NASw-410-AM-04

GENERAL ELECTRIC

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DEPARTMENT

ACE-S/C OPERATOR'S MANUAL

ACCEPTANCE CHECKOUT EQUIPMENT – SPACECRAFT

Gruhn, Charles

NASw-410-AM-04

OPERATOR'S MANUAL

ACCEPTANCE CHECKOUT EQUIPMENT-SPACECRAFT

1 MARCH 1966

THIS MANUAL REPLACES PREVIOUS OPERATOR'S
MANUAL DATED 15 JULY 1965

This document was prepared for the National Aeronautics and Space Administration/Apollo Spacecraft Program Office under Contract NASw-410, Exhibit A, Section II, paragraph B.1.2.1. Preparation of this Type II document is required by paragraph 10.4 of Exhibit III to the existing contractual requirements.

APOLLO SUPPORT DEPARTMENT
GENERAL ELECTRIC COMPANY
DAYTONA BEACH, FLORIDA

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CHAPTER 1

EQUIPMENT DESCRIPTION

SECTION I

ACE-S/C DESCRIPTION

1-1. ACCEPTANCE CHECKOUT EQUIPMENT-SPACECRAFT SYSTEM DESCRIPTION.

1-2. The Acceptance Checkout Equipment-Spacecraft (ACE-S/C) is an advanced, integrated checkout system that provides centralized, programmed control of spacecraft checkout operations. Both independent spacecraft systems testing and integrated system testing are possible. Large quantities of test data can be processed and displayed in real time, as well as recorded for later analysis, with a relatively small staff of engineering personnel.

1-3. Specifically, the ACE-S/C station performs the following functions:

a. Provides the operator controls and data processing facilities necessary to control spacecraft test stimuli equipment.

b. Processes, displays, and records spacecraft parameter data derived from the spacecraft ground and flight telemetry systems.

c. Provides self-check and calibration capability for itself and related equipment.

1-4. The ACE-S/C ground station equipment may be divided into two functional data-chain groupings: the Command Equipment and the Data Recording and Display Equipment. Figure 1-1 shows the simplified block diagram for the ACE-S/C equipment at all sites. The Command Equipment is comprised of those units that form the communication path over which all test commands and sequences (in digital form) are generated and transmitted to the spacecraft. Verification of receipt of these commands is transmitted from the spacecraft area, back through the command system, to the ACE-S/C station. Test result data from the spacecraft test area is received (in digital form) by the Data Recording and Display Equipment which presents this data for evaluation.

1-5. COMMAND EQUIPMENT.

1-6. Test commands may be initiated at various system control consoles by setting switches on units called Selection-To-Activate-Random-Testing (START) modules. The setting of these switches provides digital command inputs to the Command Computer. The result of a test command may vary, depending upon the test to be performed. Certain commands can result in the performance of individual event functions (specific relay on/off actions). Other commands can initiate computer subroutines that control sequences of events and/or various analog operations in the spacecraft.

1-7. The testing of each functional spacecraft system is controlled from an associated system control console. The following functional systems are tested:

a. Environmental Control System.
b. Fuel Cell and Cryogenics System.
c. Electrical Power System (A).
d. Power and Sequential System.
e. Electrical Power System (B).
f. Guidance and Navigation System.
g. Stabilization and Control System.

h. Service Propulsion and Reaction Control System.
i. Instrumentation System.
j. Communications System.
k. Aeromedical System.
m. Thermo Structures Facilities.

1-8. Each system control console operates simultaneously with, and independently of, the other system consoles. Each has a variety of test command capabilities necessary for complete checkout of a particular spacecraft system. In order that the Command Computer may systematically process each of the many parallel inputs from these consoles, a unit called the Communications Unit Executor (CUE), operating essentially as a commutator, interrogates each START module on all of the system control consoles in sequence. These interrogations occur at a high scanning rate. Therefore, to the individual console operators, there is no perceptible delay in their individual test procedures. When an interrogation determines that a command input exists at a particular START module, the scanning process ceases momentarily while the CUE transfers the digital command to the Command Computer.

1-9. The computer interprets and acts upon each command from a START module. Certain commands may instruct the computer to modify memory. Other commands may require some action to occur in the spacecraft. In the latter case, the computer formulates a digital command message for transmission to the spacecraft. The digital command message, which is generated by the computer in a parallel format, is converted into serial format by a Data Transmission and Verification Converter (DTVC) and transmitted to the spacecraft over a coaxial hardline link.

1-10. At the spacecraft location, the message is received and stored in registers in a Digital Test Command System (DTCS). The message is then decoded and applied to analog and relay command modules where the proper stimulus is generated and transmitted to the spacecraft.

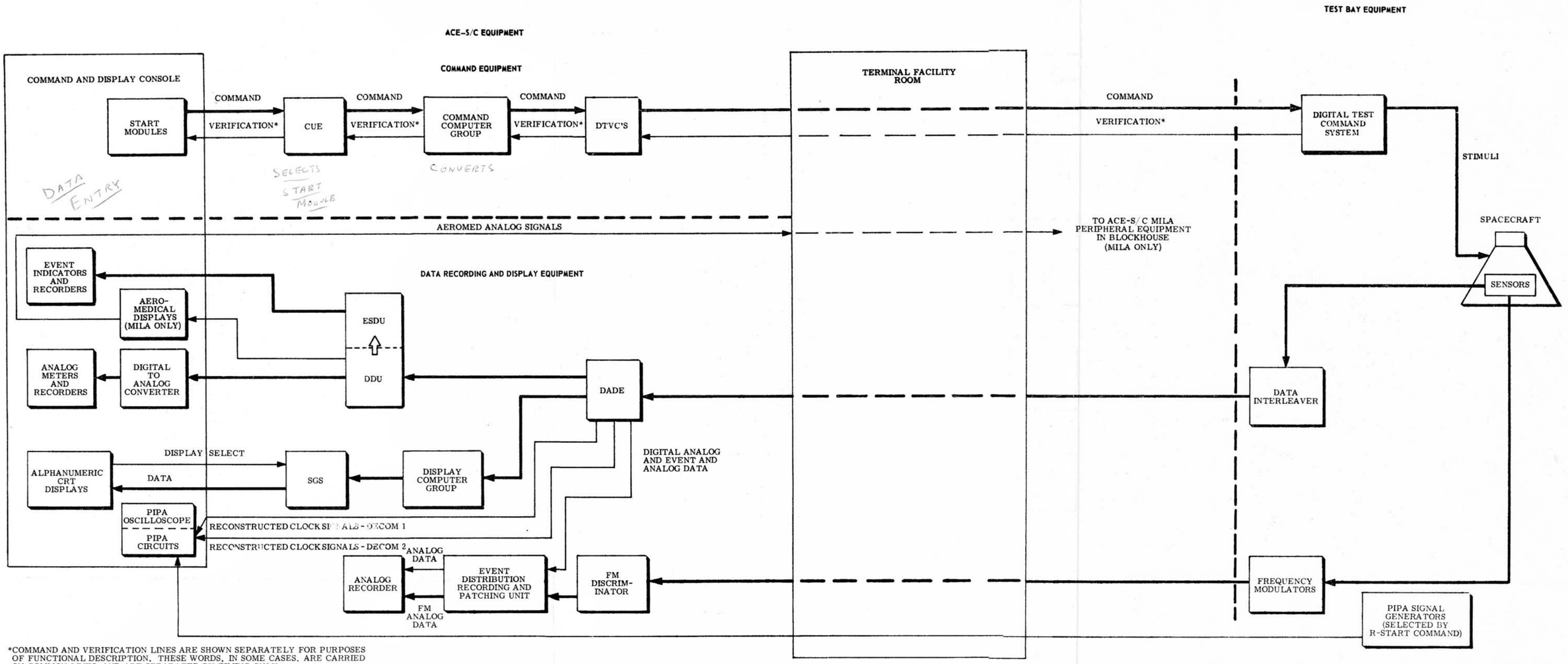
1-11. Verification of the command message is achieved by redundant transmission from the DTVC to the DTCS. A bit-by-bit comparison is made of the redundant words. In addition, checks are made of each message to determine whether it contains a legal address. A verification reply message, containing the results of the foregoing checks, is transmitted from the DTCS back to the DTVC. The delivery of a command message to the Command Computer and the verification of proper transmission from the computer to the spacecraft are indicated to the control console operator by appropriate lamps on the START modules.

1-12. DATA RECORDING AND DISPLAY EQUIPMENT.

1-13. Spacecraft performance and status data is monitored by sensors coupled to Airborne Checkout Equipment, carry-on Ground Checkout Equipment, and Ground Service Equipment. Most of the measurements are commutated, converted to digital format, interleaved, and transmitted in serial pulse-code-modulated (PCM) form over a hardline link to the data acquisition equipment in the ACE-S/C station. A small portion of the data is frequency-modulated (FM) and transmitted over a separate hardline link.

1-14. At the ACE-S/C station, the data is received by the data acquisition equipment. The Data Acquisition and Decommutation Equipment (DADE) synchronizes on the incoming serial PCM bit stream, decommutates the data, provides an address for each event and analog data word, and presents them for parallel transmission. The FM data is recorded directly on wideband magnetic tape and an oscillographic recorder. The analog and event words, derived from the PCM data, follow three paths when they leave the decommutator.

1-15. One path (addresses are not included) goes to the Display Computer where selected portions of the data are processed. This processing includes comparison of analog data with predetermined limits, and the conversion of this data into engineering units. A binary word representing the value of the data in engineering units is transferred into a memory in a Symbol Generator and Storage (SGS) Unit. The SGS uses these words to generate alphanumeric character display signals (analog) for application to control console CRT displays. These alphanumeric characters appear in "page" form on the console displays. The particular page of data



*COMMAND AND VERIFICATION LINES ARE SHOWN SEPARATELY FOR PURPOSES OF FUNCTIONAL DESCRIPTION. THESE WORDS, IN SOME CASES, ARE CARRIED ON COMMON LINES, AND ARE SEPARATED BY TIMING ONLY.

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Figure 1-1. ACE-S/C Equipment Simplified Block Diagram

to be displayed at any console is selectable by the console operator. When a parameter has been determined by the computer to be out of limits, the intensity of the character representing the parameter will be caused to fluctuate at a low rate (i.e., the character will appear to blink).

1-16. The second data path transfers the digital data to the Decommutator Distribution/ Event Storage and Distribution Unit (DD/ESDU). This unit accepts the data words and, in the case of event data, stores each bit (representing an event) in an appropriate location in storage registers. The outputs of the storage registers, connected to indicator lamps and/or event recorders on the control consoles, cause the event lamps and recorders to indicate when an event has taken place. The analog data words are fed via the decommutator distribution circuits of the DD/ESDU to all of the control consoles in parallel. When an address decoding circuit within a console recognizes its particular address in these data words, it transfers the data portion of the word via a storage register to a digital-to-analog (D/A) converter in the console. The output of the D/A converter drives meters or analog recorders located on the console.

NOTE

The MILA site contains aeromedical displays which operate from analog data that is received and processed identically to that described above. The primary difference in the aeromedical display and other analog displays is in the display devices.

1-17. The third data path transfers digital and analog data to the Event Distribution, Recording, and Patching Unit and then to roll-chart recorders in the Computer Room. The digital data is processed in a manner similar to the DD/ESDU.

1-18. Additional signals called Pulsed Integrating Pendulum Accelerometer (PIPA) signals are received from the test bay equipment. These signals are received from PIPA signal generators in the test bay. The PIPA signals are routed over a hardline from the test bay to the PIPA circuits in a command and display console of the ACE-S/C equipment. The PIPA circuits detect phase differences and phase changes between the input PIPA signal and a reference signal generated from reconstructed clock signals received from the DADE. The phase differences and changes are displayed on a PIPA oscilloscope.

1-19. SWITCHING EQUIPMENT.

1-20. The Switching Equipment consists of patching, switching, and power groups. This equipment provides fast, accurate, reliable switchover of the various major equipment groups within ground stations at a given site.

1-21. The information presently included in this manual is primarily oriented toward the ACE-S/C Switching Equipment installed at MILA. Much of the discussion, however, applies to the Switching Equipment installed at NAA, GAEC, and MSC. The Switching Equipment at each of these locations will contain similarities with the equipment at MILA; therefore, the MILA equipment will be considered typical of all sites. Where differences exist between Switching Equipment at various locations, they are appropriately noted.

1-22. The MILA ACE-S/C Switching Equipment consists of four units: the Systems Patch Terminal Unit 245, Switching Unit 240, Switching Power Unit 220, and Backup Power Unit 233. At all other sites the functions performed by both the Switching Power Unit and the Backup Power Unit at MILA are contained within a single Switching Group Power Supply Unit 241.

1-23. The units of the ACE-S/C Switching Equipment perform three functions:

a. Interface signal processing and patching.

b. ACE-S/C signal switching.

c. Generation of Switching Equipment a-c and d-c power.

1-24. Figure 1-2 is an overall block diagram of the MILA Switching Equipment. Test signals from 14 of the MILA spacecraft test areas are supplied to the Systems Patch Terminal Unit via the A2A Data Transmission System and hardlines. The A2A Data Transmission System is used over distances of 4 to 22 miles and the hardline is used to carry data from areas 6500 feet or less from the ACE-S/C stations.

NOTE

The A2A Data Transmission System is located at MILA only.

1-25. The incoming test area signals are modified in order to provide signal levels and characteristics for acceptance by the ACE-S/C station equipment. The Systems Patch Terminal Unit contains attenuators, amplifiers, equalizers, and patching panels for uplink (stimulus) and downlink (response) signal matching and patching to the Switching Unit. Ten of the 14 MILA spacecraft test areas available at the input to the Systems Patch Terminal Unit are selected and patched on wideband pairs, multi-conductor coaxial, triaxial, or audio cables to the Switching Unit.

1-26. The Switching Unit provides switching control of the 10 selected MILA test area signals to the ACE-S/C stations. The Switching Unit contains relay racks, impedance matching amplifiers, and control panels. Four control panels, containing indicator lamps and pushbutton switches, provide switching control between: (1) MILA test area and ACE-S/C Computer Rooms, (2) Computer Rooms to Control Rooms, (3) CUE to Control Room/Computer Room, and (4) DCCU to Control Room/Computer Room. These control panels provide the capability for switching up to five ACE-S/C stations to the ten MILA test areas and up to five Computer Room/Control Room, CUE, and DCCU combinations. At MSC, only two control panels are provided. The first of these panels provides switching control between the MSC test areas and the ACE-S/C Computer Rooms. The second control panel provides switching control between (1) Computer Rooms to Control Rooms, and (2) CUE to Control Room/Computer Room.

1-27. SWITCHING UNIT 240.

1-28. The Switching Unit permits four discrete groups of cables, from as many as five separate ACE-S/C ground stations, to be appropriately connected within a station or cross-connected between stations. The Switching Unit located at MSC permits three discrete groups of cables, from two separate ACE-S/C ground stations, to be appropriately connected within a station or cross-connected between stations. Each group of cables is connected by means of a pushbutton control panel which activates reed-relay switches. The following four functional cable groups may be connected to the appropriate termination points within an ACE-S/C station or cross-connected to similar terminations at any of four other ACE-S/C stations:

a. Cables which carry signals to and from spacecraft test areas and are routed between the Systems Patch Terminal Unit and an ACE-S/C station Computer Room.

b. Cables which link an ACE-S/C Control Room to an ACE-S/C Computer Room.

c. Cables which insert a selected CUE Unit between a previously selected Computer/Control Room combination.

d. Cables which insert a selected DCCU between a previously selected Computer/Control Room combination. (Not at MSC, as no DCCU is supplied for this site.)

1-29. At all sites except MSC, there are four control unit panels located on the Switching Unit, one for each of the four switched cable groups. At MSC, only two control unit panels are provided: one control unit panel for the Test Area to Computer Room cable group and one dual-function panel that serves both the Control Room to Computer Room cable group and the CUE to Control Room/Computer Room cable group. Each control unit panel contains pushbutton switches arranged in a matrix format to permit selection of any switching permutation of the respective cable group.

1-30. The Computer Room to Control Room control unit panel contains 25 pushbuttons arranged in rows and columns of five each (5 x 5). The equivalent control unit panel pushbutton matrix for MSC contain 4 pushbuttons arranged in rows and columns of two pushbuttons each (2 x 2). Each pushbutton contains a two-digit number to indicate the switching configuration that may be achieved by depressing that pushbutton. The first digit on each pushbutton indicates the Control Room selected while the second digit designates the Computer Room to which the other end of the cable group will be terminated. This two-digit nomenclature is a standardized switching matrix designation, where the first digit always represents the row, and the second denotes the column.

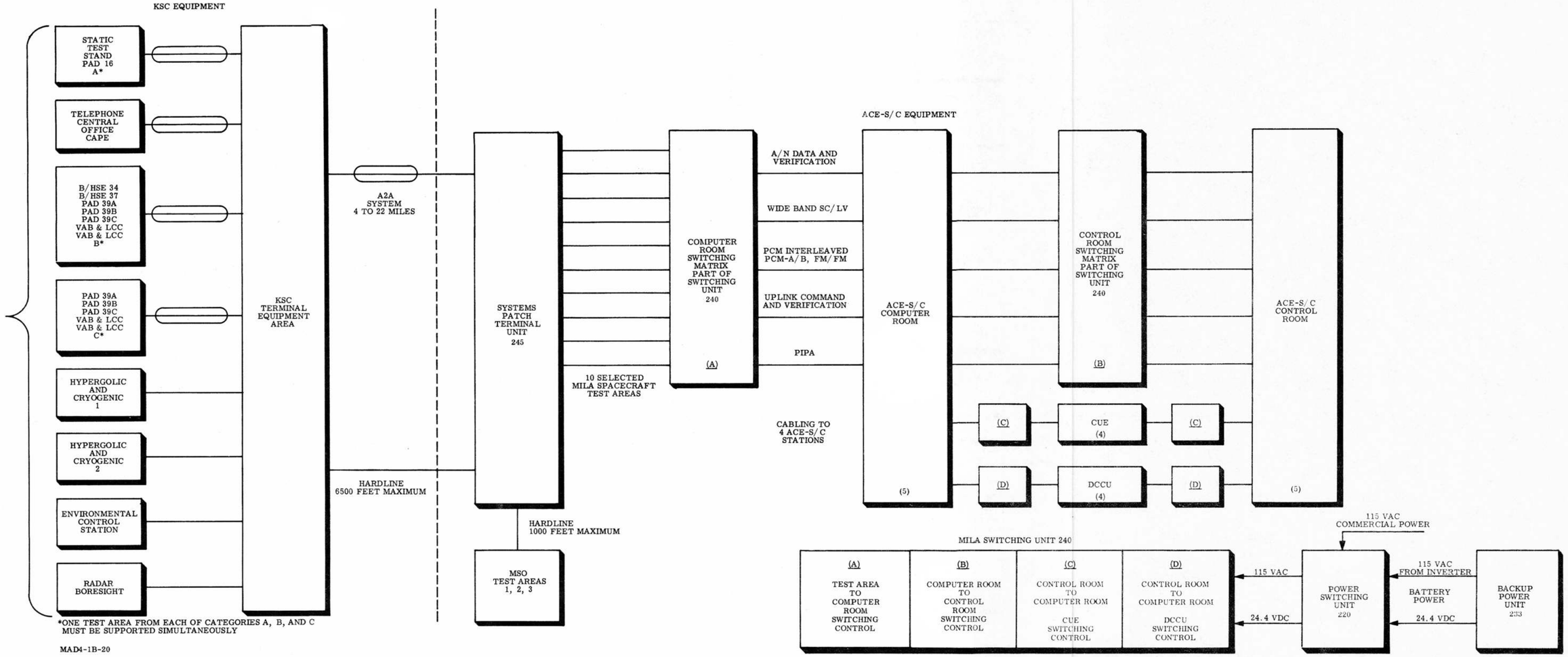

Figure 1-2. ACE-S/C MILA Switching Equipment Block Diagram

1-31. SUPPORT SYSTEMS.

1-32. There are several systems which form an integral portion of the ACE-S/C station, but cannot be categorized as portions of the Command, or Data Recording and Display Equipment. These include the Timing System, the Status Display System, and Switching Equipment.

1-33. TIMING SYSTEM. The Timing Group provides real-time signals for the use of the two computers and the various recorders. These time signals also drive wall time displays. In addition, the Timing Group supplies countdown-time signals to the computer and wall clock displays.

1-34. STATUS DISPLAY SYSTEM. The Status Display System consists of go/hold switches located on the command and display consoles for reporting the test operation status to the Test Conductor. The controls on the consoles are connected to a display panel on the Test Conductor Console that displays indications of test countdown hold conditions.

1-35. COMMAND EQUIPMENT DESCRIPTION.

1-36. All commands are initiated by positioning switches on START modules. The modules are plug-in units and are located in varying numbers on the system control consoles. There are three distinct types of START modules: R START modules providing for manual control of discrete events; C START modules providing for manual selection of computer subroutines and the parameters required by the subroutines; and a single K START module providing for manual and automatic means of inserting information into the spacecraft Apollo Guidance Computer (AGC). Figure 1-3 shows the Command Equipment at all sites except MILA and figure 1-4 shows the Command Equipment at MILA.

1-37. R START MODULE.

1-38. The R START (relay START) module contains four pushbutton function switches, an execute (XEQ) pushbutton, and appropriate lights to indicate the status of the switches and of the module. The function switches provide the means to select the specific discrete events desired, and the XEQ switch initiates the sequence resulting in their occurrence. Each module controls the occurrence of four discrete events (e.g., individual relay action at the spacecraft) by providing a logic 1 or 0 from each function switch. The presence or absence of a 1 is established by the on or off condition of the function switch.

1-39. C START MODULE.

1-40. The C START (computer communication START) module includes ten 12-position switches that provide the means to select a specific command function. Each individual switch position provides a four-bit digital word in binary-coded-decimal form for transmission to the computer. Thus, the output of the C START is a 40-bit message which instructs the computer to perform specific operations (and also may provide parameters for these operations) and instructs the computer in the disposition of the results. The C START panel also includes status indication of the switches, an XEQ pushbutton to initiate the transmission, and appropriate lights to indicate the module status.

1-41. K START MODULE.

1-42. The K START (keyboard START) module may be operated either manually (using a keyboard) or automatically (using a perforated tape reader). The keyboard provides 18 pushbutton switches. Depressing any one of these switches initiates the transmission of a five-bit word to the AGC. The module panel also includes tape reader control switches. These switches provide for automatic sequences of binary words from the tape or manual sequencing, including both forward and reverse steps. A visual tape character readout display is provided. Appropriate display lights on the panel indicate the status of the module and of various events within the AGC.

1-43. COMMUNICATIONS UNIT EXECUTOR.

1-44. The primary function of CUE is to control the two-way communication path between the test operators and the Command

Computer. To accomplish this control function, CUE sequentially interrogates all START modules in a repetitive fashion. The depression of an XEQ pushbutton (R START or C START) or a K START keyboard pushbutton results in interruption of CUE when it reaches that point in its cycle. CUE, under control of the computer, receives the command data and addresses from a START module and transmits the data and addresses to the computer. (The address assigned at this point is used for identification purposes between the START modules and the computer only.) The transmission to the computer is accomplished in two ways. If the data is from an R START, the data and address will be transferred as a single 12-bit word in parallel format. If the data is from a C START or K START, the data and address will be transferred to the computer as four consecutive 12-bit words in parallel format.

1-45. When instructed by the computer, the CUE transmits verification replies to certain lights on the START modules. In the event of a failure, and when instructed by the computer, the CUE will display malfunction codes on a maintenance panel enabling the CUE operator to isolate the cause of failure.

1-46. COMMAND COMPUTER.

1-47. The Command Computer receives the address data words from the CUE and performs the required processing. Data from an R START or K START is encoded into a 24-bit message which includes the required address for processing at the spacecraft location. Usually, C START data instructs the computer to perform preprogrammed subroutines, the results of which may or may not be transferred out of the computer.

1-48. The output of the computer is one or more 24-bit messages presented to a DTVC. Each 24-bit message is transmitted by the computer as two successive 12-bit words in parallel format. The computer selects one of three DTVC's, depending on whether the message is intended for external, carry-on, or service-equipment, DTCS.

1-49. If the Command Computer receives verification of proper message delivery from the DTVC, the CUE is instructed to indicate verification on the appropriate START module panel. Should the verification reply indicate malfunction, the computer will retransmit the message a predetermined number of times - each time waiting for verification of proper message delivery. Should the final reply still indicate failure, the computer will branch into a malfunction isolation subroutine.

1-50. DATA TRANSMISSION AND VERIFICATION CONVERTER.

1-51. The DTVC is a two-way communicator and a parallel-to-serial and serial-to-parallel converter. All computer input/output communications are in parallel format, but all transmissions to and from the DTCS at the spacecraft test area are in serial format.

1-52. The Command Computer sends a 24-bit message to the DTVC. This message is sent in the form of two successive 12-bit parallel words. The DTVC sends each 12-bit segment twice, in a serial format. Thus, the output of the DTVC is a 48-bit serial message, providing 100 percent redundancy of the original 24-bit message received from the computer.

1-53. After transmission of the message, the DTVC receives a 12-bit verification reply from the DTCS. The DTCS transmits this word twice, forming a 24-bit input to the DTVC. The DTVC reads the first 12 bits into a register and then performs a bit-by-bit comparison with the second 12 bits to assure proper reception.

1-54. The DTVC checks the verification reply to determine if the transmission was valid. The Command Computer is then informed of the results of this test.

1-55. DIGITAL TEST COMMAND SYSTEM (DTCS). (This is not a part of the ACE-S/C ground station.)

1-56. A single DTCS in its maximum configuration will contain one Receiver-Decoder, thirty-two baseplates, and one Guidance and Navigation Buffer Unit. The thirty-two baseplates are divided into four groups of eight baseplates each. Each baseplate can contain four plug-in type modules. The plug-in modules provide system capability to be

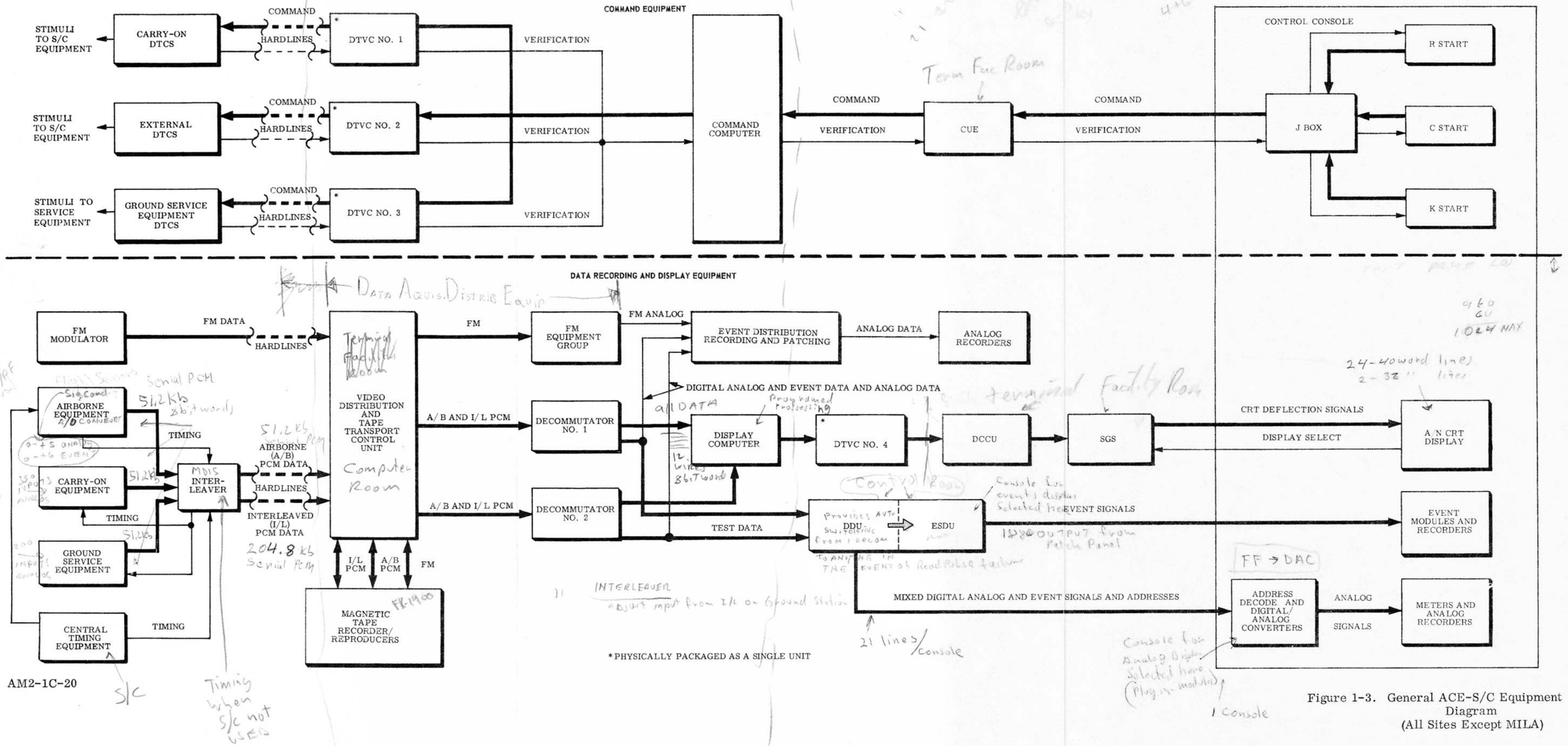

Figure 1-3. General ACE-S/C Equipment Diagram
(All Sites Except MILA)

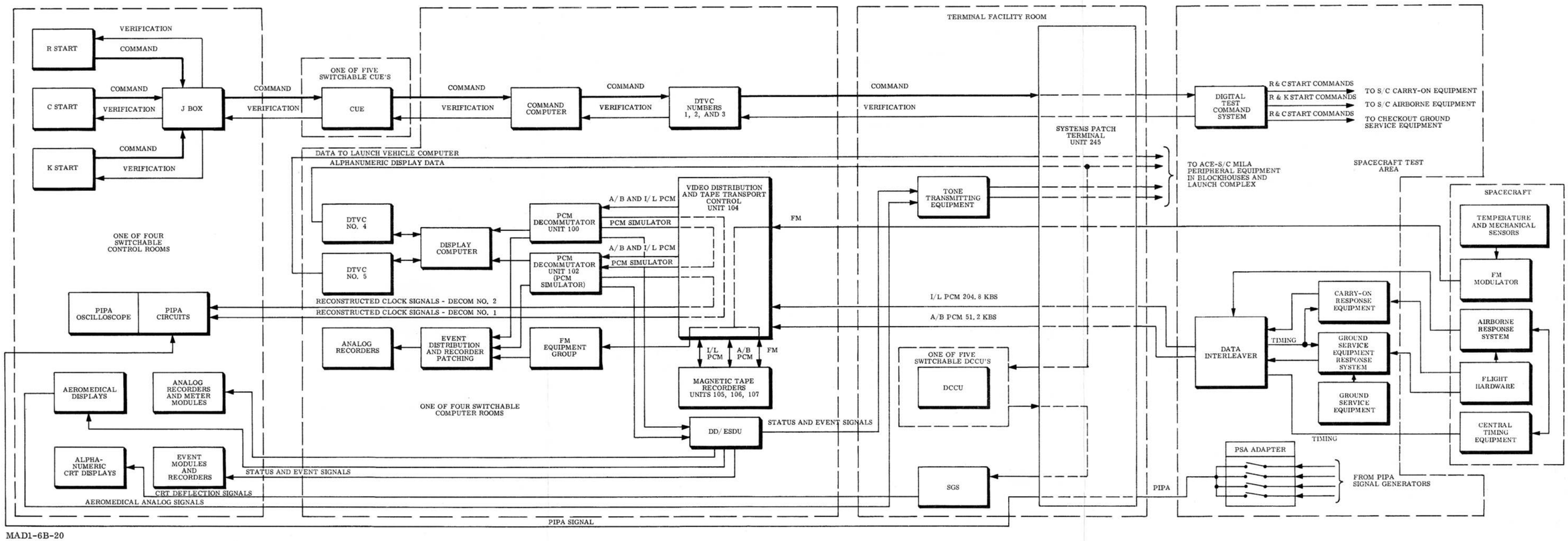

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Figure 1-4. ACE-S/C Equipment Block Diagram (MILA Only)

expanded or contracted to meet particular checkout requirements. Conventional relay and latching relay modules provide programmable relay closures. Voltage mode digital-to-analog converter (VMDAC) modules provide programmable voltages. Each analog module contains one digital-to-analog converter, while each relay module contains sixteen relays.

