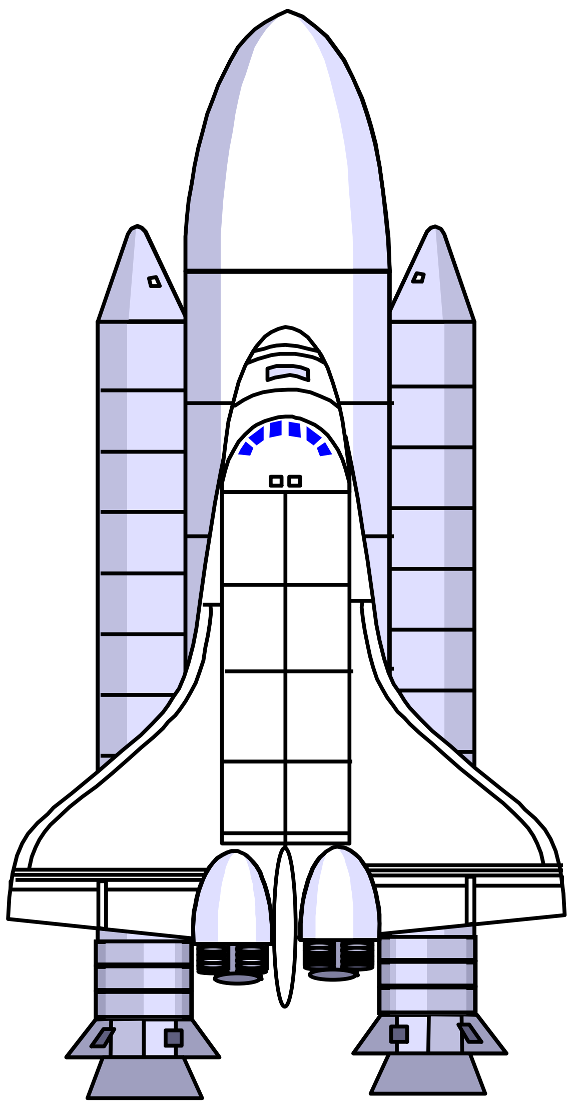
CARGO INTEGRATION TEST EQUIPMENT (CITE)

OVERVIEW MANUAL



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CARGO INTEGRATED TEST EQUIPMENT

1.1 INTRODUCTION

Cargo Integrated Test Equipment (CITE) simulates the interfaces between the space shuttle orbiter and the experiments in its cargo bay. CITE consists of a combination of hardware and software. The combination of the two is integrated to perform cargo to orbiter interface verification prior to the installation of cargo into the orbiter cargo bay.

Three CITE systems are in use at this time. The systems are located at the following sites:

- Horizontal Processing Facility (HPF)
- Vertical Processing Facility (VPF)
- Space Station Processing Facility (SSPF).

2.0 OVERVIEW

The purpose of CITE is to protect the shuttle turn around timelines and help maintain the shuttle launch schedules. The CITE system provides functional simulation of orbiter avionics and power interfaces to the payload elements in the prelaunch, ascent and on-orbit configurations. CITE is designed to do this by verifying electrical and mechanical compatibility with the orbiter and provide recovery time to repair incompatibilities. As sometimes more than one payload is carried on a flight, payload to payload compatibility is also verified.

Verification goals are summarized as follows:

- Verify cargo to orbiter interface
  - partial mechanical
  - electrical
- Verify Mission Kit compatibility with payload and orbiter
- Verify Airborne Support Equipment (ASE) compatibility with the Payload Specialist Station (PSS), The Mission Specialist Station (MSS) and the On-Orbit Station (OOS)
- Verify payload attach fittings
- Verify cable, fluid lines, and service panel connections
- Provide an Orbiter simulator to support interface testing for:
  - electrical
  - communications
  - instrumentation
- Provide capability to isolate electrical and mechanical incompatibilities
- Provide capability to support end to end testing (Payload Operations Control Center (POCC) to Cargo).
- Verify orbiter flight software compatibility with payload.

2.1 CITE SYSTEM DESCRIPTION

The CITE system includes the interface connections between the cargo and the space shuttle orbiter necessary to verify compatibility prior to orbiter mating. CITE is able to identify and resolve anomalies related to the interface between the cargo and the shuttle. If any interface anomalies are found to exist between the orbiter and a cargo, then the CITE system helps to resolve the anomaly before orbiter mating. Interface anomalies detected prior to orbiter mating in this off line manor allows the CITE system to protect the Shuttle timeline and minimize any possible impact to the shuttle turnaround schedule.

The three facilities that house CITE have major differences that make for unique capabilities. The major differences include payload orientation and the number of checkout cells at each site. In the HPF and the SSPF there is a single horizontal checkout cell while at the VPF there are two vertical checkout cells.

The VPF has an east and a west cell and both can accommodate vertical oriented payloads but only one payload can be tested at a time. In the SSPF there are eight test locations called Foot Prints (FPs) that the test stands can be moved to on air bearing pallets for testing. Two of the FPs are used for prelaunch and ascent and the other six for on-orbit configuration testing. The HPF houses Test Stand IV.

The HPF has one set of active orbiter simulation components and can only support an interface verification test in Test Stand IV. Test Stand IV consists of a Time Minus Zero (T-O) system that is available to the user to house his Ground Support Equipment (GSE) which supports his payload prior to launch. The CITE T-0 system also provides for early detection of interface problems.

The VPF has only one set of active orbiter simulation components, therefore, it can only support an active interface verification test in one cell at a time. The active components can be switched though the cell distribution panel to connect the active components to the cell with the active payload.

The SSPF has one set of active components and, therefore, can support an active interface verification test at only one FP at a time. The active components in the SSPF are mounted on a mobile Aft Flight Deck (AFD) stand that can be moved on air bearing pallets to mate with any of the FPs as required for the space station module or elements testing. The T-0 components are on a separate mobile stand (T-O Stand), but in most cases T-0 will only be required at FP #2 (Foot Print).

The SSPF CITE systems are designed to verify the Space Station launch package electrical and mechanical compatibility with the orbiter. The systems will provide functional simulation of the orbiter avionics and power interfaces to Space Station elements in the prelaunch, ascent, and on-orbiter configurations.

The SSPF system includes Shuttle Station provided Ground Support Equipment (GSE). The equipment consists of the orbiter interface unit (OIU), assembly power converter unit (APCU), remotely operated fluid umbilical (ROFU), and remotely operated electrical umbilical (ROEU).

2.1.1 TEST STANDS AND CONTROL ROOM

CITE is divided into two separate physical areas; the test stands and the control room. The test stands consist of the Structural/Mechanical (S/M) and Electrical/Electronic (E/E) components. The S/M components consist of the LPIS, AFD, and T-0 stands. The station number locations (Xo576 through Xo1307) represent, in inches, points along the X-axis from the noise of the Orbiter. The Xo576 station number is at the AFD bulkhead and the Xo1307 station number is at the T-O bulkhead. These station numbers are used to verify the following locations in the LPIS with those in the actual orbiter payload bay.

- Payload to orbiter envelopes
- Payload attach fittings
- Mission Kit compatibility with the Payload and orbiter
- Airborne Support Equipment (ASE) with AFD simulator
- Cables, fluid lines, and service panel connections.

The test stand S/M system simulates the orbiter cargo bay and AFD in the VPF, HPF, and SSPF. Each facility supports simulation with the AFD assemblies and the Standard Mixed Cargo Harness (SMCH). The HPF has a Payload Heat Exchanger Simulator (PHES).

There are two separate CITE control rooms: one located in the HPF and the other located in the SSPF. The SSPF control room interfaces with the VPF and the FPs in the SSPF lowbay, along with the Launch Processing System (LPS) Central Data System (CDS). The HPF control room interfaces with Test Stand IV and the VPF along with the Launch Processing System (LPS) Central Data System(CDS). CDS provides the CITE control room computers a large host computer to store GOAL programs and skeletons. The CDS also reduces the need for test stand hardware and simulation devices since it has the capability to simulate test stand hardware and cargo to be tested.

When payloads are integrated with the LPS and Control, Checkout and Monitor Subsystem (CCMS) hardware, specially developed software and microcode allow the CITE user to execute GOAL procedures in a firing room type environment. The control room, when integrated with the horizontal, vertical or space station test stands equipment, allows a computer controlled automated simulation of the orbiter and cargo bay interfaces.

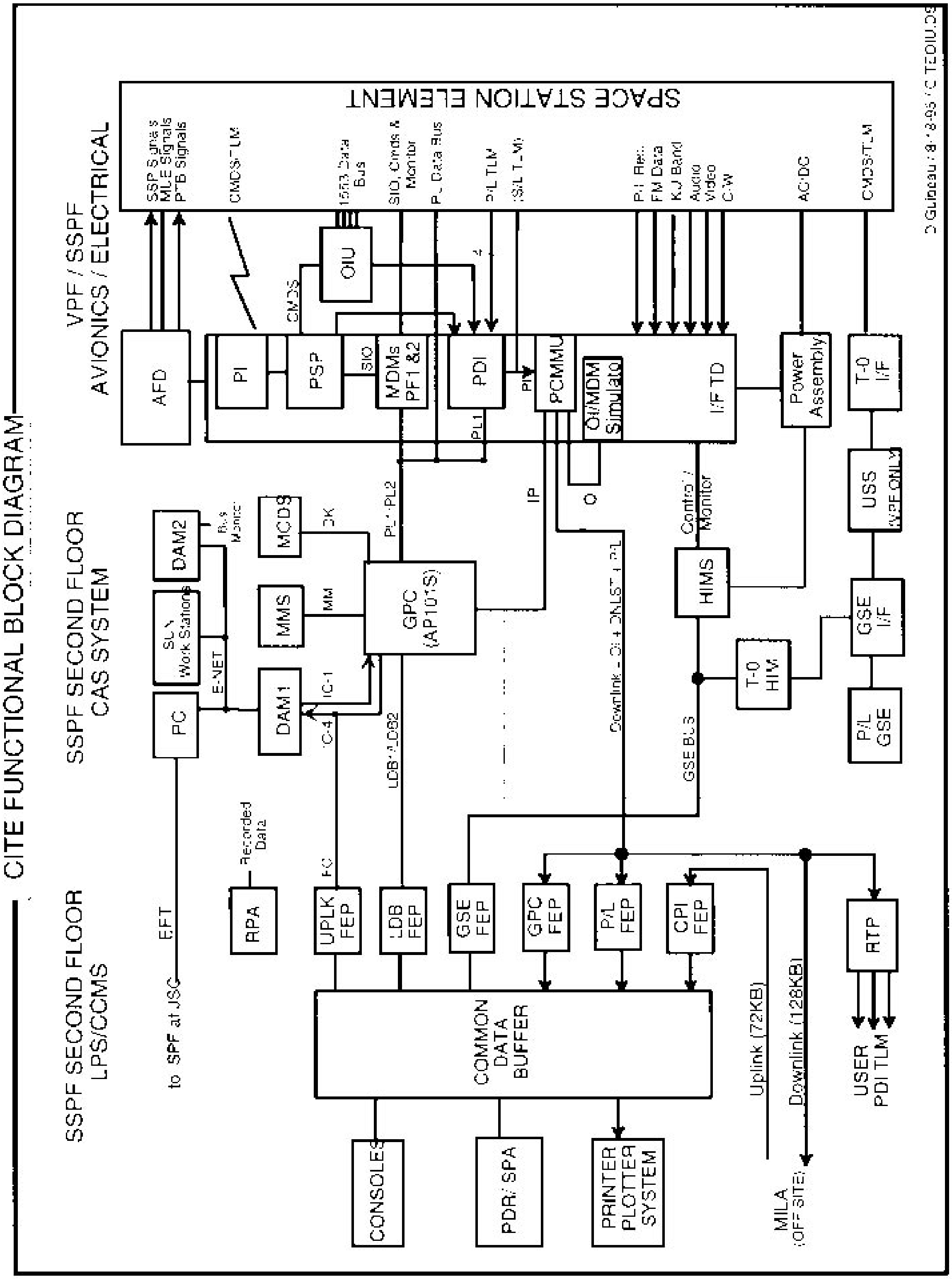
The CITE Electrical/Electronic (E/E) system is capable of interfacing with other systems. This capability allows it to perform its role as an orbiter simulator. The CITE Augmentation System (CAS) General Purpose Computer (GPC) provides the execution of actual orbiter GPC flight software. To allow operations with the GPC/CAS the Interface

Terminal Distributor (I/F TD) is used. The I/F TD allows payloads to directly access their own audio, video and high rate scientific data. This enables them to provide analysis on user provided GSE at various interface points.

The Aft Flight Deck (AFD) simulator provides a working platform and support for the Payload Specialist, On-Orbit Specialist, and Mission Specialist consoles and electrical interface panels equivalent to those found on the orbiter.

The Launch Package Integration Stand (LPIS) in the SSPF simulates the orbiter cargo bay and has cables installed in orbiter type cable trays. The LPIS also provides structural support to achieve final launch configuration and preparation of elements and payloads prior to installation into the payload canister.

The Time Minus Zero (T-0) Interface Equipment provides simulation of the equipment used in the Mobile Launch Platform (MLP) at the Pad to interface user GSE with a payload through the T-0 umbilical.


CITE FUNCTIONAL BLOCK DIAGRAM
SSPF SECOND FLOOR LPS/CCMS
SSPF SECOND FLOOR CAS SYSTEM
VPF / SSPF AVIONICS / ELECTRICAL
SPACE STATION ELEMENT
SSP Signals
MLE Signals
PTB Signals
CMDS/TLM
1553 Data Bus
SIO Cmds & Monitor
P/L TLM
AC/DC
FM Data
Audio
Video
C/W
AFD
PI
PSP
SIO
CMDS
OIU
MDMs PF1 &2
PDI
PCMMU
OI/MDM Simulator
I/F TD
Power Assembly
T-0 I/F
USS (VPF ONLY)
HIMS
Control / Monitor
T-0 HIM
GSE I/F
P/L GSE
GSE BUS
PL1
IP
PL1/PL2
GPC (AP101S)
MMS
MM
MCDS
DK
DAM2
DAM1
IC-1
IC-4
E-NET
PC
LDB1/LDB2
Downlink
EFT
to SPF at JSC
Recorded Data
RPA
UPLK FEP
LDB FEP
GSE FEP
GPC FEP
P/L FEP
CPI FEP
RTP
COMMON DATA BUFFER
CONSOLES
PDR/SPA
PRINTER PLOTTER SYSTEM
Uplink (72KB)
Downlink (128KB)
MILA (OFF SITE)
USER PDI TLM

2.1.2 HORIZONTAL PROCESSING FACILITY

The Horizontal Processing System (HPF) is located in the Operations and Checkout Building (O&C). Test Stand IV is located on the first floor of the O&C with the control room located on the third floor in room 3237. The HPF is designed to check out payloads in the horizontal position. Most payloads checked out in the HPF are either Spacelab or Spacelab type.

