

INSTRUMENTATION

QUICK REFERENCE DATA

Signal-conditioning electronics assembly

Height	8.0 inches
Width	5.25 inches
Length	23.90 inches
Weight	
Assembly 1	35.44 pounds
Assembly 2	35.25 pounds
Power requirements	
Excitation	28 volts dc
Consumption	
Assembly 1	16.04 watts
Assembly 2	14.23 watts
Temperature	
Operating	+30° to +130° F
Nonoperating	-65° to +160° F

Pulse-code-modulation and timing electronics assembly

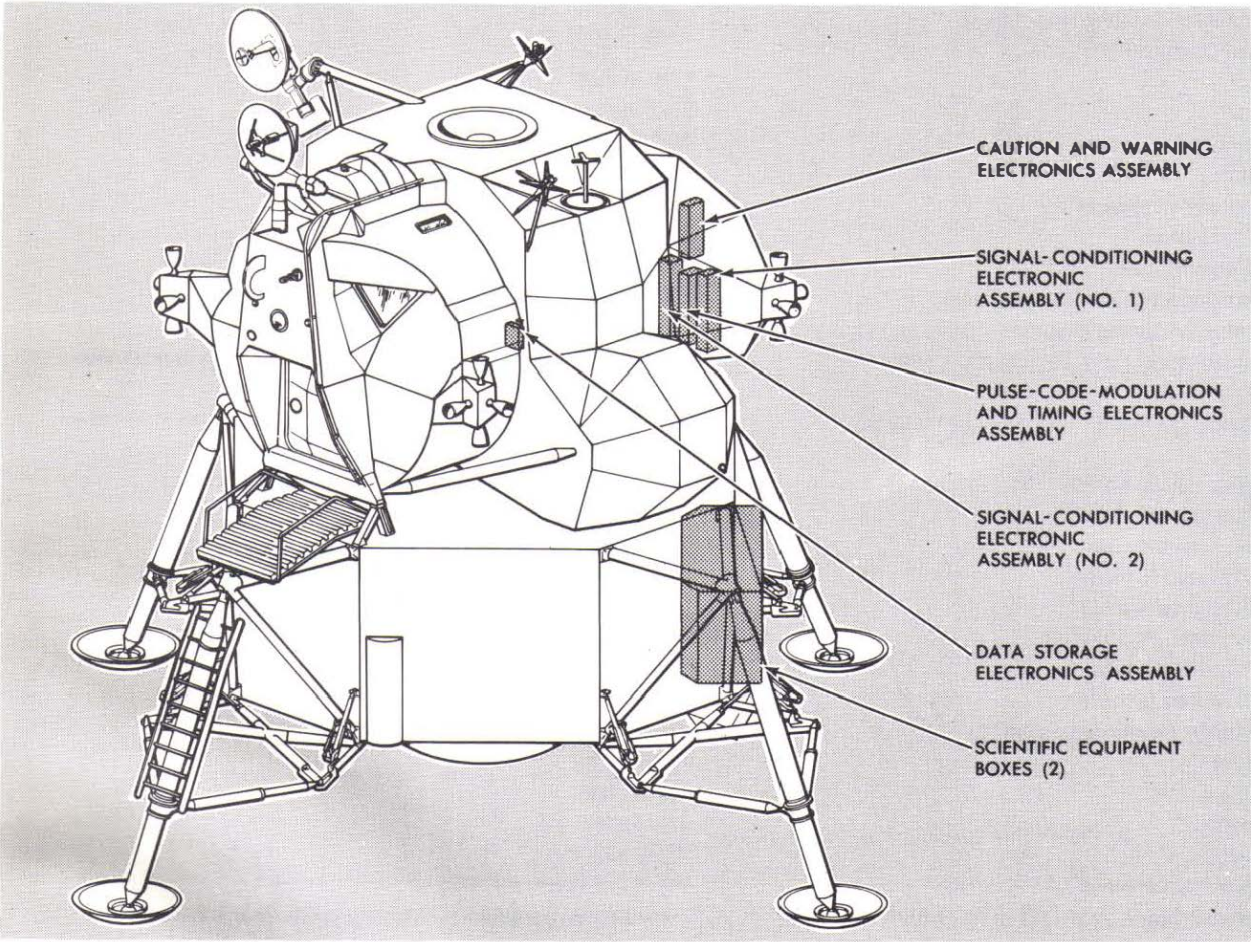
Height	6.72 inches
Width	5.12 inches
Length	19.75 inches
Weight	23.0 pounds (approximate)
Power requirements	
Excitation	28 volts dc
Consumption	11 watts
Operating temperature (ambient)	+30° to +130° F
Number of analog channels	277
Normal bit rate (51.2 kilobits per second)	200 channels externally programmed, 77 channels internally redundant
Reduced bit rate (1.6 kilobits per second)	113 channels externally programmed, 41 channels internally redundant
Parallel digital signals	
Number of channels	75
Normal bit rate	1, 10, 50, 100, or 200 samples per second
Reduced bit rate	1 sample per second
Serial digital signals	
Number of channels	2 channels, serial by bit
Normal bit rate	50 samples per second
Reduced bit rate	None