1-57. The DTCS receives the first 24-bit word from the DTVC and assembles the first 12 bits in half of a 24-position register. It then compares the remaining portion bit by bit to check redundancy. The second 24-bit word of the command message is received and the first 12 bits are assembled into the remaining spaces in the register. A bit-by-bit redundancy check is then performed. If either redundancy check fails, the register is cleared and a verification message, coded to indicate transmission error, is transmitted back over the uplink line to the DTVC.

1-58. If a successful redundancy check is completed, decoding of the message address is begun. Decoding is accomplished at several levels. At each level, a number of discrete bits is examined to determine which of several alternate routes the remaining message bits are to follow. Decoding begins with the more significant address bits. In each case, the decoded bits are dropped, and only the remaining bits of the word are transmitted to the next lower level.

1-59. At each level of decoding, the validity of the address is determined. In every case, there are fewer valid addresses than the total which the number of bits would permit. If the decoded portion of the address is found invalid, decoding ceases, and a coded verification reply is sent to the DTVC to indicate the level of decoding at which the error was detected.

1-60. The Receiver-Decoder performs the first step of address decoding and accordingly selects one of the four groups of baseplates, or the Guidance and Navigation (G&N) buffer unit. If the G&N buffer unit is selected, the remaining message bits are sent to this unit which transfers the proper data into the spacecraft onboard Apollo Guidance Computer. If one of the baseplate groups is selected, the remaining message bits are sent to all baseplates in this group for further decoding.

1-61. A baseplate group may contain as many as eight baseplates. Only one baseplate can accept the message as addressed, and decode the message further to select one of the modules installed on the baseplate. The selected module will accept the remaining bits for further decoding.

1-62. There are two types of modules mounted on the baseplates - a D/A converter module and a relay module. Any baseplate can contain up to four modules with any combination of the two types, or all four of a single type.

1-63. If a D/A converter module is selected, 8 data bits will be transferred to a buffer memory which exercises control over one digital-to-analog converter. A second transmission from the Uplink Computer provides 8 duplicate bits which are compared with those from the first transmission. If comparison is exact the first 8 data bits will be converted to the indicated positive or negative voltage level as a spacecraft stimulus. If the comparison is not exact, the data bits are not converted and a coded verification reply is sent to indicate the comparison failure, and the Receiver-Decoder is reset to accept new words. It should be noted that a verification message is also returned for a valid transmission.

1-64. If a relay module is selected, it will decode the message further to select one of four subgroups of relays controlled by the module. Four data bits will be transferred to a buffer memory of the subgroup which exercises control over four relays. A second transmission from the Uplink Computer provides four duplicate data bits which are compared with those from the first transmission. If the comparison is exact, the first four data bits are shifted from the buffer memory which causes the four relays to react to the data bits, with a 1 causing latch and a 0 causing unlatched. If the comparison is not exact, the data bits are not shifted and a coded verification reply is sent to indicate the comparison failure, and the Receiver-Decoder is reset to accept new words. It should be noted that a verification message is also returned for a valid transmission.

1-65. RECORDING AND DISPLAY EQUIPMENT DESCRIPTION.

1-66. The Recording and Display Equipment provides for receiving, recording, and displaying the spacecraft performance parameters and other data necessary for complete checkout of the spacecraft. This system is made up of the spacecraft and spacecraft vicinity equipment (not a part of ACE-S/C Ground Station), Data Acquisition and Decommutation Equipment, Data Processing, Alphanumeric Display Equipment, and Analog and Event Recording and Display Equipment. Figure 1-3 shows the Recording and Display Equipment at all sites except MILA and figure 1-4 shows the Recording and Display Equipment at MILA.

1-67. SPACECRAFT AND SPACECRAFT VICINITY EQUIPMENT.

1-68. Test data is obtained from sensors in the spacecraft (permanently installed), in the carry-on equipment (which is removed prior to flight), and in the GSE. Data obtained from the permanently installed spacecraft sensors is identical to that which is transmitted by the flight telemetry system and is called airborne (A/B) data.

1-69. The majority of data is converted to serial PCM format and transmitted to the ground station over hardlines. Certain data (e.g., the outputs of vibration sensors), which is required in raw form, is frequency modulated and transmitted to the ground station over a separate hardline.

1-70. The flight telemetry system contains the signal conditioning, commutation, encoding, and digital multiplexing equipment necessary to convert the A/B sensor outputs into a serial PCM output at 51.2 kilobits per second. This output is called A/B PCM. The carry-on equipment performs these same functions for the carry-on sensors.

1-71. The outputs of the GSE sensors are fed to a unit known as the service equipment adapter, which performs the commutation, encoding, and digital multiplexing required to convert them into a third serial PCM output, called service equipment PCM.

1-72. These three PCM outputs (A/B, carry-on, and service equipment) are fed to an interleaver which combines the PCM inputs into a single, interleaved (I/L), serial PCM output and transmits this to the ground station over a hardline at a rate of 204.8 kilobits per second. The A/B PCM, in addition to being interleaved with other data, is also transmitted intact (at its original rate of 51.2 kilobits per second) to the ground station over a separate hardline.

1-73. All PCM data, analog and event, is presented as eight-bit words. For the analog data, each eight-bit word represents a single analog sample. For the event data, each eight-bit word represents eight discrete events. Interleaving is performed on a word basis.

1-74. DATA ACQUISITION AND DECOMMUTATION EQUIPMENT (DADE).

1-75. The DADE group provides for acquiring, recording, synchronizing, decommutating, and distributing the data transmitted from the spacecraft vicinity. The three data lines (A/B, I/L, and FM) are routed to this equipment group through a Terminal Facility Patchboard. This equipment group is made up of the Video Distribution and Tape Transport Control Unit, PCM Decommutators, FM Equipment Group, and Magnetic Tape Recorders.

1-76. VIDEO DISTRIBUTION AND TAPE TRANSPORT CONTROL UNIT. The three incoming data lines are initially terminated at the Video Distribution and Tape Transport Control Unit which provides patching and switching to route the data to the desired decommutator, discriminator, and Magnetic Tape Recorder and Reproducer. The data is routed as follows:

a. All data is routed to wideband magnetic tape recorders.

b. The FM data may be routed to discriminators and then to an analog recorder.

c. The A/B PCM data is routed to the two decommutator units.

d. The interleaved stream of A/B, carry-on, and service equipment data is also routed to both decommutator units.

1-77. PCM DECOMMUTATORS 1 AND 2. The decommutator unit provides the processing

necessary to convert the incoming eight-bit serial data words into parallel format and assign addresses to them for distribution within the ground station. At the input to the decommutator, bit synchronization is achieved, and each pulse is reshaped to assure good bit definition prior to further processing. The serial data bits are read into a shift register, and as the data is shifted through the register, frame synchronization is established. Following frame synchronization, ID synchronization is established. At this point, the location and identity of each data word are known. The data is presented at the decommutator output along with the appropriate programmed address. A delayed read pulse is also presented at the decommutator output. The decommutator output (without addresses) is routed to the Alphanumeric Display System via the Decommutator/Computer Interface Unit and Display Computer, and (with addresses) to the Event and Analog Data Display System.

1-78. ALPHANUMERIC DISPLAY SYSTEM.

1-79. The Alphanumeric Display System furnishes the primary displays for monitoring analog measurements and certain event occurrences. It provides at a single location the capability of simultaneously viewing 24 lines of data presented in decimal numbers and engineering units on the screen of a CRT. Switching capability on the display module permits the callup of 40 separate data tabulations, each of which has a 12-line capacity. Suitable function and page identification are also displayed. This display system includes data processing, symbol generation and storage, and CRT display equipment.

1-80. DATA PROCESSING. Data from the decommutators is routed to the Downlink Computer through the input/output module. This data is stored in two blocks in the memory. While one block of data is being stored in one location, the computer processes data in the other block. The primary operations which the computer must perform in processing the downlink data include the following:

a. Assemble the data into proper word length and format for display on CRT's.

b. Compare any given word or words to determine whether the data falls within predetermined limits, and flag out-of-limit conditions.

c. Compute the average of a block of words and retain this average for output display.

d. Convert data into engineering units, both linear and quadratic functions, using curve techniques.

e. Convert data and place in proper format for alphanumeric CRT display.

1-81. Operating under program control, the computer provides a series of 12-bit coded words which include display data character codes, address, and associated instructions. These 12-bit words are transmitted in parallel format to the DTVC. At MSC the 12-bit words are transmitted directly to the SGS.

1-82. DATA TRANSMISSION. (All sites except MSC.) The DTVC converts each 12-bit word to serial format and transmits it redundantly as a 24-bit serial message to a DCCU. The DCCU assembles the first 12 bits into a register and then compares the second 12 bits with the first 12 bits to check redundancy. If the redundancy check is successful, the DCCU transmits the 12-bit word in parallel format to an SGS Unit. The DCCU has the capability of preventing transmission to the SGS if the redundancy check fails.

NOTE

Due to shorter transmission distances at MSC, no DTVC-DCCU link is required between the SGS and the Display Computer.

1-83. SYMBOL GENERATOR AND STORAGE UNIT. The SGS Unit receives the coded words from the DCCU. The 12-bit words, each representing two display characters, are stored in memory locations according to received instructions and addresses. The entire content of this memory is updated once per second, and it is scanned at a rate sufficient to write all alphanumeric displays at least 30 times per second.

1-84. The character repertoire of the SGS allows display of all alphanumeric characters together with a set of special symbols. Also incorporated is the capability to cause

characters to blink on the CRT screen when so instructed by the computer. This blinking indicates an out-of-tolerance condition.

1-85. Memory allocations in the SGS are sufficient to provide for display of 20 pages of data, a page consisting of 24 lines of 40 characters each plus two 32-character lines, one at the top and one at the bottom of the page. Upon demand, the SGS will provide the proper signals to cause the contents of any top half-page and any bottom half-page to appear on the screen of the requesting CRT. Any given half-page can be selected by as many as 20 CRT's simultaneously.

1-86. CRT MODULES. The CRT's utilized for the Alphanumeric Display System are 10-inch, electrostatically deflected devices. The modules include controls for selecting any top half-page and any bottom half-page of the 20 pages of data stored in the SGS for simultaneous display. In addition, the CRT module includes controls for focusing, brightness, horizontal and vertical gain and centering, and an on/off switch.

1-87. Any given half-page display contains 12 lines of identified data in decimal numbers and engineering units. In addition, a single top (or bottom) line provides page identification.

1-88. ANALOG AND EVENT DISPLAY SYSTEM.

1-89. All data words from the decommutator are applied to the decommutator distribution section of the DD/ESDU. This portion of the unit acts as a distribution amplifier, providing one 21-line output to the event storage and distribution section and one 21-line output to each console.

1-90. EVENT DATA DISPLAY. Event data words are selected from intermixed analog and event data words received from the decommutator distribution circuits in the Event Storage and Distribution Unit of the DD/ESDU. This selection (by address recognition) and the storage location of each event bit is predetermined by the selection and arrangement of plug-in logic modules within the event storage and distribution circuits.

EVENT words selected

1-91. The ESDU will select and store 150 event words, each of which consists of eight discrete event functions (a total of 1200 events). The event words are gated into registers within the ESDU. The output of each bit position in a register represents the status of a specific event (whether it has or has not occurred).

1-92. The outputs of the storage registers are routed to a patch facility in the DD/ESDU. The patching at this point determines the distribution of each event function to the various consoles and permits routing any specific event function to multiple locations. The outputs of the ESDU are fed to event recorders and/or lamp drivers (in the consoles) which cause event lamps to light.

1-93. Event modules are located on the various system control consoles. The front panel of an event module contains 24 lights arranged in three vertical rows of eight lights each. Each light is equipped with a colored lens marked to identify the event function. These lenses are replaceable, should it be desired to change the display. A lamp test switch on the module tests the function of all lamps simultaneously.

1-94. Event Recorders are utilized to provide permanent records of events where the time and/or duration of events are desired. Two types of Event Recorders are used: a 32-channel recorder providing a continuous-write, deflection-type presentation; and a 100-channel recorder providing a write/no-write indication of event status. Both recorders have paper-speed controls and each will accept time code signals.

1-95. ANALOG DATA DISPLAY SYSTEM. The intermixed analog and event data words from the decommutator distribution circuits of the DD/ESDU are routed to all system control consoles. Each control console has address selection circuits that select the analog data words to be displayed at that particular console. The addresses selected by each console are determined by plug-in modules in the console.

1-96. These address logic circuits decode the address portion of analog data words to gate the data portion of the word into a

storage register. The storage register is connected to a D/A converter that operates a meter or a pen on an analog recorder. In some consoles, the data to be displayed on a particular indicator can be selected from as many as four different addresses. This address selection is controllable by means of a switch on the console front panel.

SECTION II

ACE-S/C MILA PERIPHERAL EQUIPMENT DESCRIPTION

1-97. GENERAL DESCRIPTION.

1-98. The MILA ACE-S/C peripheral equipment (figure 1-4) provides blockhouse and Launch Control Center (LCC) equipment to monitor spacecraft checkout progress during launch operations. This equipment is an integral part of the launch control equipment, and as such, provides one portion of the range firing link.

1-99. The peripheral equipment performs five major functions:

a. Provides displays of spacecraft system readiness, and progress of mission countdown milestones, and allow the Spacecraft Test Conductor and his assistant to monitor the results of spacecraft testing during the launch countdown and thus determine whether the spacecraft is ready for launching.

b. Provides the controls and displays necessary for the Spacecraft Test Conductor to monitor the status of the LEM, CSM, launch and mission milestones, and to ascertain that the spacecraft condition is satisfactory.

c. Provides displays of astronaut respiration and heart rate that allow the Aeromedical Representative to monitor the physical reactions of the flight crew.

d. Provides control of all communications between the flight crew and ground personnel connected with the mission.

e. Provides the required interface between the Launch Vehicle Computer and the ACE-S/C ground station Display Computer to enable the interchange of spacecraft test results between the computers.

1-100. In addition to the major functions outlined above, the peripheral equipment provides a television display of the launch area to the Spacecraft Test Conductor. Generation and control of countdown timing signals is also a function of the peripheral equipment.

1-101. HARDLINE DATA TRANSMISSION AND TERMINATION EQUIPMENT.

1-102. The ACE-S/C peripheral equipment is connected to the ACE-S/C ground station by the MILA telecommunications hardlines. Various signals are received and transmitted through this system, including:

a. Video signals to drive CCTV displays.

b. Serial digital data associated with the Spacecraft Computer-Launch Vehicle Computer Interface Unit.

c. FS tone signals to operate status and event displays.

d. FM tone signals for aeromedical analog display and recording.

e. Pulse-width-modulated CW-range countdown-time signals.

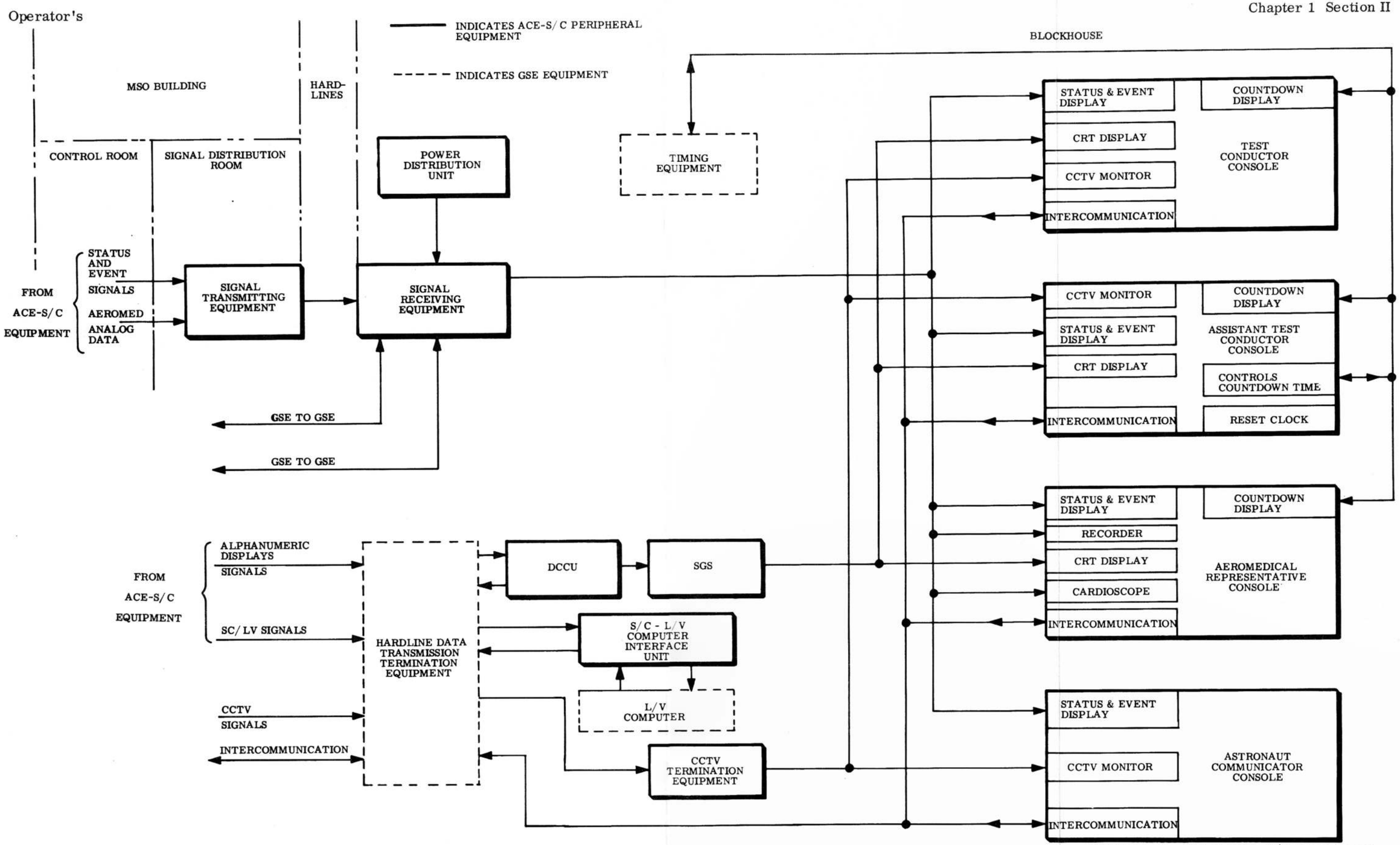
f. Voice communications.

1-103. The telecommunication lines are terminated at the blockhouses and LCC by the Hardline Data Transmission Termination Equipment. This equipment acts as the central external distribution point for signals from and/or to the control and display equipment, the Spacecraft Computer-Launch Vehicle Computer Interface Unit, and the support equipment in the LCC or blockhouses.

1-104. DATA DISPLAY AND CONTROL EQUIPMENT.

1-105. The Data Display and Control Equipment consists of display and recording modules mounted in consoles, units that supply signals to the modules, and console controls that are part of the range firing link.

1-106. This equipment monitors spacecraft checkout status during countdown to provide the Spacecraft Test Conductor in the launch control area with the basis for a go/hold decision.



AF4-1A-2

Figure 1-5. MILA ACE-S/C Peripheral Equipment Block Diagram

1-107. The displays are described in three categories: status and event displays, aeromedical analog displays, and alphanumeric displays.

1-108. STATUS AND EVENT DISPLAY.

1-109. FS tone signals, representing status and event indicators, are received from the ACE-S/C ground stations via the Hardline Data Transmission Termination Equipment. These signals are applied to tone receivers in the Signal Receiving Equipment via a patchboard and the resultant binary pulse outputs are routed to status and event indicators on the various consoles.

1-110. The front of the status panel in each console contains indicator lights grouped by function (e.g., CSM, LEM, milestones, etc.). Each light is equipped with lenses engraved to identify the event or status function. Each light is equipped with a lamp test switch to verify the operational condition of the indicator.

1-111. AEROMEDICAL ANALOG DISPLAY.

1-112. FM tone signals, representing astronaut respiration and heart action, are received from the ACE-S/C ground station via the Hardline Data Transmission Termination Equipment. These signals also go to the Signal Receiving Equipment, where they are applied via a patch panel to discriminators. The analog signal output of the discriminators is applied via a patch panel to the Aeromedical Recorder, the Cardioscope display, and the Cardiometer in the Aeromedical Console.

1-113. AEROMEDICAL RECORDER FUNCTIONS. The Cardiograph Recorder is a two-channel, hot-stylus recorder that provides a display and permanent record of heart pulse and/or respiration analog signals.

1-114. CARDIOSCOPE DISPLAY FUNCTIONS. The Cardioscope Display Unit is an oscilloscope providing four simultaneous traces (displays) of heart pulse analog signals. Four sweep rates are selectable to allow detailed examination of one pulse, or displays of several pulses.

1-115. CARDIOMETER FUNCTIONS. The Cardiometer periodically samples heart pulse counts. The resultant count is displayed on projection-type numeric indicators.

1-116. ALPHANUMERIC DISPLAY EQUIPMENT.

1-117. The Alphanumeric Display Equipment comprises a DCCU, an SGS, and CRT displays in various consoles. This equipment provides a display of selected data from an ACE-S/C ground station Display Computer.

1-118. DCCU FUNCTIONS. The DCCU receives 12-bit serial digital data words via the Hardline Data Transmission Termination Equipment. The 12-bit words are sent redundantly to the DCCU, that is, each word is sent twice. The DCCU loads the first word into a register and compares the second word with the first to check redundance. If the redundance check is successful, the DCCU transmits the 12-bit word in parallel to the SGS Unit.

1-119. SYMBOL GENERATOR SYSTEM FUNCTIONS. The SGS Unit receives the 12-bit word from the DCCU. The words are decoded, and the data is stored in memory locations in accordance with received instructions and addresses. The content of the memory is updated once per second, and the memory is scanned at least 30 times per second to refresh all CRT displays.

1-120. The character repertoire of the SGS consists of all alphabetic and numeric characters together with a set of special symbols. The unit also has the capability to cause selected characters to blink on the CRT screen when the data they represent is out of preset limits. This blink function is controlled by instructions from the ACE-S/C Display Computer.

1-121. Memory capacity in the SGS is sufficient to provide for the display of 20 pages of data. (A page consists of 24 lines of 40 characters each, plus two lines, one at the top and one at the bottom of the page, of 32 characters each.)

1-122. CRT MODULE FUNCTIONS. The alphanumeric display monitors provide a display of the data from the SGS on 10-inch CRT's. Controls are provided on the front panel of the monitors to select any of the 20

top and bottom half-pages of SGS data for simultaneous display. In addition, controls are included for adjusting focus, brightness, horizontal and vertical gain, and centering.

1-123. GSE-GSE FUNCTIONS.

1-124. The GSE-GSE Equipment provides both display and control functions. Power from the peripheral equipment power supplies is supplied via control closures on GSE relays in various areas, through the Signal Receiving Equipment, to certain of the indicator lamps in the console status and event panels. These indicators provide the status of selected general range operations (i.e., not directly associated with spacecraft checkout).

1-125. In addition, two key-operated arming switches are provided on the Test Conductor Console that are serial elements in the GSE range firing link. These switches are actuated by the Spacecraft Test Conductor when the spacecraft is in a "go" condition.

1-126. ACE SPACECRAFT COMPUTER-LAUNCH VEHICLE COMPUTER INTERFACE UNIT.

1-127. The Spacecraft Computer-Launch Vehicle Computer Interface Unit provides the facility for the data interchange between the Launch Vehicle Computer located in the blockhouses or the LCC and the ACE-S/C Display Computer located in the Manned Spacecraft Operations (MSO) Building. The three primary functions performed by the interface unit are: serial-to-parallel conversion, data transmission verification, and message format conversion.

1-128. The serial-to-parallel conversion is necessary because data is transmitted from the MSO Building to the blockhouses in serial form and the Launch Vehicle Computer input/output circuits are designed to handle data in parallel form. The data transmission verification is performed to ensure the validity of the data transmitted over the telecommunication system and to avoid errors introduced by noise inherent in such systems.

1-129. The ACE-S/C Display Computer input/output circuits are designed to handle data in 12-bit parallel form while the Launch Vehicle Computer input/output circuits operate with a 24-bit parallel word format. To accomplish the data interchange function, the interface unit operates in two modes, depending on the direction of data flow between the two computers.

1-130. TIMING EQUIPMENT FUNCTIONS.

1-131. Government Furnished Timing Equipment is located in the blockhouses and LCC and operates in conjunction with the MILA peripheral equipment. This equipment provides a common countdown time reference to various personnel and equipment engaged in launch countdown checkout activity at various locations throughout the launch area. The Timing Equipment consists of the circuits necessary to generate coded electrical signals suitable for transmission via the telecommunications system to other facilities such as the ACE-S/C ground stations in the MSO Building. The Timing Equipment is controlled by the Assistant Spacecraft Test Conductor by means of a countdown time control panel located on his console. Signals generated by the Timing Equipment are used to:

a. Display the countdown time in terms of hours, minutes, and seconds on numeric displays.

b. Identify the time that spacecraft test data is recorded on strip charts and magnetic tapes.

c. Serve as a time interval reference for the computers used as a part of the launch control and checkout operation.

1-132. To accomplish the functions outlined above, the Timing Equipment generates three types of time code signals: a serial pulse-width-modulated 1-kc signal designated Modified IRIG B, a serial 1-pps pulse-width-modulated signal designated AMR B-1, and a parallel seven-line code. The Modified IRIG B code is transmitted through the telecommunications system to time code translating equipment in other facilities for conversion to signals compatible with computer equipment and recording and display devices.

1-133. The AMR B-1 code is routed to the Aeromedical Representative Console where it serves as a time base for the Cardiometer and is recorded on the Aeromedical Analog Recorder for reference purposes. The seven-line code is routed to the Test Conductor

Console, Assistant Test Conductor Console, and Astronaut Communicator Console where it is used to operate numeric countdown time displays.

1-134. INTERCOMMUNICATIONS SYSTEM FUNCTIONS.

1-135. The Intercommunications System provides RF voice and telephone communications within the ACE-S/C equipment, between the blockhouse and the flight crew, and between the blockhouse and MSC Houston, Texas. The Intercommunications System contains three types of control units: a Dual Operator Unit, Test Conductor Unit, and a Switching and Control Unit. The Dual Operator Unit is located throughout the ACE-S/C equipment in the MSO Building. The Test Conductor Unit is located on the Test Conductor Console, Unit 12, and the Switching and Control Unit is located on the Astronaut Communicator Console, Unit 11. All communication between the flight crew and the blockhouse during final countdown is monitored and controlled at the Astronaut Communicator Console Switching and Control Unit. Telephone communications between the blockhouse and MSC Houston, Texas, are also controlled from this console.

1-136. CCTV SYSTEM FUNCTIONS.

1-137. The CCTV System provides monitoring of operations in test areas, launch stands, and/or spacecraft structures during preflight checkout. The control and selection of a particular test area and TV monitor is performed at the OTV Central Control Distribution and Switching Equipment. This switching equipment controls the selection and operation of remote cameras such as close-up, zoom, etc. Requests for a particular camera or the switching to different test areas to be monitored is performed from the consoles via communication with the switching equipment operator.

1-138. Two rack-mounted CCTV monitors are located on the Astronaut Communicator Console, Test Conductor Console, and on the Assistant Test Conductor Console, Units 11, 12, and 13 respectively. The TV monitors are 8-inch transistorized broadcast monitors employing plug-in modular circuits. Video then is fed through an isolation network either directly to a TV monitor or to a number of monitors connected in series (video looping). The video signal then is terminated at the rear of the unit through a switch and a 75-ohm terminating resistor. Monitor operation controls are located behind a hinged front panel of each monitor.

CHAPTER 2

SYSTEM UTILIZATION

SECTION I

ACE-S/C STATION UTILIZATION

2-1. ACE-S/C APPLICATIONS.

2-2. ACE-S/C systems are being installed at four locations. At the facilities of North American Aviation, Downey, California, the ACE-S/C systems will be used for subsystem and integrated system testing of the Apollo Command Module and Service Module during the various stages of assembly and checkout. The Grumman Aircraft Engineering Corporation (GAEC), Bethpage, New York, will use the system for similar testing of the Lunar Excursion Module (LEM). At the Manned Spacecraft Center (MSC), Houston, Texas, the testing of the spacecraft, both manned and unmanned, in simulated space and lunar environments will be accomplished. At the Merritt Island Launch Area, the complete range of subsystem and integrated system testing will take place. This test cycle spans from receipt of the spacecraft modules, through spacecraft and launch vehicle mating, and the final prelaunch checkout (see figure 2-1).

NOTE

Detailed checkout activities are in the planning stage. All plans are continually reviewed and modified in accordance with engineering requirements, equipment modifications, etc. Figures 2-1 and 2-2 are provided as an aid to understanding the general flow of the spacecraft through the MILA checkout cycle. They do not reflect firm program planning and should not be so interpreted.

2-3. It is evident that a wide variety of tests are performed and that these tests are accomplished in a number of different areas. The magnitude of spacecraft checkout requirements is emphasized in figure 2-2 which illustrates a test cycle for the spacecraft Environmental Control System. The ACE-S/C system is capable of meeting these diverse requirements because of its great flexibility and its ability to control a wide variety of test commands and monitor a vast number of test results.