In the HPF all cargo to orbiter interface testing is route through the control room equipment along with the Hardware Interface Module (HIM).

Interface verification testing for HPF is performed automatically through the control room equipment along with the HIMs at the test stand.

System operations in the HPF utilize Launch Processing System (LPS) GOAL software, CCMS hardware and CITE hardware. The payloads ability to properly interface with the orbiter is verified through the utilization of this software and hardware.

2.1.3 VERTICAL PROCESSING FACILITY

The Vertical Processing Facility (VPF) is designed to test payloads in an upright position with noise up and keel out. There are two test stand cells in the VPF an east cell and a west cell. Each cell may contain a payload but only one payload can be tested at a time.

Equipment in the VPF is installed at various highest. The AFD is located on the 75 foot level, the I/F TD, the HIMS and the V&DA are located at the 65 foot level, with the Power Supply Assembly (PSA) located on the 55 foot level.

In the VPF test stand timing signals except for the 1024 kHz and the 4.608 MHz are routed onto a single composite signal in the control room V&DA and then sent to the test stand. The V&DA demultiplexes the timing signals and then sends them to the Master Timing Unit (MTU) I/F Assembly in the I/F TD. One of the exceptions the 1024 kHz is split in the V&DA to provide two inputs to the MTU I/F Assembly.

Interface verification testing for VPF is performed automatically through the control room equipment along with the HIMs at the AFD stand.

2.1.4 SPACE STATION PROCESSING FACILITY

The Space Station Processing Facility (SSPF) provides for the testing of Space Station elements and experiments to ensure interface verification testing. In the SSPF there are eight Foot Prints (FPs) and at each FPs is a pedestal that provides a patching interface to CITE. Each pedestal also contains patches for the Operational

Intercommunication System, Digital (OIS-D), Close Circuit Television (CCTV) and Timing and Countdown (T&CD) for the AFD stand.

Interface verification testing for SSPF is performed automatically through the control room equipment along with the HIMs at the AFD stand.

3.0 Interface Terminal Distribution Equipment

The Interface Terminal Distributor (I/F TD) Assembly is a major element in the CITE system. I/F TD interfaces with several major elements in the system. These elements include:

- Launch Processing System/Checkout, Control and Monitoring Subsystem (LPS/CCMS)
- Power Supply Assembly (PSA)
- Aft Flight Deck (AFD) distribution panels
- General Purpose Computer/CITE Augmentation System (GPC/CAS)
- Cargo Bay payload interfaces.

These major elements along with the I/F TD provide the capability to validate individual orbiter to payload interfaces.

The I/F TD equipment is located at the test stand IV location in the O&C Building. On the 65 foot level in the VPF and the AFD stand in the SSPF Lowbay. I/F TD equipment supports both payload processing and space station elements.

The purpose of the I/F TD is to provide an electronic interface with a payload that duplicates the actual orbiter interface. This provides a central point where critical CITE payload signals are monitored with test equipment. The signal selected can also be patched for recording and certain signal paths can be rerouted to change the configuration setup. The I/F TD can also condition signals to duplicate the cargo and orbiter interface characteristics.

Simulation of payload interfaces provided through the I/F TD include:

- signal conditioning for external signals
- mounting provisions for the flight or flight type avionics units
- characteristic loads for payload signals when avionics or simulated avionics are not provided
- simulating portions of the Orbiter subsystems that interface with a payload
- provisions for routing of signals to orbiter avionics simulation equipment

The I/F TD houses two MDMs, a PCMMU, a Payload Data Interleaver (PDI), a Payload Signal Processor (PSP) and a Payload Interrogator (PI). The I/F TD provides monitor patch panels for the remote control, the remote monitor, the power and the signals between the cargo and these avionics units. Additionally, it provides a patch panel for the patching of CCTV to room 1263 in the O&C building.

The Orbiters Caution and Warning (C&W) functions applicable to payloads are simulated in the I/F TD along with the panel monitor/patch points test points for all signals that interface with the cargo.

The data buses are routed through the patch panels in the I/F TD to provide the ability to configure the data busses for operation with the General Purpose Computer (GPC). The I/F TD provides the routing and Data Bus Couplers (DBCs) required for the data bus interfaces with the avionics contained within the I/F TD. Front panel patch points with DBCs for isolation allow for the monitoring and troubleshooting of data bus traffic.

The I/F TD provides the interfaces needed to support the CAS that simulates the Orbiter Data Processing System (DPS). Interfaces in the patch panels also provide the capability for routing audio, video and KU-Band scientific data to the user's ground support equipment (GSE).

The I/F TD provides front panel monitoring and patching for the following mission unique signals:

- Payload T-0 GSE signals are split at the Payload GSE I/F distributor and routed to the I/F TD
- Remote Manipulator System (RMS), the orbiter robotic arm, signals are routed through the I/F TD
- Payload scientific data signals are routed to the I/F TD. Scientific signals include KU-band signal processor, FM signal processor and the payload recorder interfaces.

The fourteen isolation amplifiers in the I/F TD with their output signals are routed to the V&DA where they are then patched to the Record and Playback Assembly (RPA) or data processors. The inputs to the I/F TD isolation amplifiers are from the front patch points.

The I/F TD receives Master Timing Unit (MTU) Subassembly signals from the V&DA and the Wide Band Terminal (WBT) interface. These timing signals are provided with monitoring points and routed to the cargo interfaces and the CITE avionics as required. The I/F TD MTU conditions the signals to be identical to the outputs of an orbiter MTU assembly. These signals are then routed to the Payload Timing Buffer (PTB) in the AFD, the Data Acquisition System (GPC/CAS), avionics within the I/F TD, and the cargo interfaces.

The I/F TD consists of five separate racks and includes mounted test equipment. The test equipment includes a digital voltmeter, a bit synchronizer and an oscilloscope for the monitoring, testing and troubleshooting of general purpose signals.

The contents of the racks are as follows:

Rack 1
- Data Bus Audio Patch Panel
- Caution and Warning Monitor Panel
- Caution and Warning Assembly
- Two Multiplexer/Demultiplexers (MDMs)
- MDM-PF 1 Monitor Panel & Data Bus Monitor Panel
- MDM-PF 2 Monitor Panel
- Six Data Bus Couplers
- AC Power Panel
- Blower Assembly

Rack 2
- Video Monitor/Patch Panel
- Digital Voltmeter
- Oscilloscope
- Mission Unique Monitor Panels
- RMS monitor Assembly
- Blower Assembly

Rack 3
- Two Jumper Patch Panels
- Scientific Data Monitor/Patch Panel
- Bit Synchronizer
- Bit Synchronizer Patch Panel
- Payload Data Interleave (PDI)
- PDI Monitor/Patch Panel
- PCM Master Unit
- PCMMU Monitor/Patch Panel
- Seven Data Bus Couplers
- HIM Spare Patch Panels
- AC Power Panel
- Blower Assembly
- Data Bus Patch Panel
- OI MDM Simulator

Rack 4
- Two Jumper Patch Panels
- MTU Interface Subassembly
- Isolation Amplifier Subassembly
- Xo1307/GSE I/F Monitor/Patch Panel
- Blower Subassembly

Rack 5

- Two Jumper Patch Panels
- Payload Signal Processor
- PSP Monitor/Patch Panel
- Payload Interrogator
- PI Monitor/Patch Panel
- AC Power Panel
- Blower Assembly

3.1 MULTIPLEXER/DEMULTIPLEXER

Two flight like Multiplexer/Demultiplexers (MDMs) are located in RACK 1 of the I/F TD. The I/F TD routes signals between the payload MDMs (Payload Forward (PF) MDMs, PF1 and 2) and the payload. MDMs usually interface with the payload so signal conditioning of the signal between the MDMs and the payload is unnecessary. The MDMs support the orbiter to MDM signal requirements. The MDMs in Rack 1 interface the Guidance, Navigation and Control (GN&C) signals and other analog and digital signals. Monitor panels between the payload interface and the MDMs provide the capability for signal evaluation and troubleshooting.

The MDMs require the I/F TD to route a serial I/O channel from the MDM PF1 to the Payload Signal Processor (PSP). Power required by the MDMs comes through the I/F TD from the Power Supply Assembly (PSA). This power supplies both the MDM on/off indicators and the monitoring points. On the front panel of the I/F TD, a monitoring point for each MDM signal passing through is available.

The I/F TD provides cooling for the two MDMs in Rack 1. The cooling allows for proper operation of the MDMs. To ensure cooling is taking place, a vane sensor is located at the out flow of the blower and a 5 VDC indication is provided to the HIM P/P.

Communication between CITE and the MDMs in I/F TD Rack 1 is accomplished with the use of six Data Bus Couplers (DBC) and a Data Bus Monitor Panel. The Data Bus Monitor Panel allows isolation point testing and the capability to monitor or record the data buses.

3.2 PULSE CODE MODULATION MASTER UNIT

The Pulse Code Modulation Master Unit (PCMMU) is housed in the I/F TD Rack 3. There is only one PCMMU at each of the different CITE systems. The PCMMU interfaces with four of the Orbiter Subsystems: Operational Instrumentation, Payload Instrumentation, Computers and Communications. In addition, the PCMMU interfaces with the power subsystem and performs the following functions:

- Collects and stores Orbiter subsystems data
- Collects and stores payload data

- Provides data to Orbiter computers
- Accepts computer data and provides temporary storage
- Provides flexible telemetry format control
- Assembles and outputs (downlink) telemetry data signals

Data is provide to the PCMMU by the Operational Instrumentation Mutliplexer Demutliplexer (OI/MDM) over the Operational Instrumentation (OI) data bus at a 1 MHz rate. The bus provides response data to the MDM interrogation commands issued by the PCMMU OI fetch memory. To provide data bus compatibility, a Singer Blue Dot Series #2 Multiplexer Interface Adapter (MIA) is used for connection.

The PCMMU has a variety of interfaces that include timing signals, data busses, hard line status and telemetry output. The front patch jacks allow for signal monitoring and/or patching of these signals. The PCMMU outputs these reference timing signals at 100 Hz, 1 Hz and 1.52 MHz. The 1.52 MHz is used to keep the Payload Data Interleaver (PDI) in sync with the PCMMU. The PCMMU itself requires a 4.68 MHz timing signal for proper operation. The PCMMU receives this operating signal from the Master Timing Unit (MTU) Interface Assembly located in I/F TD Rack 4. The timing signal front panel jacks provide monitoring and patching of timing signals.

The PCMMU has three data buses the OI, PI1 and PI2, and computer data bus that has monitoring and patching capabilities. The OI bus is routed from the PCMMU to the data bus patch panel and is patch into the OI MDM Simulator. The Payload Interrogator (PI) busses then linked the PCMMU to the PDI and/or a payload. The PCMMU uses this bus to poll for payload data. The patch panel provides for the ability to allow the patching of either the PI1 or PI2 data buses. The computer data bus is the commanding and controlling bus. The computer data bus is routed from the PCMMU to the data bus patch panels and the bus is controlled by CAS.

The PCMMU has status and control hardwire interfaces. These signals are routed to the HIM through the HIM Patch Distributor.

The PCMMU can output two telemetry streams: 64 KBPS and 128 KBPS. These telemetry signals are usually routed to the PCM FEPs in the CITE. The PCMMU monitor and patch panel have the capability to patch the PCMMU telemetry data outputs to the PCM FEPs through the V&DA.

The PCMMU provides the capability in conjunction with GSE, if required, to isolate any discrepancies in malfunctioning Line Replacement Units (LRUs) or onboard verification of LRUs functional performance after installation.

3.3 PAYLOAD DATA INTERLEAVER

The Payload Data Interleaver (PDI) provides a major interface for payload telemetry data with the Orbiter. The PDI has the capacity to accept up to five telemetry data streams from the cargo interface at the Payload Station Distribution Panel (PSDP) for attached payloads and one data stream from the PSP for detached payloads. The telemetry stream formats can be either Bi-Phase or NRZ (Non Return to Zero) with clock.
A switching matrix along with four bit sync/decoms within the PDI allow for the processing of up to four of the six telemetry data streams at any given time. The I/F TD Rack 3 houses the PDI.

The PDI Monitor/Patch Panel provides the capability to patch any or all of the six payload telemetry streams to any or all of the seven PDI inputs. The PDI Monitor/Patch Panel can also patch one of the Payload Signal Processor (PSP) telemetry streams to one of the PDI seven inputs. The Patch Panel also includes the provision for monitoring PDI power and the required Greenwich Mean Time (GMT) timing signals.

The PDI is provide with PCMMU timing signals, PSP Pulse Code Modulation (PCM) and five payload PCM data streams through the I/F TD PDI Interface. The PCM data stream can consist of any of the following:

- NRZ-L with Bit Rate Clock
- NRZ-M with Bit Rate Clock
- NRZ-S with Bit Rate Clock
- Bi∅-L
- Bi∅-M
- Bi∅-S

The PCM input date rate is from 10 BPS to 64 BPS at each of the inputs.

3.4 PAYLOAD TIMING BUFFER

The Payload Timing Buffer (PTB) is located in the Payload Station Distribution Panel. The PTB distributes IRIG-B (Modified Greenwich Mean Time and Mission Elapsed Time) to selected Orbiter subsystems and attached payloads. The PTB is a buffer amplifier for each of the two IRIG-B timing signals from the Shuttle Orbiter Master Timing Unit (MTU). The PTB provides 12 isolated outputs, of which, 8 outputs are of Greenwich Mean Time (GMT) and 4 outputs are of Mission Elapsed Time (MET), to selected Orbiter subsystems and payloads. The PTB buffers both signal and provides isolated phased timing outputs identical to the received signals.

The PTB interfaces with the MTU, Frequency Division Multiplexer and payloads. The IRIG-B (GMT and MET) distributed by the PTB is generated by the MTU.

3.5 PAYLOAD SIGNAL PROCESSOR

The Payload Signal Processor (PSP) provides the major interface for the payload command data with the Orbiter. The PSP can output up to five command streams to the cargo interface for attached payloads and one command stream to the Payload Interrogator (PI) for detached payloads. PSP command streams are digital data on a 16 kHz subcarrier. The PSP also accepts telemetry data from the PI for detached payloads and removes the subcarrier and forwards the digital data to the PDI.

The PSP sends PCM data streams to the PDI in NRZ-L format with a Bit Clock Rate. The PDI will however accept any one of the following: NRZ-L with Bit Rate Clock, NRZ-M with Bit Clock Rate, NRZ-S with Bit Clock Rate, Bi∅-L, Bi∅-M or Bi∅-S. The I/F TD routes MDM serial command data from the MDM to the PSP. The MDM serial command data consists of configuration and payload command messages from the General Purpose Computer (GPC). The MDM signal can be monitored at the front panel. The I/F TD also routes payload command data from the PSP to the front panel where it can then be patch to either of the two payload interfaces, PSP1 or PSP2. The I/F TD routes payload command data (PSP/PI) from the PSP to the PI.

The Master Timing Unit (MTU) provides timing (1.024 MHz) for the PSP through the I/F TD and the PSP generates timing signals. The I/F TD routes the PSP control input and discrete output signals to the HIM through the HIM Patch Distributor.