Data storage electronics assembly

Height	2.05 inches
Width	4.0 inches
Length	6.22 inches
Weight	38 ounces
Power supply input	115 ± 2.5 volts rms, 400 Hz, single phase
Magnetic heads	Two record/reproduce heads to provide four tracks
Voice record amplifier	
Input level	-3 to +7 dbm
Frequency response	± 3 db from 300 Hz to 3 kHz

APOLLO NEWS REFERENCE

Tape	
Speed	0.6 inch per second
Total recording time	10 hours (maximum)
Length of tape between sensor strips	450 feet (minimum)
Transport	
Speed error	0.05 of input power frequency deviation
Record time	Total of 10 hours
Caution and warning electronics assembly	
Height	7.0 inches
Width	6.750 inches
Depth	11.750 inches
Weight	18.20 pounds
Power requirements	
Excitation	28 volts dc
Consumption	13 watts
Temperature	
Operating	+35° to +135° F
Nonoperating	-65° to +160° F



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Major Instrumentation Equipment Location

The Instrumentation Subsystem (IS) monitors the LM subsystems, performs in-flight checkout, prepares LM status data for transmission, provides timing frequencies and correlated data for LM subsystems, stores voice and time-correlation data, performs lunar surface checkout, and provides scientific instrumentation for lunar experiments.

The IS monitors various parameters (status) of LM subsystems and structure and prepares the status data for telemetering via the Communications Subsystem (CS), to MSFN. In a high-bit-rate mode of operation, MSFN receives 51,200 bits of information from 279 subsystem sensors every second. This, along with Guidance, Navigation, and Control Subsystem data, enables mission controllers to participate in major decisions, assist in spacecraft management during complicated astronaut activity, and maintain a detail subsystem performance history.

Caution and warning lights and two master alarm lights alert the astronauts to out-of-tolerance conditions (malfunctions) that affect the mission or their safety. In addition a 3-kHz alarm tone is routed to the astronaut headsets to advise the astronauts that a malfunction exists. The tone is especially helpful in alerting the astronauts when they are preoccupied or asleep. The master alarm lights can be turned off by pushing either illuminated lens; this also stops the tone. When a warning light (red) goes on, it indicates a malfunction that affects the mission, but could affect astronaut safety if not corrected.

FUNCTIONAL DESCRIPTION

The IS consists of subsystem sensors, a signal-conditioning electronics assembly, a pulse-code-modulation and timing electronics assembly, a caution and warning electronics assembly, and a data storage electronics assembly.

The sensors continuously monitor the status of LM subsystems and provide outputs indicative of temperature, pressure, frequency, gas and liquid quantity, stage-separation distance, valve and switch positions, voltage, and current. These outputs are in analog and digital form; some are routed to the signal-conditioning electronics assembly for voltage-level conditioning. If conditioning is not required, the outputs are routed directly to the pulse-code-modulation and timing electronics assembly. The signal-conditioning electronics assembly conditions its sensor-derived inputs and routes high-level analog or digital data to the pulse-code-modulation and timing electronics assembly, caution and warning electronics assembly, and crew displays.

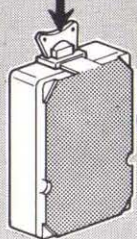
The pulse-code-modulation and timing electronics assembly converts the conditioned and unconditioned signals to several forms for telemetering. This assembly also provides subcarrier frequencies, time reference signals, and sync pulses.

The sensed subsystem data, routed in analog and digital form to the caution and warning electronics assembly, are constantly compared with internally generated references. When an out-of-tolerance condition is detected, this assembly provides a signal to light the appropriate warning or caution light and both master alarm lights and to provide the 3-kHz alarm tone to the headsets.