2-4. PREOPERATIONAL PLANNING.

2-5. Each using activity, such as North American, Grumman, etc., is to plan the test operation in detail. In planning a test operation, the using activity selects the ACE-S/C Control Room(s) to be used, the specific equipment applicable to the particular test operation, and outlines the test sequence. From this general test operation outline, the operational checkout procedures and computer programming requirements are generated.

2-6. OPERATIONAL CHECKOUT PROCEDURES.

2-7. The measurements to be made, test limits and parameters, specific display devices and records, and the test sequence are spelled out in the operational checkout procedures document. The information contained in this document is in the form of

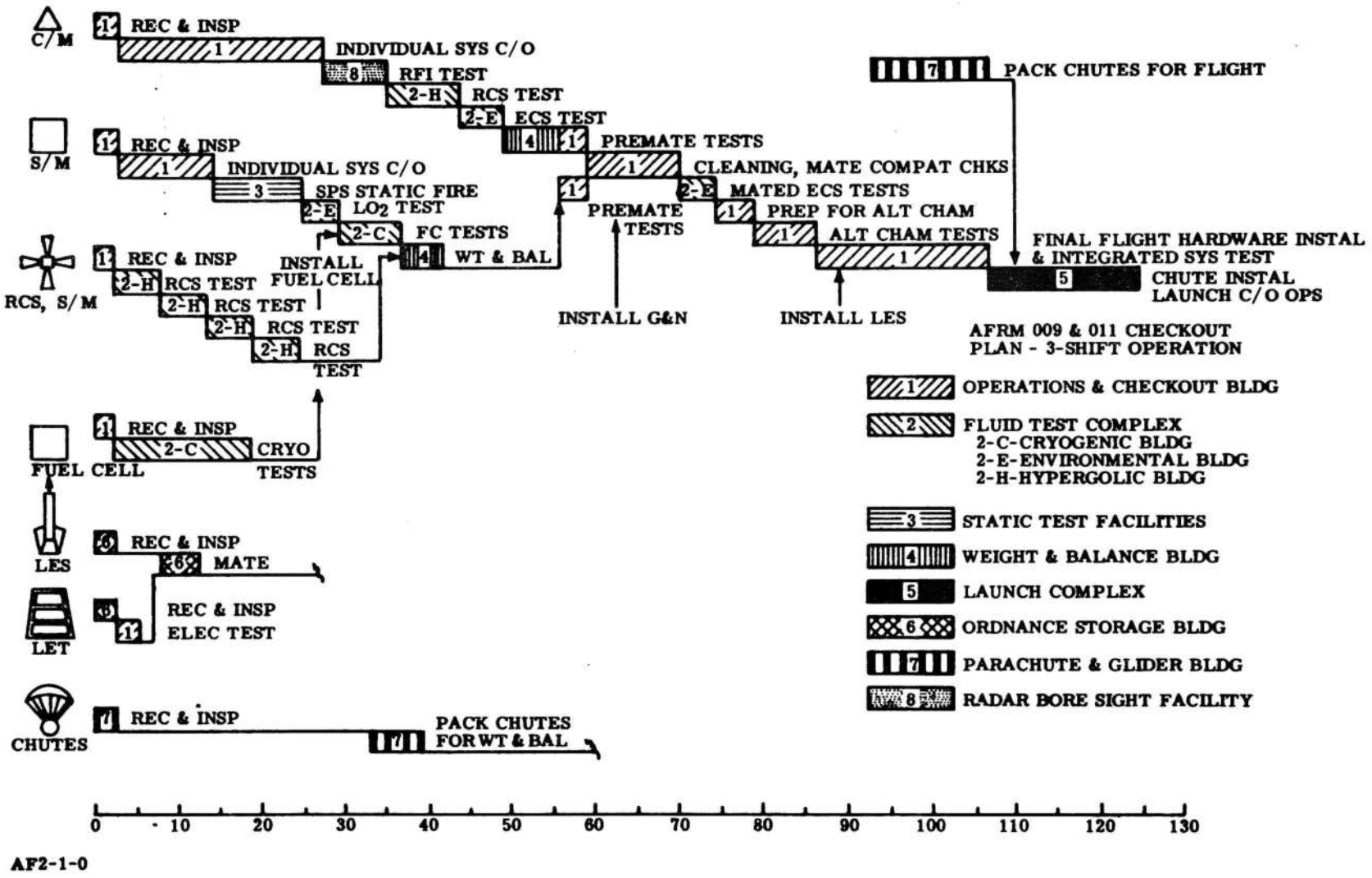
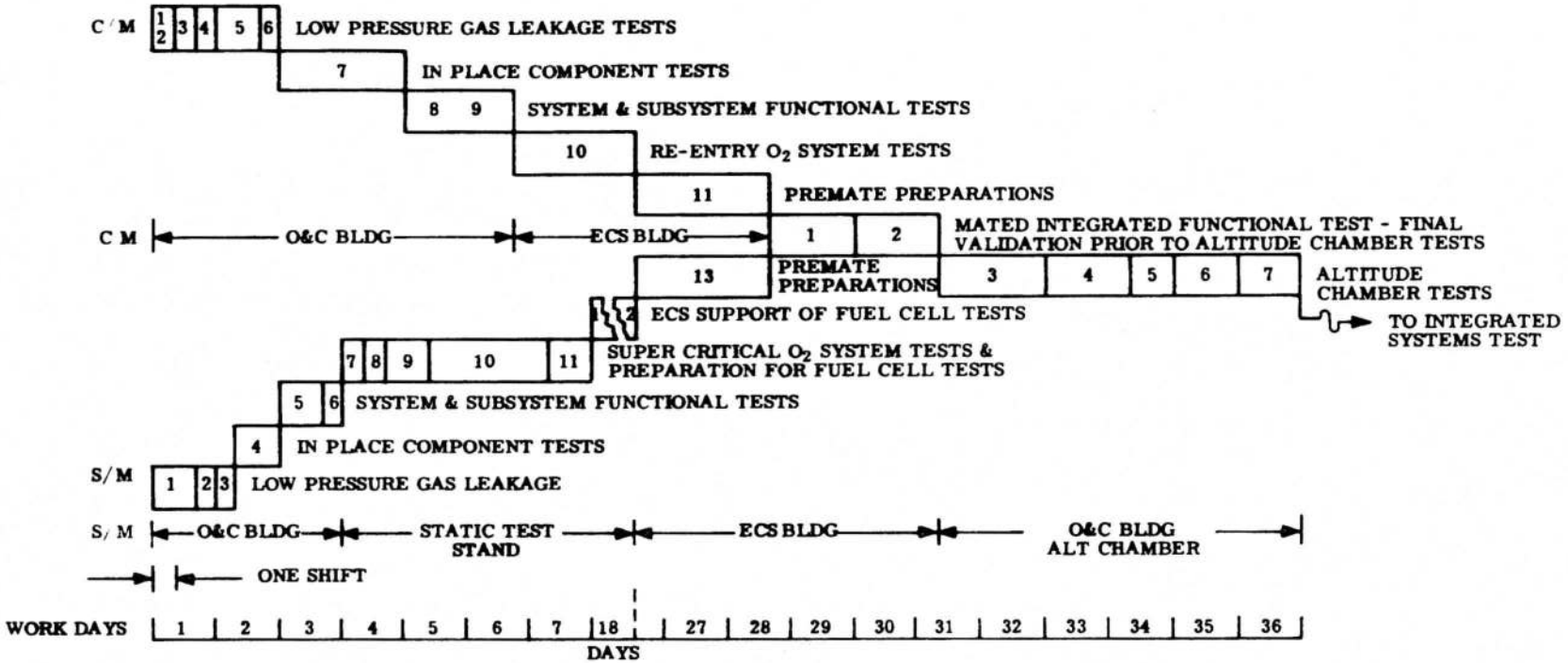


Figure 2-1. Spacecraft Test Cycle at MILA



C/M TESTS

1. FREON SYSTEM
2. SUIT CIRCUIT
3. CABIN
4. WATER SYSTEM
5. GLYCOL SYSTEM
6. MISCELLANEOUS
7. ALL COMPONENTS CHECKED WITH RESPECT TO THE FOLLOWING AS APPLICABLE:
   a. FLOWRATES
   b. VALVE CRACKING POINTS
   c. ELECTRICAL CONTINUITY
   d. POWER CONSUMPTION
   e. MECH. LINKAGE RIGGING
   f. HANDLE PULL FORCES
   g. LEAKAGE
   h. PRESSURE REGULATION
   i. FUNCTIONAL OPERATION
   j. ETC.
8. FUNCTIONAL CHECK OF COOLING SYSTEMS SERVICED WITH COOLANT
9. FUNCTIONAL CHECKS OF GAS SYSTEMS
10. HIGH PRESSURE LEAKAGE CHECK & CALIBRATION
11. PREMATE PREPARATION (ECS) NON-ECS INTERFACE CHECKS WORK PERIOD

S/M TESTS

1. GLYCOL SYSTEM
2. WATER SYSTEM
3. MISCELLANEOUS
4. SAME AS ITEM 7, C/M TESTS
5. FUNCTIONAL CHECK OF COOLING SYSTEMS SERVICED WITH COOLANT
6. FUNCTIONAL CHECKS OF GAS SYSTEMS OR SUBSYSTEMS WHERE PRACTICAL
7. COOLANT SERVICING
8. GAS LEAK CHECK
9. LOX SERVICING & CALIBRATION
10. FUNCTIONAL CHECK
    a. HEAT LEAK
    b. PRESSURE & TEMPERATURE SURVEILLANCE
    c. OPERATIONAL CHECK
11. DUMP O_2 IF REQ'D PRIOR TO MOVE TO FUEL CELL FACILITY
12. LOX & COOLANT SUPPORT (56 SHIFTS)
13. PREMATE PREPARATION (ECS) NON-ECS INTERFACE CHECKS WORK PERIOD

MATED C/M & S/M TESTS

1. SERVICE HIGH PRESSURE O_2
   SERVICE COOLANT
   SERVICE LOX
   CALIBRATION
2. SEA LEVEL INTEGRATED FUNCTIONAL CHECK OF ECS - ASTRONAUT PARTICIPATION
3. PREPARATION
   a. SERVICE
   b. CABLING
   c. ETC.
4. RUN NO. 1 - UNMANNED
   a. INSTRUMENTATION CALIBRATION
5. RUN NO. 2 - UNMANNED
   a. VALIDATION OF ECS IN ALL FLIGHT MODES WHERE PRACTICAL
6. RUN NO. 3 - MANNED
   a. SIMULATED FLIGHT: MAN-SYSTEM COMPATIBILITY IN ALL MODES
7. PREPARATION FOR/AND REMOVAL FROM CHAMBER

AF2-2-0

Figure 2-2. Spacecraft Environmental Control System (ECS) Checkout Cycle at MILA

step-by-step operating procedures and defines:

a. The START modules to be used to enter a test command.

b. The specific test commands to be generated.

c. The display devices used to monitor each test result.

d. Measurement parameters.

2-8. The Operational Checkout Procedures (OCP's) are used by the operators as the test operating procedure. All operator information necessary to conduct a test is contained in the OCP generated for a specific test. See figure 2-3 for typical OCP pages.

2-9. TEST OPERATION PROGRAMMING REQUIREMENTS.

2-10. To generate the required Command and Display Computer programs and the appropriate decommutator programs, computer programmers must be provided with detailed information concerning the specific command functions assigned to various control consoles, measurement limits, display devices to be used for the various measurements, etc. This information is provided to the programmers in the test operation programming requirements document. This document is in the form of punched cards and defines the configuration of the ACE-S/C equipment, and the content of the computer and decommutator programs.

2-11. COMPUTER PROGRAMMING.

2-12. Upon receipt of the programming requirements, the programmers generate an assembly program. This assembly program is used to assemble the test operation program by calling up existing routines and subprograms from a master file or program library tape. This method of program assembly presupposes the existence of the required routines or subprograms. These routines and subprograms are generated as the need arises and are filed in the master file or library tape.

2-13. PROGRAM LIBRARY. A central program library of official ACE-S/C computer programs, subprograms, and subroutines is maintained. The library is located at the MSC, Houston, Texas, and is operated by the General Electric Company under the direction of NASA. All programs to be used at an ACE-S/C facility are originated, validated, and distributed by the central program library. The program library contains a master card file for each program. This file is reproduced into master program magnetic tapes. From these tapes, a working library tape is prepared.

2-14. LIBRARY TAPES. The library tape contains all programs, subprograms, and subroutines in common use at a specific ACE-S/C facility. Provisions are made to replace, insert, or delete routines from the library tapes during all phases of operation, including test preparation, checkout, and spacecraft test operations.

2-15. STATION CONFIGURATION AND CHECKOUT.

2-16. Prior to any test operation, the ACE-S/C equipment must be prepared for operation and tested to ensure that it is properly configured and operational. Configuring the station requires that the General Electric site support personnel be provided with detailed information concerning the equipment to be used during the test and the specific display and recording devices to be used to monitor each measurement and event. This station configuration information is compiled by the headquarters support personnel at Daytona Beach through use of data processing techniques. The station configuration documents consist of a patch instruction list and a patch configuration list.

2-17. PATCH INSTRUCTION LIST.

2-18. Each of the Control Room consoles to be used during a test operation must be patched to route the analog and event data to the display and recording devices dictated by the test operations and programming requirements documents. In addition to the consoles in the Control Room, the DD/ESDU and certain units of Computer Room equipment must be patched. Instructions for patching this equipment are generated automatically through use of a computer.

2-19. Computer programmers at the headquarters activity process the programming requirements cards in a general-purpose

Time	Cb	Seq	C/O Cont	C/O Sta	Description/Instruction	Meas Ident	CRT Information				Display/Recorder	Comments	
							Page	Line	Lower	Upper			
NA	2	01-010	STC	HBO	a. On R065, insert 0000 and verify						3A1		
					b. Execute and verify.								
		01-011		HBO	a. On R069, insert 1000 and verify.						3A1		
					b. Execute and verify.								
					c. On console CRT, verify the following:	GC5032	3	1		85 ± 3 v rms			
						GC5033	3	2		115 ± 4 v rms			
						GC5034	3	3		115 ± 4 v rms			
						GC5035	3	6		102 ± 3 v rms			
						GC5036	3	7		115 ± 4 v rms			
						GC5037	3	8		115 ± 4 v rms			
						GC5926	3	4		400 ± 20 cps			
					d. On R069, insert 0000 and verify.						3A1		
					e. Execute and verify.								
		01-012		HBO	a. On R069, insert 0100 and verify.						3A1		
					b. Execute and verify.								
					c. On console CRT, verify the following:	GC5032	3	1		115 ± 4 v rms			
						GC5033	3	2		85 ± 3 v rms			
						GC5034	3	3		115 ± 4 v rms			
						GC5035	3	6		115 ± 4 v rms			
						GC5036	3	7		102 ± 3 v rms			
						GC5037	3	8		115 ± 4 v rms			
						GC5926	3	4		400 ± 20 cps			
					d. On R069, insert 0000 and verify						3A1		
					e. Execute and verify.								
		01-013		HBO	a. On R069, insert 0010 and verify.						3A1		
					b. Execute and verify.								
					c. On console CRT, verify the following:	GC5032	3	1		115 ± 4 v rms			
						GC5033	3	2		115 ± 4 v rms			
						GC5034	3	3		85 ± 3 v rms			
						GC5035	3	6		115 ± 4 v rms			
						GC5036	3	7		115 ± 4 v rms			
						GC5037	3	8		102 ± 3 v rms			
						GC5926	3	4		400 ± 20 cps			
		01-014		HBO	a. On R069, insert 0000 and verify.						3A1		
					b. Execute and verify.								

AO2-1-2 (Sheet 1 of2)

Figure 2-3. Typical OCP Pages (Sheet 1 of 2)

Time	Ch	Seq	C/O Cont	C/O Sta	Description/Instruction	Meas Ident.	CRT Information				Display/Recorder	Comments	
							Page	Line	Lower	Upper			
NA	2	02-018	STC	GPM/ HBO	a. Adjust power supply 2 to 30.1 vdc and verify.								
					b. On C076, insert 2203141331 and verify.						3A1		
					c. Execute and verify.								
					d. Verify 50 ± 5 amps on CRT.	GC5029	3	14					
					e. On C076, insert 2203141330 and verify.						3A1		
					f. Execute and verify.								
		02-019		GPM/ HBO	a. Adjust power supply 2 to 30.5 vdc and verify.								
					b. On C076, insert 2203141321 and verify.						3A1		
					c. Execute and verify.								
					d. Verify 60 ± 6 amps on CRT.								
					e. On C076, insert 2203141320 and verify.	GC5029	3	14			3A1		
					f. Execute and verify.								
		02-020		GPM/ HBO	a. Adjust power supply 2 to 30.9 vdc and verify.								
					b. On C076, insert 2203141311 and verify.						3A1		
					c. Execute and verify.								
					d. Verify 70 ± 7 amps on CRT.	GC5029	3	14					
					e. On C076, insert 2203141310 and verify.						3A1		
					f. Execute and verify.								
		02-021		GPM/ HBO	a. Adjust power supply 2 to 31.3 vdc and verify.								
					b. On C076, insert 2203141441 and verify.						3A1		
					c. Execute and verify.								
					d. Verify 80 ± 8 amps on CRT.	GC5029	3	14					
					e. On C076, insert 2203141440 and verify.						3A1		
					f. Execute and verify.								

AO2-1-2 (Sheet 2 of2)

Figure 2-3. Typical OCP Pages (Sheet 2 of 2)

computer. The computer produces the patch instruction listing that contains the display routing addresses and the exit and entry hubs to be patched on each equipment patchboard. The listing is printed in a numeric order that allows the patchboards to be wired beginning at the center of the board and working outward to the edges, thus making for an efficiently patched board.

2-20. PATCH CONFIGURATION LIST.

2-21. To meet the mean-time-to-repair requirement, maintenance personnel must be provided with accurate, detailed, and current documentation of the analog and event data paths through the system. Again, this is accomplished through use of data processing techniques. The programming requirements cards used to generate the patch instruction list described above are used in a similar manner to produce the patch configuration list. This list contains the equipment reference designations for all of the significant test points the maintenance personnel need to trace the patch of any analog or event signal through the equipment. Use of this form of documentation enables rapid isolation of malfunctions.

2-22. PREOPERATIONAL TESTING.

2-23. In addition to patching the equipment for a specific test operation, magnetic tape and chart paper must be loaded on the various recorders, the recorders and FM Discriminators must be calibrated, etc. Once all equipment is properly configured and calibrated, the system is tested to ensure that the equipment functions properly for the test to be accomplished.

2-24. Special test tapes are used to simulate test data to the display portion of the system. The tapes are loaded on one of the magnetic tape transports and data is patched to the input of the decommutators. The decommutators function just as they would during actual system operation. Display results are monitored on the display equipment and compared to known performance standards.

2-25. Prior to loading the command test operation program, a special checkout program is loaded into the Command Computer and the data entry equipment is tested. Test operation commands are entered into each START module and the resultant data transmission is printed out by the Command Computer typewriter. The operational command program then is loaded and the command portion of the system is ready for operation.

2-26. SPACECRAFT TEST ACTIVITIES.

2-27. During a typical spacecraft test, the Test Conductor Console is manned by the Chief Test Conductor, the Spacecraft Test Conductor, the Test Project Engineer, and the ACE-S/C Control Room Engineer. The control consoles for each spacecraft system are manned by the lead engineer for that system at the low console, and an engineer for the system at the high console.

2-28. Just prior to the start of the test, all test engineers log the console elapsed-time meter readings, perform a pretest preparation checklist (turn-on, initial control settings, etc.) and report their condition of readiness to the Spacecraft Test Conductor.

2-29. The Spacecraft Test Conductor notes the readiness reports and orders the start of the test, recording the start time. The test operation then proceeds in accordance with sequential instructions listed in the OCP for that test. Most of the test stimuli are initiated by the test engineers at the high consoles, who perform their tasks under the instructions of the lead engineers responsible for each spacecraft system test. The overall test effort is coordinated by the Spacecraft Test Conductor. The necessary control and coordination are accomplished by means of the intercommunication and go/hold status control equipment.

2-30. More detailed information concerning the use and operation of Control Room console equipment is given in Chapter 3 of this manual.

2-31. POST-TEST ACTIVITIES.

2-32. At the conclusion of a test, all roll-chart recorders are recalibrated to determine whether the validity of the recorded data is affected by long-term drift. The equipment is then shut down in accordance with step-by-step deactivation procedures

in the OCP. Each console operator records the reading of the console elapsed-time meter in the console equipment log. The Spacecraft Test Conductor records the completion time of the test, and other pertinent data such as total run time, total hold time, etc.

SECTION II

ACE-S/C MILA PERIPHERAL EQUIPMENT UTILIZATION

2-33. ACE-S/C MILA PERIPHERAL EQUIPMENT APPLICATIONS.

2-34. The ACE-S/C MILA peripheral equipment is installed at various launch complexes at MILA to provide integration of spacecraft checkout operations with overall space vehicle checkout during the final stages of prelaunch testing. The equipment provides a display of status, event, and test summary data necessary to coordinate and supervise spacecraft checkout.

2-35. PREOPERATIONAL PLANNING.

2-36. Since the peripheral equipment operates as an integral portion of the ACE-S/C equipment during prelaunch checkout, preoperational planning is a part of the overall planning for ACE-S/C. Refer to paragraph 2-4 in Chapter 2 of this manual for details.

2-37. EQUIPMENT CONFIGURATION AND CHECKOUT.

2-38. Prior to prelaunch checkout operations, the peripheral equipment must be patched properly and tested to assure operational capability. The patching and testing of this equipment will necessarily be a part of the overall ACE-S/C equipment preparation described in paragraph 2-15, Chapter 2, of this manual.

2-39. SPACECRAFT TEST ACTIVITIES.

2-40. During prelaunch checkout operations, the Test Conductor Console is manned by the Spacecraft Test Conductor, the Assistant Test Conductor Console by the Assistant Spacecraft Test Conductor, the Aeromedical Console by the Aeromedical Representative, and the Astronaut Communicator Console by the Astronaut Communicator.

2-41. Just prior to the start of the test, all console operators log the console elapsed-time meter readings, perform a pretest preparation checklist (turn-on, initial control settings, etc.) and report their condition of readiness to the Spacecraft Test Conductor. The Spacecraft Test Conductor, in turn, reports the readiness condition of the spacecraft test crew and equipment to the Blockhouse Test Supervisor.

2-42. Once the checkout operation is underway, the Spacecraft Test Conductor and Assistant Spacecraft Test Conductor monitor the progress of spacecraft checkout and coordinate spacecraft checkout with overall countdown operations. The Aeromedical Representative maintains a continuous surveillance of the physical reactions of the flight crew, and the Astronaut Communicator provides all communication with the flight crew.

CHAPTER 3

CONTROL ROOM EQUIPMENT OPERATION

SECTION I

ACE-S/C STATION EQUIPMENT OPERATION

3-1. INTRODUCTION.

3-2. Chapter 3 presents a description of various panels and subassemblies located in the Control Room and operated by the control console operators and the Test Conductor. The description of these various panels and subassemblies is limited to a general discussion of controls and indicators. Specific application of panels and subassemblies will be determined by the test operating instructions at each particular site.

3-3. EVENT MODULE OPERATION.

3-4. The event modules provide the means to indicate the occurrence of discrete events (within the spacecraft) to the control console operators. These modules (figure 3-1) contain three rows of eight indicators each, providing a capacity for displaying up to 24 events. The indicator lamps light when the particular events associated with those lamps have occurred. The LIGHT TEST switch is provided to verify that all of the indicator lamps are operating properly.

3-5. R START MODULE OPERATION.

3-6. The R START module is one of the subassemblies used to control operations in the test bays. Entering a test operation command into the R START module causes the Command Computer to transmit a command (or series of commands) to the spacecraft test area.

3-7. Some test operation commands entered at the R START modules cause the computer to issue a single command, calling for one action such as a relay closure. Other test operation commands cause the computer to issue a series of commands, calling for a series of actions at the test area. The computer issues the series of commands through use of a subroutine.

3-8. Each R START panel (figure 3-2) contains four R START modules. The controls located on the R START modules, and their functions, are described in the following paragraphs.

3-9. FUNCTION SWITCHES.

3-10. Each R START module contains four function switches; they are bistable pushbutton switch indicators. Each switch indicator is divided into upper and lower halves. The lower half is manually controlled and illuminates red to indicate an entry of a binary 1; the upper half is computer controlled and illuminates white to indicate transmission (and verification) of a binary 1. Pressing any function switch that is on will turn the lower half off, while depressing any function switch that is off will turn the lower half on.

3-11. XEQ/SEAL SWITCH.

3-12. The XEQ/SEAL switch is a split-legend, momentary-contact, pushbutton switch

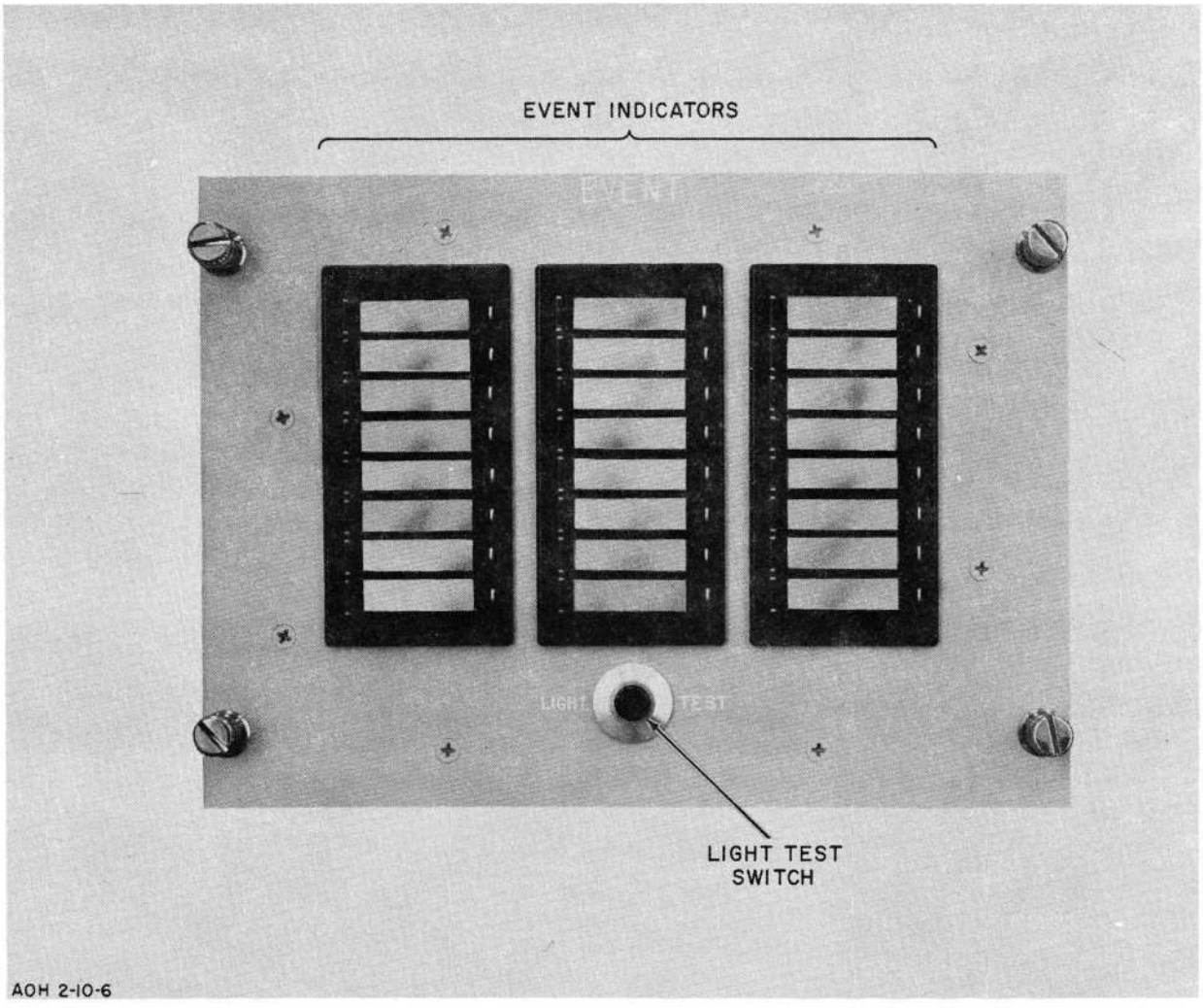


Figure 3-1. Event Module Panel

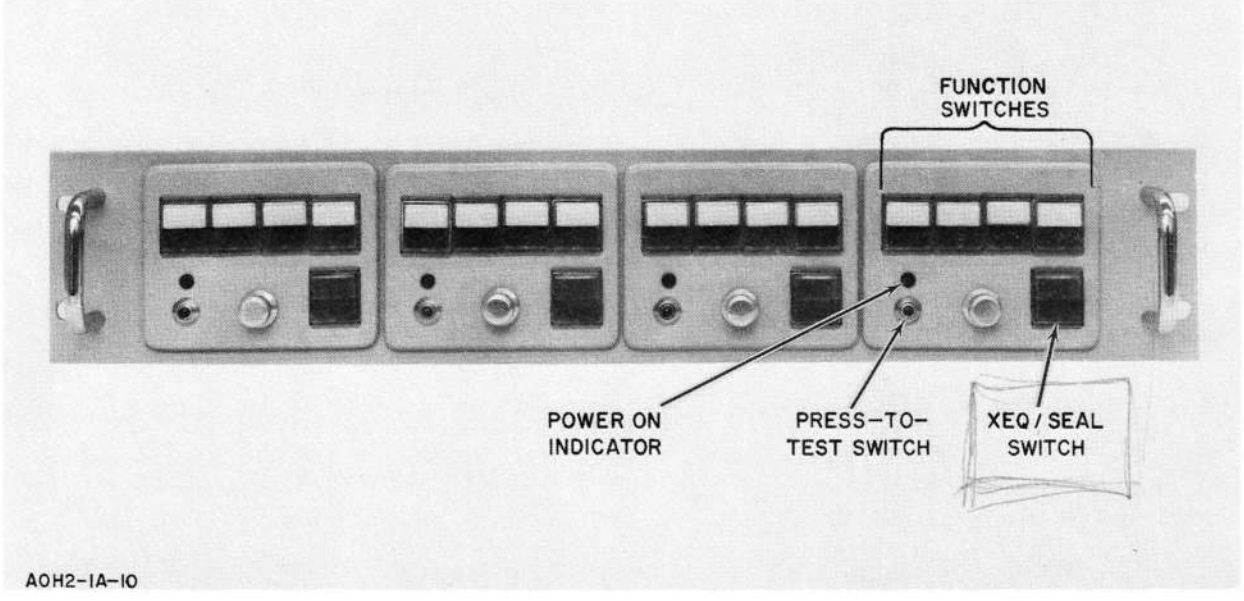


Figure 3-2. R START Panel

indicator. The upper half (XEQ) lights green to indicate an R START command is being processed by the Command Computer. The lower half (SEAL) lights red to indicate that the R START module is in a SEAL condition. When the SEAL portion of the XEQ/SEAL switch is lighted, no command function code can be executed.