The PSP has both telemetry and command interfaces with the PI. The PSP receives from the PI a 1.024 MHz subcarrier Phase Shift Keyed (PSK) modulated by the payload telemetry data. The PSP transmits a 16 kHz sinewave subcarrier unmodulated or PSK modulated by the payload command data or idle pattern to the Payload (P/L) Interrogator.

The PSP sends telemetry data to the PDI in PCM data and bit rate clock format. The PSP provides NRZ-L telemetry data and its clock to the PDI.

Data and control signals are sent to the PSP from the payload MDM serial I/O channel. The MDM serial digital data is half duplex, self clocking Bi-Phase-L transformer coupled at a one Megabit rate.

3.6 PAYLOAD INTERROGATOR

The Payload Interrogator (PI) provides the major interface for communications between the Orbiter and a detached payload, both for telemetry and commands. The PI consists of transmitters, receivers, radio frequency (RF) devices and control modules necessary for non-simulation operation in the Spacecraft Tracking and Data Network (STDN), Deep Space Network (DSN) or Space Ground Link System (SGLS) modes. The STDN and SGLS modes provide for duplex communication with STDN and SGLS compatible payloads, with the DSN mode providing duplex and simplex communications for selected RF links. The PI is capable of simultaneous transmission of commands to and reception of telemetry from a DSN and STDN compatible transponder equipped payload.

The PI sends a 1.024 MHz subcarrier PSK modulated signal by the payload telemetry data to the PSP. The PI sends the signal to the PSP for timing of the telemetry commands. The PI also receives payload commands and idle commands from the PSP. The PSP transmits the commands with a 16 kHz sinewave subcarrier unmodulated or a PSK modulated signal by payload command data. The 16 kHz signal allows for carrier phase modulation and transmission to STDN and DSN compatible payloads.

The PI provides capable operation with both S-band or Ku-band. The PI can send/receive S-band modulated or unmodulated RF from the Payload Antenna. While the PI provides demodulated digital or analog telemetry only through the Ku-band Signal Processor.

3.7 MISSION UNIQUE CABLING

Mission Unique Equipment consist of both hardware and cables. Mission Unique Cables can be constructed to interface between the SMCH and Orbiter, the Standard Interface Panels (SIPs) and the payload interfaces, T-0 GSE and payload or the AFD and SIPs. The cables can be built by JSC, Lockheed, Rockwell, MDSS or the users.

3.8 CAUTION AND WARNING

A Caution and Warning (C&W) Assembly and C&W monitor panel located in Rack 1 provide a way to evaluate the C&W interface of the payload. The C&W Assembly simulates the payload portion of the orbiter C&W function. The C&W Assembly also performs active monitoring and manual safe/active control of a payload. CITE is able to accept and generate all selected Orbiter C&W signals that are payload related.

The C&W Assembly monitors specific predetermined input signals from the cargo and provides Safing commands to the cargo. The C&W Assembly only accepts two types of inputs: analog and discrete signals and provides positive discrete outputs. The C&W Assembly contains the ability to process the payload signals and respond with audible tones and signals to any payload and to the C&W front panel. The C&W also provides an audio tone at the front panel speaker that indicates the type of anomaly detected. The C&W Assembly also is capable of manually Safing the cargo either locally or remotely (the SSPF does have a connection to the control room safing panel). The C&W assembly routes the C&W signals between the C&W assembly, the Payload interfaces and other CITE interfaces.

The Safing command function provides five different Safe/Active commands to the cargo interface in the HPF and the VPF. The payload provides a voltage usually 28 V that can switch to either the Safing output or the Active output depending on the position of the switches at the C&W Assembly and Safing Panel. The C&W Assembly can switch up to 8.5 amps to the payload and provide an isolated 5 V discrete interface to the HIM Patch Panel to monitor the status of the five redundant interfaces. The payload Safing function is designed so that either CITE location can safe the payload, but both locations must be used to activate the payload. The Safing function is designed such that the power off condition or a system failure will route the payload voltage to the Safing output. In the SSPF CITE the Safing Panel will not be connected in the Control Room.

The C&W Assembly provides functional interfaces to the Klaxon Functional Area, System Status Functional Area, Master Alarm Functional Area, Tone Functional Area and the Siren Functional Area.

4.0 POWER SUPPLY ASSEMBLY

The Power Supply Assembly (PSA) provides simulated Orbiter electrical power to cargo interfaces and selected shuttle avionics assemblies located within the I/F TD. The CITE PSA is capable of providing peak power continuously which is sufficient for the Orbiter requirements of 7kW of DC power continuously (12kW peak) and .69 kW of AC power continuously (1kW peak) in support of payload interface verification. The PSA is located at the level 4 test stand in the HPF, on the 55 foot level in the VPF and on the AFD at the SSPF.

Payload power is provided to Xo576, Xo645, Xo1307, RMS and Retention System Power (RSP) interfaces. The purpose is to provide simulated orbiter electrical power to the cargo undergoing checkout. AC power is provided to the AFD and the Xo576 interfaces through mission kits. DC power is provided to Xo576, Xo1307 and AFD interfaces.

The remote control and monitoring of the PSA and its output are controlled through the GSE type I FEP located in the CITE Control Room. The GSE FEP provides for the determination of power drawn by a payload and provides the capability to control the PSA so that a specific output could, under software control, react to payload changes similar to an Orbiter fuel cell. The GSE FEP uses the monitoring and output capabilities of the HIM through the HIM P/P to accomplish the control and monitoring.

The Facility Power Distributor accepts prime power from the facility, provides circuit breaker protection and distributes prime power to the AC & DC power supplies. Input power to the AC and DC supplies is controlled either locally, by front panel switches and circuit breakers, or remotely through the HIM P/P interface. The DC power supplies convert the facility prime power into 28V DC power for use by the payload and avionics assemblies. The HIM interface controls the voltage of the supplies and monitors the load parameters in order to simulate an Orbiter fuel cell and to determine payload user power usage for the CITE. The AC power converter converts the facility prime power into three phase, 400 Hz, 115/200 VAC power for use by the payload panels in the AFD. The DC power Distribution and Control function distributes and controls DC power to the Cargo, the AFD and the avionics. The Retention System Power (RSP) Control and Monitor function distributes 400 Hz, 3∅, 115 VAC and 28 VDC to latch power outlets in the payload bay.

The Power Supply Assembly consists of the following racks of equipment:

- AC Power Distribution Rack
- DC Power Distribution Rack
- Two modified Sorensen DC Power Supplies

The subassemblies contained in the racks are listed below:

AC Power Distribution Rack subassemblies:

- AC Power Distribution and Control Panel
- Facility Power Distribution Panel
- Retention System Power Control and Monitor Panel
- One UNITRON AC Frequency (AC Power Supply)

DC Power Supply Subassemblies:

- PS1 Power Distribution and Control Panel
- PS2 Power Distribution
- PS2 Extended Distribution and Control Panel
- PS3 28 Volt Control Voltage Power Supply

Two Sorensen DC Power supplies and filters.

The DC Power Supplies are two modified standard Sorensen DC supplies. The modification to the Sorensen DC supplies include the addition of a 2 farad filter to reduce transient affects and ripple in the DC power system. Each of the supplies is capable of providing up to 500 amps at 28 VDC, has remote sensing capability and is remotely programmable.

The Power Supply 1 (PS1) Power Distribution and Control Panel is located in the DC Power Distribution rack. The output of PS1 is distributed to the Xo645 bulkhead primary payload bus interface through this panel and provides up to 7kW of continuous power to the cargo interface. The PS1 power kill function operates when 28 volts is applied to Xo645 J37. The DC return is tied to the isolated ground bus in the DC rack.

The PS2 DC Power Distribution and Control Panel is located in the DC Power Distribution rack. The output of PS2 is distributed to CITE interfaces through this panel and to the I/F TD. The DC return is tied to the isolated ground bus in the DC rack.

The elapse timer is activated when the 208 VAC circuit breaker is positioned on at the Facility Power Distribution Panel, the Control Voltage Supply is on and the AC Power is activated by the HIM command, front panel switch on the PS2 Power Distribution and Control Panel (local control mode only).

The PS2 Extended Distribution and Control Panel is located in the DC Power Distribution Rack. This panel contains an extension of the PS2 Power Bus from the PS2 Power Distribution and Control Assembly. Control and monitor of the Remote Manipulator System (RMS) power and control of the Retention System Power (RSP) DC status Excitation Voltage is provided in this assembly. The RSP DC status Excitation to the AC rack can only be controlled from the PS2 Extended Distribution and Control Front Panel.

The DC voltage for the RMS function is distributed to the RMS monitor panel in rack 2 of the I/F TD.

The Control Voltage Power Supply PS3 is a standard Lambda power supply rated at 6 amps. The power supply is normally adjusted to 28 VDC for relay control operation. The Control Voltage Supply supplies the voltage to operate relays in the PS1 and PS2 Power Distribution and Control panels as well as relays and lamps in the AC power Distribution and Control panel and RSP panel. The DC return is tied to the isolated ground bus in the DC rack.

The AC Power Distribution Subassemblies provide the following capabilities.

- The remote control of the power interfaces and the AC power supplies from the control Room assemblies through the HIM interface.
- Isolation of the different power interfaces to prevent out of limits conditions in one area from affecting other areas.
- Voltage and current monitoring to the CITE Control Room assemblies through the HIM interface for all power interfaces except RSP.
- Analog and discrete indications of the voltage and current parameters from the 400 Hz AC power to the Control Room.
- No single failure in a load or succession of propagation of failures in a load will cause an out of limit condition to exist.
- Circuit breakers protection is provided for all interfaces to the cargo.
- Supply 115 VAC, 3∅, 400 Hz power to 1 through 5 or 1 through 12, Retention Systems Power interfaces.
- Provide phase sequencing to reverse motor operations for the Retention System Power Interfaces.

The Single Unitron AC converter provides both AC power and RSP power.

The AC power converter provides 5000 VoltAmps (VA) continuously at 115/208 volts RMS, 400 Hz, 3 phase.

The AC Distribution and Control panel is located in the AC Power Distribution rack. The output of the AC converter is distributed to the AFD through the AC power bus systems, AC2 and AC3. Each bus is capable of providing 690 VA continuously (1000VA peak). The time limitation of the peak power is a maximum of 2 minutes every two hours (per Orbiter criteria). AC3 is provided directly to the Xo576 bulkhead and both AC2 and AC3 can be provided to orbiter Xo576 interfaces by using mission kit harness at the Mission Station Distribution Panel (MSDP). The AC neutral is tied to the isolated ground bus in the AC rack.

The AC Power Distribution and Control panel provides the capacity for commanding the AC converter on or off, commanding it to supply an AC output or to discontinue the AC output and provide voltage and current indications to the HIM Assembly through the HIM patch distributor. These remote control features are executable locally from the front of the AC Control and distribution rack by substituting a blind plug instead of the HIM patch panel cables.

In addition to the AC 400 Hz available at the AFD, AC 400 Hz power is also extended from the AFD to Cargo bay interfaces.

The RSP Control and Monitor panel is located in the AC power Distribution rack. The output of the RSP AC converter is distributed to the payload bay interfaces through two AC power bus systems, system 1 and system 2. Each of these systems has a 3 amp breaker protection.

The RSP Control and Monitor Panel provides manual switch control for the AC power, phase sequencing and the DC excitation voltage. There are no remote control capabilities for the retention system power. However, remote power monitoring is provided for any of the two combinations of the five retention systems by the RSP Monitor Assembly. The RSP Monitor Assembly is connected in line with the RSP Control and Monitor panel in the AC I/F TD rack and connected through monitor points to the spare HIM functions on Rack 3 I/F TD.

The 2 amp circuit breaker protection for each DC excitation interface is also provided through the RSP Control and Monitor panel. The RSP Control and Monitor Panel provide test points for monitoring the AC power being sent to the Payload Bay interfaces and the 28 VDC status signals returned from the cargo. In addition to the test points, indicator lights are provided for the returned status signals. The latched and released indications control logic to inhibit and enable the AC power in the same manner as the Orbiter Retention System Power.

The power Distribution Panel is located in the AC Power Distribution Rack. The 120/208 VAC, 3∅ power and VAC, 3∅ power is provided to the Facility Power Distribution Panel from the appropriate power distribution network. The Facility Power Distribution Panel supplies 480 VAC, 3∅ to PS1 and PS2 power supplies and 120 VAC to plugmold strips in the AC and DC power distribution racks, to PS1 and PS2 Power

Distribution and Control Panels, to PS3 and supplies 208 VAC, 3∅ to the AC 400 Hz power converters.

5.0 T-0 EQUIPMENT

There is a T-0 stand located at each of the testing facilities: the HPF, VPF and the SSPF. The T-0 stand equipment is a duplication of the equipment used in the Mobile Launch Platform (MLP). The T-0 equipment interfaces GSE with a payload through the T-0 umbilical. A device called the Umbilical Separation Simulator (USS) is provided and simulates separation of the T-0 umbilical. This umbilical provides a means to evaluate what happens at launch when there is an interruption of data flow and what the reaction of the payload is at launch (the USS is not used at this time).

The Payload GSE hardware provides the following:

- 28 volts DC
- Control/discrete circuits
- Impedance transitions
  - 50/124 ohm wideband landline
  - 78/124 ohm wideband
  - 50/75 ohm RF
- Open circuits which when patched provide the user with
  - Payload circuits
  - S- band circuits
  - Landline

Payload GSE consists of Control/Discrete Voltage Interface Rack, User GSE Interface Rack, Payload Wideband Interface Rack and a Landline Interface Rack. Also included in the Payload GSE are the terminal distributor, J-Boxes and the USS.

The Control/Discrete Voltage Interface Rack interfaces control and discrete voltages with the user GSE, payload and telephone landlines. The rack provides a patch panel distributor for signal routing, a 28 VDC subsystem for the distributing 28 VDC and fuse panels. The fuses maintain a safety factor for payload instrumentation in case of GSE failure.

The User GSE Interface Rack interfaces all of the user GSE and provides access to the payload. The rack contains five interface panels: the 124 ohm interface, 75 ohm interface panel, 78 ohm interface panel, 50 ohm interface panel and the control/discrete special power interface panel.

The Payload Interface Rack is the payload interface for the wideband circuits. The rack contains two patch fields, a 78 ohm balanced field and a 75/50 ohm unbalanced field.

The Landline Interface Rack contains the landline interface consisting of a patch field and matching transformers. The transformers are matching bi-directional and provide the following line matching:

- 124 ohm balanced twinaxial cable to 78 ohm balanced twinaxial cable
- 124 ohm balanced twinaxial cable to 75 ohm unbalanced coaxial cable
- 124 ohm balanced twinaxial cable to 50 ohm unbalanced coaxial cable

The USS consists of two units' one for power and data signals and one for RF data signals, with a control panel common to both units. In the VPF the control panel has HIM interfaces that allow the user remote control of the USS. There is no requirement for the USS in the HPF or SSPF.

