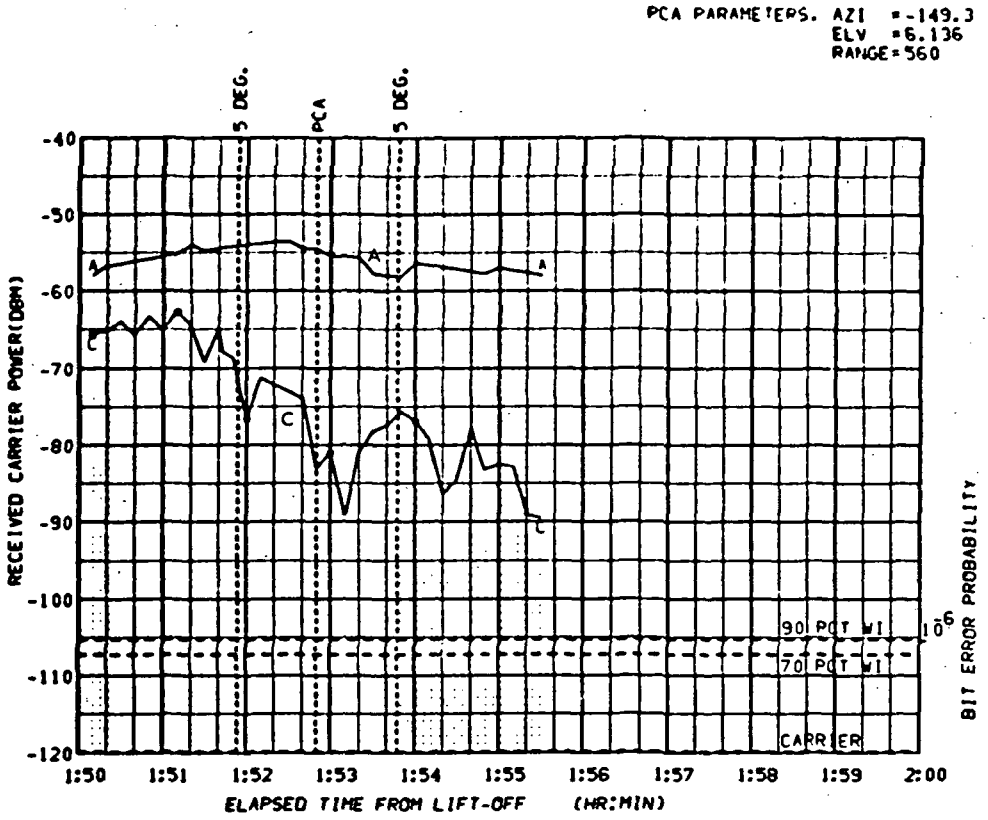

FIGURE 6-20c. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

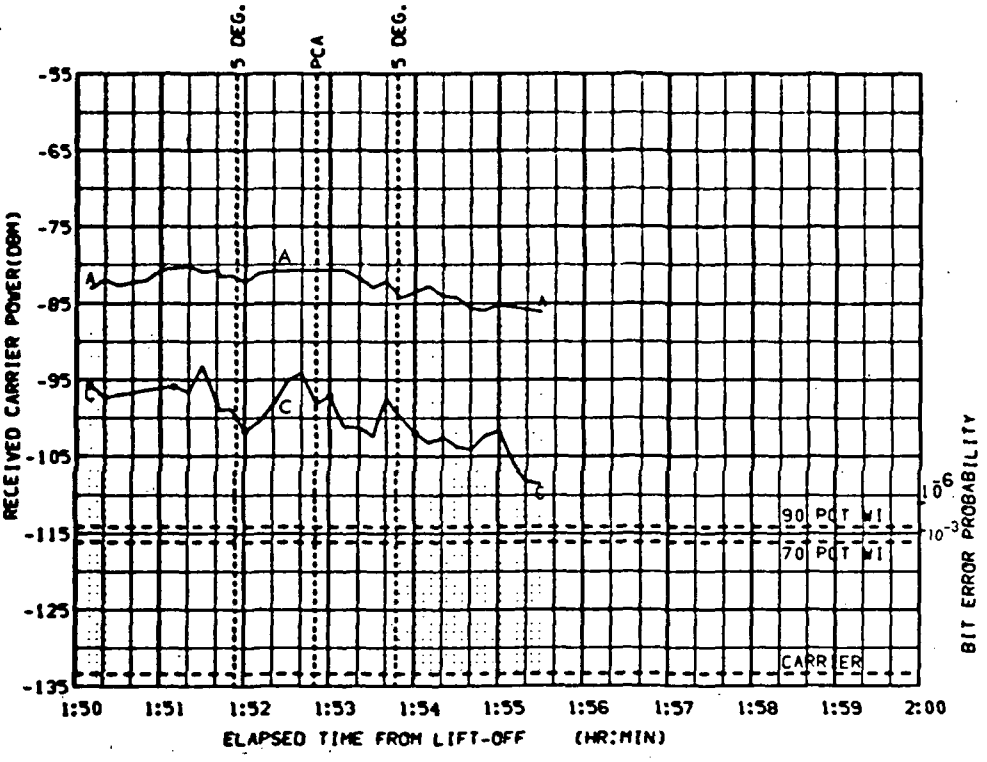

FIGURE 6-20d. CYI ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

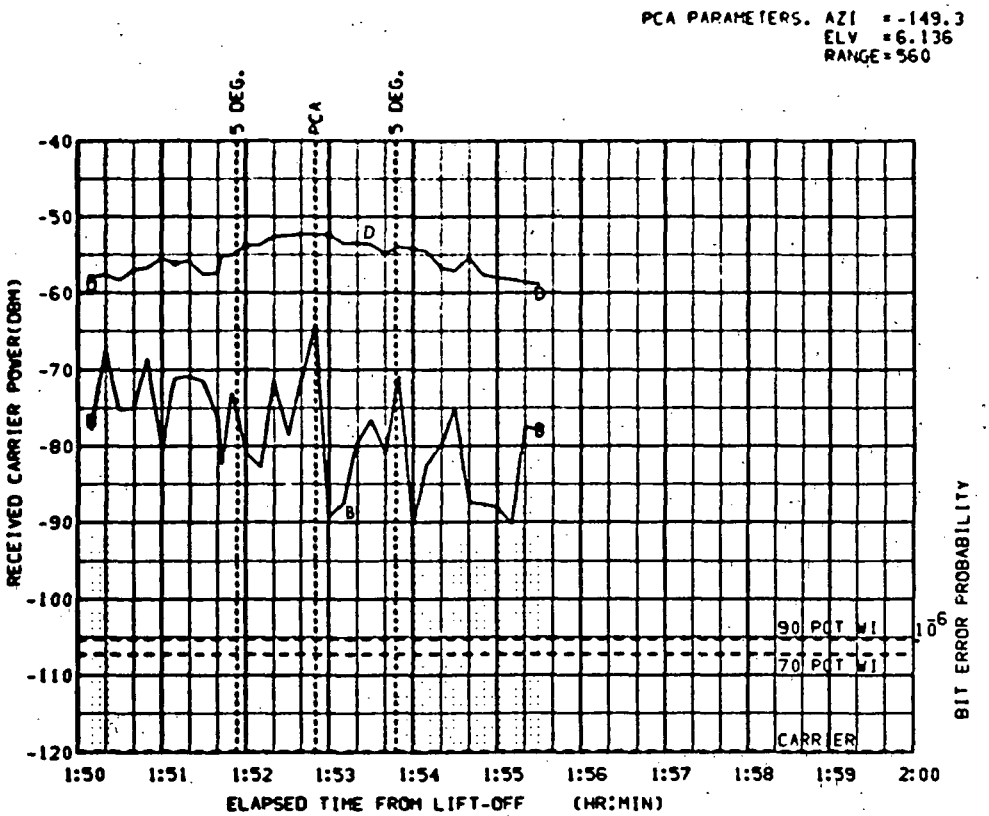

FIGURE 6-20e. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

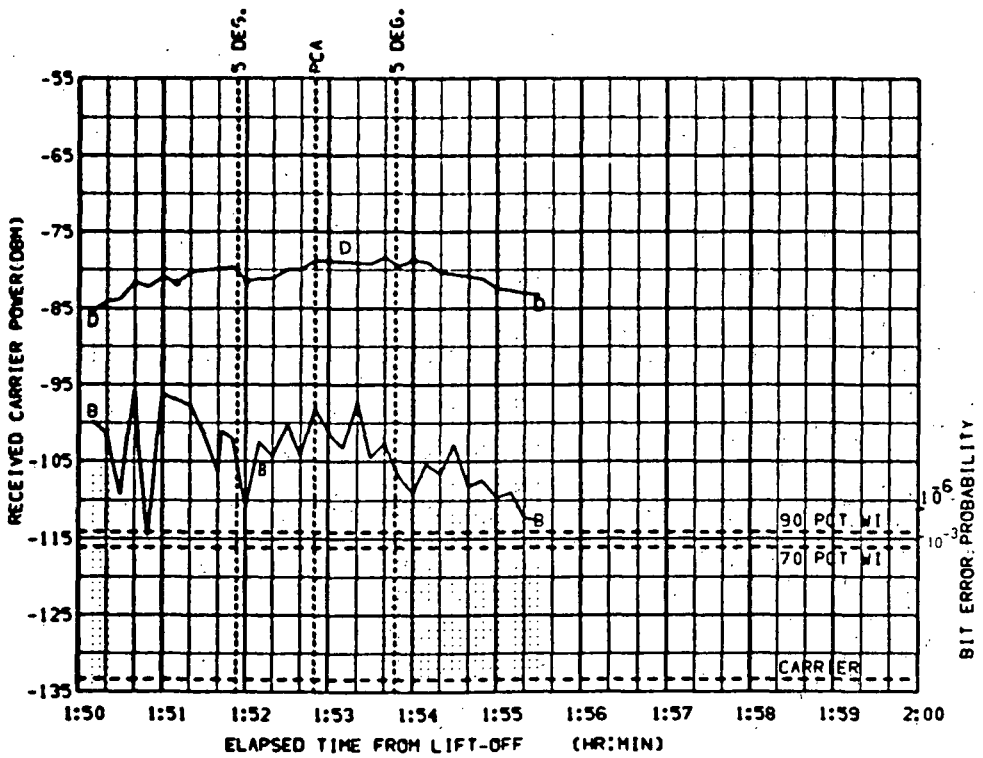

FIGURE 6-20f. CYI ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

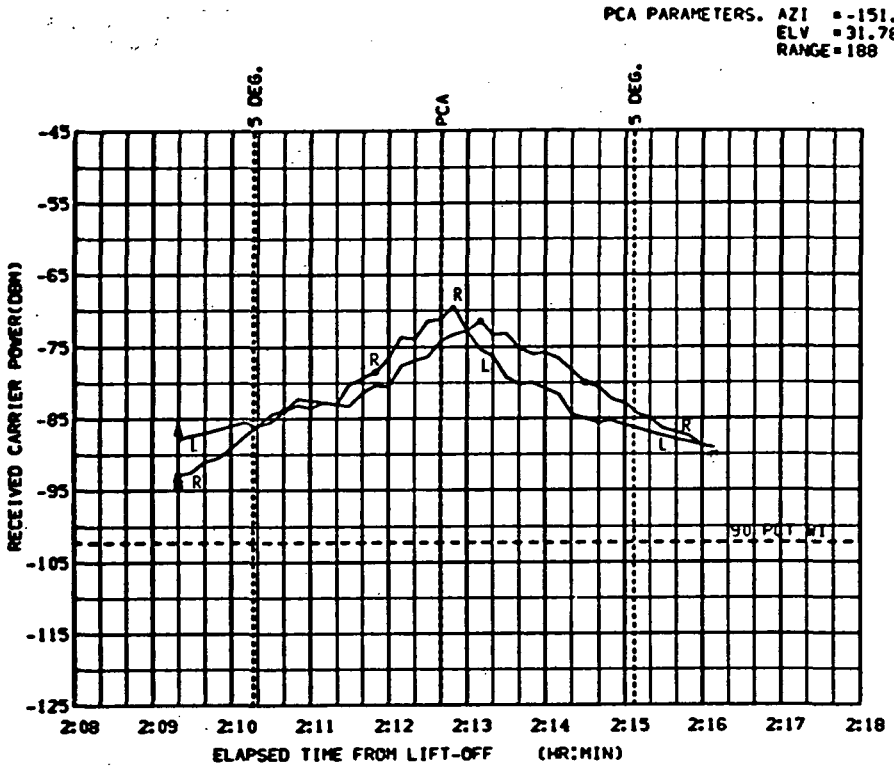

FIGURE 6-21a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

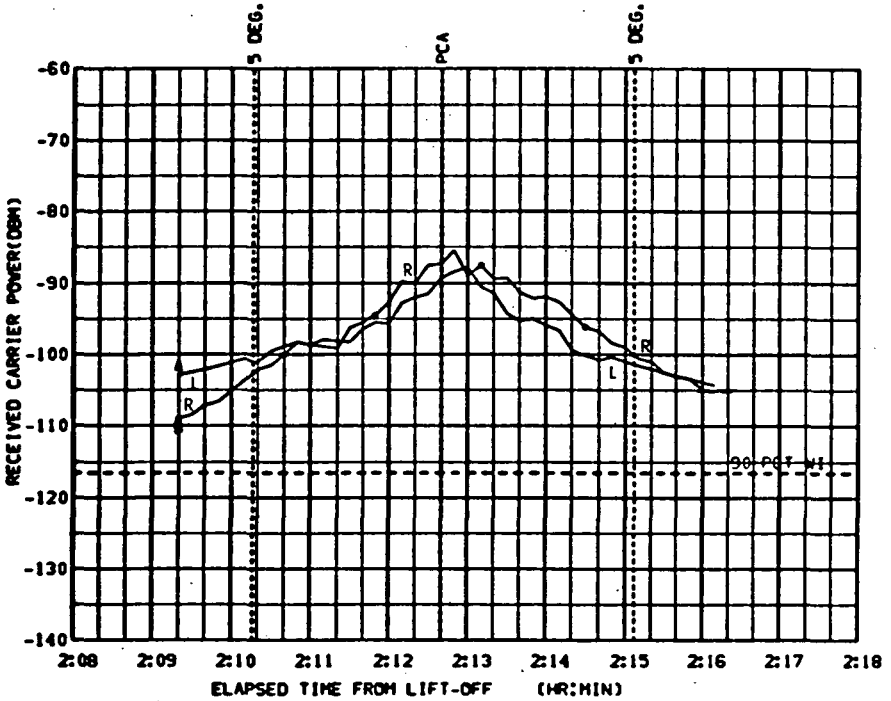

FIGURE 6-21b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

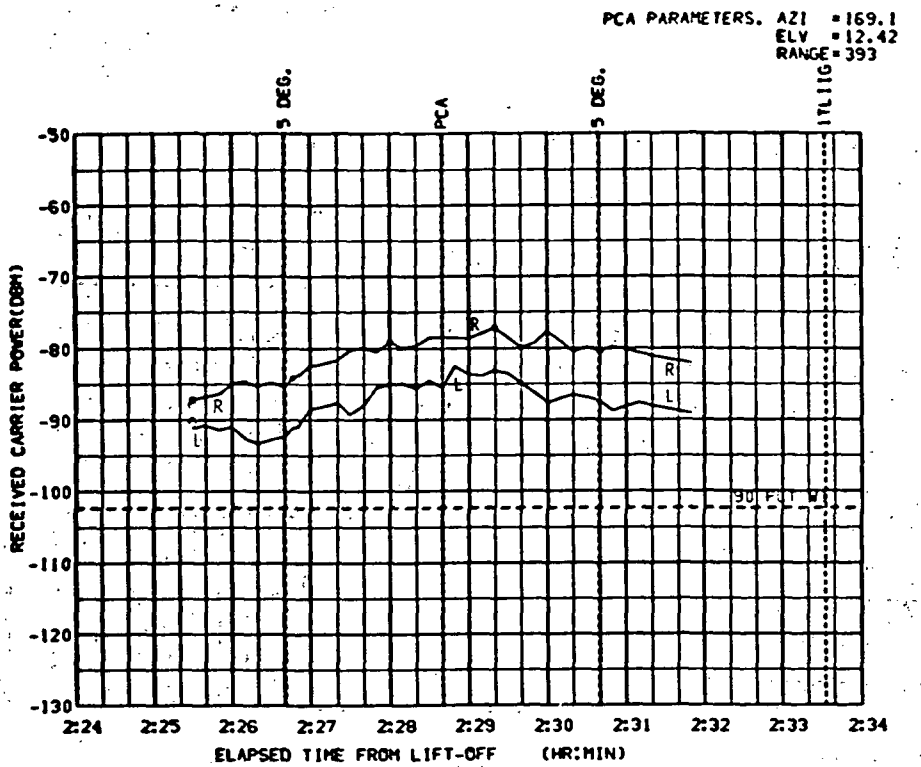

FIGURE 6-22a. CRO UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

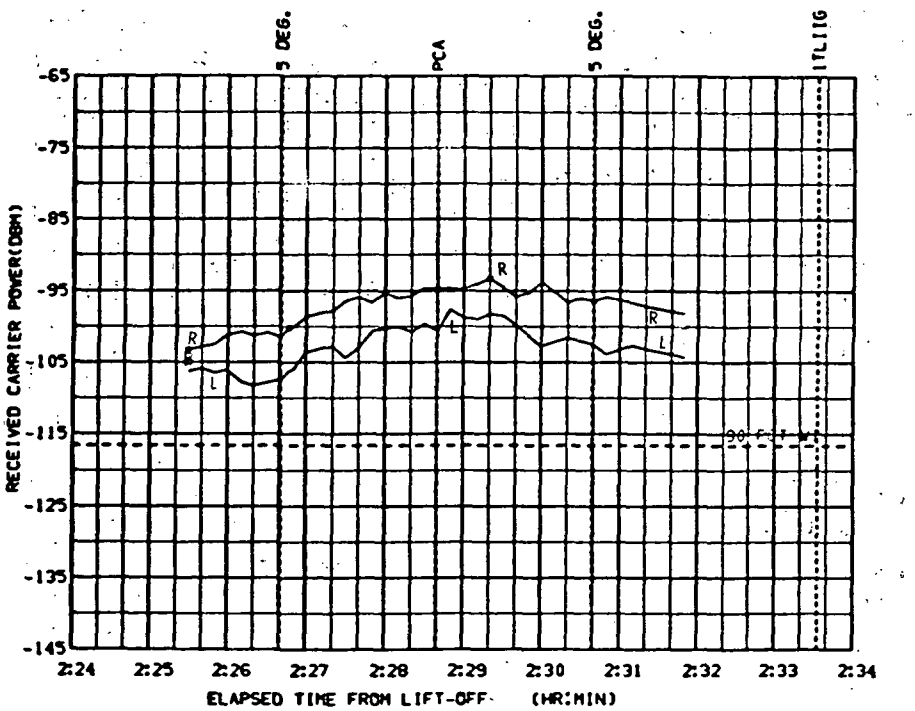

FIGURE 6-22b. CRO DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

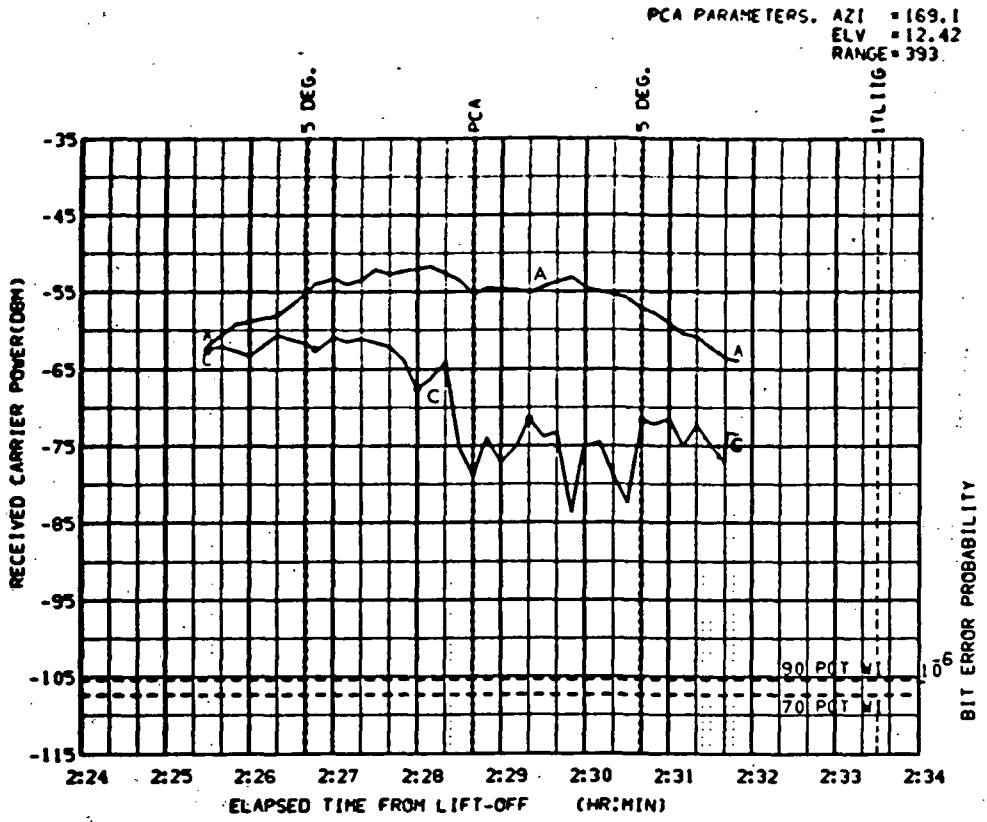

FIGURE 6-22c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

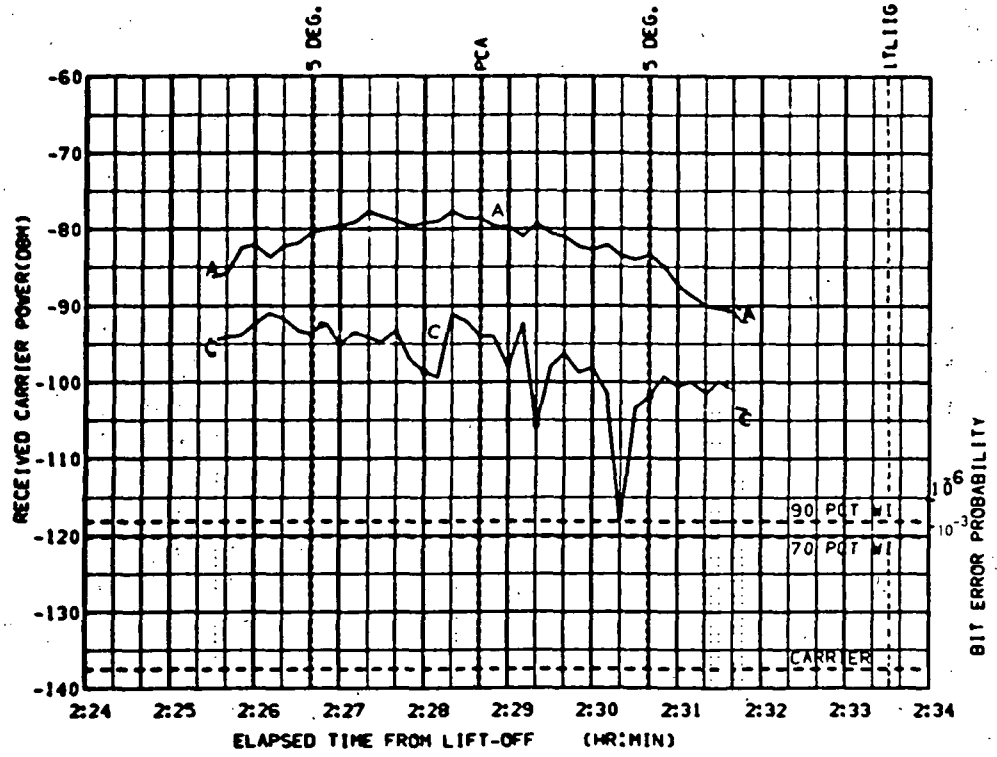

FIGURE 6-22d. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

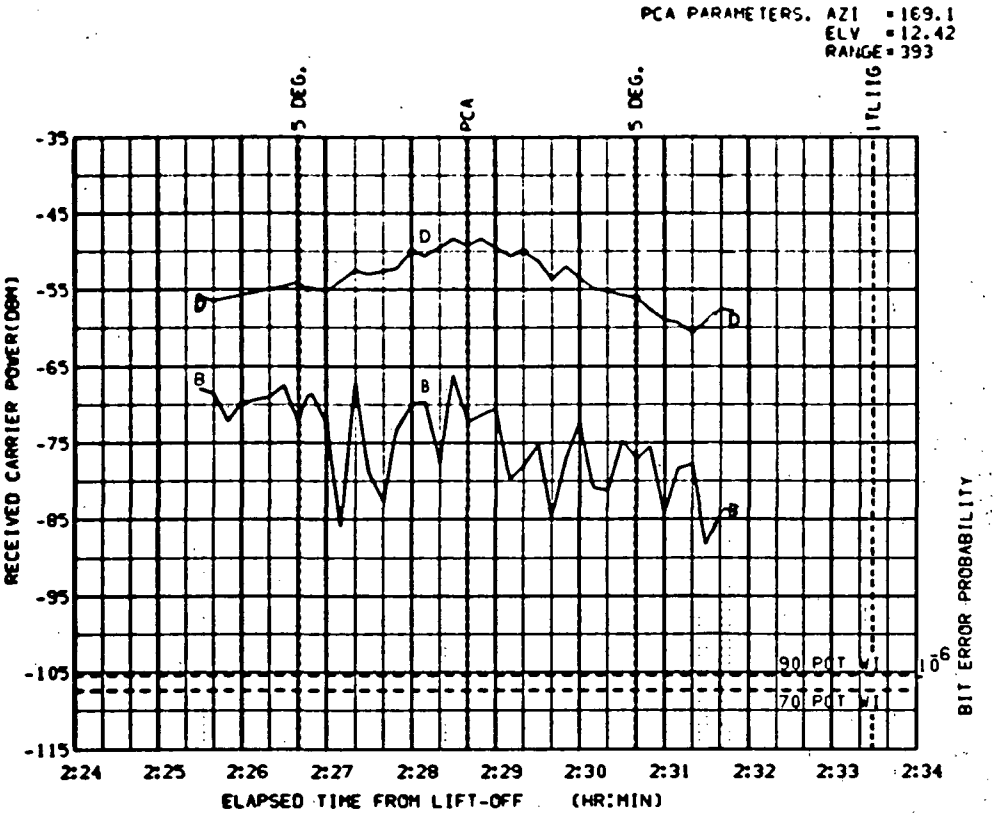

FIGURE 6-22e. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

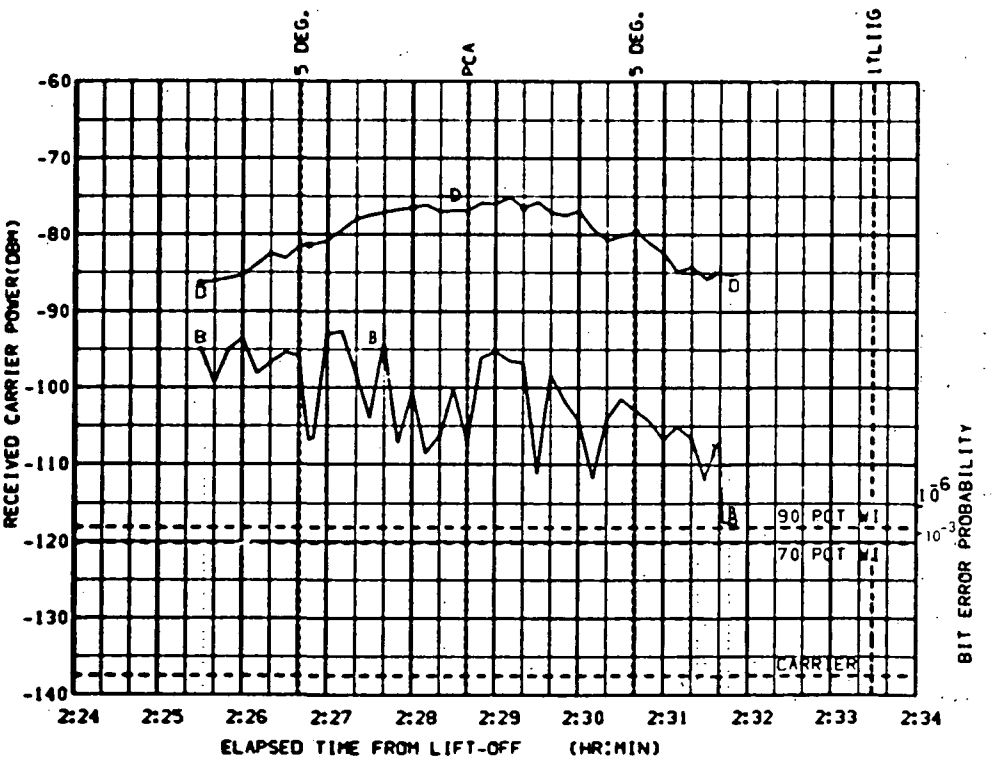

FIGURE 6-22f. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

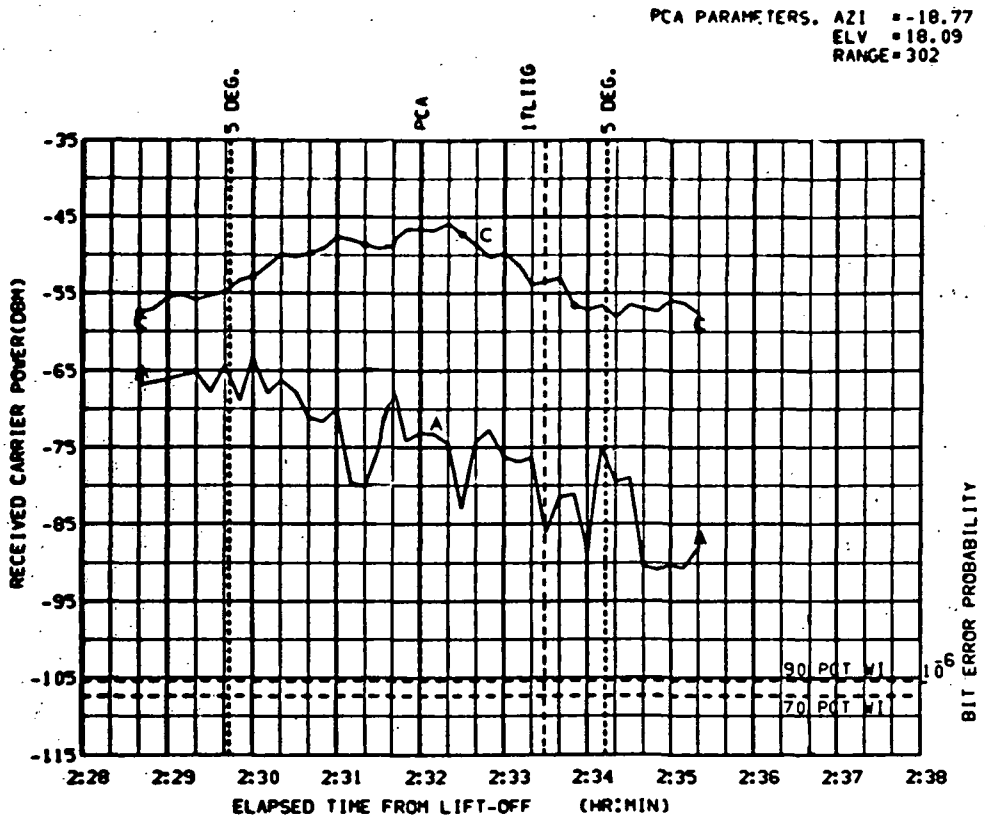

FIGURE 6-23a. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

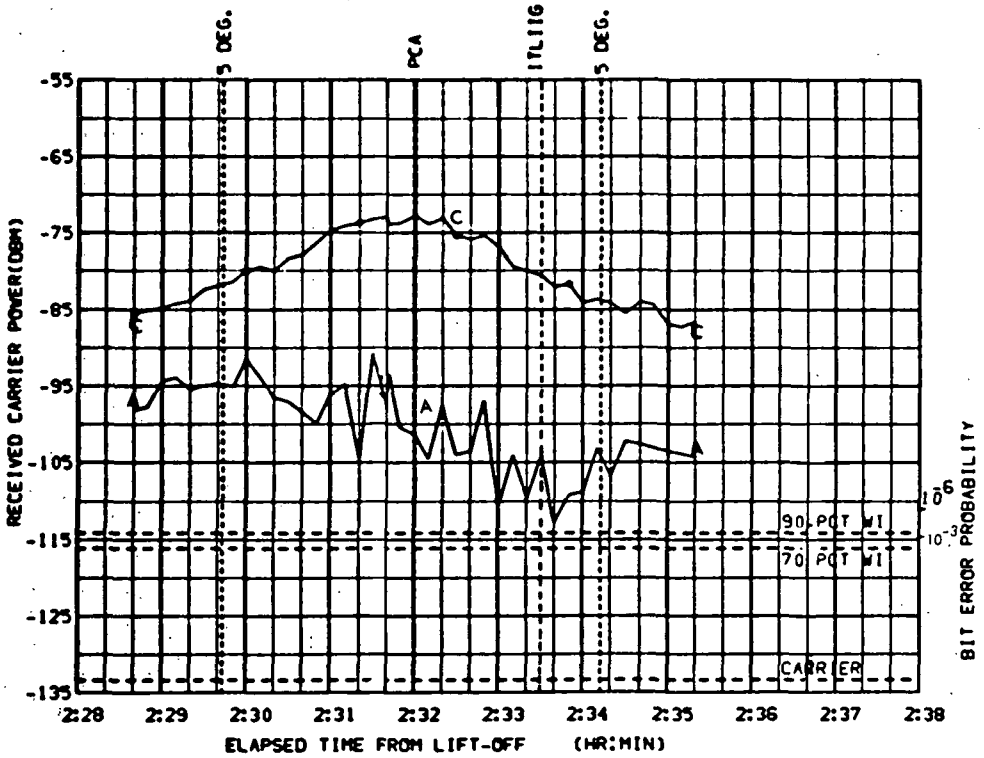

FIGURE 6-23b. MER DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

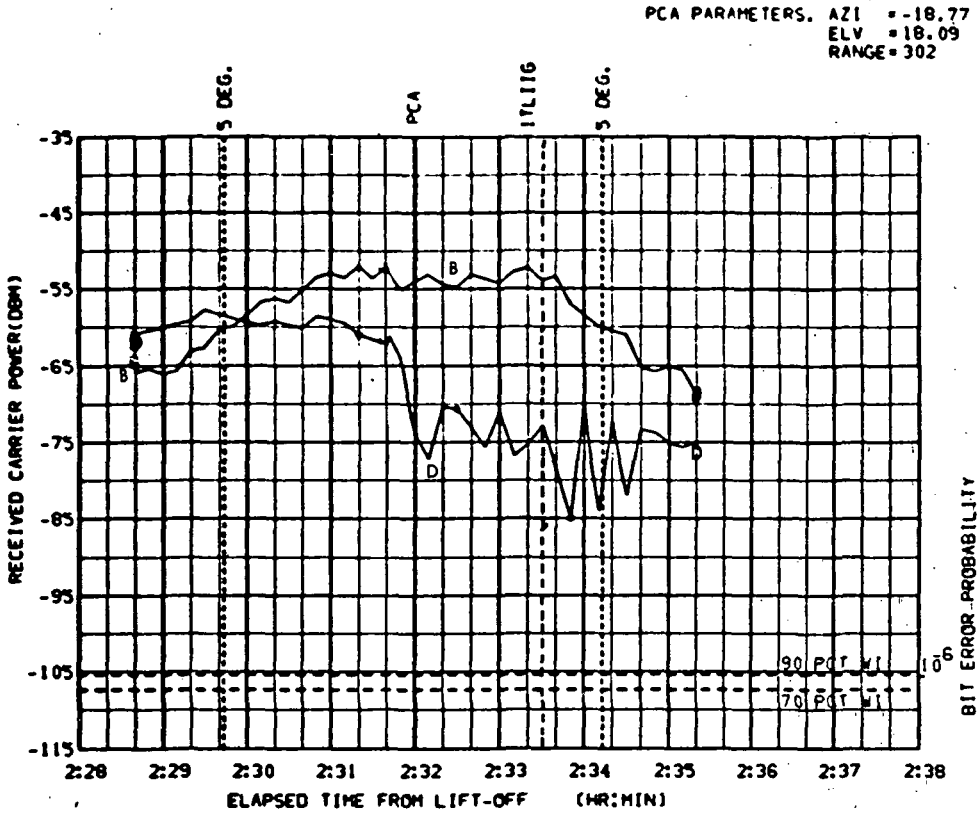

FIGURE 6-23c. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

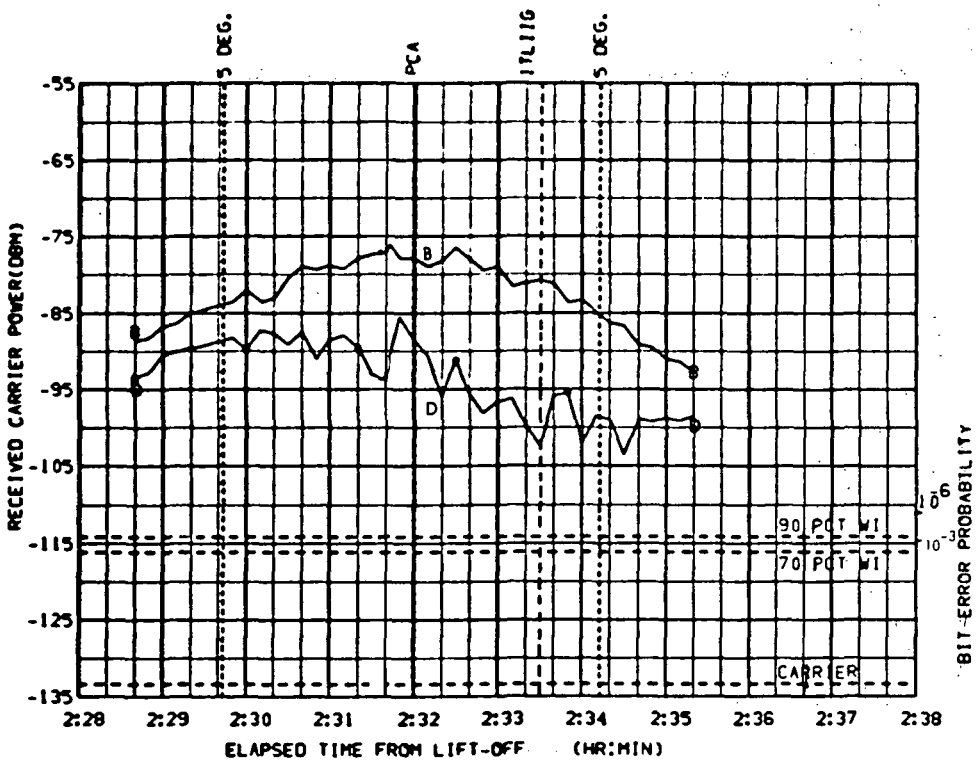

FIGURE 6-23d. MER DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

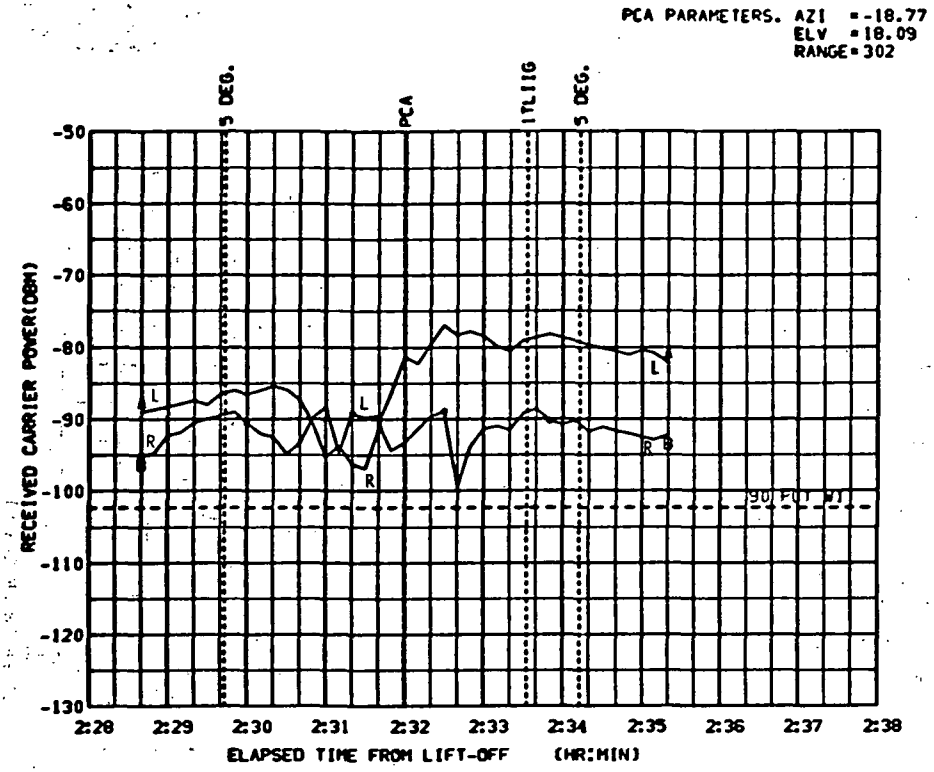

FIGURE 6-23e. MER UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

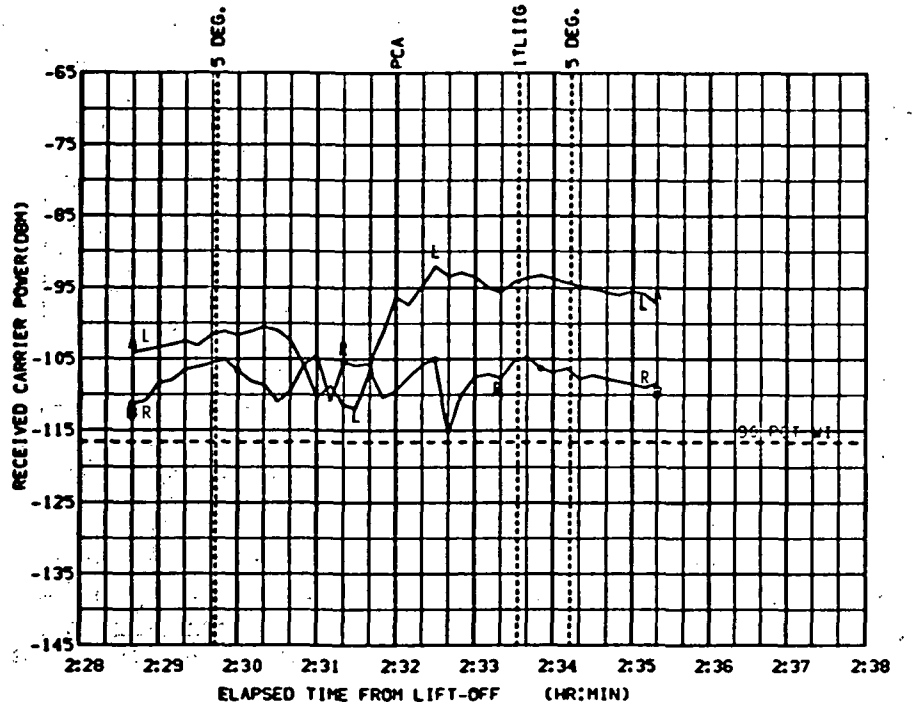

FIGURE 6-23f. MER DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

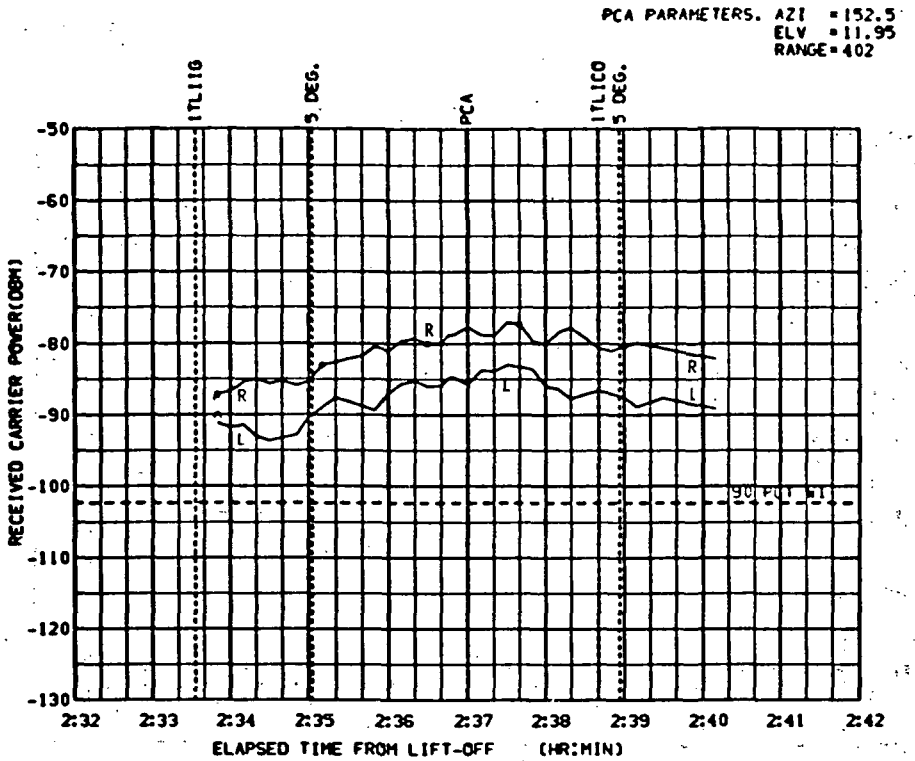

FIGURE 6-24a. RED UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

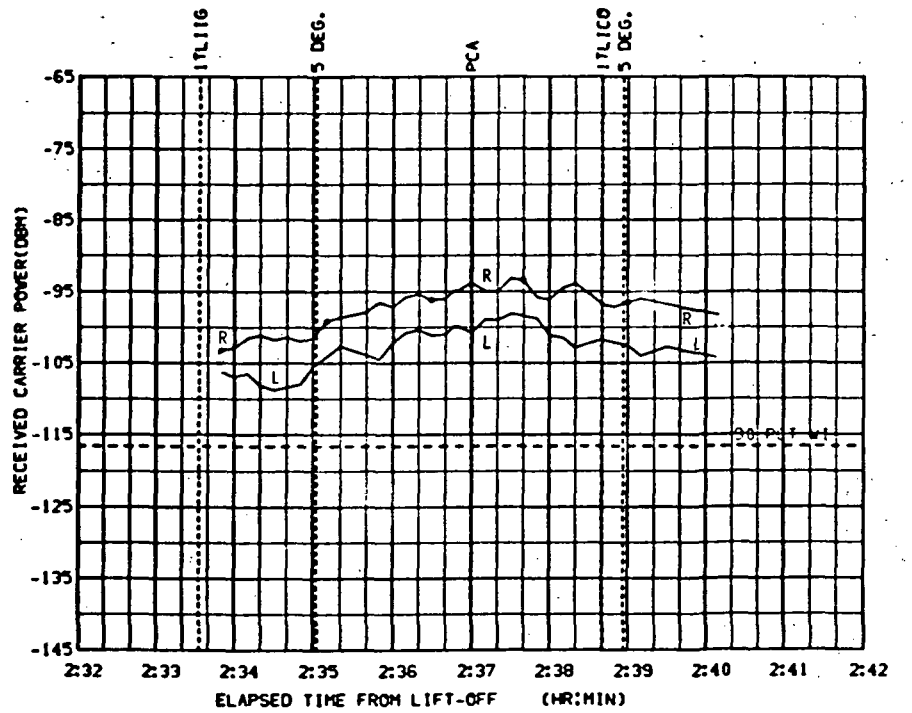

FIGURE 6-24b. RED DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

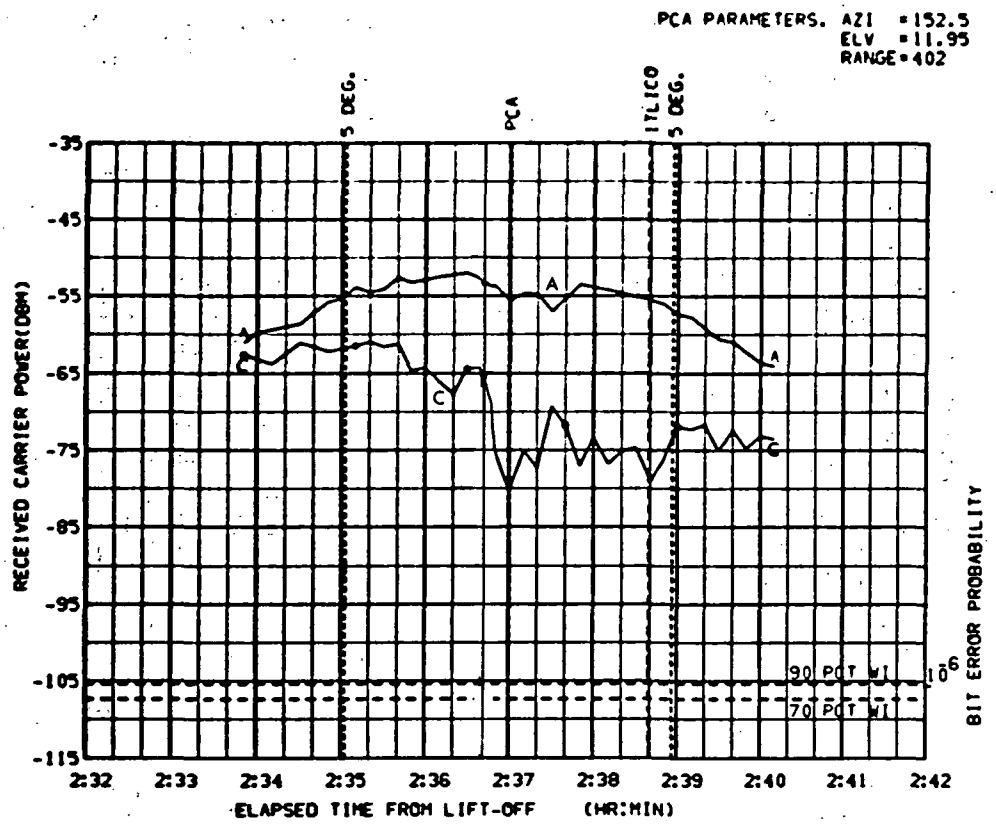

FIGURE 6-24c. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

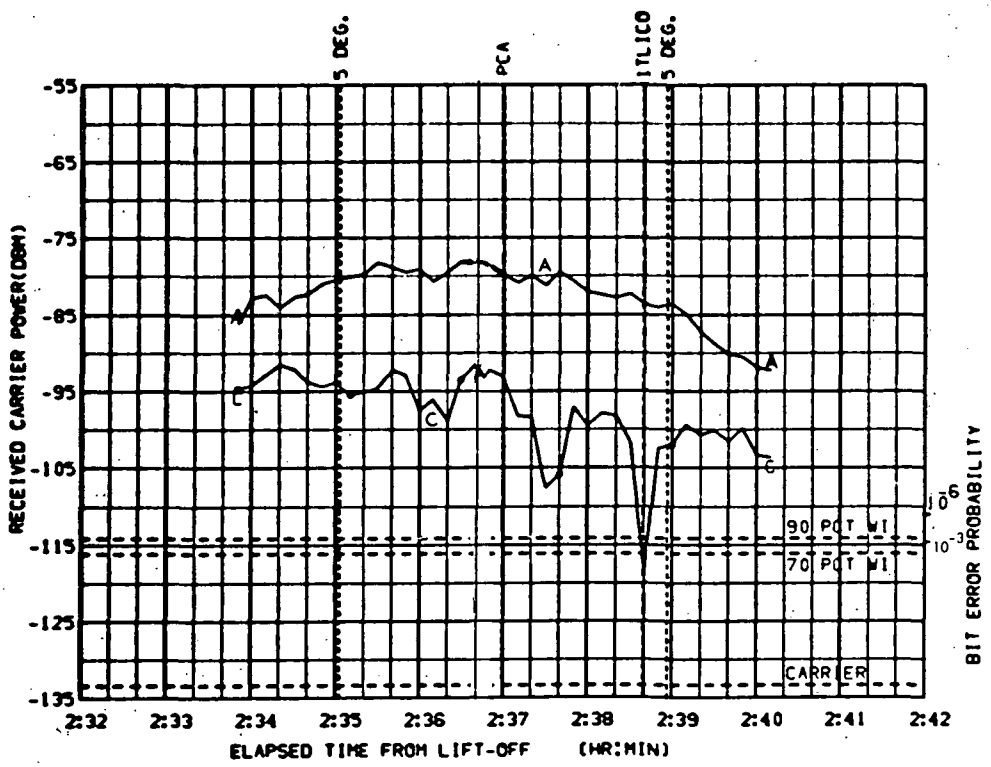

FIGURE 6-24d. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

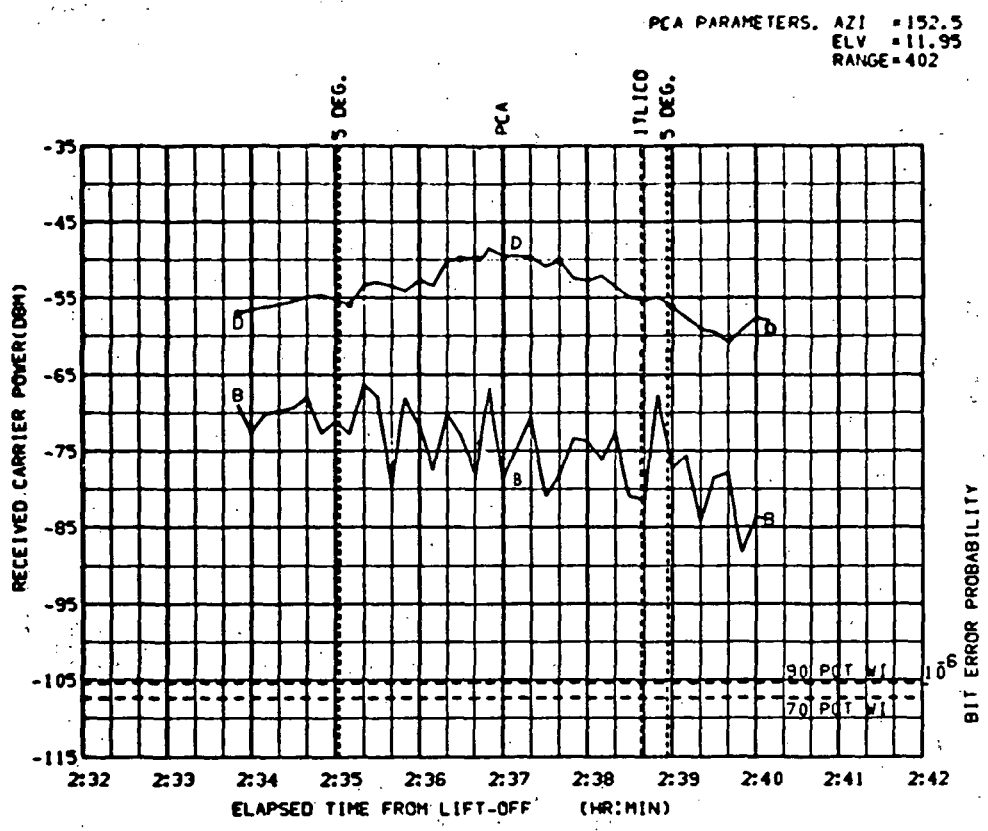

FIGURE 6-24e. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

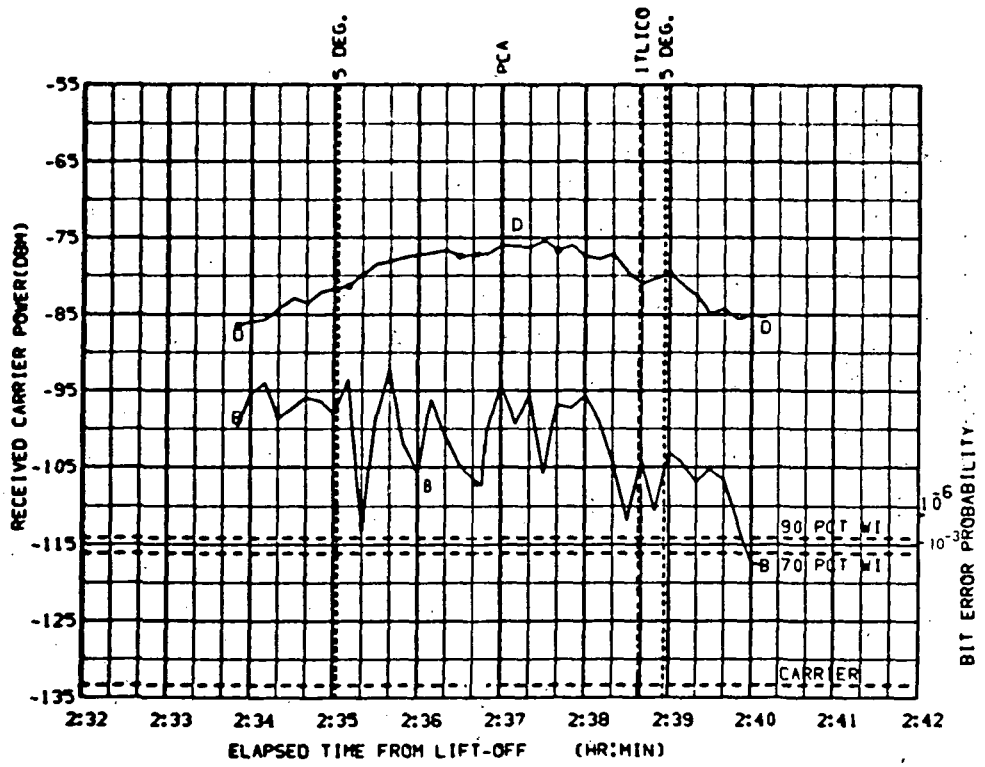

FIGURE 6-24f. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

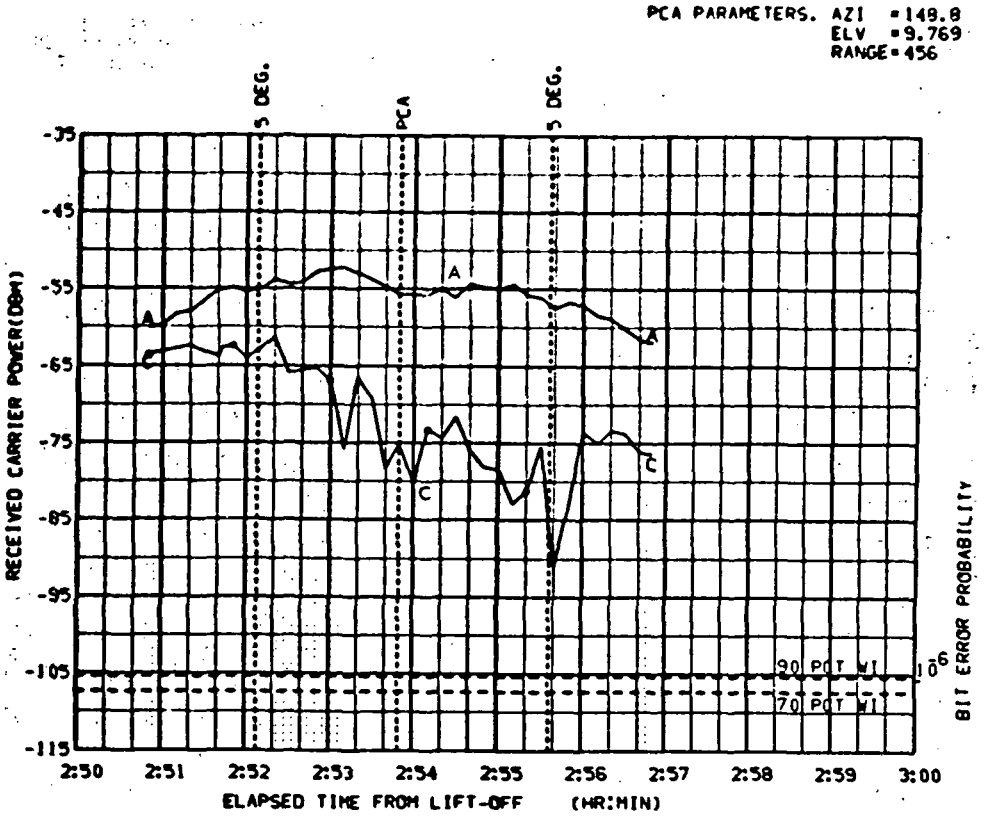

FIGURE 6-25a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

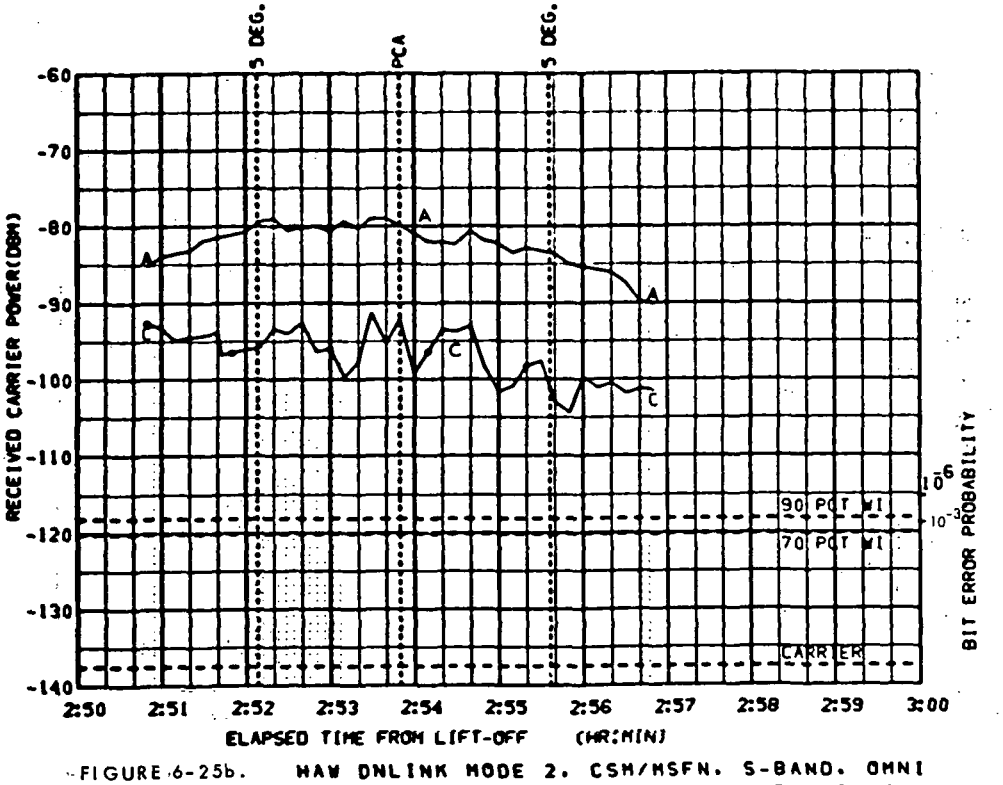

FIGURE 6-25b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

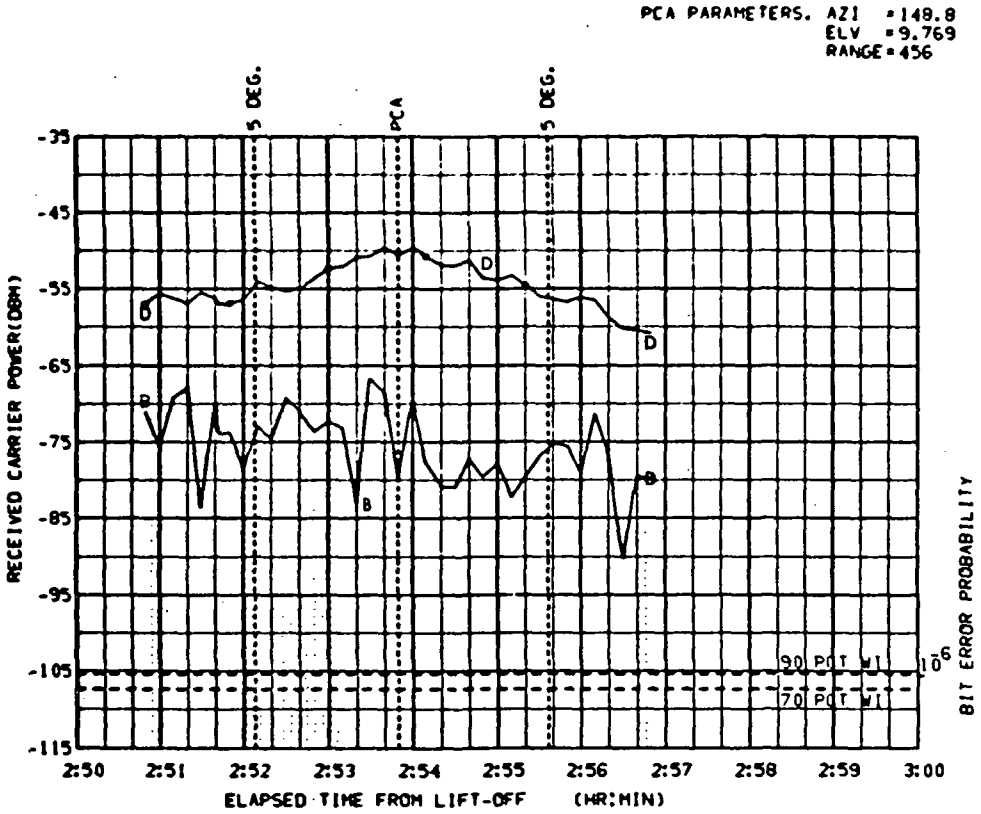

FIGURE 6-25c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

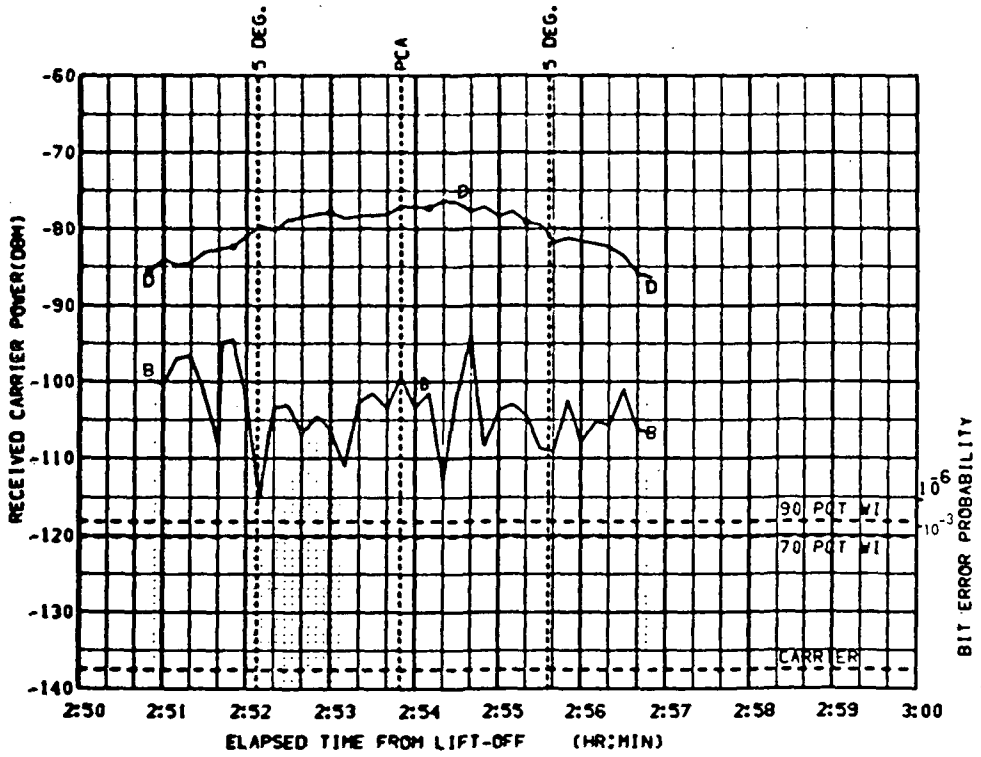

FIGURE 6-25d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

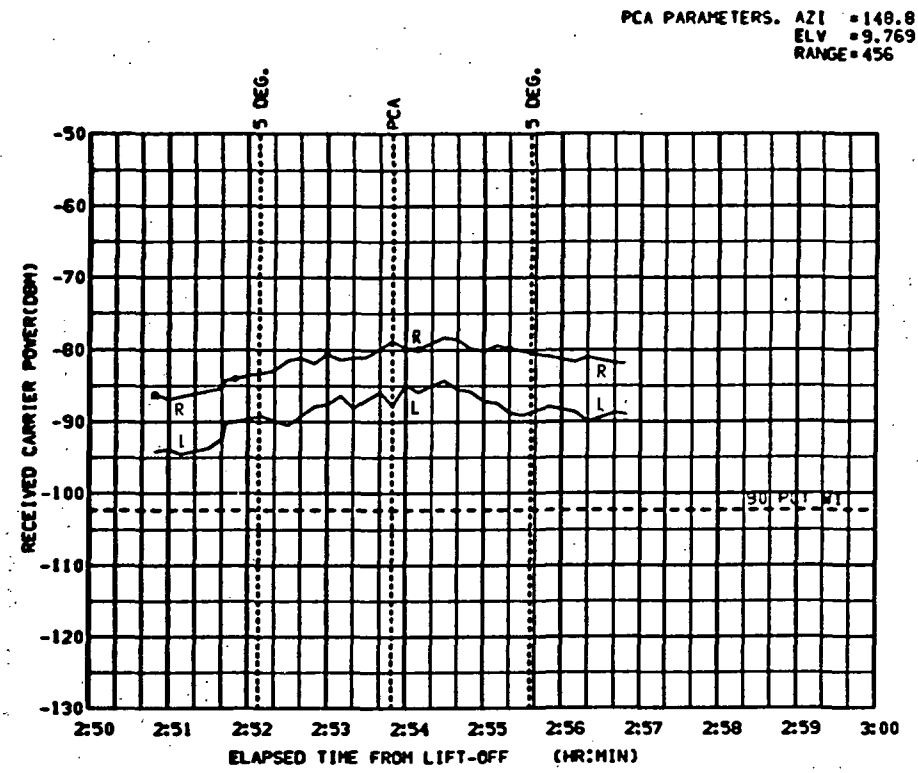

FIGURE 6-25e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

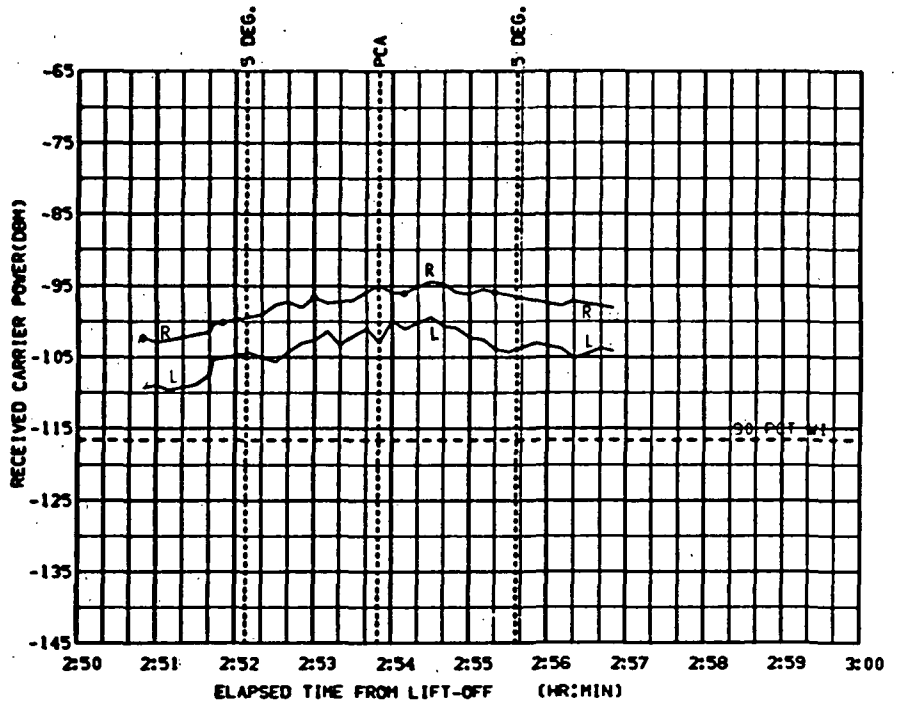

FIGURE 6-25f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

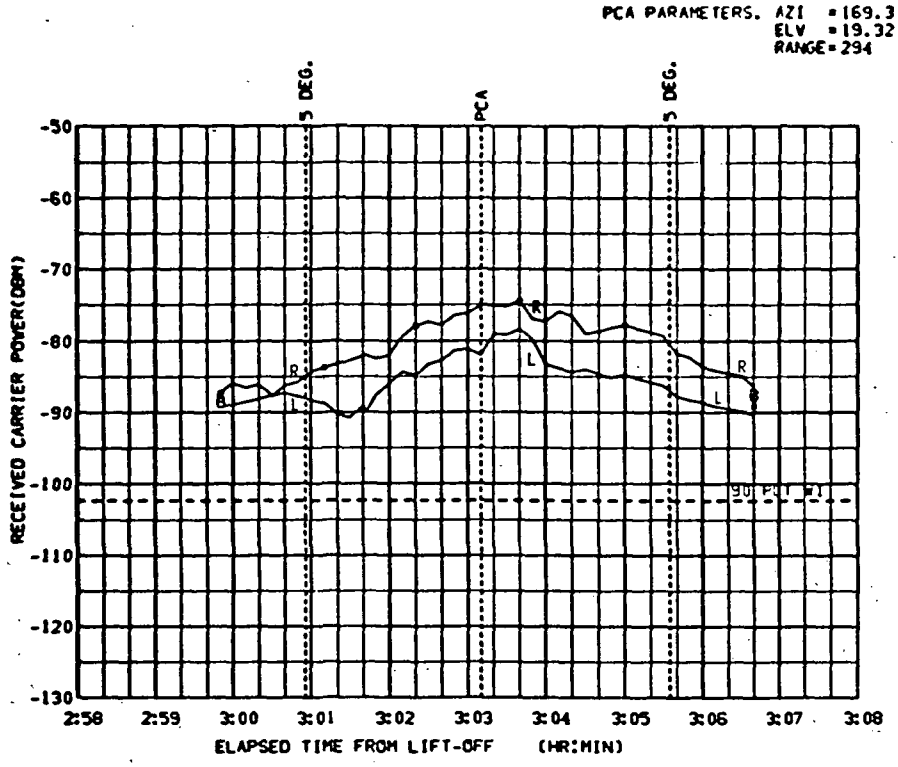

FIGURE 6-26a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

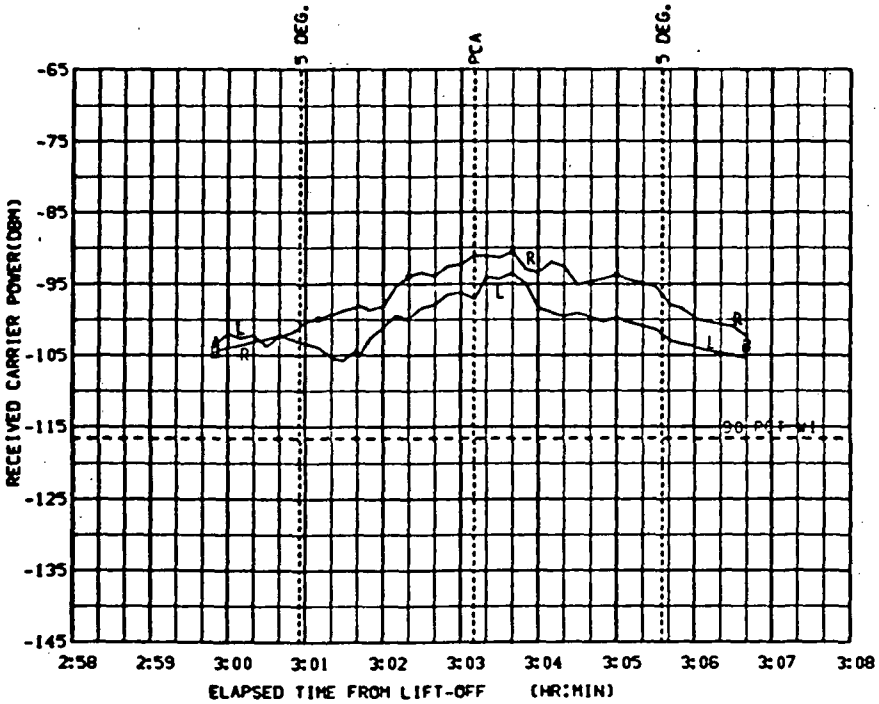

FIGURE 6-26b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

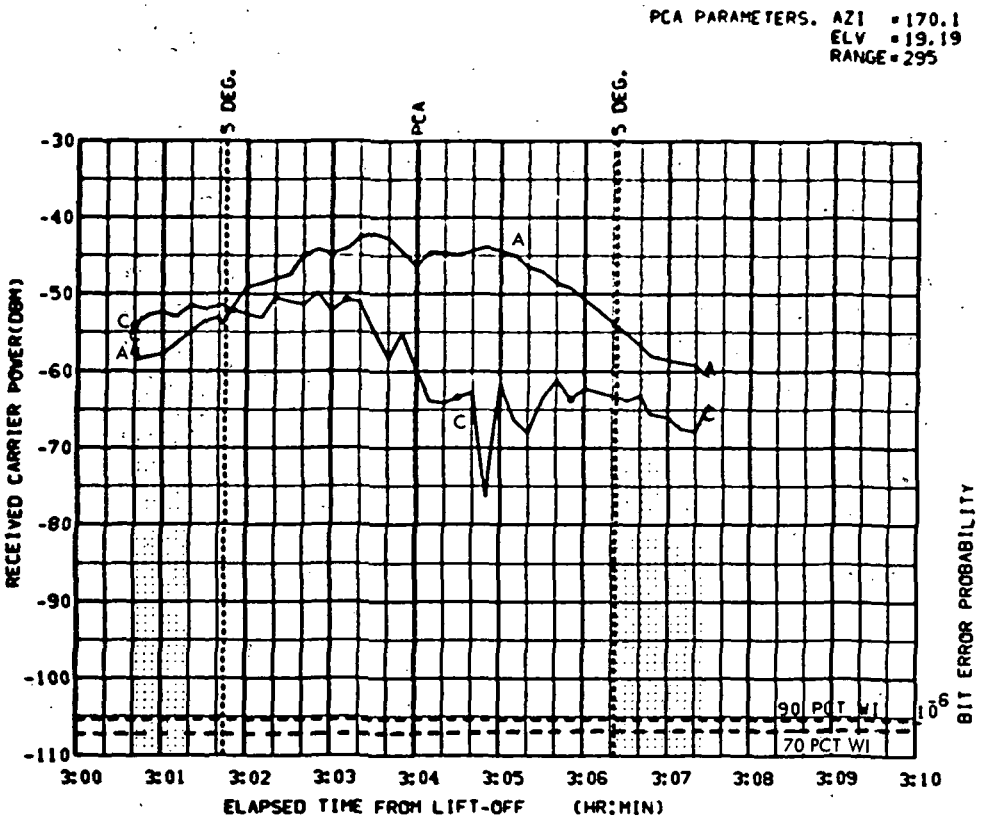

FIGURE 6-27a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

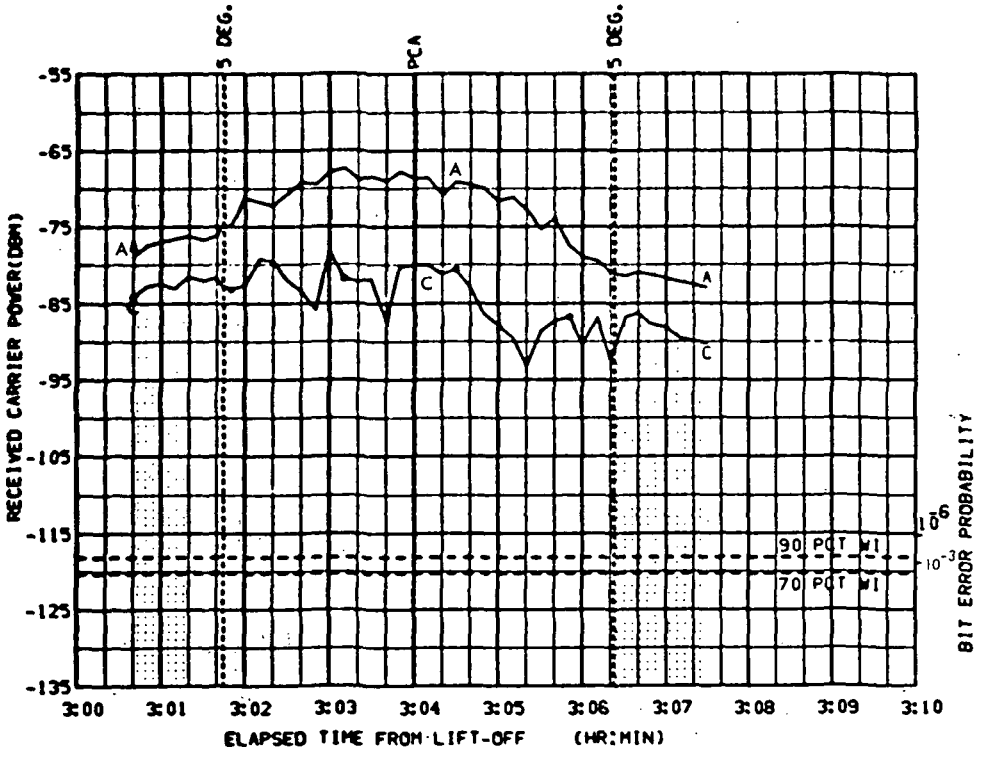

FIGURE 6-27b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

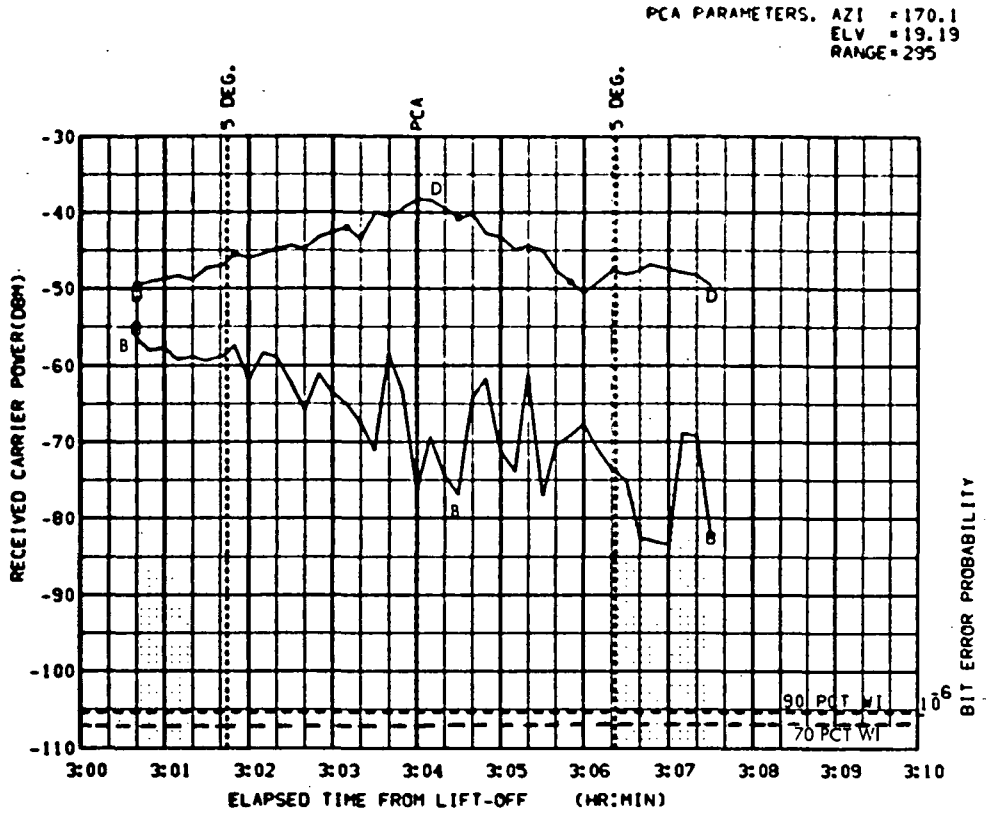

FIGURE 6-27c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

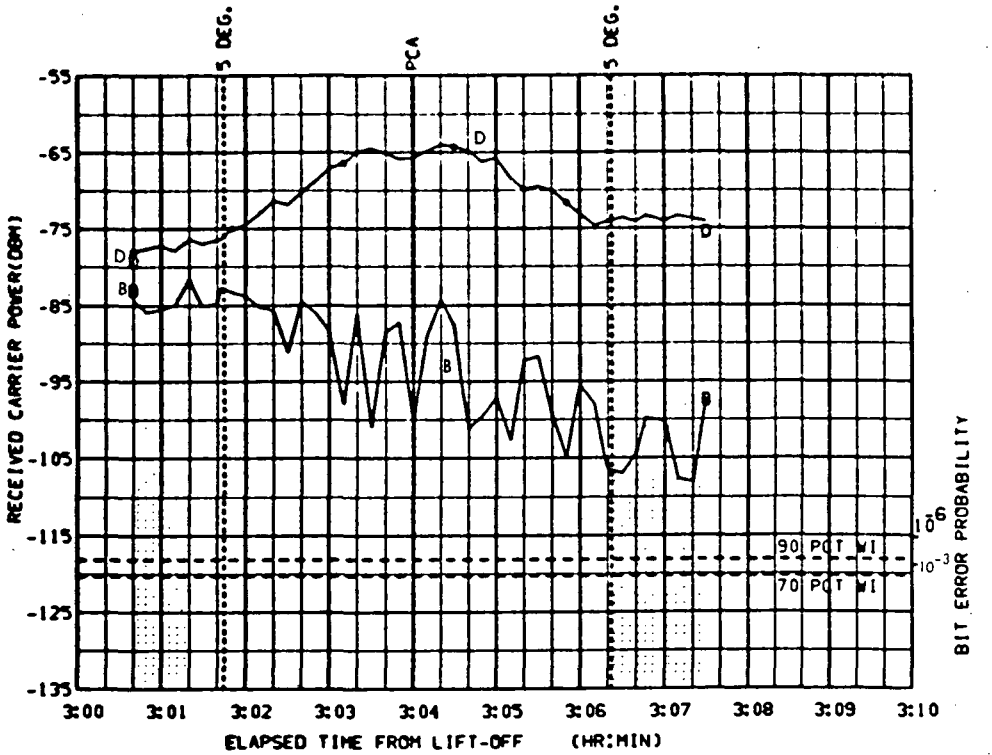

FIGURE 6-27d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

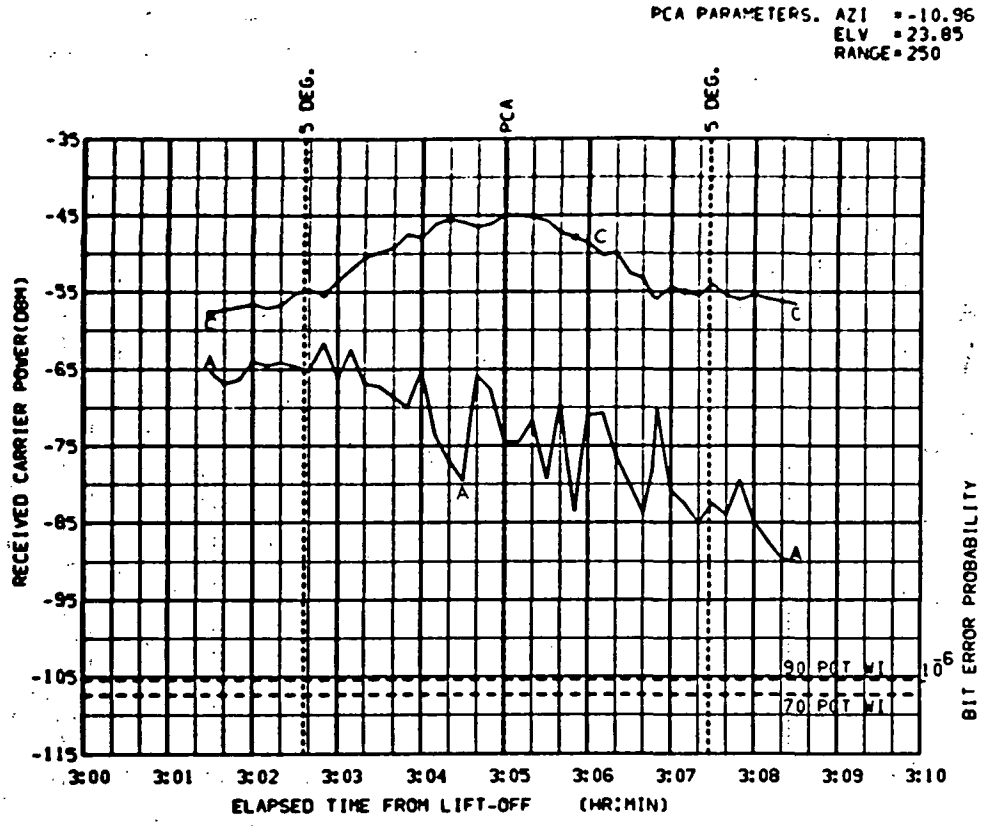

FIGURE 6-28a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

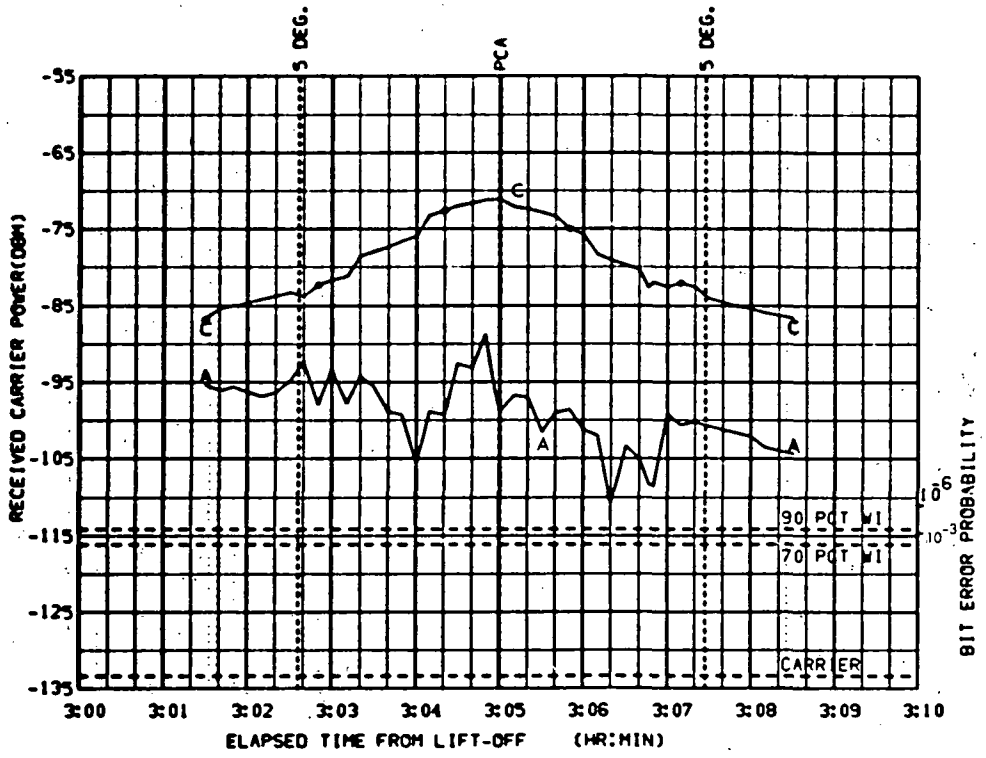

FIGURE 6-28b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

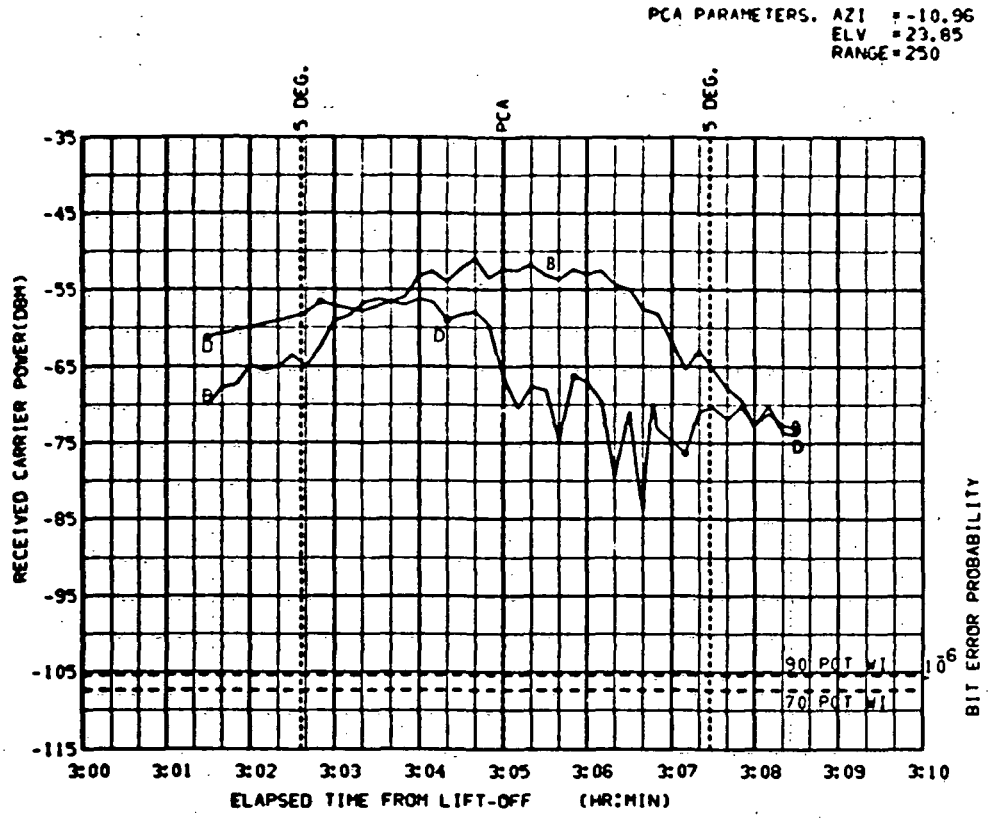

FIGURE 6-28c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

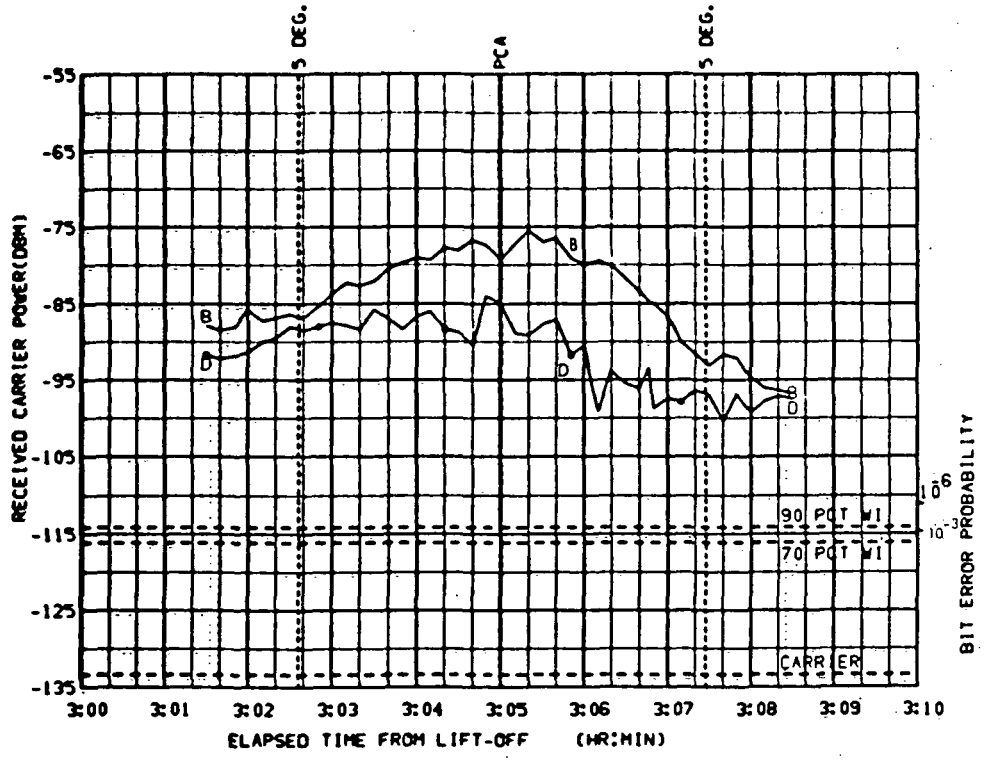

FIGURE 6-28d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

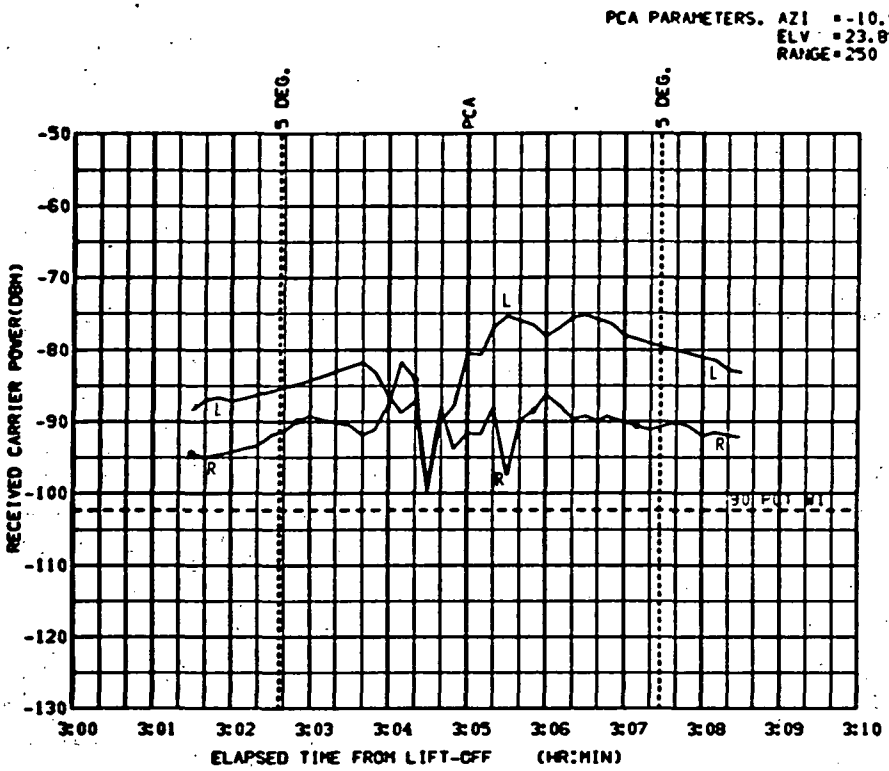

FIGURE 6-28e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

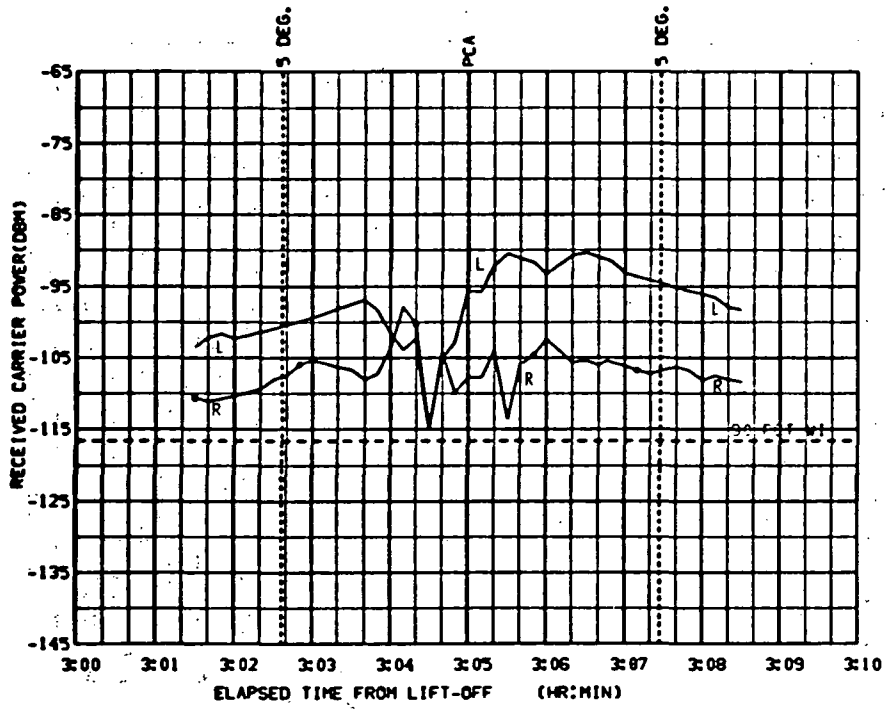

FIGURE 6-28f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

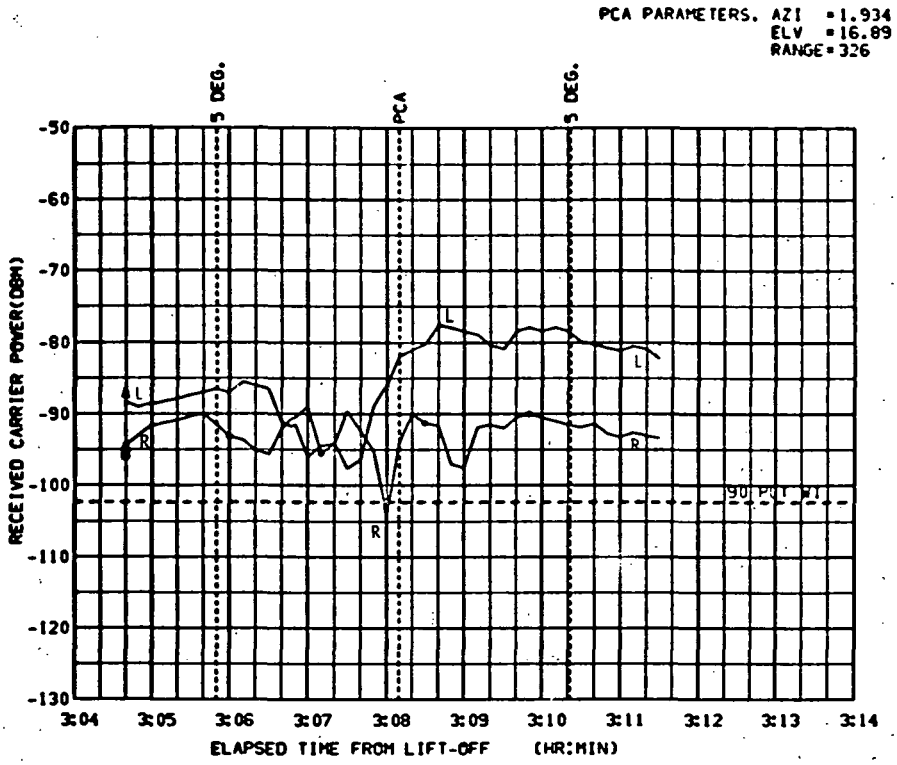

FIGURE 6-29a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

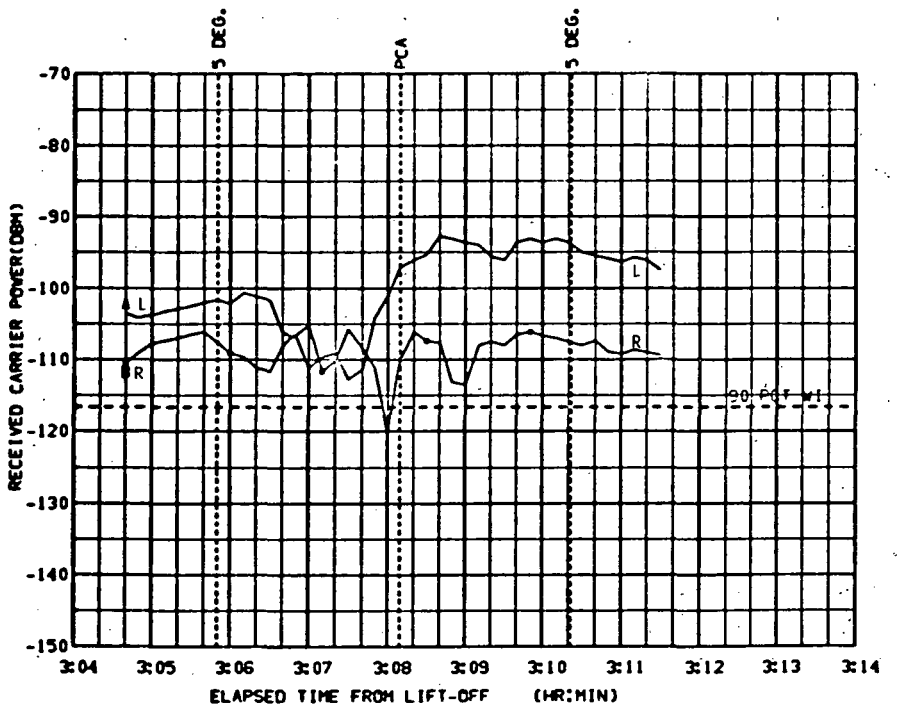

FIGURE 6-29b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

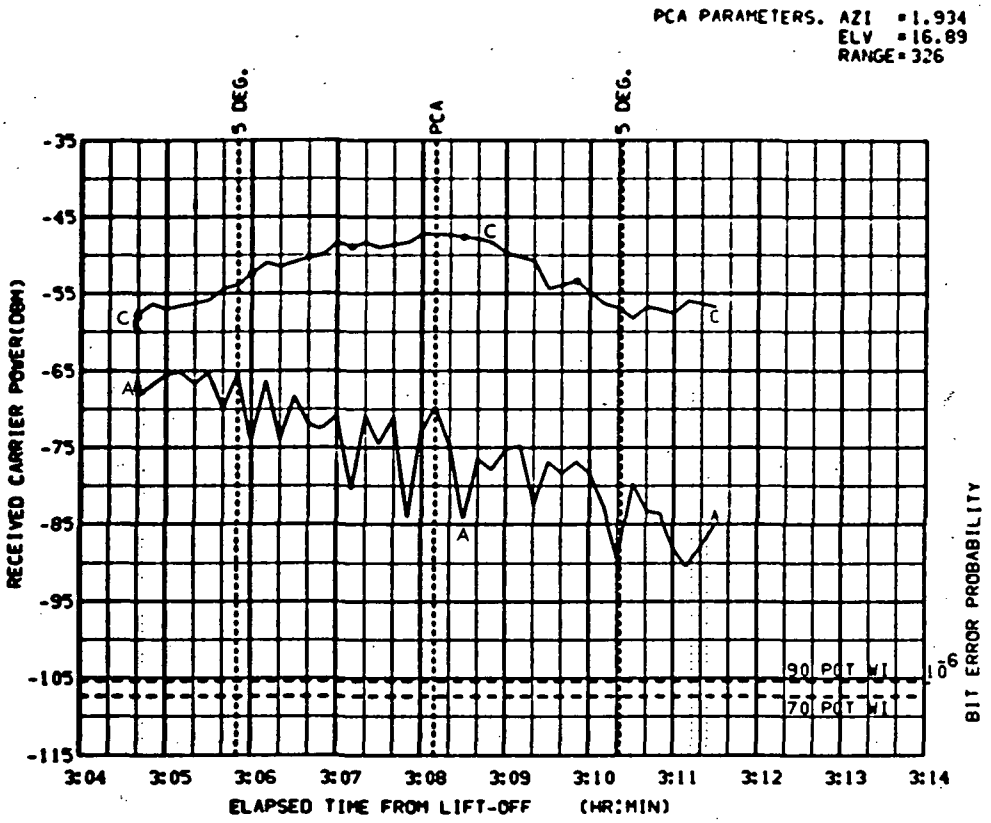

FIGURE 6-29c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

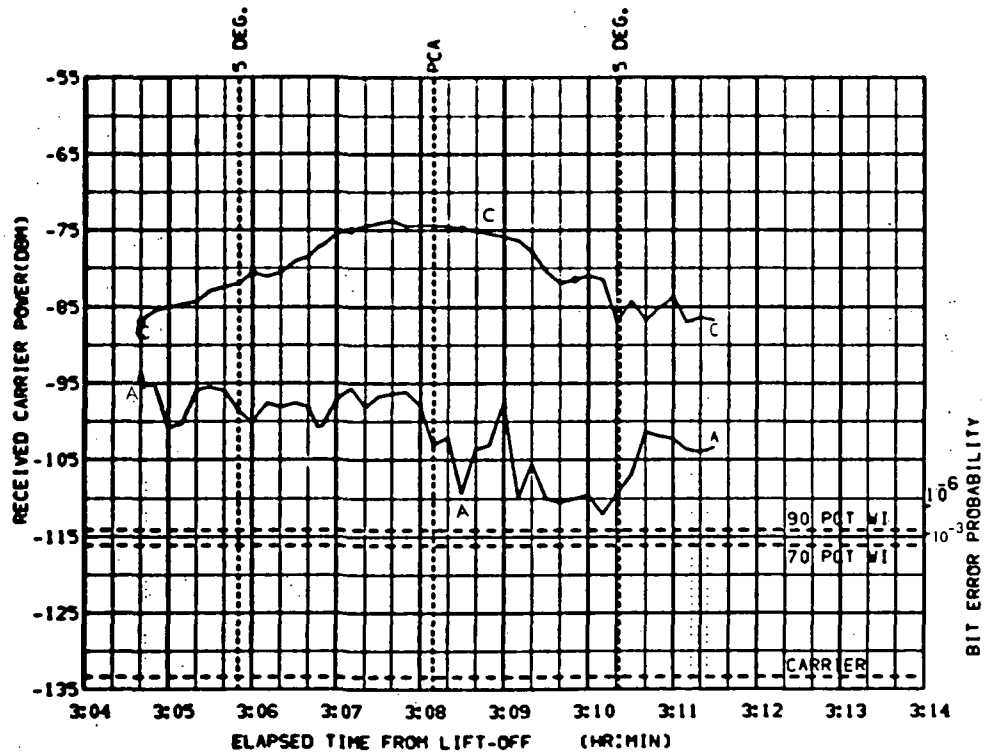

FIGURE 6-29d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

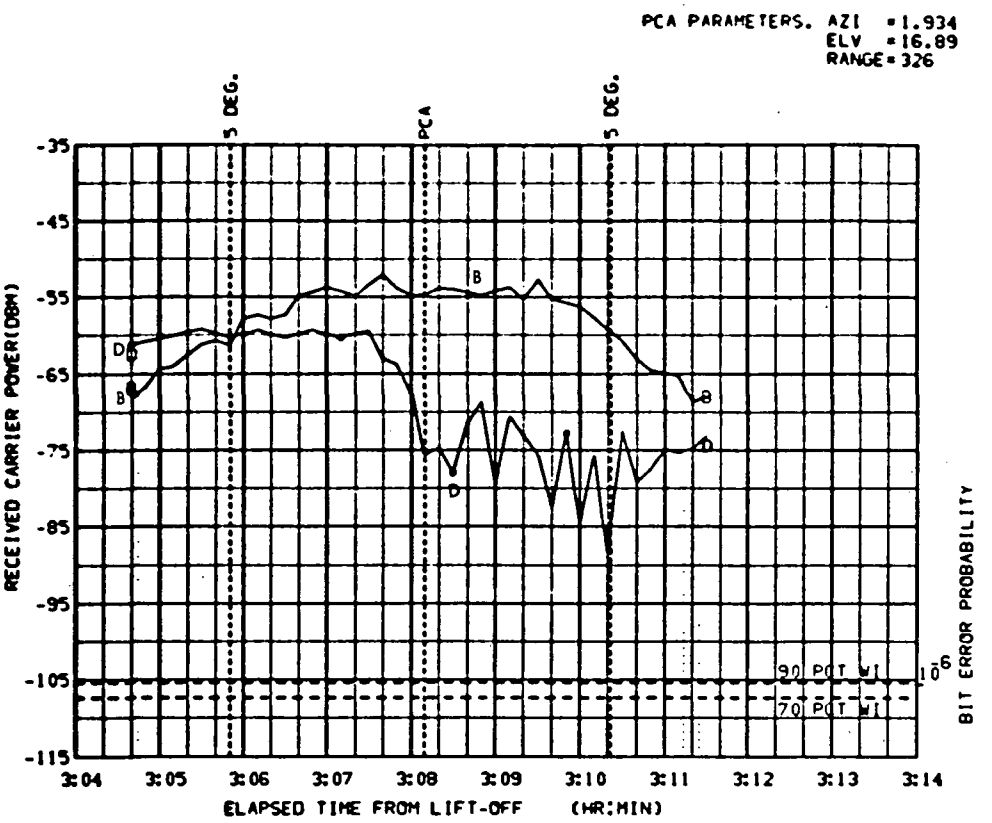

FIGURE 6-29e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

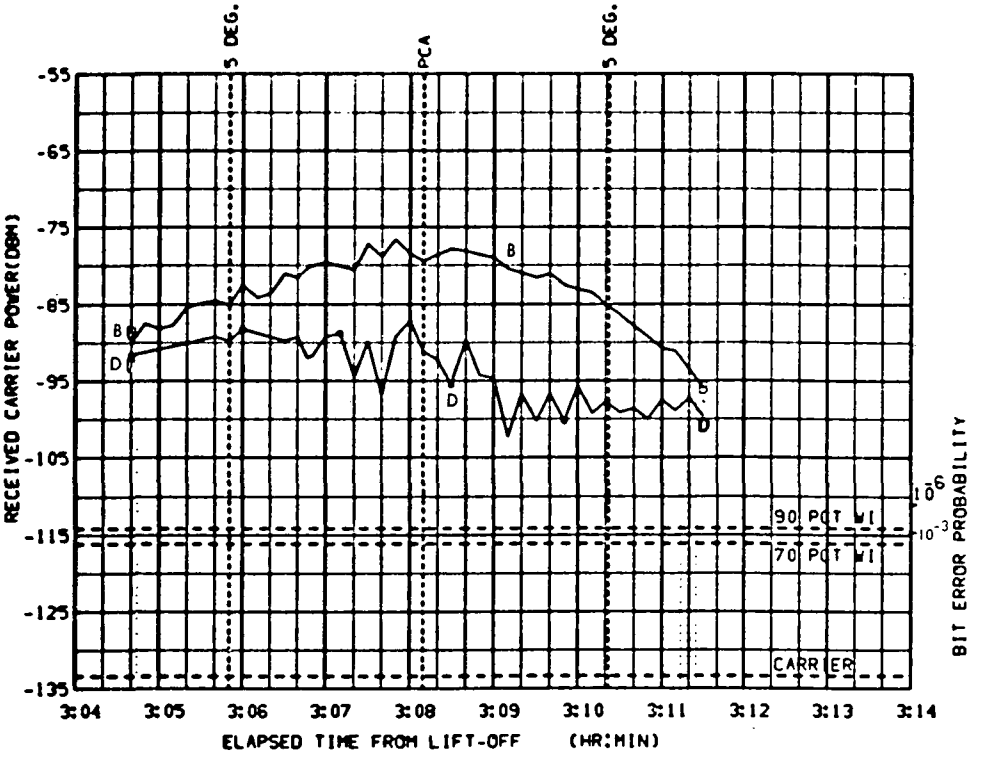

FIGURE 6-29f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

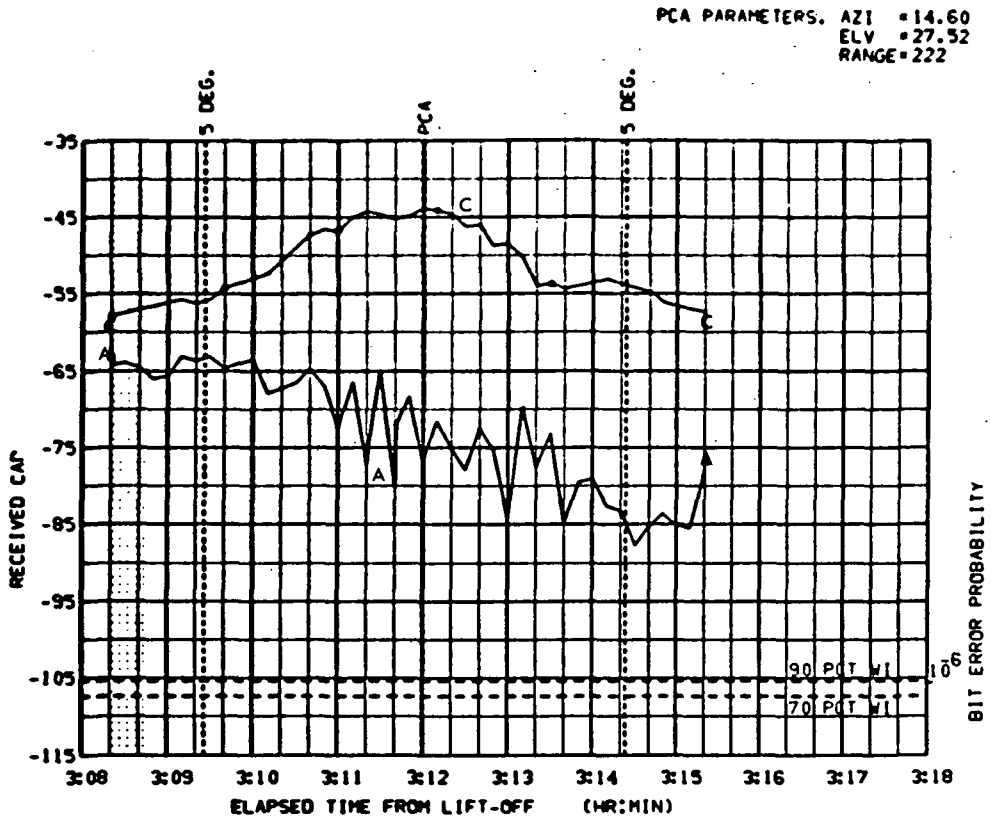

FIGURE 6-30a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

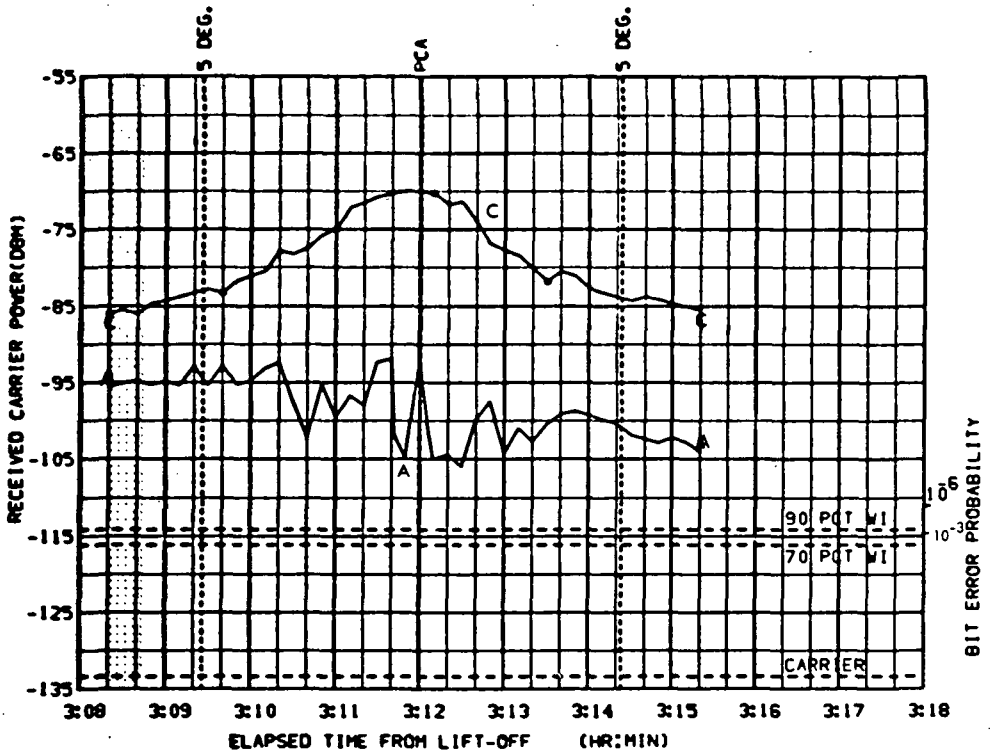

FIGURE 6-30b. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

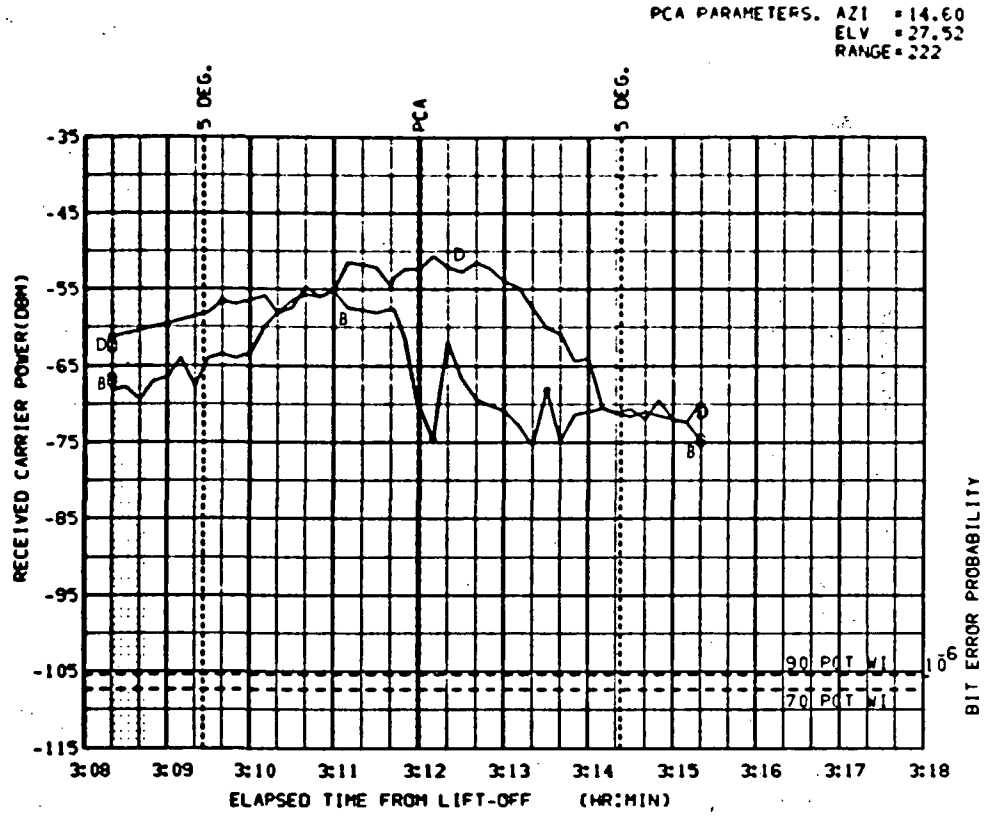

FIGURE 6-30c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

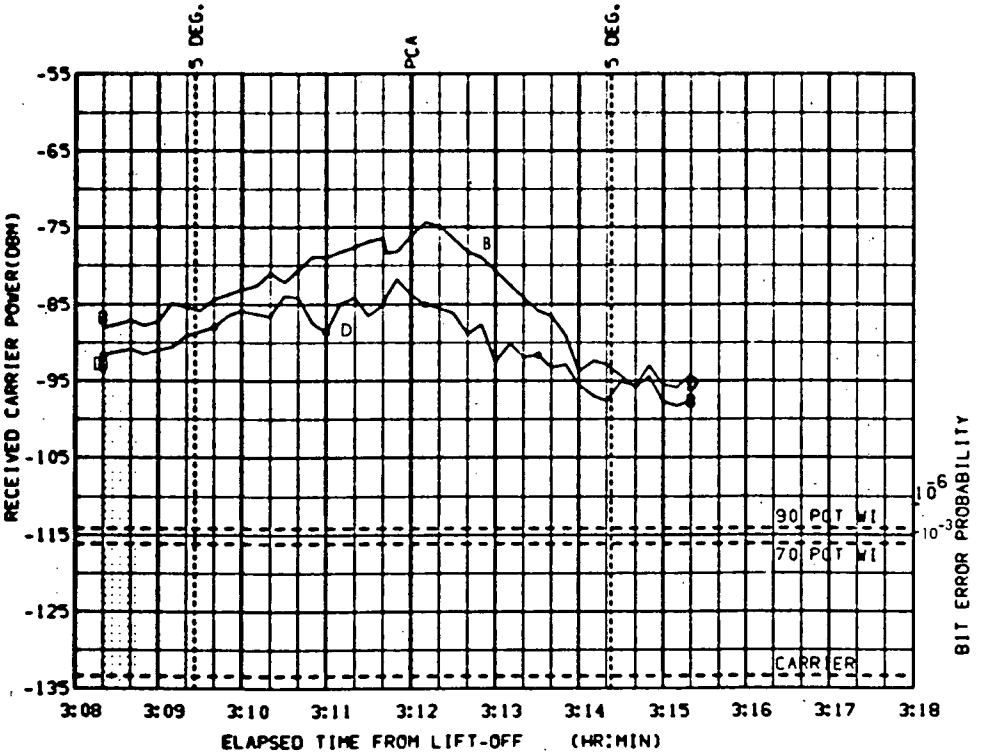

FIGURE 6-30d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

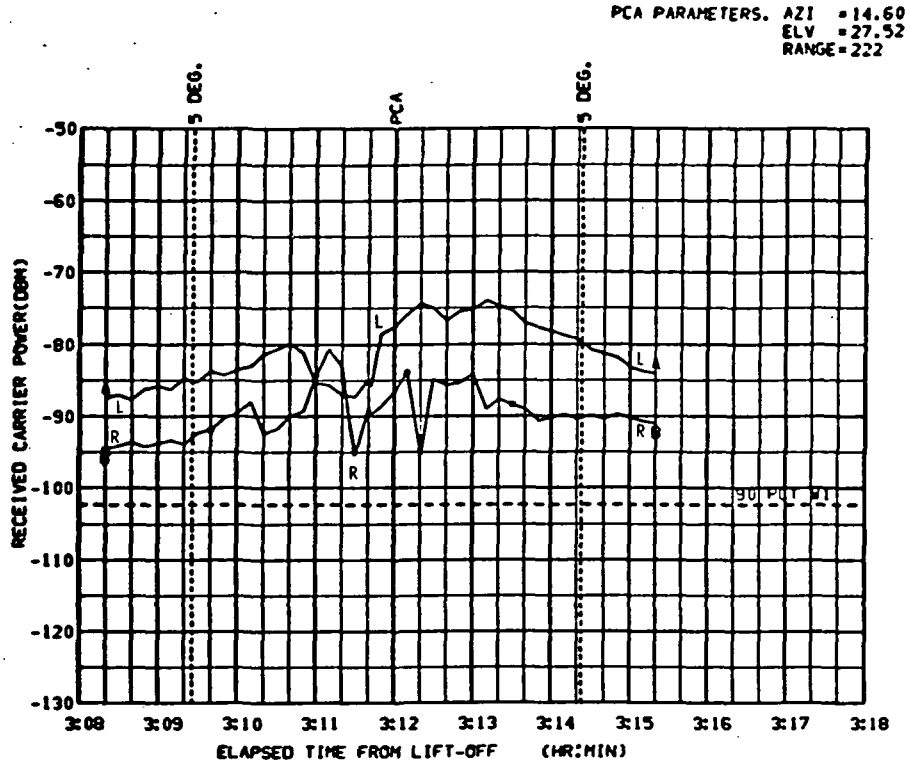

FIGURE 6-30e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

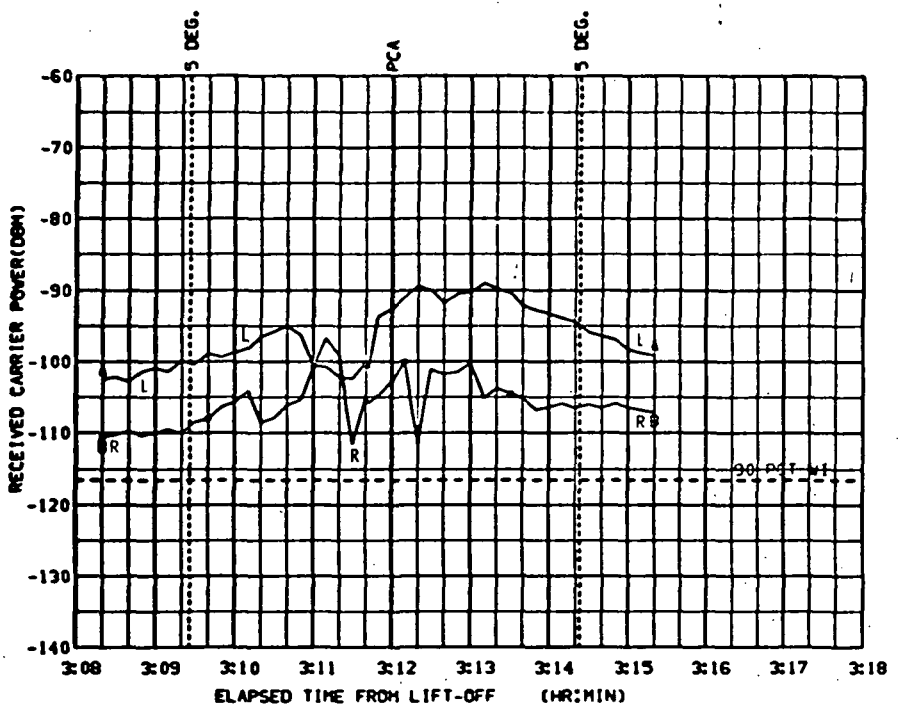

FIGURE 6-30f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

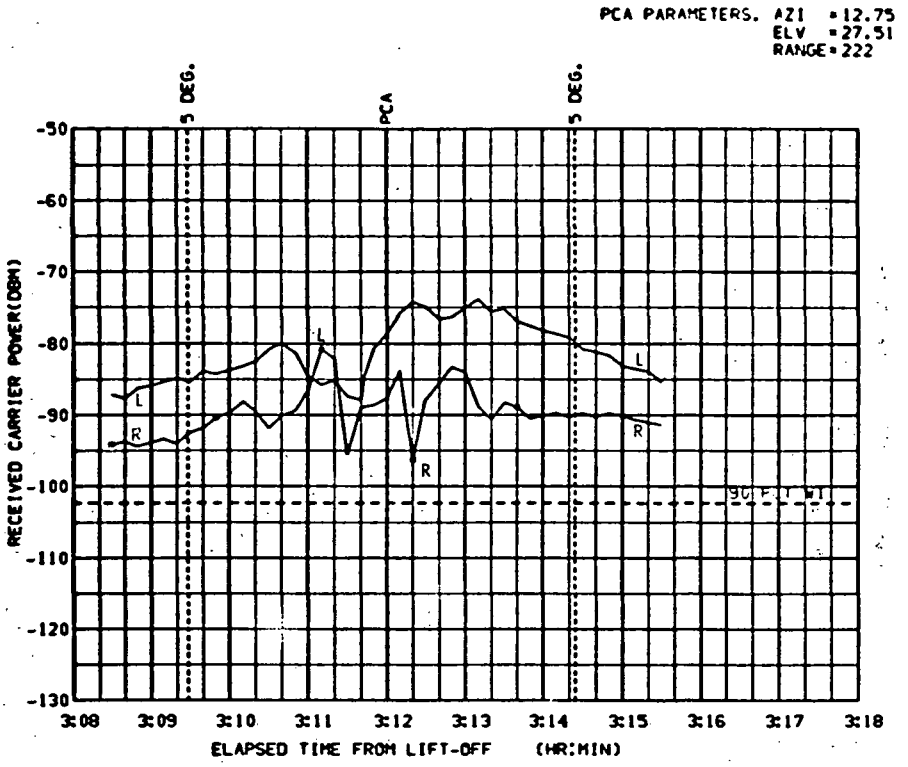

FIGURE 6-31a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

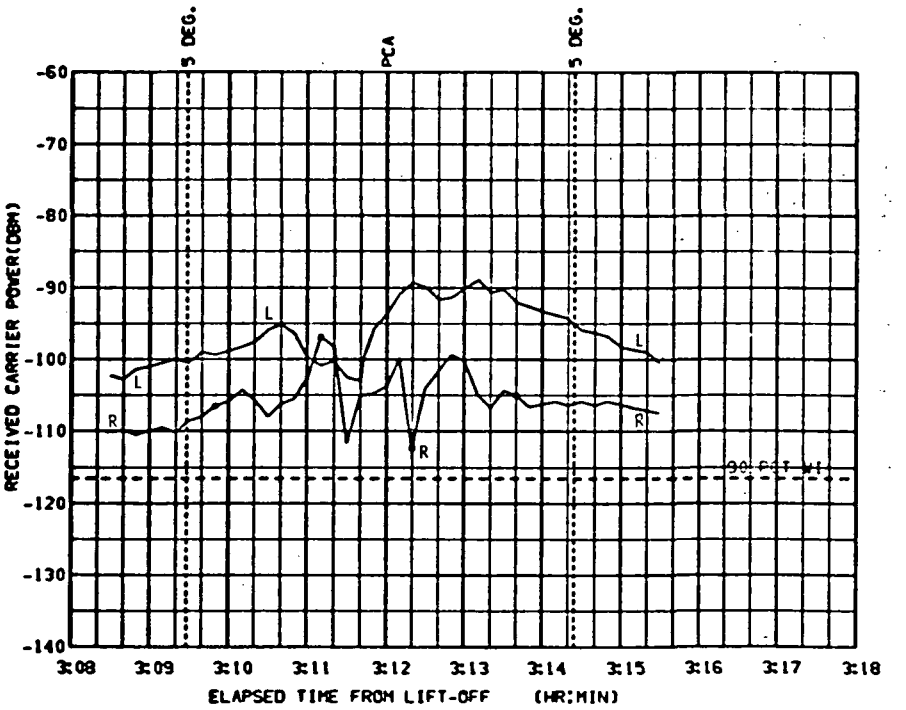

FIGURE 6-31b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

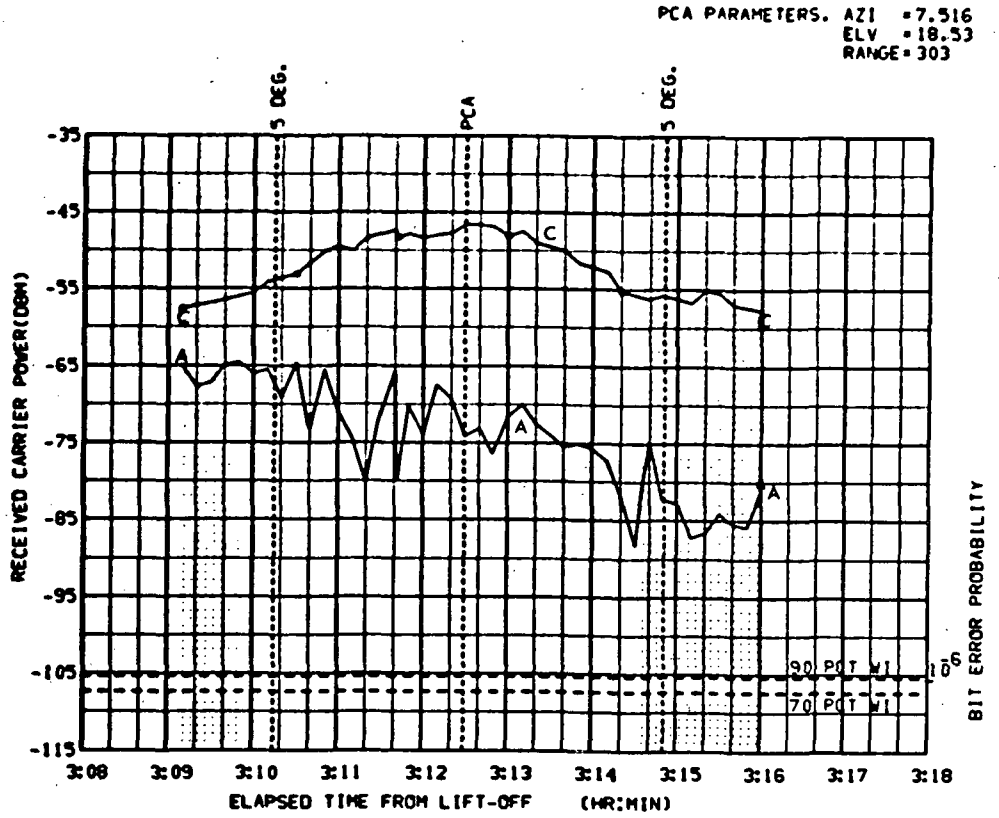

FIGURE 6-32a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

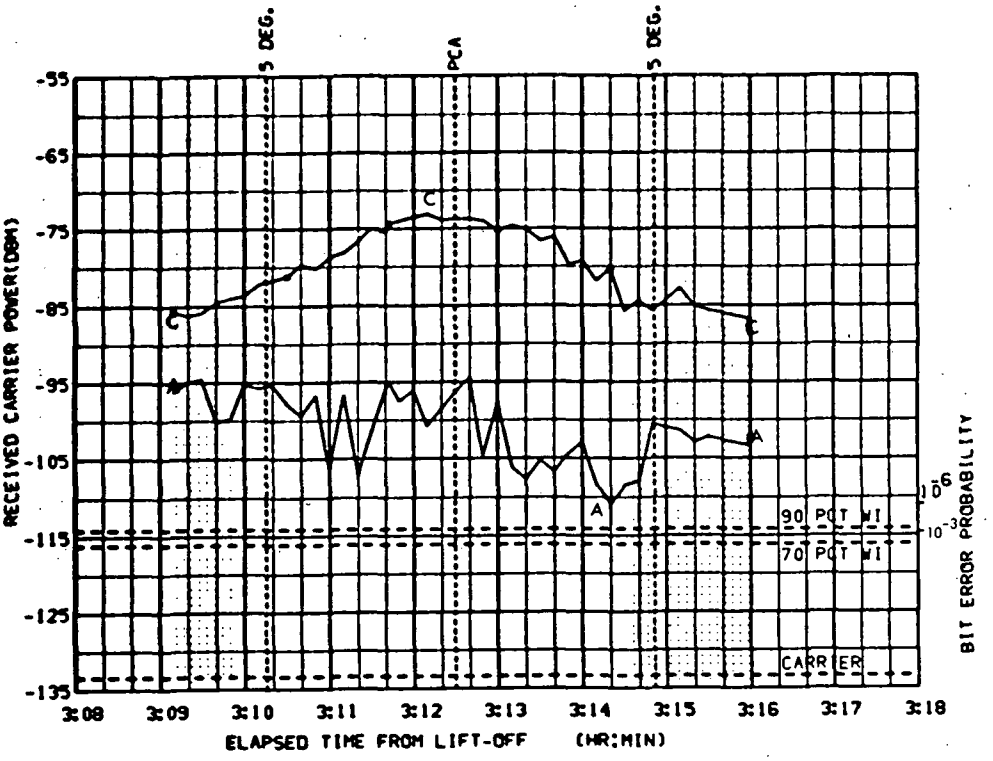

FIGURE 6-32b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

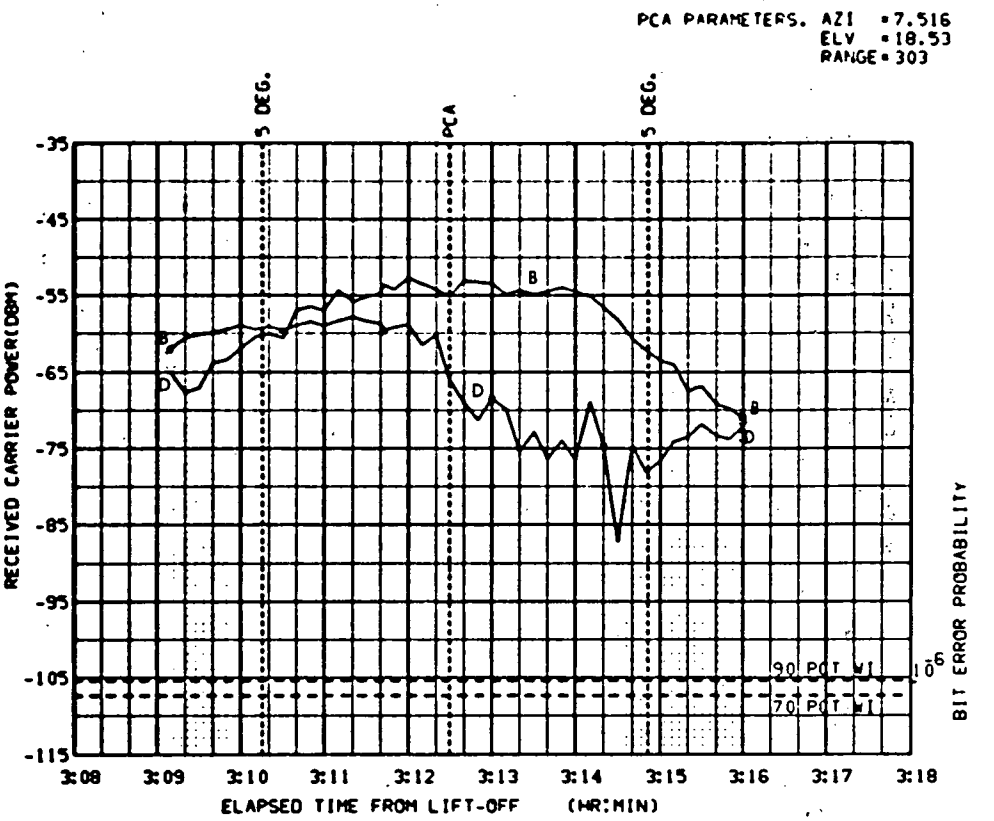

FIGURE 6-32c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

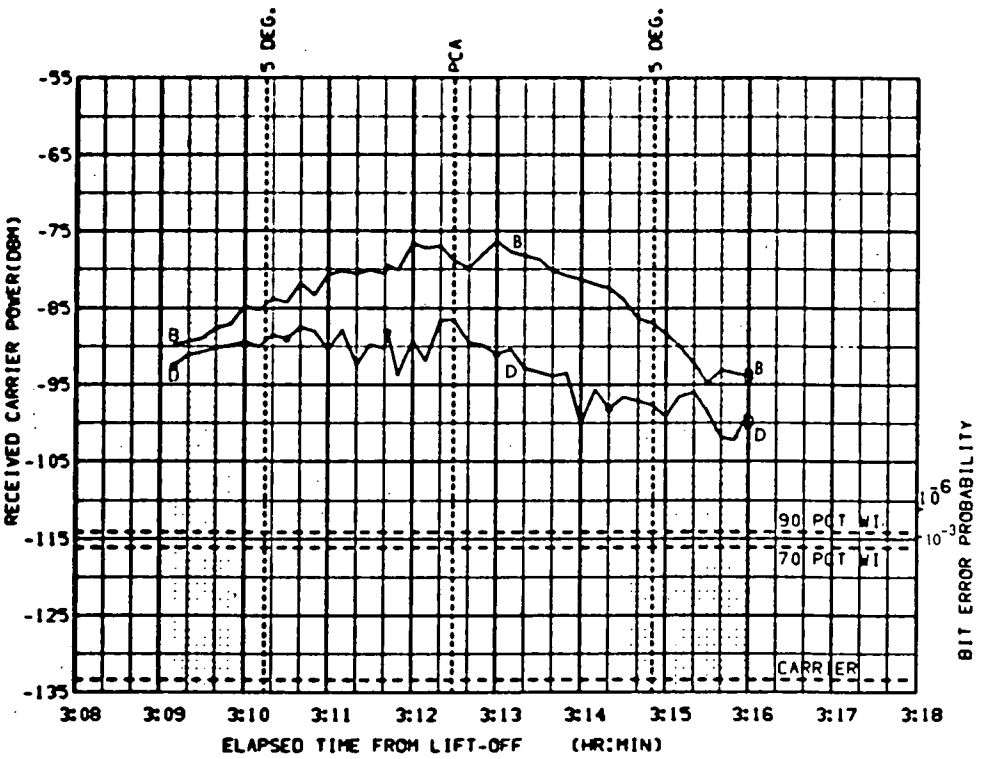

FIGURE 6-32d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

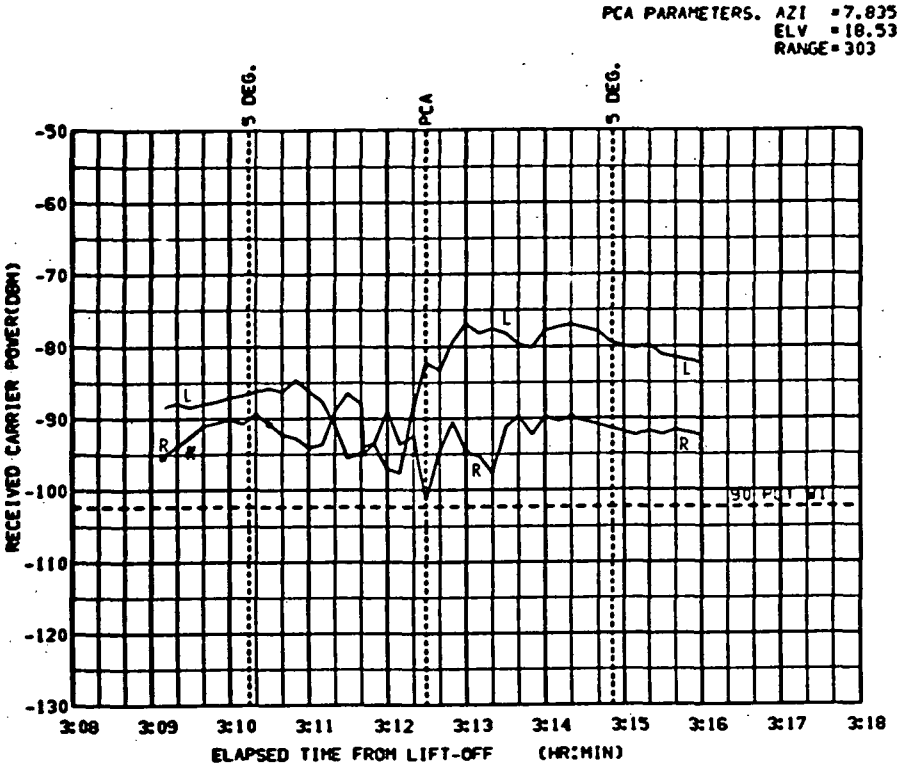

FIGURE 6-32e. GBI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

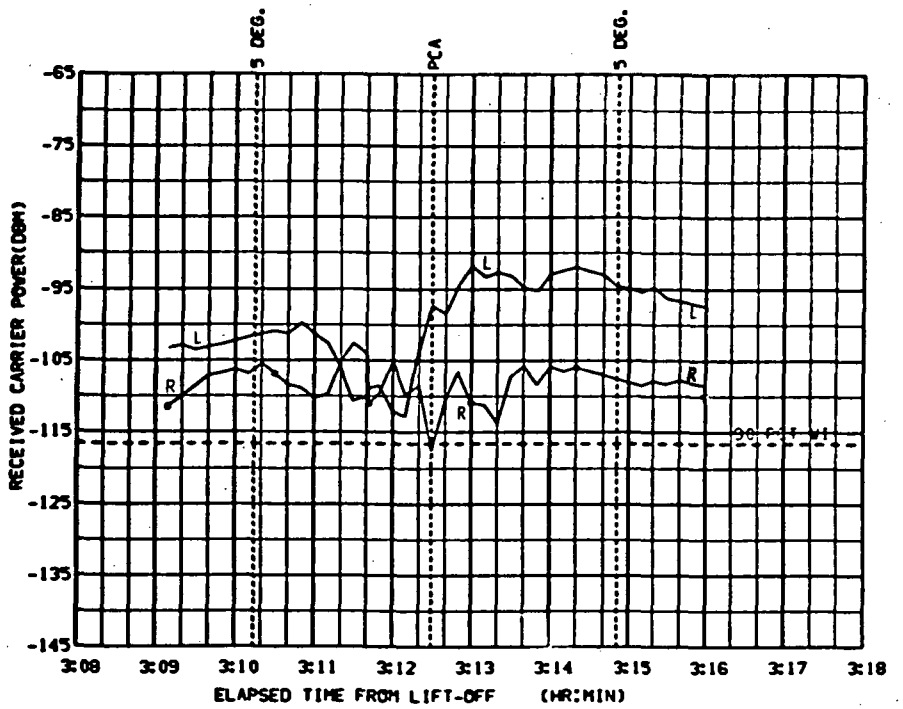

FIGURE 6-32f. GBI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

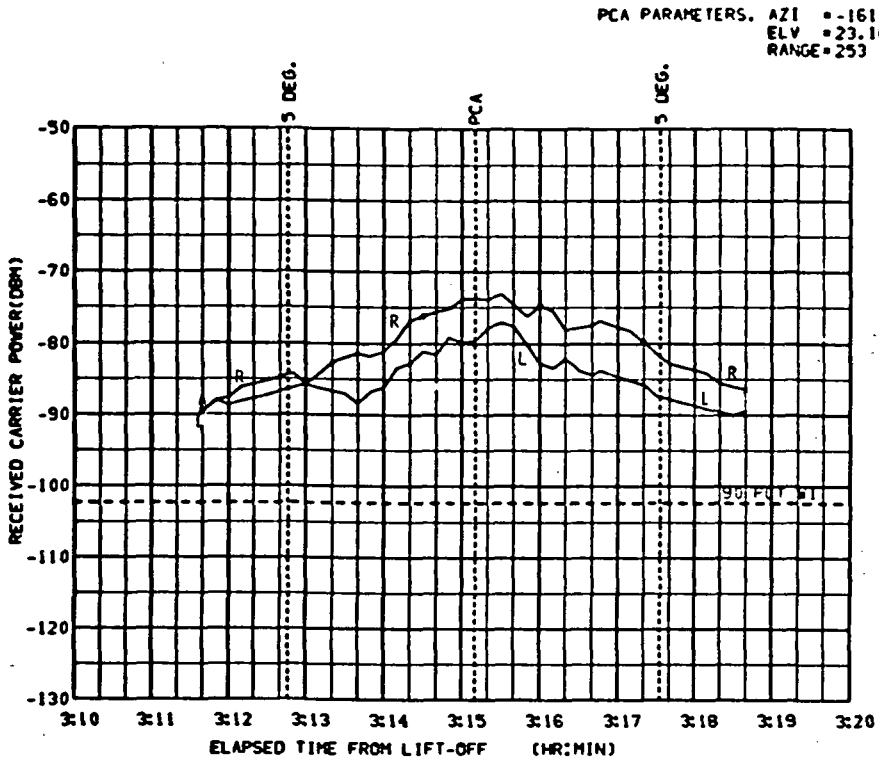

FIGURE 6-33a. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

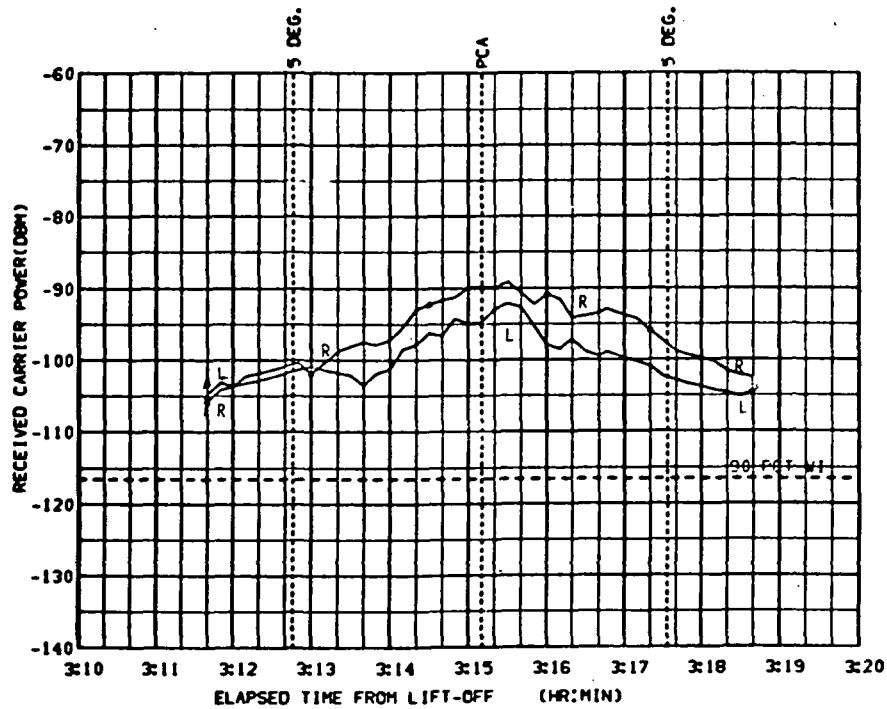

FIGURE 6-33b. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

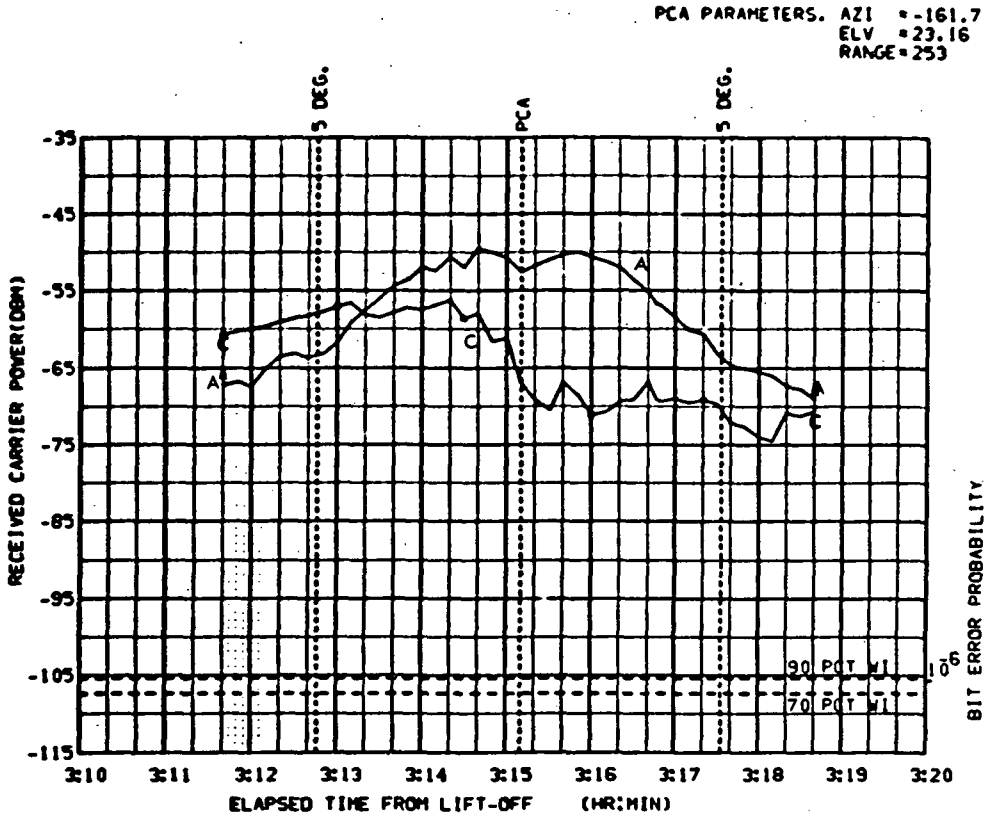

FIGURE 6-33c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

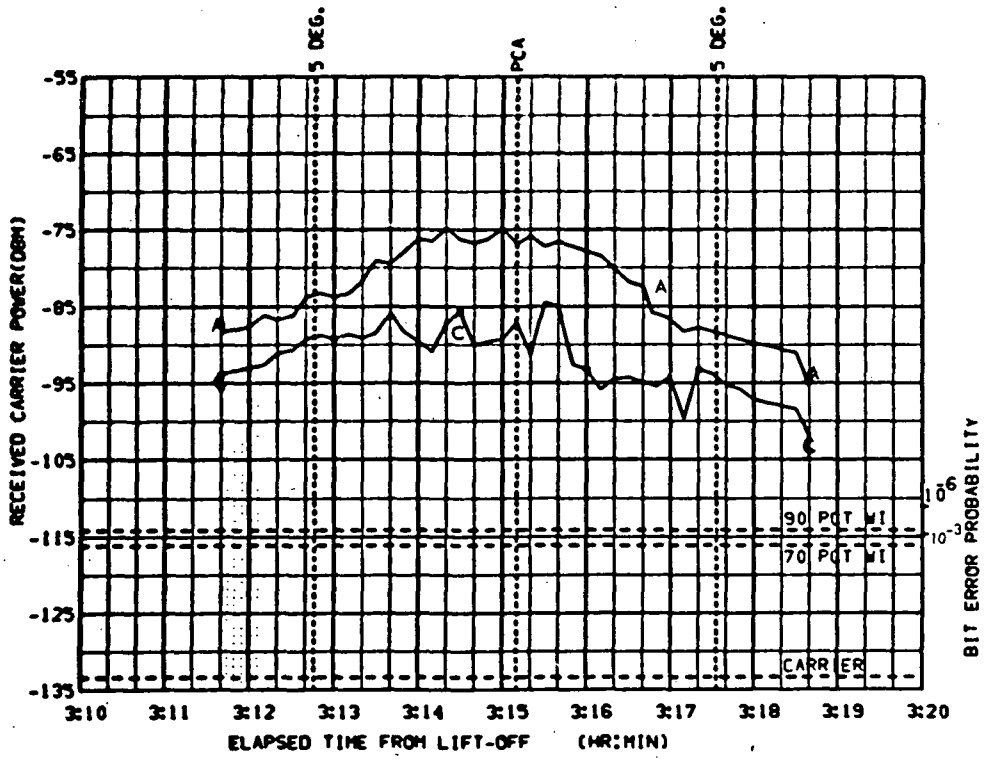

FIGURE 6-33d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

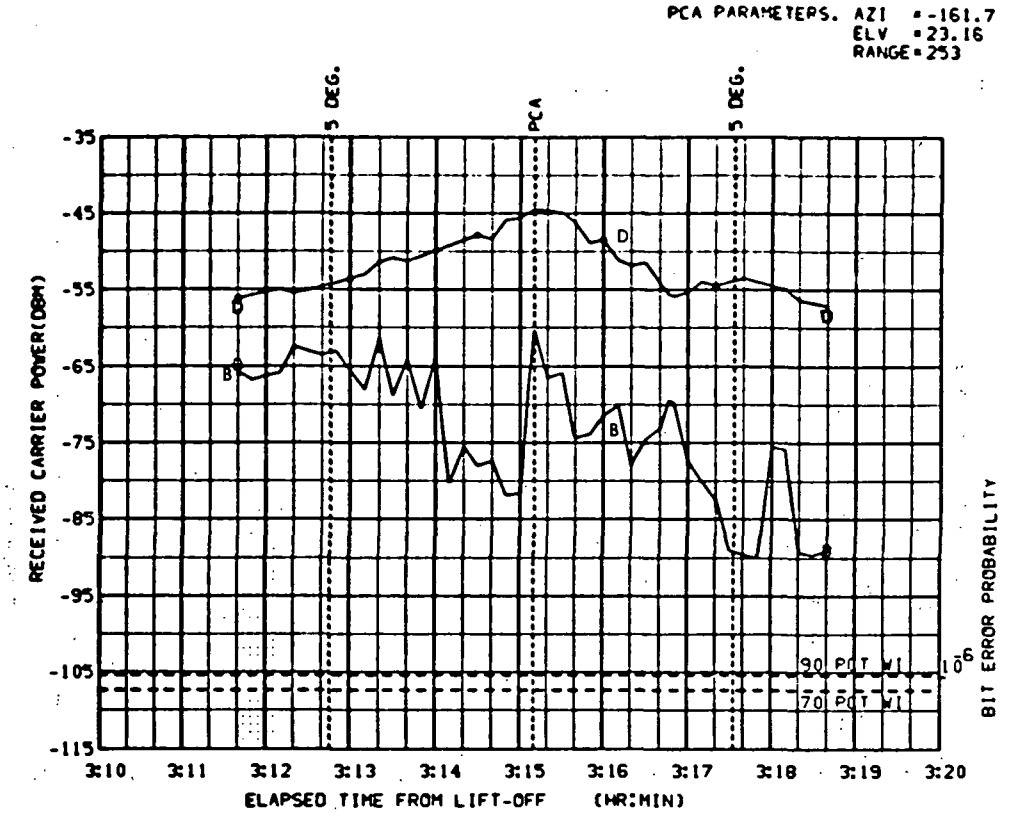

FIGURE 6-33e. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

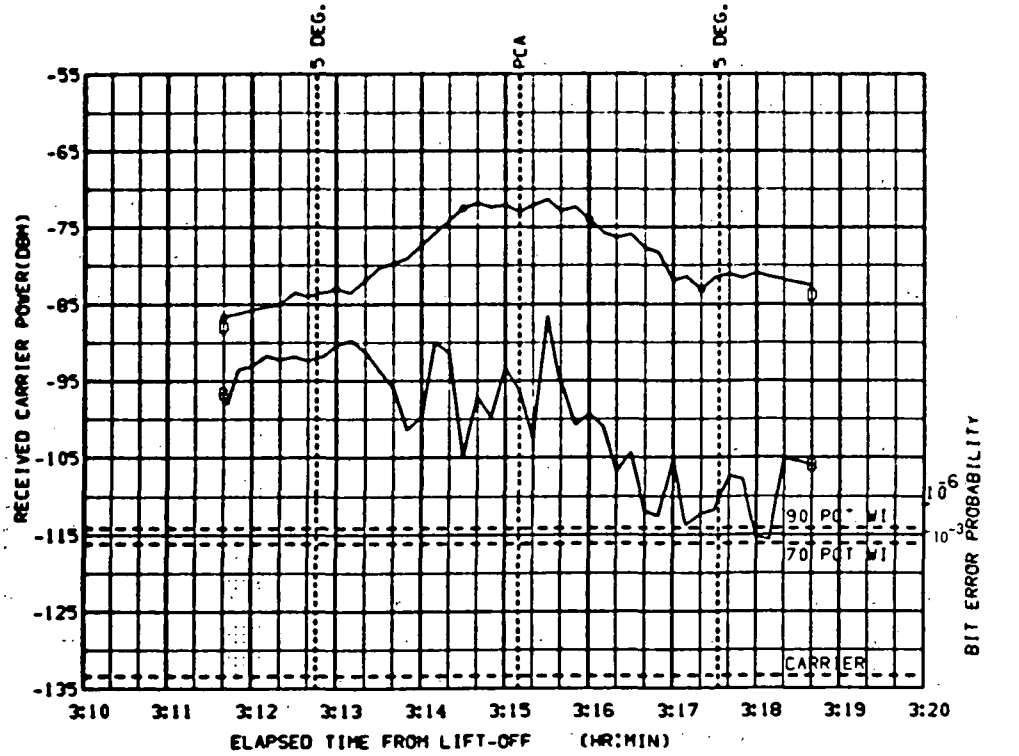

FIGURE 6-33f. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

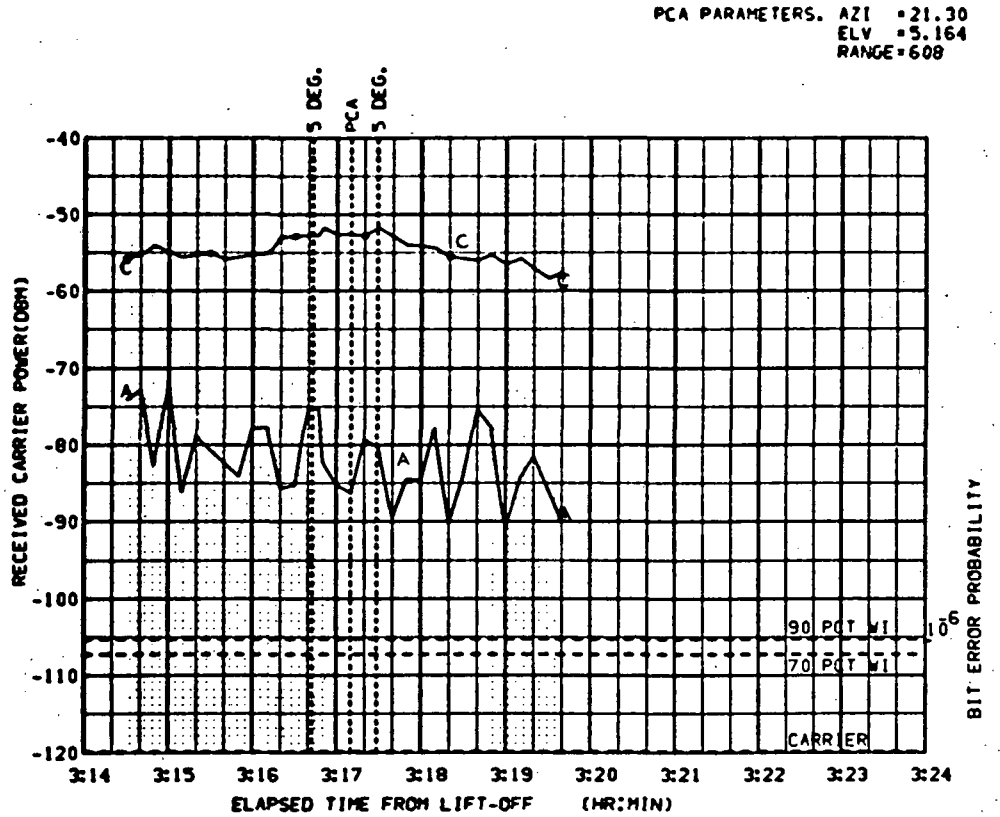

FIGURE 6-34a. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

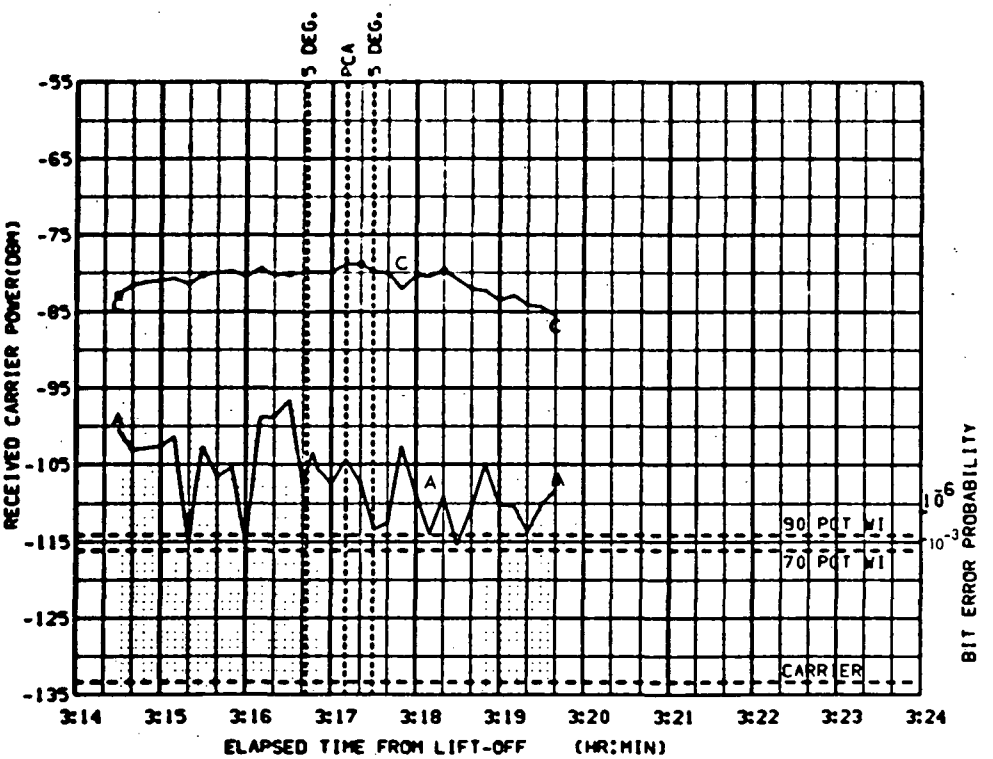

FIGURE 6-34b. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

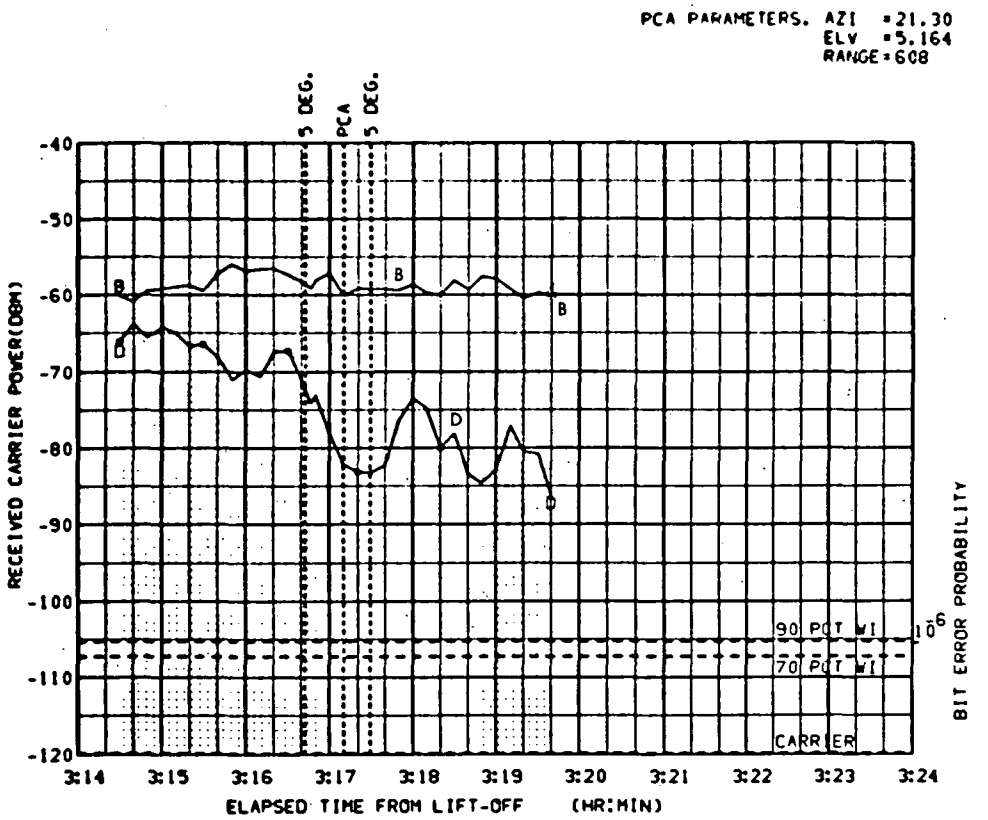

FIGURE 6-34c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

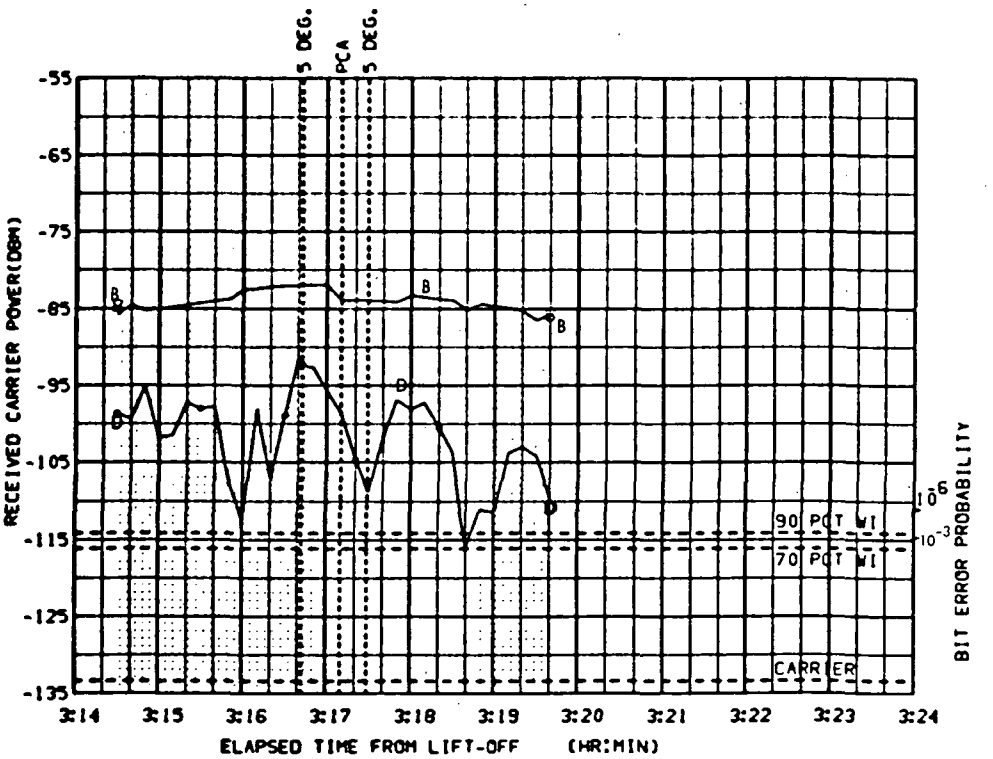

FIGURE 6-34d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

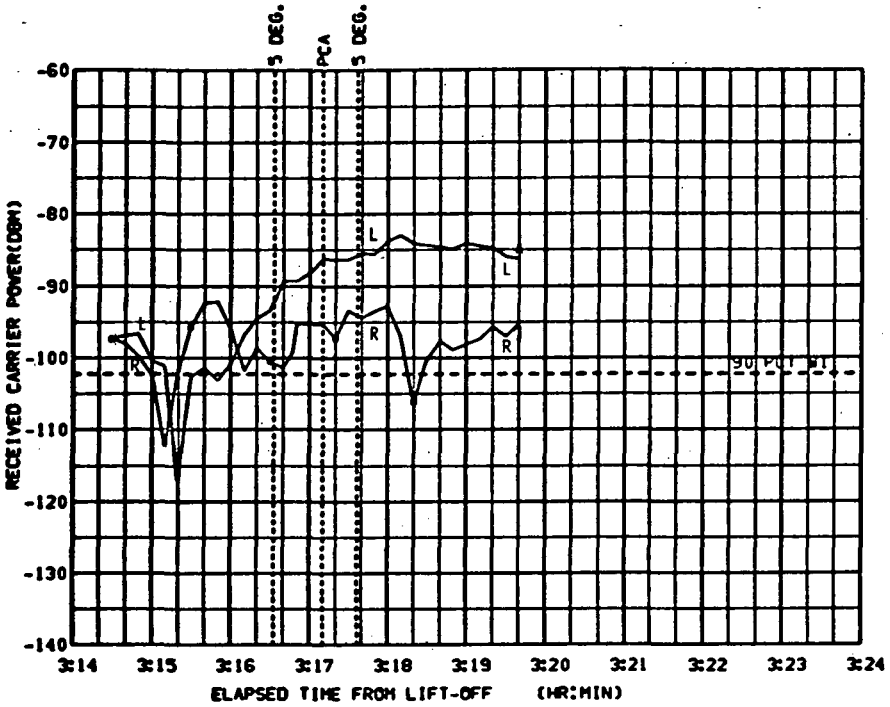

FIGURE 6-34e. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

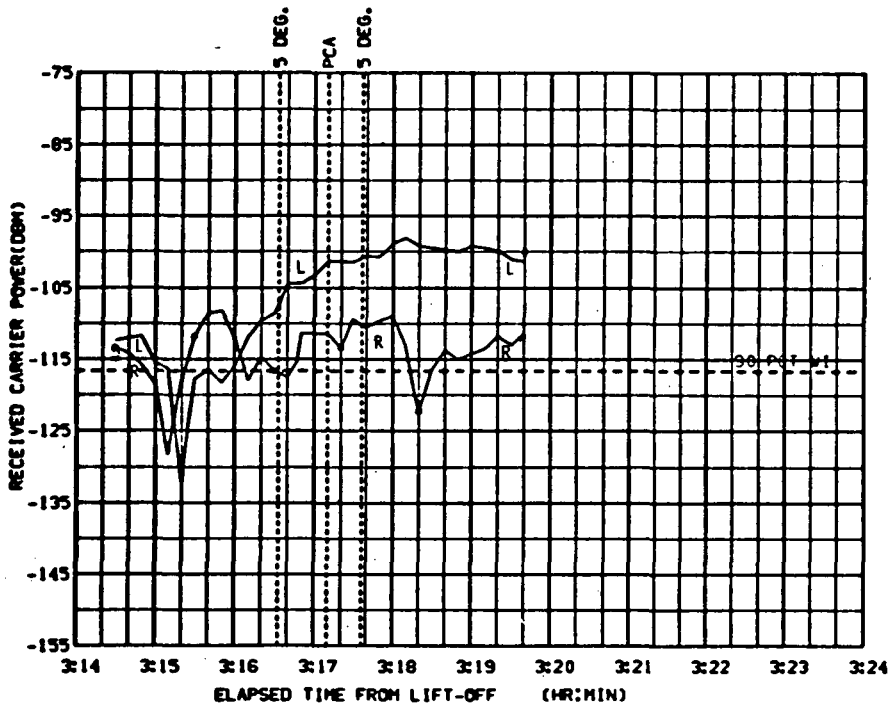

FIGURE 6-34f. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

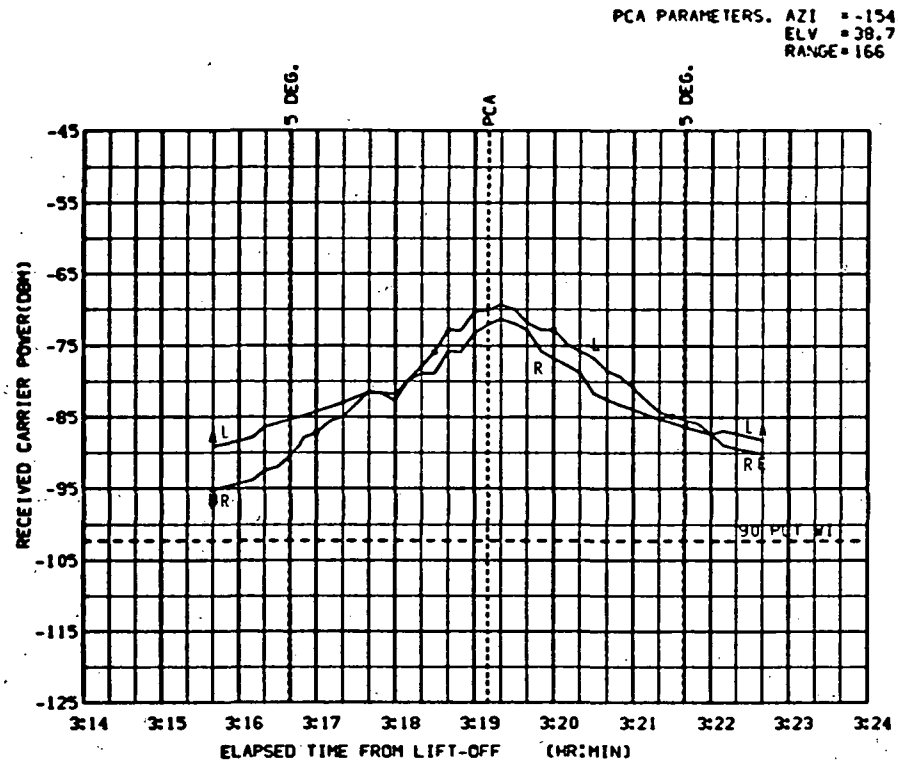

FIGURE 6-35a. VAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

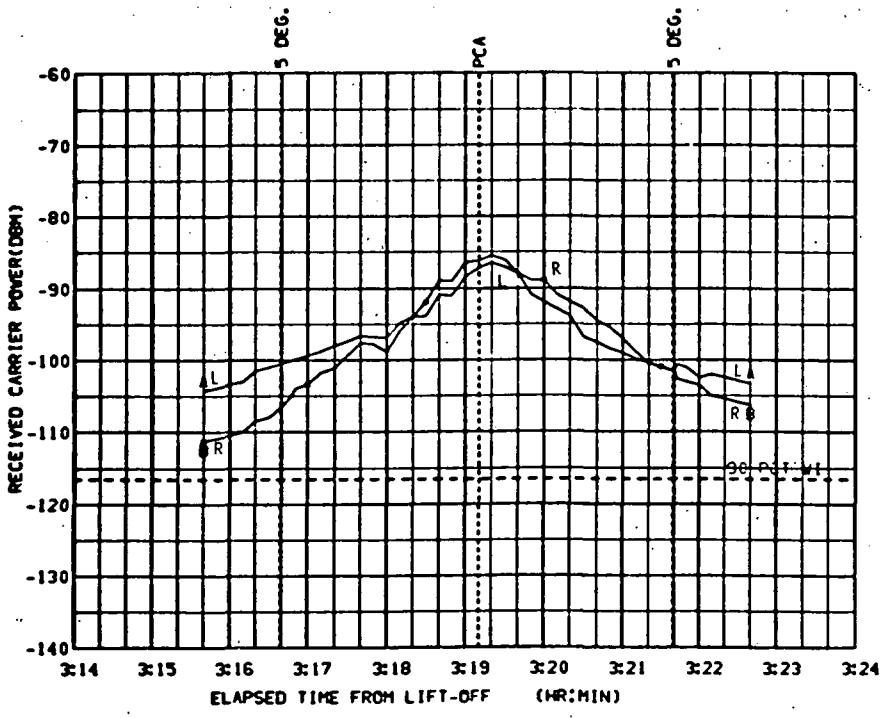

FIGURE 6-35b. VAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

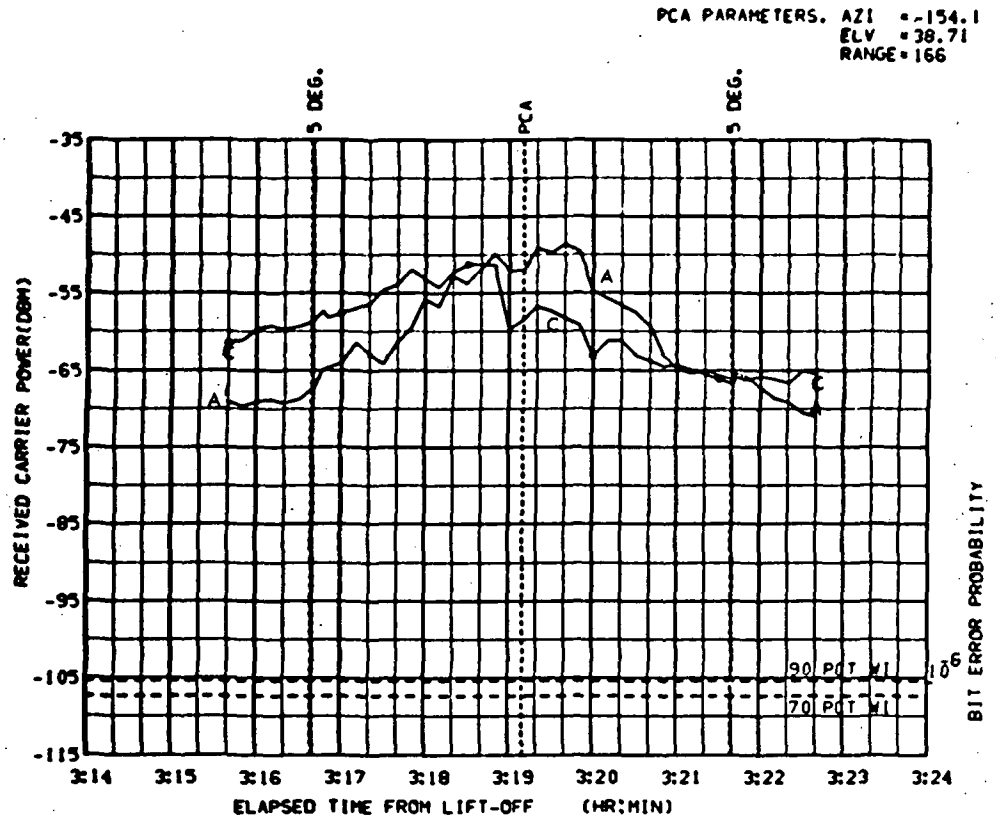

FIGURE 6-35c. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

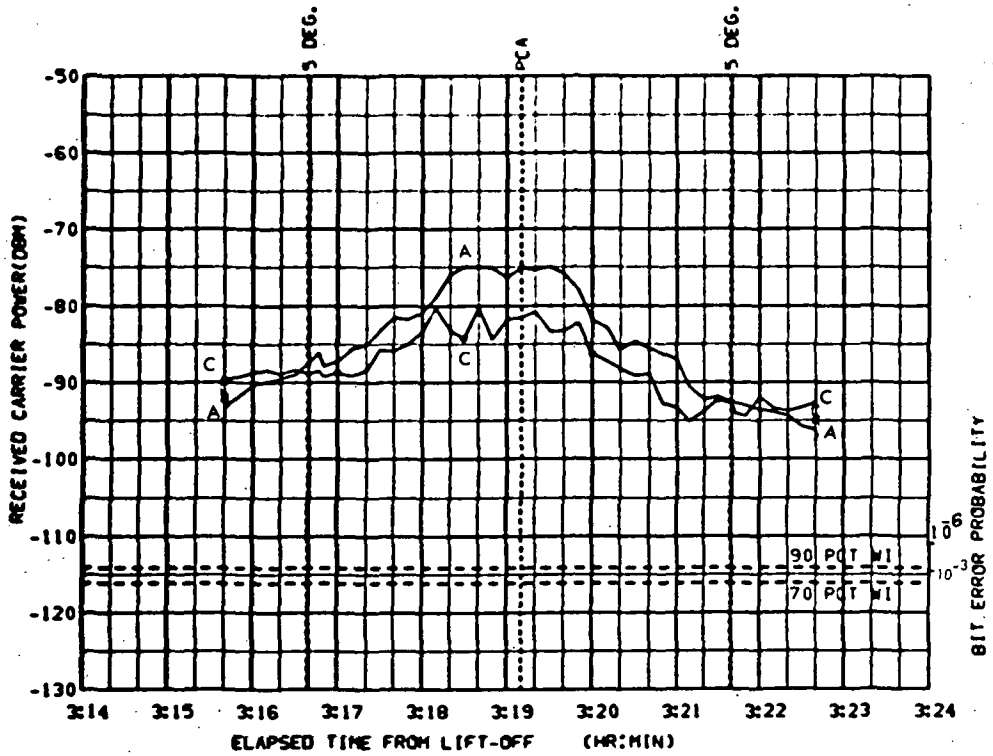

FIGURE 6-35d. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

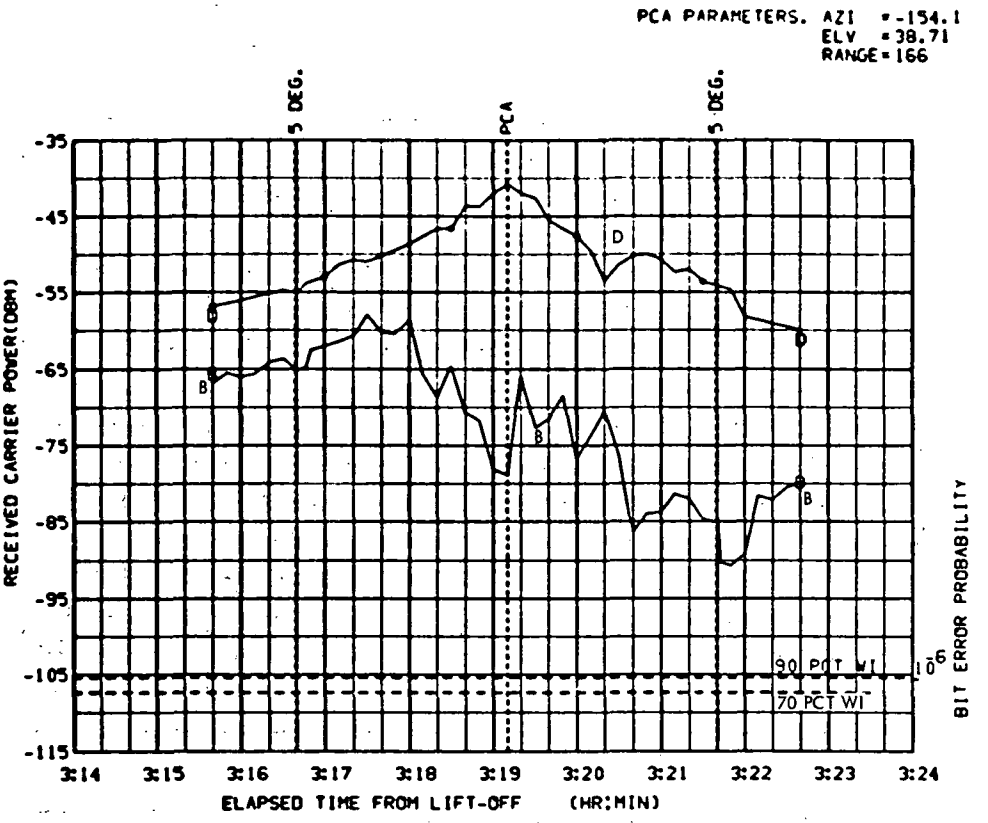

FIGURE 6-35e. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

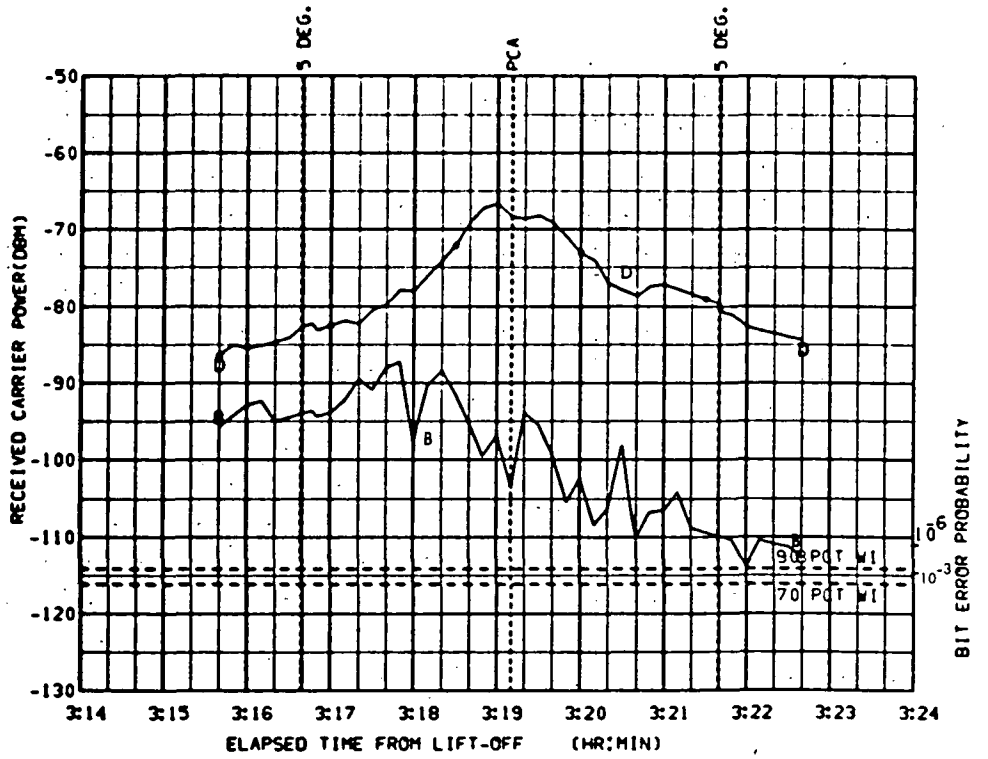

FIGURE 6-35f. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

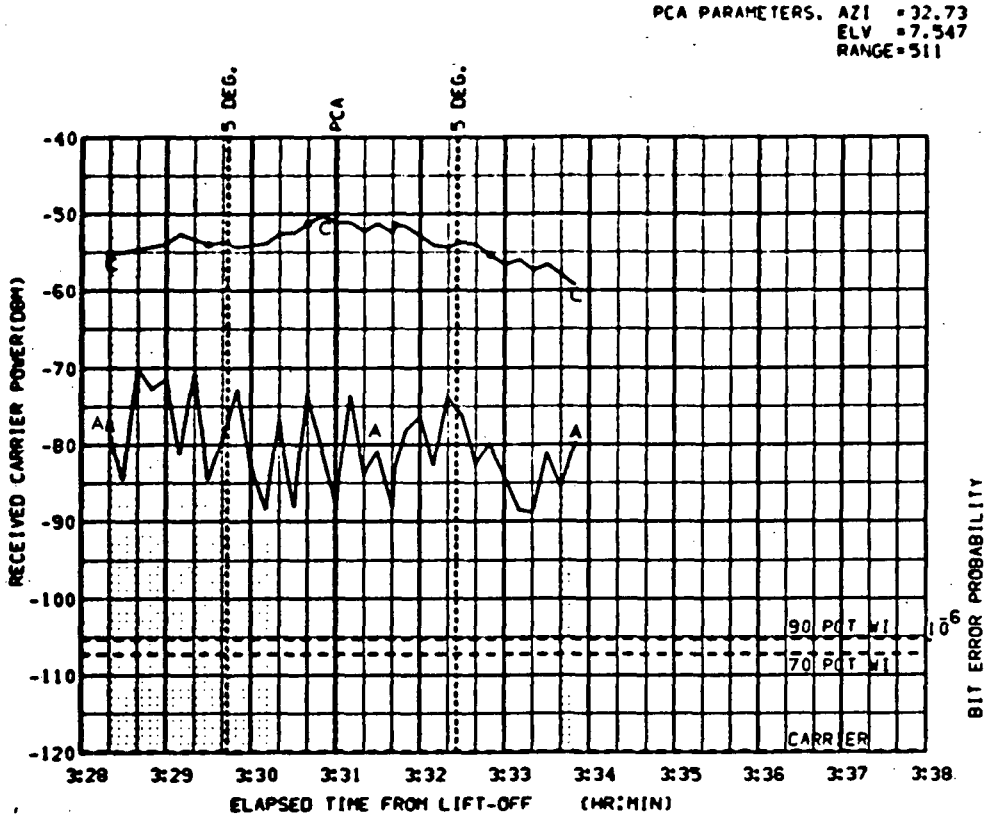

FIGURE 6-36a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

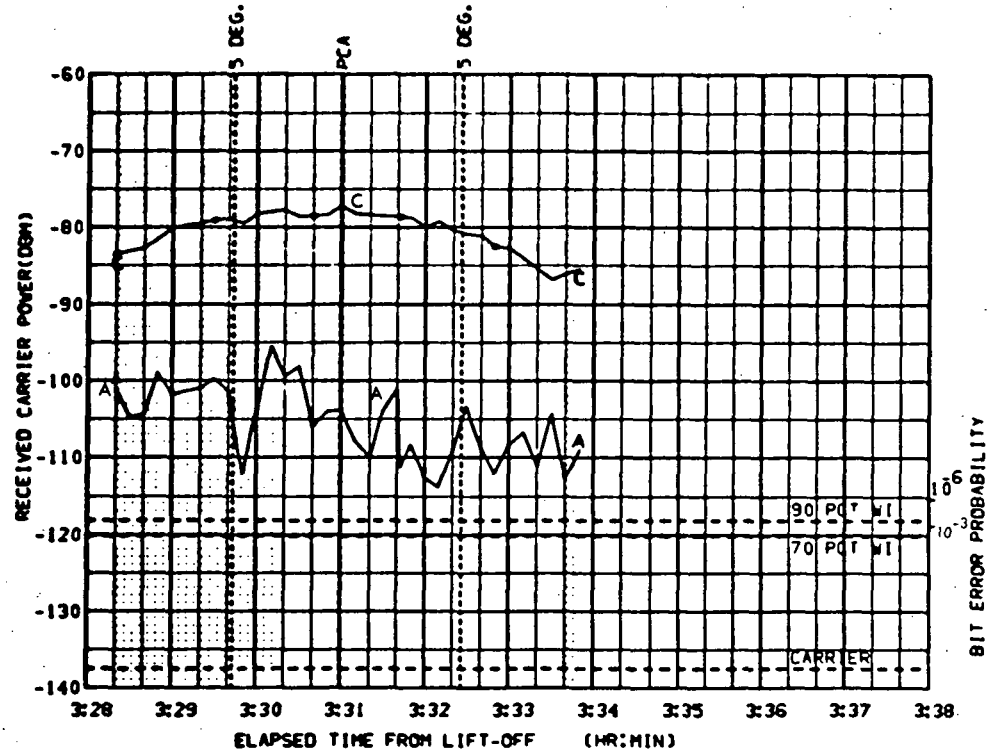

FIGURE 6-36b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

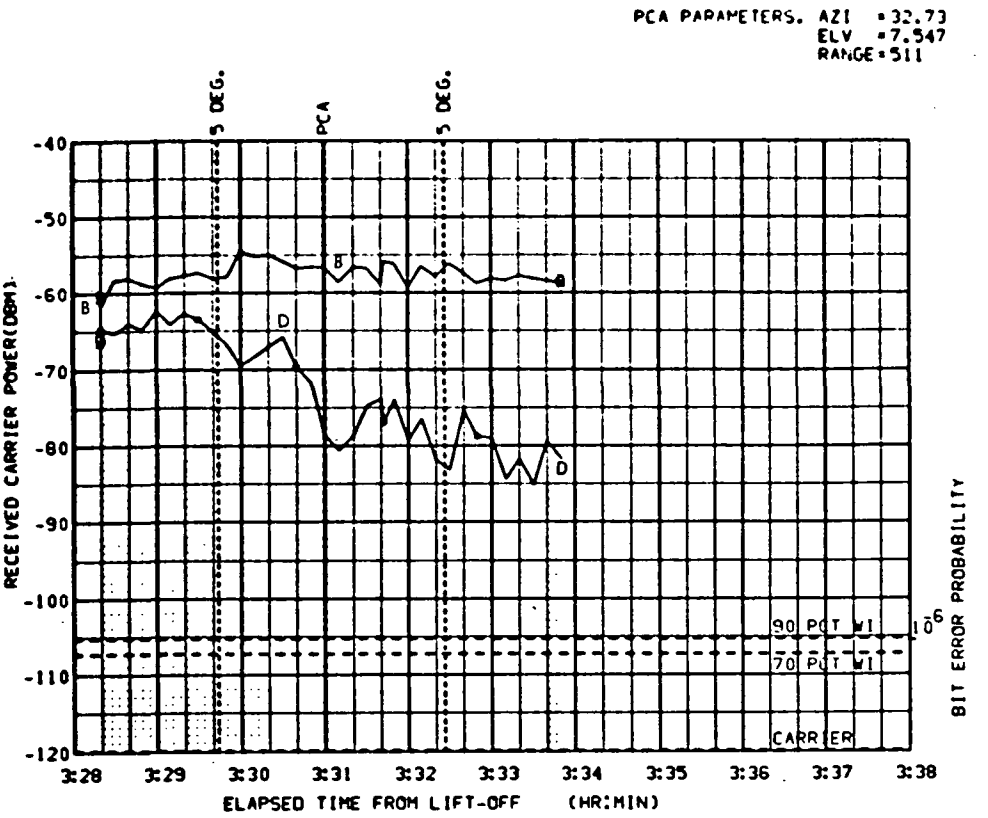

FIGURE 6-36c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

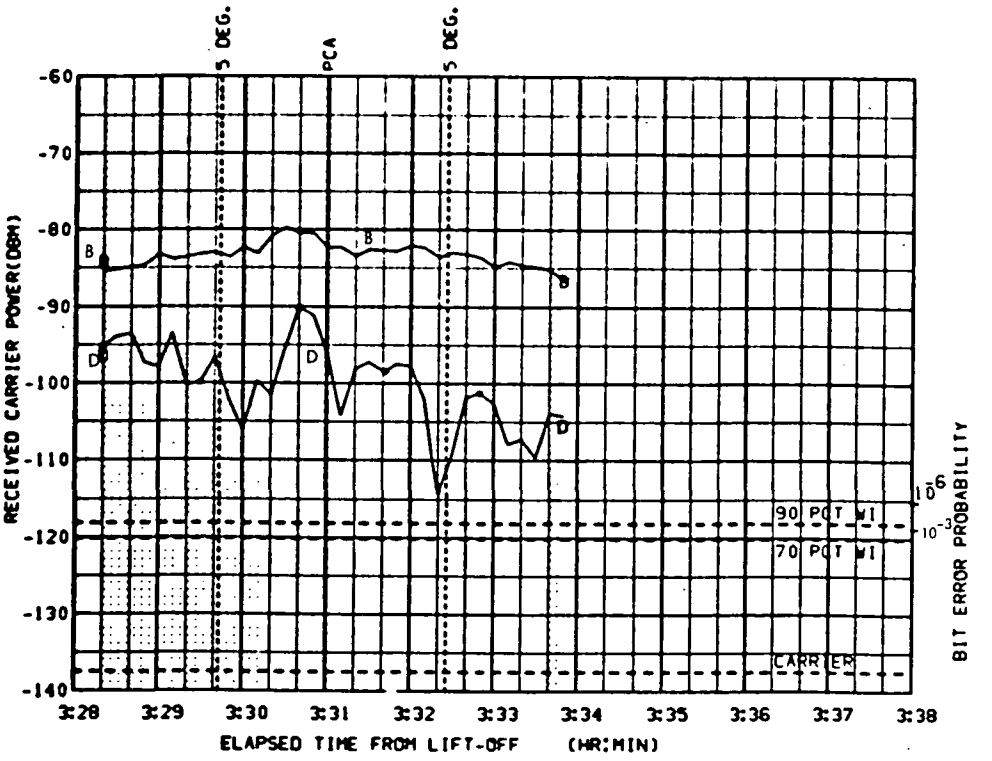

FIGURE 6-36d. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

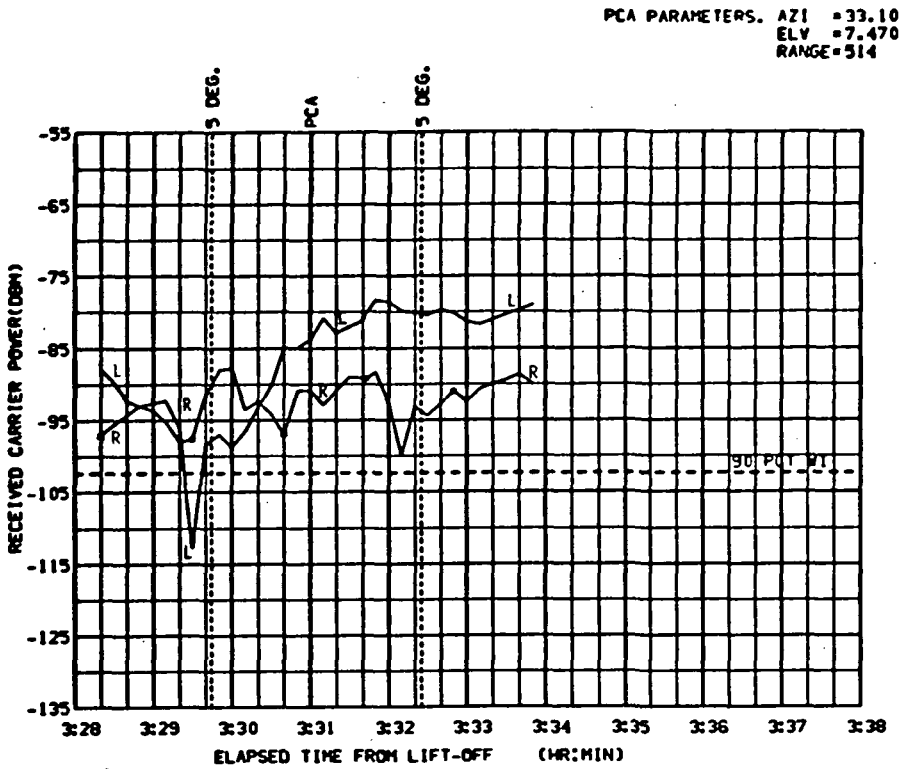

FIGURE 6-36e. ASC UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

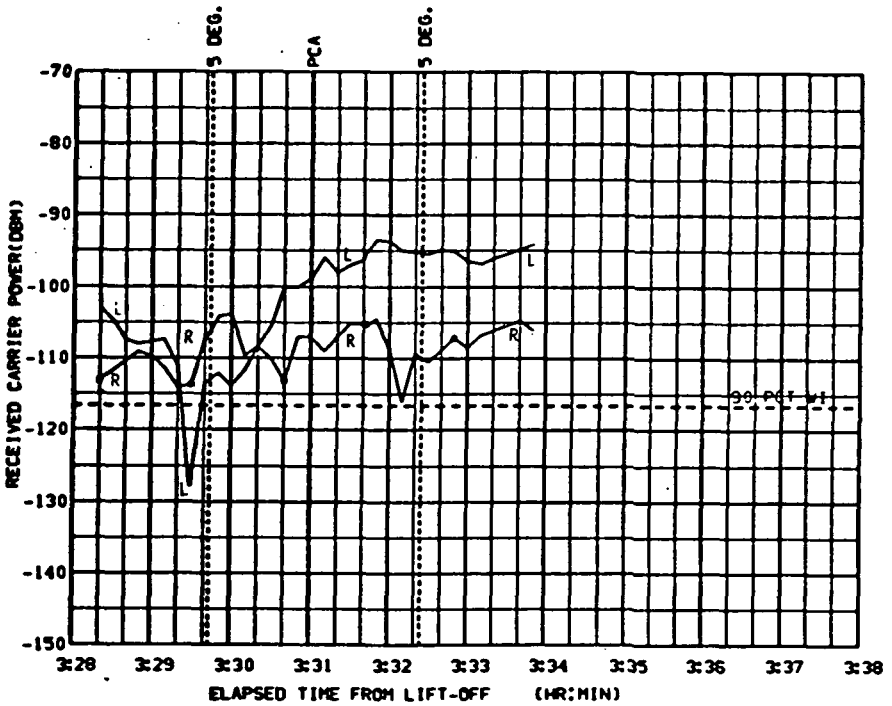

FIGURE 6-36f. ASC DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

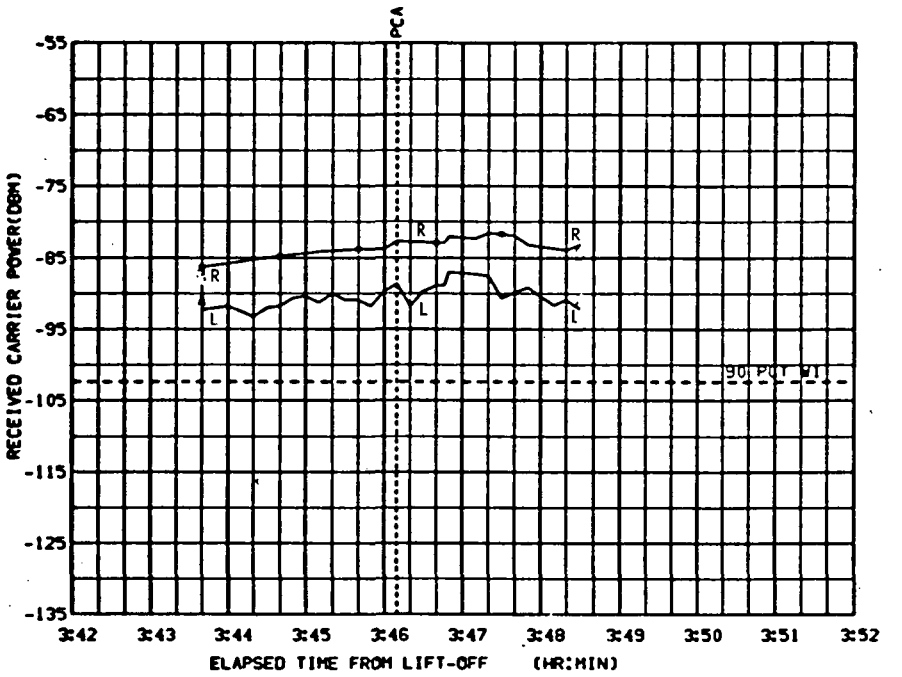

FIGURE 6-37a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

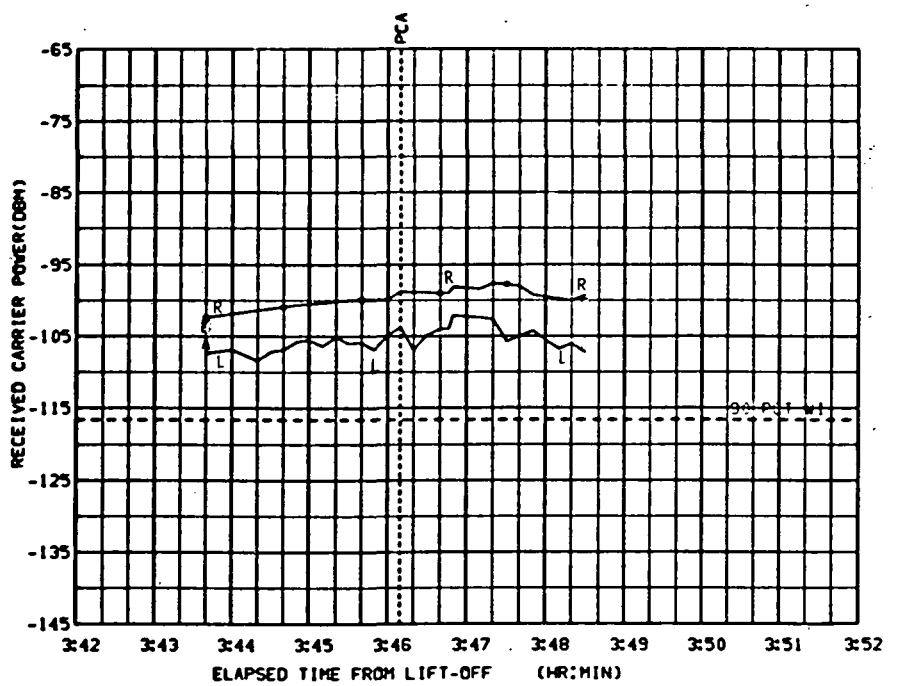

FIGURE 6-37b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

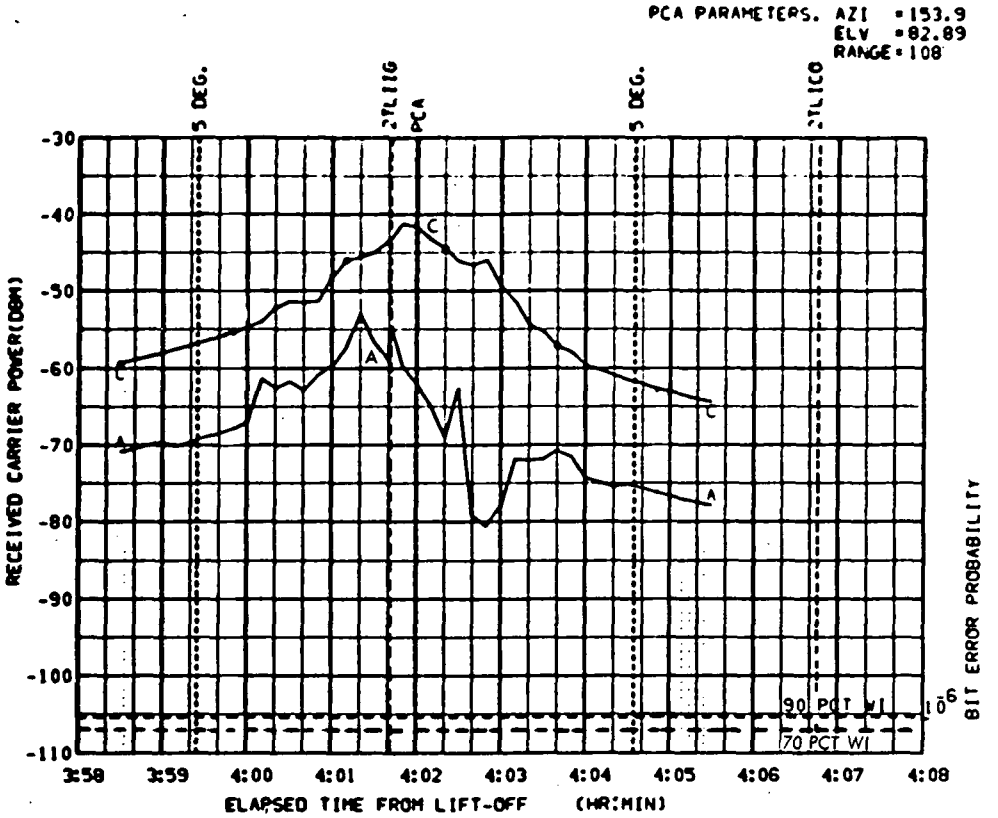

FIGURE 6-38a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

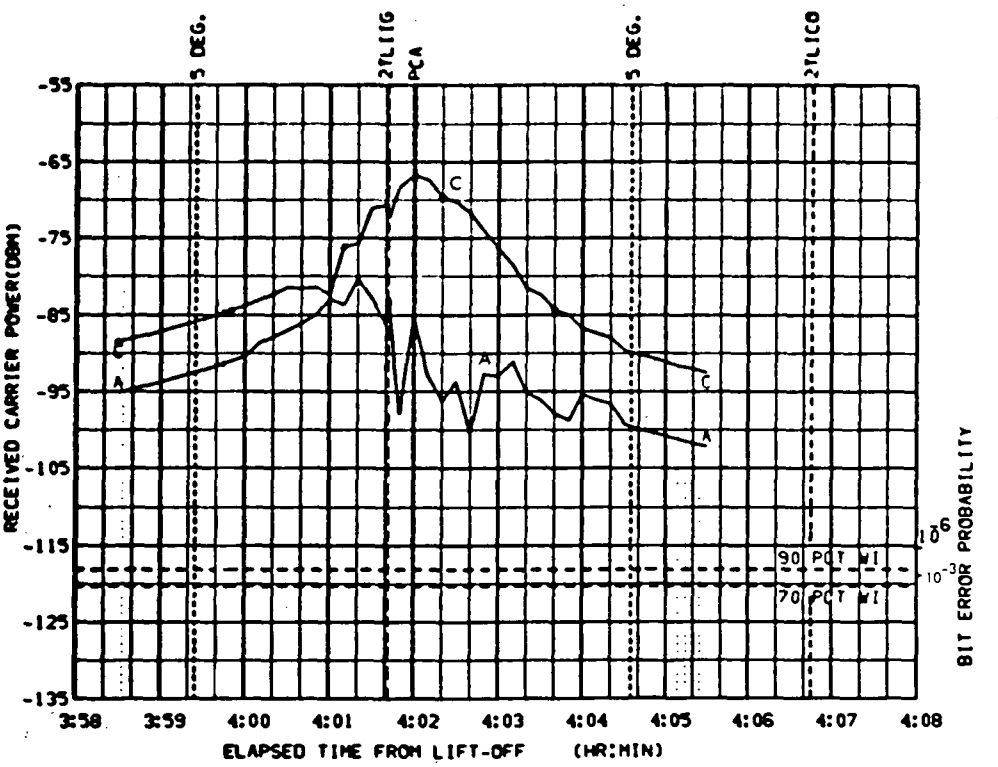

FIGURE 6-38b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

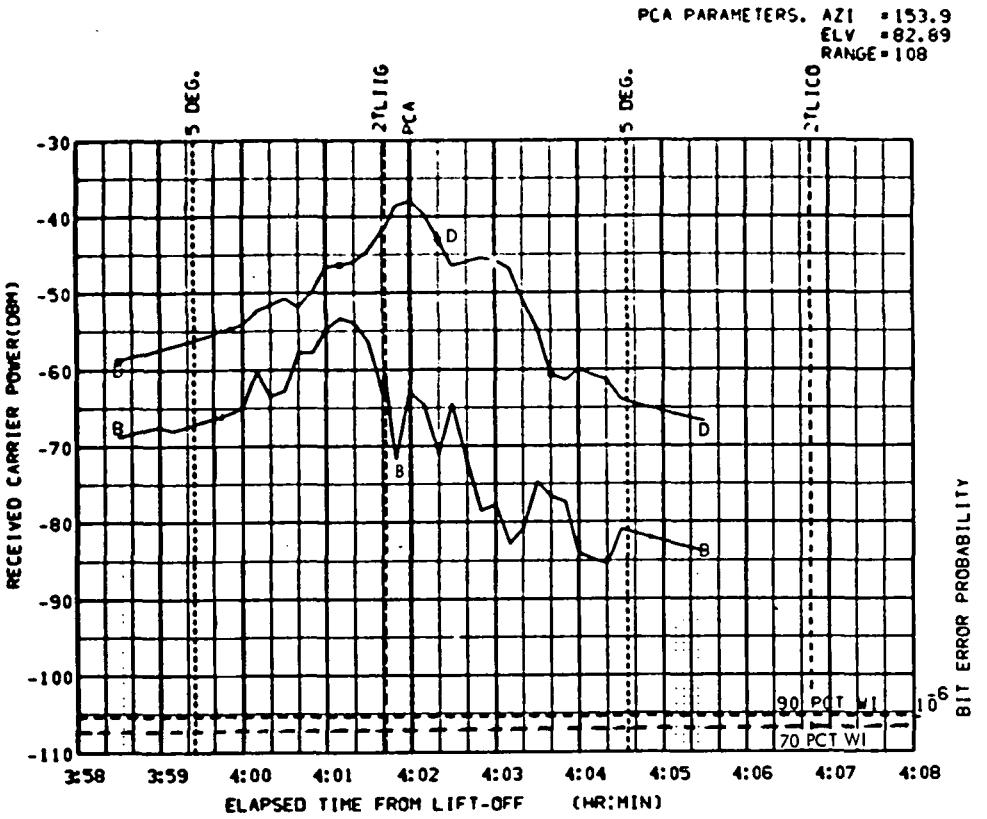

FIGURE 6-38c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

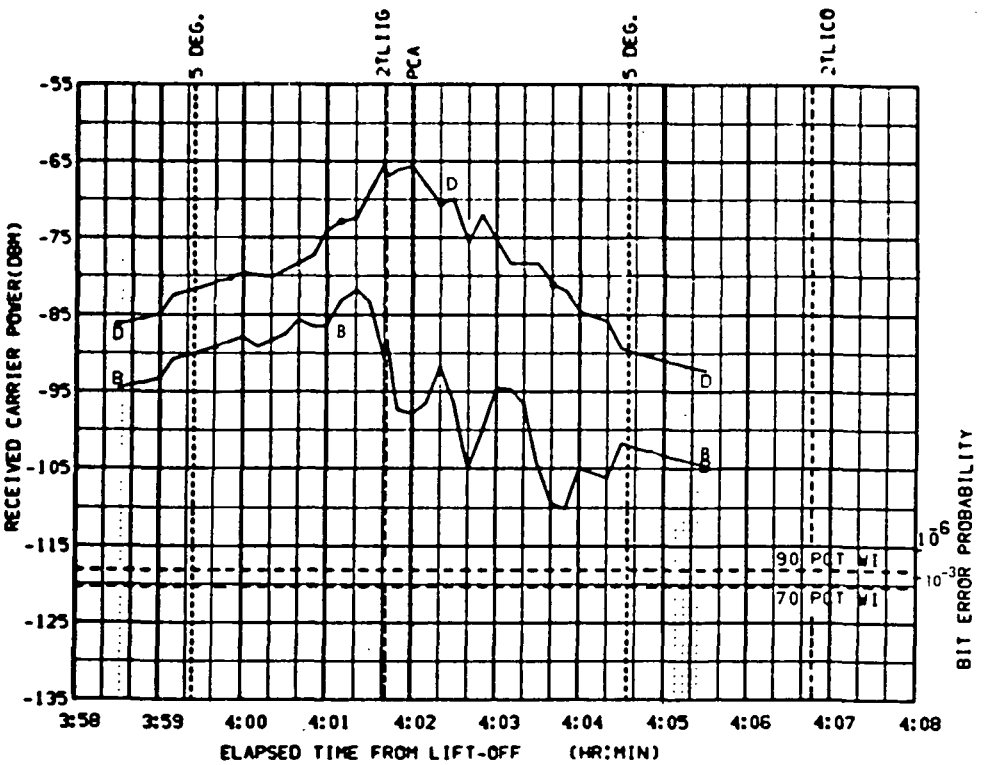

FIGURE 6-38d. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

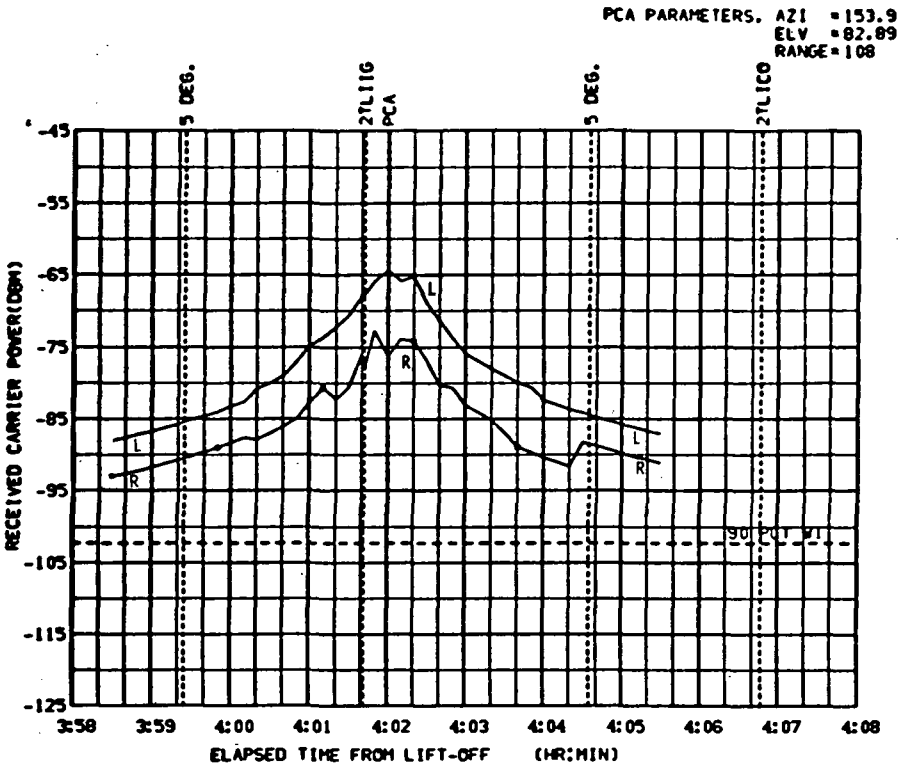

FIGURE 6-38e. CRO UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

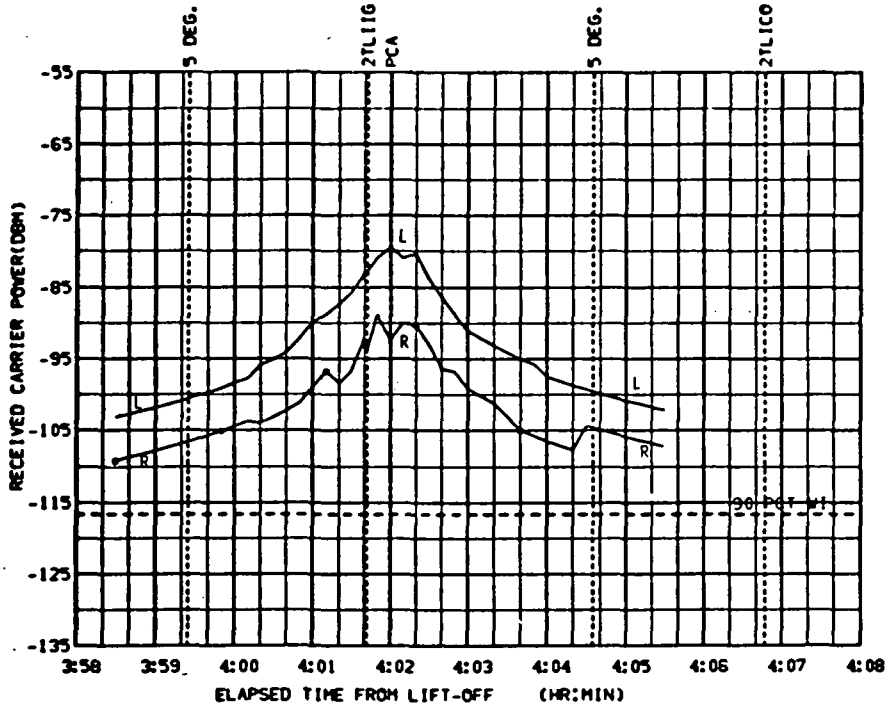

FIGURE 6-38f. CRO DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

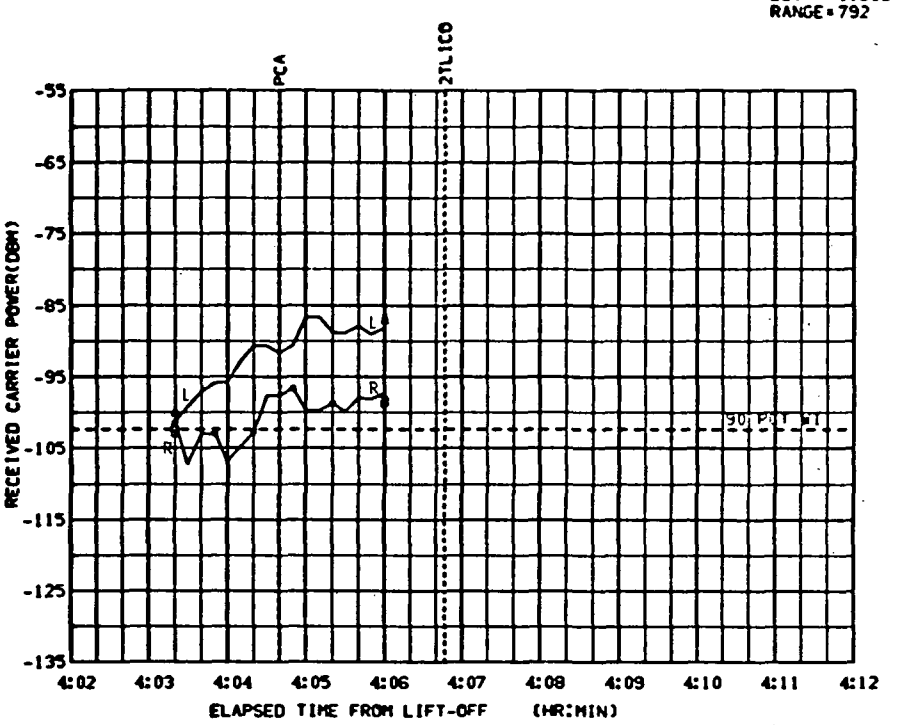

FIGURE 6-39a. MER UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

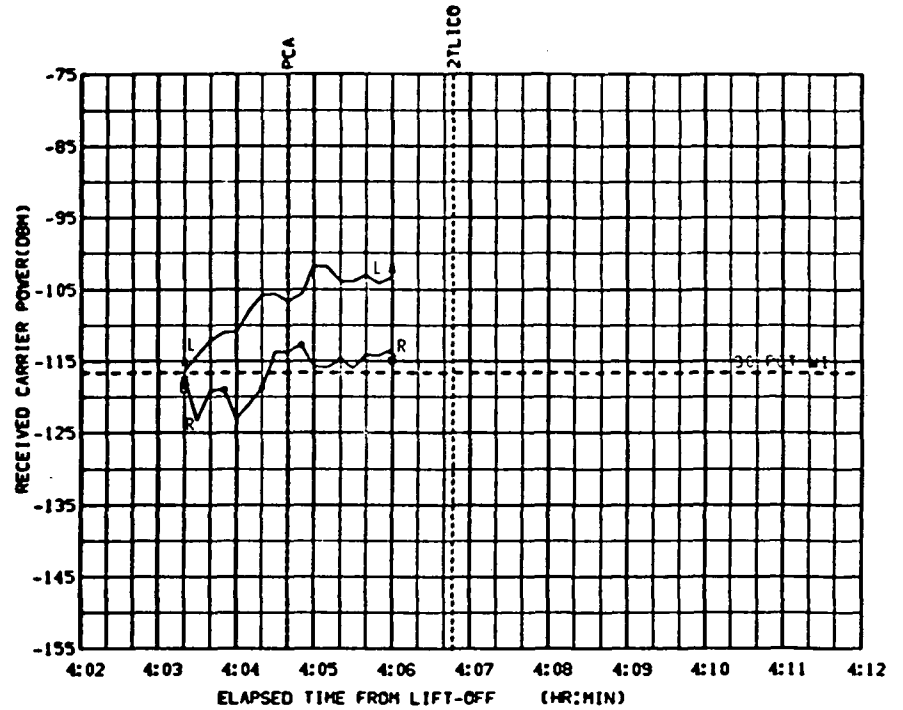

FIGURE 6-39b. MER DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

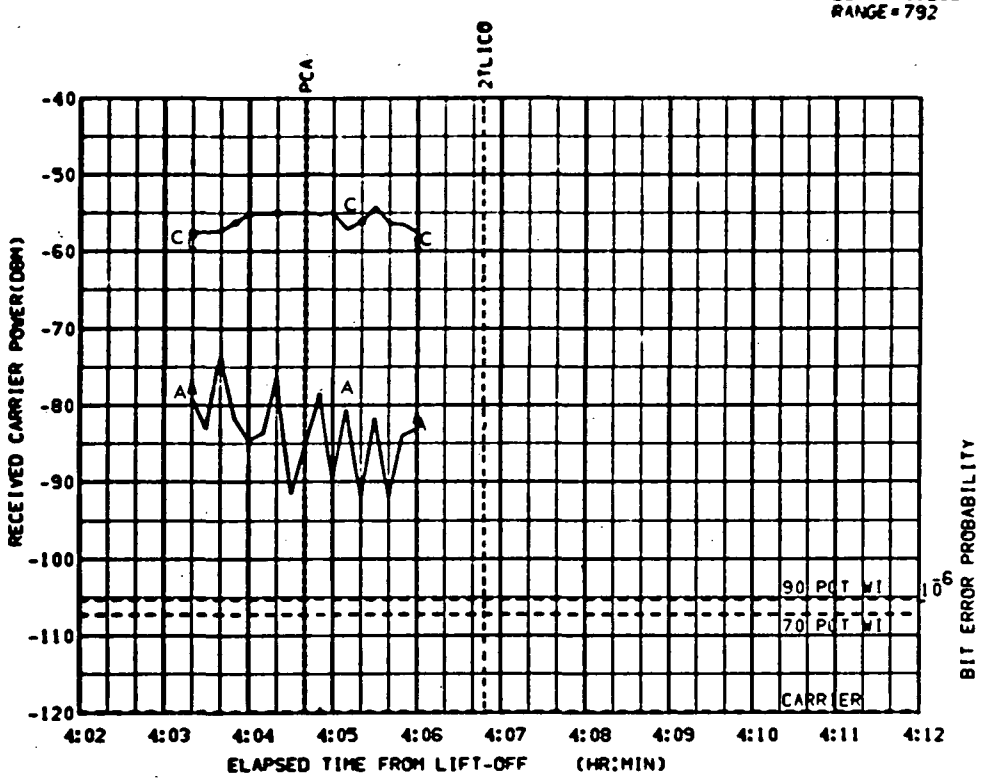

FIGURE 6-39c. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

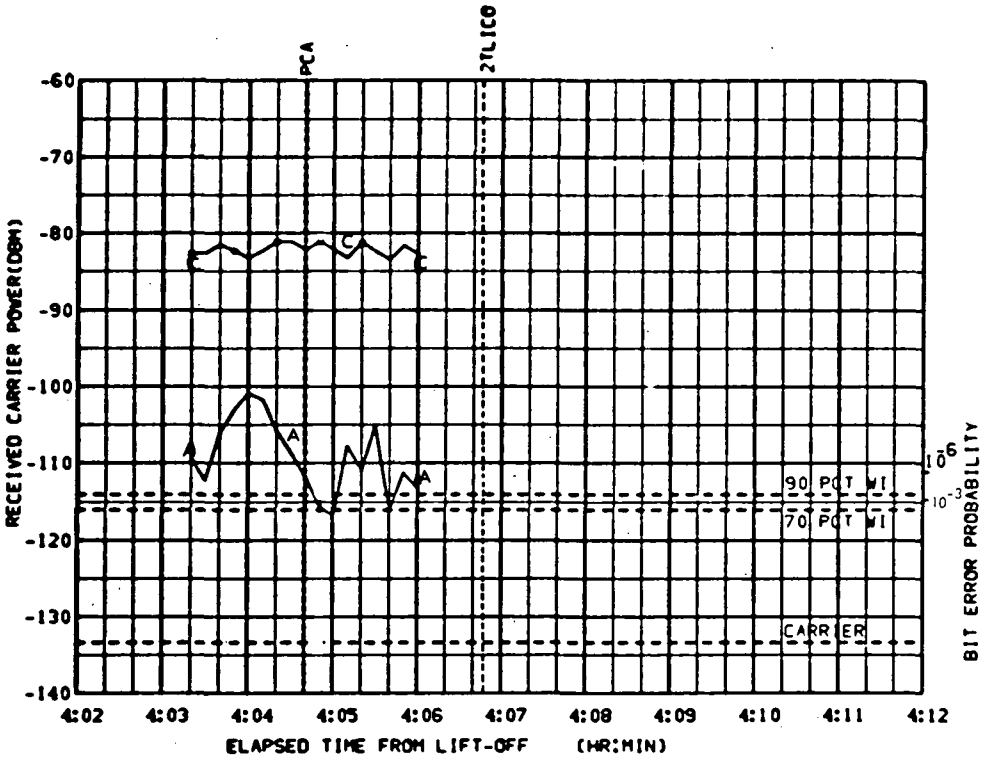

FIGURE 6-39d. MER DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

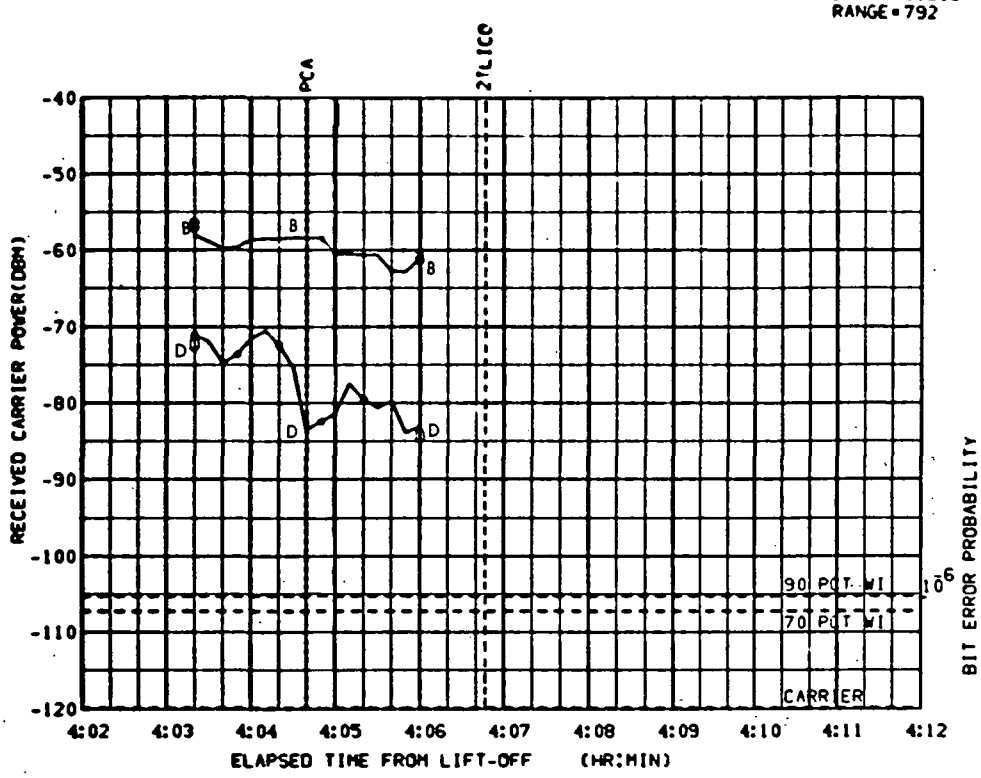

FIGURE 6-39e. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

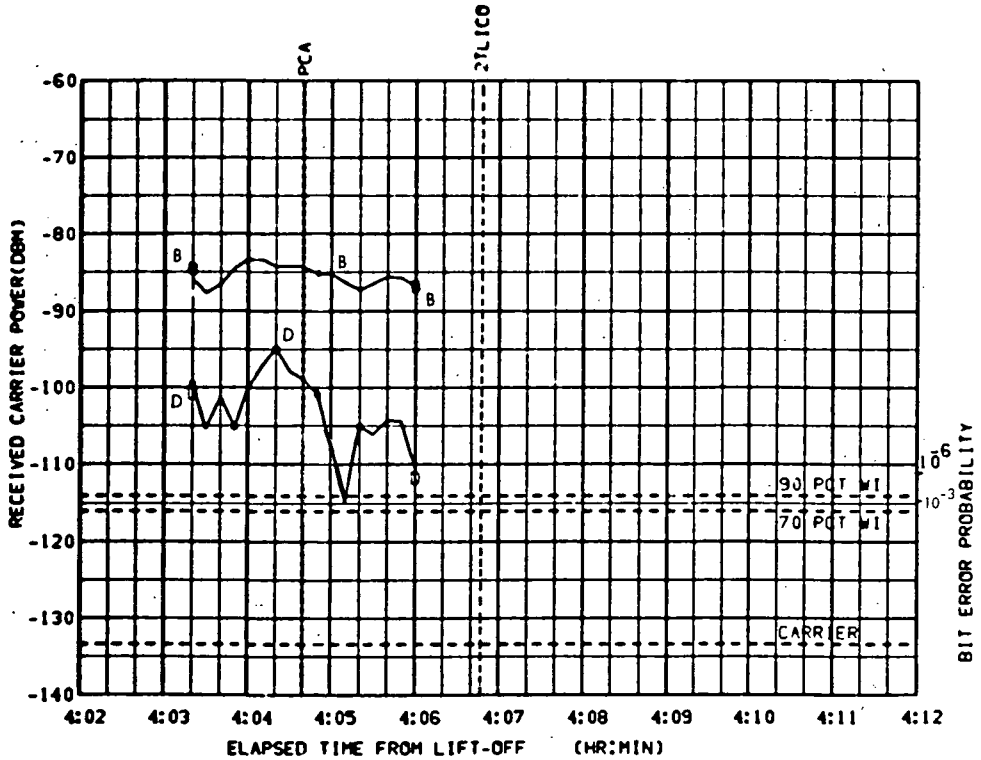

FIGURE 6-39f. MER DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

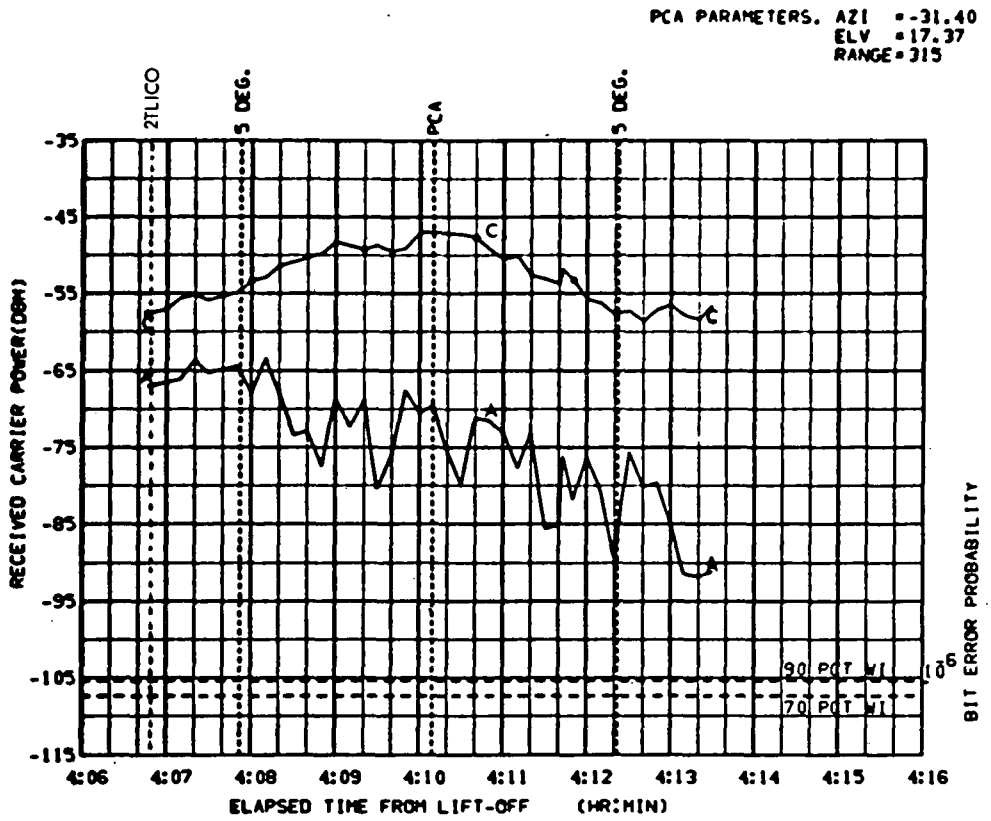

FIGURE 6-40a. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

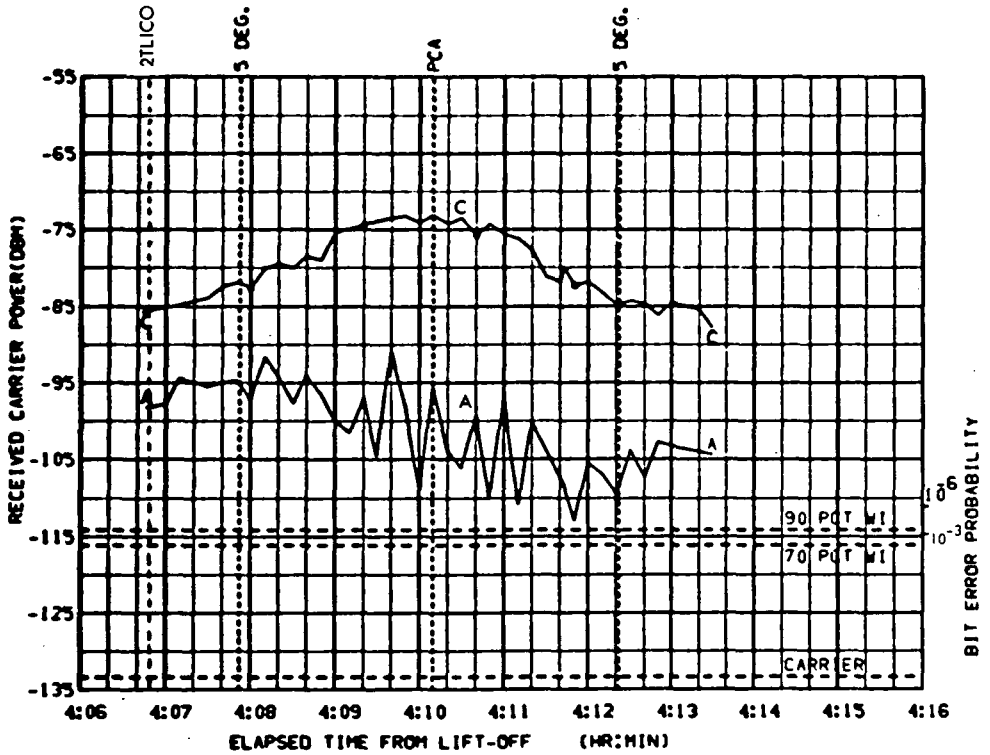

FIGURE 6-40b. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

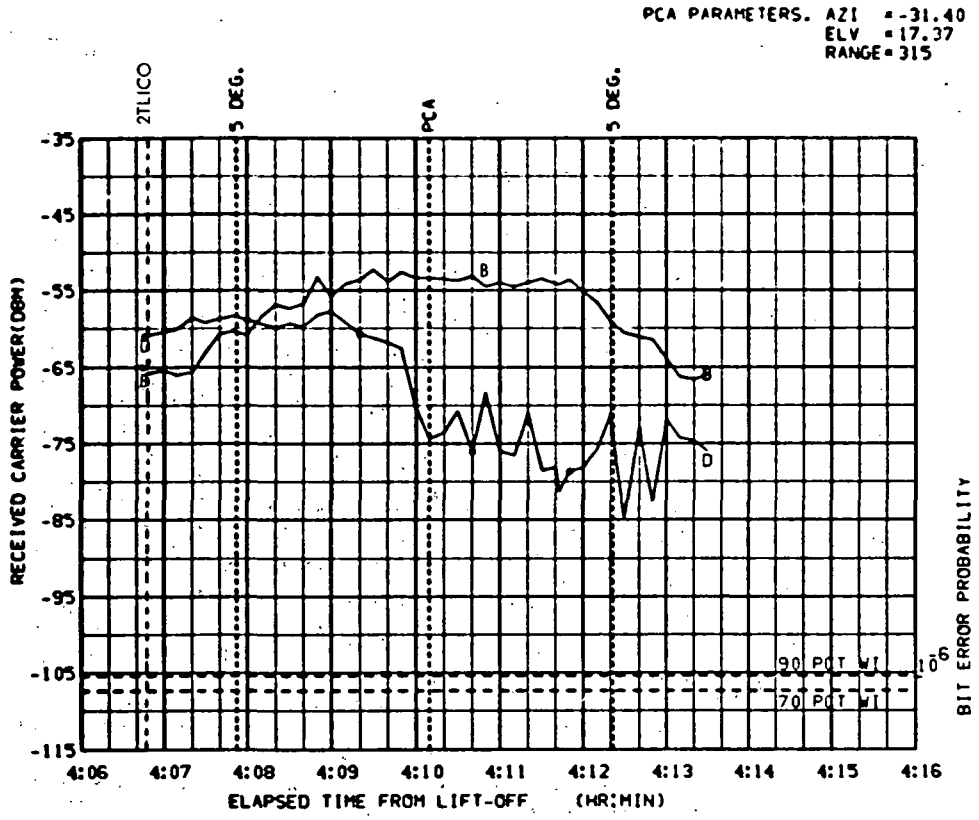

FIGURE 6-40c. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

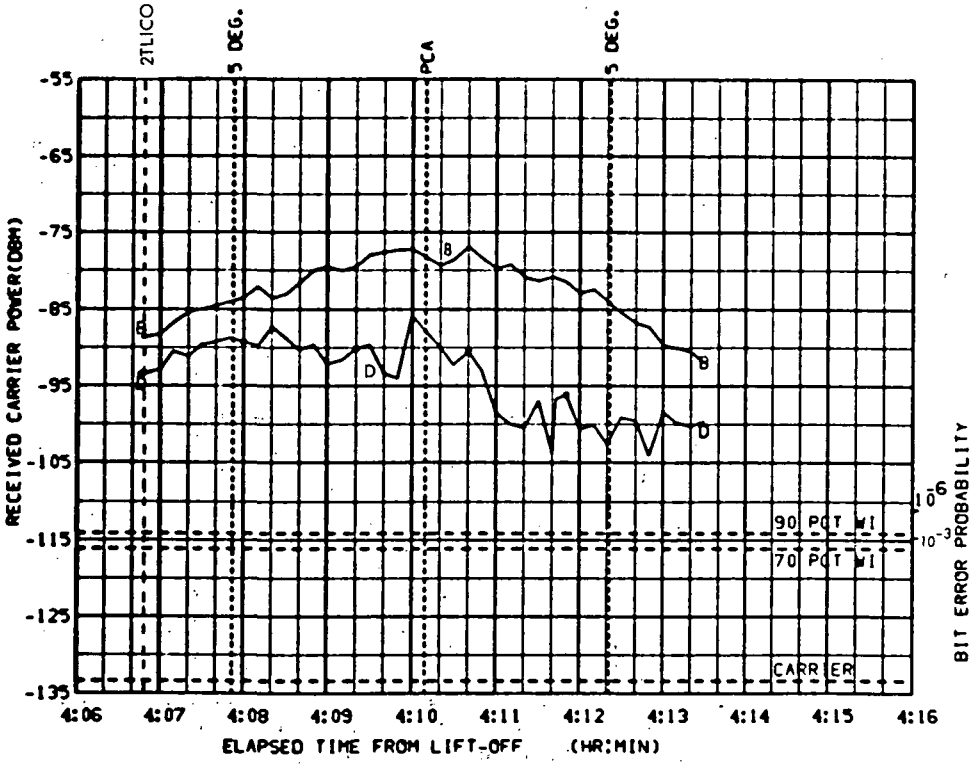

FIGURE 6-40d. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

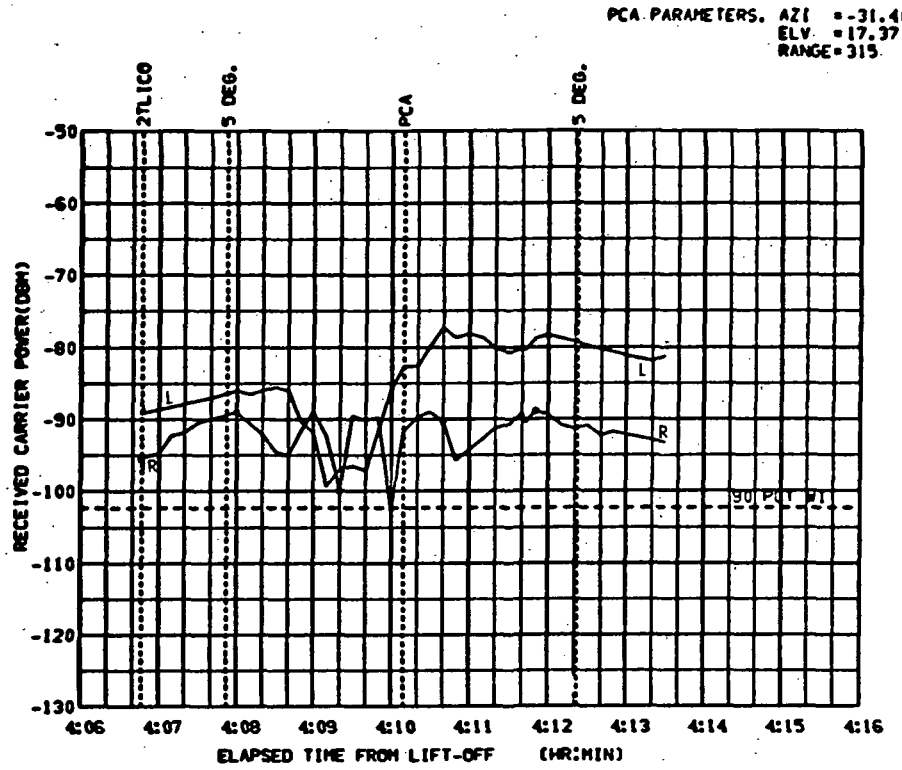

FIGURE 6-40e. RED UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

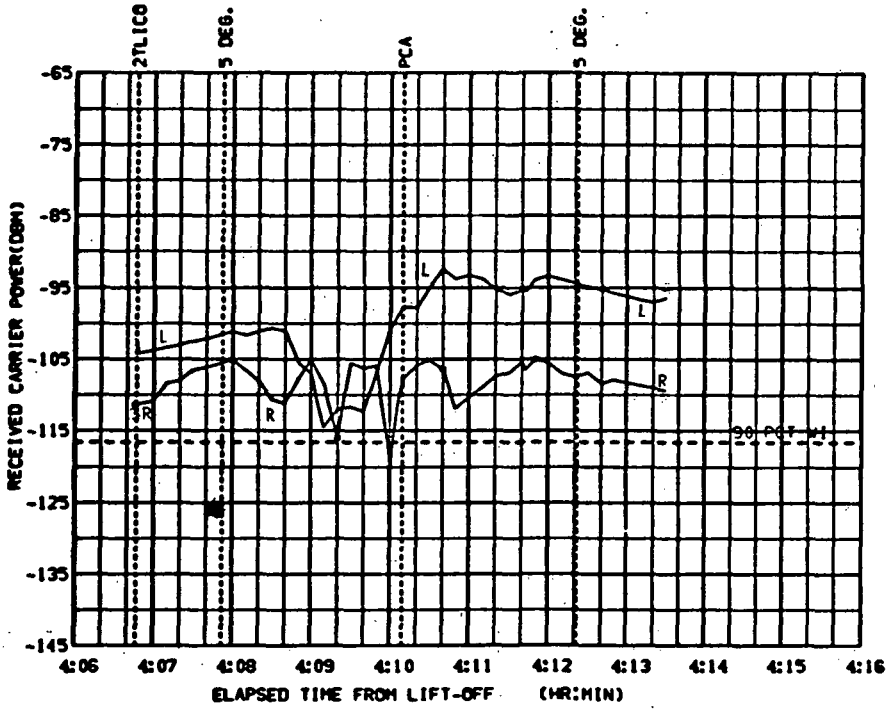

FIGURE 6-40f. RED DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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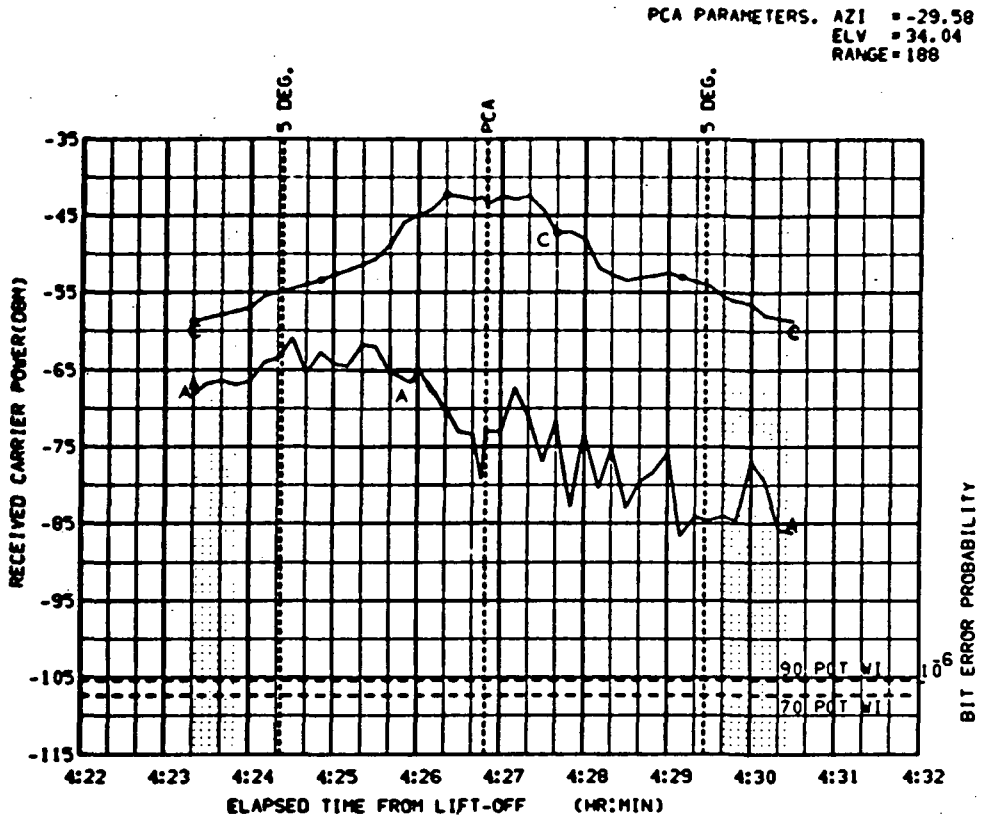

FIGURE 6-41a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

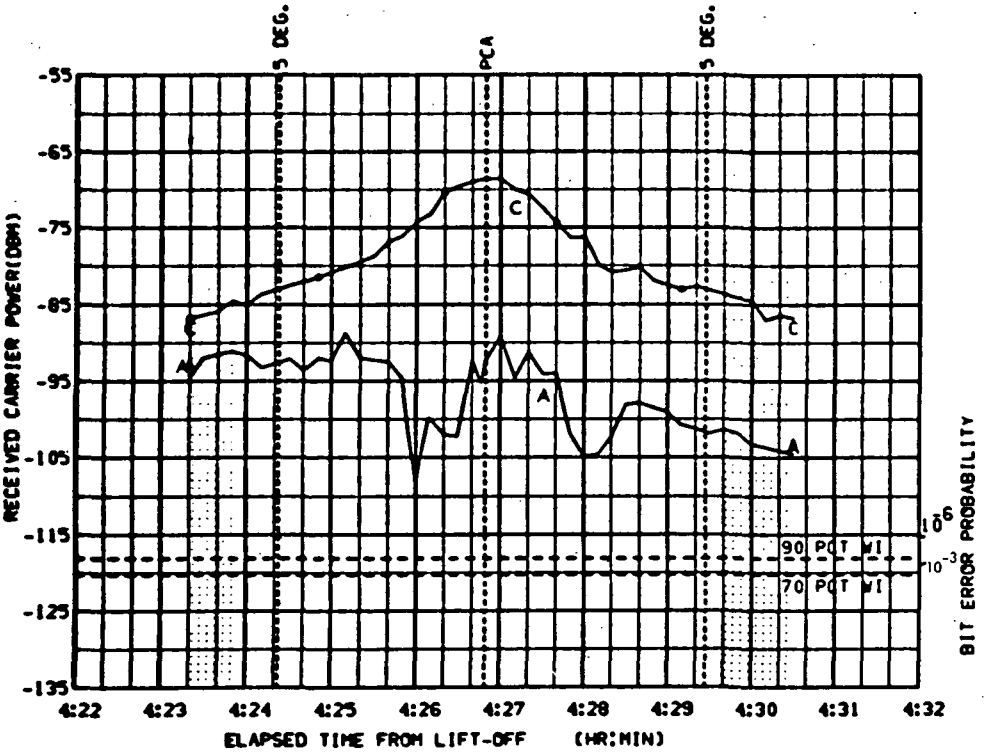

FIGURE 6-41b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

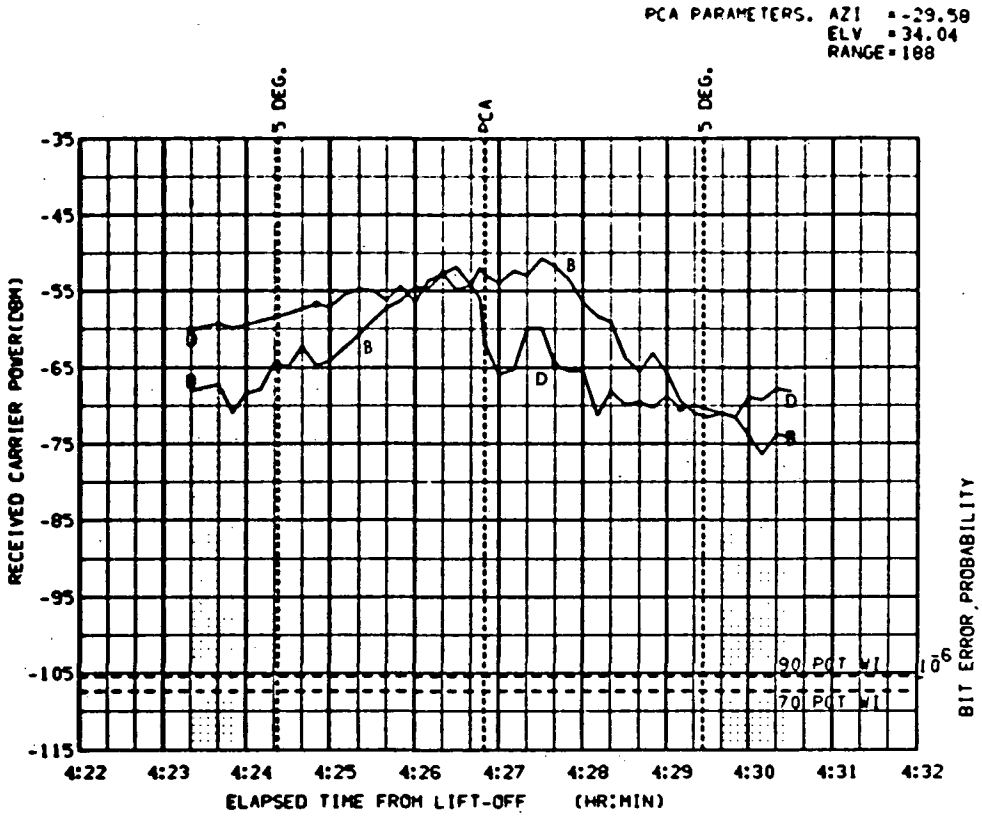

FIGURE 6-41c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

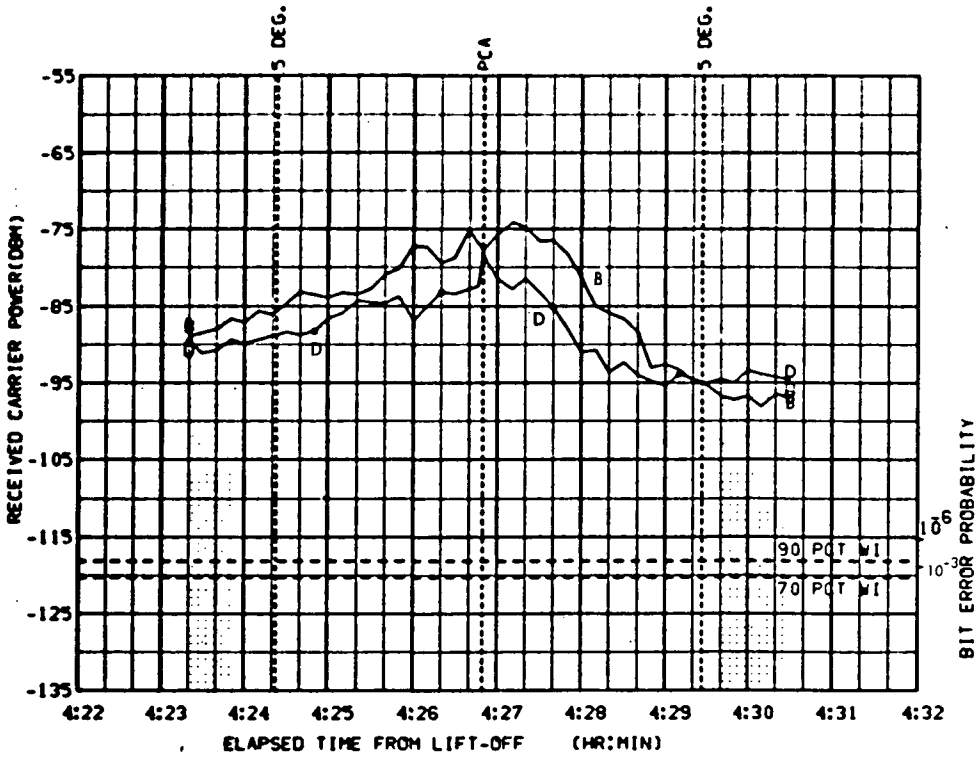

FIGURE 6-41d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

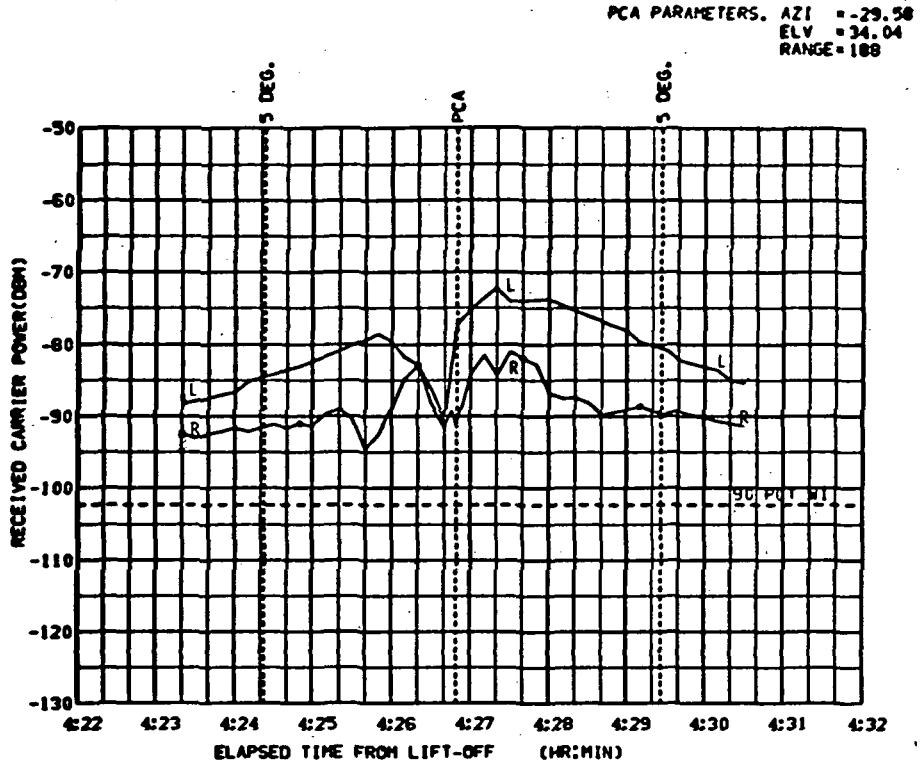

FIGURE 6-41e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

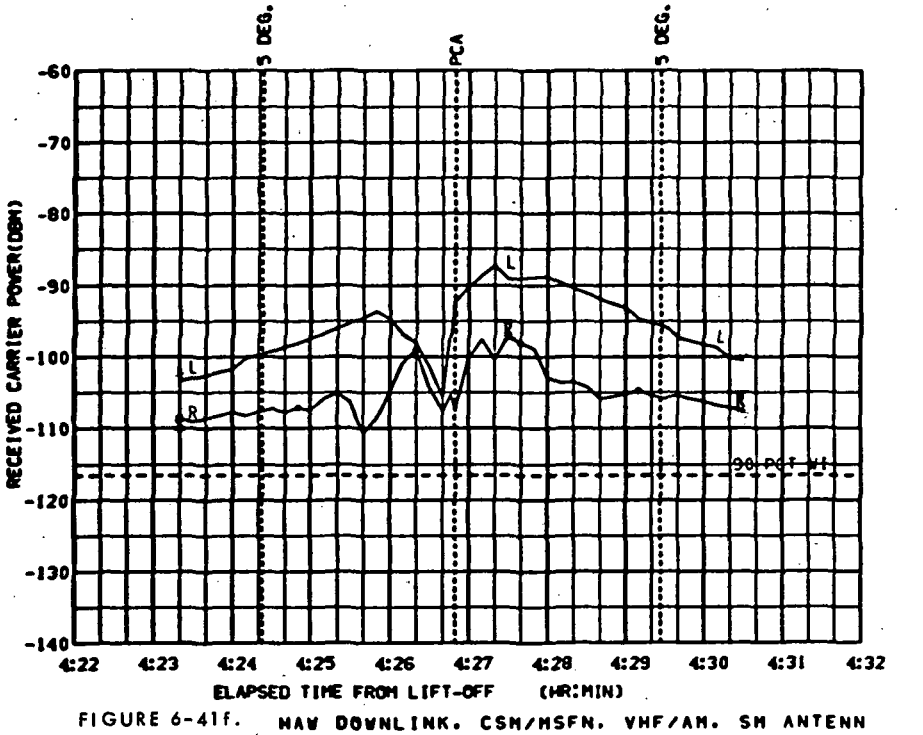

FIGURE 6-41f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

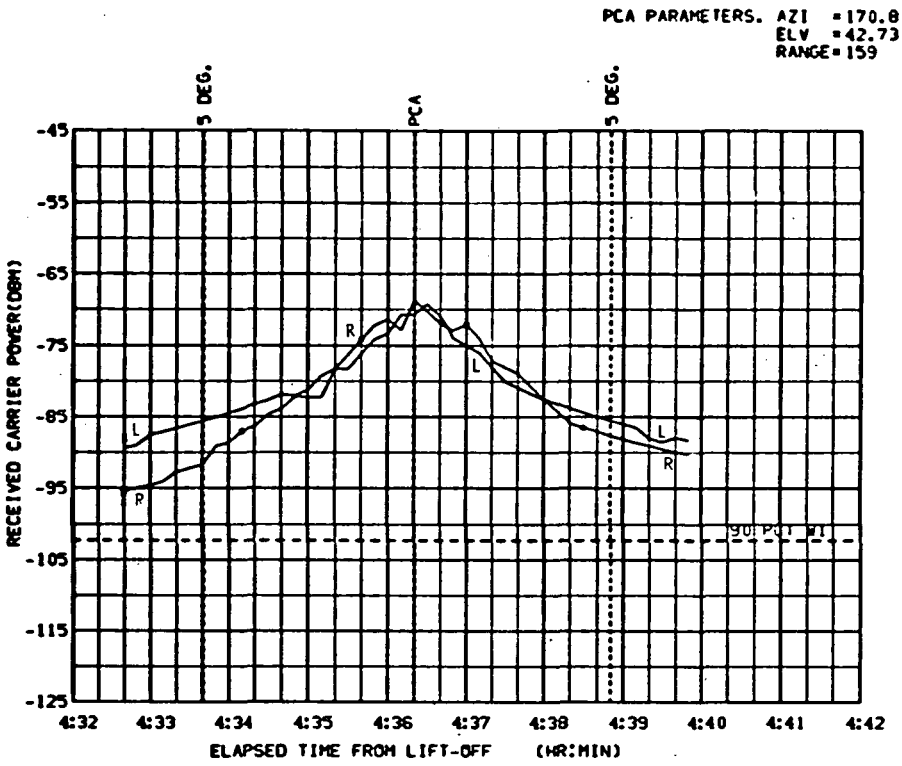

FIGURE 6-42a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

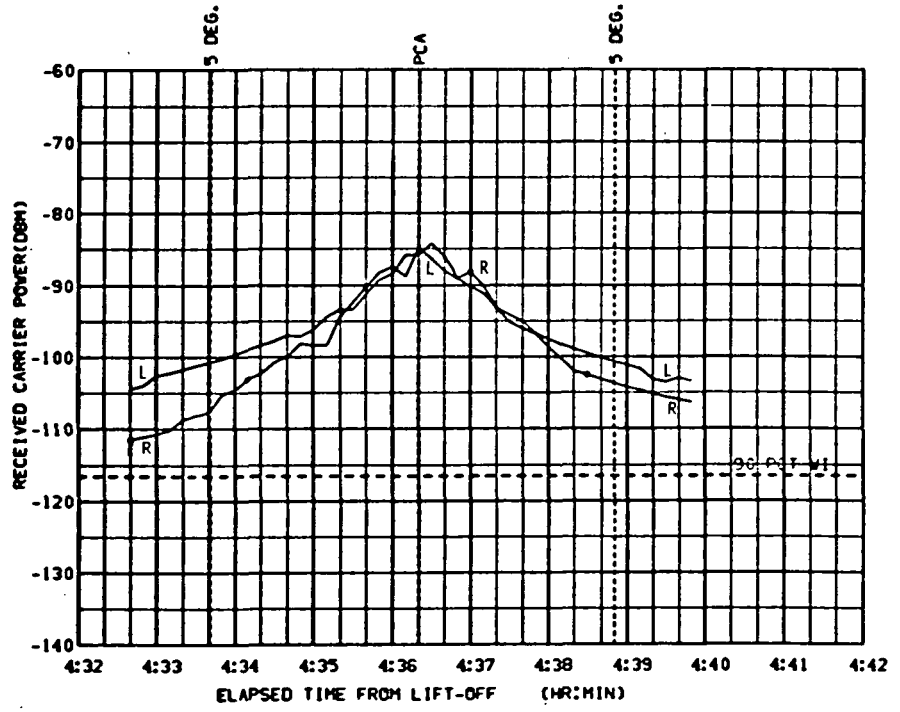

FIGURE 6-42b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

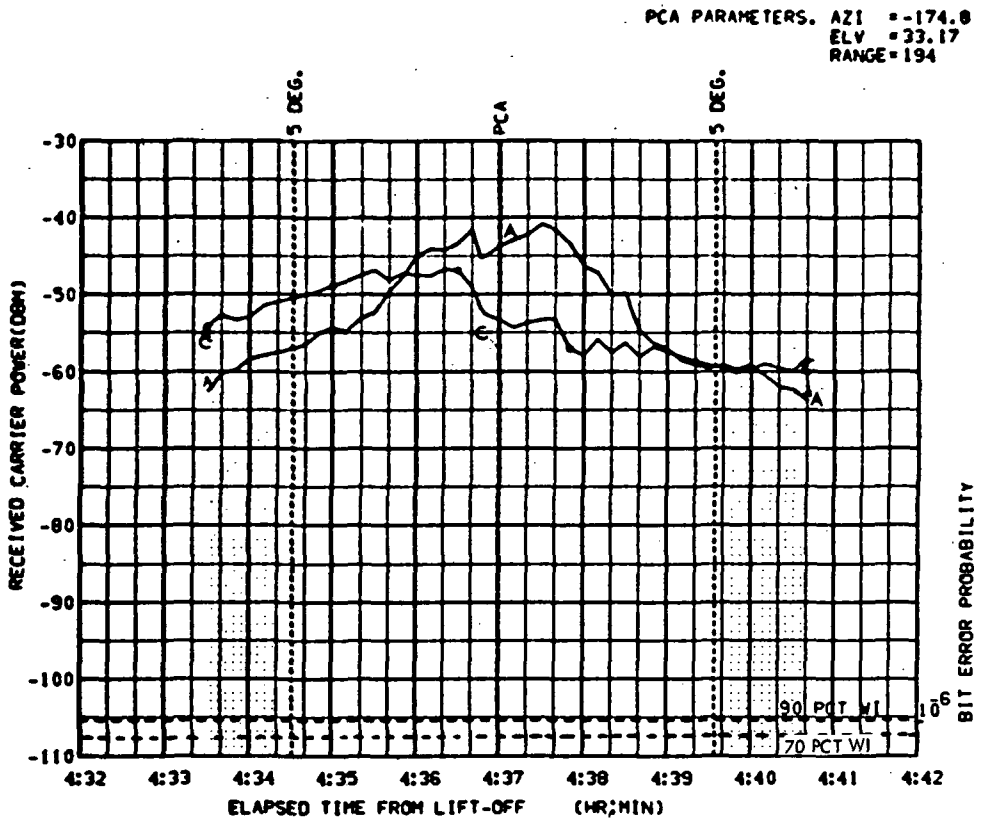

FIGURE 6-43a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

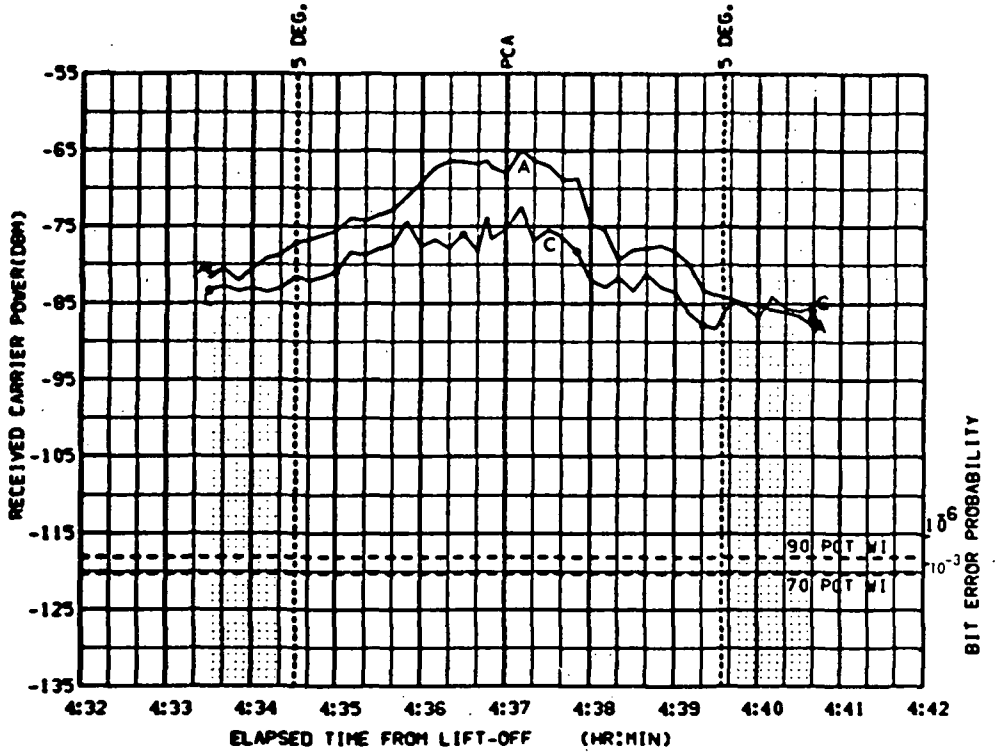

FIGURE 6-43b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

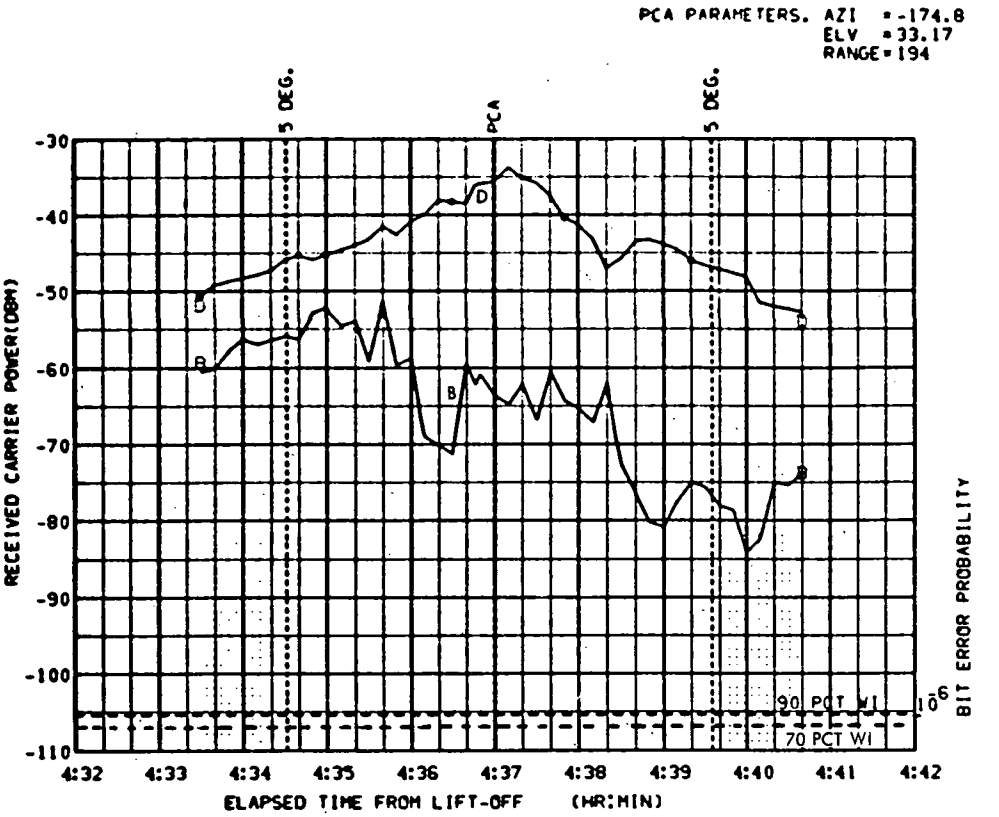

FIGURE 6-43c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

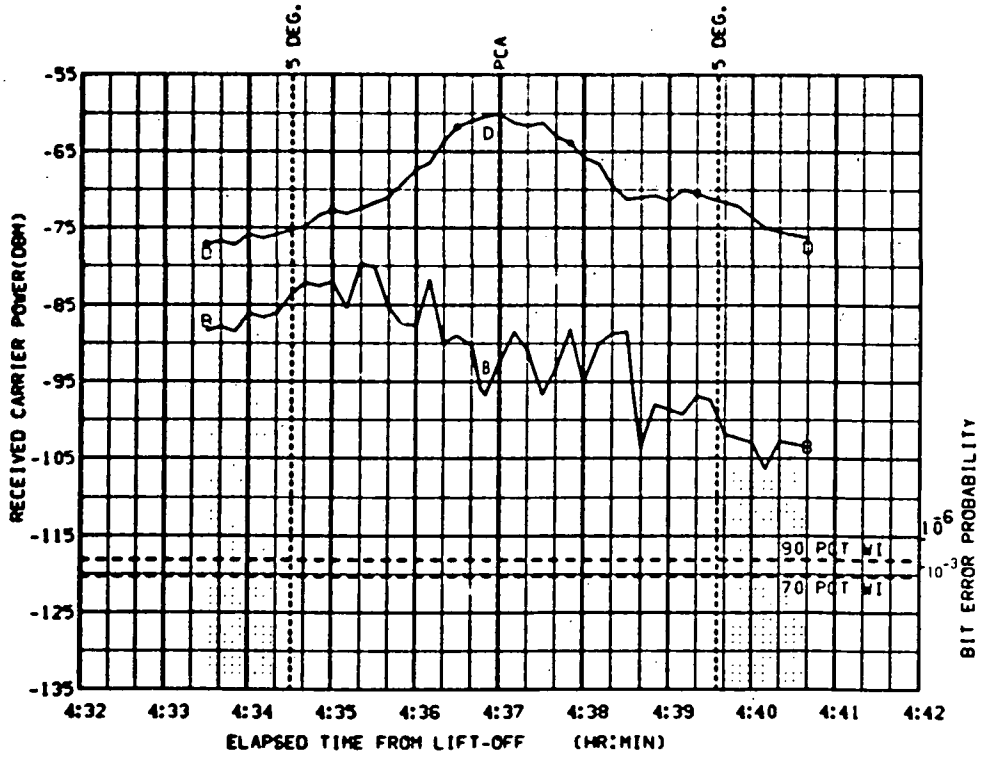

FIGURE 6-43d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

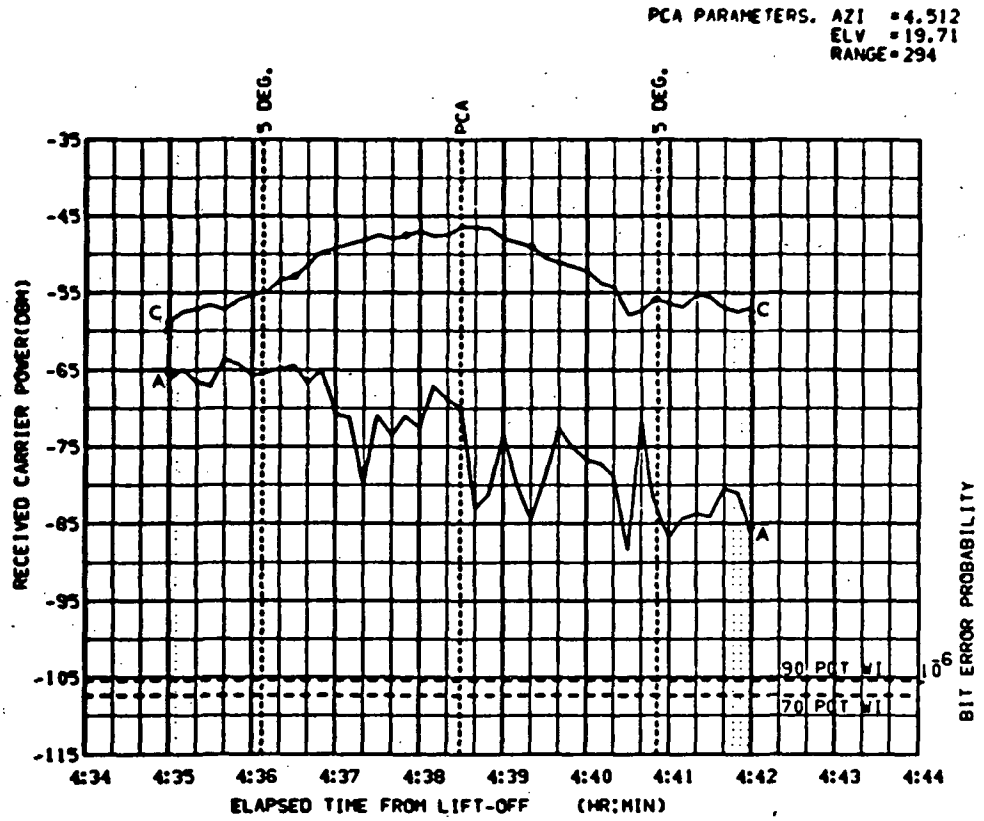

FIGURE 6-44a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

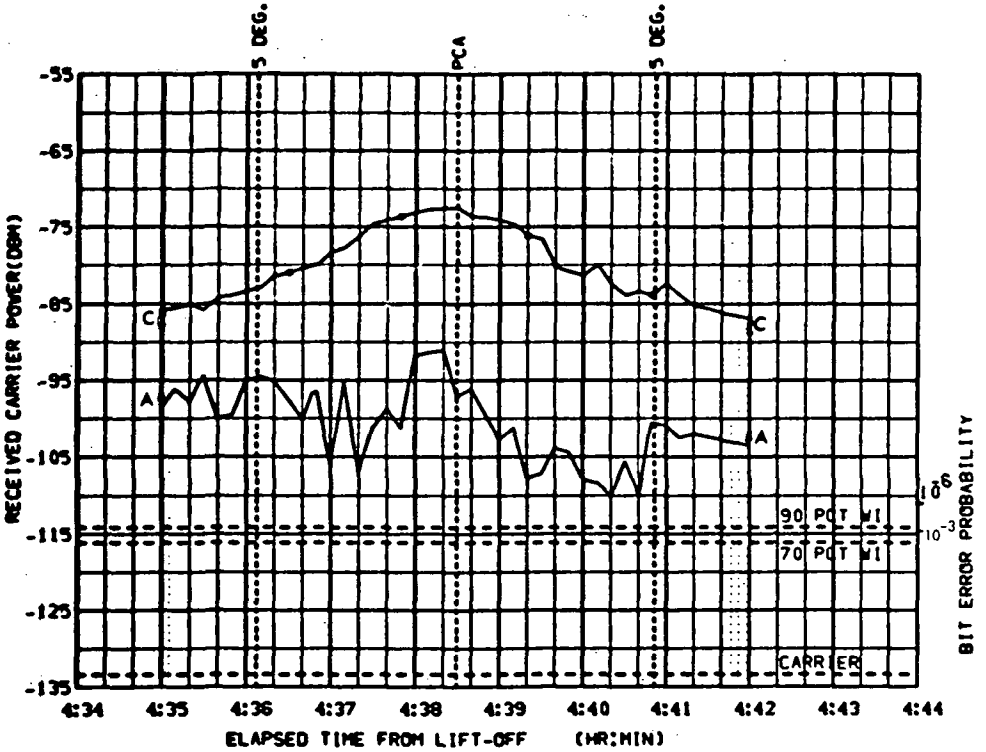

FIGURE 6-44b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

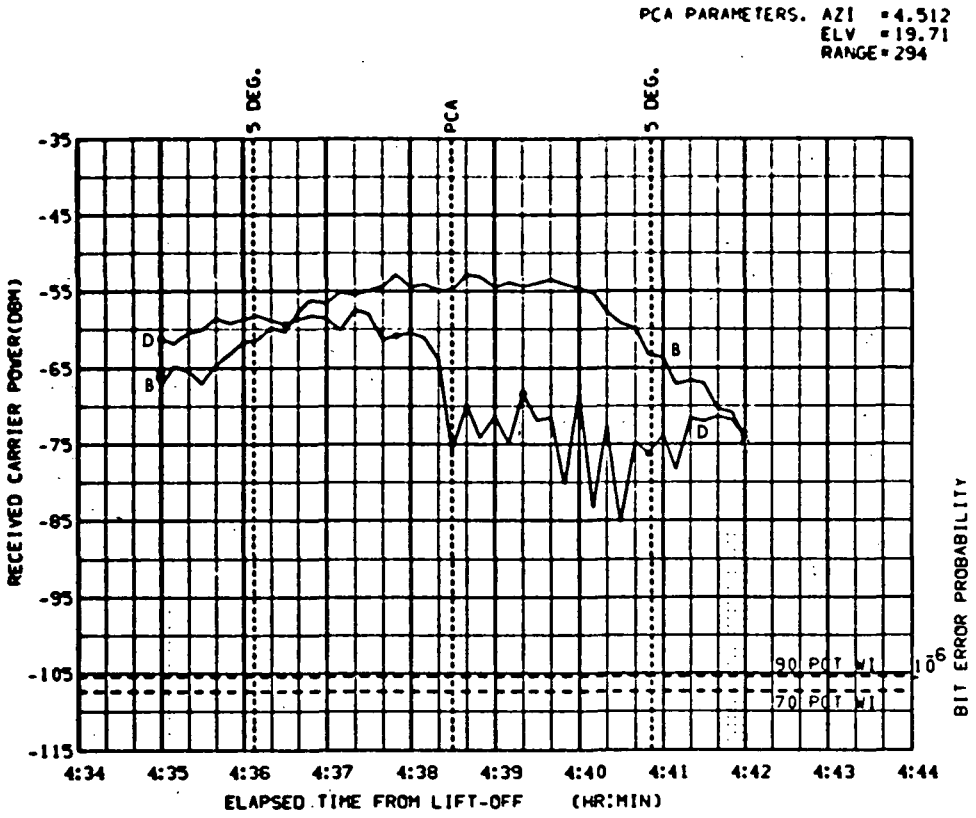

FIGURE 6-44c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

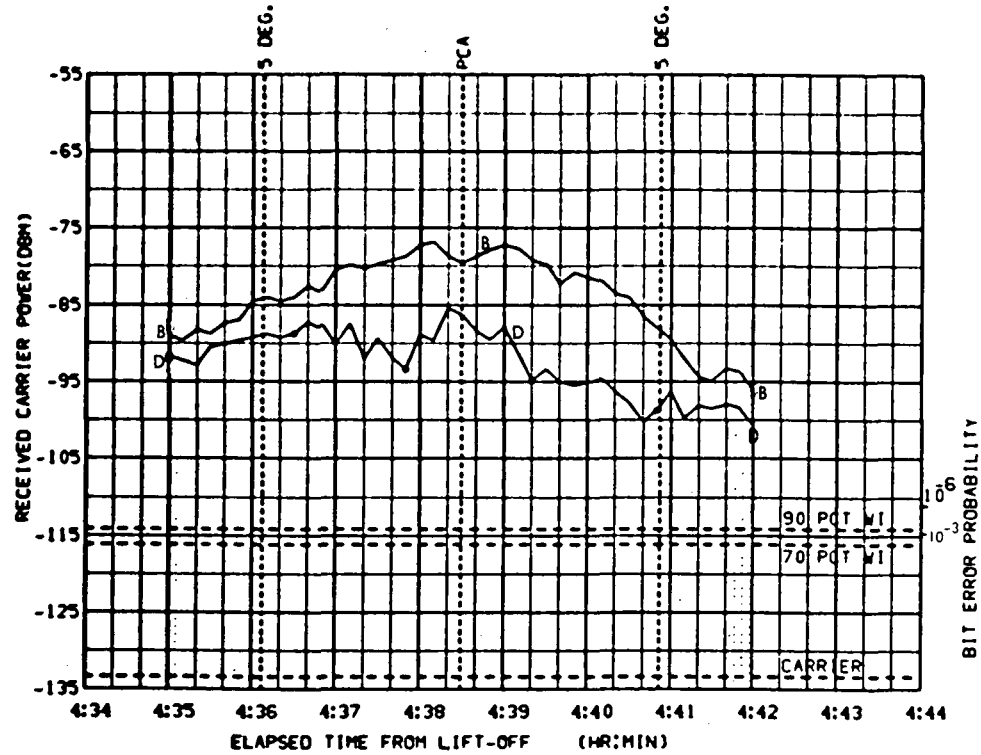

FIGURE 6-44d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

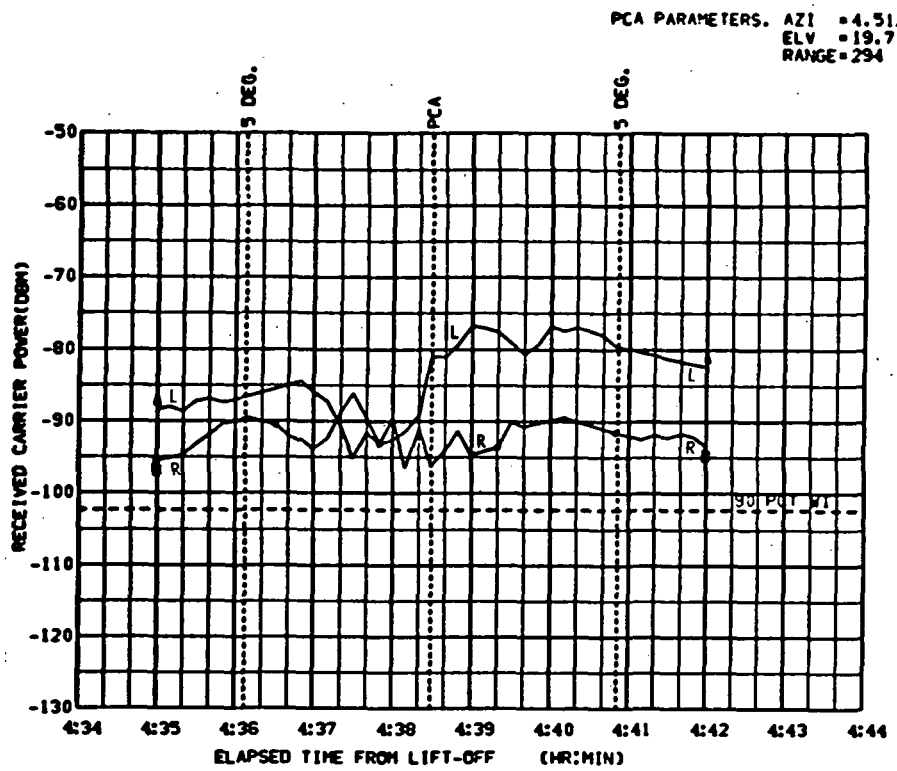

FIGURE 6-44e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

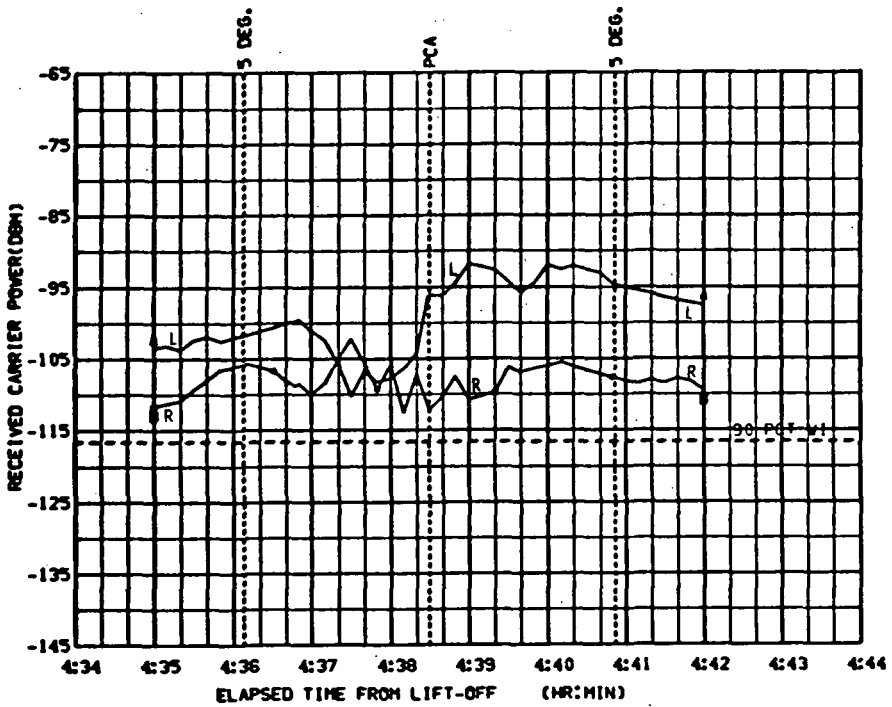

FIGURE 6-44f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

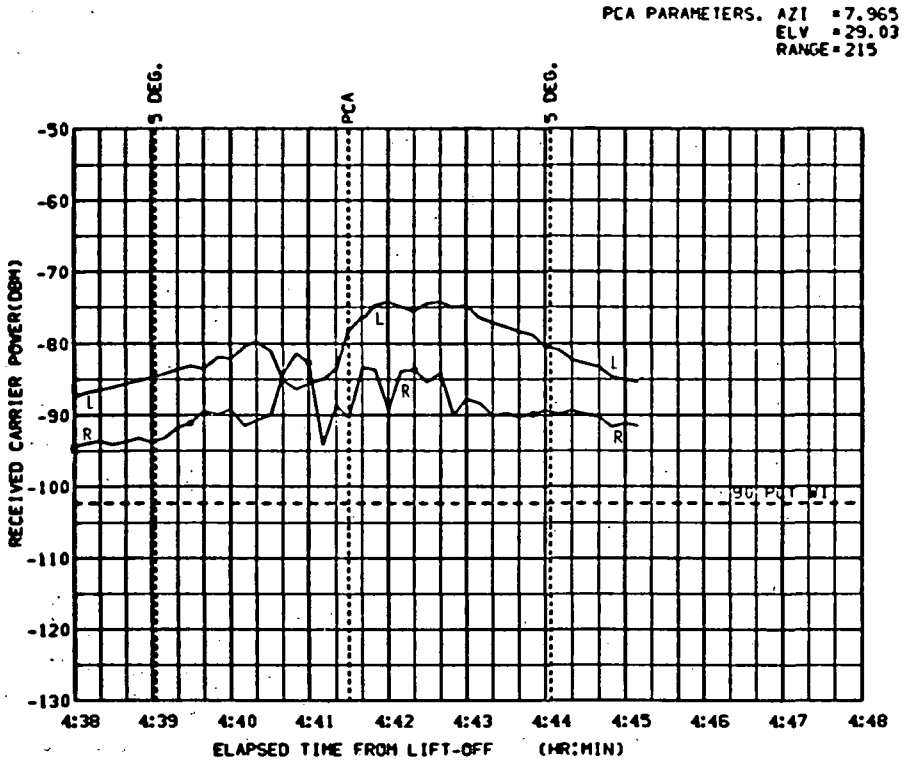

FIGURE 6-45a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

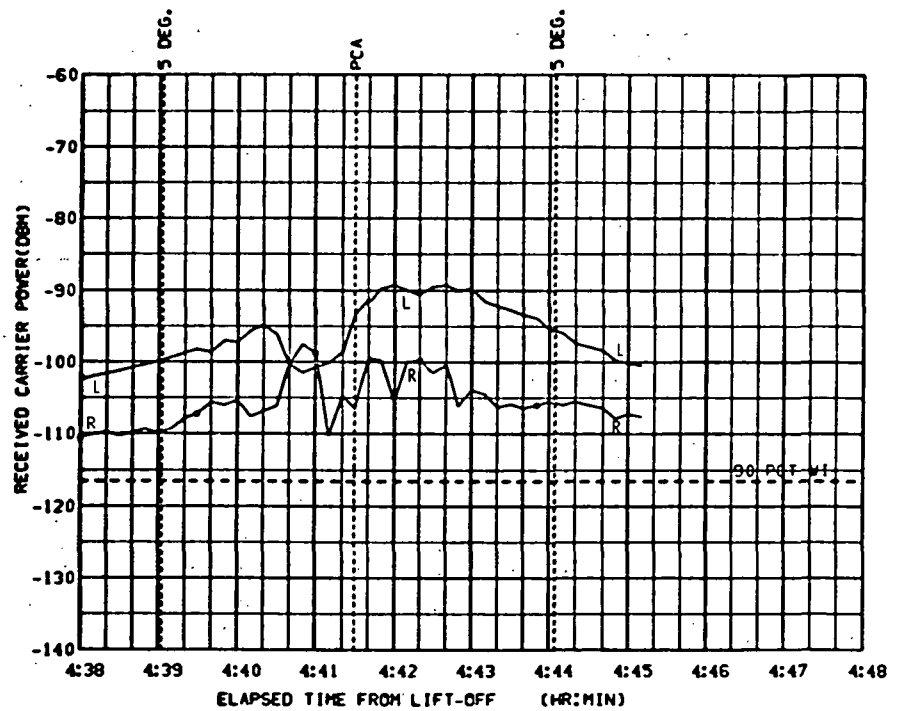

FIGURE 6-45b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

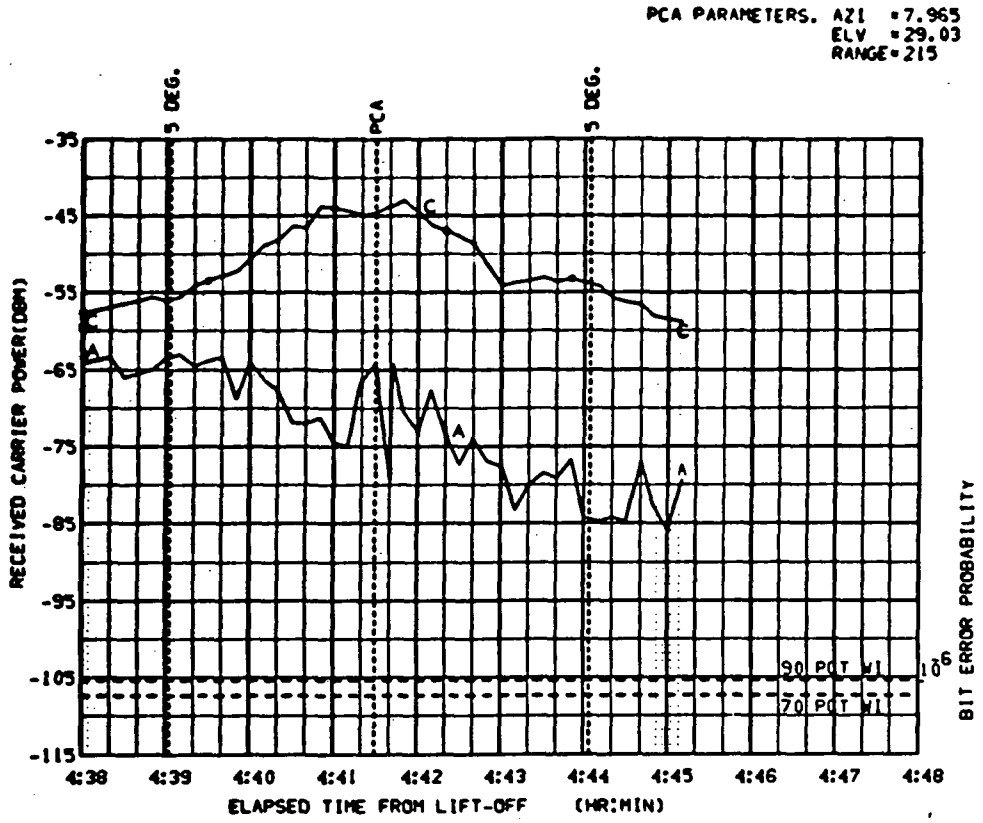

FIGURE 6-45c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

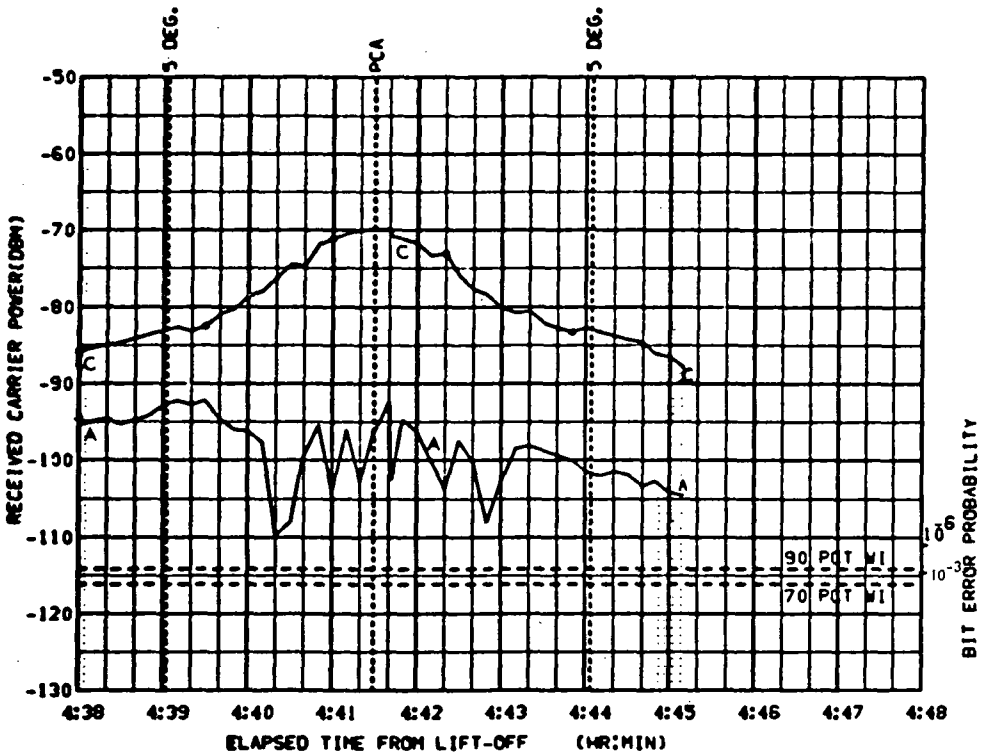

FIGURE 6-45d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

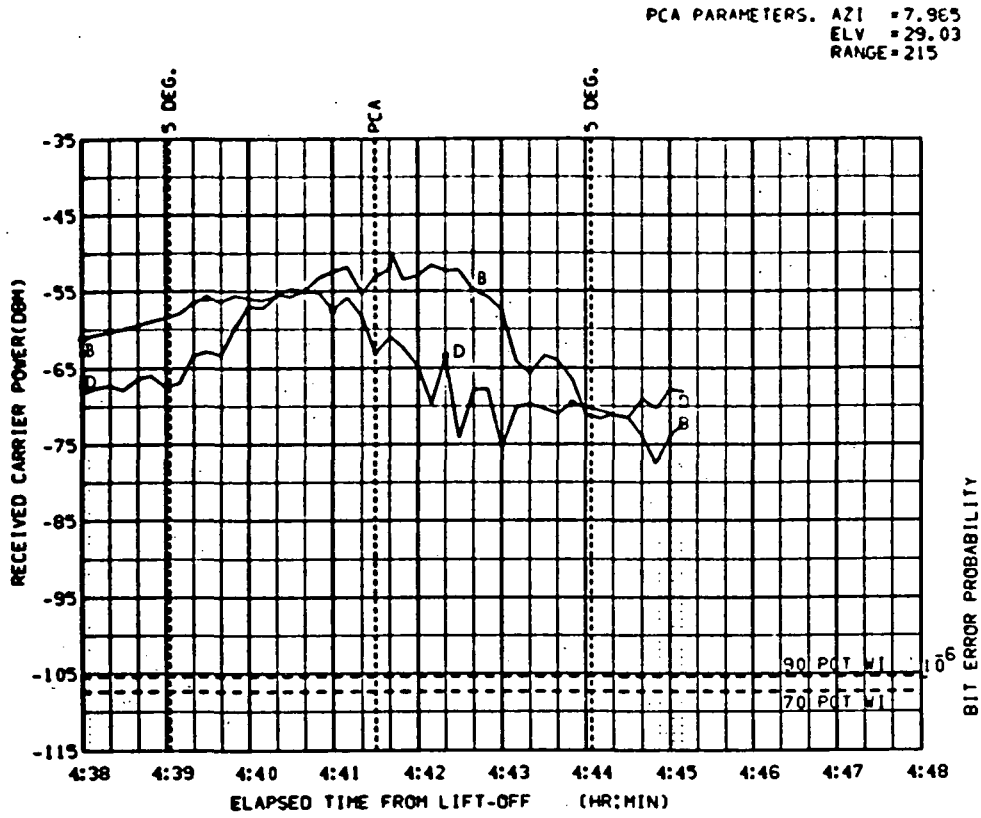

FIGURE 6-45e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

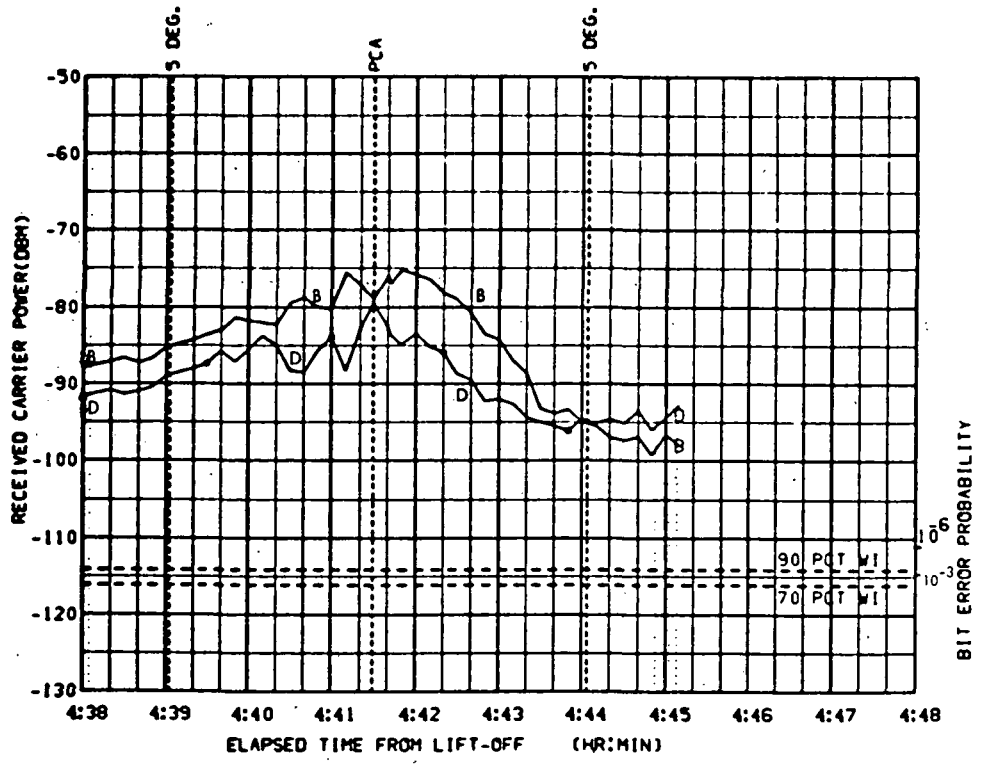

FIGURE 6-45f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

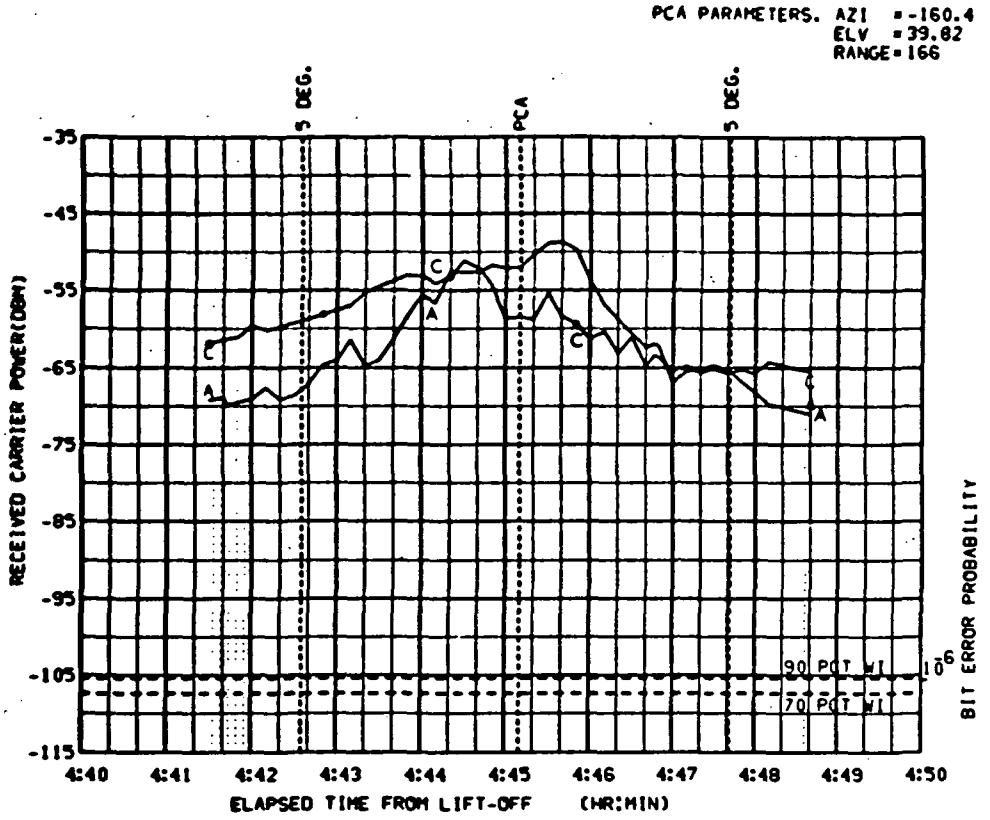

FIGURE 6-46a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

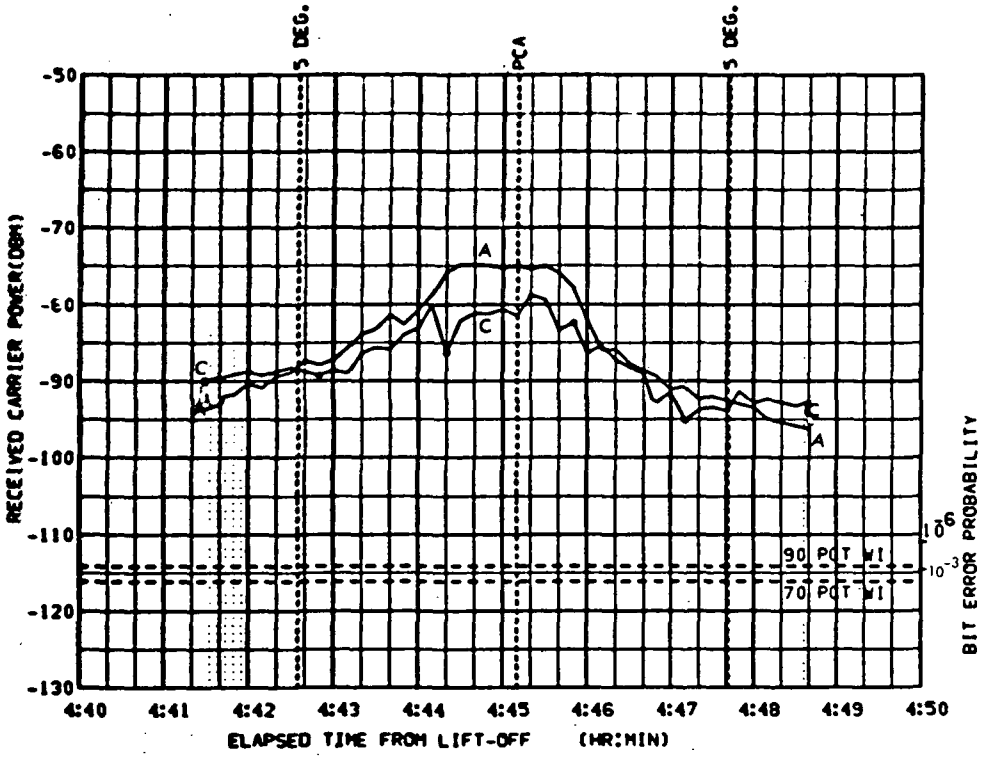

FIGURE 6-46b. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

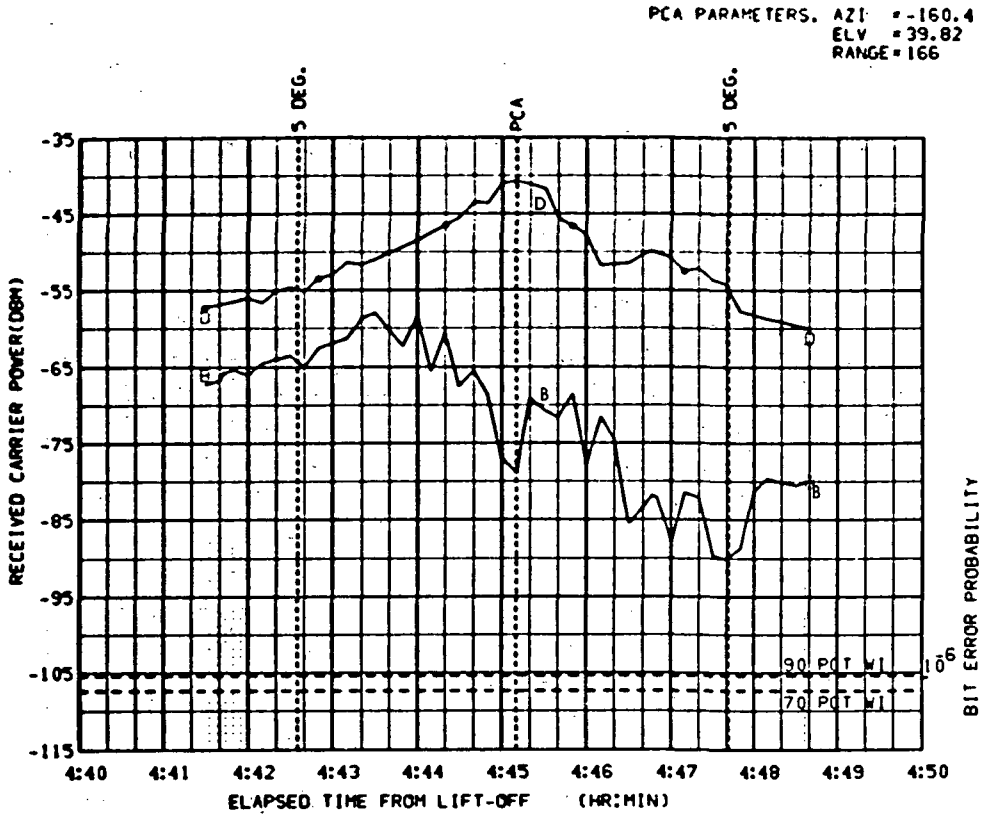

FIGURE 6-46c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

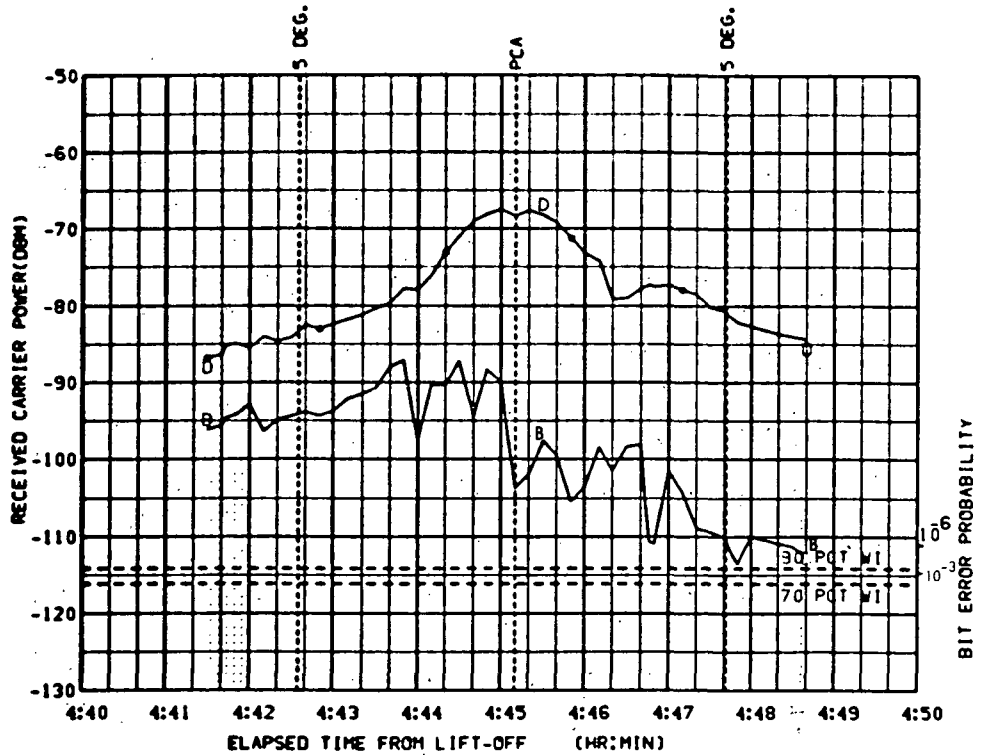

FIGURE 6-46d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

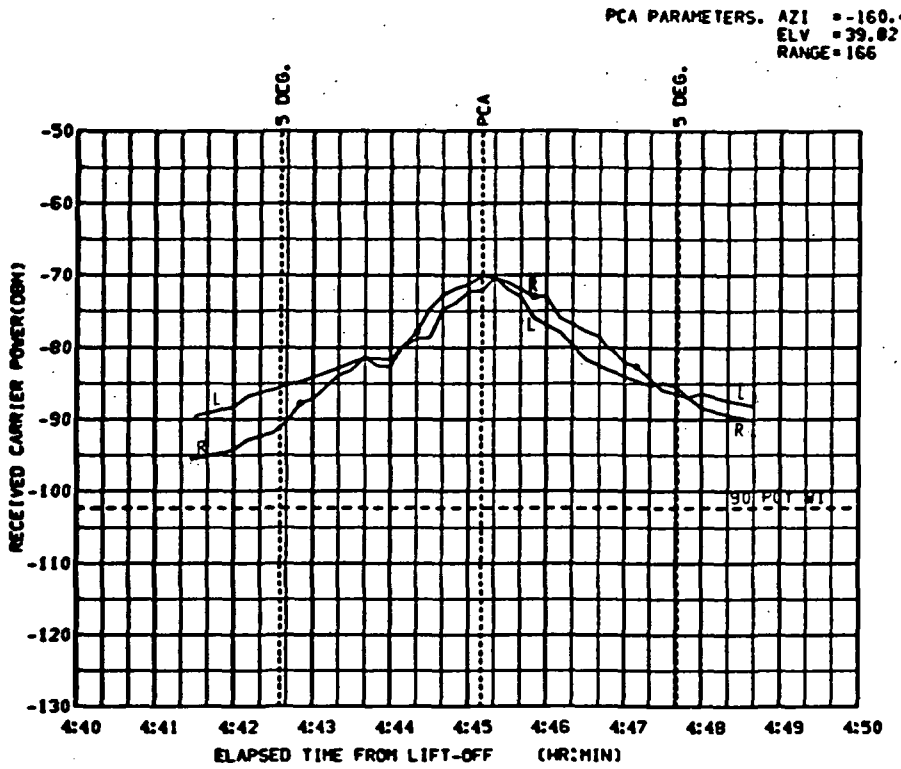

FIGURE 6-46e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

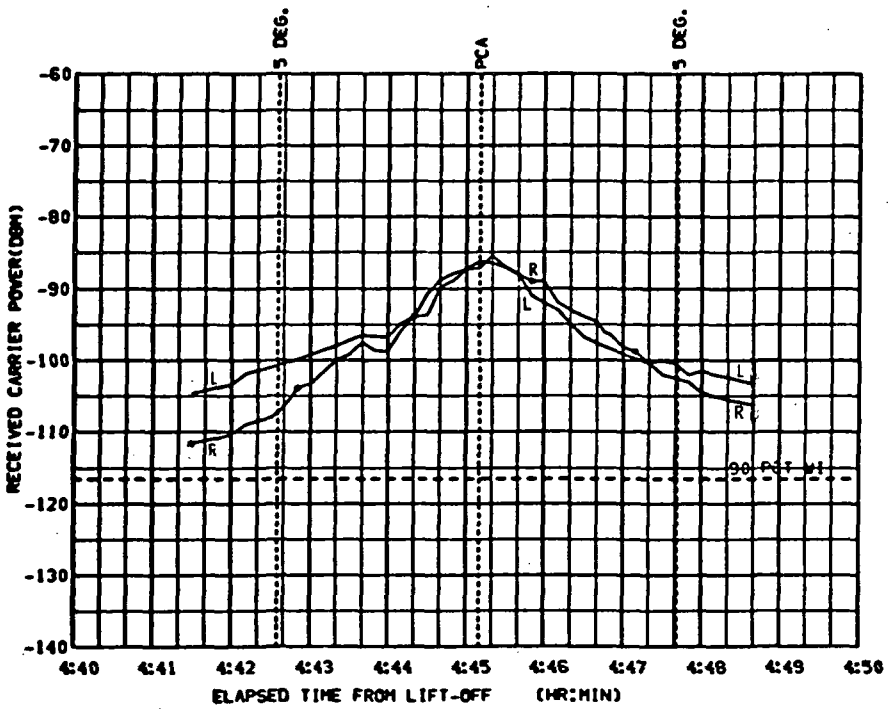

FIGURE 6-46f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

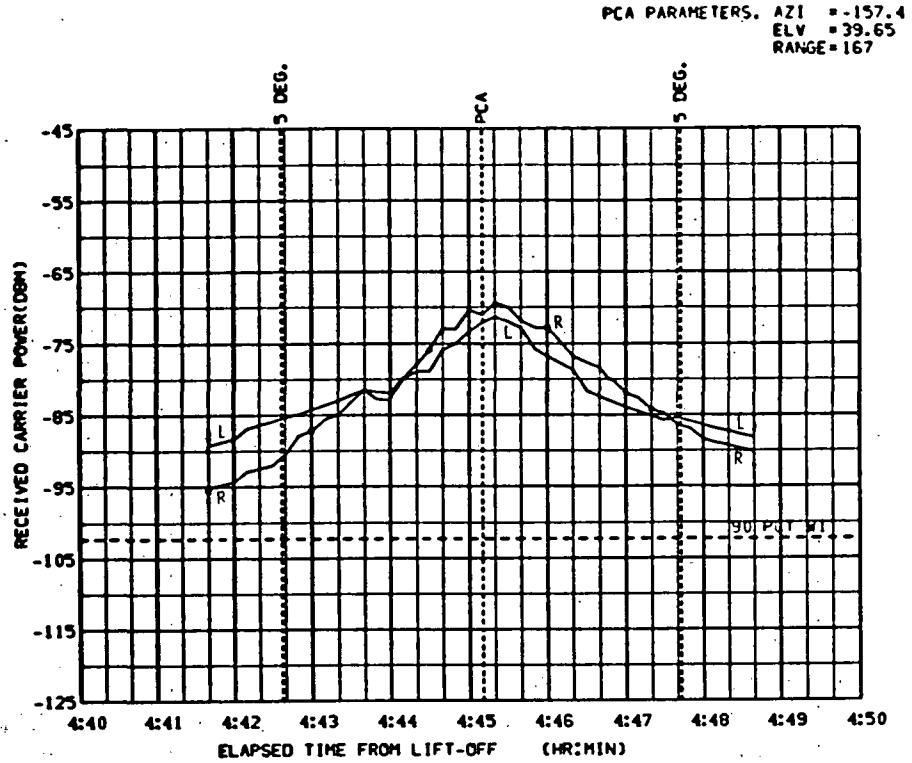

FIGURE 6-47a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

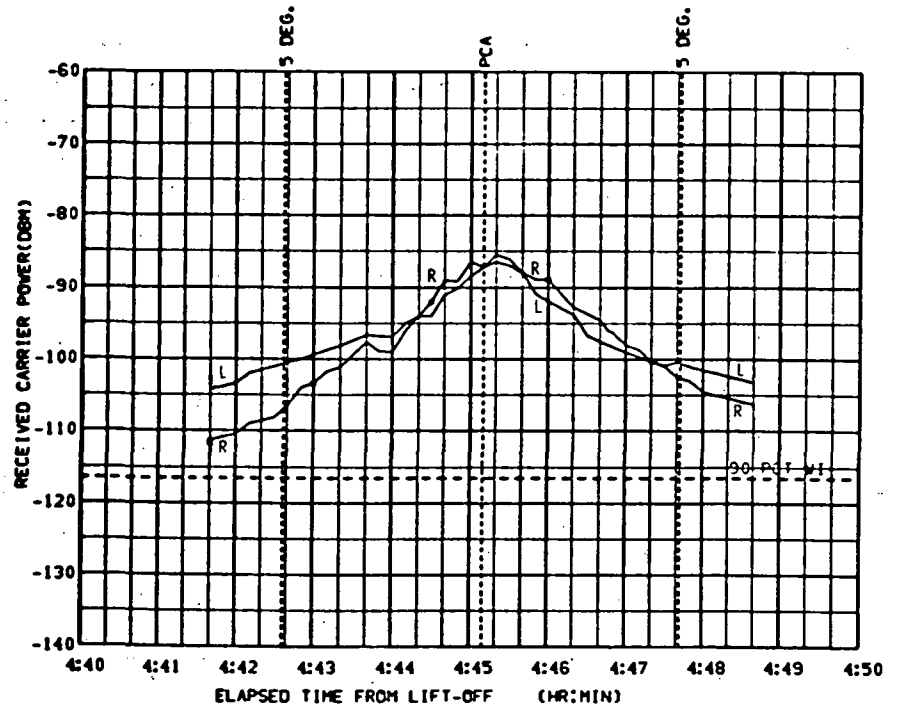

FIGURE 6-47b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

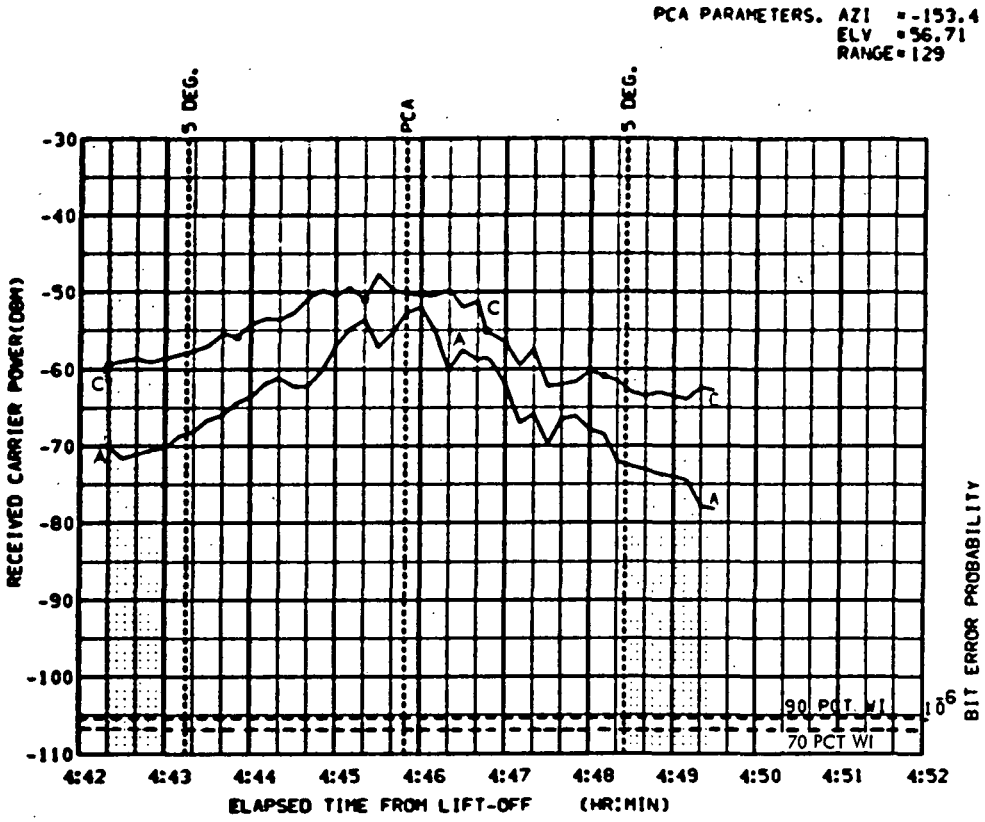

FIGURE 6-48a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

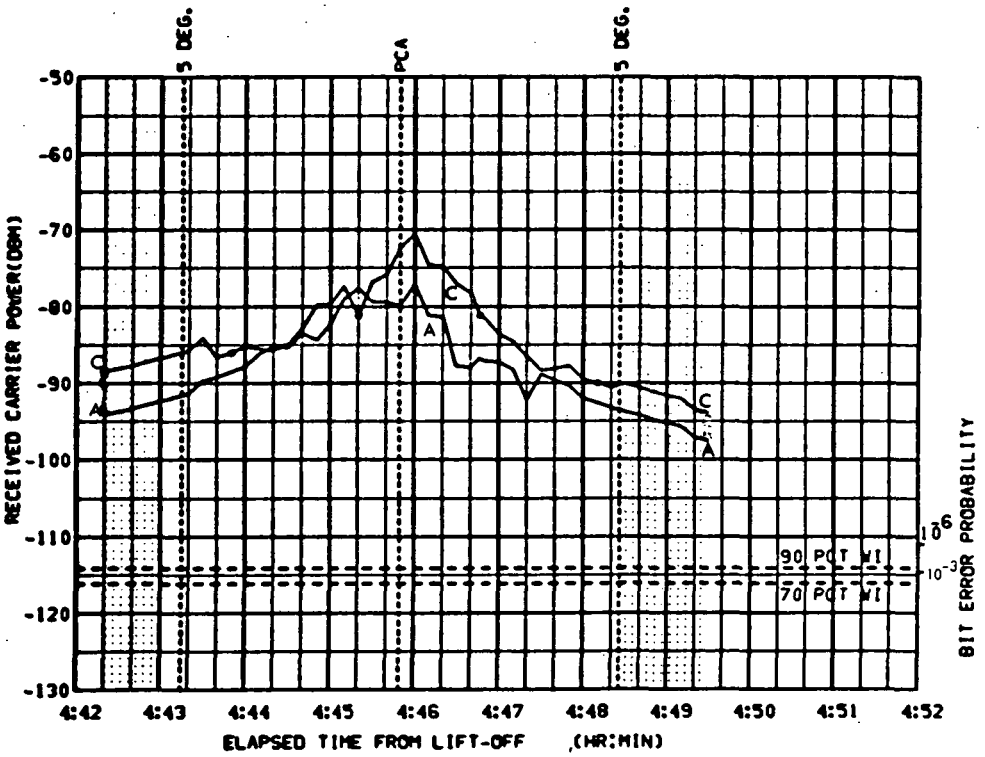

FIGURE 6-48b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

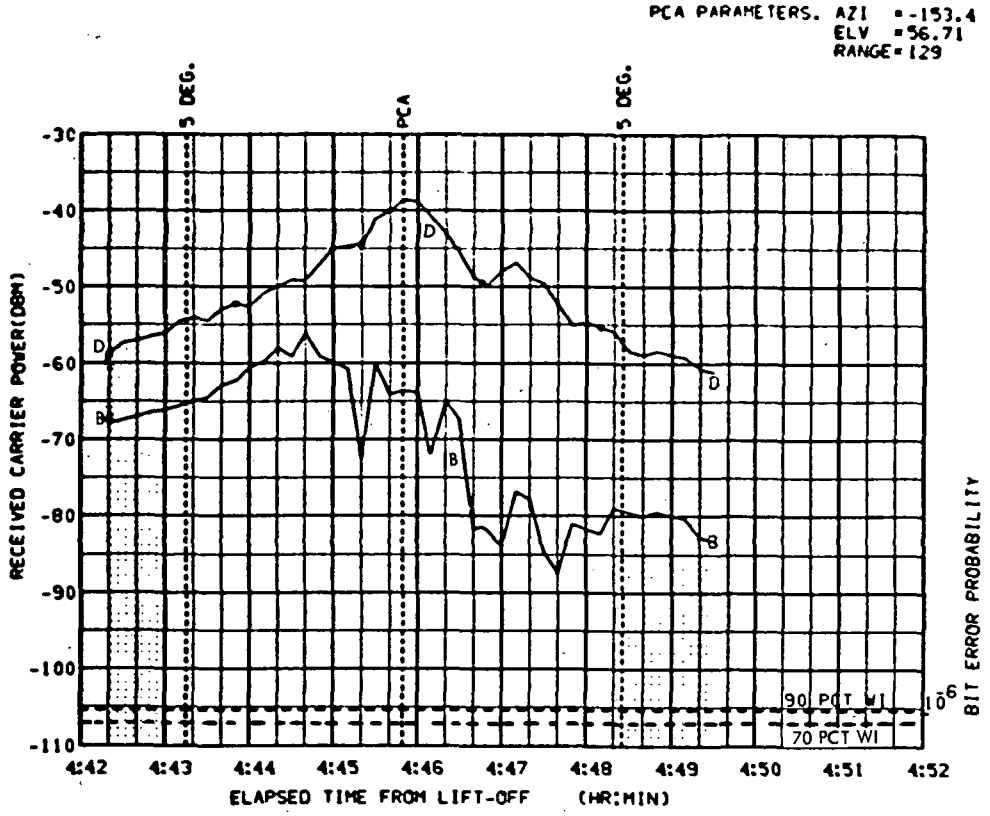

FIGURE 6-48c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

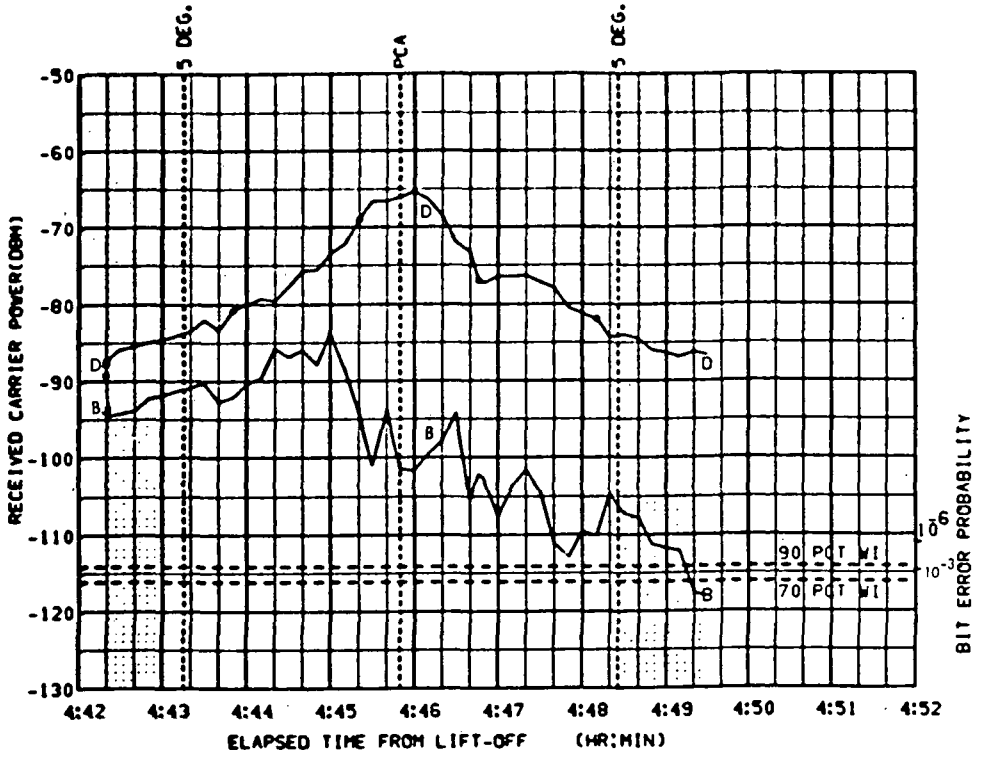

FIGURE 6-48d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

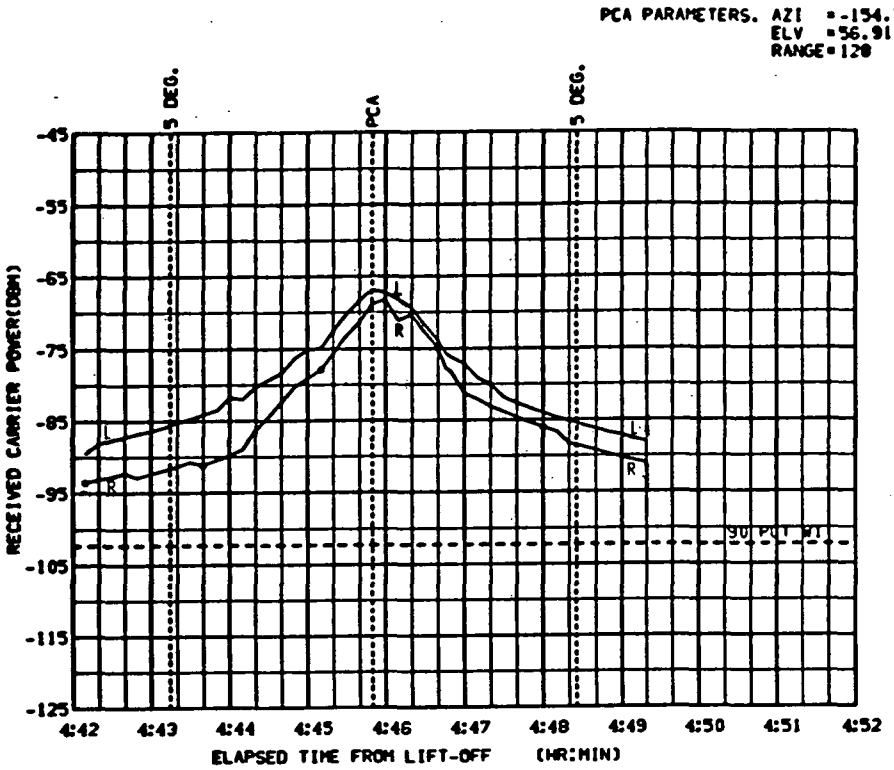

FIGURE 6-48e. GBI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

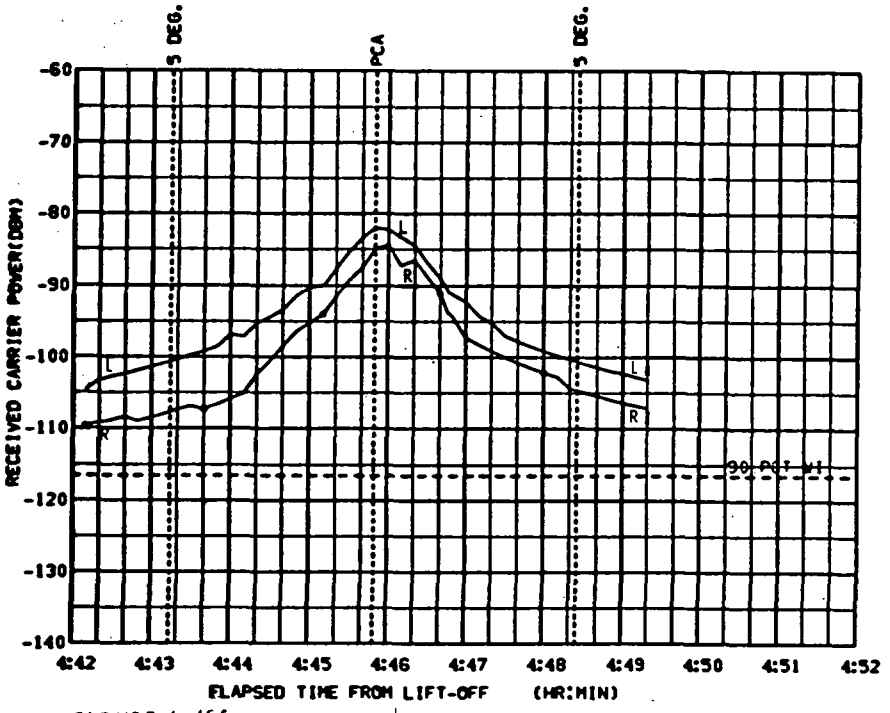

FIGURE 6-46f. GBI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -151.6
ELV = 3.104
RANGE = 701

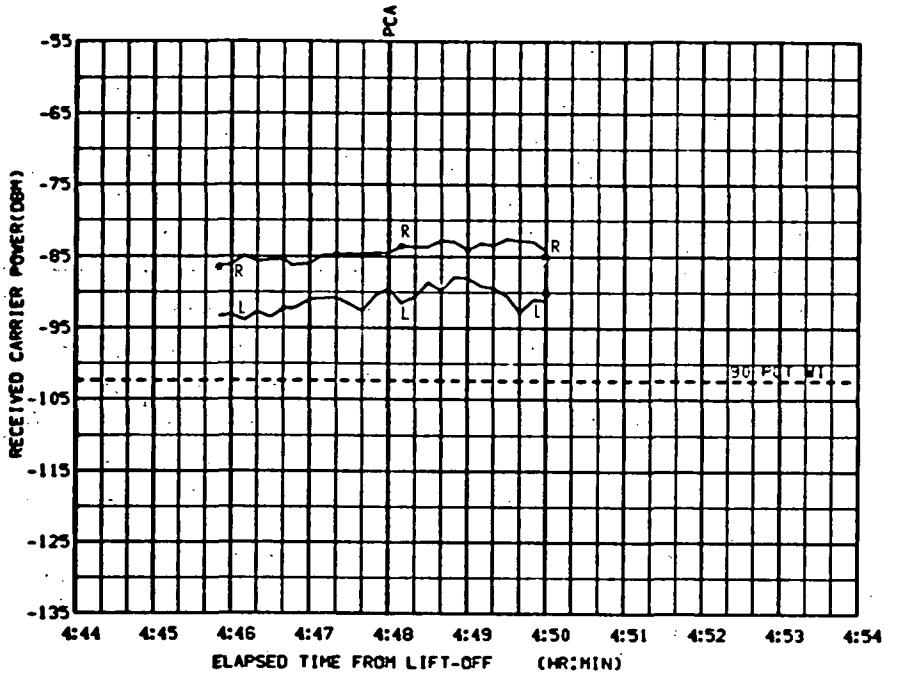

FIGURE 6-49a. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

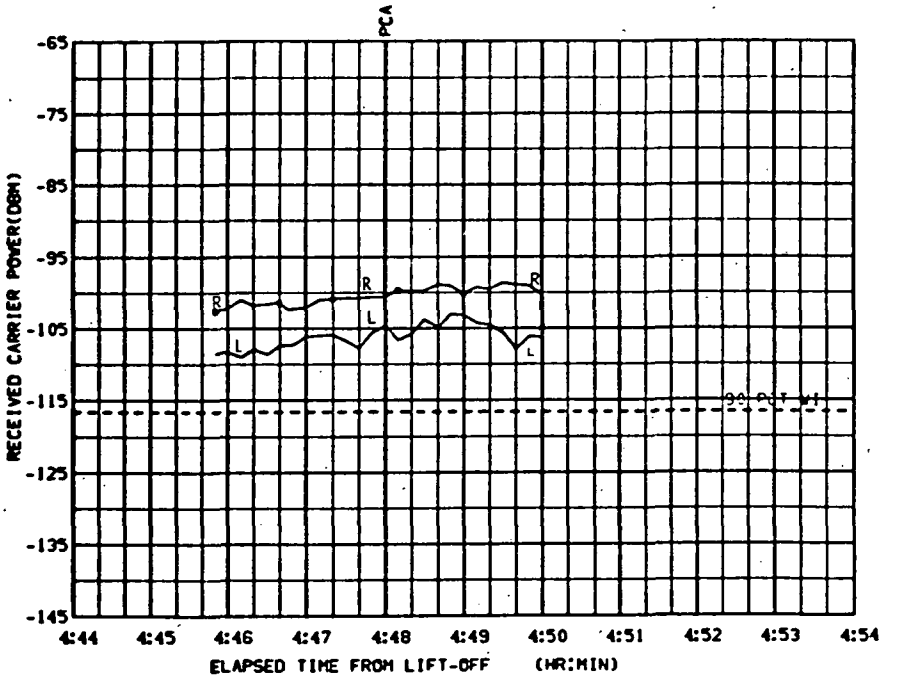

FIGURE 6-49b. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

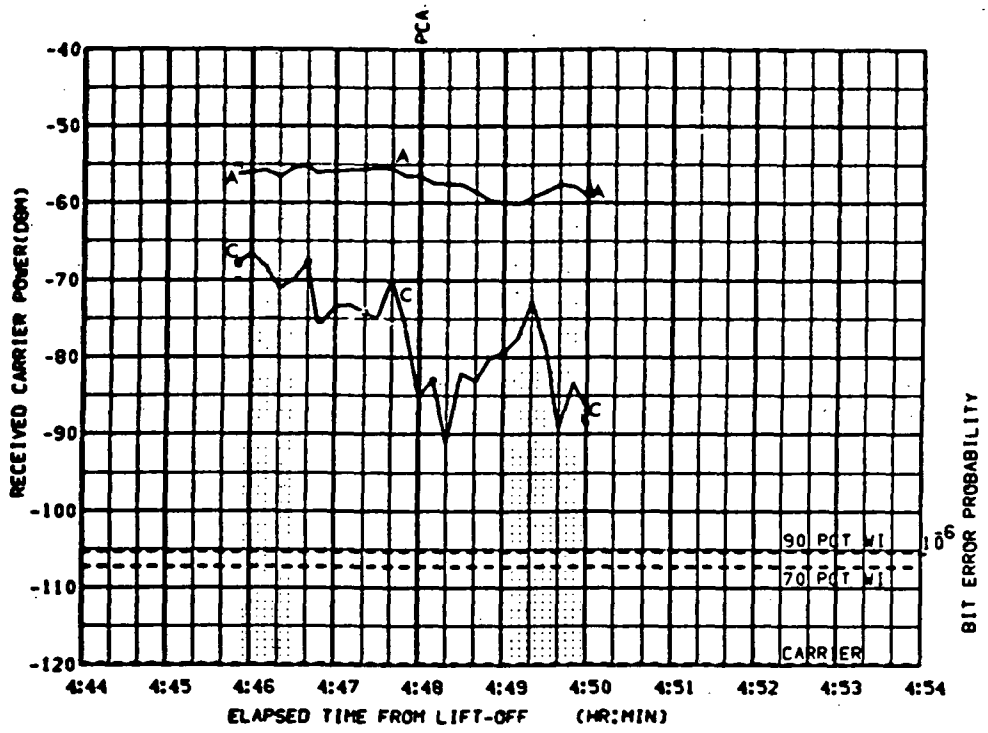

FIGURE 6-49c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

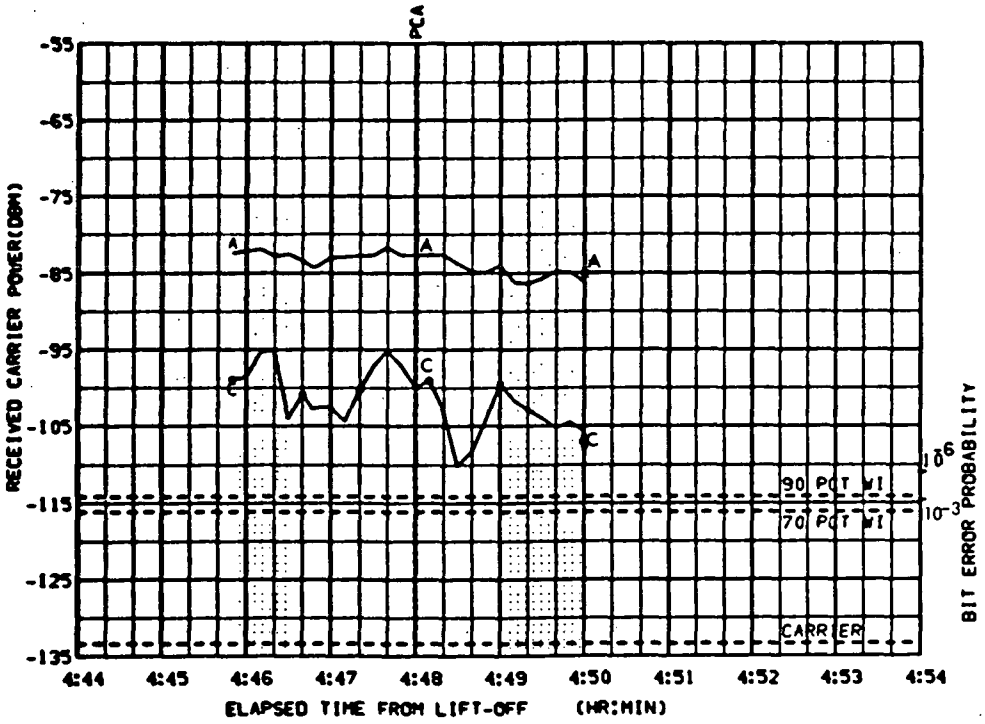

FIGURE 6-49d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -151.6
ELV = 3.104
RANGE = 701

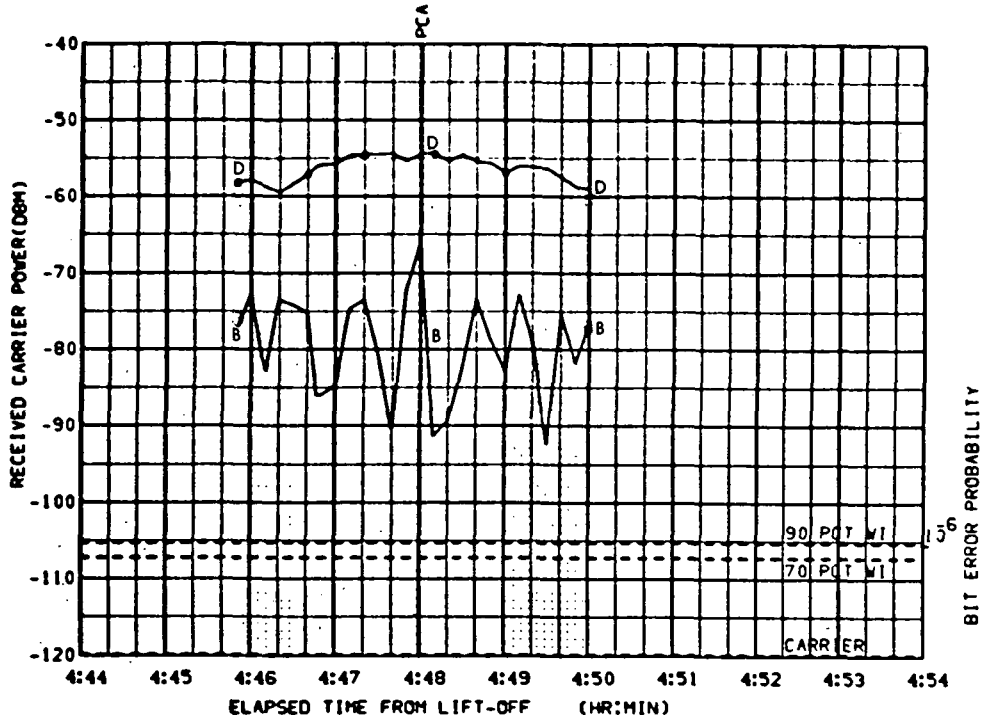

FIGURE 6-49e. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

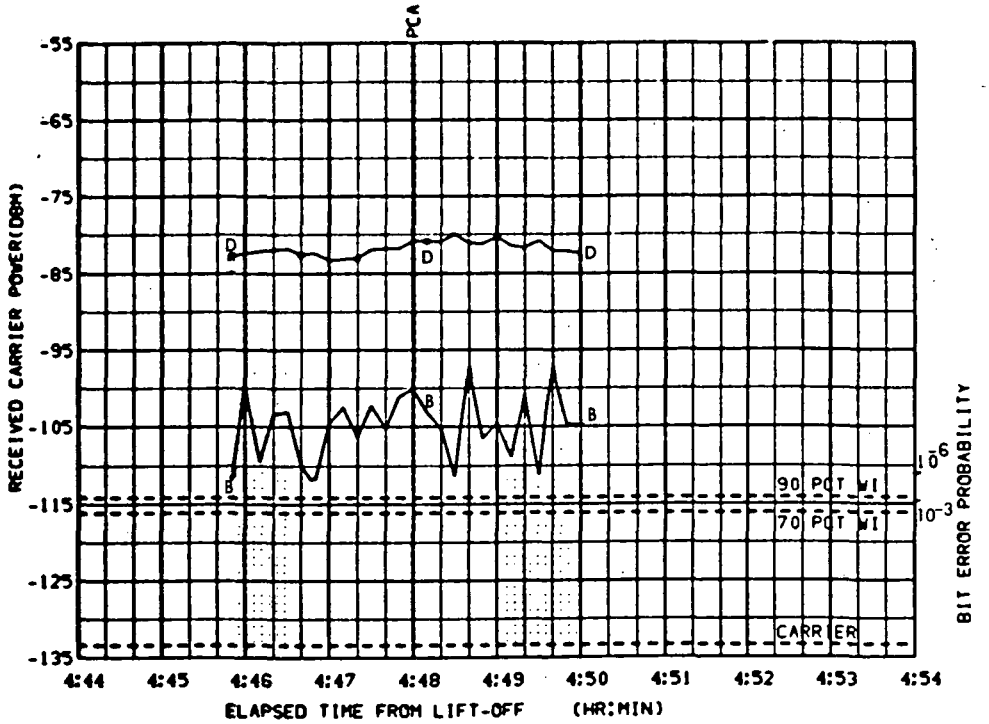

FIGURE 6-49f. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

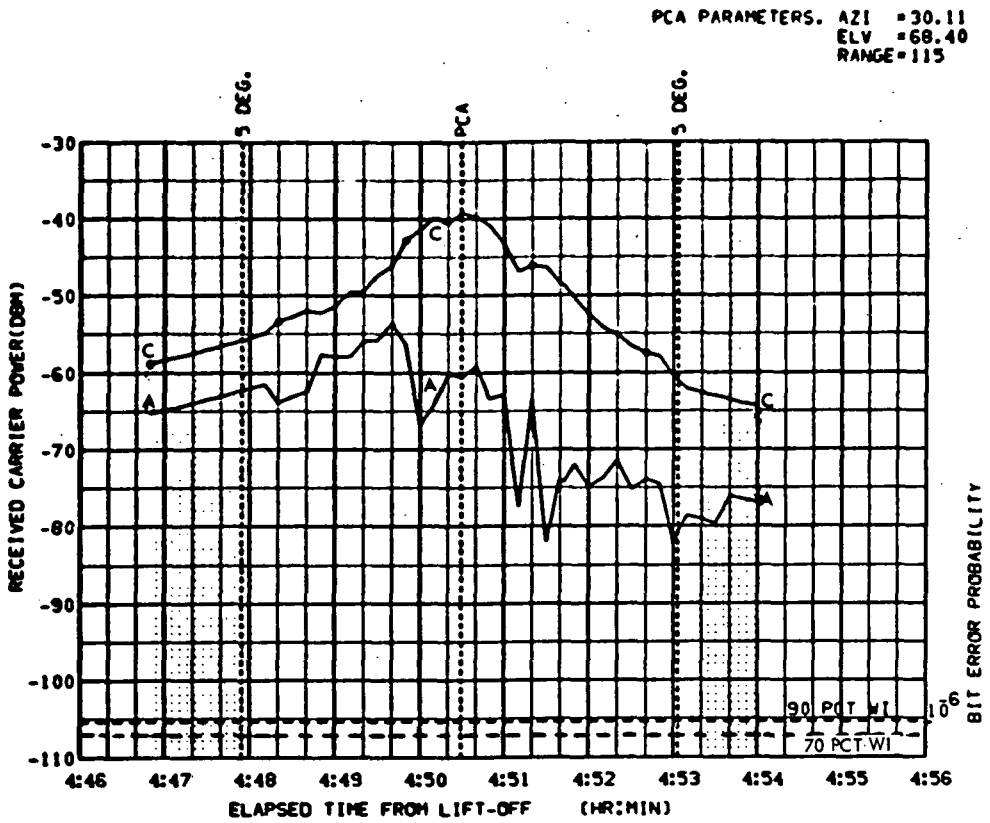

FIGURE 6-50a. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

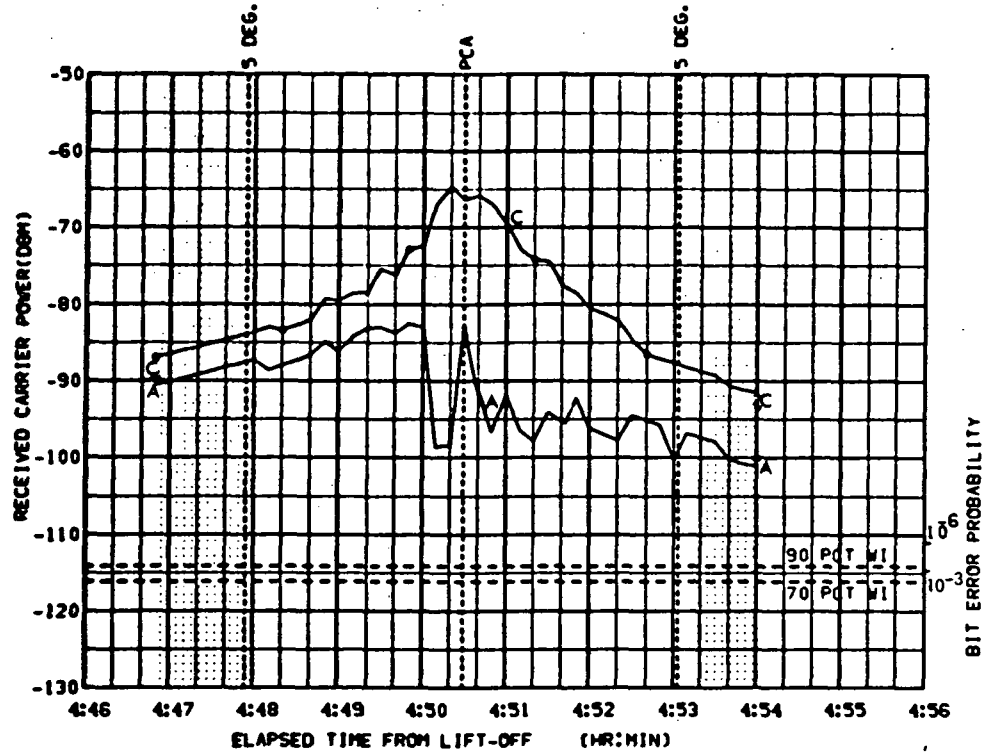

FIGURE 6-50b. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

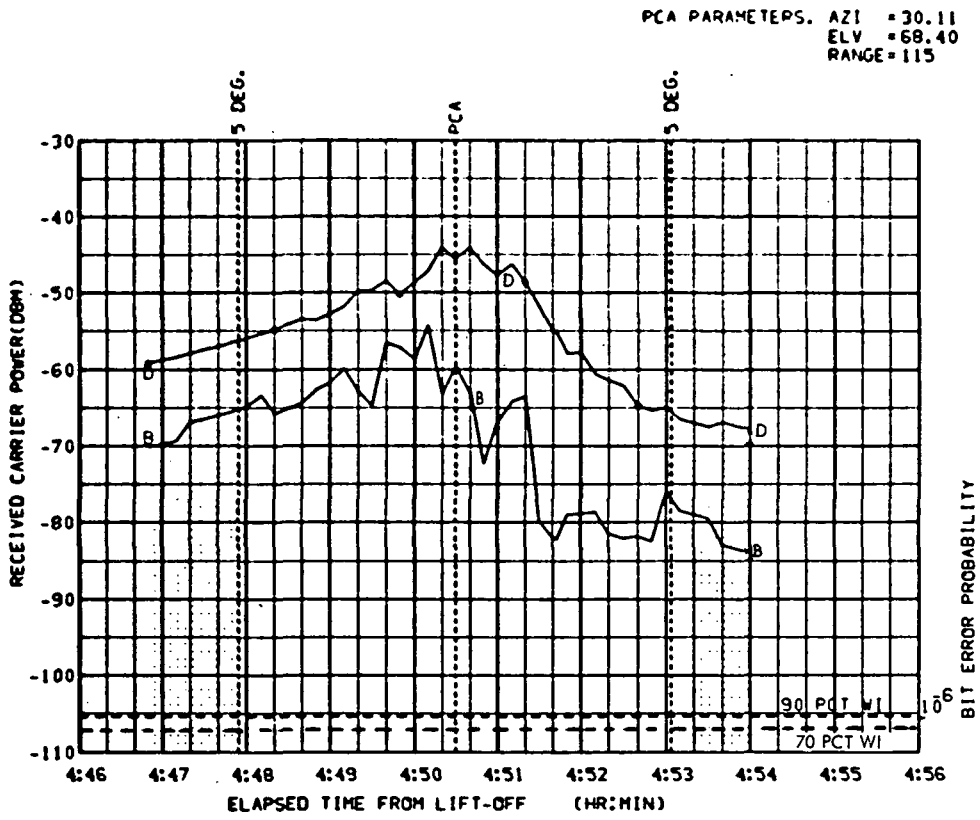

FIGURE 6-50c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

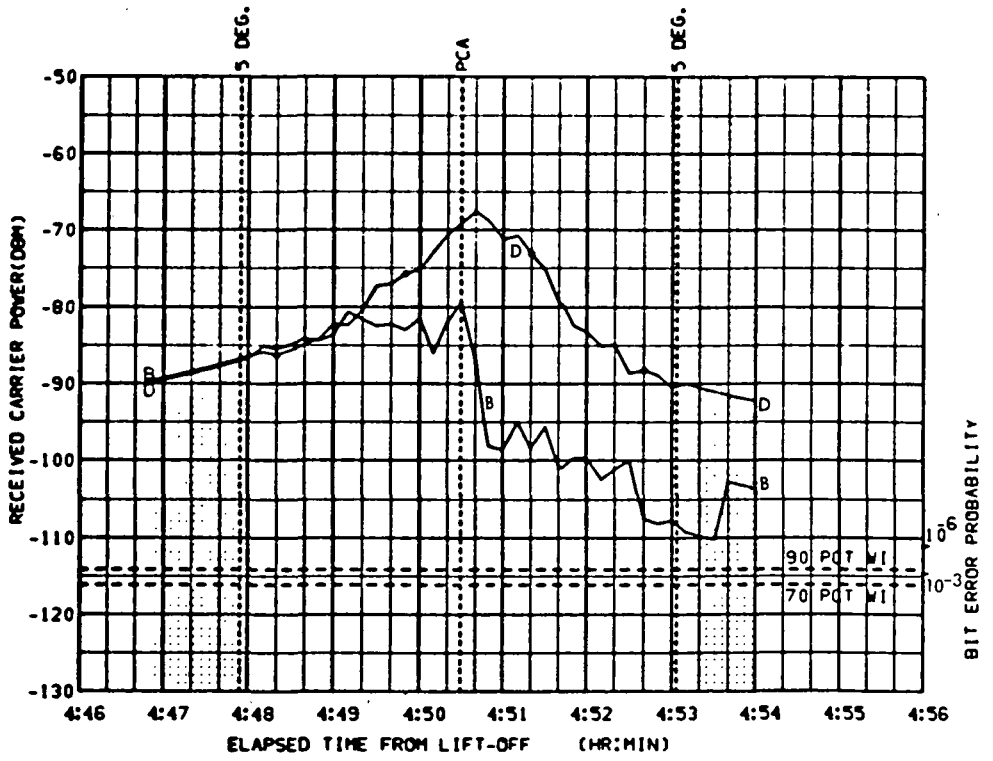

FIGURE 6-50d. ANG ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

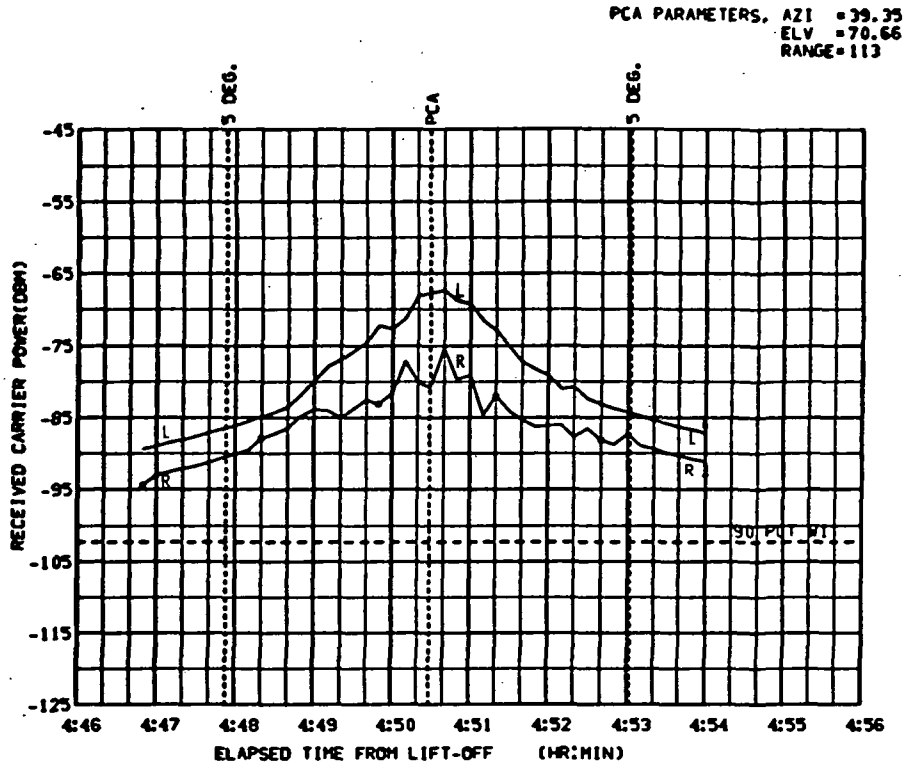

FIGURE 6-50e. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

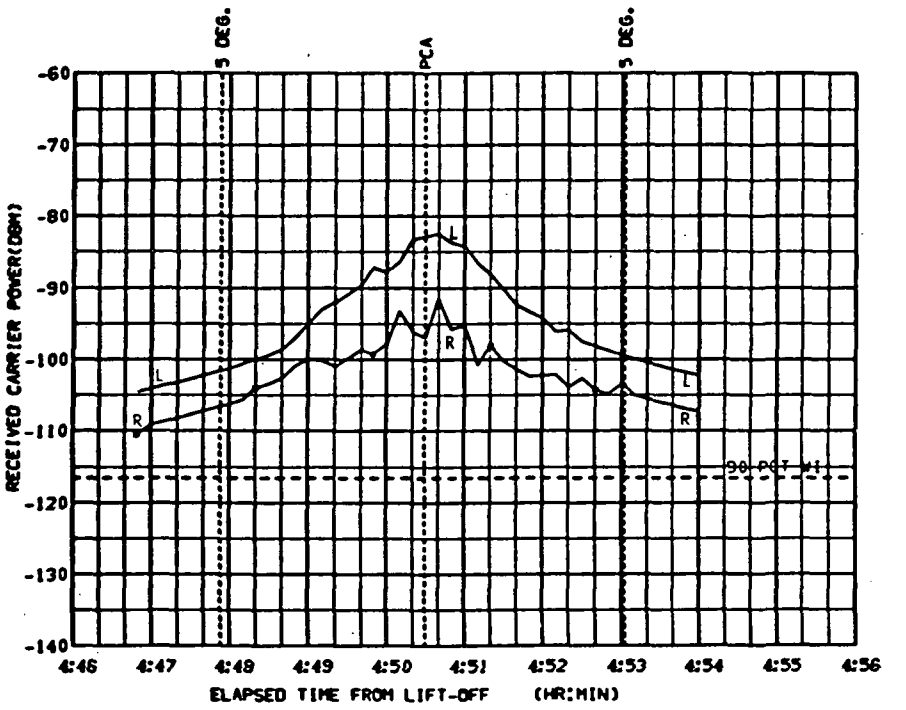

FIGURE 6-50f. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (72 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