3-13. When the R START module is in a SEAL condition, a function code command can be entered in the lower halves of the function switches. However, commands cannot be transmitted from the module until the SEAL condition is removed. If a command is entered during SEAL operation, it will be transmitted to the Command Computer after removal of the SEAL status, and after the XEQ/SEAL switch is depressed.

3-14. PRESS-TO-TEST SWITCH.

3-15. All lamps in the function switches and in the XEQ/SEAL switch are lighted for confidence test purposes by depressing the PRESS-TO-TEST switch. This switch applies +6 volts to the function switch lamps through fuse F1. There is no blown fuse indicator associated with this fuse. Therefore, the only indication that +6 volts is not present or that fuse F1 is blown is the failure of the function switch lamps to light when the PRESS-TO-TEST switch is depressed.

3-16. POWER ON INDICATOR.

3-17. The power on indicator lamp will light when the J-Box associated with the R START is turned on. This indicator monitors the +4 volts power through fuse F2 and will not light if the fuse is blown. Instructions for operation of an R START module are contained in table 3-1.

3-18. C START MODULE OPERATION.

3-19. The C START module contains ten 12-position rotary switches, ten projection-type indicators that indicate verification of switch position, also verification indicators, power on lamp, and an XEQ/SEAL pushbutton switch. This module may be used to call up and modify Command Computer subroutines, and to supplement the data stored in the computer memory.

3-20. The C START module is used by the operator to call up a test control subroutine and enter test operation parameters into that subroutine. These parameters can cause the subroutine to:

a. Enter time controlling the start and stop of an analog function.

b. Enter time interval controlling the time between discrete steps of an analog function.

c. Vary the frequency and amplitude of an analog function.

d. Enter time controlling the start and stop of a sequence of switching events.

e. Enter time interval controlling the time between each event of a sequence of switching events.

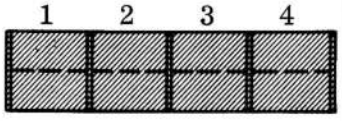
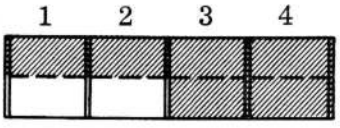
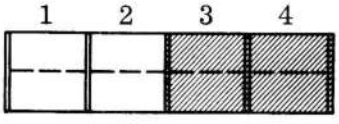
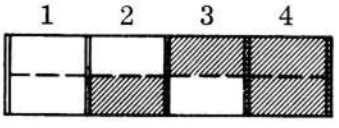
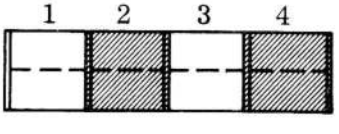
f. Institute a prestored sequence of switching events or analog functions.

3-21. For example, assume that a subroutine contains a sequence of instructions to be performed on capsule internal pressure. Further assume that the subroutine contains all the instructions and data necessary to perform this sequence with the exception of the upper and lower pressure limits of the capsule. These limits could be entered into the C START module and combined with the instructions and data in the subroutine to produce a complete sequence of test operations in the test bay.

3-22. During normal operation, command data is entered in the C START module (figure 3-3) by properly positioning the ten rotary switches. As each switch is positioned, the projection indicator above that switch indicates the character selected by that switch. (The characters include the digits zero through nine, a plus sign, and a minus sign.) The projection indicators are then compared with the switch settings for correct command entry. After the command has been entered and visually verified, the XEQ/SEAL switch is depressed, causing the upper half of the XEQ/SEAL switch to light. This may or may not be visible to the operator, since the switch remains lighted only as long as the command is on the lines. When the command has been processed, the computer will send a verify signal to the module which will illuminate the verification indicators.

3-23. The verification indicators (located directly over the XEQ/SEAL switch) indicate

Table 3-1. R START Operation

STEP	OPERATION	INDICATION
	NOTE The function switches are numbered in the illustrations for purposes of this description only. These numbers do not appear on the actual equipment.	
	Assume that at the start of this operation, the function switches and the XEQ/SEAL switch are off, as shown at the right.	
1	To enter a command function code (1100 in this example), press the function switches corresponding to the 1's in the function code.	
	In this case, switches 1 and 2 are depressed. This will cause the lower halves of these switches to light red.	
2	To transmit the command, press the XEQ/SEAL switch. The upper halves of function switches 1 and 2 should light as shown. This indicates that the Command Computer has completed processing the command and the command was successfully transmitted to and accepted by the DTCS.	
		
	NOTE Upon pressing the XEQ/SEAL switch, the upper half of this switch may light very briefly. The XEQ portion of this switch is lighted by pressing the switch and is turned off by action of the computer. The computer response may be so fast that the flash of the XEQ/SEAL switch cannot be seen.	
3	Assume that the next function code to be entered is 1010. Compare the function code to be entered with the function code previously transmitted, and note that the only differences are in the second and third digits. Press function switches 2 and 3 and note that the bottom halves light as shown. It is unnecessary to touch switches 1 and 4 since the bottom halves of these switches already correspond to the function code to be entered.	
		
4	Press the XEQ/SEAL switch. This will cause the upper halves of function switches 1 and 3 to light as shown.	
		

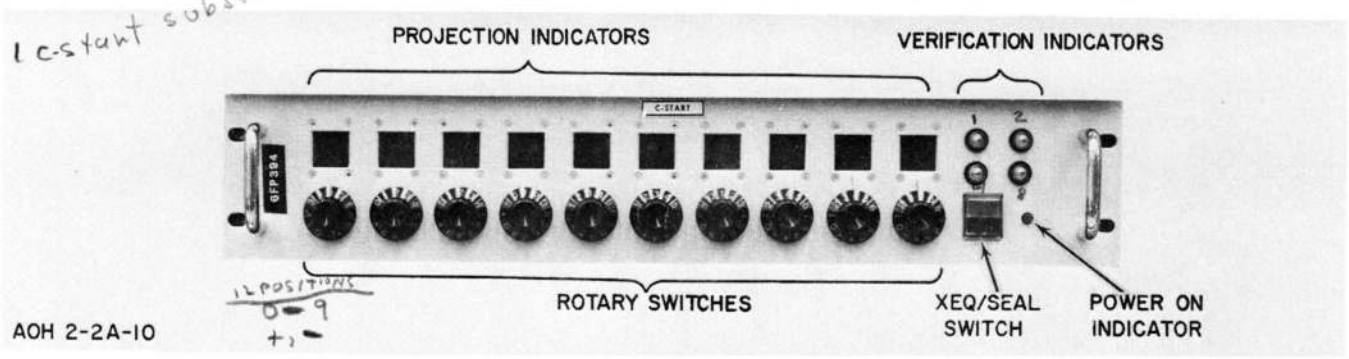


Figure 3-3. C START Panel

verification of commands as they are entered and processed by the computer. The specific pattern (or combination) of indicators which light to denote a verification is a function of the computer program. To illustrate a possible application of the verification indicators, assign a binary numeric weight to each indicator: upper left 1, upper right 2, lower left 4, lower right 8. Assume that the computer program is written so that the 4-bit data word entered by the rotary switch on the extreme left end of the C START panel is verified. Setting the left-hand rotary switch to 5 will cause the corresponding verification indicators to light upon processing of the entry by the computer, specifically the upper left (numeric weight 1) and the lower left (numeric weight 4). Usually, however, all four lights illuminate to indicate verification, and different light combinations are used to indicate various command errors.

3-24. K START OPERATION.

3-25. The K START control panel provides the means to enter and transmit digital commands to the spacecraft onboard Guidance and Navigation Computer via the ACE-S/C Command Computer. The programming and/or stimulus to the spacecraft onboard Guidance and Navigation Computer may be modified by the operator through the use of the K START control. The operator may select to enter commands into the K START manually by the K START keyboard, or automatically, by the perforated paper-tape reader. The functions of controls and indicators necessary for the operation of the K START are identified in figure 3-4 and are described in the following paragraphs.

3-26. EVENT INDICATORS.

3-27. The left-hand portion of the K START control panel contains three columns of eight indicators each, providing a capacity for displaying up to 24 events. These event indicator lamps indicate the occurrence of selected events to the operator. An indicator lamp will light when the particular event associated with that lamp has occurred. A PRESS-TO-TEST pushbutton switch is provided to verify that all indicator lamps are operating properly.

3-28. DATA DISPLAY INDICATORS.

3-29. The eight data display indicators provide a visual display of the last command word entered into the K START either from the keyboard of from the perforated paper-tape reader. These indicators are arranged in a binary format with the most significant digit (2^7) located at the extreme left and the least significant digit (2^0) at the extreme right.

3-30. NON-VERIFY INDICATOR SWITCH.

3-31. The NON/VER indicator will light whenever an error occurs during a digital command transmission. Momentarily pressing the NON/VER indicator switch turns the indicator off and illuminates the VERIFY indicator, this then allows the operator to enter another command.

3-32. EXECUTE/SEAL INDICATOR.

3-33. The upper half of this split-legend indicator (XEQ) will be lighted whenever the K START is receiving command data from

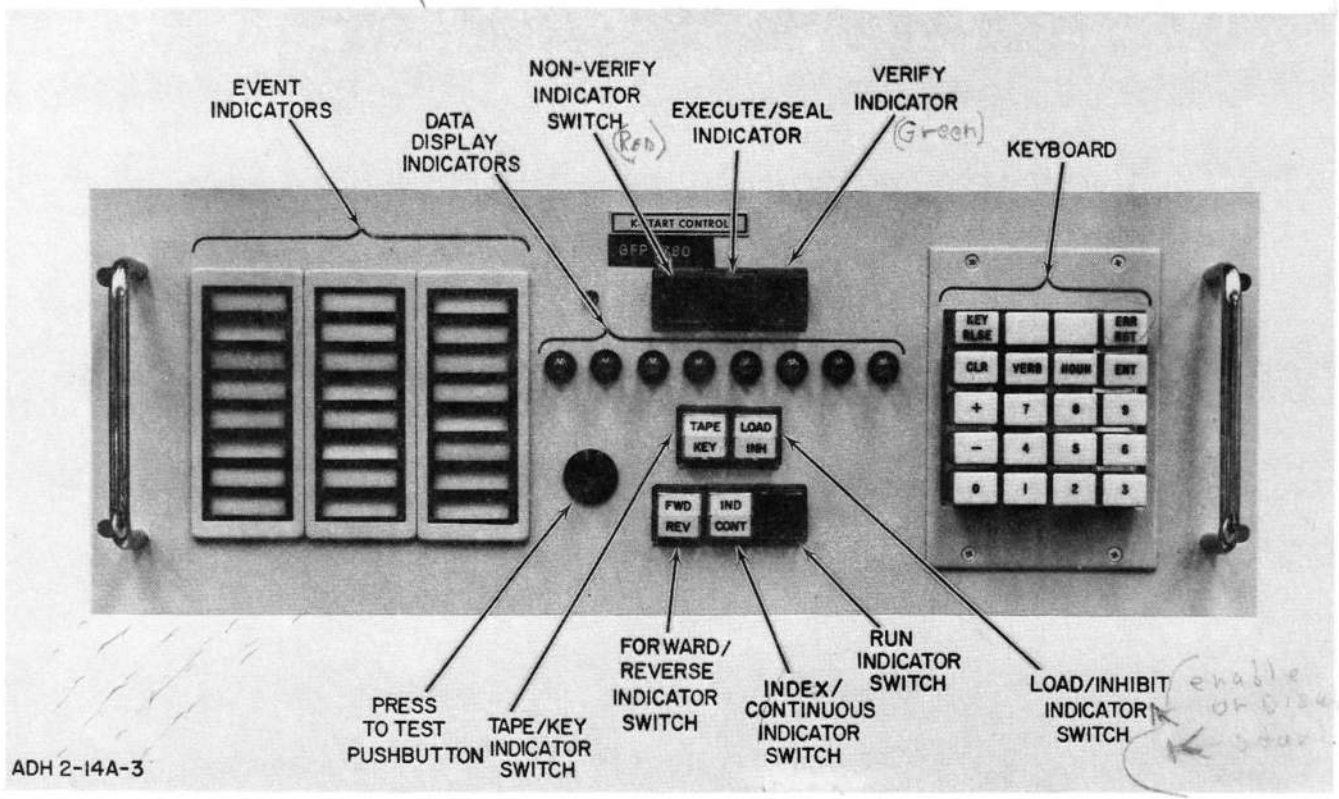


Figure 3-4. K START Control Panel Front View

either the keyboard or perforated paper-tape reader pending readout by the CUE. The SEAL command received by the K START causes the lower half of the indicator to light indicating the SEAL condition. The K START is unable to transmit any data or execute signals to the CUE in the SEAL condition.

3-34. VERIFY INDICATOR.

3-35. The VER indicator is lighted whenever a command data entry is successfully received, processed, and transmitted by the ACE-S/C Command Computer to the spacecraft Guidance and Navigation Computer.

3-36. TAPE/KEY INDICATOR SWITCH.

3-37. The TAPE/KEY indicator switch allows the operator to select either the perforated paper-tape reader or the keyboard as a source of command data to the K START. The upper half of this split-legend indicator is lighted when the Tape Mode of operation has been selected. The lower half of the indicator is lighted when the Keyboard Mode of operation has been selected. The TAPE/KEY indicator switch is an alternate action, momentarily operated switch. Successive depressions of the TAPE/KEY switch will alternately cause the Tape and Keyboard Modes of operation to be selected.

3-38. LOAD/INHIBIT INDICATOR SWITCH.

3-39. The operator can enable or disable the K START transmit function by the use of the LOAD/INH indicator switch. When the upper half of this split-legend indicator lights, it indicates that the K START is able to transmit command data to the CUE. When the lower half of this indicator is lighted, it indicates that the K START is unable to transmit command data to the CUE. The LOAD/INH indicator switch is an alternate action, momentarily operated switch. Successive depressions of this switch will cause the LOAD and INH indicator segments to light alternately.

3-40. FORWARD/REVERSE INDICATOR SWITCH.

3-41. The FWD/REV indicator switch allows the operator to control the perforated paper-tape movement. When the upper half of this split-legend indicator switch is lighted, it signifies that the perforated paper tape will move in a forward direction when the RUN

indicator switch is depressed. When the lower half of this indicator switch is lighted, it signifies that the perforated paper tape will move backward or in a reverse direction when the RUN indicator switch is depressed. The FWD/REV indicator switch is an alternate action, momentarily operated switch. Successive depressions of this switch will cause the FWD and REV indicator segments to light alternately.

3-42. INDEX/CONTINUOUS INDICATOR SWITCH.

3-43. The IND/CONT indicator switch allows the operator to select one of two paper-tape reader operating modes. When the upper half of this split-legend switch is lighted (IND Mode), the paper-tape reader will move the tape one character position in the direction specified by the FWD/REV indicator switch for each depression of the RUN indicator switch. When the lower half of this switch is lighted (CONT Mode), the paper-tape reader will advance the tape one character at a time continuously until a programmed stop instruction is read, or the RUN indicator switch is again depressed. The IND/CONT indicator switch is an alternate action, momentarily operated switch. Successive depressions of this switch will cause the IND and CONT indicator segments to light alternately.

3-44. RUN INDICATOR SWITCH.

3-45. The RUN indicator switch allows the operator to start the paper-tape reader drive as specified by other K START controls. Depressing this indicator switch, when the CONT Mode is selected, causes the RUN indicator to light and the tape to feed continuously through the paper-tape reader. Depressing this switch again halts the tape motion and turns the indicator off. Depressing this indicator switch, when the IND Mode is selected, causes the RUN indicator to light and the tape to advance one character. Depressing this switch again causes the tape to advance another character.

3-46. KEYBOARD.

3-47. The K START keyboard contains 20 momentarily operated, pushbutton-type switches. The keyboard provides the operator with the means to manually enter command data codes into the K START for transmission to the CUE. Depressing any of the keyboard pushbuttons causes the proper binary code associated with that particular pushbutton to be placed on the K START output lines. This code (5-bit character) is also displayed in binary format on the K START data display indicators (2^0 through 2^4). Table 3-2 lists the general function of each keyboard key and the specific binary code assigned to each key. A binary 1 is represented by a lighted data display indicator.

3-48. TAPE READER OPERATION.

3-49. The tape reader (figure 3-5) is a self-contained, bidirectional, asynchronous assembly for reading an eight-channel perforated paper or metal tape. Activation of the tape reader and direction of tape movement is controlled by pushbutton switches located on the K START module. The tape reader allows the operator to rapidly and automatically enter a large quantity of test commands into the K START for subsequent transmission to the onboard Guidance and Navigation Computer.

3-50. The bidirectional tape reels are mounted on each side of the read head. Perforated tape may be easily removed or placed on the six-inch reels by applying a light pressure to the demountable reel front flange to release the ball detent lock. Since the tape unit is bidirectional, either reel can be the take-up or the supply side, depending upon direction of tape movement. No tape threading change is required when reversing the direction of tape movement. All slack on the supply reel is taken up through the action of the tension arms. Motor drive power is applied to the tape reader by depressing the POWER ON indicator switch. This switch is an alternate action, momentarily operated switch.

3-51. TAPE THREADING INSTRUCTIONS.

3-52. To thread any standard eight-channel perforated tape onto the tape reader, perform the following procedure:

a. Expose the tape reader capstan by raising the read-head, lift lever handle.

Table 3-2. K START Keyboard Key Functions and Code Assignments

KEY DESIGNATION	DATA CODE	FUNCTION
1 2 3 4 5 6 7 8 9 0	00001 00010 00011 00100 00101 00110 00111 01000 01001 10000	To enter data, address code, and requested action code into K START for transmission to the onboard Guidance and Navigation Computer.
VERB	10001	Conditions the onboard Guidance and Navigation Computer to interpret the next two numeral characters entered into the K START as an action request code.
NOUN	11111	Conditions the onboard Guidance and Navigation Computer to interpret the next two numerical characters entered into the K START as to what the action is to be performed on.
+ -	11010 11011	To inform the onboard Guidance and Navigation Computer that the data to follow is decimal and enters the sign (+ or -) of that data.
ENT	11100	To inform the onboard Guidance and Navigation Computer that the current data command is complete and to execute the function(s) requested.
CLR	11110	Clears data words erroneously entered into the G&N Computer data registers, provided the ENT key has not been depressed.
ERR RST	10010	Not used.
KEY RLSE	11001	Not used.

b. Lift the right and left tension arms up to the vertical standby position (arms will remain in this position).

c. Remove demountable flange from supply reel and place tape on reel shaft such that the tape sprocket holes are nearest the operator. In addition, when the left-hand reel is to be the supply reel, the tape should leave the left reel in a clockwise direction and enter the right-hand reel in a clockwise direction and vice versa when the right-hand reel is to be the supply reel.

NOTE

When the FWD (forward) Mode of operation is selected on the K START module, the tape movement is right to left and the right-hand reel is the supply reel. When the REV (reverse) Mode of operation is selected, the tape movement is left to right. In this case, the left-hand reel is the supply reel.

d. Thread out enough tape to go across read head and start winding up on take-up reel.

e. Lay the tape across the capstan so that the sprocket pins project through the tape sprocket holes. Be sure the tape is positioned so that the sprocket pins do not project through the holes of a data channel.

f. Wind remaining tape up on the take-up reel.

g. While holding the tape in position on the capstan, push the read-head lift lever down until lever locks in a slightly over-center position.

h. Push right and left tension arms toward the center of the tape reader so that the tension arms ride on the tape surface. The tape is now properly threaded, and the reader is ready for use.

3-53. TAPE READER OPERATION.

3-54. Operation of the K START paper-tape reader is performed in the following manner:

a. Depress the tape reader POWER ON switch to ON.

b. Set the LOAD/INH switch to LOAD, thus enabling the K START to transmit the data to the CUE.

c. Set the TAPE/KEY switch to TAPE to select the K START for input from the tape reader.

d. Set the FWD/REV and the IND/CONT switches to the desired positions for tape movement.

e. Press the RUN switch. This action allows the tape reader to read one character and transmit it to the CUE.

3-55. CRT MODULE OPERATION.

3-56. CRT modules (figure 3-6) are located on consoles in the Control Room and Computer Room. They are used to display analog and event data from the spacecraft that has been processed by the Display Computer. The CRT module basically consists of: (1) a CRT screen that displays 26 lines of alphabetic, decimal numeric, and special symbols; (2) PAGE CALLUP thumbwheel switches; and (3) various controls for adjusting the display on the CRT screen. These controls are located behind an access door on the front panel.

3-57. CRT SCREEN.

3-58. The CRT screen displays information in 26-line "page" formats, so arranged that the top half or bottom half of any of 20 such "pages" can be selected by the operator. The top and bottom lines, which can display 32 alphanumeric characters each, are used for page identification. The top line on the display identifies the top half-page selected, while the bottom line identifies the bottom half-page selected. The remaining 24 lines on the screen can display 40 alphanumeric characters each. The 24 lines are divided into two groups of 12 lines each (top half-page and bottom half-page). Thus, each half-page display consists of one page identity line and 12 lines of alphanumeric data.

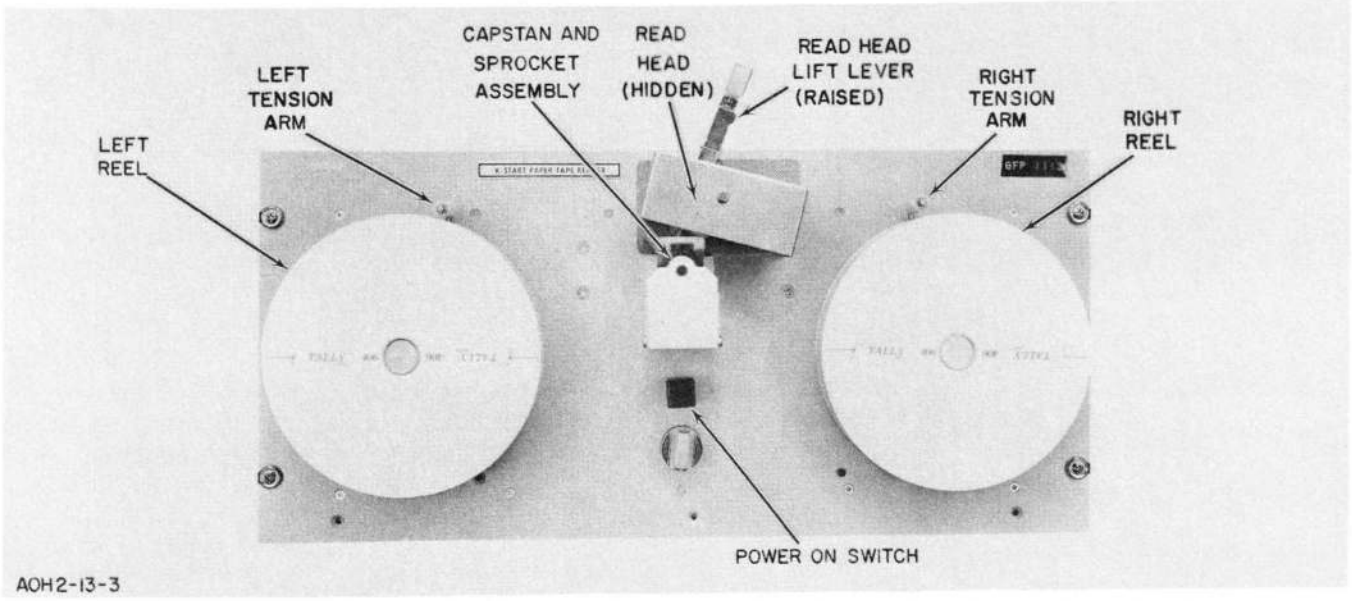


Figure 3-5. K START Paper Tape Reader Front View

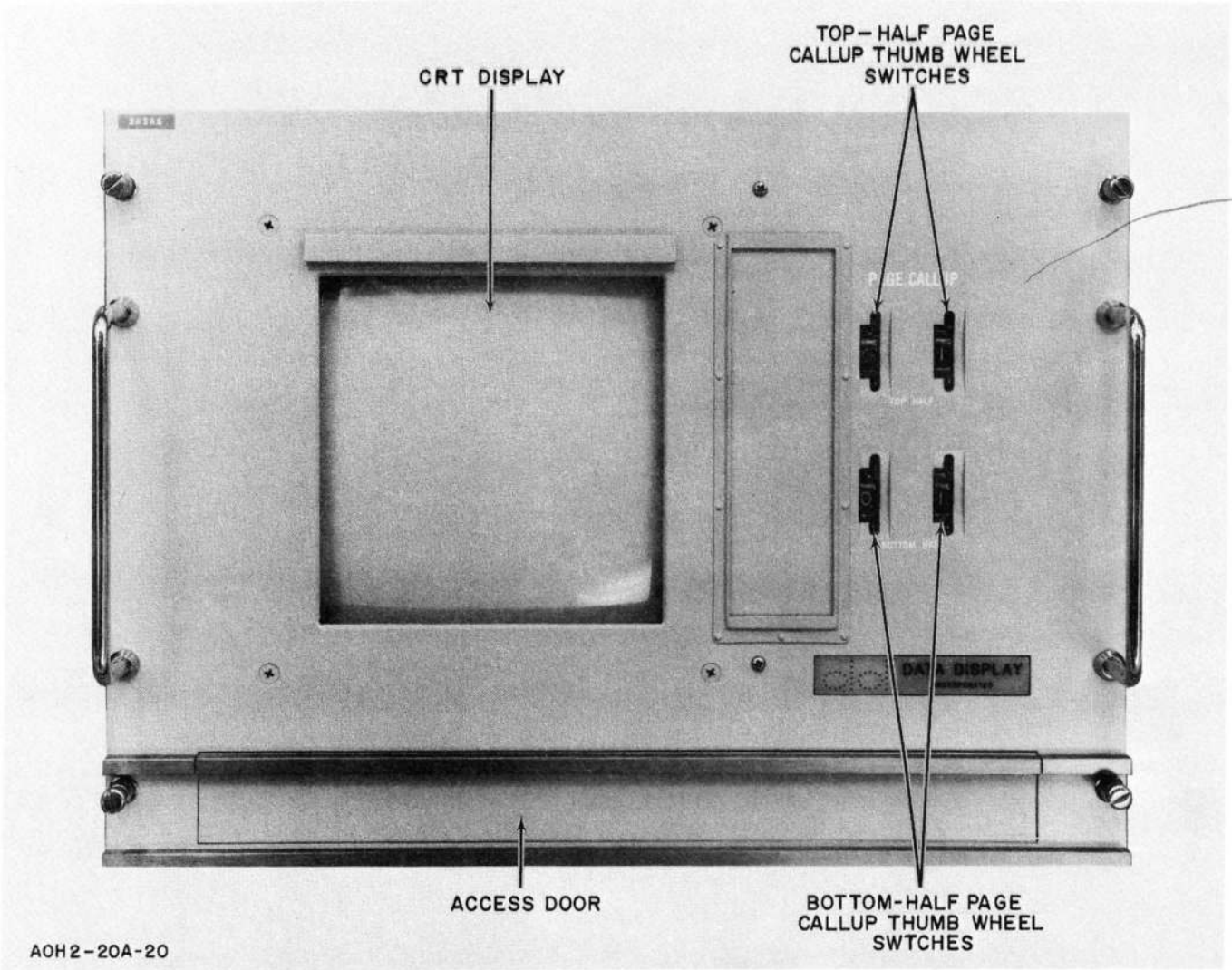


Figure 3-6. CRT Module

3-59. PAGE CALLUP THUMBWHEEL SWITCHES.

3-60. The PAGE CALLUP thumbwheel switches allow a Control Room operator to select the upper and lower half-page displays appropriate to his particular test operation. The two upper thumbwheel switches select the TOP-HALF display and the two lower thumbwheel switches select the BOTTOM-HALF display.

3-61. ACCESS DOOR.

3-62. The following controls, used to adjust the display on the CRT screen, are located behind the access door:

a. VERTICAL GAIN - The VERTICAL GAIN control is used to vary the vertical size of the display on the CRT.

b. VERTICAL CENTERING - The VERTICAL CENTERING control is used to position the display in the vertical direction.

c. HORIZONTAL GAIN - The HORIZONTAL GAIN control varies the horizontal size of the display on the CRT.

d. HORIZONTAL CENTERING - The HORIZONTAL CENTERING control is used to position the display in the horizontal direction.

e. INTENSITY - The INTENSITY control is used to control the brightness of the display.

f. FOCUS - The FOCUS control is used to adjust image focus at the center of the display.

g. ASTIGMATISM - The ASTIGMATISM control adjusts the image focus at the edges of the display.

h. ON/OFF switch - The ON/OFF switch provides a means of turning power to the CRT module on and off.

3-63. METER MODULE OPERATION.

3-64. Meter modules (figure 3-7) are utilized to display current analog data transmitted from the spacecraft to the control console operators. Each meter module contains four edgewise 0- to 1-milliampere meters, each capable of displaying a different analog signal. Insert tags are provided above each meter to indicate the measurement identity. These tags are readily removed and replaced without removing a meter from the module. Each meter contains a meter scale insert which can be easily removed for the insertion of different meter scale inserts as required. Certain meter modules are interchangeable with the event modules to accommodate varying test requirements.

3-65. RECORDER ATTENUATOR PANEL.

3-66. A recorder attenuator panel (figure 3-8) is associated with each Analog Recorder to provide input signal gain control. For each of the eight channels in the Analog Recorder, there is an associated SENSITIVITY control, SENSITIVITY X1 control, and a PEN POSITION control on the recorder attenuator panel. Operation of the attenuator panel controls is normally a function of the maintenance personnel and is included here for information purposes only.