Basically, all caution and warning lights operate in the same manner. The following is a typical example. Signals are routed from Reaction Control Subsystem (RCS) helium tank pressure sensors to comparators in the caution and warning electronics assembly. If comparison indicates a low-pressure condition, solid-state electronic circuits are enabled, causing the RCS caution light to go on. The astronauts then monitor helium tank pressure on indicators to determine actual pressure levels.

SUBSYSTEM SENSORS	
STABILIZATION AND CONTROL	COMMUNICATIONS
REACTION CONTROL	RADAR
ENVIRONMENTAL CONTROL	STRUCTURES
GUIDANCE AND NAVIGATION	EXPLOSIVE DEVICES
ELECTRICAL POWER	PROPULSION

VOICE FROM COMMUNICATION SUBSYSTEM



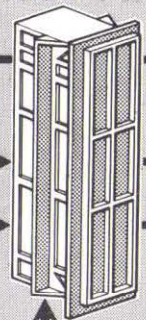
DATA STORAGE ELECTRONICS ASSEMBLY (TAPE RECORDER)

END-OF-TAPE INDICATION



PULSE-CODE-MODULATION AND TIMING ELECTRONICS ASSEMBLY

TIME REFERENCE SIGNAL



SYNC-SIGNALS

TO SUBSYSTEMS

SUBCARRIER TIMING (5.12 KPPS)

TO COMMUNICATIONS SUBSYSTEMS

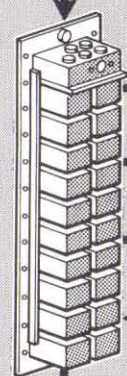
DIGITAL DATA

ANALOG DATA

TELEMETRY

SUBSYSTEM S ATUS SIGNALS

SIGNAL-CONDITIONING ELECTRONICS ASSEMBLY



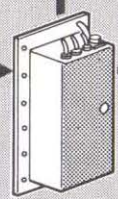
TELEMETRY AND MASTER ALARM SIGNALS

(SEE NOTE)

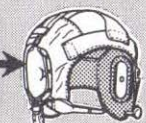
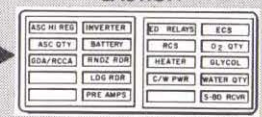
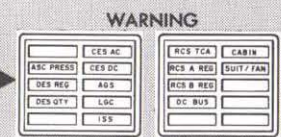
CAUTION AND WARNING DATA