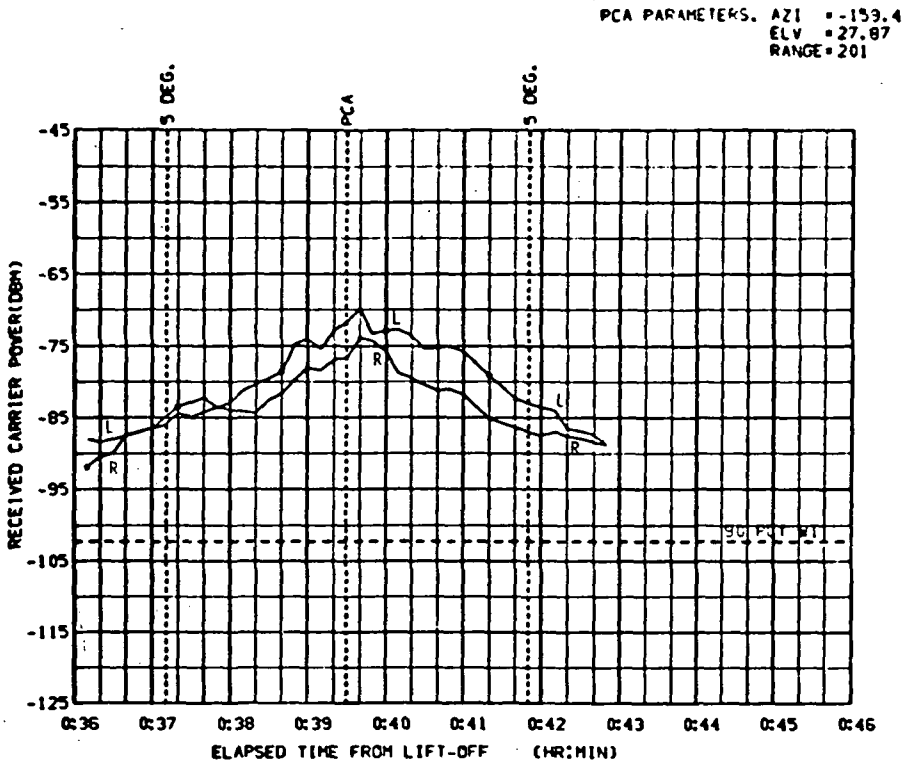

FIGURE 6-51a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

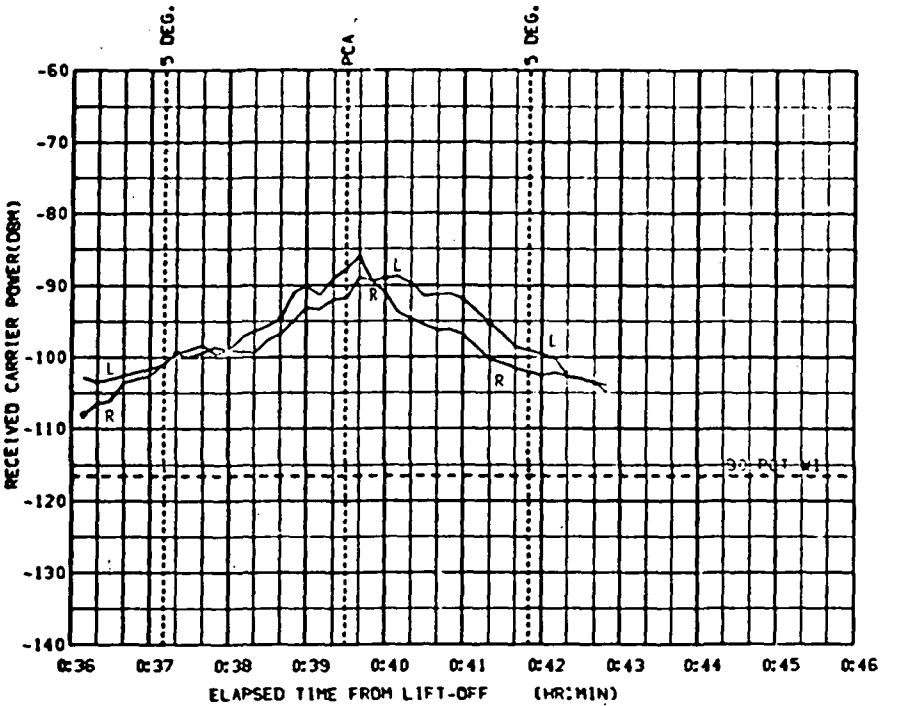

FIGURE 6-51b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

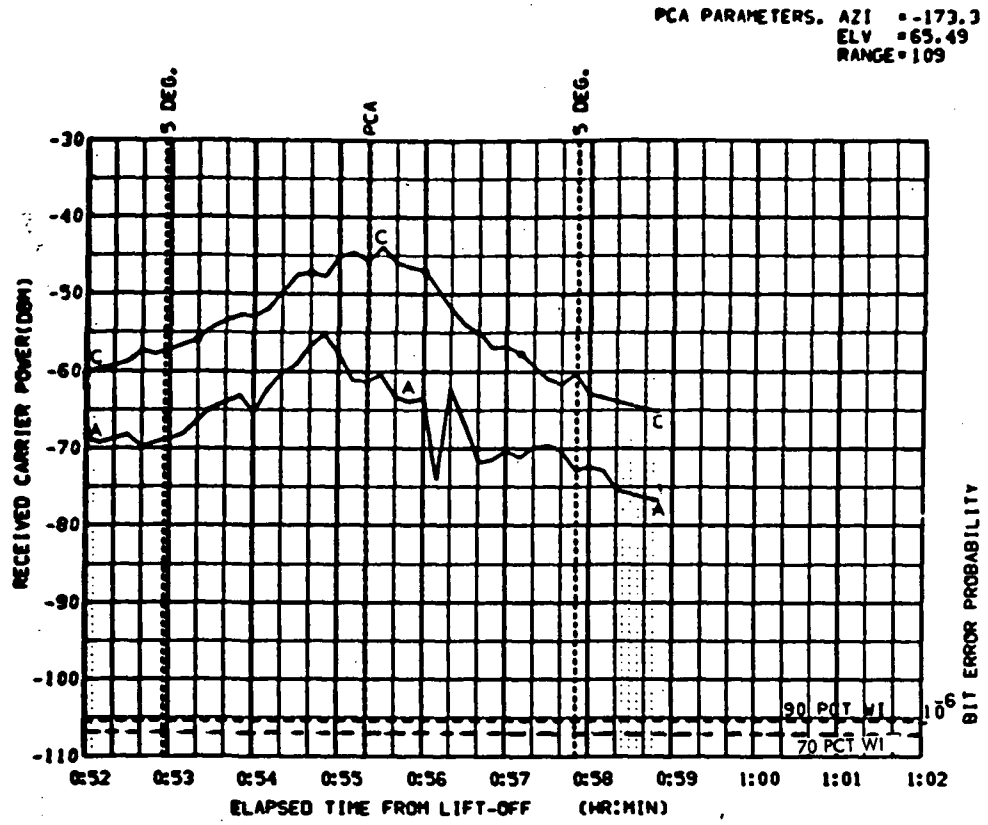

FIGURE 6-52a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

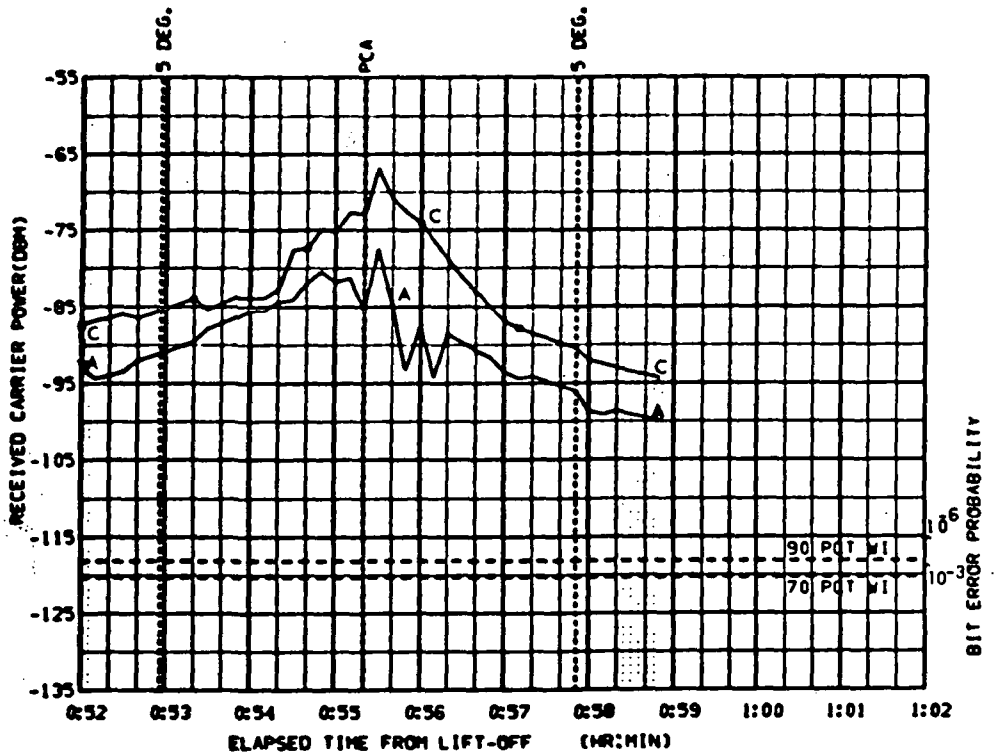

FIGURE 6-52b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

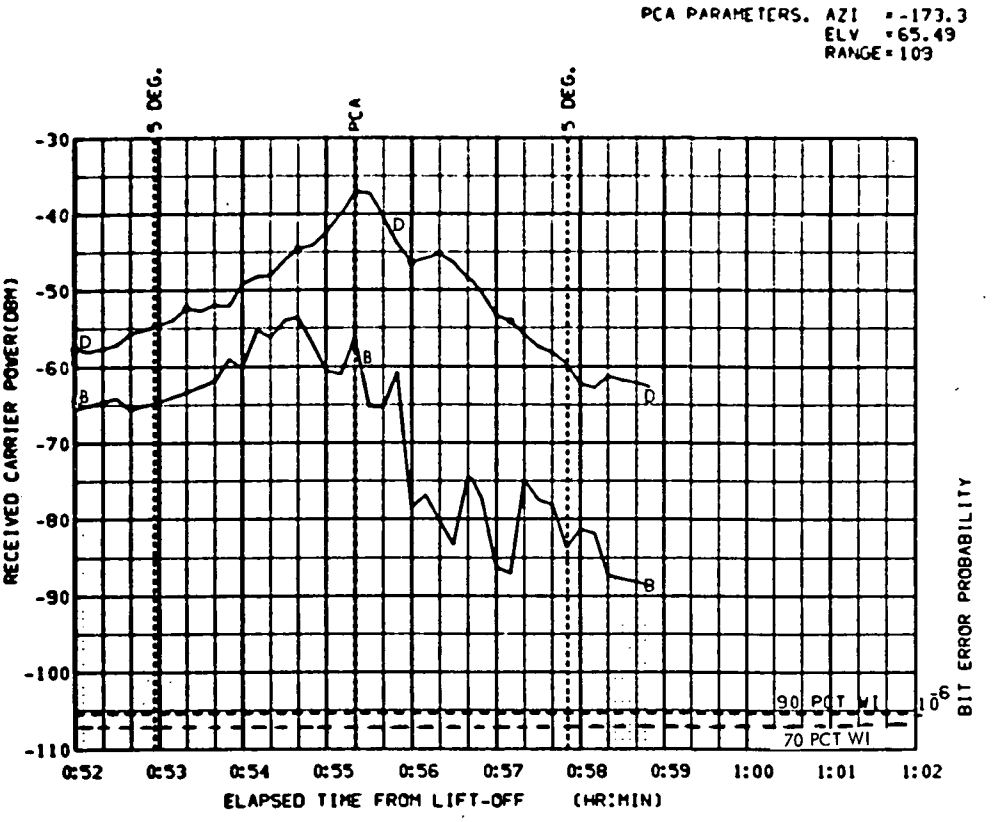

FIGURE 6-52c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

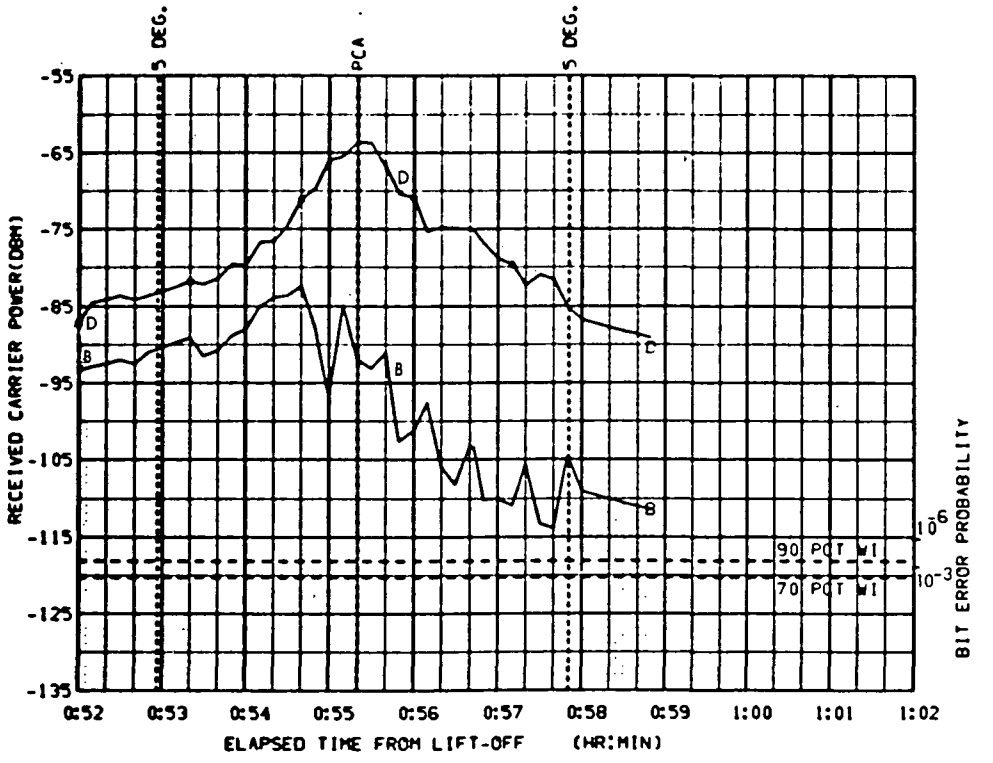

FIGURE 6-52d. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

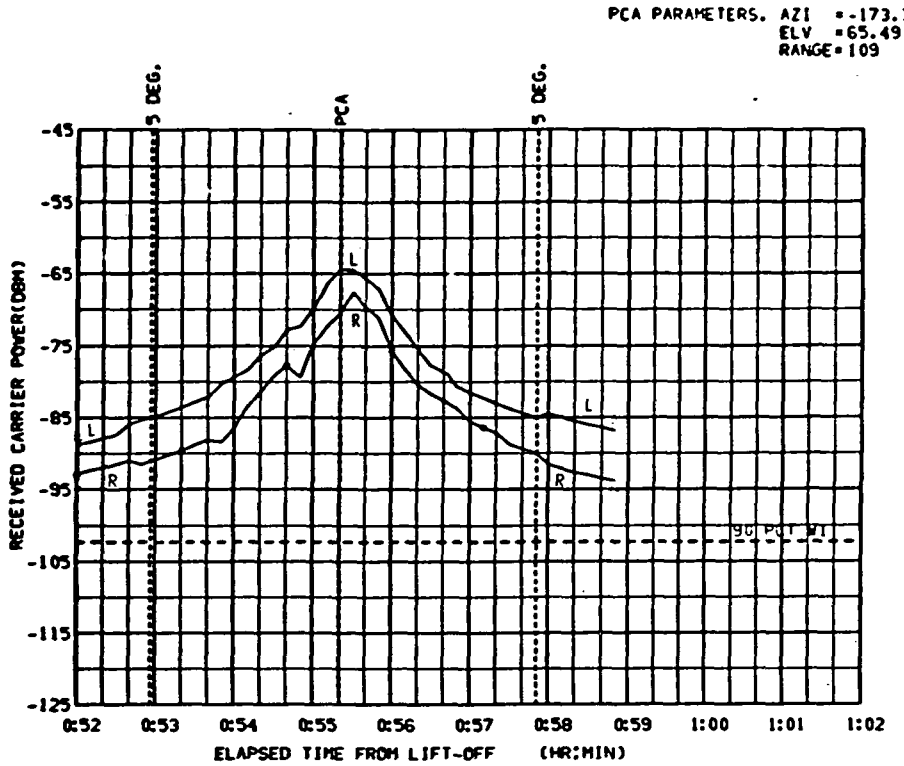

FIGURE 6-52e. CRO UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

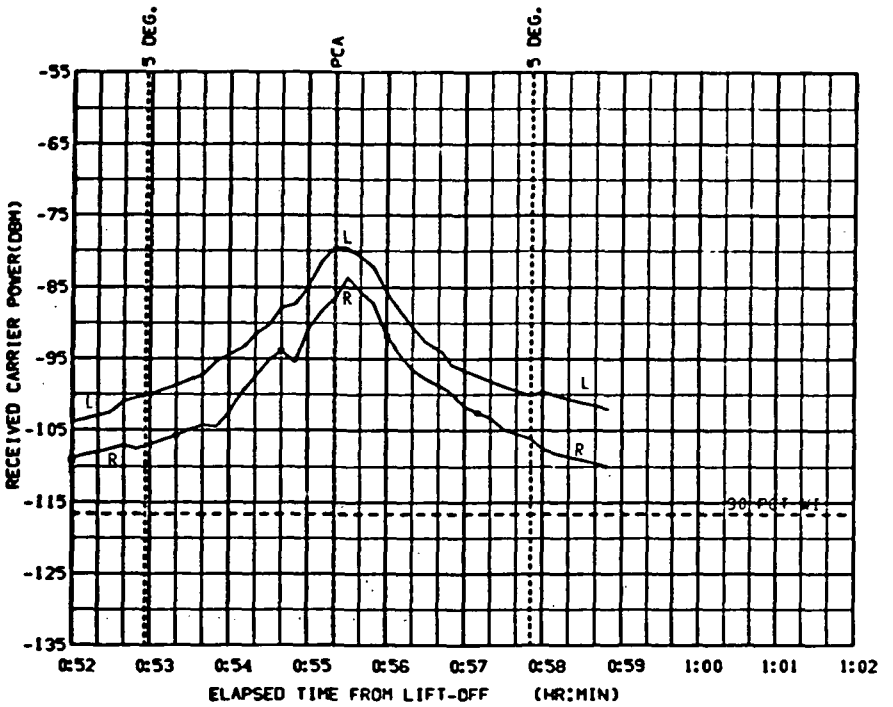

FIGURE 6-52f. CRO DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -23.41
ELV = 3.309
RANGE = 659

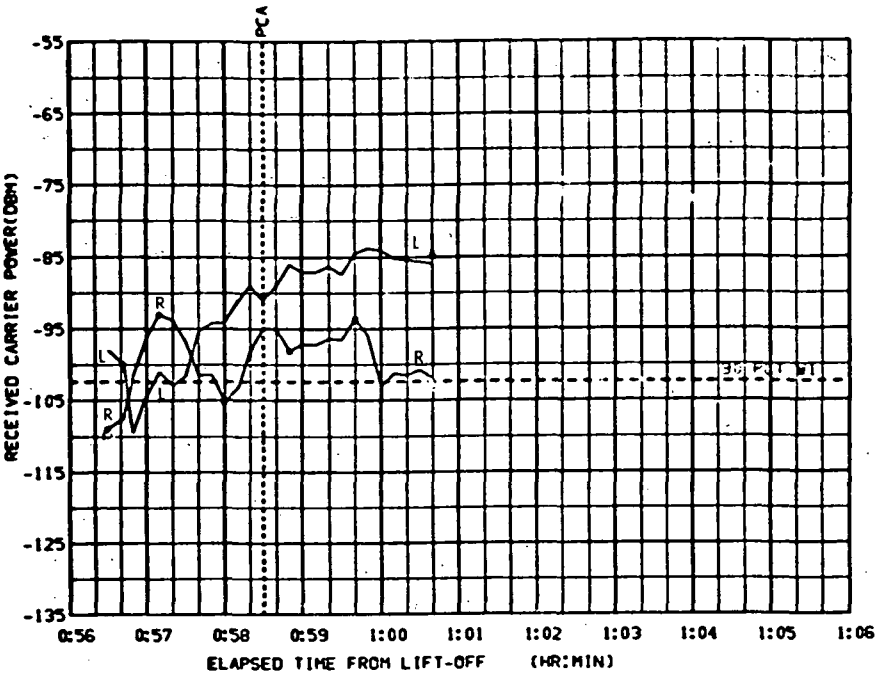

FIGURE 6-53a. MER UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

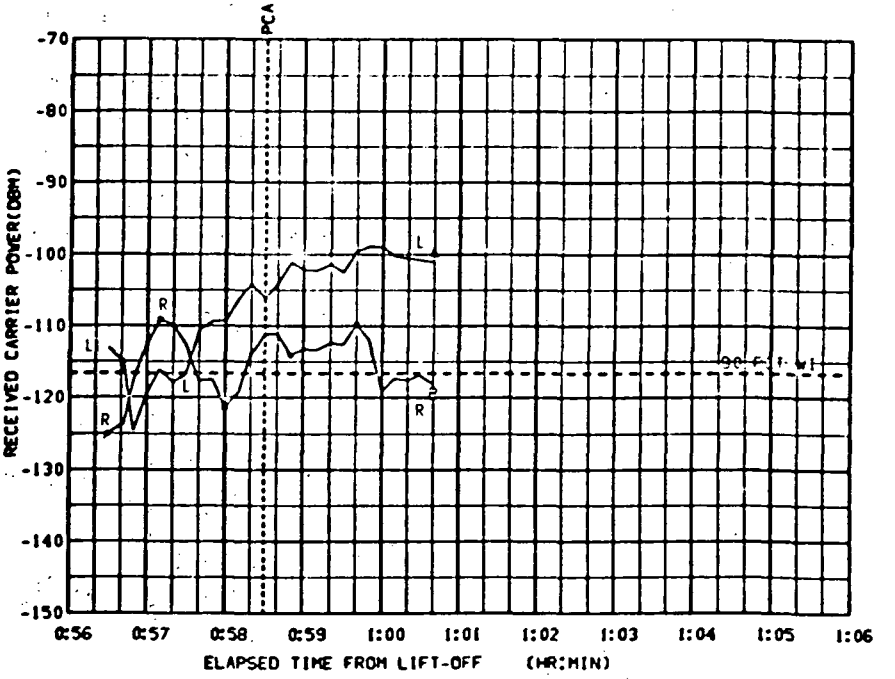

FIGURE 6-53b. MER DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

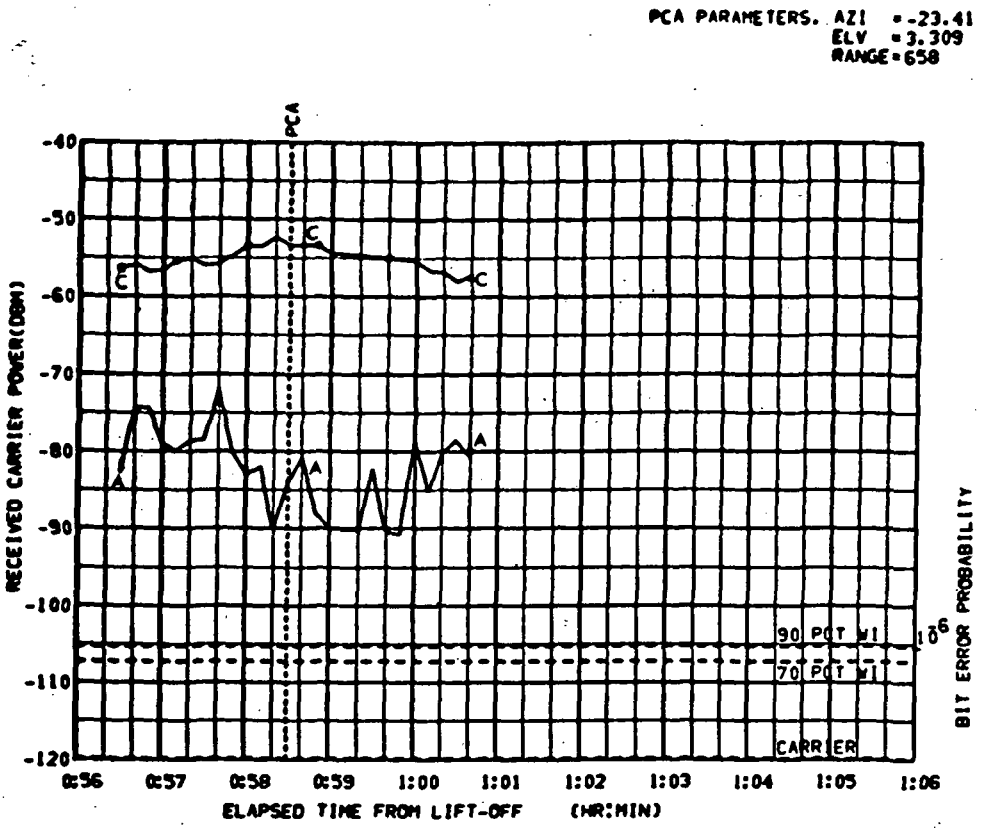

FIGURE 6-53c. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

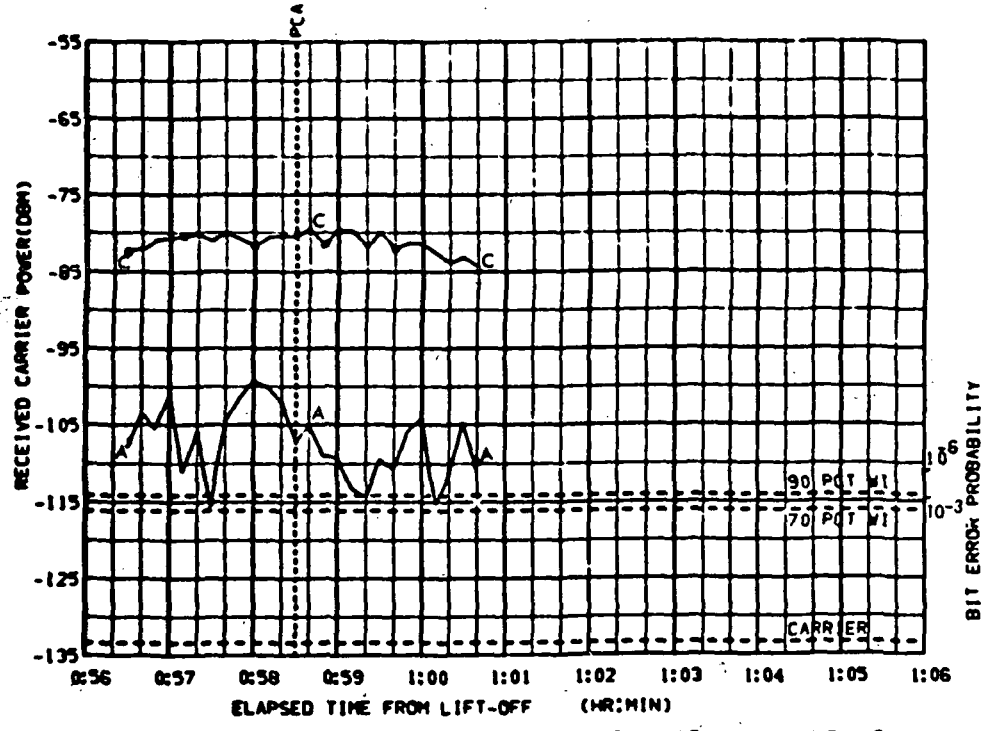

FIGURE 6-53d. MER DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

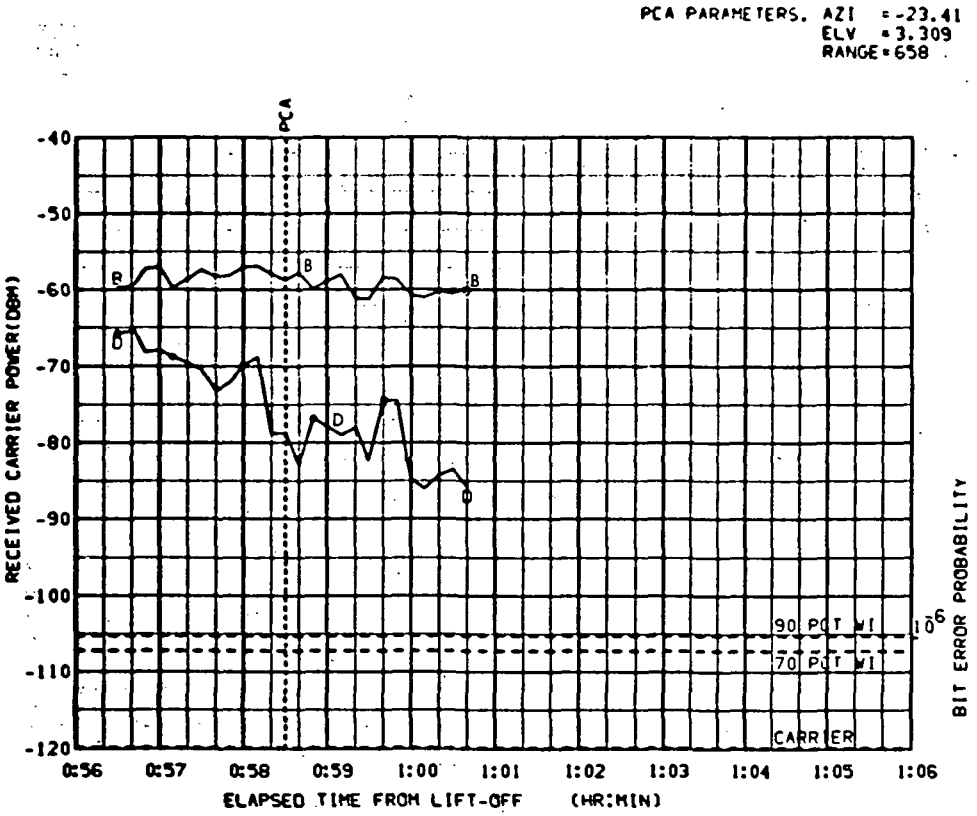

FIGURE 6-53e. MER UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

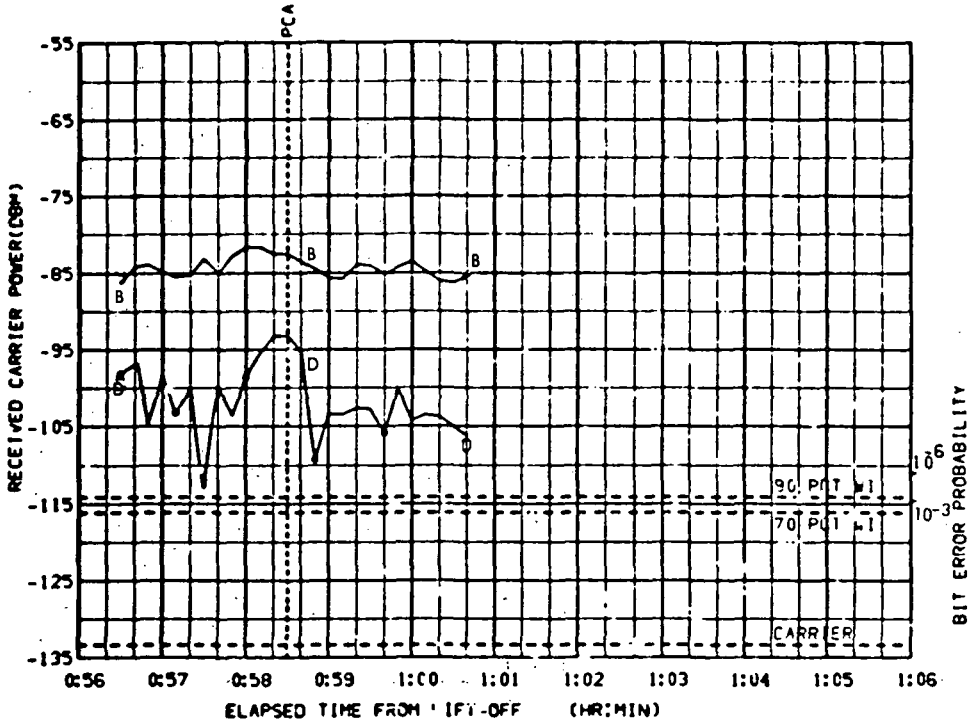

FIGURE 6-53f. MER DOWNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

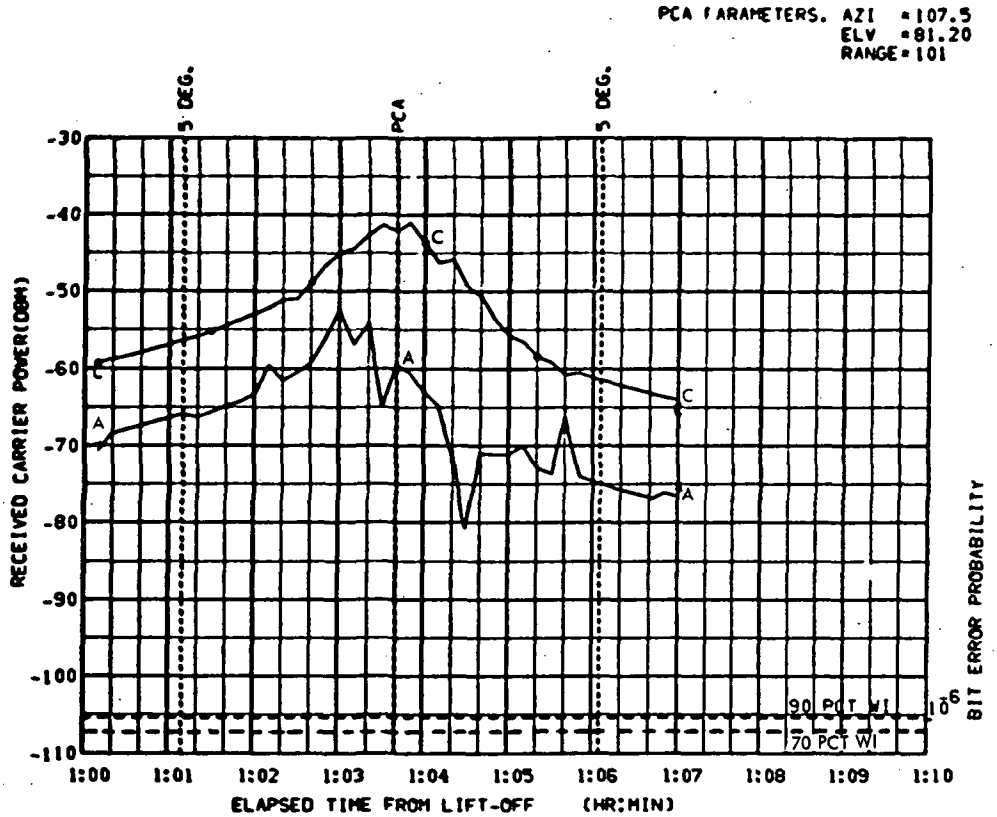

FIGURE 6-54a. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

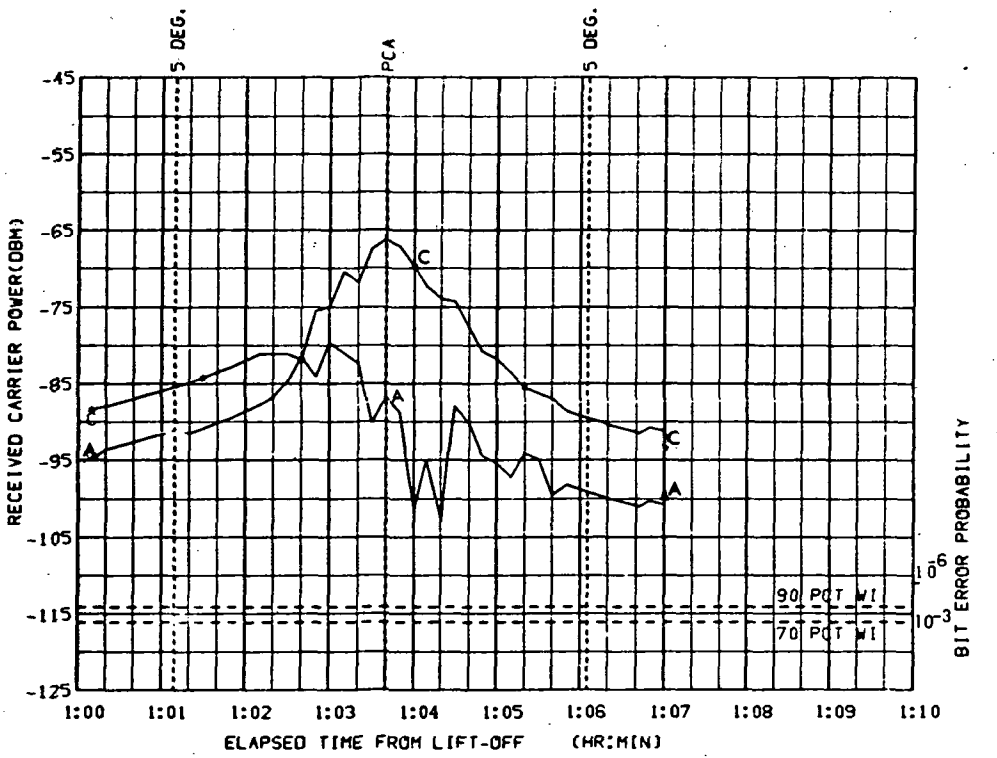

FIGURE 6-54b. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

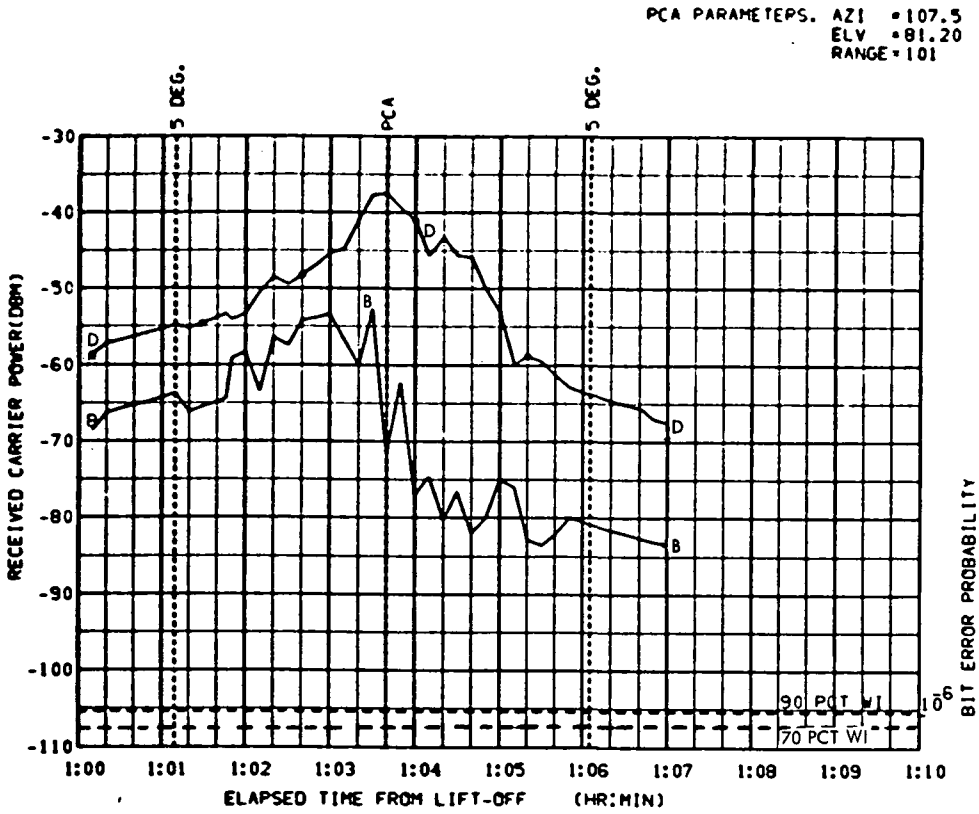

FIGURE 6-54c. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

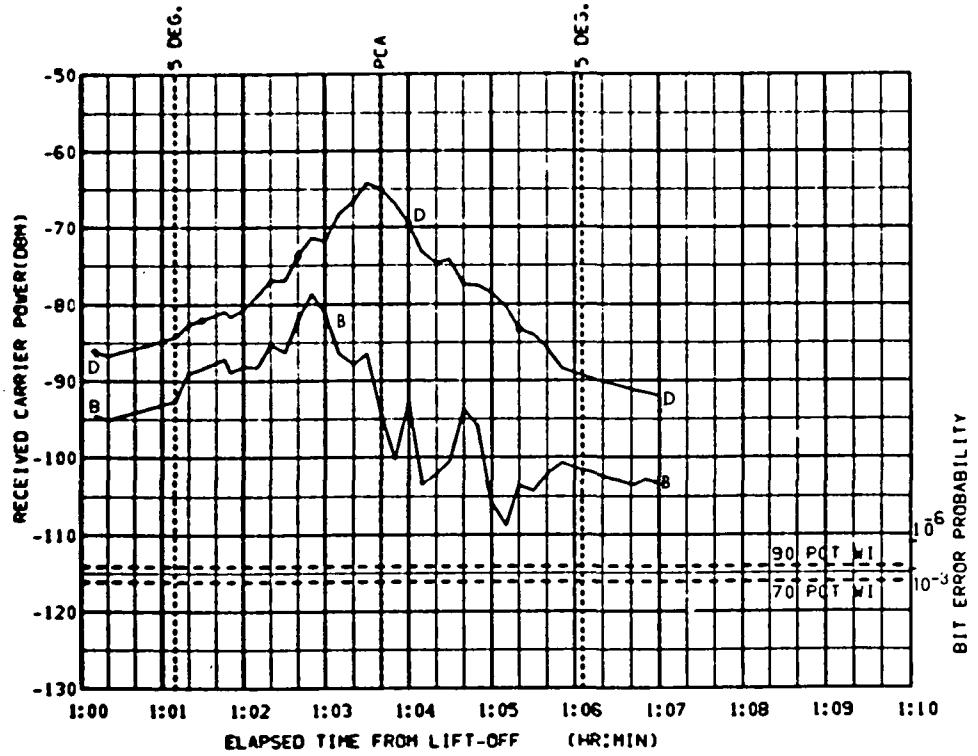

FIGURE 6-54d. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

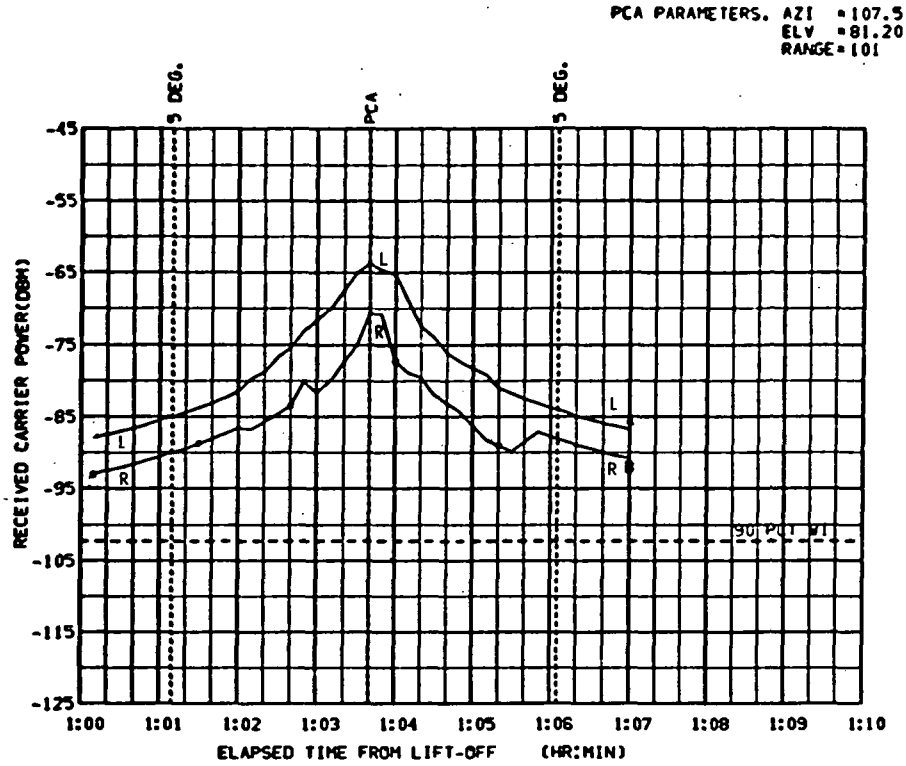

FIGURE 6-54e. RED UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

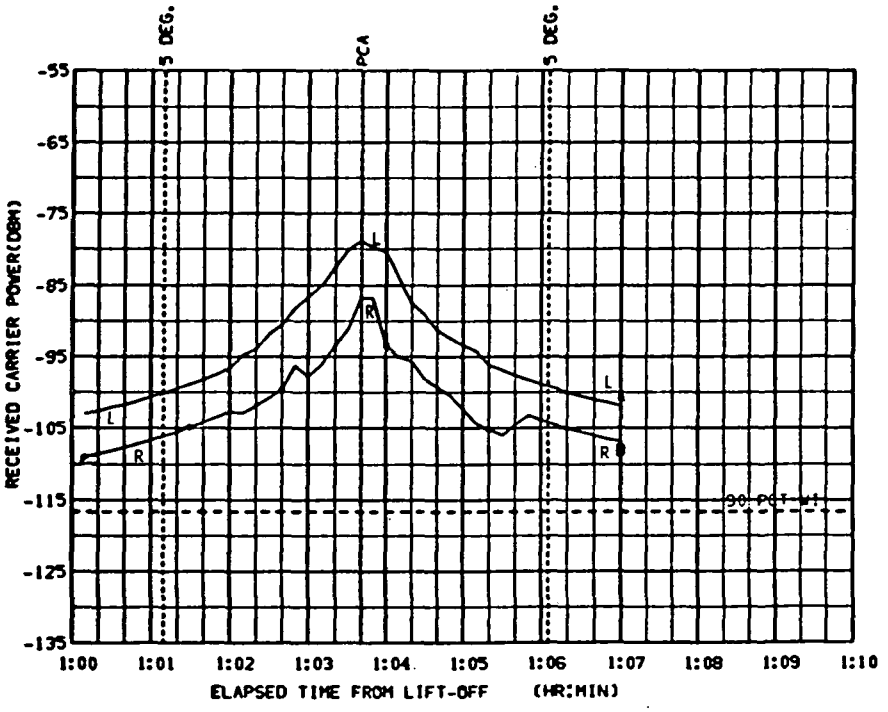

FIGURE 6-54f. RED DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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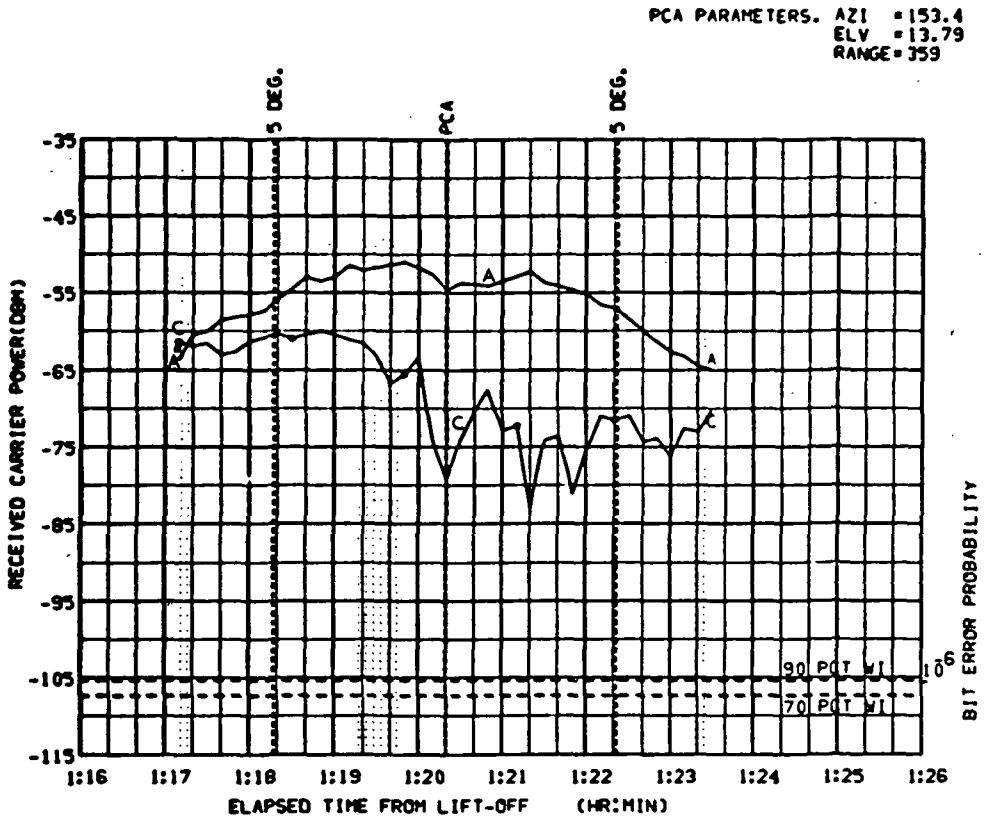

FIGURE 6-55a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

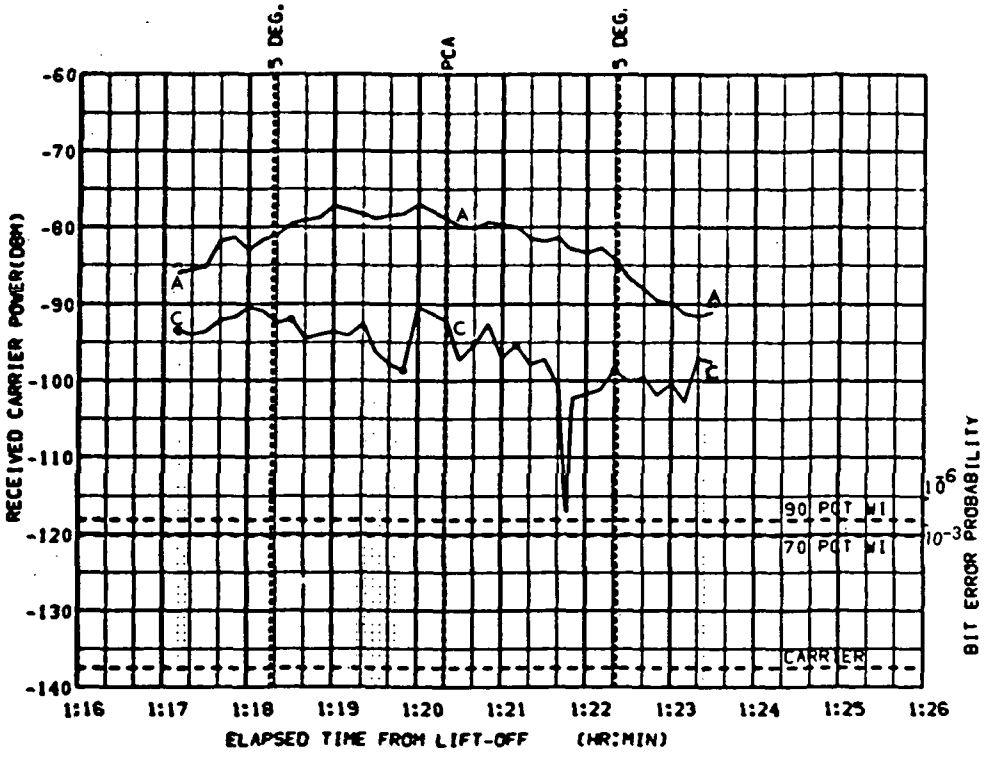

FIGURE 6-55b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

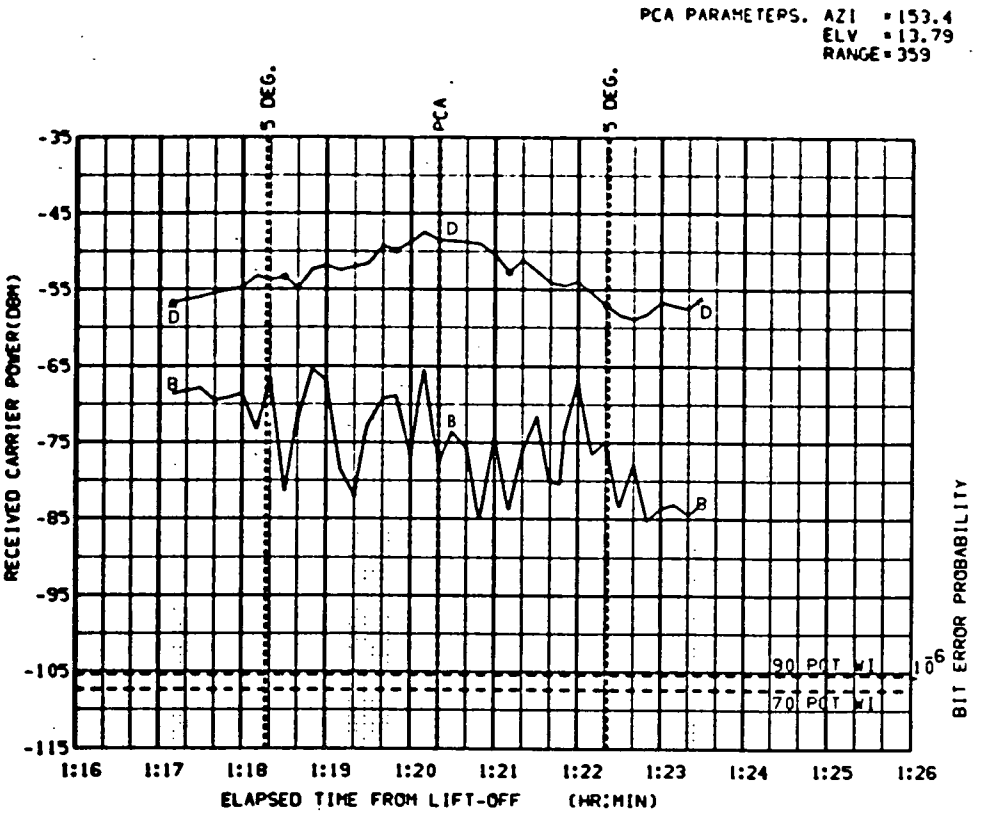

FIGURE 6-55c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

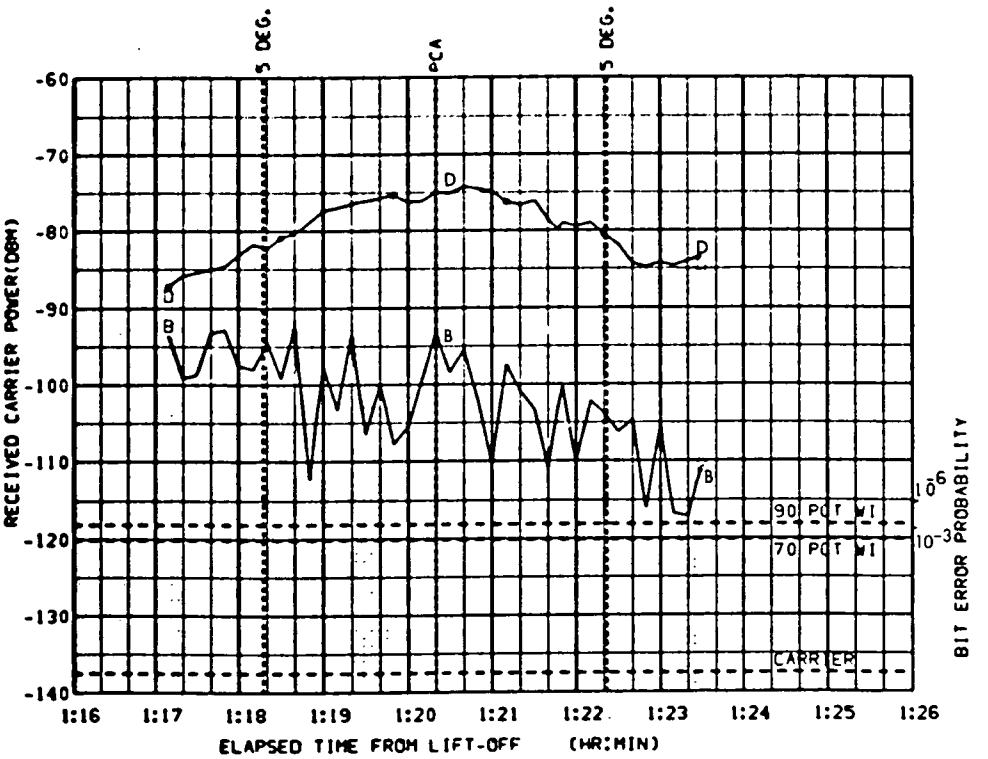

FIGURE 6-55d. MAW ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

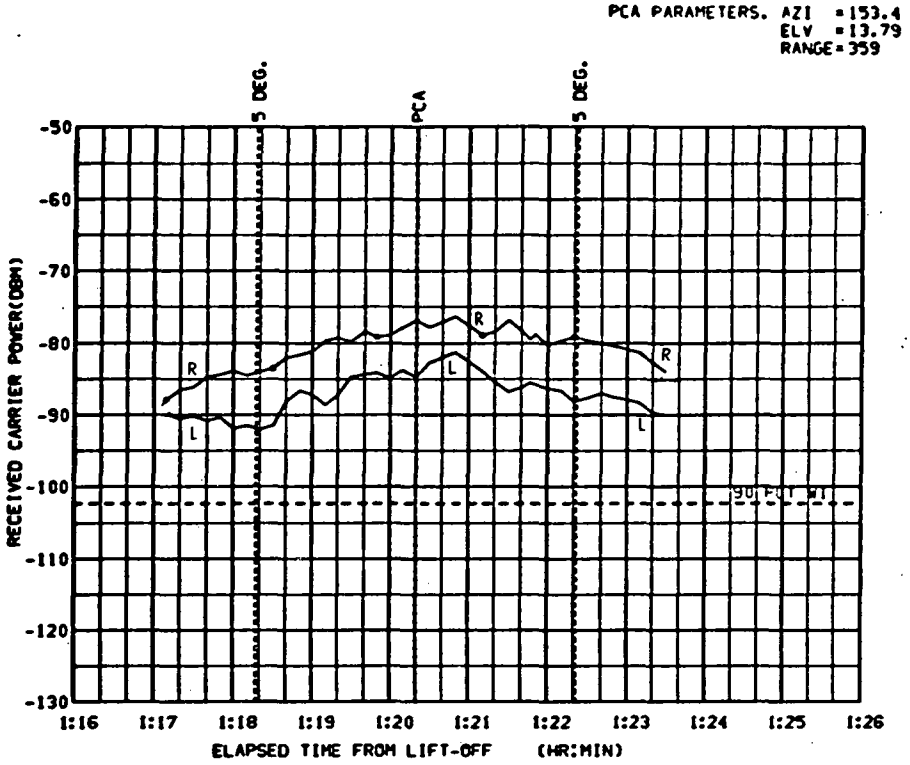

FIGURE 6-55e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

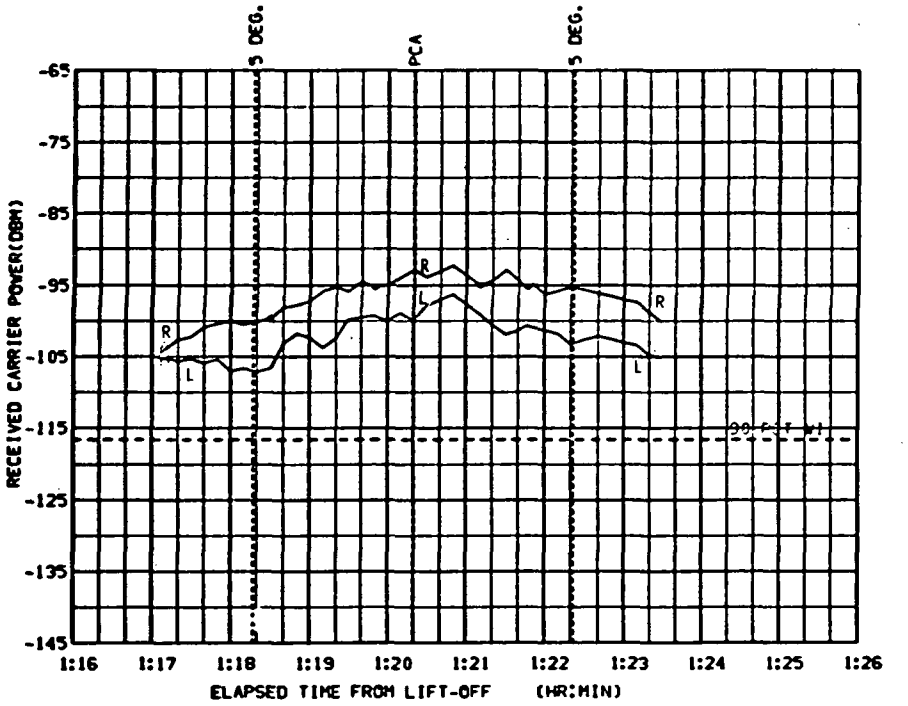

FIGURE 6-55f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

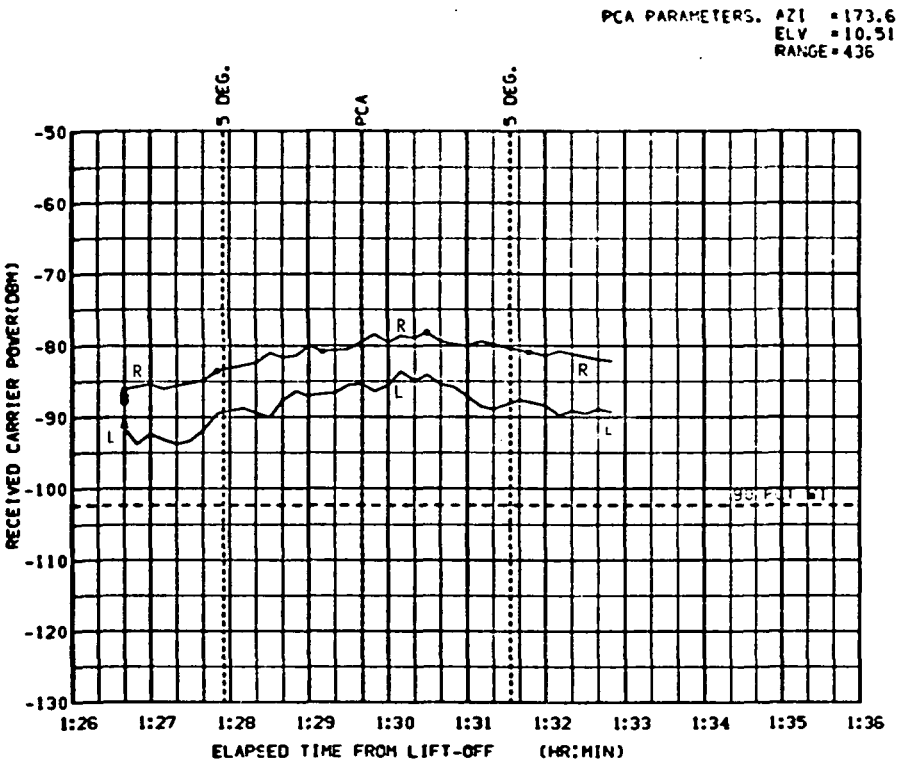

FIGURE 6-56a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

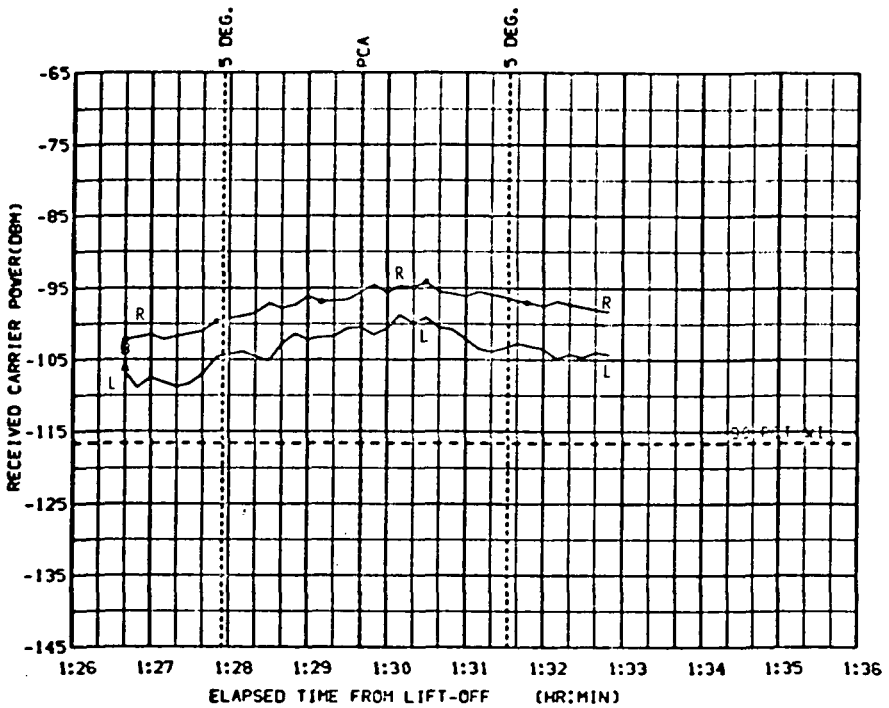

FIGURE 6-56b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

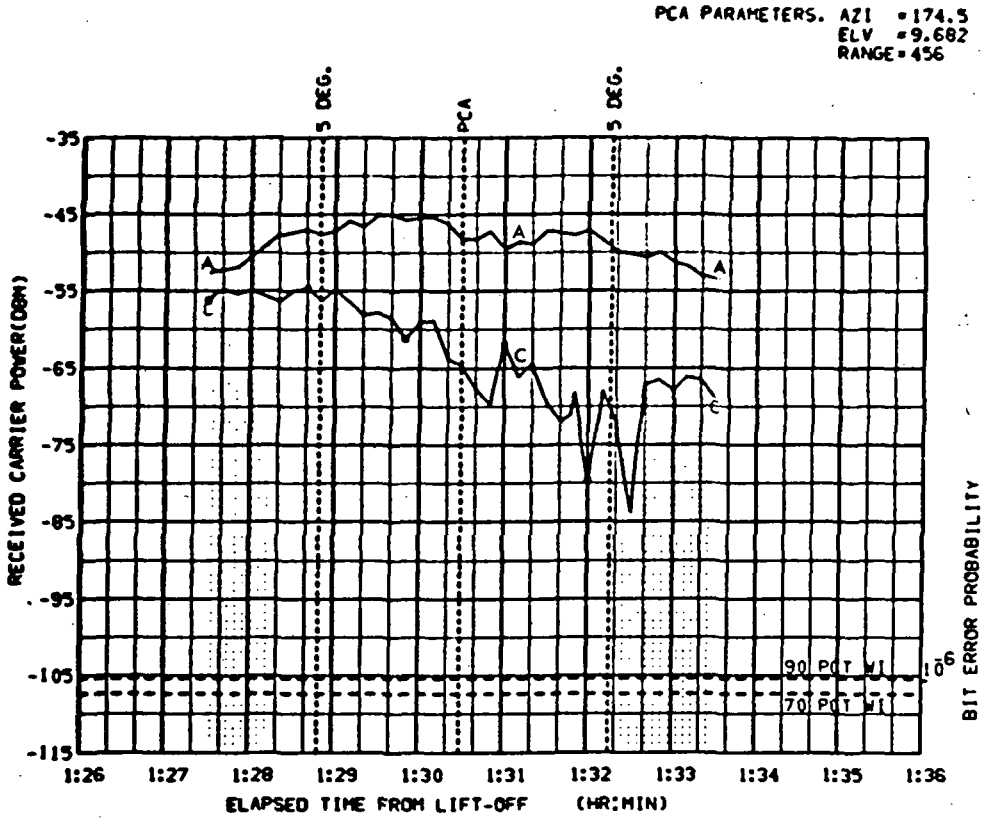

FIGURE 6-57a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

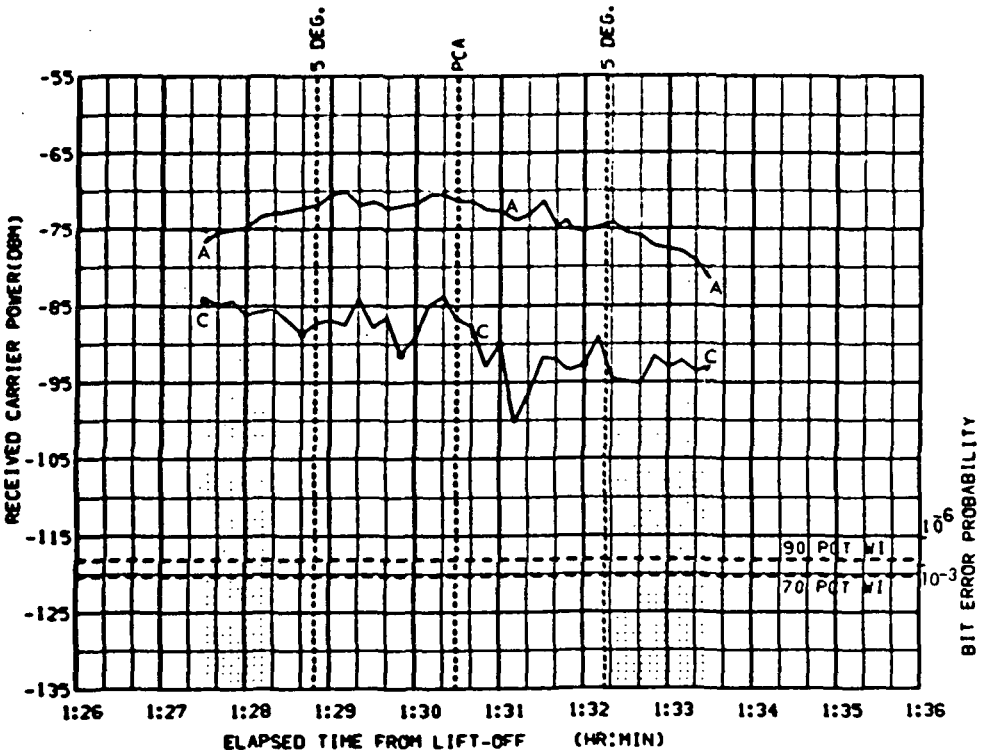

FIGURE 6-57b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

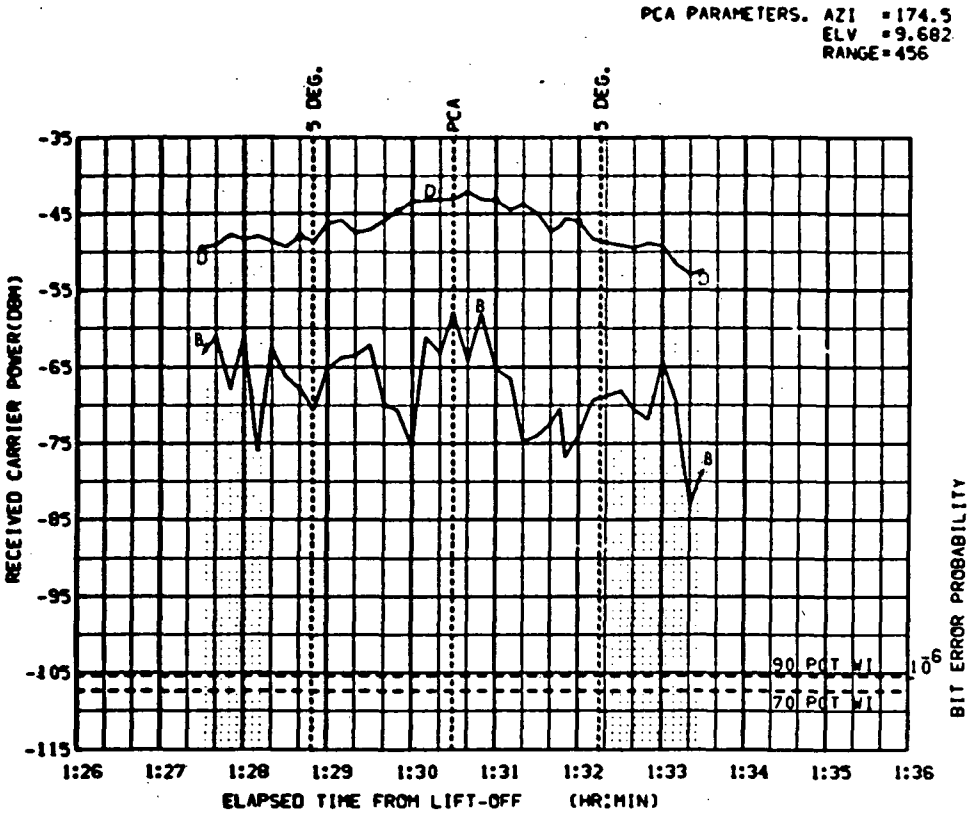

FIGURE 6-57c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

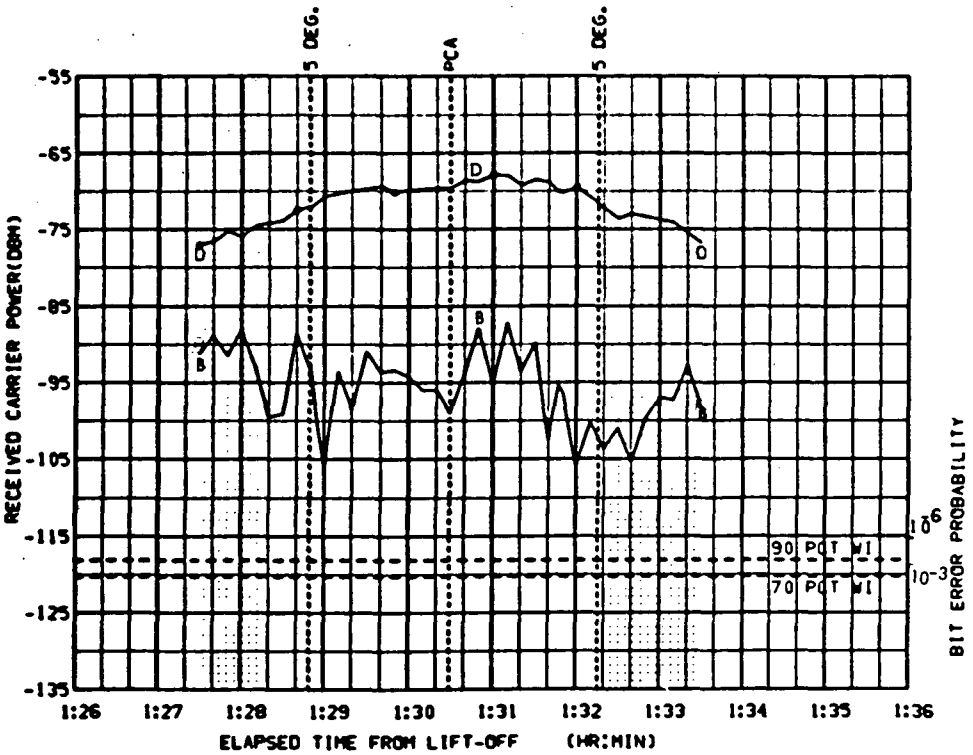

FIGURE 6-57d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

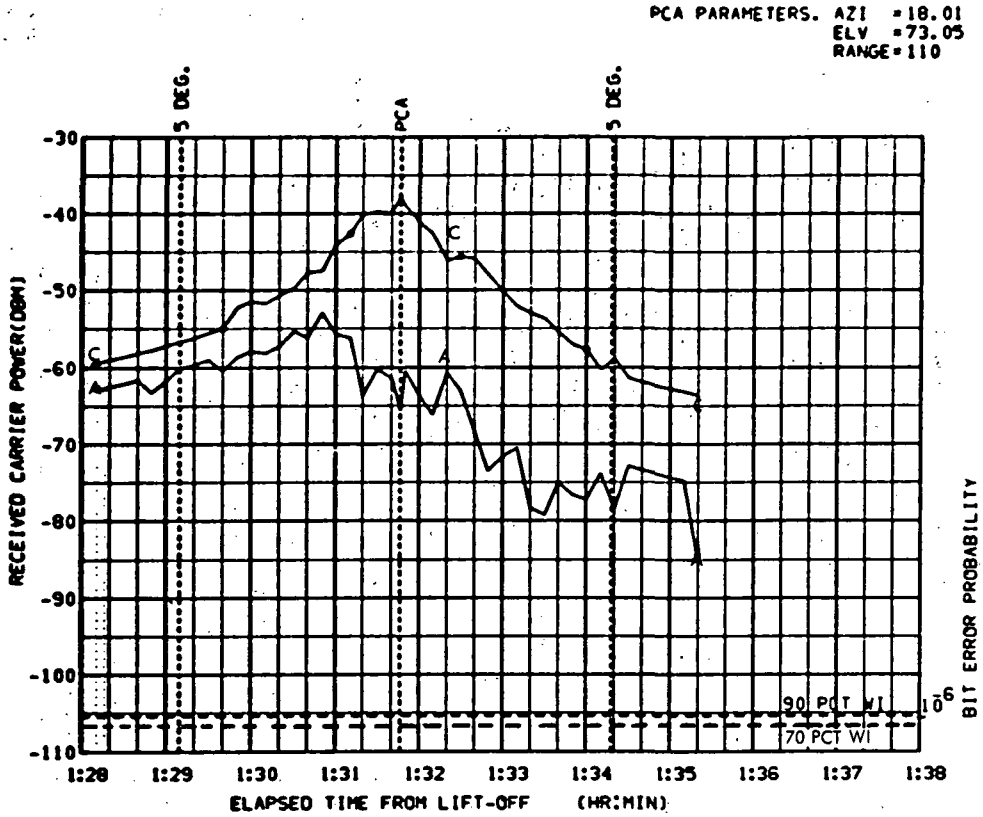

FIGURE 6-58a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

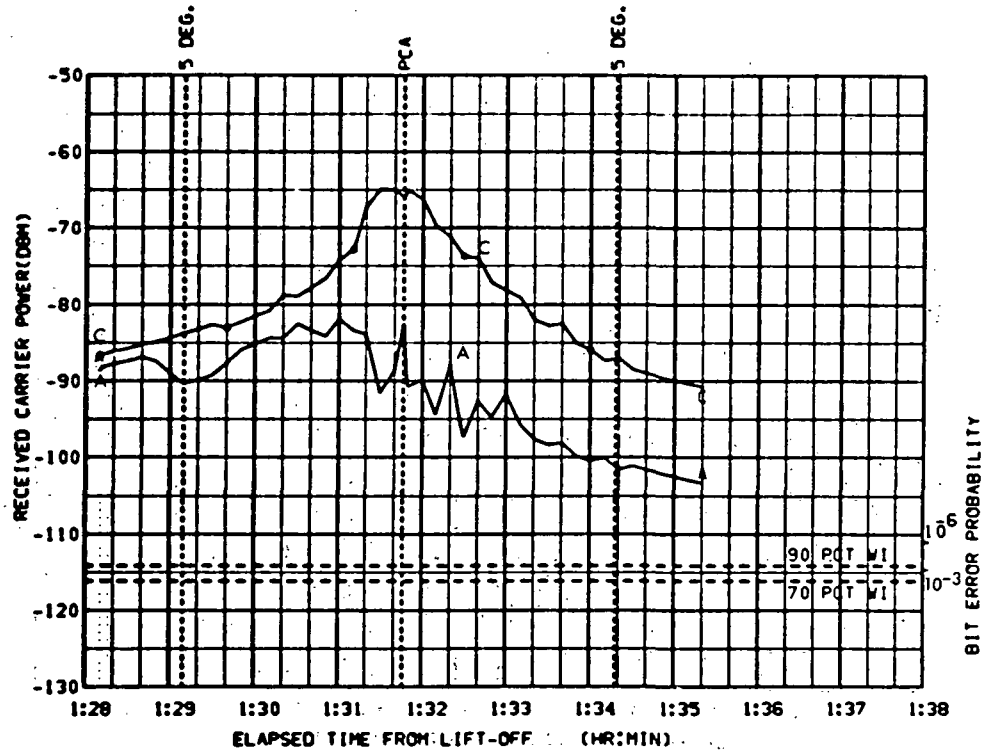

FIGURE 6-58b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

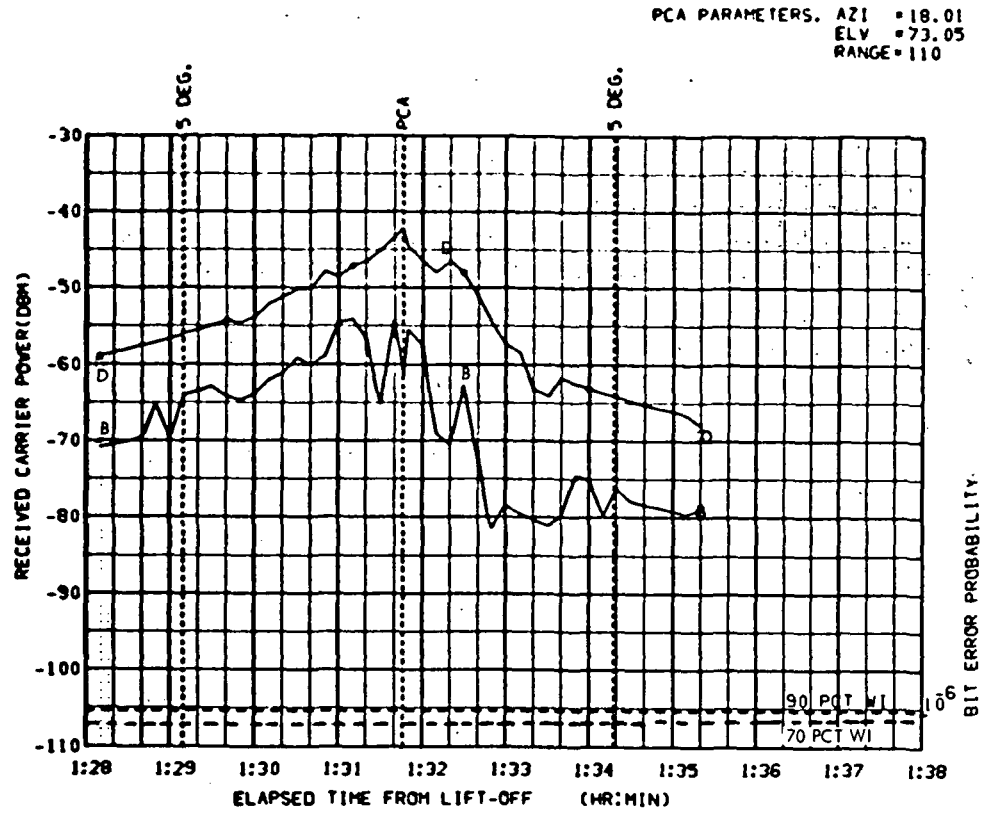

FIGURE 6-58c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

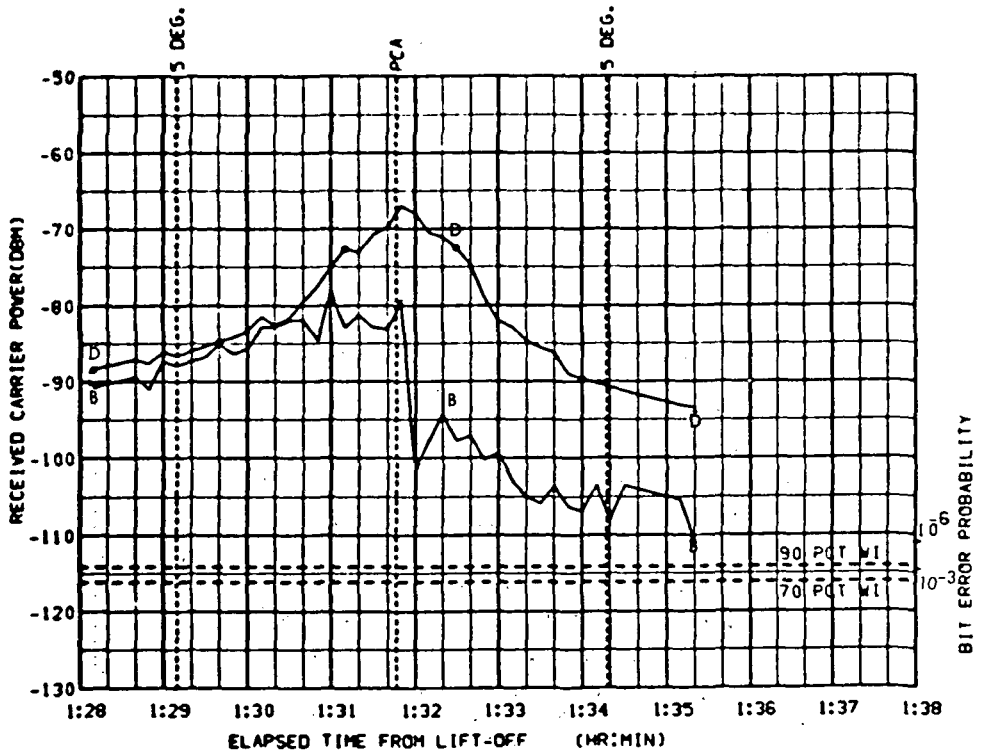

FIGURE 6-58d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

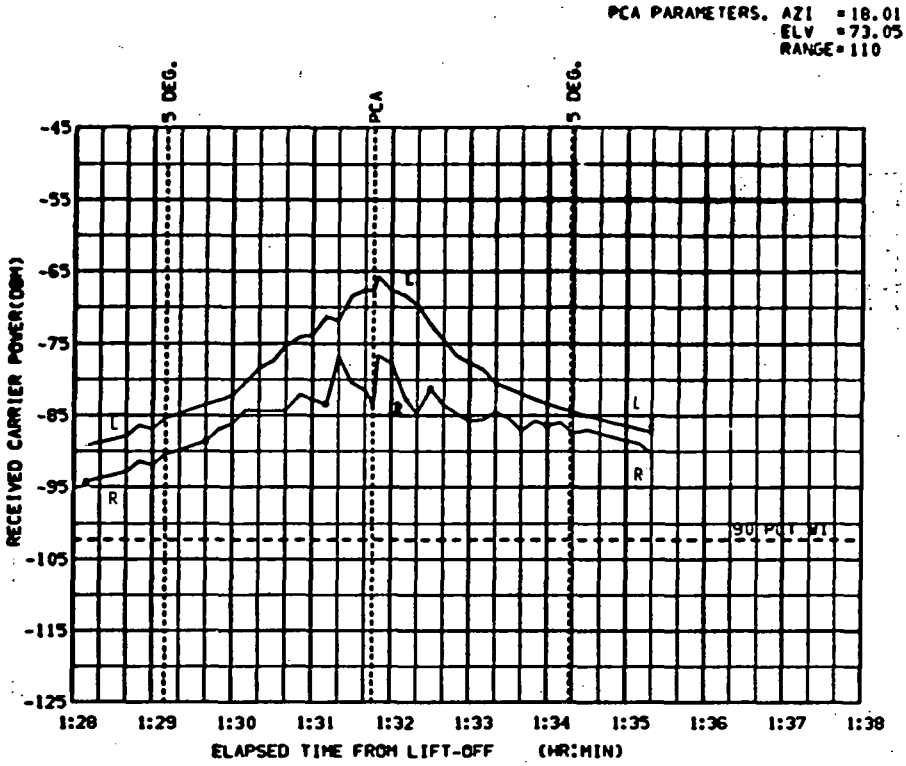

FIGURE 6-58e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

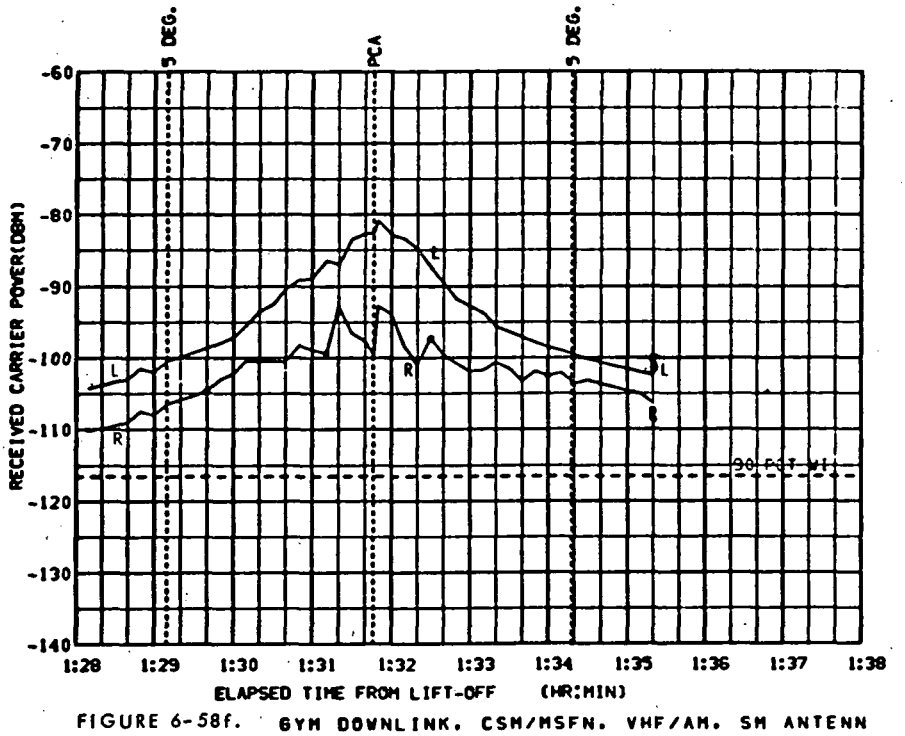

FIGURE 6-58f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

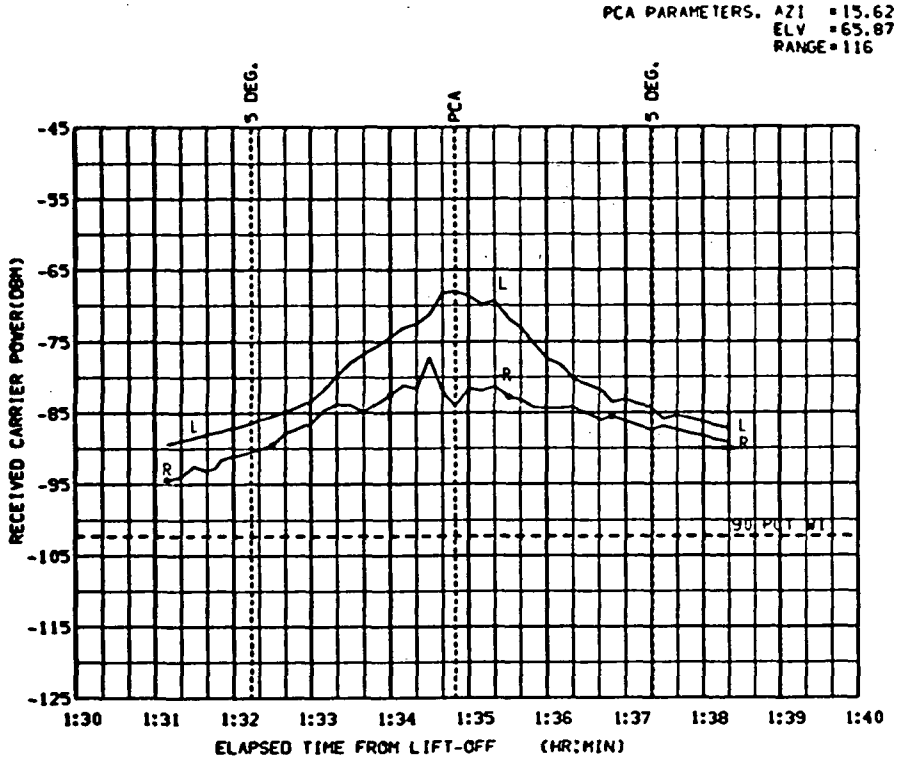

FIGURE 6-59a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

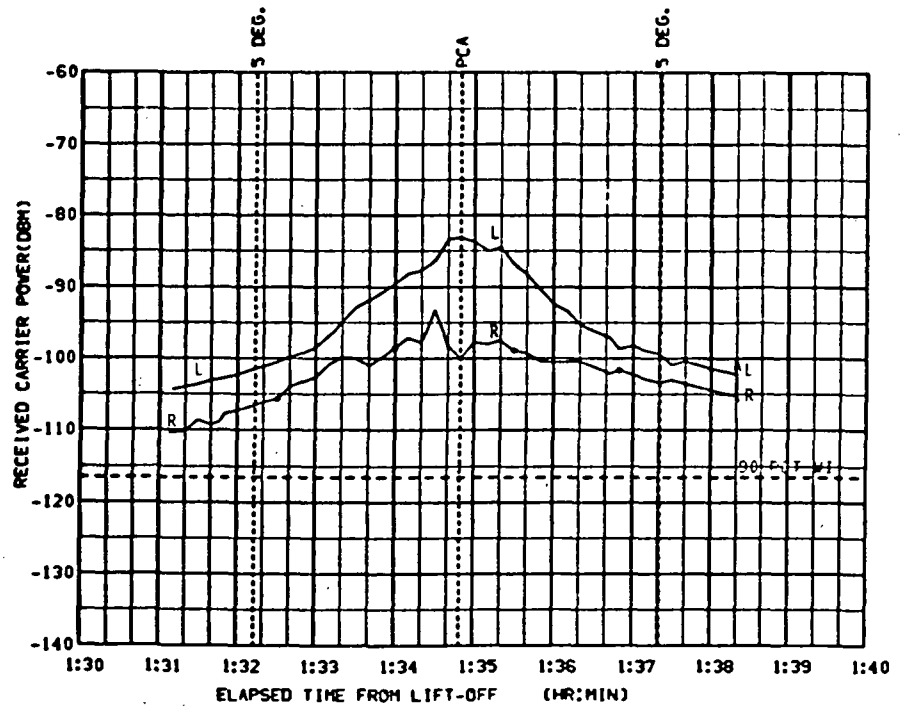

FIGURE 6-59b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

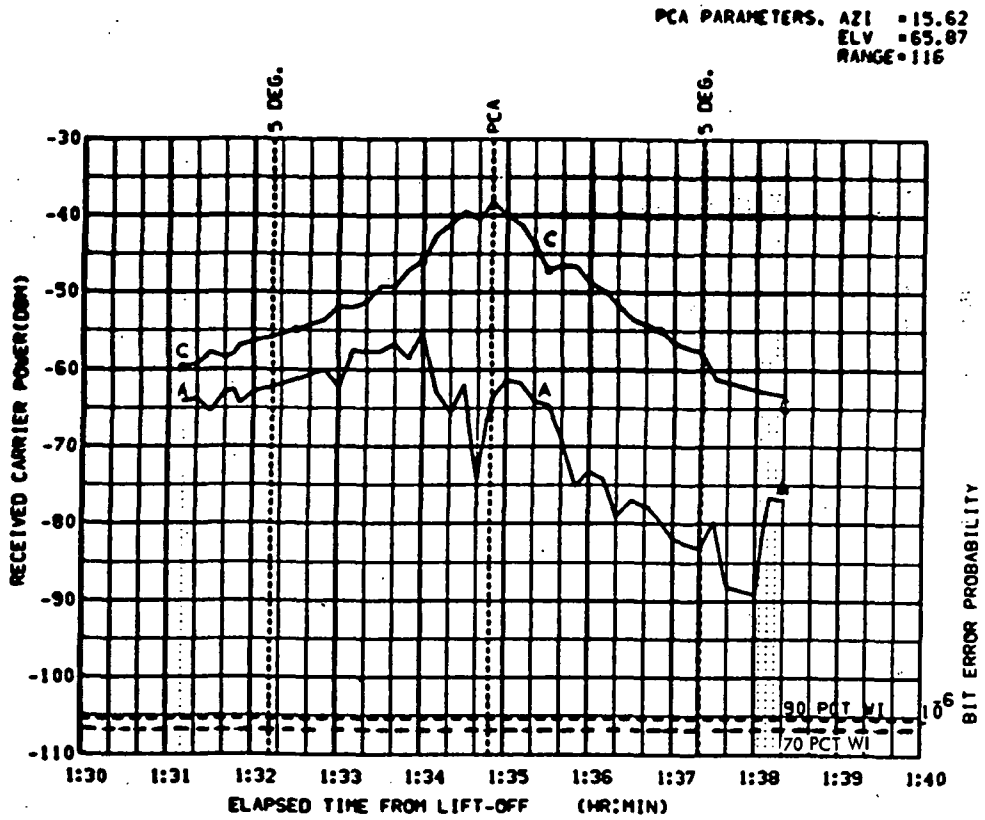

FIGURE 6-59c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

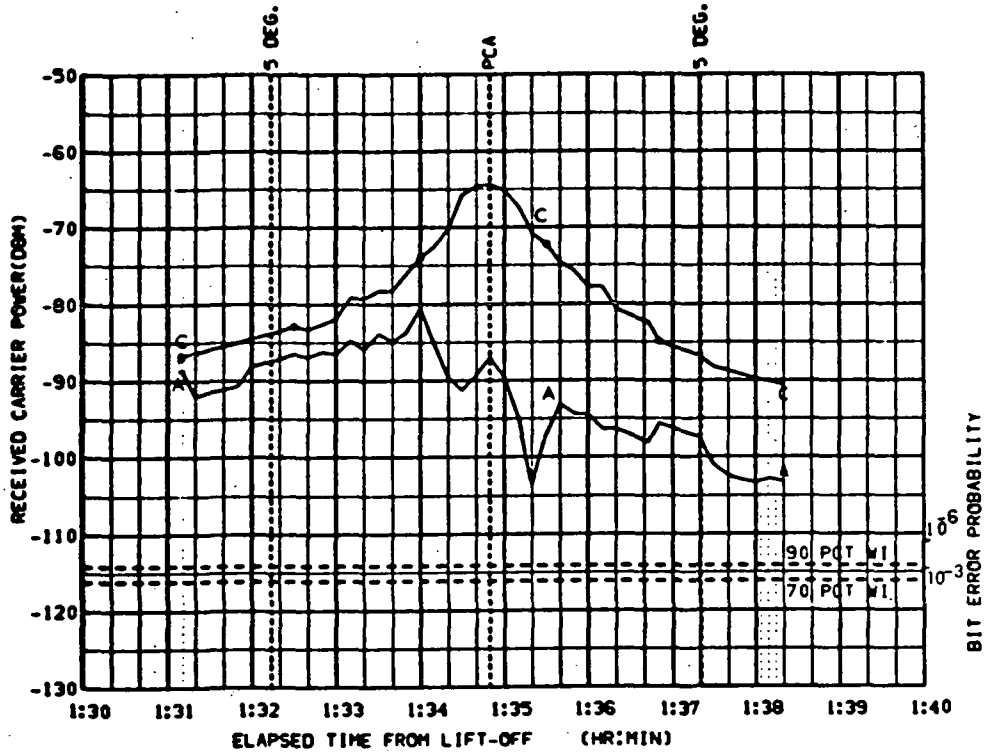

FIGURE 6-59d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

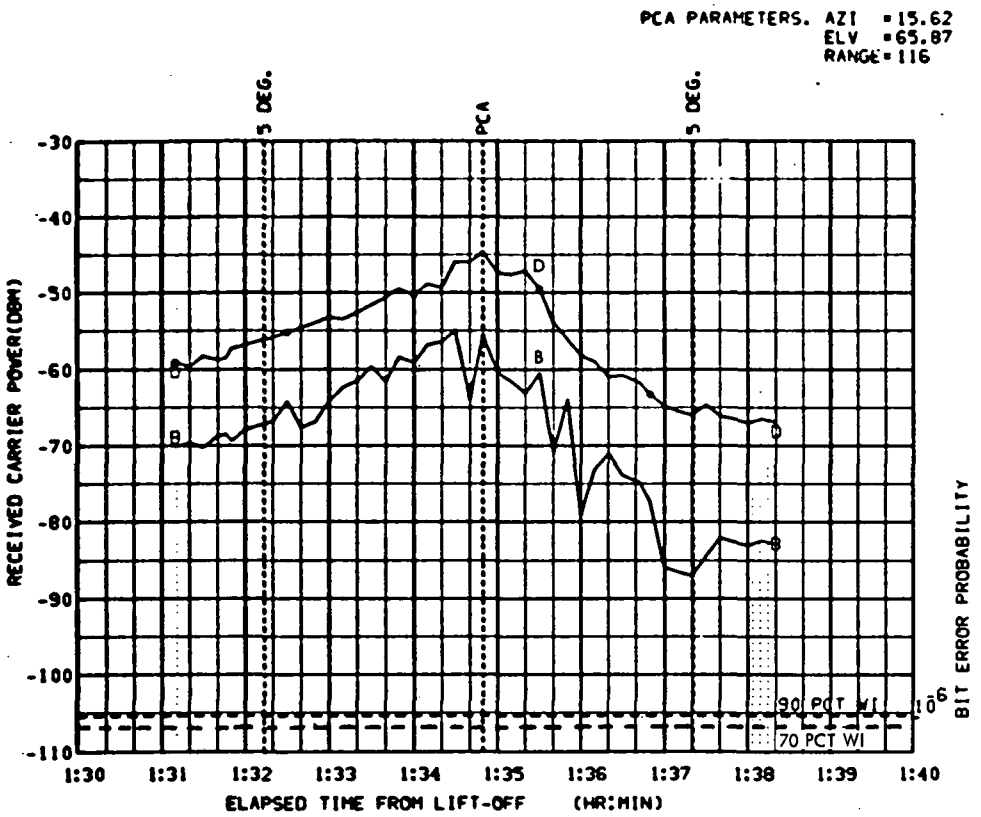

FIGURE 6-59e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

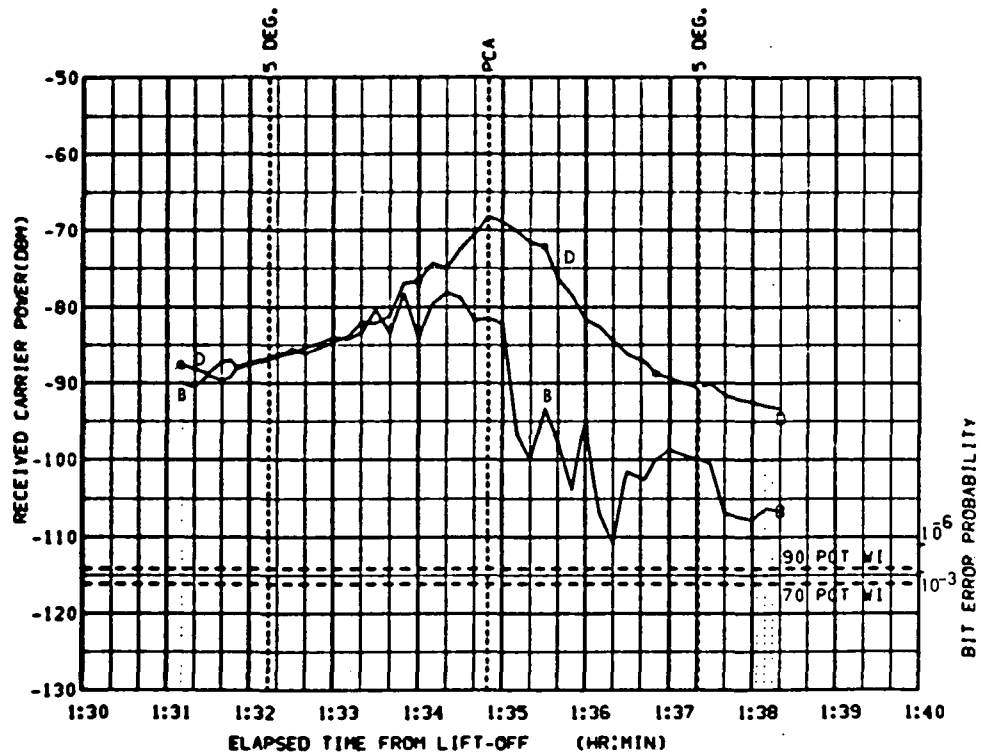

FIGURE 6-59f. TEX ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

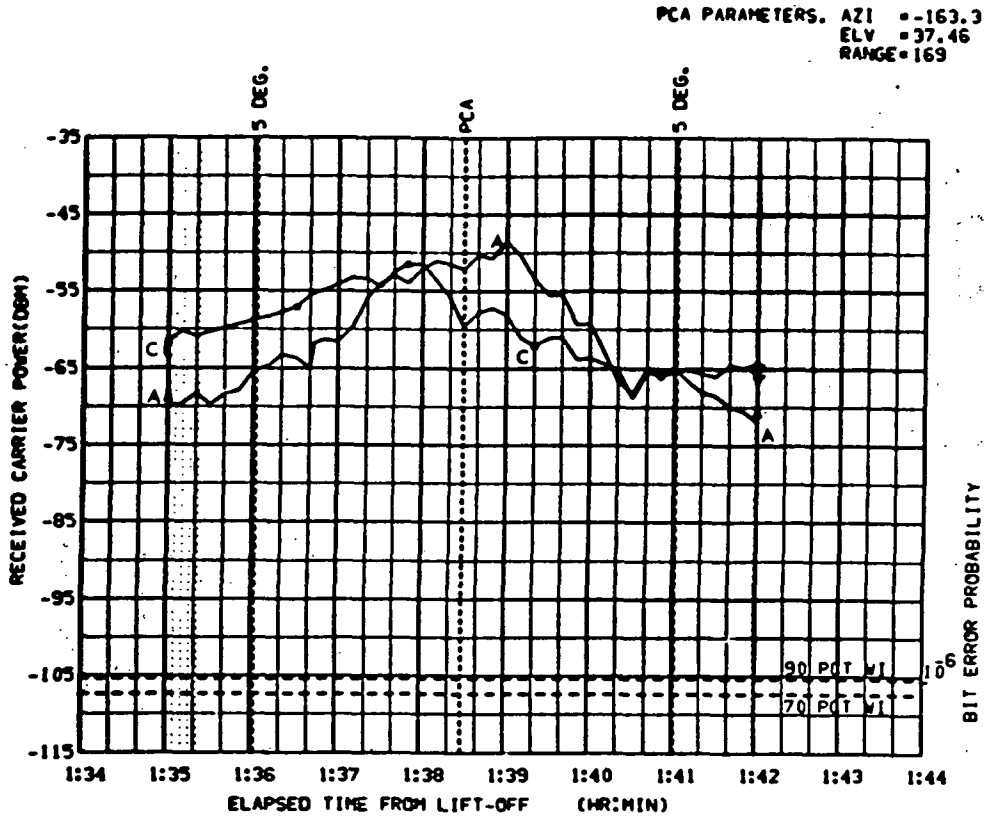

FIGURE 6-60a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

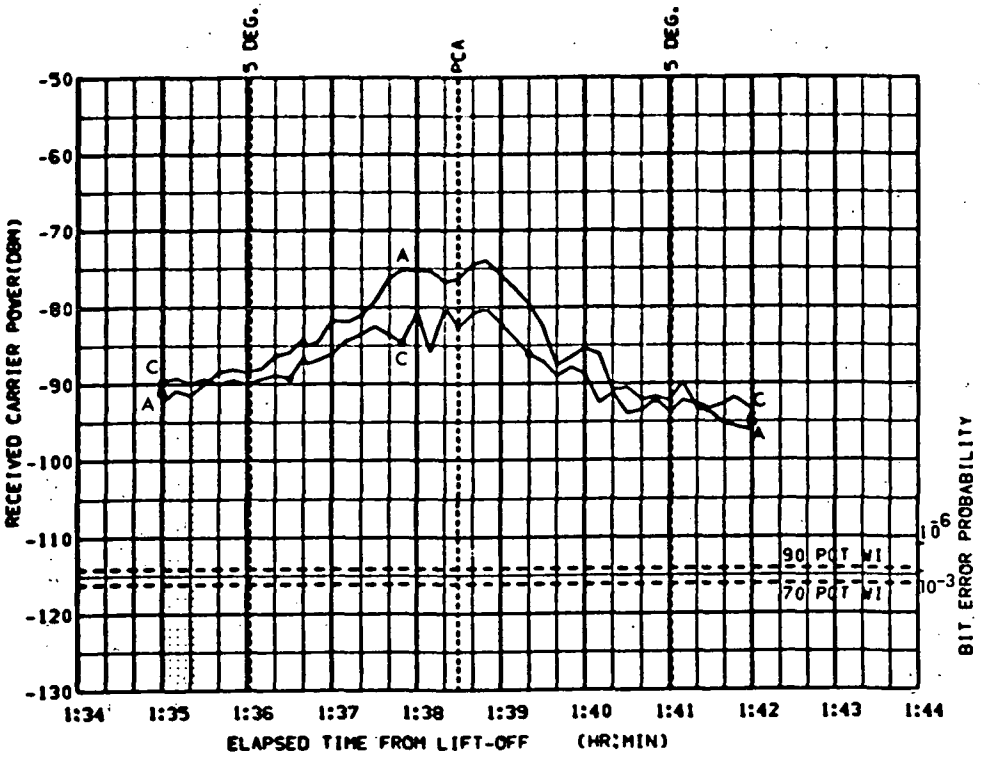

FIGURE 6-60b. MIL ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

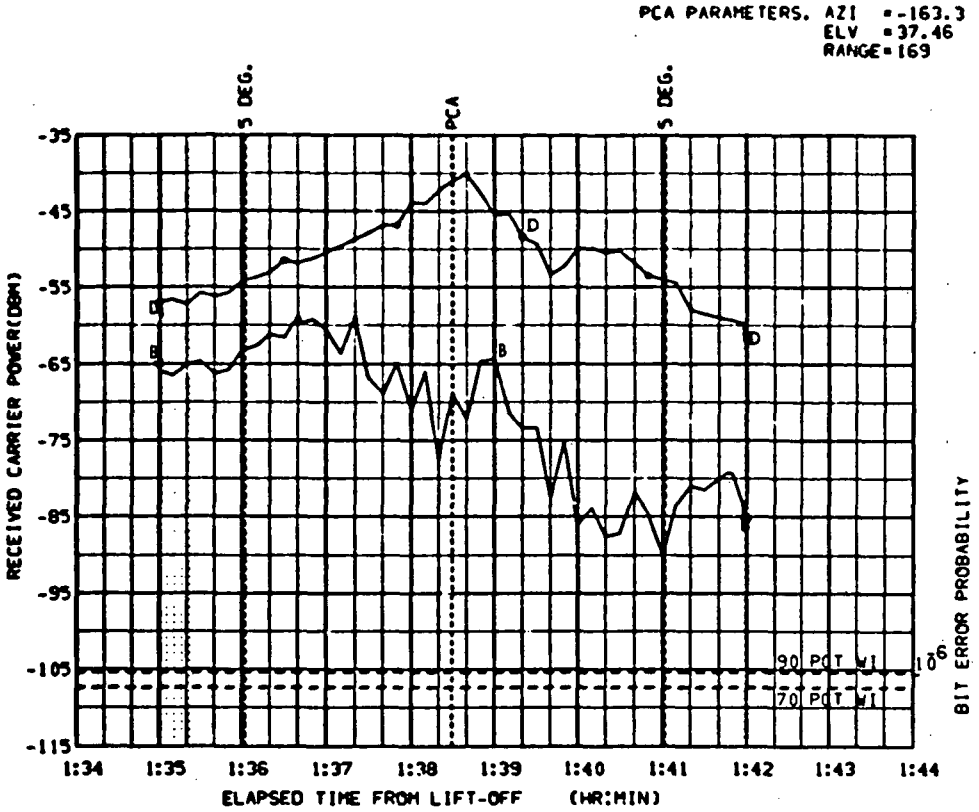

FIGURE 6-60c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

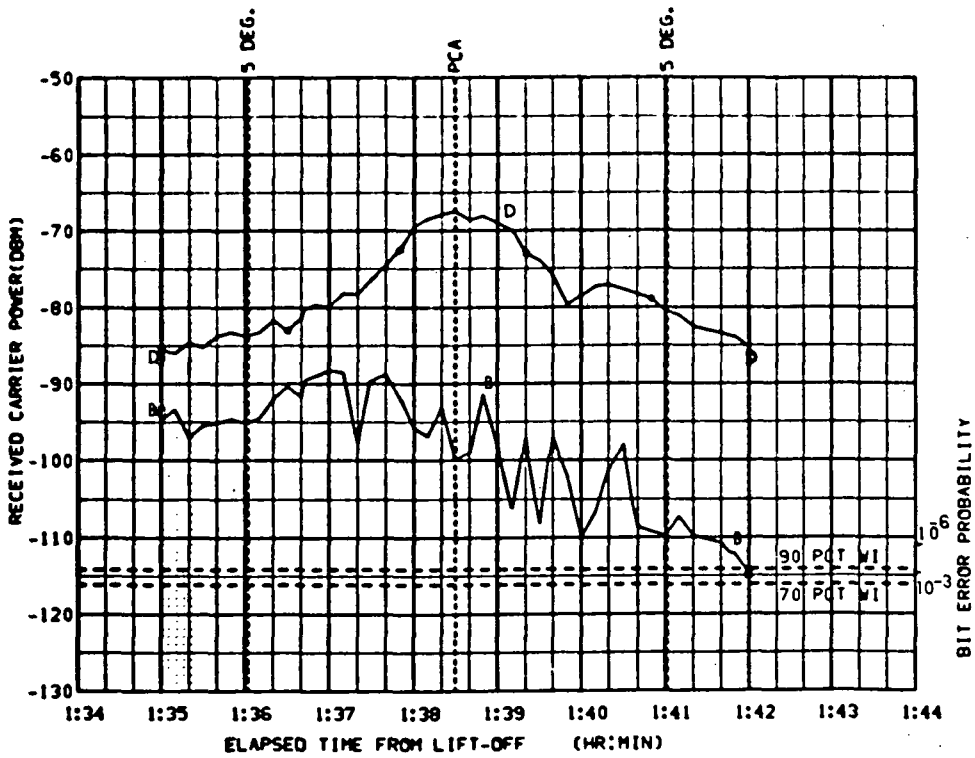

FIGURE 6-60d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

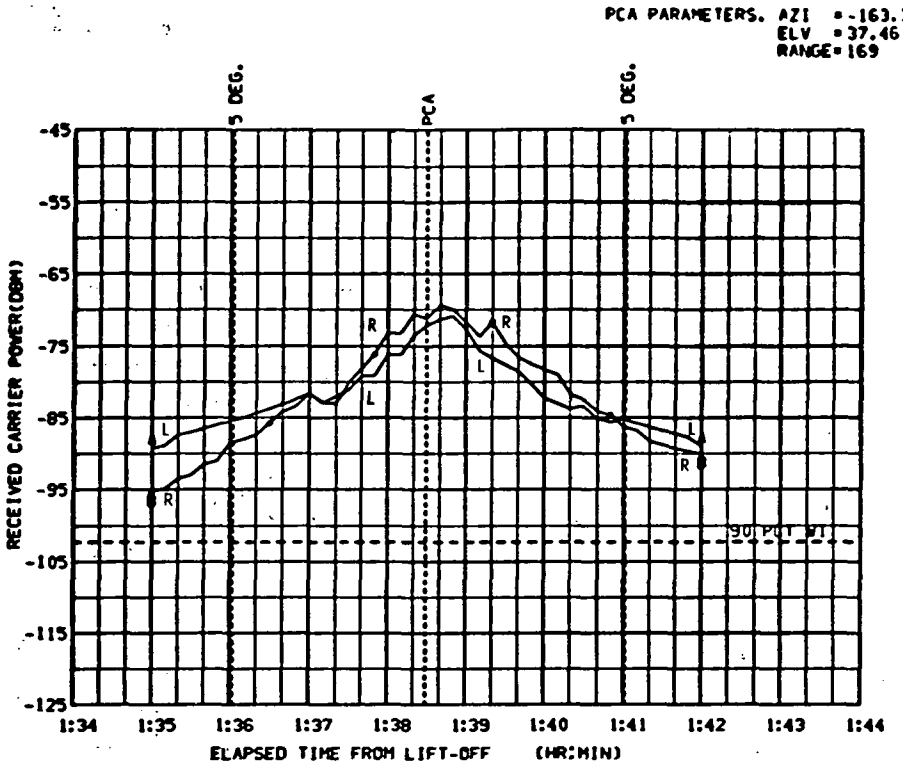

FIGURE 6-60e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

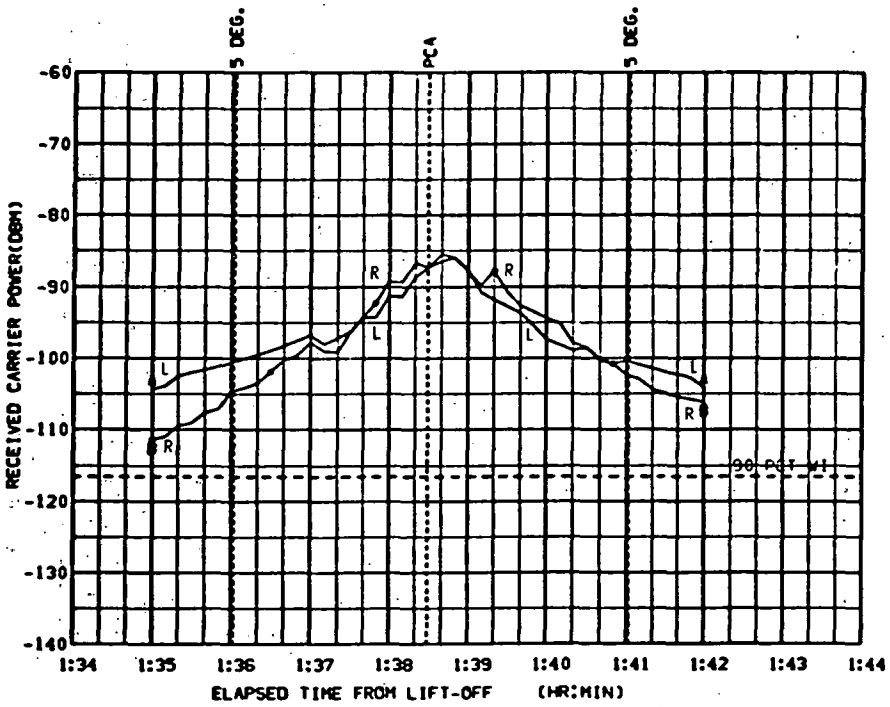

FIGURE 6-60f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

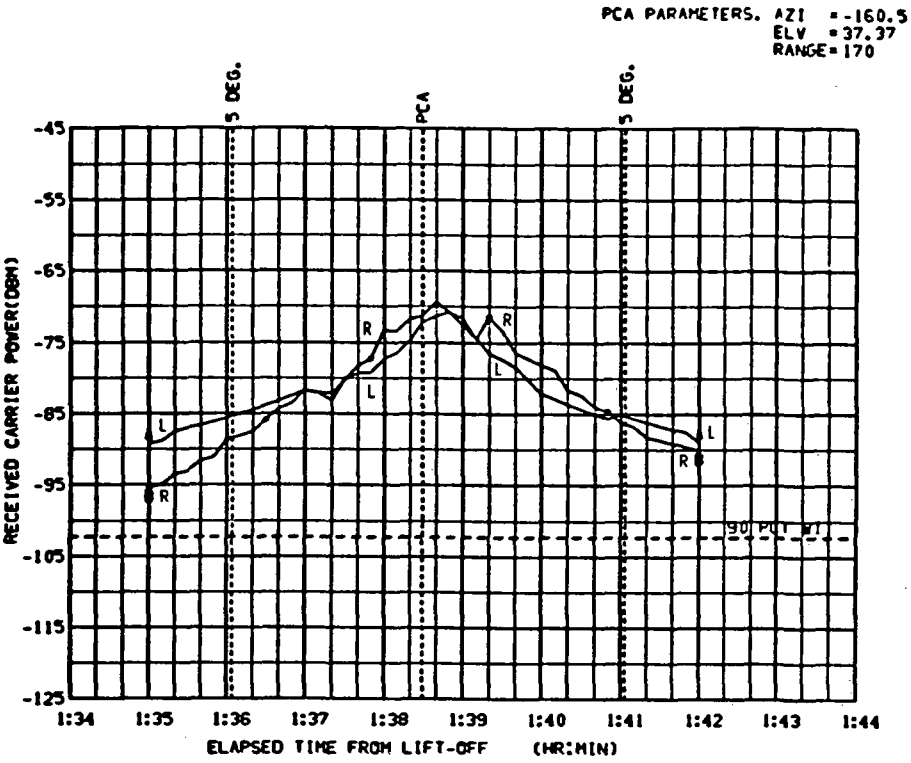

FIGURE 6-61a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

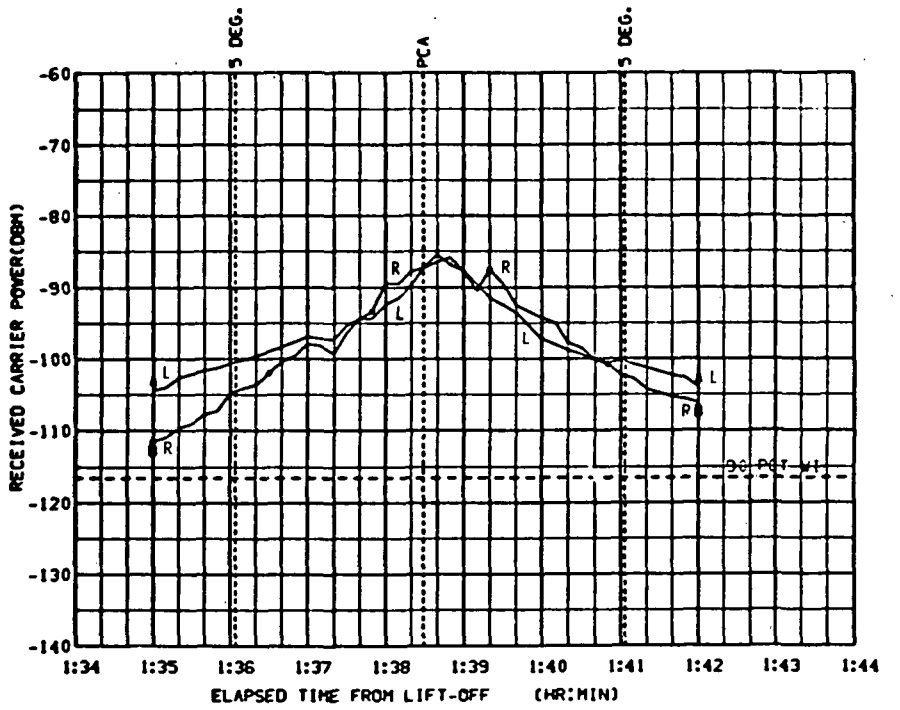

FIGURE 6-61b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

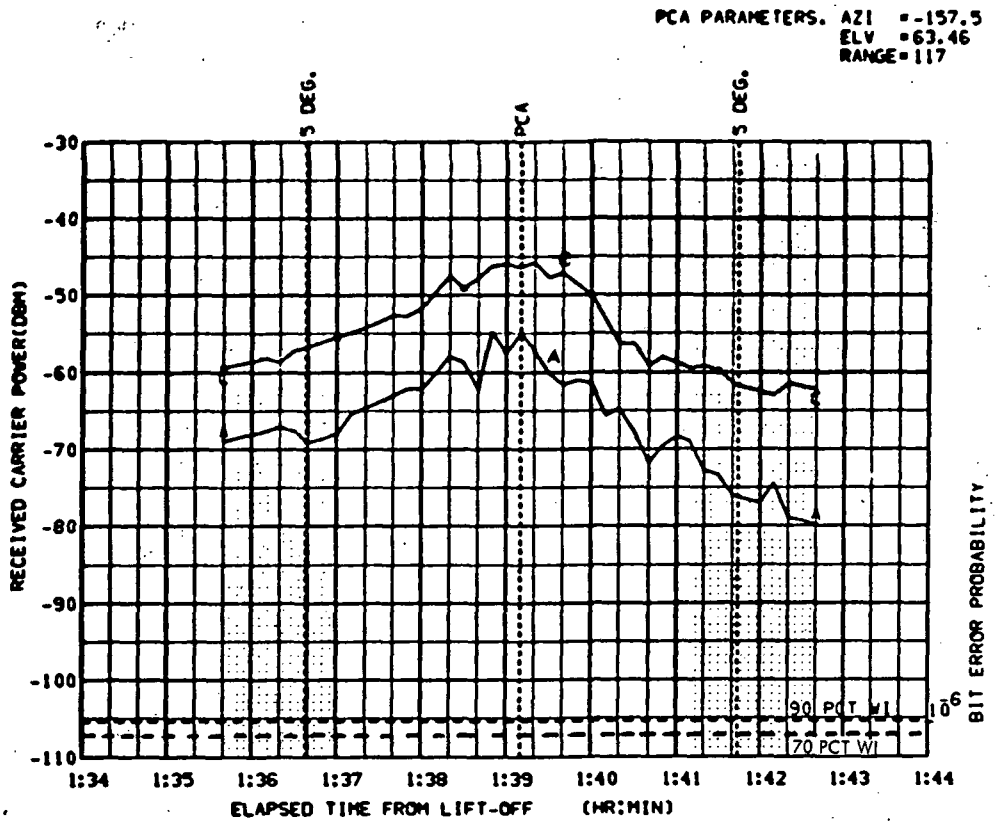

FIGURE 6-62a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

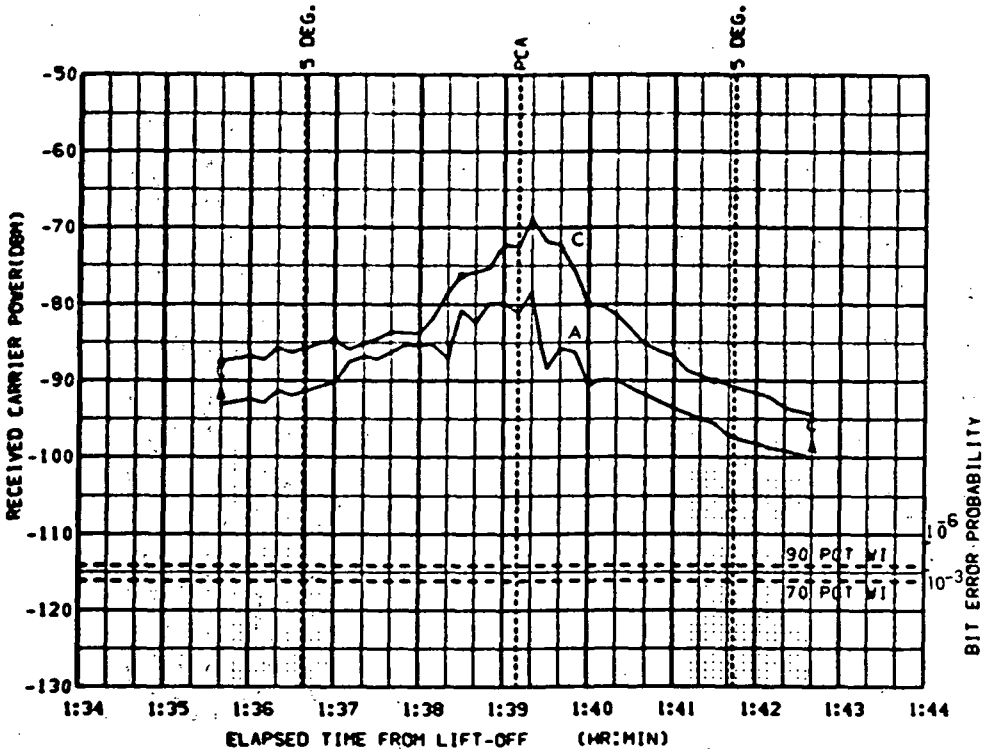

FIGURE 6-62b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

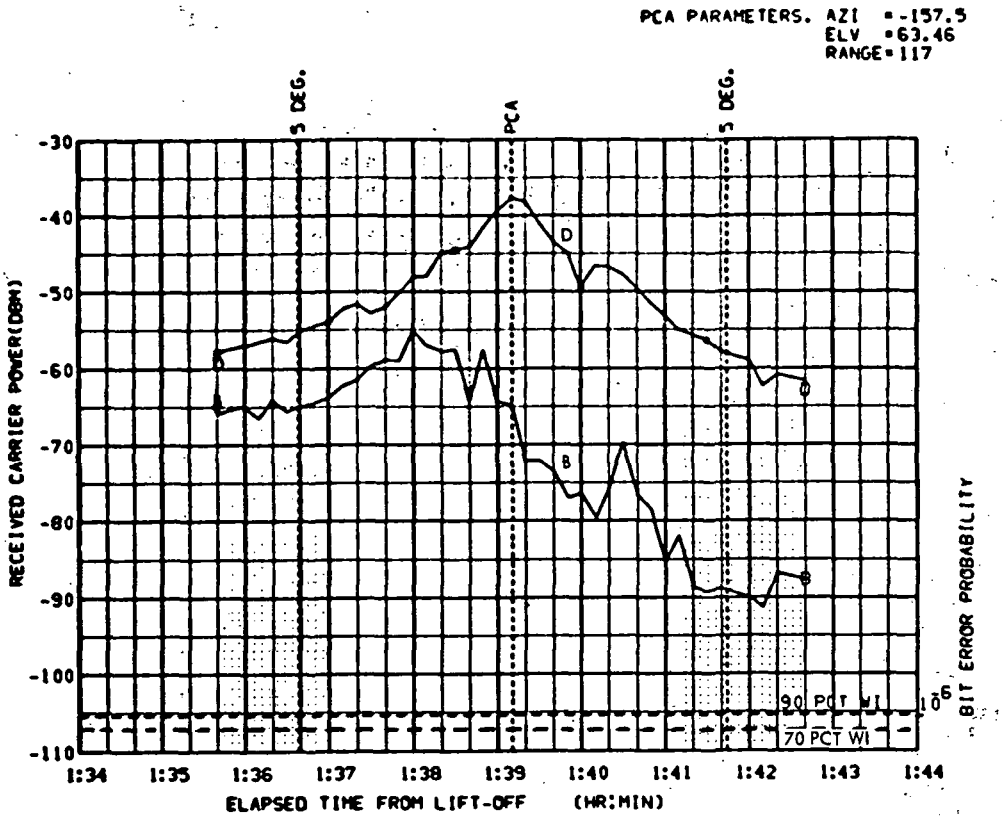

FIGURE 6-62c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

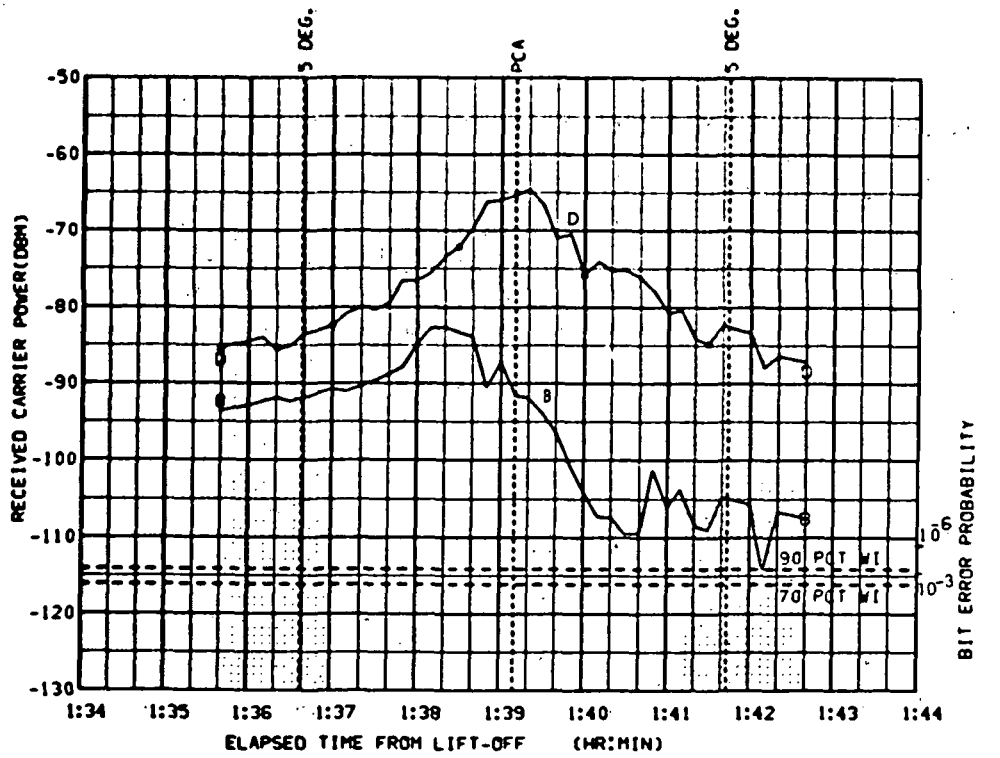

FIGURE 6-62d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

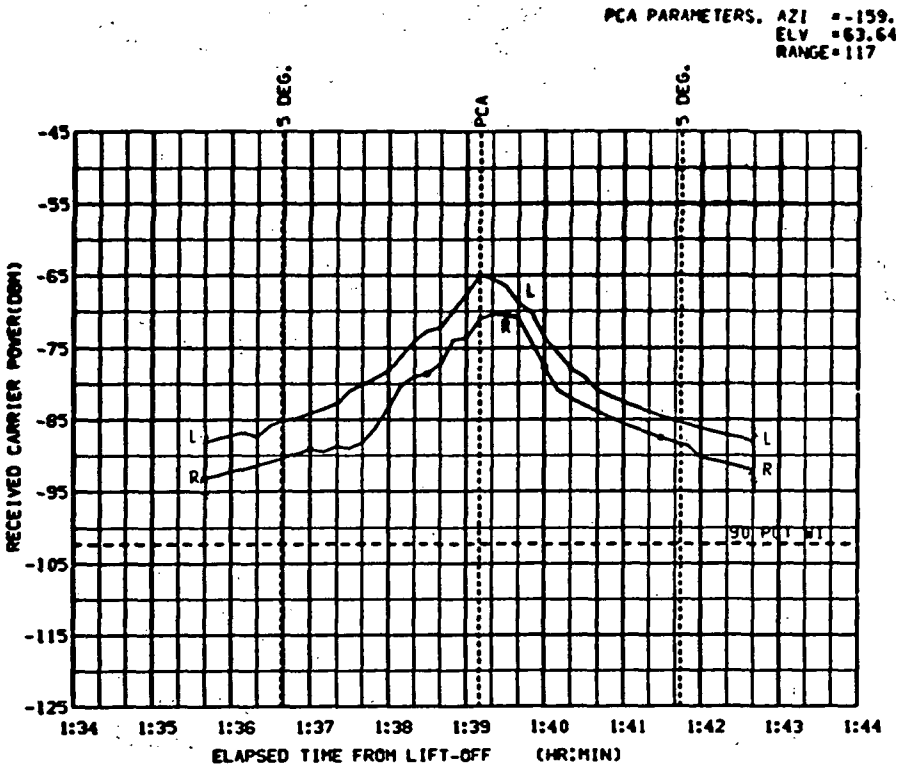

FIGURE 6-62e. GBI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

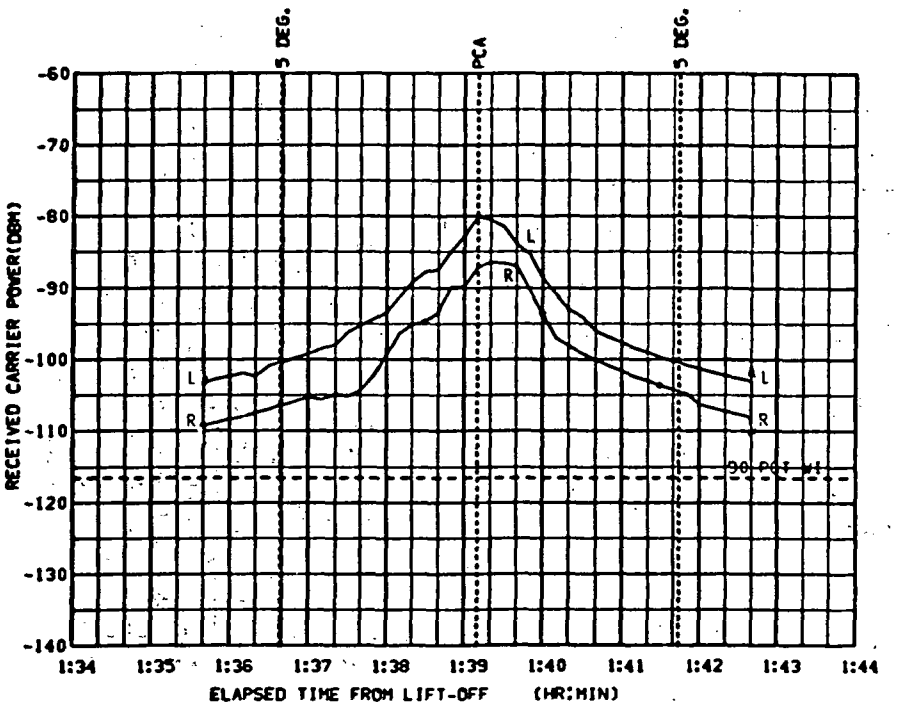

FIGURE 6-62f. GBI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

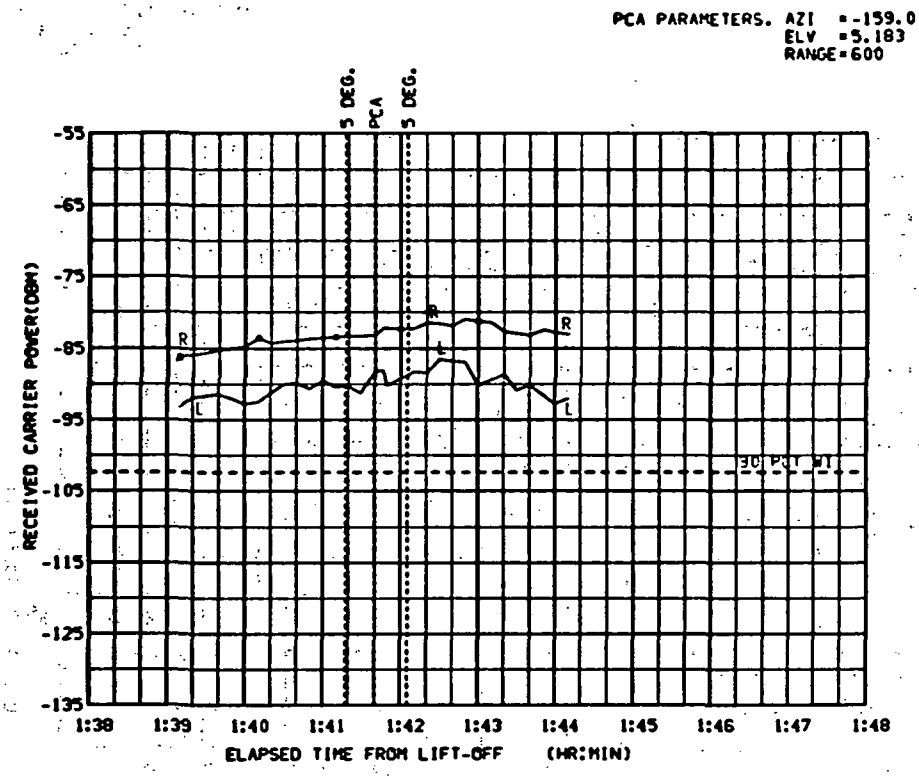

FIGURE 6-63a. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

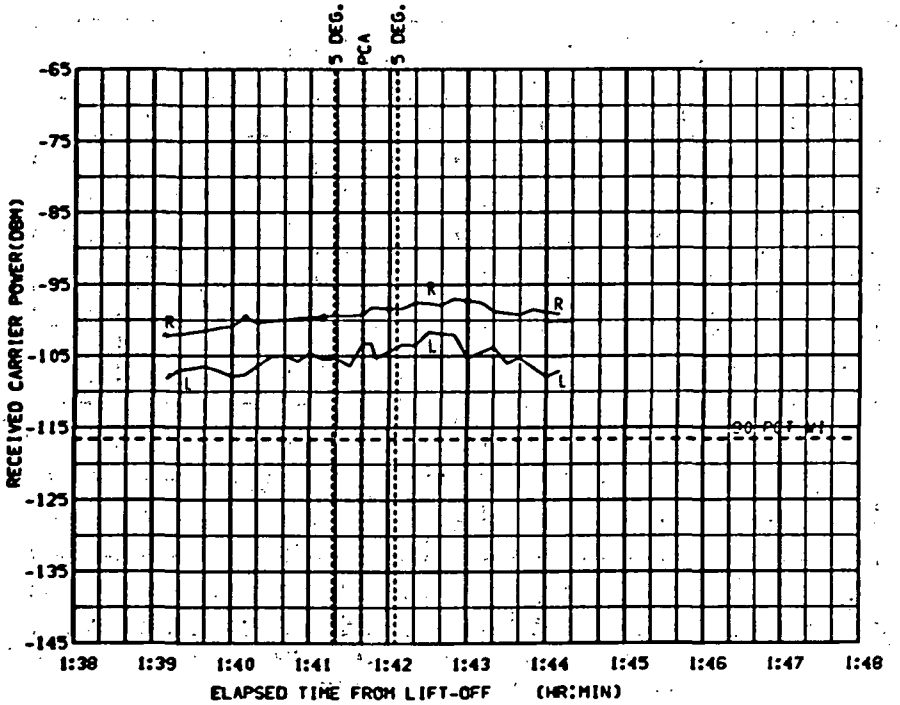

FIGURE 6-63b. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

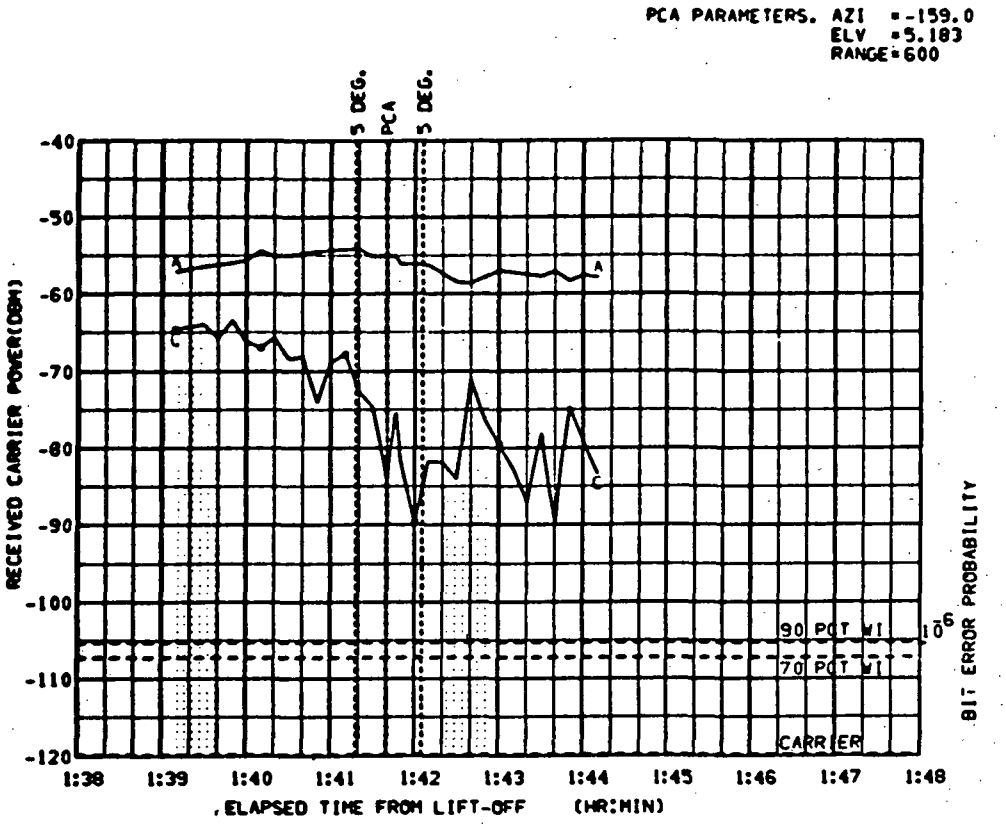

FIGURE 6-63c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

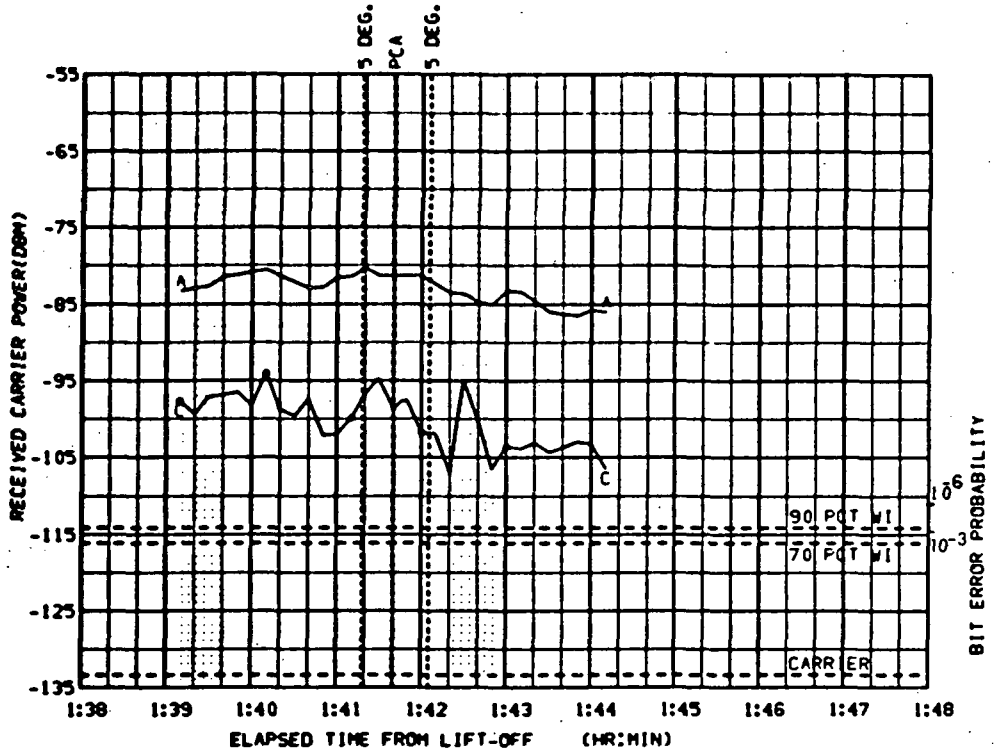

FIGURE 6-63d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

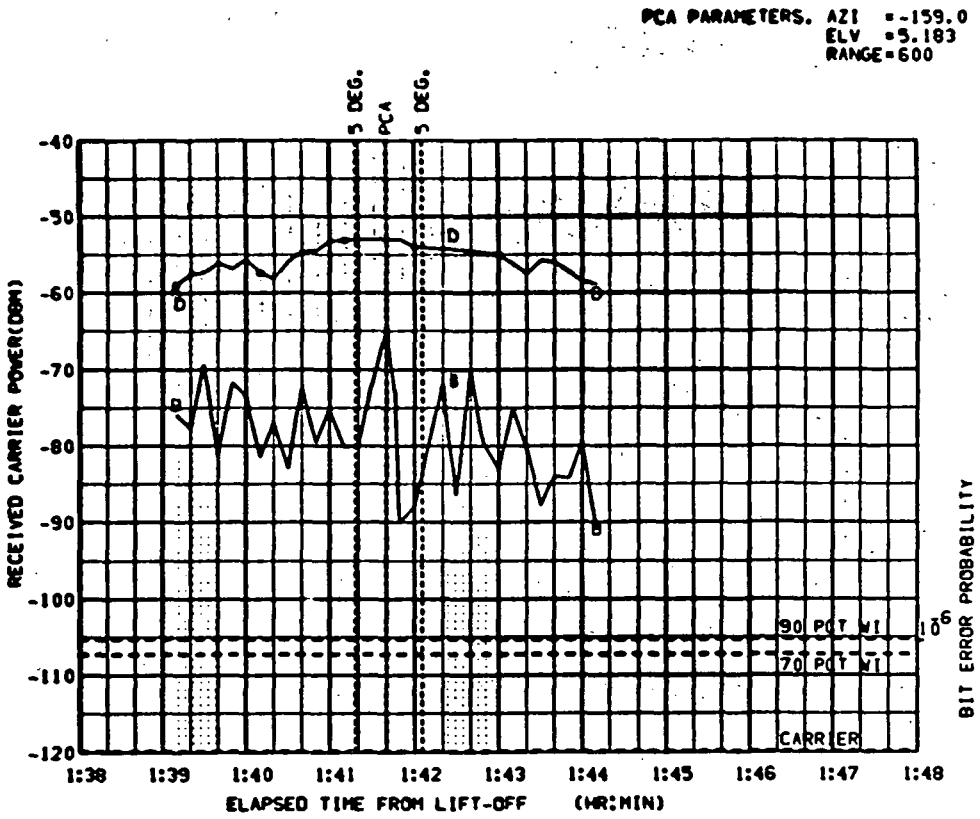

FIGURE 6-63e. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

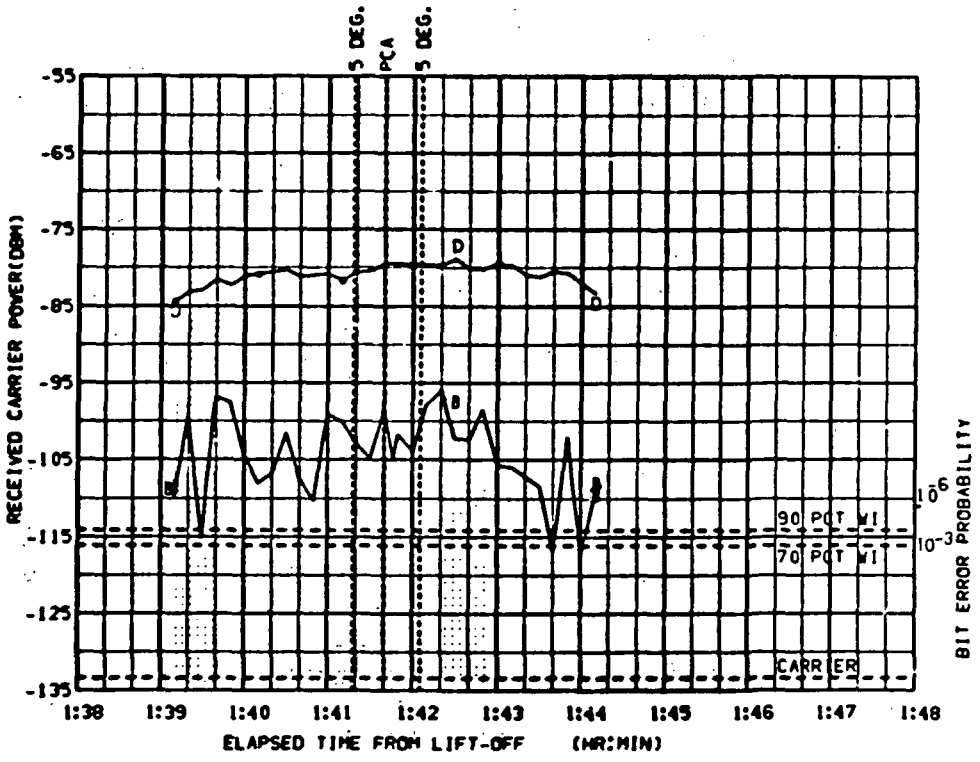

FIGURE 6-63f. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

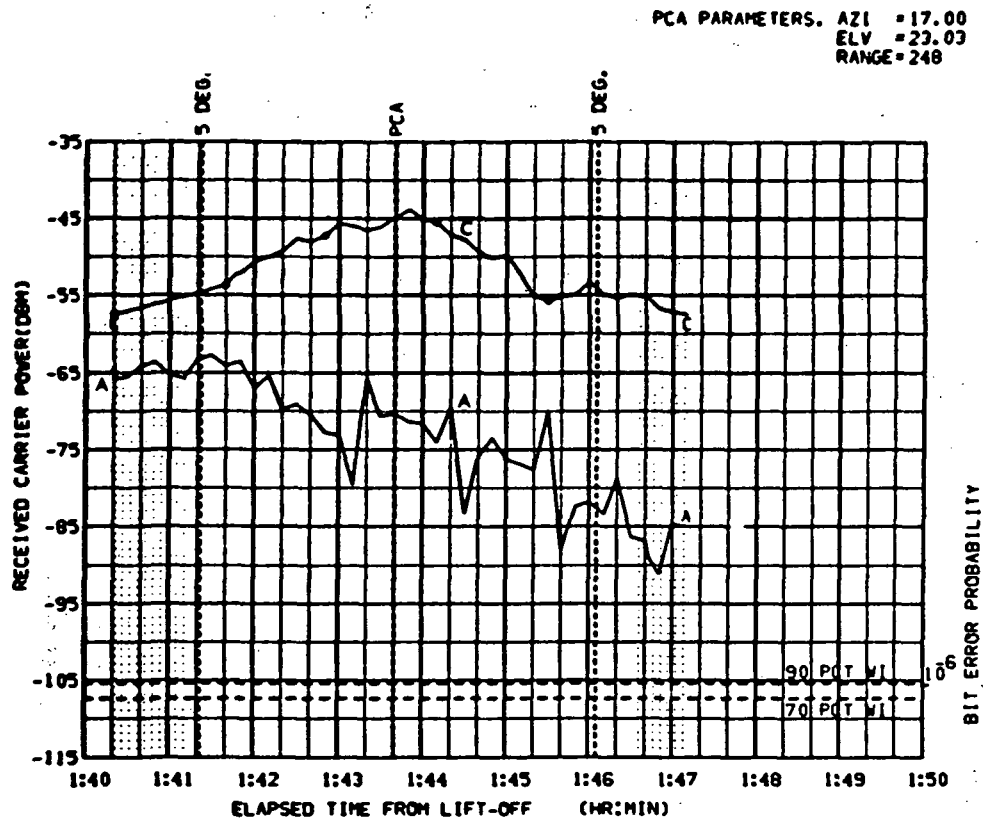

FIGURE 6-64a. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

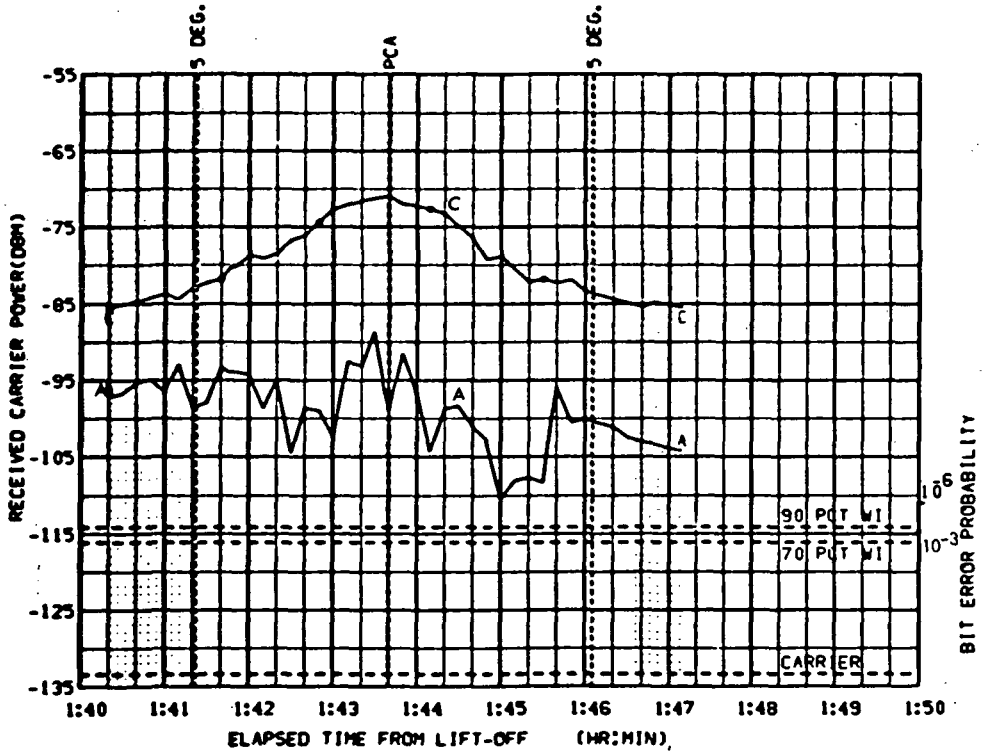

FIGURE 6-64b. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

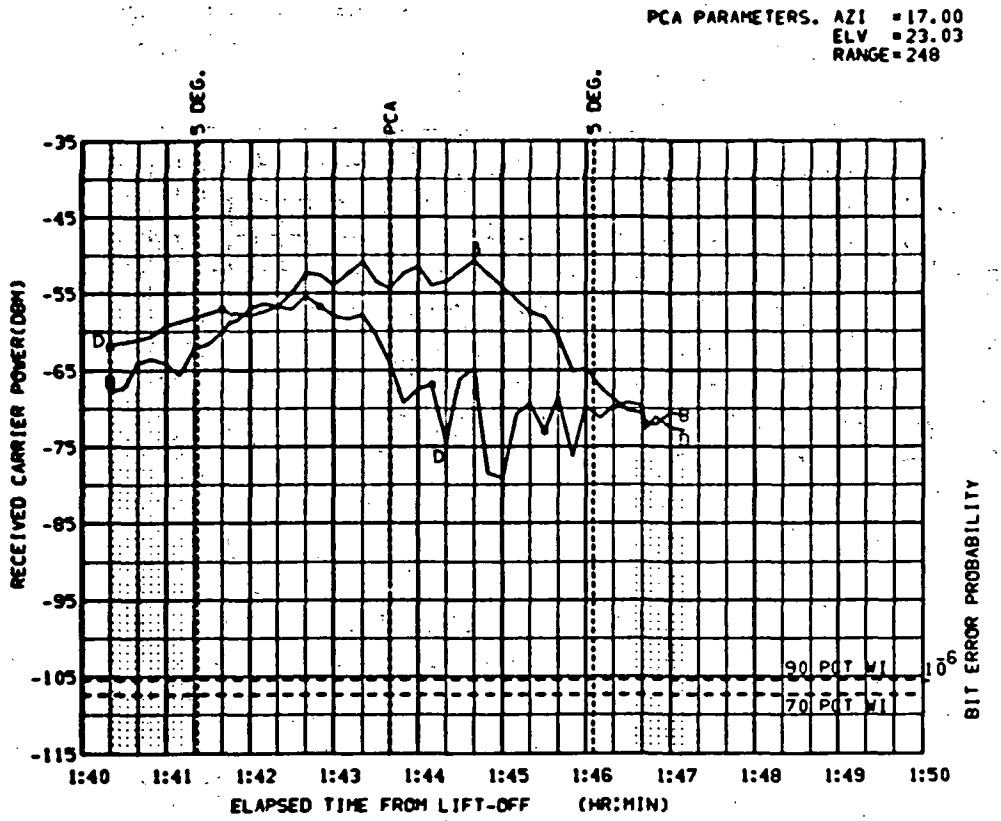

FIGURE 6-64c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

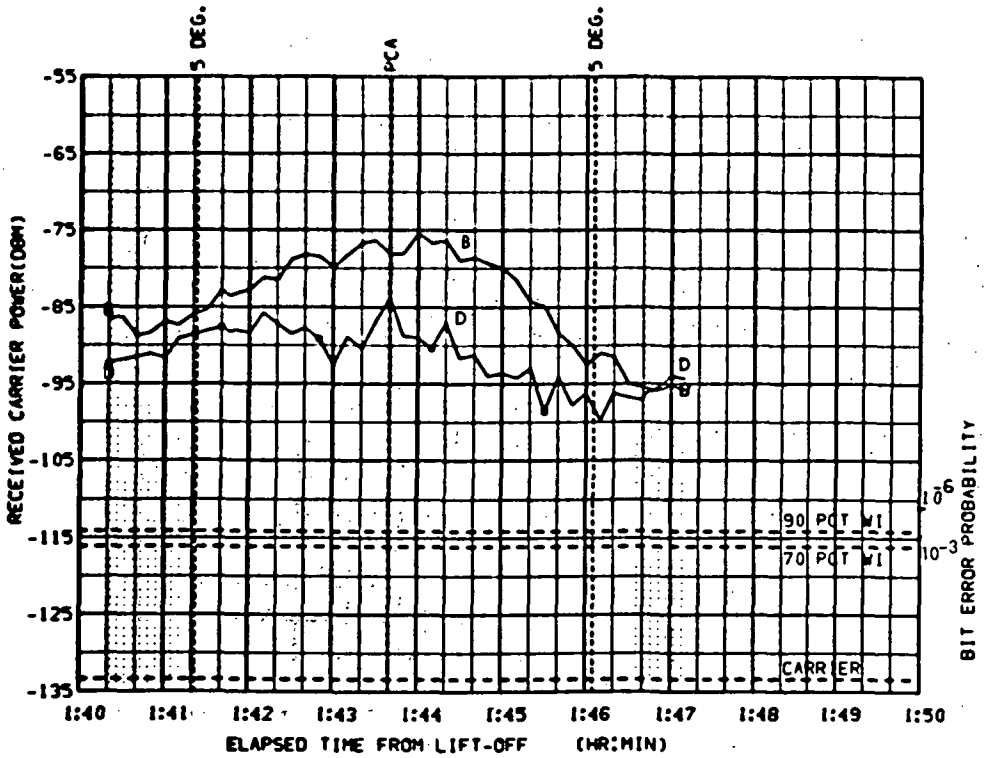

FIGURE 6-64d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

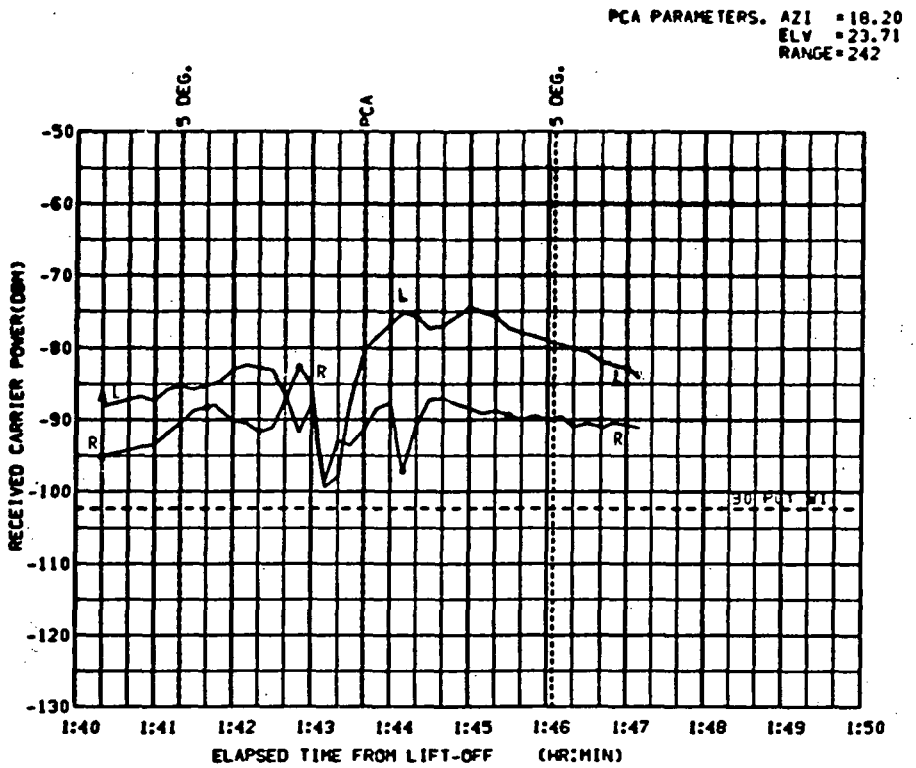

FIGURE 6-64e. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

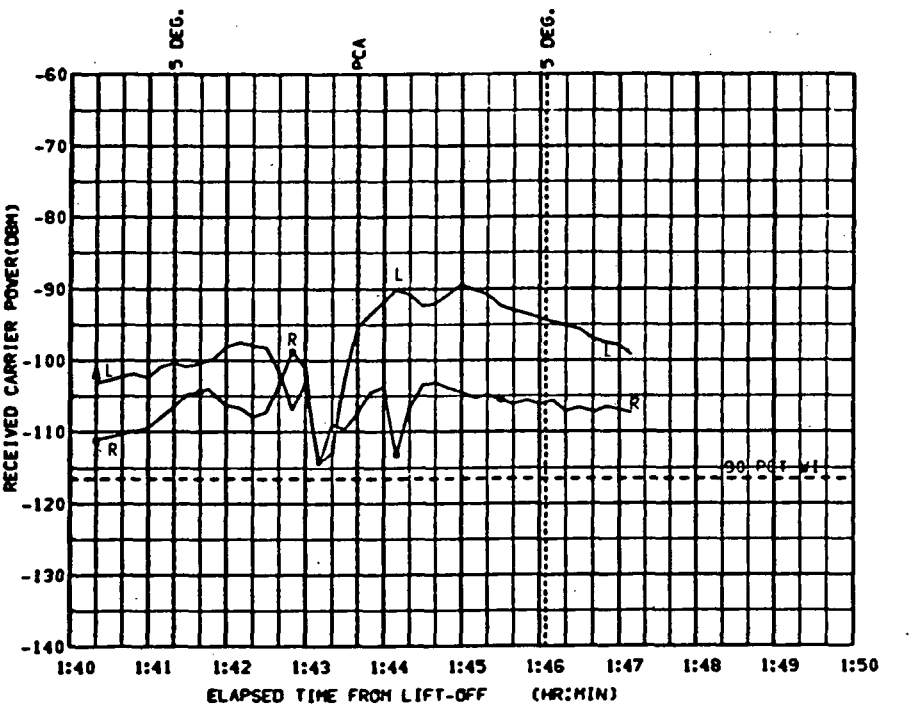

FIGURE 6-64f. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

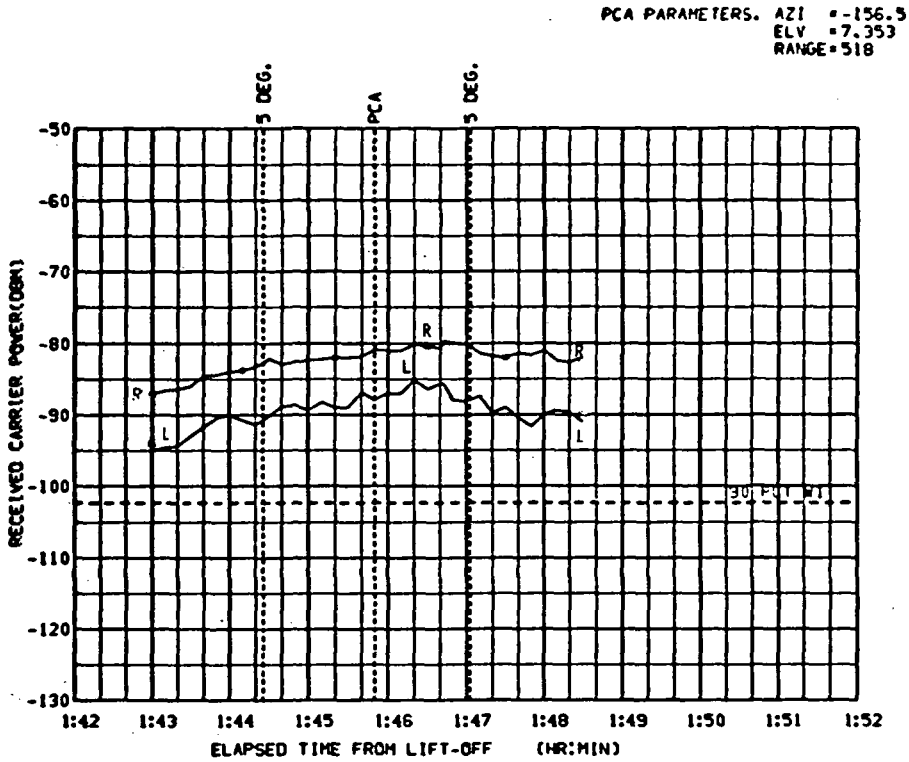

FIGURE 6-65a. VAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

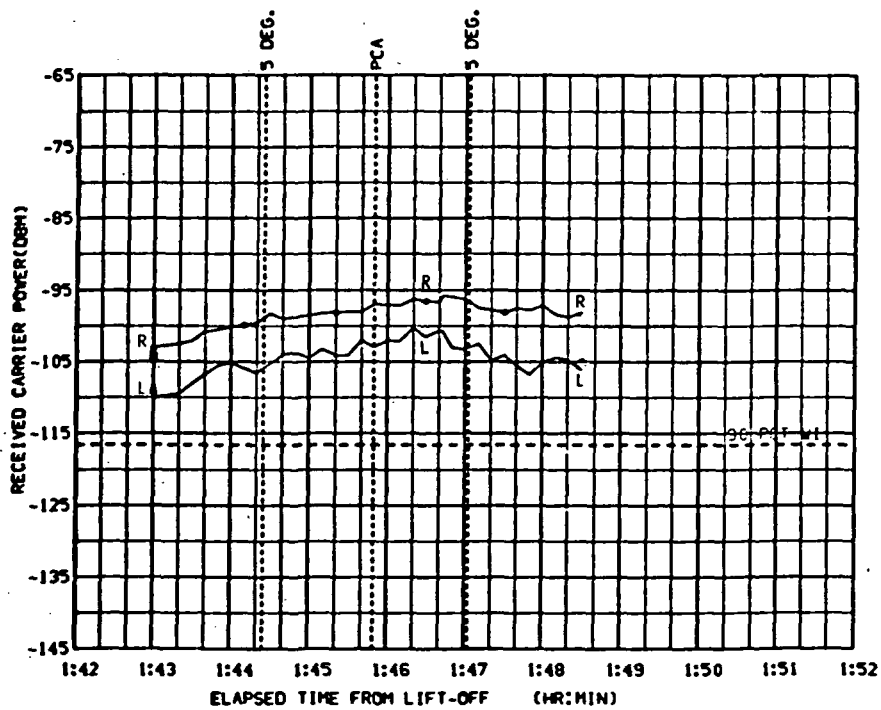

FIGURE 6-65b. VAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

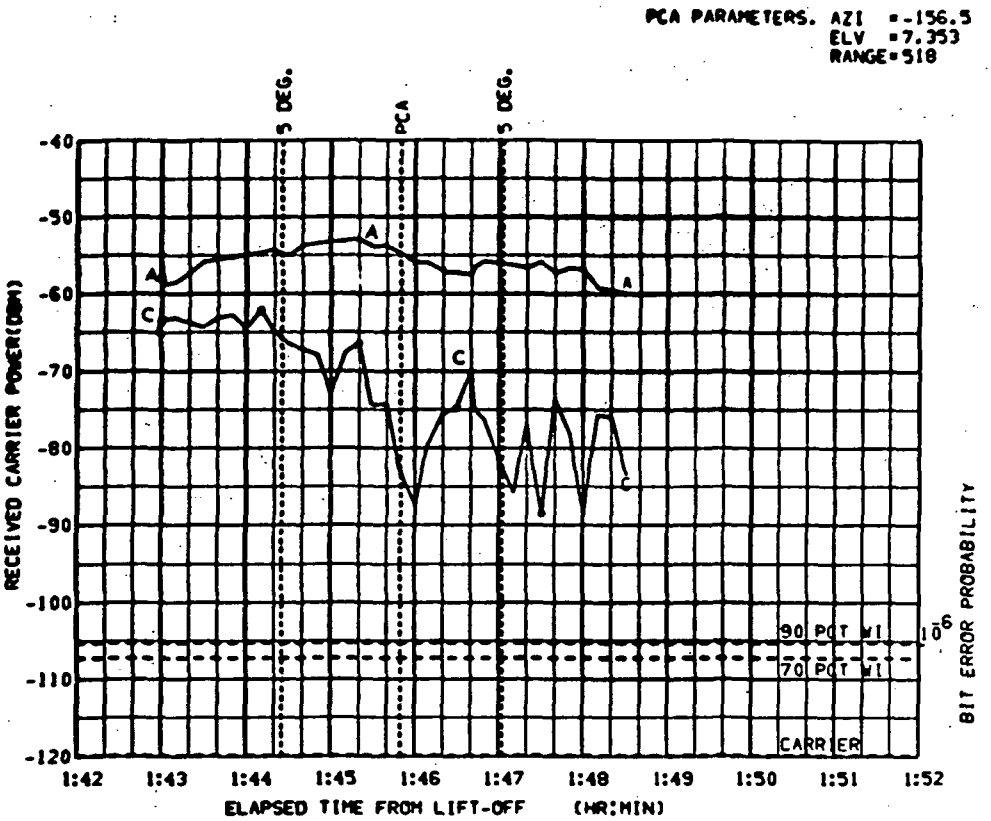

FIGURE 6-65c. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

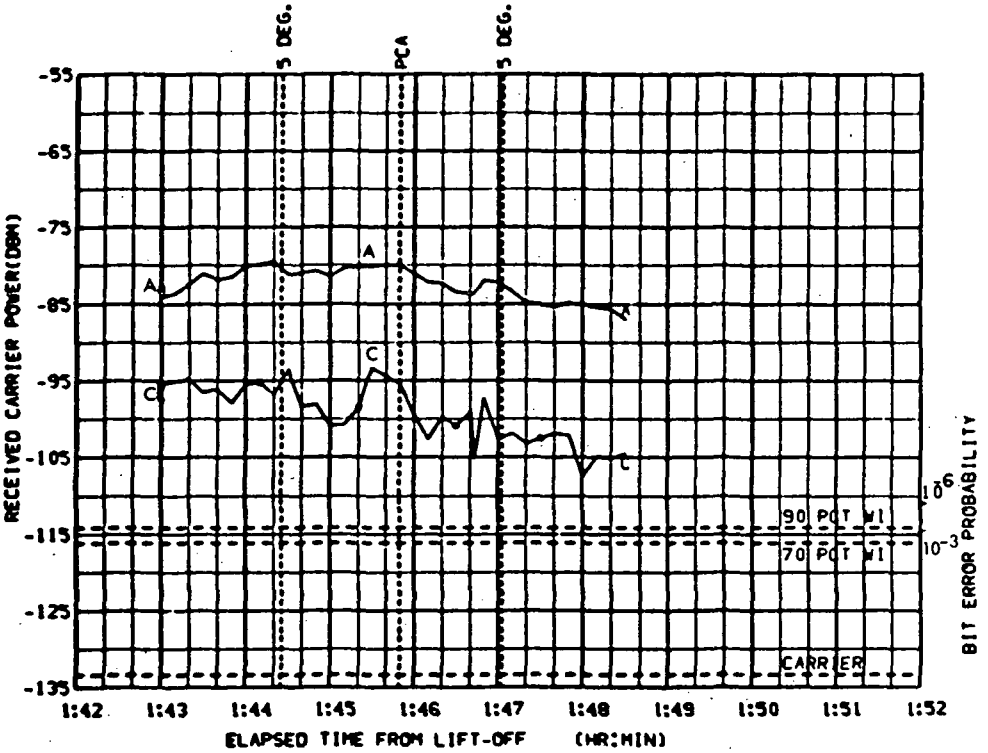

FIGURE 6-65d. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

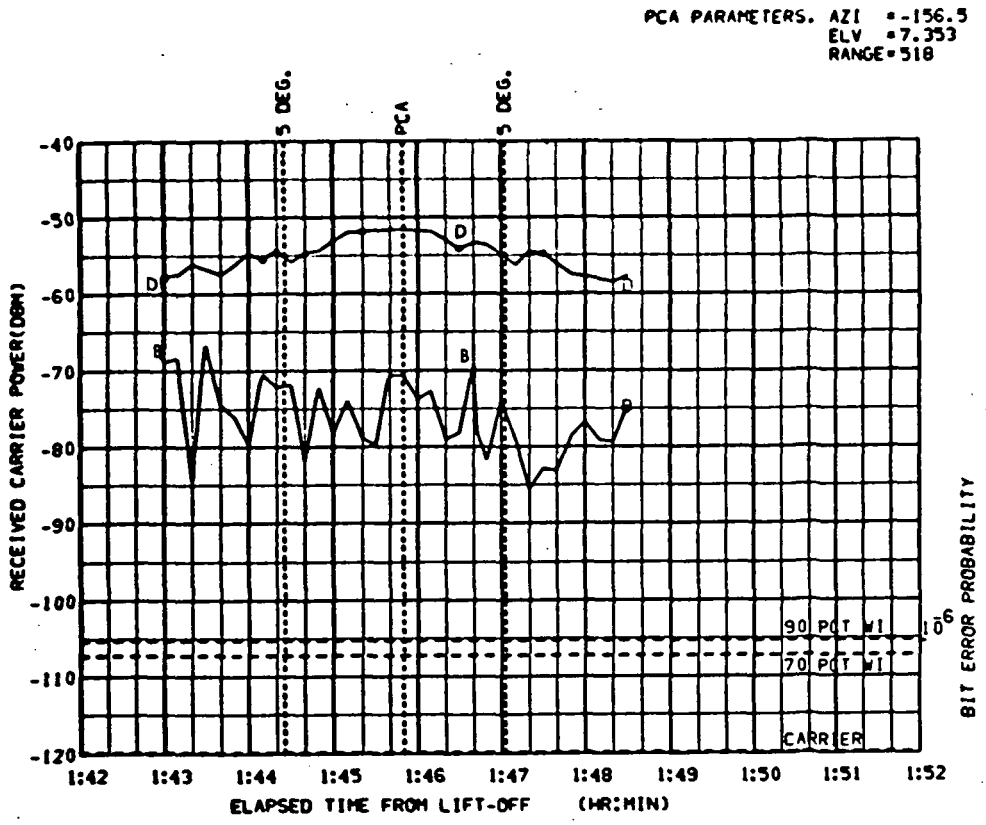

FIGURE 6-65e. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

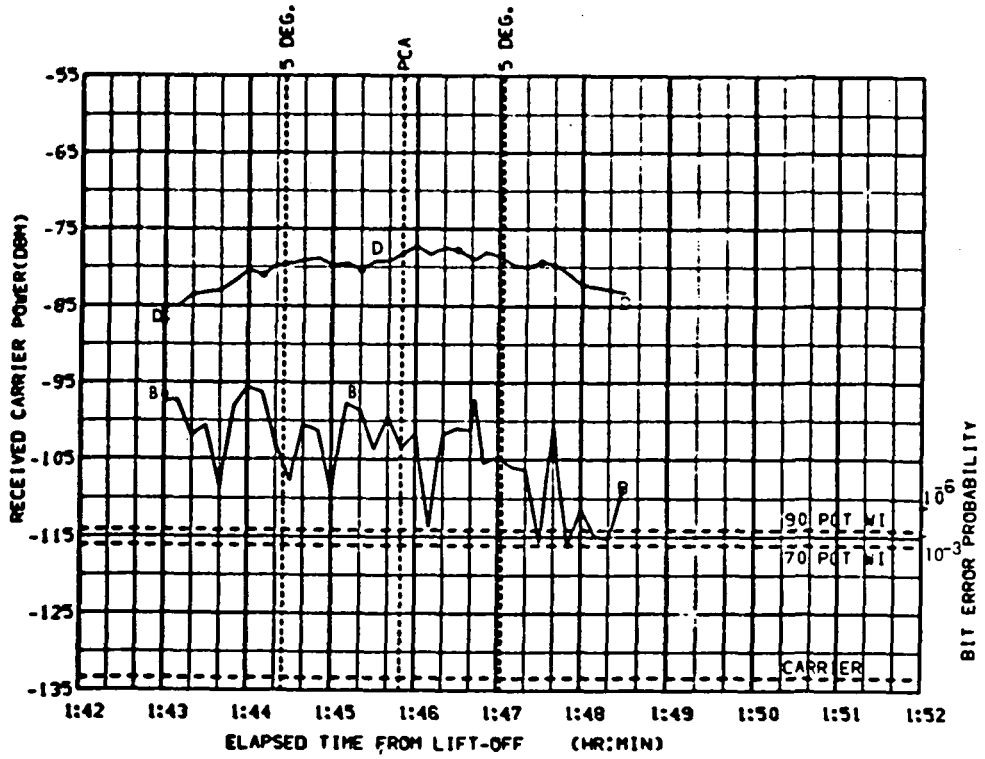

FIGURE 6-65f. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

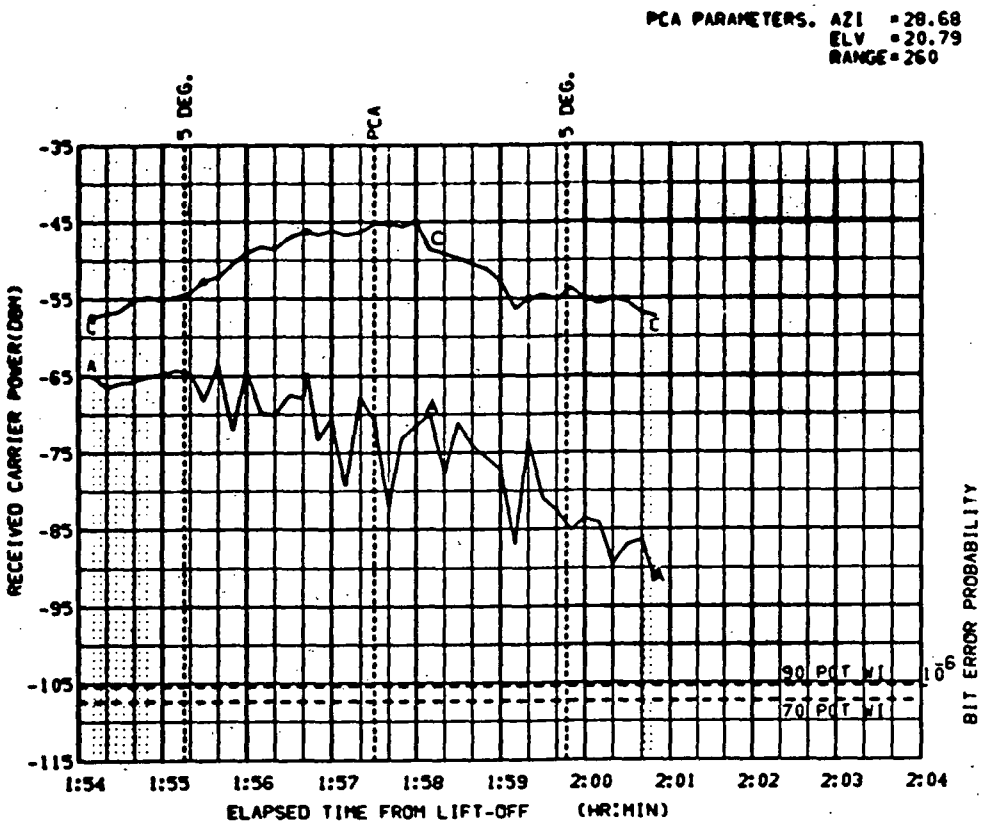

FIGURE 6-66a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

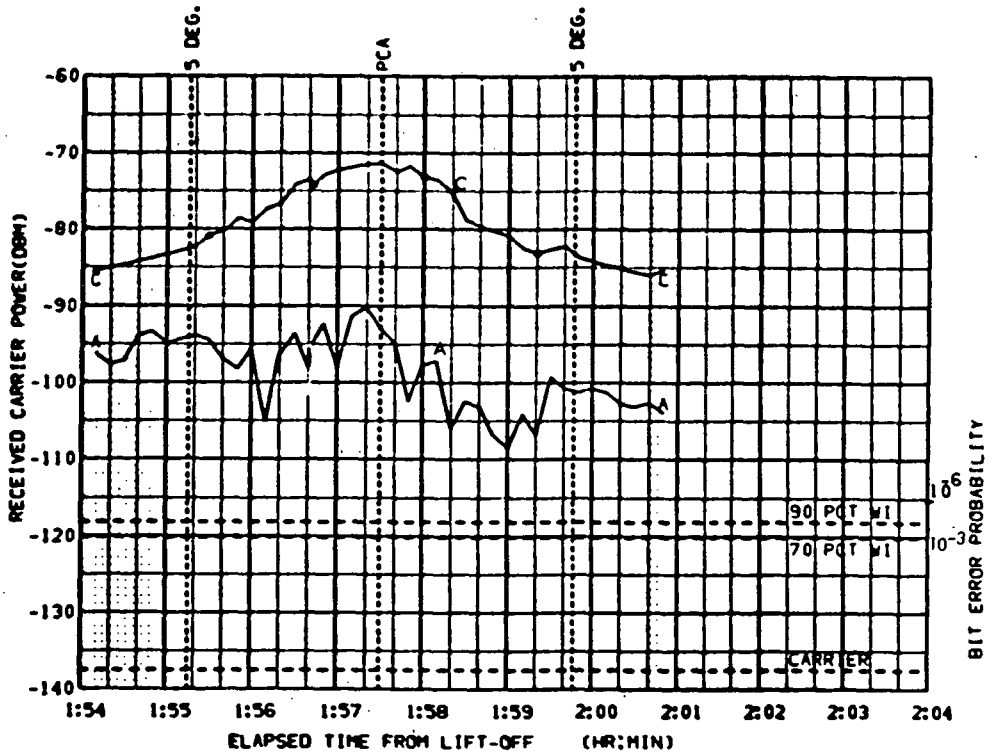

FIGURE 6-66b. ACN ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

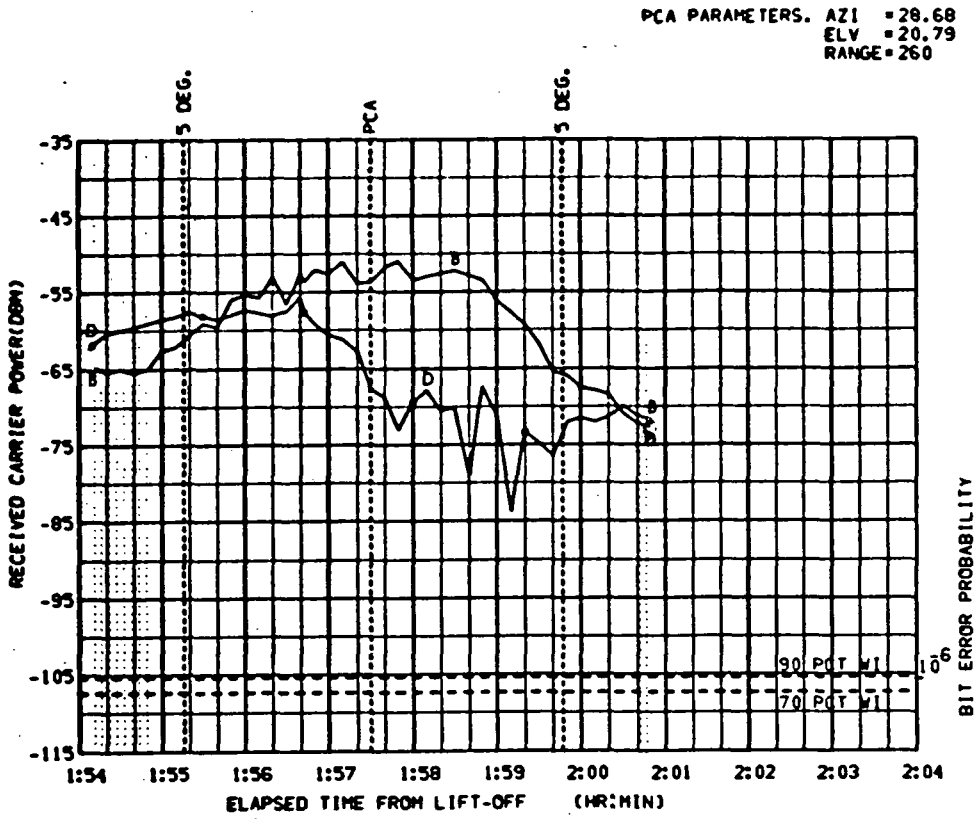

FIGURE 6-66c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

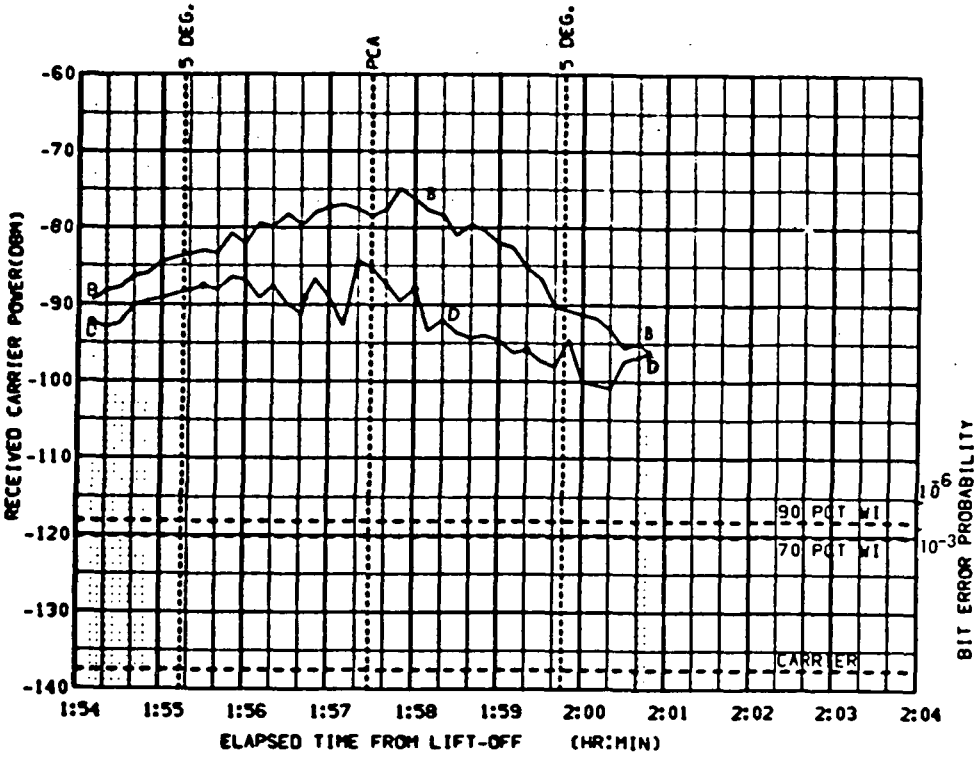

FIGURE 6-66d. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

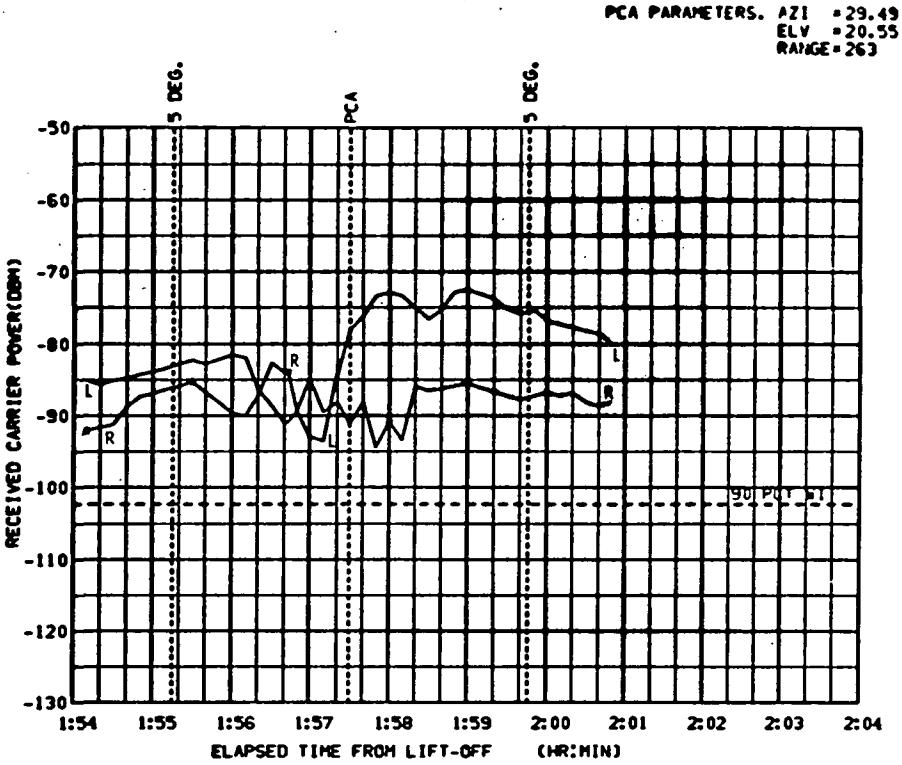

FIGURE 6-66e. ASC UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

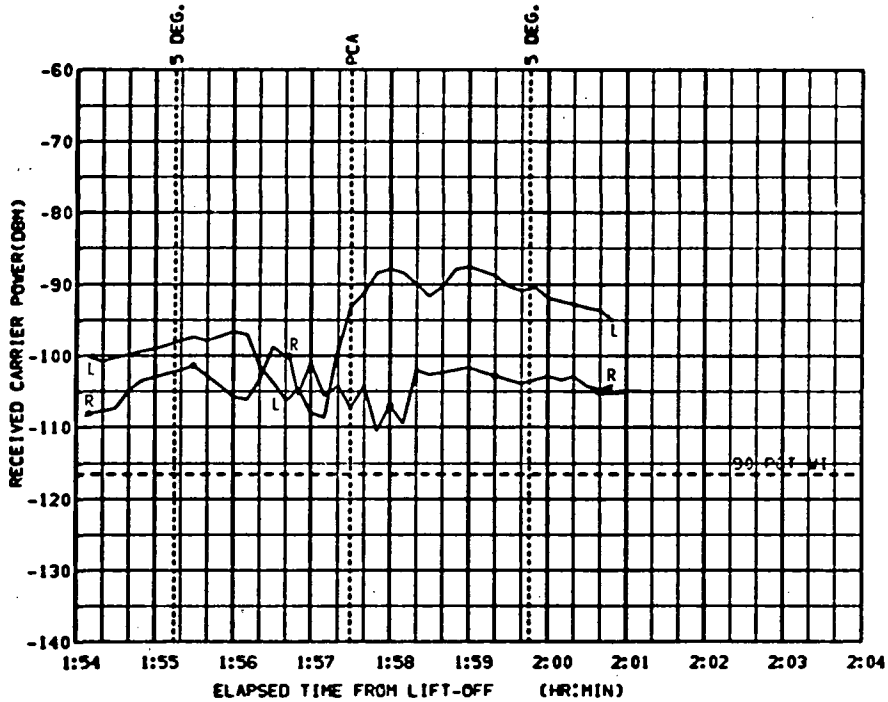

FIGURE 6-66f. ASC DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

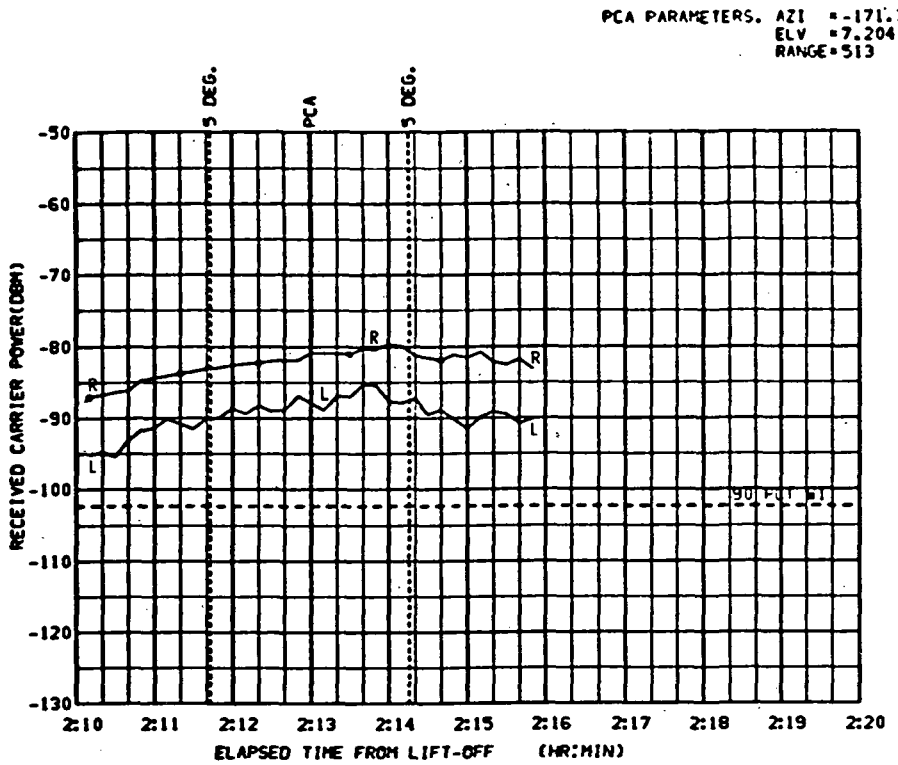

FIGURE 6-67a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

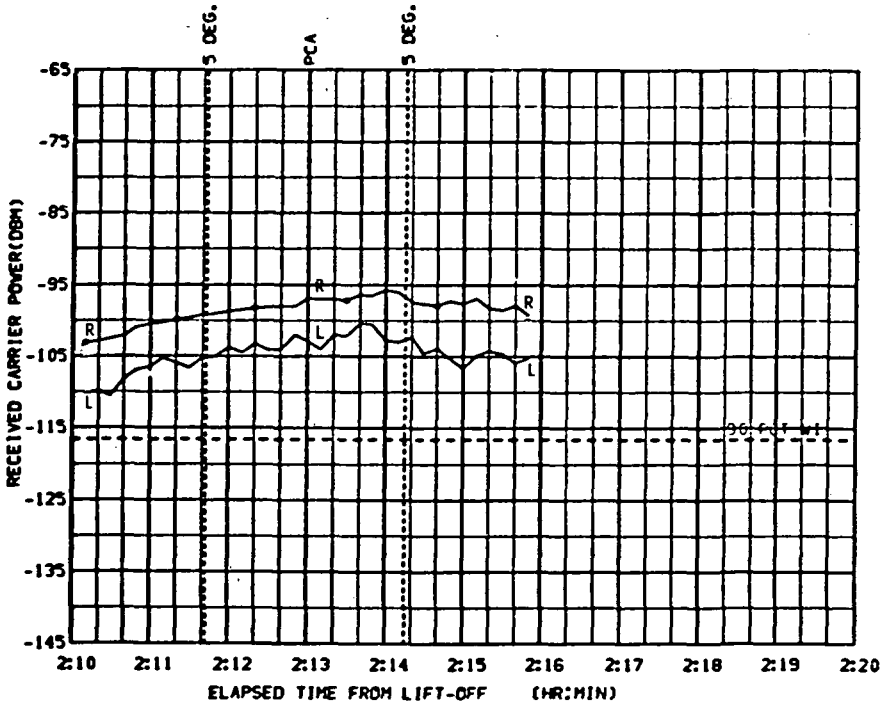

FIGURE 6-67b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

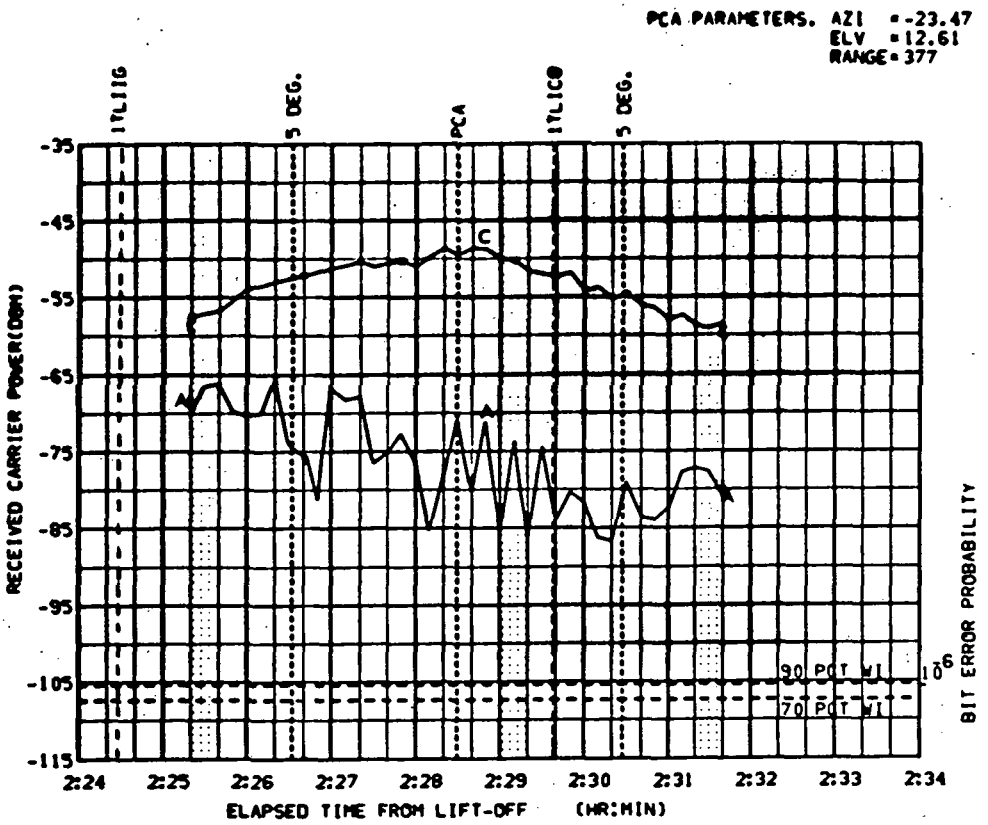

FIGURE 6-68a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

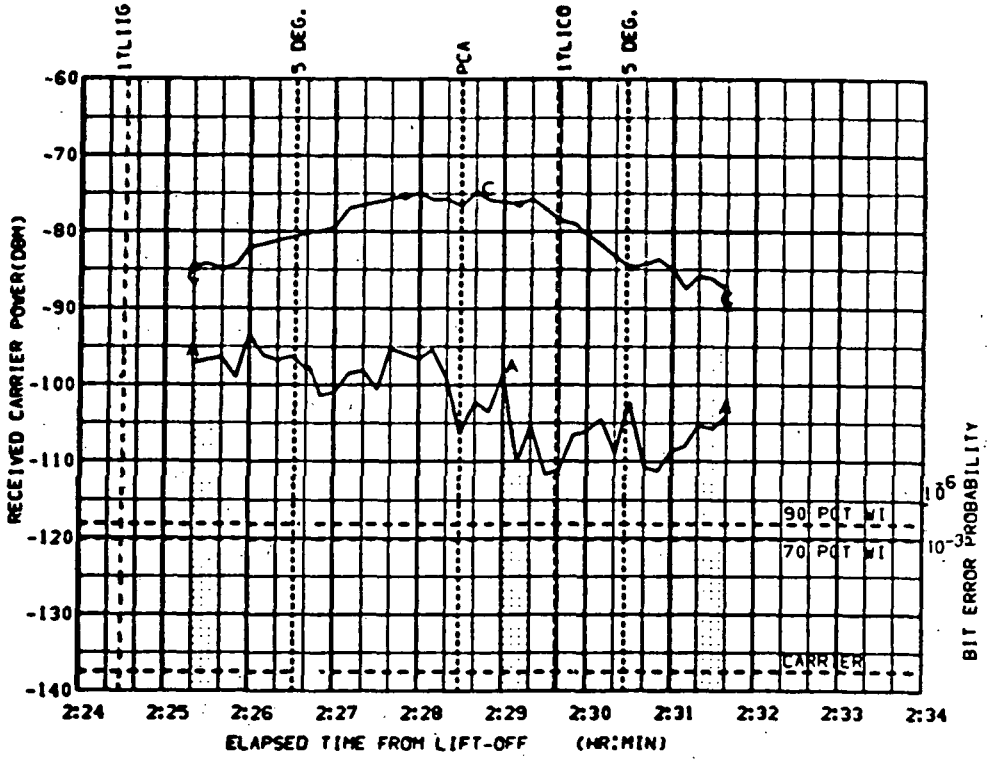

FIGURE 6-68b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

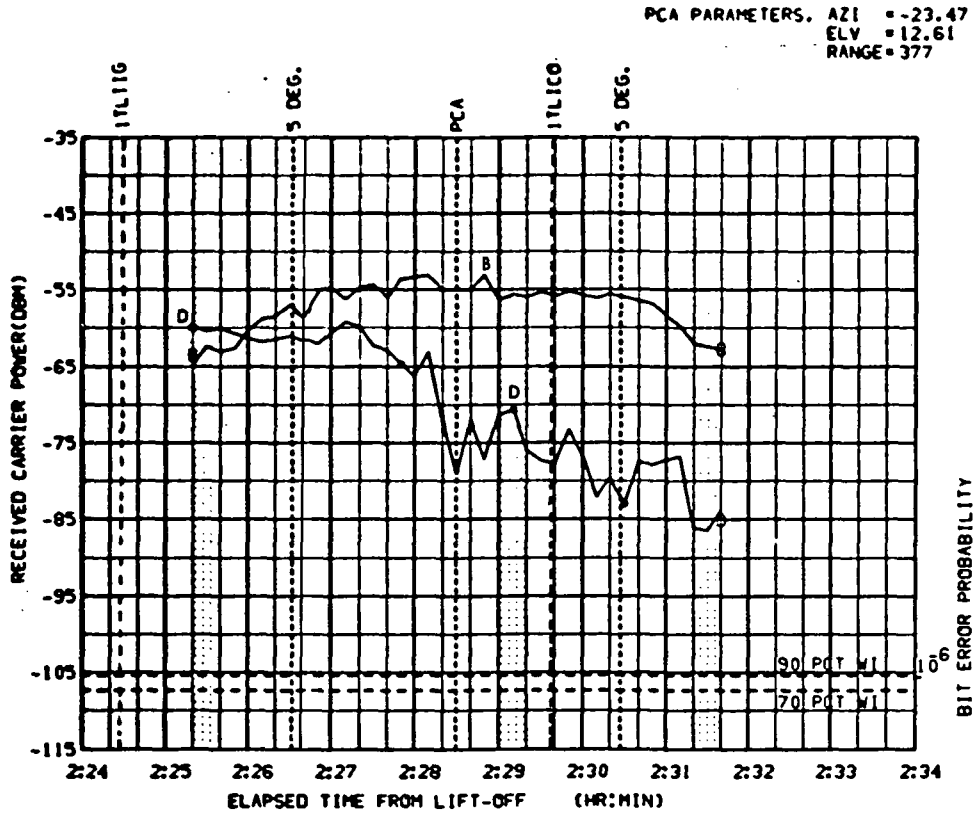

FIGURE 6-68c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

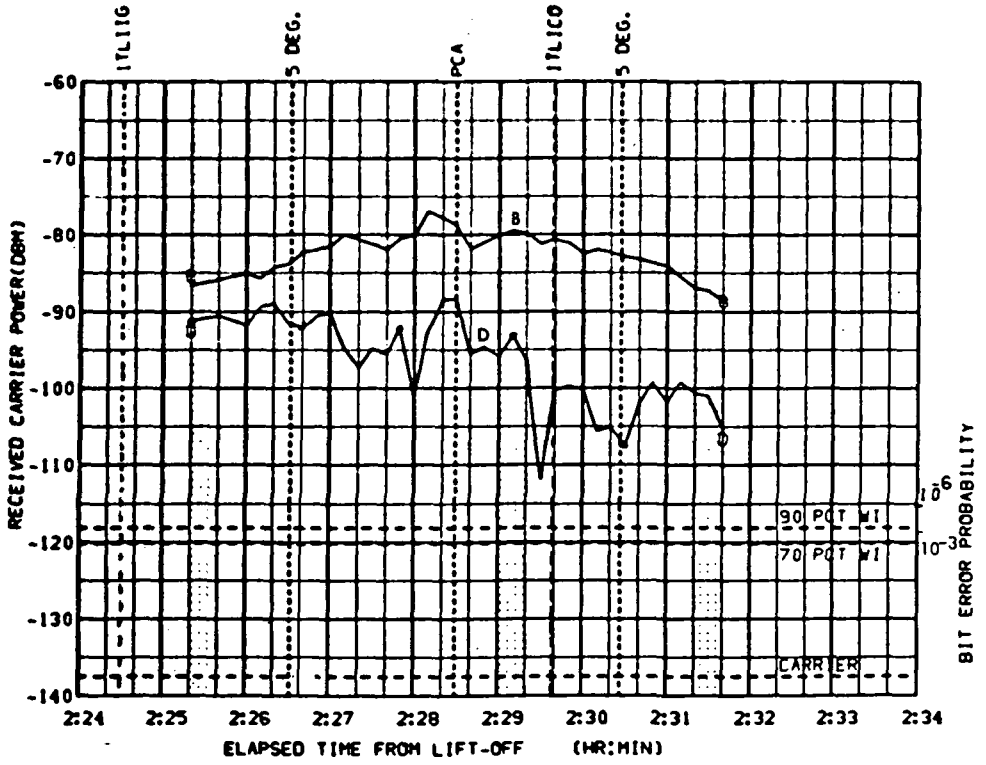

FIGURE 6-68d. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

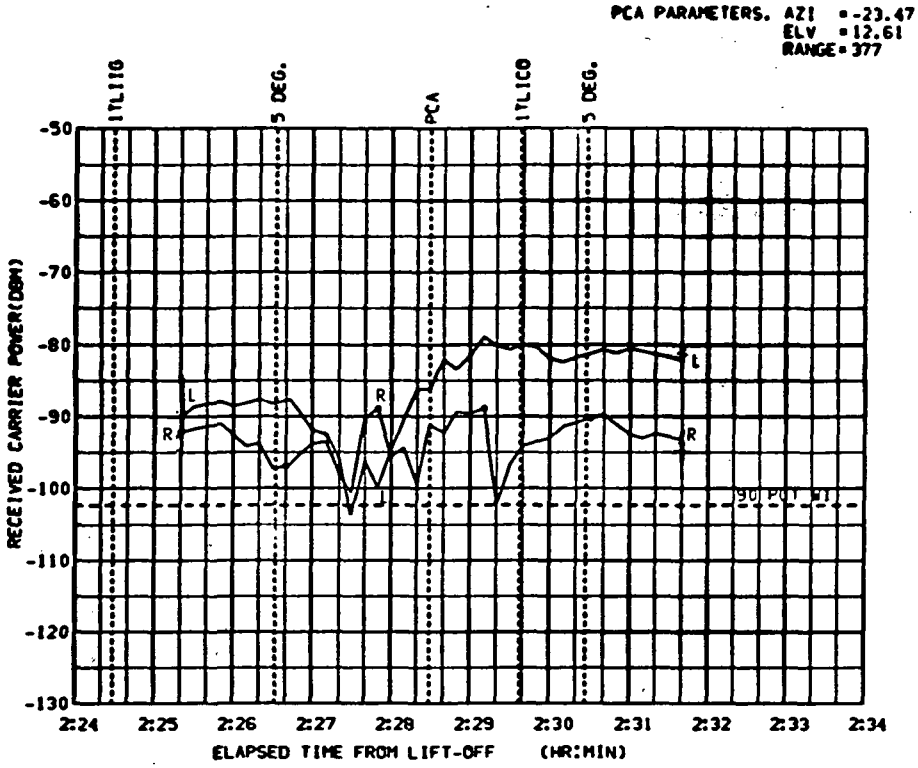

FIGURE 6-68e. CRO UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

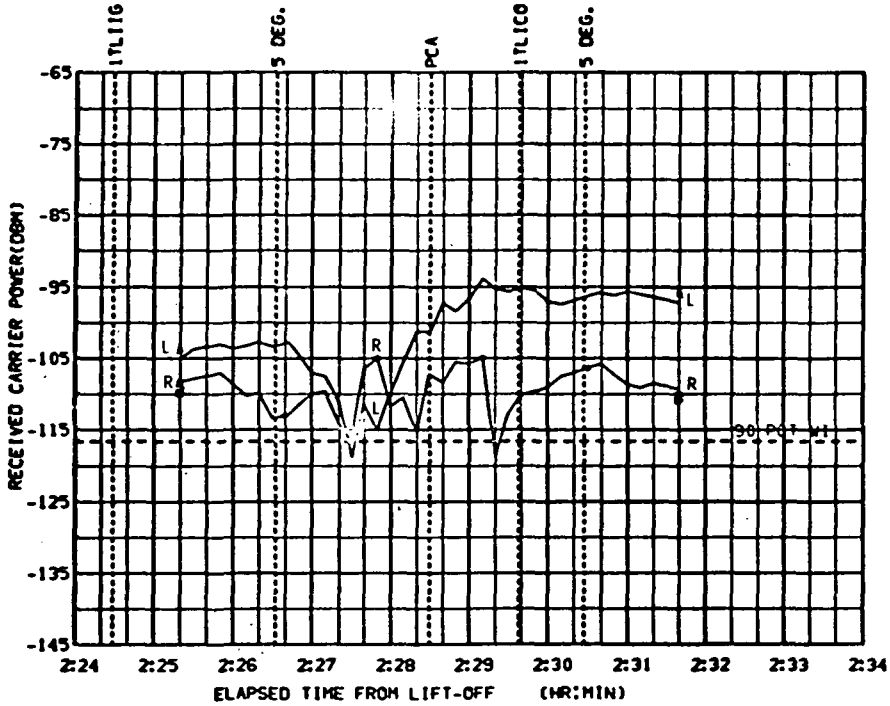

FIGURE 6-68f. CRO DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

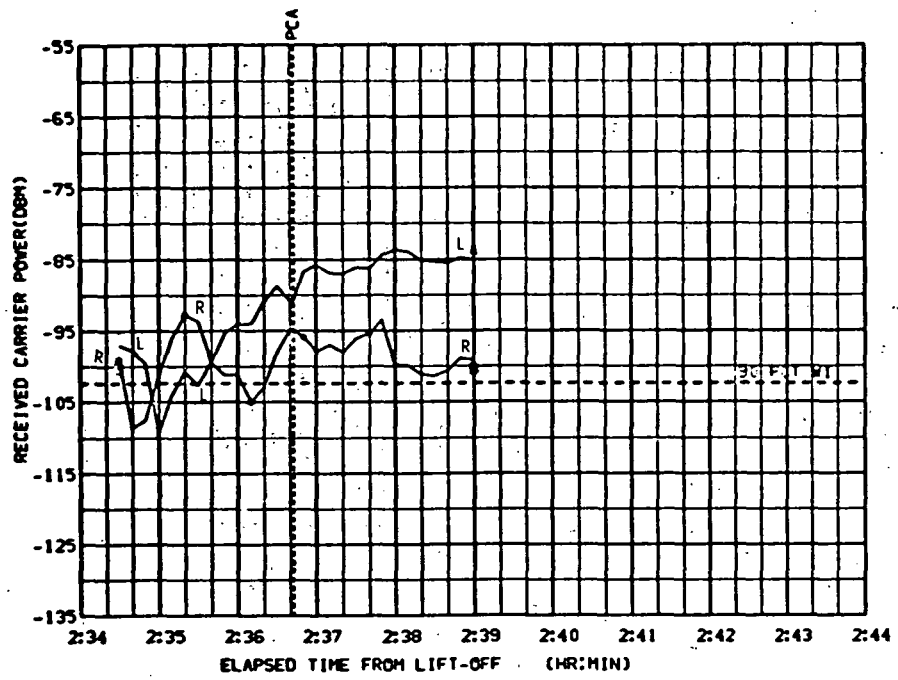

FIGURE 6-69a. RED UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

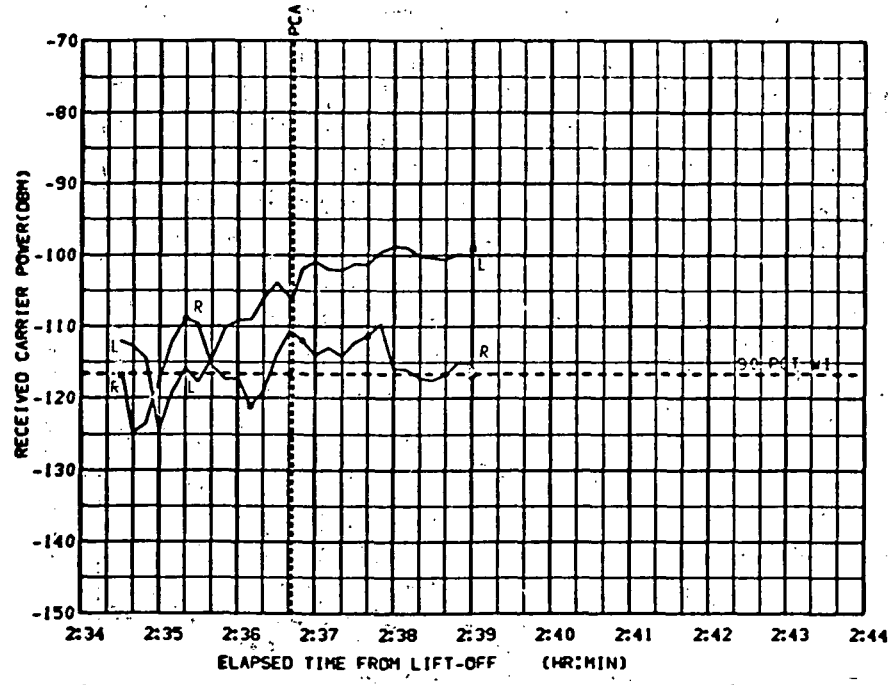

FIGURE 6-69b. RED DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

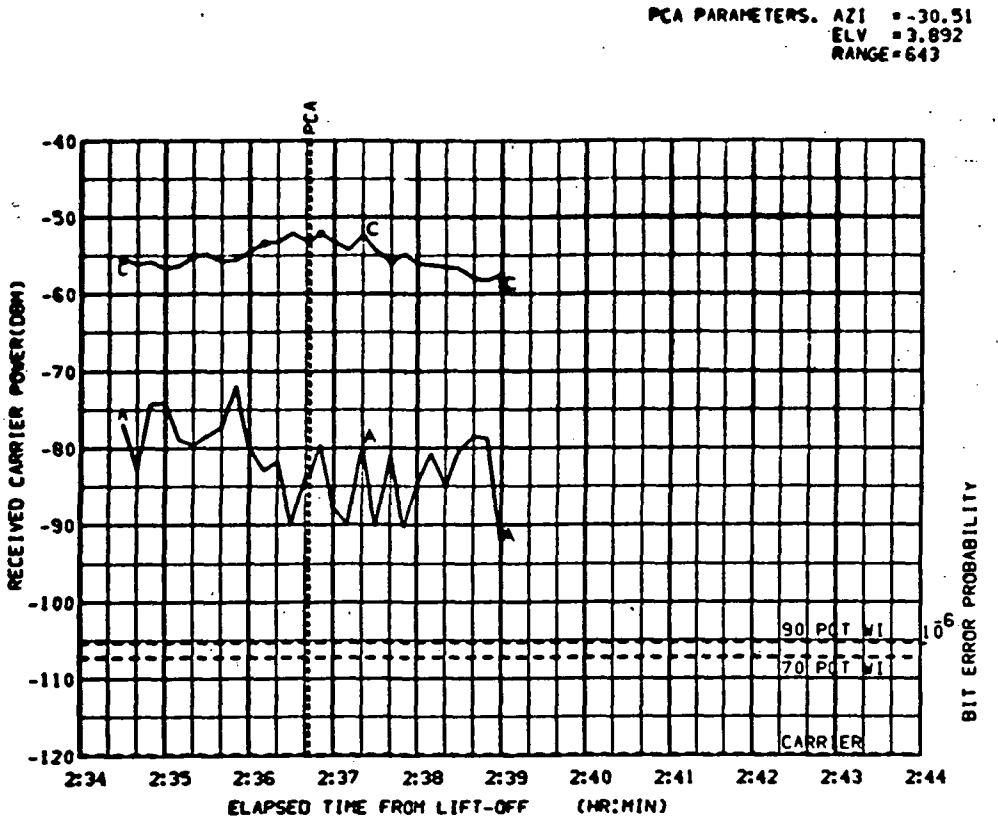

FIGURE 6-69c. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

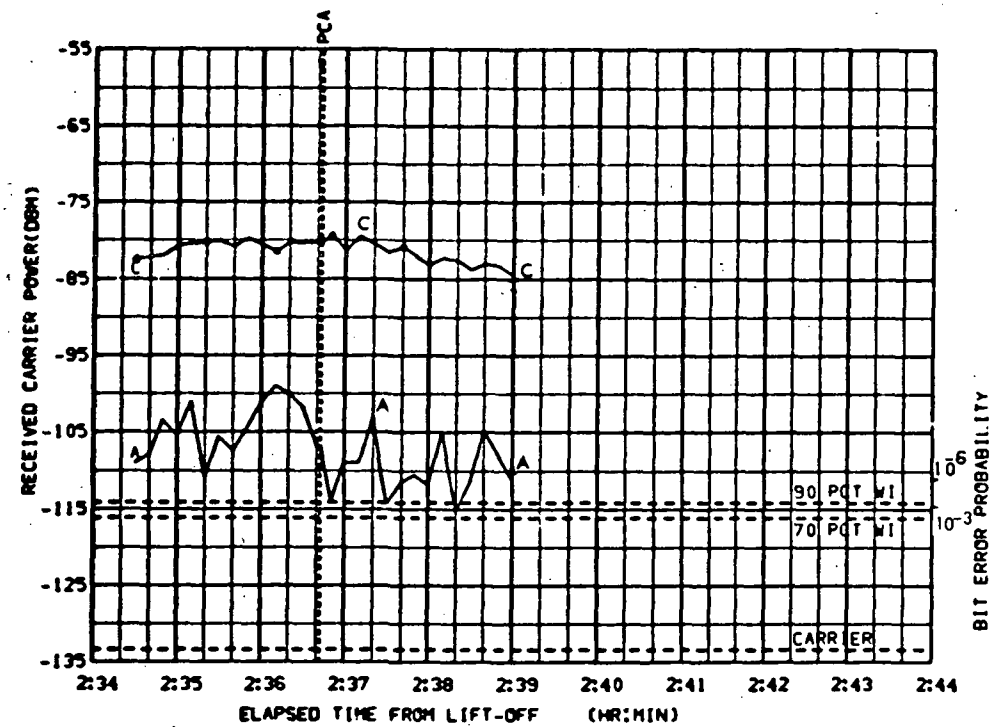

FIGURE 6-69d. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -30.51
ELV = 3.892
RANGE = 643

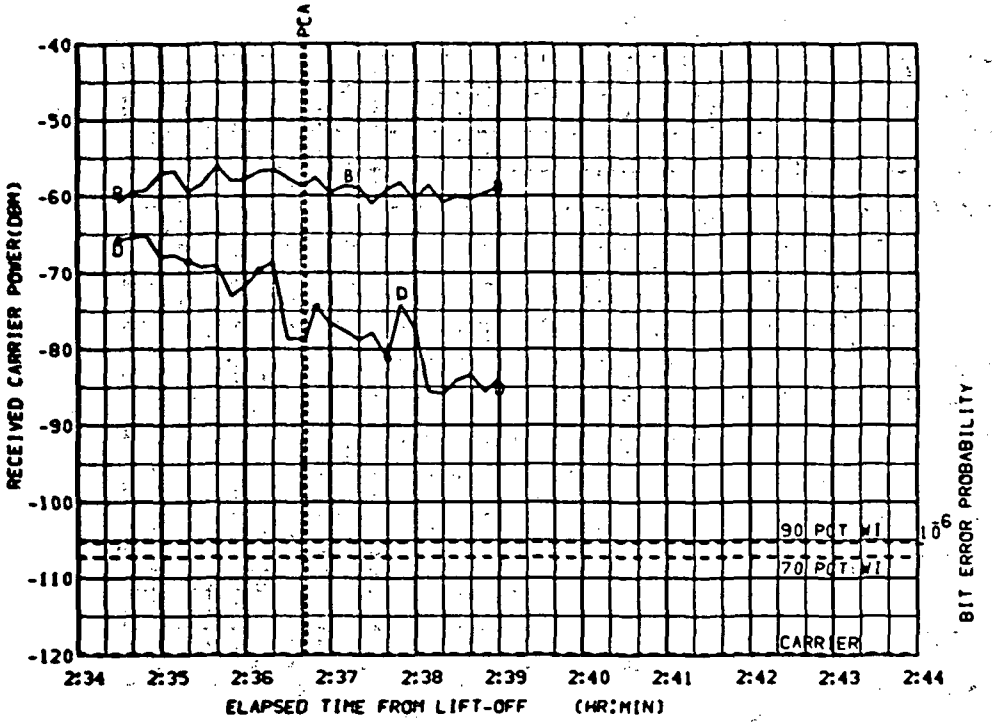

FIGURE 6-69e. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

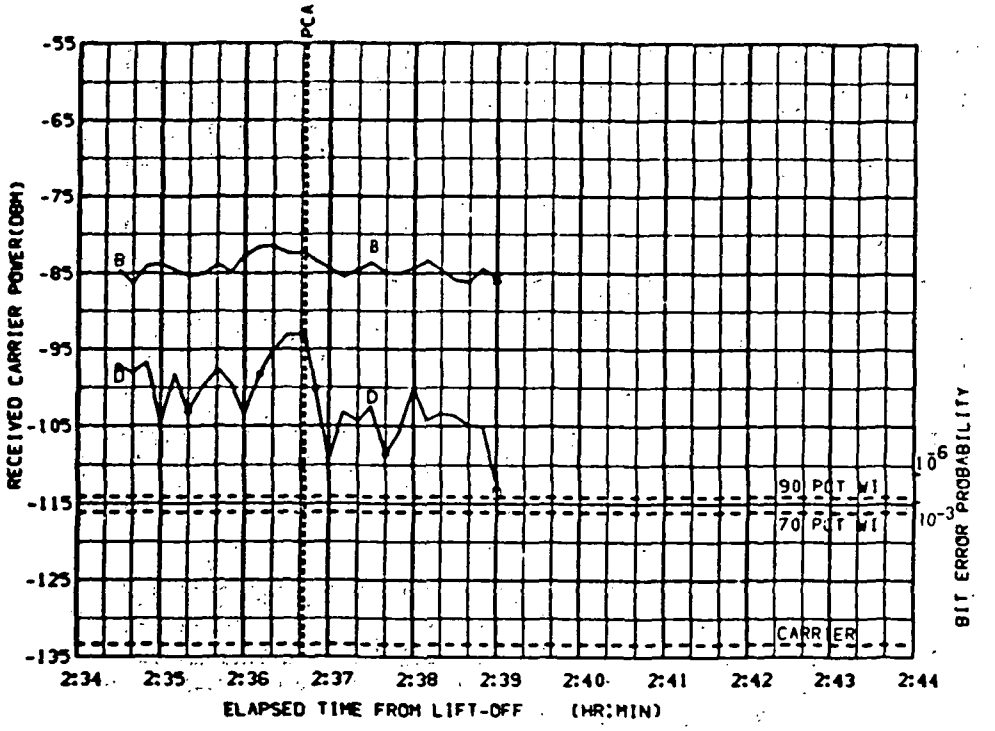

FIGURE 6-69f. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

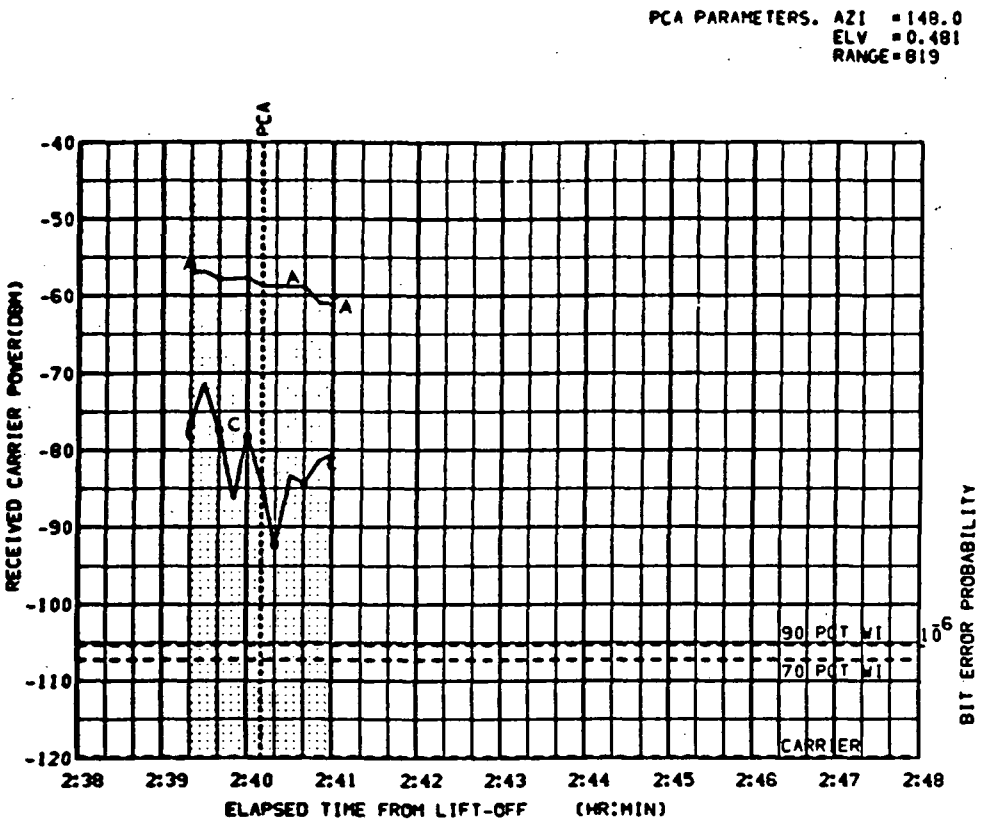

FIGURE 6-70a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

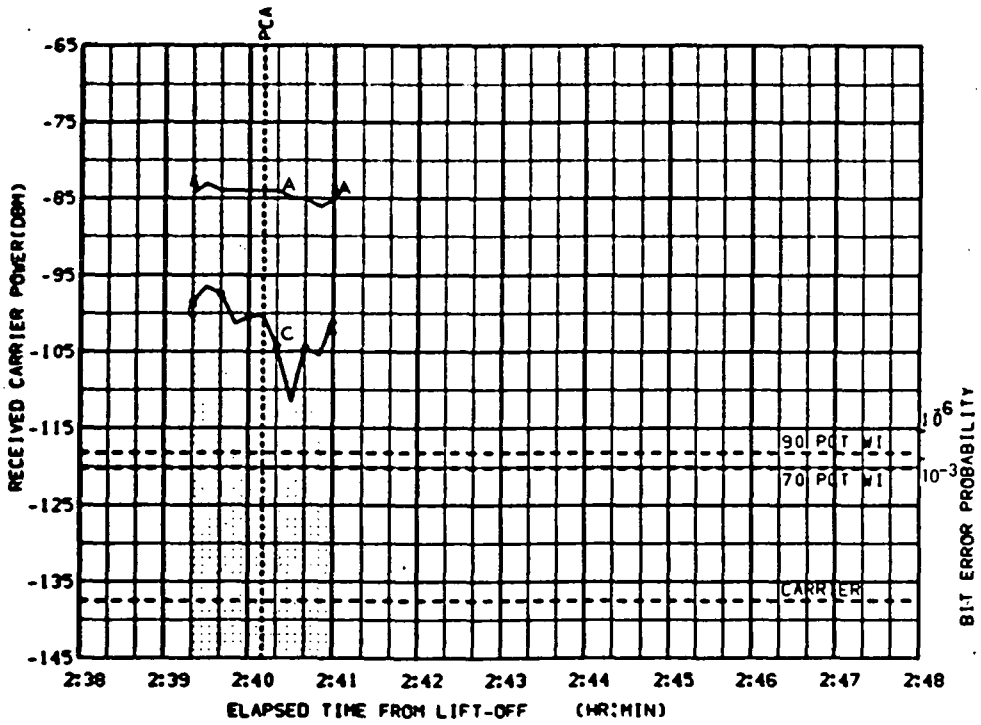

FIGURE 6-70b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

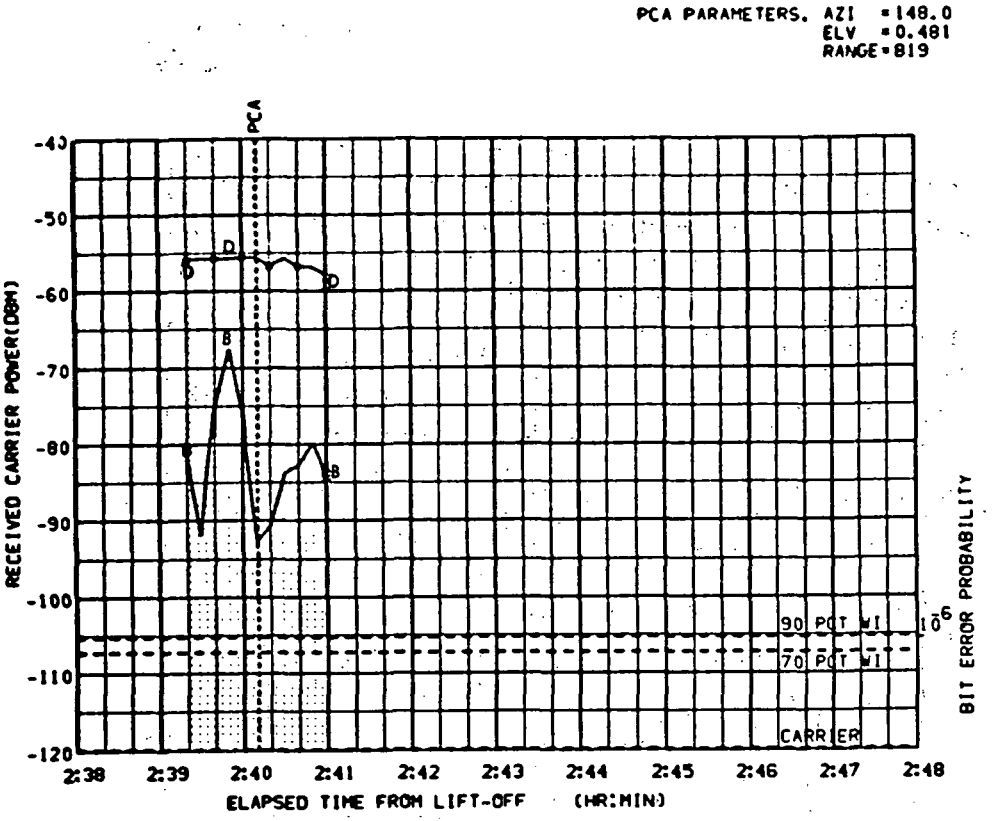

FIGURE 6-70c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

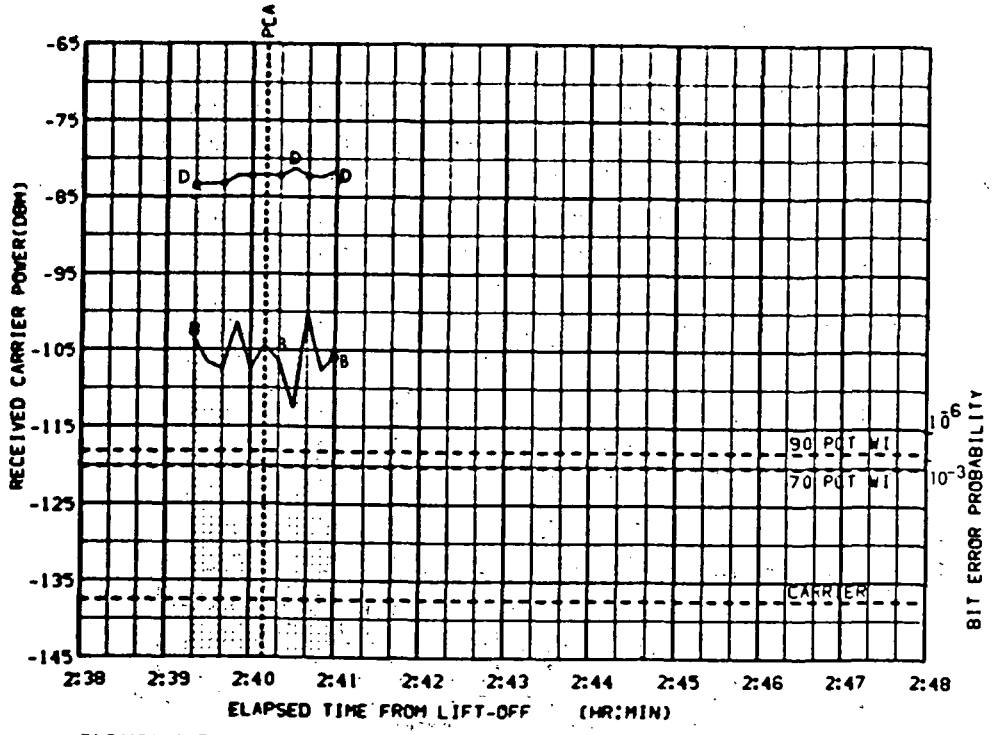

FIGURE 6-70d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

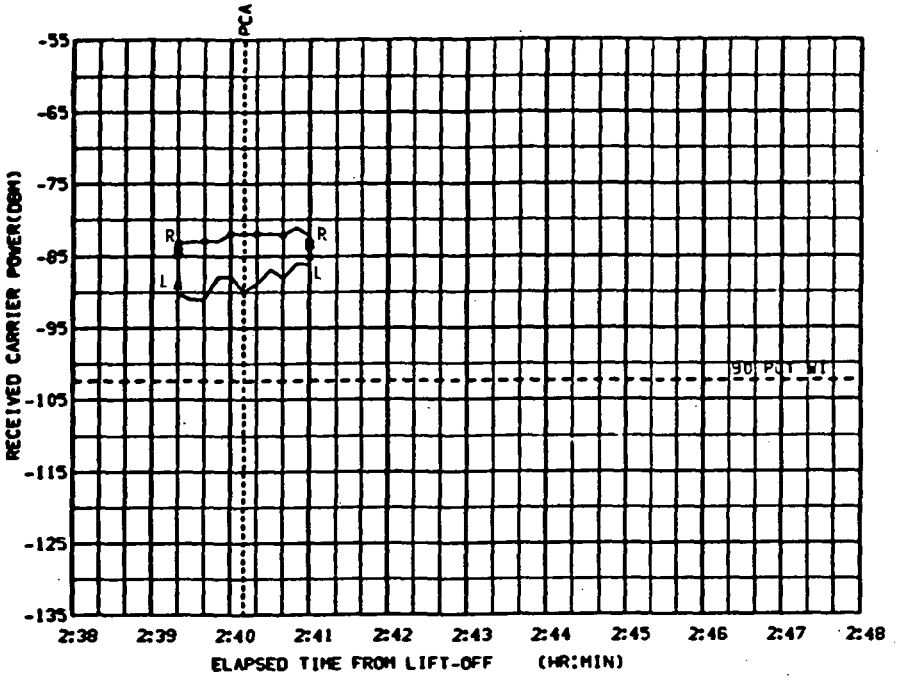

FIGURE 6-70e. GWM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

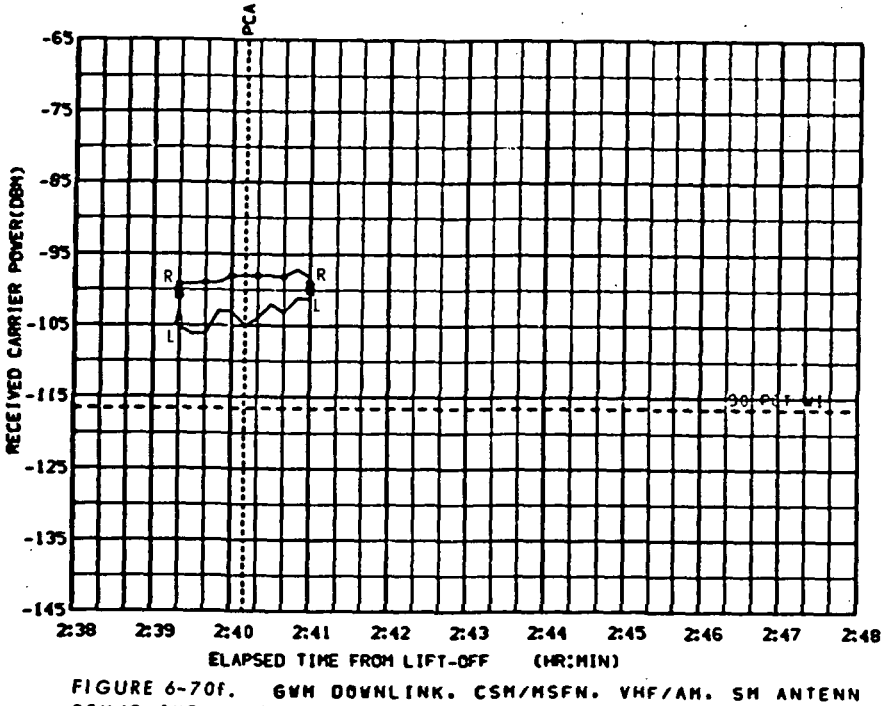

FIGURE 6-70f. GWM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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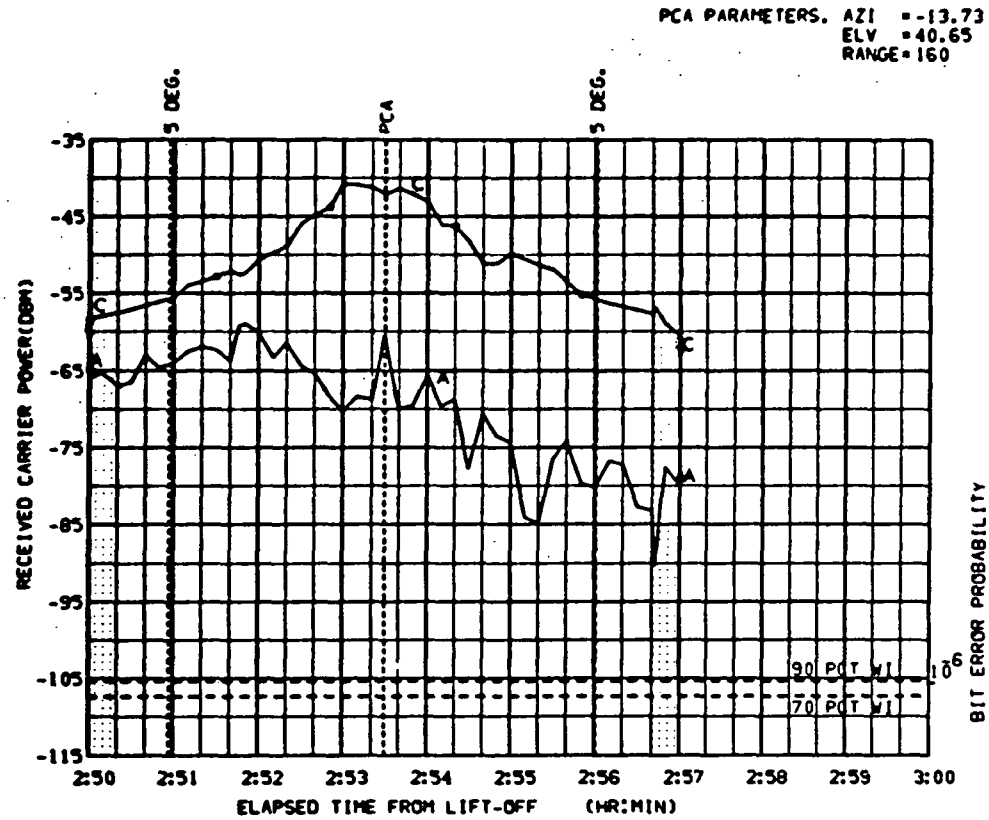

FIGURE 6-71a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

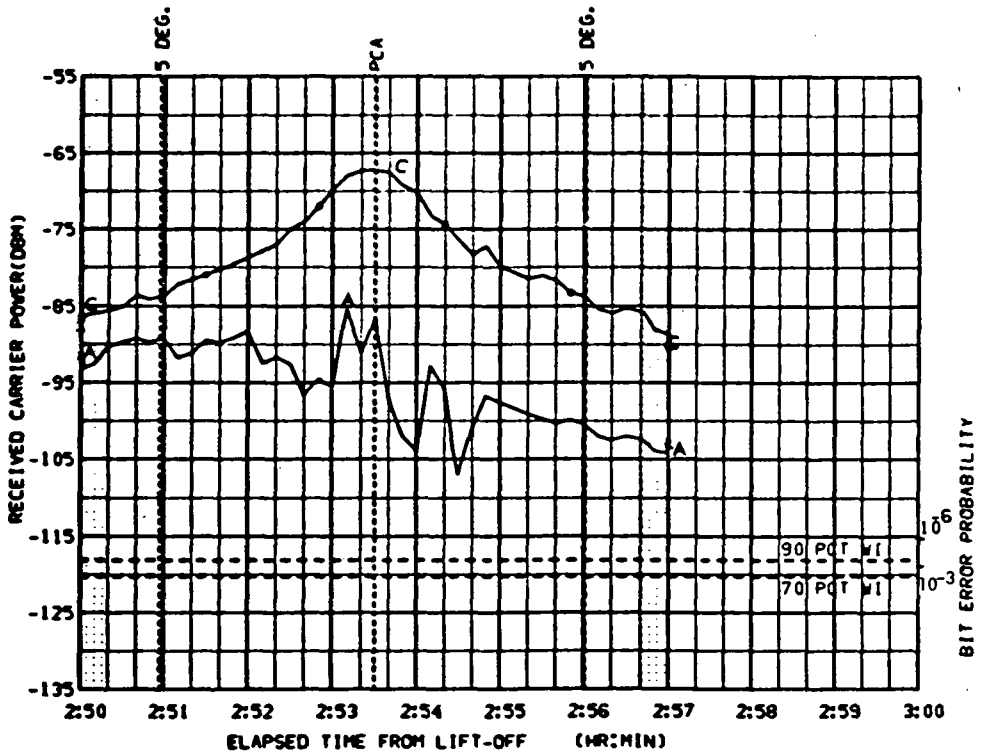

FIGURE 6-71b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

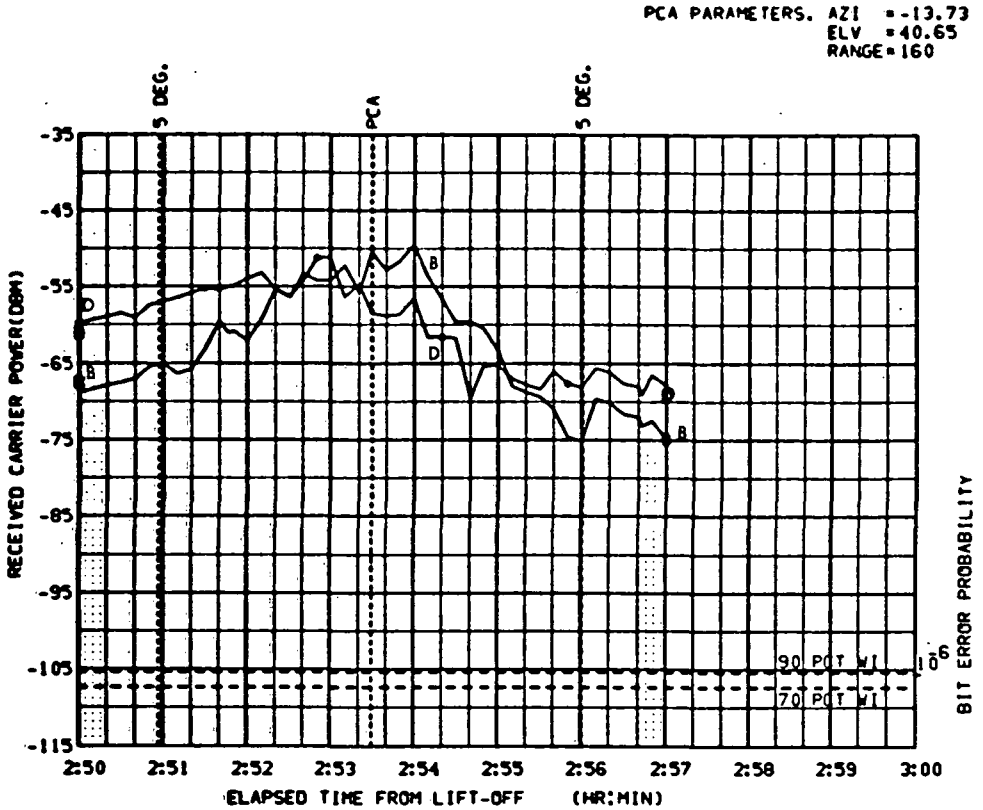

FIGURE 6-71c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

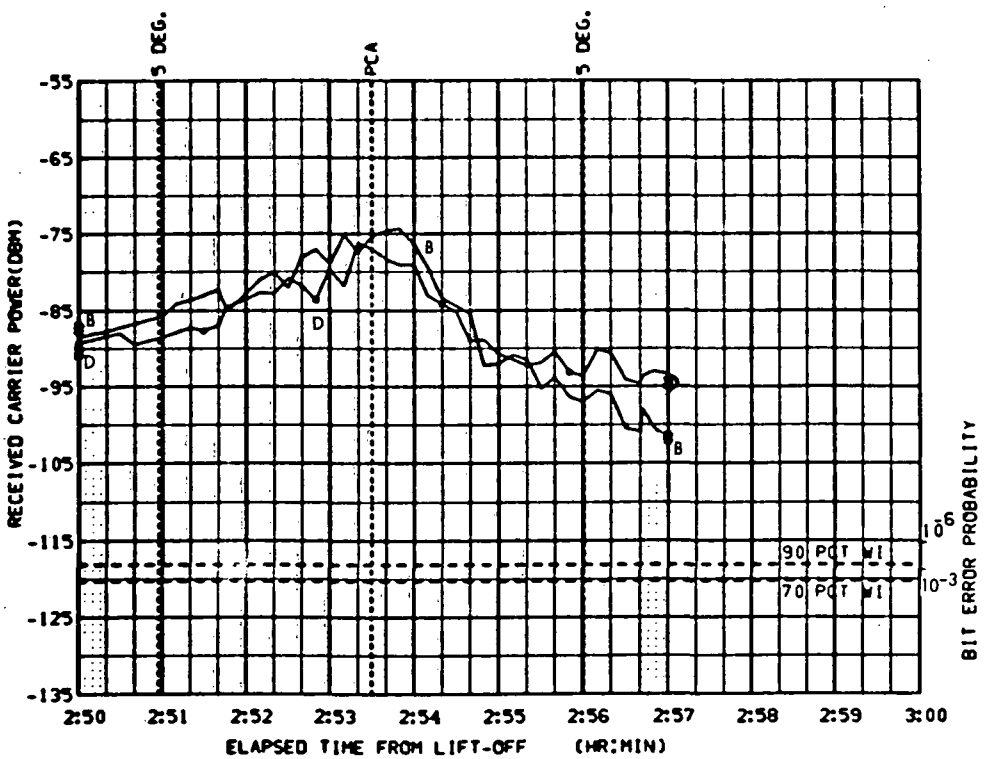

FIGURE 6-71d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

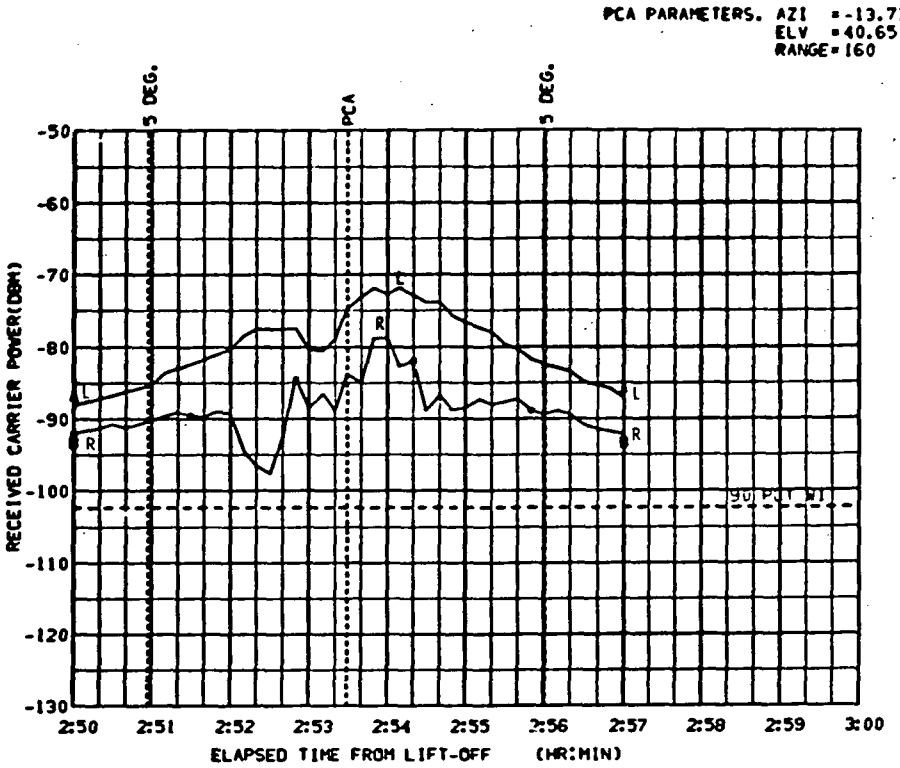

FIGURE 6-71e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

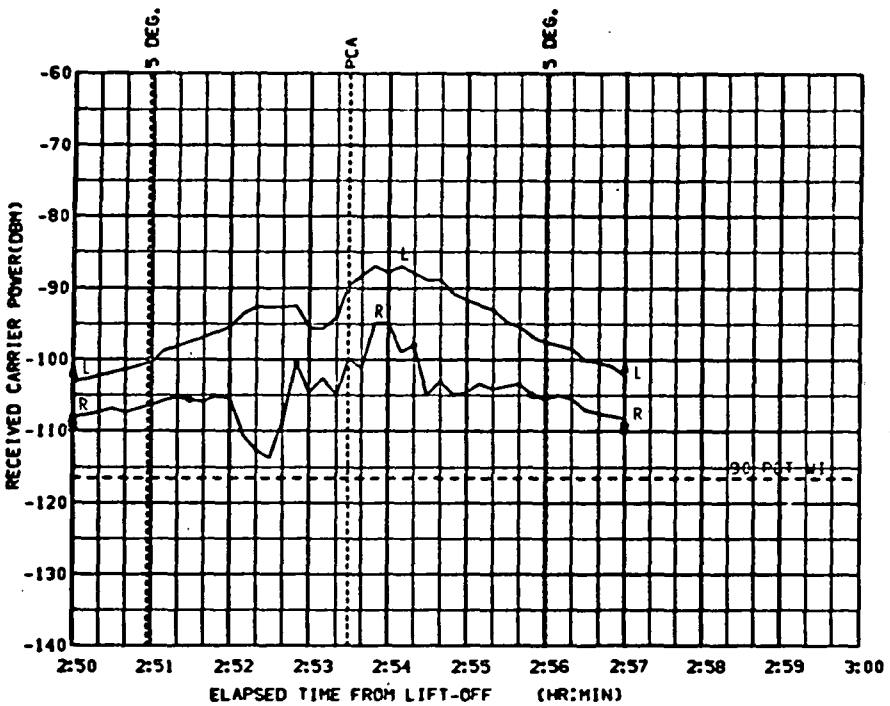

FIGURE 6-71f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

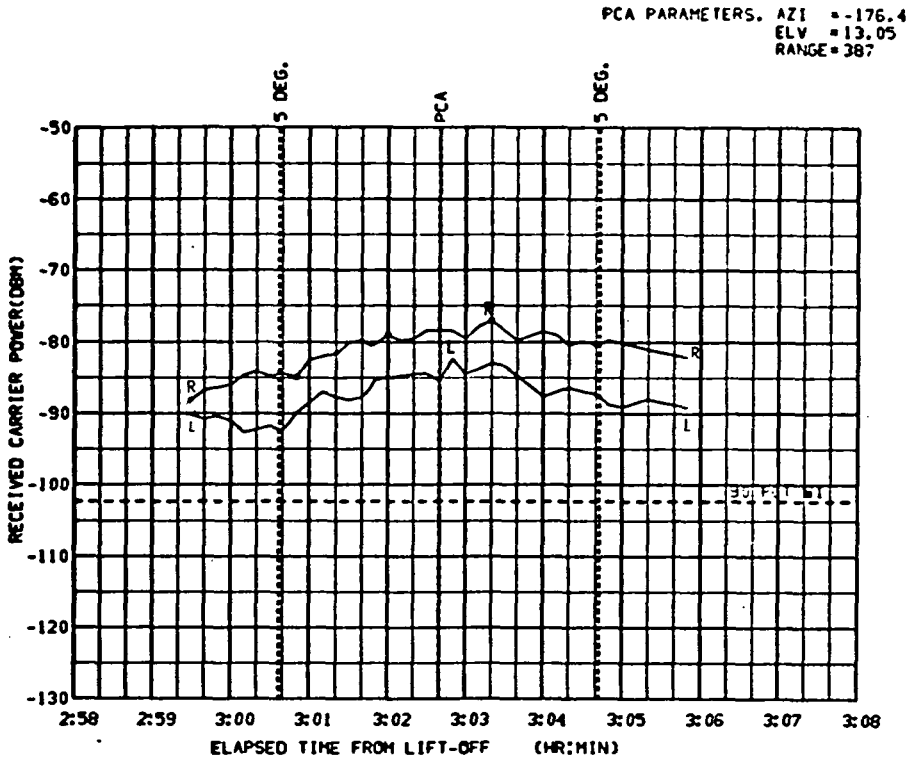

FIGURE 6-72a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

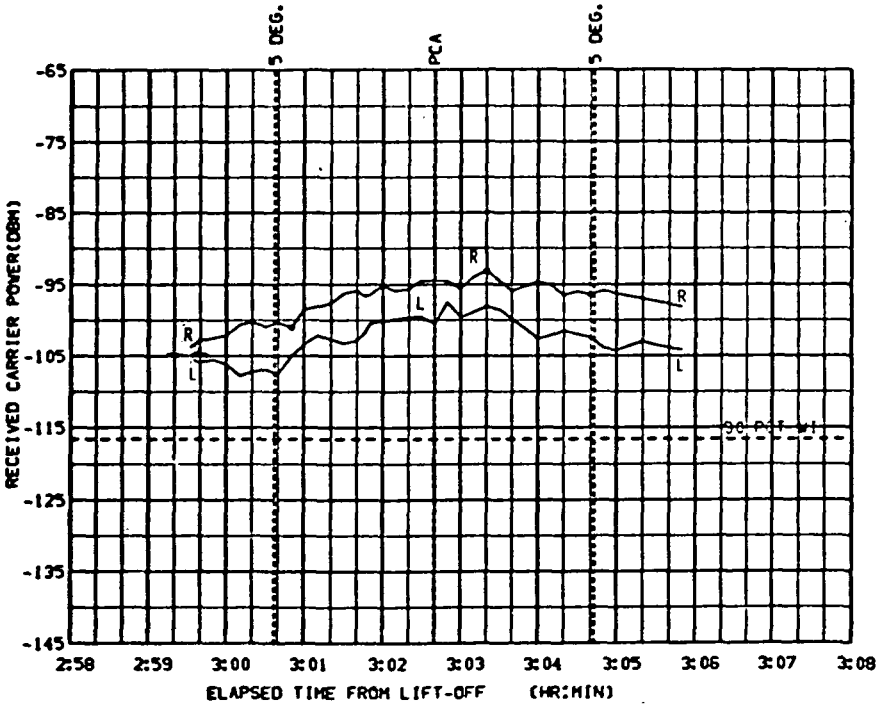

FIGURE 6-72b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

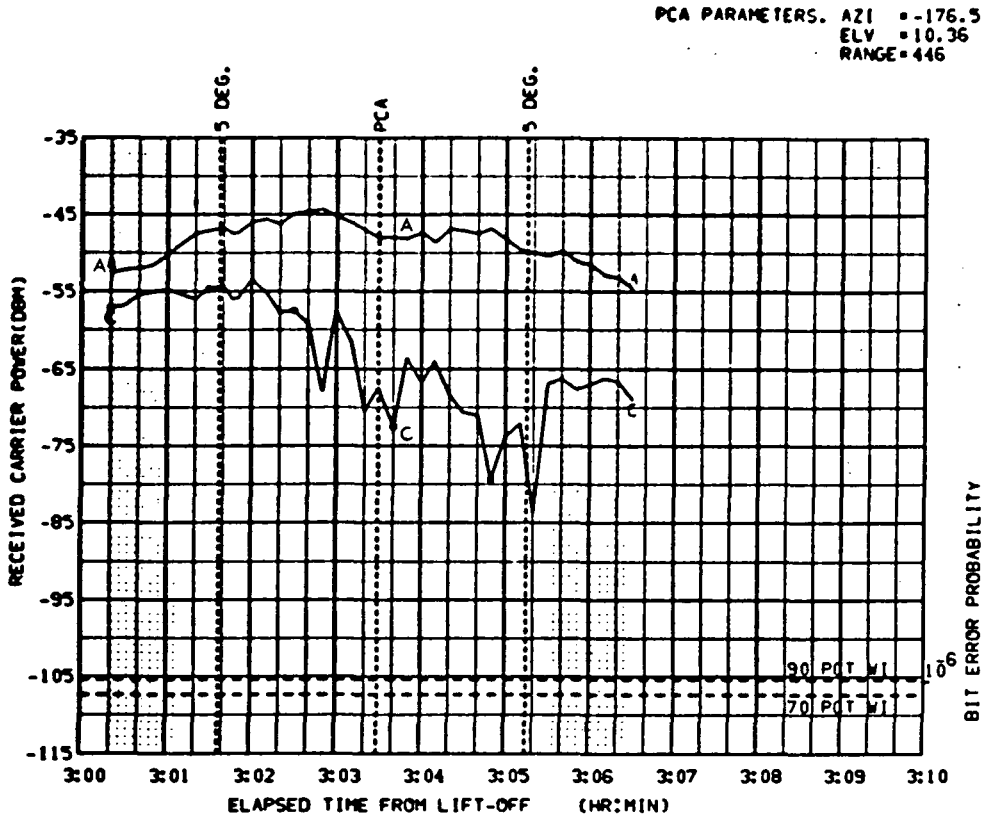

FIGURE 6-73a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

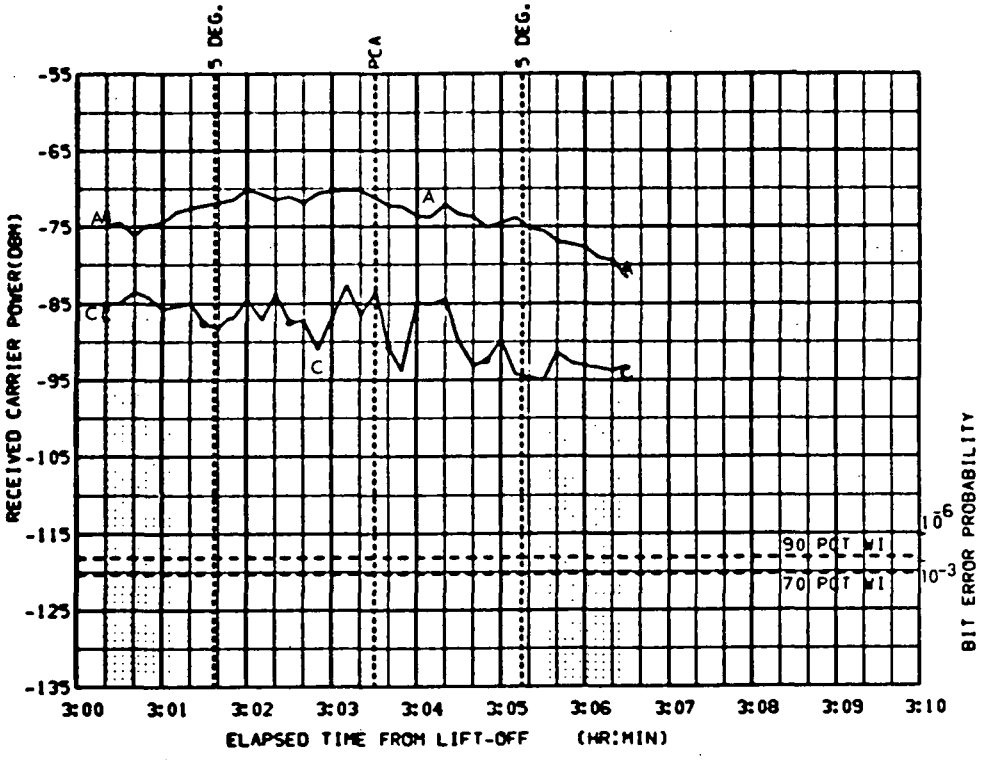

FIGURE 6-73b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

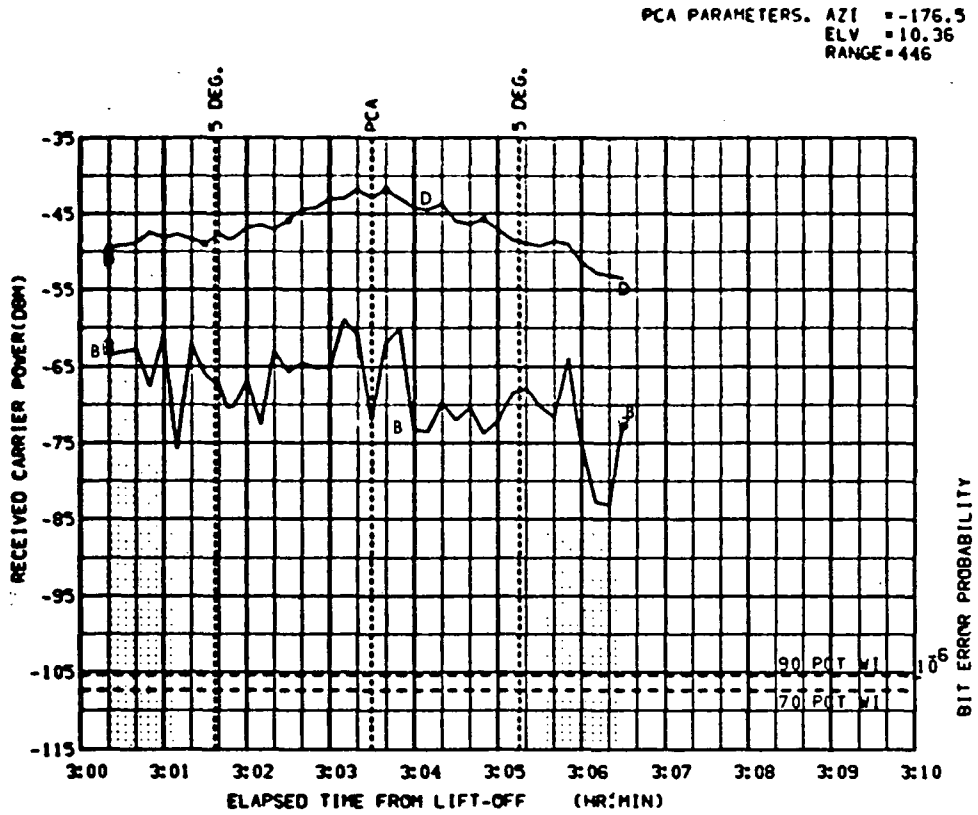

FIGURE 6-73c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

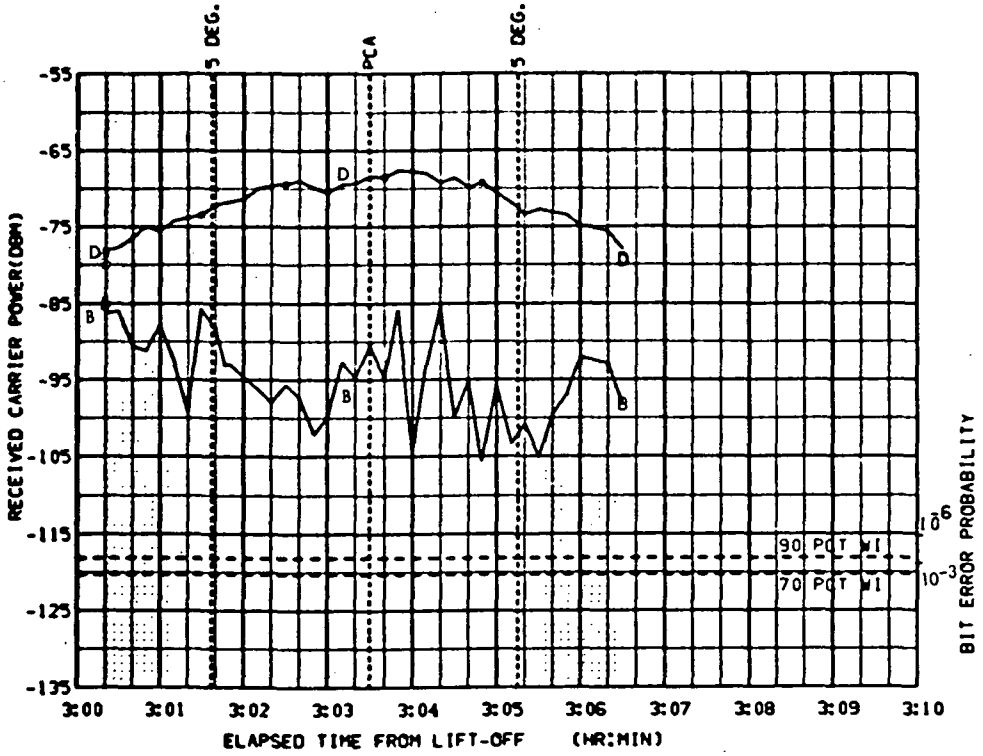

FIGURE 6-73d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

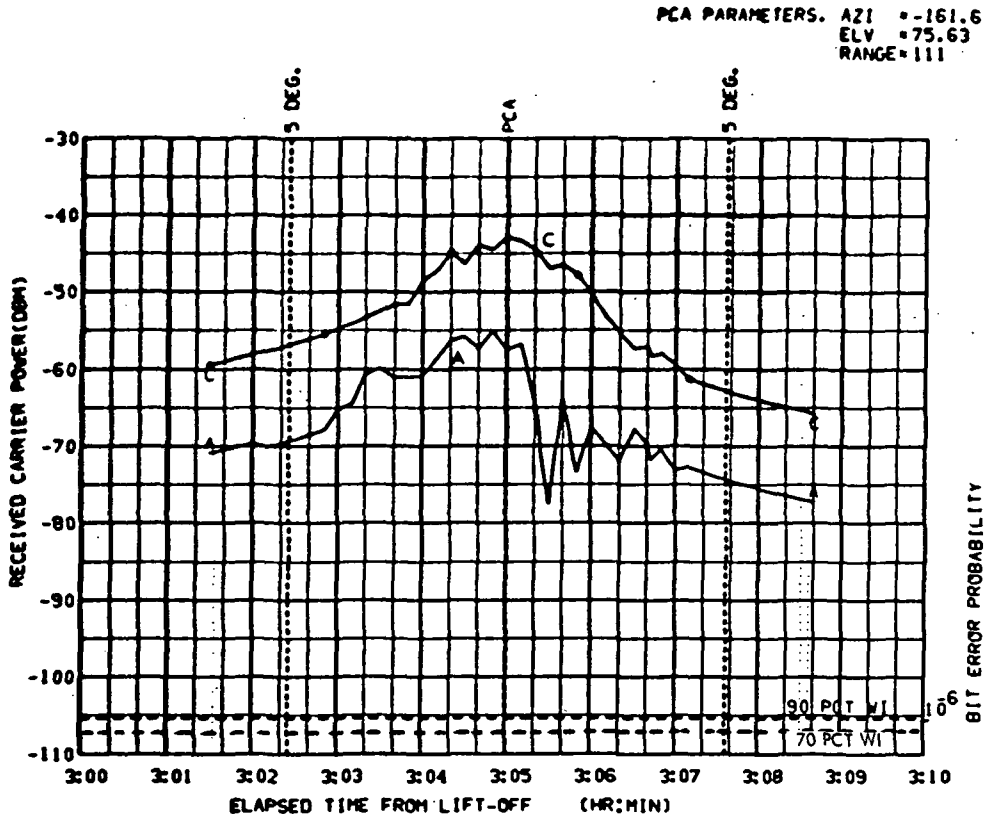

FIGURE 6-74a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

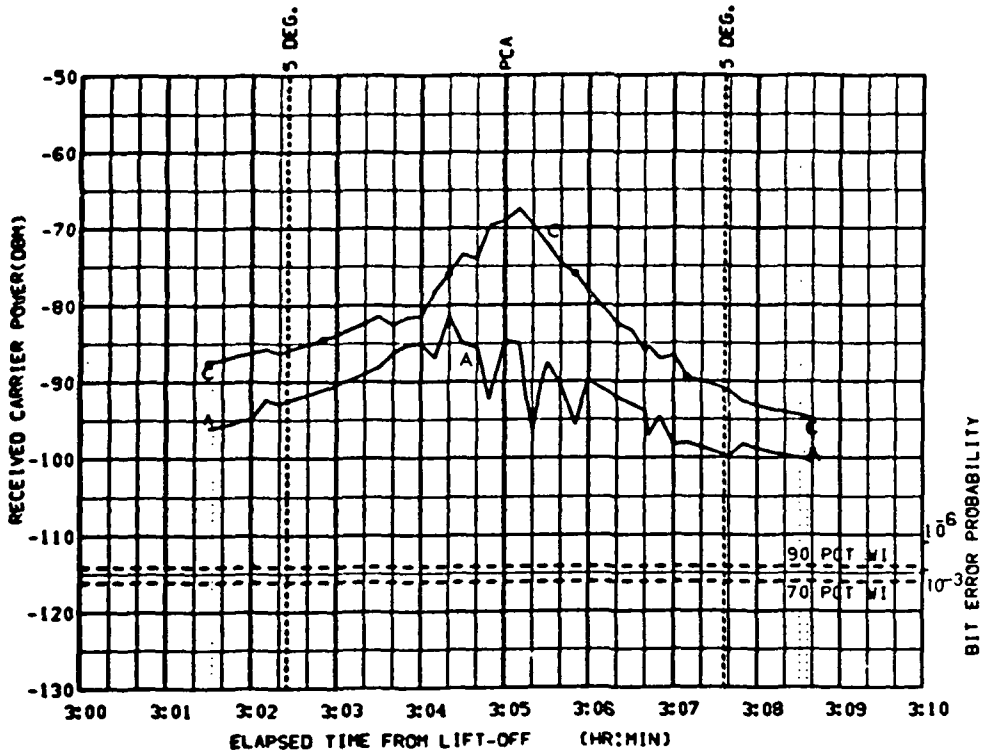

FIGURE 6-74b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

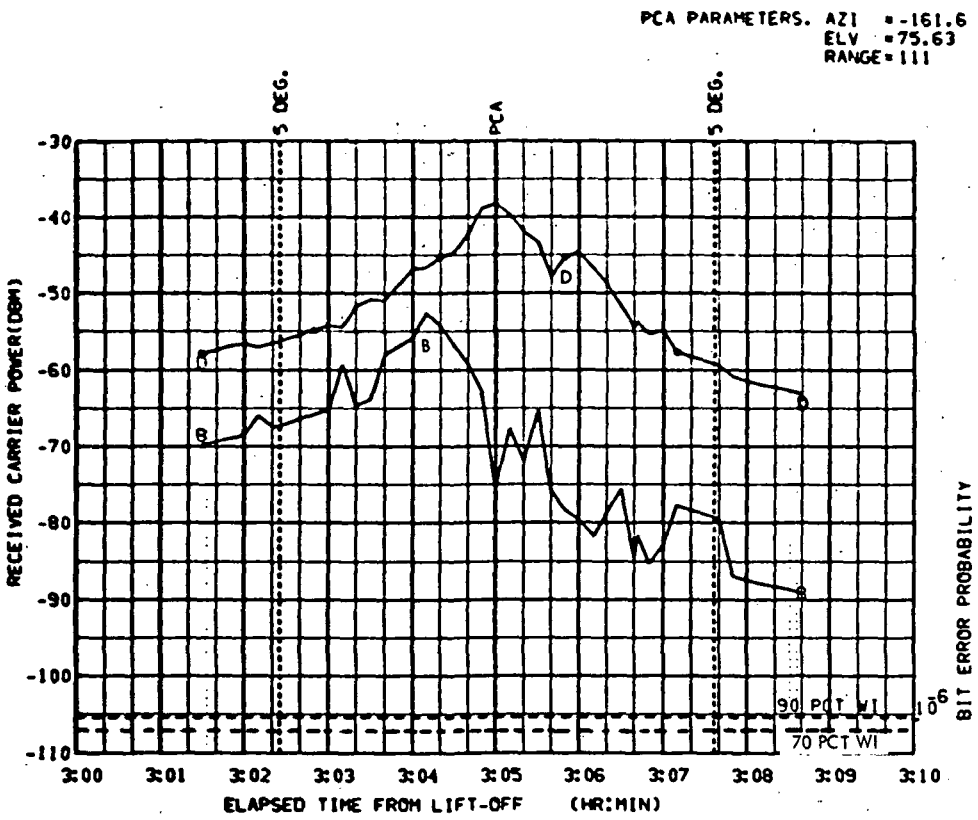

FIGURE 6-74c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

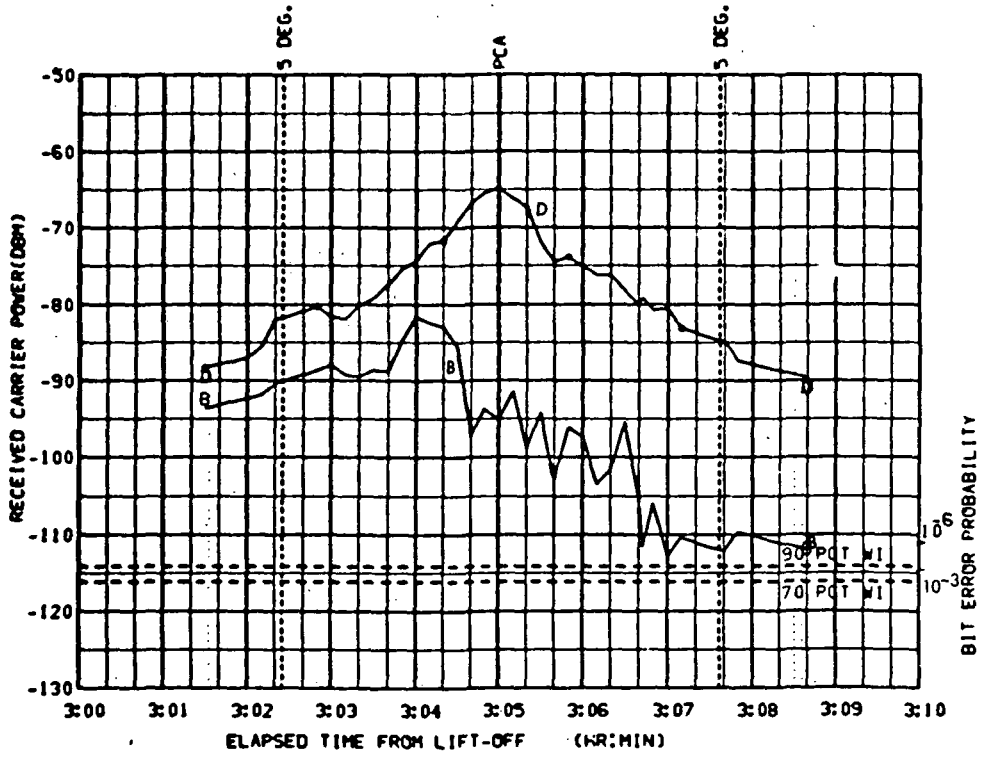

FIGURE 6-74d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

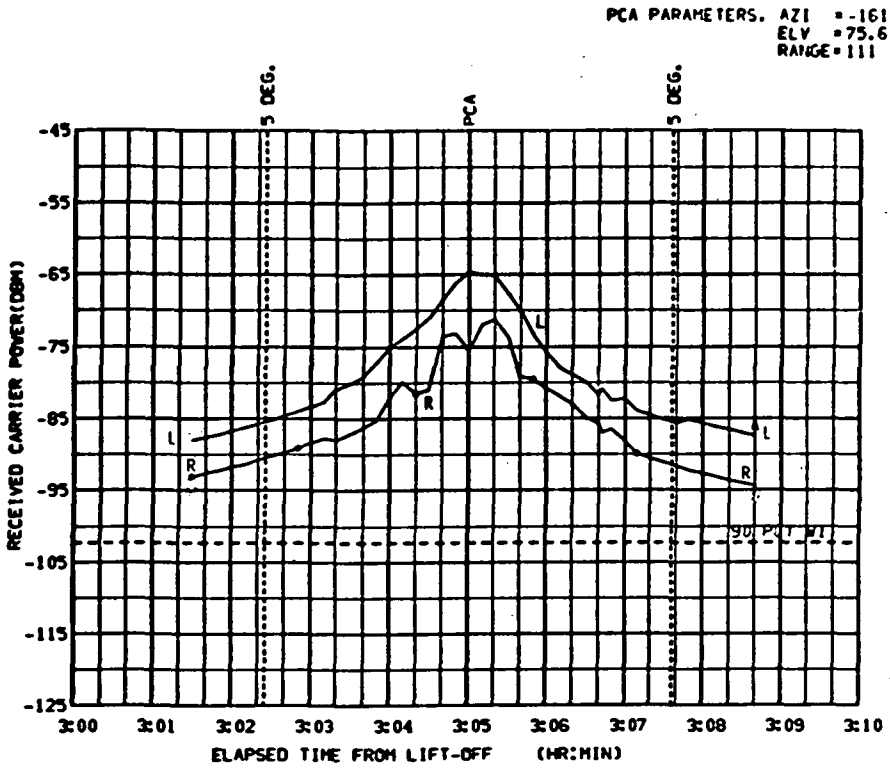

FIGURE 6-74e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

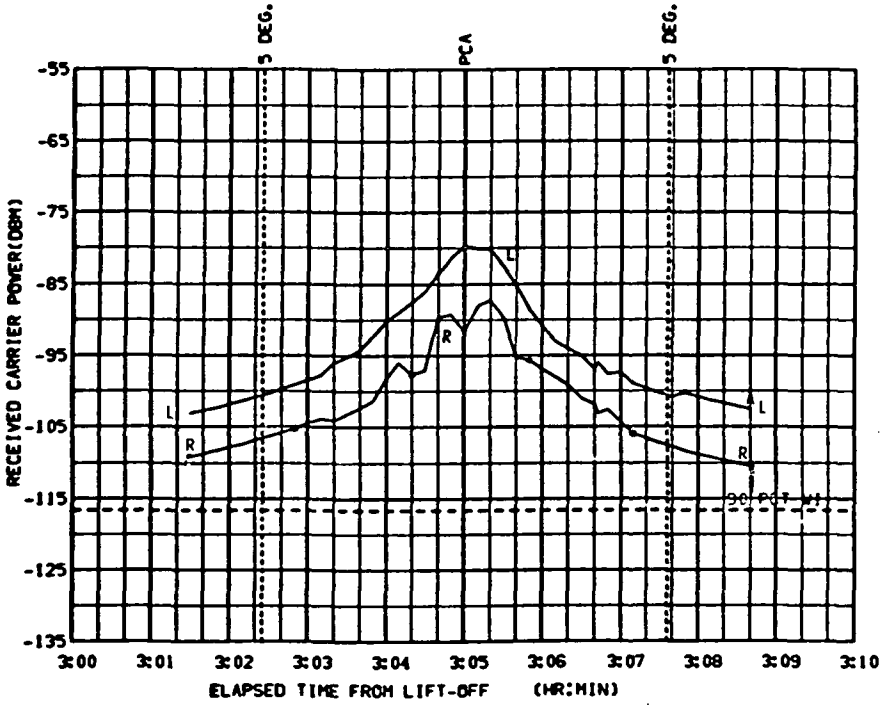

FIGURE 6-74f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

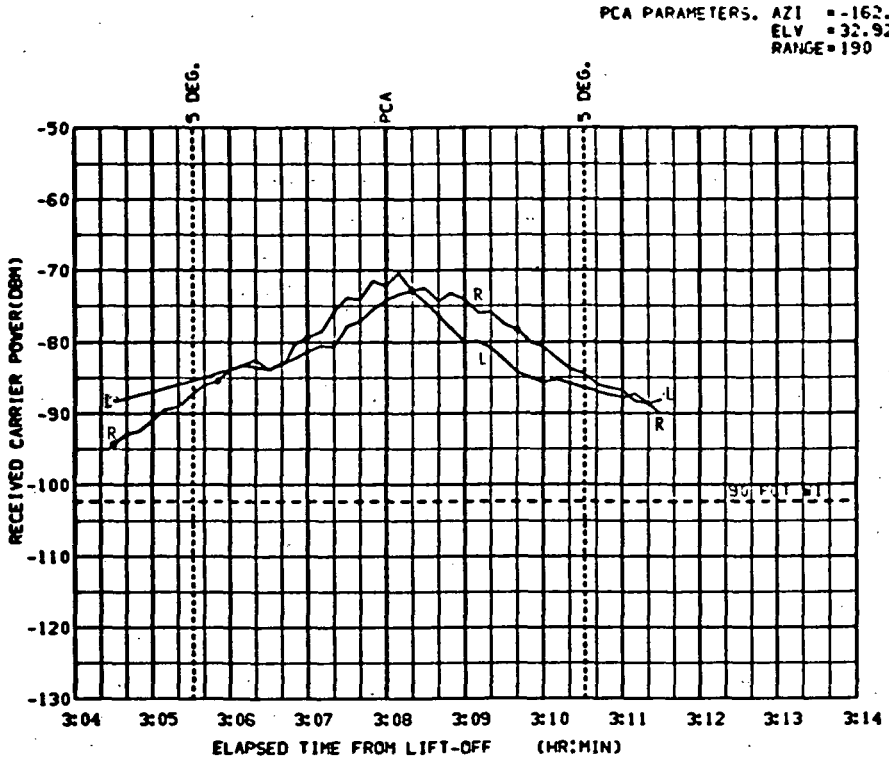

FIGURE 6-75a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

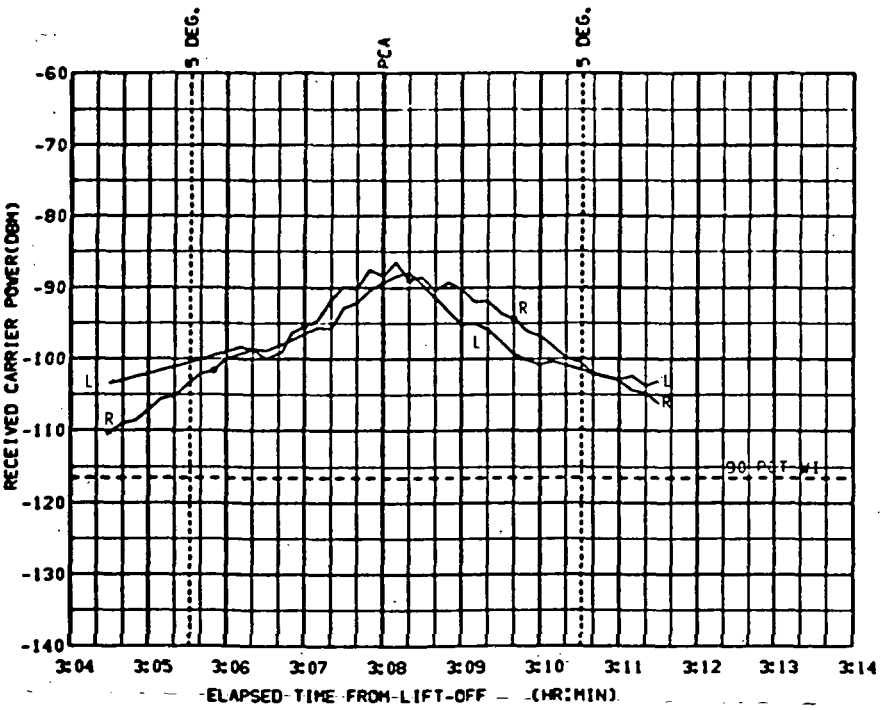

FIGURE 6-75b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

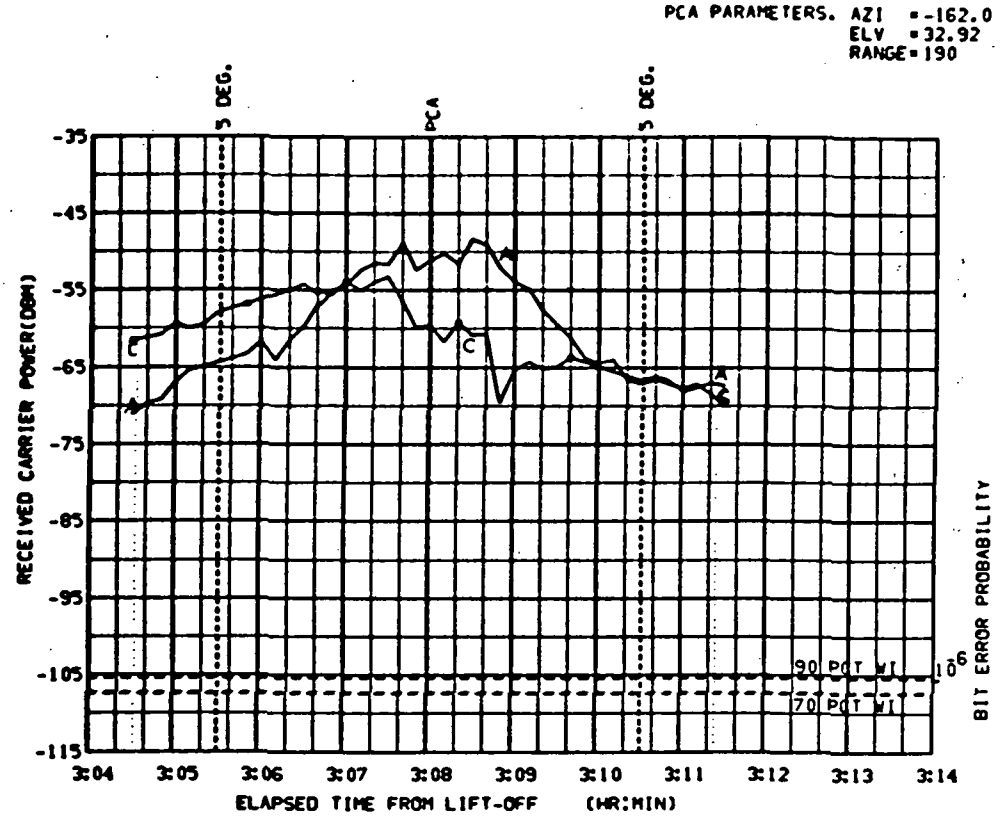

FIGURE 6-75c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

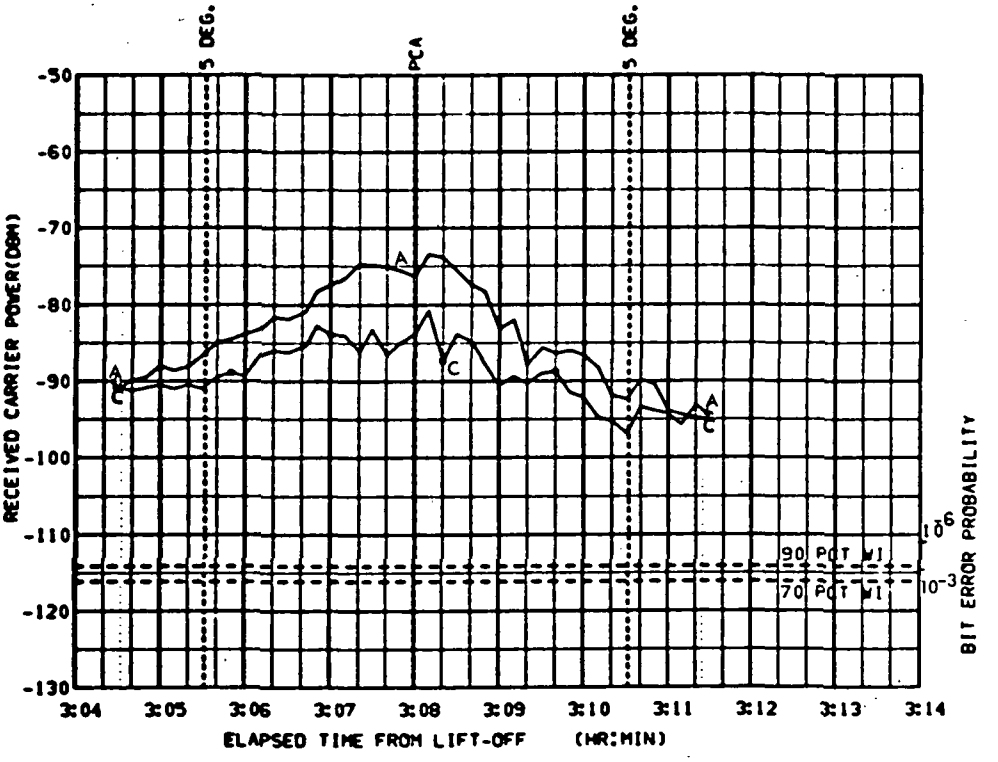

FIGURE 6-75d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

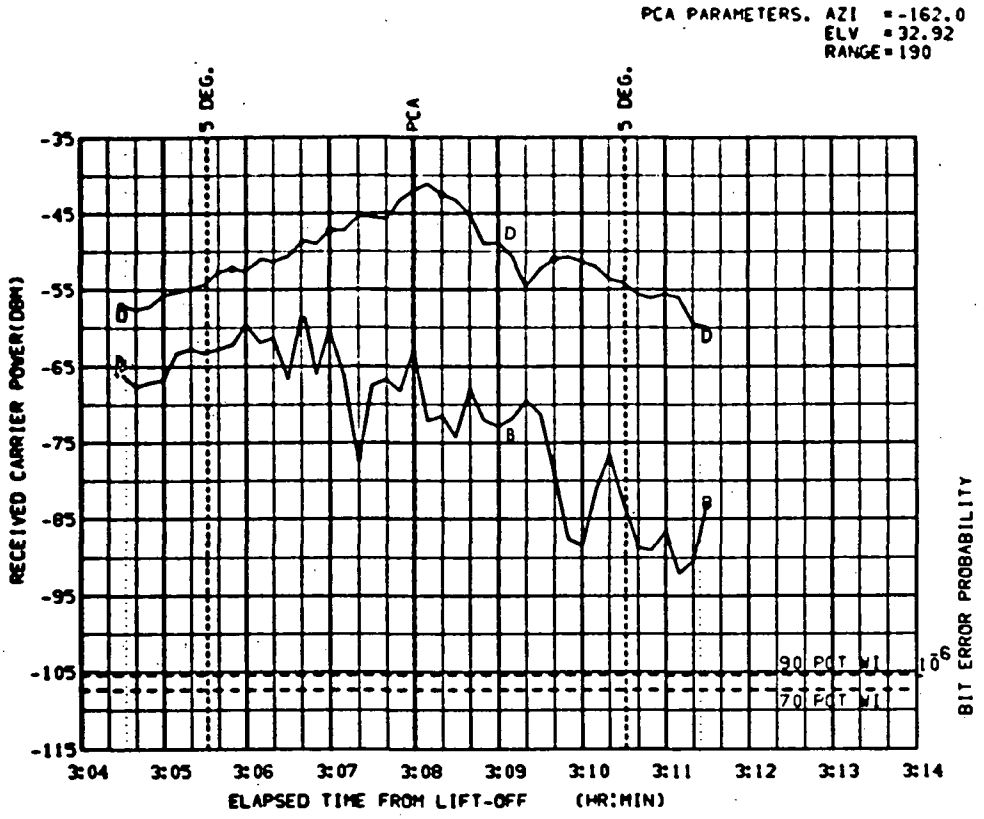

FIGURE 6-75e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

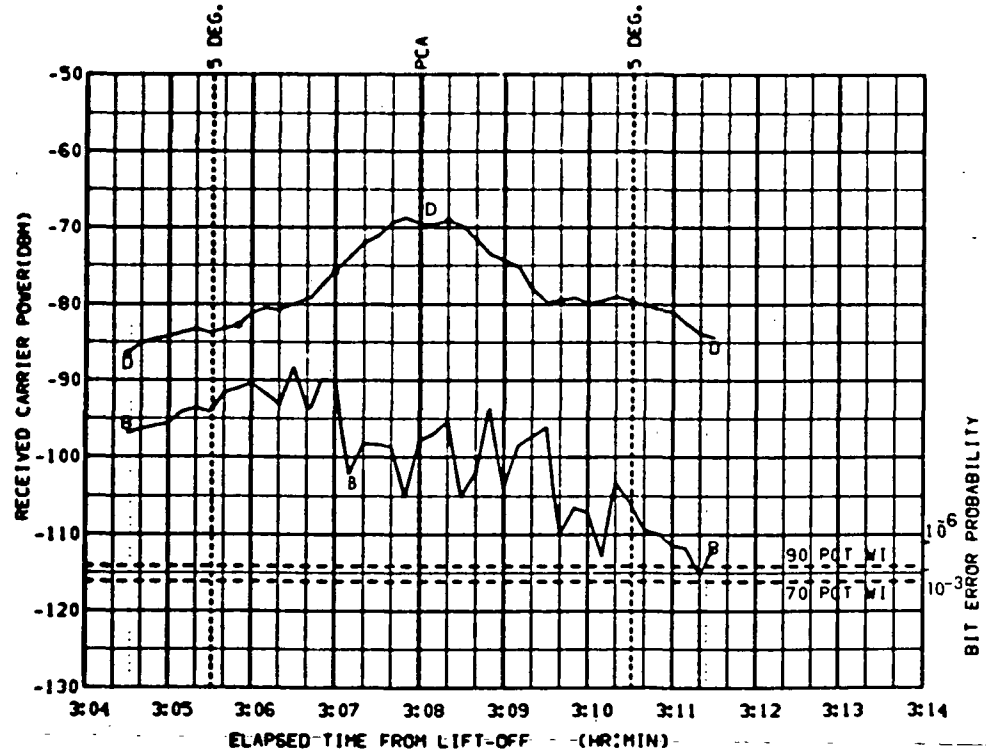

FIGURE 6-75f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

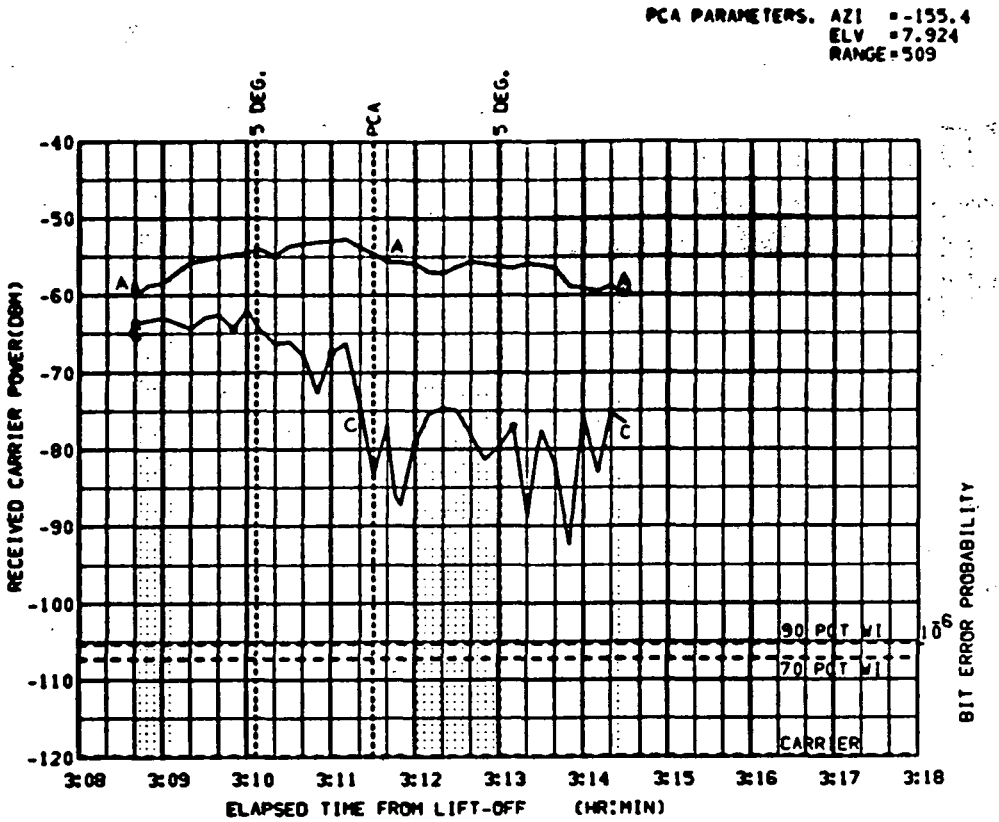

FIGURE 6-76a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

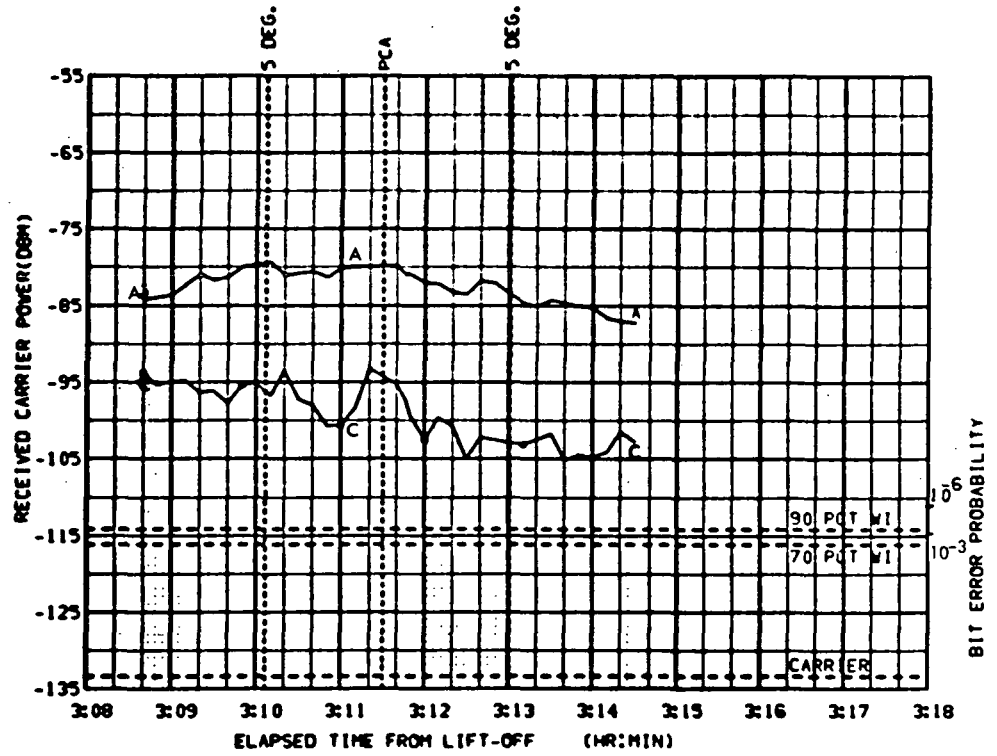

FIGURE 6-76b. MIL ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

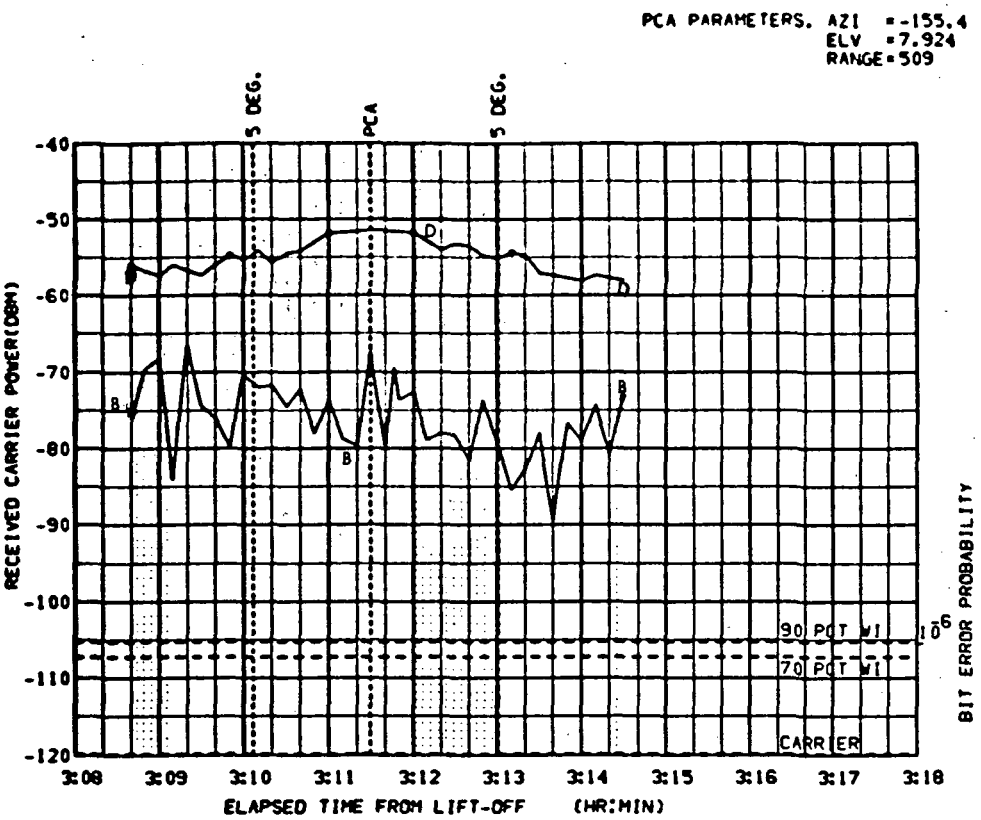

FIGURE 6-76c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

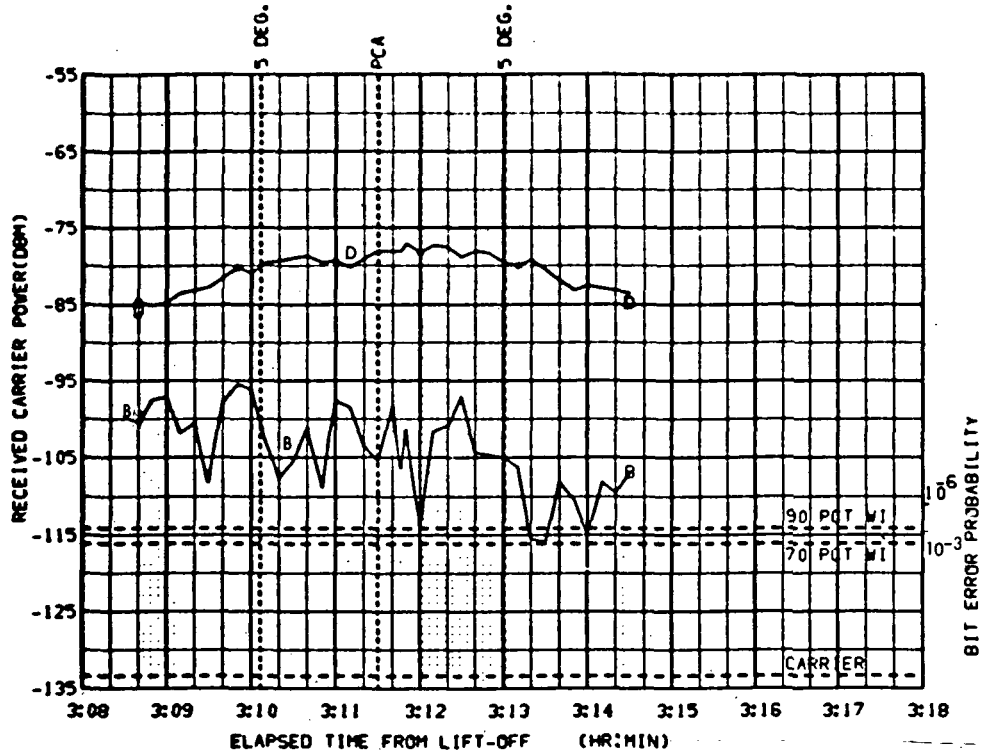

FIGURE 6-76d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

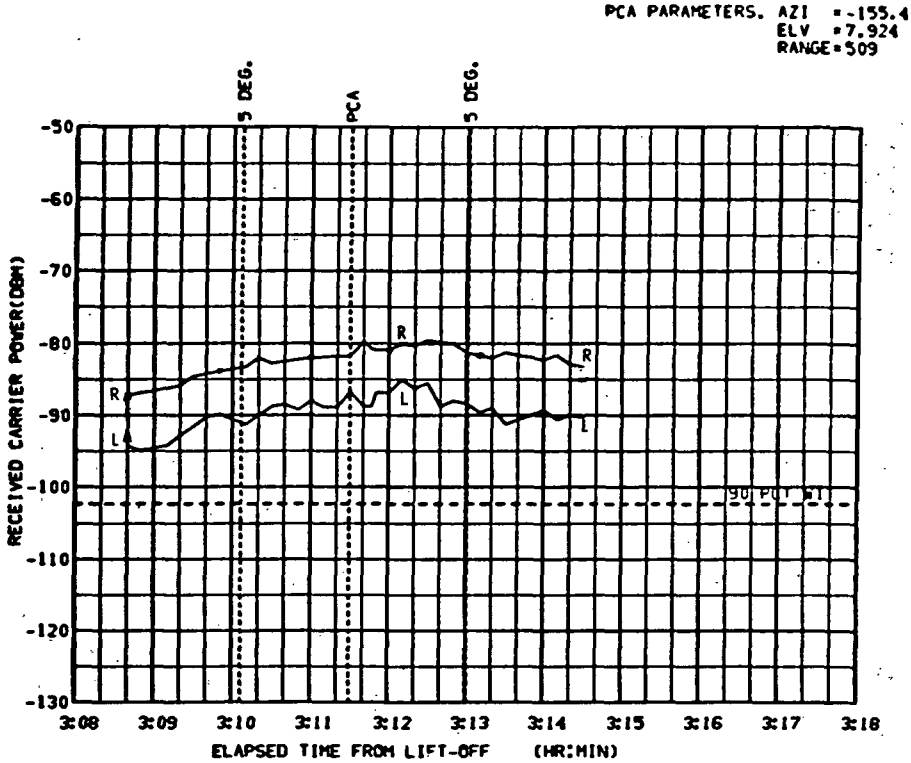

FIGURE 6-76e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

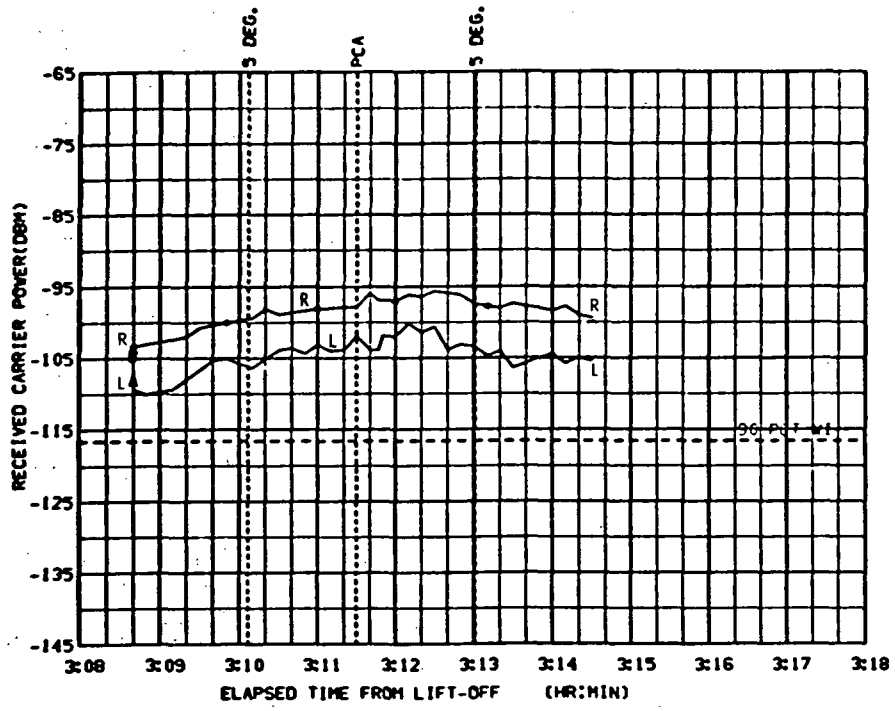

FIGURE 6-76f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

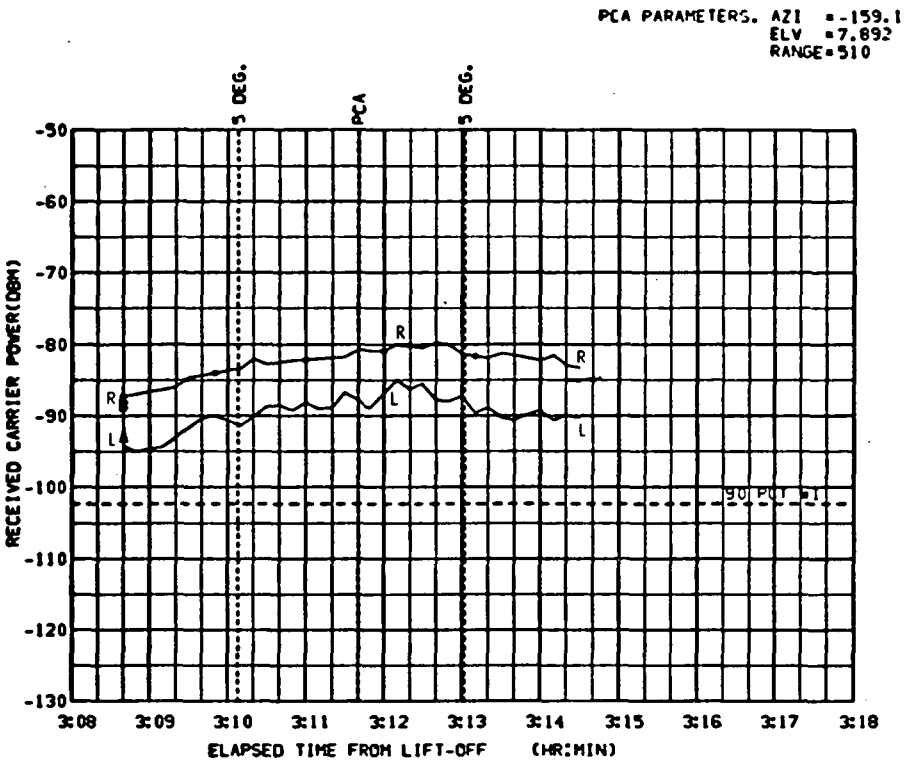

FIGURE 6-77a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

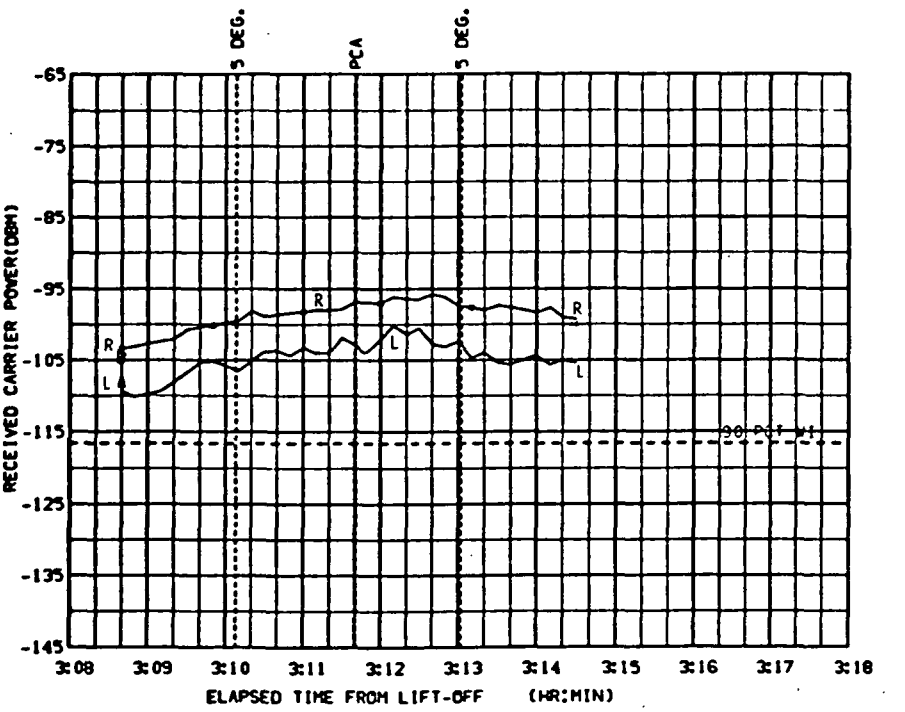

FIGURE 6-77b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

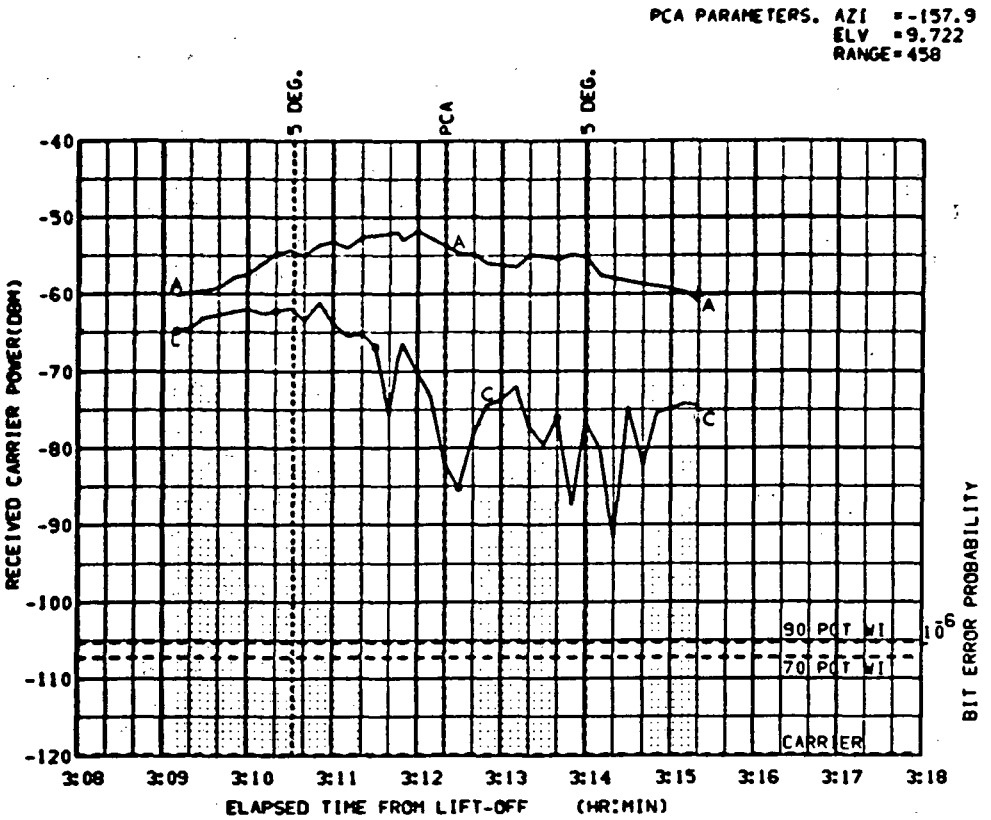

FIGURE 6-78a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

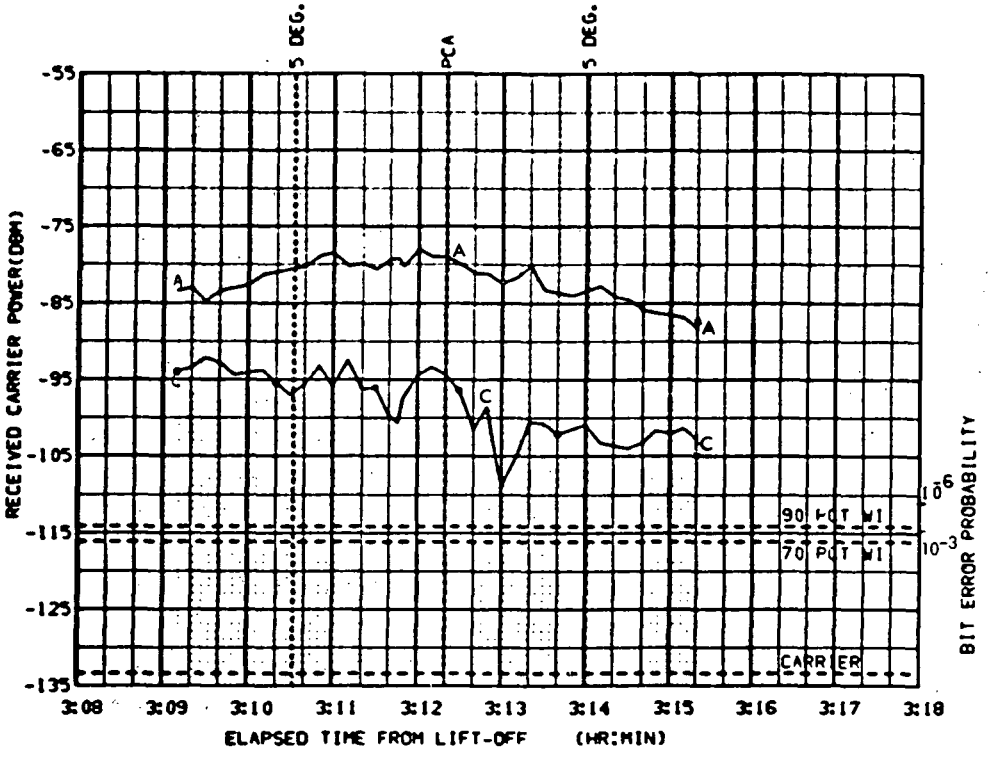

FIGURE 6-78b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

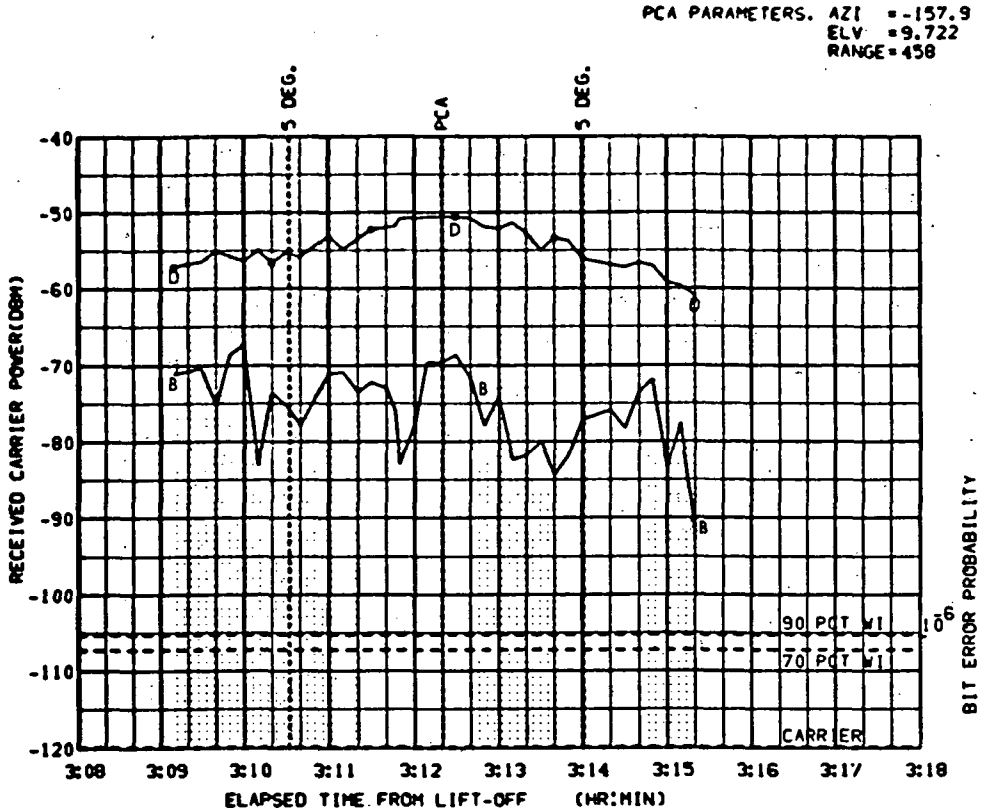

FIGURE 6-78c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

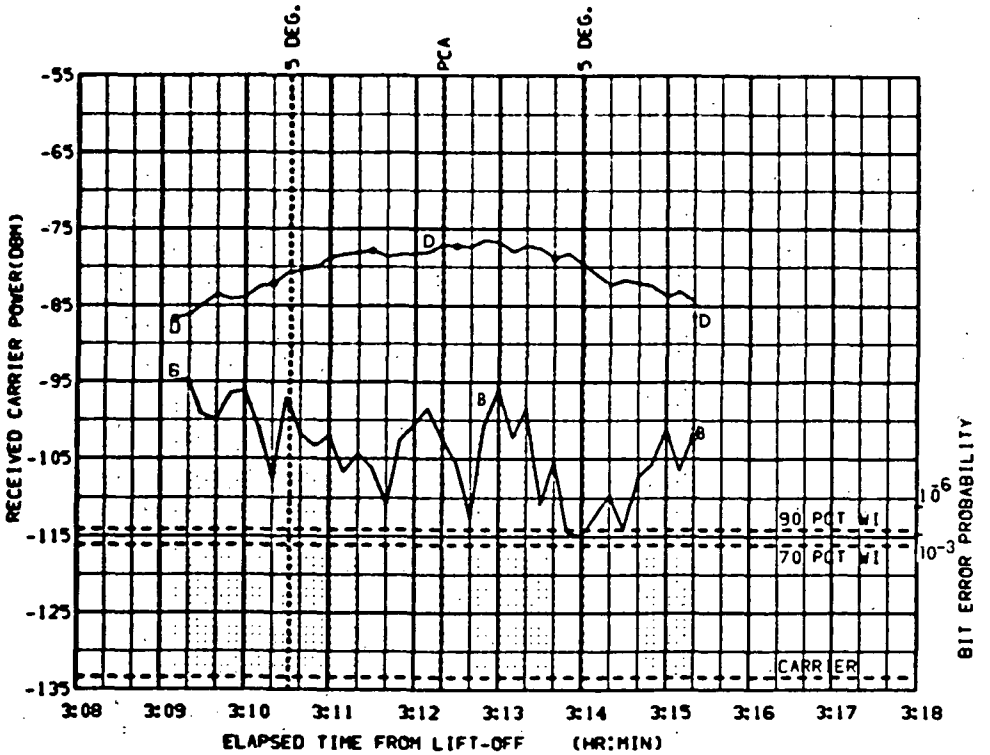

FIGURE 6-78d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

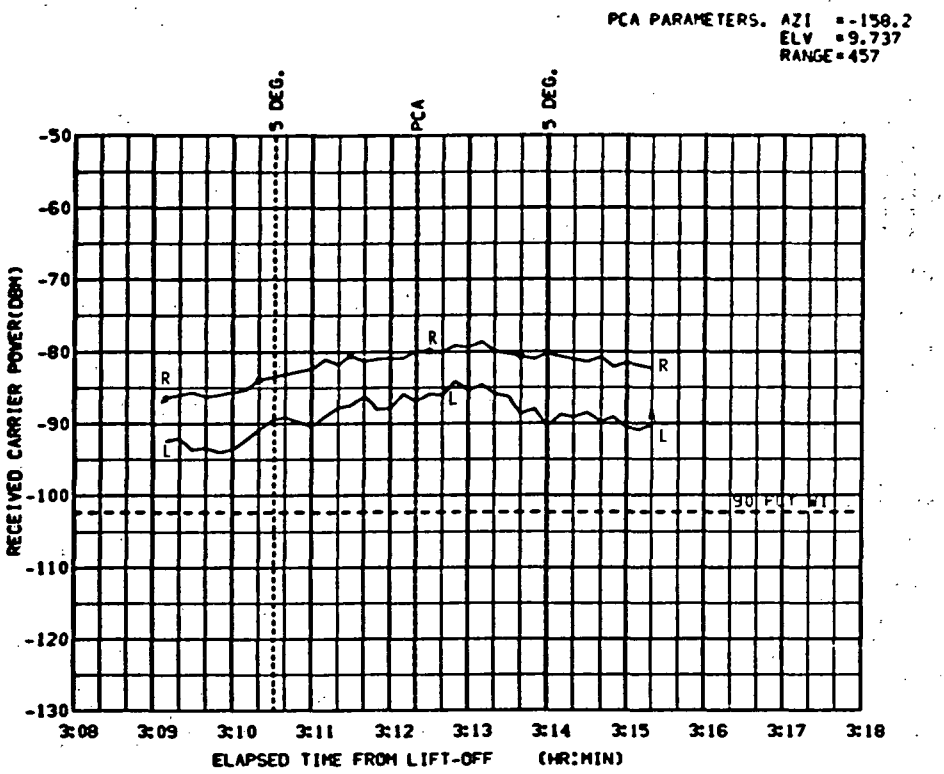

FIGURE 6-78e. 6BI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

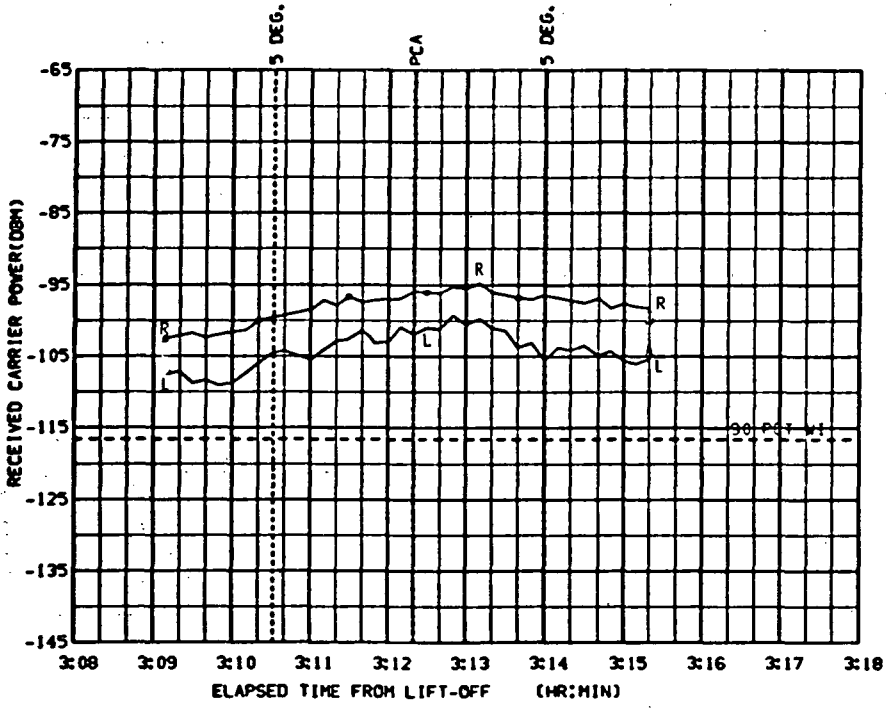

FIGURE 6-78f. 6BI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

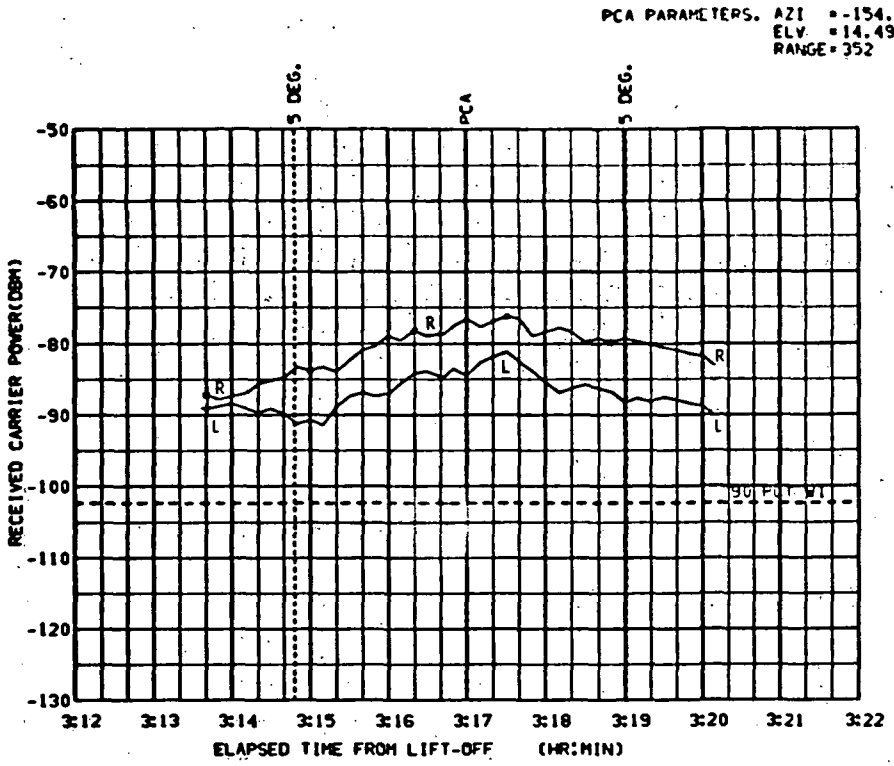

FIGURE 6-79a. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

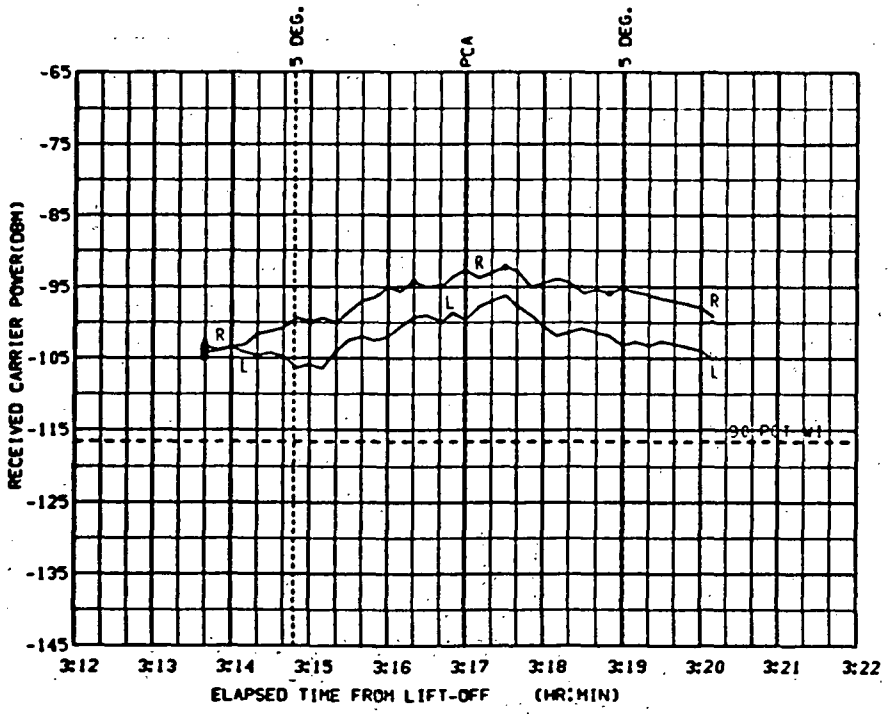

FIGURE 6-79b. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

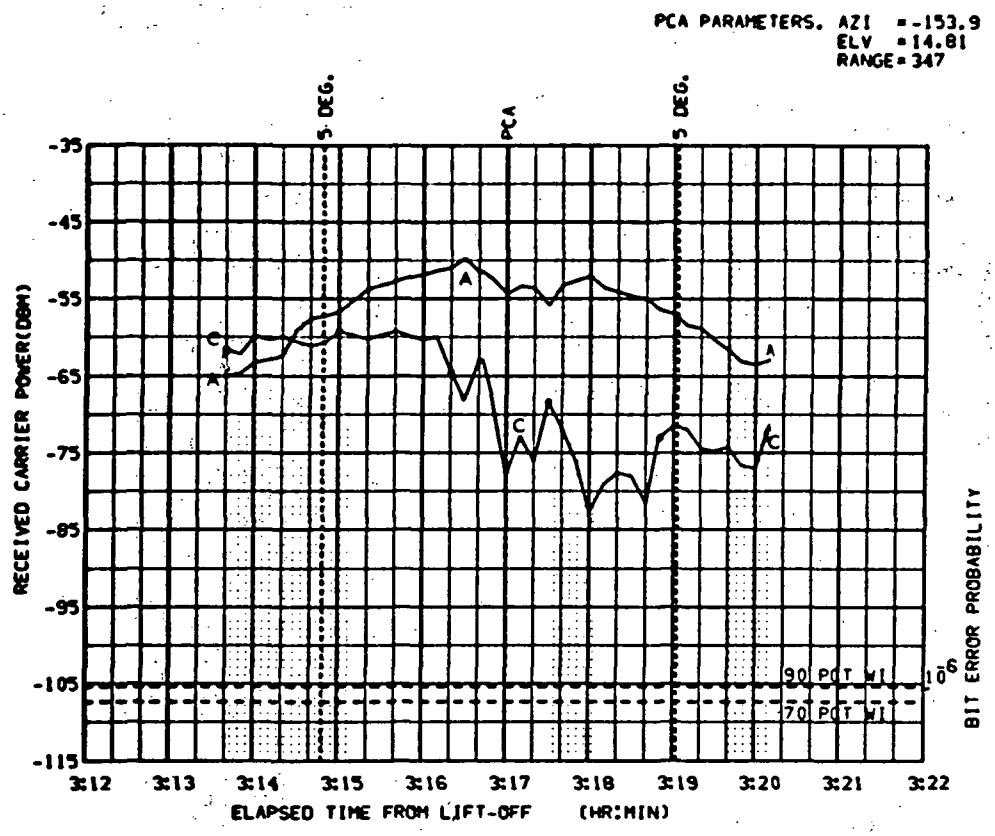

FIGURE 6-79c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

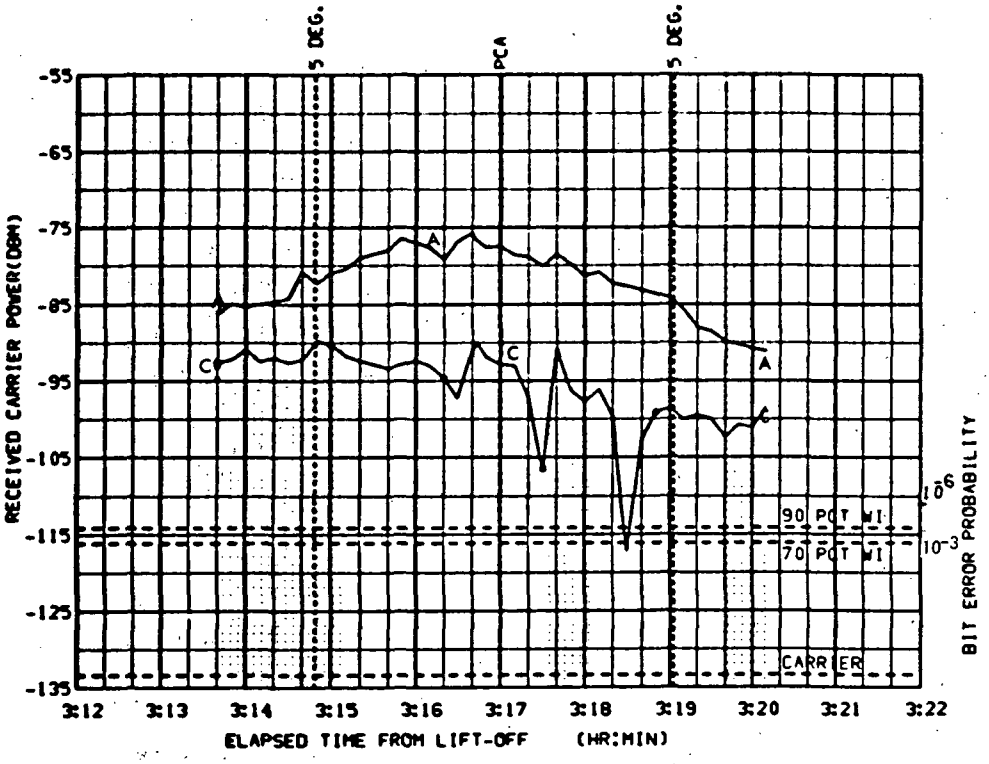

FIGURE 6-79d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

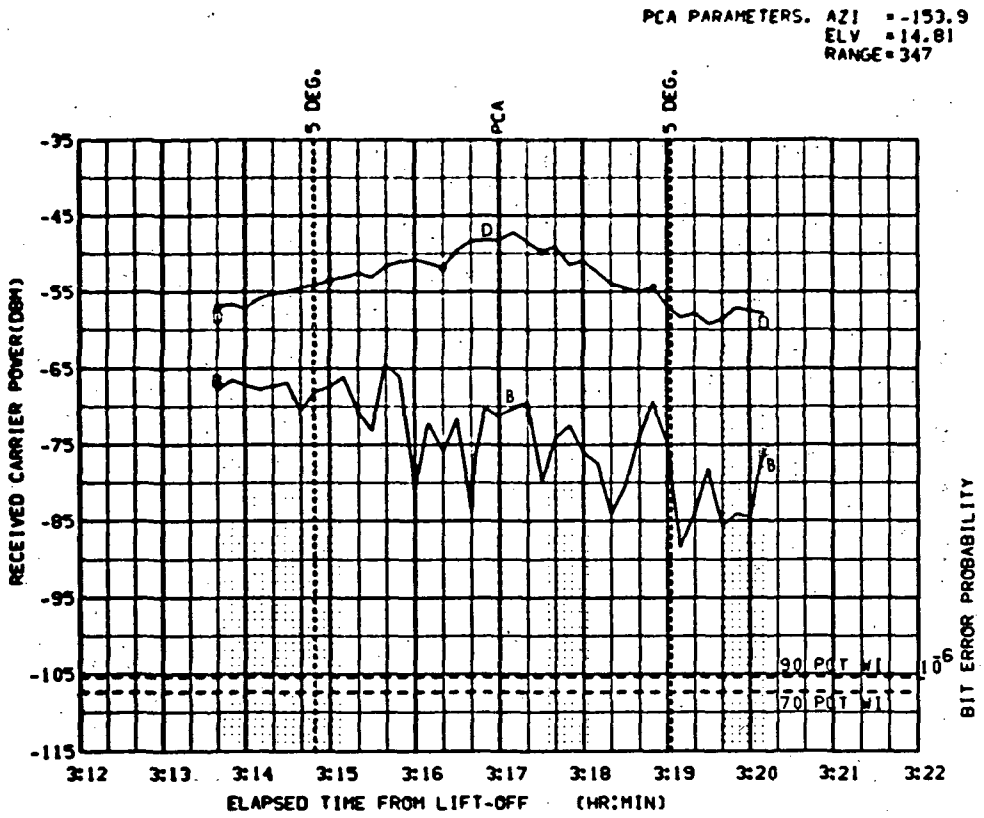

FIGURE 6-79e. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

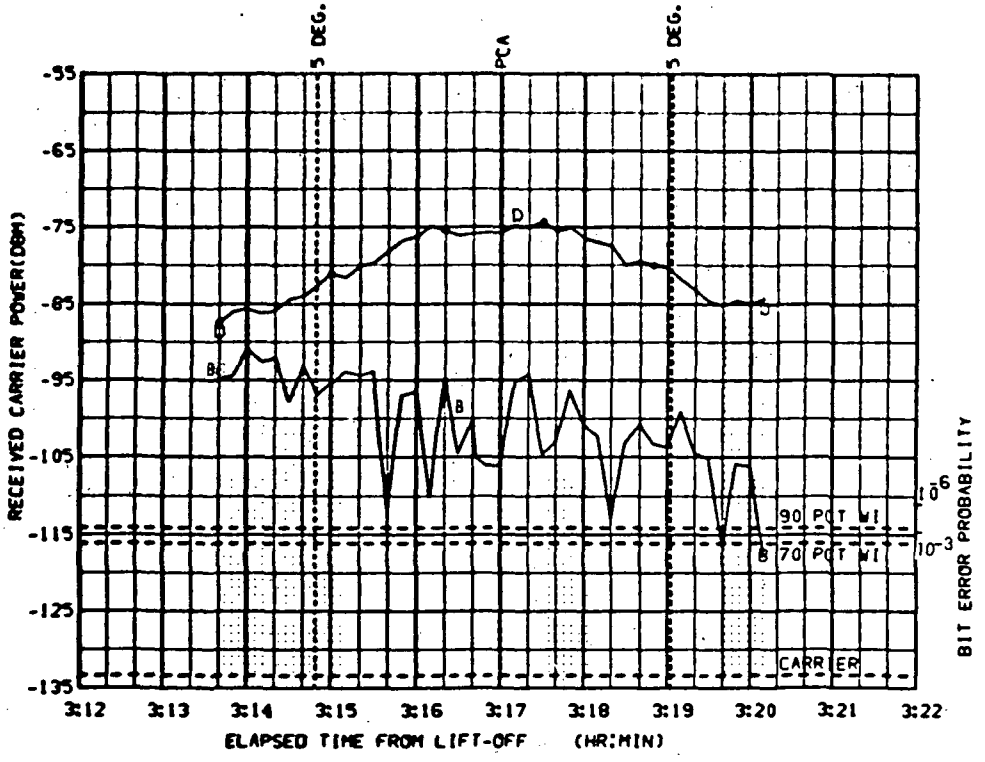

FIGURE 6-79f. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

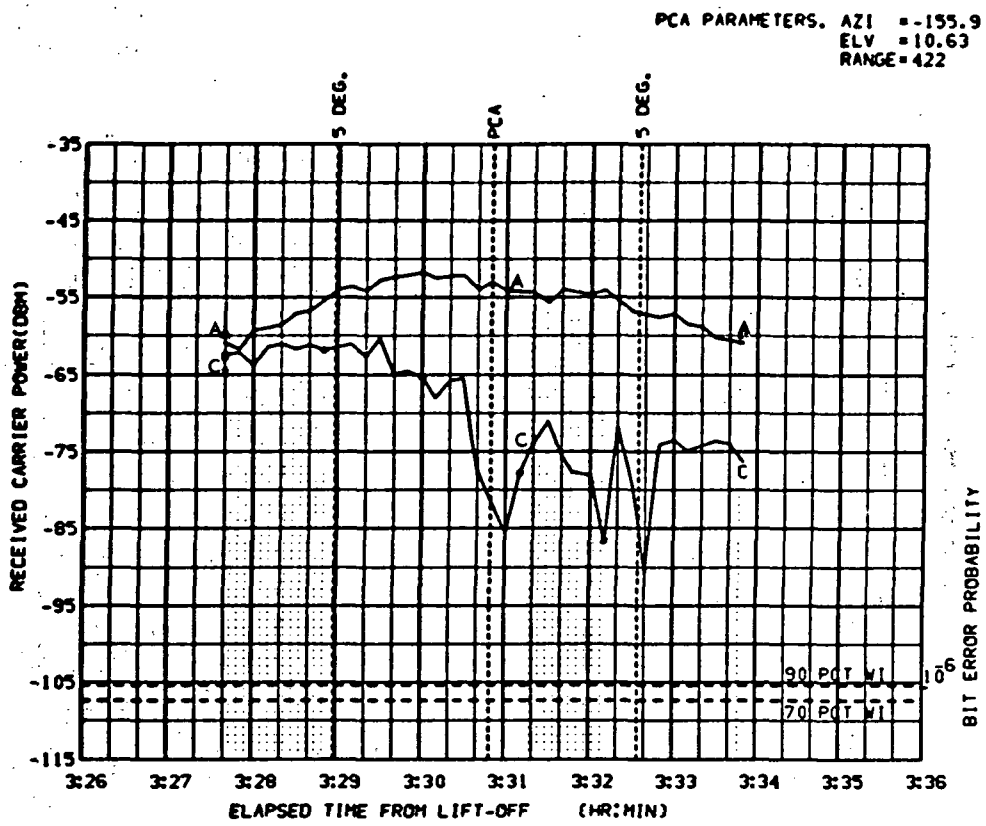

FIGURE 6-80a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

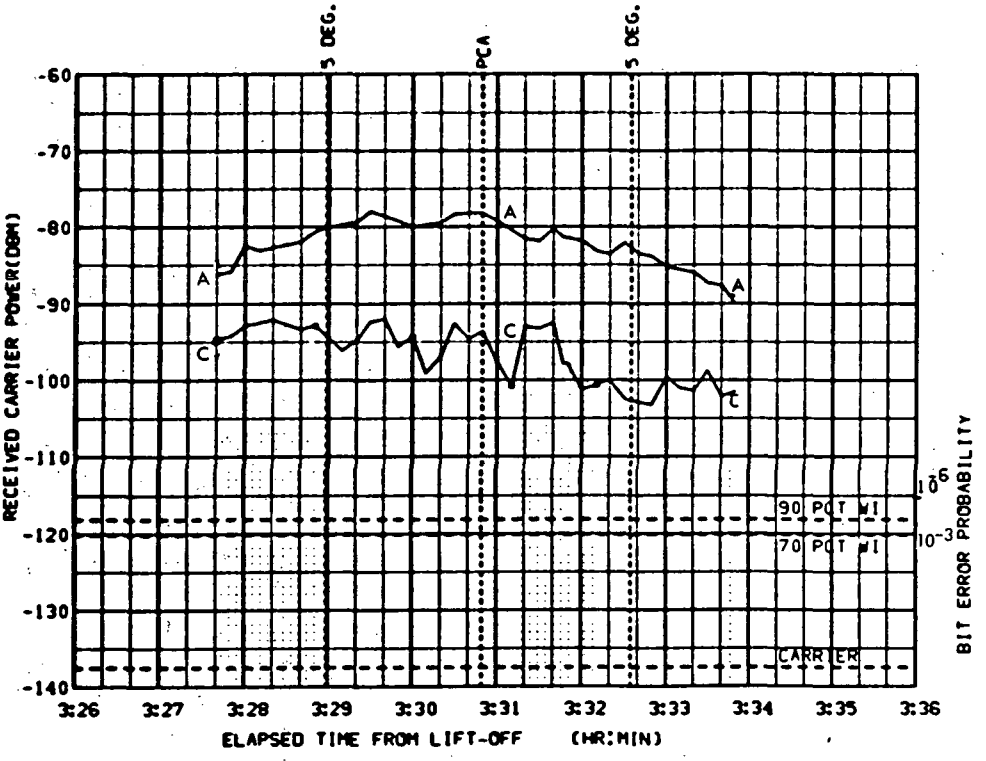

FIGURE 6-80b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

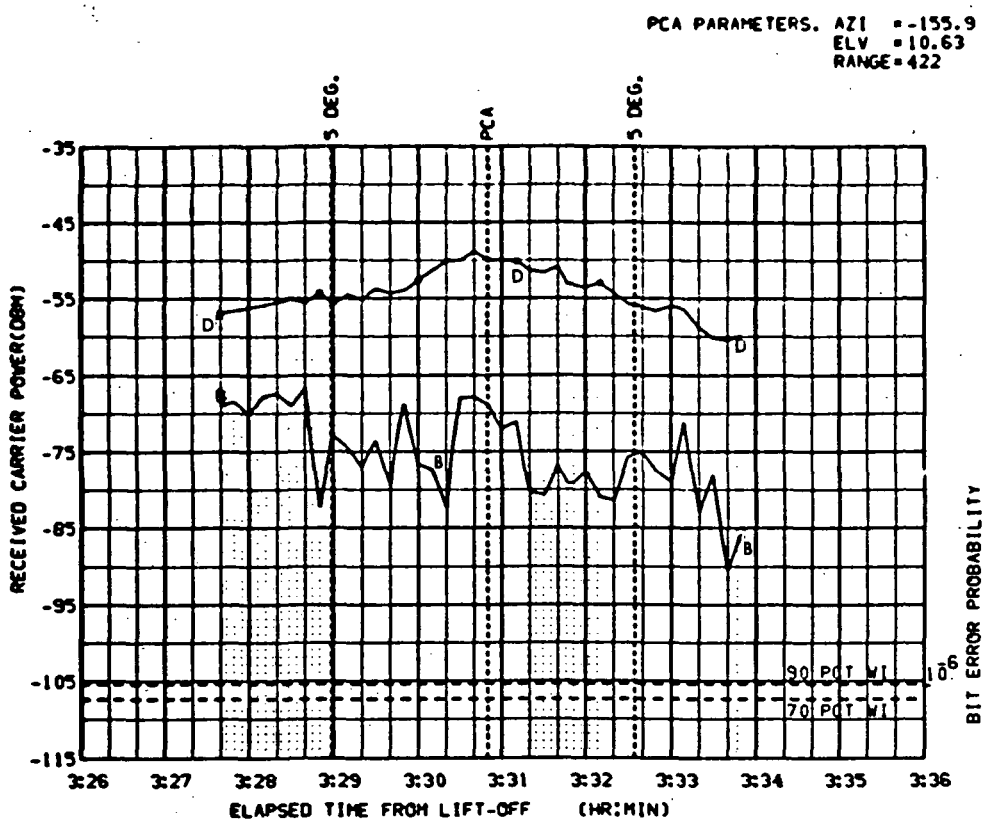

FIGURE 6-80c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

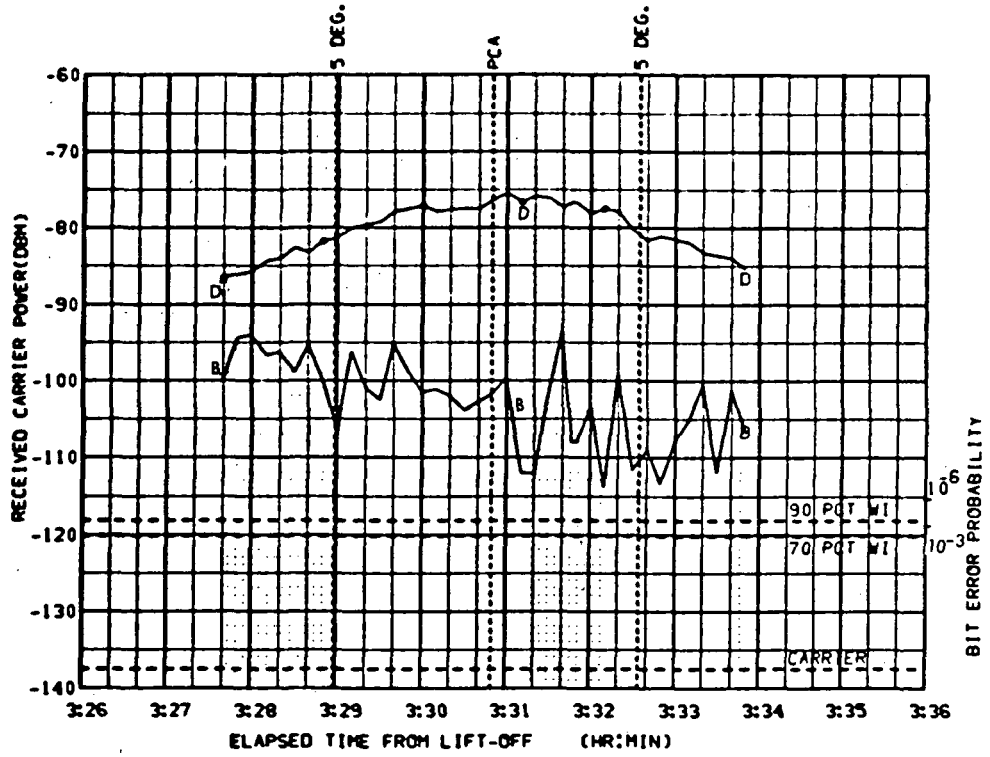

FIGURE 6-80d. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

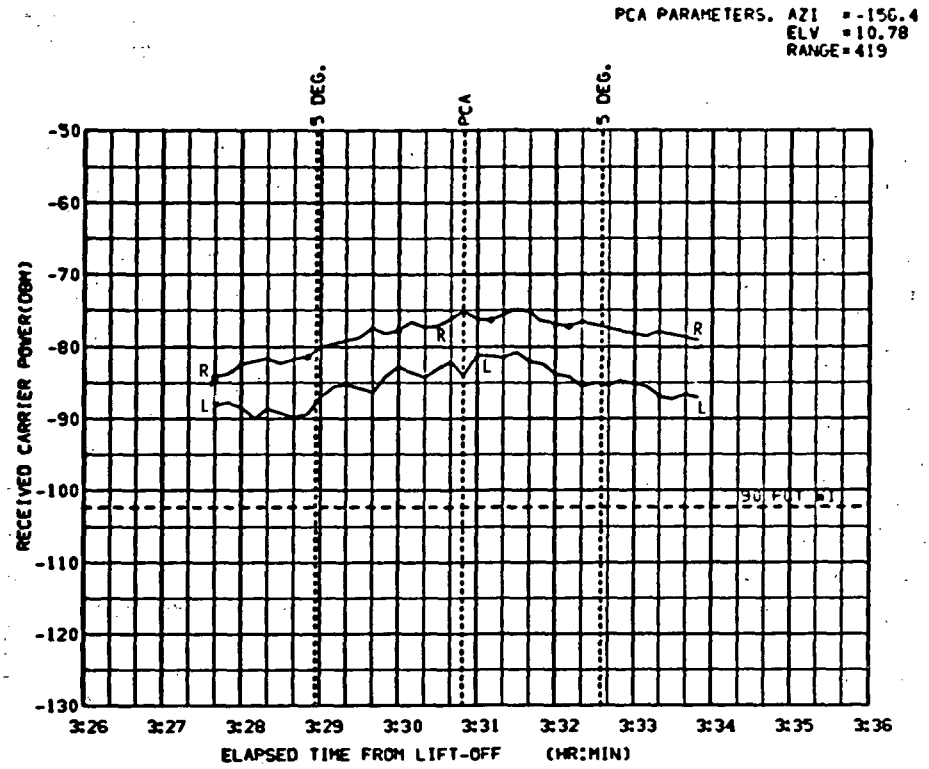

FIGURE 6-80e. ASC UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

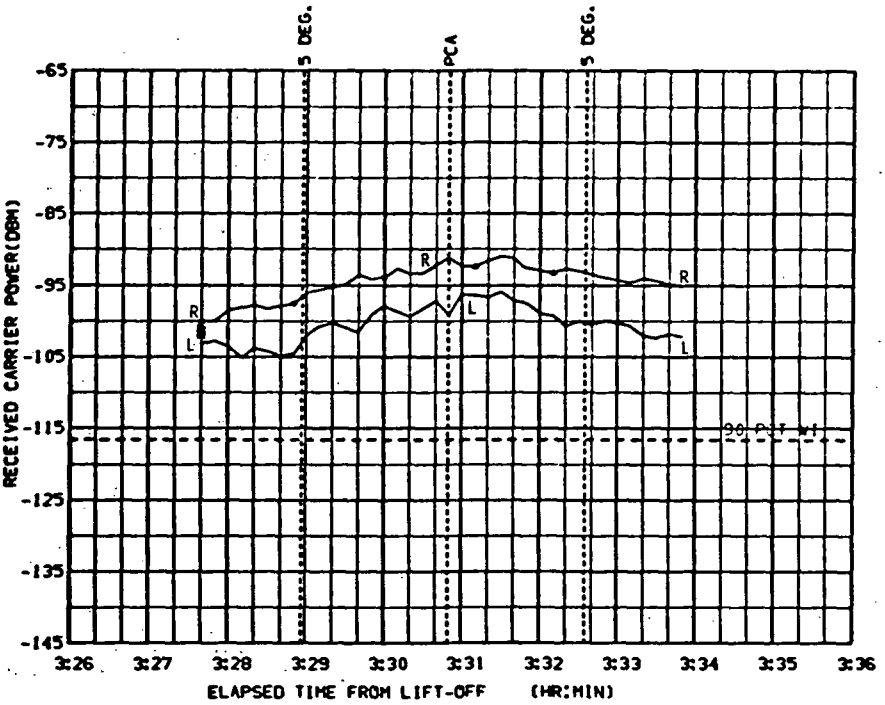

FIGURE 6-80f. ASC DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

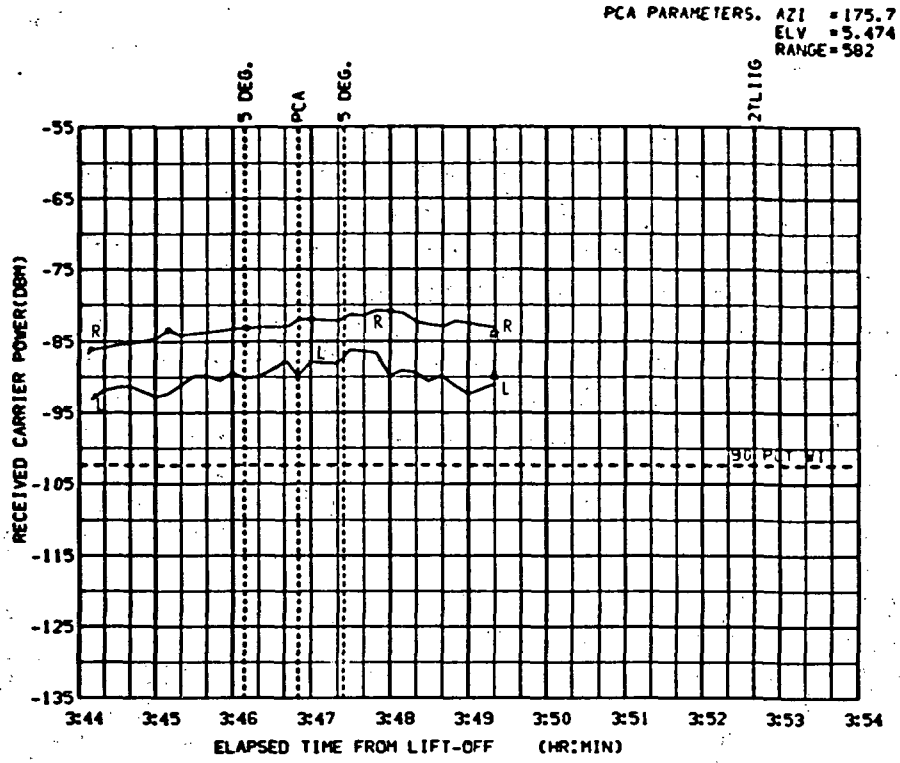

FIGURE 6-81a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

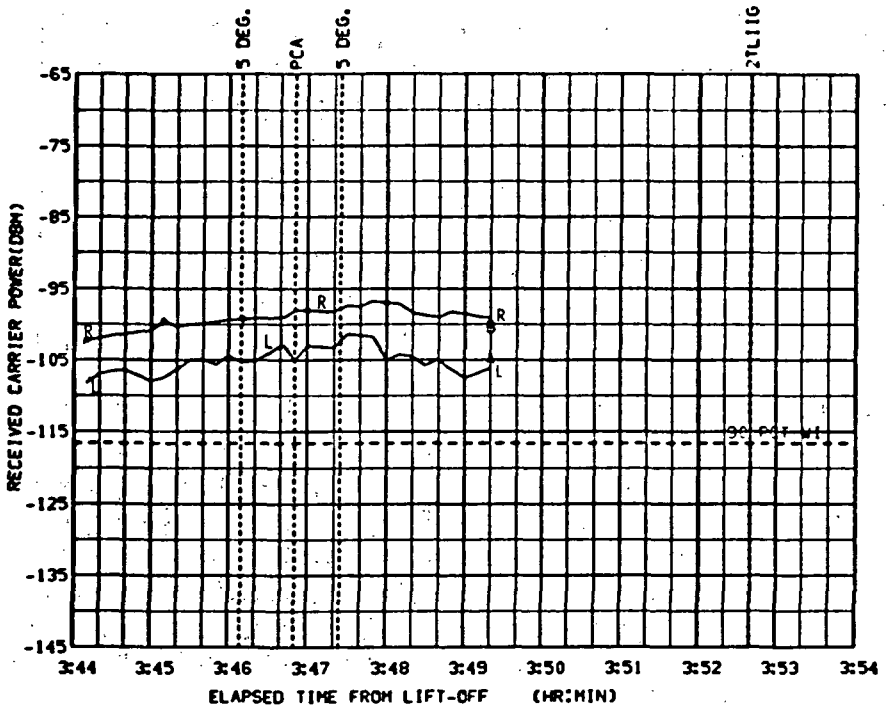

FIGURE 6-81b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

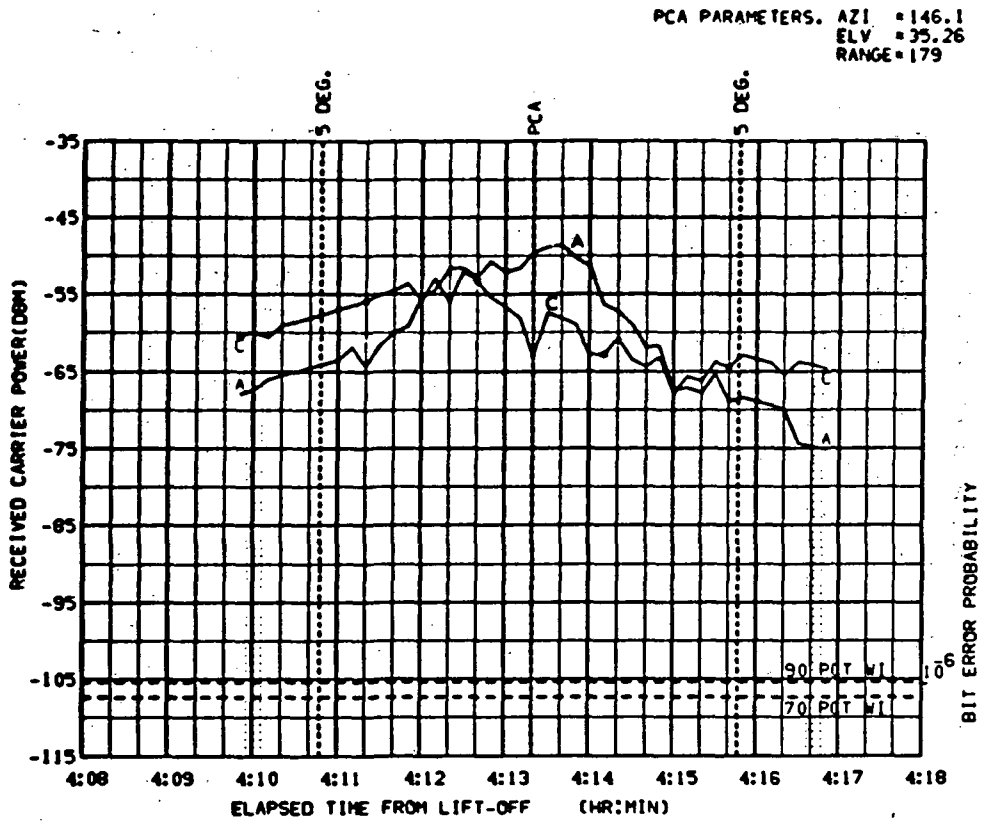

FIGURE 6-82a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

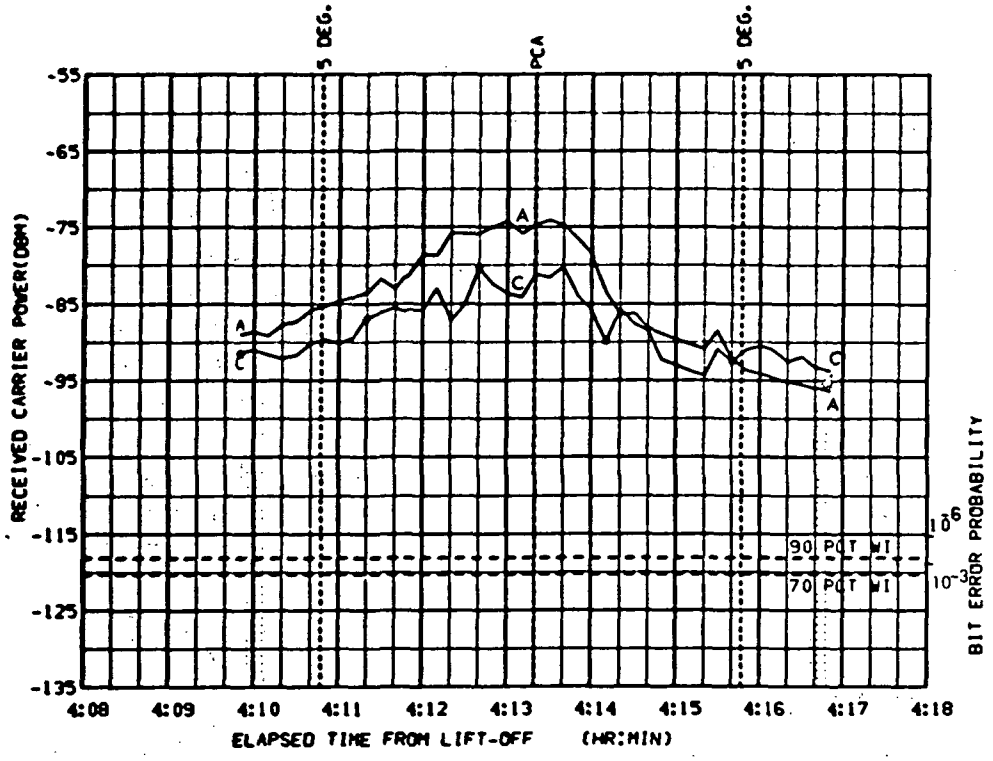

FIGURE 6-82b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

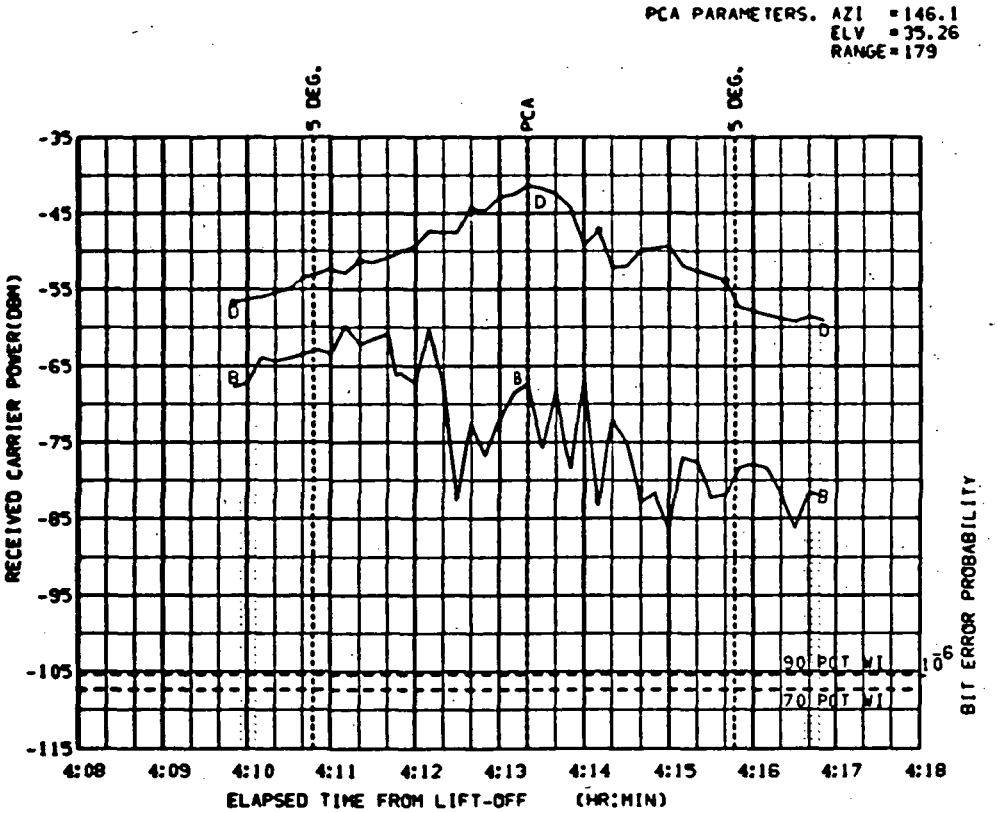

FIGURE 6-82c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

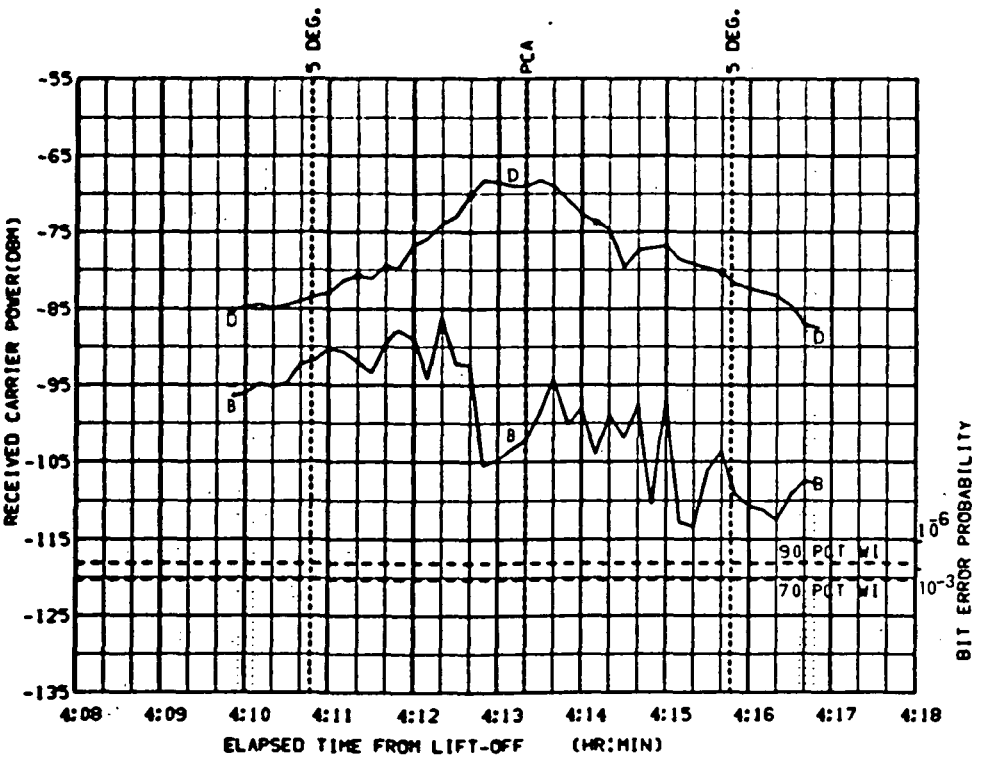

FIGURE 6-82d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

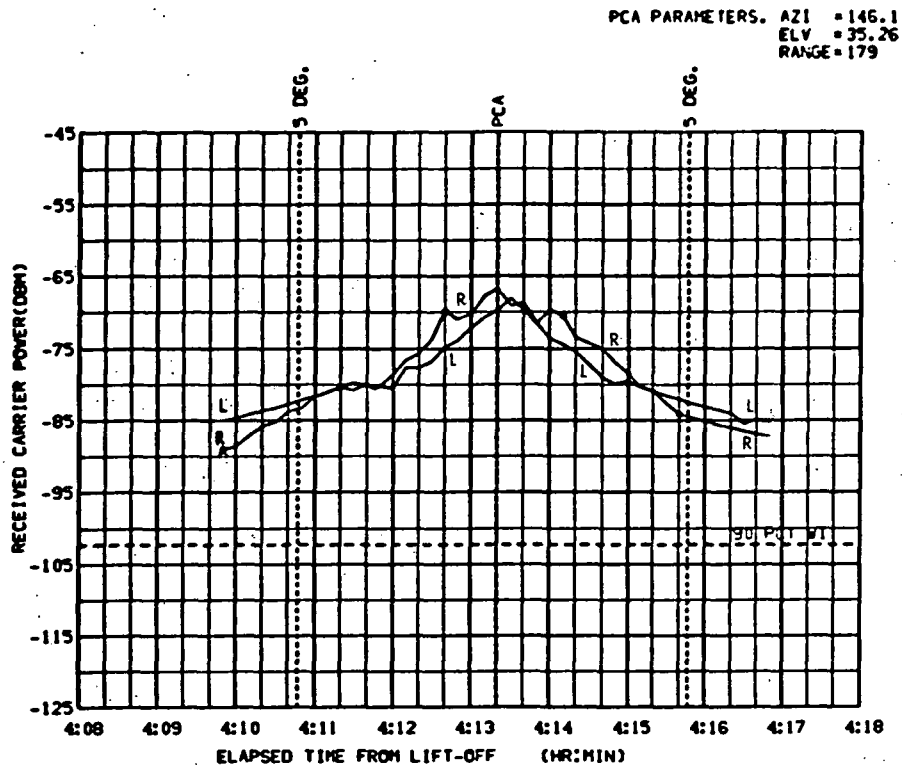

FIGURE 6-82e. GWM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

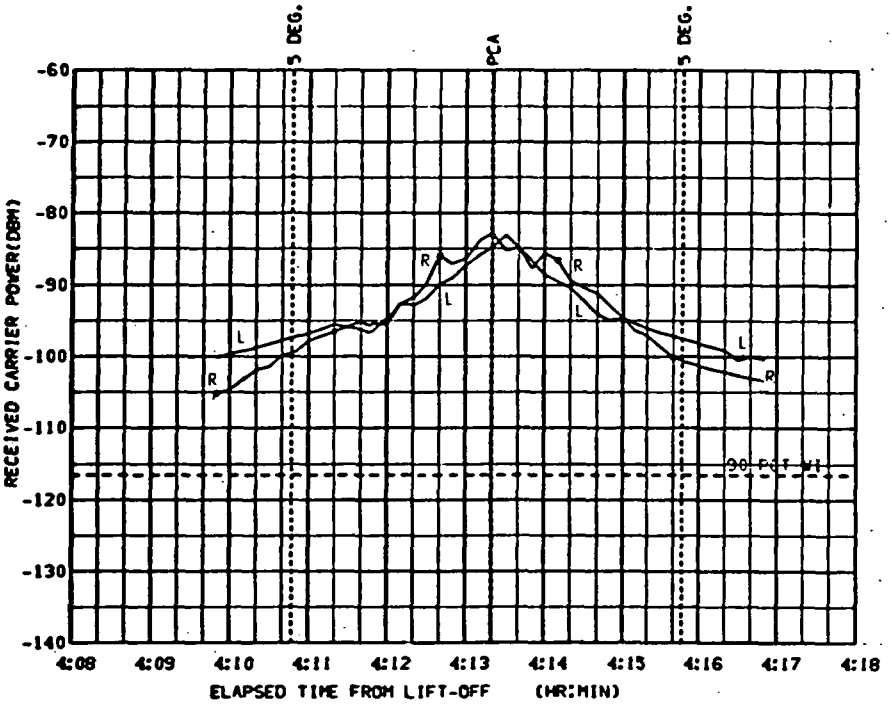

FIGURE 6-82f. GWM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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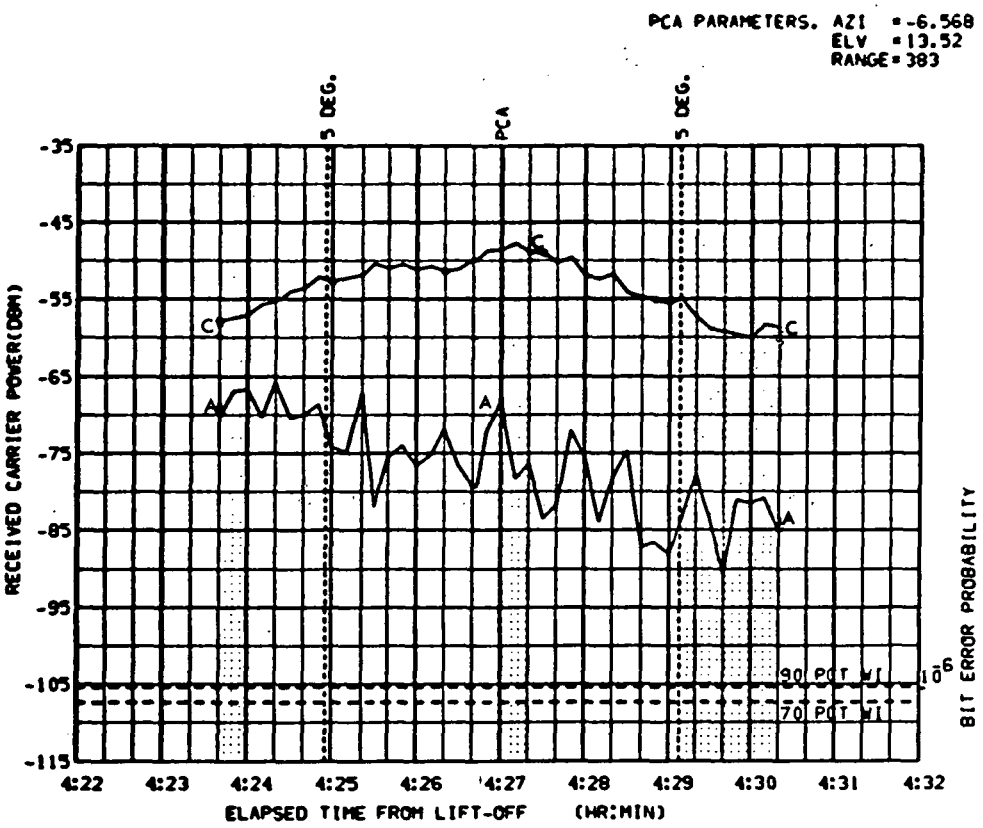

FIGURE 6-83a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

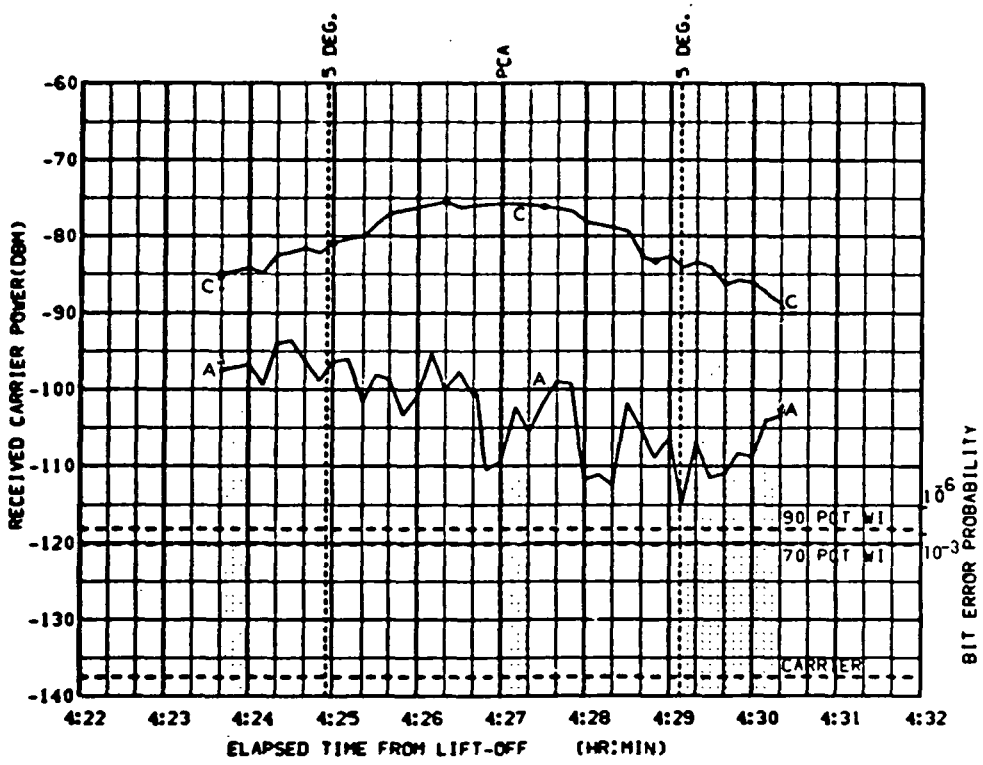

FIGURE 6-83b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

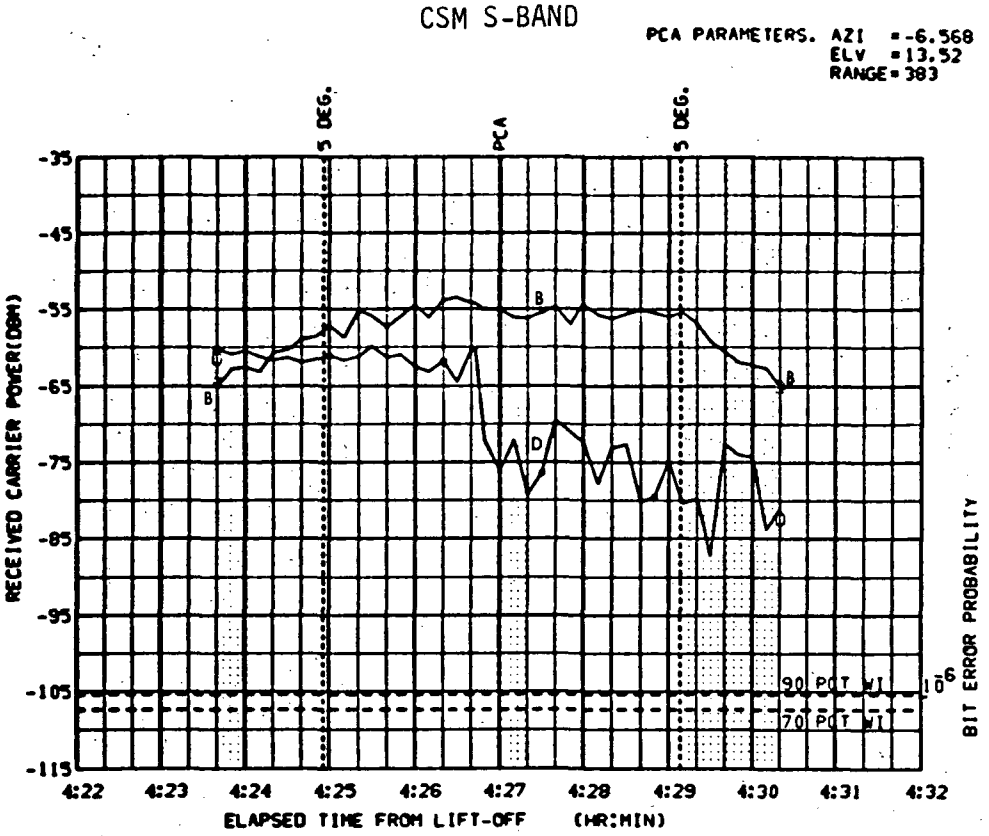

FIGURE 6-83c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

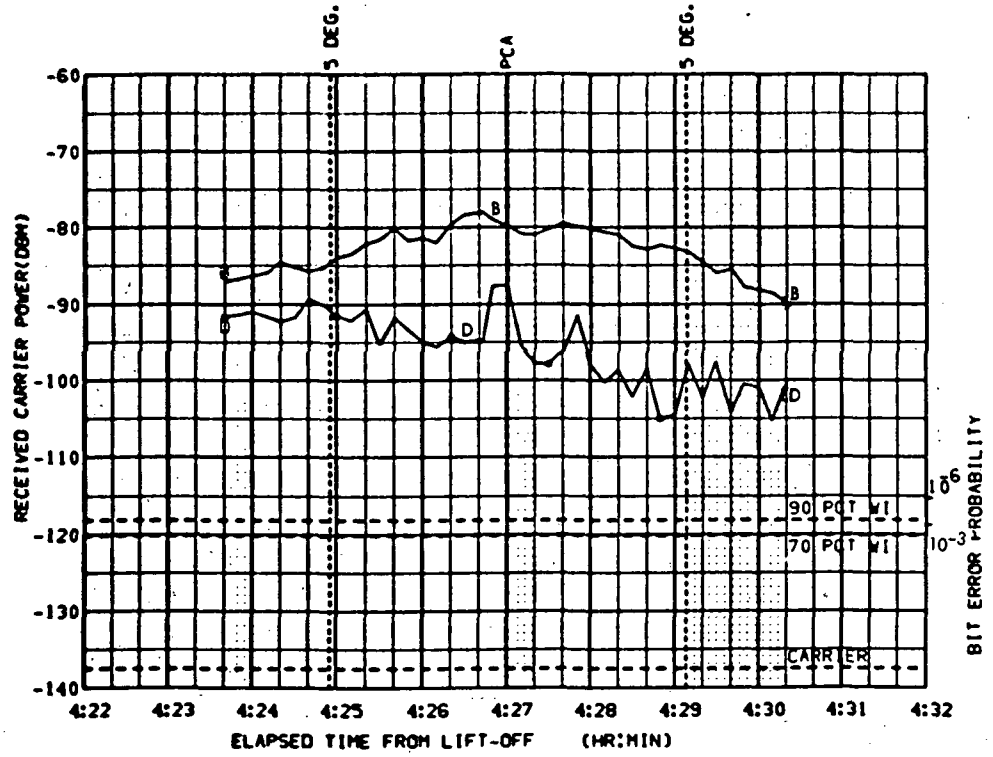

FIGURE 6-83d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

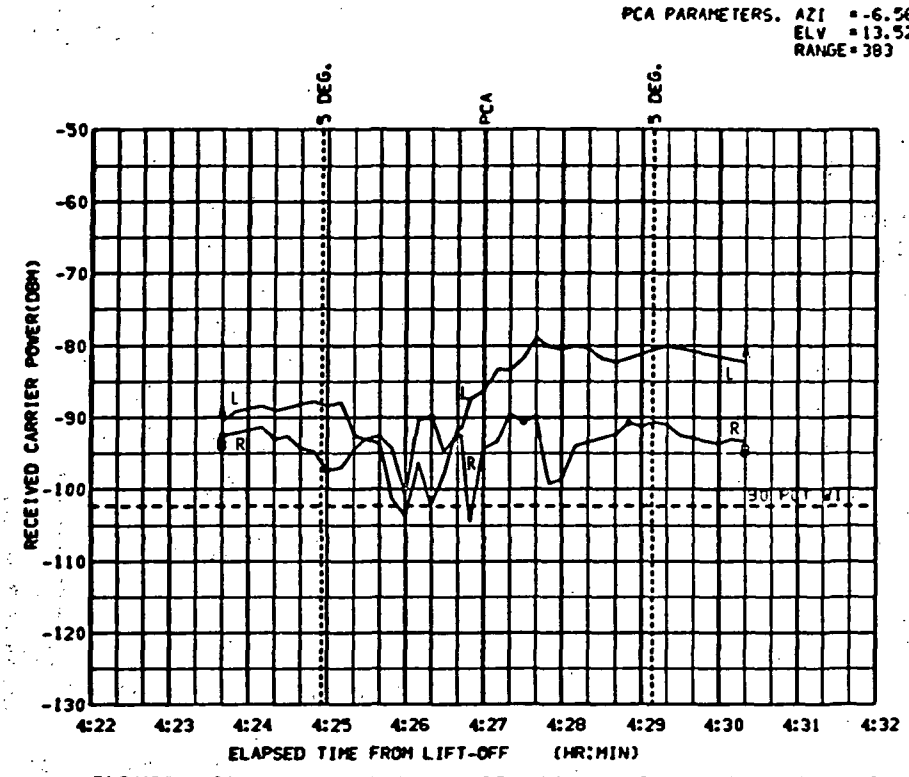

FIGURE 6-83e. HAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

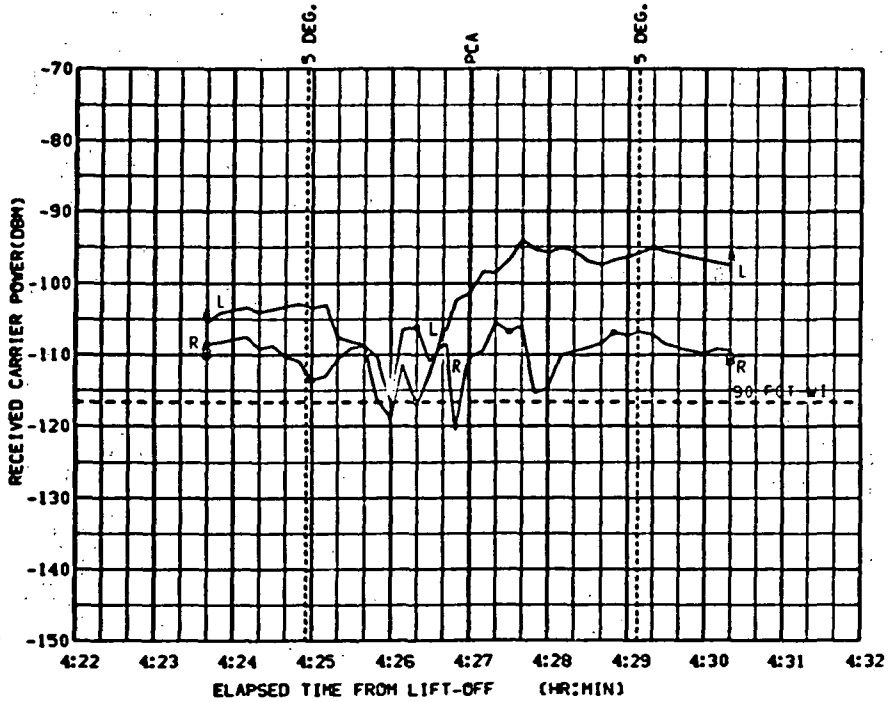

FIGURE 6-83f. HAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-165.7
ELV =6.484
RANGE=566