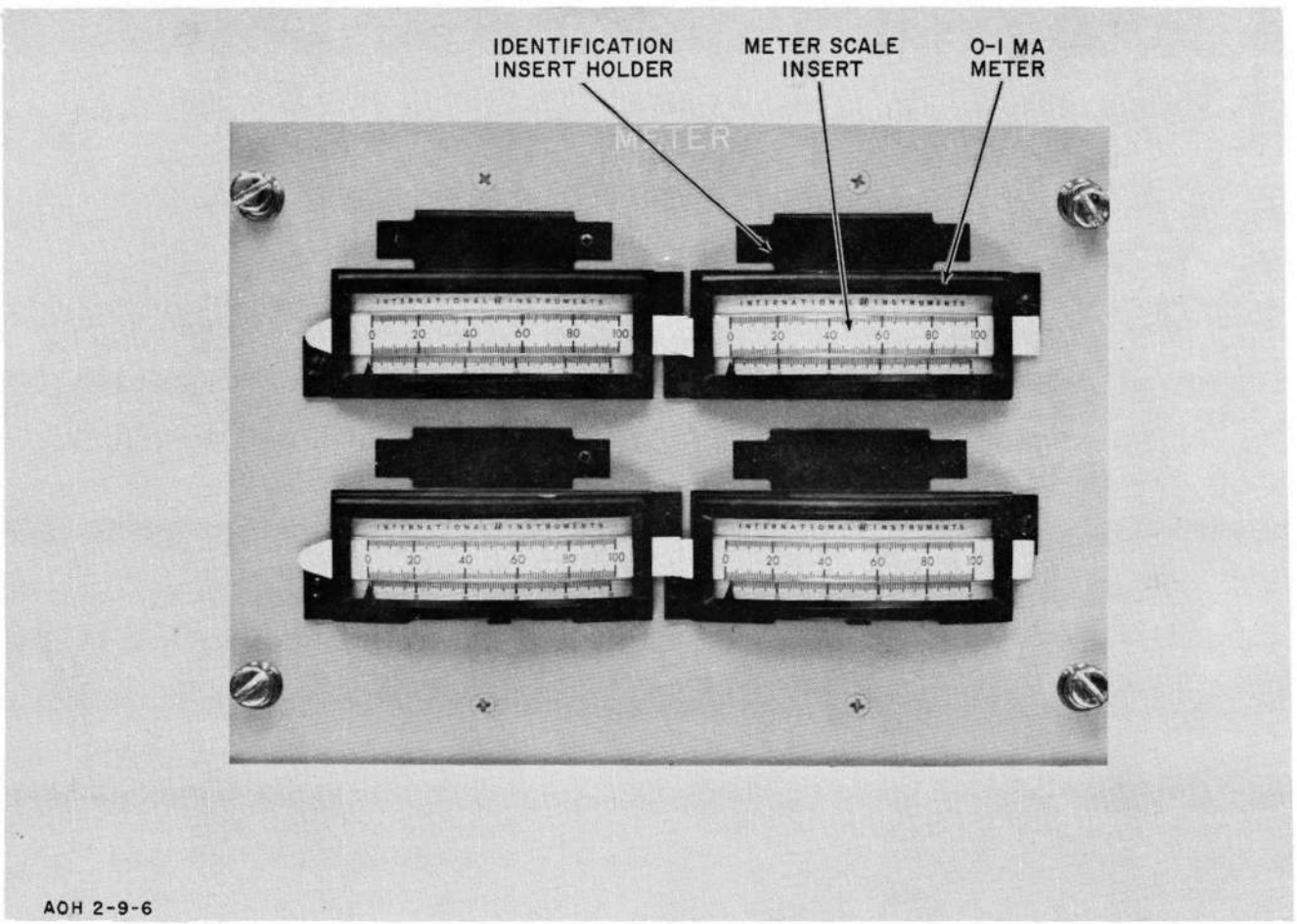


Figure 3-7. Meter Module Panel

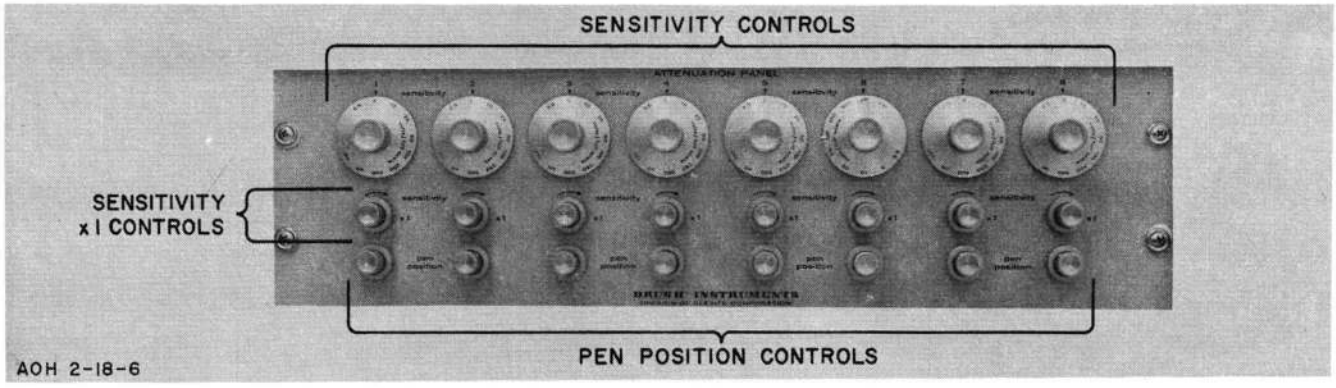


Figure 3-8. Recorder Attenuator Panel

3-67. SENSITIVITY CONTROLS.

3-68. The SENSITIVITY controls are switches with nine attenuator positions (2.5, 5, 10, 25, 50, 100, 250, 500 VOLTS/ FULL SCALE, OFF and CAL). In the CAL position, all external signals are removed and a standard one-volt calibration signal is substituted.

3-69. SENSITIVITY X1 CONTROLS.

3-70. The SENSITIVITY X1 controls are variable attenuation controls that provide for intermediate attenuation values between each of the nine attenuator positions. Associated with each variable attenuation control is a locking knob so that inadvertent turning of the variable attenuator knob in a clockwise direction is difficult.

3-71. PEN POSITION CONTROLS.

3-72. The PEN POSITION controls permit each pen to be positioned anywhere within the channel and allows either edge of the channel, or any point between, to be used as a baseline (zero signal position). Each PEN POSITION control is fitted with a locking knob so that once a pen is positioned, inadvertent turning is difficult.

3-73. ANALOG RECORDER.

3-74. The Analog Recorders (figure 3-9) are eight-channel, ink-trace recording devices incorporating a vertical oscillograph. The function controls of indicators necessary for operation of the recorders are described in the following paragraphs.

3-75. INTERLOCK WARNING.

3-76. The INTERLOCK WARNING lamp lights when the paper supply roll is empty or when the bezel lock is not engaged.

3-77. CONTROL MODE GROUP.

3-78. The Control Mode Group is a three-position switch labeled PARTIAL REMOTE, FULL REMOTE, and LOCAL. Switch functions are as follows:

a. PARTIAL REMOTE - When the CONTROL MODE switch is in the PARTIAL REMOTE position, chart drive "on-off" control is transferred to a remote location. Chart speed control remains at the oscillograph.

b. FULL REMOTE - When the CONTROL MODE switch is in the FULL REMOTE position all chart speed control is transferred to a remote location.

c. LOCAL - When the CONTROL MODE switch is in the LOCAL position full control is maintained at the oscillograph control panel.

NOTE

In the ACE-S/C Ground Station there are no remote control panels available. Therefore, only the LOCAL button should be used for operation of this recorder.

3-79. CHART SPEED MM/SEC SWITCH.

3-80. The CHART SPEED MM/SEC switch is a seven-pushbutton switch containing a STOP pushbutton and six additional pushbuttons for selecting various chart travel

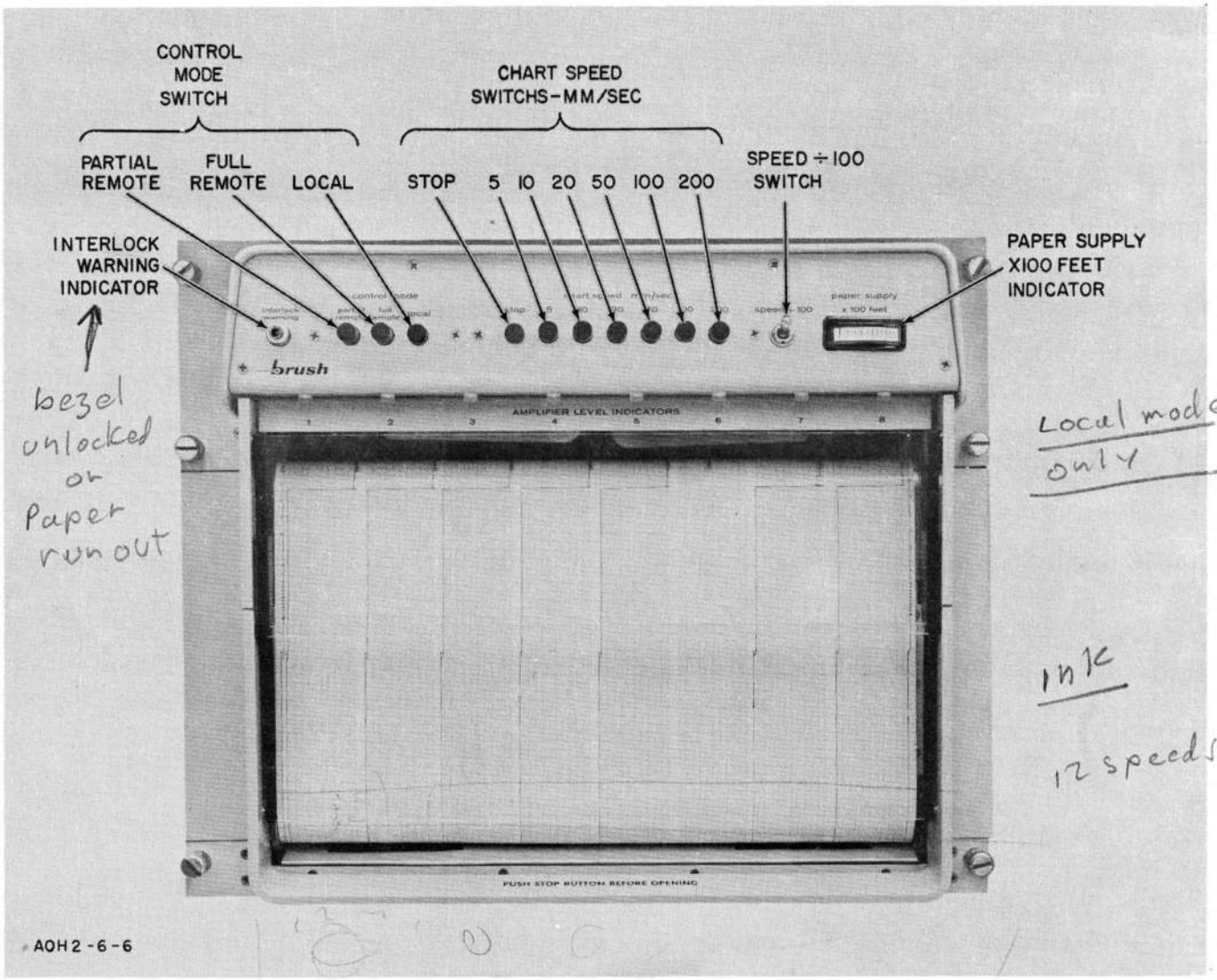


Figure 3-9. Eight-Channel Analog Recorder

speeds. Switch functions are as follows:

a. STOP PUSHBUTTON - When the STOP pushbutton of the CHART SPEED MM/SEC switch is depressed, the chart driver motor stops and power is removed from the oscillograph pens.

b. CHART SPEED SWITCHES - The CHART SPEED MM/SEC switch has six additional pushbuttons marked 5, 10, 20, 50, 100, and 200. When one of these switches is depressed, power is applied to the chart drive motor driving the chart at the speed indicated by the selected switch.

3-81. SPEED ÷ 100 SWITCH.

3-82. the SPEED ÷ 100 switch is a two-position toggle switch. When placed in the up position, chart speeds indicated on the CHART SPEED MM/SEC switch are divided by 100. The chart speeds then available are 0.05, 0.1, 0.2, 0.5, 1, and 2 MM/SEC. When placed in the down position, chart speeds are as indicated on the CHART SPEED MM/SEC switch.

3-83. PAPER SUPPLY X 100 FEET INDICATOR.

3-84. The PAPER SUPPLY X 100 FEET indicator is a meter which reads the amount of paper contained on the supply roll in increments from zero through ten. This reading must be multiplied by 100 to determine the actual amount of paper on the roll.

3-85. AMPLIFIER LEVEL INDICATORS.

3-86. The eight AMPLIFIER LEVEL indicators partially light when the amplifier is producing moderate output and fully light when the amplifier output is saturated.

3-87. ANALOG RECORDER OPERATION.

3-88. The recorder will be turned on, checked and adjusted by maintenance personnel (prior to spacecraft test operations), and left in a standby condition. Test operation, therefore, involves only depressing the desired SPEED switch to start the recorder, and depressing the STOP switch to stop the recorder. Refer to the test operation instructions to determine when to start a particular recorder, the chart speed to use, and when to turn the recorder off.

3-89. Operation of the remaining controls is normally a function of the maintenance personnel and is included for information purposes only.

3-90. Each unit containing analog recorders also contains an analog power panel. There are three types of analog power panels available, designated as Analog Power 2, Analog Power 3, and Analog Power 4 (figure 3-10). Those units containing two analog recorders utilize an Analog Power 2 panel, those units containing three analog recorders utilize an Analog Power 3 panel, and those units containing four analog recorders utilize an Analog Power 4 panel. Each power panel contains an ON/OFF toggle switch and an associated indicator for each recorder. When the toggle switch for a particular recorder, as indicated by the label on the panel, is placed in the ON position, 115 vac is applied to the appropriate recorder and the associated indicator lights. Operation of these controls is normally a function of the maintenance personnel and is included here for information purposes only.

3-91. ANALOG SELECT PANELS.

3-92. Analog Select Panels are provided on certain consoles to allow the display of any one of several analog measurements on a single meter or recorder channel. Three types of panels, each containing eight analog select switches, are available - Analog Select 2-1 (allowing the selection of one of two measurements for each meter), Analog Select 3-1 (allowing the selection of one of three measurements for each meter), and Analog Select 4-1 (allowing the selection of one of four measurements for each meter). Figure 3-11 shows an Analog Select 4-1 panel containing eight 4-position analog select switches. The other panels are similar except for the number of switch positions. Each of the eight switches services a single Analog Recorder channel or analog meter. Refer to your test operation instructions to determine the proper position of each switch.

3-93. 32-CHANNEL EVENT RECORDER.

3-94. The 32-Channel Event Recorder (figure 3-12) is a moving paper, roll-chart, multi-stylus recorder. The on/off event status of each channel is recorded by the deflection of an ink-supplied pen. Each event

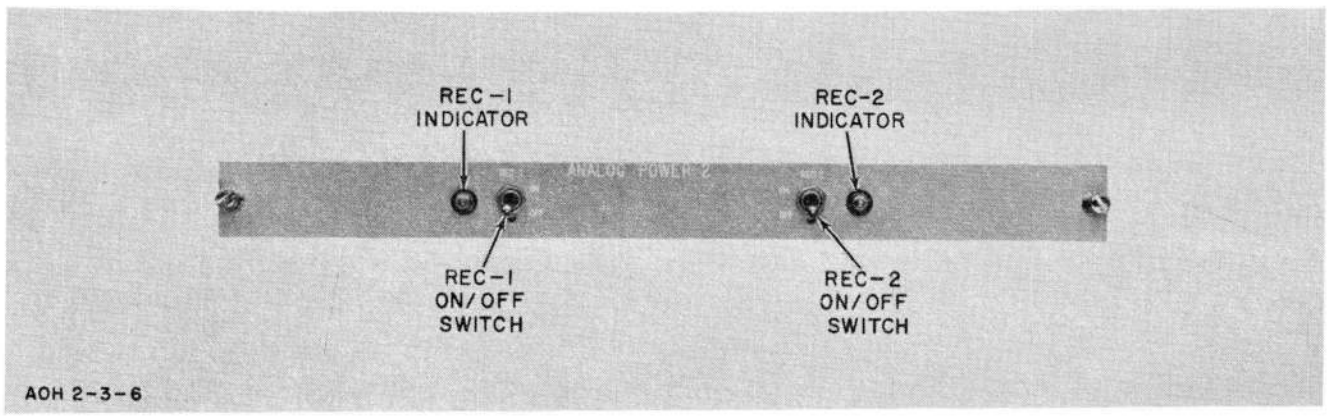


Figure 3-10. Typical Analog Power Panel

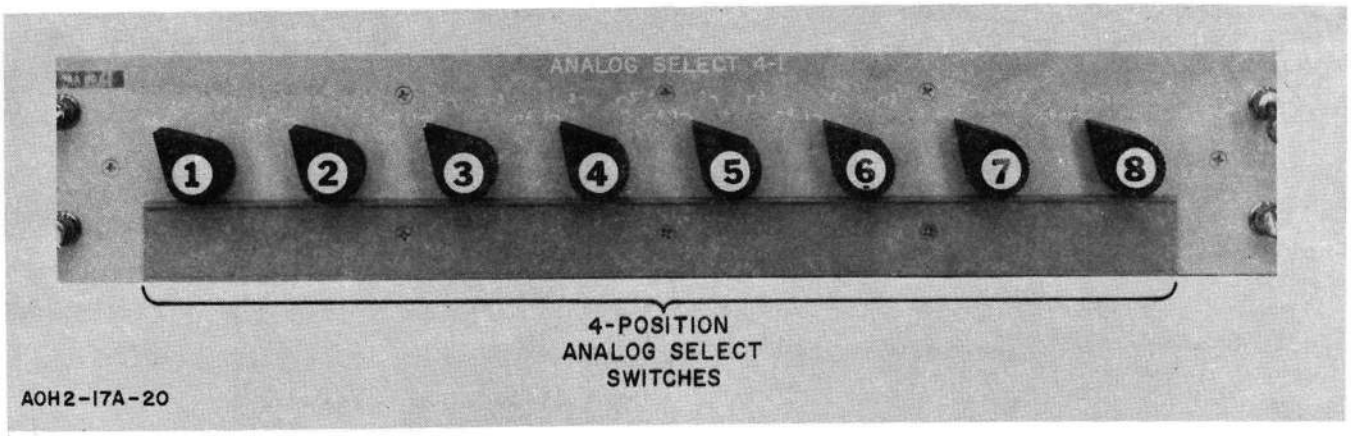


Figure 3-11. Analog Select Panel

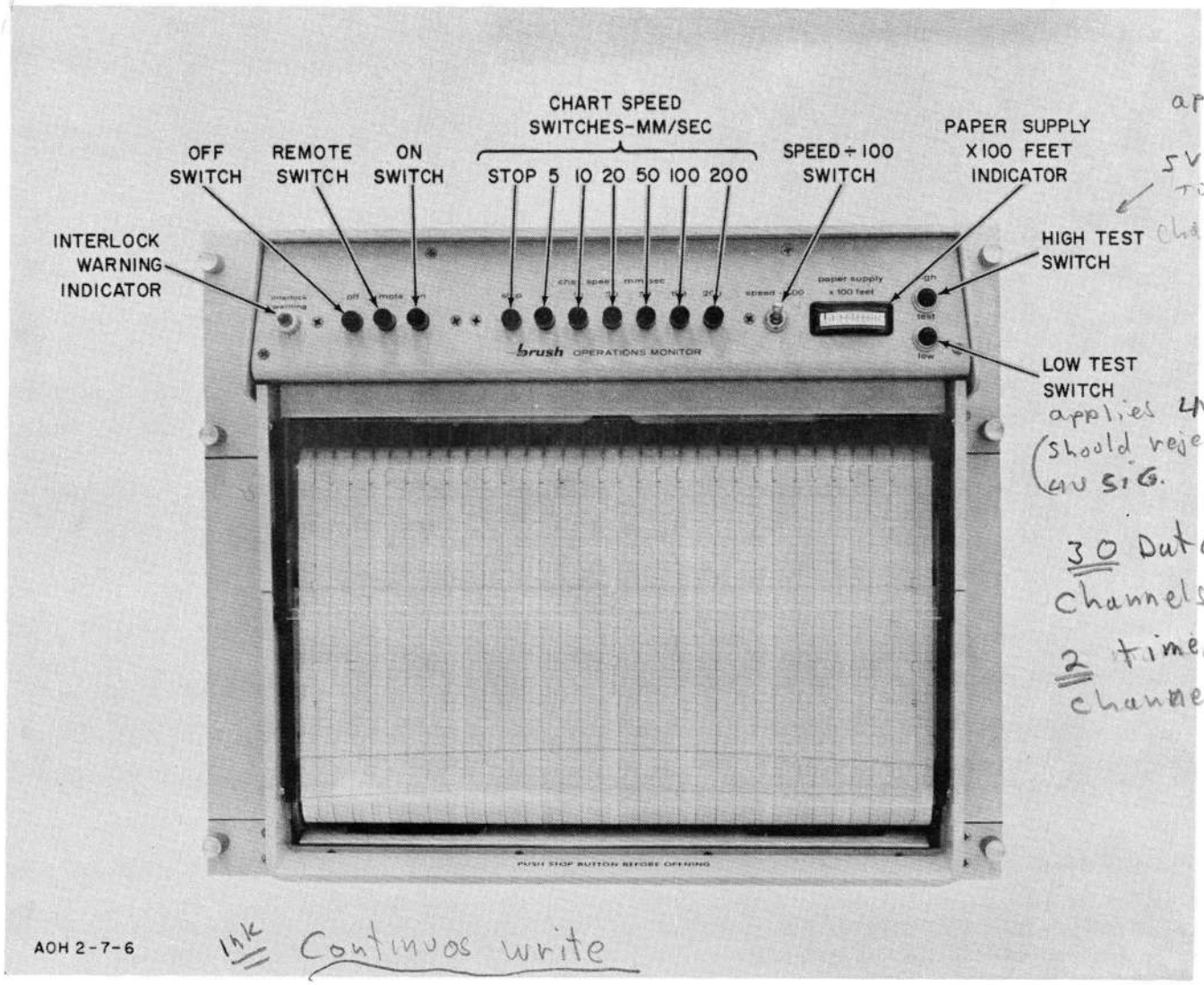


Figure 3-12. 32-Channel Event Recorder

is shown in time relationship to the others, providing an immediate picture of the situation monitored. The controls and indicators associated with the recorder are described in the following paragraphs.

3-95. INTERLOCK WARNING INDICATOR.

3-96. The INTERLOCK WARNING indicator is controlled by an interlock switch located in the paper supply drawer behind the writing table. When the INTERLOCK WARNING indicator lights, it indicates that either the interlock switch has opened due to an empty paper supply roll, or that the bezel lock is not engaged.

3-97. OFF-REMOTE-ON SWITCH.

3-98. The OFF-REMOTE-ON switch is a group of three pushbutton switches used to control recorder operations. When the OFF button is pressed, all power to the recorder is off. When the REMOTE button is pressed, power is applied to the recorder and all chart speed control is transferred to the remote location. When the ON button is pressed, power is applied to the recorder and all chart speed control remains at the recorder.

NOTE

In the ACE-S/C Ground Station there are no remote control panels available. Therefore, only the ON button should be used for operation of this recorder.

3-99. CHART SPEED MM/SEC SWITCH.

3-100. The CHART SPEED MM/SEC switch is a seven-pushbutton switch for selecting various chart speeds for recorder operation. The selectable chart speeds are 5, 10, 20, 50, 100, and 200 MM/SEC. In addition, one of the switch positions is designated as STOP which stops chart drive motor and turns off power to the recorder pens.

NOTE

Pressing any position of the CHART SPEED switch except the STOP pushbutton releases the STOP pushbutton and turns on the chart drive motor.

3-101. SPEED ÷ 100 SWITCH.

3-102. The SPEED ÷ 100 switch is a two-position toggle switch. When in the down position, chart speeds of 5, 10, 20, 50, 100, and 200 MM/SEC are available. When in the up position, these chart speeds are divided by 100 and become 0.05, 0.1, 0.2, 0.5, 1, and 2 MM/SEC.

3-103. PAPER SUPPLY X 100 FEET INDICATOR.

3-104. The PAPER SUPPLY X 100 FEET indicator is a meter that provides a convenient indication of the amount of chart paper contained on the supply roll. The meter dial consists of increments from 0 to 10. The meter reading multiplied by 100 indicates the amount of paper on the roll.

3-105. HIGH TEST AND LOW TEST SWITCH.

3-106. The HIGH TEST and LOW TEST switches are used to check the operation of the recorder. Pressing the HIGH TEST switch applies 5 volts to the amplifier input which should cause all the pens to deflect to the left. Pressing both the HIGH TEST and LOW TEST switches simultaneously should cause no deflection of the pens.

3-107. 32-CHANNEL EVENT RECORDER OPERATION.

3-108. Operation of this recorder is identical to operation of the Analog Recorder (refer to paragraph 3-87).

3-109. AEROMEDICAL RECORDER.

3-110. The Aeromedical Recorder (figure 3-13) is an eight-channel, ink-trace, horizontal oscillograph. The controls and indicators necessary for operation of the recorder are described in the following paragraphs. (Similar to Eight-Channel Analog Recorder.)

3-111. INTERLOCK WARNING.

3-112. The INTERLOCK WARNING lamp lights when the paper supply roll is empty or when the bezel lock is not engaged.

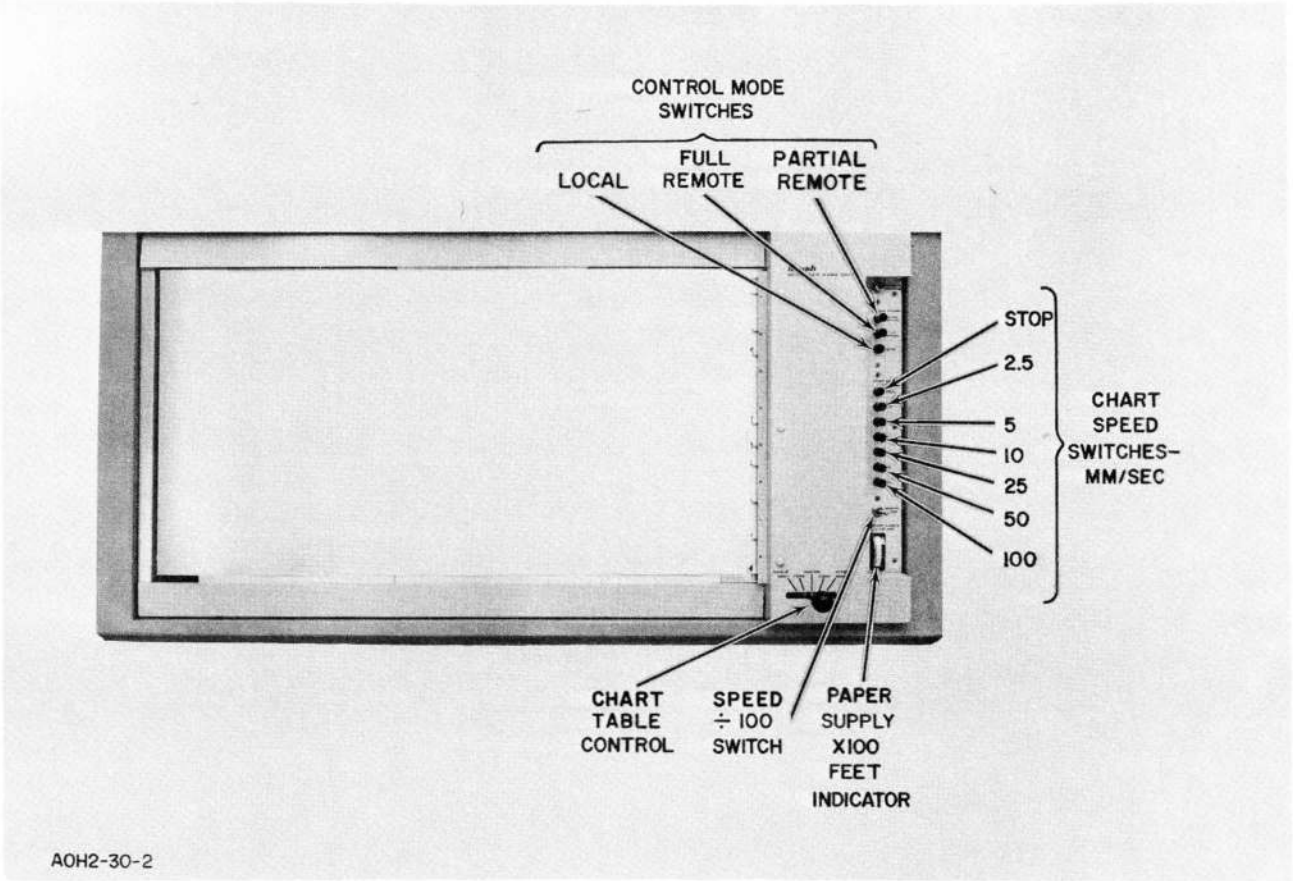


Figure 3-13. 8-Channel Horizontal Analog Recorder

3-113. CONTROL MODE GROUP.

3-114. The CONTROL MODE Group is a three-pushbutton switch labeled PARTIAL REMOTE, FULL REMOTE, and LOCAL. The switch functions are as follows:

a. PARTIAL REMOTE - When the CONTROL MODE switch is in the PARTIAL REMOTE position, chart drive on-off control is transferred to a remote location. Chart speed control remains at the oscillograph.

b. FULL REMOTE - When the CONTROL MODE switch is in the FULL REMOTE position all chart speed control is transferred to a remote location.

c. LOCAL - When the CONTROL MODE switch is in the LOCAL position full control is maintained at the oscillograph control panel.

3-115. CHART SPEED MM/SEC SWITCH.

3-116. The CHART SPEED MM/SEC switch is a seven-pushbutton switch consisting of a STOP pushbutton and six pushbuttons for selecting chart travel speeds. Switch functions are as follows:

a. STOP PUSHBUTTON - When the STOP pushbutton is depressed, the chart drive motor stops and power is removed from the oscilloscope pens.

b. CHART SPEED MM/SEC SWITCHES- The CHART SPEED MM/SEC switch has six additional pushbuttons marked 2.5, 5, 10, 25, 50, and 100. When one of these switches is depressed, power is applied to the chart drive motor, driving the chart at the speed indicated by the selector switch.

3-117. SPEED ÷ 100 SWITCH.

3-118. The SPEED ÷ 100 switch is a two-position toggle switch. When the switch is in the up position, chart speeds indicated on the CHART SPEED MM/SEC switch are divided by 100. The chart speeds then available are 0.025, 0.05, 0.1, 0.25, 0.5, and 1 MM/SEC. When the switch is in the down position, chart speeds are as indicated on the CHART SPEED MM/SEC switch.

3-119. CHART TABLE CONTROL.

3-120. The Chart Table Control moves the chart table to provide access to the supply and take-up reels for paper loading.

3-121. CARDIOSCOPE.

3-122. The Cardioscope (figure 3-14) monitors astronaut heartbeat analog information. Heartbeat information from four sources may be simultaneously displayed. The controls necessary to operate the Cardioscope are described in the following paragraphs.

3-123. INTENSITY CONTROL.

3-124. The INTENSITY control turns input power on or off, and adjusts trace intensity from off up to a maximum preset brightness.

3-125. DISPLAY CALIBRATE SWITCH.

3-126. The DISPLAY CALIBRATE pushbutton switch causes the simultaneous application of an amplitude-calibrated 10-cps square wave to all four channels.

3-127. LEAD SELECT SWITCHES.

3-128. The four LEAD SELECT thumbwheel switches allow the selection of any one of ten input signals for display on the channel associated with the switch.