TO CABIN DISPLAYS

CAUTION AND WARNING ELECTRONICS ASSEMBLY



CAUTION AND WARNING STATUS INFORMATION

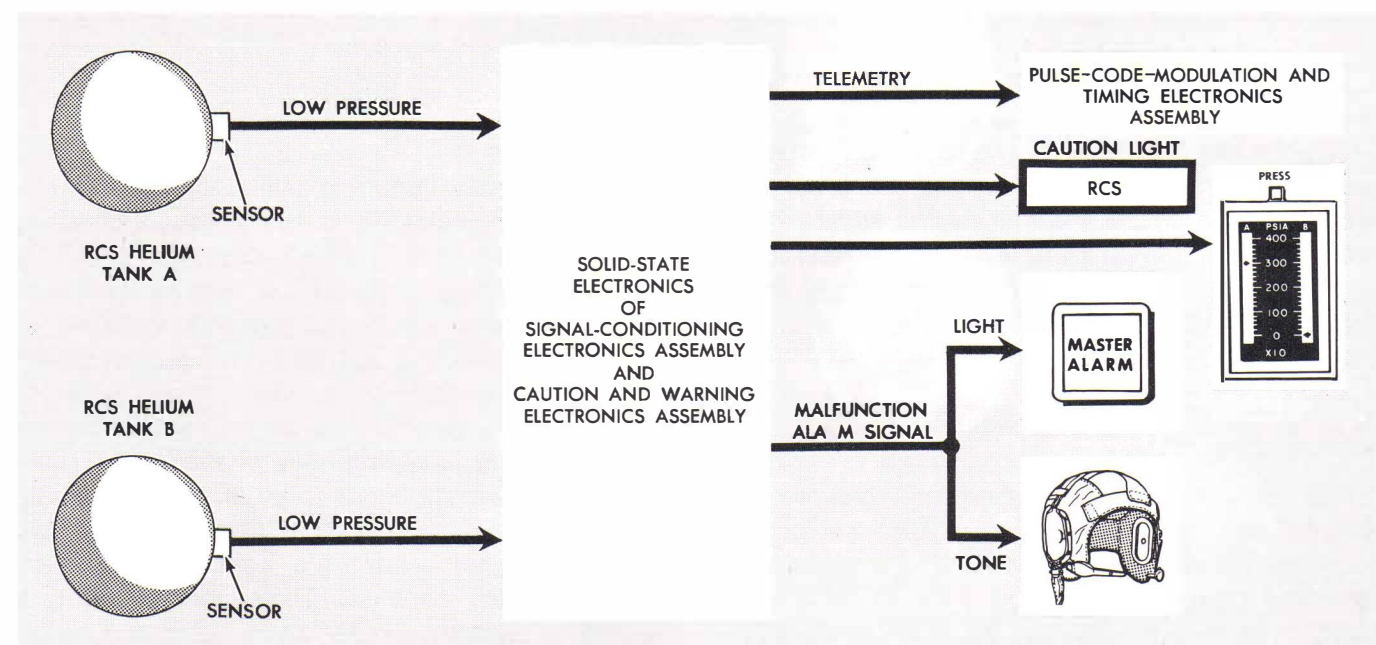


NOTE
ALL CAUTION AND WARNING SIGNALS ARE ROUTED TO CWEA LIGHTS. THE AGS POWER FAILURE, CES A-C POWER FAILURE, CES D-C POWER FAILURE, CWEA POWER FAILURE, AND MASTER ALARM SIGNAL ARE TELEMETERED IN REAL TIME.

WARNING

CAUTION

Diagram of Instrumentation Subsystem



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RCS Failure Detection

The data storage electronics assembly is a tape recorder that records voice and time-correlation data (mission elapsed time). The voice and data inputs are multiplexed and recorded. The recorder can be operated manually or semiautomatically. In the manual mode, an astronaut closes a push-to-talk switch on his attitude controller assembly or electrical umbilical and speaks into his microphone. In the semiautomatic mode, CS equipment senses voice inputs from within the cabin or from the communications receivers and activates the recorder. Voice signals from the CS intercom bus are also recorded, together with mission elapsed time.

EQUIPMENT

SUBSYSTEM SENSORS

The sensors fall into four general categories: mechanical, resistive, variable reluctance, and elec-

trical. They are located throughout the various LM subsystems and structure and are used to change physical data into electrical signals.

SIGNAL CONDITIONING ELECTRONICS ASSEMBLY

This assembly consists of two electronic replaceable assemblies, each capable of housing up to 22 plug-in subassemblies of 11 different types (converters, amplifiers, etc.). Each subassembly contains its own power supply, which is isolated from the other subassemblies. Loss of one subassembly, due to a power supply failure does not affect operation of the other subassemblies. The subassemblies perform one or more of the following seven functions: amplify d-c voltages, attenuate d-c voltages, convert ac to dc, convert frequency to dc, phase-modulate ac to dc, convert resistance variations to d-c voltages, and isolate signals.

Pulse-Code-Modulation and Timing Electronics Assembly

This assembly comprises two sections: timing electronics and pulse code modulation. The timing electronics section develops timing signals for the pulse code modulation section, and the LM subsystems including the mission elapsed timer. The pulse-code-modulation section converts analog and digital signals to one of two formats, normal and reduced, for telemetering: 51,200 bits per second and 1600 bits per second.

Data Storage Electronics Assembly

This assembly is a single-speed, four-track, magnetic tape recorder that stores voice and time-correlation data. A maximum of 10 hours of recording time is provided (2.5 hours on each track) by driving the tape, at 0.6 inch per second, over the record head and, on completion of a pass,

automatically switching to the next track and reversing tape direction. One tape (450 feet) is supplied in a magazine.

Caution and Warning Electronics Assembly

This assembly compares analog signals (between 0 and 5 volts dc), from the signal-conditioning electronics assembly, with preselected internally generated limits supplied by the caution and warning power supply as reference voltages. In addition to analog inputs, it receives discrete on-off and contact closure signals. All inputs are routed to detectors; the detected signals are routed through logic circuitry, enabling relay contacts that cause caution or warning lights to go on or causing talk-backs to change state. Simultaneously, the detected signal energizes a master relay driver, enabling relay contacts. These contacts route a signal to light the master alarm lights and trigger the 3-kHz tone to the headsets.