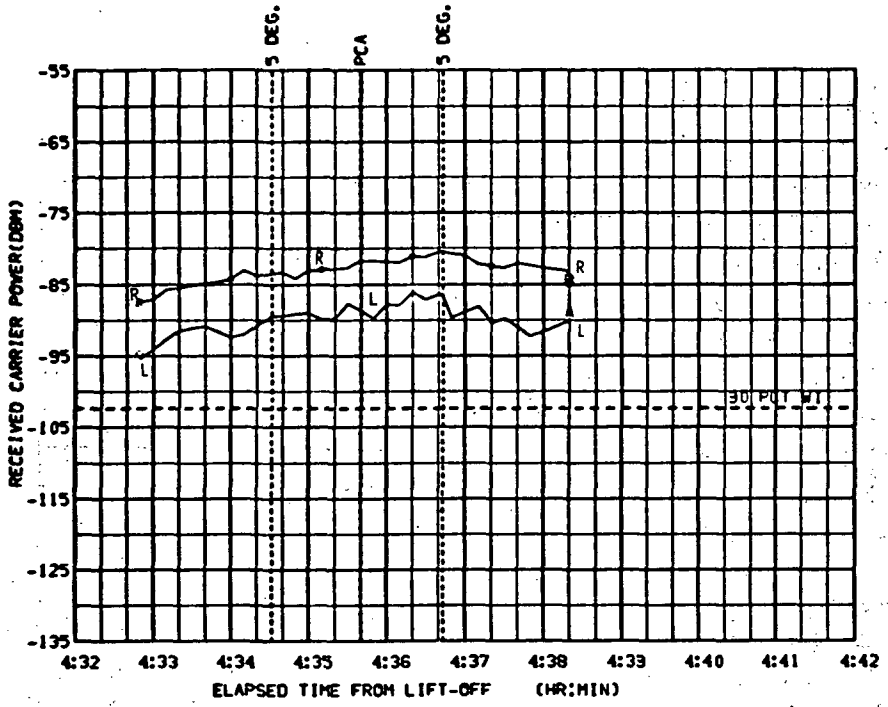

FIGURE 6-84a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

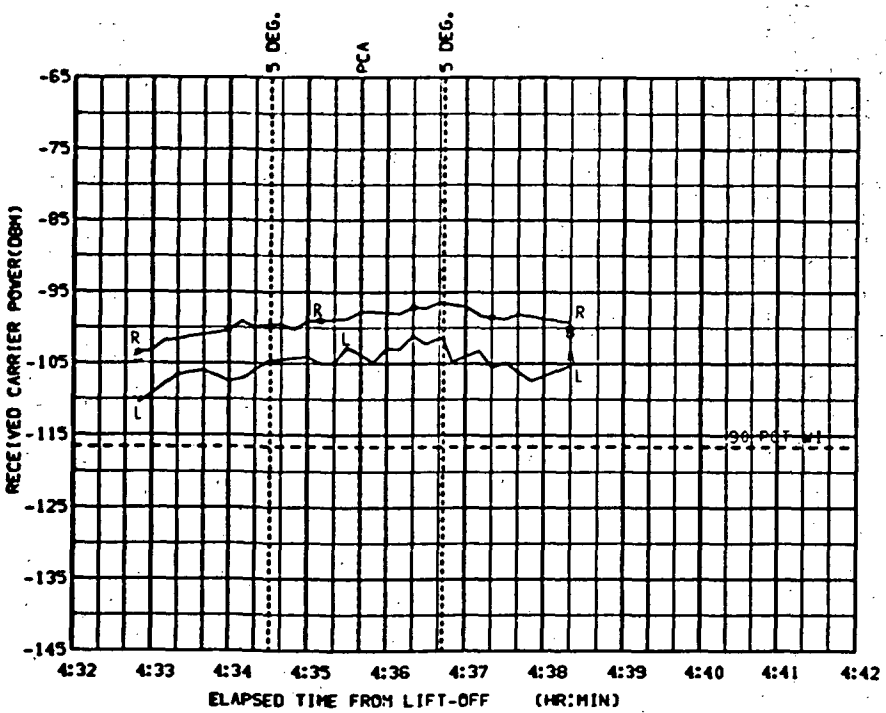

FIGURE 6-84b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

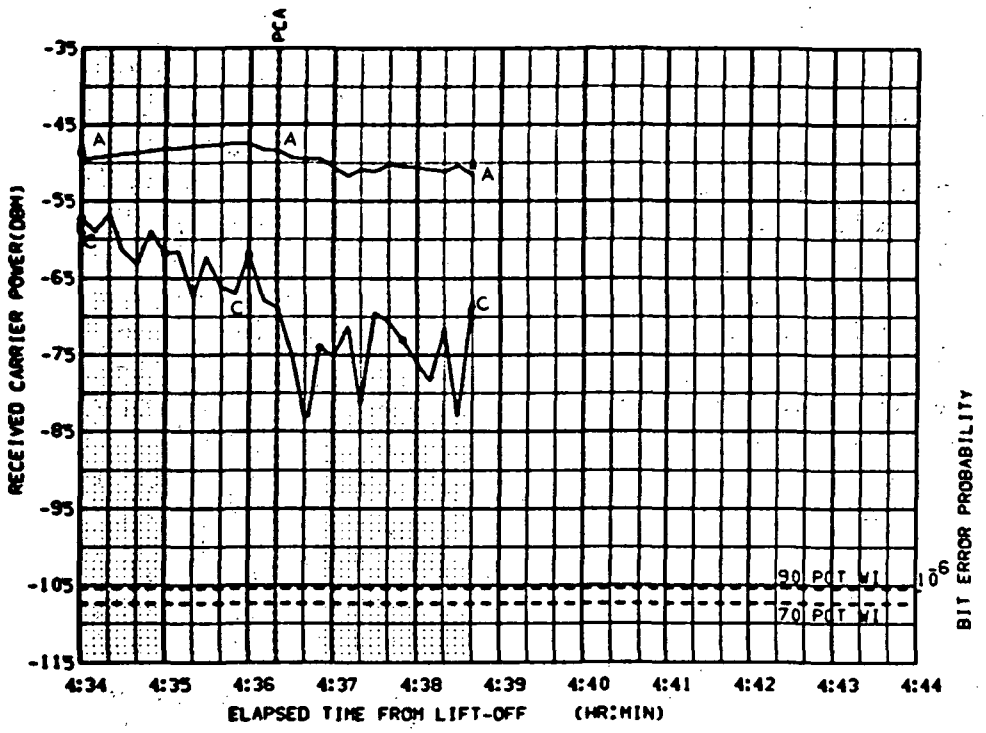

FIGURE 6-85a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

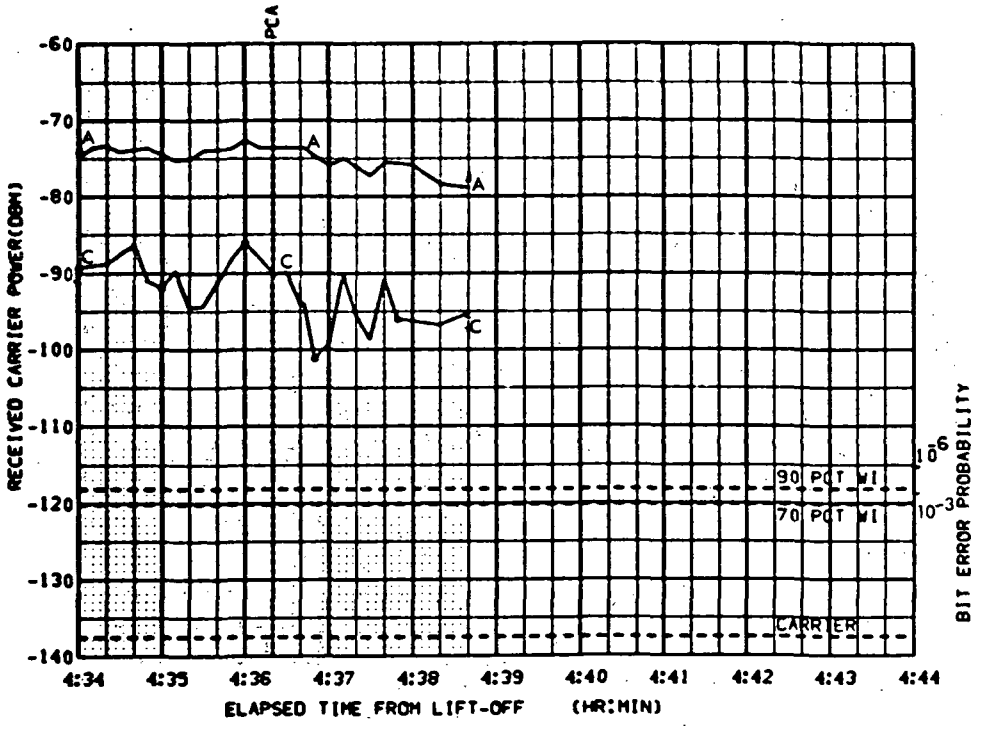

FIGURE 6-85b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

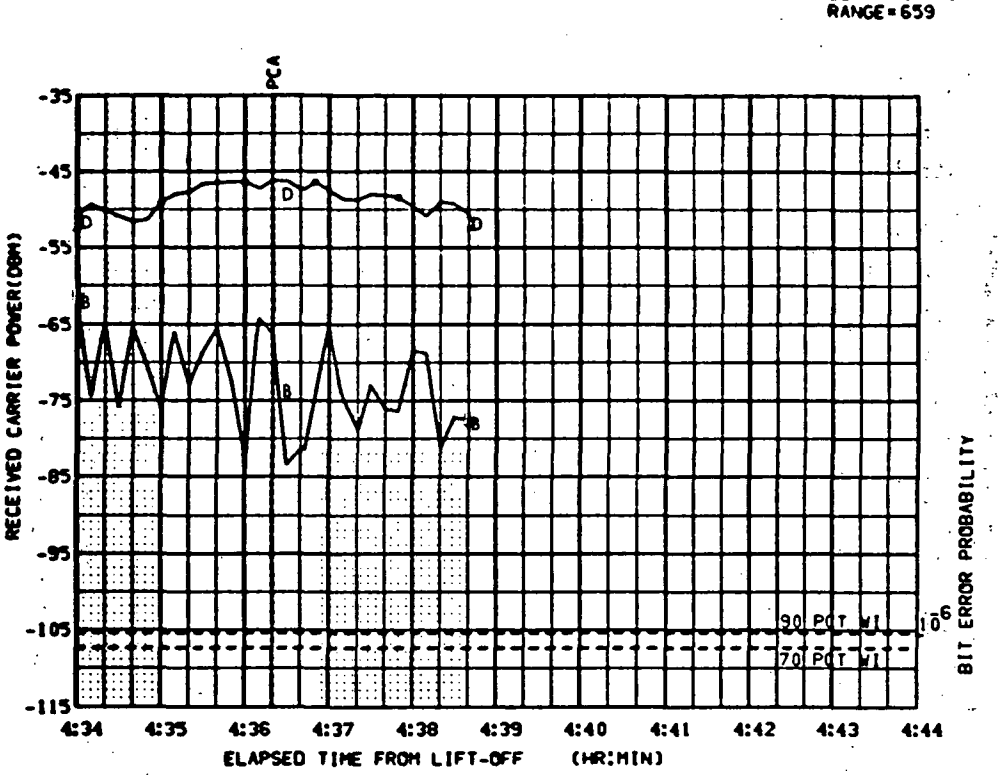

FIGURE 6-85c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

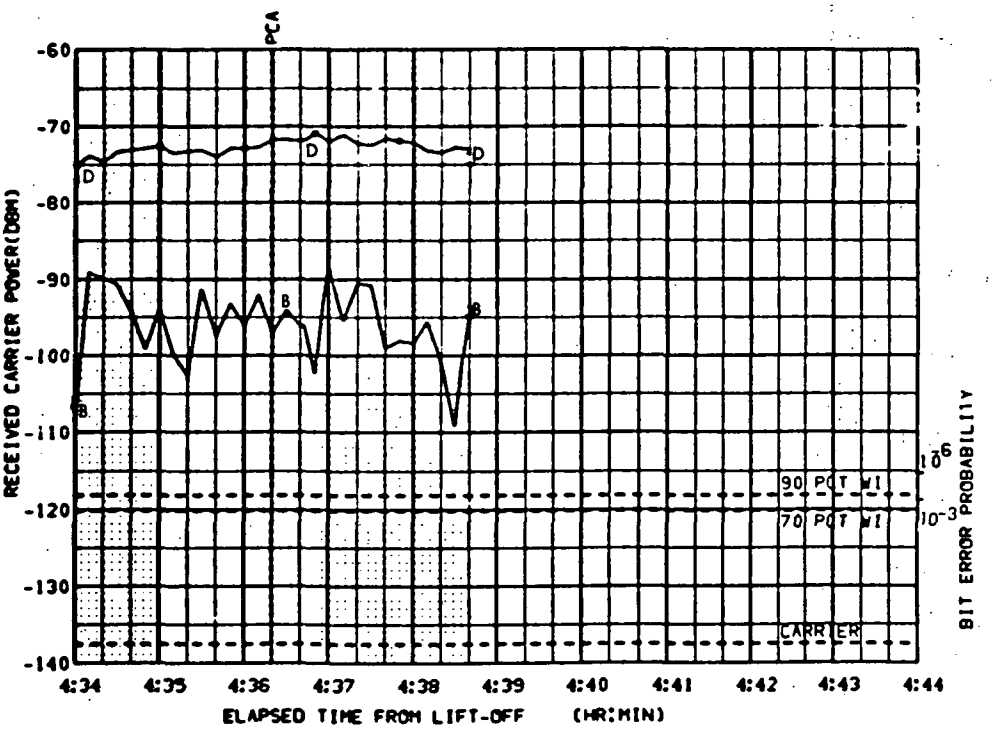

FIGURE 6-85d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

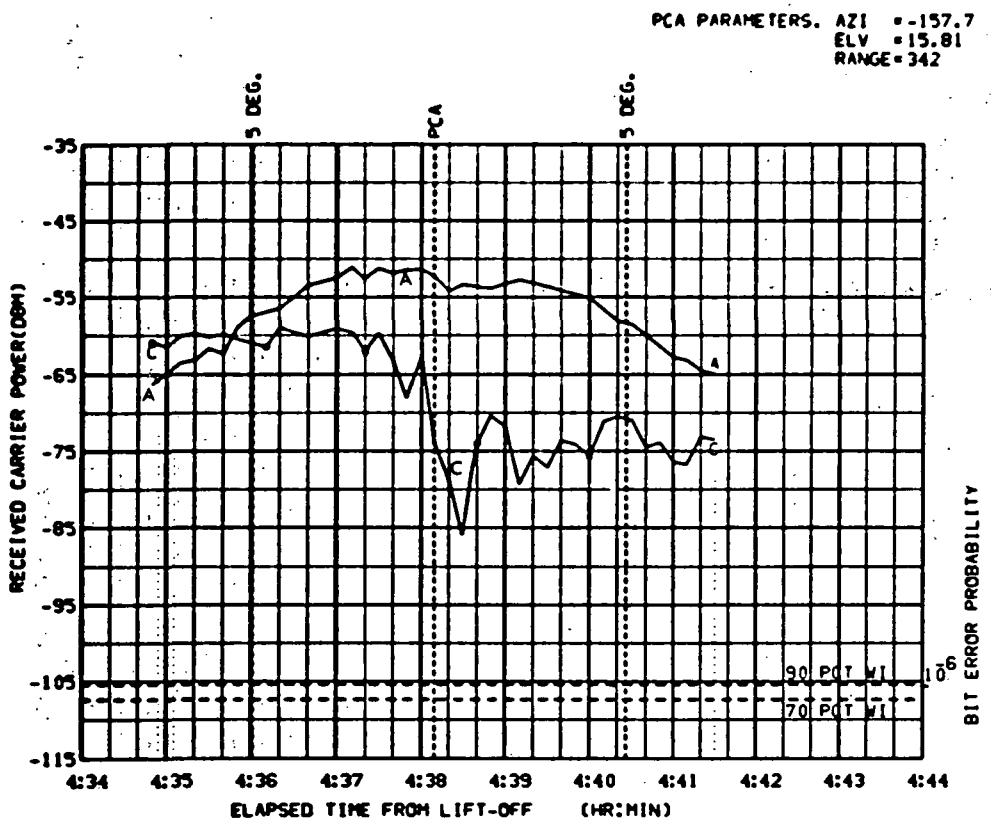

FIGURE 6-86a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

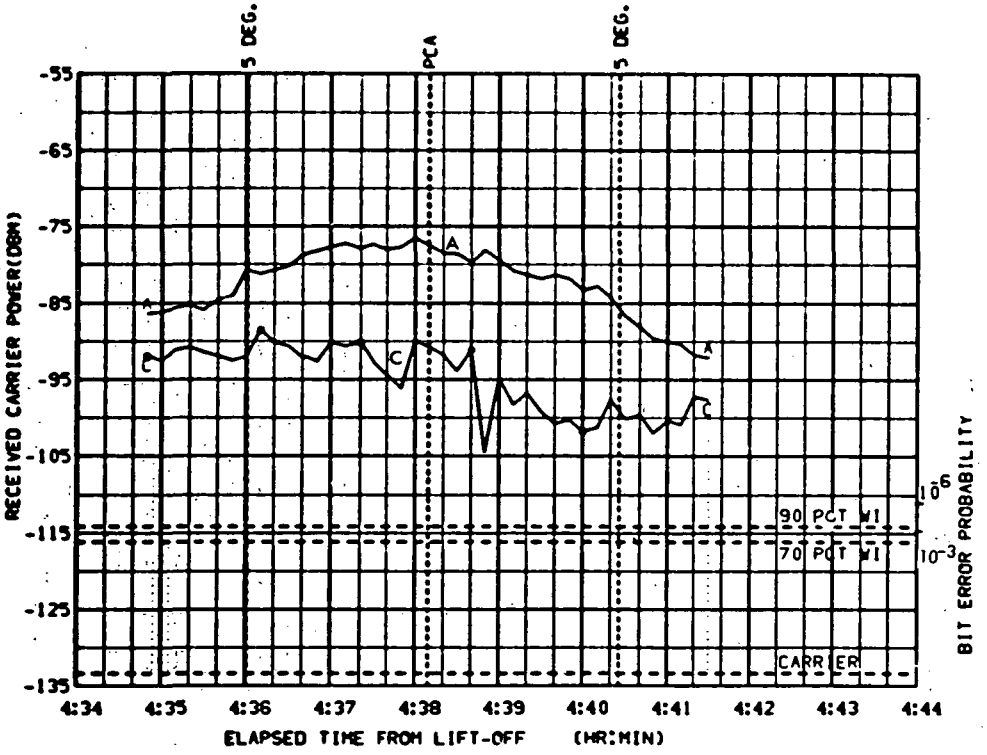

FIGURE 6-86b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

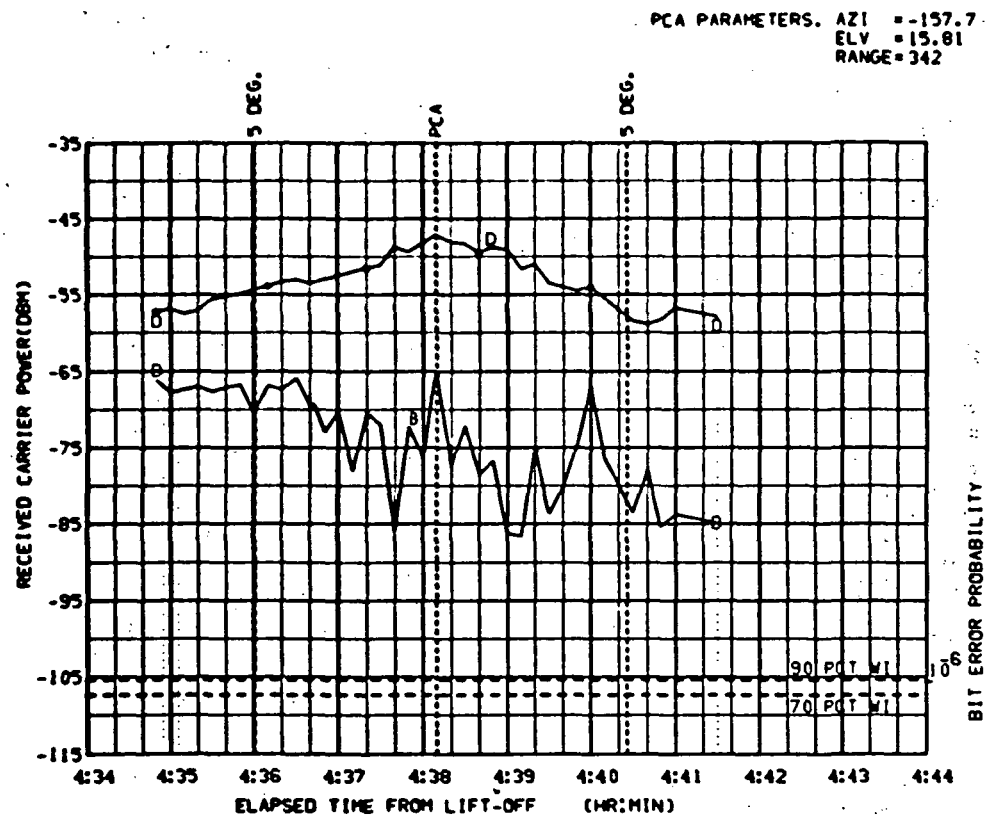

FIGURE 6-86c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

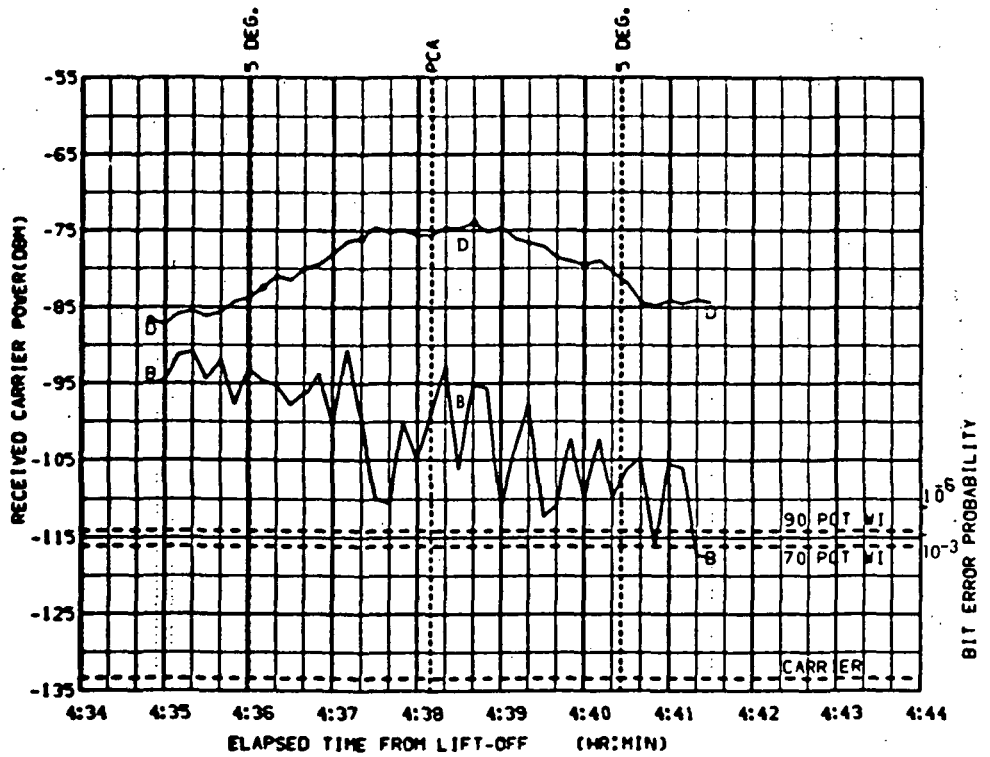

FIGURE 6-86d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

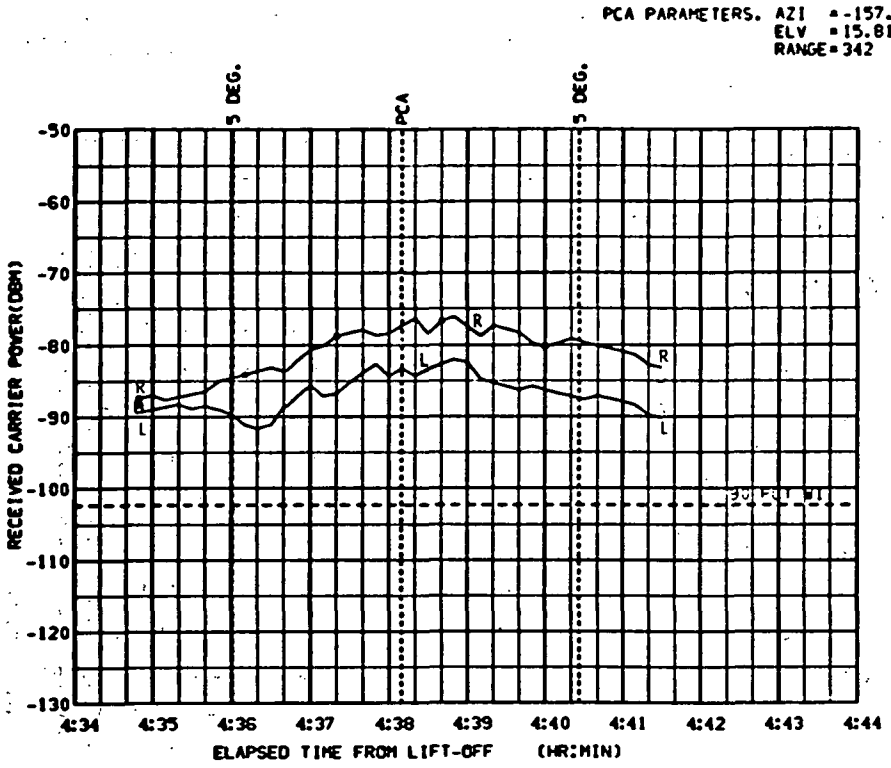

FIGURE 6-86e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

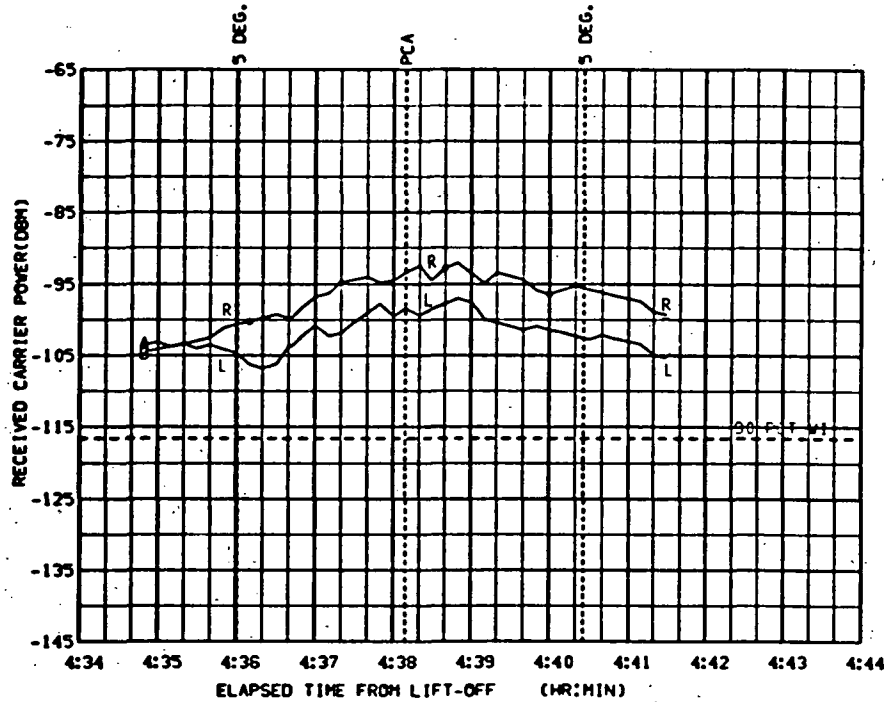

FIGURE 6-86f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

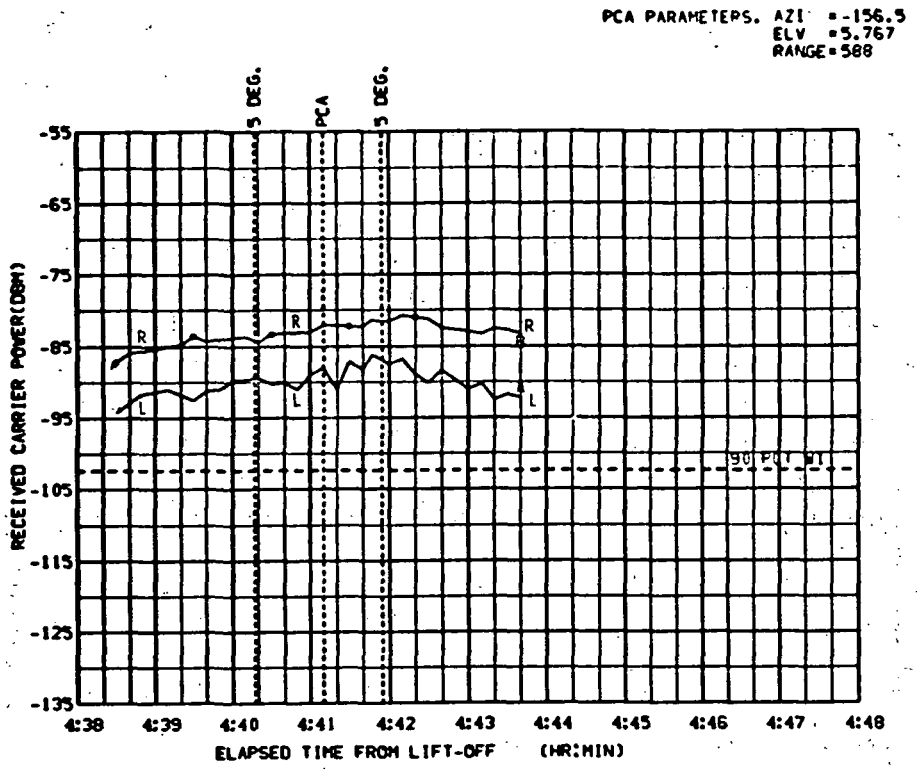

FIGURE 6-87a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

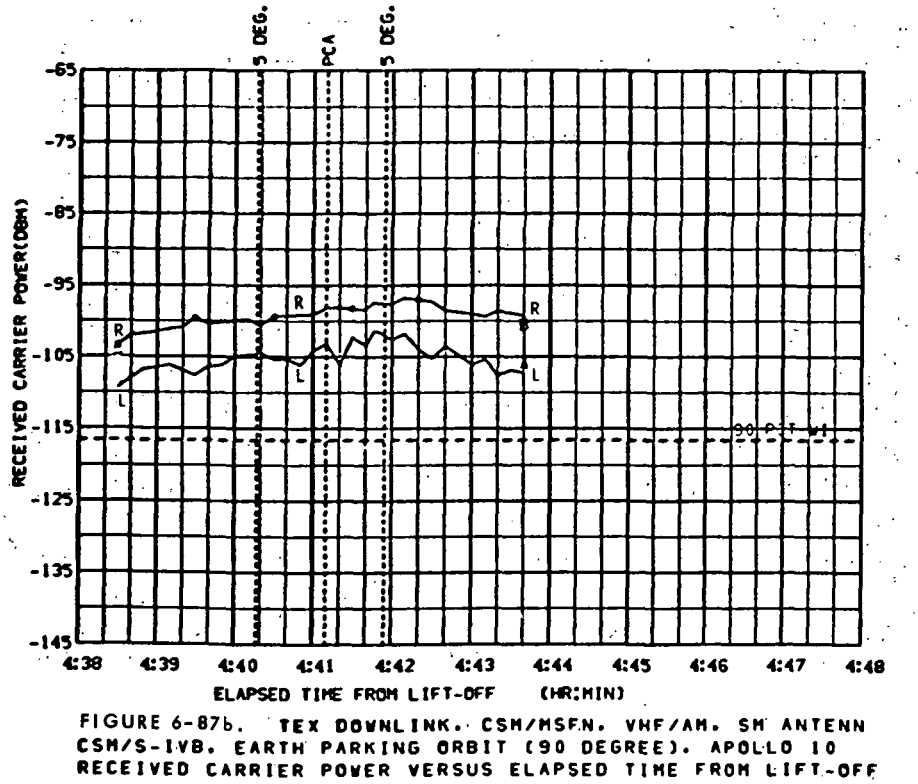

FIGURE 6-87b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

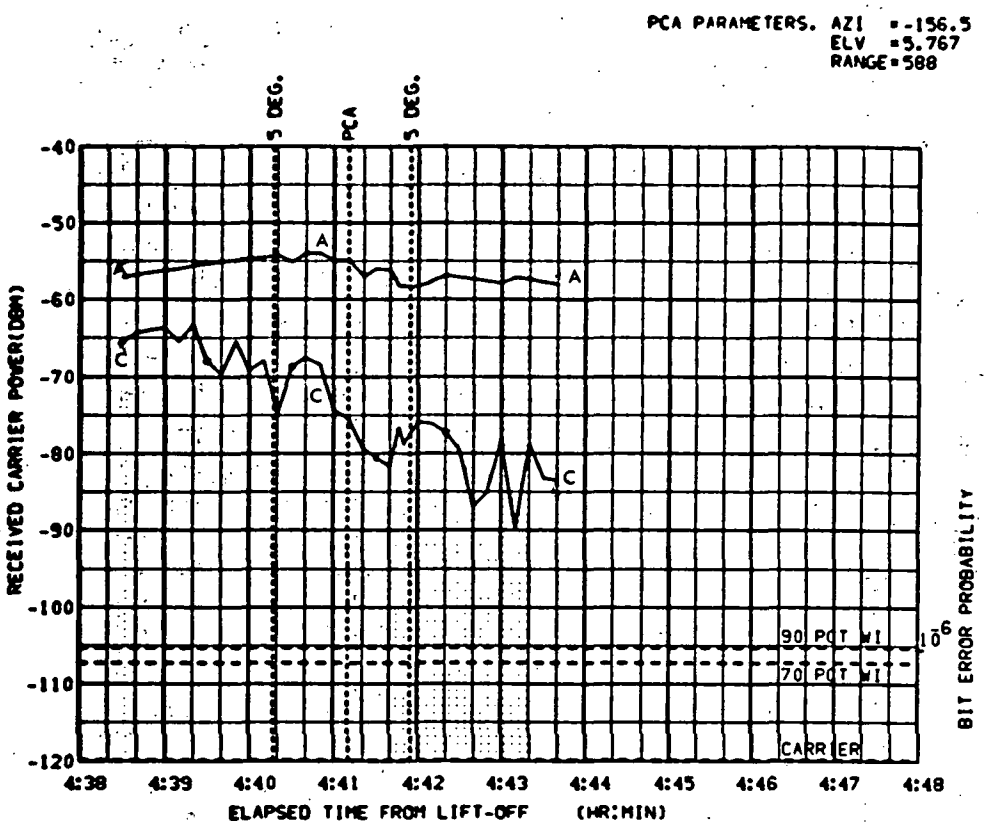

FIGURE 6-87c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

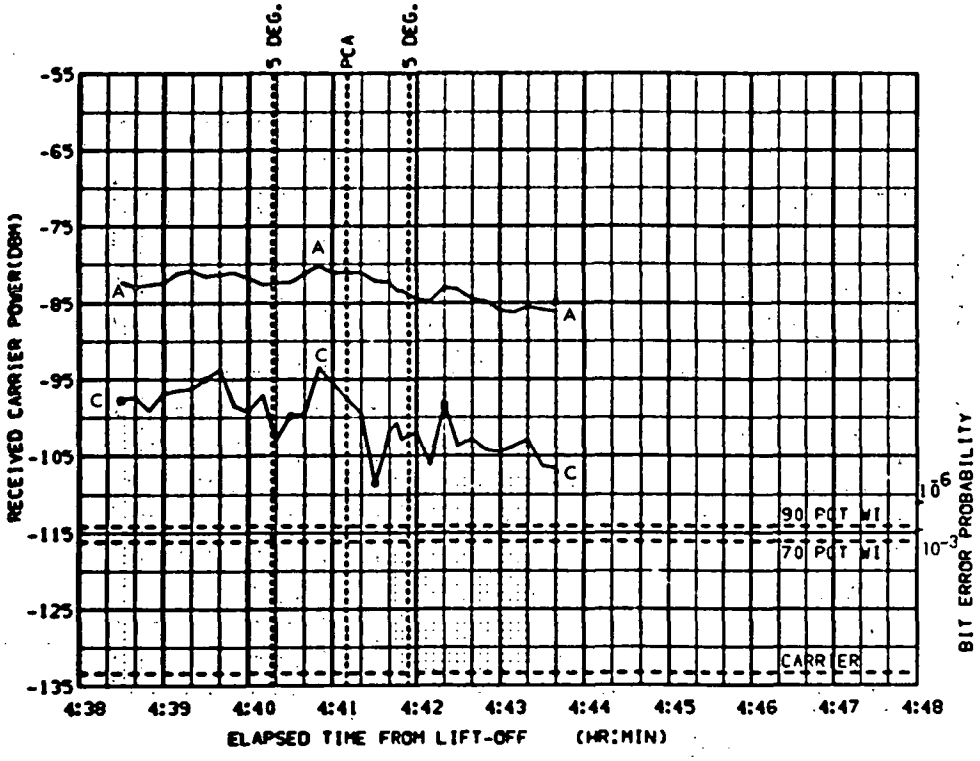

FIGURE 6-87d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

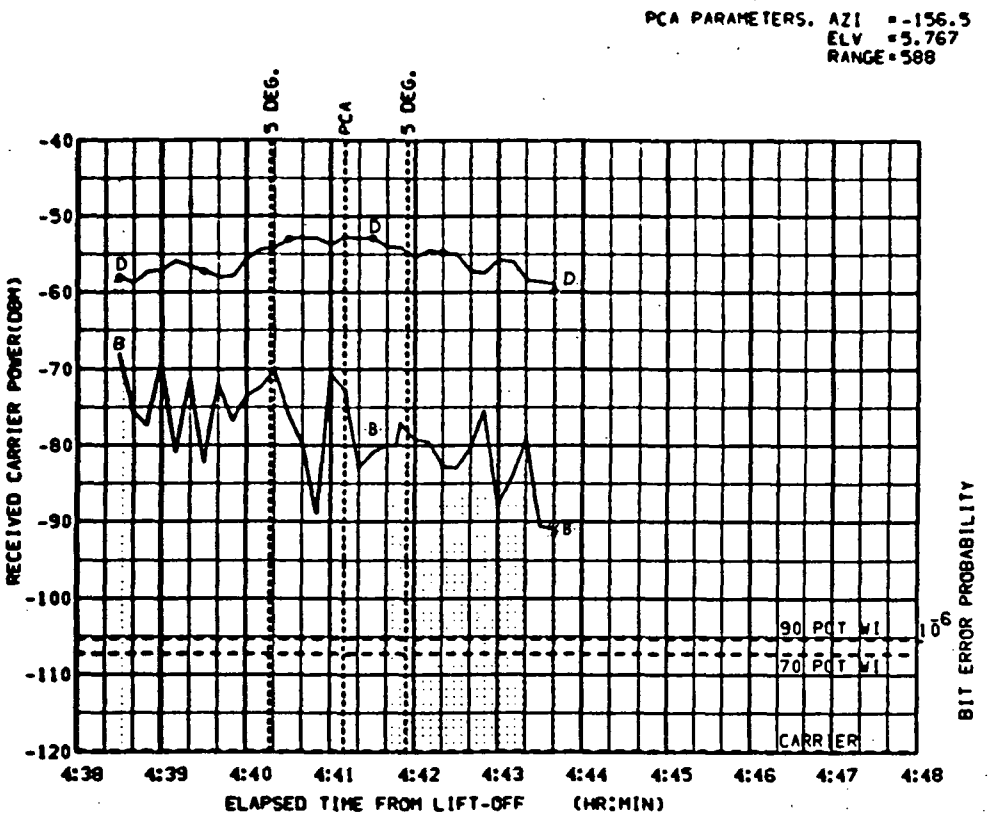

FIGURE 6-87e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

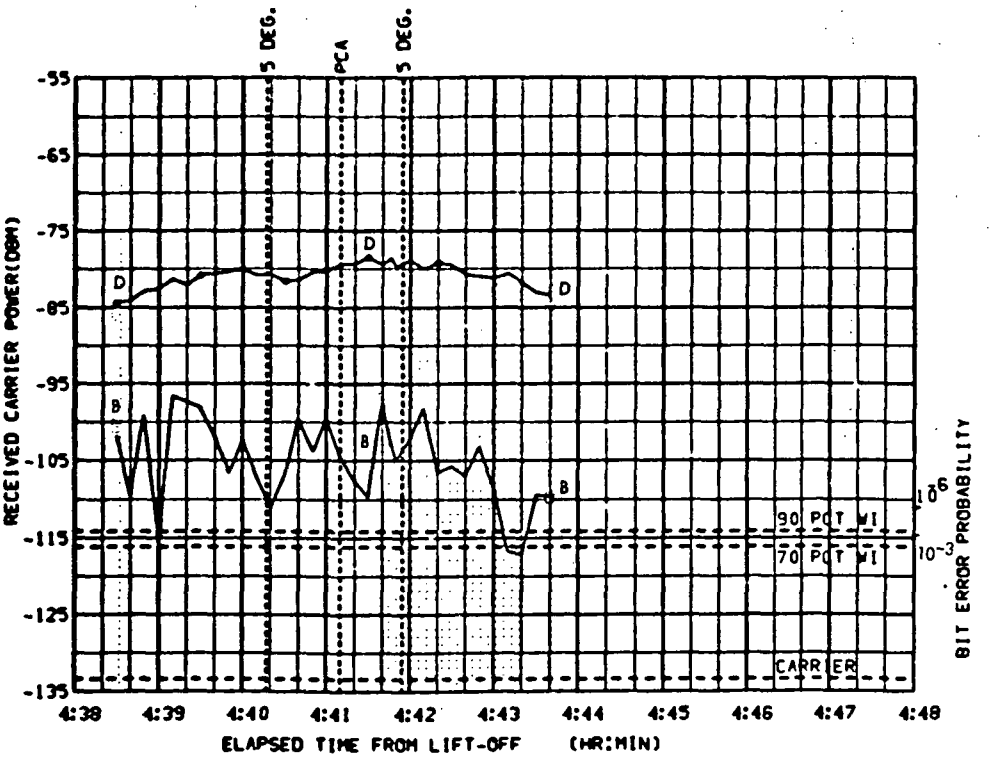

FIGURE 6-87f. TEX ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (90 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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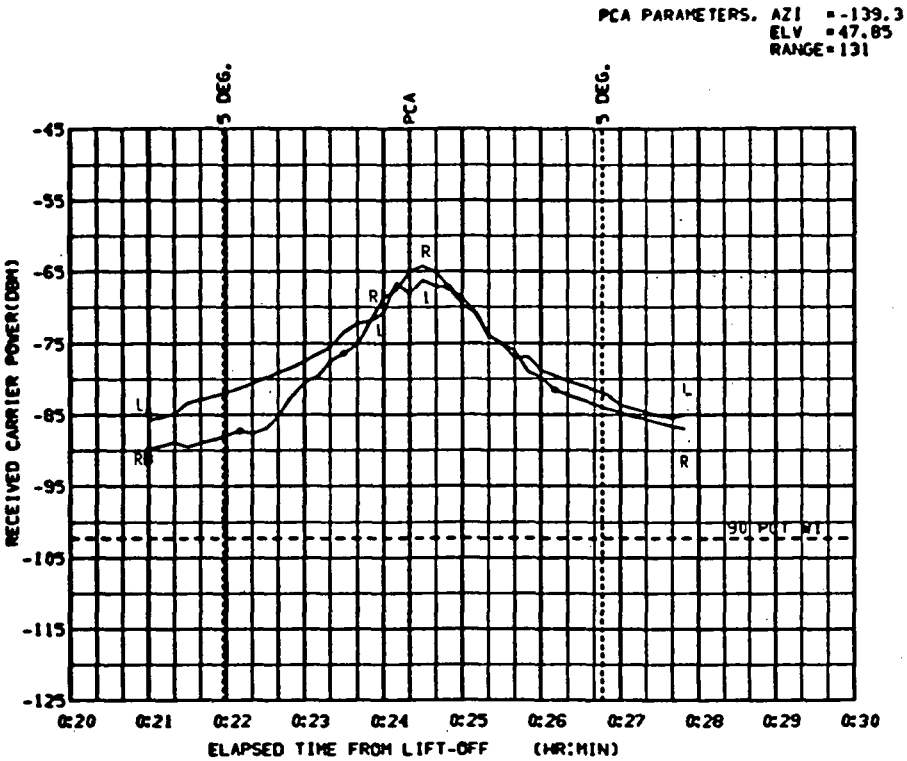


FIGURE 6-88a. ASC UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

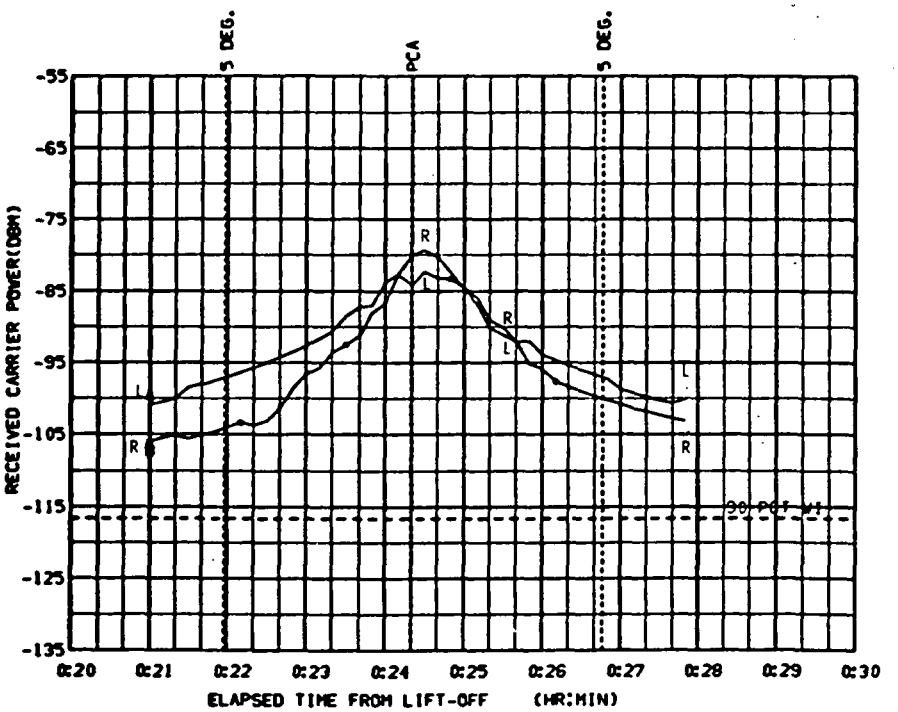


FIGURE 6-88b. ASC DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

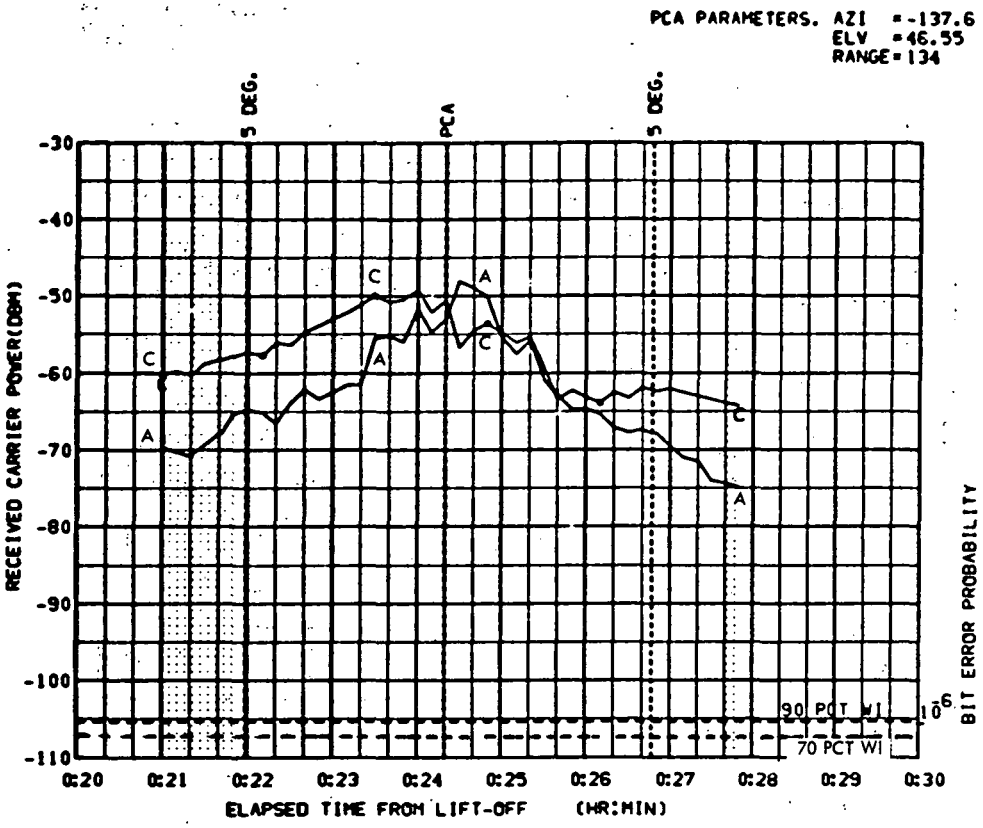


FIGURE 6-88c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

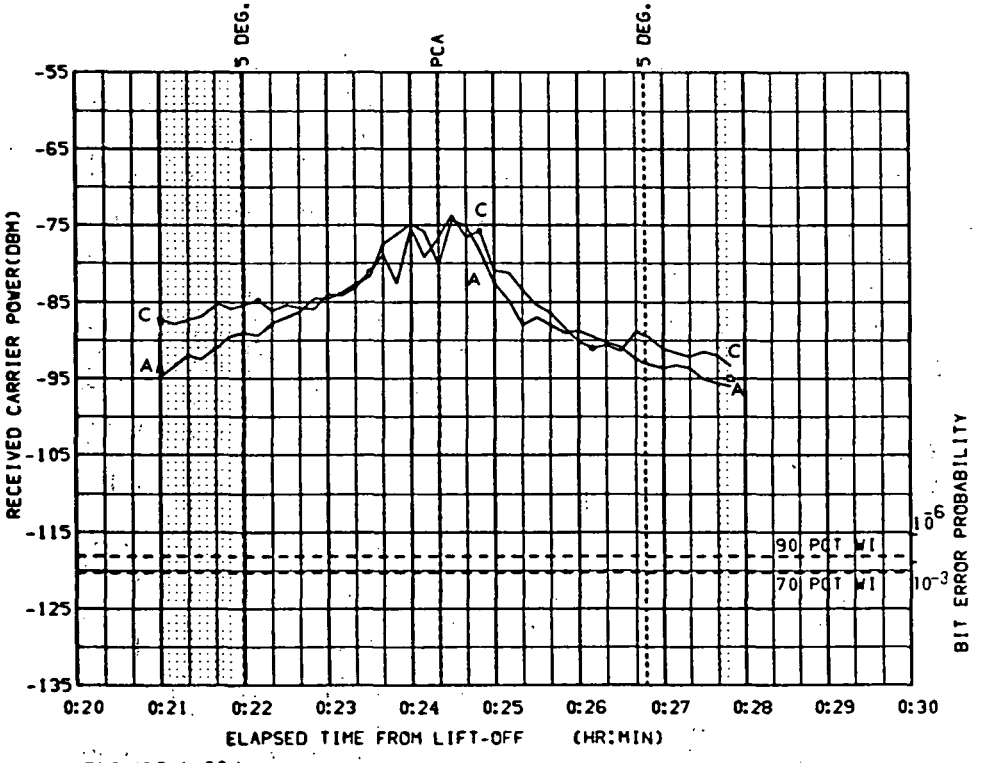


FIGURE 6-88d. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

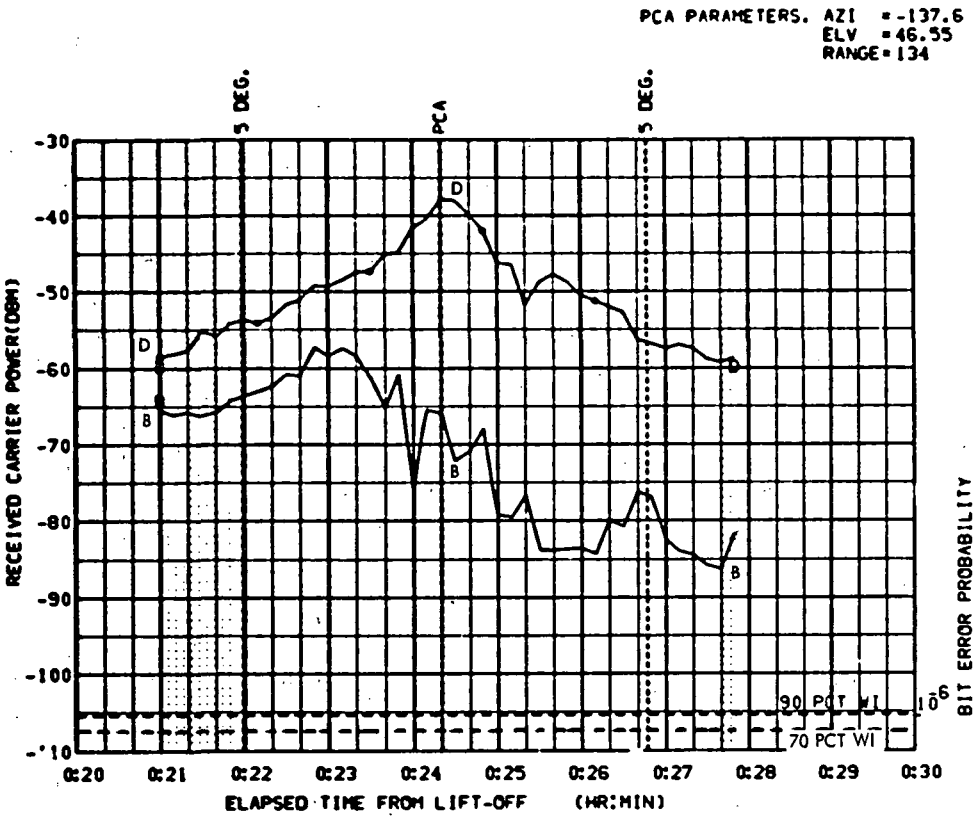


FIGURE 6-88e. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

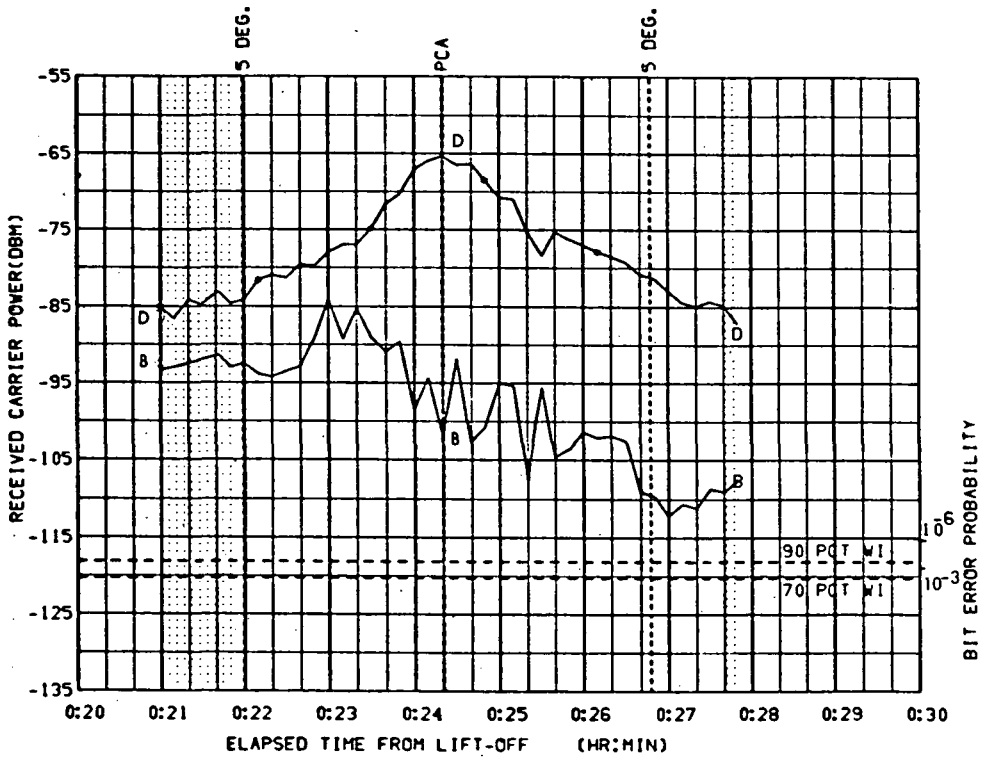


FIGURE 6-88f. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

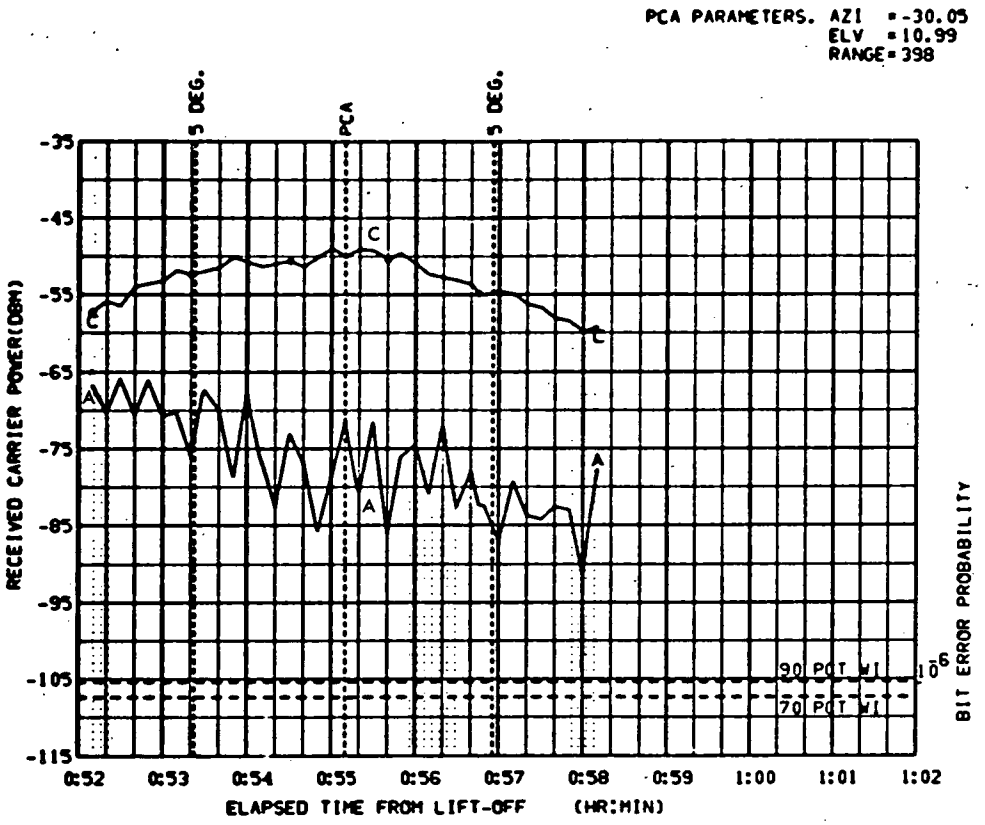


FIGURE 6-89a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

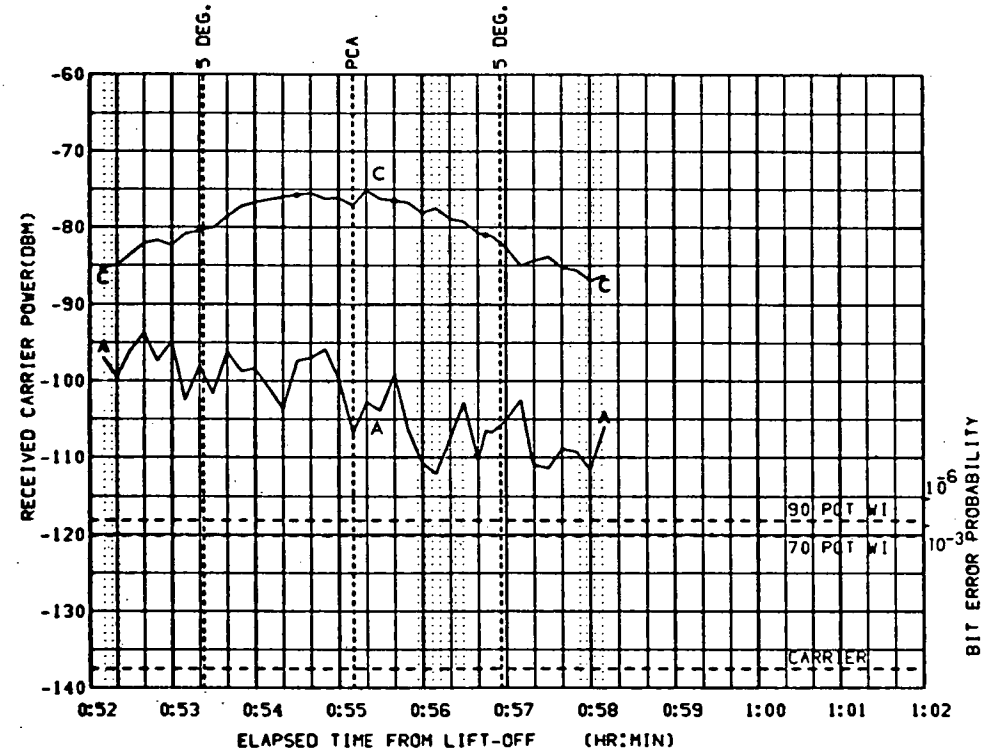


FIGURE 6-89b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

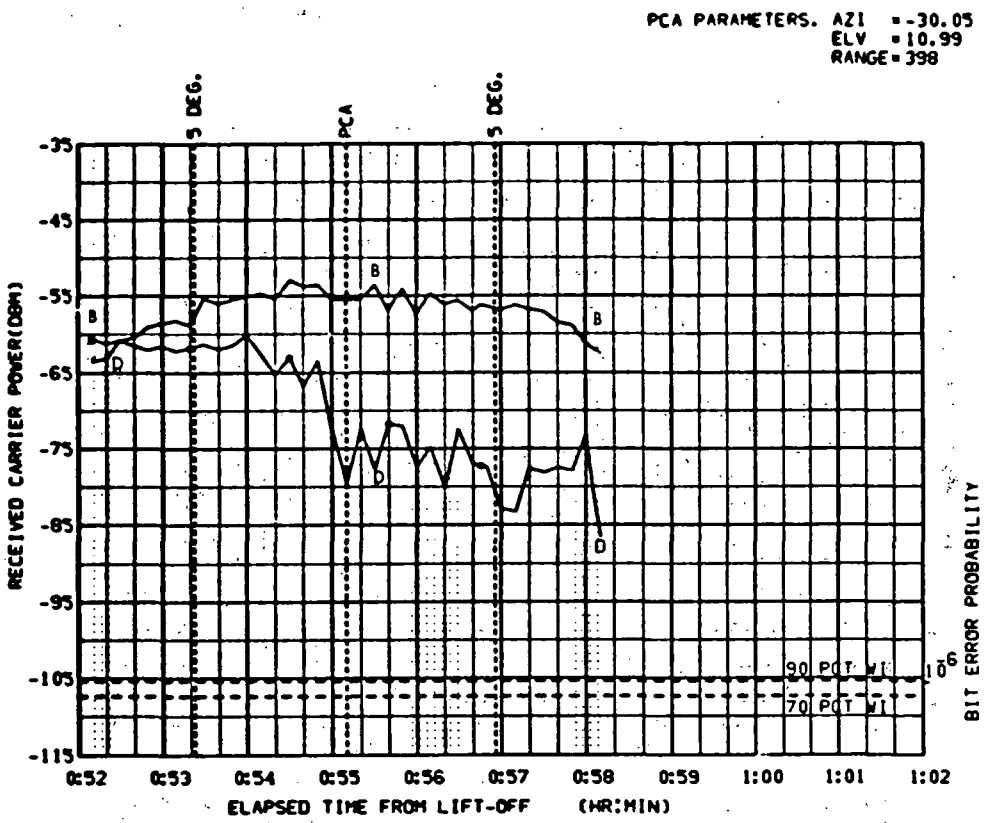


FIGURE 6-89c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

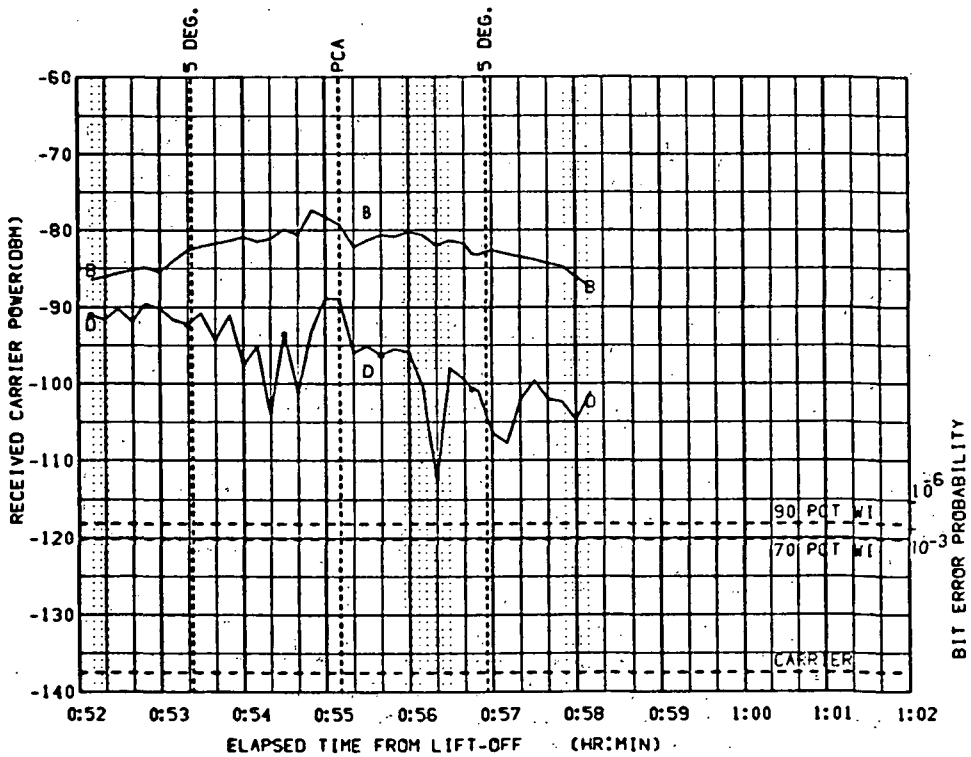


FIGURE 6-89d. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

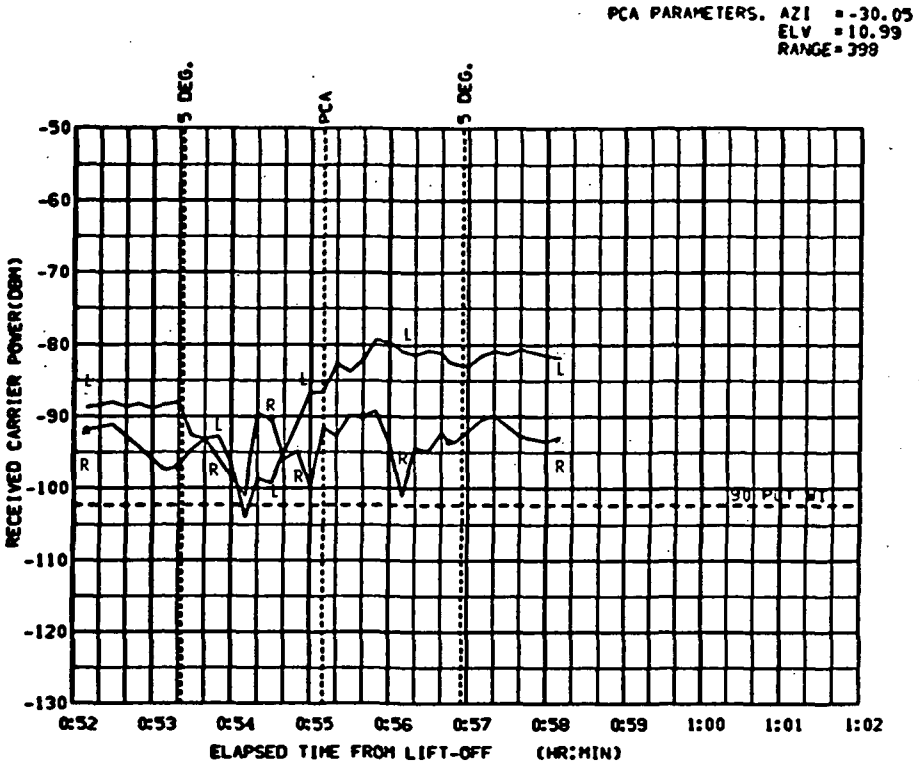


FIGURE 6-89e. CRO UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

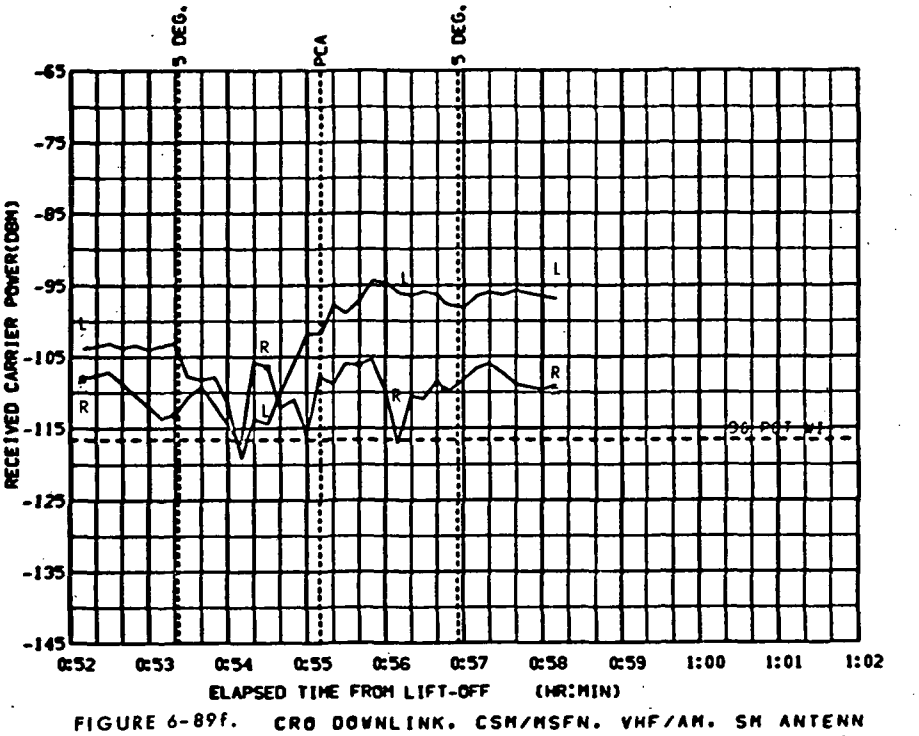


FIGURE 6-89f. CRO DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

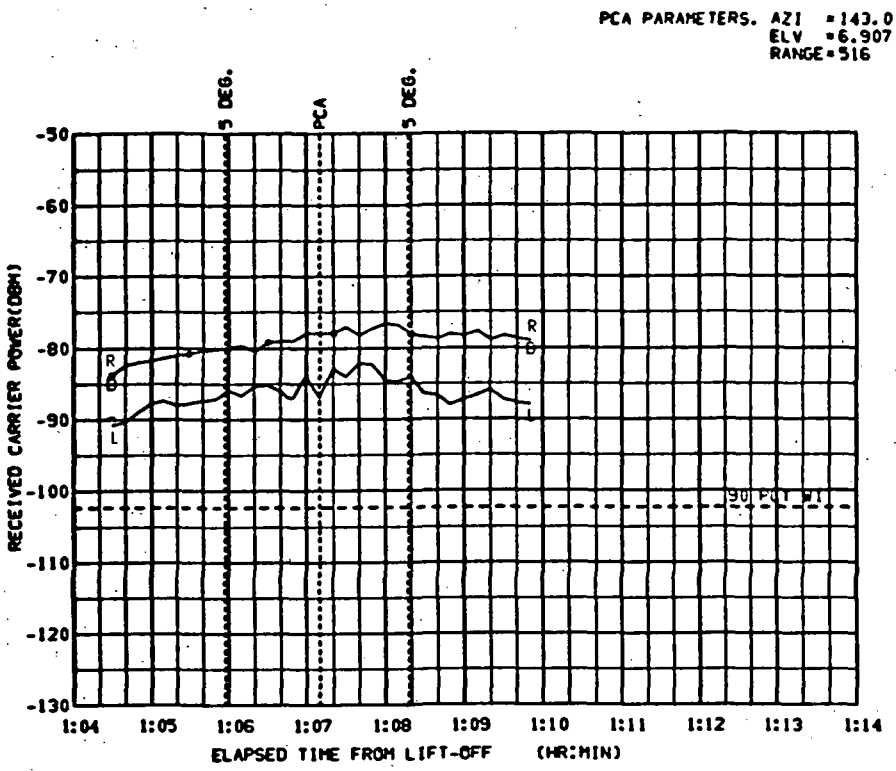


FIGURE 6-90a. GWM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

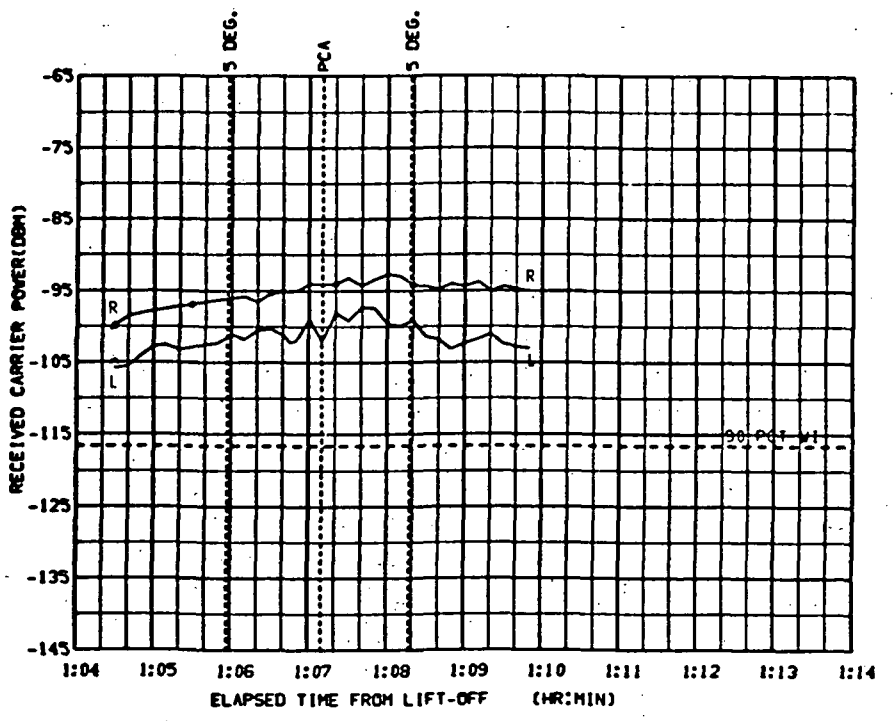


FIGURE 6-90b. GWM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

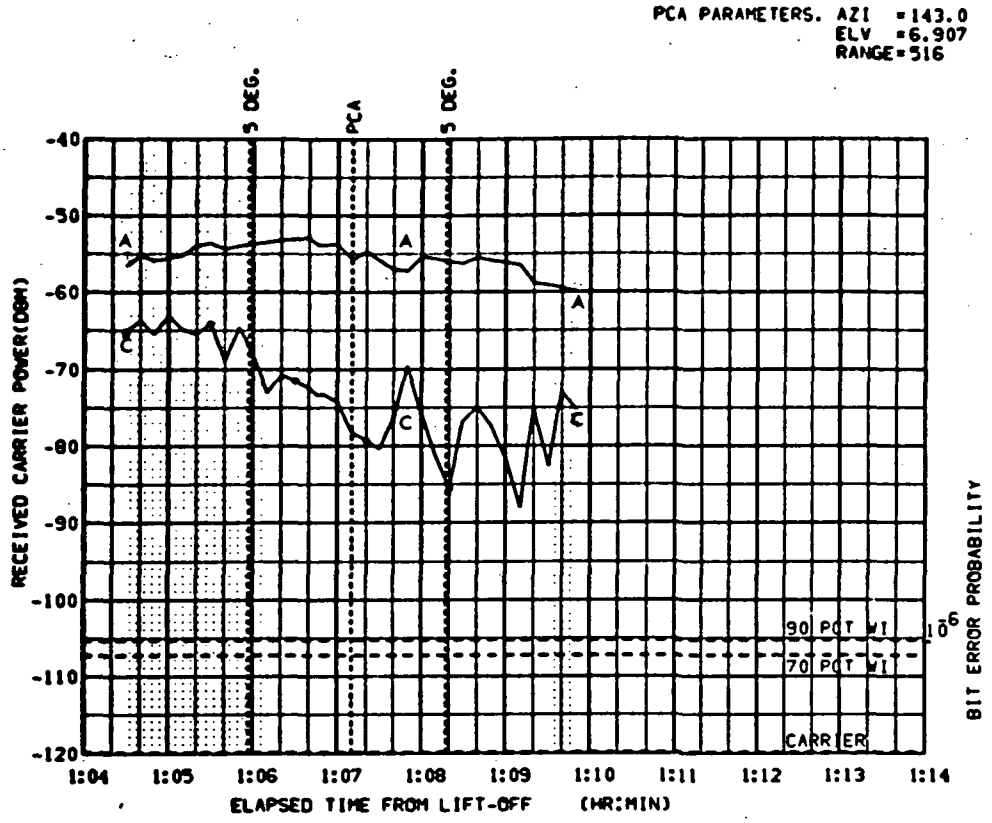


FIGURE 6-90c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

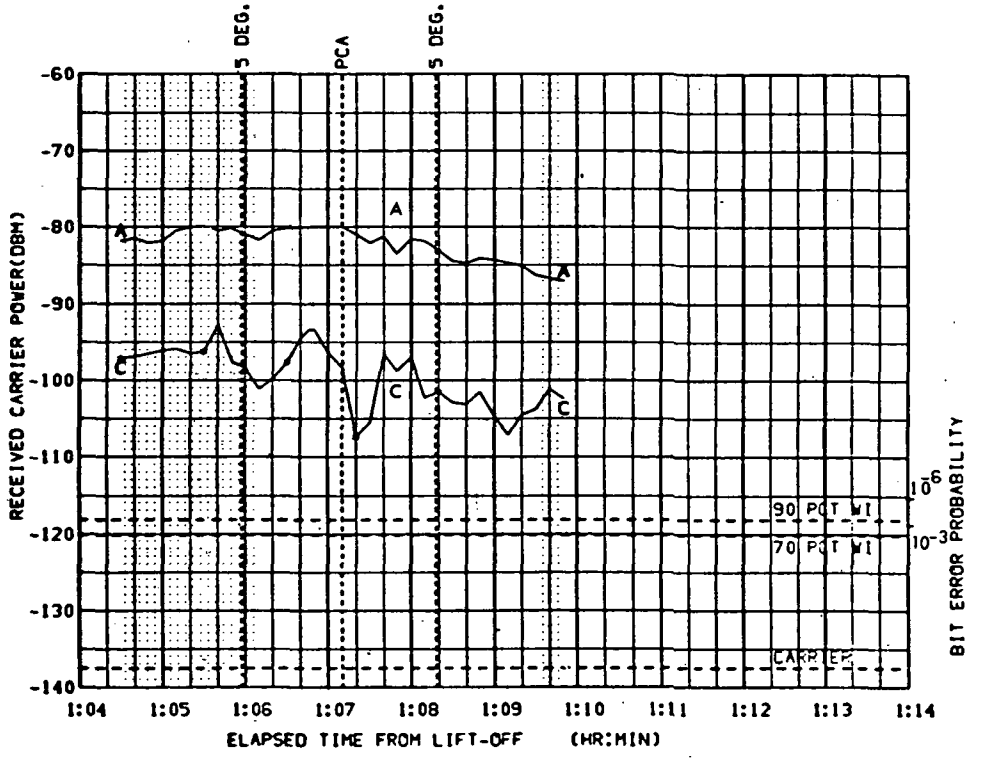


FIGURE 6-90d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

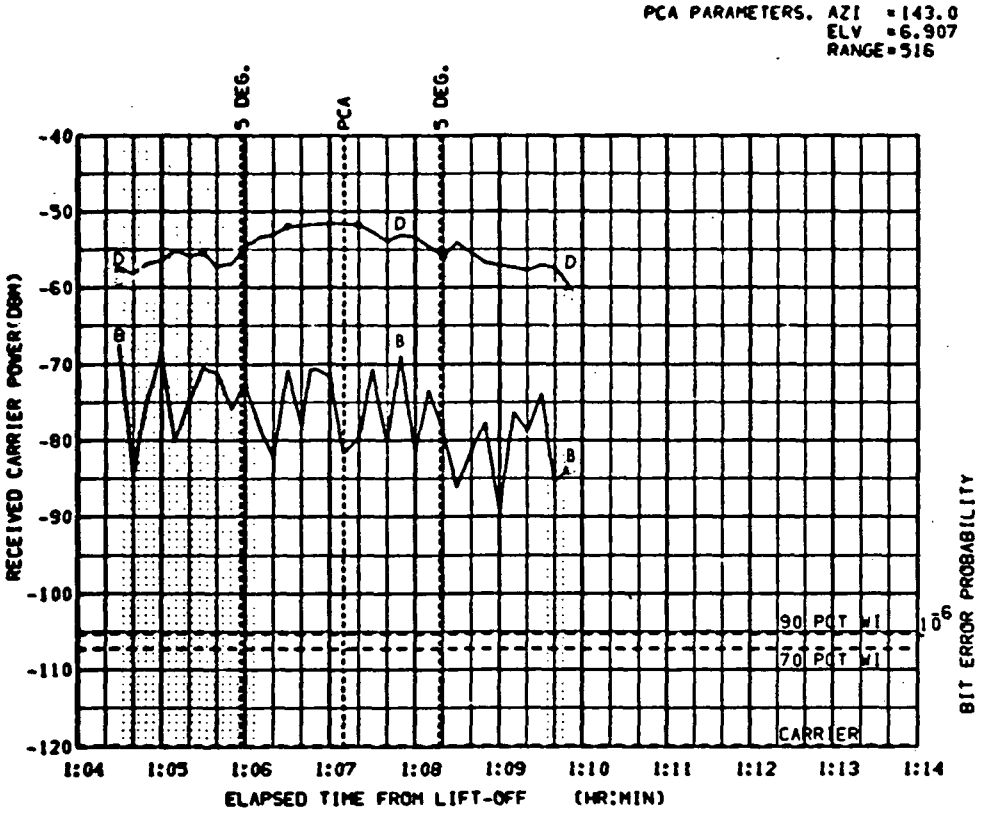


FIGURE 6-90e. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

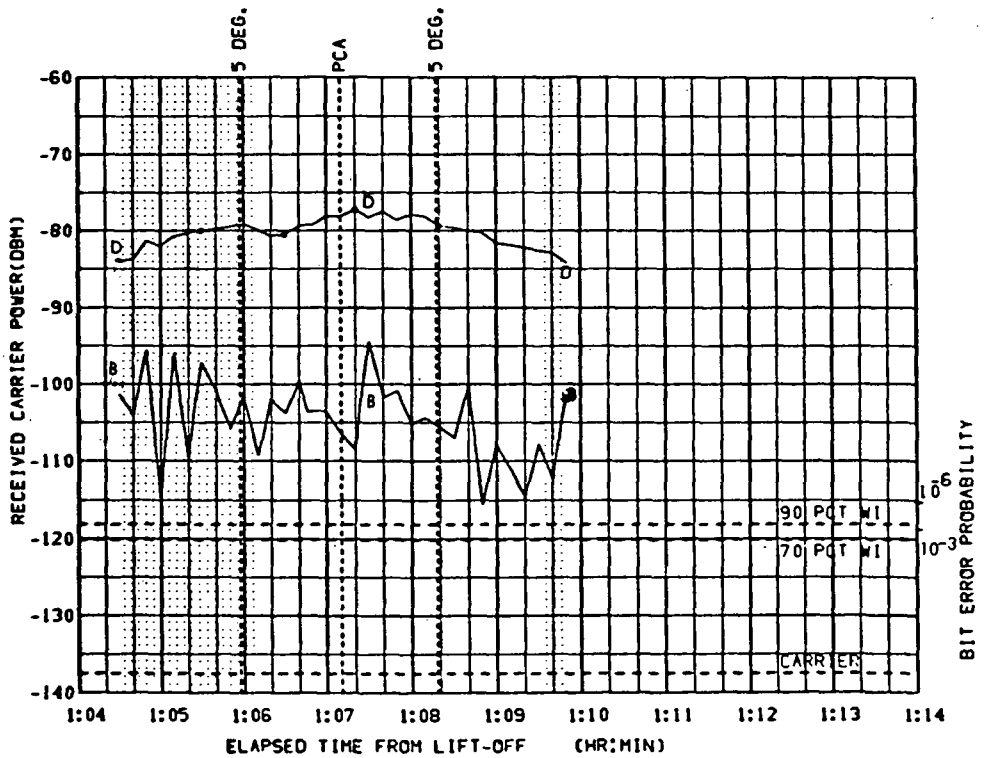


FIGURE 6-90f. GWM ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

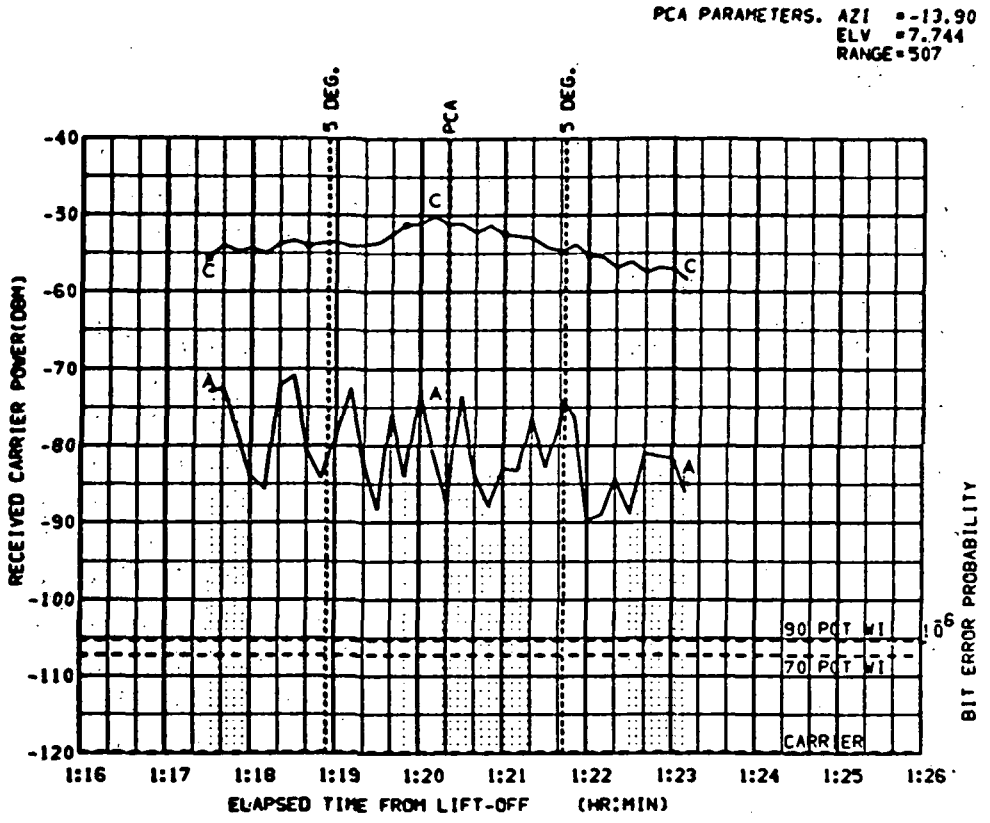


FIGURE 6-91a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

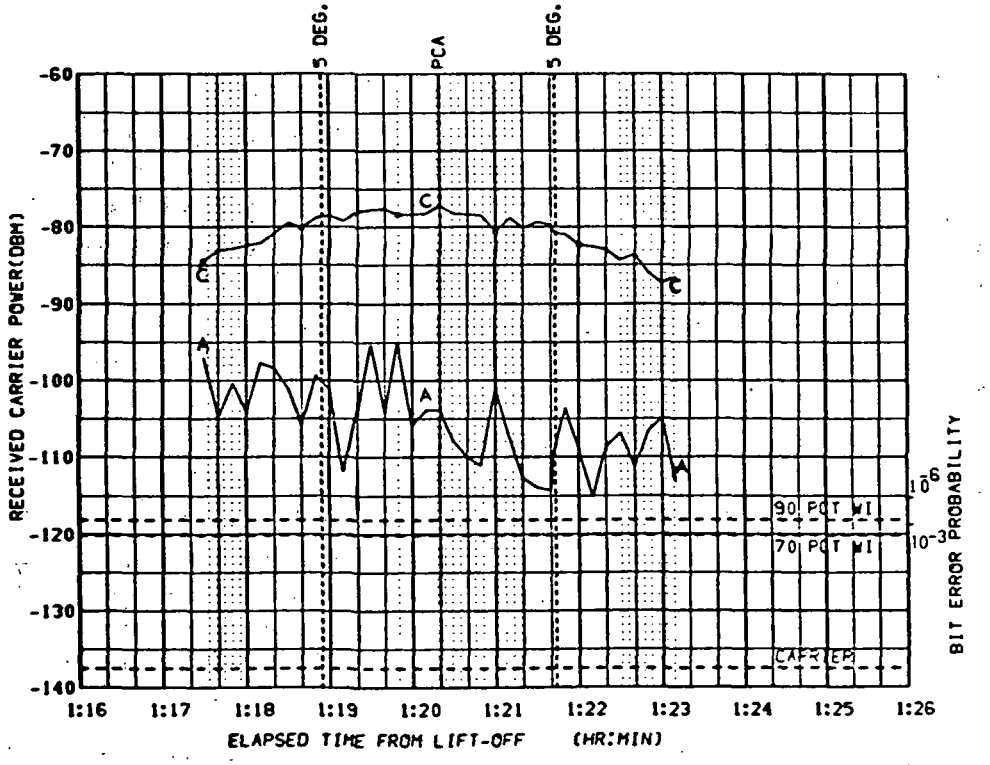


FIGURE 6-91b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

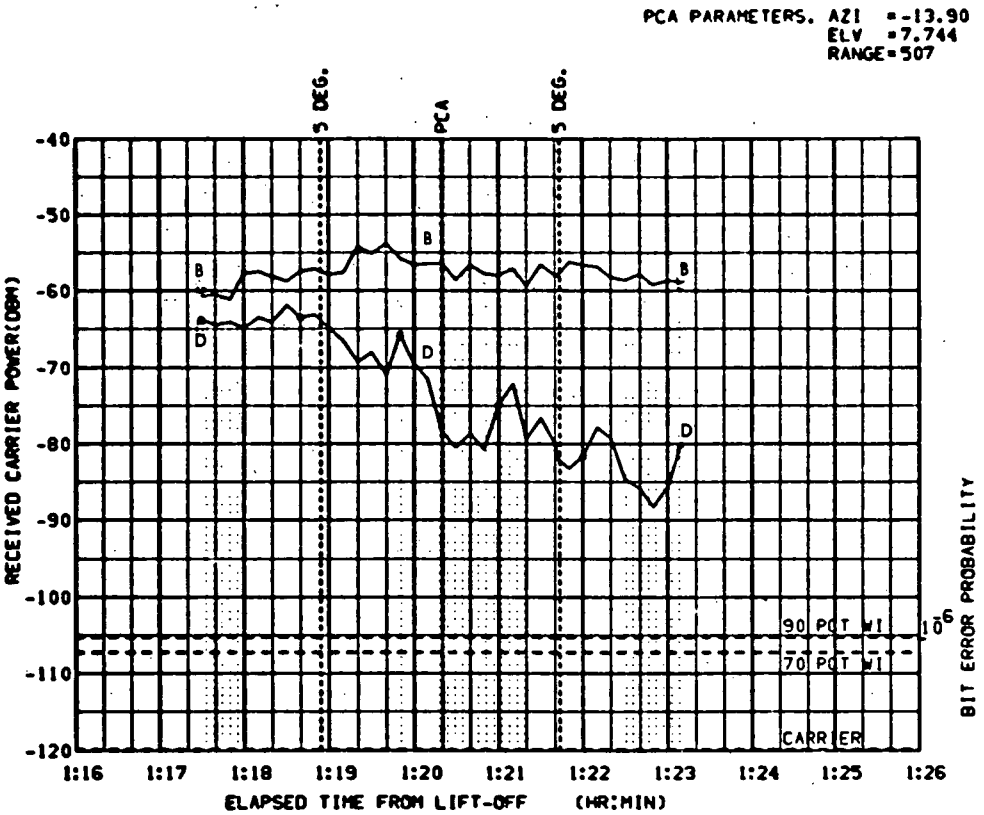


FIGURE 6-91c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

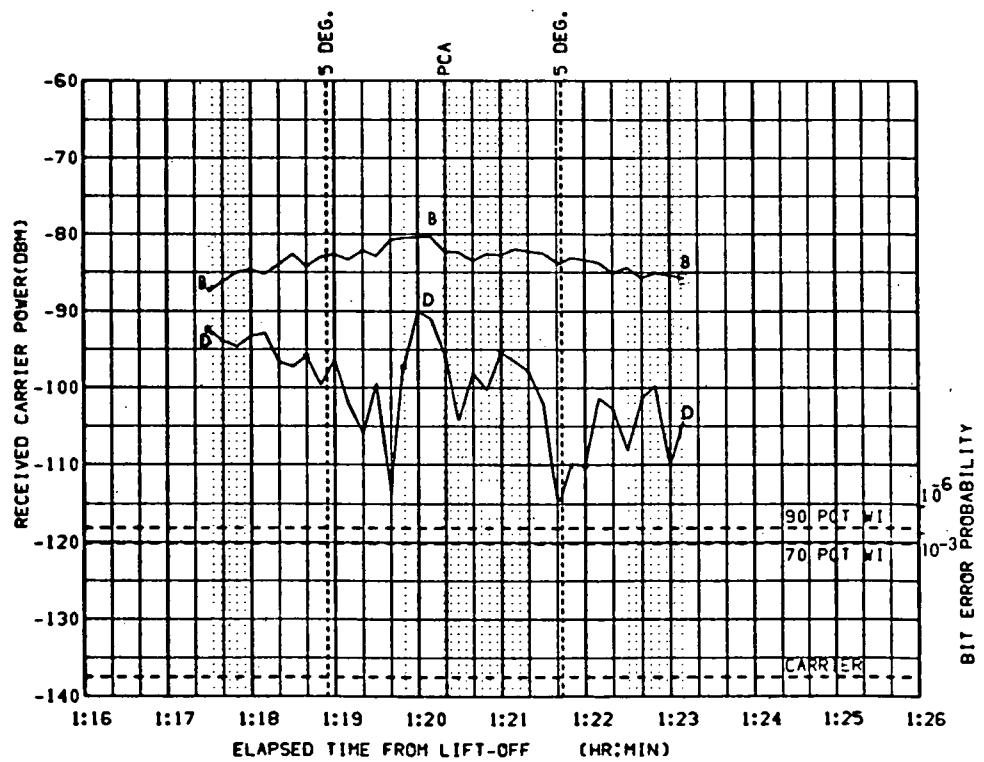


FIGURE 6-91d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

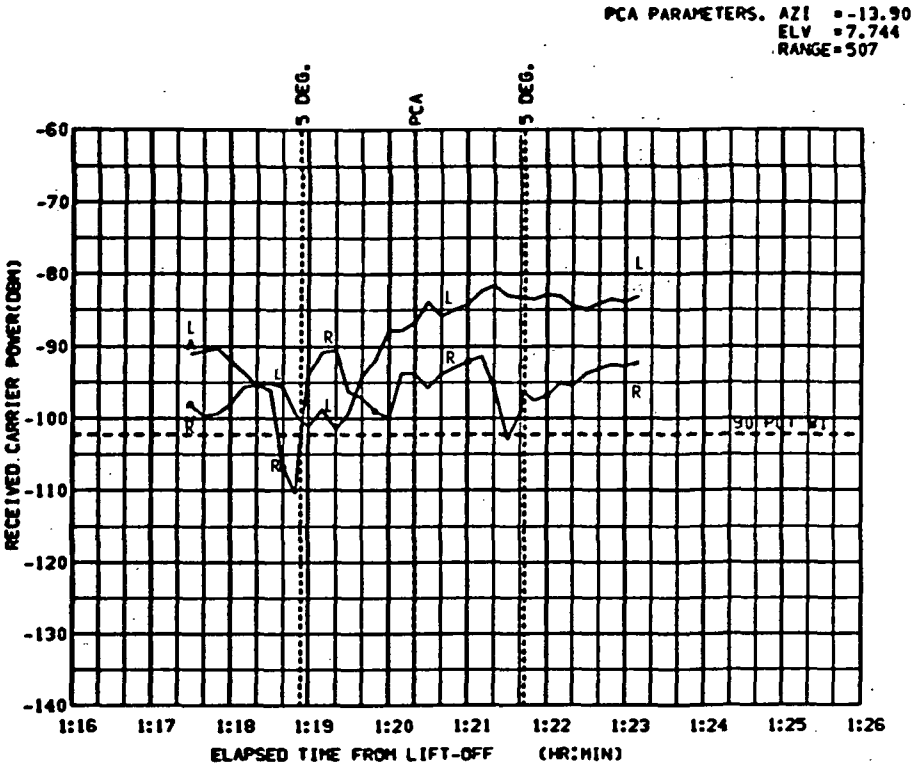


FIGURE 6-91e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

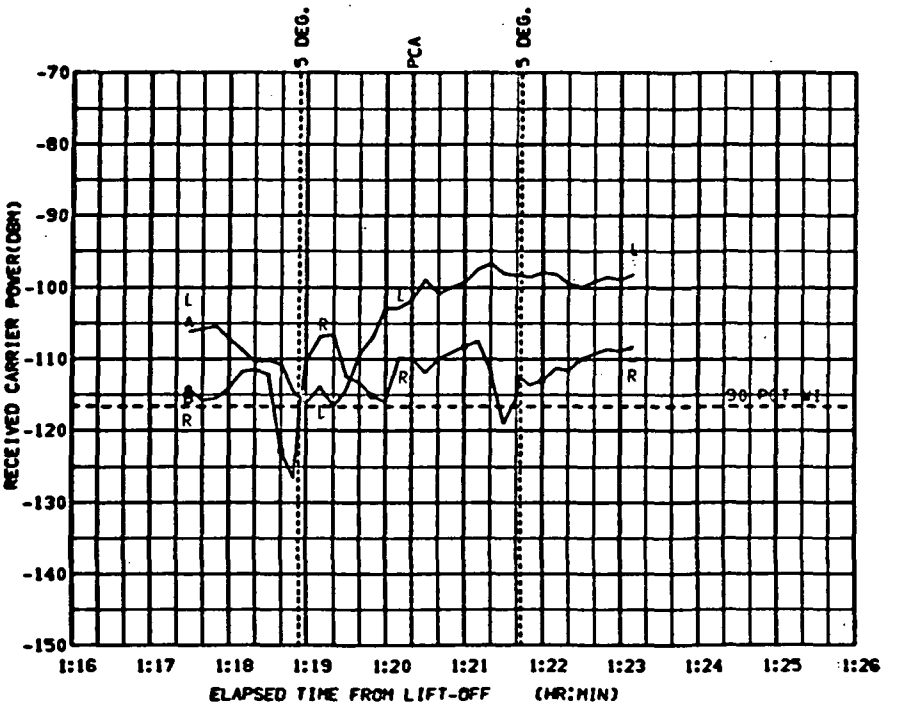


FIGURE 6-91f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

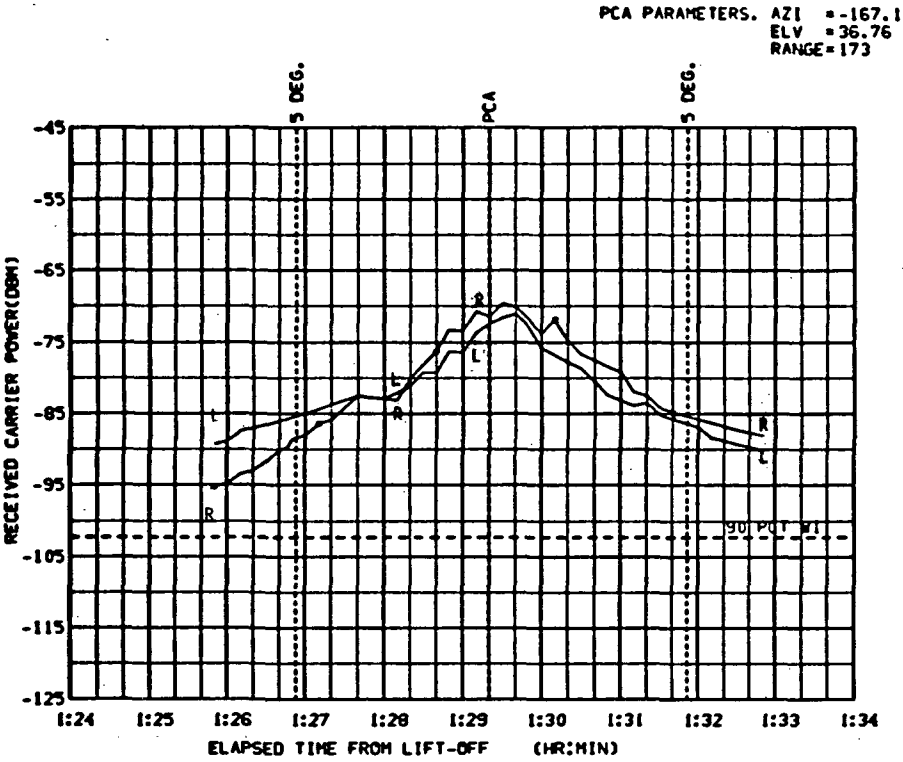


FIGURE 6-92a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

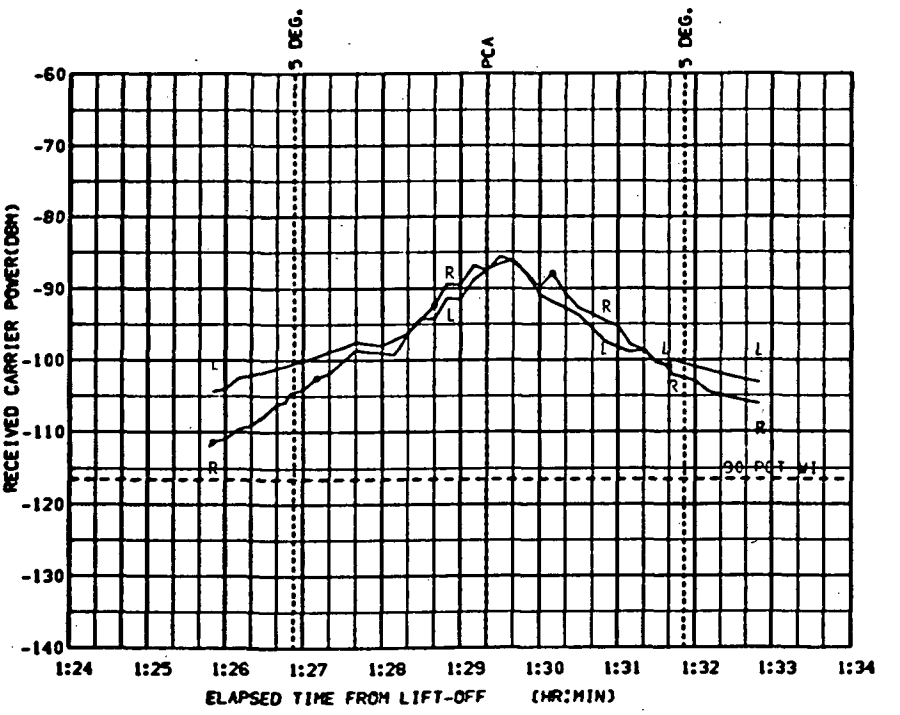


FIGURE 6-92b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

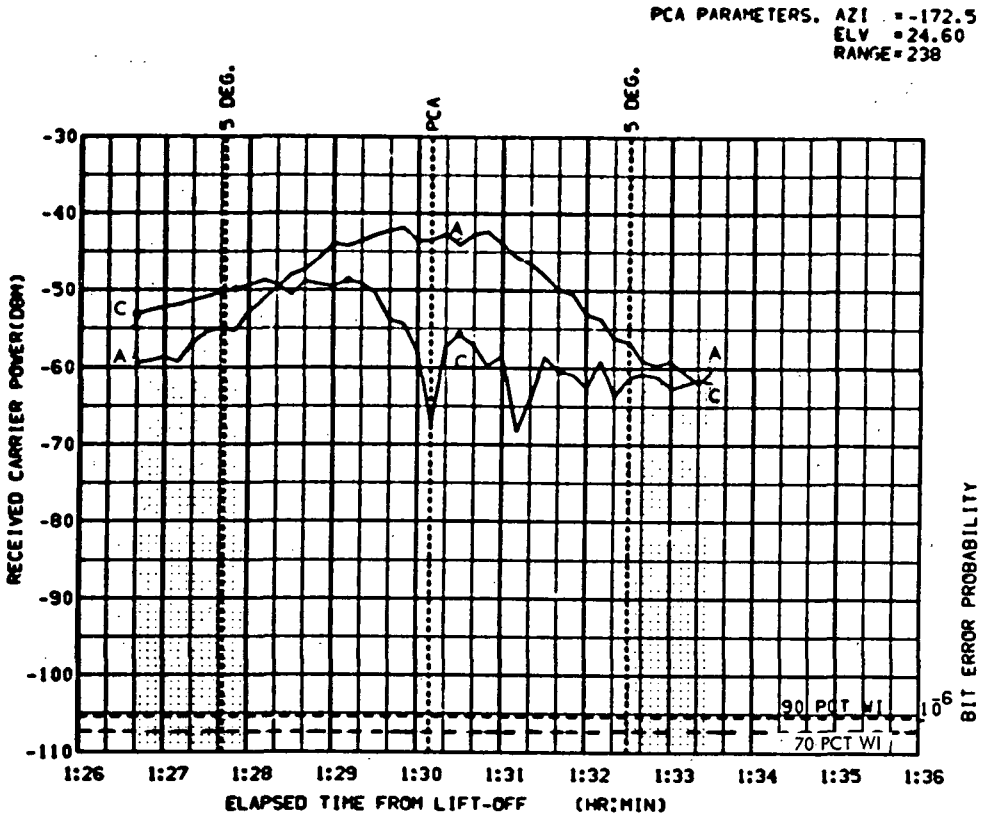


FIGURE 6-93a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

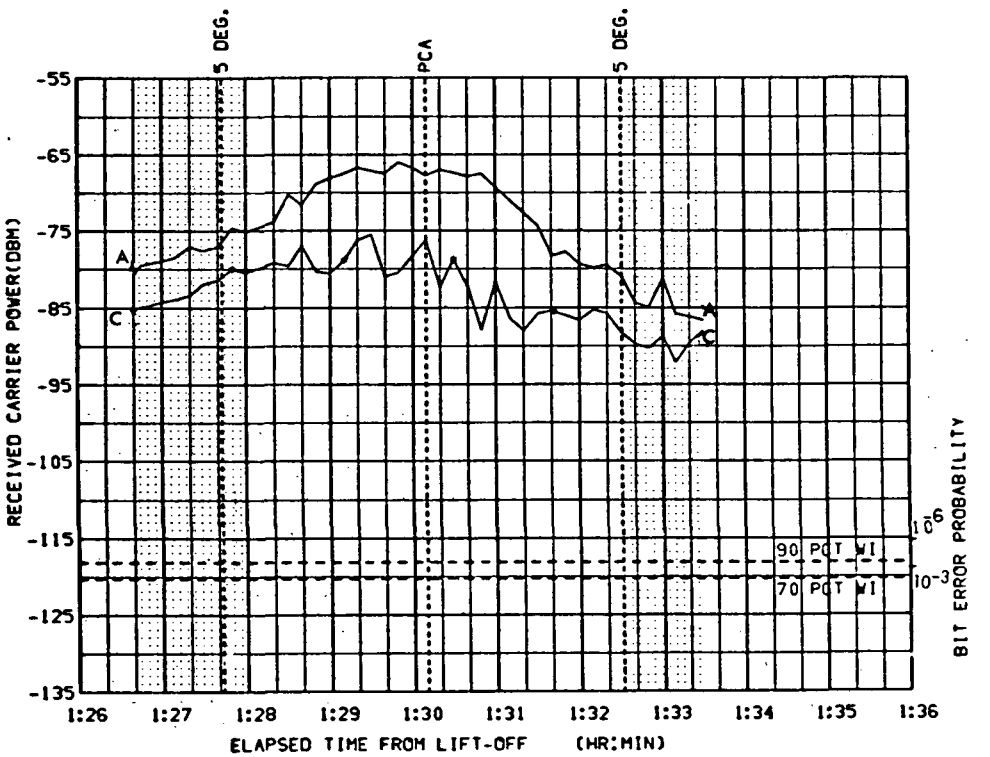


FIGURE 6-93b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

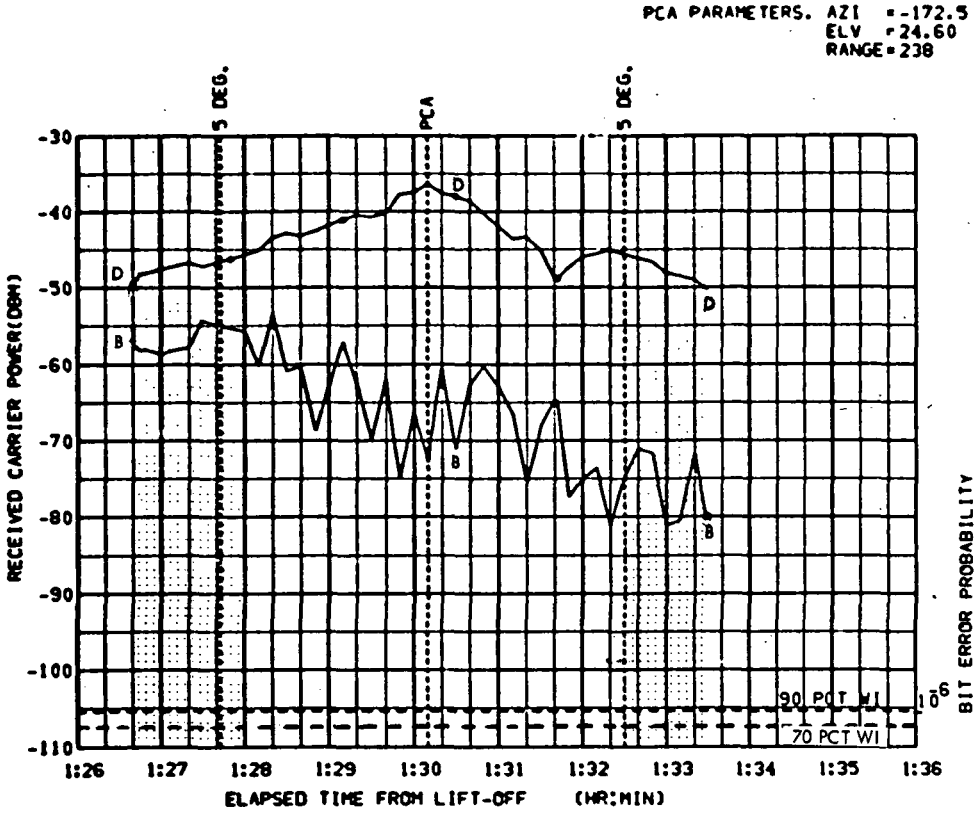


FIGURE 6-93c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

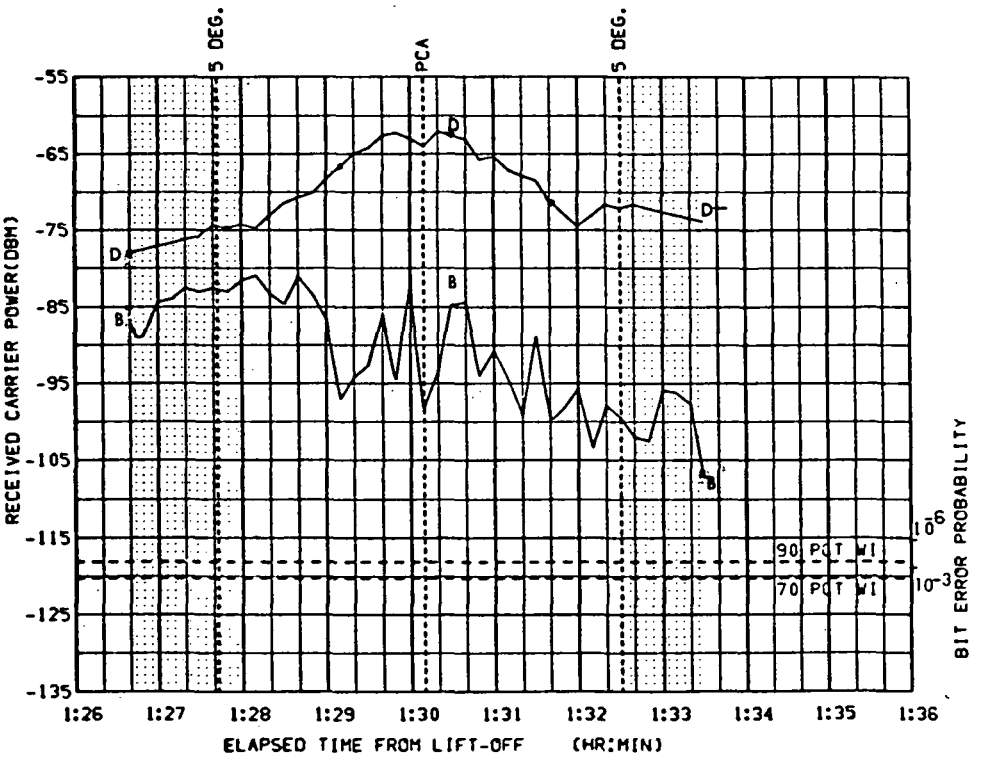


FIGURE 6-93d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

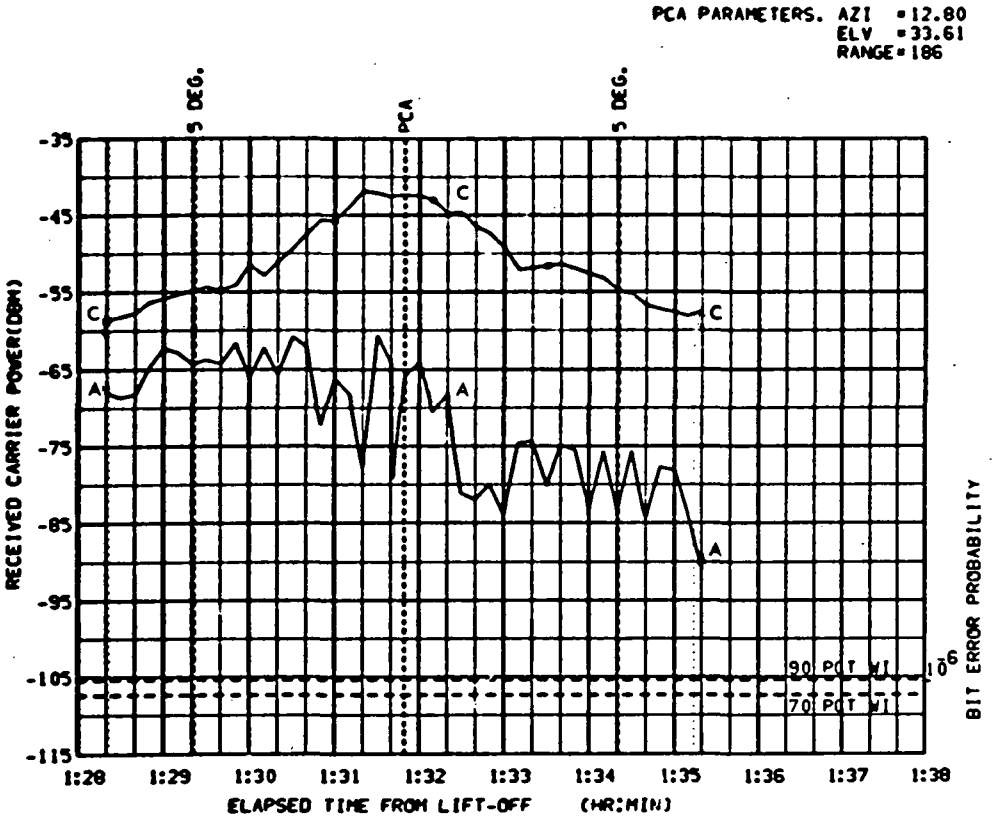


FIGURE 6-94a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

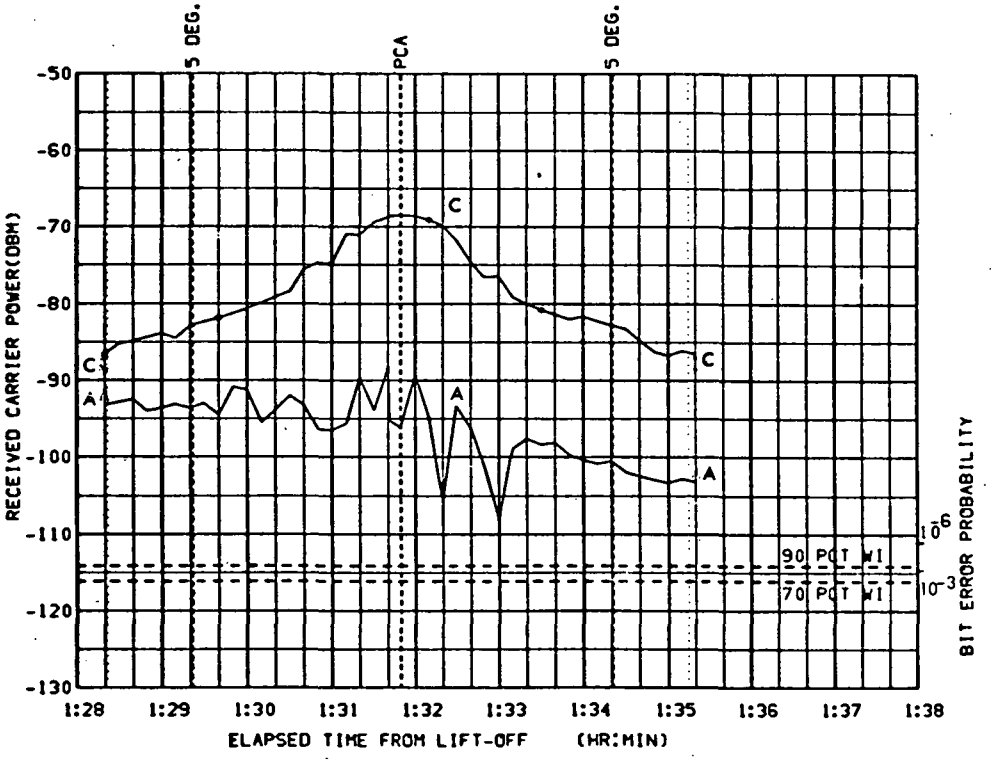


FIGURE 6-94b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

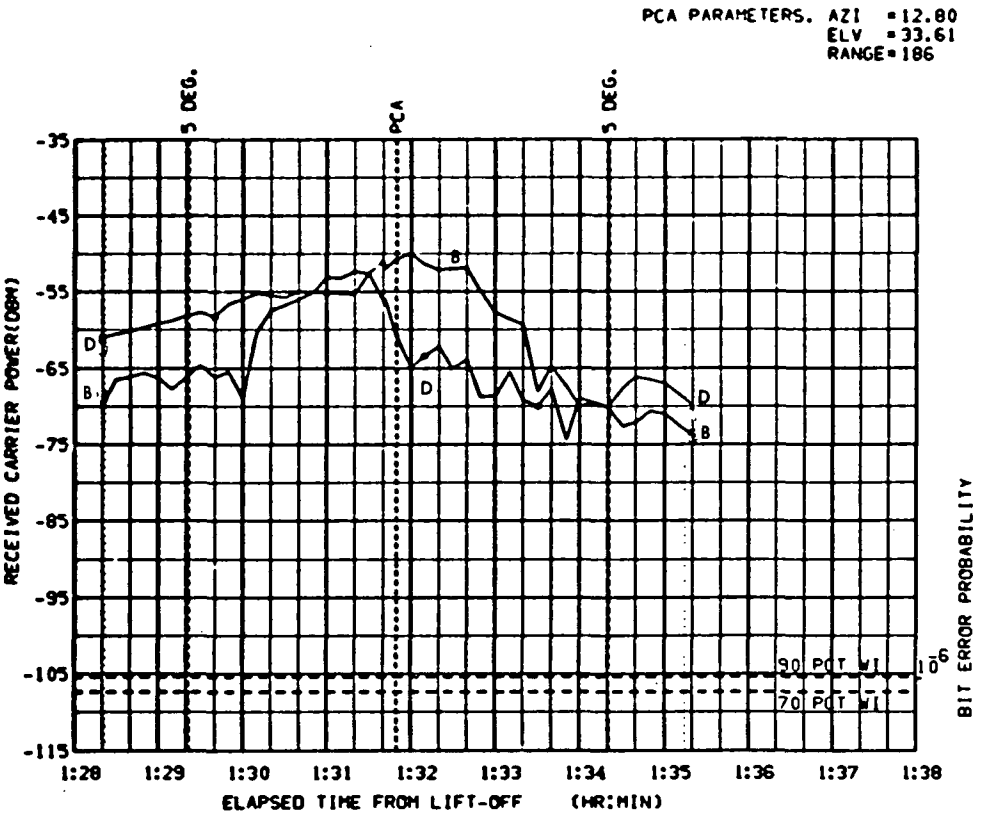


FIGURE 6-94c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

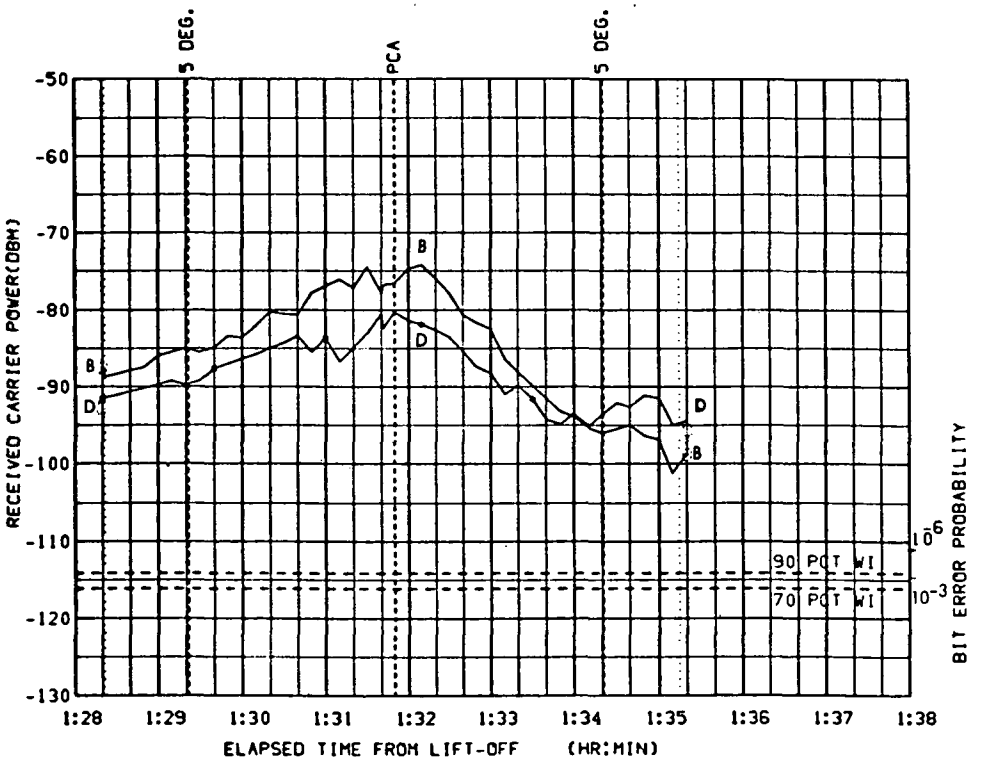


FIGURE 6-94d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

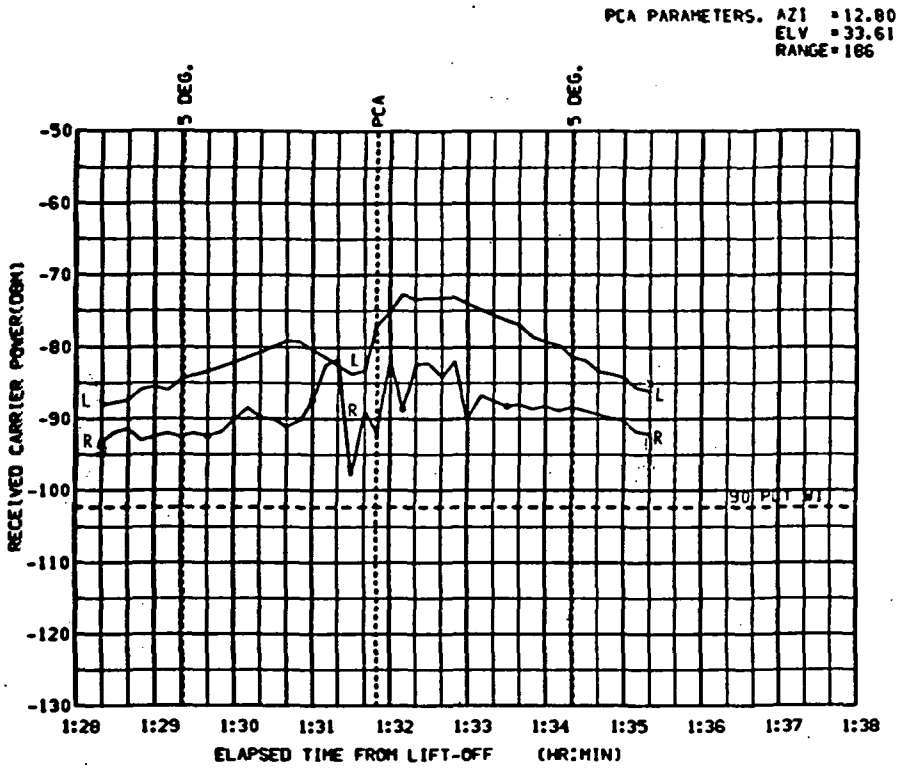


FIGURE 6-94e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

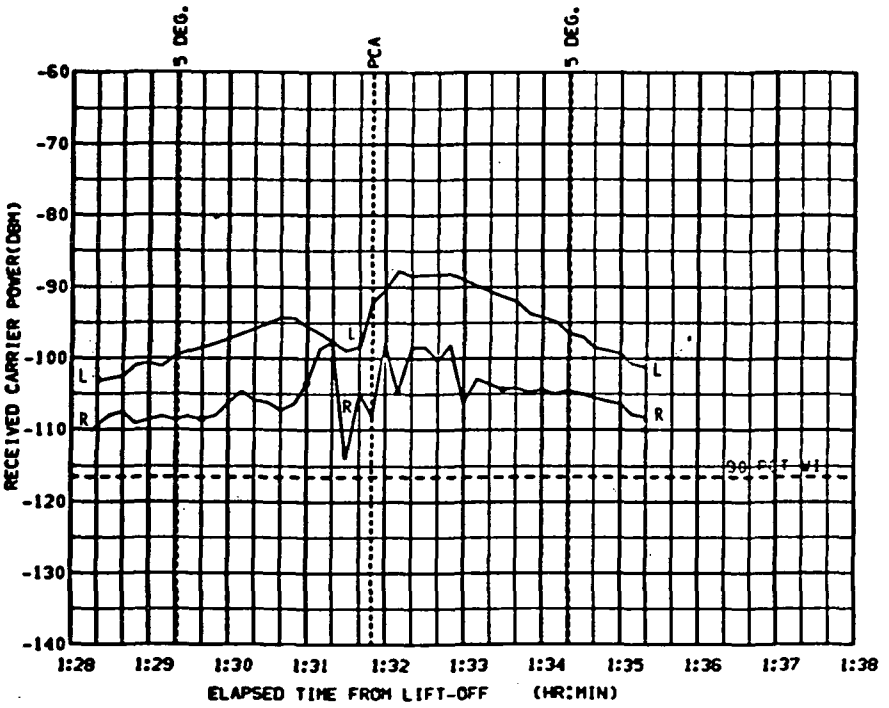


FIGURE 6-94f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

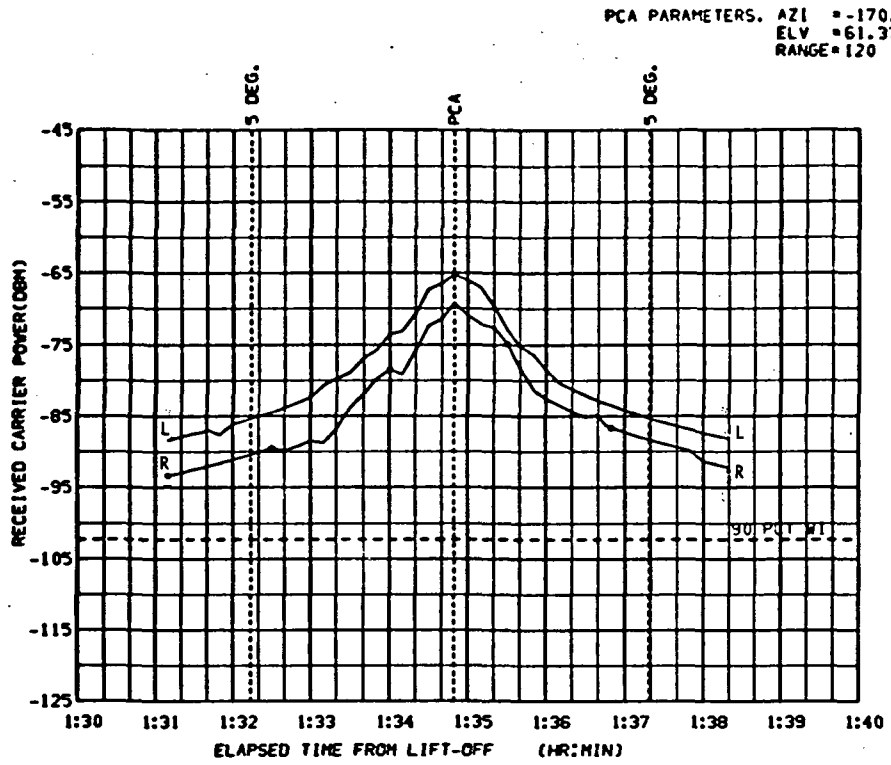


FIGURE 6-95a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

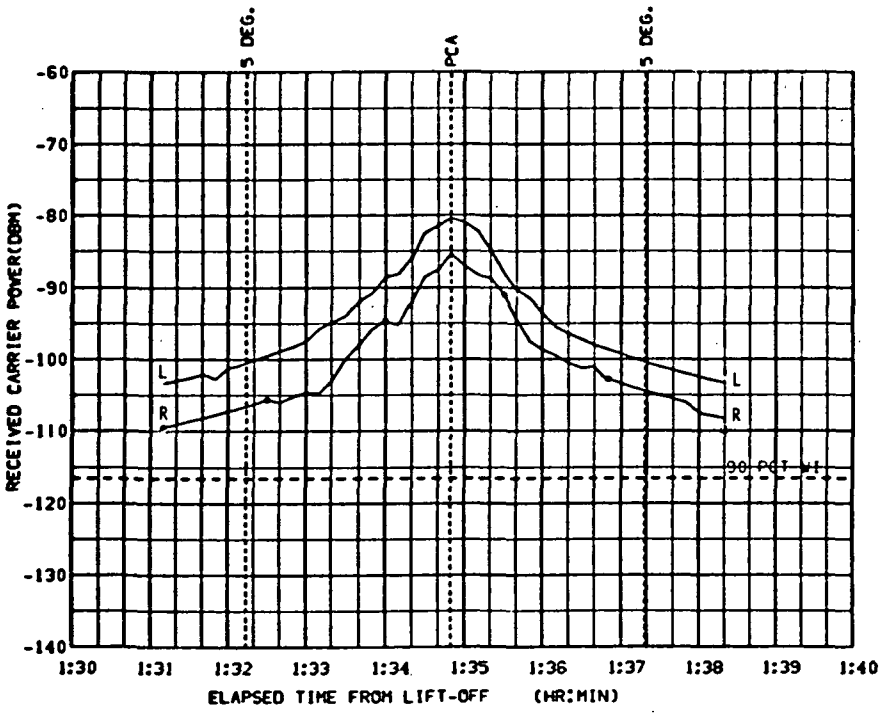


FIGURE 6-95b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

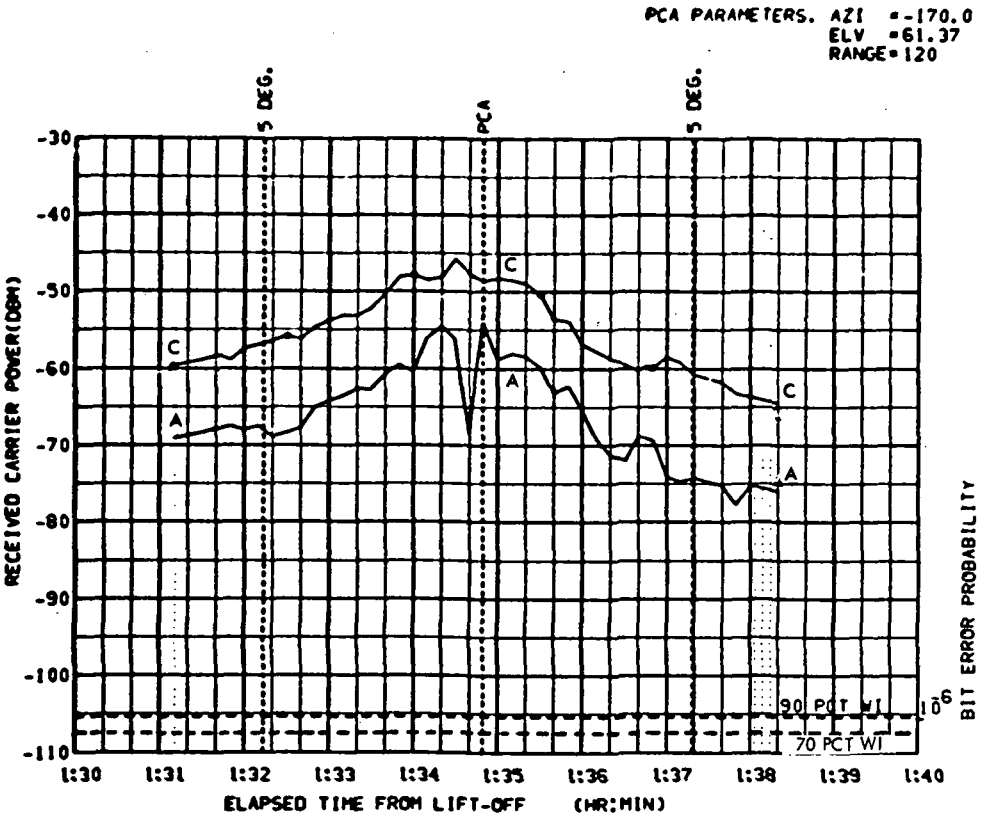


FIGURE 6-95c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

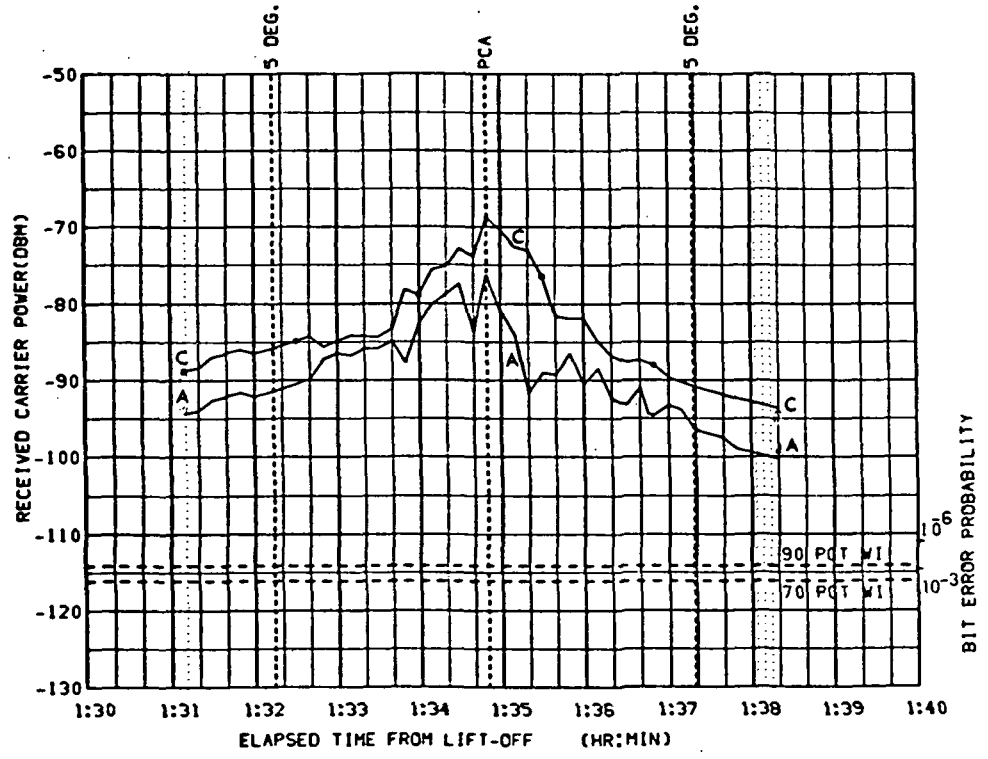


FIGURE 6-95d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

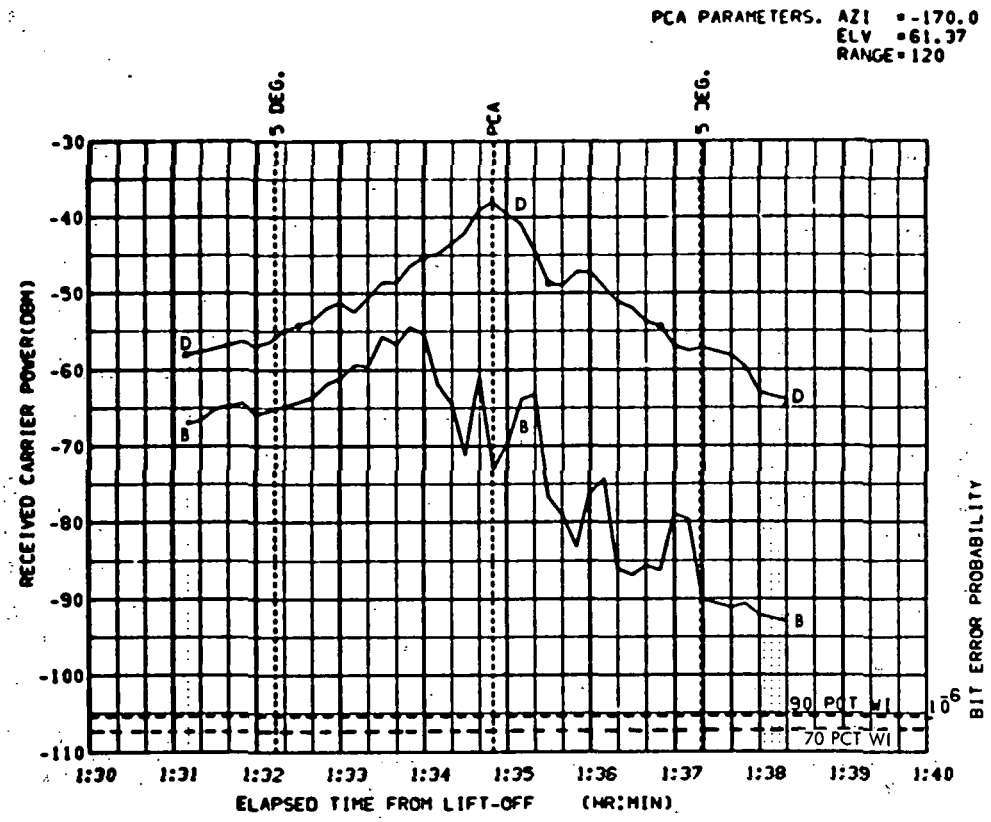


FIGURE 6-95e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

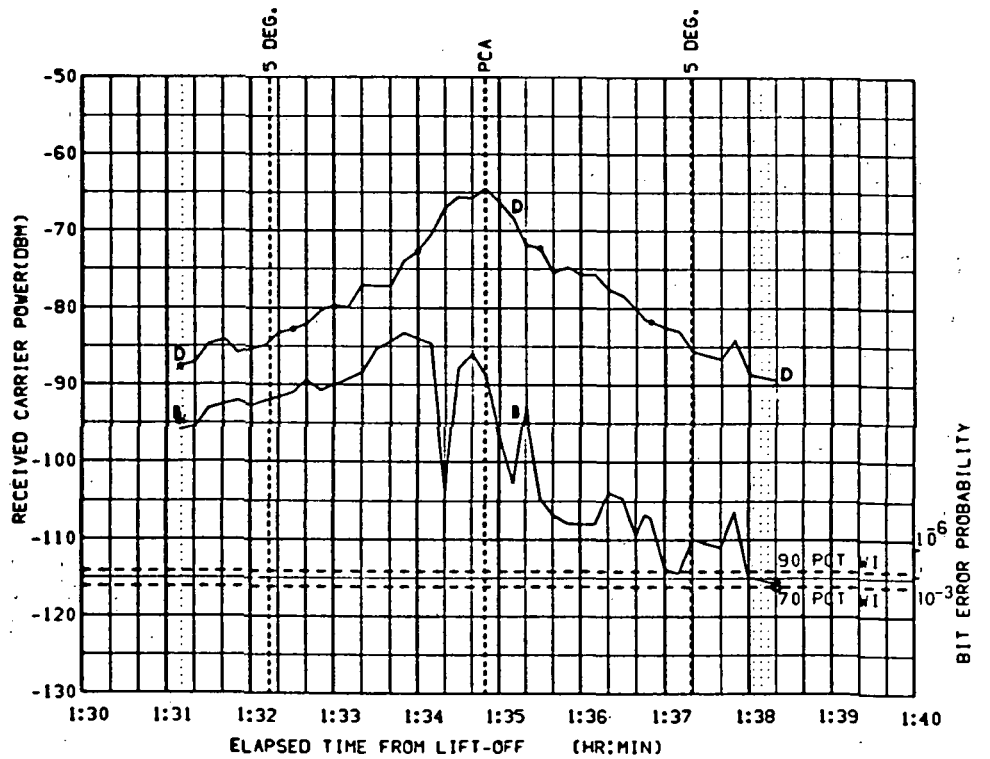


FIGURE 6-95f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

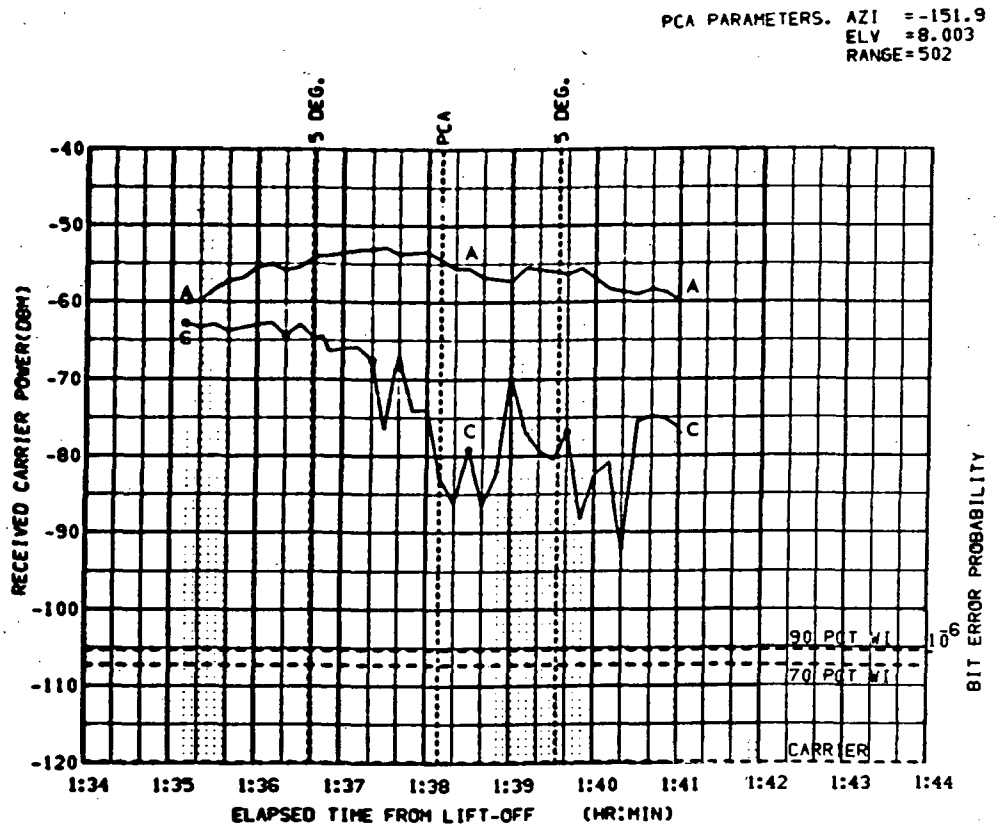


FIGURE 6-96a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

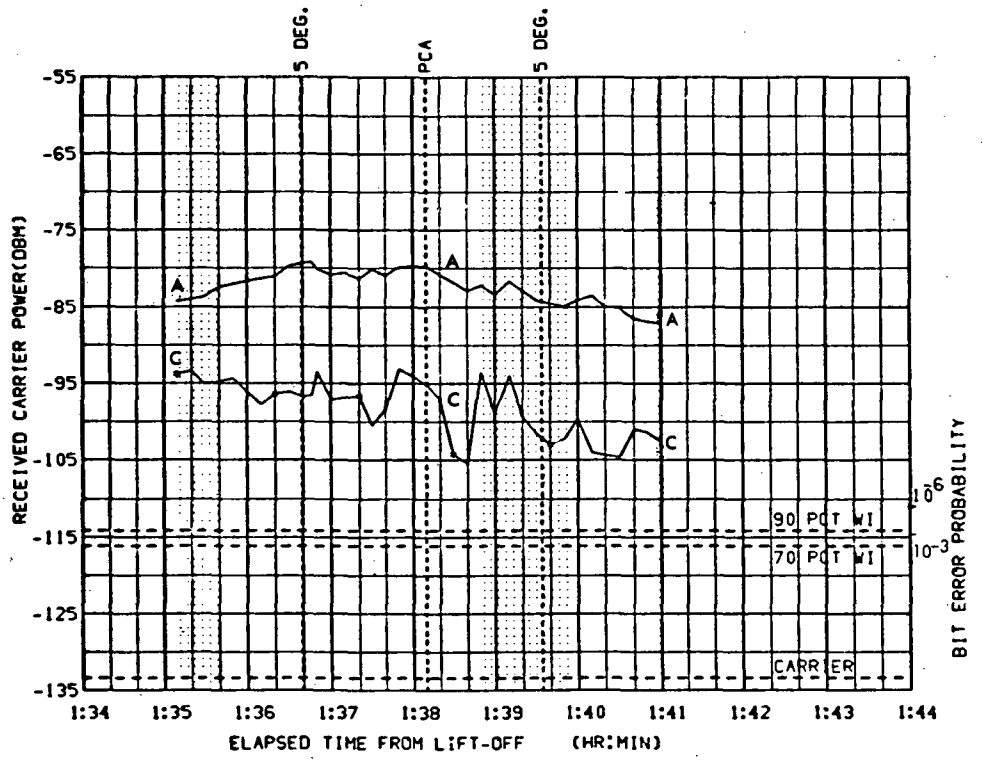


FIGURE 6-96b. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

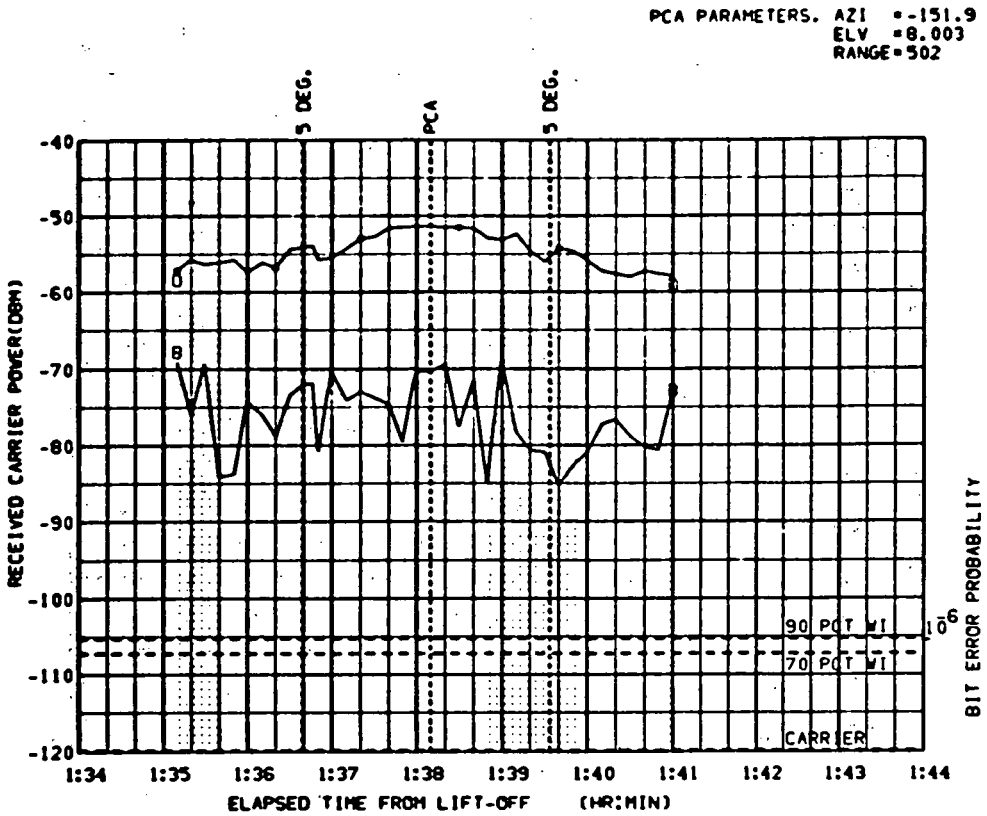


FIGURE 6-96c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

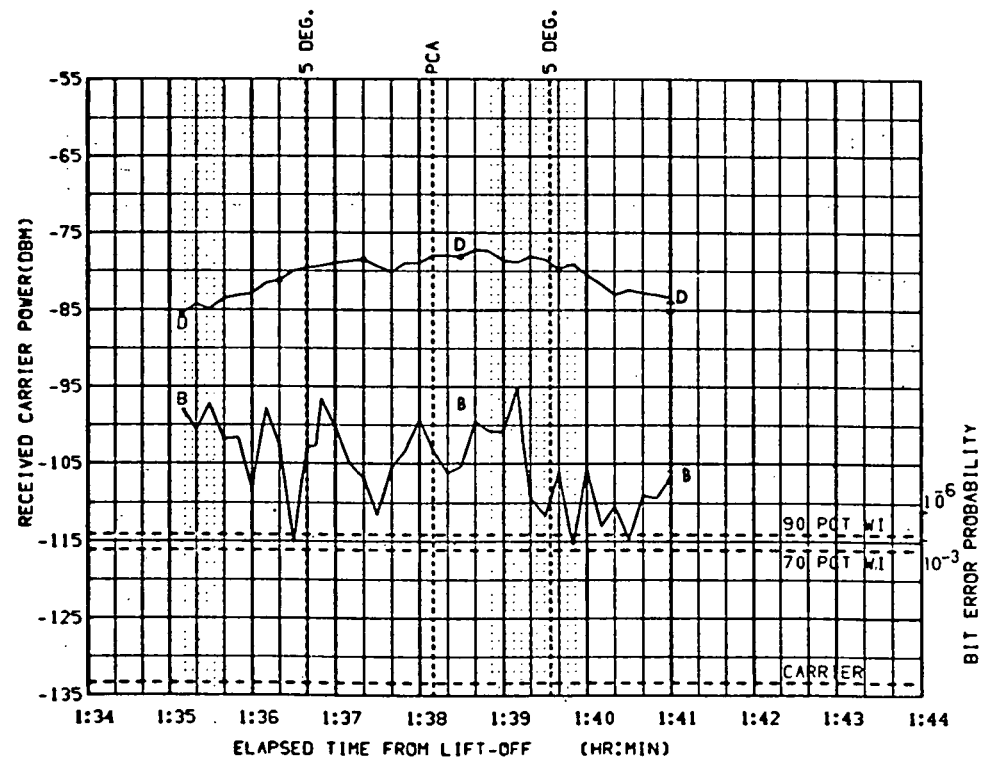


FIGURE 6-96d. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

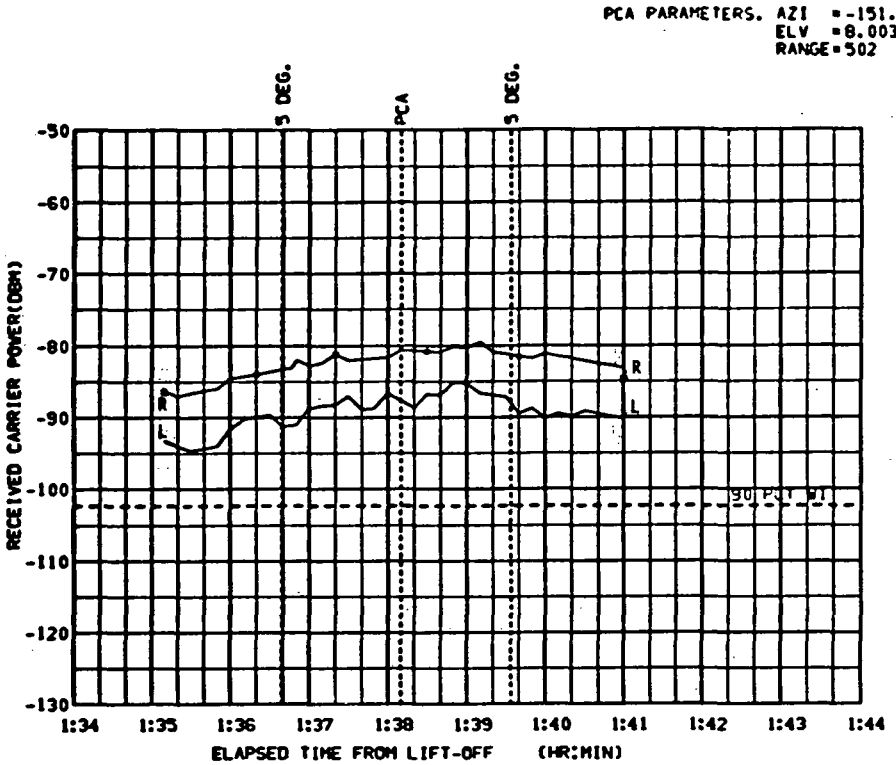


FIGURE 6-96e. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

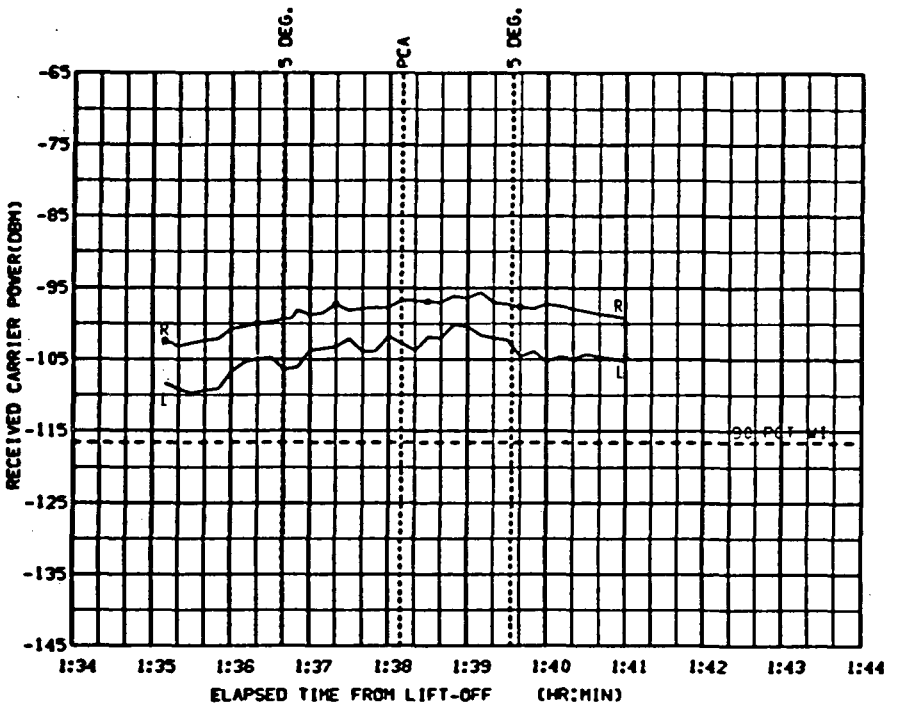


FIGURE 6-96f. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

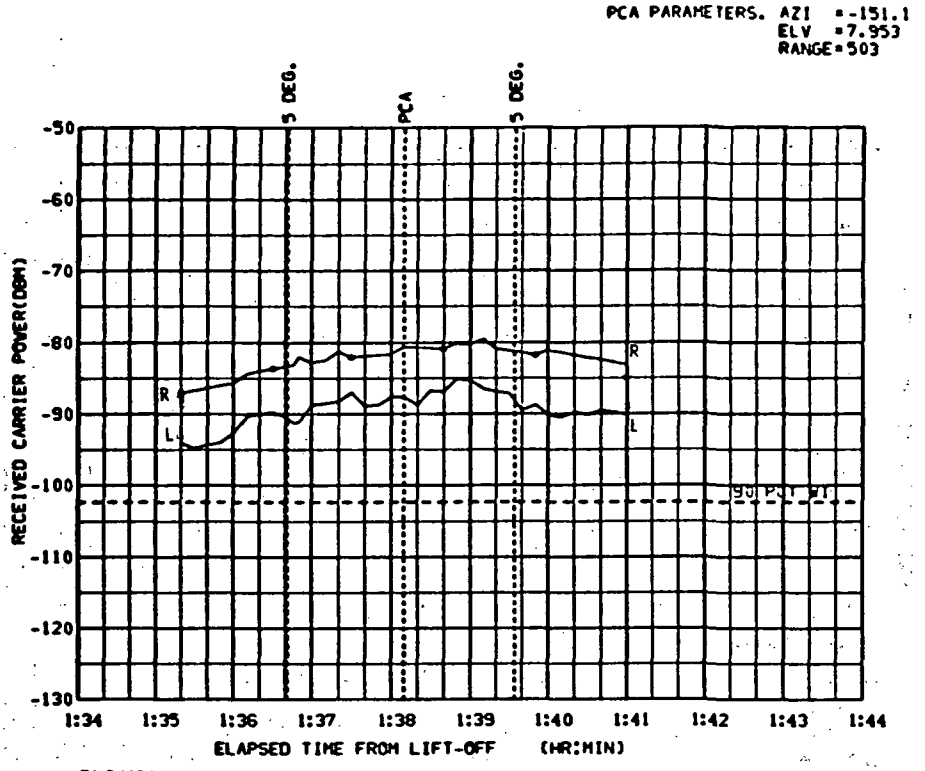


FIGURE 6-97a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

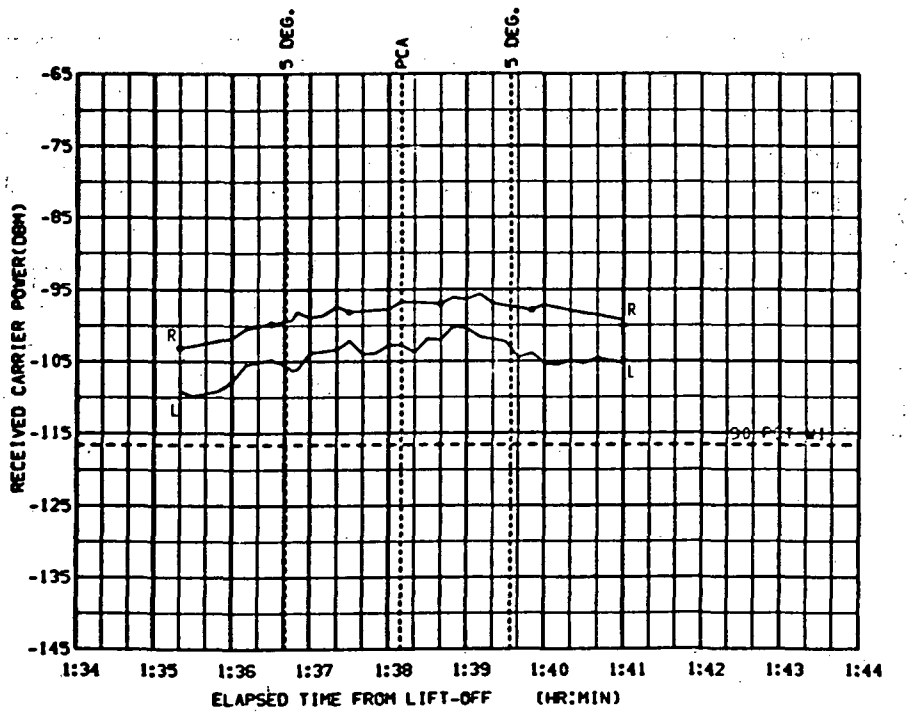


FIGURE 6-97b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

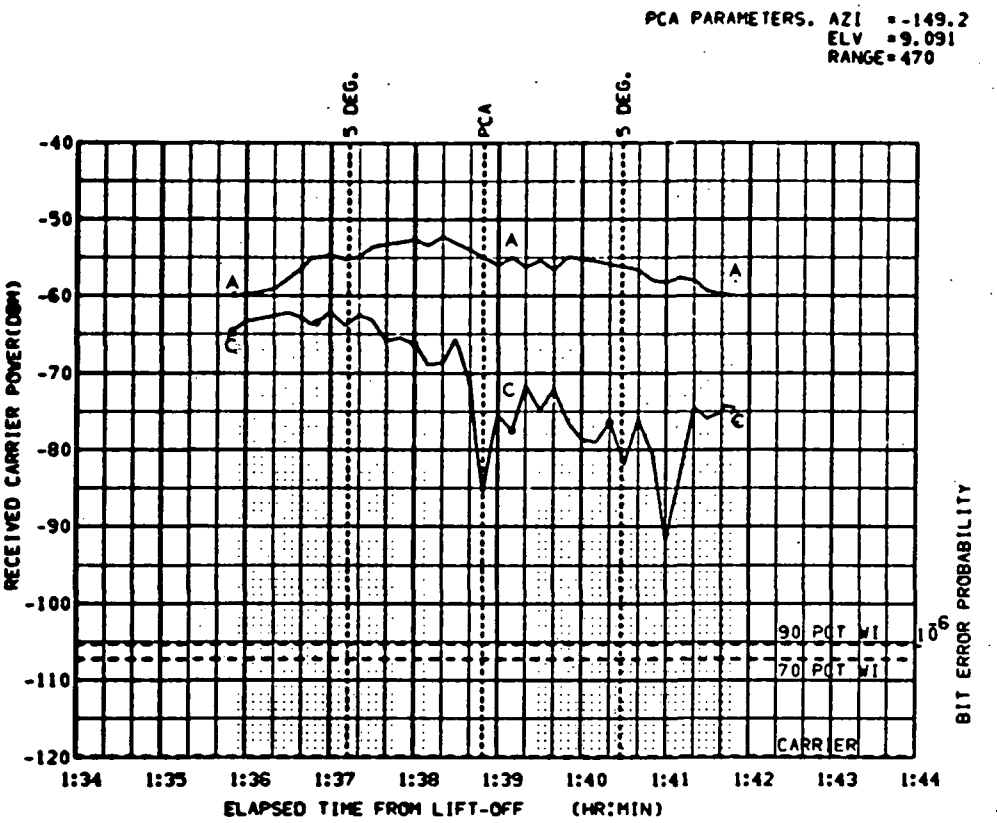


FIGURE 6-98a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

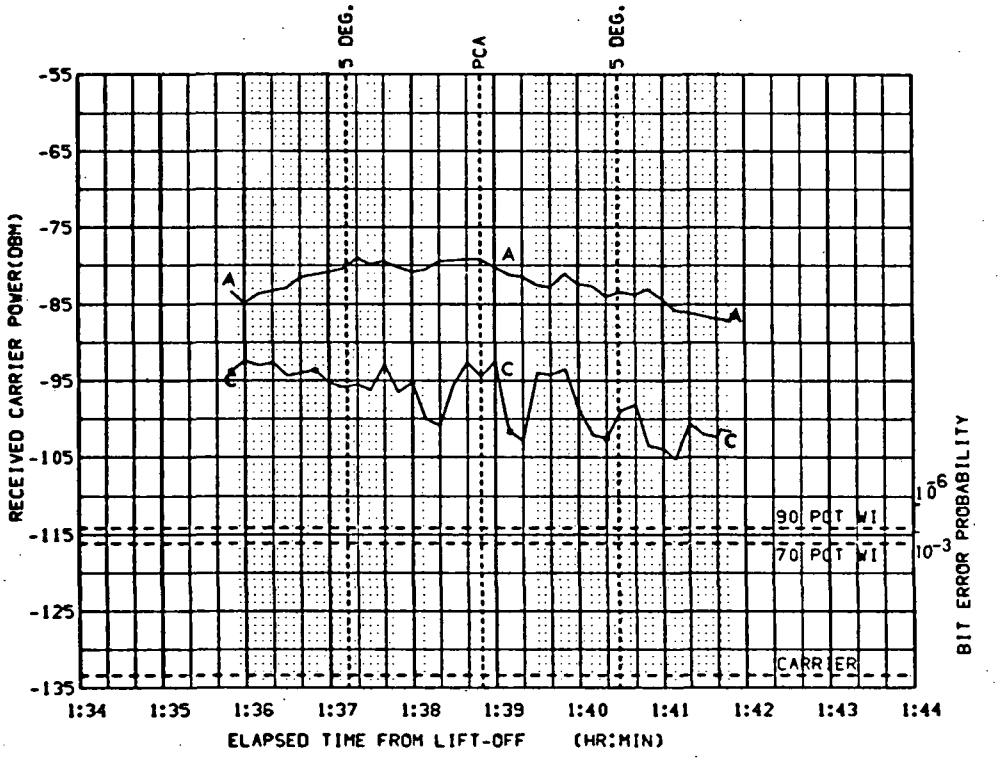


FIGURE 6-98b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

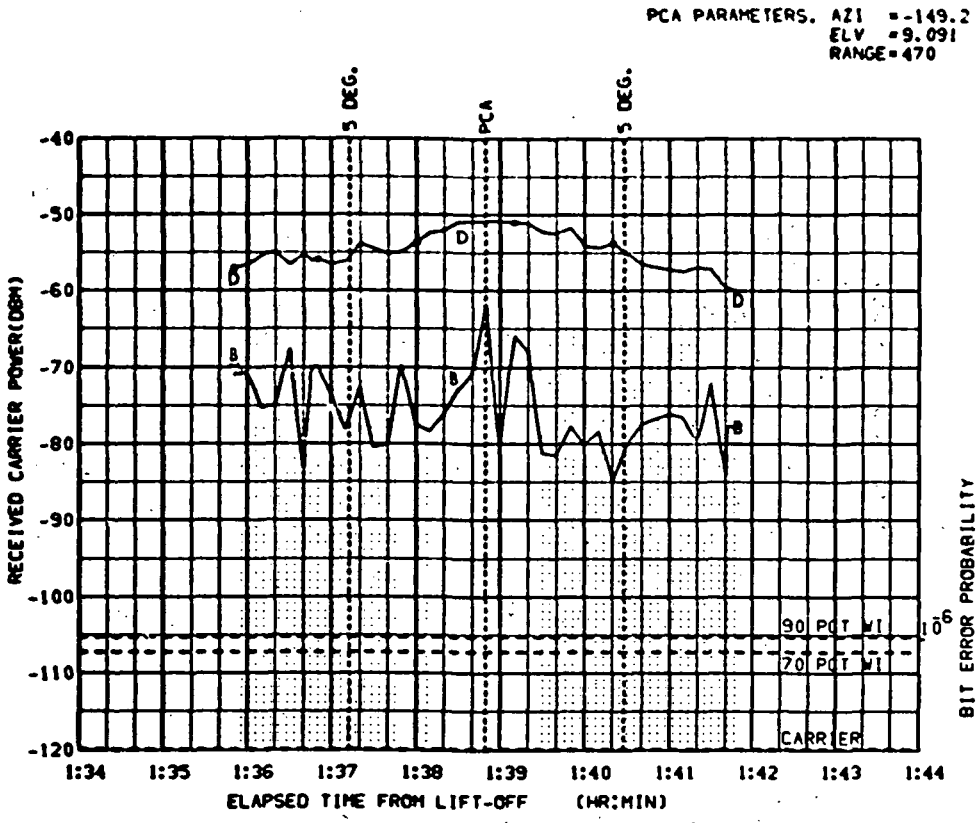


FIGURE 6-98c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

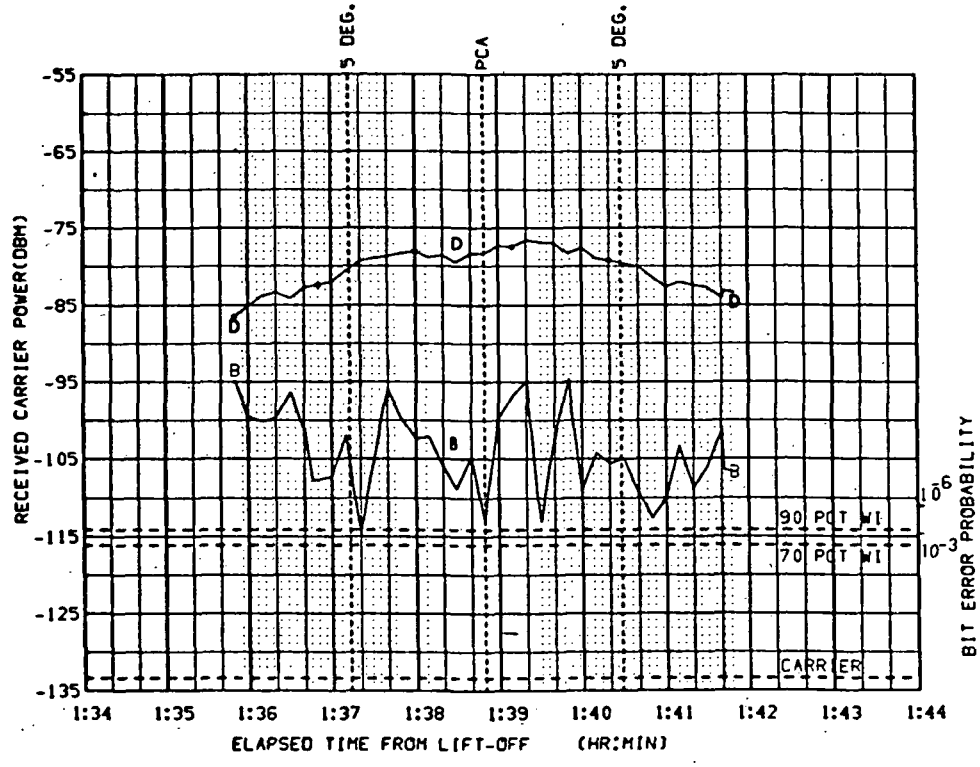


FIGURE 6-98d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

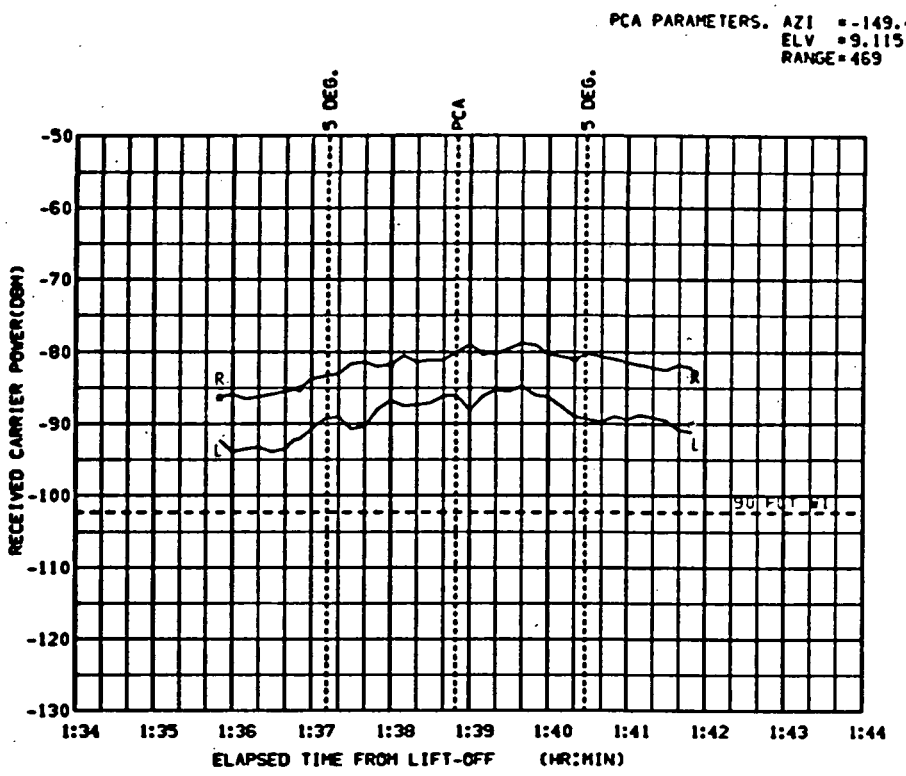


FIGURE 6-98e. GBI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

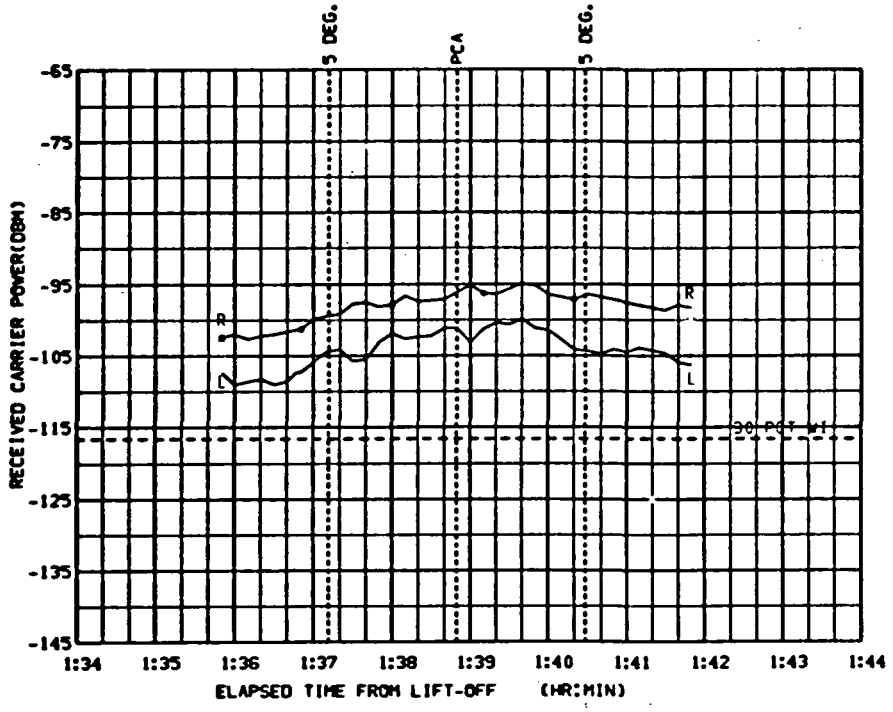


FIGURE 6-98f. GBI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-145.2
ELV =8.326
RANGE=486

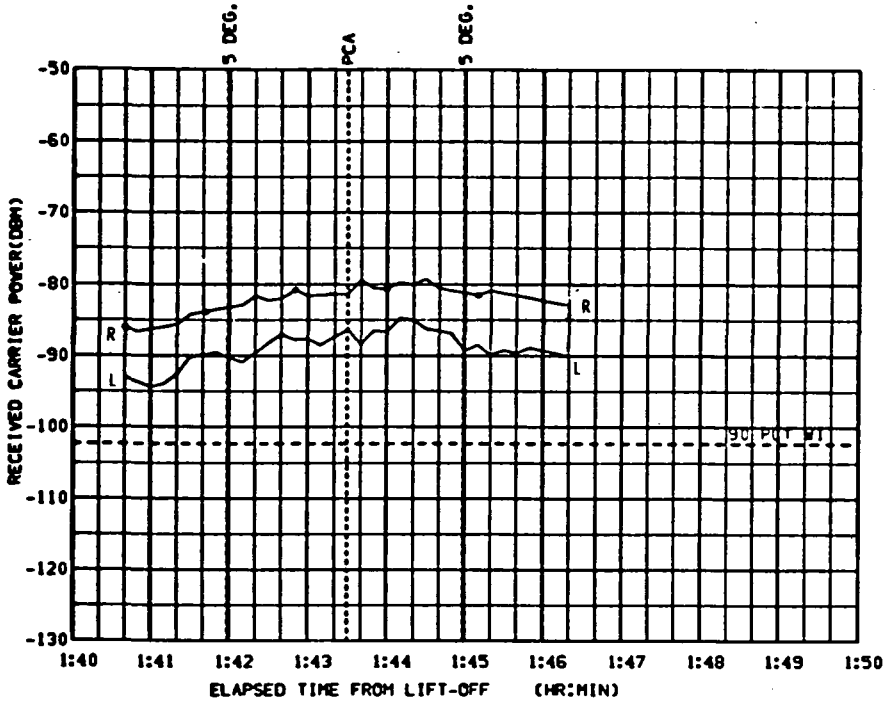


FIGURE 6-99a. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

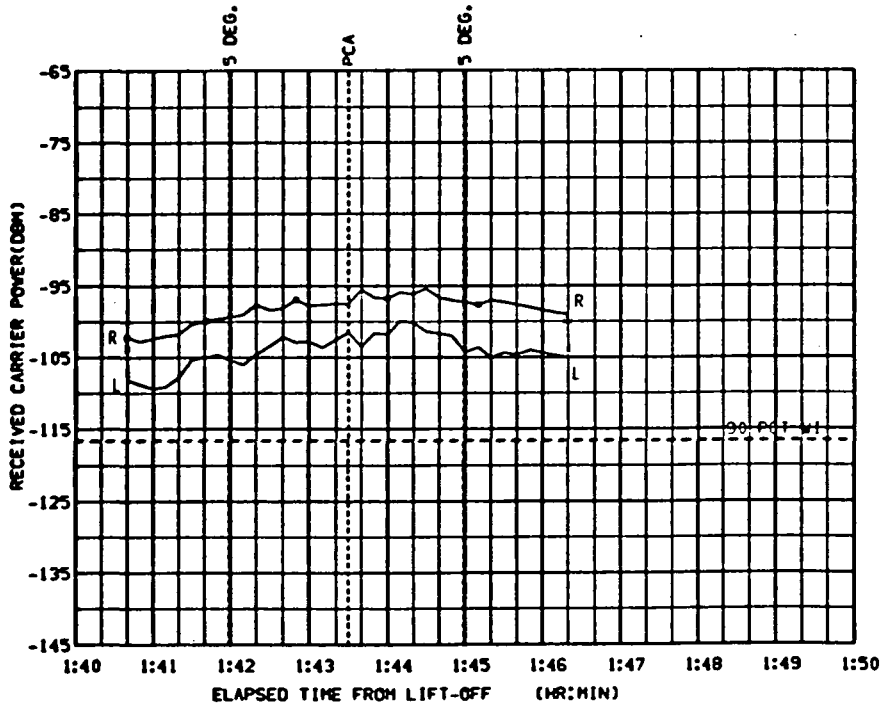


FIGURE 6-99b. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

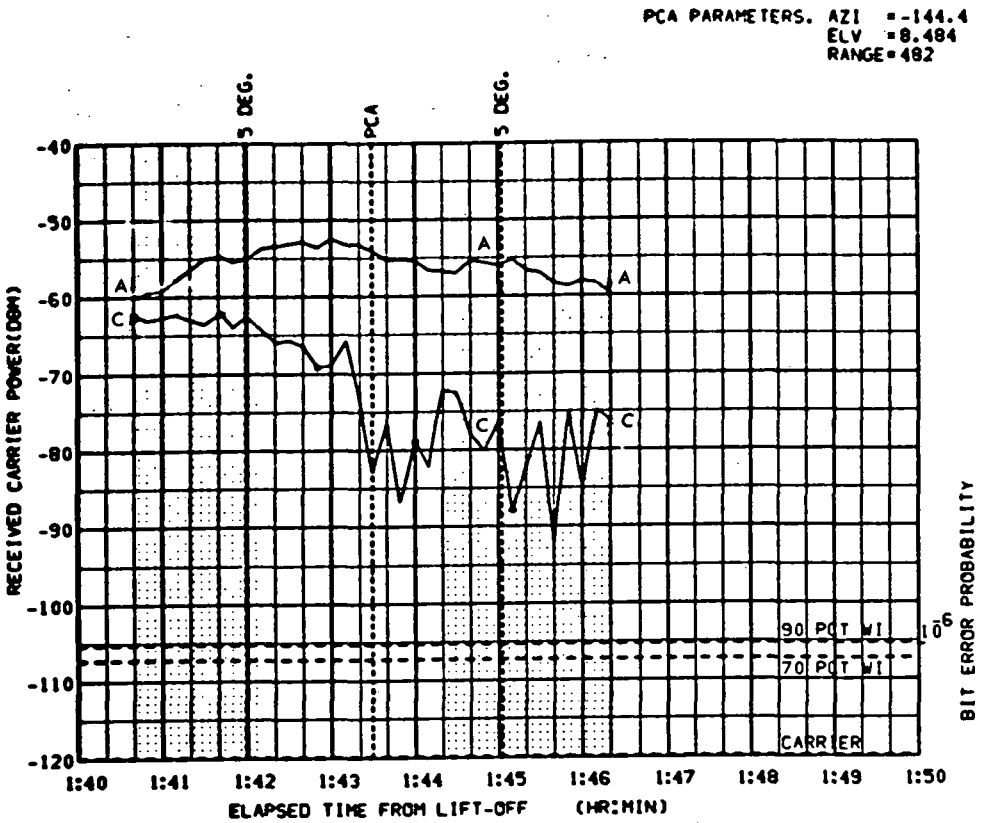


FIGURE 6-99c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

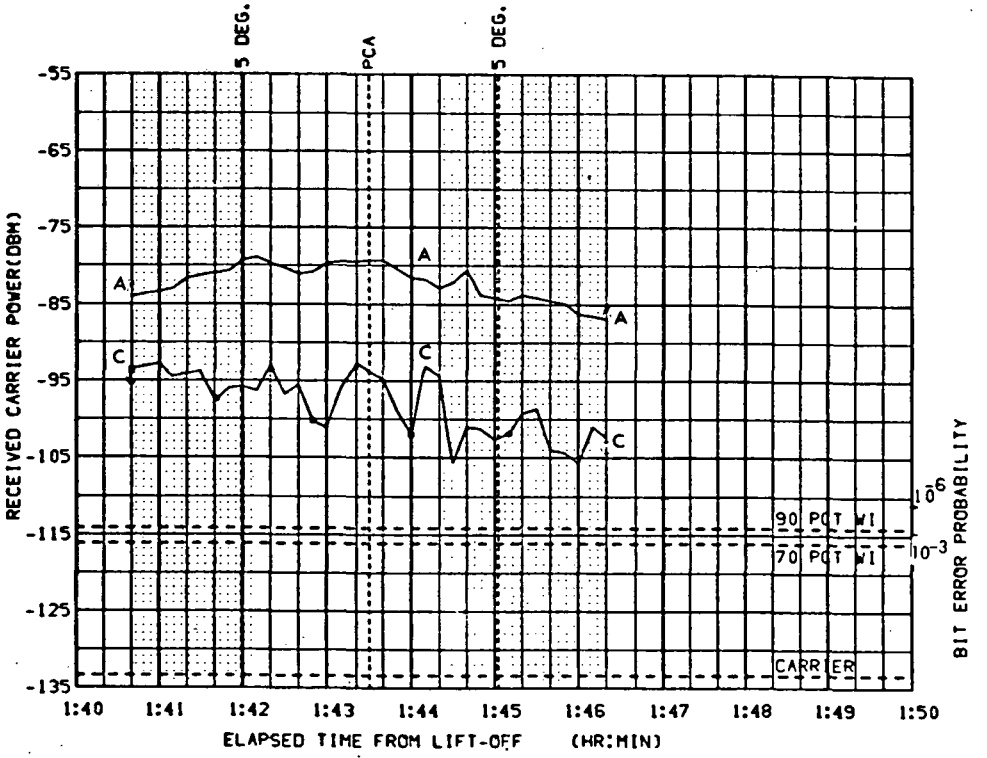


FIGURE 6-99d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

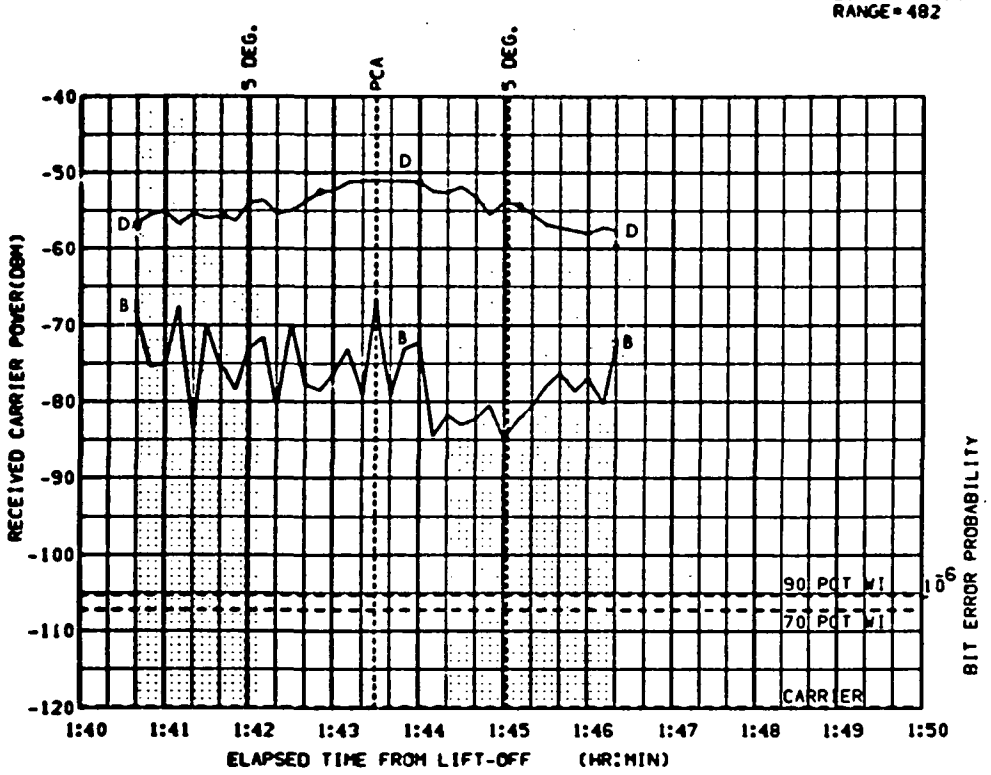


FIGURE 6-99e. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

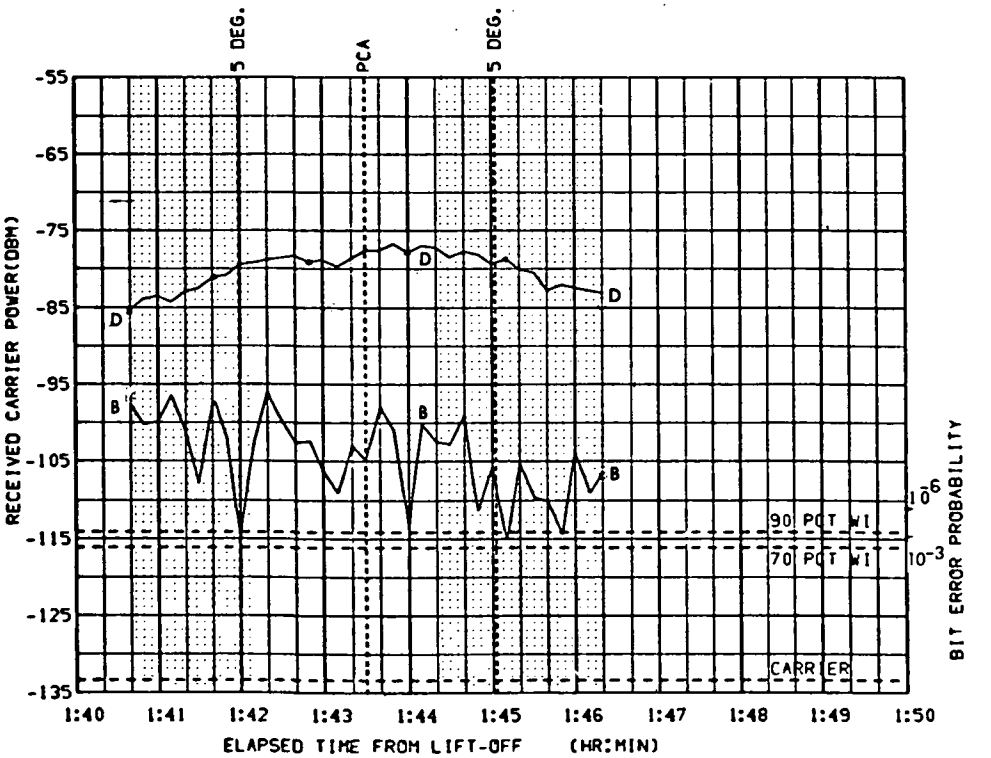


FIGURE 6-99f. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -153.3
ELV = 0.722
RANGE = 796

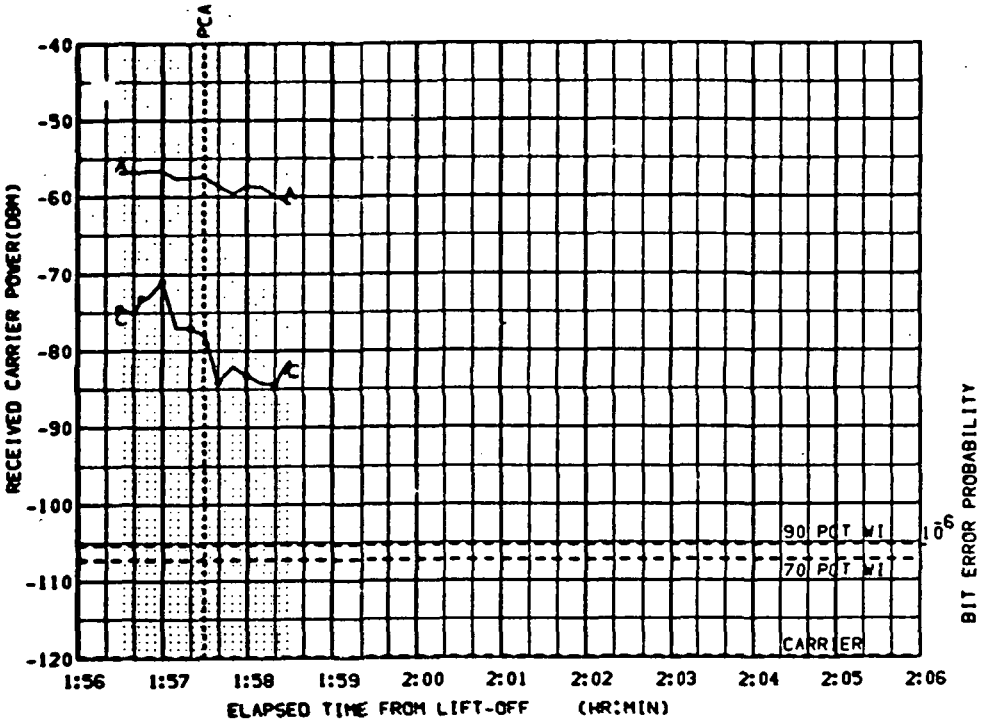


FIGURE 6-100a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

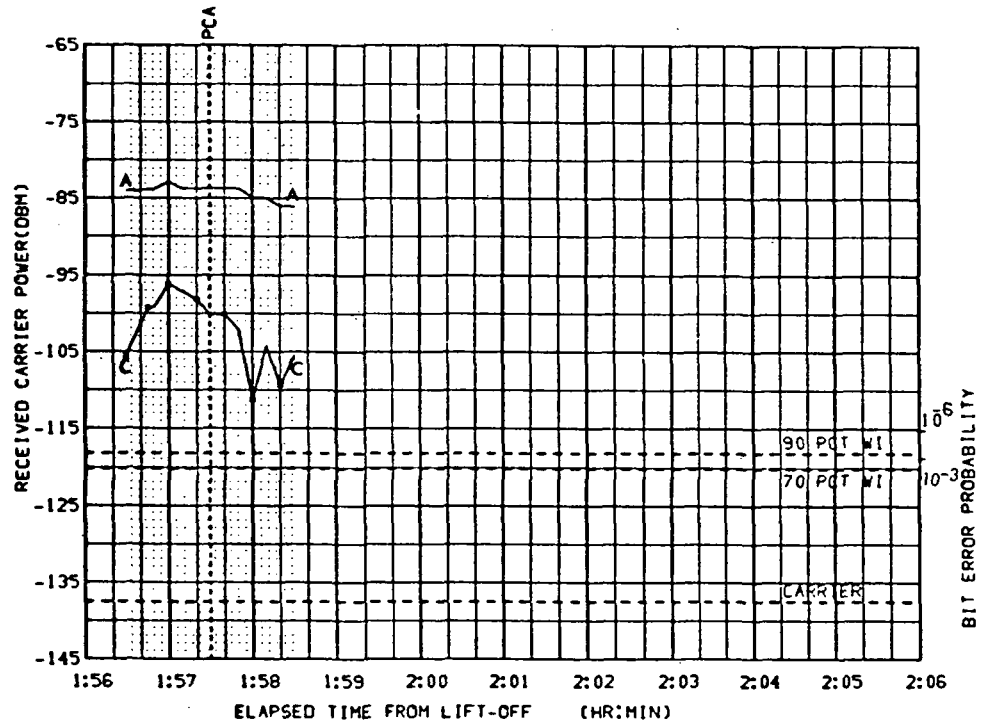


FIGURE 6-100b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -153.3
ELV = 0.722
RANGE = 796

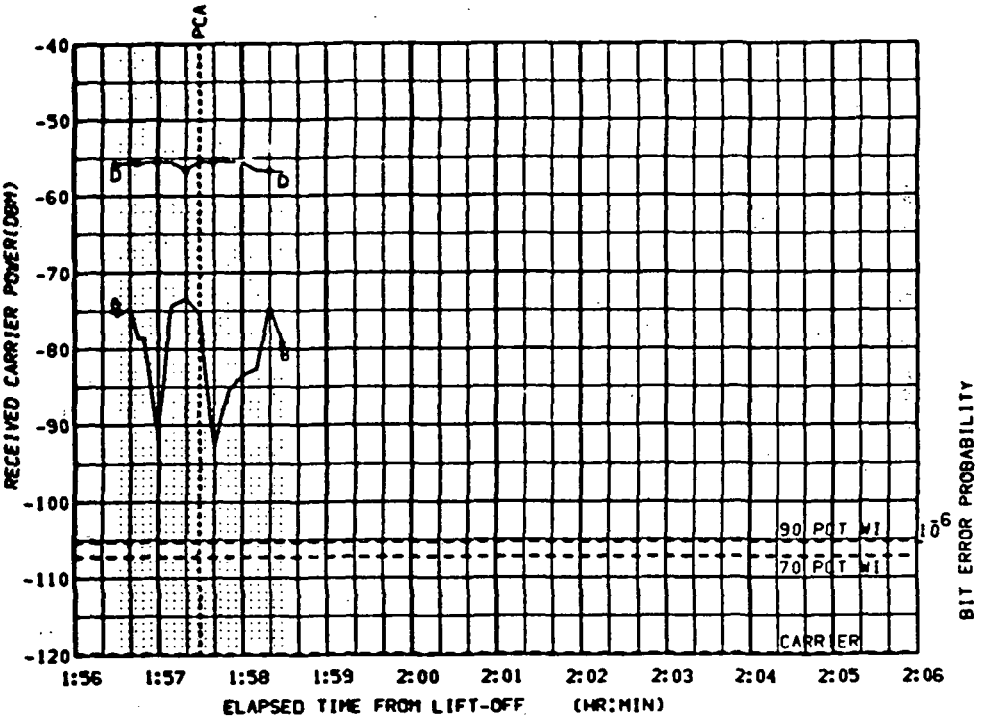


FIGURE 6-100c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

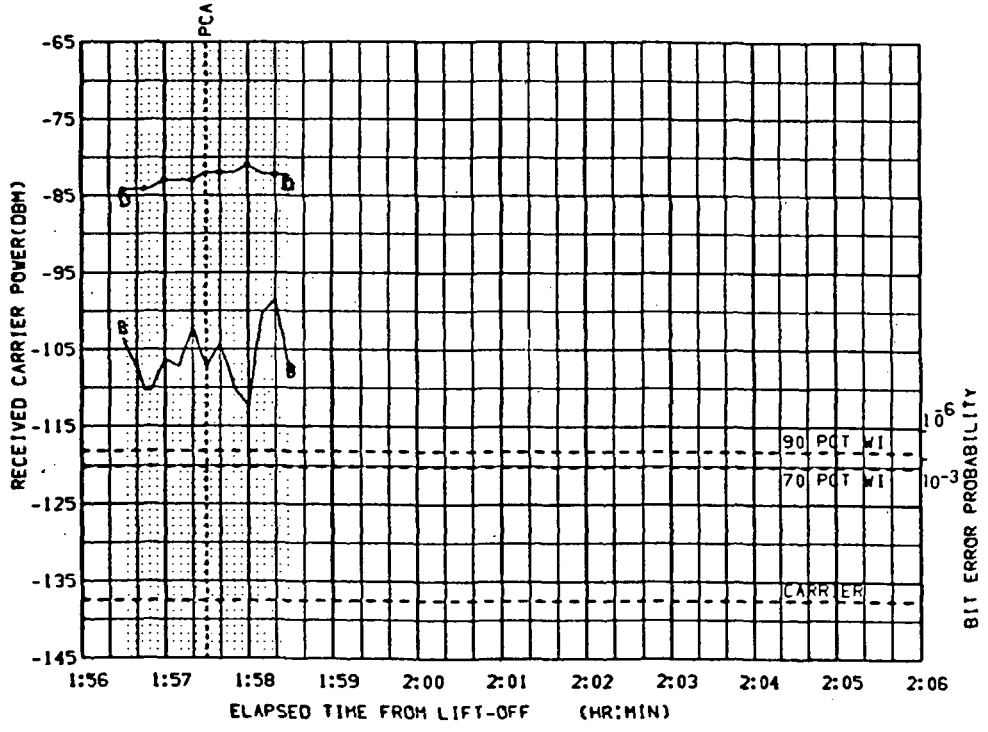


FIGURE 6-100d. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -153.5
ELV = 0.789
RANGE = 793

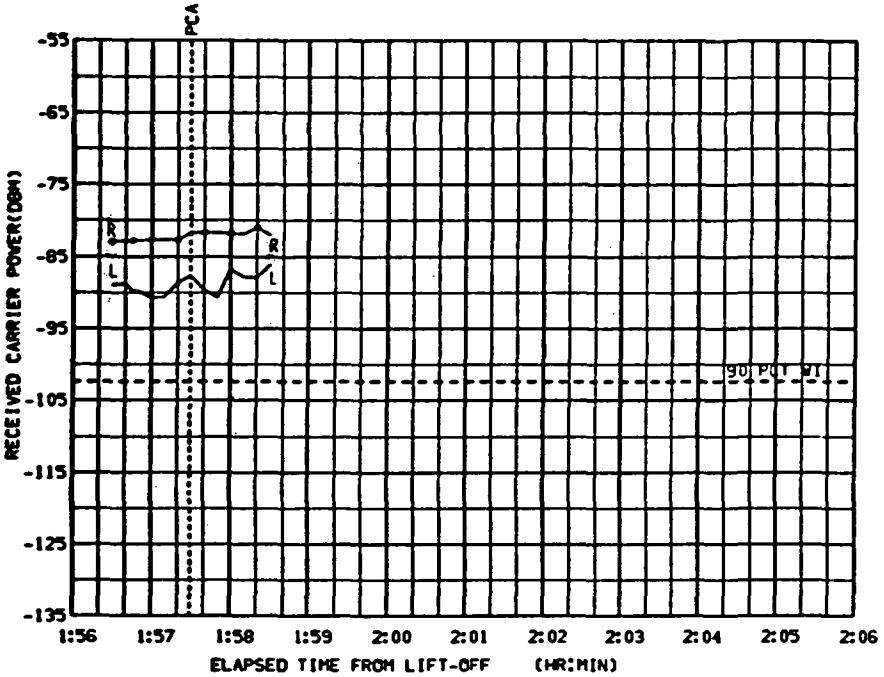


FIGURE 6-100e. ASC UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

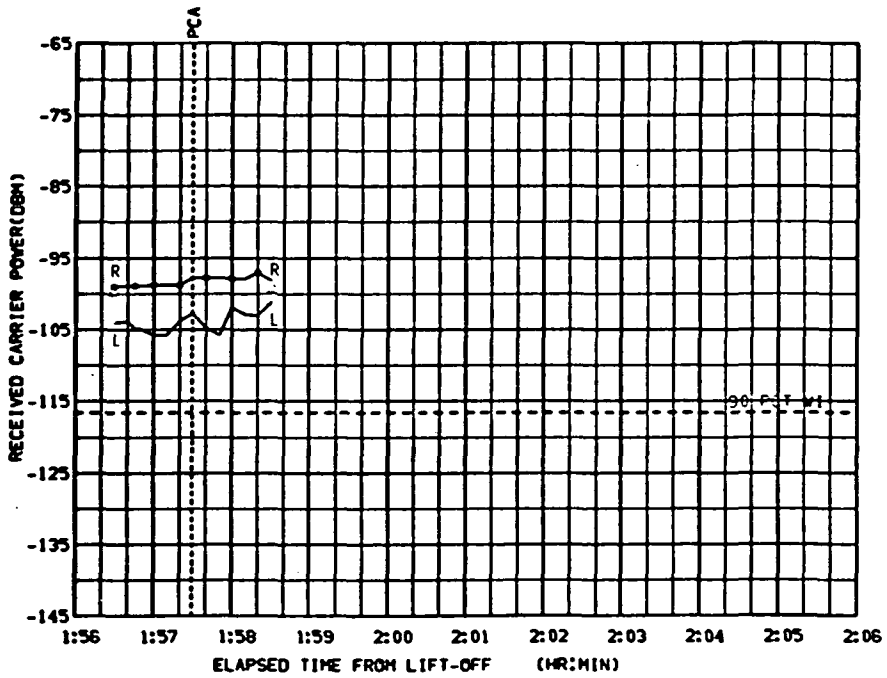


FIGURE 6-100f. ASC DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

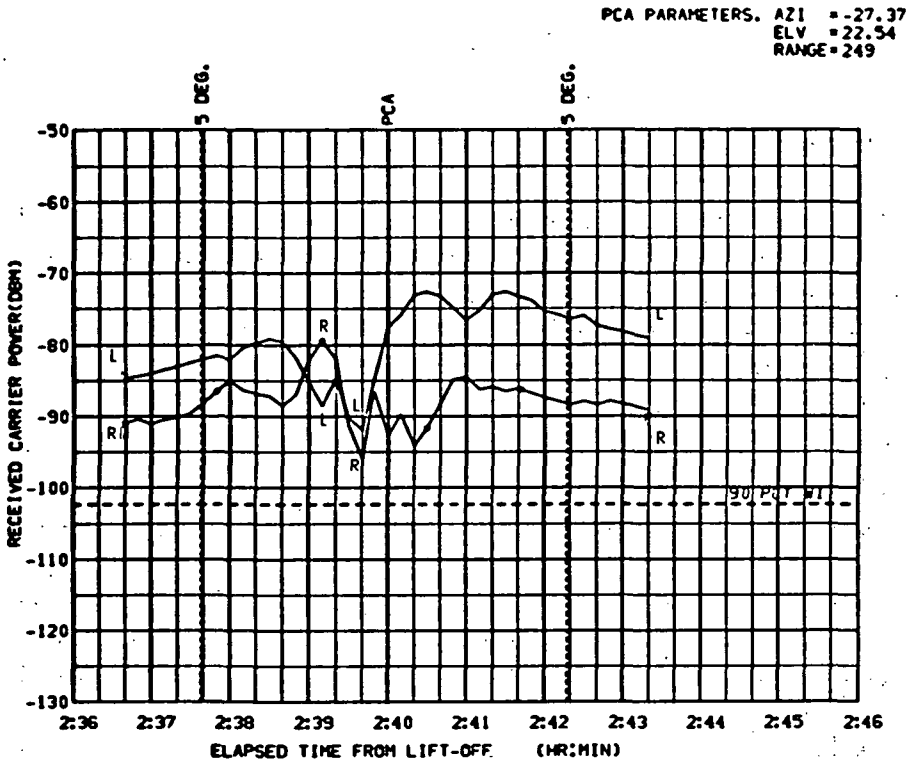


FIGURE 6-101a. GWM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

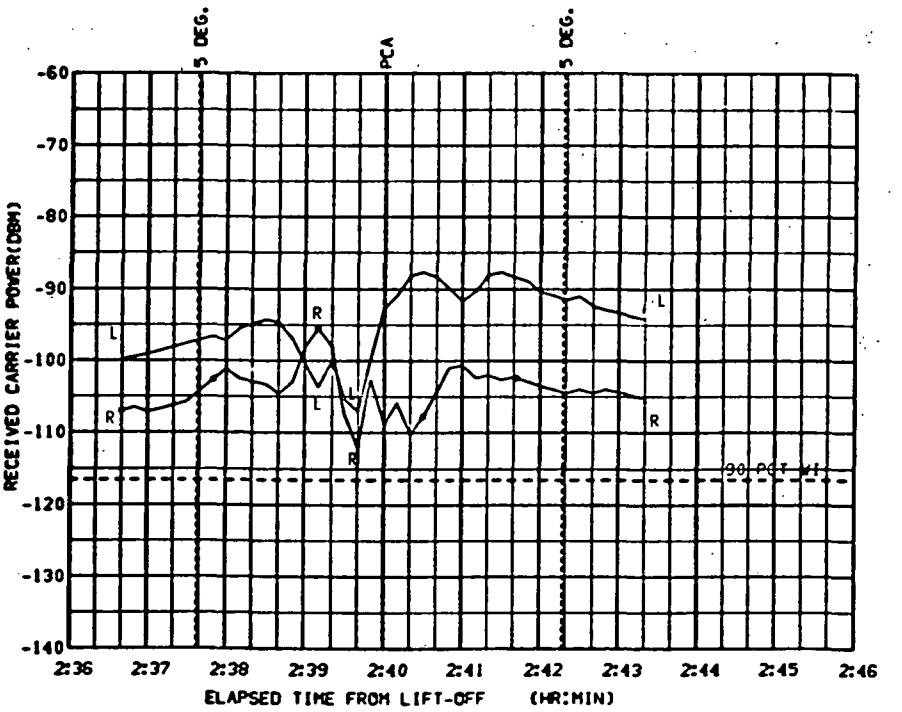


FIGURE 6-101b. GWM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

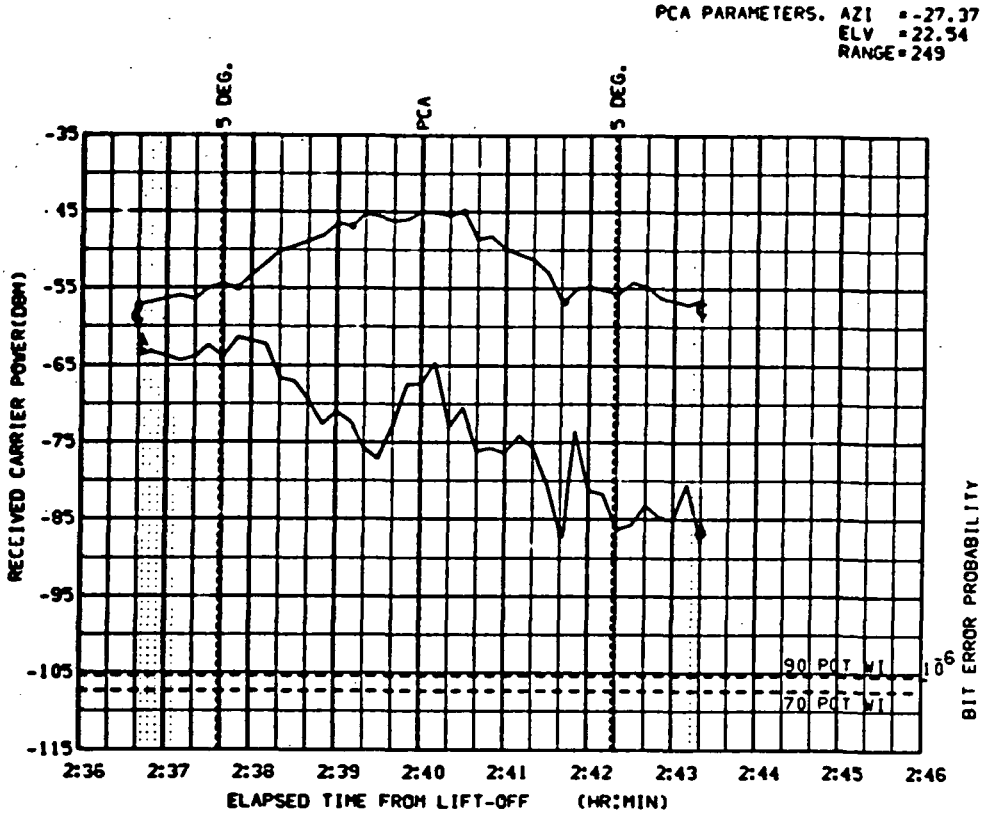


FIGURE 6-101c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

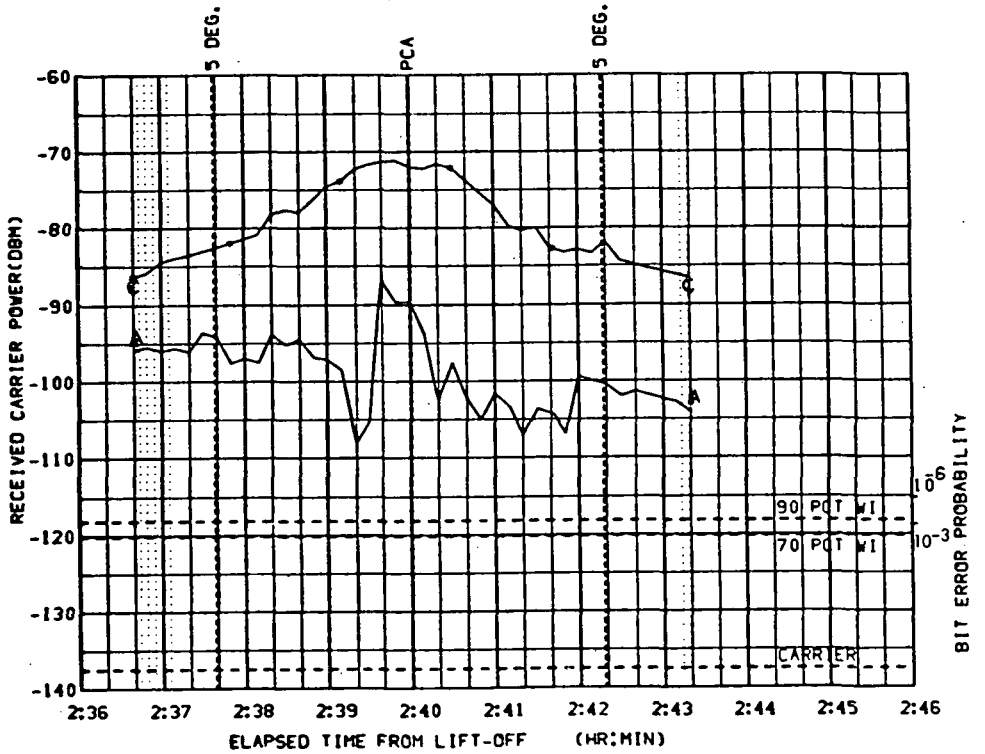


FIGURE 6-101d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

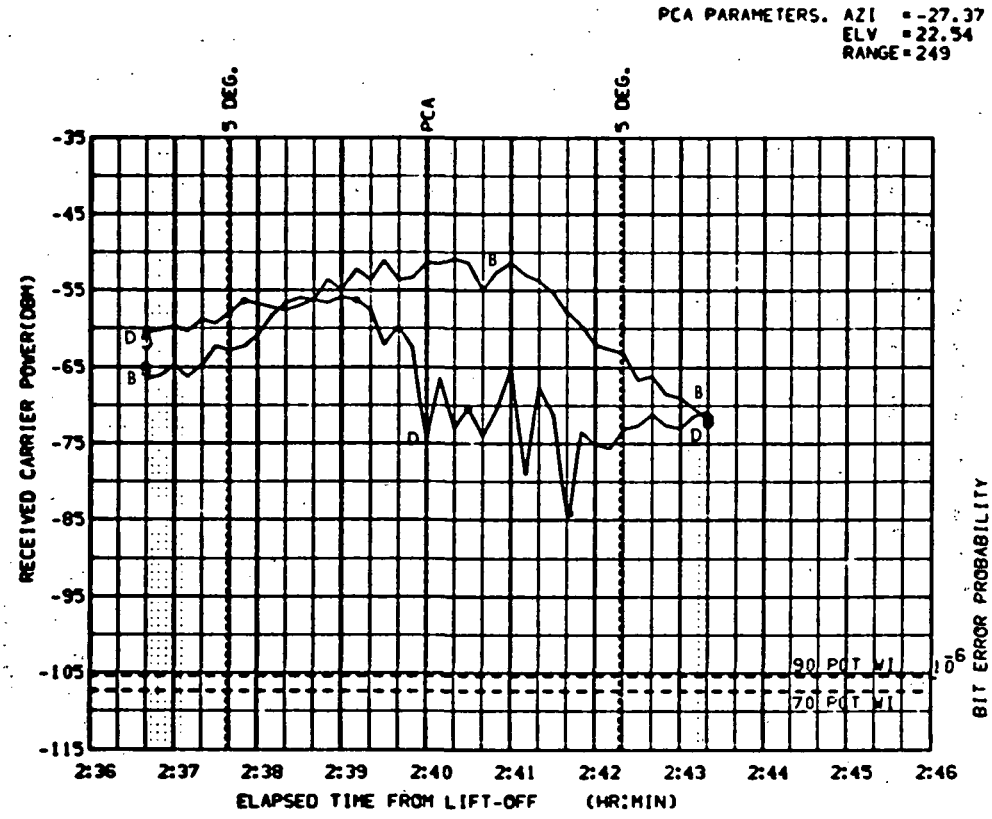


FIGURE 6-101e. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

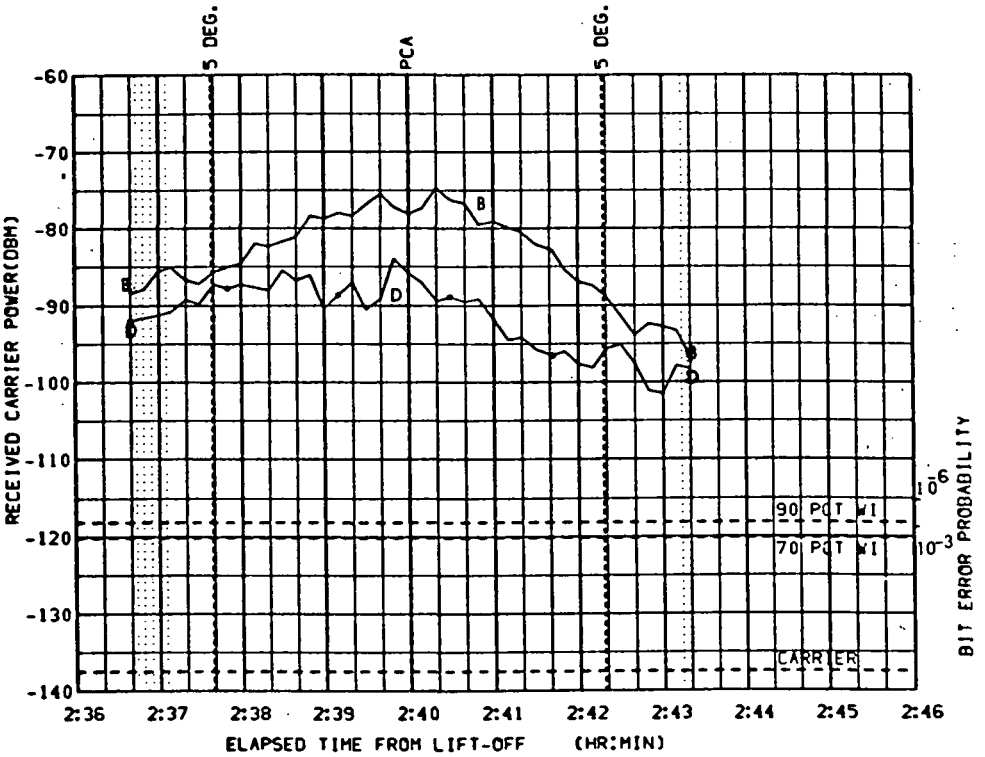


FIGURE 6-101f. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -2.573
ELV = 3.437
RANGE = 684

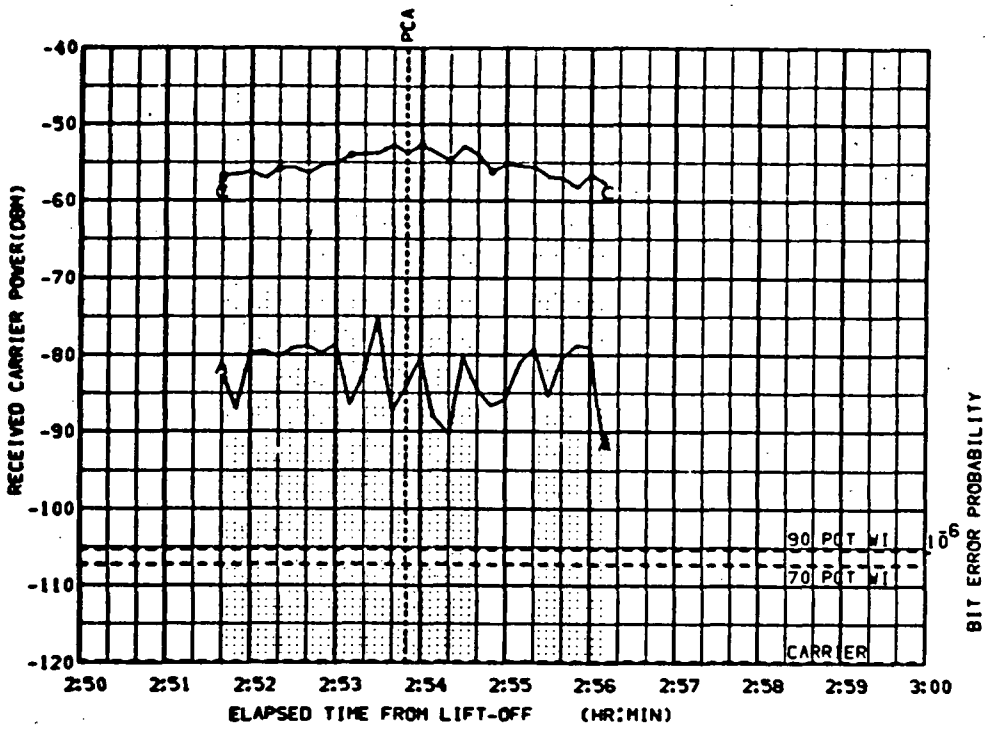


FIGURE 6-102a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

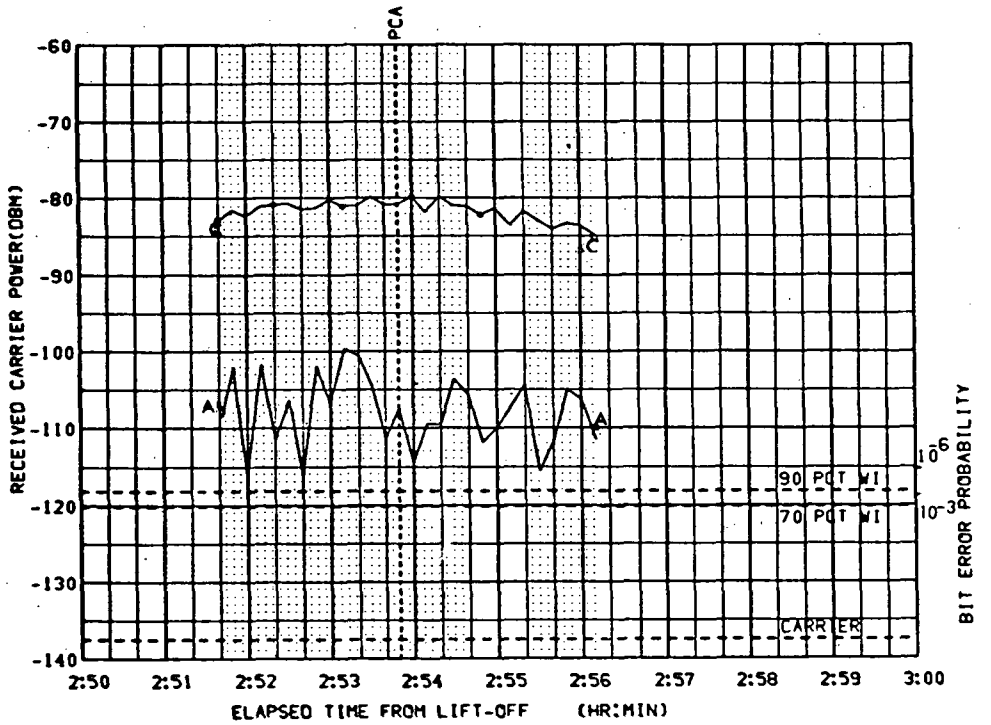


FIGURE 6-102b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -2.573
ELV = 3.437
RANGE = 684

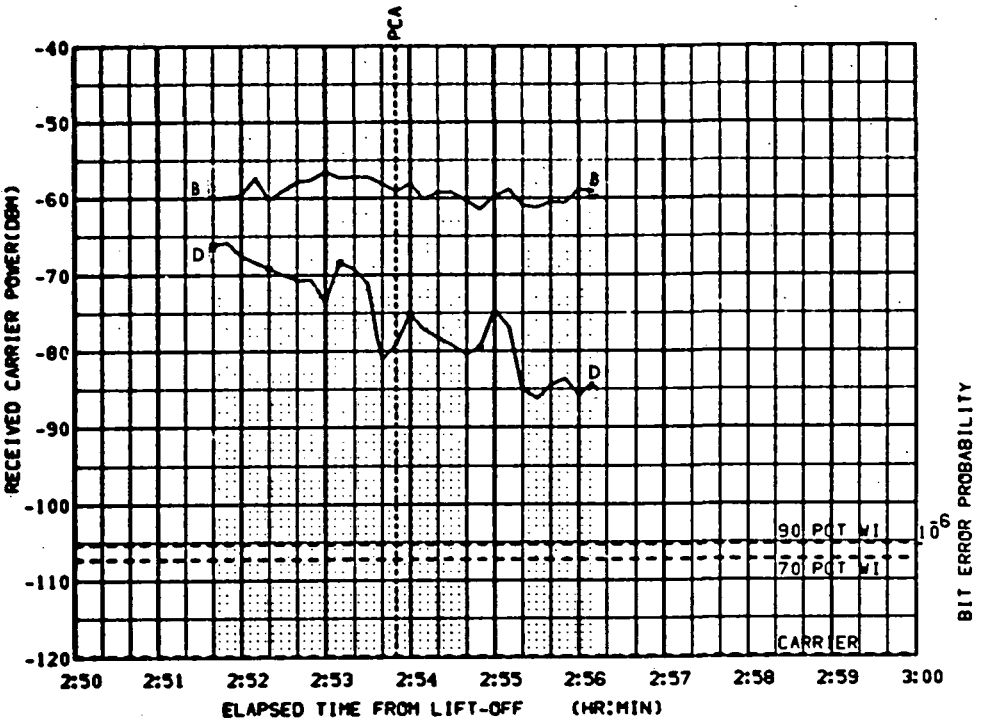


FIGURE 6-102c. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

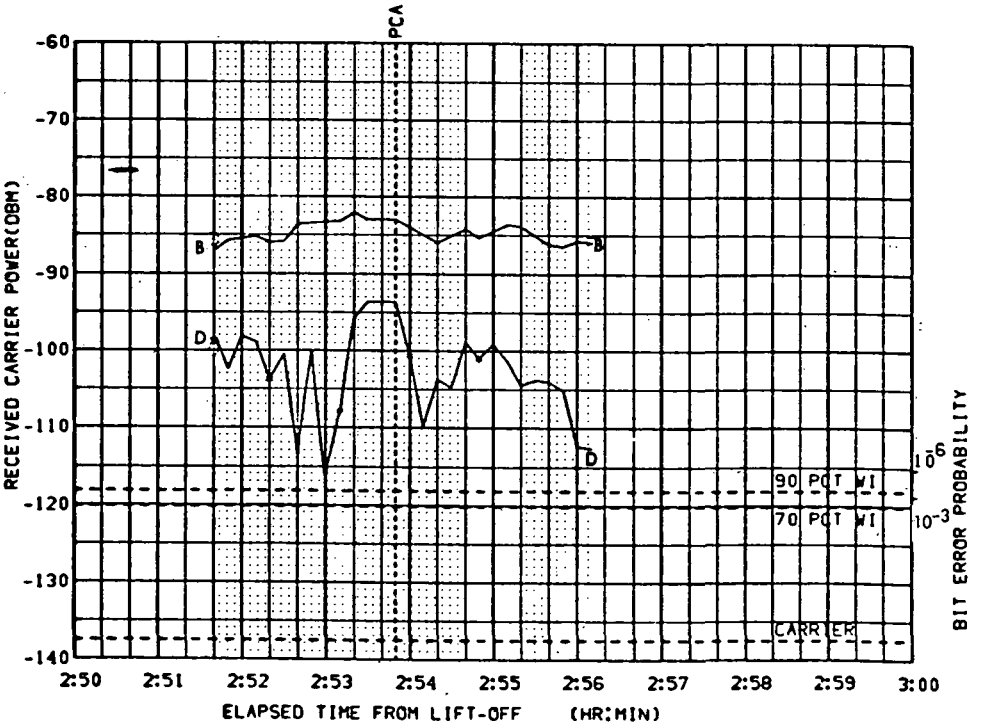


FIGURE 6-102d. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS, AZI = -2.573
ELV = 3.437
RANGE = 684

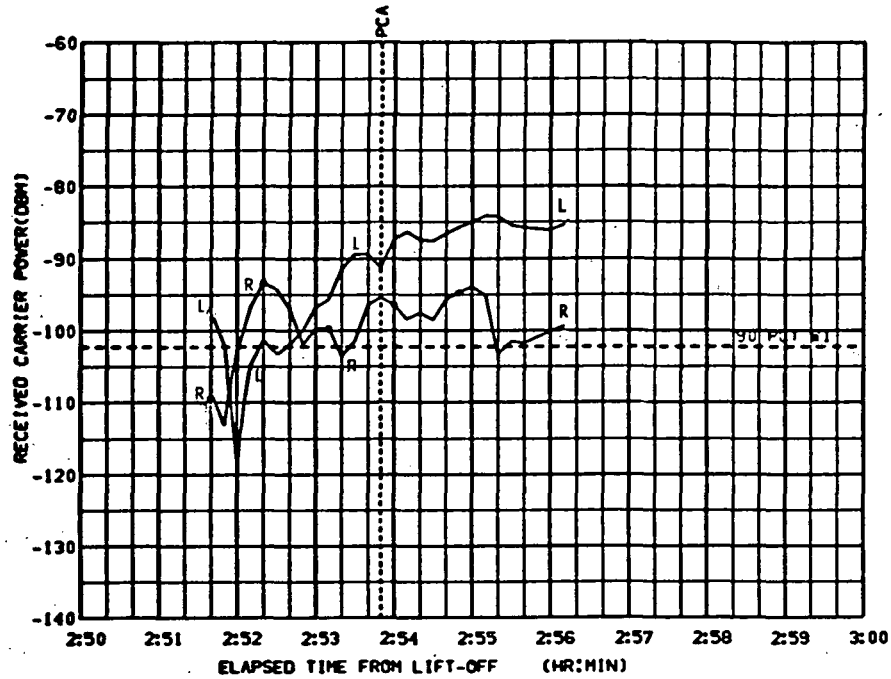


FIGURE 6-102e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

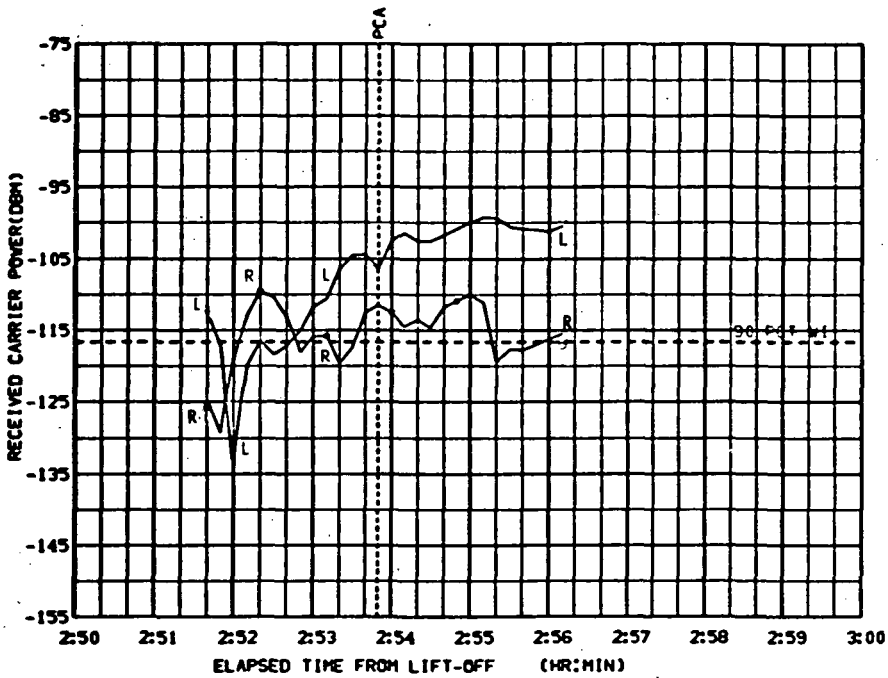


FIGURE 6-102f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

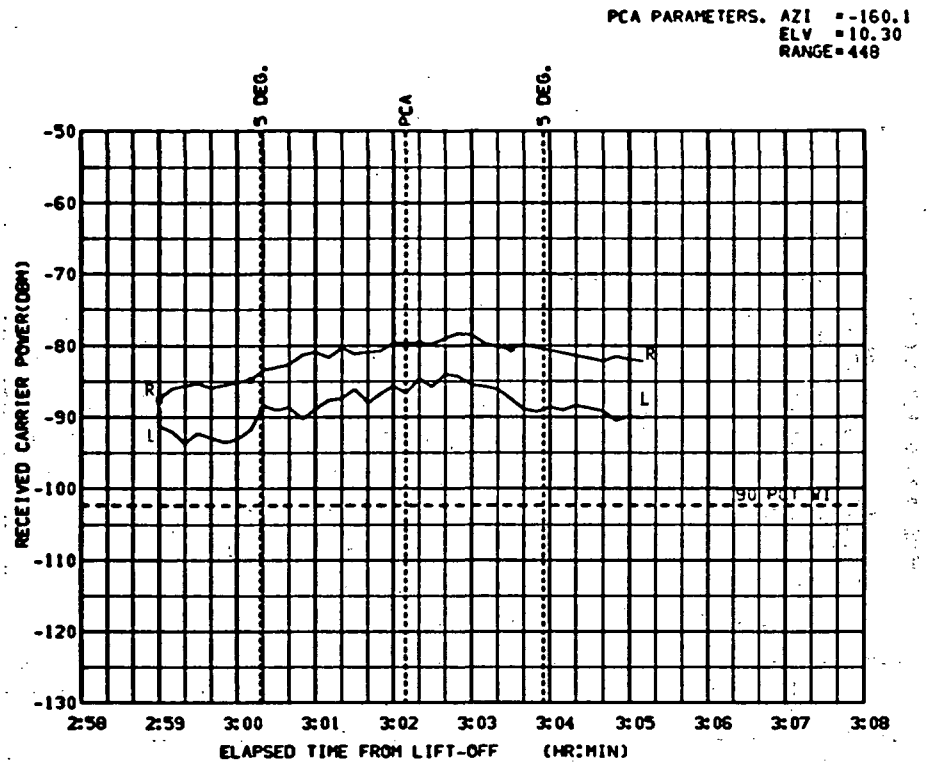


FIGURE 6-103a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

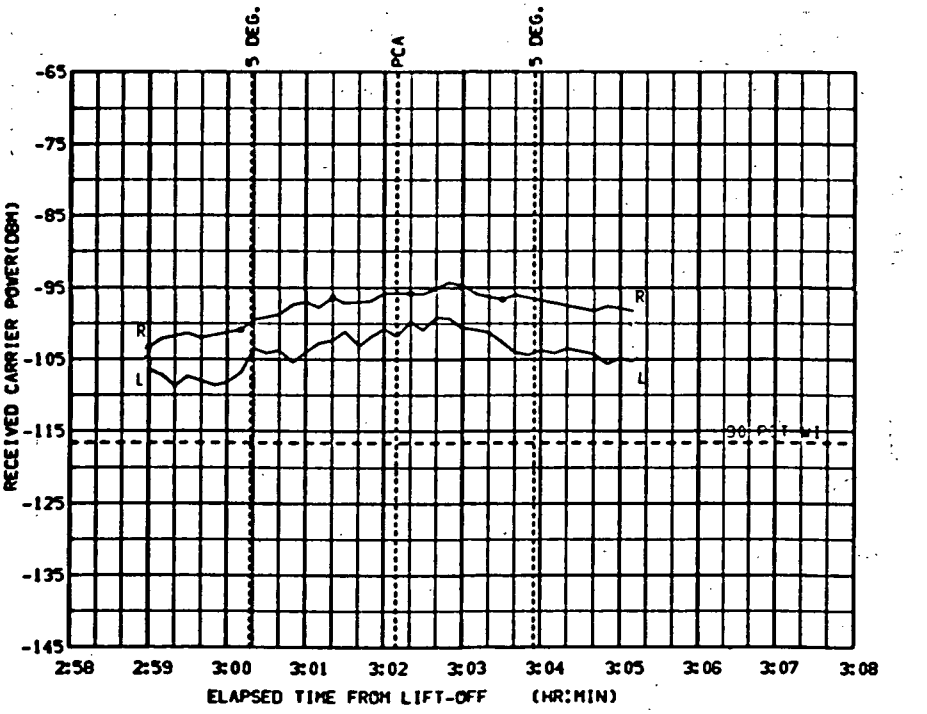


FIGURE 6-103b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

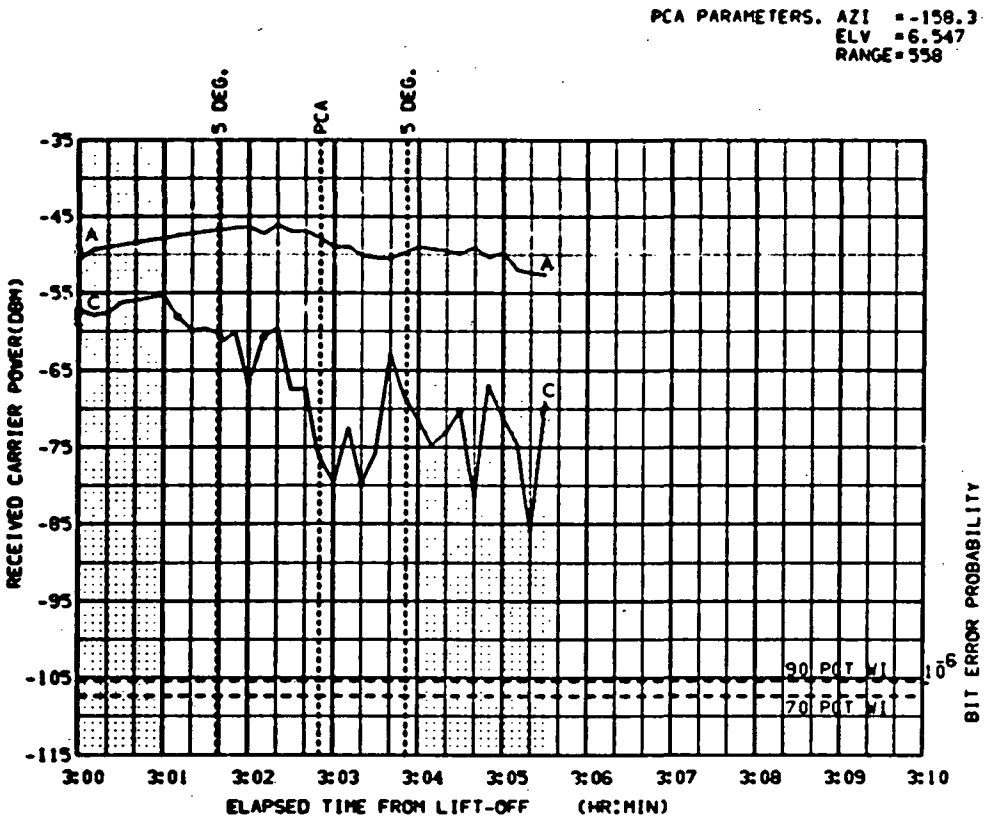


FIGURE 6-104a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

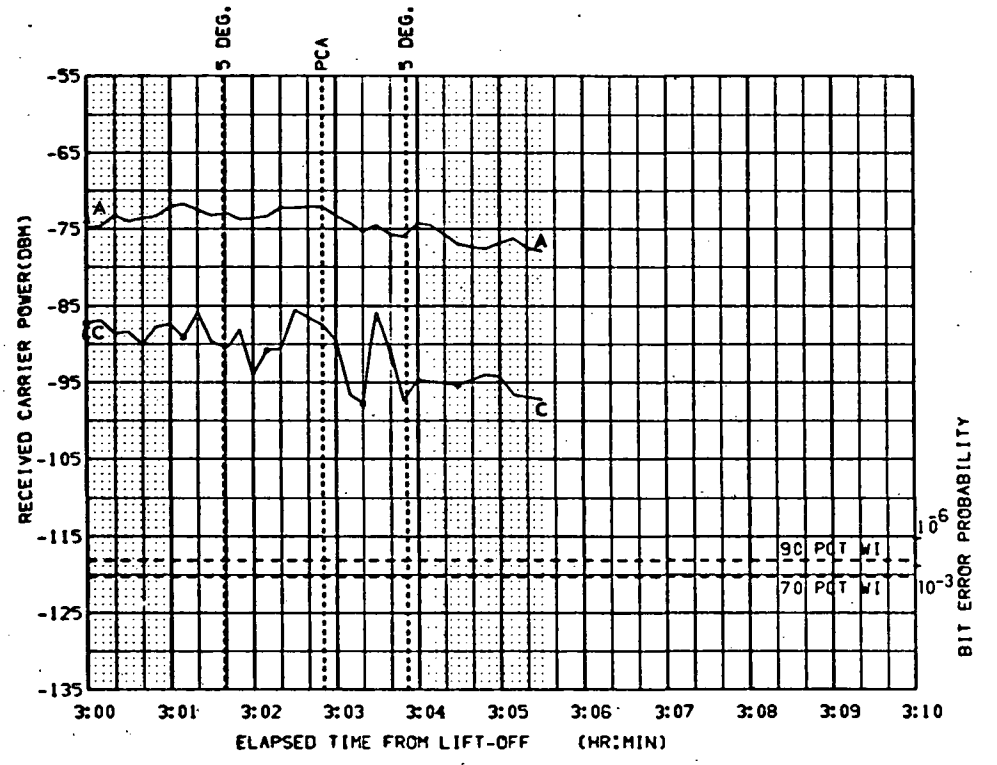


FIGURE 6-104b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

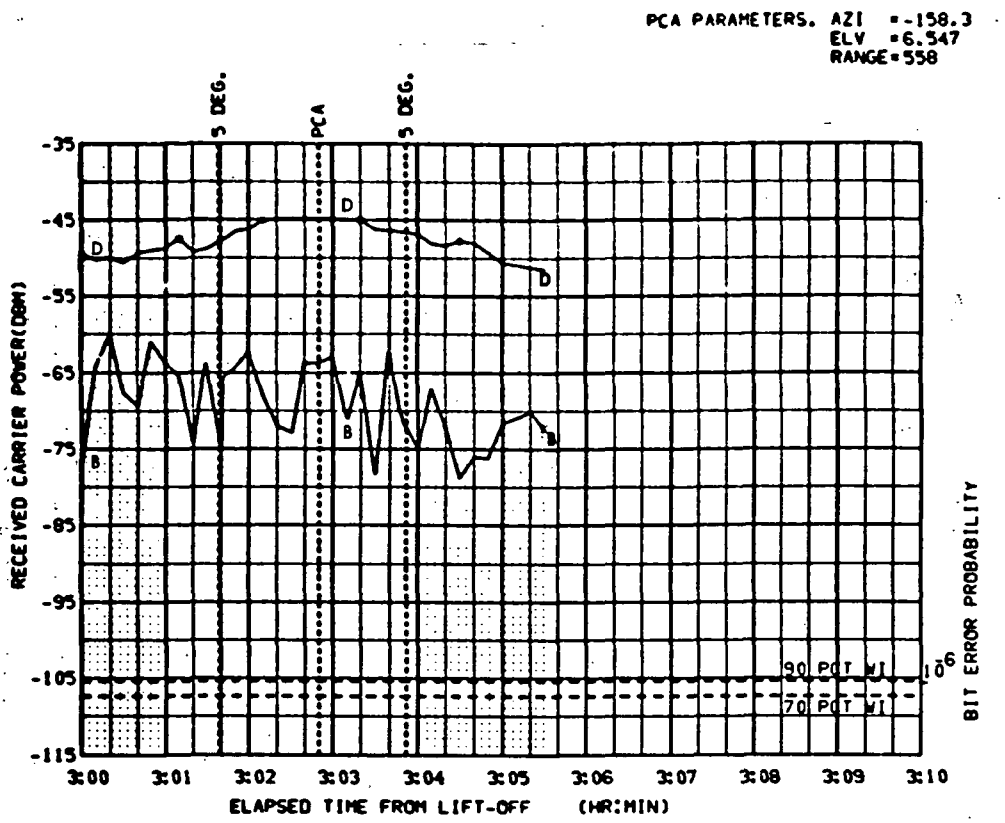


FIGURE 6-104c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

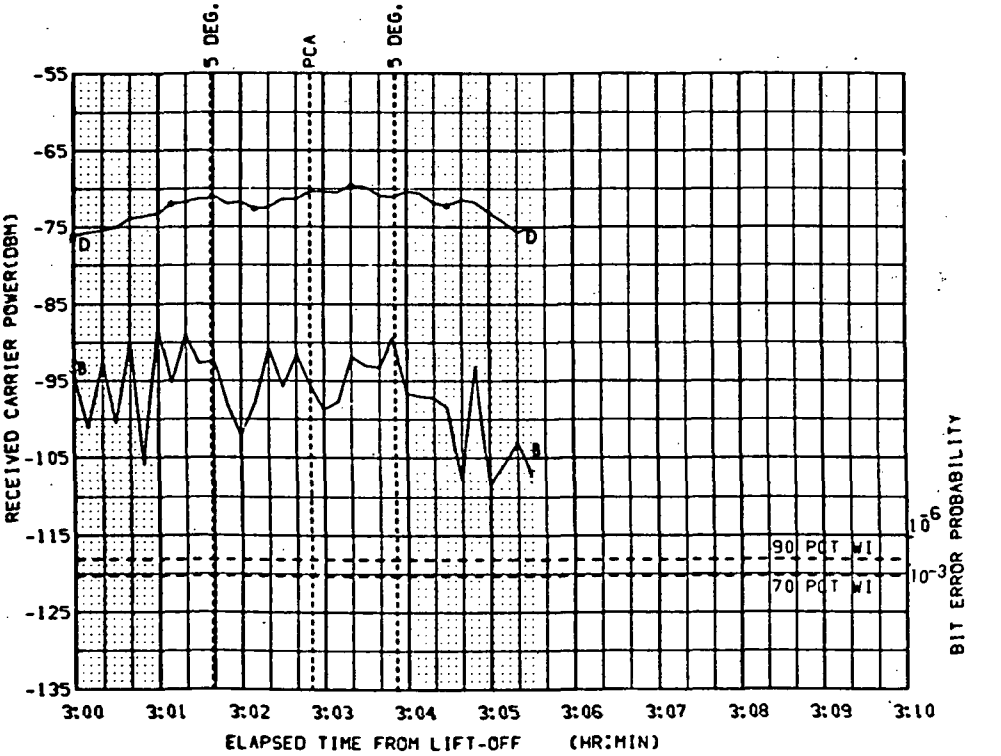


FIGURE 6-104d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

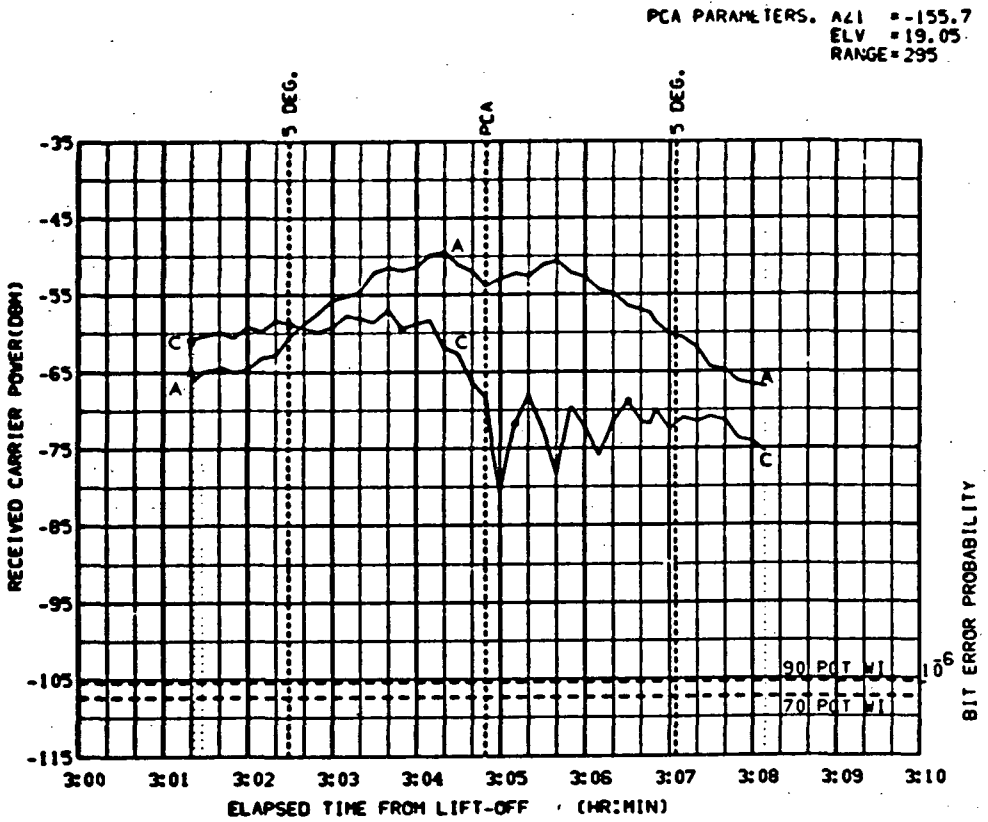


FIGURE 6-105a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

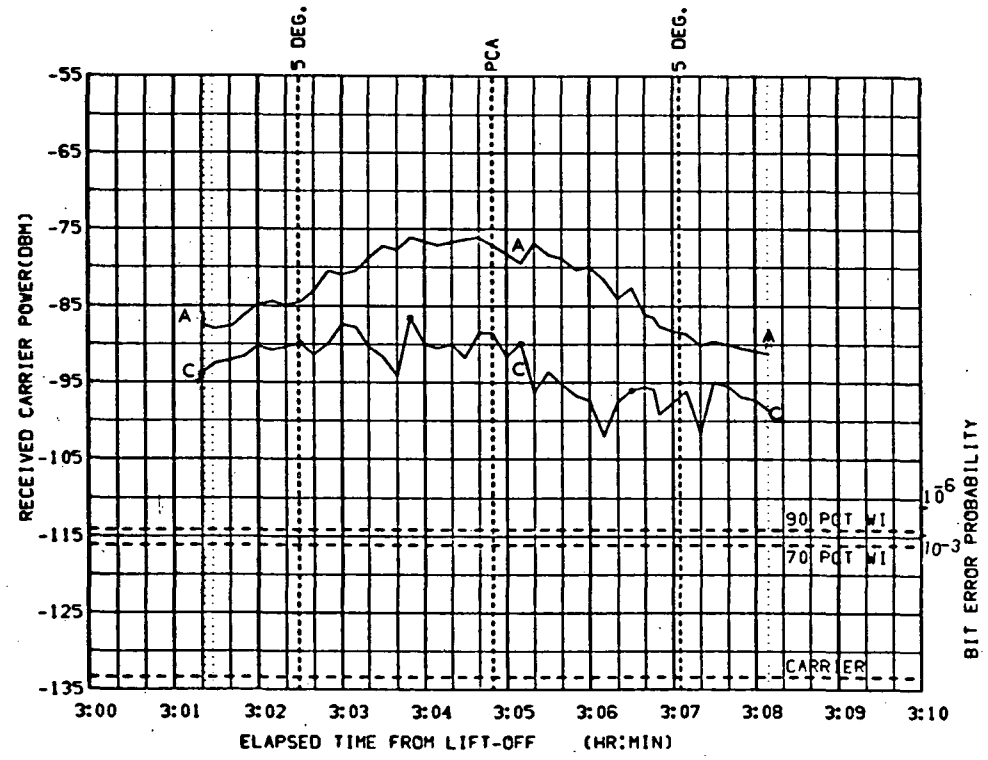


FIGURE 6-105b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

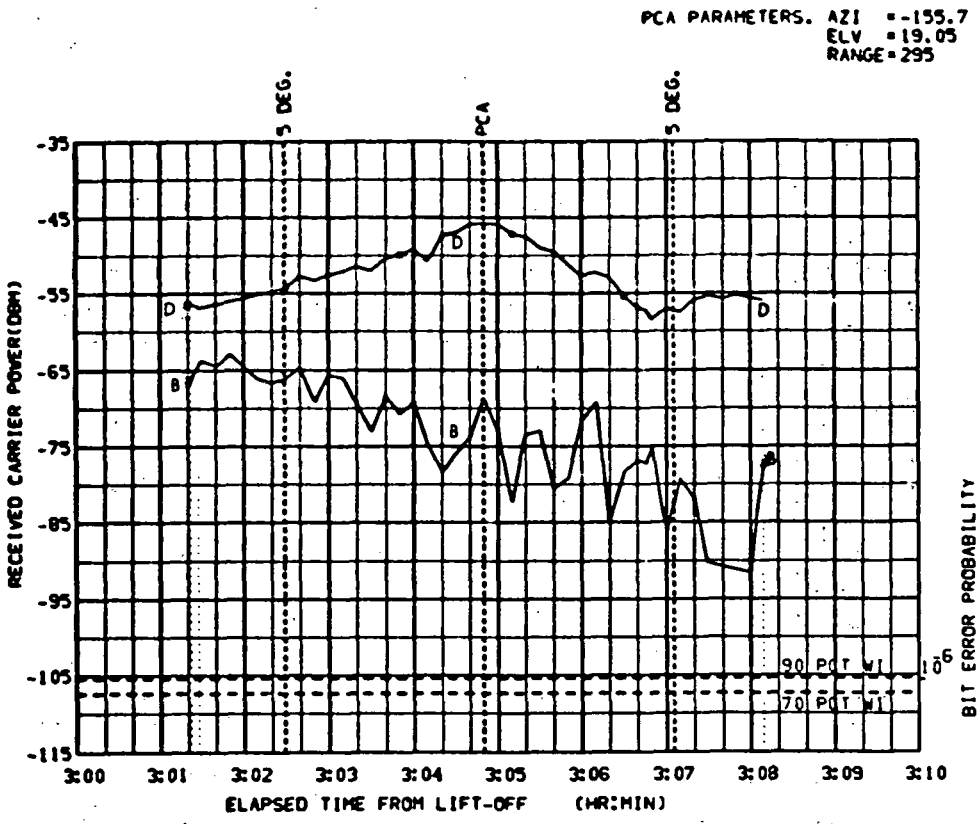


FIGURE 6-105c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

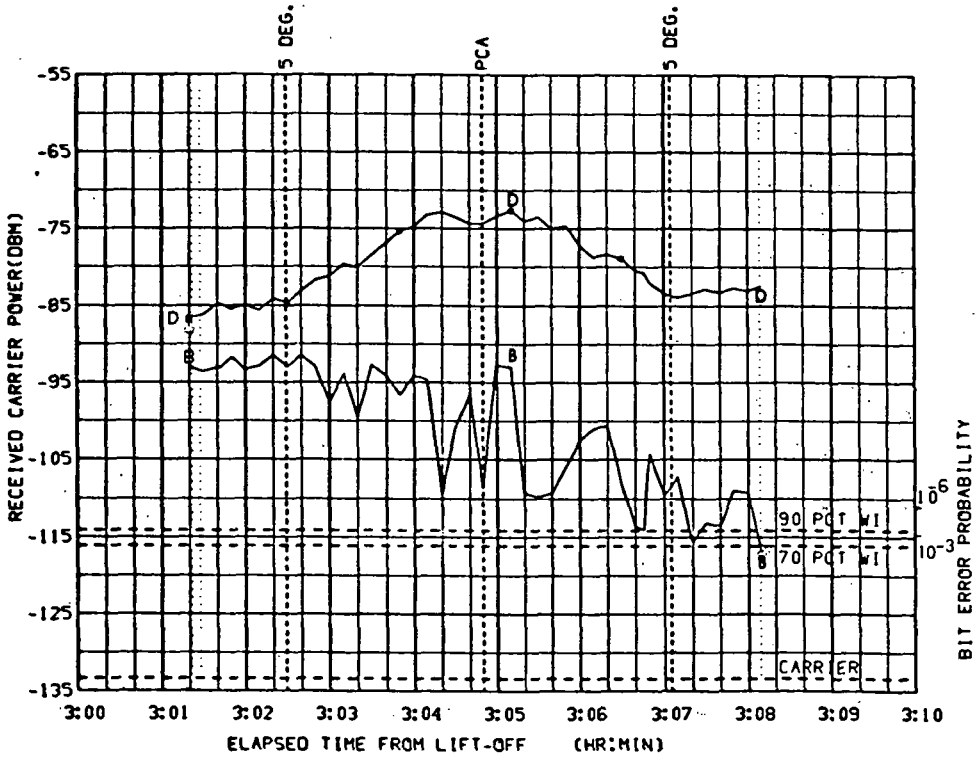


FIGURE 6-105d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

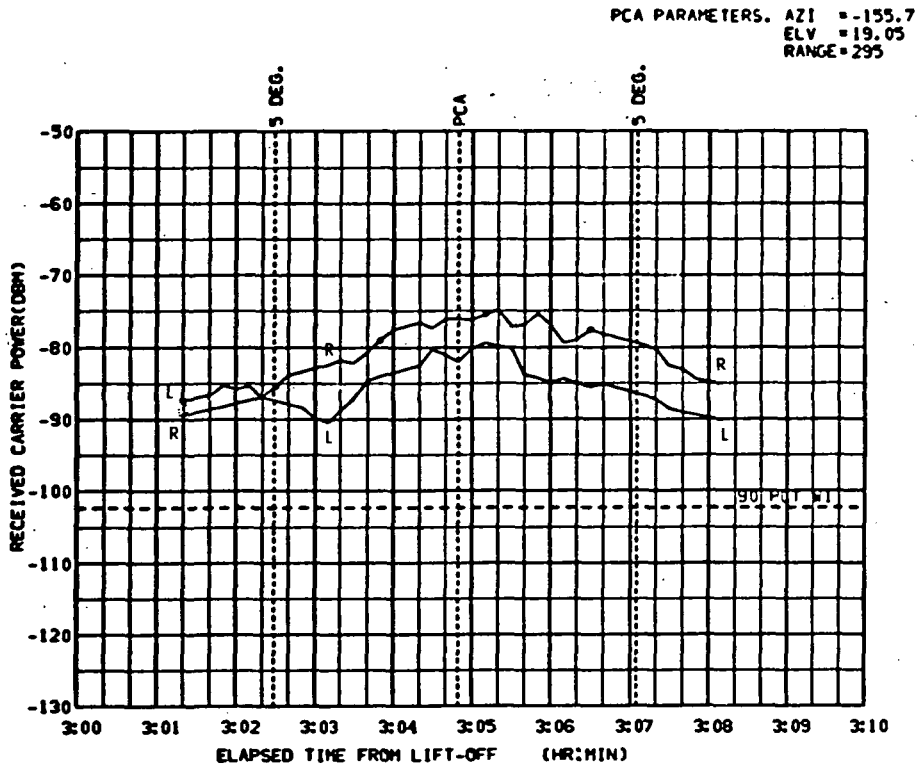


FIGURE 6-105e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

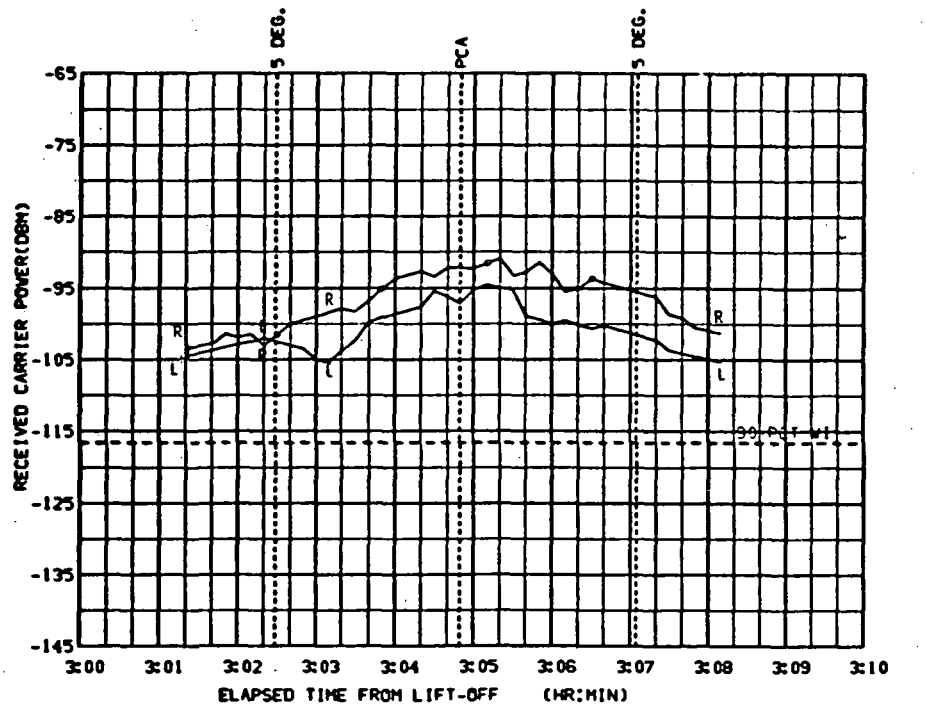


FIGURE 6-105f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-148.1
ELV =4.948
RANGE=615

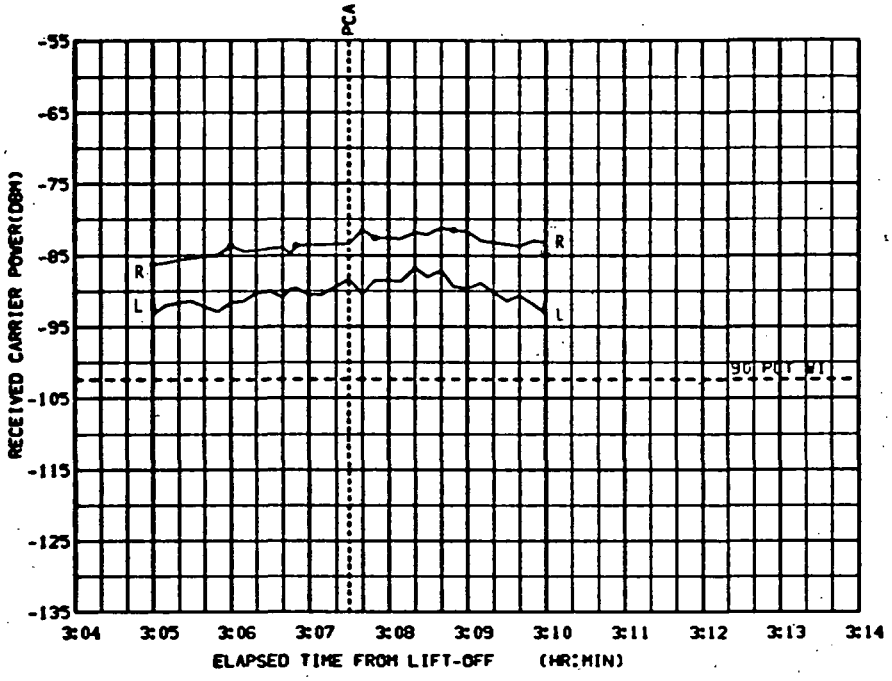


FIGURE 6-106a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

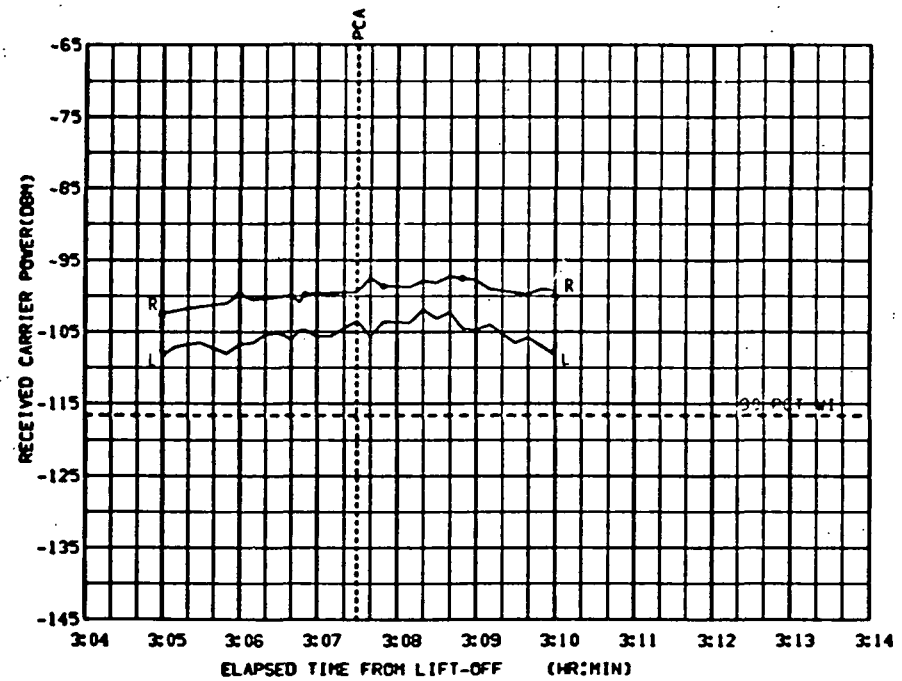


FIGURE 6-106b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-148.1
ELV =4.948
RANGE=615

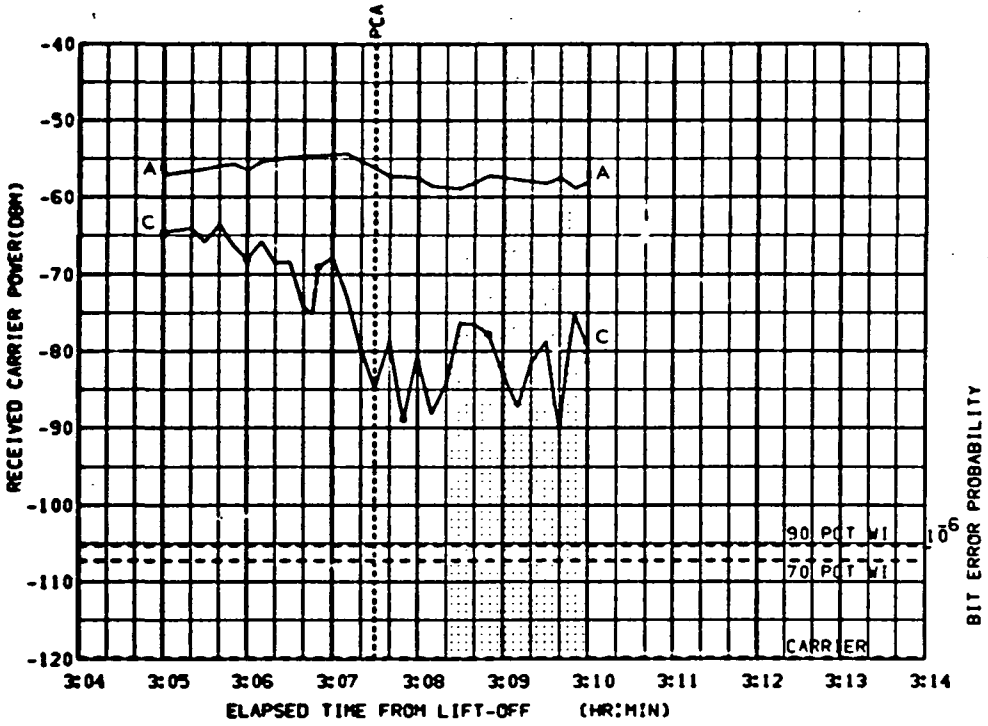


FIGURE 6-106c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

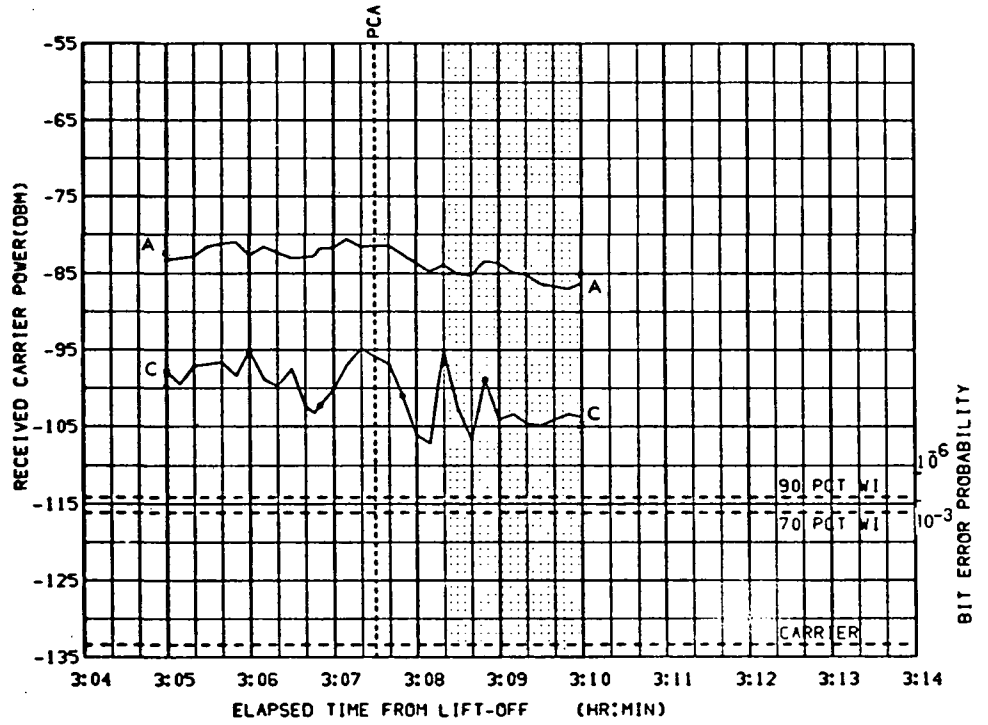


FIGURE 6-106d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-148.1
ELV =4.948
RANGE=615

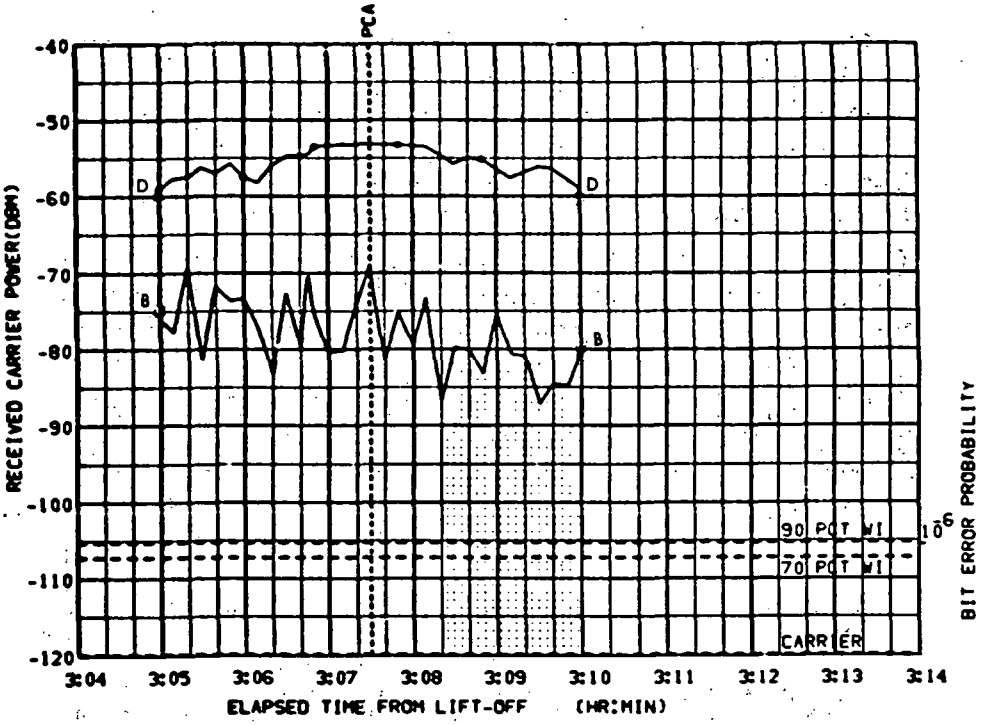


FIGURE 6-106e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

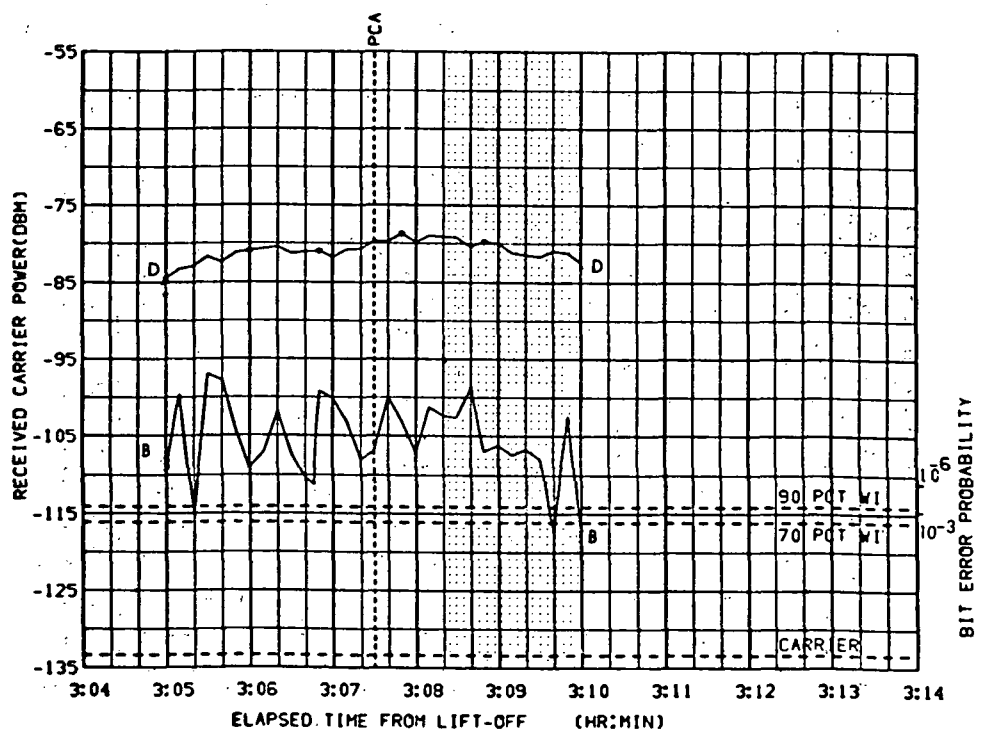


FIGURE 6-106f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

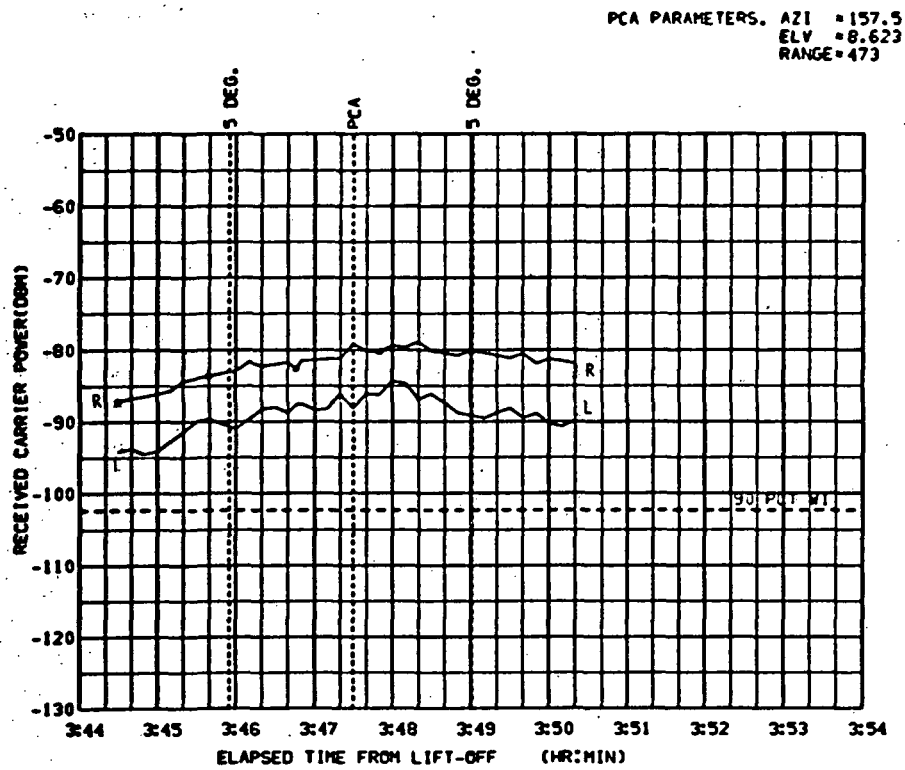


FIGURE 6-107a. TAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

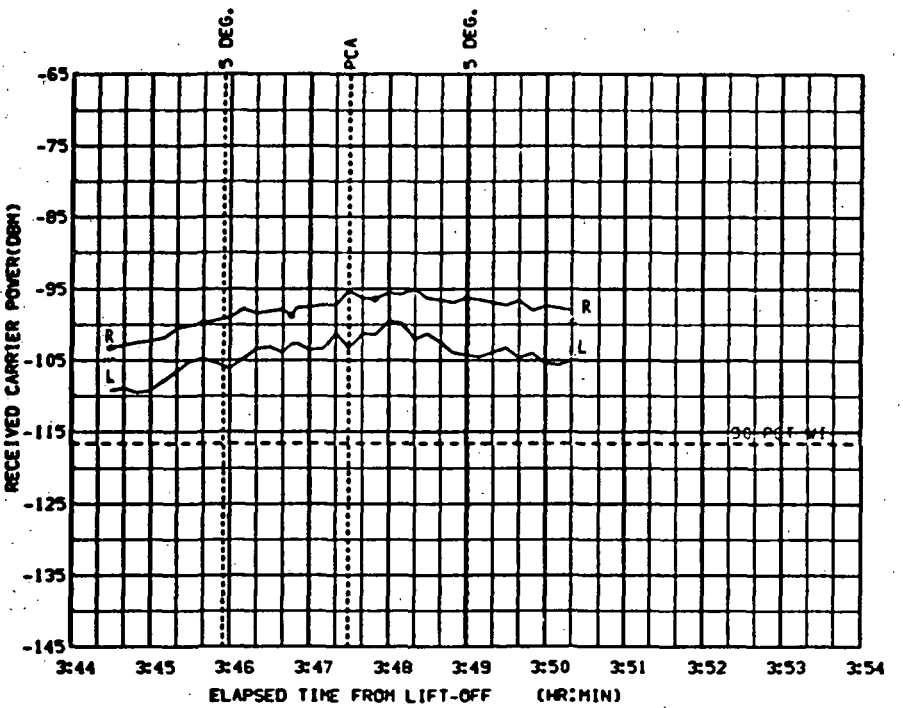


FIGURE 6-107b. TAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-20.98
ELV =0.730
RANGE=822

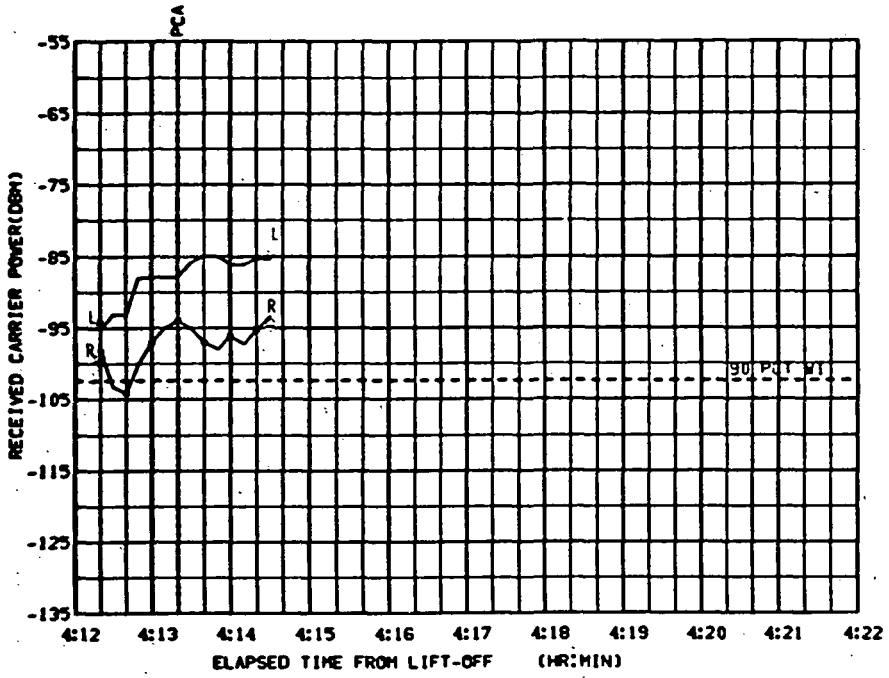


FIGURE 6-108a. GWM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

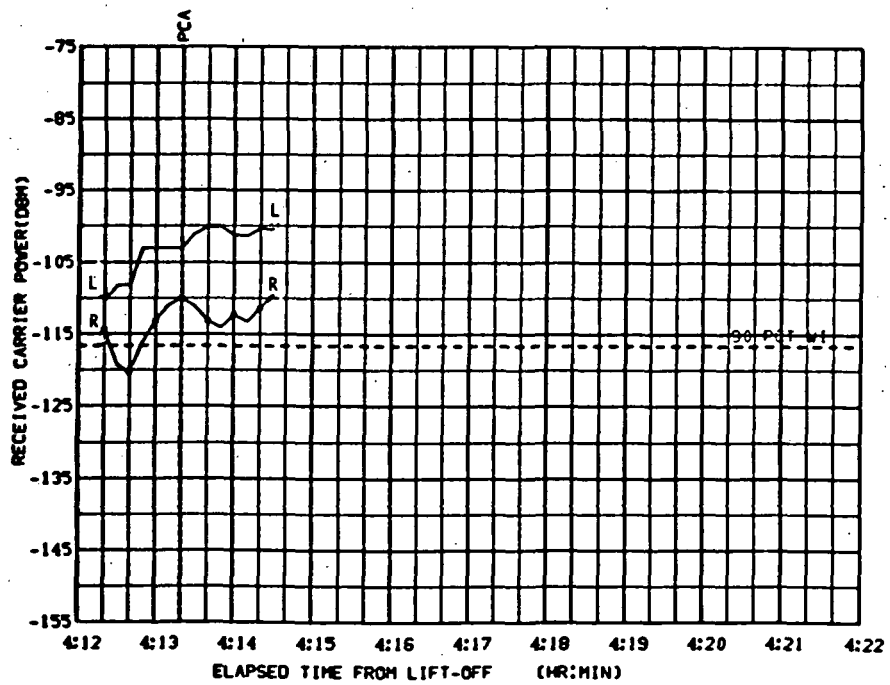


FIGURE 6-108b. GWM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

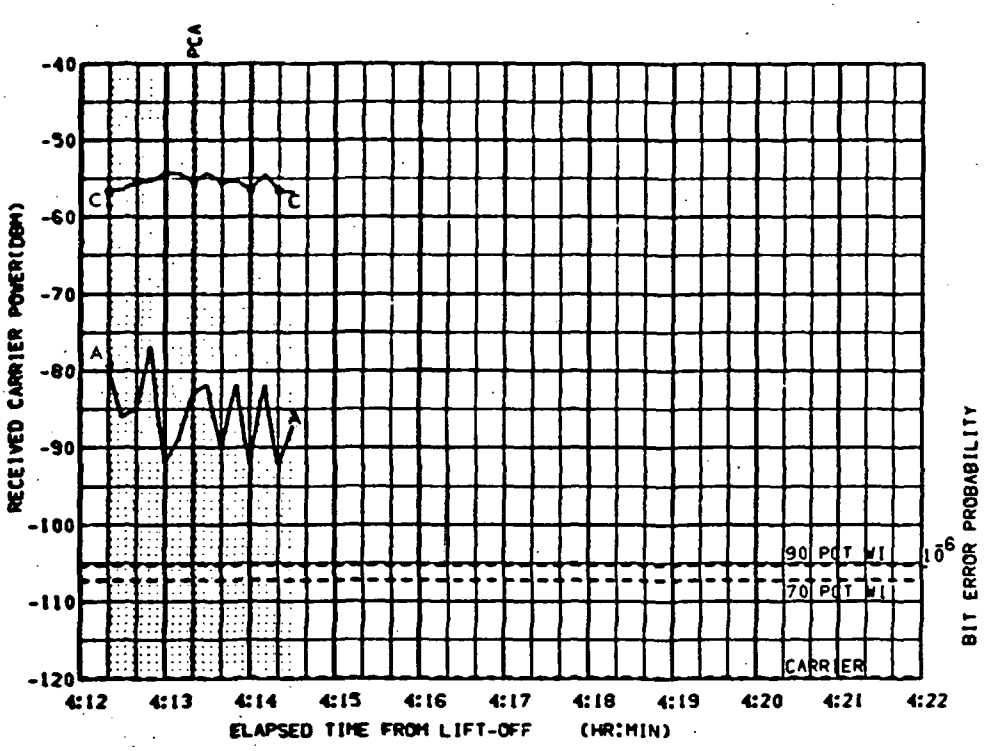


FIGURE 6-108c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

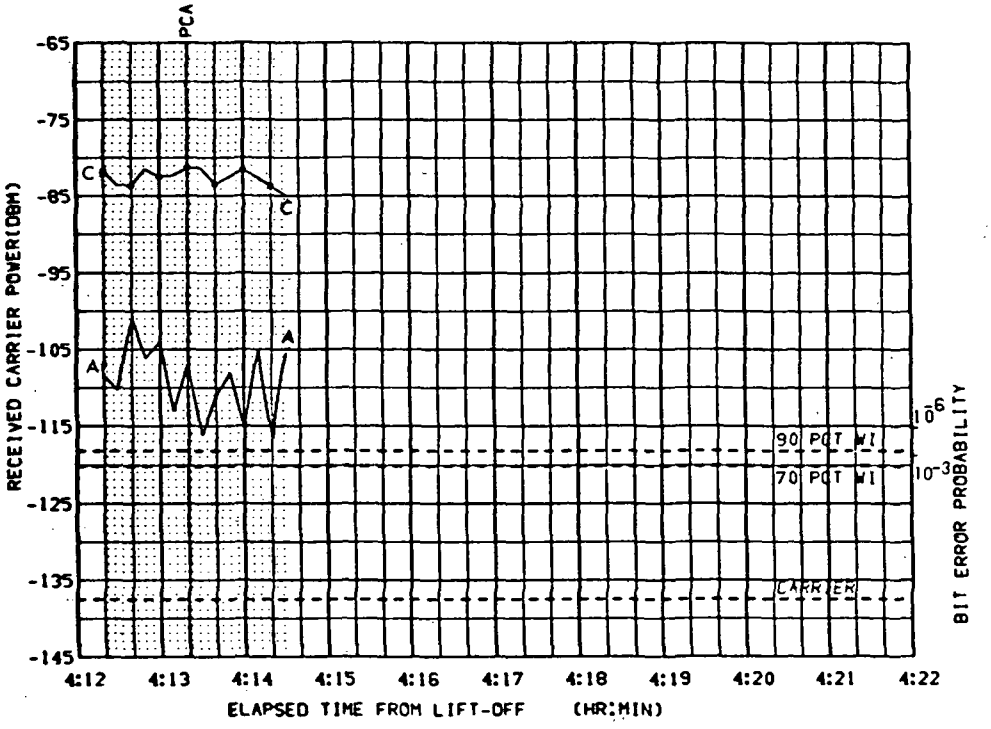


FIGURE 6-108d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

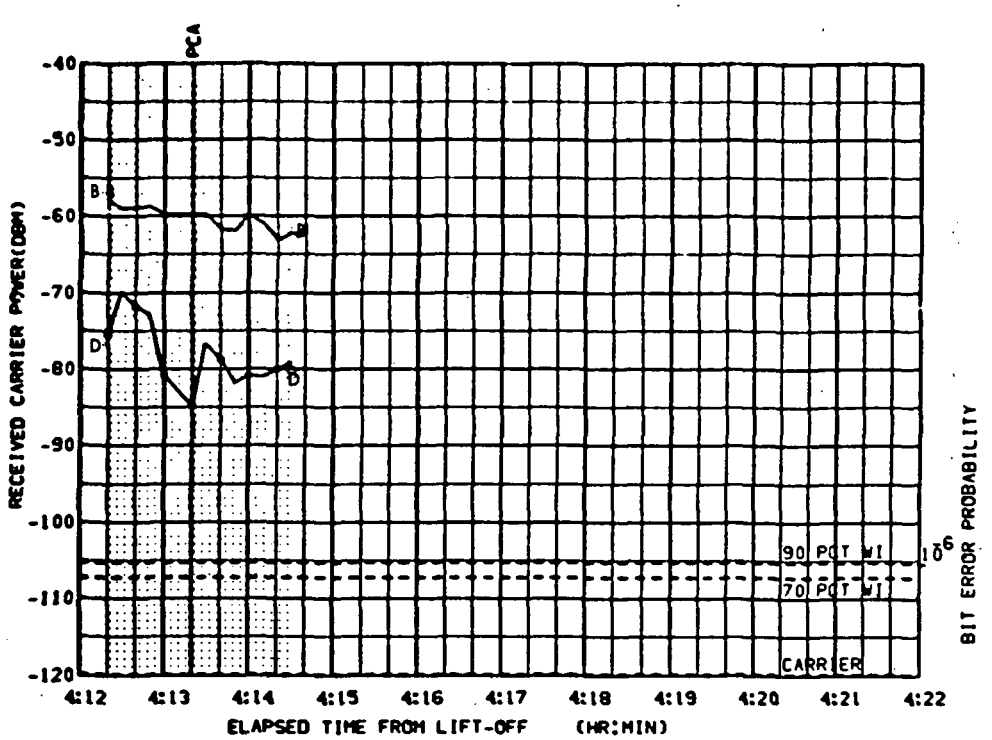


FIGURE 6-108e. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

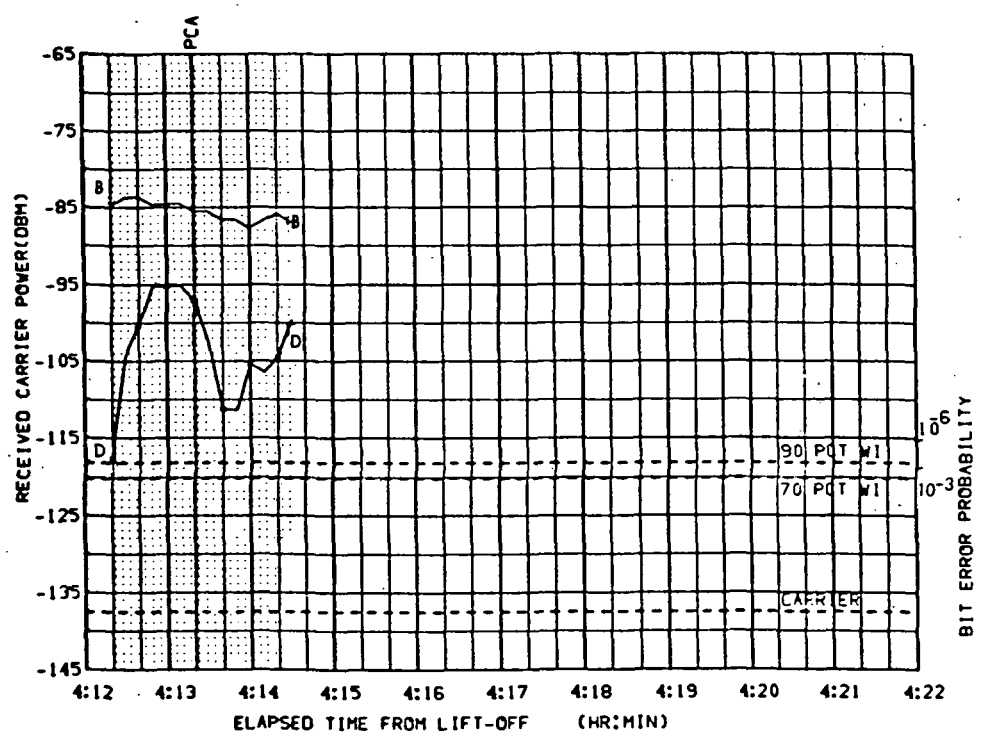


FIGURE 6-108f. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

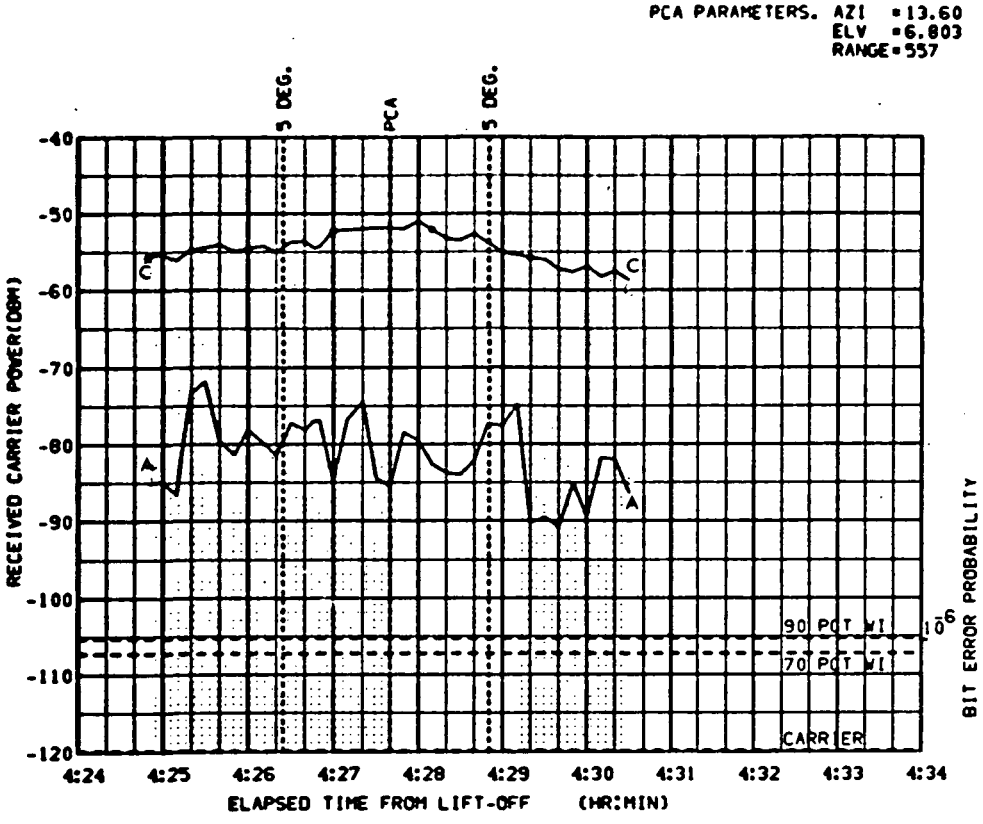


FIGURE 6-109a. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

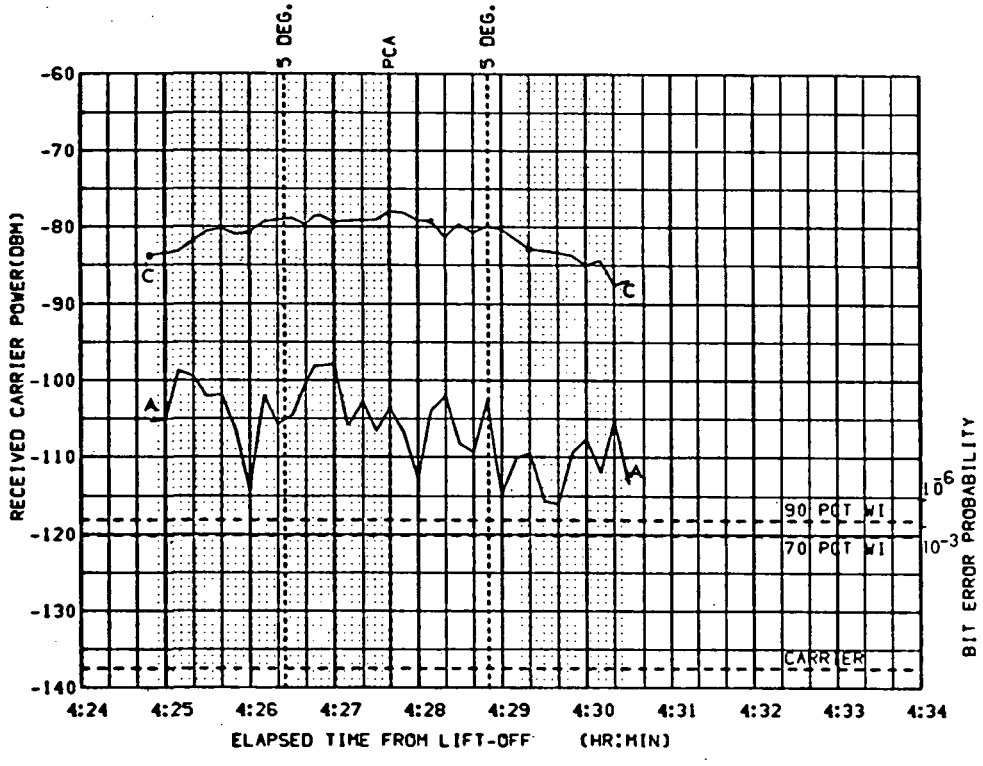


FIGURE 6-109b. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

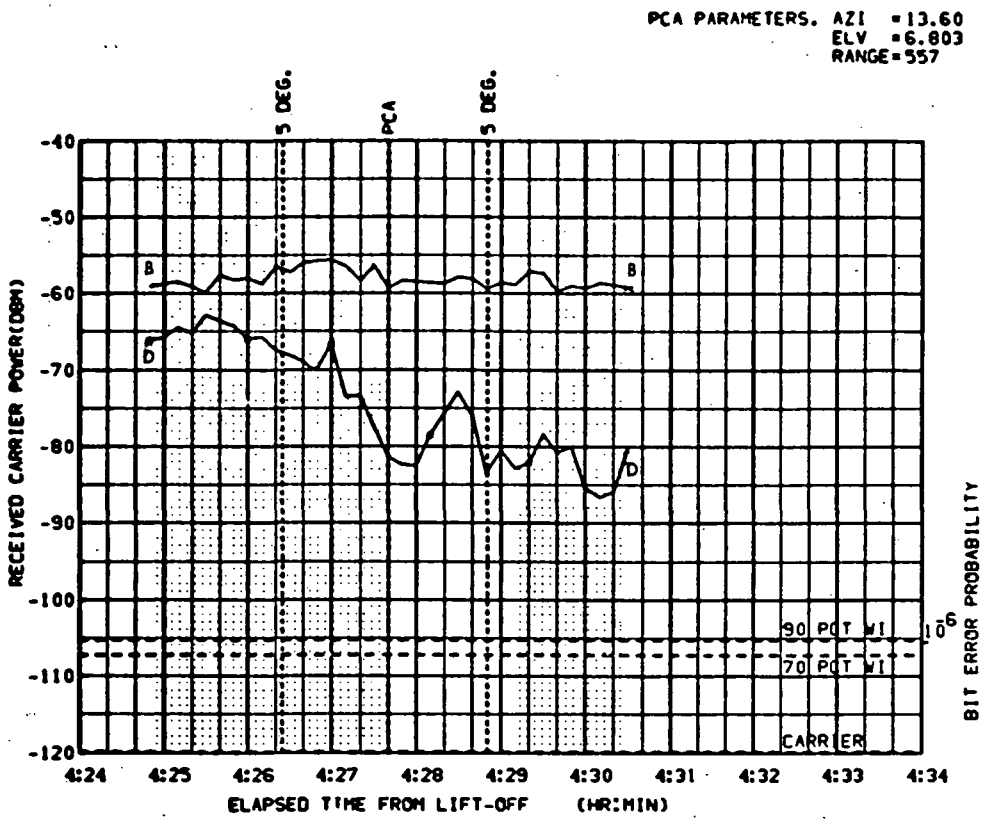


FIGURE 6-109c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

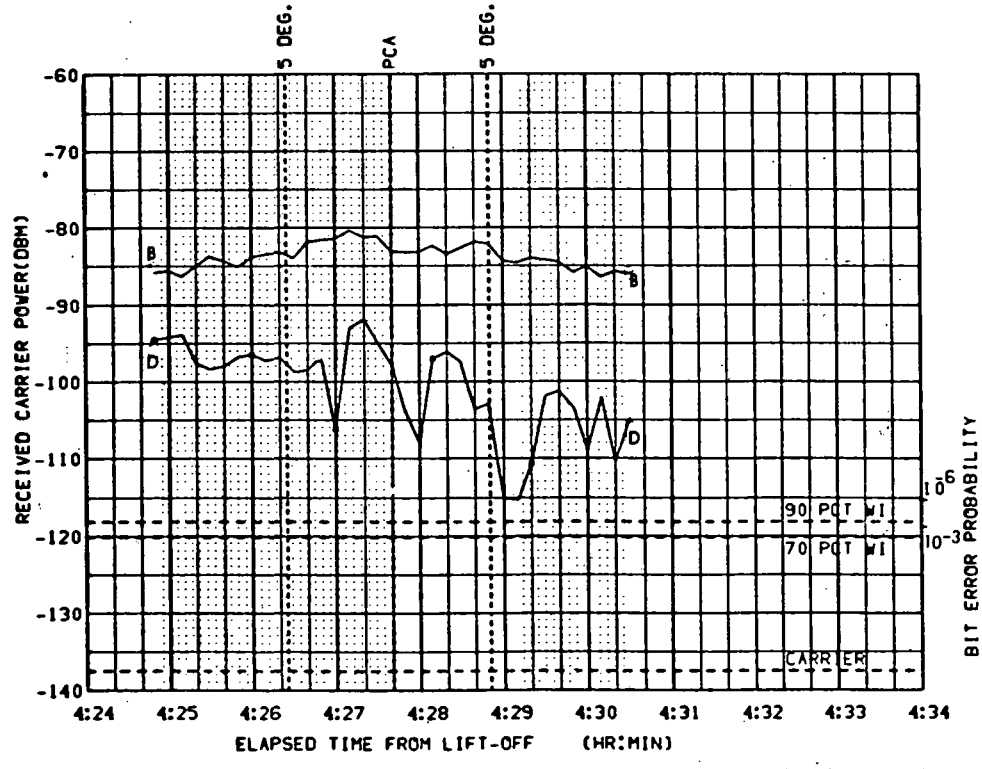


FIGURE 6-109d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

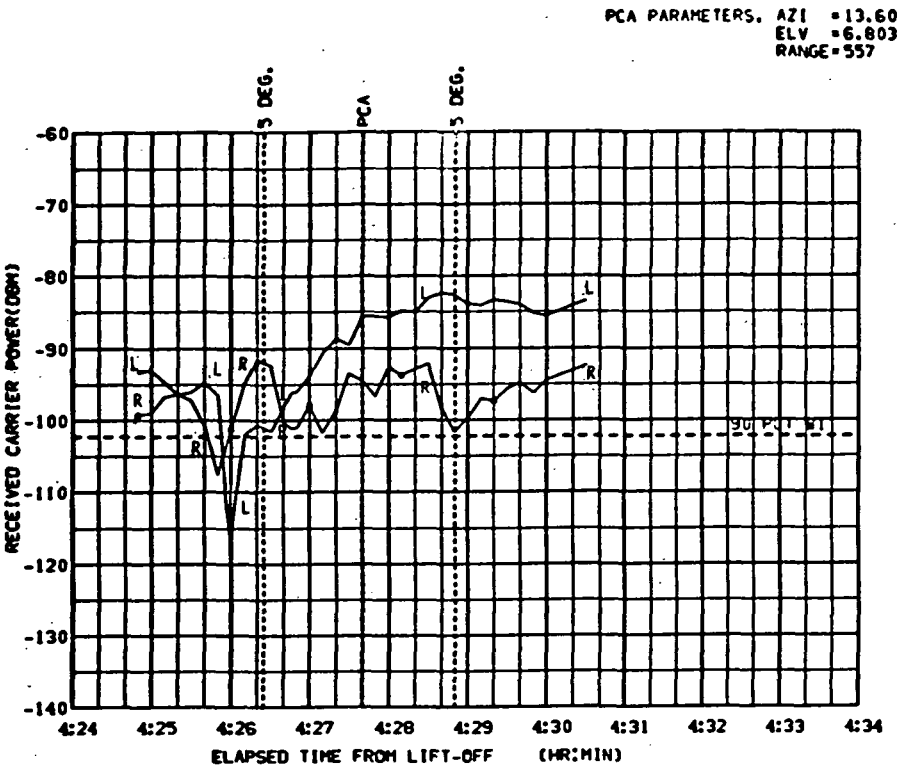


FIGURE 6-109e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

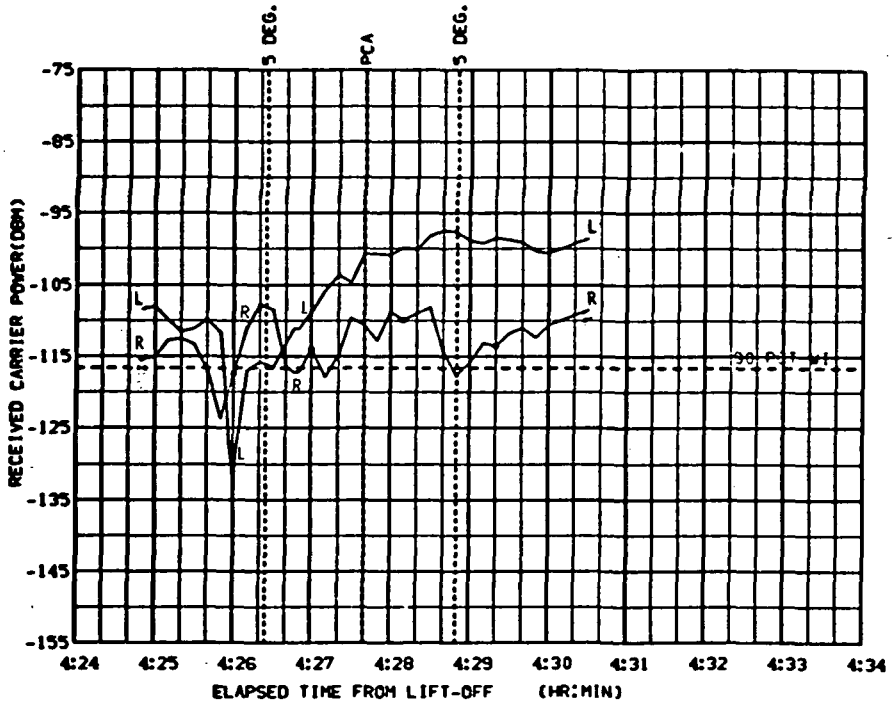


FIGURE 6-109f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN CSM/S-IVB. EARTH PARKING ORBIT (108 DEGREE). APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

7. TRANSPOSITION AND DOCKING

7.1 INTRODUCTION

This section discusses the communications coverage during the transposition and docking phase (T and D) of the Apollo 10 mission. The T and D phase covers the time period from translunar injection to the S-IVB slingshot maneuver.

Communication analysis and recommendations are provided for the CSM S-band and VHF/AM systems. Trajectory data for a 17 May 1969 launch date mission were used in the generation of received carrier power versus elapsed time plots for this phase of the mission.

The following communications recommendations are contained in this section:

a) GDS should be primary S-band receiving station.

b) Handover sequence should be from HTV to HAW to GDS as soon as possible after acquisition of signal at each station.

c) HAW should be primary VHF/AM station.

d) Maintain ground command selection of CSM omni antenna D until handover to GDS. Ground command antenna A at start of CSM/S-IVB separation maneuver. Manually select omni antenna B just prior to LM spring ejection.

e) Use omni antenna A and 85-foot GDS antenna combination for color TV transmission scheduled during T and D phase.

f) Use LEFT CSM VHF/AM antenna prior to CSM/S-IVB separation. Use RIGHT antenna from CSM/S-IVB separation and until termination of VHF/AM communications.

g) The bar graphs and computer plots reflect a 72-degree launch azimuth and a first opportunity TLI. The event times shown on the computer plots are for a 17 May launch date. The event times for the 18 May launch date are given in Section 4 and on the bar graph.

7.2 COMMUNICATION CONFIGURATION

The communication configuration for the T and D phase is shown in Figure 7-1. This configuration consists of both VHF/AM and S-band communications between the CSM and MSFN. The S-band system will use uplink PM mode 6 (full uplink) and downlink PM mode 2 (full downlink). An FM downlink is also available for dumping the contents of the data storage equipment (DSE). The VHF/AM system will be operated in the Simplex A mode; i.e., uplink and downlink VHF/AM voice will be transmitted on a frequency of 296.8 MHz.

7.3 RF COVERAGE SUMMARY

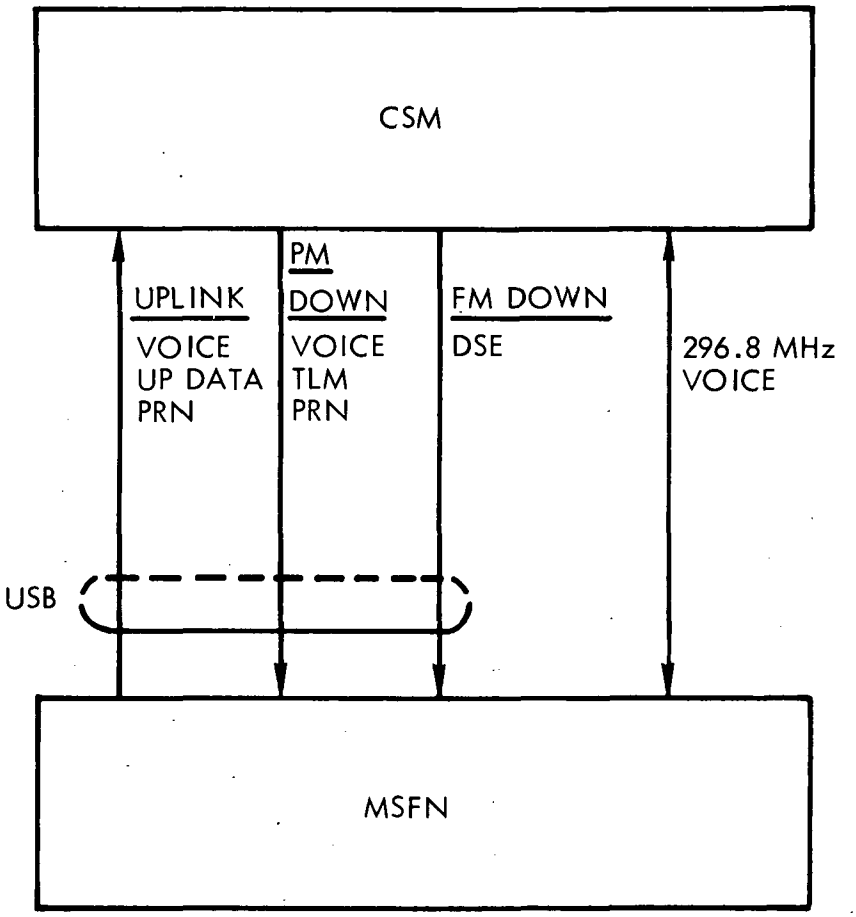
A bar graph summary of RF communications for the T and D phase is provided for a 17 May 1969 launch date and for an 18 May 1969 launch date in Figures 7-2a and 7-2b, respectively. The bar charts show station coverage, recommended spacecraft antenna selections, and recommended handover sequence. The spacecraft antenna recommendations are based on the following criteria and in this order of precedence:

a) Antennas which provide the largest positive circuit margin (carrier power above the 70 percent WI voice threshold and 10^{-3} BEP telemetry threshold on S-band downlink and carrier power above 90 percent WI voice threshold on VHF/AM downlink)

b) Antennas which allow minimum spacecraft switching

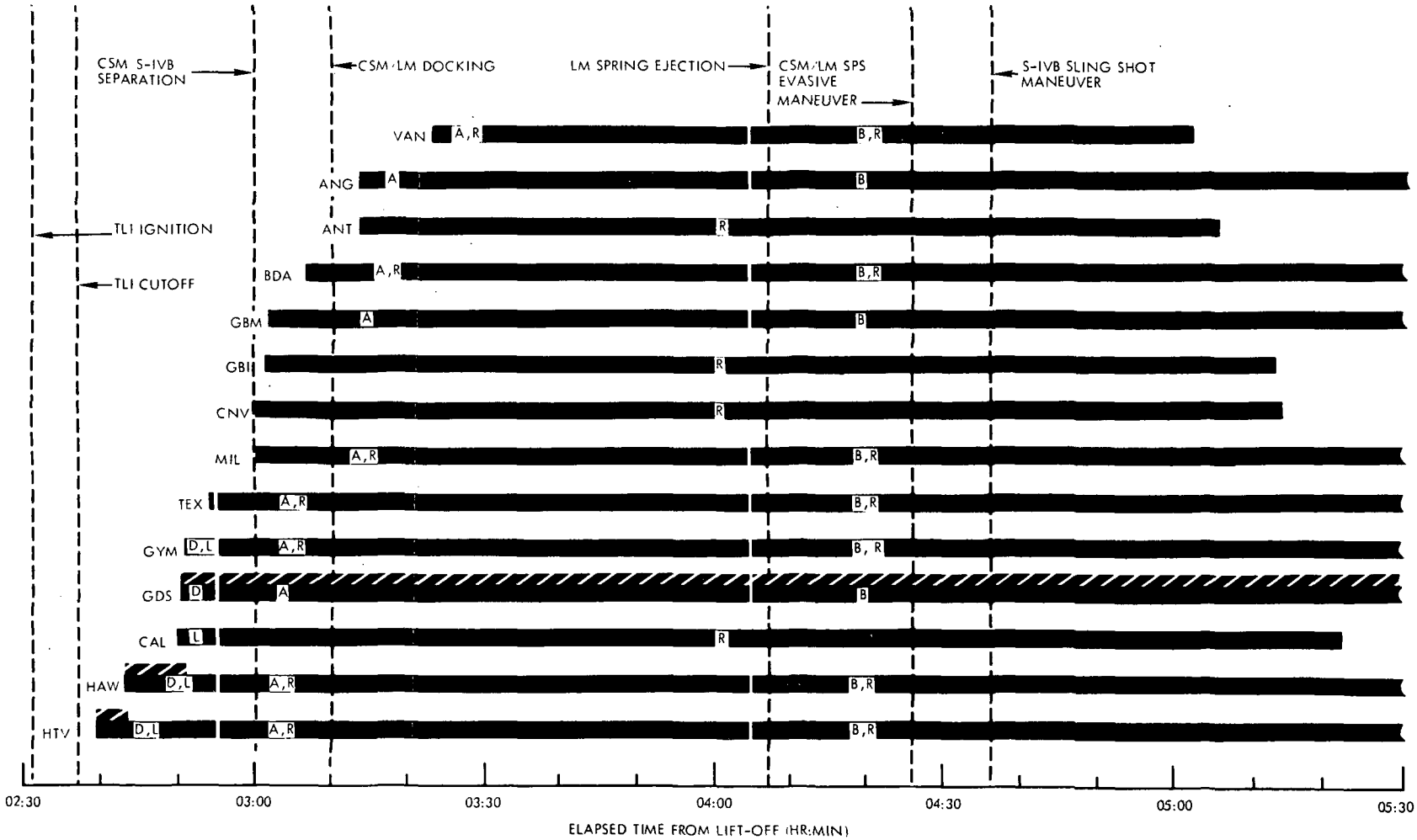
c) Maintenance of ground command antenna switching

Computer plots of received carrier power versus elapsed time from lift-off (Figures 7-3 through 7-14) are presented for each station providing S-band or VHF/AM coverage. A plot is provided for each pair of diametrically opposite CSM S-band omnidirectional antennas (i.e., A and C, B and D) for both uplink and downlink signals. A plot is also provided for the two CSM VHF/AM scimitar antennas for both uplink and downlink signals. The letters L and R are used on the bar graphs and VHF/AM plots to designate the CSM VHF LEFT and RIGHT antennas. Plots have not been provided for the CSM high-gain antennas since it is not normally activated during this phase of the mission.



NOTES:
1. ALL AUDIO CENTERS HAVE VHF AND S-BAND VOLUMES UP
2. S-BAND SQUELCH ENABLED
3. VHF SIMPLEX A WILL BE SELECTED FOR TRANSPOSITION AND DOCKING OPERATIONS

Figure 7-1. Communication Configuration for Transposition and Docking Phase



LEGEND:
LETTERS WITHIN BAR INDICATE RECOMMENDED ANTENNAS (S-BAND OMNI ANTENNAS A,B,C, AND D; VHF/AM ANTENNAS L AND R)
RECOMMENDED ANTENNA SWITCHING TIMES SHOWN BY BREAK IN BAR
INDICATES RECOMMENDED STATION

Figure 7-2a. RF Coverage Summary for Transposition and Docking Phase (17 May 1969 Launch)

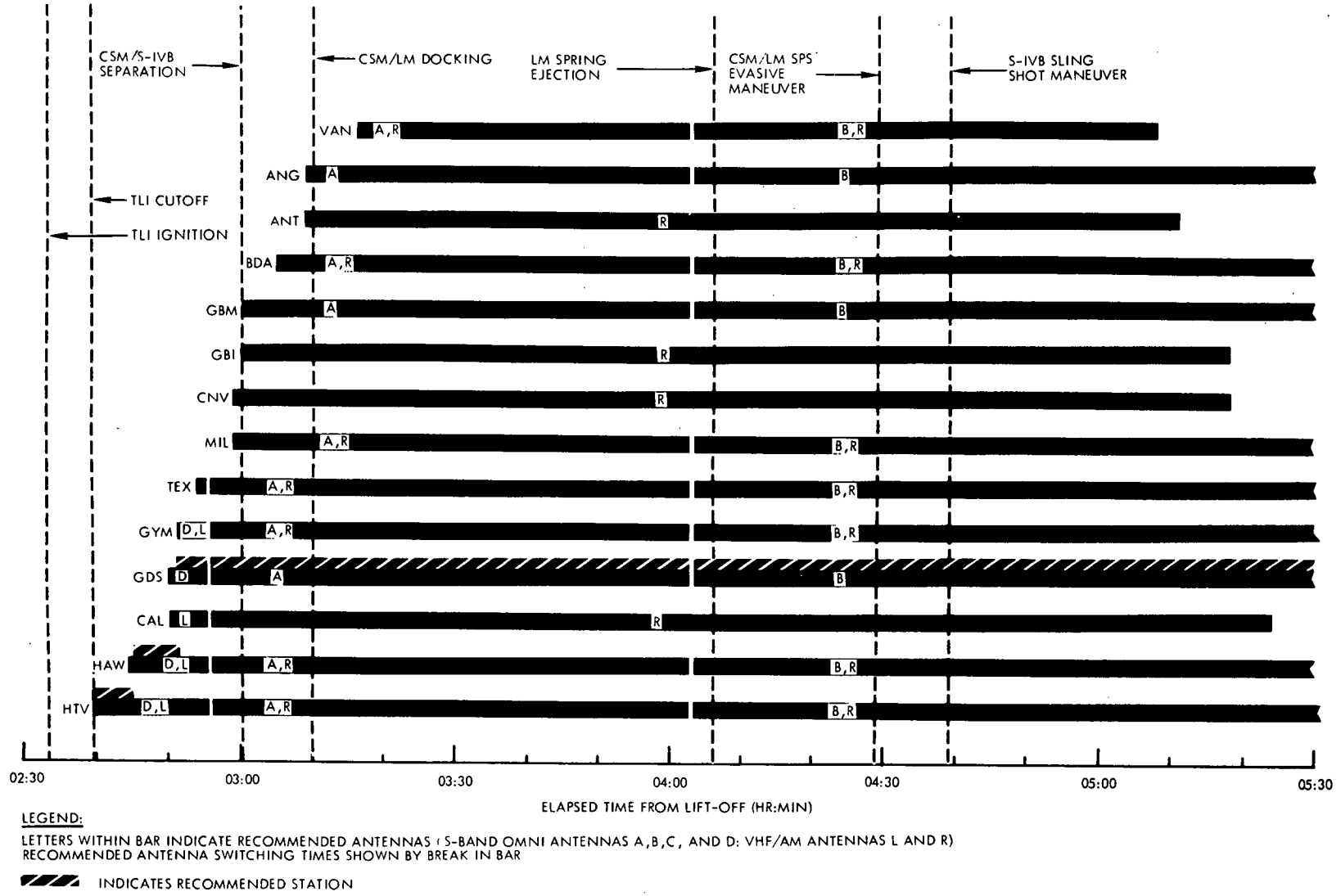


Figure 7-2b. RF Coverage Summary for Transposition and Docking Phase (18 May 1969 Launch)

The plots are shown in the order of station acquisition of signal. The VHF/AM and S-band plots are grouped for each station. Section 2 presents a complete description of the RF coverage computer plots provided in this document.

Uplink mode 6 (PRN ranging, voice, and updata) and downlink mode 2 (PRN ranging, voice, and 51.2-kbps telemetry) were used for the S-band computer plots during the transposition and docking phase of the mission.

The bar graphs and computer plots reflect a 72-degree launch azimuth and a first opportunity TLI. The event times shown on the computer plots are for a 17 May launch date. The event times for the 18 May launch date are given in Section 4 and on the bar graph.

The AOS times at the MSFN stations on the 18 May launch date will be from 1 to 4 minutes different than the acquisition times shown for the 17 May launch date. The differences in AOS times and the resulting differences in MSFN to CSM look angles do not invalidate the antenna selection or station coverage recommendations made in this section.

7.4 S-BAND PERFORMANCE

S-band communication coverage for the T and D phase is provided by HTV, HAW, GDS, GYM, TEX, MIL, GBM, BDA, ANG, and VAN. Acquisition of signal will occur at HTV first, followed by HAW and GDS, in that order. Since the acquisition sequence is from a 12-foot station (HTV) to a 30-foot station (HAW) to an 85-foot station (GDS), handover from HTV to HAW to GDS should be accomplished as soon as possible after acquisition of signal at each station. GDS should be the primary S-band receiving station for the remainder of the T and D phase. CSM omni antenna D will provide good communications during the handover sequence and until shortly before CSM/S-IVB separation.

Antenna A will provide the best communications after the attitude changes associated with S-IVB/CSM separation begin and until shortly before LM spring ejection.

In the earth parking orbit discussion, it was recommended that antenna D be selected by ground command prior to TLI and the S BAND ANTENNA switches S-40 and S-41 in the CSM be set to OMNI and OMNI A, respectively, to allow subsequent ground command of antenna A at the start of the S-IVB/CSM separation maneuver.

A CSM attitude change at LM spring ejection results in omni B providing the best coverage during and after the LM ejection. Switching to CSM omni B should be accomplished just prior to the LM spring ejection. CSM omni B will provide good communication coverage for the remainder of this phase of the mission which includes the CSM/LM SPS evasive maneuver and the S-IVB sling shot maneuver.

Color television transmission is scheduled to begin at approximately 3 hours after lift-off and terminate approximately 25 minutes later. The CSM/S-IVB separation and CSM/LM docking events will occur during this time period. Omni antenna A will provide sufficient signal strength at GDS during this time period to produce a good quality color TV picture (a minimum total received power level of -95 dBm is required at an 85-foot station to obtain a good quality color television picture).

7.5 VHF/AM SYSTEM PERFORMANCE

The VHF/AM communication coverage for the T and D phase is provided by HTV, HAW, CAL, GYM, TEX, MIL, CNV, GBI, BDA, ANT, and VAN (with acquisition of spacecraft signal in the order listed).

Prior to CSM/S-IVB separation, the LEFT CSM VHF antenna provides the best communication coverage for HTV, HAW, CAL, GYM, and TEX. After CSM/S-IVB separation, the RIGHT VHF antenna provides better communication coverage for all the VHF/AM stations covering this phase of the mission.

After CSM/S-IVB separation, however, the received carrier power at the MSFN stations will be considerably below the 90 percent WI voice threshold using either CSM VHF antenna, and therefore, may not be usable. This is due initially to the unfavorable spacecraft attitude and

later to the slant range of the spacecraft from the MSFN stations. (The maximum range capability, based on 0-dB antenna gain, for 90 percent WI voice on the VHF/AM system is approximately 8,555 nautical miles. Greater range capability can be obtained with the higher antenna gains provided by favorable spacecraft attitudes.)

HAW provides the best overall uplink and downlink VHF/AM coverage and should be the primary VHF/AM station.