3-129. SWEEP SPEED VARIABLE CONTROL.

3-130. The sweep speed VARIABLE control allows continuous variation of sweep speed between positions of the STEP switch. When

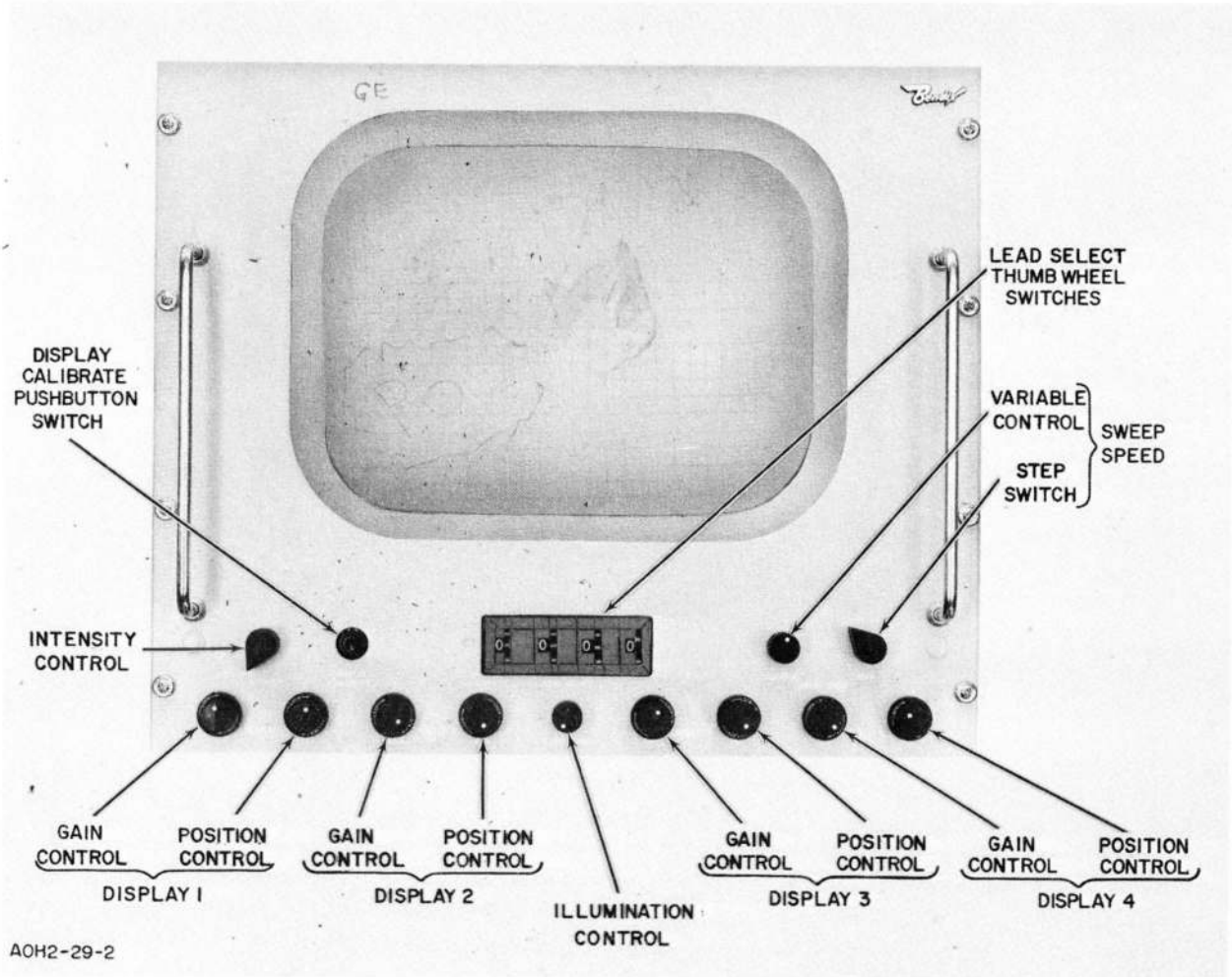


Figure 3-14. Cardioscope Display

the VARIABLE control is in the CAL X1 position the sweep speeds are as indicated by STEP switch.

3-131. SWEEP SPEED STEP SWITCH.

3-132. The sweep speed STEP switch sets the sweep speed at 5, 10, 25, or 50 mm/sec (when the VARIABLE control is in the CALX1 position).

3-133. ILLUMINATION CONTROL.

3-134. The ILLUMINATION control adjusts the display screen graticule illumination intensity. This control is continuously variable from off to maximum brilliance.

3-135. CHANNEL GAIN CONTROL.

3-136. The GAIN control for each channel adjusts the vertical gain (height) of the display for that channel.

3-137. CHANNEL POSITION CONTROLS.

3-138. The POSITION control for each channel adjusts the vertical position of the trace for that channel.

3-139. DIGITAL CARDIOMETER PANEL.

3-140. The Digital Cardiometer panel (figure 3-15) provides controls to operate the Cardiometer, and a display of the astronaut heart pulse rate. The panel contains a readout display and controls to control the display, determine the source, and select the sampling rate.

3-141. The THRESHOLD ADJUST control sets the signal threshold level of signal that the Cardiometer will accept. This control is adjusted just above the point at which the Cardiometer starts counting heart pulses, as indicated by an alternate flashing of upper and lower lamps in the DISPLAY RESET switch indicator.

3-142. The DISPLAY RESET switch indicator, in addition to indicating that the Cardiometer is counting, is depressed immediately after the threshold is adjusted to initialize the counter circuits in the Cardiometer.

3-143. The ECG SOURCE switch selects the source of heart pulse data by selecting the D/A address that will accept incoming PCM data. A test position selects a 1 PPS input for verification purposes. When the switch is in the TEST position the display should read 60.

3-144. The SAMPLE PERIOD switch indicator contains an alternate-action switch to select the period over which a count is accumulated prior to display. This count is internally multiplied by six in the 10-second position, and by four in the 15-second position, prior to display. The rate selected is indicated by the lighting of the appropriate half of the split-legend indicator.

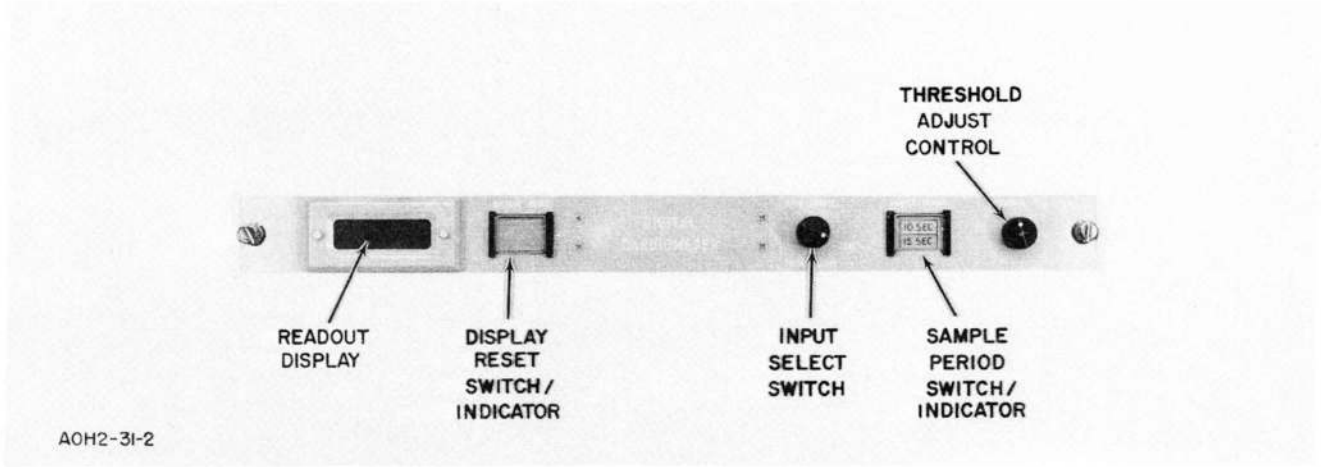


Figure 3-15. Digital Cardiometer Display Panel

3-145. The display portion of the panel is a numeric readout device that indicates the heart-pulse rate in pulses per minute.

3-146. EVENT SELECT PANEL.

3-147. The Event Select Panel (figure 3-16) consists of two 30-pole, two-position switches. Each switch is connected to 60 event lines and a 32-Channel Event Recorder. If an EVENT SELECT switch is in position 1, 30 of the 60 events will be selected for recording. Likewise, if the switch is in position 2, the other 30 event lines will be selected. The same action holds true for the other EVENT SELECT switch. Thus, a total of 60 out of a possible 120 events may be recorded at any given time.

NOTE

The only Event Select Panel in the system is located in the Power and Sequential System Console, Unit 3. The events selectable at the panel are determined by test operation requirements.

3-148. 100-CHANNEL EVENT RECORDER.

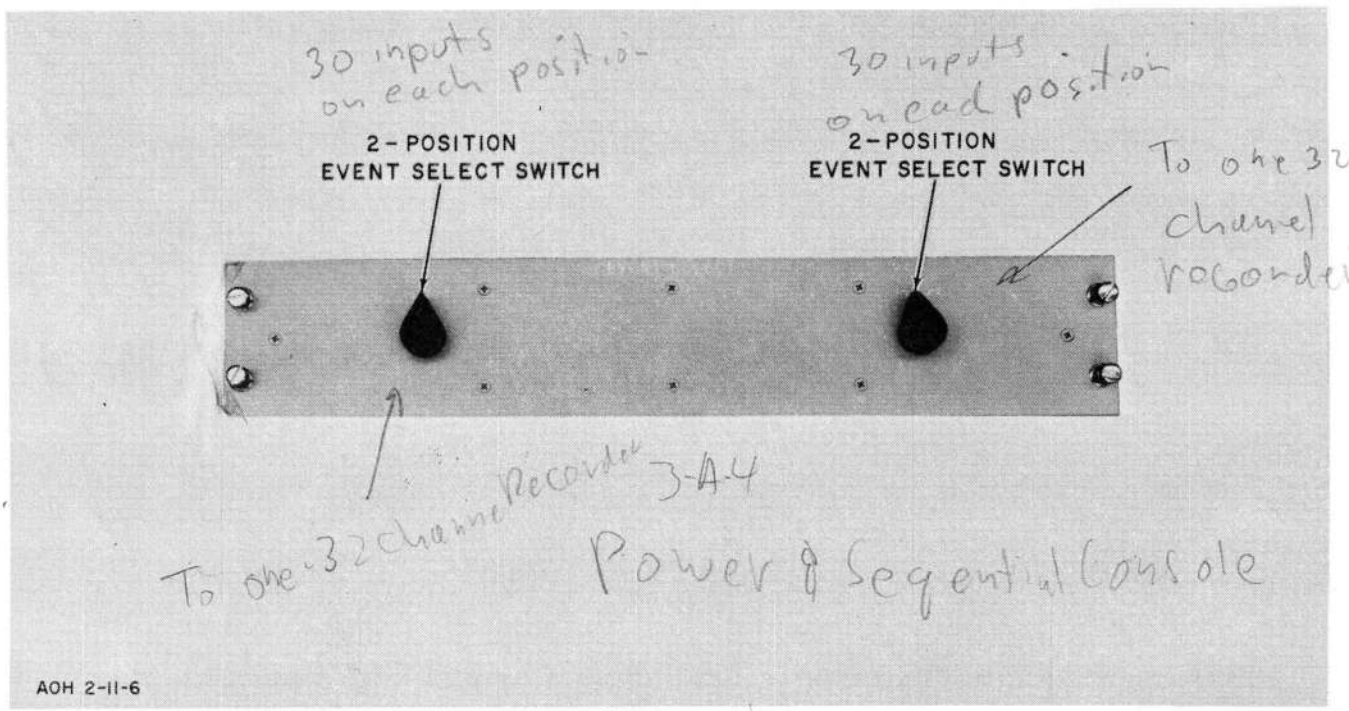
3-149. The 100-Channel Event Recorder (figure 3-17) is a moving paper, roll-chart multi-stylus recorder. The on/off event status of each channel is recorded by an electric-writing, stationary metal stylus that remains in contact with electro-sensitive paper. Each event is shown in time relationship to the others and provides an immediate picture of the situation monitored. The 100-Channel Event Recorder contains basically the same controls and indicators as the 32-Channel Event Recorder.

3-150. The writing process is accomplished through the use of a high voltage potential applied to each of the 100 writing pens during the occurrence of an event signal.

WARNING

High voltage is present on the pens. Do not touch the pens while the recorder is in operation.

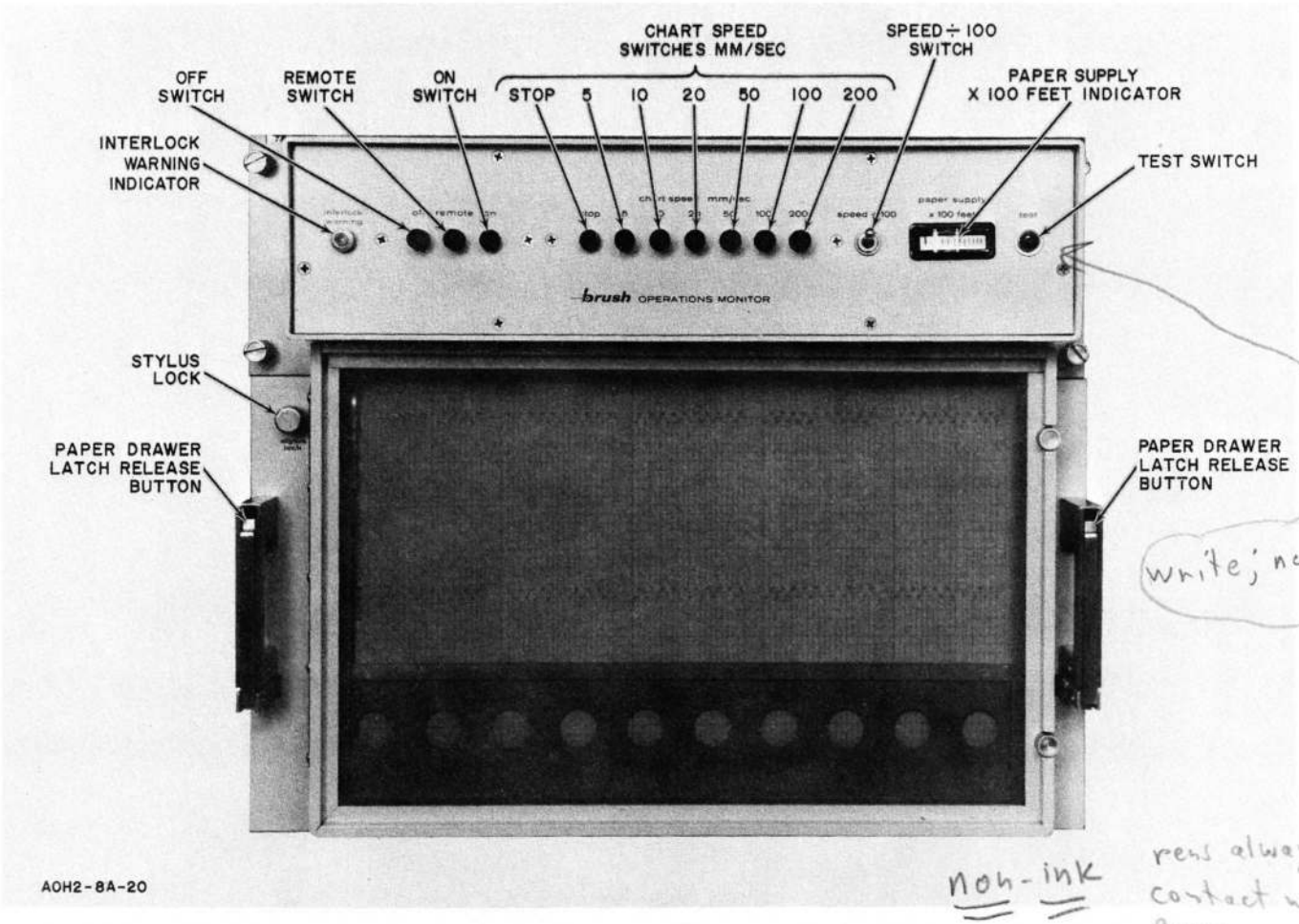
3-151. The glass RFI door must be closed during the operation to keep RFI (resulting from the high voltage writing arc) at a minimum. The 100-Channel Event Recorder controls are described in the following paragraphs.



32 channel

Figure 3-16. Event Select Panel

98 Data Channels
2 Time Code Channels



write; no write

non-ink

pens always in contact with paper,

500V pulse when writing

Figure 3-17. 100-Channel Event Recorder

3-152. PAPER DRAWER LATCH RELEASE BUTTON.

3-153. The two paper drawer latch release buttons are pressed inward and upward to release the paper drawer latches.

3-154. STYLUS LOCK SWITCH.

3-155. The STYLUS LOCK switch must be depressed to engage the stylii with the paper.

3-156. DOOR LATCHING SCREWS.

3-157. The door latching screws are two thumbscrews used to hold the front door.

3-158. 100-CHANNEL EVENT RECORDER OPERATION.

3-159. The operation of this recorder is identical to operation of the Analog Recorder (refer to paragraph 3-87).

3-160. STATUS DISPLAY PANEL.

3-161. The Status Display Panel (figure 3-18) contains indicators for displaying 55 events associated with RF systems, POWER systems, ARMING, MISSION MILESTONES, ACE, and other parameters as required. There are 8 lamp-type indicators for RF systems, 10 for POWER systems, 11 for ARMING, 20 for MISSION MILESTONES, and 6 for ACE. Each lamp unit contains two lamps and an associated PRESS TO TEST switch. In addition to these 55 events, the Status Display Panel contains ten back-lighted indicators which are divided into two segments. The lower segment is designated GO and is colored green, while the upper segment is designated HOLD and is colored red. These indicators display the status of the control consoles in the Control Room, and receive their inputs from the console status control panels. When the operator at a particular control console depresses the GO or HOLD

switch on the status control panel for that console, the green or red indicator on the Status Display Panel corresponding to that unit will light.

3-162. A LAMP TEST switch is provided on the Status Display Panel that, when depressed, lights all the indicators on the panel to verify that they are operating properly.

3-163. RANGE TIME PANEL.

3-164. The Range Time Panel (figure 3-19) contains nine decimal in-line indicators that display range time in days, hours, minutes, and seconds. Each decimal indicator is made up of seven back-lighted segments that are turned on in various combinations to form the desired decimal characters. Three indicators are utilized for days, two for hours, two for minutes, and two for seconds.

3-165. The right-hand portion of the Range Time Panel contains an ON/OFF toggle switch that controls the application of power to the panel.

3-166. An INTENSITY control at the upper right-hand side of the Range Time Panel, when adjusted, varies the brightness of the characters being displayed.

3-167. COUNTDOWN TIME PANEL.

3-168. The Countdown Time Panel (figure 3-20) contains seven decimal, in-line indicators used to display countdown time in

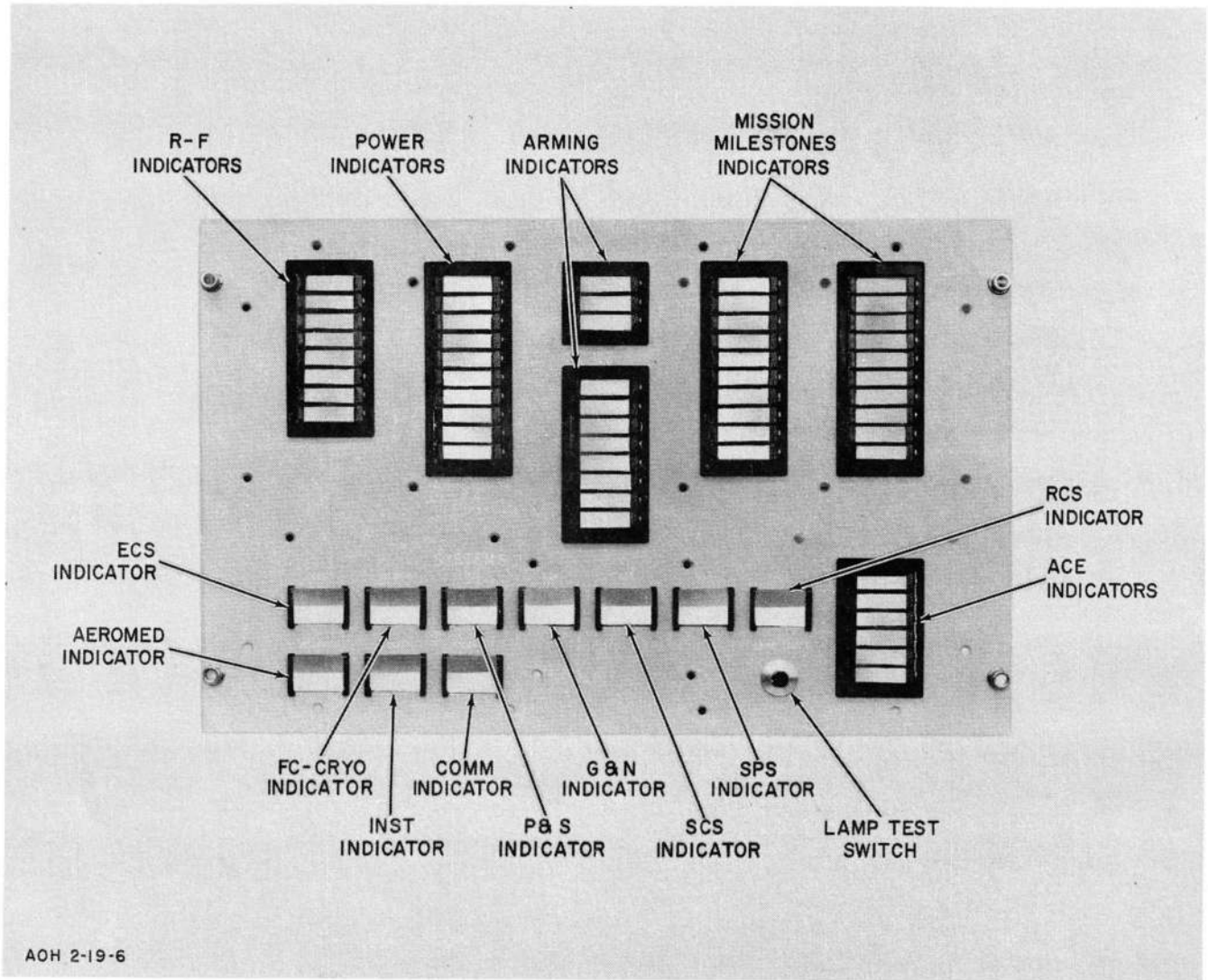


Figure 3-18. Status Display Panel

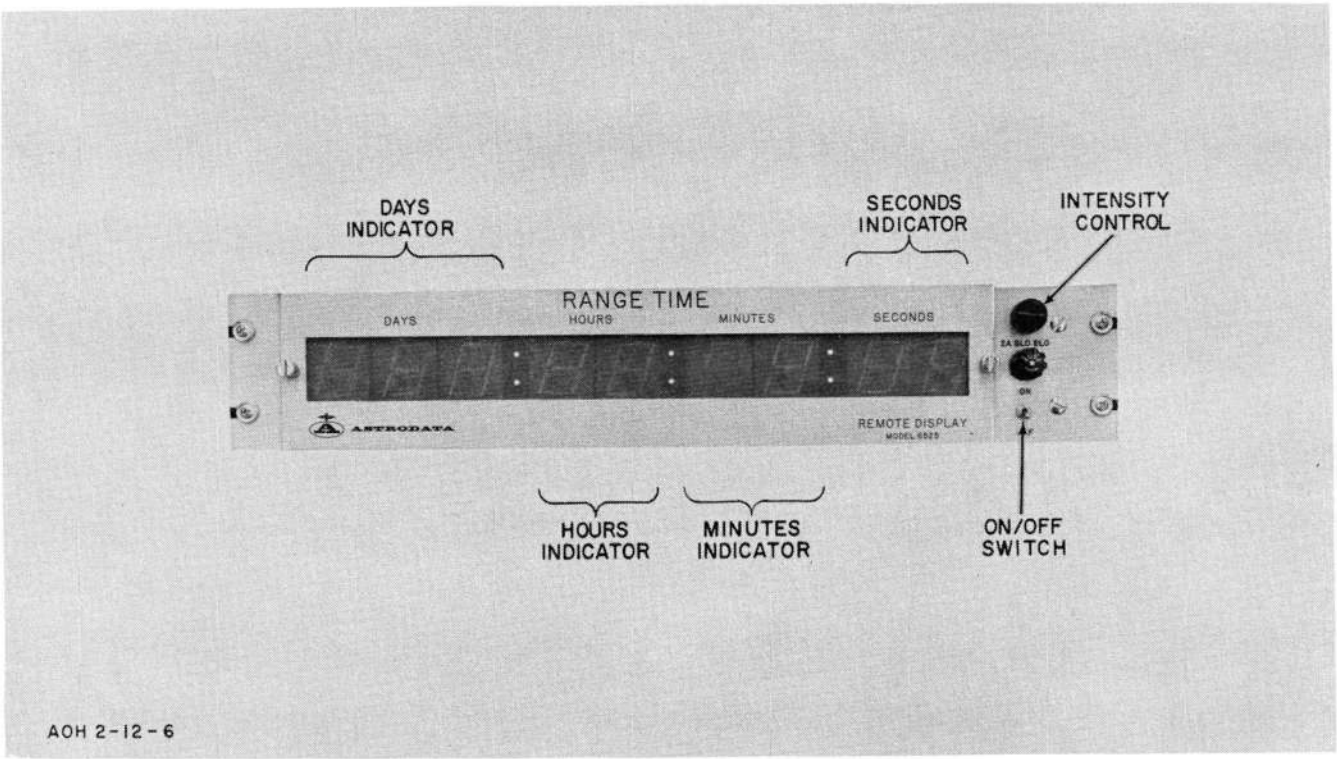


Figure 3-19. Range Time Panel

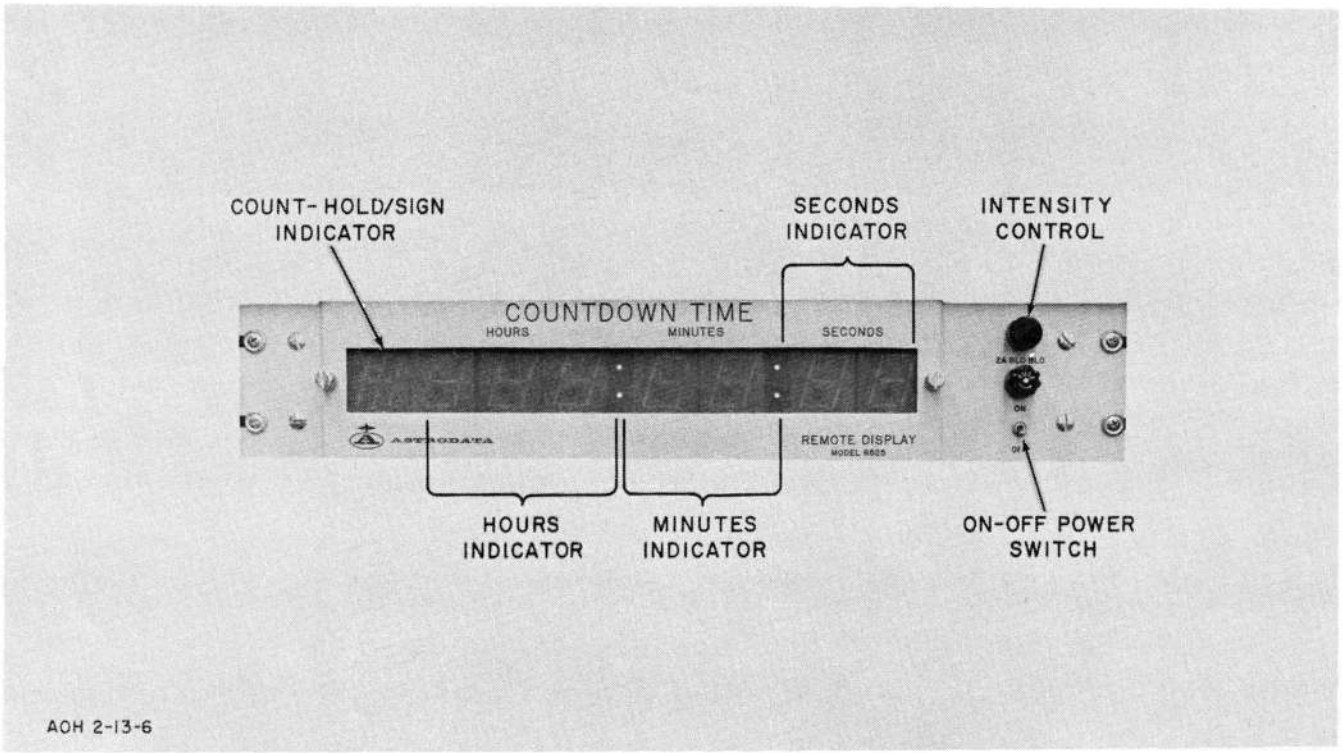


Figure 3-20. Countdown Time Panel

hours, minutes, and seconds. These indicators are identical to those used on the Range Time Panel (refer to paragraph 3-163). Three indicators are utilized for hours readout, two for minutes readout, and two for seconds readout. Maximum readout occurs at 999 hours, 59 minutes, and 59 seconds.

3-169. In addition to the numeric indicators, a special indicator is provided at the left-hand side of the display that can display "+, " "-, " or "H. " The "+" indicates a count in the forward direction (away from zero), the "-" indicates a count in the reverse direction (toward zero), and the "H" indicates a "hold" condition at the time displayed.

3-170. An ON/OFF toggle switch at the right-hand side of the Countdown Time Panel controls the application of power to the panel. The upper right-hand portion of the Countdown Time Panel also contains an INTENSITY control that varies the brightness of the characters being displayed.

3-171. COUNTDOWN GENERATOR REMOTE CONTROL PANEL.

3-172. The Countdown Generator Remote Control Panel (figure 3-21) is used in conjunction with the Countdown Generator that generates time data and a specific time code word. The time data is displayed on the front panel of the Countdown Generator and on the Countdown Generator Remote Display.

3-173. The Countdown Generator Remote Control Panel consists of an a-c power indicator, eight digital thumbwheel switches, and a LOCAL/REMOTE switch. The operation of these controls and indicators is discussed below.

3-174. AC POWER INDICATOR.

3-175. When illuminated, this lamp indicates the application of a-c power.