The HPF Payload GSE racks are combined with a terminal distributor and impedance matching rack similar to the one found at the SSPF Launch Package Integration Stand (LPIS) stand.

The SSPF LPIS Payload GSE racks mount on the T-0 stand and combines with a terminal distributor and an impedance matching rack to match the line impedance equivalent of the MLP.

CITE CCMS

6.0 CCMS OVERVIEW

The Checkout, Control, and Monitor Subsystem (CCMS) is one of the three subsystems that makes up the Launch Processing System (LPS). The LPS's purpose is to provide high speed digital computer operated control to enable engineers to test and launch the Space Shuttle. CCMS is the heart of the LPS and is one of the systems that is critical to the launch process of the shuttle.

A duplication of the LPS CCMS called the Cargo Integration Test Equipment (CITE) CCMS is located in the Horizontal Processing Facility (HPF) and the Space Station Processing Facility (SSPF). The duplicate systems allow for the testing of Spacelabs and payloads to ensure that all systems are functioning properly. This allows for a faster and more effective processing of payloads and reduces the turn around time of the Shuttle.

The CITE CCMS is primarily contained in the CITE control room (both the SSPF and the HPF have a control room) and provides the operator an interface at the point where all tests are controlled for the HPF, the Vertical Processing Facility (VPF), and the SSPF. The remainder of the CCMS system consisting of the Hardware Interface Modules (HIMs) and the Video and Data Assembly (V&DA) are located at the test stands in the HPF and VPF. In the SSPF the HIMs and V&DA are located at the test stand and additional V&DA is located in room 2293 of the SSPF.

Communication between the CITE equipment and the CITE CCMS equipment in the different locations is through the V&DA. Communication in the HPF and VPF between CITE CCMS equipment and the CITE equipment is accomplished utilizing the Wide Band Terminal System (WBTS), and in the SSPF utilizing the Wide Band Fiber Optic system (WBFO).

The CCMS is comprised of the Common Data Buffer (CDBFR), Front End Processor (FEP), Video and Data Assembly (V&DA), Hardware Interface Module (HIM), Processed Data Recorder (PDR), Shared Peripheral Area (SPA), Engineering Support Area (ESA) and Consoles.

6.1 CONSOLES

The CITE CCMS consoles serve as the major interface point for control of the CITE operation. The consoles enable the operator to send commands and monitor measurements. There are two complete sets of consoles: one located in the Operations and Checkout Building (O&C Building) in Room 3237 and the other in the SSPF on the second floor in room 2397.

The CCMS console assembly consists of a computer subassembly, a CRT display subassembly, a Programmable Function Panel (PFP) subassembly, a remote Safing Panel (SP) subassembly (not required in the SSPF), and a printer/plotter subassembly. There are two types of consoles, a Type II console referred to as the master console and the Type I console referred to as the operations console. The only difference between the two types of consoles is that the Type II console contains a second hard disk.

The Master console performs loads and initialization, status monitoring, functional test and recoveries and reconfigurations. The CCMS Master consoles load and initialization determines where the consoles, Processed Data Recorder (PDR), Shared Peripheral Area (SPA), etc. are directed through the Common Data Buffer (CDBFR) to load their subsystem software. Status monitoring checks the health and status indicators for all subsystems and notifies all subsystems of any up or down status, and switches redundant elements if a failure in the primary element occurs. The Operation consoles are capable of performing procedure execution and control, displaying format generation, showing options, command capabilities and data monitoring options.

A console assembly consists of three operator stations called main modules that contain the human machine interface. There are two console groups consisting of six main modules and each one is an operational position for a particular user function. Each main module provides a CRT display, a keyboard, the PFP and its power supply, an SP (not required in the SSPF), and an Operational Intercommunication System - Digital (OIS-D) unit.

The support module consists of bays containing console support equipment including the computer and peripherals, printer/plotter, and Display Generator (DG).

6.2 FRONT END PROCESSORS

The Front End Processor (FEP) is a control processor (minicomputer) which operates as a pre-processing device for all data and communications to and from the payload and affiliate Ground Support Equipment (GSE). The FEP preprocesses payload and GSE uplink and downlink data, performs limit and validity checks, and converts the data to an engineering format acceptable to the consoles and the CCMS Common Data Buffer (CDBFR). A PCM frame synchronizer, bit synchronizer, bit clock, simulator and oscilloscope are all chassis mounted into the respective FEP rack.

There are six FEPs and four different types of FEPs that link the CCMS to the CITE Augmentation System (CAS) and Avionics and Electrical test equipment, through different buses. The six FEPs are the Uplink (UPLK) FEP, Launch Data Bus (LDB) FEP, GSE FEP, General Purpose Computer (GPC) FEP, Payload (P/L) FEP and CITE POCC Interface (CPI) FEP. The four types of FEPs used include the Type I - GSE, the Type IV - Pulse Code Modulation (PCM), the Type V - LDB, and the Type VI - PCM Simulator.

The Type I FEP is linked by the GSE data bus to the Hardware Interface Modules (HIMS) at the test stand. Through the HIMs the Type I FEP controls and monitors the test stand equipment such as the Power Supply Assembly (PSA), Caution and Warning (C&W) and Time Zero (T - 0) stand. The Type I FEP issues commands to the HIMS upon request from the console and causes a HIMs generated message to the CITE hardware. Between the FEP and the HIMs two way communications is possible resulting in a transfer of data back to the FEP. The GSE data bus transfer of data is accomplished using a bi-phase Manchester II Code and a non-valid Manchester synchronous pattern that operates at a one megabit rate. Communication on the GSE bus, however, is performed asynchronous and is bi-directional. The Type IV FEP provides for PCM uplink and downlink. This communication consists of one way PCM data and thus involves no two way communications. This FEP processes the telemetry data streams from the PCM Master Unit (PCMMU) and the uplink commands from the Payload Operations Control Center (POCC) and provides general purpose cargo uplink. The Type V FEP allows for communication between the CDBFR and the General Purpose Computer (GPC)/CITE Augmentation System (CAS). The Type VI FEP has a support module that includes an oscilloscope, a digital pattern generator, and a PCM Simulator, which are used for testing purposes.

The GSE FEP polls its bus for measurements, processes the data, issues commands to the HIMs, conducts console request and performs exception monitoring.

The LDB FEP allows for the conducting of console request, supporting of General Purpose Computer (GPC) periodic polling and commanding to the insuring the proper GPC state for transmissions. The LDB FEP however does not support any exception monitoring.

The UPLK FEP sends output to the GPC/CAS and processes console request. It does not, however, have a return path to send back verification of successful receipt or performance of the command. The UPLK FEP is unique to the CITE configuration and allows for the emulation of the Firing Rooms UPLK FEP, as well as the Orbiter's Network Signal Processor (NSP) and Flight Forward (FF) MDM.

6.3 COMMON DATA BUFFER

The Checkout Control and Monitor Subsystem Common Data Buffer (CDBFR) is a high speed solid state memory device controller. It acts as the medium of data flow for the FEPs, consoles, Processed Data Recorder/Shared Peripheral Area (PDR/SPA), and printer/plotter. The CDBFR provides a sequential interface for up to 64 external devices. The CDBFR memory is arrayed as 32 bits by 64 words and is implemented with Random Access Memory (RAM) elements in planar configuration. To communicate, the CDBFR uses a pipeline or cycle sharing method.

The CDBFR provides computer to computer communication, measurement and command status, Central Data Subsystem (CDS) interface, buffer to buffer communication, time for all central processing units (CPUs) and CCMS status (health checks). The CDBFR is storage medium that does not contain historical data only present value data. To maintain time status, the CDBFR uses the Time Code Generators (TCGs). The TCGs are components of the timing rack and generate Greenwich Mean Time (GMT) and Mission Elapsed Time (MET).

The CDBFR is a partitioned device that is made up of three areas that include the normal read/write mode, extend Page 1 (P1) read/write (block mode control) and extend Page 0 (P0) read/write (CPU - CPU interrupt). The memory in the CDBFR contains the P0, P1 and the FEPs Private Write Area (PWAs) and console PWAs. The PWAs of the CDBFR can only be written to by a specific console but all consoles are able to read from it.

The CDBFR is contained in three racks. Two of the racks are support racks. One of the support racks houses the power supplies, the power monitor panel, and the external device rack cabling that maintains all three racks. The other support rack contains five logic module chassis, four Buffer Access Card (BAC) scanner subassemblies, one memory subassembly, and the AC power distribution panel.

6.4 PROCESSED DATA RECORDER/SHARED PERIPHERAL AREA

The Processed Data Recorder/Shared Peripheral Area (PDR/SPA) are two closely related CCMS functions that run on identical Hardware and share certain hardware devices. Each function includes a Modcomp processor, tape drive, disk drive and a first in first out (FIFO) buffer.

The PDR/SPA is the CCMS equipment used to record CCMS data and to retrieve data previously recorded. The primary function of the PDR/SPA subsystem is to record data as it is written into the CDBFR. The PDR records selected data written into the CDBFR and records it on magnetic tape. The selected data types to be recorded can include measurement activity, computer to computer parameters, CCMS error conditions, commands from the console or command status from the FEP to test an article. The SPA is used to backup the PDRs, process PDR logged data like near real time data retrieval, post process data retrieval, spool goal data, data reduction and route specific test and system message data for output to line printers.

Historical data from the last thirty minutes can be playedback using the SPA. Data older than thirty minutes, however, is stored on tape.

There are four types of PDA/SPA utilized in the CCMS sets. The Type II is the one used in CITE. The Type II PDA/SPA includes six subassemblies that contain the low speed First In First Out (FIFO) buffer, Processed Data Recorder (PDR) computer, SPA computer, magnetic disk bulk storage and magnetic tape recording/playback. The PDR portion of the PDR/SPA consists of two racks and has a CRT terminal as a stand alone unit. The SPA portion is housed in three racks and has a CRT terminal, card reader, and one line printer as a stand alone unit. The PDR and SPA also share bulk disk drives, two magnetic tape units and two control units.

6.5 STRIP CHART RECORDER SUBSYSTEM

The Strip Chart Recorder Subsystem (SCRS), also called the Printer Plotter (P/P) Subsystem, can produce real time or archival hard copy graphic and texture outputs of requested data. Besides the graphical output, the retrievals can contain hexadecimal, ASCII, time tags, engineering units, limit values, and alphanumeric information. Data to be plotted is selected through the console, SPA and SCRS keyboard.

To plot real time data, the SCRS polls the CDBFR for plot data. When the plot is not near real time (archival retrievals) data plot data is created and sent by the SPA to the SCRS.

6.6 VIDEO AND DATA ASSEMBLY

The Video and Data Assembly (V&DA) provides data interconnections and condition signals for areas served by CITE. Impedance matching, signal splitting and patch panels signal routings are provided by the V&DAs. The conditioning of the signal is performed by Transmission Line Conditioning Equipment (TLCE). Signal multiplexing and demultiplexing functions are also provided in the V&DAs to support the timing signals in the VPF. The timing signals at the VPF test stand (except for the 1024 kHz and the 4.608 MHz) are multiplexed onto a single composite signal by the control room V&DA and sent to the test stand. Demultiplexing of the timing signal is performed by the V&DA located at the test stand and sent to the Interface Terminal Distributor (I/F TD).

All the uplink/downlink and data bus signals between the FEPs and the I/F TD are routed through the V&DAs. Signals sent to the Record and Playback Assembly (RPA) from the I/F TD are also routed through the V&DAs.

There are several V&DA types in CITE that include Type XI, Type XII and Type XIII. The O&C CITE Control Room uses Type XI that is composed of three racks and at the test stand Type XII is used and is contained in one rack. The Type XIII is used in the VPF at the 65 foot level and is contained in two racks. In the SPPF the Type of V&DA is yet to be determined.

6.7 HARDWARE INTERFACE MODULE

The Hardware Interface Module (HIM) is a general purpose interface with the Ground Support Equipment (GSE). They are the I/O devices for CCMS operations that allow remote monitoring and control of GSE functions by the GSE FEPs. The GSE FEP issues commands to the HIM upon request from an appropriate console that results in a HIM generated signal to the GSE hardware. The HIMs has the capacity for two way communications with the GSE FEP and can acknowledge request sent. Each HIM has a unique address that allows the GSE bus to accommodate multiple HIMs. One of the HIMs is equipped with a split/combinder assembly (HIM 1) that allows for up to 8 HIMs to operate on the serial data bus.

The HIM performs analog input and output, discrete input and output, relay closure and self test functions. The HIM assembly provides a general interface with the Power Supply Assembly (PSA), I/F TD and Umbilical Separation Simulator (USS). CITE HIM applications include remote operation of the PSA and portions of the I/F TD under control of a Type I FEP through a serial bus with local operation under the control of the HIM control and display panel. HIMs are in all three of the testing areas. The HPF and SSPF each has three HIMs with the VPF having four HIMs. Two of the HIMs at each of the locations are for CITE testing. In the HPF and the SSPF one HIM is used for T - 0 testing and at the VPF two HIMs are for T-0 testing.

The HIM is not a computer but a rack with cards, 30 of which contain user functions and 3 cards that are for control and self testing purposes. A large variety of CITE interface requirements are handled by the I/O cards. I/O cards perform requested operations and return reply data that are displayed on the control consoles or sent to an FEP. The I/O cards contain mostly analog to digital and digital to analog I/O cards, and have four to sixteen I/O paths.

6.7.1 HIM PATCH PANEL

A HIM patch panel is provided at the Aft Flight Deck (AFD) access stand in the HPF, VPF and the SSPF. The HIM patch panel allows an interface to be made from the CITE HIMs to any of the avionics/electrical assemblies in CITE. This allows the hardware to be monitored and commanded.

A HIM patch panel contains labeled mating receptacles on one side and 61 pin bulkhead connectors mounted on the backside. The bulkhead connectors can be connected by cable and routed to the appropriate hardware rack.

6.8 RECORD AND PLAYBACK ASSEMBLY

The purpose of the Record and Playback Assembly (RPA) is to record and display data like data bus traffic, Pulse Code Modulation Master Unit (PCMMU) downlink, command uplink, and payload telemetry. The RPA also provides a patching capability to the desired location. The interface to record and display are provide by the isolation amplifiers in Rack 4 of the I/F TD.

The RPAs consist of the Input/Output (I/O) Subassembly, Raw Data Recorder, and FM Subassembly.

The I/O Subassembly provides the interface between the remainder of the RPA and the Type XI V&DA, the MTU of the CDBFR and the hardware distribution system. The I/O subassembly also provides FM multiplexing and demultiplexing, MTU de-multiplexing, and calibration and control signal distribution to other RPA subassemblies.

The Raw Data Recorder (RDR) uses four magnetic tape recorders to record and playback direct data on 14 data tracks per recorder. A fifth RDR rack in CITE contains the patch panels, degaussers, an oscilloscope and a signal generator. Each recorder has capstan speed control, with tape or servo options, voice annotation, central monitoring and tracking control and automatic sequential operation.