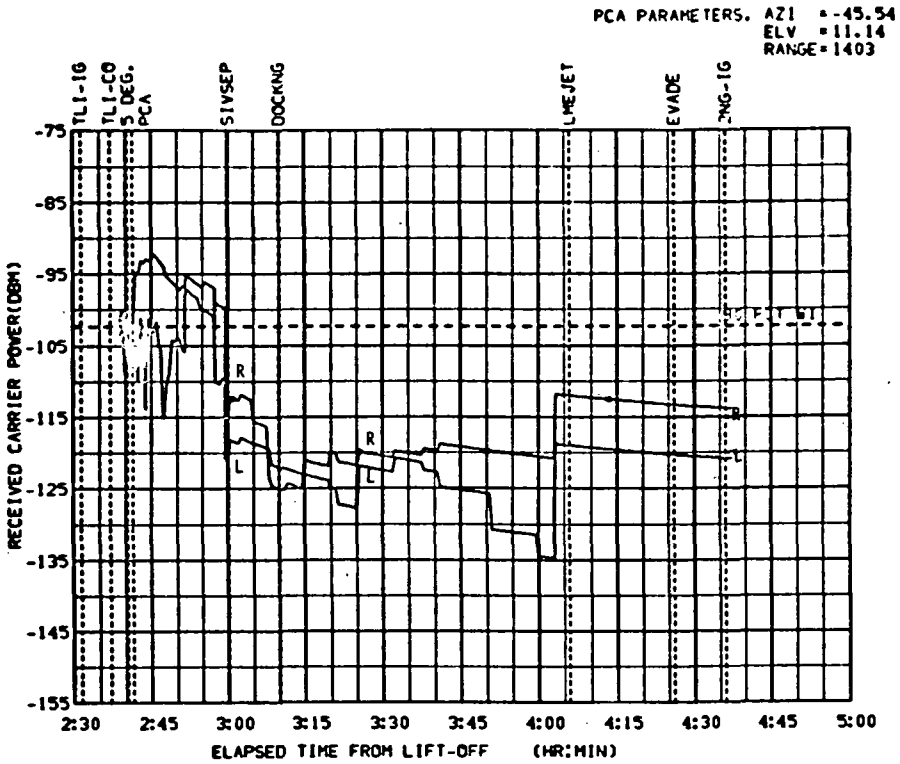


FIGURE 7-3a. HTV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

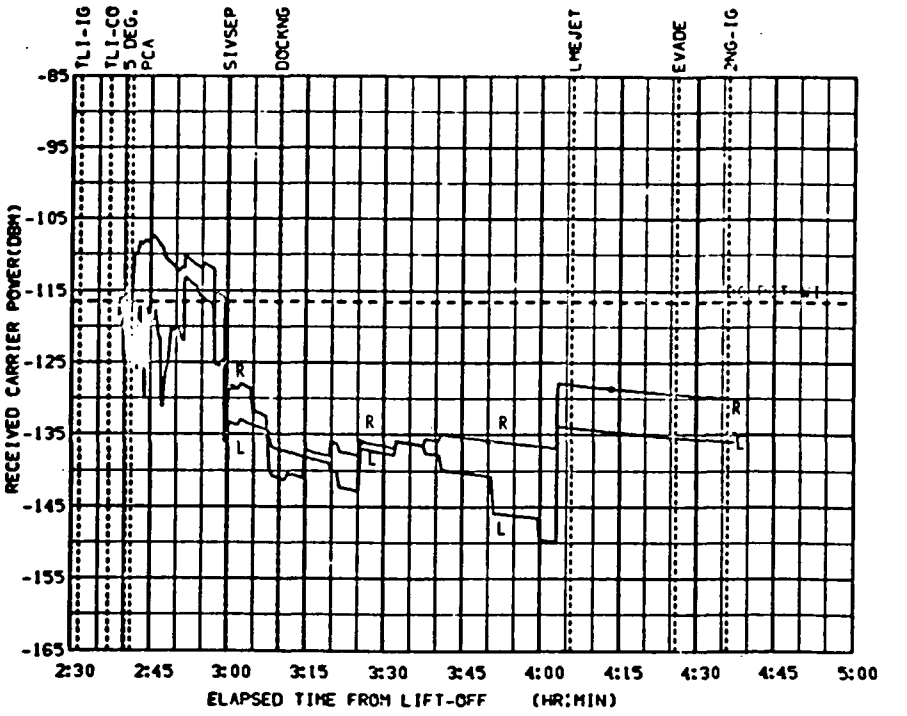


FIGURE 7-3b. HTV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

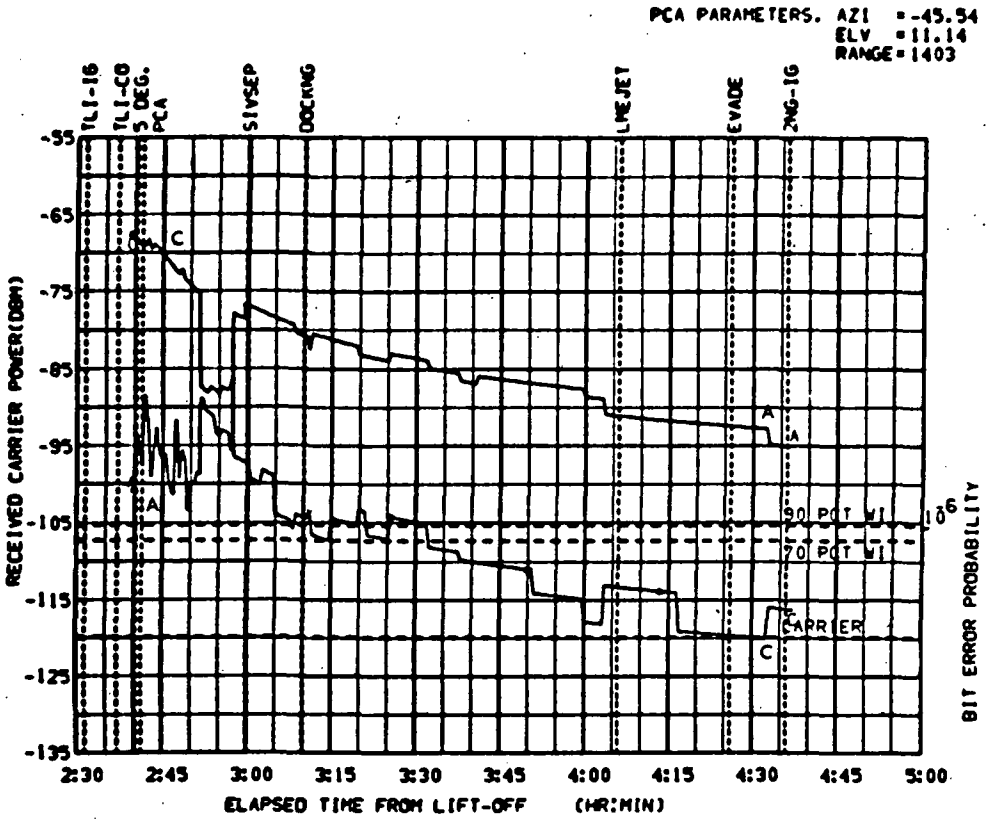


FIGURE 7-3c. HTV UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

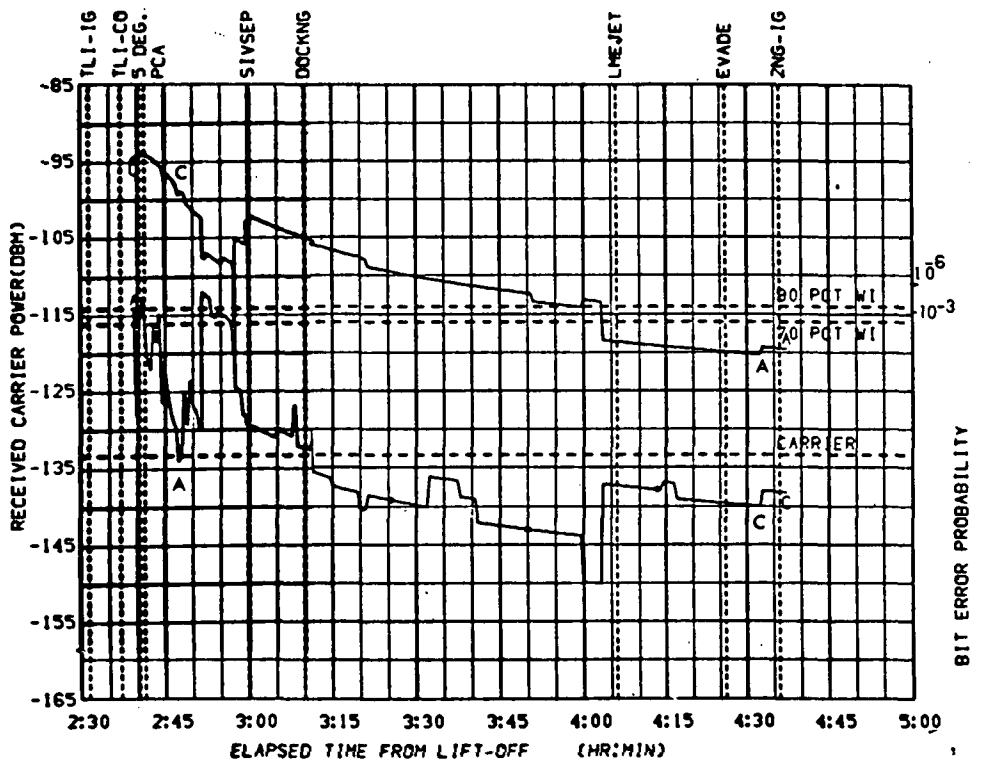


FIGURE 7-3d. HTV DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

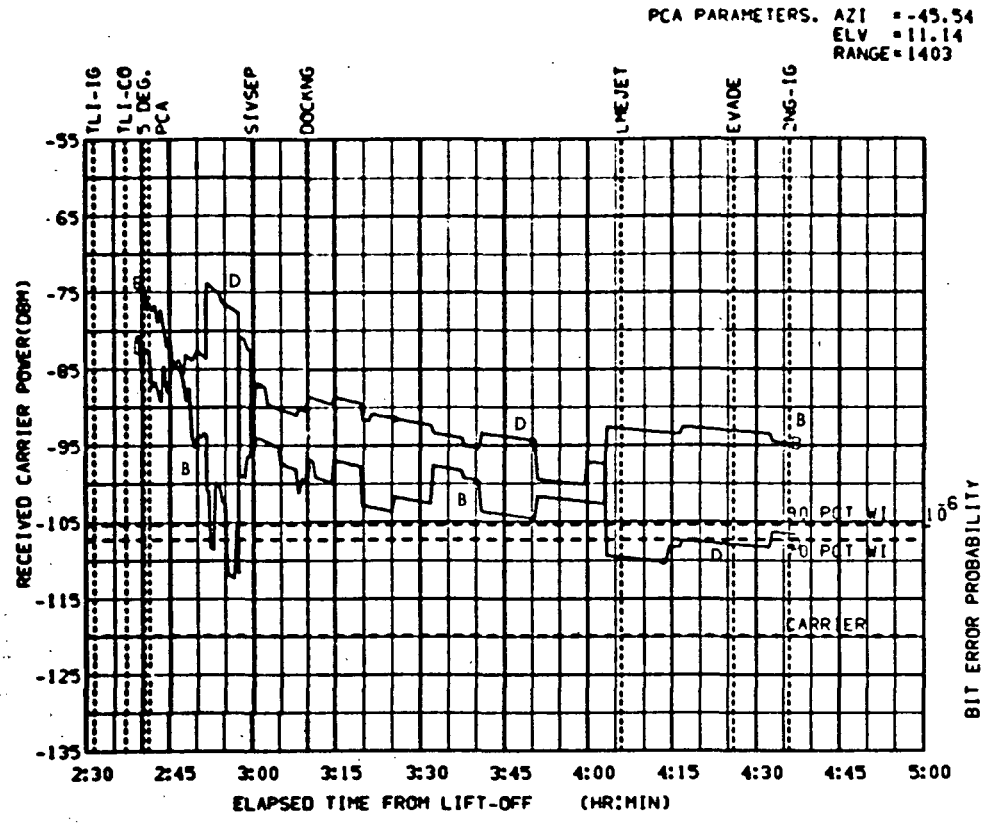


FIGURE 7-3e. HTV UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

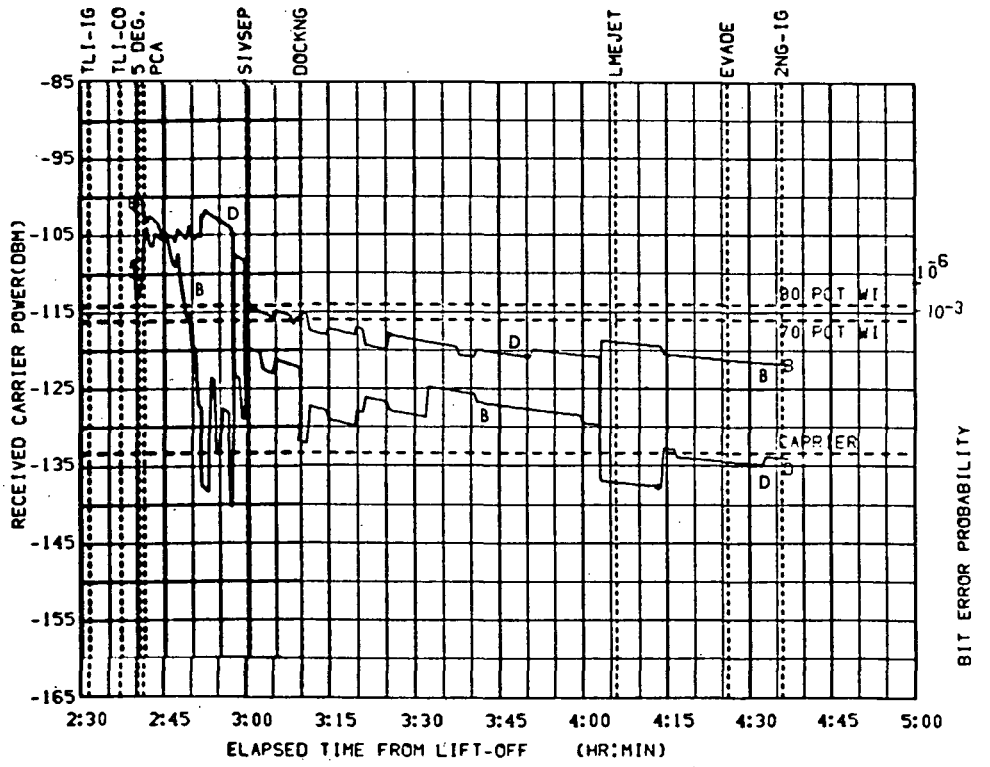


FIGURE 7-3f. HTV DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

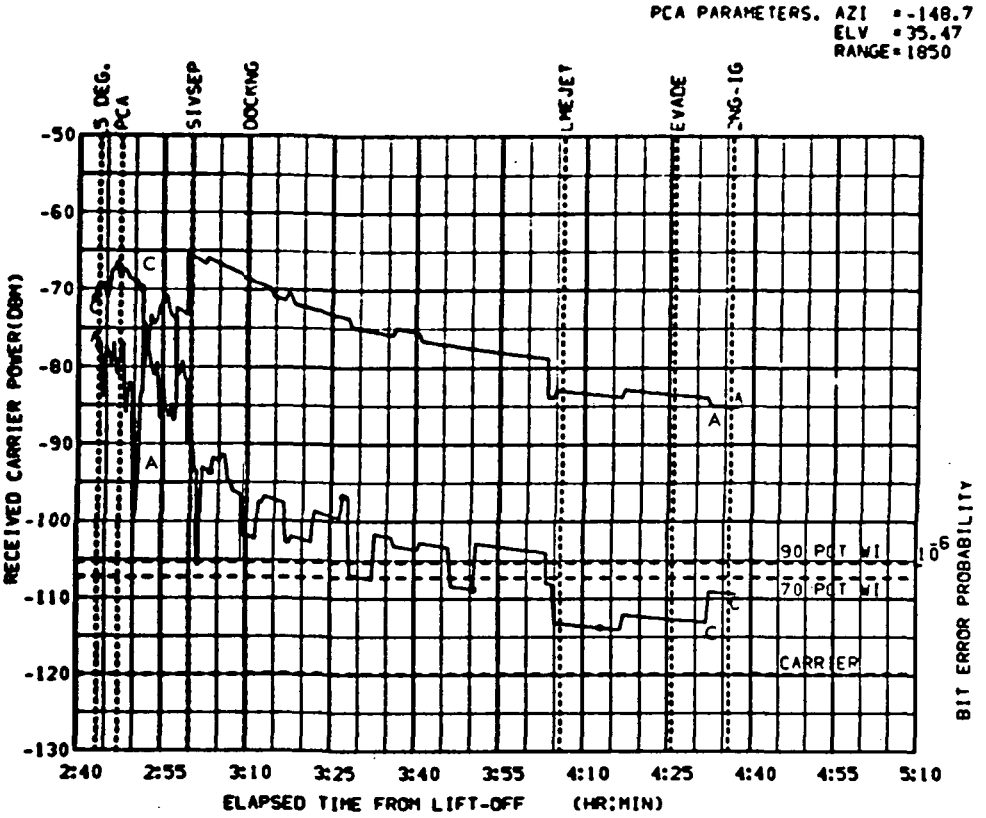


FIGURE 7-4a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

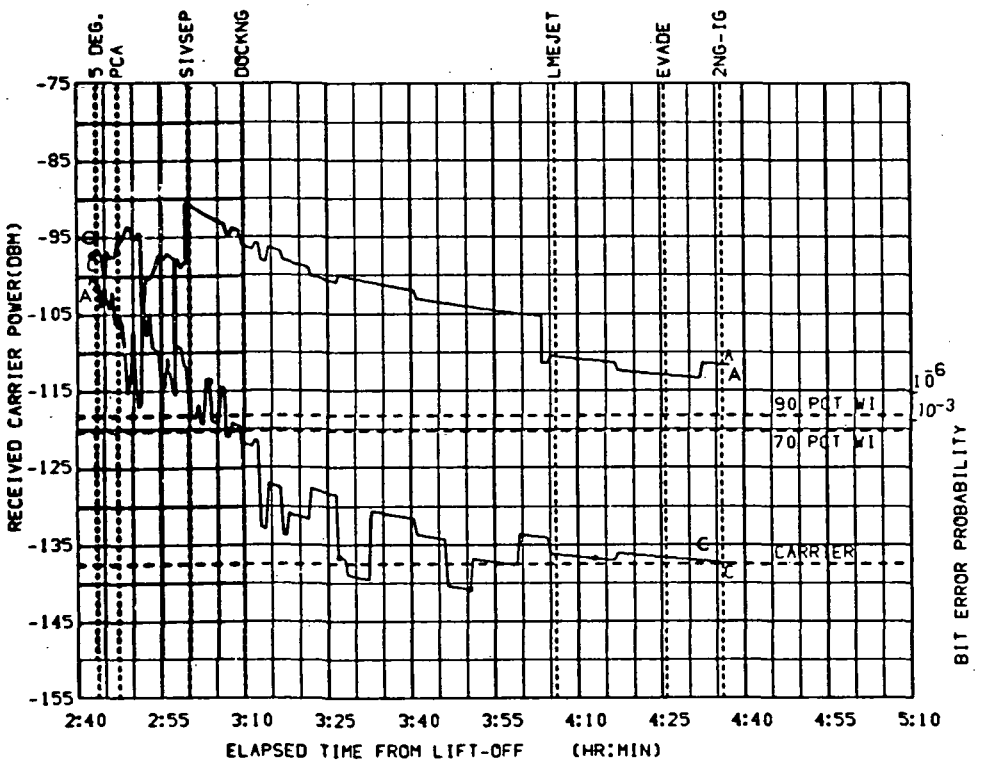


FIGURE 7-4b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

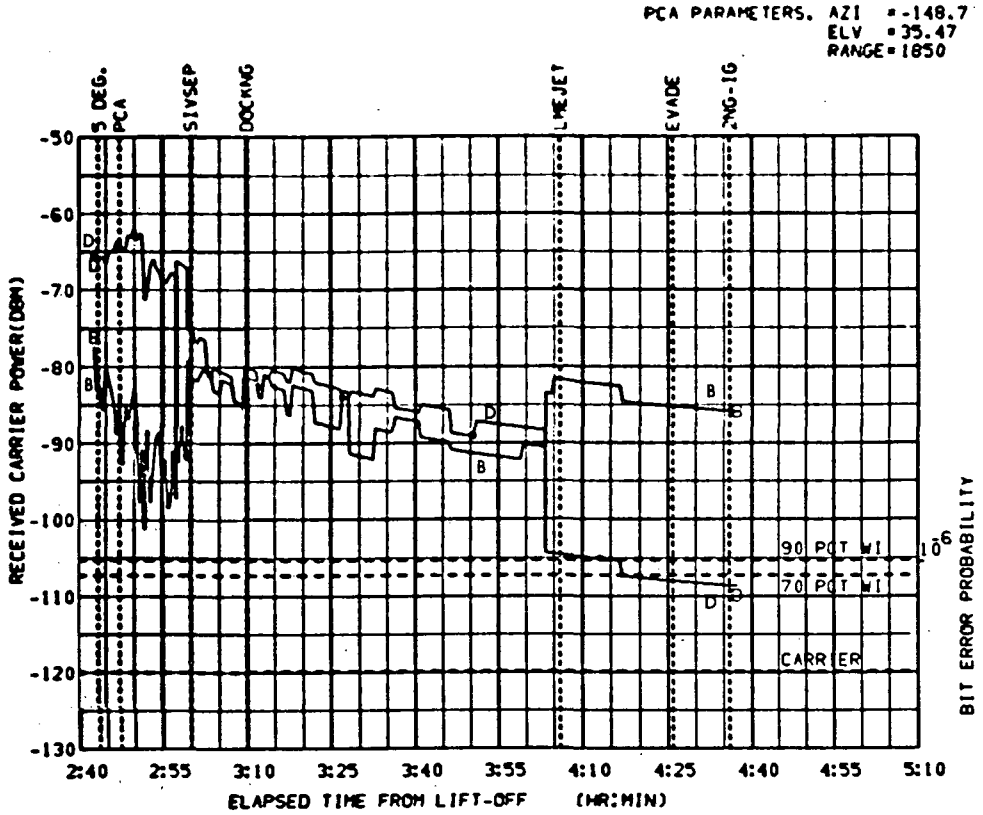


FIGURE 7-4c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

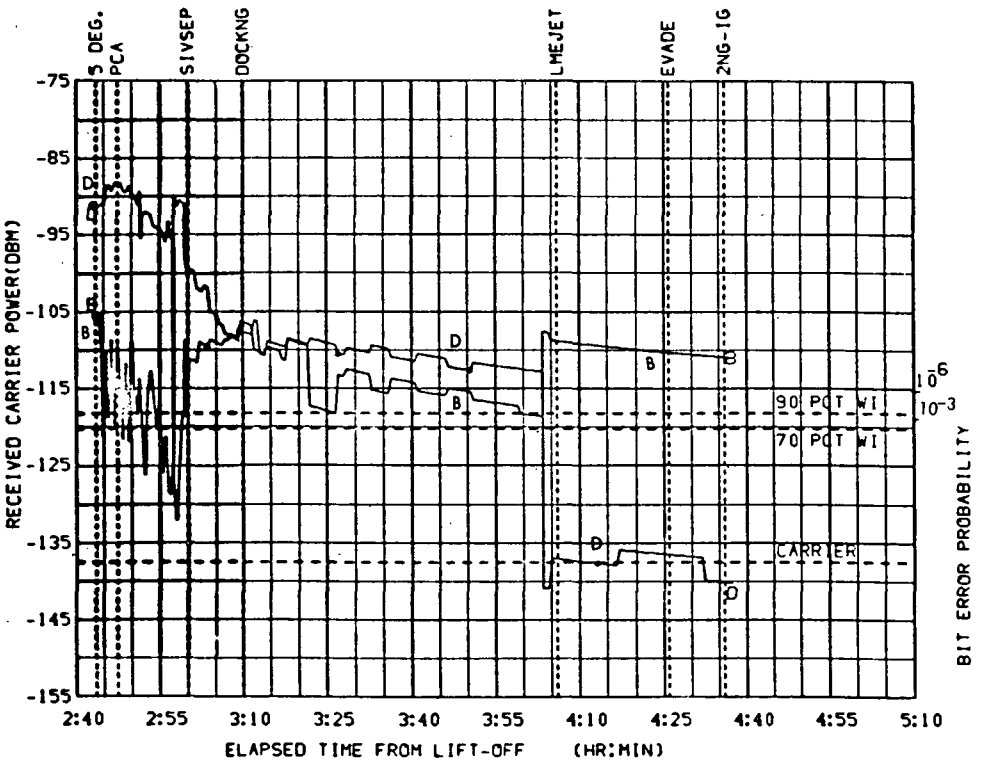


FIGURE 7-4d. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

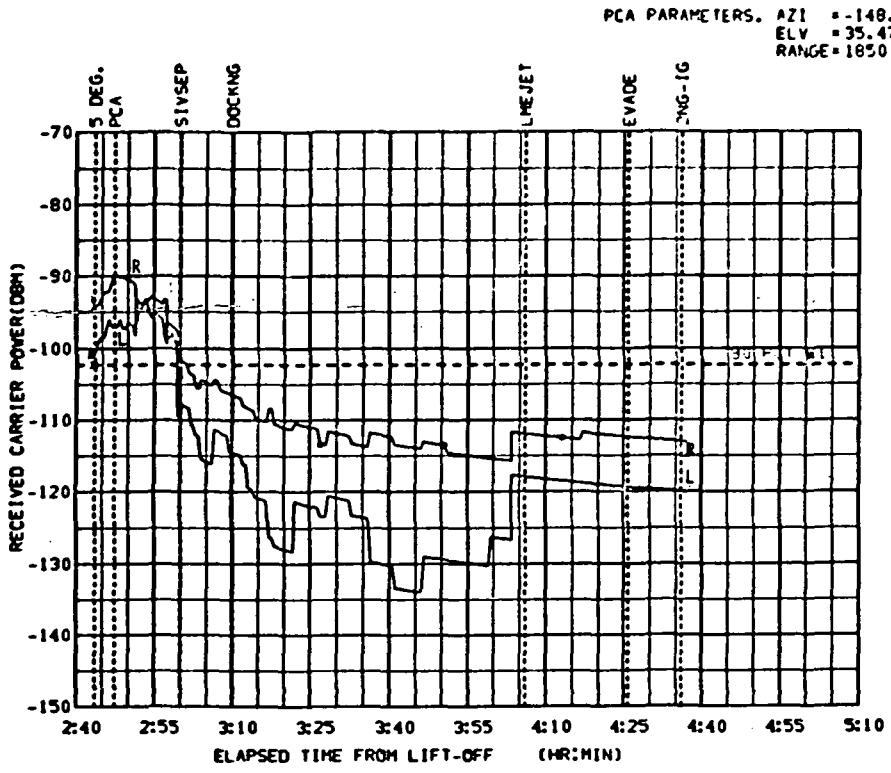


FIGURE 7-4e. MAW UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

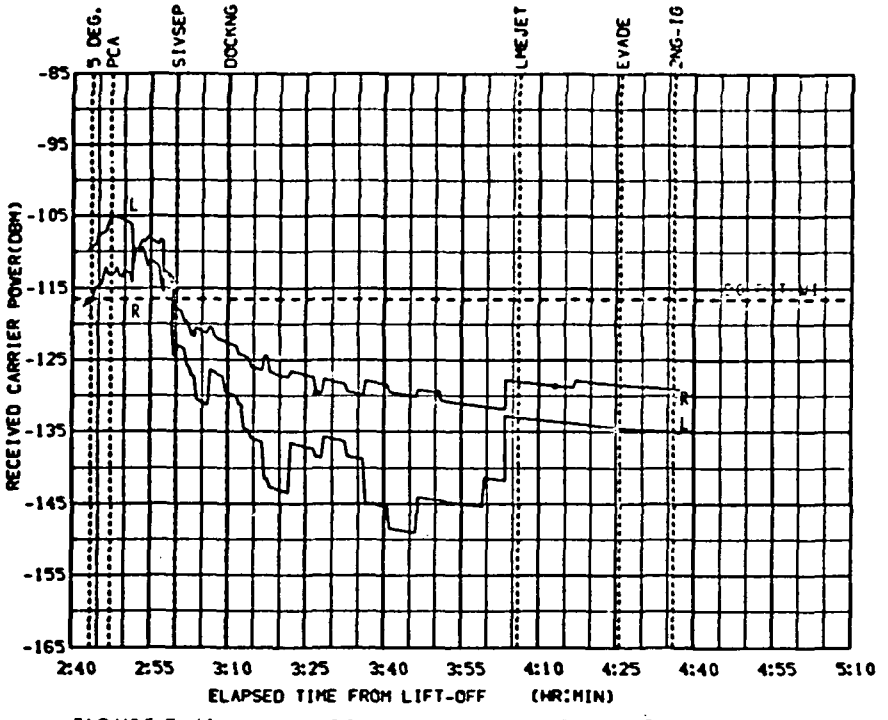


FIGURE 7-4f. MAW DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

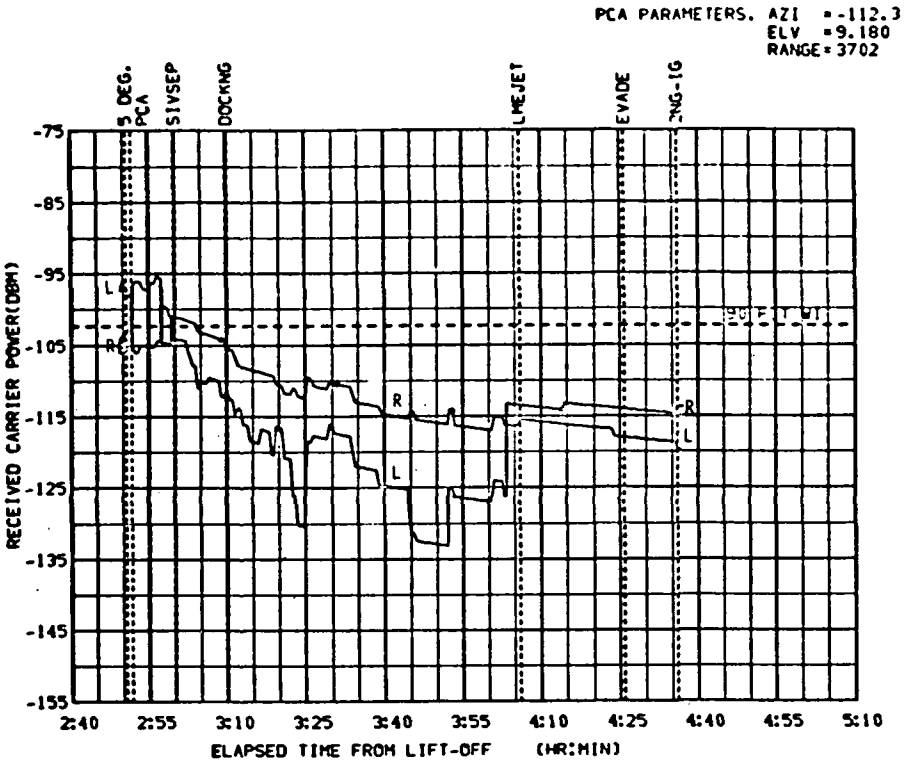


FIGURE 7-5a. CAL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

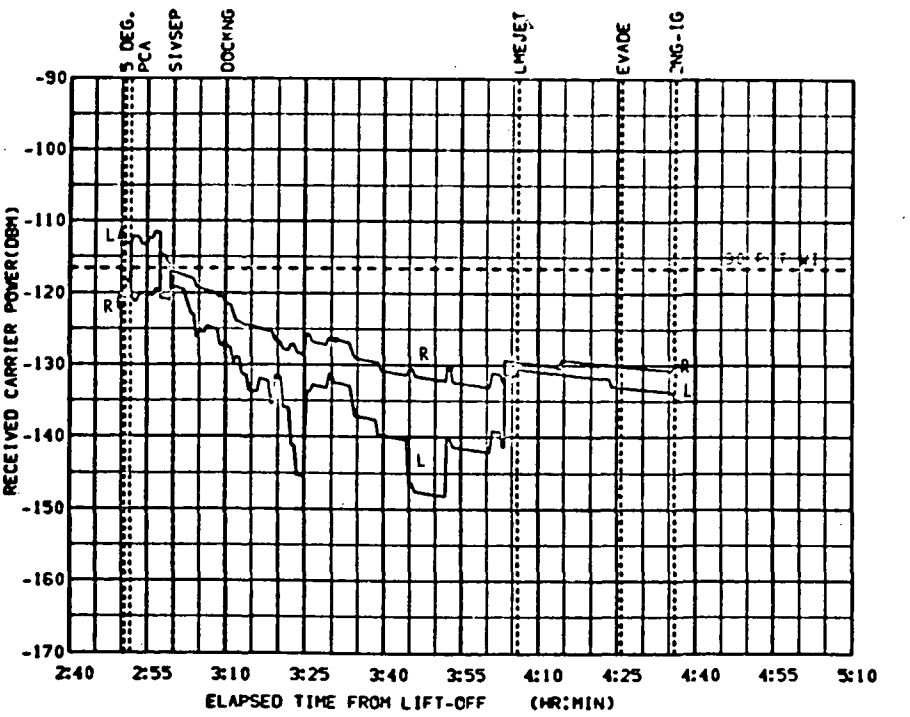


FIGURE 7-5b. CAL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

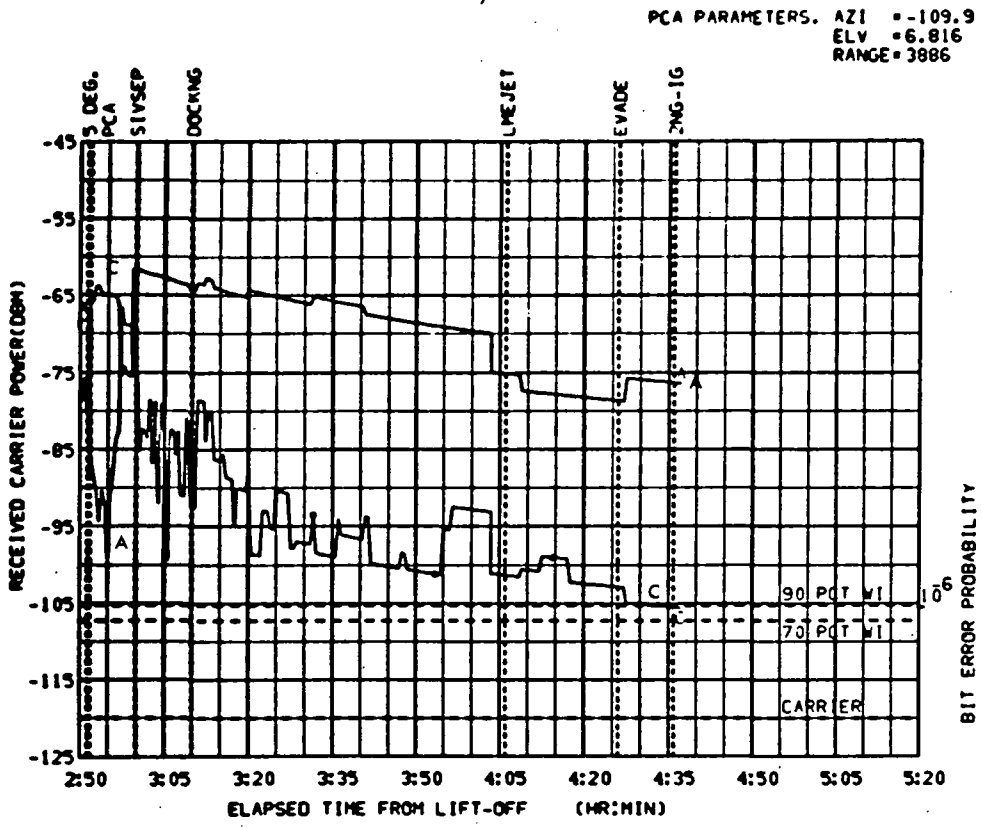


FIGURE 7-6a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

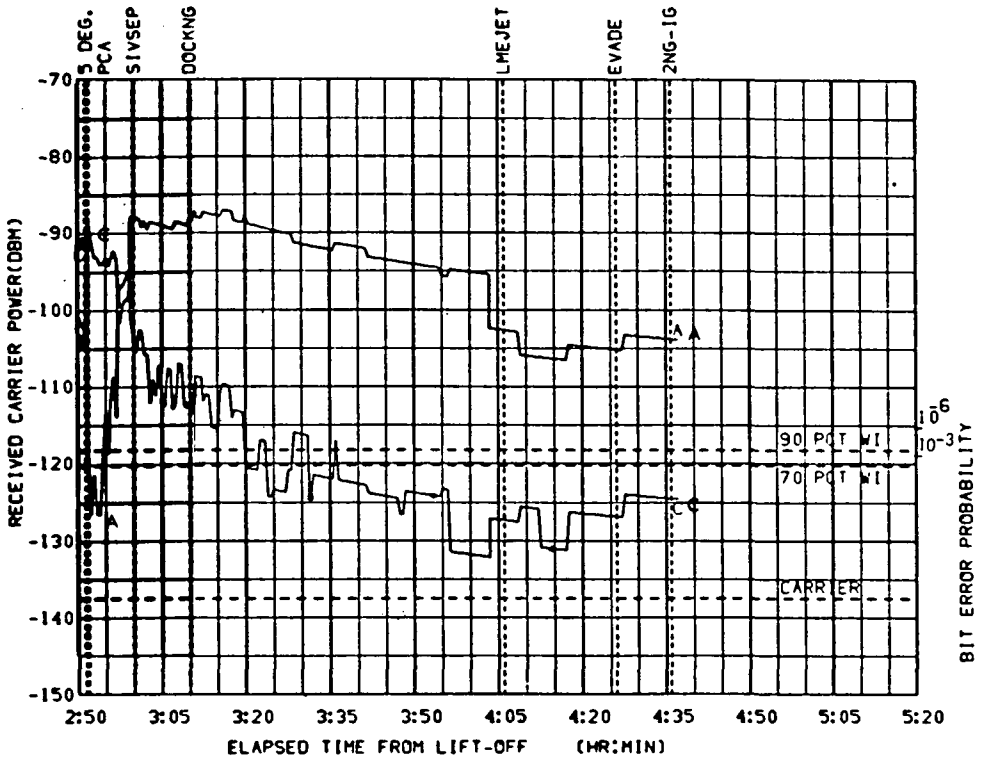


FIGURE 7-6b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

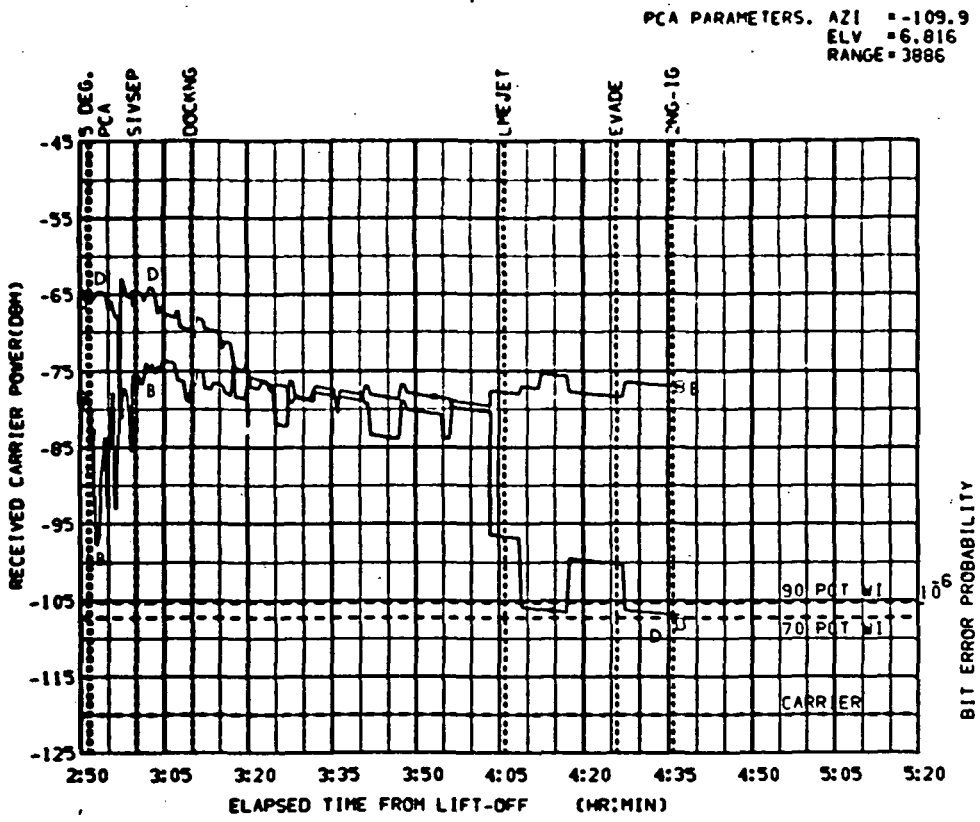


FIGURE 7-6c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

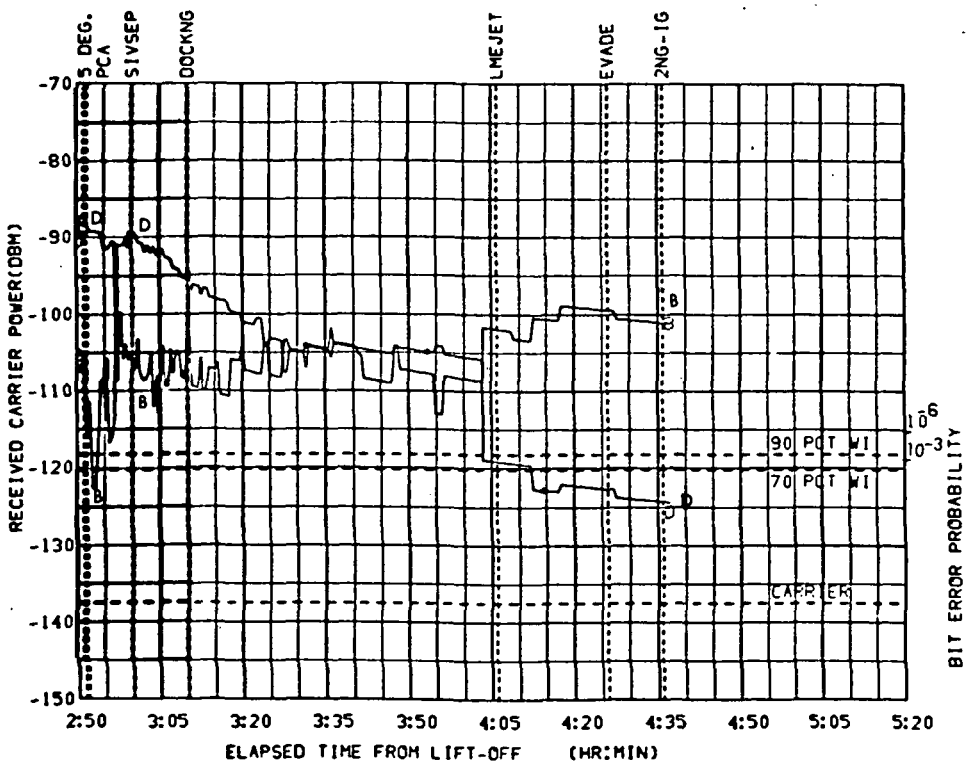


FIGURE 7-6d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

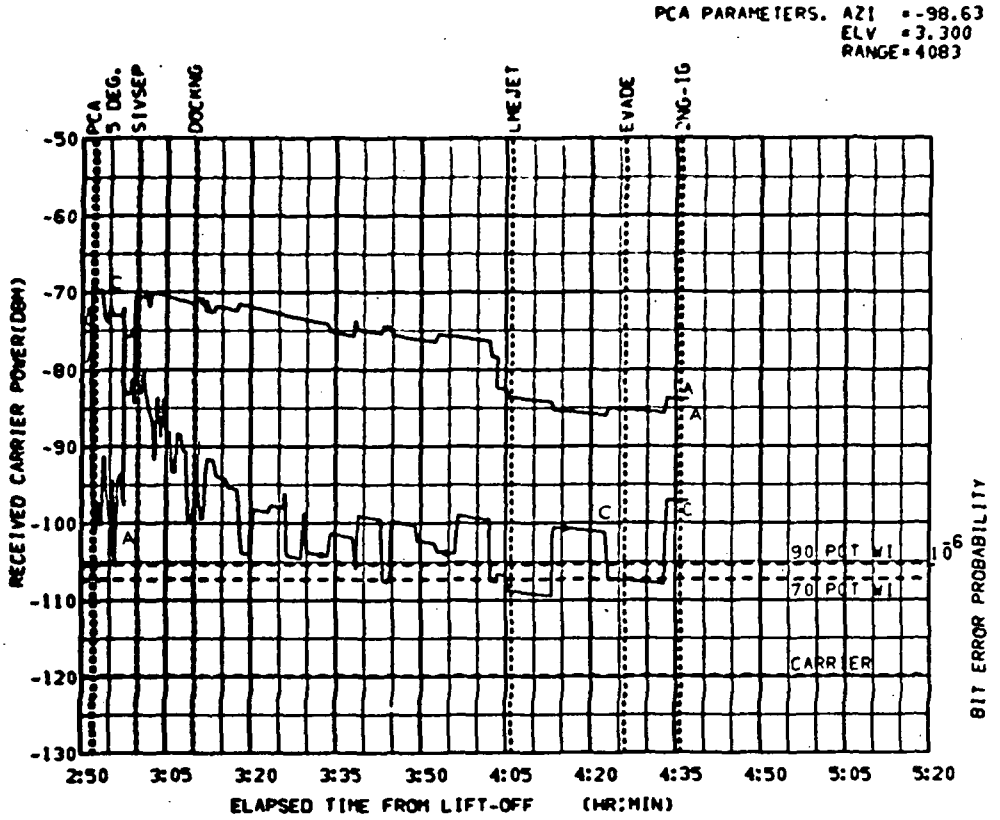


FIGURE 7-7a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

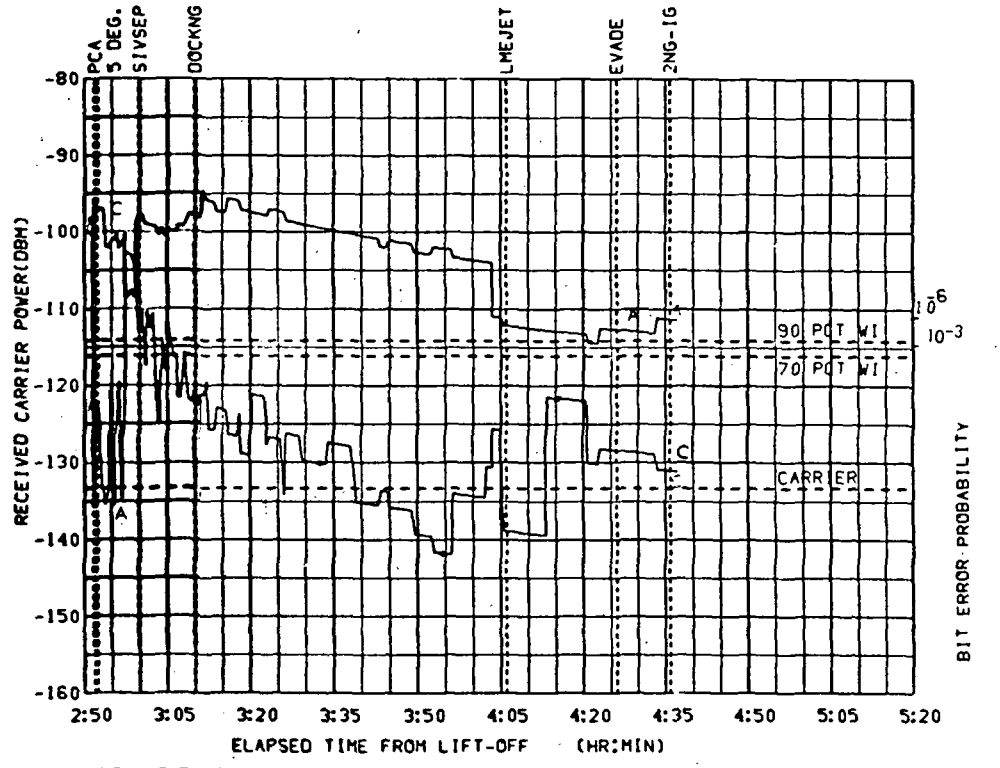


FIGURE 7-7b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

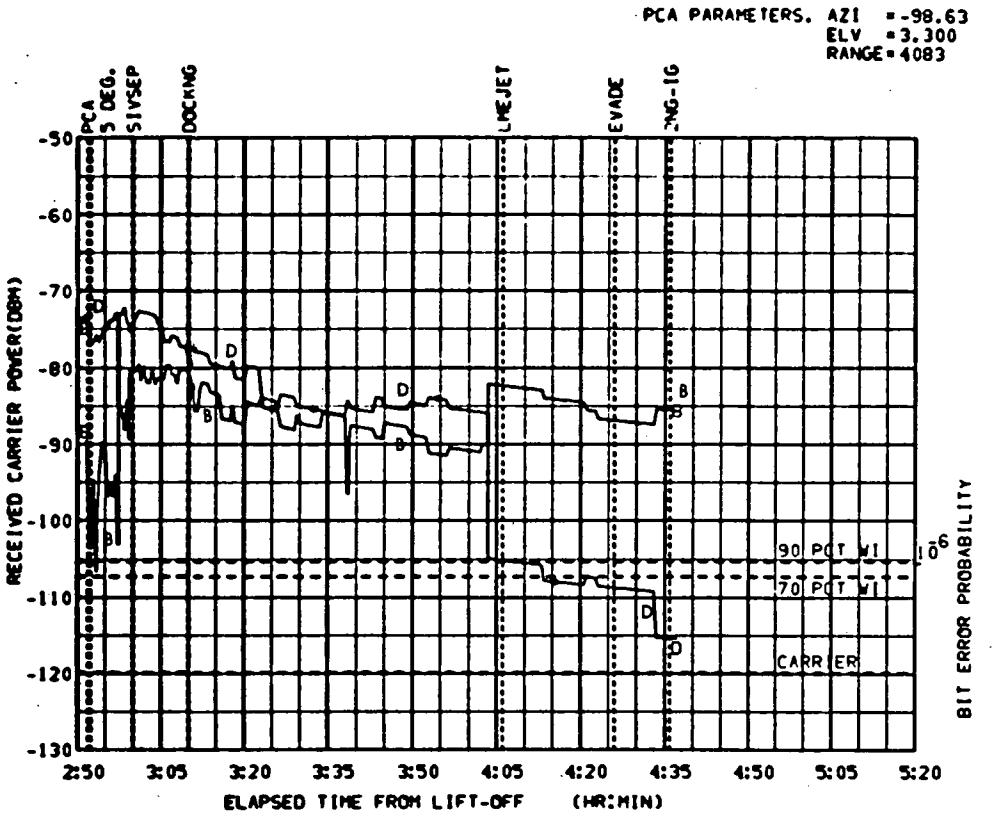


FIGURE 7-7c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

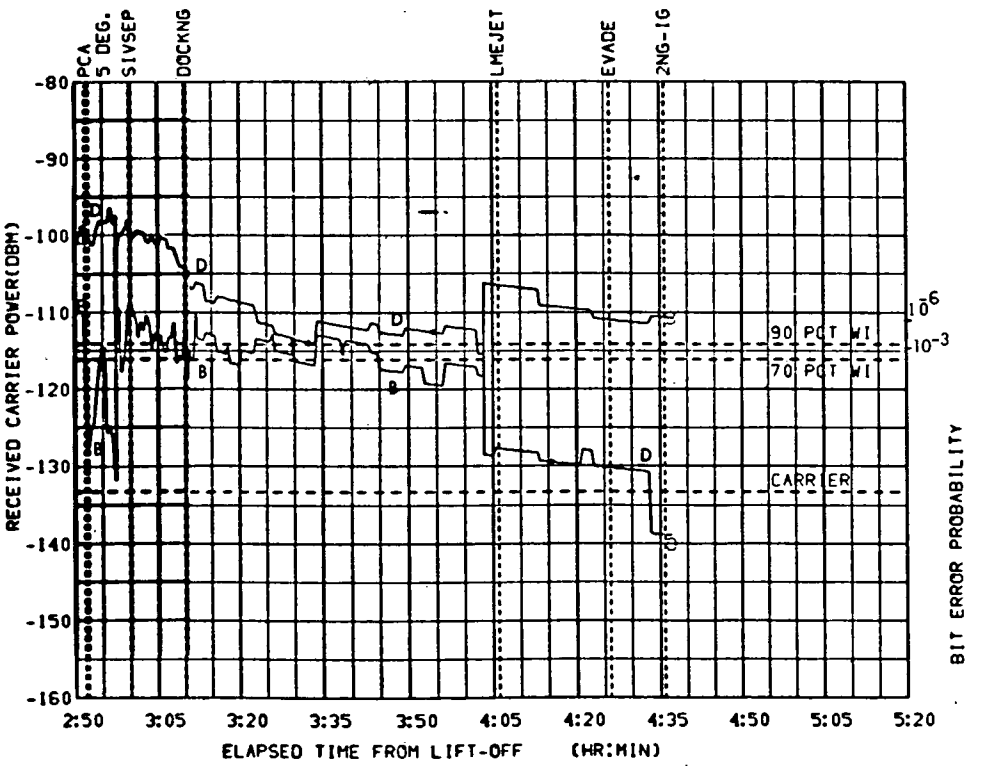


FIGURE 7-7d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM VHF/AM
17 May Launch

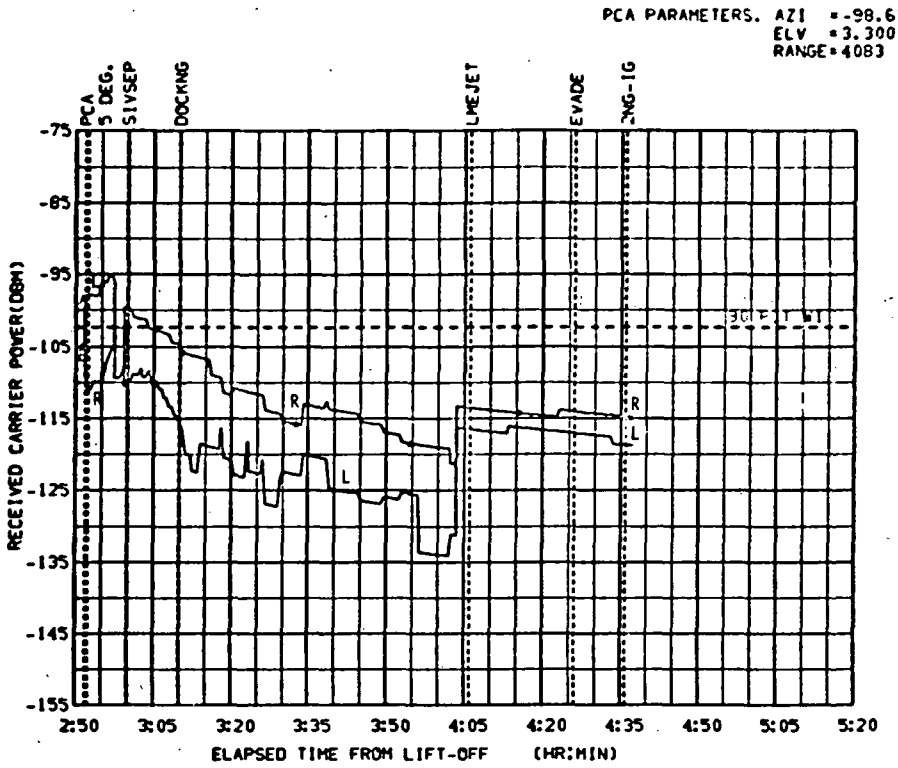


FIGURE 7-7e. GYM UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

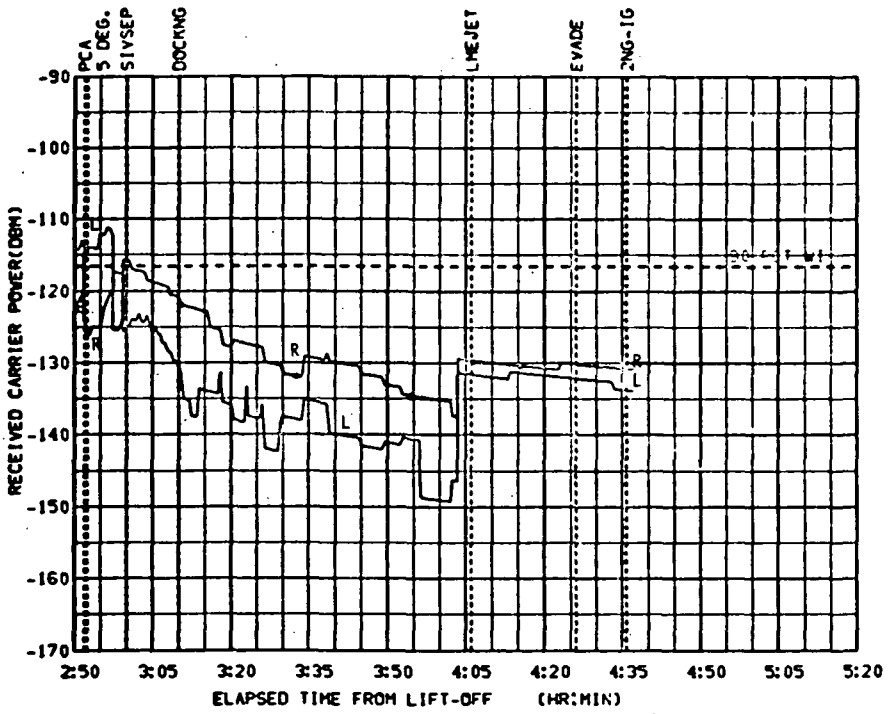


FIGURE 7-7f. GYM DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

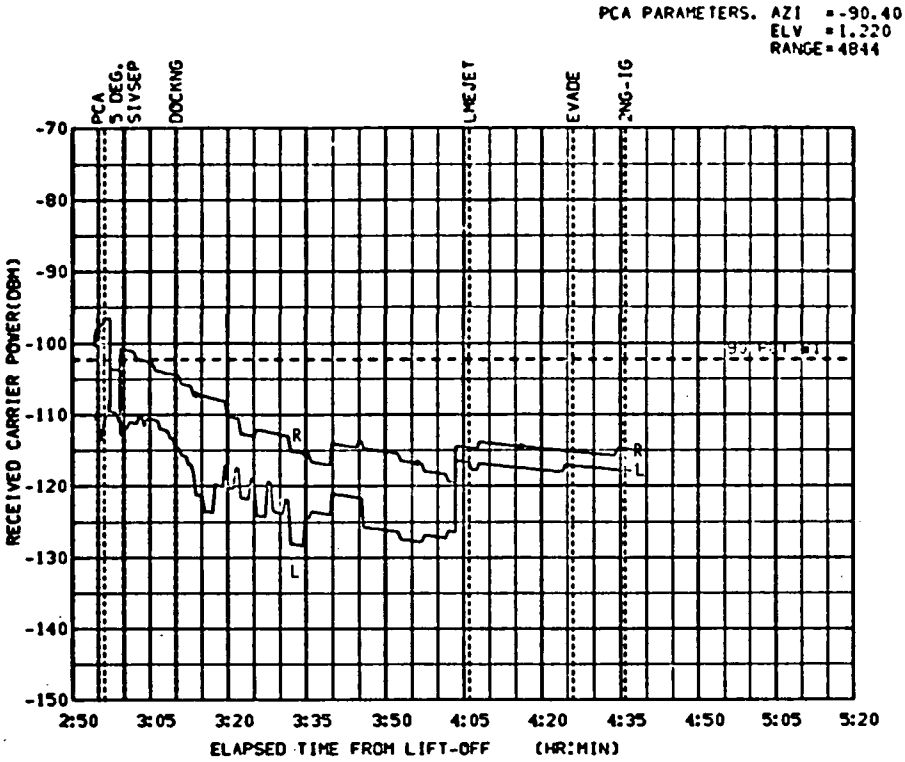


FIGURE 7-8a. TEX UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

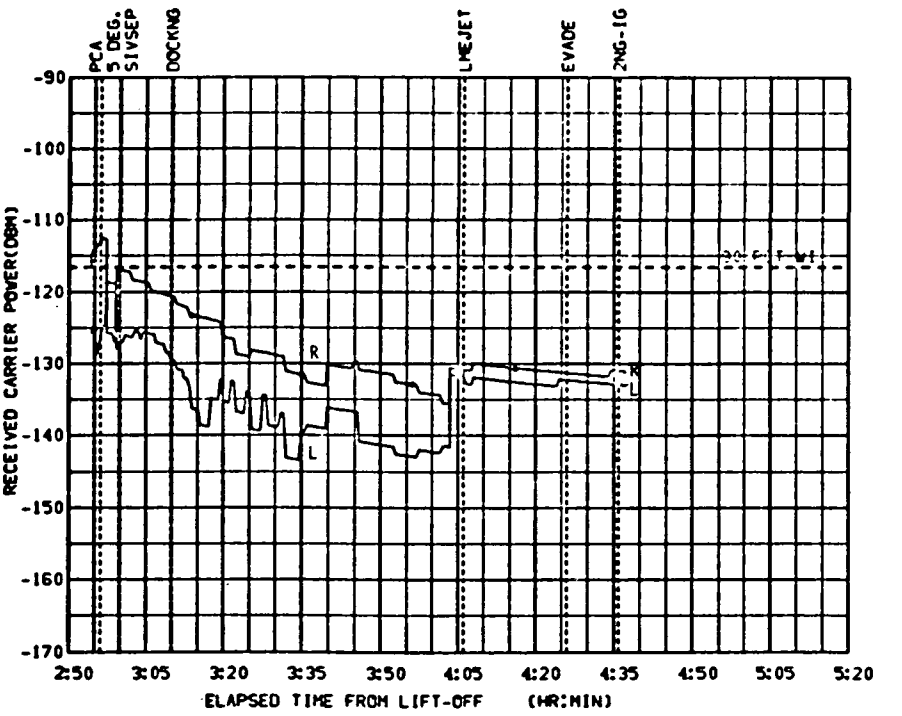


FIGURE 7-8b. TEX DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

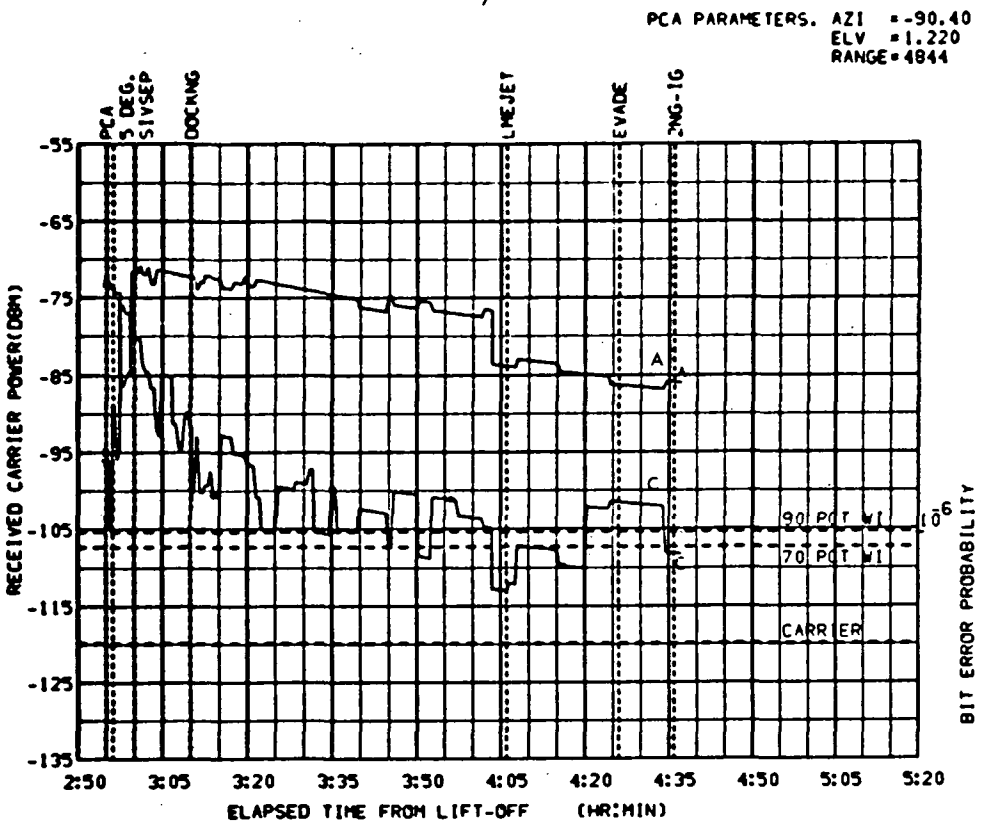


FIGURE 7-8c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

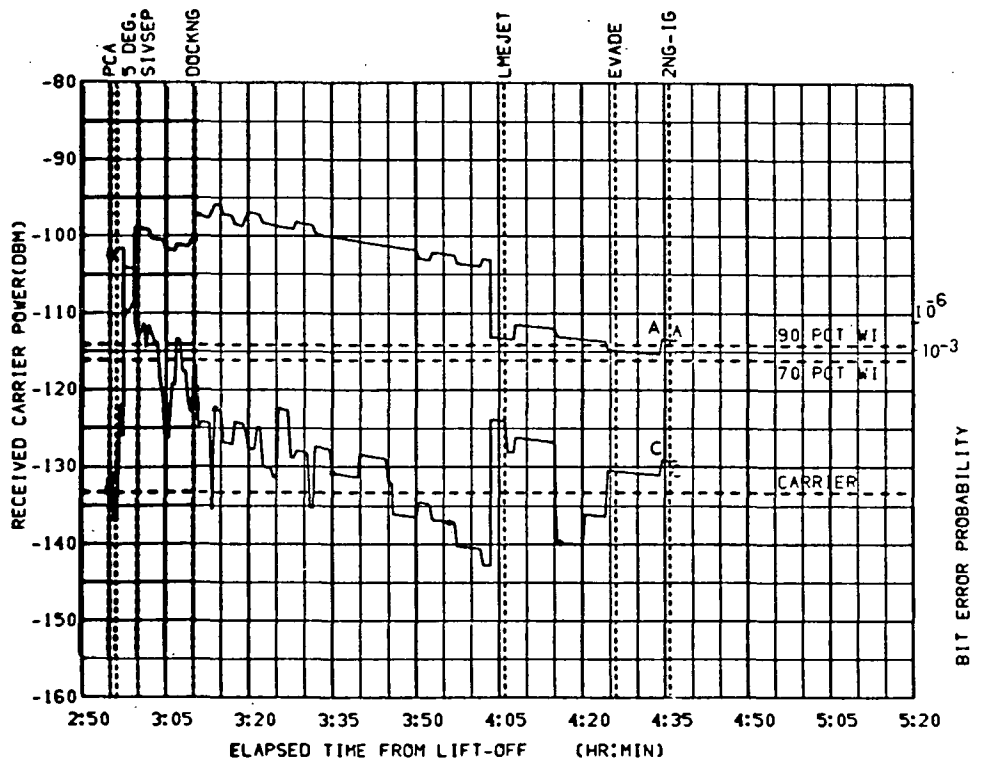


FIGURE 7-8d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

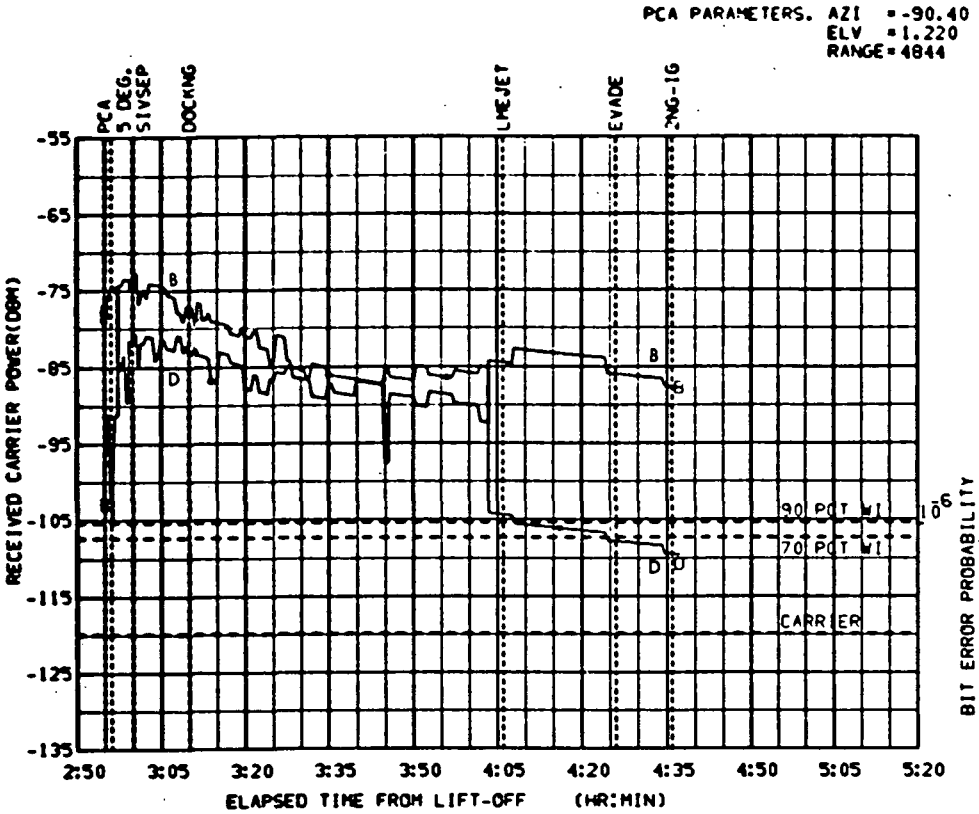


FIGURE 7-8e. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

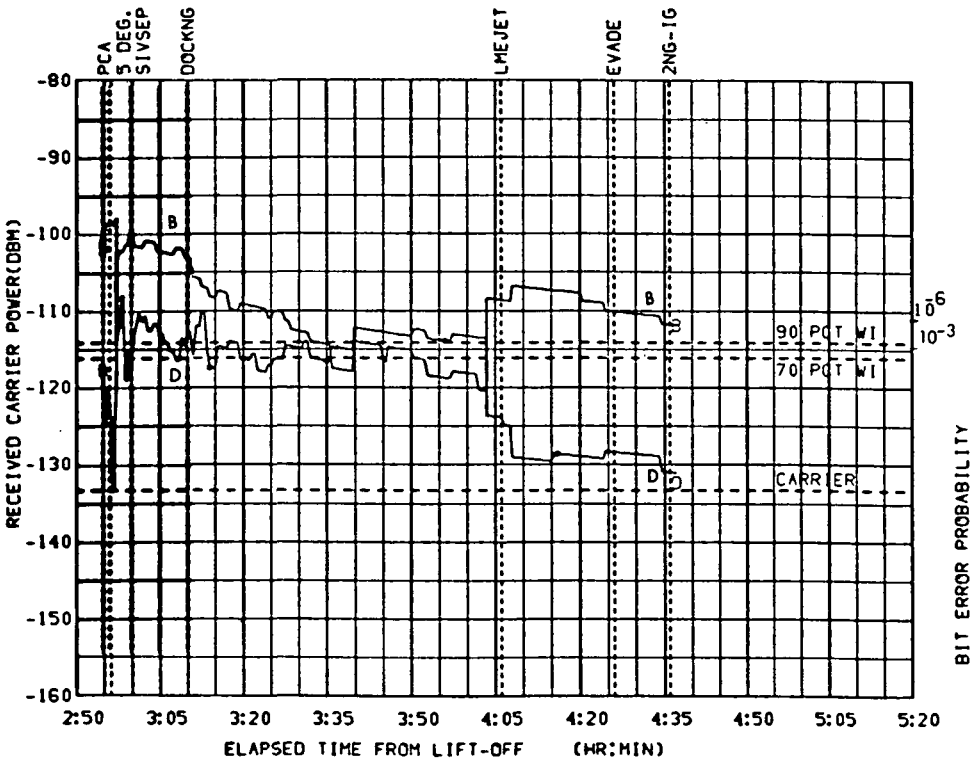


FIGURE 7-8f. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

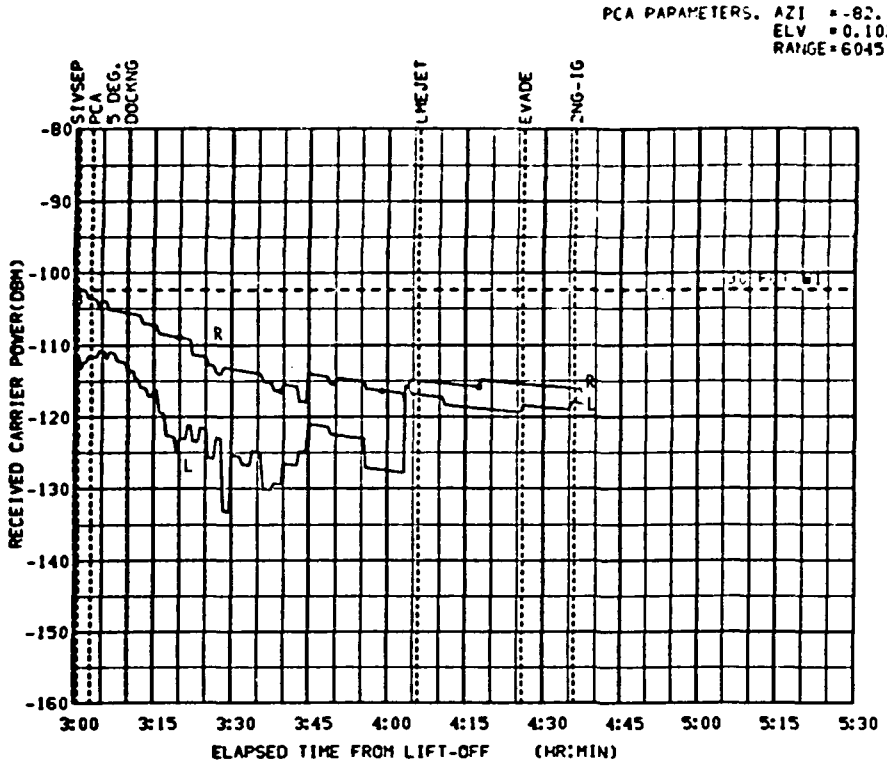


FIGURE 7-9a. CNV UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

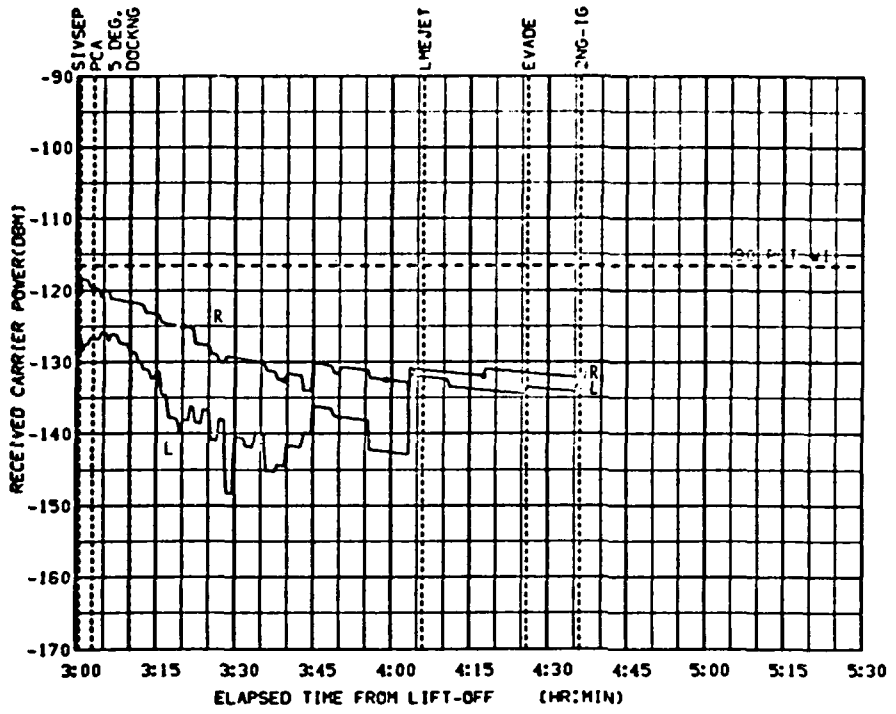


FIGURE 7-9b. CNV DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

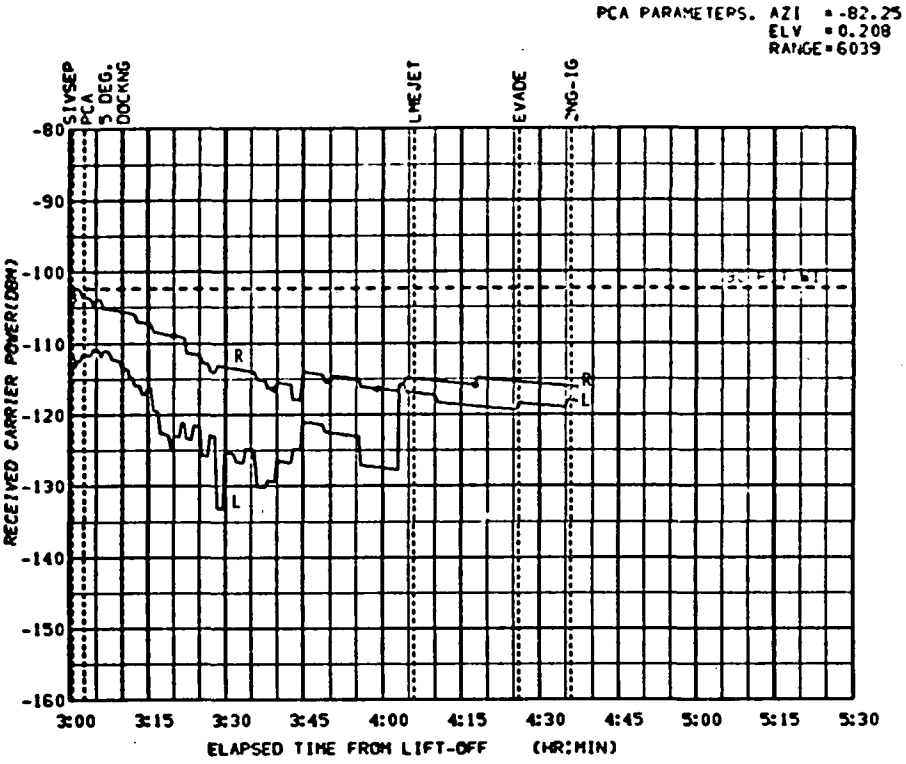


FIGURE 7-10a. MIL UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

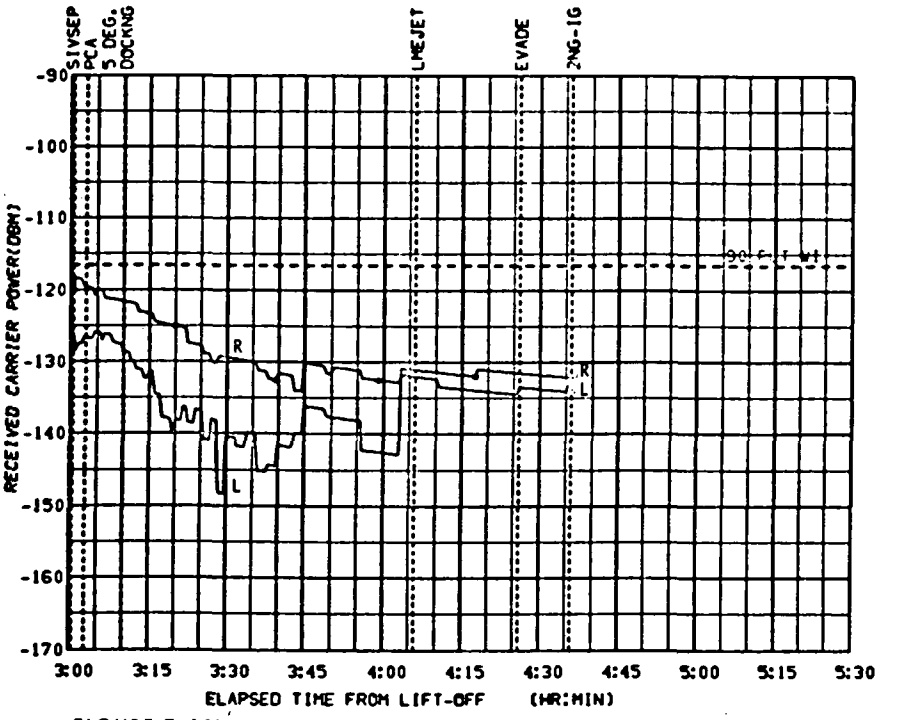


FIGURE 7-10b. MIL DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

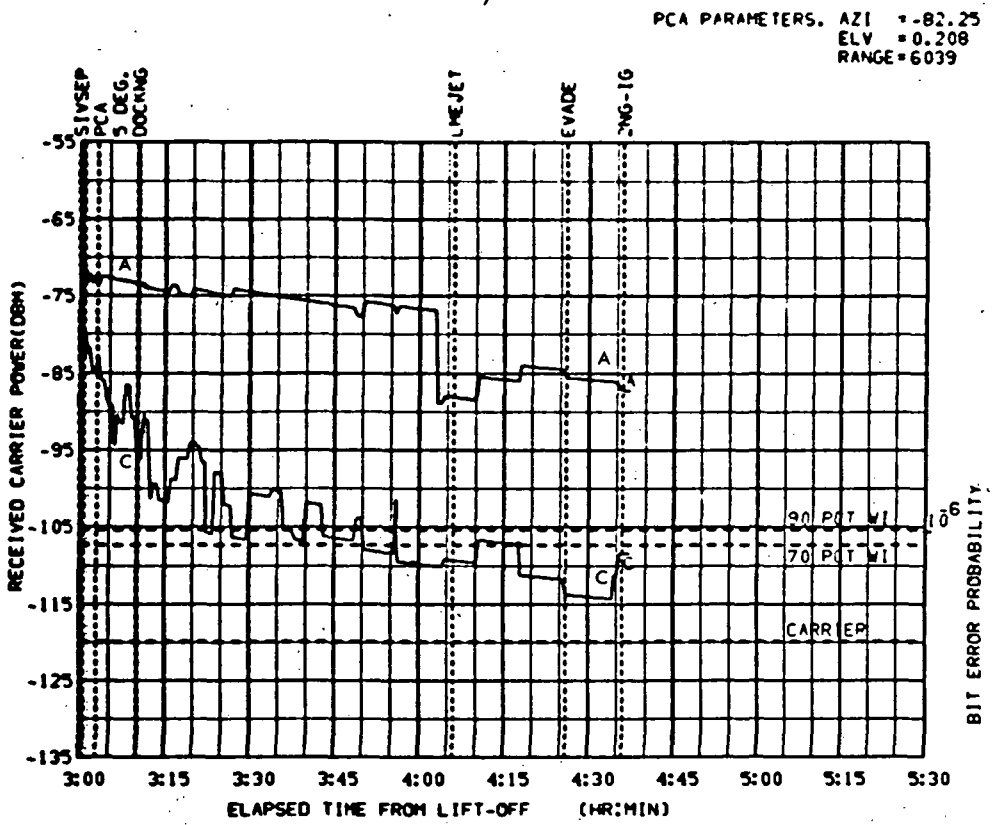


FIGURE 7-10c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

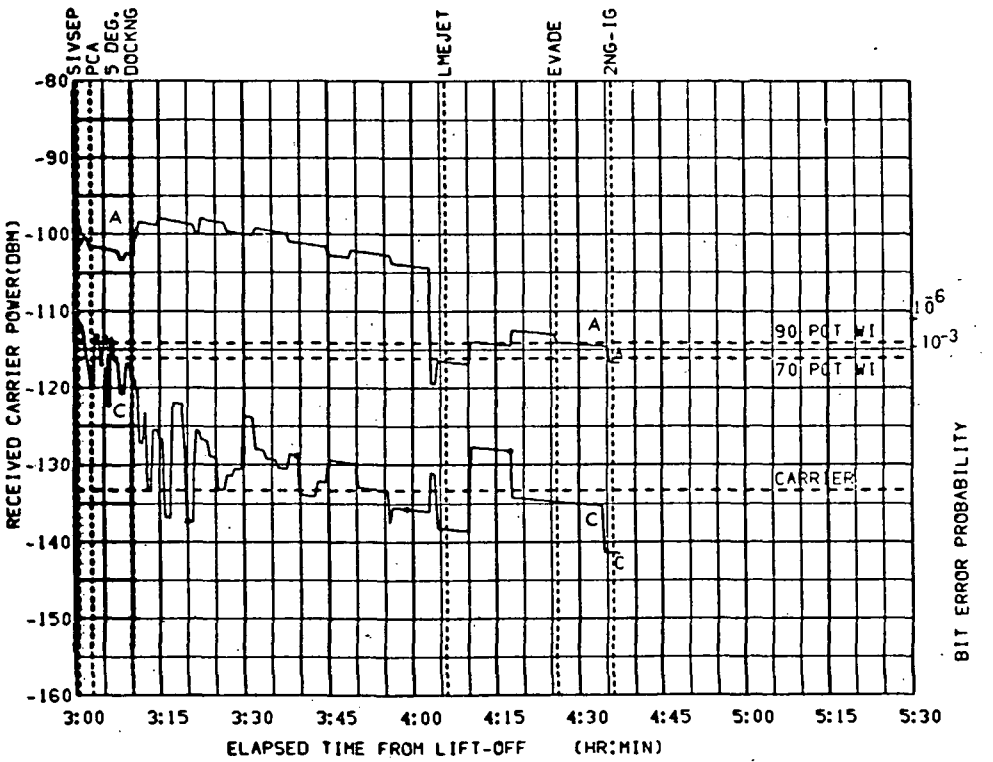


FIGURE 7-10d. MIL ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

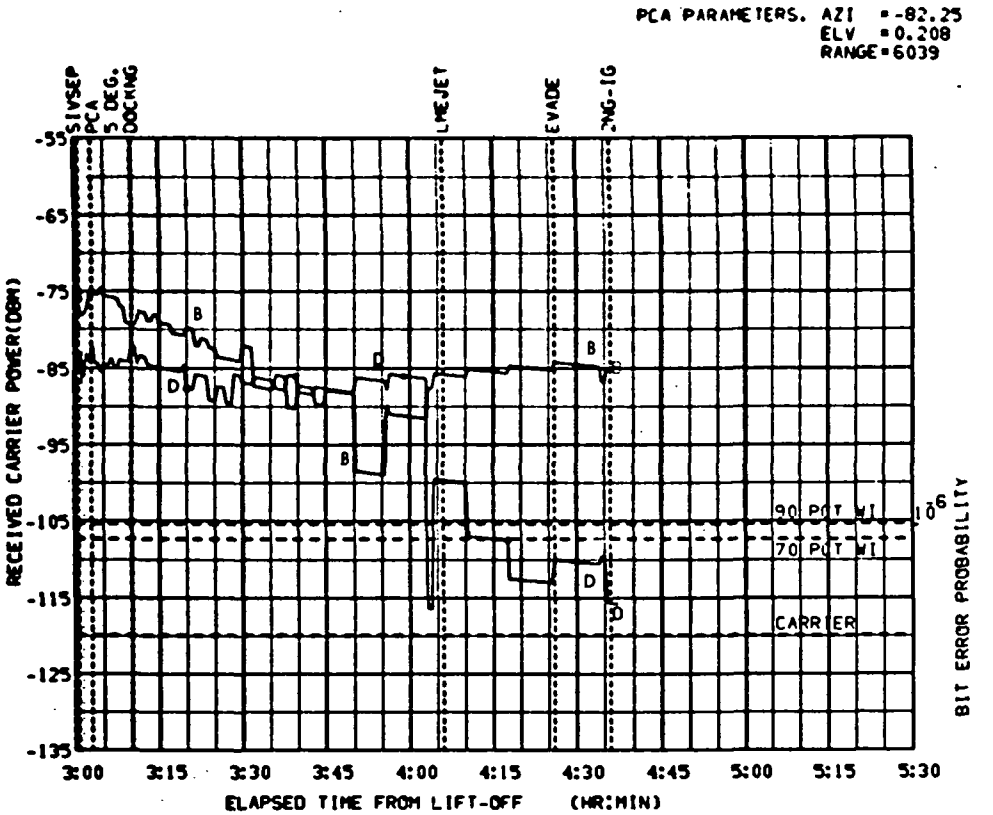


FIGURE 7-10e. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

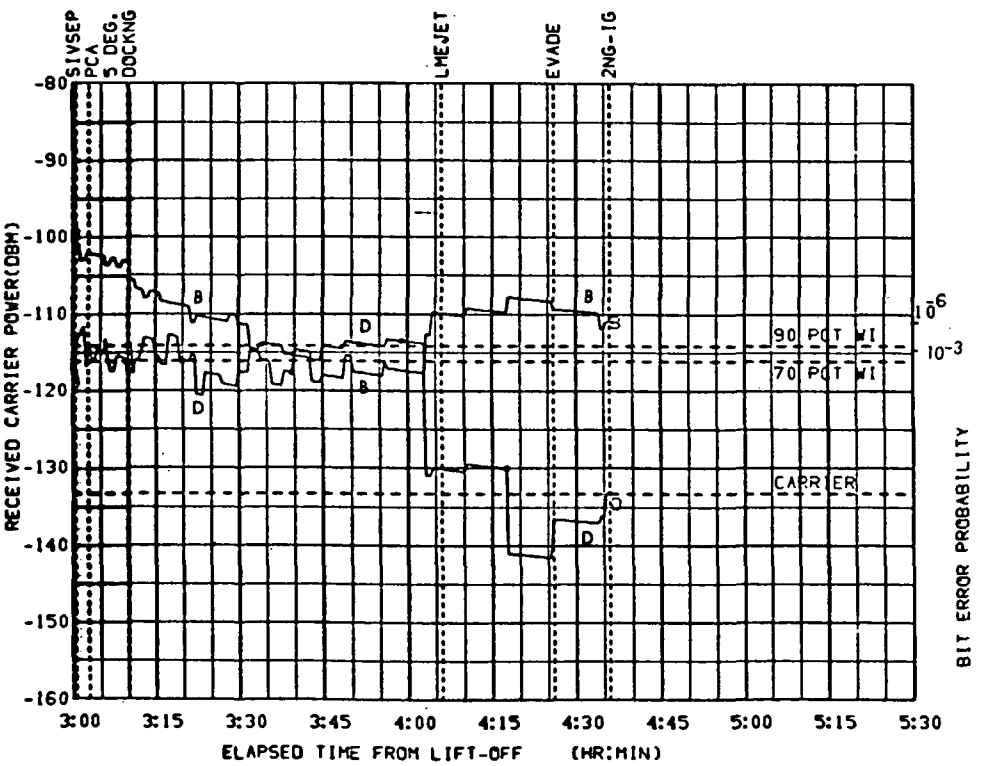


FIGURE 7-10f. MIL DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

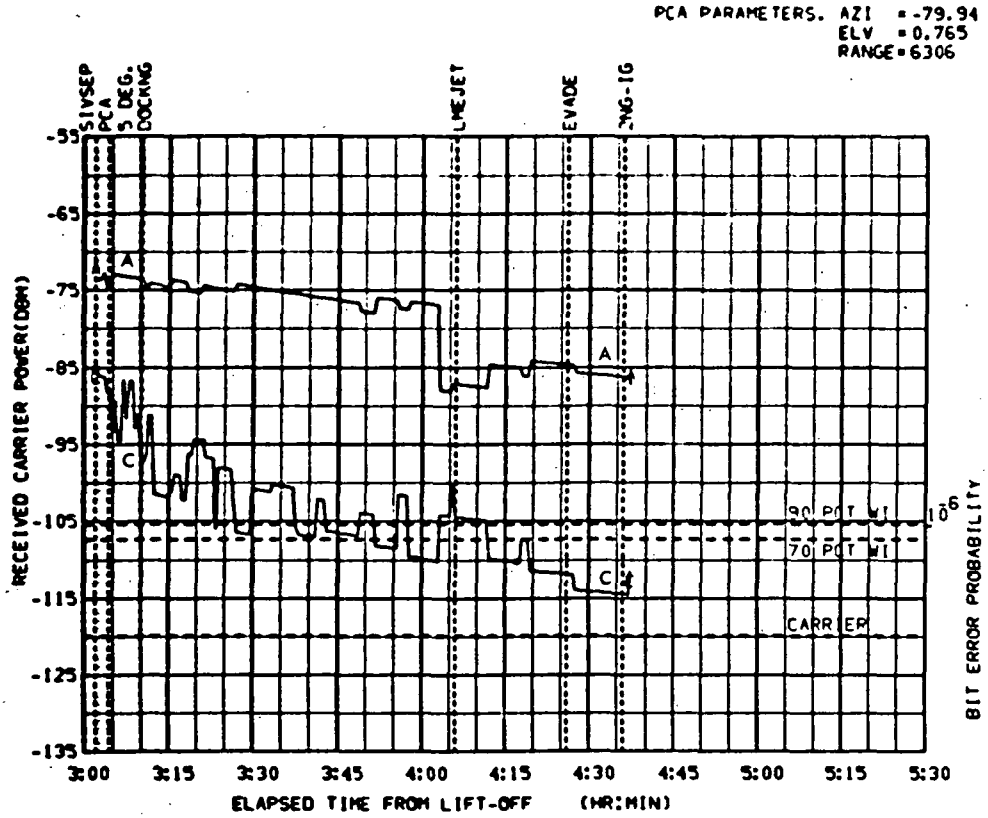


FIGURE 7-11a. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

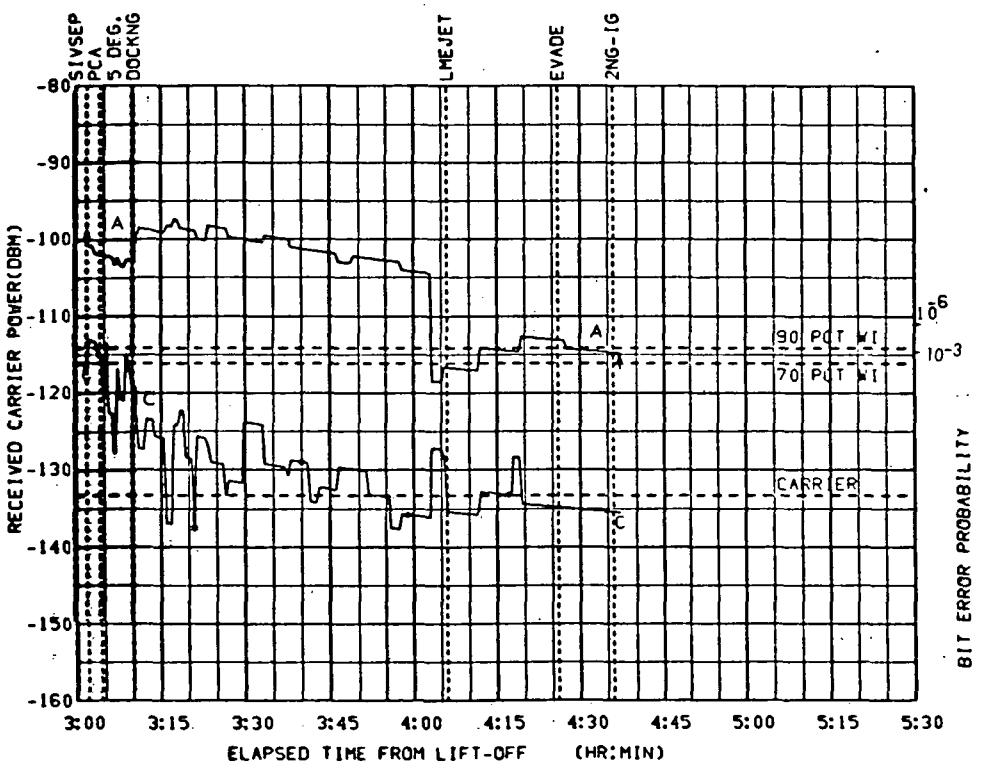


FIGURE 7-11b. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

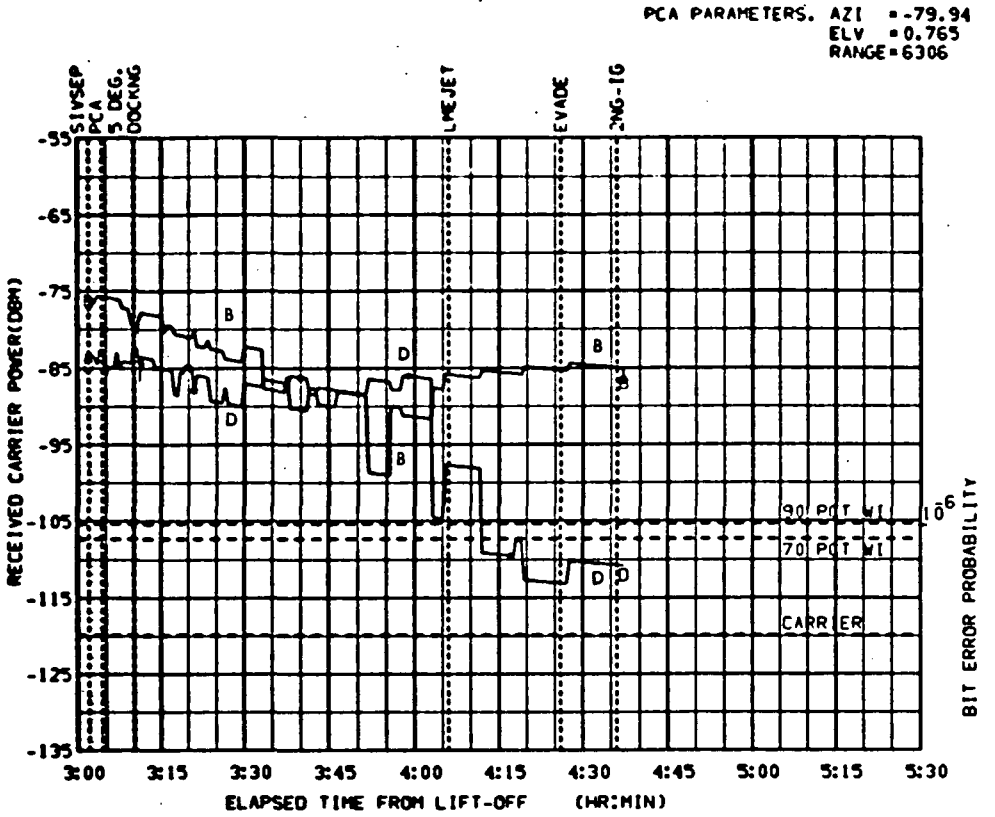


FIGURE 7-11c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

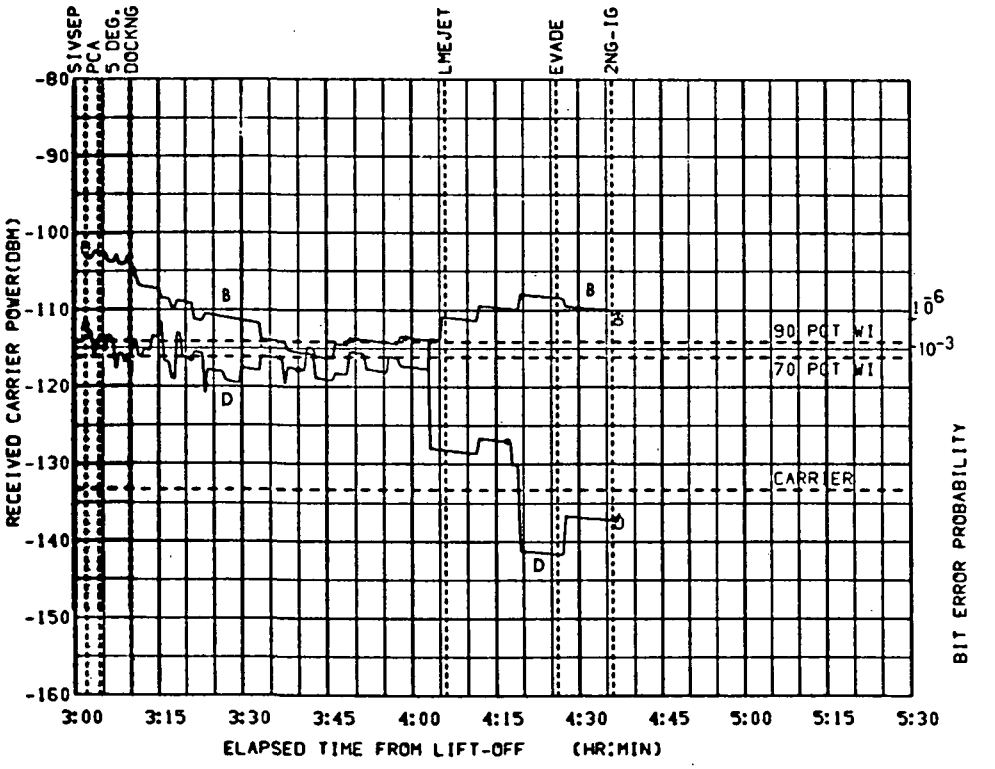


FIGURE 7-11d. GBM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

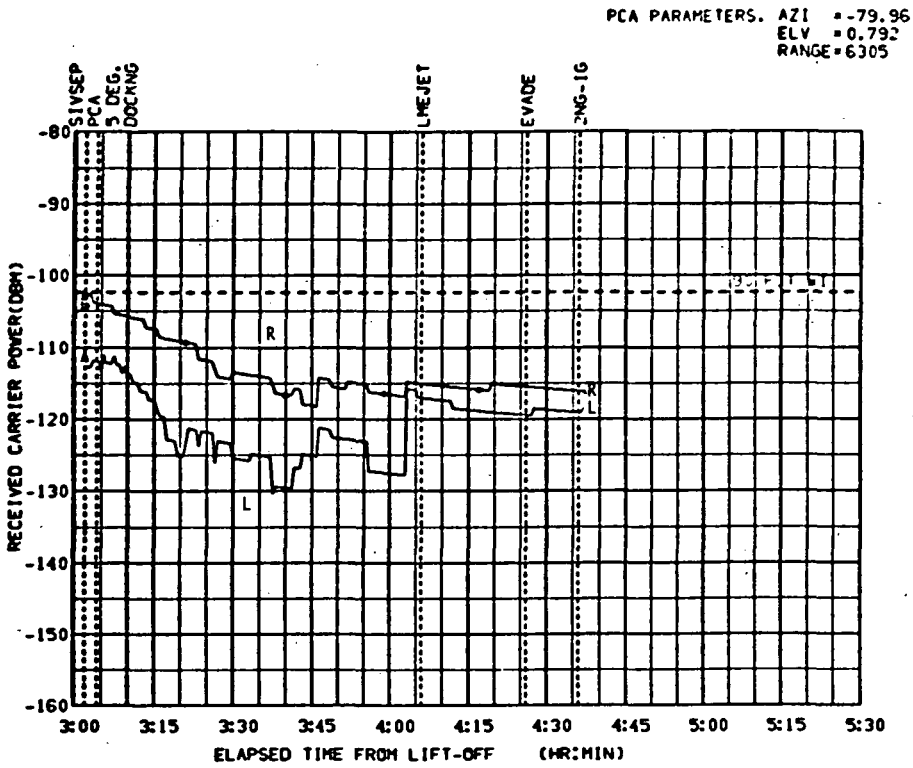


FIGURE 7-11e. GBI UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

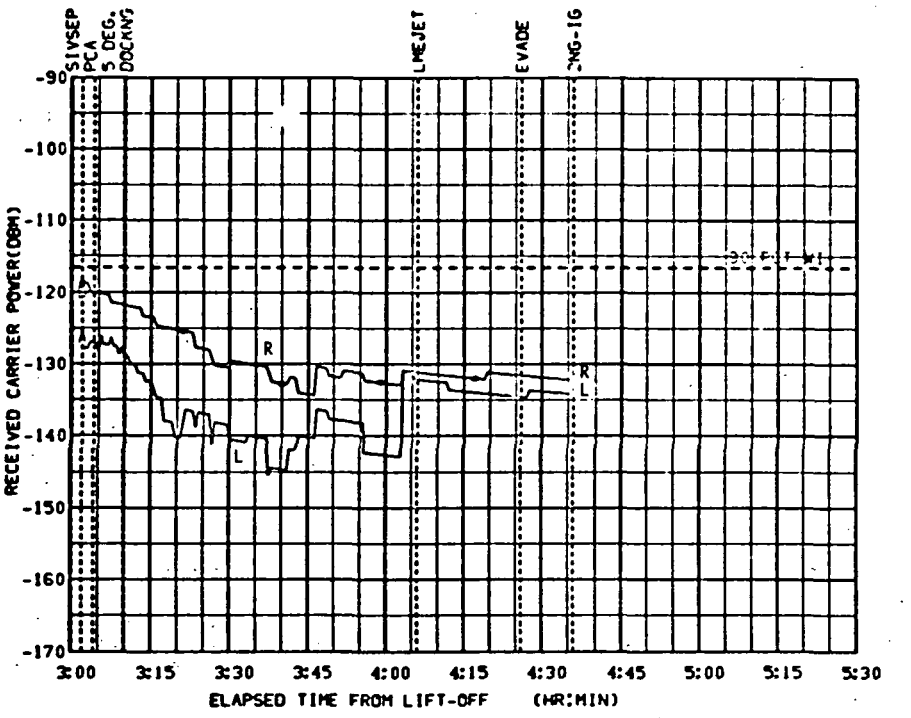


FIGURE 7-11f. GBI DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN
TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

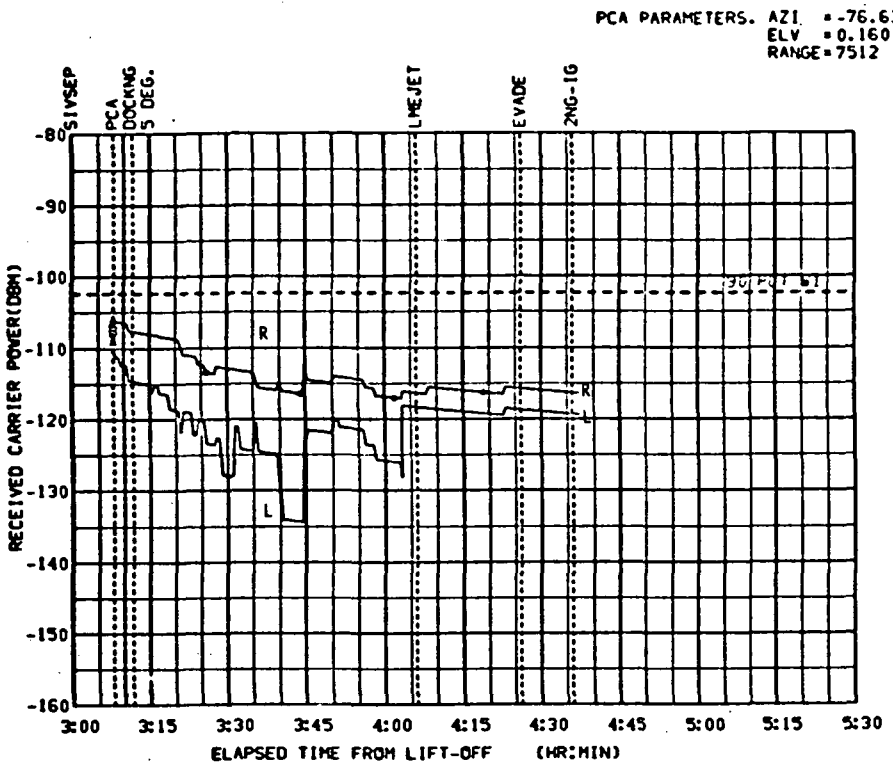


FIGURE 7-12a. BDA UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

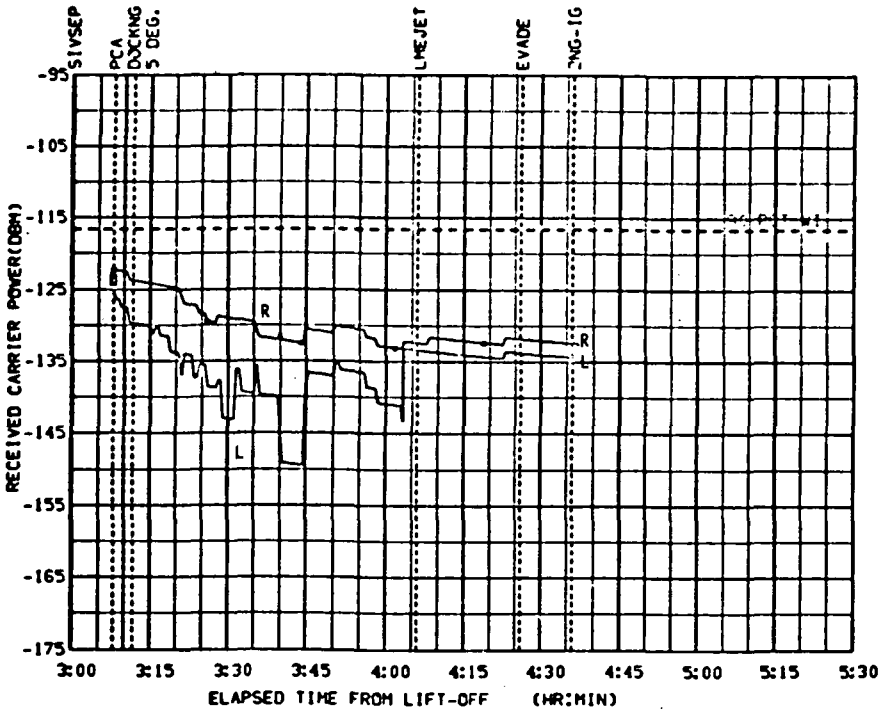


FIGURE 7-12b. BDA DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

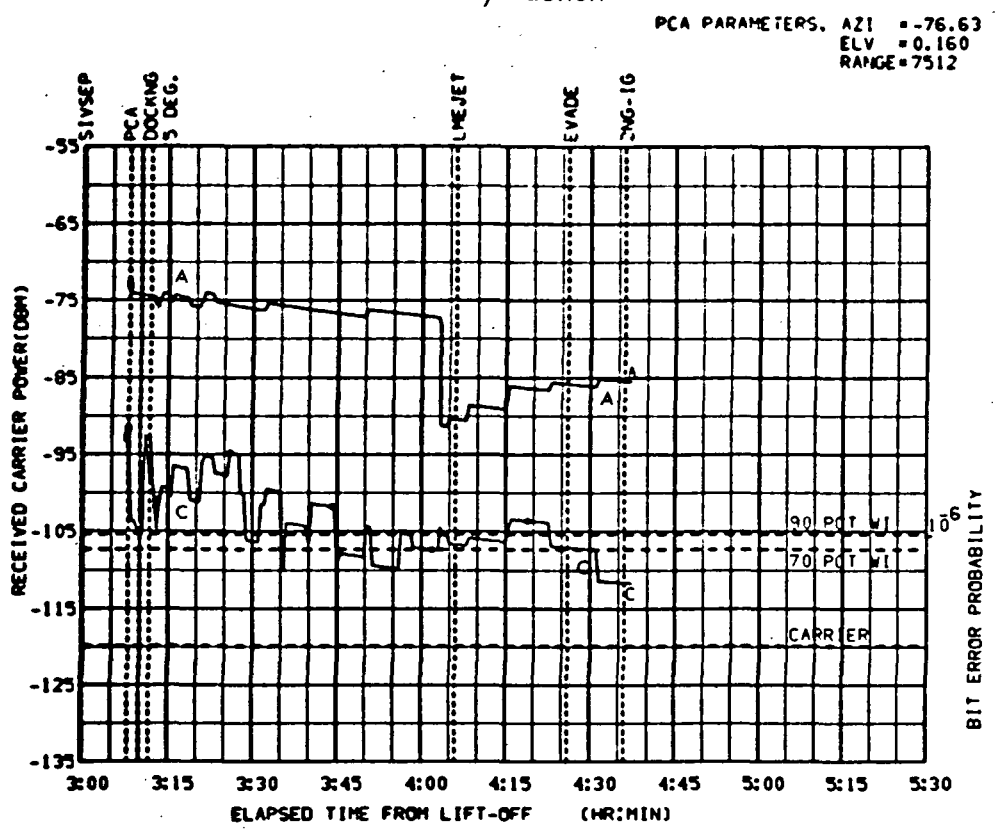


FIGURE 7-12c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

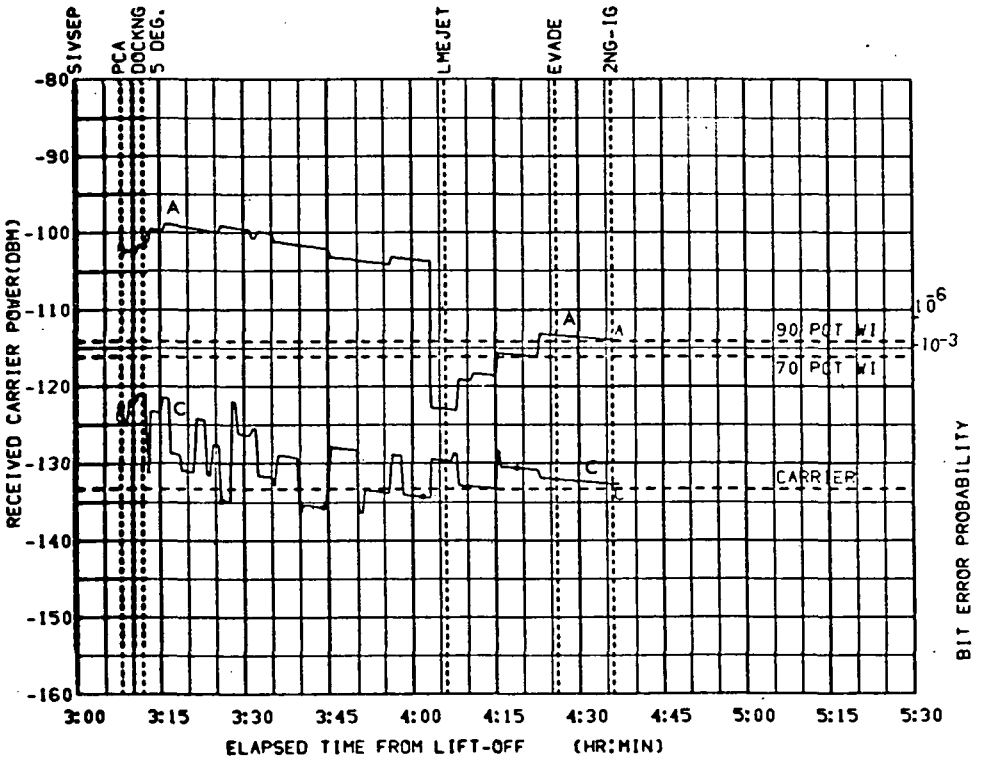


FIGURE 7-12d. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

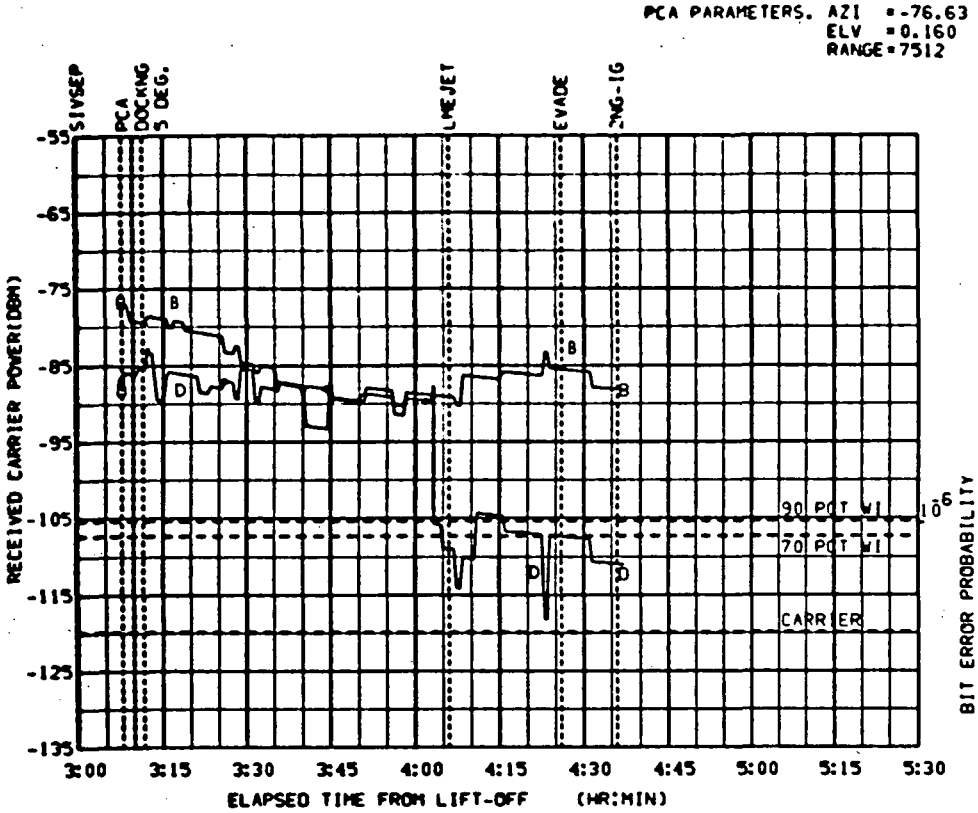


FIGURE 7-12e. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

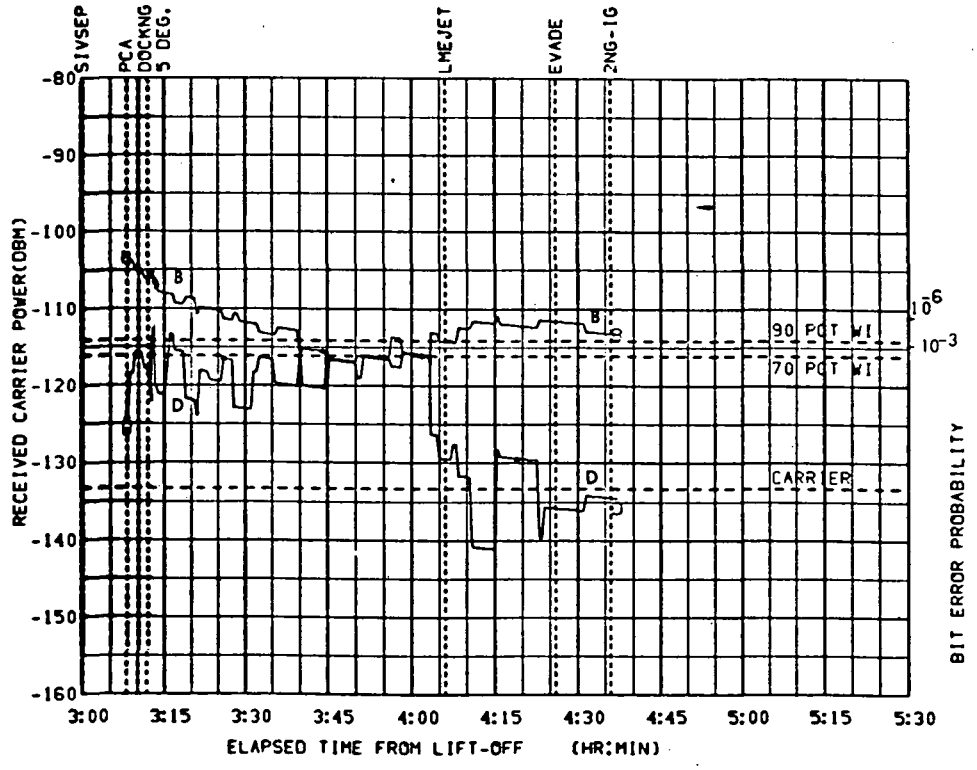


FIGURE 7-12f. BDA DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

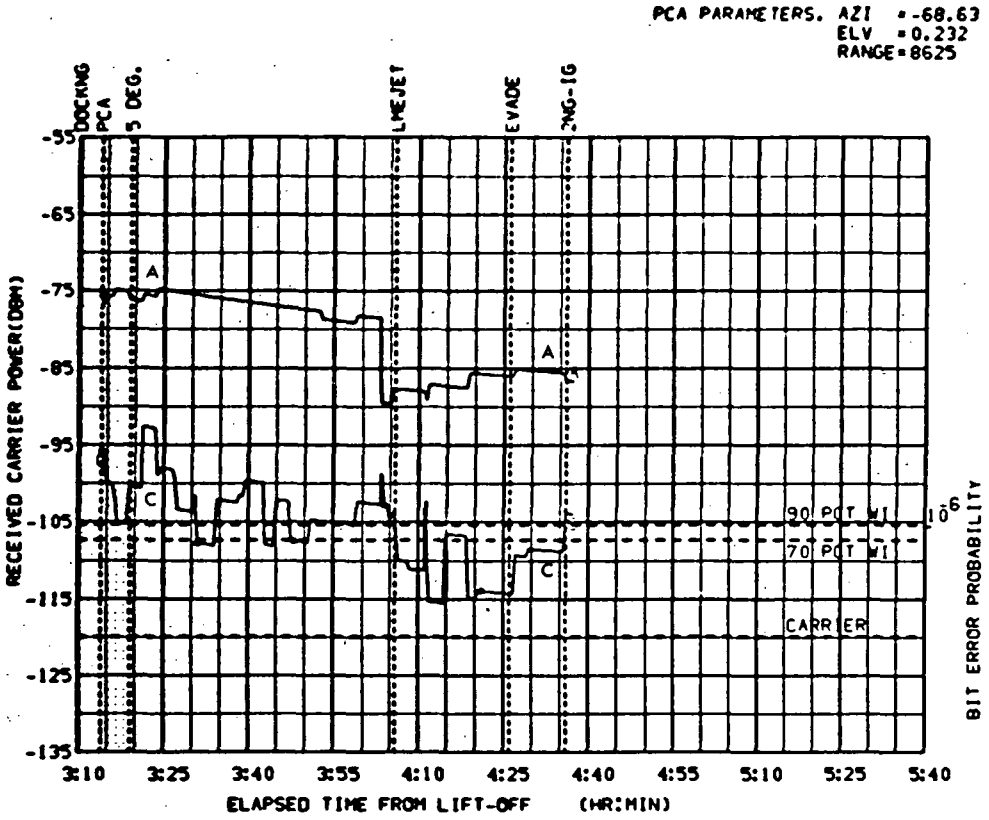


FIGURE 7-13a. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

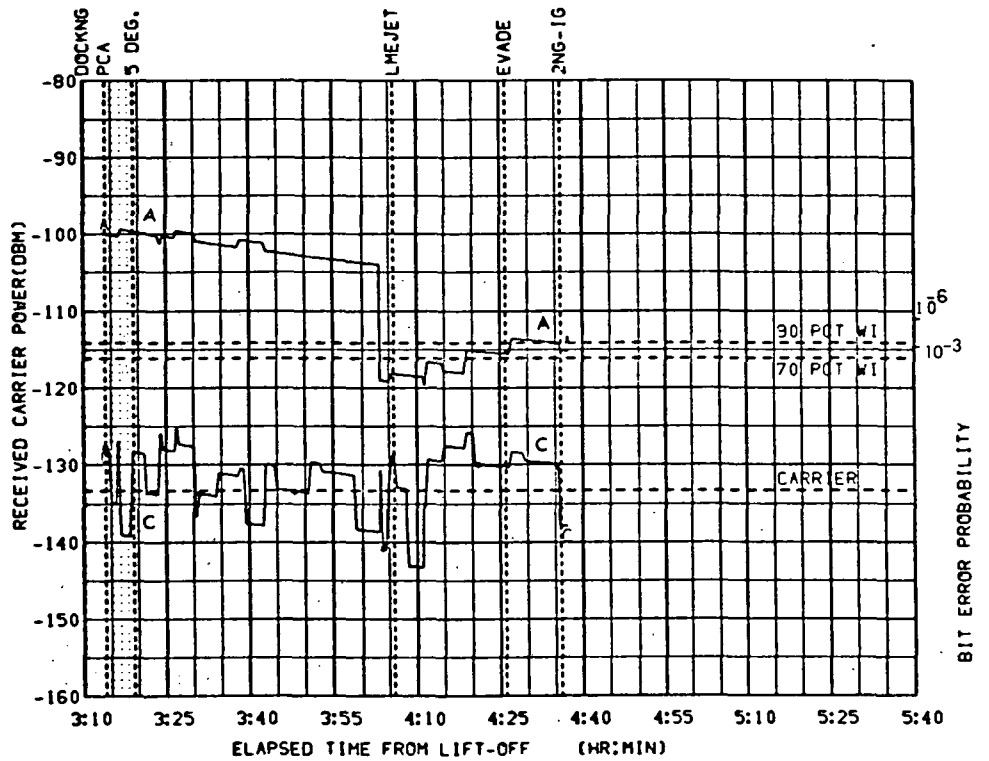


FIGURE 7-13b. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

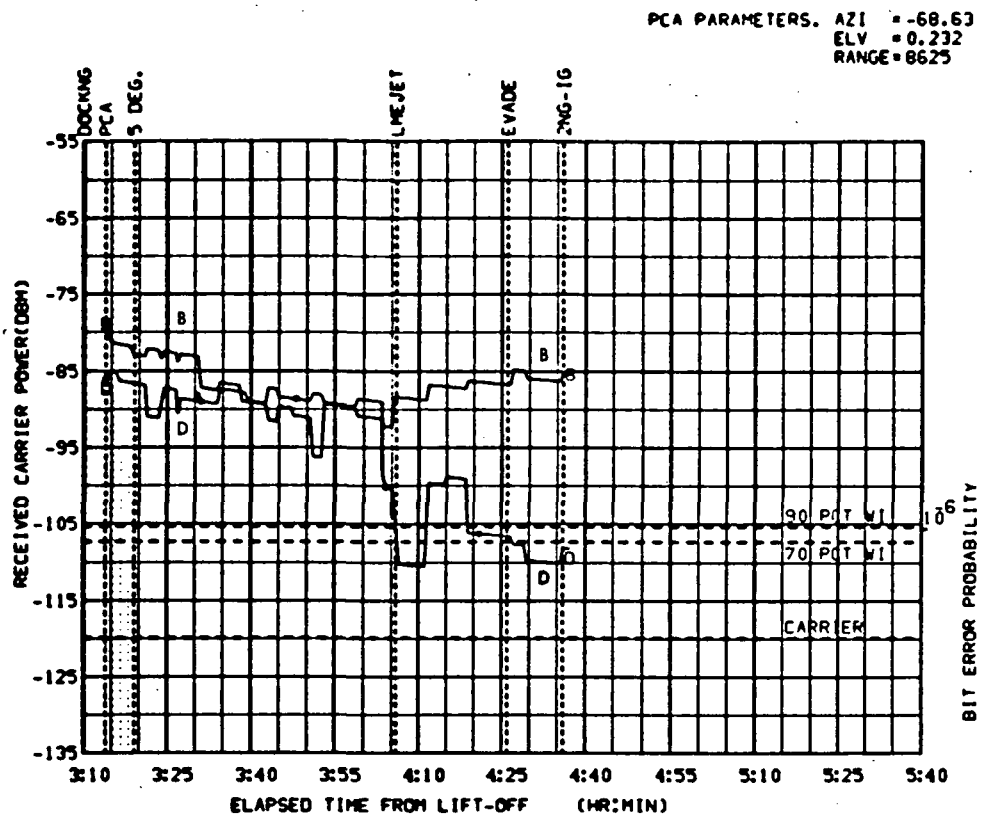


FIGURE 7-13c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

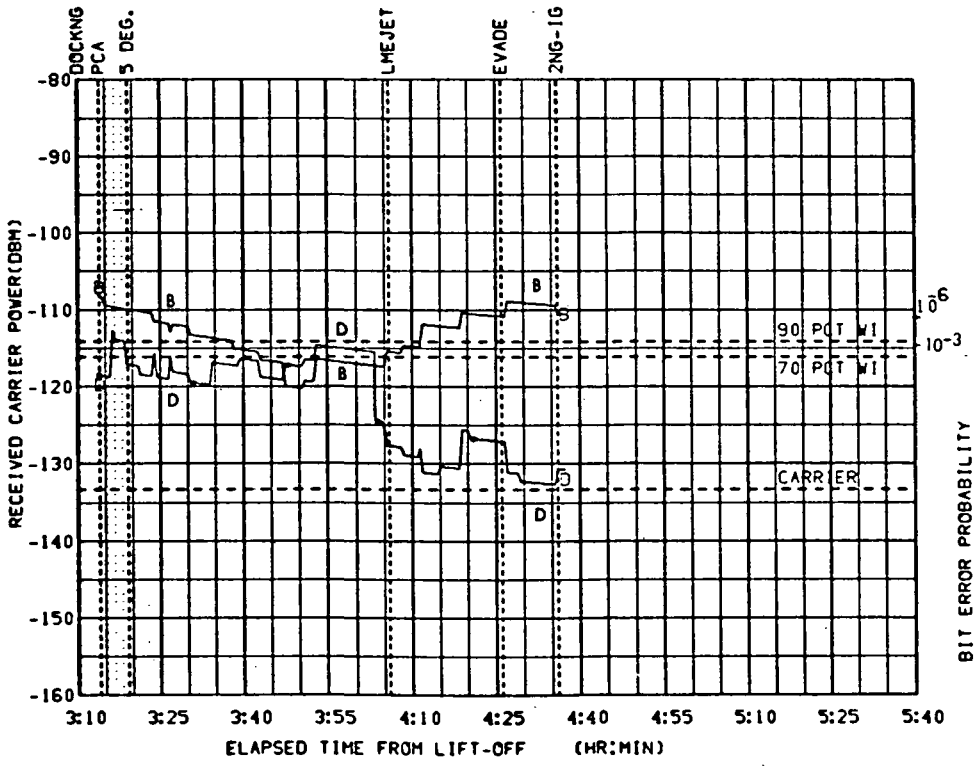


FIGURE 7-13d. ANG DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

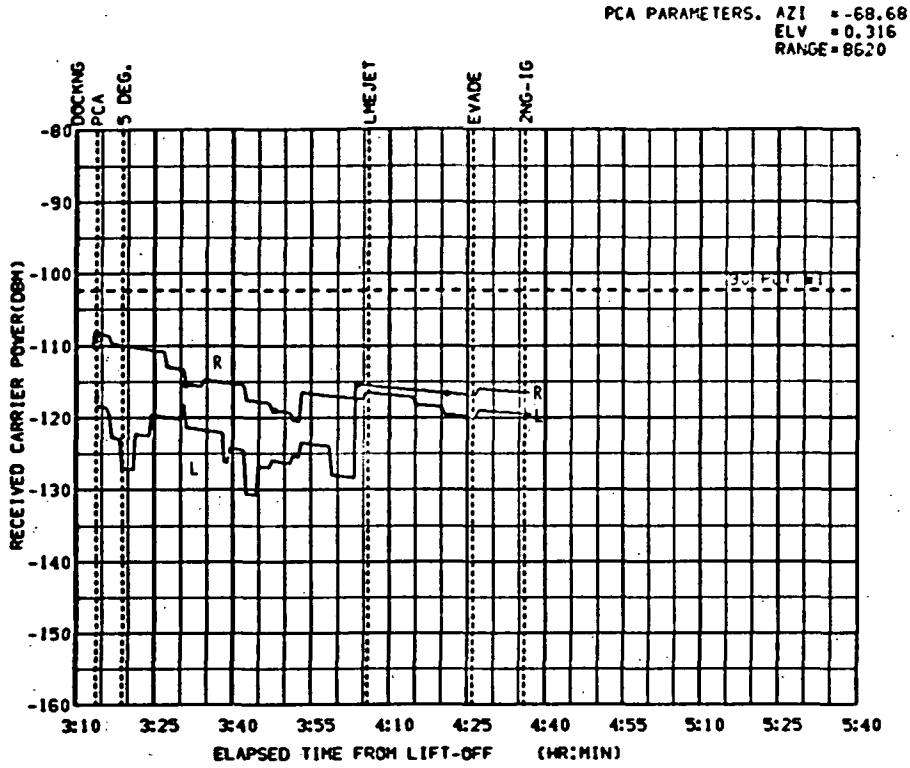


FIGURE 7-13e. ANT UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

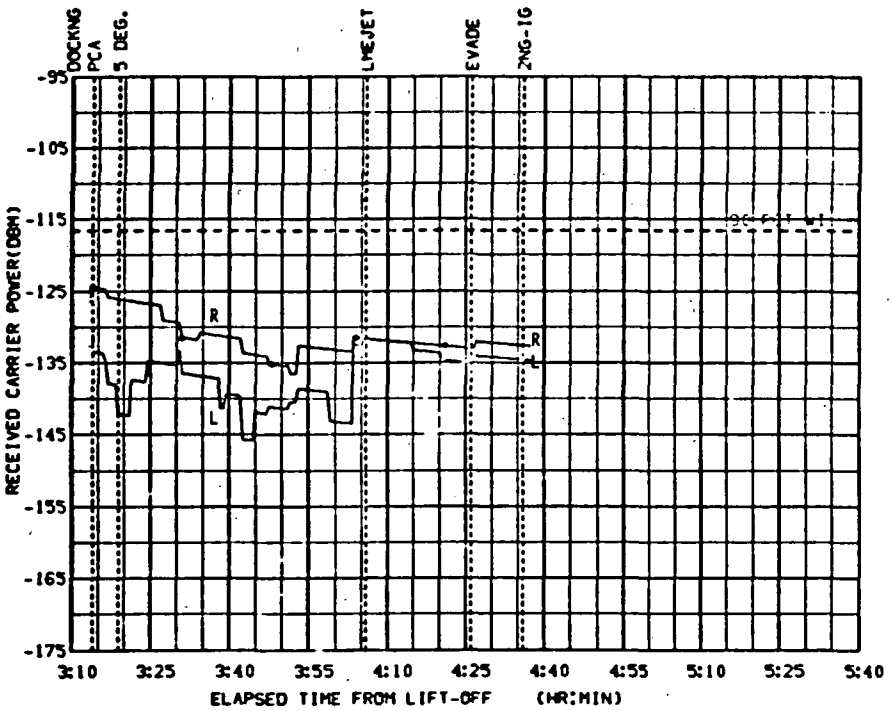


FIGURE 7-13f. ANT DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

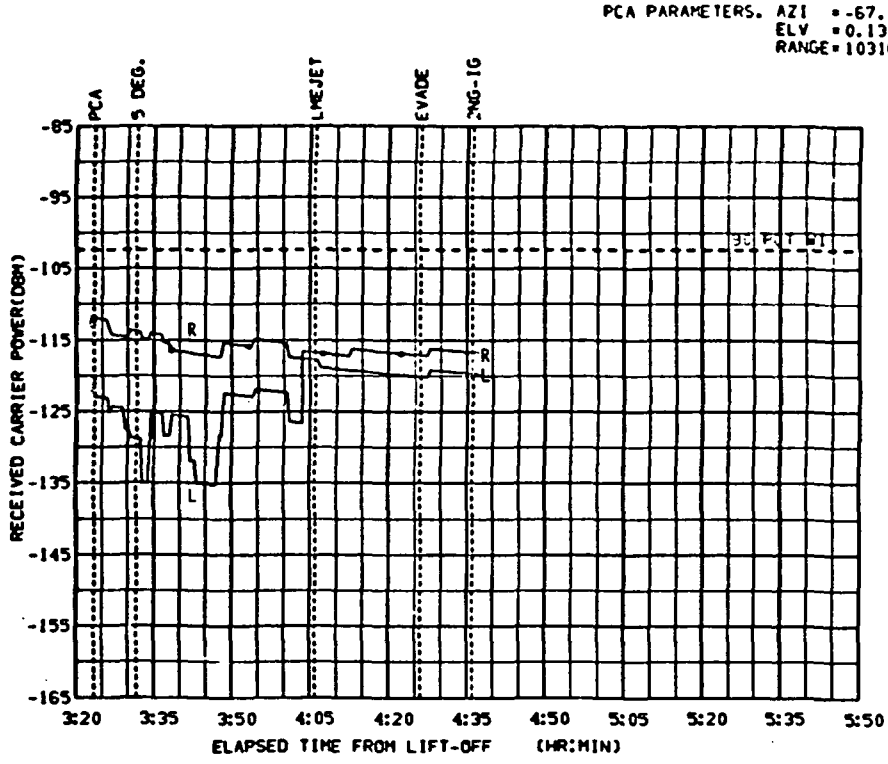


FIGURE 7-14a. VAN UPLINK. MSFN/CSM. VHF/AM. SM ANTENNAS TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

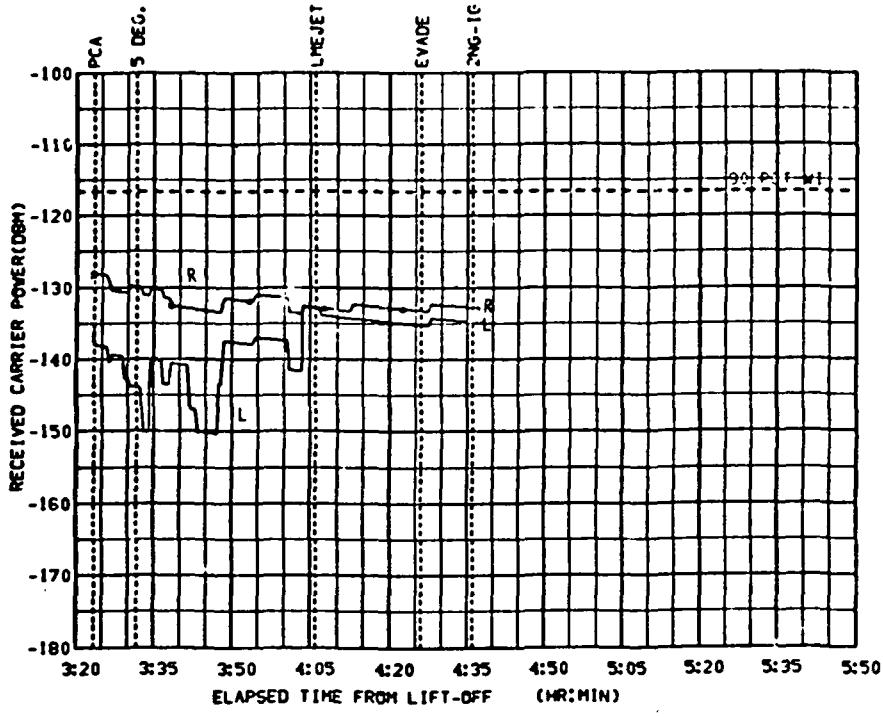


FIGURE 7-14b. VAN DOWNLINK. CSM/MSFN. VHF/AM. SM ANTENN TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

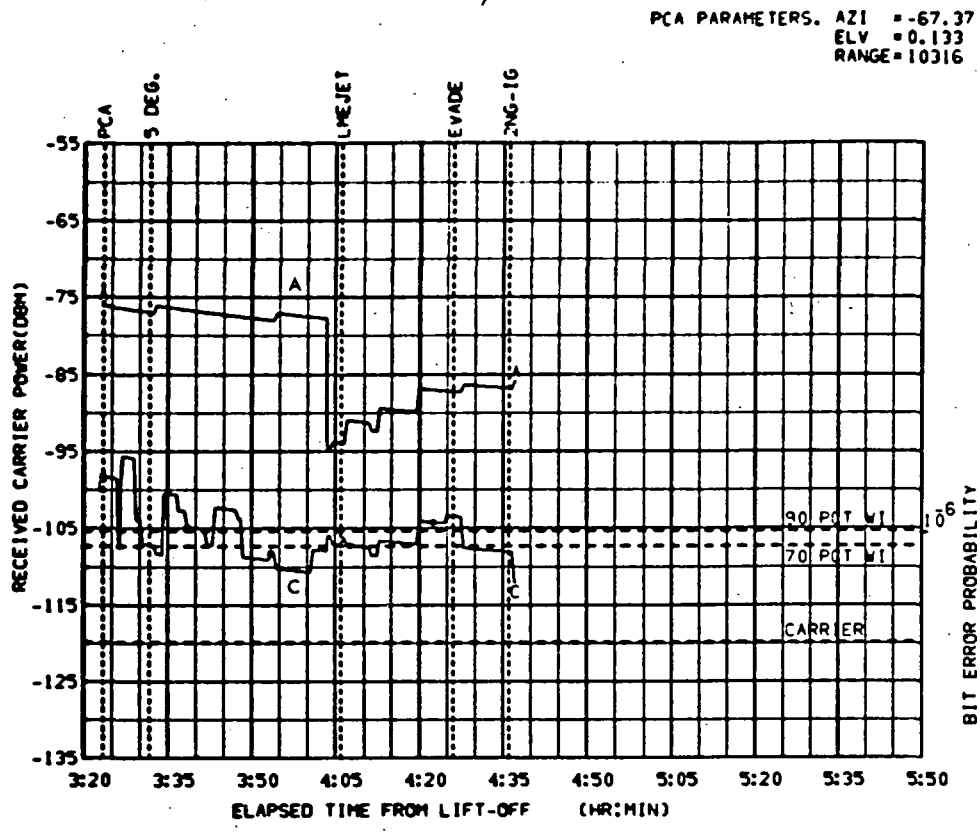


FIGURE 7-14c. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

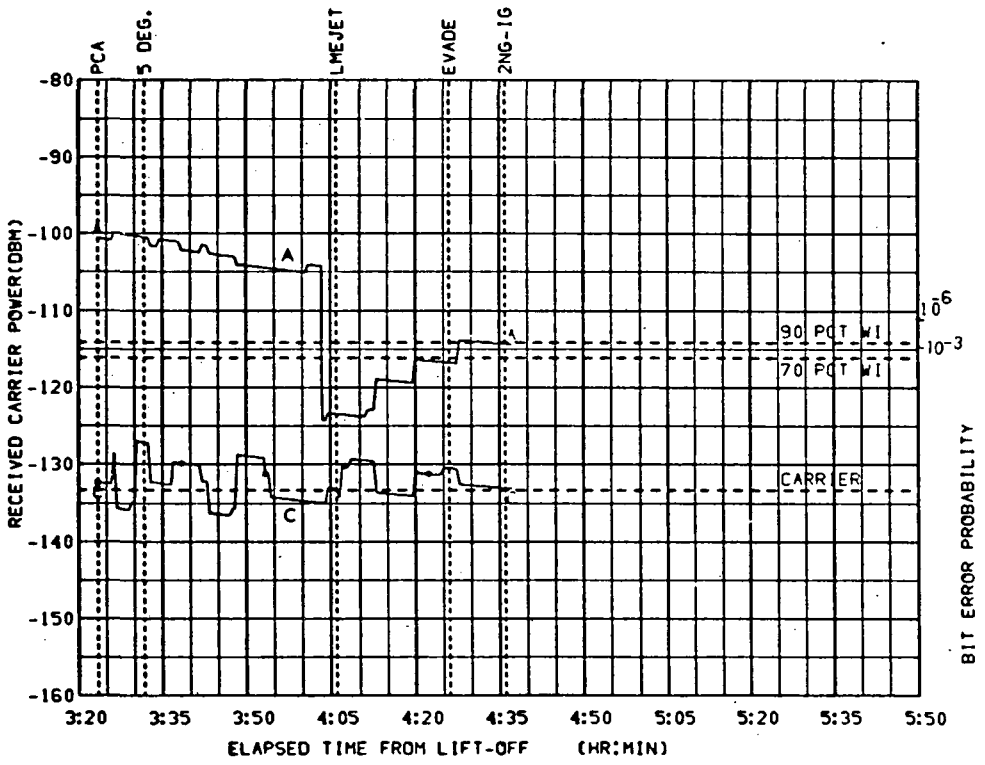


FIGURE 7-14d. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

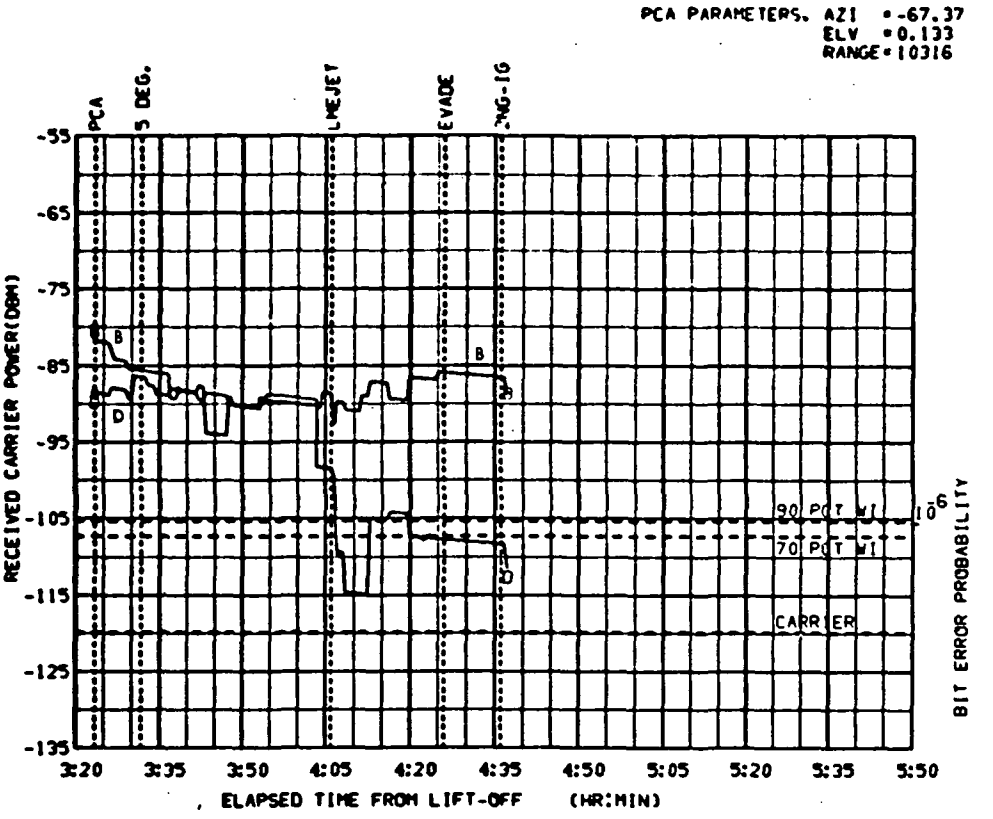


FIGURE 7-14e. VAN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

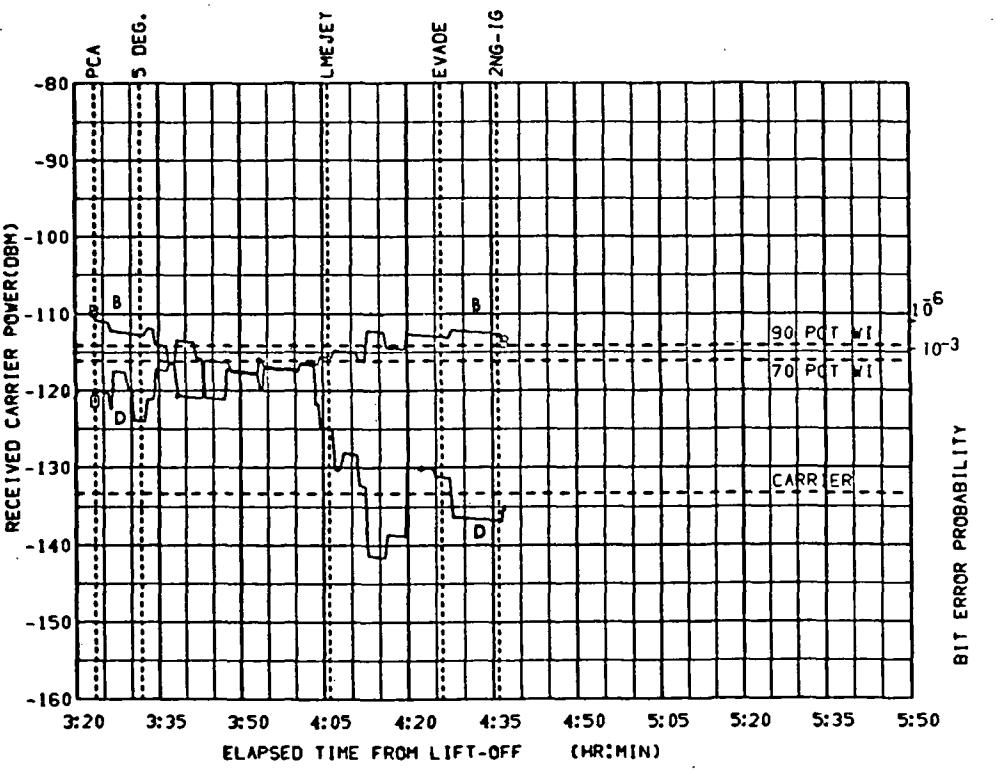


FIGURE 7-14f. VAN DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI TRANSPOSITION AND DOCKING. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

8. TRANSLUNAR COAST

8.1 INTRODUCTION

This section discusses the communication coverage for the translunar coast phase. Communications analysis and recommendations are provided for the CSM S-band communication system.

The following communication recommendations are provided in this section:

a) The CSM omni antennas should be used as the primary means of S-band communications during passive thermal control (PTC) periods.

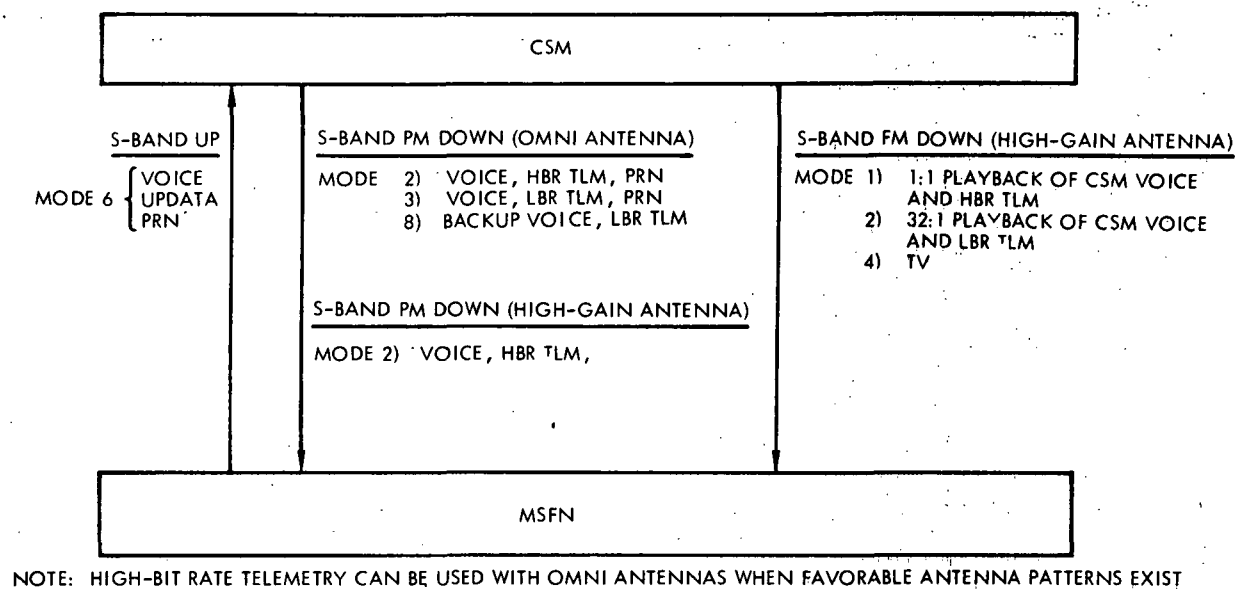
b) Switching between CSM omni antennas should be accomplished by ground command whenever possible.

c) The CSM HGA/GDS 210-foot antenna combination must be used to obtain color TV pictures of satisfactory quality during the scheduled transmission periods from near lunar distances because the maximum range (170,000 nautical miles) for satisfactory color TV pictures from the CSM HGA/85-foot MSFN antenna combination will be exceeded.

8.2 COMMUNICATION CONFIGURATION

During the translunar period, the CSM will be docked with the LM. The LM S-band communication system will not be activated during translunar coast. The spacecraft will be in the PTC mode except when other activities require different attitudes. The S-band communication configuration for crew active periods is shown in Figure 8-1. This configuration will provide full uplink communications (PM mode 6) for transmission of voice, updata, and PRN. Full downlink communications (PM mode 2) are available with the CSM high-gain antenna (HGA) for transmission of voice, HBR TLM, and PRN. Downlink PM mode 2 may also be available at near earth distances with the CSM omni antennas if favorable antenna patterns exist. In most cases, however, downlink communication with the omni antennas at near earth distances will be limited to PM mode 3 (voice, LBR TLM, and PRN). Downlink communications with the omni antennas from near lunar distances can be accomplished with PM mode 8 (low bit rate telemetry and backup voice). S-band FM downlink communications

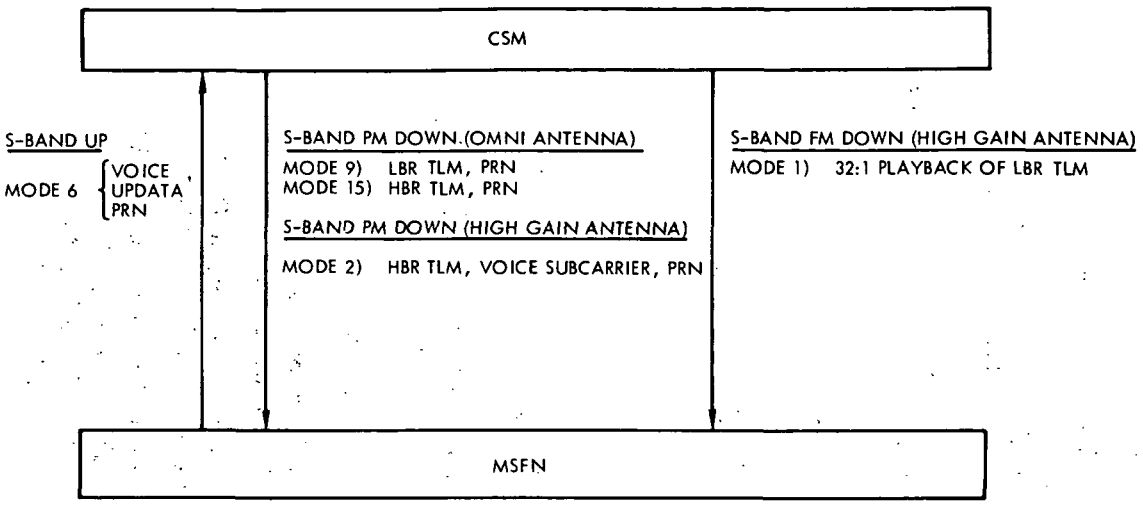
are available by means of the HGA for 1:1 playback of CSM voice and HBR TLM (FM mode 1), 32:1 playback of CSM voice and LBR TLM (FM mode 2), and television (FM mode 4).



NOTE: HIGH-BIT RATE TELEMETRY CAN BE USED WITH OMNI ANTENNAS WHEN FAVORABLE ANTENNA PATTERNS EXIST

Figure 8-1. Basic Communication Configuration for Translunar Coast Phase (Crew Active)

The communication configuration for crew rest periods is shown in Figure 8-2. This configuration is essentially the same as the crew active configuration except for the absence of downlink voice communication. Downlink PM mode 2 will continue to be used with the HGA except that the voice subcarrier will be unmodulated. Downlink communications with the CSM omni will be by means of PM mode 9 (LBR TLM and PRN). PM mode 15 (HBR TLM and PRN) is available (based on 0-dB omni gain) to approximately 144,000 nautical miles for the 85-foot MSFN stations.



NOTE: DURING CISLUNAR CREW REST PERIODS, THERE ARE THREE OPTIONS FOR MAINTAINING COMMUNICATIONS:
(1) COMMAND SWITCHING BETWEEN TWO OMNI ANTENNAS AND
(2) HIGH GAIN AUTOMATIC REACQUISITION MODE
(3) COMMAND SWITCHING BETWEEN HGA AND OMNI D

Figure 8-2. Basic Communication Configuration for Translunar Coast Phase (Crew Rest)

The downlink mode availability for various CSM/MSFN antenna combinations for the translunar coast phase is presented in Table 8-1. Appendix C provides detailed data on the S-band system capability.

For the crew rest communication configuration, there are three options for maintaining communications during PTC periods. The first is to command antenna switching between two omni antennas, the second is to operate the spacecraft HGA in the automatic reacquisition mode, and the third utilizes the spacecraft HGA and omni D. The automatic reacquisition mode would require recording LBR data on the DSE when the HGA exceeds the tracking limits and dumping the contents of the DSE after reacquisition. The third option will not be used because of the possibility of HGA instability on reacquisition.

8.3 S-BAND COVERAGE SUMMARY

A bar graph summary of the MSFN station coverage during the translunar coast phase is given in Figure 8-3. Received carrier power plots versus elapsed time are shown in Figures 8-4 through 8-21 for two 1-hour passive thermal control (PTC) periods, one beginning at approximately 55,000 nautical miles (near earth period) and one beginning at

Table 8-1. CSM S-band Downlink Mode Availability for Translunar Coast

	CSM Modes Which Meet Required Performance Levels	
	30-ft Cooled MSFN Stations	85-ft MSFN Stations
Near Earth (<140,000 n mi) (Quiet Sky)	• Omni antennas: PM modes 5, 7, 8, and 10 • High-gain antenna (WBW): PM modes 5, 7, 8, 9, and 10 • High-gain antenna (NBW): all PM modes; black and white TV	• Omni antennas: PM modes 3 through 10, 15 • High-gain antenna (WBW): all PM modes • High-gain antenna (NBW): all PM modes; color TV • All FM modes
Near Lunar (>140,000 n mi) (Quiet Sky)	• Omni antennas: PM mode 10 only • High-gain antenna (WBW): PM modes 5, 7, 8, and 10 • High-gain antenna (NBW): PM modes 1 through 5 and 7 through 10, 15; black and white TV*	• Omni antennas: PM modes 3 through 10 • High-gain antenna (WBW): all PM modes • High-gain antenna (NBW): all PM modes; color TV* • All FM modes
Near Lunar (Moon-at-Zenith)	• Omni antennas: PM mode 10 only • High-gain antenna (WBW): PM modes 5, 7, 8, and 10 • High-gain antenna (NBW): PM modes 1 through 5 and 7 through 10	• Omni antennas: PM modes 5 through 10 • High-gain antenna (WBW): PM modes 3 through 10 • High-gain antenna (NBW): all PM modes; black and white TV. All FM modes except color TV

Note: Derived from data in Appendix C. All omni information shown is based on 0-dB omni antenna gain.

*Picture will be of degraded quality.

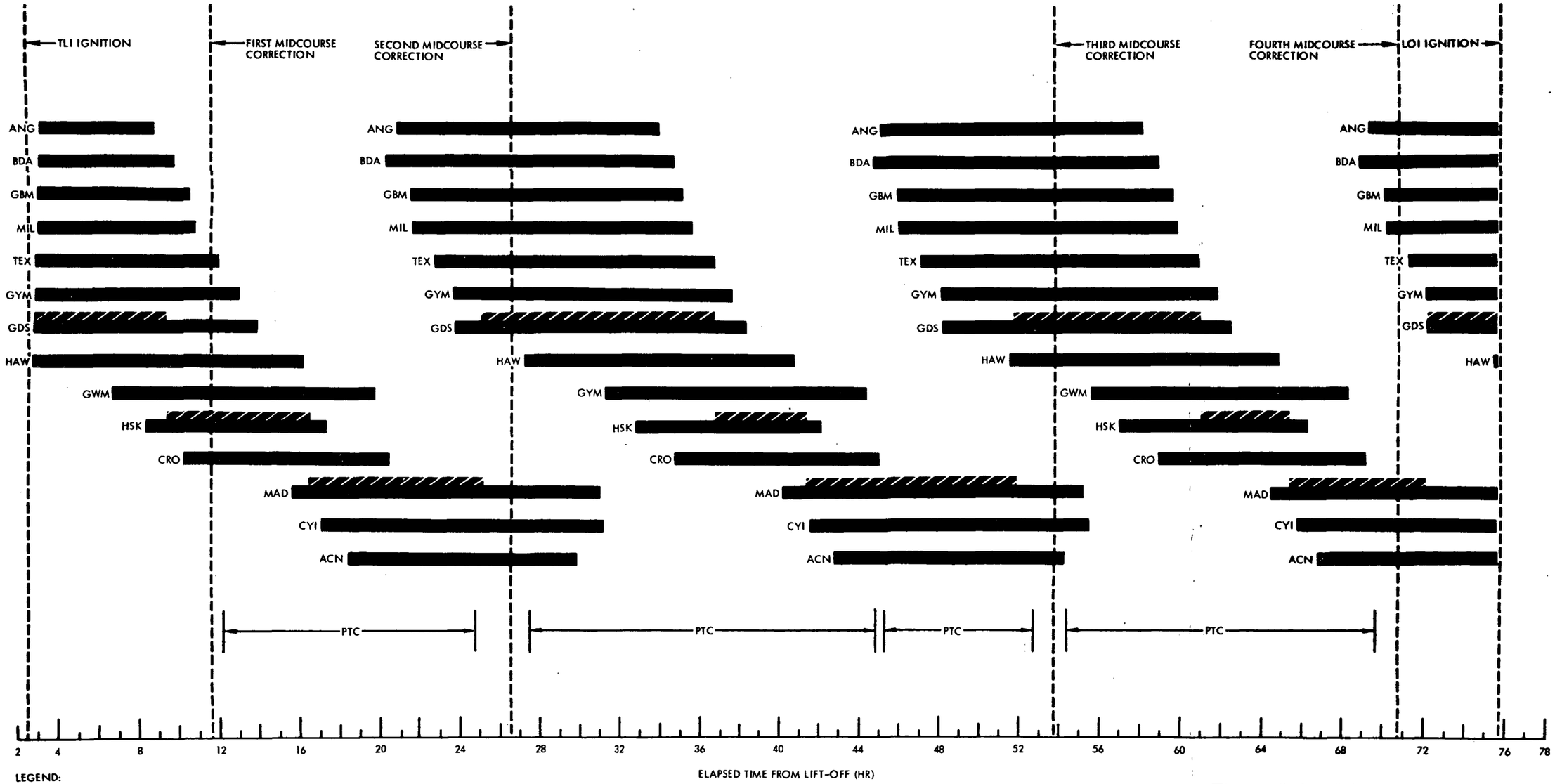


Figure 8-3. S-band Coverage Summary for Translunar Coast Phase

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approximately 172,000 nautical miles (near lunar period). CSM omni antenna plots are provided for all stations having line of sight during those periods. CSM HGA plots are provided for typical 30-foot uncooled, 30-foot cooled, and 85-foot MSFN stations since all stations of the same type will receive approximately the same level of carrier power with the HGA. For calculation of received carrier power, quiet sky pointing conditions are assumed from TLI until 1 hour prior to LOI, after which moon at zenith pointing conditions are assumed. (When the moon is within the beam width of the ground station, the noise contribution of the moon degrades the ground station receiver sensitivity.)

Uplink PM mode 6 (voice, updata, and PRN ranging) and downlink PM mode 2 (voice, HBR telemetry, and PRN ranging) were used for the HGA for both near earth and near lunar PTC periods.

Uplink PM mode 6 was used for the uplink omni antenna plots for the near earth and near lunar PTC periods. Downlink mode 2 was used for the near earth PTC period, and downlink PM mode 8 (backup voice, and LBR telemetry) was used for the near lunar PTC period for the downlink omni plots.

8.4 S-BAND PERFORMANCE

PTC will be used during translunar coast except where other activities require different attitudes. The intent of the PTC mode is to achieve thermal cycling by means of continuous spacecraft rotation. Since the omni antennas will be operating at ranges where attitude is critical, the continuous rotation of the spacecraft will have an adverse effect on communications, and frequent antenna and/or mode switching will be required for 100 percent coverage. This continuous rotation will also periodically block the HGA line of sight to the MSFN stations.

It is recommended that the CSM omni antenna switching be accomplished by ground command whenever possible during crew active periods or the crew be advised of the optimum switching frequency with respect to the MSFN receivers. If the crew performs the antenna switching on the basis of high headset noise levels, the received carrier power at the MSFN will usually fall below threshold levels prior to each antenna switch.

It is recommended that the omni antennas be used as the primary means of communication during all PTC periods. Communications using the HGA are subject to shadowing by the LM and CSM structure and gimbal limitations. (Additional information on usability of HGA during PTC roll periods is given in Appendix E.) When the HGA antenna is used during the PTC periods, LBR TLM is automatically recorded in DSE when HGA exceeds gimbal limits. The contents of the DSE are dumped after reacquisition. Difficulties in reacquisition could result in loss of data. The command switching of HGA and omni D option is not recommended because of possible HGA instability on reacquisition.

Color TV transmission will be provided during the translunar coast phase. Two 10-minute broadcasts are scheduled over GDS at 27 hours 15 minutes and 54 hours (elapsed time from lift-off) and one 15 minute transmission over GDS at 72 hours 20 minutes.

The HGA (NBW)/85-foot MSFN antenna combination will provide a TV picture of adequate quality during the first transmission period. In order to obtain adequate quality color TV pictures for the remaining transmission periods (near lunar distance) periods, the GDS 210-foot antenna must be used.

8.4.1 Near Earth PTC Period

Adequate communication coverage for PM downlink mode 2 is provided by the 85-foot MSFN stations and the spacecraft omni antennas during the near earth PTC period covered by the plots by using the switching sequence D - C - B - A - D . . . . This switching should occur approximately every 15 minutes. This method of switching can be accomplished only during crew active periods. The 85-foot MSFN stations will provide 100 percent coverage with downlink PM mode 3 by switching between two diametrically opposite omni antennas. The switching sequence would be A - C - A . . . or B - D - B . . . and the switching should occur approximately every 30 minutes. The B - D - B . . . switching sequence can be used for crew rest periods by ground command switching.

The coverage provided by the CSM omni/30-foot uncooled MSFN antenna combination with downlink PM mode 2 and by switching between the four omni antennas will be below threshold. The coverage provided by the CSM omni/30-foot cooled MSFN antenna combination with downlink PM

mode 2 and by switching between the four omni antennas will be marginal. Adequate coverage should be provided by the CSM omni/30-foot cooled MSFN antenna combination with downlink PM mode 3 and by switching between the four omni antennas.

The CSM HGA in either WBW or NBW mode will provide good coverage for downlink PM mode 2 during the near earth PTC period at the 85-foot MSFN stations. Adequate coverage will be provided by the HGA in NBW mode at the 30-foot cooled stations; however, the coverage will be marginal in the WBW mode. The HGA/30-foot uncooled station combination will provide adequate coverage in the NBW mode but below threshold coverage in the WBW mode.

8.4.2 Near Lunar PTC Period

The CSM omni/30-foot uncooled MSFN antenna combination provide marginal communications with downlink PM mode 8 during the near lunar PTC period by switching between the four omni antennas. The CSM omni/30-foot cooled MSFN antenna combination will provide adequate communications with downlink PM mode 8 by switching between the four omni antennas. The switching sequence is D - C - B - A - D . . . . The switching should occur approximately every 15 minutes. The 85-foot MSFN stations will provide higher received carrier power levels for the same switching sequence. This method of providing communication coverage can be used during crew active periods.

For crew rest periods, ground command switching between diametrically opposite omni antennas will provide received carrier power levels well above the 70 percent WI voice threshold at the 85-foot MSFN stations. The sequence of switching is B - D - B . . . , and the switching occurs approximately every 30 minutes. Switching between two diametrically opposite omni antennas would also provide adequate coverage at the 85-foot stations during the crew active period.

The HGA NBW mode will provide adequate downlink PM mode 2 coverage at the 30-foot uncooled, 30-foot cooled, and 85-foot MSFN stations during the near lunar PTC mode covered. The HGA WBW mode is marginal for the 85-foot stations and below threshold for the 30-foot stations.

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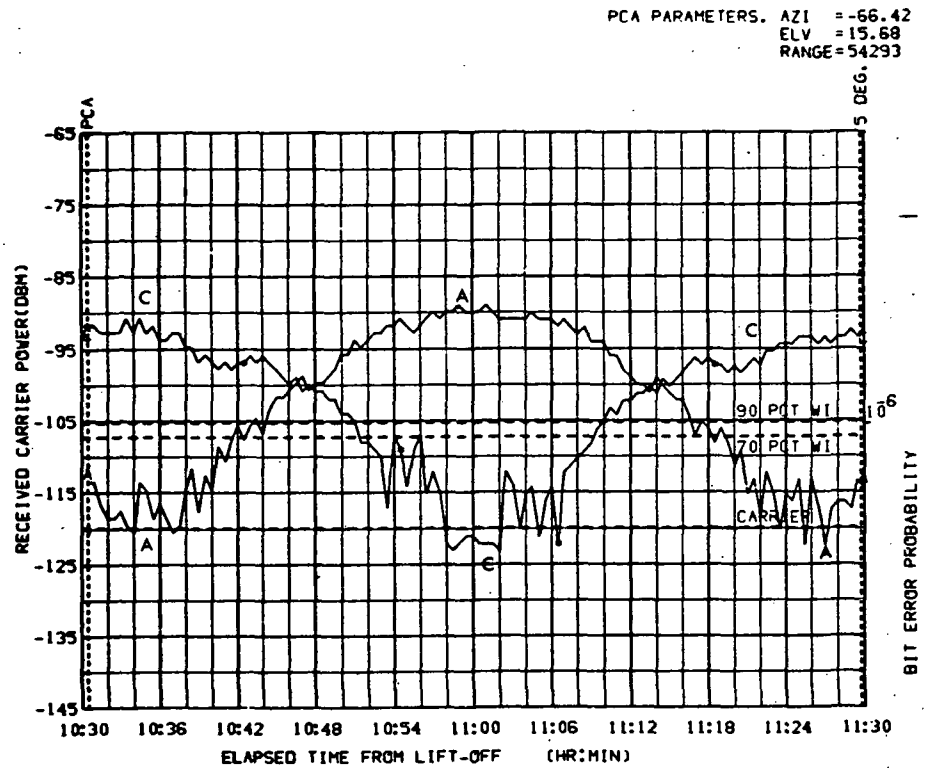

FIGURE 8-4a. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

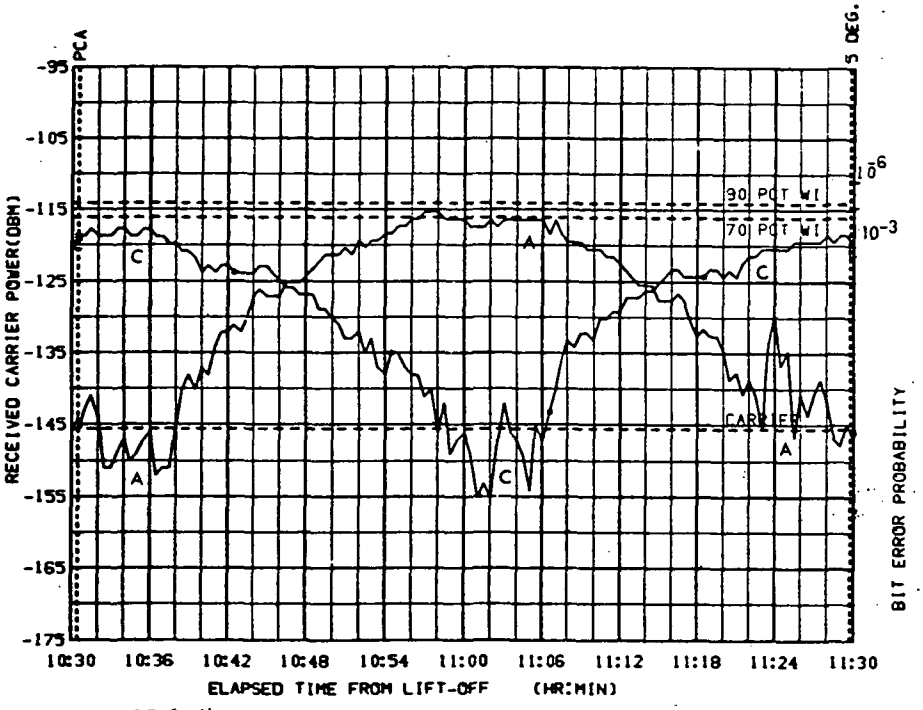

FIGURE 8-4b. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

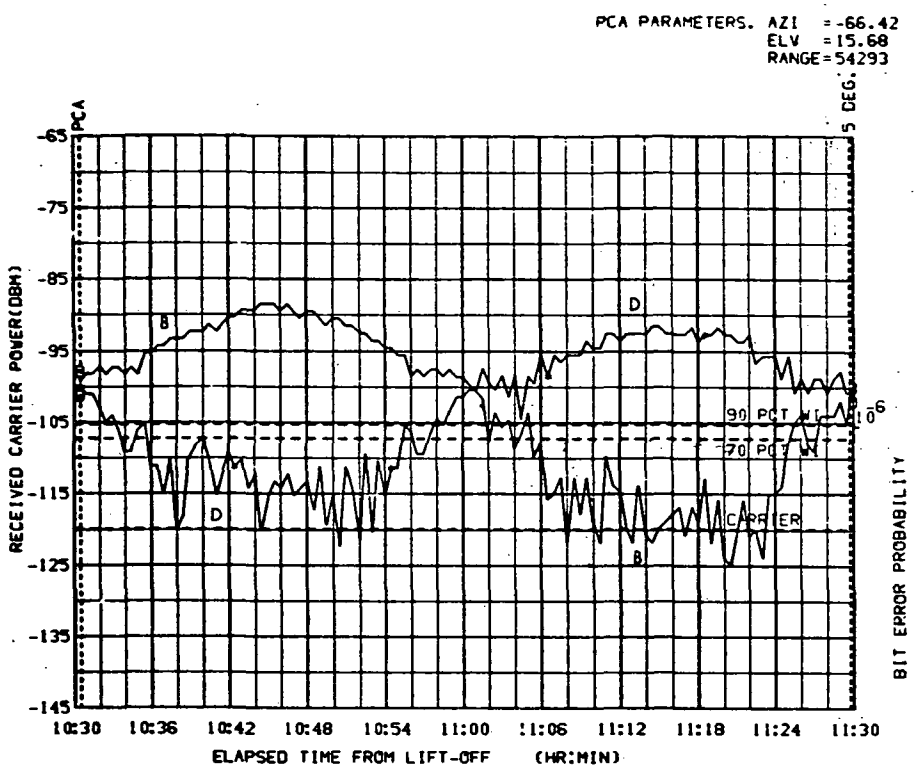

FIGURE 8-4c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

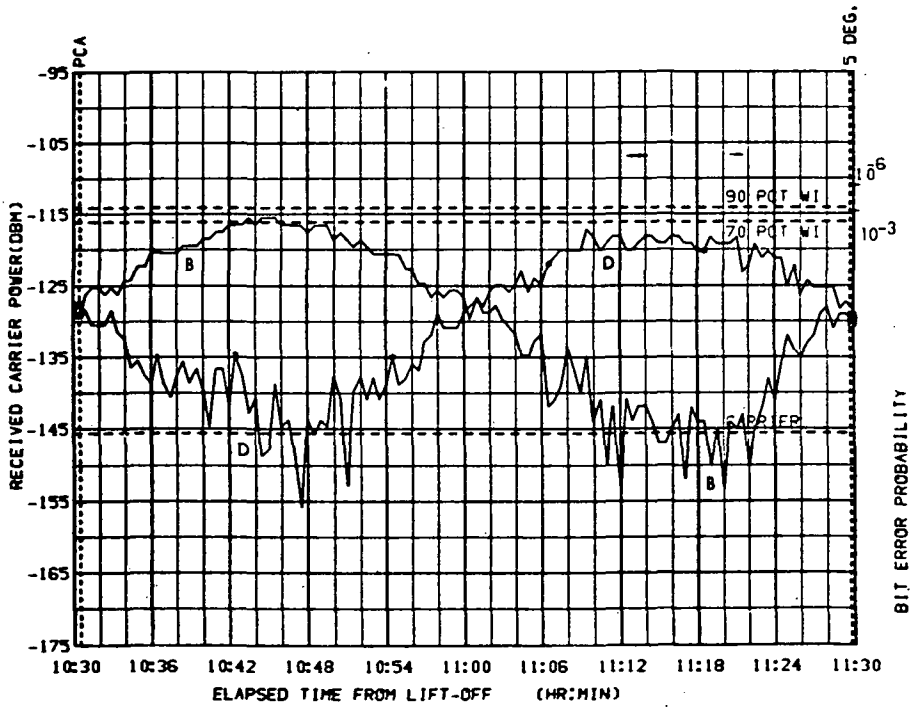

FIGURE 8-4d. TEX DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

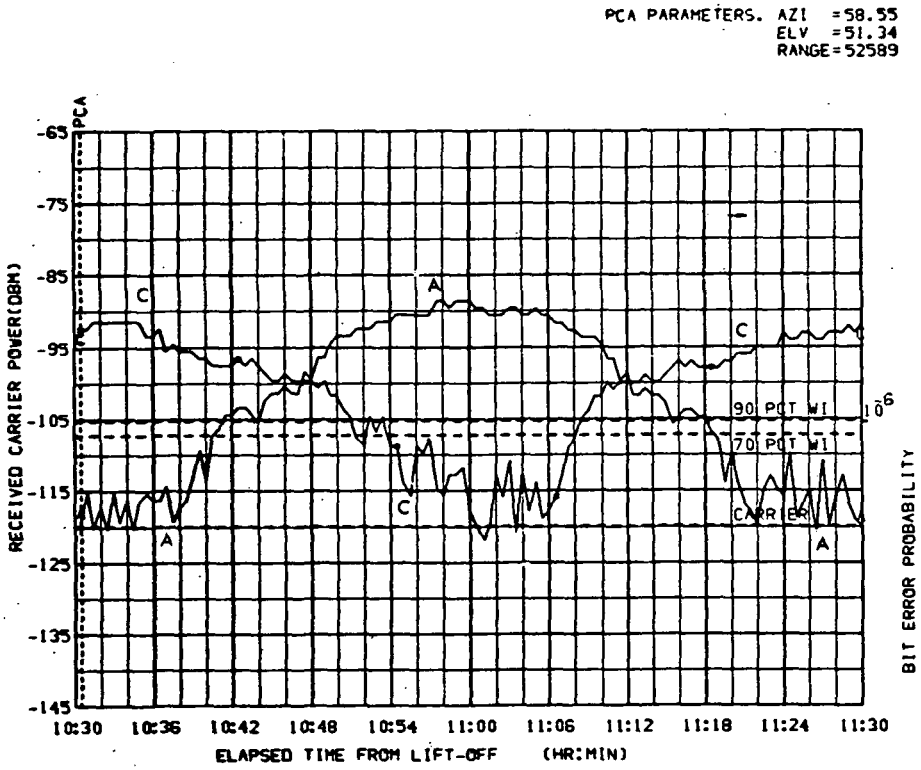

FIGURE 8-5a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

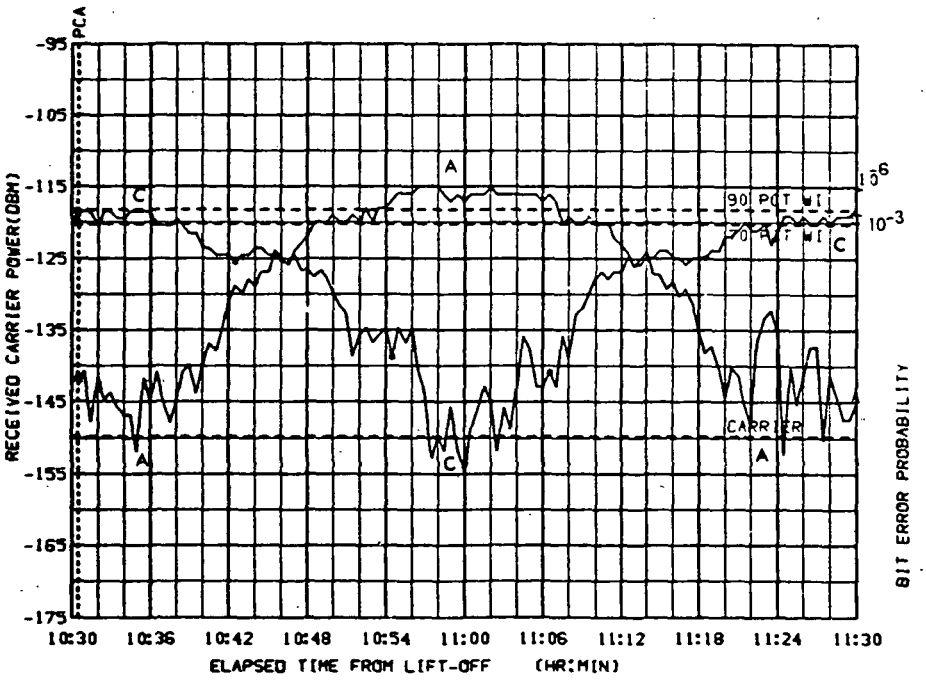

FIGURE 8-5b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

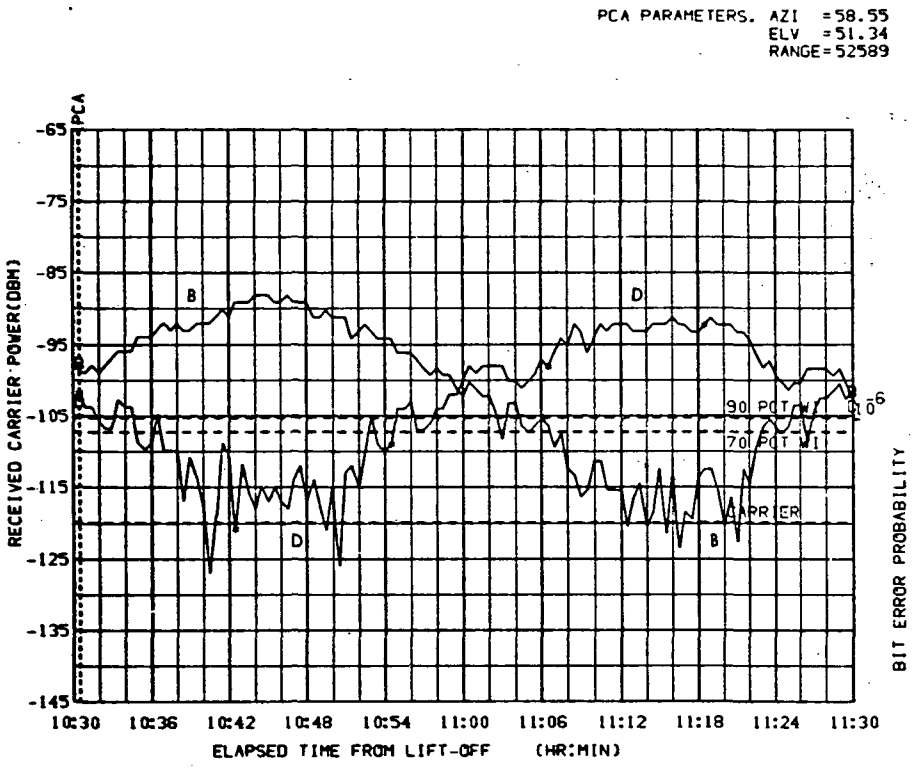

FIGURE 8-5c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

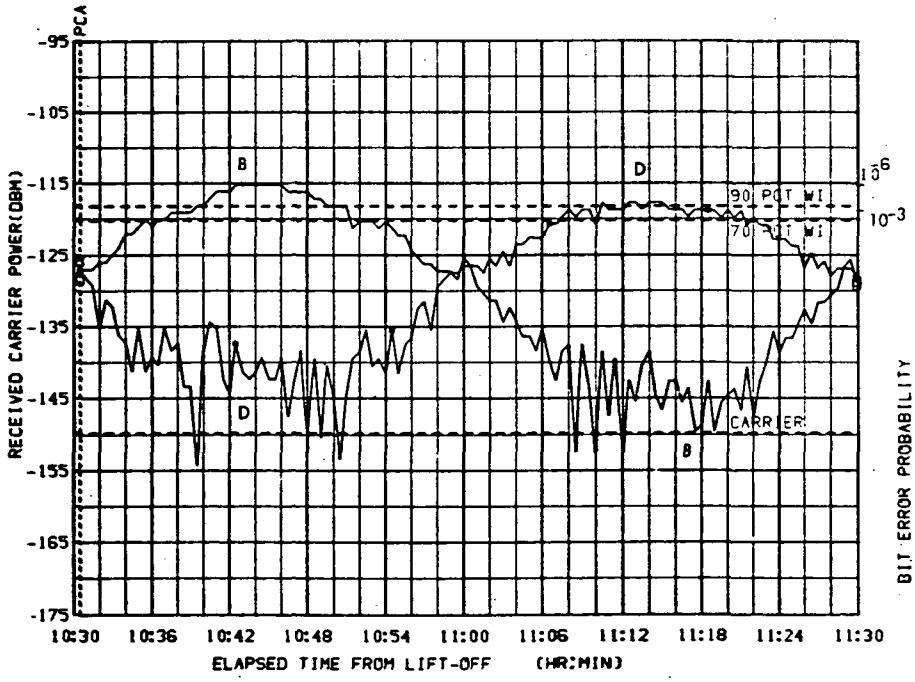

FIGURE 8-5d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

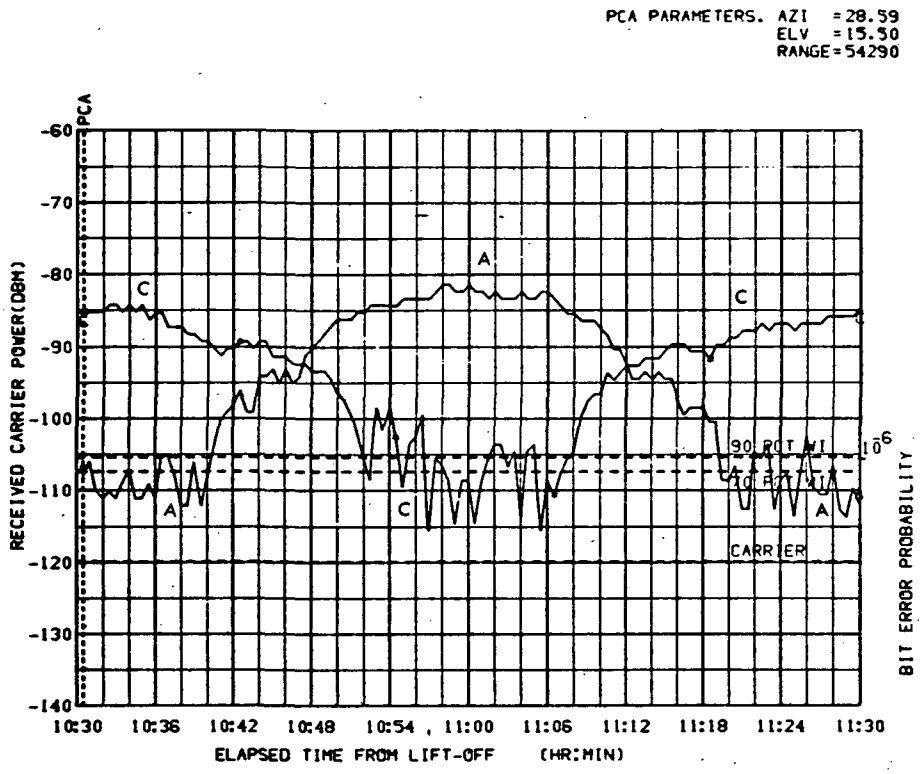

FIGURE 8-6a. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

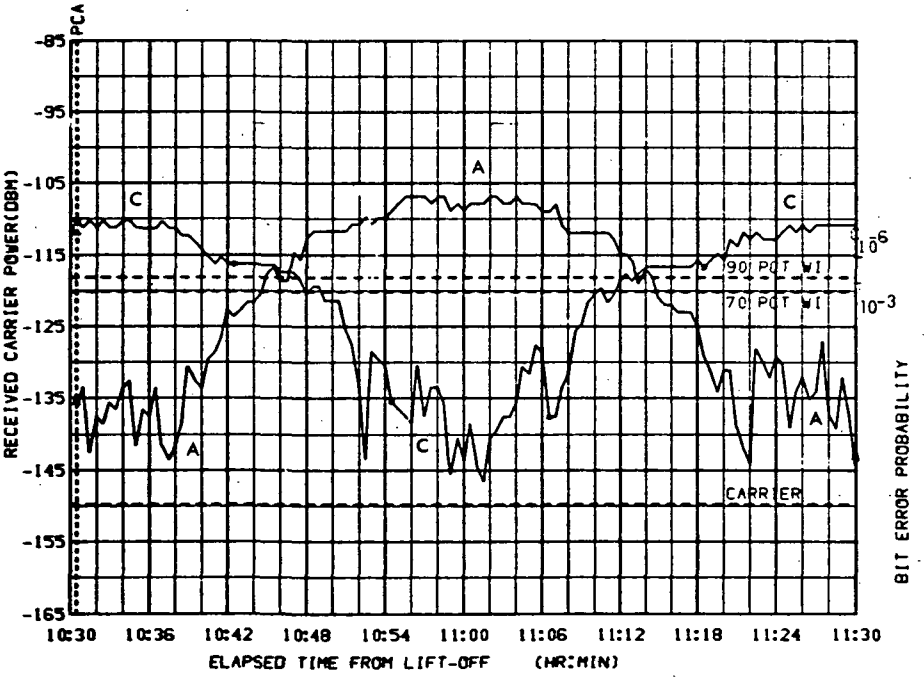

FIGURE 8-6b. HSK DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

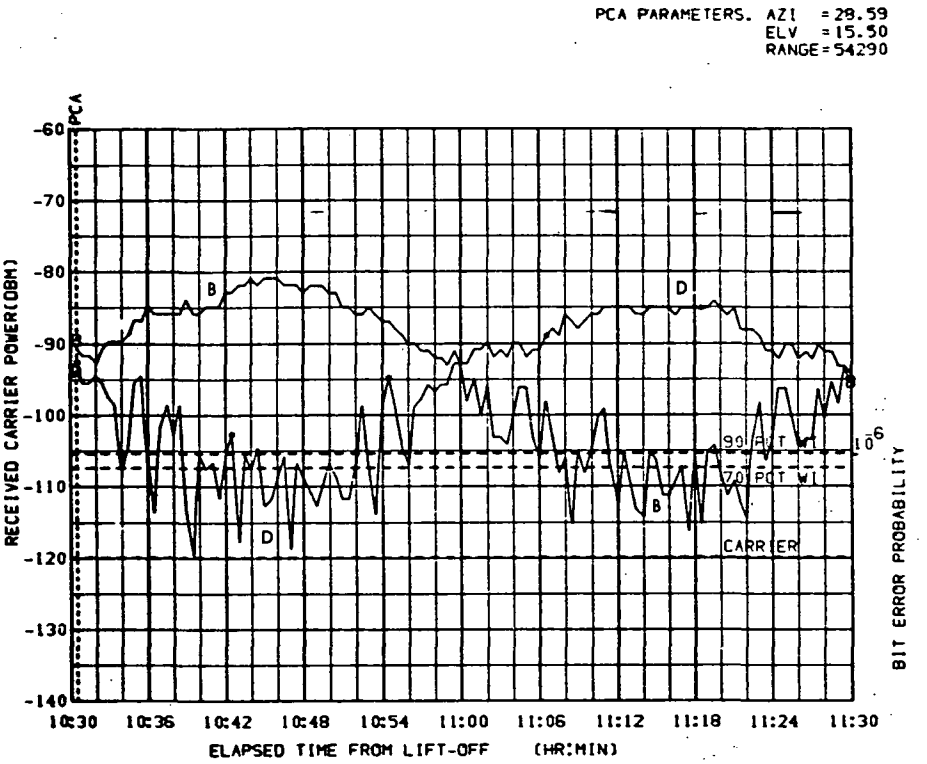

FIGURE 8-6c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

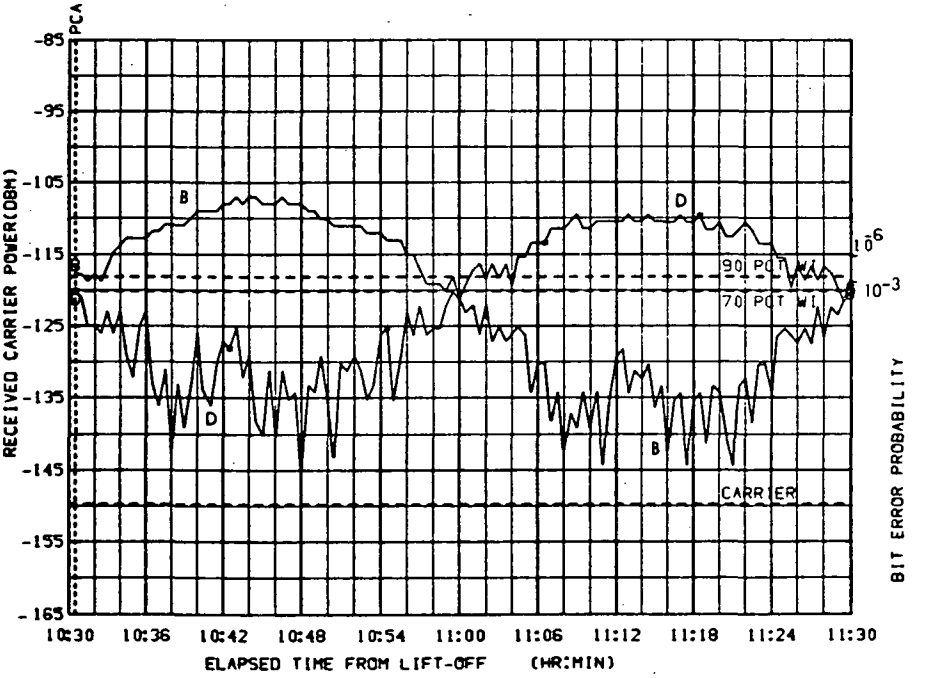

FIGURE 8-6d. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

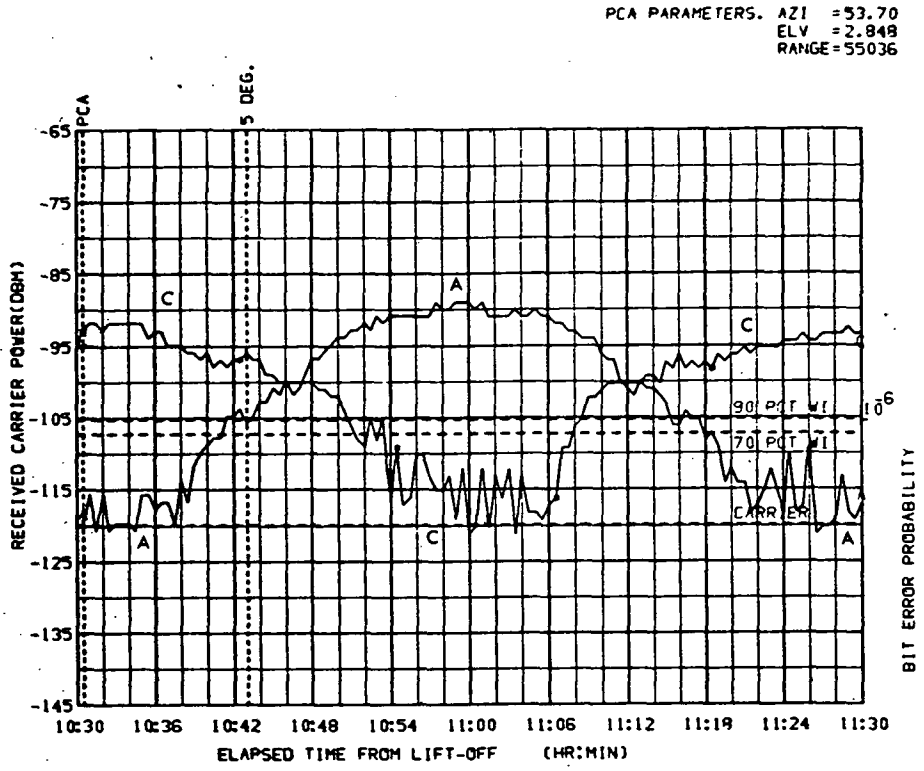

FIGURE 8-7a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

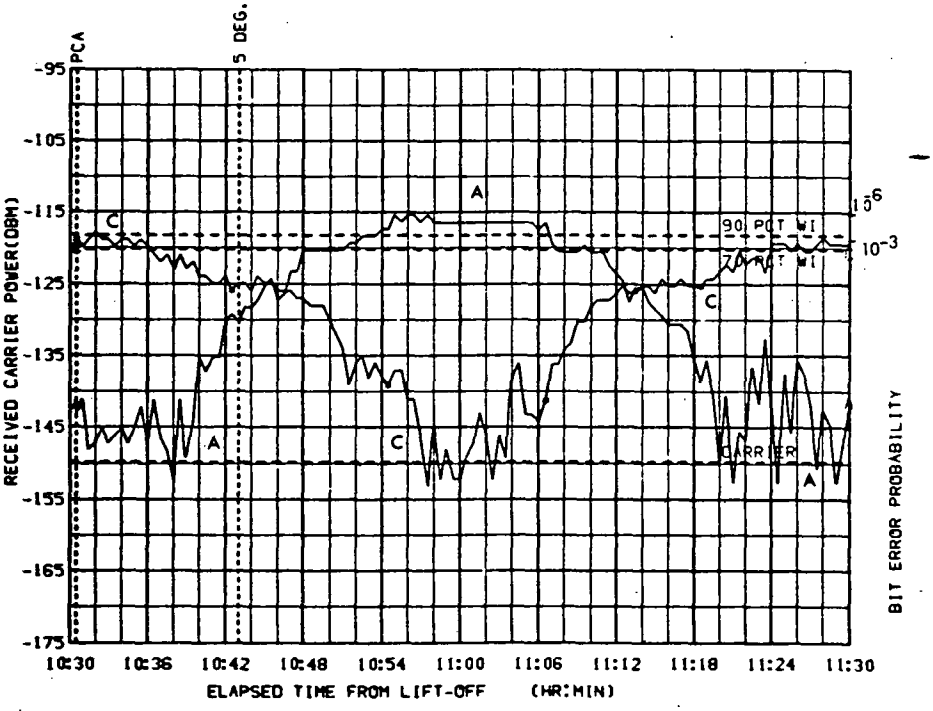

FIGURE 8-7b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

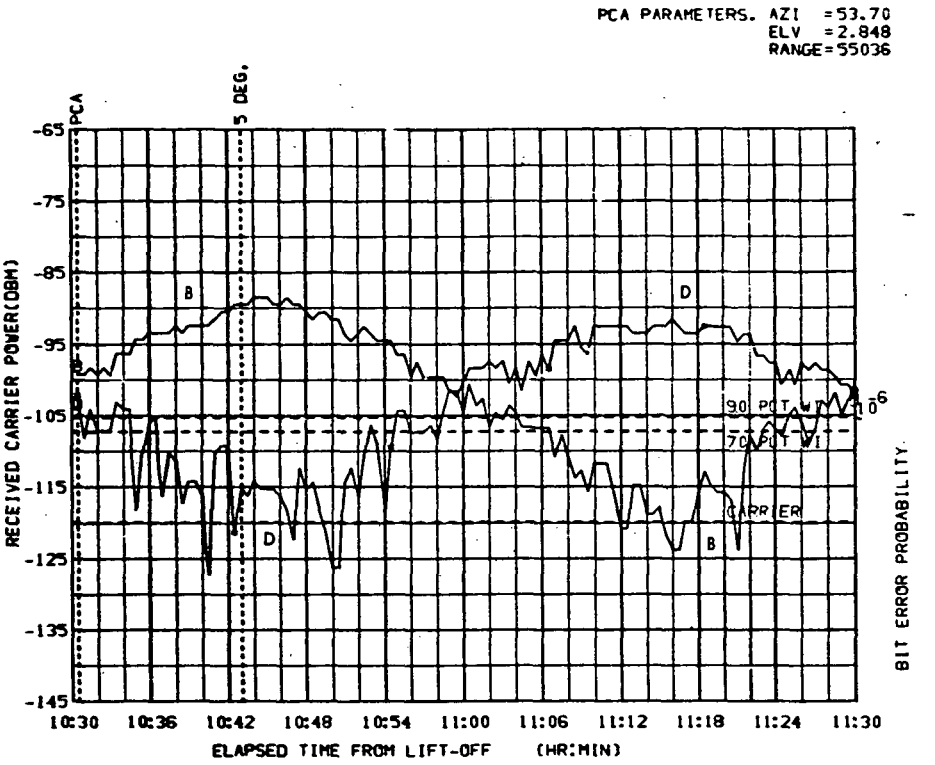

FIGURE 8-7c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

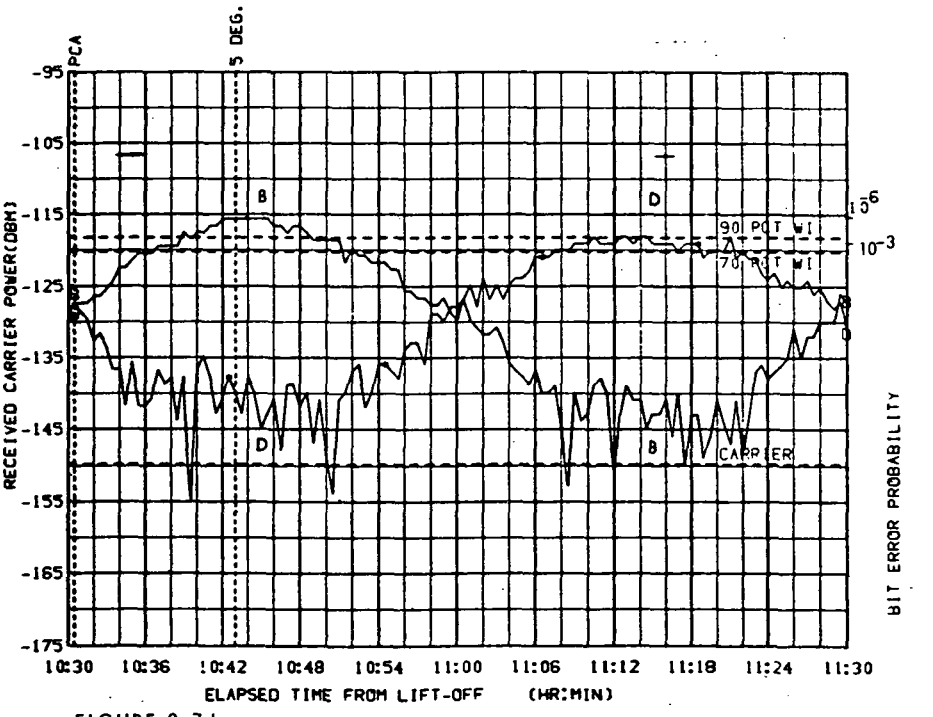

FIGURE 8-7d. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

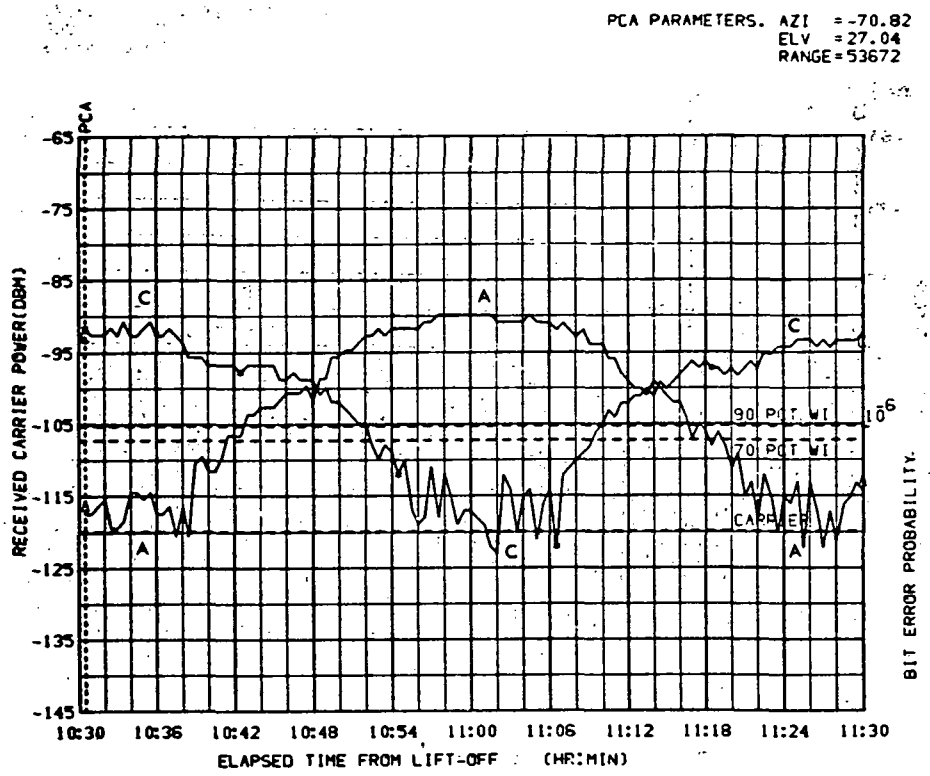

FIGURE 8-8a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

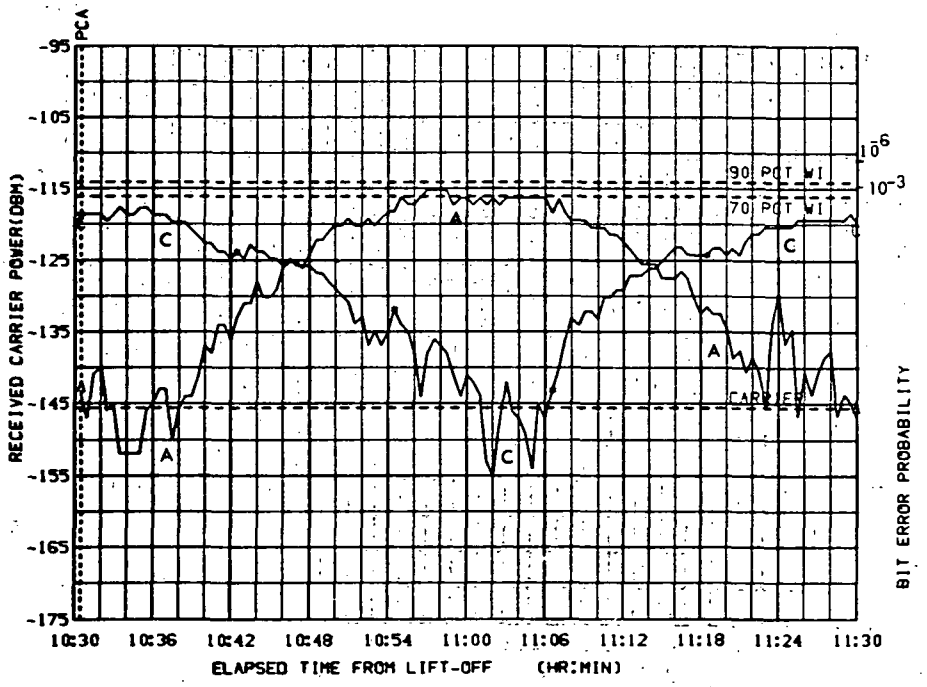

FIGURE 8-8b. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

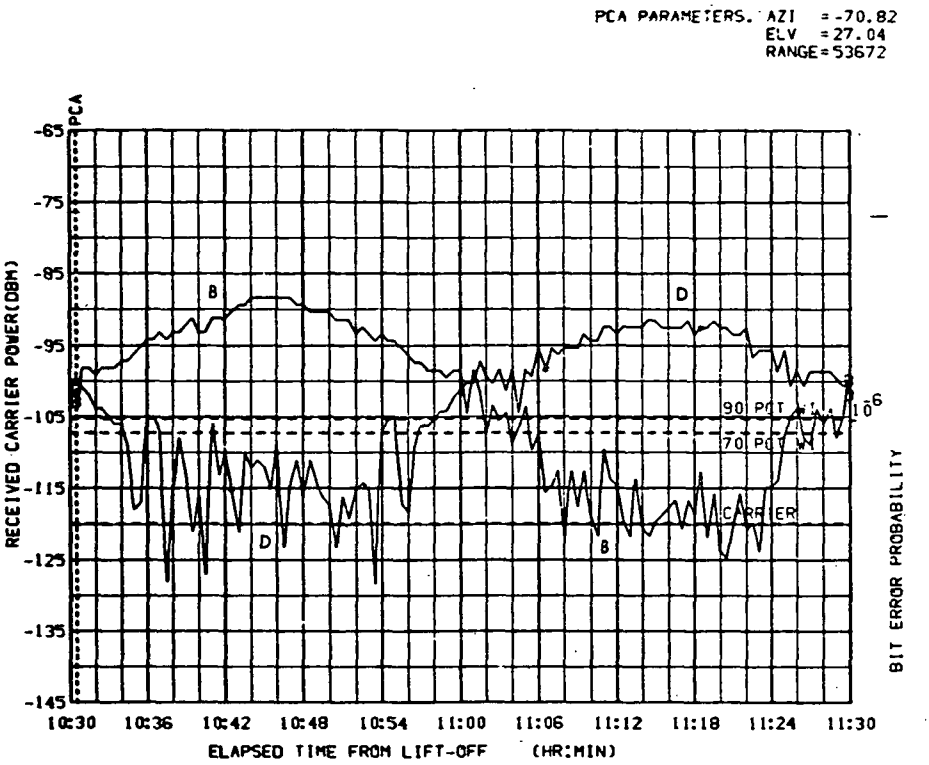

FIGURE 8-8c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

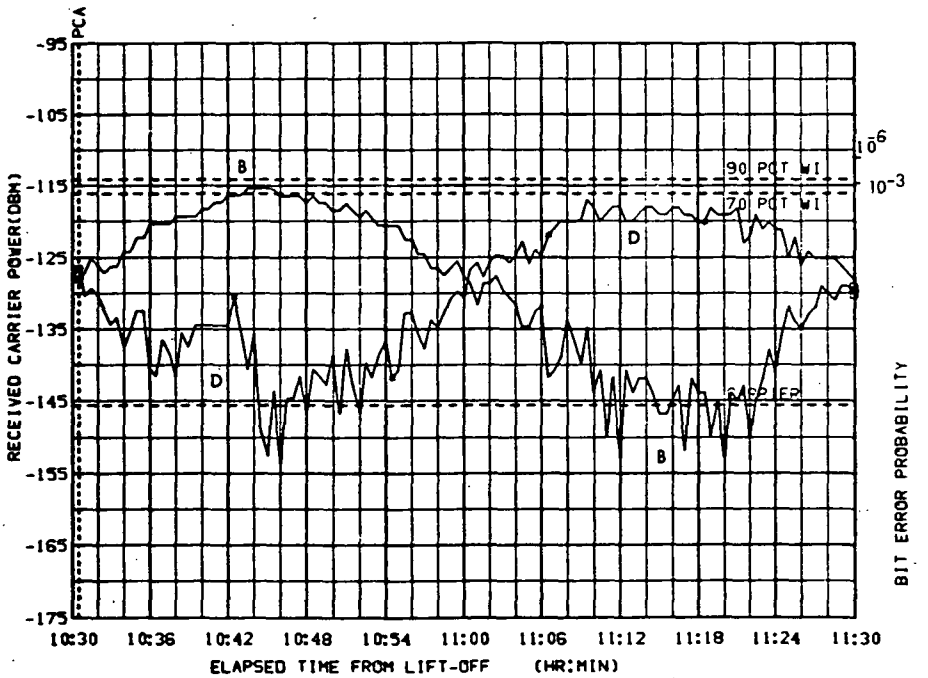

FIGURE 8-8d. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -70.82
ELV = 27.04
RANGE = 53672

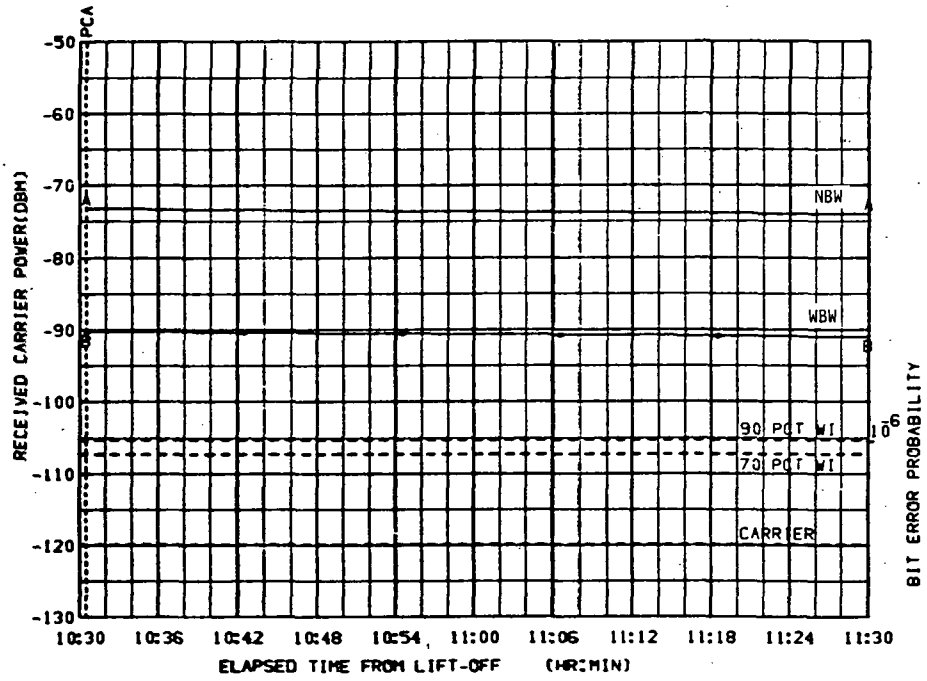

FIGURE 8-8e. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

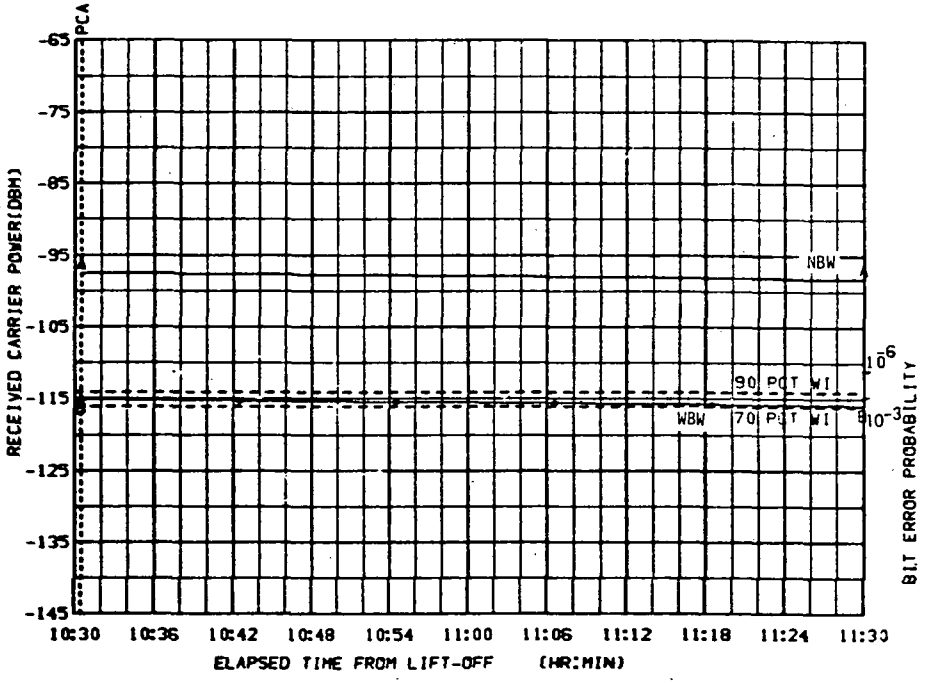

FIGURE 8-8f. GYM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

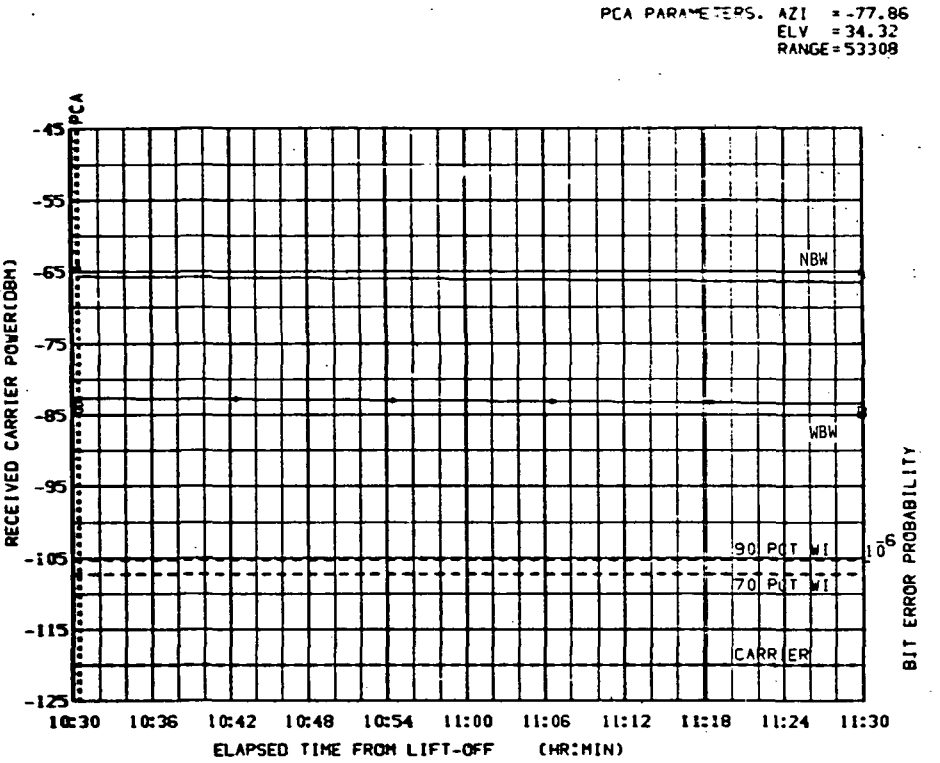

FIGURE 8-9a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

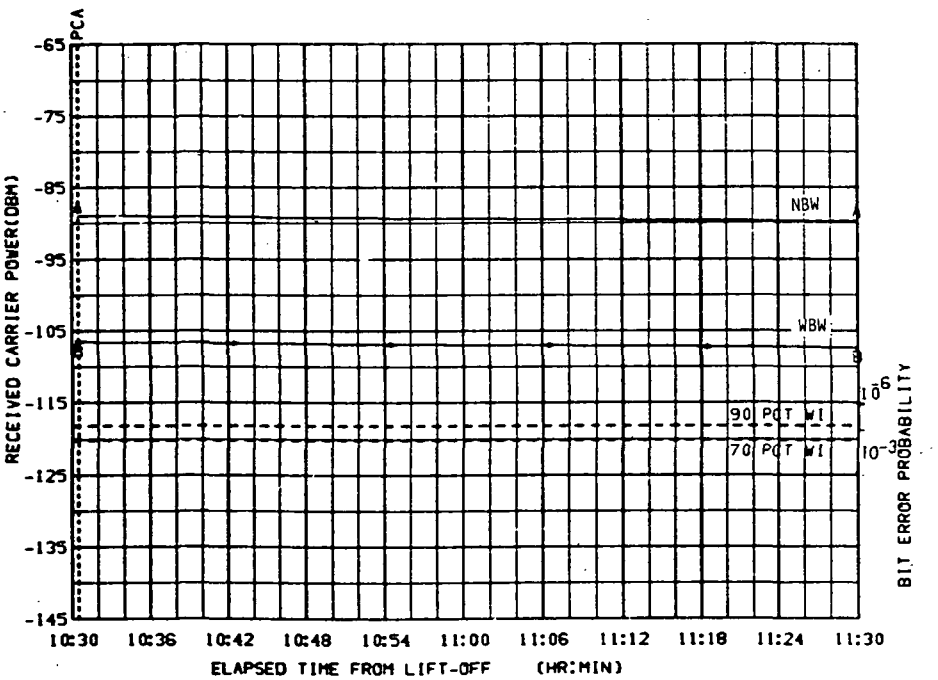

FIGURE 8-9b. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

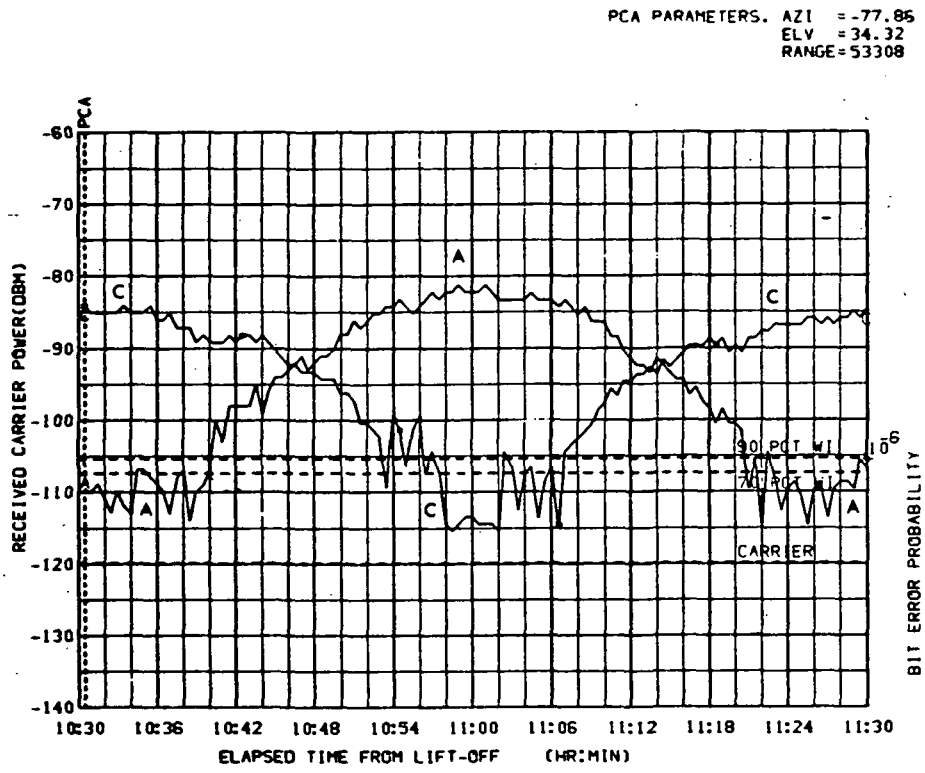

FIGURE 8-9c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

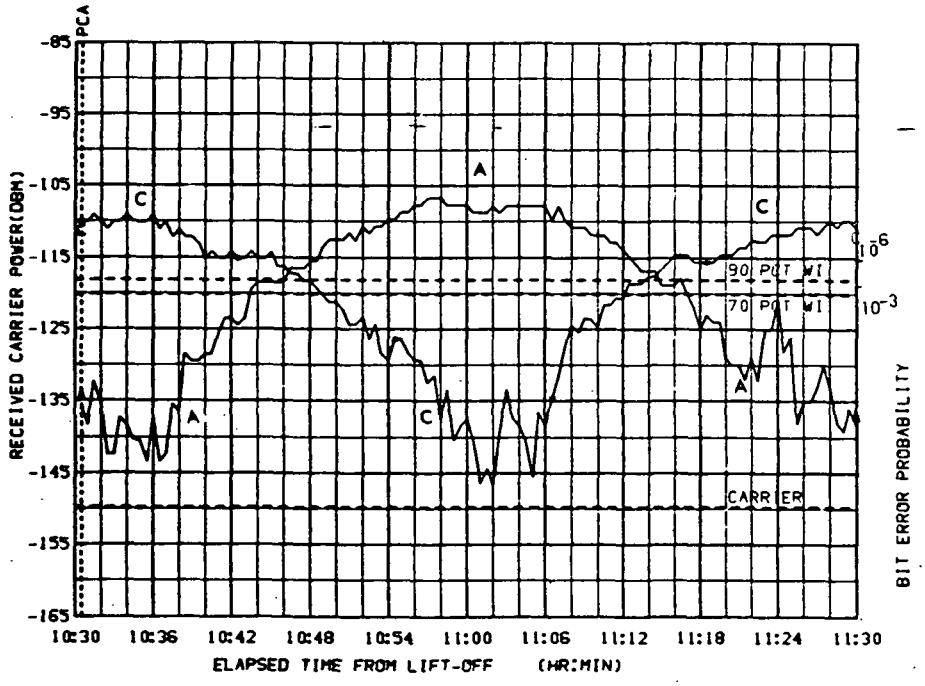

FIGURE 8-9d. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

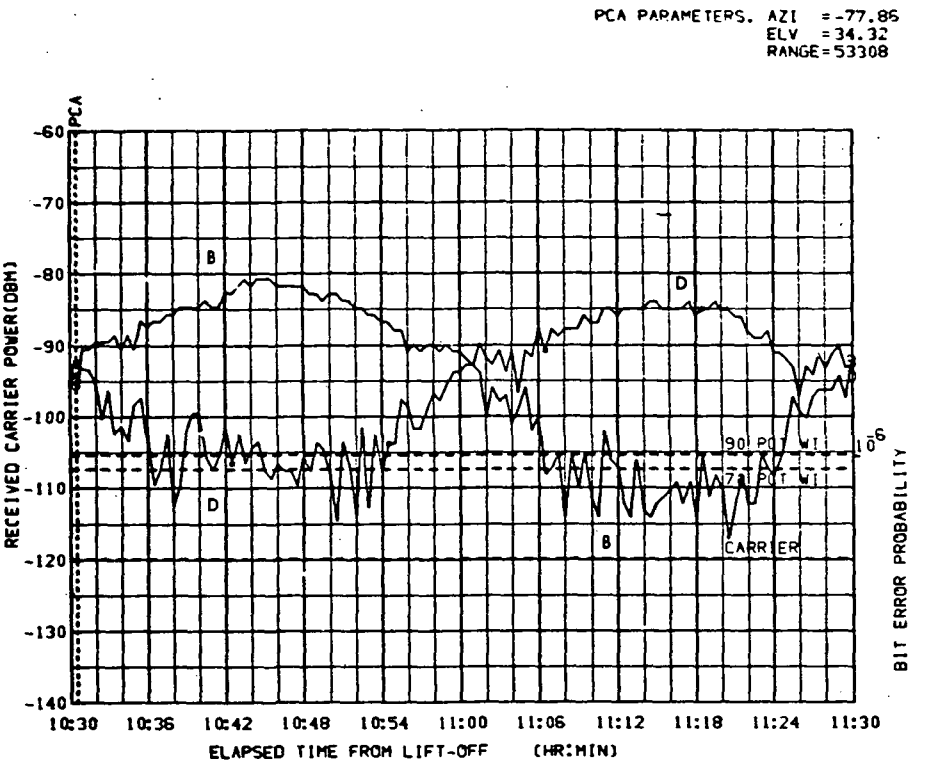

FIGURE 8-9e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

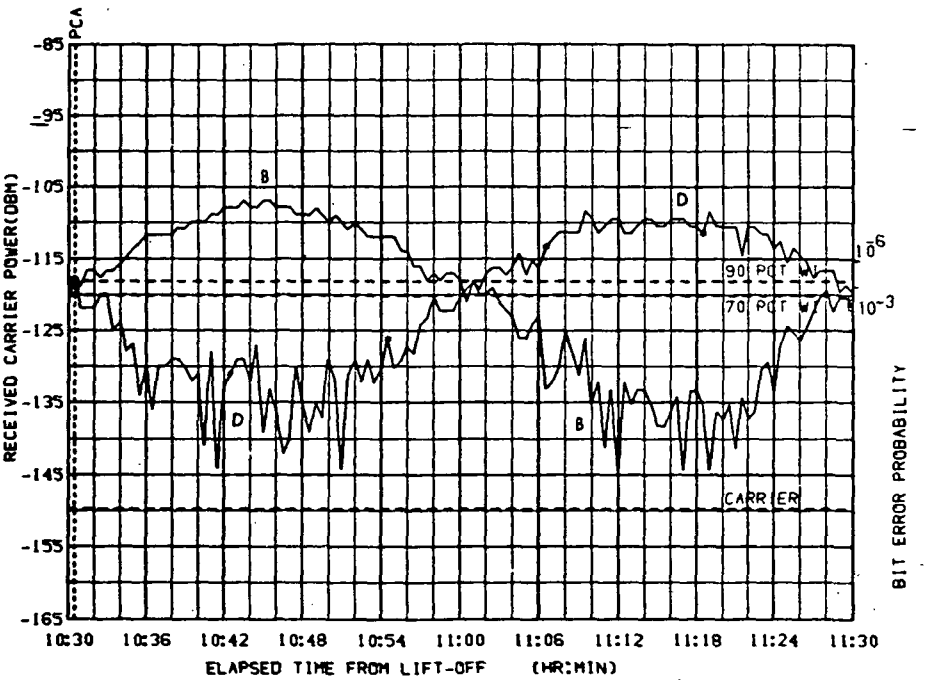

FIGURE 8-9f. GDS ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

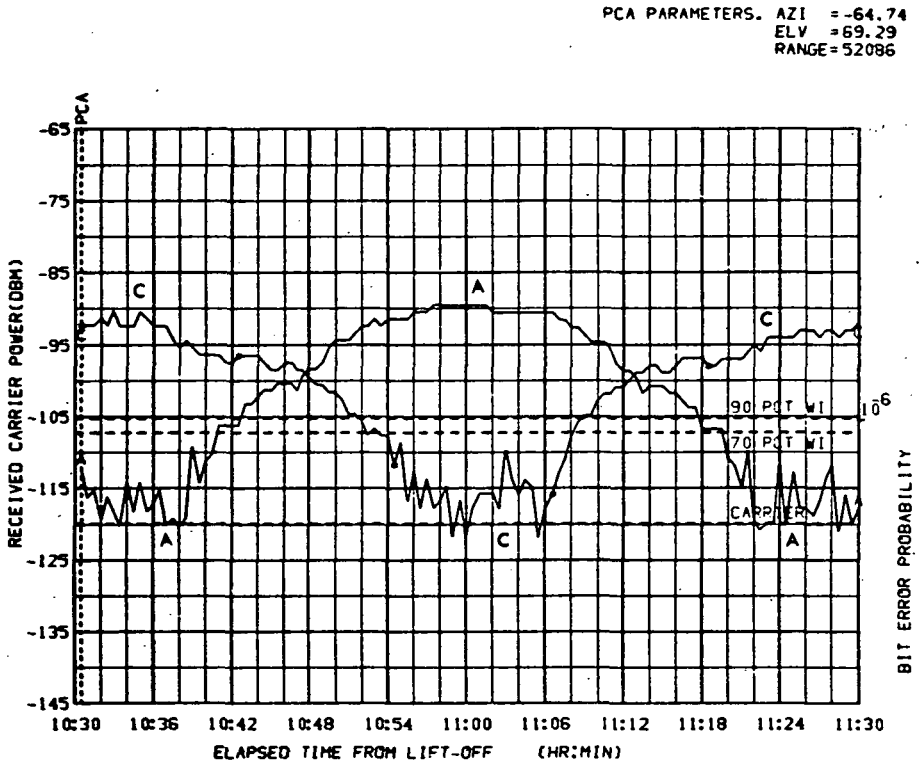

FIGURE 8-10a. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

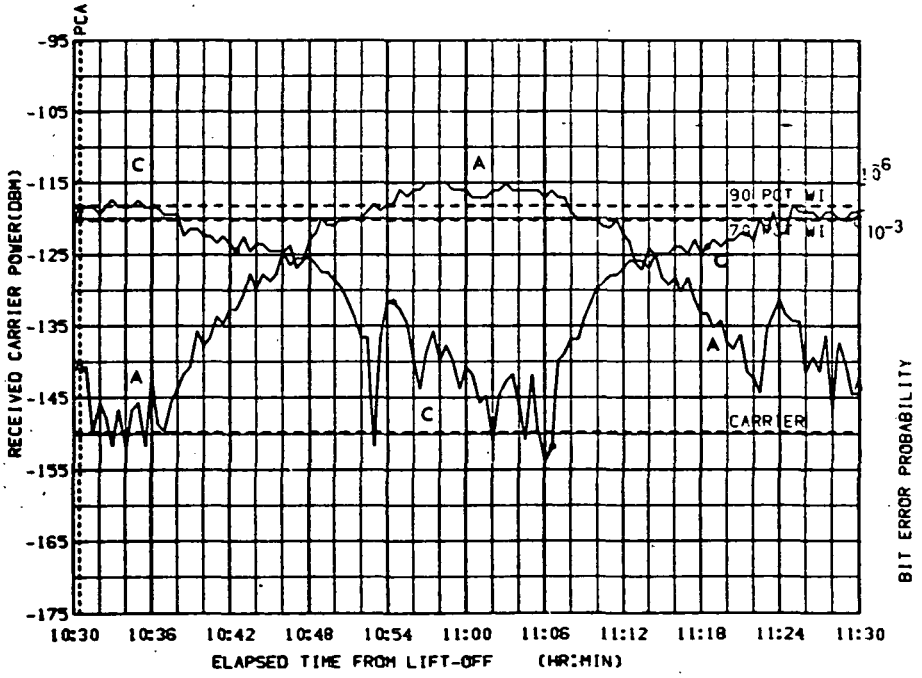

FIGURE 8-10b. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

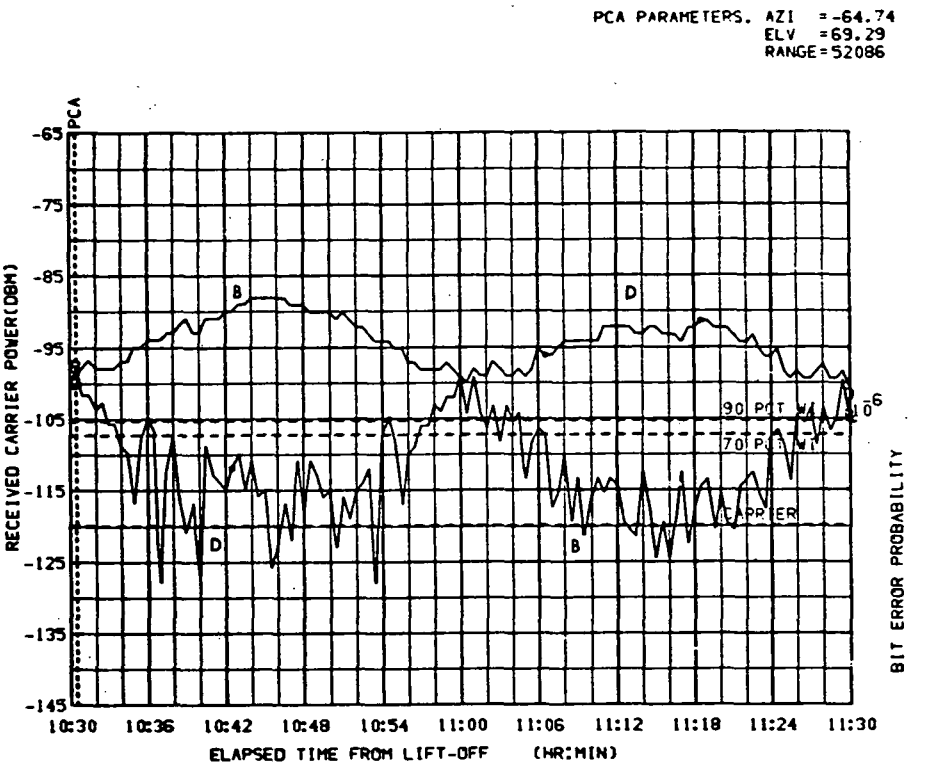

FIGURE 8-10c. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

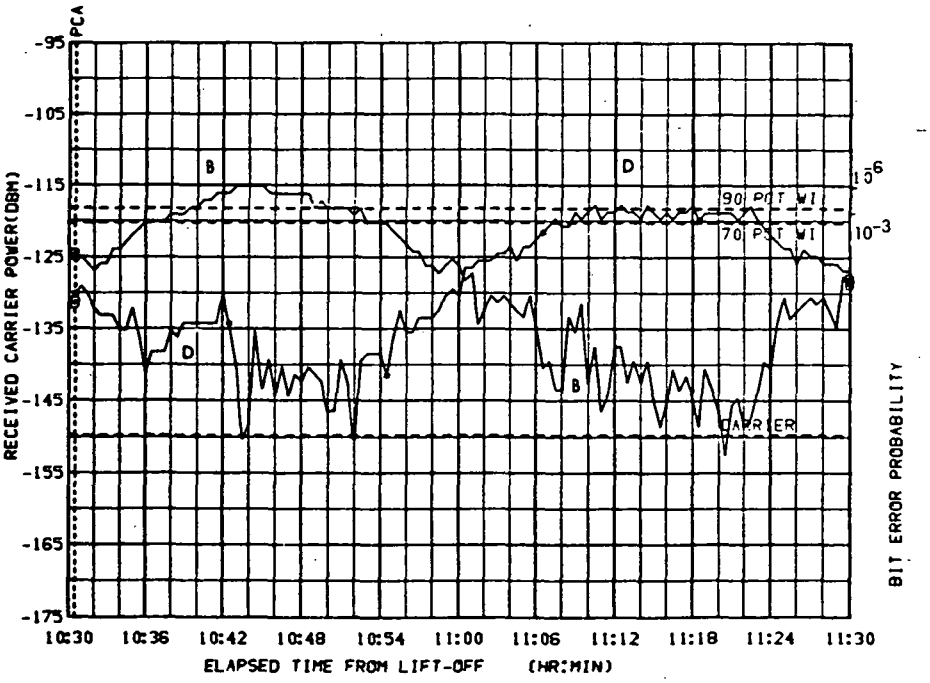

FIGURE 8-10d. HAW ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

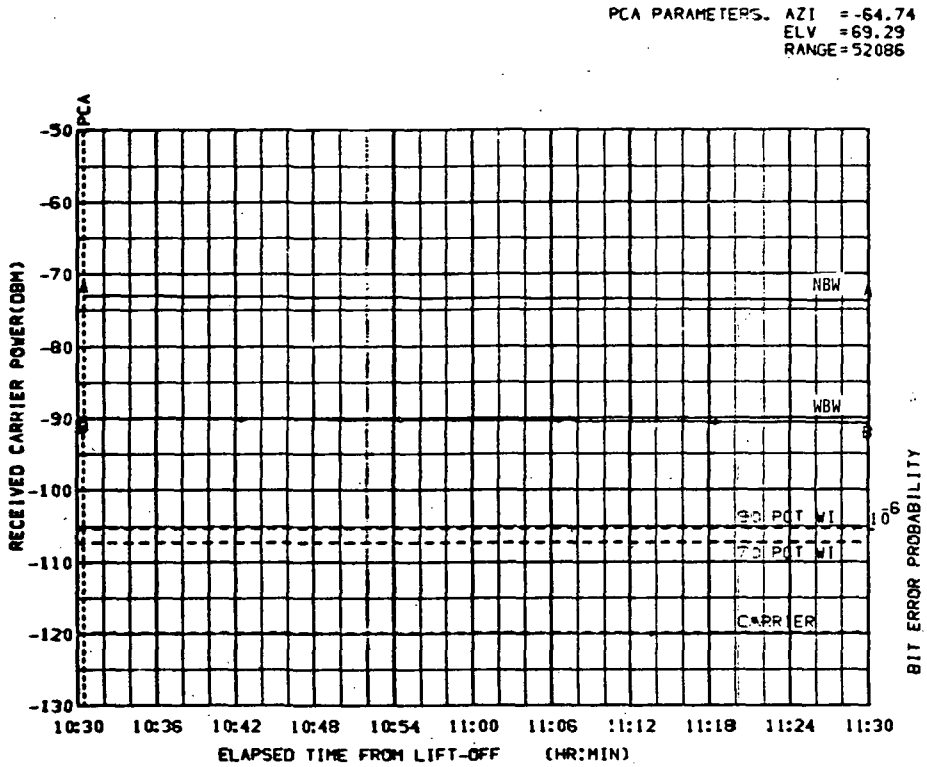

FIGURE 8-10e. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

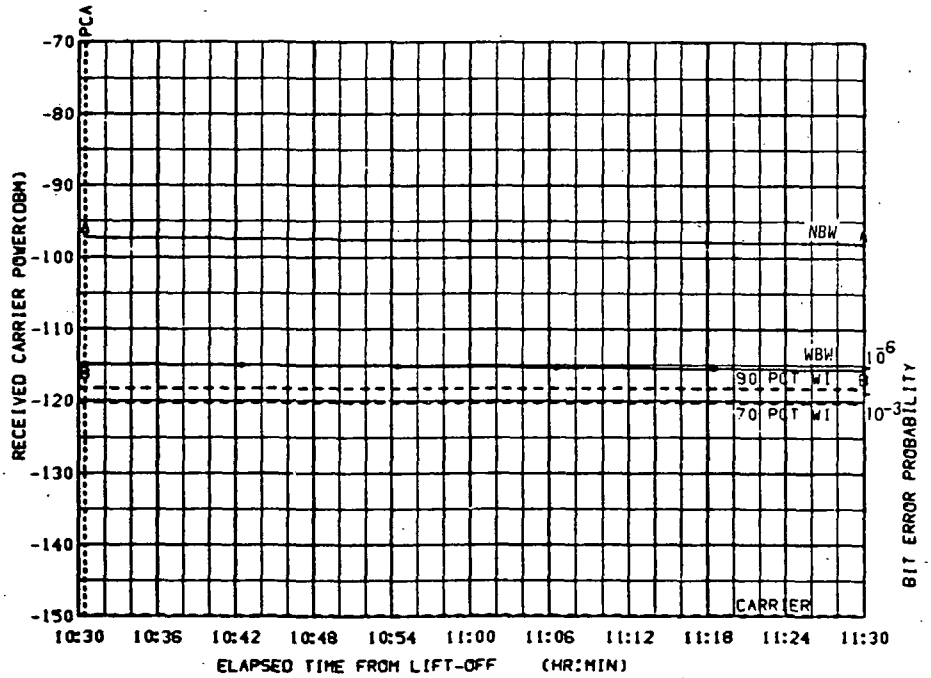

FIGURE 8-10f. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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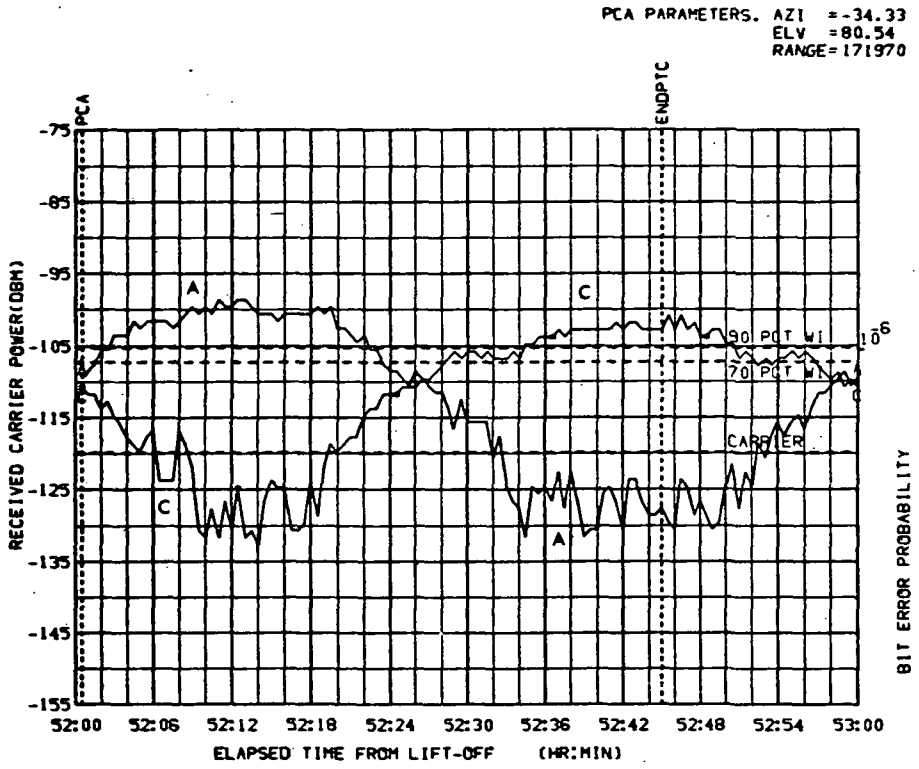


FIGURE 8-11a. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

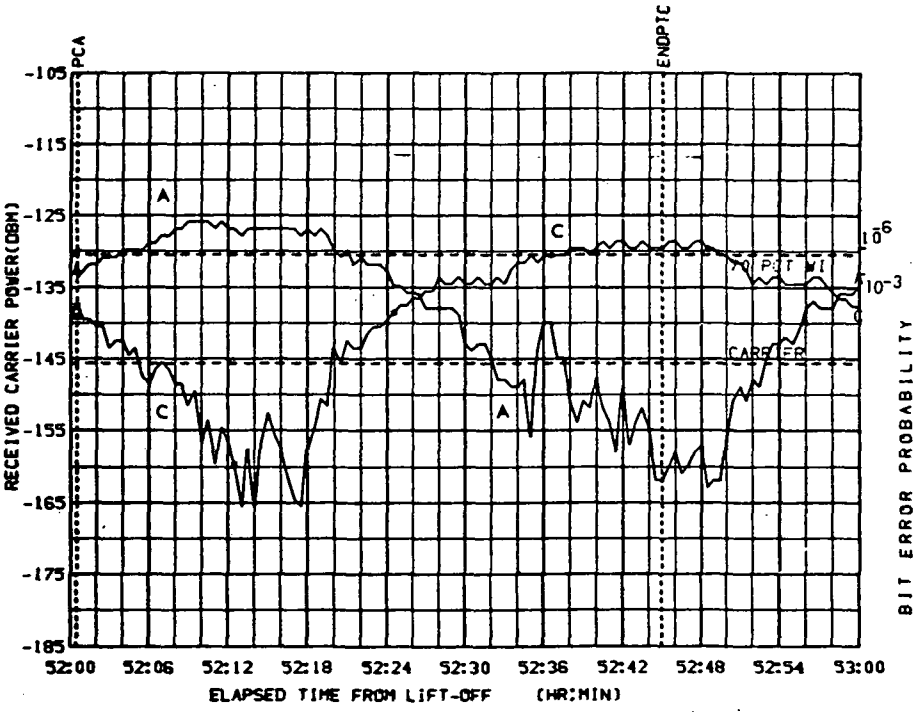


FIGURE 8-11b. ANG DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

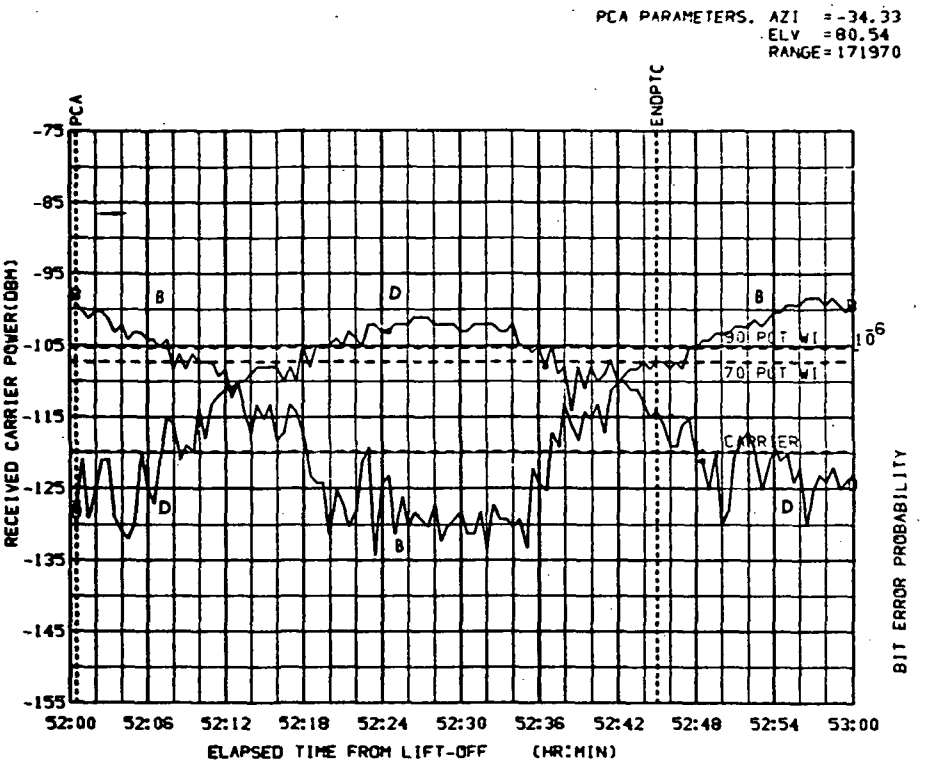


FIGURE 8-11c. ANG UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

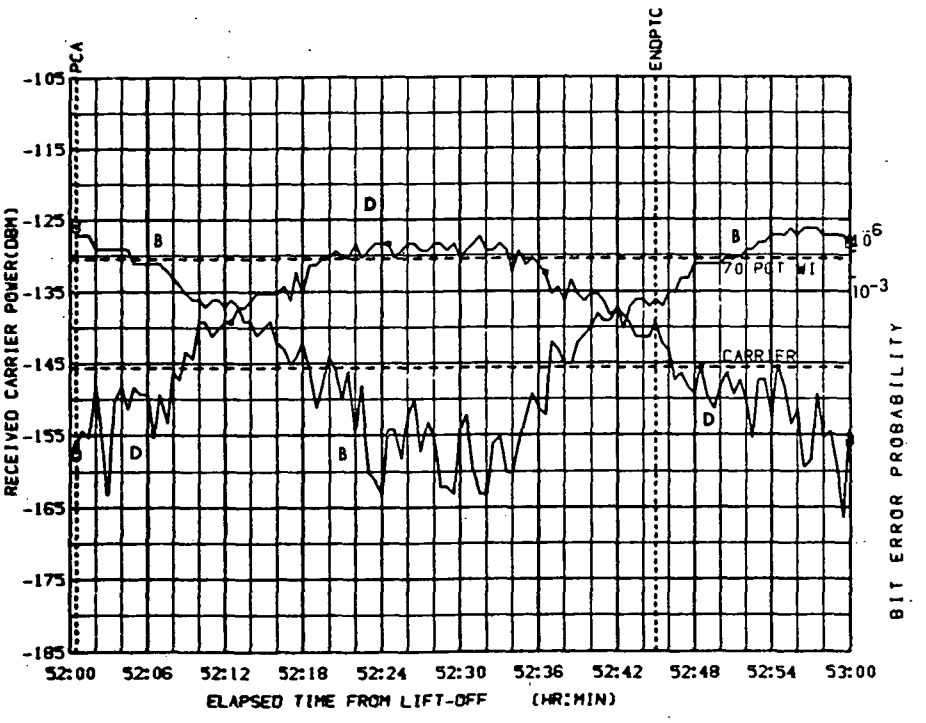


FIGURE 8-11d. ANG DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

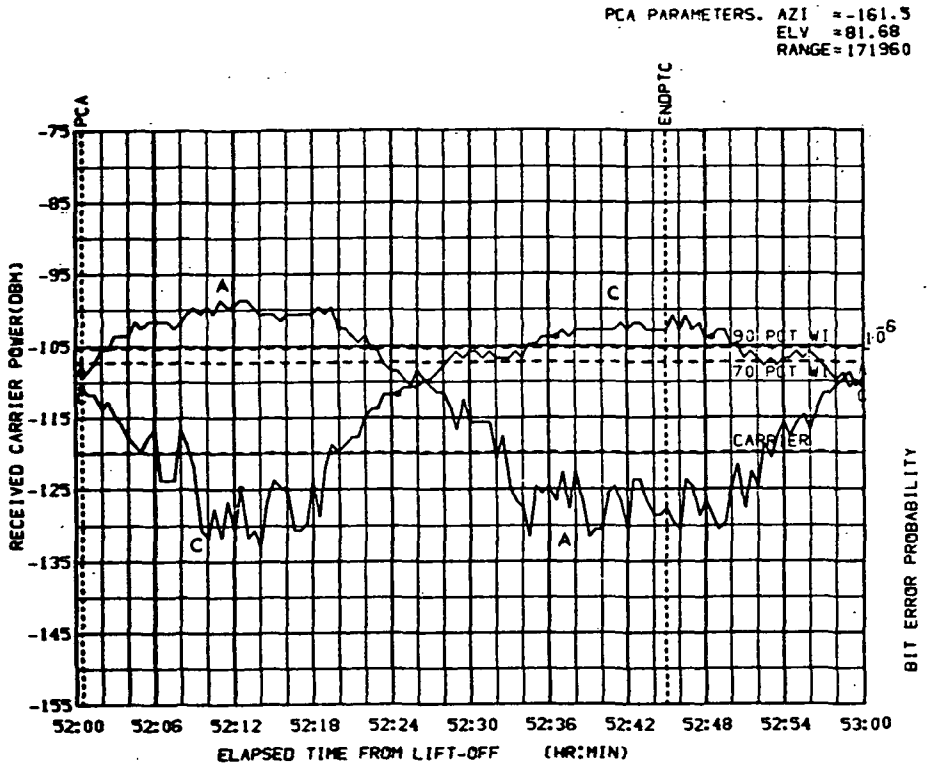


FIGURE 8-12a. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

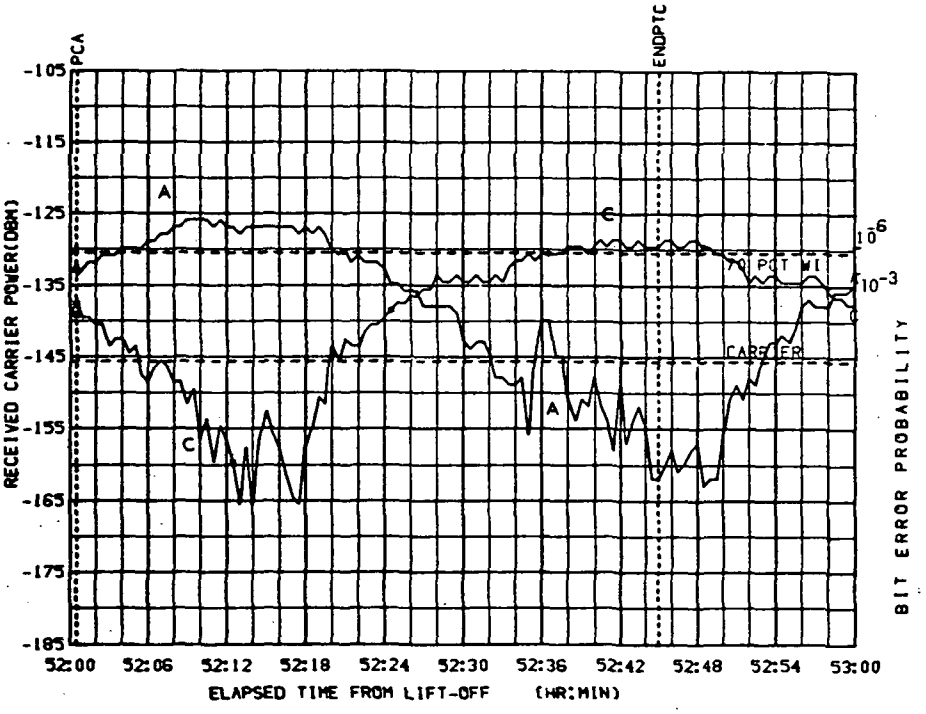


FIGURE 8-12b. BDA DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

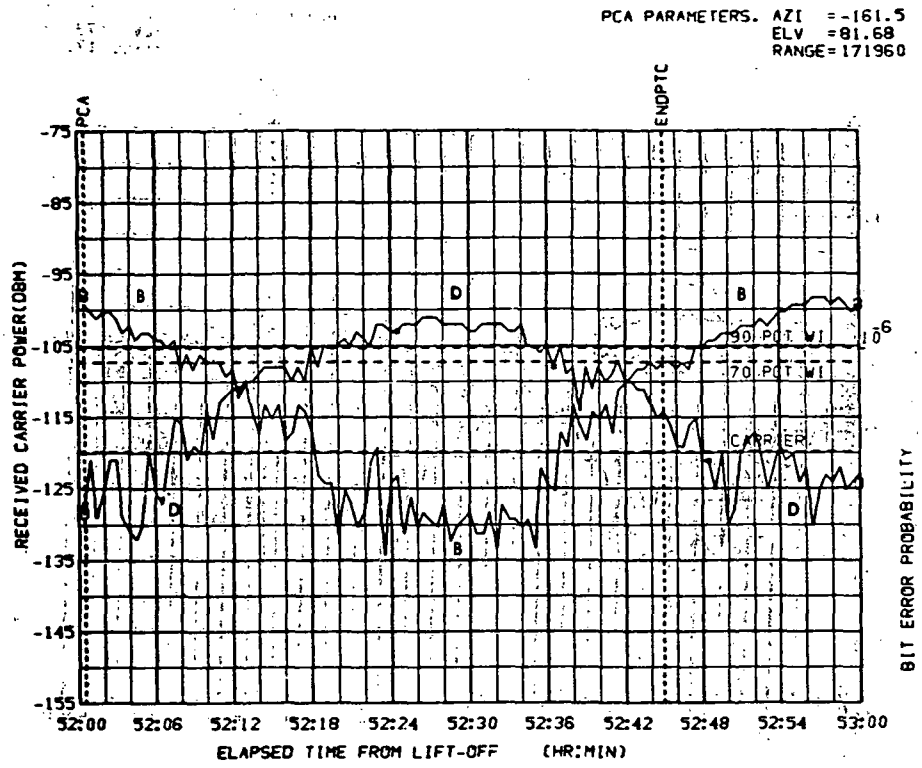


FIGURE 8-12c. BDA UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

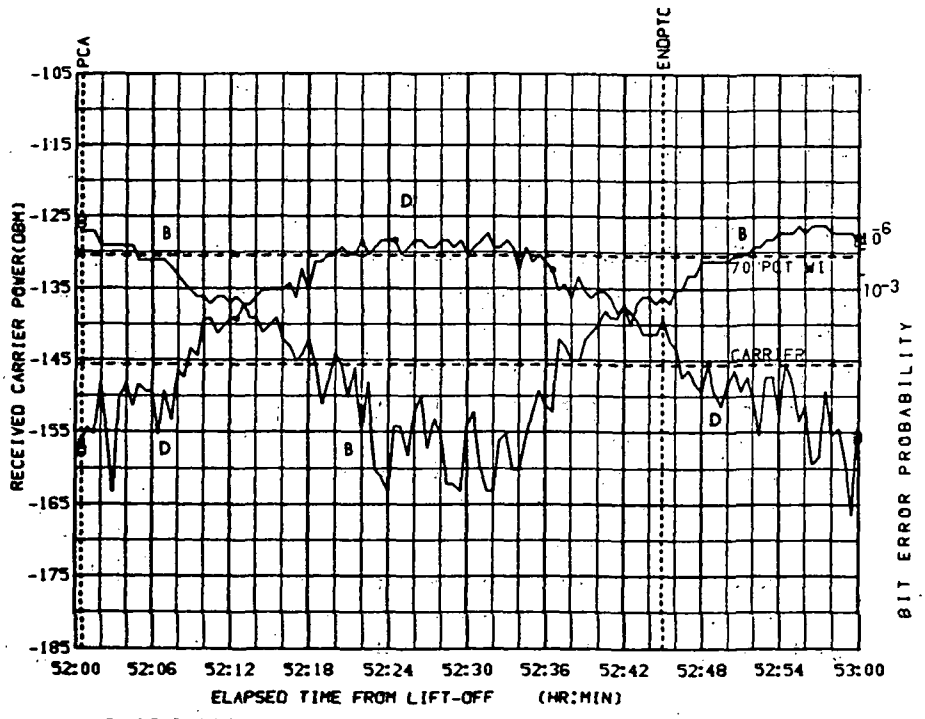


FIGURE 8-12d. BDA DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

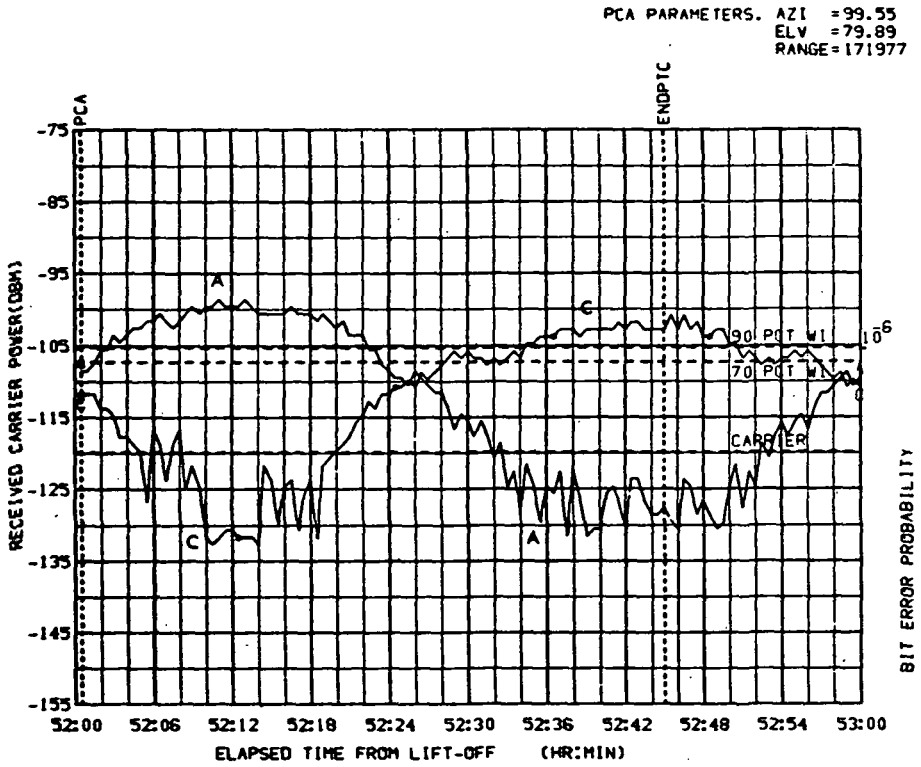


FIGURE 8-13a. 68M UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

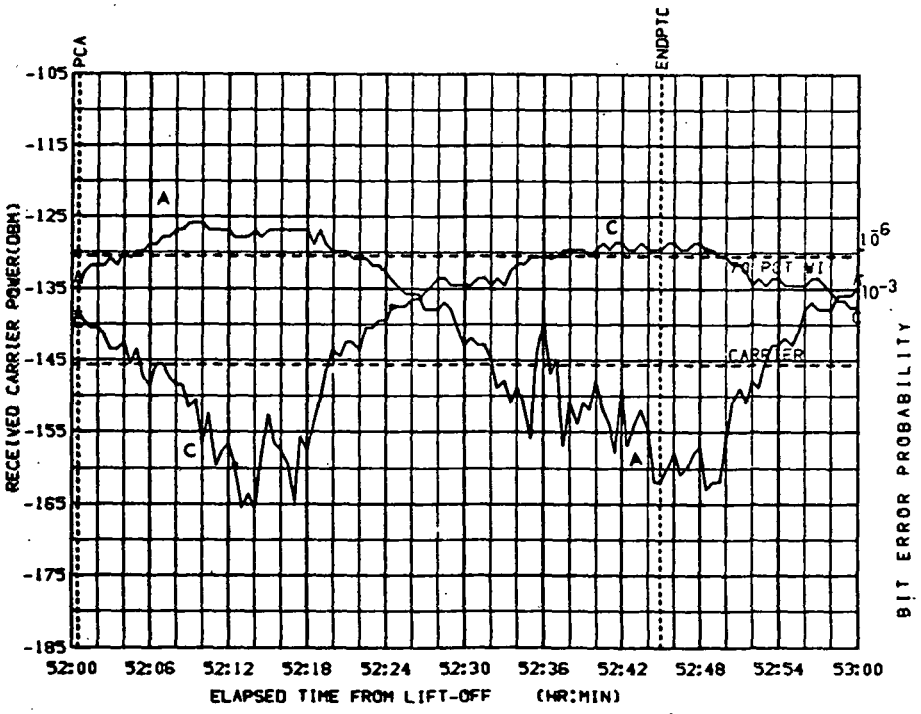


FIGURE 8-13b. 68M DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

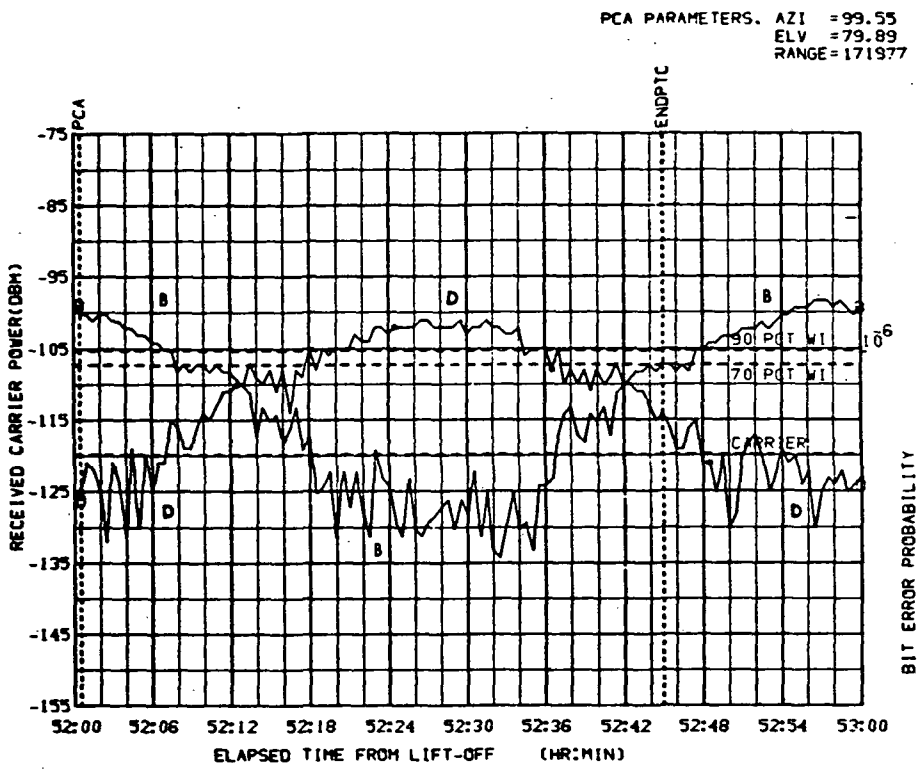


FIGURE 8-13c. GBM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

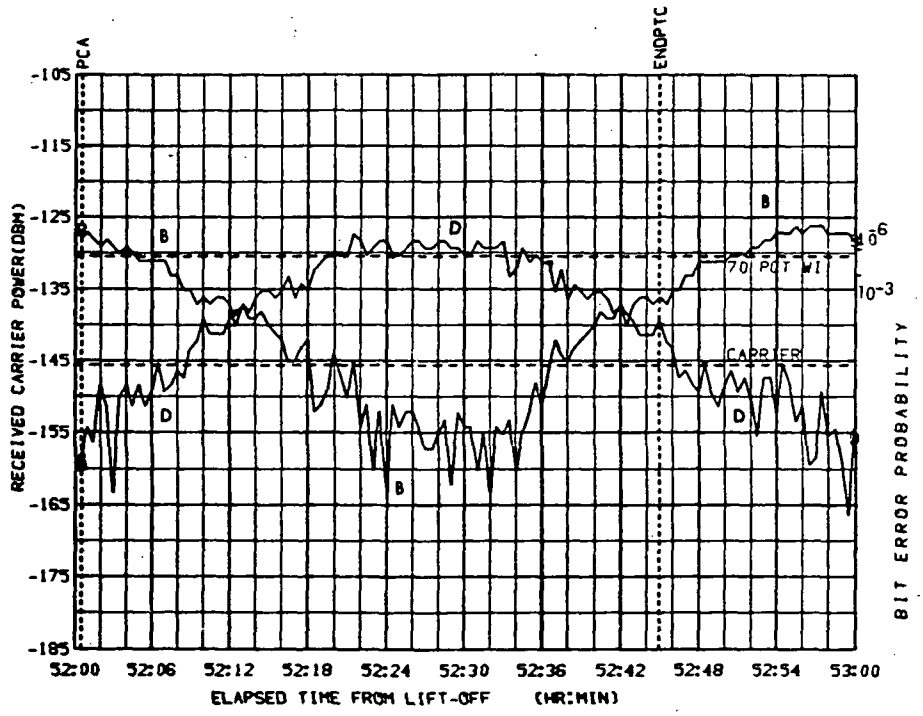


FIGURE 8-13d GBM DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

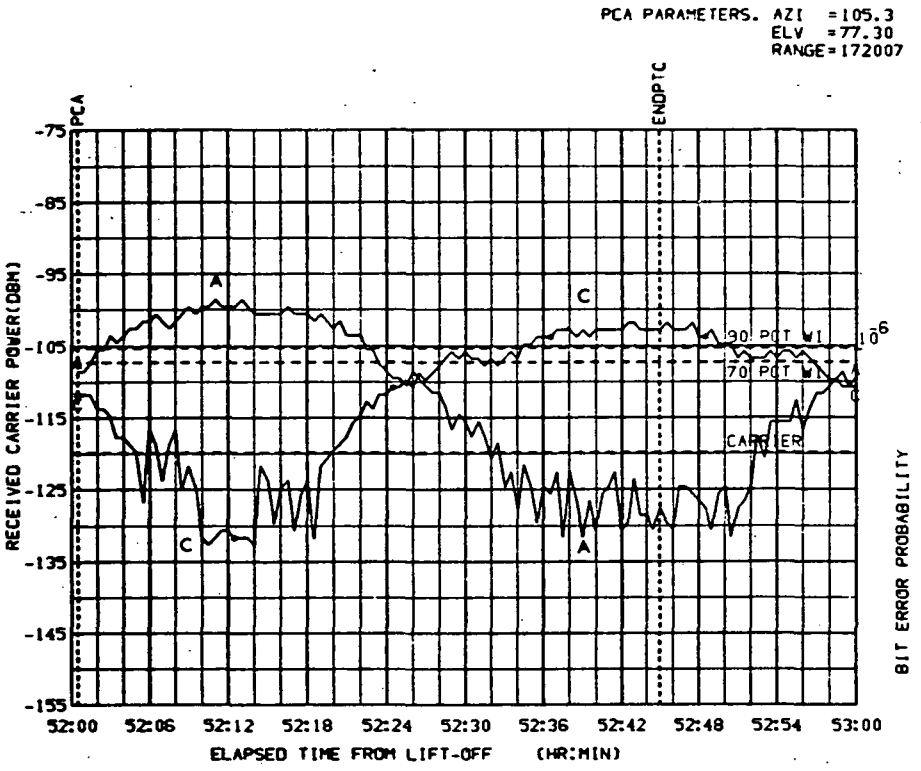


FIGURE 8-14a. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

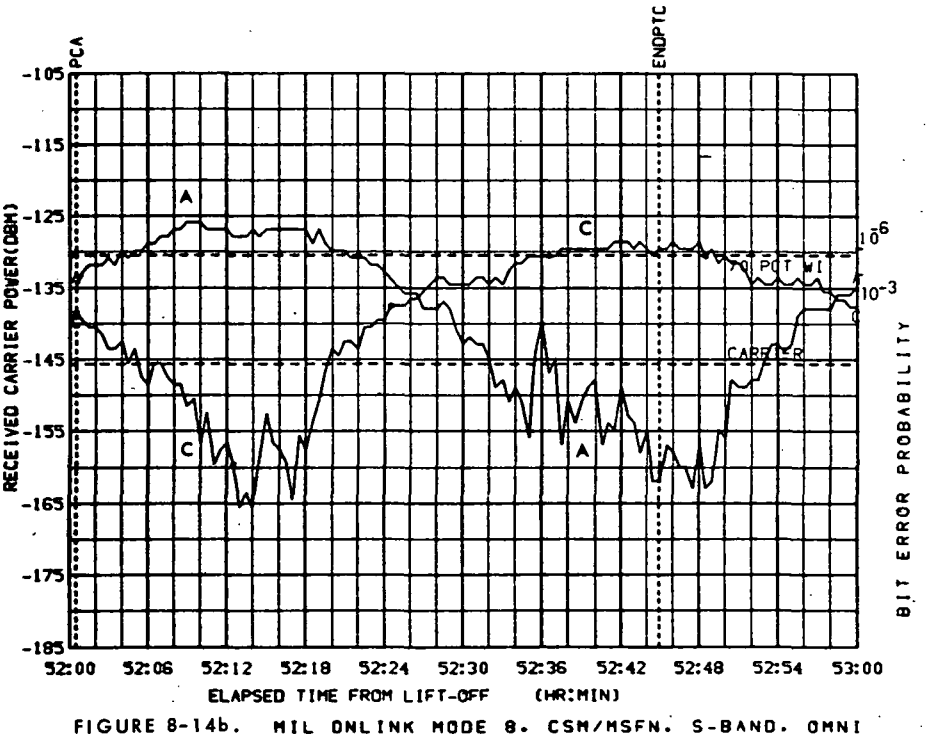


FIGURE 8-14b. MIL ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

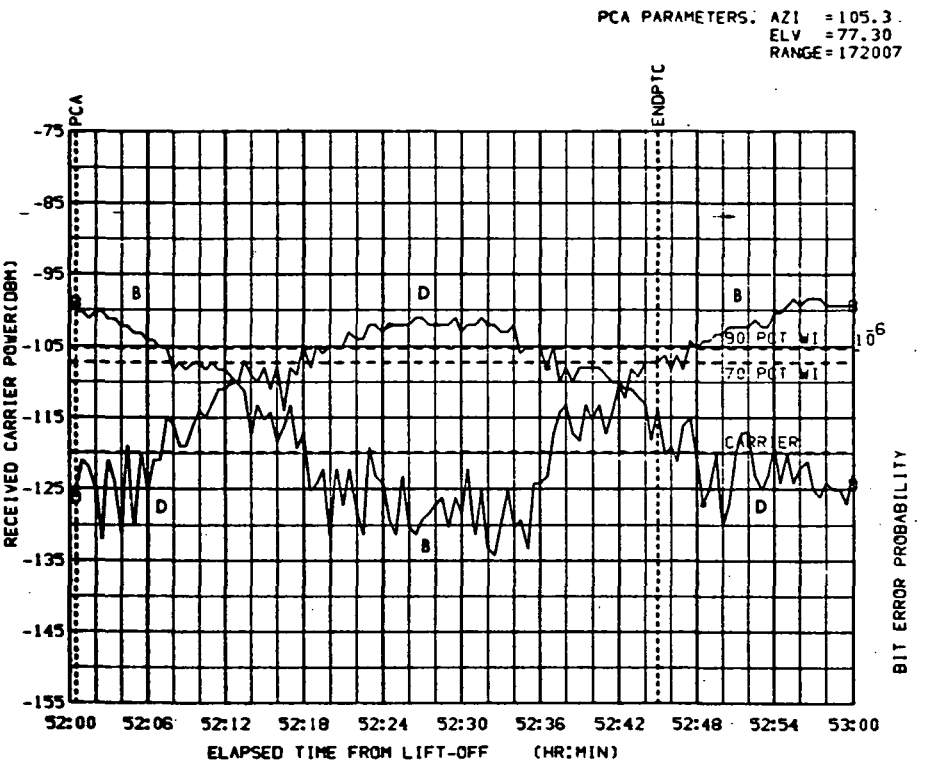


FIGURE 8-14c. MIL UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

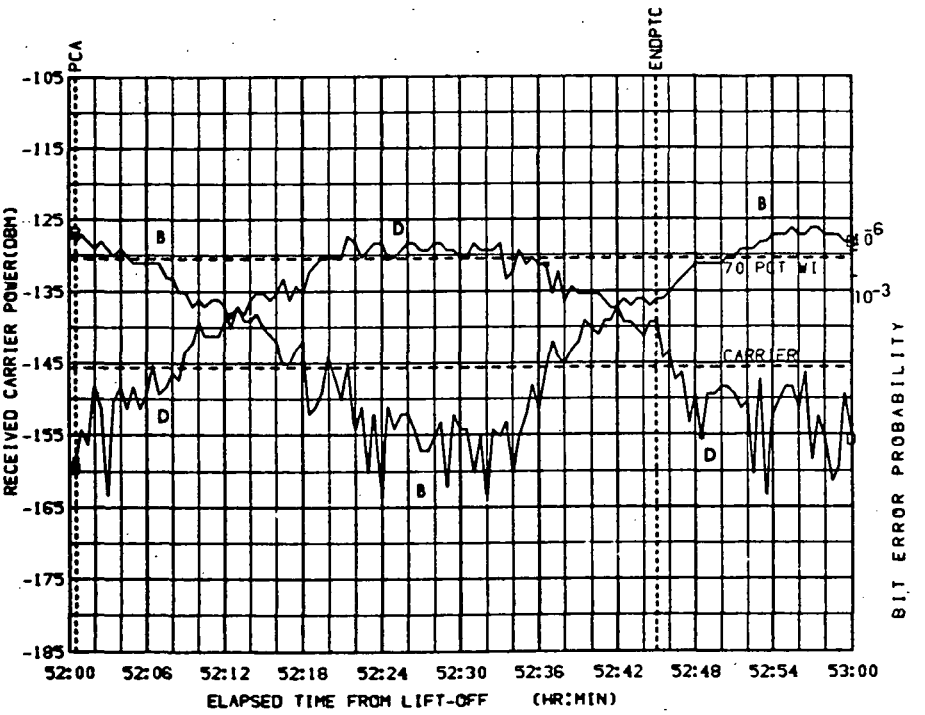


FIGURE 8-14d. MIL ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

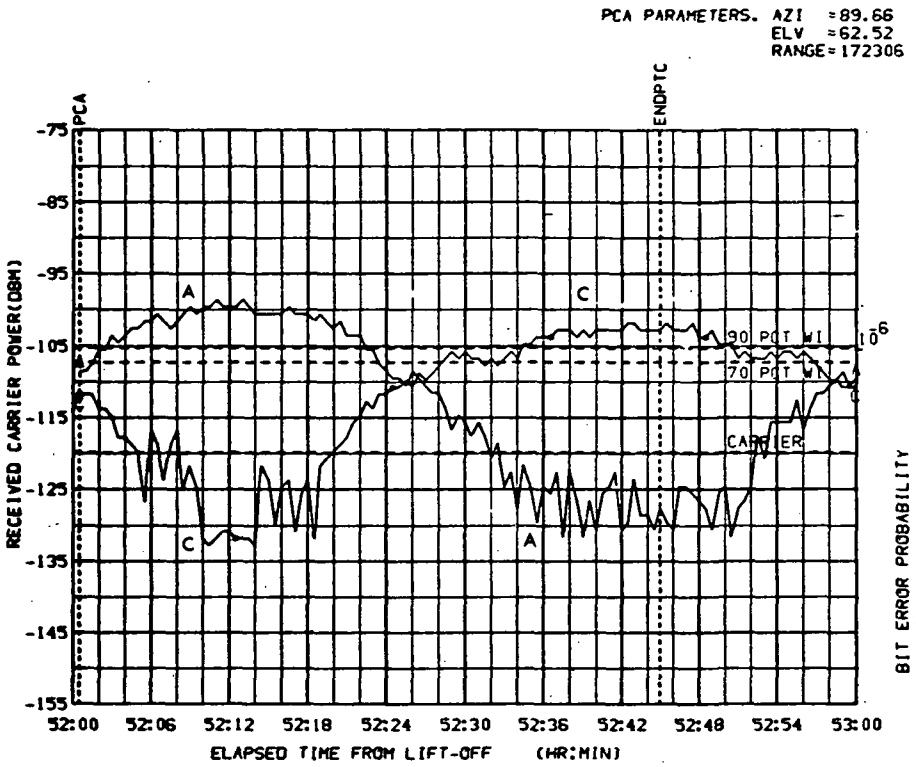


FIGURE 8-15a. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

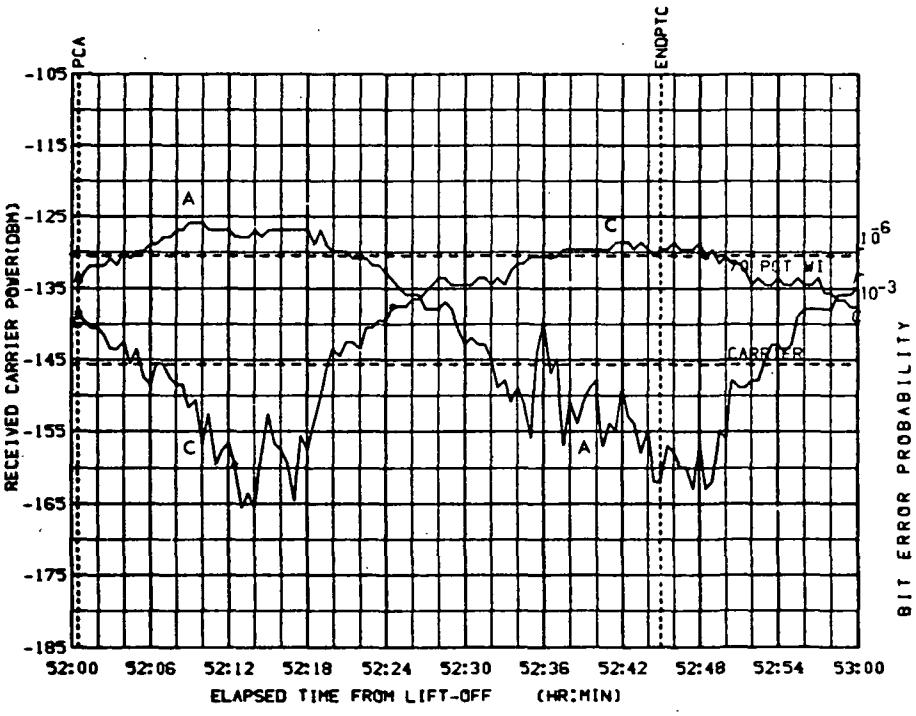


FIGURE 8-15b. TEX DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

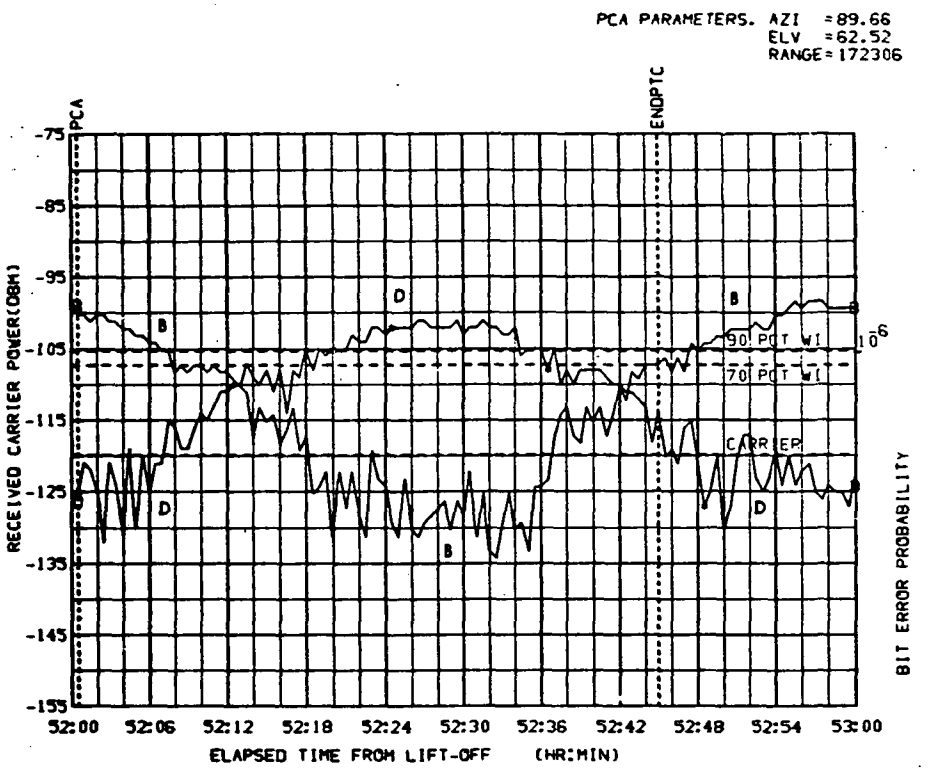


FIGURE 8-15c. TEX UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

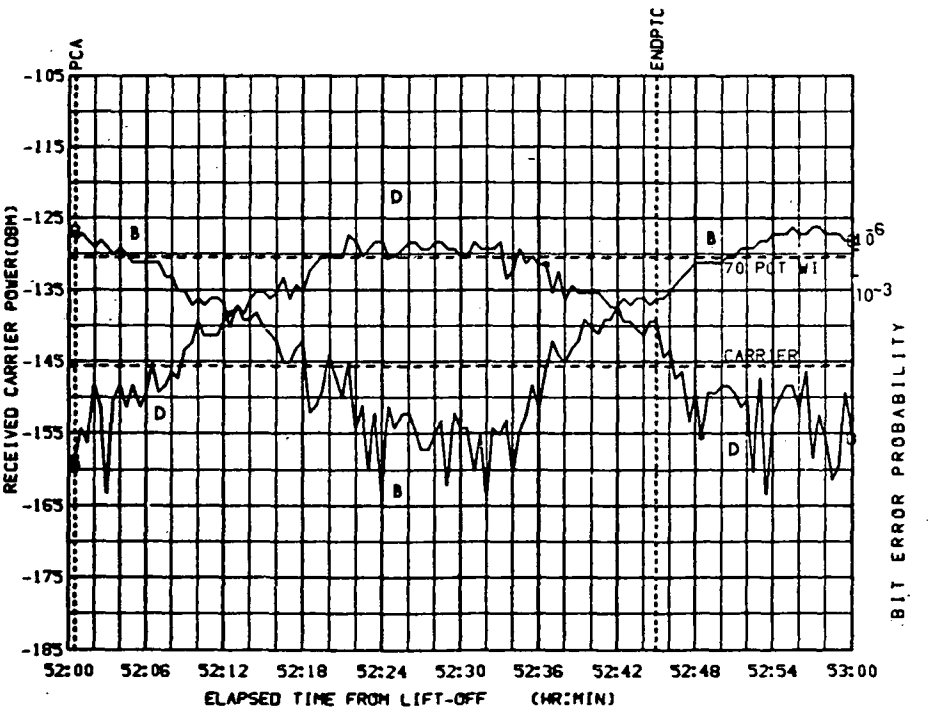


FIGURE 8-15d. TEX DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

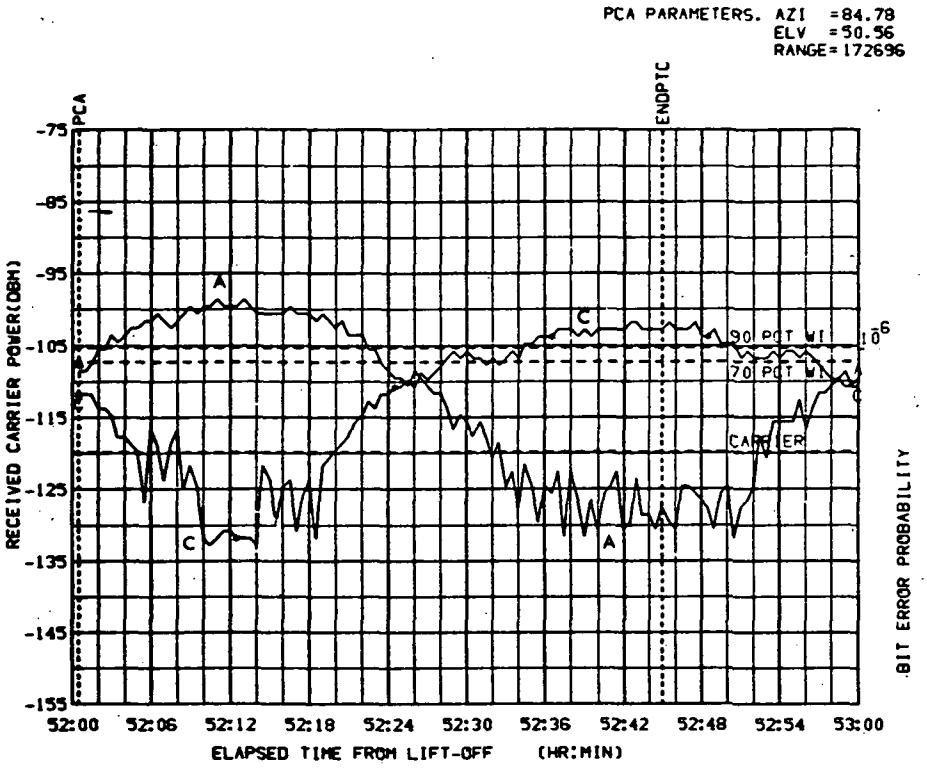


FIGURE 8-16a. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

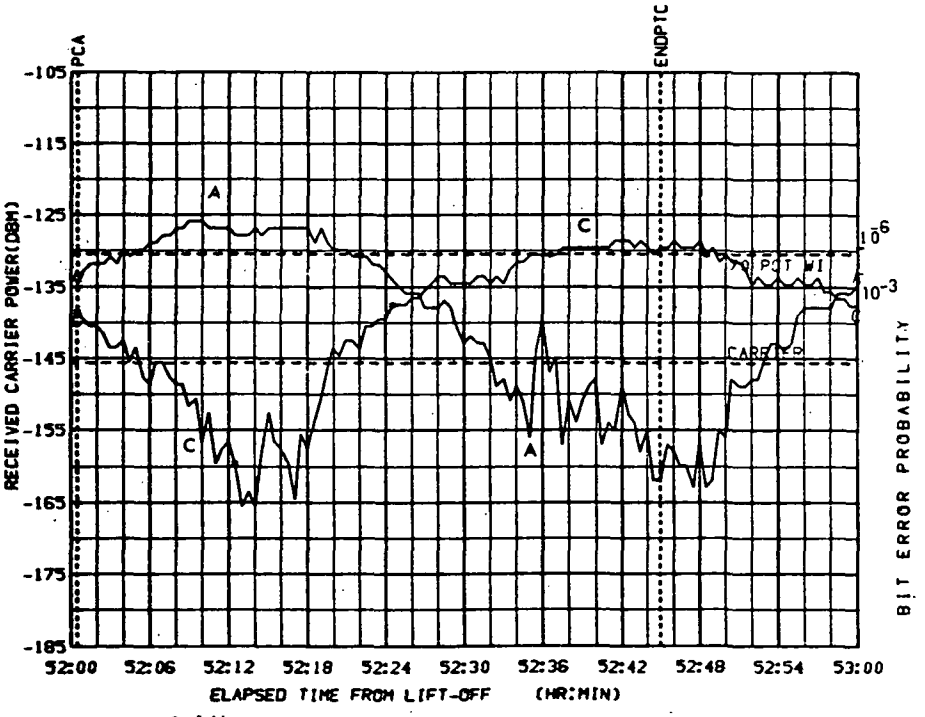


FIGURE 8-16b. GYM DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

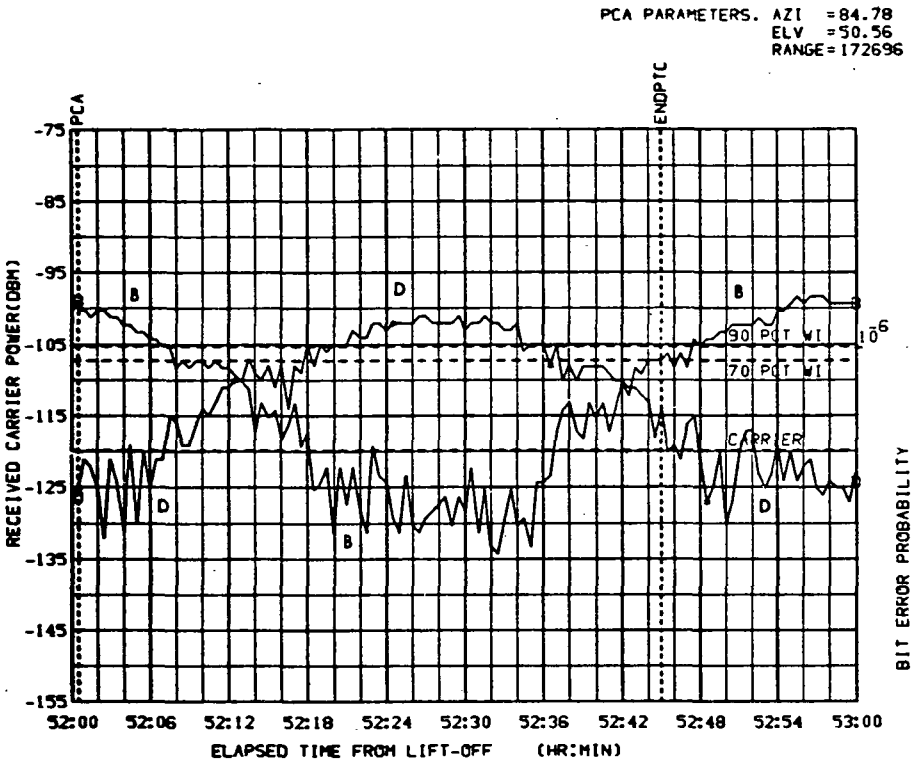


FIGURE 8-16c. GYM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

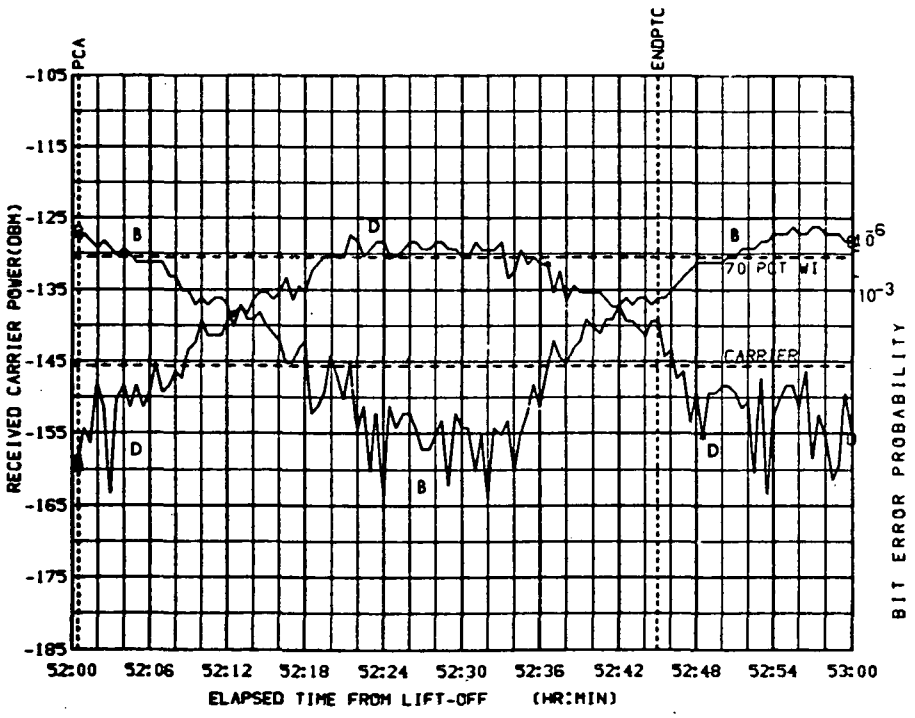


FIGURE 8-16d. GYM DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

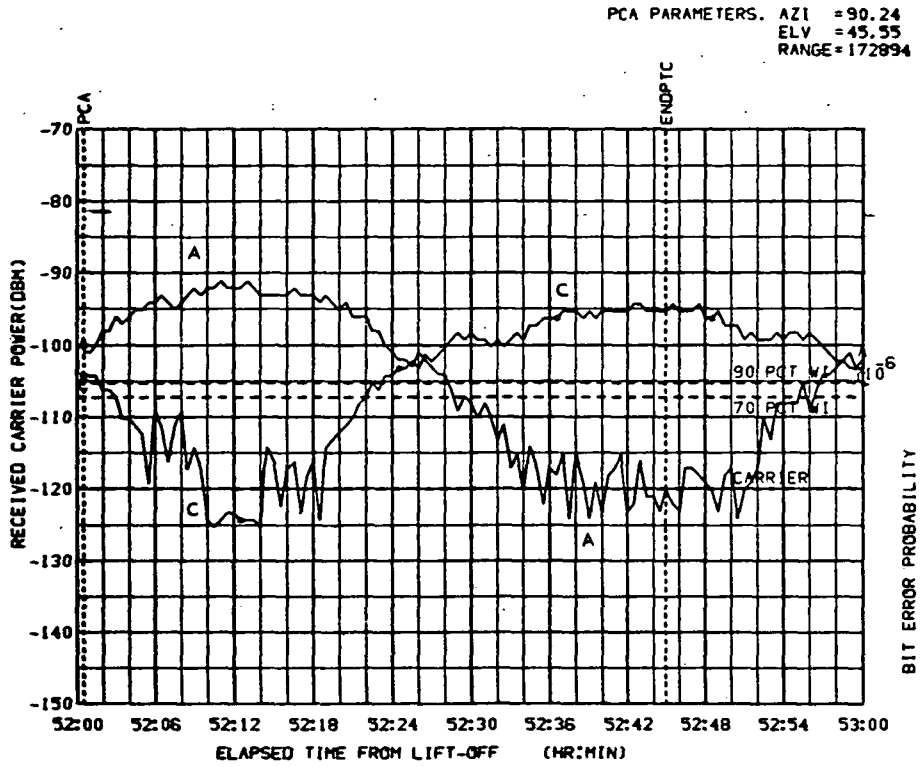


FIGURE 8-17a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

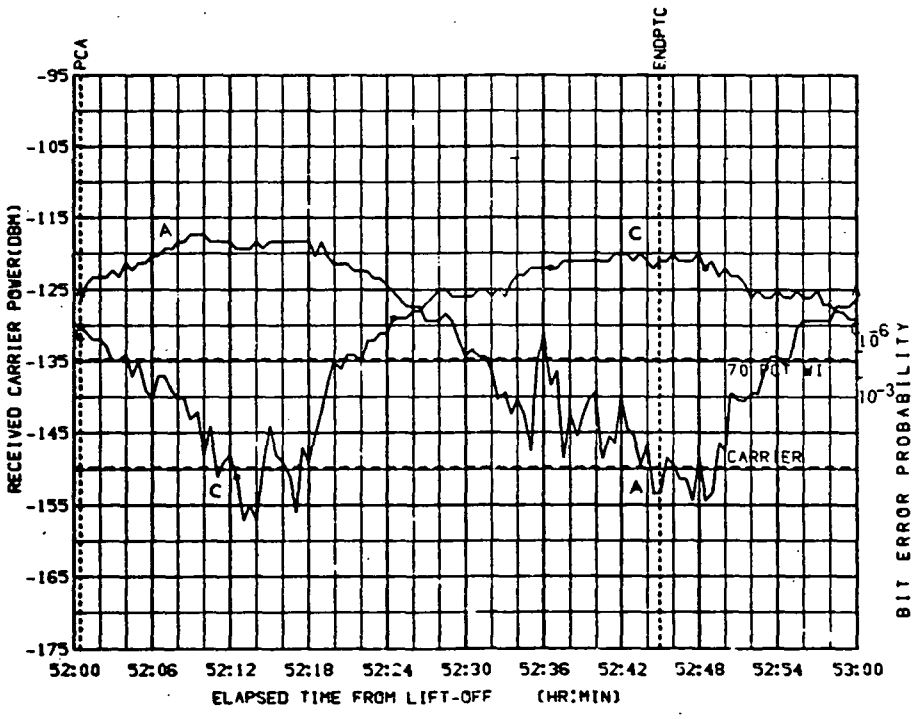


FIGURE 8-17b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

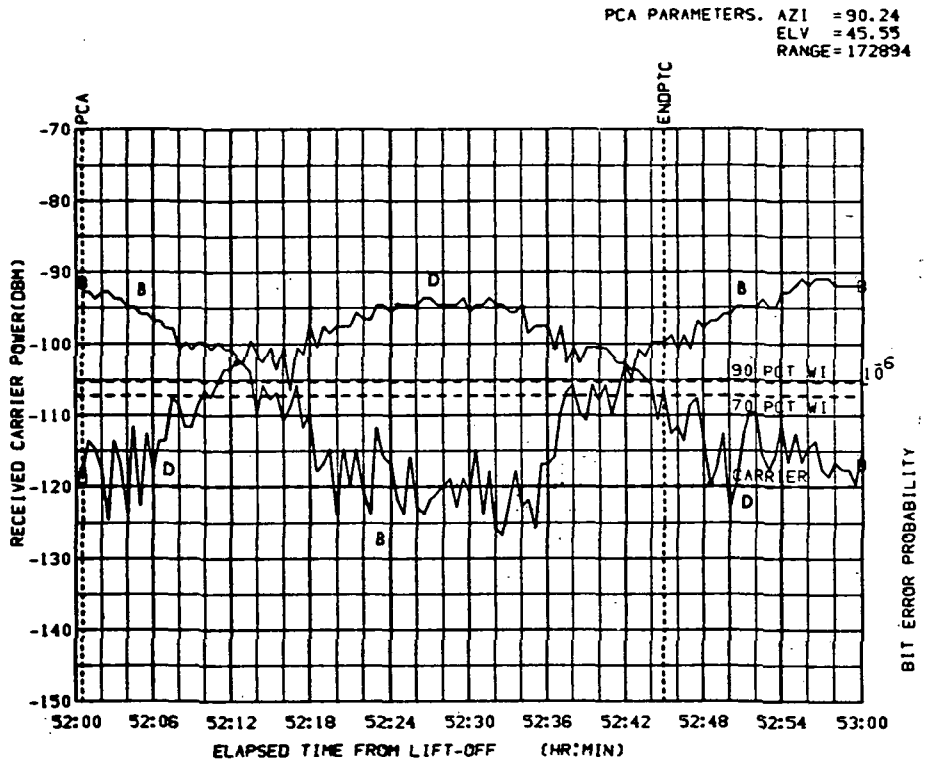


FIGURE 8-17c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

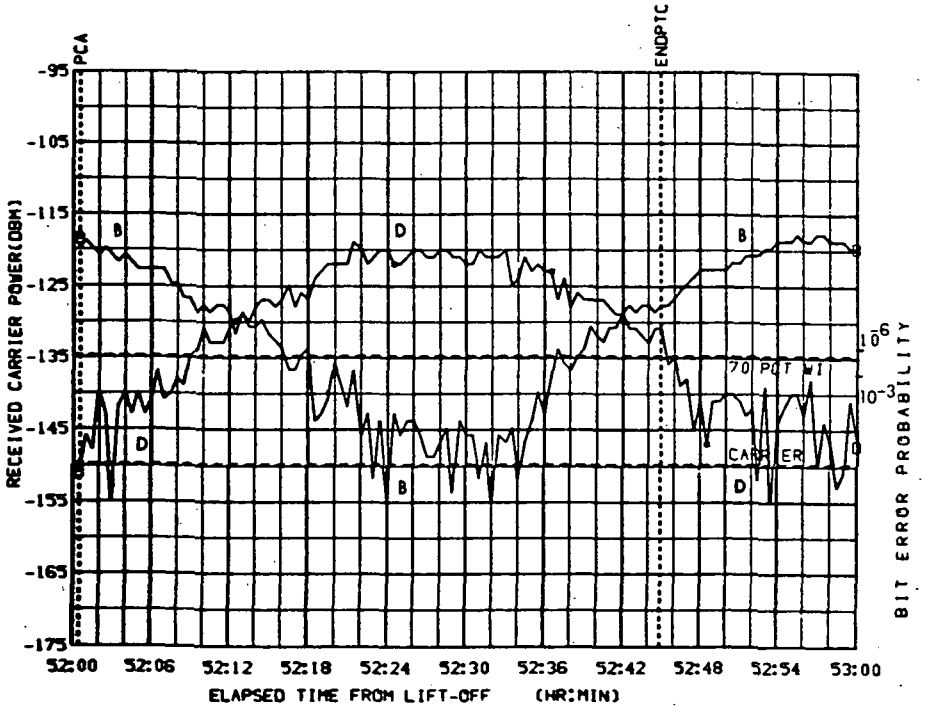


FIGURE 8-17d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

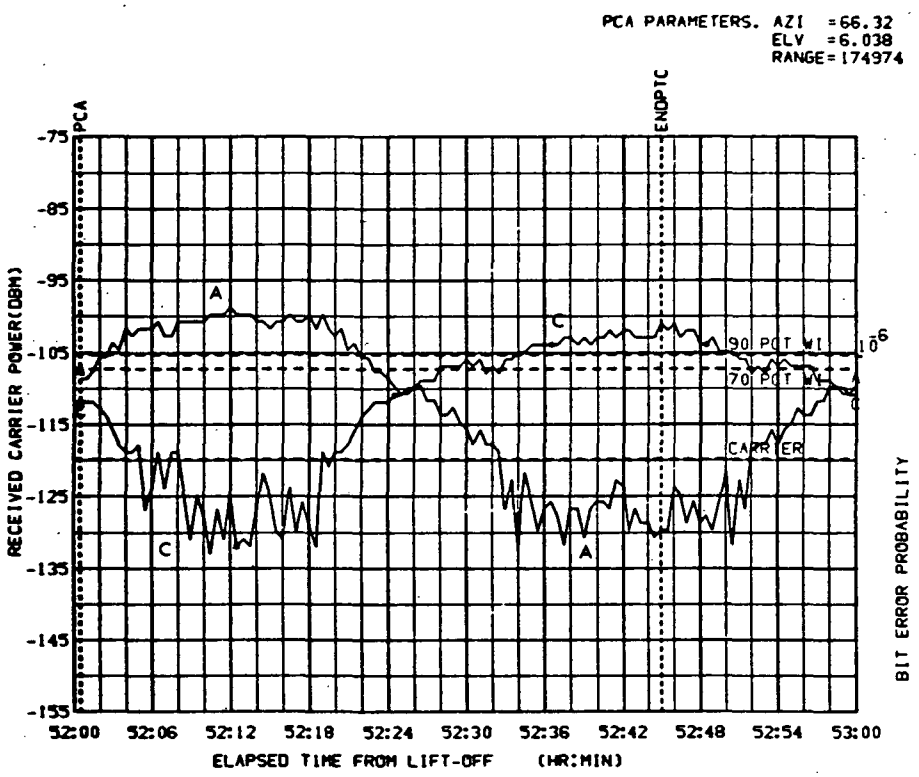


FIGURE 8-18a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

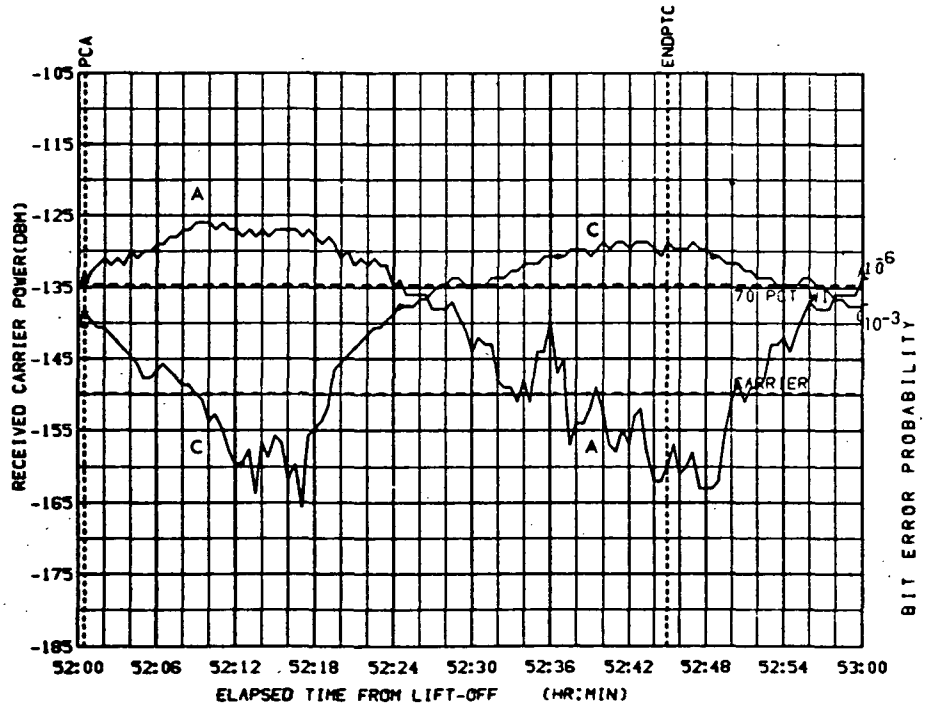


FIGURE 8-18b. MAW DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

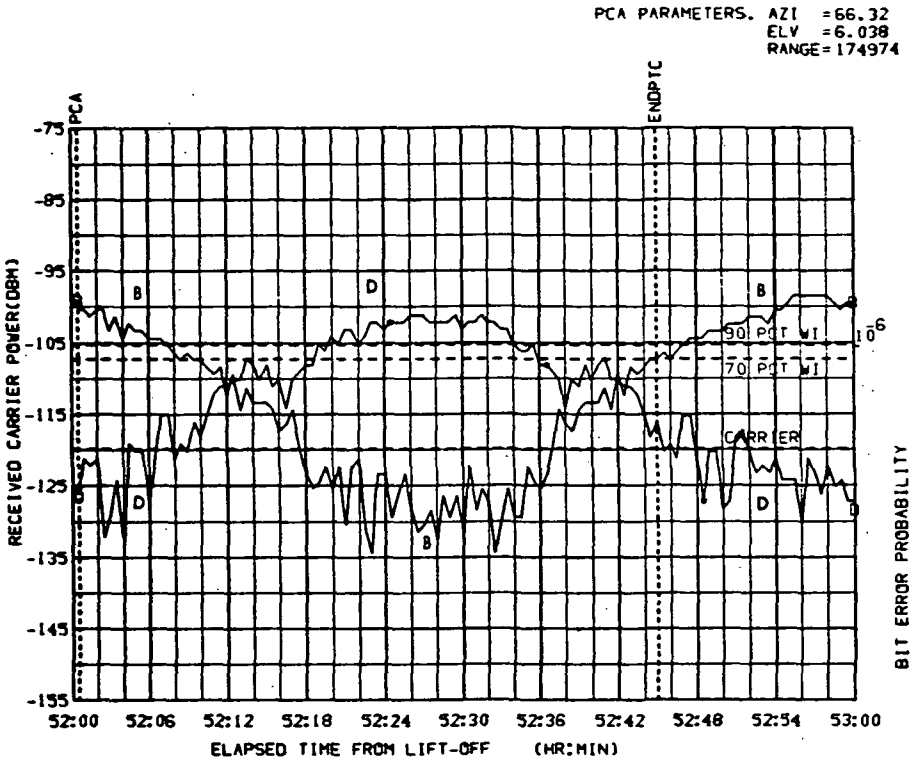


FIGURE 8-18c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

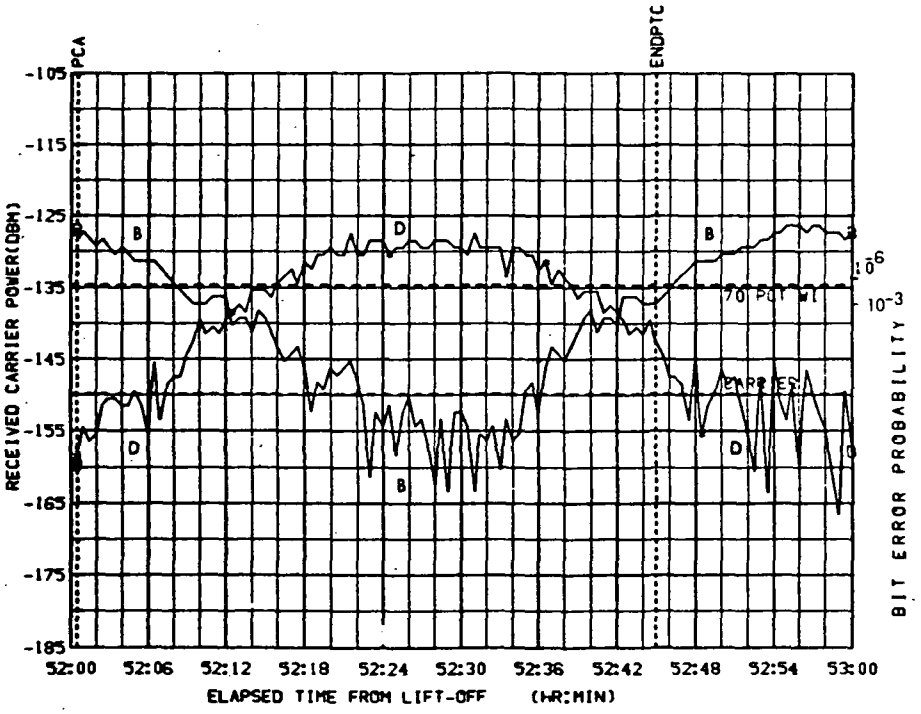


FIGURE 8-18d. MAW DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

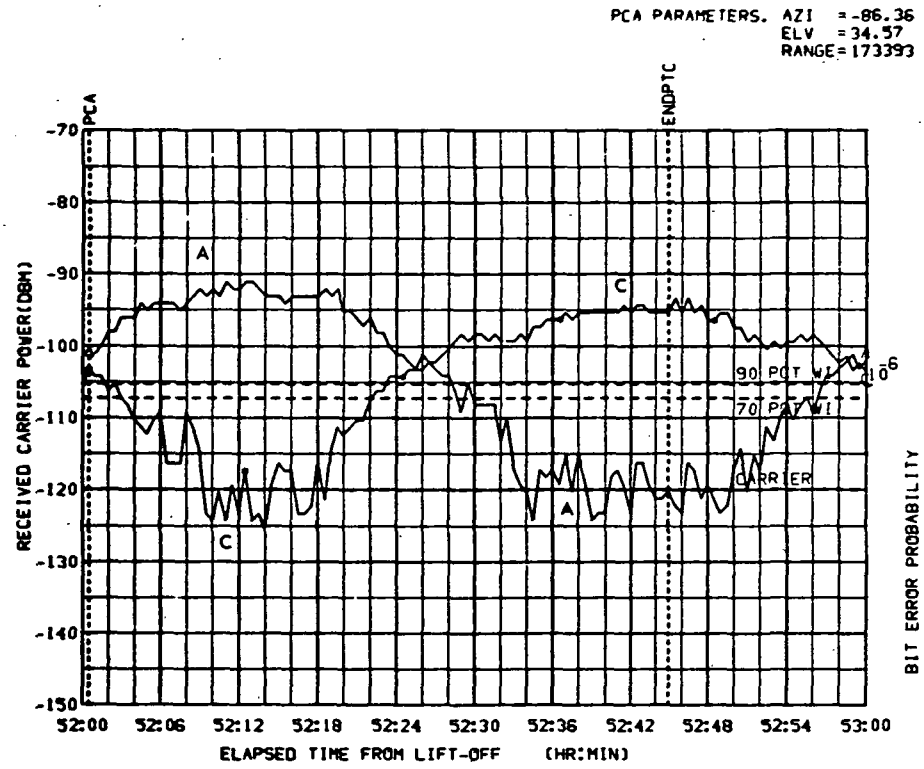


FIGURE 8-19a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

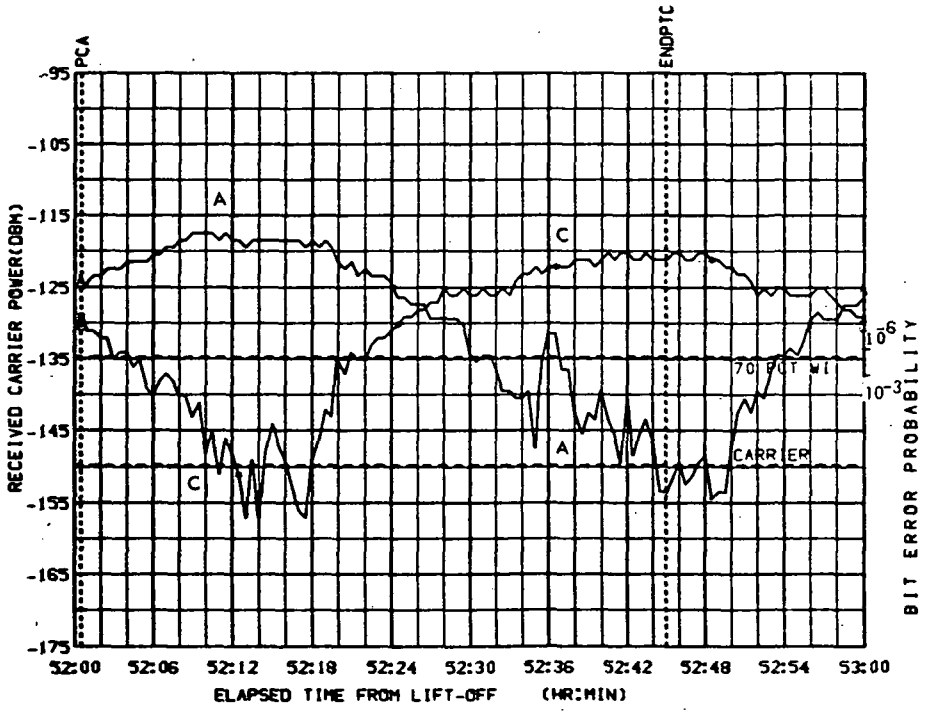


FIGURE 8-19b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

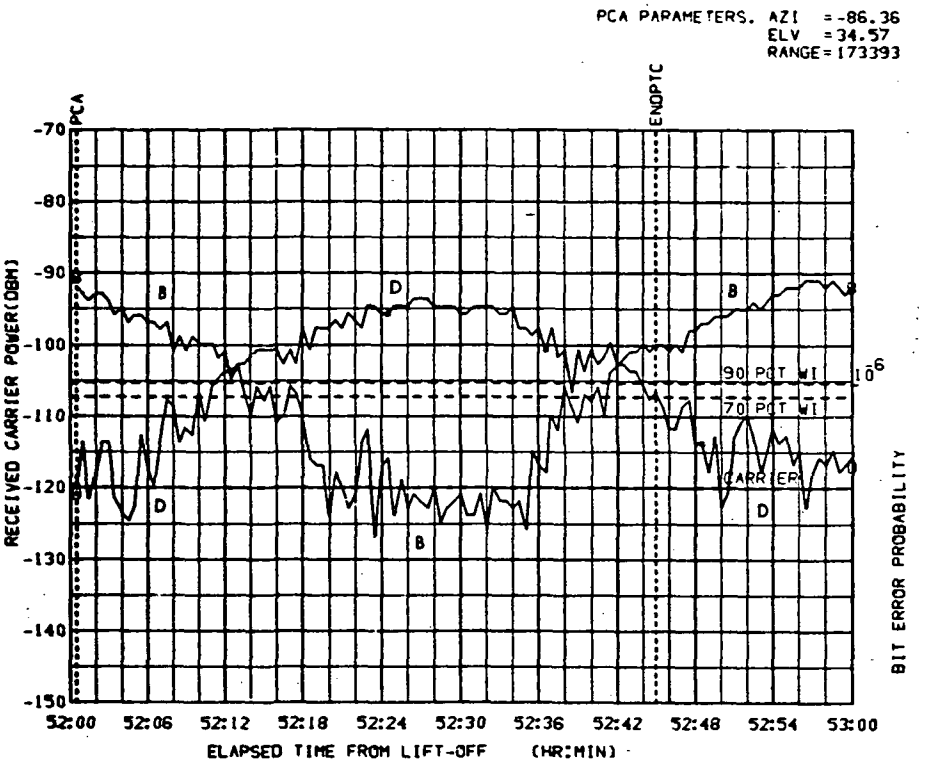


FIGURE 8-19c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

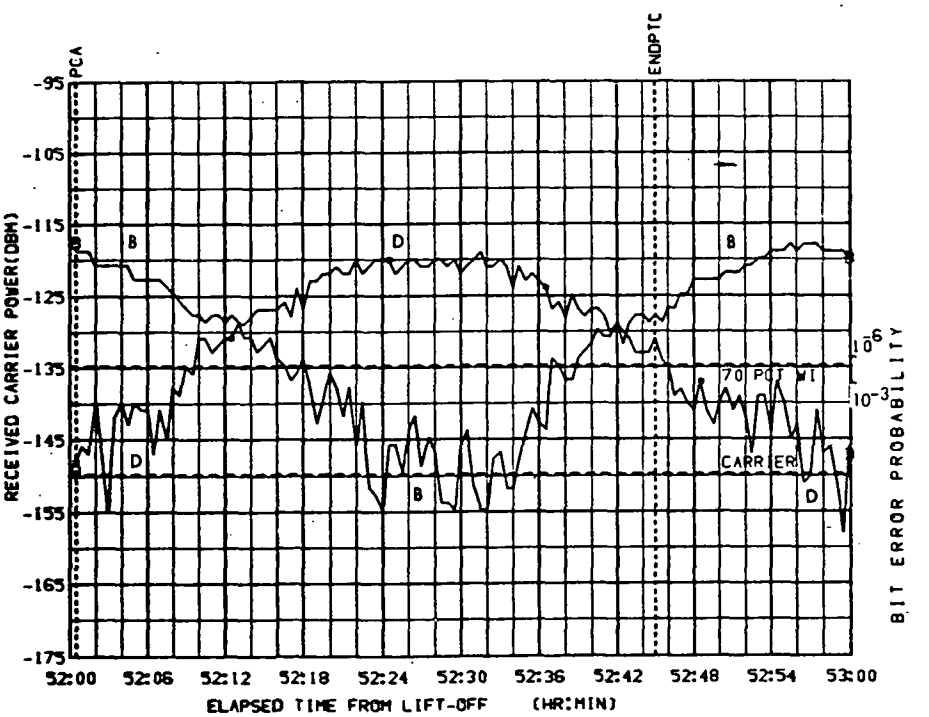


FIGURE 8-19d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

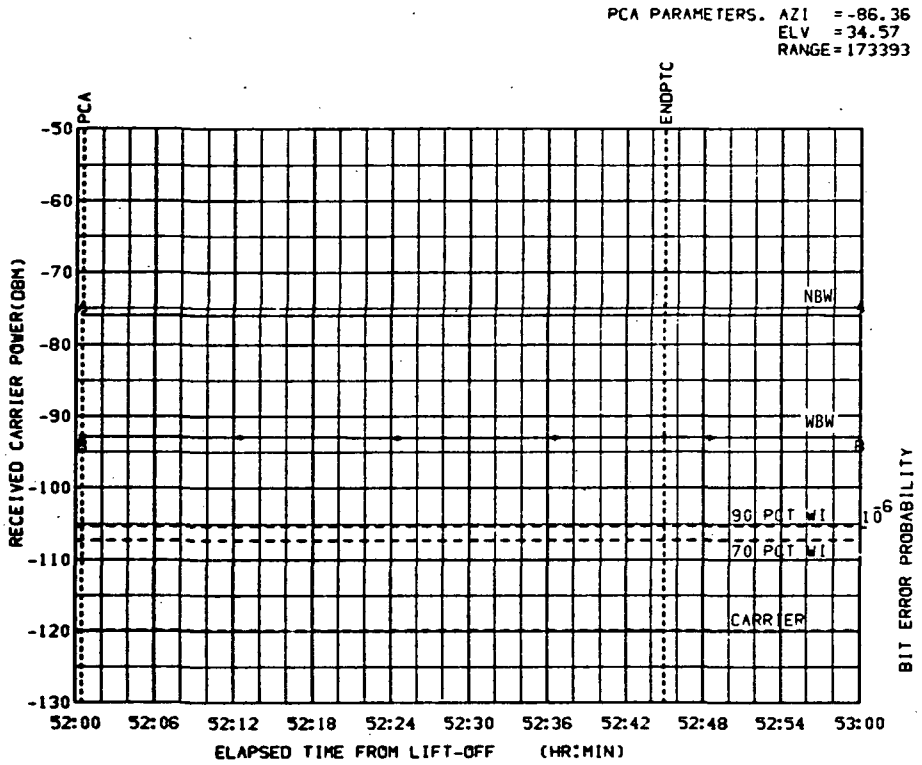


FIGURE 8-19e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

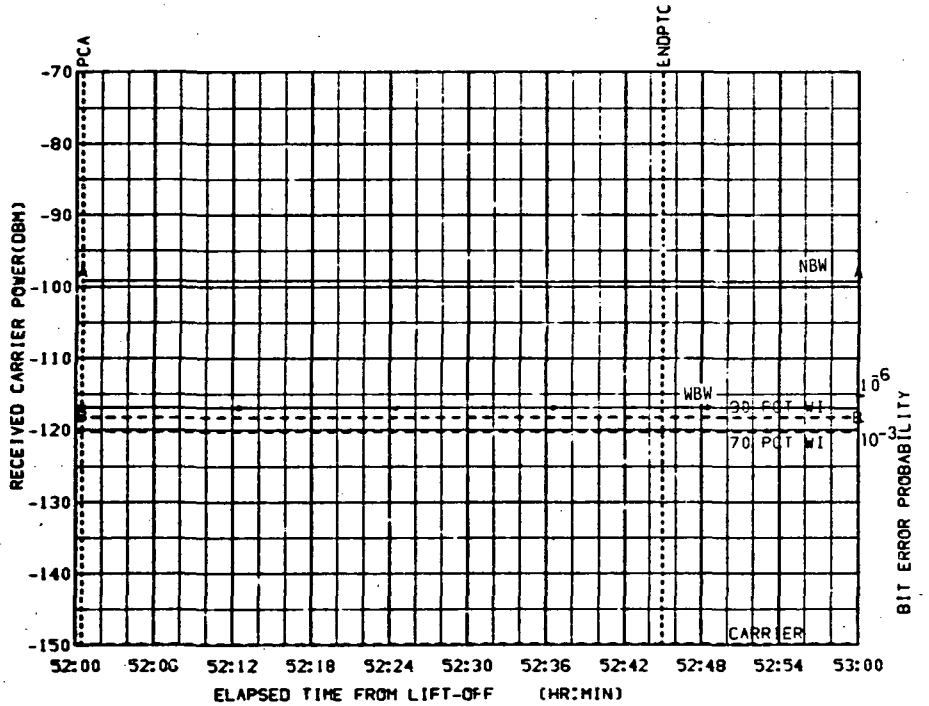


FIGURE 8-19f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

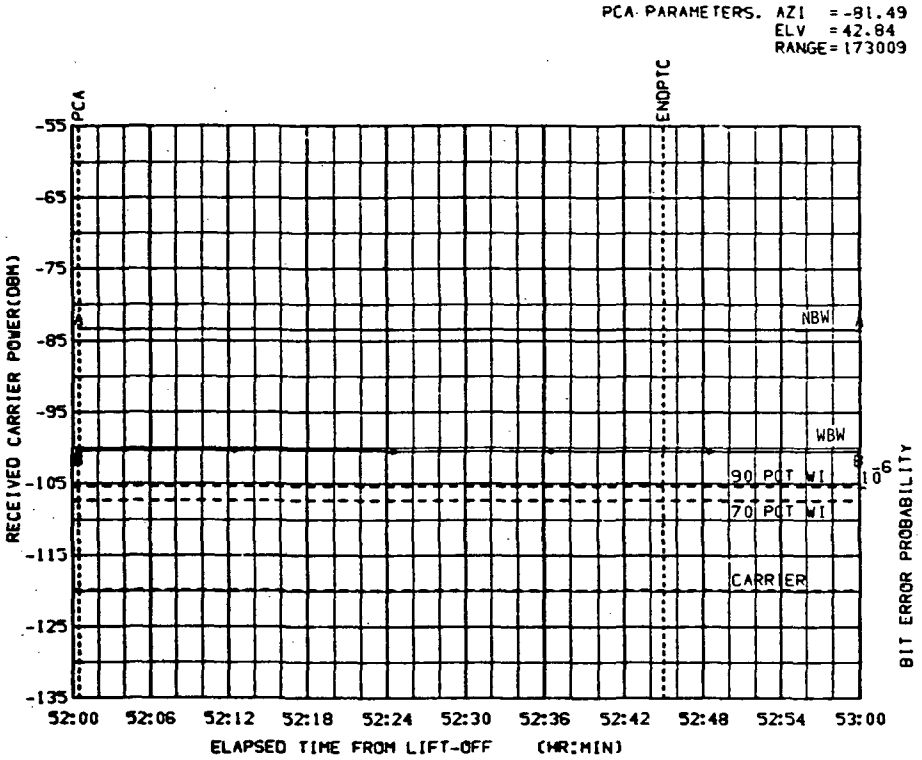


FIGURE 8-20a. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

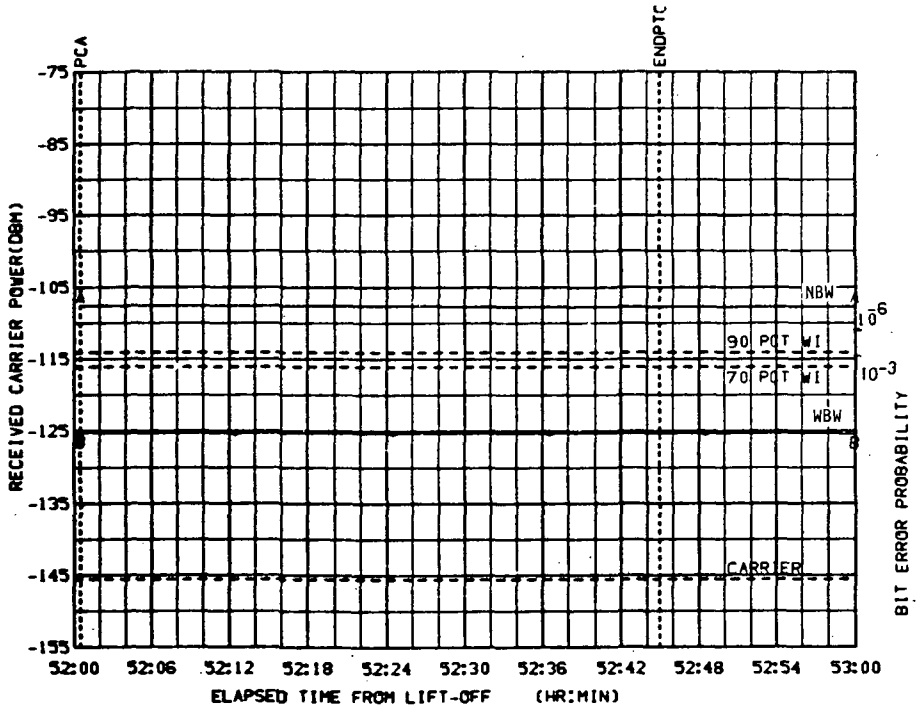


FIGURE 8-20b. CYI DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

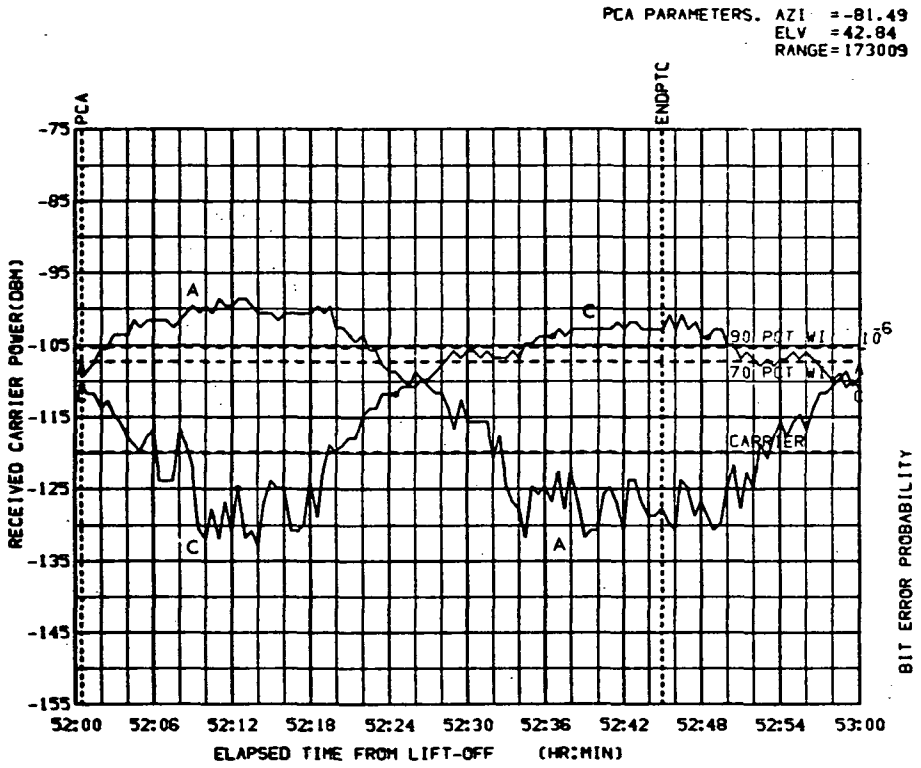


FIGURE 8-20c. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

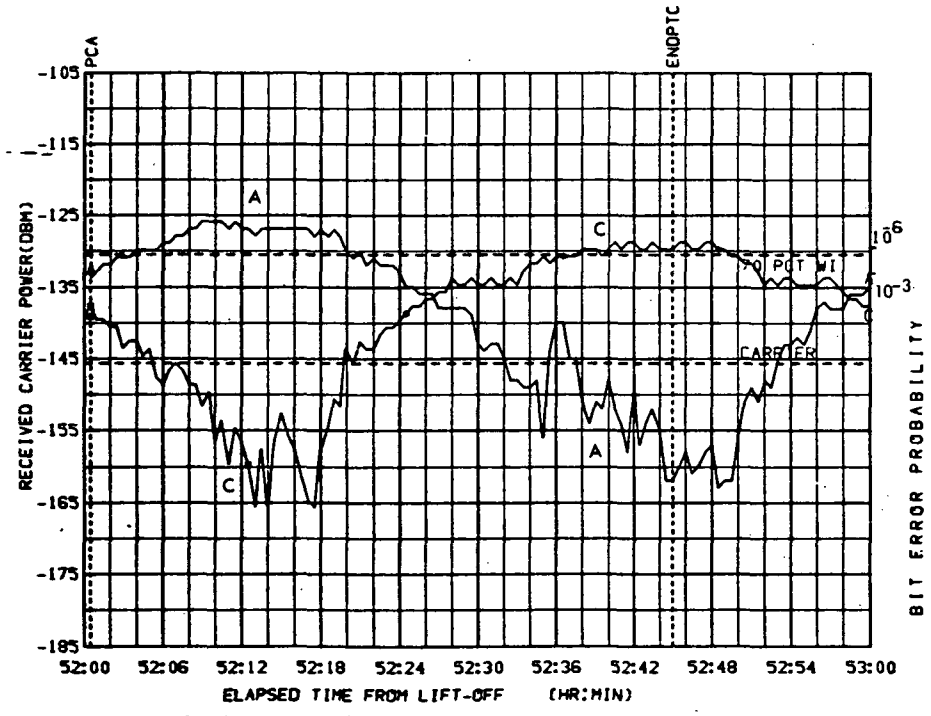


FIGURE 8-20d. CYI DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

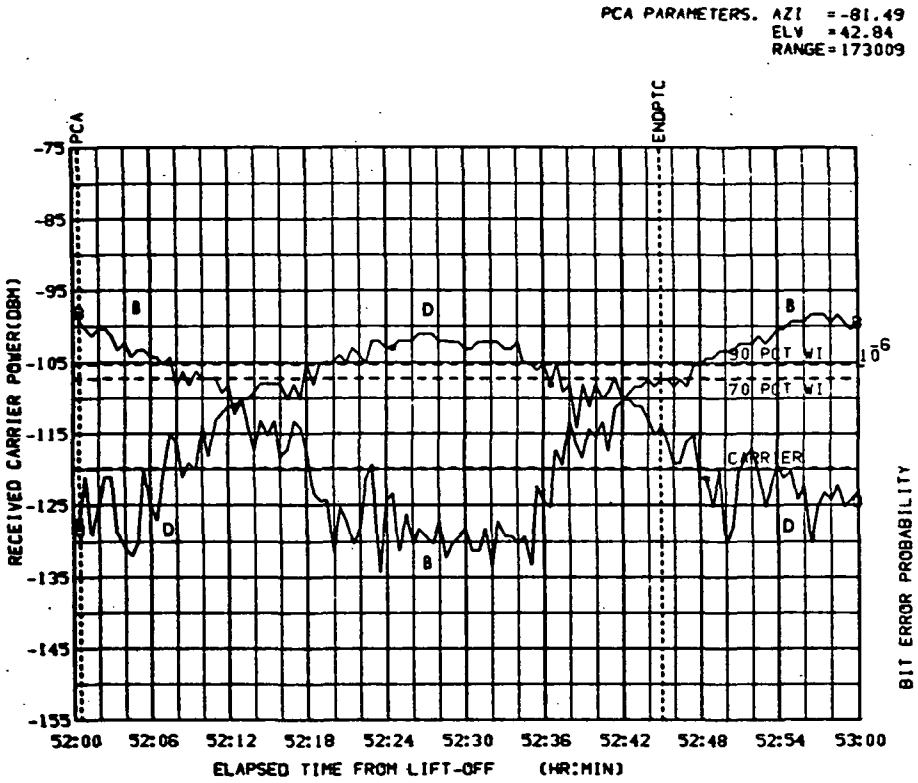


FIGURE 8-20e. CYI UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

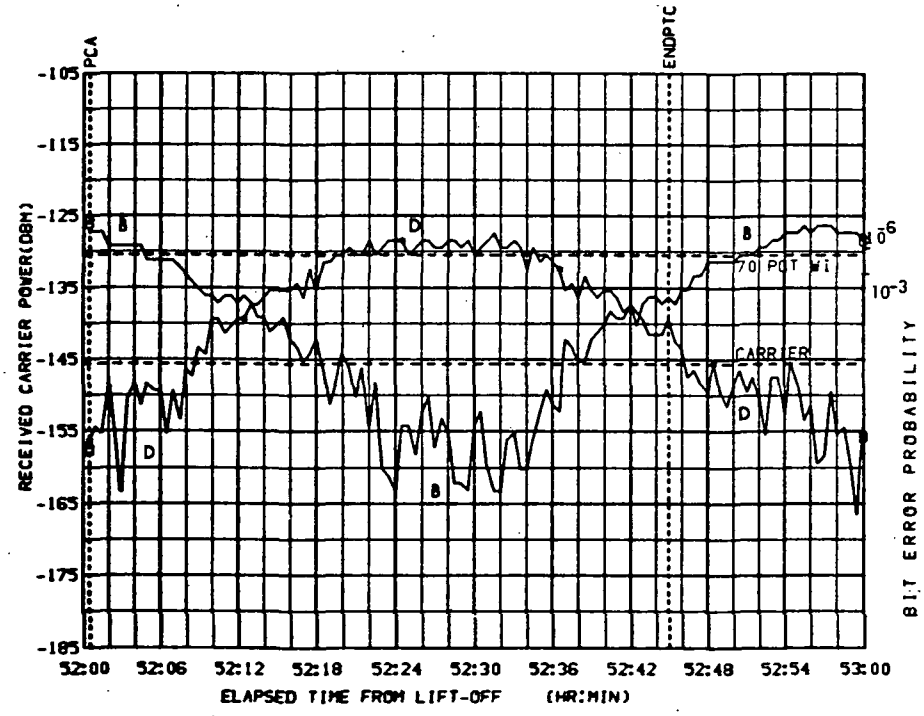


FIGURE 8-20f. CYI DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

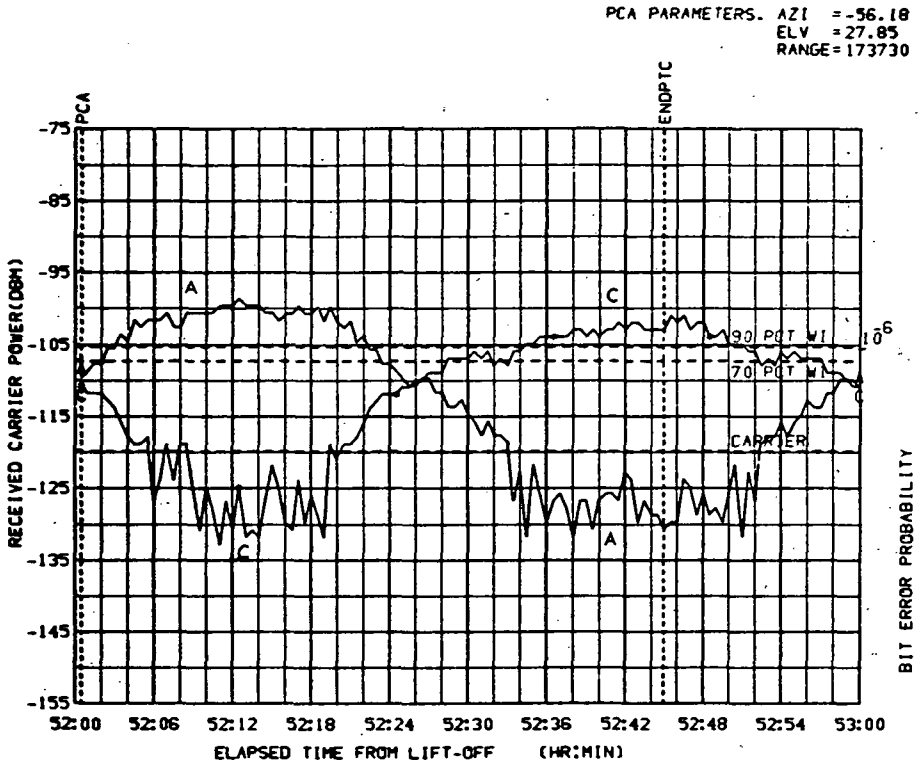


FIGURE 8-21a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

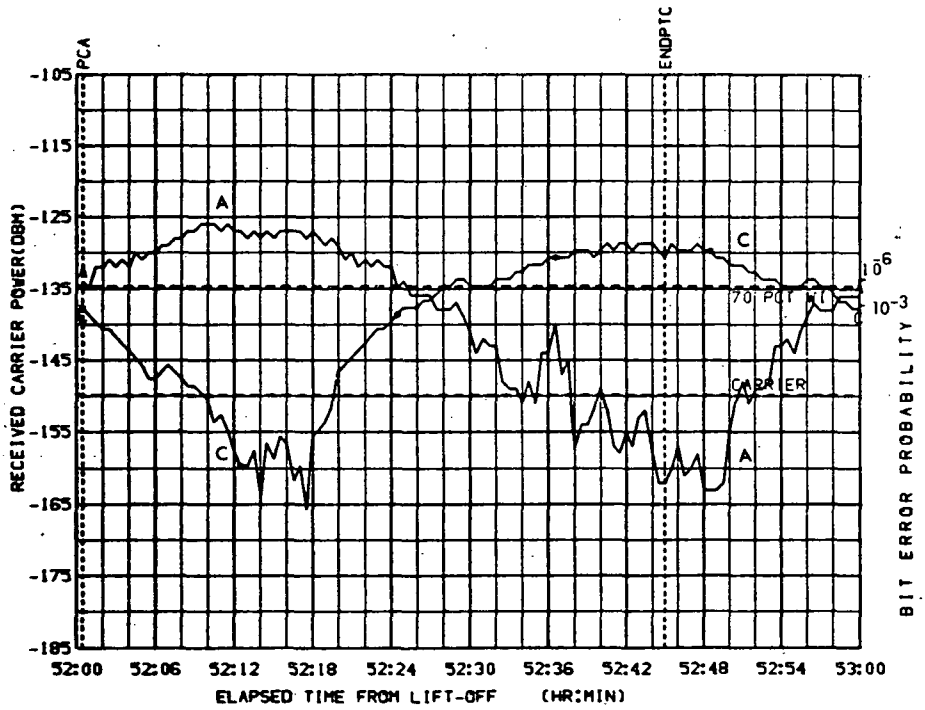


FIGURE 8-21b. ACN ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

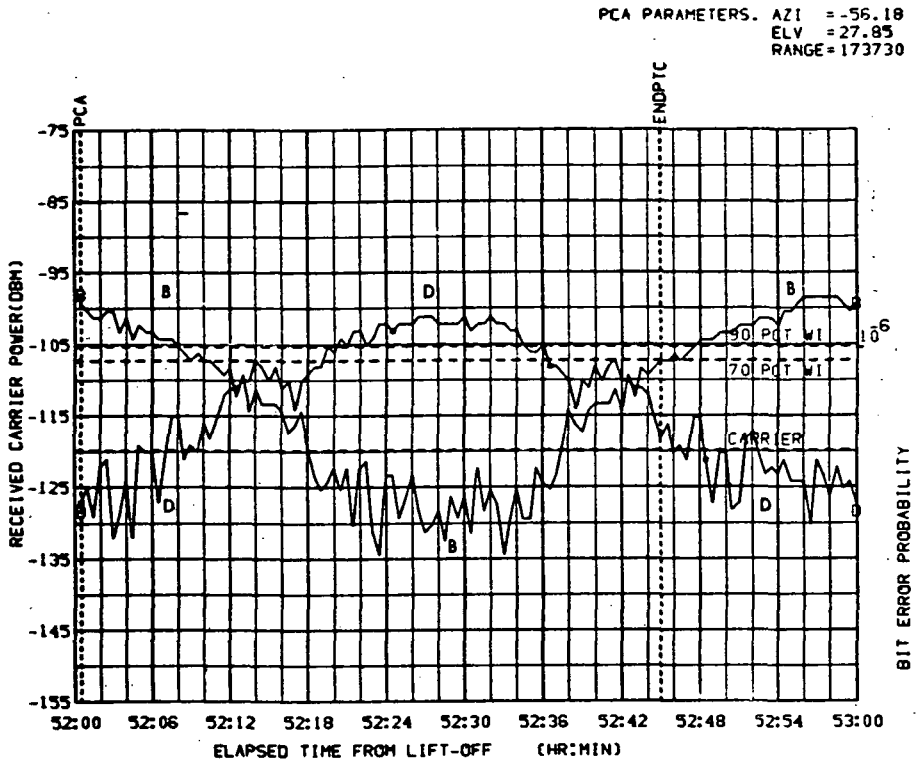


FIGURE 8-21c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

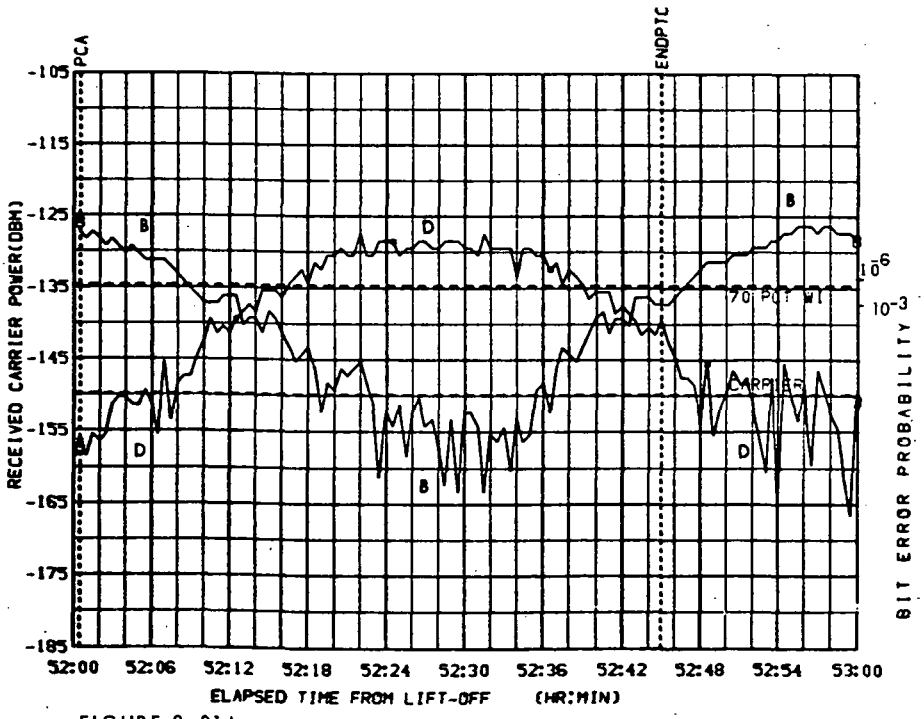


FIGURE 8-21d. ACN DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

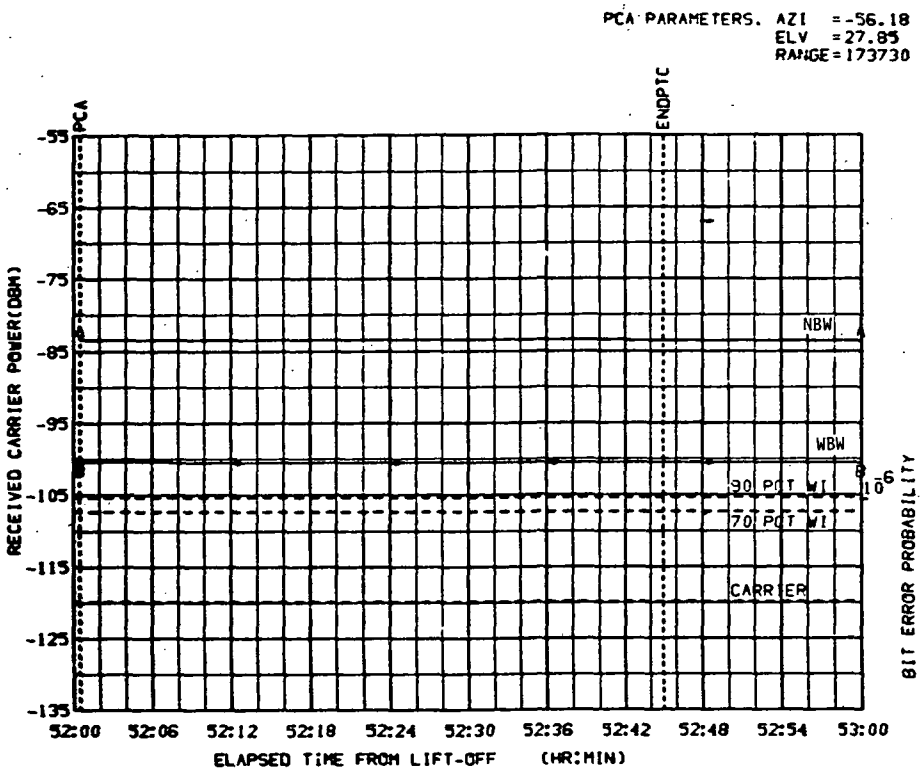


FIGURE 8-21e. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

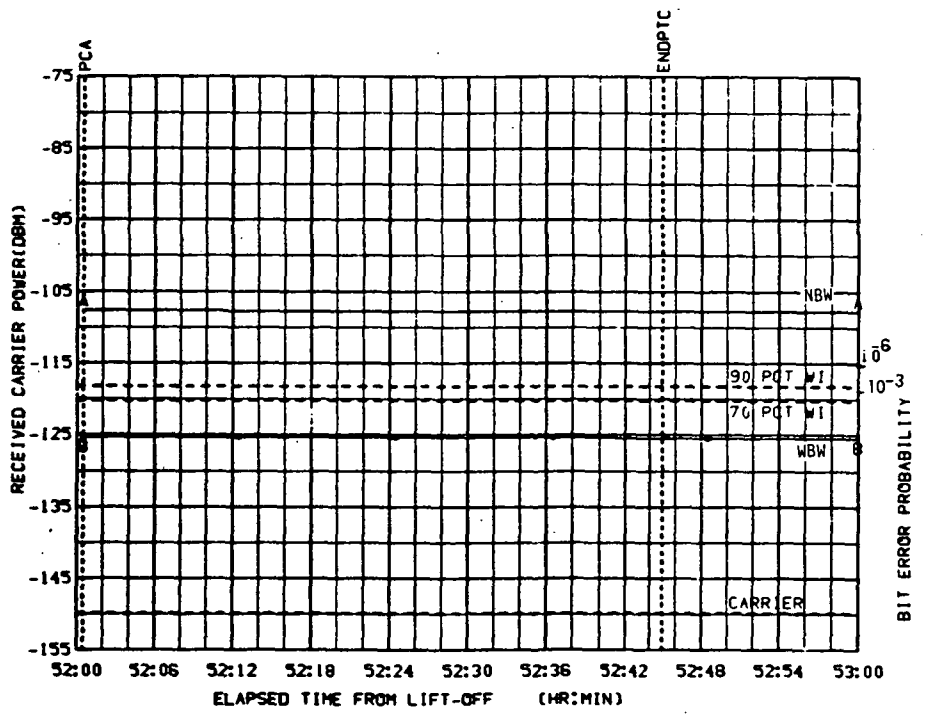


FIGURE 8-21f. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. TRANSLUNAR COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

9. LUNAR PARKING ORBIT

9.1 INTRODUCTION

This section describes the communication coverage during the lunar orbit phase of the Apollo 10 mission. Lunar orbit begins with insertion of the spacecraft into lunar orbit and ends with initiation of transearth injection. Communications analysis and recommendations are provided for the CSM and LM S-band communication systems.

The following communications or considerations are contained in this section:

a) The GDS 210-foot antenna must be used for color television at lunar distances to obtain satisfactory picture quality.

b) Recommended station coverage is shown in Figures 9-5 through 9-7.

c) Received carrier power versus elapsed time from lift-off plots are based on a 17 May 1969 launch. The levels shown for the CSM high-gain antenna and the LM steerable antenna are the levels that will also be received during the mission launched 18 May 1969. The levels shown for the CSM omni antennas and LM S-band omni (inflight) antennas are representative of the general capability of these antennas at lunar distances. The differences in MSFN to spacecraft look angles that will exist during the 18 May mission, however, preclude the use of these plots in providing detailed spacecraft antenna recommendations for the 18 May mission.

9.2 BASIC COMMUNICATION CONFIGURATIONS

The basic communication configurations for the CSM and the LM while in lunar orbit are depicted in Figures 9-1 through 9-4. The basic configurations are

a) Command Module Communications (Crew Awake)

b) Command Module Communications (Crew Asleep)

c) Lunar Module Communications (Steerable Antenna)

d) Lunar Module Communications (Omni Inflight Antennas)

During the lunar orbit period, the undocked CSM and LM spacecraft will also be configured to test the following conference modes:

a) Simultaneous voice communication between the LM and MSFN via S-band and between the LM and CSM via VHF

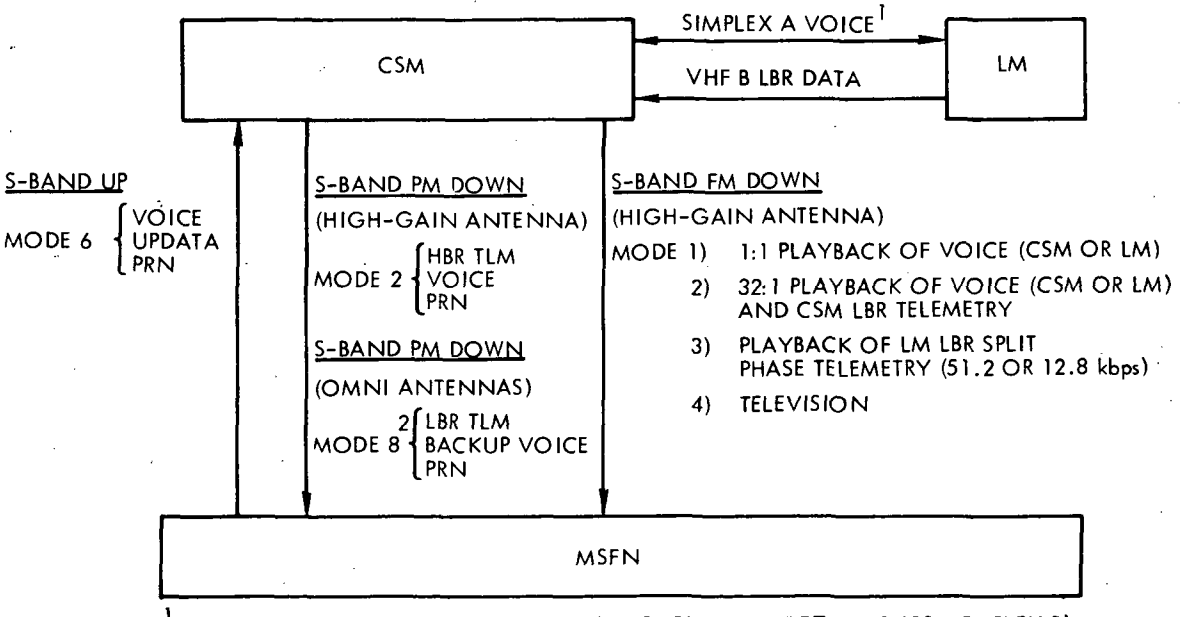
b) Voice conference communication between LM, MSFN, and CSM utilizing the LM S-band steerable antenna and the CSM high-gain antenna with MSFN acting as a voice relay

c) Voice conference communication between the LM, CSM, and MSFN using VHF voice communications between the LM and the CSM with the CSM providing voice relay to MSFN via S-band

d) Voice communication between the CSM, LM, and MSFN using VHF voice between the CSM and LM with the LM providing voice relay via S-band

9.2.1 CSM Communications (Crew Awake)

The communication configuration for the CSM when the crew is active is shown in Figure 9-1. S-band full uplink (PM mode 6) communications are available by use of either the CSM high-gain antenna or the recommended omni antennas for the transmission of voice updata and PRN.



[1]VHF VOICE AND RANGING CAN BE USED DURING RENDEZVOUS (CSM DUPLEX B)

[2]THIS MODE HAS BEEN MODIFIED TO INCLUDE PRN

Figure 9-1. Basic CSM Communication Configuration for Lunar Orbit (Crew Awake)

Full downlink (PM mode 2) communications are available for the transmission of voice, high bit rate telemetry, and PRN.

During periods in which the CSM high-gain antenna is unable to see the MSFN, the omni antennas may be selected to provide limited downlink communications. Omni antenna D will usually provide good coverage during the periods of CSM/HGA blockage.

When communication between MSFN and CSM is not possible, CSM and LM voice, CSM and LM low bit rate telemetry, and LM split-phase telemetry are stored in the digital storage equipment for subsequent playback to MSFN via the S-band FM system.

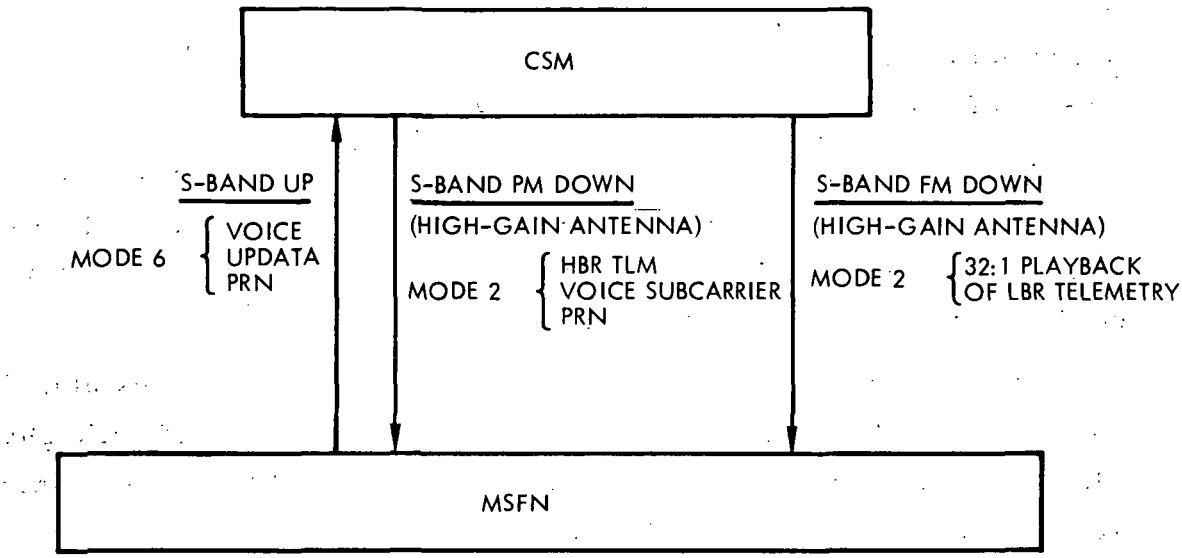
Voice communications between the CSM and LM are by means of the VHF 296.8-MHz channel; LM low bit rate split phase PCM data are transmitted to the CSM via the 259.7-MHz VHF channel.

9.2.2 CSM Communications (Crew Asleep)

Figure 9-2 depicts the communications configuration during the crew sleep period. During periods of simultaneous sleep for the crew members, the CSM will be referenced to a landing site and placed in an inertial hold mode with the attitude fixed to allow the high-gain antenna to see MSFN without interference. MSFN real-time command will select high bit rate telemetry (HBR/TLM) when the spacecraft is on the earth side of the moon and will select low bit rate/digital storage equipment prior to lunar occultation. Stored data will be dumped on command after AOS via FM downlink mode 2.

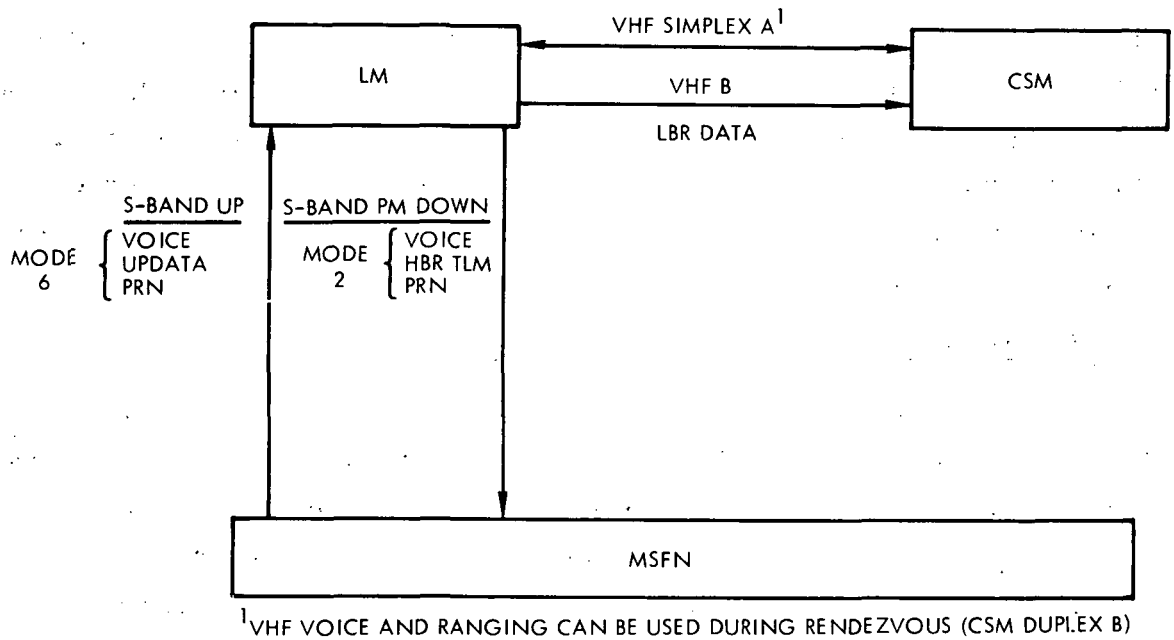
9.2.3 LM Communications Configuration

Figure 9-3 shows the primary configuration for lunar orbit communications between the LM and MSFN when the steerable S-band antenna is in use in tracking MSFN. The MSFN will acquire the LM steerable antenna for each tracking period unless otherwise specified by the flight plan. Uplink information (voice, updata, and PRN) are transmitted by MSFN S-band system. Downlink S-band PM consist of high bit rate telemetry, PRN, and voice.



NOTE: HIGH-GAIN ANTENNA WILL BE UTILIZED IN THE AUTOMATIC REACQUISITION MODE WITH LOW BIT RATE DATA BEING RECORDED BEHIND THE MOON AND PLAYED BACK DURING MSFN COVERAGE.

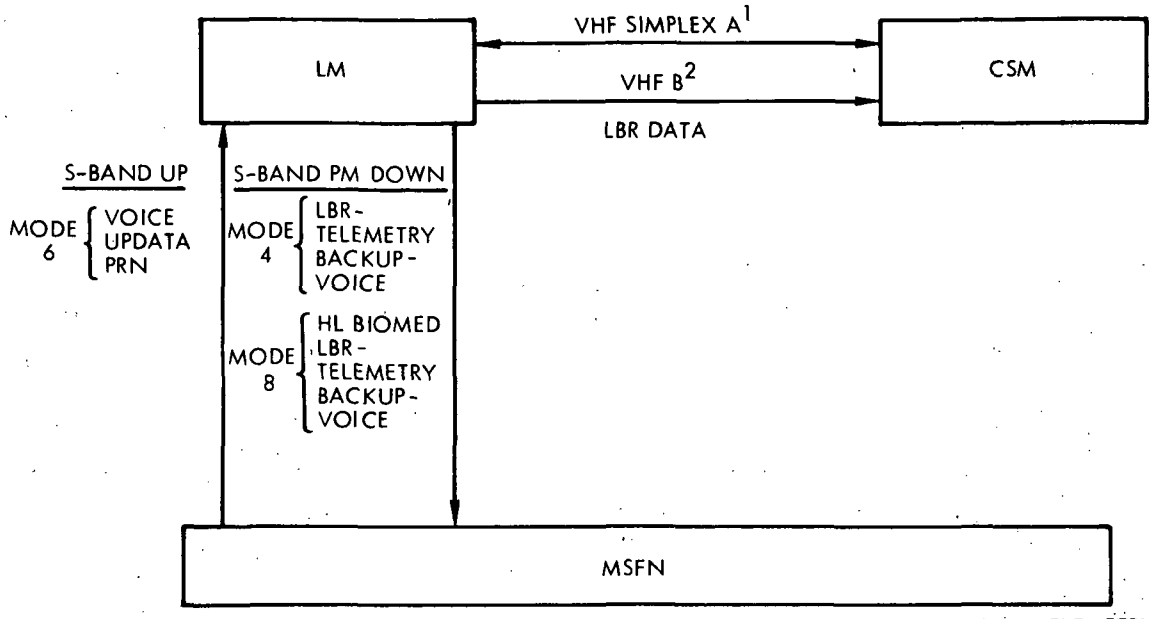
Figure 9-2. Basic CSM Communication Configuration for Lunar Orbit (Crew Asleep)



[1]VHF VOICE AND RANGING CAN BE USED DURING RENDEZVOUS (CSM DUPLEX B)

Figure 9-3. Basic LM Communication Configuration for Lunar Orbit (Steerable Antenna)

The inflight antenna communication configuration depicted in Figure 9-4 will provide backup capability for communications during periods in which the tracking of the steerable antenna is restricted by the stops.



NOTES: NO PRN CAPABILITY EXISTS SIMULTANEOUSLY WITH DOWNVOICE AND TELEMETRY.

1. VHF VOICE AND RANGING CAN BE USED DURING RENDEZVOUS (CSM DUPLEX B).
2. LBR DATA WILL BE RECORDED DURING LUNAR OCCLUSION.

Figure 9-4. Basic LM Communication Configuration for Lunar Orbit (Inflight Antenna)

The CSM S-band emergency backup modes will not be tested during the mission; therefore, the LM S-band system will be the backup for the CSM S-band system. In case of failure of the CSM S-band, the LM S-band with the steerable antenna will become the means of communications between the MSFN and the spacecraft.

Communications between spacecraft will be by means of VHF Simplex A (296.8 MHz) with LBR data transmitted by the LM on 259.7 MHz. An analysis of spacecraft to spacecraft VHF communication is presented in Reference 17.

9.3 RF COVERAGE SUMMARY

Computer plots of received carrier power versus elapsed time from lift-off are provided for the CSM and LM S-band communication systems. The 17 May 1969 launch trajectory data were used in the generation of these plots. Computer plots of received carrier power versus elapsed time from lift-off for the CSM and LM S-band systems based on an 18 May 1969 launch date will be published in an addendum to this report when the new trajectory data become available. The computer plots contained in this section, however, are still applicable in many respects and are useful in determining spacecraft communication system performance for an Apollo 10 mission having an 18 May 1969 launch date. Conclusions and recommendations with respect to the 18 May launch will be given later in this section.

Figures 9-8 through 9-59 are plots of downlink received signal power versus elapsed time from lift-off for the CSM and LM spacecraft. (An explanation of the computer plots contained in this document is presented in Section 2.) CSM omni antenna plots are provided for one typical 85-foot station for each lunar revolution. CSM HGA plots are provided for one typical 85-foot station and one typical 30-foot cooled station for each lunar revolution. Plots for the LM inflight and steerable antennas are chosen similarly. CSM downlink omni antenna plots are for PM mode 8. LM downlink inflight antenna plots are for PM mode 4. CSM HGA and LM steerable downlink plots are for PM mode 2.

Figures 9-5a, 9-6a, and 9-7a provide a bar graph summary of the MSFN stations which have the opportunity of communication with the spacecraft and the times of possible acquisition and loss of signal based on MSFN 0-degree antenna elevation for an Apollo 10 mission having a 17 May 1969 launch date. During the lunar orbit, the loss of communications that will occur during periods of lunar occultation are indicated by the breaks in the station coverage.

The bar graphs also indicate the recommended MSFN stations for each lunar orbit. A bar graph summary for an Apollo 10 mission having an 18 May launch date is provided by Figures 9-5b, 9-6b, and 9-7b.

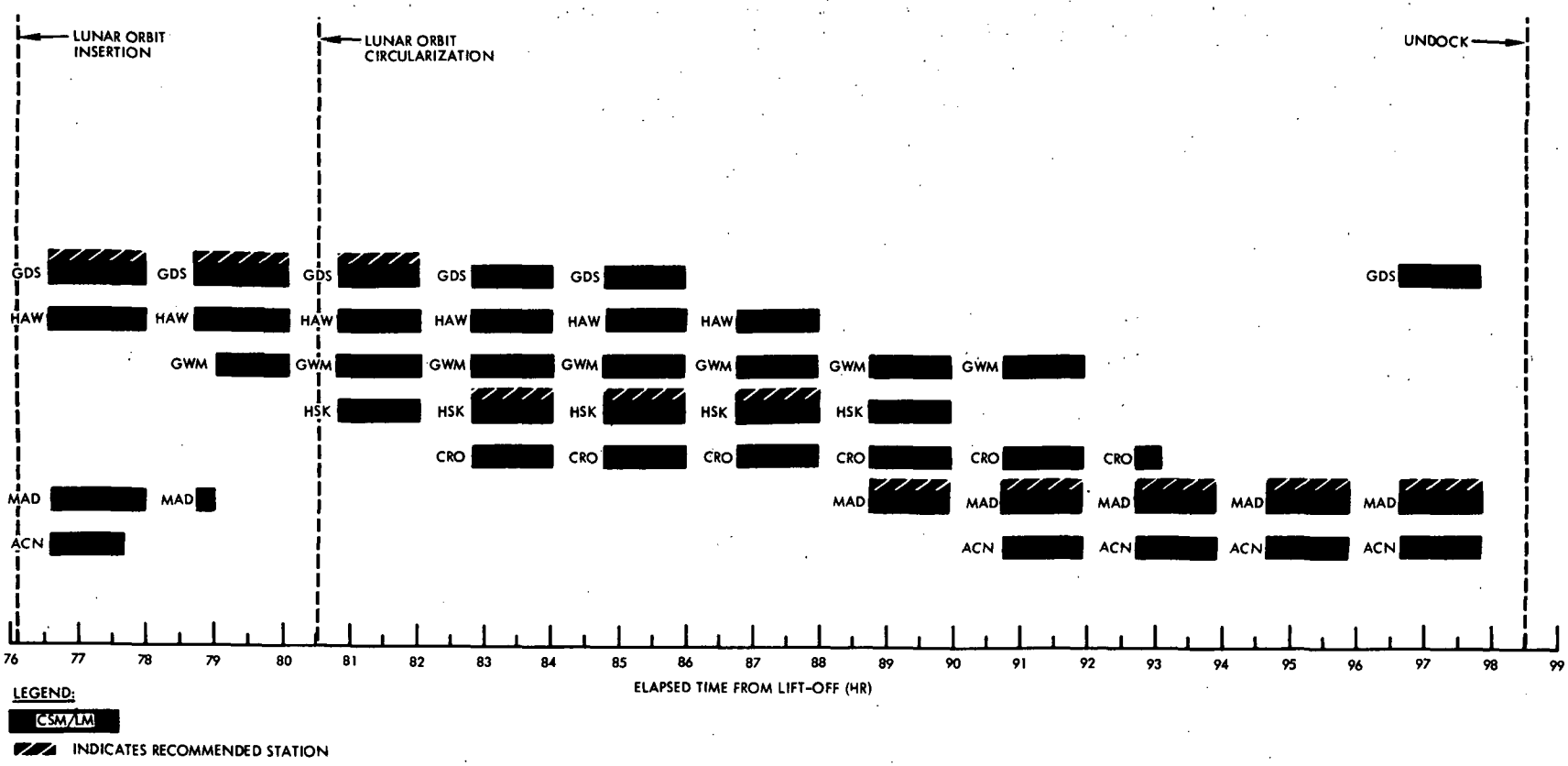


Figure 9-5a. RF Coverage Summary for Lunar Parking Orbit (LOI to Undock), 17 May 1969 Launch

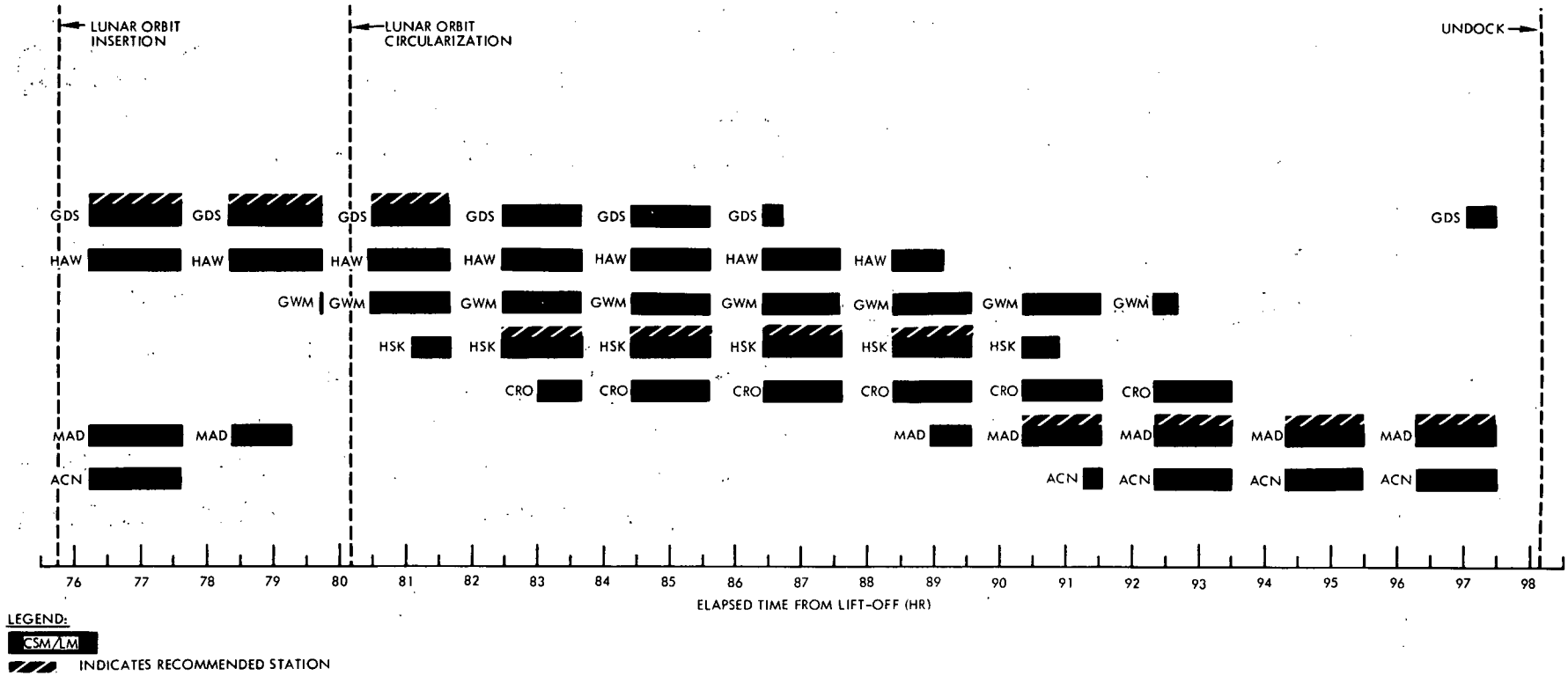


Figure 9-5b. RF Coverage Summary for Lunar Parking Orbit (LOI to Undock), 18 May 1969 Launch

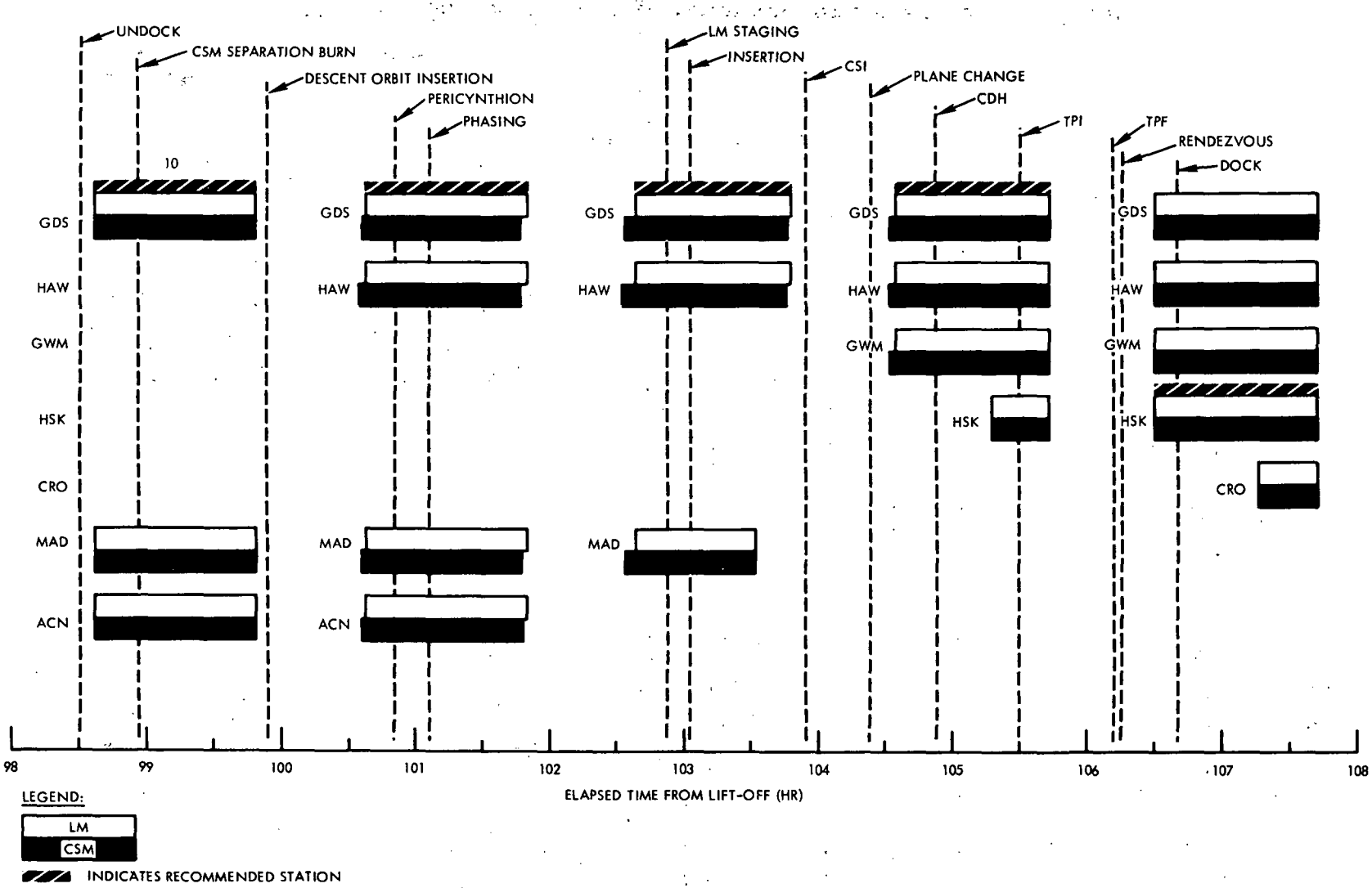


Figure 9-6a. RF Coverage Summary for Lunar Parking Orbit (Undock to Docking), 17 May 1969 Launch

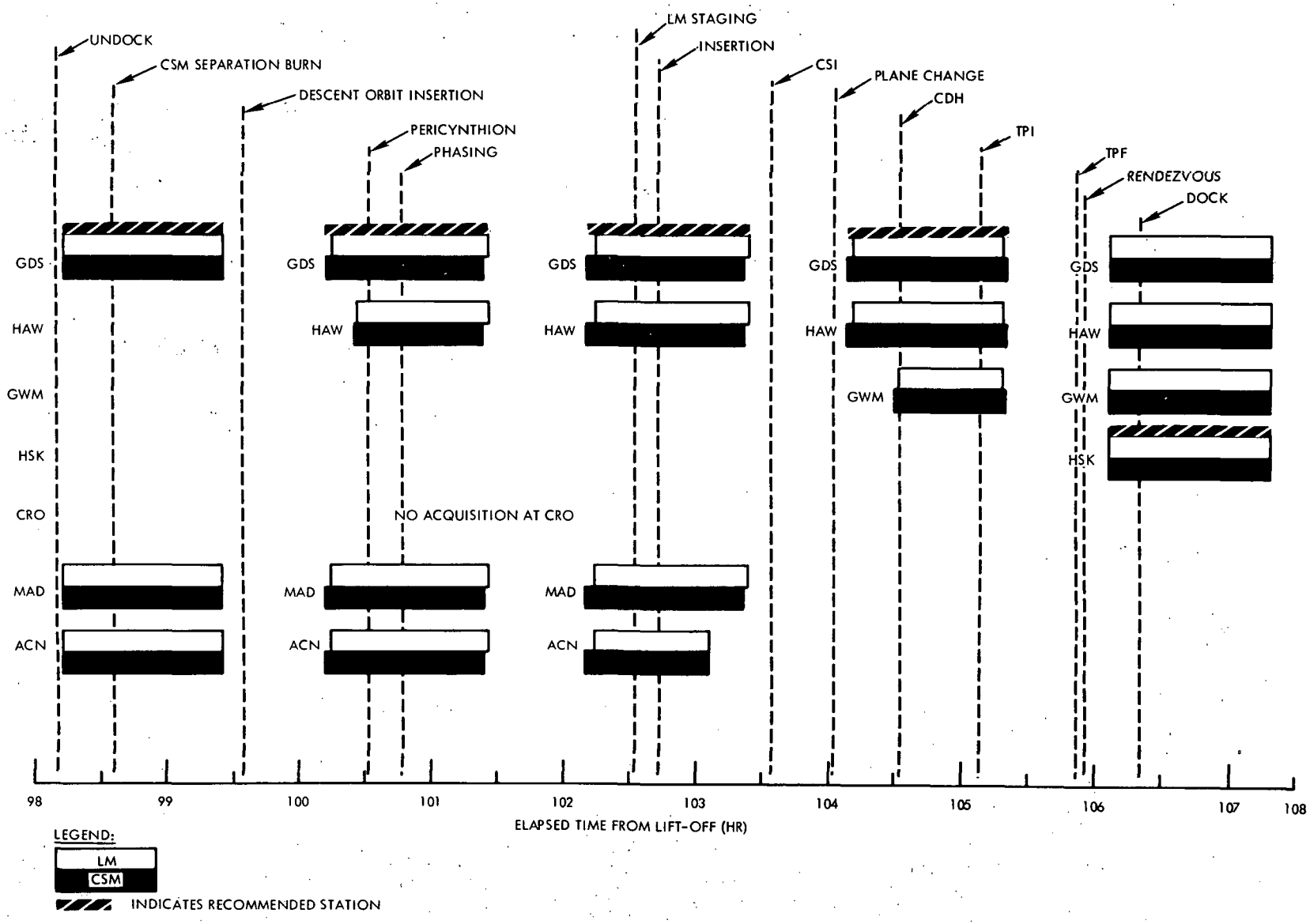


Figure 9-6b. RF Coverage Summary for Lunar Parking Orbit (Undock to Docking), 18 May 1969 Launch

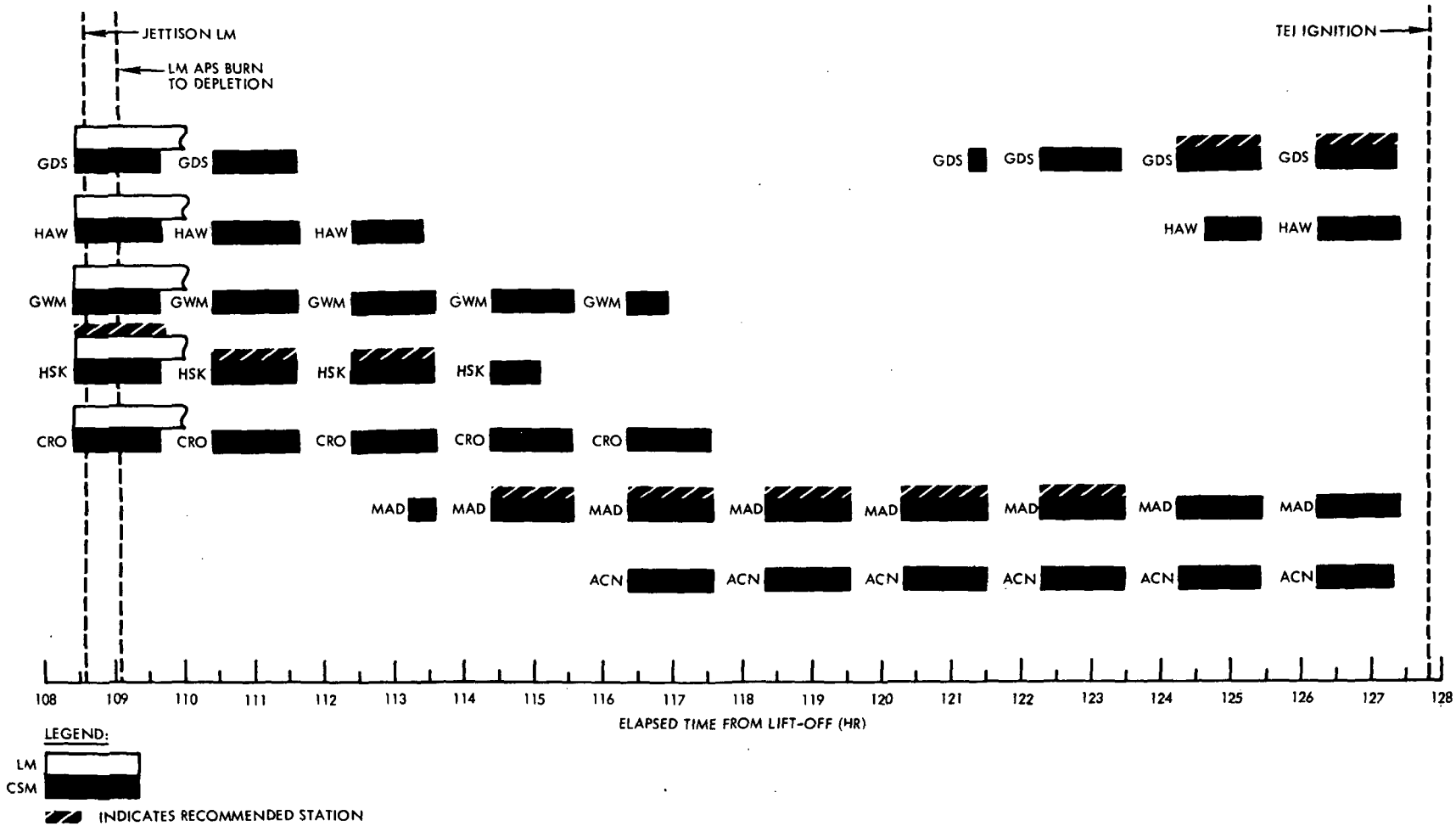


Figure 9-7a. RF Coverage Summary for Lunar Parking Orbit (LM Jettison to TEI), 17 May 1969 Launch

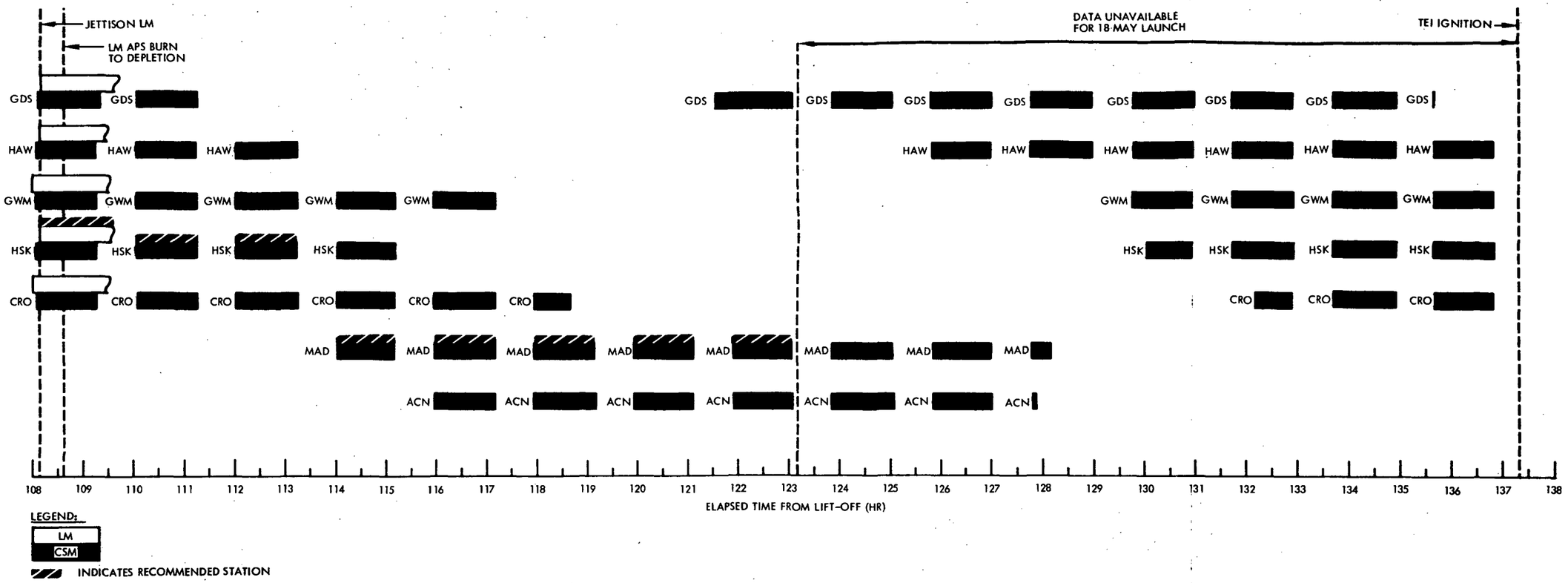


Figure 9-7b. RF Coverage Summary for Lunar Parking Orbit (LM Jettison to TEI), 18 May 1969 Launch

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Table 9-1 presents a listing of CSM omni and LM antenna recommendations along with the recommended times for antenna switching and the recommended stations for omni or inflight communications on a per revolution basis for the 26 revolutions planned for the 17 May 1969 mission. Choice of omni or inflight antenna and receiving station is based on maintaining a positive circuit margin with a minimum of antenna switching. Omni and inflight recommendations are made for backup purposes in case the HGA or steerable antenna malfunction or in case spacecraft attitude makes the use of the HGA or steerable antennas impossible. Where available information indicated that use of either the HGA or the steerable antenna was impossible over a significant period of time due to spacecraft attitude, that period of time is listed in Table 9-1.

The analysis throughout this section assumes moon at zenith. Due to the range of the spacecraft from the MSFN during this part of the mission, only certain of the downlink modes are available with a positive circuit margin when using the omni and inflight antennas on the CSM and LM, respectively. All CSM PM modes, however, will exhibit positive circuit margins using the high-gain antenna (NBW). Table 9-2 presents pertinent PM mode availability data taken from Appendix C. FM mode-as-a-whole analysis shows that the CSM FM modes will also be available using the CSM high-gain antenna (NBW). LM PM modes 1-5, 7 and 8 are available using the LM steerable antenna. FM test data analysis indicates the LM FM mode 9 (voice, telemetry) will operate satisfactorily at lunar distance with the LM steerable/85-foot MSFN antenna combination. Appendix C presents the capabilities of the CSM and LM PM and FM modes.

The time between events and maneuvers during the undock to dock period remain the same for a mission launched on 18 May 1969. The time of events during this period occur approximately 20 minutes earlier than they would have on a mission launched on 17 May 1969. The AOS and LOS times for each lunar orbit occur approximately 23 minutes earlier for the 18 May mission. The time of major events for lunar orbit for a 17 May launch date mission are given in Table 9-3. The times of major events for the 18 May launch date mission are given in Section 4.

Table 9-1. Lunar Parking Orbit Station and Antenna Recommendations*

(17 May Launch)

Orbit	Station	CSM Omni[1]	LM Inflight[2]	HGA Limitations[3]	
				Exceeds Elec. Limit	Exceeds Mech. Limit
1	GDS	B	AFT	None	None
2	GDS	B to 79:45 C to LOS	AFT to 97:45 FWD to LOS	79:45 to LOS	79:45 to LOS
3	GDS	A	AFT	None	None
4	HSK	A	AFT	None	None
5	HSK	A to 85:00 D to 85:24 B to LOS	AFT to 85:00 FWD to 85:24 AFT to LOS	85:00 to 85:25	85:11 to 85:25
6	HSK	B	AFT	None	None
7	MAD	B	AFT	None	None
8	MAD	B	AFT	None	None
9	MAD	B	AFT	None	None
10	MAD	A	AFT	None	None
11	MAD	A to 96:45 D to 97:03 A to LOS	AFT to 96:45 FWD to 97:03 AFT to LOS	96:45 to 97:03	97:01 to 97:03
12	GDS	D to 98:56 B to LOS	FWD to 98:56 AFT to LOS	AOS to 98:56	None

Table 9-1. Lunar Parking Orbit Station and Antenna Recommendations* (Continued)

(17 May Launch)

Orbit	Station	CSM Omni [1]	LM Inflight [2]	HGA Limitations [3]	
				Exceeds Elec. Limit	Exceeds Mech. Limit
13	GDS	B to 101:20 A to 101:32 D to LOS	FWD to 101:20 AFT to LOS	101:33 to LOS	None
14	GDS	B	AFT to 102:53 FWD to LOS	None	None
15	GDS	D to 104:40 B to LOS	AFT to 104:42 FWD to 104:53 AFT to 105:15 FWD to LOS	AOS to 104:41	AOS to 104:33
16	HSK	C to 107:10 B to LOS	FWD to 107:10 AFT to LOS	AOS to 107:10	106:35 to 107:10
17	HSK	B	FWD	None	None
18	HSK	B	NA	None	None
19	HSK	B	NA	None	None
20	MAD	B	NA	None	None
21	MAD	B	NA	None	None
22	MAD	B	NA	None	None
23	MAD	B	NA	None	None
24	MAD	C to 122:45 A to LOS	NA	122:21 to 122:50	122:40 to 122:50

Table 9-1. Lunar Parking Orbit Station and Antenna Recommendations* (Continued)

(17 May Launch)

Orbit	Station	CSM Omni[1]	LM Inflight[2]	HGA Limitations[3]	
				Exceeds Elec. Limit	Exceeds Mech. Limit
25	GDS	C to 124:45 A to LOS	NA	124:20 to 124:50	124:39 to 124:50
26	GDS	B to 127:10 D to LOS	NA	127:10 to LOS	127:10 to LOS

*Time in hr:min from lift-off

Notes: 1 Omni D is usually the best omni antenna when HGA blockage occurs.

2 LM steerable is free track during CSM/LM undock periods.

3 The times at which the CSM high-gain antenna scan warning limits, electrical scan limits, and mechanical limits are exceeded are indicated on the high-gain antenna plots as WL WW, SL SW, and ML MW, respectively.

Table 9-2. S-band Downlink Mode Availability for Lunar Parking Orbit

	Modes Which Meet Required Performance Levels	
	30-ft Cooled MSFN Stations	85-ft MSFN Stations
CSM	• Omni antennas: PM mode 10 only • High-gain antenna (WBW): PM modes 5, 7, 8, and 10 • High-gain antenna (NBW): PM modes 1 through 5 and 7 through 10, 15	• Omni antennas: PM modes 5 through 10 • High-gain antenna (WBW): PM modes 3 through 10 • High-gain antenna (NBW): all PM modes • FM modes 1, 2, 3, and 4
LM	• Inflight antennas: PM modes 3 and 5 • Steerable antenna: PM modes 1, 2, 3, 4, 5, 7, and 8	• Inflight antennas: PM modes 3, 4, and 5 • Steerable antenna: PM modes 1, 2, 3, 4, 5, 7, and 8 • FM mode 9

Note: Derived from data in Appendix C. All omni and inflight information shown is based on 0-dB gain for the omni and inflight antennas.

Table 9-3. Lunar Parking Orbit Sequence of Key Events for 72-Degree Launch Azimuth, 17 May 1969 Launch

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)
Lunar orbit insertion burn	LOI-1	76:08:18	03:04:08:18
Lunar orbit circularization burn	LOI-2	80:32:12	03:08:32:12
Intravehicular transfer to LM	IVT-LM	82:07:00	03:10:07:00
Intravehicular transfer to CSM	IVTCSM	83:55:00	03:11:55:00
Begin 8-hr rest period	BEREST	86:00:00	03:14:00:00
End 8-hr rest period	ENREST	94:00:00	03:22:00:00
LMP intravehicular transfer to LM	IVT-LM	95:00:00	03:23:00:00
CDR intravehicular transfer to LM	IVT-LM	95:08:00	03:23:08:00
S-band steerable antenna checks	STEERA	95:27:00	03:23:27:00
Secondary S-band T/R and power amplifier check	SECCHK	95:31:00	03:23:31:00
LMP intravehicular transfer to CSM	IVTCSM	95:34:00	03:23:34:00
LMP intravehicular transfer to LM	IVT-LM	95:50:00	03:23:50:00
Switch to S-band steerable antenna	SWSTEE	97:15:00	04:01:15:00
Undock	UNDOCK	98:30:44	04:02:30:44
CSM SEP	CSMSEP	98:55:44	04:02:55:44
Rendezvous radar and VHF ranging checks	RR/VHF	99:04:00	04:03:04:00

Table 9-3. Lunar Parking Orbit Sequence of Key Events for 72-Degree Launch Azimuth, 17 May 1969 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)
Landing radar test	LDGRDR	99:39:00	04:03:39:00
LM DPS descent orbit insertion burn	DPSDOI	99:54:12	04:03:54:12
Initiate rendezvous radar tracking	RR-ON	99:56:00	04:03:56:00
Terminate RR tracking	RR-OFF	100:20:00	04:04:20:00
LM descent orbit pericynthion	PERICN	100:51:31	04:04:51:31
LM DPS phasing burn	DPSPHA	101:06:35	04:05:06:35
Initiate RR tracking and VHF ranging	RR-ON	101:10:00	04:05:10:00
Terminate RR tracking	RR-OFF	101:18:00	04:05:18:00
Initiate RR tracking	RR-ON	101:38:00	04:05:38:00
Terminate RR tracking	RR-OFF	101:53:00	04:05:53:00
Initiate RR tracking	RR-ON	102:30:00	04:06:30:00
Terminate RR tracking	RR-OFF	102:49:00	04:06:49:00
LM RCS staging	RCSSTG	102:53:00	04:06:53:00
LM APS insertion burn	LMNSRT	103:03:29	04:07:03:29
Initiate RR tracking	RR-ON	103:21:00	04:07:21:00
LM RCS CSI	LM-CSI	103:54:40	04:07:54:40
LM RCS plane change	LM-PC	104:23:54	04:08:23:54
LM RCS CDH	LM-CDH	104:52:41	04:08:52:41
LM RCS TPI	LM-TPI	105:28:59	04:09:28:59
First LM midcourse correction (RCS)	MCC-1	105:43:59	04:09:43:59

Table 9-3. Lunar Parking Orbit Sequence of Key Events for 72-Degree Launch Azimuth, 17 May 1969 Launch (Continued)

Event	Mnemonic	Time from Lift-off (hr:min:sec)	Time from Lift-off (day:hr:min:sec)
Second LM midcourse correction (RCS)	MCC-2	105:58:59	04:09:58:59
Rendezvous	RENDEZ	106:15:30	04:10:15:30
LM active docking	LMDOCK	106:40:00	04:10:40:00
Begin LM S-band omni tests	OMTEST	106:50:00	04:10:50:00
End LM S-band omni tests		107:00:00	04:11:00:00
Begin LM S-band steerable tests	STTEST	107:20:00	04:11:20:00
CDR intravehicular transfer to CSM	IVTCSM	107:30:00	04:11:30:00
LMP intravehicular transfer to CSM	IVTCSM	107:40:00	04:11:40:00
Jettison LM	JETTLM	108:34:00	04:12:34:00
LM APS burn to depletion	LMAPSD	109:04:00	04:13:04:00
Begin 8-hr rest period	BEREST	109:49:00	04:13:49:00
End 8-hr rest period	ENREST	118:00:00	04:22:00:00
Transearth injection burn	TEI	129:50:00	05:09:50:00

Analysis of the RF coverage data contained in this section results in the following conclusions and recommendations for the lunar parking orbit for an 18 May 1969 launch:

a) The station coverage recommended for the first 26 revolutions will apply with the exception that HSK should continue providing prime station coverage through the seventh revolution and MAD should begin providing prime station coverage on the eighth revolution. The same general sequence of prime station coverage will apply for the additional revolutions planned for the 18 May 1969 mission.

b) The received carrier power predicted for the high-gain antenna and the steerable antenna will remain the same for like stations.

c) The frequency and time duration of HGA limitations given in Table 9-1 are representative of the limitations to be expected on the 18 May launch. The time that the HGA exceeds its electrical or mechanical limits with respect to a maneuver associated with a particular event will remain essentially the same.

d) The general performance of the omni antennas indicated in the received carrier power plots is representative of the performance to be expected on an 18 May 1969 launch. The plots show the relative changes in carrier power and the frequency of antenna switching that would be required to maintain positive circuit margins during the various maneuvers. Due to differences in MSFN look angles for the two missions, the carrier power levels shown for the individual antennas will not necessarily remain the same. A particular omni antenna shown in the plots as providing the best coverage for a particular station and event may not necessarily provide the best coverage for the 18 May launch.

e) Antenna D will normally be usable when the HGA is not available. The omni antenna recommendations for the times the HGA is not usable will not necessarily apply due to the differences in MSFN station look angles.

9.4 CSM S-BAND PERFORMANCE

The 85-foot MSFN stations will normally be used for all lunar distance CSM communications. During lunar orbit, CSM/LM docked, crew awake, coasting flight operations, an inertial attitude will be maintained that will allow MSFN to acquire either the CSM HGA or LM steerable antenna without crew assistance. During the sleep periods the spacecraft will be oriented so that HGA faces MSFN without interference from the

SPS engine bell. During the sleep period, the HGA will be in the auto REACO mode and the S-band system will be controlled by RTC to select TLM - HBR on the lunar earth side and LBR/DSE recording on the lunar far side. This procedure will provide for playback of LBR data recorded on the lunar far side when the spacecraft after acquisition on the earth side. Due to spacecraft attitude, the CSM HGA will not be in view of MSFN during any CSM landing site tracking period.

All CSM HBR data at lunar distance will require the use of the CSM high-gain antenna in combination with either a 30-foot cooled or 85-foot MSFN station.

Lunar multipath may cause poor communications for periods of less than one minute duration at times of reacquisition after lunar occultation. This may cause large errors in data transmission and possibly erratic antenna tracking. Normal acquisition procedures should not be affected because of the short duration of the lunar multipath effects.

FM mode-as-a-whole analysis (excluding color TV) shows FM availability from the CSM at lunar distance only when using the CSM HGA (NBW) antenna in combination with an 85-foot MSFN station. The CSM FM modes will normally be used for DSE playbacks and CSM real-time TV; however, the CSM FM transmitter can also be used for real-time TLM and voice backup.

Color TV will be transmitted during the post-LOI period and during undocking. Black and white television is also available during the lunar parking orbit phase. The maximum range of the CSM HGA/85-foot MSFN antenna combination for excellent color TV picture quality is approximately 170,000 nautical miles; therefore, the 210-foot antenna at GDS must be used for color TV reception. A detailed analysis of CSM FM modes for the Apollo 10 mission is presented in Appendix F.

On Apollo 10 and subsequent missions, 85-foot MSFN stations will have new phase lock loop FM demodulators with selectable two sided loop bandwidths of 3.6 MHz (narrow) or 10 MHz (wide). To assure proper demodulation of CSM and LM FM signals, the demodulators must be configured as follows:

a) CSM FM mode 1 - narrow
b) CSM FM mode 2 - narrow
c) CSM FM mode 3 - narrow

d) CSM FM mode 4 - wide
e) LM FM mode 9 - wide
f) LM FM mode 10 - wide

If these configurations are not used, CSM and LM data will be severely degraded (especially CSM mode 4 and LM mode 10 which have TV with large frequency deviations).

9.5 LM S-BAND PERFORMANCE

The 85-foot antenna MSFN stations will normally be used for all lunar distance LM communication. During CSM/LM lunar orbit, docked, crew awake, coasting flight operations an attitude will be maintained that will allow MSFN to acquire either the CSM HGA or LM steerable antenna without crew assistance. All LM HBR data at lunar distance will require the use of the steerable antenna in combination with either a 30-foot cooled or an 85-foot MSFN station.

Hard line biomed data are available from the LM at lunar distance only on the steerable antenna in combination with either a 30-foot cooled or 85-foot MSFN station LM downlink PM mode 11 (PRN only) will be available on S-band inflight antennas.

Due to the broad ground station antenna beamwidth at lunar distance (approximately 1100 nautical miles), there is only a remote possibility that during separation activities the LM (CSM) will not be within the ground station antenna beam that is tracking the CSM (LM). Should this occur, however, use of a JPL wing site will enable the same station to talk to both spacecrafts simultaneously. The steerable antenna will be in free track while on earth side of moon.