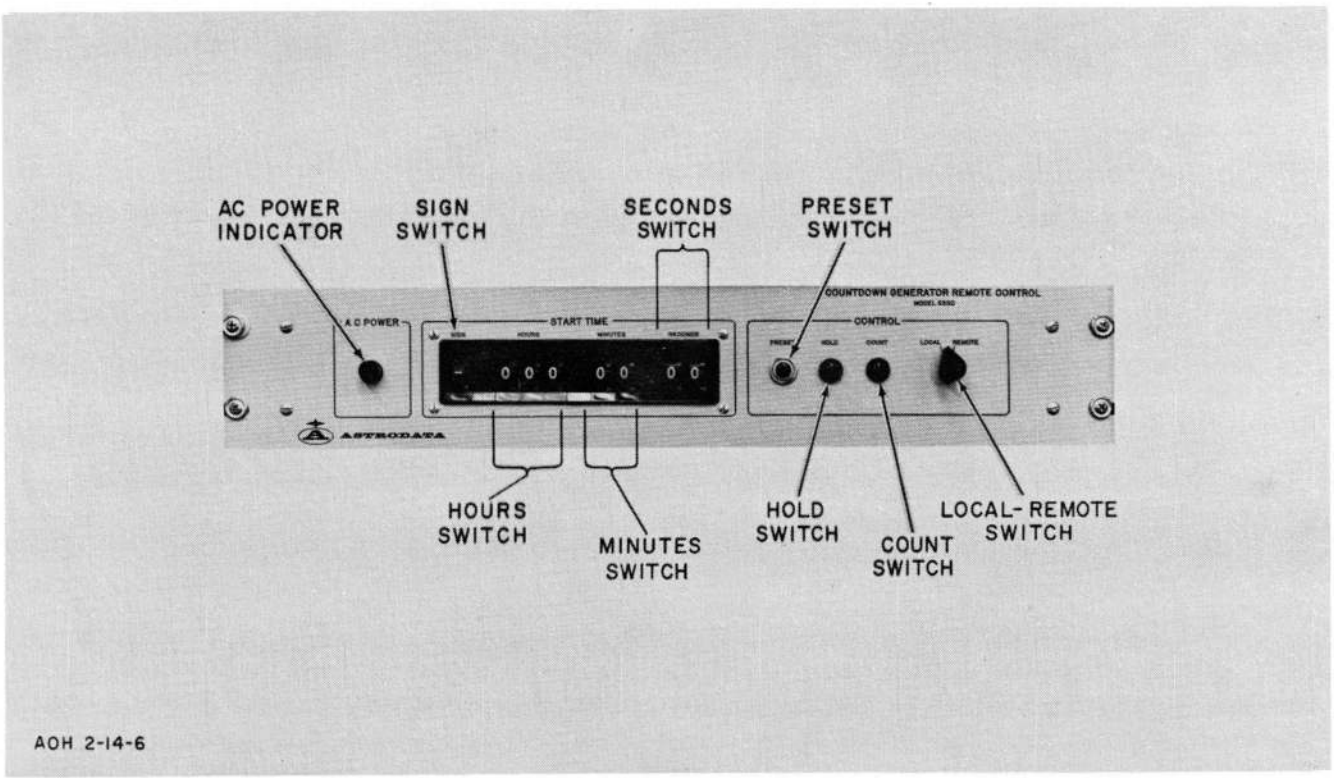


Figure 3-21. Countdown Generator Remote Control Panel

3-176. START TIME THUMBWHEEL SWITCHES.

3-177. The Countdown Generator Remote Control Panel consists of eight digital thumbwheel switches. The thumbwheel switches provide the means of setting in the countdown time at which the clock is to start running. The first thumbwheel switch from the left selects the direction of the count. A "+" causes the Countdown Generator to count up from the preset time while a "-" causes the Countdown Generator to count down from the preset time. When the Countdown Generator is counting down (indicated by a "-") and the time passes through zero, the Countdown Time Panel will change to "+" and the Countdown Generator will begin counting up. The remaining seven thumbwheel switches are used to indicate the start countdown time in hours, minutes, and seconds.

3-178. PRESET SWITCH.

3-179. The PRESET switch, when depressed, automatically stops the count and causes the sign and time on the Countdown Time Panel to change to the sign and time which has been set into the thumbwheel switches.

3-180. HOLD AND COUNT SWITCHES.

3-181. Momentarily depressing the HOLD switch causes the Countdown Generator to stop and retain the time accumulated up to the point that the HOLD switch was depressed. The H (HOLD) indicator on the Countdown Time Panel lights in place of the "+" or "-" sign. The count may then be continued from this point by momentarily depressing the COUNT switch.

3-182. LOCAL-REMOTE SWITCH.

3-183. The LOCAL-REMOTE switch provides for LOCAL control in the LOCAL position and remote control in the REMOTE position.

3-184. POWER MONITOR PANEL.

3-185. Certain consoles contain Power Monitor Panels which allow the control console operator to turn the power on or off to that particular console and to warn the console operator of console or cabinet overheat conditions. Each Power Monitor Panel (see figure 3-22) contains the following controls and indicators.

3-186. POWER CONTROL SWITCH AND INDICATORS.

3-187. A POWER ON/OFF switch is provided on each Power Monitor Panel to control the input power to that particular console. Associated with each POWER ON/OFF switch is a power-on indicator which lights when power is on, and an ELAPSED TIME meter which indicates time (in hours and tenths of hours) that the console has been in operation. The operator is to use this switch only under emergency power off condition.

3-188. TEMPERATURE ALARM.

3-189. The Temperature Alarm consists of a TEMP ALARM indicator (red lamp-type indicator), cabinet temperature sensing units, and an OVERRIDE/NORMAL switch. The TEMP ALARM indicator flashes whenever the cooling air temperature (under operating conditions) in any associated system console rack exceeds a maximum value. (An additional lamp is provided in each console rack to identify the location of the fault.) When the TEMP ALARM indicator flashes, the console will automatically shut down after a 30-second time delay. The OVERRIDE/NORMAL switch, when in the OVERRIDE position, overrides the automatic shutdown if a critical test is in progress.

3-190. STATUS CONTROL PANEL.

3-191. Status control panels are located on various consoles and provide the means to (1) turn the power on or off on that particular console, (2) warn the console operator of console or cabinet overheat conditions, and (3) allow the console operator to report his operational status to the Test Conductor by means of GO/HOLD signals. Each status control panel (figure 3-23) contains the following controls and indicators.

3-192. GO/HOLD SWITCHES AND INDICATORS.

3-193. The control console operator evaluates the spacecraft test data supplied to his console and makes a decision based on his

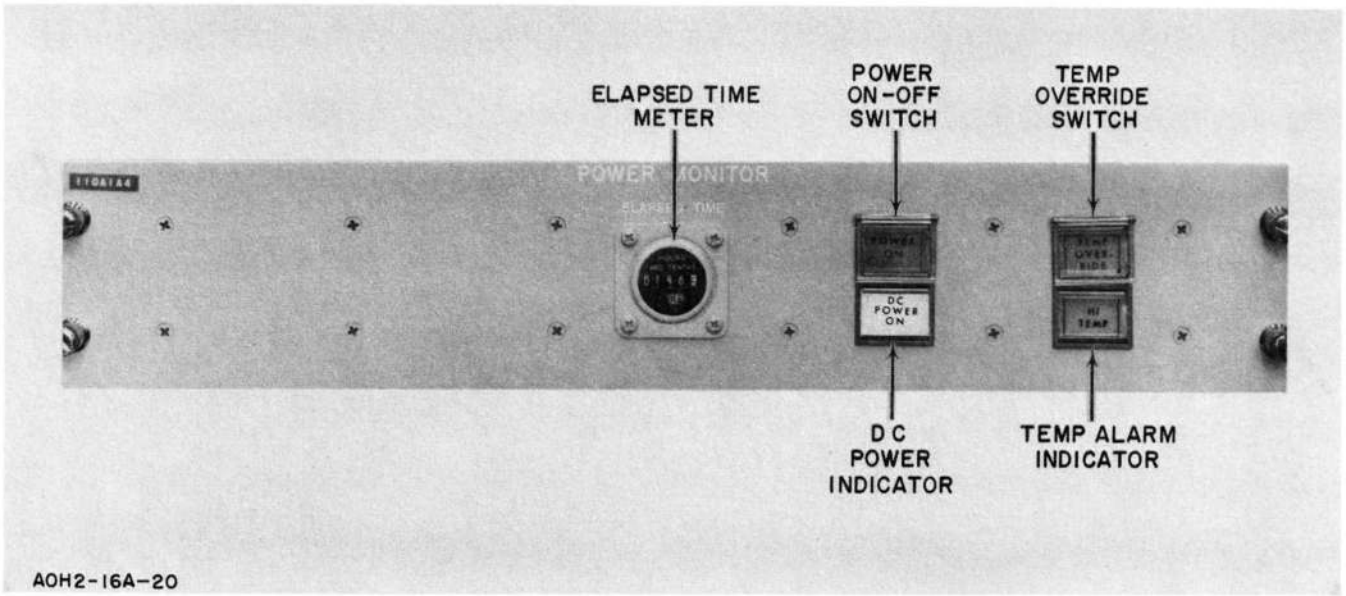


Figure 3-22. Power Monitor Panel

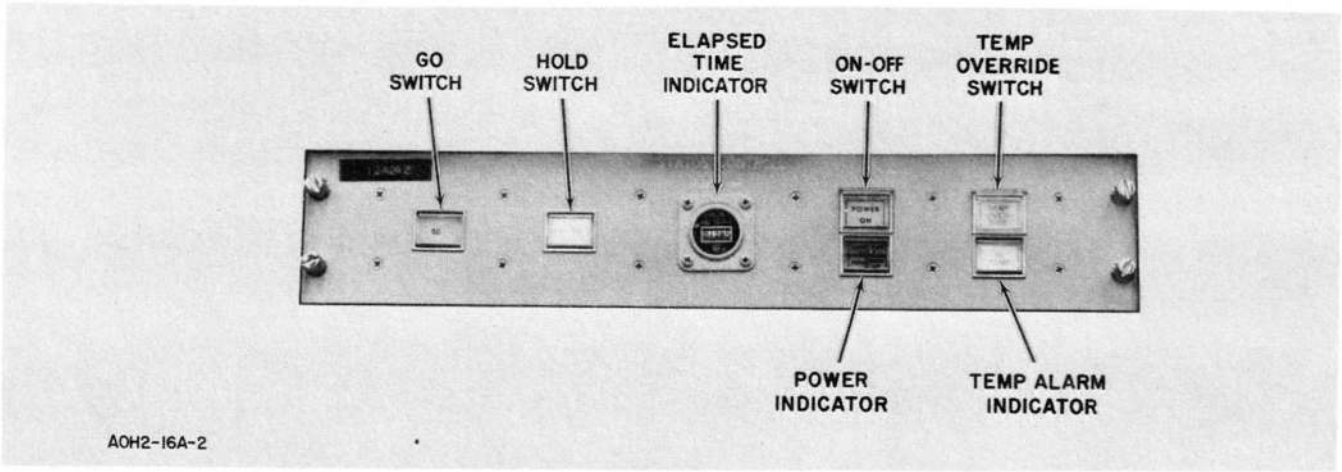


Figure 3-23. Status Control Panel

observations as to whether to continue the test. The control console operator informs the Test Conductor of this decision by actuating one of two rectangular back-lighted switches on the status control panel labeled GO or HOLD. These switches are interlocked to prevent simultaneous activation. Upon depressing a switch, it will become back-lighted (green for GO and red for HOLD) and remain back-lighted until the other switch is depressed or by depressing the same switch a second time.

3-194. POWER CONTROL SWITCH AND INDICATORS.

3-195. The POWER ON switch is an alternate-action pushbutton switch that turns console power on or off. The switch is lighted when power is on. The switch has a hinged protective cover that must be raised to operate the switch. This prevents accidental application or removal of console power. The operator is to use this switch only under emergency power off condition.

3-196. A three-segment logic power indicator provides an indication of the operational status of the console logic power supply. The LOGIC POWER LOSS segment is illuminated when a logic power failure has occurred in a high-boy console. The PRIM POWER segment is illuminated under normal operating conditions and indicates power is being supplied from the local power supply. The BACK-UP POWER segment is illuminated when a local power failure has occurred and power is supplied by an adjacent console. In the event of both PRIM power and BACK-UP power failures neither segment of the indicator will illuminate.

3-197. An ELAPSED TIME meter provides a cumulative total of time, in hours and tenths, that power has been applied to the console.

3-198. TEMPERATURE ALARM.

3-199. The temperature alarm consists of a HI TEMP indicator, and a TEMP OVERRIDE switch. The HI TEMP indicator flashes if the cooling air temperature in any console exceeds a predetermined value. When an overtemperature condition exists, the console will automatically shut down the subsystem console after a 30-second time delay. The TEMP OVERRIDE switch is provided to override the automatic shutdown if a critical test is in progress. This TEMP OVERRIDE switch is also protected by a hinged cover to prevent accidental operation.

3-200. RF SYSTEMS PANEL.

3-201. The RF Systems Panel (see figure 3-24) consists of nine lamp-type indicator units and a LAMP TEST switch. The indicator lamps may be tested collectively by depressing the LAMP TEST switch or individually by depressing each lamp lens. The following six signals may be displayed on the RF Systems Panel:

a. C-Band.
b. S-Band.
c. VHF FM.
d. VHF AM.
e. VHF RECY.
f. VHF XCVR.

3-202. These signals are comprised of eight-bit data words. The three most significant bits of each data word is supplied to a converter NOR gate while all eight bits are supplied to a D/A converter. If any or all of the three most significant bits applied to the converter NOR gate are at a "1" logic level, the output of the NOR gate (after passing through additional circuitry) will light the indicator on the RF Systems panel which was patched to this data word. When the indicator lights, this signifies that the analog parameter being displayed on the panel is greater than 12.5 percent of the maximum analog voltage output of the D/A converter.

3-203. The PRESS-TO-TEST switch, when depressed, checks all the lamps to insure that they are operating properly.

3-204. WALL CLOCK DISPLAY UNITS.

3-205. Three wall clocks (see figure 3-25) are located in the Control Room (Units 29, 30, and 31) and two are located in the Computer Room (Units 134 and 135). Each Wall Clock Display consists of two sets of in-line decimal display indicators - one set for real-time display (actual or range time) and one set for countdown-time display.

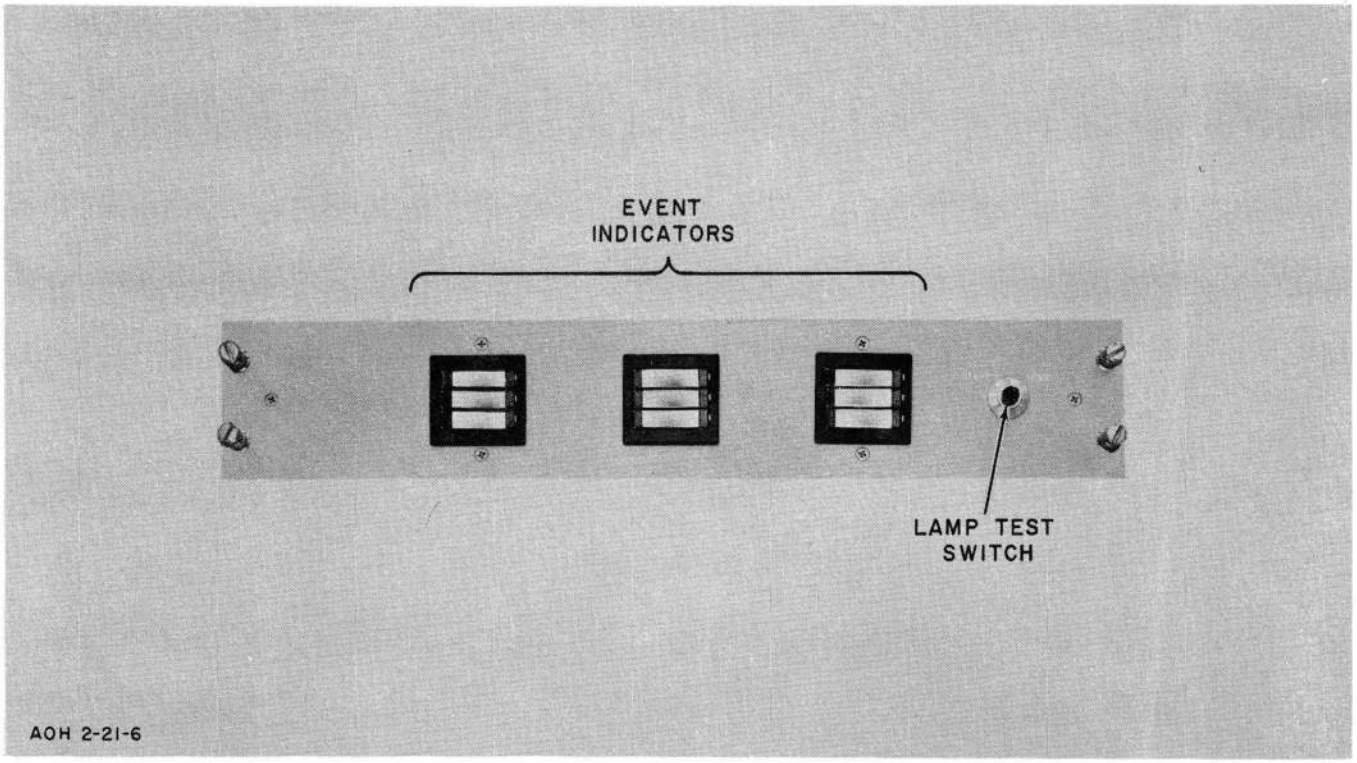


Figure 3-24. RF Systems Panel

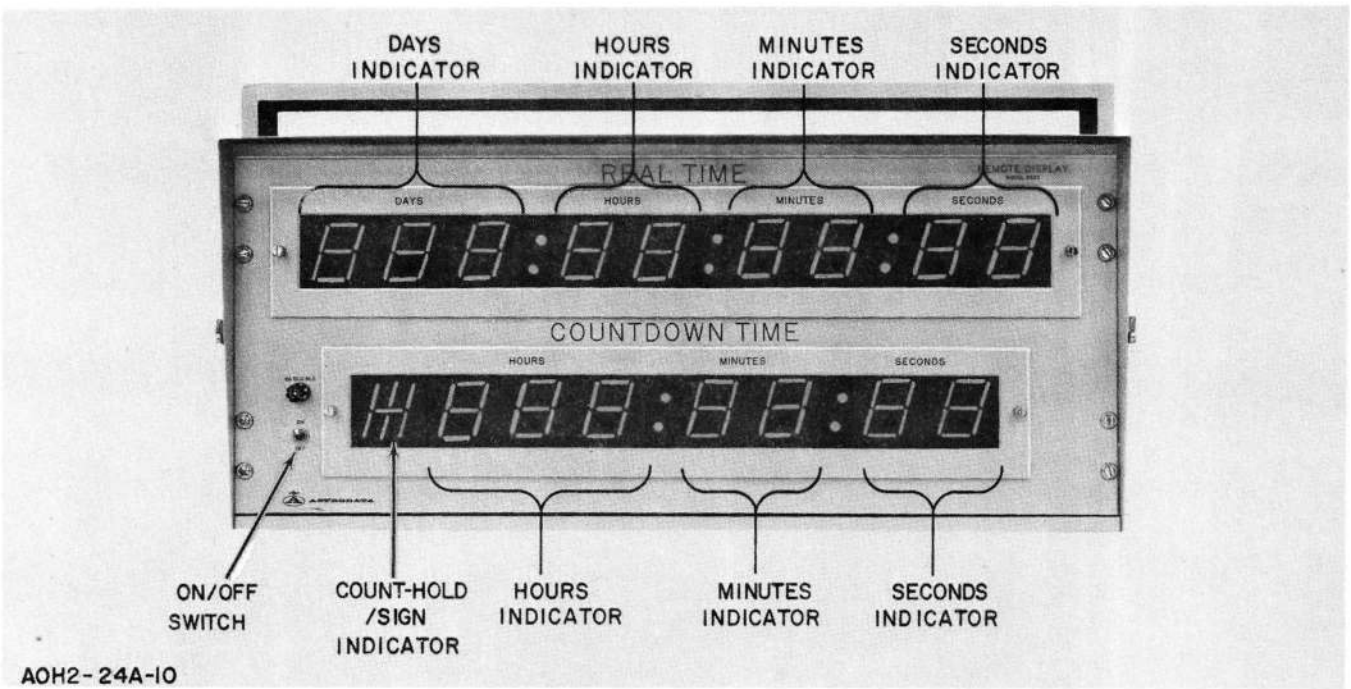


Figure 3-25. Wall Clock Display Unit

3-206. The real-time portion of the Wall Clock Display shows the current time of year or range time - never playback real time. This display contains nine decimal in-line indicators; three to indicate days, two to indicate hours, two to indicate minutes, and two to indicate seconds. Each indicator is made up of seven separate back-lighted segments that are turned on in various combinations to form the desired decimal characters.

3-207. The countdown time portion of the Wall Clock Display shows current countdown time, never playback countdown time. The countdown wall clock contains eight in-line decimal indicators; one to indicate "+, " "-, " or H (HOLD); three to indicate hours, two to indicate minutes, and two to indicate seconds. Each decimal indicator contains seven back-lighted segments that are turned on in various combinations to form the desired decimal characters.

3-208. The Wall Clock Display contains an ON/OFF switch which, when set in the ON position, applies 115-vac power to the Wall Clock Display power supply which supplies +22 volts to the REAL TIME and COUNTDOWN TIME readout indicators and to the sign indicator.

3-209. PIPA DISPLAY.

3-210. The Pulse Integrating Pendulum Accelerometer (PIPA) Display, located in the Guidance and Navigation Console, provides a phase display of the operation of the PIPA operation in the spacecraft guidance and navigation system. The display is composed of an oscilloscope and a phase shifter panel.

3-211. PIPA OSCILLOSCOPE.

3-212. The PIPA oscilloscope (see figure 3-26) is a conventional X-Y scope providing controls for vertical and horizontal sweep and beam trace.

3-213. HORIZONTAL DISPLAY/VERNIER CONTROL. The HORIZONTAL DISPLAY switch provides 15 sweep speed selections and three external input sensitivity positions. The HORIZONTAL VERNIER control adjusts horizontal sensitivity between ranges.

3-214. VERTICAL SENSITIVITY/VERNIER CONTROL. The VERTICAL SENSITIVITY switch provides four positions of vertical sensitivity. The VERTICAL VERNIER control adjusts sensitivity between ranges.

3-215. TRIGGER SOURCE/LEVEL CONTROL. The TRIGGER SOURCE switch provides the selection of four sources of sweep synchronization. The TRIGGER LEVEL control determines the level of trigger point on the trigger waveform.

3-216. POSITION CONTROLS. The HORIZONTAL and VERTICAL POSITION controls position the trace on the face of the oscilloscope.

3-217. SWEEP MAGNIFIER SWITCH. In the X1 position of the SWEEP MAGNIFIER switch, sweep speed is selected by the HORIZONTAL DISPLAY switch. In the X5 position sweep speed is five times faster.

3-218. AC-DC SWITCHES. These switches provide either a direct-coupled or compositor input to the associated (horizontal or vertical) channel.

3-219. FOCUS CONTROL. This control adjusts the focus of the CRT electron beam.

3-220. INTENSITY AND POWER CONTROL. This control adjusts the intensity of the CRT electron beam. A switch at the full CCW position controls the application of primary power to the unit.

3-221. BEAM FINDER SWITCH. The BEAM FINDER pushbutton switch returns the beam to the CRT face regardless of the horizontal and vertical control settings.

3-222. PHASE SHIFTER PANEL.

3-223. The Phase Shifter Panel (see figure 3-27) adjusts the phase of the incoming PIPA reference signal. Controls are provided for source selection and phase shift.

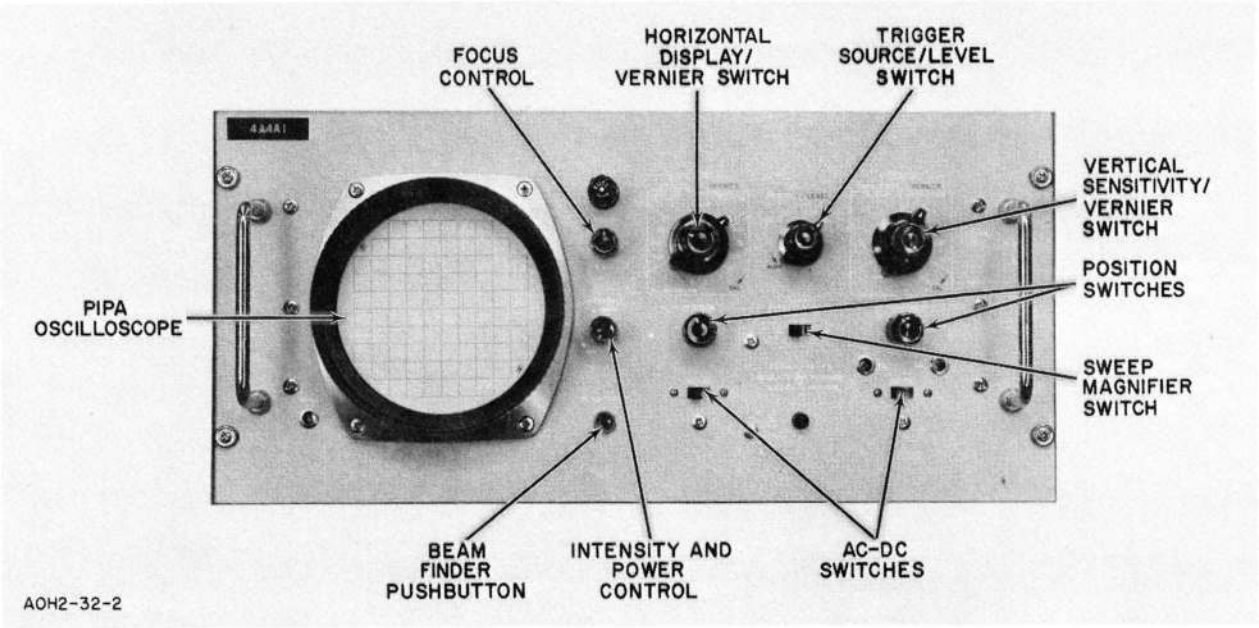


Figure 3-26. PIPA Oscilloscope

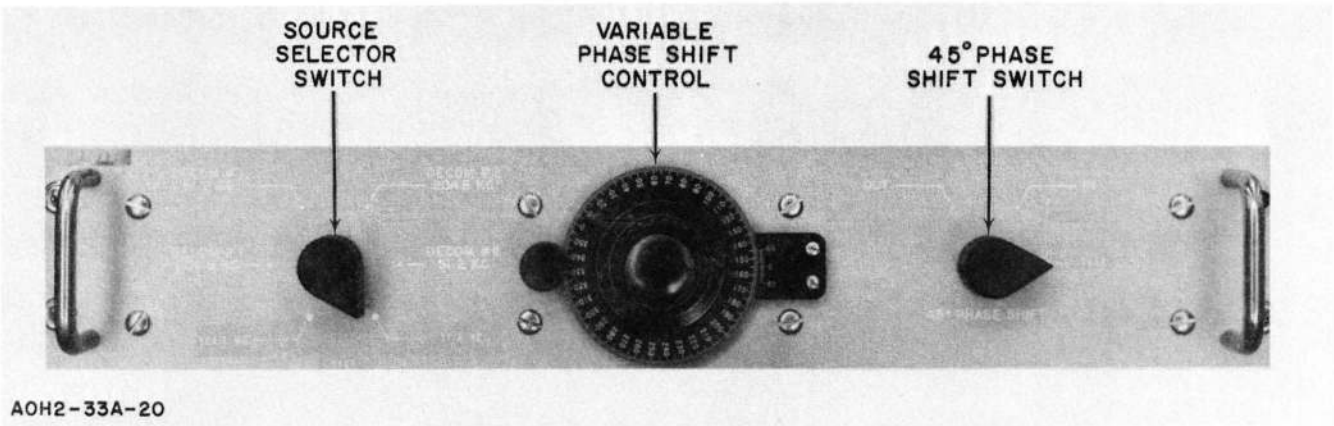


Figure 3-27. Phase Shifter Panel

3-224. SOURCE SELECTOR SWITCH. The Source Selector switch allows the selection of either decommutator at airborne or interleaved data rates as the reference source.

3-225. VARIABLE PHASE SHIFT CONTROL. The Variable Phase Shift control allows shifting of the incoming signal over a continuous range of 0 to 360 degrees. Main dial graduations are 1 degree apart, and a vernier allows settings to 6 minutes of a degree.

3-226. 45° PHASE SHIFT SWITCH. The 45° PHASE SHIFT switch adds an additional 45 degree shift to that provided by the variable control, when the switch is in the IN position.

SECTION II

ACE-S/C MILA PERIPHERAL EQUIPMENT OPERATION

3-227. INTRODUCTION.

3-228. The following paragraphs briefly describe the use and operation of the various control and display devices available to the ACE-S/C peripheral console operators.

3-229. UNITS COMMON TO ALL CONSOLES.

3-230. The descriptions of the following units are grouped since they are used on more than one console and are not unique to any of the functional equipment areas.

3-231. ALPHANUMERIC CRT DISPLAY.

3-232. The function and operation of these units are identical to CRT display units in the ACE-S/C ground stations.

3-233. CCTV DISPLAY.

3-234. The GFE CCTV monitors can display simultaneously any two of nine areas covered by closed-circuit TV cameras. The two areas to be viewed are selected by requesting their display from the video patch operator in the MSO Building, using the intercommunication system.

3-235. Controls are provided in the monitor front panel for horizontal and vertical hold, focus, vertical height and linearity, contrast, brightness, and power.

3-236. TEST CONDUCTOR CONSOLE OPERATION.

3-237. The following paragraphs describe the function and operation of the Test Conductor Status Display Panel, the only unit unique to the Test Conductor Console.

3-238. TEST CONDUCTOR STATUS DISPLAY PANEL.

3-239. The Test Conductor Status Display Panel (figure 3-28) provides a summary status indication of checkout progress for the Apollo Command and Service Module (CSM) and the Lunar Excursion Module (LEM), an indication of overall mission progress (MILESTONES), and controls and indicators that are part of the range firing link (ARM ENABLE).

3-240. The controls are key-operated switches that are actuated when the spacecraft is in a "go" condition.

3-241. CSM AND LEM INDICATORS. Both the CSM and LEM displays contain essentially the same type of indications. Event indicators are provided to indicate the occurrence of specified events in the POWER, RF, and ARMING systems.

3-242. The MAJOR SYSTEM split-legend indicators display the GO/HOLD status of the consoles for each major CSM and LEM system.

3-243. MILESTONES INDICATORS. The MILESTONES indicators provide a display of selected PRELAUNCH and MISSION milestones, received from launch complex Ground Support Equipment.