The FM Subassembly provides the ability to process FM signals and extracts data contained within. To support it a digital voltmeter, a frequency counter and a spectrum analyzer are contained in the subassembly.

6.9 RETRANSMISSION PROCESSOR

The Retransmission Processor (RTP) decommutates the Orbiter Downlink (OD) telemetry data, extracts Payload Data Interleaver (PDI) data and provides for the retransmission in serial format. The RTP will accept any of the OD formats, automatically track changes in the OD telemetry configuration, and simultaneously output up to four payload data streams. The RTP incorporates automatic output bit rate adjustments to compensate for variable length fill in the incoming telemetry streams. The RTP can also decommutate a payload data stream and output up to four embedded areas.

The RTP is a self contained grouping of Versa Module Europe (VME) electronic modules enclosed in a rack. The electronic modules consist of 6U VME cards:

- One Processor Card

- One PCM Bit Synchronizer Card
- One PCM Decommutator Card
- Two Serial Output Cards

The processor, a Motorola MVME133A-20 microcomputer, is a single board containing a MC68020 microprocessor and a MC68881 coprocessor.

The bit synchronizer extracts data from noisy PCM signals and outputs a reconstructed serial data stream and phase coherent clock.

The PCM decommutator performs frame subframe synchronization on a serial PCM data source and generates fully decommutated buffers of data in on board memory.

The two Serial Output Cards combine to output 4 serial data streams in different formats. The output formats are standard IRIG-B PCM codes: NRZ-L, NRZ-M, NRZ-S, Bi-Phase-L, Bi-Phase-M and Bi-Phase-S.

To interface the RTP a standard personal computer using Microsoft Windows applications is used with a Visual Basic built graphical interface.

CARGO INTEGRATION TEST EQUIPMENT AUGMENTATION SYSTEM (CAS)

7.0 CAS OVERVIEW

The purpose of the Cargo Integration Test Equipment Augmentation System (CAS) is to perform or support functions, operations, and procedures necessary for the complete interface verification of payloads. The performance or support of functions, operations and procedures necessary for verification are performed on a AP101S General Purpose Computer (GPC). Verification of the payload interfaces is performed with the actual payload hardware. CAS contains a diverse complement of simulated flight hardware (such as GPC, MMU) and capabilities (such as command uplink) to verify actual payload interfaces.

The CAS also provides functions to verify the interaction between the payload hardware and payload unique software. These functions include:

- GPC control and debugging capabilities
- Guidance, Navigation and Control (GN&C) computer simulation, including on-orbit navigation updates and uplink functions
- Data bus monitoring on the 28 bit and 20 bit serial data buses (20 bit uses the serial I/O converter) including recording the data bus traffic on the optical disk and a quicklook post processing capabilities
- Ability to monitor the Operational Instrumentation and Payload (OI/PL) PCM RAM data
- Display Electronic Unit (DEU) Keystrokes simulation

- OI Multiplexer/Demultiplexer (MDM) simulation
- Electronic File Transfer (EFT) capabilities

and may be performed simultaneously.

The CAS operations consist of the following:

- Supports payload ground software validation in conjunction with flight sofware
- CAS equipment provides power control and monitoring to avionics equipment, such as the GPC and DEU
- CAS equipment provides selected data bus (IC1, IC4, PL1 and PL2) monitoring and recording
- Performing I/F verification (IVT), abbreviated mission sequence test (MST), end to end (E-E) test and procedure checkout using the CITE and CAS
- CAS equipment provides LDB and downlink telemetry data commanding/processing
- CAS equipment provides uplink support.

7.1 CAS EQUIPMENT

The CAS makeup consists of the Data Acquisition System (DAS), the Data Processing System (DPS) and two workstations with peripherals and a personal computer.

7.1.1 DATA PROCESSING SYSTEM

The DPS console houses the AP101S General Purpose Computer (GPC), Mass Memory Simulator (MMS), and Display Electronics Unit (DEU), together with the power, cooling monitoring and control devices. It also contains the AC Power Control Assembly (ACPCA), the DC Power Assembly (DCPCA), the Display Unit (DU) Video Buffer and the Data Bus Coupler (DBC) panel.

The DC power for the Shuttle Line Replacement Units (LRUs) is provided by Power Supply 1 (PS1), PS2 and PS3. These PSs provide 28 VDC and are controlled by the IEEE 488 controller. The PS outputs are then routed to the DCPCA where they are then routed to the appropriate LRU. The GPC/Mass Memory Control Assembly (GMMCA) provides the control for the Mass Memory Simulator (MMS)and the avionics ground equipment (AGE) interfaces to the GPC.

7.1.2 DATA ACQUISITION SYSTEM

The DAS console houses the Time Code Reader/Generator, Modem, RS232C Switch Matrix, Data Acquisition Module (DAM) 1 and 2, Optical Disks, Triaxial Switch Matrix and AC Power Outlet Panel.

The DAS console contains the Data Acquisition Modules (DAM) 1 and 2. DAM 1 and DAM 2 both have embedded processors that perform special functions. DAM 1 provides the analog and discrete input and output functions, the IEEE 488 power control and the Versa Module European (VME)/GMMCA Interface (VGI). It also has two Data Bus Elements Simulator (DBES) card sets to interface with the IC1 and IC4 data buses. DAM 2 provides four DBES card sets for data bus monitoring. Both DAM 1 and DAM 2 have Interrange Instrumentation Group B (IRIG - B) readers that receive their input from the CITE. The time is also displayed on the time code reader/generator.

The system manager processors in DAM 1 and DAM 2 are connected via an ethernet transceiver and cable to the workstations. Two 4x8 RS232C switches allow the workstations to connect to any of the embedded processors or the MMS for diagnostic purposes. The switches are cross connected so that either workstation may access any embedded processor.

The DAM 2 system manager has two 594 megabyte (MB) optical disk drives attached to its Small Computers Systems Interface (SCSI) port. These disks provide the data storage for the bus monitoring operations. A 4x20 programmable switch matrix and DBC panel provide the ability to connect DAM 2 to the DPS.

Primary cooling is provided by the blower assemblies; two at the bottom of each console. Cooling for DAM 1 and DAM 2 is provided by a fan drawer in each of the card cages. Auxiliary power outlets are provided on the front of the right hand bay.

7.1.3 WORKSTATIONS

The work stations in CAS are Sun Sparcstation IIs. Each Sparcstation II contains 32 MB of main memory, dual RS232C ports, dual 424 MB internal magnetic disk drives, an ethernet port and a SCSI port. Connected to the workstations through the SCSI port is a 105 MB cartridge tape, a 594 MB optical disk, a 644 MB compact disk read only memory (CD-ROM) and shared between the two workstations using a SCSI switch is a nine track 6250/1600 bpi tape unit. The ethernet port on the workstations connects them to the PC, DAS and to two print servers. One print server connects to a laser printer and the other to a printer using Centronics compatible interfaces. One RS232C port on each workstation connects to its respective 4x8 RS232C switch. This is provided principally for diagnostic purposes.

7.1.4 PERSONAL COMPUTER

The Personal Computer (PC) is a standard commercial off the shelf International Business Machine (IBM). Its consist of a CPU (33 MHz 80486 32 bit microcomputer), Memory (4 MB), two floppy drives (a 1.2 MB 5.25″ and a 1.44 MB 3.5″), hard disk (200 MB IDE), video card (Super VGA 1024x768 resolution), display (Super VGA color Monitor 13″), I/O ports (2 serial and 1 parallel), mouse and standard 101 key keyboard. The PC also has a modem adapter card and a Personal Computer Network File System

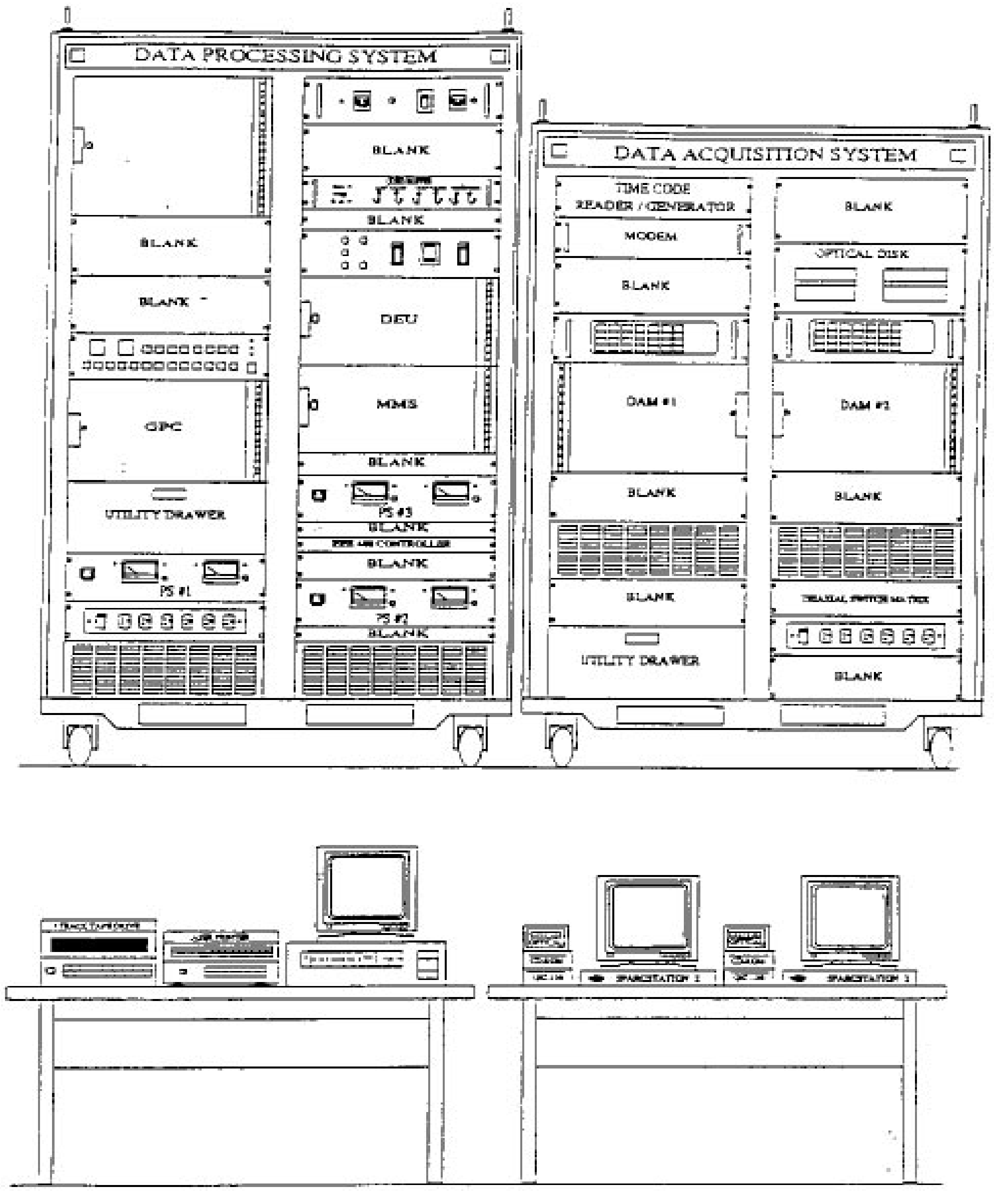
(PC - NFS) that are compatible to the ethernet. The PC - NFS allows the workstations and the PC to talk with each other.

7.2 CAS SOFTWARE FEATURES AND CAPABILITIES

The CAS software consists of five major elements: Operating Systems, Network Applications, Device Controller Interfaces, Diagnostics and Applications. In each of these elements the C programming language is used exclusively. The CAS software provides the ability to perform CAS diagnostics, payload support and utilities.