Prior to LM jettison, the LM S-band steerable antenna will be set at a fixed position for the APS burn to depletion, DATA will be in the HBR position. MSFN will attempt to track the LM and obtain TLM data after the APS burn to depletion. Received carrier power versus elapsed time are provided for the time period from LM jettison to one hour after the APS burn. The LM S-band system, however, will remain in operation until onboard power is exhausted.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =107.6
ELV =68.22
RANGE=214658

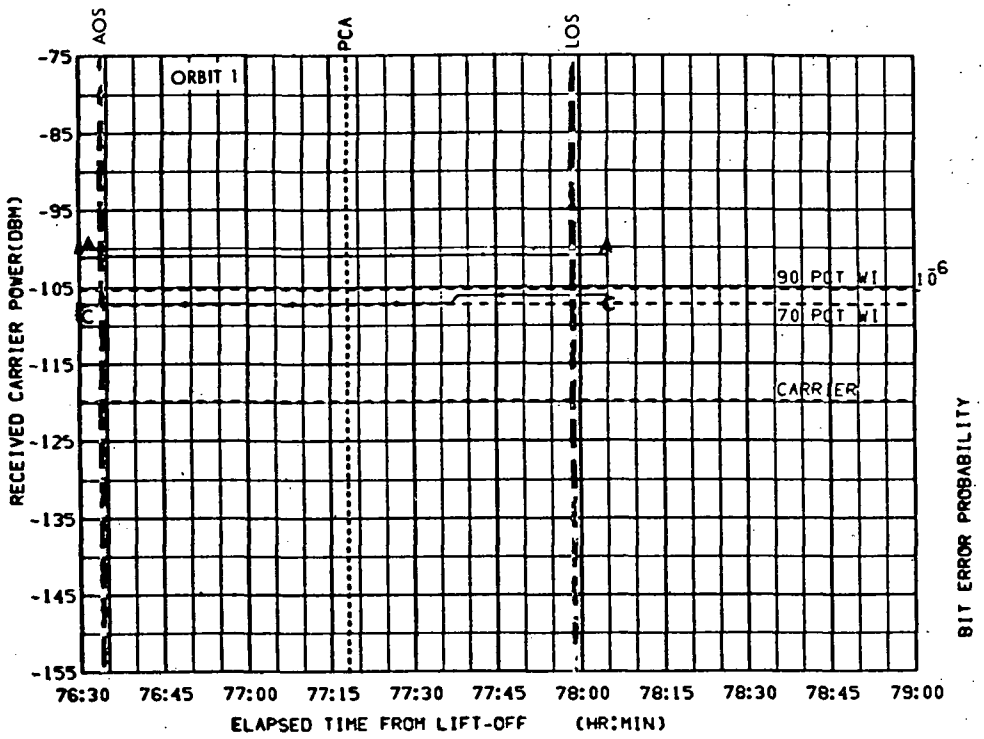

FIGURE 9-8a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

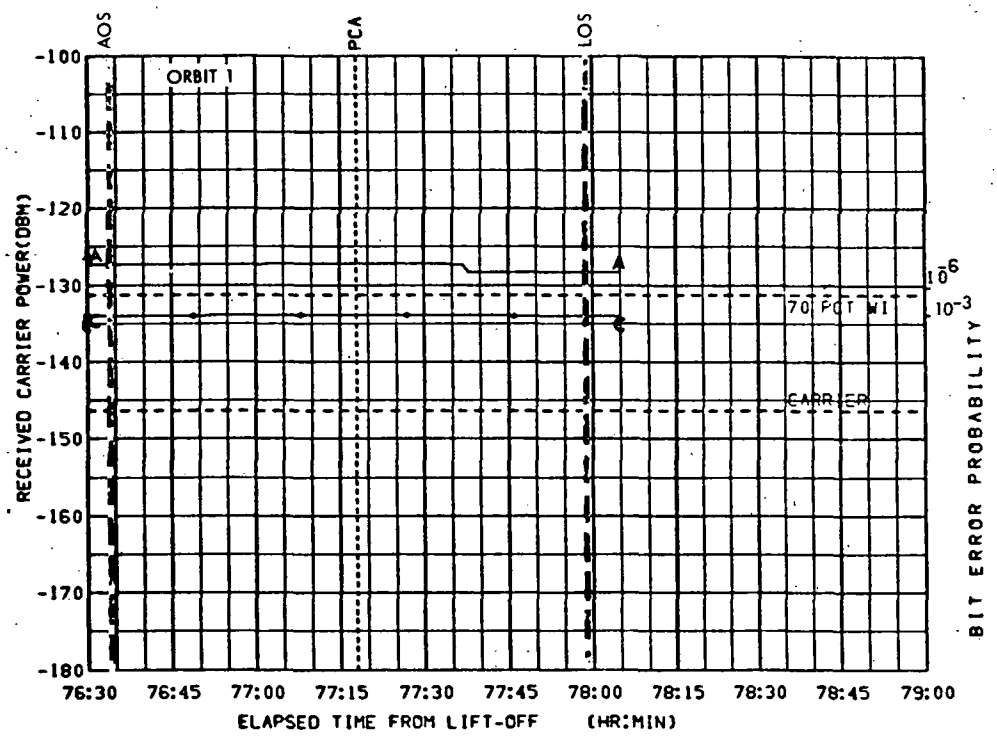

FIGURE 9-8b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =107.6
ELV =68.22
RANGE=214658

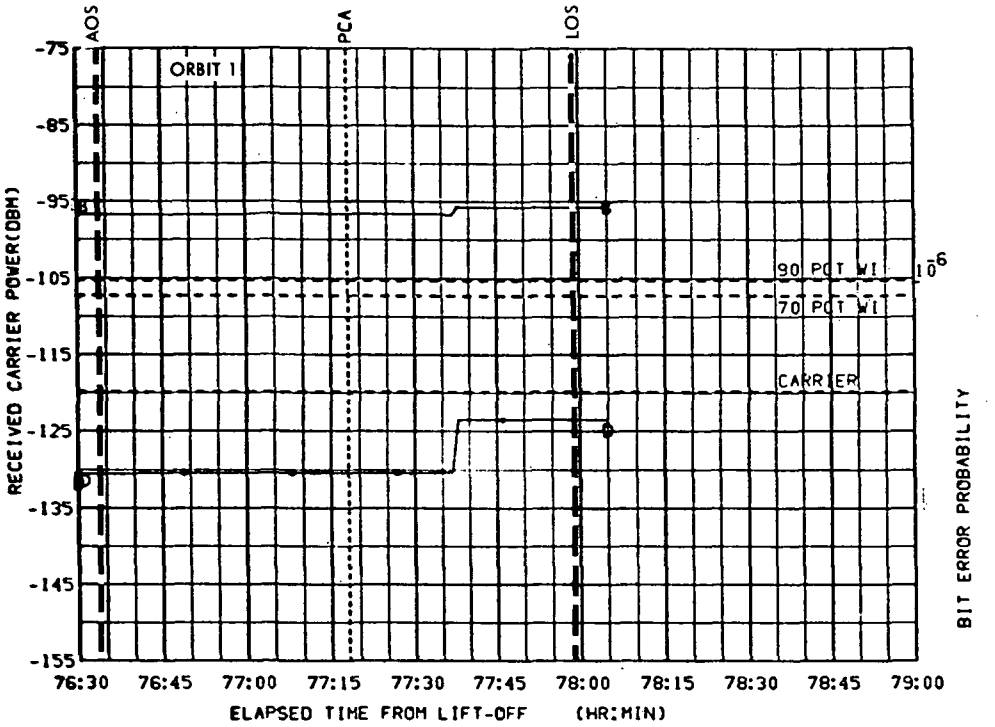

FIGURE 9-8c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

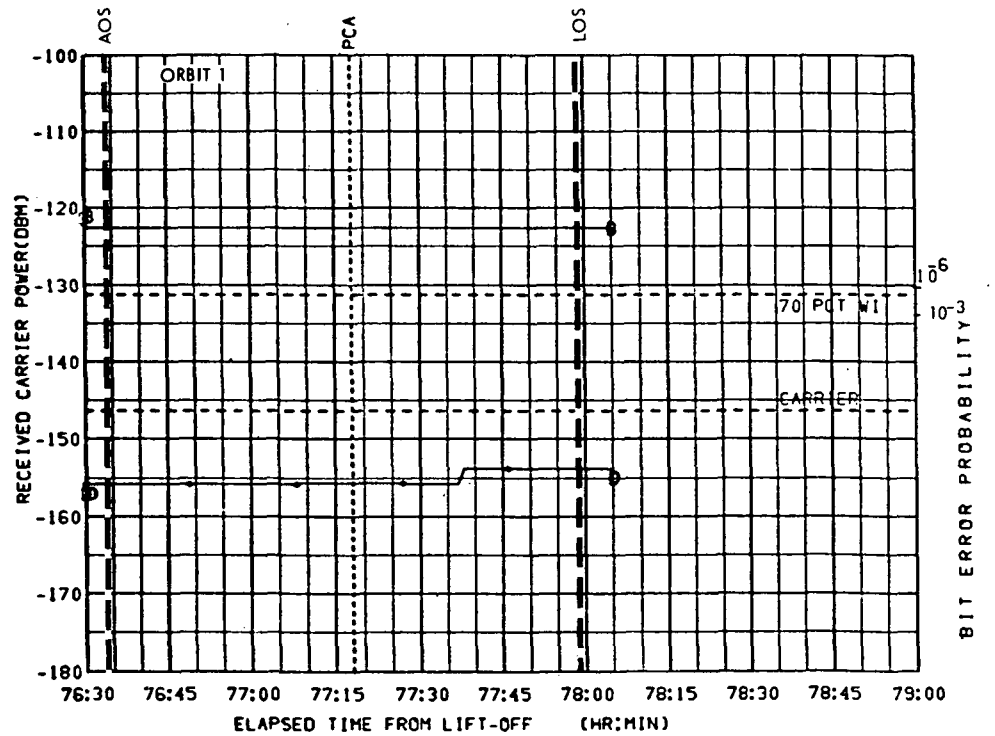

FIGURE 9-8d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =107.6
ELV =68.22
RANGE=214658

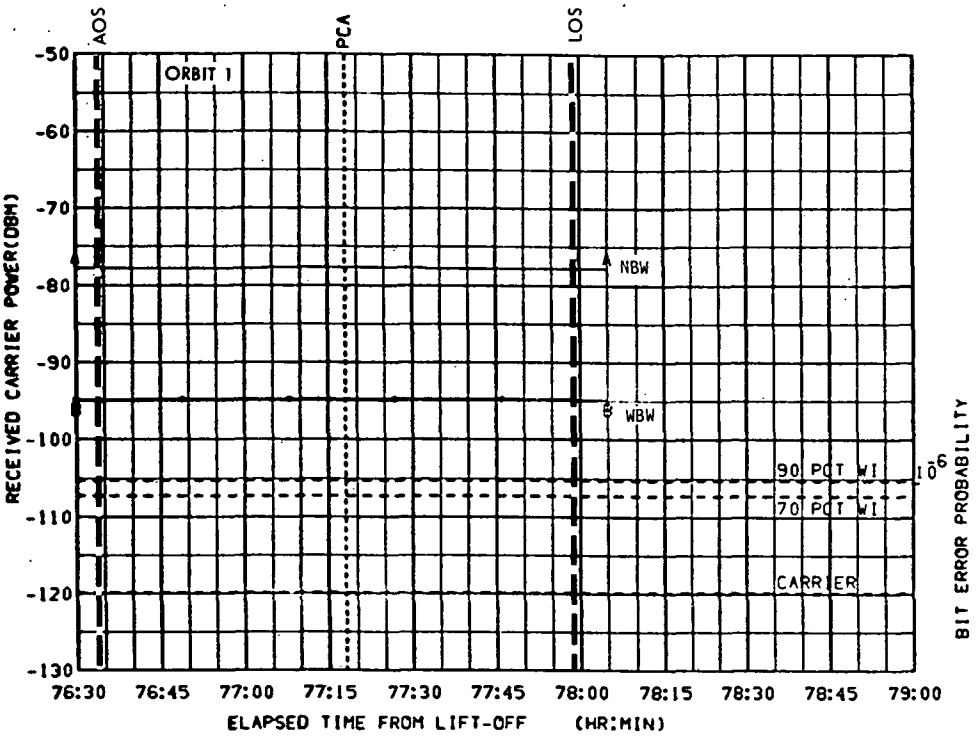

FIGURE 9-8e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT- LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

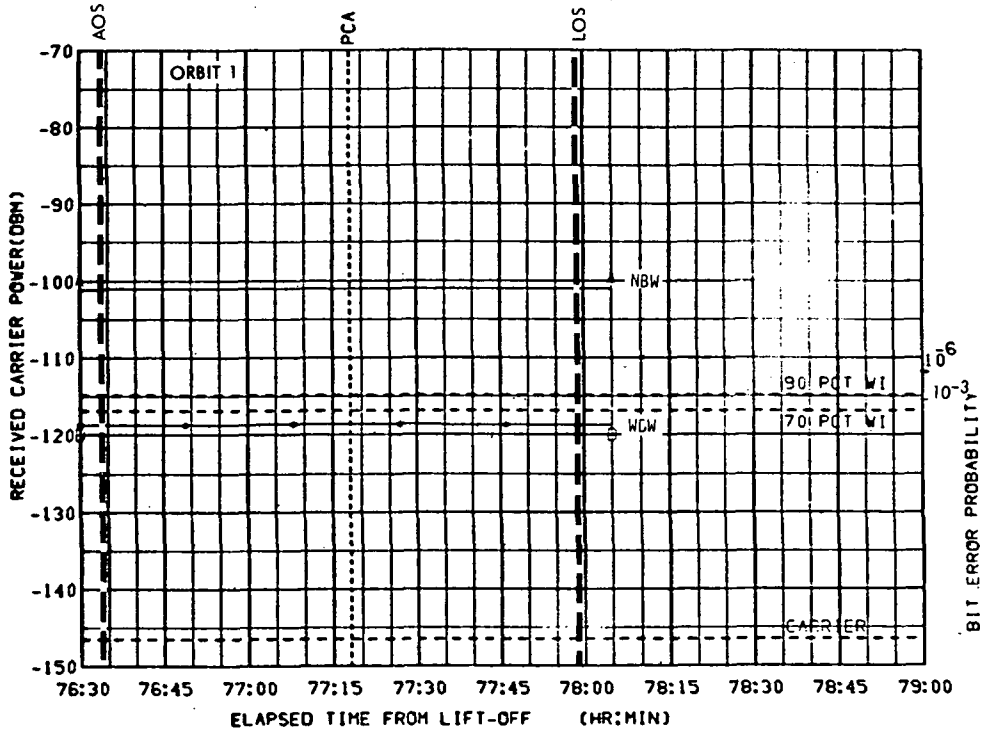

FIGURE 9-8f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

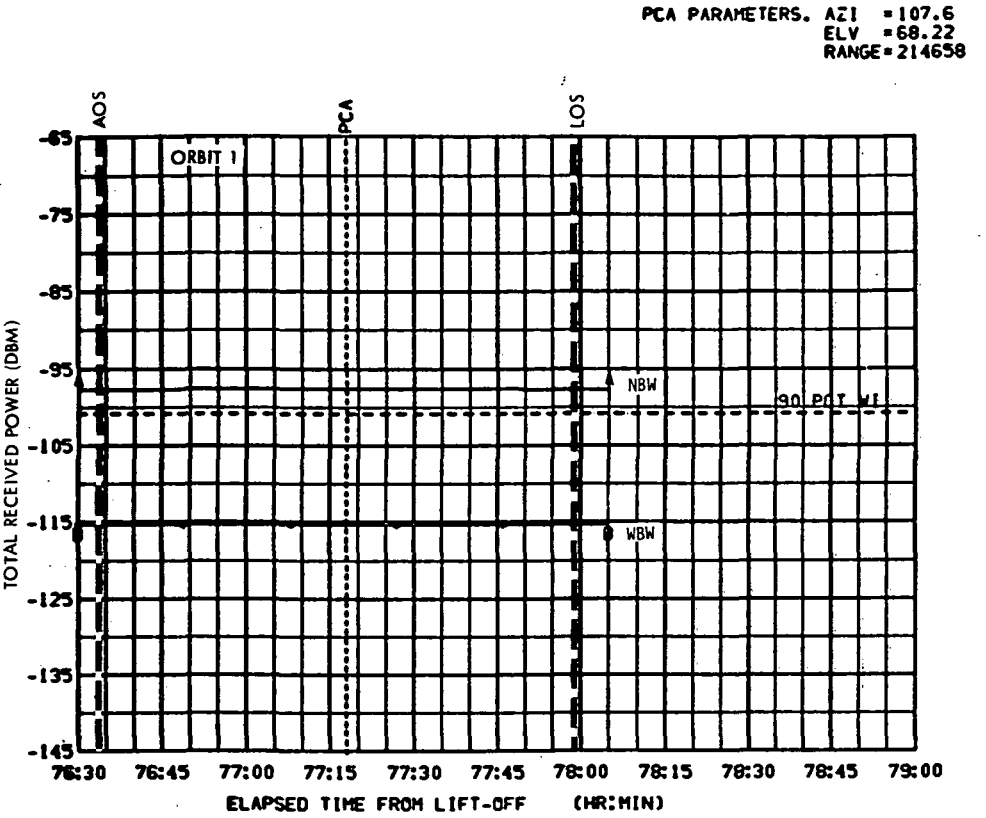

FIGURE 9-8g. GDS DNLINK FM MODES CSM/MSFN S-BAND HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

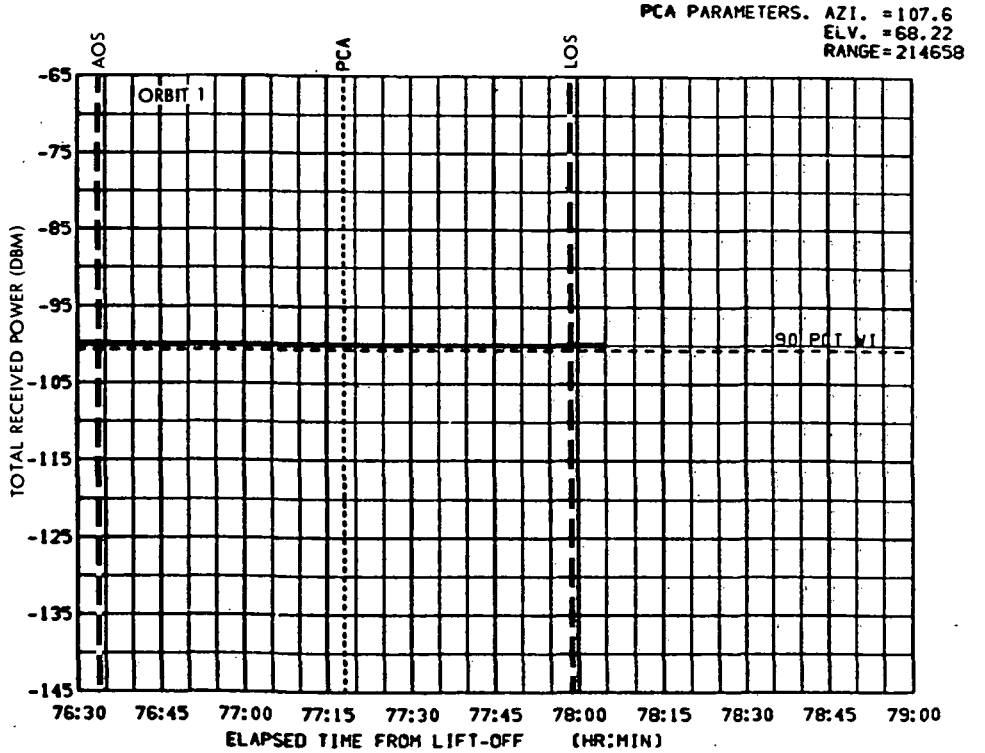

FIGURE 9-8h. GDS DNLINK FM MODES LM/MSFN S-BAND STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 107.6
ELV = 68.22
RANGE = 214658

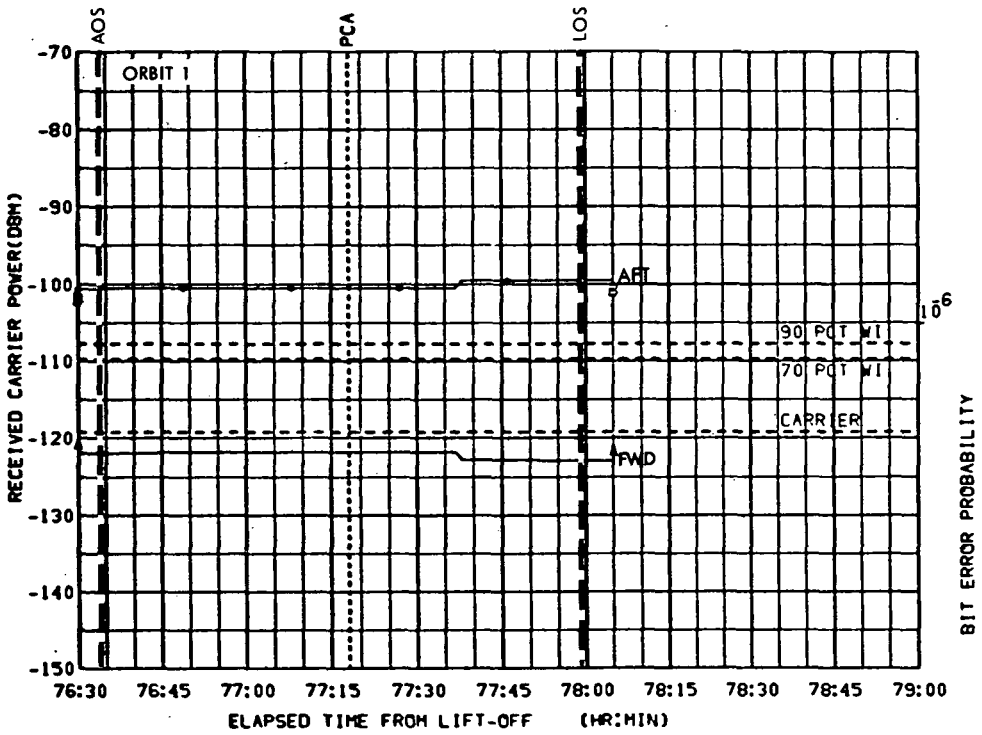

FIGURE 9-8i. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

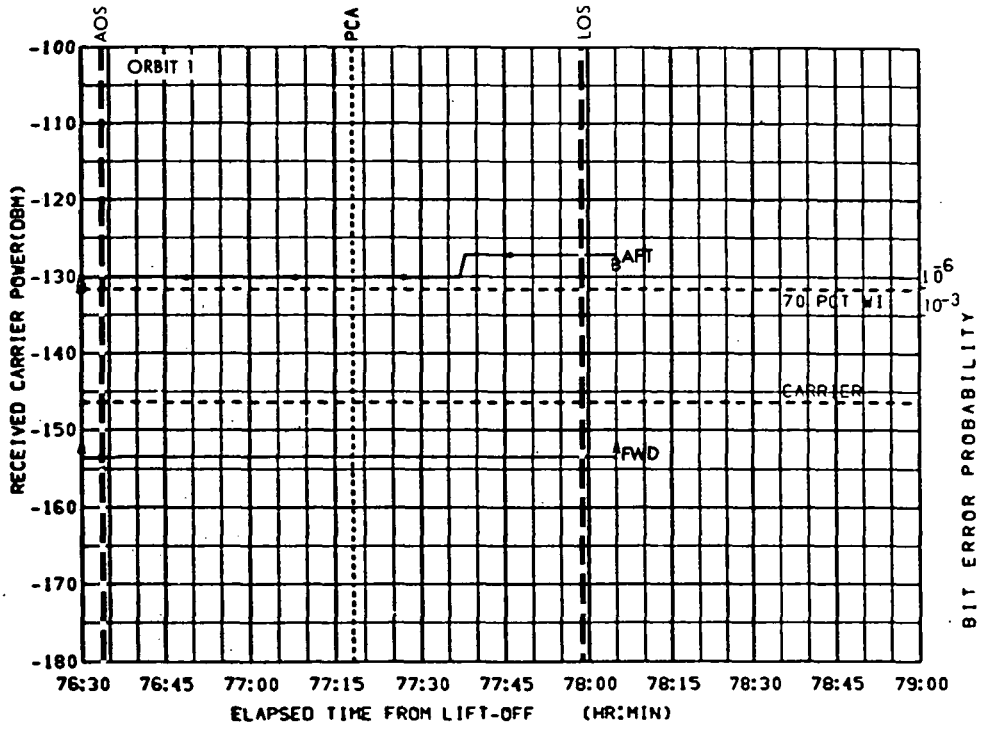

FIGURE 9-8j. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. =107.6
ELV. =68.22
RANGE=214658

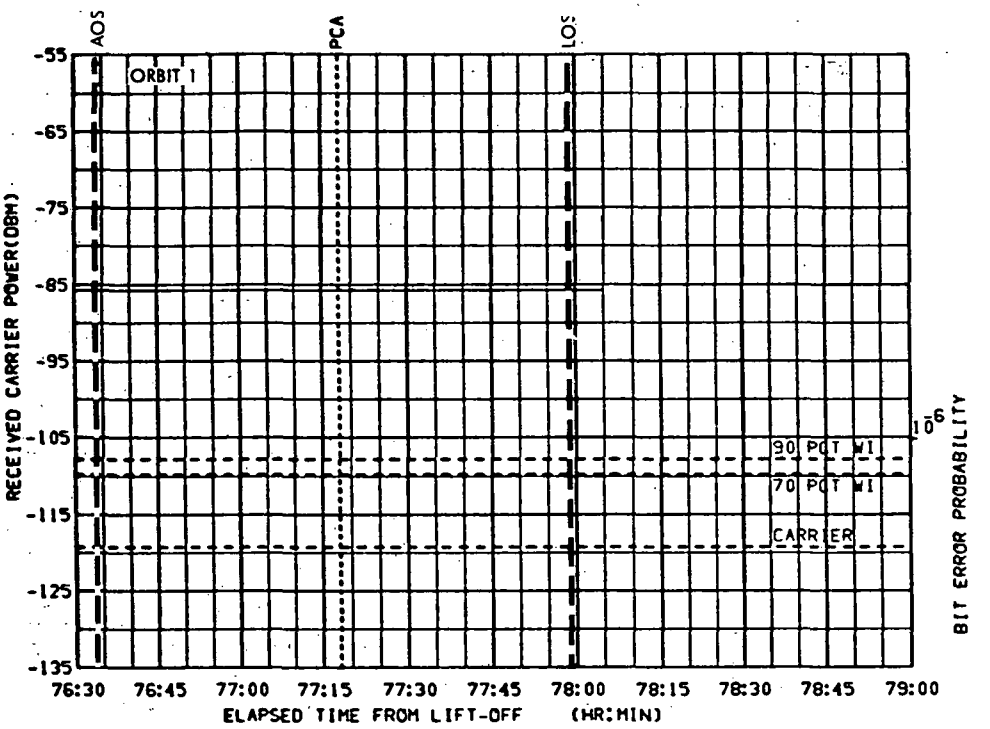

FIGURE 9-8k. GDS UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

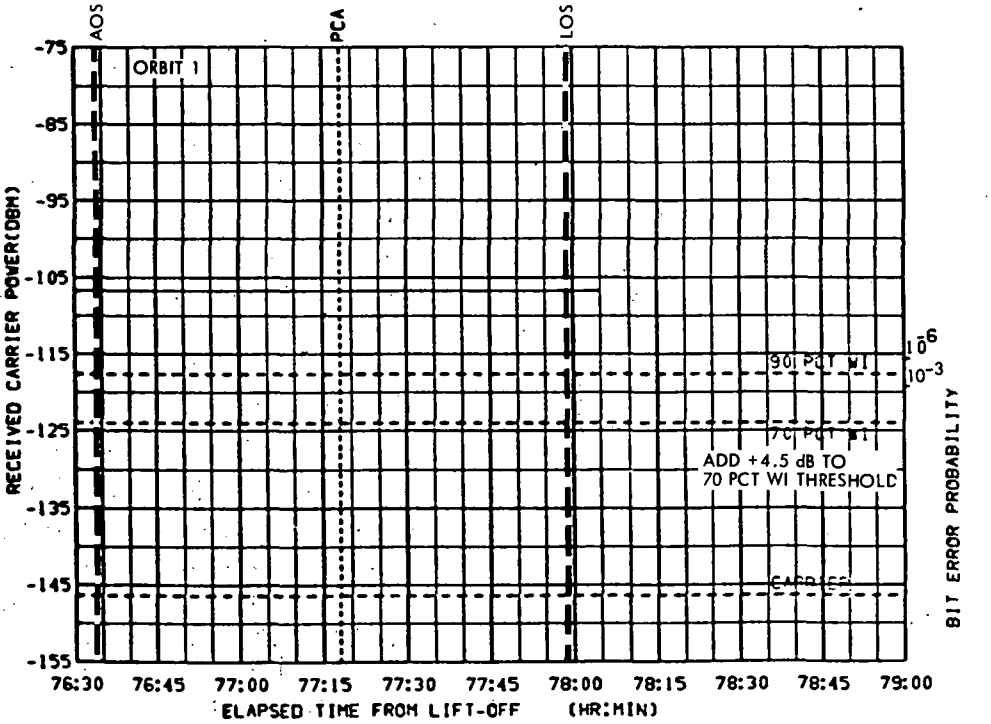

FIGURE 9-8l. GDS DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =-61.74
ELV =6.093
RANGE=217491

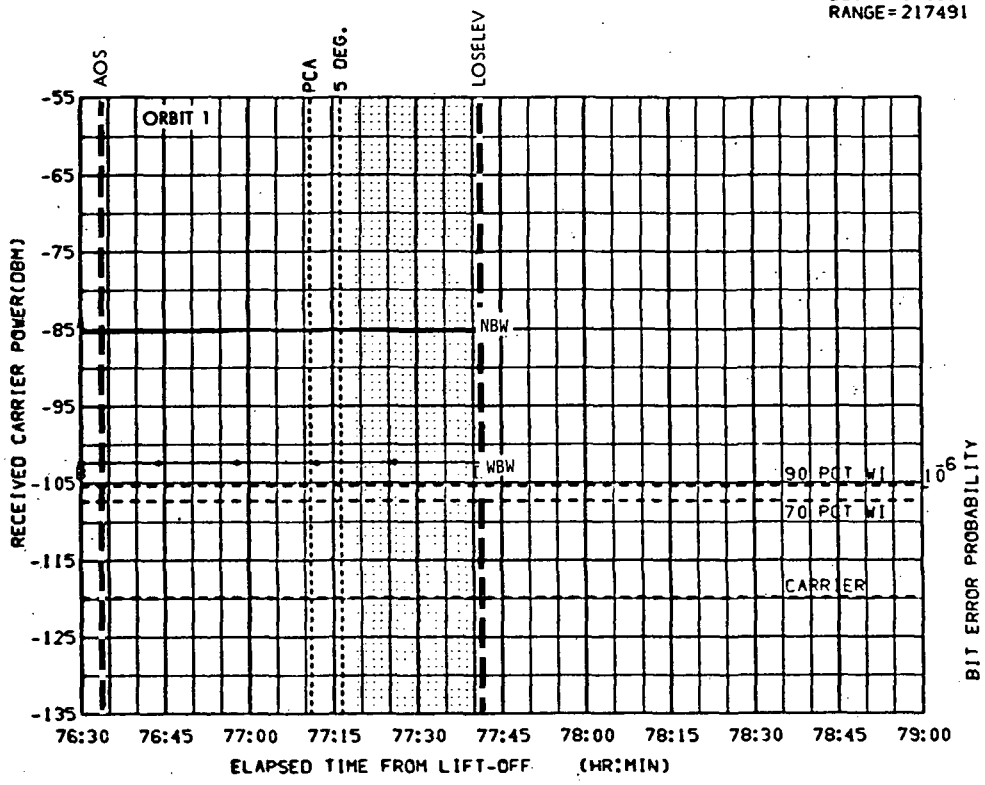

FIGURE 9-9a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

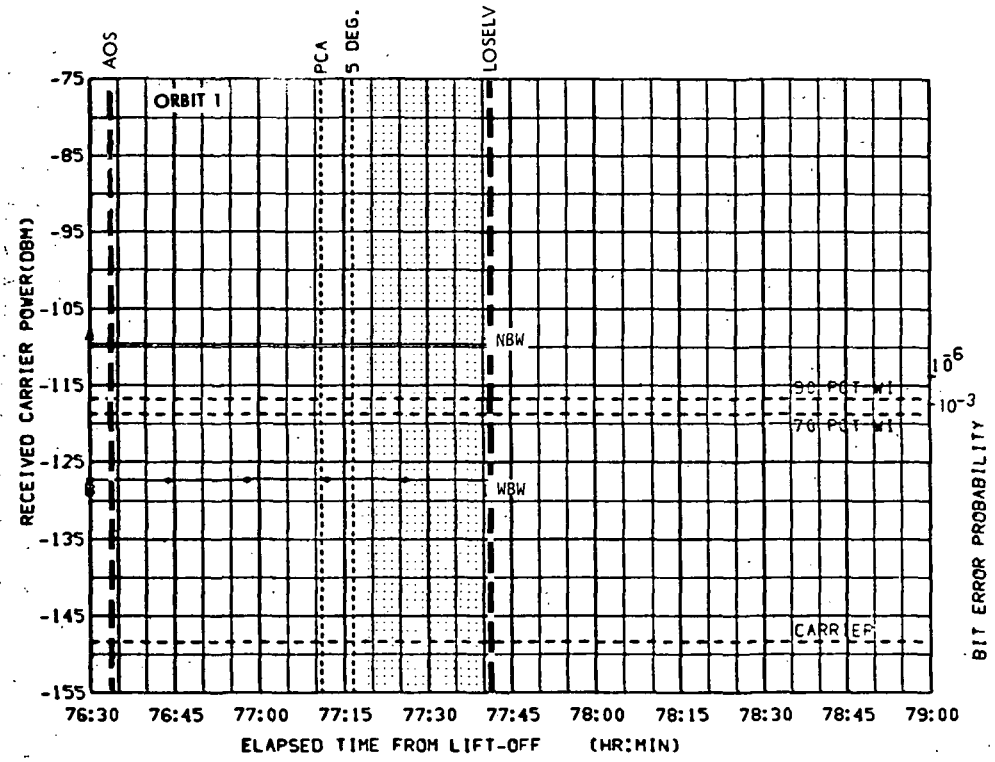

FIGURE 9-9b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. =-61.74
ELV. =6.093
RANGE=217491

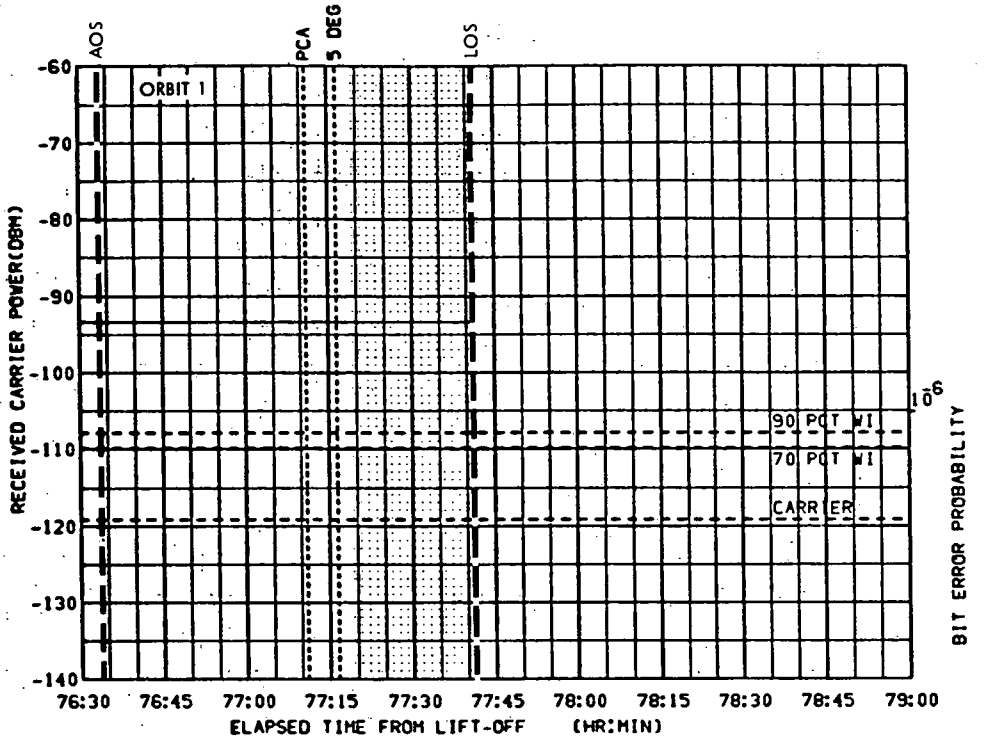

FIGURE 9-9c. ACN UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

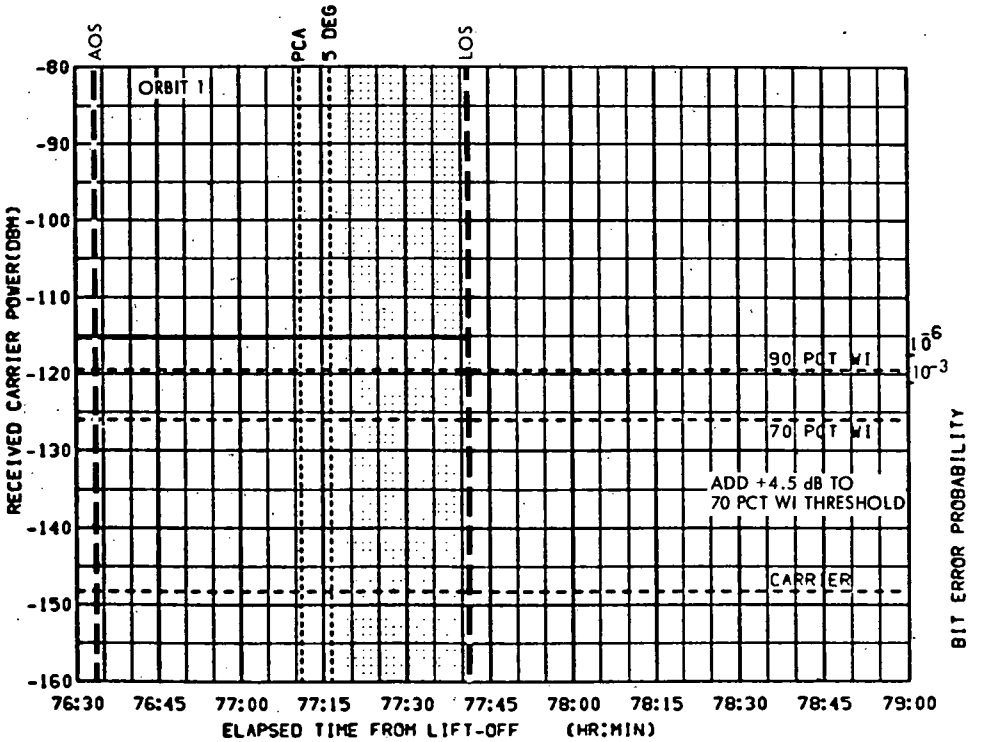

FIGURE 9-9d. ACN DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

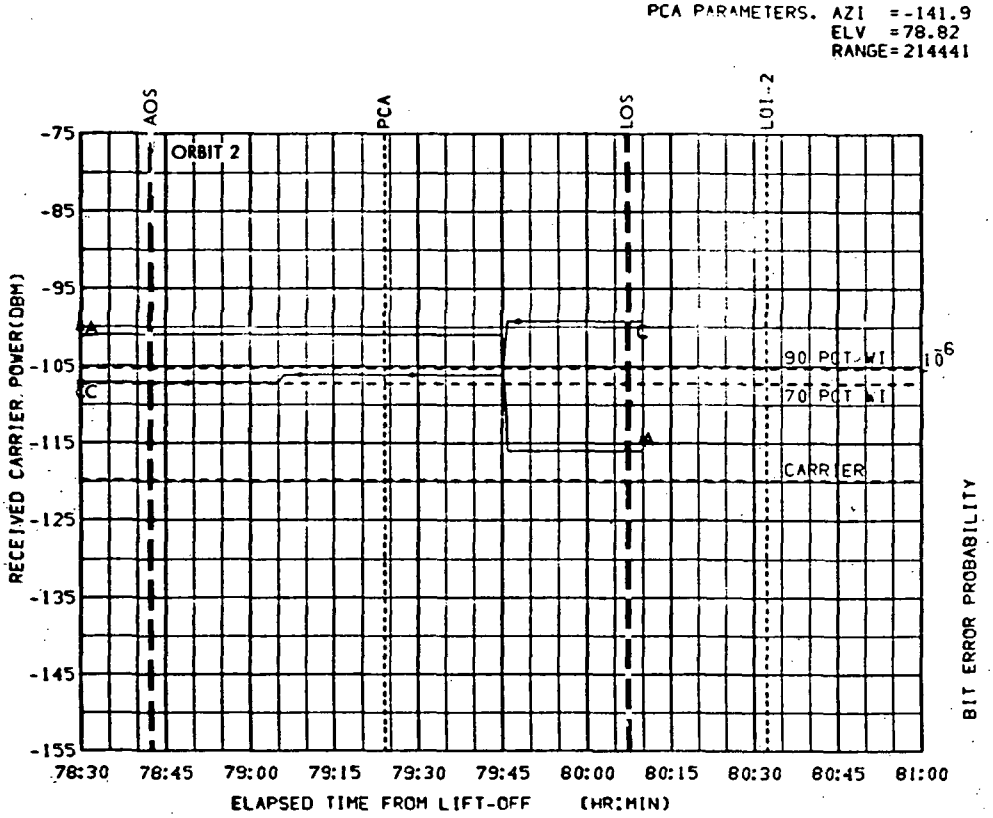

FIGURE 9-10a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

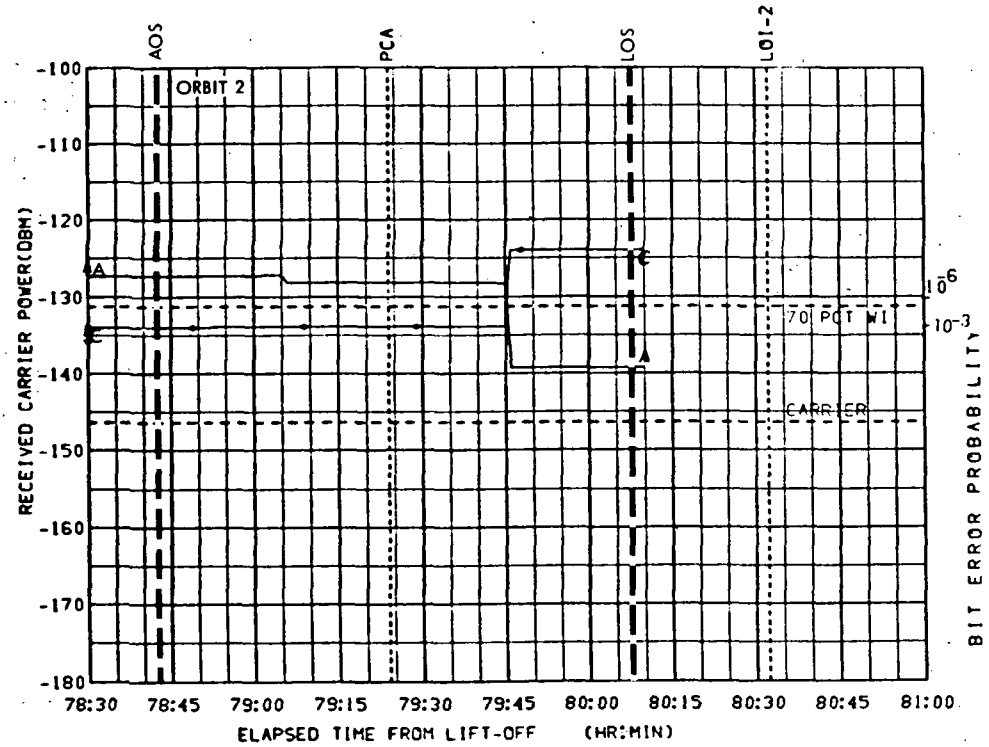

FIGURE 9-10b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

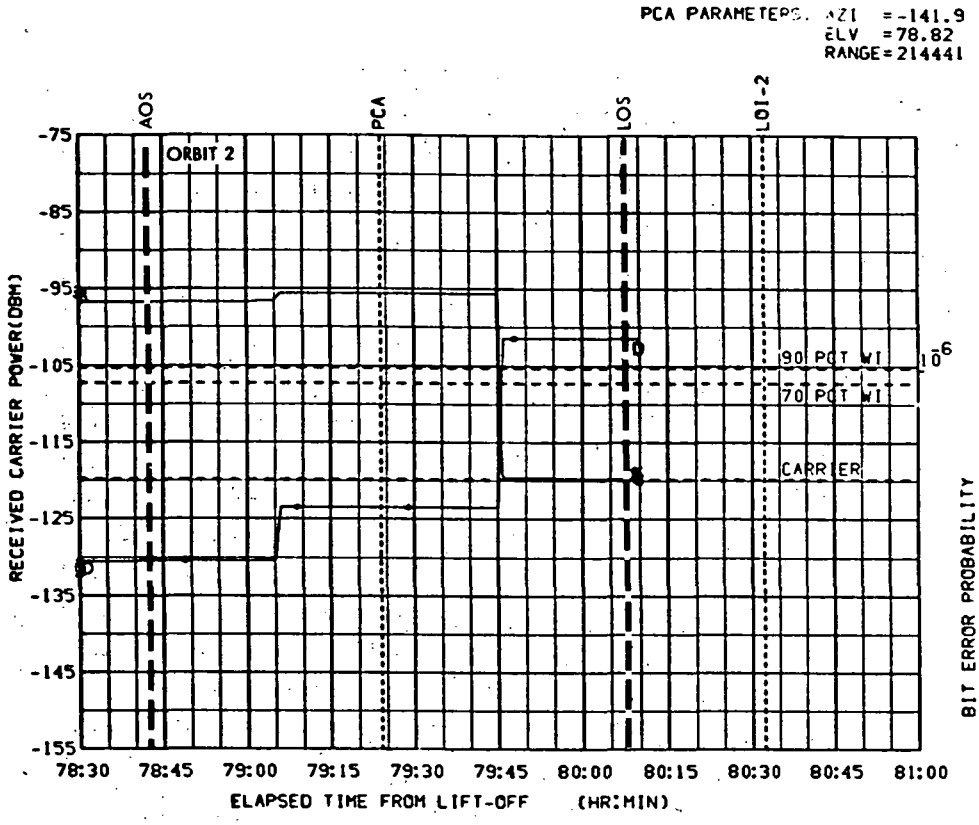

FIGURE 9-10c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

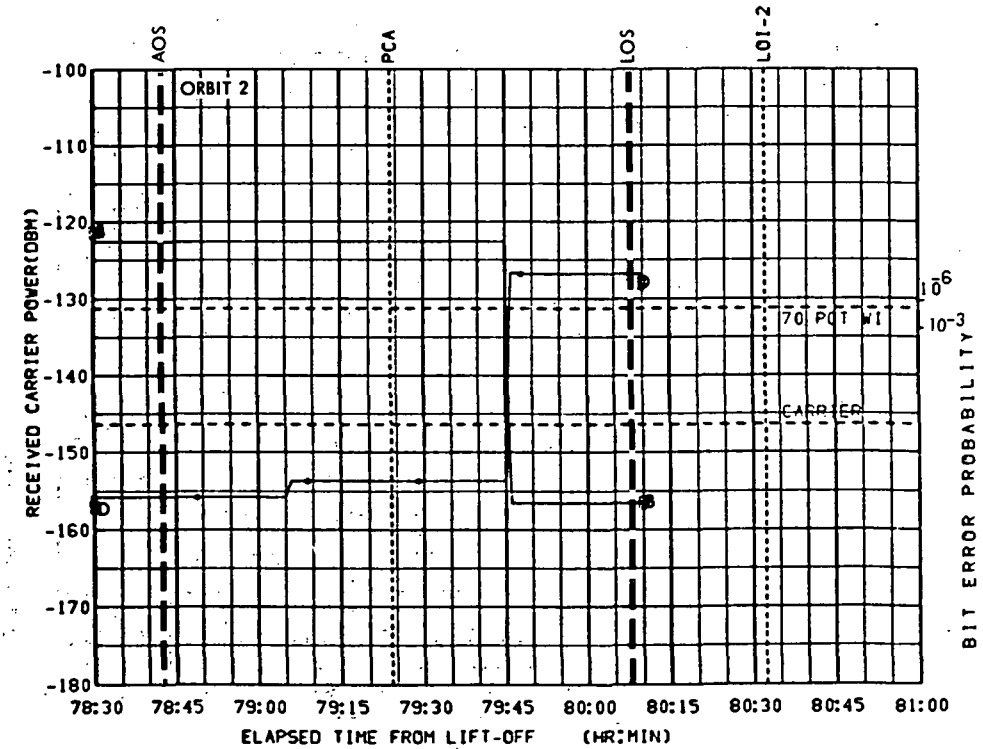

FIGURE 9-10d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =-141.9
ELV =78.82
RANGE=214441

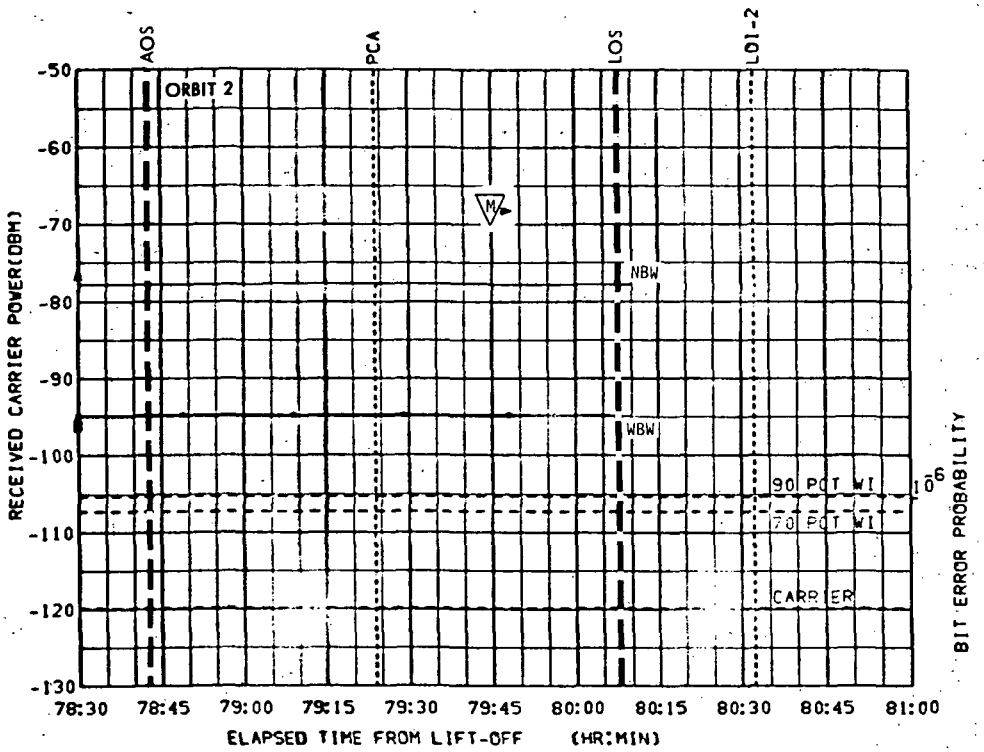

FIGURE 9-10e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

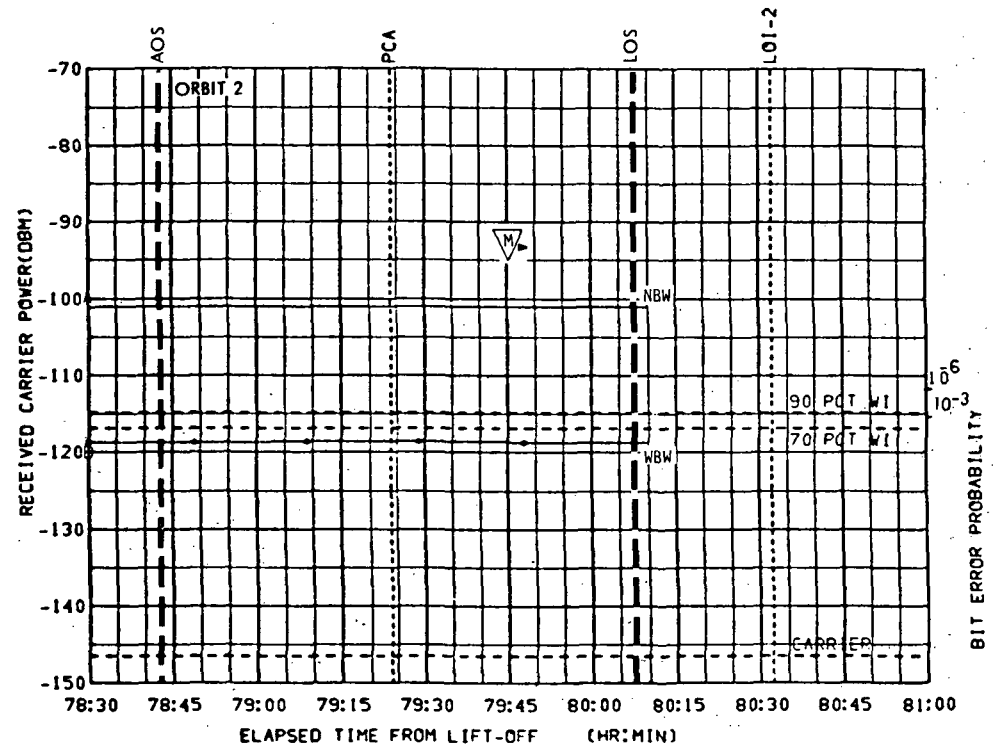

FIGURE 9-10f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

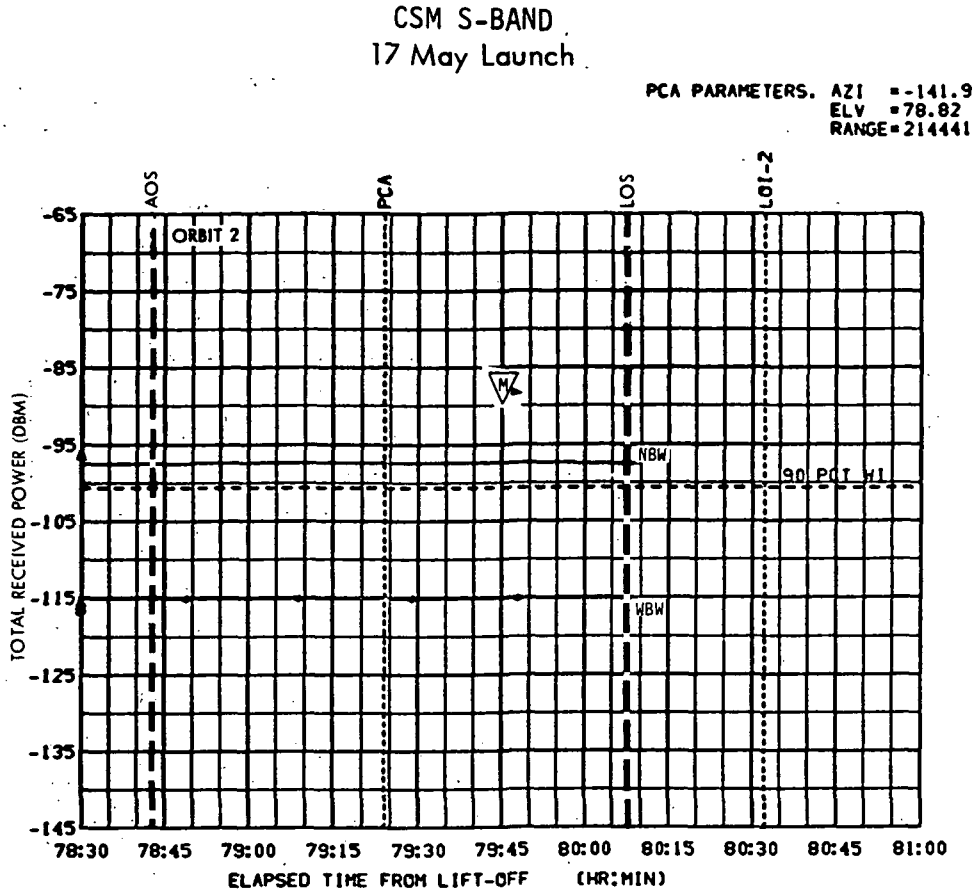

FIGURE 9-10g. GDS DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

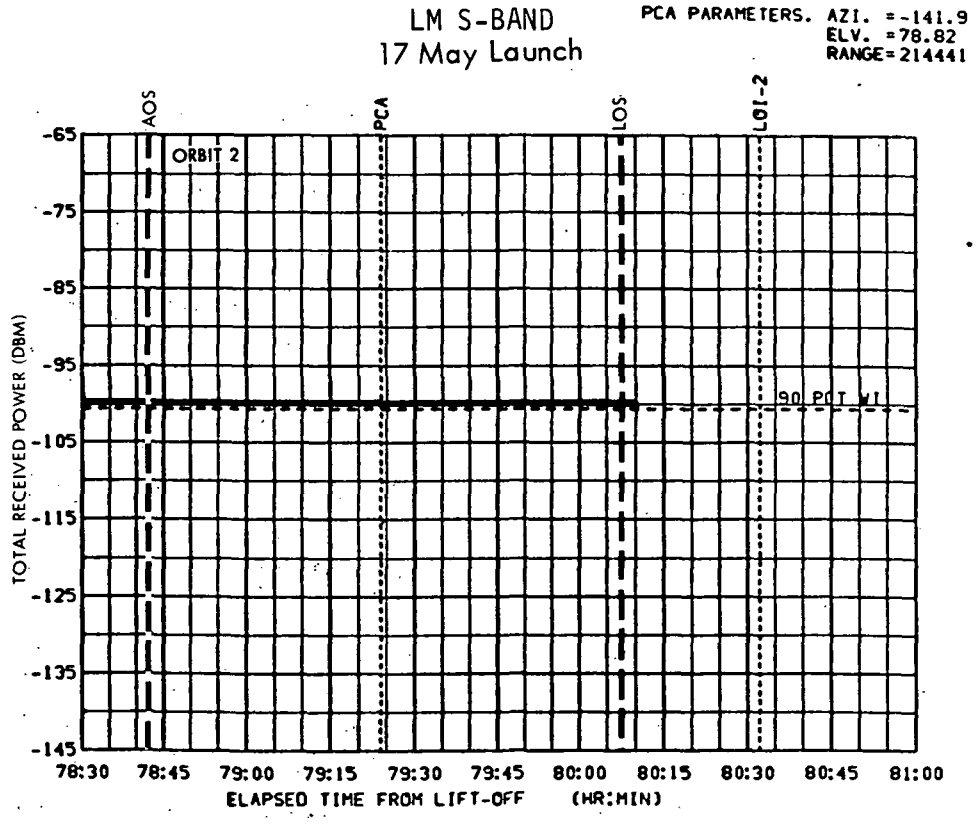

FIGURE 9-10h. GDS DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

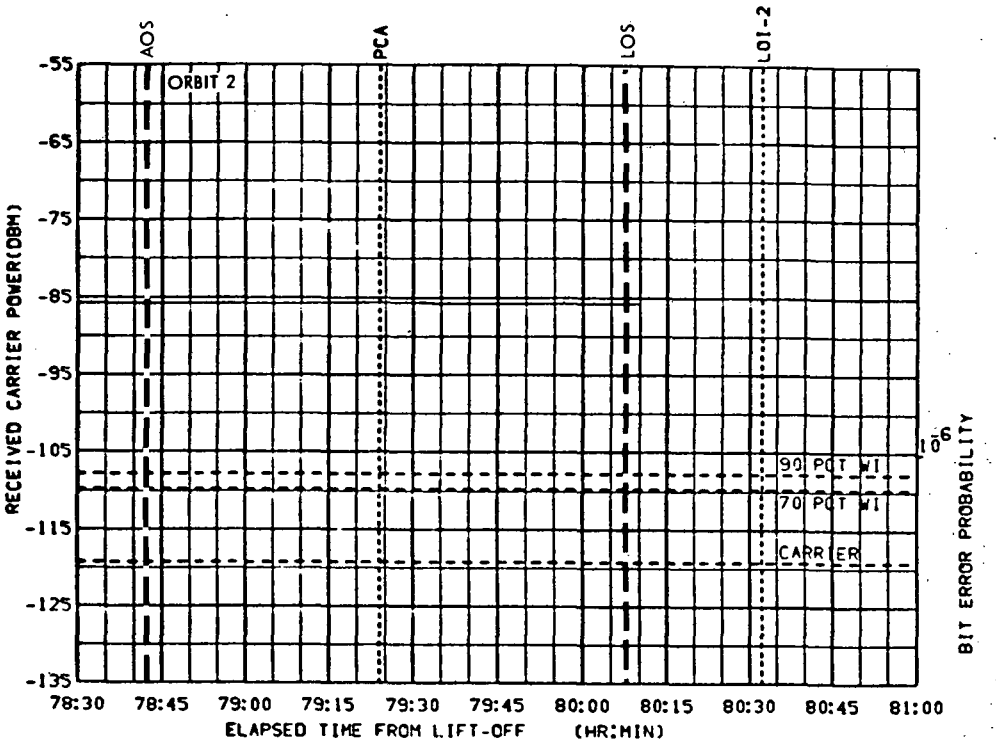

FIGURE 9-10i. GDS UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

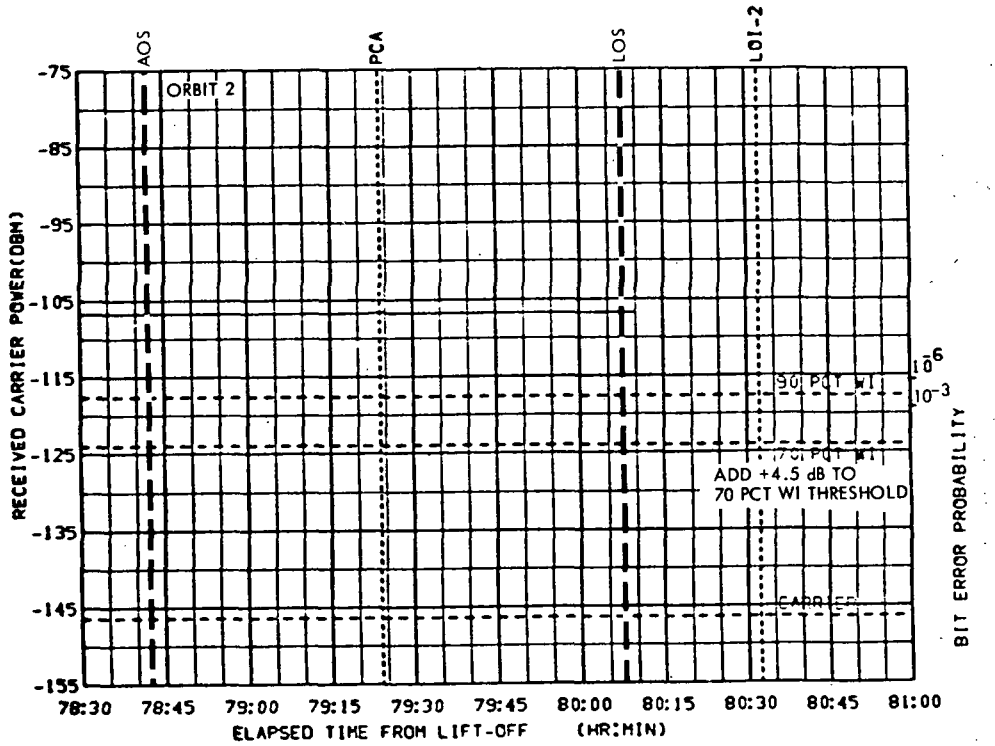

FIGURE 9-10j. GDS DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

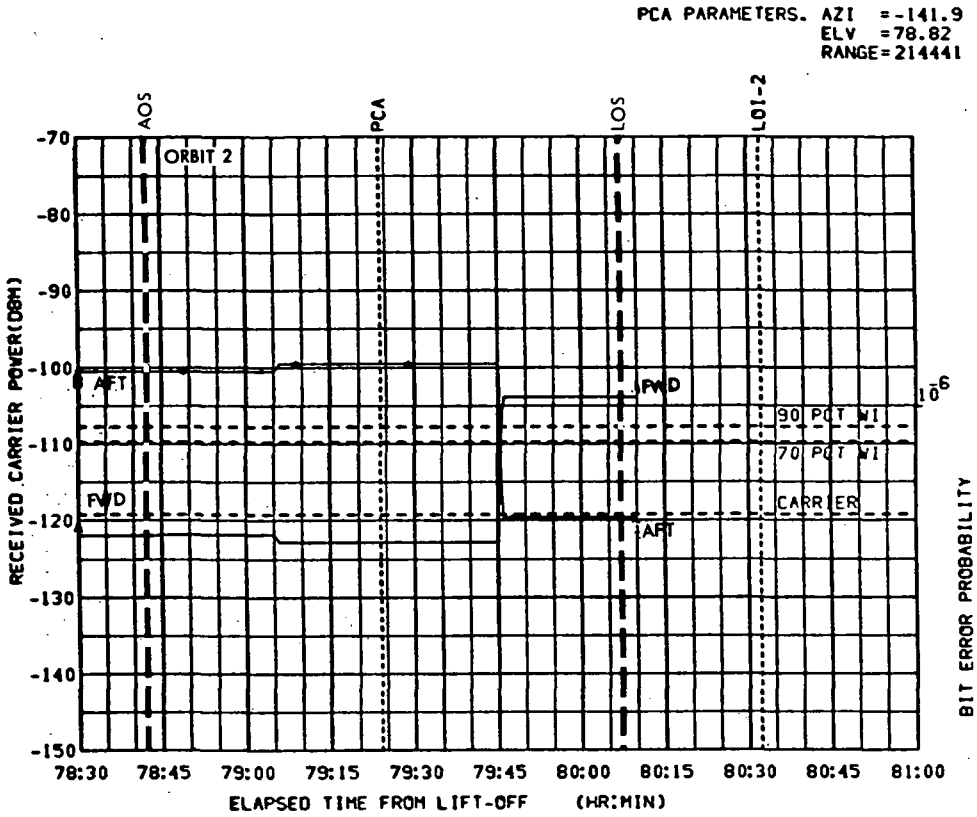

FIGURE 9-10k. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

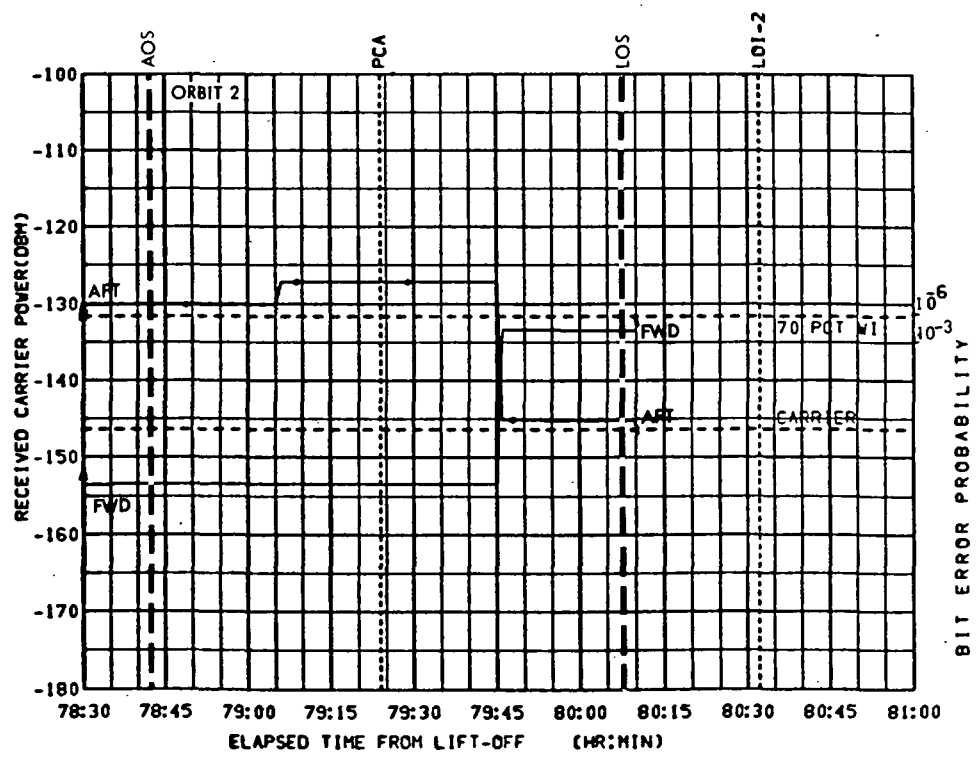

FIGURE 9-10l. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

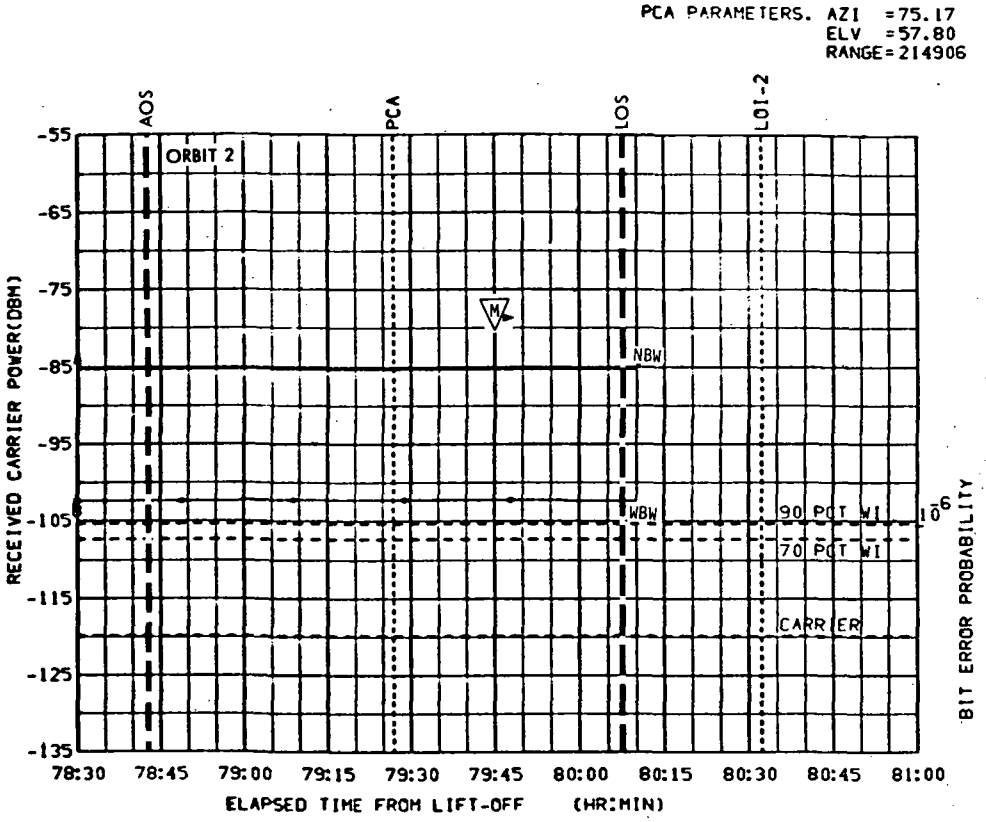

FIGURE 9-11a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

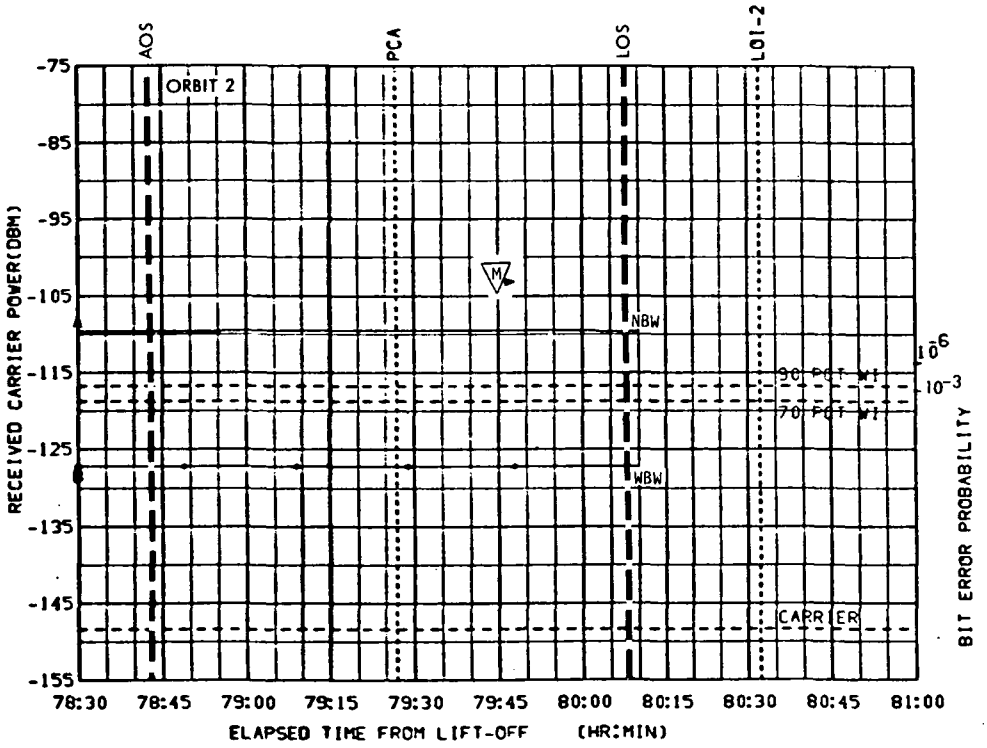

FIGURE 9-11b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

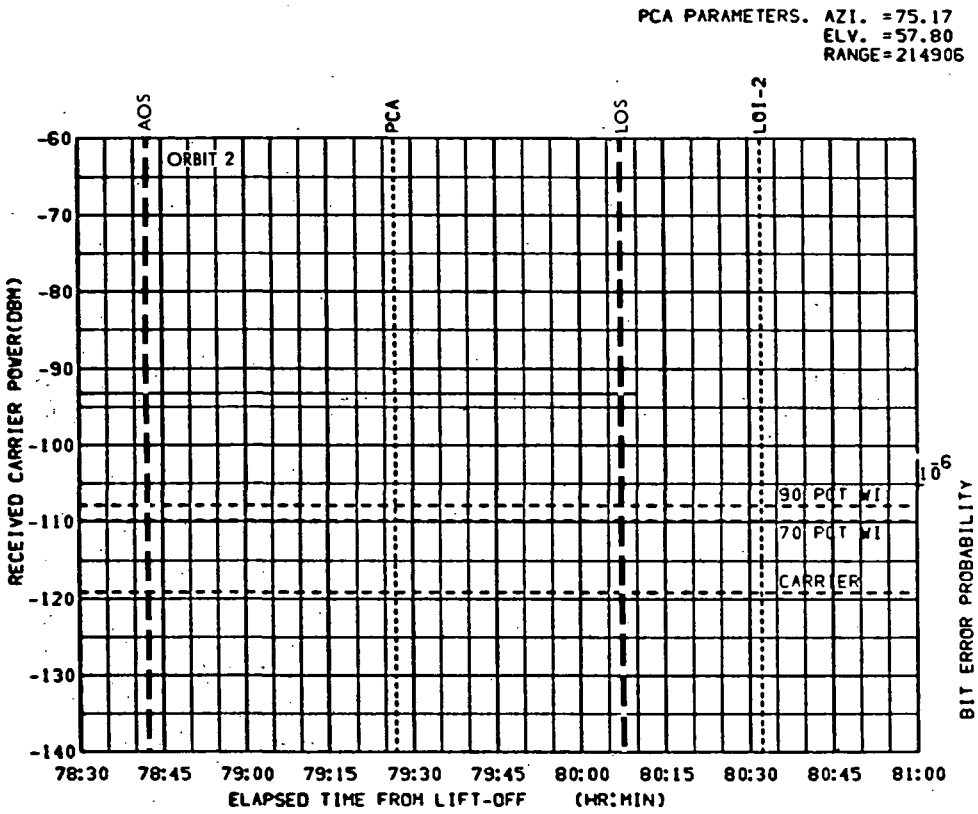

FIGURE 9-11c. MAW UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

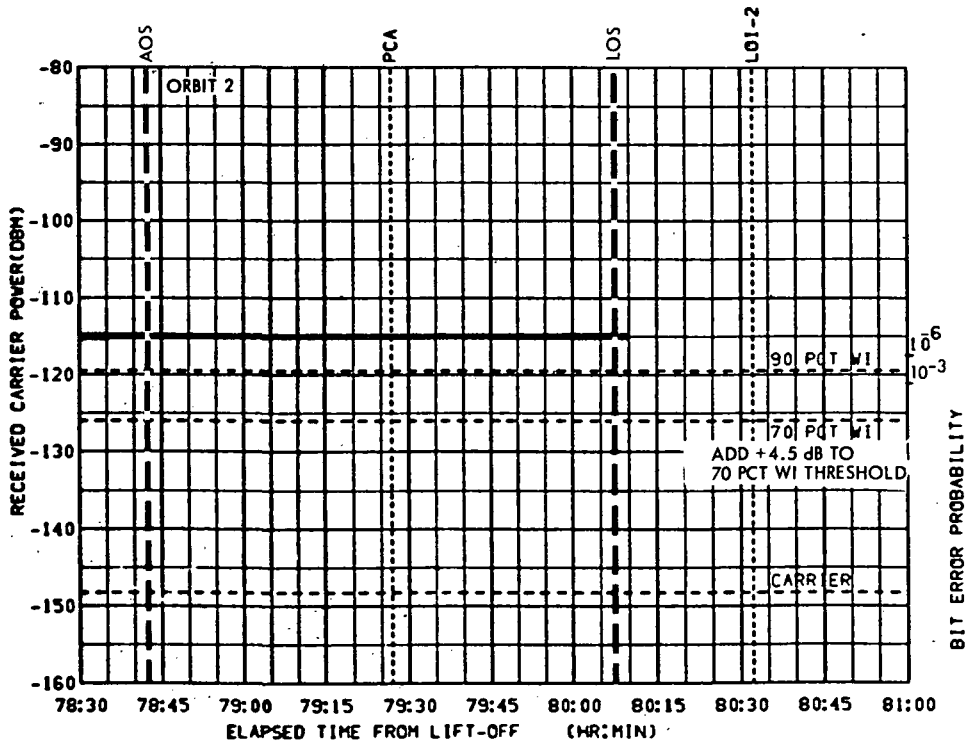

FIGURE 9-11d. MAW DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

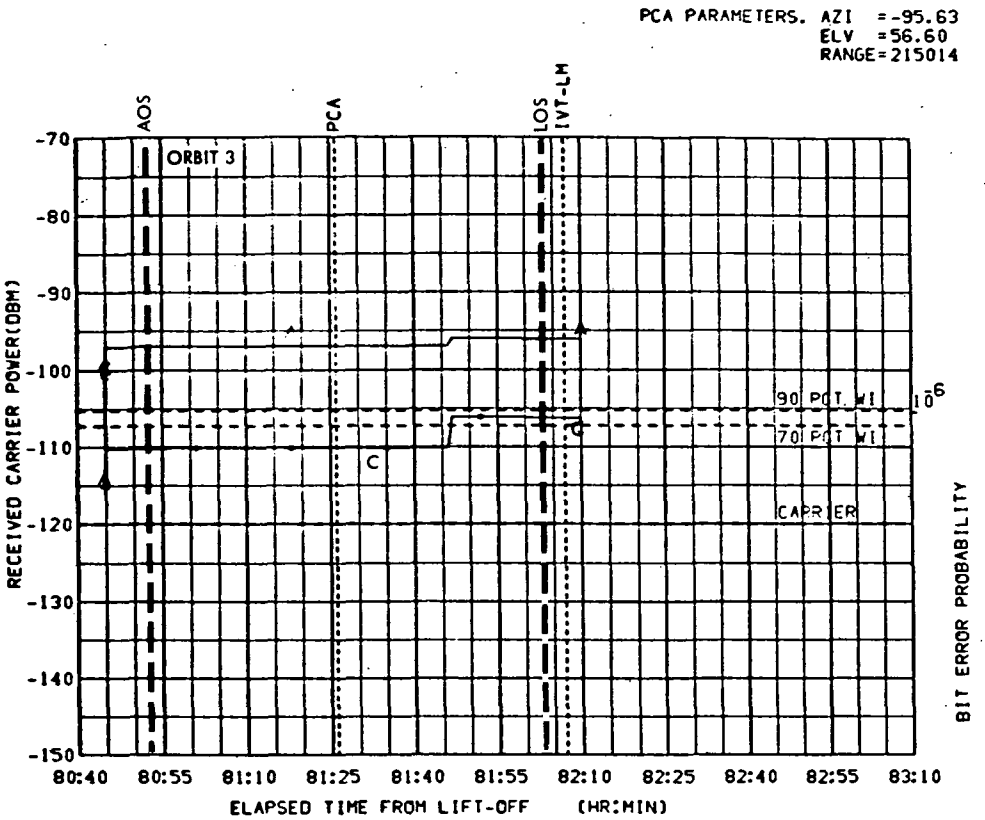

FIGURE 9-12a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

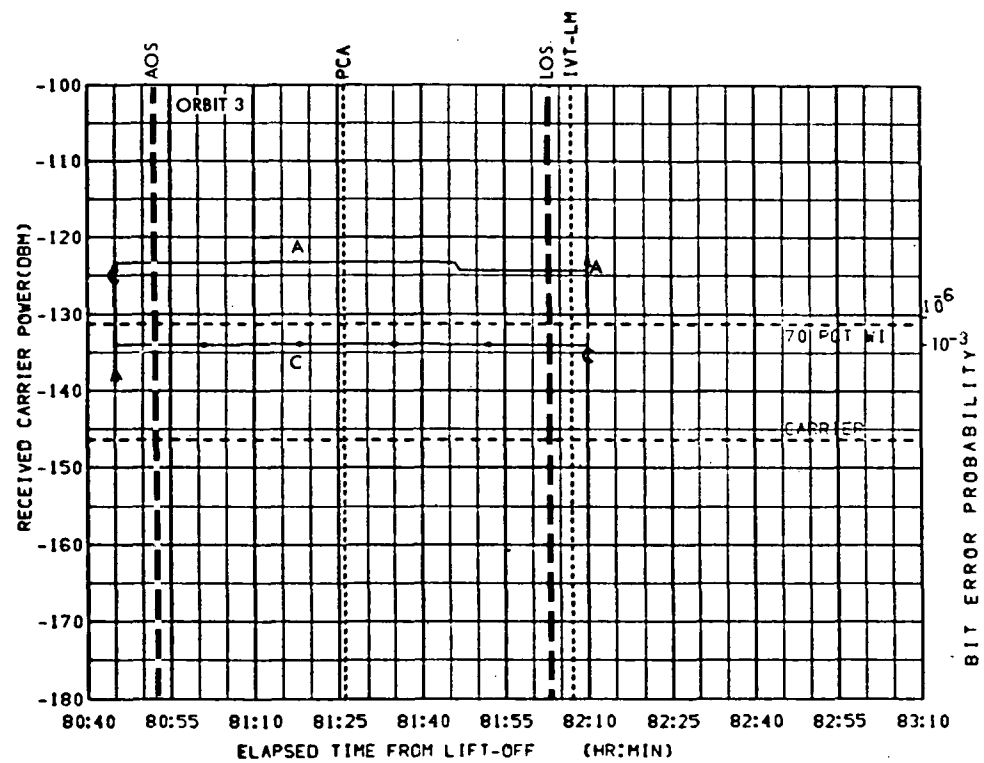

FIGURE 9-12b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

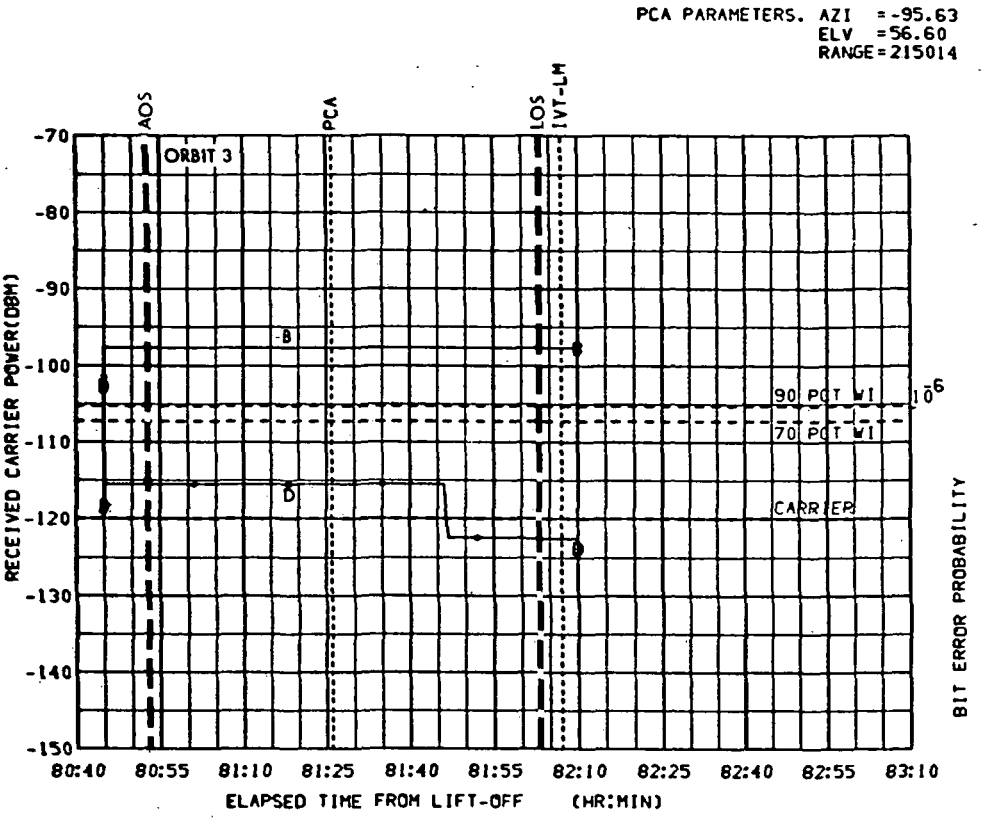

FIGURE 9-12c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

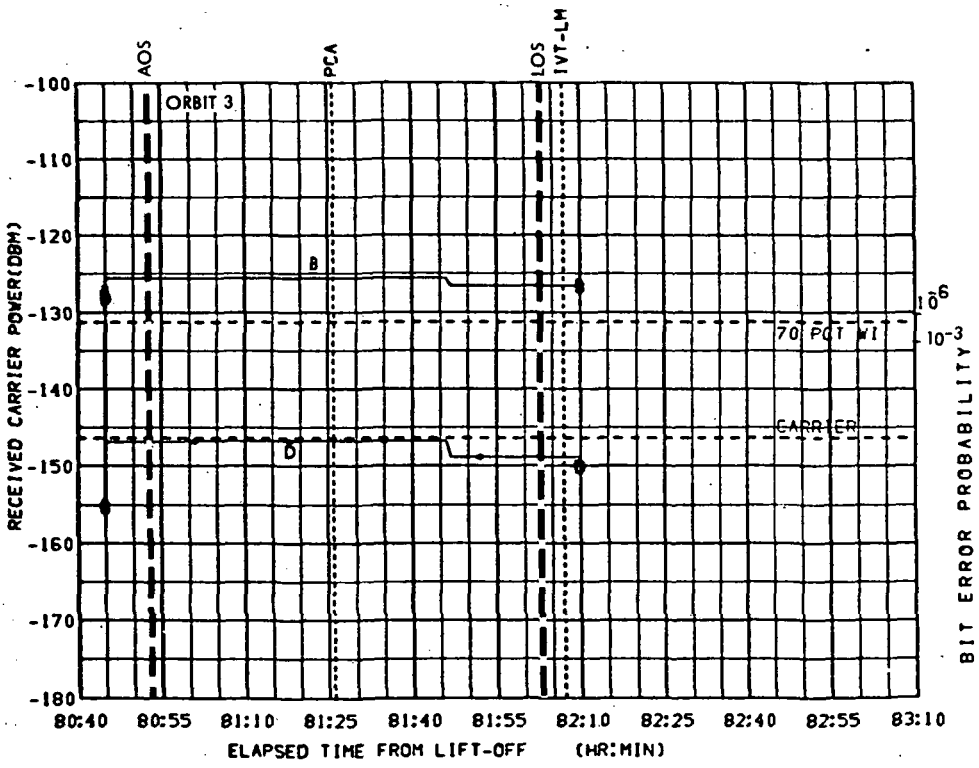

FIGURE 9-12d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

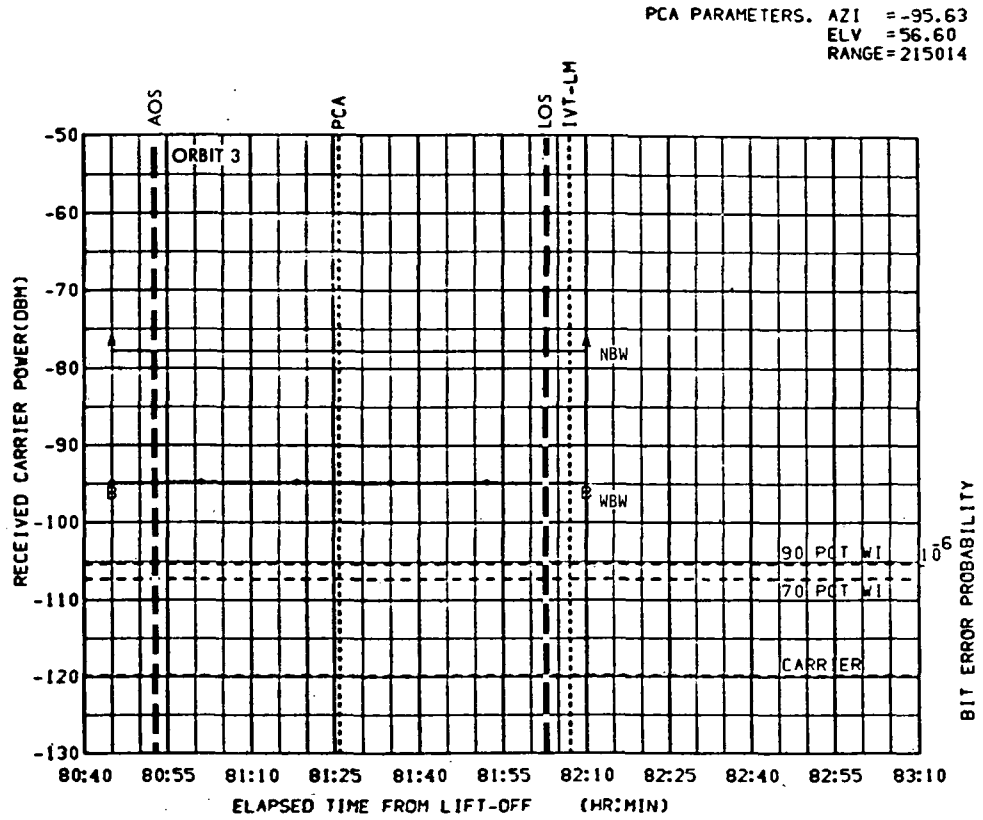

FIGURE 9-12e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

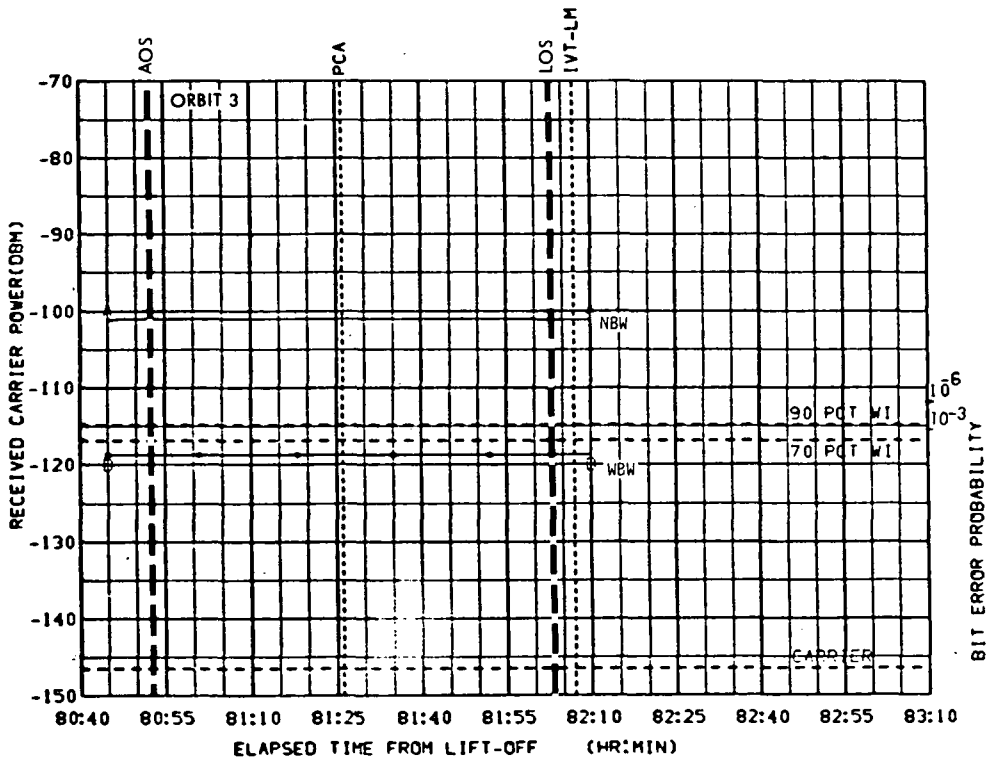

FIGURE 9-12f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

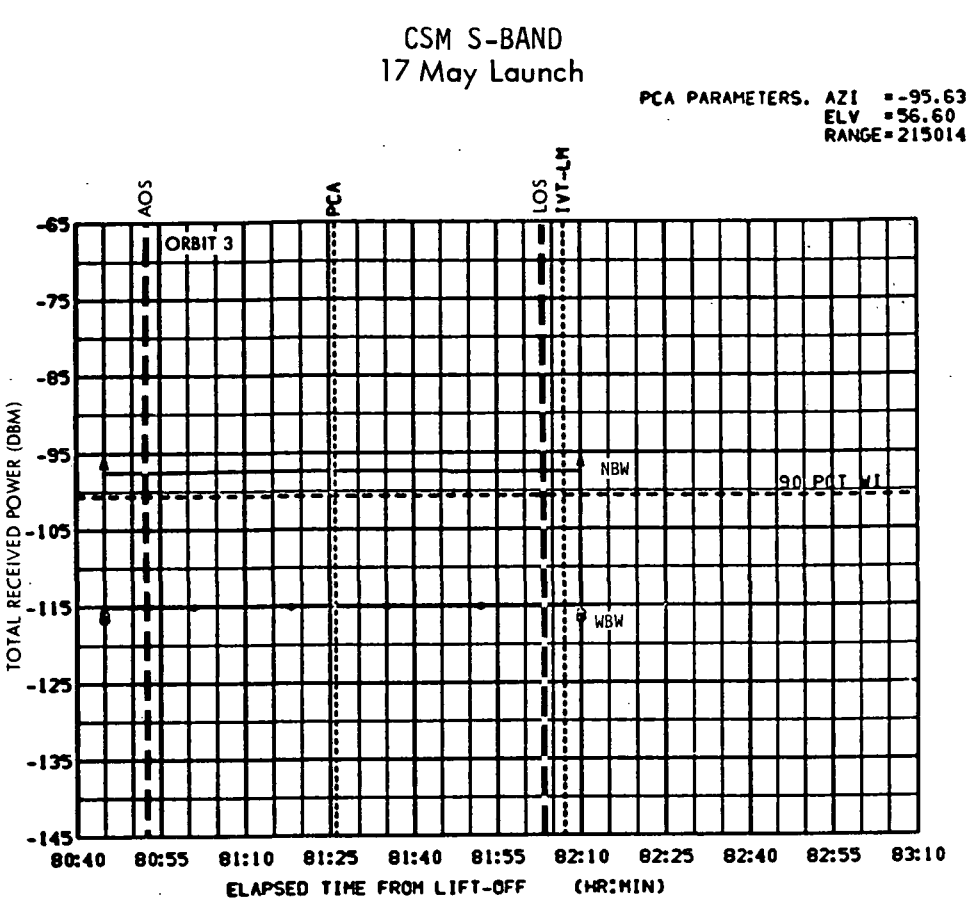

FIGURE 9-12g. GDS DNLINK FM MODES CSM/MSFN S-BAND HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

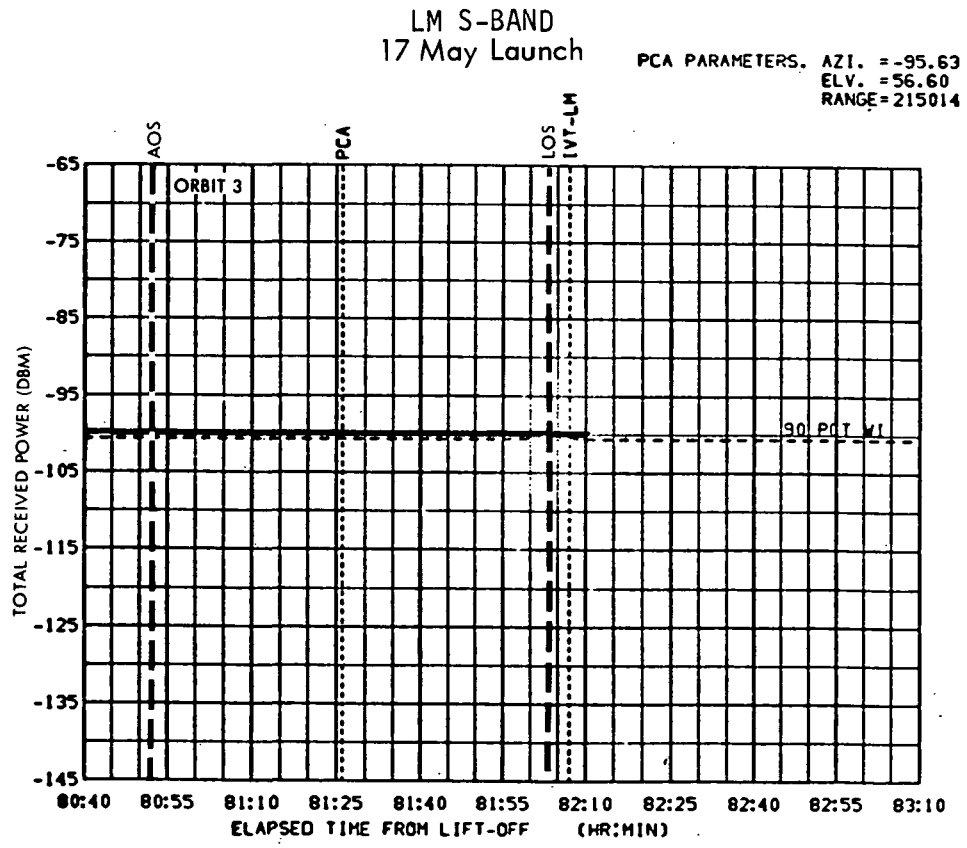

FIGURE 9-12h. GDS DNLINK FM MODES LM/MSFN S-BAND STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

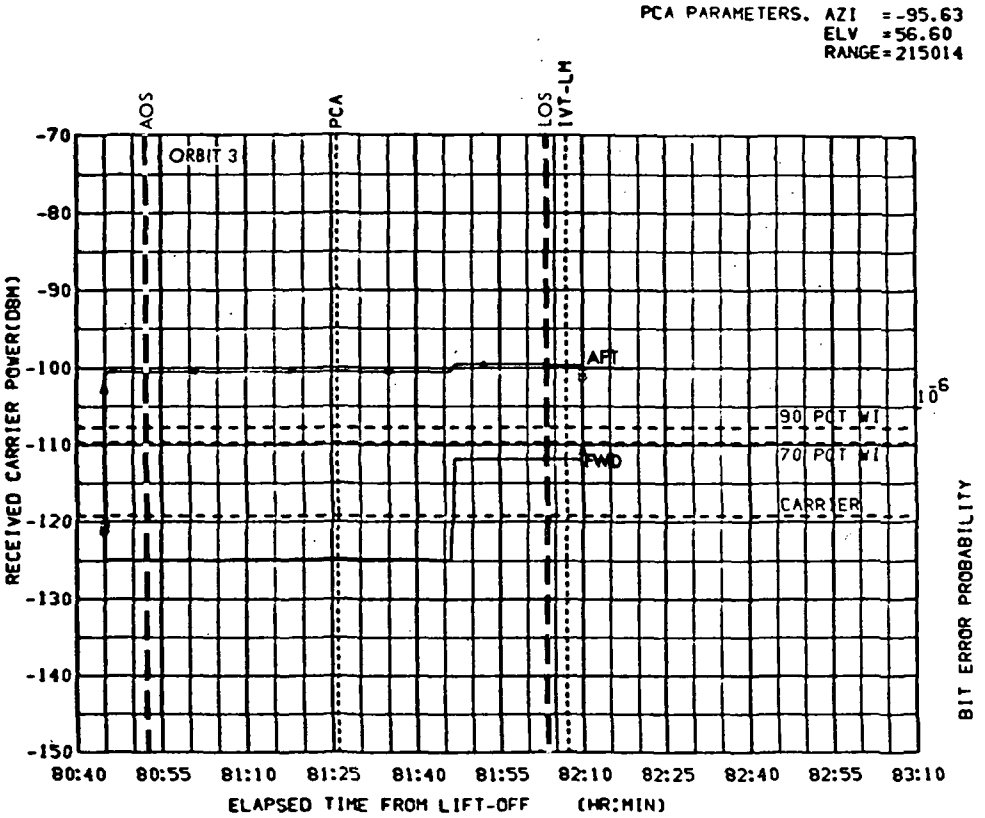

FIGURE 9-12i. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

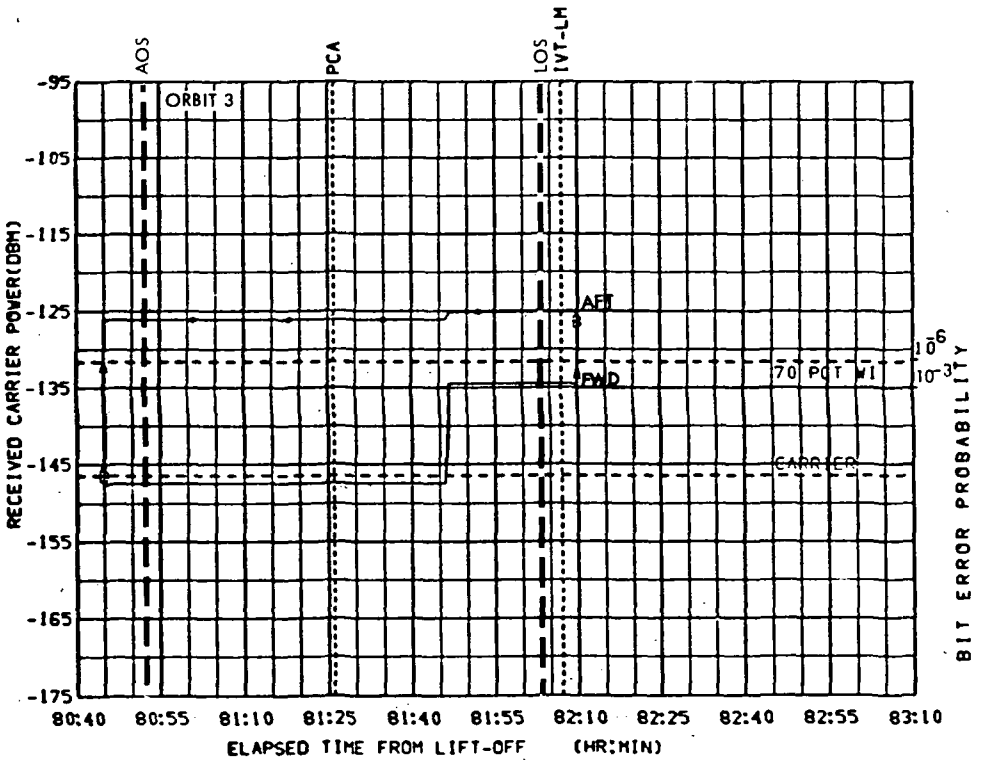

FIGURE 9-12j. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

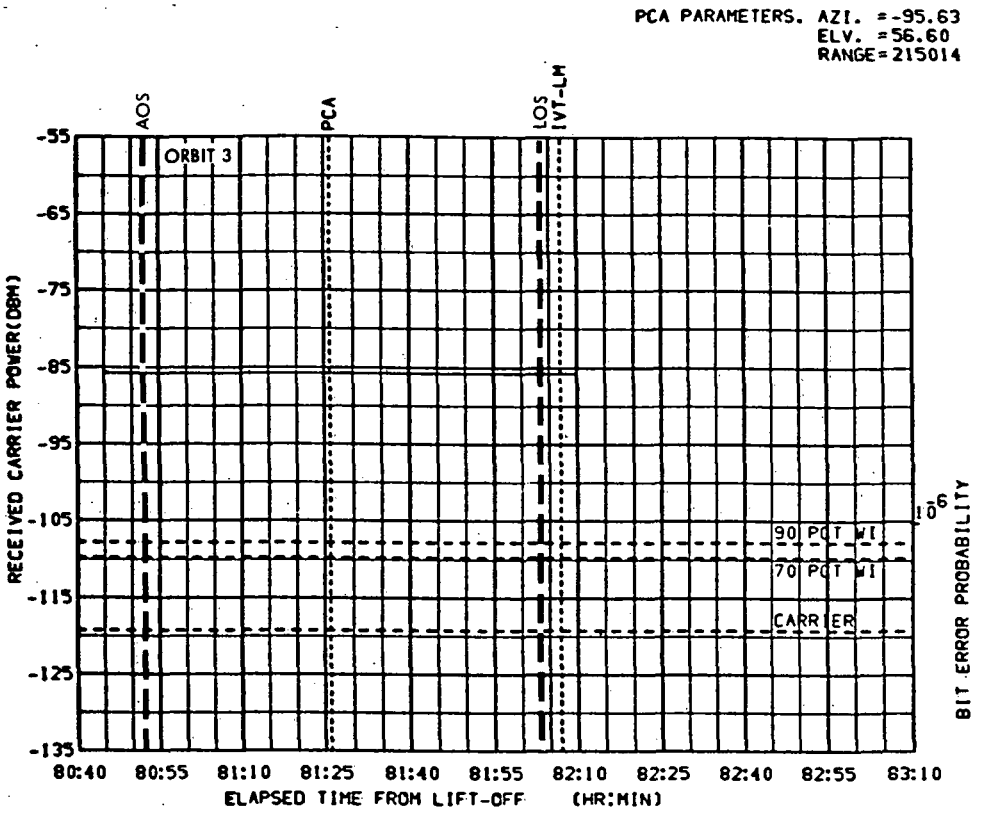

FIGURE 9-12k. GDS UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

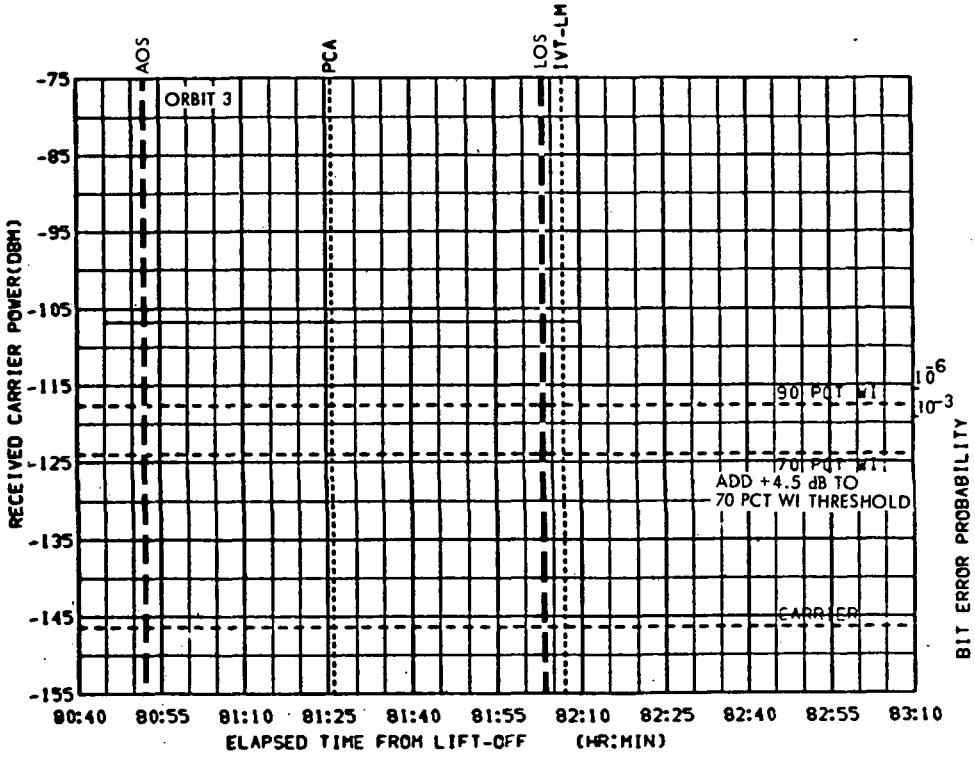

FIGURE 9-12l. GDS DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =67.20
ELV =31.81
RANGE=216076

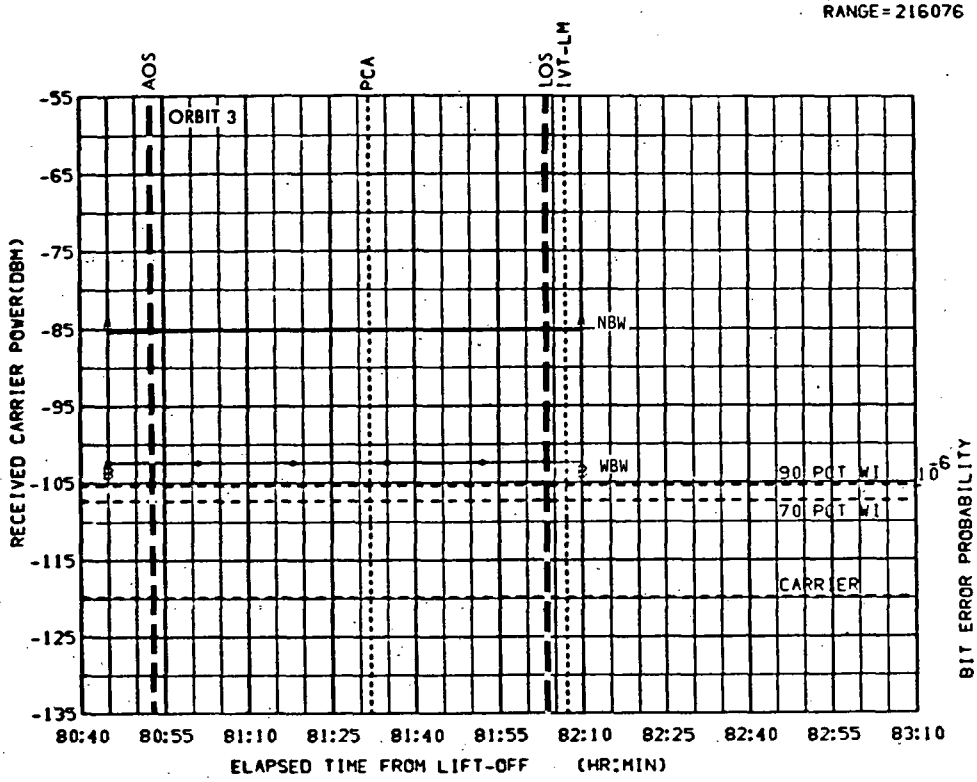

FIGURE 9-13a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

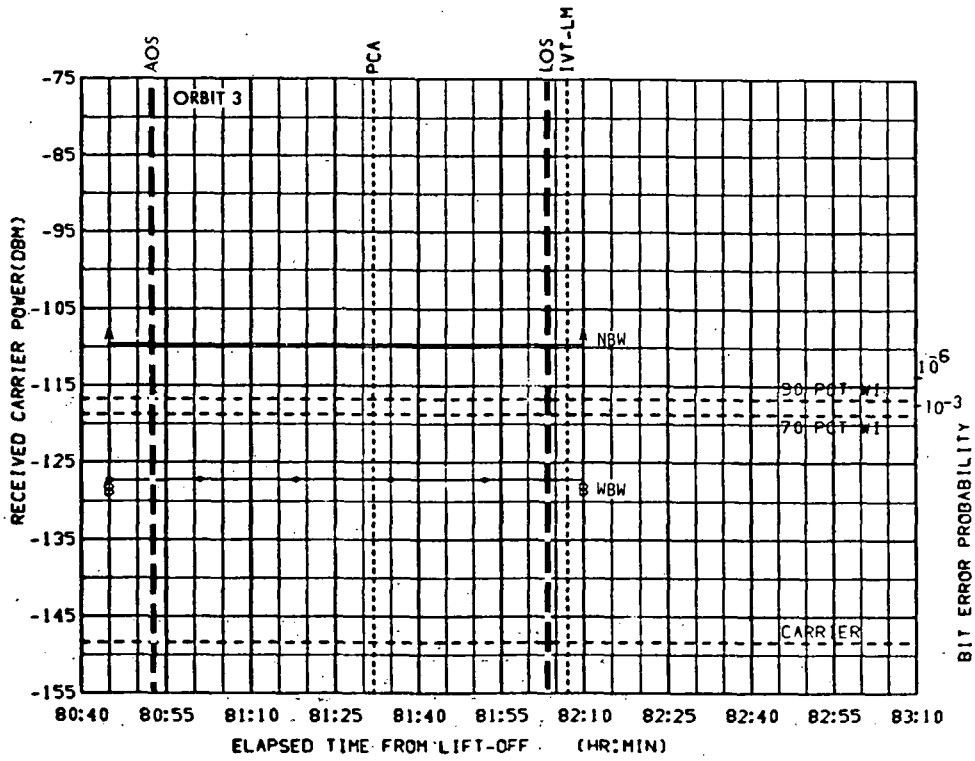

FIGURE 9-13b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. =67.20
ELV. =31.81
RANGE=216076

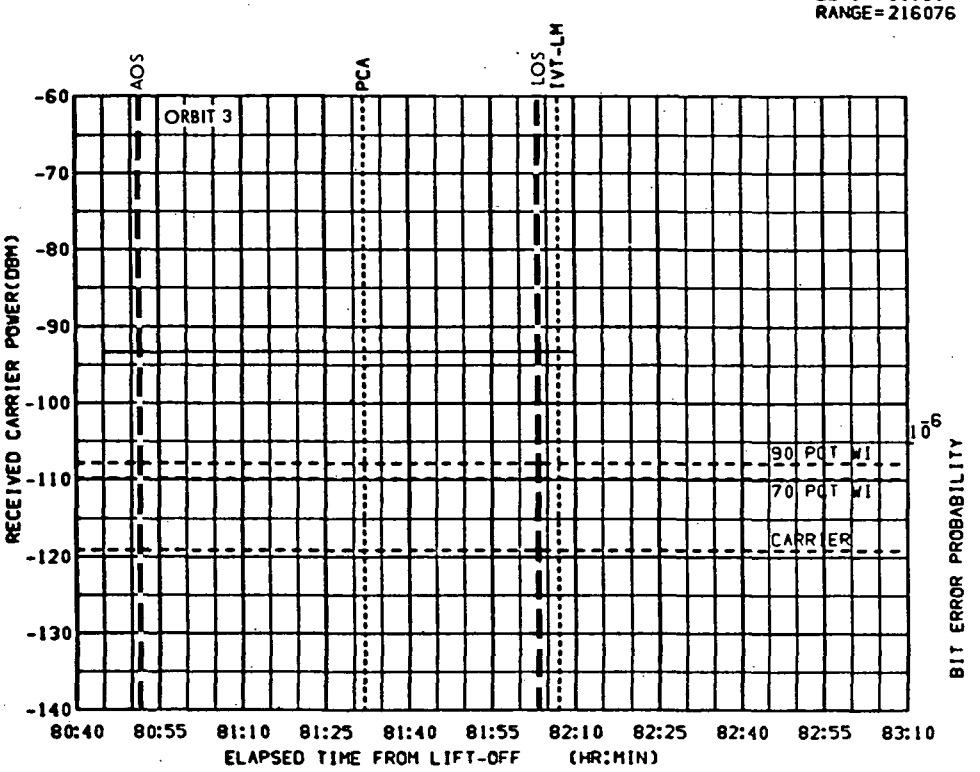

FIGURE 9-13c. GWM UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

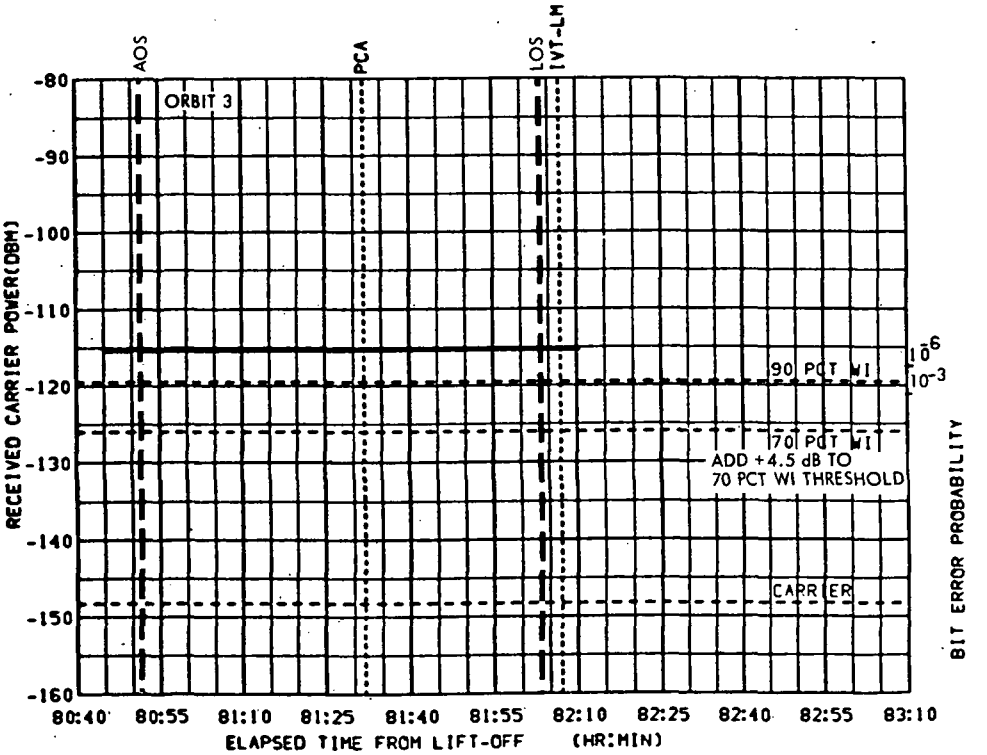

FIGURE 9-13d. GWM DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 26.96
ELV = 22.24
RANGE = 216516

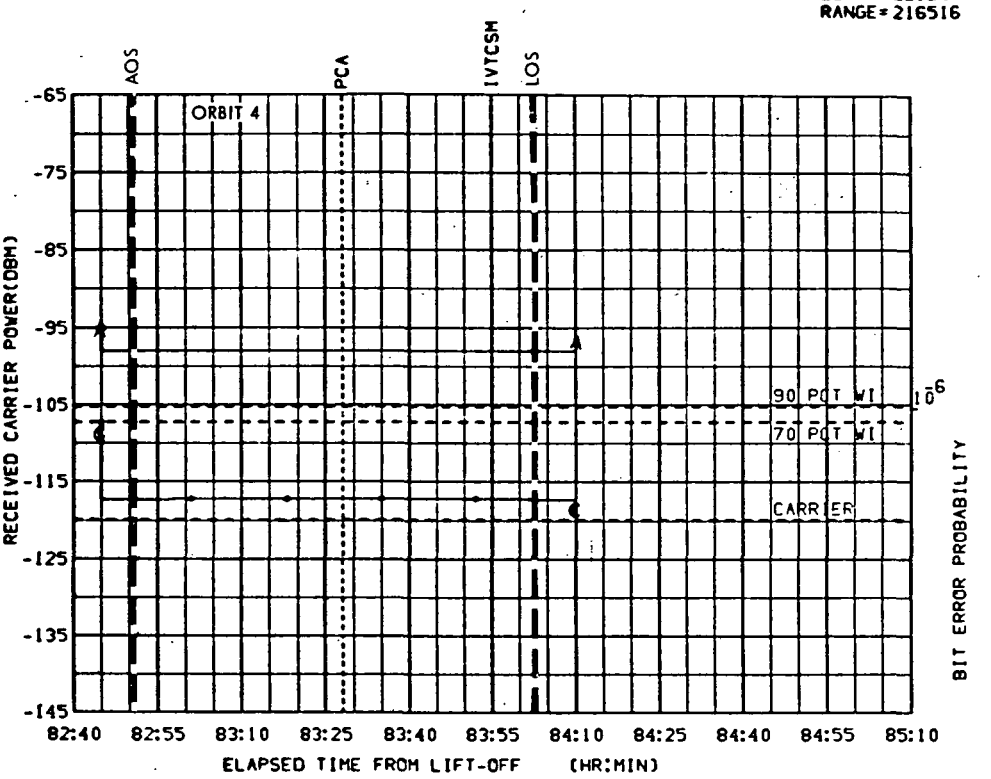

FIGURE 9-14a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

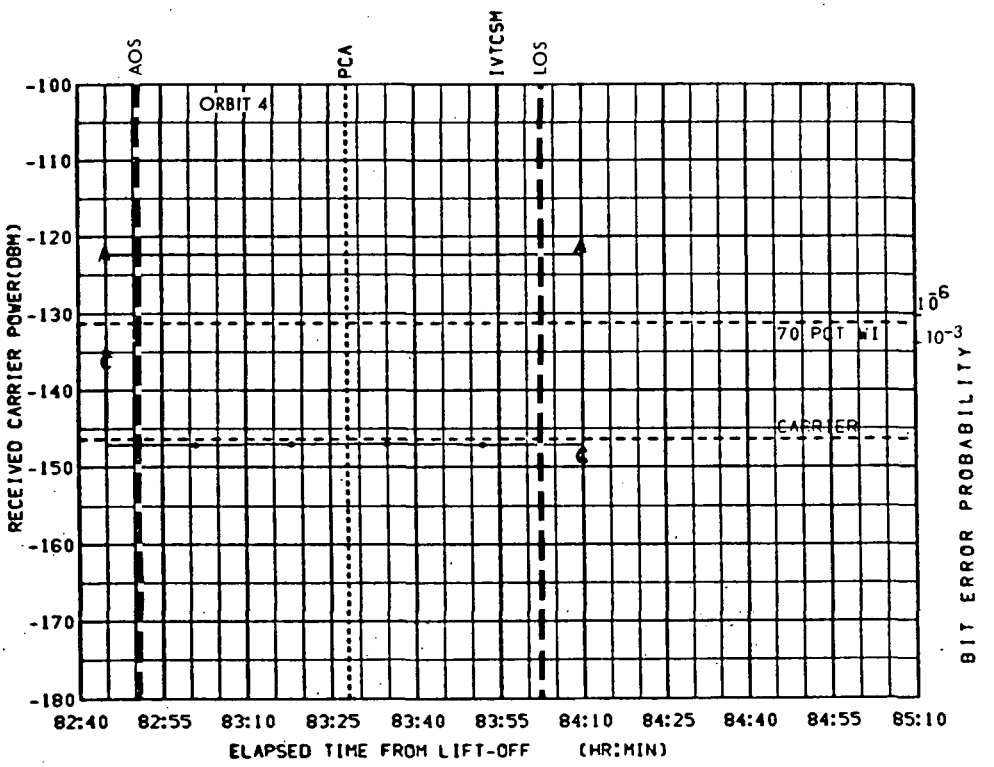

FIGURE 9-14b. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

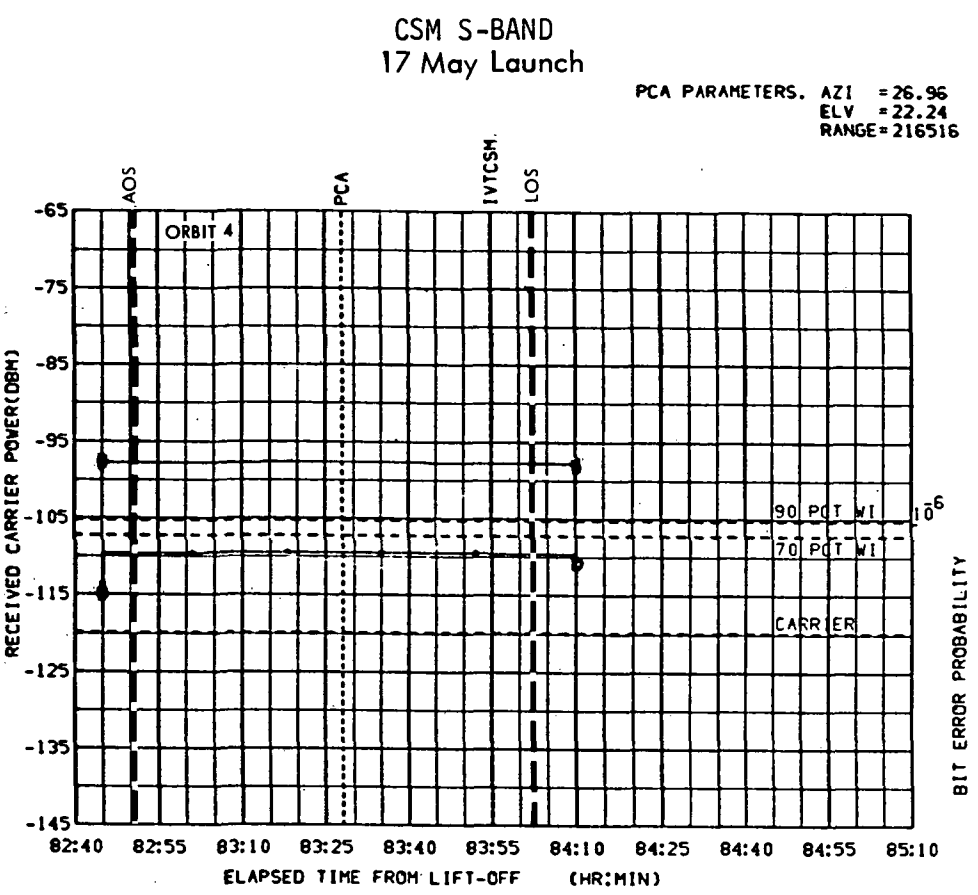

FIGURE 9-14c. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

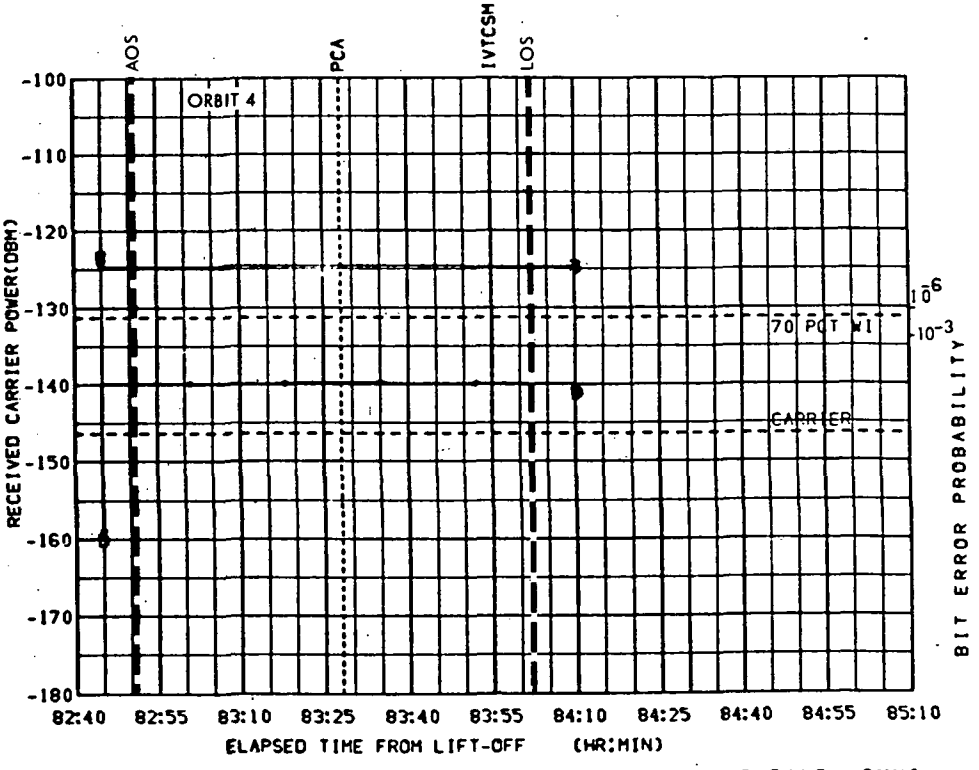

FIGURE 9-14d. HSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

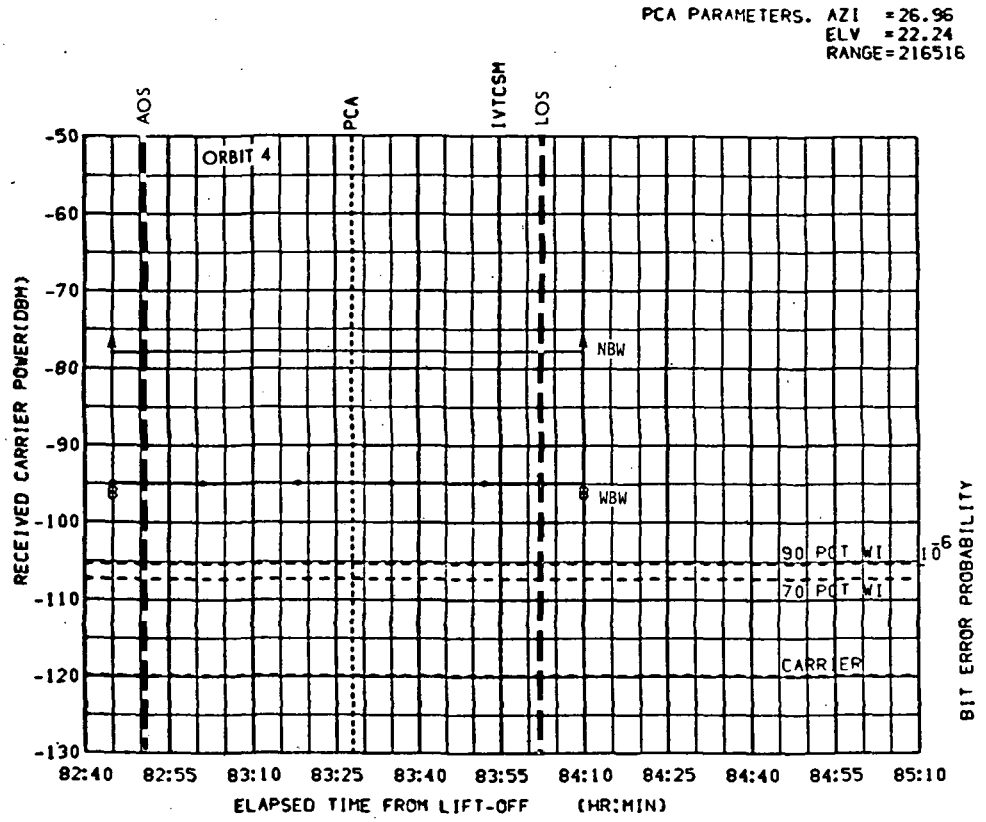

FIGURE 9-14e. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

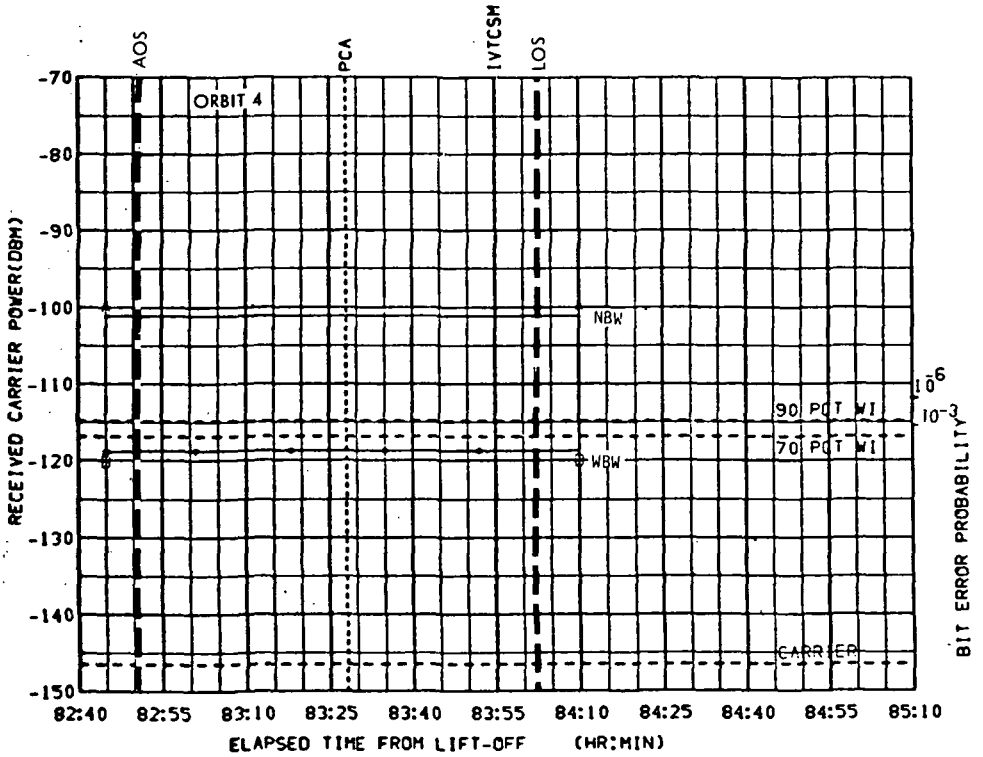

FIGURE 9-14f. HSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

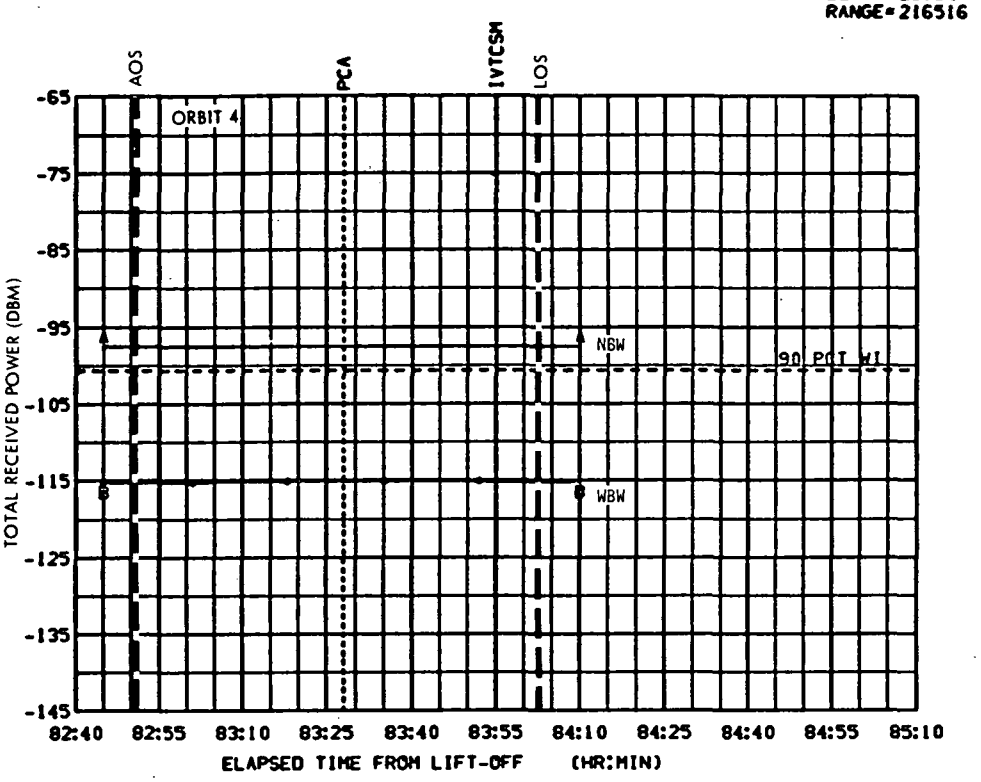

FIGURE 9-14g. MSK DNLINK FM MODES CSM/MSFN S-BAND HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

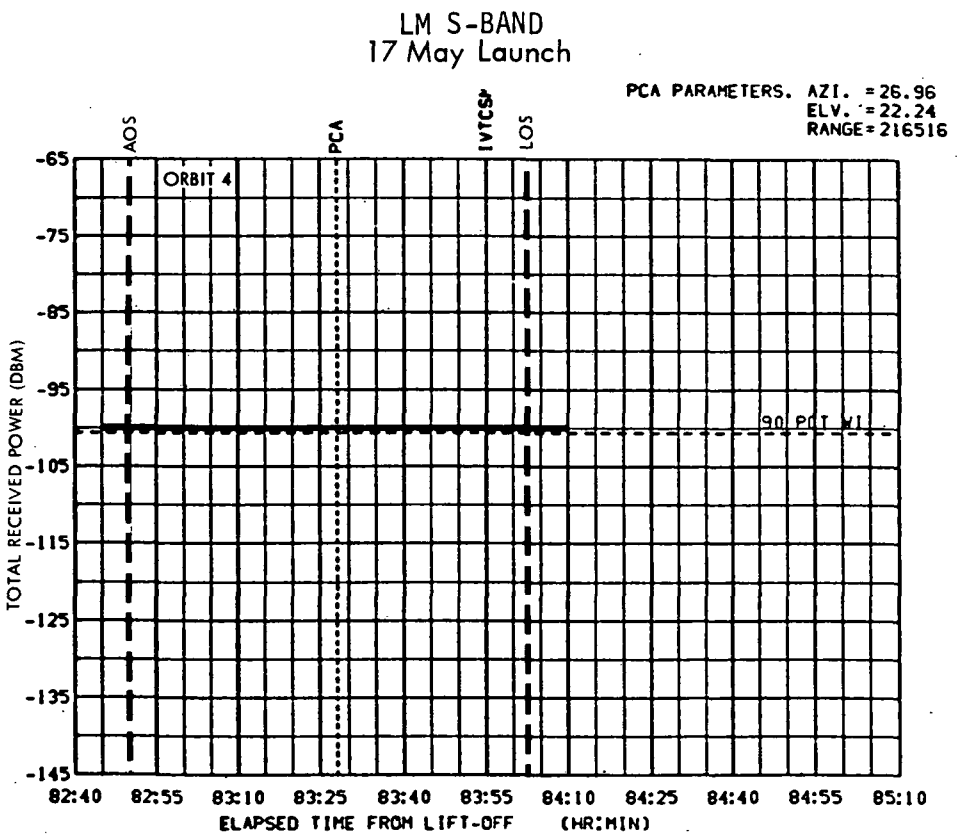

FIGURE 9-14h. MSK DNLINK FM MODES LM/MSFN S-BAND STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

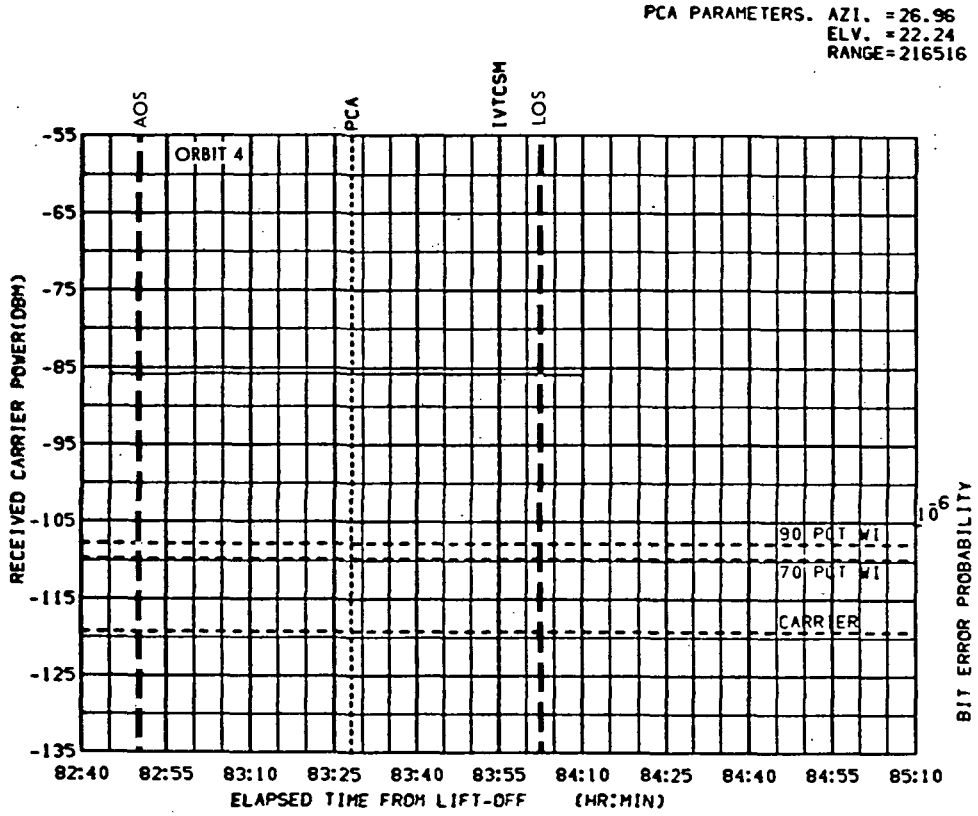

FIGURE 9-14i. MSK UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

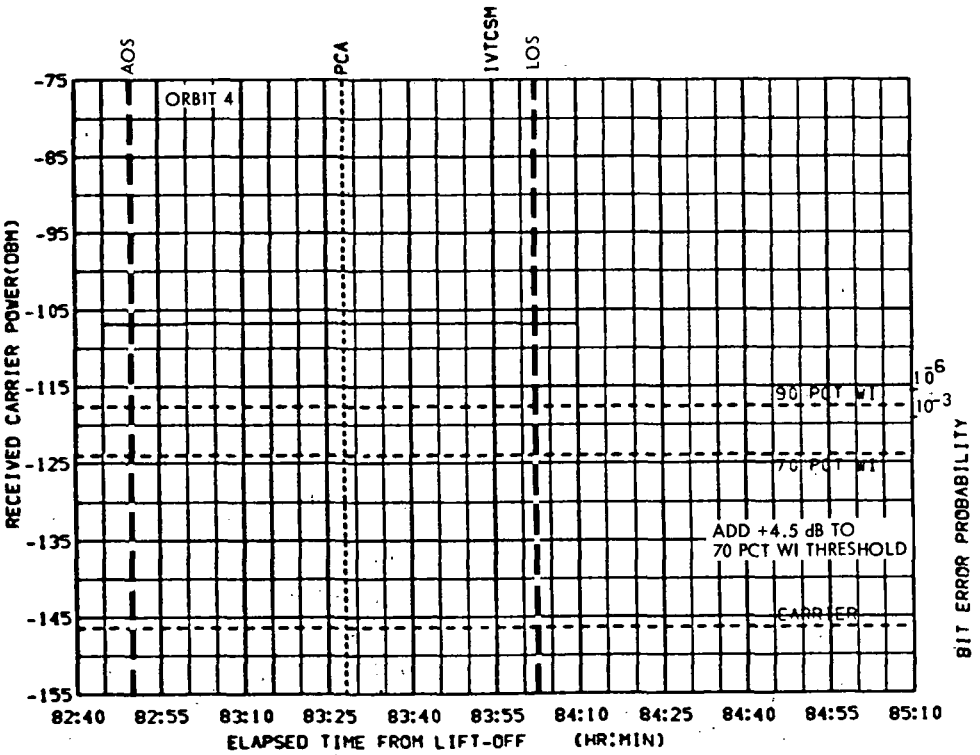

FIGURE 9-14j. MSK DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 26.96
ELV = 22.24
RANGE = 216516

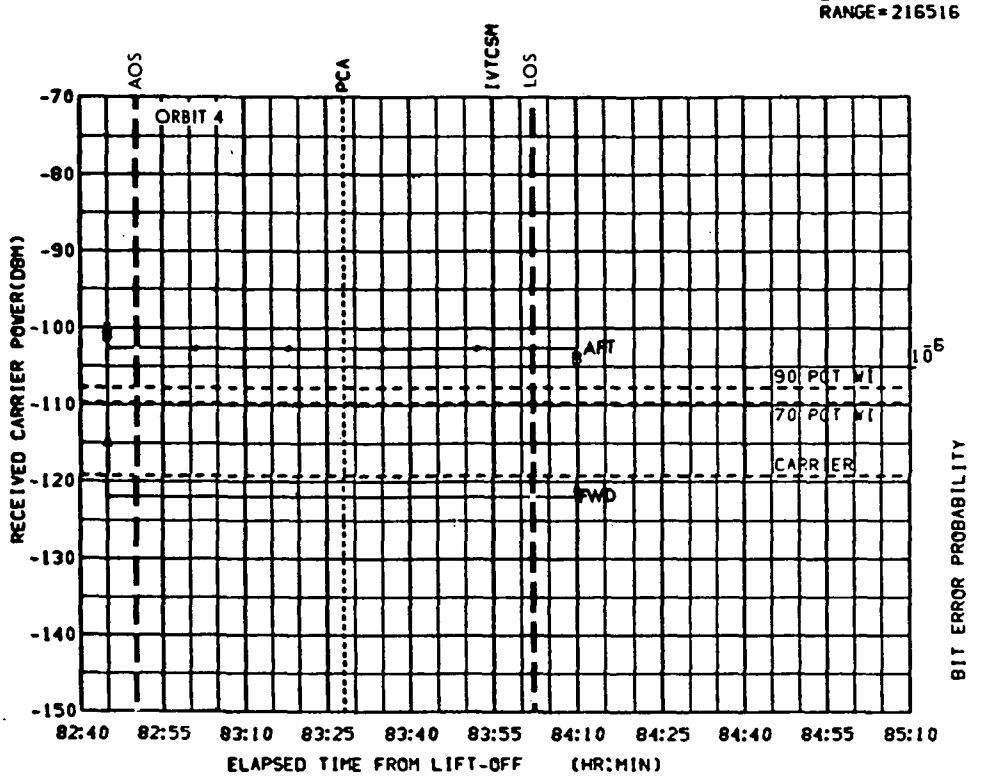

FIGURE 9-14k. MSK UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

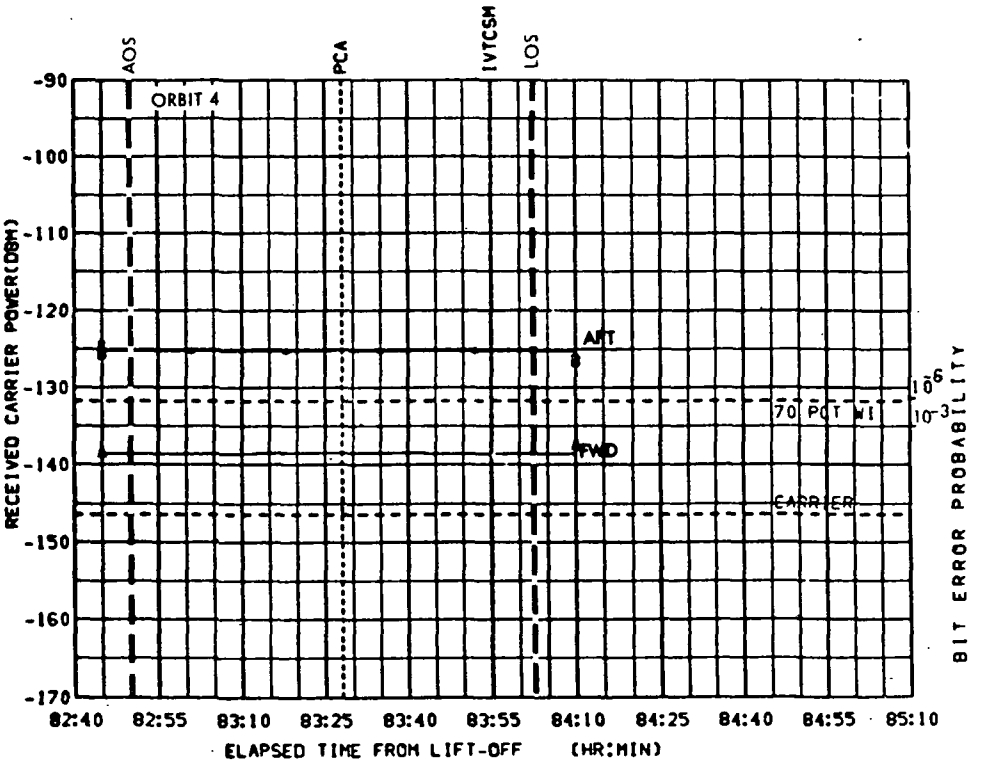

FIGURE 9-14l. MSK DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

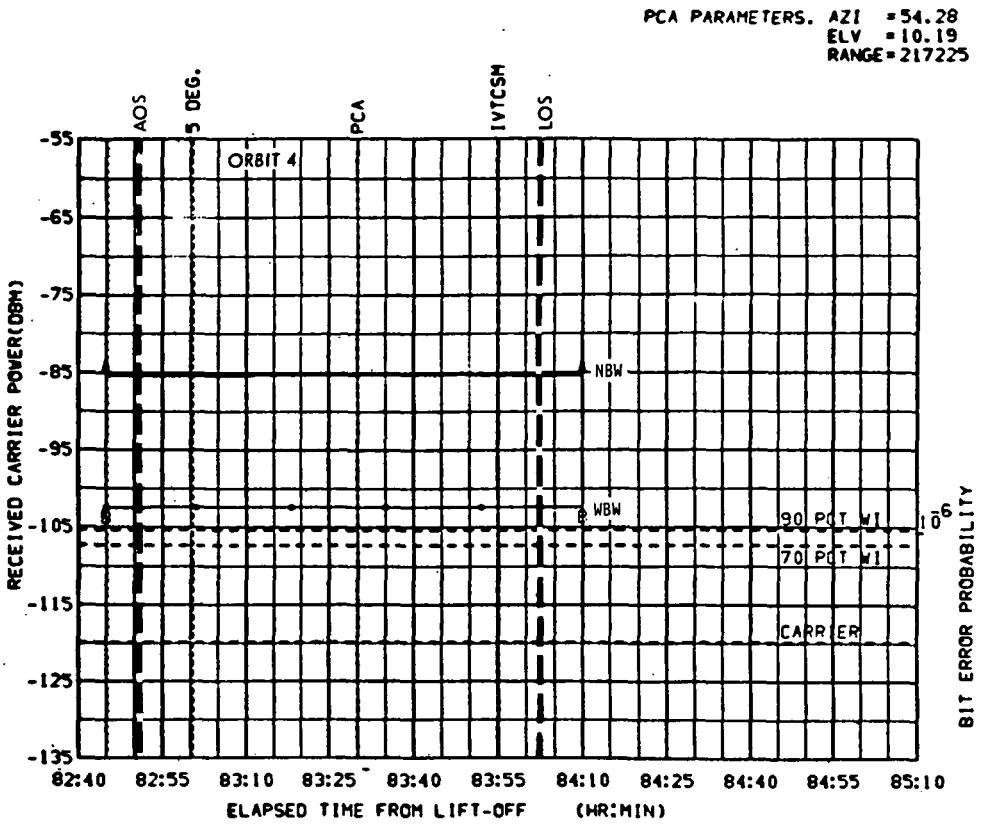

FIGURE 9-15a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

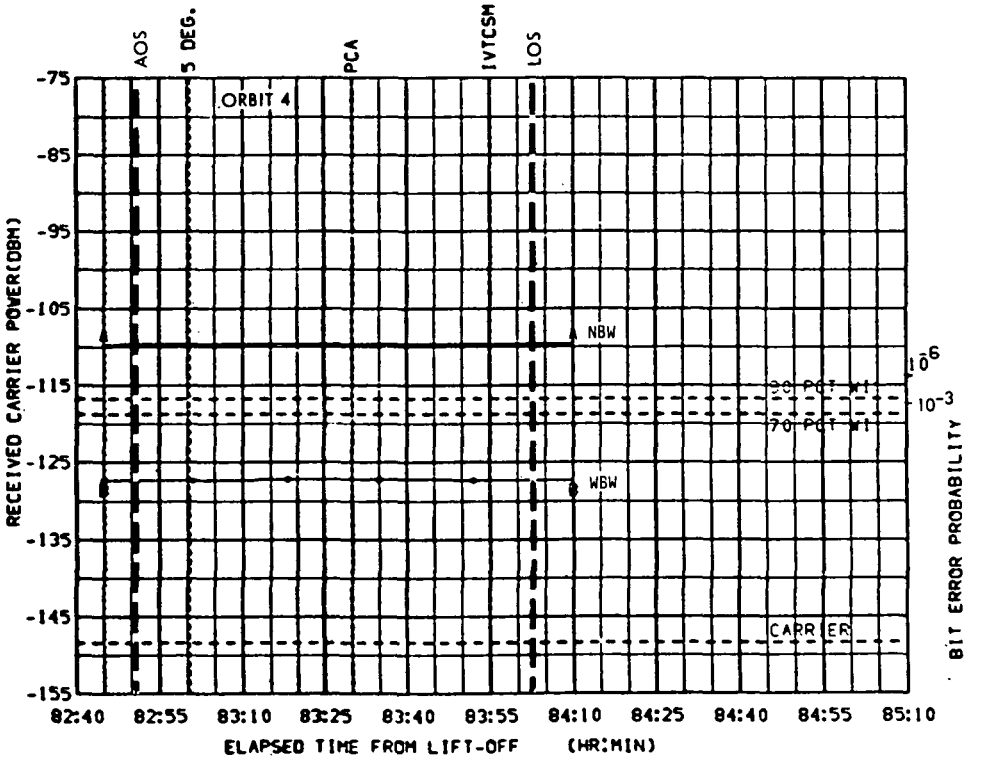

FIGURE 9-15b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

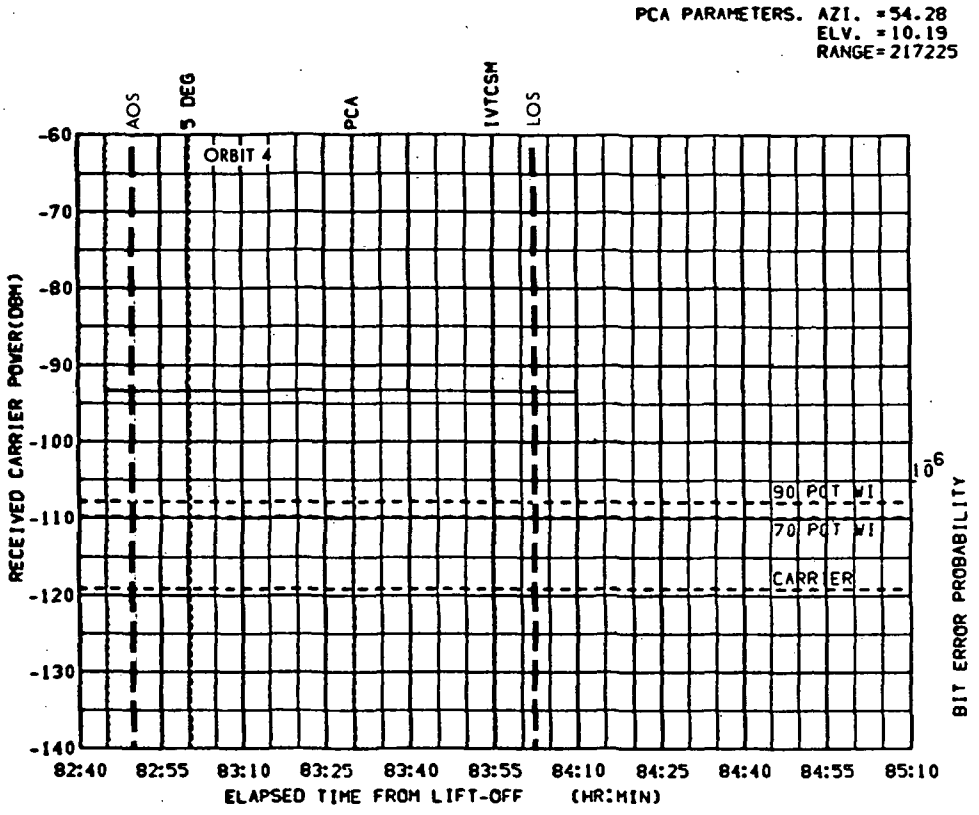

FIGURE 9-15c. CRO UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

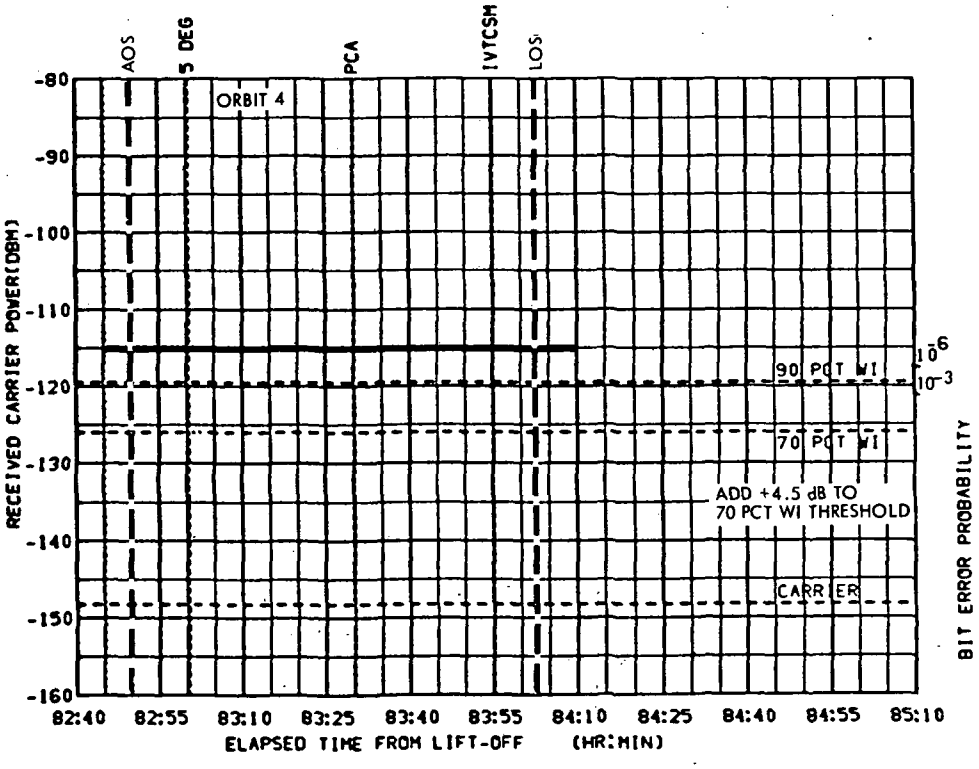

FIGURE 9-15d. CRO DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

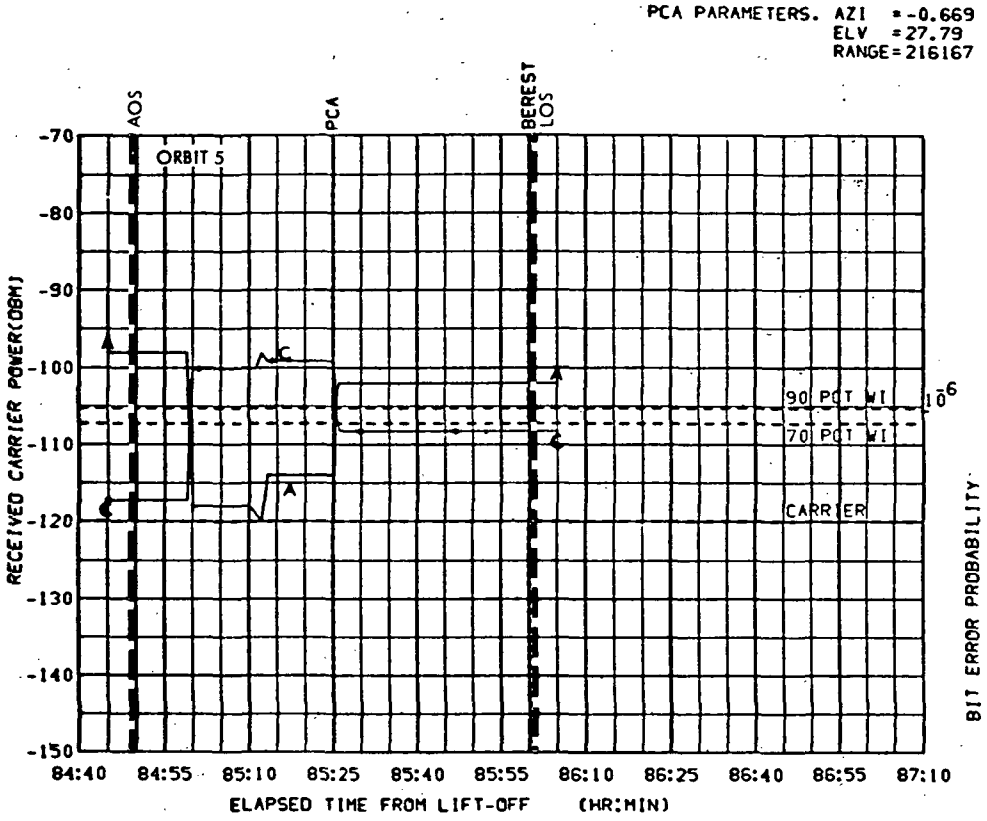

FIGURE 9-16a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

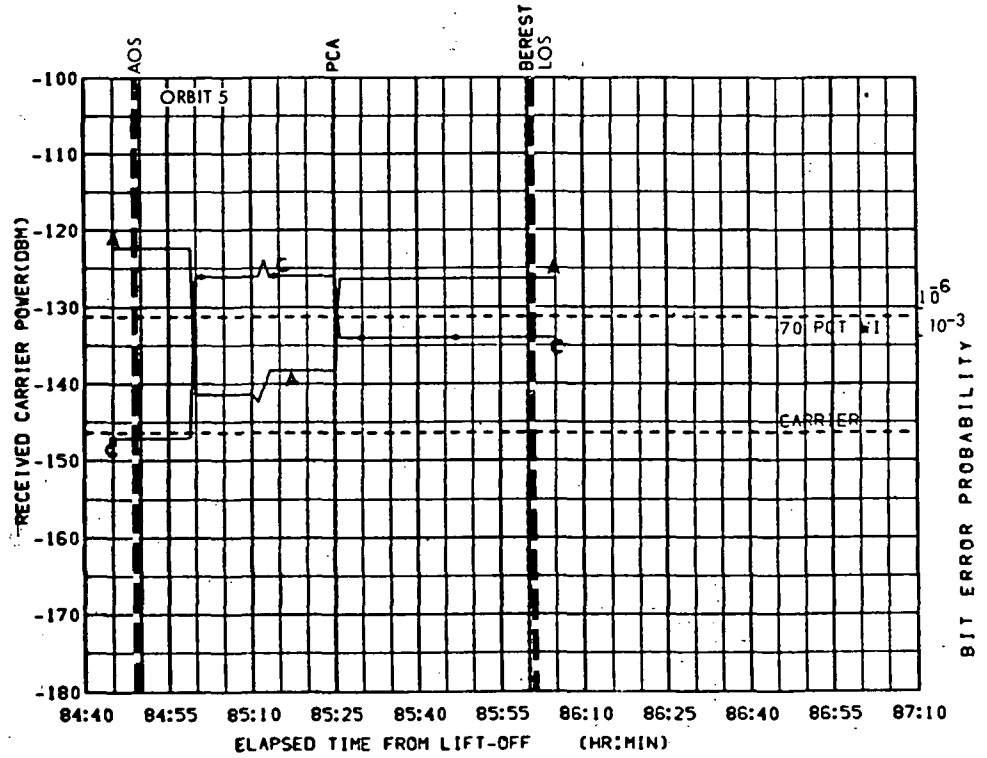

FIGURE 9-16b. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -0.669
ELV = 27.79
RANGE = 216167

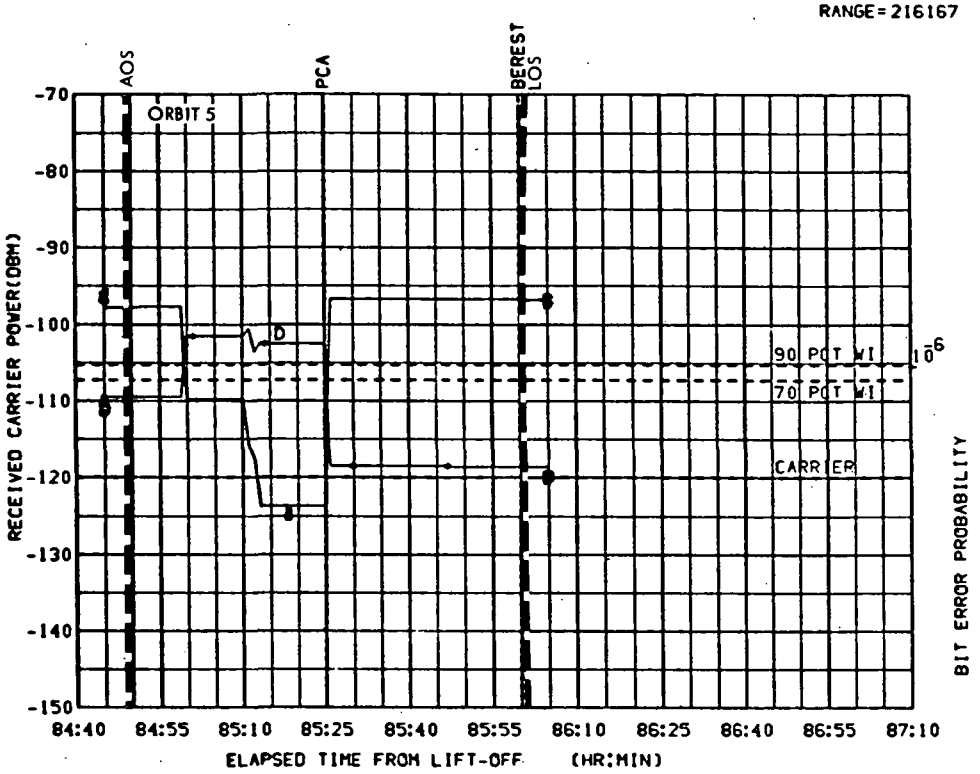

FIGURE 9-16c. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

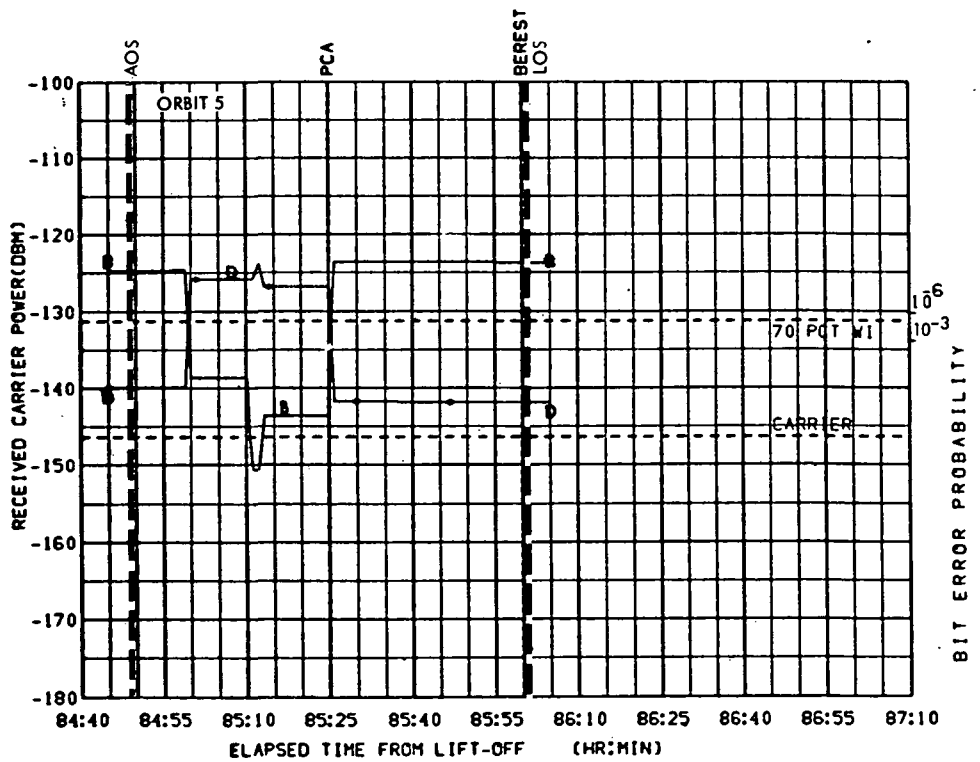

FIGURE 9-16d. HSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -0.669
ELV = 27.79
RANGE = 216167

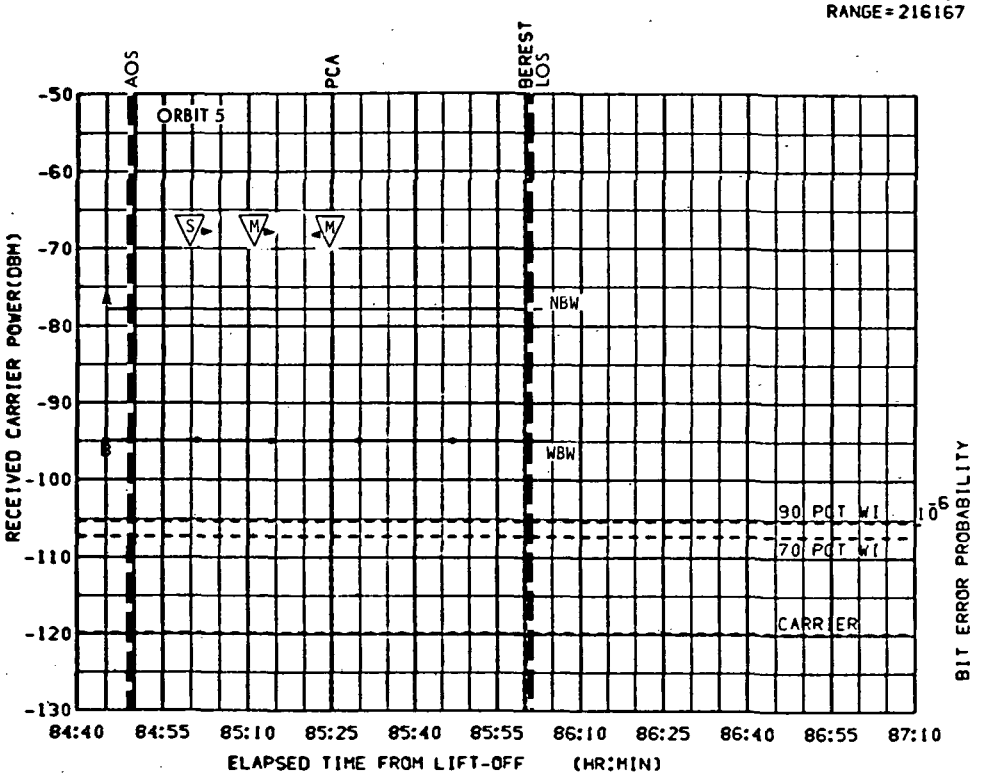

FIGURE 9-16e. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

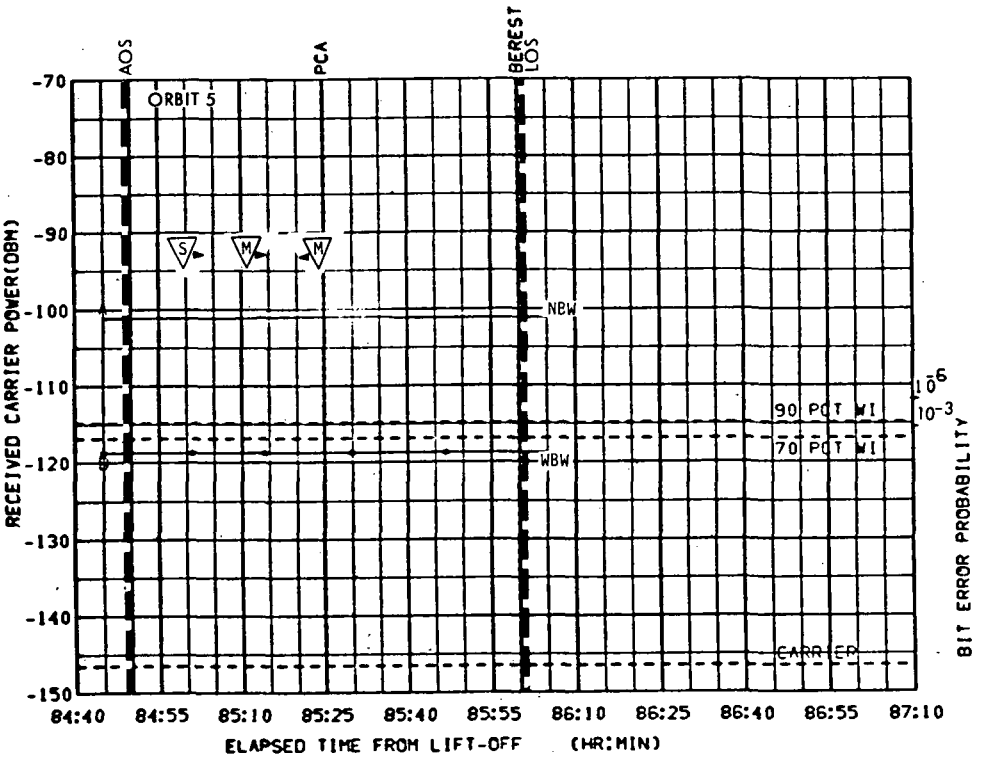

FIGURE 9-16f. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

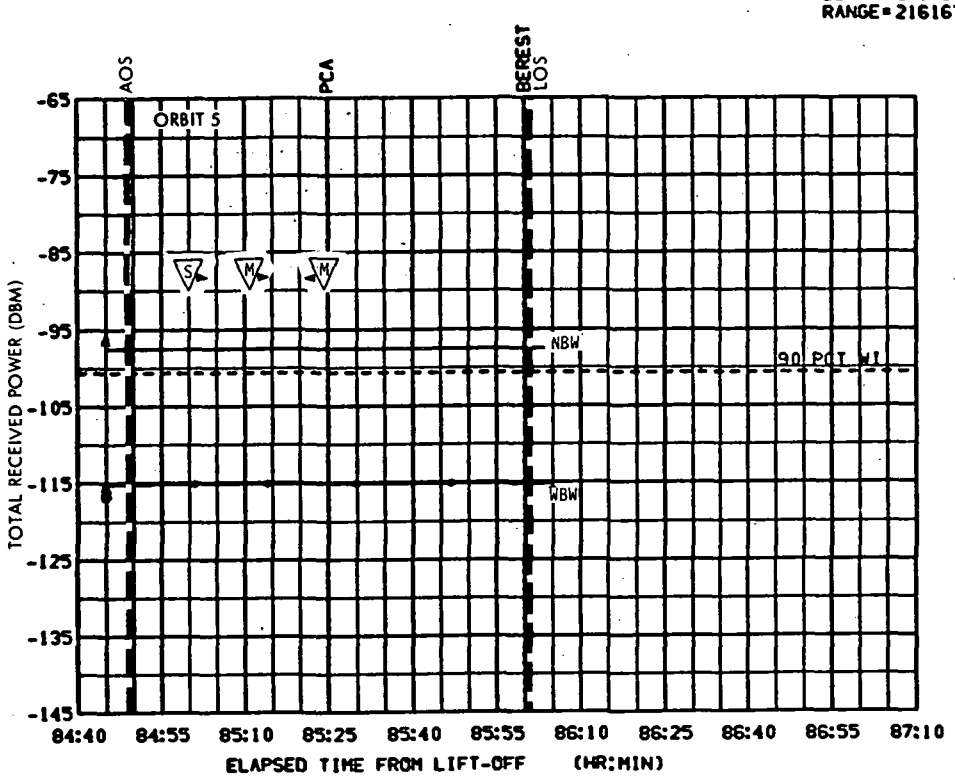

FIGURE 9-16g. MSK DNLINK FM MODES CSM/MSFN S-BAND HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

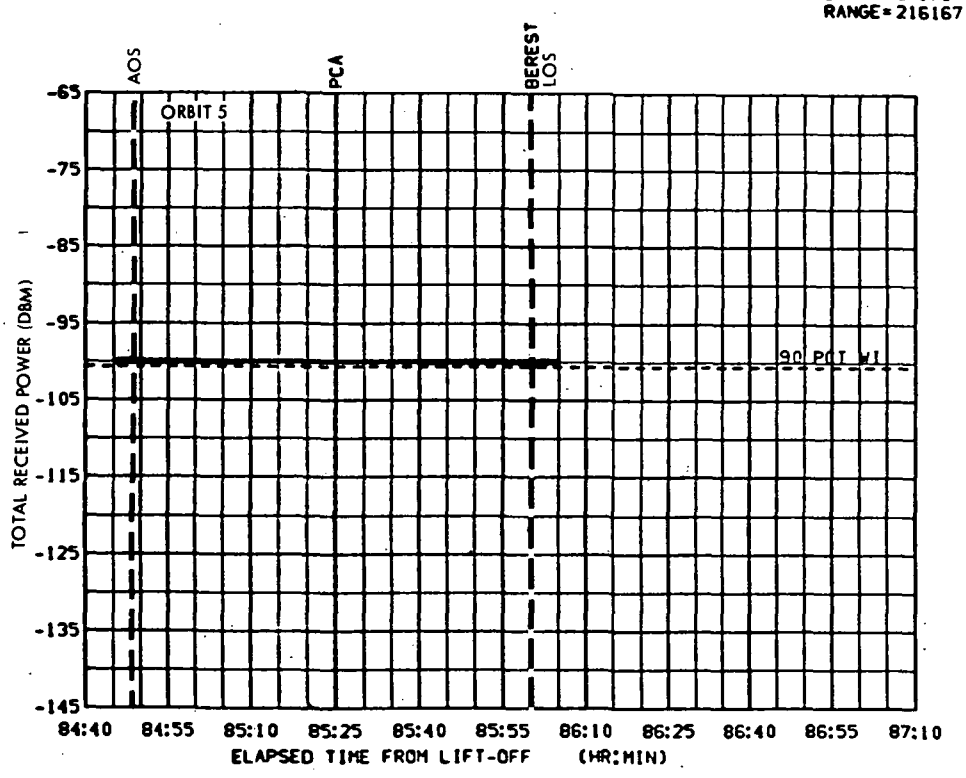

FIGURE 9-16h. MSK DNLINK FM MODES LM/MSFN S-BAND STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

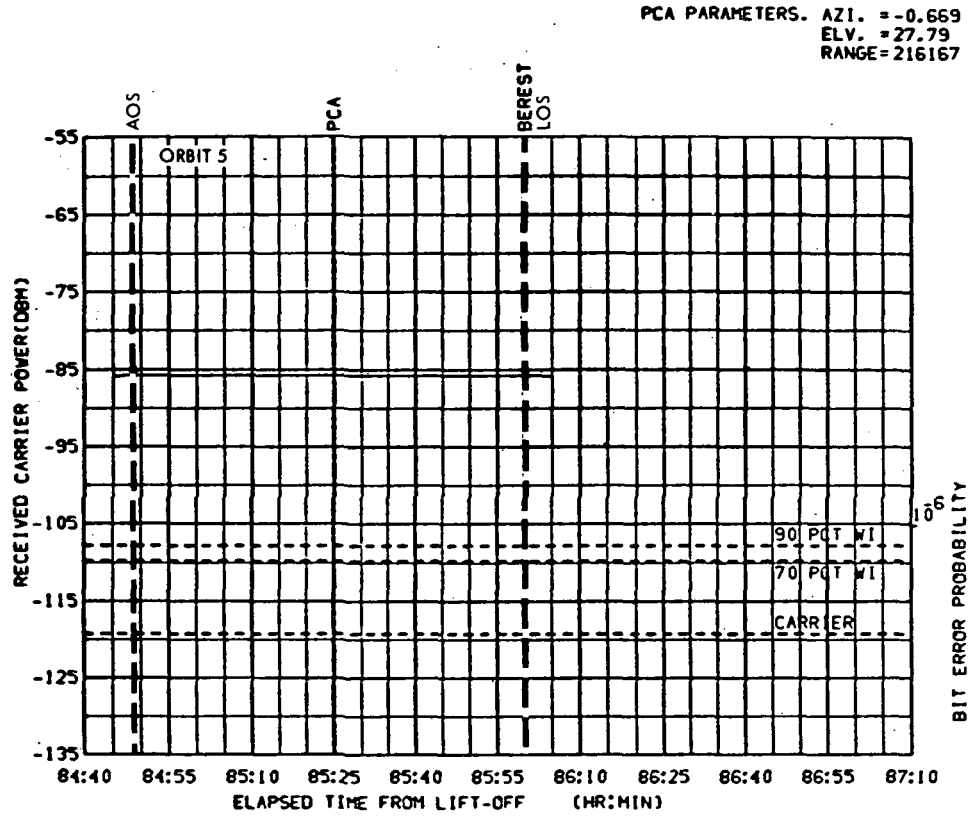

FIGURE 9-16i. MSK UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

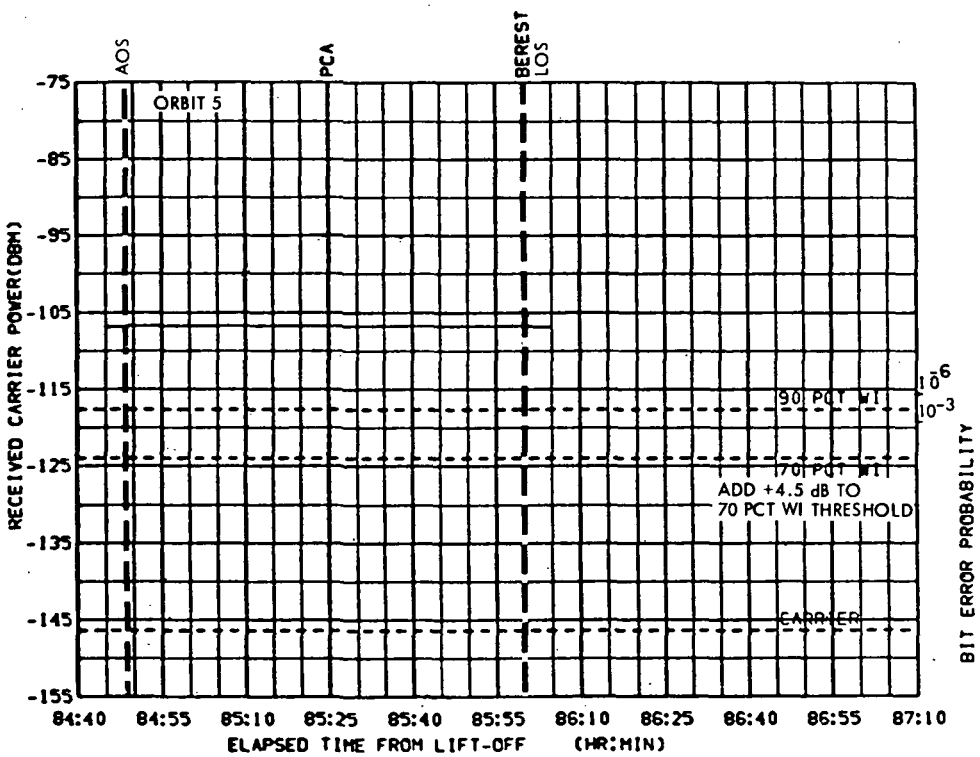

FIGURE 9-16j. MSK DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -0.669
ELV = 27.79
RANGE = 216167

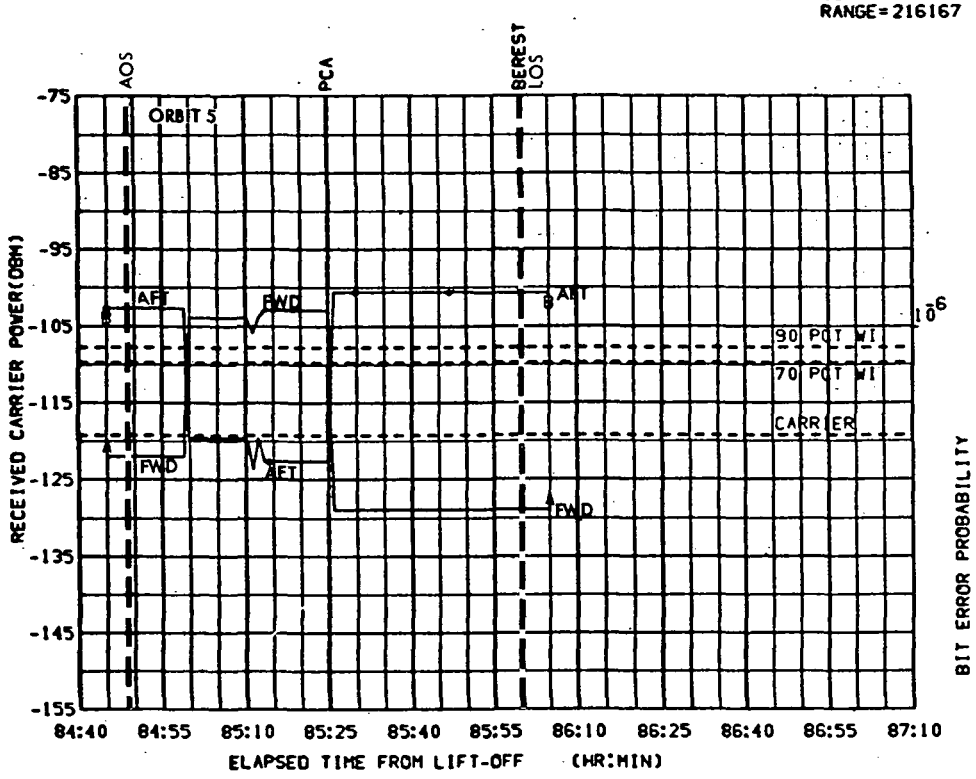

FIGURE 9-16k. MSK UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

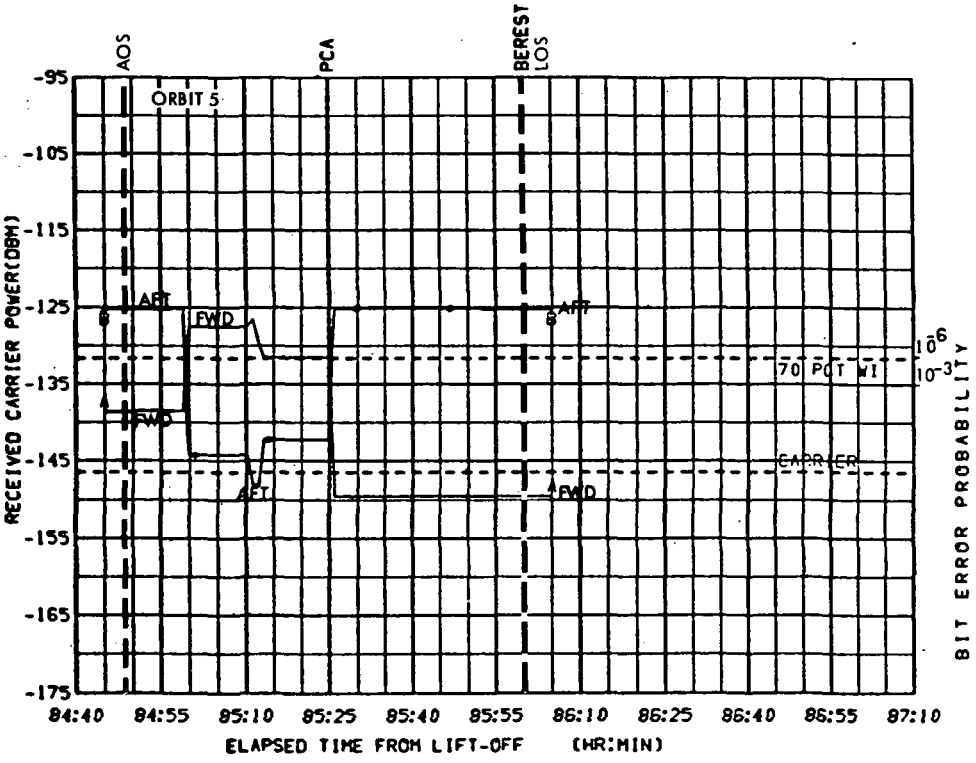

FIGURE 9-16l. MSK DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =14.55
ELV =76.83
RANGE=214449

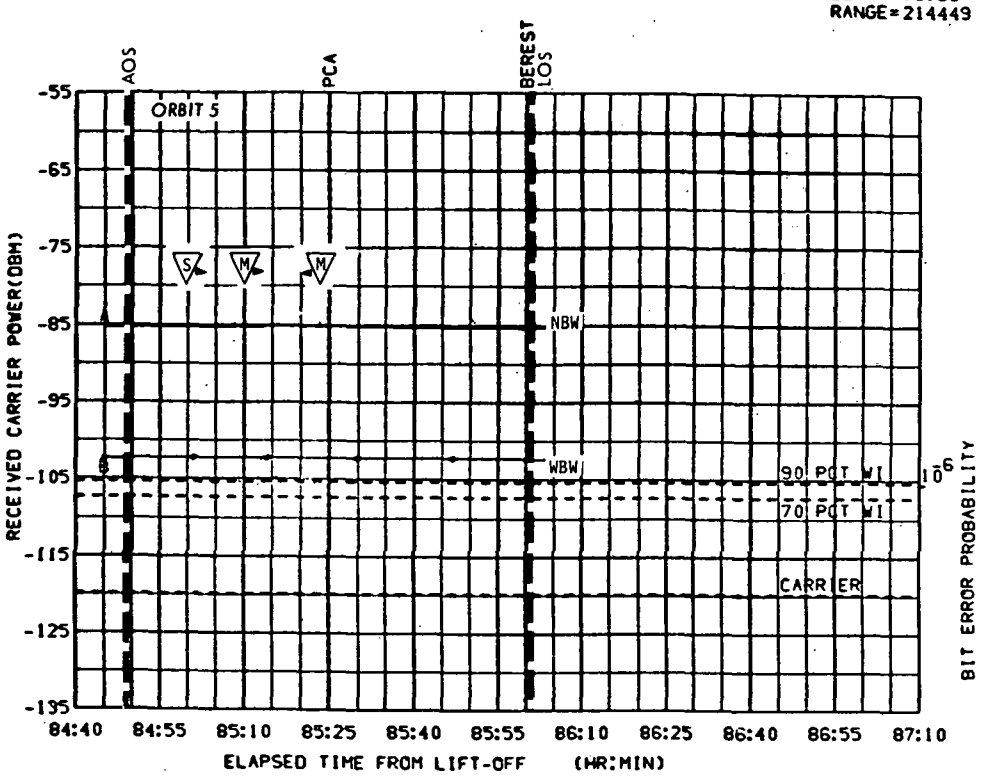

FIGURE 9-17a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

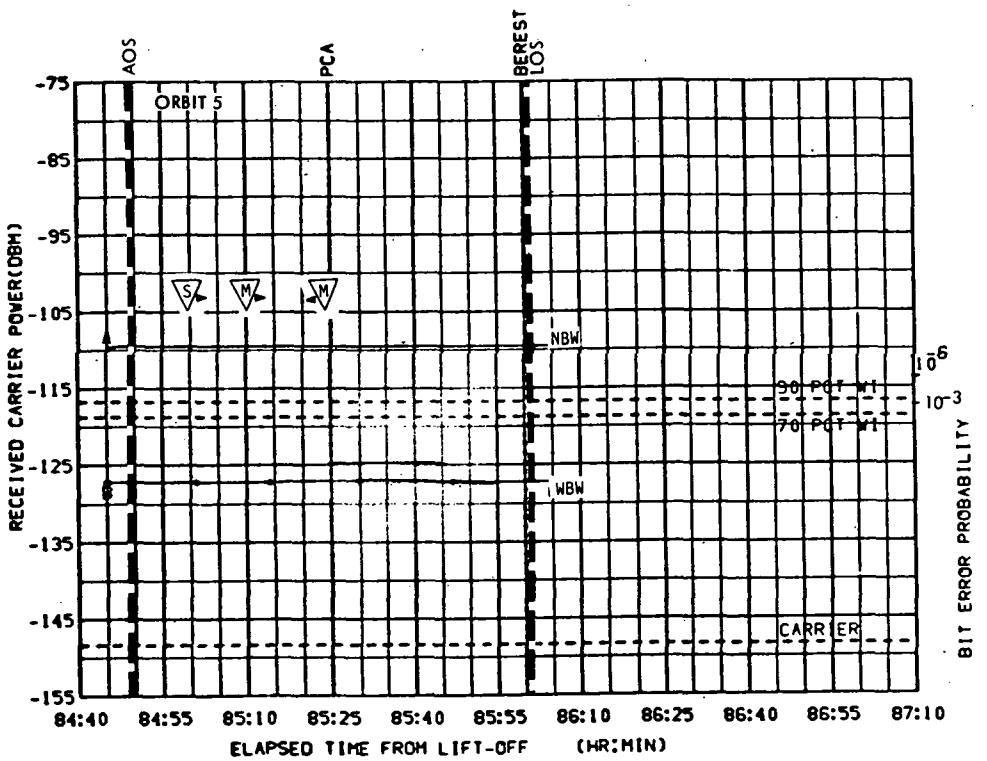

FIGURE 9-17b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

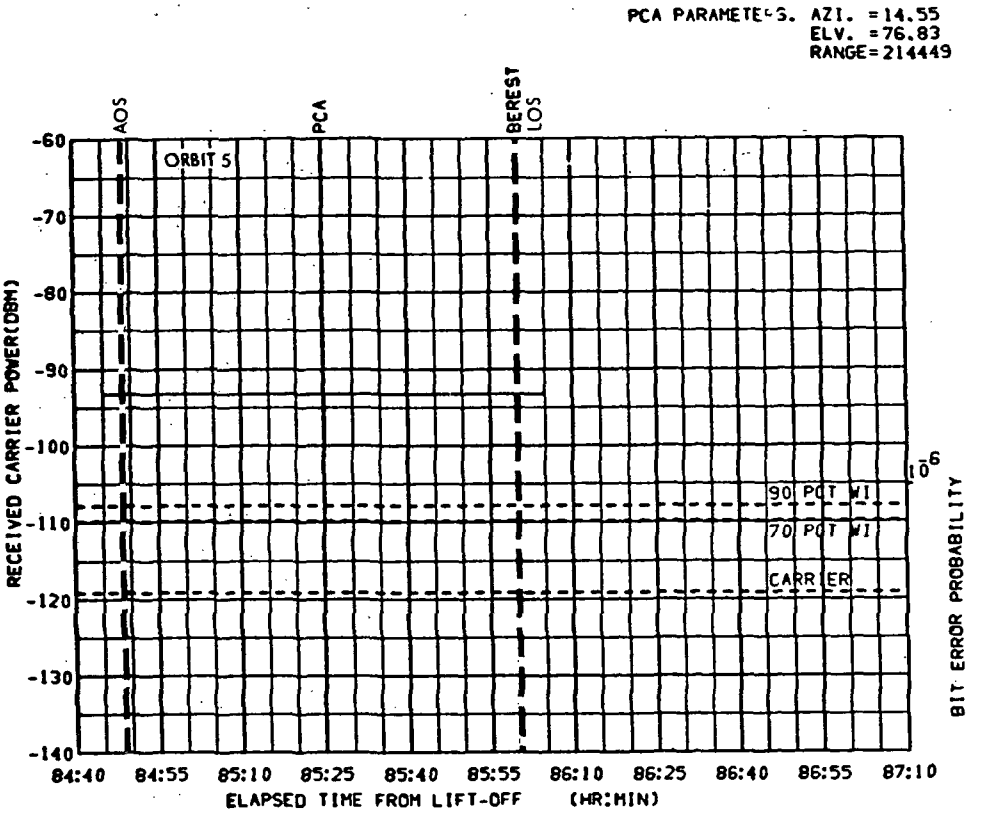

FIGURE 9-17c. GWM UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

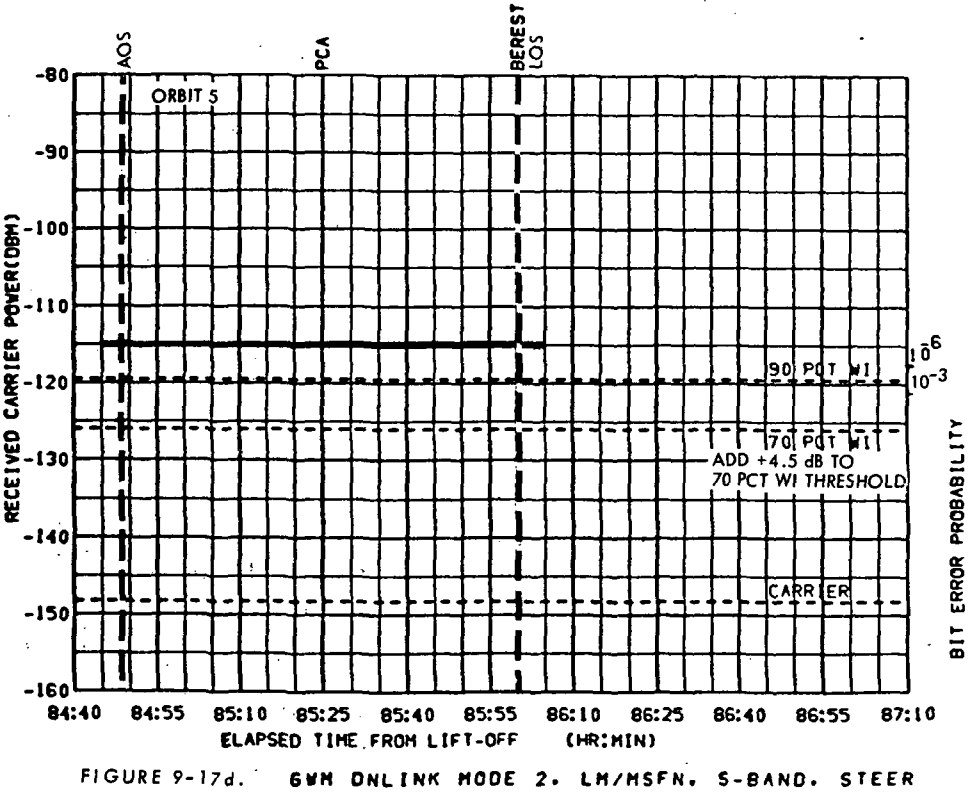

FIGURE 9-17d. GWM ONLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -28.10
ELV = 22.20
RANGE = 216426

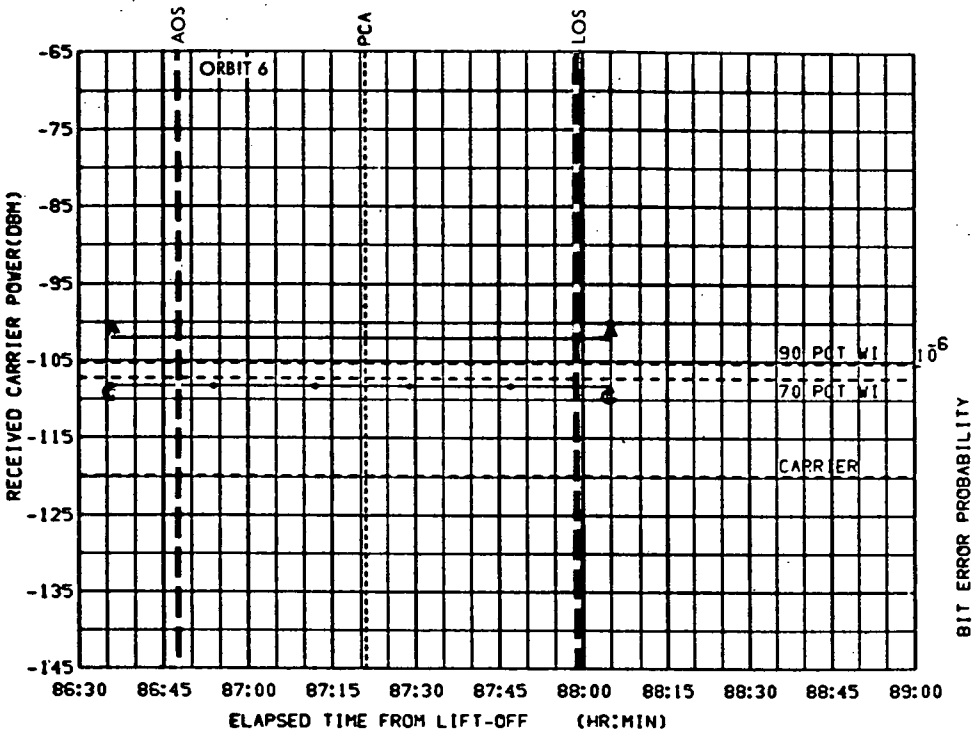

FIGURE 9-18a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

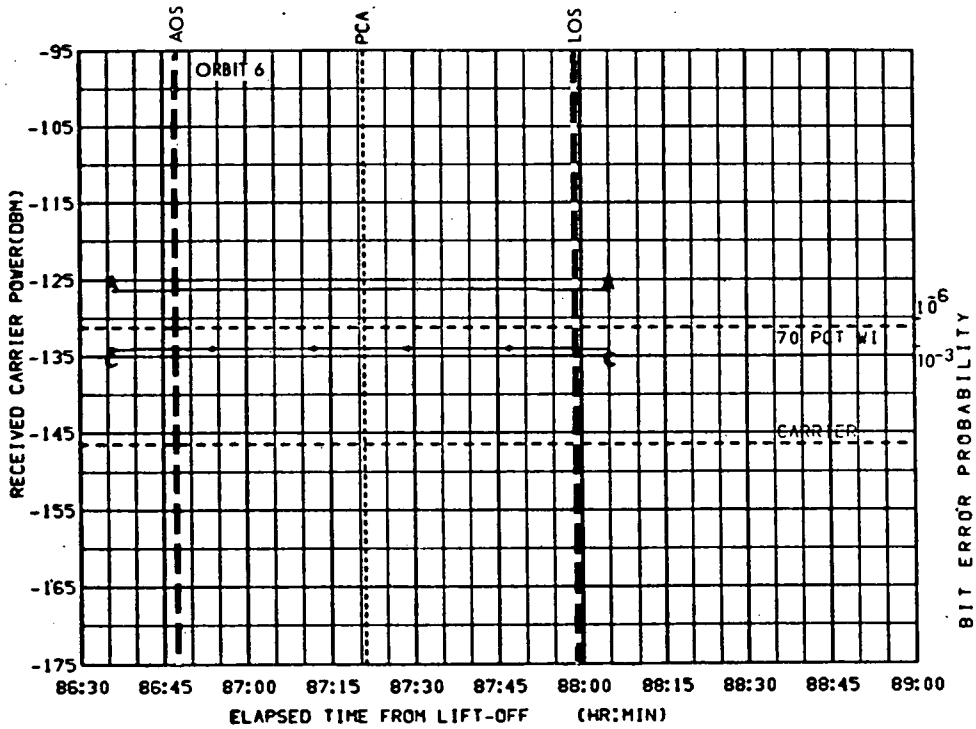

FIGURE 9-18b. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -28.10
ELV = 22.20
RANGE = 216426

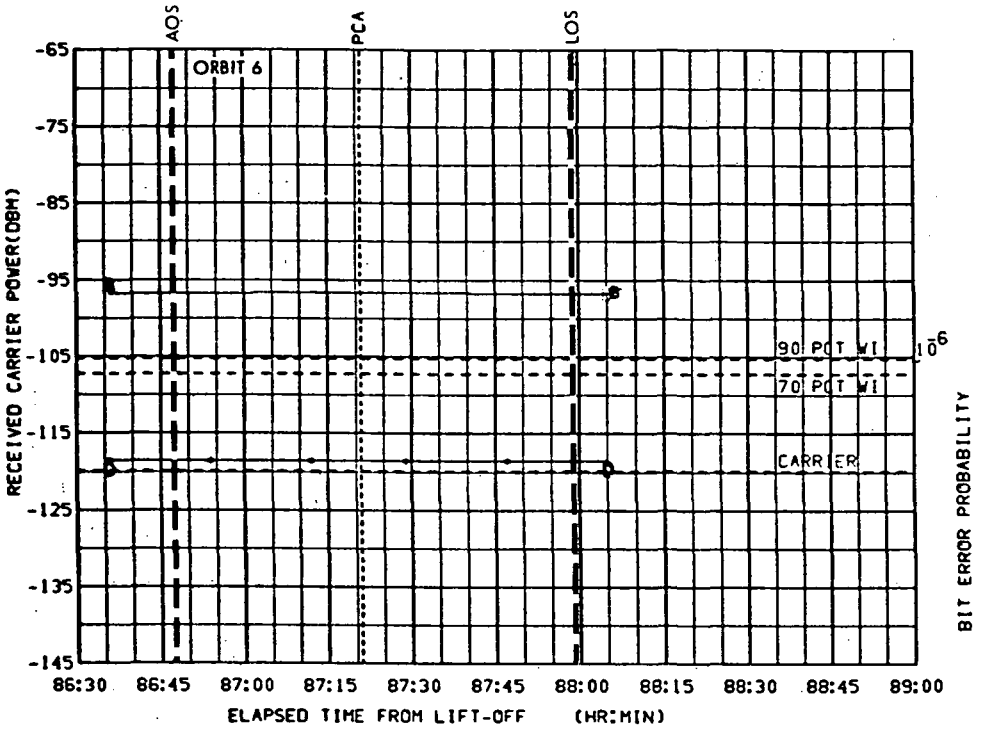

FIGURE 9-18c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

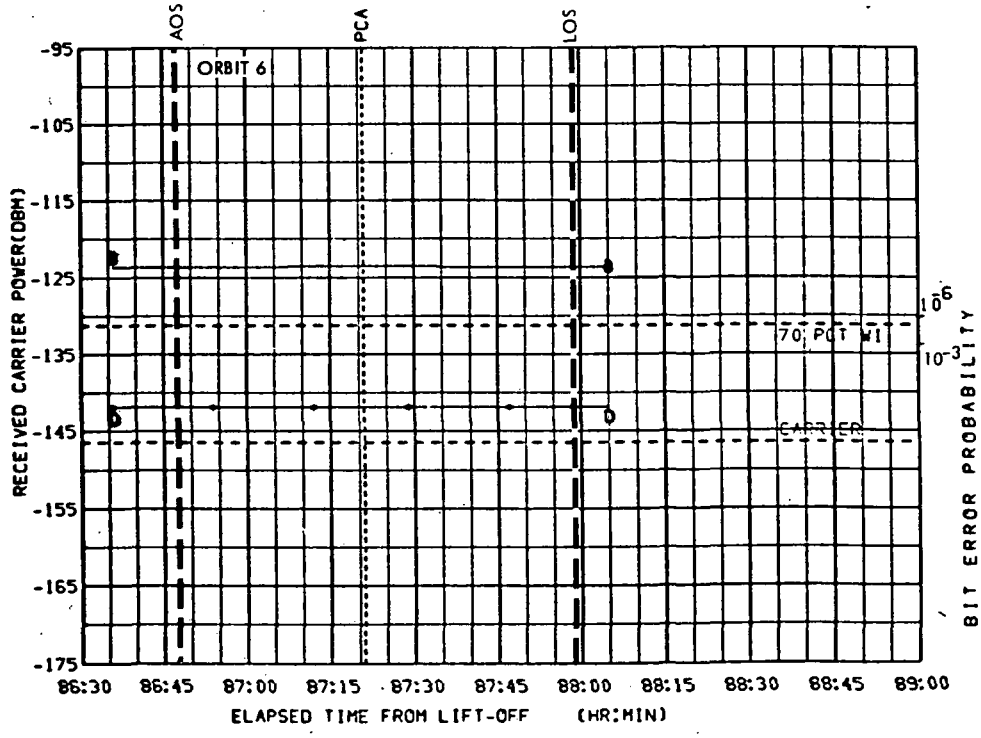

FIGURE 9-18d. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

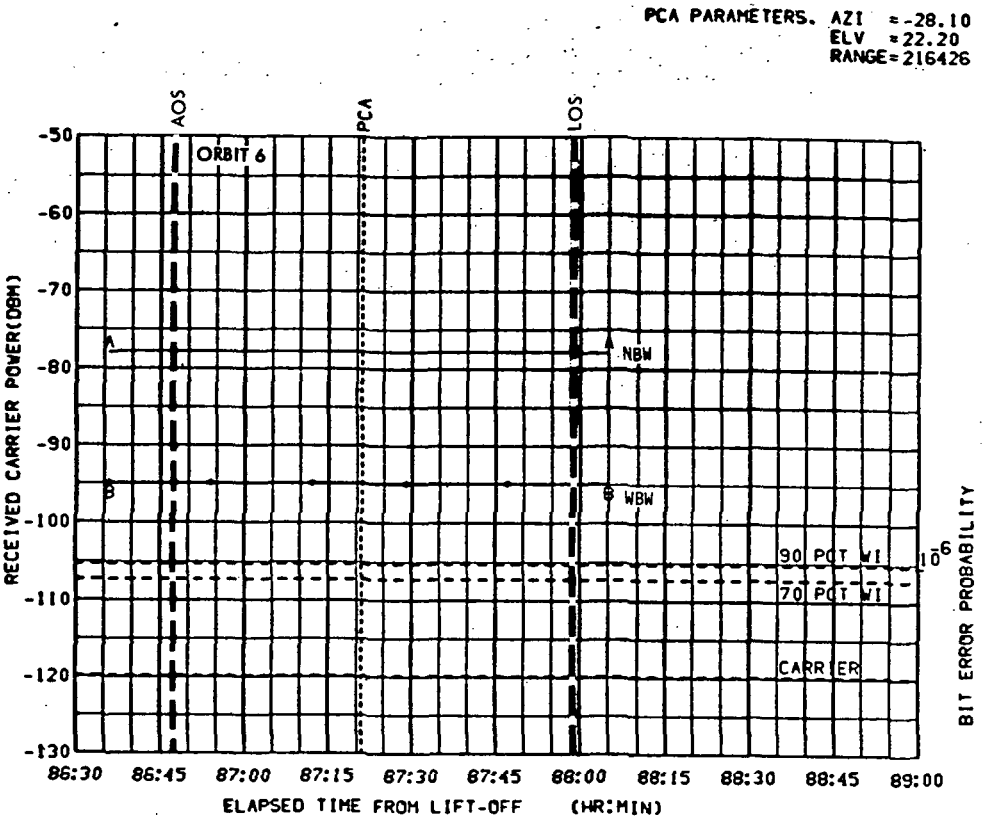

FIGURE 9-18e. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

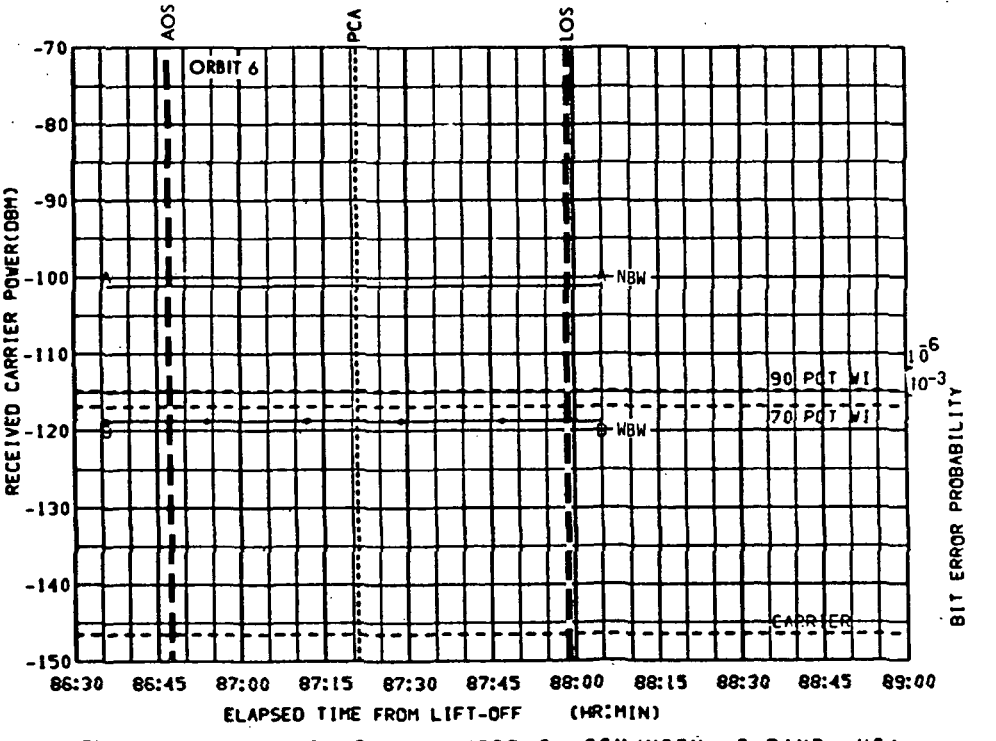

FIGURE 9-18f. HSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -28.10
ELV = 22.20
RANGE = 216426

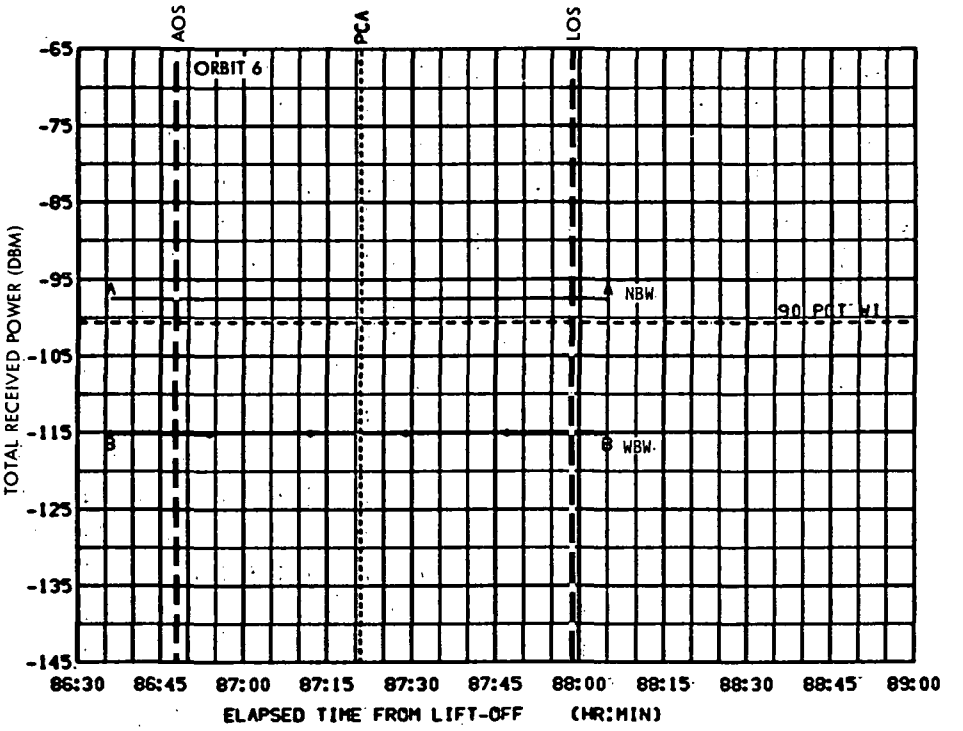

FIGURE 9-18g. MSK DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. = -28.10
ELV. = 22.20
RANGE = 216426

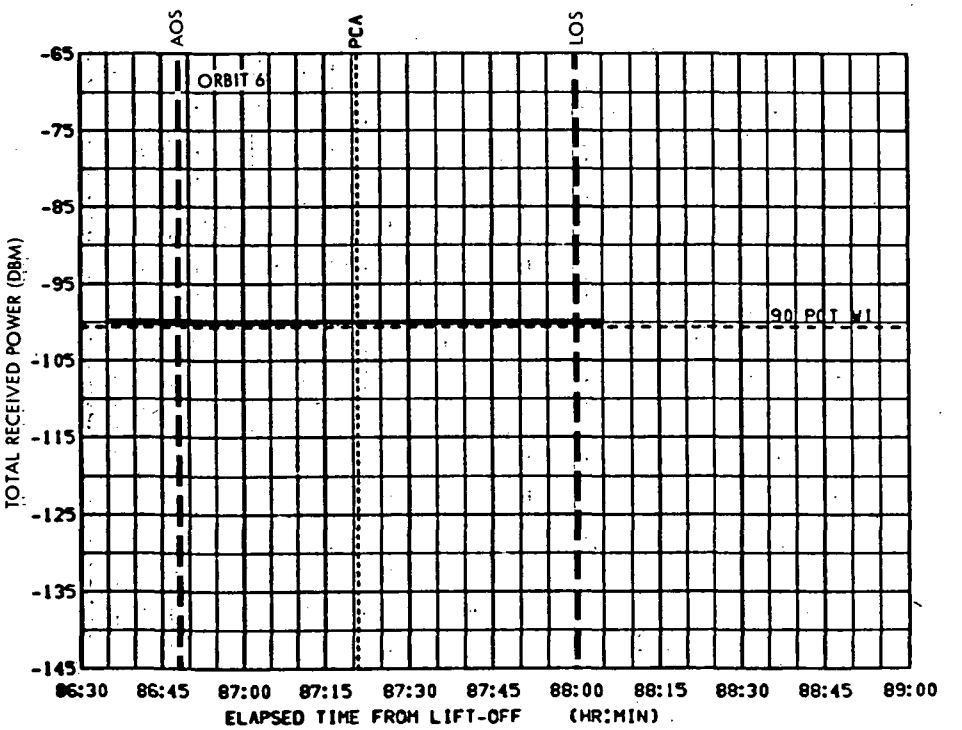

FIGURE 9-18h. MSK DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

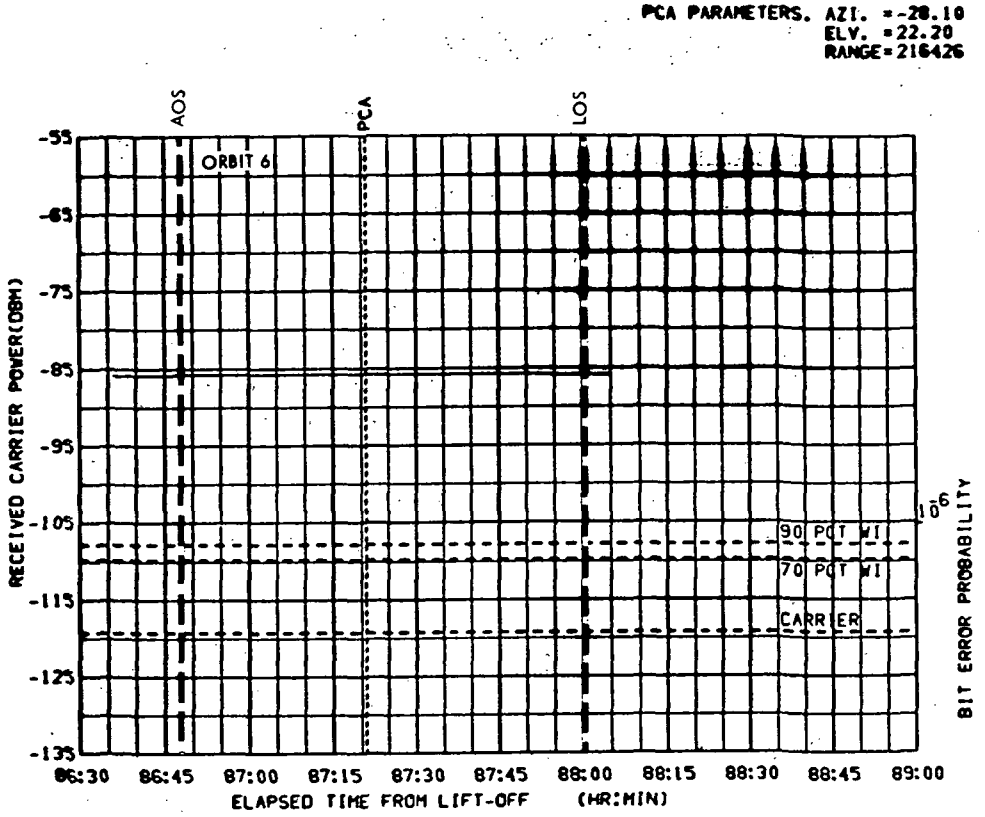

FIGURE 9-18i. HSK UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

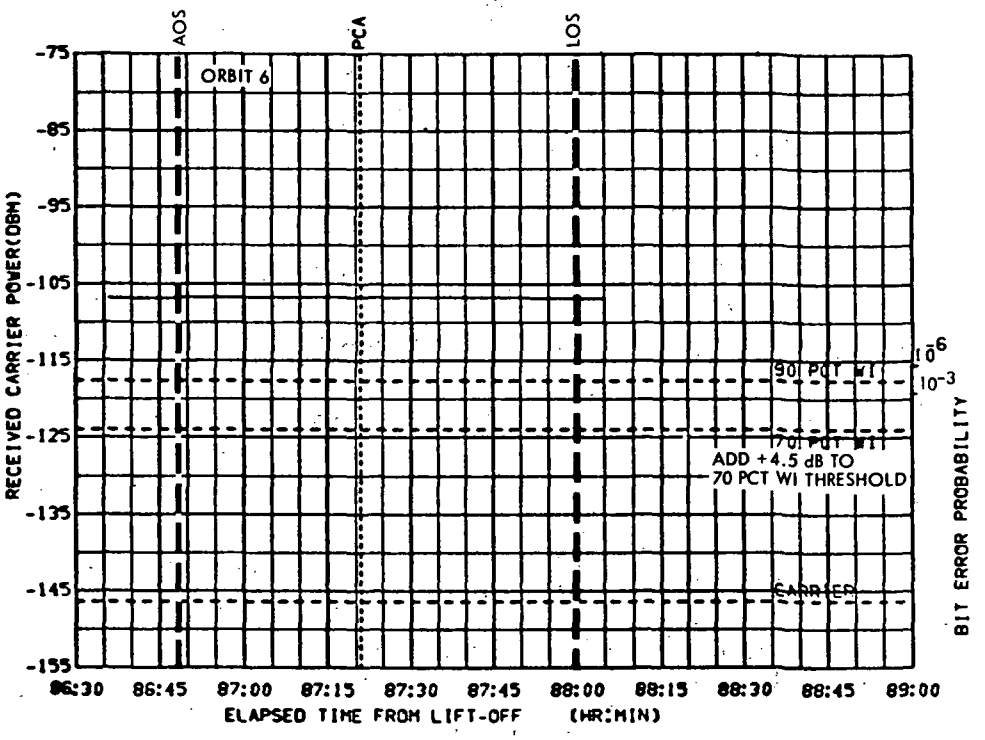

FIGURE 9-18j. HSK DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI =-28.10
ELV =22.20
RANGE=216426

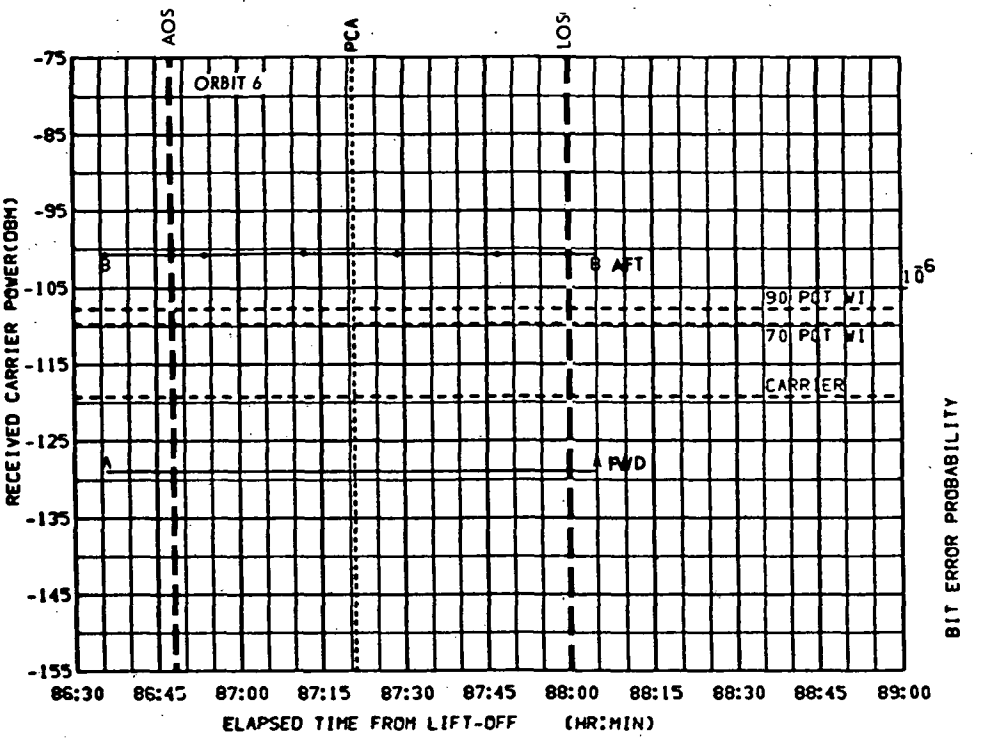

FIGURE 9-18k. MSK UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

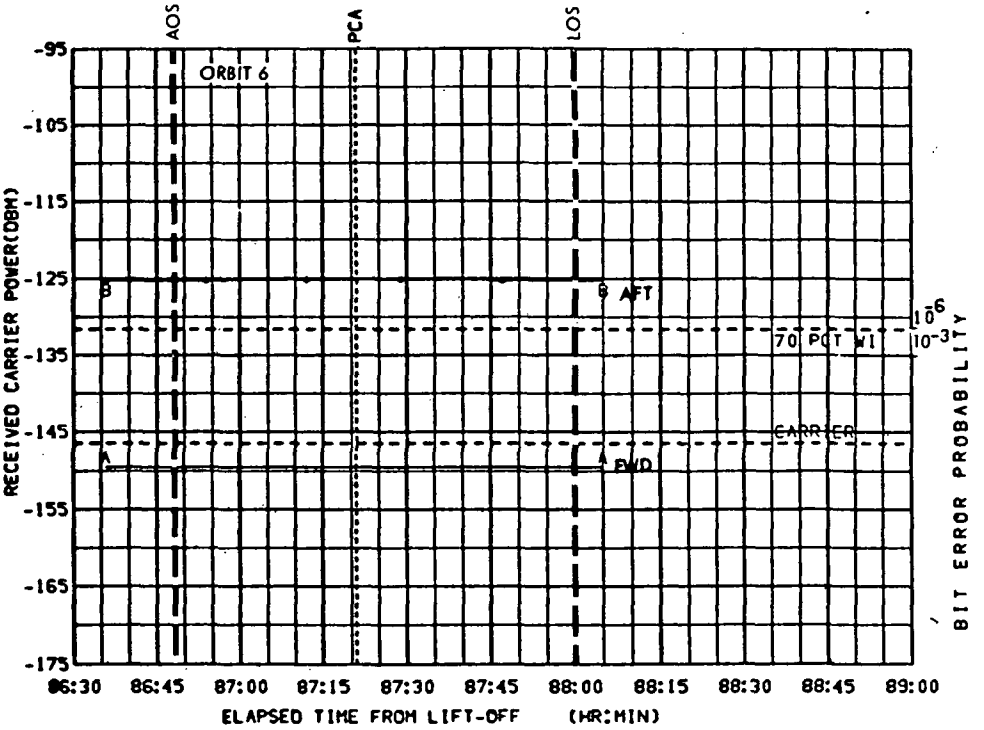

FIGURE 9-18l. MSK DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =-58.18
ELV =63.49
RANGE=214673

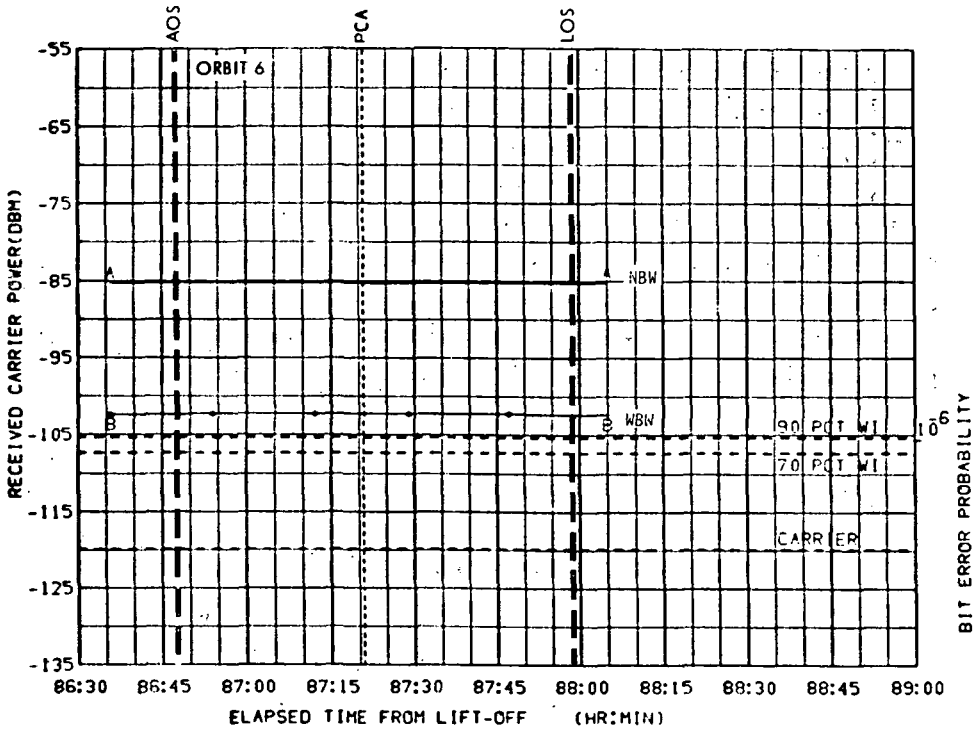

FIGURE 9-19a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

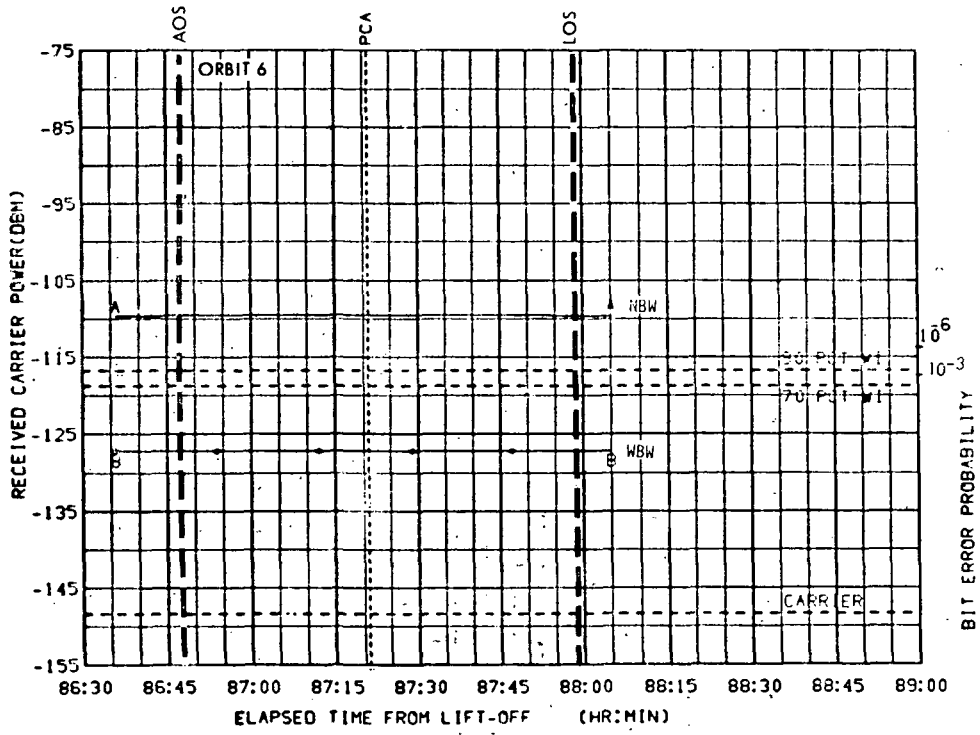

FIGURE 9-19b GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI. =-58.18
ELV. =63.49
RANGE=214673

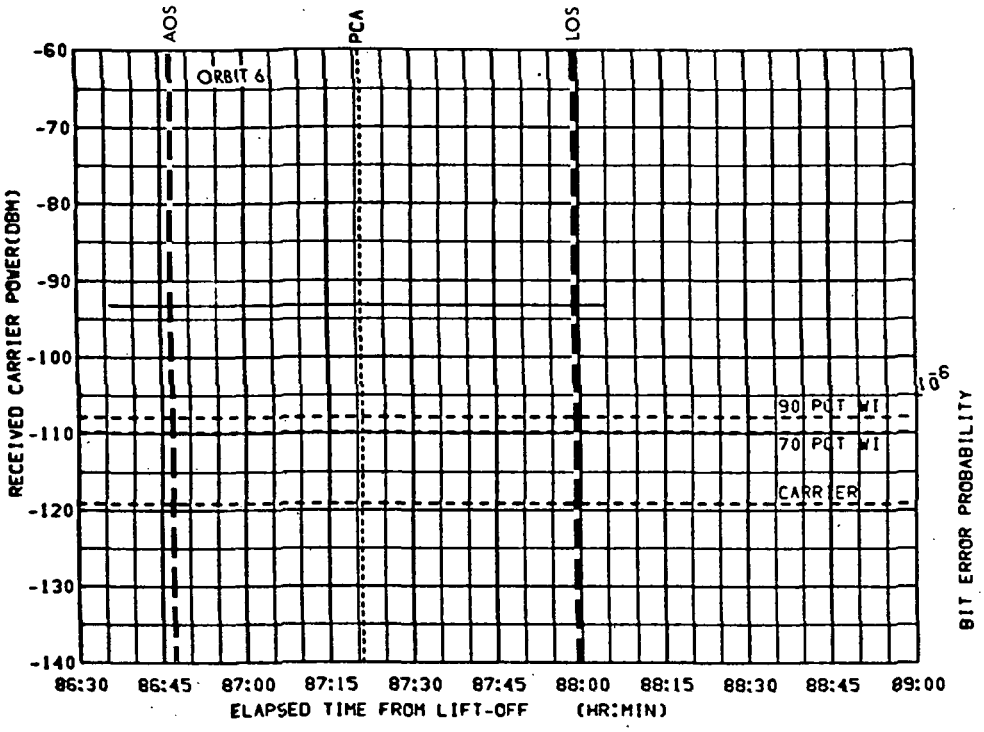

FIGURE 9-19c. GWM UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

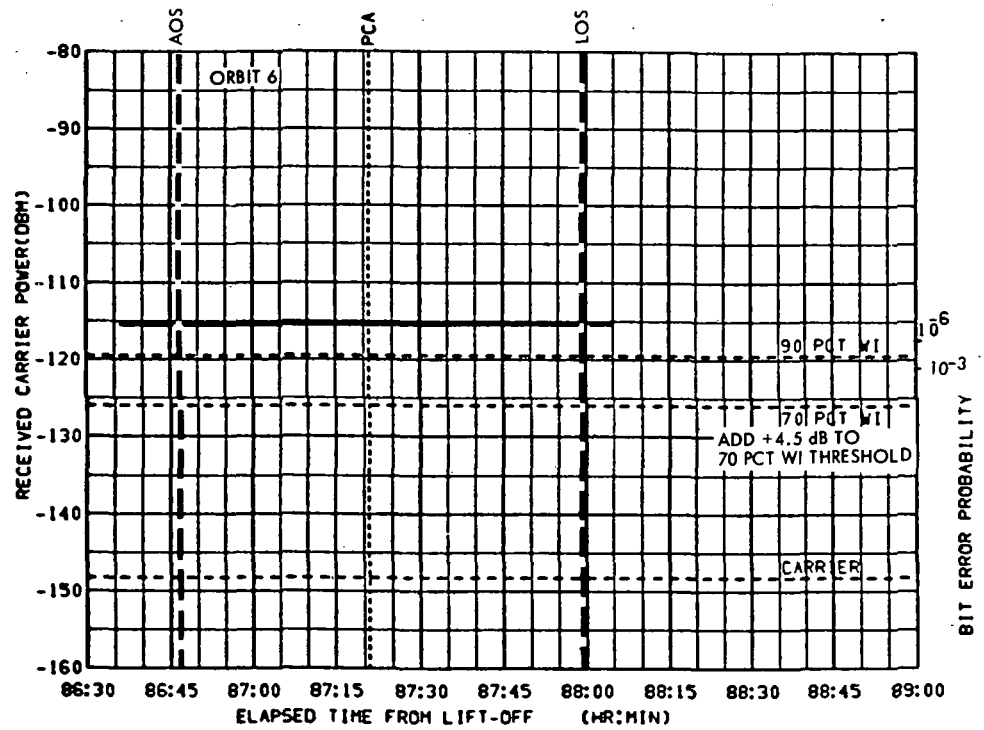

FIGURE 9-19d. GWM DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

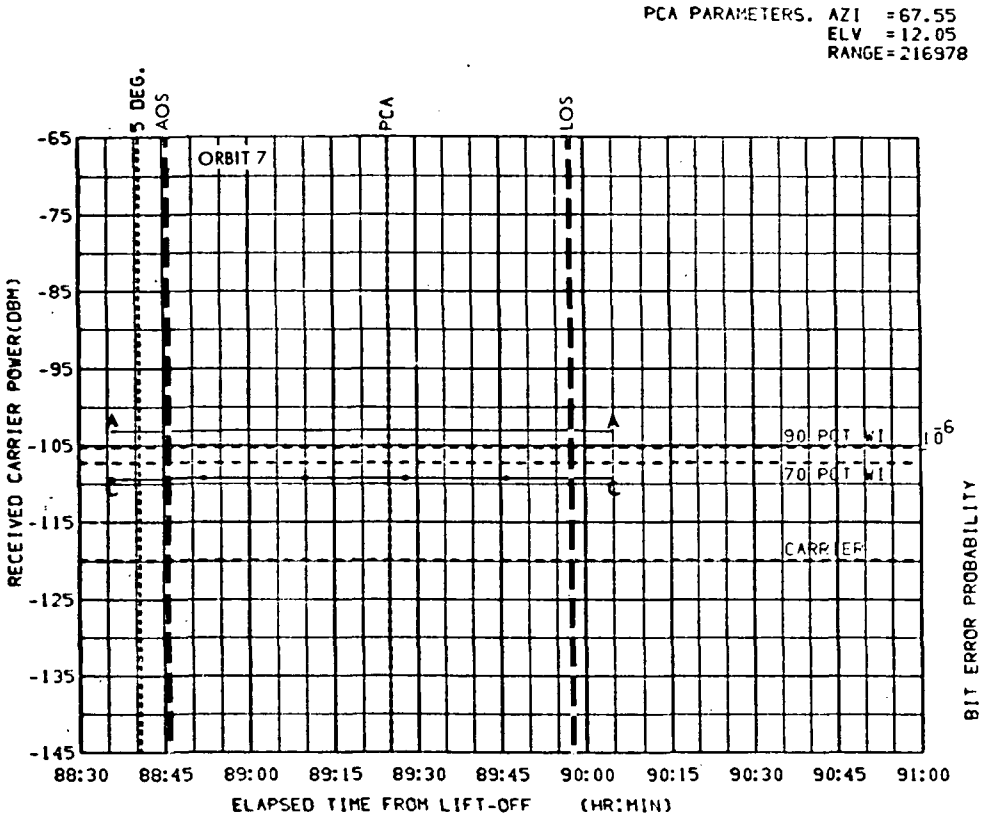

FIGURE 9-20a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

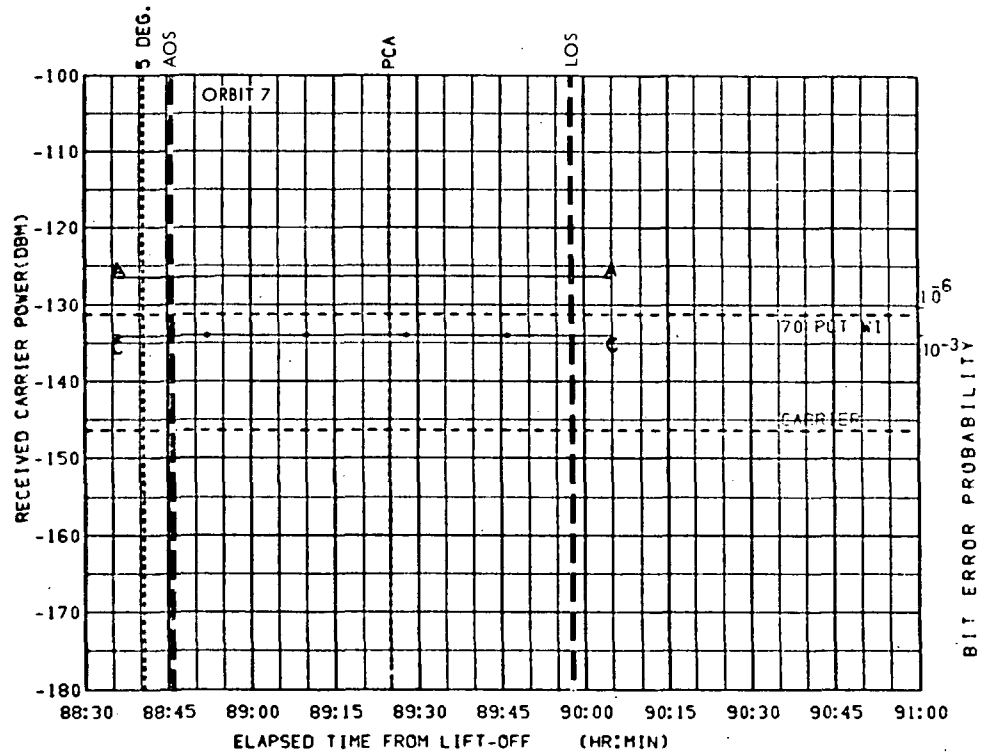

FIGURE 9-20b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =67.55
ELV =12.05
RANGE=216978

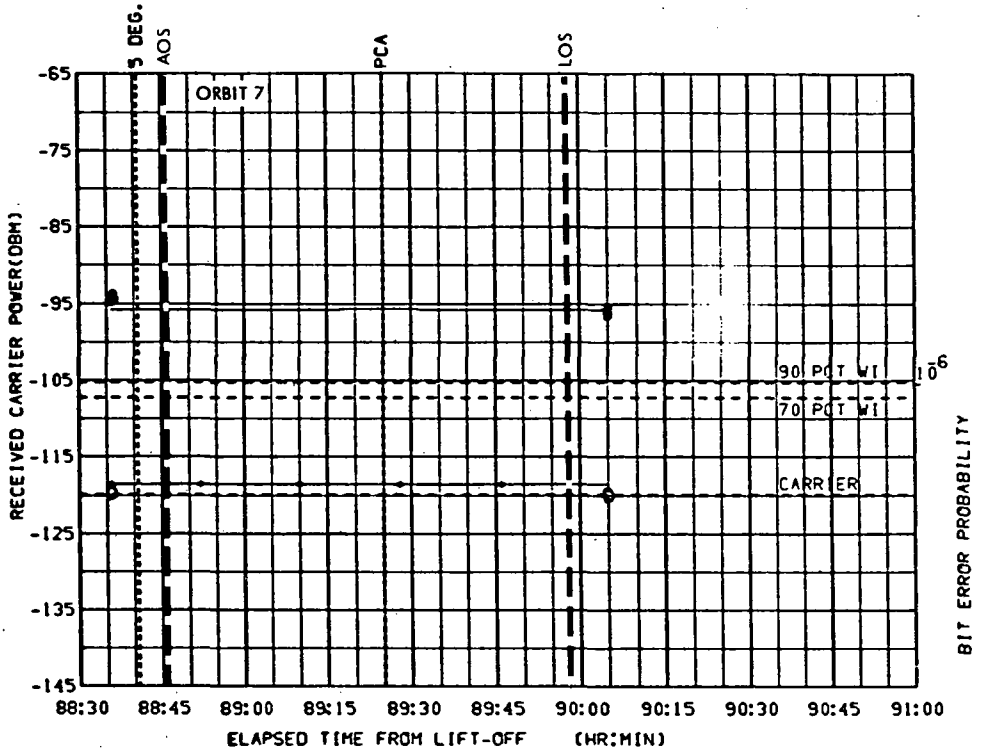

FIGURE 9-20c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

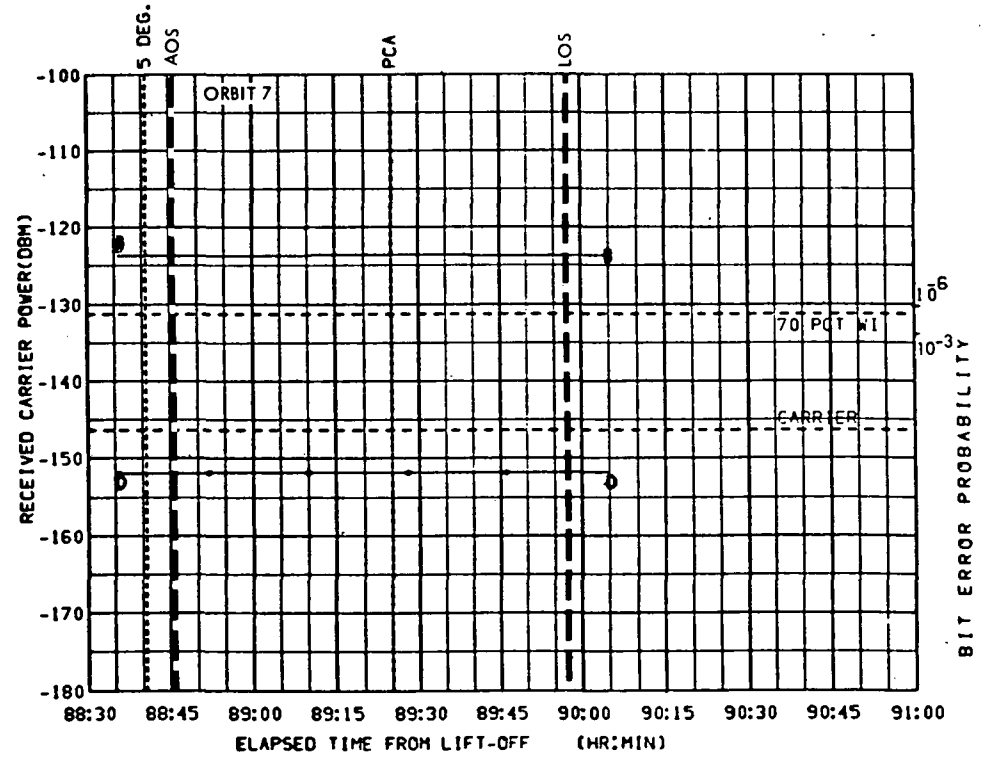

FIGURE 9-20d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

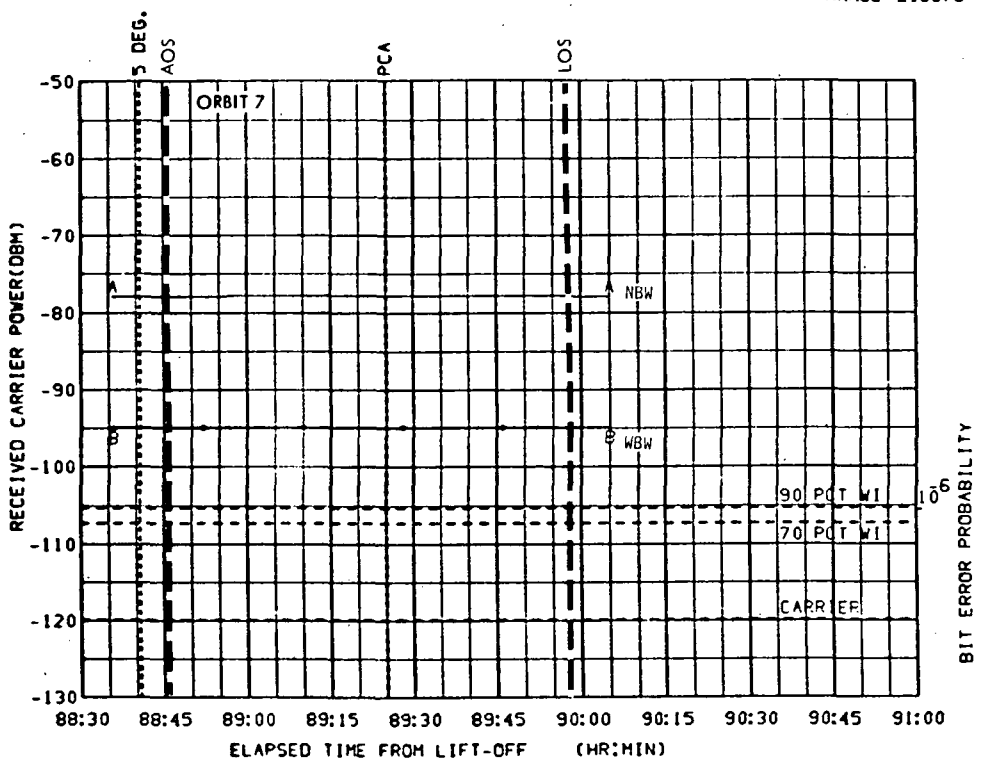

FIGURE 9-20e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

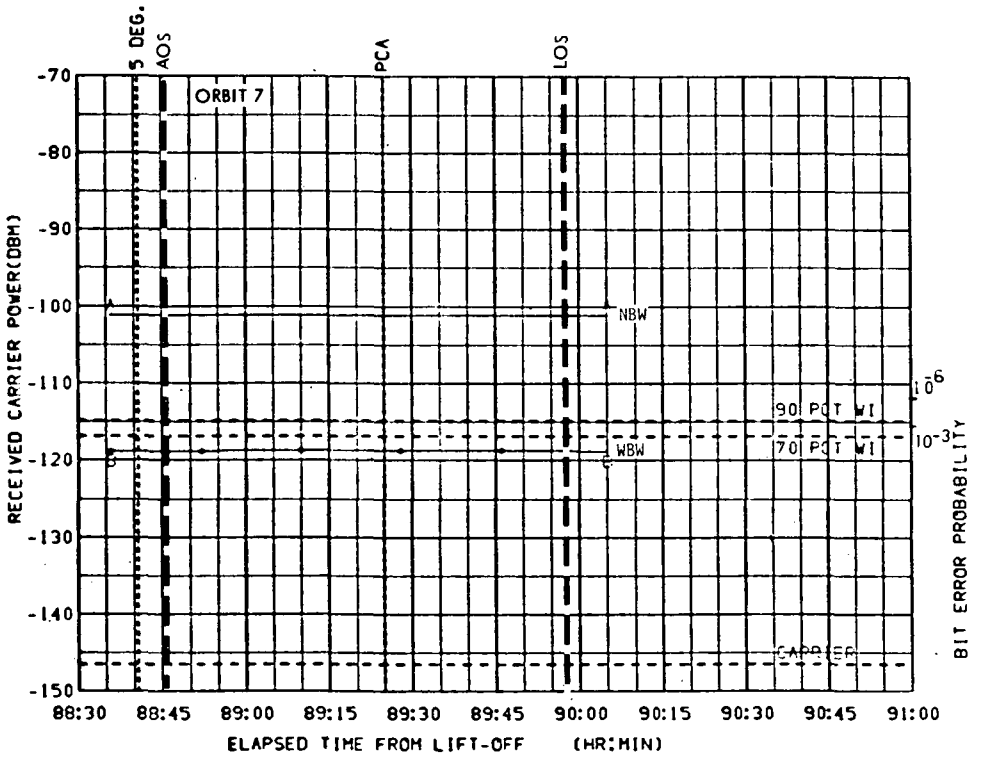

FIGURE 9-20f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

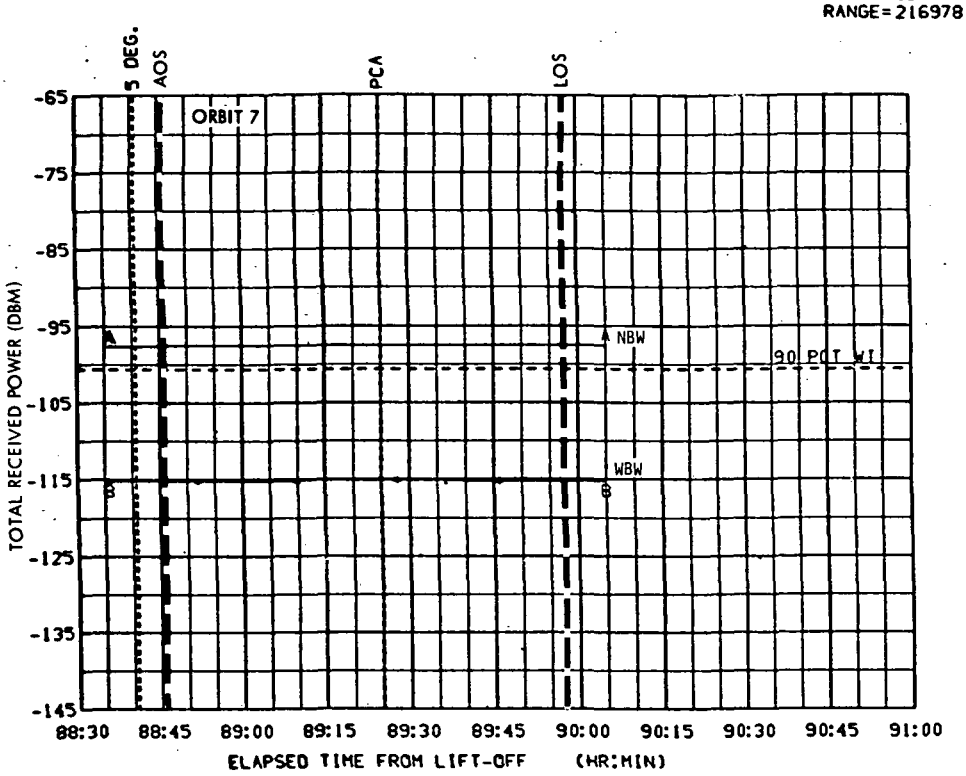

FIGURE 9-20g. MAD DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

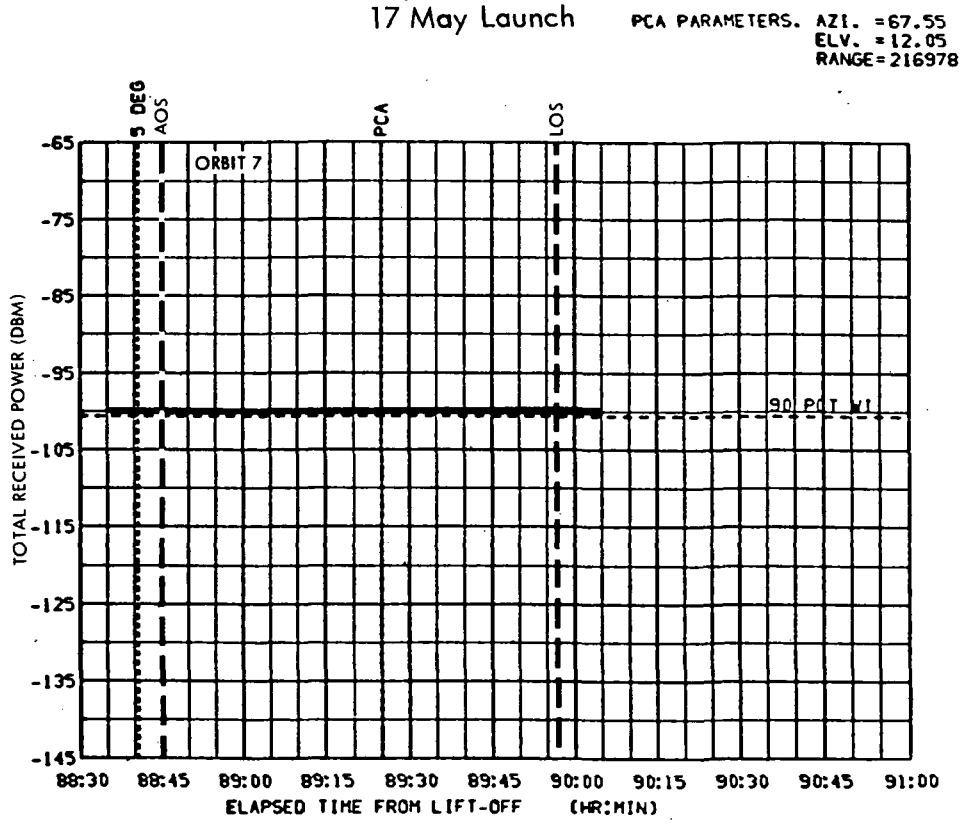

FIGURE 9-20h. MAD DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. =67.55
ELV. =12.05
RANGE=216978

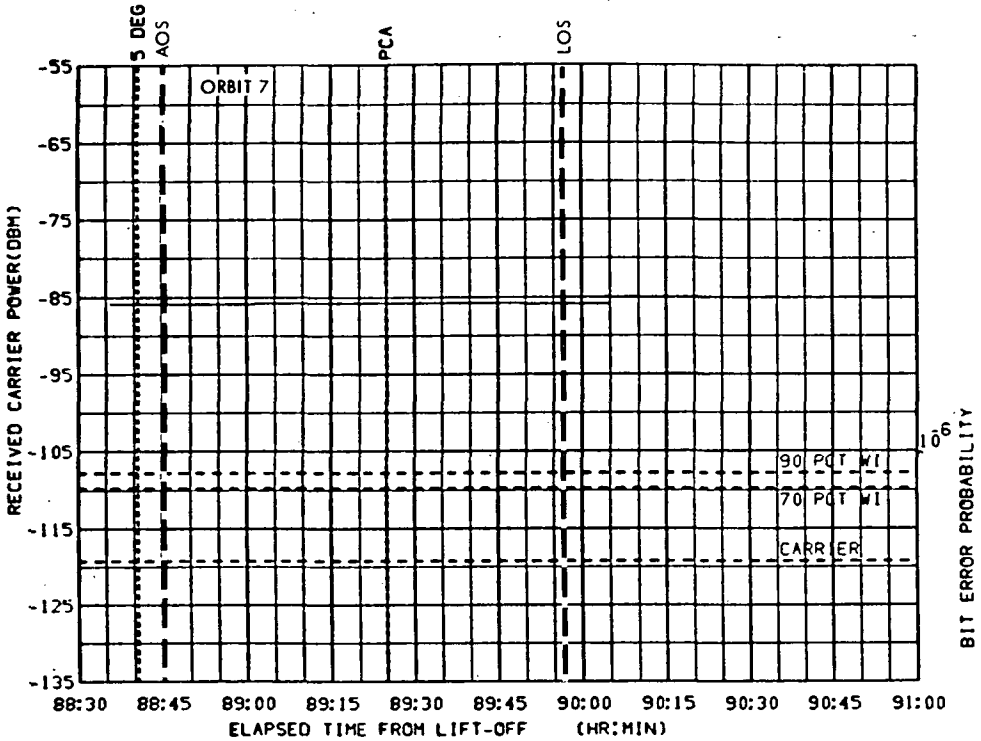

FIGURE 9-20i. MAD UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

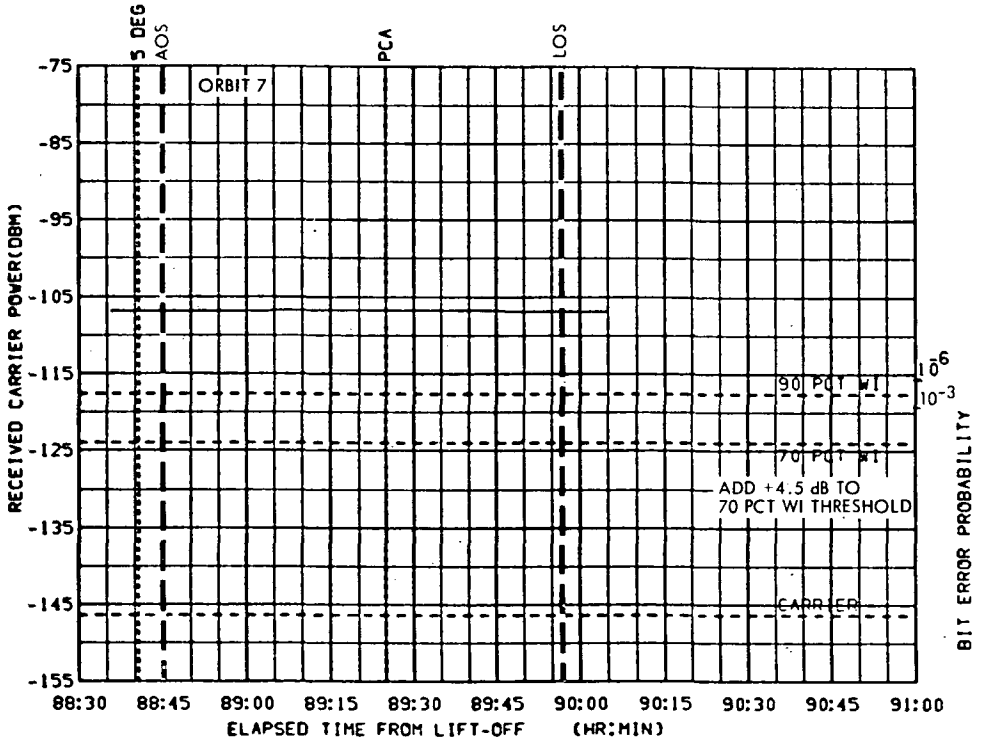

FIGURE 9-20j. MAD DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI =67.55
ELV =12.05
RANGE=216978

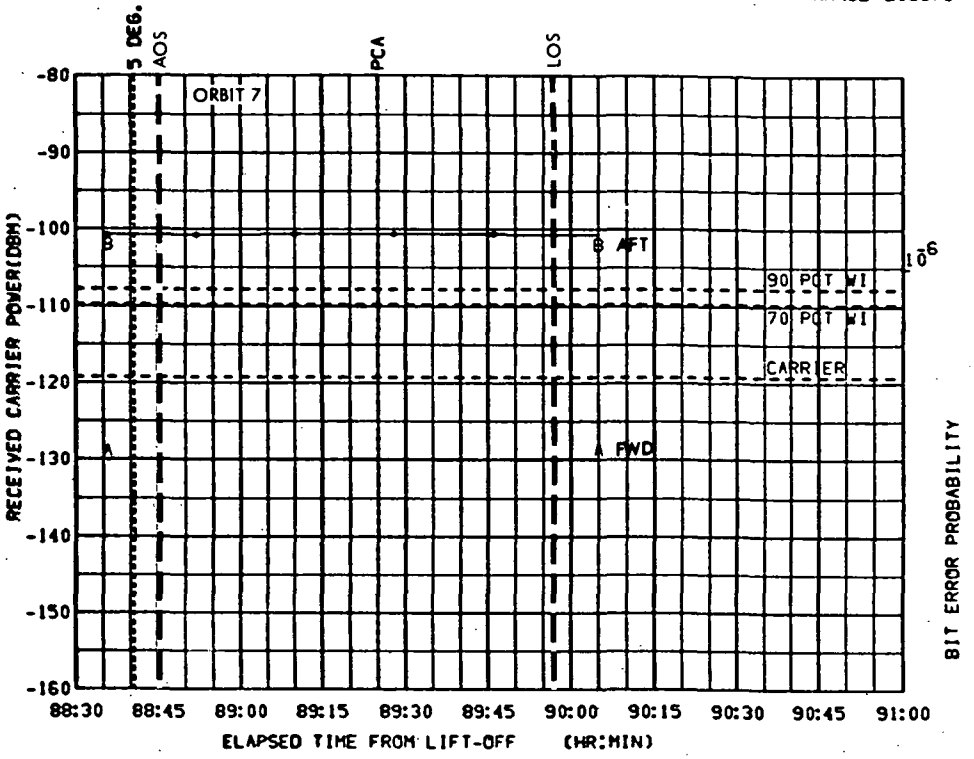

FIGURE 9-20k. MAD UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

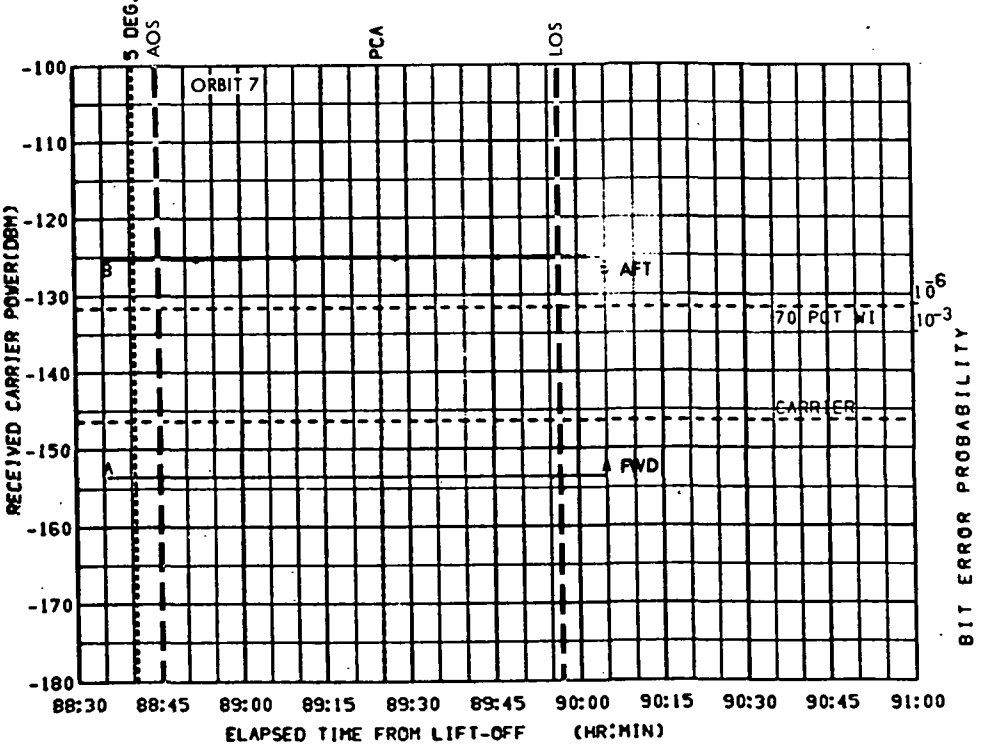

FIGURE 9-20l. MAD DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -24.77
ELV = 34.54
RANGE = 215725

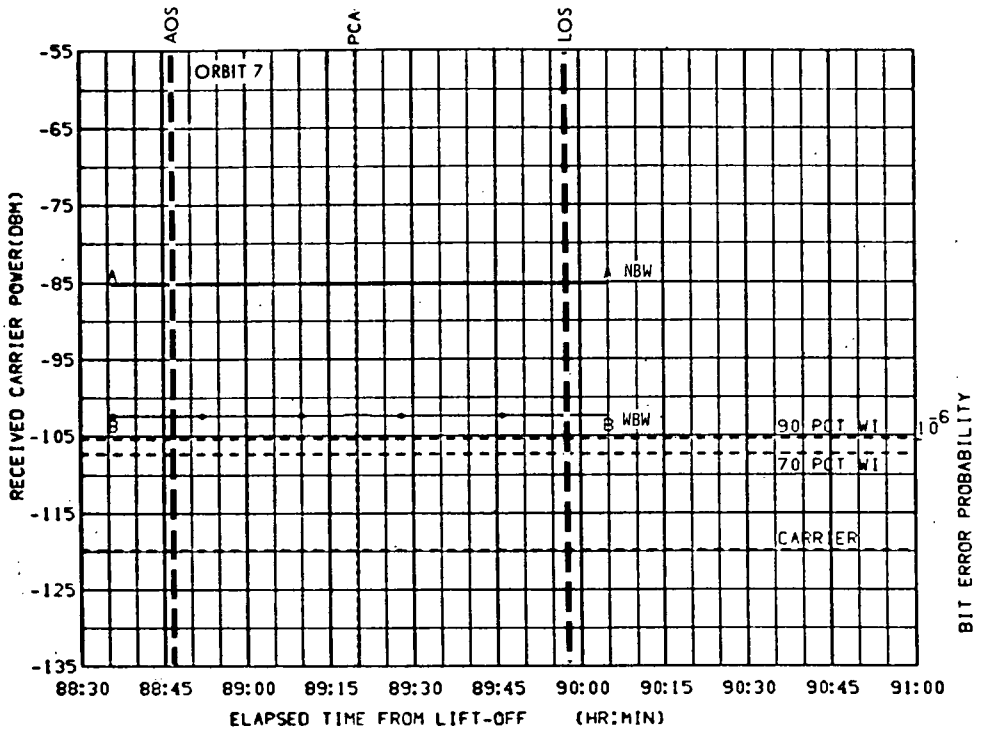

FIGURE 9-21a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

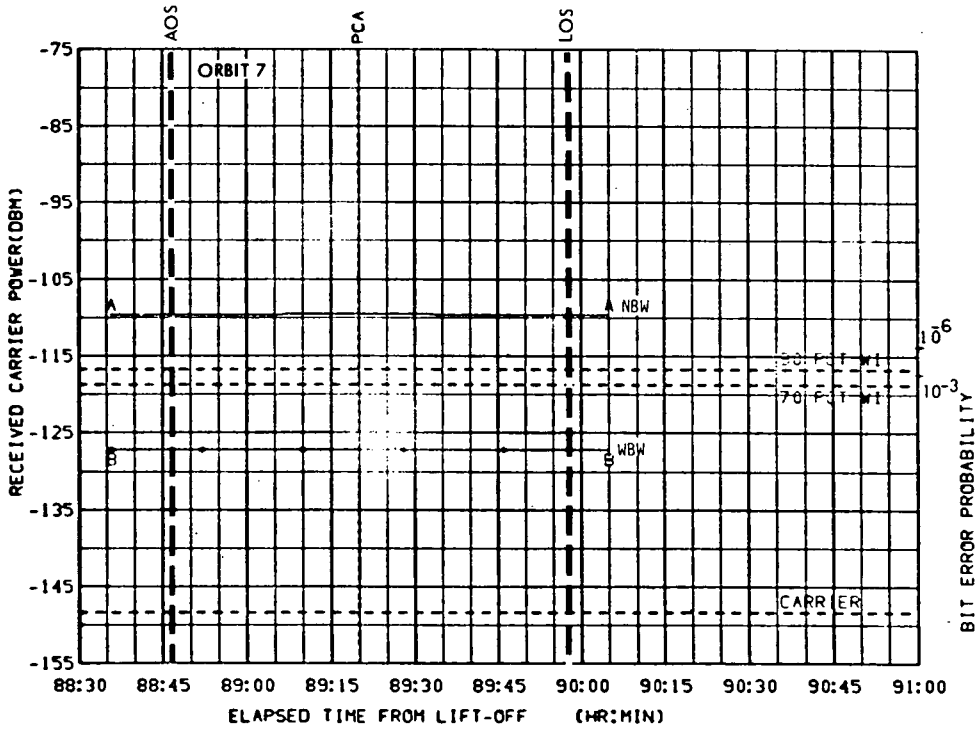

FIGURE 9-21b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI. =-24.77
ELV. =34.54
RANGE=215725

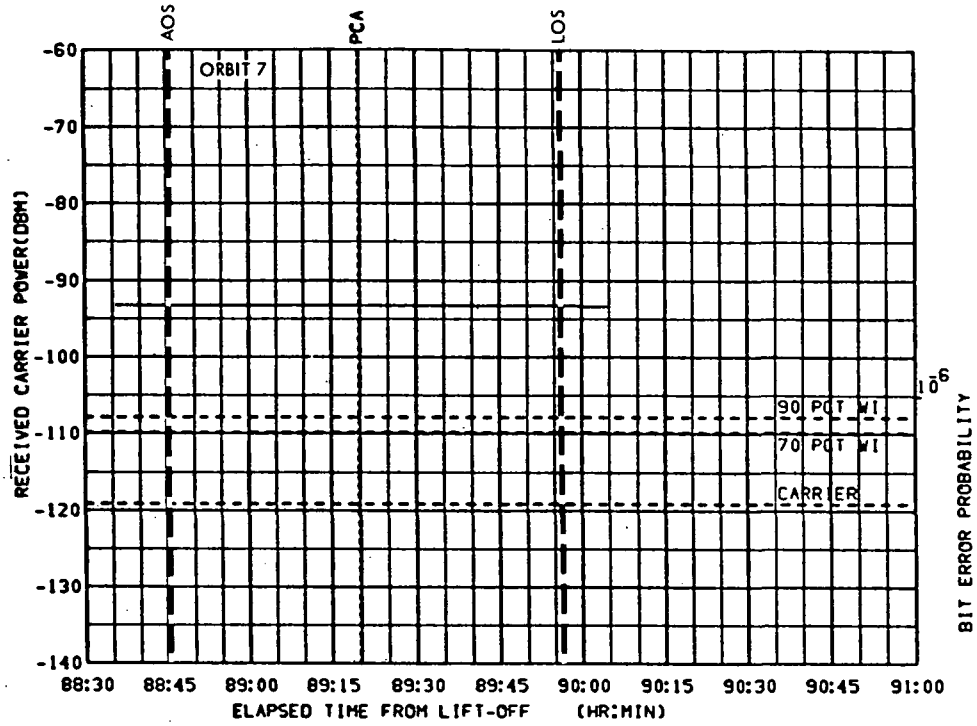

FIGURE 9-21c. CRO UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

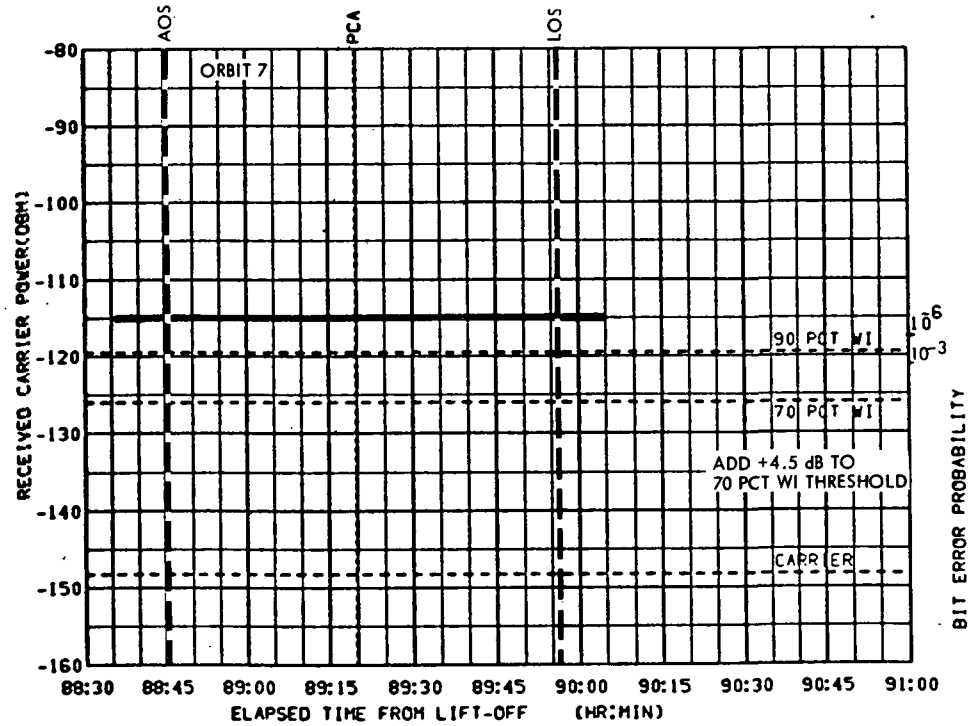

FIGURE 9-21d. CRO DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =84.19
ELV =33.03
RANGE=215765

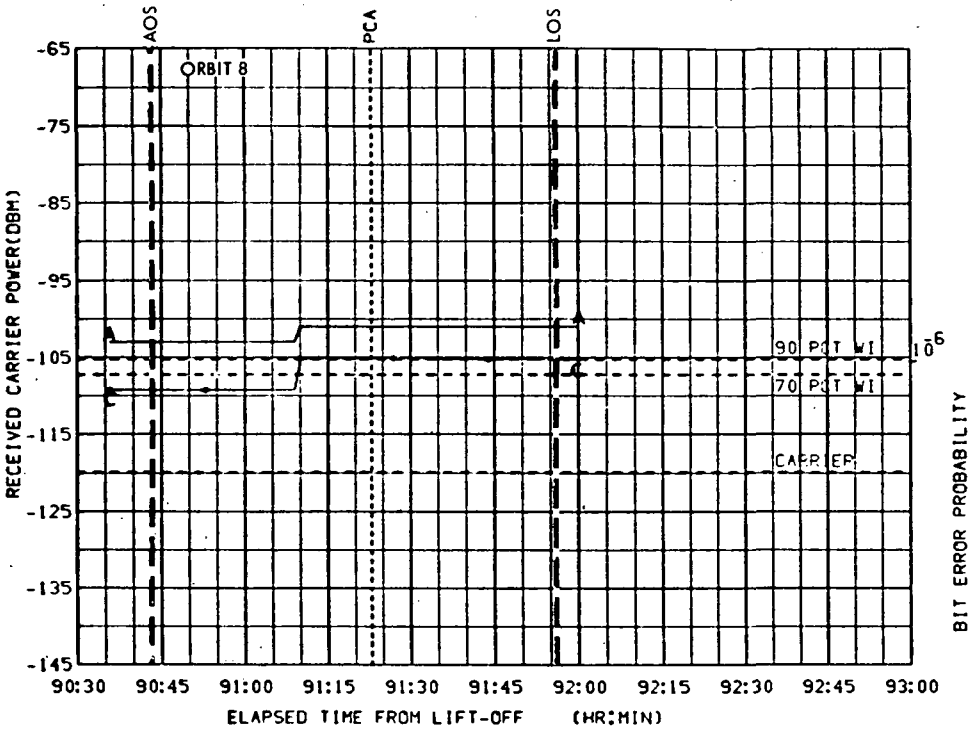

FIGURE 9-22a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

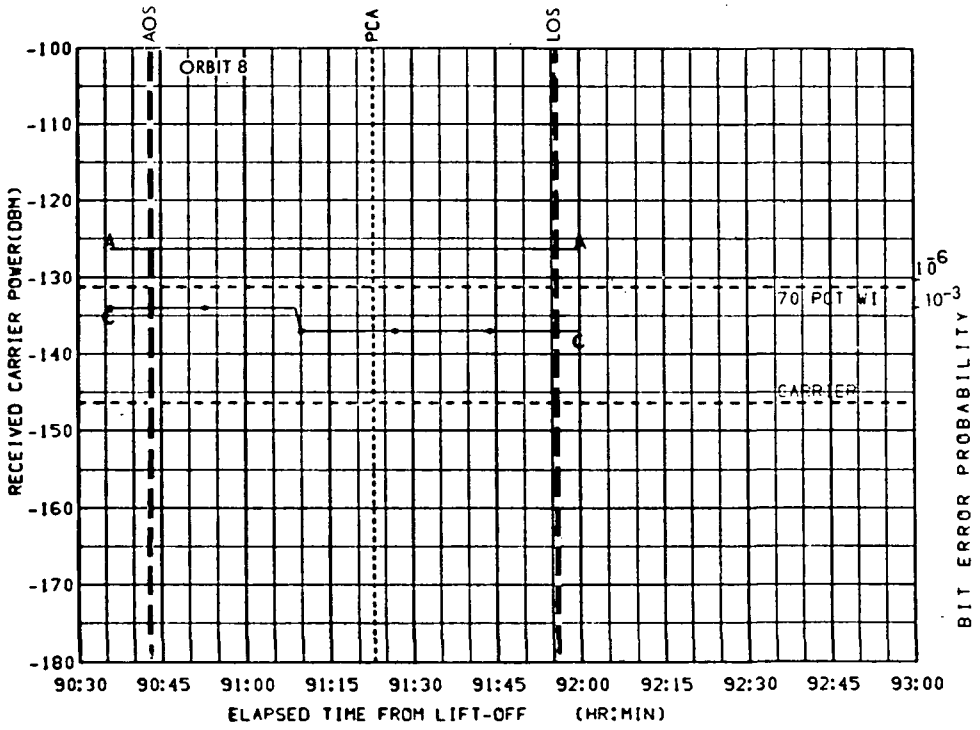

FIGURE 9-22b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =84.19
ELV =33.03
RANGE=215765

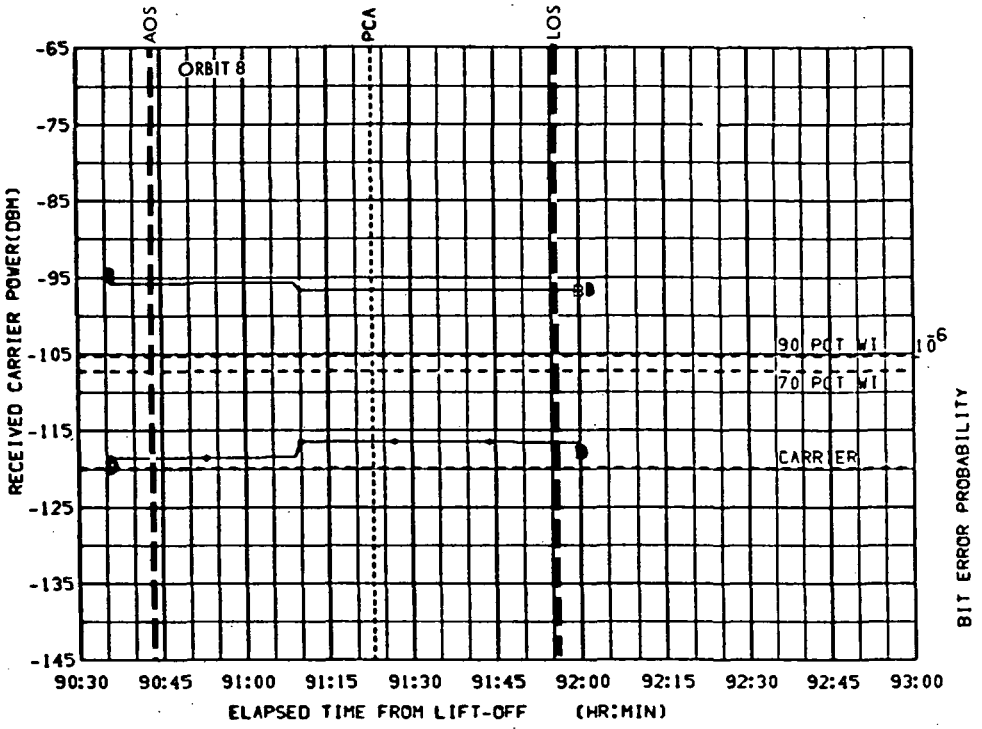

FIGURE 9-22c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

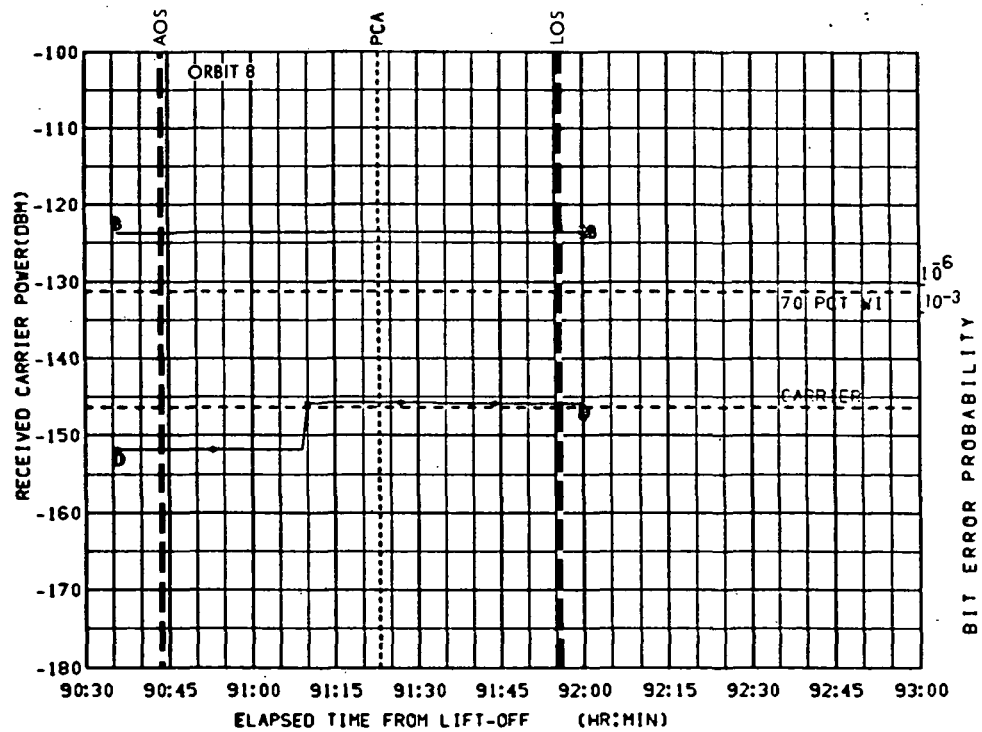

FIGURE 9-22d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =84.19
ELV =33.03
RANGE=215765

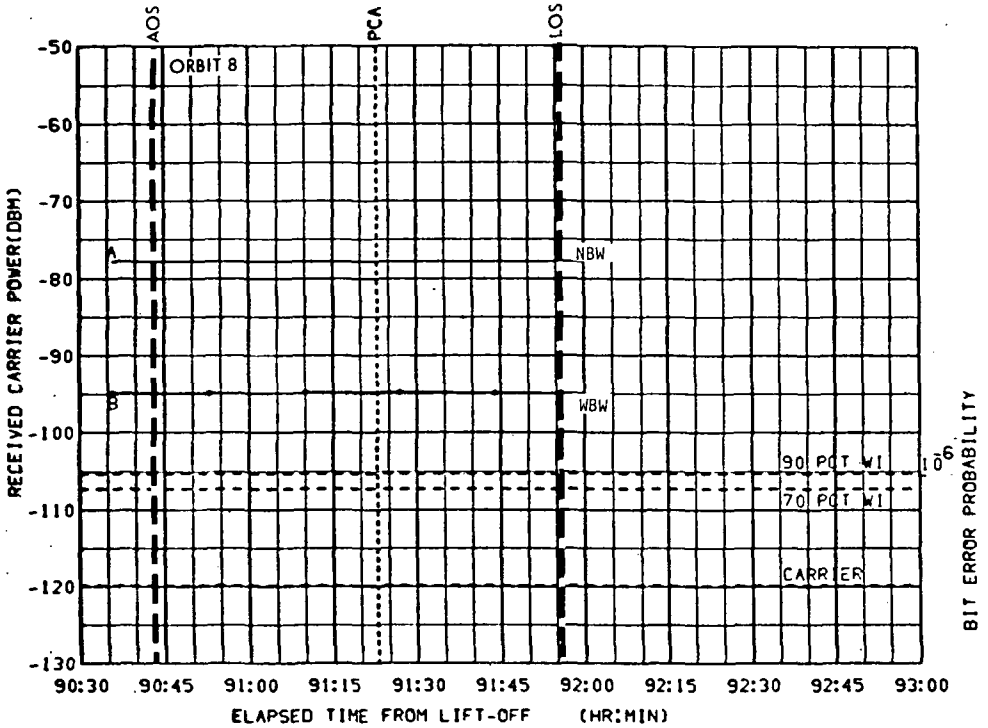

FIGURE 9-22e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

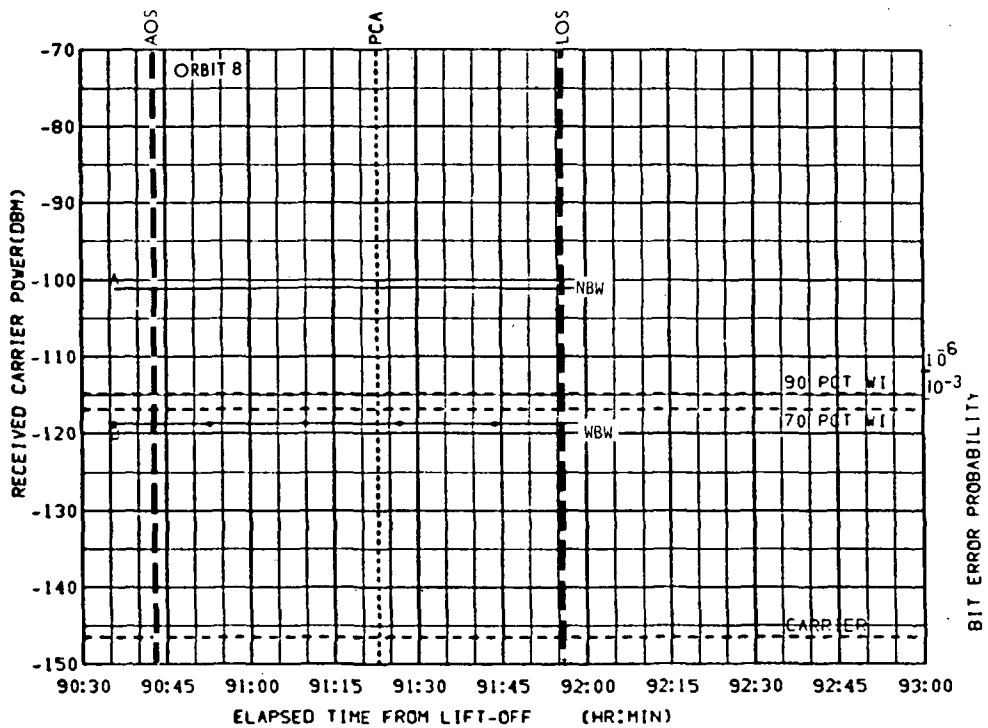

FIGURE 9-22f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =84.19
ELV =33.03
RANGE=215765

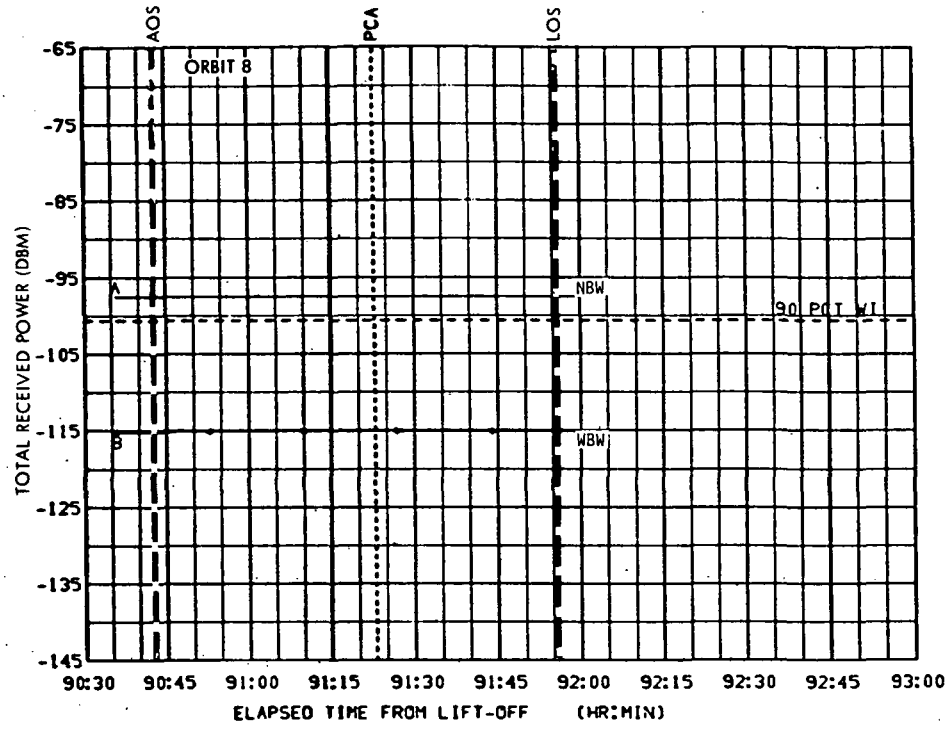

FIGURE 9-22g. MAD DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. =84.19
ELV. =33.03
RANGE=215765

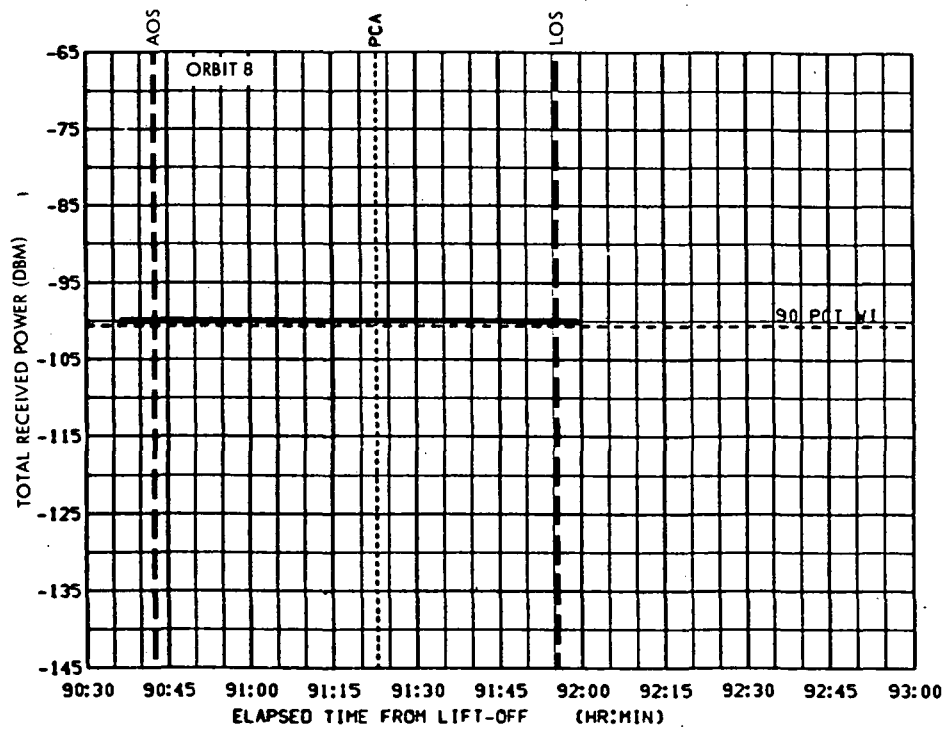

FIGURE 9-22h. MAD DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

PCA PARAMETERS. AZI. =84.19
ELV. =33.03
RANGE=215765

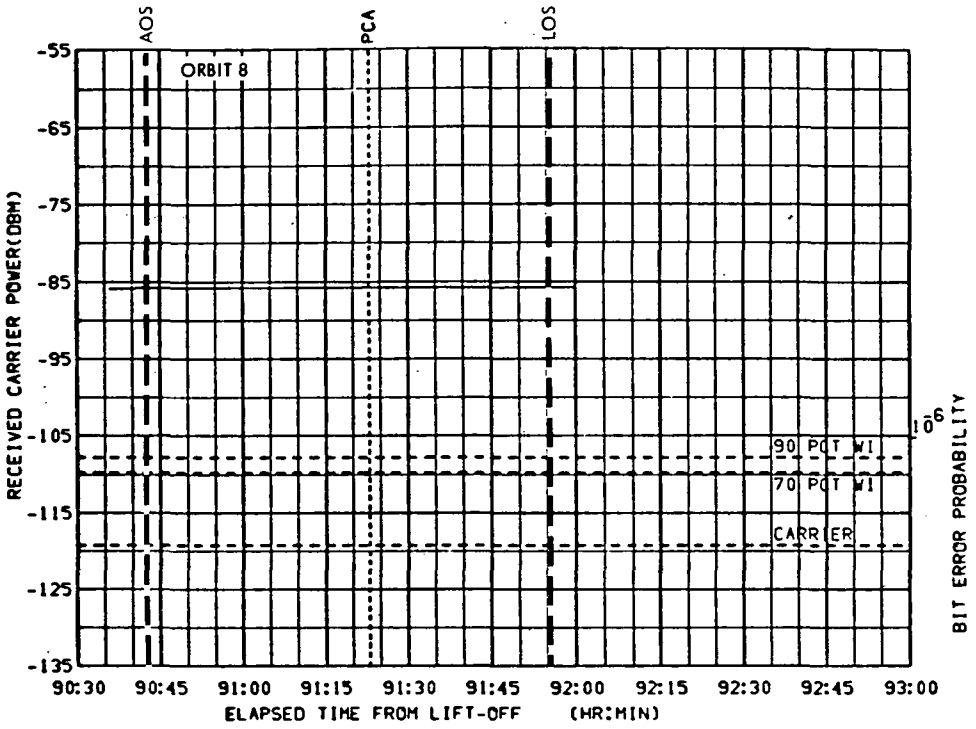

FIGURE 9-22i. MAD UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

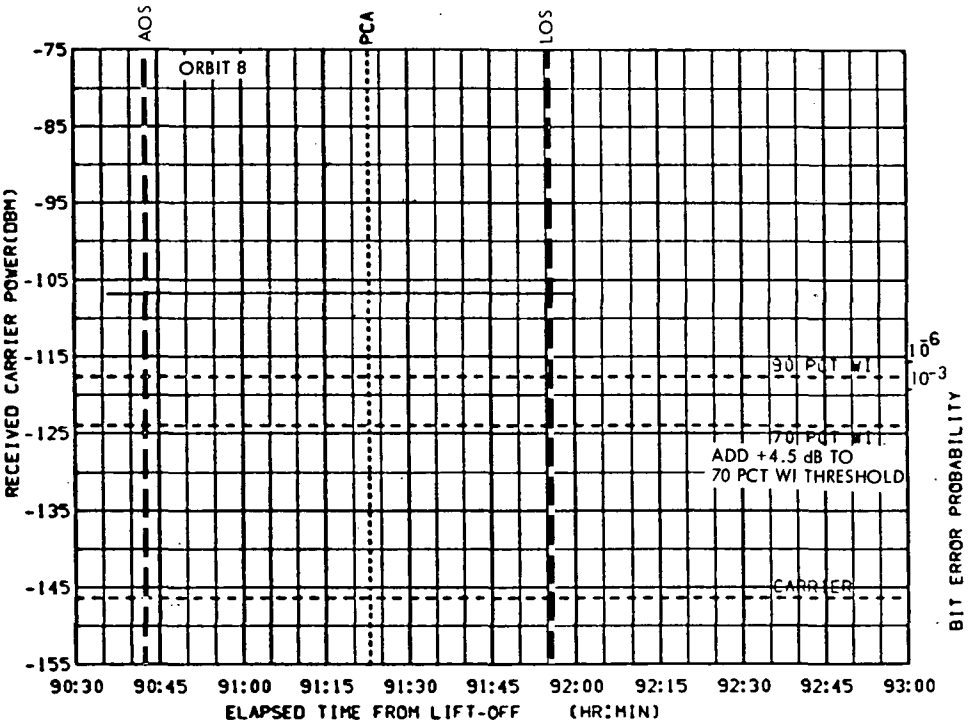

FIGURE 9-22j. MAD DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI =84.19
ELV =33.03
RANGE=215765

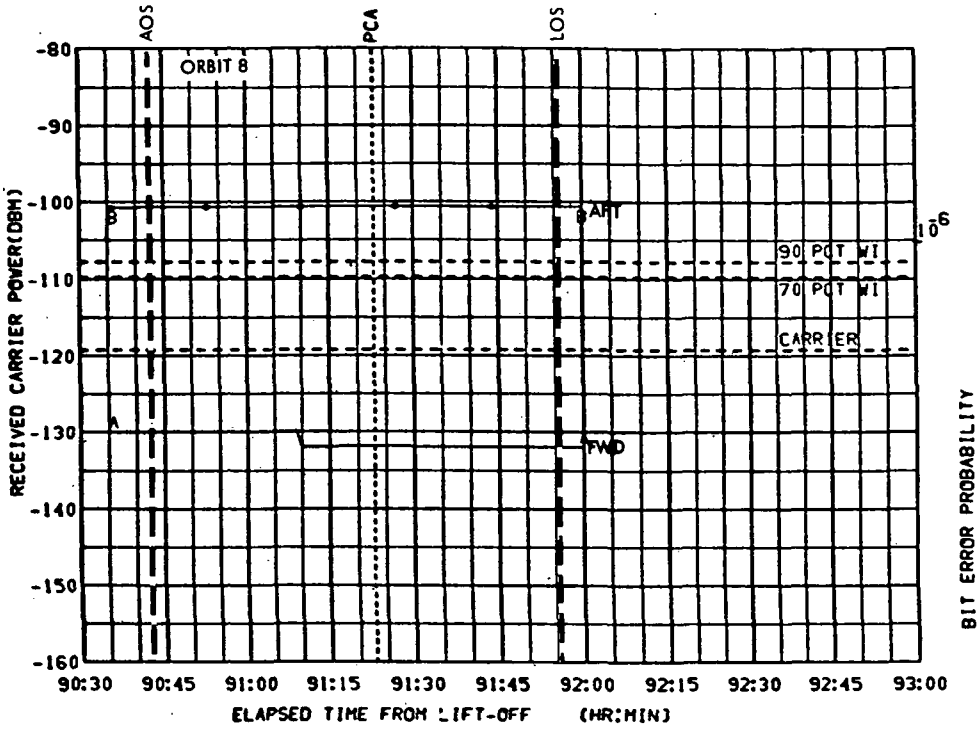

FIGURE 9-22k. MAD UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

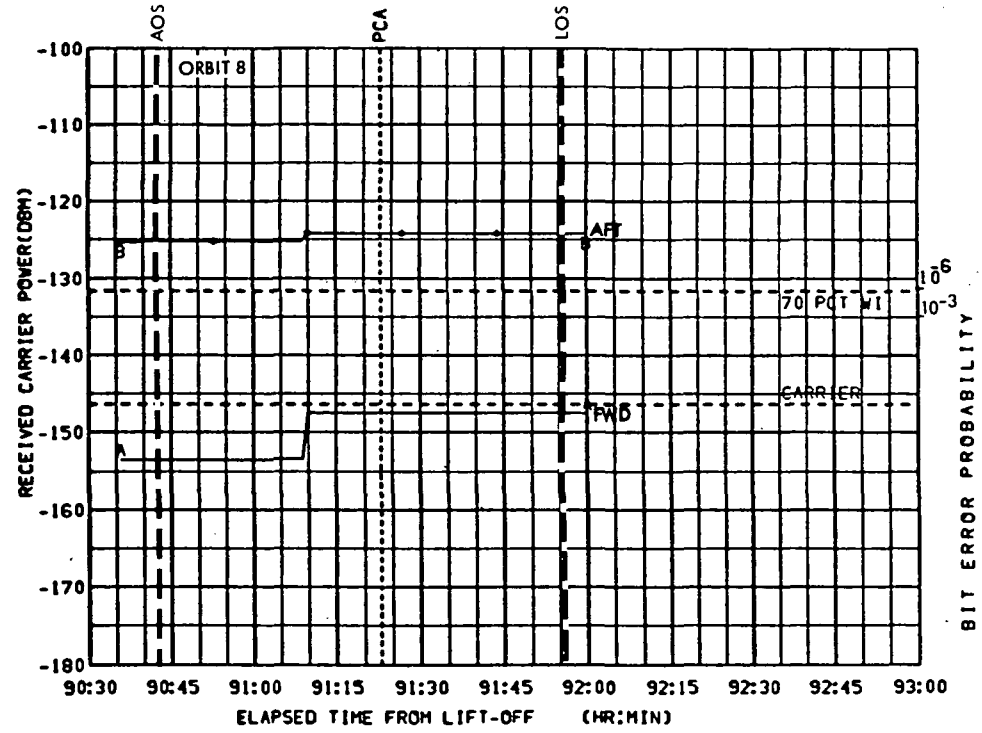

FIGURE 9-22l. MAD DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =62.80
ELV =8.294
RANGE=217144

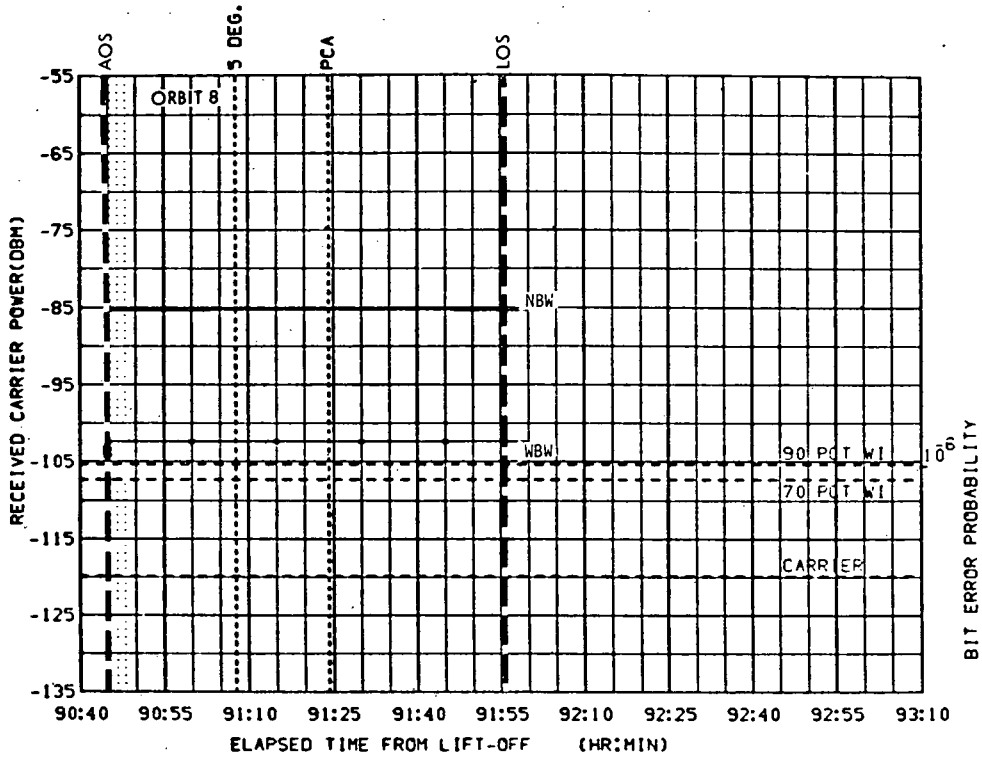

FIGURE 9-23a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

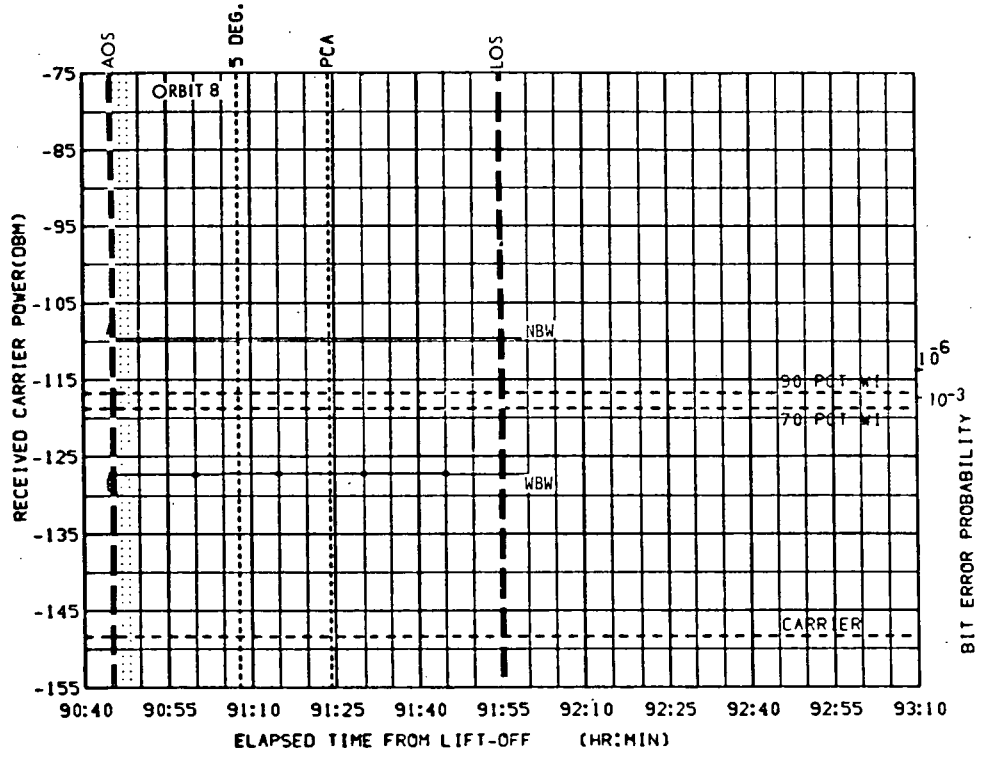

FIGURE 9-23b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

PCA PARAMETERS. AZI. =62.80
ELV. =8.294
RANGE=217144

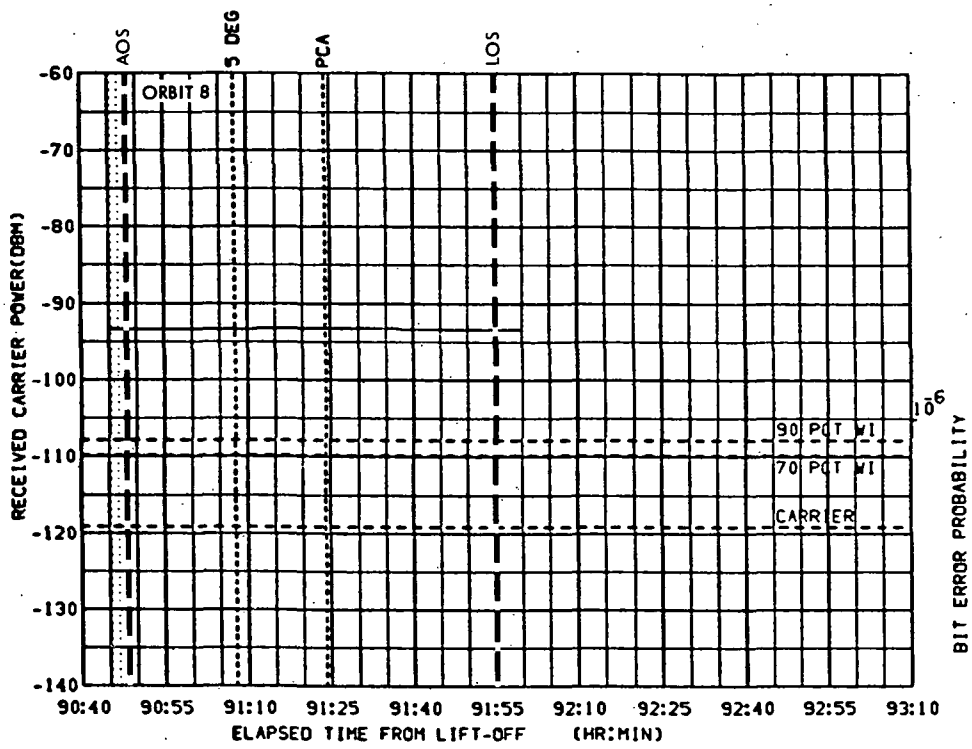

FIGURE 9-23c. ACN UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

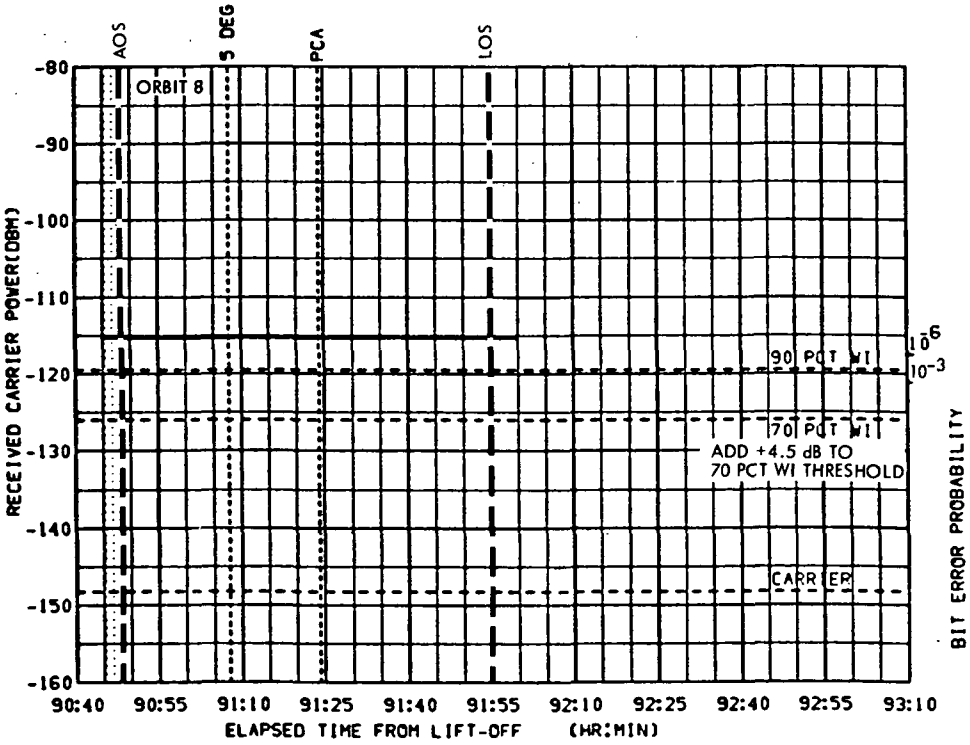

FIGURE 9-23d. ACN DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

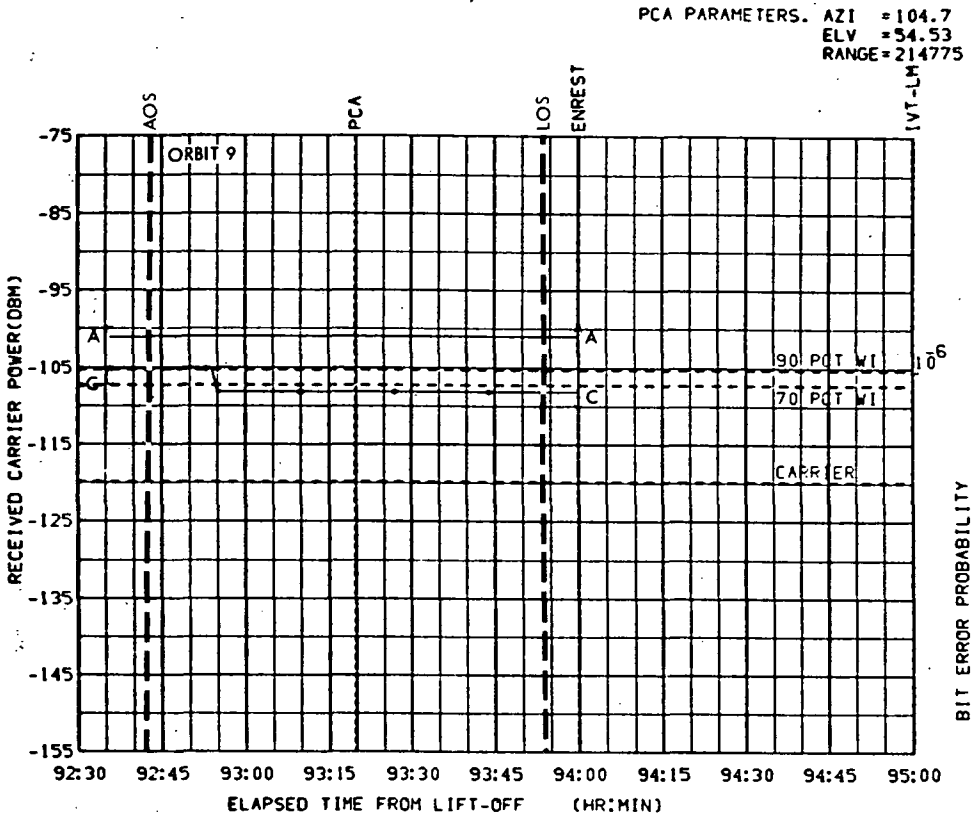

FIGURE 9-24a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

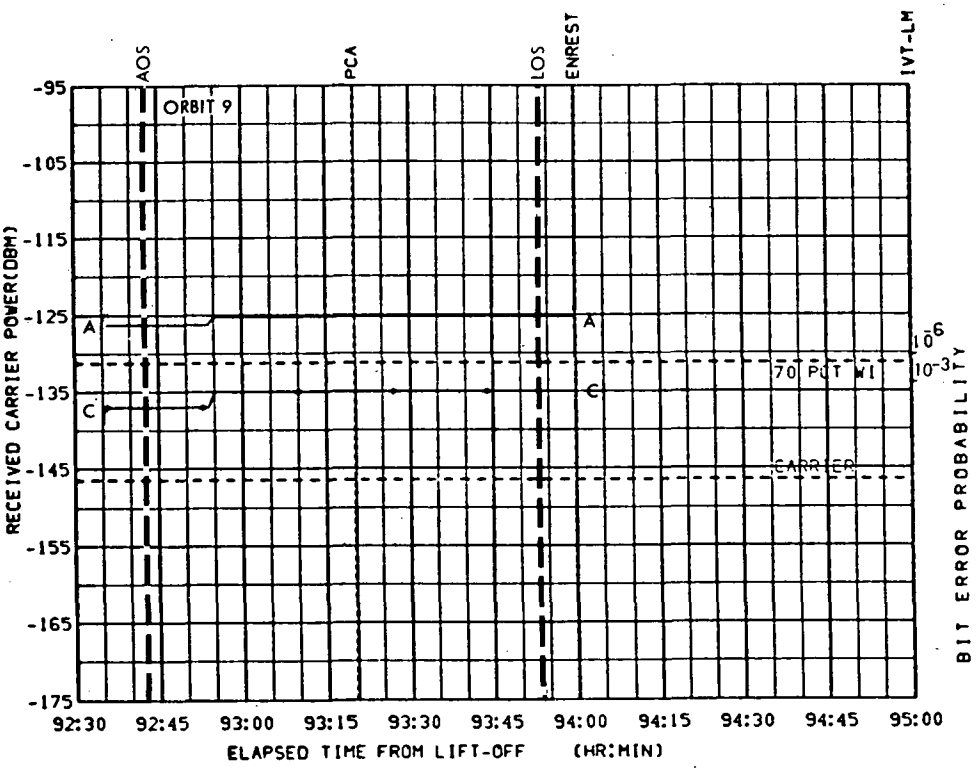

FIGURE 9-24b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

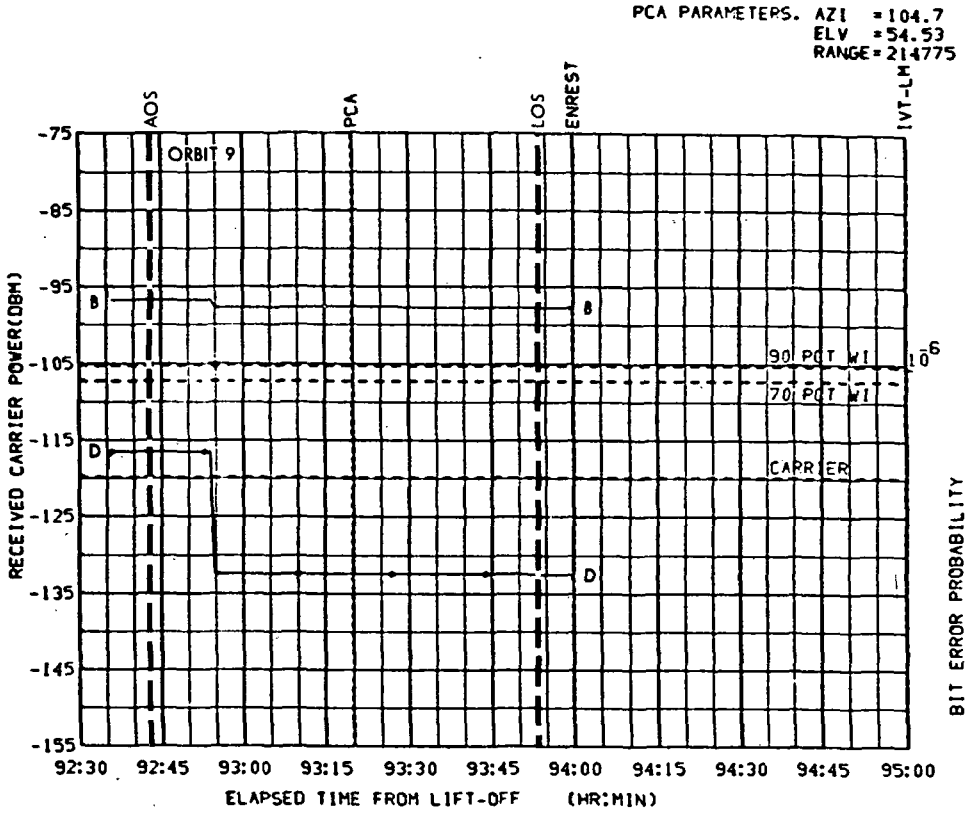

FIGURE 9-24c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

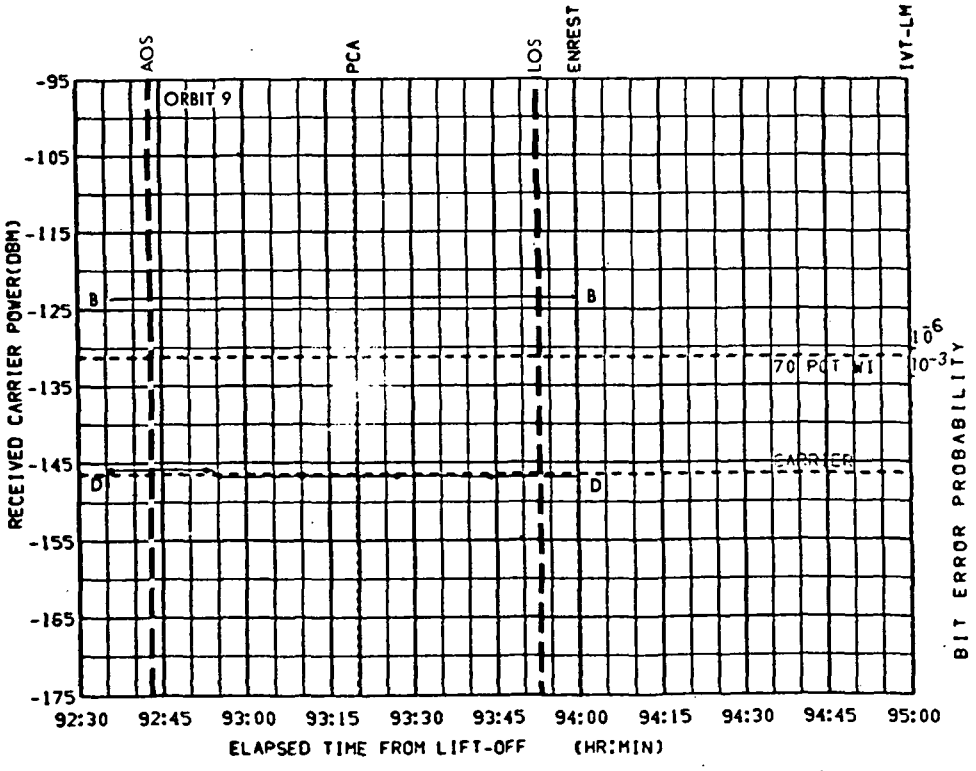

FIGURE 9-24d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

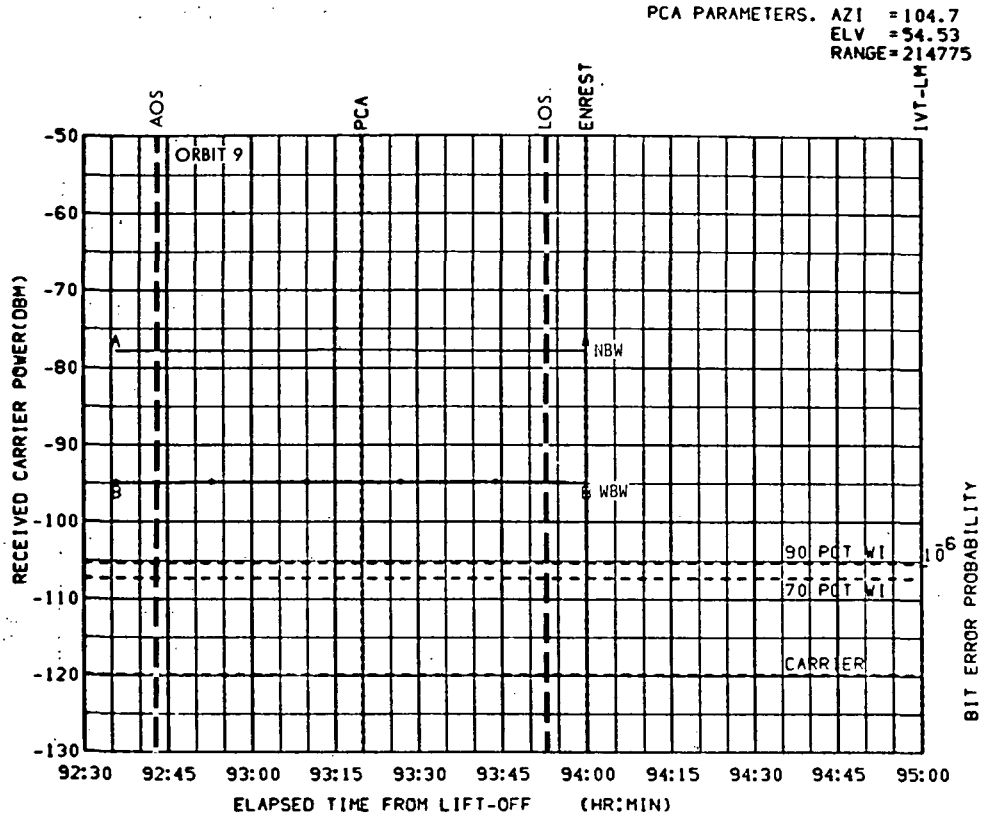

FIGURE 9-24e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

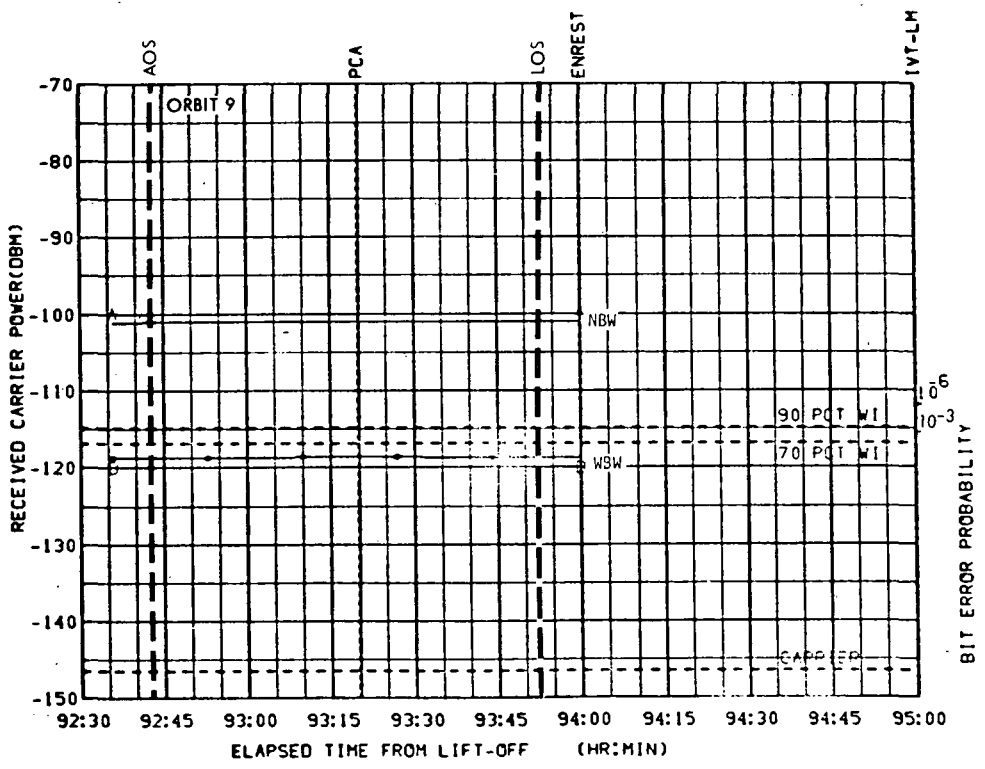

FIGURE 9-24f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

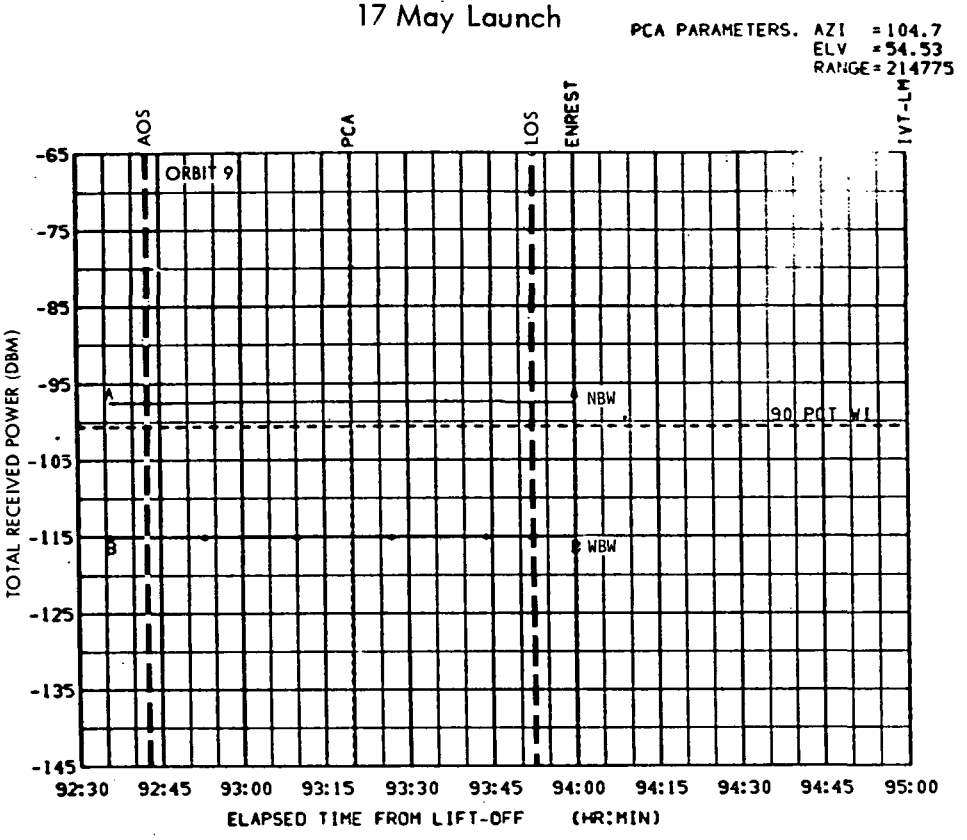

FIGURE 9-24g. MAD DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

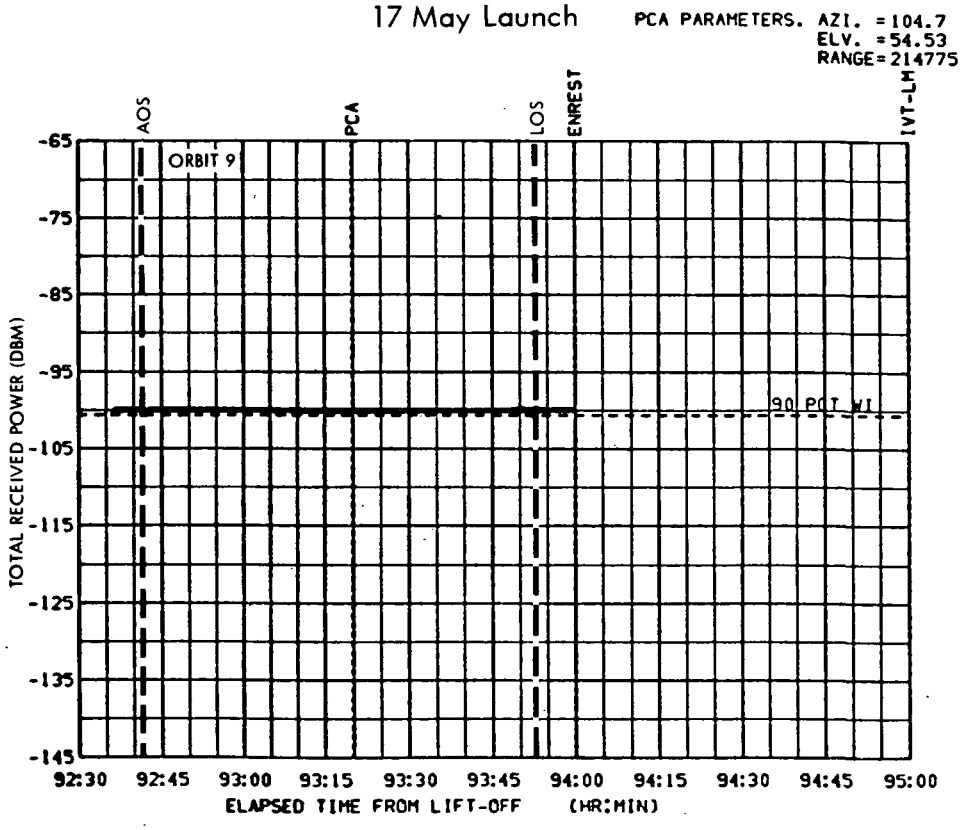

FIGURE 9-24h. MAD DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

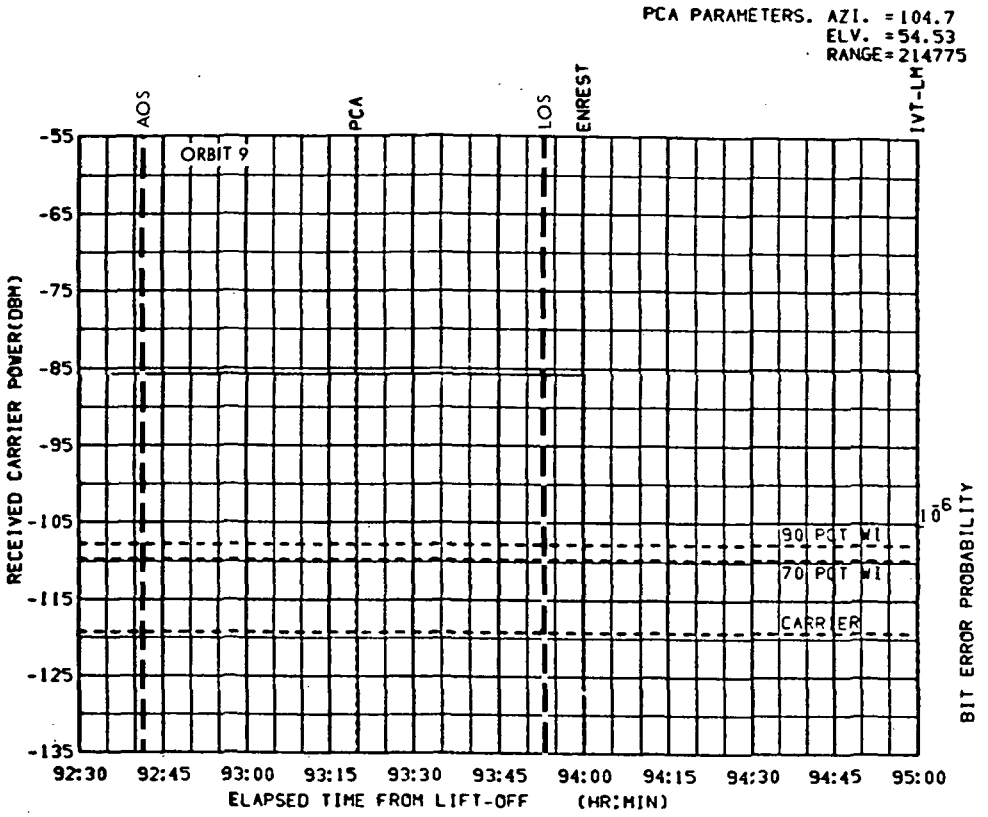

FIGURE 9-24i. MAD UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

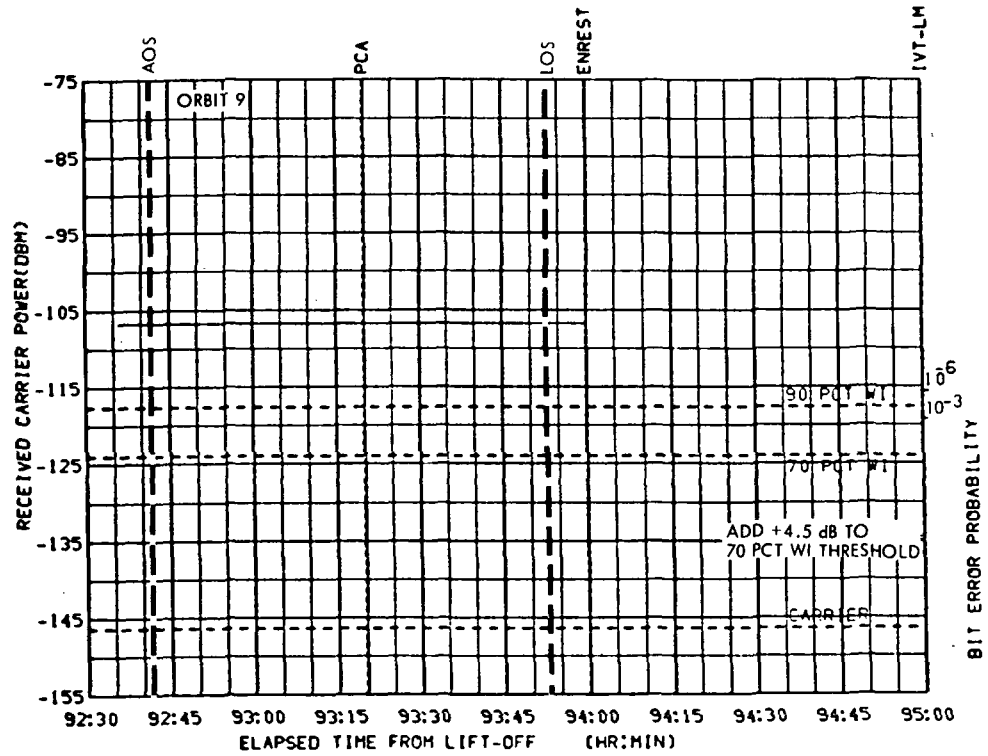

FIGURE 9-24j. MAD DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

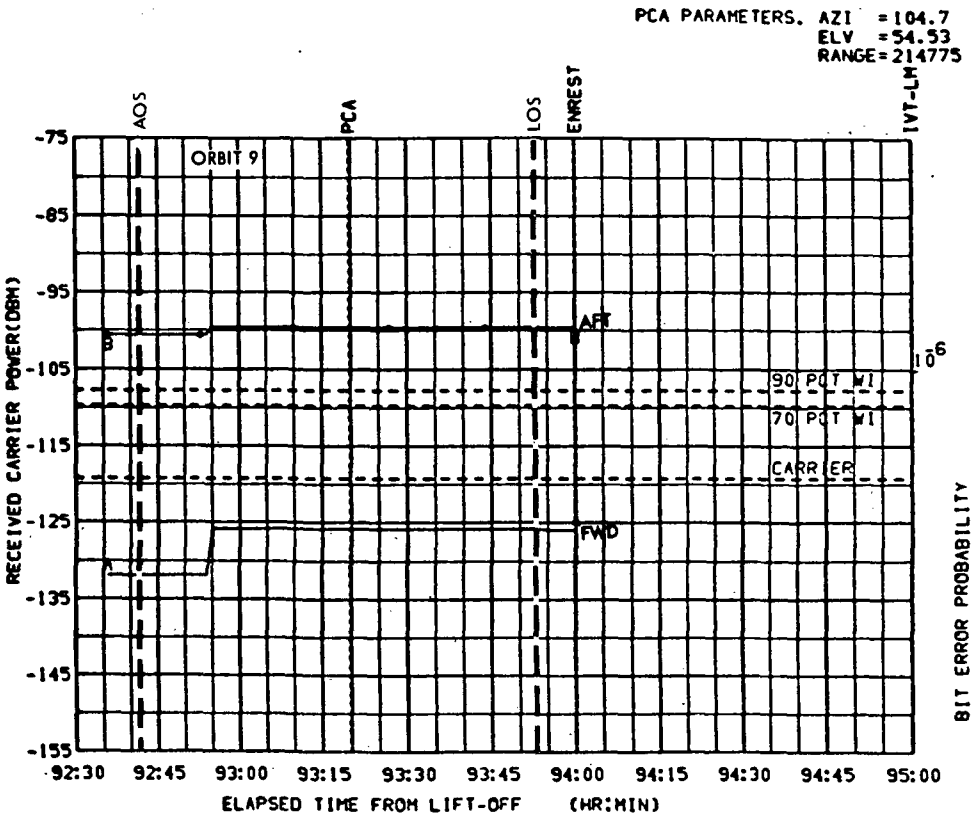

FIGURE 9-24k. MAD UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

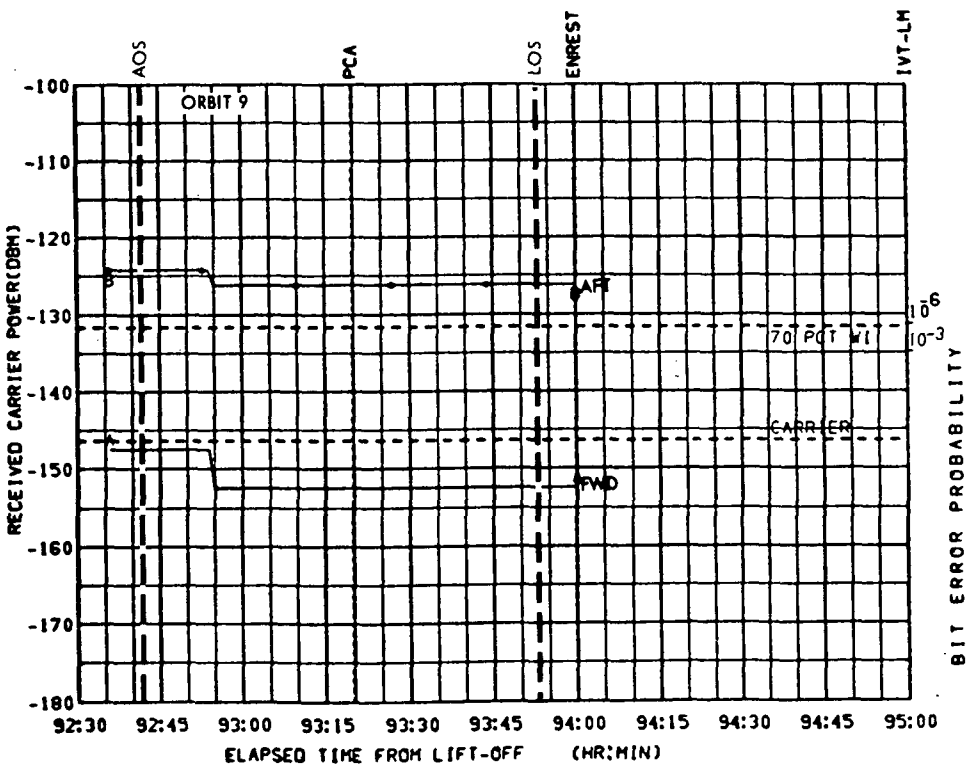

FIGURE 9-24l. MAD DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

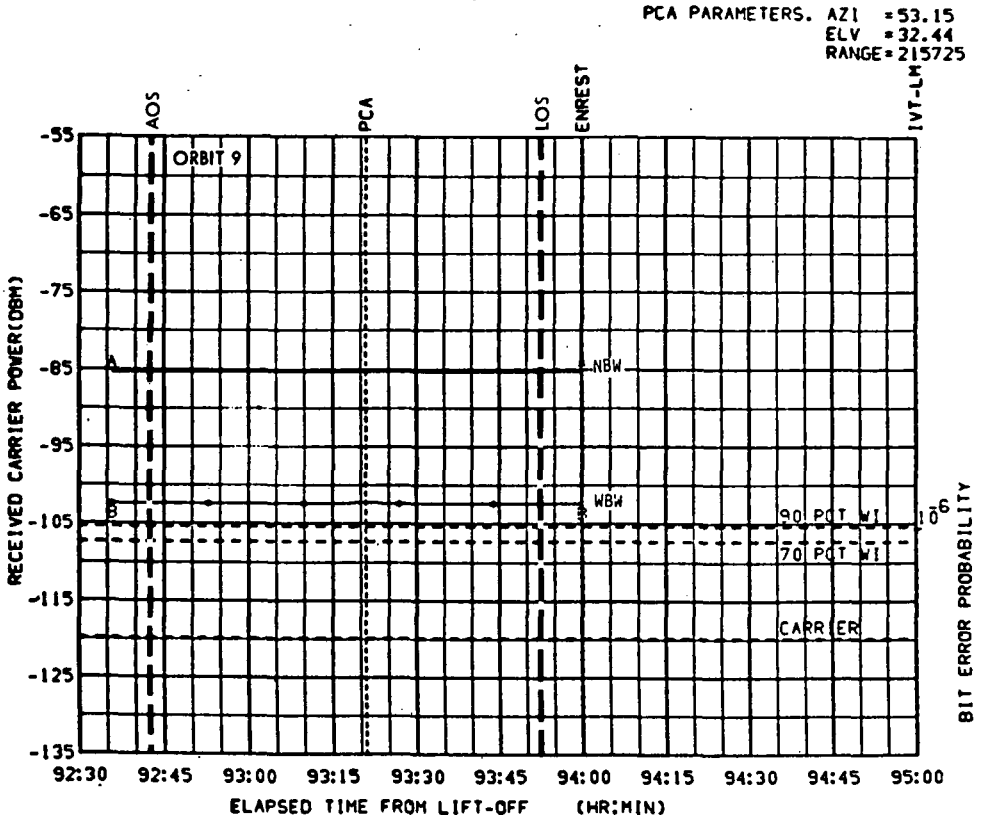

FIGURE 9-25a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

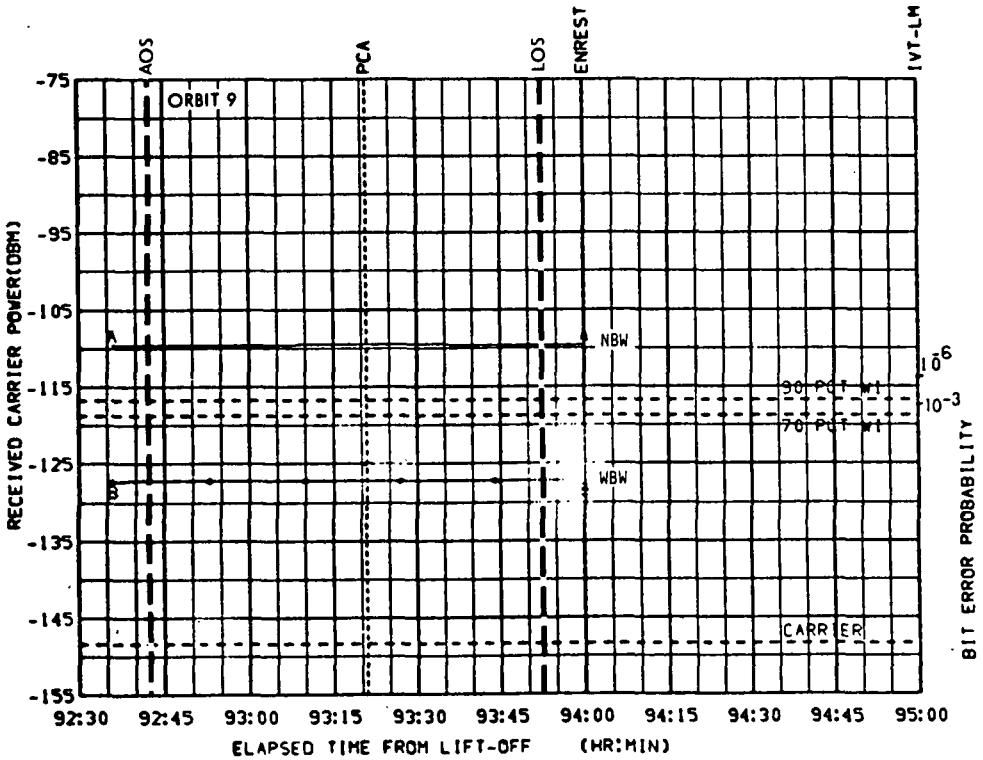

FIGURE 9-25b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

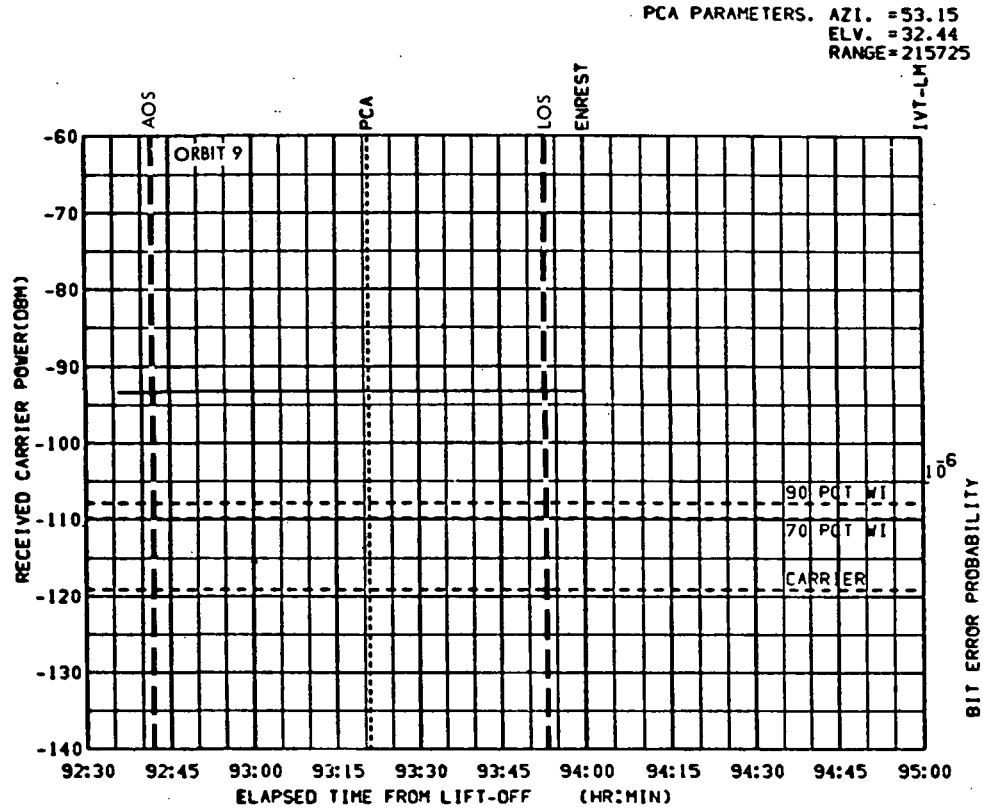

FIGURE 9-25c. ACN UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

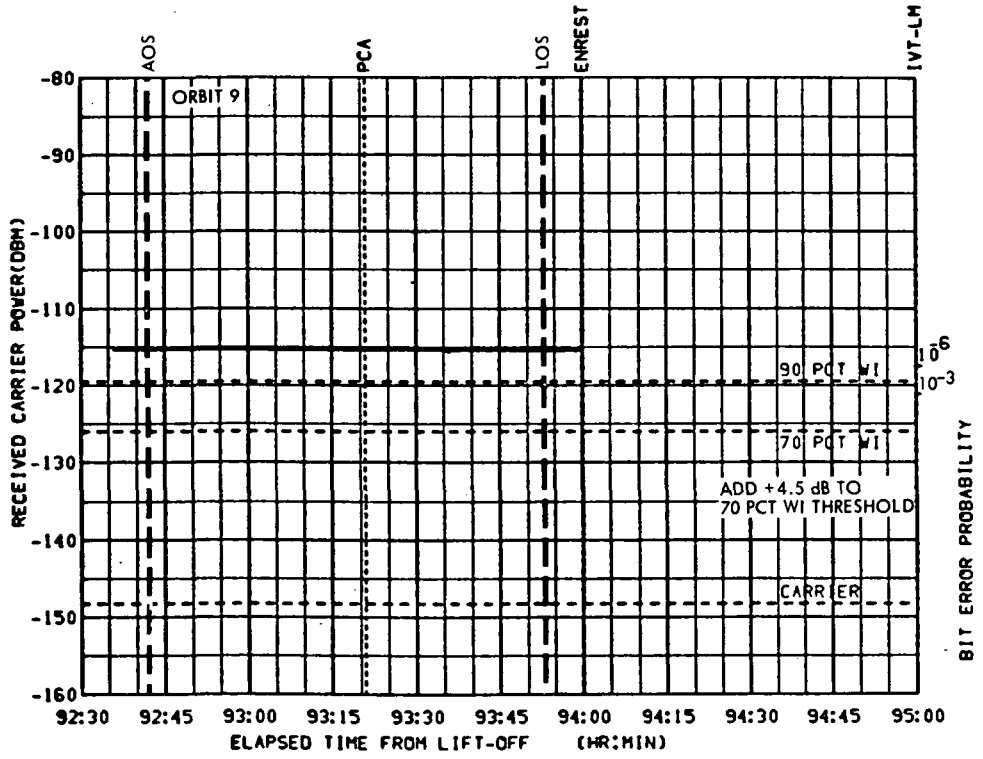

FIGURE 9-25d. ACN DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

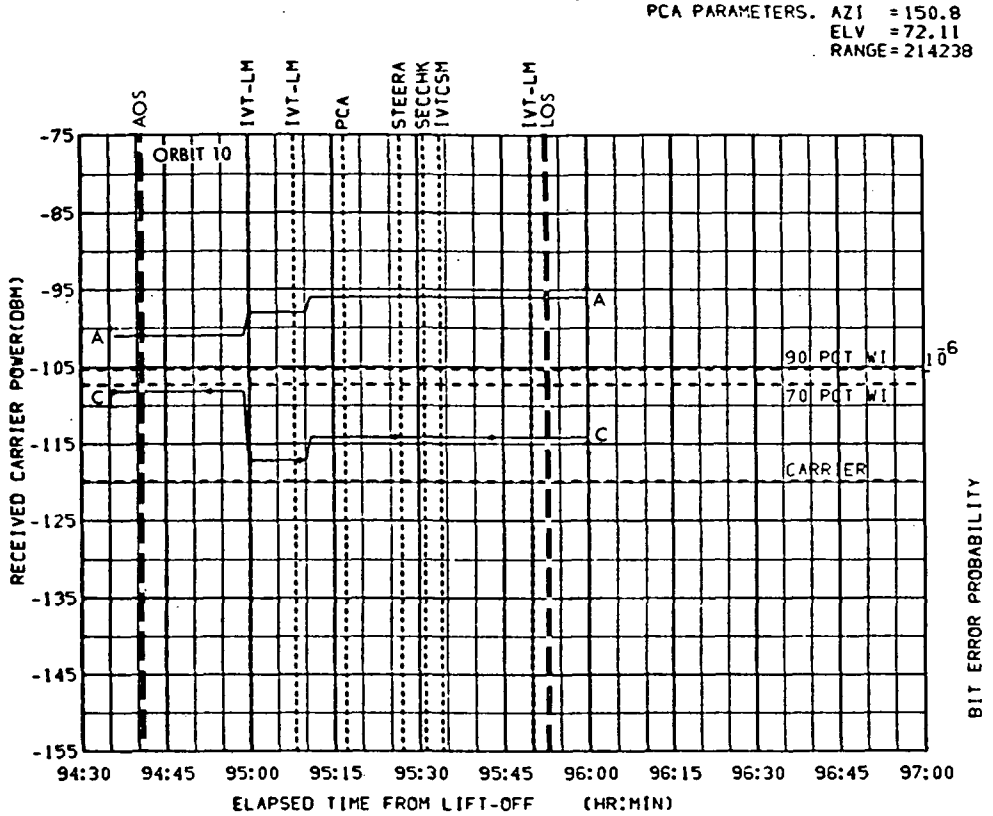

FIGURE 9-26a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

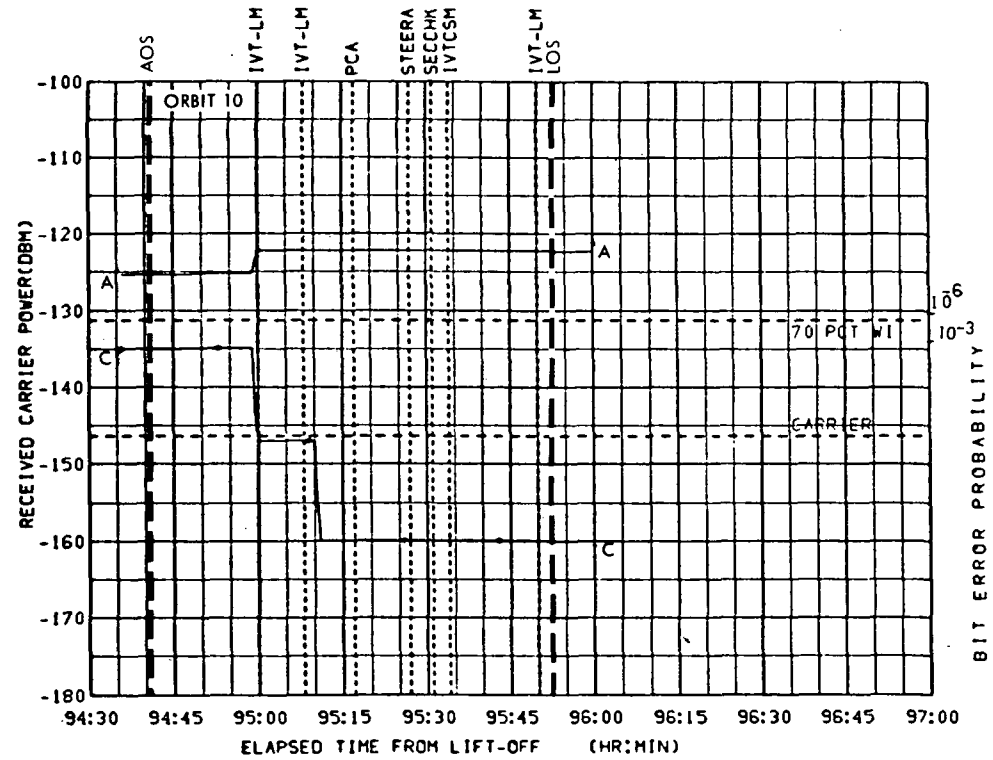

FIGURE 9-26b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

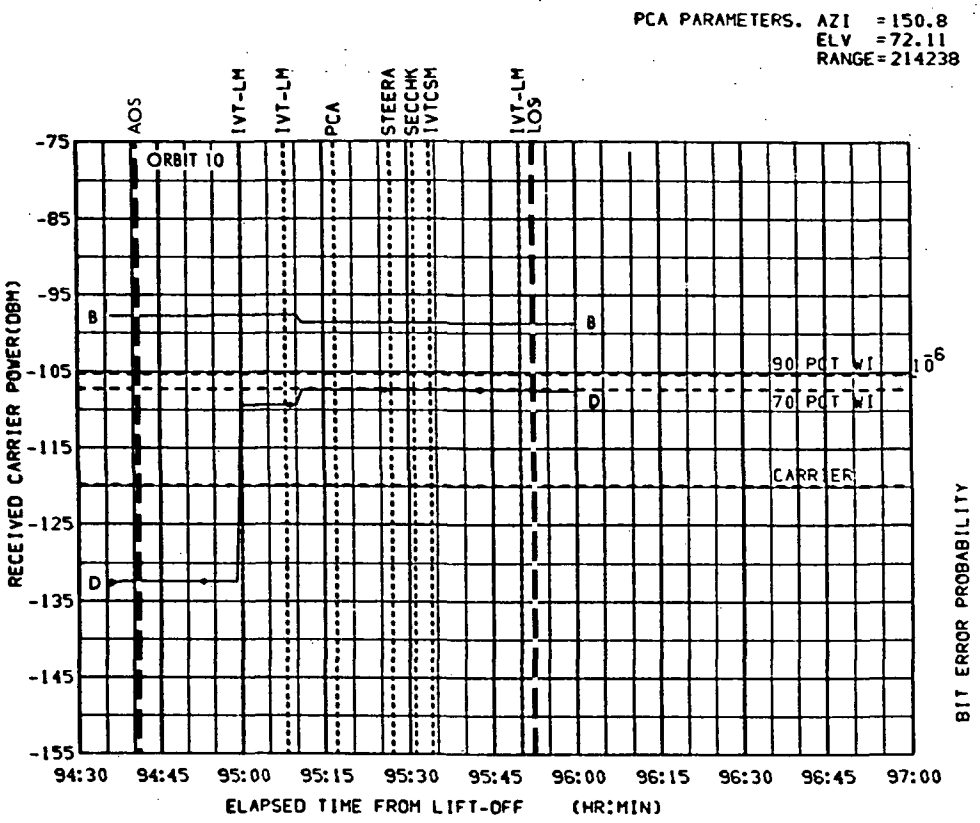

FIGURE 9-26c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

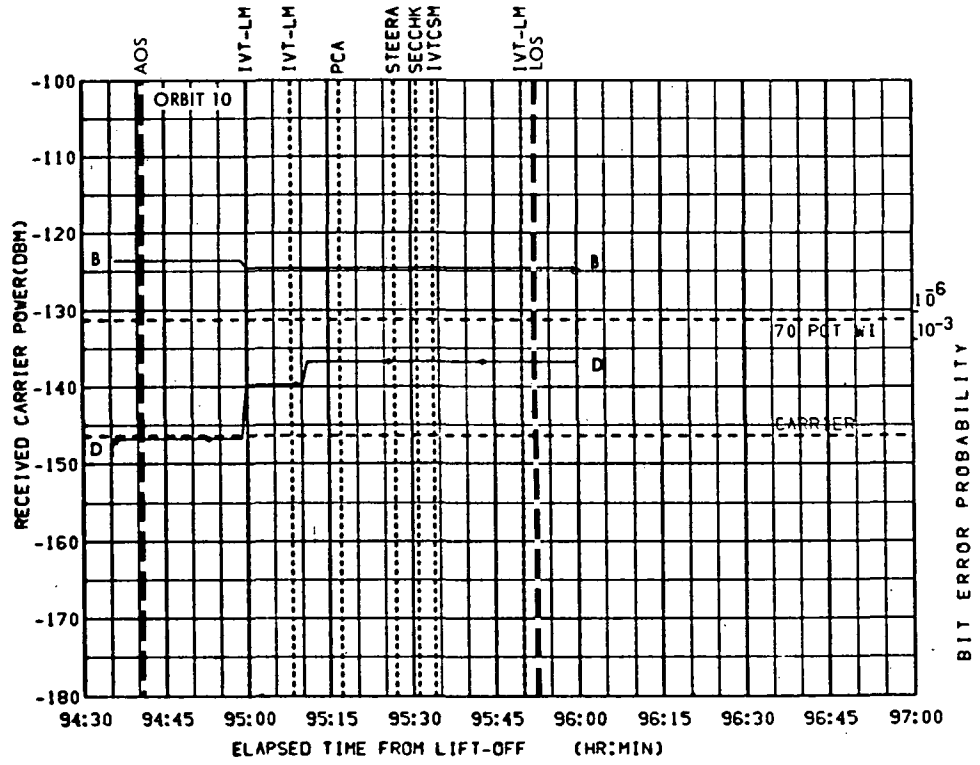

FIGURE 9-26d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

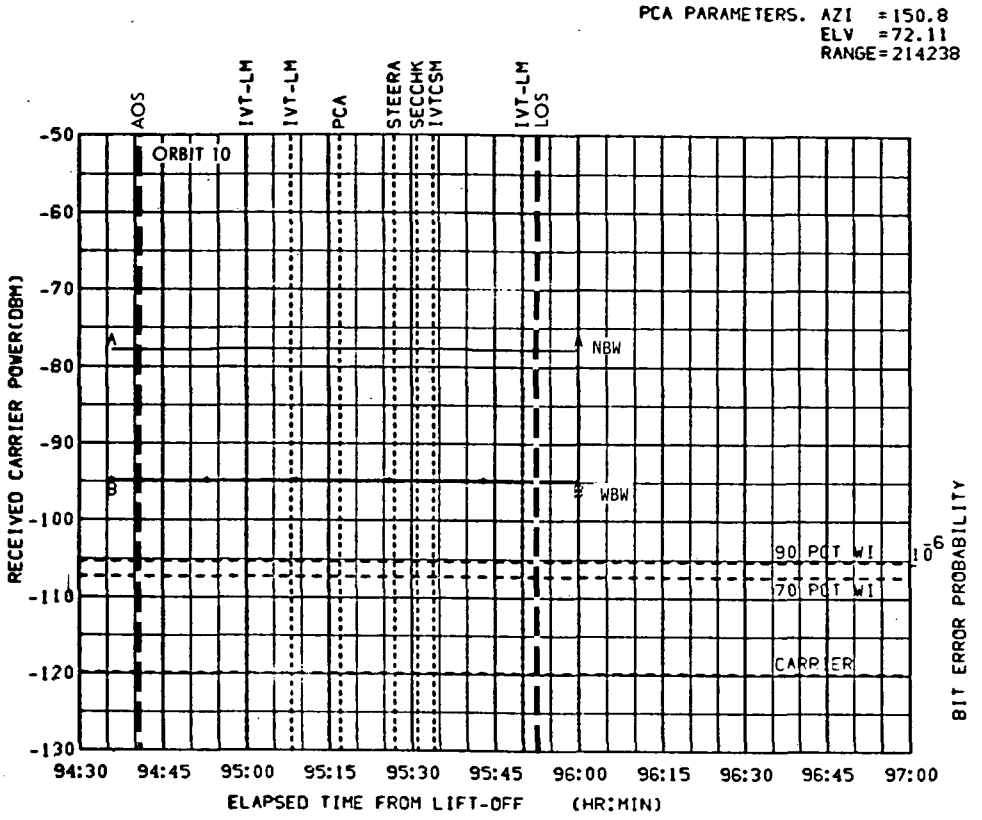

FIGURE 9-26e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

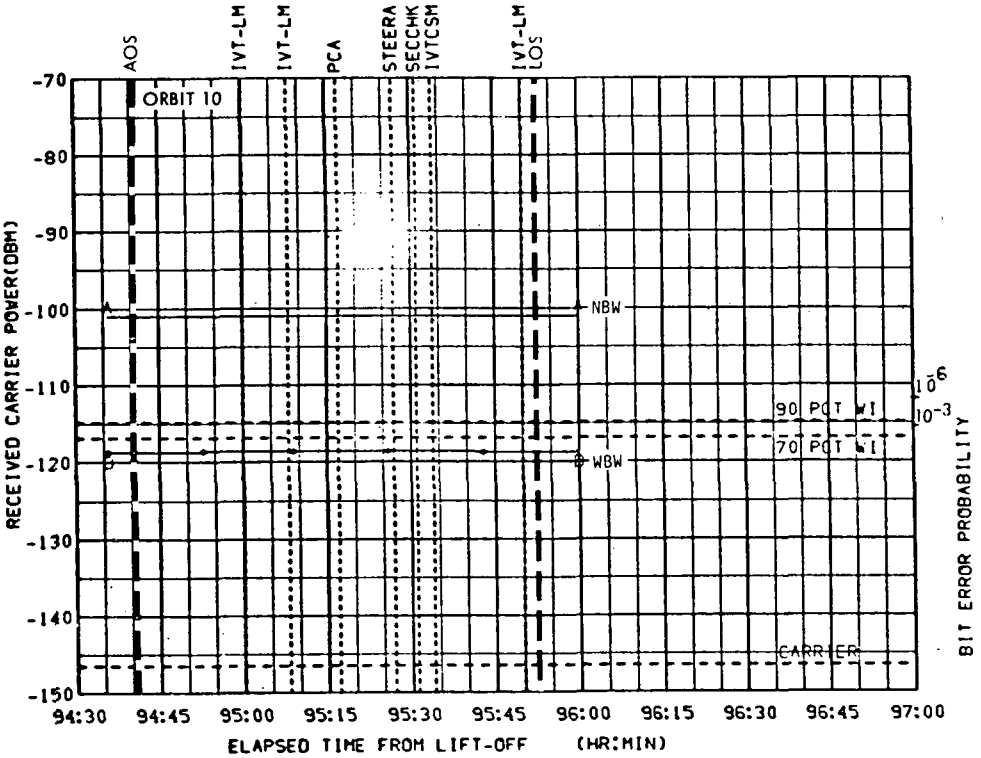

FIGURE 9-26f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

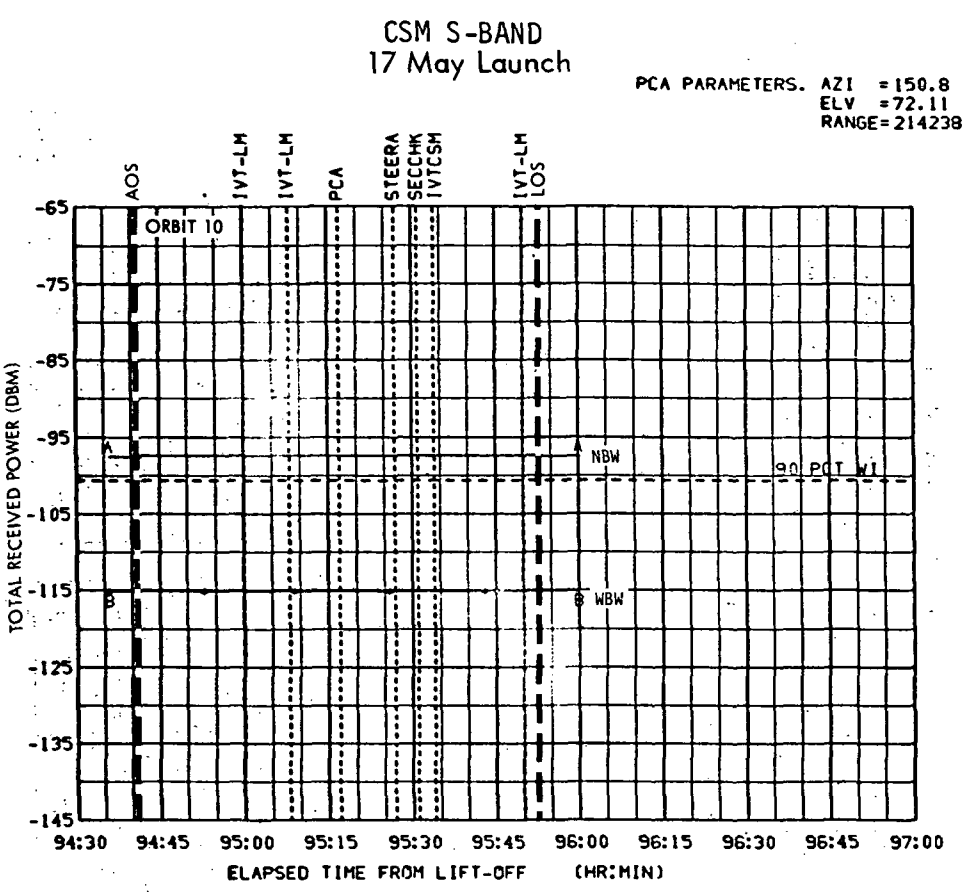

FIGURE 9-26g. MAD DNLINK FM MODES CSM/MSFN S-BAND HGA CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

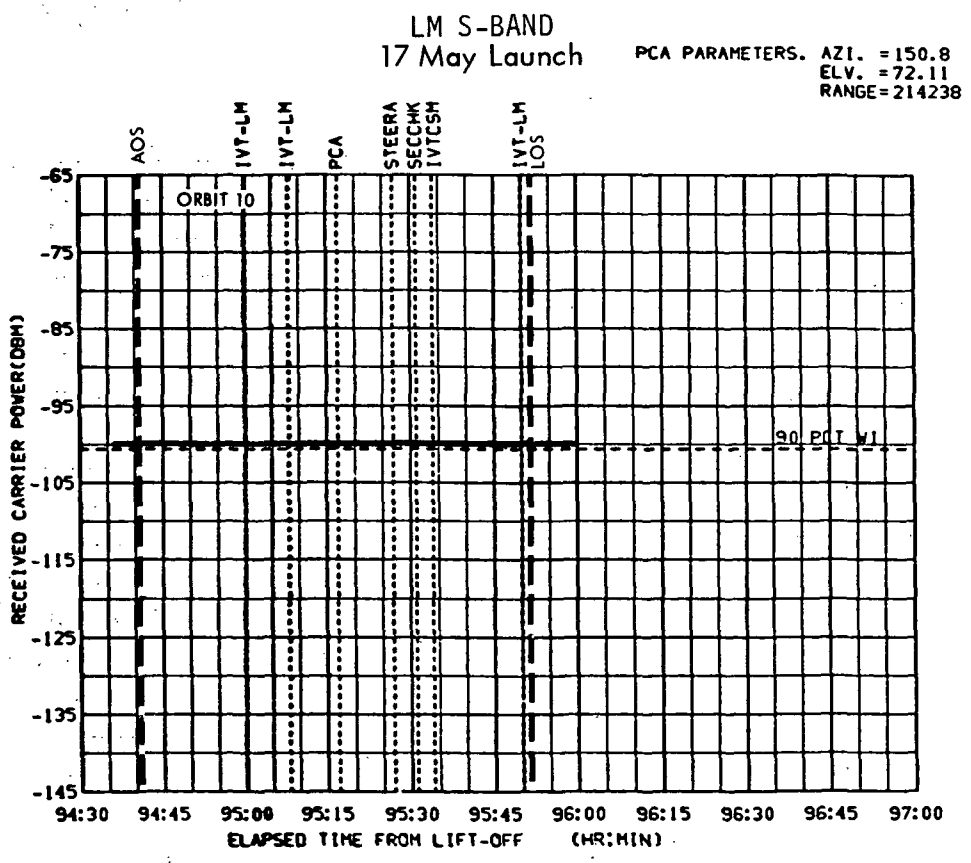

FIGURE 9-26h. MAD DNLINK FM MODES LM/MSFN S-BAND STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

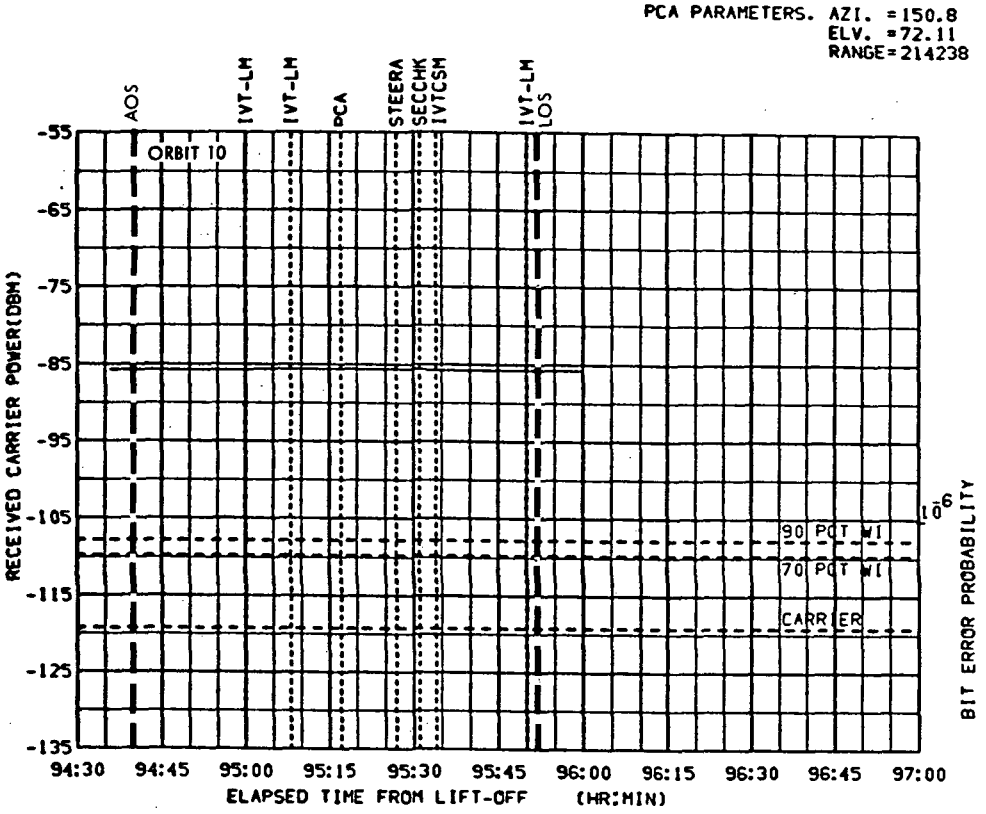

FIGURE 9-26i. MAD UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

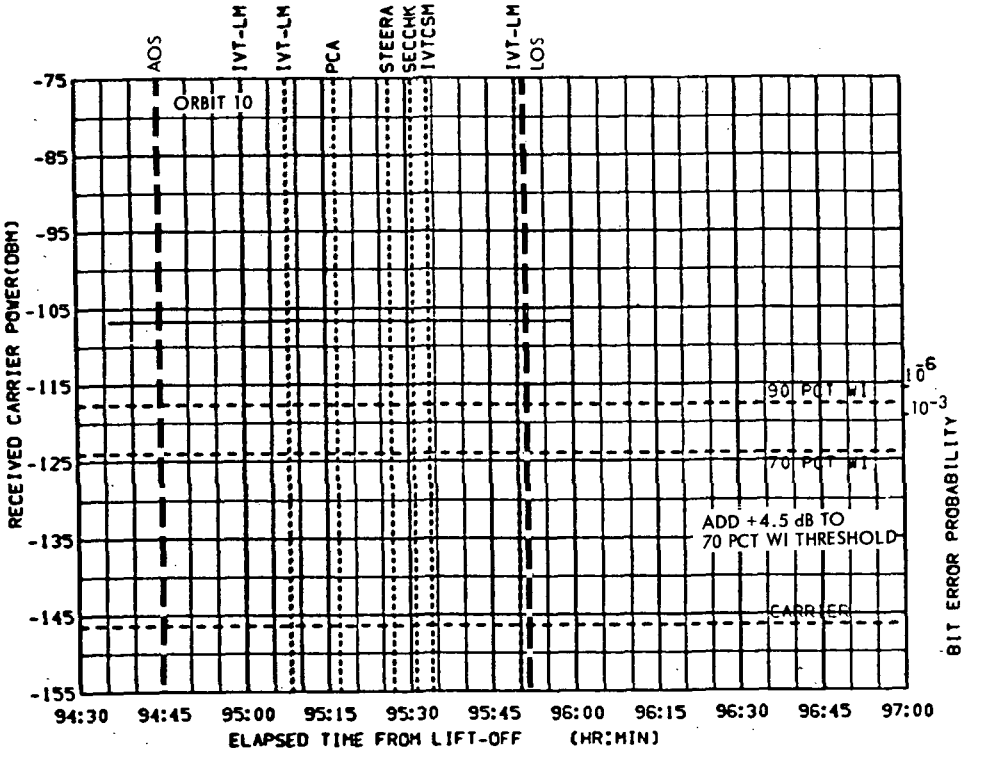

FIGURE 9-26j. MAD DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

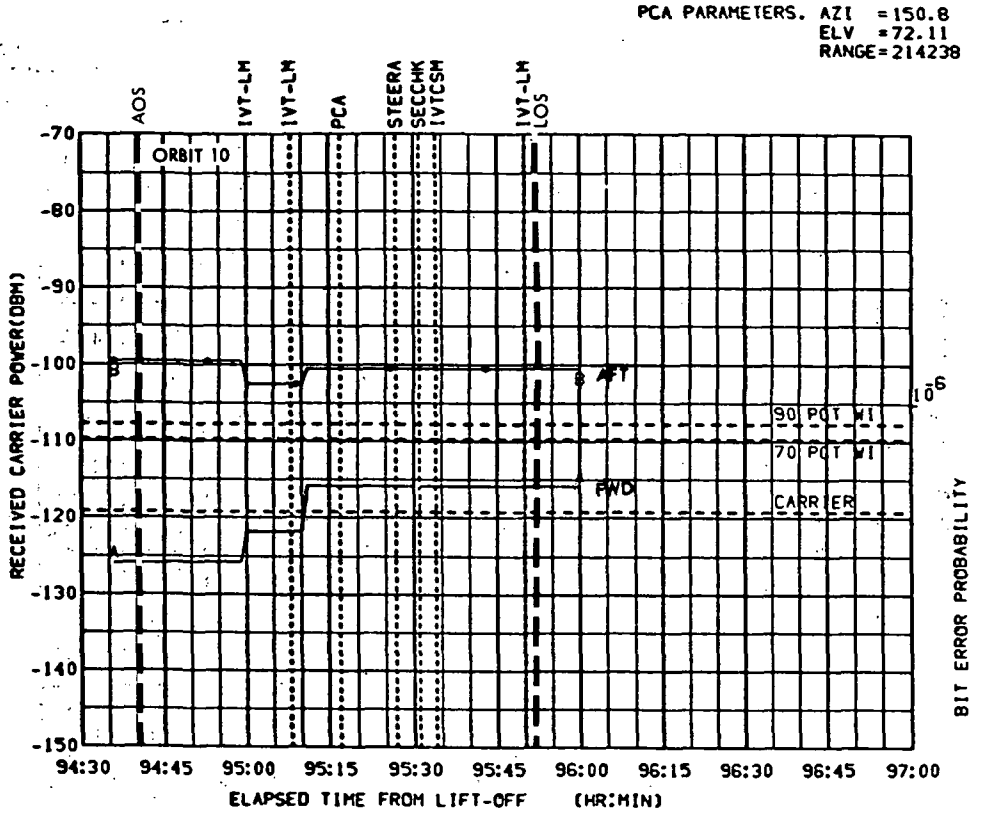

FIGURE 9-26k. MAD UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

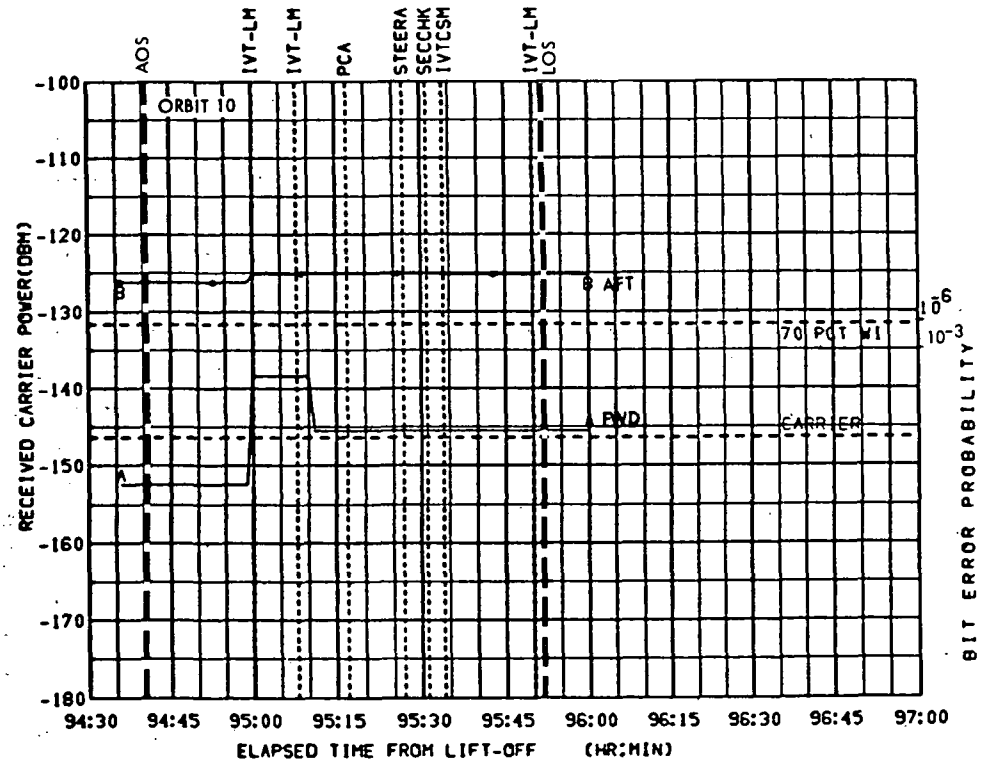

FIGURE 9-26l. MAD DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

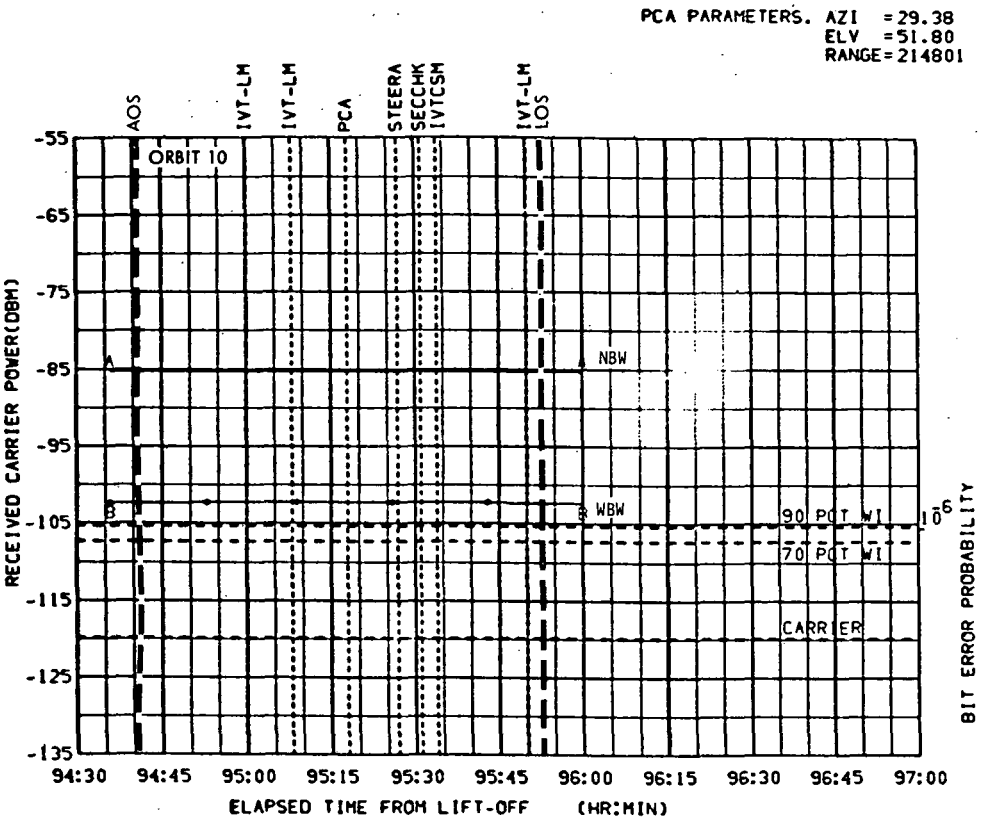

FIGURE 9-27a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

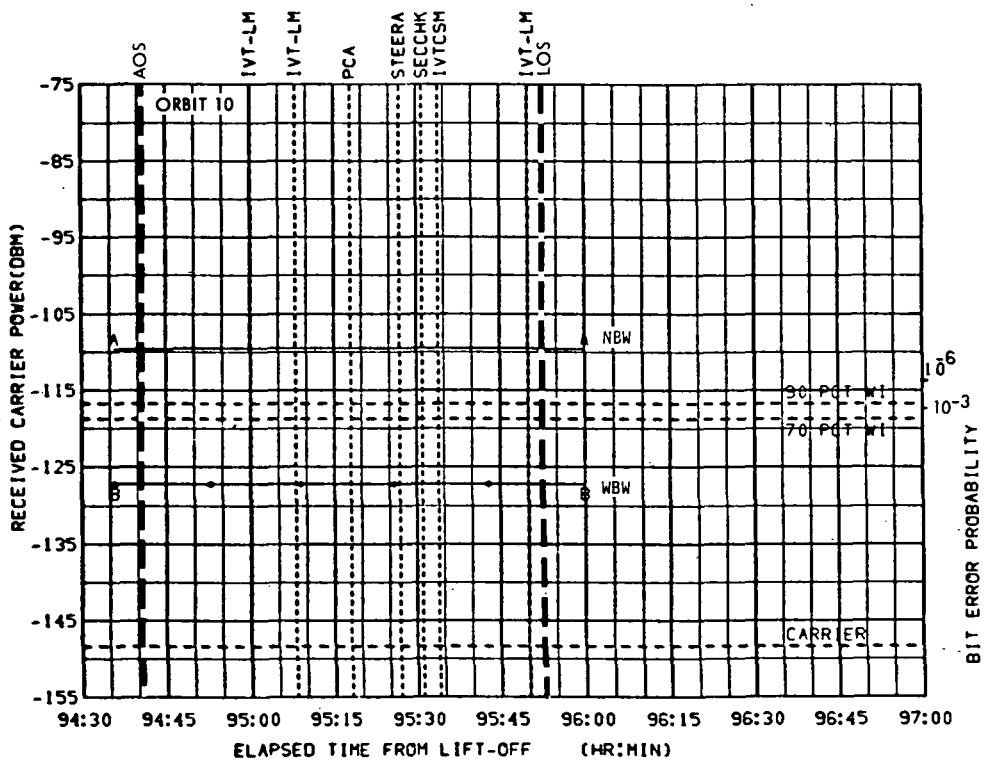

FIGURE 9-27b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

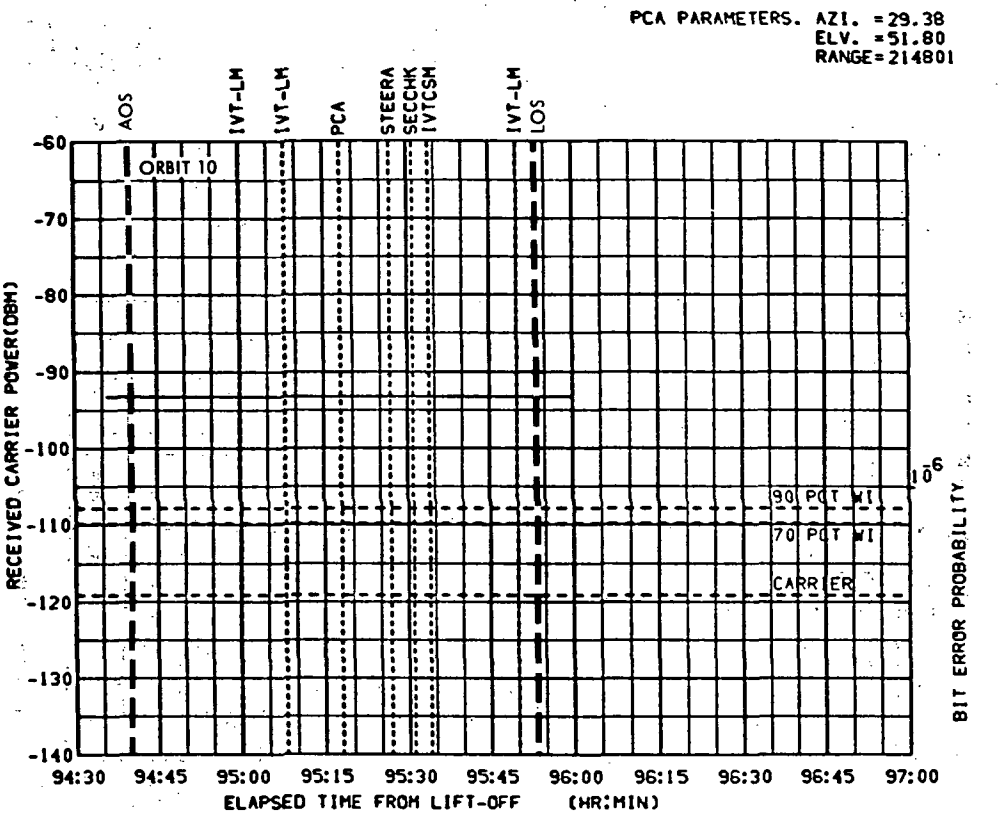

FIGURE 9-27c. ACN UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

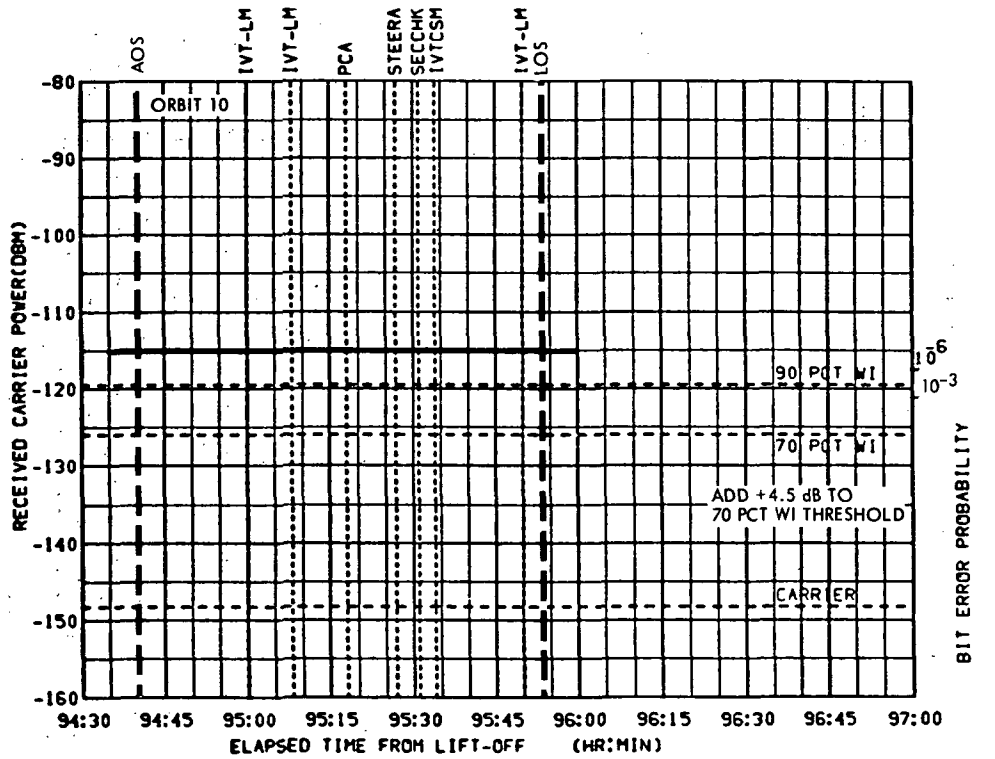

FIGURE 9-27d. ACN DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

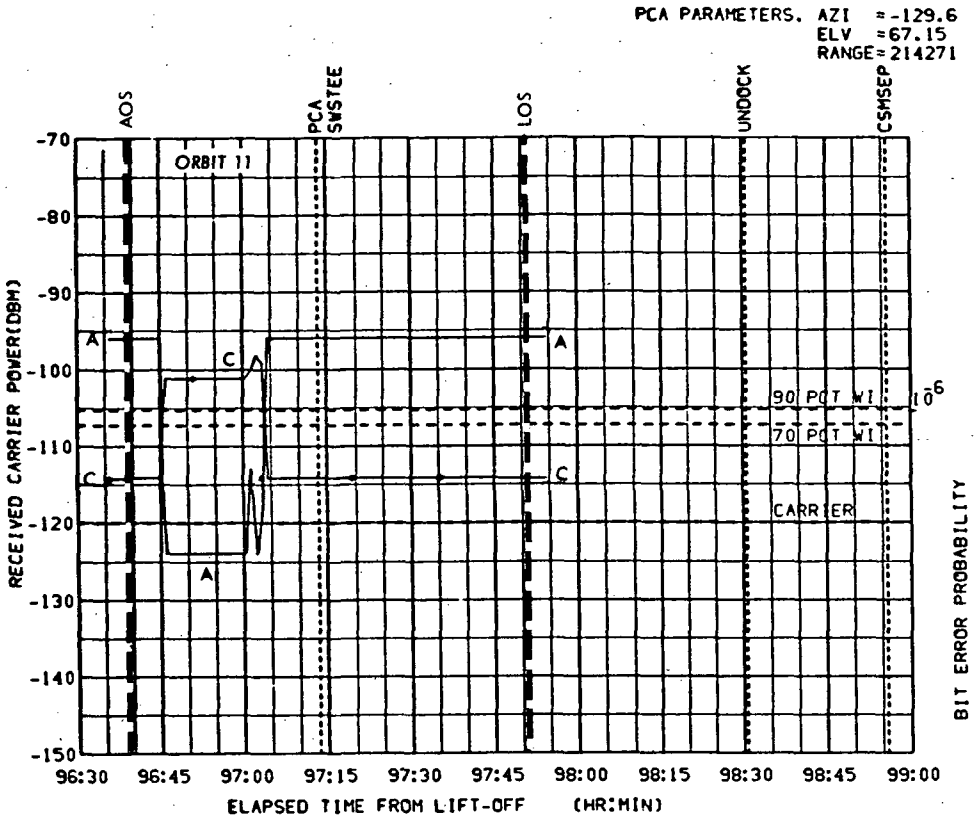

FIGURE 9-28a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

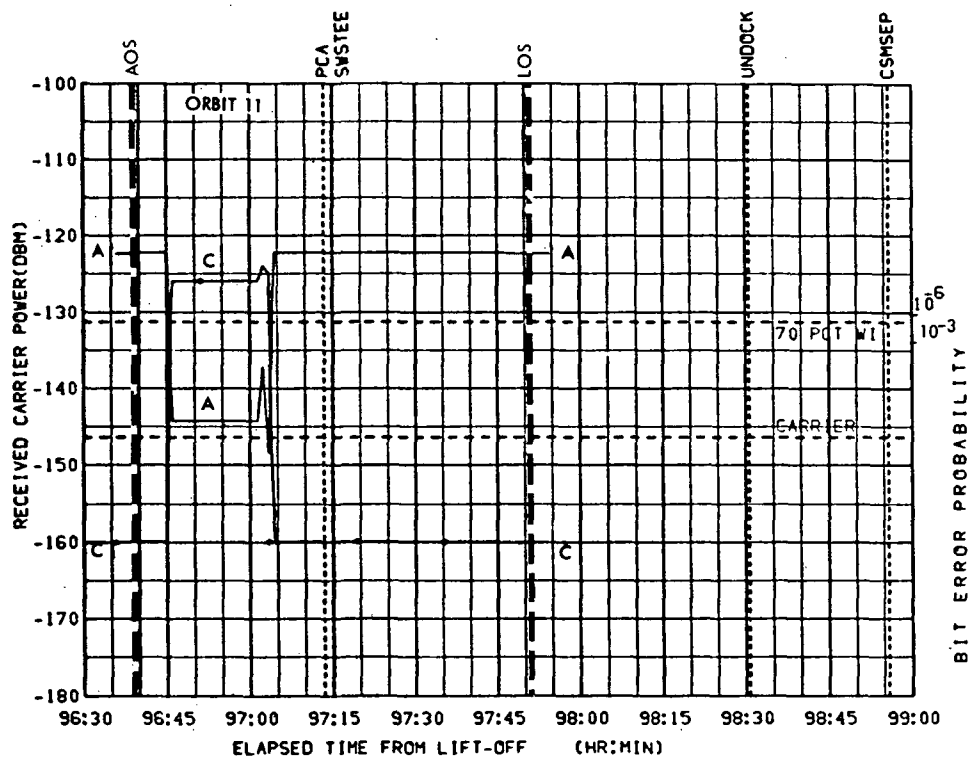

FIGURE 9-28b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

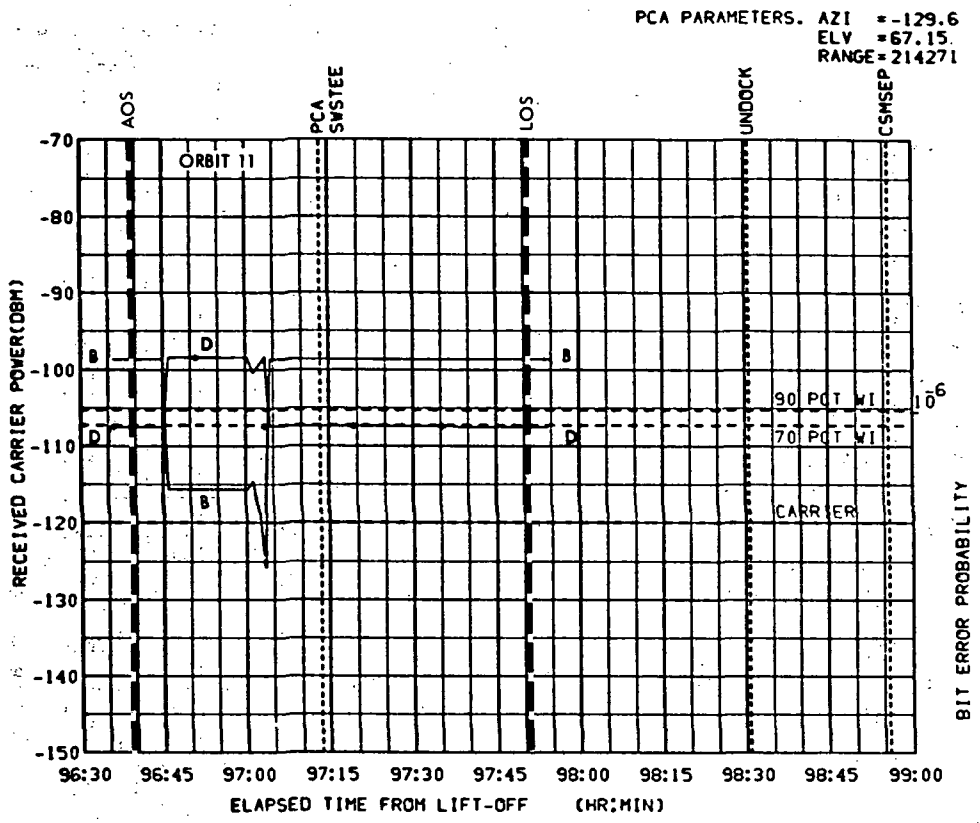

FIGURE 9-28c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

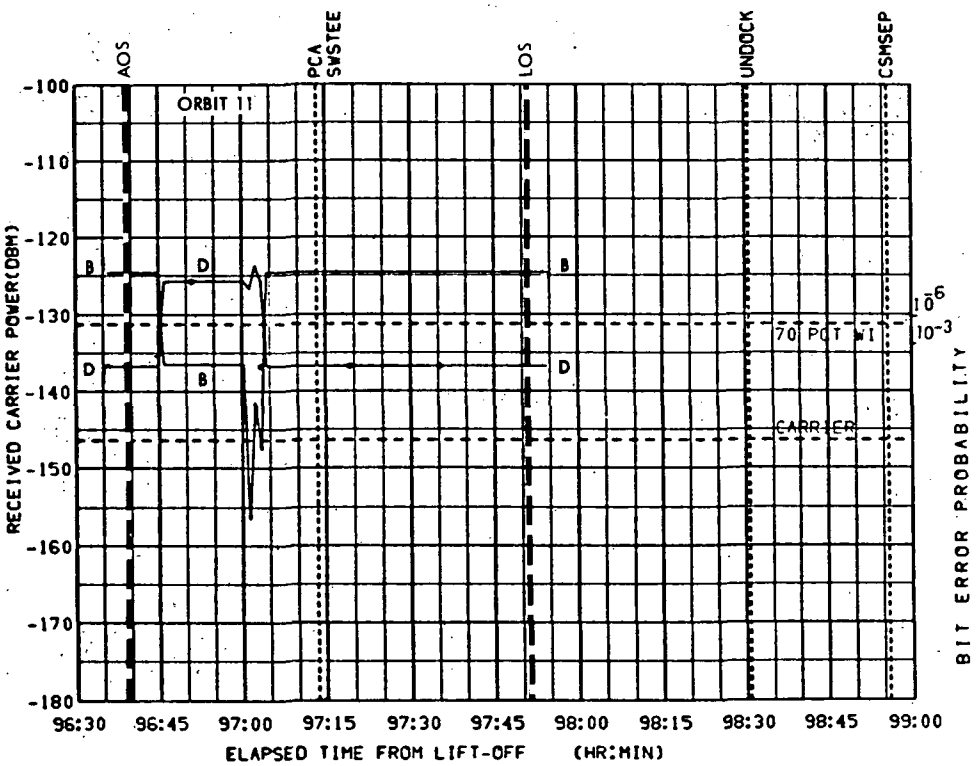

FIGURE 9-28d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

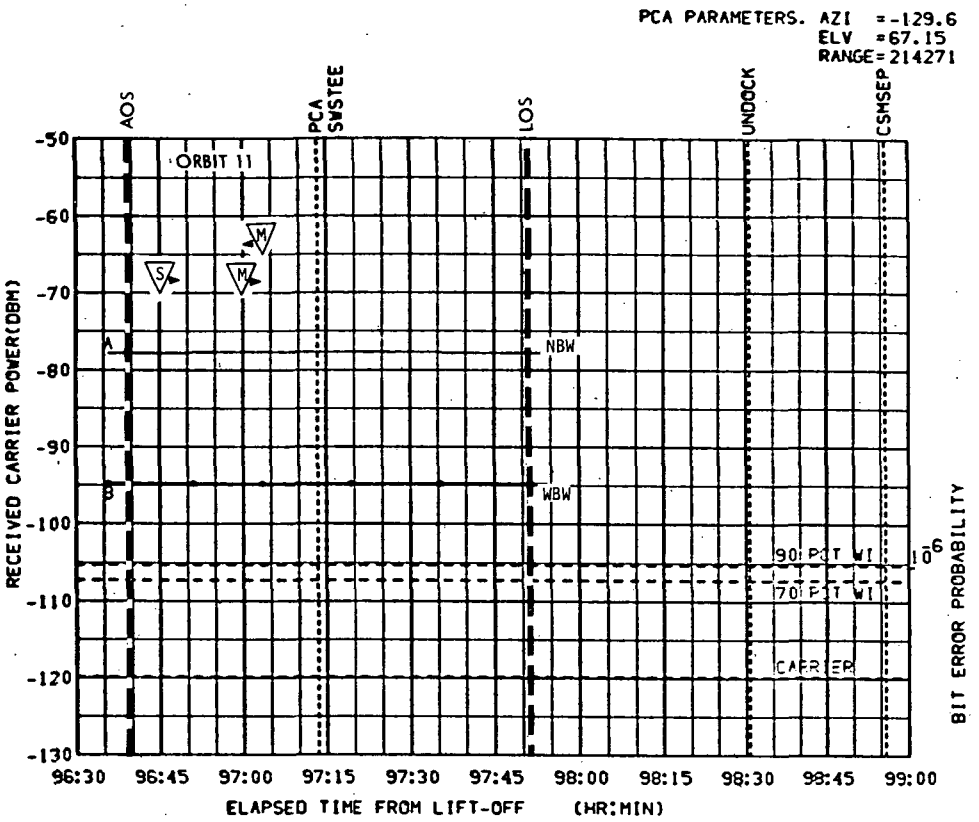

FIGURE 9-28e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

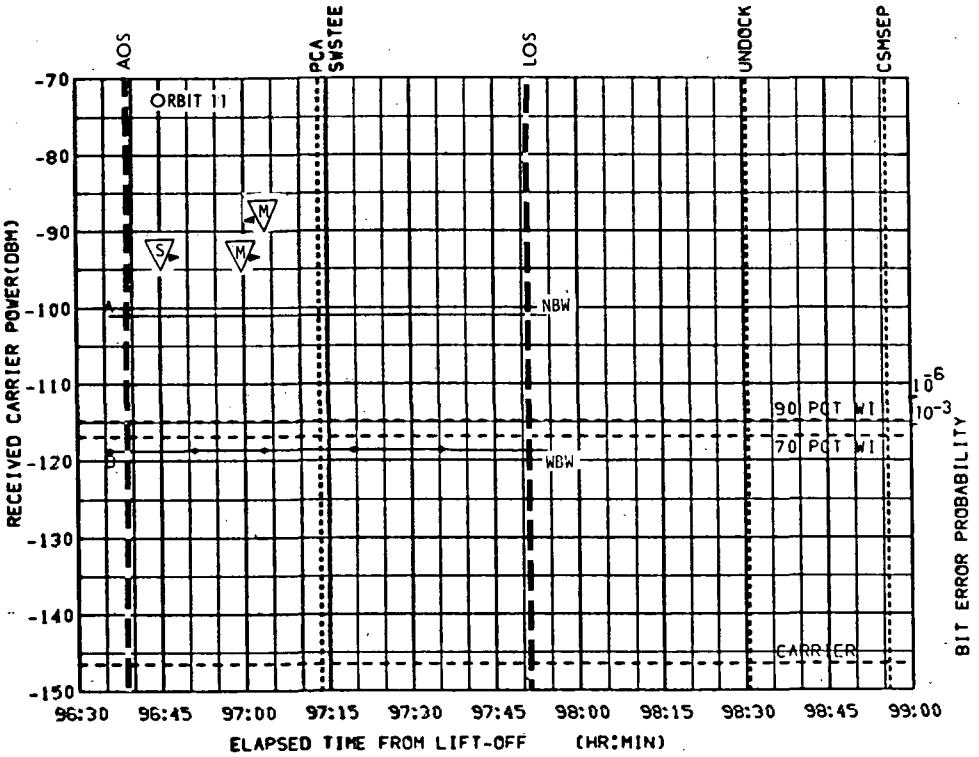

FIGURE 9-28f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

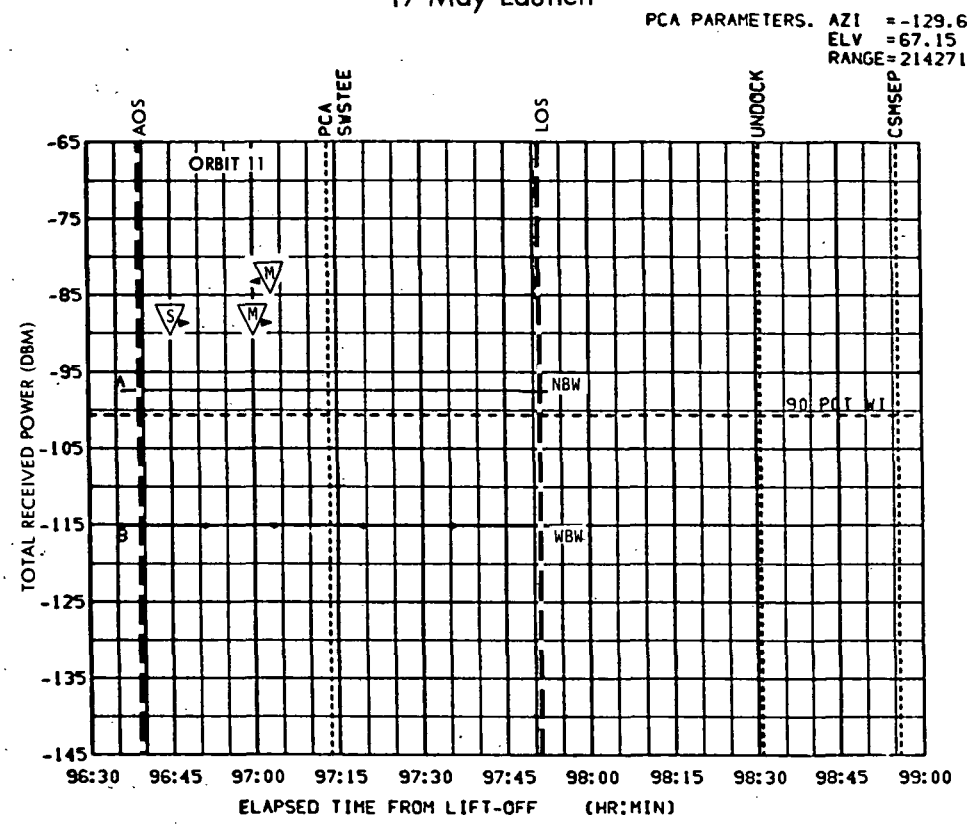

FIGURE 9-28g. MAD DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

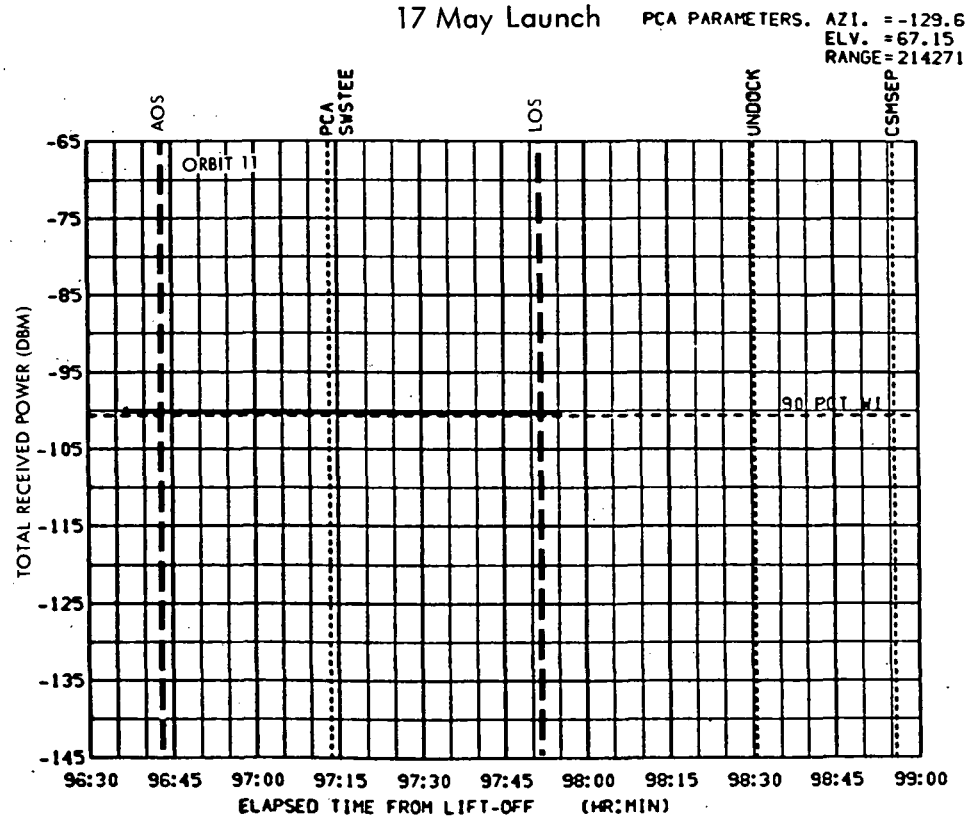

FIGURE 9-28h. MAD DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

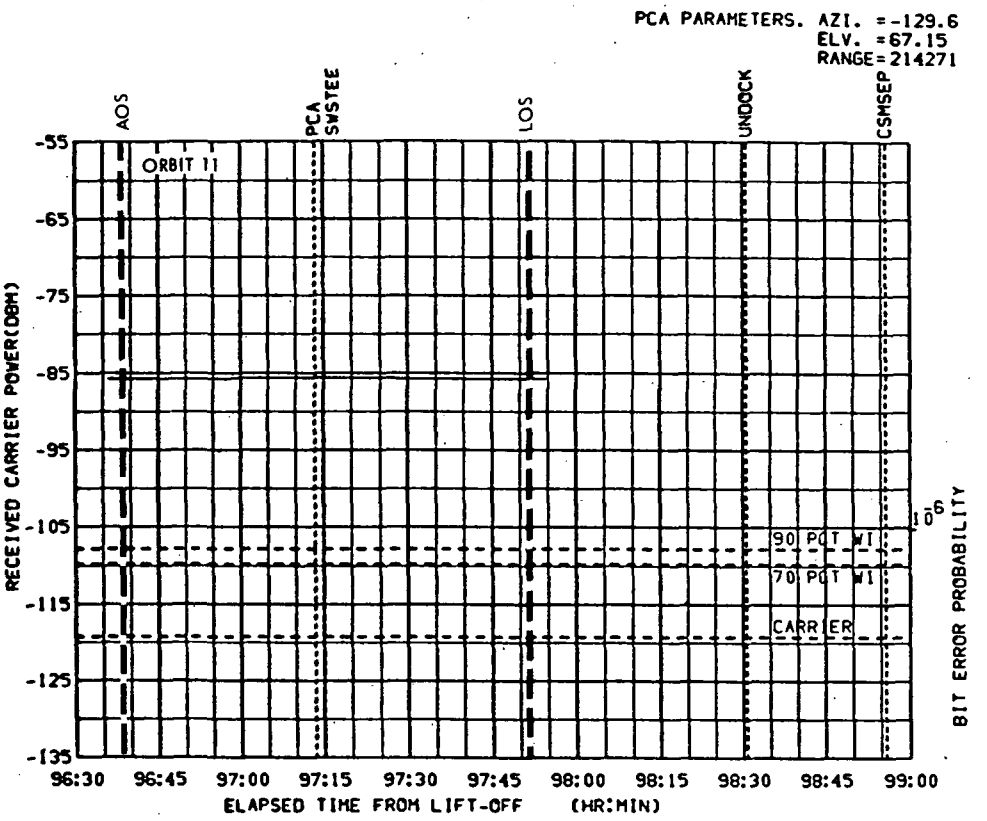

FIGURE 9-28i. MAD UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

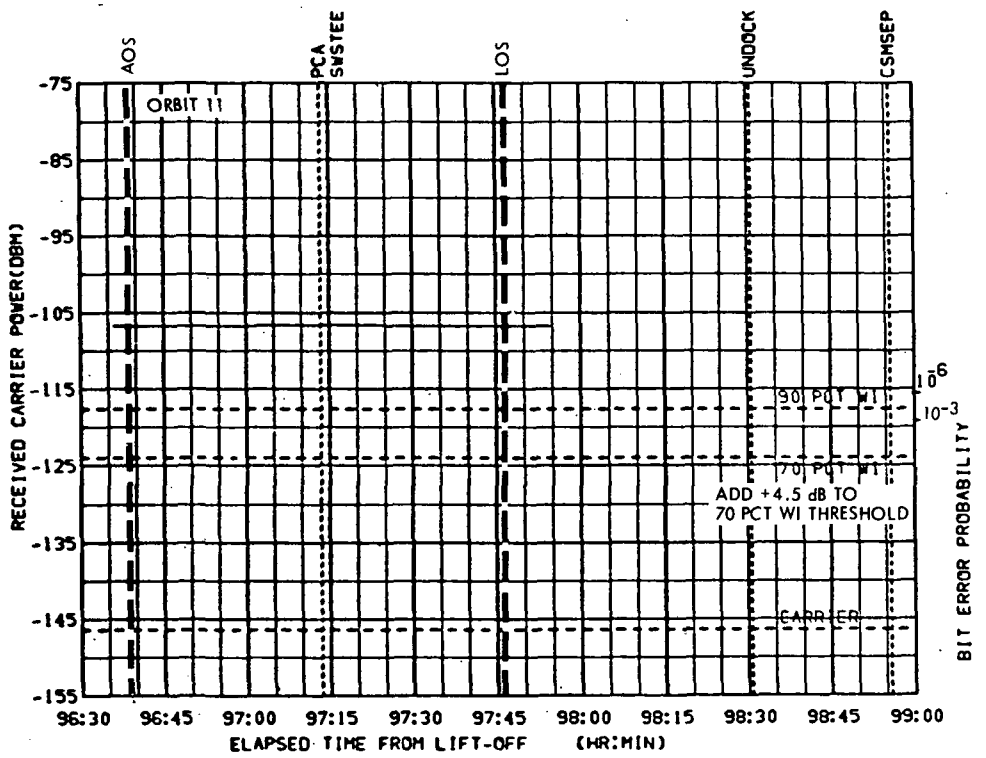

FIGURE 9-28j. MAD DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

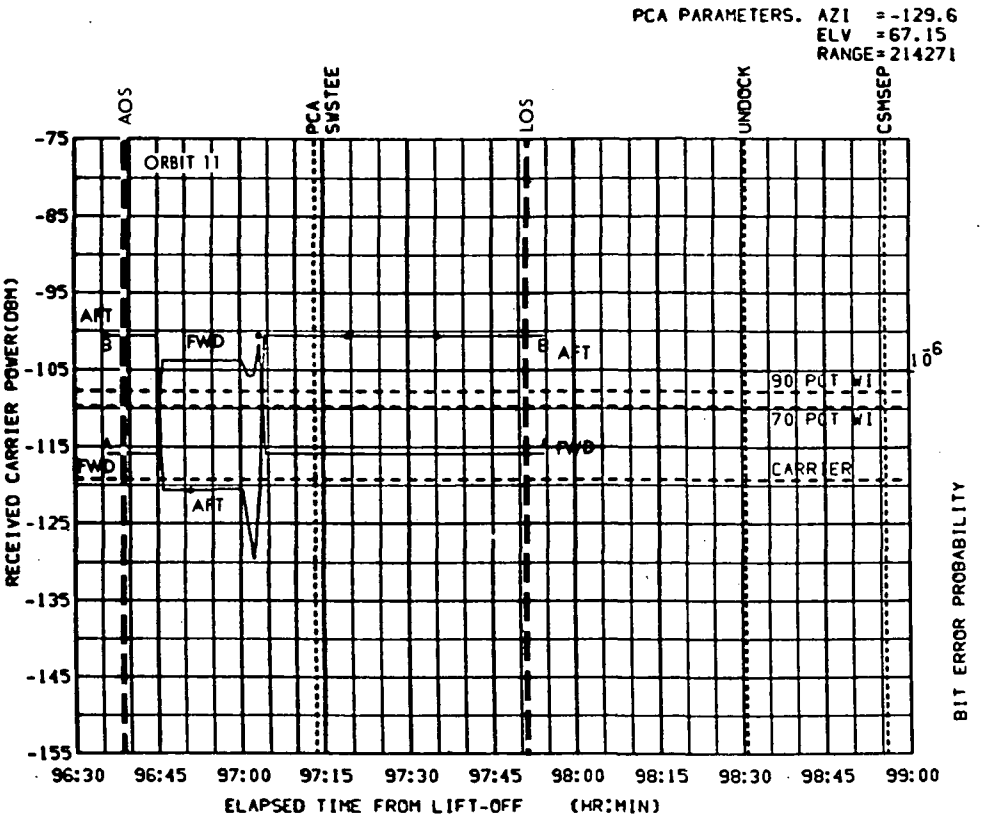

FIGURE 9-28k. MAD UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

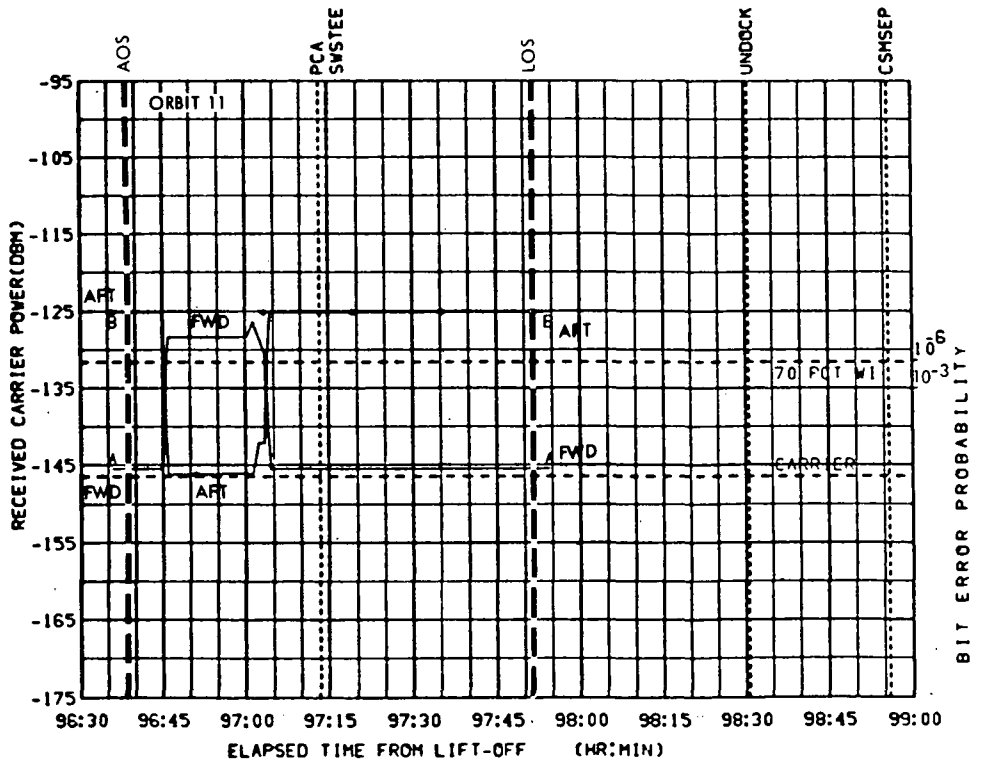

FIGURE 9-28l. MAD DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

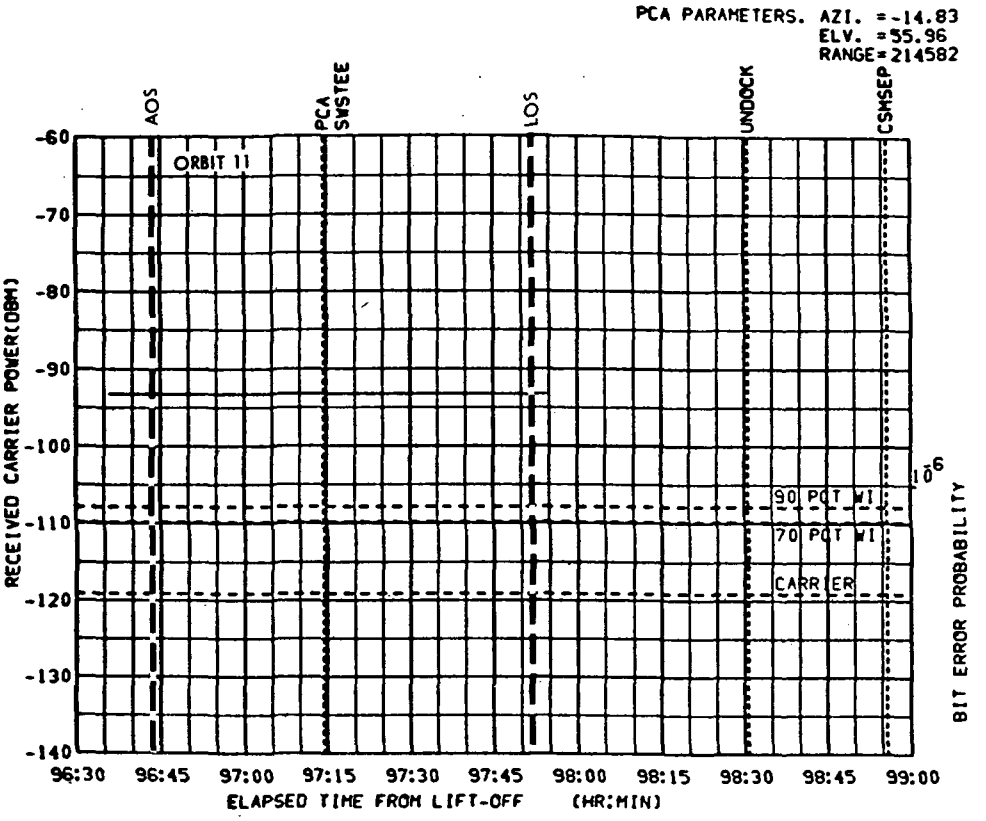

FIGURE 9-29a. ACN UPLINK MODE 6 MSFN/LM. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