3-244. ARM ENABLE CONTROLS AND INDICATORS. The CSM and LEM ARM ENABLE controls and indicators provide

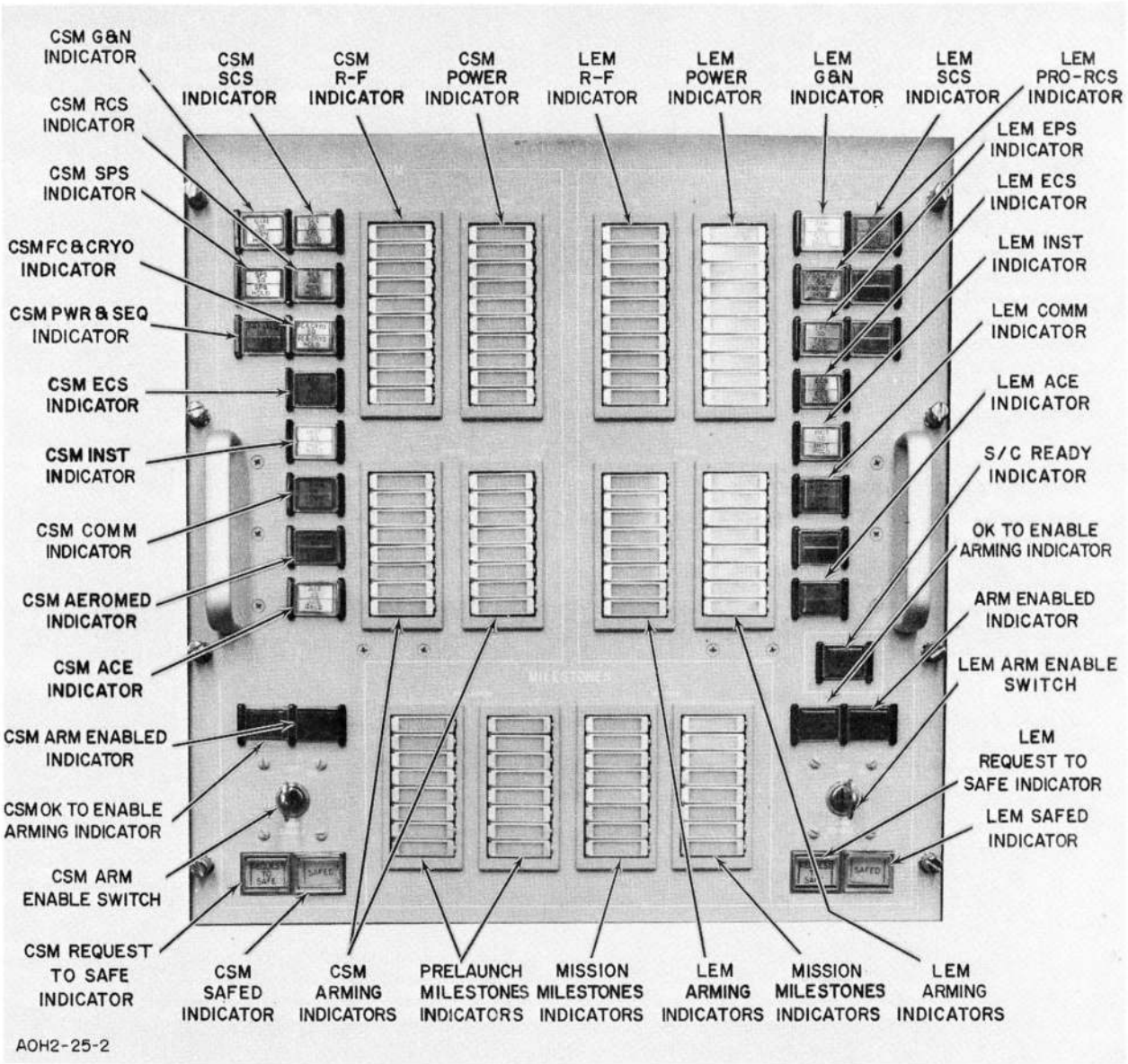


Figure 3-28. Test Conductor Status Display Panel (MILA Peripheral)

the spacecraft portion of the range arming and firing links. The OK TO ENABLE ARMING indicators signal that the spacecraft may be armed by turning the ARM ENABLE key switches. The ARM ENABLED indicator lights when the spacecraft has been armed.

3-245. The S/C READY switch indicator is depressed, when the spacecraft is ready, to provide an indication of this status to the Launch Vehicle Test Conductor. The indicator portion of the switch lights to indicate that the switch has been activated. This is an alternate action switch, therefore, a second actuation of the switch will turn off the spacecraft ready indication.

3-246. The REQUEST TO SAFE indicator lights when it is necessary to safe the spacecraft pyrotechnics. The safe condition is initiated by raising the cover over the SAFED switch indicator, and depressing the switch. The SAFED indicator lights when this has been accomplished.

3-247. AEROMEDICAL REPRESENTATIVE CONSOLE OPERATION.

3-248. In addition to common units previously described, the Aeromedical Representative Console contains a Cardiometer, Cardioscope, Aeromedical Recorder, and an Aeromedical Display Panel.

3-249. CARDIOMETER OPERATION.

3-250. Refer to paragraph 3-139.

3-251. CARDIOSCOPE OPERATION.

3-252. Refer to paragraph 3-121.

3-253. AEROMEDICAL TWO-CHANNEL RECORDER.

3-254. The Two-Channel Cardiograph Recorder (figure 3-29) provides a record of selected heart pulse waveshapes on heat-sensitive paper. The functions of controls and indicators used for operation are described in the following paragraphs. These controls are divided into two categories: common controls, and channel controls.

3-255. COMMON CONTROLS.

3-256. The common controls are those that affect both recording channels. These controls include the speed, test and MARK EVENT switches, and the paper supply indicator/chart adjust control.

3-257. CHART SPEED MM/SEC SWITCH. This is a seven-pushbutton switch comprising a STOP pushbutton and six additional pushbuttons for selecting various chart travel speeds. When the STOP pushbutton is depressed the chart drive motor stops and power is removed from the pens. The speed pushbuttons are marked 5, 10, 25, 50, 100, and 200. When one of these six pushbuttons is depressed, power is applied to the chart drive motor to drive the chart at the indicated speed.

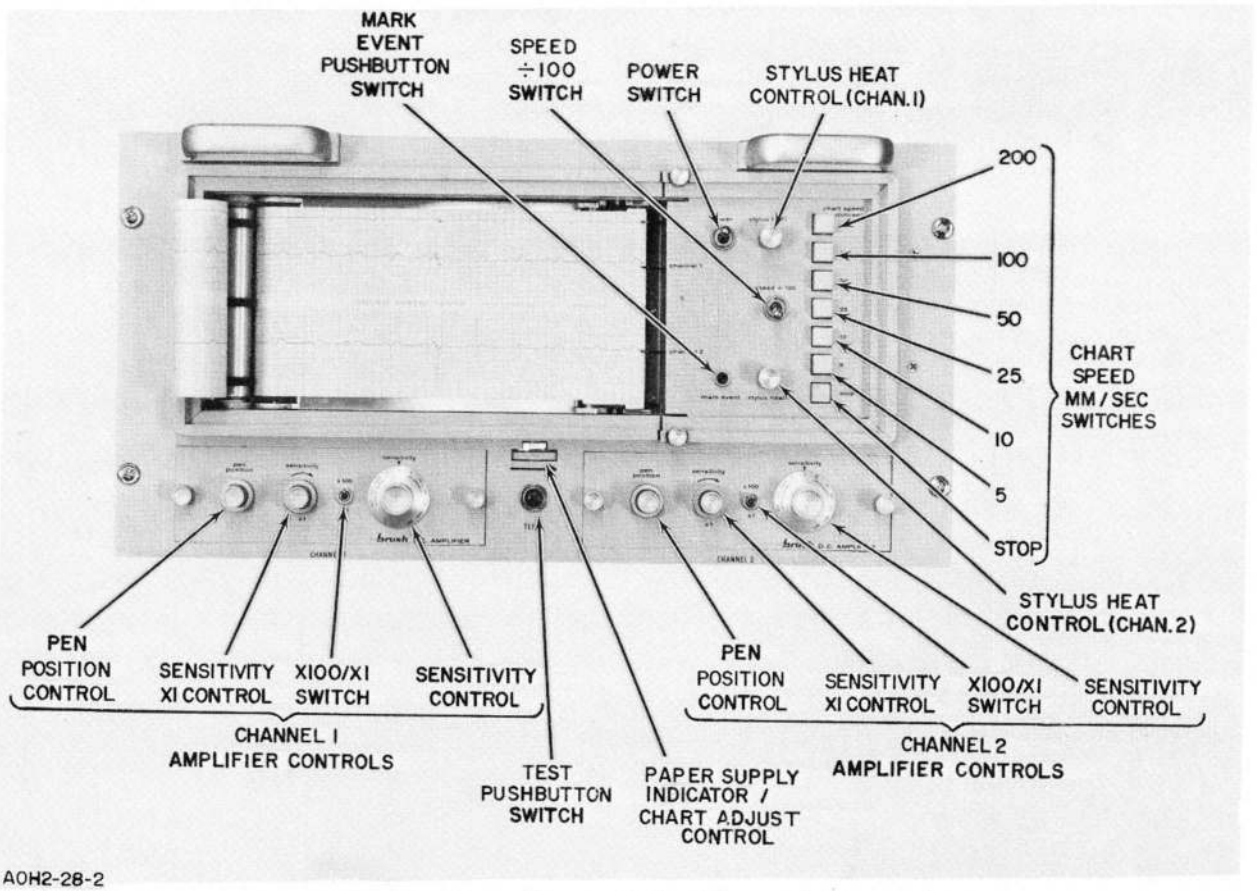


Figure 3-29. Two-Channel Cardiograph Recorder

3-258. SPEED ÷ 100 SWITCH. When this toggle switch is in the up position chart speeds are one one-hundredth of the panel indications. The speeds then available are 0.05, 0.1, 0.25, 0.5, 1.0, and 2.0 mm/sec. When the switch is in the down position chart speeds are as indicated on the panel.

3-259. MARK EVENT PUSHBUTTON SWITCH. When the MARK EVENT pushbutton is depressed, an event marker is placed on the time marker trace, in addition to the time markers.

3-260. PAPER SUPPLY INDICATOR/CHART ADJUST CONTROL. The Paper Supply Indicator/Chart Adjust control provides a visible indication of the amount of paper remaining on the supply roll, and permits removal of slack from the roll.

3-261. CHANNEL CONTROLS.

3-262. The channel controls affect only the channel with which they are associated. These controls affect the gain and intensity of the analog traces.

3-263. STYLUS HEAT CONTROLS. The STYLUS HEAT controls provide individual manual adjustment of the writing intensity of each analog channel.

3-264. SENSITIVITY CONTROL. This is a ten-position selector switch that permits selection of input sensitivity over a range of 100 microvolts to 100 millivolts per chart line.

3-265. SENSITIVITY X1 CONTROL. The SENSITIVITY X1 control allows continuous variations over a 2.5 to 1 range between positions of the SENSITIVITY control.

3-266. X100/X1 SWITCH. When this switch is in the X1 position input sensitivity is as indicated on the SENSITIVITY control. When the switch is in the X100 position, the SENSITIVITY control readings are multiplied by 100.

3-267. PEN POSITION CONTROL. This control adjusts the zero or resting position of the stylus.

3-268. AEROMEDICAL DISPLAY PANEL.

3-269. The Aeromedical Display Panel (figure 3-30) provides summary status indication of the CSM aeromedical, instrumentation, and FCS systems, and indications of overall mission progress. Each indicator lamp is equipped with a built-in press-to-test switch.

3-270. MILESTONES INDICATORS. The MILESTONES indicators display selected events received from the launch complex GFE equipment. Sixteen indicators are provided for PRELAUNCH MILESTONES, and 16 for MISSION MILESTONES.

3-271. CSM INDICATORS. Eight event indicators are provided to display the status of the CSM RF systems and eight to display CSM POWER status.

3-272. ECS EMERGENCY O_2 INDICATOR. (To be supplied.)

3-273. GO/HOLD STATUS INDICATORS. The split-legend GO/HOLD status indicators display the status received from the ACE-S/C consoles for the ECS, Instrumentation, and Aeromedical systems.

3-274. CONSOLE CONTROLS AND INDICATORS. The LAMP TEST pushbutton switch simultaneously lights all lamps on the panel for test purposes. The CONSOLE POWER indicator lights when power is applied to the console. The console TEMP ALARM lights when an overheat condition is present in the console.

3-275. ASSISTANT TEST CONDUCTOR CONSOLE OPERATION.

3-276. The Assistant Test Conductor shares the Test Conductor Console Status and Event Display Panel which, in addition to the common units previously described, contains units to display and control countdown time and an equipment power control.

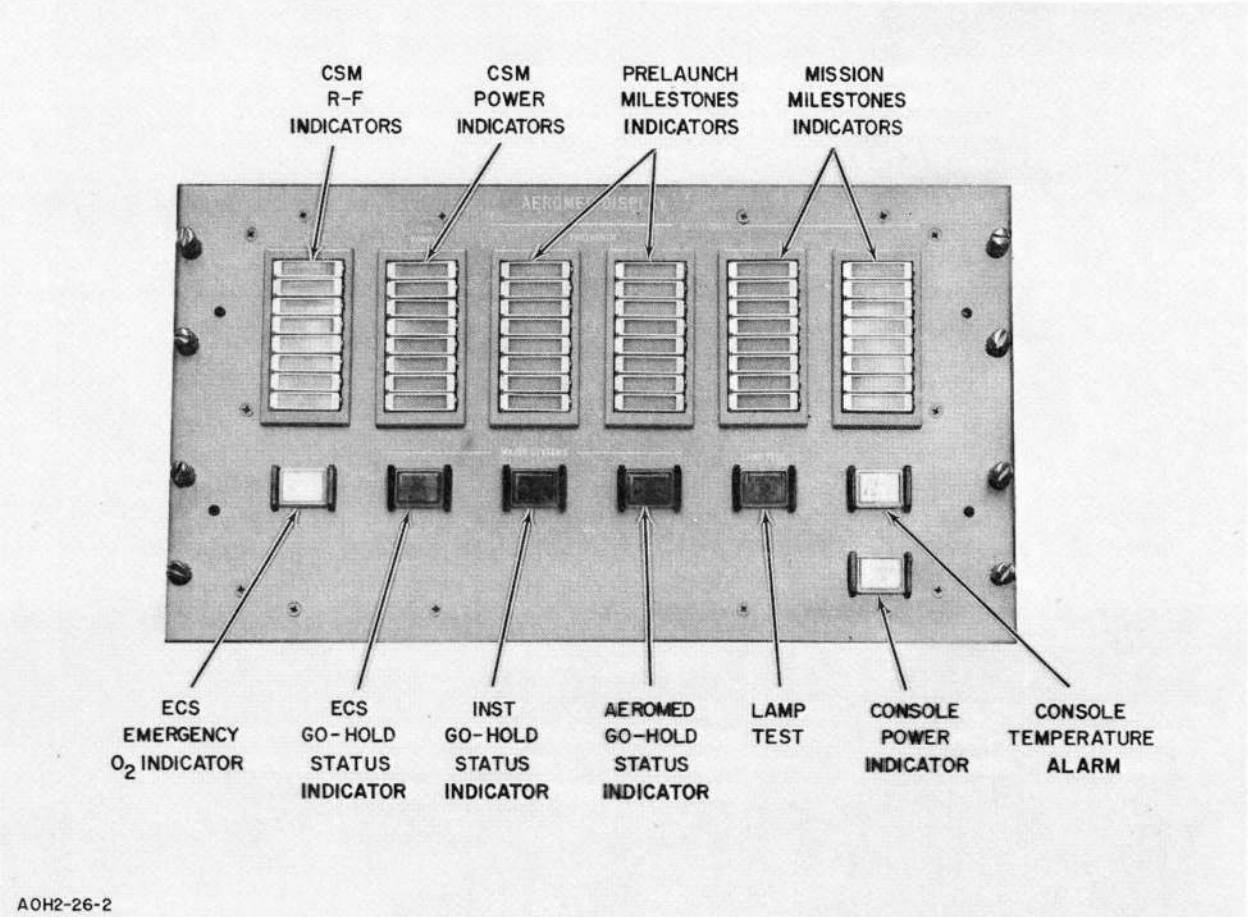


Figure 3-30. Aeromedical Display Panel

3-277. COUNTDOWN TIME DISPLAY PANEL.

3-278. The Range Countdown Time Display Panel consists of eight in-line decimal display indicators: one to indicate "+, " "-, " or H (HOLD); one to indicate days; two to indicate hours; two to indicate minutes, and two to indicate seconds. This panel indicates range countdown time from the GSE countdown time code generator.

3-279. COUNTDOWN TIME CONTROL PANEL OPERATION.

3-280. The Countdown Time Control Panel is used to control operation of the GSE timing equipment. The control panel contains eight thumbwheel START TIME set switches, a PRESET pushbutton switch to enter the start time, a COUNT HOLD pushbutton switch, and a COUNT RESUME pushbutton switch.

3-281. INDEPENDENT CLOCK OPERATION.

3-282. The independent clock (figure 3-31) provides a reference source of countdown time in the event that the main timing equipment is inoperative. This is a self-contained unit, and the only display provided is on the unit itself.

3-283. The independent clock control panel contains a time display, power and clock control switches. The operation of these controls and indicators is described in the following paragraphs.

3-284. COUNTDOWN TIME DISPLAY. The countdown time display consists of seven decimal, in-line indicators displaying countdown time in days, hours, minutes, and seconds.

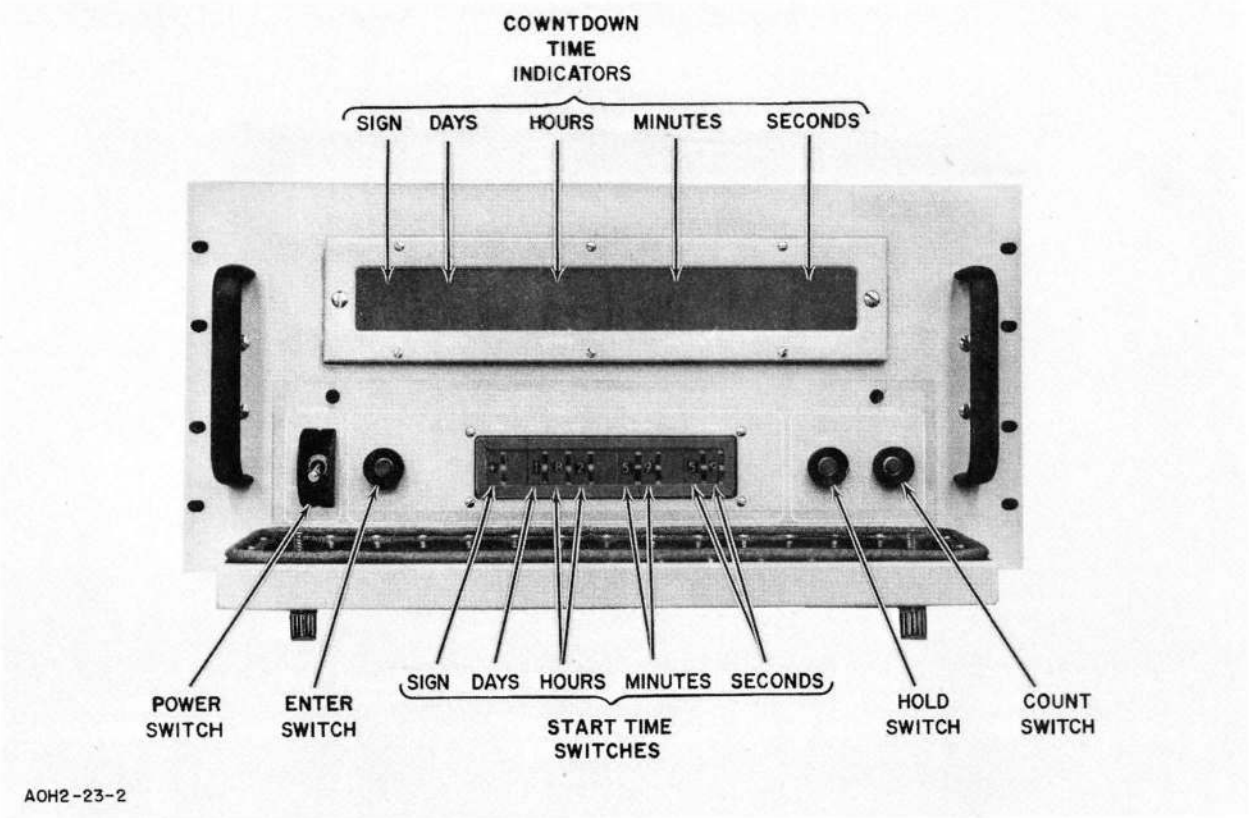


Figure 3-31. Independent Clock

3-285. An additional indicator, at the left-hand end of the display, provides an indication of "+," "–," or "H." The "+" indicates a count in the forward direction (away from zero), the "–" indicates a count in the reverse direction (toward zero), and the "H" indicates a hold condition.

3-286. POWER SWITCH. This switch controls the application of a-c power to the independent clock.

3-287. PRESET THUMBWHEEL SWITCHES. The eight thumbwheel switches provide the means of setting the independent clock to the start time from which the clock is to count. The switch on the left controls the direction of the count. A "+" causes the clock to count up from the preset time. A "–" causes the clock to count down from the preset time. The remaining seven switches select the start time in days, hours, minutes, and seconds.

3-288. ENTER SWITCH. The ENTER switch, when depressed, sets the clock counters and control circuits to the condition specified by the thumbwheel switches.

3-289. HOLD AND COUNT SWITCHES. Momentarily depressing the HOLD switch causes the clock to stop counting, and retain the time accumulated up to the time the switch was depressed. At this time, the "H" (HOLD) indicator on the time display lights in place of the "+" or "–" sign. The count may then be continued by momentarily depressing the COUNT switch.

3-290. POWER STATUS AND CONTROL PANEL OPERATION.

3-291. The Assistant Test Conductor Power Status and Control Panel (figure 3-32) provides controls for the application of power to various blockhouse units, and displays overtemperature warnings for selected equipment.

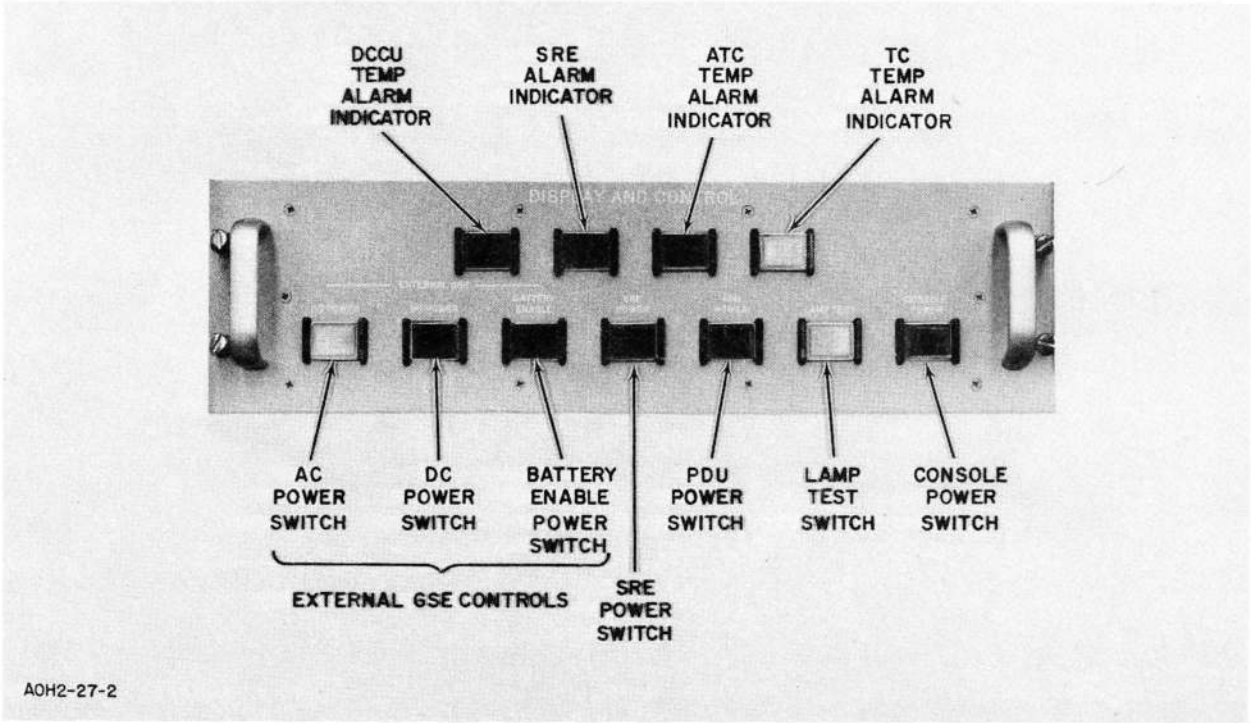


Figure 3-32. Power Status and Control Panel

3-292. POWER CONTROLS.

3-293. The power controls are alternate-action switch-indicators that light to indicate the application of power to the units with which they are associated.

3-294. CONSOLE POWER SWITCH. The CONSOLE POWER switch controls the application of power to the Test Conductor Console and the Assistant Test Conductor Console.

3-295. LAMP TEST SWITCH. The LAMP TEST switch simultaneously lights all lamps on the panel for confidence check purposes.

3-296. PDU POWER SWITCH. The PDU POWER switch controls the application of primary power to the power distribution unit.

3-297. SRE POWER SWITCH. The SRE POWER switch controls the application of power to the Signal Receiving Equipment.

3-298. EXTERNAL GSE CONTROLS. The EXTERNAL GSE switches control equipment located in the AGCS room at the launch pad.

3-299. TEMPERATURE ALARM INDICATORS. The temperature alarm indicators light when cabinet temperature, in the unit with which they are associated, exceeds normal limits.

3-300. ASTRONAUT COMMUNICATOR CONSOLE OPERATION.

3-301. The Astronaut Communicator Console contains indicators to enable the astronaut communicator to monitor astronaut-associated functions, and controls to supervise all communications with the flight crew during final countdown. In addition to the common units previously described, the Astronaut Communicator Console contains a GFE Astronaut Communication Panel and an Astronaut Communicator Display Panel.

3-302. ASTRONAUT COMMUNICATOR DISPLAY PANEL.

3-303. The Astronaut Communicator (Astrocom) Display Panel (figure 3-33) provides a display of selected milestones, RF event indications, and major system status indications.

In addition, controls and indicators associated with console power are located on this panel.

3-304. MILESTONES DISPLAY.

3-305. Sixteen indicators are provided to display selected PRELAUNCH events (MILESTONES), and 16 for overall MISSION MILESTONES. The signals to operate these indicators are received from the launch area GSE equipment.

3-306. RF INDICATORS.

3-307. The CSM RF and LEM RF event indicators display signals, received from the ACE-S/C stations, concerning the status of the various spacecraft communications systems.

3-308. MAJOR SYSTEMS INDICATORS.

3-309. The MAJOR SYSTEMS split-legend indicators display the summary GO/HOLD status of the CSM AEROMEDICAL and COMMunications, and LEM COMMunications systems. These signals are received from the status controls on the ACE-S/C systems consoles.

3-310. LAMP TEST SWITCH.

3-311. The LAMP TEST pushbutton switch simultaneously lights all indicators on the panel for confidence check purposes.

3-312. TEMPERATURE ALARM INDICATOR.

3-313. The TEMPerature ALARM indicator lights if the cabinet temperature rises beyond a predetermined limit.

3-314. CONSOLE POWER SWITCH.

3-315. The CONSOLE POWER alternate-action pushbutton switch controls application and removal of power from the Astrocommunication Console. The switch contains an indicator lamp that lights when power is applied to the console.

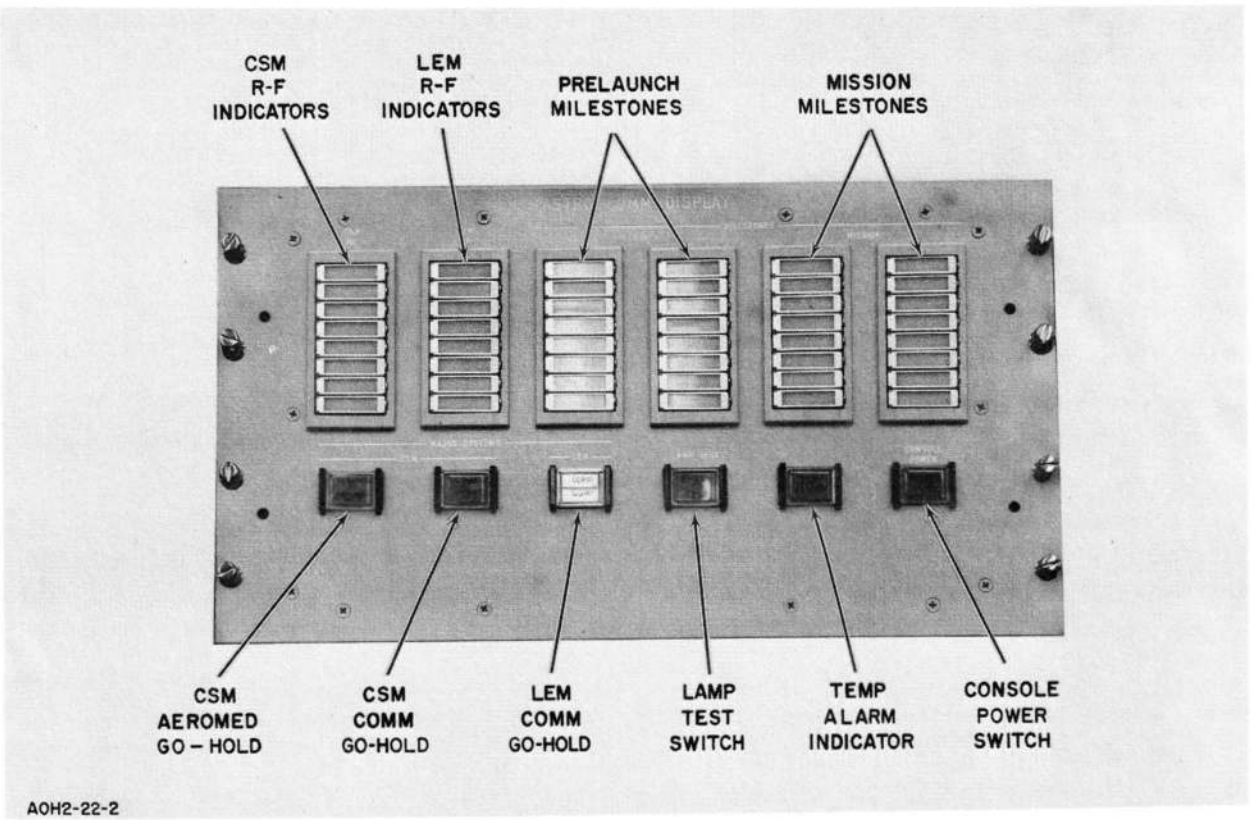


Figure 3-33. Astronaut Communicator Display Panel

Progress Is Our Most Important Product

GENERAL ELECTRIC