7.2.1 OPERATING SYSTEMS

The CAS has three software platforms: Sun Sparc workstations, Motorola embedded processors and IBM compatible personal computers. The operating system on the Sun Sparc workstations is UNIX, on the Motorola embedded processors is VxWorks and on the IBM compatible personal computer is the Microsoft Disk Operating System (MS-DOS).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GPC
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PS #3
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PS #2
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TIME CODE
READER / GENERATOR
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MODEM
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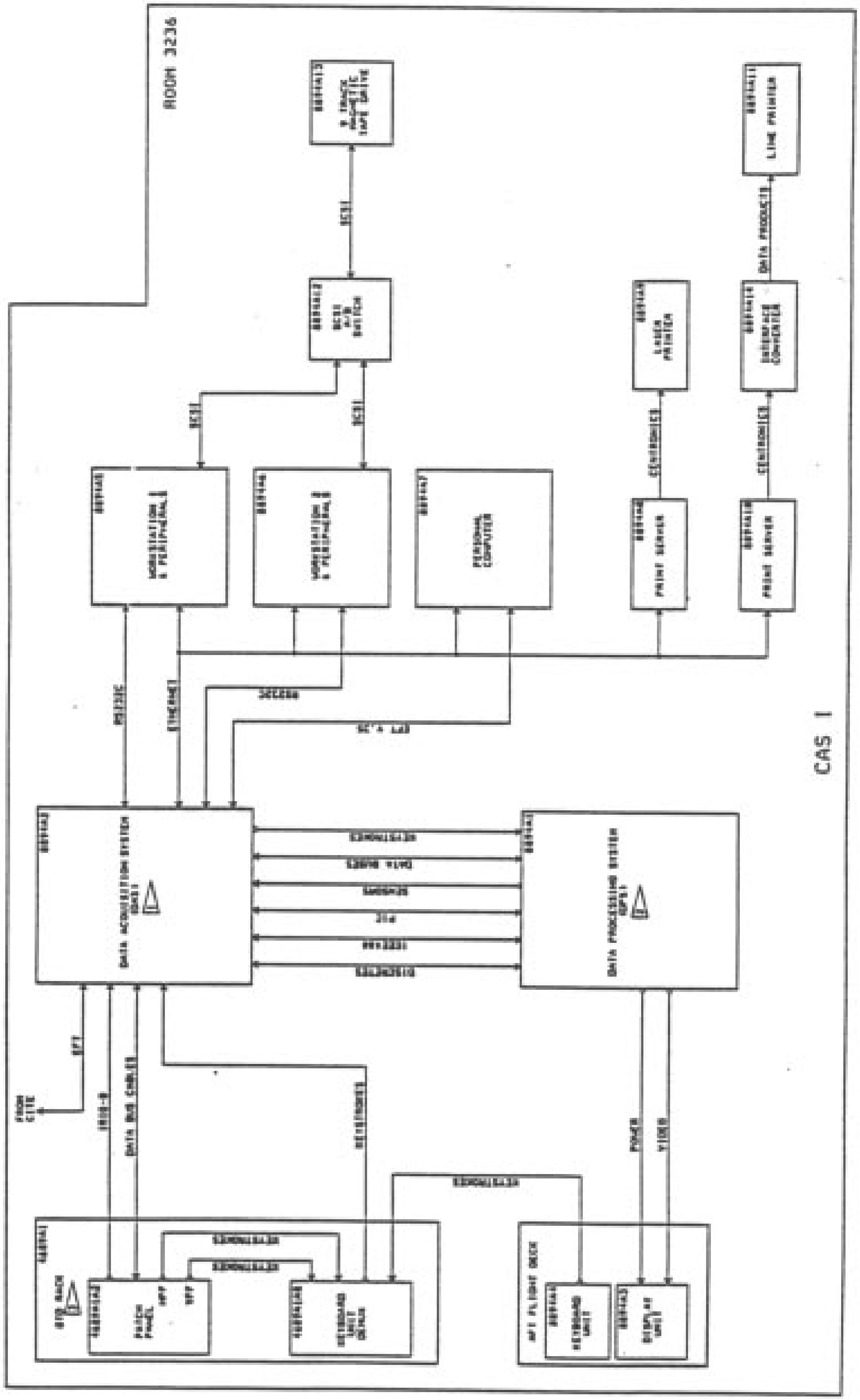
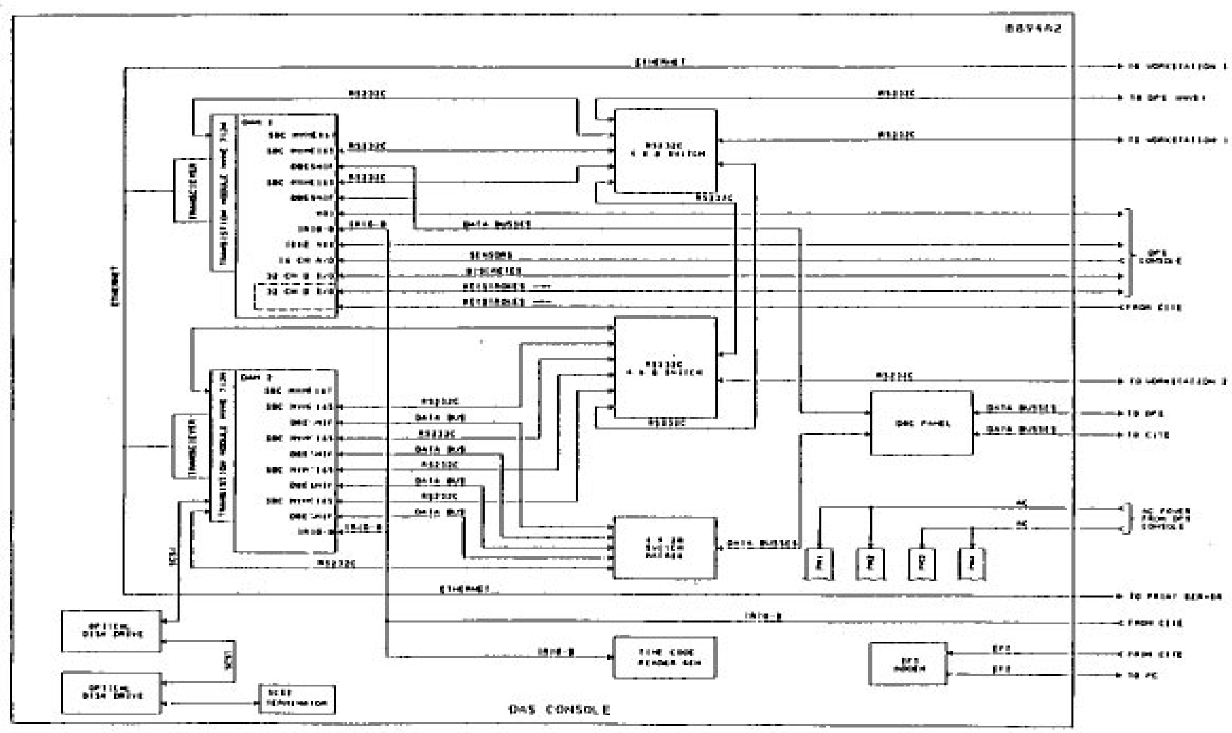

ROOM 3236
CAS I

DAS



7.2.1.1 UNIX

The workstation UNIX operating system provides the software environment necessary to develop applications and diagnostic software, supporting CAS operations and post delivery software maintenance. UNIX is used to run non-time critical application software and to edit, compile, link, and store real time C code that is then debugged under VxWorks.

7.2.1.2 VxWorks

VxWorks is a UNIX compatible real time operating system that is hosted in the 68040 embedded processor on the Motorola MVME-165 and MVME-167 single board computers. The MVME-165 and MVME-167 are installed in DAM 1 and DAM 2 of the DAS console. VxWorks runs application software that interfaces with and emulates parts of the Shuttle data processing and system software.

7.2.1.3 MICROSOFT DISK OPERATING SYSTEM

The MS-DOS is used on the IBM compatible computers and is limited to creating software backup disks and running PC diagnostics. The PC’s and their peripherals interface the CAS workstations to an IBM mainframe that is located at Johnson Space Center (JSC). The connection is made to JSC’s software production facility via the network data mover (NDM) wide area network. This enables the electronic data transfer of Shuttle data tapes, mass memory load tapes and universal patch format files.

7.2.2 NETWORK APPLICATIONS

In network applications commercial off the shelf network applications are used for the data link between the software production facility at JSC and the CAS at KSC. The Network Data Mover supports the wide area network used in the transfer of data between JSC and KSC. For access from the PC’s to the Sun workstations an Attachmate EXTRA adapter card is used along with the Personal Computer Network File System (PC-NFS).

7.2.2.1 NETWORK DATA MOVER

The Network Data Mover is a wide area network (WAN) protocol package.

7.2.2.2 ATTACHMATE EXTRA

The Attachmate EXTRA adapter card supports the IBM’s synchronous data link control (SDLC) communication protocol. The Attachmate Extra adapter card provides the ability to perform mass memory transfers from the Software Production Facility at JSC for each mission. It also provides an RS-232 interface to the 56 kbits/s modem, and is AT bus compatible.

7.2.2.3 PERSONAL COMPUTER NETWORK FILE SYSTEM (PC-NFS)

The PC-NFS provides the Transmission Control Protocol/Internet Protocol (TCP/IP) communication protocol for the ethernet link between the PC and the Sun workstation.

7.2.3 DEVICE CONTROLLER INTERFACES

The device controller interface software provides an interactive system that supports CAS operations in both run time and diagnostic modes of operation. Device controller interface software includes commercial off the shelf (COTS), reusable off the shelf (OTS) and development software to control all devices.

Standard COTS device controller interface software provided by the vendor is used by: workstations and MVME-167 single board computer (SBC) processors, MVME-165 SBC processors, nine track tape drive, laser printer, IEEE - 488 controller, synchronous data link control (SDLC) adapter, CD - ROM drive, cartridge tape drive, optical disk, workstation magnetic disk and ethernet.

Custom or modified COTS device controller interface software is used by: Interrange Instrumentation Group B (IRIG-B) reader interface, discrete I/O interface, A/D converter, data bus element simulator, switch matrix and Versa Module European (VME)/GMMCA Interface (VGI/GMMCA).

7.2.4 DIAGNOSTIC SOFTWARE

Diagnostic software is used to test CAS hardware, associated flight Line Replacement Units (LRU's) and commercial off the shelf (COTS) hardware.

7.2.4.1 FLIGHT AVIONICS EQUIPMENT PC STP

Primary avionics subsystem software provides diagnostics for the DEU, GPC, MMU, PCM and the Payload Multiplexer/Demultiplexer (PLMDMs)

7.2.4.1.1 DEU SELF TEST PROGRAM (STP)

The DEU STP is executed following a GPC Initial Program Load (IPL) by keying in item entries on the IPL display menu. The program is then loaded into the DEU from the mass memory and DEU figure and character generation is observed on the Multifunction CRT Display System (MCDS) display unit.

7.2.4.1.2 GPC STP

To initiate the GPC self test program there is no special action required. The test is performed whenever the GPC is Initial Program Loaded (IPLed). The self test is loaded from the mass memory along with the software loader program and following the IPL.

7.2.4.1.3 VEHICLE UTILITY FLIGHT SOFTWARE

The Vehicle Utility (VU) flight software provides the test programs for the Pulse Code Modulation (PCM), Mass Memory Unit (MMU) and the payload MDMs in G9. The GPC/bus terminal unit (BTU) display contains six fields from which the LRU tests are run: BTU selection, port selection, level, status, module and BTU cyclic BITE.

7.2.4.2 Commercial of the Shelf (COTS):

COTS software provides diagnostics for the Sun workstation equipment and the Motorola embedded processors (MVME 167 and MVME 165) single board computers located in DAM 1 and DAM 2.

7.2.4.2.1 SUN WORKSTATION EQUIPMENT

The Sun workstation diagnostics are all available in the Sun's Sundiag package provided by the vendor Sun Microsystems.

7.2.4.2.2 SINGLE BOARD COMPUTERS (SBC)

The complete diagnostic package exists in the firmware on the Motorola 68040 processors. This includes utilities and tests to debug the MVME165 and MVME 167 SBCs.

7.2.4.3 CAS EQUIPMENT

The CAS equipment diagnostics are provided for Rockwell designed and some COTS equipment. Any failures detected by the diagnostics generate error messages.

7.2.4.3.1 LRU HEALTH AND STATUS EQUIPMENT:

A Rockwell developed diagnostic is provided for this equipment that monitors and controls voltage, current, temperature and air flow; parameters critical to the protection of the Shuttle LRU's are housed in the CAS DPS console.

7.2.4.3.2 VGI/GMMCA

Rockwell developed diagnostic provides tests for the VGI, VGI/GMMCA no Avionics Ground Equipment (AGE), VGI/GMMCA with AGE and no GPC and the

VGI/GMMCA/AGE/GPC. To execute each set of test a menu is called from the main GMMCA menu.

7.2.4.3.3 DATA BUS ELEMENT SIMULATOR (DBES)

Rockwell developed diagnostics are provided for the DBES. The DBES are a two card set that is capable of simulating bus terminal units or monitoring traffic on the Shuttle serial Manchester data busses. The DBES consists of a MVME 165 card and a Rockwell designed Manchester interface card that is used in DAM 1 for the Intercomputer Communication (ICC) 1 and 4 busses that are between the simulated GN&C GPC and the real Systems Management (SM) GPC, and are also in the DAM 2, for the four channel bus monitor.

7.2.4.3.4 TRIAXIAL SWITCH MATRIX

The triaxial switch matrixes are a computer controlled 4 by 20 switch matrixes that allows each of the four DBES channels to be connected to any of the twenty Shuttle serial Manchester data buses. The capability to connect to the Shuttle serial Manchester data buses provides the ability to record 4 data buses during all major testing. To test the triaxial switch matrix Rockwell provides two tests. One that includes addressing all eighty switch points in the matrix, and the second which executes a connectivity that cycles through all the possible combinations of the DBES channels and Shuttle data buses.

7.2.4.3.5 OPTICAL DISK

The Rockwell diagnostic provides access to the diagnostic tests built into the optical disk drive. After completion of the test results from the diagnostic are displayed on the screen.

7.2.4.3.6 OPERATIONAL INSTRUMENTATION (OI) MDM SIMULATOR

A Rockwell diagnostic provides two sets of OI MDM Simulator tests, a go/no go test that verifies the simulator and selectable tests to troubleshoot failures that occur during the go/no go testing.

7.2.4.3.7 TIME CODE - PC03V

A Rockwell diagnostic test read the readability of the PC03V board through the VME bus and performs a simple test of time registers. The test reads time, delays two seconds and reads time again, and then verifies that the two readings are two seconds apart.

7.2.4.3.8 DBES MEMORY

A Rockwell diagnostic for the DBES Memory Card verifies that the first and last one thousand bytes are accessible through the VME and VME Subsystem Bus (VSB) busses. Byte, short and long words accesses are then verified through the VME and VSB busses.

7.2.5 APPLICATION SOFTWARE

Application software is used in support of the major functional areas in the CAS. The functional areas included GPC Control and Debugging, Four Channel Bus Monitoring, DEU Keystroke Simulation, GN&C Computer Simulation and MMU Utilities.

7.2.5.1 GPC CONTROL AND DEBUGGING

Commands are provided to control the execution of the GPC, allow the GPC memory to be read or written and to trace GPC execution when the GPC is Executing. This is accomplished by issuing commands through the AGE interface of the GPC. This is rarely used function of the GPC.

7.2.5.2 FOUR CHANNEL BUS MONITOR

The capability is provided to simultaneously monitor and store all commands and data words on one of four busses. This is possible for both the 20 bit and 28 bit serial I/O data busses. The 20 bit serial I/O data busses will be monitored with the use of the serial I/O converter assembly.

7.2.5.3 DEU KEYSTROKE SIMULATION

The DEU keystrokes are simulated using the workstation and an interface unit connected to the DEU. In the simulation a software switch is provided to disable the CAS from the multifunction CRT display System keyboard operation. In the DEU keystroke simulation mode, the user can either enter the strokes at the CAS keyboard or may input the message in a command file for simulation at a specific time.

7.2.5.4 GN&C COMPUTER SIMULATION

The GN&C simulation will only support SM (System Management) Operations (OPS) 4 (Memory Configuration 4), and OPS 0 (Memory Configuration 0) of the primary flight software.

7.2.5.5 MASS MEMORY UNIT UTILITIES

This application software provides a graphical interface for the Mass Memory Unit utilities support for both the orbiter and the Spacelab Mass Memory Units. Options in this utility include clearing memory, setting memory with a pattern, loading memory, verifying a load patching and saving memory to a disk file.

7.3 CAS WORKSTATIONS

The CAS workstation consists of two Sun Sparcstation II computers and one personal Computer (PC). The workstations are all connected to the ethernet. One of the Sun workstations is consider the primary terminal for the CAS operations and the other is the backup, in case of primary failures. The PC's main use is for the electronic file transfer of Orbiter data products.

The primary terminal (Sun workstation) during testing is responsible for downloading to the DAMs, starting their execution and starting software to communicate with the DAMs. The backup Sun workstation during testing is used for the software development and ORACLE data base queries and updates. In testing the backup can take over the role of the primary terminal. This is done by resetting the ethernet addressing of the backup to the primary terminals address and then rebooting the terminal and the DAMs.

7.3.1 SPARCSTATION 2

The work stations in CAS are Sun Sparcstation II. Each Sparcstation II has 32 MB of main memory, dual RS423 serial ports that are RS232C compatible, dual 424 MB internal magnetic disk drives, an ethernet port and a SCSI-2 port. On the SCSI port is a 105 MB cartridge tape, a 594 MB optical disk, a 644 MB compact disk read only memory (CD-ROM) and shared between the two workstations using a SCSI switch a nine track 6250/1600 bpi tape unit. The ethernet port connects to the PC, DAS and to two print servers. One print server connects to a laser printer and the other to a printer using Centronics compatible interfaces. One RS232C port on each workstation connects to its respective 4x8 RS232C switch. This is provided principally for diagnostic purposes.