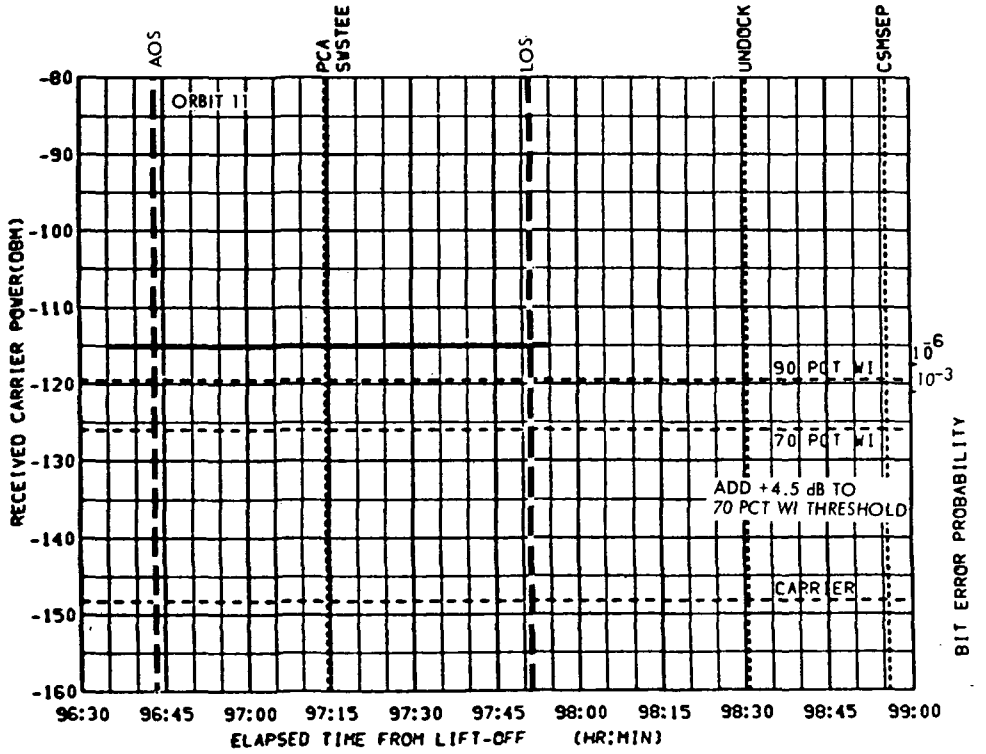

FIGURE 9-29b. ACN DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

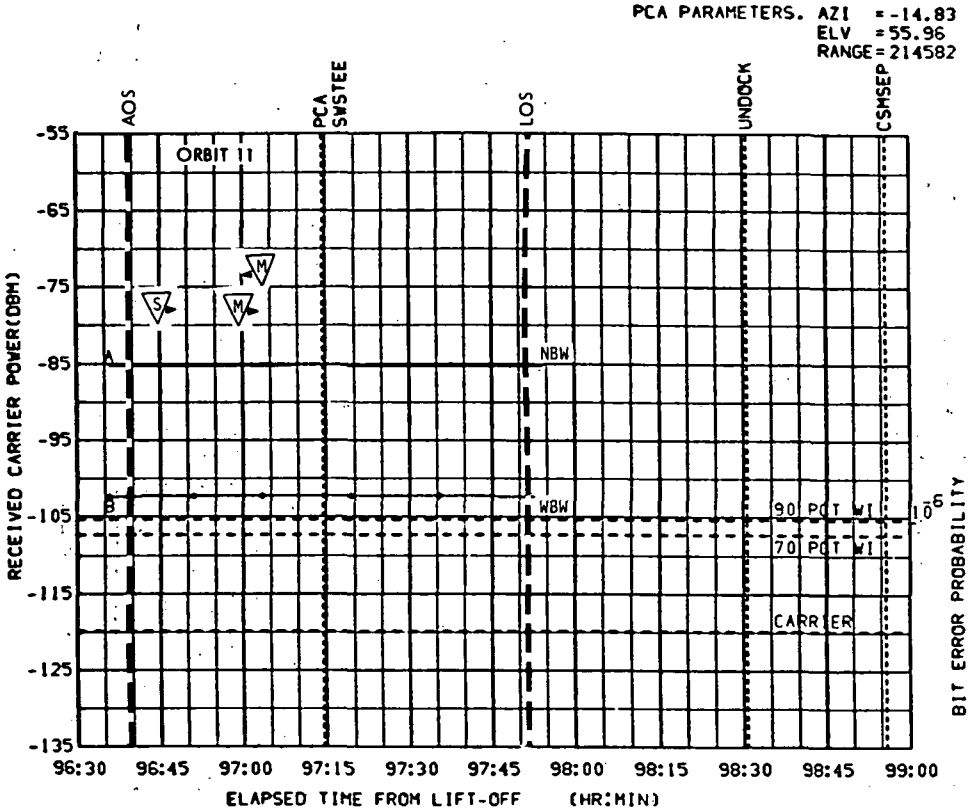

FIGURE 9-29c. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

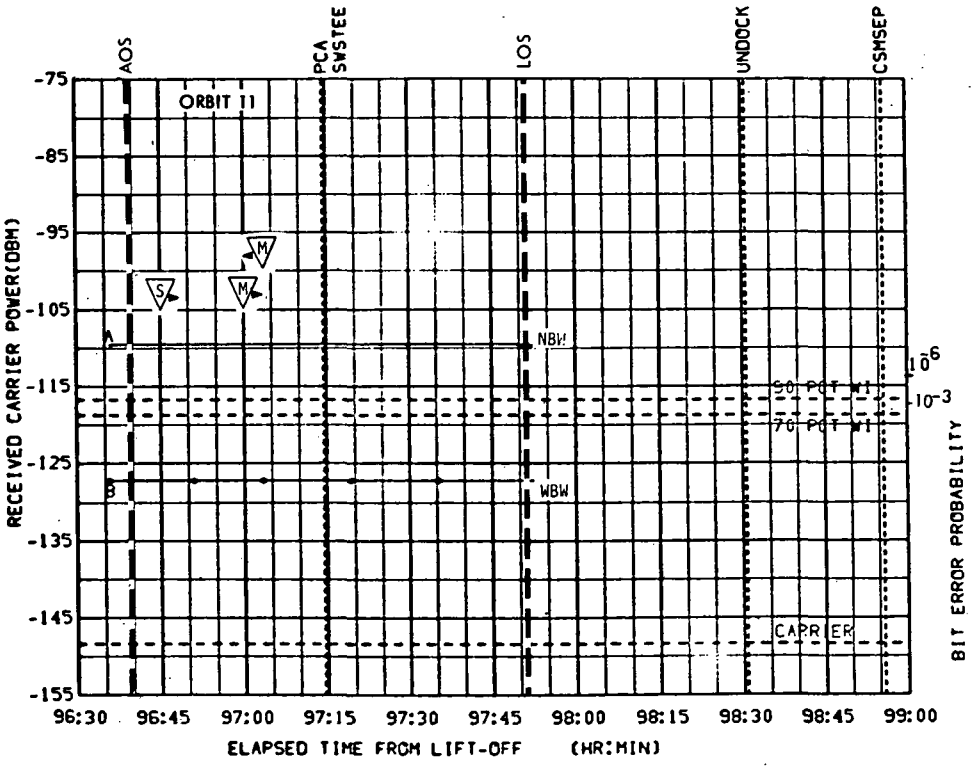

FIGURE 9-29d. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

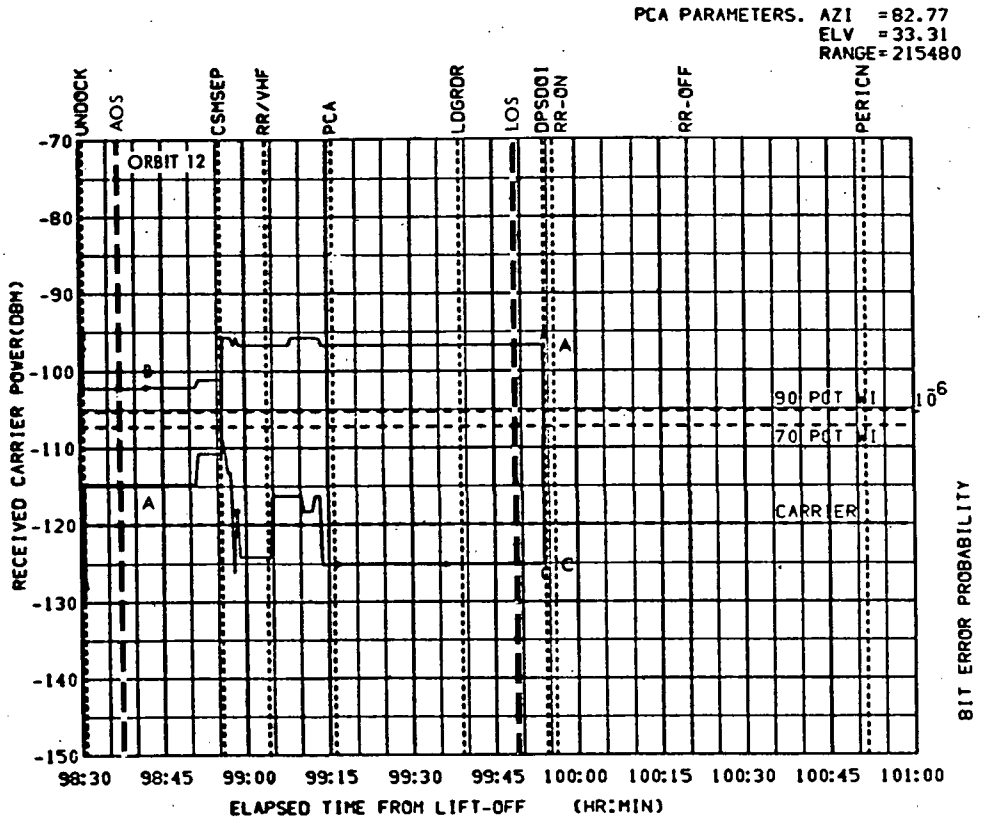

FIGURE 9-30a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

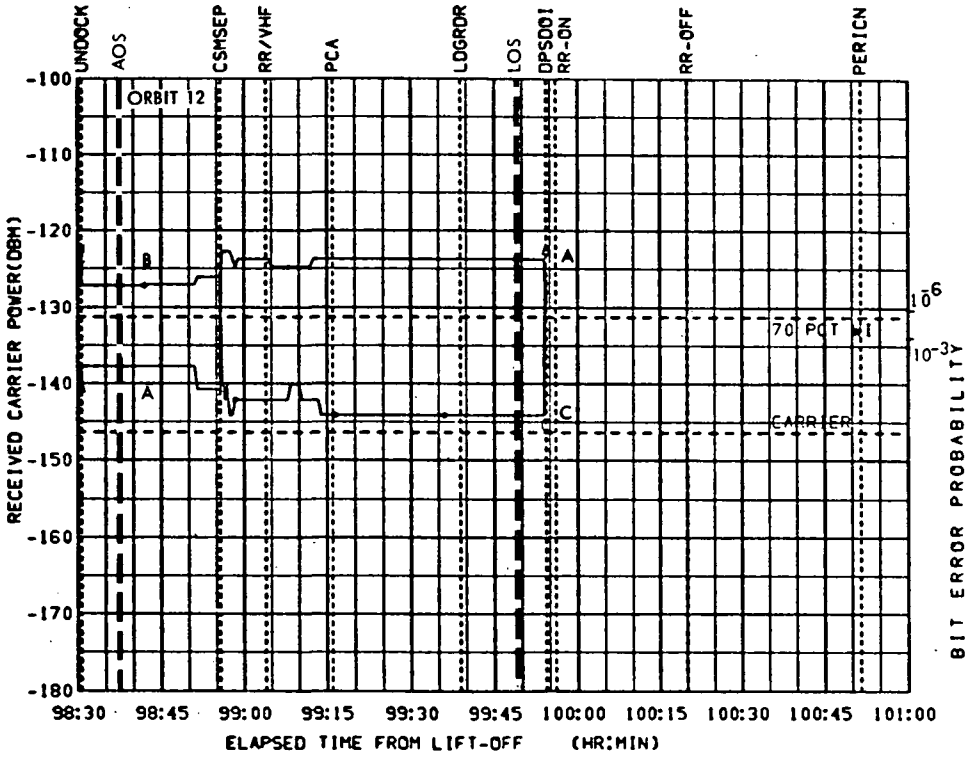

FIGURE 9-30b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

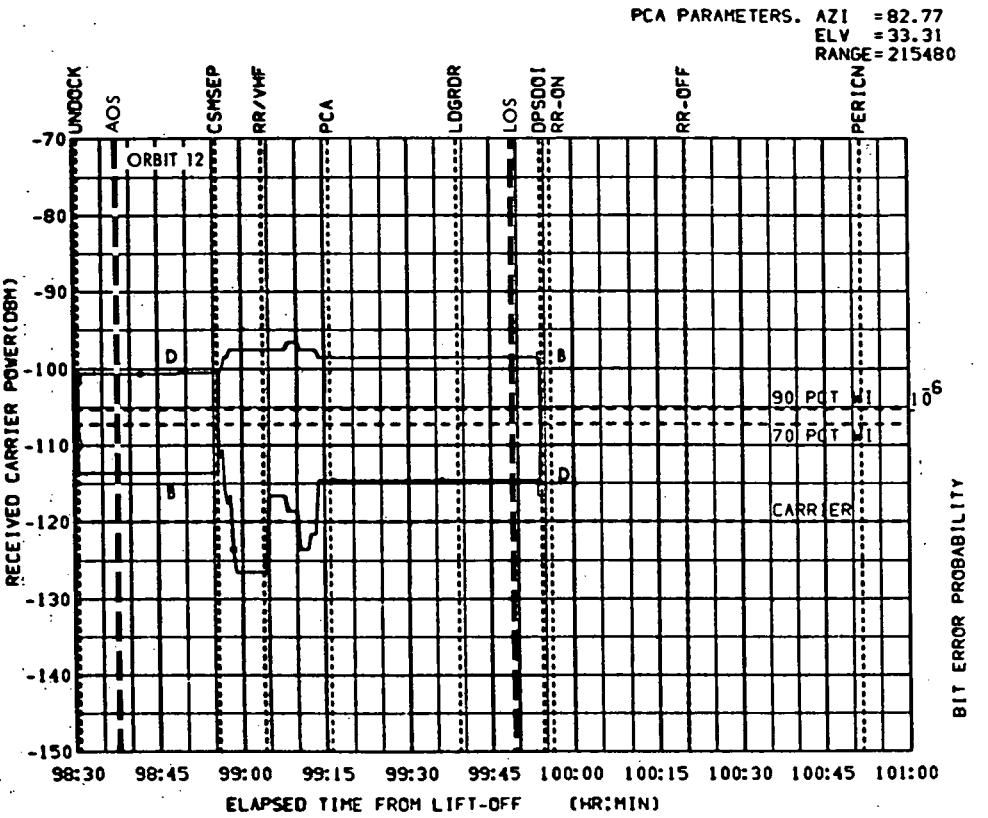

FIGURE 9-30c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

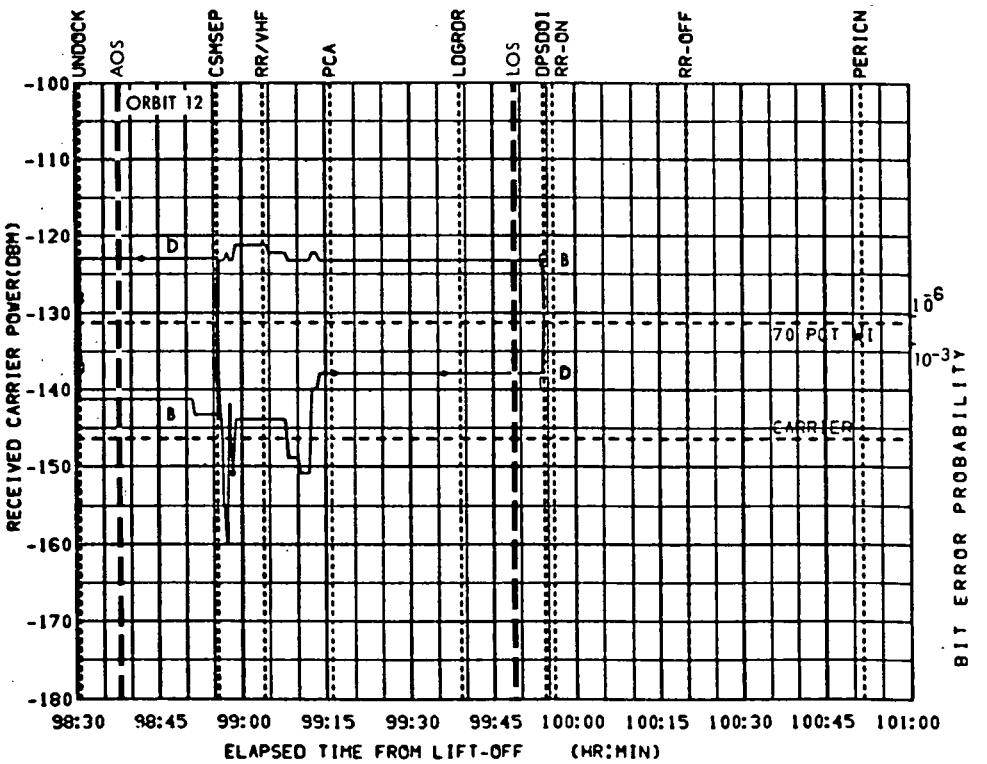

FIGURE 9-30d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

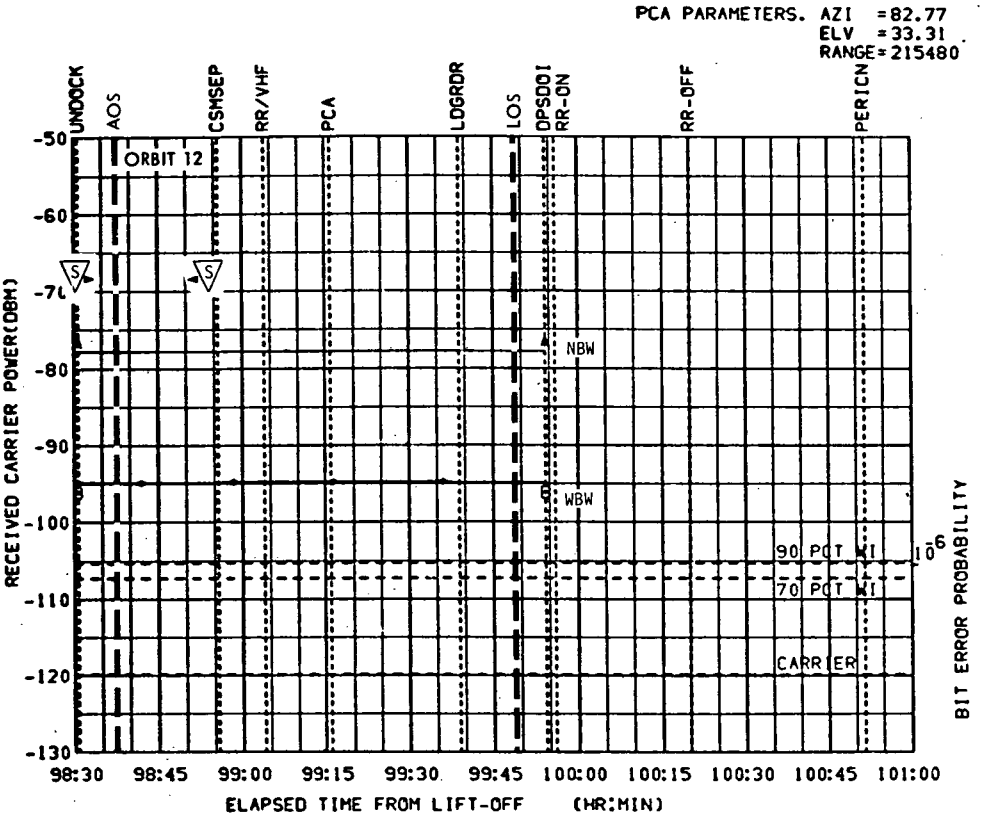

FIGURE 9-30e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

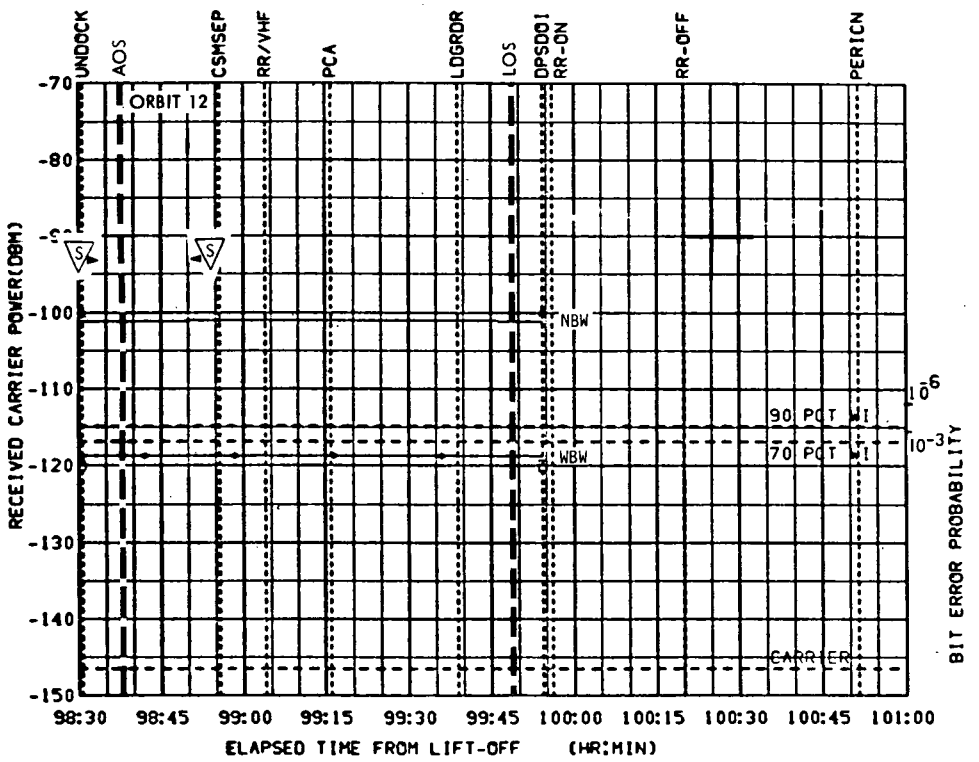

FIGURE 9-30f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

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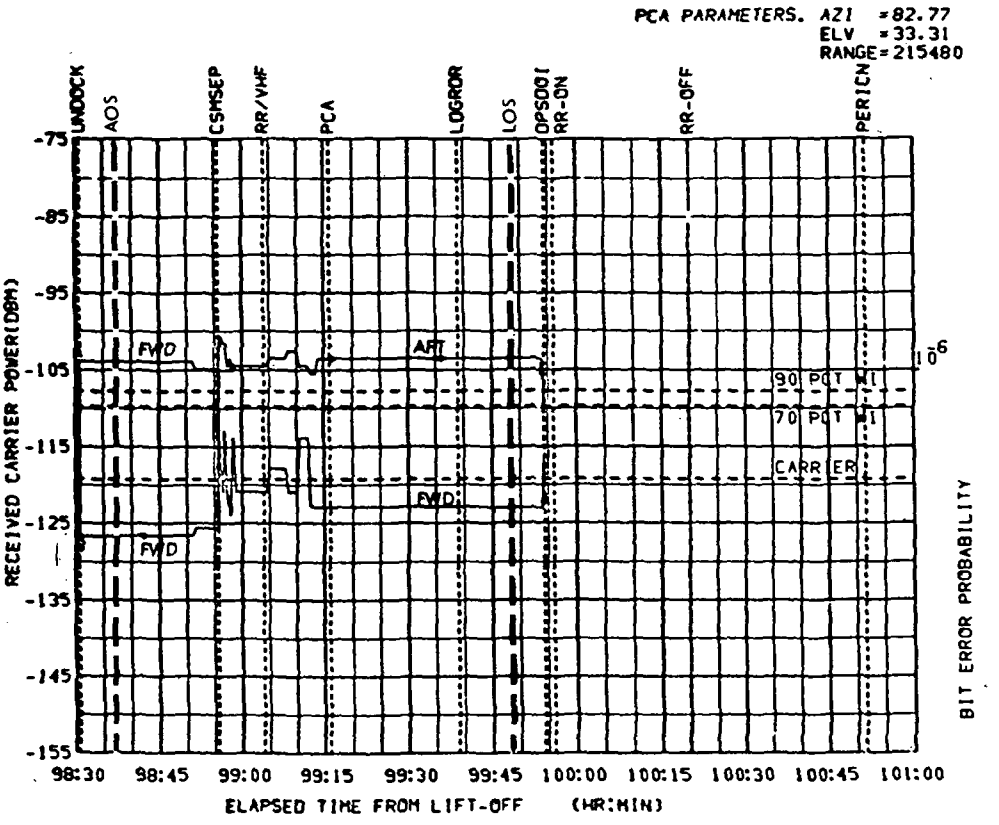


FIGURE 9-30k. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

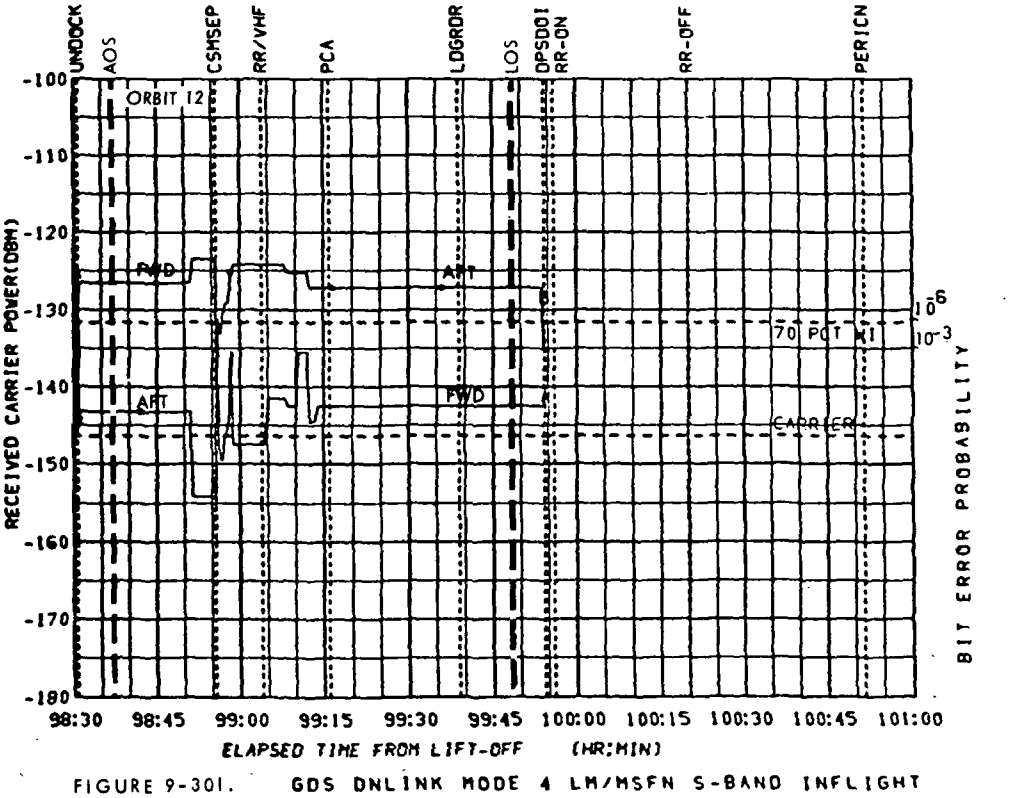


FIGURE 9-30l. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

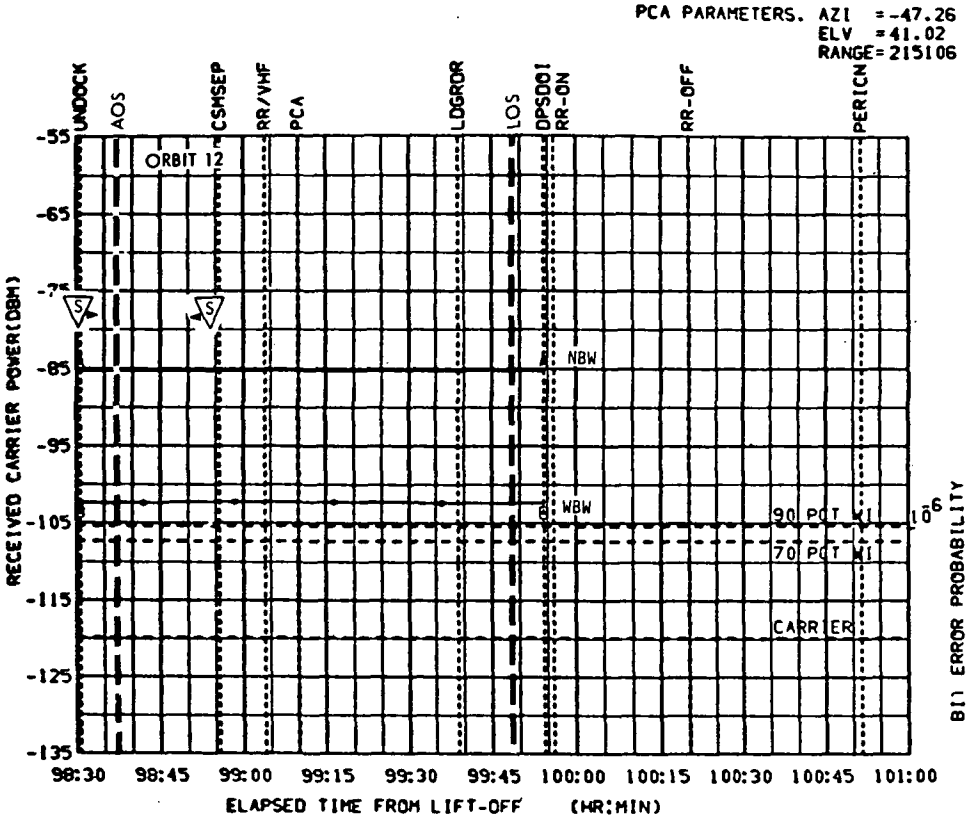


FIGURE 9-31a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

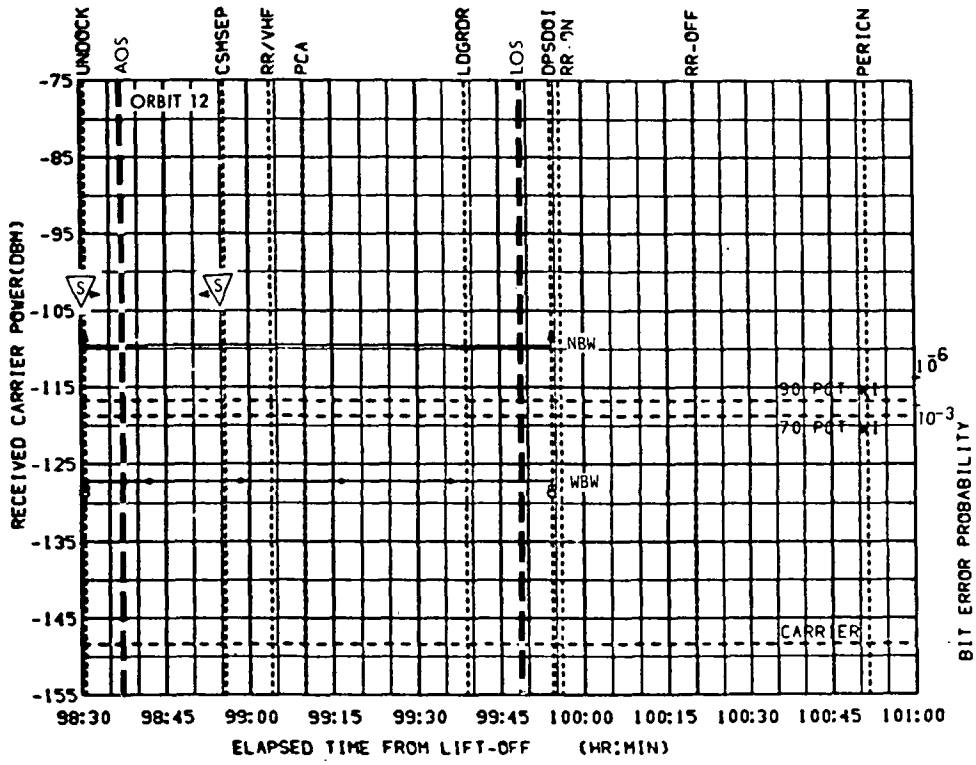


FIGURE 9-31b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

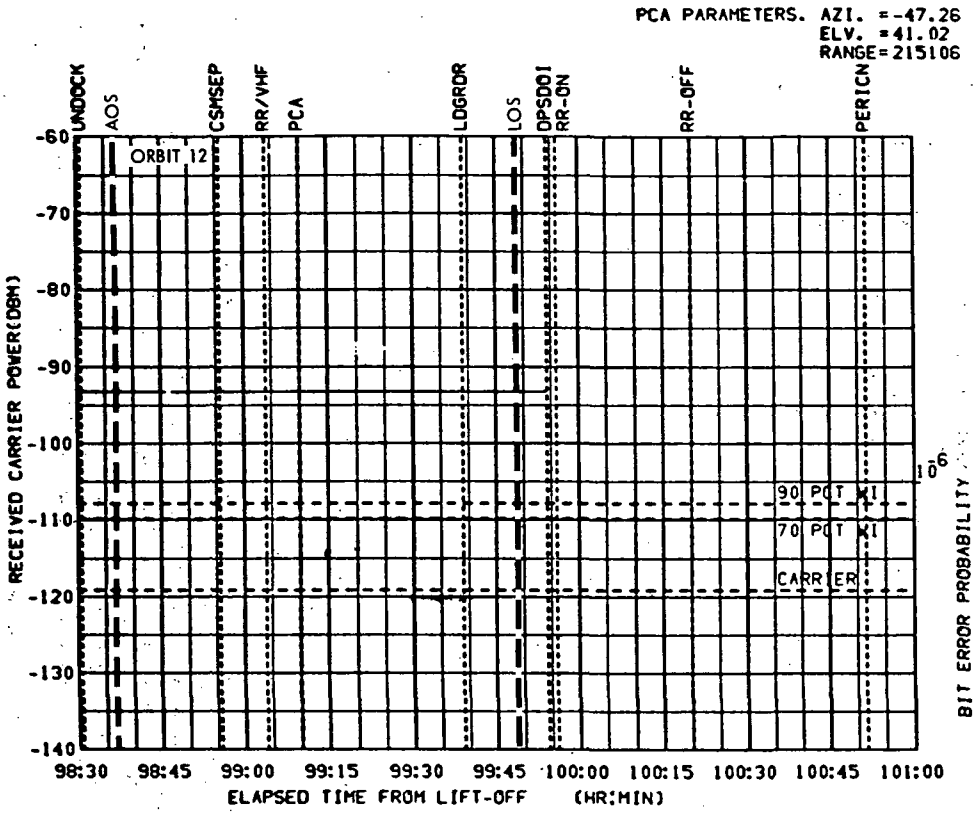


FIGURE 9-31c. ACN UPLINK MODE 6. MSFN/LM. S-BAND. STEER LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

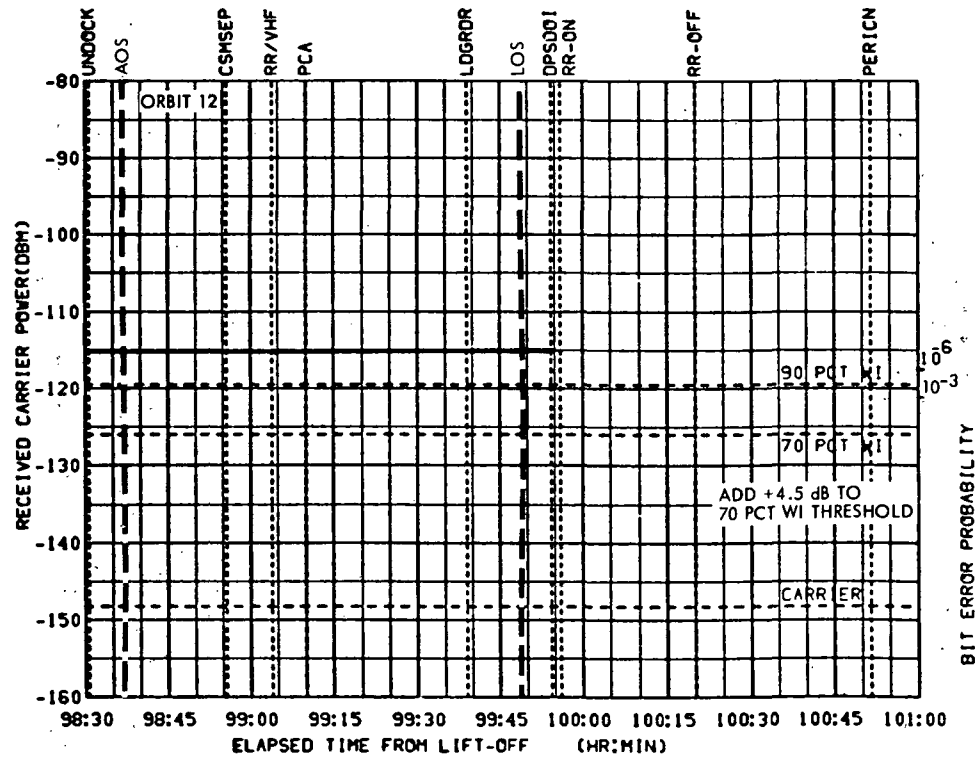


FIGURE 9-31d. ACN DNLINK MODE 2. LM/MSFN. S-BAND. STEER LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

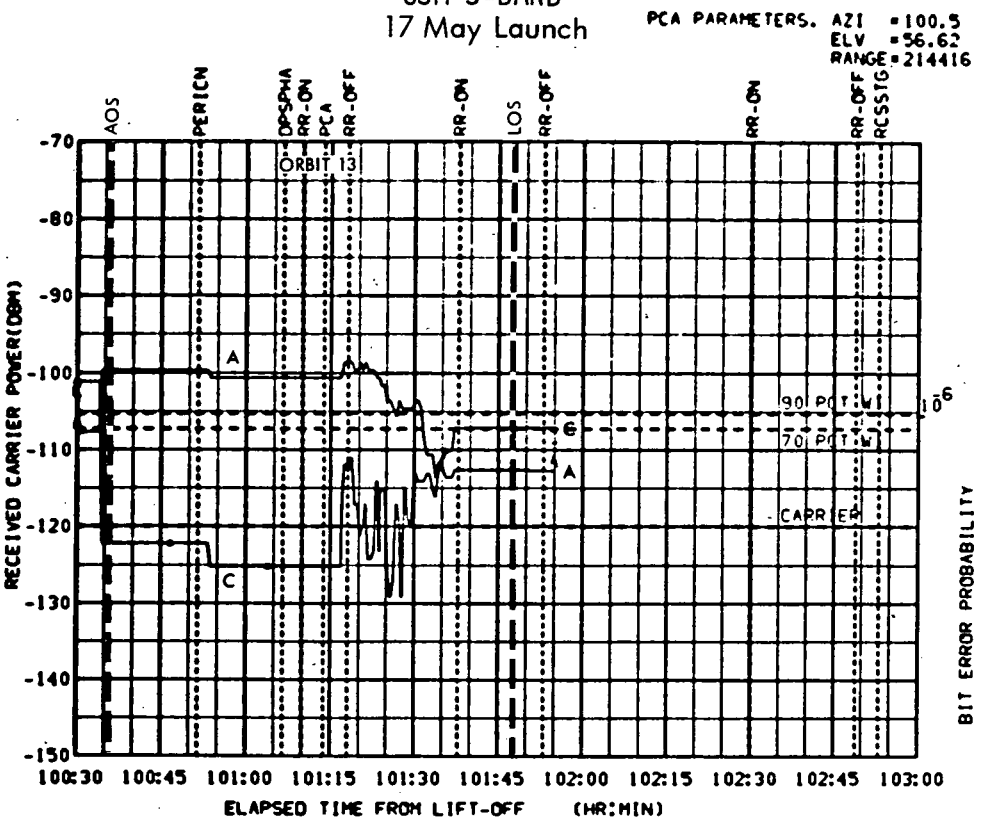


FIGURE 9-32a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

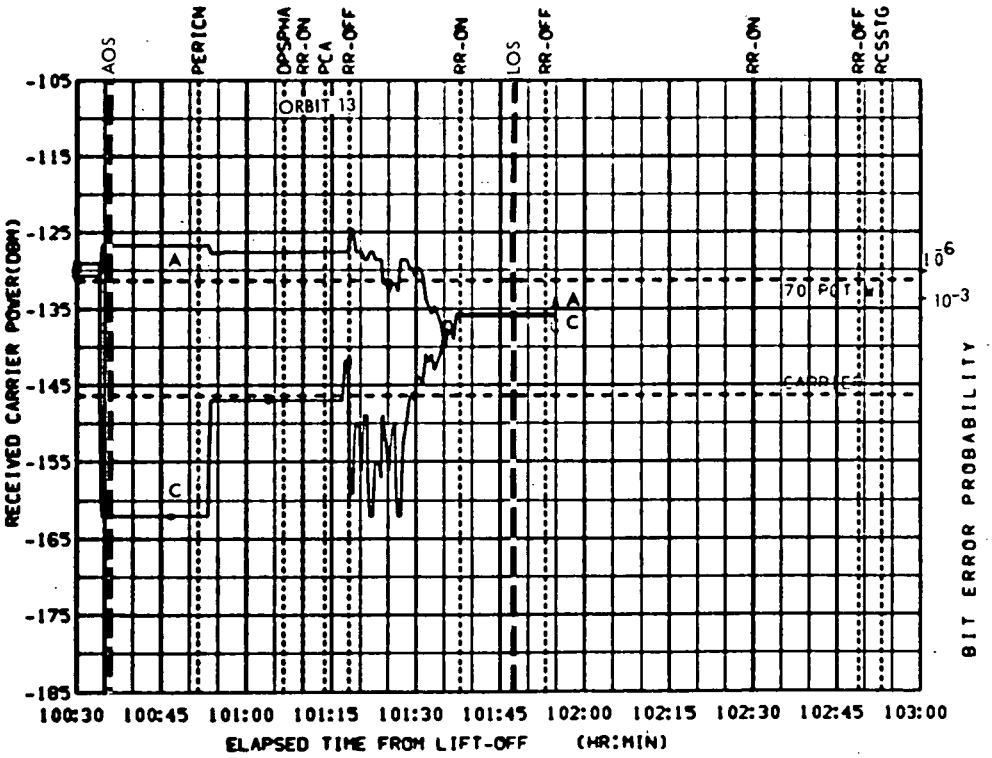


FIGURE 9-32b. GDS ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

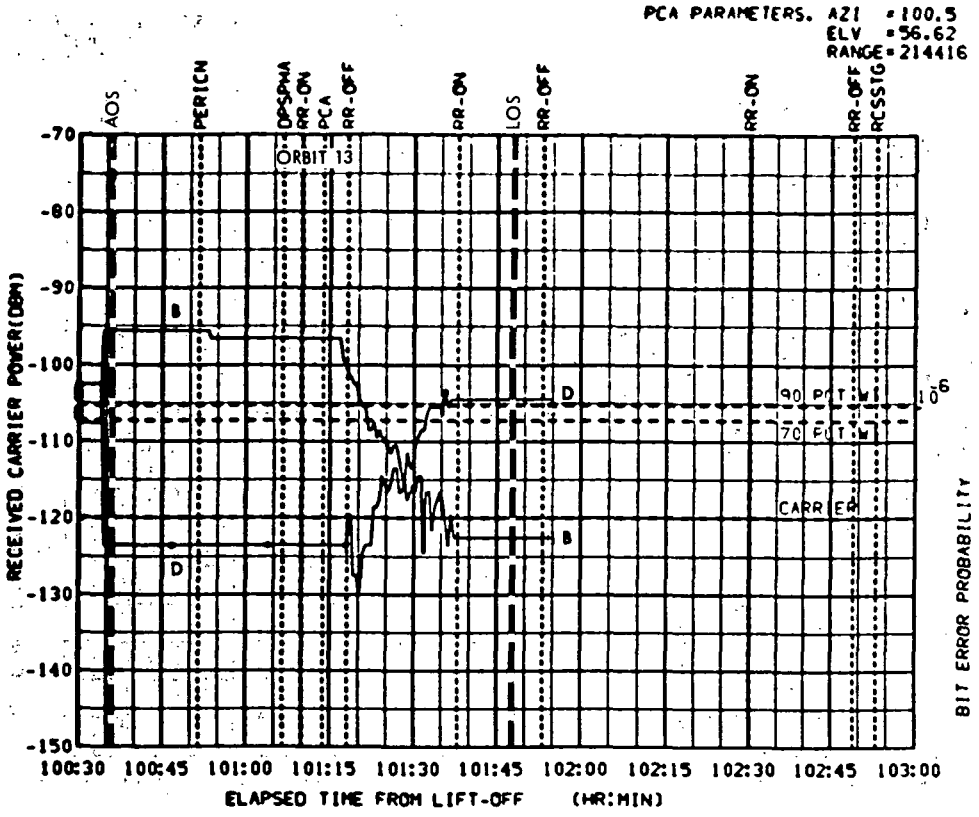


FIGURE 9-32c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

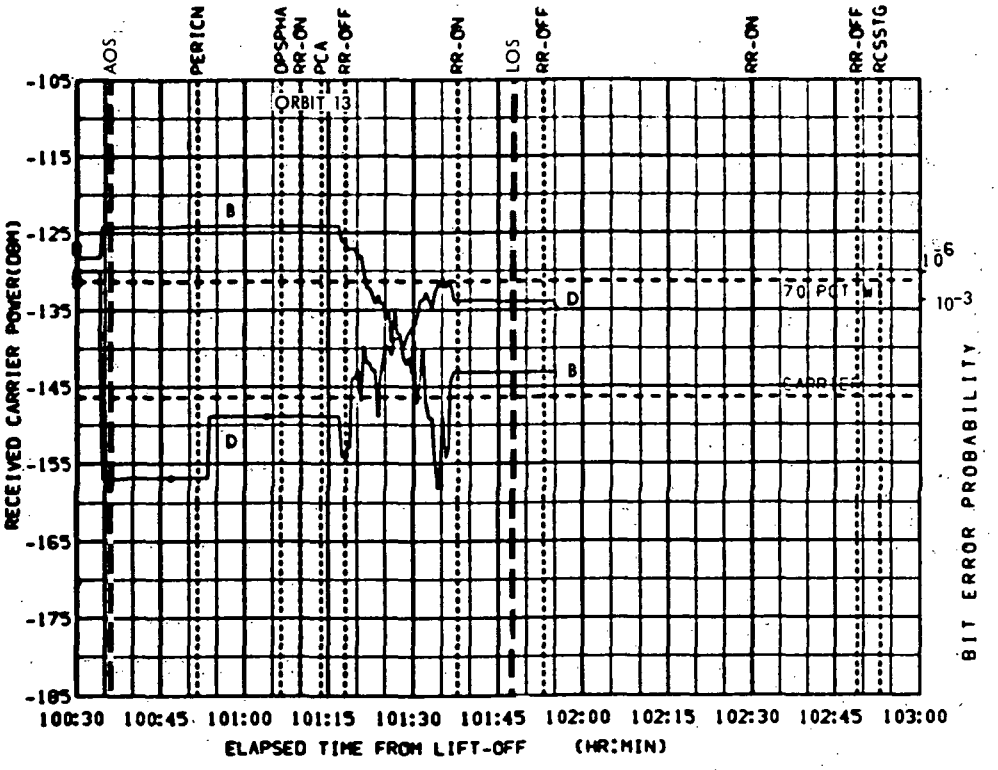


FIGURE 9-32d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

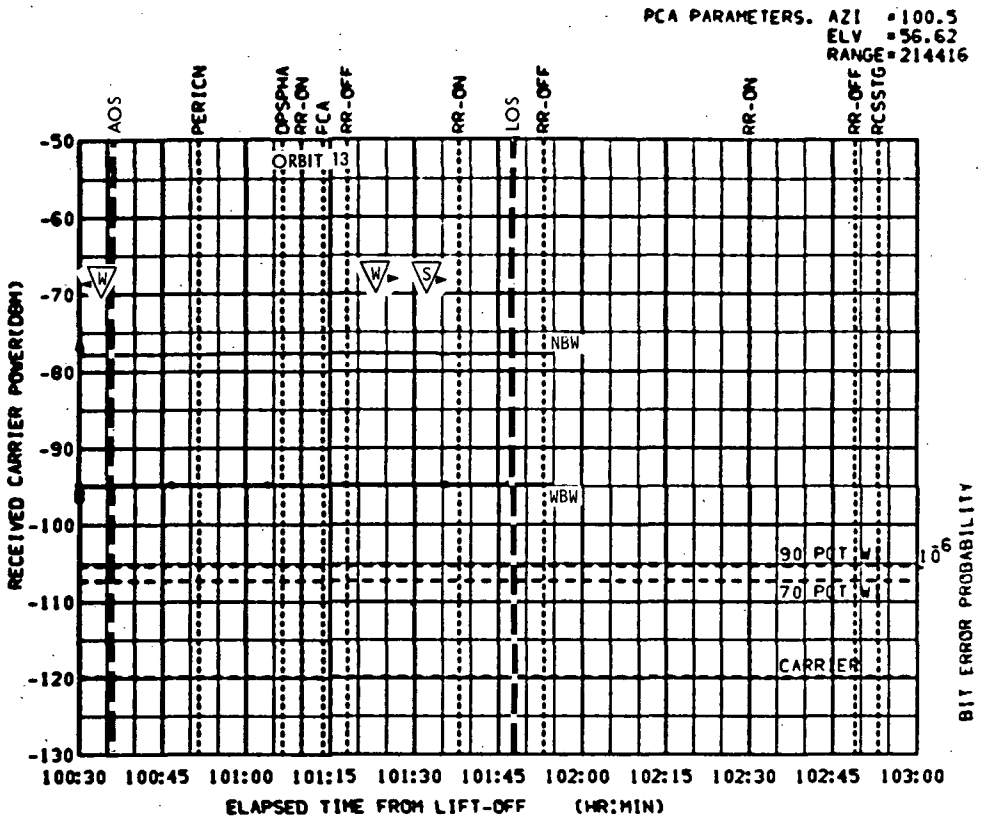


FIGURE 9-32e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

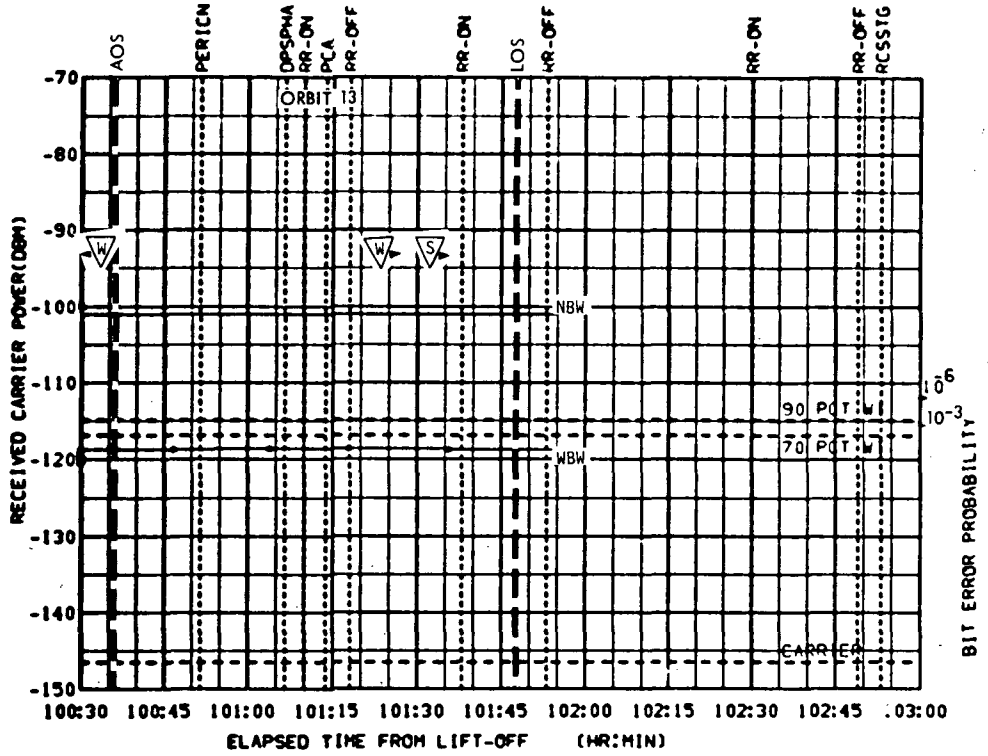


FIGURE 9-32f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

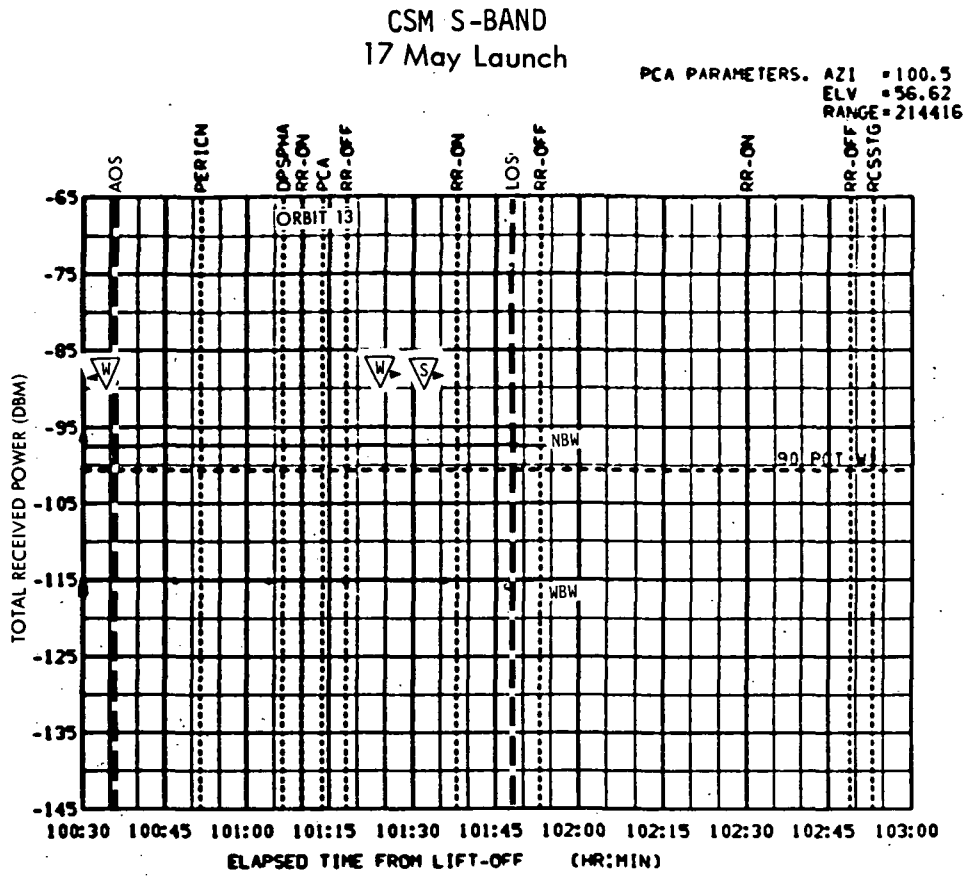


FIGURE 9-32g. GDS DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

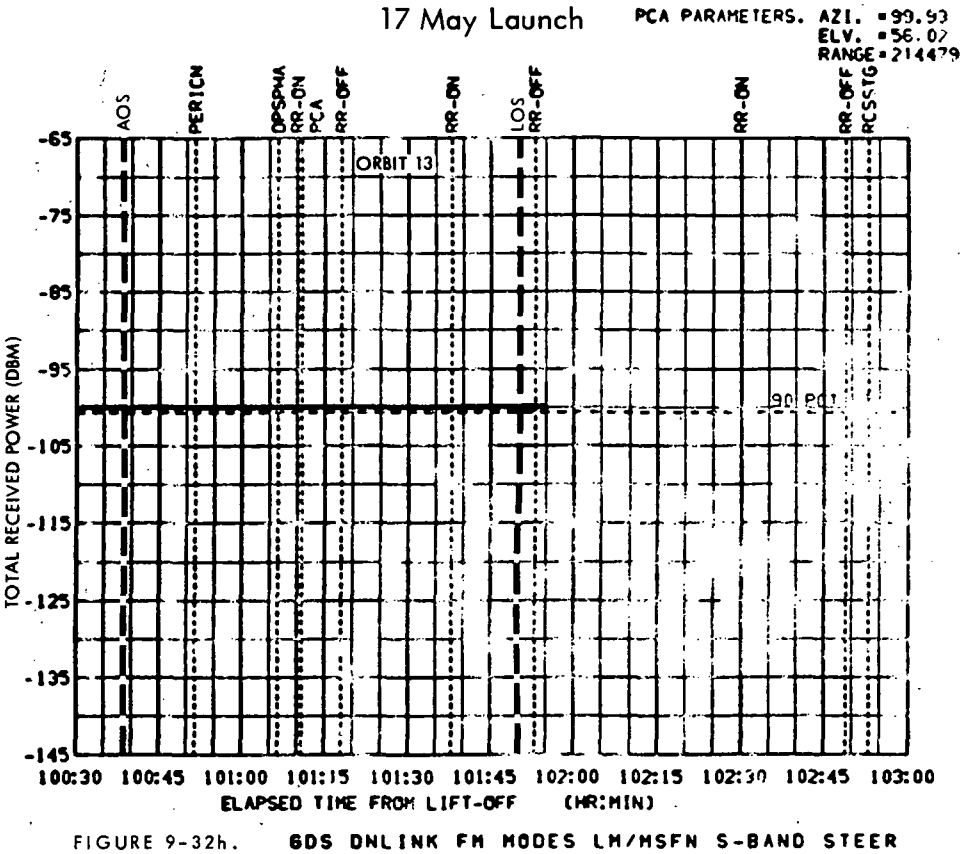


FIGURE 9-32h. GDS DNLINK FM MODES LM/MSFN S-BAND STEER
LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

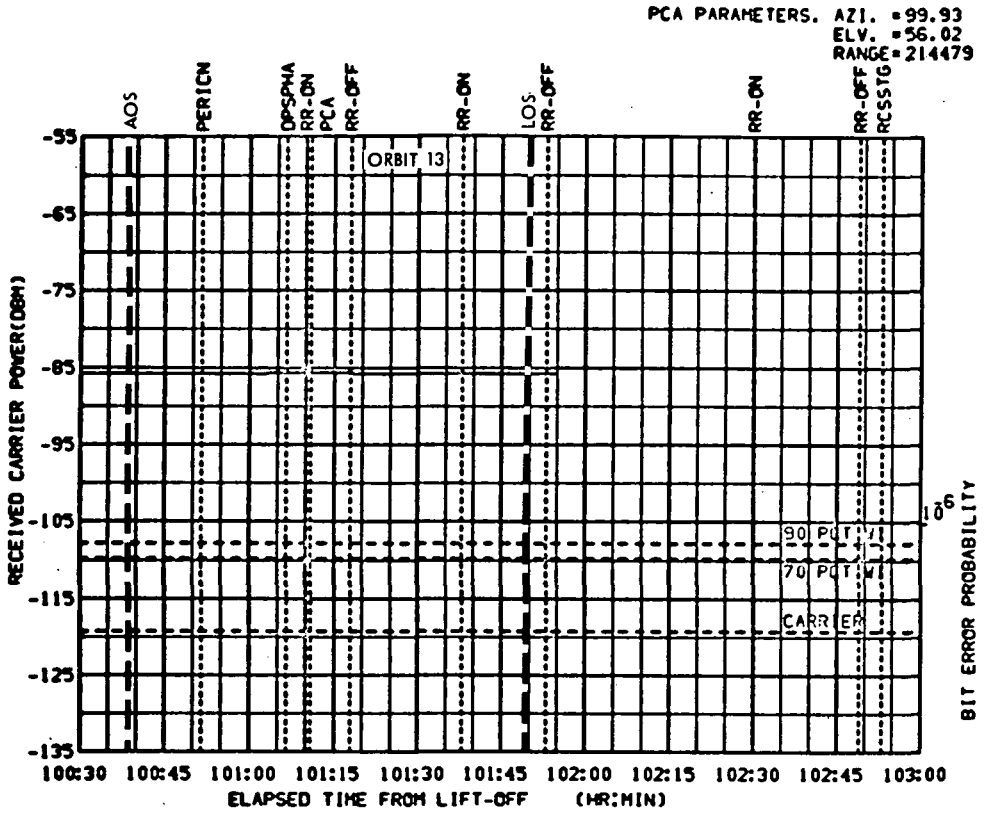


FIGURE 9-32i. GDS UPLINK MODE 6. MSFN/LM. S-BAND. STEER LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

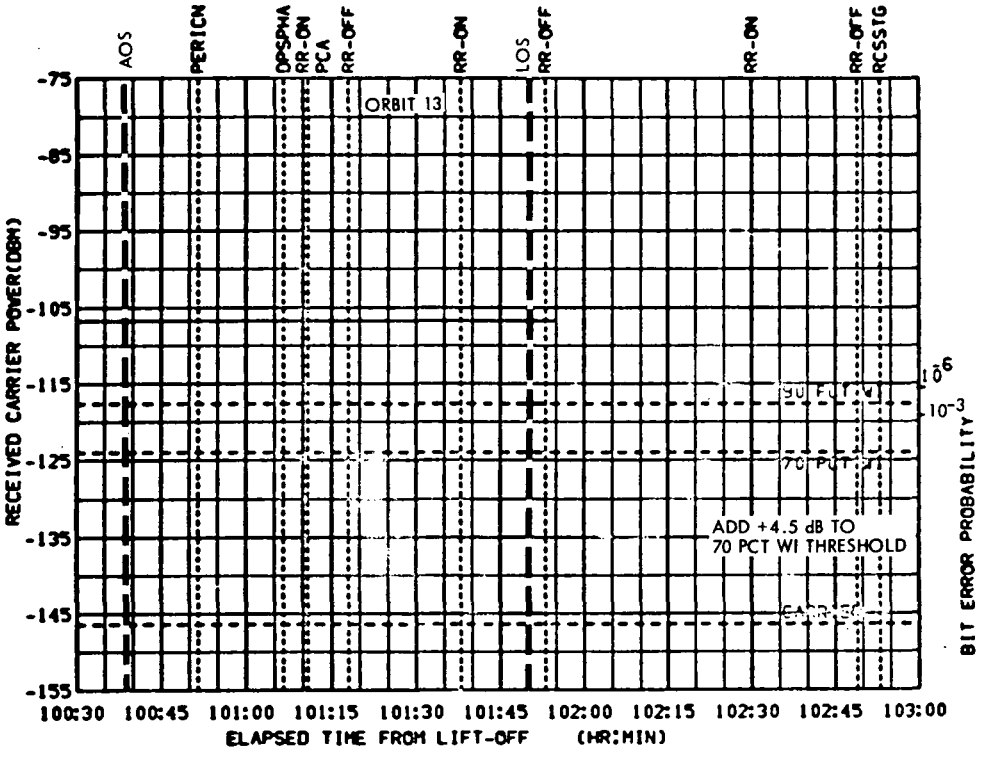


FIGURE 9-32j. GDS DNLINK MODE 2. LM/MSFN. S-BAND. STEER LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

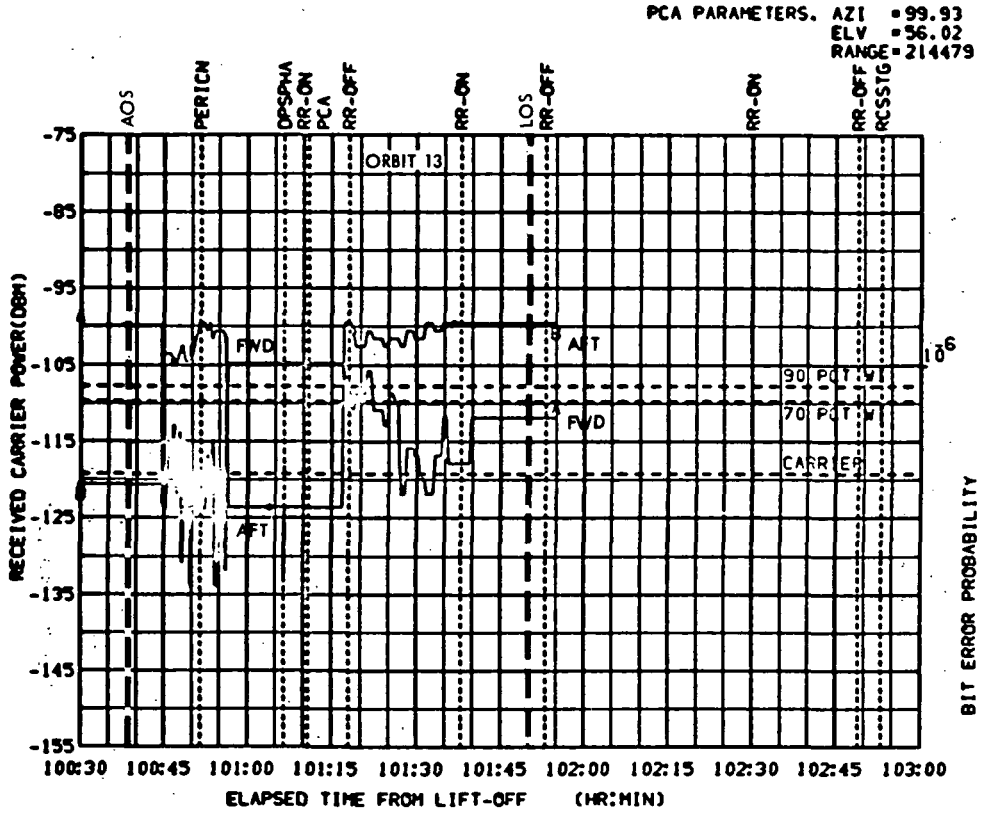


FIGURE 9-32k. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

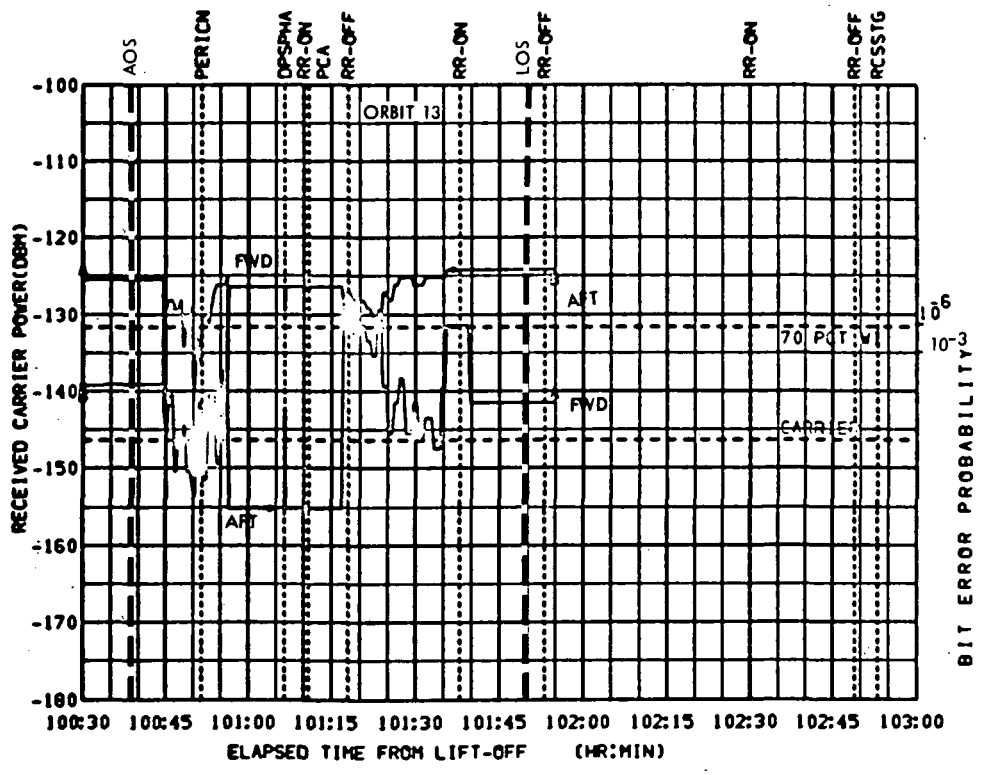


FIGURE 9-32l. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT LM DESCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

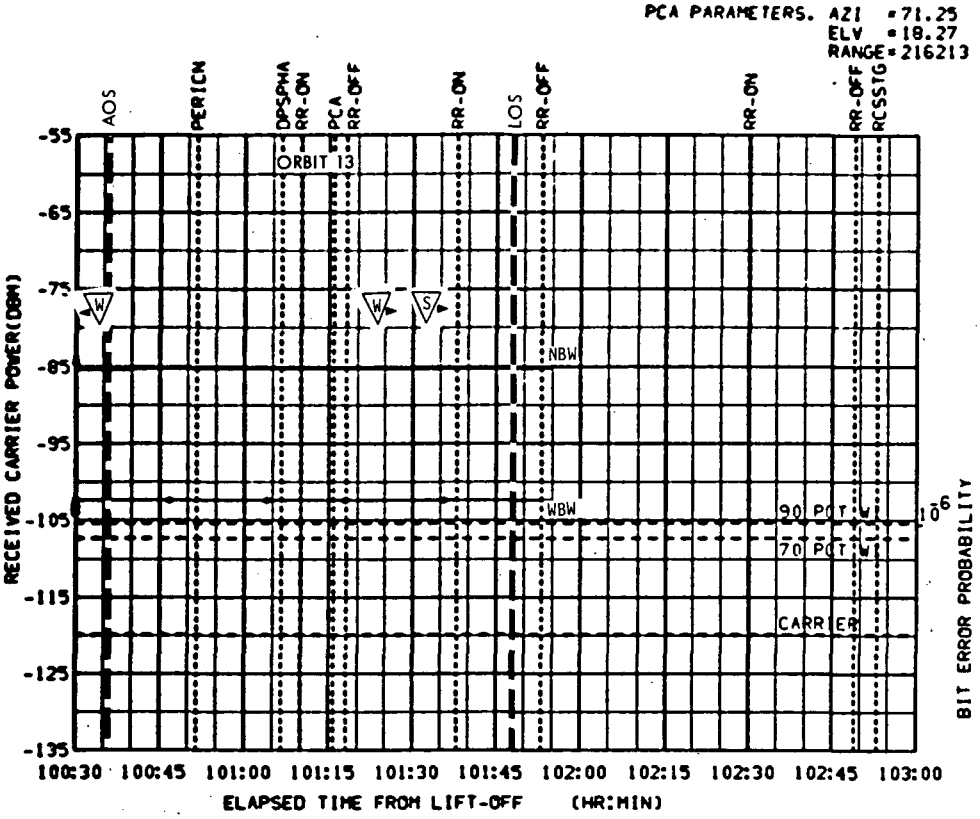


FIGURE 9-33a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

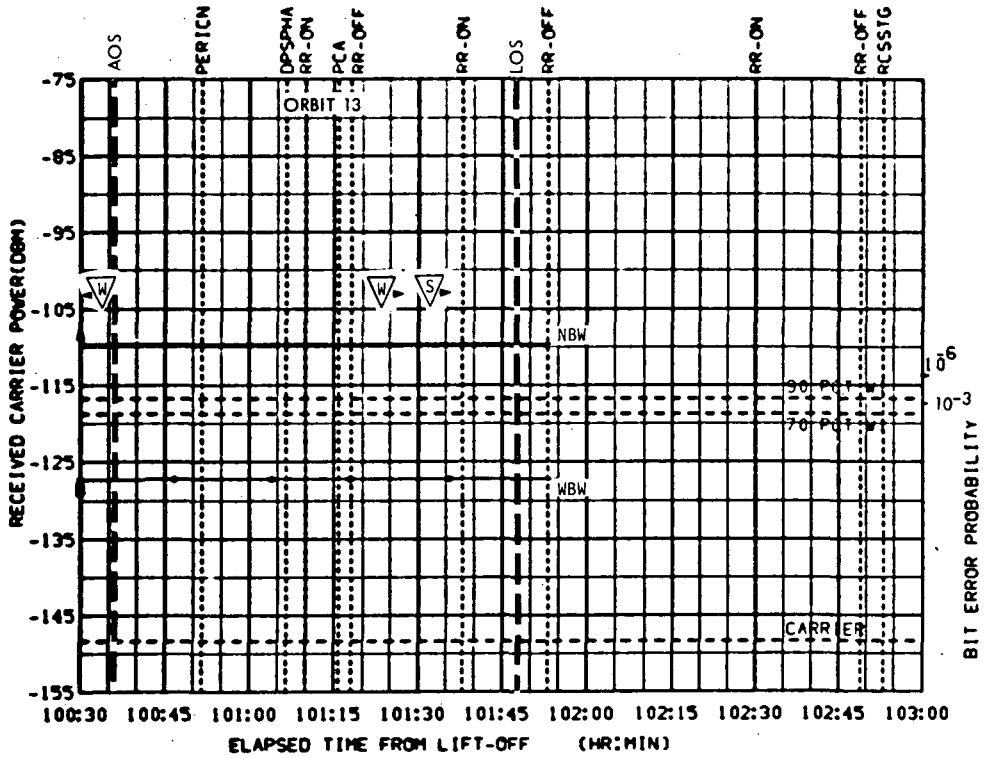


FIGURE 9-33b. MAW ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

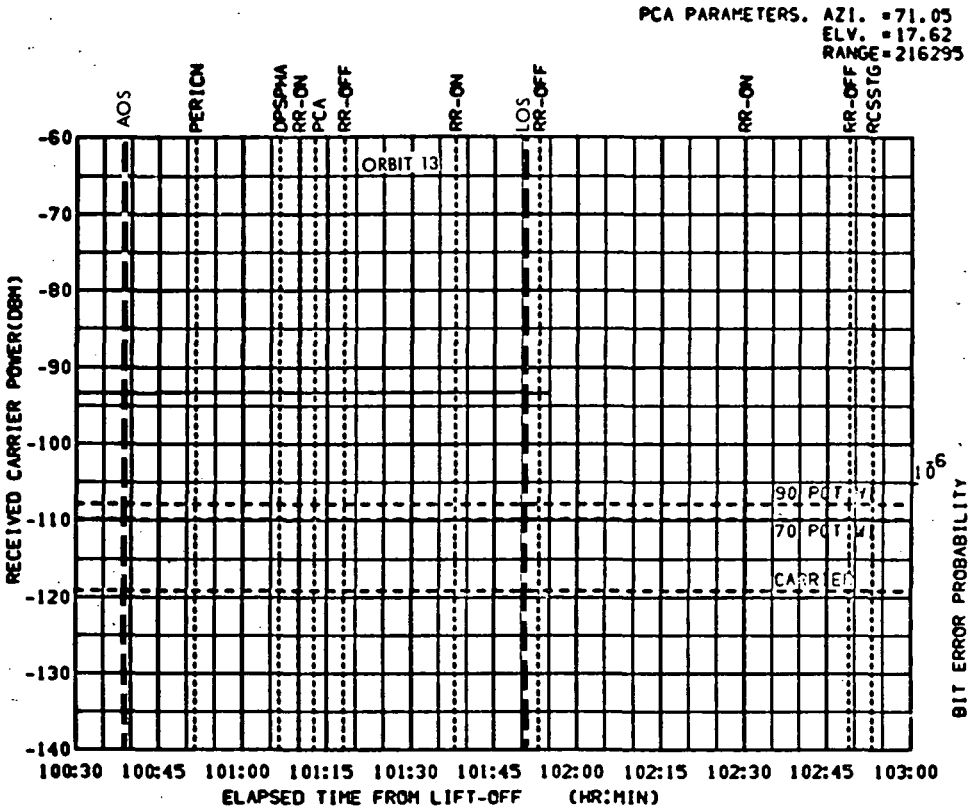


FIGURE 9-33c. MAW UPLINK MODE 6. MSFN/LM. S-BAND. STEER
LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

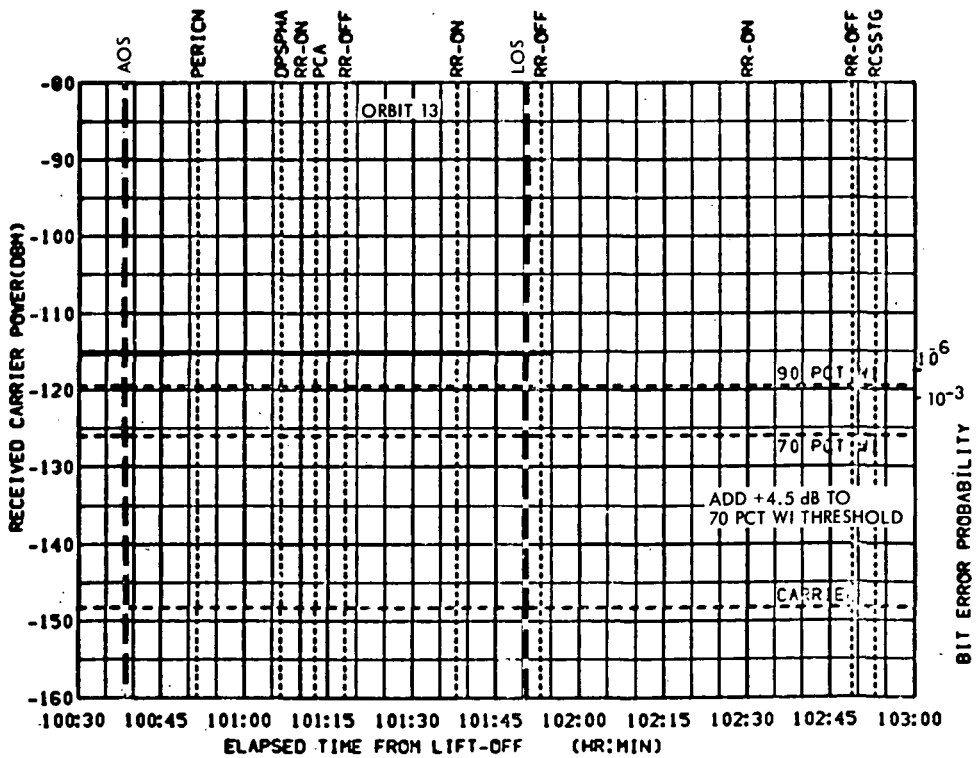


FIGURE 9-33d. MAW DNLINK MODE 2. LM/MSFN. S-BAND. STEER
LM DESCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

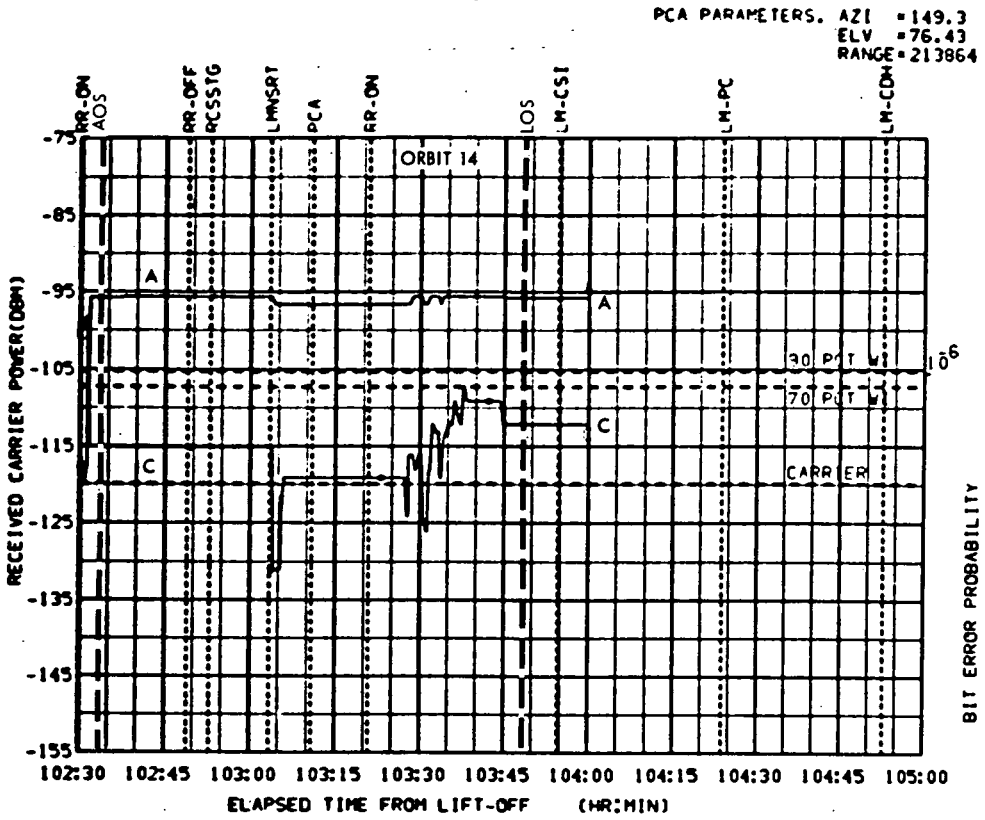


FIGURE 9-34a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

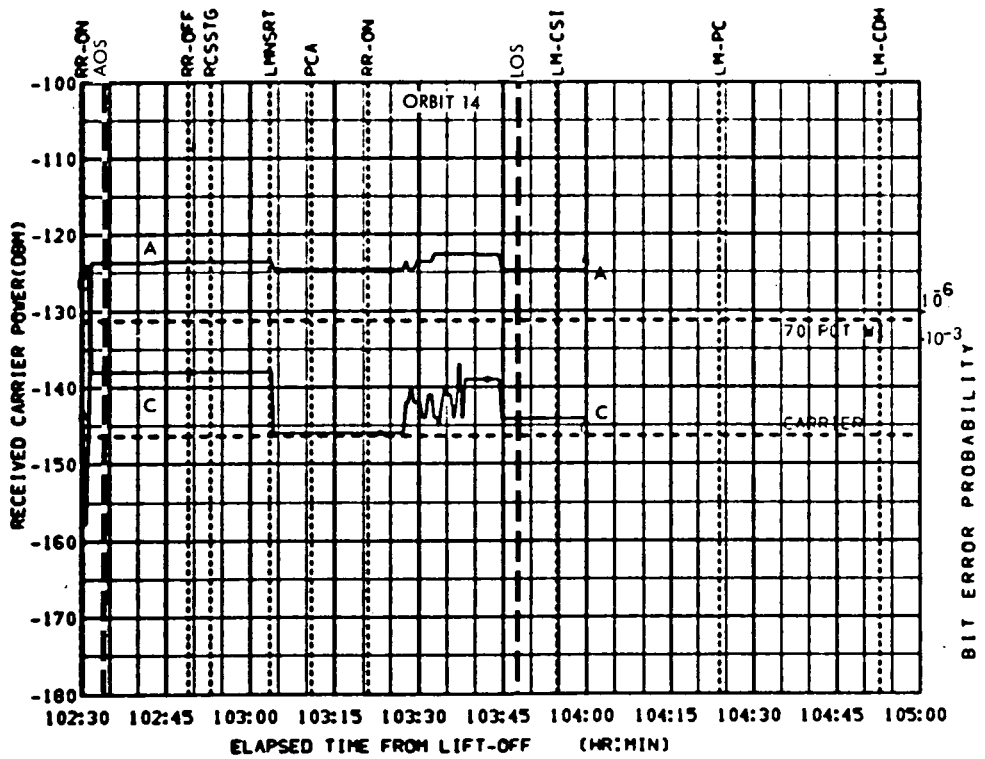


FIGURE 9-34b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

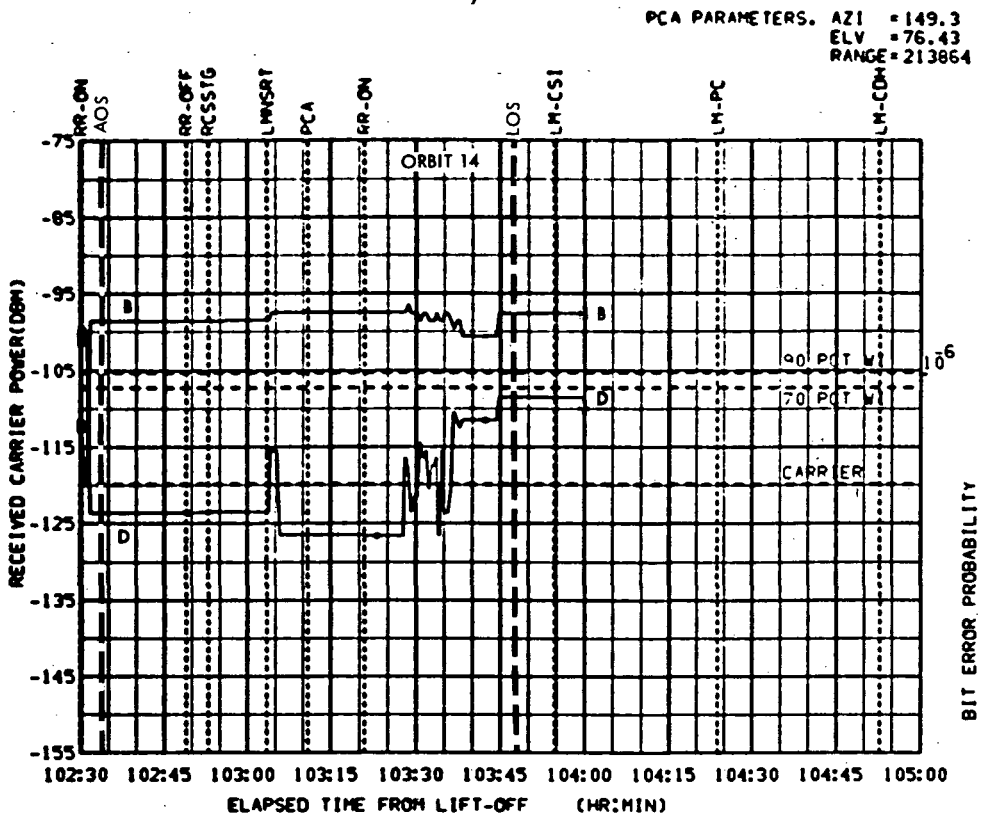


FIGURE 9-34c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

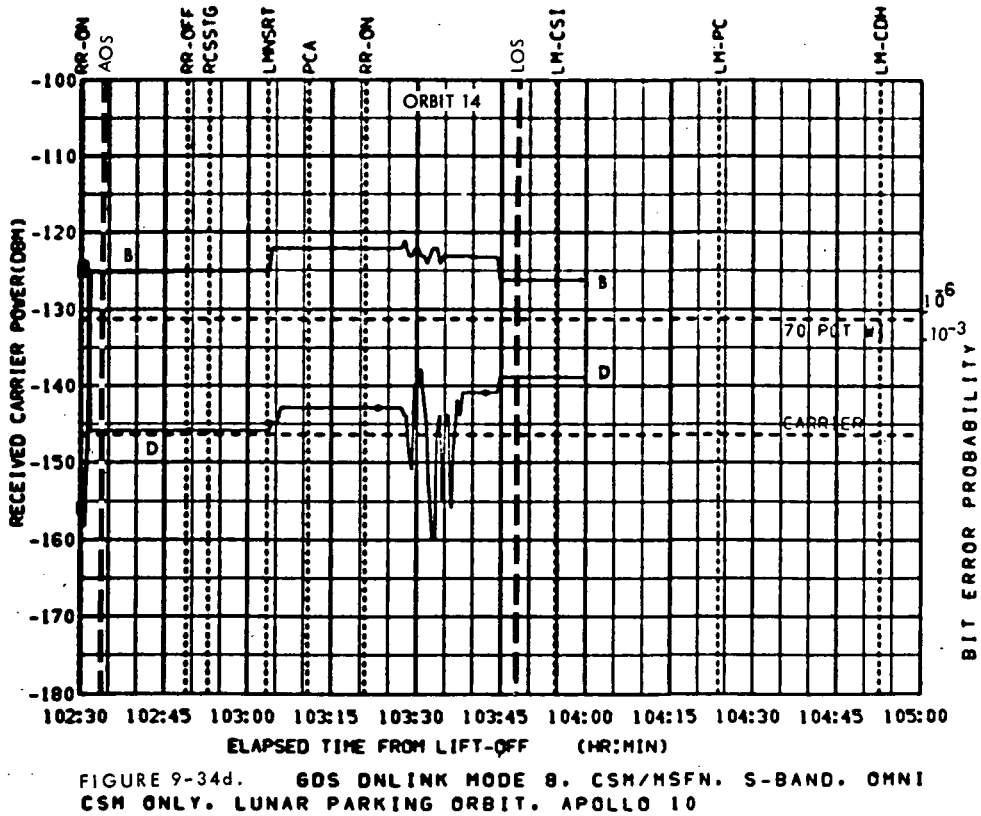


FIGURE 9-34d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

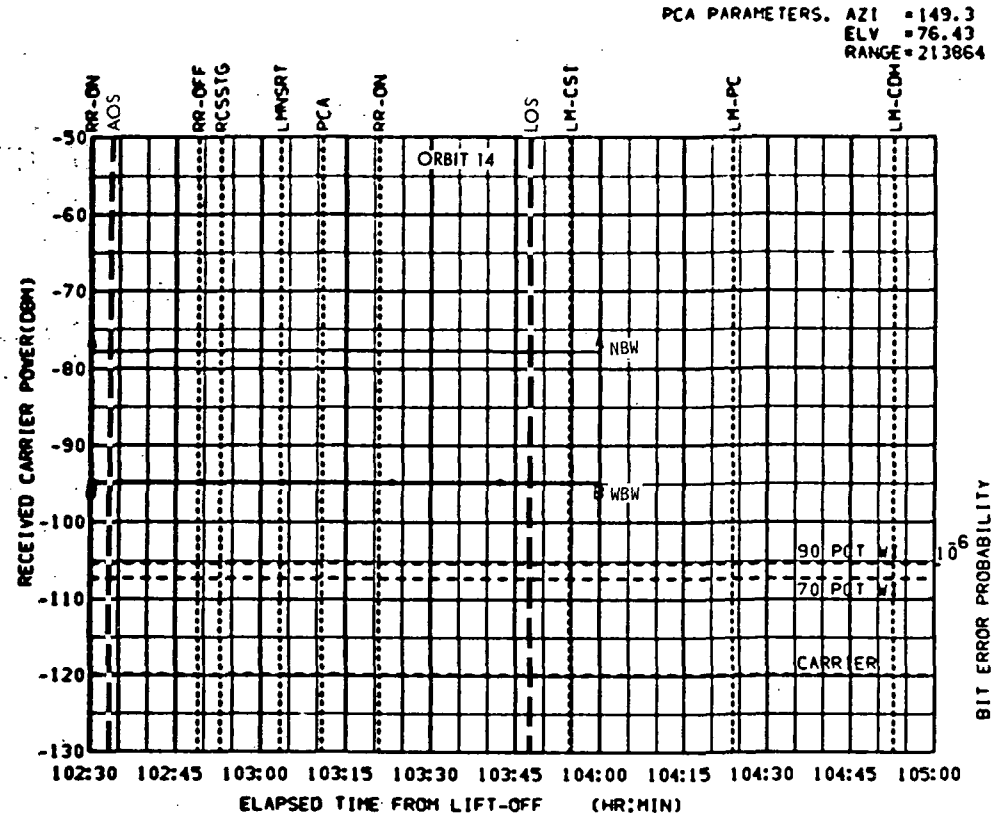


FIGURE 9-34e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

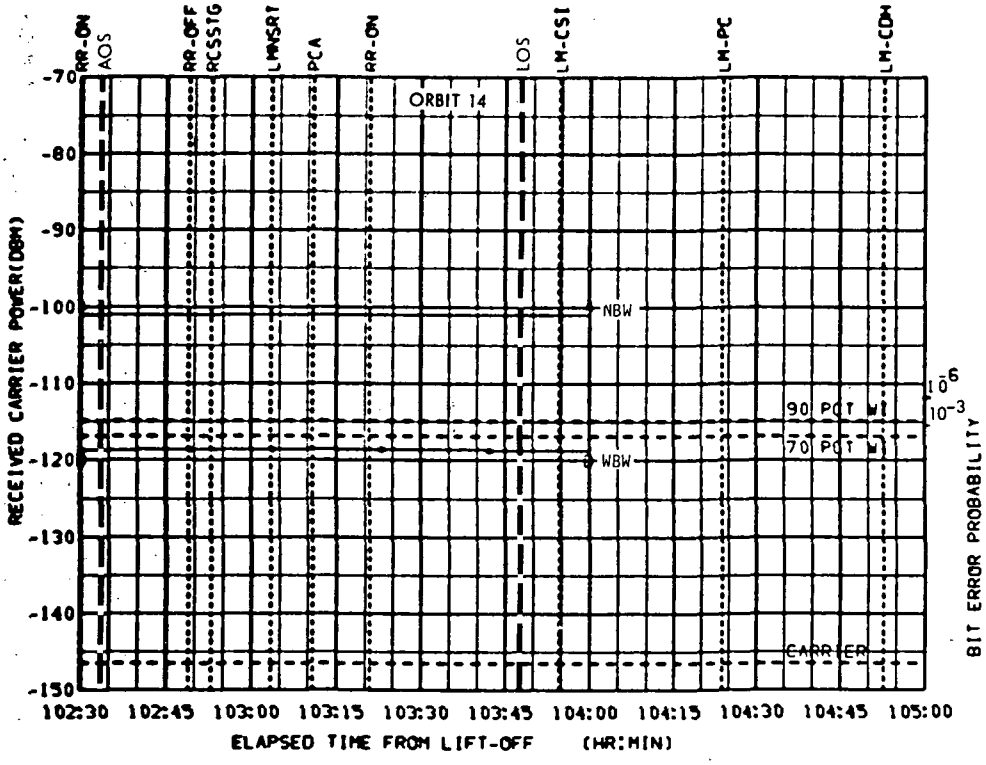


FIGURE 9-34f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

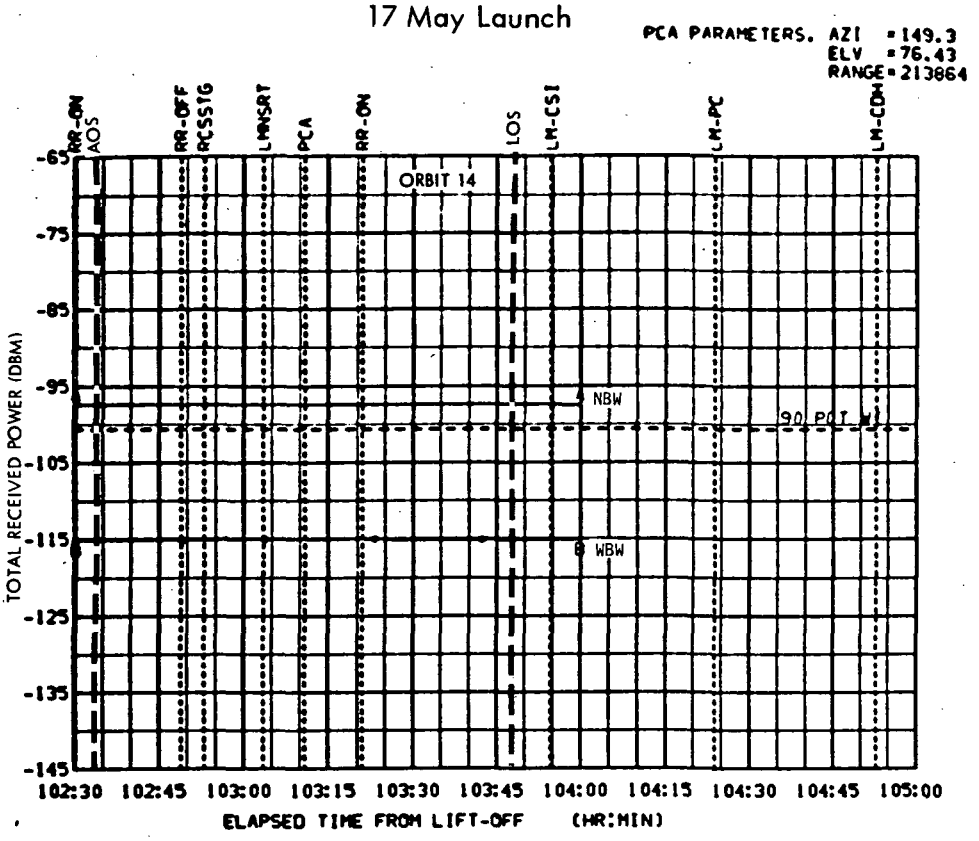


FIGURE 9-34g. GDS DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

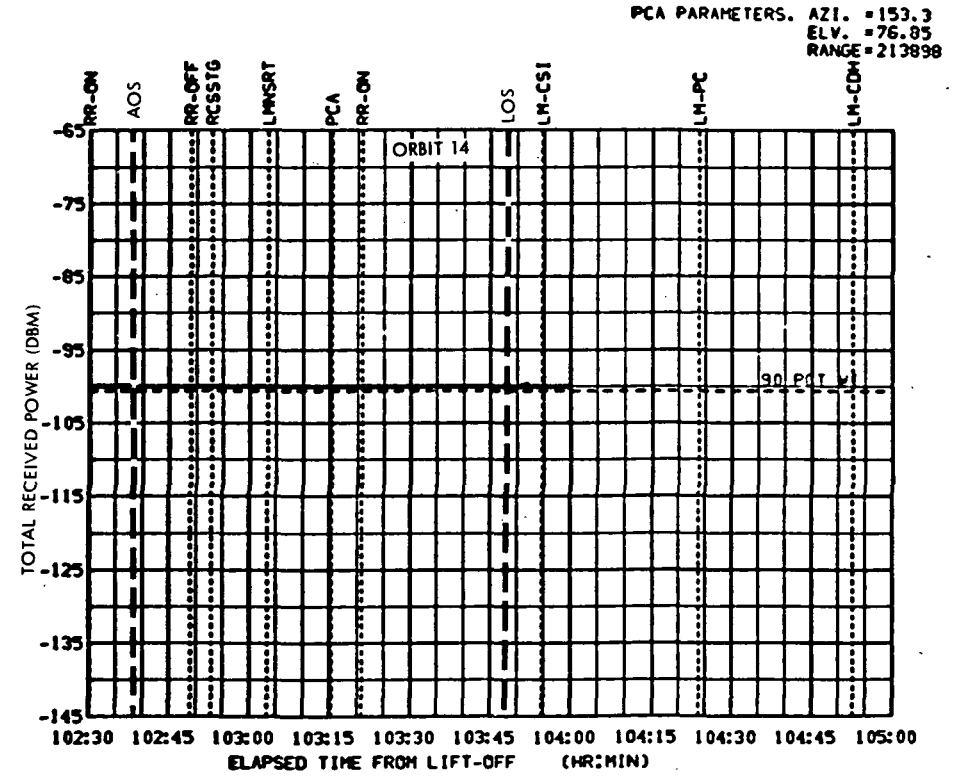


FIGURE 9-34h. GDS DNLINK FM MODES LM/MSFN S-BAND STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

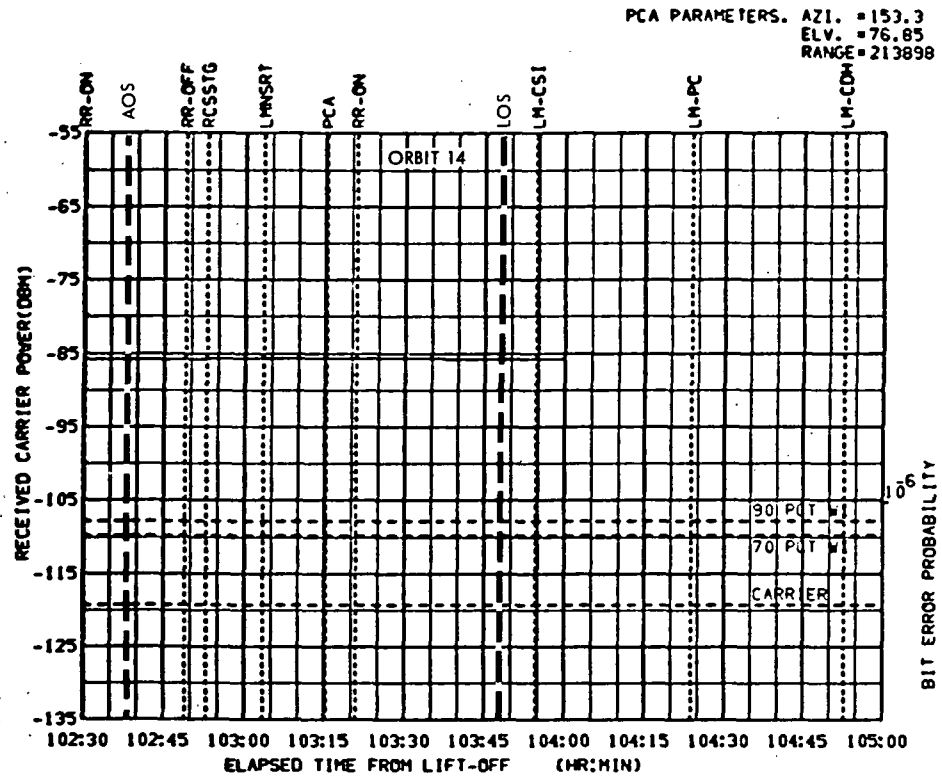


FIGURE 9-34i. GDS UPLINK MODE 6. MSFN/LM. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

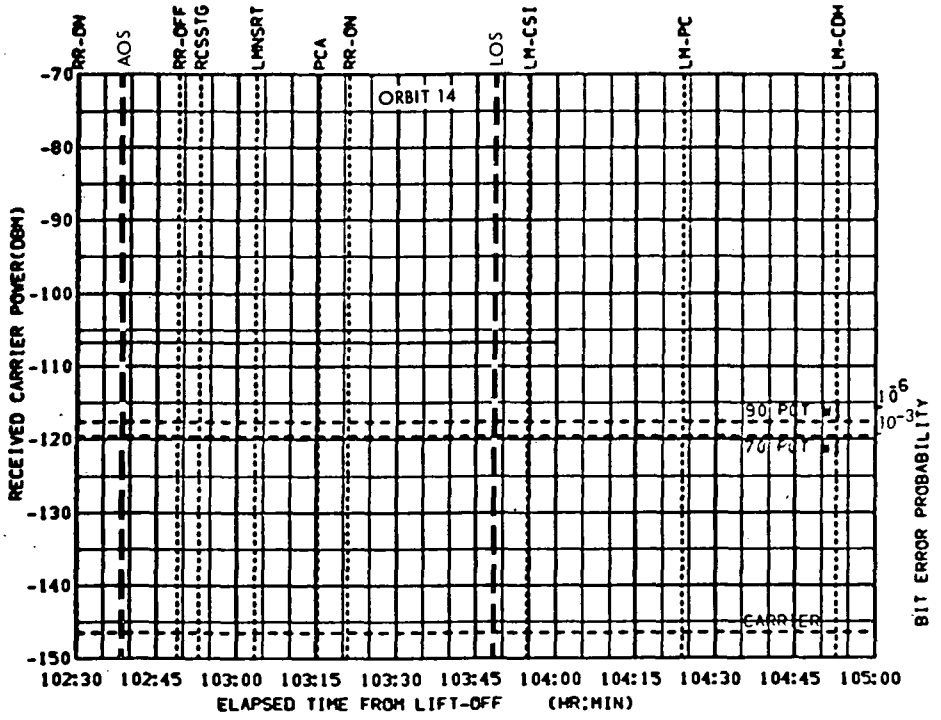


FIGURE 9-34j. GDS DNLINK MODE 2. LM/MSFN. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

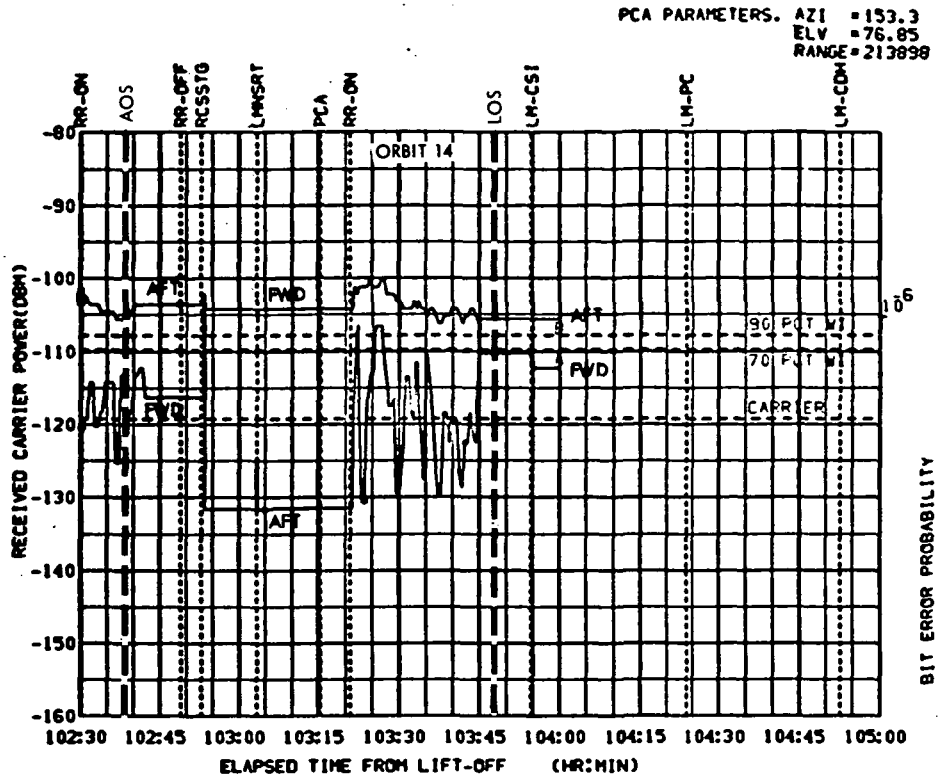


FIGURE 9-34k. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT
LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

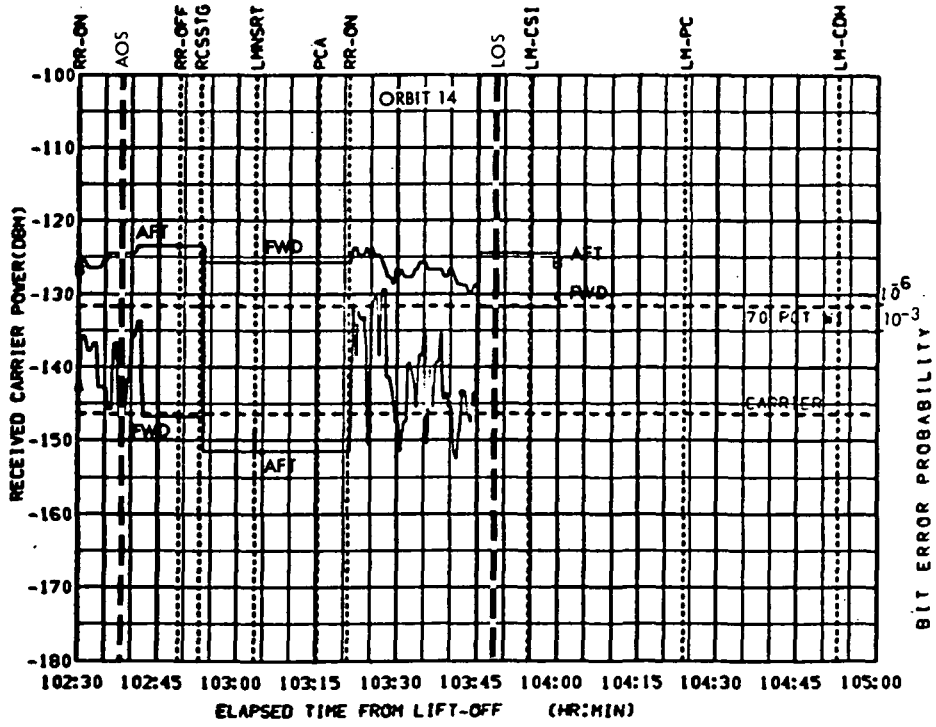


FIGURE 9-34l. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT
LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

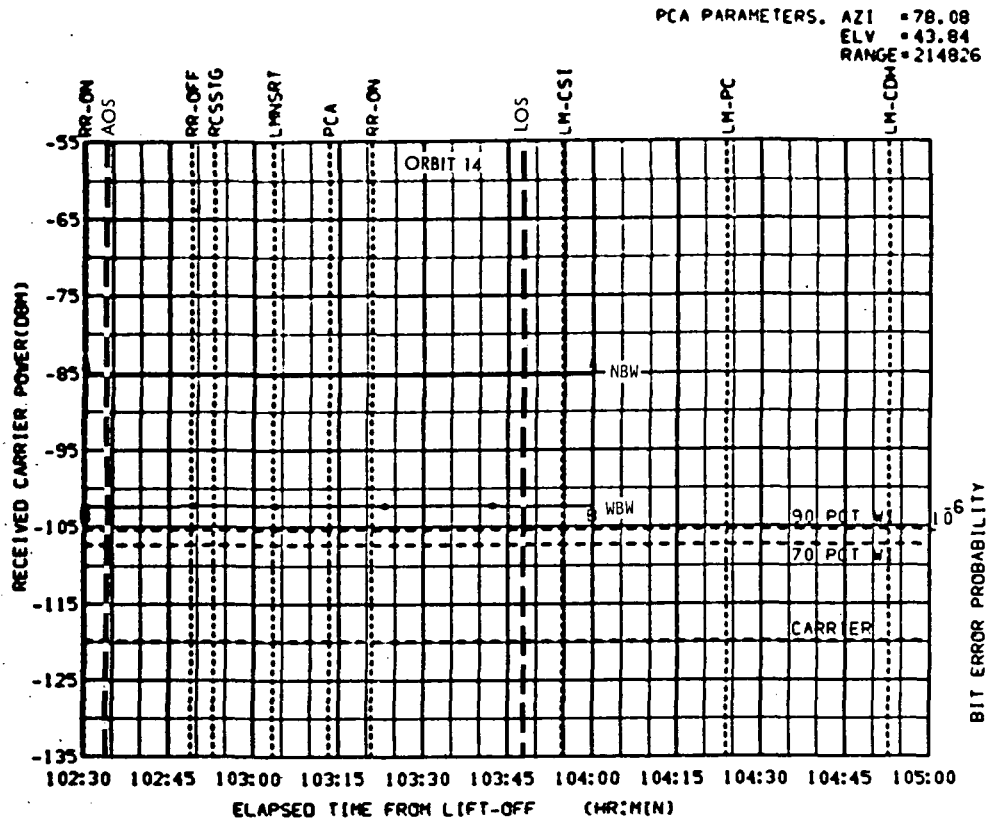


FIGURE 9-35a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

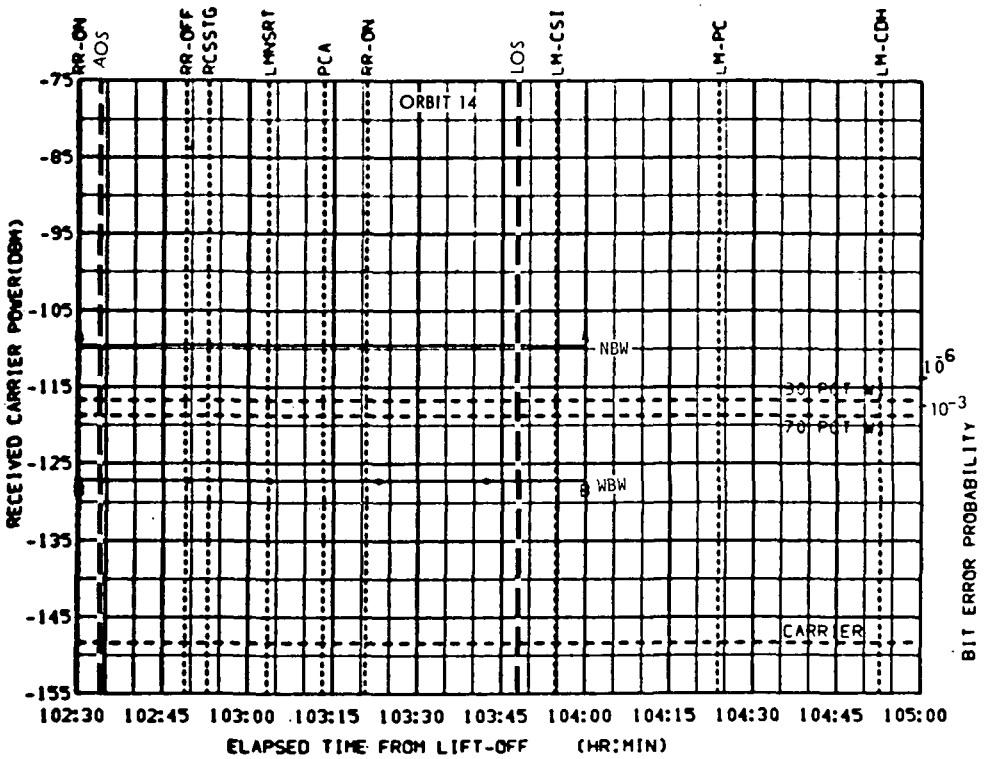


FIGURE 9-35b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

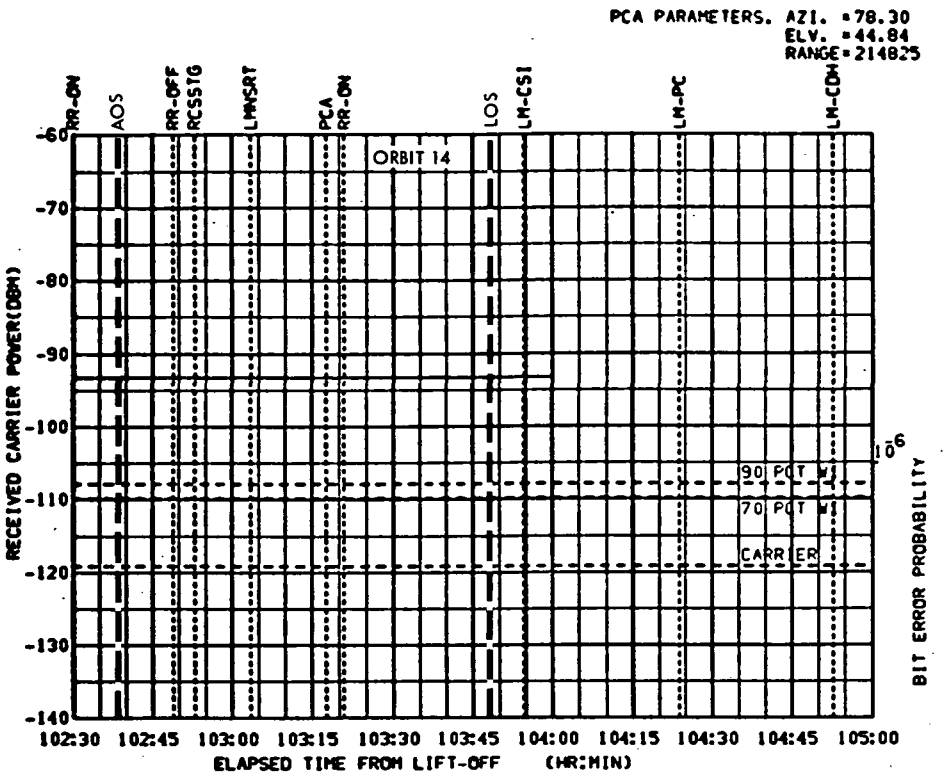


FIGURE 9-35c. MAW UPLINK MODE 6. MSFN/LM. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

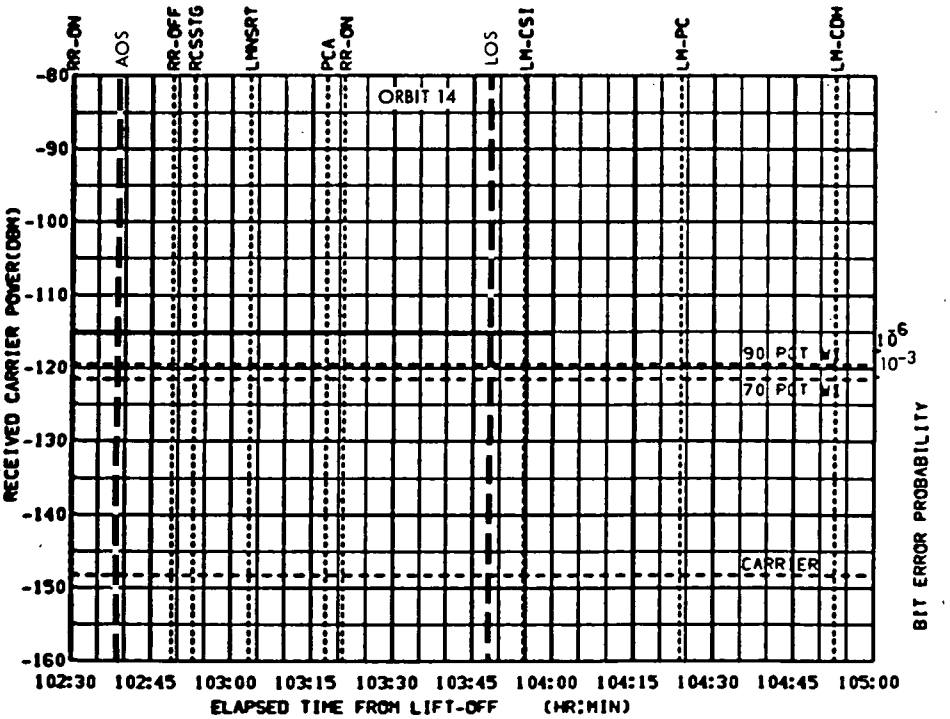


FIGURE 9-35d. MAW DNLINK MODE 2. LM/MSFN. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

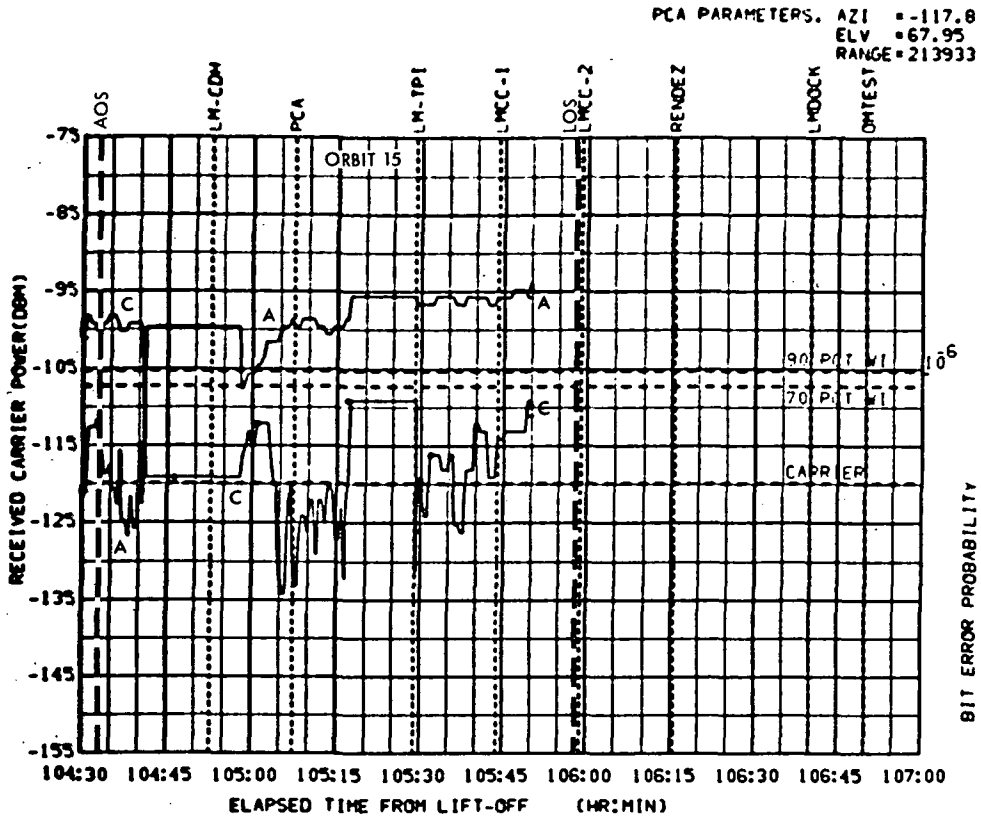


FIGURE 9-36a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

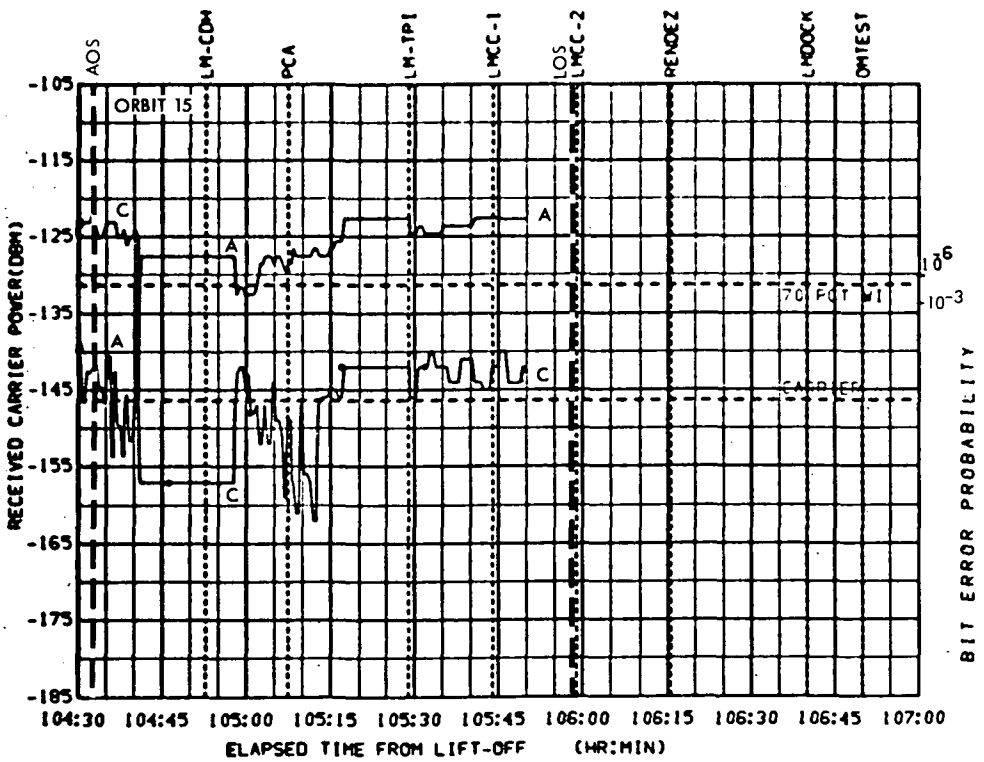


FIGURE 9-36b. GDS ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

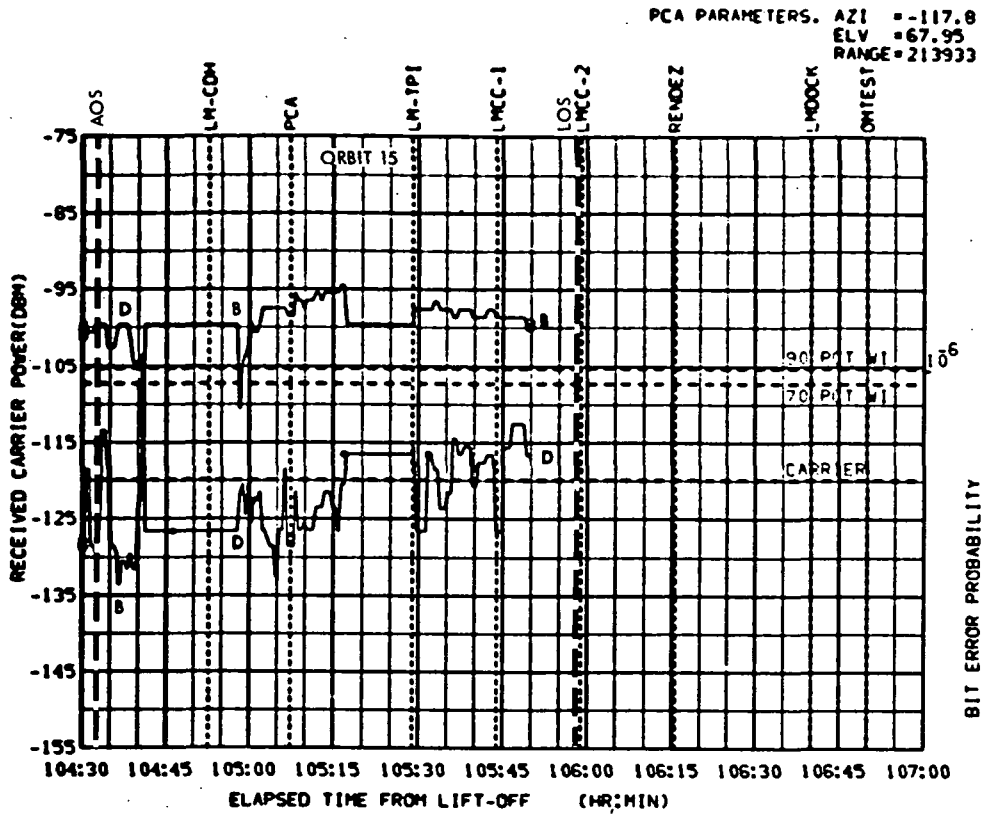


FIGURE 9-36c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

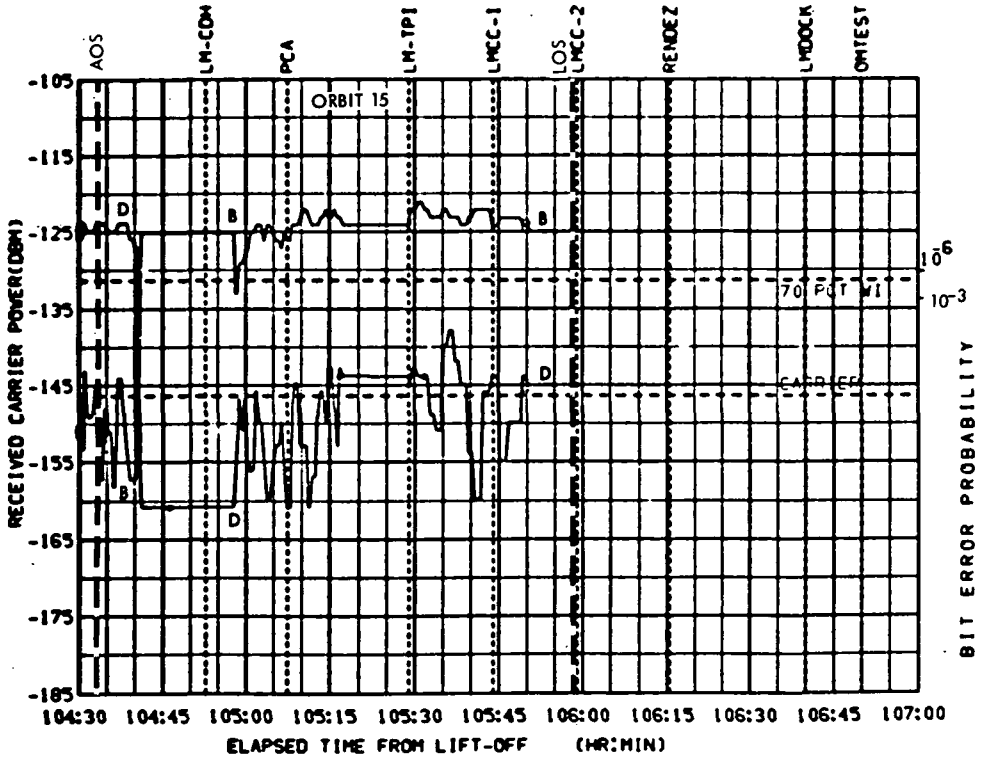


FIGURE 9-36d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

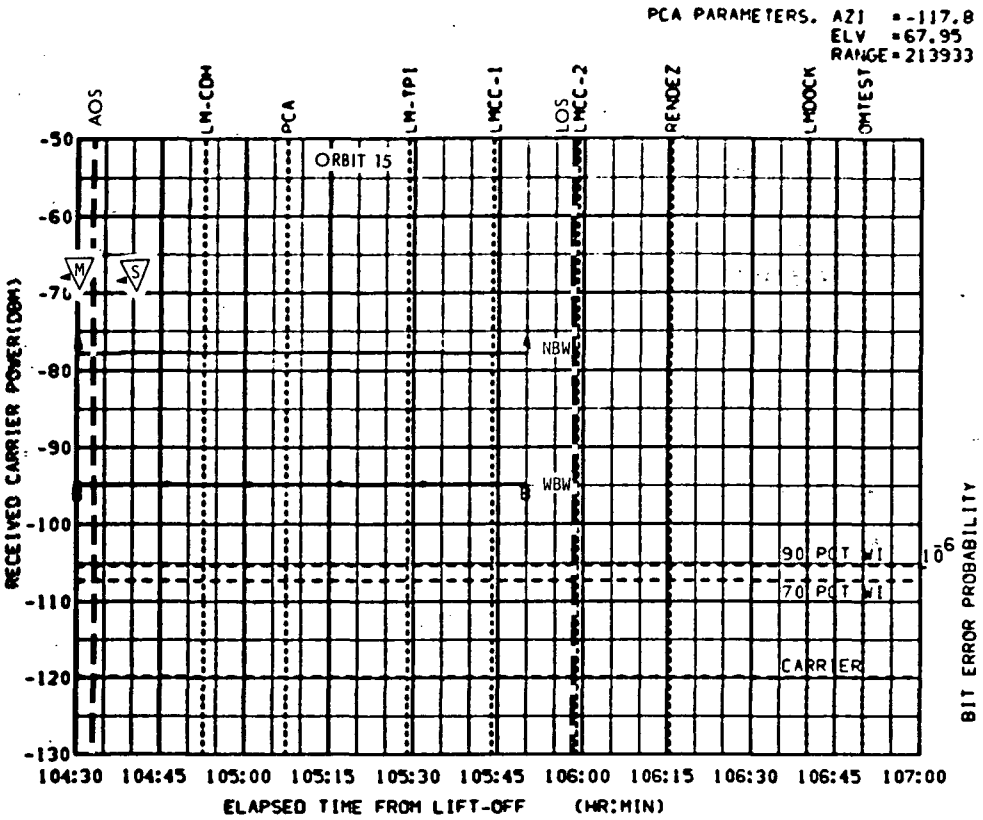


FIGURE 9-36e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

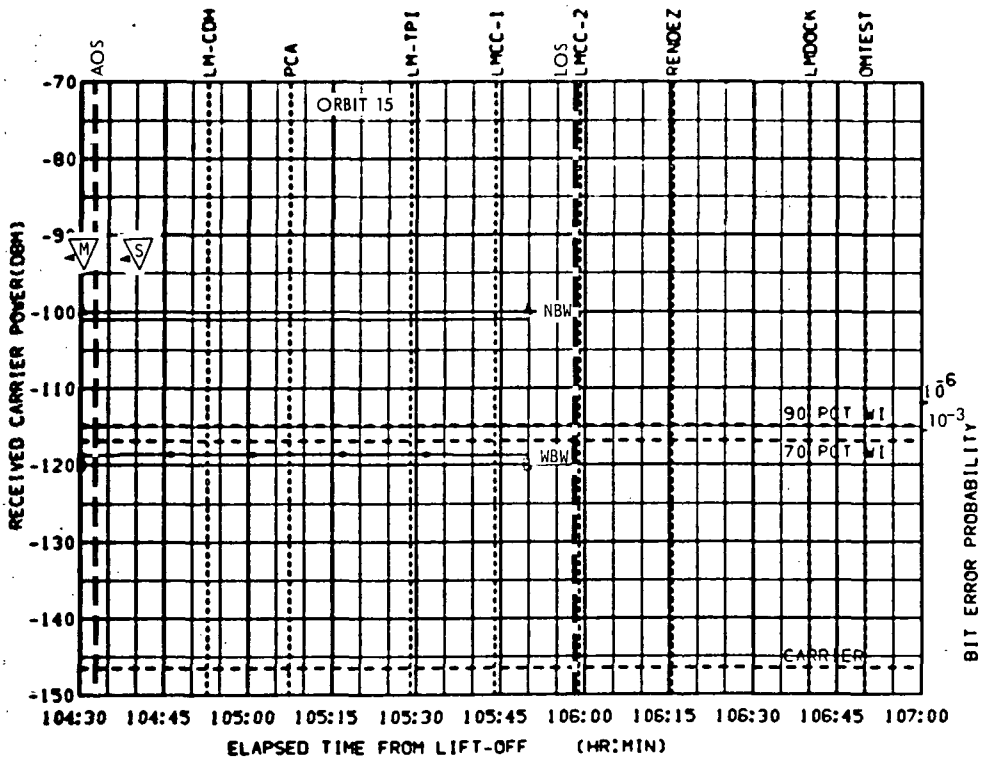


FIGURE 9-36f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

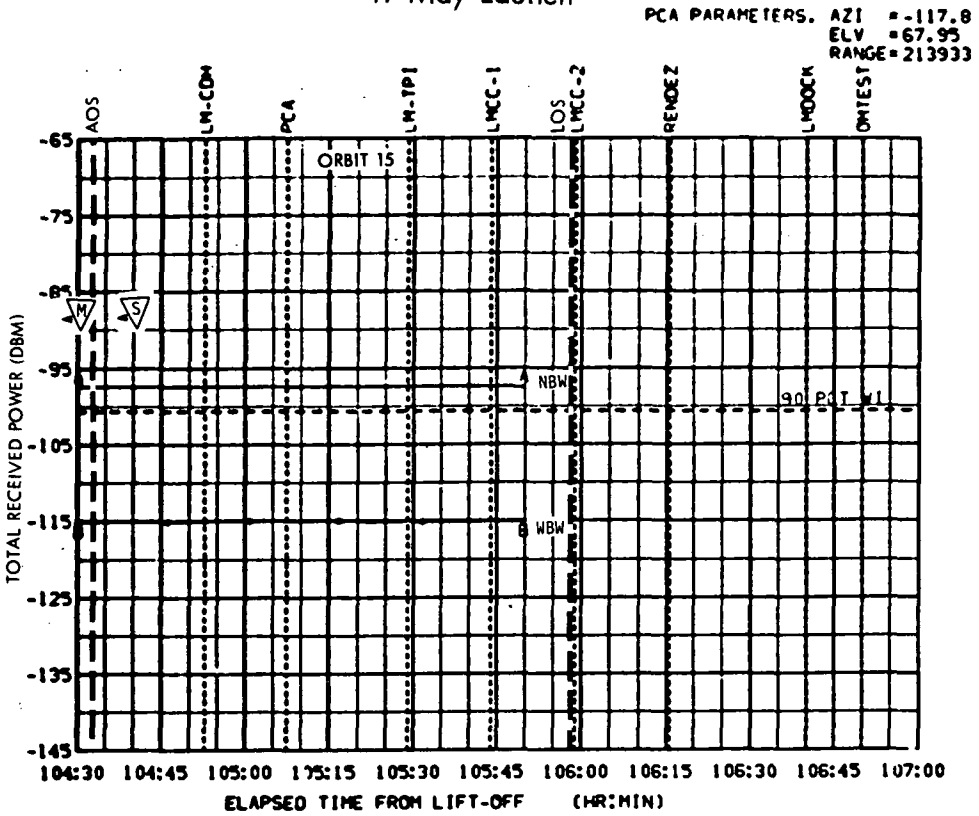


FIGURE 9-36g. 6DS DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

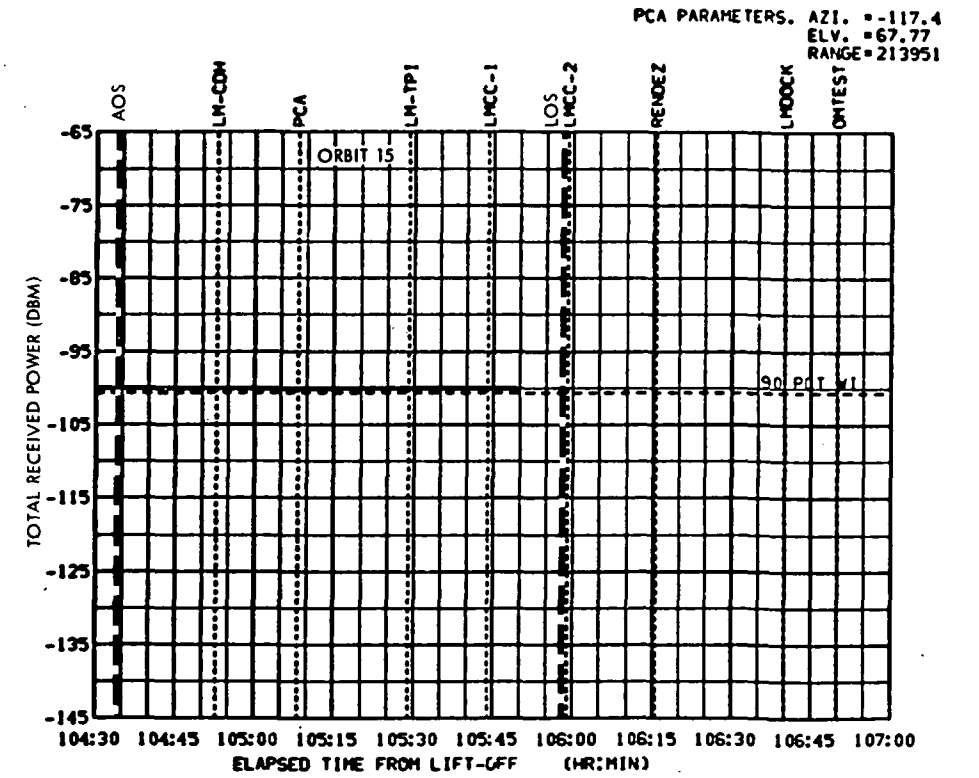


FIGURE 9-36h. 6DS DNLINK FM MODES LM/MSFN S-BAND STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

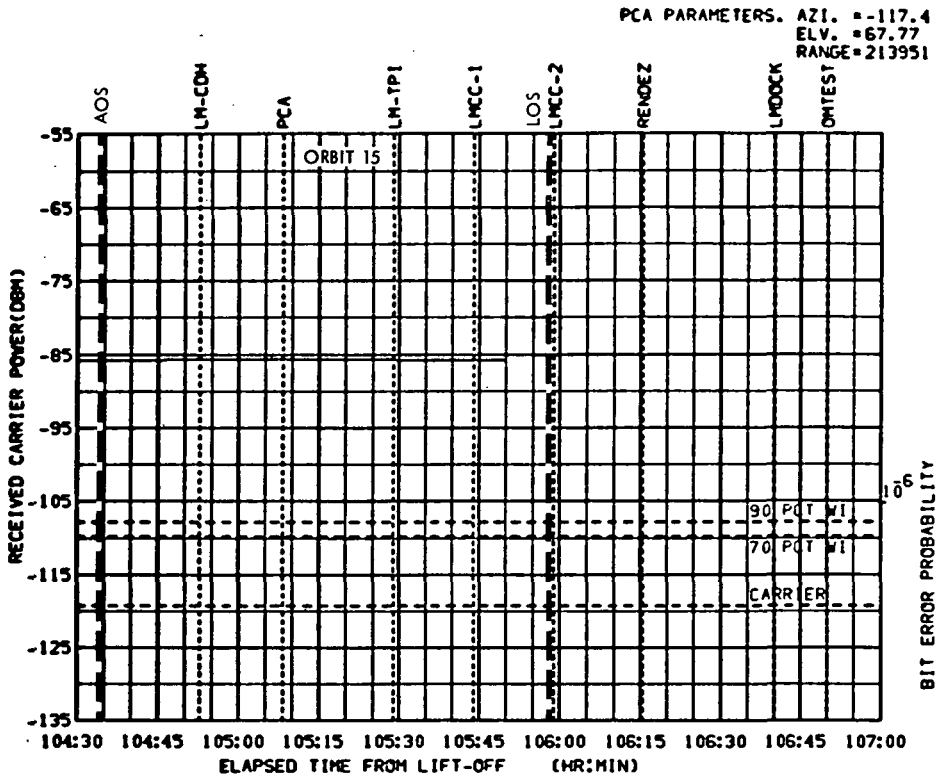


FIGURE 9-36i. GDS UPLINK MODE 6. MSFN/LM. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

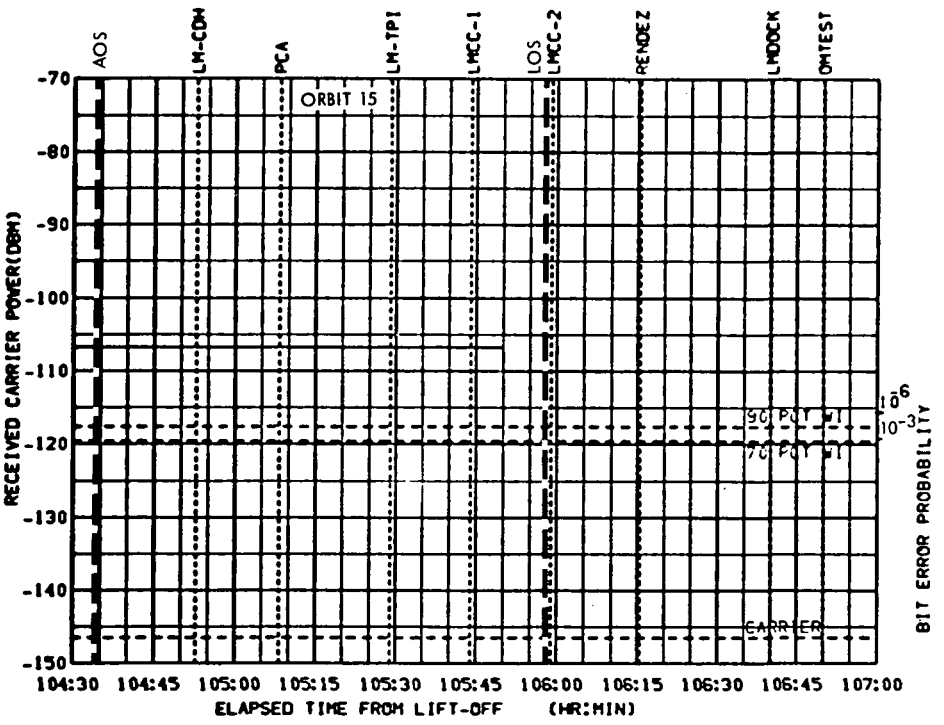


FIGURE 9-36j. GDS DNLINK MODE 2. LM/MSFN. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

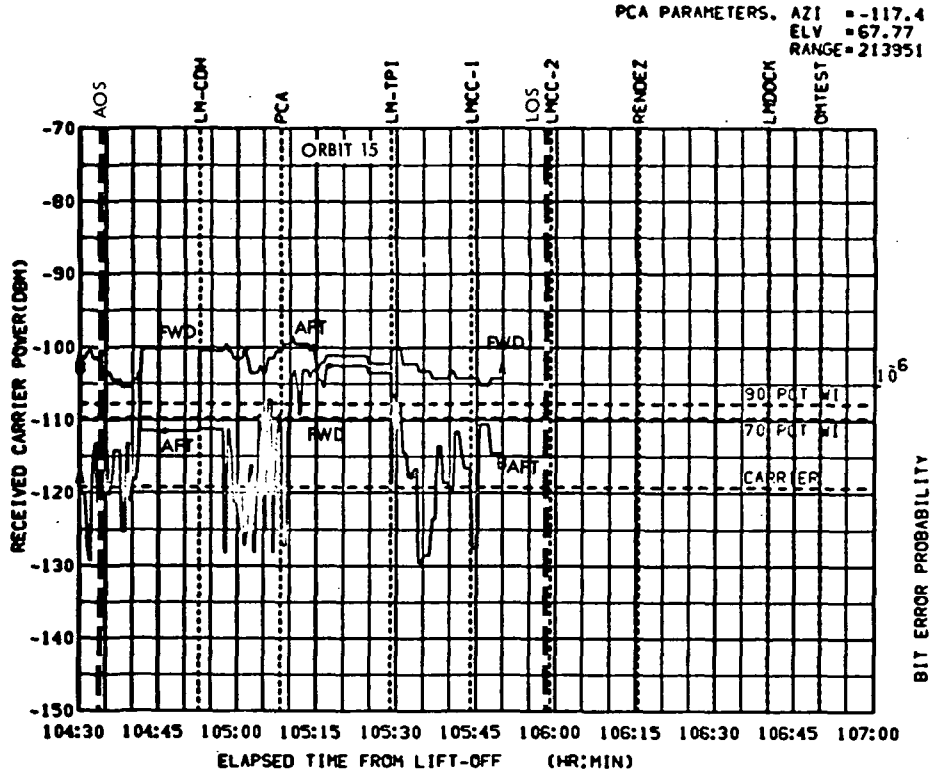


FIGURE 9-36k. GDS UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT
LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

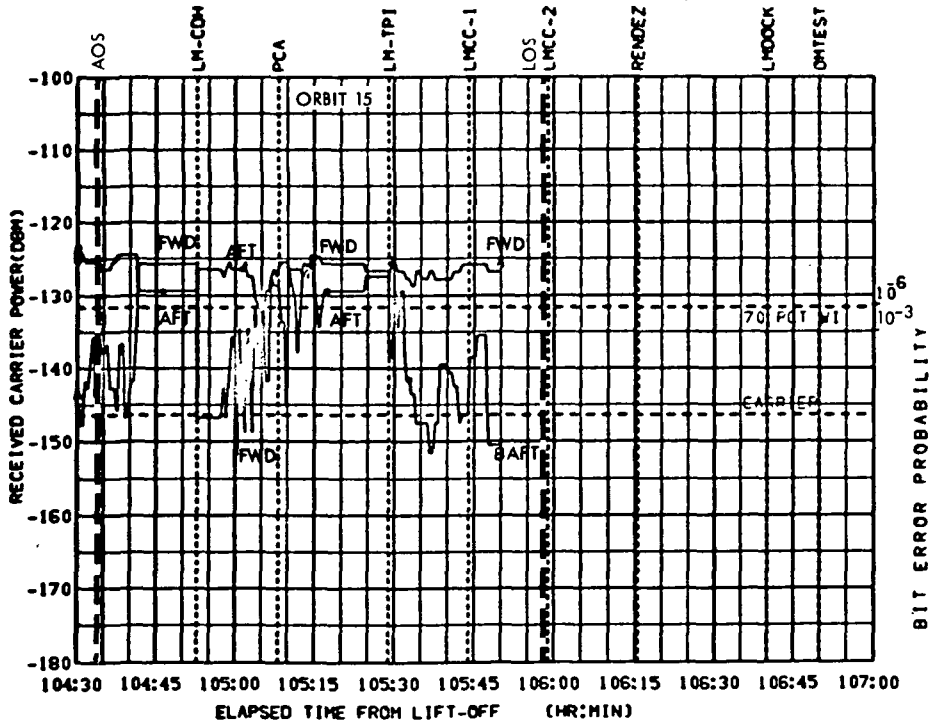


FIGURE 9-36l. GDS DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT
LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

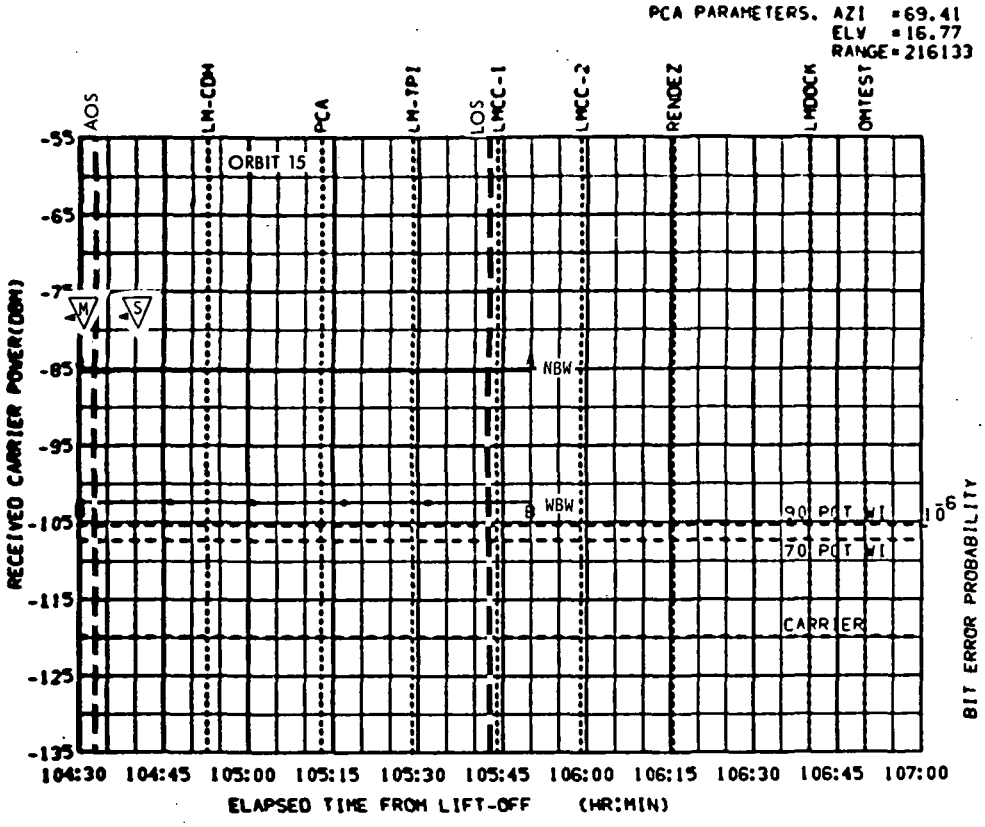


FIGURE 9-37a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

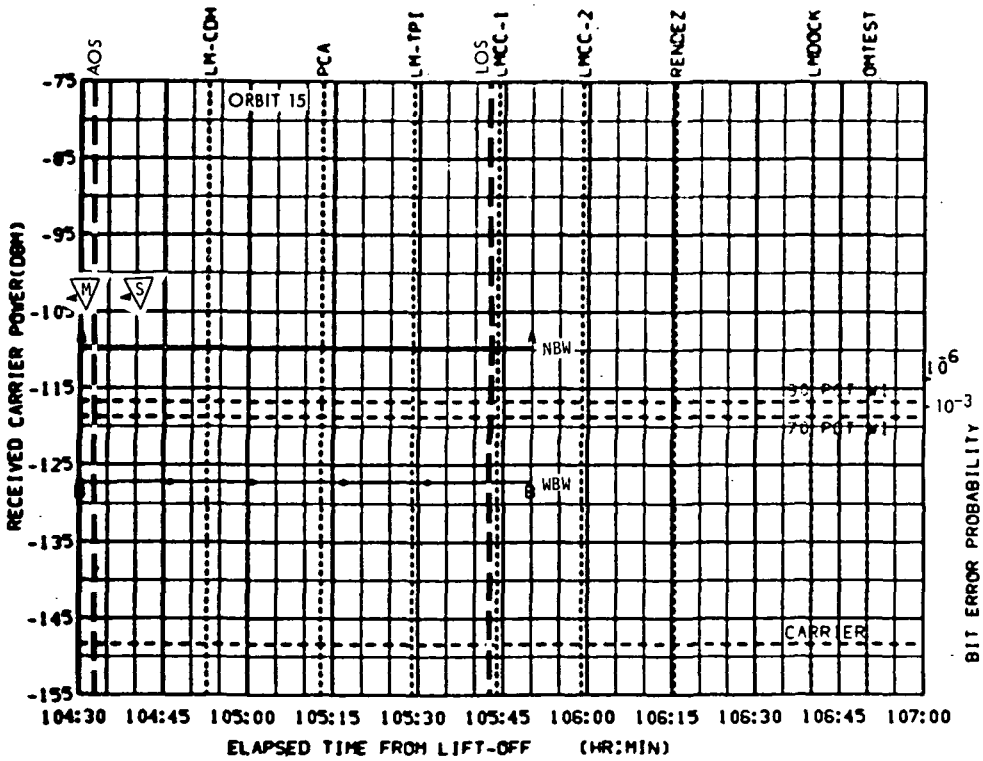


FIGURE 9-37b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

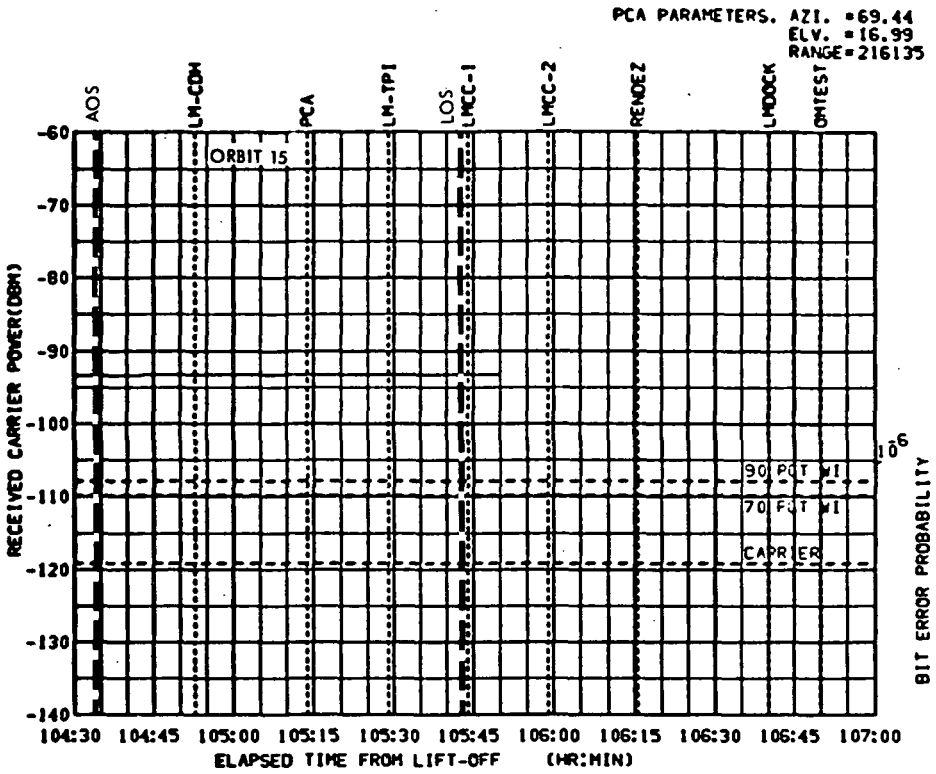


FIGURE 9-37c. GVM UPLINK MODE 6. MSFN/LM. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

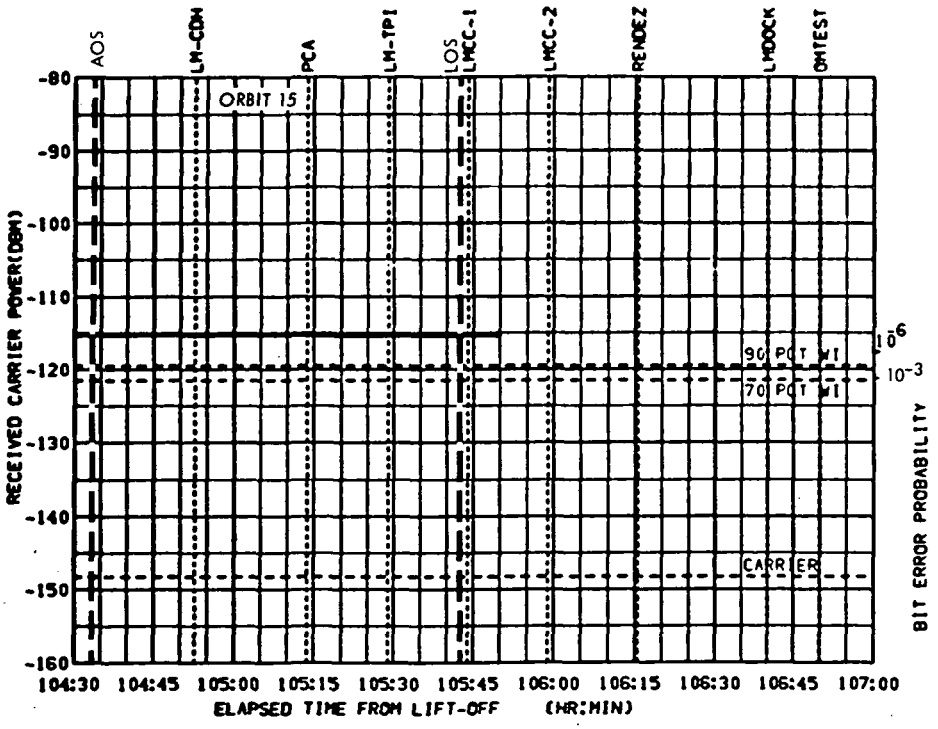


FIGURE 9-37d. GVM DNLINK MODE 2. LM/MSFN. S-BAND. STEER
LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

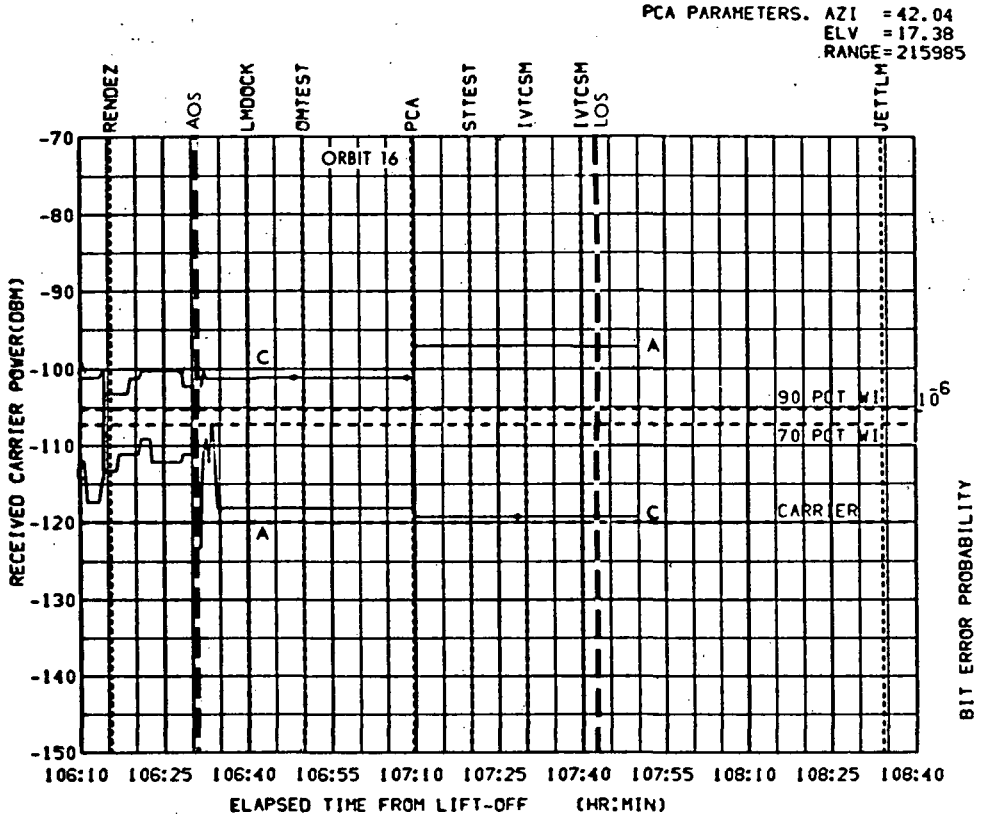


FIGURE 9-38a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

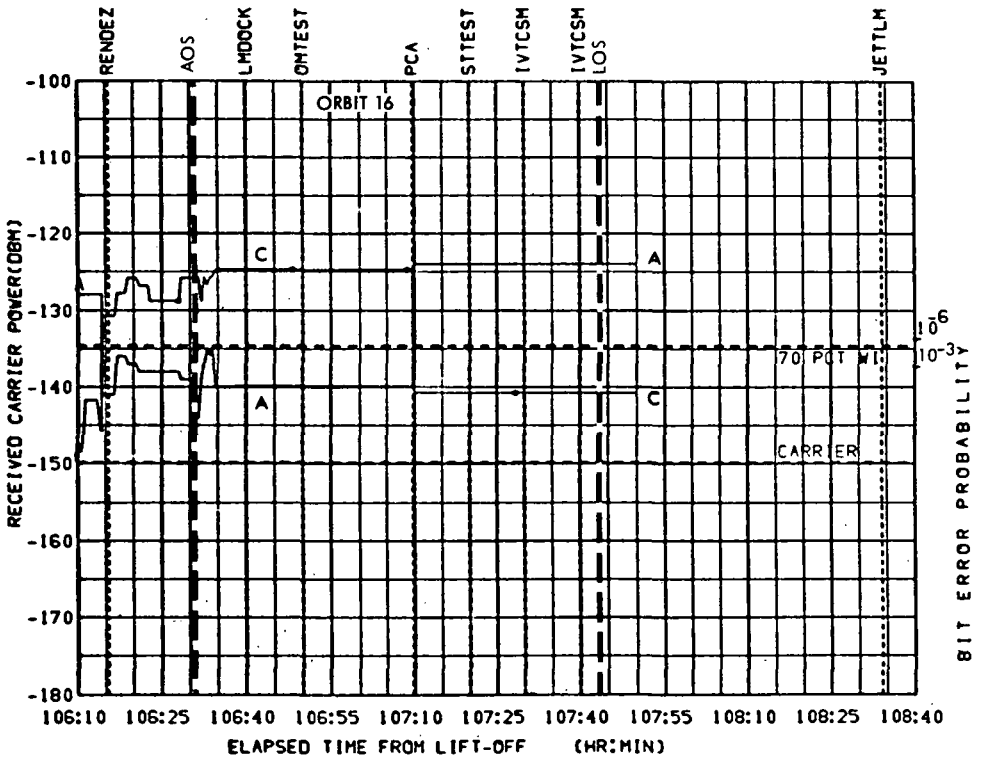


FIGURE 9-38b. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

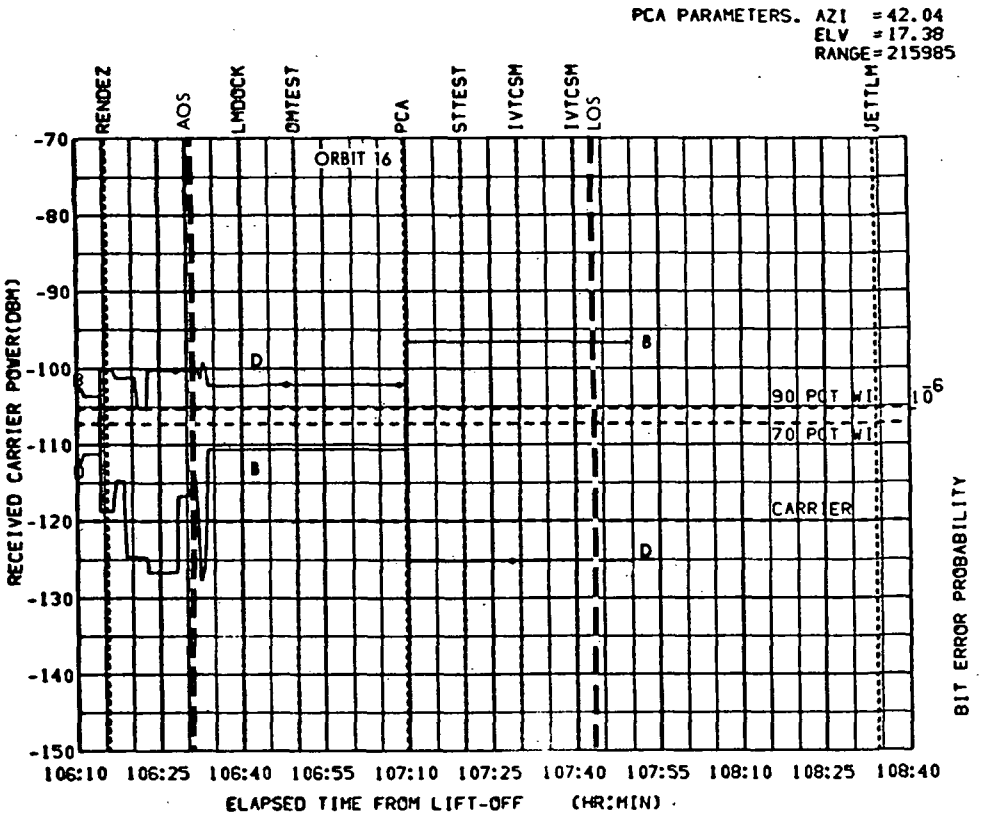


FIGURE 9-38c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

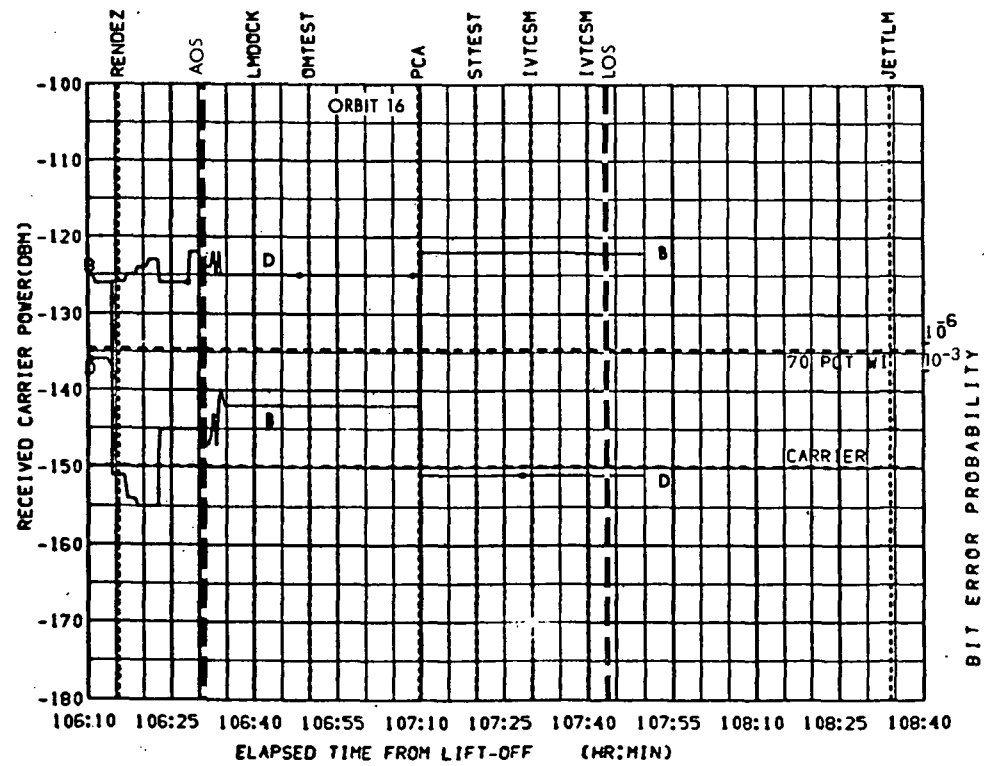


FIGURE 9-38d. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

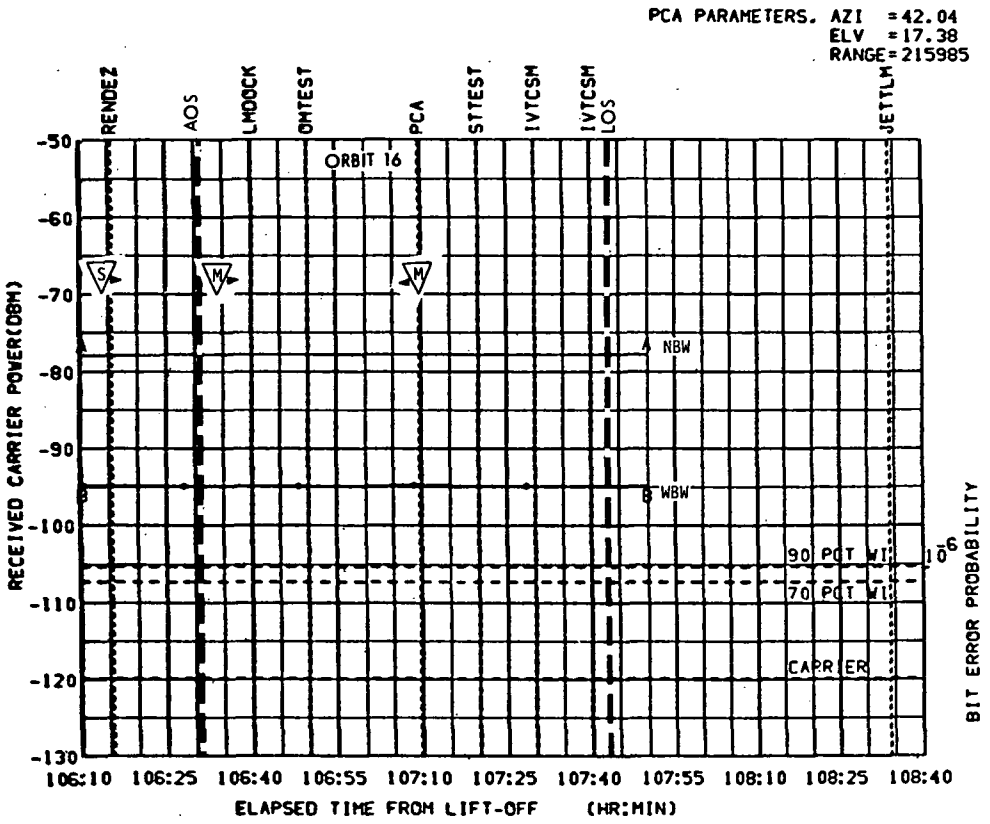


FIGURE 9-38e. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

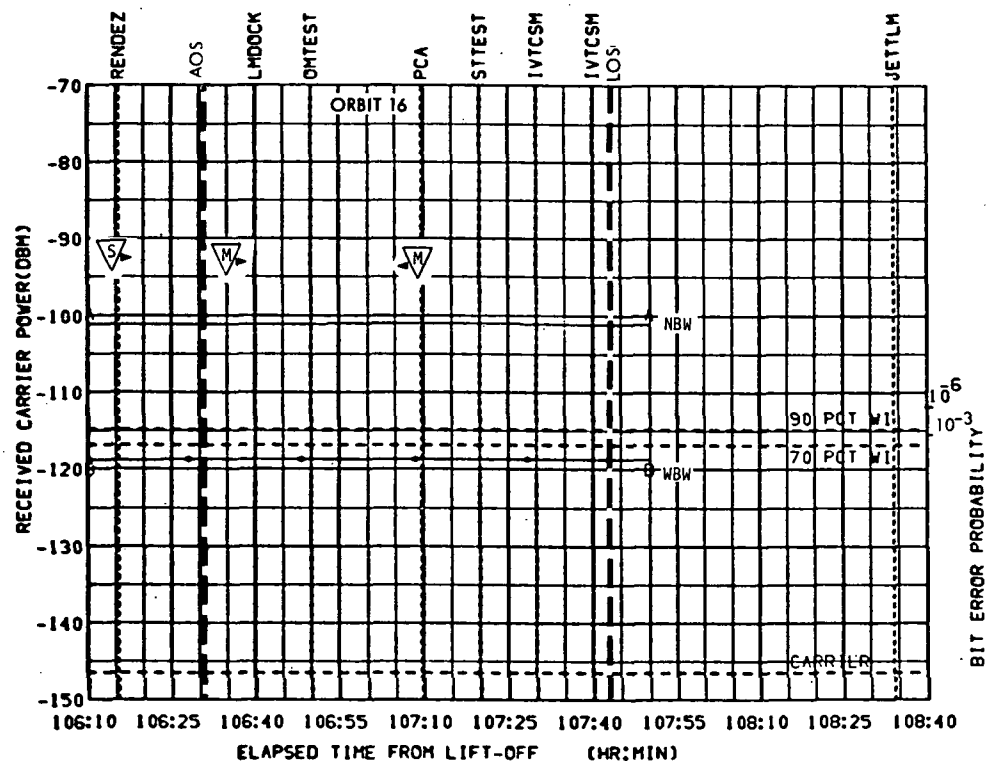


FIGURE 9-38f. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

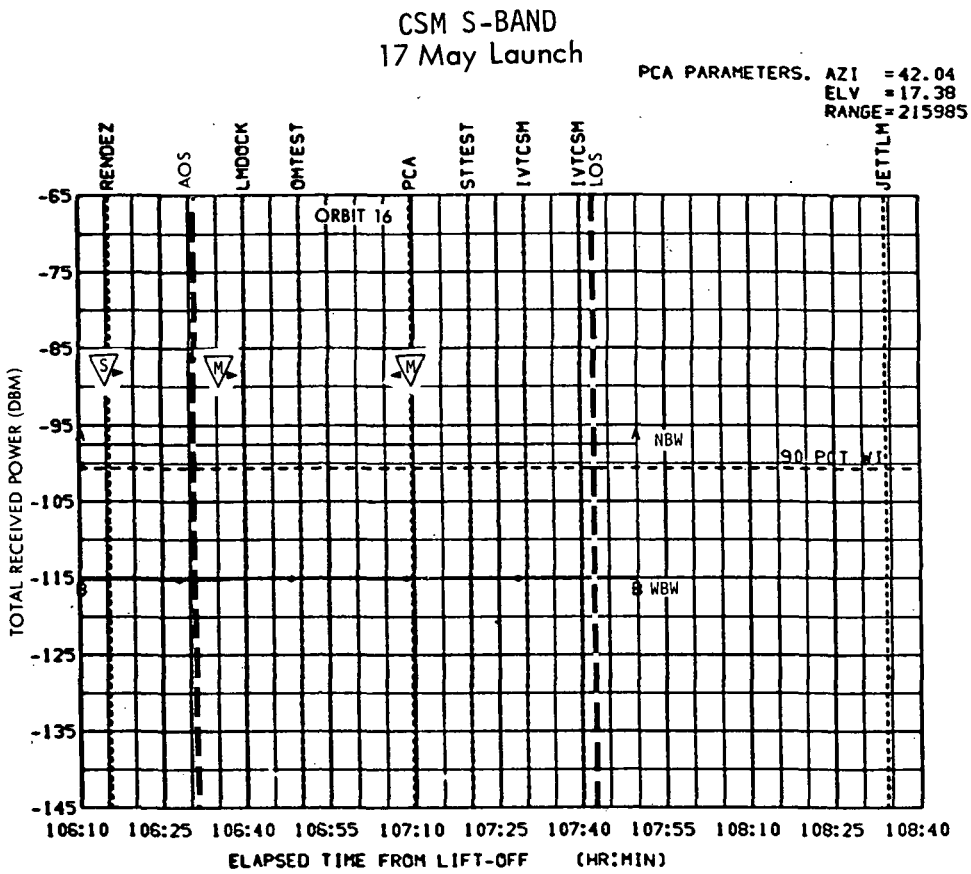


FIGURE 9-38g. MSK DNLINK FM MODES CSM/MSFN S-BAND HGA
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

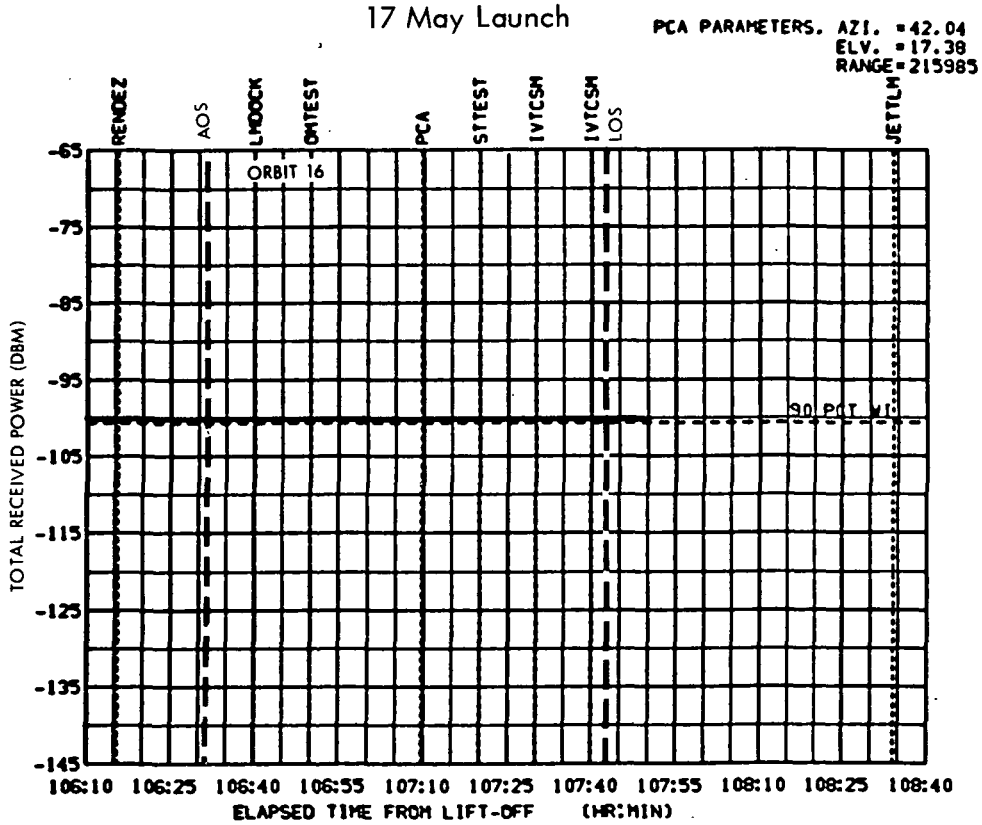


FIGURE 9-38h. MSK DNLINK FM MODES LM/MSFN S-BAND STEER
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

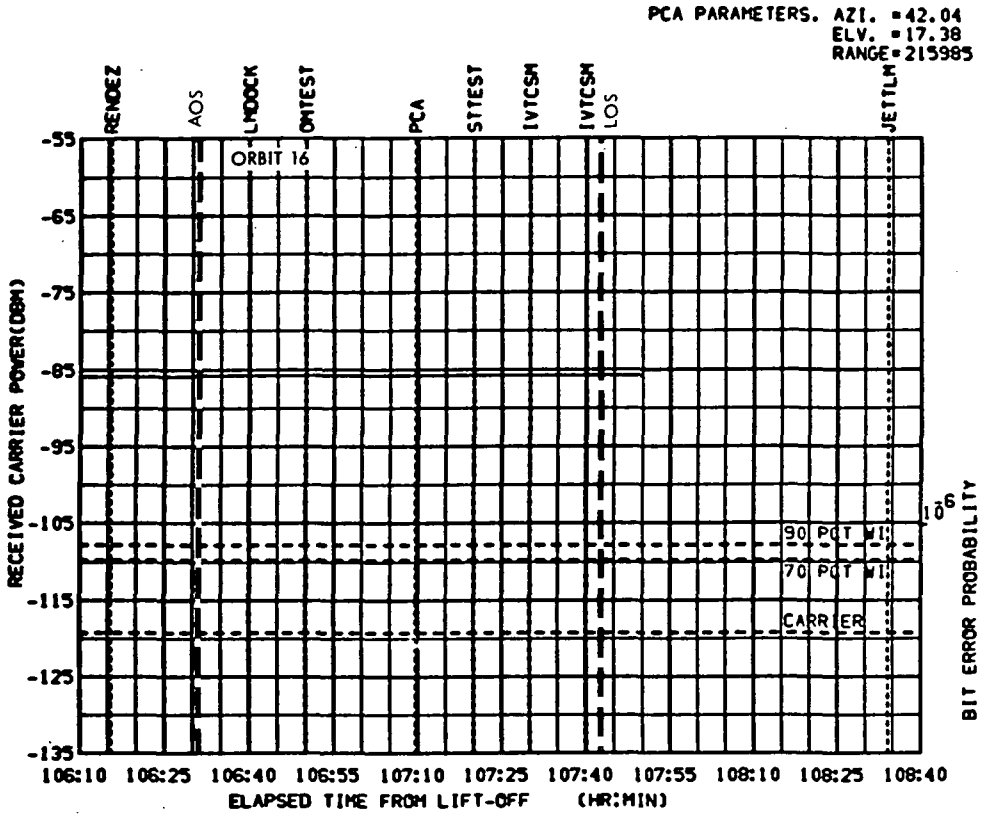


FIGURE 9-38i. MSK UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

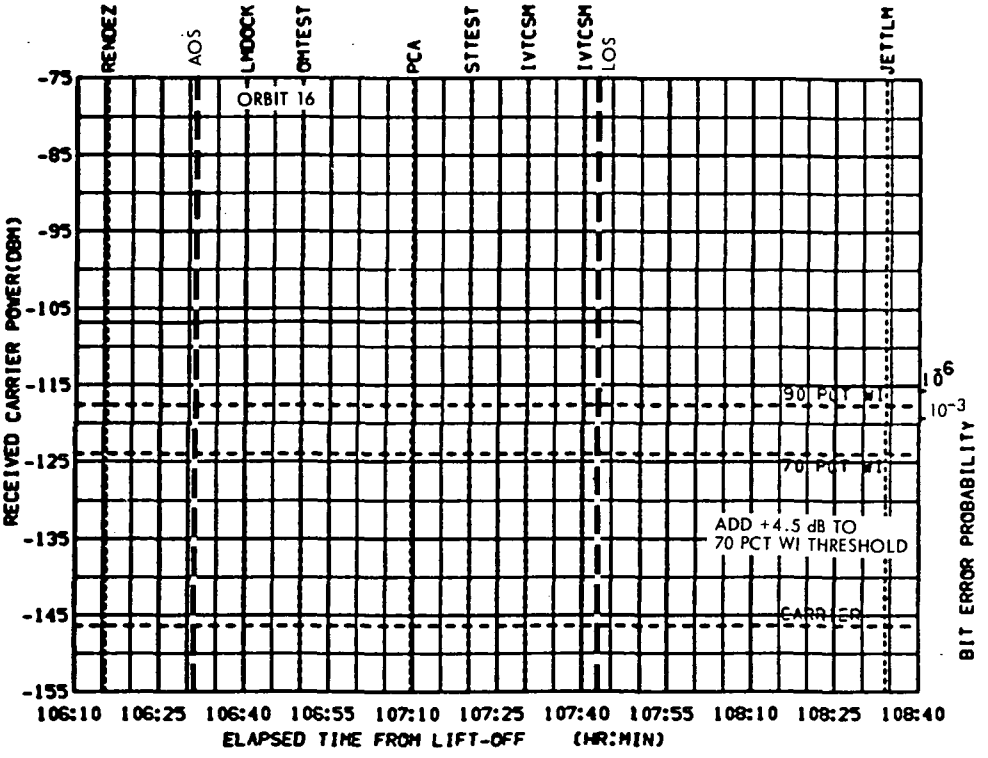


FIGURE 9-38j. MSK DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

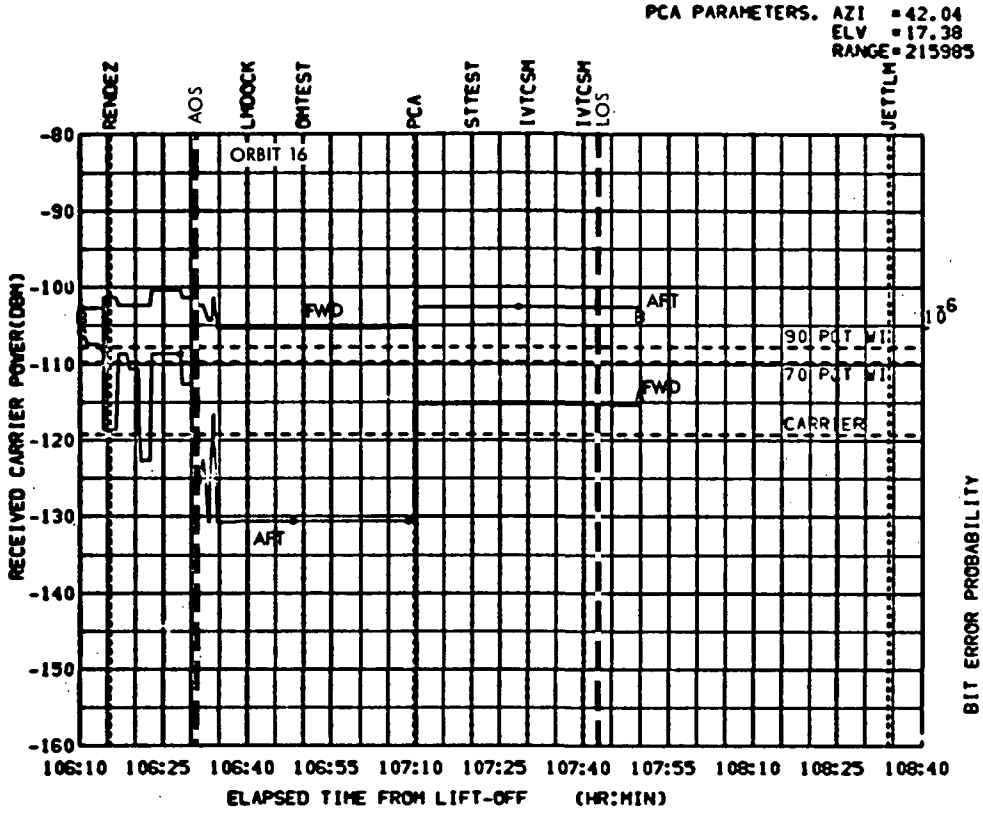


FIGURE 9-38k. MSK UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT CSM/LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

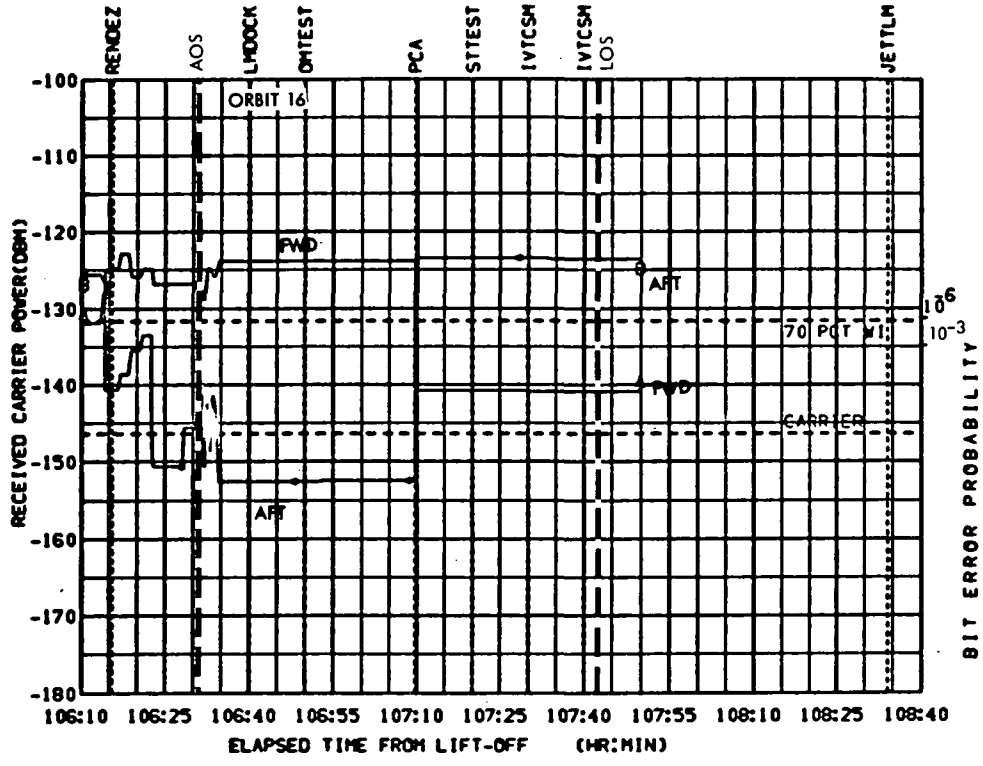


FIGURE 9-38l. MSK DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT CSM/LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

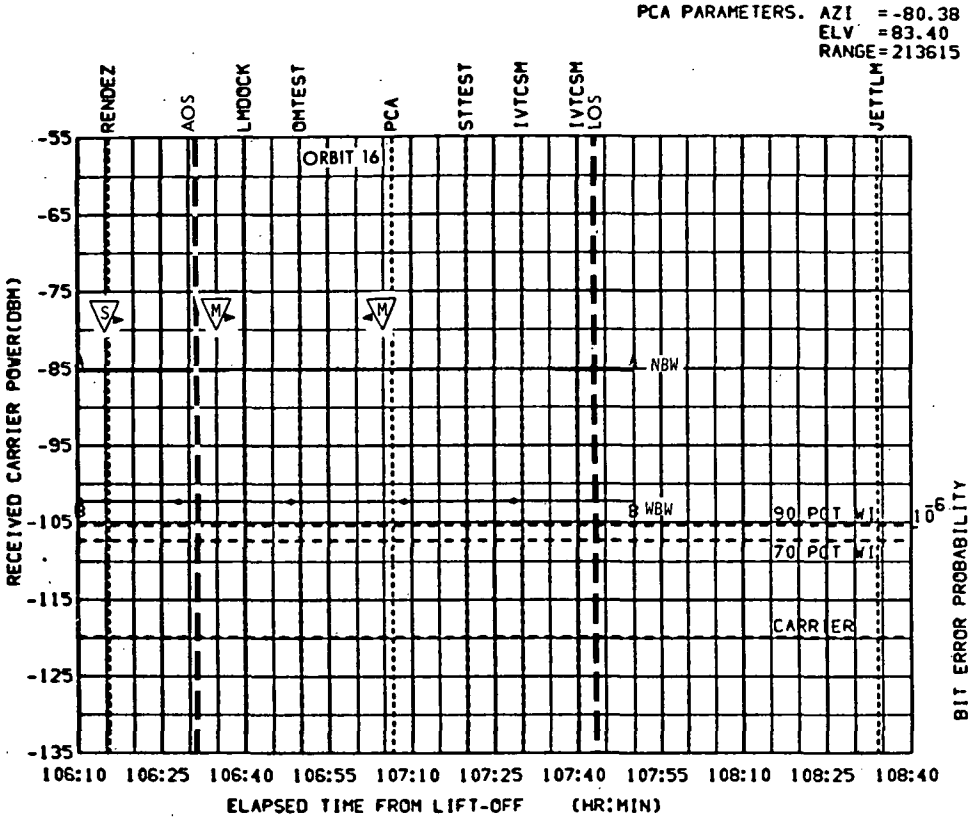


FIGURE 9-39a. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

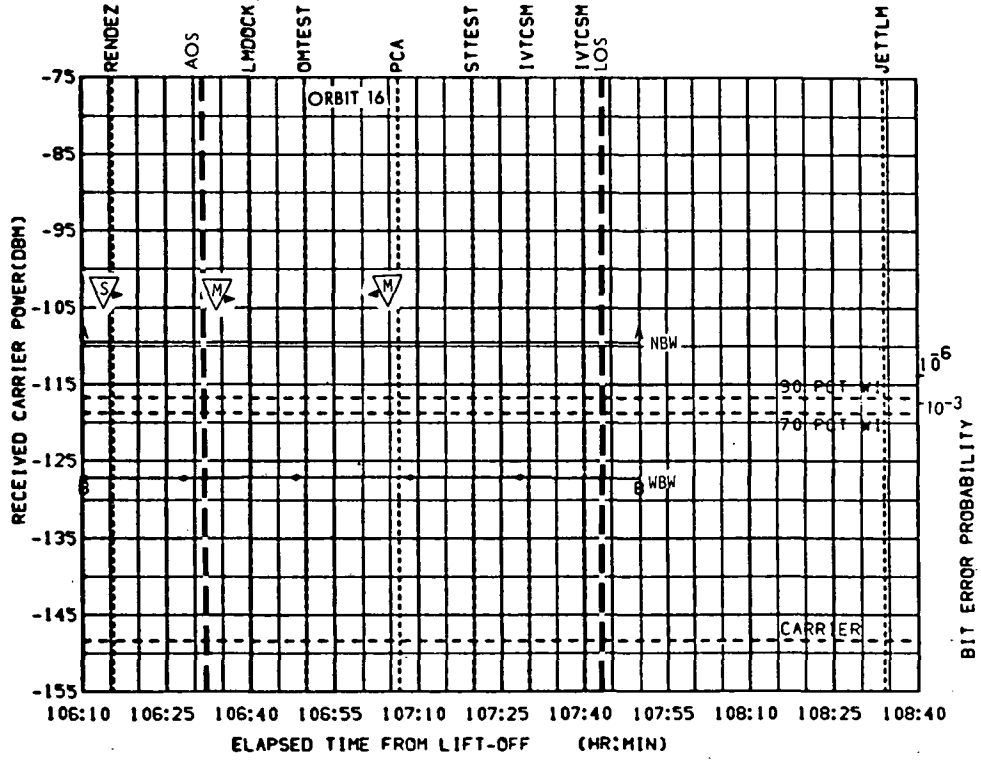


FIGURE 9-39b. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

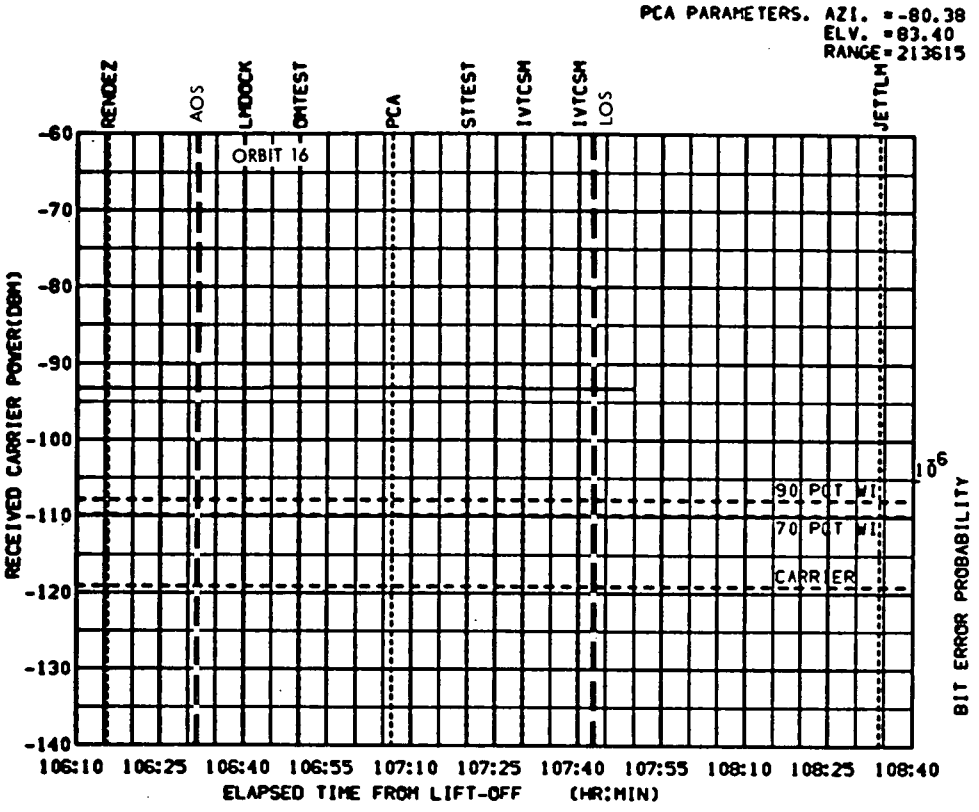


FIGURE 9-39c. MAW UPLINK MODE 6. MSFN/LM. S-BAND. STEER CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

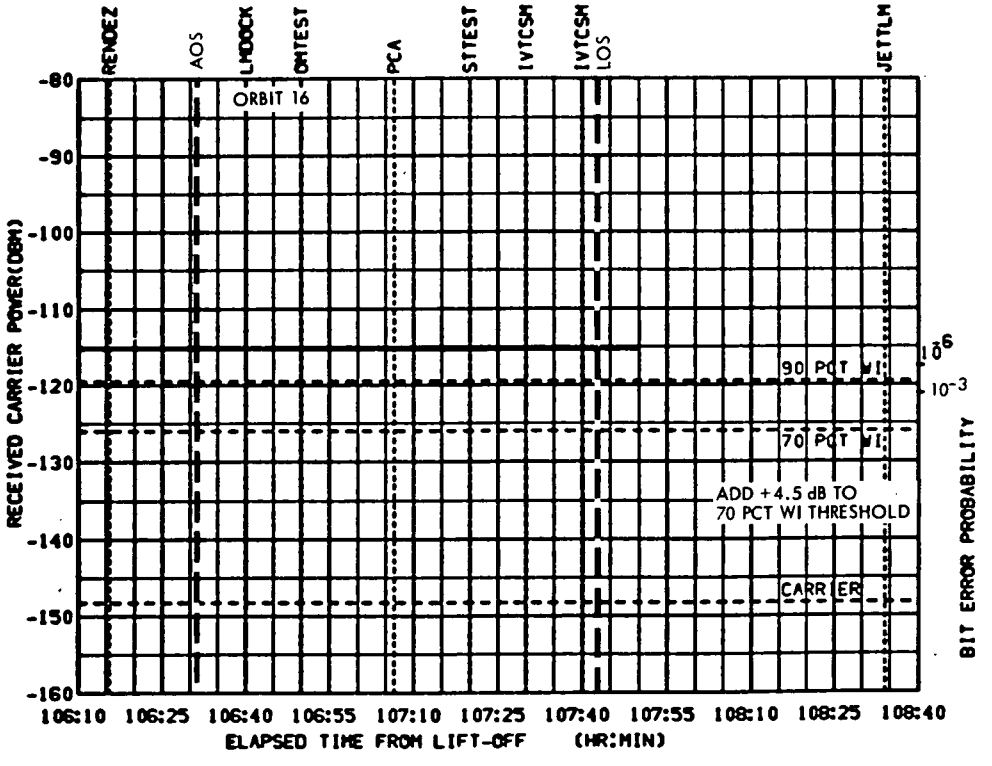


FIGURE 9-39d. MAW DNLINK MODE 2. LM/MSFN. S-BAND. STEER CSM/LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

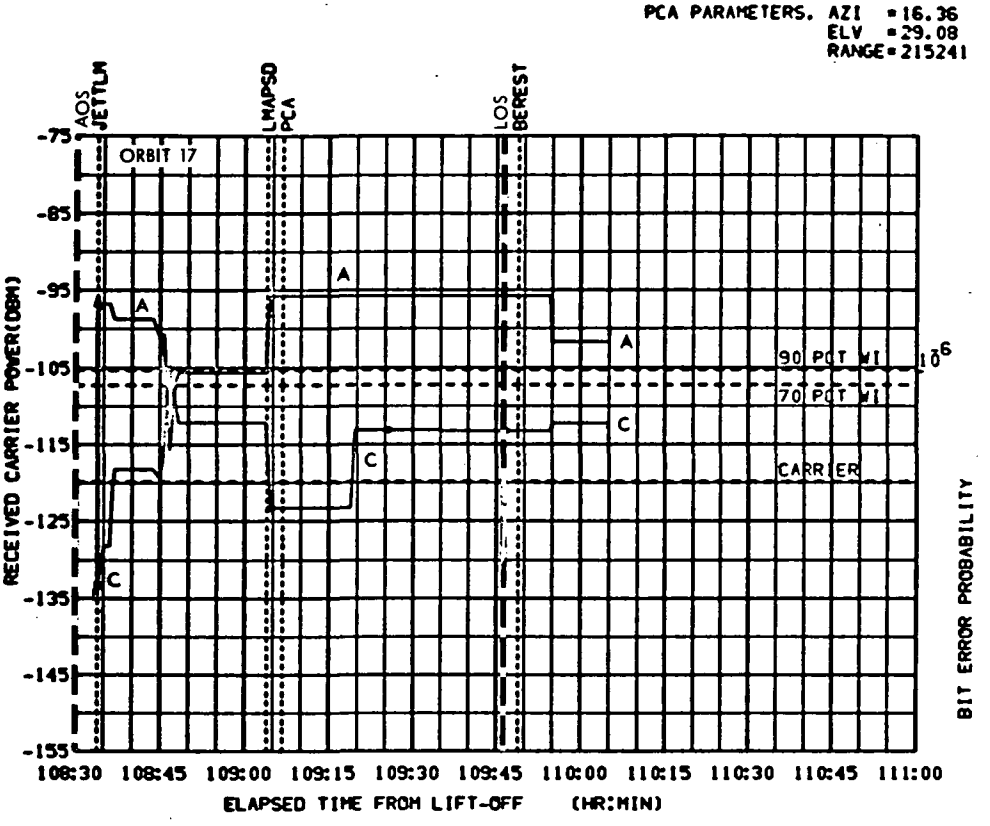


FIGURE 9-40a. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

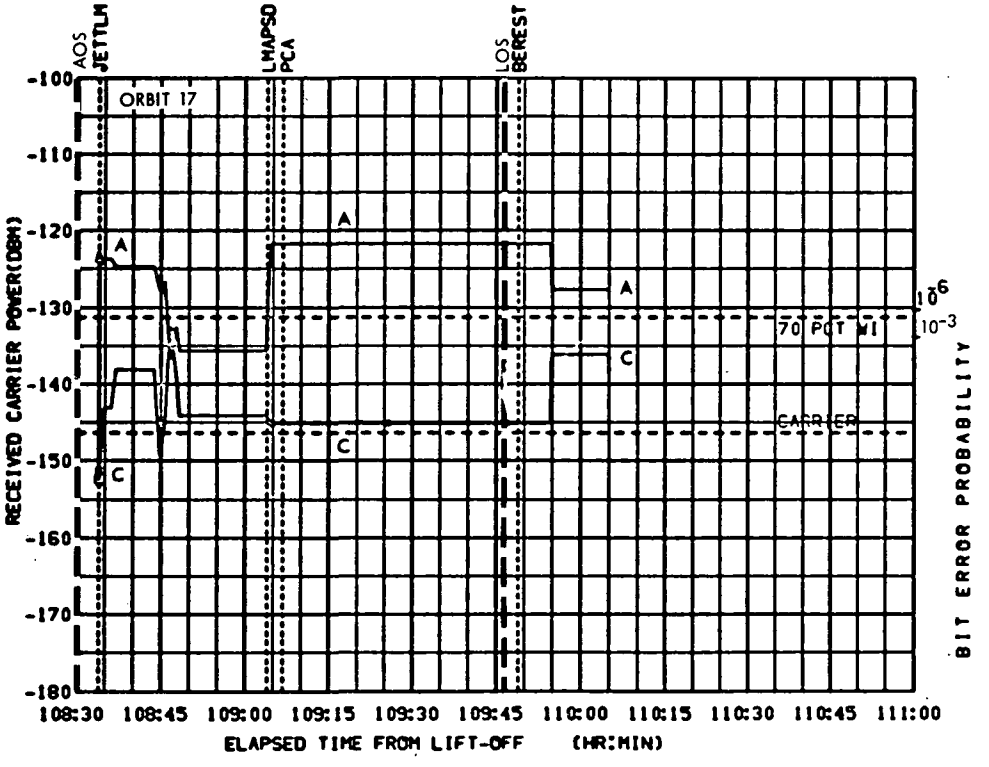


FIGURE 9-40b. HSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

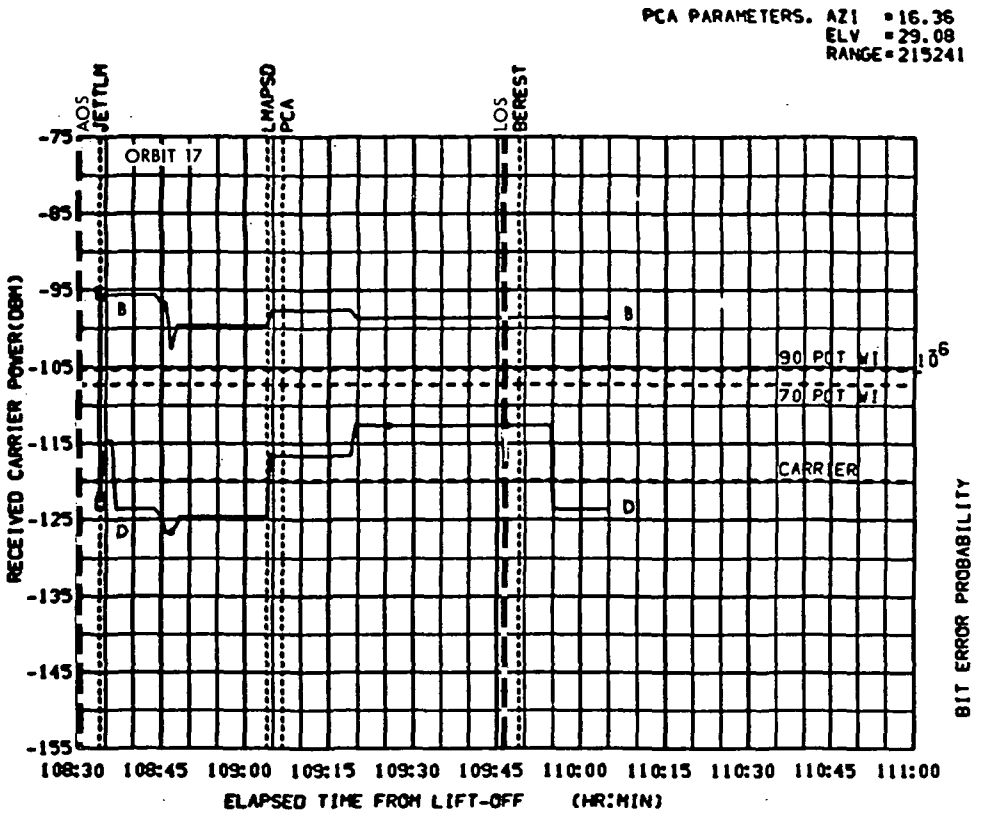


FIGURE 9-40c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

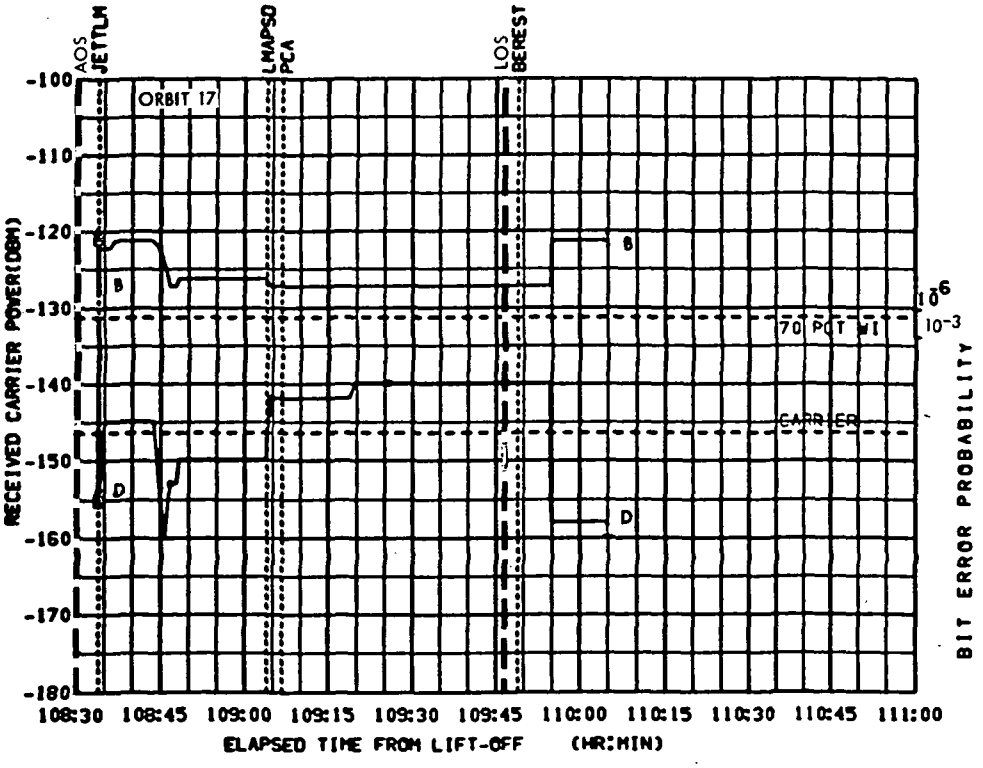


FIGURE 9-40d. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

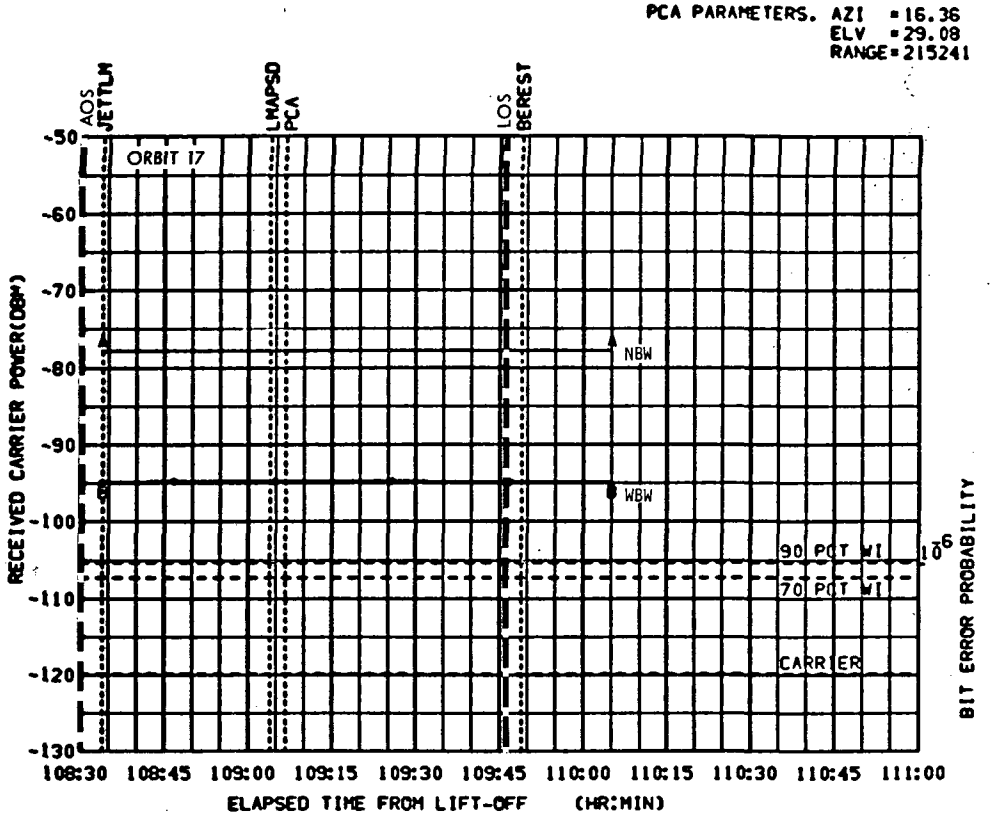


FIGURE 9-40e. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

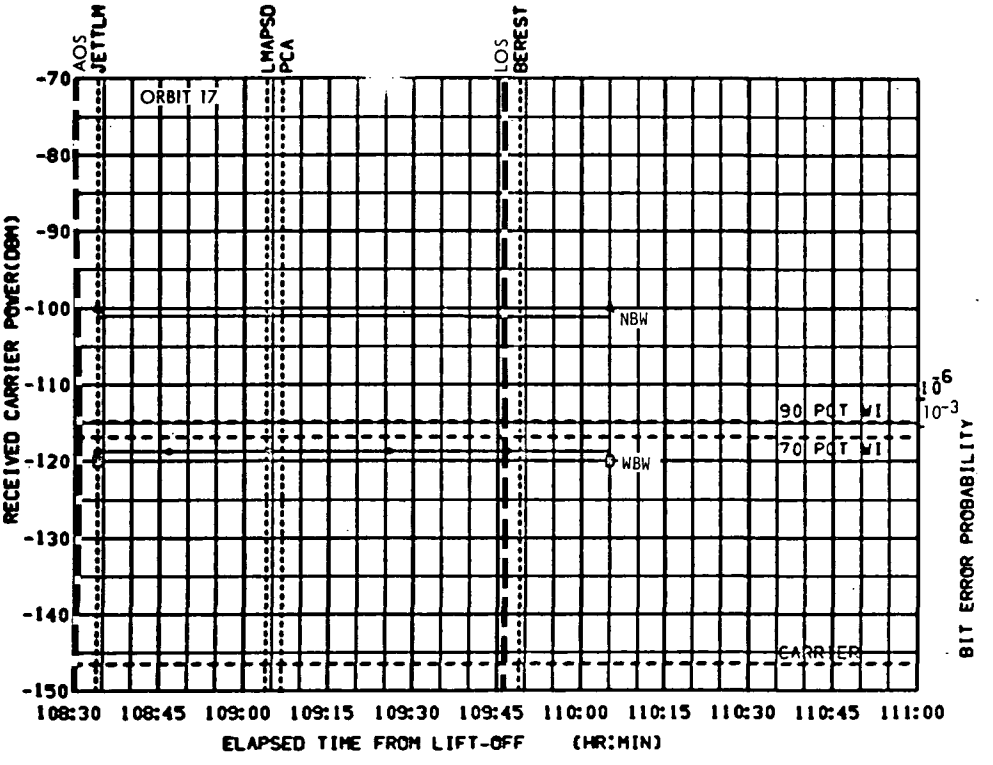


FIGURE 9-40f. MSK ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

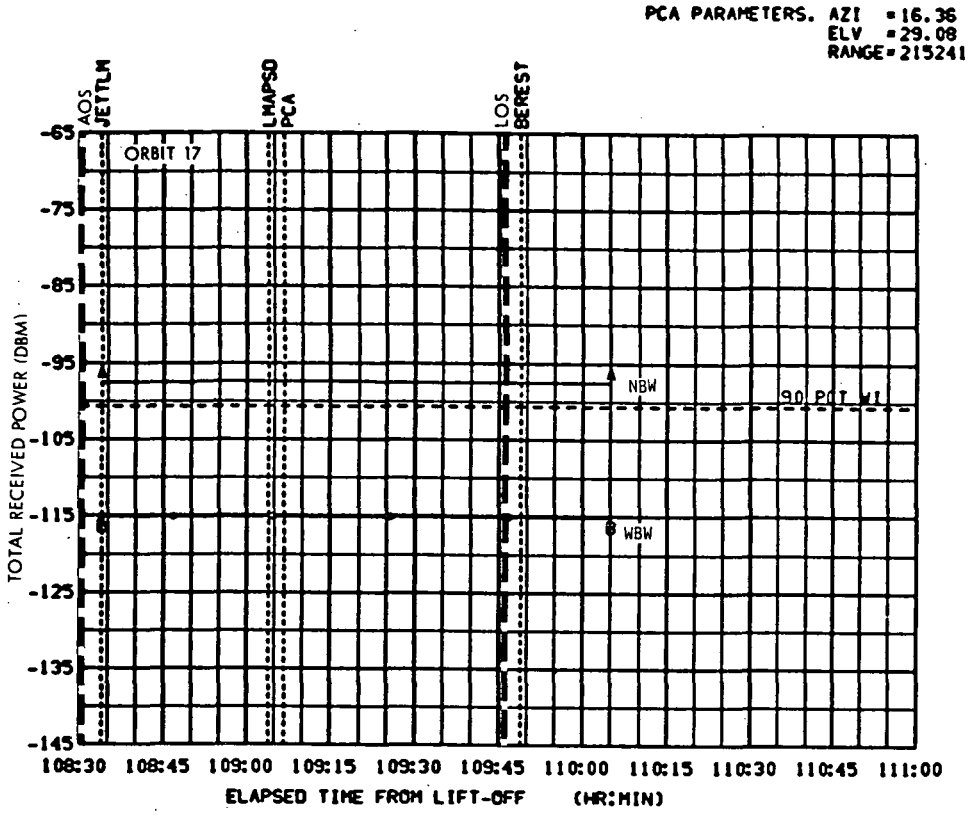


FIGURE 9-40g. MSK CSM ONLY. LUNAR PARKING ORBIT. APOLLO ONLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

LM S-BAND
17 May Launch

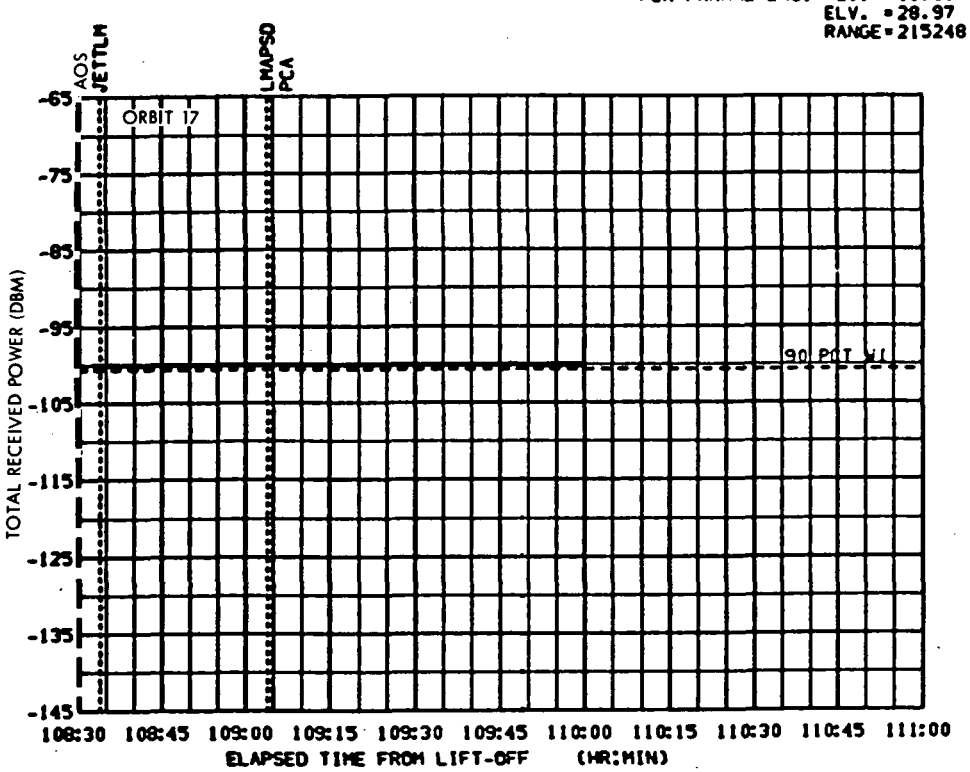


FIGURE 9-40h. MSK ONLINK FM MODES LM/MSFN S-BAND STEER LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

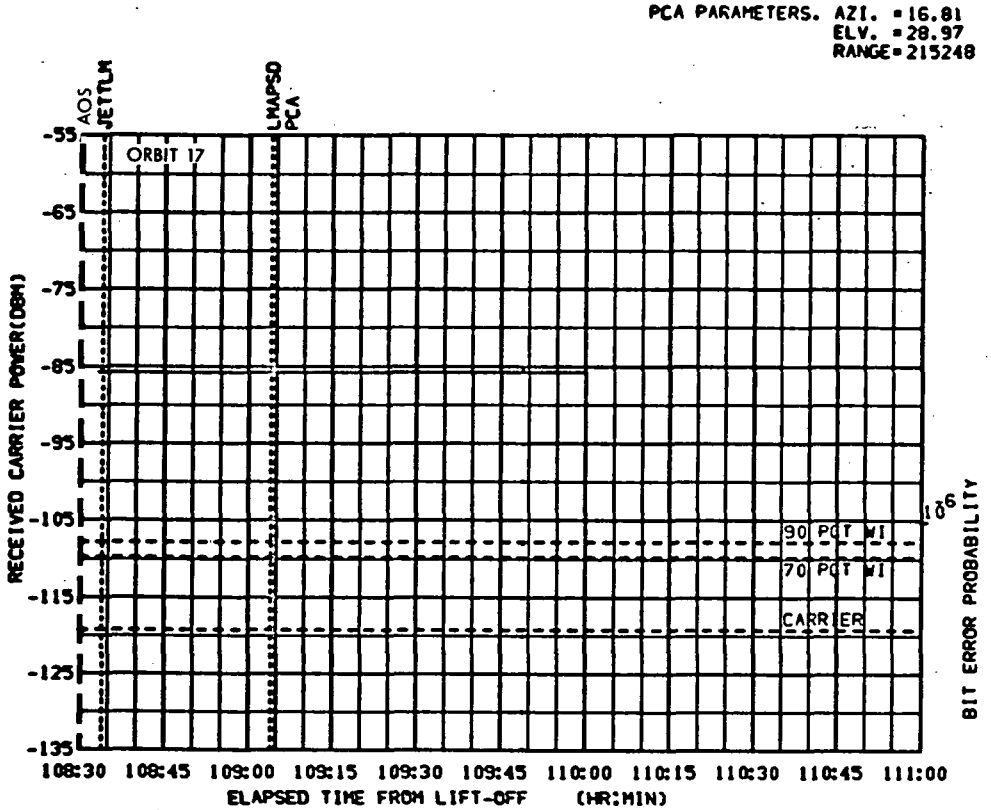


FIGURE 9-40i. MSK UPLINK MODE 6. MSFN/LM. S-BAND. STEER LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

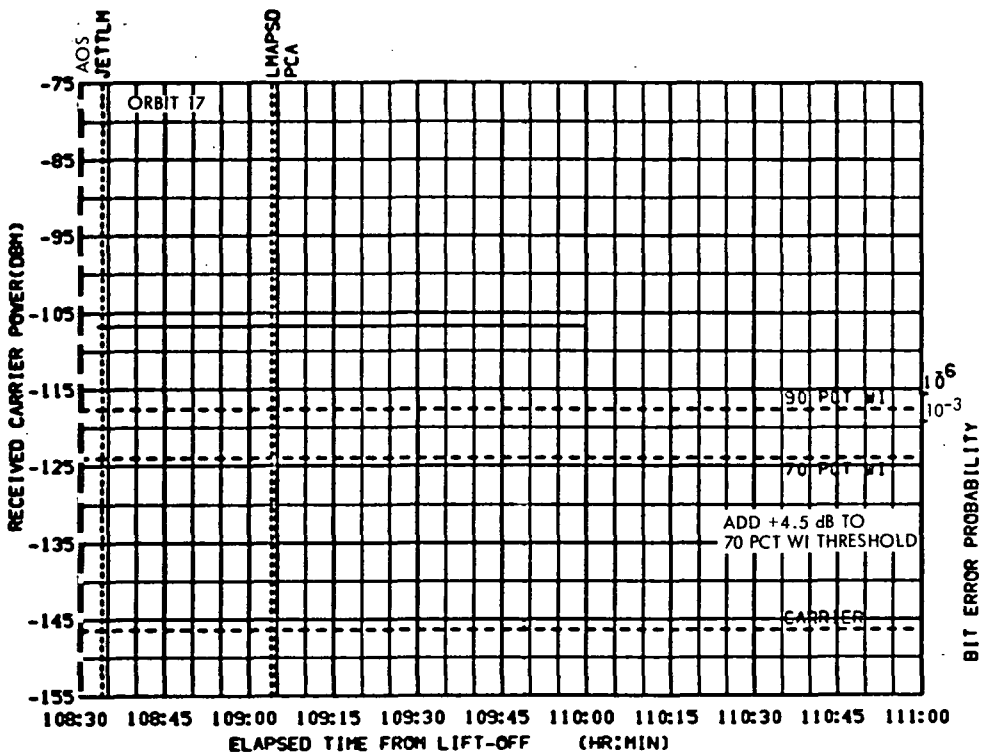


FIGURE 9-40j. MSK DNLINK MODE 2. LM/MSFN. S-BAND. STEER LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

LM S-BAND
17 May Launch

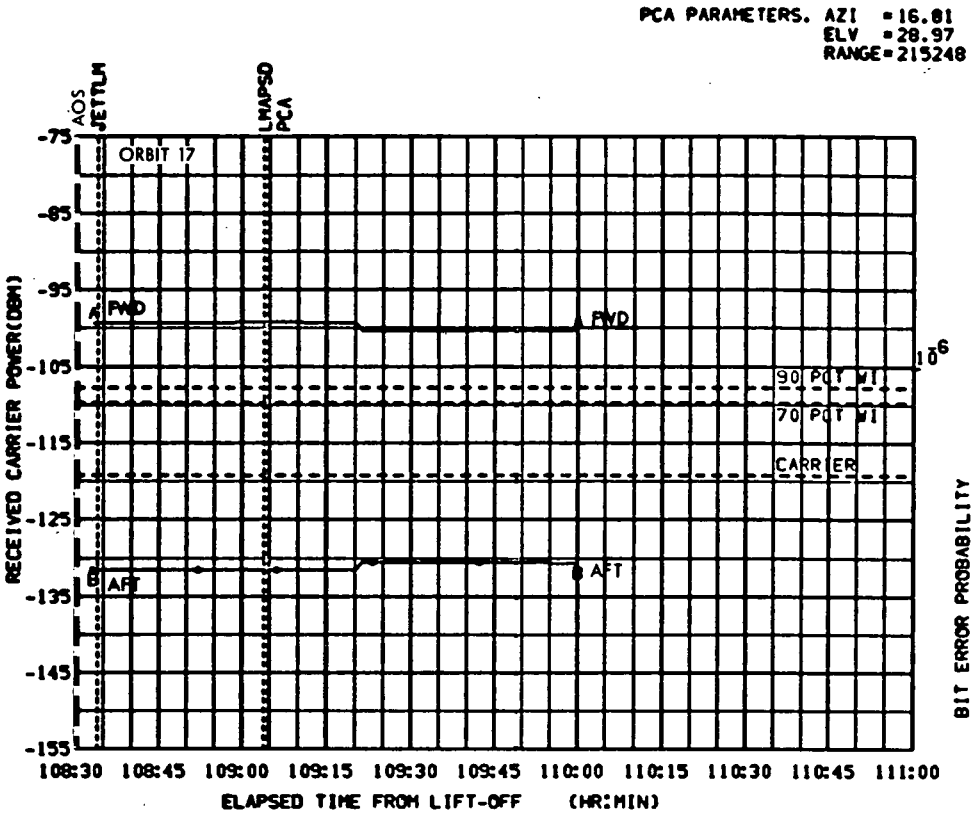


FIGURE 9-40k. HSK UPLINK MODE 6 MSFN/LM S-BAND INFLIGHT LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

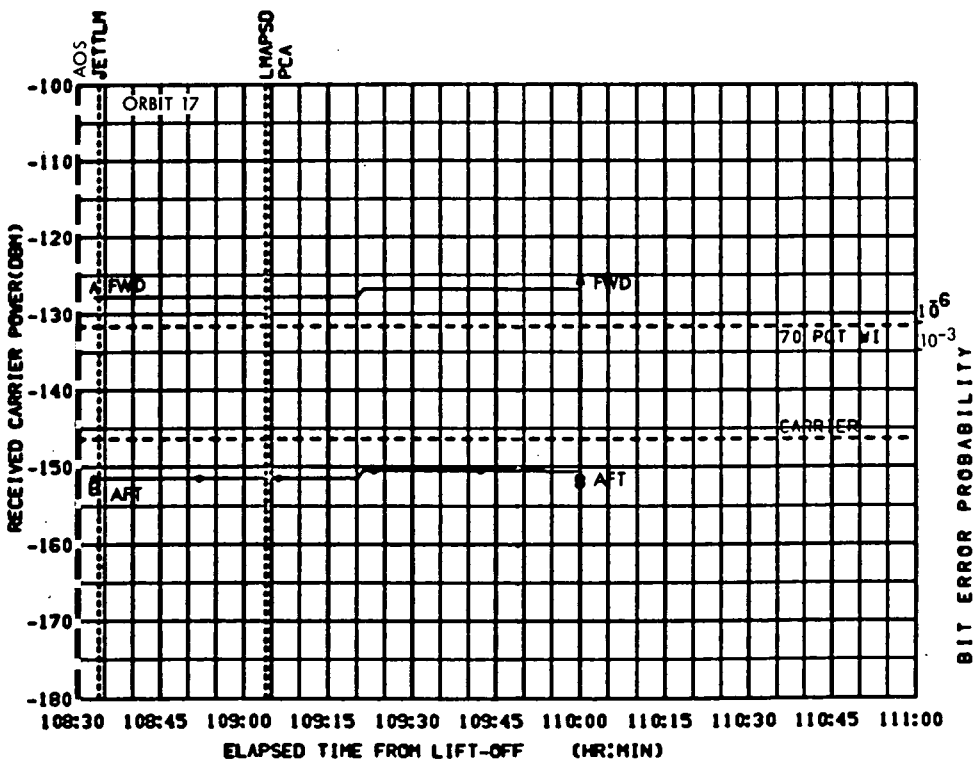


FIGURE 9-40l. HSK DNLINK MODE 4 LM/MSFN S-BAND INFLIGHT LM ASCENT, LUNAR PARKING ORBIT, APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

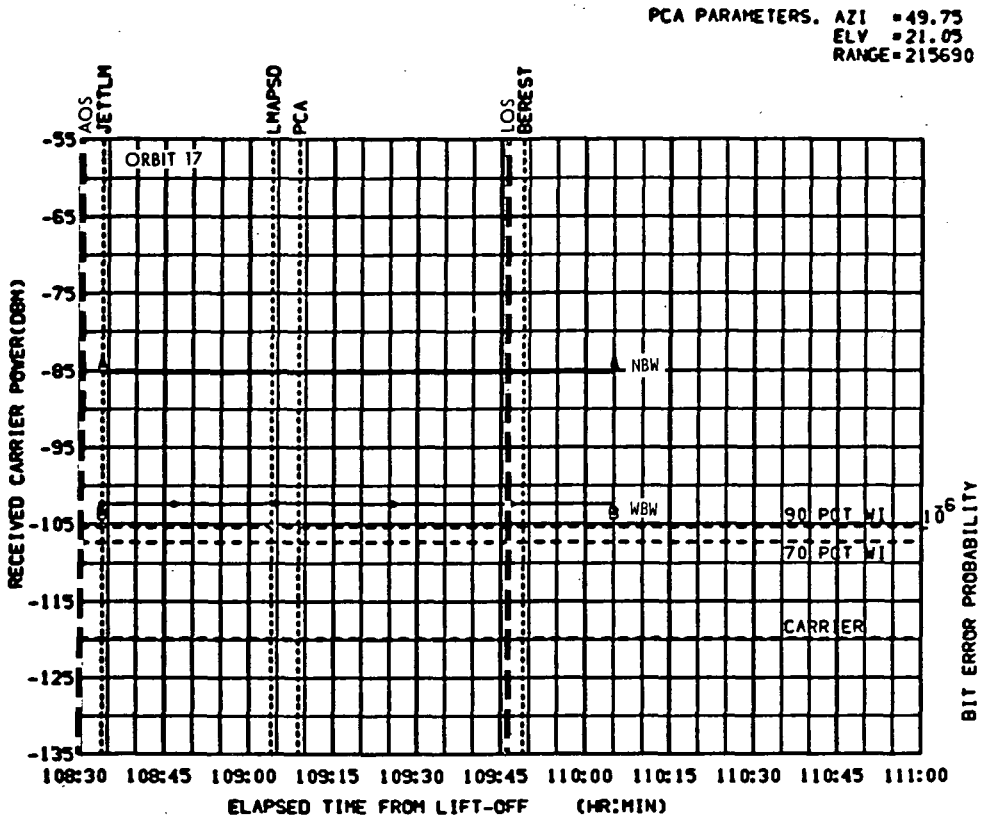


FIGURE 9-41a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

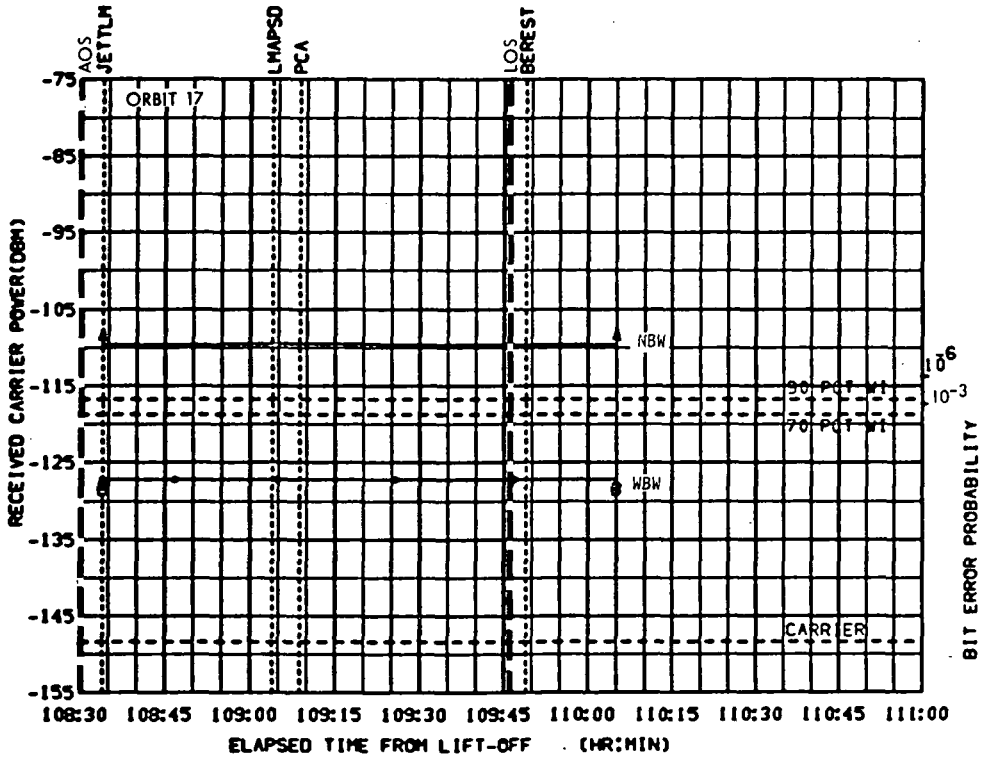


FIGURE 9-41b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI. =50.13
ELV. =20.63
RANGE=215710

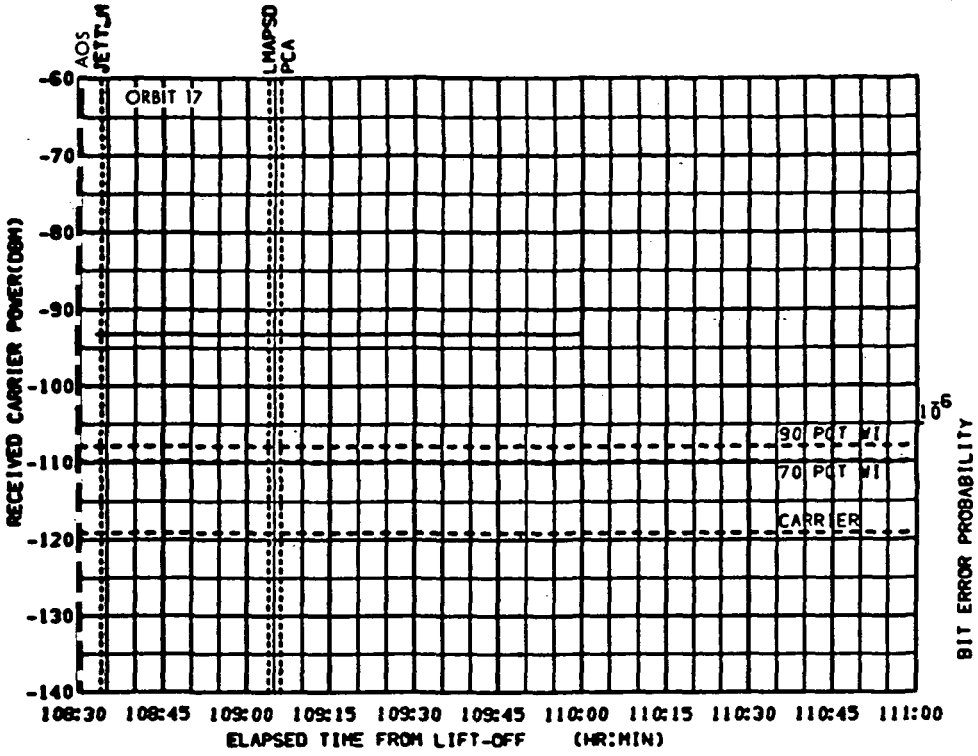


FIGURE 9-41c. CRO UPLINK MODE 6. MSFN/LM. S-BAND. STEER LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

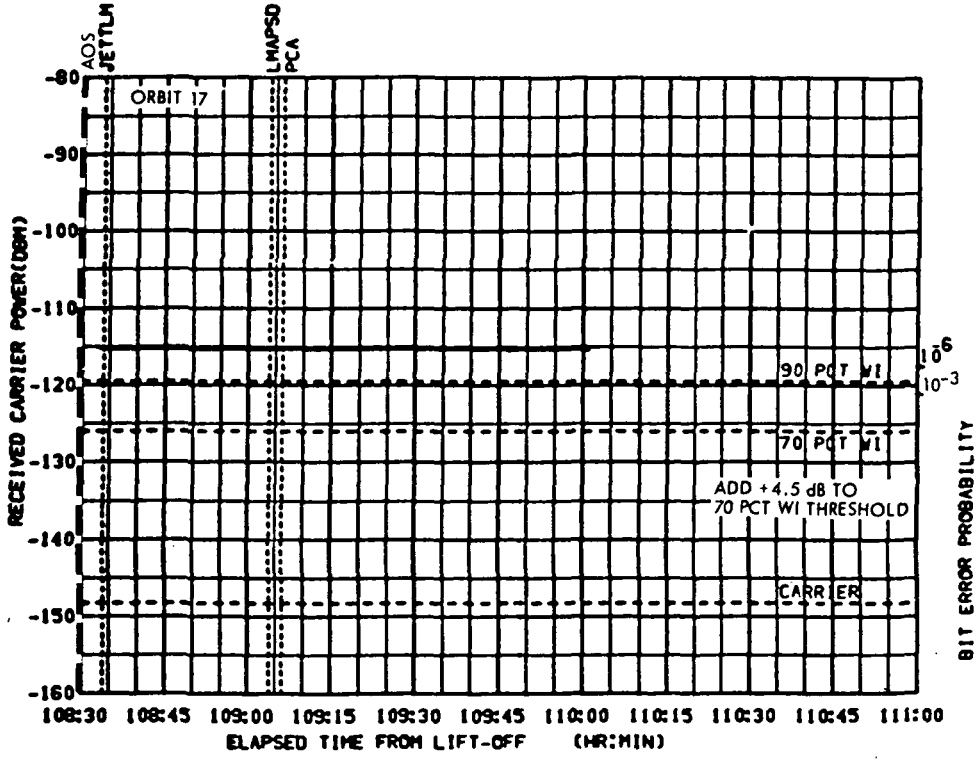


FIGURE 9-41d. CRO DNLINK MODE 2. LM/MSFN. S-BAND. STEER LM ASCENT. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF.

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -13.80
ELV = 29.90
RANGE = 215098

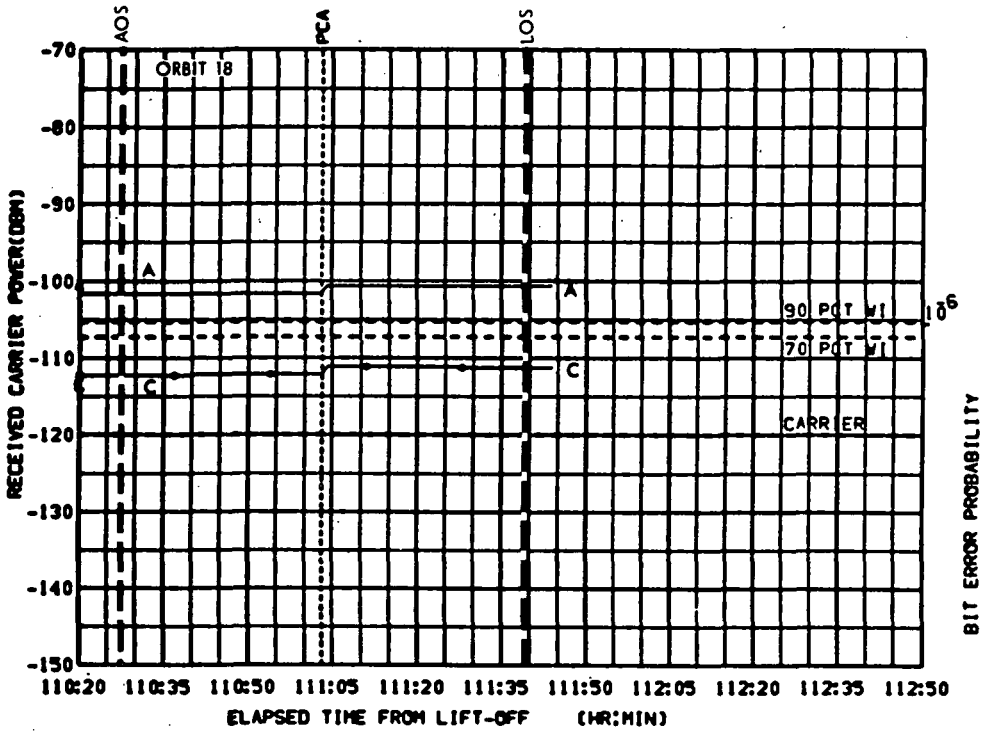


FIGURE 9-42a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

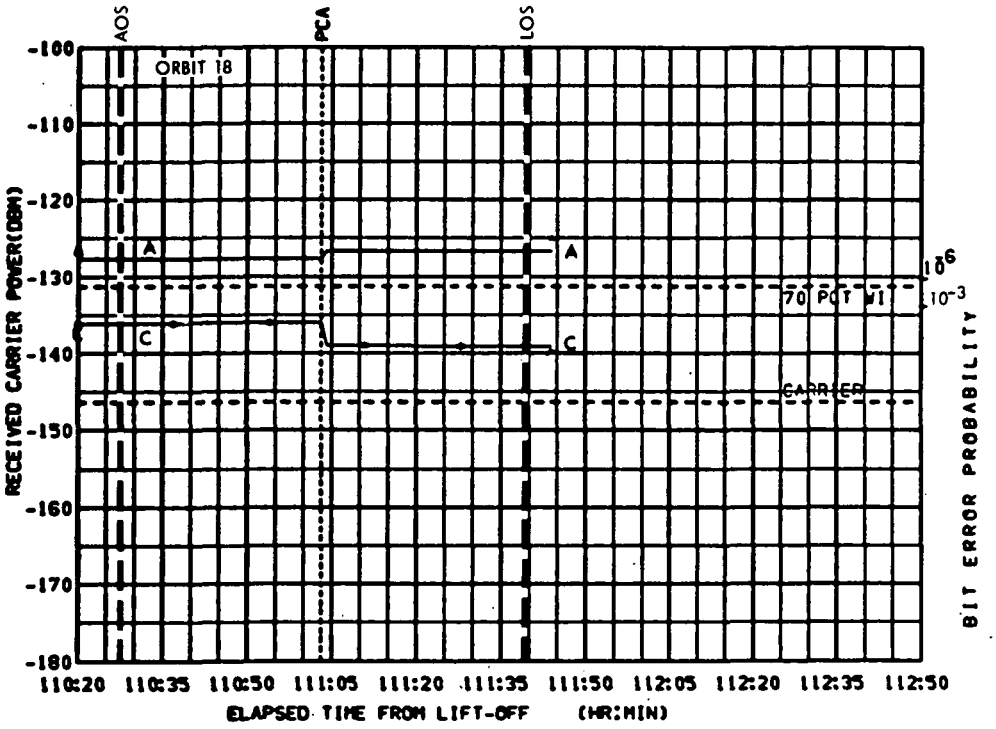


FIGURE 9-42b. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -13.80
ELV = 29.90
RANGE = 215098

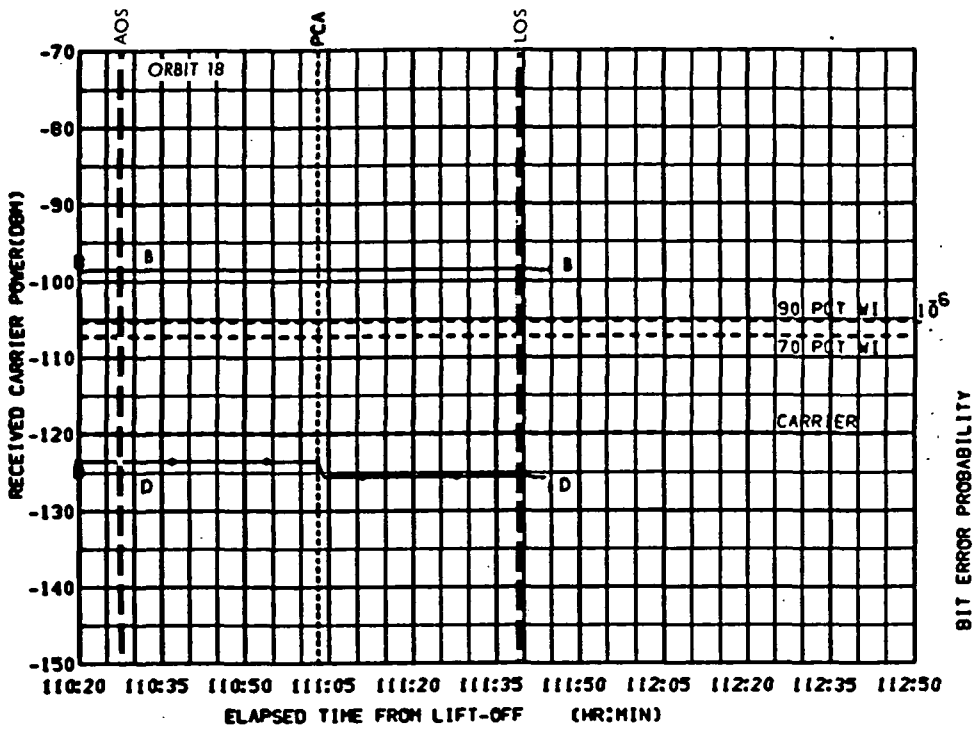


FIGURE 9-42c. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

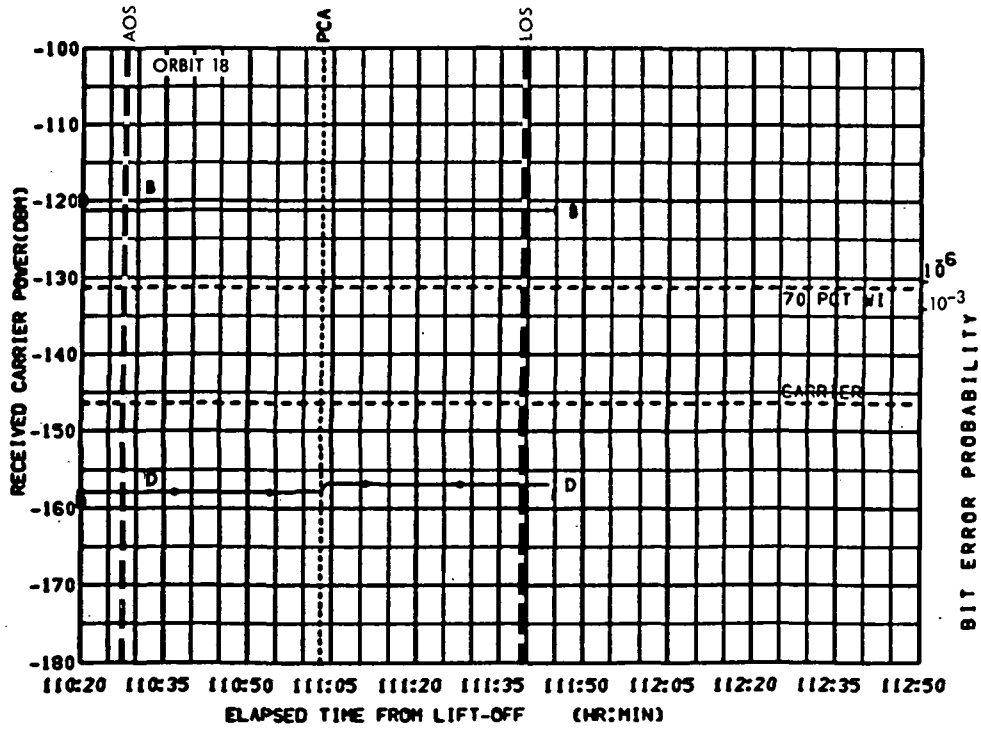


FIGURE 9-42d. HSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -13.80
ELV = 29.90
RANGE = 215098

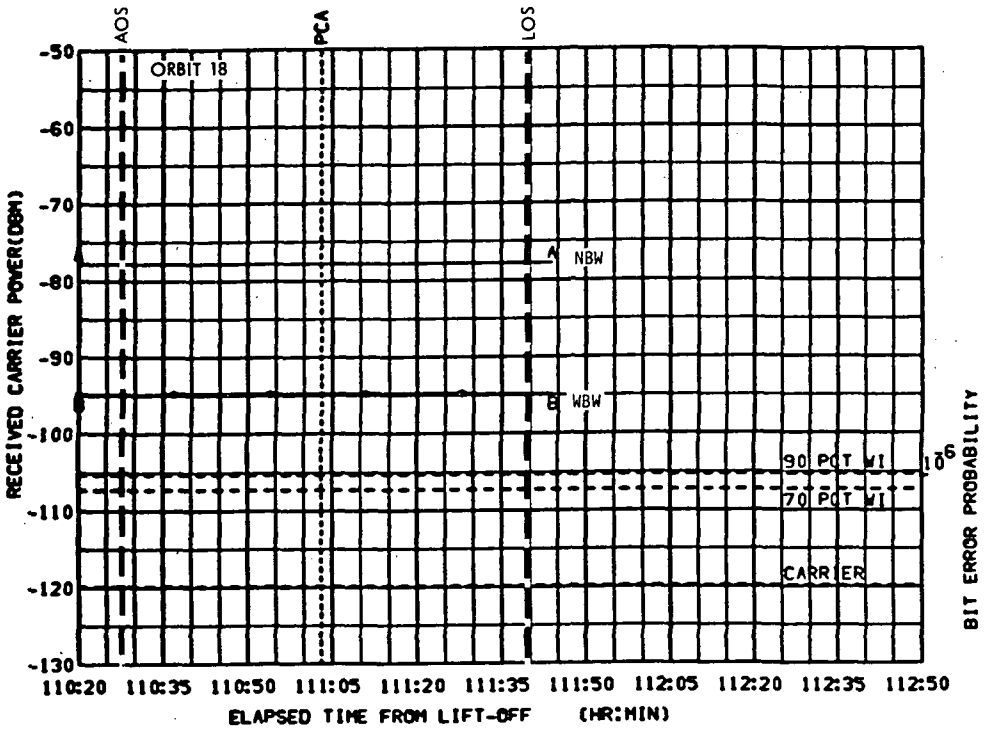


FIGURE 9-42e. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

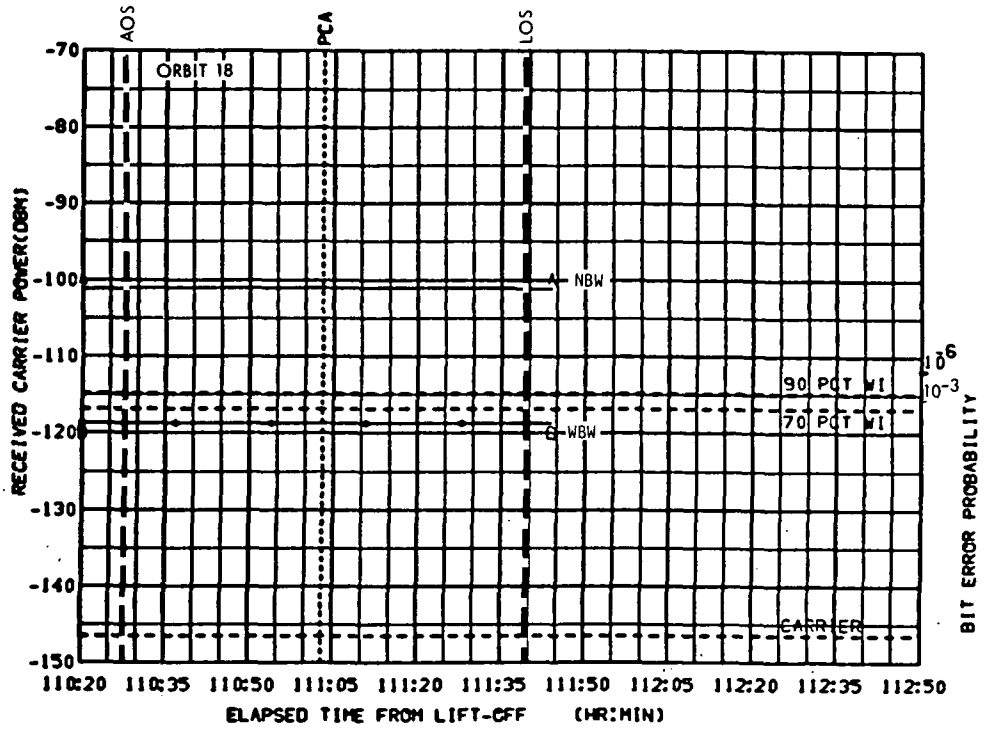


FIGURE 9-42f. HSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

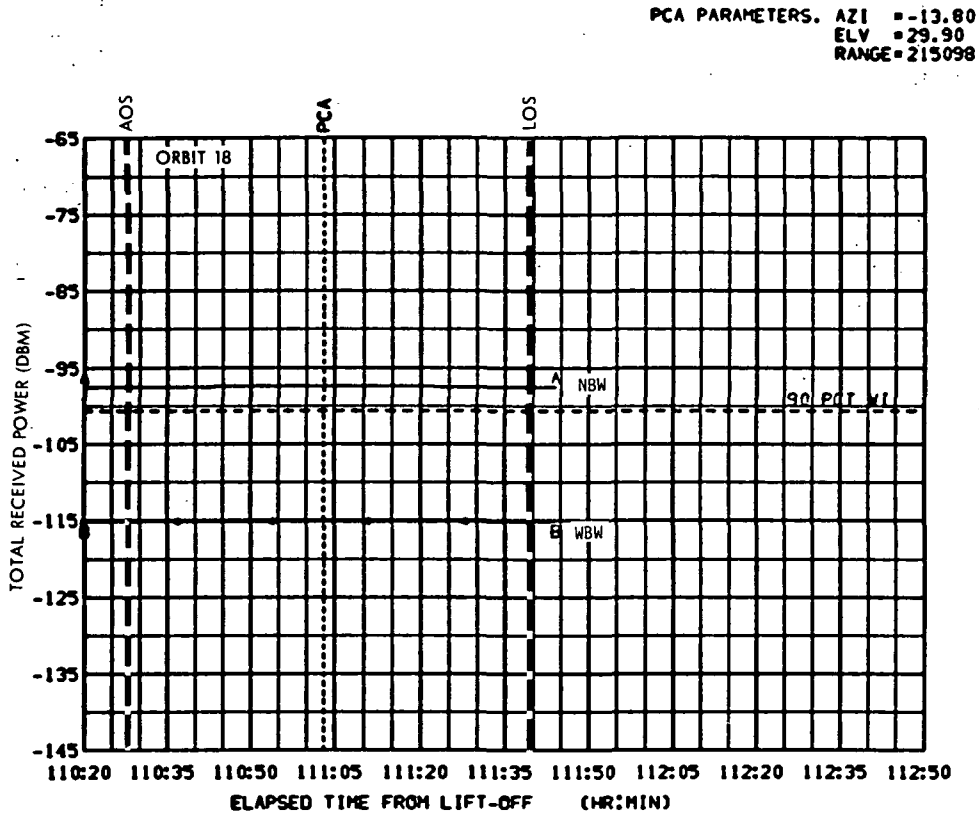


FIGURE 9-42g. MSK CSM ONLY. LUNAR PARKING ORBIT. APOLLO DNLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-40.49
ELV =77.53
RANGE=213480

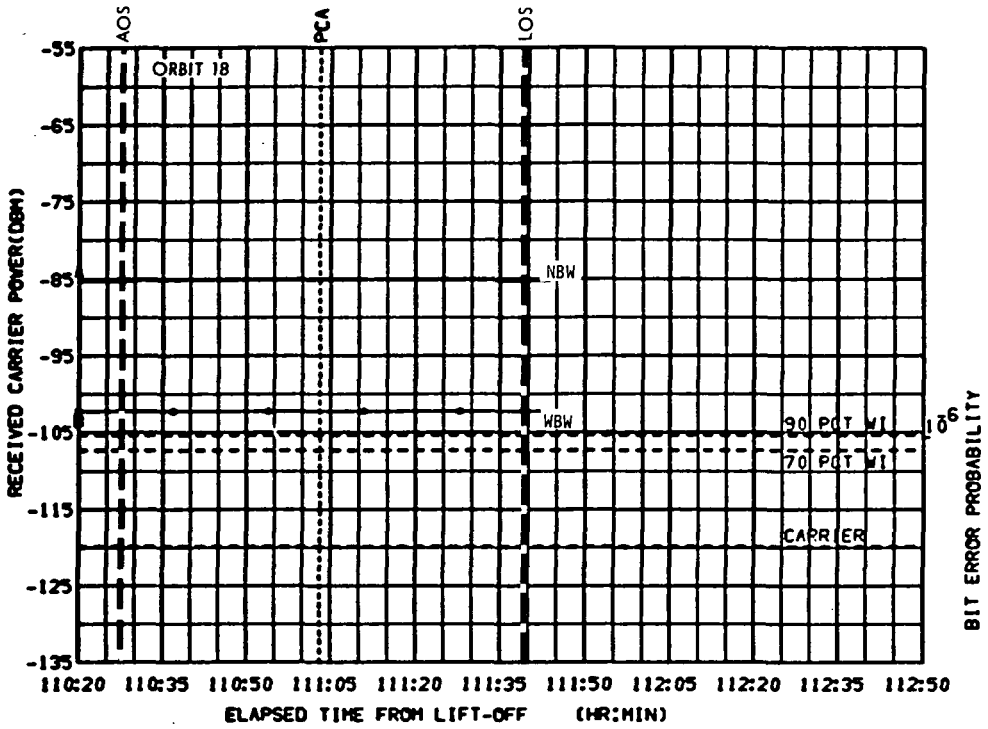


FIGURE 9-43a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

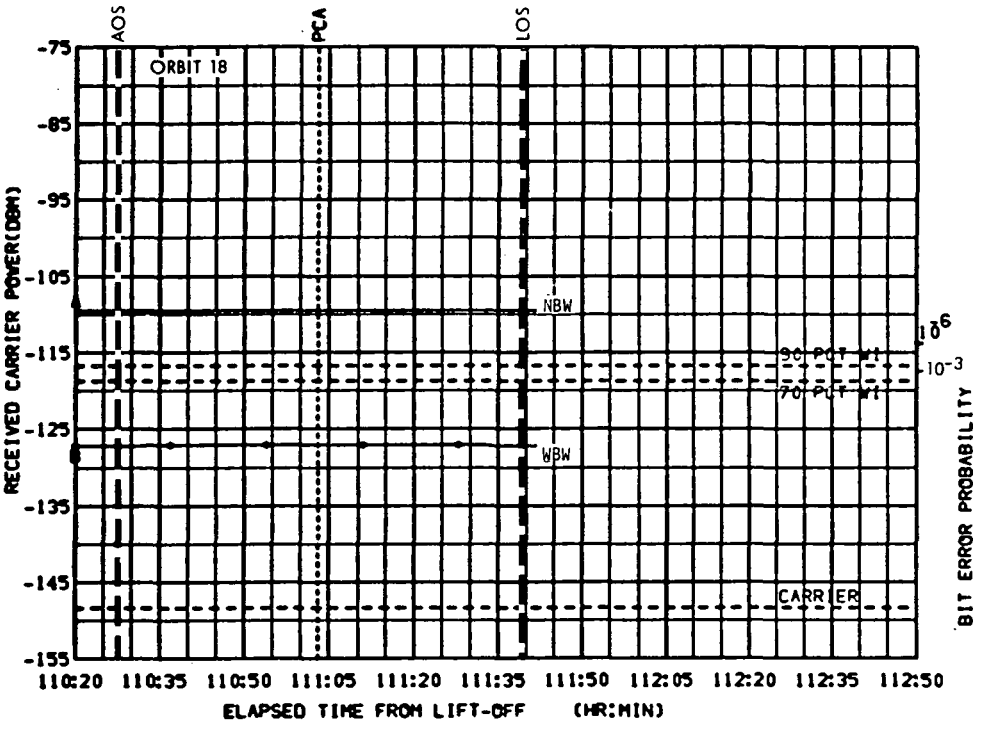


FIGURE 9-43b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -70.45
ELV = 53.48
RANGE = 213976

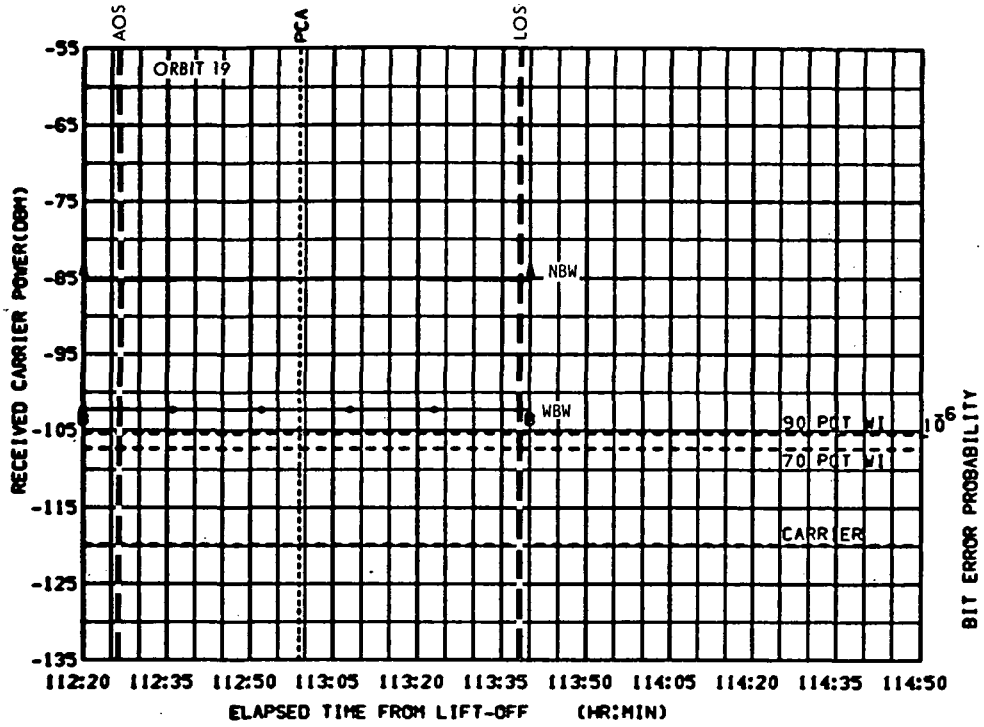


FIGURE 9-44a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

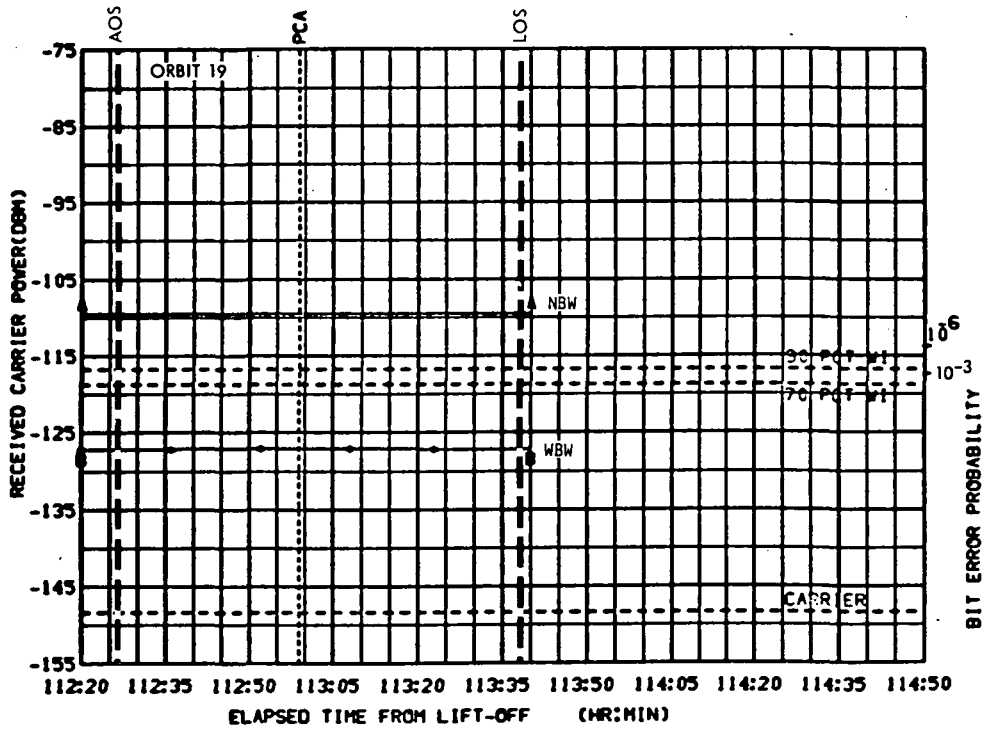


FIGURE 9-44b. GWM ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -40.56
ELV = 19.45
RANGE = 215567

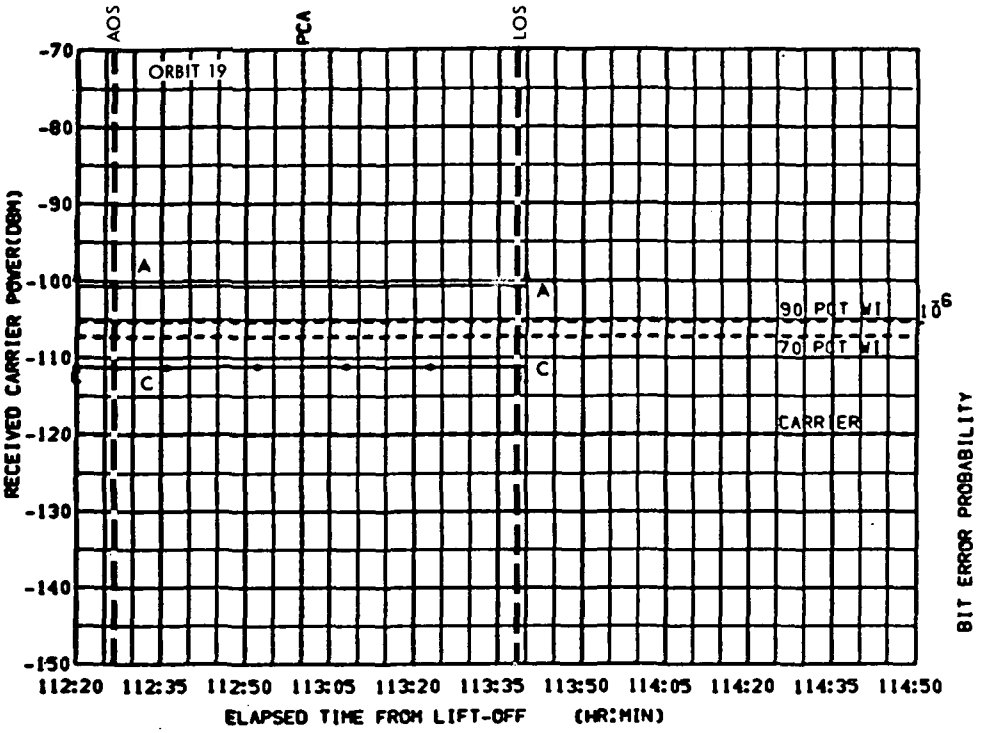


FIGURE 9-45a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

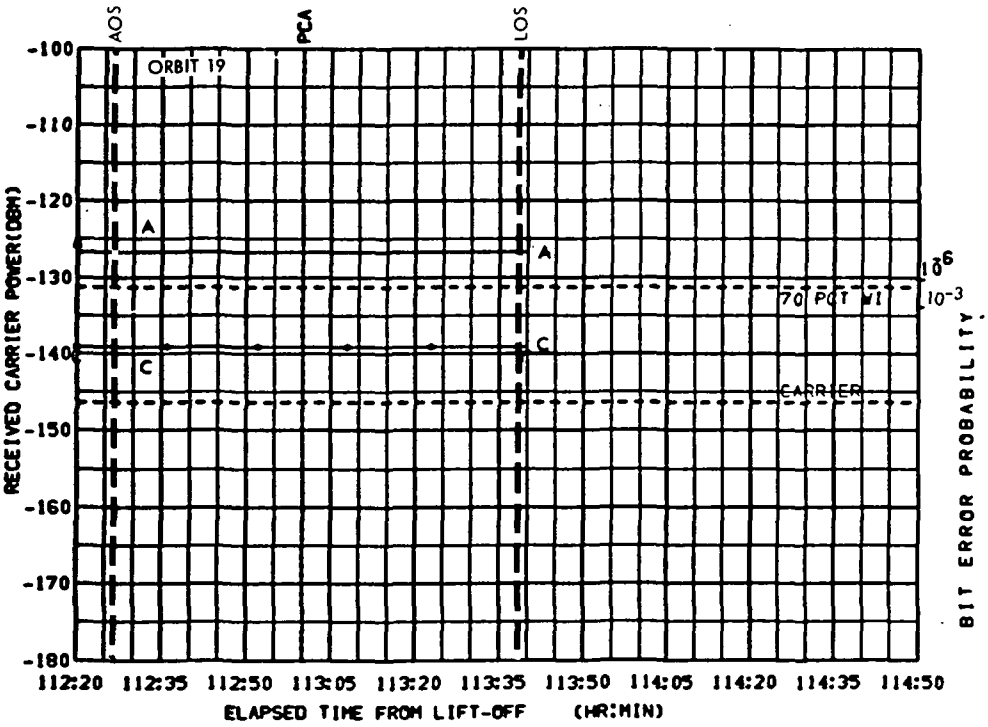


FIGURE 9-45b. MSK ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -40.56
ELV = 19.45
RANGE = 215567

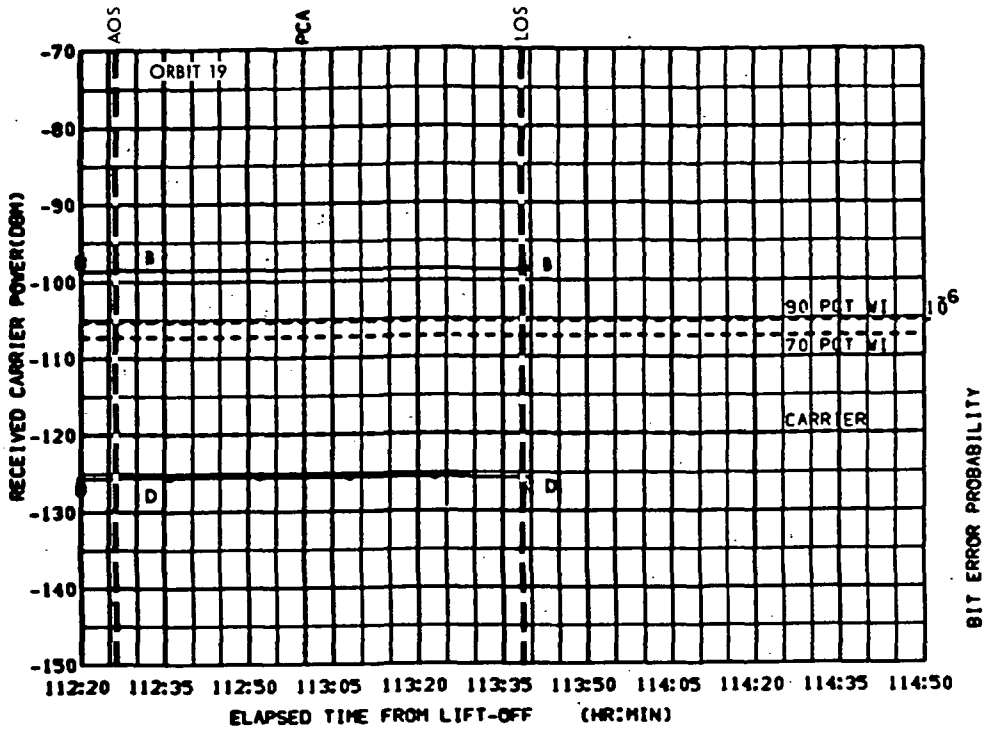


FIGURE 9-45c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

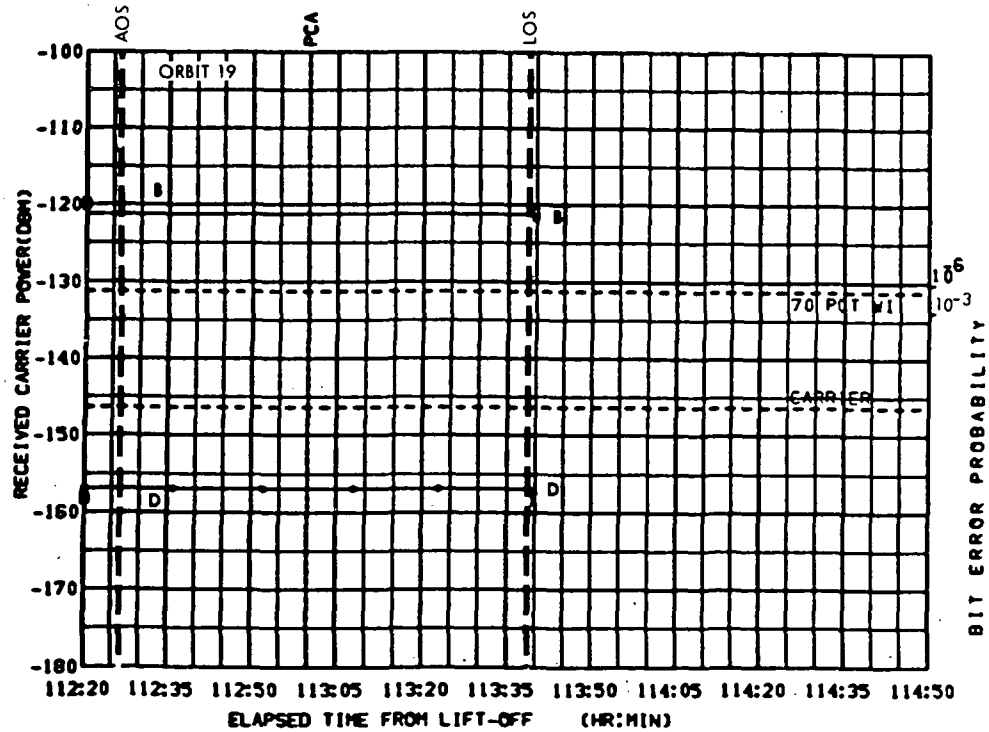


FIGURE 9-45d. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -40.56
ELV = 19.45
RANGE = 215567

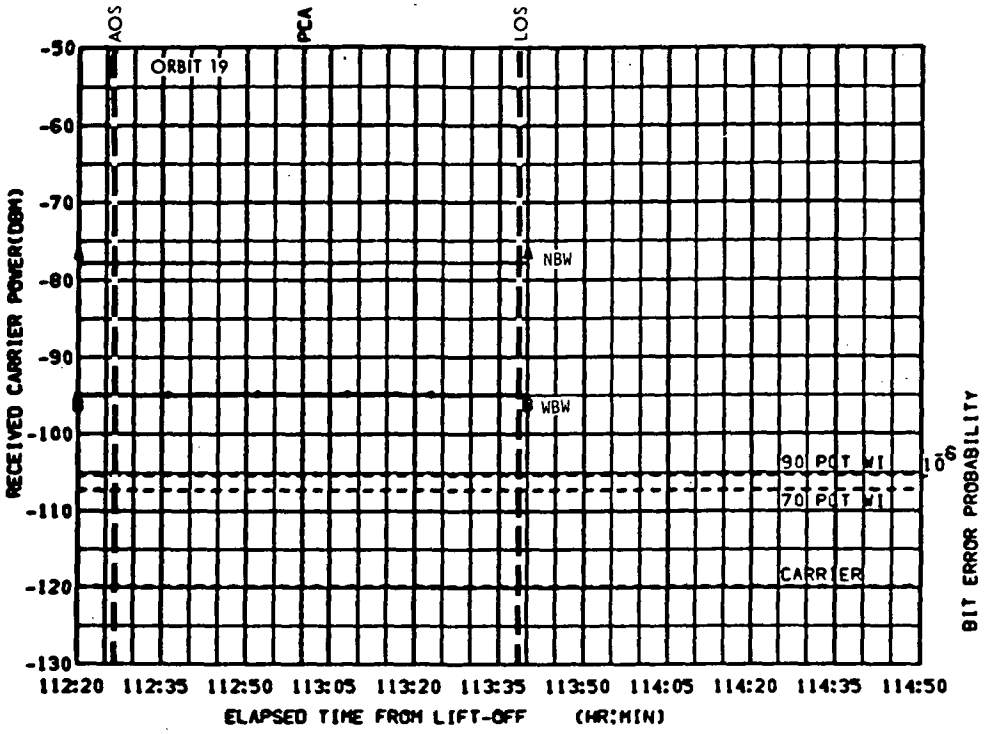


FIGURE 9-45e. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

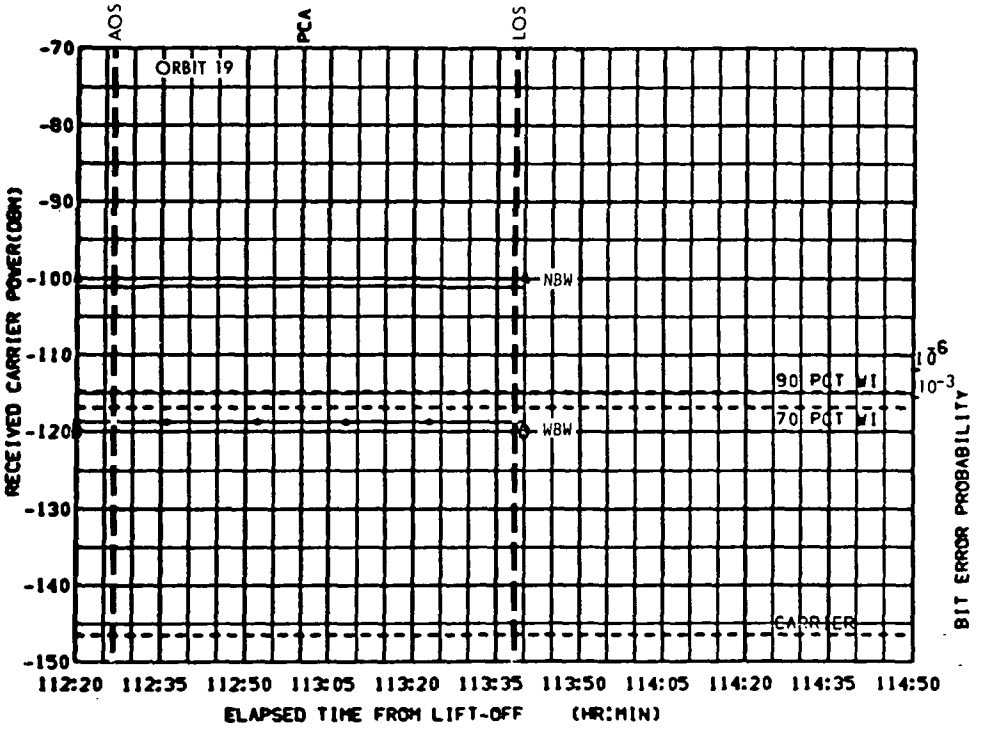


FIGURE 9-45f. MSK ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

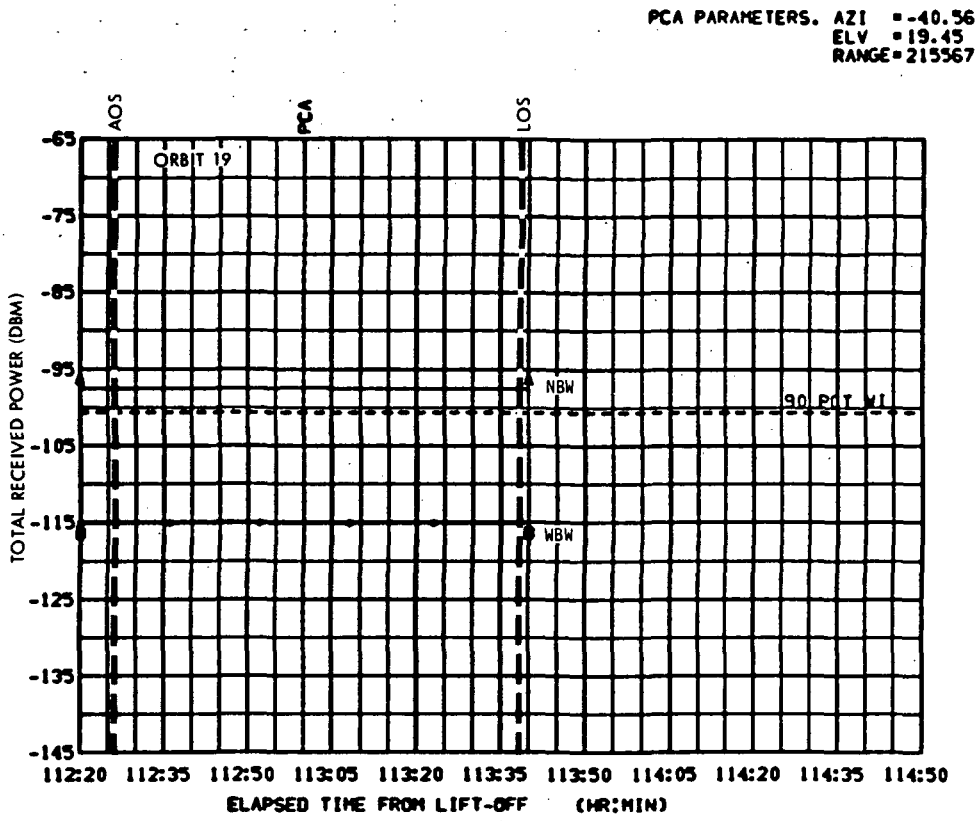


FIGURE 9-45g. MSK CSM ONLY. LUNAR PARKING ORBIT. APOLLO DNLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =77.78
ELV =18.98
RANGE=215508

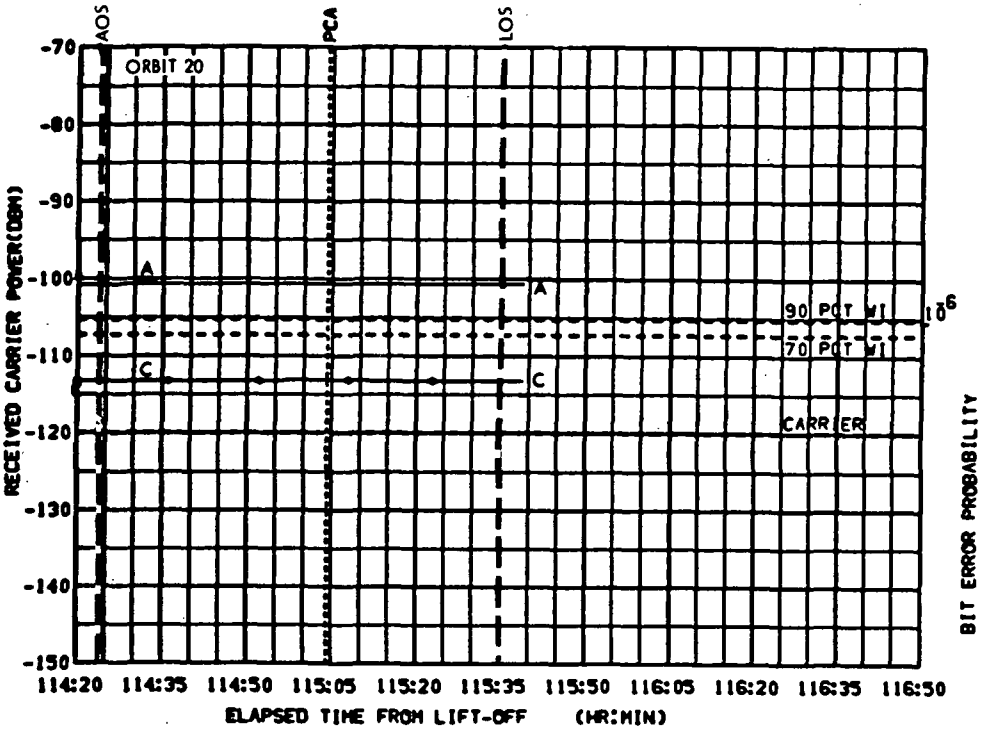


FIGURE 9-46a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

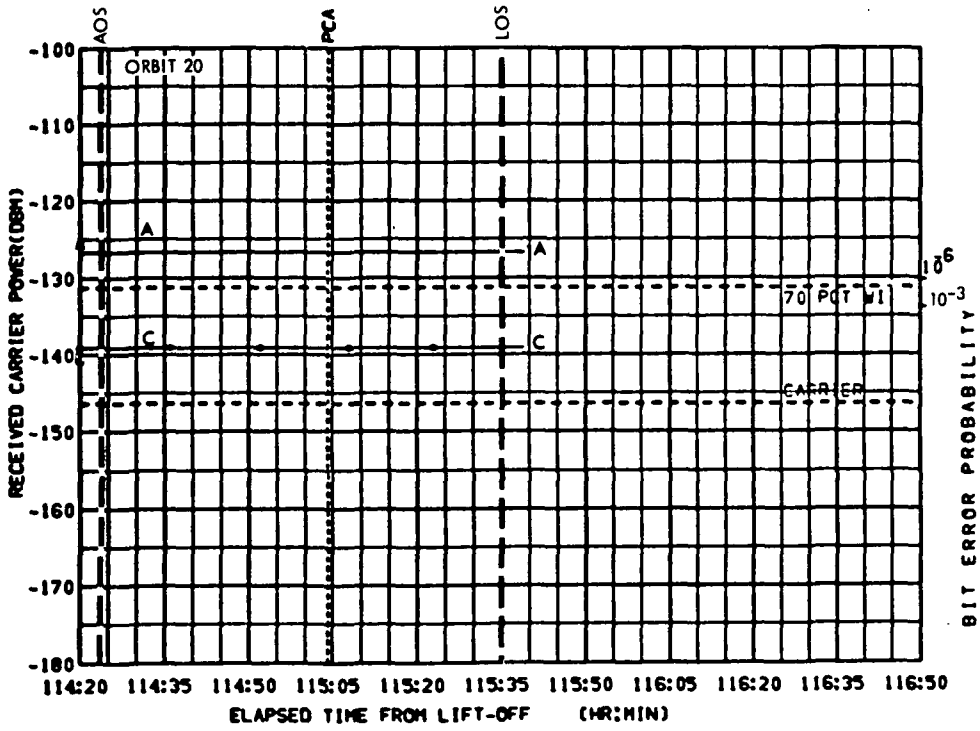


FIGURE 9-46b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 77.78
ELV = 18.98
RANGE = 215508

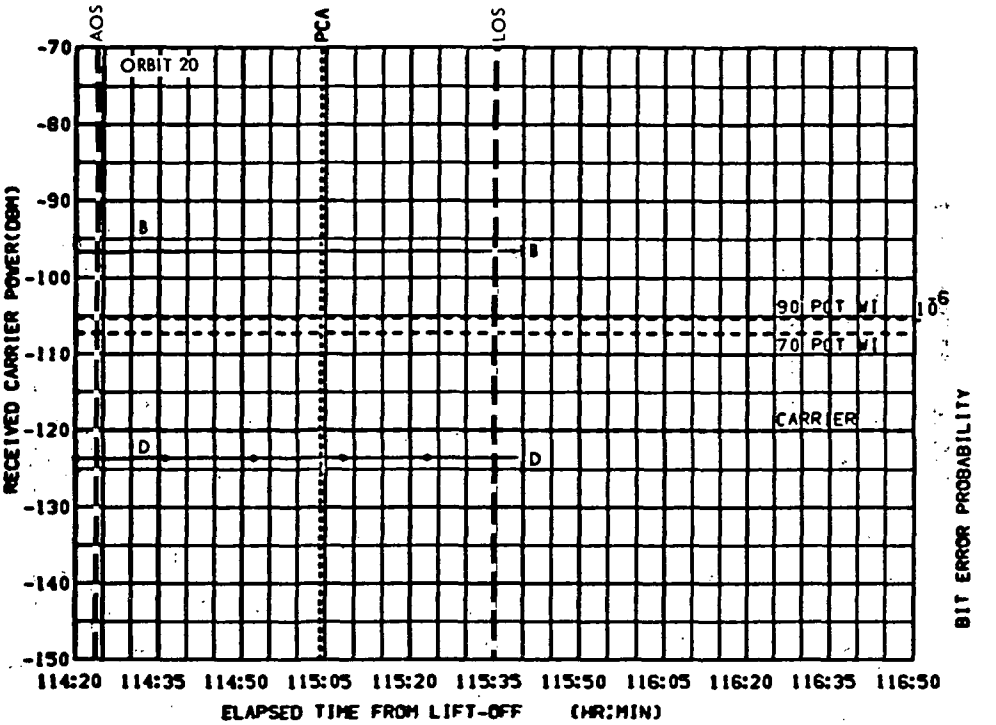


FIGURE 9-46c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

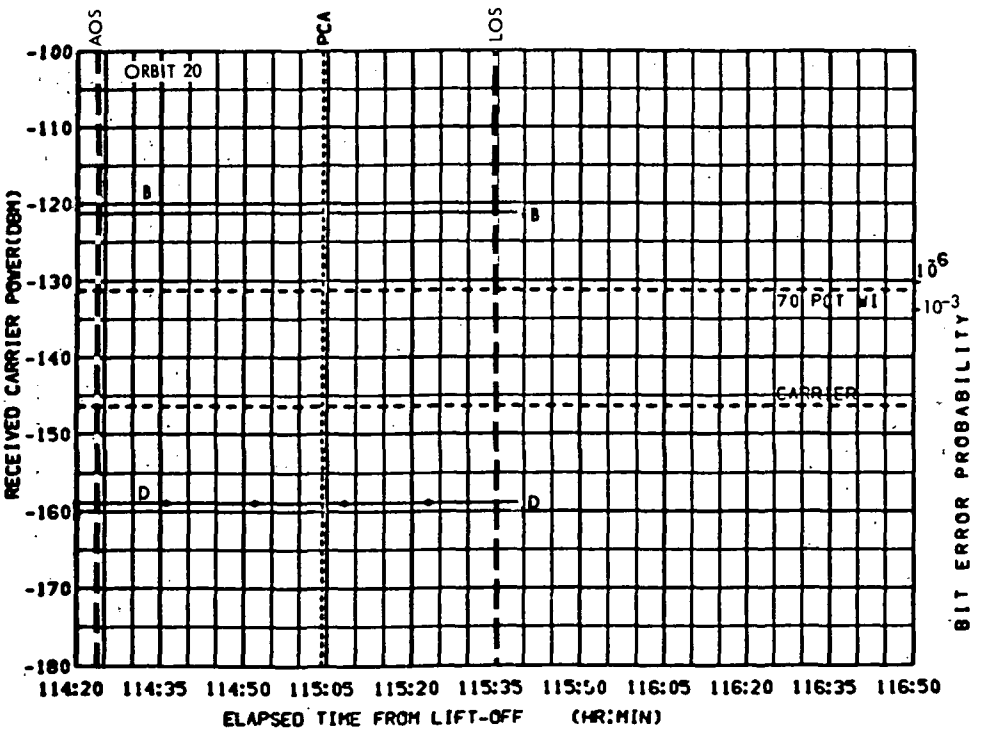


FIGURE 9-46d. MAD ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 77.78
ELV = 18.98
RANGE = 215508

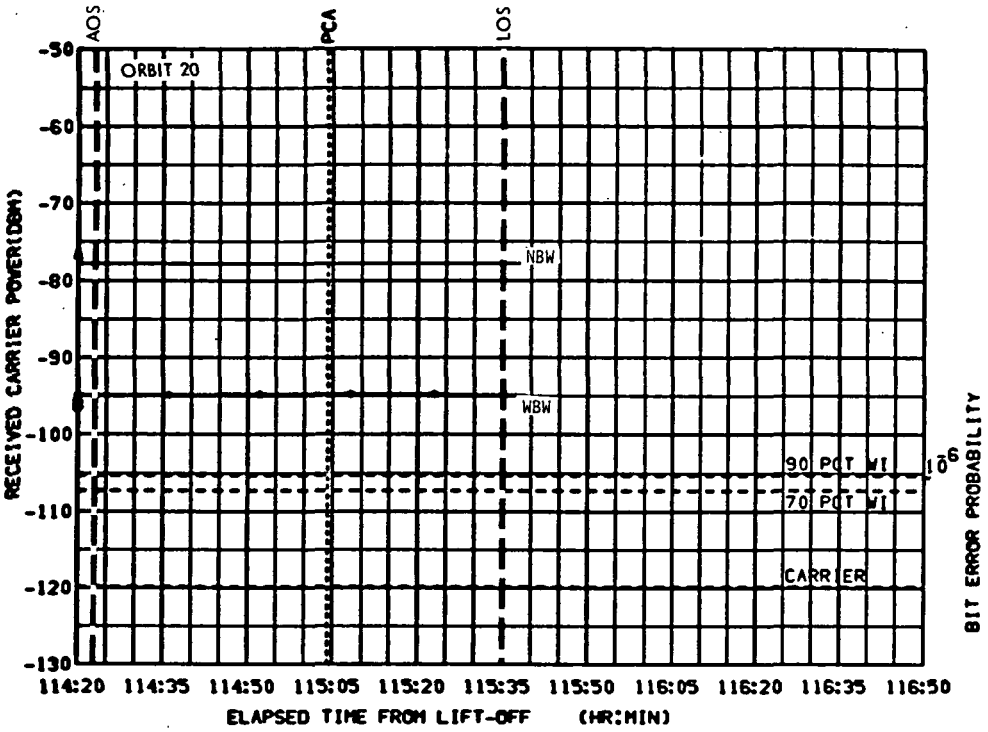


FIGURE 9-46e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

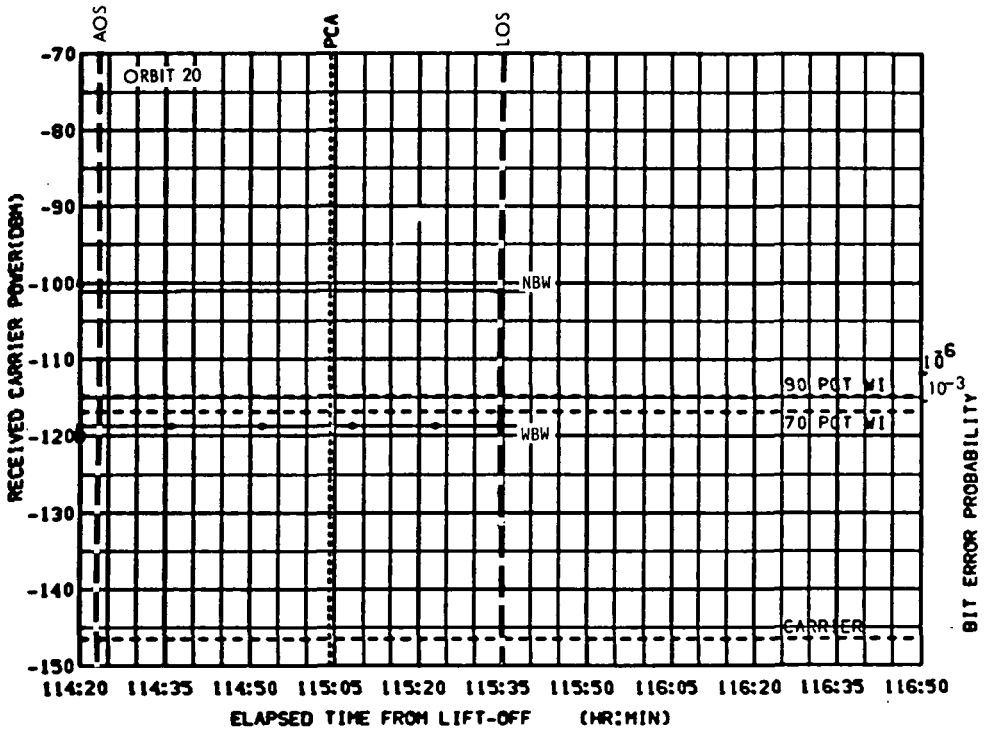


FIGURE 9-46f. MAD ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

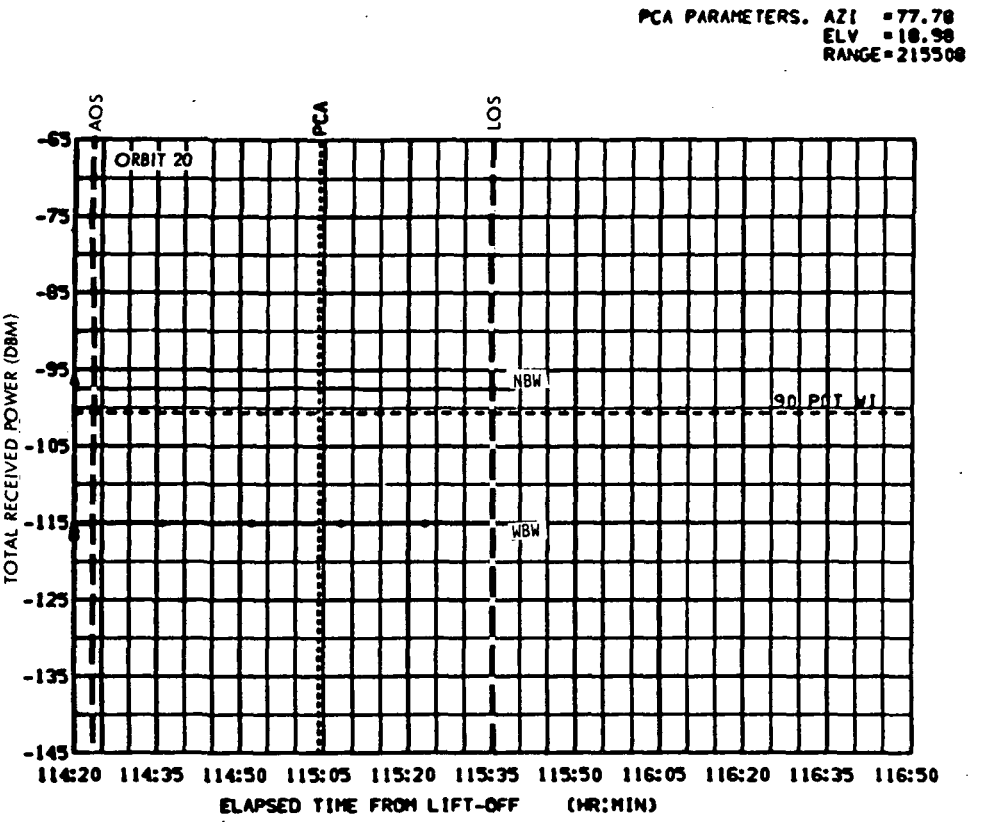


FIGURE 9-46g. MAD CSM ONLY. LUNAR PARKING ORBIT. APOLLO ONLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -38.56
ELV = 31.68
RANGE = 214807

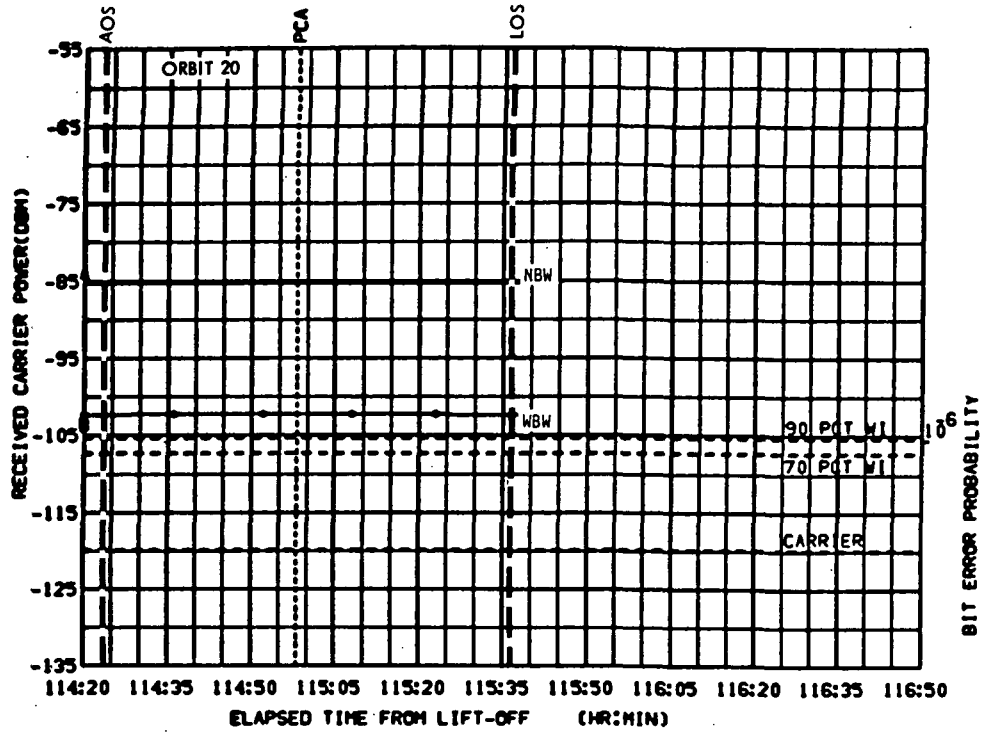


FIGURE 9-47a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

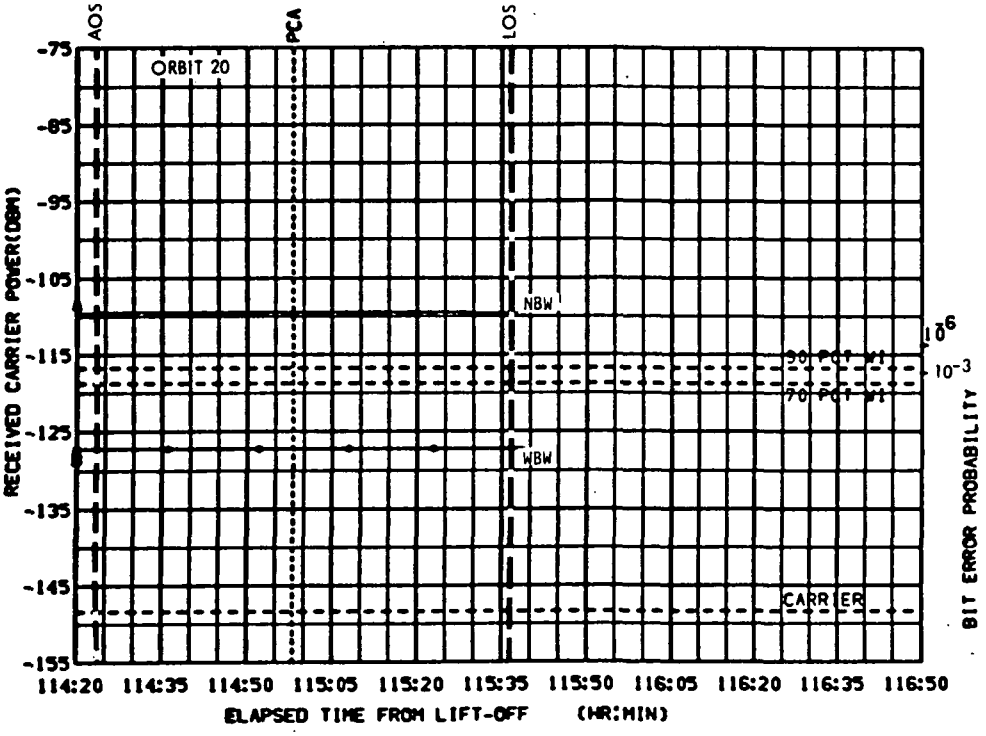


FIGURE 9-47b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

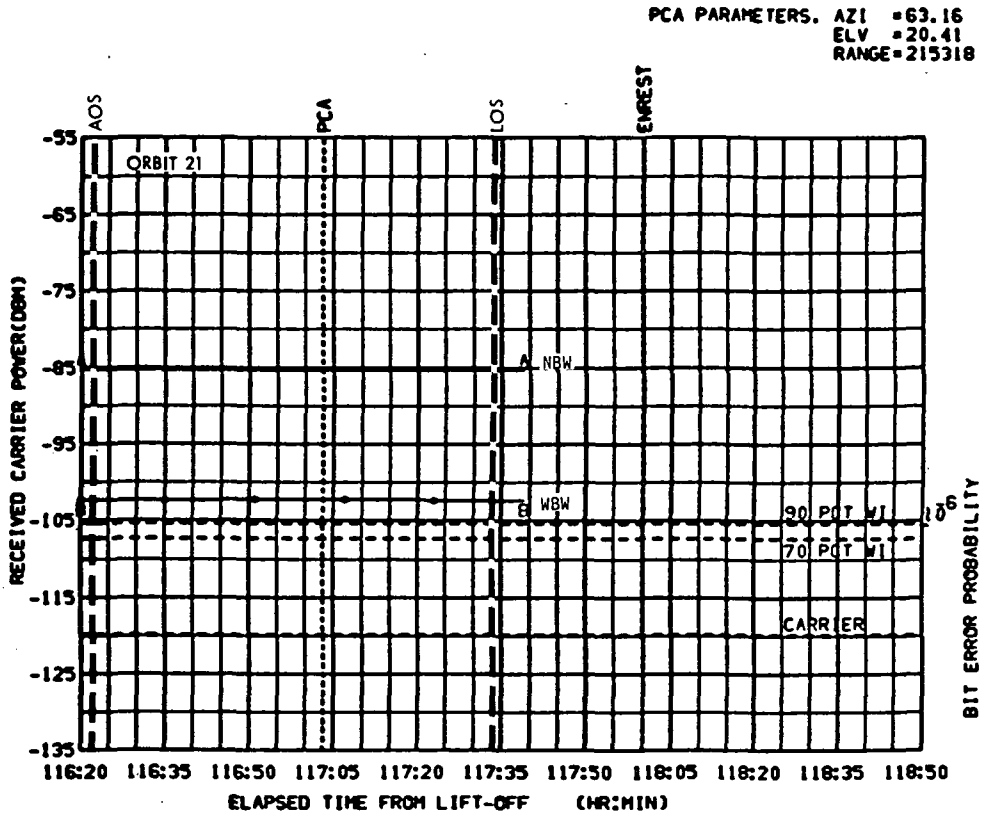


FIGURE 9-48a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

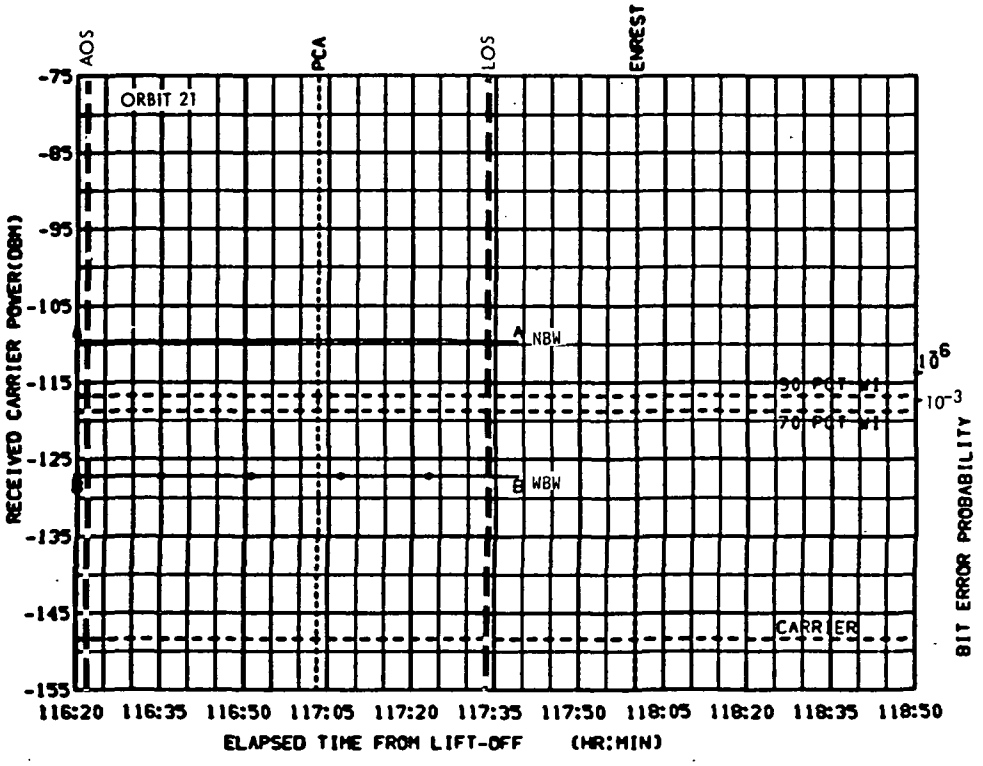


FIGURE 9-48b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

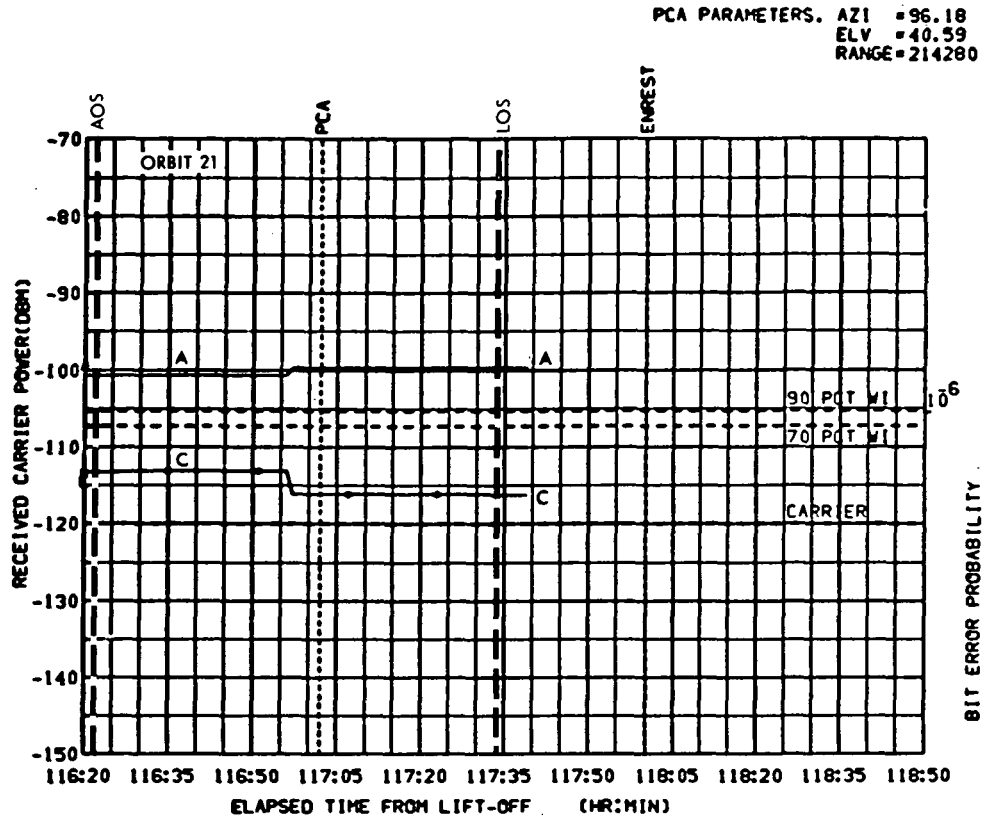


FIGURE 9-49a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

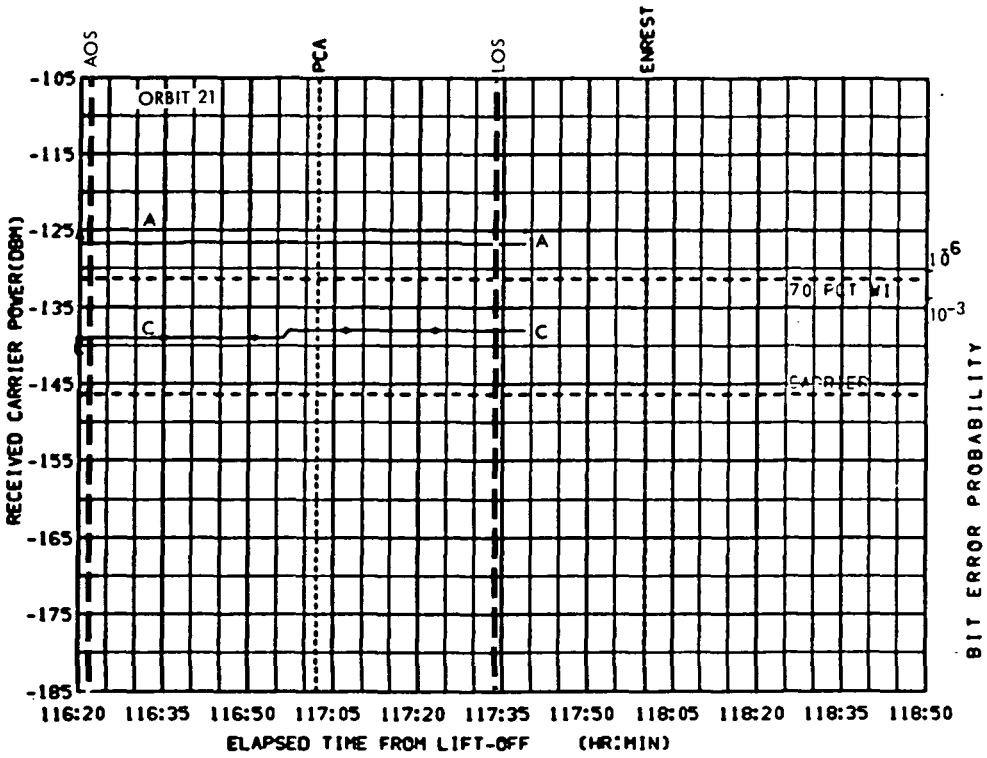


FIGURE 9-49b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =96.18
ELV =40.59
RANGE=214280

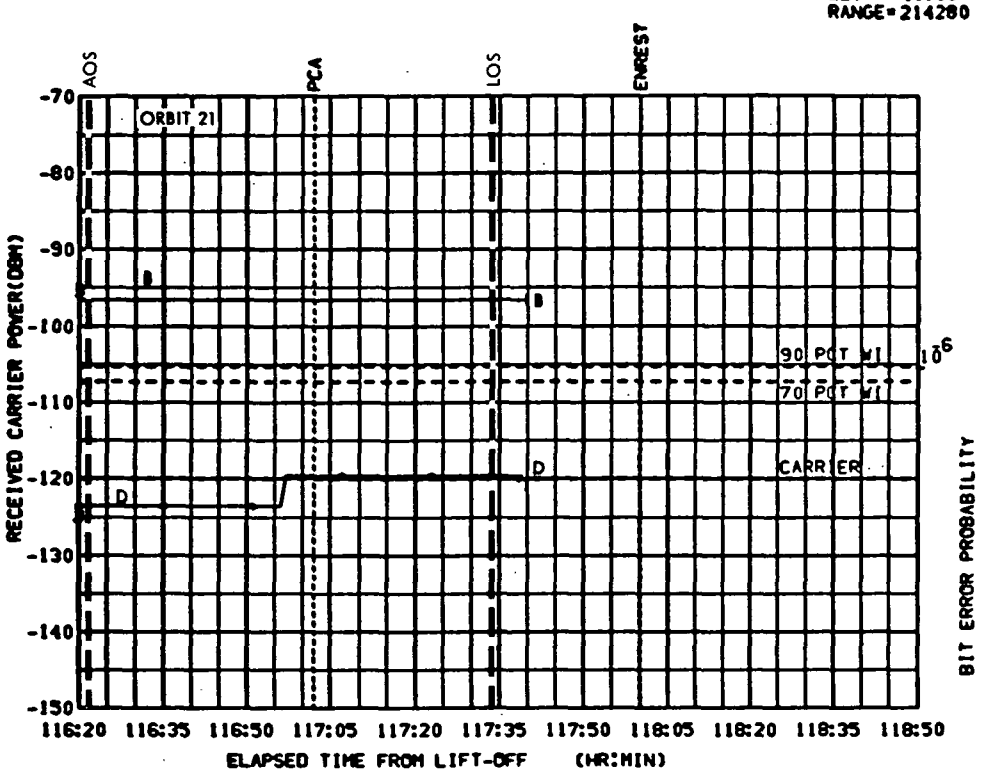


FIGURE 9-49c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

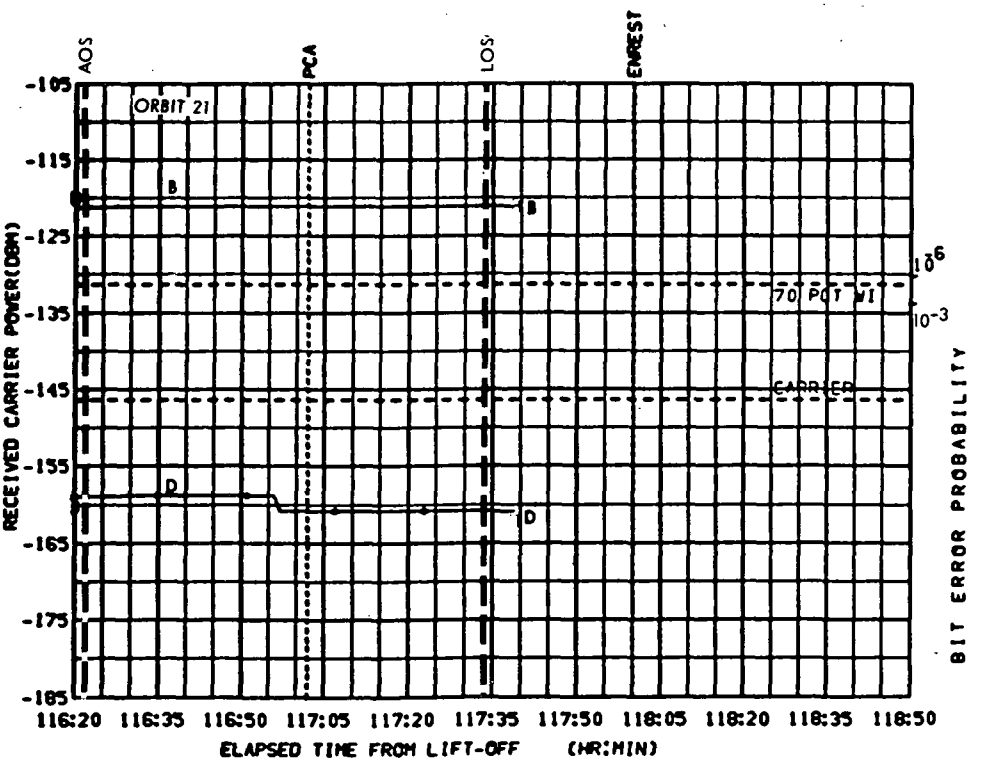


FIGURE 9-49d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

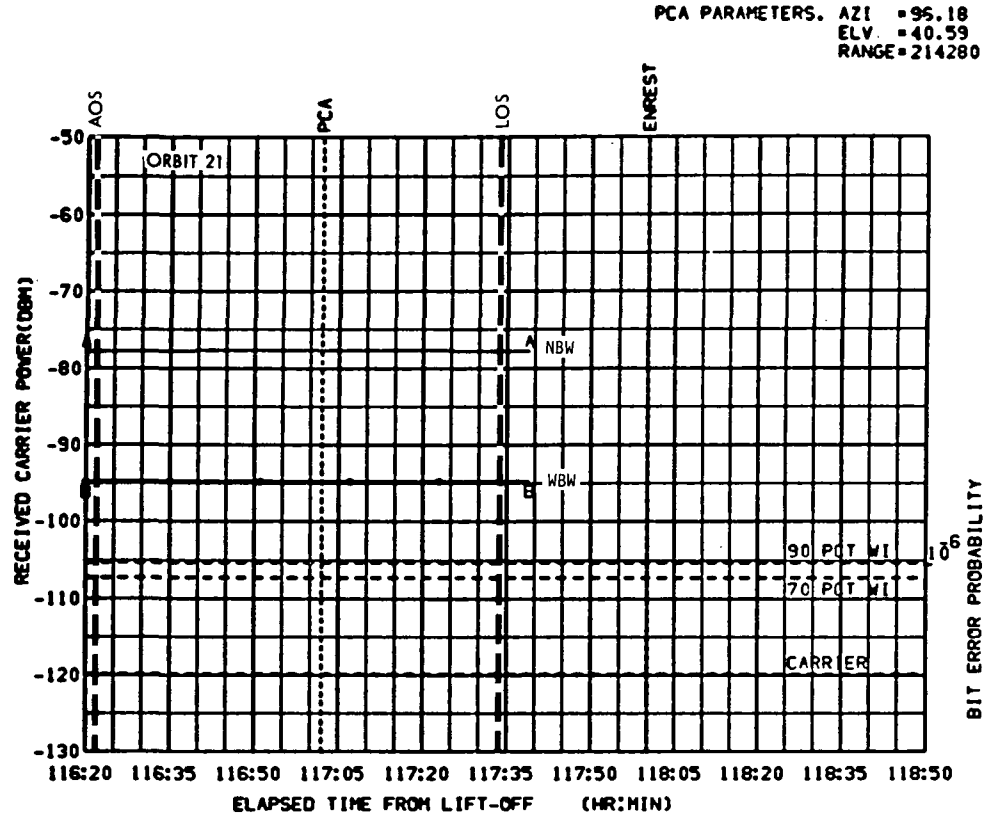


FIGURE 9-49e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

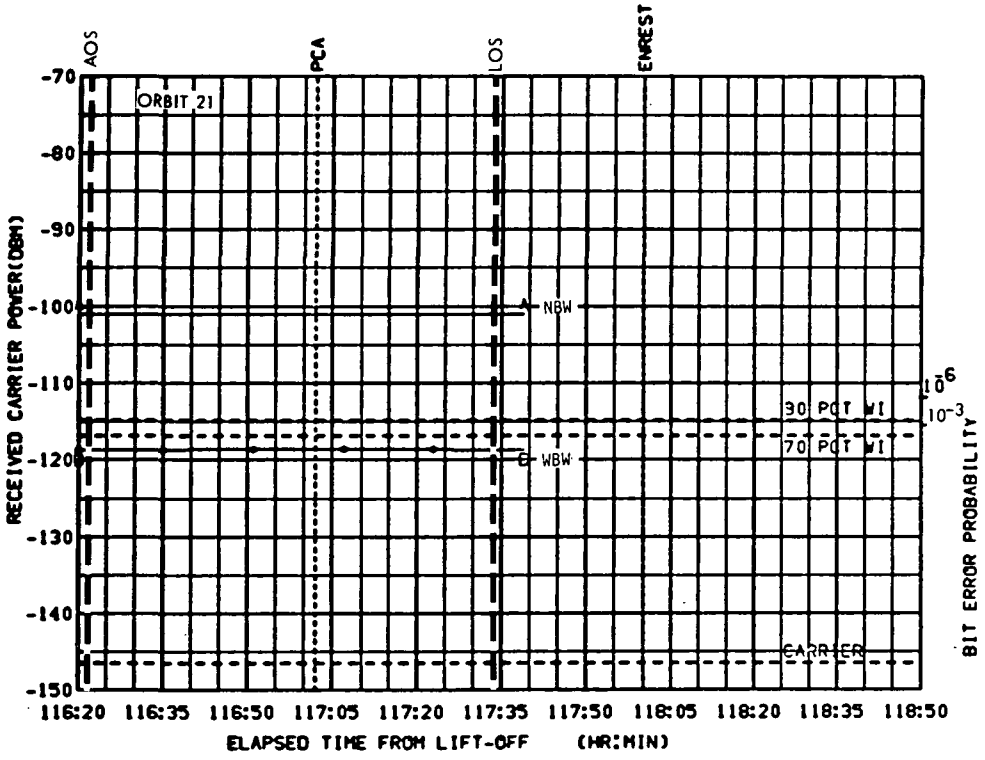


FIGURE 9-49f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

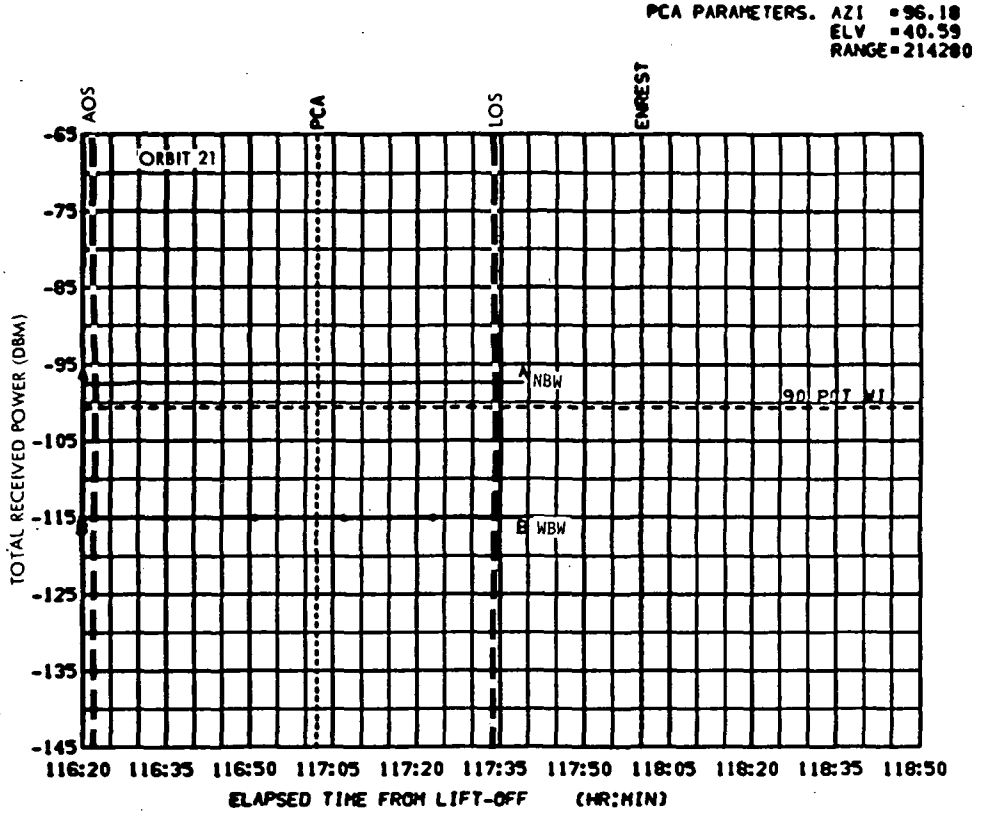


FIGURE 9-49g MAD CSM ONLY. LUNAR PARKING ORBIT. APOLLO DNLINK FM MODES CSM/MSFN S-BAND HGA
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =124.6
ELV =60.87
RANGE=213395

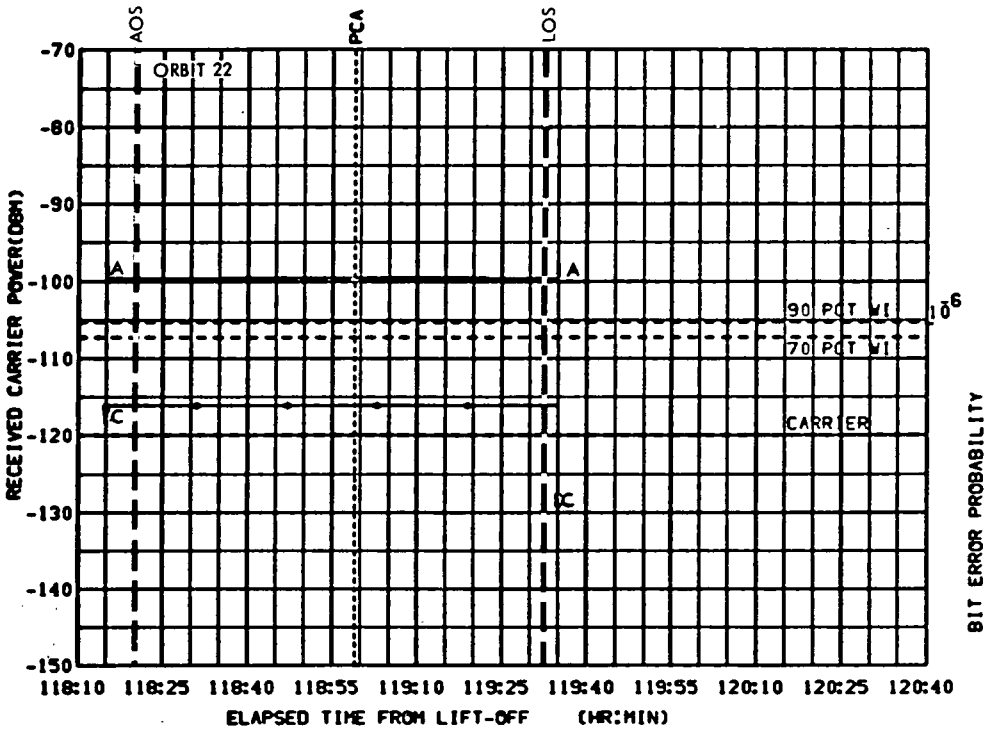


FIGURE 9-50a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

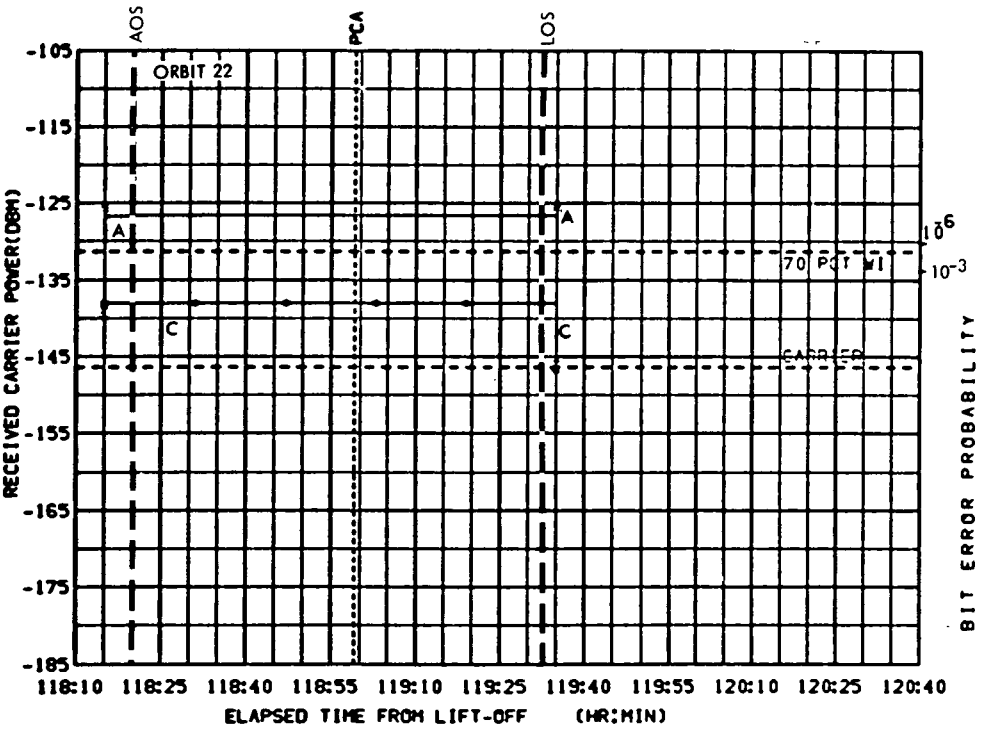


FIGURE 9-50b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =124.6
ELV =60.87
RANGE=213395

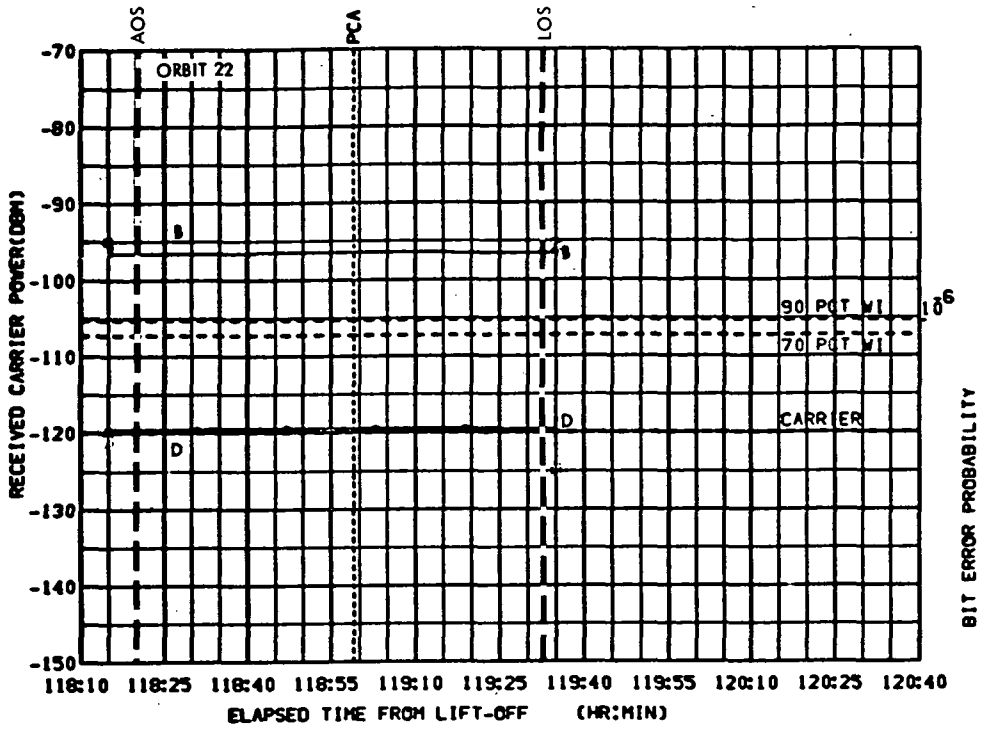


FIGURE 9-50c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

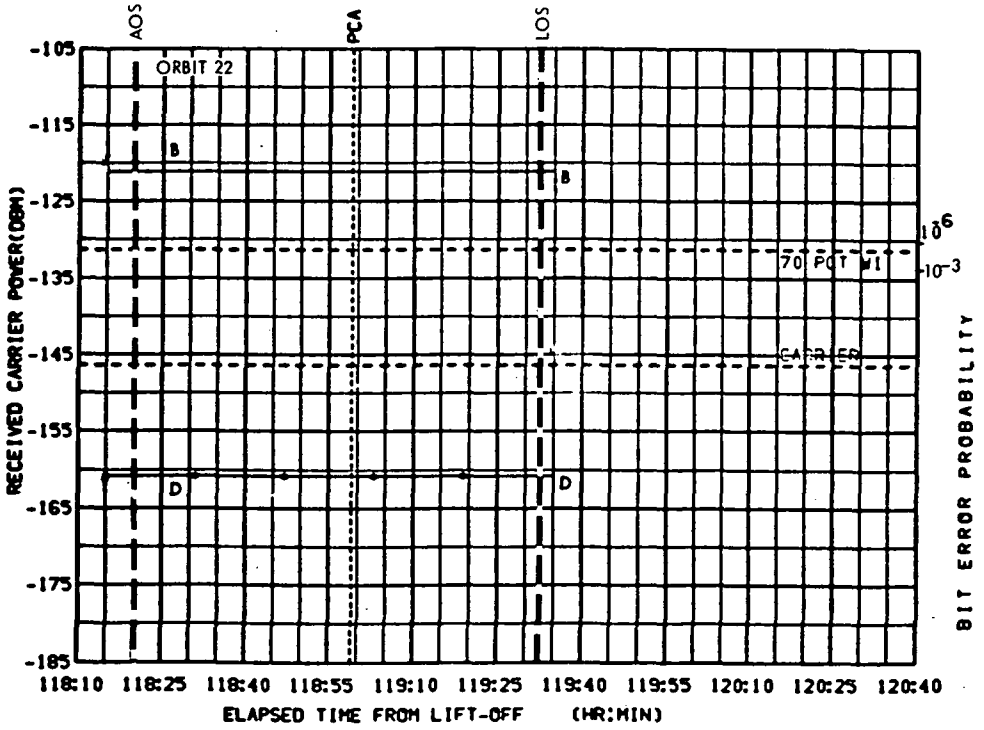


FIGURE 9-50d. MAD ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = 124.6
ELV = 60.87
RANGE = 213395

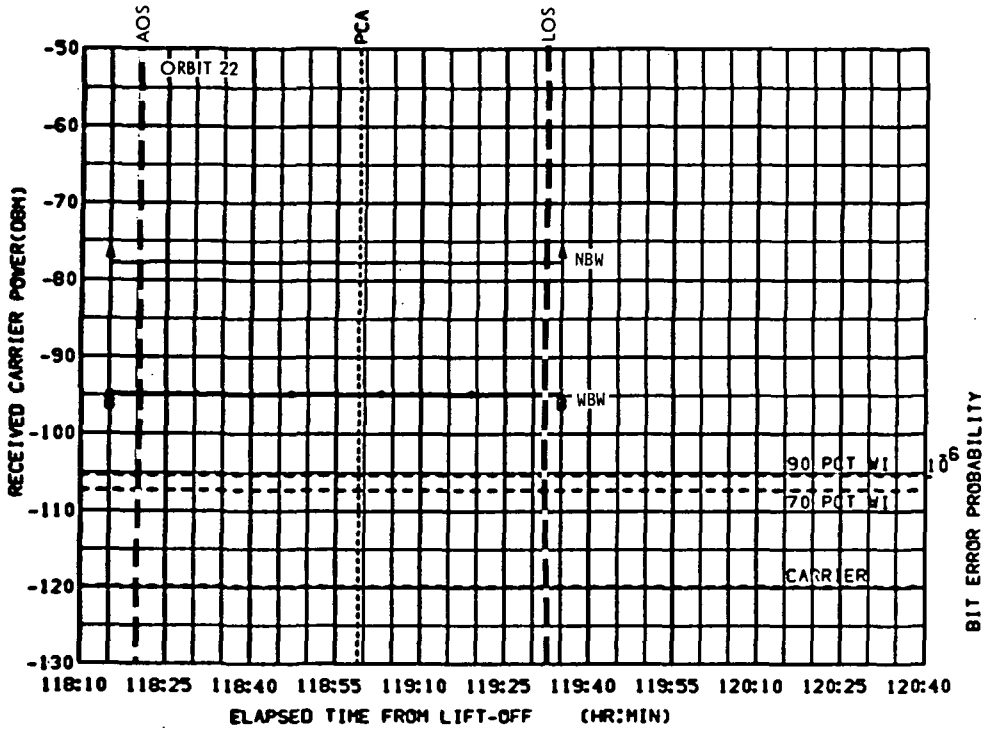


FIGURE 9-50e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

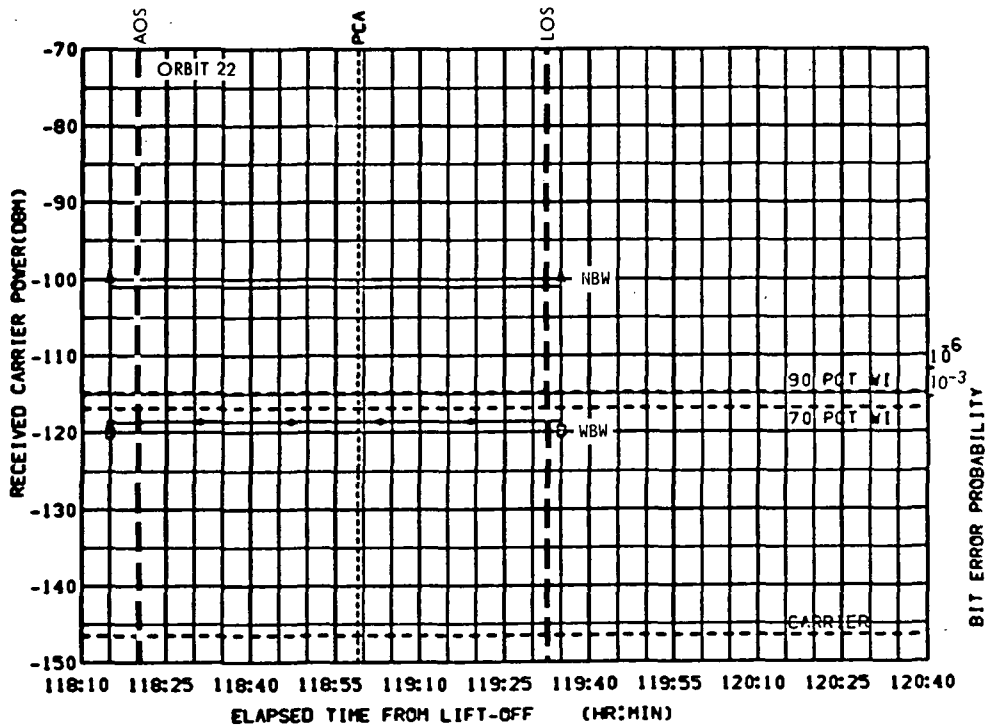


FIGURE 9-50f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

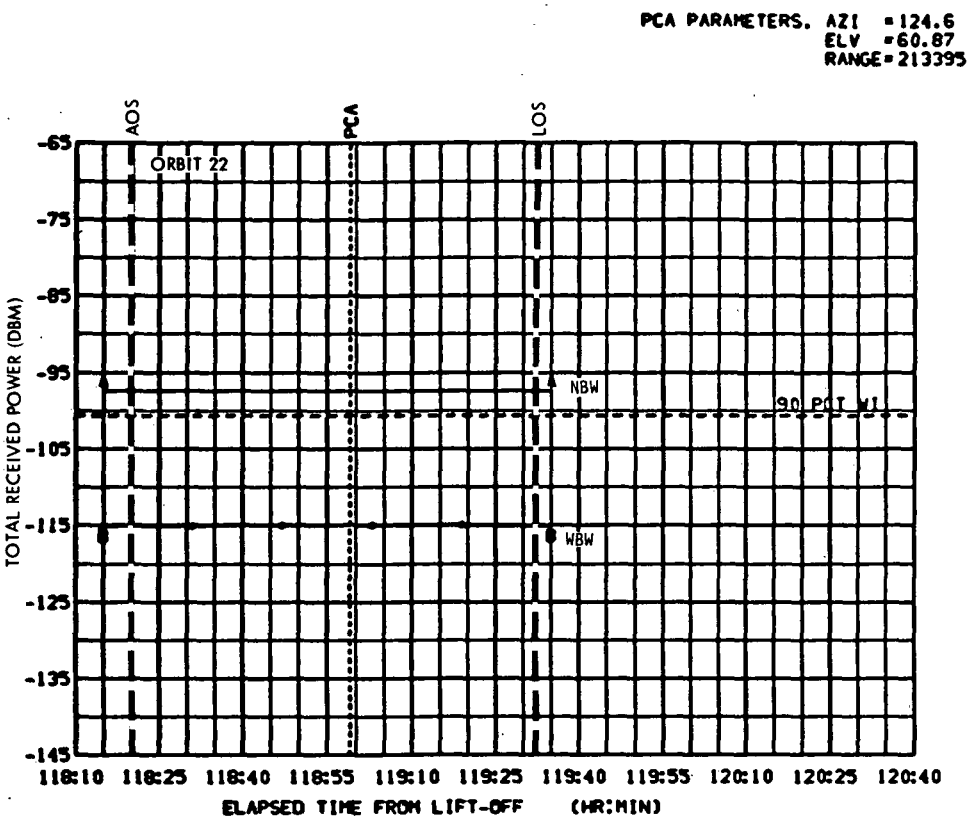


FIGURE 9-50g. MAD CSM ONLY. LUNAR PARKING ORBIT. APOLLO DNLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 49.06
ELV = 44.31
RANGE = 213994

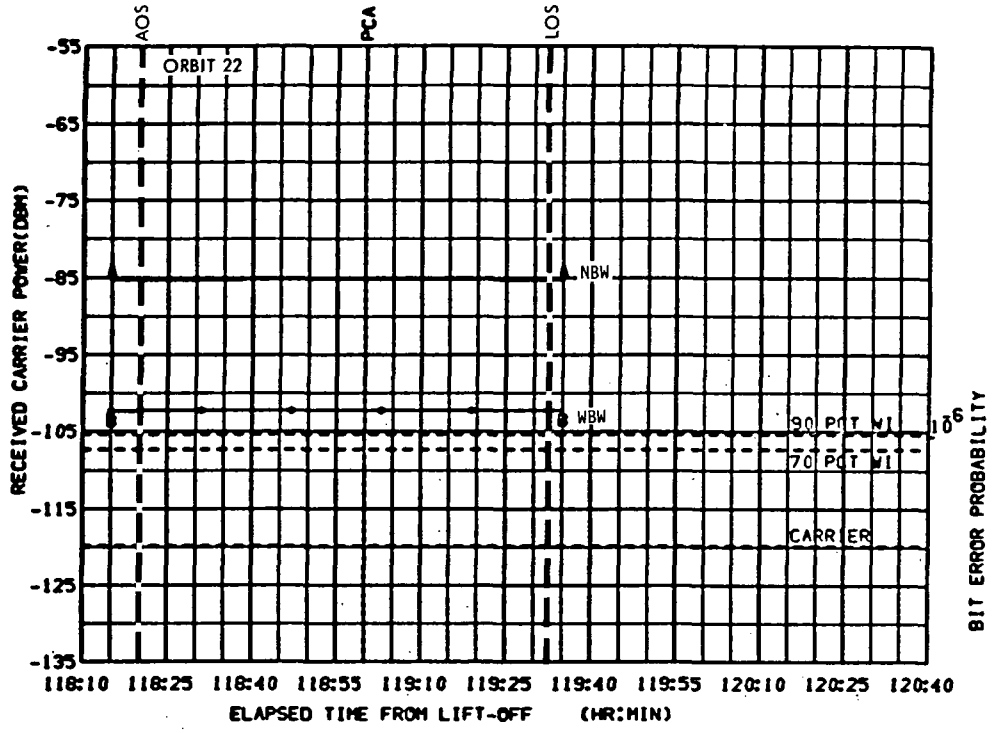


FIGURE 9-51a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

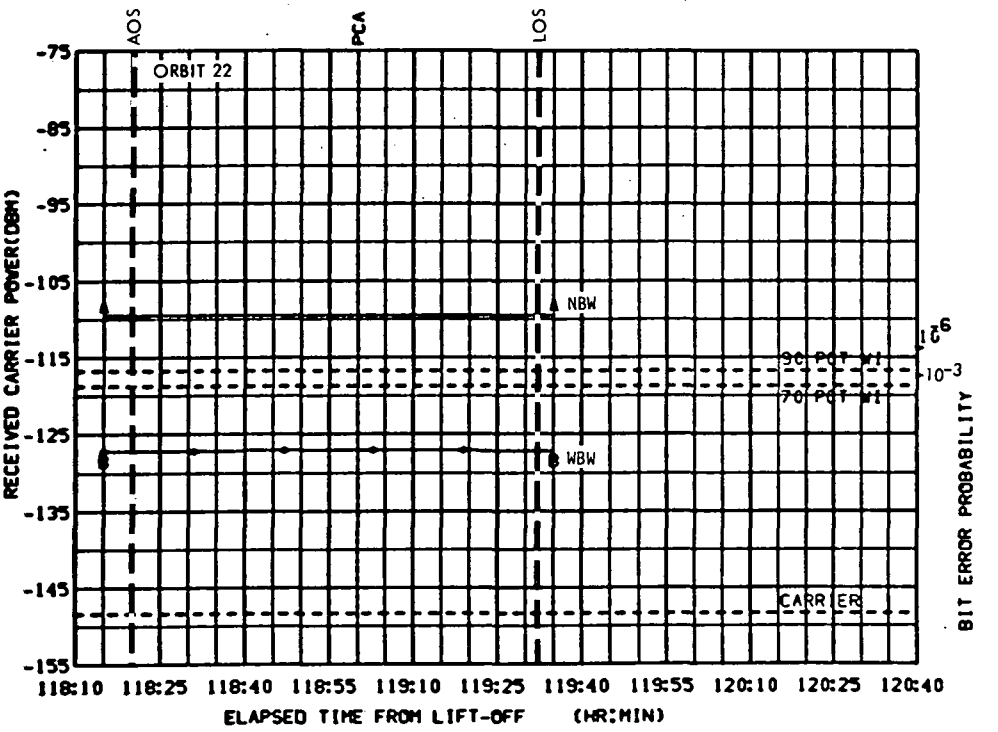


FIGURE 9-51b. ACN ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =13.01
ELV =59.95
RANGE=213296

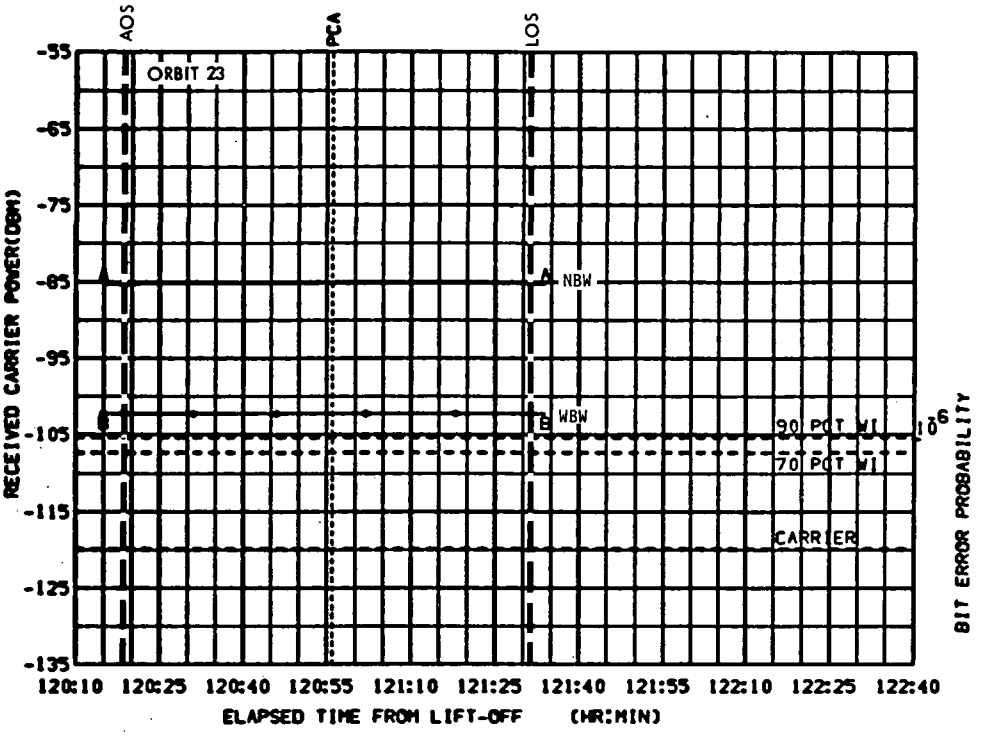


FIGURE 9-52a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

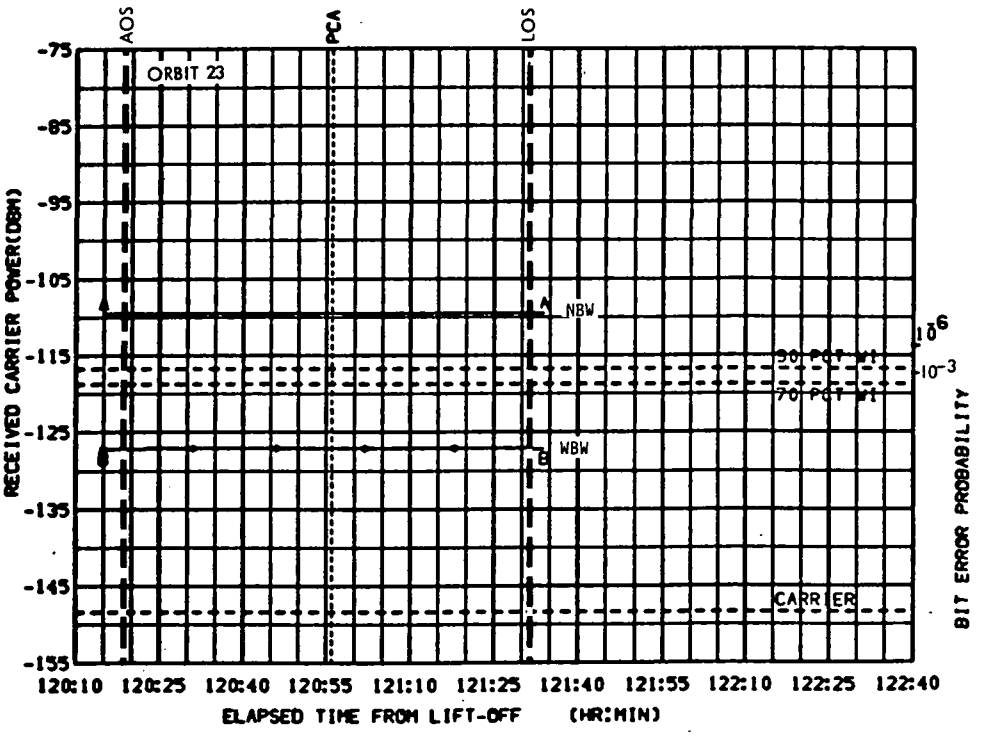


FIGURE 9-52b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =-171.4
ELV =69.92
RANGE=213048