7.3.1.1 ETHERNET

The ethernet port on the workstations is compatible with the Network File Server (NFS), Transmission Control Protocol/Internet protocol (TCP/IP) and the PC-NFS. The connection to the network is made using a MIL-05T transceiver and thin coaxial cable. The data rate of transfer is 10 Mb/sec. The ethernet network includes both sun workstations, the PC, DAM 1, DAM 2 and both the laser and line printers.

7.3.1.2 LASER PRINTER

The laser printer is a Hewlett Packard LaserJet III.

7.3.1.3 SMALL COMPUTER SYSTEM INTERFACE (SCSI)

The SCSI-2 port provides access to the 594 MB optical disk, the 5.25 inch 644 MB CD-ROM, the QIC-150 0.25 inch 150 MB cartridge tape unit and through the dual ported SCSI switch a 9 track 6250/1600 BPI tape unit.

7.3.1.3.1 SCSI SWITCH

The SCSI switching is performed by a Gafford Technology SCZE-SHARE unit that allows for the sharing of ports and one shared port. The unit is a single ended device with an internal termination.

7.3.1.3.2 OPTICAL DISK

The optical disk contains a Sony D501 drive unit and uses a 5.25 inch disk that can store up to 594 Mbs. Communications to the SCSI are performed through a Sony C501 disk controller. The optical disk is used to provide for the processing of the bus monitor data.

7.3.1.3.3 CD-ROM

The CD-ROM has a maximum of 644 MB of available storage space.

7.3.1.3.4 1/4 INCH TAPE

The 1/4 inch cartridge tapes have a capacity of 150 megabytes and are used for software loads, saving work files and backing up files.

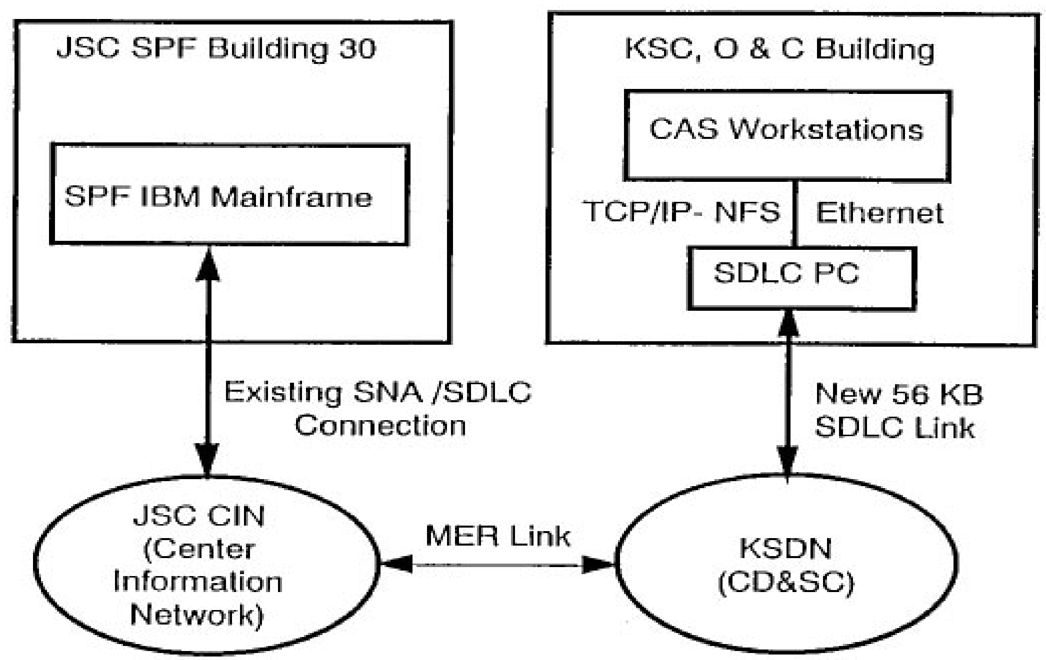
7.3.1.3.5 NINE TRACK TAPE

The 9 track tape unit is a 6250/1600/800 BPI SCSI device whose purpose is to provide compatibility with the existing tape transfer capabilities. The tape unit was used in the past to read the mass memory unit load that was previously supplied on nine track tapes but now it is provided electronically.

7.3.2 PERSONAL COMPUTER (PC)

The PC contains a Micronics 80486-33 MHz EISA motherboard, VGA graphic board, a multi I/O IDE card, an attachmate Advanced SDLC Adapter Board and a 3COM Ethernet II ethernet board. The monitor is a SONY multi scan color display.

EFT FUNCTIONAL FLOW



7.3.2.1 ADVANCED FUNCTION SYNCHRONOUS DATA LINK CONTROL (SDLC) ADAPTER

The Advance Function SDLC Adapter card contains selectable I/O address and interrupt levels, selectable shared memory, SDLC communication protocol, RS-232C connector and cable, and an RS-232 to V.35 converter cable. The Advance Function SDLC Adapter card is also compatible with the IBM PC AT.

In CAS the adapter card serves as the interface to the Software Production Facility at JSC for the Electronic Transfer of Files (EFT) of the Orbiter data products. The card operates at a speed of 56 Kb using the V.35 external modem.

7.3.2.2 ETHERNET

The IBM PC contains a 3COM Ethernet II card that allows it to be supported by the Sun Microsystems PC-NFS File System This allows for the Sun to receive data products from the Software Production Facility (SPF) through the EFT and store them on workstation disk.

The EtherLink II card is configured with a base address of 310 to 31F (hex). The card is set to operate with the DMA channel 1.

7.4 DPS CONSOLE

The DPS console is a two bay console with casters, eyebolts and forklift tunnels for easy of movement and set up

7.4.1 DPS AC POWER CONTROL ASSEMBLY

The AC Power Control Assembly (ACPCA) distributes facility power to the console DC power control assembly, blowers, utility outlets, power strips and the Data Acquisition Console. All AC power is routed through the DPS AC power control assembly, including the AC power for the DAS. The ACPCA contains a +5 V DC power supply, PS1 and a digital logic card assembly.

7.4.2 ORBITER AVIONICS

The Orbiter Line Replacement Units (LRUs) employed in the CAS system are AP-101S GPC, Display Electronics Unit (DEU), Display Unit (DU), Keyboard Unit (KBU) and the Mass memory Unit (MMU) which is either real or simulated. The AP-101S GPC, DEU and the MMU all reside in the DPS console, with the KBU and DU residing in the Aft Flight Deck (AFD) console of the CITE.

7.4.2.1 GENERAL PURPOSE COMPUTER (GPC)

The GPC is an IBM AP-101S microprogram controlled CPU with an input output processor interface to the serial data bus network. The CPU initiates all the input output actions by sending instructions to the Input/Output Processor (IOP). Data words are transferred between the CPU and the IOP on a bi-directional parallel word data bus. Except for the initiation process, the IOP is an independent of the CPU and executes its own programs which reside in the common main memory.

7.4.2.2 DISPLAY ELECTRONICS UNIT

The DEU provides analog video deflection and intensity signals for use by the DU in displaying any one of a predetermined number of selectable formats. A memory is included in the DEU to store instructions used in processing information and to store format programs required by the DEU symbol generator. The data used to establish and update the variable portions of the display presentation are received by the DEU in block message form from the GPC through one of the system data buses. Display format selections are made through the keyboard by the operator information that is entered into the GPC is displayed on the DEU for operator validation before entry is made.

7.4.2.2.1 DISPLAY UNIT

The Display Unit receives buffered analog X and Y deflection voltages and Z intensity modulation from the DEU. These signals are first buffered by the Video Buffer Assembly before being sent to the DU.

7.4.2.2.2 KEYBOARD UNIT

The Keyboard Unit (KU) is a 32 keyboard that serves as the input device for the AP101S GPC. The keyboard is routed through the digital I/O card in DAM 1.

7.4.2.3 MASS MEMORY

The CAS is able to function with either the operational Mass Memory Unit or a Mass Memory Simulator Unit.

7.4.2.3.1 MASS MEMORY SIMULATOR

In the CAS a Mass Memory Simulator (MMS) is used to simulate the function of the GSE MMU for the CAS system. The MMS unlike the MMU has a hard disk instead of a tape.

7.4.3 AVIONICS SUPPORT

Avionics supports consist of the GMMCA, power supplies and control elements, air cooling, monitoring devices, video buffer, data bus coupler panel and the OI MDM simulator.

7.4.3.1 GPC MMU MONITOR AND CONTROL ASSEMBLY (GMMCA)

The GMMCA provides CAS the ability to control the Space Shuttle GPC and the ability to assist in the simulation of a DPS common set by simulating the sync codes of the primary GPC in the common set. Also provide by the GMMCA is the interface to the GPC AGE port that allows GPC debugging, program monitoring and control.

7.4.3.2 AVIONICS POWER

The avionics LRU power is supplied by three power supplies that are controlled and monitored by the IEEE 488 Power Supply Controller. The +28 VDC is distributed by the DC Power Control Assembly. The overall control of the power is, however, performed by the DAM 1 System Manager Processor through the IEEE 488 GPIB controller and the discrete I/O card.

7.4.3.2.1 POWER SUPPLIES

Three power supplies PS1, PS2 and PS3, provide the power to the GPC, DEU, DU and the MMU when used. PS1 and PS2 provide 28 VDC at 15 amps maximum.

7.4.3.2.2 IEEE POWER SUPPLY CONTROLLER

The Institute of Electrical and Electronic Engineers (IEEE) 488 Power Supply Controller controls and monitors the voltage and current parameters of the three power supplies. The IEEE 488 Power Supply Controller communicates with the IEEE 488 Versa Module European (VME) controller in DAM 1. This standard is also known as the General Purpose Interface Bus (GPIB).

7.4.3.2.3 DC POWER CONTROL ASSEMBLY (DCPCA)

The DCPCA provides power control to the GPC, DEU, MMU, or MMS and DU. It provides +28 VDC from the LRU power supplies PS1, PS2 and PS3 and routes it to the DCPCA solid state relays which indicate input voltage. These relays are activated by the by DAM 1 discretes. The DCPCA also contains a +/- 15 VDC power supply, PS1 that is used to supply power to the flow/temperature modules.

7.4.3.3 VIDEO BUFFER

The Video Buffer consists of three encapsulated fixed gain video amplifiers package together with a +/- 15 VDC power module. The overall gain of the amplifier is 1.1 when it is loaded.

7.4.3.4 DATA BUS COUPLER (DBC) PANEL

The DPS DBC panel provides access to all GPC buses required by DAS. The data buses are routed to the couplers. Coupler outputs are then further routed to the Data Bus I/O Panel and then on to the DAS console or to CITE.

7.4.3.5 OI MDM SIMULATOR

The OI MDM Simulator simulates various flight instrumentation MDM responses to be received by a PCMMU through the bus.

7.5 DAS CONSOLE

The DAS console contains DAM 1 and DAM 2, bus monitor optical disks, the RS-232C switch matrices, the triaxial switch matrix for the data bus selection, the modem for the EFT function, and a time code reader/generator for time display.

7.5.1 DAS PRIMARY POWER

The DAS console receives its primary power from the DPS console. The power control is delivered through the DPS ACPCA. Distribution of power in the DAS is performed by means of power strips. Grounding of the DAS is perform by a single stud at the DAS console and then connected to the facility ground.

7.5.2 DAM 1

To provide an interface for the IC 1 and IC 4 GPC busses, DAM 1 uses two DBES card sets. DAM 1 also provides the GMMCA interface to the GPC AGE through the VGI. Power Control and Monitoring for the LRUs are accomplished by the IEEE 488 interface card. Monitoring of the LRU airflow and temperatures are handled by the A/D card and a Digital Input/Output (DIO) card. All keyboard functions and other discrete operations are provide for by the discrete I/O card.

7.5.2.1 CARD CAGE

The card cage is a commercial 21 slot unit with an internal modular 750 watt power supply. The system manager and other cards are mounted in the cage and an ethernet transceiver is attached. Two slots are overlays are used for the DBES card sets install in DAM 1.

7.5.2.1.1 SYSTEM MANAGER PROCESSOR

The System Manager Processor is a Motorola MVME 167 double high VME board single board computer with 4 MB of Dynamic Random Access Memory (DRAM). The System Manager Processor provides for I/O connections to the SBC. The SBC is a 68040 processor operating at a clock speed of 25 MHz. The chip has an internal battery backed 8k x 8NVRAM with time of day clock, reset, and abort switches.

7.5.2.1.2 DATA BUS ELEMENTS SIMULATOR

DAM 1 contains two DBES cards that provide for the data bus interface to the GPC IC1 and IC4 busses. The DBESs both contain a MVME 165 DBES processor and a Rockwell designed DBES Manchester Interface card that operates its bus emulation mode.

7.5.2.1.2.1 DBES PROCESSOR

The DBES processor is a Motorola MVME 165 double high VME board single board computer with a VSB, a time of day clock NVRAM and four MB of DRAM. The DBES is a 68040 processor that operates at clock speed of 25 MHz.

7.5.2.1.3 VME/GMMCA INTERFACE

The VGI is Rockwell designed card that provides the VME interface of the GMMCA together with the timing and synchronization to facilitate common set synchronization. The VGI interfaces to the PC03V IRIG - B reader using an overlay to allow it to timetag events that occur in the GPC. The VGI provides interrupts to the DAM 1 System Manager Processor and also interfaces to the IC1 Data Bus Element Simulator Manchester Interface (DBESMIF) discrete I/O register to provide the DBES with synchronization cues.