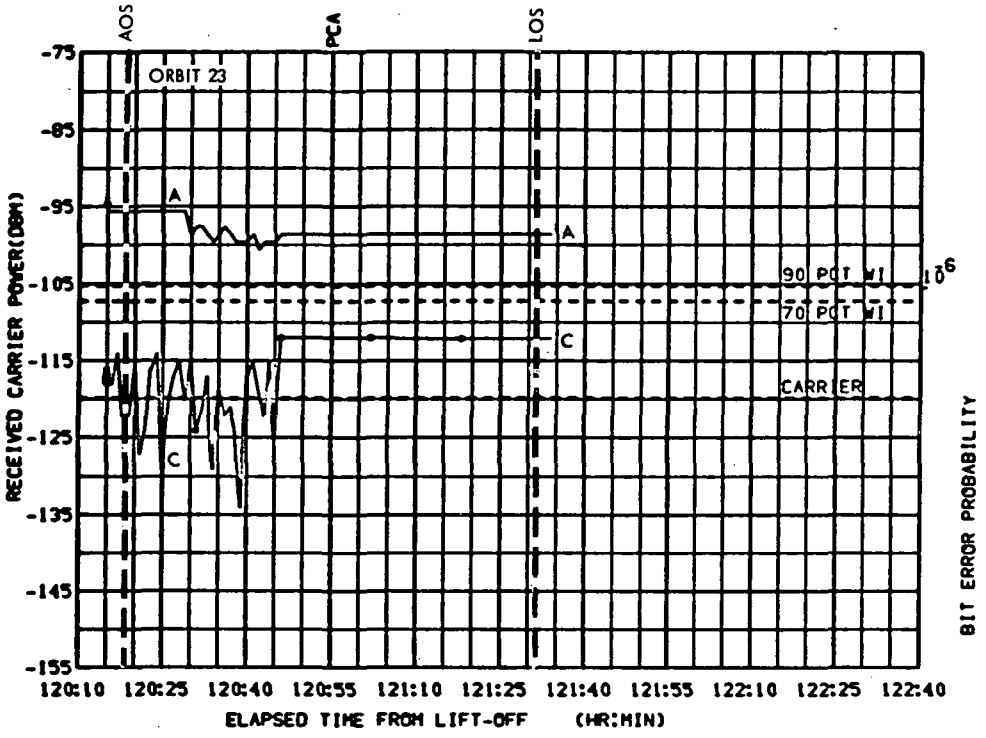


FIGURE 9-53a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

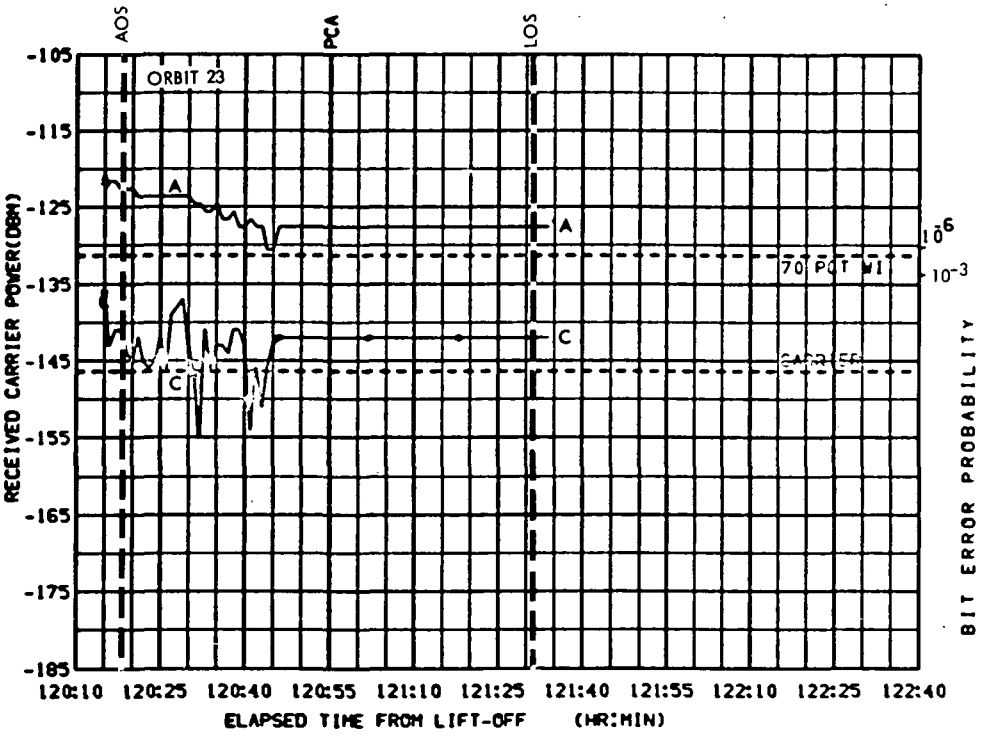


FIGURE 9-53b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -171.4
ELV = 69.92
RANGE = 213048

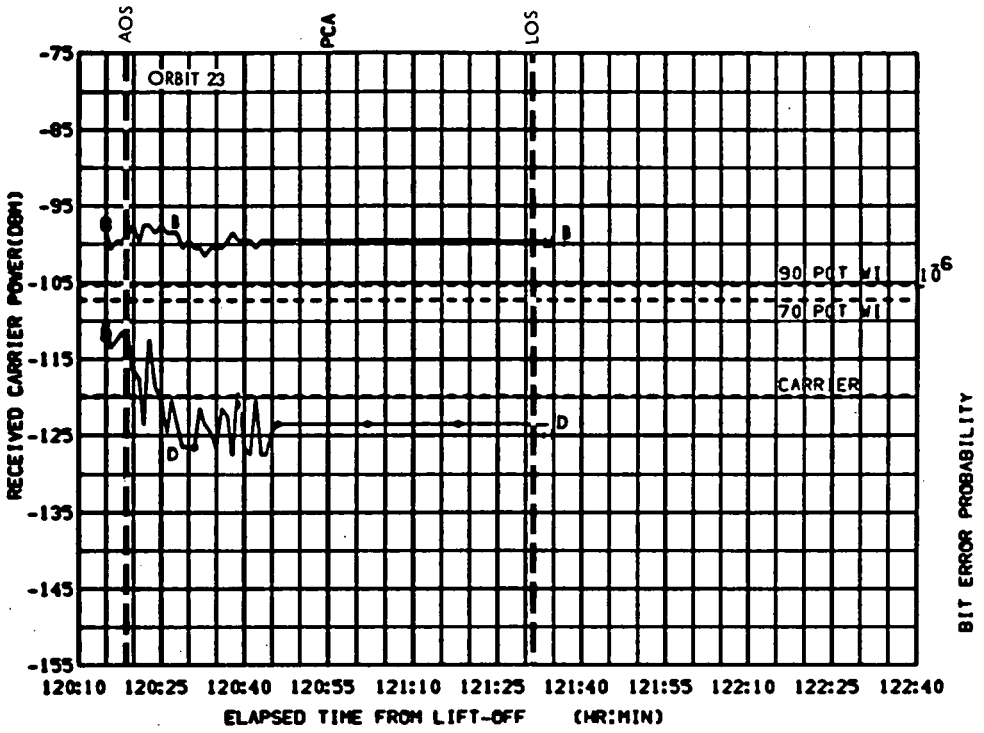


FIGURE 9-53c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

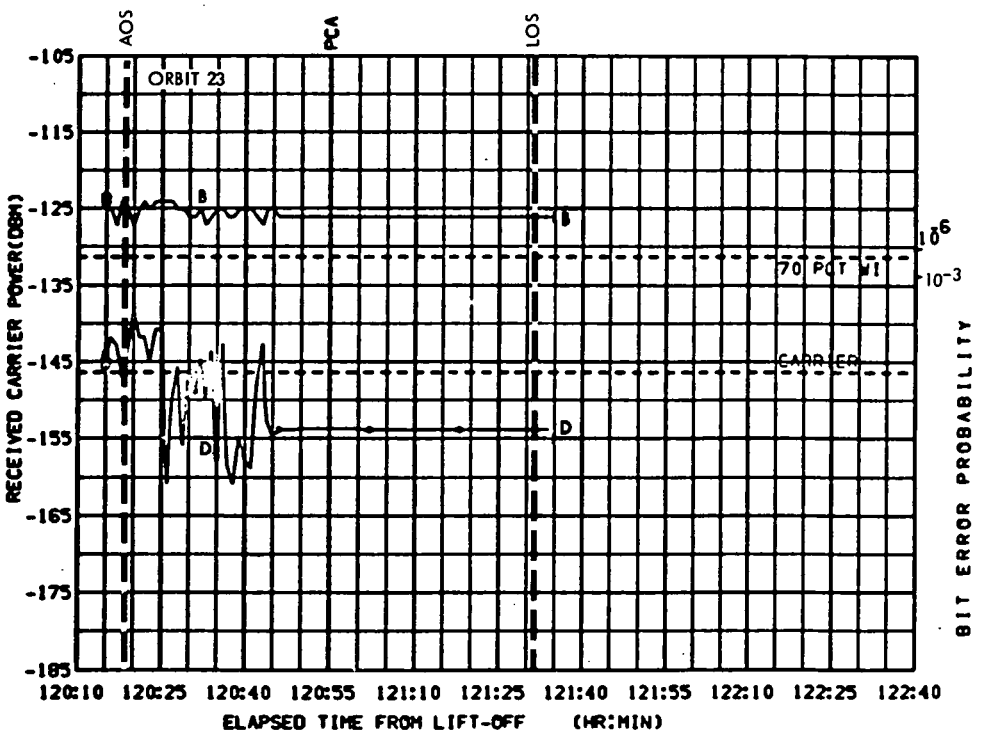


FIGURE 9-53d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -171.4
ELV = 69.92
RANGE = 213048

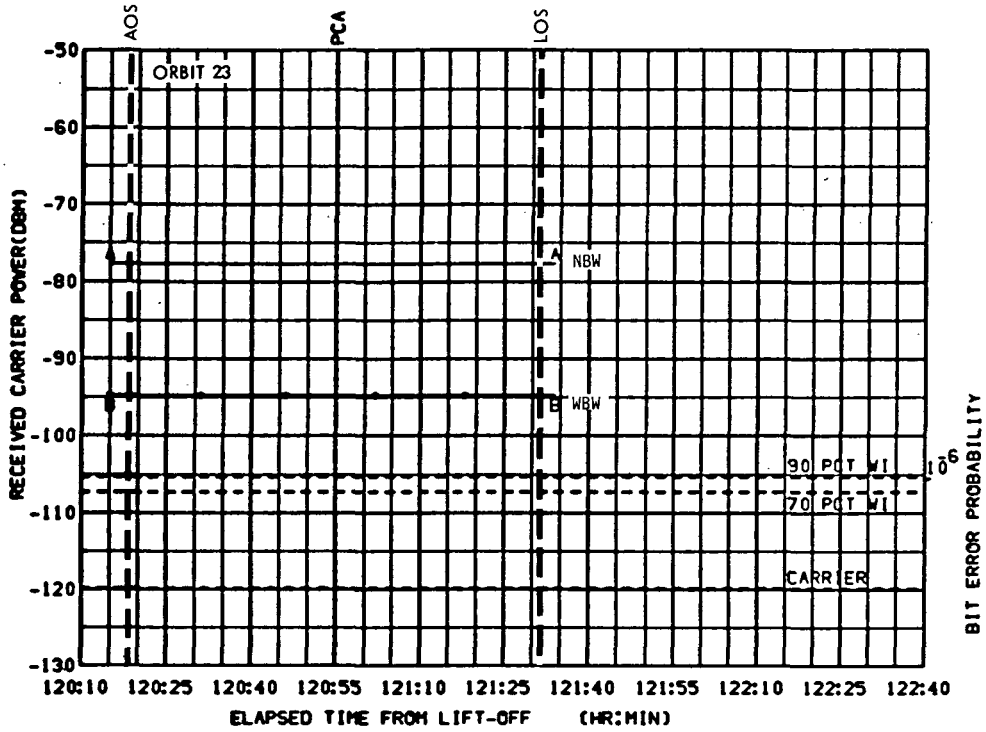


FIGURE 9-53e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

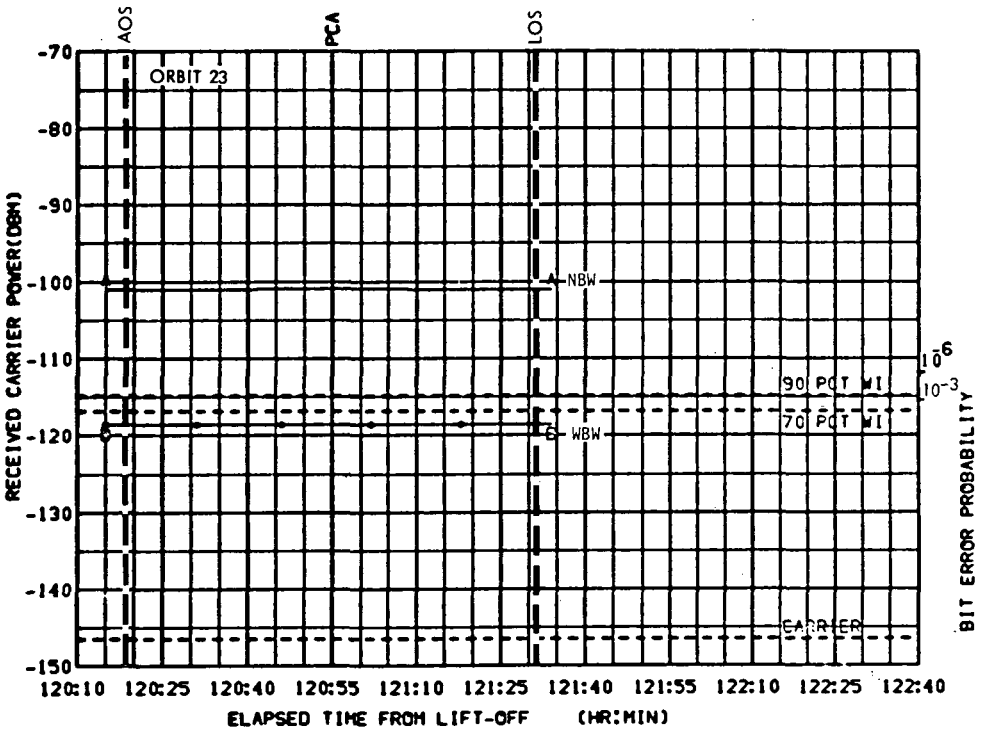


FIGURE 9-53f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

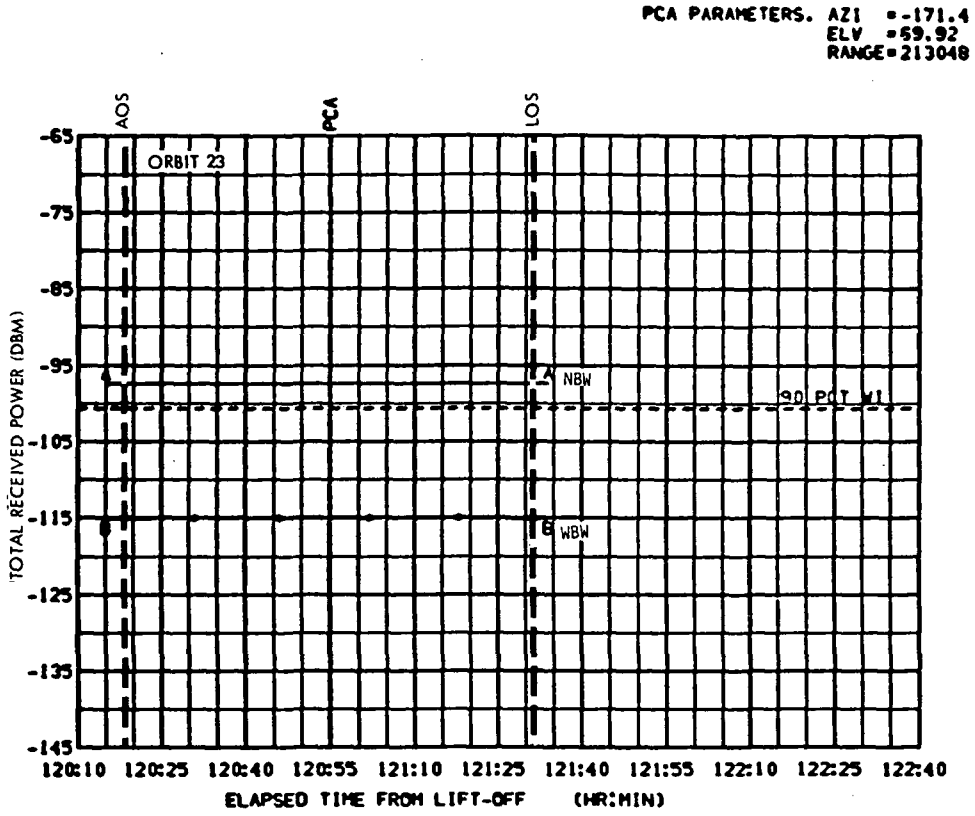


FIGURE 9-53g. MAD CSM ONLY. LUNAR PARKING ORBIT. APOLLO DNLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

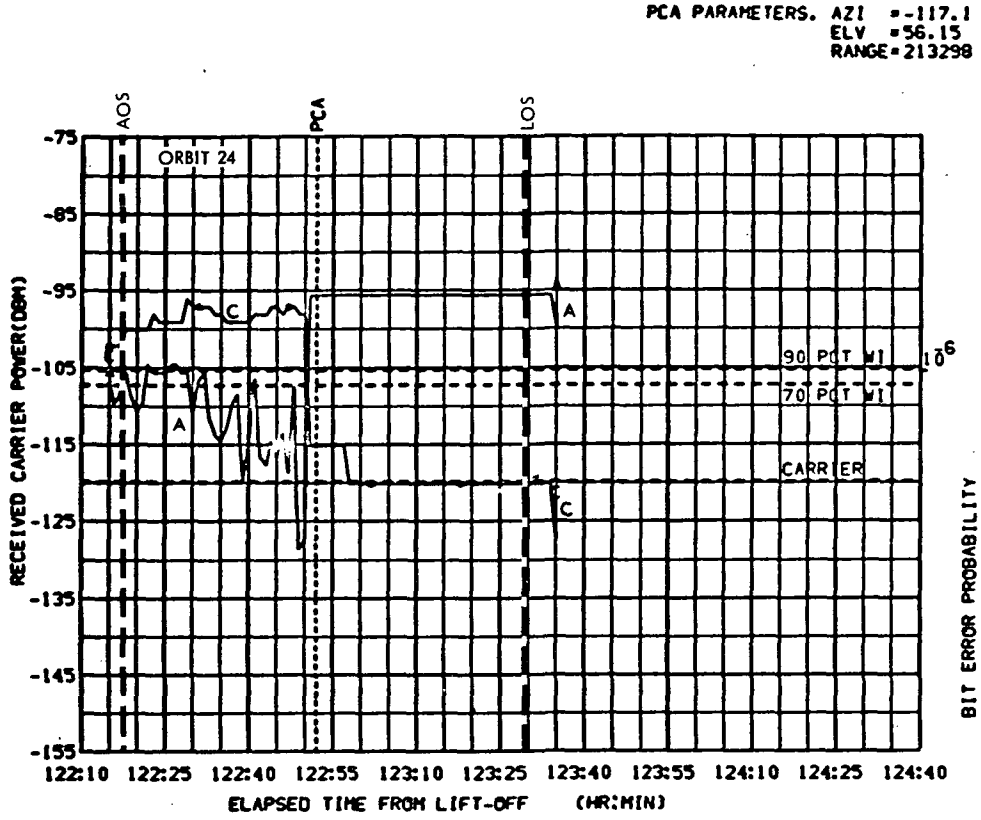


FIGURE 9-54a. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

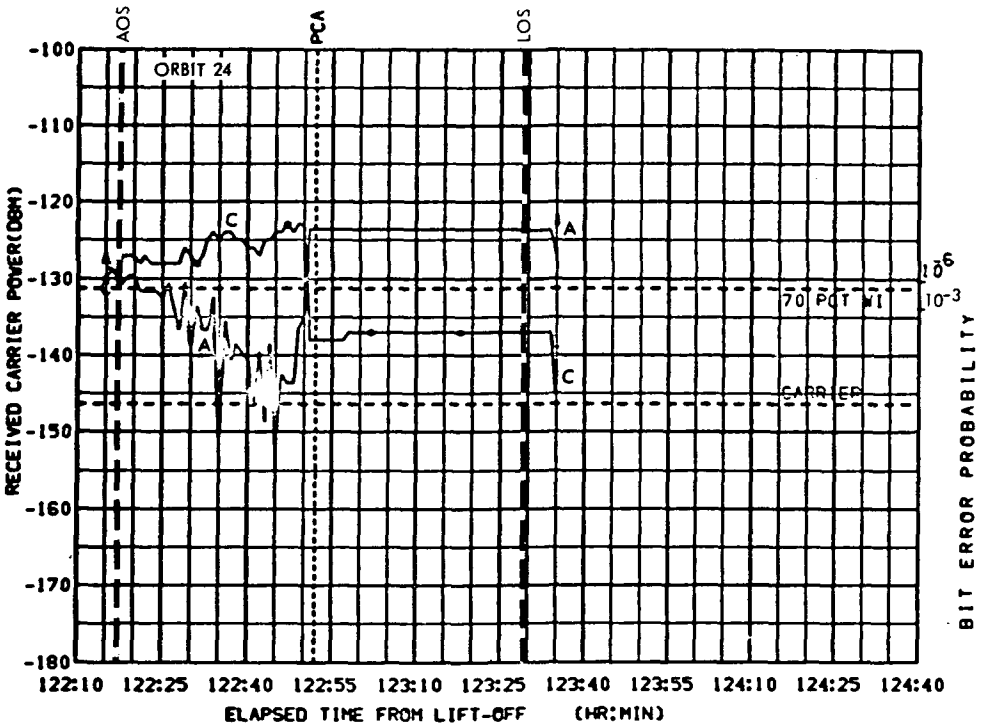


FIGURE 9-54b. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -117.1
ELV = 56.15
RANGE = 213298

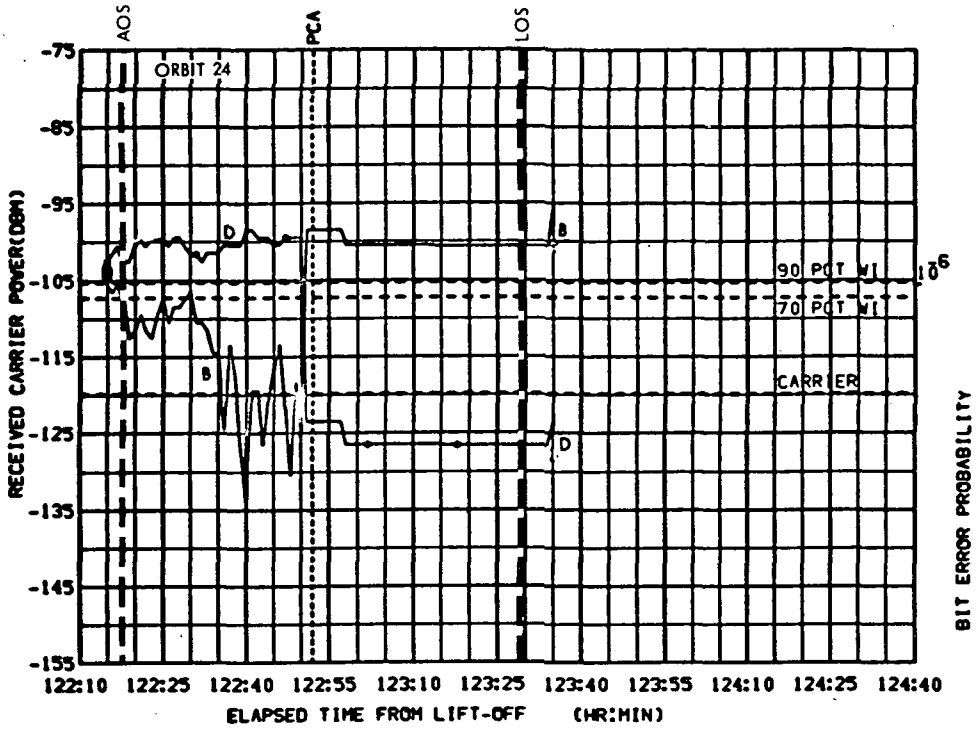


FIGURE 9-54c. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

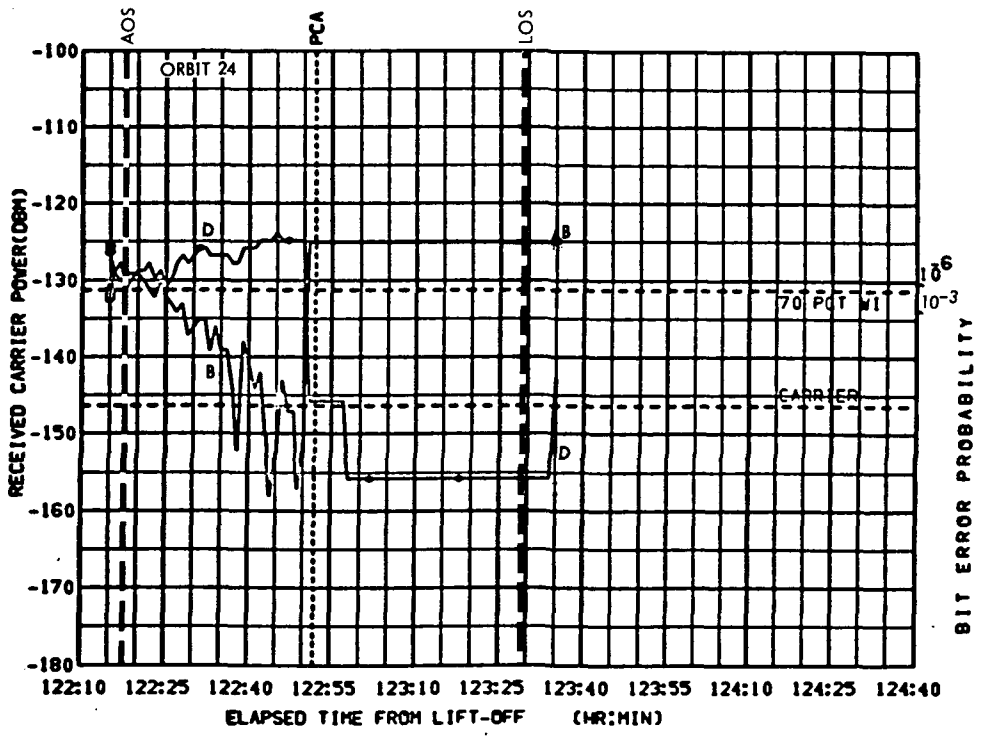


FIGURE 9-54d. MAD DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = -117.1
ELV = 56.15
RANGE = 213298

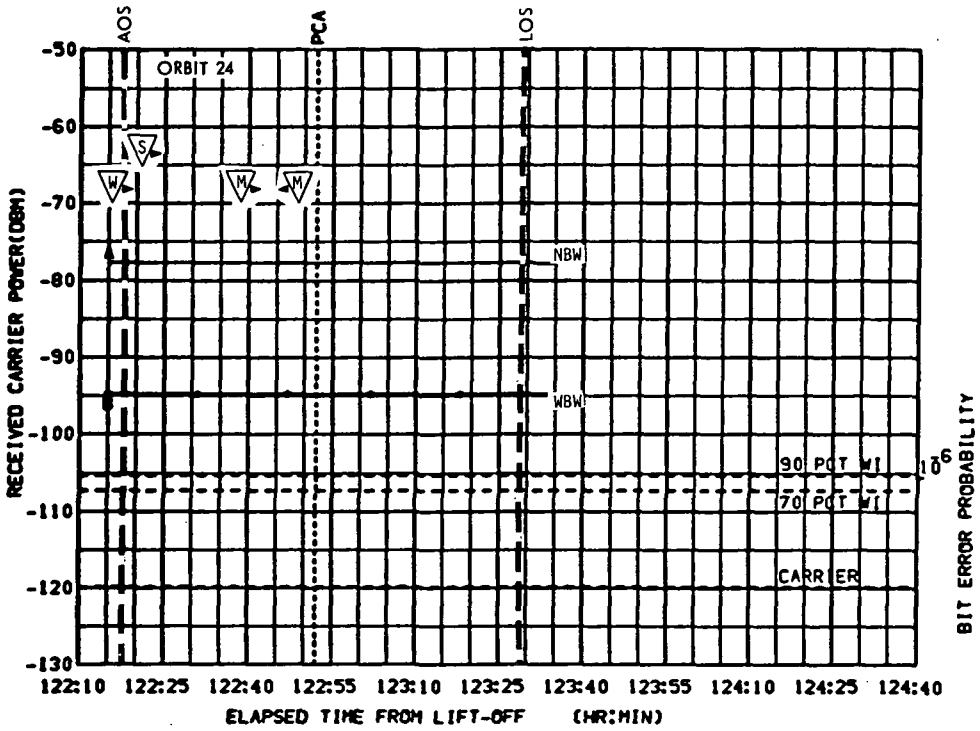


FIGURE 9-54e. MAD UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

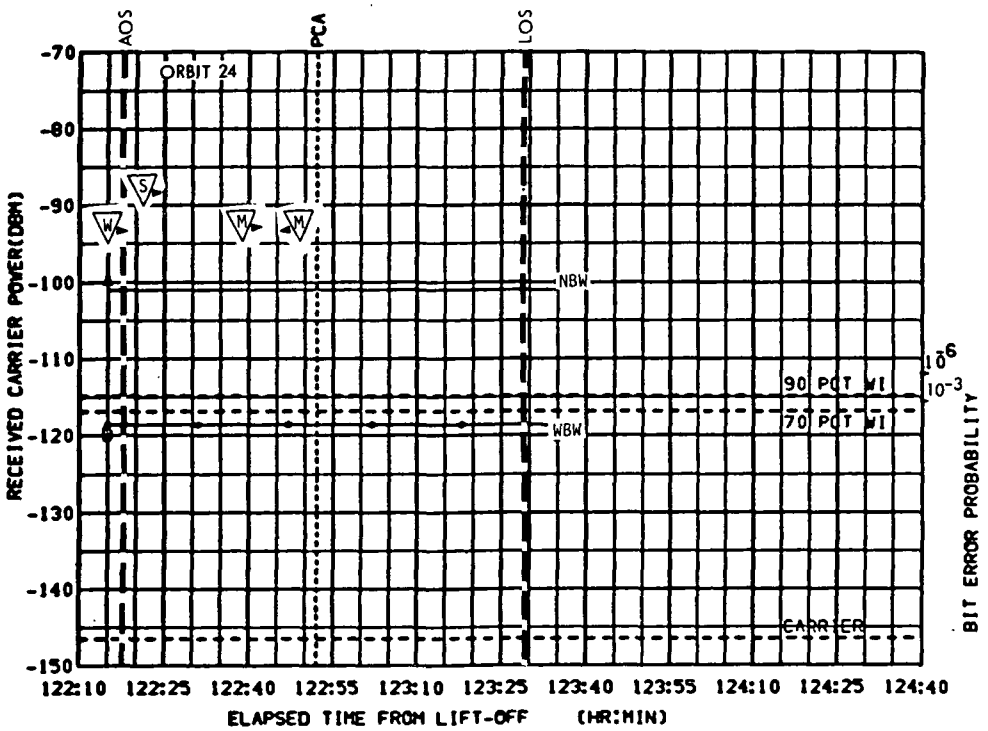


FIGURE 9-54f. MAD DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

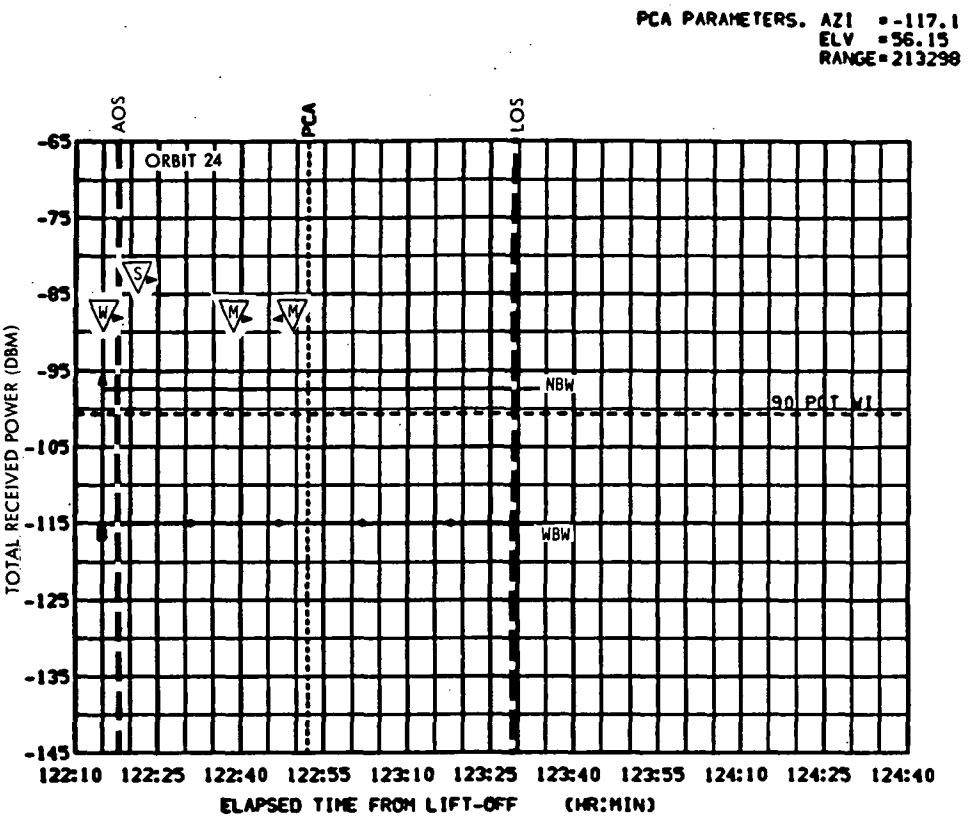


FIGURE 9-54g. MAD CSM ONLY. LUNAR PARKING ORBIT. APOLLO ONLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -36.00
ELV = 54.09
RANGE = 213366

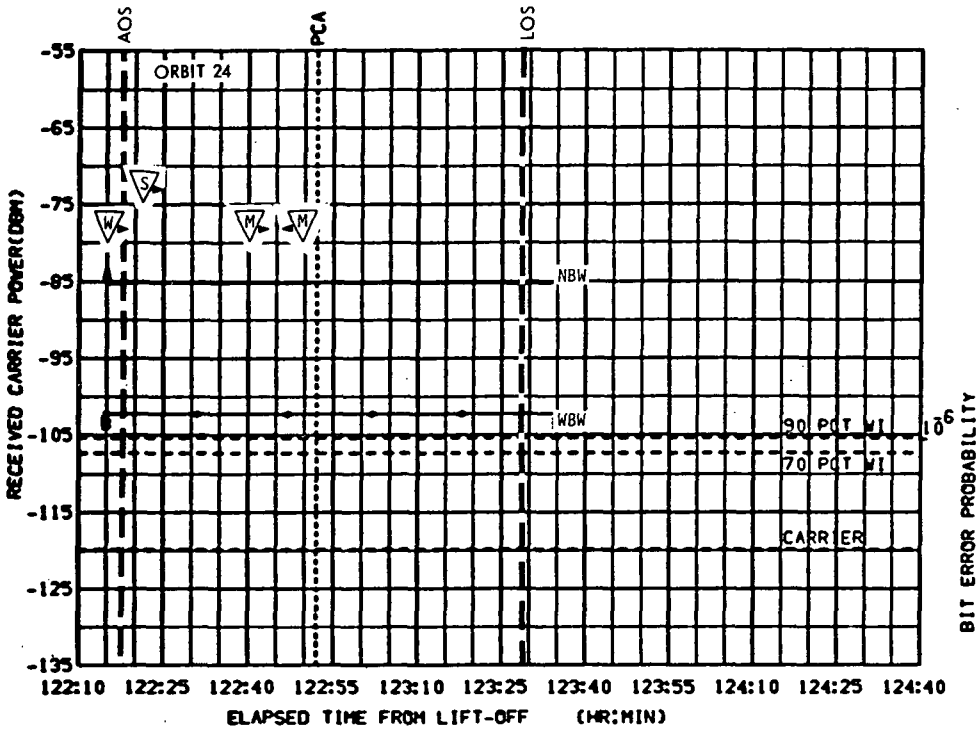


FIGURE 9-55a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

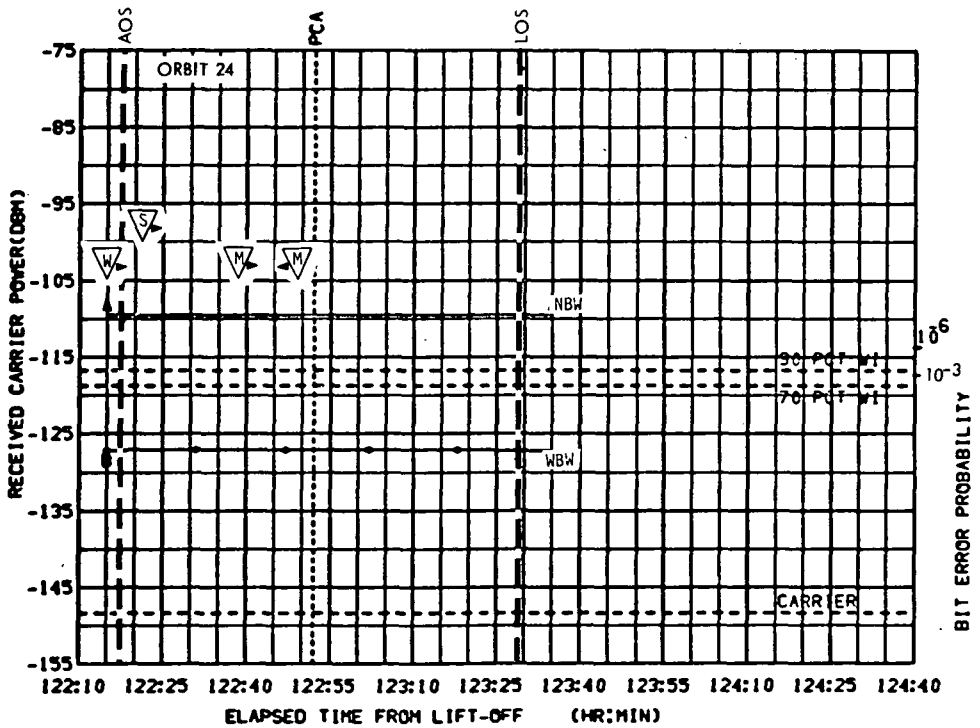


FIGURE 9-55b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -59.22
ELV = 32.83
RANGE = 214160

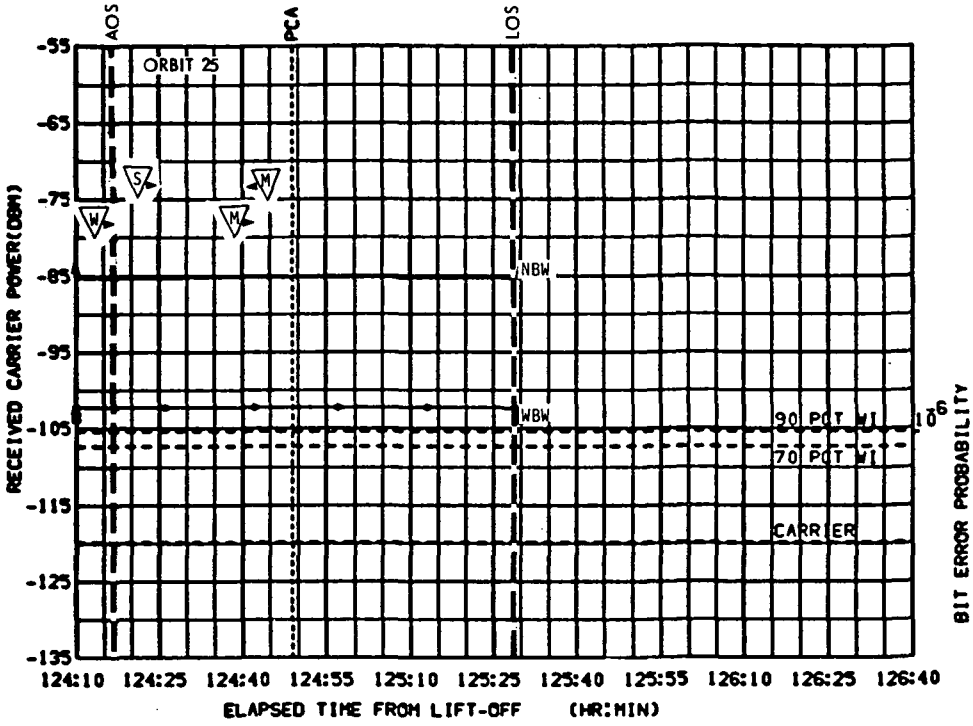


FIGURE 9-56a. ACN UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

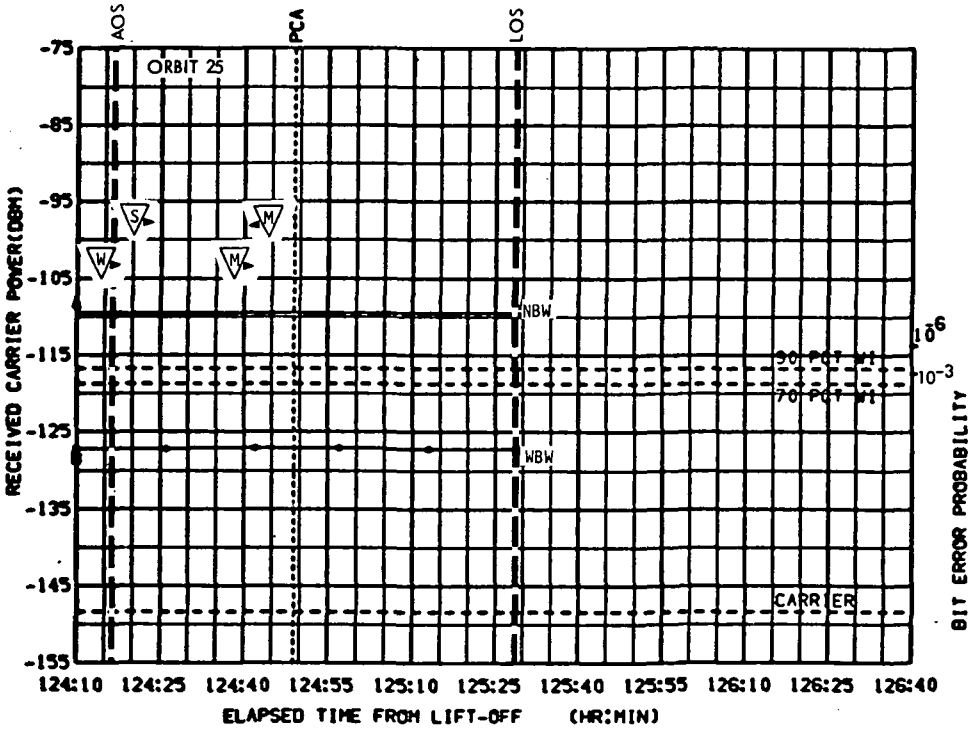


FIGURE 9-56b. ACN DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =94.42
ELV =41.86
RANGE=213731

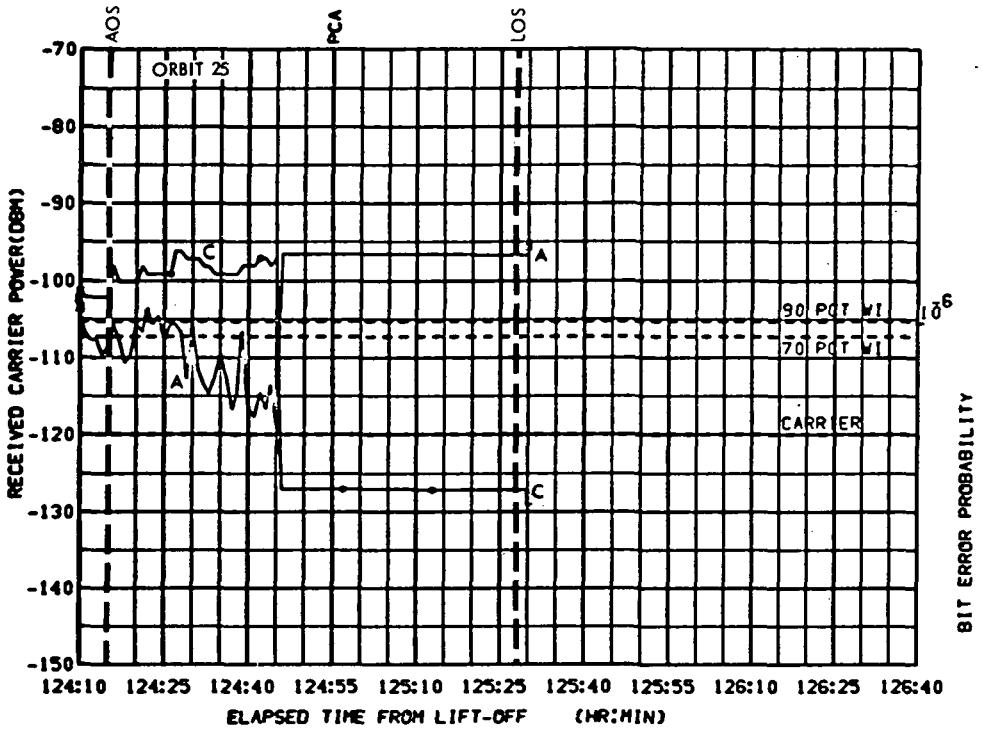


FIGURE 9-57a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

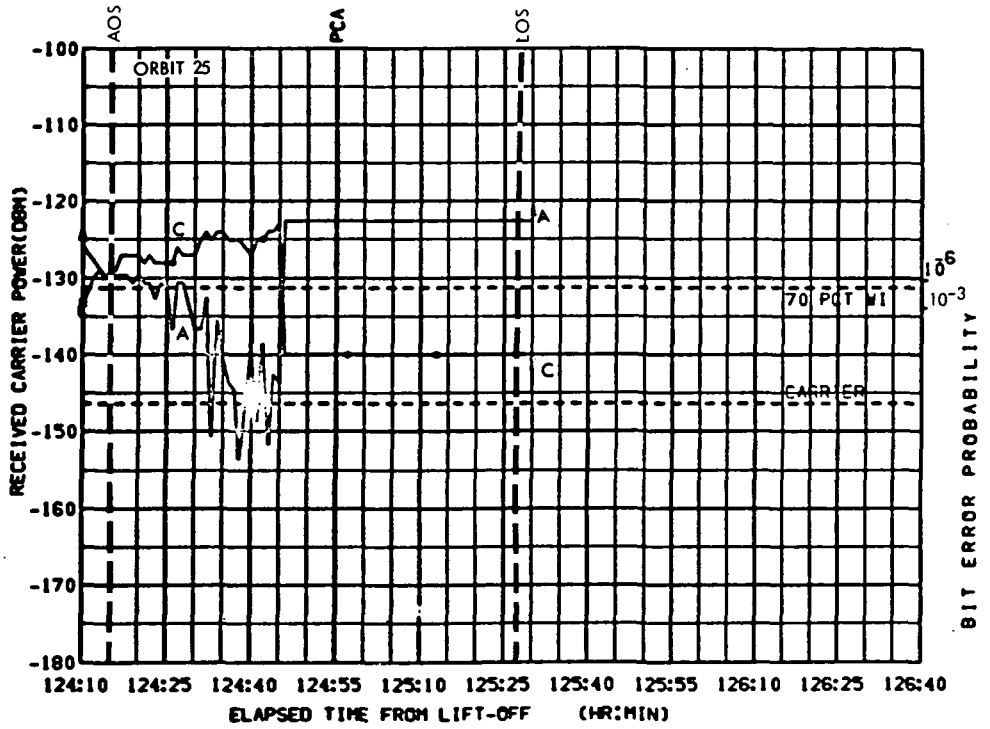


FIGURE 9-57b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =94.42
ELV =41.86
RANGE=213731

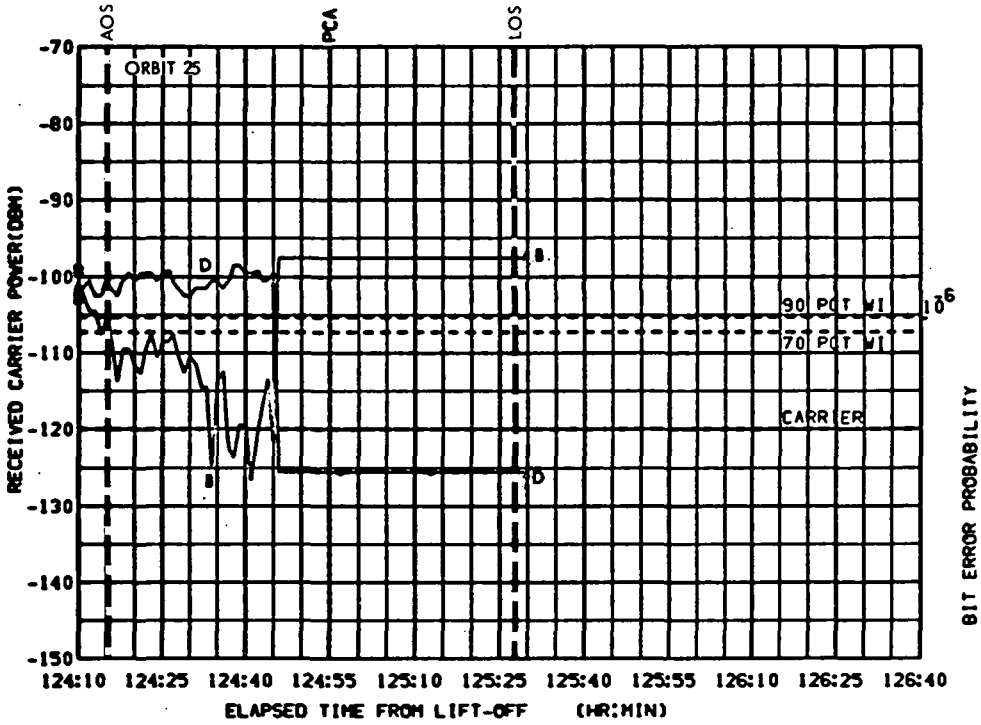


FIGURE 9-57c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

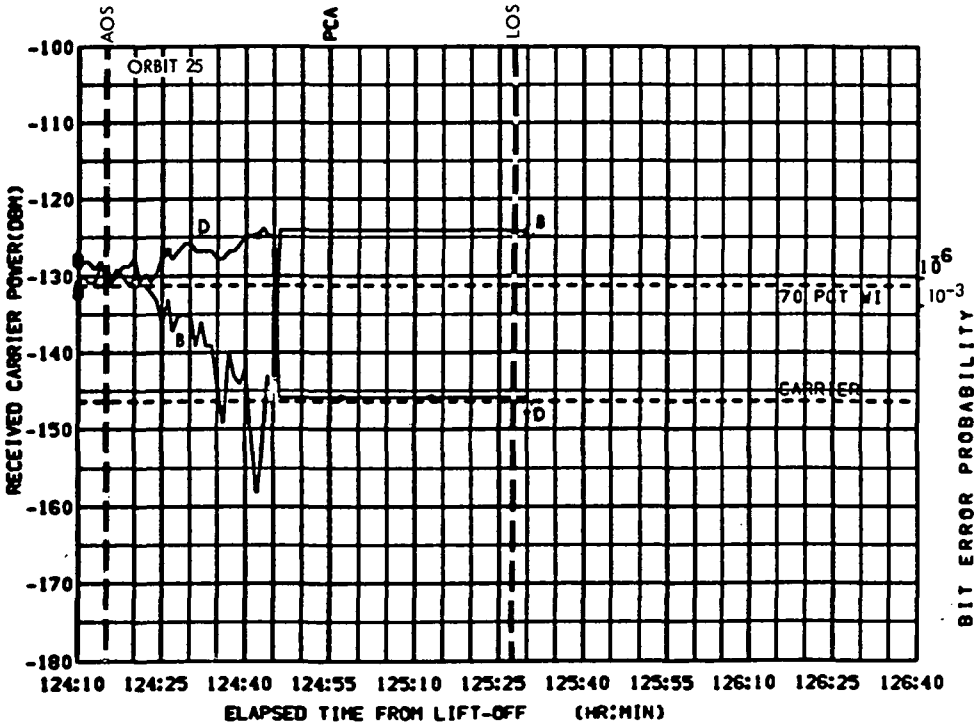


FIGURE 9-57d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10 RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =94.42
ELV =41.86
RANGE=213731

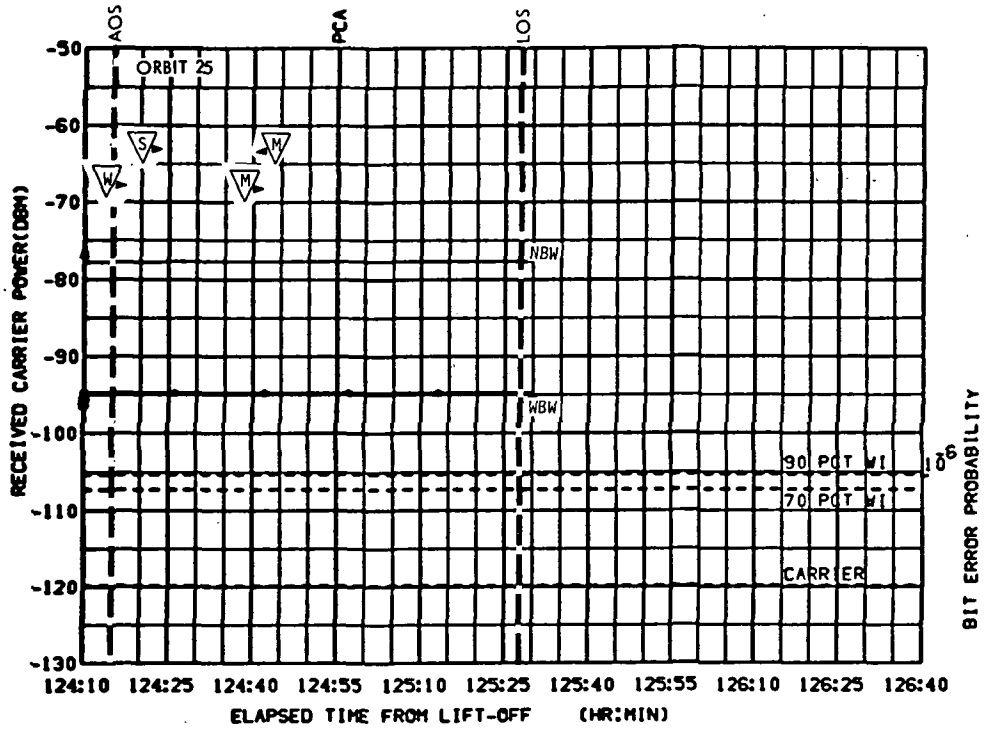


FIGURE 9-57e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

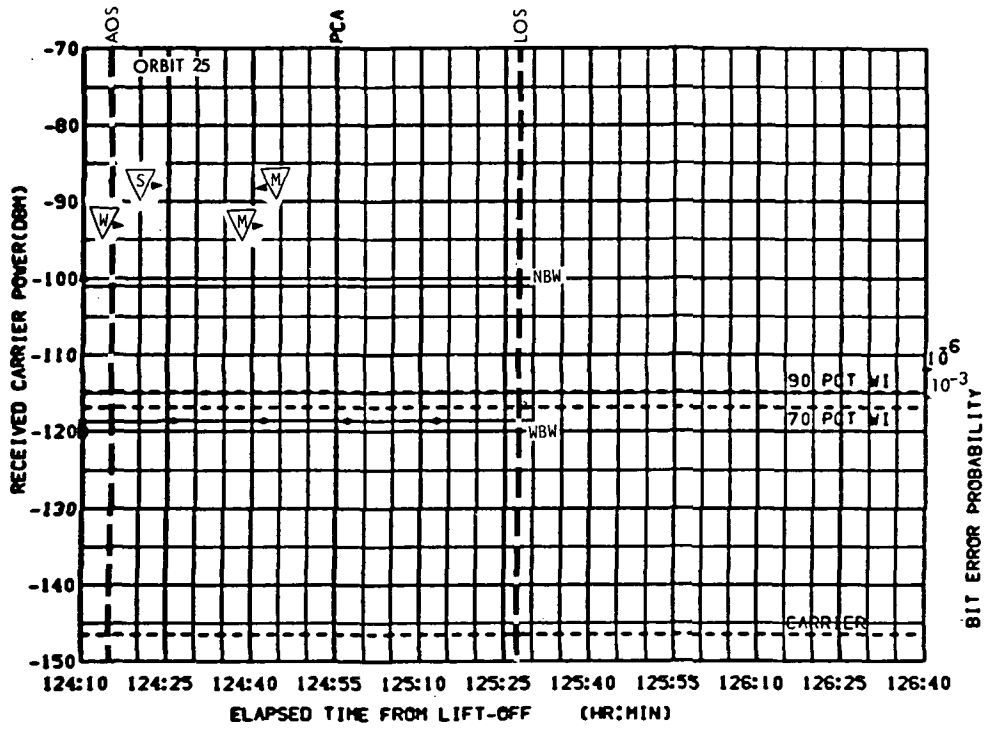


FIGURE 9-57f. GDS ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

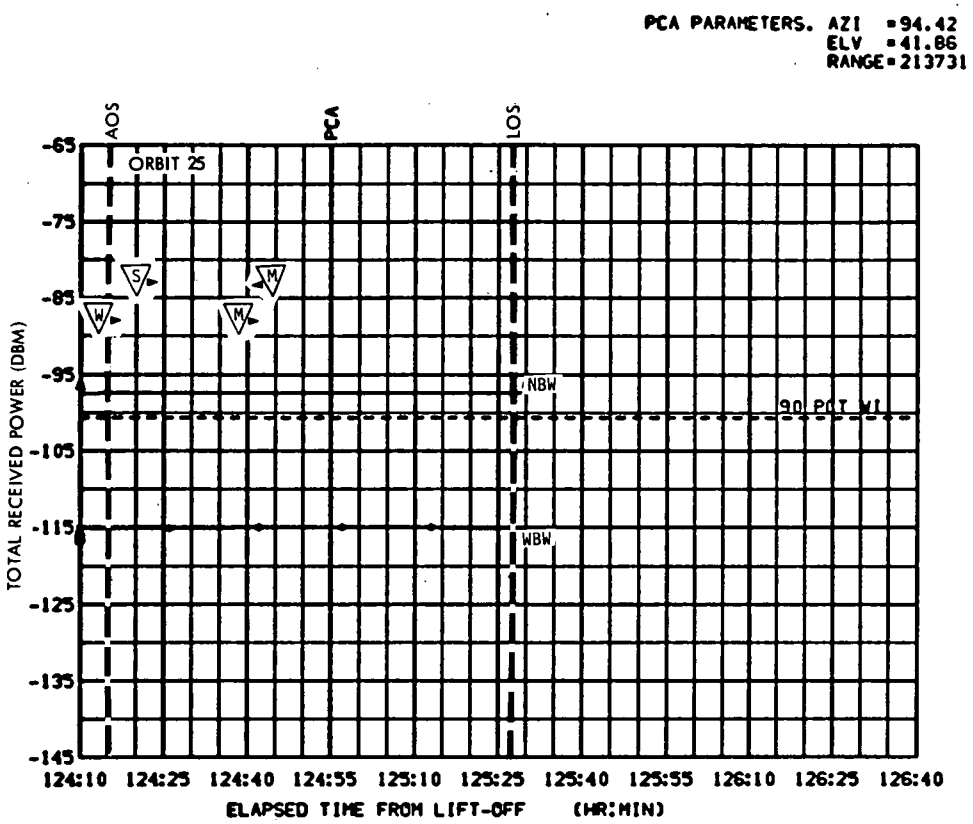


FIGURE 9-57g. GDS CSM ONLY. LUNAR PARKING ORBIT. APOLLO ONLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 121.3
ELV = 64.06
RANGE = 212802

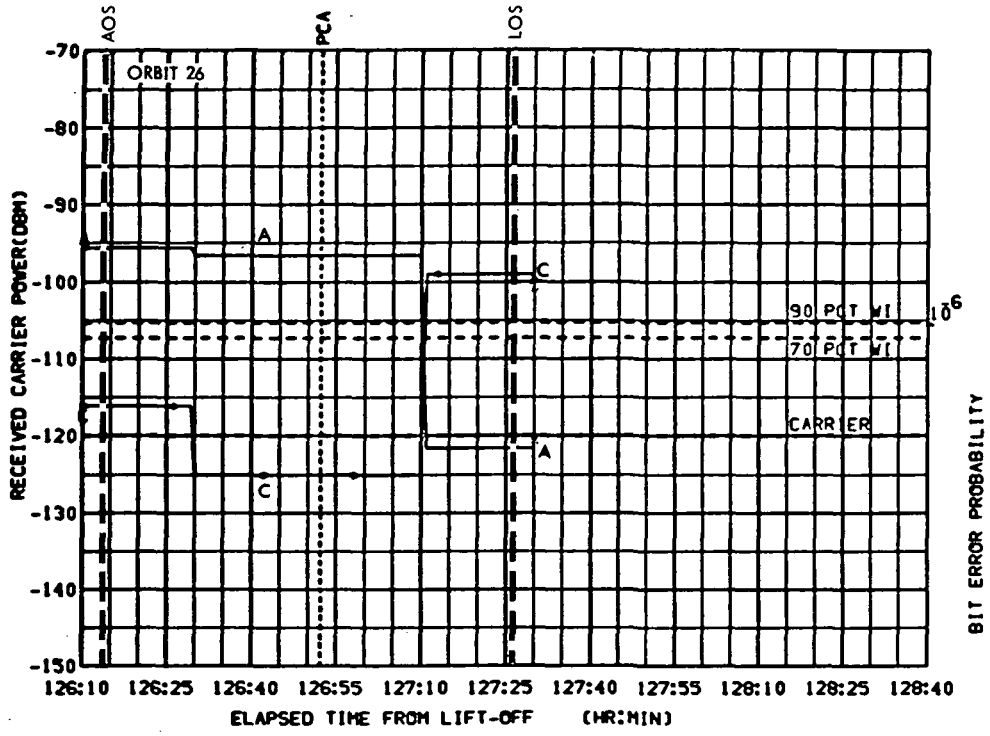


FIGURE 9-58a. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

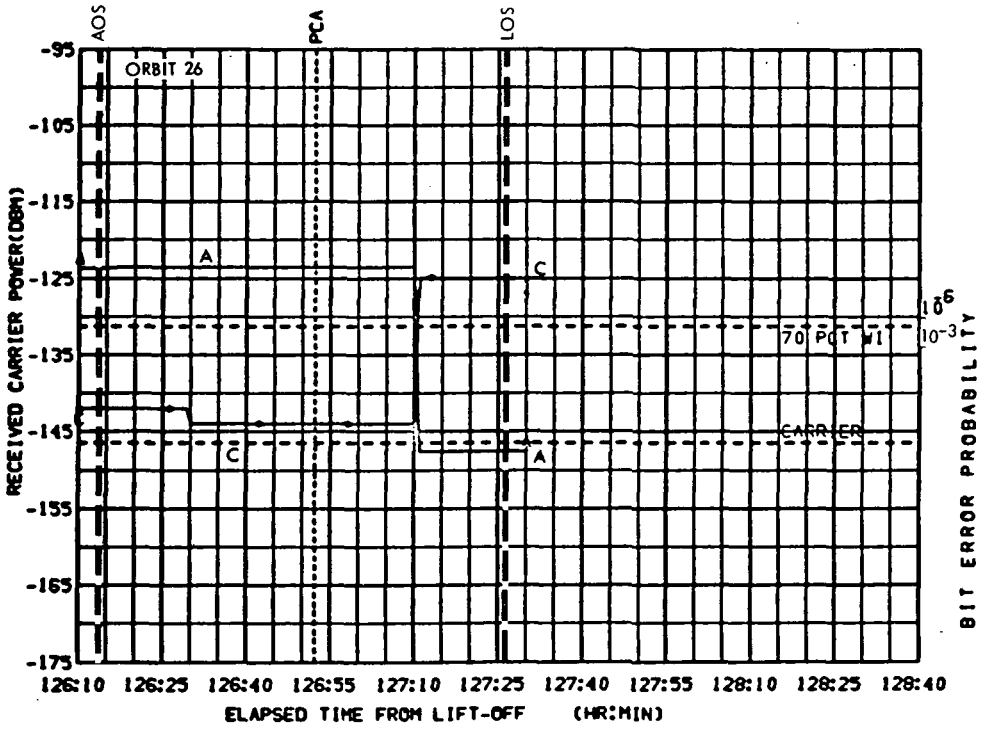


FIGURE 9-58b. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI = 121.3
ELV = 64.06
RANGE = 212802

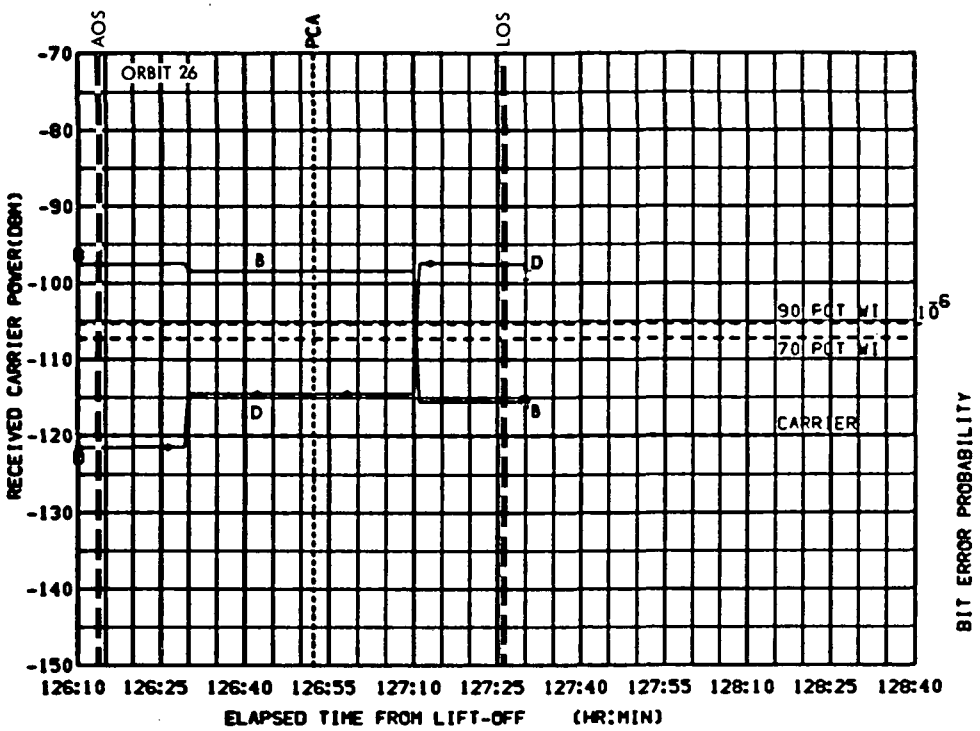


FIGURE 9-58c. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

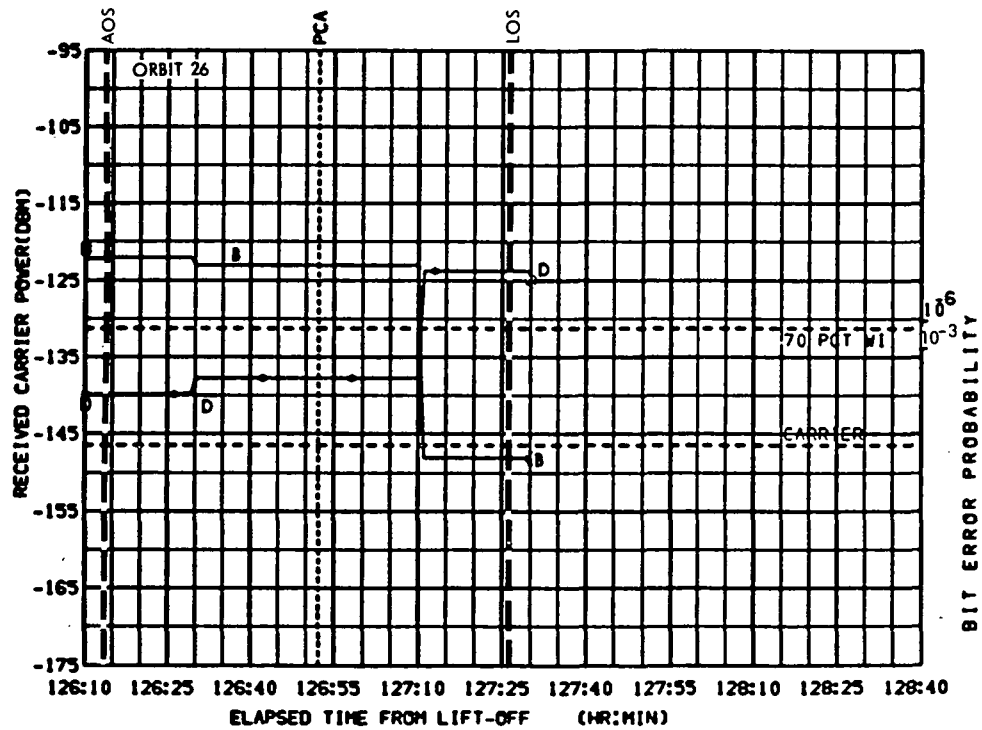


FIGURE 9-58d. GDS DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =121.3
ELV =64.06
RANGE=212802

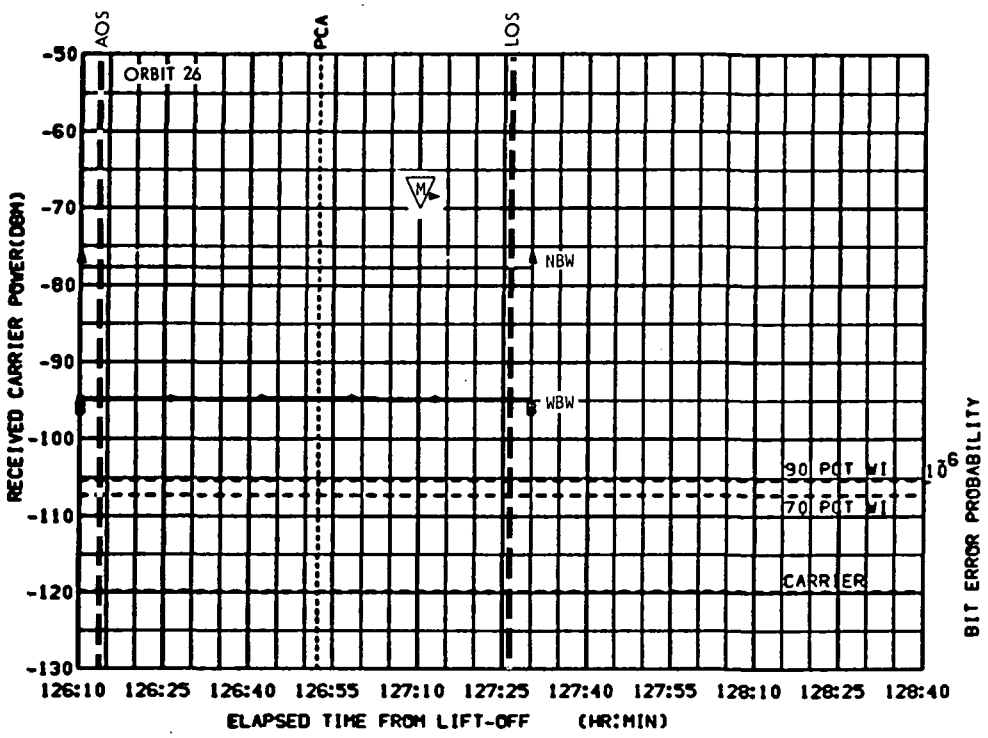


FIGURE 9-58e. GDS UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

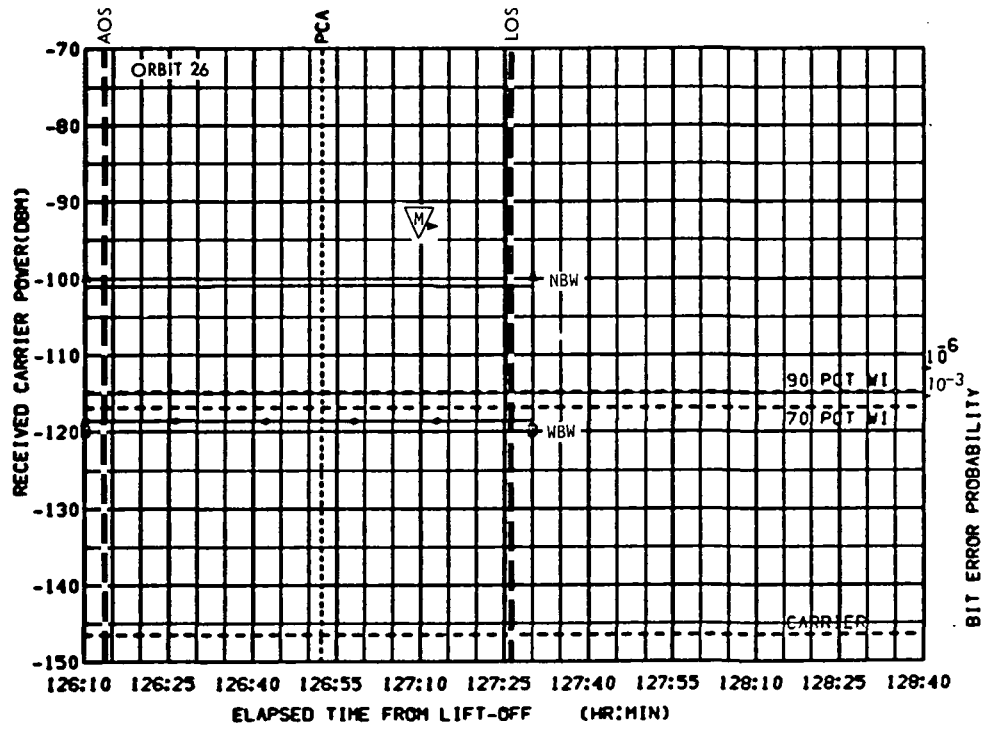


FIGURE 9-58f. GDS DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

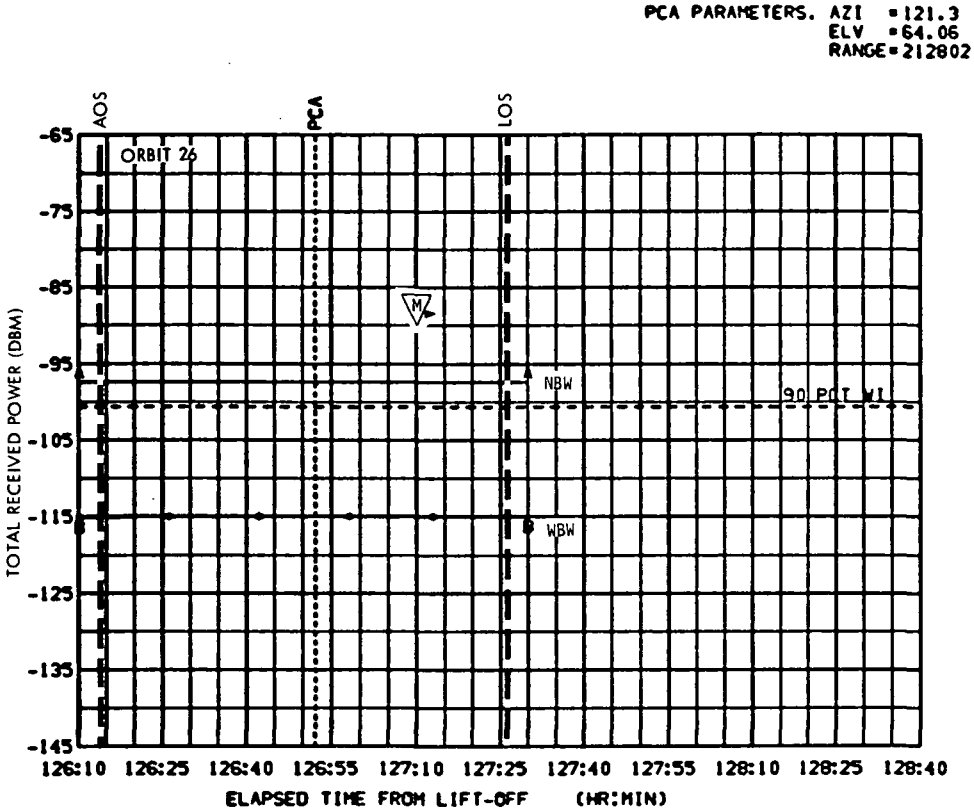


FIGURE 9-58g. GDS CSM ONLY. LUNAR PARKING ORBIT. APOLLO DNLINK FM MODES CSM/MSFN S-BAND HGA RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

CSM S-BAND
17 May Launch

PCA PARAMETERS. AZI =78.99
ELV =28.58
RANGE=214251

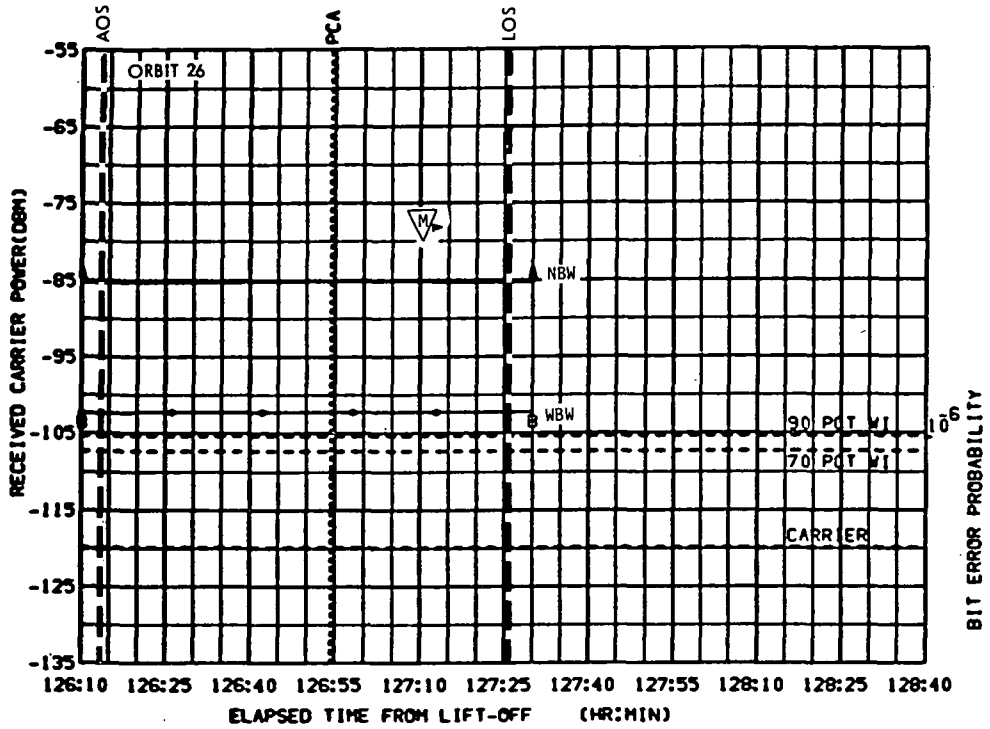


FIGURE 9-59a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

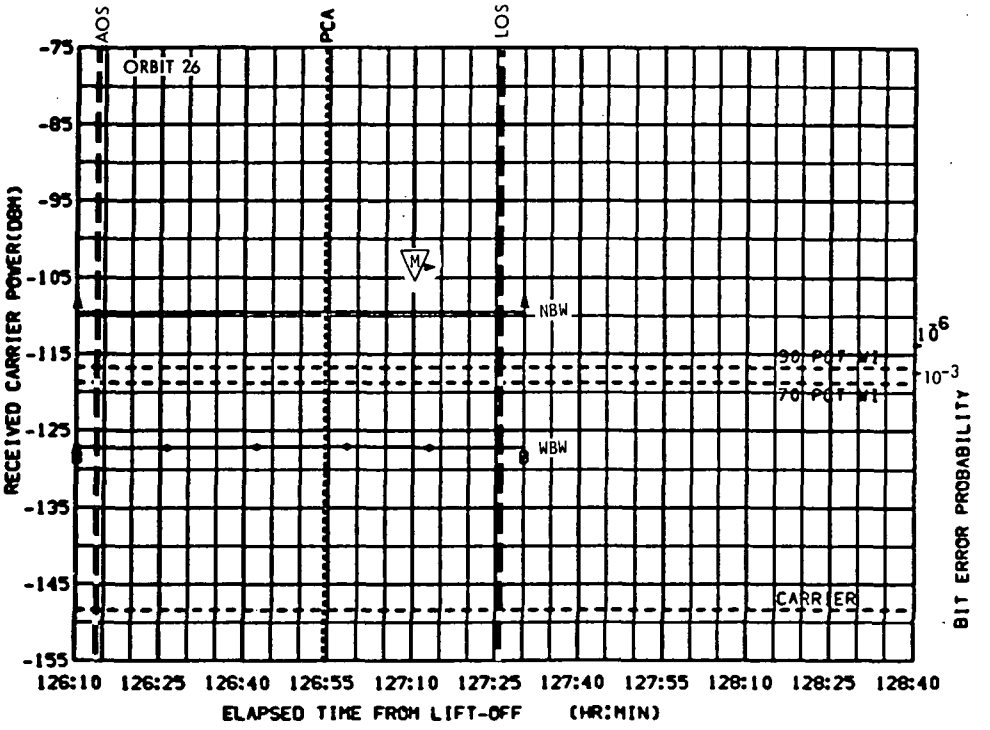


FIGURE 9-59b. MAW DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. LUNAR PARKING ORBIT. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

10. TRANSEARTH COAST

10.1 INTRODUCTION

This section discusses the communication coverage for the transearth coast phase. Communications analysis and recommendations are provided for the CSM S-band communication system.

The following communication recommendations are provided in this section:

a) The CSM omni antennas should be used as the primary means of S-band communications during passive thermal control (PTC) periods.

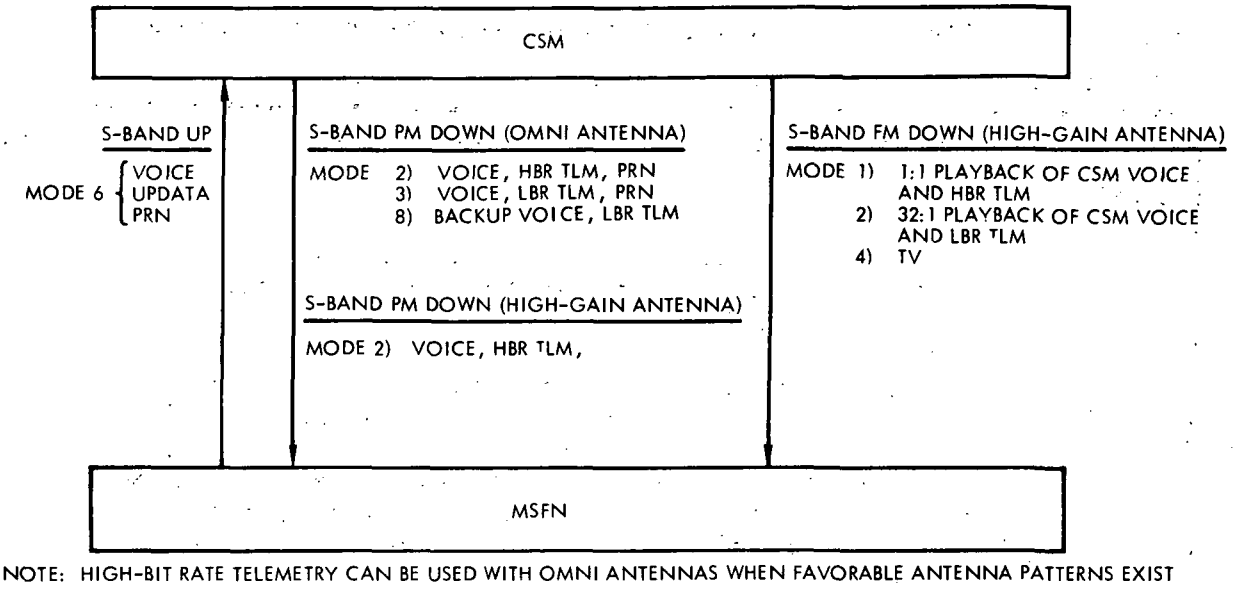
b) Switching between CSM omni antennas should be accomplished by ground command whenever possible.

c) The CSM HGA/GDS 210-foot antenna combination must be used to obtain color TV pictures of satisfactory quality during the scheduled transmission periods from near lunar distances because the maximum range (170,000 nautical miles) for satisfactory color TV pictures from the CSM HGA/85-foot MSFN antenna combination will be exceeded.

10.2 COMMUNICATION CONFIGURATION

During the transearth period the spacecraft will be in the PTC mode except when other activities require different attitudes. The S-band communication configuration for crew active PTC periods is shown in Figure 10-1. This configuration will provide full uplink communications (PM mode 6) for transmission of voice, updata, and PRN. Full downlink communications (PM mode 2) are available with the CSM high-gain antenna (HGA) for transmission of voice, HBR TLM, and PRN. Downlink PM mode 2 may also be available at near earth distances with the CSM omni antennas if favorable antenna patterns exist. In most cases, however, downlink communication with the omni antennas at near earth distances will be limited to PM mode 3 (voice, LBR TLM, and PRN). Downlink communications with the omni antennas from near lunar distances can be accomplished with downlink PM mode 8 (low bit rate telemetry and backup

voice). S-band FM downlink communications are available by means of the HGA for 1:1 playback of CSM voice and HBR TLM (FM mode 1), 32:1 playback of CSM voice and LBR TLM (FM mode 2), and television (FM mode 4).



NOTE: HIGH-BIT RATE TELEMETRY CAN BE USED WITH OMNI ANTENNAS WHEN FAVORABLE ANTENNA PATTERNS EXIST

Figure 10-1. Basic Communication Configuration for Transearth Coast Phase (Crew Active)

The communication configuration for crew rest PTC periods is shown in Figure 10-2. This configuration is essentially the same as the crew active configuration except for the absence of downlink voice communication. Downlink PM mode 2 will continue to be used with the HGA except that the voice subcarrier will be unmodulated. Downlink communications with the CSM omni will be by means of PM mode 9 (LBR TLM and PRN). PM mode 15 (HBR TLM and PRN) is available (based on 0-dB omni gain) within approximately 140,000 nautical miles for the 85-foot MSFN stations.

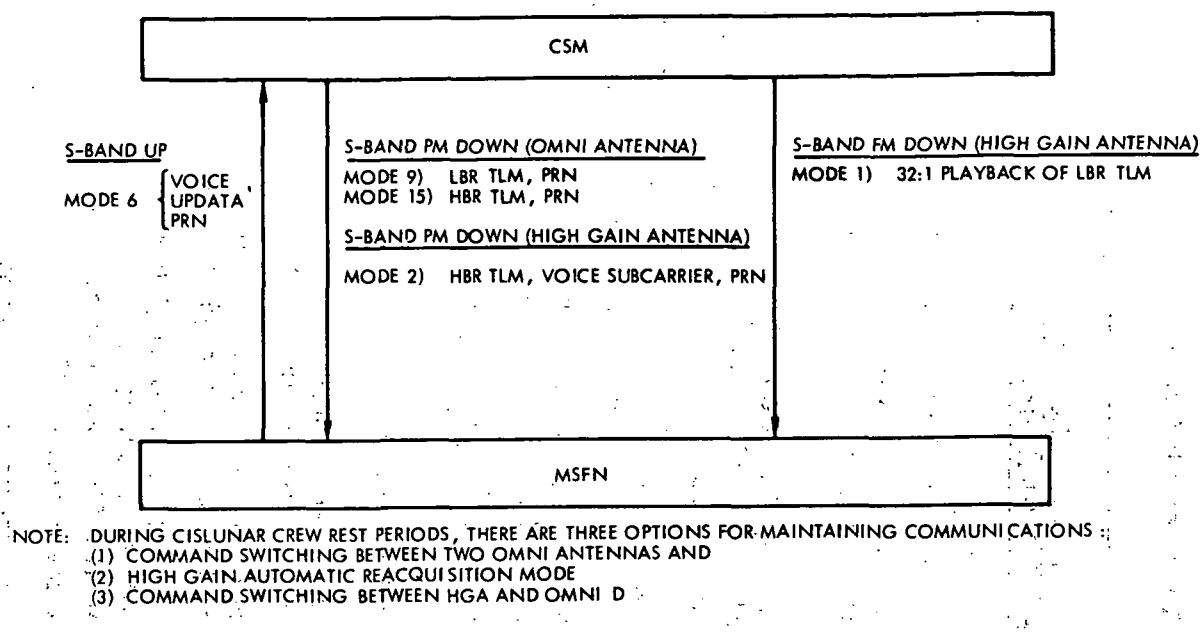


Figure 10-2. Basic Communication Configuration for Transearth Coast Phase (Crew Rest)

The downlink mode availability for various CSM/MSFN antenna combinations for the transearth coast phase is presented in Table 10-1. Appendix C provides detailed data on the S-band system capability.

For the crew rest communication configuration, there are three options for maintaining communications during PTC periods. The first is to command antenna switching between two omni antennas, the second is to operate the spacecraft HGA in the automatic reacquisition mode, and the third utilizes the spacecraft HGA and omni D. The automatic reacquisition mode would require recording LBR data on the DSE when the HGA exceeds the tracking limits and dumping the contents of the DSE after reacquisition. The third option will not be used because of the possibility of HGA instability on reacquisition.

10.3 S-BAND COVERAGE SUMMARY

A bar graph summary of the MSFN station coverage during the transearth coast phase is given in Figure 10-3. Received carrier power plots versus elapsed time are shown in Figures 10-4 through 10-15 for a 1-hour period following TEI ignition (TEI to TEI +1 hour) and for two 1-hour passive thermal control (PTC) periods, one beginning at approximately 150,000 nautical miles (near lunar period) and one beginning at approximately 50,000 nautical miles (near earth period).

Table 10-1. CSM S-band Downlink Mode Availability for Transearth Coast

	CSM Modes Which Meet Required Performance Levels	
	30-ft Cooled MSFN Stations	85-ft MSFN Stations
Near Earth (<140,000 n mi) (Quiet Sky)	• Omni antennas: PM modes 5, 7, 8, and 10 • High-gain antenna (WBW): PM modes 5, 7, 8, 9, and 10 • High-gain antenna (NBW): all PM modes; black and white TV	• Omni antennas: PM modes 3 through 10, 15 • High-gain antenna (WBW): all PM modes • High-gain antenna (NBW): all PM modes; color TV • All FM modes
Near Lunar (>140,000 n mi) (Quiet Sky)	• Omni antennas: PM mode 10 only • High-gain antenna (WBW): PM modes 5, 7, 8, and 10 • High-gain antenna (NBW): PM modes 1 through 5 and 7 through 10, 15; black and white TV*	• Omni antennas: PM modes 3 through 10 • High-gain antenna (WBW): all PM modes • High-gain antenna (NBW): all PM modes; color TV* • All FM modes
Near Lunar (Moon-at-Zenith)	• Omni antennas: PM mode 10 only • High-gain antenna (WBW): PM modes 5, 7, 8, and 10 • High-gain antenna (NBW): PM modes 1 through 5 and 7 through 10	• Omni antennas: PM modes 5 through 10 • High-gain antenna (WBW): PM modes 3 through 10 • High-gain antenna (NBW): all PM modes; black and white TV. All FM modes except color TV

Note: Derived from data in Appendix C. All omni information shown is based on 0-dB omni antenna gain.

*Picture will be of degraded quality.

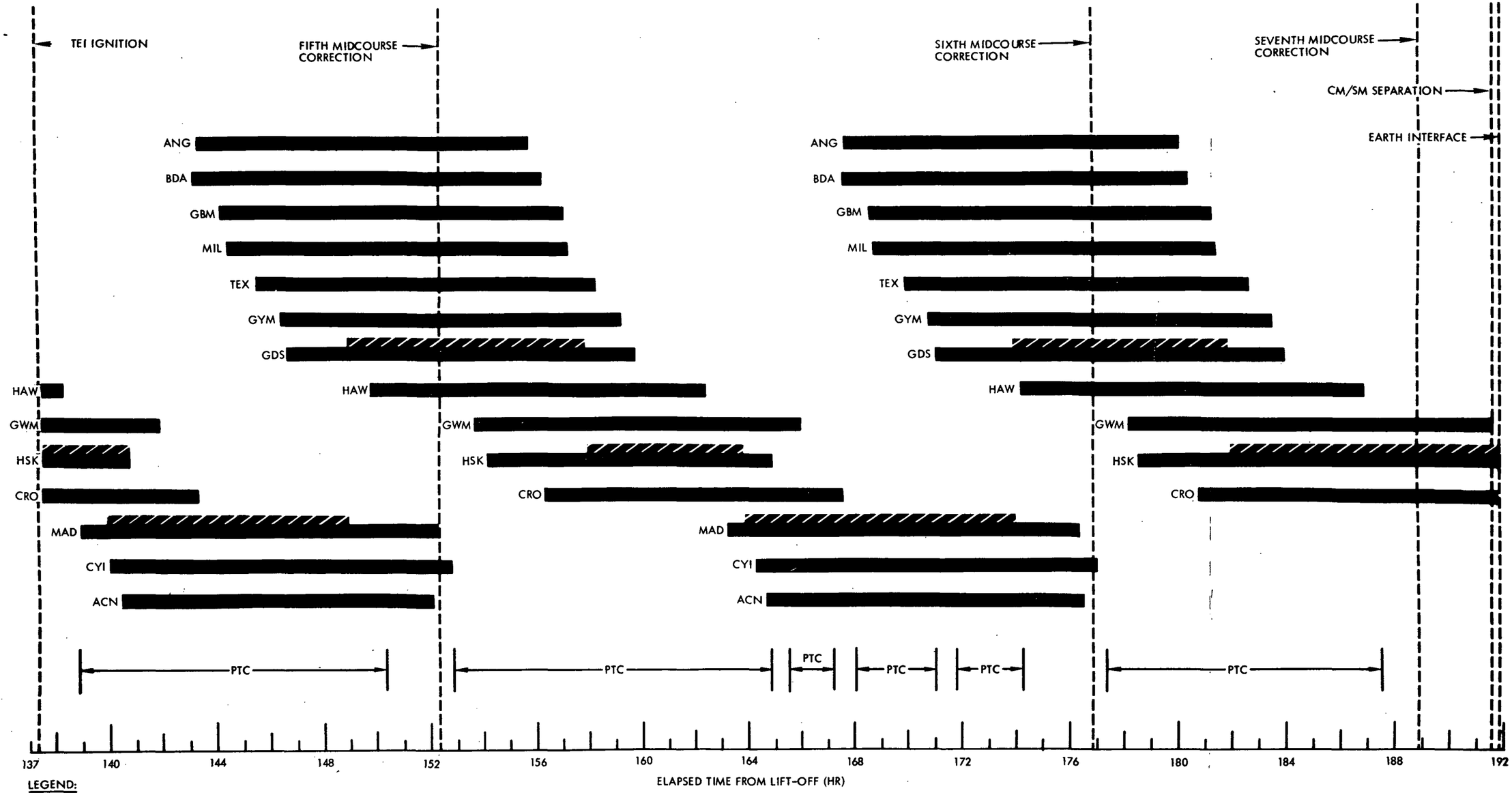


Figure 10-3. S-band Coverage Summary for the Transearth Coast Phase

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CSM HGA plots are provided for a typical 30-foot cooled station and for a typical 85-foot station during the TEI to TEI +1 hour period since all stations of the same type will receive approximately the same level of carrier power with the HGA.

CSM omni antenna plots are provided for all stations having line of sight during the PTC periods. CSM HGA plots are provided for typical 30-foot cooled, and 85-foot MSFN stations. (No 30-foot uncooled MSFN stations have line of sight during either of the PTC periods covered).

For calculation of received carrier power, quiet sky pointing conditions are assumed for the two PTC periods. Moon at zenith pointing conditions are assumed during the TEI to TEI +1 hour period. (When the moon is within the beam width of the ground station, the noise contribution of the moon degrades the ground station receiver sensitivity.)

Uplink PM mode 6 (voice, updata, and PRN ranging) and downlink PM mode 2 (voice, HBR telemetry, and PRN ranging) were used for the HGA for near earth, and near lunar, PTC periods and for the TEI to TEI +1 hour period.

Uplink PM mode 6 was used for the uplink omni antenna plots for the near earth and near lunar PTC periods. Downlink mode 2 was used for the near earth PTC period, and downlink PM mode 8 (backup voice, and LBR telemetry) was used for the near lunar PTC period and for the TEI to TEI +1 hour period.

10.4 S-BAND PERFORMANCE

PTC will be used during transearth coast except where other activities require different attitudes. The intent of the PTC mode is to achieve thermal cycling by means of continuous spacecraft rotation. Since the omni antennas will be operating at ranges where attitude is critical, the continuous rotation of the spacecraft will have an adverse effect on communications, and frequent antenna and/or mode switching will be required for 100 percent coverage. This continuous rotation will also periodically block the HGA line of sight to the MSFN stations.

It is recommended that the CSM omni antenna switching be accomplished by ground command whenever possible during crew active periods or the crew be advised of the optimum switching frequency with respect to the MSFN receivers. If the crew performs the antenna switching on the basis of high headset noise levels, the received carrier power at the MSFN will usually fall below threshold levels prior to each antenna switch.

It is recommended that the omni antennas be used as the primary means of communication during all PTC periods. Communications using the HGA are subject to shadowing by the LM and CSM structure and gimbal limitations. (Additional information on usability of HGA during PTC roll periods is given in Appendix E.) When the HGA antenna is used during the PTC periods, LBR TLM is automatically recorded in DSE when HGA exceeds gimbal limits. The contents of the DSE are dumped after reacquisition. Difficulties in reacquisition could result in loss of data. The command switching of HGA and omni D option is not recommended because of possible HGA instability on reacquisition.

Color TV transmission will be provided during the transearth coast phase. Color broadcasts are scheduled over GDS at 152 hours 35 minutes (near lunar distance) and 186 hours 50 minutes (near earth distance). A black and white broadcast is scheduled over GDS at approximately 137 hours 45 minutes.

The HGA (NBW)/85-foot MSFN antenna combination will provide a TV picture of adequate quality during the black and white TV transmission period and during the second color TV transmission period. In order to obtain adequate quality color TV pictures during the first color TV transmission period (near lunar distance), the GDS 210-foot antenna must be used.

10.4.1 TEI to TEI +1 Hour Period

The CSM HGA/85-foot MSFN antenna combination and the CSM HGA/30-foot cooled MSFN antenna combination will provide good communications with downlink PM mode 2 and in the NBW mode of operation. The WBW mode of operation will be below the threshold of both antenna combinations.

The CSM omni/85-foot MSFN antenna will provide good communications with downlink PM mode 2. The CSM omni/30-foot cooled MSFN stations will provide below threshold communications with uplink PM mode 6 and marginal coverage with downlink PM mode 8.

10.4.2 Near Lunar PTC Period

The CSM omni/30-foot uncooled MSFN antenna combination provide marginal communications with downlink PM mode 8 during the near lunar PTC period by switching between the four omni antennas. No 30-foot uncooled MSFN station has line of sight during the period considered. The CSM omni/30-foot cooled MSFN antenna combination will provide adequate communications with downlink PM mode 8 by switching between the four omni antennas. The switching sequence is D - C - B - A - D . . . . The switching should occur approximately every 15 minutes. The 85-foot MSFN stations will provide higher received carrier power levels for the same switching sequence. This method of providing communication coverage can only be used during crew active periods.

For crew rest periods, ground command switching between diametrically opposite omni antennas will provide received carrier power levels well above the 70 percent WI voice threshold at the 85-foot MSFN stations. The sequence of switching is B - D - B . . . , and the switching occurs approximately every 30 minutes. Switching between two diametrically opposite omni antennas would also provide good coverage at the 85-foot stations during the crew active period.

The HGA NBW mode will provide adequate downlink PM mode 2 coverage at the 30-foot uncooled, 30-foot cooled, and 85-foot MSFN stations during the near lunar PTC mode covered. The HGA WBW mode is above the 10^{-3} BEP telemetry threshold for the 85-foot stations and below that threshold for the 30-foot stations.

10.4.3 Near Earth PTC Period

Good communication coverage for PM downlink mode 2 is provided by the 85-foot MSFN stations and the spacecraft omni antennas during the

near earth PTC period covered by the plots by using the switching sequence D - C - B - A - D . . . . This switching should occur approximately every 15 minutes. This method of switching can be accomplished only during crew active periods. The 85-foot MSFN stations will provide 100 percent coverage with downlink PM mode 2 by switching between two diametrically opposite omni antennas. The switching sequence would be A - C - A . . . or B - D - B . . . and the switching should occur approximately every 30 minutes. The B - D - B . . . switching sequence can be used for crew rest periods by ground command switching.

The coverage provided by the CSM omni/30-foot uncooled MSFN antenna combination with downlink PM mode 2 and by switching between the four omni antennas will be marginal or below threshold. (No 30-foot uncooled MSFN station has line of sight during the period covered.) The coverage provided by the CSM omni/30-foot cooled MSFN antenna combination with downlink PM mode 2 and by switching between the four omni antennas will be adequate.

The CSM HGA in either WBW or NBW mode will provide good coverage for downlink PM mode 2 during the near earth PTC period at the 85-foot MSFN stations. Good coverage will be provided by the HGA in NBW or WBW mode at the 30-foot cooled stations. The HGA/30-foot uncooled station combination should provide marginal coverage in the NBW mode but below threshold coverage in the WBW mode.

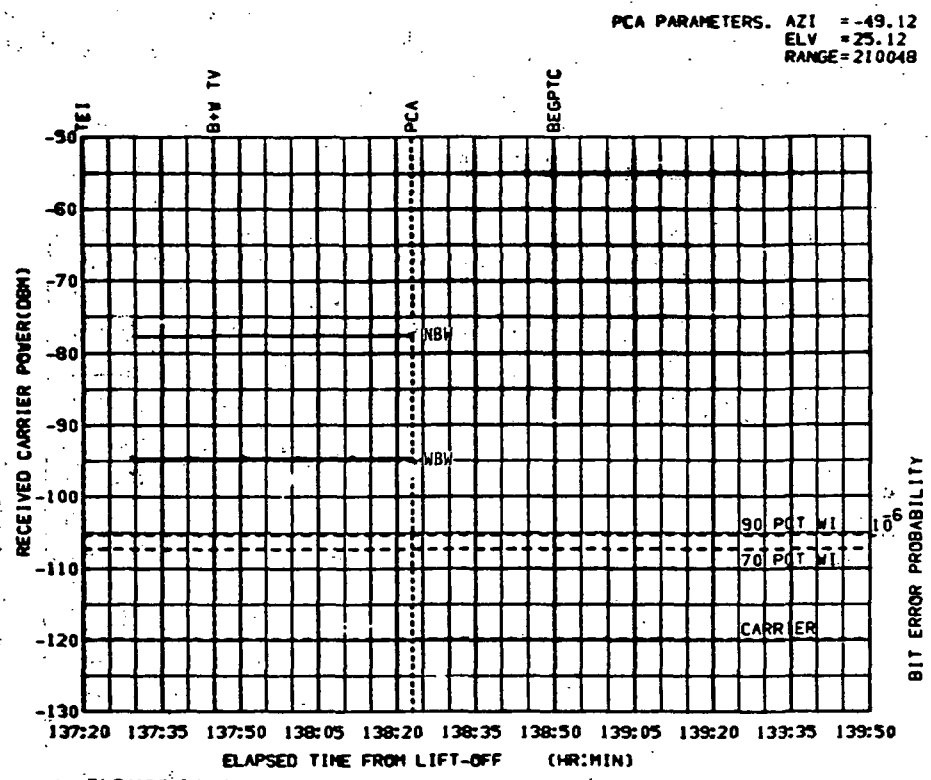

FIGURE 10-4a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

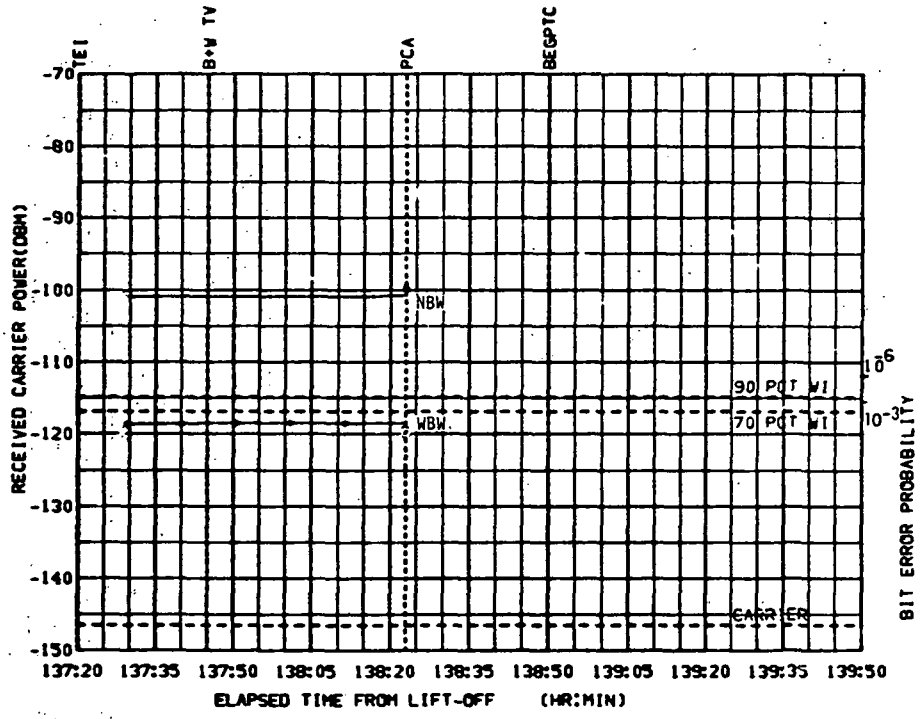

FIGURE 10-4b. MSK ONLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

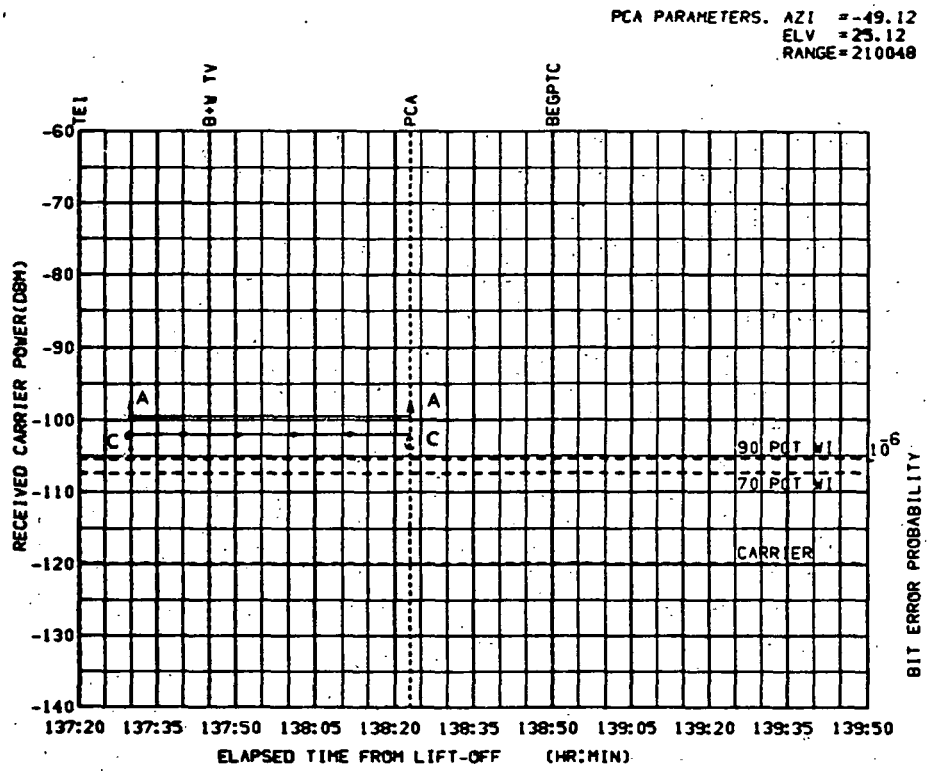

FIGURE 10-4c. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

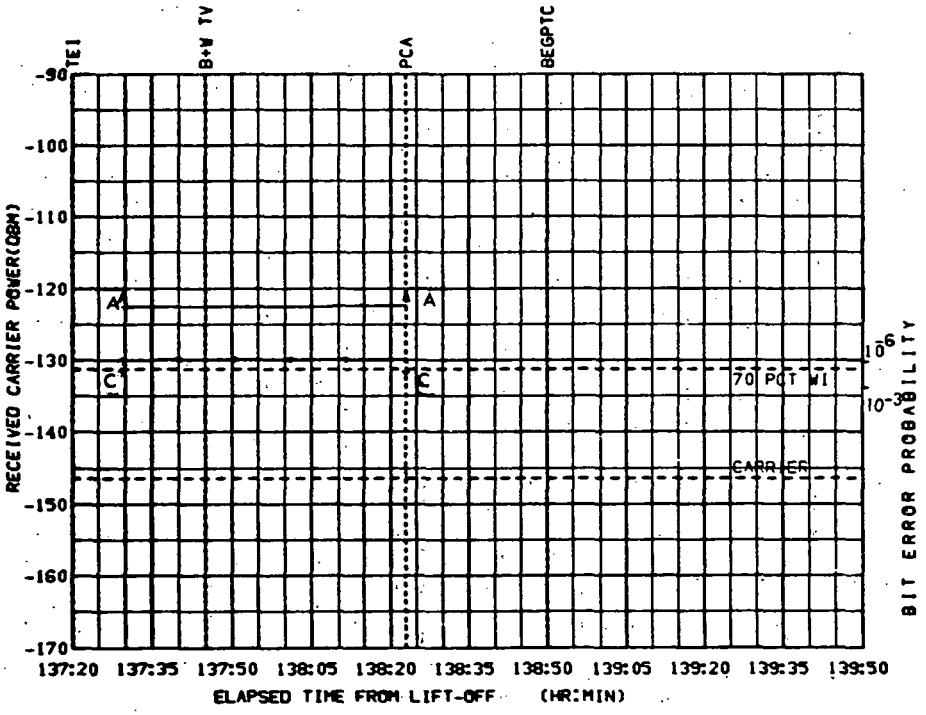

FIGURE 10-4d. HSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

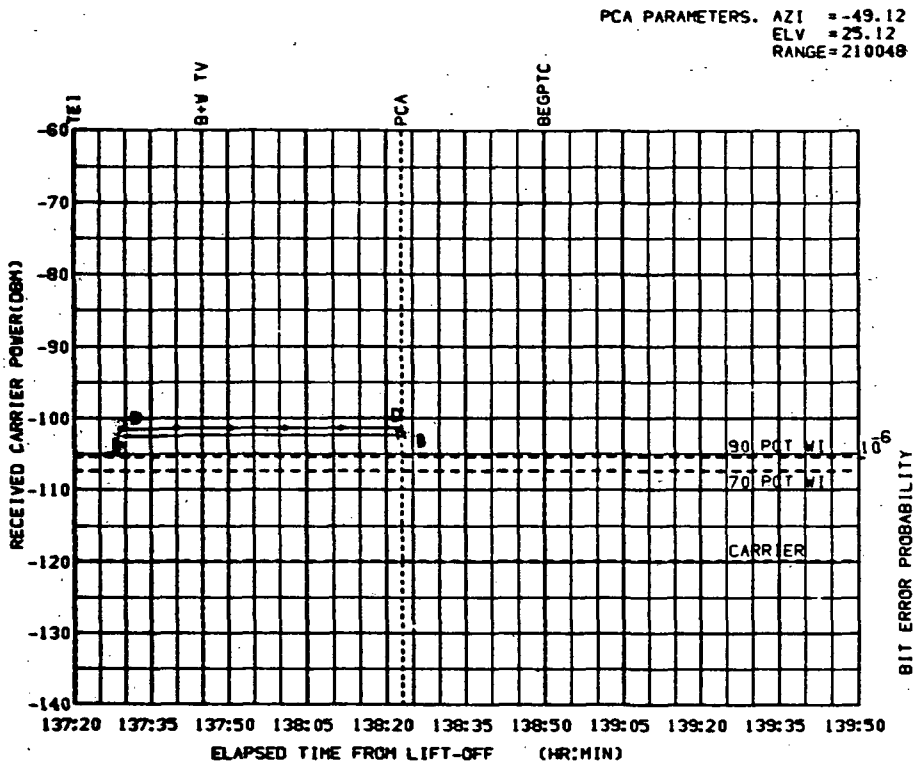

FIGURE 10-4e. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

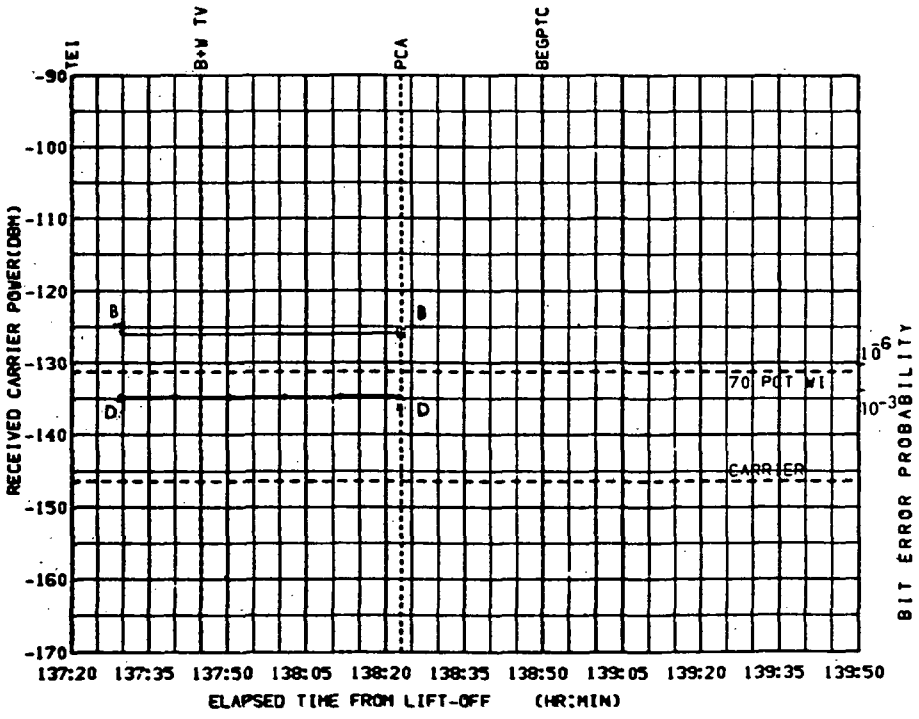

FIGURE 10-4f. HSK ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

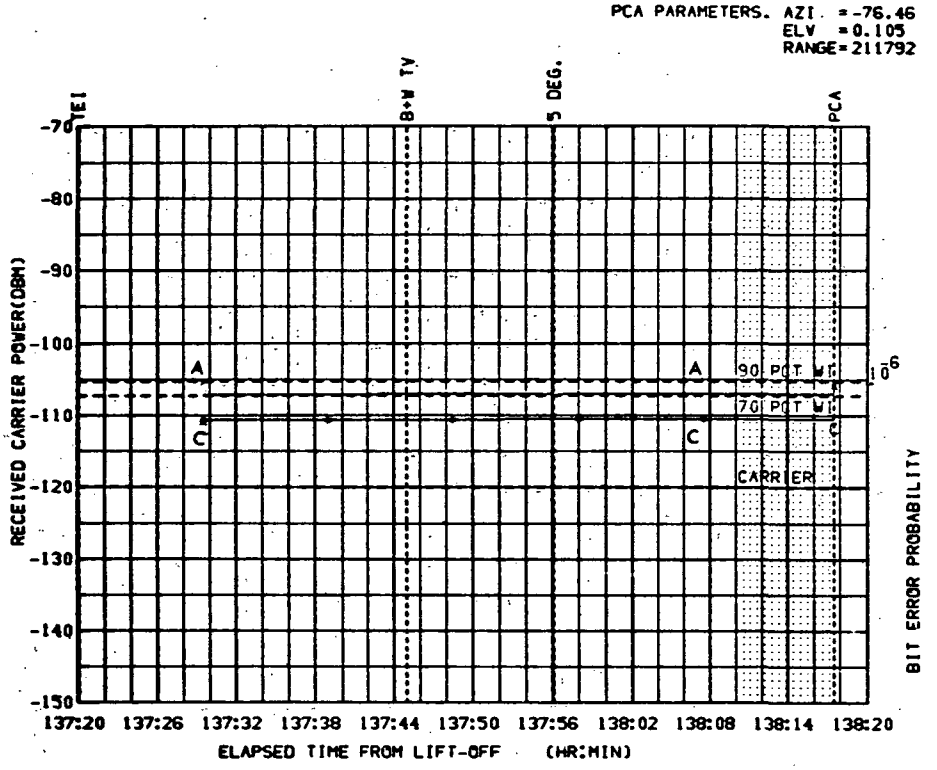

FIGURE 10-5a. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

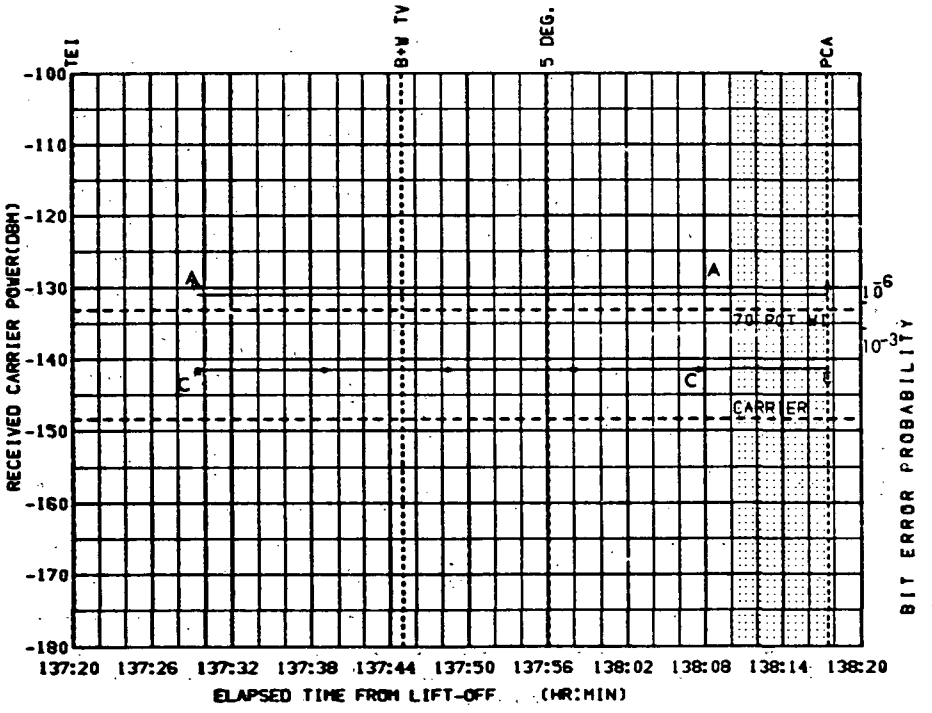

FIGURE 10-5b. MAW DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

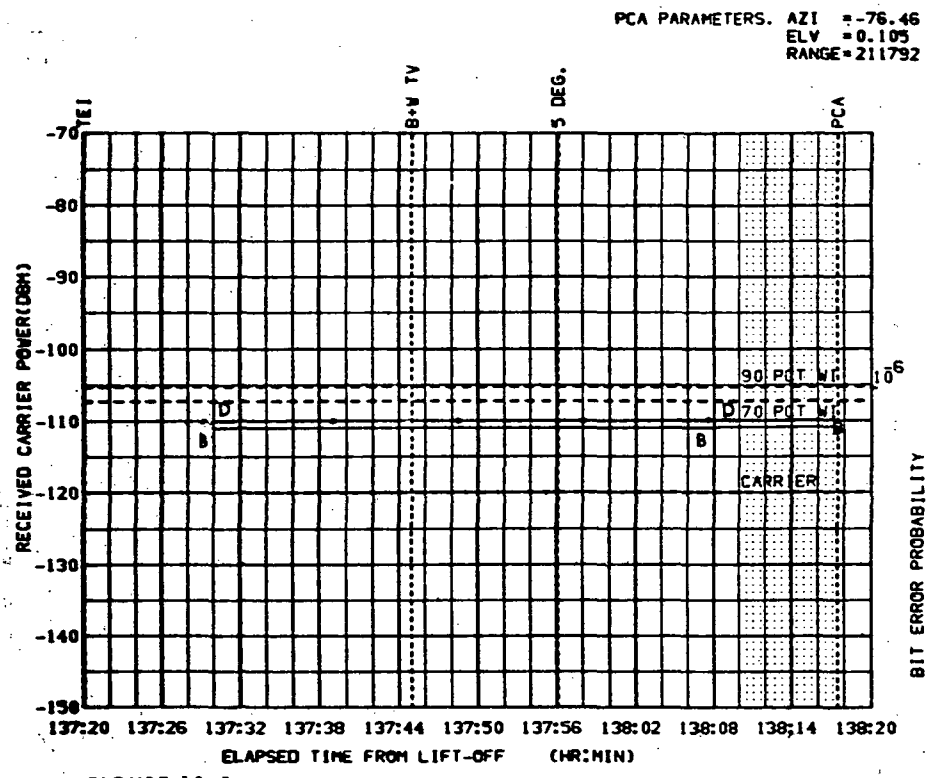

FIGURE 10-5c. MAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

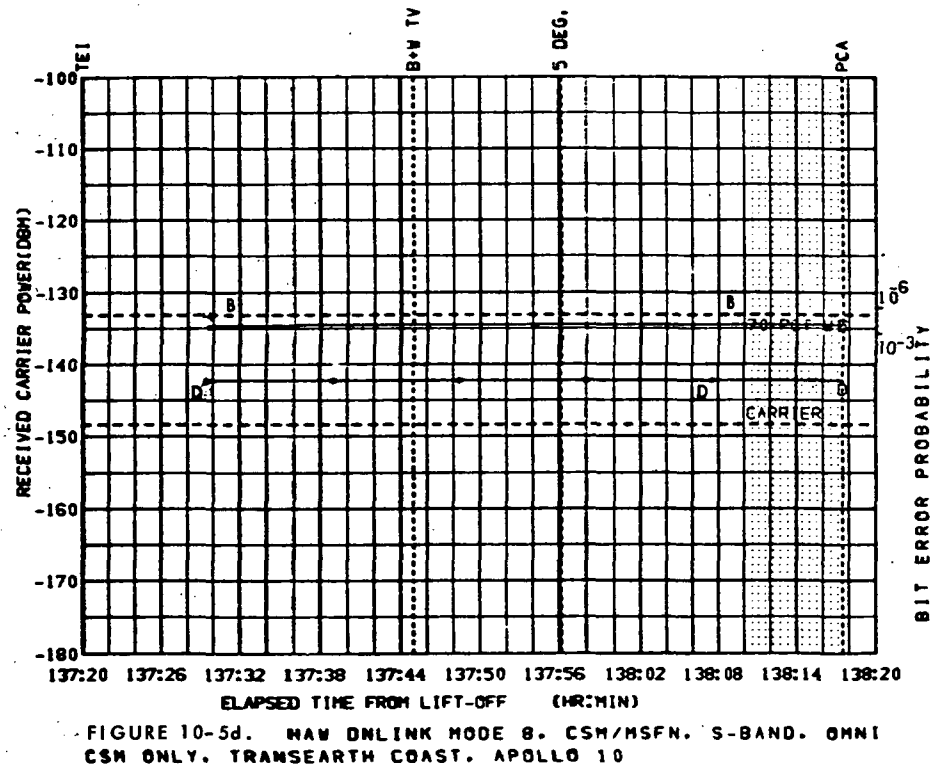

FIGURE 10-5d. MAW DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

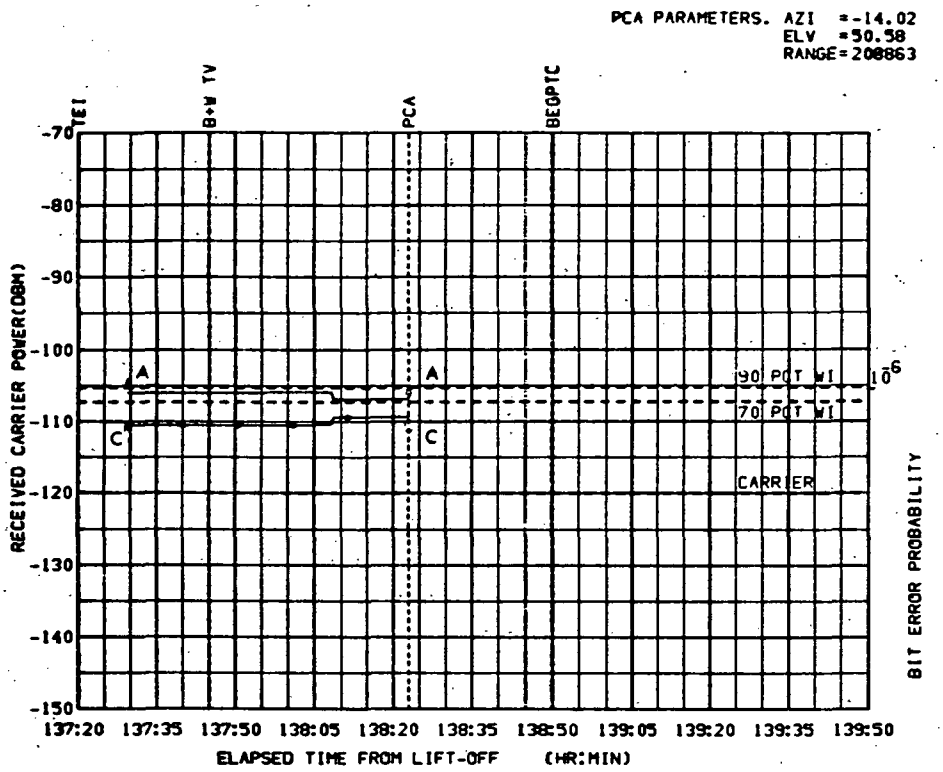

FIGURE 10-6a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

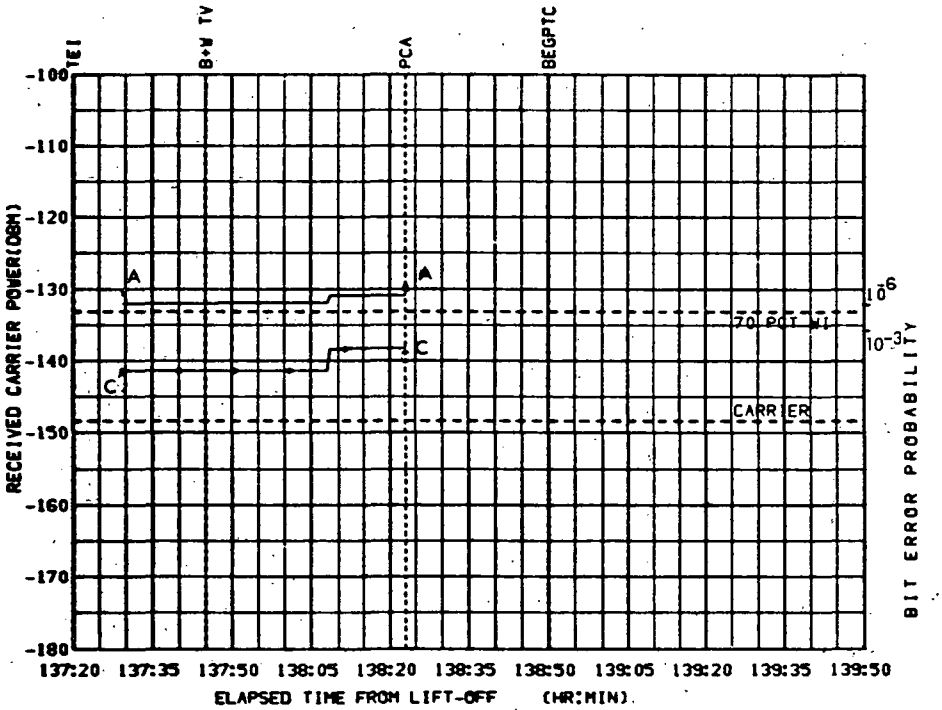

FIGURE 10-6b. CRO ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

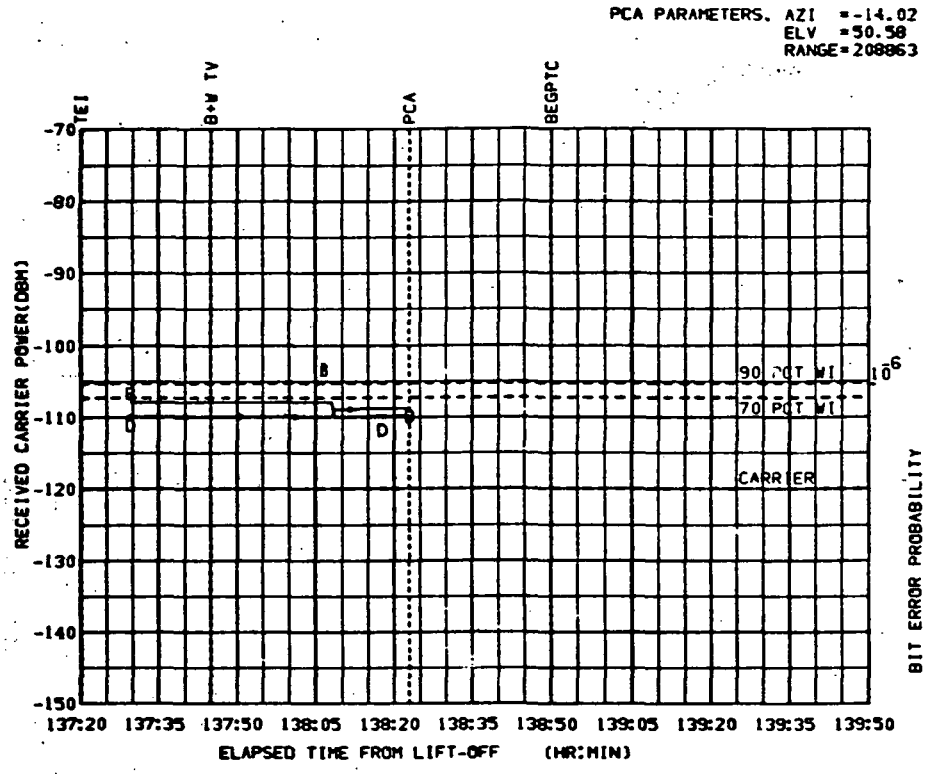

FIGURE 10-6c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

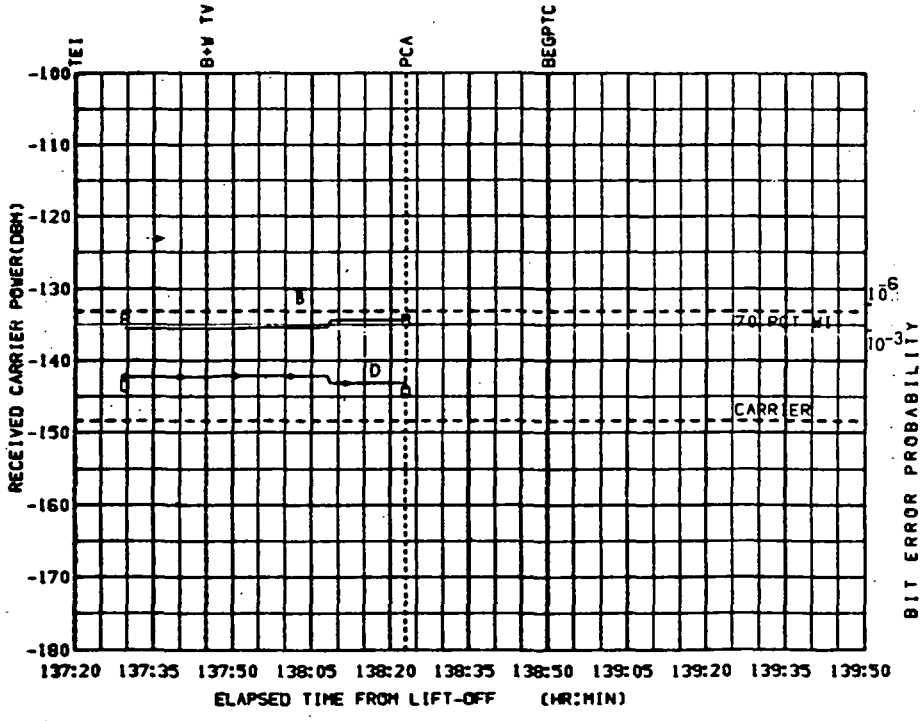

FIGURE 10-6d. CRO ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

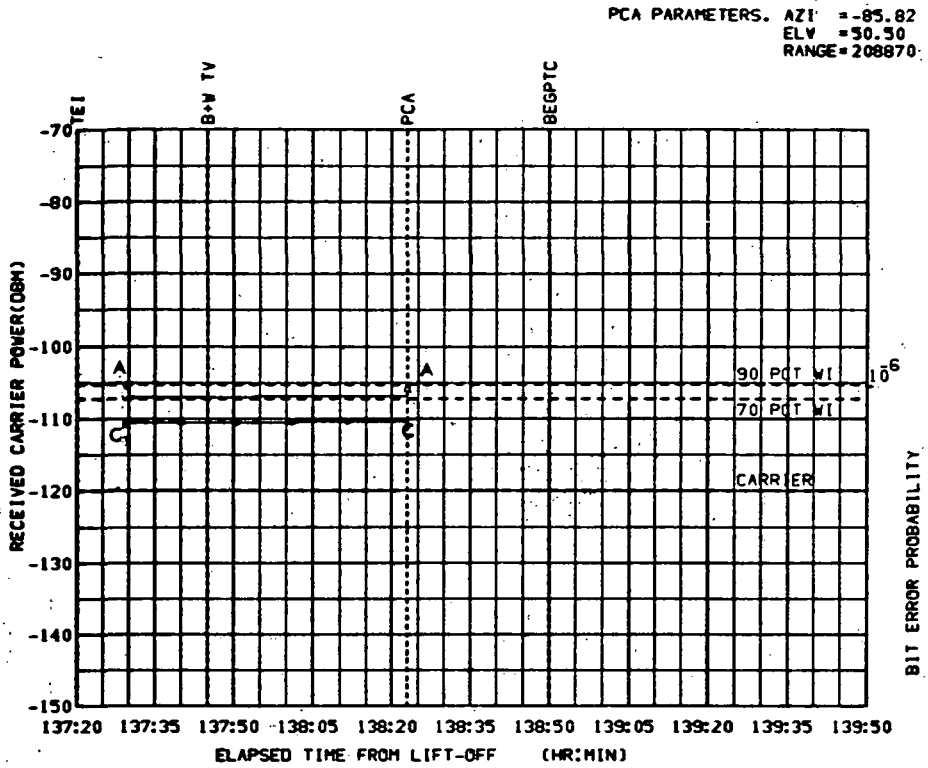

FIGURE 10-7a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

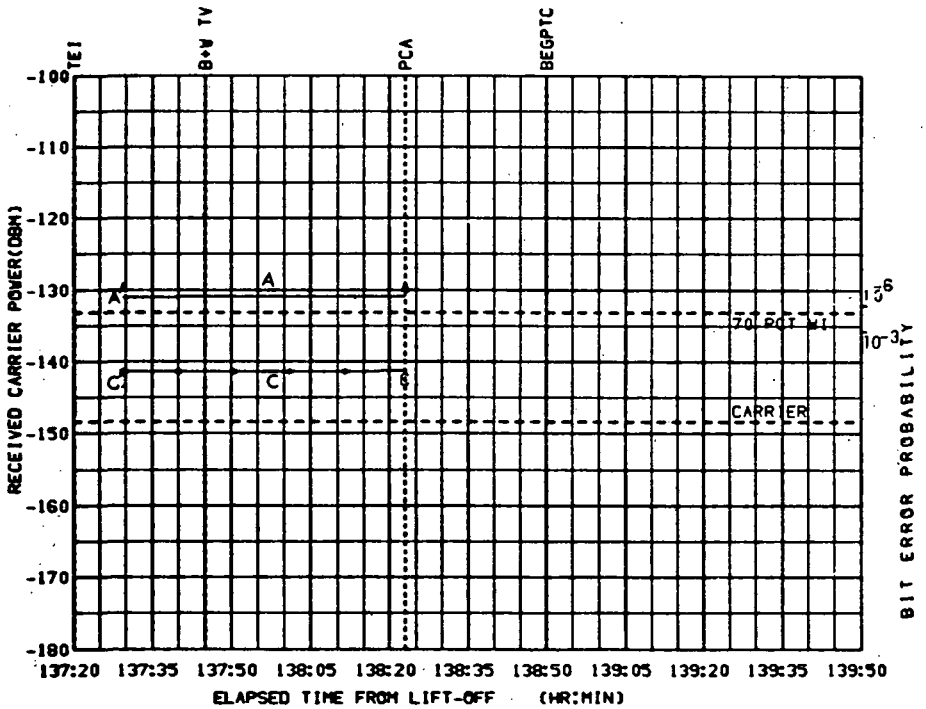

FIGURE 10-7b. GWM ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

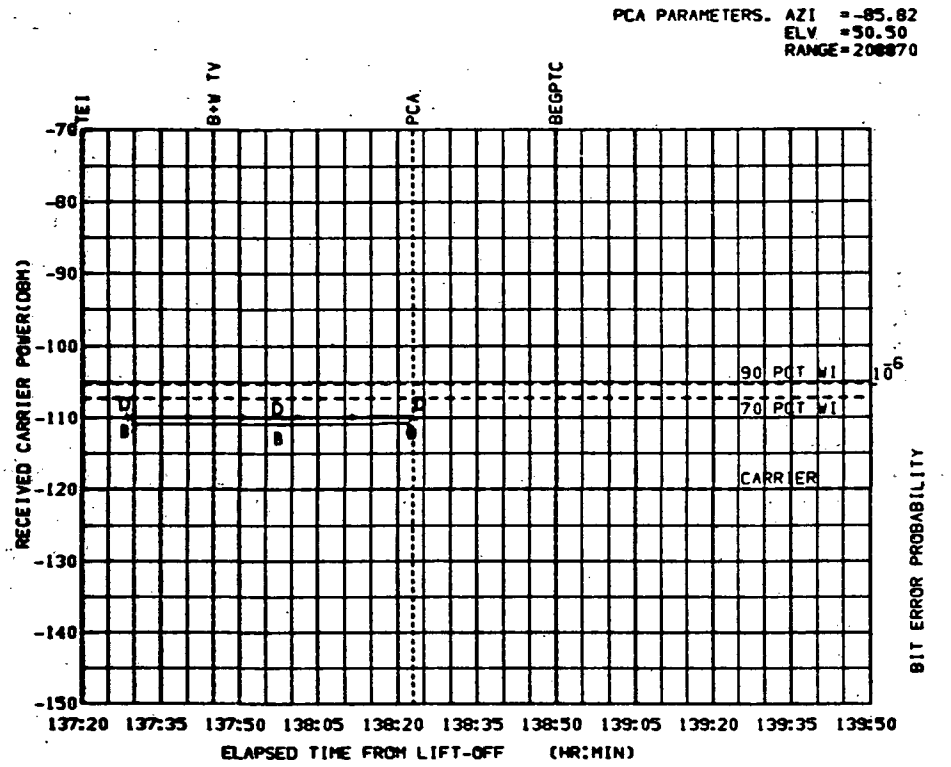

FIGURE 10-7c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

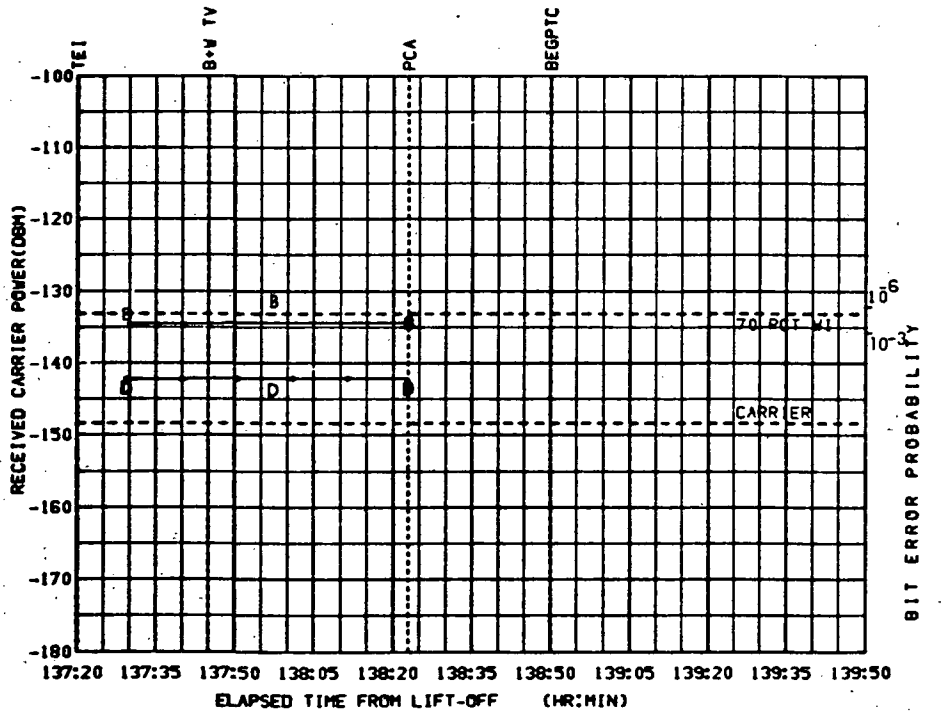

FIGURE 10-7d. GWM DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

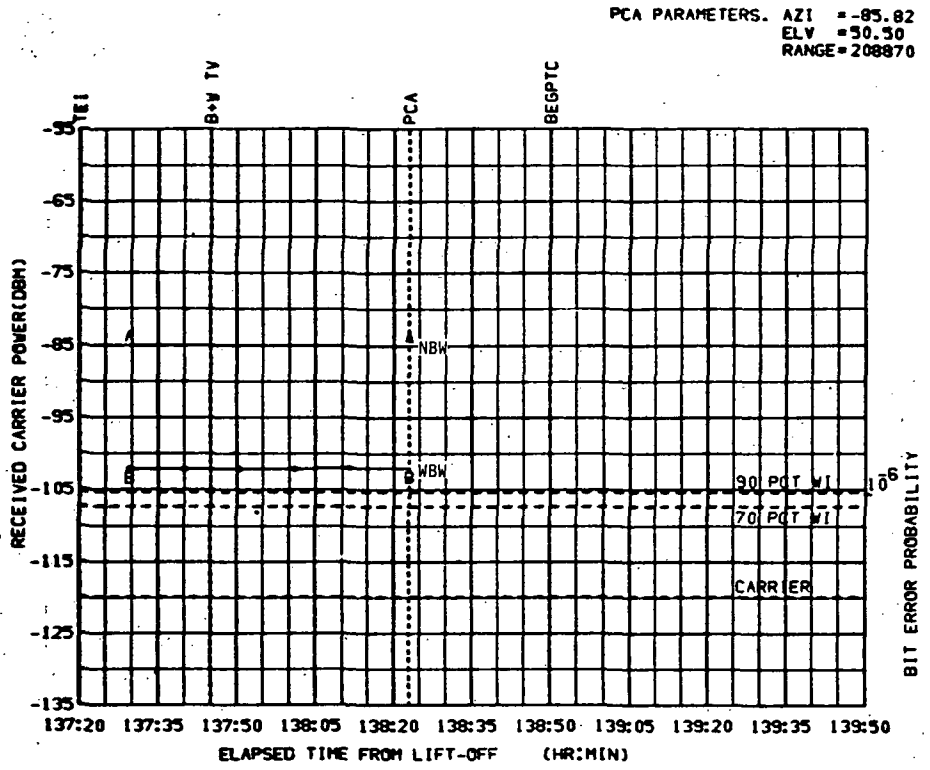

FIGURE 10-7e. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

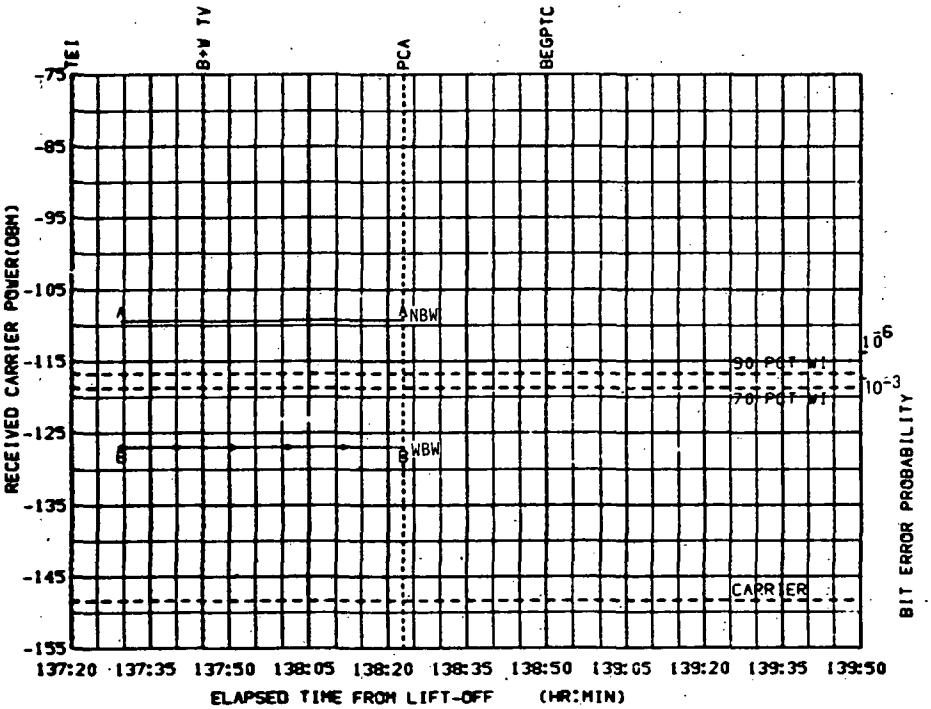

FIGURE 10-7f. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -20.63
ELV = 39.23
RANGE = 144661

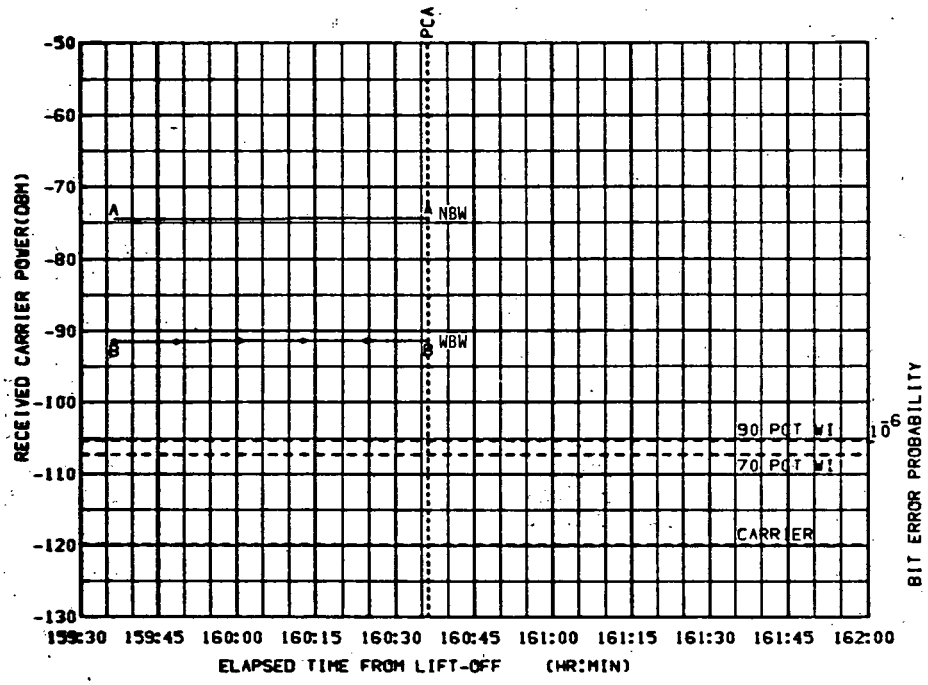

FIGURE 10-8a. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

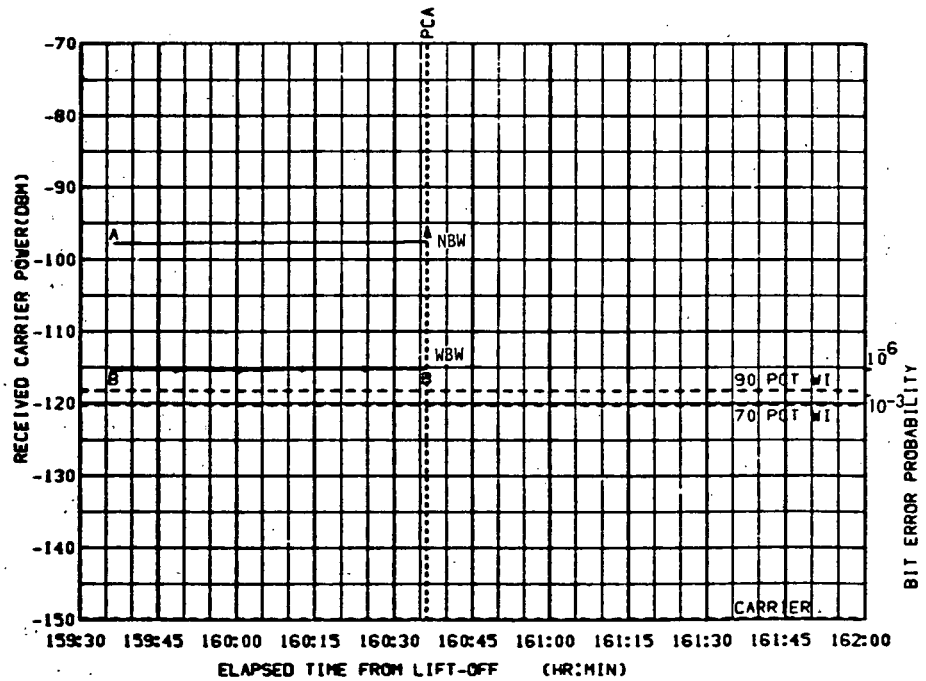

FIGURE 10-8b. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

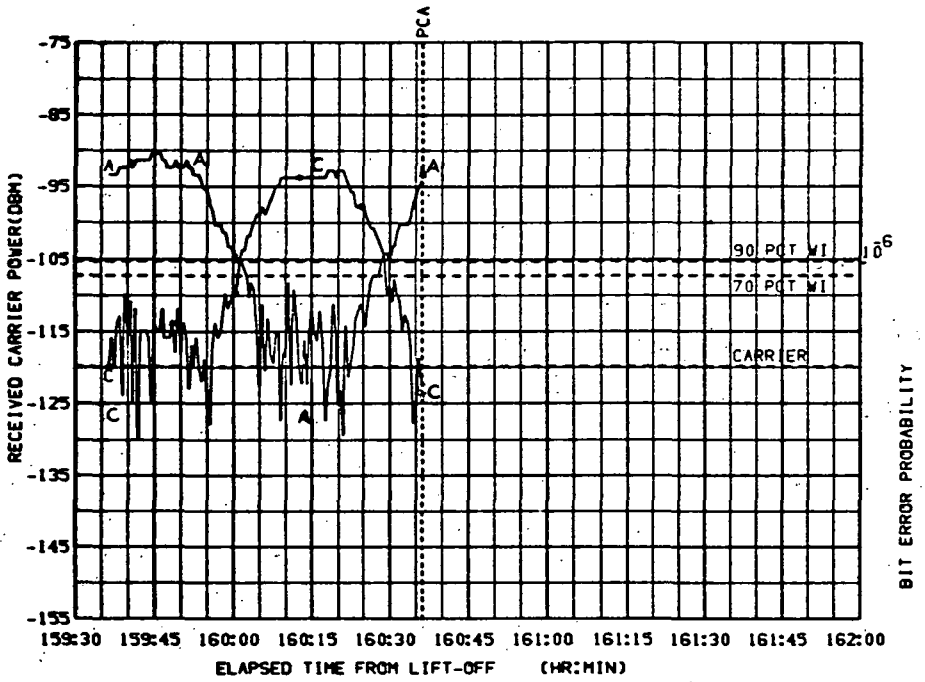

FIGURE 10-8c. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

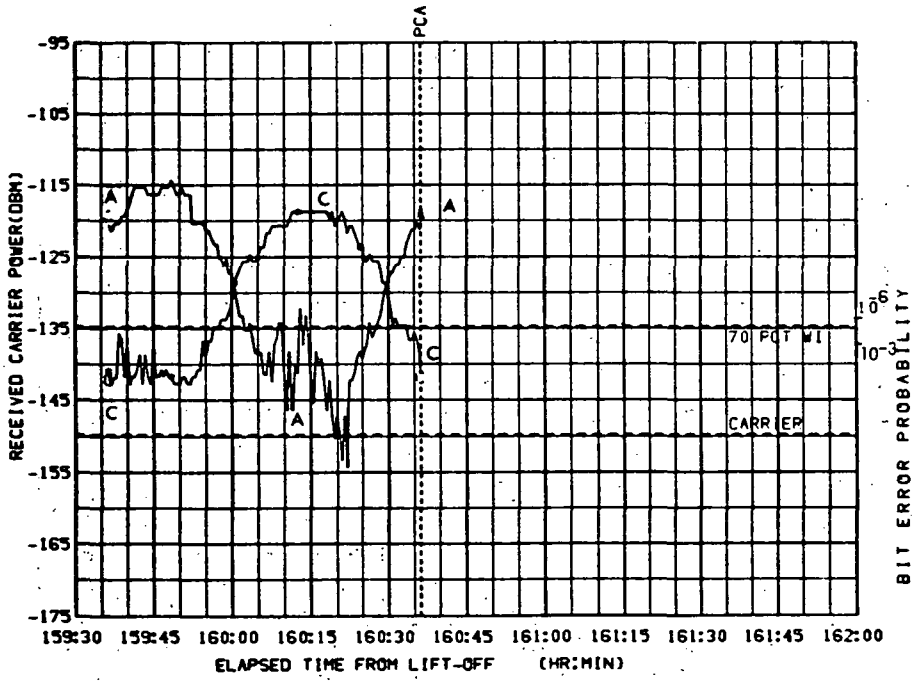

FIGURE 10-8d. HSK ONLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -20.63
ELV = 39.23
RANGE = 144661

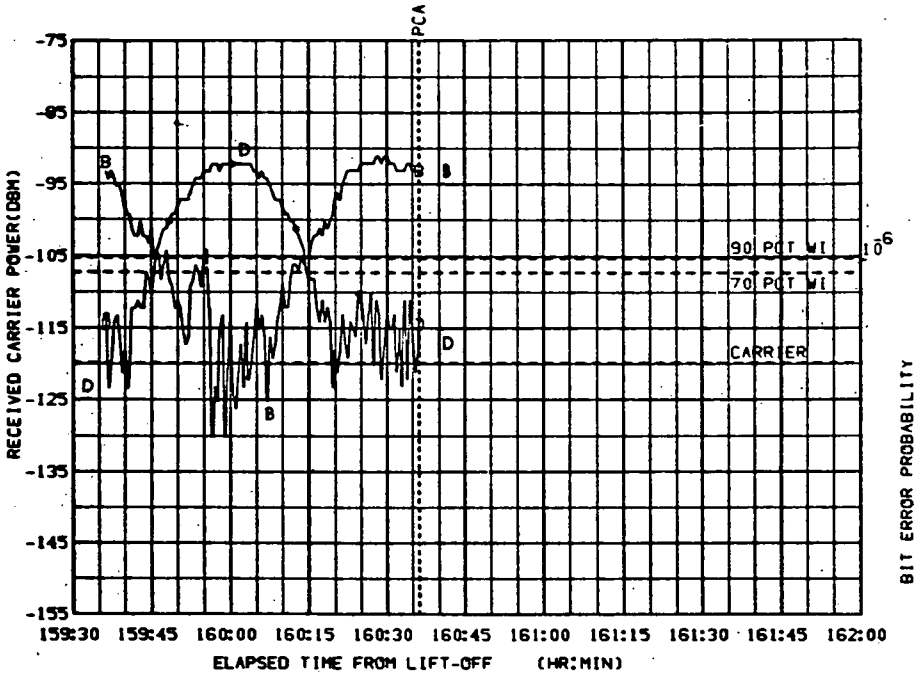

FIGURE 10-8e. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

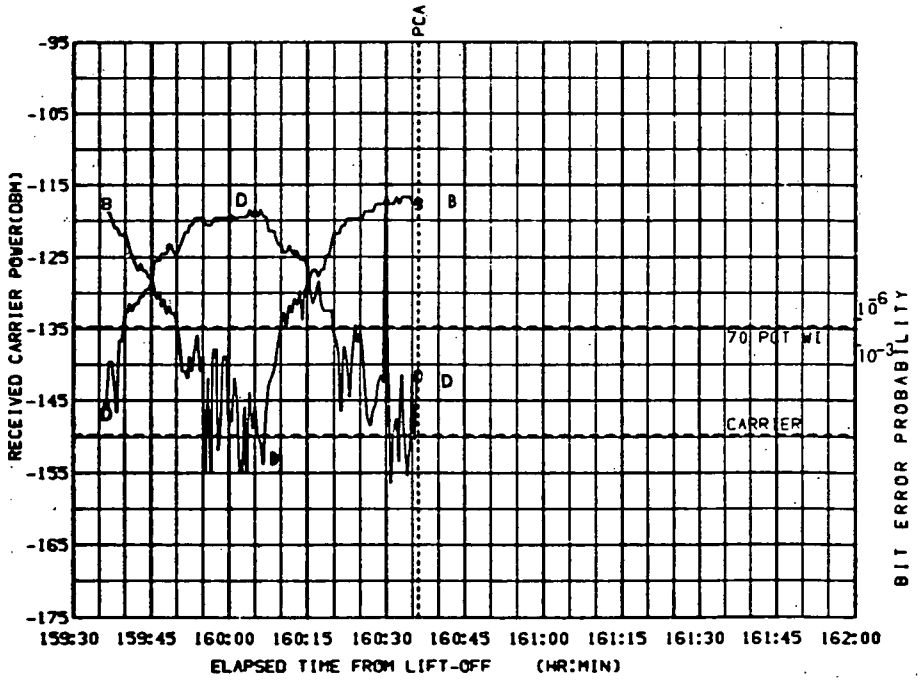

FIGURE 10-8f. MSK DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

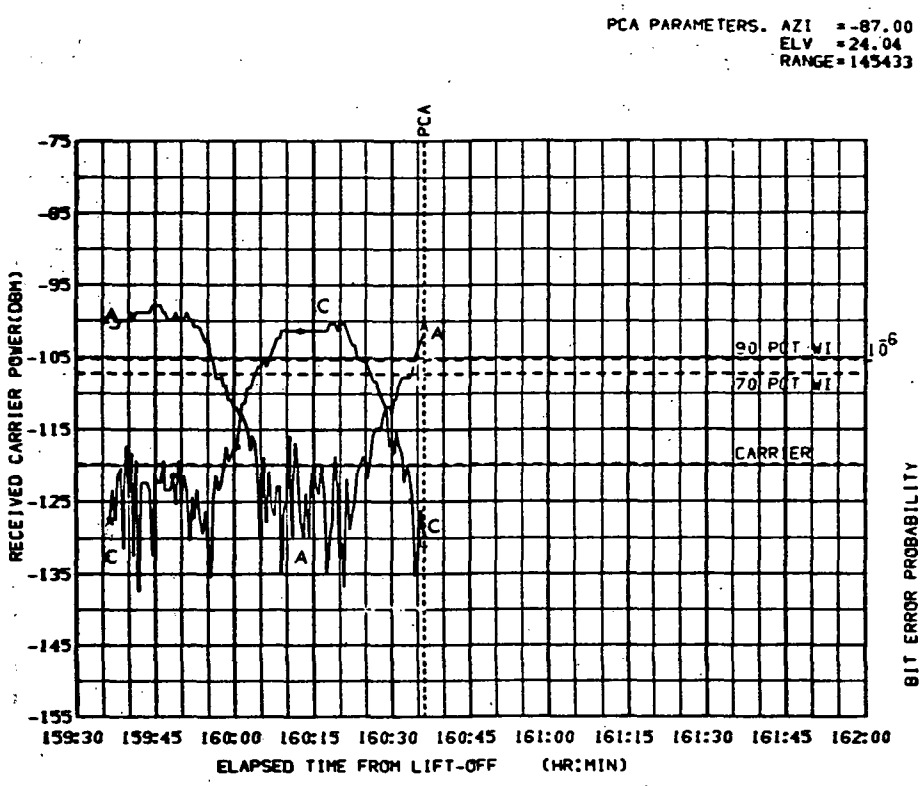

FIGURE 10-9a. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

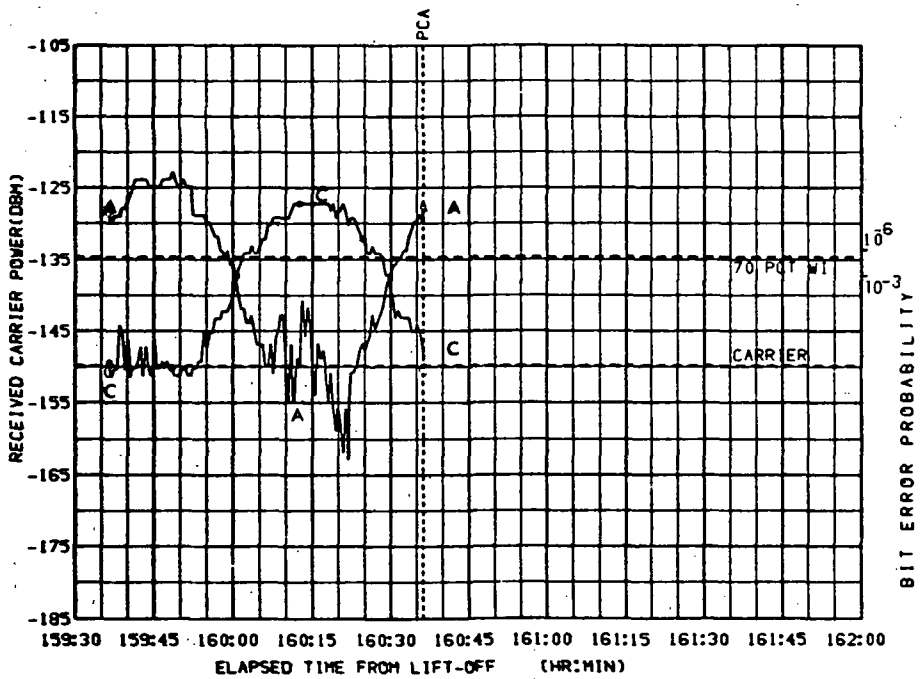

FIGURE 10-9b. HAW DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

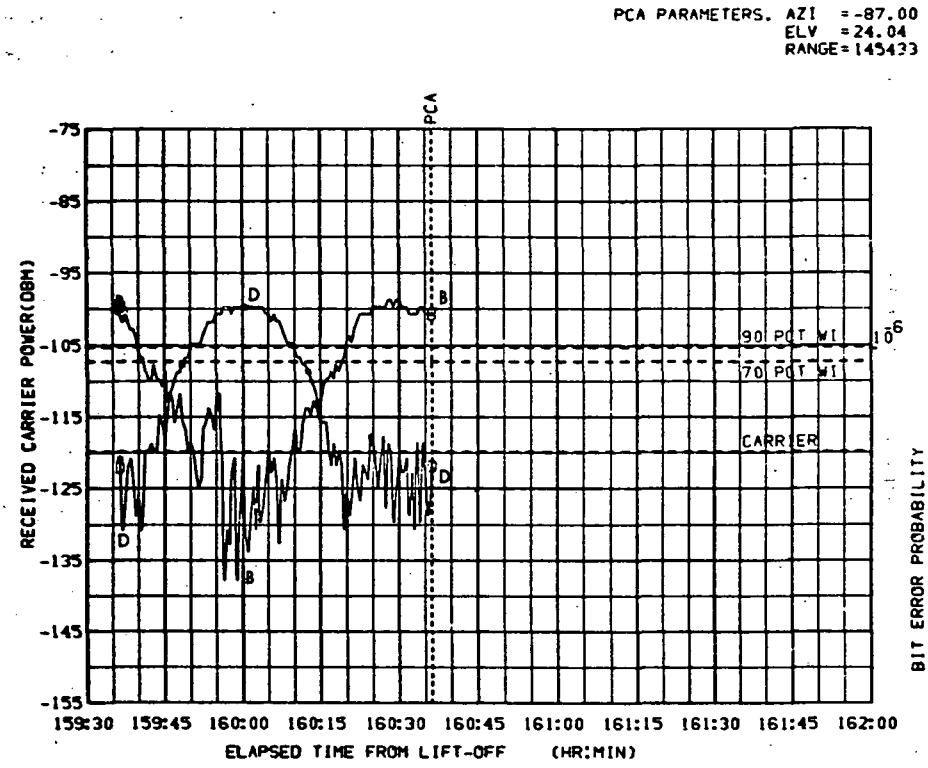

FIGURE 10-9c. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER, VERSUS ELAPSED TIME FROM LIFT-OFF

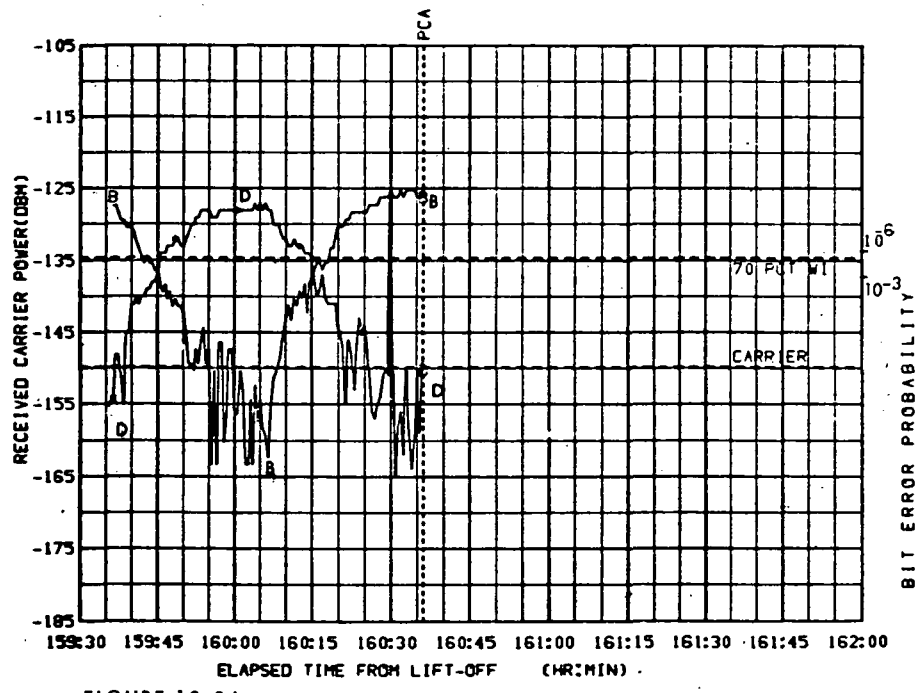

FIGURE 10-9d. HAW DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

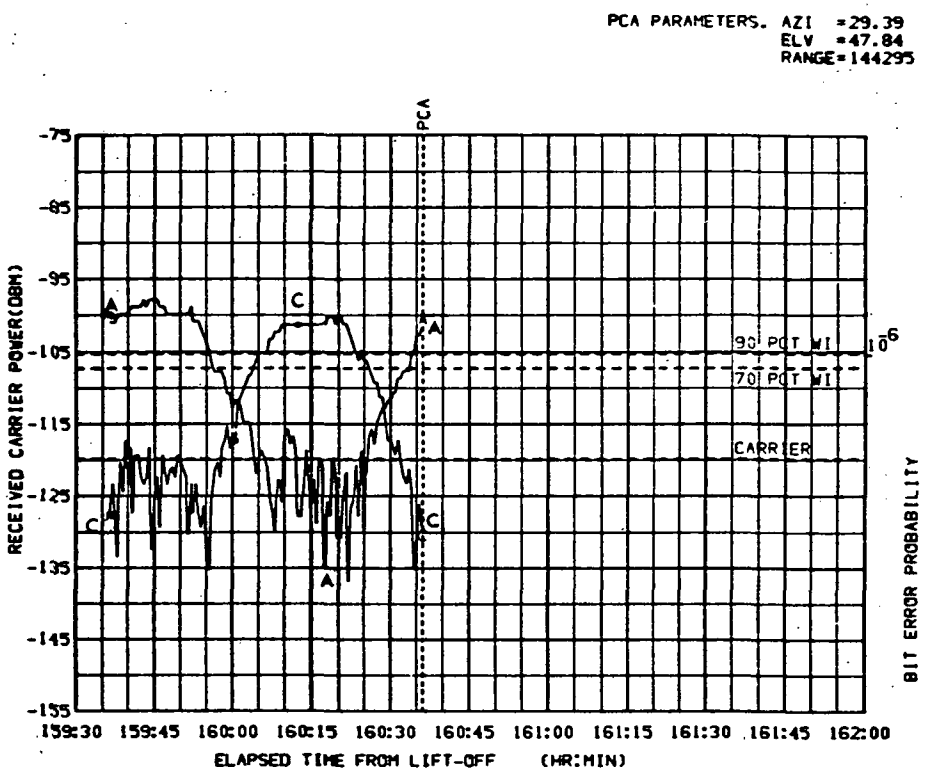

FIGURE 10-10a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

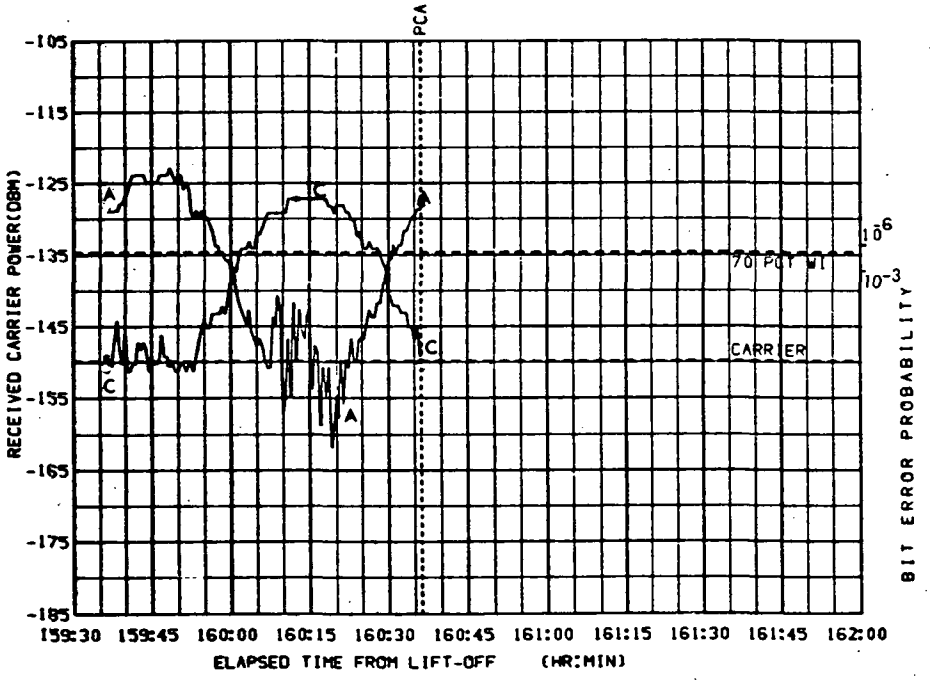

FIGURE 10-10b. CRO DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI =29.39
ELV =47.84
RANGE=144295

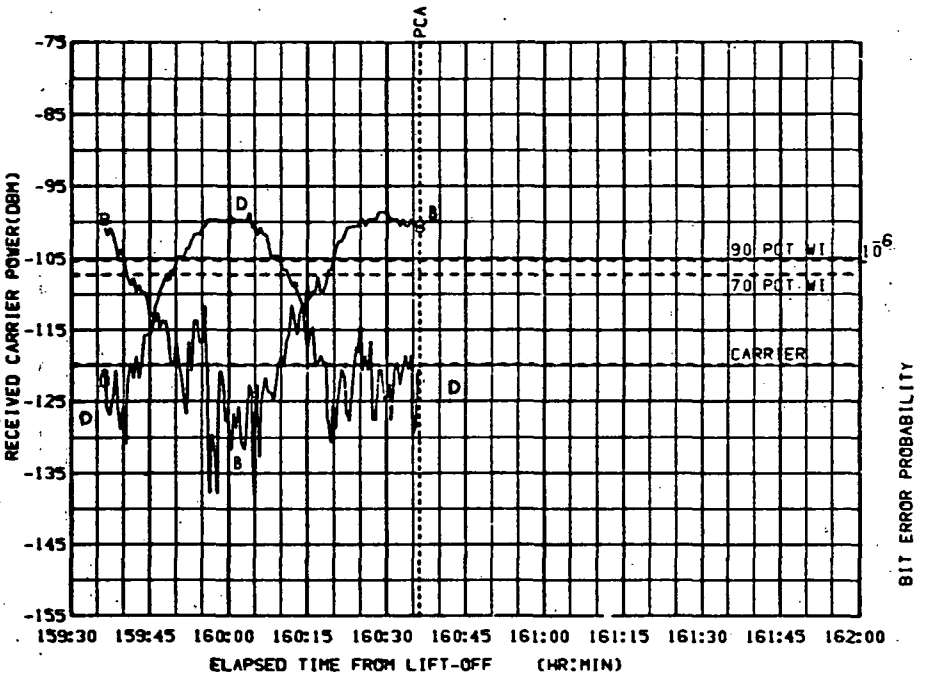

FIGURE 10-10c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

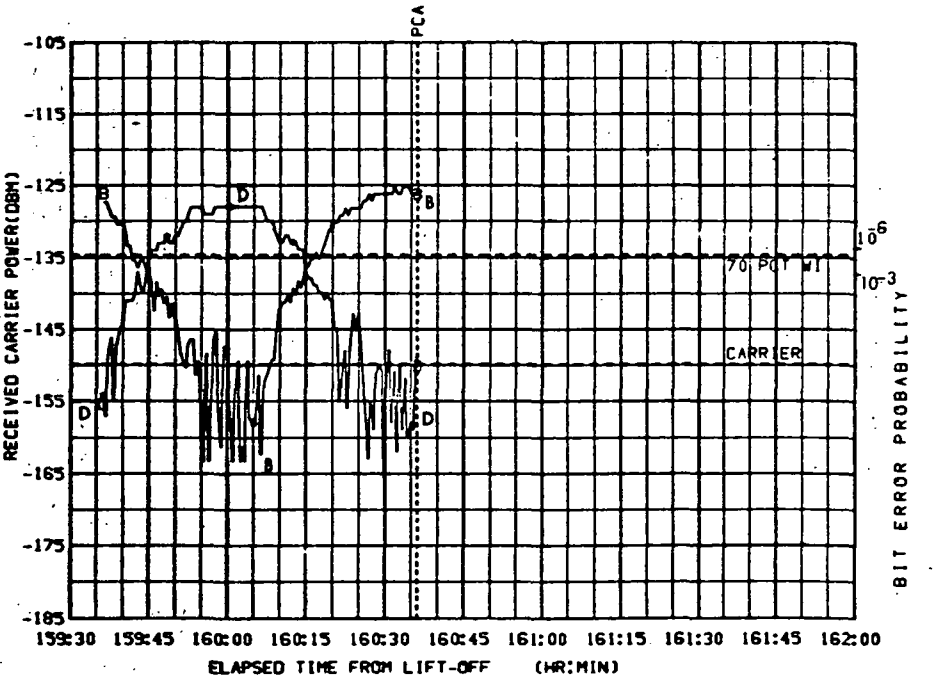

FIGURE 10-10d. CRO DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

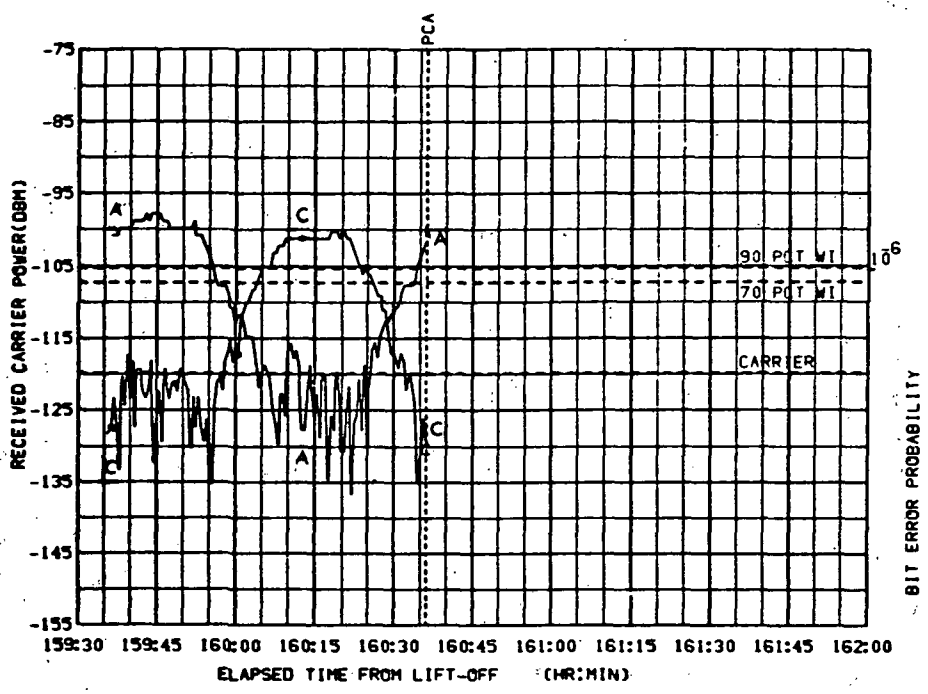

FIGURE 10-11a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

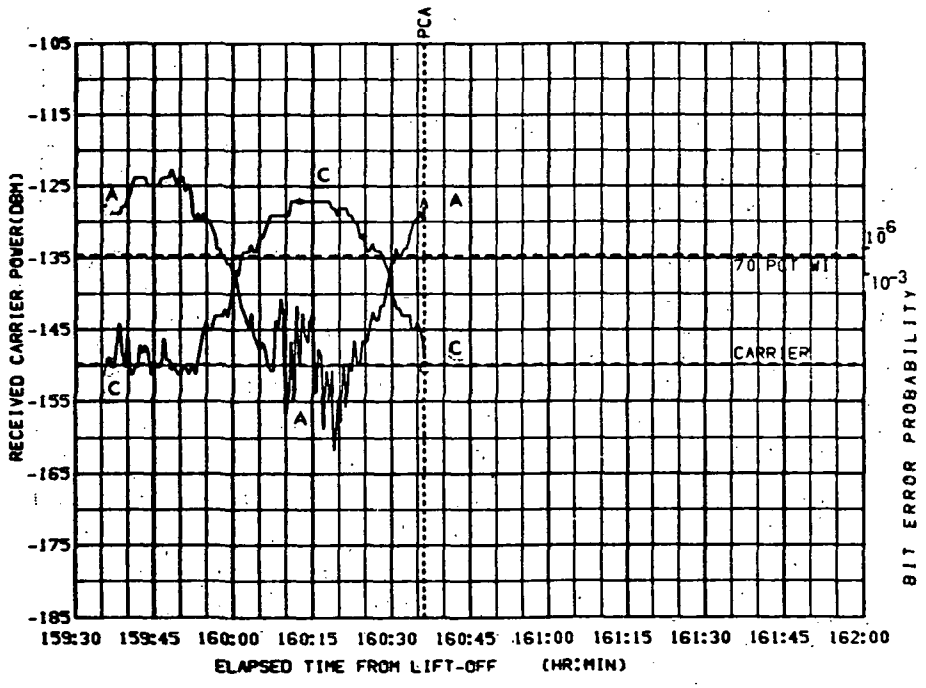

FIGURE 10-11b. GWM DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

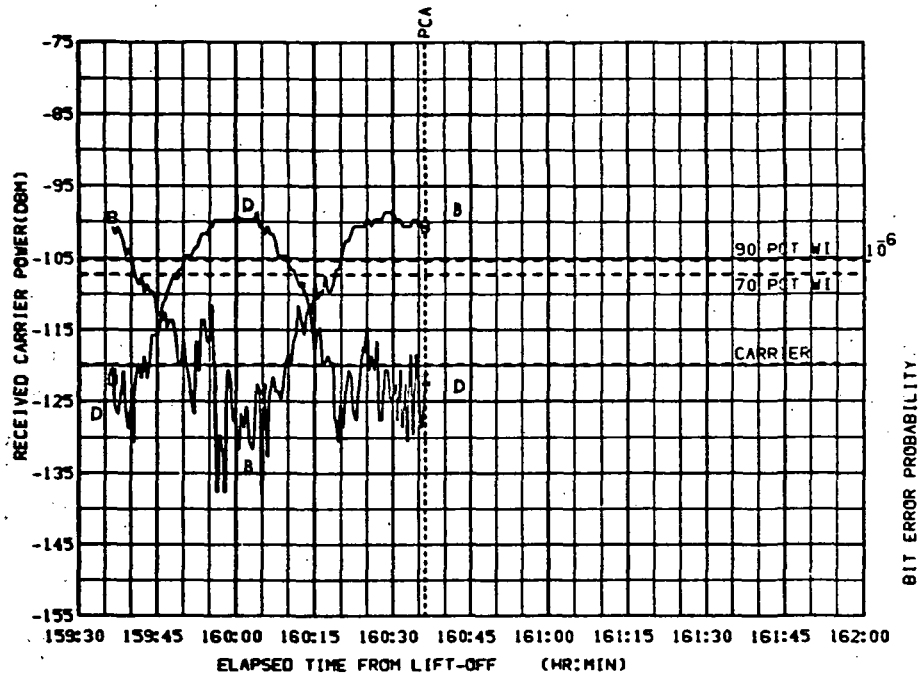

FIGURE 10-11c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

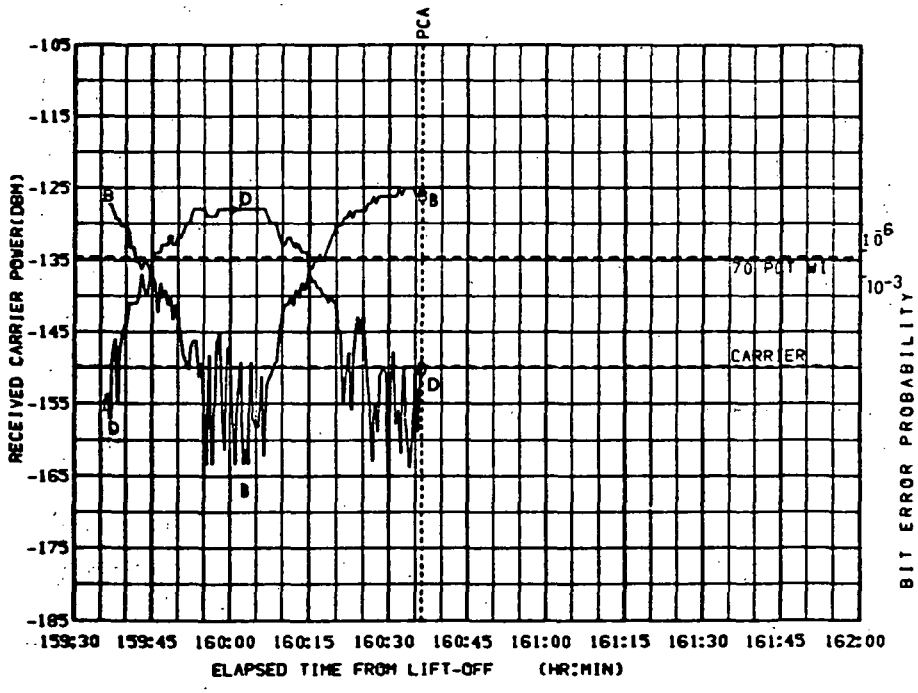

FIGURE 10-11d. GWM DNLINK MODE 8. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

PCA PARAMETERS. AZI = -96.20
ELV = 78.20
RANGE = 143497

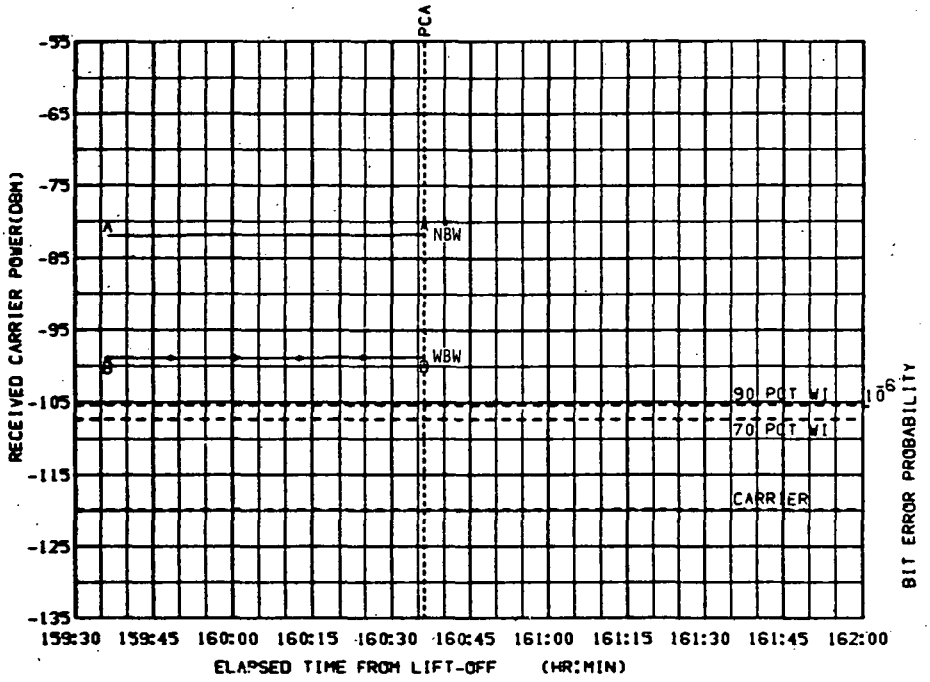

FIGURE 10-11e. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

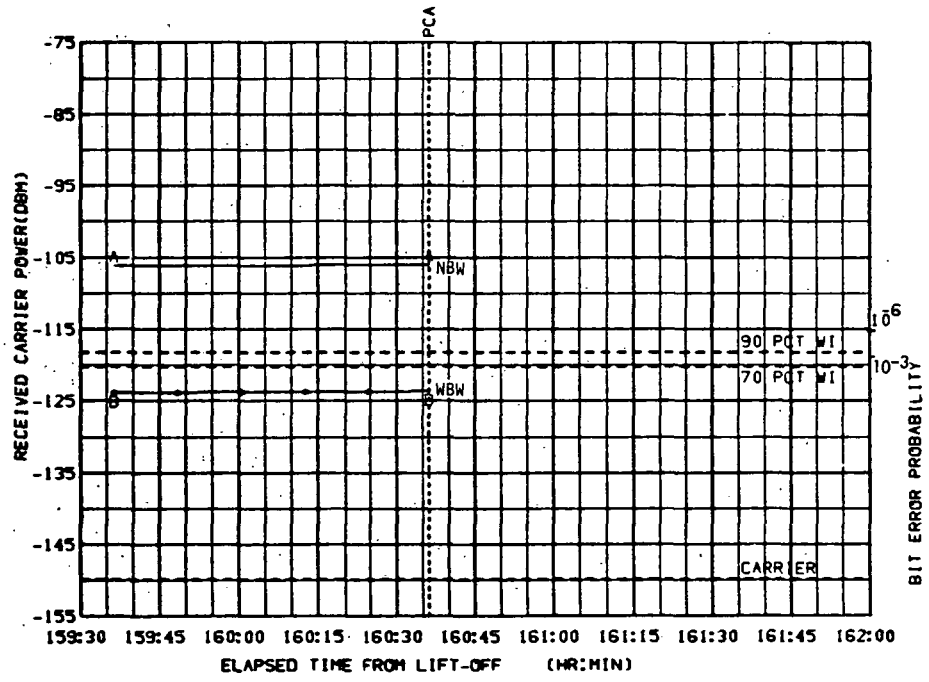

FIGURE 10-11f. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

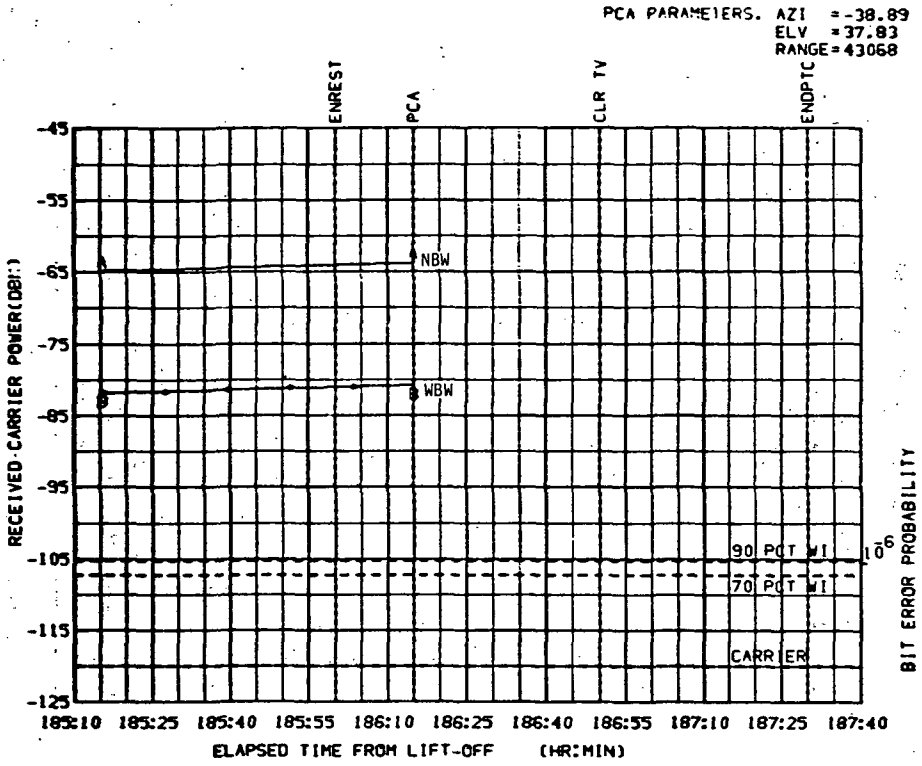

FIGURE 10-12a. HSK UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

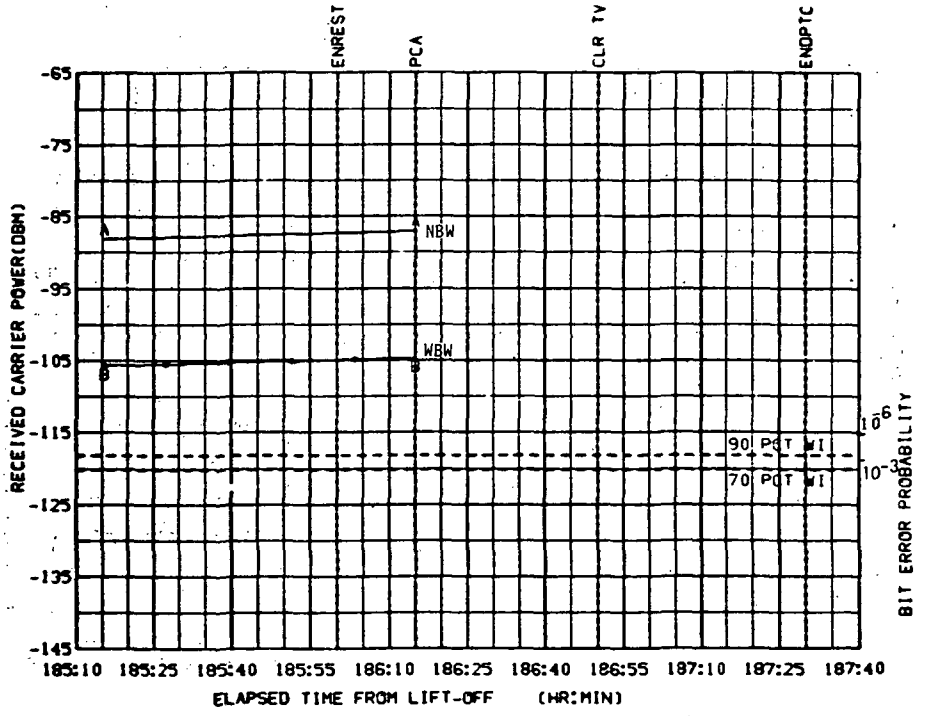

FIGURE 10-12b. HSK DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

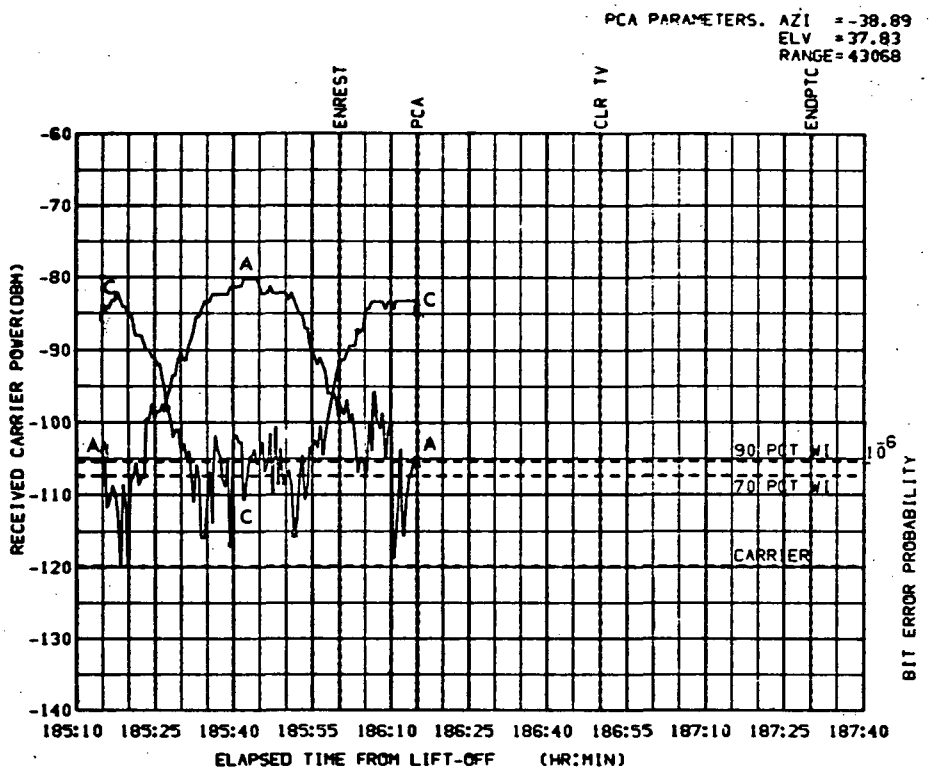

FIGURE 10-12c. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

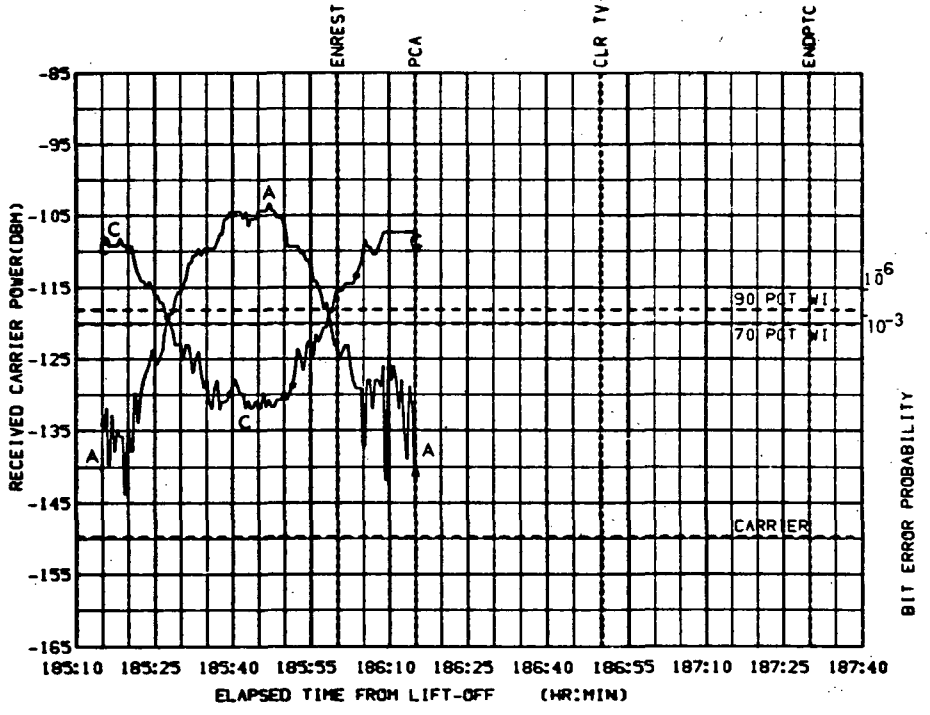

FIGURE 10-12d. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

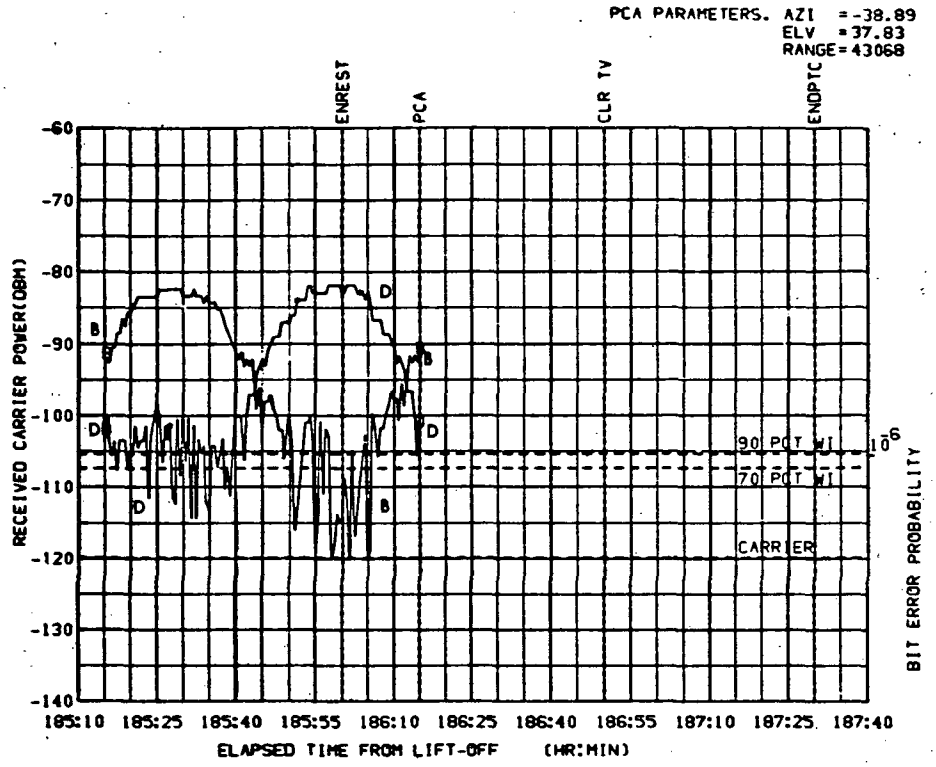

FIGURE 10-12e. MSK UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

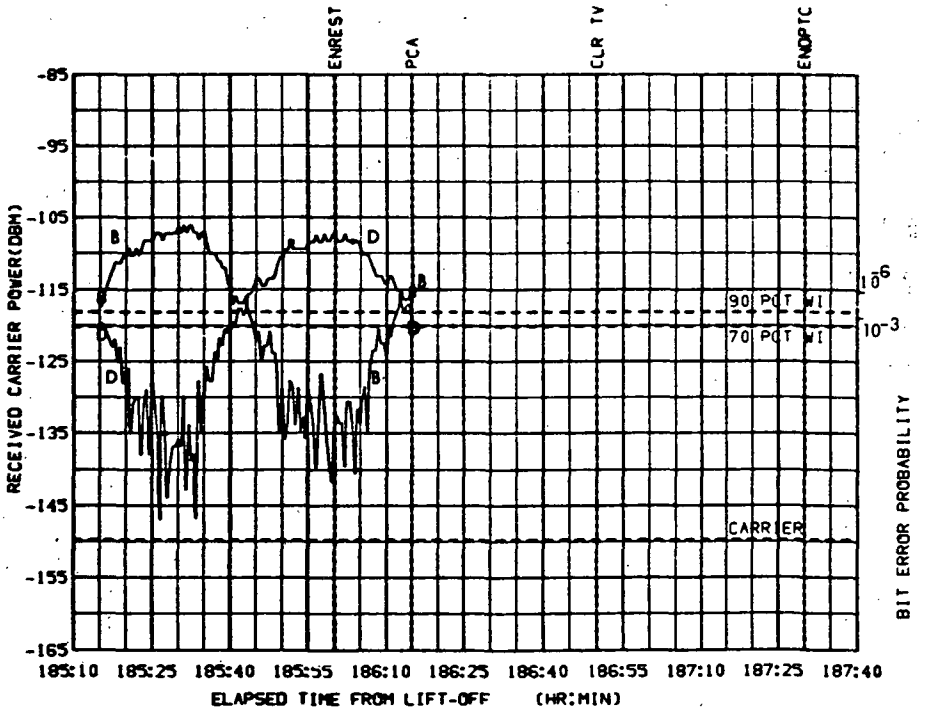

FIGURE 10-12f. MSK DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

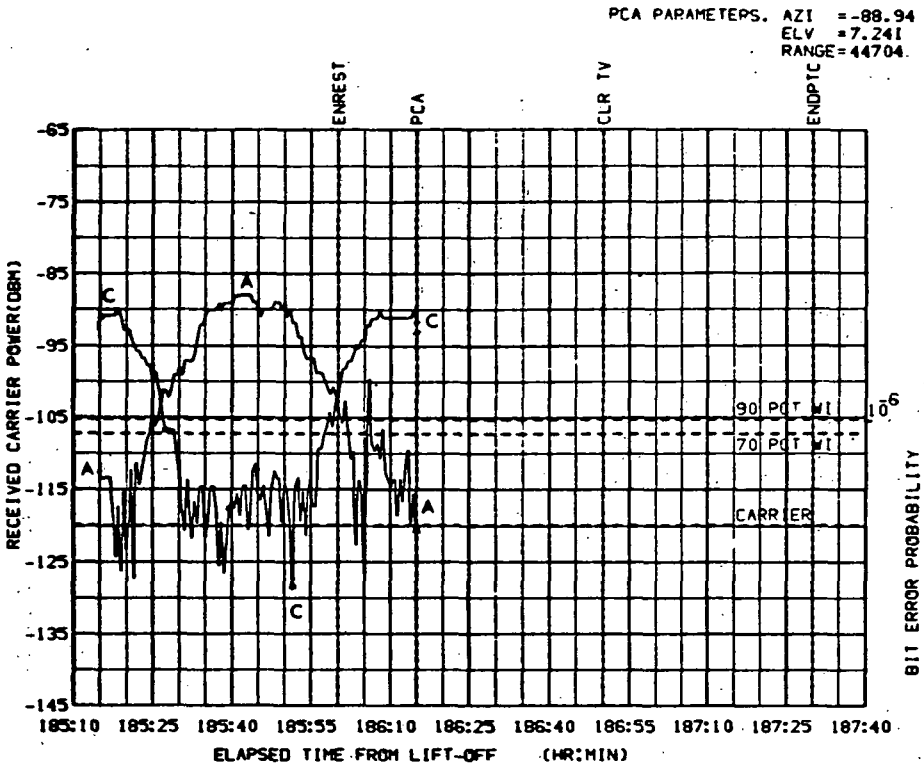

FIGURE 10-13a. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

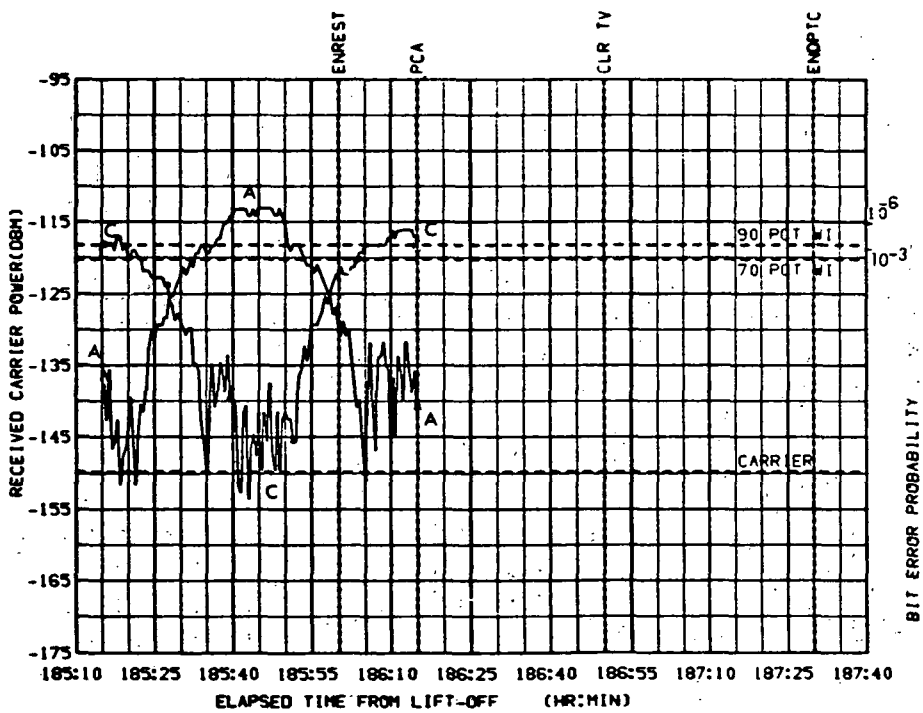

FIGURE 10-13b. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

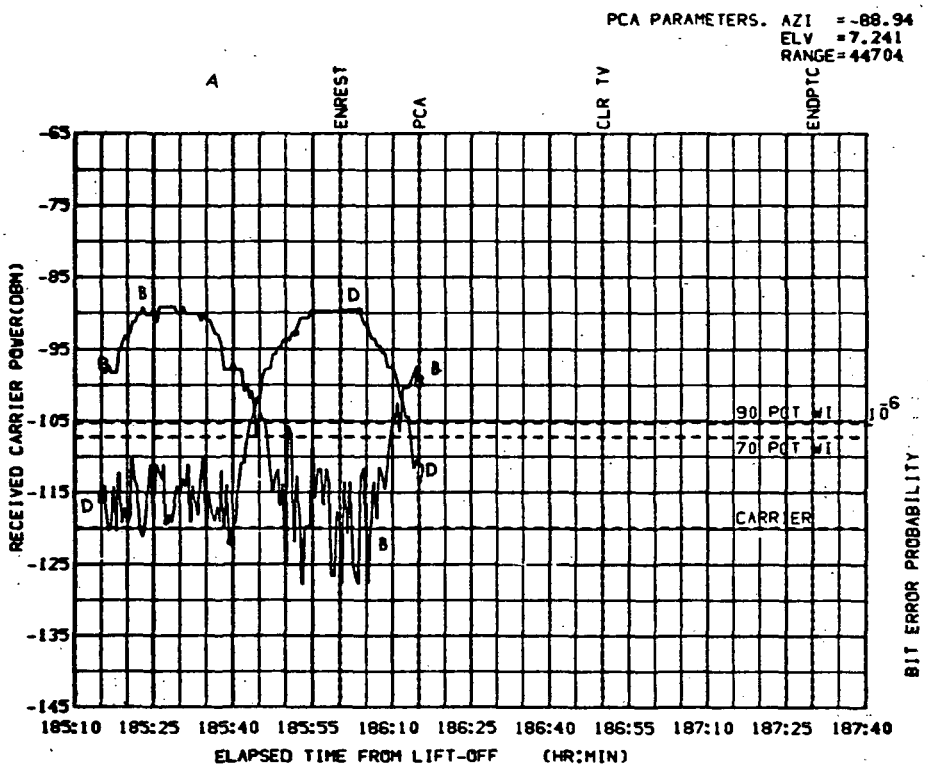

FIGURE 10-13c. HAW UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

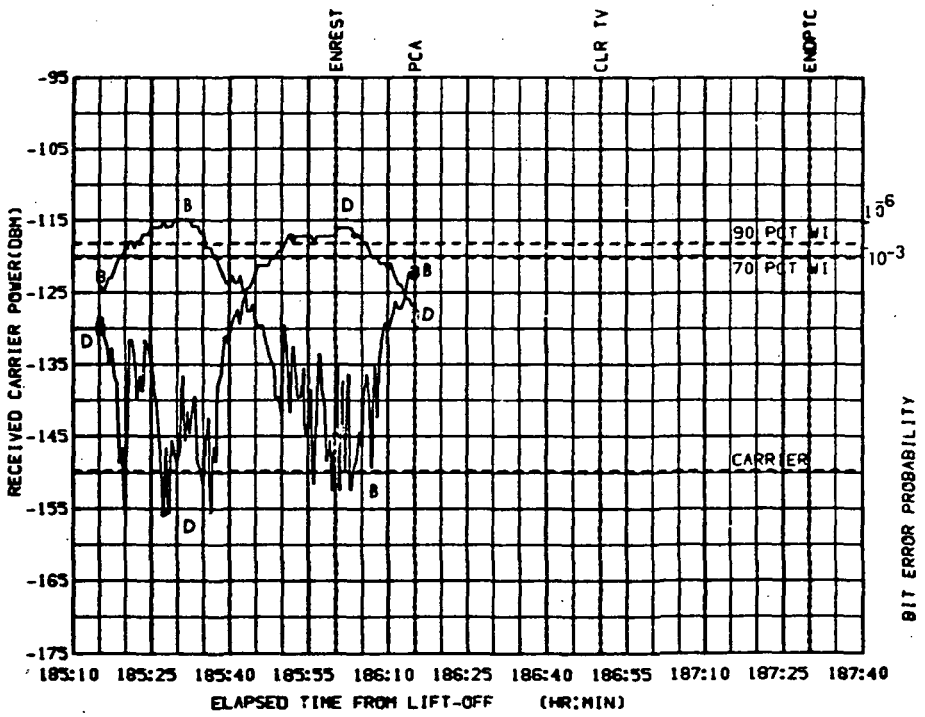

FIGURE 10-13d. HAW DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

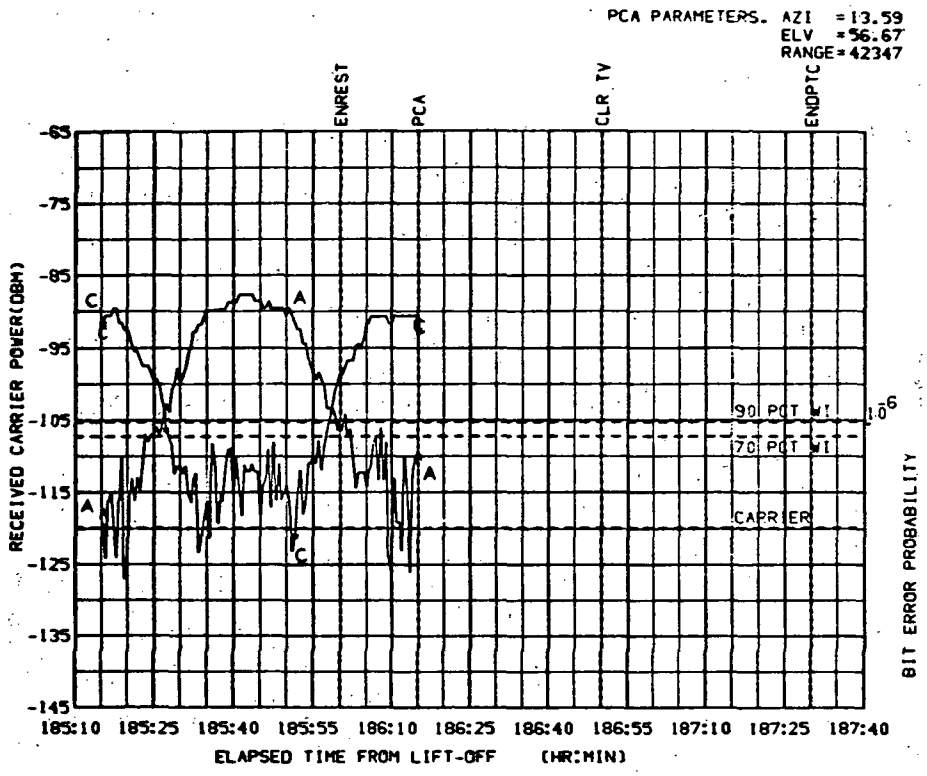

FIGURE 10-14a. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

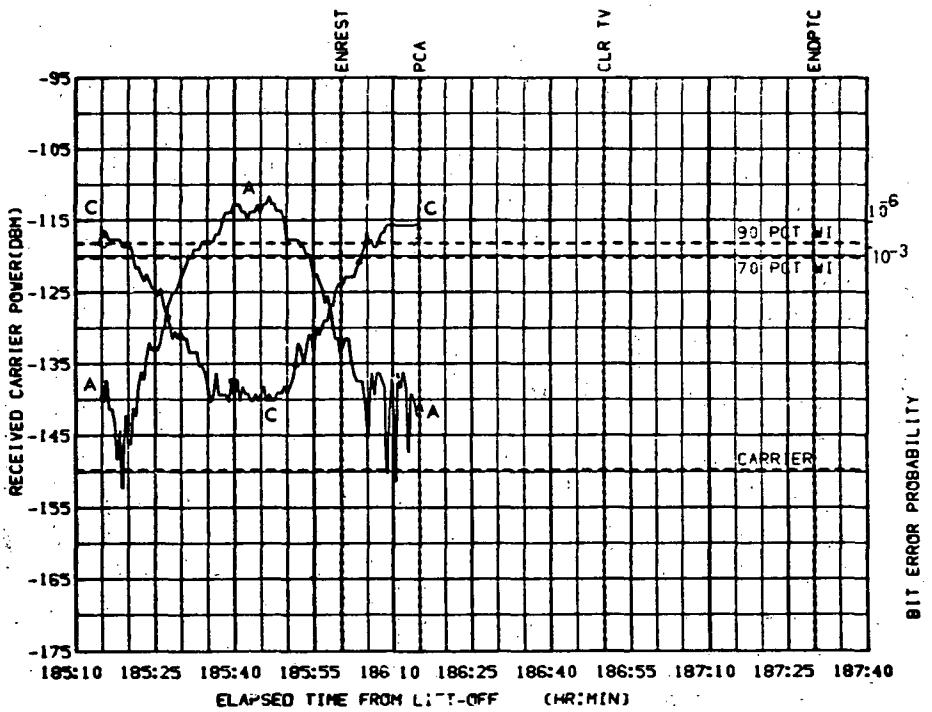

FIGURE 10-14b. CRO DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

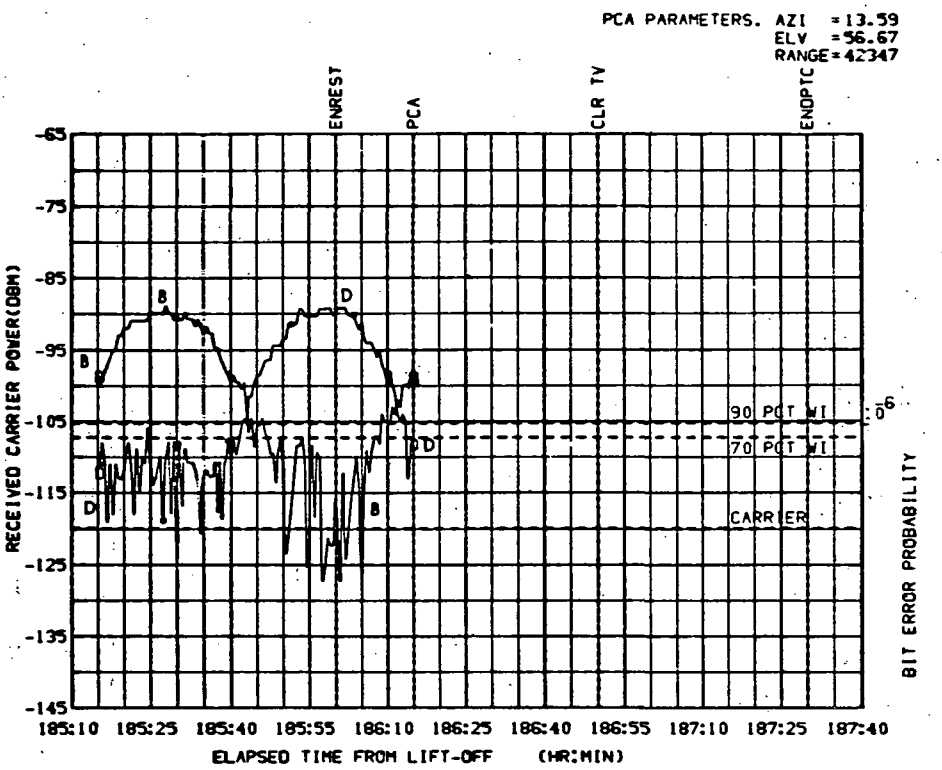

FIGURE 10-14c. CRO UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

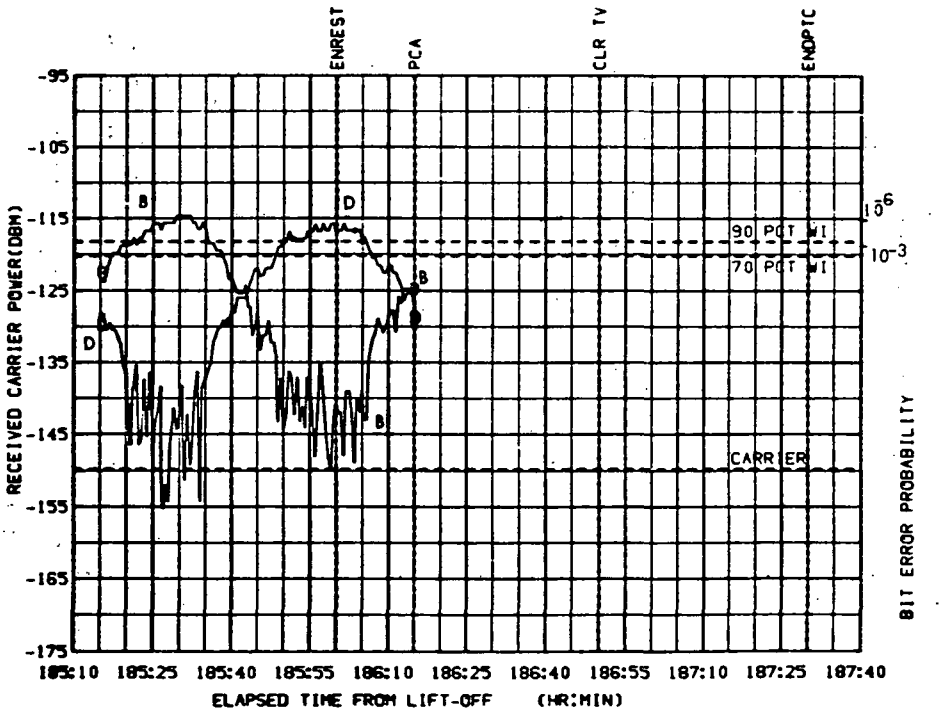

FIGURE 10-14d. CRO ONLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

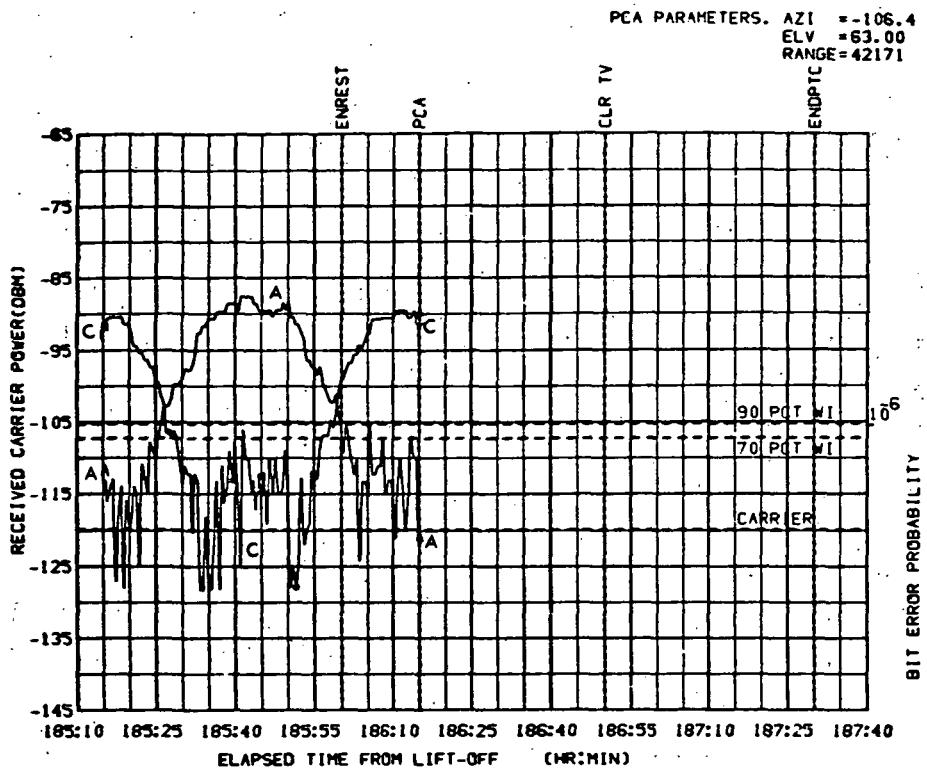

FIGURE 10-15a. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

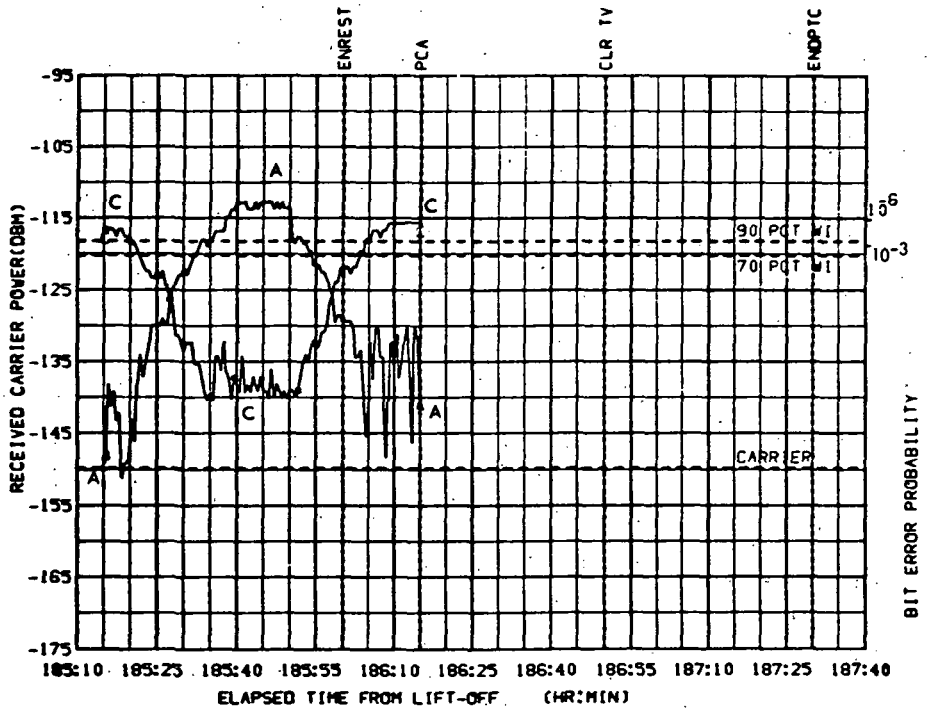

FIGURE 10-15b. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

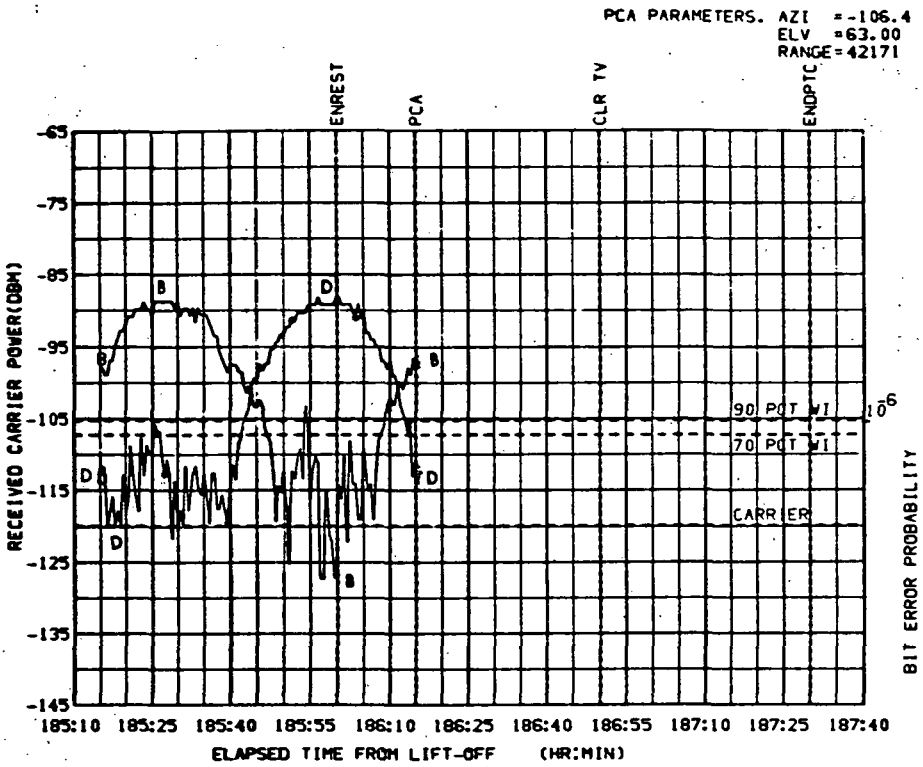

FIGURE 10-15c. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

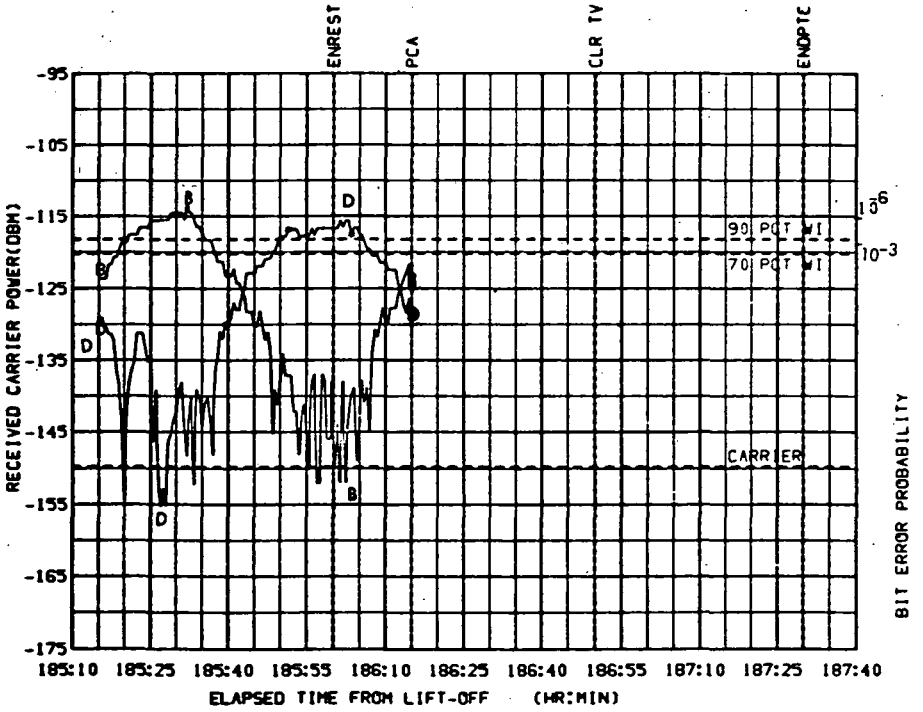

FIGURE 10-15d. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

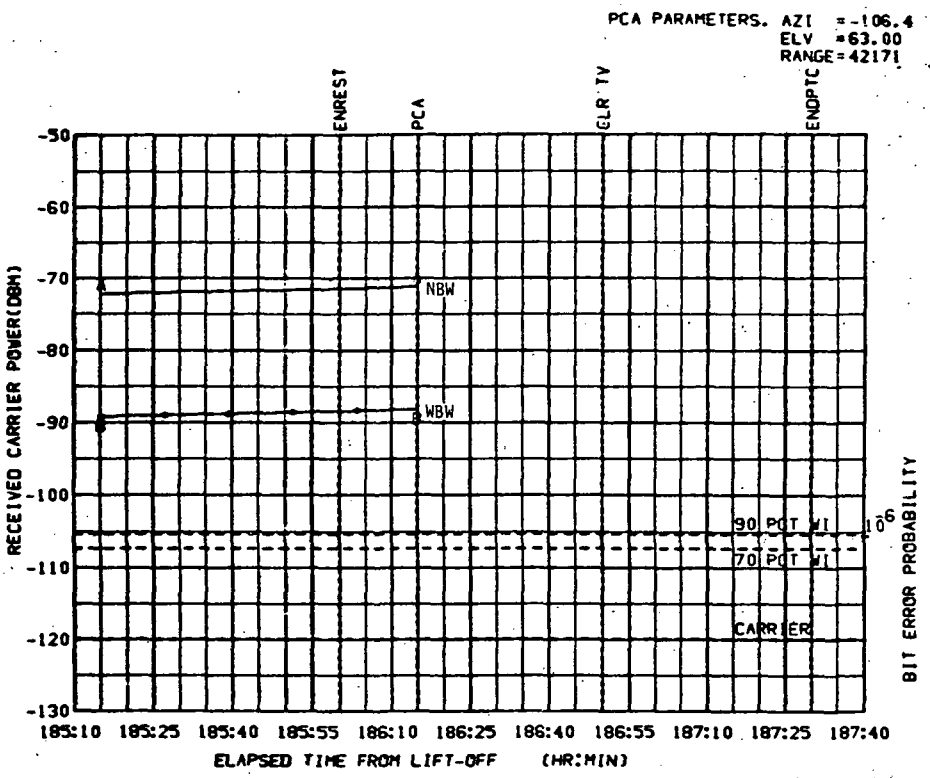

FIGURE 10-15e. GWM UPLINK MODE 6. MSFN/CSM. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

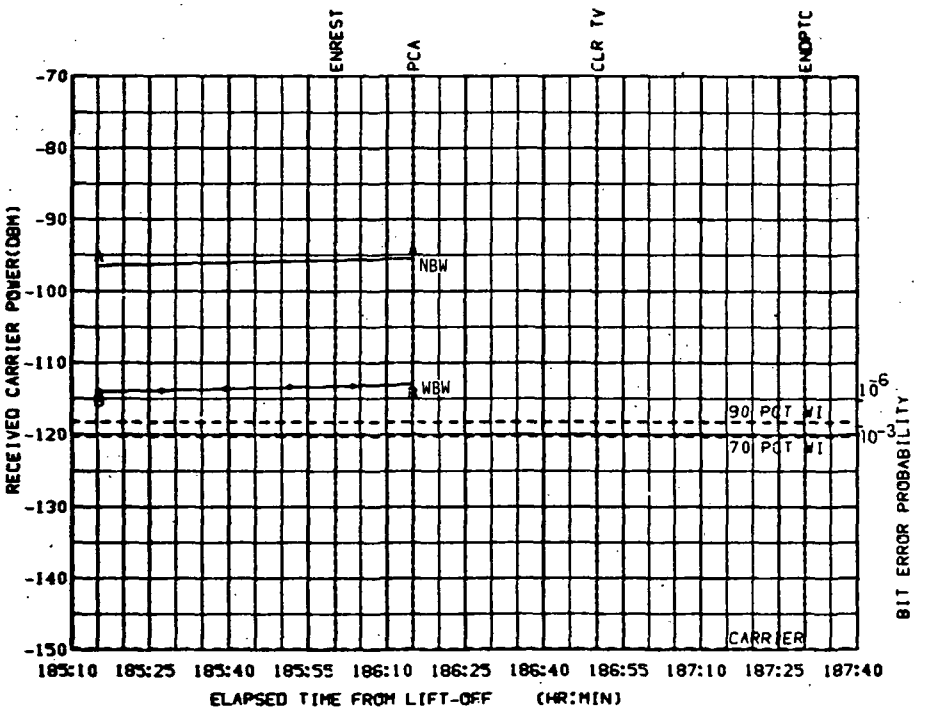

FIGURE 10-15f. GWM DNLINK MODE 2. CSM/MSFN. S-BAND. HGA
CSM ONLY. TRANSEARTH COAST. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

11. REENTRY

This section discusses the communications coverage for the reentry phase.

11.1 COMMUNICATION CONFIGURATION

Figure 11-1 depicts the basic communication configuration for the reentry phase of Apollo 10. The only communications between the command module and MSFN prior to chute deployment is via the S-band system. After chute deployment, communication with the recovery forces is via VHF/AM using the recovery antennas.

11.2 COVERAGE SUMMARY

Received carrier power versus elapsed time from lift-off plots (Figures 11-2a through 11-2d) for the CSM S-band system are provided for the tracking ship RED. The reentry trajectory data used in the generation of the plots are based on a 17 May 1969 launch date. The level of received carrier power shown for RED prior to S-band blackout can be expected during the reentry phase of the 18 May launch date mission since the reentry phase and ship position were not changed significantly for the 18 May mission.

The event times associated with the reentry phase for the 18 May mission are given in Section 4.

After providing TLI coverage support, the tracking ship HTV will be repositioned to provide C-band skin tracking during the reentry phase. HTV is expected to provide skin tracking coverage from approximately 60 seconds after exit C-band blackout to approximately the 180,000-foot altitude.

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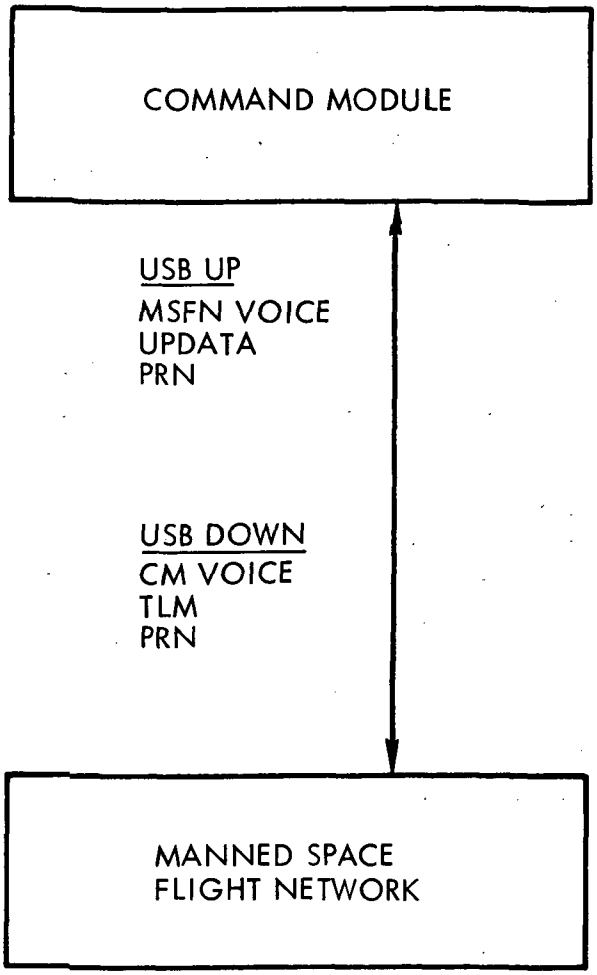

Figure 11-1. Communications Configuration for Reentry Phase

17 May Launch

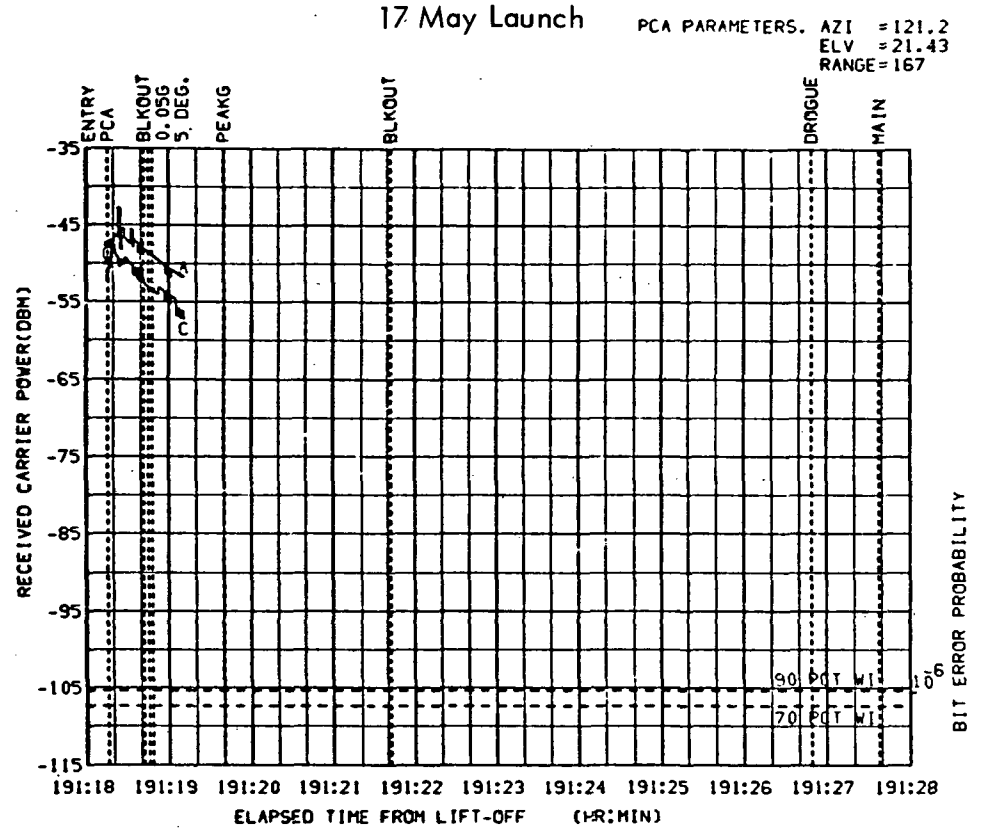

FIGURE 11-2a. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI CM ONLY. REENTRY. APOLLO 10
RECEIVED CARPIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

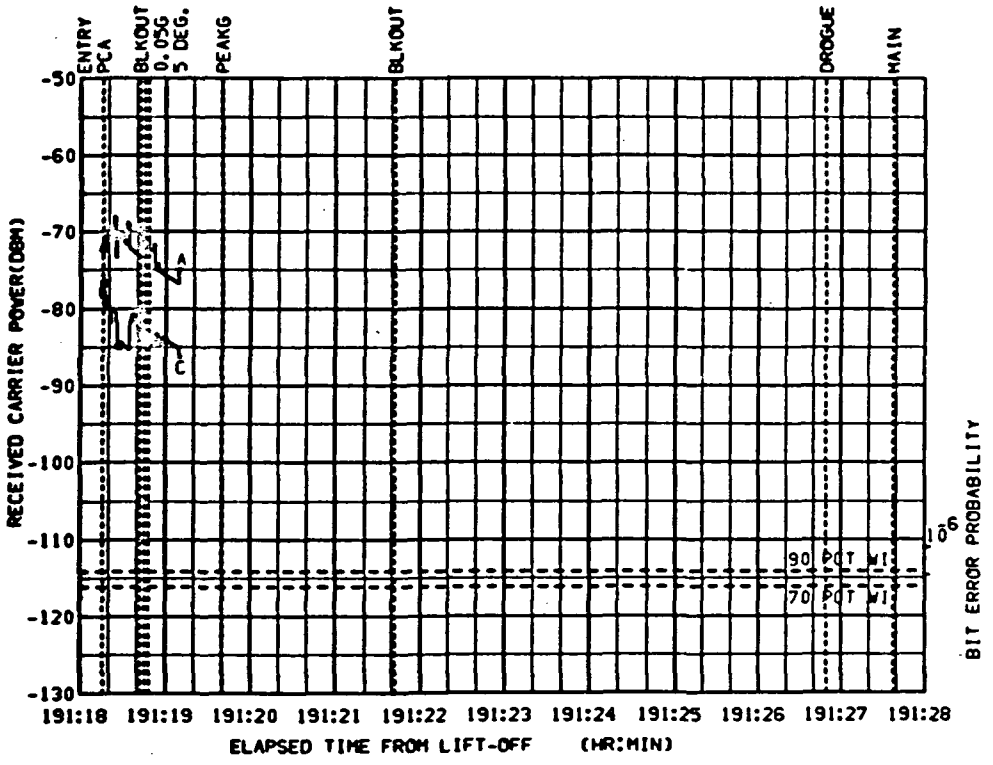

FIGURE 11-2b. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI CM ONLY. REENTRY. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

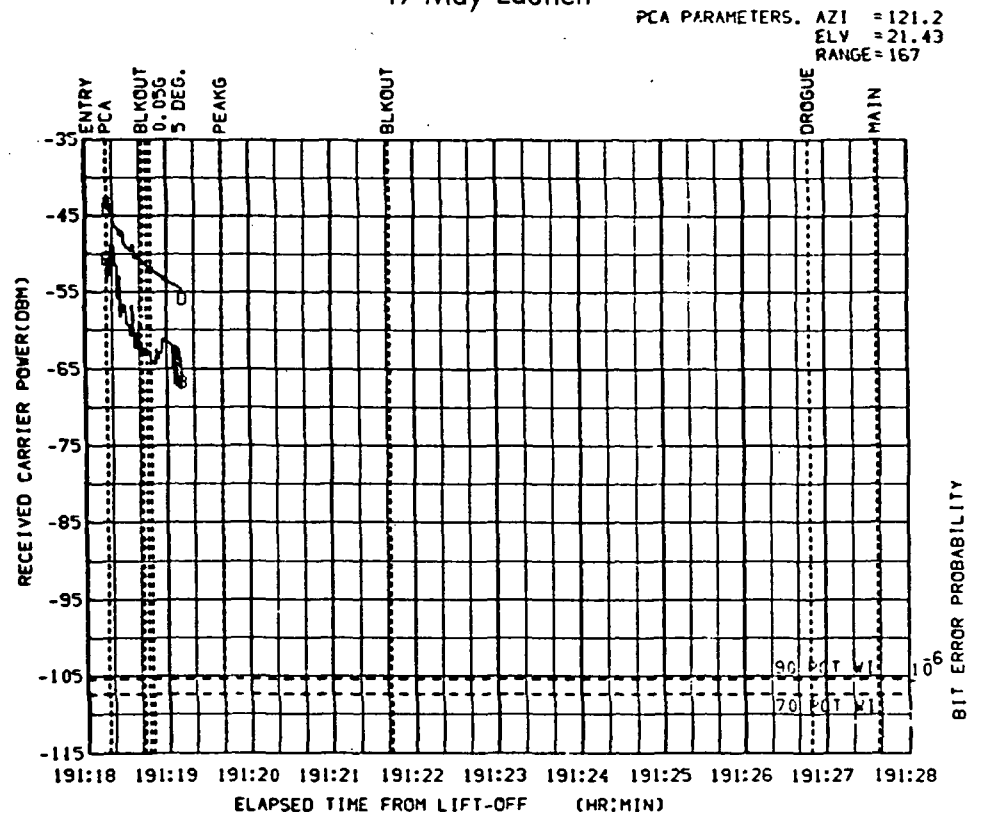

FIGURE11-2c. RED UPLINK MODE 6. MSFN/CSM. S-BAND. OMNI
CM ONLY. REENTRY. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

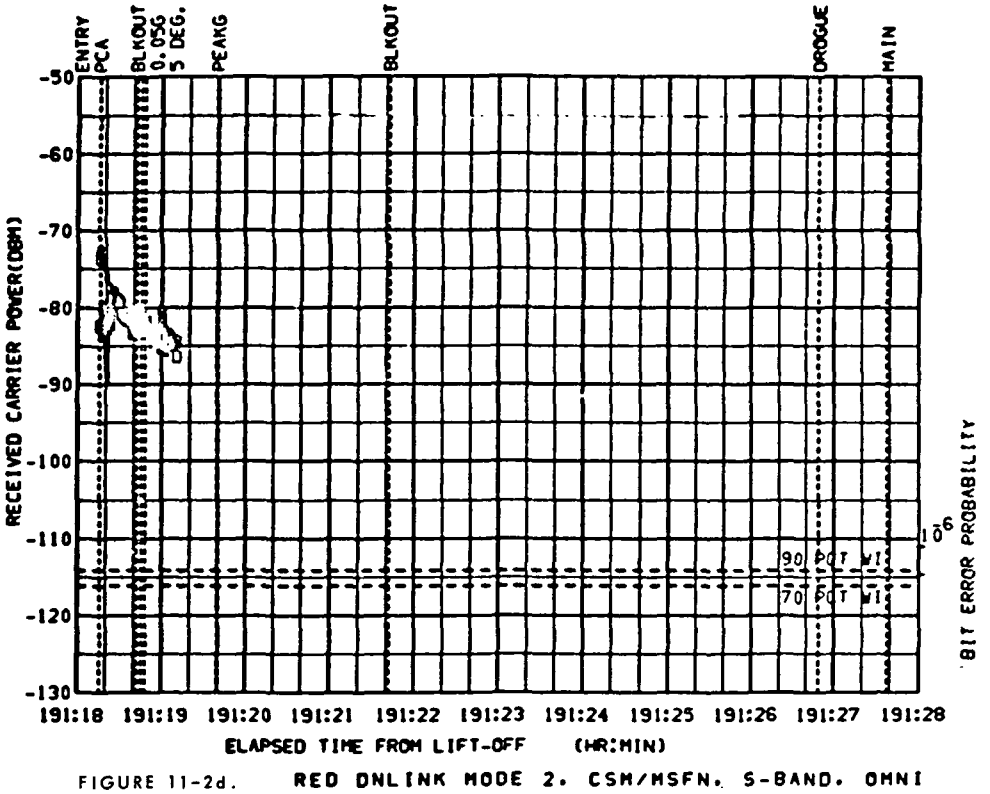

FIGURE 11-2d. RED DNLINK MODE 2. CSM/MSFN. S-BAND. OMNI
CM ONLY. REENTRY. APOLLO 10
RECEIVED CARRIER POWER VERSUS ELAPSED TIME FROM LIFT-OFF

APPENDIX A
SYSTEM PARAMETERS

S-BAND PARAMETERS
MSFN to CSM

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
100	MSFN transmitting frequency	2,106.40625	MHz	4	
Transmitted Powers					
101	MSFN transmitted high power	9,500	watt	4	
102	MSFN transmitted low power	1,900	watt	4	
Antenna Gains					
103	MSFN 12-ft (reentry ship) antenna transmitting gain	35	dB	4	
104	MSFN 30-ft antenna transmitting gain	43	dB	4	
105	MSFN 85-ft antenna transmitting gain	50.5	dB		1
106	CSM high-gain antenna (2106.4 MHz) receiving gain WBW	6.7	dB	11	
107	CSM high-gain antenna (2106.4 MHz) receiving gain MBW	24.1	dB	11	
108	CSM high-gain antenna (2106.4 MHz) receiving gain NBW	23.7	dB	11	

MSFN to CSM (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Losses					
109	CSM omni A antenna receiving losses (antenna output to triplexer input)	2.2	dB	9	
110	CSM omni B antenna receiving losses (antenna output to triplexer input)	3.0	dB	9	
111	CSM omni C antenna receiving losses (antenna output to triplexer input)	4.0	dB	9	
112	CSM omni D antenna receiving losses (antenna output to triplexer input)	3.5	dB	9	
113	CSM high-gain antenna receiving losses (antenna output to triplexer input)	5.1	dB	9	
114	CSM high-gain antenna receiving pointing loss	0.2	dB	4	
Modulation Indices					
115	Mode 1 - Ranging PM modulation index	1.34	radian	4	
116	Mode 2 - Voice PM modulation index	1.85	radian	4	
117	Mode 3 - Updata PM modulation index	1.85	radian	4	

MSFN to CSM (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Modulation Indices (Continued)					
118	Mode 4 - Voice PM modulation index	1.2	radian	4	
119	- Ranging PM modulation index	0.38	radian	4	
120	Mode 5 - Updata PM modulation index	1.2	radian	4	
121	- Ranging PM modulation index	0.38	radian	4	
122	Mode 6 - Voice PM modulation index	1.0	radian	4	
123	- Updata PM modulation index	1.0	radian	4	
124	- Ranging PM modulation index	0.44	radian	4	
125	Mode 7 - Voice PM modulation index	1.1	radian	4	
126	- Updata PM modulation index	1.1	radian	4	
127	Mode 8 - Upvoice backup PM modulation index	1.20	radian	2	
	- Ranging PM modulation index	0.38	radian	2	

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Spectral Density Constants					
128	CSM noise spectral density constant A	5,800	^{o}K	7	
129	CSM noise spectral density constant B	2.7×10^{13}	^{o}K/watt		2
Noise Bandwidths					
130	CSM PM carrier loop noise bandwidth	800	Hz	4	
131	CSM updata (or upvoice backup) subcarrier noise bandwidth (predetection)	24,200	Hz	4	
132	CSM PM voice subcarrier noise bandwidth (predetection)	24,200	Hz	4	
133	CSM IF noise bandwidth	4,900,000	Hz	4	
134	CSM video noise bandwidth	1,700,000	Hz	4	
Required Signal-to-Noise Ratios (rms/rms)					
135	CSM required carrier-to-noise ratio	12	dB	4	
136	CSM required voice S/N for 90% WI (predetection)	10	dB	4	
137	CSM required voice S/N for 70% WI (predetection)	8	dB		2

MSFN to CSM (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Required Signal-to-Noise Ratios (rms/rms)(Continued)					
138	CSM required updata S/N for 6.6×10^{-6} BEP (predetection)	10	dB	4	
139	CSM required upvoice backup S/N for 70% WI (predetection)	8	dB		2

CSM to MSFN

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
200	CSM transmitting PM frequency (phase locked)	2, 287. 5	MHz	4	
201	CSM transmitting FM frequency	2, 272. 5	MHz	4	
202	CSM PM primary auxiliary oscillator transmitting frequency	2, 287. 50008	MHz	3	
203	CSM PM secondary auxiliary oscillator transmitting frequency	2, 287. 5001	MHz	3	
Transmitting Powers					
204	CSM PM transmitted high power (PA output, P91)	12. 3	watt	3	
205	CSM PM transmitted low power (PA output, P91)	3. 09	watt	3	
206	CSM PM transmitted bypass power (PA output, P91)	0. 125	watt	4	
207	CSM FM transmitted high power	12. 8	watt	3	
Antenna Gains					
208	MSFN 12-ft antenna (reentry ship) receiving gain	36	dB	4	
209	MSFN 30-ft antenna receiving gain	44	dB	4	

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Antenna Gains (Continued)					
210	MSFN 85-ft antenna receiving gain	52.5	dB		1
211	CSM high-gain antenna (2272.5 MHz) transmitting gain WBW	8.4	dB	11	
212	CSM high-gain antenna (2272.5 MHz) transmitting gain MBW	19.7	dB	11	
213	CSM high-gain antenna (2272.5 MHz) transmitting gain NBW	26.0	dB	11	
Losses					
214	CSM omni A antenna transmitting losses (PA output, P91) to antenna input)	1.7	dB	9	
215	CSM omni B antenna transmitting losses (PA output, P91) to antenna input)	2.3	dB	9	
216	CSM omni C antenna transmitting losses (PA output, P91) to antenna input)	3.6	dB	9	
217	CSM omni D antenna transmitting losses (PA output, P91) to antenna input)	3.0	dB	9	

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Losses					
218	CSM high-gain antenna transmitting losses (PA output, P91) to antenna input)	5.1	dB	9	
219	CSM high-gain antenna transmitting pointing loss	0.2	dB	4	
Modulation Indices (PM)					
220	Mode 1 - Voice PM modulation index	0.69	radian		3
221	- HBR telemetry PM modulation index	0.96	radian		4
222	Mode 2 - Voice PM modulation index	0.69	radian		3
223	- HBR telemetry PM modulation index	0.96	radian		4
224	- Ranging PM modulation index (function of uplink mode)		radian		
225	Mode 3 - Voice PM modulation index	1.19	radian		3
226	- LBR telemetry PM modulation index	0.7	radian		3
227	- Ranging PM modulation index (function of uplink mode)		radian		

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Modulation Indices (PM) (Continued)					
228	Mode 4 - Voice PM modulation index	1.19	radian		3
229	- LBR telemetry PM modulation index	0.7	radian		3
230	Mode 5 - LBR telemetry PM modulation index	1.6	radian		3
231	Mode 6 - Key PM modulation index	1.0	radian		3
232	Mode 7 - Ranging PM modulation index (function of uplink mode)		radian		
233	Mode 8 - Backup voice PM modulation index	0.77	radian		3
234	- LBR telemetry PM modulation index	1.2	radian		3
235	Mode 9 - LBR telemetry PM modulation index	1.6	radian		3
236	- Ranging PM modulation index (function of uplink mode)		radian		
237	Mode 10 - Backup voice PM modulation index	1.21	radian	3	
237A	Mode 15 - HBR telemetry PM modulation index	1.6	radian	2	
	- Ranging PM modulation index (function of uplink mode)		radian		

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Frequency Deviations of Carrier (FM)					
238	Mode 1 - PB voice (1:1) frequency deviation of carrier	86,500	Hz		3
239	- PB HBR telemetry (1:1) frequency deviation of carrier	539,000	Hz		3
240	Mode 2 - PB voice (32:1) frequency deviation of carrier	86,500	Hz		3
241	- PB LBR telemetry (32:1) frequency deviation of carrier	539,000	Hz		3
242	Mode 3 - PB LM LBR telemetry (32:1) frequency deviation of carrier	137,000	Hz		3
243	Mode 4 - Television frequency deviation of carrier	977,000	Hz		3
Noise Spectral Density Constants					
244	MSFN PM noise spectral density constant B	3.05×10^{15}	^{o}K/watt	4	
245	MSFN FM noise spectral density constant B	0.0	^{o}K/watt	4	
246	MSFN 85-ft antenna NSD constant A (quiet sky)	96	^{o}K	4	

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Spectral Density Constants (Continued)					
247	MSFN 85-ft antenna NSD constant A (moon at zenith)	210	°K	4	
248	MSFN 85-ft antenna NSD constant A (horizon) (for 5-deg elevation)	126	°K	4	
249	MSFN 30-ft cooled antenna NSD constant A (quiet sky)	96	°K	4	
250	MSFN 30-ft cooled antenna NSD constant A (moon at zenith)	135	°K	4	
251	MSFN 30-ft cooled antenna NSD constant A (horizon) (for 5-deg elevation)	126	°K	4	
252	MSFN 30-ft uncooled antenna NSD constant A (quiet sky)	250	°K	4	
253	MSFN 30-ft uncooled antenna NSD constant A (moon at zenith)	289	°K	4	
254	MSFN 30-ft uncooled antenna NSD constant A (horizon) (for 5-deg elevation)	280	°K	4	
Noise Bandwidths (PM)					
255	MSFN PM carrier loop wide bandwidth noise bandwidth (earth orbit, T&D, reentry)	840	Hz	4	

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Bandwidths (PM) (Continued)					
256	MSFN PM carrier loop narrow bandwidth noise bandwidth (all mission phase except earth orbit, T&D, reentry)	50	Hz	4	
257	MSFN PM voice/biomed noise bandwidth (predetection)	48,000	Hz	4	
258	MSFN PM HBR telemetry noise bandwidth (predetection)	198,000	Hz	4	
259	MSFN PM LBR telemetry noise bandwidth (predetection)	7,975	Hz	4	
260	MSFN PM key noise bandwidth (predetection)	1,485	Hz	4	
261	MSFN PM backup voice bandwidth (postdetection)	3,156	Hz	4	
262	MSFN PM PRN ranging noise bandwidth (predetection)	1.0	Hz	4	
263	MSFN IF noise bandwidth	5,300,000	Hz	4	
Required Signal-to-Noise Ratios (PM) (rms/rms)					
264	MSFN required PM carrier-to-noise ratio	12	dB	4	
265	MSFN required PM voice S/N for 90% WI (predetection)	8	dB	4	

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Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
	Required Signal-to-Noise Ratios (PM) (rms/rms) (Continued)				
266	MSFN required PM voice S/N for 70% WI (predetection)	6	dB		2
267	MSFN required PM HBR telemetry S/N for 10^{-6} BEP (predetection)	8.5	dB	4	
268	MSFN required HBR telemetry S/N for 10^{-4} BEP (predetection)	6.4	dB	4	
269	MSFN required PM HBR telemetry S/N for 10^{-3} BEP (predetection)	4.9	dB	4	
270	MSFN required PM LBR telemetry S/N for 10^{-6} BEP (predetection)	5.9	dB		2
271	MSFN required PM LBR telemetry S/N for 10^{-4} BEP (predetection)	3.8	dB		2
272	MSFN required PB LBR telemetry S/N for 10^{-3} BEP (predetection)	2.3	dB		2
273	MSFN required PM backup voice S/N for 70% WI (postdetection)	4.0	dB	4	
274	MSFN required PM key S/N (predetection)	-10.5	dB	4	
275	MSFN required ranging S/N (predetection)	32.0	dB	4	

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Bandwidths (FM)					
276	MSFN FM PB CSM voice noise bandwidth (carrier demodulator postdetection)	67,200	Hz	4	
277	MSFN FM PB CSM telemetry noise bandwidth (carrier demodulator postdetection)	198,000	Hz	4	
278	MSFN FM television noise bandwidth (carrier demodulator postdetection)	530,250	Hz	4	
279	MSFN FM LM PB telemetry noise bandwidth (carrier demodulator postdetection)	90,000	Hz	4	
280	MSFN FM PB voice noise bandwidth (predetection) (wide-wide demodulator configuration)	4,800,000	Hz	4	
281	MSFN FM PB CSM telemetry noise bandwidth (predetection)	4,800,000	Hz	4	
282	MSFN FM PB LM telemetry noise bandwidth (predetection)(narrow-wide demodulator configuration)	1,200,000	Hz	4	
283	MSFN FM television noise bandwidth (predetection)	4,800,000	Hz	4	

CSM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Required Signal-to-Noise Ratio (FM) (rms/rms)					
284	MSFN FM required mode as a whole S/N (predetection)	8	dB	4	
Rho and Rho Squared					
285	Rho squared for FM normal voice (where ρ = rms/peak)	0.5			2
286	Rho squared for PB voice (where ρ = rms/peak)	0.264			2
287	Rho squared for PB LM split-phase telemetry (where ρ = rms/peak)	1.0			2
288	Rho squared for television (where ρ = rms/peak)	0.5			2
289	Rho for PM backup voice, 24 dB clipping (where ρ = rms/peak)	0.66			2
Transponder Constants					
290	CSM transponder ranging gain constant	0.61			2
291	CSM transponder turnaround ratio	0.4		3	

MSFN to LM

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
300	MSFN transmitting frequency	2,101.802	MHz	5	
Transmitted Powers					
301	MSFN transmitted high power	9,500	watt	5	
302	MSFN transmitted low power	1,900	watt	5	
Antenna Gains					
303	MSFN 30-ft antenna transmitting gain	43	dB	5	
304	MSFN 85-ft antenna transmitting gain	50.5	dB		1
305	LM steerable antenna receiving gain	16.5	dB	5	
306	Erectable antenna receiving gain		dB		5
Losses					
307	LM omni FWD (+Z) antenna receiving losses (antenna output to receiver input)	6.0	dB	10	
308	LM omni AFT (-Z) antenna receiving losses (antenna output to receiver input)	6.2	dB	10	

MSFN to LM (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Losses (Continued)					
309	LM steerable antenna receiving losses (antenna output to receiver input)	5.6	dB	10	
310	LM steerable antenna receiving pointing loss	0.5	dB	5	
311	Erectable antenna receiving losses (antenna output to receiver input)		dB		5
312	Erectable antenna pointing loss		dB		5
Modulation Indices					
313	Mode 1 - Ranging PM modulation index	1.34	radian	5	
314	Mode 2 - Voice PM modulation index	1.85	radian	5	
315	Mode 3 - Updata PM modulation index	1.85	radian	5	
316	Mode 4 - Voice PM modulation index	1.2	radian	5	
317	- Ranging PM modulation index	0.38	radian	5	

MSFN to LM (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Modulation Indices (Continued)					
318	Mode 5 - Updata PM modulation index	1.2	radian	5	
319	- Ranging PM modulation index	0.38	radian	5	
320	Mode 6 - Voice PM modulation index	1.0	radian	5	
321	- Updata PM modulation index	1.0	radian	5	
322	- Ranging PM modulation index	0.44	radian	5	
323	Mode 7 - Voice PM modulation index	1.1	radian	5	
324	- Updata PM modulation index	1.1	radian	5	
325	Mode 8 - Upvoice backup PM modulation index	1.20	radian	2	
	- Ranging PM modulation index	0.38	radian		
Noise Spectral Density Constants					
326	LM noise spectral density constant A	3,600	^{o}K	12	
327	LM noise spectral density constant B	1.26×10^{14}	^{o}K/watt		2

MSFN to LM (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Bandwidths					
328	LM PM carrier loop noise bandwidth	1,500	Hz	5	
329	LM PM voice subcarrier noise bandwidth (predetection)	22,000	Hz	5	
330	LM PM updata (or upvoice backup) subcarrier noise bandwidth (predetection)	27,000	Hz	5	
331	LM PM IF noise bandwidth	5,100,000	Hz	5	
332	LM PM video noise bandwidth	1,800,000	Hz	5	
Required Signal-to-Noise Ratios (rms/rms)					
333	LM required carrier-to-noise ratio	12	dB	5	
334	LM required voice S/N for 90% WI (predetection)	10	dB	5	
335	LM required voice S/N for 70% WI (predetection)	8	dB		2
336	LM required updata S/N for 9.08×10^{-6} BEP (predetection)	12	dB	5	
337	LM required upvoice backup S/N for 70% WI (predetection)	8.0	dB		2

LM to MSFN

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
400	LM PM transmitting frequency	2,282.5	MHz	5	
401	LM FM transmitting frequency	2,282.5	MHz	5	
Transmitted Powers					
402	LM transmitted high power (primary PA) at PA assembly output (PM or FM)	18.6	watt	5	
403	LM transmitted high power (secondary PA) at PA assembly output (PM or FM)	14.8	watt	5	
404	LM transmitted low power at PA assembly output (PM or FM)	0.34	watt	5	
Antenna Gain					
405	MSFN 30-ft antenna receiving gain	44	dB	5	
406	MSFN 85-ft antenna receiving gain	52.5	dB		1
407	LM steerable antenna transmitting gain	20.3	dB	5	
Losses					
408	LM omni FWD (+Z) antenna transmitting losses (PA output to antenna input)	4.0	dB	10	

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Losses (Continued)					
409	LM omni AFT (-Z) antenna transmitting losses (PA output to antenna input)	4.2	dB	10	
410	LM steerable antenna transmitting losses (PA output to antenna input)	3.6	dB	10	
411	LM steerable antenna transmitting pointing loss	0.5	dB	5	
412	Erectable antenna transmitting losses (PA output to antenna input)		dB		5
413	Erectable antenna transmitting pointing loss		dB		5
Modulation Indices (PM)					
414	Mode 1 - Voice/HL biomed PM modulation index	0.9	radian	5	
415	- HBR telemetry PM modulation index	1.3	radian	5	
416	Mode 2 - Voice/HL biomed PM modulation index	0.9	radian	5	
417	- HBR telemetry PM modulation index	1.3	radian	5	
418	- PRN ranging PM modulation index (function of uplink mode)		radian	5	

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Modulation Indices (PM)(Continued)					
419	Mode 3 - LBR telemetry PM modulation index	1.3	radian	5	
420	Mode 4 - Backup voice PM modulation index	0.8	radian	5	
421	- LBR telemetry PM modulation index	1.3	radian	5	
422	Mode 5 - Backup voice PM modulation index	0.8	radian	5	
423	Mode 6 - Key PM modulation index	1.4	radian	5	
424	Mode 7 - Voice/HL biomed PM modulation index	1.3	radian	5	
425	- LBR telemetry PM modulation index	0.7	radian	5	
426	Mode 8 - Voice PM modulation index	0.73	radian	5	
427	- HL biomed PM modulation index	0.2	radian	5	
428	- 3.9-KHz subcarrier EMU data PM modulation index	0.16	radian	5	
429	- 5.4-KHz subcarrier EMU data PM modulation index	0.18	radian	5	

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Modulation Indices (PM)(Continued)					
430	Mode 8 - 7.35-KHz subcarrier EMU data PM modulation index	0.31	radian	5	
431	- 10.5-KHz subcarrier EMU data PM modulation index	0.36	radian	5	
432	- LBR (or HBR) telemetry PM modulation index	1.3	radian	5	
433	Mode 11 - PRN ranging PM modulation index (function of uplink mode)		radian	5	
Frequency Deviations of Subcarrier					
434	Mode 9a - Voice/EMU/biomed frequency deviation of subcarrier	215,000	Hz		6
435	- LBR telemetry frequency deviation of subcarrier	432,000	Hz		6
436	Mode 9b - Voice/EMU/biomed frequency deviation of subcarrier	215,000	Hz		6
437	- HBR telemetry frequency deviation of subcarrier	432,000	Hz		6

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Frequency Deviations of Subcarrier (Continued)					
438	Mode 10a - Voice/EMU/biomed frequency deviation of subcarrier	215,000	Hz		5,6
439	- LBR telemetry frequency deviation of subcarrier	432,000	Hz		5,6
440	- Television frequency deviation of subcarrier	1,100,000	Hz		5,6
441	Mode 10b - Voice/EMU/biomed frequency deviation of subcarrier	215,000	Hz		5,6
442	- HBR telemetry frequency deviation of subcarrier	432,000	Hz		5,6
443	- Television frequency of subcarrier	1,100,000	Hz		5,6
Noise Spectral Density Constants					
444	MSFN PM noise spectral density constant B	3.05×10^{15}	^{o}K/watt	5	
445	MSFN FM noise spectral density constant B	0.0	^{o}K/watt	5	
446	MSFN 85-ft antenna NSD constant A (quiet sky)	96	^{o}K	5	

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Spectral Density Constants (Continued)					
447	MSFN 85-ft antenna NSD constant A (moon at zenith)	210	°K	5	
448	MSFN 85-ft antenna NSD constant A (horizon)(for 5-deg elevation)	126	°K	5	
449	MSFN 30-ft cooled antenna NSD constant A (quiet sky)	96	°K	5	
450	MSFN 30-ft cooled antenna NSD constant A (moon at zenith)	135	°K	5	
451	MSFN 30-ft cooled antenna NSD constant A (horizon)(for 5-deg elevation)	126	°K	5	
452	MSFN 30-ft uncooled antenna NSD constant A (quiet sky)	250	°K	5	
453	MSFN 30-ft uncooled antenna NSD constant A (moon at zenith)	289	°K	5	
454	MSFN 30-ft uncooled antenna NSD constant A (horizon)(for 5-deg elevation)	280	°K	5	
Noise Bandwidths (PM)					
455	MSFN PM carrier loop narrow bandwidth	50	Hz	5	
456	MSFN PM voice/biomed noise bandwidth (predetection)	48,000	Hz	5	

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Bandwidths (PM)(Continued)					
457	MSFN PM HBR telemetry noise bandwidth (predetection)	198,000	Hz	5	
458	MSFN PM LBR telemetry noise bandwidth (predetection)	7,975	Hz	5	
459	MSFN PM key noise bandwidth (predetection)	1,485	Hz	5	
460	MSFN PM backup voice noise bandwidth (postdetection)	3,156	Hz	5	
461	MSFN PM PRN ranging noise bandwidth (predetection)	1.0	Hz	5	
462	MSFN PM baseband voice noise bandwidth (postdetection)	3,156	Hz	5	
463	MSFN PM HL biomed noise bandwidth (predetection)	2,684	Hz	5	
464	MSFN PM 3.9-KHz subcarrier EMU data noise bandwidth (predetection)	720	Hz	5	
465	MSFN PM 5.4-KHz subcarrier EMU data noise bandwidth (predetection)	955	Hz	5	
466	MSFN PM 7.35-KHz subcarrier EMU data noise bandwidth (predetection)	1,355	Hz	5	

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Noise Bandwidths (PM)(Continued)					
467	MSFN PM 10.5 KHz subcarrier EMU data noise bandwidth (predetection)	1,939	Hz	5	
Required Signal-to-Noise Ratios (PM)(rms/rms)					
468	MSFN required PM carrier-to-noise ratio	12	dB	5	
469	MSFN required PM normal voice S/N for 90% WI (predetection)	8	dB	5	
470	MSFN required PM normal voice S/N for 70% WI (predetection)	6	dB		2
471	MSFN required PM HBR telemetry S/N for 10^{-6} BEP (predetection)	8.5	dB	5	
472	MSFN required PM HBR telemetry S/N for 10^{-4} BEP (predetection)	6.4	dB	5	
473	MSFN required PM HBR telemetry S/N for 10^{-3} BEP (predetection)	4.9	dB		2
474	MSFN required PM LBR telemetry S/N for 10^{-6} BEP (predetection)	5.9	dB	5	
475	MSFN required PM LBR telemetry S/N for 10^{-4} BEP (predetection)	3.8	dB	5	
476	MSFN required PM LBR telemetry S/N for 10^{-3} BEP (predetection)	2.3	dB		2

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Required Signal-to-Noise Ratios (PM) (rms/rms) (Continued)					
477	MSFN required PM backup LM voice S/N for 70% WI (post detection)	4.0	dB	5	
478	MSFN required PM key S/N (pre-detection)	-10.5	dB	5	
479	MSFN required PM ranging S/N (predetection)	32.0	dB	5	
480	MSFN required PM baseband voice S/N for 70% WI (postdetection)	4.0	dB	5	
481	MSFN required PM HL biomed S/N	8.5	dB	5	
482	MSFN required 3.9-KHz subcarrier EMU data S/N	8.5	dB	5	
483	MSFN required 5.4-KHz subcarrier EMU data S/N	8.5	dB	5	
484	MSFN required 7.35-KHz subcarrier EMU data S/N	11.0	dB	5	
485	MSFN required 10.5-KHz subcarrier EMU data S/N	11.0	dB	5	

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Subcarrier Center Frequency					
486	Voice FM subcarrier center frequency	1.25	MHz	5	
487	Telemetry FM subcarrier center frequency	1.024	MHz	5	
Noise Bandwidths (FM)					
488	MSFN FM predetection noise bandwidth (television, voice, telemetry, EMU data, HL biomed)(unfiltered-wide demodulator configuration)	5.3	MHz	5	
489	MSFN FM loop noise bandwidth (wide position)	12.1	MHz	5	
490	MSFN FM television noise bandwidth (postdetection)	530,250	Hz	5	5
491	MSFN FM voice/EMU/HL biomed noise bandwidth (predetection)	48,000	Hz	5	
492	MSFN HBR telemetry noise bandwidth (predetection)	198,000	Hz	5	
493	MSFN LBR telemetry noise bandwidth (predetection)	7,975	Hz	5	
Required Signal-to-Noise Ratios (FM) (rms/rms)					
494	MSFN required FM mode as a whole S/N (predetection)	8	dB	5	

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Required Signal-to-Noise Ratios (FM) (rms/rms)(Continued)					
495	MSFN required FM television S/N (predetection)	8	dB	5	5
496	MSFN required FM voice/EMU/HL biomed S/N (predetection)	12	dB	5	
497	MSFN required FM PCM telemetry (predetection)	8.0	dB	5	
498	MSFN required FM television S/N (postdetection)	19	dB	5	5
499	MSFN required FM voice S/N (post-detection)	8	dB	5	
500	MSFN required FM EMU/HL biomed S/N (postdetection)	10	dB	5	
501	MSFN required FM HBR telemetry S/N (postdetection)	8.5	dB	5	
502	MSFN required FM LBR telemetry S/N (postdetection)	5.9	dB	5	
Rho and Rho Squared					
503	Rho squared for FM normal voice (where ρ = rms/peak)	0.5			2

LM to MSFN (Continued)

Computer ID Number	S-band Parameter	Value	Unit	Reference	Note
Rho Squared (Continued)					
504	Rho squared for LM split-phase telemetry (where ρ = rms/peak)	0.5			2
505	Rho squared for television (where ρ = rms/peak)	0.5			2, 5
506	Rho for PM baseband voice, no clipping (where ρ = rms/peak)	0.189			2
507	Rho for PM baseband voice, 12 dB clipping (where ρ = rms/peak)	0.512			2, 5
508	Rho for PM baseband voice, 24 dB clipping (where ρ = rms/peak)	0.66			2
Transponder Constants					
509	LM transponder ranging gain constant	0.52			2
510	LM transponder turnaround ratio	0.51			2

VHF PARAMETERS

MSFN to CSM

Computer ID Number	VHF Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
600	MSFN transmitting frequency	259.7, 296.8	MHz	6	
Transmitted Power					
601	MSFN transmitted power	100	watt	6	
Modulation Index					
602	Voice modulation index	0.9		6	
Antenna Gains					
603	MSFN transmitting antenna gain (stations ASC and GWM)	21	dB	4	
604	MSFN transmitting antenna gain (all others)	18	dB	4	
Losses					
605	CSM receiving losses (circuit, pointing)	5.7	dB	6	
606	MSFN to CSM polarization loss	3.0	dB	6	

MSFN to CSM (Continued)

Computer ID Number	VHF Parameter	Value	Unit	Reference	Note
Required Signal-to-Noise Ratios (rms/rms)					
607	CSM required voice S/N for 90% WI (postdetection)	27	dB	6	
608	CSM required voice S/N for 70% WI (postdetection)	17	dB	4	
System Temperature					
609	CSM system noise temperature	1154.2	^{o}K	6	
Noise Spectral Density					
610	CSM noise spectral density	-168.0	dBm/Hz	6	
Noise Bandwidths					
611	CSM IF noise bandwidth (-6dB)	70,000	Hz	4	
612	CSM audio noise bandwidth	3,000	Hz	6	

CSM to MSFN

Computer ID Number	VHF Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
613	CSM transmitting frequency	259.7, 296.8	MHz	6	
Transmitted Power					
614	CSM transmitter A transmitted power	5.0	watt	4	
615	CSM transmitter B transmitted power	5.0	watt	4	
Modulation Index					
616	Voice modulation index	1.0		6	
Losses					
617	CSM antenna LEFT (309 deg) transmitting losses (circuit, pointing)	5.7	dB	14	
618	CSM antenna RIGHT (129 deg) transmitting losses (circuit, pointing)	5.7	dB	14	
619	CSM to MSFN polarization loss	3.0	dB	2	

CSM to MSFN (Continued)

Computer ID Number	VHF Parameter	Value	Unit	Reference	Note
Required Signal-to-Noise Ratios (rms/rms)					
620	MSFN required voice S/N for 90% WI (postdetection)	14	dB	6	
621	MSFN required voice S/N for 70% WI (postdetection)	4	dB	4	
Noise Temperature					
622	MSFN system noise temperature	1048.6	^{o}K	6	
Noise Spectral Density					
623	MSFN noise spectral density	-168.9	dBm/Hz	6	
Noise Bandwidths					
624	MSFN IF noise bandwidth	65,000	Hz	4	
625	MSFN audio noise bandwidth	3,000	Hz	6	

CSM to LM

Computer ID Number	VHF Paremter	Value	Unit	Reference	Note
Transmitting Frequency					
800	CSM transmitting frequency	259.7, 296.8	MHz	14	
Transmitted Power					
801	CSM transmitted power at transmitter output (voice only)	5	watt	14	
802	CSM transmitted power at transmitter output (ranging only)	10	watt	13	
Modulation Index					
803	Voice modulation index	1.0		14	
Losses					
804	LM receiving losses (circuit)	1.9	dB	14	
805	CSM transmitting losses (circuit)	5.7	dB	14	
806	CSM to LM polarization loss	3.0	dB	2	
Required Signal-to-Noise Ratios					
807	LM required received power for ranging	-104.5	dBm	13	
808	LM required voice S/N for 70% WI (postdetection) (peak/rms)	7.0	dB	2	

CSM to LM (Continued)

Computer ID Number	VHF Paremter	Value	Unit	Reference	Note
System Temperature					
809	LM system noise temperature	1,371.6	^{o}K		2
Noise Bandwidths					
810	LM IF noise bandwidth	70,000	Hz	14	
811	LM audio noise bandwidth (post-detection)	3,000	Hz	14	

LM to CSM

Computer ID Number	VHF Parameter	Value	Unit	Reference	Note
Transmitting Frequency					
812	LM transmitting frequency	259.7, 296.8	MHz	14	
Transmitted Power					
813	LM transmitted power (at PA output) (average modulated power output)	5	watt	14	
Modulation Index					
814	Voice modulation index	1.0		14	
815	PCM TLM modulation index	1.0		14	
Losses					
816	CSM receiving losses (circuit)	5.7	dB	14	
817	LM transmitting losses (circuit)	1.9	dB	14	
818	LM to CSM polarization loss	3.0	dB	2	
Required Signal-to-Noise Ratios					
819	CSM required PCM TLM S/N (postdetection)	6	dB	14	
820	CSM required voice S/N for 70% WI (postdetection) (peak/rms)	7	dB	2	

LM to CSM (Continued)

Computer ID Number	VHF Parameter	Value	Unit	Reference	Note
System Temperature					
821	CSM system noise temperature	1154.2	^{o}K		2
Noise Bandwidths					
822	CSM IF noise bandwidth	70,000	Hz	14	
823	CSM audio noise bandwidth (post-detection)	3,000	Hz	14	

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NOTES FOR APPENDIX A

1. Expected minimum gain based on Apollo 8 performance
2. Engineering estimate
3. Based on ATP data from USBE Serial No. 7 and PMP Serial No. 7
4. Expected value based on test data and accounts for reduction in TLM subcarrier modulation index with bits on the subcarrier
5. N/A for "F" Mission
6. Based on vender ATP data from transceiver #121 and Signal Processor Assembly #119.
7. Used in this report.

APPENDIX B

COMMUNICATION SYSTEMS MATHEMATICAL MODELS

B. 1 COMMUNICATION SYSTEMS DESCRIPTION

The primary communications between CSM, LM, MSFN, and EVA consist of the S-band and VHF communication systems. The communications systems are depicted in Figure B-1.

The S-band communication system provides the capability for transmission of voice, telemetry, and television between the space vehicles and MSFN for various phases of the mission. The information to be transmitted determines the mode of operation, the communication link involved, and the modulation technique (FM or PM). The system also provides the capability for accurate ranging through the use of a pseudorandom noise code.

The VHF communication system provides the capability for transmission of voice, PCM telemetry, and biomedical data between the space vehicles, EVA, and MSFN for various phases of the mission. The information to be transmitted determines the mode of operation and the communication link involved. VHF ranging is also provided during rendezvous of LM and CSM.

B. 2 S-BAND MATHEMATICAL MODEL

The Apollo S-band communication system is designed to provide tracking and communication between the MSFN ground stations and the CSM and the LM during the earth orbital and lunar phases of the mission. The S-band communication system consists of uplink (2106. 40625 MHz) from MSFN to CSM, two downlinks (2287. 5 MHz and 2272. 5 MHz) from CSM to MSFN, one uplink (2101. 802 MHz) from MSFN to LM, and one downlink (2282. 5 MHz) from LM to MSFN.

The Apollo S-band communication system was analyzed to define each distinct communication function and to formulate the functions into mathematical expressions called blocks. By correctly sequencing the blocks, each mode of operation in the Apollo S-band communication system can be simulated.

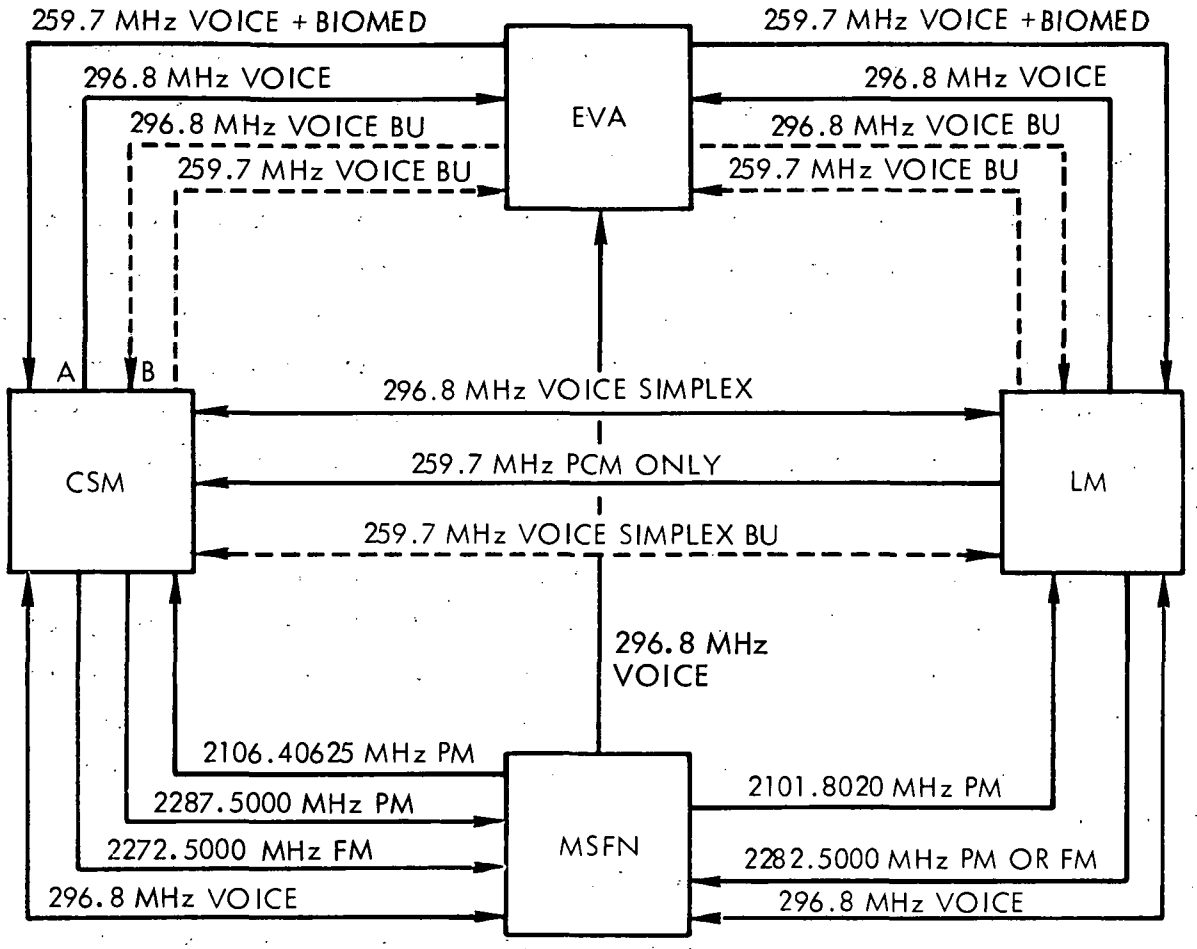

Figure B-1. Communications Links and Frequencies

B.2.1 Functional Blocks

The following is a partial listing of the blocks available in the computer program.

Figure	Title
B-2	Received Signal Level Calculation
B-3	Uplink Carrier Power Calculation
B-4	Downlink Carrier Power Calculation
B-5	Noise Spectral Density Calculation
B-6	IF SNR Calculation
B-7	Transponder Constants Calculation
B-8	Downlink PRN SNR Calculation
B-9	Updata Subcarrier SNR in Predetection Bandwidth Calculation
B-10	Downlink PM Mode High Bit Rate TLM SNR in Predetection Bandwidth Calculation
B-11	Downlink PM Mode Low Bit Rate TLM SNR in Predetection Bandwidth Calculation
B-12	Probability of Bit Error Rate Calculation
B-13	Uplink PM Mode Voice Subcarrier SNR in Predetection Bandwidth Calculation
B-14	Downlink PM Mode Voice Subcarrier SNR in Predetection Bandwidth Calculation
B-15	Backup Voice SNR in Postdetection Bandwidth Calculation

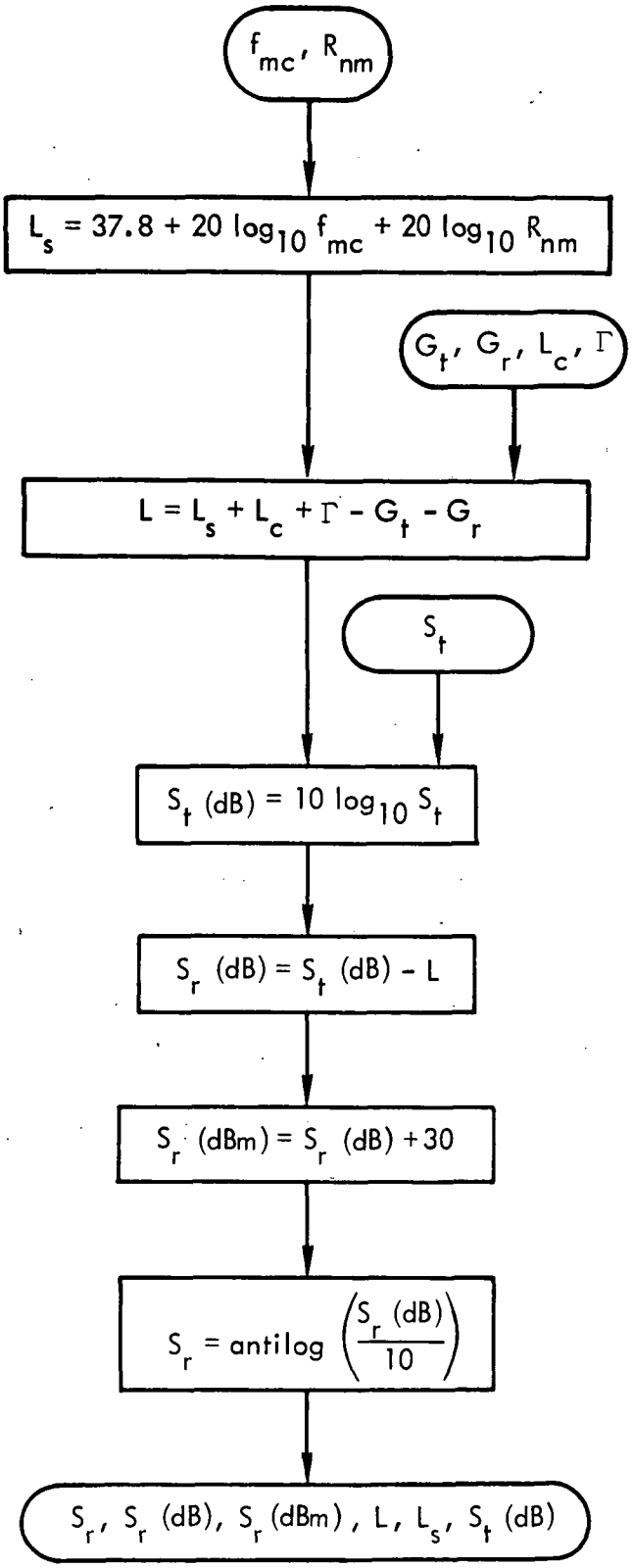

Figure B-2. Received Signal Level Calculation

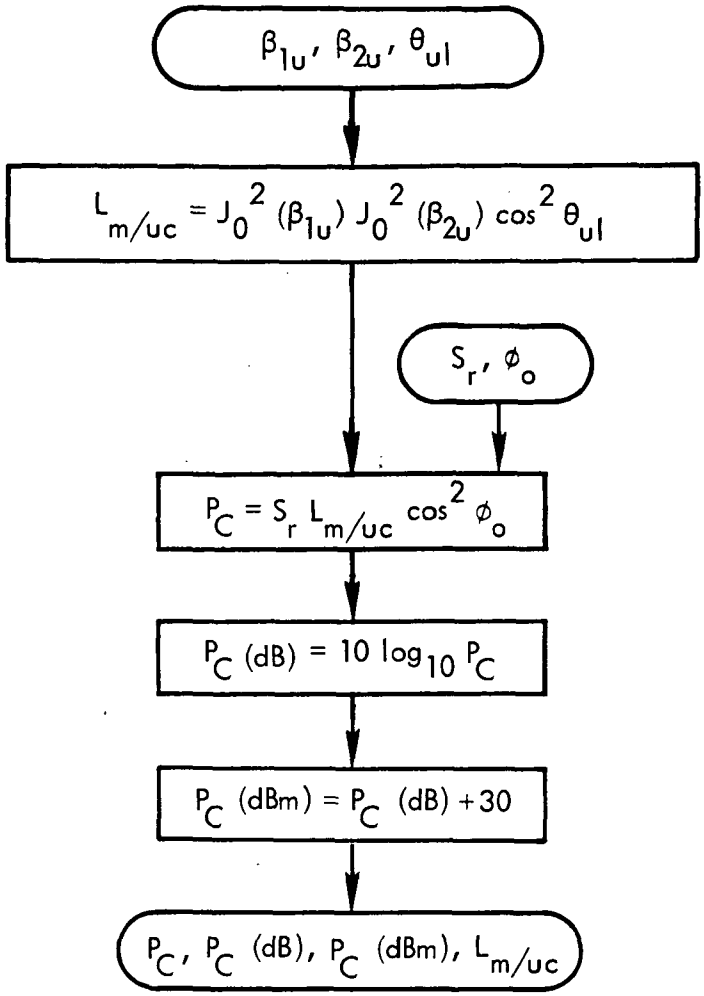

Figure B-3. Uplink Carrier Power Calculation

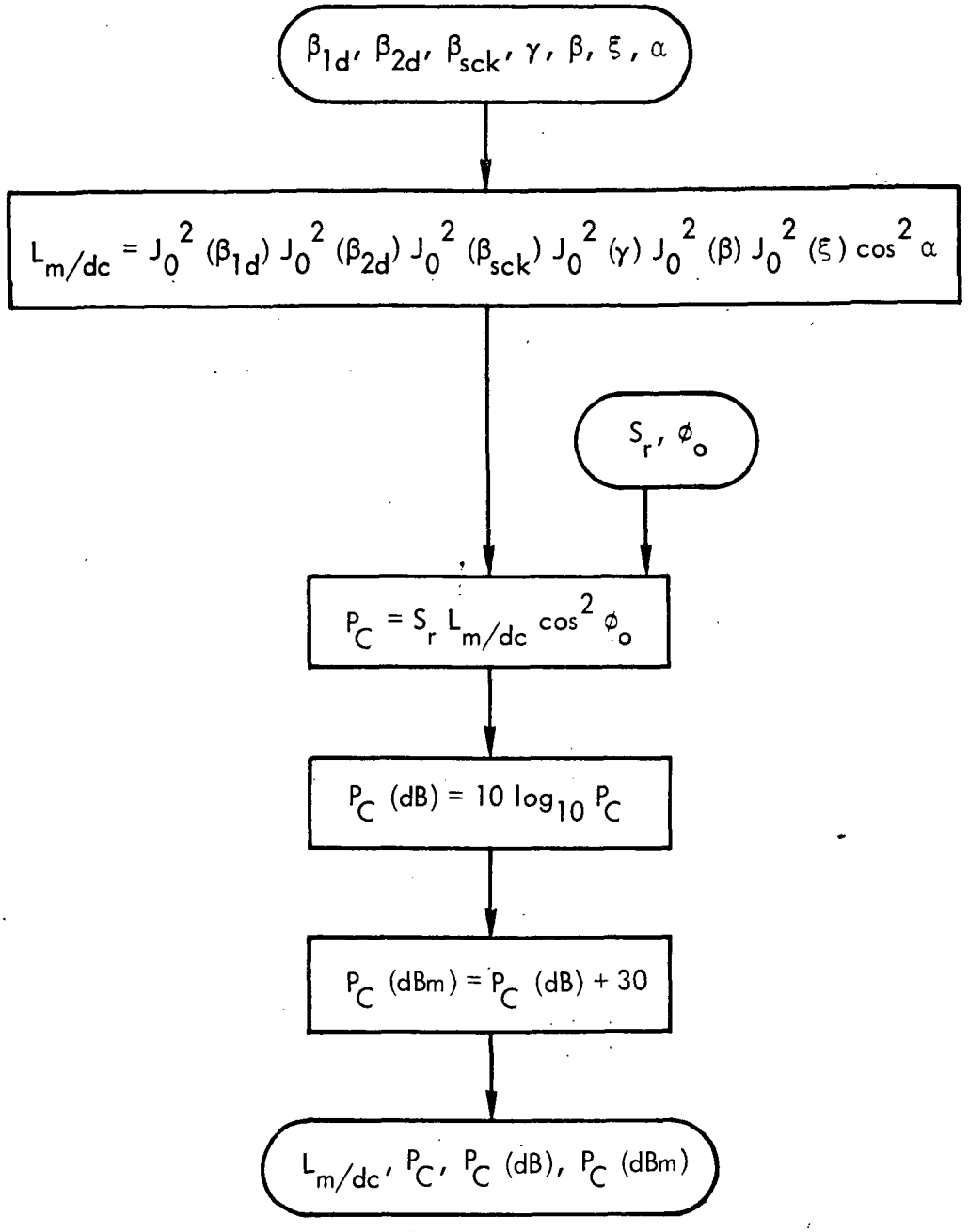

Figure B-4. Downlink Carrier Power Calculation

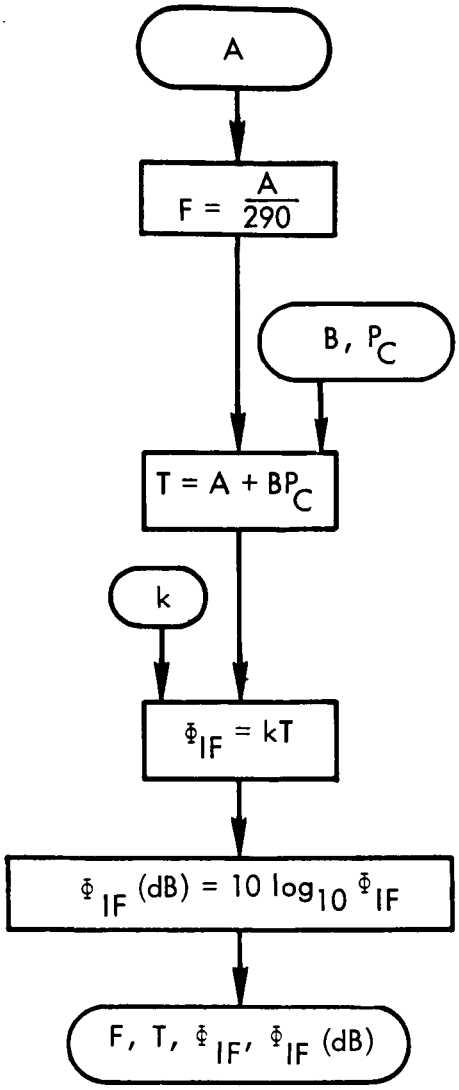

Figure B-5. Noise Spectral Density Calculation

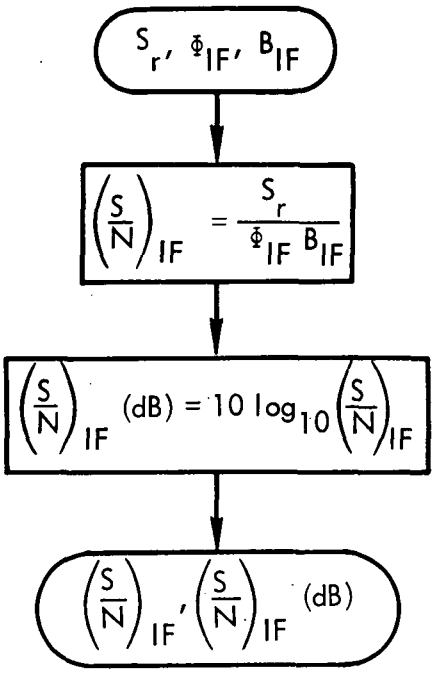

Figure B-6. IF SNR Calculation

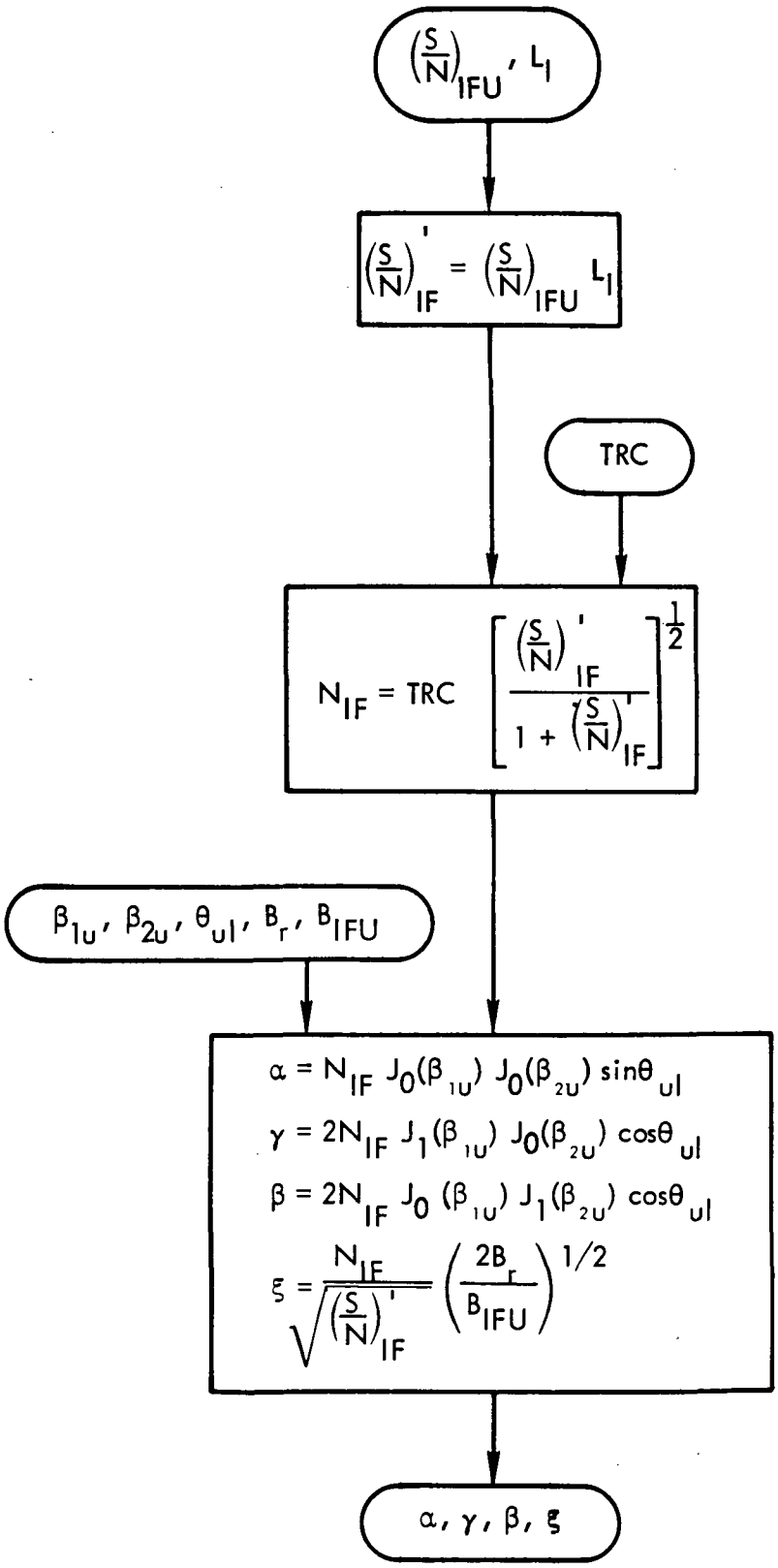

Figure B-7. Transponder Constants Calculation

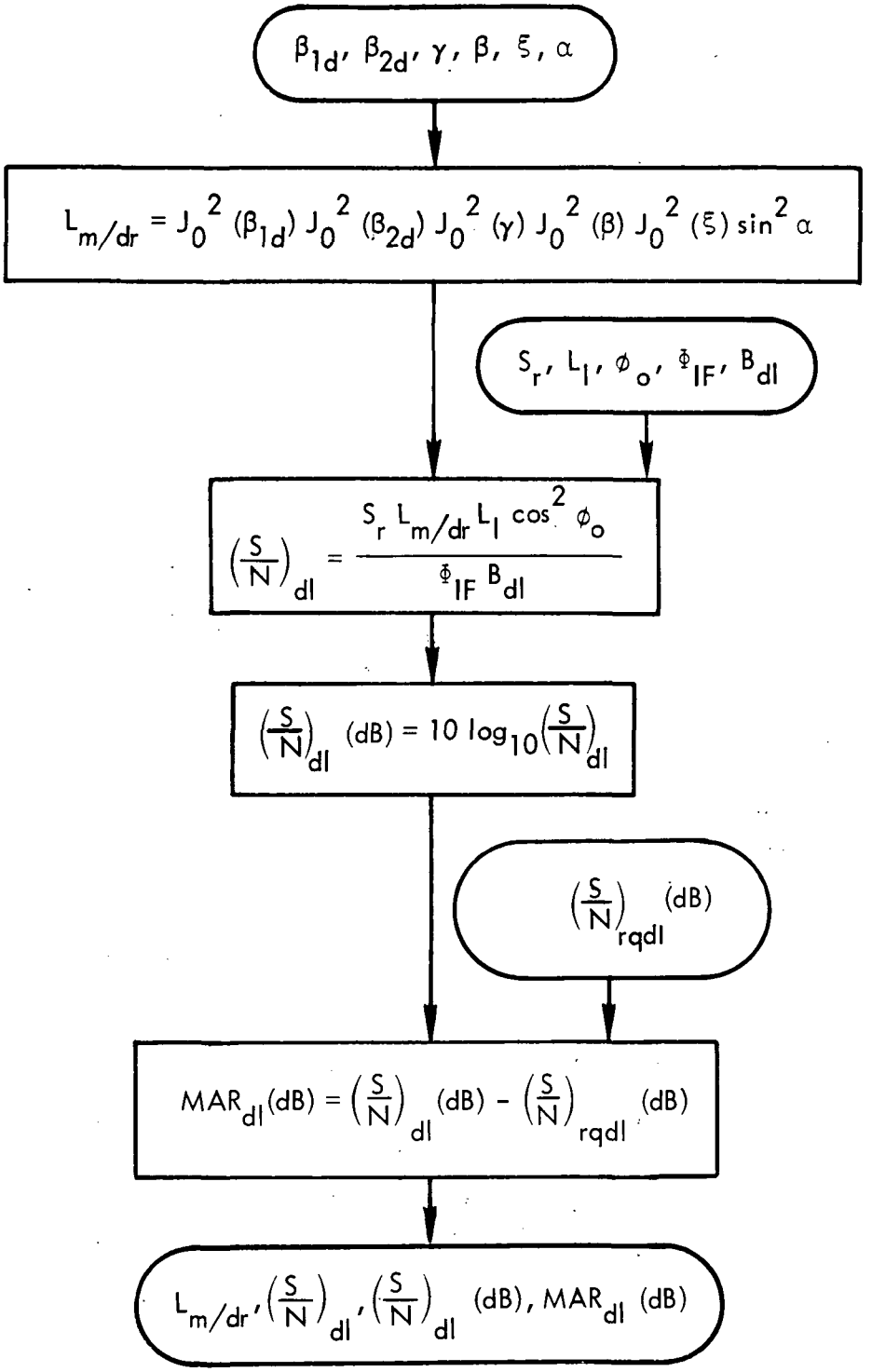

Figure B-8. Downlink PRN SNR Calculation

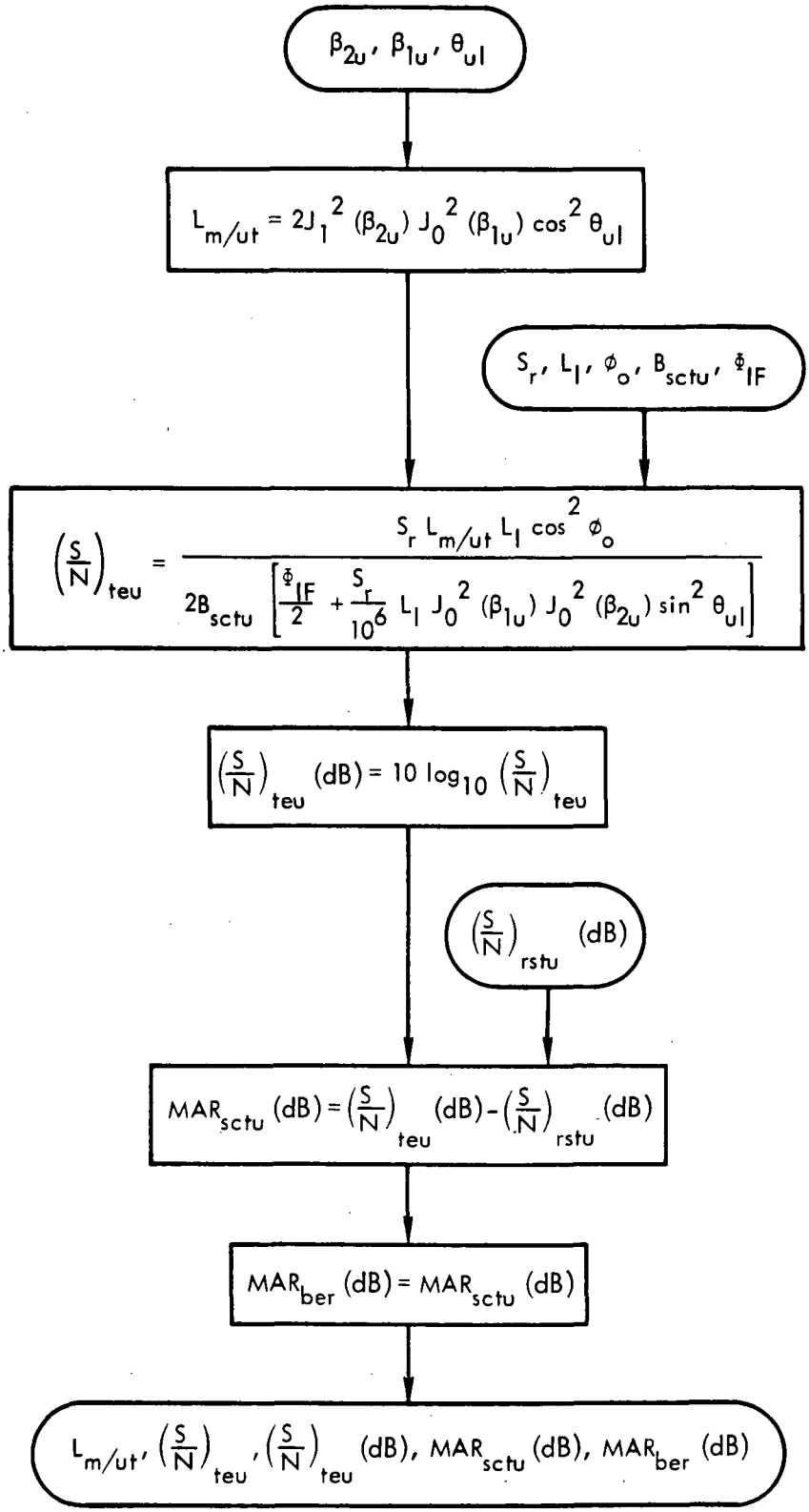

Figure B-9. Updata Subcarrier SNR in Predetection Bandwidth Calculation

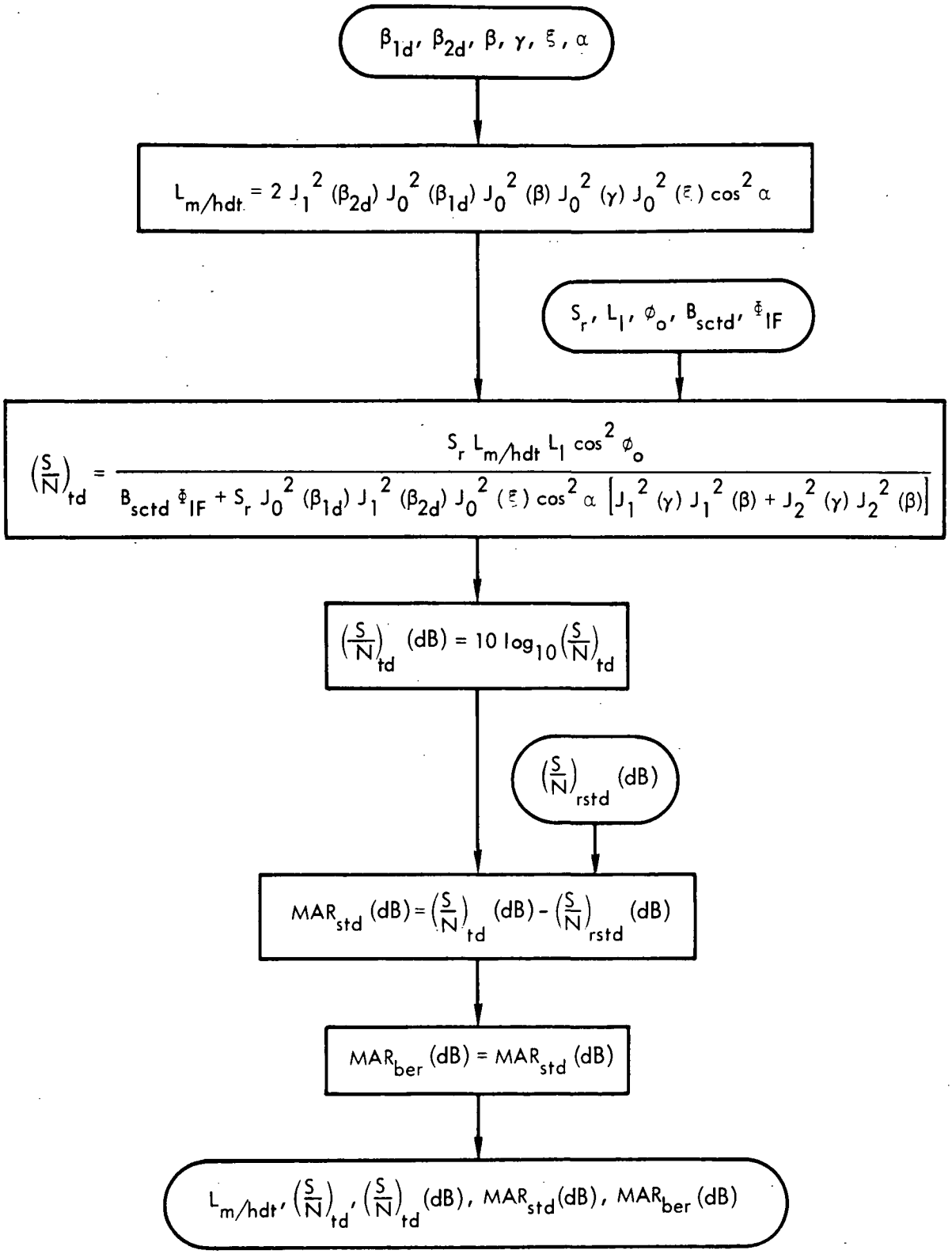

Figure B-10. Downlink PM Mode High Bit Rate TLM SNR in Predetection Bandwidth Calculation

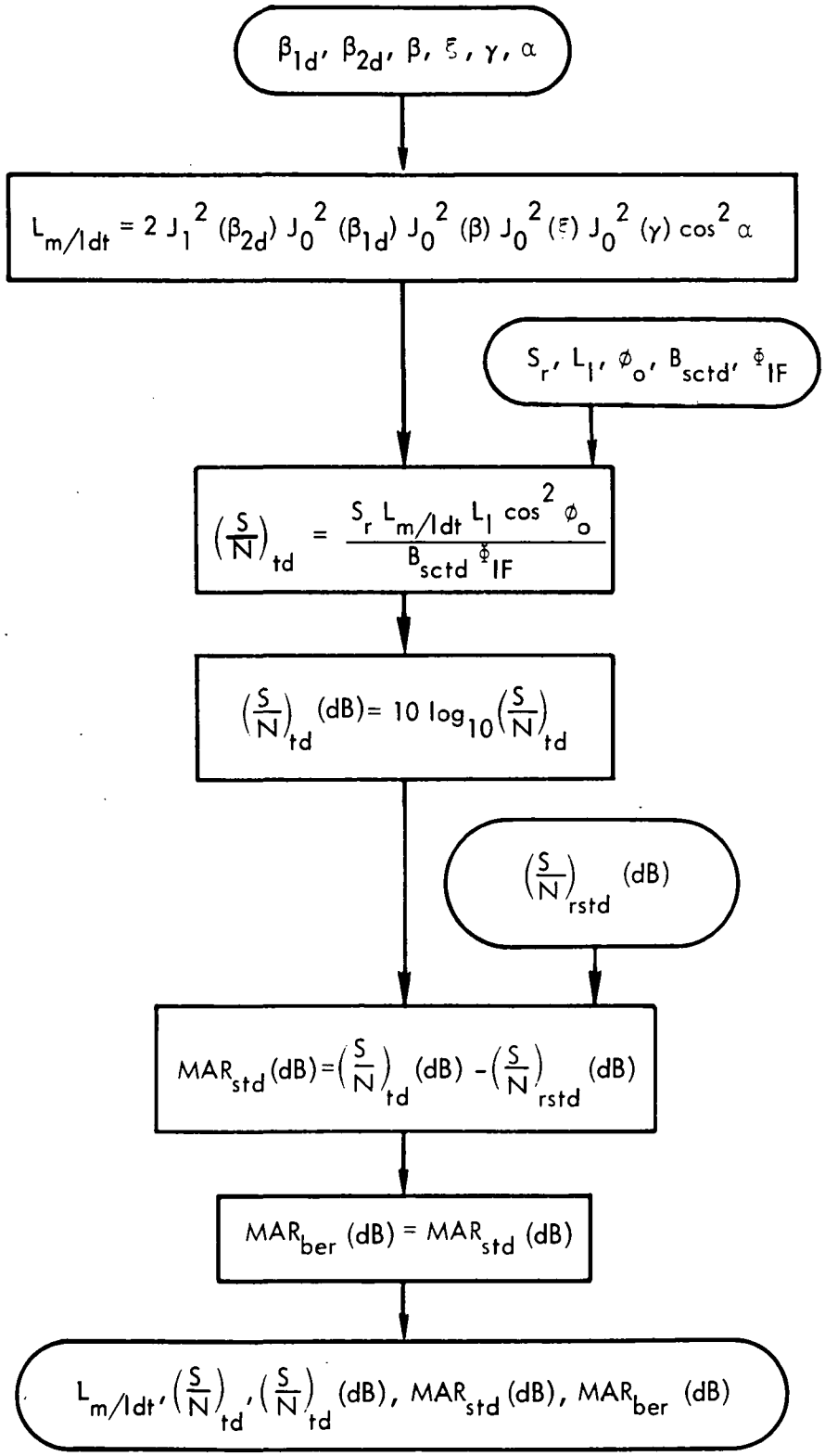

Figure B-11. Downlink PM Mode Low Bit Rate TLM SNR in Predetection Bandwidth Calculation

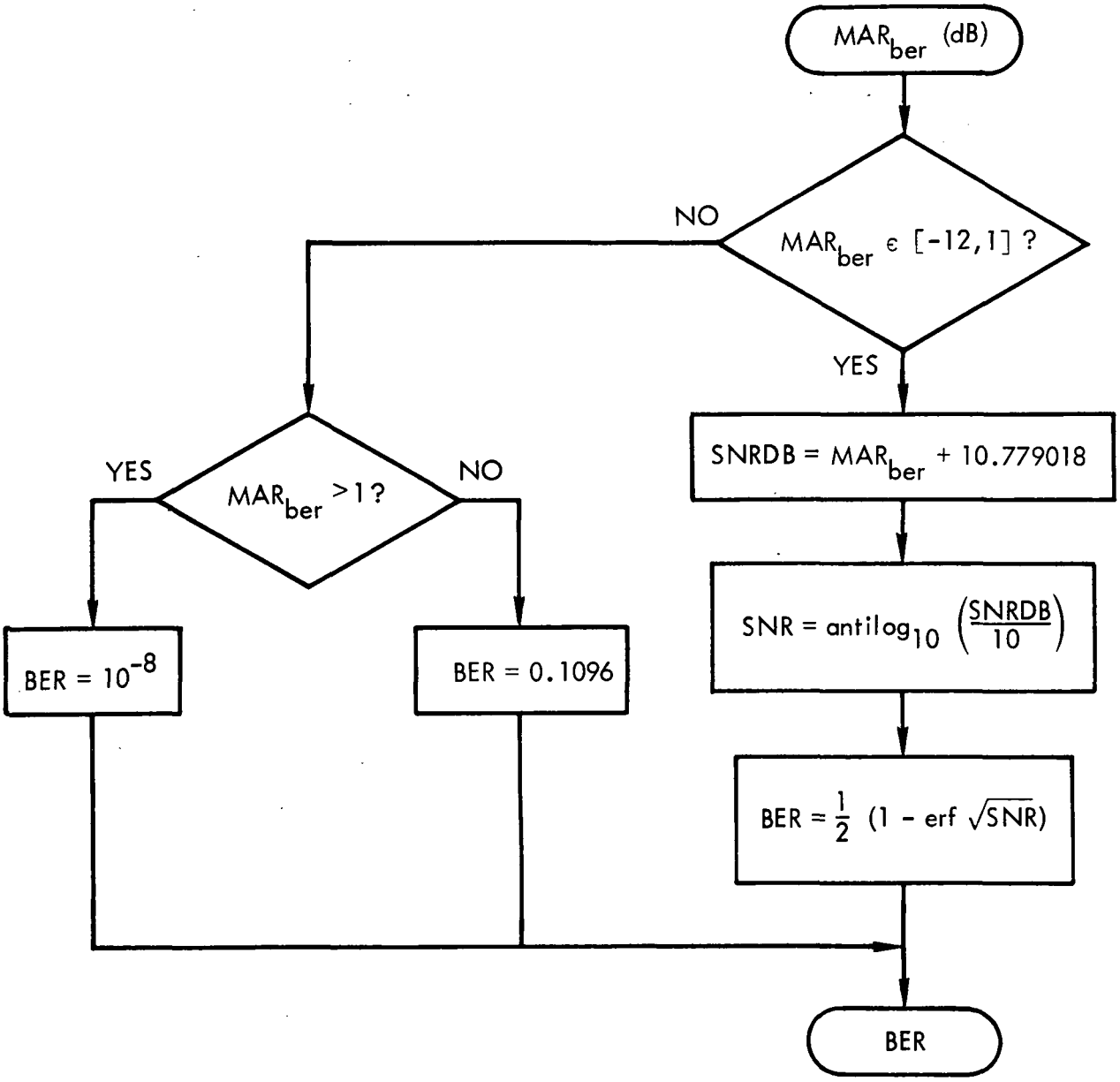

Figure B-12. Probability of Bit Error Rate Calculation

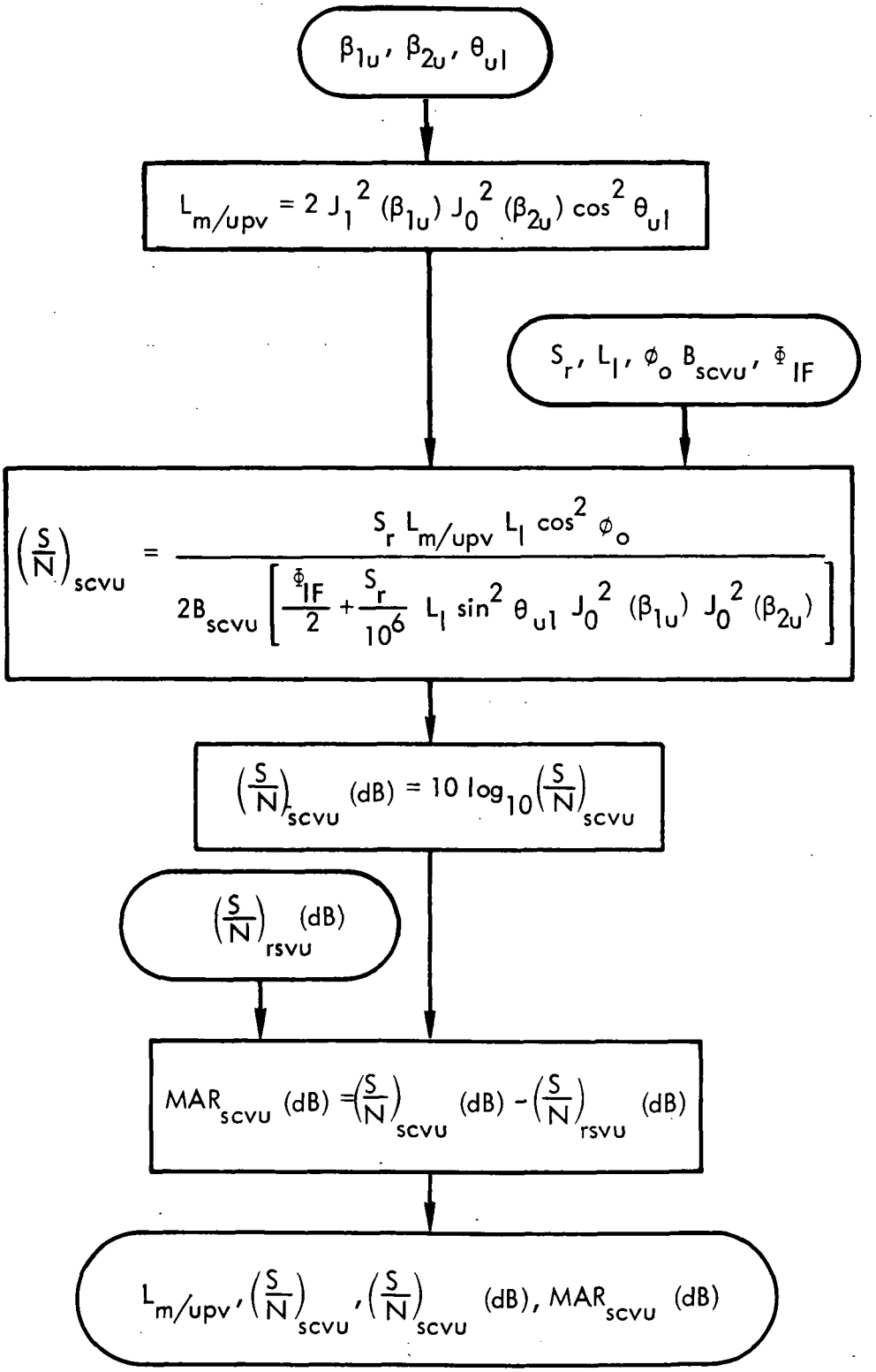

Figure B-13. Uplink PM Mode Voice Subcarrier SNR in Predetection Bandwidth Calculation

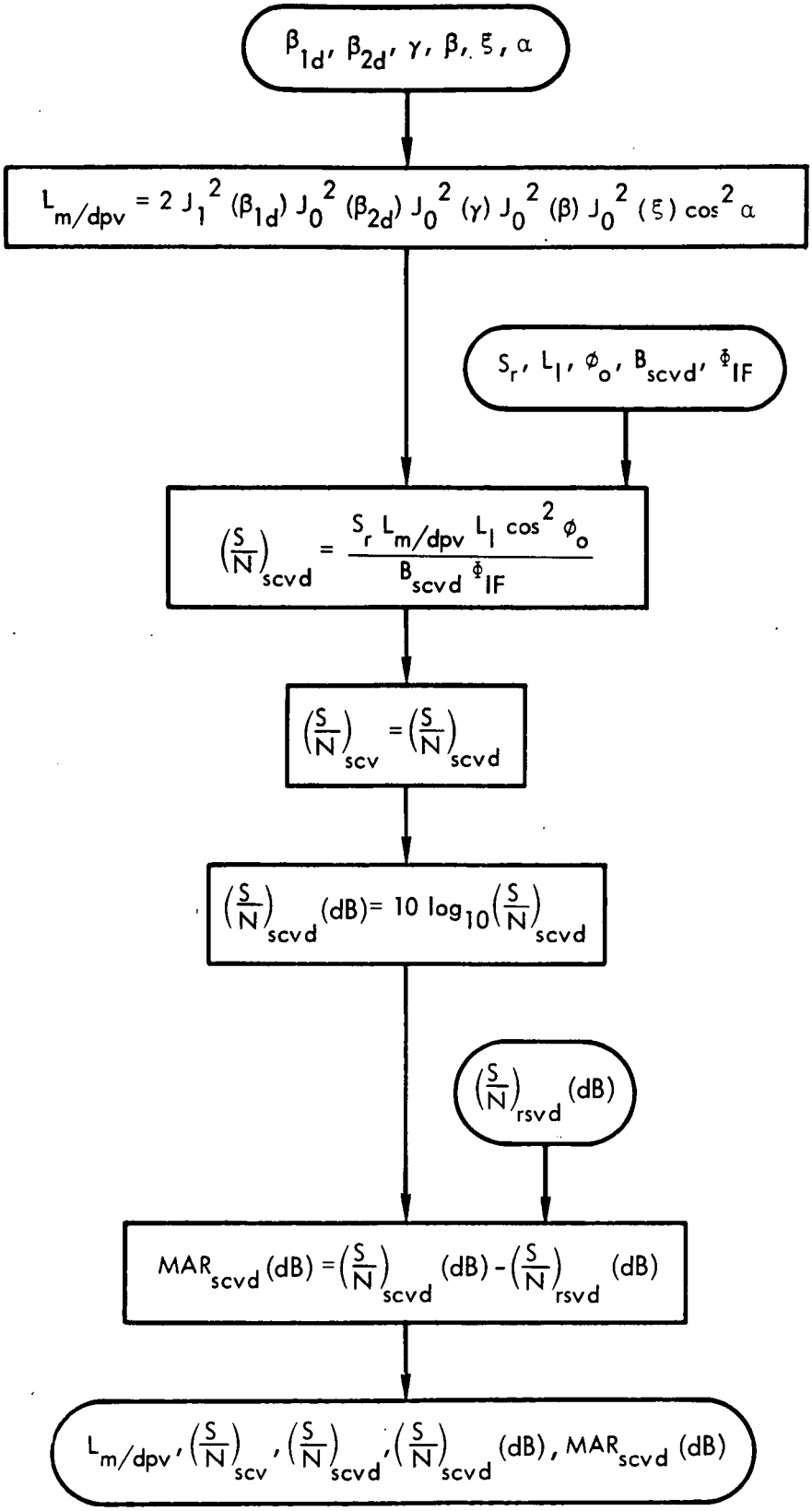

Figure B-14. Downlink PM Mode Voice Subcarrier SNR in Predetection Bandwidth Calculation

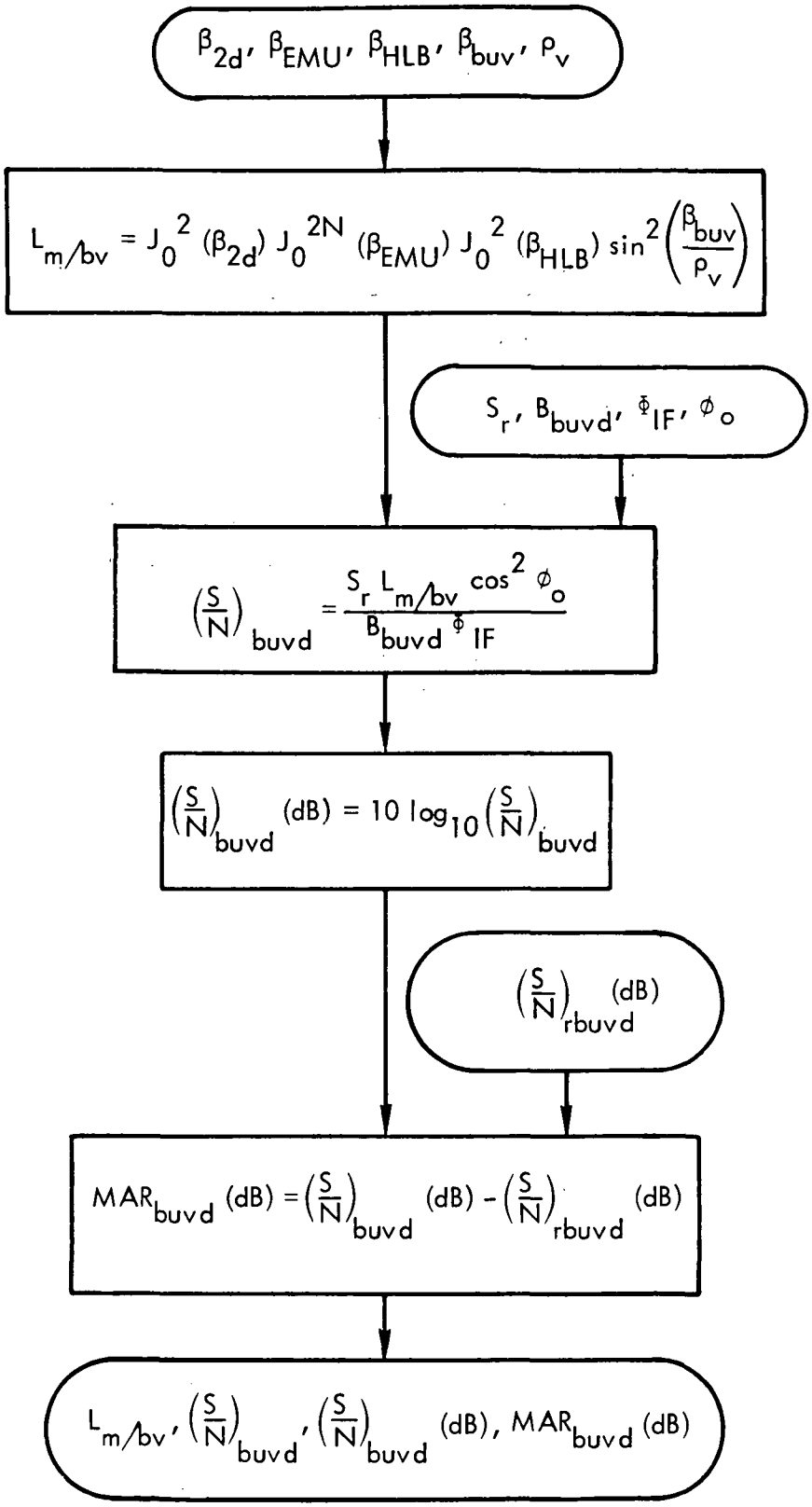

Figure B-15. Backup Voice SNR in Postdetection Bandwidth Calculation

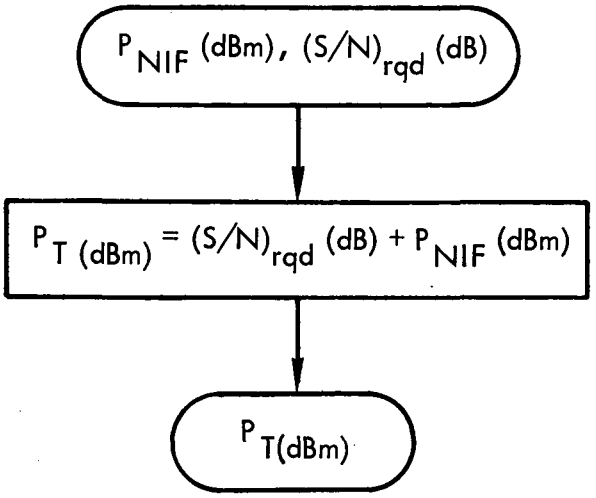

Figure B-16. FM Mode as a Whole Threshold Equation

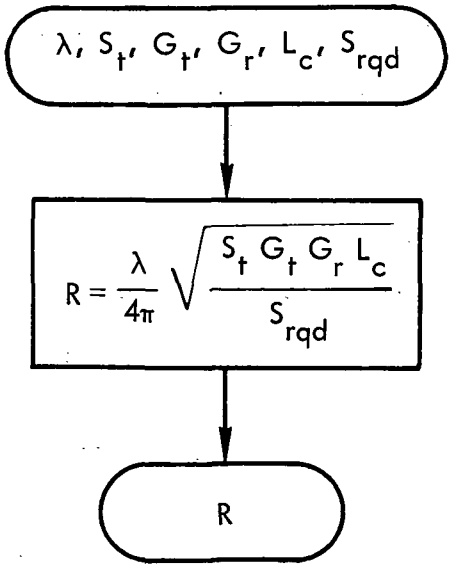

Figure B-17. Range Equation

B. 2. 2 Symbol Listing

The following is a list and description of each symbol used in the equations.

Symbol	Description
A	noise spectral density constant
B_{buvd}	back-up voice postdetection noise bandwidth
B_{IF}	IF noise bandwidth
B_{dtv}	television effective click bandwidth
B_{dl}	PRN ranging bandwidth
B_{r}	transponder video bandwidth
B_{sctu}	PM mode PCM telemetry predetection noise bandwidth
B_{sctd}	PM mode PCM telemetry predetection noise bandwidth
B_{scvu}	PM mode voice predetection noise bandwidth
B_{scvd}	PM mode voice predetection noise bandwidth
B_{tv}	television postdetection noise bandwidth
K	television degradation factor due to non-rectangular output bandwidth
f_{mc}	transmitting frequency
Δf_{tv}	television frequency deviation of carrier
Γ	losses due to spacecraft attitude
G_{r}	receiver antenna gain
G_{t}	transmitter antenna gain
K	Boltzmann's Constant
L_{c}	circuit losses
β_{buv}	back-up voice phase deviation
β_{EMU}	EVA phase deviation with voice on carrier
β_{HLB}	HLB phase deviation with voice on carrier

Symbol	Description
ϕ_o	static phase error in carrier loop
β_{sck}	emergency key phase deviation of carrier
θ_{ul}	PRN ranging phase deviation of carrier
β_{2u}	PCM telemetry subcarrier phase deviation of carrier
β_{2d}	PCM telemetry subcarrier phase deviation of carrier
β_{1u}	voice subcarrier phase deviation of carrier
β_{1d}	voice subcarrier phase deviation of carrier
$(S/N)_{rbuvd}(dB)$	required back-up voice SNR in postdetection bandwidth
$(S/N)_{rgdl}(dB)$	required PRN SNR
ρ_v	RMS to peak factor for voice
ρ_{tv}	RMS to peak factor for television
$(S/N)_{rstu}(dB)$	PM mode required PCM telemetry SNR in predetection bandwidth
$(S/N)_{rstd}(dB)$	PM mode required PCM telemetry SNR in predetection bandwidth
$(S/N)_{rsvu}(dB)$	PM mode required voice SNR in predetection bandwidth
$(S/N)_{rsvd}(dB)$	PM mode required voice SNR in predetection bandwidth
S_t	transmitting signal power
TRC	transponder gain constant
α	turned-around updata modulation index
β	turned-around updata modulation index
D_{tv}	television below FM threshold degradation in postdetection bandwidth
$D_{tv}(dB)$	television below FM threshold degradation in postdetection bandwidth

Symbol	Description
L_l	limiter losses
N_{IF}	transponder constant
γ	turned-around upvoice modulation index
L	total losses in communication link
L_s	space loss
MAR_{ber}(dB)	telemetry margin for BER calculation
P_c	carrier power
Φ_{IF}	noise spectral density
R_{nm}	slant range between spacecraft and ground station
S_r	received signal level
T	effective system noise temperature
ξ	turned-around thermal noise modulation index
BER	probability of bit-error rate
MAR_{buvd}(dB)	backup voice margin in predetection bandwidth
MAR_{dl}(dB)	PRN ranging margin
MAR_{std}(dB)	PM mode telemetry margin in predetection bandwidth
MAR_{sctu}(dB)	updata margin in predetection bandwidth
MAR_{scvu}(dB)	PM mode voice margin in predetection bandwidth
MAR_{scvd}(dB)	PM mode voice margin in predetection bandwidth
$L_{m/bv}$	back-up voice modulation loss
$L_{m/dc}$	downlink carrier modulation loss
$L_{m/hdt}$	downlink PM mode high bit rate telemetry modulation loss

Symbol	Description
$L_{m/ldt}$	downlink PM mode low bit rate telemetry modulation loss
$L_{m/dr}$	downlink PRN modulation loss
$L_{m/dpv}$	downlink PM mode voice modulation loss
$L_{m/uc}$	uplink carrier modulation loss
$L_{m/ut}$	uplink PM mode telemetry modulation loss
$L_{m/upv}$	uplink PM mode voice modulation loss
F	noise figure
$(S/N)_{buvd}$(dB)	back-up voice SNR in postdetection bandwidth
$(S/N)_{IF}$(dB)	IF SNR
$(S/N)_{dl}$(dB)	PRN ranging SNR
$(S/N)_{tev}$(dB)	PM mode telemetry SNR in predetection bandwidth
$(S/N)_{td}$(dB)	PM mode telemetry SNR in predetection bandwidth
$(S/N)_{scvu}$(dB)	PM mode voice SNR in predetection bandwidth
$(S/N)_{scvd}$(dB)	PM mode voice SNR in predetection bandwidth
$(S/N)_{scv}$(dB)	FM mode voice SNR in predetection bandwidth
$(S/N)_{tv}$(dB)	television SNR in postdetection bandwidth
λ	wave length of transmitting frequency
S_{rqd}	required received power
P_{NIF}(dBm)	IF noise power
$(S/N)_{rqd}$(dB)	FM mode as a whole required predetection SNR

B. 3 VHF MATHEMATICAL MODEL

The VHF communication system provides various communication and relay links depending on the phase of the mission. During the earth orbital phase of the mission, the VHF communication system provides the capability for two-way voice communications between LM and CSM, LM and MSFN, and CSM and MSFN. The system provides a two-way voice communication relay link between EVA and MSFN via the CSM S-band transmitter-receiver during the earth orbital phase.

The VHF communication system provides capability for two-way voice communication between LM and CSM during the lunar orbit phase of the mission. A link for PCM data transmission between LM and CSM during lunar orbit is provided by the VHF system. The system also provides two-way voice communication between EVA and LM during the lunar stay phase of the mission. A two-way voice communication link between LM and MSFN during the lunar stay is accomplished through the CSM relay. VHF ranging is provided during rendezvous of LM and CSM.

B. 3. 1 VHF System Calculations

The following equations are used in calculations for the VHF/AM system in this document.

Total Received Power Equation

$$P_R = P_{TR} - L_S - L_T - L_R - L_{PZ} - L_P + G_{TR} + G_R$$

where

P_R = received power in dBm

P_{TR} = transmitted power in dBm

L_S = space loss in dB = $20 \log R_{NM} + 20 \log F_{MHZ} + 37.8$

F_{MHZ} = transmitted frequency in MHz

R_{NM} = slant range in nautical miles

L_T = transmitter circuit losses in dB

L_R = receiver circuit losses in dB

L_{PZ} = polarization loss in dB

L_P = pointing loss in dB

G_R = receiving antenna gain

G_{TR} = transmitting antenna gain

Voice and Carrier Modulation Loss Equations

$L_{M/UV}$ = upvoice modulation loss = $10 \log M^2$

$L_{M/DV}$ = downvoice modulation loss = $10 \log M^2$

$L_{M/UC}$ = upcarrier modulation loss = 0.0 dB

$L_{M/DC}$ = downcarrier modulation loss = $10 \log \left[\frac{1}{1 + M^2}\right]$

where

M = percent modulation

System Noise Temperature Equation

$$T_S = T_A + (1 - 1/L)\, T_{AMB} + (N_F - 1)\, T_{RCVR}$$

where

T_S = system noise temperature in ^oK

T_A = effective antenna temperature in ^oK

T_{AMB} = ambient temperature of electrical networks between antenna and receiver in ^oK

T_{RCVR} = operating temperature of receiver assembly in ^oK

N_F = receiver noise figure

L = circuit loss between antenna and receiver

Noise Spectral Density and IF Noise Power Equations

$$NSD = KT_S$$

$$P_{NIF} = NSD\ (BW_{IF}) = KT_S\, BW_{IF}$$

where

NSD = noise spectral density

BW_{IF} = IF noise bandwidth

T_S = system noise temperature

P_{NIF} = IF noise power

Uplink (or Downlink) Total Received Power Equations

$$P_R = P_C + P_V \text{ watts}$$

$$P_R = P_C + M^2 P_C = P_C (1 + M^2) \text{ watts}$$

$$P_R(\text{dBm}) = P_C(\text{dBm}) + (1 + M^2) \text{ (dB)}$$

where

P_R = total received power

P_V = voice power

P_C = carrier power

M = modulation index

Receiver Threshold Equation

$$P_{RC}(\text{dBm}) = (S/N)_{RGD}(\text{dB}) - L_{M/V}(\text{dB}) - BW_I(\text{dB}) + P_{NIF}(\text{dBm})$$

where

$(S/N)_{RGD}$ = required postdetection SNR

$L_{M/V}$ = voice modulation loss (uplink or downlink)

BW_I = bandwidth improvement factor = $BW_{IF}/2BW_{AUDIO}$

BW_{IF} = IF noise bandwidth

BW_{AUDIO} = audio bandwidth

P_{RC} = received carrier power

P_{NIF} = IF noise power

Range Equation

$$R = \frac{\lambda}{4\pi} \frac{S_t \; G_t \; G_r \; L}{S_{rqd}}$$

where

R = range

λ = wave length of transmitting frequency

S_t = transmitted power

G_t = transmitting antenna gain

G_r = receiving antenna gain

L = system losses

S_{rqd} = required received power

APPENDIX C

COMMUNICATIONS SYSTEMS CAPABILITIES

C-1 INTRODUCTION

This appendix describes the performance and capabilities of the Apollo 10 communications system for the CSM and LM. Included are discussions and tables for S-band PM, S-band FM, and VHF/AM. The information of this appendix is limited to the spacecraft/MSFN communication links; hence, LM VHF/AM is not discussed.

All tables presented in this appendix were derived from measured (CSM-106 and LM-4) parameters wherever possible; otherwise, worst case specification parameters were used. Appendix A lists the communications system parameters for the Apollo 10 mission.

Tables C-1 through C-15 present the CSM S-band PM performance, and Tables C-16 through C-27 present the LM S-band PM performance. The S-band FM performance for both vehicles is presented in Tables C-28 through C-32. Tables C-33 and C-34 present the CSM VHF/AM performance with respect to MSFN VHF stations. Section 4 describes the communication services available at MSFN stations.

C-2 DISCUSSION OF MODES

Each of the uplink and downlink S-band modes provides a unique combination of information transmission. The information content of the CSM S-band PM modes is given in Tables C-1 and C-2, the information content of the LM S-band PM modes is given in Tables C-16 and C-17, and the information content of the CSM and LM S-band FM modes is given in Tables C-28 and C-29.

The performance of the communications systems is defined by the circuit margin for a particular information item within a given mode or by the circuit margin of the mode as a whole. In either case, the circuit margin is the ratio of two signal-to-noise ratios, as follows:

Assume, $SNR_{(actual)}$ = actual signal-to-noise ratio received

$SNR_{(required)}$ = signal-to-noise ratio required for specified quality of information

then, the circuit margin is:

$$MAR = SNR_{(actual)}/SNR_{(required)} \quad \text{(units)} \qquad (1)$$

or, $$MAR_{(dB)} = 10 \log_{10} (MAR) \quad \text{(dB)} \qquad (2)$$

The threshold for a particular information item within a given mode or for the mode as a whole is the received carrier power (or the total received power required in the case of FM) required to produce the signal-to-noise ratio necessary for a specified quality of information, i.e., 90 percent word intelligibility of voice or 10^{-3} bit error probability of decommutated telemetry.

C-3 RECEIVING THRESHOLDS

The thresholds for CSM S-band PM modes are given in Tables C-3 through C-8 and for LM S-band PM modes in Tables C-18 through C-21. These thresholds are calculated for each information channel within each mode. The downlink thresholds are calculated assuming that full uplink (uplink mode 6) was used. The uplink mode has an effect on downlink threshold because a certain portion (different for each uplink mode) of uplink information is retransmitted as noise in the downlink modes. The effects of this factor are discussed in Section C-4, Effects of Mode Switching.

The thresholds for uplink modes are defined as follows:

Carrier	Required received carrier power to maintain carrier loop frequency tracking
Normal voice	Required received carrier power for 90% and 70% word intelligibility of speech
Updata	Required received carrier power for a 6.6×10^{-6} bit error probability in the computer words
Upvoice backup	Required received carrier power for 70% word intelligibility of speech

The thresholds for downlink modes are defined as follows:

Carrier	Required received carrier power to maintain carrier loop frequency tracking
Normal voice	Required received carrier power for 90% and 70% word intelligibility
Telemetry	Required received carrier power for 10^{-6}, 10^{-4}, and 10^{-3} bit error probability in the received decommutated telemetry
Backup voice	Required received carrier power for 70% word intelligibility of speech
PRN	Required received carrier power for a specified PRN code acquisition
Key	Required received carrier power for a specified copy rate and accuracy

The thresholds for CSM and LM S-band FM modes are given in Table C-30 and calculated for mode as a whole (all FM modes). The FM thresholds are independent of uplink mode. The thresholds for CSM VHF/AM are given in Table C-33 for uplink (spacecraft) and downlink (MSFN). Refer to Appendix A for a listing of parameters used to calculate thresholds.

C-4 EFFECTS OF MODE SWITCHING

The effects of CSM S-band PM mode switching for uplink and downlink are given in Tables C-12 and C-13, respectively. The same tables for LM are given in Tables C-24 and C-25, respectively. These tables are provided as a quick reference for the comparison of the threshold tables. A circuit margin will increase if the actual received carrier power increases or if the required received carrier power (threshold) decreases. The effects of mode switching tables assume a constant actual received carrier power and compare the thresholds of each mode. Carrier thresholds are compared to carrier thresholds; normal voice (70 percent) and backup voice (70 percent) are compared with each other; updata (for downlink, telemetry) is compared with updata; and PRN is compared with PRN. In cases where no value appears, there can be no comparison because one, or both, of the modes compared do not have that particular information content.

For example, referring to Table C-24 in switching from mode 4 (row 4) to mode 2 (column 2), the effects are an increase in the voice circuit margin of 8.03 dB and no change in the carrier margin. Neither mode 4 nor mode 2 has updata. A negative value on the switching tables represents a decrease in the circuit margin.

For example, in the same table in switching from mode 5 to mode 6, the effect would be a decrease in the circuit margin (performance) of updata by 2.21 dB with no effect on carrier performance. Again, no value is given for voice because one of the modes, mode 5, has no voice capability, and a comparison cannot be made.

C-5 RANGE CAPABILITIES

The range capabilities for CSM S-band PM modes are given in Tables C-9 through C-11 and for LM S-band PM modes in Tables C-22 and C-23. The S-band FM mode range capabilities for CSM and LM are given in Tables C-31 and C-32, respectively. The CSM VHF/AM range capabilities are given in Table C-34.

The range capabilities for uplink S-band PM modes, are calculated for the algebraically largest threshold among the carrier, voice (90% WI), TLM (10^{-6} BEP), and backup voice thresholds. The downlink range capabilities for S-band PM modes are calculated for the algebraically largest threshold among the carrier, voice (70%), TLM (10^{-3} BEP), and backup voice thresholds.

The downlink range capabilities for all modes were calculated for cooled paramp stations while using uplink mode 6. The range capabilities for the omni or inflight antennas were based on a 0-dB gain.

C-6 EFFECTS OF ANTENNA VIEWING CONDITIONS

Antenna viewing conditions affect the system temperature of the MSFN stations which has an effect on the S-band thresholds, both PM and FM. The MSFN thresholds, in turn, affect the range capability of the downlink modes for both CSM and LM. Tables C-14 and C-15 give the effects of these conditions on CSM S-band downlink range capabilities and thresholds, and Tables C-26 and C-27 give these effects on LM S-band downlink range capabilities and thresholds.

These tables present a ready conversion and comparison of the effects of antenna viewing conditions on range and thresholds. The condition of quiet sky exists when the MSFN antenna elevation angle to the spacecraft is greater than 5 degrees, and the moon or sun is not present within a cone with radius of approximately two MSFN antenna beamwidths centered at the antenna pointing axis. The condition of moon at zenith exists when the MSFN antenna cone of two beamwidths centered at the antenna pointing axis contains the moon.

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Table C-1. Information Content of CSM S-band Uplink PM Modes

Information \ Mode	1	2	3	4	5	6	7	8
Carrier	X	X	X	X	X	X	X	X
Voice		X		X		X	X	
Updata			X		X	X	X	
PRN	X			X	X	X		
Voice Backup								X

Table C-2. Information Content of CSM S-band Downlink PM Modes

Information \ Mode	1	2	3	4	5	6	7	8	9	10
Carrier	X	X	X	X	X	X	X	X	X	X
Voice	X	X	X	X						
Telemetry (HBR)*	X	X								
Telemetry (LBR)*			X	X	X			X	X	
PRN		X	X				X		X	
Voice Backup								X		X
Key						X				

*HBR - high bit rate ; LBR - low bit rate

Table C-3. Receiving Thresholds of CSM S-band Uplink PM Modes

Information Content	Received Carrier Power (dBm)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Carrier	-119.9	-119.9	-119.9	-119.9	-119.9	-119.9	-119.9	-119.9
Voice (90%)	-	-115.5	-	-107.5	-	-105.3	-106.4	-
Voice (70%)	-	-117.5	-	-109.5	-	-107.3	-108.4	-
Updata (6.6×10^{-6})	-	-	-115.5	-	-107.5	-105.3	-106.4	-
BU Voice	-	-	-	-	-	-	-	-117.5

Table C-4. Receiving Thresholds of CSM S-band Downlink PM Modes (30-foot Uncooled, Quiet Sky)*

Information Content	Received Carrier Power (dBm)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Carrier[1]	-133.3	-133.3	-133.3	-133.3	-133.3	-139.3	-133.3	-133.3	-133.3	-133.3
Carrier[2]	-145.6	-145.6	-145.6	-145.6	-145.6	-151.6	-145.6	-145.6	-145.6	-145.6
Voice (90%)	-114.1	-114.1	-120.1	-120.1	-	-	-	-	-	-
Voice (70%)	-116.1	-116.1	-122.1	-122.1	-	-	-	-	-	-
Telemetry(10^{-6})	-110.8	-110.8	-124.1	-124.1	-134.6	-	-	-129.2	-134.6	-
Telemetry(10^{-4})	-112.9	-112.9	-126.2	-126.2	-136.7	-	-	-131.3	-136.7	-
Telemetry(10^{-3})	-114.4	-114.4	-127.7	-127.7	-138.2	-	-	-132.8	-138.2	-
BU Voice	-	-	-	-	-	-	-	-130.5	-	-135.8
PRN	-	-126.0	-126.0	-	-	-	-126.0	-	-126.0	-
Key	-	-	-	-	-	-151.6	-	-	-	-

*Calculated for uplink mode 6.

Notes: 1. Calculated for 840-Hz carrier loop bandwidth used during earth parking orbit, transposition and docking, and reentry phases.

2. Calculated for 50-Hz carrier loop bandwidth used during translunar coast, lunar orbit, and transearth coast phases.

Table C-5. Receiving Thresholds of CSM S-band Downlink PM Modes (30-foot Uncooled, Moon at Zenith)*

Information Content	Received Carrier Power (dBm)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Carrier[1]	-132.7	-132.7	-132.7	-132.7	-132.7	-138.7	-132.7	-132.7	-132.7	-132.7
Carrier[2]	-145.0	-145.0	-145.0	-145.0	-145.0	-151.0	-145.0	-145.0	-145.0	-145.0
Voice (90%)	-113.4	-113.4	-119.4	-119.4	-	-	-	-	-	-
Voice (70%)	-115.4	-115.4	-121.4	-121.4	-	-	-	-	-	-
Telemetry (10^{-6})	-110.2	-110.2	-123.5	-123.5	-134.0	-	-	-128.6	-134.0	-
Telemetry (10^{-4})	-112.3	-112.3	-125.6	-125.6	-136.1	-	-	-130.7	-136.1	-
Telemetry (10^{-3})	-113.8	-113.8	-127.1	-127.1	-137.6	-	-	-132.2	-137.6	-
BU Voice	-	-	-	-	-	-	-	-129.9	-	-135.2
PRN	-	-125.3	-125.3	-	-	-	-125.3	-	-125.3	-
Key	-	-	-	-	-	-150.9	-	-	-	-

*Calculated for uplink mode 6

Notes: 1. Calculated for 840-Hz carrier loop bandwidth used during earth parking orbit, transposition and docking, and reentry phases.

2. Calculated for 50-Hz carrier loop bandwidth used during translunar coast, lunar orbit, and transearth coast phases.

Table C-6. Receiving Thresholds of CSM S-band Downlink PM Modes (30-and 85-foot Cooled, Quiet Sky)*

Information Content	Received Carrier Power (dBm)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Carrier[1]	-137.5	-137.5	-137.5	-137.5	-137.5	-143.5	-137.5	-137.5	-137.5	-137.5
Carrier[2]	-149.8	-149.8	-149.8	-149.8	-149.8	-155.8	-149.8	-149.8	-149.8	-149.8
Voice (90%)	-118.2	-118.2	-124.2	-124.2	-	-	-	-	-	-
Voice (70%)	-120.2	-120.2	-126.2	-126.2	-	-	-	-	-	-
Telemetry(10^{-6})	-115.0	-115.0	-128.3	-128.3	-138.8	-	-	-133.4	-138.8	-
Telemetry(10^{-4})	-117.1	-117.1	-130.4	-130.4	-140.9	-	-	-135.5	-140.9	-
Telemetry(10^{-3})	-118.6	-118.6	-131.9	-131.9	-142.4	-	-	-137.0	-142.4	-
BU Voice	-	-	-	-	-	-	-	-134.7	-	-140.0
PRN	-	-130.1	-130.1	-	-	-	-130.1	-	-130.1	-
Key	-	-	-	-	-	-155.7	-	-	-	-

*Calculated for uplink mode 6

Notes: 1. Calculated for 840-Hz carrier loop bandwidth used during earth parking orbit, transposition and docking, and reentry phases.

2. Calculated for 50-Hz carrier loop bandwidth used during translunar coast, lunar orbit, and transearth coast phases.

Table C-7. Receiving Thresholds of CSM S-band Downlink PM Modes (30-foot Cooled, Moon at Zenith)*

Information Content	Received Carrier Power (dBm)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Carrier[1]	-136.0	-136.0	-136.0	-136.0	-136.0	-142.0	-136.0	-136.0	-136.0	-136.0
Carrier[2]	-148.3	-148.3	-148.3	-148.3	-148.3	-154.3	-148.3	-148.3	-148.3	-148.3
Voice (90%)	-116.7	-116.7	-122.8	-122.8	-	-	-	-	-	-
Voice (70%)	-118.7	-118.7	-124.8	-124.8	-	-	-	-	-	-
Telemetry (10^{-6})	-113.5	-113.5	-126.8	-126.8	-137.3	-	-	-131.9	-137.3	-
Telemetry (10^{-4})	-115.6	-115.6	-128.9	-128.9	-139.4	-	-	-134.0	-139.4	-
Telemetry (10^{-3})	-117.1	-117.1	-130.4	-130.4	-140.9	-	-	-135.5	-140.9	-
BU Voice	-	-	-	-	-	-	-	-133.2	-	-138.5
PRN	-	-128.6	-128.6	-	-	-	-128.6	-	-128.6	-
Key	-	-	-	-	-	-154.2	-	-	-	-

*Calculated for uplink mode 6

Notes: 1. Calculated for 840-Hz carrier loop bandwidth used during earth parking orbit, transposition and docking, and reentry phases.

2. Calculated for 50-Hz carrier loop bandwidth used during translunar coast, lunar orbit, and transearth coast phases.

Table C-8. Receiving Thresholds of CSM S-band Downlink PM Modes (85-foot Cooled, Moon at Zenith)*

Information Content	Received Carrier Power (dBm)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Carrier[1]	-134.1	-134.1	-134.1	-134.1	-134.1	-140.1	-134.1	-134.1	-134.1	-134.1
Carrier[2]	-146.4	-146.4	-146.4	-146.4	-146.4	-152.4	-146.4	-146.4	-146.4	-146.4
Voice (90%)	-114.8	-114.8	-120.8	-120.8	-	-	-	-	-	-
Voice (70%)	-116.8	-116.8	-122.8	-122.8	-	-	-	-	-	-
Telemetry (10^{-6})	-111.6	-111.6	-124.9	-124.9	-135.4	-	-	-130.0	-135.4	-
Telemetry (10^{-4})	-113.7	-113.7	-127.0	-127.0	-137.5	-	-	-132.1	-137.5	-
Telemetry (10^{-3})	-115.2	-115.2	-128.5	-128.5	-139.0	-	-	-133.6	-139.0	-
BU Voice	-	-	-	-	-	-	-	-131.3	-	-136.6
PRN	-	-126.7	-126.7	-	-	-	-126.7	-	-126.7	-
Key	-	-	-	-	-	-152.3	-	-	-	-

*Calculated for uplink mode 6

Notes: 1. Calculated for 840-Hz carrier loop bandwidth used during earth parking orbit, transposition and docking, and reentry phases.

2. Calculated for 50-Hz carrier loop bandwidth used during translunar coast, lunar orbit, and transearth coast phases.

Table C-9. Range Capabilities of CSM S-band Uplink Modes

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
30 ft/0	364,064	299,759	299,759	238,383	238,383	156,940	174,569	377,374
30 ft/1	693,709	571,179	571,179	454,229	454,229	299,043	332,634	719,072
30 ft/2	5,142,541	4,234,213	4,234,213	3,367,253	3,367,253	2,216,842	2,465,853	5,330,559
30 ft/3	4,911,088	4,043,642	4,043,642	3,215,701	3,215,701	2,117,067	2,354,871	5,090,644
85 ft/0	863,331	710,841	710,841	565,295	565,295	372,164	413,968	894,896
85 ft/1	1,645,044	1,354,480	1,354,480	1,077,148	1,077,148	709,144	788,800	1,705,189
85 ft/2	12,194,886	10,040,902	10,040,902	7,985,015	7,985,015	5,256,961	5,847,460	12,640,747
85 ft/3	11,646,026	9,588,987	9,588,987	7,625,630	7,625,630	5,020,358	5,584,281	12,071,820

Note: CSM antennas: 0 = omni, 1 = high gain(WBW), 2 = high gain(MBW), 3 = high gain(NBW)

Table C-10. Range Capabilities of CSM S-band Downlink PM Modes (Quiet Sky)

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6*	Mode 7**	Mode 8	Mode 9**	Mode 10
30 ft/0	34,120	34,120	70,650	70,650	346,043	NA	1,775,942	199,177	346,043	437,039
30 ft/1	75,512	75,512	156,356	156,356	765,827	NA	3,930,328	440,799	765,827	967,209
30 ft/2	277,342	277,342	574,270	574,270	2,812,747	NA	14,435,401	1,618,979	2,812,747	3,552,391
30 ft/3	572,818	572,818	1,186,087	1,186,087	5,809,393	NA	29,814,591	3,343,807	5,809,393	7,337,037
85 ft/0	98,785	98,785	187,982	187,982	920,726	7,824,413	4,725,294	529,957	920,726	1,162,842
85 ft/1	200,917	200,917	416,022	416,022	2,037,655	17,316,167	10,457,523	1,172,846	2,037,655	2,573,479
85 ft/2	737,932	737,932	1,527,976	1,527,976	7,483,948	63,599,216	38,408,634	4,307,658	7,483,948	9,451,935
85 ft/3	1,524,111	1,524,111	3,155,853	3,155,853	15,457,197	-	79,328,431	8,896,952	15,457,197	19,521,840
210 ft/0	241,555	241,555	500,168	500,168	2,449,800	20,818,611	12,572,709	1,410,071	2,449,800	3,094,003
210 ft/1	534,584	534,584	1,106,921	1,106,921	5,421,641	46,073,559	27,824,596	3,120,622	5,421,641	6,847,322
210 ft/2	1,963,436	1,963,436	4,065,526	4,065,526	19,912,728	-	-	11,461,494	19,912,728	25,149,002
210 ft/3	4,055,241	4,055,241	8,396,857	8,396,857	41,127,353	-	-	23,672,344	41,127,353	51,942,251

Notes: 1. CSM antennas; 0 = omni, 1 = high gain (WBW), 2 = high gain (MBW), 3 = high gain (NBW)

*Calculated for high power; for bypass power, multiply ranges in column by 0.1.

**Calculated for uplink modes 2 through 8; when using uplink mode 1, multiply ranges in column by 4.0.

Table C-11. Range Capabilities of CSM S-band Downlink PM Modes (Moon at Zenith)

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi)									
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6*	Mode 7**	Mode 8	Mode 9**	Mode 10
12 ft/3	131,424	131,424	272,162	272,162	1,333,034	NA	6,841,315	767,188	1,333,034	1,683,377
30 ft/0	28,771	28,771	59,581	59,581	291,825	NA	1,497,688	167,951	291,825	368,522
30 ft/1	63,673	63,673	131,858	131,858	645,837	NA	3,314,527	371,692	645,837	815,574
30 ft/2	233,861	233,861	484,294	484,294	2,372,048	NA	12,173,672	1,365,161	2,372,048	2,995,460
30 ft/3	483,013	483,013	1,000,252	1,000,252	4,899,181	NA	25,143,262	2,819,577	4,899,181	6,186,763
85 ft/0	61,378	61,378	127,106	127,106	622,559	5,290,561	3,195,058	358,295	622,559	786,177
85 ft/1	135,836	135,836	281,298	281,298	1,377,782	11,708,513	7,070,967	792,941	1,377,782	1,739,885
85 ft/2	498,903	498,903	1,033,158	1,033,158	5,060,352	43,003,298	25,970,413	2,912,334	5,060,352	6,390,292
85 ft/3	1,030,425	1,030,425	2,133,864	2,133,864	10,451,551	88,818,159	53,638,777	6,015,078	10,451,551	13,198,384
210 ft/0	163,311	163,311	338,194	338,194	1,656,459	14,076,729	8,501,173	953,325	1,656,459	2,091,802
210 ft/1	361,423	361,423	748,456	748,456	3,665,901	31,153,135	18,813,901	2,109,799	3,665,901	4,629,358
210 ft/2	1,327,445	1,327,445	2,748,949	2,748,949	13,464,206	-	69,100,130	7,748,921	13,464,206	17,002,812
210 ft/3	2,741,680	2,741,680	5,677,625	5,677,625	27,808,705	-	-	16,004,468	27,808,705	35,117,271

Notes: 1. CSM antennas; 0 = omni, 1 = high gain (WBW), 2 = high gain (MBW), 3 = high gain (NBW)

*Calculated for high power; for bypass power, multiply ranges in column by 0.1.

**Calculated for uplink modes 2 through 8; when using uplink mode 1, multiply ranges in column by 4.0.

Table C-12. Effects of Uplink Mode Switching on CSM S-band Uplink Circuit Margins (dB)*

From \ To	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Mode 1	Carrier Voice Updata	0. - -	0. - -	0. - -	0. - -	0. - -	0. - -	0. - -
Mode 2	0. - -	Carrier Voice Updata	0. - -	0. -8.03 -	0. - -	0. -10.24 -	0. -9.12 -	0. 0. -
Mode 3	0. - -	0. - -	Carrier Voice Updata	0. - -	0. - -8.03	0. - -10.24	0. - -9.12	0. - -
Mode 4	0. - -	0. 8.03 -	0. - -	Carrier Voice Updata	0. - -	0. -2.21 -	0. -1.09 -	0. 8.00 -
Mode 5	0. - -	0. - -	0. - 8.03	0. - -	Carrier Voice Updata	0. - -2.21	0. - -1.09	0. - -
Mode 6	0. - -	0. 10.24 -	0. - 10.24	0. 2.21 -	0. - 2.21	Carrier Voice Updata	0. 1.12 1.12	0. 10.20 -
Mode 7	0. - -	0. 9.12 -	0. - 9.12	0. 1.09 -	0. - 1.09	0. -1.12 -1.12	Carrier Voice Updata	0. 9.10 -
Mode 8	0. - -	0. 0. -	0. - -	0. -8.00 -	0. - -	0. -10.20 -	0. -9.10 -	Carrier Voice Updata

*Plus (+) indicates a circuit margin increase; minus (-) indicates a circuit margin decrease.

Table C-13. Effects of Downlink Mode Switching on CSM Downlink Circuit Margins (dB)*

From \ To	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Mode 1	Carrier	0.	0.	0.	0.	6.00	0.	0.	0.	0.
	Voice	0.	6.00	6.00	-	-	-	14.40	-	19.70
	TLM	0.	13.25	13.25	23.75	-	-	18.39	23.75	-
	PRN	-	-	-	-	-	-	-	-	-
Mode 2	0.	Carrier	0.	0.	0.	6.00	0.	0.	0.	0.
	0.	Voice	6.00	6.00	-	-	-	14.40	-	19.70
	0.	TLM	13.25	13.25	23.75	-	-	18.39	23.75	-
	-	PRN	0.	-	-	-	0.	-	0.	-
Mode 3	0.	0.	Carrier	0.	0.	6.00	0.	0.	0.	0.
	-6.00	-6.00	Voice	0.	-	-	-	8.40	-	13.70
	-13.25	-13.25	TLM	0.	10.50	-	-	5.14	10.50	-
	-	0.	PRN	-	-	-	0.	-	0.	-
Mode 4	0.	0.	0.	Carrier	0.	6.00	0.	0.	0.	0.
	-6.00	-6.00	0.	Voice	-	-	-	8.40	-	13.70
	-13.25	-13.25	0.	TLM	10.50	-	-	5.14	10.50	-
	-	-	-	PRN	-	-	-	-	-	-
Mode 5	0.	0.	0.	0.	Carrier	6.00	0.	0.	0.	0.
	-	-	-	-	Voice	-	-	-	-	-
	-23.75	-23.75	-10.50	-10.50	TLM	-	-	-5.36	0.	-
	-	-	-	-	PRN	-	-	-	-	-
Mode 6	-6.00	-6.00	-6.00	-6.00	-6.00	Carrier	-6.00	-6.00	-6.00	-6.00
	-	-	-	-	-	Voice	-	-	-	-
	-	-	-	-	-	TLM	-	-	-	-
	-	-	-	-	-	PRN	-	-	-	-

*Plus (+) indicates a circuit margin increase; minus(-) indicates a circuit margin decrease.

Table C-13. Effects of Downlink Mode Switching on Downlink CSM Circuit Margins (dB)* (Continued)

From \ To	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8	Mode 9	Mode 10
Mode 7	0. - - -	0. - - 0.	0. - - 0.	0. - - -	0. - - -	6.00 - - -	Carrier Voice TLM PRN	0. - - -	0. - - 0.	0. - - -
Mode 8	0. -14.40 -18.39 -	0. -14.40 -18.39 -	0. -8.40 -5.14 -	0. -8.40 -5.14 -	0. - 5.36 -	6.00 - - -	0. - - -	Carrier Voice TLM PRN	0. - 5.36 -	0. 5.30 - -
Mode 9	0. - -23.75 -	0. - -23.75 0.	0. - -10.50 0.	0. - -10.50 -	0. - 0. -	6.00 - - -	0. - - 0.	0. - -5.36 -	Carrier Voice TLM PRN	0. - - -
Mode 10	0. -19.70 - -	0. -19.70 - -	0. -13.70 - -	0. -13.70 - -	0. - - -	6.00 - - -	0. - - -	0. -5.30 - -	0. - - -	Carrier Voice TLM PRN

*Plus (+) indicates a circuit margin increase; minus(-) indicates a circuit margin decrease.

Table C-14. Effects of Different MSFN Stations and Antenna Viewing Conditions on CSM S-band Downlink Range Capabilities

From \ To	85 ft or 210 ft			12 ft or 30 ft					
				Cooled			Uncooled		
	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon
85 ft or 210 ft Quiet sky	1.00	0.67	0.87	-	-	-	-	-	-
85 ft or 210 ft Moon at zenith	1.47	1.00	1.29	-	-	-	-	-	-
85 ft or 210 ft Horizon	1.14	0.77	1.00	-	-	-	-	-	-
12 ft or 30 ft (cooled) Quiet sky	-	-	-	1.00	0.84	0.87	0.61	0.57	0.58
12 ft or 30 ft (cooled) Moon at zenith	-	-	-	1.18	1.00	1.03	0.73	0.68	0.69
12 ft or 30 ft (cooled) Horizon	-	-	-	1.14	0.96	1.00	0.70	0.66	0.67
12 ft or 30 ft (uncooled) Quiet sky	-	-	-	1.61	1.36	1.40	1.00	0.93	0.94
12 ft or 30 ft (uncooled) Moon at zenith	-	-	-	1.73	1.46	1.51	1.07	1.00	1.01
12 ft or 30 ft (uncooled) Horizon	-	-	-	1.70	1.44	1.49	1.05	0.98	1.00

*Multiplication factor for range tables.

Table C-15. Effects of Different MSFN Stations and Antenna Viewing Conditions on CSM S-band Downlink Receiving Thresholds

To / From	85 ft or 210 ft			12 ft or 30 ft					
				Cooled			Uncooled		
	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon
85 ft or 210 ft Quiet sky	0.0	3.39	1.18	0.0	1.48	1.18	4.15	4.78	4.64
85 ft or 210 ft Moon at zenith	-3.39	0.0	-2.21	-3.39	-1.91	-2.21	0.75	1.38	1.24
85 ft or 210 ft Horizon	-1.18	2.21	0.0	-1.18	0.29	0.0	2.97	3.60	3.46
12 ft or 30 ft (cooled) Quiet sky	0.0	3.39	1.18	0.0	1.48	1.18	4.15	4.78	4.64
12 ft or 30 ft (cooled) Moon at zenith	-1.48	1.91	-0.29	-1.48	0.0	-0.29	2.67	3.30	3.16
12 ft or 30 ft (cooled) Horizon	-1.18	2.21	0.0	-1.18	0.29	0.0	2.97	3.60	3.46
12 ft or 30 ft (uncooled) Quiet sky	-4.15	-0.75	-2.97	-4.15	-2.67	-2.97	0.0	0.62	0.49
12 ft or 30 ft (uncooled) Moon at zenith	-4.78	-1.38	-3.60	-4.78	-3.30	-3.60	-0.62	0.0	-0.13
12 ft or 30 ft (uncooled) Horizon	-4.64	-1.24	-3.46	-4.64	-3.16	-3.46	-0.49	0.13	0.0

*Algebraic change in dB to downlink threshold tables.

Table C-16. Information Content of LM S-band Uplink PM Modes

Information \ Modes	1	2	3	4	5	6	7	8
Carrier	X	X	X	X	X	X	X	X
Voice		X		X		X	X	
Updata			X		X	X	X	
PRN Ranging	X			X	X	X		
Voice Backup								X

Table C-17. Information Content of LM S-band Downlink PM Modes

Information \ Modes	1	2	3	4	5	6	7	8**	11
Carrier	X	X	X	X	X	X	X	X	
Voice/HL Biomed/EMU	X	X					X	X	
Telemetry (HBR)*	X	X							
Telemetry (LBR)*			X	X			X	X	
PRN Ranging		X							X
Voice Backup				X	X				
Key						X			

*HBR - high bit rate; LBR - low bit rate

**Voice, EMU, HLB, LBR

Table C-18. Receiving Thresholds of LM S-band Uplink PM Modes

Information Content	Received Carrier Power (dBm)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Carrier	-119.2	-119.2	-119.2	-119.2	-119.2	-119.2	-119.2	-119.2
Voice(90%)	-	-118.0	-	-110.0	-	-107.8	-108.9	-
Voice (70%)	-	-120.0	-	-112.0	-	-109.8	-110.9	-
Telemetry(10^{-6})	-	-	-115.1	-	-107.1	-104.9	-106.0	-
BU Voice	-	-	-	-	-	-	-	-119.1

Table C-19. Receiving Thresholds of LM S-band Downlink PM Modes (30-foot Uncooled, Moon at Zenith)*

Information Content	Received Carrier Power (dBm)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Carrier[1]	-145.0	-145.0	-145.0	-145.0	-145.0	-151.0	-145.0	-145.0
Voice (90%)	-116.2	-116.2	-	-	-	-	-120.6	-113.6
Voice (70%)	-118.2	-118.2	-	-	-	-	-122.6	-115.6
Telemetry (10^{-6})	-114.0	-114.0	-130.5	-129.7	-	-	-123.5	-130.1
Telemetry (10^{-4})	-116.1	-116.1	-132.6	-131.8	-	-	-125.6	-132.2
Telemetry (10^{-3})	-117.6	-117.6	-134.1	-133.3	-	-	-127.1	-133.7
BU Voice	-	-	-	-130.3	-130.3	-	-	-
PRN	-	-125.3	-	-	-	-	-	-
Key	-	-	-	-	-	-154.7	-	-

*Calculated for uplink mode 6

Note: 1. Calculated for 50-Hz carrier loop bandwidth

Table C-20. Receiving Thresholds of LM S-band Downlink PM Modes (30-foot Cooled, Moon at Zenith)*

Information Content	Received Carrier Power (dBm)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Carrier[1]	-148.3	-148.3	-148.3	-148.3	-148.3	-154.3	-148.3	-148.3
Voice (90%)	-119.5	-119.5	-	-	-	-	-124.0	-116.9
Voice (70%)	-121.5	-121.5	-	-	-	-	-126.0	-118.9
Telemetry (10^{-6})	-117.3	-117.3	-133.8	-133.0	-	-	-126.8	-133.4
Telemetry (10^{-4})	-119.4	-119.4	-135.9	-135.1	-	-	-128.9	-135.5
Telemetry (10^{-3})	-120.9	-120.9	-137.4	-136.6	-	-	-130.4	-137.0
BU Voice	-	-	-	-133.6	-133.6	-	-	-
PRN	-	-128.6	-	-	-	-	-	-
Key	-	-	-	-	-	-158.0	-	-

*Calculated for uplink mode 6

Note: 1. Calculated for 50-Hz carrier loop bandwidth

Table C-21. Receiving Thresholds of LM S-band Downlink PM Modes (85-foot Cooled, Moon at Zenith)*

Information Content	Received Carrier Power (dBm)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Carrier[1]	-146.3	-146.3	-146.3	-146.3	-146.3	-152.3	-146.3	-146.3
Voice (90%)	-117.6	-117.6	-	-	-	-	-122.0	-115.0
Voice (70%)	-119.6	-119.6	-	-	-	-	-124.0	-117.0
Telemetry (10^{-6})	-115.4	-115.4	-131.9	-131.0	-	-	-124.9	-131.5
Telemetry (10^{-4})	-117.5	-117.5	-134.0	-133.1	-	-	-127.0	-133.6
Telemetry (10^{-3})	-119.0	-119.0	-135.5	-134.6	-	-	-128.5	-135.1
BU Voice	-	-	-	-131.7	-131.7	-	-	-
PRN	-	-127.0	-	-	-	-	-	-
Key	-	-	-	-	-	-156.2	-	-

*Calculated for uplink mode 6

Note: 1. Calculated for 50-Hz carrier loop bandwidth

Table C-22. Range Capabilities of LM S-band Uplink Modes

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
30 ft/0	261,955	309,758	222,086	246,334	176,634	116,287	129,350	351,983
30 ft/1	1,875,978	2,218,312	1,590,460	1,764,110	1,264,957	832,788	926,333	2,520,709
*30 ft/2	534,844	632,445	453,443	502,951	360,641	237,429	264,099	718,658
85 ft/0	621,194	734,552	526,650	584,151	418,866	275,762	306,737	834,685
85 ft/1	4,448,645	5,260,448	3,771,575	4,183,365	2,999,685	1,974,852	2,196,682	5,977,543
*85 ft/2	1,268,316	1,499,763	1,075,282	1,192,685	855,215	563,034	626,278	1,704,208
210 ft/0	1,854,503	2,192,919	1,572,254	1,743,916	1,250,477	823,255	915,729	2,491,855
210 ft/1	13,280,908	15,704,451	11,259,595	12,488,945	8,955,209	5,895,691	6,557,937	17,845,255
*210 ft/2	3,786,411	4,477,367	3,210,131	3,560,621	2,553,146	1,680,872	1,869,679	5,087,714

Notes: 1. LM antennas; 0 = omni, 1 = steerable, 2 = erectable

*Not applicable for Apollo 10.

Table C-23. Range Capabilities of LM S-band Downlink PM Modes (Moon at Zenith)

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi)							
	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6*	Mode 7**	Mode 8
30 ft/0	36,956	36,956	307,426	184,798	298,021	NA	72,163	33,191
30 ft/1	409,916	409,916	3,409,893	2,049,742	3,305,576	NA	800,416	368,156
30 ft/2	59,937	59,937	498,586	299,708	483,333	NA	117,035	53,831
85 ft/0	78,841	78,841	655,840	394,236	635,776	4,507,705	153,947	70,809
85 ft/1	874,486	874,486	7,274,413	4,372,768	7,051,873	49,998,330	1,707,548	785,398
85 ft/2	127,865	127,865	1,063,648	639,376	1,031,108	7,310,641	249,673	114,839
210 ft/0	209,774	209,774	1,745,010	1,048,954	1,691,626	11,993,764	409,612	188,403
210 ft/1	2,326,767	2,326,767	19,355,215	11,634,735	18,763,096	-	4,543,316	2,089,729
210 ft/2	340,214	340,214	2,830,075	1,701,204	2,743,497	19,451,607	664,313	305,555

Notes: 1. LM antennas; 0 = omni, 1 = steerable, 2 = erectable

*Calculated for high power; for bypass power, multiply ranges in column by 0.1.

**Calculated for uplink modes 2 through 8; when using uplink mode 1, multiply ranges in column by 4.0.

Table C-24. Effects of Uplink Mode Switching on LM S-band Uplink Circuit Margins (dB)*

From \ To	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Mode 1	Carrier Voice Updata	0. - -	0. - -	0. - -	0. - -	0. - -	0. - -	0. - -
Mode 2	0. - -	Carrier Voice Updata	0. - -	0. -8.03 -	0. - -	0. -10.24 -	0. -9.12 -	0. -0.90 -
Mode 3	0. -	0. -	Carrier Voice Updata	0. - -	0. - -8.02	0. - -10.24	0. - -9.12	0. - -
Mode 4	0. - -	0. 8.03 -	0. - -	Carrier Voice Updata	0. - -	0. -2.21 -	0. 1.09 -	0. -7.10 -
Mode 5	0. - -	0. - -	0. - 8.02	0. - -	Carrier Voice Updata	0. - -2.21	0. - -1.09	0. - -
Mode 6	0. - -	0. 10.24 -	0. - 10.24	0. 2.21 -	0. - 2.21	Carrier Voice Updata	0. 1.12 1.12	0. 10.70 -
Mode 7	0. - -	0. 9.12 -	0. - 9.12	0. 1.09 -	0. - 1.09	0. -1.12 -1.12	Carrier Voice Updata	0. 8.20 -
Mode 8	0. - -	0. 0.90 -	0. - -	0. -7.10 -	0. - -	0. -10.70 -	0. -8.20 -	Carrier Voice Updata

*Plus (+) indicates a circuit margin increase; minus (-) indicates a circuit margin decrease.

Table C-25. Effects of Downlink Mode Switching on LM Downlink Circuit Margins (dB)*

From \ To	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Mode 1	Carrier Voice TLM PRN	0. 0. 0. -	0. - 16.54 -	0. 7.70 15.70 -	0. 7.70 - -	6.00 - - -	0. -2.00 9.48 -	0. -0.30 16.16 -
Mode 2	0. 0. 0. -	Carrier Voice TLM PRN	0. - 16.54 -	0. 7.70 15.70 -	0. 7.70 - -	6.00 - - -	0. -2.00 9.48 -	0. -0.30 16.16 -
Mode 3	0. - -16.54 -	0. - -16.54 -	Carrier Voice TLM PRN	0. - -0.84 -	0. - - -	6.00 - - -	0. - -7.06 -	0. - -0.37 -
Mode 4	0. -7.70 -15.70 -	0. -7.70 -15.70 -	0. - -0.85 -	Carrier Voice TLM PRN	0. 0. - -	6.00 - - -	0. -9.70 -6.21 -	0. -8.00 0.46 -
Mode 5	0. -7.70 - -	0. -7.70 - -	0. - - -	0. 0. - -	Carrier Voice TLM PRN	6.00 - - -	0. -9.70 - -	0. -8.00 - -
Mode 6	-6.00 - - -	-6.00 - - -	-6.00 - - -	-6.00 - - -	-6.00 - - -	Carrier Voice TLM PRN	-6.00 - - -	-6.00 - - -

*Plus (+) indicates a circuit margin increase; minus (-) indicates a circuit margin decrease.

Table C-25. Effects of Downlink Mode Switching on LM Downlink Circuit Margins (dB)* (Continued)

From \ To	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6	Mode 7	Mode 8
Mode 7	0. 2.00 -9.48 -	0. 2.00 -9.48 -	0. - 7.06 -	0. 9.70 6.21 -	0. 9.70 - -	6.00 - - -	Carrier Voice TLM PRN	0. -1.70 6.68 -
Mode 8	0. -0.30 -16.16 -	0. -0.30 -16.16 -	0. - 0.37 -	0. 8.00 -0.46 -	0. 8.00 - -	6.00 - - -	0. 1.70 -6.68 -	Carrier Voice TLM PRN

*Plus (+) indicates a circuit margin increase; minus (-) indicates a circuit margin decrease.

Table C-26. Effects of Different MSFN Stations and Antenna Viewing Conditions on LM S-band Downlink Range Capabilities

From \ To	85 ft or 210 ft			12 ft or 30 ft					
				Cooled			Uncooled		
	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon
85 ft or 210 ft Quiet sky	1.00	0.67	0.87	-	-	-	-	-	-
85 ft or 210 ft Moon at zenith	1.47	1.00	1.29	-	-	-	-	-	-
85 ft or 210 ft Horizon	1.14	0.77	1.00	-	-	-	-	-	-
12 ft or 30 ft (cooled) Quiet sky	-	-	-	1.00	0.84	0.87	0.61	0.57	0.58
12 ft or 30 ft (cooled) Moon at zenith	-	-	-	1.18	1.00	1.03	0.73	0.68	0.69
12 ft or 30 ft (cooled) Horizon	-	-	-	1.14	0.96	1.00	0.70	0.66	0.67
12 ft or 30 ft (uncooled) Quiet sky	-	-	-	1.61	1.36	1.40	1.00	0.93	0.94
12 ft or 30 ft (uncooled) Moon at zenith	-	-	-	1.73	1.46	1.51	1.07	1.00	1.01
12 ft or 30 ft (uncooled) Horizon	-	-	-	1.70	1.44	1.49	1.05	0.98	1.00

*Multiplication factor for range tables

Table C-27. Effects of Different MSFN Stations and Antenna Viewing Conditions on LM S-band Downlink Receiving Thresholds

From \ To	85 ft or 210 ft			12 ft or 30 ft					
				Cooled			Uncooled		
	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon	Quiet Sky	Moon at Zenith	Horizon
85 ft or 210 ft Quiet sky	0.0	3.39	1.18	0.0	1.48	1.18	4.15	4.78	4.64
85 ft or 210 ft Moon at zenith	-3.39	0.0	-2.21	-3.39	-1.91	-2.21	0.75	1.38	1.24
85 ft or 210 ft Horizon	-1.18	2.21	0.0	-1.18	0.29	0.0	2.97	3.60	3.46
12 ft or 30 ft (cooled) Quiet sky	0.0	3.39	1.18	0.0	1.48	1.18	4.15	4.78	4.64
12 ft or 30 ft (cooled) Moon at zenith	-1.48	1.91	-0.29	-1.48	0.0	-0.29	2.67	3.30	3.16
12 ft or 30 ft (cooled) Horizon	-1.18	2.21	0.0	-1.18	0.29	0.0	2.97	3.60	3.46
12 ft or 30 ft (uncooled) Quiet sky	-4.15	-0.75	-2.97	-4.15	-2.67	-2.97	0.0	0.62	0.49
12 ft or 30 ft (uncooled) Moon at zenith	-4.78	-1.38	-3.60	-4.78	-3.30	-3.60	-0.62	0.0	-0.13
12 ft or 30 ft (uncooled) Horizon	-4.64	-1.24	-3.46	-4.64	-3.16	-3.46	-0.49	0.13	0.0

*Algebraic change in dB to downlink threshold tables

Table C-28. Information Content of CSM S-band Downlink FM Modes

Information \ Mode	1	2	3	4
Carrier	X	X	X	X
Playback Voice (1:1)	X			
Playback 51.2 TLM (1:1)	X			
Playback Voice (32:1)		X		
Playback 1.6 TLM (32:1)		X		
Playback LM 1.6 TLM (32:1)			X	
Television				X

Table C-29. Information Content of LM S-band Downlink FM Modes

Information \ Modes	9a	9b	10a	10b
Carrier	X	X	X	X
Voice/EMU/Biomed	X	X	X	X
Telemetry (HBR)*		X		X
Telemetry (LBR)*	X		X	
Television			X	X

*HBR - high bit rate; LBR - low bit rate

Table C-30. Receiving Thresholds of CSM and LM Downlink FM Modes (Mode-as-a-Whole)

Station	Total Received Power (dBm)
30 ft (cooled) Quiet sky	-104.0
30 ft (cooled) Moon at zenith	-102.5
30 ft (cooled) Horizon	-102.8
85 ft, Quiet sky	-104.0
85 ft, Moon at zenith	-100.6
85 ft, Horizon	-102.8

Table C-31. Range Capabilities of CSM S-band Downlink FM Modes (Mode-as-a-Whole)*

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi) Quiet Sky	Moon at Zenith	Horizon
30 ft/0	10,100	8,383	8,787
30 ft/1	22,927	19,029	19,946
30 ft/2	84,032	64,747	73,108
30 ft/3	173,720	144,188	151,136
85 ft/0	26,866	18,135	23,273
85 ft/1	61,105	41,246	53,161
85 ft/2	223,210	150,667	194,193
85 ft/3	455,510	307,469	396,294

Note: CSM antennas: 0 = omni (0 dB gain), 1 = high gain (WBW), 2 = high gain (MBW), 3 = high gain (NBW)

*All values are for cooled paramp.

Table C-32. Range Capabilities of LM S-band Downlink FM Modes (Mode-as-a-Whole)*

Antenna Combination (MSFN/Spacecraft)	Range Capability (n mi) Quiet Sky	Moon at Zenith	Horizon
30 ft/0	12,100	10,043	10,527
30 ft/1	78,045	64,777	67,899
30 ft/2		N/A for Apollo 10	
85 ft/0	32,186	21,726	28,002
85 ft/1	206,910	139,664	180,012
85 ft/2		N/A for Apollo 10	

Note: LM antennas: 0 = omni (0 dB gain), 1 = steerable, 2 = erectable

*All values are for cooled paramp.

Table C-33. Receiving Thresholds for CSM VHF

Information \ Receiver	Spacecraft	MSFN
Voice (90% WI)	-102.3 dBm	-116.6 dBm
Voice (70% WI)	-112.3 dBm	N/A

Table C-34. Range Capabilities for VHF Communications (CSM)

Information	Range Capability (n mi)*	
	Uplink	Downlink
90% Word Intelligibility	7,375	8,555
70% Word Intelligibility	23,054	N/A

*Calculated for 296.8MHz; for 257.9MHz, multiply ranges by 1.15. Assumes 18-db MSFN antenna gain; for 21-db MSFN antenna gain, multiply ranges by 1.4. Assumes 0-db spacecraft antenna gain.

APPENDIX D

MSFN COVERAGE SUMMARY

A detailed ground station tracking coverage summary based on an elevation angle of zero degree is presented in this appendix. (These data were obtained from Reference 16.)

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
BDA SB	0	1	18	0	0	11	24	154	8	84	6	84	6	548	0	0	12	42	160	6	83	0	90	7	850
BDA CB	0	1	18	0	0	11	24	154	8	84	6	84	6	548	0	0	12	42	160	6	83	0	90	7	850
SHIP 1	0	4	8	0	0	11	24	-37	56	-29	6	-78	60	560	0	0	15	32	-172	29	57	0	90	33	847
CYI SB	0	7	7	0	0	16	29	18	16	-72	0	-90	18	848	0	0	23	36	-162	-19	112	0	90	-22	841
CYI CB	0	7	7	0	0	16	29	18	16	-72	0	-90	18	848	0	0	23	36	-162	-19	112	0	90	-22	841
KNO TM	0	6	45	0	0	23	42	40	45	-43	0	-90	47	839	0	0	30	26	-129	-14	104	0	90	-14	830
TAN TM	0	5	34	0	0	37	1	137	63	-20	0	-90	70	824	0	0	42	35	-85	2	87	0	90	3	827
CAR CB	0	5	46	0	0	52	15	151	-29	-122	0	-90	-32	833	0	0	58	1	4	-33	127	0	90	-37	834
CAR SB	0	5	47	0	0	52	15	151	-28	-122	0	-90	-32	833	0	0	58	1	4	-33	127	0	90	-37	834
CNB DS	0	6	5	0	0	59	30	-151	9	-79	0	-90	-79	832	0	1	5	35	-8	37	43	0	-90	43	829
GYM SB	0	7	5	0	1	28	15	-36	-24	-118	0	-90	-28	840	0	1	35	19	139	13	75	0	90	15	848
CAL CB	0	4	21	0	1	28	19	10	-54	-169	0	-90	-79	838	0	1	32	40	106	-21	115	0	90	-25	845
GLD DS	0	4	44	0	1	28	55	5	-51	-163	0	90	-17	839	0	1	33	39	111	-19	113	0	90	67	845
WHS CB	0	6	45	0	1	29	42	-23	-31	-127	0	-90	-37	839	0	1	36	27	137	1	89	0	90	1	845
TEX SB	0	7	2	0	1	31	8	-34	-4	-95	0	-90	-5	844	0	1	38	11	157	21	66	0	90	24	850
EGL CB	0	7	7	0	1	33	35	-24	-2	-92	0	-90	-2	847	0	1	40	42	164	12	76	0	90	14	848
MIL SB	0	6	52	0	1	35	2	-24	10	-78	0	-90	12	847	0	1	41	53	174	18	69	0	90	21	850
MLA CB	0	6	51	0	1	35	3	-24	11	-78	0	-90	12	847	0	1	41	53	174	19	69	0	90	21	850
KEN CB	0	6	51	0	1	35	4	-24	11	-78	0	-90	12	847	0	1	41	55	174	18	69	0	90	21	850
PAT CB	0	6	49	0	1	35	4	-25	12	-77	0	-90	13	847	0	1	41	53	174	19	68	0	90	22	850

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GPI CB	0	6	28	0	1	35	45	-26	20	-68	0	-90	22	849	0	1	42	13	179	25	62	0	90	28	849
GBI SB	0	6	28	0	1	35	46	-26	20	-68	0	-90	22	849	0	1	42	13	179	25	62	0	90	28	849
BDA SB	0	7	10	0	1	38	27	-5	5	-84	0	-90	6	850	0	1	45	37	178	-4	95	0	90	-5	848
BDA CB	0	7	10	0	1	38	27	-5	5	-84	0	-90	6	850	0	1	45	37	178	-4	95	0	90	-5	848
GTI CB	0	4	9	0	1	38	37	-36	50	-34	0	-90	56	849	0	1	42	45	-161	48	37	0	90	53	848
SHIP 1	0	6	39	0	1	42	32	-2	31	-55	0	-90	35	849	0	1	49	11	-161	6	83	0	90	7	843
CYI SB	0	5	22	0	1	50	1	55	-9	-100	0	-90	-10	843	0	1	55	23	179	-57	161	0	90	-71	835
CYI CB	0	5	22	0	1	50	1	55	-9	-100	0	-90	-10	843	0	1	55	23	179	-57	161	0	90	-71	835
KNO TM	0	5	35	0	1	57	3	76	-1	-91	0	-90	-1	833	0	2	2	38	-135	-68	162	0	90	-72	826
PRE CB	0	3	11	0	2	7	55	-158	63	6	0	90	84	825	0	2	11	7	-94	26	61	0	90	29	828
TAN TM	0	6	50	0	2	9	7	123	15	-75	0	-90	15	827	0	2	15	58	-46	-35	128	0	90	-38	829
CAP CB	0	6	14	0	2	25	22	170	-34	-128	0	-90	-38	835	0	2	31	36	17	-15	106	0	90	-16	833
CAR SB	0	6	14	0	2	25	22	170	-34	-128	0	-90	-38	835	0	2	31	36	17	-15	106	0	90	-16	833
18 MAY 69 UPDATE 72.1 TLI BO TO EVASIVE MANEUVER IG																									
HAW CB	1	45	5	0	2	43	43	-58	-43	-137	0	-90	-47	2029	0	4	28	48	90	32	67	41	46	17	17668
HAW SB	1	45	5	0	2	43	43	-58	-43	-137	0	-90	-47	2029	0	4	28	48	90	32	67	41	46	17	17667
CAL CB	1	39	2	0	2	49	45	-27	-18	-112	0	-90	-22	3374	0	4	28	48	83	31	117	83	7	-3	16680
GLD DS	1	38	22	0	2	50	25	-24	-16	-110	0	90	-70	3522	0	4	28	48	82	31	147	85	4	3	16668
GYM SB	1	37	39	0	2	51	9	-25	-8	-99	0	-90	-9	3682	0	4	28	48	81	32	-37	84	-3	4	16670
WHS CB	1	36	35	0	2	52	13	-20	-8	-100	0	-90	-10	3915	0	4	28	48	80	31	-94	82	-8	-1	16683
TEX SB	1	34	38	0	2	54	9	-15	0	-90	0	-90	0	4337	0	4	28	48	78	32	-71	72	-17	6	16798

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SB	1	29	46	0	2	59	1	-1	7	-82	0	-90	8	5367	0	4	28	48	75	31	-75	55	-34	8	17168
MLA CB	1	29	45	0	2	59	2	-1	7	-82	0	-90	8	5370	0	4	28	48	75	31	-75	55	-34	8	17169
PAT CB	1	29	43	0	2	59	4	-1	7	-82	0	-90	8	5377	0	4	28	48	75	31	-75	55	-34	9	17173
GRI CB	1	28	48	0	2	59	60	1	9	-80	0	-90	10	5567	0	4	28	48	75	31	-72	52	-36	11	17259
GBI SB	1	28	47	0	3	0	0	1	9	-80	0	-90	10	5569	0	4	28	48	75	31	-72	52	-36	11	17260
GTI CB	1	25	19	0	3	3	28	7	15	-74	0	-90	16	6271	0	4	28	48	73	32	-66	43	-44	17	17578
BDA SB	1	23	46	0	3	5	2	13	11	-77	0	-90	13	6581	0	4	28	48	73	30	-77	41	-48	10	17671
BDA CB	1	23	46	0	3	5	2	13	11	-77	0	-90	13	6582	0	4	28	48	73	30	-77	41	-48	10	17671
ANT CB	1	19	26	0	3	9	22	17	20	-69	0	-90	21	7424	0	4	28	48	72	32	-63	32	-54	23	18043
ANT SB	1	19	22	0	3	9	26	18	20	-69	0	-90	21	7435	0	4	28	48	72	32	-63	32	-55	23	18048
SHIP 1	1	12	35	0	3	16	13	29	20	-68	0	-90	22	8703	0	4	28	48	71	30	-67	24	-64	21	18444
18 MAY 65 UPDATE 72.1 EVASIVE MANEUVER BD TC MIDCOURSE IG																									
SHIP 1	0	38	60	0	4	28	50	72	30	-67	24	-64	21	18451	0	5	7	50	80	30	-67	23	-65	21	23400
ANT CB	0	42	18	0	4	28	50	72	32	-63	32	-54	23	18049	0	5	11	9	81	31	-63	31	-56	23	23400
BDA CB	0	45	26	0	4	28	50	73	30	-77	41	-48	10	17677	0	5	14	17	82	30	-76	39	-50	11	23400
GTI CB	0	46	13	0	4	28	50	73	32	-66	43	-44	17	17585	0	5	15	3	82	31	-66	41	-46	17	23400
HAW CB	0	48	7	0	4	28	50	90	32	67	41	46	17	17674	0	5	16	58	95	32	67	47	41	16	23400
GBI CB	0	48	58	0	4	28	50	75	31	-72	52	-36	11	17265	0	5	17	49	84	31	-73	50	-39	11	23400
PAT CB	0	49	39	0	4	28	50	75	31	-75	55	-34	9	17179	0	5	18	30	84	31	-75	52	-37	9	23390
MLA CB	0	49	41	0	4	28	50	75	31	-75	55	-34	8	17176	0	5	18	31	84	31	-75	53	-37	9	23390
WHS CB	0	54	33	0	4	28	50	80	31	-94	82	-8	-1	16689	0	5	23	23	88	31	-92	77	-13	0	23397

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAL CR	0	55	7	0	4	28	50	83	31	117	83	7	-3	16686	0	5	23	57	90	31	161	86	1	-4	23397
ANT SB	4	16	15	0	4	28	50	72	32	-63	32	-55	23	18054	0	8	45	6	99	28	-60	0	-90	30	46497
MIL SB	5	9	56	0	4	28	50	75	31	-75	55	-34	8	17174	0	9	38	46	101	28	-65	12	-77	25	50344
GBI SB	5	9	56	0	4	28	50	75	31	-72	52	-36	11	17266	0	9	38	46	101	28	-63	9	-80	26	50508
BDA SB	5	9	56	0	4	28	50	73	30	-77	41	-48	10	17677	0	9	38	46	102	27	-58	1	-89	32	50961
HAW SB	5	9	56	0	4	28	50	90	32	67	41	46	17	17673	0	9	38	46	104	30	-45	79	-8	8	47768
GYM SB	5	9	56	0	4	28	50	81	32	-37	84	-3	4	16677	0	9	38	46	102	29	-74	37	-52	13	49008
TEX SB	5	9	56	0	4	28	50	78	32	-71	72	-17	6	16804	0	9	38	46	101	28	-70	25	-63	18	49590
GLD DS	5	9	56	0	4	28	50	82	31	147	85	4	3	16674	0	9	38	46	102	28	-83	44	-7	-46	48704
GUM SB	3	38	4	0	6	0	42	101	30	60	0	90	30	30713	0	5	38	46	108	30	62	41	46	21	48830
CNB DS	1	14	13	0	8	24	33	106	33	48	0	-90	48	44685	0	9	38	46	108	33	37	10	-78	37	50441
18 MAY 69 UPDATE 72.1 MIDCOURSE BO TO LOI1 IG																									
BDA SB	0	7	55	0	9	38	55	102	27	-58	1	-89	32	50974	0	9	46	49	102	27	-57	0	-90	33	51700
GBI SB	0	51	14	0	9	38	55	101	28	-63	9	-80	26	50521	0	10	30	9	103	27	-59	0	-90	31	55191
MIL SB	1	8	3	0	9	38	55	101	28	-65	12	-77	25	50357	0	10	46	57	104	27	-59	0	-90	31	56512
TEX SB	2	19	19	0	9	38	55	101	28	-70	25	-63	18	49602	0	11	58	13	105	27	-59	0	-90	31	61925
GYM SB	3	18	14	0	9	38	55	102	29	-74	37	-52	13	49021	0	12	57	8	107	27	-59	0	-90	31	66196
GLD DS	4	7	52	0	9	38	55	102	28	-83	44	-7	-46	48716	0	13	46	47	108	26	-57	0	-90	-57	69670
HAW SB	6	30	57	0	9	38	55	104	30	-45	79	-8	8	47780	0	16	9	52	110	27	-61	0	-90	29	79127
CNB DS	7	40	34	0	9	38	55	108	33	37	10	-78	37	50451	0	17	19	28	111	29	-53	0	-90	-53	83465
GUM SB	10	2	33	0	9	38	55	108	30	62	41	46	21	48840	0	19	41	28	112	27	-63	0	-90	27	91905

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR SB	10	9	19	0	13	14	6	110	31	55	0	90	35	53904	0	20	23	26	113	28	-59	C	-90	31	94292
MAD DS	15	23	36	0	15	38	58	114	26	55	0	-90	55	77150	1	7	2	34	118	25	-57	0	-90	-57	126509
CYI SB	14	3	52	0	17	7	59	116	26	60	0	90	30	82768	1	7	11	50	118	25	-61	0	-90	29	126927
ASC SB	11	27	22	0	18	23	56	117	28	62	0	90	28	87365	1	5	51	18	117	26	-63	0	-90	27	123236
BDA SB	14	24	2	0	20	18	29	117	26	59	0	90	31	94020	1	10	42	31	119	25	-60	C	-90	30	136176
ANT SB	13	8	58	0	20	45	25	118	26	62	0	90	28	95535	1	9	54	23	118	25	-64	0	-90	26	134107
GBI SB	13	52	31	0	21	30	13	118	26	61	0	90	29	98023	1	11	22	44	119	25	-62	0	-90	28	137879
MIL SB	14	2	1	0	21	35	21	118	26	60	0	90	30	98306	1	11	37	22	119	25	-61	0	-90	29	138497
TEX SB	13	56	28	0	22	46	16	118	26	61	0	90	29	102144	1	12	42	45	119	25	-62	C	-90	28	141221
GYM SB	13	57	15	0	23	40	12	118	26	61	0	90	29	104996	1	13	37	27	119	25	-62	0	-90	28	143465
GLD DS	14	37	24	0	23	44	29	118	25	58	0	-90	58	105221	1	14	21	53	120	24	-59	0	-90	-59	145265
HAW SB	13	26	55	1	3	14	44	120	26	62	0	90	28	115813	1	16	41	39	120	25	-63	0	-90	27	150801
GUM SB	12	47	44	1	7	20	7	121	25	64	0	90	26	127298	1	20	7	50	121	25	-65	0	-90	25	158640
CNB DS	9	11	13	1	8	53	7	121	27	56	0	-90	56	131432	1	18	4	20	120	26	-57	C	-90	-57	153980
CAR SB	10	11	43	1	10	44	57	121	26	61	0	90	29	136270	1	20	56	40	121	26	-62	0	-90	28	160438
MAD DS	14	57	34	1	16	15	13	122	24	57	0	-90	57	149770	2	7	12	47	123	24	-58	0	-90	-58	181693
CYI SB	13	46	15	1	17	37	43	123	24	62	0	90	28	152971	2	7	23	58	123	24	-63	0	-90	27	182053
ASC SB	11	24	48	1	18	44	22	123	25	64	0	90	26	155507	2	6	9	9	122	25	-65	C	-90	25	179609
BDA SB	14	7	51	1	20	44	13	123	24	61	0	90	29	159988	2	10	52	4	123	24	-62	C	-90	28	188672
ANT SB	12	58	51	1	21	7	37	123	25	64	0	90	26	160846	2	10	6	28	123	24	-65	0	-90	25	187241

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI SB	13	39	31	1	21	53	23	123	24	63	0	90	27	162515	2	11	32	53	123	24	-63	0	-90	27	189944
MIL SB	13	48	18	1	21	58	45	123	24	62	0	90	28	162711	2	11	47	4	123	24	-63	0	-90	27	190383
TEX SB	13	43	54	1	23	8	5	124	24	62	0	90	28	165205	2	12	51	59	123	24	-63	0	-90	27	192383
GYM SB	13	45	6	2	0	1	11	124	24	62	0	90	28	167091	2	13	46	17	123	24	-63	0	-90	27	194042
GLD DS	14	22	43	2	0	6	47	124	24	60	0	-90	60	167290	2	14	29	30	123	24	-61	0	-90	-61	195354
HAW SB	13	18	13	2	3	31	37	124	24	64	0	90	26	174363	2	16	49	50	124	24	-64	0	-90	26	199566
GUM SB	12	42	37	2	7	33	6	125	24	65	0	90	25	182347	2	20	15	42	124	24	-66	0	-90	24	205633
CNB DS	9	20	31	2	8	57	56	125	25	59	0	-90	59	185063	2	18	18	28	124	25	-59	0	-90	-59	202180
CAR SB	10	16	4	2	10	51	20	125	25	62	0	90	28	188642	2	21	7	25	124	24	-63	0	-90	27	207126
MAD DS	11	10	22	2	16	27	46	125	23	59	0	-90	59	198932	3	3	38	8	124	24	-91	39	1	-51	216958
CYI SB	9	50	28	2	17	47	42	126	24	63	0	90	27	201287	3	3	38	10	124	24	-85	48	-42	4	216564
ASC SB	8	47	57	2	18	50	16	126	24	66	0	90	24	203120	3	3	38	13	124	24	-54	33	-51	30	217233
BDA SB	6	45	3	2	20	52	60	126	23	62	0	90	28	206714	3	3	38	2	125	24	160	81	3	-8	215741
ANT SP	6	22	55	2	21	15	9	126	24	65	0	90	25	207370	3	3	38	4	125	24	3	83	0	7	215725
GBI SB	5	36	45	2	22	1	16	126	23	64	0	90	26	208718	3	3	38	0	125	24	96	74	16	-2	215825
MIL SB	5	31	30	2	22	6	31	126	23	63	0	90	27	208867	3	3	38	0	125	24	100	72	18	-3	215868
TEX SB	4	22	22	2	23	15	35	126	23	63	0	90	27	210900	3	3	37	58	125	24	88	57	33	1	216246
GYM SB	3	30	5	3	0	7	51	126	23	63	0	90	27	212444	3	3	37	56	125	24	83	45	45	5	216689
GLD DS	3	23	22	3	0	14	34	126	23	61	0	-90	61	212651	3	3	37	56	125	24	88	40	-3	50	216895
HAW SB	0	3	44	3	3	34	9	126	24	64	0	90	26	219007	3	3	37	53	126	24	65	1	89	25	219064

18 MAY 69 UPDATE 72.1 LOI1 BO TO LOI2 IG

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW SB	1	24	44	3	4	12	11	125	24	68	8	81	22	218196	3	5	36	54	127	24	74	26	63	15	217169
GLD DS	1	24	45	3	4	12	17	125	24	93	48	2	42	216158	3	5	37	1	126	23	109	64	9	25	215600
GYM SB	1	24	42	3	4	12	18	125	24	87	53	37	2	215956	3	5	37	1	126	24	98	71	19	-3	215439
TEX SB	1	24	45	3	4	12	20	125	24	92	65	25	-1	215589	3	5	37	5	126	24	119	82	7	-4	215283
GBI SB	1	24	44	3	4	12	25	125	24	108	82	7	-2	215296	3	5	37	9	125	24	-103	79	-11	-2	215321
MIL SB	1	24	42	3	4	12	25	125	24	113	79	10	-4	215322	3	5	37	8	126	24	-117	80	-9	-5	215304
BDA SB	1	24	41	3	4	12	29	124	24	-148	80	-5	-8	215311	3	5	37	9	125	24	-105	66	-24	-6	215558
ANT SB	1	24	42	3	4	12	30	124	24	-47	79	-8	7	215320	3	5	37	12	125	24	-71	62	-27	9	215649
MAD DS	1	24	38	3	4	12	36	124	24	-85	32	-7	-57	216839	3	5	37	14	125	23	-74	17	-42	-67	217664
CYI SB	1	24	40	3	4	12	37	124	24	-81	40	-49	7	216449	3	5	37	17	125	23	-75	23	-66	14	217341
ASC SB	1	24	41	3	4	12	40	124	24	-58	26	-60	29	217162	3	5	37	21	125	24	-64	9	-80	25	218160
HAW SB	1	24	39	3	6	20	24	126	24	76	36	53	11	216600	3	7	45	3	127	23	80	54	36	6	215802
GLD DS	1	24	40	3	6	20	33	126	24	126	72	11	15	215346	3	7	45	13	127	23	-162	77	12	-4	215243
GYM SB	1	24	40	3	6	20	34	126	24	114	80	9	-4	215226	3	7	45	14	127	23	-113	79	-10	-4	215220
TEX SB	1	24	39	3	6	20	37	125	24	-138	85	-4	-4	215189	3	7	45	16	126	23	-96	68	-22	-2	215415
MIL SB	1	24	41	3	6	20	40	125	24	-100	71	-19	-3	215363	3	7	45	21	126	23	-88	53	-37	1	215857
GBI SB	1	24	41	3	6	20	40	125	24	-93	69	-21	-1	215404	3	7	45	21	126	23	-85	51	-39	3	215942
BDA SB	1	24	39	3	6	20	43	125	24	-96	56	-34	-3	215742	3	7	45	22	126	23	-85	35	-51	4	216425
ANT SB	1	24	39	3	6	20	44	125	24	-73	52	-37	10	215891	3	7	45	23	126	23	-73	33	-55	14	216695
MAD DS	0	56	58	3	6	20	44	125	23	-67	9	-67	-66	218038	3	7	17	42	126	23	-59	0	-90	-59	217336

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CYI SB	1	10	13	3	6	20	48	125	23	-70	14	-76	19	217779	3	7	31	0	126	23	-64	0	-90	26	217885
GUM SB	0	2	51	3	7	42	6	128	23	66	0	90	24	218434	3	7	44	57	128	23	66	1	89	24	218530
18 MAY 69 UPDATE 72.1 LOI2 80 TO LM SEPARATION																									
HAW SB	1	13	42	3	8	27	52	127	23	82	64	26	4	215467	3	9	41	35	128	23	82	80	10	1	215012
GUM SB	1	11	47	3	8	29	37	128	23	69	11	78	21	217813	3	9	41	23	129	23	71	26	62	17	216855
GLD DS	1	11	44	3	8	29	58	126	23	-127	72	11	-15	215193	3	9	41	42	127	23	-105	59	9	-30	215459
GYM SB	1	11	45	3	8	29	60	126	23	-98	70	-20	-3	215234	3	9	41	45	127	23	-89	54	-36	1	215606
TEX SB	1	11	42	3	8	30	4	126	23	-90	58	-32	0	215544	3	9	41	46	127	23	-83	42	-47	5	216077
GBI SB	1	11	39	3	8	30	9	126	23	-81	40	-49	7	216211	3	9	41	48	127	23	-76	25	-64	13	216920
BDA SB	1	11	38	3	8	30	10	126	23	-80	30	-60	9	216740	3	9	41	48	127	23	-73	15	-74	17	217475
MIL SB	1	11	36	3	8	30	11	126	23	-84	43	-47	5	216102	3	9	41	47	127	23	-78	28	-61	11	216782
ANT SB	1	11	37	3	8	30	14	126	23	-71	23	-66	17	217082	3	9	41	52	127	23	-68	8	-82	21	217928
CNB DS	0	38	33	3	9	2	57	128	24	60	0	-90	60	217101	3	9	41	29	128	24	55	6	-79	54	217990
GUM SB	1	11	28	3	10	28	6	128	23	71	37	51	15	216282	3	11	39	33	129	23	69	53	35	12	215553
CNB DS	1	11	30	3	10	28	13	128	24	47	14	-70	45	217521	3	11	39	42	129	24	33	23	-63	30	216943
HAW SB	1	11	31	3	10	28	20	128	23	-53	88	-1	1	214927	3	11	39	51	128	23	-84	73	-17	2	215027
GLD DS	1	11	31	3	10	28	27	127	23	-95	49	5	-41	215745	3	11	39	58	128	23	-86	35	-6	-55	216322
BDA SB	0	33	27	3	10	28	29	127	23	-67	6	-83	23	217972	3	11	1	56	127	23	-63	0	-90	27	217013
GYM SB	1	11	30	3	10	28	29	127	23	-84	44	-46	4	215962	3	11	39	59	128	23	-78	29	-61	10	216640
TEX SB	1	11	28	3	10	28	31	127	23	-79	32	-58	9	216516	3	11	39	60	128	23	-73	17	-72	16	217275
GBI SB	1	11	26	3	10	28	33	127	23	-72	15	-74	18	217434	3	11	39	59	128	22	-65	1	-89	25	218238

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SB	1	11	25	3	10	28	33	127	23	-73	18	-71	16	217281	3	11	39	58	128	22	-67	4	-86	23	218072
CAR SB	0	38	54	3	11	0	37	129	23	64	0	90	26	217015	3	11	39	32	130	23	60	7	81	30	217828
CAR SB	1	11	45	3	12	26	8	129	23	54	16	70	35	217291	3	13	37	53	130	23	42	28	52	41	216567
GUM SB	1	11	48	3	12	26	12	129	23	65	64	24	11	215203	3	13	37	59	130	23	41	77	8	10	214857
CNB DS	1	11	43	3	12	26	20	129	24	22	27	-61	20	216670	3	13	38	3	130	23	5	31	-59	4	216423
HAW SB	1	11	40	3	12	26	29	128	23	-83	62	-28	3	215235	3	13	38	9	129	22	-80	46	-43	7	215732
GLD DS	1	11	32	3	12	26	37	128	22	-80	26	-20	-62	216760	3	13	38	8	129	22	-71	12	-56	-68	217479
GYM SB	1	11	35	3	12	26	38	128	23	-74	19	-70	15	217137	3	13	38	13	129	22	-67	5	-85	23	217929
TEX SB	0	38	48	3	12	26	40	128	22	-69	7	-82	21	217795	3	13	5	28	128	22	-65	0	-90	25	216921
CAR SB	1	11	31	3	14	24	39	130	23	32	35	37	44	216201	3	15	36	10	131	23	14	41	15	47	215840
GUM SB	1	11	34	3	14	24	44	130	23	-17	80	-3	9	214784	3	15	36	19	130	22	-62	69	-19	10	214914
CNB DS	1	11	32	3	14	24	49	130	23	-8	31	-59	-7	216389	3	15	36	21	130	23	-25	27	-61	-22	216536
GLD DS	0	17	47	3	14	24	53	129	22	-65	3	-83	-65	217958	3	14	42	39	129	22	-63	0	-90	-63	217238
HAW SB	1	11	32	3	14	24	53	129	22	-77	35	-54	10	216165	3	15	36	25	130	22	-74	20	-69	15	216931
CAR SB	1	11	38	3	16	22	53	131	23	-1	42	-1	48	215743	3	17	34	31	132	23	-22	39	-24	46	215810
GUM SB	1	11	33	3	16	23	2	130	22	-69	58	-30	11	215140	3	17	34	35	131	22	-72	42	-46	13	215687
CNB DS	1	11	33	3	16	23	3	130	23	-36	22	-63	-33	216746	3	17	34	36	131	23	-50	13	-71	-48	217223
HAW SB	0	47	4	3	16	23	7	130	22	-70	10	-80	20	217468	3	17	10	11	131	22	-66	0	-90	24	216878
MAD DS	0	36	20	3	16	57	48	132	22	61	0	-90	61	216711	3	17	34	8	133	21	67	6	-76	66	217637
CYI SB	1	11	25	3	18	20	49	133	22	66	1	89	24	217909	3	19	32	14	134	21	73	15	75	16	216993

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MAD DS	1	11	27	3	18	20	51	132	21	74	14	-48	69	217117	3	19	32	18	133	21	84	27	-12	63	216330
CAR SB	1	11	37	3	18	21	14	131	23	-34	34	-39	43	215996	3	19	32	50	132	22	-48	25	-58	38	216463
GUM SB	1	11	34	3	18	21	17	131	22	-72	31	-57	15	216153	3	19	32	50	132	21	-71	16	-74	18	216966
CNB DS	0	31	15	3	18	21	19	131	23	-57	5	-81	-57	217619	3	18	52	34	131	22	-62	0	-90	-62	216616
ASC SB	0	16	9	3	19	16	7	134	22	68	0	90	22	217056	3	19	32	16	134	22	67	4	86	23	217647
CYI SB	1	11	37	3	20	18	56	133	21	78	25	65	11	216408	3	21	30	33	134	21	85	40	50	4	215571
MAD DS	1	11	39	3	20	18	57	133	21	92	36	2	54	215852	3	21	30	36	134	21	105	48	13	40	215202
ASC SB	1	11	37	3	20	18	57	134	22	65	14	74	24	216997	3	21	30	35	135	22	60	29	57	26	216074
GUM SB	0	22	4	3	20	19	32	132	21	-69	5	-85	21	217533	3	20	41	36	132	21	-68	0	-90	22	216738
CAR SB	1	11	30	3	20	19	34	132	22	-56	16	-71	33	216865	3	21	31	4	133	22	-64	3	-87	26	217597
ANT SB	1	11	27	3	22	17	14	135	21	70	6	83	20	217362	3	23	28	41	136	21	74	21	68	15	216379
BDA SB	1	11	26	3	22	17	15	134	21	71	9	81	19	217203	3	23	28	41	136	21	79	22	67	10	216324
CYI SB	1	11	32	3	22	17	19	134	21	90	50	40	0	215100	3	23	28	50	135	21	100	65	25	-4	214541
ASC SB	1	11	34	3	22	17	22	134	22	53	39	45	27	215557	3	23	28	55	135	21	39	52	27	29	214956
MAD DS	1	11	30	3	22	17	23	134	21	116	57	16	29	214861	3	23	28	53	135	21	143	67	19	14	214506
GBI SB	0	49	35	3	22	39	6	135	21	67	0	90	23	216654	3	23	28	41	136	21	72	10	80	18	217066
MIL SB	0	42	49	3	22	45	51	135	21	66	0	90	24	216454	3	23	28	41	136	21	71	8	81	19	217153
TEX SB	1	11	34	4	0	15	18	136	21	69	4	86	21	217397	4	1	26	52	137	20	76	18	72	13	216460
MIL SB	1	11	35	4	0	15	20	135	21	76	18	71	13	216554	4	1	26	55	137	20	83	33	57	6	215669
GBI SB	1	11	36	4	0	15	20	136	21	76	20	70	13	216459	4	1	26	56	137	20	83	35	55	6	215573

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SP	1	11	35	4	0	15	22	135	21	76	32	57	12	215777	4	1	26	57	136	21	78	48	41	8	214961
BDA SB	1	11	35	4	0	15	23	135	21	85	32	57	4	215777	4	1	26	58	136	20	94	47	43	-3	215027
CYI SB	1	11	34	4	0	15	35	135	21	115	75	13	-6	214299	4	1	27	9	136	21	-160	82	-3	-7	214138
MAD DS	1	11	33	4	0	15	37	135	21	173	70	20	2	214388	4	1	27	10	136	20	-144	66	20	-13	214391
ASC SB	1	11	32	4	0	15	40	135	21	23	58	14	29	214697	4	1	27	12	136	21	-8	61	-4	29	214542
GYM SB	0	34	31	4	0	52	22	136	20	67	0	90	23	216251	4	1	26	53	137	20	71	7	83	19	217119
GLD DS	0	24	22	4	1	2	30	136	20	65	0	-90	65	216409	4	1	26	52	137	20	68	4	-79	68	217259
GLD DS	0	21	39	4	2	13	36	136	20	75	13	-48	70	216695	4	2	35	16	137	20	77	18	-35	69	215385
GYM SB	0	21	39	4	2	13	36	136	20	75	17	73	14	216511	4	2	35	16	137	20	78	21	68	12	215184
TEX SB	0	21	37	4	2	13	39	136	20	81	28	61	8	215871	4	2	35	16	137	20	83	33	57	6	214565
MIL SB	0	21	34	4	2	13	41	136	20	88	43	47	2	215151	4	2	35	16	136	20	90	48	42	0	213890
GBI SB	0	21	33	4	2	13	42	136	20	87	45	45	2	215059	4	2	35	16	136	20	89	50	40	0	213803
BDA SB	0	21	31	4	2	13	44	136	20	102	57	33	-7	214627	4	2	35	16	136	20	107	61	28	-8	213429
ANT SB	0	21	31	4	2	13	44	136	21	78	59	30	6	214539	4	2	35	16	136	21	78	64	25	5	213335
CYI SB	0	21	20	4	2	13	56	135	21	-115	75	-14	-6	214180	4	2	35	16	136	20	-107	70	-19	-6	213198
MAD DS	0	21	20	4	2	13	56	135	20	-124	60	18	-25	214519	4	2	35	16	135	20	-117	56	17	-29	213568
ASC SB	0	21	17	4	2	13	58	135	21	-28	57	-17	29	214605	4	2	35	16	136	21	-36	54	-23	28	213638
18 MAY 69 UPDATE 72.1 LM SEPARATION BO TO LM JETTISON IG																									
GYM SB	0	49	42	4	2	35	23	137	20	78	21	68	12	215179	4	3	25	4	138	20	82	31	59	6	215614
GLD DS	0	49	43	4	2	35	23	137	20	77	18	-35	69	215379	4	3	25	5	137	20	84	27	-12	63	215843
TEX SB	0	49	44	4	2	35	23	137	20	83	33	57	6	214559	4	3	25	7	137	20	88	43	47	2	215054

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SR	0	49	47	4	2	35	23	136	20	90	48	42	0	213884	4	3	25	10	137	20	97	58	32	-4	214496
GBI SR	0	49	49	4	2	35	23	136	20	89	50	40	0	213798	4	3	25	11	137	20	96	60	30	-3	214423
BDA SR	0	49	52	4	2	35	23	136	20	107	61	28	-8	213424	4	3	25	15	137	20	123	70	17	-11	214187
ANT SR	0	49	53	4	2	35	23	136	21	78	64	25	5	213330	4	3	25	15	137	20	75	75	14	4	214089
MAD DS	0	50	2	4	2	35	23	135	20	-117	56	17	-29	213564	4	3	25	25	136	20	-106	48	14	-40	214867
CYI SR	0	50	3	4	2	35	23	136	20	-107	70	-19	-6	213194	4	3	25	26	136	20	-98	60	-30	-4	214443
ASC SR	0	50	6	4	2	35	23	136	21	-36	54	-23	28	213635	4	3	25	28	136	21	-48	47	-35	27	214918
GLD DS	1	11	34	4	4	11	49	137	20	90	37	0	53	215326	4	5	23	22	138	20	102	50	10	39	214637
GYM SR	1	11	33	4	4	11	50	137	20	87	42	48	2	215087	4	5	23	23	138	20	96	57	33	-3	214410
TEX SR	1	11	37	4	4	11	51	137	20	93	54	36	-2	214608	4	5	23	28	138	20	107	68	21	-6	214091
GBI SR	1	11	37	4	4	11	56	137	20	105	71	19	-5	214130	4	5	23	33	138	20	160	83	2	-7	213883
MIL SR	1	11	37	4	4	11	57	137	20	108	68	21	-6	214185	4	5	23	34	138	20	151	80	5	-9	213907
BDA SR	1	11	36	4	4	11	60	137	20	155	77	6	-12	214030	4	5	23	36	138	20	-139	74	-11	-12	213991
ANT SR	1	11	39	4	4	12	0	137	20	40	86	3	3	213948	4	5	23	39	137	20	-75	76	-13	3	213959
MAD DS	1	11	39	4	4	12	9	136	20	-97	39	8	-51	215197	4	5	23	48	137	19	-86	26	-9	-64	215795
CYI SR	1	11	43	4	4	12	9	136	20	-91	49	-41	-1	214748	4	5	23	52	137	20	-84	34	-56	5	215362
ASC SR	1	11	46	4	4	12	13	136	21	-56	37	-48	26	215273	4	5	23	59	137	20	-64	23	-65	24	215974
HAW SR	0	57	53	4	4	25	22	138	20	68	0	90	22	216651	4	5	23	15	139	20	73	12	78	16	216560
HAW SR	1	11	31	4	6	9	56	138	20	77	22	67	12	215929	4	7	21	27	139	19	82	38	52	6	215026
GLD DS	1	11	33	4	6	10	4	138	20	113	59	13	28	214282	4	7	21	37	139	19	142	70	16	12	213909

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GYM SB	1	11	29	4	6	10	8	138	20	106	67	22	-6	214078	4	7	21	38	139	19	144	80	6	-8	213770
TEX SB	1	11	29	4	6	10	12	138	20	128	78	10	-7	213880	4	7	21	41	139	19	-140	80	-7	-8	213773
MIL SB	1	11	29	4	6	10	17	137	20	-143	79	-7	-9	213860	4	7	21	46	138	19	-107	66	-23	-7	214006
GBI SB	1	11	29	4	6	10	18	137	20	-126	79	-9	-6	213862	4	7	21	47	138	19	-101	65	-25	-5	214049
BDA SB	1	11	26	4	6	10	21	137	20	-116	66	-22	-10	214097	4	7	21	47	138	19	-100	52	-38	-6	214449
ANT SB	1	11	29	4	6	10	23	137	20	-79	65	-25	5	214113	4	7	21	52	138	20	-80	49	-41	7	214561
MAD DS	1	11	24	4	6	10	26	137	19	-79	17	-33	-70	216218	4	7	21	49	138	19	-69	4	-78	-68	216885
CYI SB	1	11	22	4	6	10	30	137	20	-79	24	-66	10	215821	4	7	21	53	138	19	-73	9	-80	17	216597
ASC SB	0	55	14	4	6	10	33	137	20	-67	12	-77	22	216493	4	7	5	47	138	20	-70	0	-90	20	216336
HAW SB	1	11	37	4	8	8	15	139	19	85	49	41	3	214521	4	9	19	52	140	19	92	65	25	-1	213911
GLD DS	1	11	46	4	8	8	23	139	19	177	74	16	1	213803	4	9	20	9	139	19	-134	68	16	-15	213838
GYM SB	1	11	44	4	8	8	25	138	19	-148	80	-5	-8	213721	4	9	20	9	139	19	-108	67	-22	-7	213854
TEX SB	1	11	43	4	8	8	30	138	19	-111	71	-18	-7	213857	4	9	20	12	139	19	-97	56	-34	-4	214184
GBI SB	1	11	48	4	9	8	31	138	19	-93	54	-36	-2	214314	4	9	20	19	139	19	-86	39	-51	3	214882
MIL SB	1	11	46	4	8	8	32	138	19	-97	56	-34	-4	214245	4	9	20	17	139	19	-89	41	-49	1	214776
BDA SB	1	11	45	4	8	8	33	138	19	-92	42	-48	-2	214801	4	9	20	17	139	19	-84	27	-63	5	215451
ANT SB	1	11	49	4	8	8	34	138	20	-78	38	-52	9	214982	4	9	20	24	139	19	-76	22	-68	13	215743
GUM SB	0	49	5	4	8	30	34	140	19	70	0	90	20	215994	4	9	19	40	141	19	73	11	79	17	216358
GUM SB	1	11	30	4	10	6	23	140	19	74	22	68	14	215692	4	11	17	52	141	19	76	38	52	11	214754
CNB DS	1	11	27	4	10	6	31	140	20	60	6	-78	60	216594	4	11	17	58	141	20	49	17	-64	46	215817

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW SB	1	11	30	4	10	6	36	140	19	99	76	14	-2	213636	4	11	18	6	141	19	-150	86	-2	-3	213445
GLD DS	1	11	28	4	10	6	45	139	19	-116	60	14	-27	213973	4	11	18	13	140	19	-101	47	10	-42	214369
GYM SB	1	11	28	4	10	6	48	139	19	-98	57	-33	-4	214062	4	11	18	16	140	19	-90	42	-48	0	214570
TEX SB	1	11	26	4	10	6	51	139	19	-90	45	-45	0	214501	4	11	18	17	140	19	-84	30	-60	6	215143
MIL SB	1	11	23	4	10	6	53	139	19	-84	30	-59	5	215194	4	11	18	16	140	19	-77	16	-74	12	215936
BDA SB	1	11	22	4	10	6	53	139	19	-78	17	-72	11	215911	4	11	18	15	140	18	-70	3	-86	20	216659
GBI SB	1	11	23	4	10	6	54	139	19	-82	28	-62	7	215319	4	11	18	17	140	19	-76	13	-76	14	216086
ANT SB	0	50	51	4	10	6	58	139	19	-73	11	-79	16	216278	4	10	57	50	139	19	-70	0	-90	20	215885
CAR SB	0	4	48	4	12	4	36	141	19	66	6	84	24	216463	4	12	9	24	141	19	65	7	83	25	216153
GUM SB	0	4	48	4	12	4	36	141	19	76	49	40	9	214235	4	12	9	24	141	19	76	50	39	9	213940
CNB DS	0	4	41	4	12	4	43	141	20	40	24	-60	36	215400	4	12	9	24	141	20	39	25	-60	34	215122
HAW SB	0	4	34	4	12	4	50	140	19	-102	76	-13	-3	213480	4	12	9	24	140	19	-100	75	-14	-3	213255
GLD DS	0	4	30	4	12	4	54	140	19	-93	37	4	-53	214738	4	12	9	24	140	19	-92	36	3	-54	214545
GYM SB	0	4	29	4	12	4	55	140	19	-84	32	-58	5	215008	4	12	9	24	140	19	-84	31	-59	5	214822
MIL SB	0	4	27	4	12	4	56	140	18	-72	6	-84	18	216462	4	12	9	24	140	18	-72	5	-85	18	216283
TEX SB	0	4	27	4	12	4	57	140	19	-79	20	-70	11	215641	4	12	9	24	140	19	-78	19	-71	11	215461
GBI SB	0	4	27	4	12	4	57	140	18	-71	3	-87	19	216622	4	12	9	24	140	18	-70	2	-88	20	216443
18 MAY 69 UPDATE 72.1 LM JETTISON BO TO TEI IG																									
GBI SB	0	9	57	4	12	9	29	140	18	-70	2	-88	20	216439	4	12	19	26	140	18	-69	0	-90	21	216035
MIL SB	0	23	47	4	12	9	29	140	18	-72	5	-85	18	216279	4	12	33	17	140	18	-69	0	-90	21	215523
CAR SB	1	6	42	4	12	9	29	141	19	65	7	83	25	216147	4	13	16	11	142	19	57	19	67	31	215554

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GUM SB	1	6	48	4	12	9	29	141	19	76	50	39	9	213934	4	13	16	17	142	19	74	65	24	6	213607
CNB DS	1	6	57	4	12	9	29	141	20	38	25	-60	34	215116	4	13	16	26	142	19	23	32	-56	20	214906
HAW SB	1	7	3	4	12	9	29	140	19	-100	75	-14	-3	213251	4	13	16	32	141	18	-92	61	-29	-1	213741
GLD DS	1	7	8	4	12	9	29	140	19	-92	36	3	-54	214541	4	13	16	38	141	18	-84	23	-15	-66	215389
GYM SB	1	7	10	4	12	9	29	140	19	-84	31	-59	5	214818	4	13	16	39	141	18	-78	17	-73	12	215751
TEX SB	1	7	11	4	12	9	29	140	19	-78	19	-71	11	215457	4	13	16	41	141	18	-72	5	-85	18	216429
CAR SB	1	11	33	4	14	2	54	142	19	49	28	55	35	215038	4	15	14	28	143	19	34	39	35	40	214407
GUM SB	1	11	34	4	14	2	59	142	19	66	76	13	6	213337	4	15	14	33	143	18	-36	84	-4	5	213161
CNB DS	1	11	30	4	14	3	7	142	19	10	35	-55	8	214697	4	15	14	37	142	19	-9	35	-55	-8	214587
HAW SB	1	11	29	4	14	3	14	141	18	-87	50	-40	2	214039	4	15	14	43	142	18	-83	34	-56	6	214664
GLD DS	1	11	25	4	14	3	15	141	18	-77	13	-43	-72	215845	4	15	14	40	142	18	-68	0	-90	-68	216563
GYM SB	0	32	3	4	14	3	19	141	18	-73	6	-83	17	216255	4	14	35	22	141	18	-70	0	-90	20	215314
CAR SB	1	11	43	4	16	1	12	143	19	21	44	20	42	214131	4	17	12	55	143	18	-2	47	-2	43	213917
GUM SB	1	11	47	4	16	1	16	142	18	-70	74	-15	5	213215	4	17	13	3	143	18	-78	58	-31	7	213521
CNB DS	1	11	46	4	16	1	20	142	19	-23	32	-56	-19	214656	4	17	13	6	143	18	-39	25	-58	-35	214939
HAW SB	1	11	43	4	16	1	24	142	18	-79	23	-67	10	215163	4	17	13	8	143	17	-74	7	-82	16	215984
CAR SB	1	11	28	4	17	59	35	143	18	-18	45	-17	42	213918	4	19	11	3	144	18	-38	38	-38	39	214142
GUM SB	1	11	25	4	17	59	41	143	18	-78	47	-43	8	213843	4	19	11	6	144	17	-78	30	-59	11	214518
CNB DS	1	11	25	4	17	59	43	143	18	-49	19	-63	-46	215218	4	19	11	8	144	18	-61	8	-74	-60	215786
MAD DS	1	10	36	4	17	59	60	144	17	67	0	-90	67	216319	4	19	10	36	145	17	78	12	-45	73	215528

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CYI SR	1	11	34	4	19	57	19	145	17	76	9	81	14	215655	4	21	8	53	146	17	83	24	66	6	214692
ASC SR	1	11	36	4	19	57	21	145	18	72	0	90	18	216182	4	21	8	57	146	17	69	16	73	20	215117
MAD DS	1	11	33	4	19	57	23	145	17	85	21	-13	69	214982	4	21	8	56	146	17	97	33	10	56	214187
CAR SB	1	11	48	4	19	57	49	144	18	-48	30	-52	35	214434	4	21	9	37	145	17	-60	18	-69	28	215028
GUM SB	1	11	44	4	19	57	49	143	17	-76	19	-70	13	215052	4	21	9	33	145	17	-74	3	-87	16	215914
CYI SB	1	11	30	4	21	55	35	146	17	88	34	56	2	214104	4	23	7	5	147	16	97	49	41	-5	213316
ASC SB	1	11	29	4	21	55	38	146	17	66	27	61	21	214465	4	23	7	7	147	17	59	42	43	23	213604
MAD DS	1	11	28	4	21	55	39	146	17	106	42	17	45	213720	4	23	7	7	147	16	123	54	22	30	213141
CAR SB	0	43	50	4	21	56	12	145	17	-66	9	-81	24	215483	4	22	40	2	145	17	-71	0	-90	19	214730
BDA SB	0	37	28	4	22	29	31	147	16	71	0	90	19	214663	4	23	6	59	147	16	75	7	83	15	215482
ANT SB	0	25	37	4	22	41	21	147	16	73	0	90	17	214770	4	23	6	58	147	16	75	6	84	15	215566
MIL SB	1	11	39	4	23	53	41	147	16	73	2	87	17	215725	5	1	5	20	148	16	81	17	73	9	214749
BDA SB	1	11	41	4	23	53	42	147	16	81	17	73	8	214878	5	1	5	23	148	16	90	31	59	0	213978
GBI SB	1	11	38	4	23	53	42	147	16	74	4	86	16	215630	5	1	5	20	148	16	81	19	71	8	214643
ANT SB	1	11	39	4	23	53	42	147	16	77	17	73	12	214889	5	1	5	22	148	16	81	32	57	7	213898
CYI SB	1	11	46	4	23	53	48	147	16	105	60	30	-8	212916	5	1	5	35	148	16	131	73	13	-11	212484
ASC SB	1	11	52	4	23	53	51	147	17	49	52	31	24	213172	5	1	5	43	148	17	26	63	13	24	212716
MAD DS	1	11	44	4	23	53	52	147	16	140	61	23	18	212877	5	1	5	36	147	16	176	65	25	2	212644
TFX SB	0	10	40	5	0	54	36	148	16	72	0	90	18	215194	5	1	5	16	148	16	73	2	88	17	215606
GYM SB	1	11	21	5	1	51	60	148	16	73	1	89	17	215633	5	3	3	21	149	15	80	15	75	9	214649

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI SR	1	11	27	5	1	52	1	148	16	86	29	61	4	214018	5	3	3	27	149	16	94	44	46	-3	213170
TEX SB	1	11	24	5	1	52	1	148	16	78	12	77	11	214955	5	3	3	24	149	15	86	27	63	4	213997
MIL SR	1	11	24	5	1	52	1	148	16	86	27	63	4	214125	5	3	3	25	149	15	94	42	48	-3	213270
BDA SR	1	11	26	5	1	52	2	148	16	97	41	49	-5	213441	5	3	3	29	149	15	110	55	34	-12	212765
ANT SR	1	11	28	5	1	52	3	148	16	84	44	46	4	213316	5	3	3	31	149	16	88	60	30	1	212599
CYI SR	1	11	27	5	1	52	14	147	16	173	78	1	-12	212332	5	3	3	41	148	16	-127	71	-15	-11	212335
MAD DS	1	11	26	5	1	52	16	147	16	-157	64	24	-10	212605	5	3	3	43	148	15	-129	56	23	-26	212747
ASC SR	1	11	26	5	1	52	21	147	17	0	65	0	25	212559	5	3	3	46	148	16	-35	61	-18	24	212591
GLD DS	1	2	53	5	2	0	30	148	16	71	0	-90	71	215240	5	3	3	22	149	15	79	11	-43	74	214876
GLD DS	1	11	41	5	3	50	5	149	15	86	21	-11	69	214291	5	5	1	46	150	15	96	35	9	55	213438
GYM SR	1	11	44	5	3	50	6	149	15	85	26	64	4	214033	5	5	1	49	150	15	94	41	49	-3	213161
TEX SB	1	11	46	5	3	50	7	149	16	91	38	52	-1	213430	5	5	1	53	150	15	101	52	37	-7	212679
MIL SB	1	13	42	5	3	50	9	149	16	102	52	37	-7	212811	5	5	3	52	150	15	120	67	20	-12	212347
GBI SR	1	11	47	5	3	50	11	149	16	101	55	35	-6	212720	5	5	1	58	150	15	119	69	18	-10	212204
BDA SR	1	11	51	5	3	50	12	148	16	125	64	22	-15	212448	5	5	2	3	149	15	164	72	5	-17	212143
ANT SR	1	11	50	5	3	50	13	148	16	91	71	19	0	212274	5	5	2	3	149	15	130	87	2	-2	211983
MAD DS	1	11	46	5	3	50	24	148	15	-115	48	21	-37	212968	5	5	2	10	149	15	-101	35	15	-53	213428
CYI SR	1	11	47	5	3	50	25	148	16	-110	62	-27	-9	212494	5	5	2	11	149	15	-97	47	-43	-5	212909
ASC SR	1	11	51	5	3	50	26	148	16	-50	53	-30	23	212786	5	5	2	16	149	16	-63	39	-48	21	213268
HAW SR	1	11	24	5	5	48	23	150	15	76	6	83	14	214949	5	6	59	47	151	15	82	22	68	7	213925

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA										STATION TERMINATION DATA									
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GLD DS	1	11	25	5	5	48	27	150	15	104	44	14	44	212941	5	6	59	52	151	15	121	57	19	28	212334
GYM SB	1	11	23	5	5	48	30	150	15	101	51	38	-7	212665	5	6	59	53	151	15	117	65	22	-11	212097
TEX SB	1	11	25	5	5	48	32	150	15	112	63	26	-10	212288	5	6	59	58	150	15	145	75	9	-13	211908
MIL SB	1	11	24	5	5	48	37	149	15	145	74	9	-13	212034	5	7	0	1	150	15	-151	74	-8	-14	211912
GBI SB	1	11	24	5	5	48	38	149	15	150	77	7	-11	211992	5	7	0	3	150	15	-139	75	-10	-11	211909
BDA SB	1	11	25	5	5	48	41	149	15	-158	72	-7	-17	212074	5	7	0	6	150	15	-123	62	-24	-15	212193
ANT SB	1	11	24	5	5	48	44	149	15	-99	80	-10	-1	211948	5	7	0	8	150	15	-91	64	-26	0	212139
MAD DS	1	11	23	5	5	48	48	148	15	-92	26	5	-64	213799	5	7	0	12	149	14	-82	13	-31	-75	214438
CYI SB	1	11	25	5	5	48	51	148	15	-91	36	-54	-1	213285	5	7	0	15	149	15	-84	21	-69	5	213984
ASC SB	1	11	25	5	5	48	56	148	16	-68	28	-60	20	213701	5	7	0	21	149	15	-73	12	-77	17	214495
HAW SB	1	11	47	5	7	46	29	151	15	86	33	57	3	213306	5	8	58	16	152	14	93	48	42	-2	212460
GYM SB	1	11	50	5	7	46	37	150	15	141	73	11	-13	211874	5	8	58	27	151	14	-155	75	-6	-13	211725
GLD DS	1	11	46	5	7	46	38	150	15	139	64	20	16	212068	5	8	58	23	151	14	-179	69	21	0	211835
TEX SB	1	11	47	5	7	46	42	150	15	-168	77	-3	-13	211819	5	8	58	28	151	14	-122	67	-20	-12	211880
MIL SB	1	11	47	5	7	46	44	150	15	-123	67	-20	-12	211996	5	8	58	31	151	14	-105	53	-36	-9	212299
GBI SB	1	11	45	5	7	46	47	150	15	-115	66	-22	-10	212018	5	8	58	31	151	14	-101	51	-38	-7	212363
BDA SB	1	11	46	5	7	46	48	150	15	-110	53	-36	-12	212416	5	8	58	33	151	14	-98	39	-51	-6	212900
ANT SB	1	11	45	5	7	46	49	149	15	-88	52	-38	1	212427	5	8	58	34	150	14	-84	36	-54	5	213015
MAD DS	0	24	5	5	7	46	49	149	14	-75	4	-74	-74	214888	5	8	10	54	150	14	-71	0	-90	-71	213969
CYI SB	0	52	11	5	7	46	53	149	15	-79	11	-79	11	214502	5	8	39	4	150	14	-74	0	-90	16	214100

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ASC SB	0	3	58	5	7	46	57	149	15	-75	1	-89	15	215077	5	7	50	54	149	15	-75	0	-90	15	214915
GUM SB	1	11	22	5	9	44	46	152	14	77	6	84	13	214616	5	10	56	8	153	14	80	22	68	9	213540
HAW SB	1	11	28	5	9	44	55	151	14	99	59	30	-5	212010	5	10	56	23	152	14	119	74	14	-8	211538
GLD DS	1	11	24	5	9	45	5	151	14	-150	66	21	-12	211817	5	10	56	28	152	14	-122	56	20	-28	211996
GYM SB	1	11	26	5	9	45	6	151	14	-125	68	-18	-12	211774	5	10	56	32	152	14	-106	54	-35	-9	212063
TEX SB	1	11	23	5	9	45	12	151	14	-108	57	-31	-9	212058	5	10	56	35	151	14	-97	42	-47	-5	212527
MIL SB	1	11	23	5	9	45	13	150	14	-97	43	-47	-5	212619	5	10	56	36	151	14	-89	28	-62	1	213252
BDA SB	1	11	20	5	9	45	16	150	14	-91	28	-62	-1	213303	5	10	56	36	151	14	-83	14	-76	7	214009
GBI SB	1	11	22	5	9	45	16	150	14	-94	41	-49	-3	212707	5	10	56	38	151	14	-87	25	-65	3	213375
ANT SB	1	11	21	5	9	45	19	150	14	-82	25	-65	8	213498	5	10	56	41	151	14	-78	9	-81	12	214321
CNB DS	0	54	48	5	10	1	27	152	15	71	0	-90	71	214085	5	10	56	15	153	15	64	10	-68	62	214225
GUM SB	1	11	49	5	11	42	51	153	14	82	33	56	7	212898	5	12	54	40	154	14	85	50	40	4	212024
CNB DS	1	11	47	5	11	42	58	153	15	56	18	-60	52	213693	5	12	54	45	153	14	42	29	-53	36	212971
HAW SB	1	11	52	5	11	43	1	152	14	166	82	2	-8	211390	5	12	54	53	153	14	-118	73	-15	-8	211372
GLD DS	1	11	47	5	11	43	9	151	14	-110	47	17	-40	212253	5	12	54	56	152	13	-97	33	11	-56	212763
BDA SB	0	21	3	5	11	43	11	151	14	-76	4	-86	13	214515	5	12	4	14	151	14	-74	0	-90	16	213699
GYM SB	1	11	47	5	11	43	12	151	14	-98	44	-46	-6	212393	5	12	54	58	152	13	-89	29	-61	0	213013
MIL SB	1	11	47	5	11	43	12	151	14	-83	17	-73	6	213750	5	12	54	59	152	13	-76	2	-88	14	214515
GBI SB	1	10	22	5	11	43	13	151	14	-82	15	-75	8	213888	5	12	53	35	152	13	-75	0	-90	15	214588
TEX SB	1	11	46	5	11	43	13	151	14	-90	32	-58	0	212950	5	12	54	59	152	13	-83	17	-73	6	213667

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR SB	0	44	36	5	12	10	3	153	14	74	0	90	16	213502	5	12	54	38	154	14	70	5	80	20	214083
CAR SB	1	11	24	5	13	41	17	154	14	64	19	69	25	213445	5	14	52	40	155	14	53	32	51	31	212590
GUM SB	1	11	24	5	13	41	20	153	14	86	61	29	2	211565	5	14	52	44	154	13	89	78	12	0	211093
CNB DS	1	11	25	5	13	41	25	153	14	30	35	-51	24	212604	5	14	52	50	154	14	10	40	-50	8	212236
HAW SB	1	11	21	5	13	41	35	152	14	-104	63	-26	-6	211509	5	14	52	57	153	13	-95	47	-43	-3	211936
GLD DS	1	11	21	5	13	41	38	152	13	-90	24	1	-66	213173	5	14	52	59	153	13	-81	10	-42	-77	213870
GYM SB	1	11	21	5	13	41	39	152	13	-84	18	-72	6	213487	5	14	53	1	153	13	-77	3	-87	13	214262
TEX SB	0	30	22	5	13	41	41	152	13	-78	6	-84	12	214174	5	14	12	3	152	13	-75	0	-90	15	213232
CNB DS	1	13	41	5	15	37	37	154	14	-4	40	-50	-3	212239	5	16	51	18	155	13	-26	37	-50	-21	212181
CAR SB	1	11	50	5	15	39	21	154	14	42	40	38	34	212155	5	16	51	11	155	13	22	49	18	37	211650
GUM SB	1	11	49	5	15	39	25	154	13	98	90	0	0	210960	5	16	51	14	155	13	-90	74	-16	0	210968
GLD DS	0	1	26	5	15	39	33	153	13	-75	0	-89	-75	214348	5	15	40	58	153	13	-74	0	-90	-74	214293
HAW SB	1	11	46	5	15	39	34	153	13	-90	36	-54	0	212341	5	16	51	21	154	13	-84	20	-70	5	213067
18 MAY 69 UPDATE 72.1 TEI 80 TO ENTRY																									
CAR SB	5	49	43	5	17	29	19	155	13	7	51	6	38	211764	5	23	19	2	154	13	-75	0	-90	15	197382
GUM SB	4	22	14	5	17	29	21	154	13	-88	64	-26	1	211370	5	21	51	35	154	13	-77	0	-90	13	201463
CNB DS	3	13	57	5	17	29	22	154	14	-37	33	-51	-30	212576	5	20	43	20	154	13	-73	0	-90	-73	204674
HAW SB	0	48	34	5	17	29	23	154	13	-81	11	-79	9	213771	5	18	17	58	154	13	-76	0	-90	14	211771
MAD DS	13	19	34	5	18	58	35	155	12	74	0	-90	74	209712	6	8	18	9	155	12	-75	0	-90	-75	171953
CYI SB	12	46	41	5	20	1	43	156	12	76	0	90	14	206619	6	8	48	24	155	12	-77	0	-90	13	170478
ASC SB	11	39	35	5	20	30	30	156	13	77	0	90	13	205289	6	8	10	5	155	13	-77	0	-90	13	172341

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
BDA SB	12	57	29	5	23	12	35	156	12	75	0	90	15	197719	6	12	10	3	155	11	-76	0	-90	14	160498
ANT SB	12	24	46	5	23	18	4	156	12	77	0	90	13	197427	6	11	42	50	155	12	-78	0	-90	12	161861
GBI SB	12	44	25	6	0	13	53	156	12	76	0	90	14	194875	6	12	58	18	155	12	-77	0	-90	13	158064
MIL SB	12	48	5	6	0	22	3	156	12	76	0	90	14	194467	6	13	10	8	155	11	-77	0	-90	13	157465
TEX SB	12	46	26	6	1	29	47	156	12	76	0	90	14	191345	6	14	16	13	155	11	-77	0	-90	13	154095
GYM SB	12	46	36	6	2	23	30	156	12	76	0	90	14	188807	6	15	10	6	156	11	-77	0	-90	13	151320
GLD DS	13	3	37	6	2	39	21	156	12	75	0	-90	75	188069	6	15	42	58	156	11	-76	0	-90	-76	149615
HAW SB	12	34	29	6	5	46	35	156	12	77	0	90	13	179248	6	18	21	4	156	11	-78	0	-90	12	141265
GUM SB	12	18	4	6	9	39	16	157	12	78	0	90	12	167986	6	21	57	20	157	11	-79	0	-90	11	129413
CNB DS	10	43	14	6	10	11	13	157	13	74	0	-90	74	166410	6	20	54	27	157	12	-75	0	-90	-75	132912
CAR SB	11	10	22	6	12	19	46	157	13	76	0	90	14	160005	6	23	30	8	157	12	-77	0	-90	13	124152
MAD DS	13	8	15	6	19	14	7	159	11	76	0	-90	76	138408	7	8	22	22	160	8	-79	0	-90	-79	91324
CYI SB	12	42	8	6	20	15	23	159	11	78	0	90	12	135068	7	8	57	31	160	9	-80	0	-90	10	88950
ASC SB	11	46	9	6	20	40	47	159	12	78	0	90	12	133669	7	8	26	56	159	10	-80	0	-90	10	91014
BDA SB	12	49	13	6	23	30	55	160	10	78	0	90	12	124109	7	12	20	8	162	7	-81	0	-90	9	74577
ANT SB	12	24	52	6	23	33	12	160	11	79	0	90	11	123978	7	11	58	4	161	8	-82	0	-90	8	76206
GBI SB	12	39	33	7	0	32	8	160	10	79	0	90	11	120575	7	13	11	41	162	7	-82	0	-90	8	70698
MIL SB	12	42	32	7	0	40	24	160	10	78	0	90	12	120095	7	13	22	55	162	7	-82	0	-90	8	69838
TEX SB	12	41	6	7	1	49	38	161	10	79	0	90	11	116024	7	14	30	43	163	6	-83	0	-90	7	64534
GYM SB	12	41	39	7	2	44	10	161	10	79	0	90	11	112765	7	15	25	49	164	6	-83	0	-90	7	60062

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(a) CSM

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GLD DS	12	52	45	7	3	2	17	161	10	78	0	-90	78	111671	7	15	55	2	164	5	-84	C	-90	-84	57622
HAW SB	12	37	3	7	6	11	7	162	9	80	0	90	10	99922	7	18	48	10	167	3	-87	C	-90	3	41936
GUM SB	13	27	3	7	10	9	11	165	9	81	0	90	9	84009	7	23	36	13	-160	-48	-140	0	-90	-50	4037
CNB DS	13	18	28	7	10	30	26	165	11	77	0	-90	77	82513	7	23	48	54	-9	27	56	C	-90	56	1046
CAR SB	10	58	58	7	12	46	27	167	10	79	0	90	11	72607	7	23	45	25	-19	-11	102	C	90	-12	1883
CAR CB	2	28	51	7	21	16	34	176	4	-52	47	-36	25	23400	7	23	45	25	-19	-11	102	C	90	-12	1883
TAN TM	2	15	17	7	21	17	51	-175	3	66	43	44	17	23400	7	23	33	8	-88	-14	105	0	90	-15	4730
PRE CB	2	1	1	7	21	25	5	-173	4	73	24	65	15	23400	7	23	26	6	-110	-8	99	0	90	-9	6221

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SB	0	9	50	4	2	35	23	136	20	90	48	42	0	213884	4	2	45	23	137	20	92	50	40	-1	213547
GBI SB	0	9	60	4	2	35	23	136	20	89	50	40	0	213798	4	2	45	23	137	20	90	52	38	0	213462
BDA SB	0	9	60	4	2	35	23	136	20	107	61	28	-8	213424	4	2	45	23	136	20	109	63	26	-9	213114
ANT SB	0	9	60	4	2	35	23	136	21	78	64	25	5	213330	4	2	45	23	136	21	77	67	23	5	213018
CYI SB	0	9	60	4	2	35	23	136	20	-107	70	-19	-6	213194	4	2	45	23	136	20	-105	68	-21	-5	212978
ASC SB	0	9	60	4	2	35	23	136	21	-36	54	-23	28	213634	4	2	45	23	136	21	-38	53	-25	28	213424
GYM SB	0	9	60	4	2	35	23	137	20	78	21	68	12	215178	4	2	45	23	137	20	79	23	67	11	214811
TEX SB	0	9	60	4	2	35	23	137	20	83	33	57	6	214559	4	2	45	23	137	20	84	35	55	5	214201
MAD DS	0	9	60	4	2	35	23	135	20	-117	56	17	-29	213564	4	2	45	23	136	20	-115	55	17	-32	213361
GLD DS	0	9	60	4	2	35	23	137	20	77	18	-35	69	215379	4	2	45	23	137	20	79	19	-29	68	215018
RENDEZVOUS RADAR TRACKING *																									
MIL SB	0	38	29	4	2	45	23	137	20	92	50	40	-1	213547	4	3	23	51	137	20	97	58	32	-4	214940
GBI SB	0	38	29	4	2	45	23	137	20	90	52	38	0	213462	4	3	23	51	137	20	96	60	30	-3	214806
BDA SB	0	38	29	4	2	45	23	136	20	109	63	26	-9	213114	4	3	23	51	137	20	142	70	17	-11	214123
ANT SB	0	38	29	4	2	45	23	136	21	77	67	23	5	213018	4	3	23	51	137	20	75	75	14	4	214025
CYI SB	0	38	29	4	2	45	23	136	20	-105	68	-21	-5	212978	4	3	23	51	136	20	-98	60	-29	-4	213956
ASC SB	0	38	29	4	2	45	23	136	21	-38	53	-25	28	213424	4	3	23	51	136	21	-48	47	-35	27	213827
GYM SB	0	38	29	4	2	45	23	137	20	79	23	67	11	214811	4	3	23	51	137	20	82	31	59	7	214567
TEX SB	0	38	29	4	2	45	23	137	20	84	35	55	5	214201	4	3	23	51	137	20	87	43	47	2	214004
MAD DS	0	38	29	4	2	45	23	136	20	-115	55	17	-32	213361	4	3	23	51	136	20	-106	48	14	-40	213779
GLD DS	0	38	29	4	2	45	23	137	20	79	19	-29	68	215018	4	3	23	51	137	20	84	27	-13	63	215794
COAST TO SOI BURN *																									

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE	Z RADAR TABLE TRACKING TIME HRS	MIN	SEC	STATION ACQUISITION DATA DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	STATION TERMINATION DATA DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GLD DS	0	1	19	4	3	23	51	137	20	84	27	-13	53	215794	4	3	25	5	137	20	89	27	-12	63	215891
GYM SB	0	1	19	4	3	23	51	137	20	82	31	59	7	215567	4	3	25	5	136	20	82	31	59	6	215613
TEX SB	0	1	15	4	3	23	51	137	20	87	43	47	2	215004	4	3	25	0	137	20	88	43	47	2	215052
MIL SB	0	1	20	4	3	23	51	137	20	97	58	32	-4	214940	4	3	25	11	137	20	97	58	32	-4	214995
GBI SB	0	1	21	4	3	23	51	137	20	96	60	30	-3	214366	4	3	25	12	137	20	96	60	30	-3	214422
BDA SB	0	1	22	4	3	23	51	137	20	122	70	17	-11	214123	4	3	25	14	137	20	123	70	17	-11	214184
ANT SB	0	1	25	4	3	23	51	137	20	75	75	14	4	214025	4	3	25	17	137	20	75	75	14	4	214088
CYI SB	0	1	33	4	3	23	51	136	20	-98	60	-29	-4	214356	4	3	25	25	136	20	-98	60	-30	-4	214440
MAD DS	0	1	35	4	3	23	51	136	20	-106	48	14	-10	214779	4	3	25	26	136	20	-106	48	14	-10	214866
ASC SB	0	1	40	4	3	23	51	136	21	-48	47	-35	27	214827	4	3	25	31	136	21	-48	47	-35	27	214919

ULLAGE FOR DOI BURN

DOI BURN

REND EZVOUS RADAR TRACKING •

TEX SB	0	21	57	4	4	14	16	137	20	94	54	36	-2	214417	4	4	36	13	137	20	97	59	31	-3	213239
GLD DS	0	21	56	4	4	14	17	137	20	91	37	1	23	213127	4	4	36	13	138	20	94	41	4	49	213045
GYM SB	0	21	56	4	4	14	18	137	20	88	42	48	2	214888	4	4	36	13	138	20	90	47	93	0	213068
GBI SB	0	21	51	4	4	14	22	137	20	106	71	18	-5	213946	4	4	36	13	137	20	114	76	13	-6	212851
MIL SB	0	21	51	4	4	14	23	137	20	108	69	20	-7	213999	4	4	36	13	137	20	116	73	15	-7	212896
BDA SB	0	21	47	4	4	14	27	137	20	158	77	5	-12	213852	4	4	36	13	137	20	160	78	0	-12	212849
ANT SB	0	21	44	4	4	14	30	137	20	33	86	2	3	213769	4	4	36	13	137	20	-39	86	-3	3	212755
MAD DS	0	21	41	4	4	14	33	136	20	-96	38	8	-31	215044	4	4	36	13	136	20	-93	39	4	-35	214423
ASC SB	0	21	35	4	4	14	38	136	21	-57	37	-48	26	215121	4	4	36	13	136	21	-59	32	-54	25	214925
CYI SB	0	21	35	4	4	14	39	136	20	-91	49	41	0	214591	4	4	36	13	136	20	-88	44	-46	1	213774

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE	2	RADAR TABLE TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
		HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	
HAW	SB	0	10	41	4	4	25	32	138	20	68	0	90	22	216582		4	4	36	13	138	20	89	2	88	21	216036	
					COAST TO PHASE MANEUVER																							
MIL	SB	0	9	60	4	4	36	13	137	20	116	73	15	-7	212896		4	4	46	13	137	20	140	75	13	-8	212751	
GBI	SB	0	9	60	4	4	36	13	137	20	119	76	13	-6	212851		4	4	46	13	137	20	119	78	11	-6	212710	
BDA	SB	0	9	60	4	4	36	13	137	20	180	78	0	-12	212829		4	4	46	13	137	20	-170	77	-2	-12	212711	
ANT	SB	0	9	60	4	4	36	13	137	20	-39	86	-3	3	212755		4	4	46	13	137	20	-56	89	-5	3	212648	
CYI	SB	0	9	60	4	4	36	13	136	20	-88	44	-46	1	213774		4	4	46	13	136	20	-88	42	-48	2	213745	
ASC	SB	0	9	60	4	4	36	13	136	21	-59	32	-54	25	214325		4	4	46	13	136	20	-61	30	-56	25	214308	
HAW	SB	0	9	60	4	4	36	13	138	20	69	2	88	21	216036		4	4	46	13	138	20	70	4	86	20	215802	
GYM	SB	0	9	60	4	4	36	13	138	20	90	47	43	0	213668		4	4	46	13	138	20	91	49	41	-1	213471	
TEX	SB	0	9	60	4	4	36	13	137	20	97	59	31	-3	213239		4	4	46	13	138	20	98	61	29	-4	213063	
MAD	DS	0	9	60	4	4	36	13	136	20	-93	39	4	-55	214223		4	4	46	13	137	20	-91	33	2	-57	214195	
GLD	DS	0	9	60	4	4	36	13	138	20	99	91	4	49	213905		4	4	46	13	138	20	95	93	6	47	213708	
					ULLAGE FOR PHASING BURN																							
MIL	SB	0	0	8	4	4	46	13	137	20	120	75	13	-8	212751		4	4	46	21	137	20	121	75	13	-8	212751	
GBI	SB	0	0	8	4	4	46	13	137	20	119	78	11	-6	212710		4	4	46	21	137	20	120	78	11	-6	212710	
BDA	SB	0	0	8	4	4	46	13	137	20	-170	77	-2	-12	212711		4	4	46	21	137	20	-170	77	-2	-12	212711	
ANT	SB	0	0	8	4	4	46	13	137	20	-56	89	-5	3	212648		4	4	46	21	137	20	-56	89	-5	3	212648	
CYI	SB	0	0	8	4	4	46	13	136	20	-88	42	-46	2	213745		4	4	46	21	136	20	-88	42	-48	2	213746	
ASC	SB	0	0	8	4	4	46	13	136	20	-61	30	-56	25	214308		4	4	46	21	136	20	-61	30	-56	25	214309	
HAW	SB	0	0	8	4	4	46	13	136	20	70	4	86	20	215802		4	4	46	21	138	20	70	4	86	20	215801	
GYM	SB	0	0	8	4	4	46	13	138	20	91	49	41	-1	213471		4	4	46	21	138	20	91	49	41	-1	213470	

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 NOMINAL TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
TEX SB	0	0	8	4	4	46	13	138	20	98	61	29	-4	213063	4	4	46	21	138	20	98	61	29	-4	213063
MAD DS	0	0	8	4	4	46	13	137	20	-91	33	2	-57	214195	4	4	46	21	137	20	-91	33	2	-57	214197
GLD DS	0	0	8	4	4	46	13	138	20	95	43	6	47	213708	4	4	46	21	138	20	95	43	6	47	213707
PHASING BURN																									
MIL SB	0	0	42	4	4	46	21	137	20	121	75	13	-8	212751	4	4	47	3	137	20	121	75	13	-8	212752
GBI SB	0	0	42	4	4	46	21	137	20	120	78	11	-6	212710	4	4	47	3	137	20	120	78	11	-6	212712
BDA SB	0	0	42	4	4	46	21	137	20	-170	77	-2	-12	212711	4	4	47	3	137	20	-170	77	-2	-12	212715
ANT SB	0	0	42	4	4	46	21	137	20	-56	84	-5	3	212648	4	4	47	3	137	20	-57	84	-5	3	212652
CYI SB	0	0	42	4	4	46	21	136	20	-88	42	-48	2	213746	4	4	47	3	137	20	-87	42	-48	2	213756
ASC SB	0	0	42	4	4	46	21	136	20	-61	30	-56	25	214309	4	4	47	3	136	20	-61	30	-56	25	214320
HAW SB	0	0	42	4	4	46	21	138	20	70	4	86	20	215801	4	4	47	3	138	20	70	4	85	20	215797
GYM SB	0	0	42	4	4	46	21	138	20	91	49	41	-1	213470	4	4	47	3	138	20	91	49	41	-1	213468
TEX SB	0	0	42	4	4	46	21	138	20	98	61	29	-4	213063	4	4	47	3	138	20	99	61	29	-4	213062
MAD DS	0	0	42	4	4	46	21	137	20	-91	33	2	-57	214197	4	4	47	3	137	20	-91	33	2	-57	214207
GLD DS	0	0	42	4	4	46	21	138	20	95	43	6	47	213707	4	4	47	3	138	20	96	43	6	46	213705
COAST AT BURN ATTITUDE *																									
MIL SB	0	7	60	4	4	47	3	137	20	121	75	13	-8	212752	4	4	55	3	138	20	125	76	11	-8	212868
GBI SB	0	7	60	4	4	47	3	137	20	120	78	11	-6	212712	4	4	55	3	138	20	145	79	9	-6	212831
BDA SB	0	7	60	4	4	47	3	137	20	-170	77	-2	-12	212715	4	4	55	3	137	20	-162	77	-4	-12	212856
ANT SB	0	7	60	4	4	47	3	137	20	-57	84	-5	3	212652	4	4	55	3	137	20	-64	82	-7	3	212798
CYI SB	0	7	60	4	4	47	3	137	20	-87	42	-48	2	213756	4	4	55	3	137	20	-87	40	-50	2	213966
ASC SB	0	7	60	4	4	47	3	136	20	-61	30	-56	25	214320	4	4	55	3	137	20	-61	29	-58	25	214537

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE & RADAR	TABLE TRACKING TIME			STATION ACQUISITION DATA										STATION TERMINATION DATA									
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW SB	0	7	60	4	4	47	3	136	20	70	4	85	20	215797	4	4	55	3	138	20	71	6	84	19	215847
GYM SB	0	7	60	4	4	47	3	138	20	91	49	41	-1	213468	4	4	55	3	136	20	92	51	39	-1	213541
TEX SB	0	7	60	4	4	47	3	136	20	99	61	29	-4	213062	4	4	55	3	138	20	100	63	27	-5	213152
MAD DS	0	7	60	4	4	47	3	137	20	-91	33	2	-57	214207	4	4	55	3	137	20	-90	31	0	-59	214415
GLD DS	0	7	60	4	4	47	3	138	20	96	43	6	46	213705	4	4	55	3	138	20	97	45	7	45	213777
COAST TO JETTISON DESCENT STAGE																									
HAW SB	0	30	11	4	4	55	3	138	20	71	6	84	19	215837	4	5	25	14	139	20	74	12	77	16	216787
GYM SB	0	30	20	4	4	55	3	136	20	92	51	39	-1	213541	4	5	25	23	138	20	97	57	33	-4	214047
GLD DS	0	30	20	4	4	55	3	138	20	97	45	7	45	213777	4	5	25	23	138	20	102	50	10	38	214075
TEX SB	0	30	25	4	4	55	3	138	20	100	63	27	-6	213152	4	5	25	28	138	20	107	69	20	-6	214033
GBI SB	0	30	30	4	4	55	3	138	20	125	79	9	-6	212831	4	5	25	33	138	20	144	83	2	-7	213142
MIL SB	0	30	31	4	4	55	3	138	20	125	76	11	-8	212868	4	5	25	34	138	20	153	80	4	-9	213155
BDA SB	0	30	33	4	4	55	3	137	20	-162	77	-4	-12	212856	4	5	25	36	138	20	-138	74	-11	-12	213246
ANT SB	0	30	39	4	4	55	3	137	20	-64	82	-7	3	212798	4	5	25	42	138	20	-76	76	-14	3	213416
MAD DS	0	30	45	4	4	55	3	137	20	-90	31	0	-59	214415	4	5	25	48	137	19	-85	25	-10	-64	214063
CYI SB	0	30	48	4	4	55	3	137	20	-87	40	-50	2	213965	4	5	25	51	137	20	-84	34	-56	5	213629
ASC SB	0	30	54	4	4	55	3	137	20	-61	29	-58	25	214537	4	5	25	57	137	20	-64	22	-66	24	214241
HAW SB	0	19	14	4	6	14	5	138	20	77	23	66	12	216003	4	6	33	19	139	20	79	27	62	10	216776
GLD DS	0	19	1	4	6	14	18	138	20	114	60	13	27	214379	4	6	33	19	138	20	120	64	14	23	213490
GYM SB	0	18	57	4	6	14	22	138	20	107	68	21	-6	214178	4	6	33	19	138	20	113	72	17	-7	213119
TEX SB	0	18	52	4	6	14	26	138	20	132	79	4	-6	213991	4	6	33	19	136	20	152	81	4	-8	212983

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SB	0	18	45	4	6	14	34	138	20	-138	79	-8	-8	213984	4	6	33	19	138	20	-145	76	-12	-8	213049
GBI SB	0	18	44	4	6	14	35	137	20	-123	78	-10	-6	213988	4	6	33	19	138	20	-113	75	-14	-6	213065
BDA SB	0	18	41	4	6	14	38	137	20	-114	65	-23	-10	214235	4	6	33	19	137	20	-109	61	-27	-9	213359
ANT SB	0	16	35	4	6	14	43	137	20	-79	64	+26	5	214253	4	6	33	19	137	20	-80	60	-30	5	213905
MAD DS	0	18	29	4	6	14	49	137	19	-78	16	+36	-70	216376	4	6	33	19	137	19	-75	13	-49	-71	215607
CYI SB	0	16	28	4	6	14	51	137	20	-79	23	+67	10	215987	4	6	33	19	137	20	-77	19	-71	12	216243
ASC SB	0	18	21	4	6	14	58	137	20	-68	11	+78	42	216662	4	6	33	19	137	20	-69	7	-83	21	215947
LM-DESCENT STAGE JETTISON •																									
MIL SB	0	0	9	4	6	33	19	138	20	-125	76	+12	-8	213049	4	6	33	28	138	20	-145	76	-12	-8	213042
GBI SB	0	0	9	4	6	33	19	138	20	-113	75	-14	-6	213065	4	6	33	28	138	20	-113	75	-14	-6	213058
BDA SB	0	0	9	4	6	33	19	137	20	-109	61	-27	-9	213359	4	6	33	28	137	20	-109	61	-27	-9	213353
ANT SB	0	0	9	4	6	33	19	137	20	-80	60	-30	5	213905	4	6	33	28	137	20	-80	60	-30	5	213899
CYI SB	0	0	9	4	6	33	19	137	20	-77	19	-71	12	216243	4	6	33	28	137	20	-77	19	-71	12	216237
ASC SB	0	0	9	4	6	33	19	137	20	-69	7	-83	41	215947	4	6	33	28	137	20	-69	7	-83	41	215941
HAW SB	0	0	9	4	6	33	19	139	20	79	27	62	10	214776	4	6	33	28	139	20	79	28	62	10	214767
GYM SB	0	0	9	4	6	33	19	138	20	113	72	17	-7	213114	4	6	33	28	138	20	113	72	17	-7	213106
TEX SB	0	0	9	4	6	33	19	138	20	152	81	4	-8	212983	4	6	33	28	138	20	152	81	4	-8	212975
MAD DS	0	0	9	4	6	33	19	137	19	-75	13	-49	-71	215607	4	6	33	28	137	19	-75	13	-49	-71	215601
GLD DS	0	0	9	4	6	33	19	138	20	120	64	14	23	213296	4	6	33	28	138	20	140	64	14	23	213288
LM ASCENT RETRO BURN •																									
MIL SB	0	0	3	4	6	33	28	138	20	-125	76	+12	-8	213042	4	6	33	31	138	20	-145	76	-12	-8	213040
GBI SB	0	0	3	4	6	33	28	138	20	-113	75	-14	-6	213058	4	6	33	31	138	20	-113	75	-14	-6	213056

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
BDA SB	0	0	3	4	6	33	28	137	20	-109	61	-27	-9	213353	4	6	33	31	137	20	-109	61	-27	-9	213351
ANT SB	0	0	3	4	6	33	28	137	20	-80	60	-30	5	213399	4	6	33	31	137	20	-80	60	-30	5	213397
CYI SB	0	0	3	4	6	33	28	137	20	-77	19	-71	12	215237	4	6	33	31	137	20	-77	19	-71	12	215236
ASC SB	0	0	3	4	6	33	28	137	20	-69	7	-83	21	215941	4	6	33	31	137	20	-69	7	-83	21	215940
HAW SB	0	0	3	4	6	33	26	139	20	79	28	62	10	214767	4	6	33	31	139	20	79	28	62	10	214764
GYM SB	0	0	3	4	6	33	28	138	20	113	72	17	-7	213106	4	6	33	31	138	20	113	72	17	-7	213104
TEX SB	0	0	3	4	6	33	28	138	20	152	81	4	-8	212975	4	6	33	31	138	20	152	81	4	-8	212973
MAD DS	0	0	3	4	6	33	28	137	19	-75	13	-49	-71	215601	4	6	33	31	137	19	-75	13	-49	-71	215600
GLD DS	0	0	3	4	6	33	28	138	20	120	64	14	23	213286	4	6	33	31	138	20	120	64	14	23	213286
				COAST TO INSERTION *																					
MIL SB	0	9	44	4	6	33	31	138	20	-125	76	-12	-8	213040	4	6	43	14	138	20	-120	74	-14	-8	212717
GBI SB	0	9	44	4	6	33	31	138	20	-113	75	-14	-6	213056	4	6	43	14	138	20	-110	73	-16	-6	212738
BDA SB	0	9	44	4	6	33	31	137	20	-109	61	-27	-9	213351	4	6	43	14	138	20	-107	59	-29	-9	213055
ANT SB	0	9	44	4	6	33	31	137	20	-80	60	-30	5	213397	4	6	43	14	137	20	-80	58	-32	6	213113
CYI SB	0	9	44	4	6	33	31	137	20	-77	19	-71	12	215236	4	6	43	14	137	19	-76	17	-73	13	214997
ASC SB	0	9	44	4	6	33	31	137	20	-69	7	-83	21	215940	4	6	43	14	137	20	-69	5	-85	21	215713
HAW SB	0	9	44	4	6	33	31	139	20	79	28	62	10	214764	4	6	43	14	139	20	79	30	60	9	214507
GYM SB	0	9	44	4	6	33	31	138	20	113	72	17	-7	213104	4	6	43	14	138	20	117	74	15	-7	212722
TEX SB	0	9	44	4	6	33	31	138	20	152	81	4	-8	212973	4	6	43	14	138	20	166	82	2	-8	212617
MAD DS	0	9	44	4	6	33	31	137	19	-75	13	-49	-71	215600	4	6	43	14	137	19	-74	11	-55	-71	215348
GLD DS	0	9	44	4	6	33	31	138	20	120	64	14	23	213286	4	6	43	14	138	20	124	65	14	20	212896
				ULLAGE FOR INSERTION BURN																					

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SB	0	0	4	4	6	43	14	138	20	-120	74	-14	-8	212717	4	6	43	18	138	20	-140	74	-14	-8	212716
GBI SB	0	0	4	4	6	43	14	138	20	-110	73	-16	-6	212738	4	6	43	18	138	20	-110	73	-16	-6	212737
BDA SB	0	0	4	4	6	43	14	138	20	-107	59	-29	-9	213055	4	6	43	18	138	20	-107	59	-30	-9	213054
ANT SB	0	0	4	4	6	43	14	137	20	-80	58	-32	6	213113	4	6	43	18	137	20	-80	58	-32	6	213112
CYI SB	0	0	4	4	6	43	14	137	19	-76	17	-73	13	214997	4	6	43	18	137	19	-76	17	-73	13	214996
ASC SB	0	0	4	4	6	43	14	137	20	-69	5	-85	21	215713	4	6	43	18	137	20	-69	5	-85	21	215712
HAW SB	0	0	4	4	6	43	14	139	20	79	30	60	9	214307	4	6	43	18	139	20	79	30	60	9	214306
GYM SB	0	0	4	4	6	43	14	138	20	117	74	15	-7	212722	4	6	43	18	138	20	117	74	15	-7	212720
TEX SB	0	0	4	4	6	43	14	138	20	166	82	2	-8	212617	4	6	43	18	138	20	166	82	2	-8	212616
MAD DS	0	0	4	4	6	43	14	137	19	-74	11	-55	-71	215348	4	6	43	18	137	19	-74	11	-55	-71	215347
GLD DS	0	0	4	4	6	43	14	138	20	124	65	14	20	212896	4	6	43	18	138	20	124	65	14	20	212895
				INSERTION BURN																					
MIL SB	0	0	15	4	6	43	18	138	20	-120	74	-14	-8	212716	4	6	43	33	138	20	-140	74	-14	-8	212710
GBI SB	0	0	15	4	6	43	18	138	20	-110	73	-16	-6	212737	4	6	43	33	138	20	-110	73	-16	-6	212731
BDA SB	0	0	15	4	6	43	18	138	20	-107	59	-30	-9	213054	4	6	43	33	138	20	-107	59	-30	-8	213050
ANT SB	0	0	15	4	6	43	18	137	20	-80	58	-32	6	213112	4	6	43	33	137	20	-80	57	-32	6	213107
CYI SB	0	0	15	4	6	43	18	137	19	-76	17	-73	13	214996	4	6	43	33	137	19	-76	17	-73	13	214993
ASC SB	0	0	15	4	6	43	18	137	20	-69	5	-85	21	215712	4	6	43	33	137	20	-69	5	-85	21	215710
HAW SB	0	0	15	4	6	43	18	139	20	79	30	60	9	214305	4	6	43	33	139	20	79	30	60	9	214304
GYM SB	0	0	15	4	6	43	18	138	20	117	74	15	-7	212720	4	6	43	33	138	20	117	74	15	-7	212719
TEX SB	0	0	15	4	6	43	18	138	20	166	82	2	-8	212616	4	6	43	33	138	20	167	82	2	-8	212610

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MAD DS	0	0	15	4	6	43	18	137	19	-74	11	55	-71	215347	4	6	43	33	137	19	-74	11	-56	-71	215349
GLD DS	0	0	15	4	6	43	18	138	20	124	65	14	20	212895	4	6	43	33	138	20	124	65	14	20	212888
COAST TO RENDEZVOUS RADAR TRACKING •																									
MIL SB	0	18	0	4	6	43	33	138	20	-120	74	-14	-8	212710	4	7	1	33	138	20	-113	70	-18	-8	212845
GBI SB	0	18	0	4	6	43	33	138	20	-110	73	-16	-6	212731	4	7	1	33	138	20	-105	69	-20	-5	212875
BDA SB	0	18	0	4	6	43	33	138	20	-107	59	-30	-8	213050	4	7	1	33	138	19	-103	56	-33	-7	213233
ANT SB	0	18	0	4	6	43	33	137	20	-80	57	-32	6	213107	4	7	1	33	138	20	-80	54	-36	6	213313
CYI SB	0	18	0	4	6	43	33	137	19	-76	17	-73	13	214993	4	7	1	33	138	19	-75	13	-76	15	215275
ASC SB	0	18	0	4	6	43	33	137	20	-69	5	-85	21	215710	4	7	1	33	137	20	-70	1	-89	20	216011
HAW SB	0	18	0	4	6	43	33	139	20	79	30	60	9	214296	4	7	1	33	139	20	81	33	56	8	214179
GYM SB	0	18	0	4	6	43	33	138	20	117	74	15	-7	212714	4	7	1	33	139	20	126	77	11	-8	212740
TEX SB	0	18	0	4	6	43	33	138	20	147	82	2	-8	212610	4	7	1	33	138	20	-106	82	-2	-8	212684
MAD DS	0	18	0	4	6	43	33	137	19	-74	11	-55	-71	215344	4	7	1	33	138	19	-71	8	-67	-70	215600
GLD DS	0	18	0	4	6	43	33	138	20	124	65	14	20	212888	4	7	1	33	139	19	131	68	16	17	212899
RENDEZVOUS RADAR TRACKING •																									
ASC SB	0	4	12	4	7	1	33	137	20	-70	1	-89	20	216011	4	7	5	45	138	20	-70	0	-90	20	216205
HAW SB	0	22	4	4	7	1	33	139	20	81	33	56	8	214179	4	7	23	37	139	19	82	38	52	6	214958
MIL SB	0	22	13	4	7	1	33	138	20	-113	70	-18	-8	212845	4	7	23	46	138	19	-107	66	-23	-7	213965
GBI SB	0	22	13	4	7	1	33	138	20	-105	69	-20	-5	212875	4	7	23	46	138	19	-100	64	-25	-5	214007
BDA SB	0	22	13	4	7	1	33	138	19	-103	56	-33	-7	213233	4	7	23	46	138	19	-100	51	-38	-6	214412
ANT SB	0	22	13	4	7	1	33	138	20	-80	54	-36	6	213313	4	7	23	46	138	20	-79	49	-41	7	214521
CYI SB	0	22	13	4	7	1	33	138	19	-75	13	-76	15	215275	4	7	23	46	138	19	-73	9	-81	17	216363

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	A	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	A	Y	RANGE
GYM SB	0	22	13	4	7	1	33	139	20	126	77	11	-8	212740	4	7	23	46	139	19	146	80	6	-8	213722
TEX SB	0	22	13	4	7	1	33	138	20	-166	82	-2	-8	212684	4	7	23	46	139	19	-138	79	-7	-8	213728
MAD DS	0	22	13	4	7	1	33	138	19	-71	9	-67	-70	215600	4	7	23	46	138	19	-68	4	-79	-68	216851
GLD DS	0	22	13	4	7	1	33	139	19	131	68	15	17	212899	4	7	23	46	139	19	143	71	16	12	213859
COAST TO CSI																									
GLD DS	0	0	2	4	7	23	46	139	19	143	71	16	12	213859	4	7	23	48	139	19	143	71	16	12	213857
GYM SB	0	0	3	4	7	23	46	139	19	146	80	6	-8	213722	4	7	23	49	139	19	146	80	6	-8	213721
TEX SB	0	0	7	4	7	23	46	139	19	-138	79	-7	-8	213728	4	7	23	53	139	19	-138	79	-7	-8	213730
MIL SB	0	0	9	4	7	23	46	138	19	-107	66	-23	-7	213965	4	7	23	55	138	19	-107	66	-23	-7	213969
GBI SB	0	0	11	4	7	23	46	138	19	-100	64	-25	-5	214007	4	7	23	57	138	19	-100	64	-25	-5	214019
BDA SB	0	0	11	4	7	23	46	138	19	-100	51	-38	-6	214412	4	7	23	57	138	19	-100	51	-38	-6	214418
MAD DS	0	0	13	4	7	23	46	138	19	-68	4	-79	-68	216851	4	7	23	59	138	19	-68	4	-79	-68	216859
ANT SB	0	0	16	4	7	23	46	138	20	-79	49	-41	7	214521	4	7	24	2	138	20	-80	48	-41	7	214532
CYI SB	0	0	17	4	7	23	46	138	19	-73	9	-81	17	216563	4	7	24	3	138	19	-73	9	-81	17	216576
CSI BURN																									
COAST TO RENDEZVOUS RADAR TRACKING •																									
RENDEZVOUS RADAR TRACKING •																									
HAW SB	0	12	36	4	8	11	7	139	19	85	49	41	3	214440	4	8	23	42	139	19	86	52	38	2	213666
GLD DS	0	12	23	4	8	11	20	139	19	180	74	16	0	213741	4	8	23	42	139	19	-170	74	16	-3	213869
GYM SB	0	12	22	4	8	11	21	139	19	-145	80	-6	-8	213664	4	8	23	42	139	19	-133	78	-9	-8	213629
TEX SB	0	12	18	4	8	11	24	138	19	-110	70	-17	-7	213809	4	8	23	42	138	19	-107	66	-22	-6	213812
MIL SB	0	12	13	4	8	11	29	138	19	-97	53	-34	-4	214209	4	8	23	42	138	19	-95	53	-37	-3	213948
GBI SB	0	12	11	4	8	11	31	138	19	-93	53	-37	-2	214273	4	8	23	42	138	19	-91	51	-39	-1	213925
BDA SB	0	12	11	4	8	11	32	138	19	-92	41	-49	-1	214764	4	8	23	42	138	19	-90	39	-51	0	214439

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE	Z RADAR TABLE TRACKING TIME HRS	MIN	SEC	STATION ACQUISITION DATA DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	STATION TERMINATION DATA DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SB	0	12	7	4	8	11	35	138	20	-78	37	-52	9	214947	4	8	23	42	138	19	-78	34	-56	10	214941
COAST TO CDH																									
MIL SB	0	7	60	4	8	23	42	138	19	-95	53	-37	-3	213648	4	8	31	42	138	19	-94	51	-39	-3	213353
GBI SB	0	7	60	4	8	23	42	139	19	-91	51	-39	-1	213725	4	8	31	42	138	19	-91	49	-41	0	213434
BDA SB	0	7	60	4	8	23	42	138	19	-90	39	-51	0	214234	4	8	31	42	138	19	-89	37	-53	0	213954
ANT SB	0	7	60	4	8	23	42	138	19	-78	34	-55	10	214941	4	8	31	42	138	19	-77	33	-57	11	214172
HAW SB	0	7	60	4	8	23	42	139	19	86	52	38	2	213666	4	8	31	42	139	19	87	54	36	2	213247
GYM SB	0	7	60	4	8	23	42	139	19	-133	78	-9	-8	213029	4	8	31	42	139	19	-128	77	-11	-8	212690
TEX SB	0	7	60	4	8	23	42	138	19	-107	68	-22	-6	213212	4	8	31	42	138	19	-105	66	-23	-6	212894
GLD DS	0	7	60	4	8	23	42	139	19	-170	74	16	-3	213089	4	8	31	42	139	19	-169	73	16	-5	212740
GUM SB	0	1	12	4	8	30	31	140	19	70	0	90	20	216061	4	8	31	42	140	19	70	0	90	20	216001
CDH BURN																									
MIL SB	0	0	2	4	8	31	42	138	19	-94	51	-39	-3	213353	4	8	31	45	138	19	-94	51	-39	-3	213351
GBI SB	0	0	2	4	8	31	42	138	19	-91	49	-41	0	213434	4	8	31	45	138	19	-91	49	-41	0	213433
BDA SB	0	0	2	4	8	31	42	138	19	-89	37	-53	0	213954	4	8	31	45	138	19	-89	37	-53	0	213953
ANT SB	0	0	2	4	8	31	42	138	19	-77	33	-57	11	214172	4	8	31	45	138	19	-77	33	-57	11	214171
GUM SB	0	0	2	4	8	31	42	140	19	70	0	90	20	216001	4	8	31	45	140	19	70	0	90	20	215999
HAW SB	0	0	2	4	8	31	42	139	19	87	54	36	2	213247	4	8	31	45	139	19	87	54	36	2	213245
GYM SB	0	0	2	4	8	31	42	139	19	-128	77	-11	-8	212690	4	8	31	45	139	19	-128	77	-11	-8	212689
TEX SB	0	0	2	4	8	31	42	138	19	-105	66	-23	-6	212894	4	8	31	45	138	19	-105	66	-23	-6	212892
GLD DS	0	0	2	4	8	31	42	139	19	-164	73	16	-5	212740	4	8	31	45	139	19	-164	73	16	-5	212738
COAST TO RENDEZVOUS RADAR TRACKING																									
MIL SB	0	3	60	4	8	31	45	138	19	-94	51	-39	-3	213351	4	8	35	45	138	19	-94	50	-40	-2	213252

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI SB	0	3	60	4	8	31	45	138	19	-91	49	941	0	213433	4	8	35	45	138	19	-70	48	-42	0	213335
BDA SB	0	3	60	4	8	31	45	138	19	-89	37	953	0	213793	4	8	35	45	138	19	-69	36	-54	1	213861
ANT SB	0	3	60	4	8	31	45	138	19	-77	33	957	11	214171	4	8	35	45	138	19	-77	32	-58	11	214085
GUM SB	0	3	60	4	8	31	45	140	19	70	0	90	20	215999	4	8	35	45	140	19	70	1	89	20	216018
HAW SB	0	3	60	4	8	31	45	139	19	87	54	36	2	213245	4	8	35	45	139	19	87	55	35	2	213085
GYM SB	0	3	60	4	8	31	45	139	19	-128	77	911	-8	212689	4	8	35	45	139	19	-125	76	-12	-8	212568
TEX SB	0	3	60	4	8	31	45	138	19	-105	66	-23	-6	212892	4	8	35	45	139	19	-104	65	-24	-6	212782
GLD DS	0	3	60	4	8	31	45	139	19	-164	73	16	-5	212738	4	8	35	45	139	19	-161	73	16	-6	212612
				RENDEZVOUS RADAR TRACKING •																					
MIL SB	0	18	60	4	8	35	45	138	19	-94	50	940	-2	213252	4	8	54	45	139	19	-92	46	-44	-1	213379
GBI SB	0	18	60	4	8	35	45	138	19	-90	48	942	0	213335	4	8	54	45	139	19	-89	44	-46	1	213471
BDA SB	0	18	60	4	8	35	45	138	19	-89	36	-54	1	213861	4	8	54	45	139	19	-87	32	-58	3	214018
ANT SB	0	18	60	4	8	35	45	138	19	-77	32	958	11	214085	4	8	54	45	138	19	-77	28	-62	12	214270
GUM SB	0	18	60	4	8	35	45	140	19	70	1	89	20	215818	4	8	54	45	140	19	71	5	86	18	215561
HAW SB	0	18	60	4	8	35	45	139	19	87	55	35	2	213085	4	8	54	45	140	19	89	59	31	0	212920
GYM SB	0	18	60	4	8	35	45	139	19	-125	76	-12	-8	212568	4	8	54	45	139	19	-116	73	-16	-8	212595
TEX SB	0	18	60	4	8	35	45	139	19	-104	65	-24	-6	212782	4	8	54	45	139	19	-101	61	-28	-5	212957
GLD DS	0	18	60	4	8	35	45	139	19	-161	73	16	-6	212612	4	8	54	45	139	19	-158	71	16	-10	212815
				COAST TO TPI •																					
MIL SB	0	16	24	4	8	54	45	139	19	-92	46	944	-1	213379	4	9	11	8	139	19	-90	43	-47	0	214197
GBI SB	0	16	24	4	8	54	45	139	19	-89	44	946	1	213471	4	9	11	8	139	19	-87	41	-49	2	214297
BDA SB	0	16	24	4	8	54	45	139	19	-87	32	958	3	214018	4	9	11	8	139	19	-85	29	-61	4	214059

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SB	0	16	24	4	8	54	45	138	19	-77	28	-62	12	214270	4	9	11	8	139	19	-76	24	-65	13	215136
GUM SB	0	16	24	4	8	54	45	140	19	71	5	85	18	215551	4	9	11	8	141	19	72	9	81	18	216012
HAW SB	0	16	24	4	8	54	45	140	19	89	59	31	0	212920	4	9	11	8	140	19	91	63	27	0	213493
GYM SB	0	16	24	4	8	54	45	139	19	-116	73	-16	-8	212595	4	9	11	8	139	19	-111	69	-19	-7	213329
TEX SB	0	16	24	4	8	54	45	139	19	-101	61	-28	-5	212857	4	9	11	8	139	19	-98	58	-32	-4	213633
GLD DS	0	16	24	4	8	54	45	139	19	-148	71	16	-10	212615	4	9	11	8	139	19	-139	69	16	-13	213326
				TPI BURN																					
MIL SB	0	0	16	4	9	11	8	139	19	-90	43	-47	0	214197	4	9	11	24	139	19	-90	43	-47	0	214213
GBI SB	0	0	16	4	9	11	8	139	19	-87	41	-49	2	214297	4	9	11	24	139	19	-87	41	-49	2	214313
BDA SB	0	0	16	4	9	11	8	139	19	-85	29	-61	4	214059	4	9	11	24	139	19	-85	29	-61	4	214076
ANT SB	0	0	16	4	9	11	8	139	19	-76	24	-65	13	215136	4	9	11	24	139	19	-76	24	-66	13	215153
GUM SB	0	0	16	4	9	11	8	141	19	72	9	81	18	216012	4	9	11	24	141	19	72	9	81	17	216028
HAW SB	0	0	16	4	9	11	8	140	19	91	63	27	0	213493	4	9	11	24	140	19	91	63	27	0	213509
GYM SB	0	0	16	4	9	11	8	139	19	-111	69	-19	-7	213329	4	9	11	24	139	19	-111	69	-19	-7	213345
TEX SB	0	0	16	4	9	11	8	139	19	-98	58	-32	-4	213633	4	9	11	24	139	19	-98	58	-32	-4	213648
GLD DS	0	0	16	4	9	11	8	139	19	-139	69	16	-13	213326	4	9	11	24	139	19	-139	69	16	-13	213340
				COAST TO 1ST BRAKING GATE																					
GUM SB	0	7	53	4	9	11	24	141	19	72	9	81	17********		4	9	19	17	141	19	73	10	79	17********	
HAW SB	0	8	2	4	9	11	24	140	19	91	63	27	0********		4	9	19	26	140	19	92	64	26	-1********	
GLD DS	0	8	9	4	9	11	24	139	19	-139	69	16	-13********		4	9	19	33	139	19	-135	68	16	-15********	
GYM SB	0	8	12	4	9	11	24	139	19	-111	69	-19	-7********		4	9	19	36	139	19	-108	68	-21	-7********	
TEX SB	0	8	19	4	9	11	24	139	19	-98	58	-32	-4********		4	9	19	38	139	19	-97	56	-34	-4********	

Table D-1. Zero-Degree Elevation Angle Acquisition and Loss Summary

(b) LM

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA										STATION TERMINATION DATA									
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MIL SB	0	8	15	4	9	11	24	139	19	-90	43	-47	0	*******	4	9	19	39	139	19	-89	41	-49	1	*******
BDA SB	0	8	16	4	9	11	24	139	19	-85	29	-61	4	*******	4	9	19	40	139	19	-84	27	-63	5	*******
GBI SB	0	8	18	4	9	11	24	139	19	-87	41	-49	2	*******	4	9	19	42	139	19	-86	39	-51	3	*******
ANT SB	0	8	19	4	9	11	24	139	19	-76	24	-66	13	*******	4	9	19	43	139	19	-76	22	-67	13	*******
				COAST TO 2ND BRAKING GATE								•													
				2ND BRAKING MANEUVER					•																
				COAST TO 3RD BRAKING GATE								•													
				3RD BRAKING MANEUVER																					
				COAST TO 4TH BRAKING GATE								•													
				4TH BRAKING MANEUVER					•																
				COAST TO 5TH BRAKING GATE								•													
				5TH BRAKING MANEUVER																					
				COAST TO DOCKING								•													

APPENDIX E

OPERATIONAL AIDS

E-1 INTRODUCTION

This appendix contains charts to be used as operational aids for deriving useful PM and FM S-band modes at particular spacecraft ranges from an MSFN station. These charts illustrate S-band modes slant-range capabilities (or range limitation) for various antenna combinations and, thereby, provide an approximation as to when S-band mode changes may be needed.

Figure E-1 provides the range of the spacecraft versus ground elapsed time (GET) for the Apollo 10 mission during translunar coast (TLC) and transearth coast (TEC). Each curve within Figure E-1 has a separate vertical ordinate scale.

Figures E-2 through E-7 contain bar charts that illustrate the maximum range capabilities of selected S-band modes for spacecraft/MSFN antenna combinations. S-band mode range limitations are given for both the LM and CSM from MSFN 85-foot, 35-foot cooled, and 35-foot uncooled antenna stations. These mode range limitations are also divided into categories of quiet sky or moon at zenith, CSM HGA or omni antenna, and LM steerable or in-flight antennas. The quiet sky downlink bars are typical of most TLC and TEC periods, but the moon at zenith should be used when the spacecraft is near the moon or in lunar orbit. Expected ranges are functions of spacecraft antenna gain variants. Hence, range bars are given for the CSM HG antenna wide, medium, and narrow beamwidths; for CSM omni -6 dB, 0 dB, and +5 dB ranges; and for LM omni -9 dB, 0 dB, and +3 dB ranges.

Figures E-8 through E-54 illustrate received carrier power versus a slant range from the transmitter. These figures may be used to predict carrier signal levels that will occur for a known range, as well as showing range limits for PRN, telemetry, updata, and voice threshold ranges.

The selected S-band mode charts are given for various MSFN and spacecraft antenna combinations and for quiet sky or moon at zenith.

Figure E-55 illustrates the CSM HG antenna line-of-sight angles during passive thermal control (PTC). If HGA (ϕ, θ) angles and roll rate are known, this figure may be used to aid predictions of when the HGA scan limit warning is likely to be given and when the antenna is likely to reach the scan limit during the PTC phase of the mission. Figures E-56 through E-61 define antenna locations and spherical coordinate systems of the CSM and LM vehicles.

E-2 USE OF RANGE CAPABILITY CHARTS

Referring to Figure E-4, the range capability chart shows that for PM downlink mode 2, with a 30-foot uncooled MSFN station and quiet sky, the receiving range is limited to a 10,000-nautical mile range for reliable signal coverage (-6 dB omni antenna gain). However, usable signal may exist up to 42,000 nautical miles with +5 dB omni antenna gain and up to 23,000 nautical miles with 0 dB antenna gain. Figure E-3 presents ranges of 18,000, 34,000, and 60,000 nautical miles, respectively, for a 30-foot cooled MSFN station with -6 dB, 0 dB, and +5 dB omni antenna gain for downlink PM mode 2, with a quiet sky. Using the 0 dB data and referring to Figure E-1, it can be determined that after a GET of 7 hours, 30-foot MSFN station coverage will generally become unusable for PM mode 2 with CSM omni antennas.

Using this same method for an 85-foot MSFN station (refer to Figure E-2), PM mode 2 with quiet sky provides a 98,000-nautical mile range for 0 dB omni antenna gain. The associated GET is 22 hours. Also, PM mode 15 (retaining the same antenna configuration) provides coverage to 145,000 nautical miles (0 dB gain) and to GET of 40 hours. Coverage by PM mode 8 is available throughout the mission.

For reliable signal coverage for PM mode 2 operation after 22 hours, GET, the HGA should be used. It is expected that, during midcourse burn, the HGA will be used with PM mode 2, or the omni antennas will be used to a GET of 40 hours with PM mode 15. PM mode 8, used during near lunar PTC, does not include PRN.

Carrier power-range interpolations from the expected-carrier-power charts are keyed from the diagonal antenna gain lines to the ordinate scales. For example, referring to Figure E-30 (assuming a downlink PM mode 2 with quiet sky and omni antennas), a 30-foot cooled MSFN station can expect to receive a carrier signal of approximately -103 dBm to -114 dBm (dependent on omni antenna gain) at a spacecraft range of 10,000 nautical miles.

Maximum range limitations for subcarrier intelligence is determined by use of the slant range ordinate only. The antenna gain range is read vertically down the chart to where it intersects the range ordinate. For example in Figure E-30, the expected maximum range limitation of telemetry information is 18,000 to 60,000 nautical miles (dependent on the omni antenna gain).

E-3 NOTES

a) Uplink PM mode 6 is used for the various MSFN and spacecraft antenna combinations. For most downlink PM modes, the range capability of uplink 6 is greater.

b) This appendix contains some PM mode, received-carrier-power-versus-range charts for quiet sky configurations that are not shown in the moon-at-zenith chart. A PM mode quiet sky chart may readily be converted to a moon-at-zenith chart (using the same PM mode and antenna configuration) by obtaining the moon-at-zenith threshold from Appendix C and drawing the threshold level across the quiet sky chart.

c) TV coverage and thresholds are discussed in Appendix F.

d) Appendix C also contains a range table for a 0 dB omni gain and WBW, MBW, and NBW antennas.

e) Appendix C contains a table to show the effect on thresholds (in dB) when modes are switched. Threshold levels for a 30-foot antenna are dependent on whether it is cooled or uncooled. However, the received carrier power is independent of being cooled or uncooled.

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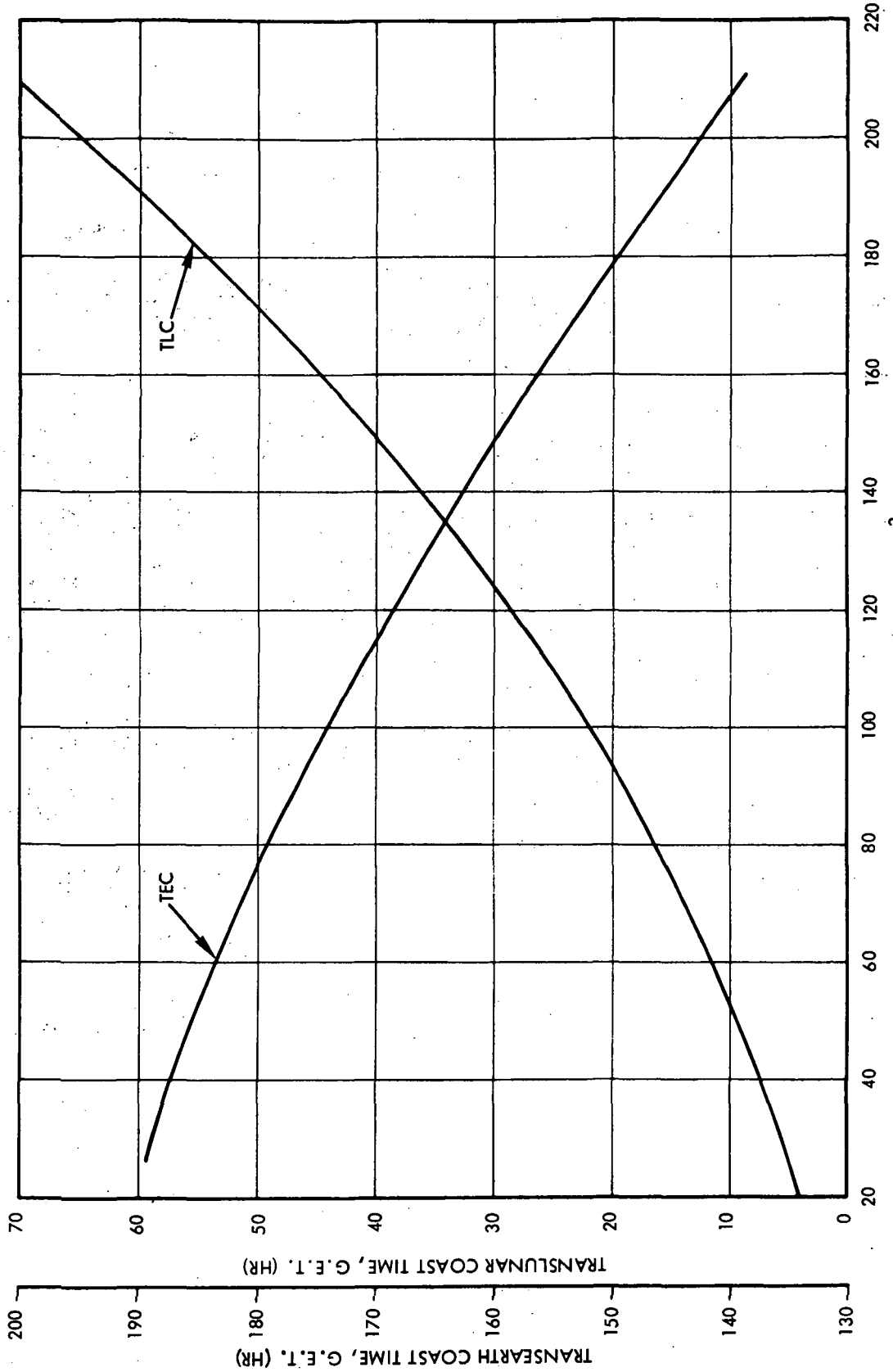


Figure E-1. Range versus Ground Elapsed Time for Apollo 10 Mission

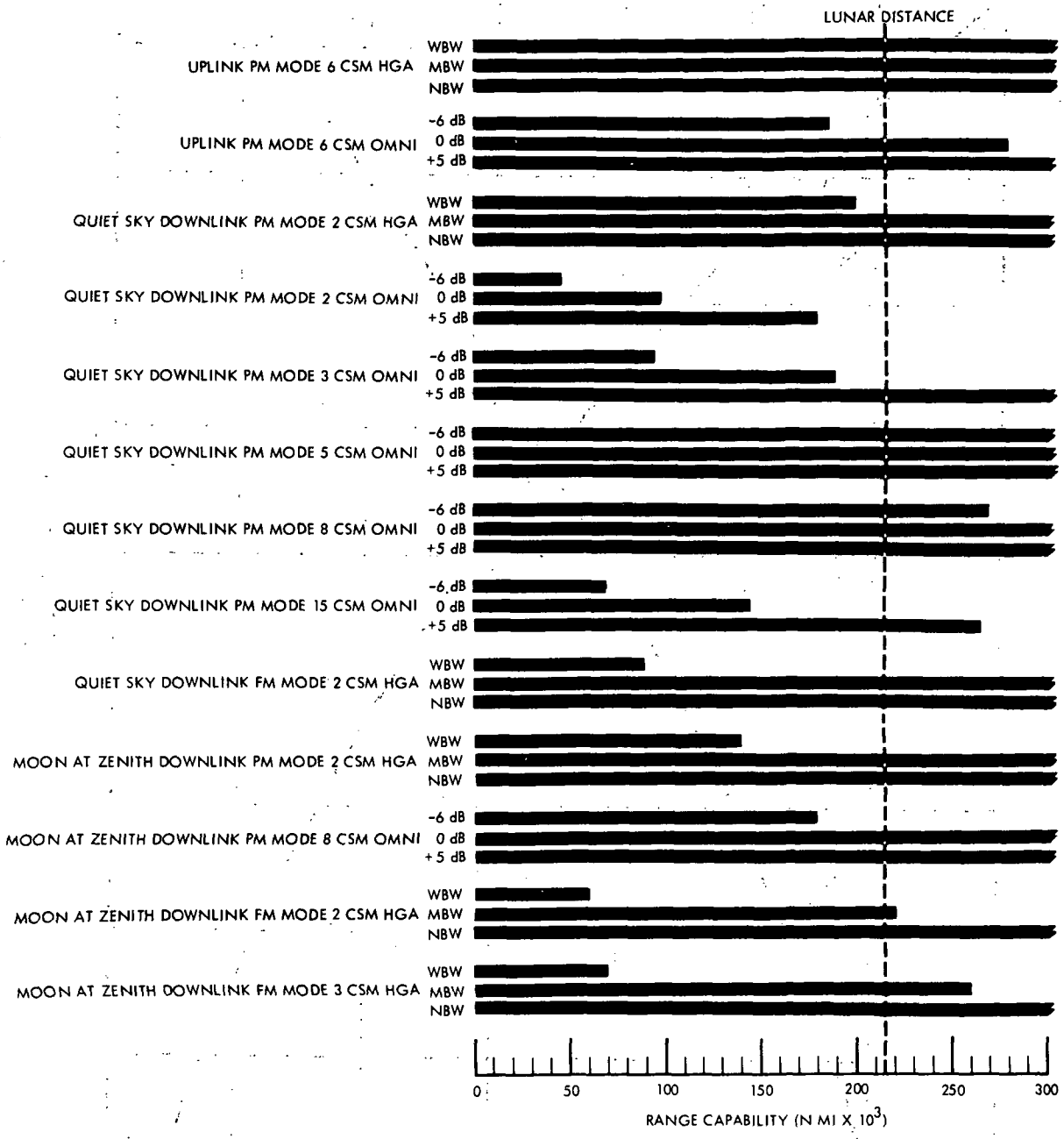


Figure E-2. Range Capability of 85-foot MSFN/CSM Antenna Combination

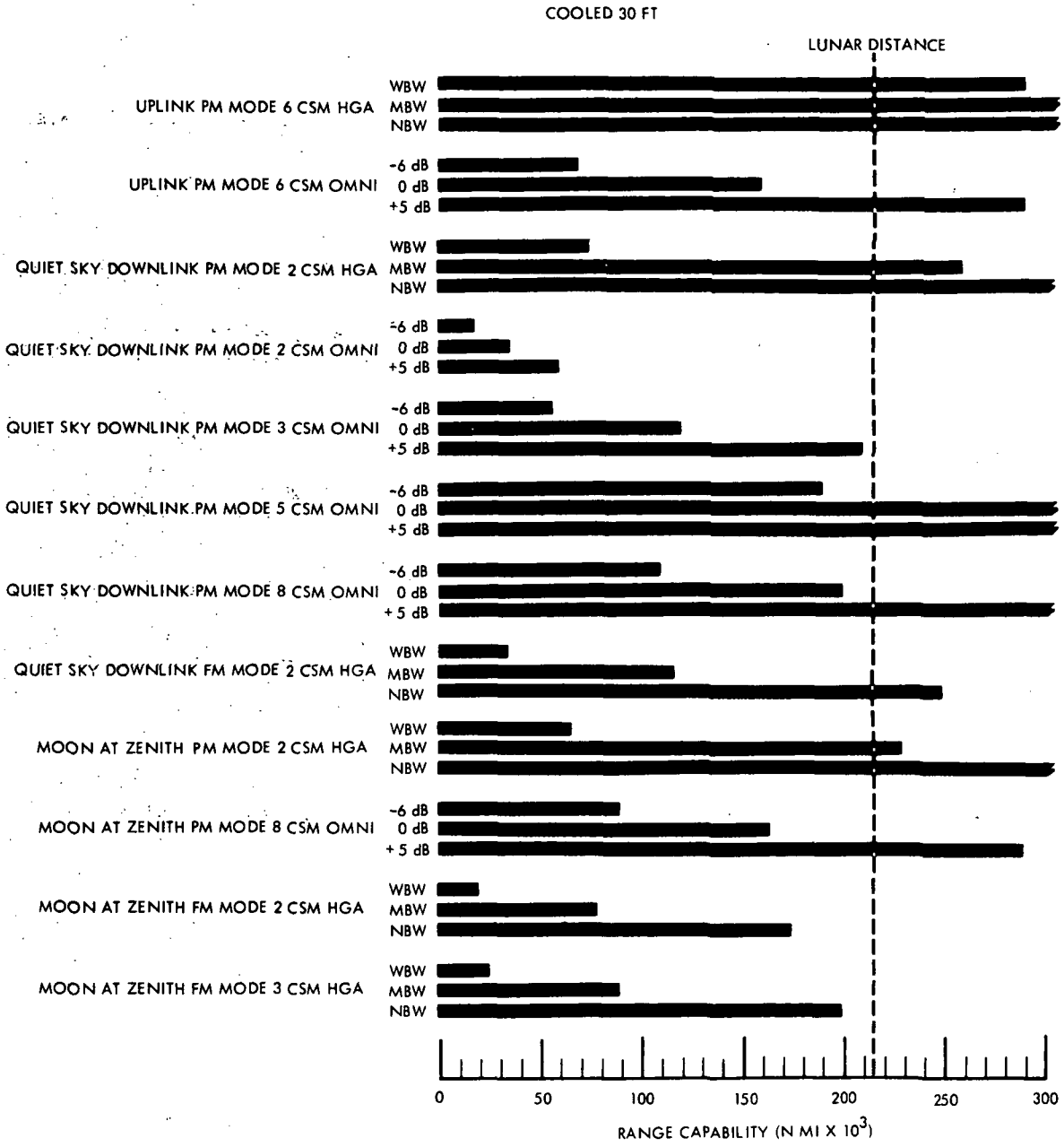


Figure E-3. Range Capability of 30-foot Cooled MSFN/CSM Antenna Combination

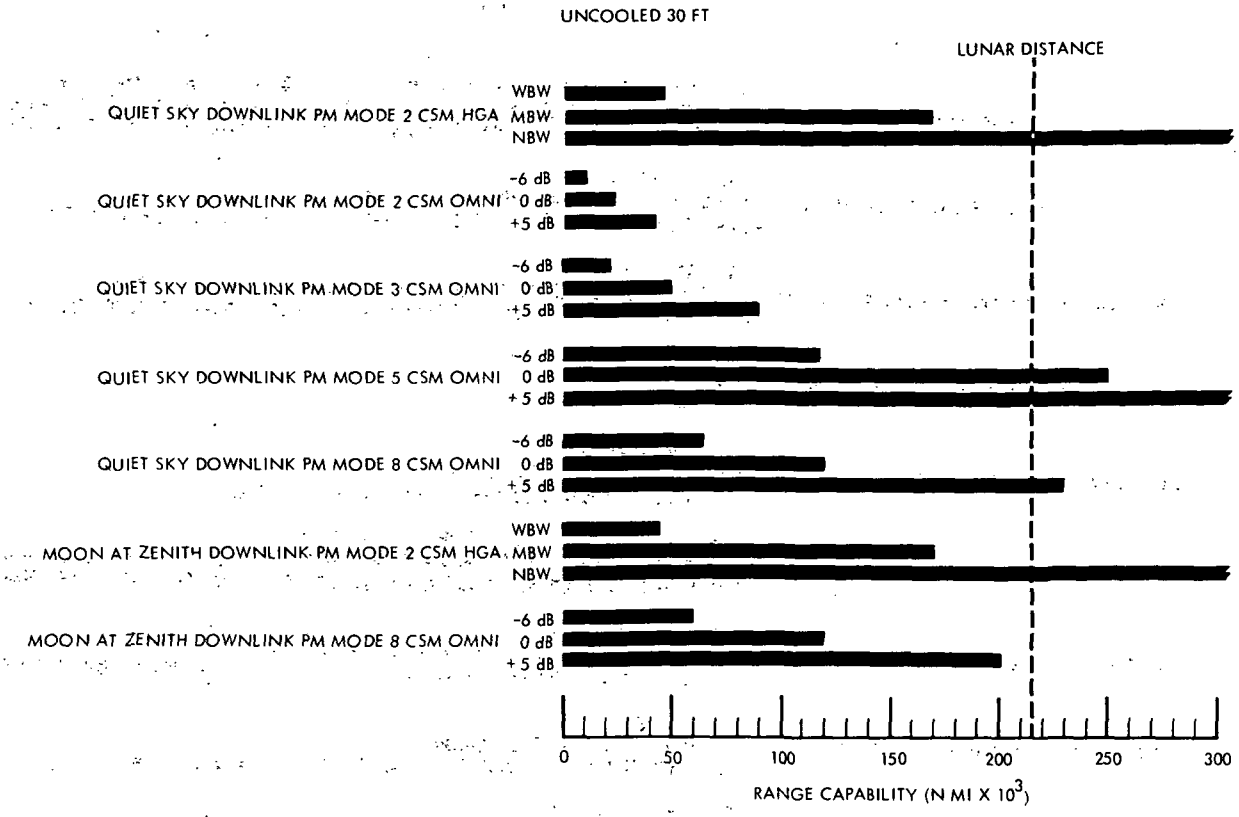


Figure E-4. Range Capability of 30-foot Uncooled MSFN/CSM Antenna Combination

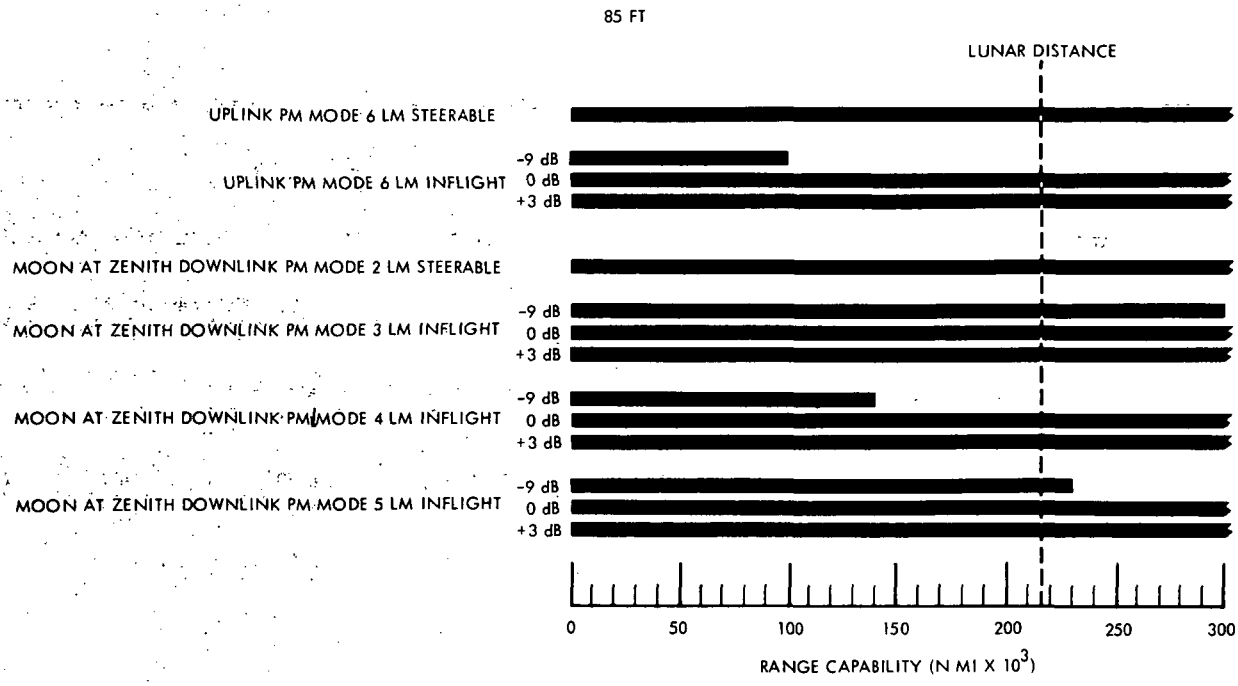


Figure E-5. Range Capability of 85-foot MSFN/LM Antenna Combination

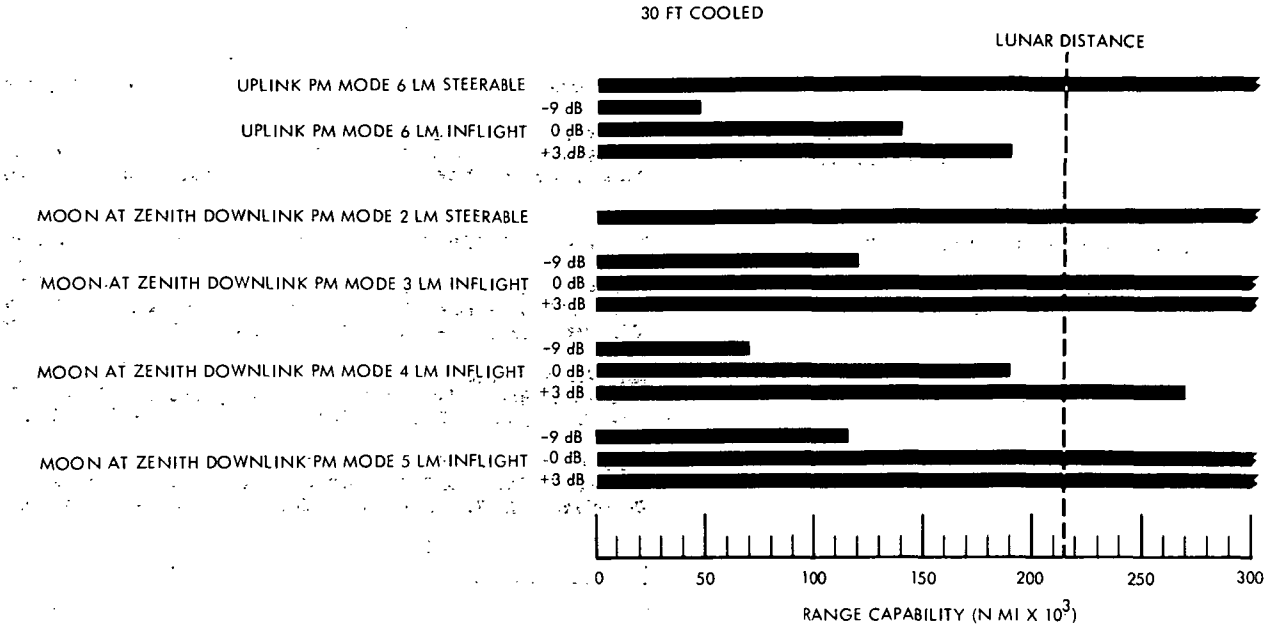


Figure E-6. Range Capability of 30-foot Cooled MSFN/LM Antenna Combination

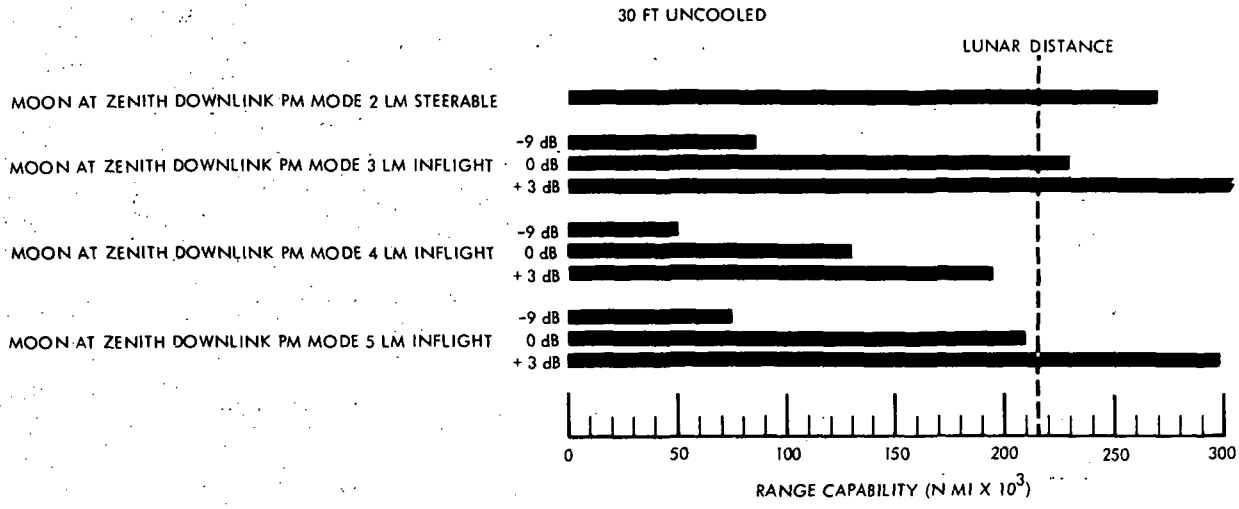


Figure E-7. Range Capability of 30-foot Uncooled MSFN/LM Antenna Combination

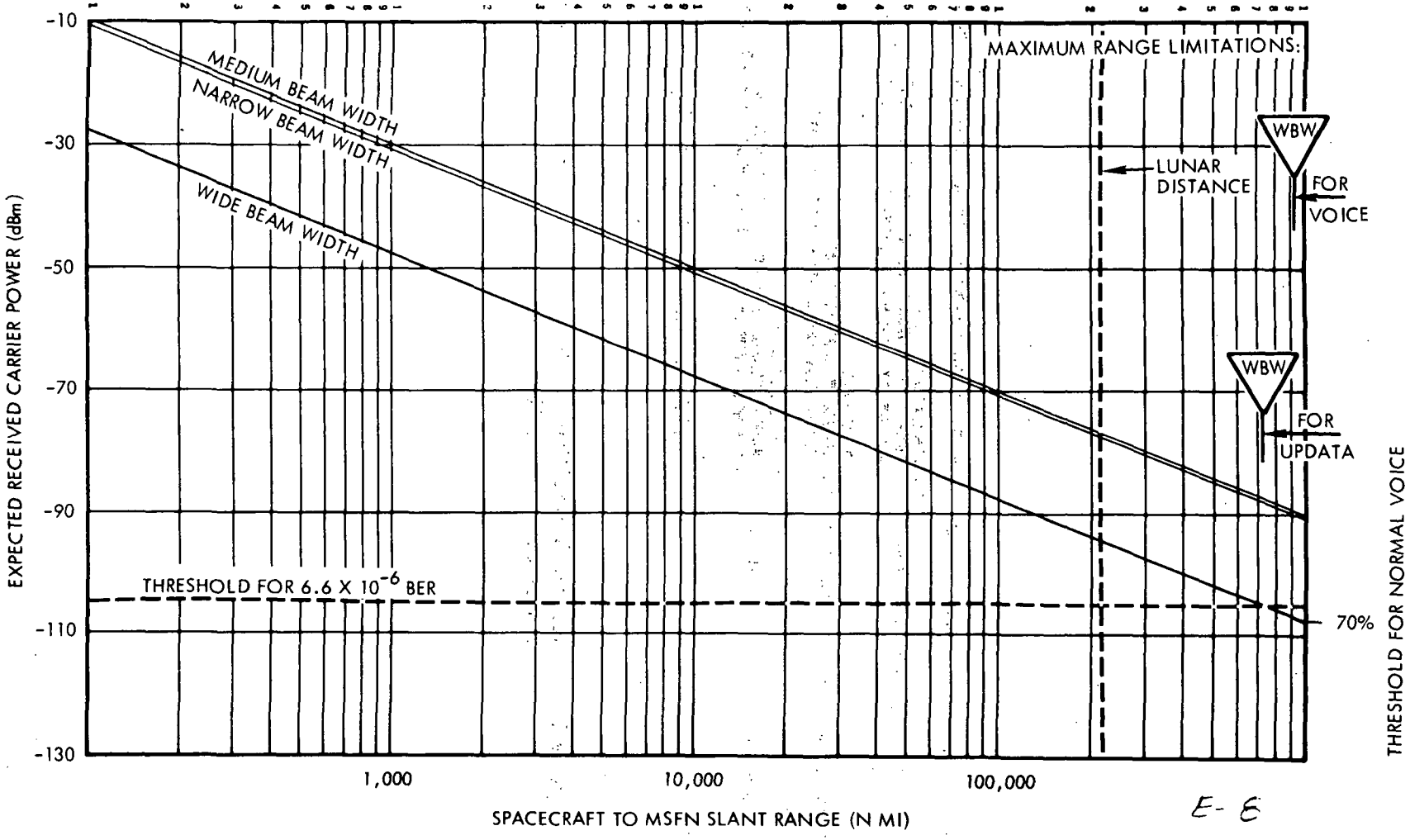


Figure E-8. Expected Apollo 10 Spacecraft Received Carrier Power versus MSFN to Spacecraft Slant Range for 85-foot MSFN/CSM High-Gain Antenna Combination (Uplink PM Mode 6)

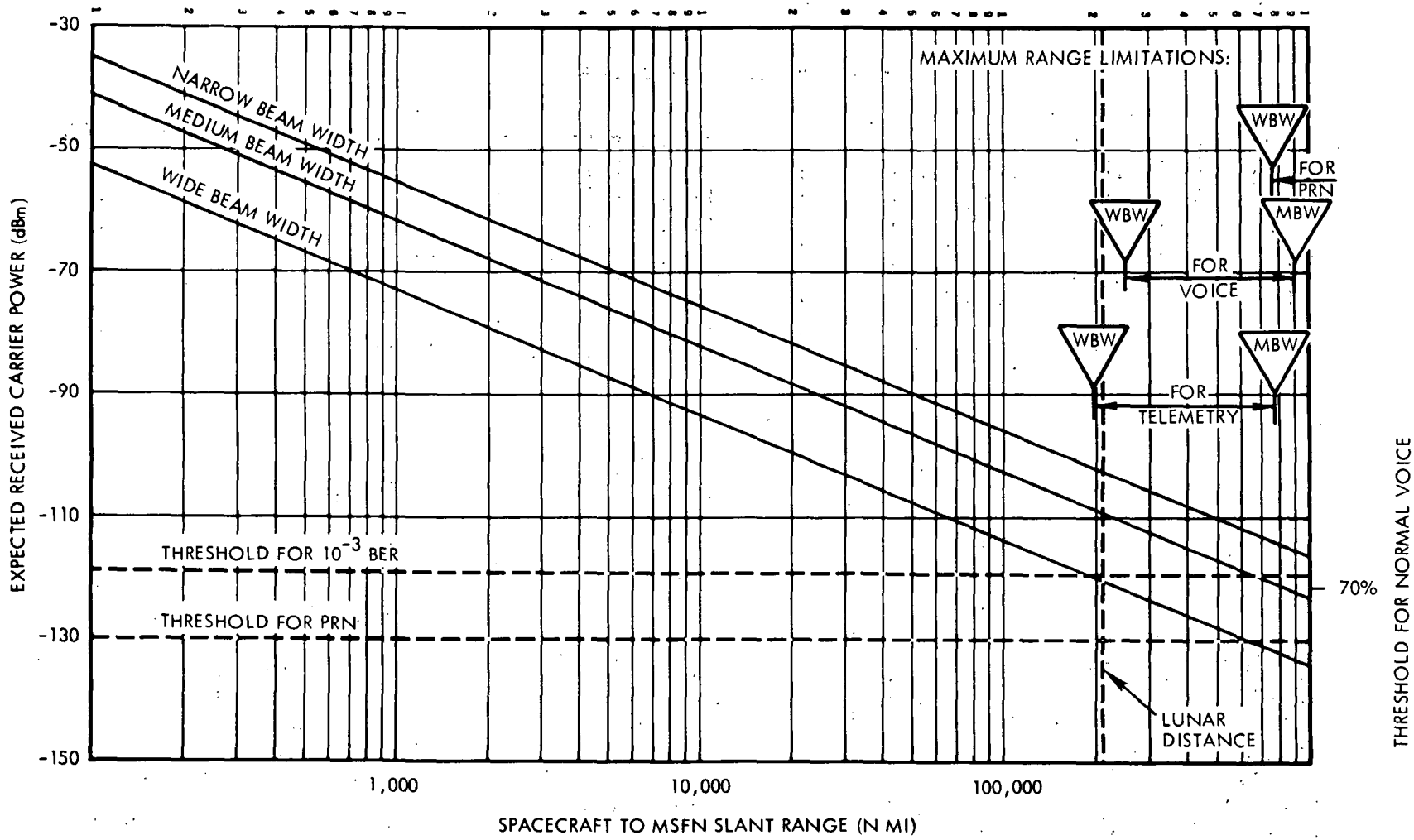


Figure E-9. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM High-Gain Antenna Combination (Downlink PM Mode 2 - Quiet Sky)

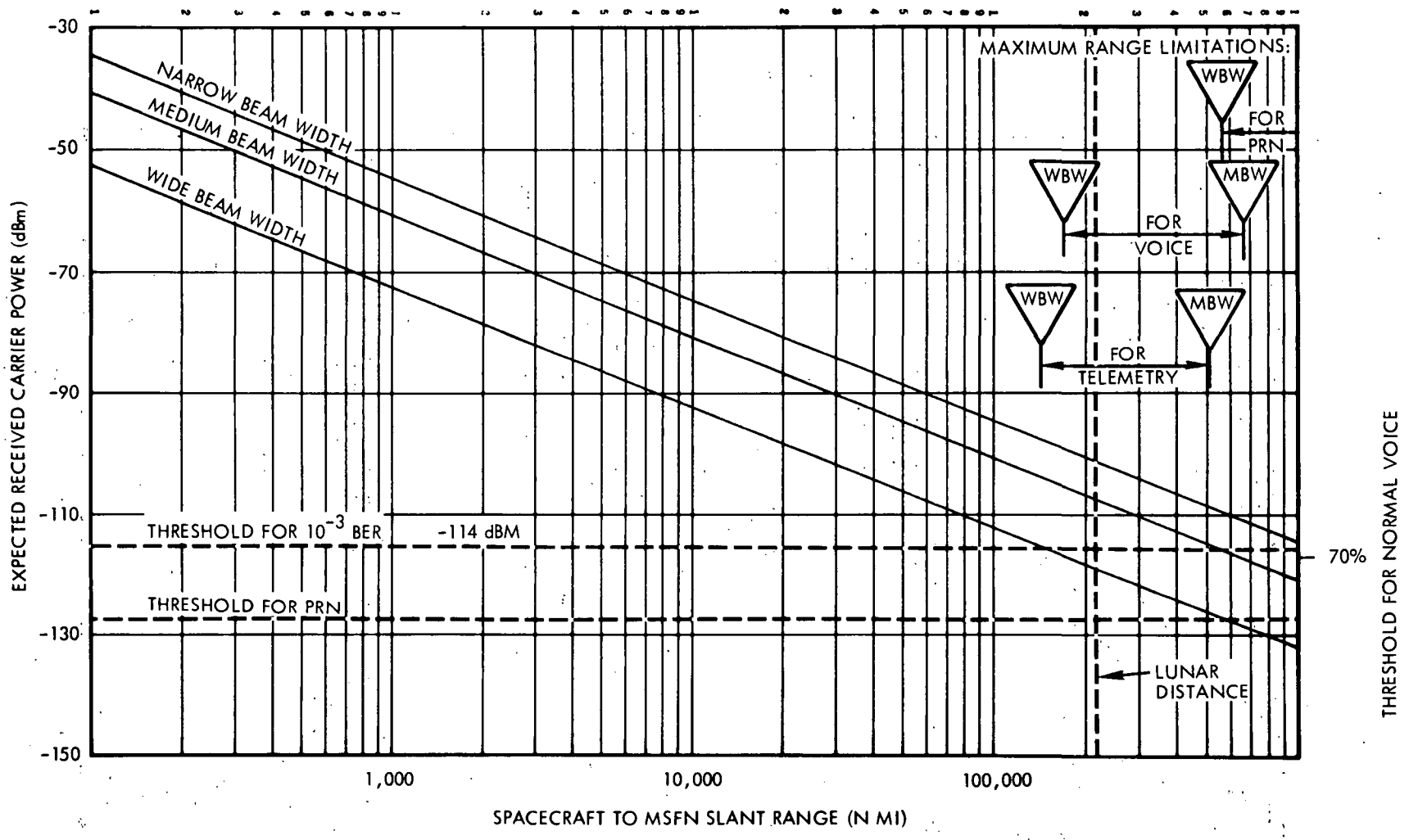


Figure E-10. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM High-Gain Antenna Combination (Downlink PM Mode 2 - Moon at Zenith)

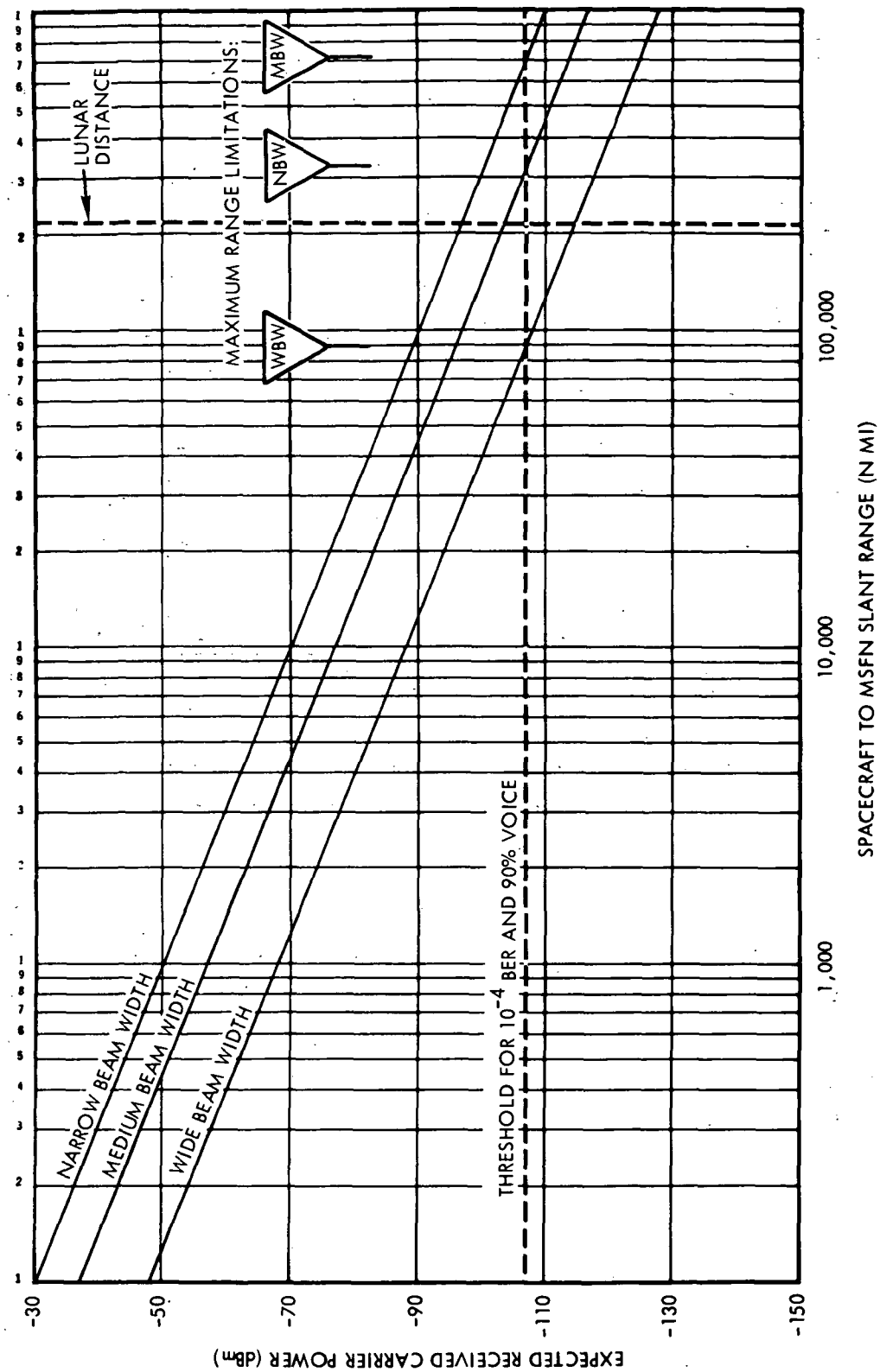


Figure E-11. Expected Apollo 10 MSFN Total Received Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM High-Gain Antenna Combination (Downlink FM Mode 2 - Quiet Sky)

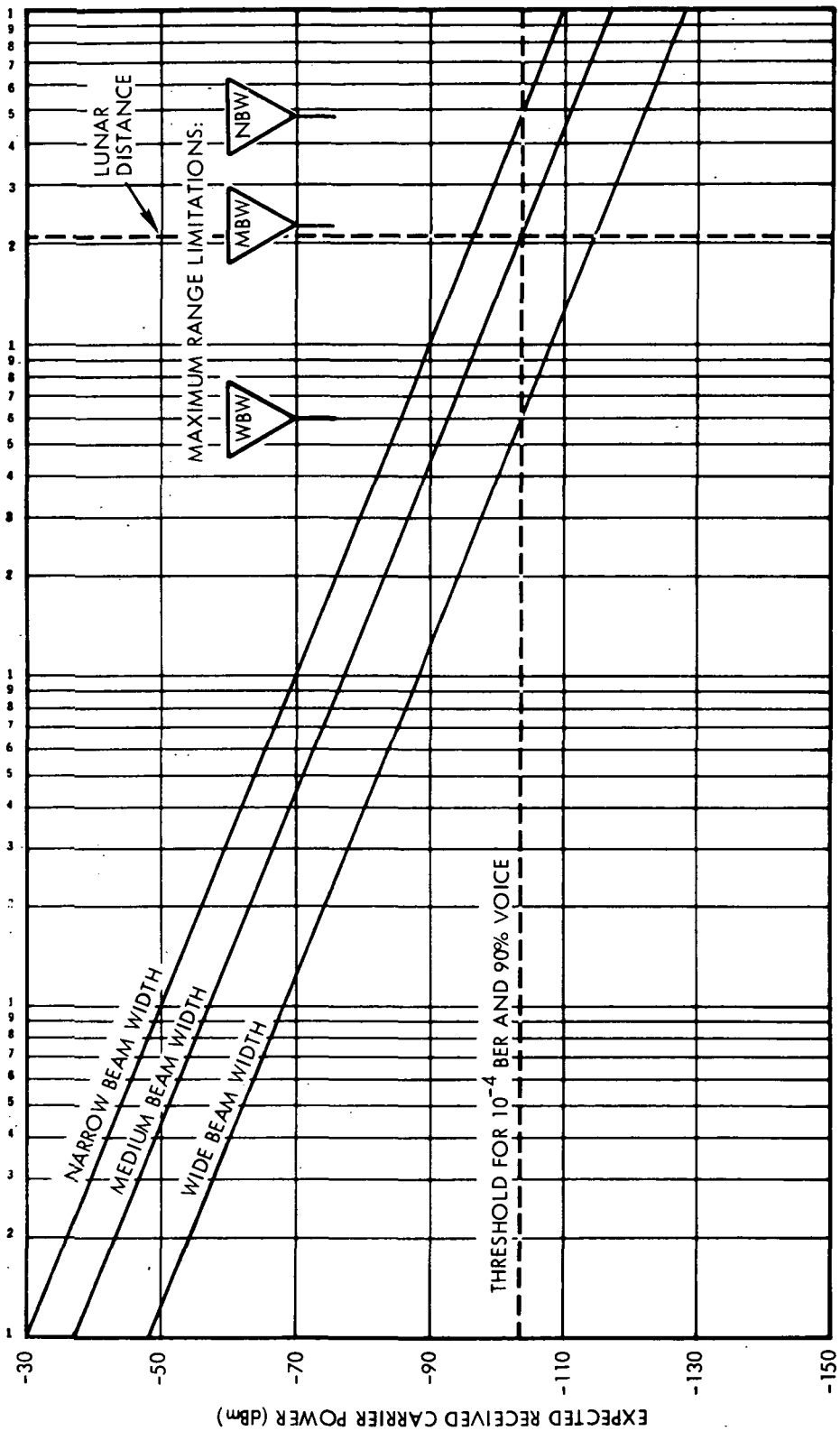


Figure E-12. Expected Apollo 10 MSFN Total Received Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM High-Gain Antenna Combination (Downlink FM Mode 2 - Moon at Zenith)

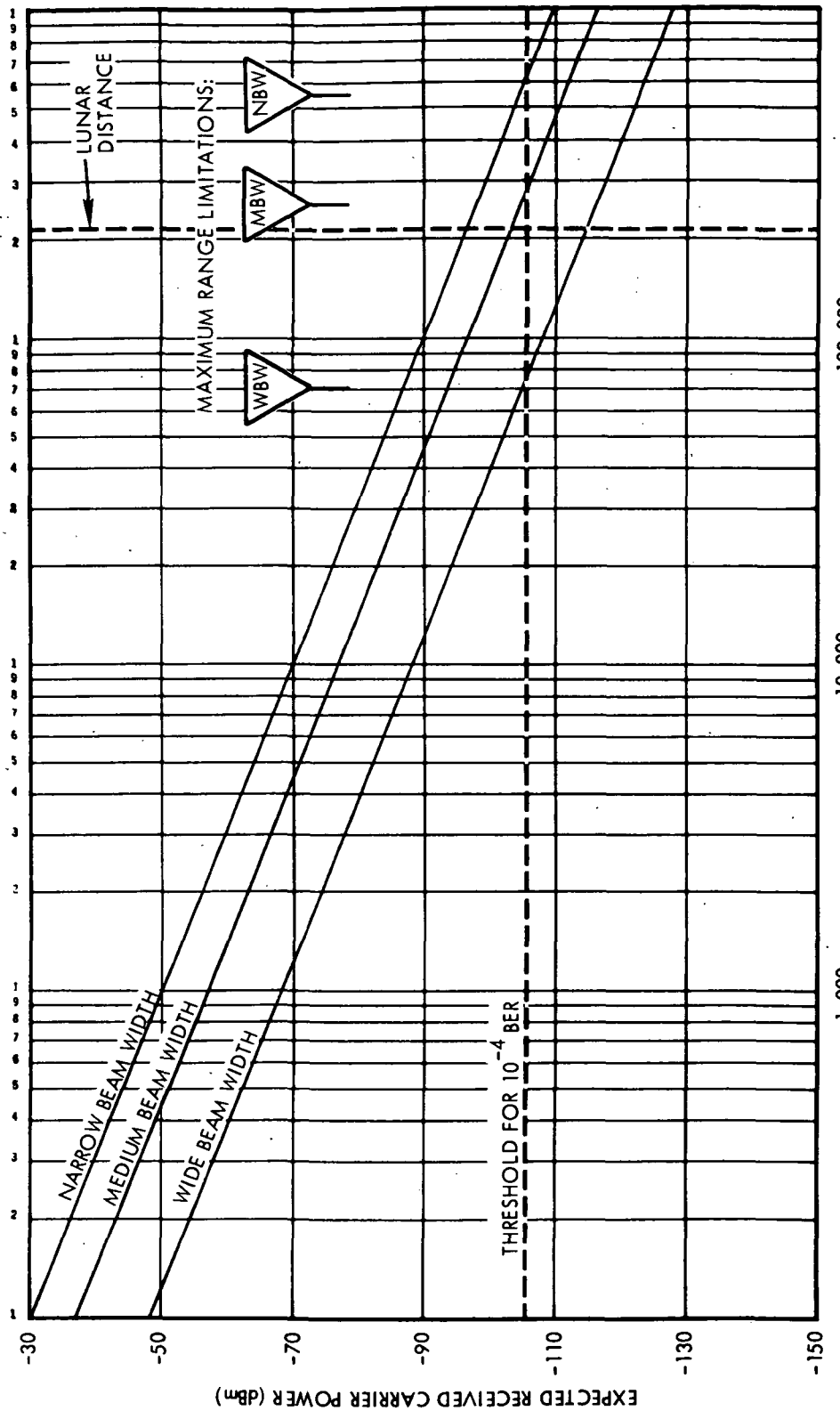


Figure E-13. Expected Apollo 10 MSFN Total Received Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM High-Gain Antenna Combination (Downlink FM Mode 3 - Moon at Zenith)

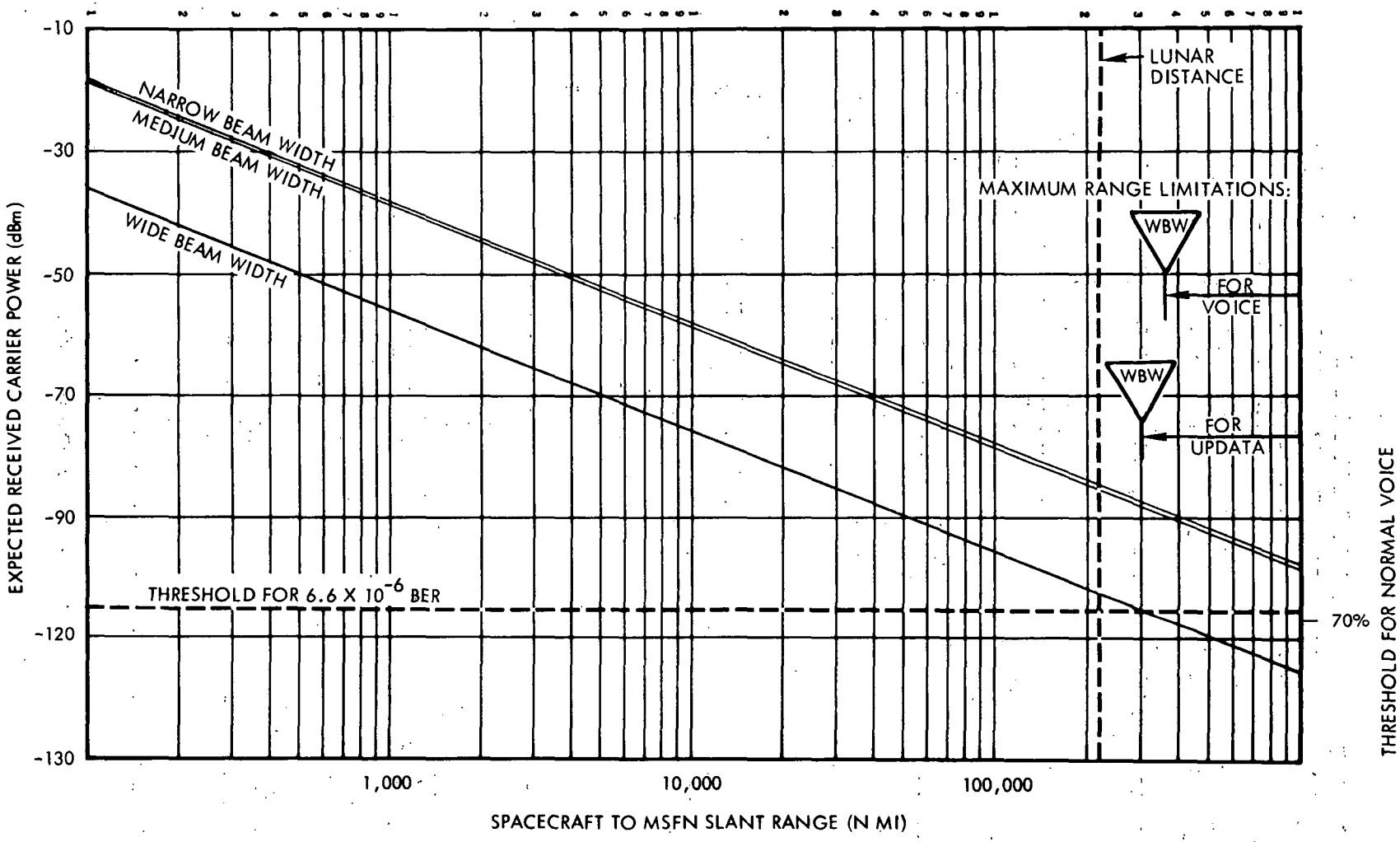


Figure E-14. Expected Apollo 10 Spacecraft Received Carrier Power versus MSFN to Spacecraft Slant Range for 30-foot Cooled or Uncooled MSFN/CSM High-Gain Antenna Combination (Uplink PM Mode 6)

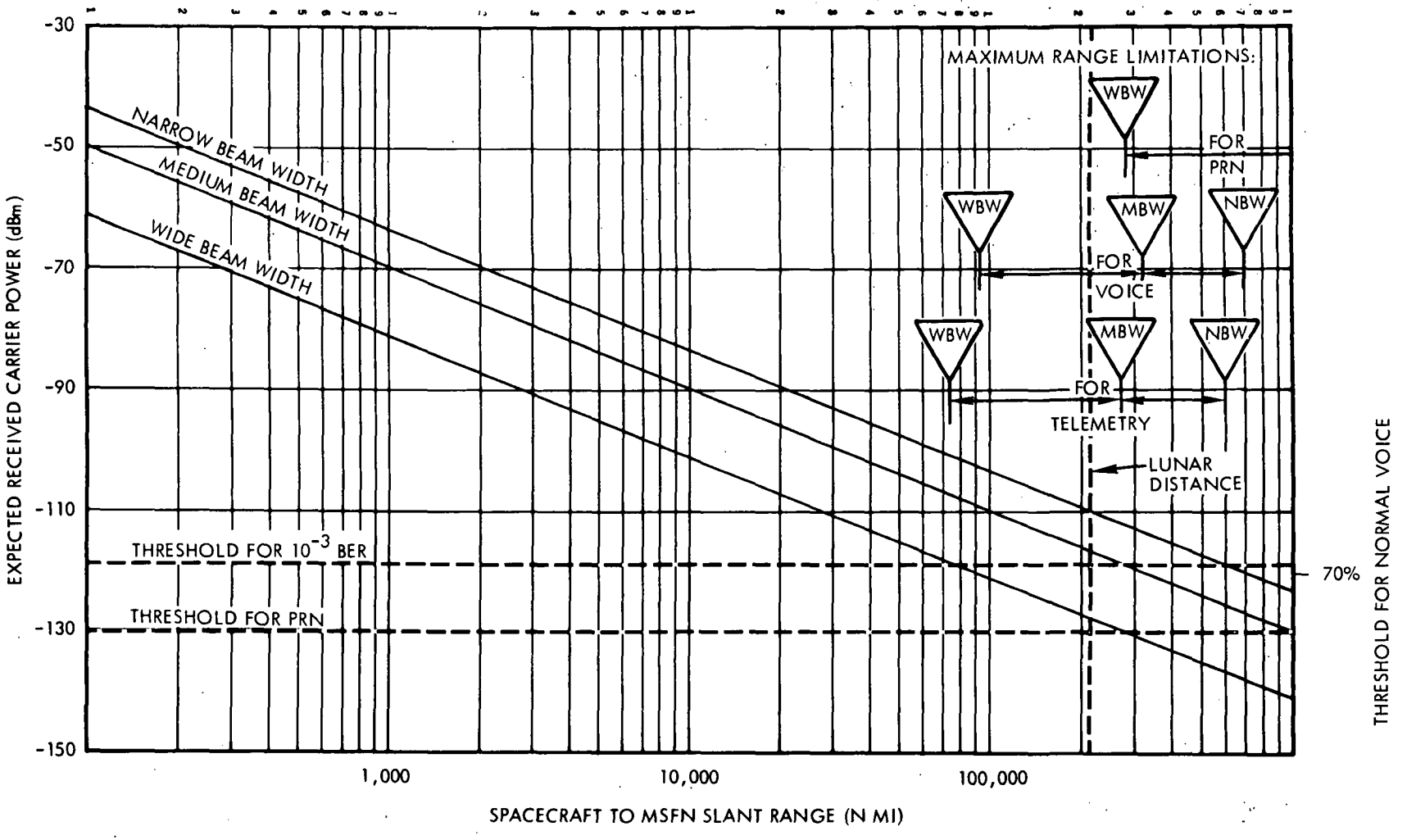


Figure E-15. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM High-Gain Antenna Combination (Downlink PM Mode 2 - Quiet Sky)

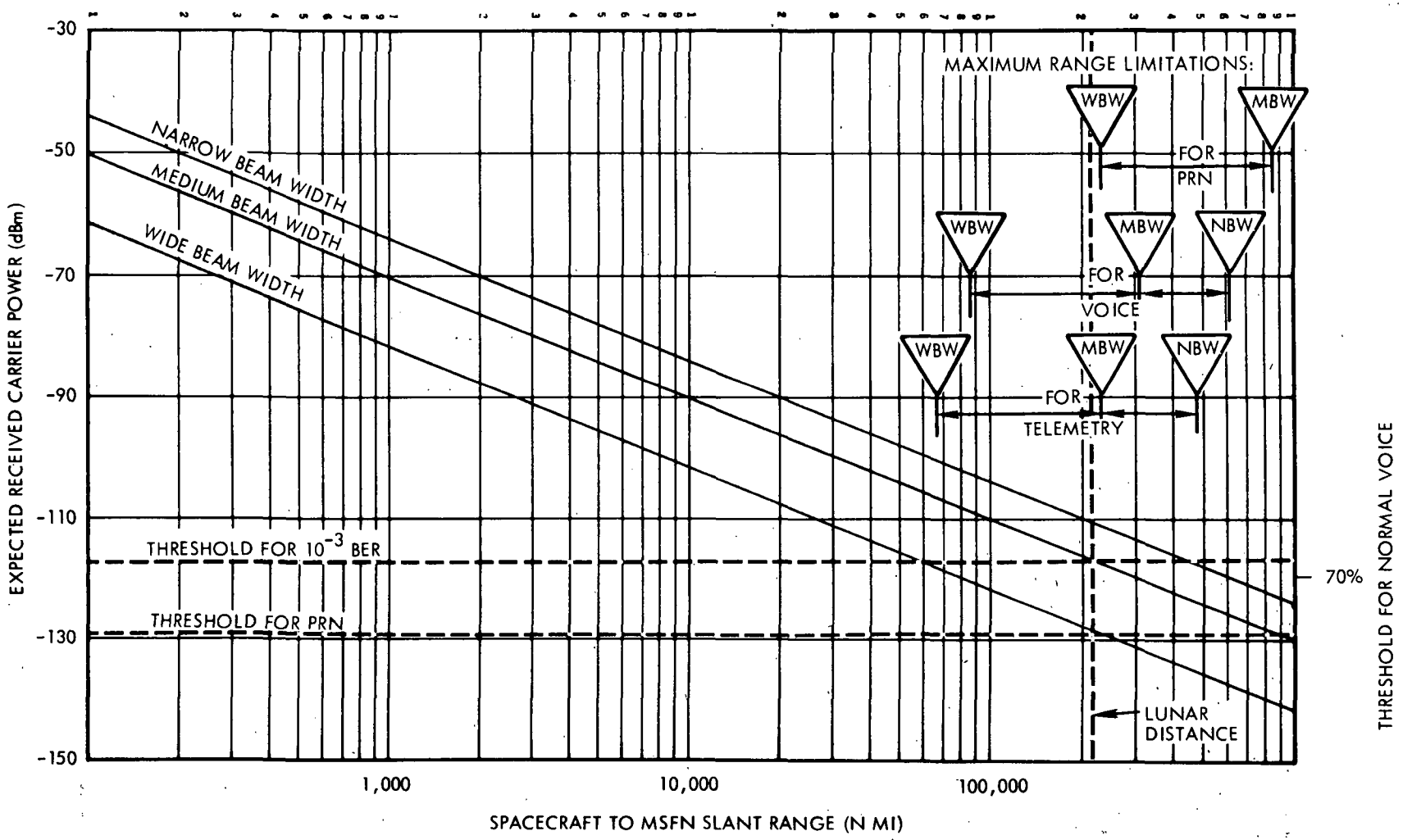


Figure E-16. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM High-Gain Antenna Combination (Downlink PM Mode 2 - Moon at Zenith)

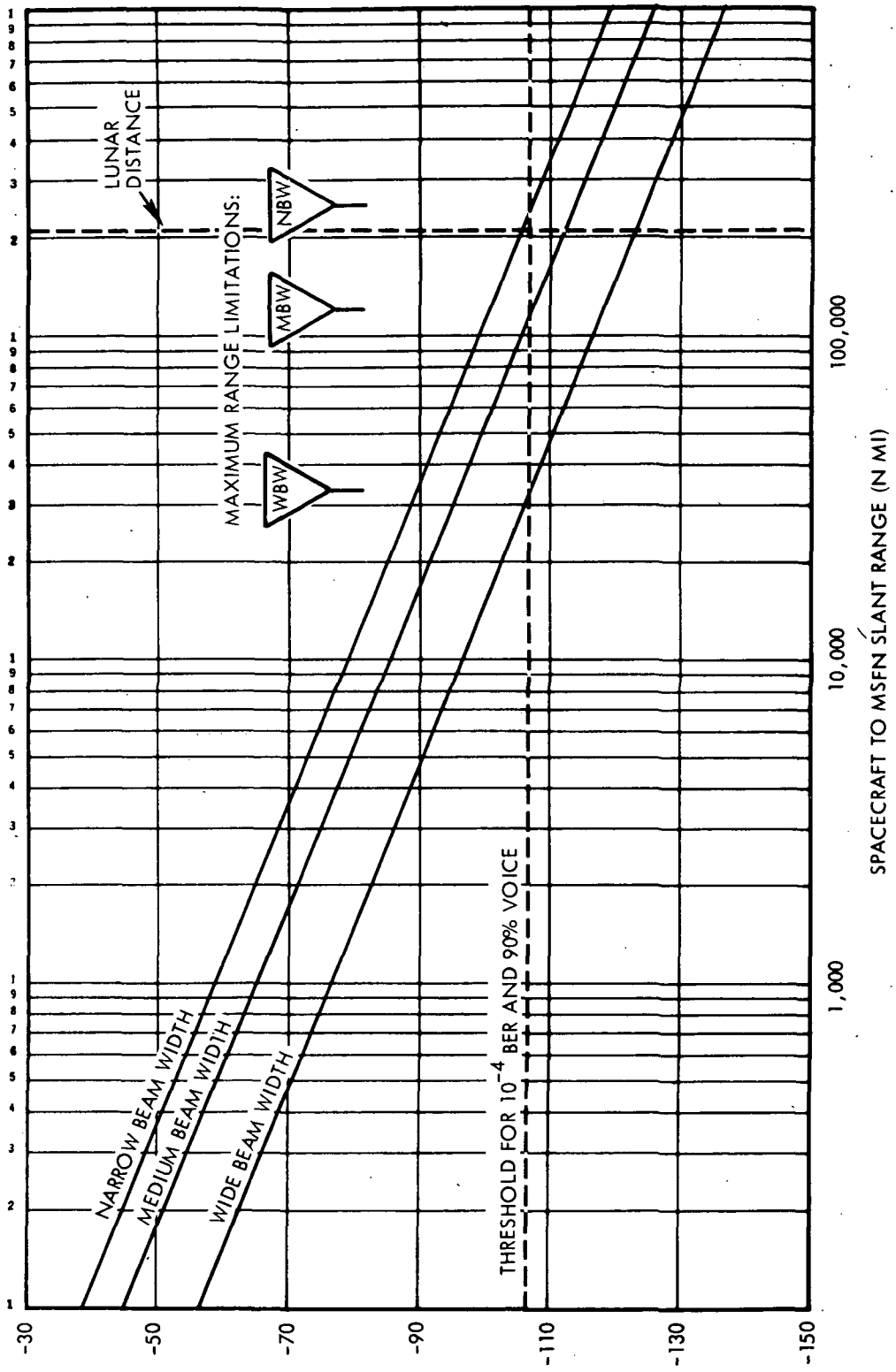


Figure E-17. Expected Apollo 10 MSFN Total Received Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM High-Gain Antenna Combination (Downlink FM Mode 2 - Quiet Sky)

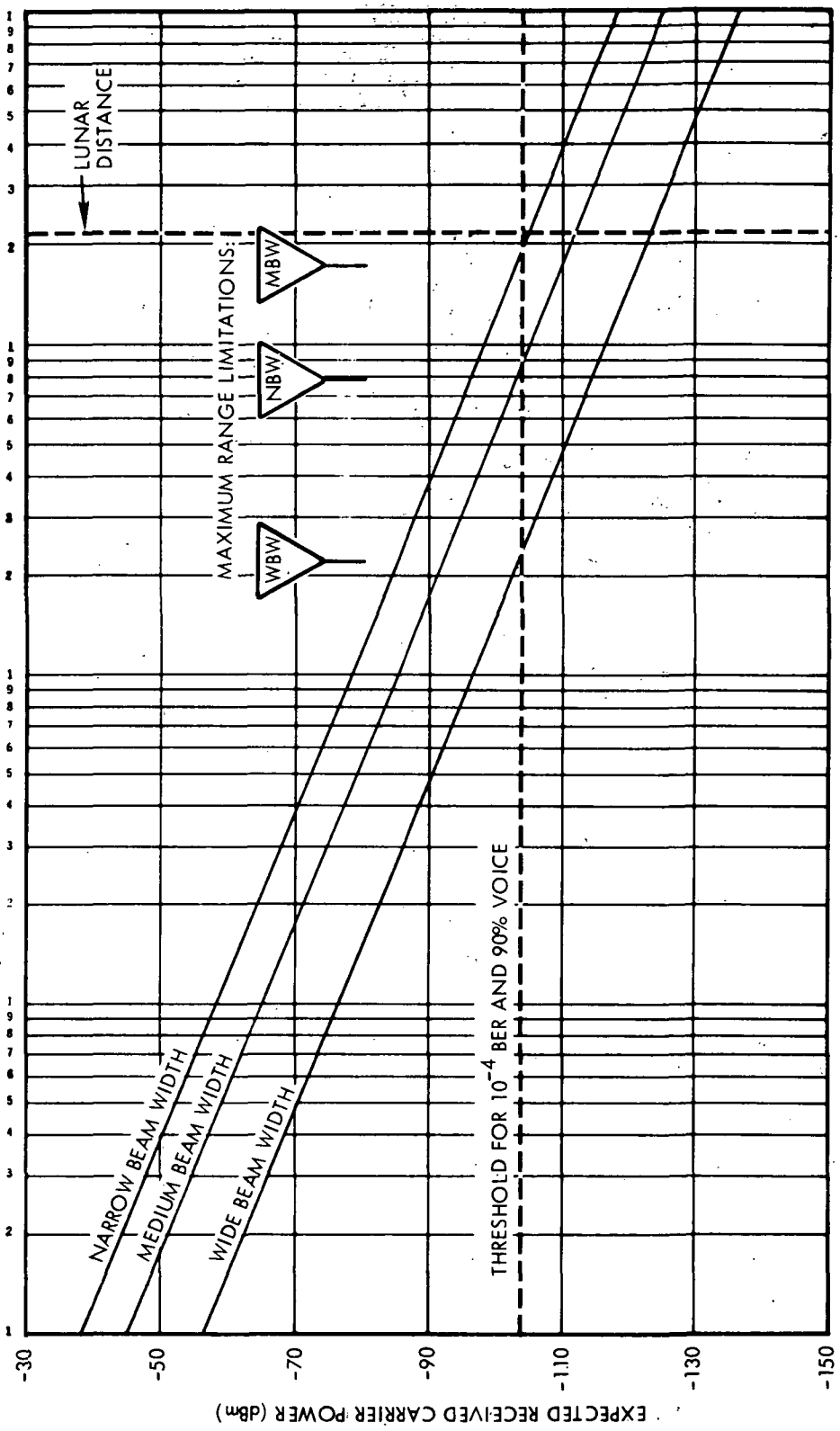


Figure E-18. Expected Apollo 10 MSFN Total Received Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM High-Gain Antenna Combination (Downlink FM Mode 2 - Moon at Zenith)

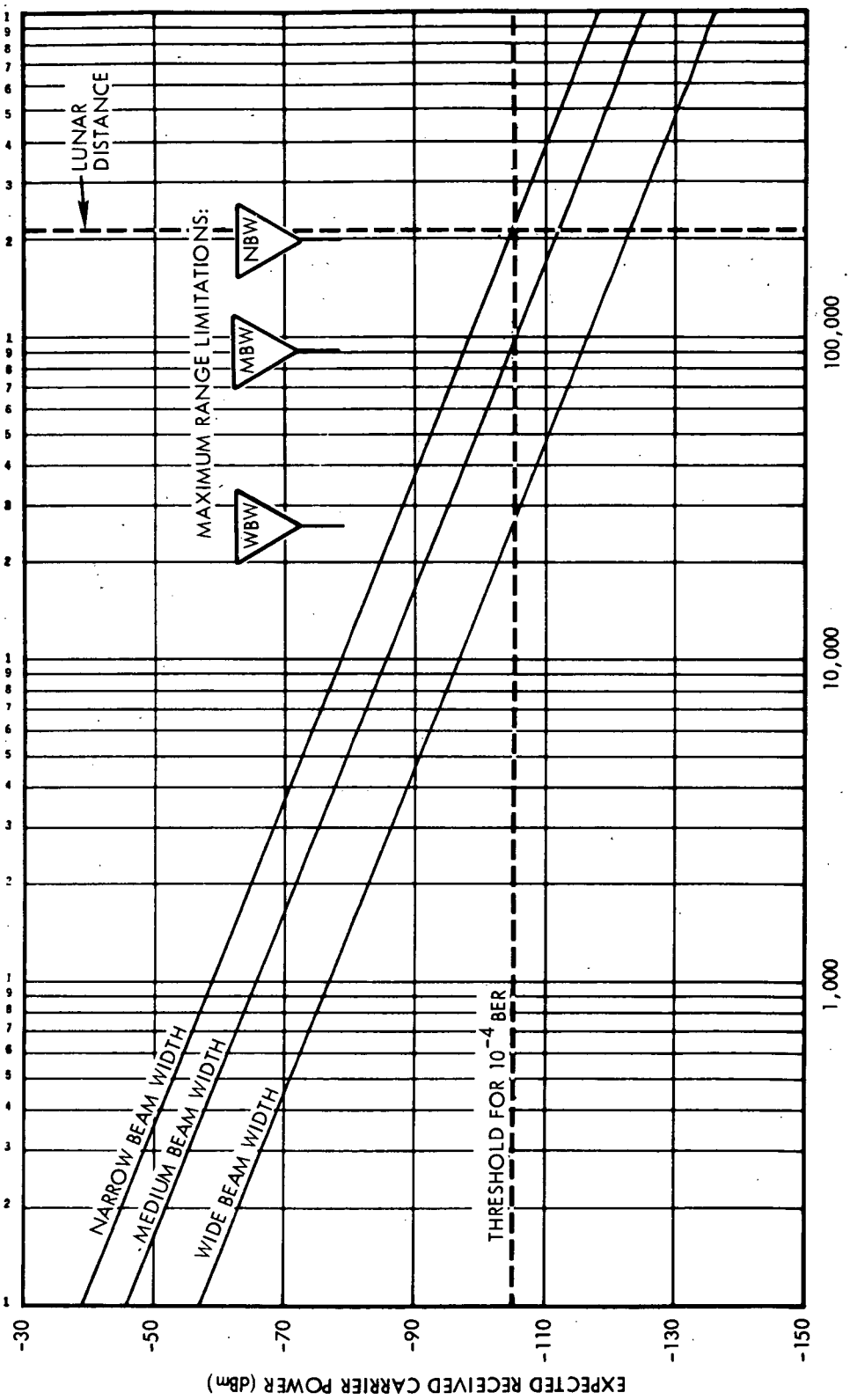


Figure E-19. Expected Apollo 10 MSFN Total Received Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM High-Gain Antenna Combination (Downlink FM Mode 3 - Moon at Zenith)

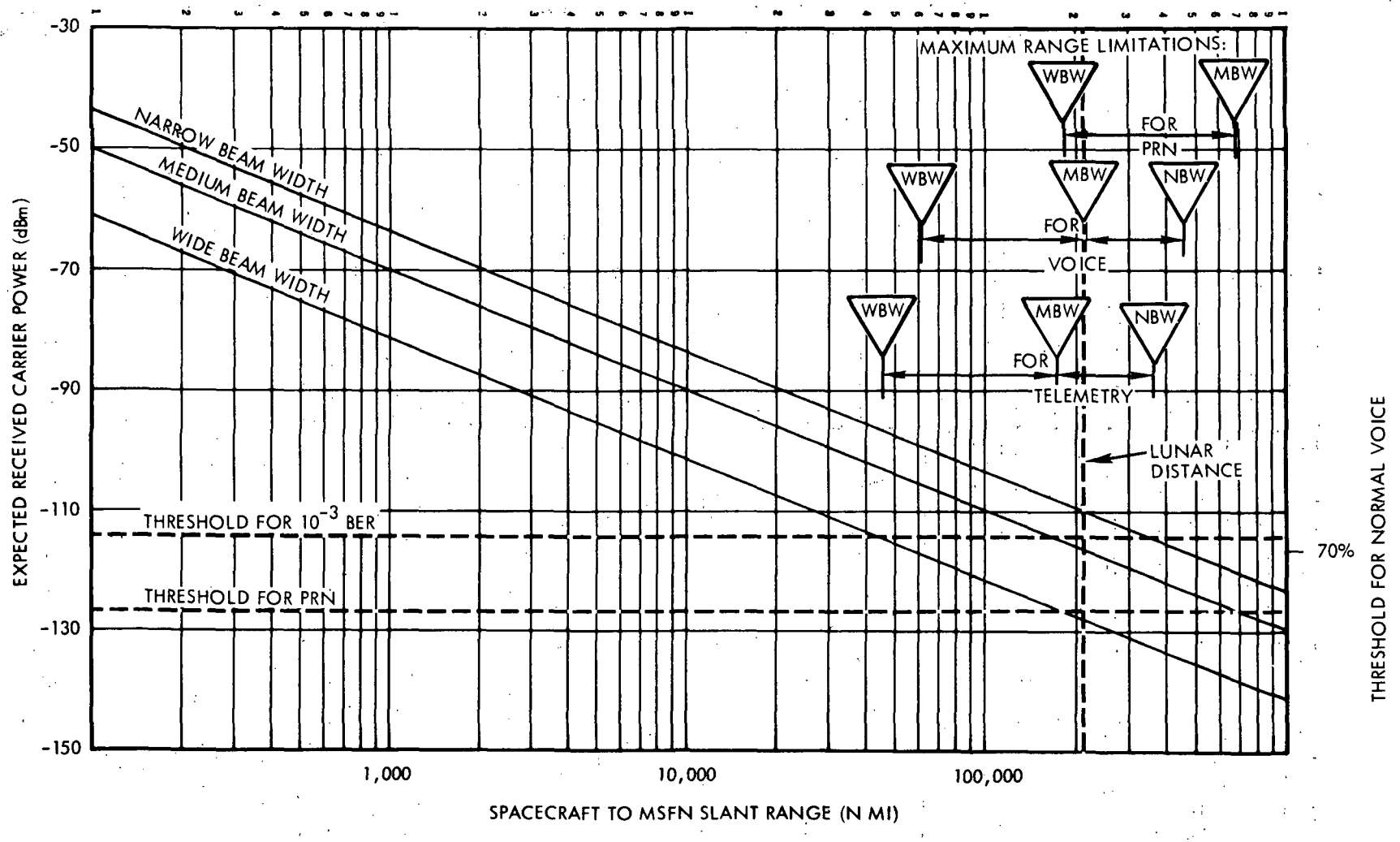


Figure E-20. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM High-Gain Antenna Combination (Downlink PM Mode 2 - Quiet Sky)

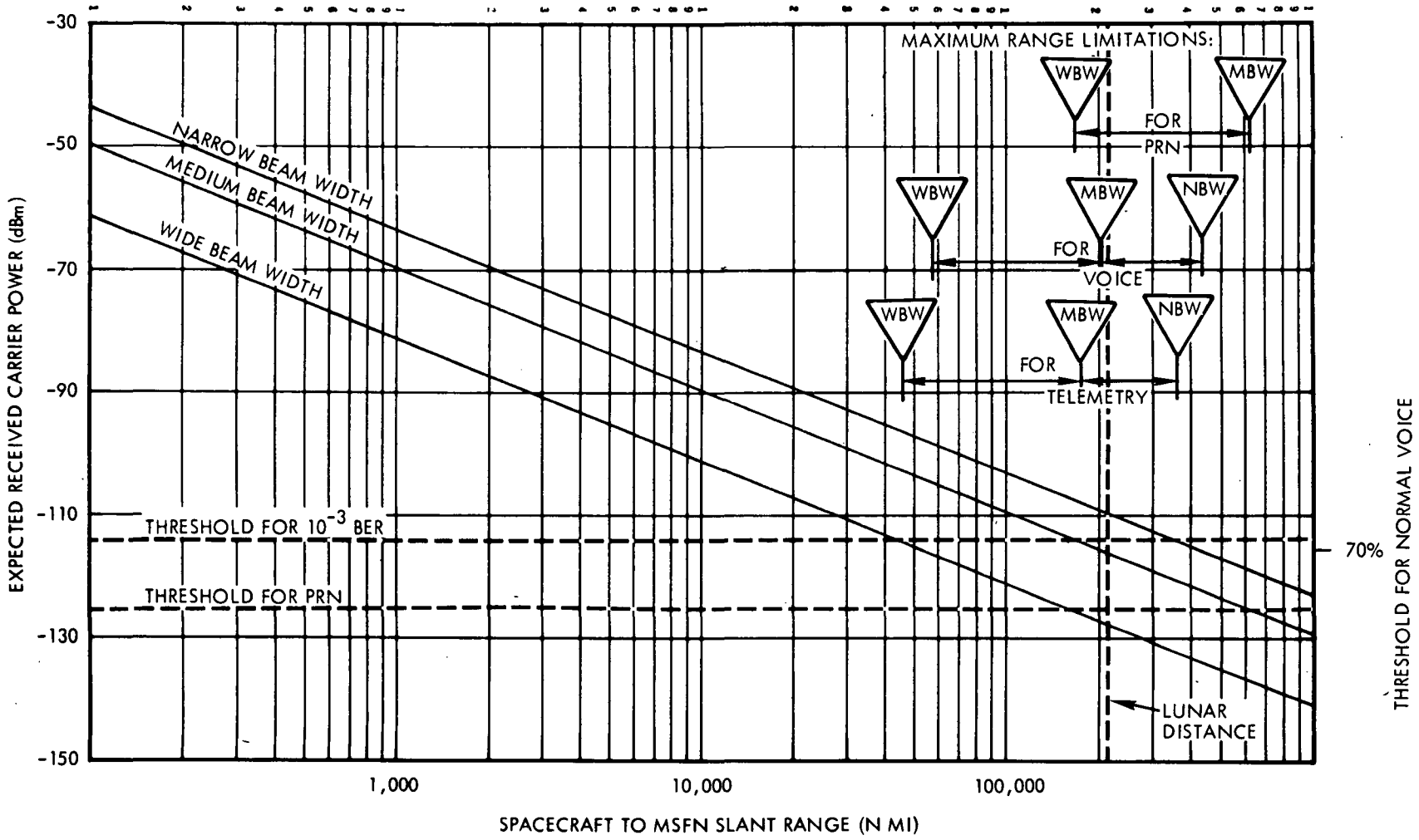


Figure E-21. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM High-Gain Antenna Combination (Downlink PM Mode 2- Moon at Zenith)

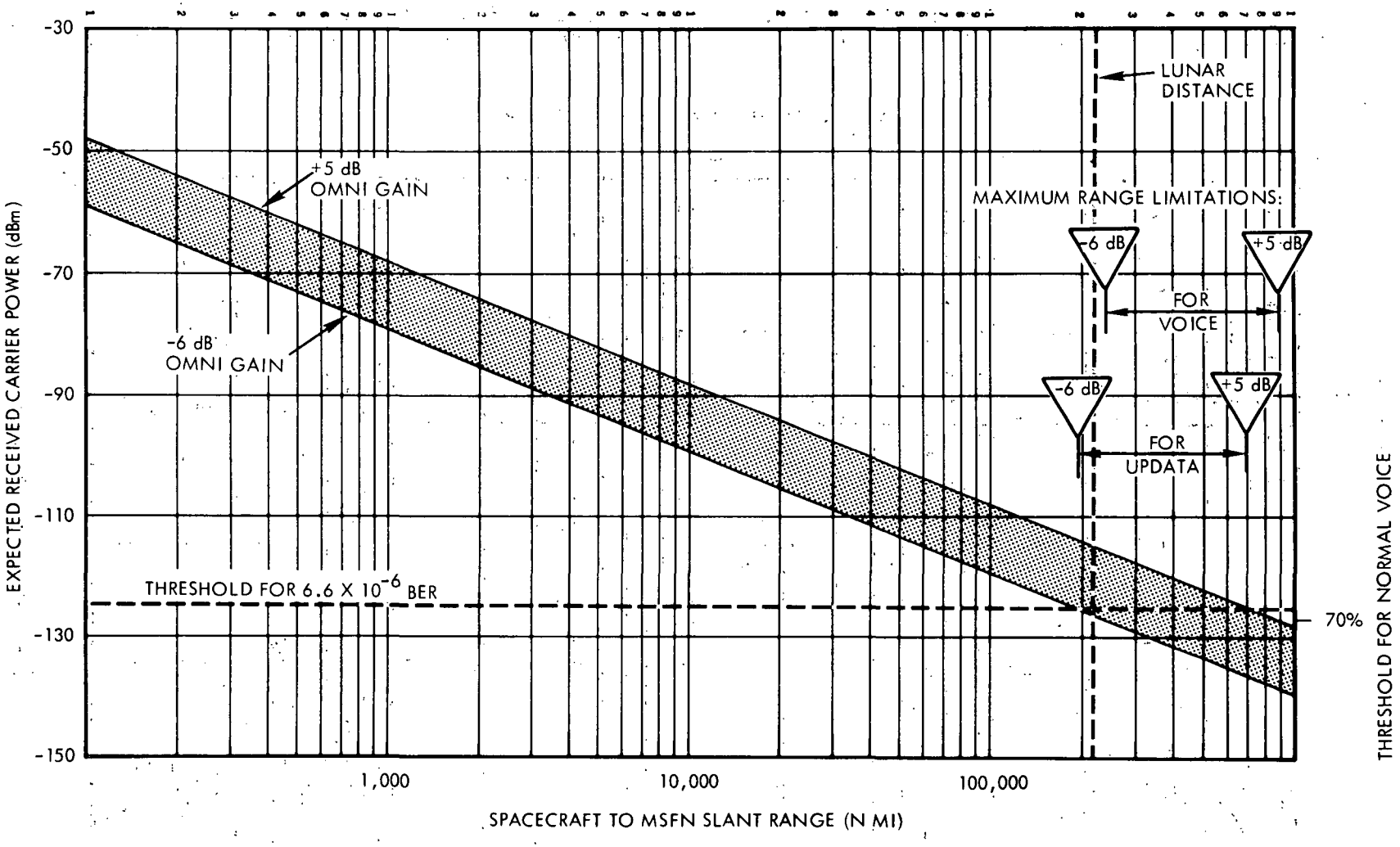


Figure E-22. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Uplink PM Mode 6)

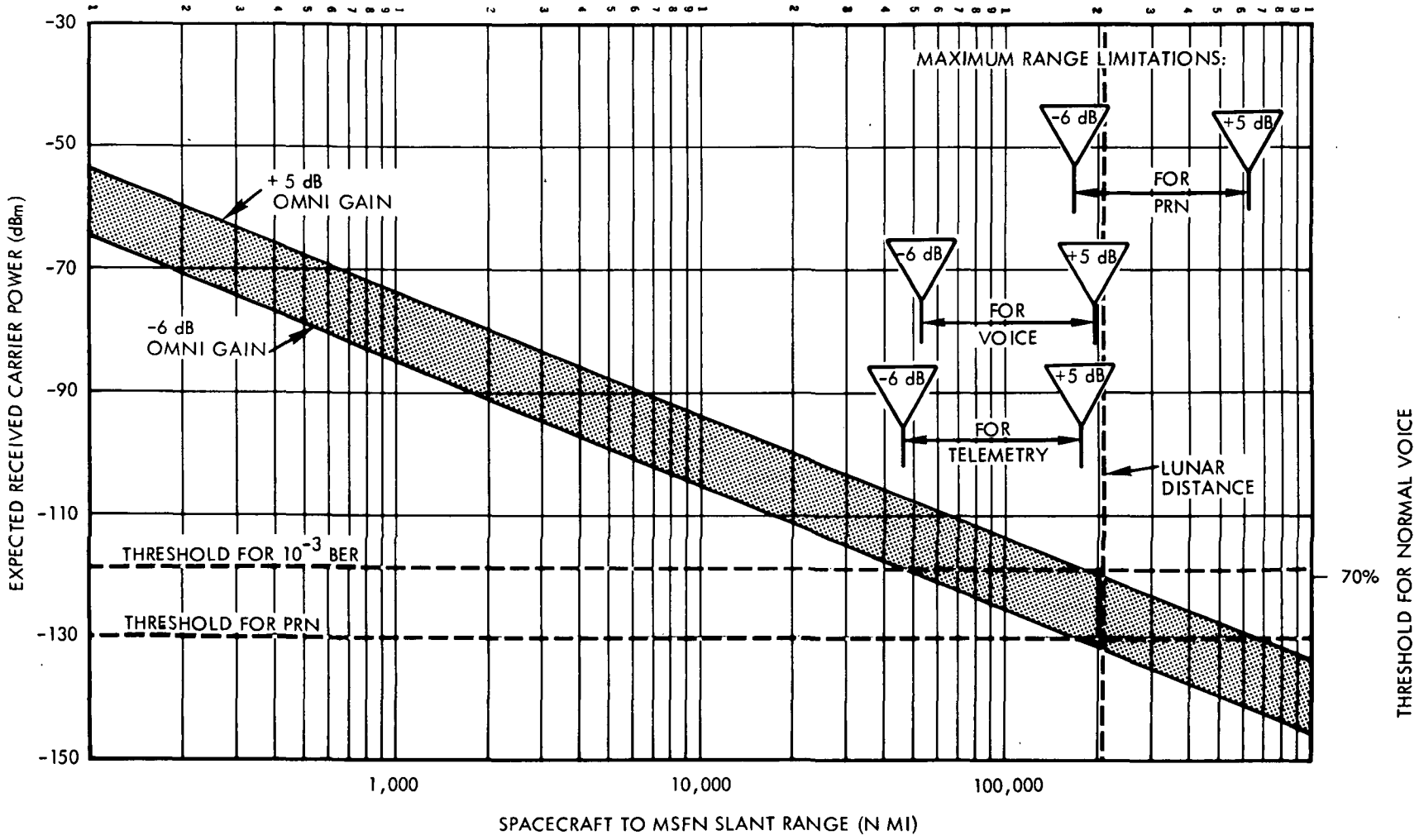


Figure E-23. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Downlink PM Mode 2 - Quiet Sky)

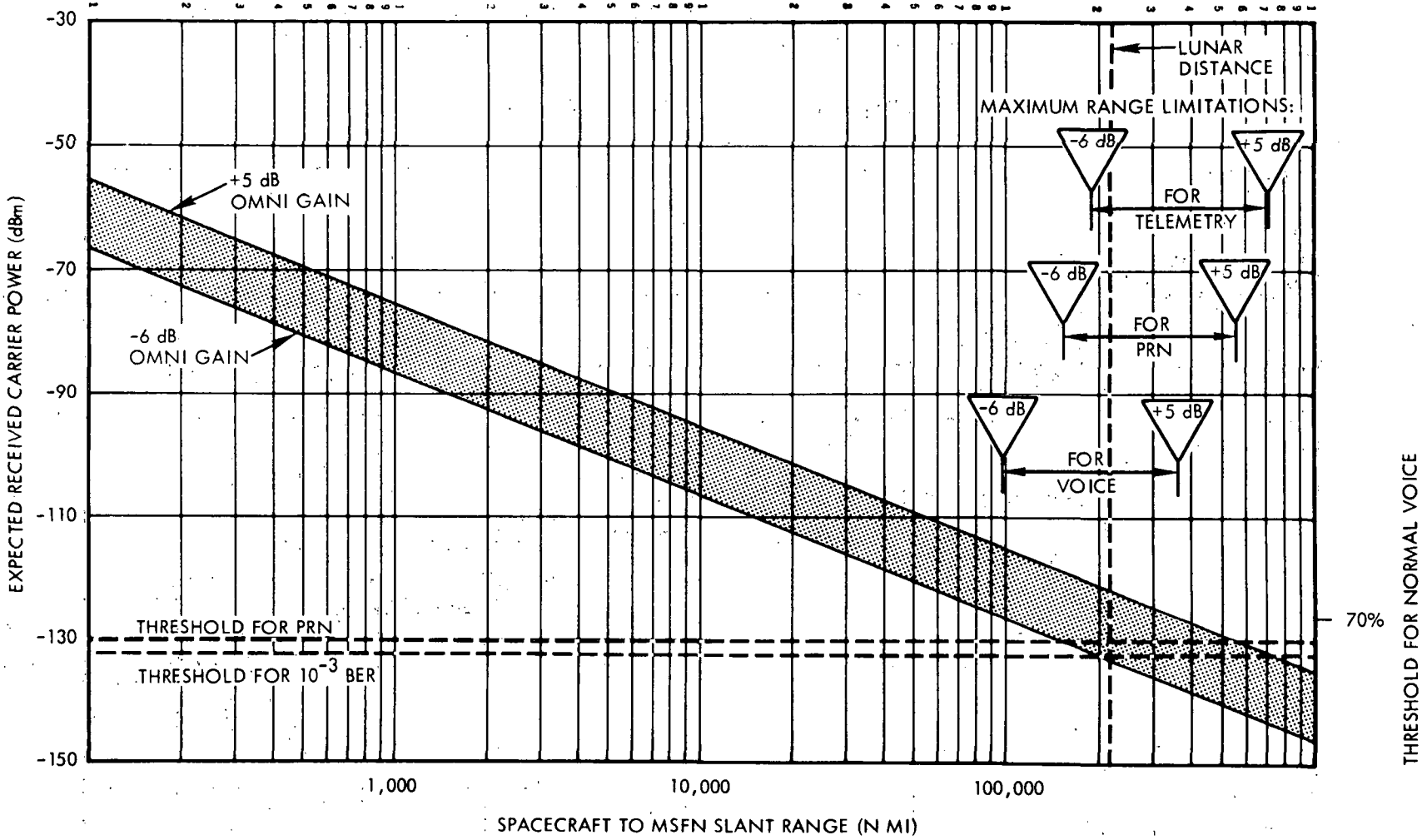


Figure E-24. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Downlink PM Mode 3 - Quiet Sky)

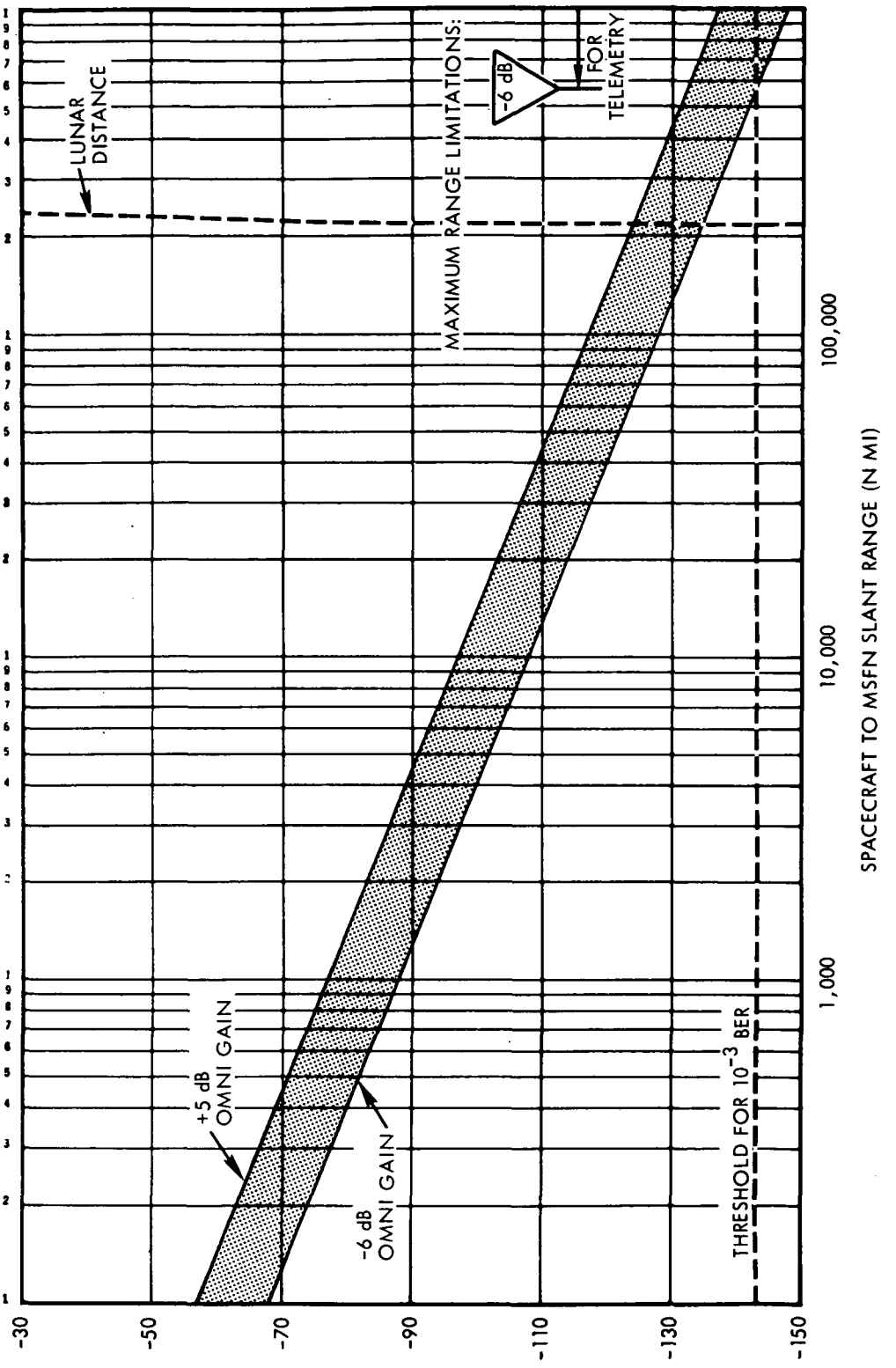


Figure E-25. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Downlink PM Mode 5 - Quiet Sky)

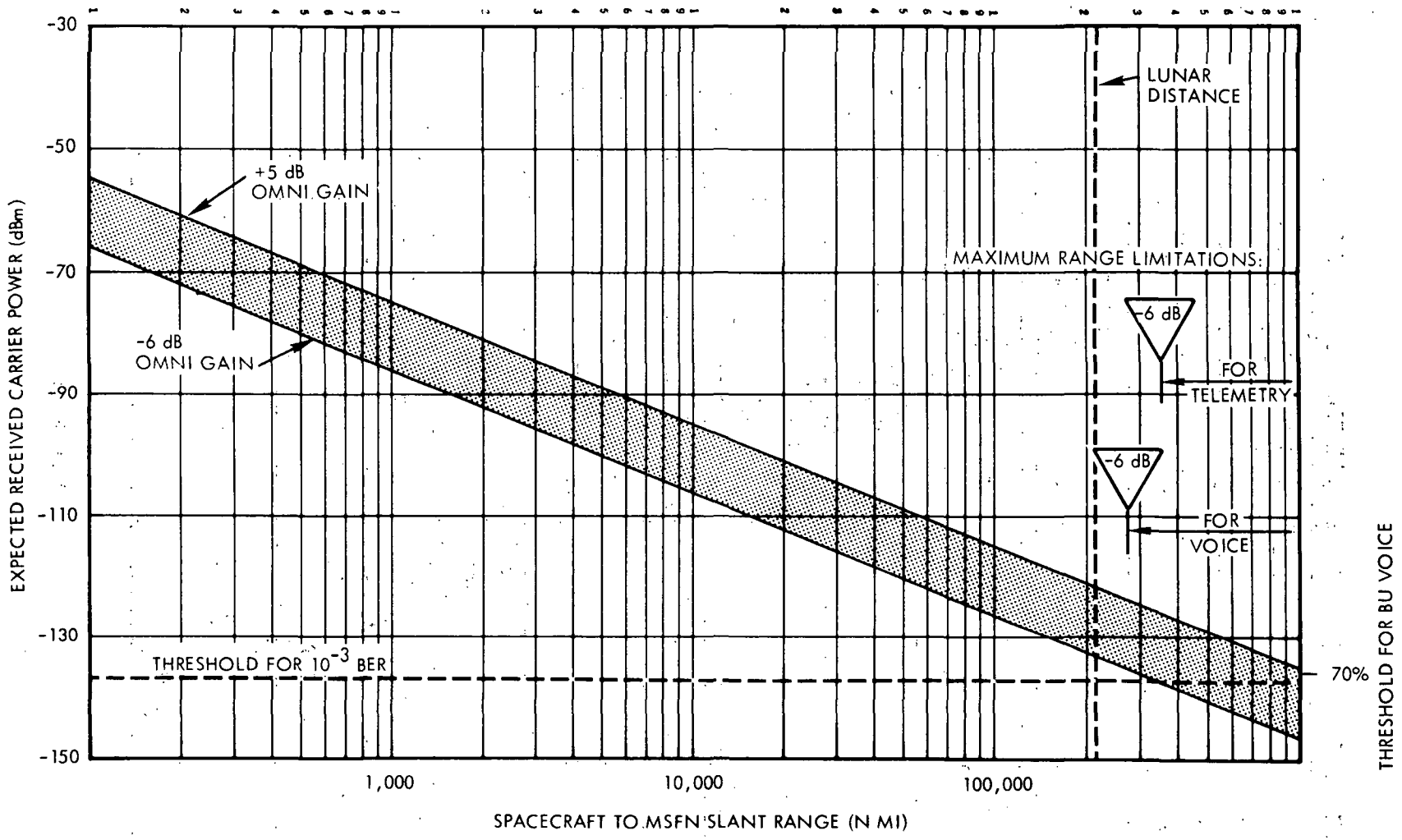


Figure E-26. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Downlink PM Mode 8 - Quiet Sky)

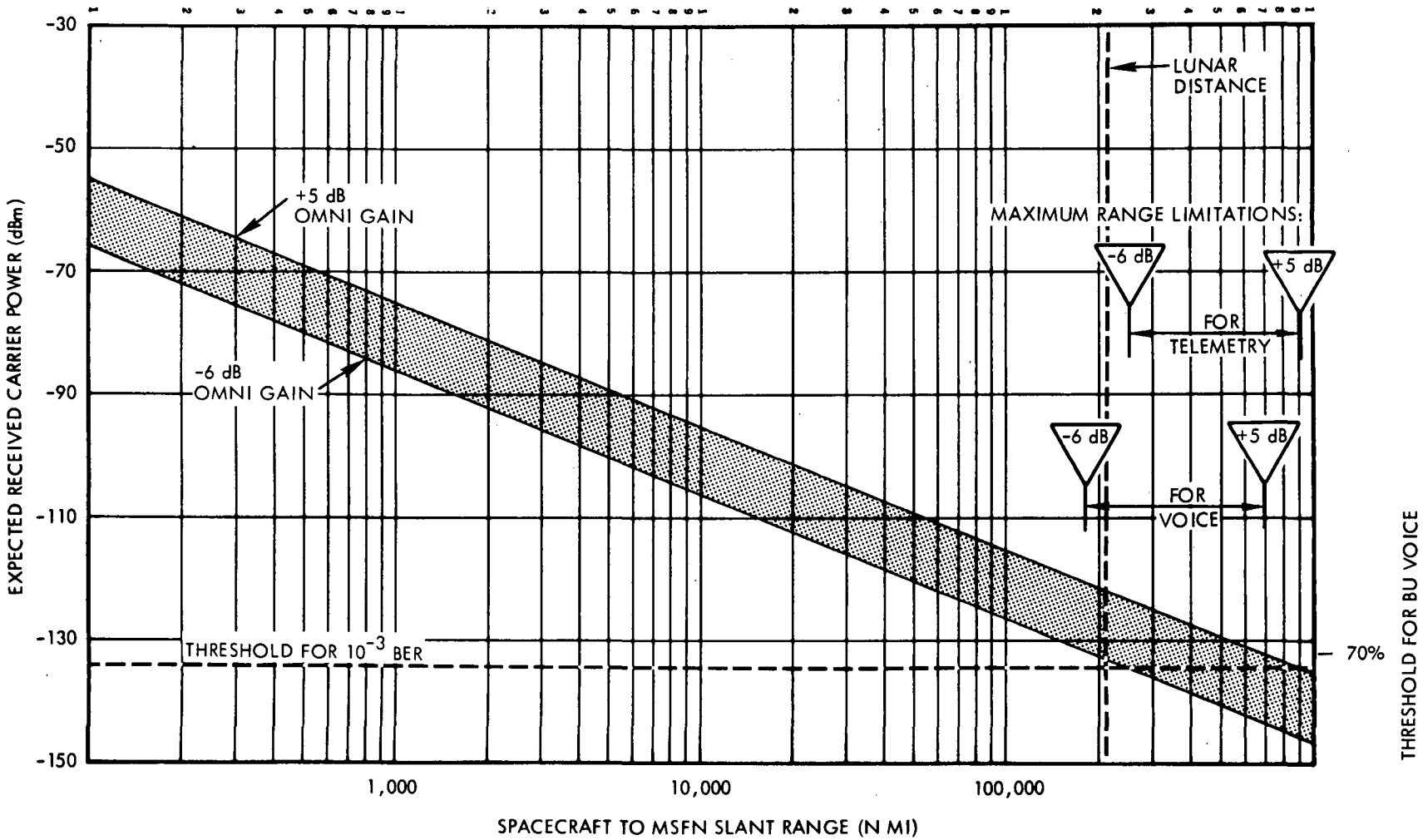


Figure E-27. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Downlink PM Mode 8 - Moon at Zenith)

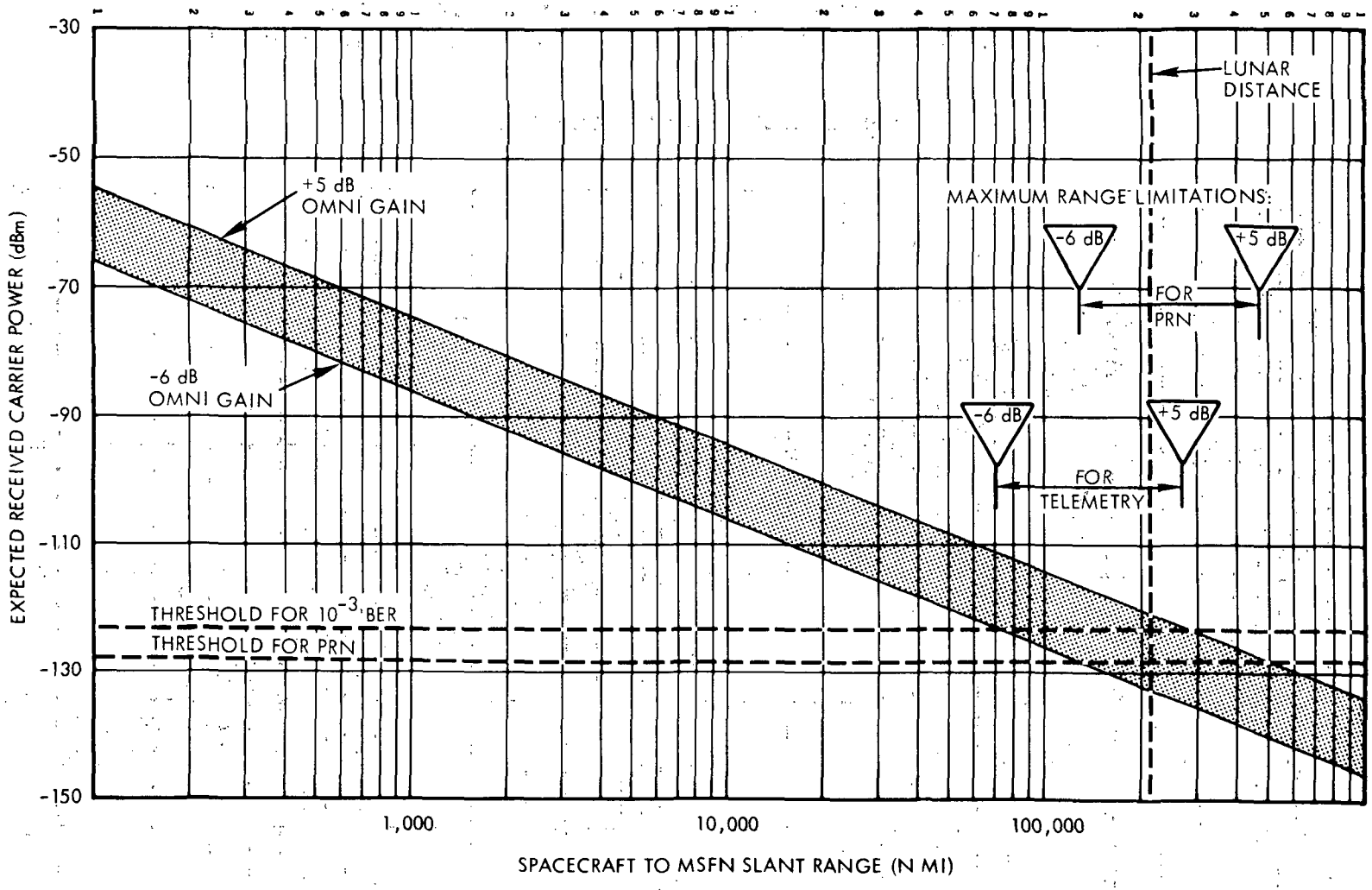


Figure E-28. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/CSM Omni Antennas Combination (Downlink PM Mode 15 - Quiet Sky)

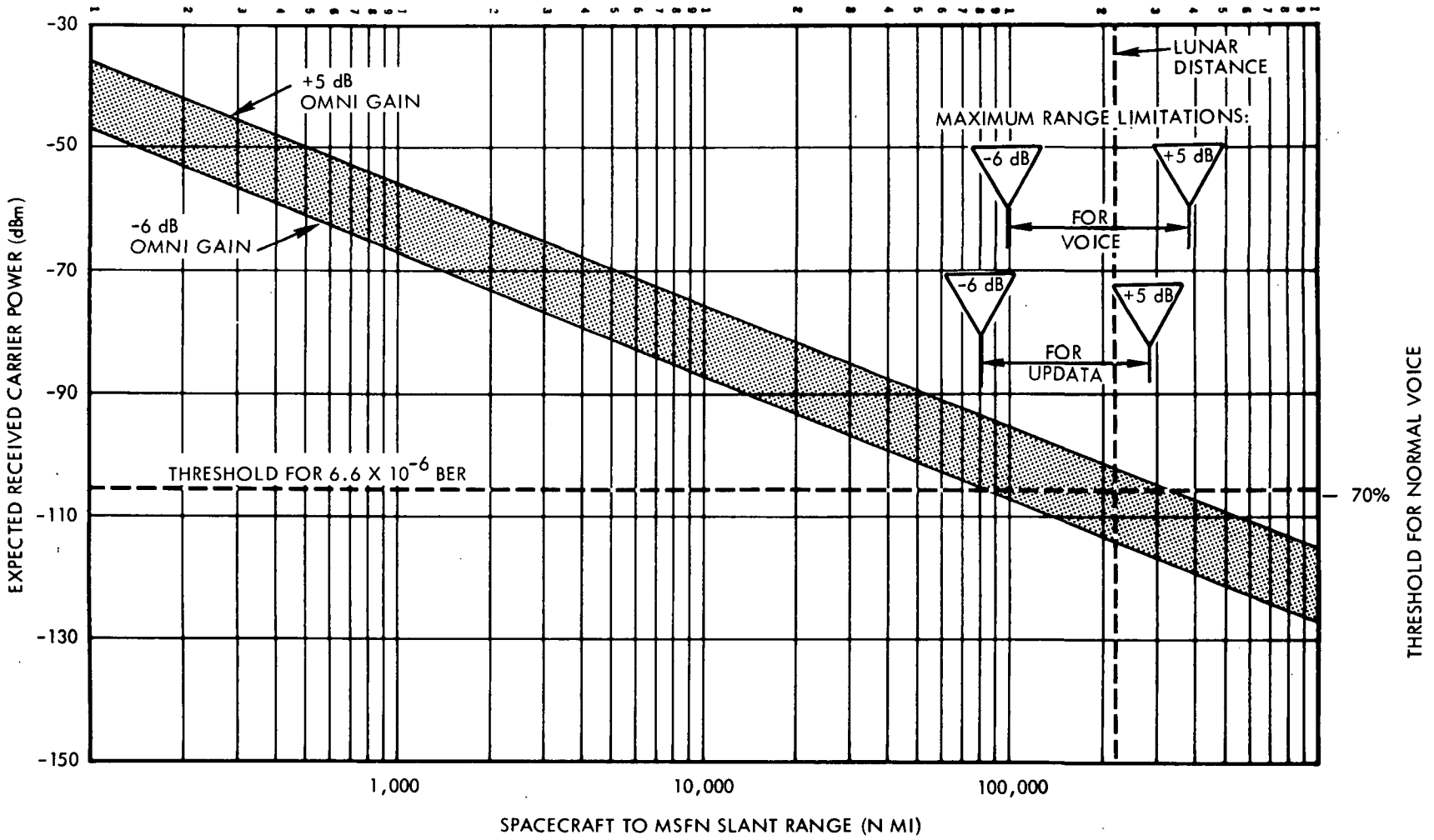


Figure E-29. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled or Uncooled MSFN/CSM Omni Antennas Combination (Uplink PM Mode 6)

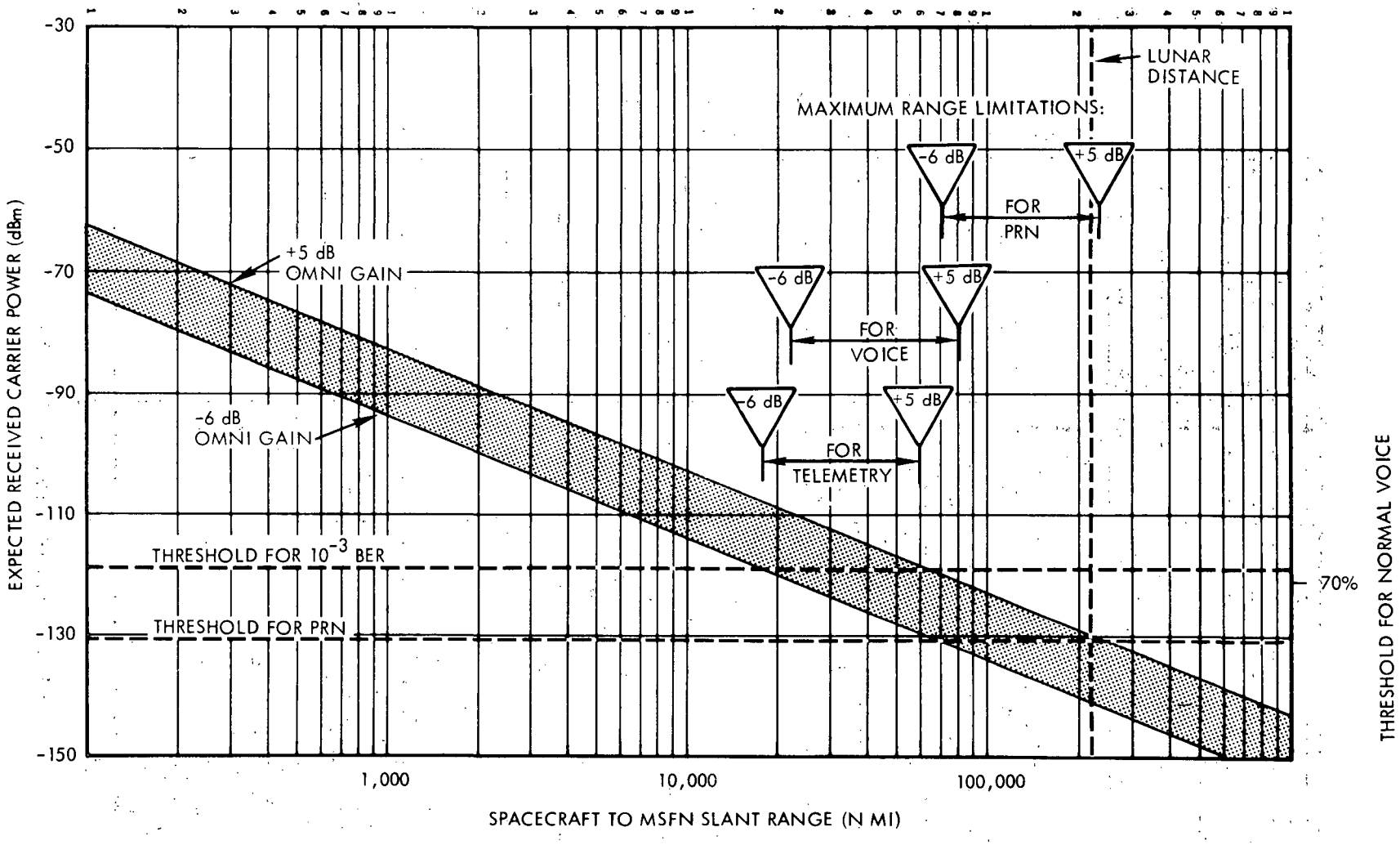


Figure E-30. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 2 - Quiet Sky)

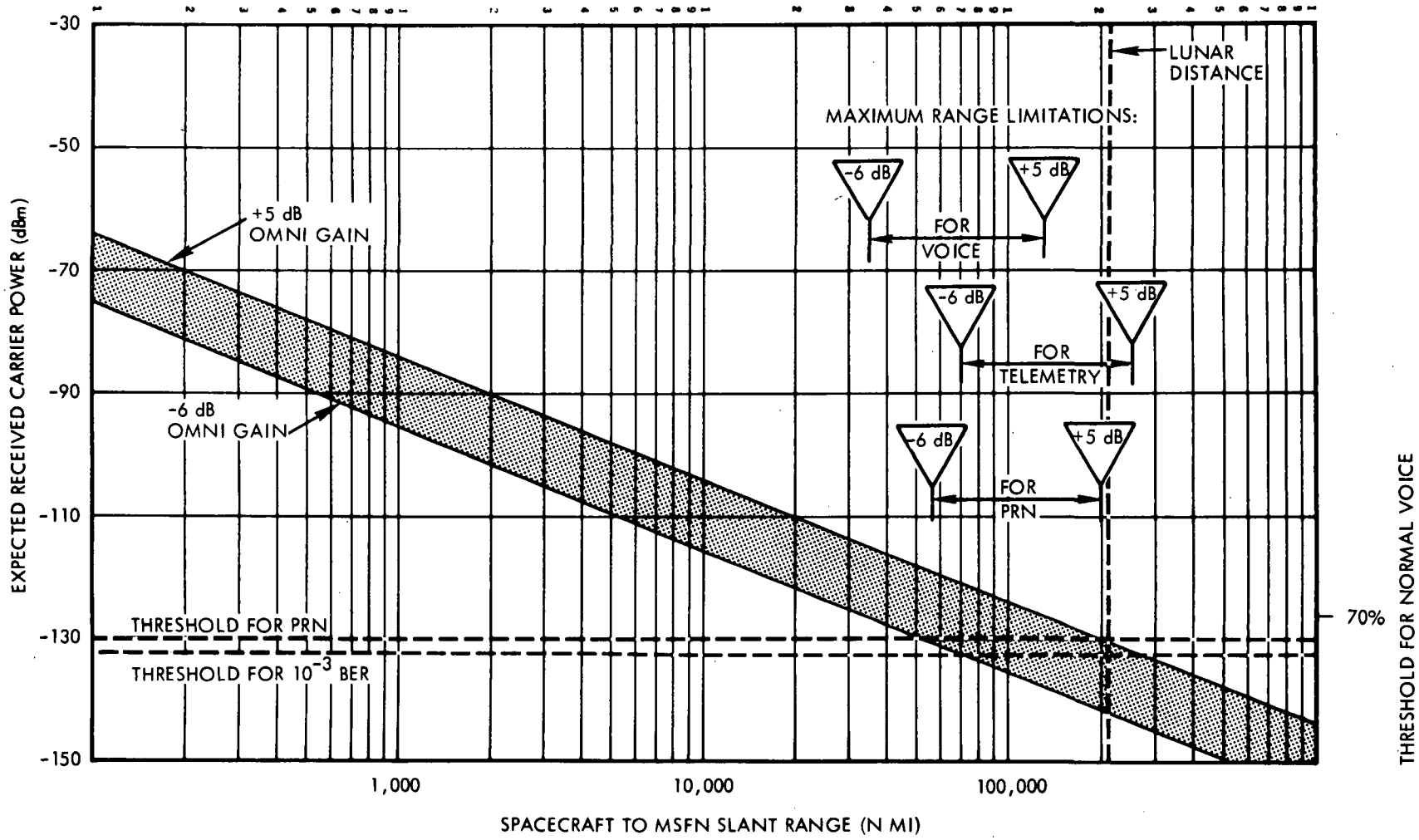


Figure E-31. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 3 - Quiet Sky)

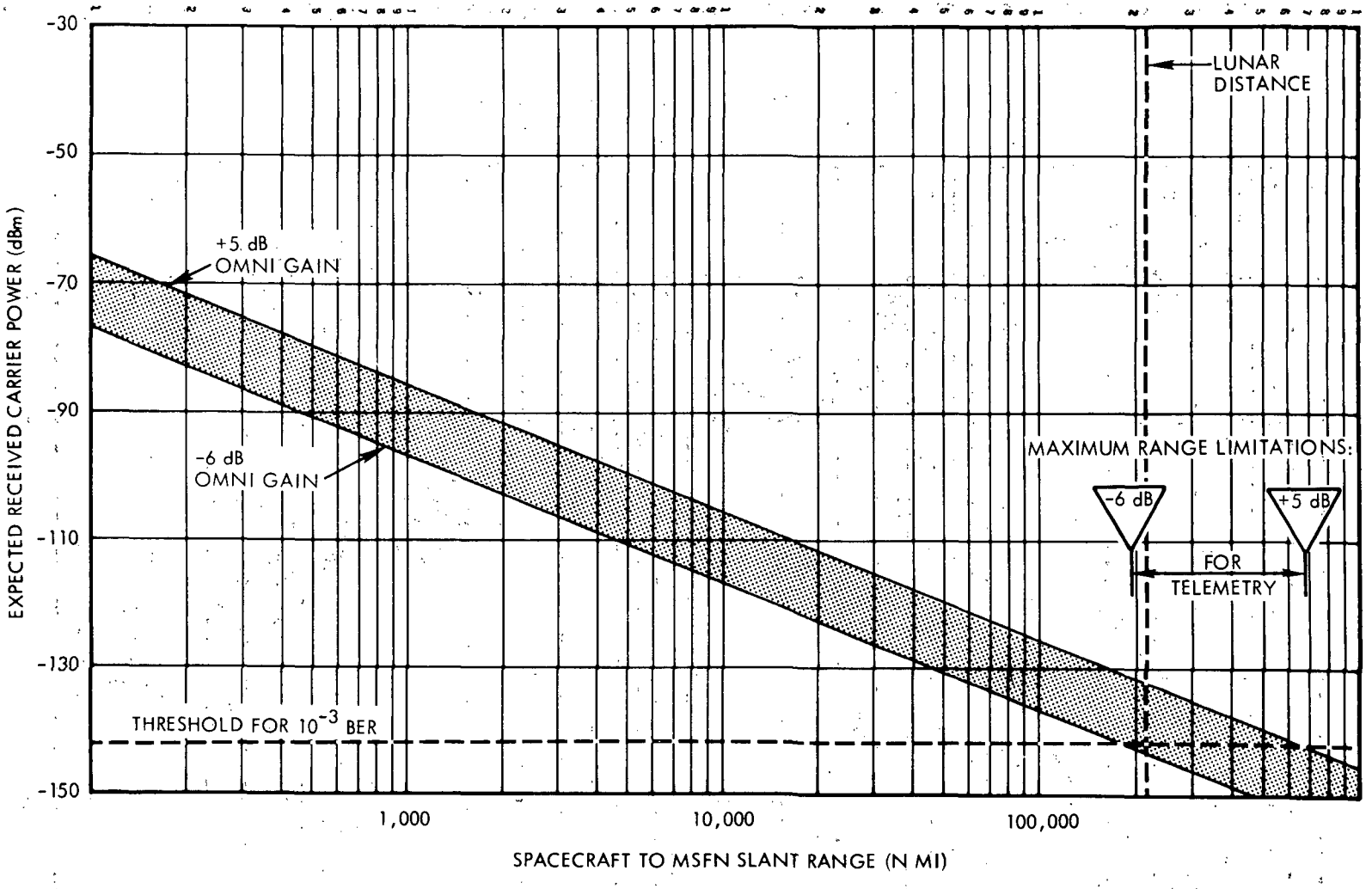


Figure E-32. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 5 - Quiet Sky)

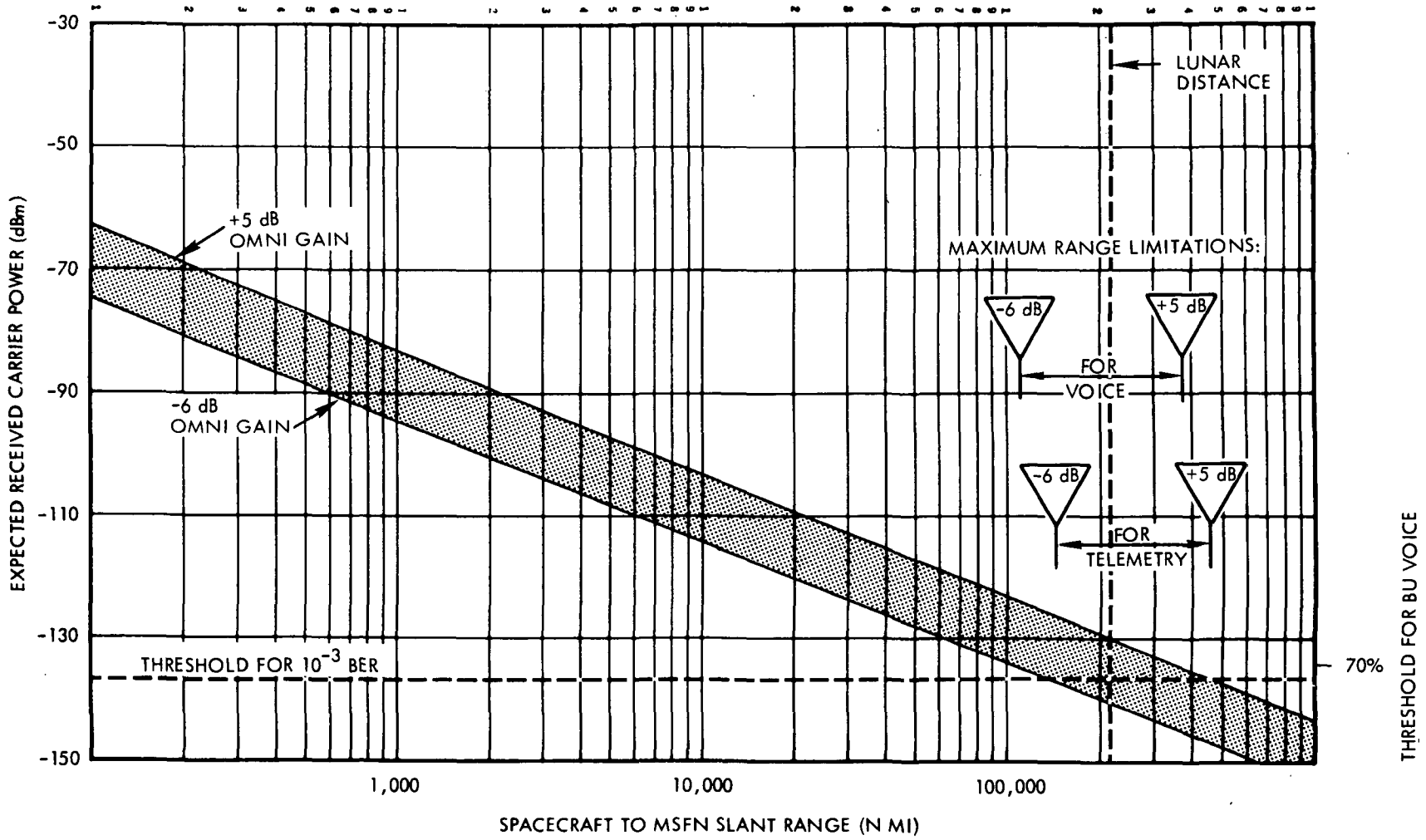


Figure E-33. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 8 - Quiet Sky)

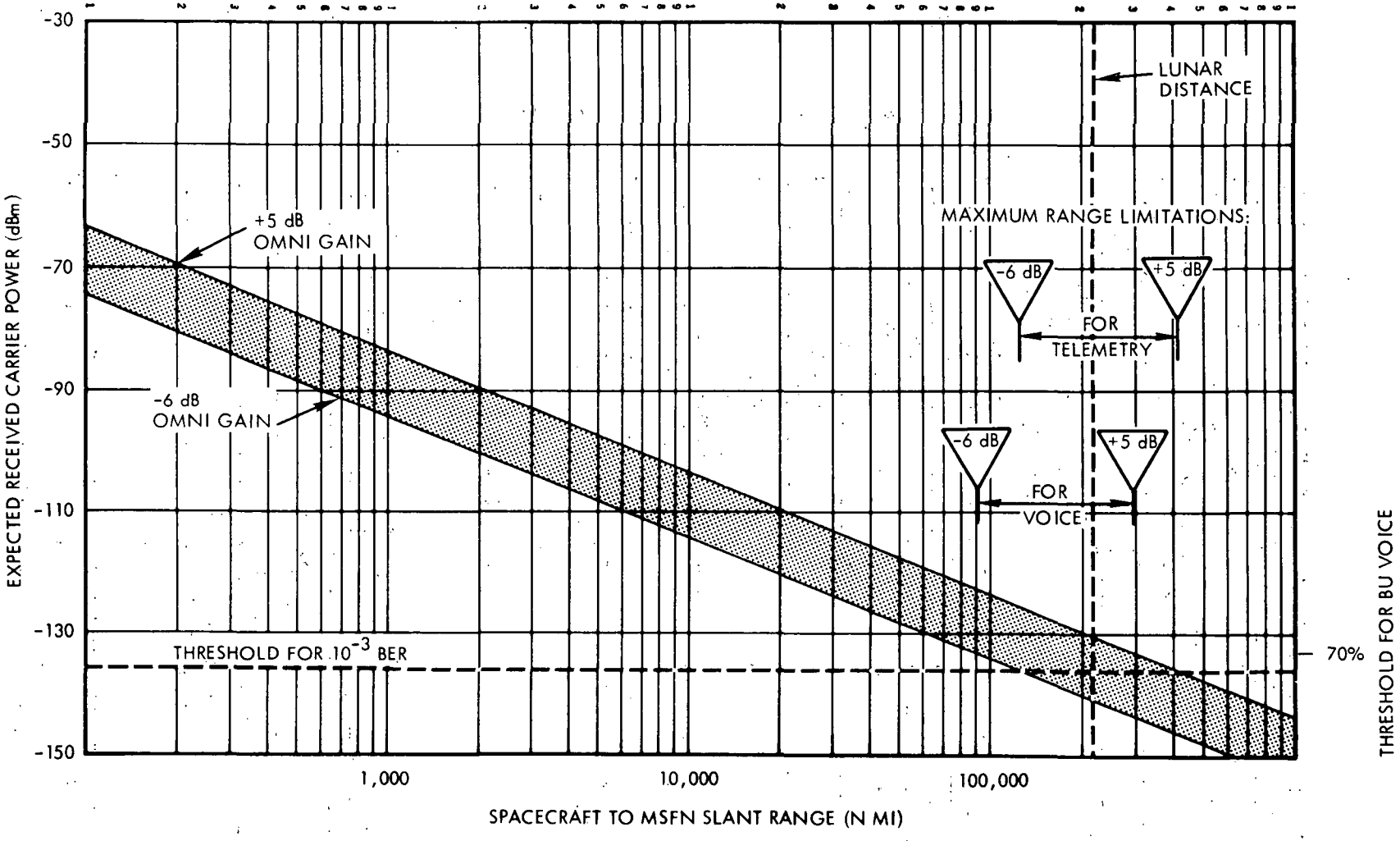


Figure E-34. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 8 - Moon at Zenith)

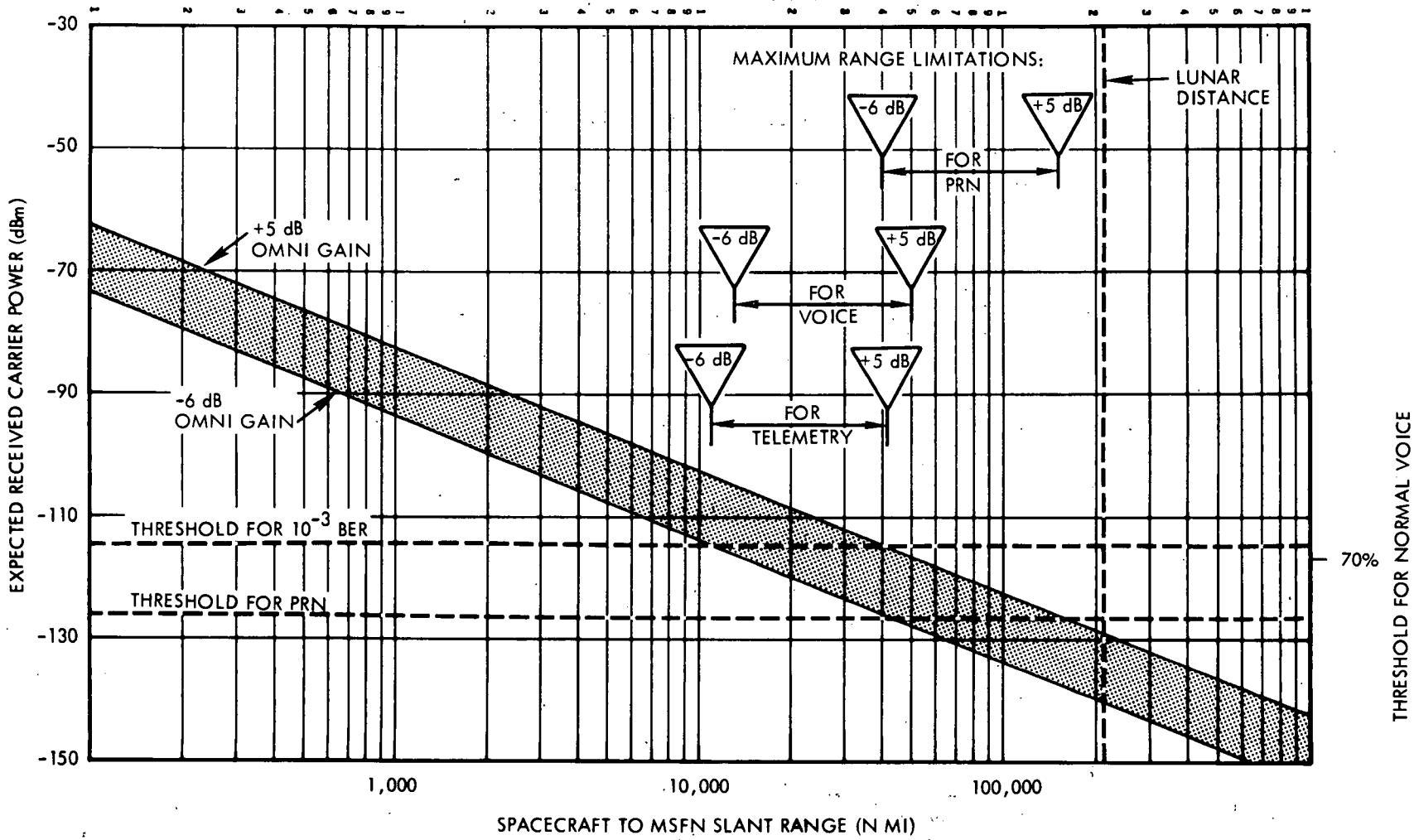


Figure E-35. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 2 - Quiet Sky)

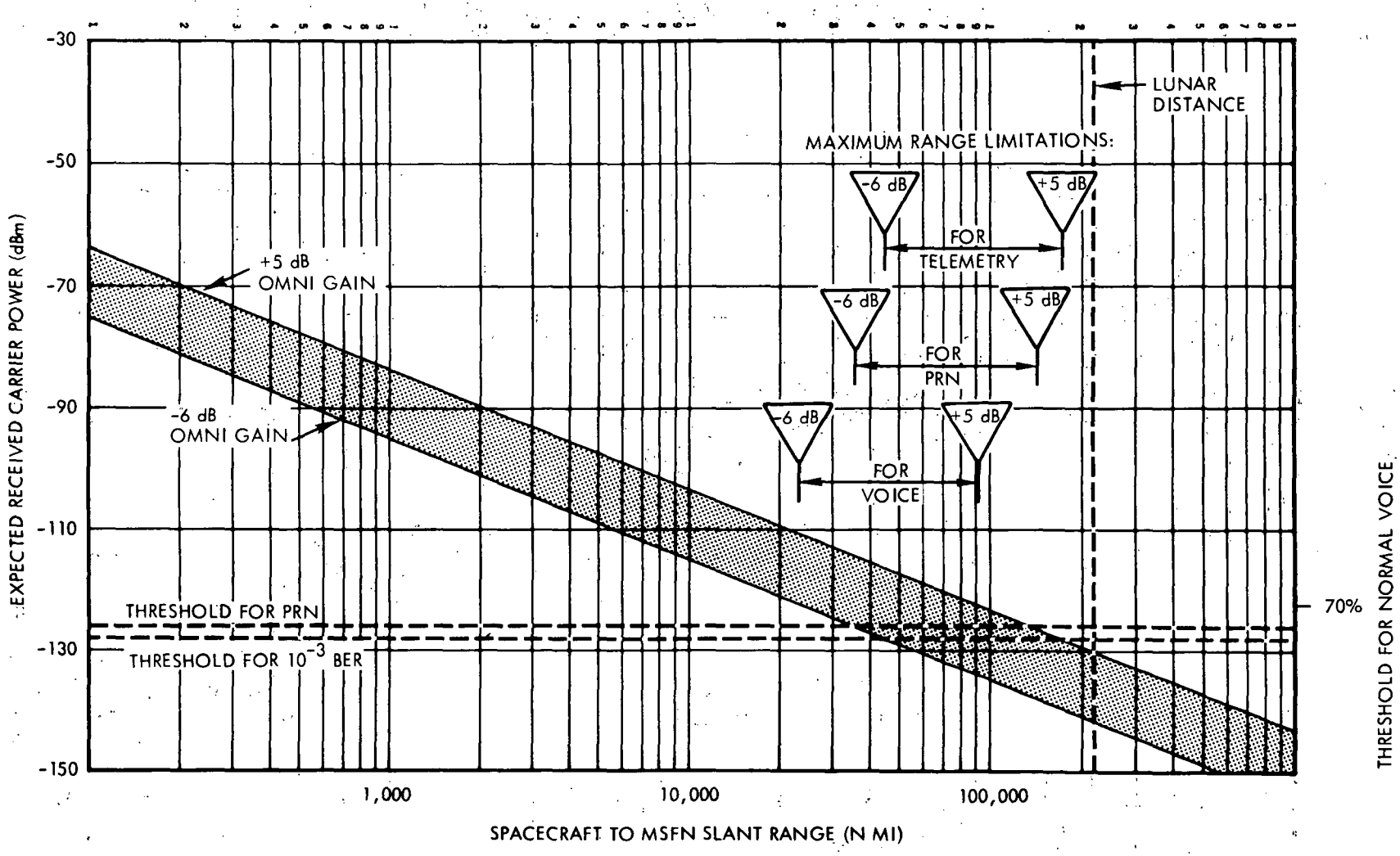


Figure E-36. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 3 - Quiet Sky)

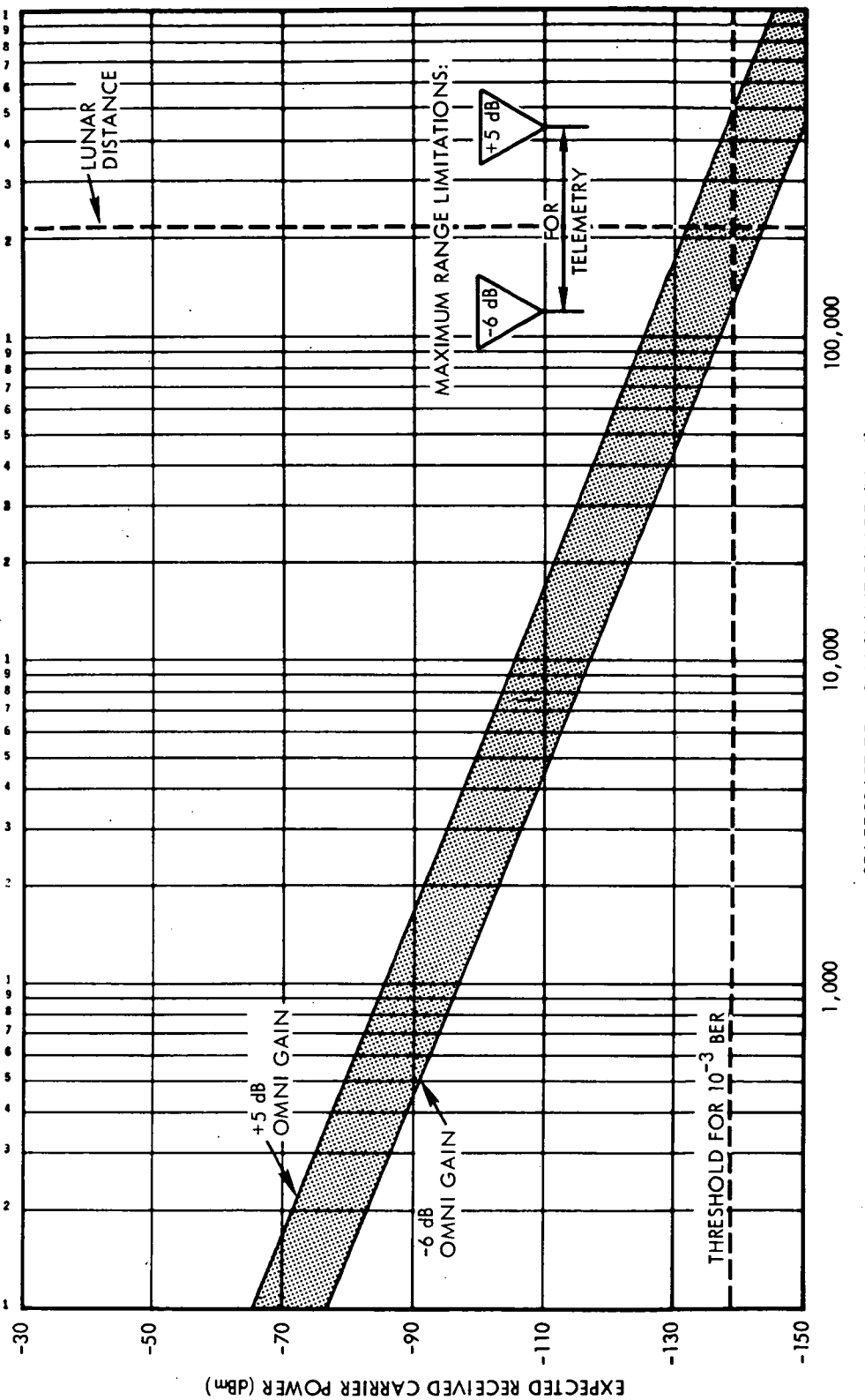


Figure E-37. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 5 - Quiet Sky)

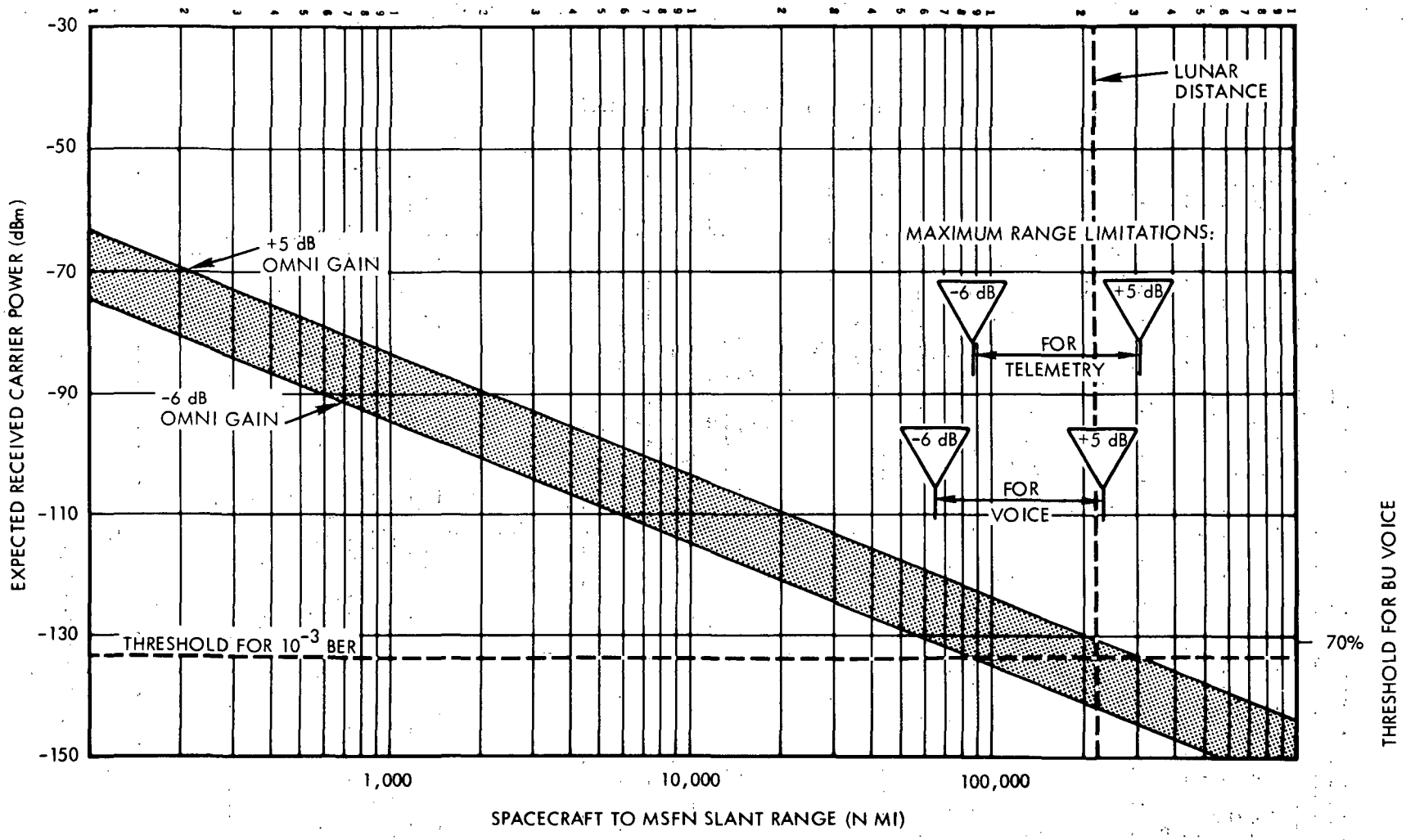


Figure E-38. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 8 - Quiet Sky)

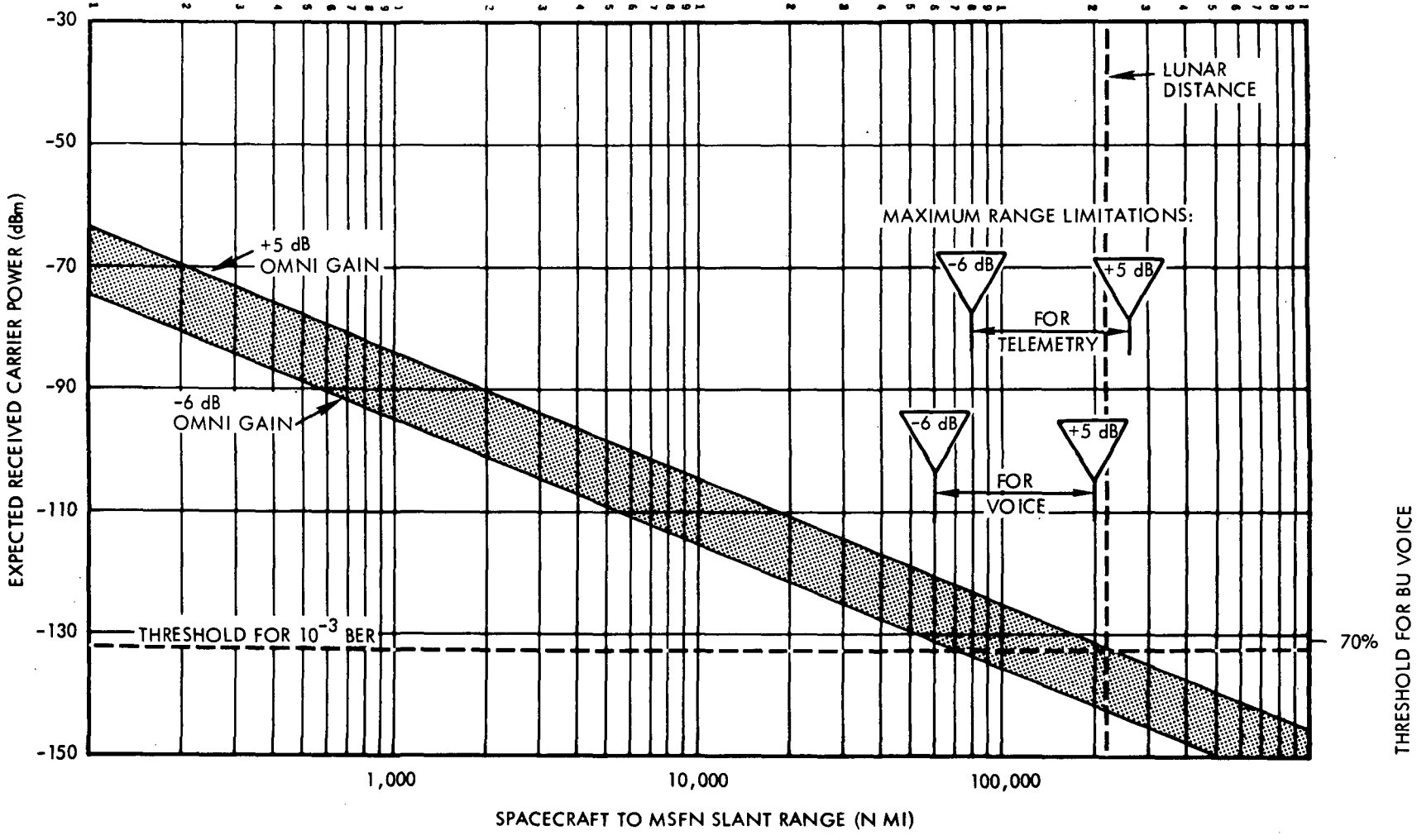


Figure E-39. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/CSM Omni Antennas Combination (Downlink PM Mode 8 - Moon at Zenith)

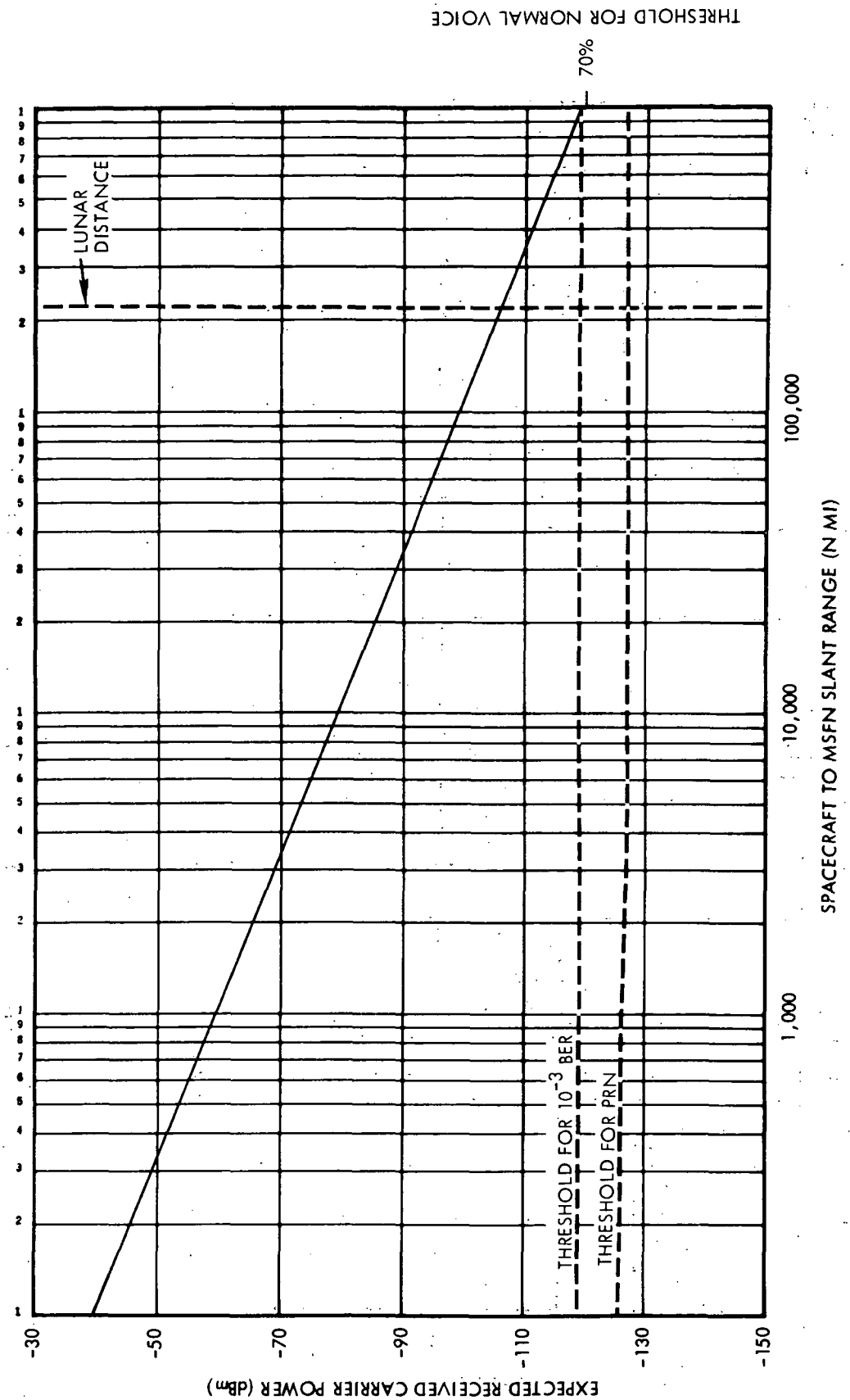


Figure E-40. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/LM Steerable Antenna Combination (Downlink PM Mode 2 - Moon at Zenith)

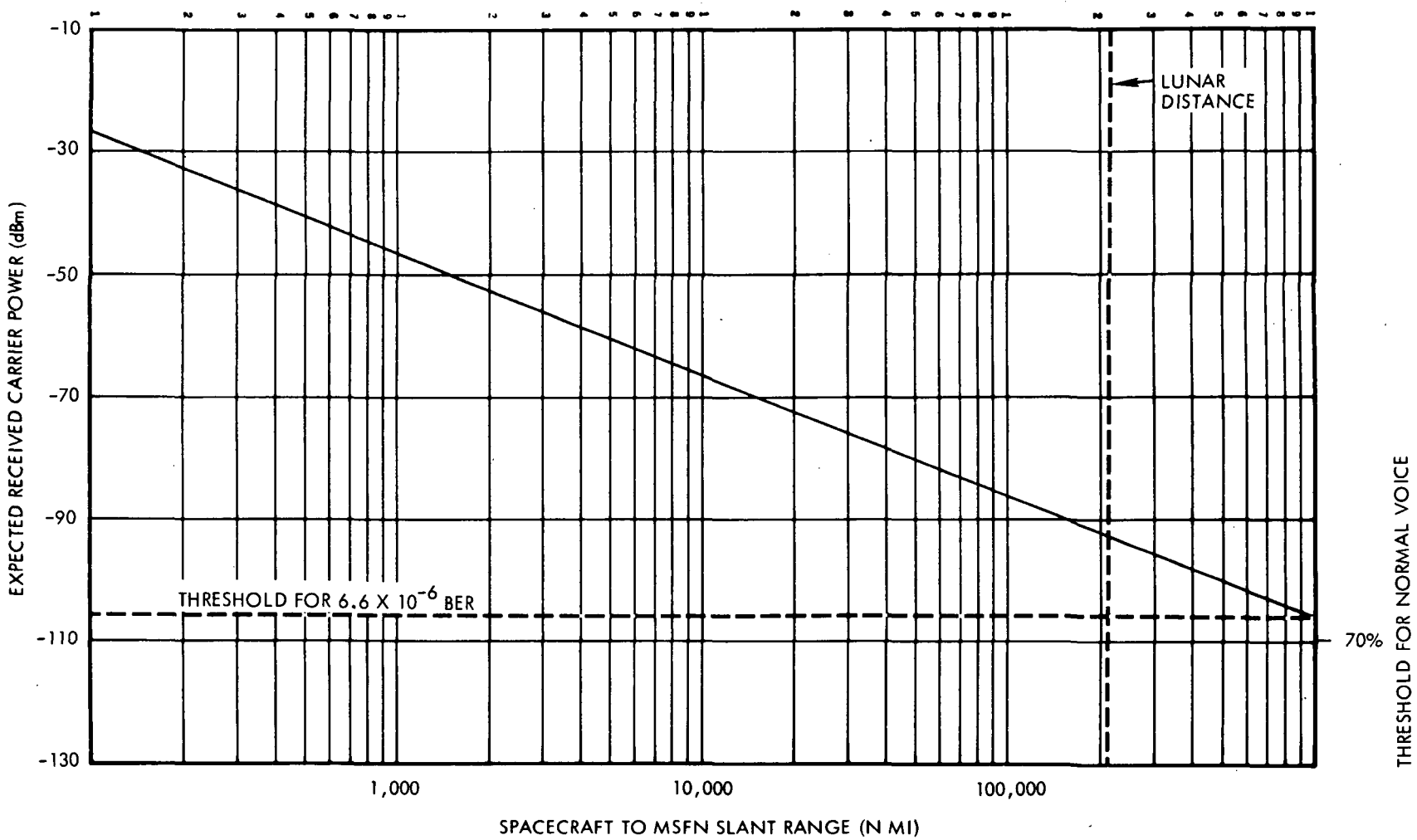


Figure E-41. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled or Uncooled MSFN/LM Steerable Antenna Combination (Uplink PM Mode 6)

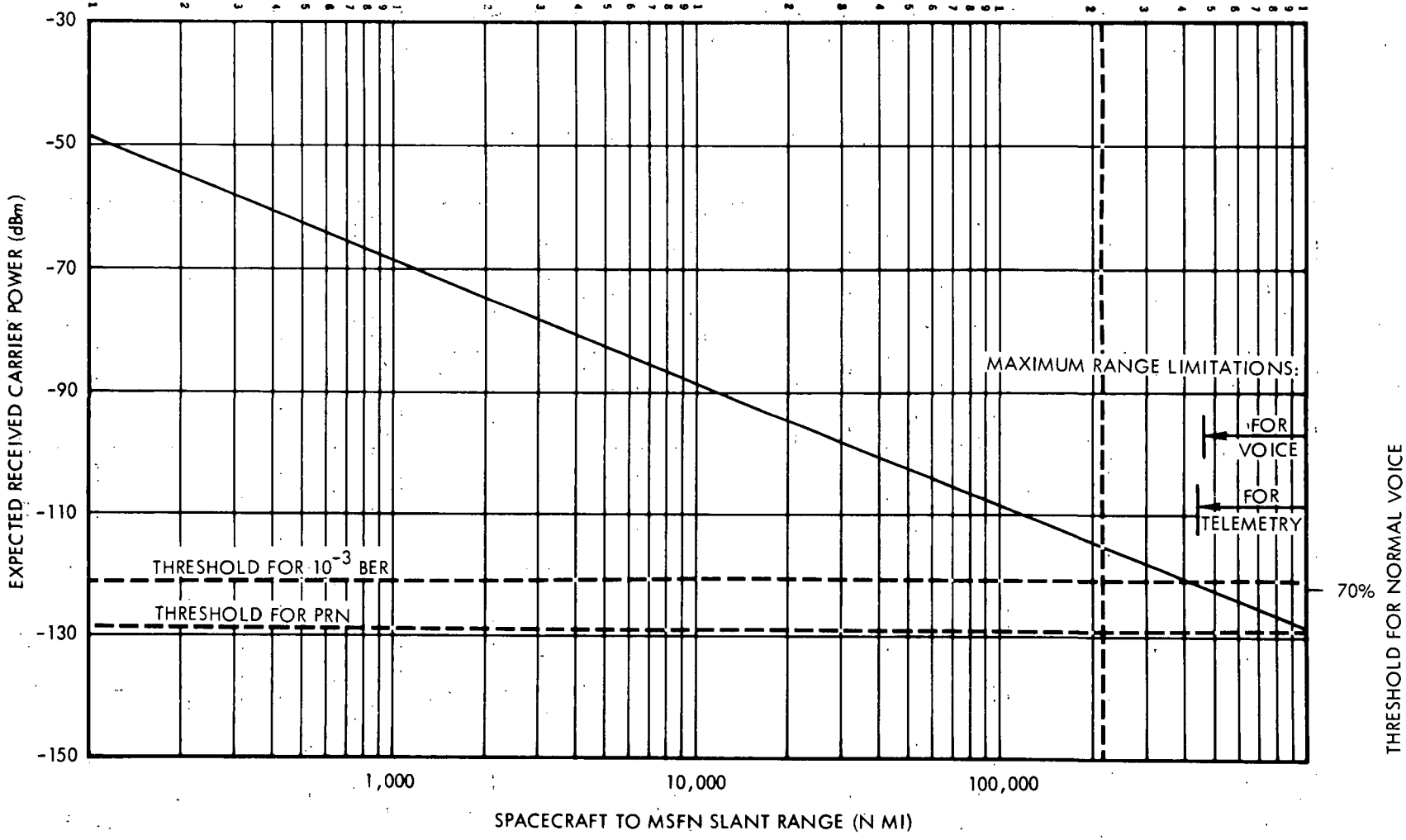


Figure E-42. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/LM Steerable Antenna Combination (Downlink PM Mode 2 - Moon at Zenith)

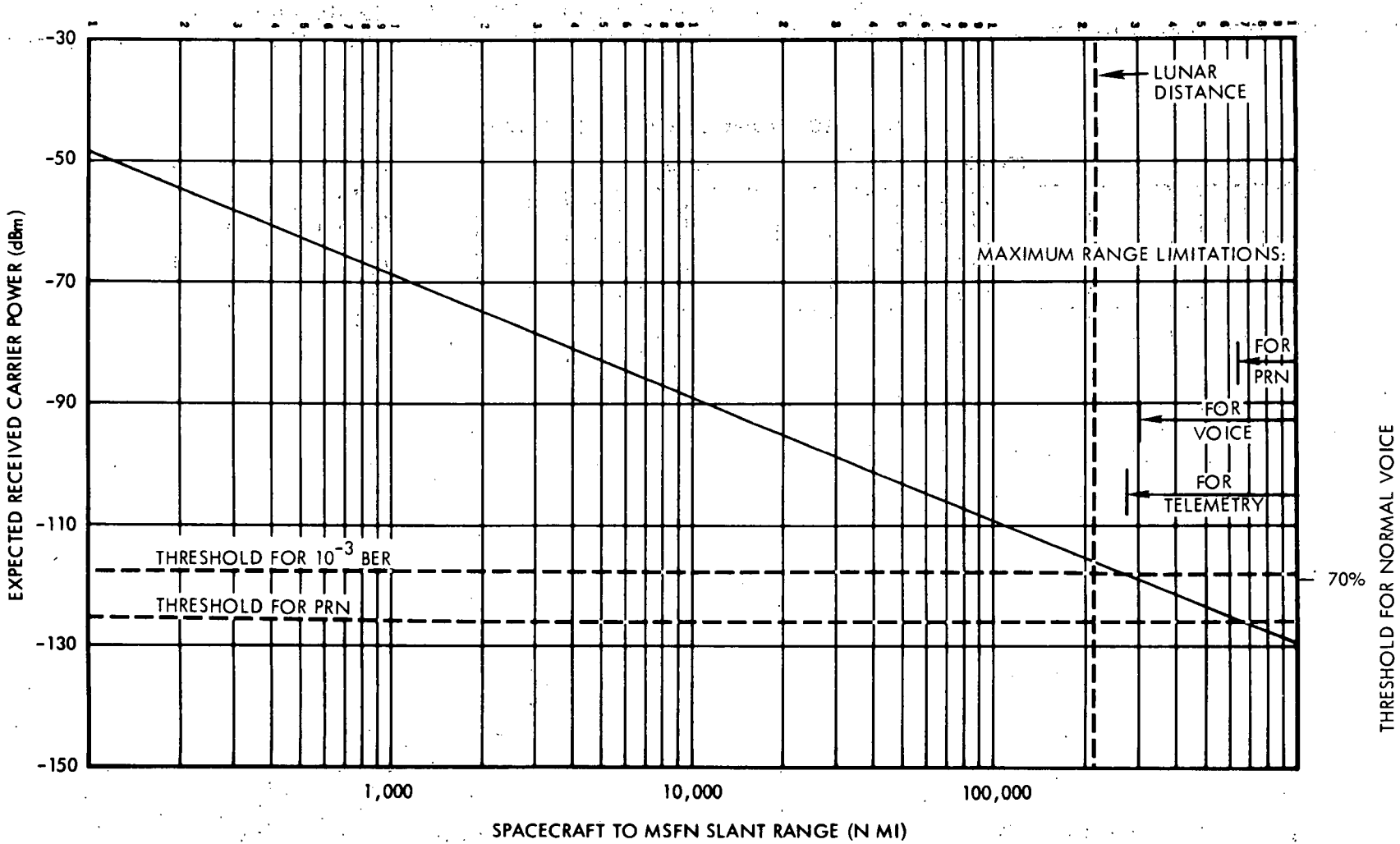


Figure E-43. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/LM Steerable Antenna Combination (Downlink PM Mode 2 - Moon at Zenith)

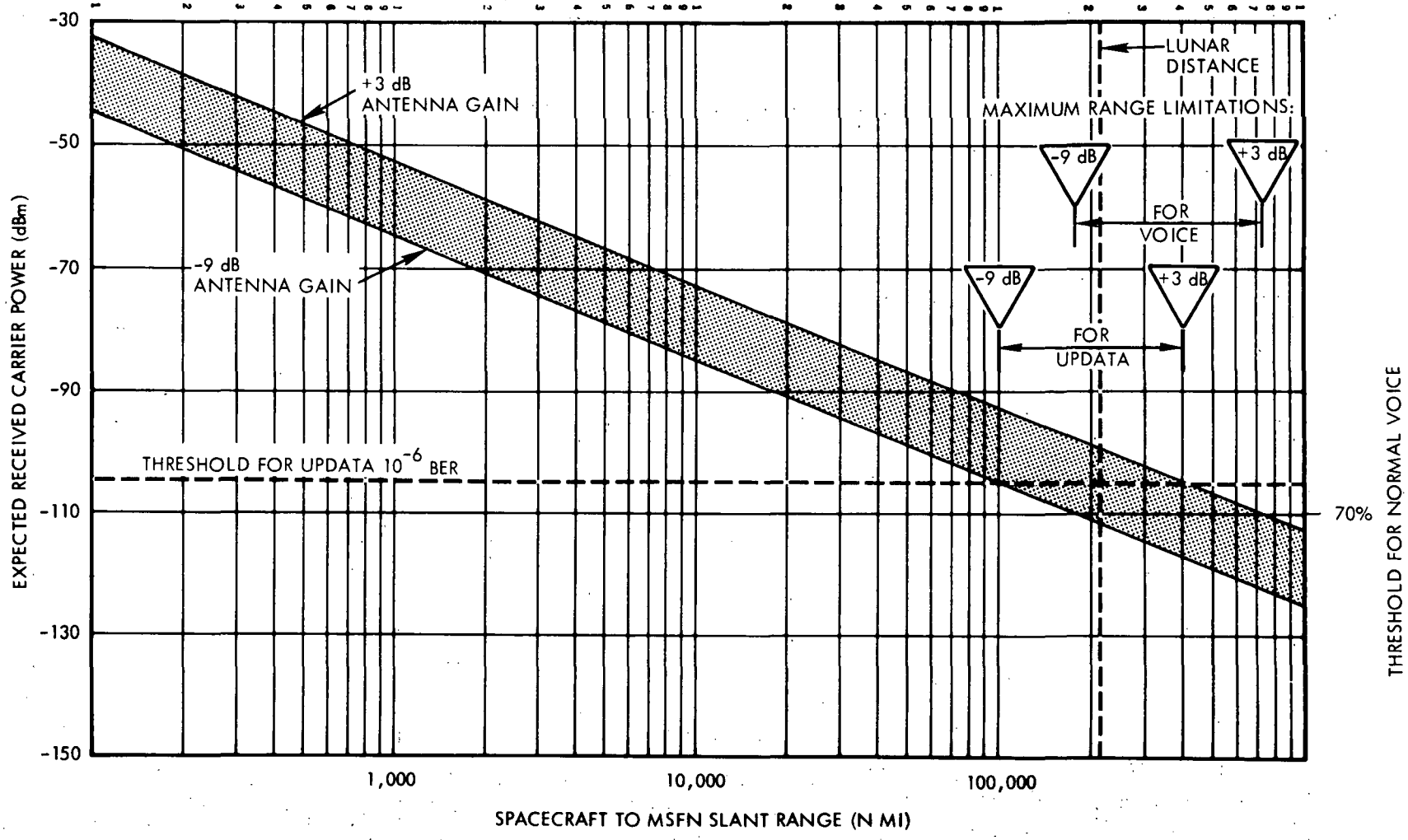


Figure E-44. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/LM S-band Inflight Antennas Combination (Uplink Mode 6)

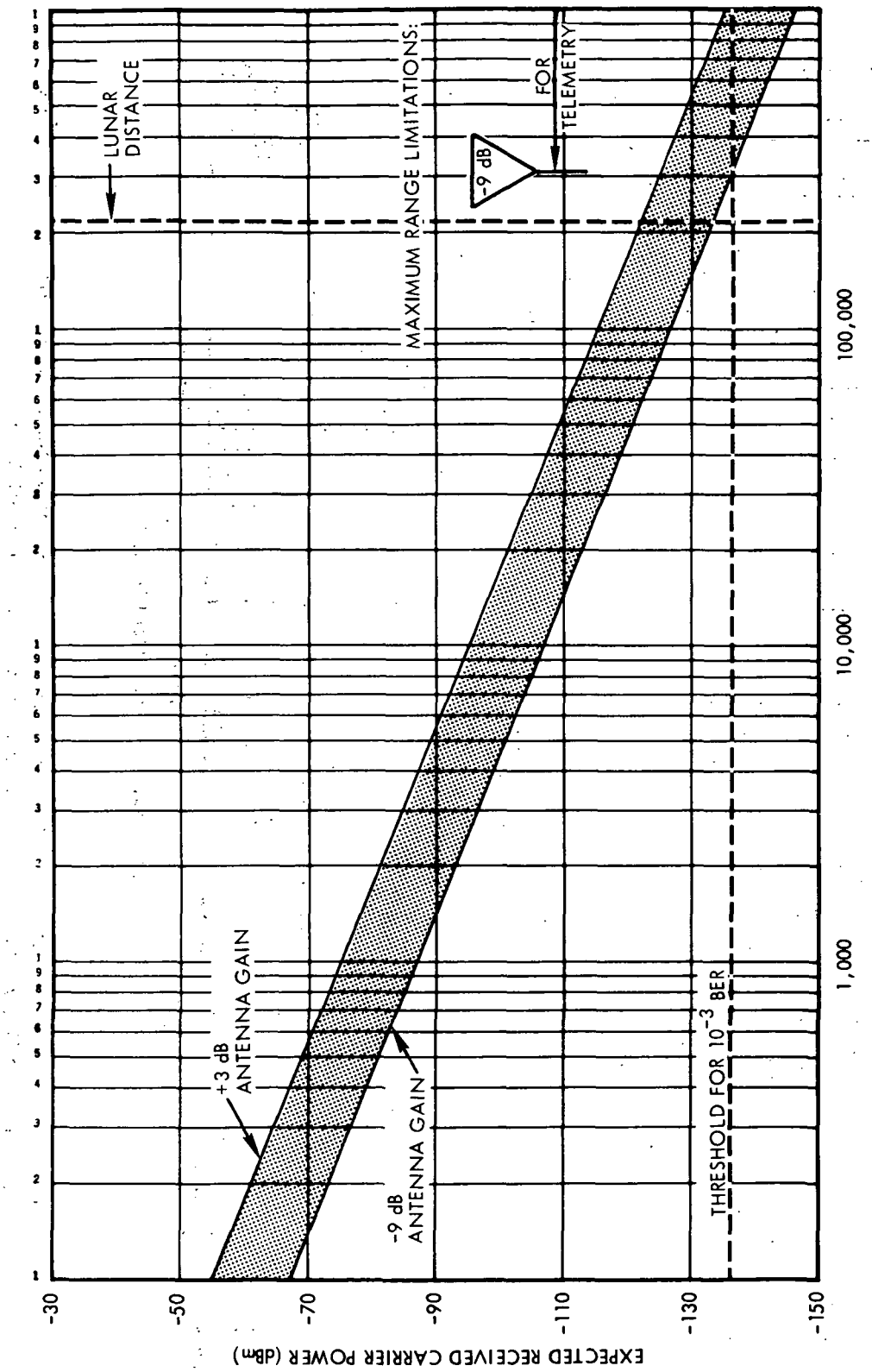


Figure E-45. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 3 - Moon at Zenith)

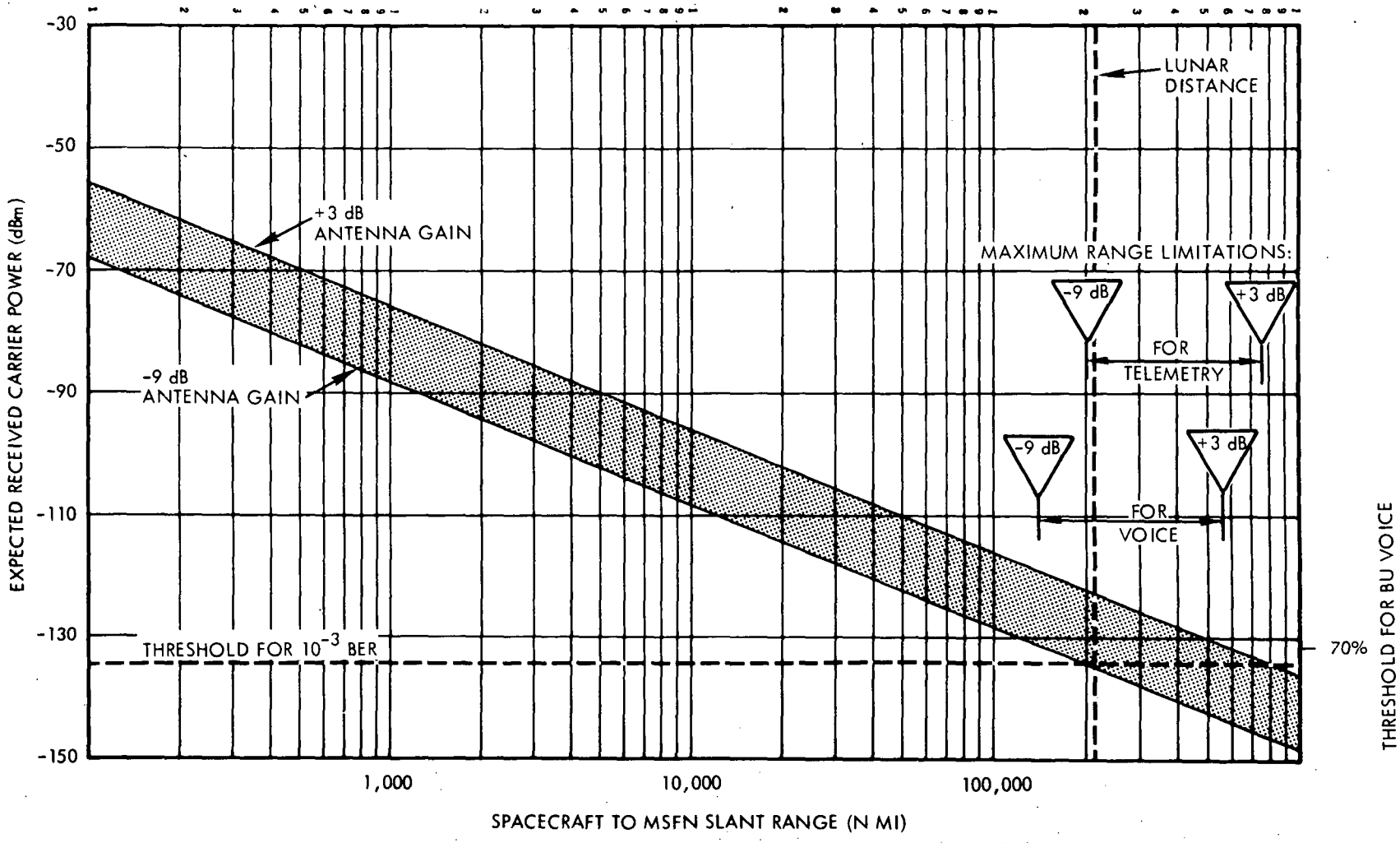


Figure E-46. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 4 - Moon at Zenith)

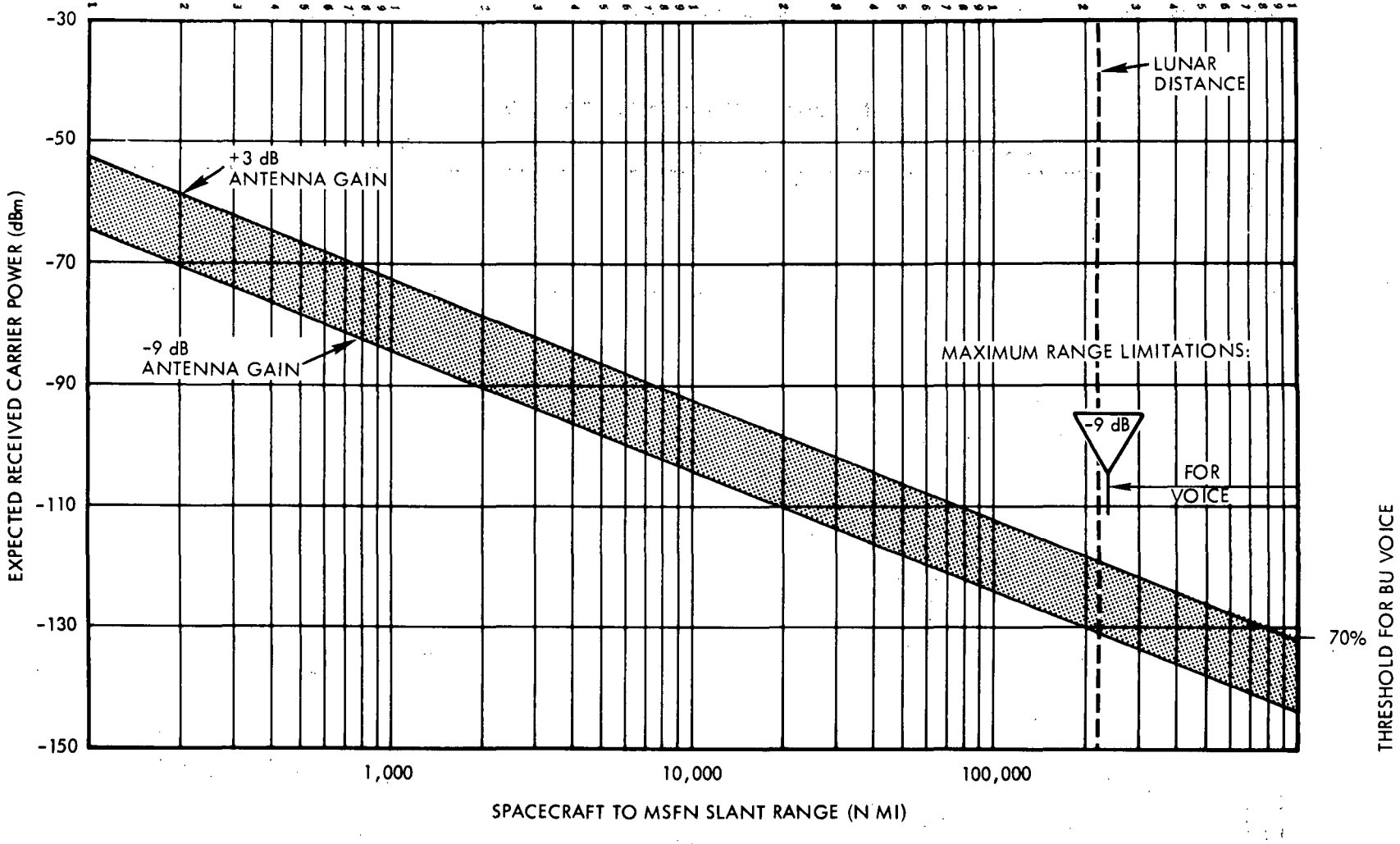


Figure E-47. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 85-foot MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 5 - Moon at Zenith)

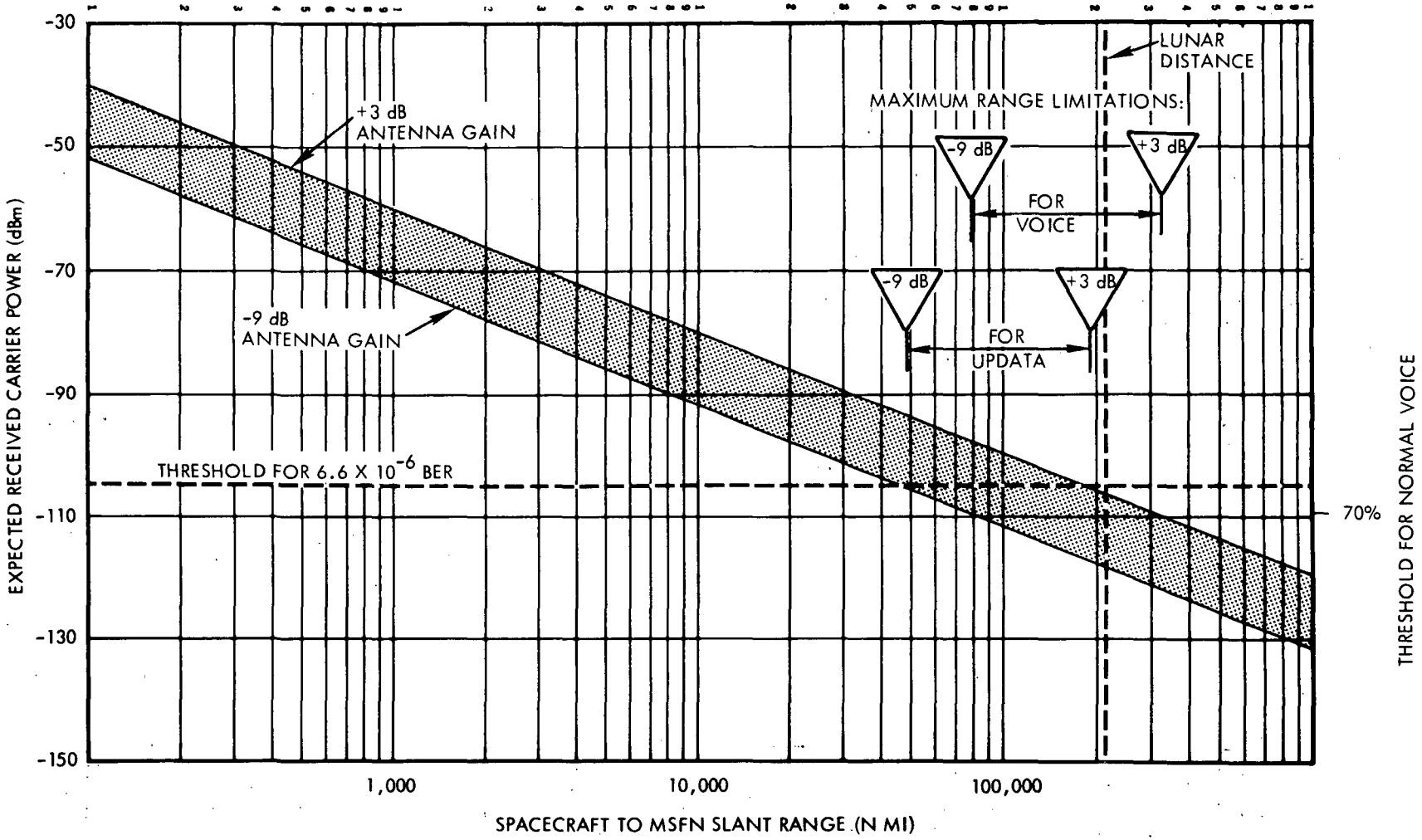


Figure E-48. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled or Uncooled MSFN/LM S-band Inflight Antennas Combination (Uplink PM Mode 6)

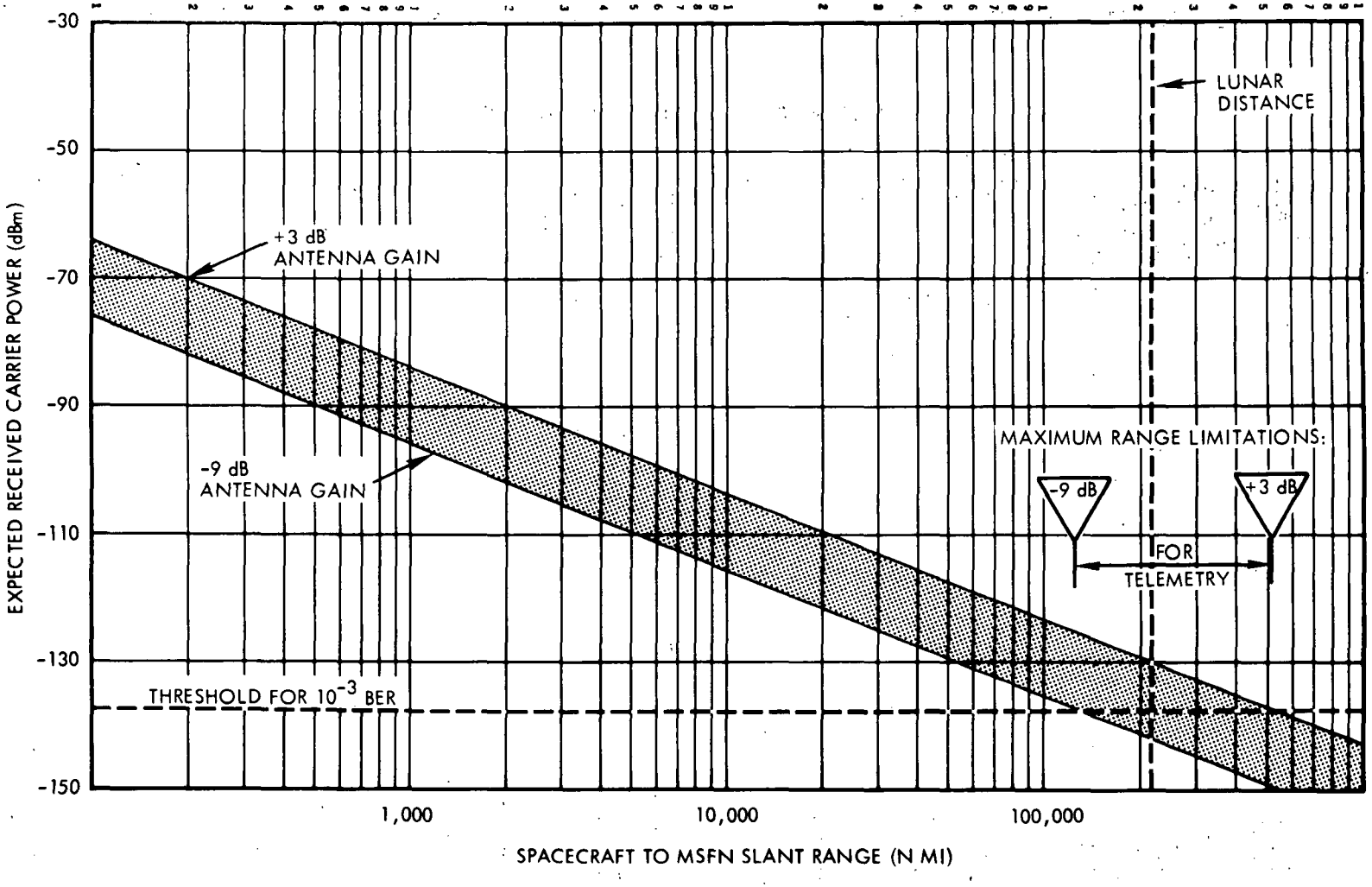


Figure E-49. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 3 - Moon at Zenith)

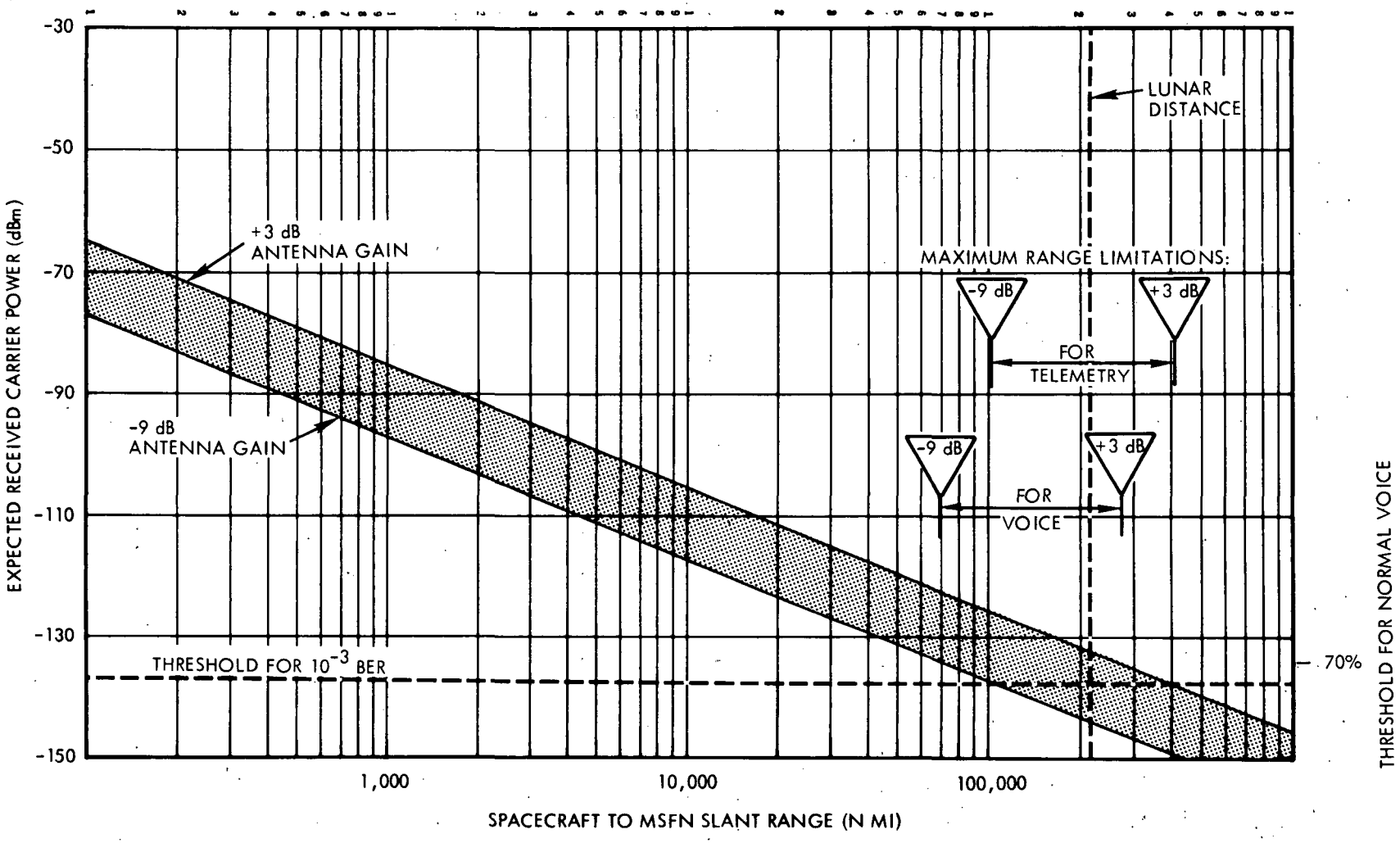


Figure E-50. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 4 - Moon at Zenith)

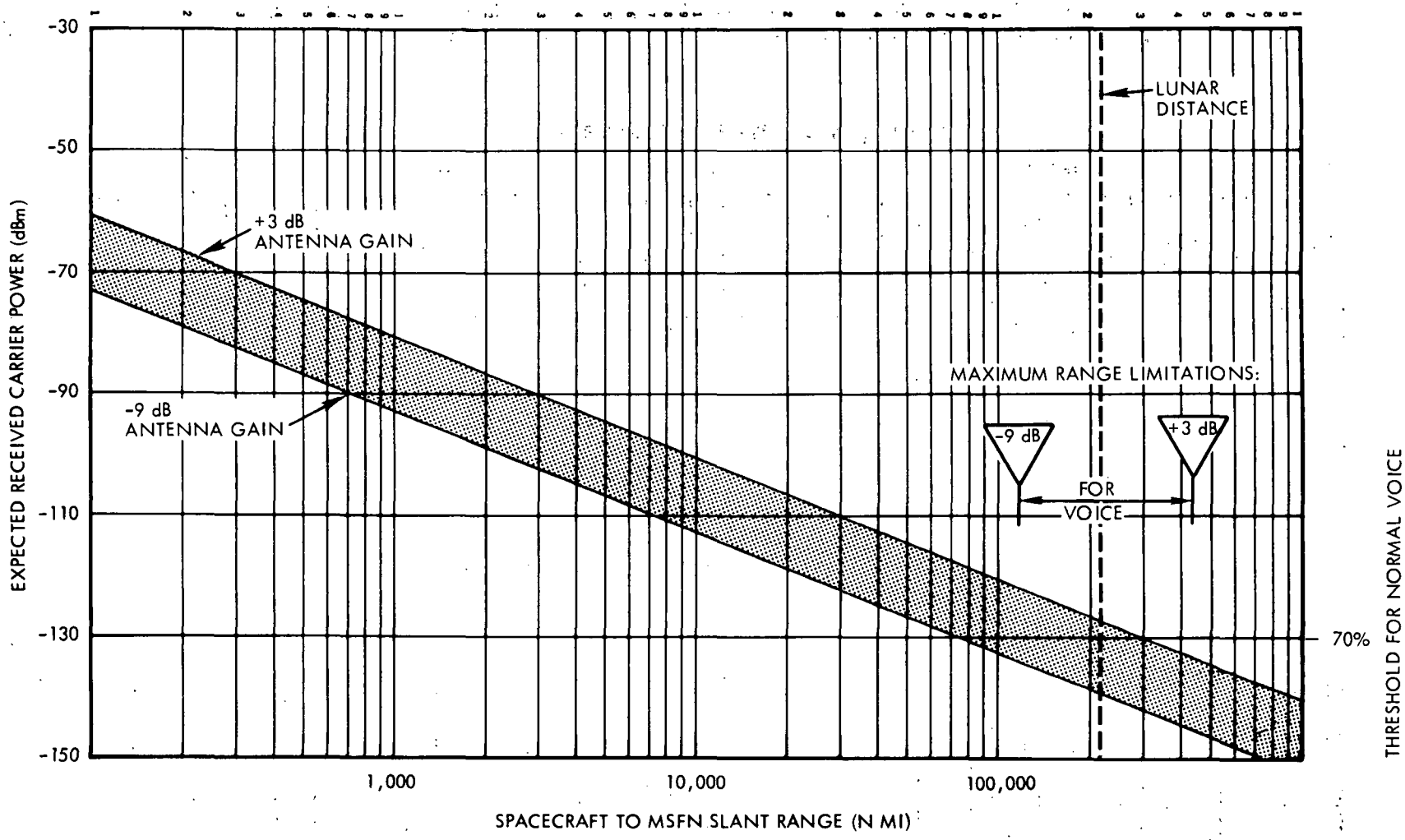


Figure E-51. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Cooled MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 5 - Moon at Zenith)

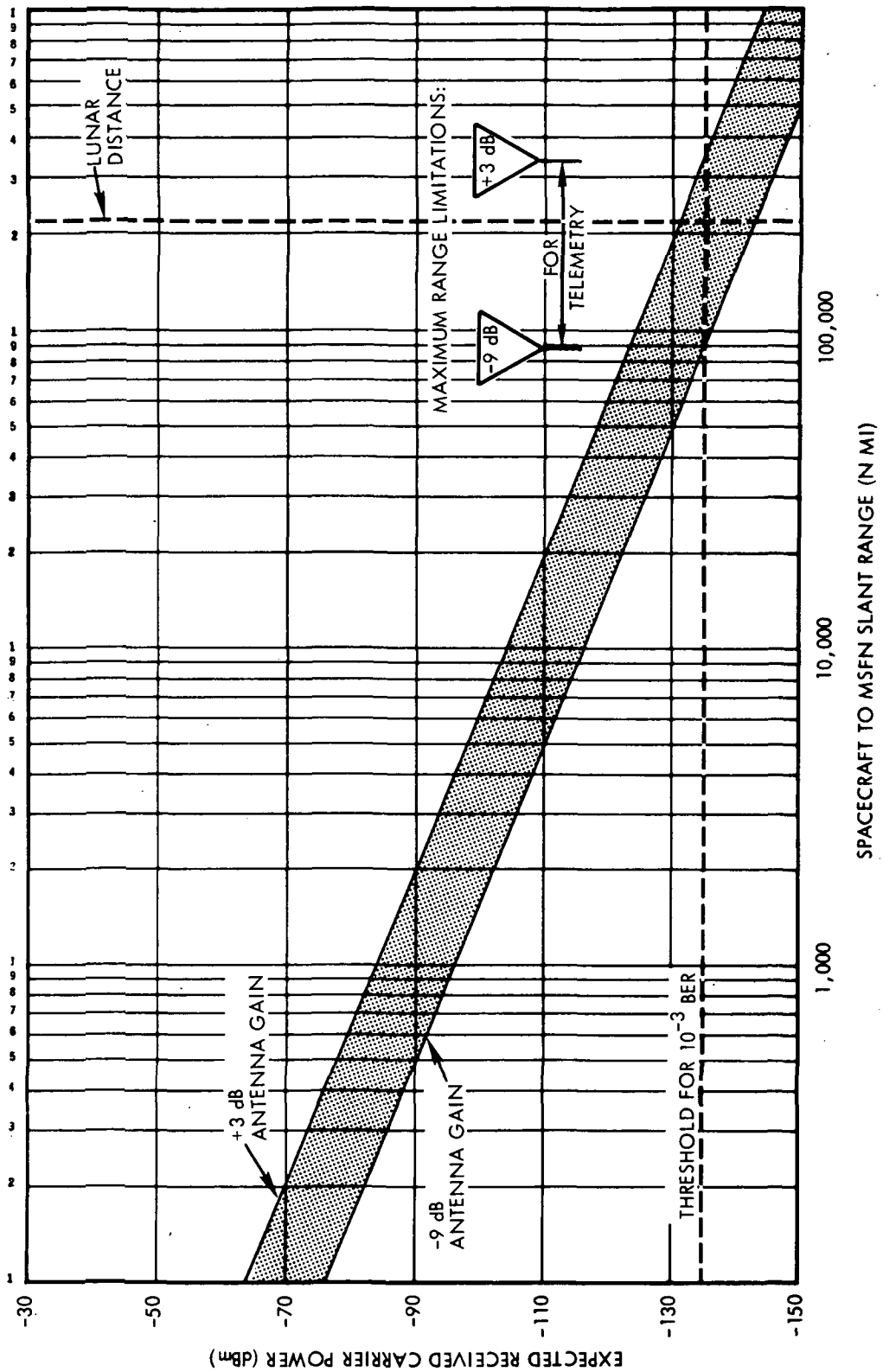


Figure E-52. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 3 - Moon at Zenith)

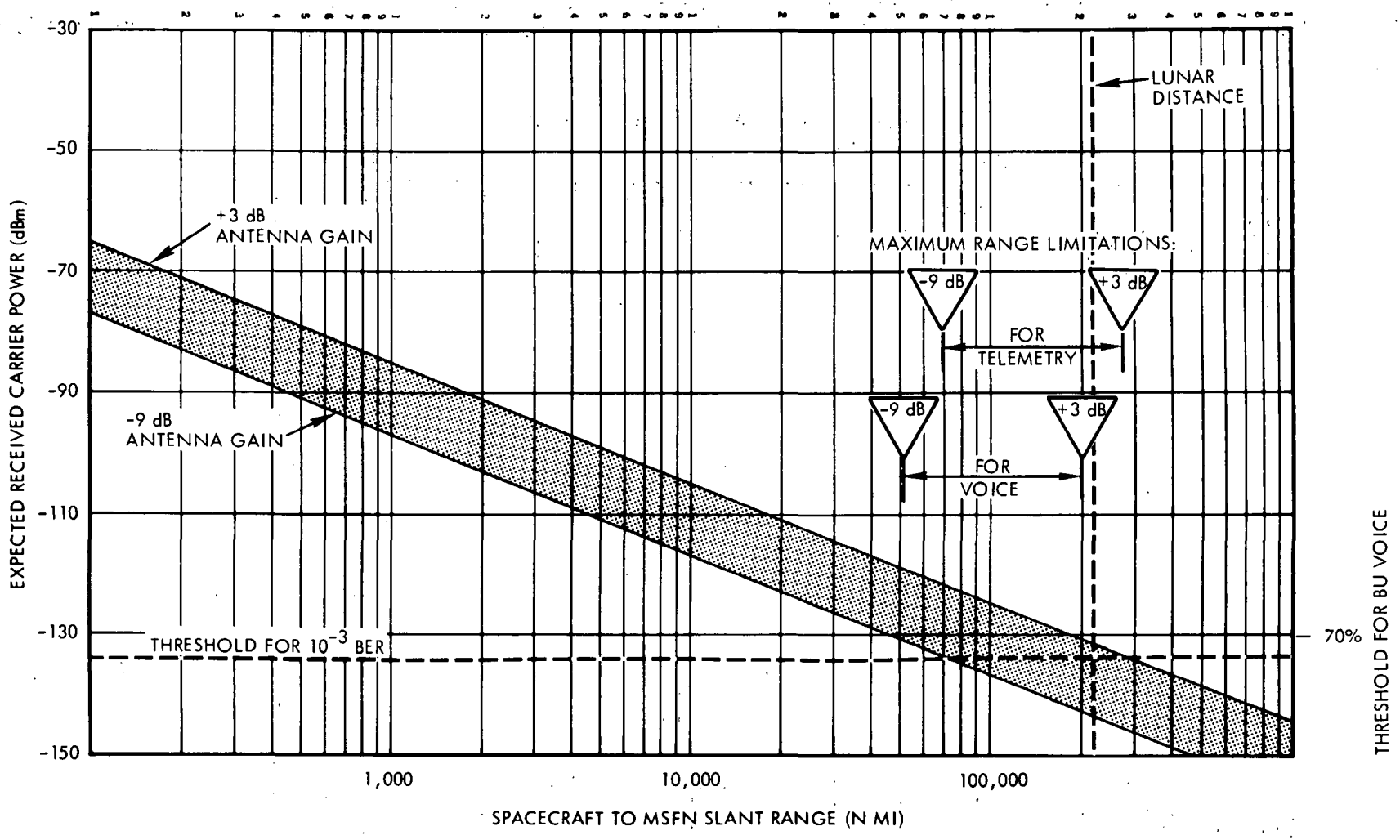


Figure E-53. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 4 - Moon at Zenith)

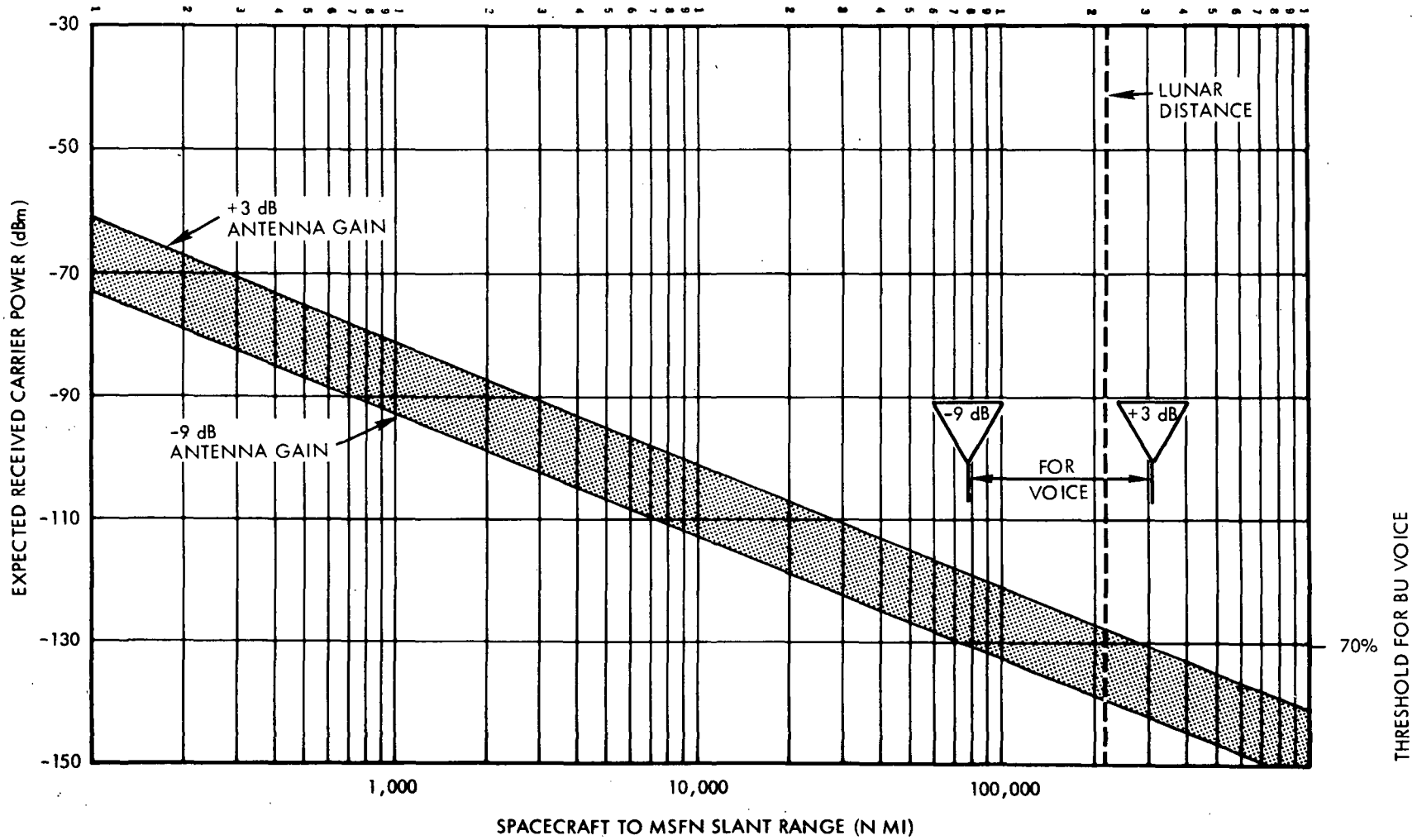
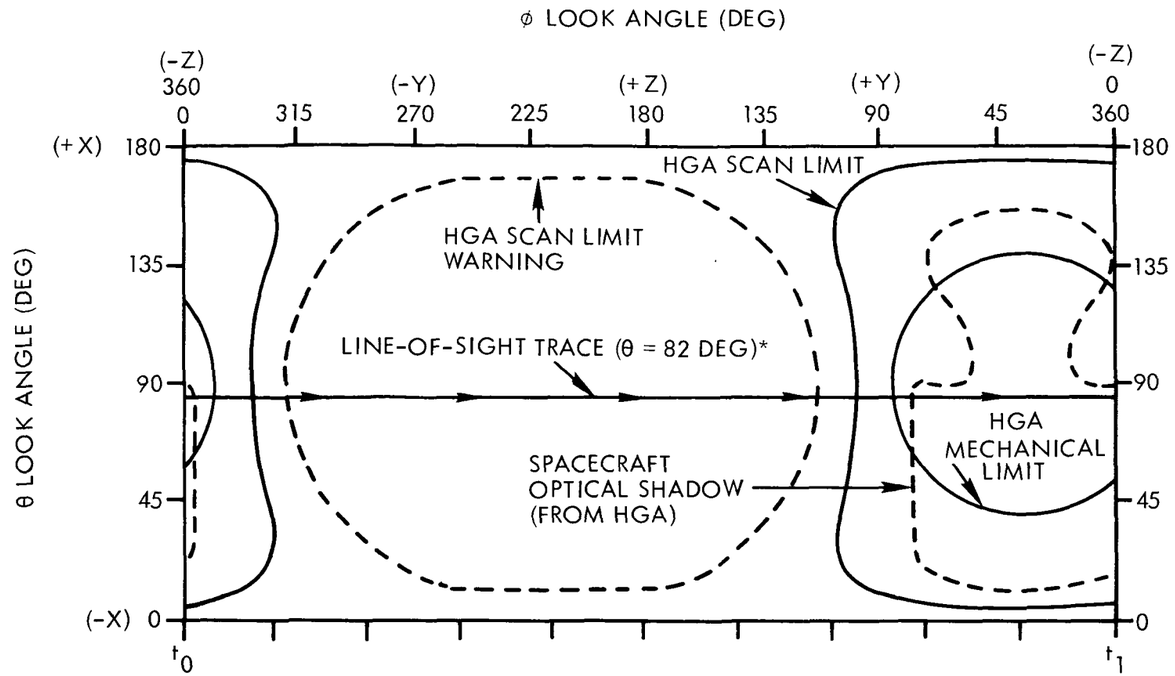
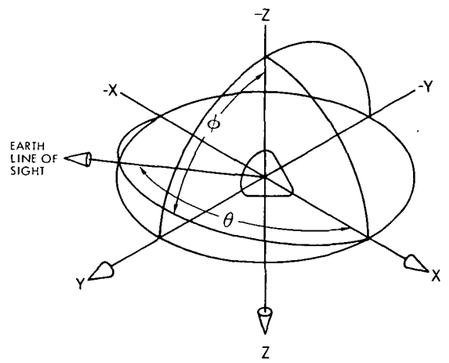


Figure E-54. Expected Apollo 10 MSFN Received Carrier Power versus Spacecraft to MSFN Slant Range for 30-foot Uncooled MSFN/LM S-band Inflight Antennas Combination (Downlink PM Mode 5 - Moon at Zenith)





Note:

At any specific time during the mission, the plot can be converted to real time by identifying, at that particular time, the ϕ angle and the roll rate. For example, if ϕ should be 0 deg at 10 hr 37 min mission elapsed time, then the initial point on the graph, t_0, becomes 10 hr 37 min. The other end point, t_1, on the time axis is then determined by the roll rate; for example, t_1 would become 11 hr 37 min for 1 rev/hr, 11 hr 7 min for 2 rev/hr, etc.

*θ (all ϕ) will vary slightly from ground station to ground station but no more than 1 to 2 deg at lunar range and about 6 to 8 deg (max) at 50,000 n mi. During the translunar and transearth coast periods of F mission, θ will be constrained during PTC to lie approximately between 77 deg and 87 deg. (The general trend shows θ tends to increase slightly with range, within these approximate limits).

Figure E-55. CSM/MSFN Line-of-Sight Trace Through CSM High-Gain Antenna Coverage Sphere During PTC

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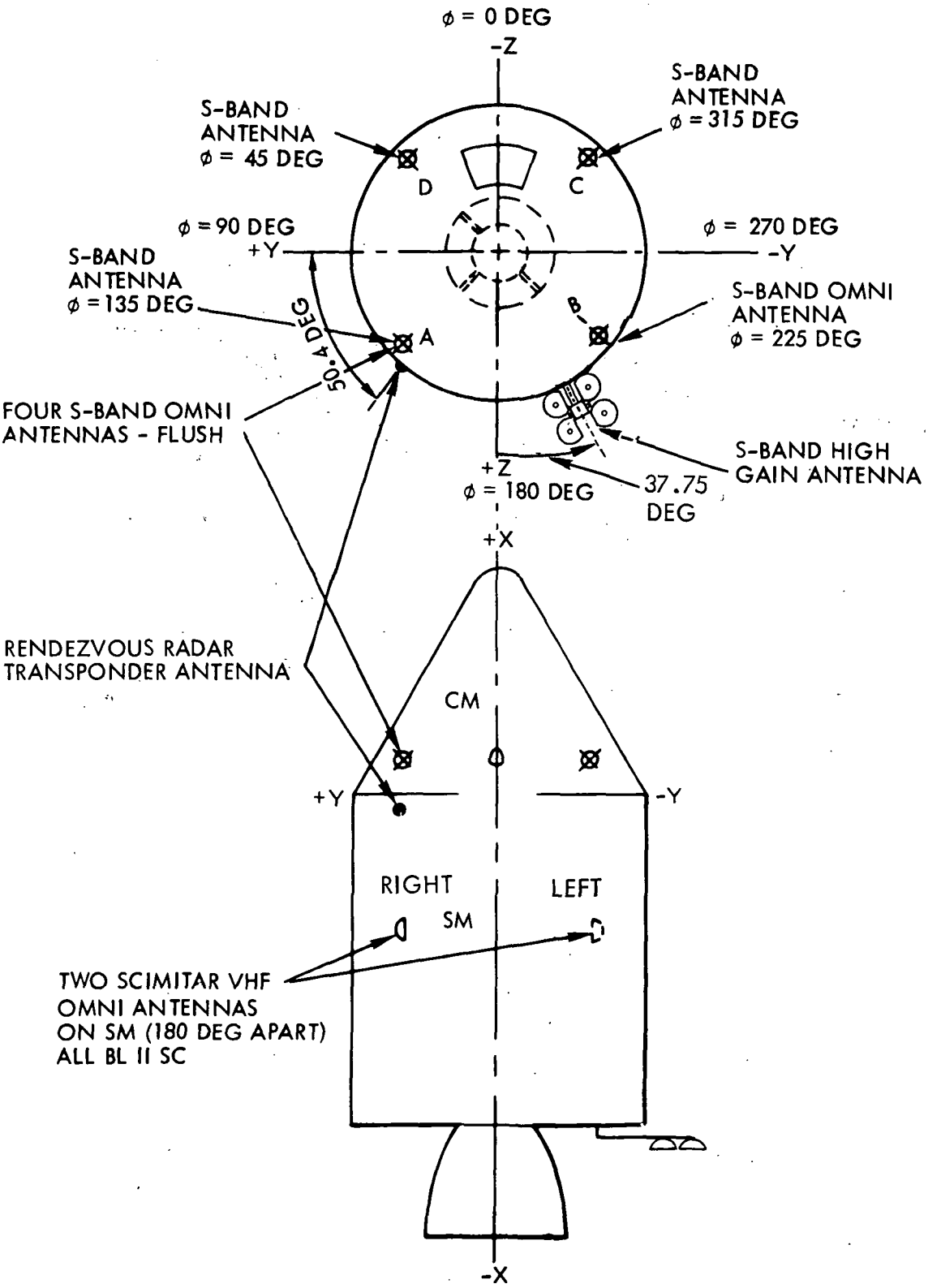
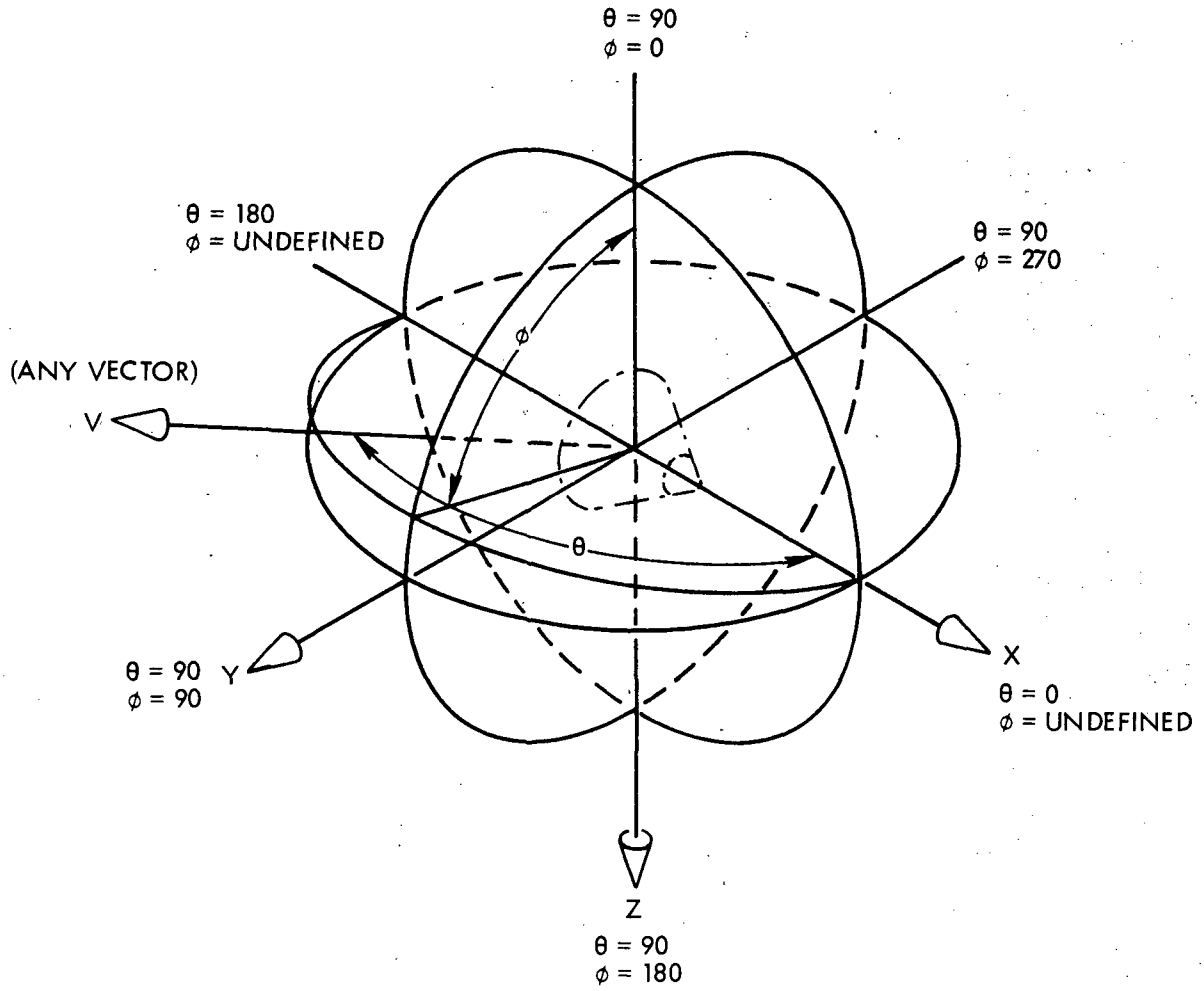


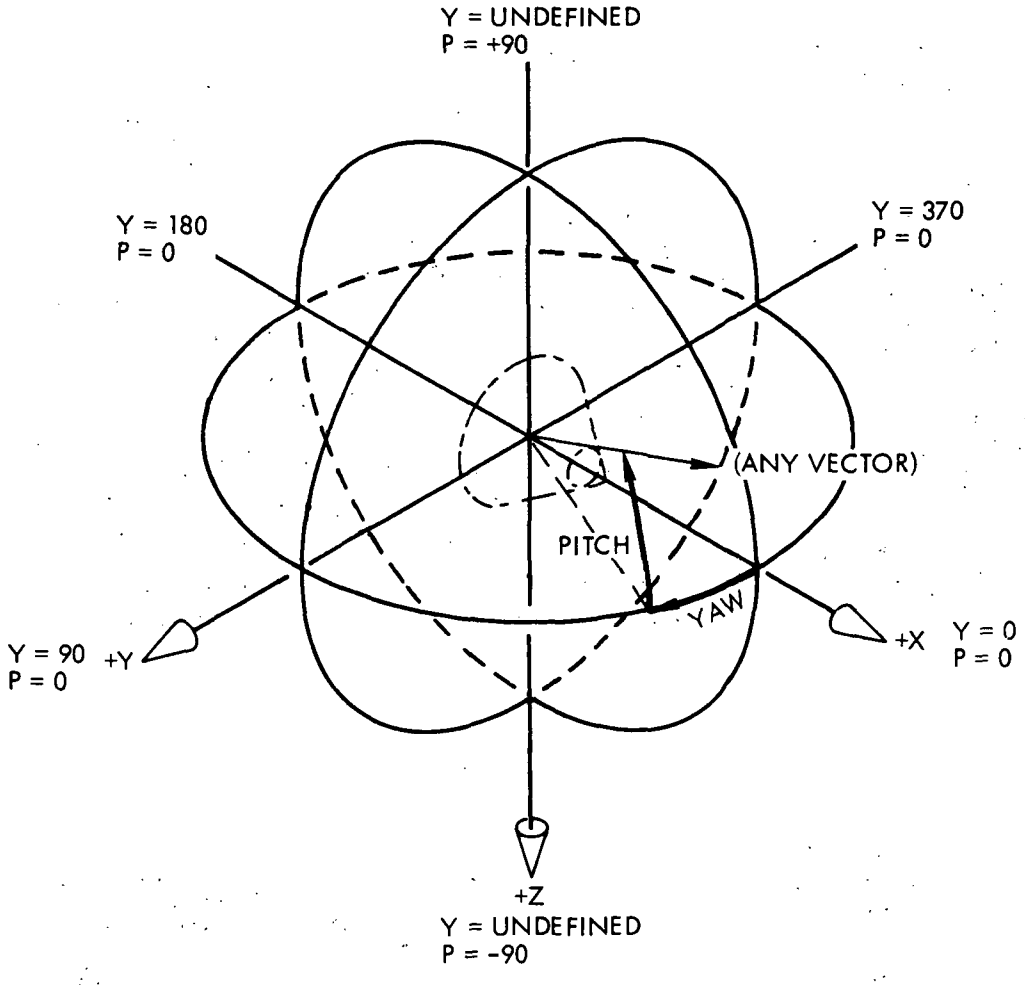
Figure E-56. CSM Block II Antenna Locations



ϕ MEASURED FROM -Z BODY AXIS POSITIVELY ABOUT X BODY AXIS TO VECTOR PROJECTION IN Y-Z PLANE

θ SMALLEST ANGLE MEASURED FROM +X BODY AXIS TO VECTOR

Figure E-57. CSM Theta/Phi Coordinate System



YAW MEASURED IN THE X-Y PLANE, POSITIVELY ABOUT Z FROM THE +X AXIS

PITCH MEASURED FROM THE YAW PLANE, POSITIVELY IN THE -Z HEMISPHERE, NEGATIVELY IN THE +Z HEMISPHERE

Figure E-58. CSM Yaw/Pitch Coordinate System

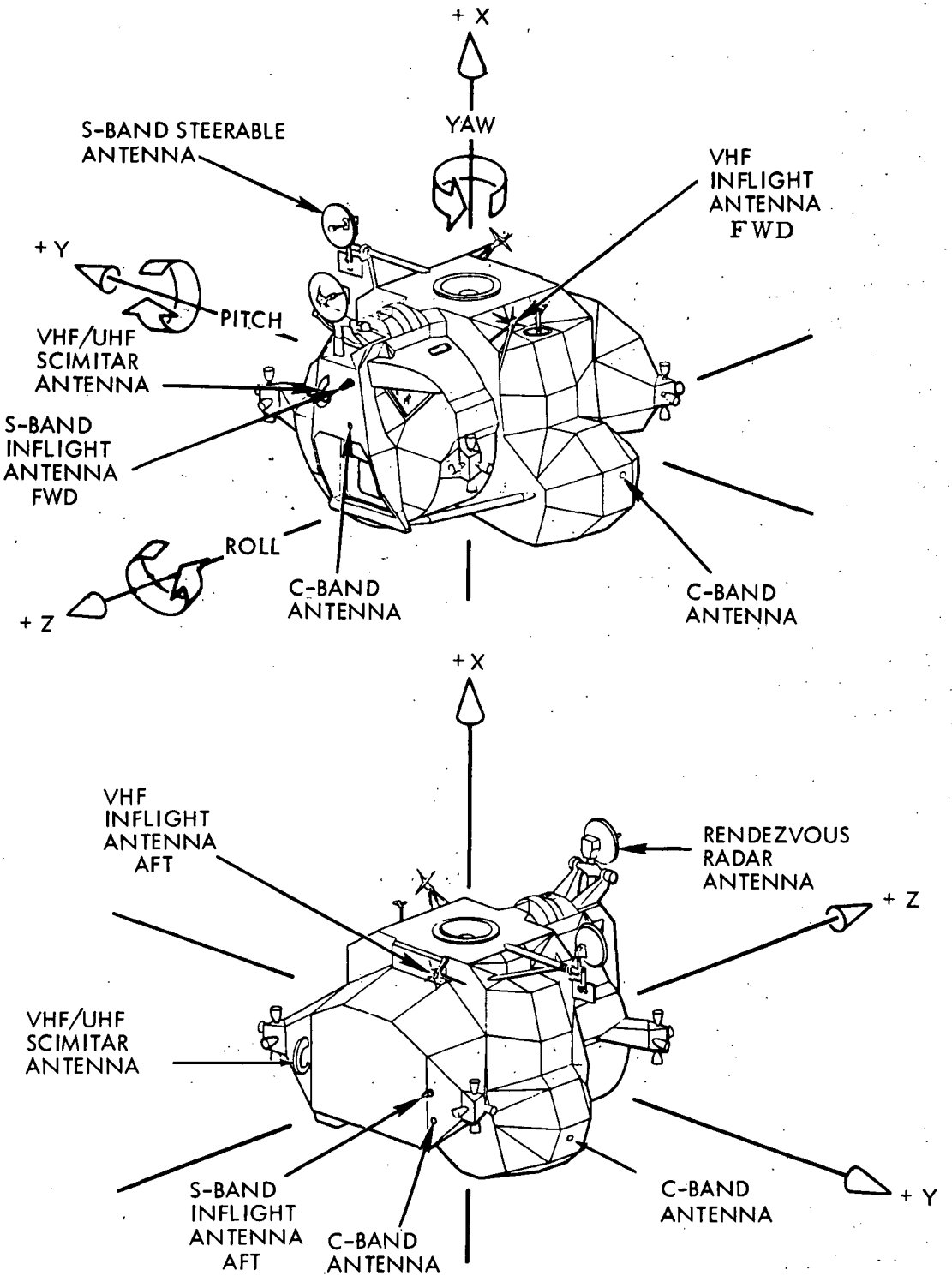
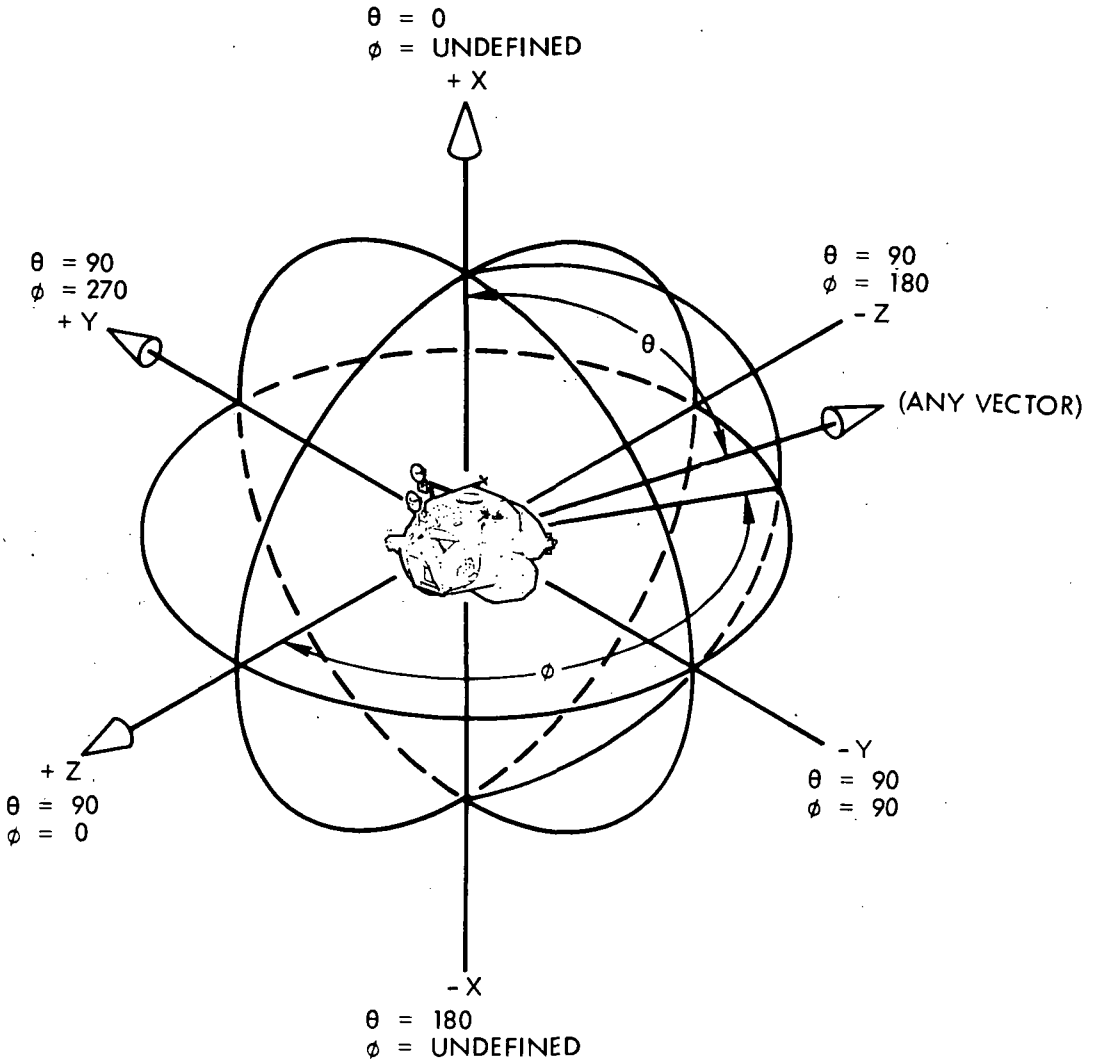


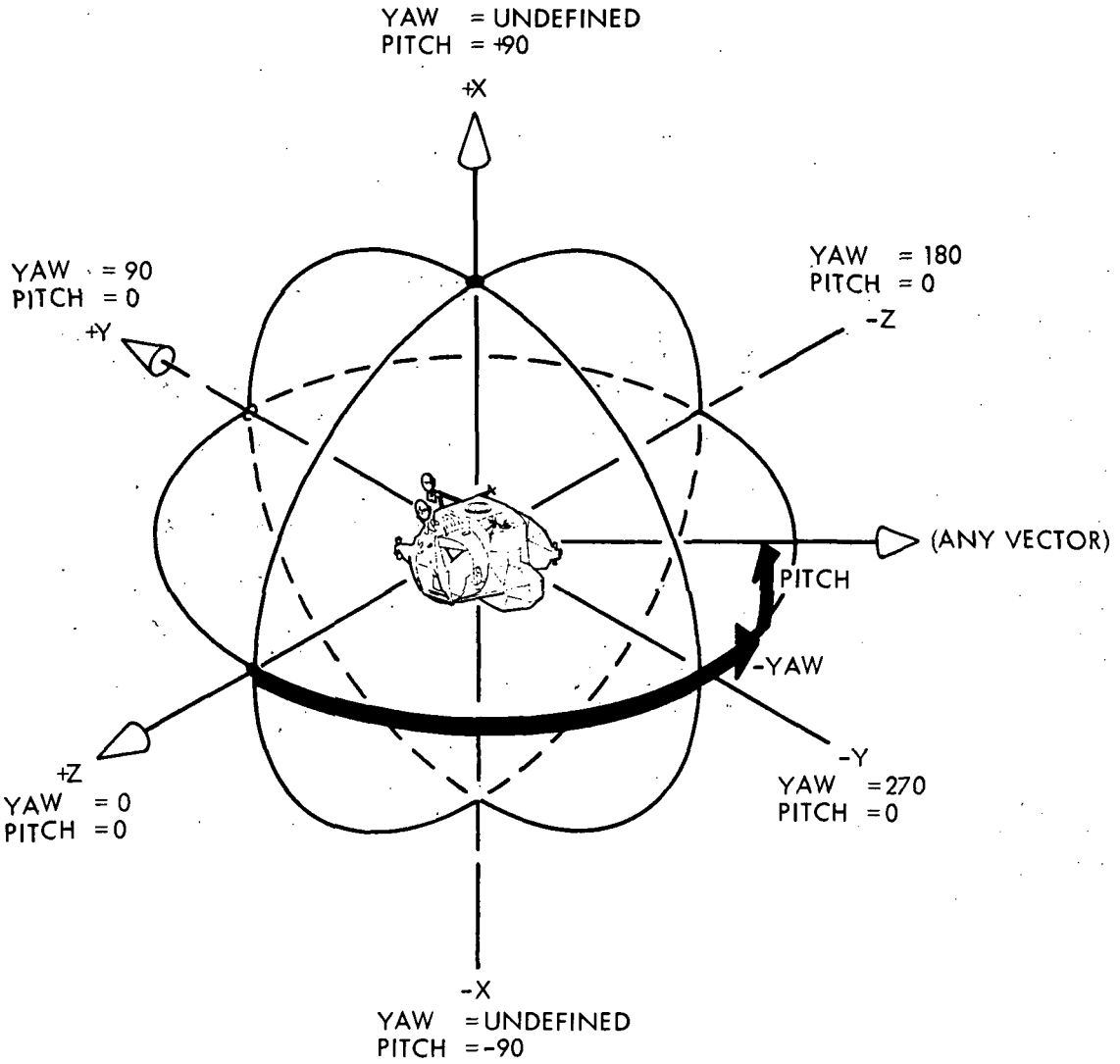
Figure E-59. LM Antenna Locations



ϕ MEASURED FROM +Z BODY AXIS POSITIVELY ABOUT X BODY AXIS TO VECTOR PROJECTION IN Y-Z PLANE.

θ MEASURED FROM +X BODY AXIS TO VECTOR

Figure E-60. LM Theta/Phi Coordinate System



YAW MEASURED IN THE Y-Z PLANE, FROM THE + Z AXIS

PITCH MEASURED FROM THE YAW PLANE, POSITIVELY IN THE +X HEMISPHERE, NEGATIVELY IN THE -X HEMISPHERE

Figure E-61. LM Yaw/Pitch Coordinate System

APPENDIX F

CSM FM MODES ANALYSIS

F-1 INTRODUCTION

The purpose of this appendix is to present a performance analysis of the CSM FM modes that will be used during the Apollo 10 mission. This analysis is based on measured test data obtained from the Information Systems Division (ISD), Electronic Systems Compatibility Laboratory (ESCL), during April 1969. This test series was conducted with actual spacecraft and MSFN ground station equipment.

The ESCL tests were used to evaluate a Motorola phase-lock loop (PLL) FM demodulator that will be used at all 85-foot ground stations during the Apollo 10 and subsequent lunar missions. The performance of the Motorola demodulator differs greatly from that of the previous MSFN PLL demodulators so that a reevaluation of the Apollo CSM FM modes is required. This appendix summarizes the results of the April 1969 ESCL FM tests and relates the results of the test series to the expected performance of the CSM FM modes for the Apollo 10 mission.

F-2 CSM PLAYBACK VOICE MODES (FM MODES 1 AND 2)

Figure F-1 represents the measured performance of the 32:1 playback voice channel (CSM downlink FM mode 2). These data are presented in terms of postdetection SNR versus total received RF power.

The test results indicate that, for the CSM mode 2 playback voice channel, the Motorola demodulator has an FM threshold at a total received power level of -103 dBm for an 85- or 30-foot cooled MSFN ground station. This RF level corresponds to a demodulator predetection SNR of 3.0 dB referenced in a 7.5-MHz bandwidth. (It is anticipated that the predetection bandwidth will be determined by the 7.5-MHz FM filter in the MSFN receiver.)

The Motorola demodulator performs significantly better than the previous MSFN PLL demodulators for the CSM playback voice modes. The total received RF power required for 90 percent word intelligibility, using

the Motorola demodulator, represents an FM threshold improvement of approximately 4 dB, compared with the previous MSFN demodulators. The improved performance obtained with the Motorola demodulators indicates that a positive circuit margin of 6.8 dB exists for the CSM playback voice modes at lunar distance using the CSM HGA and an 85-foot MSFN ground station.

F-3 PLAYBACK OF LM SPLIT-PHASE TLM (CSM FM MODE 3)

Figure F-2 represents the measured performance of the CSM downlink, mode 3, playback of LM split-phase TLM channel. These data are presented in terms of bit error rate versus total received power.

An analysis of the measured data using the Motorola demodulator indicates that a total received power level of -105 dBm is required to achieve a 10^{-4} BER. This value of total received power corresponds to a demodulator predetection SNR of 1.6 dB referenced to a 75-MHz bandwidth.

The performance of the Motorola demodulator, with respect to the required total received power for 10^{-4} BER, is approximately 1 dB better than the performance of the previous MSFN PLL demodulator for CSM FM mode 3.

The improved threshold performance of the Motorola demodulator indicates that a positive circuit margin of 6 dB will be obtained at lunar distance for this mode when the CSM HGA and 85-foot MSFN ground stations are used.

F-4 CSM FM MODE 4 (TV)

The CSM 106 spacecraft will be equipped with both the standard Apollo block I slow-scan black and white (B&W) television (TV) camera and a Navy/DOD color TV camera.

Significant differences exist between the B&W and color cameras. The signal characteristics of both the B&W and color TV channel are listed in Table F-1.

Table F-1. Apollo CSM B&W and Color TV Channel Parameters

	Frame Rate	Peak Frequency Deviation	Maximum Information Bandwidth	Postdetection Bandwidth
Apollo CSM Block I B&W TV	10 fps	1.0 MHz	410 kHz	500 kHz
Apollo CSM Color TV	30 fps	1.75 MHz	2.5 MHz	5.5 MHz

The measured performance of the B&W TV channel is presented in Figure F-3 in terms of postdetection SNR versus total received power. A postdetection SNR of 19 dB is required for acceptable video quality. This value of postdetection SNR is obtained with a total received power level of -102.5 dBm using the CSM HGA and a cooled 30- or 85-foot MSFN ground station as shown in Figure F-3.

The performance of the Motorola demodulator, with respect to the CSM B&W TV channel, is adequate to provide positive circuit margins at lunar distance using the CSM HGA and an 85-foot MSFN ground station.

The expected video quality for the B&W TV channel using the Motorola demodulator is shown in Figure F-4, representing the expected video quality at lunar distance for a worst-case total received power level of -99 dBm using the CSM HGA and an 85-foot MSFN ground station. This picture represents a positive circuit margin of 3.5 dB based on a required postdetection SNR of 19 dB and a total received power threshold value of -102.5 dBm.

The performance of the Apollo CSM color TV channel is shown in Figures F-5, F-6, and F-7. Figure F-5 represents the video quality of the color TV channel for worst-case lunar distance conditions using the CSM HGA and an 85-foot MSFN ground station. The picture quality shown in Figure F-5 is severely degraded since the demodulator is operating below FM threshold.

Figure F-6 represents the color TV performance for nominal case lunar distance conditions using the CSM HGA and an 85-foot MSFN ground station. The picture quality of Figure F-6 is better than that shown in Figure F-5. However, the video quality is still degraded by the FM demodulator operating near threshold.

Figure F-7 represents the performance of the color TV channel at lunar distance for worst-case conditions using the CSM HGA and the 210-foot ground station. The video quality in Figure F-7 corresponds to a postdetection SNR of approximately 19 dB referenced in the information bandwidth which is 2 MHz. A postdetection SNR of 19 dB is required for acceptable Apollo TV video quality.

The quality of the TV picture shown in Figure F-7 indicates that the demodulator is operating above FM threshold.

The data presented in these figures show that acceptable picture quality for the CSM color TV channel cannot be obtained with an 85-foot MSFN ground station. Therefore, it is mandatory that the 210-foot GDS antenna be used to obtain color TV at lunar distance.

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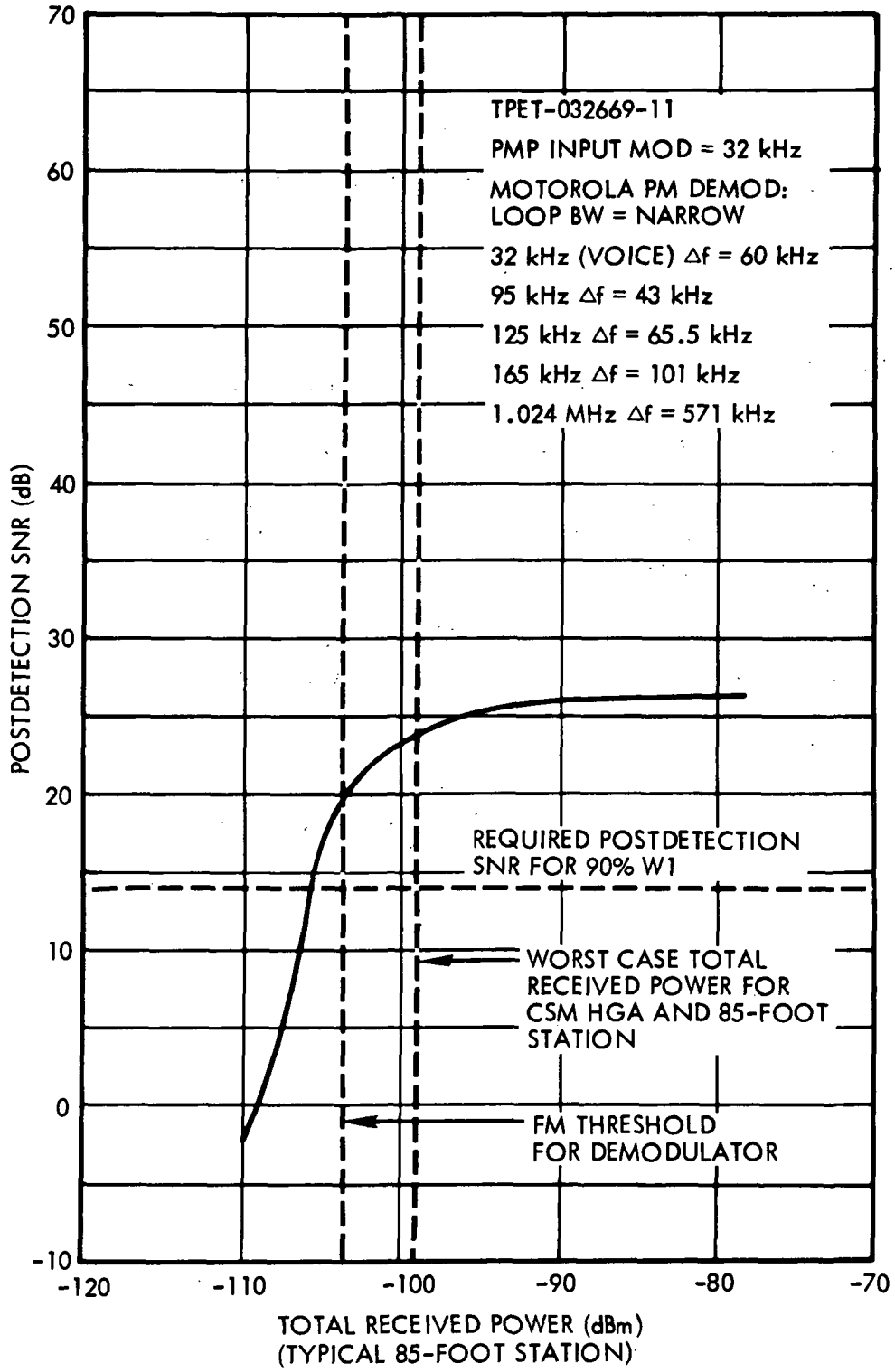

Figure F-1. CSM Mode 2 (32:1 Playback of Voice) Postdetection SNR versus MSFN Total Received Power

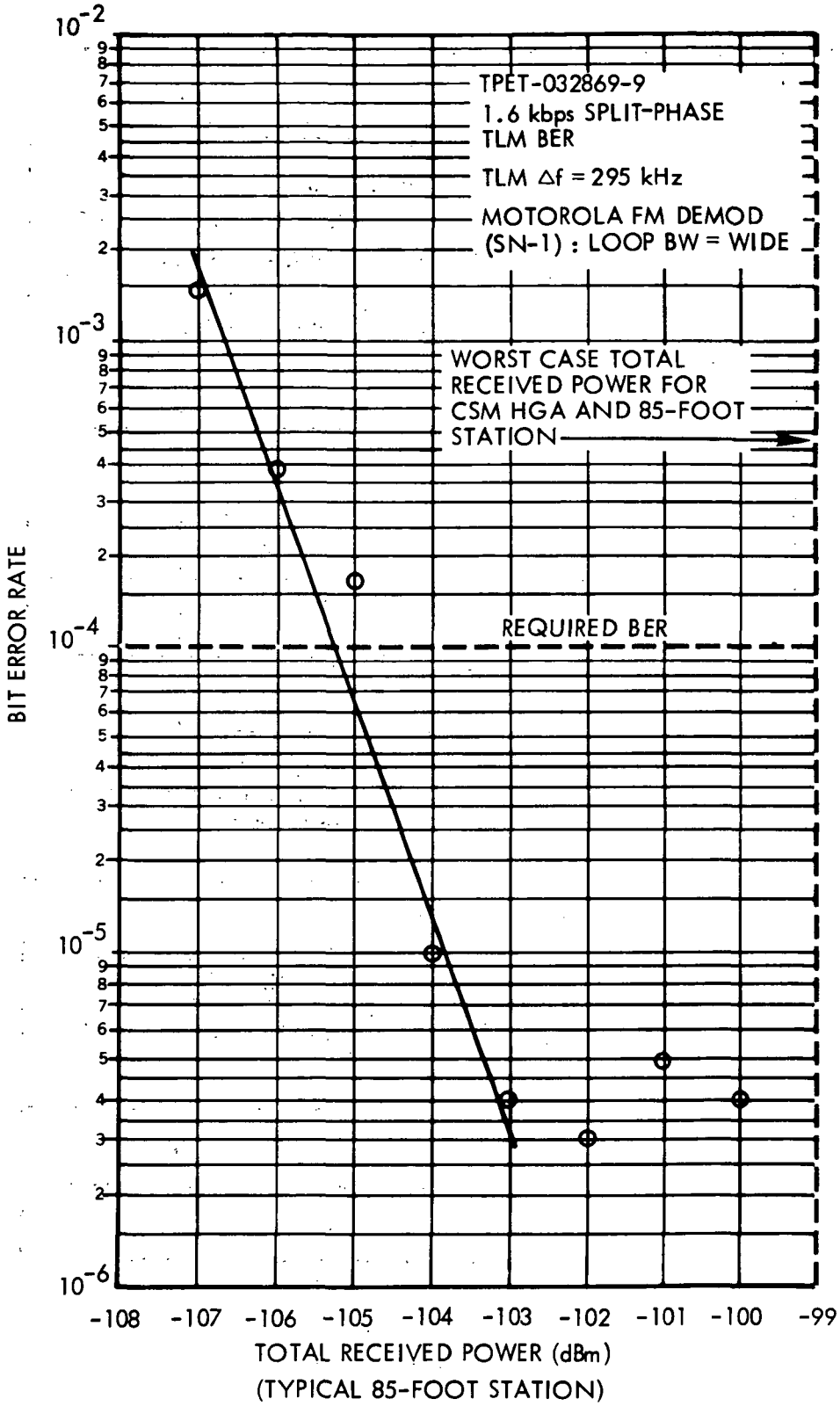

Figure F-2. CSM Mode 3 (Playback of LM Split Phase TLM BER versus MSFN Total Received Power

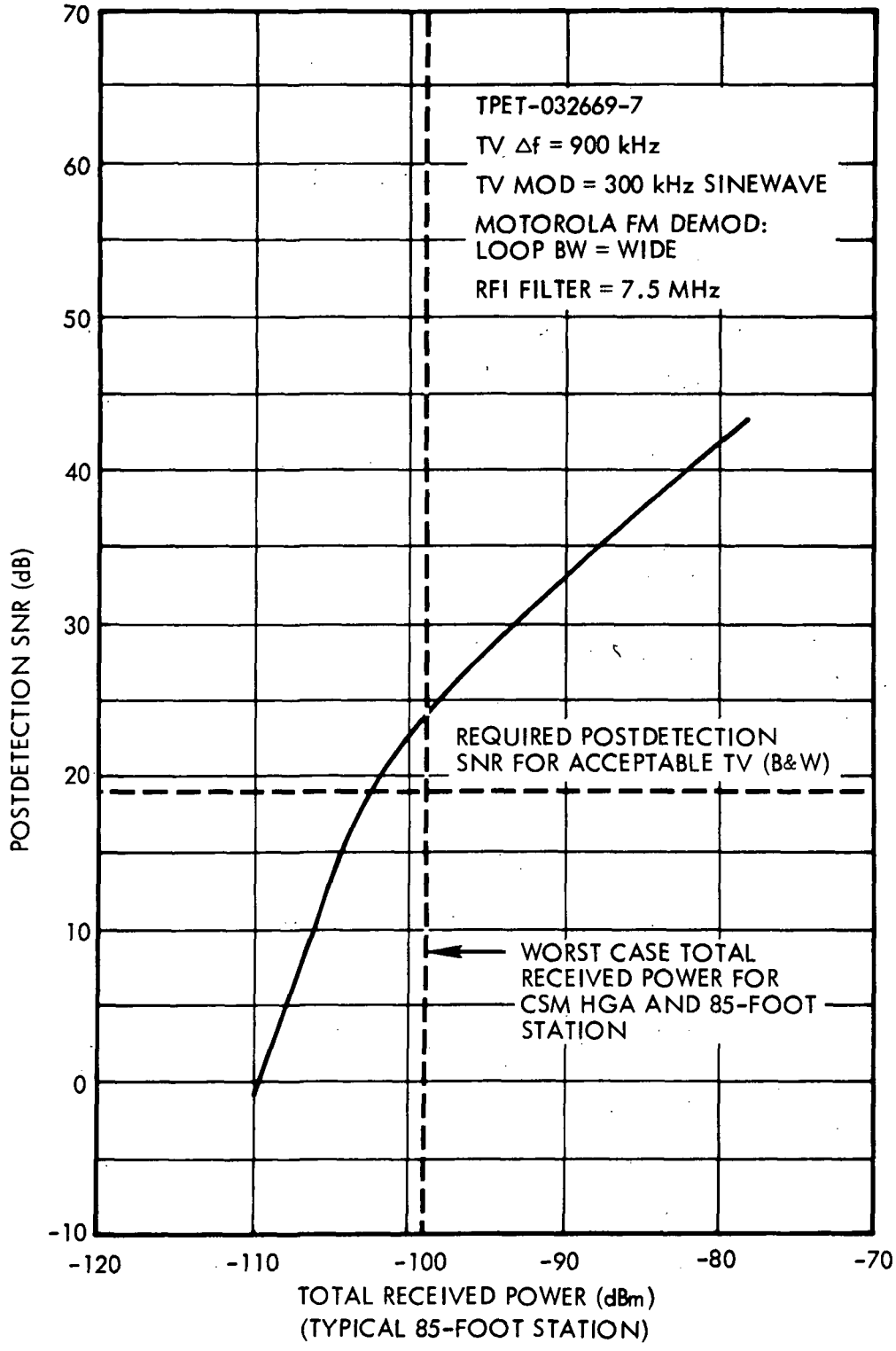

Figure F-3. CSM Mode 4 (B&W TV) Postdetection SNR versus MSFN Total Received Power

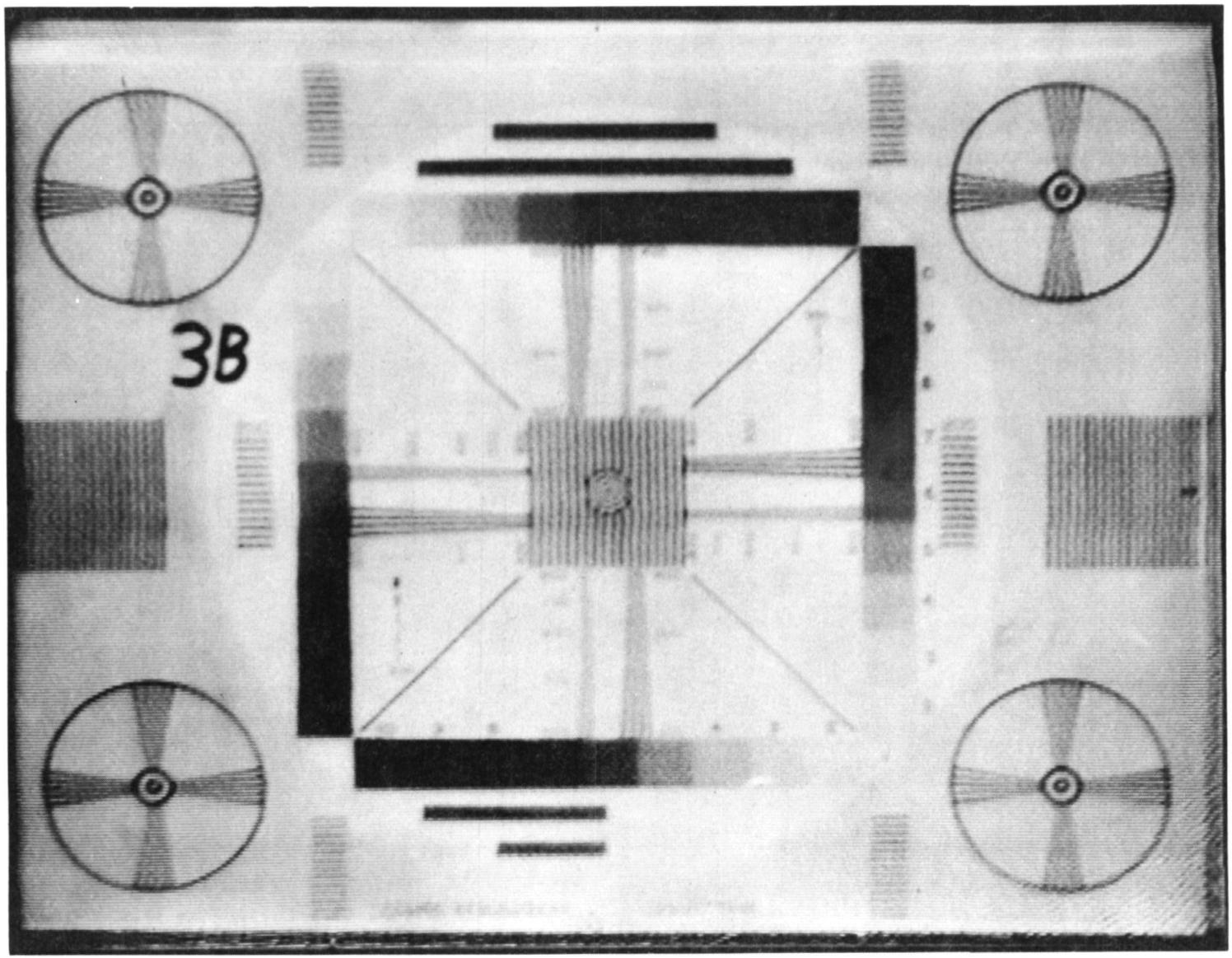

Figure F-4. CSM Mode 4 Black and White TV Picture Quality at Lunar Distance for a Worst Case Total Received Power Level of -99 dBm Using the CSM HGA and a Typical 85-Foot MSFN Station

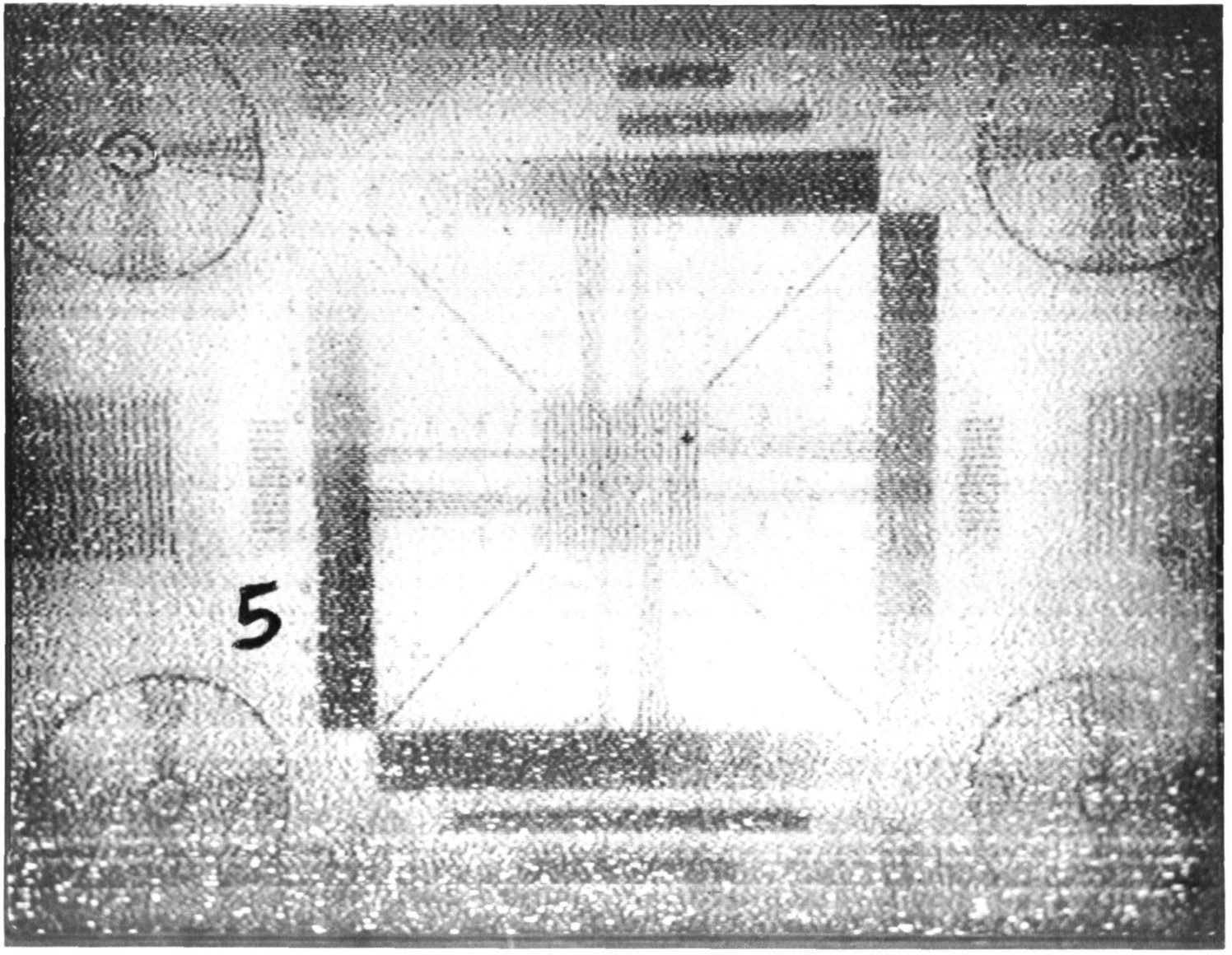

Figure F-5. CSM Mode 4 Color TV Picture Quality at Lunar Distance for a Worst Case Total Received Power Level of -99 dBm Using the CSM HGA and a Typical 85-Foot MSFN Station

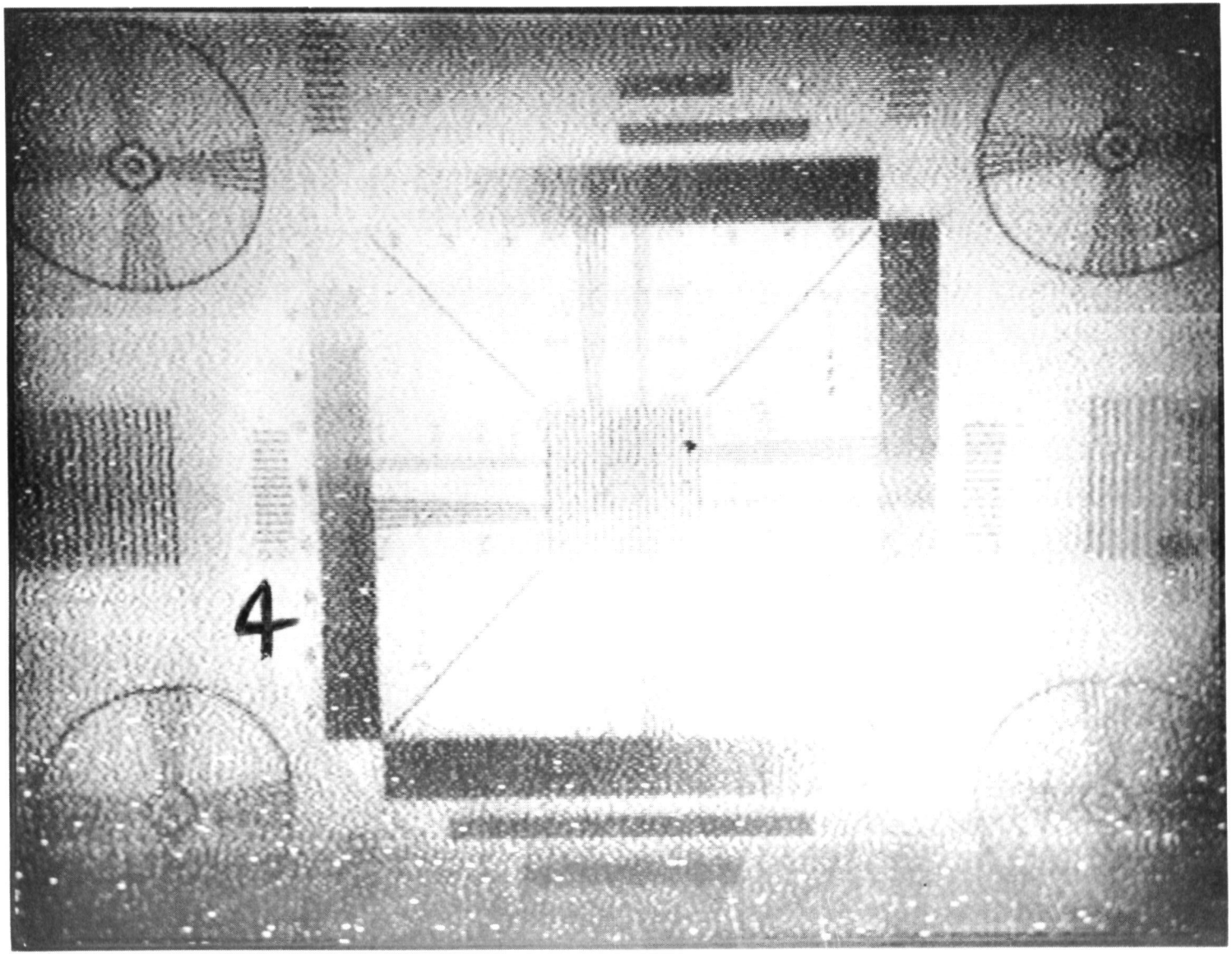

Figure F-6. CSM Mode 4 Color TV Picture Quality at Lunar Distance for a Nominal Case Total Received Power Level of -98.7 dBm Using the CSM HGA and a Typical 85-Foot MSFN Station

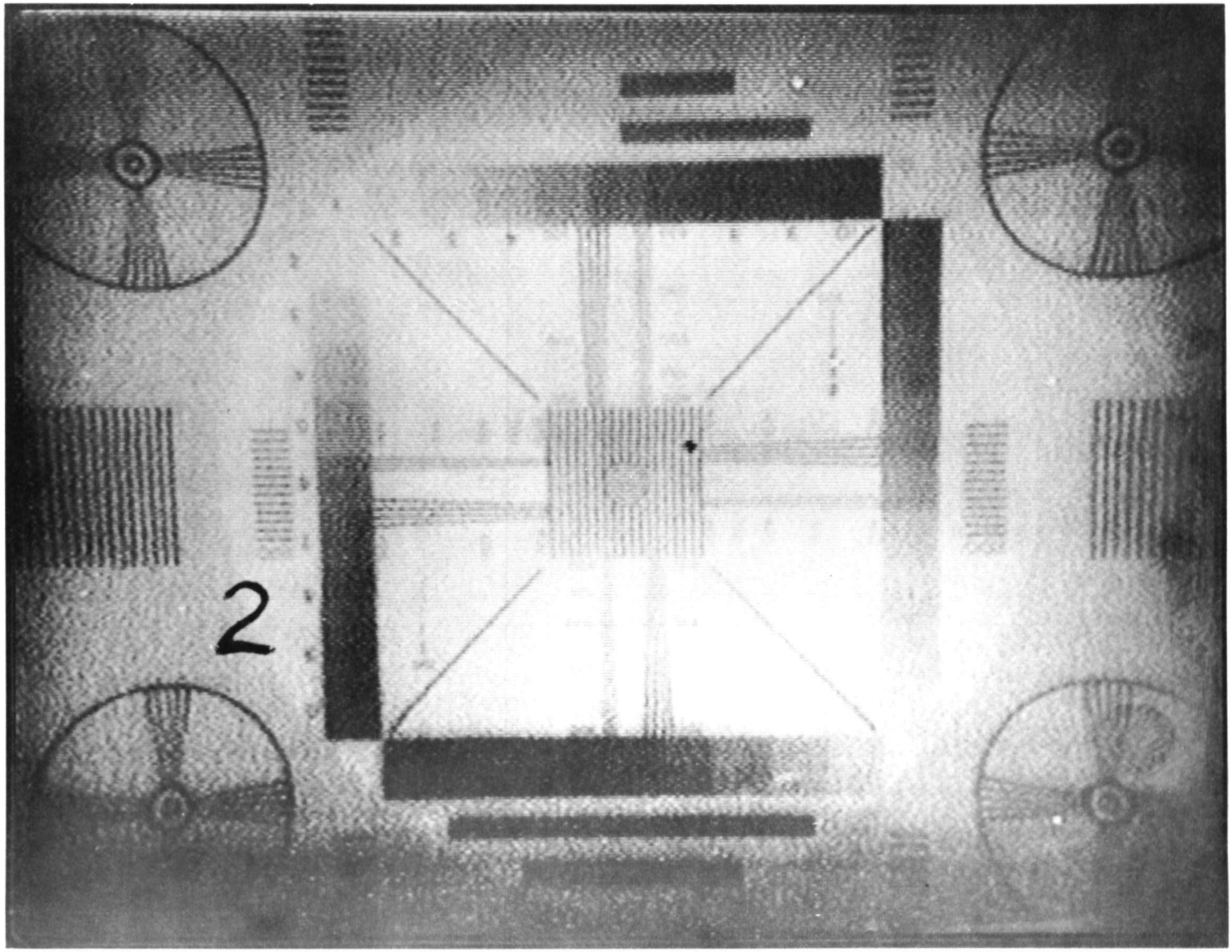

Figure F-7. CSM Mode 4 Color TV Picture Quality at Lunar Distance for a Worst Case Total Received Power Level of -92 dBm Using the CSM HGA and a 210-Foot Ground Station

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