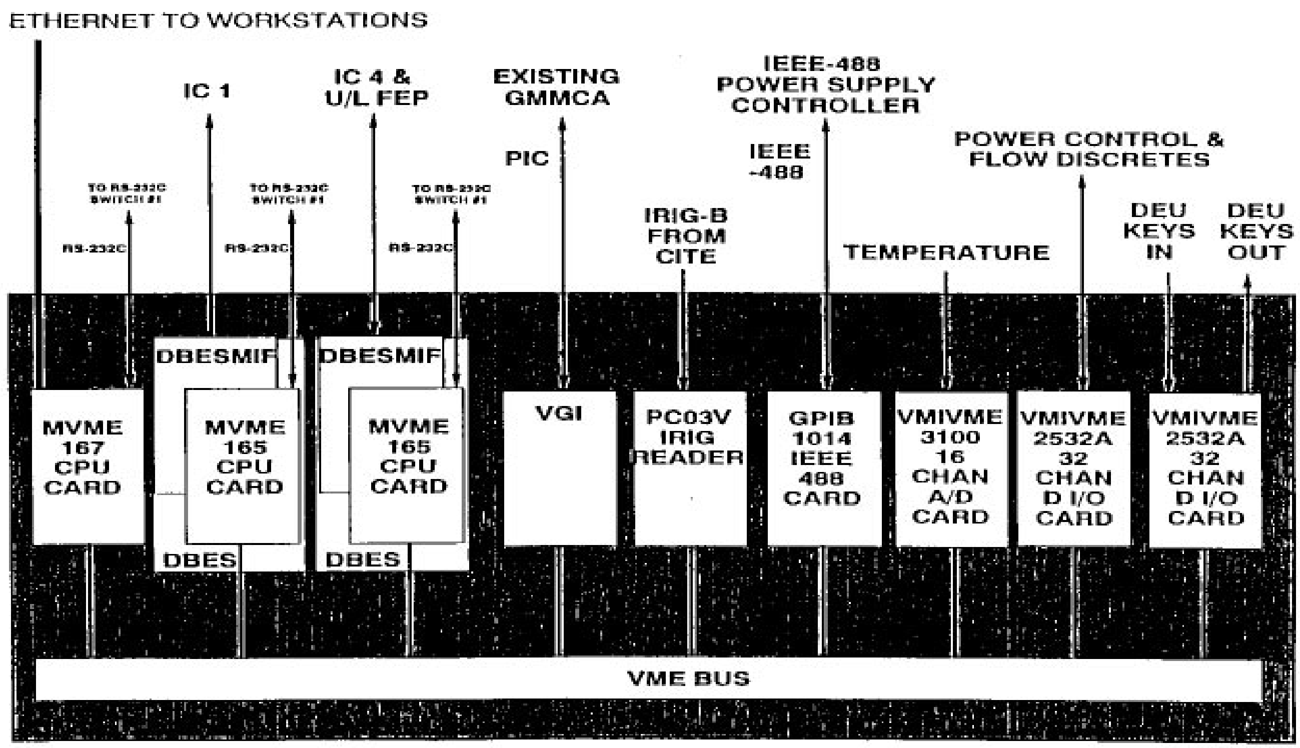
7.5.2.1.4 ANALOG I/O

The VMIVME-3100-0-11-1-1 analog to digital board features 12 bit resolution, 9 microsecond conversion time, 16 single ended or 8 differential inputs, and resistor selectable input ranges. It has on board over voltage protection and built in test logic.

7.5.2.1.5 DISCRETE I/O

Inside the CAS there are two discrete boards. One board is dedicated to the MCDS keyboard. This board is factory configured to 24 V contact sense input and open collector output. The second board provides two flow discrete inputs, three circuit breaker inputs, one power on discrete input from both the ACPCA and the DCPCA, and seven outputs to the DEU. It is factory configured for 5 V voltage sense and 5V open collector outputs.

DAM 1


ETHERNET TO WORKSTATIONS
IC 1
IC 4 &
U/L FEP
EXISTING
GMMCA
PIC
IEEE-488
POWER SUPPLY
CONTROLLER
IEEE
-488
POWER CONTROL &
FLOW DISCRETES
TO RS-232C
SWITCH #1
RS-232C
IRIG-B
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CITE
TEMPERATURE
DEU
KEYS
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CHAN
D I/O
CARD
VME BUS

7.5.2.1.6 IRIG - B - READER

The IRIG - B reader is a Bancomm PC03V processor that has been factory modified to provide access to the internal clock by buffering it making it available. The clock provides resolution to one microsecond for the DBES time tag. It is distributed to the DAM 2 DBESMIF cards along with a 1PPS sync pulse. The IRIG format selection is a software controlled process.

7.5.2.1.7 IEEE CONTROLLER

The IEEE 488 controller is a VME bus card used to control the IEEE 488 Power Supply Controller in the DPS console. The provides the overall control for the LRU power supplies PS 1, PS 2 and PS 3. The IEEE 488 has complete Talker/Listener/Controller capability. It also supports the DMA rates up to 500 kbytes/sec. and is fully controlled by the software.

7.5.3 DAM 2

DAM 2 provides the bus monitor functions using the four DBES card sets augmented by the dual port memory. The system manager processor has the dual optical disk attached to the SCSI port for the storage of bus monitoring data. Data inputs to the DBES monitors are selected from the various GPC Manchester busses by means of the 4 x 20 switch matrix.

7.5.3.1 CARD CAGE

The card cage is a commercial 21 slot unit with an internal modular 750 watt power supply. The system manager and other cards are mounted in the cage and an ethernet transceiver is attached. Three slot overlays are used for the DBES bus monitor card sets installed into DAM 2.

7.5.3.1.1 SYSTEM MANAGER PROCESSOR

The System Manager Processor for DAM 2 is the same as for the DAS. Please refer to the section on System Manager Processor for the DAS.

7.5.3.1.2 DATA BUS ELEMENTS SIMULATOR

The four DBESs in DAM 2 operate in the bus monitor mode and require a dual port VSB memory in addition to the DBES processor and the DBESMIF. The DBES, DBESMIF and the dual port memory cards are connected through the VSB overlay.

7.5.3.1.2.1 DBES PROCESSOR

The DBES Processor acts just like the DBES in DAM 1. Refer to the DAM 1 DBES section.

7.5.3.1.2.2 DUAL PORT RAM

The RAM is a16 MB VME card with VSB and capable with the VME bus and the VME Subsystem Bus. The dual port RAM supports even parity and detection with an error reporting capacity. It as features the Addition ability to support mode transfers with block sizes up to 256 kbytes on the VME bus and 64 kbytes on the VSB.

The four cards are configured to reside in the DAM 2 extended address table. Each card has a Control/Status Register that is configured to the DAM 2 Short Address Table. All four of the cards are configured in the same manner.

7.5.3.1.3 IRIG - B - READER:

The DAM 2 IRIG - B - Reader is modified and behaves as the DAM 1 IRIG - B - Reader.

7.5.4 DUAL OPTICAL DISK

The dual optical disk is an erasable optical disk using a 5.25 inch magneto optical disk. It can store approximately 594 Mb at 512 bytes per sector. The data retrieve rate is 7.40 megabits per second using a 2400 rpm rotational speed. The optical disk contains the mechanical and optical components, the analog circuitry for the data separation, servo systems and the digital circuitry for drive control, formatting and interfacing with the disk controller.

7.5.5 TRIAXIAL SWITCH MATRIX

The triaxail switch matrix is a 4 x 20 unit custom package. The triaxail switch matrix is remotely controlled by the RS-232C connector.

7.5.6 RS-232C SWITCH MATRIX

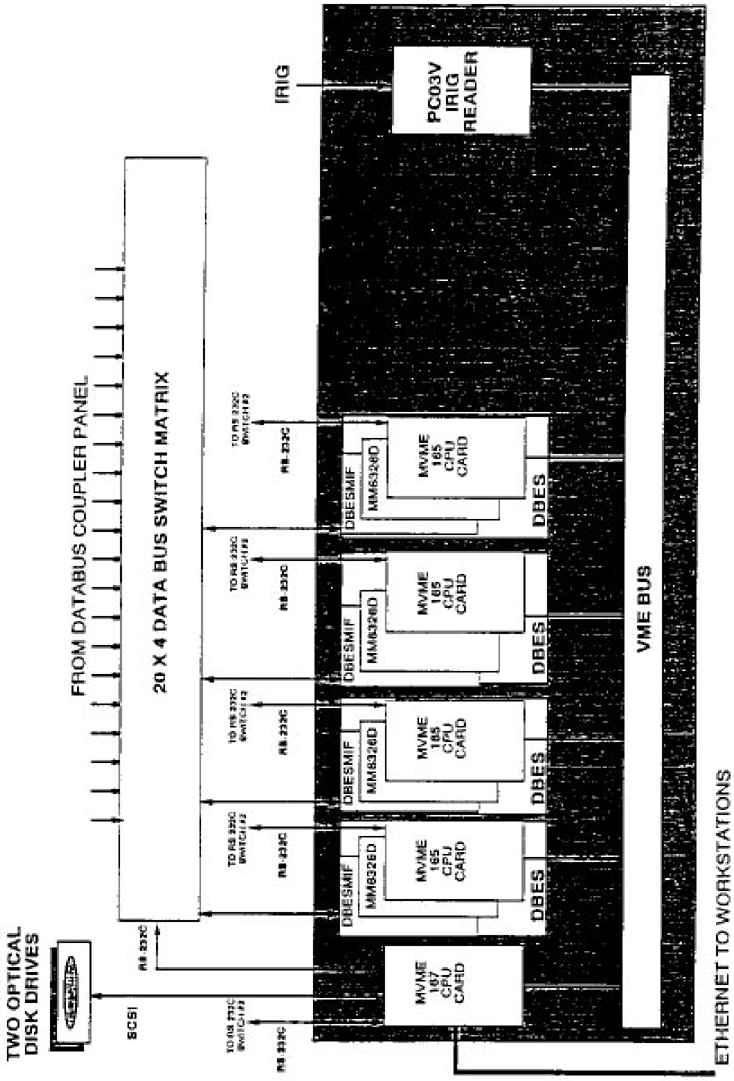
Each of the 4 x 8 RS-232C matrix switches is connected to serial port A on one of the Sun workstations. The RS-232C can be connected to either DAM 1 and the MMS or DAM 2 through the RS-232C matrix switch. All of the RS-232C links are full duplex.

7.5.7 MODEM

The Modem is a V.35 compatible operating at 56 kilobits per second. Its function is to provide a communication interface for the EFT of the Shuttle data products from the Software Production Facility at JSC. The modem also provides the connection between the PC and the 56 kbs digital communications service.

7.5.9 TIME CODE READER/GENERATOR

The Time code Reader/Generator receives IRIG - B time from the CITE and displays the time in standard days, hours, minutes, seconds format.



8.0 OUTFITTING EQUIPMENT

The Outfitting Assembly (OFA) provides the Electrical/Electronic (E/E) interface between the cargo, Payload GSE and the rest of the CITE (E/E) system. The OFA provides the following functions:

- Electronically interconnect all payload dedicated, orbiter equivalent interfaces with E/E CITE
- Electronically interface with the Xo1307 bulkhead panels via the payload GSE distributor (payload users provide the cabling and GSE set that connects to the payload GSE distributor, to exercise/test cargo functions which normally go through the T-0 umbilical)
- Physically verify the mechanical form, fit and function of the payload panels and cables by ensuring the following
  - Duplication of active orbiter interface signals in both the cargo bay and the AFD
  - Simulation of the passive orbiter interface panels and AFD console panel/cable installations

The OFA consists of the following major subassemblies:

- AFD simulation panels and payload close-out panels
- AFD payload interface E/E distribution panels
- Xo576 feed through connector panels
- Xo1307 interface connector panels
- Xo1307 GSE I/F distributor
- Xo645 interface connector panel
- Xo583 interface connector panels and data bus coupler brackets
- Xo795 interface
- PI/RF interface connector bracket
- RMS interface connector bracket
- Retention system power interface
- System cable distribution panel for the VPF
- Test stand cables
- Mission kit panels and cables

The E/E hardware that interfaces with cargo or cargo GSE consists of equivalent connectors, interconnectors and panels to simulate the actual orbiter configuration whenever possible. Cables and wire lengths simulate the orbiter lengths as closely as possible.

The CITE system provides a simulation of the orbiter to the extent that all payload electrical interfaces may be verified. In addition, physical simulation to verify volumetric envelopes and mechanical compatibility is provided at some CITE stand active interfaces. The AFD station is simulated in a like manner however; added emphasis is placed on physical simulation of orbiter display and control console envelopes and cables routed above and inboard of the station distribution panels.

The CITE OFA provides the electrical interfaces between the cargo and the CITE E/E system, the payload GSE interface, the electrical interface at the AFD and the physical simulation of certain AFD panels. Payload interface electrical distribution panels at the AFD, all the cargo bay interfaces and the GSE I/F Distributor provide necessary electrical functions for the cargo checkout with the simulated orbiter. The HPF and the SSPF provide the highest fidelity mechanical simulation of the orbiter of the three facilities that house CITE. The OFA provides the same electrical interfaces at the VPF test stand as in the HPF and the SSPF test stands except the simulated orbiter cargo bay electrical interface panel locations are vertical.

The HPF test stand 4 CITE E/E system cables interconnect the CITE E/E System with the payload bay interfaces located within the test stand and the AFD. The SMCH and ski slope cables provided by Johnson Space Center (JSC) complete the HPF cable set and provide the primary payload interfaces. The ski slope cables extend from the orbiter simulated bulkhead interface plates into the cargo bay cable trays. The ski slope cables extend from Xo576 to the Xo603 location and from the Xo1307 to the Xo1203 location.

Connected to the Xo603 and Xo1203 ski slope are the SMCH cables. Contained in trays the SMCH cables stretch down the port and starboard sides of the LPIS. The SMCH cables provide the cargo with an interface accessible in the test cell payload envelope. The test/verification cables provide a test capability for verifying the copper paths between the CITE E/E System and the cargo interfaces. By utilizing the cable verification unit, the DC load bank, the AC Verification Unit, and the PI/RF test set with the appropriate test verification cables, all cargo interfaces in the AFD and the payload bay may be verified.

The VPF E/E system cable set provides a two test cell capability utilizing a separate cable set for each test cell. Most of the cables that require switching from one cell to the other interface with the CITE E/E hardware through a switch cable distribution panel. The remaining cables that need switched are connected to the Power Supply Assembly (PSA) and Payload GSE I/F Distributor. The cables from the single I/F TD, PSA and other CITE equipment interface with the cell cables at the system cable distribution panel and then are routed to the individual test cell.

The SSPF CITE E/E cables interconnect the CITE system with the payload bay interfaces located within the test stand and the AFD. The ski slope and the SMCH cables complete the SSPF LPIS stand cable set and provide the primary payload interface points. The ski slope cables extend from the orbiter simulated bulkhead interface plates into the cargo bay tray through the simulated short section of the cargo bay cable tray. The short section of the cargo bay tray is fasten to the AFD access stand. This section contains the forward ski slope cables and the Xo603 panels. The aft ski slope cables attached to the Xo1203 panels and are in the work stand. The aft cables stretch from Xo1203 to Xo1307 in the bulkhead.

8.1 MISSION KITS

Mission kits for CITE provide most of the hardware and in some cases all of the hardware required to process specific cargo through CITE. The hardware consist of cables and interface panels required to process the Payload through CITE. On occasion, it is necessary to use flight spares to complete a mission kit. Each and every mission requires a mission kit to complete the signal routing required for that particular mission. Mission kits consist of all or subsets of the Payload Pallet Integrated Hardware (PPIH), Standard Mixed Cargo Harness (SMCH), Aft Flight Deck (AFD) and the payload Unique Kits.

8.2 AFT FLIGHT DECK

The Aft Flight Deck (AFD) at the test stand is a simulated component of the Orbiter hardware. The AFD provides a working platform and support for the Payload Specialist, On-Orbit Specialist (OOS) and the Mission Specialist consoles and electrical interface panels. The AFD consists of the On-Orbit Station (OOS), Mission Specialist Station (MSS) and the Payload Specialist Station (PSS). The Standard Switch Panels are housed in the AFD.

The DC distribution, AC distribution, I/F TD, HIM P/P and the Video distribution and amplifier are contained at the AFD.

8.3 STANDARD SWITCH PANELS

The Standard Switch Panels (SSPs) are located in the AFD test stand. The SSPs have both two and three position switches. Overlays for the SSPs switches are provide for every mission by JSC. The switch overlays show what each switch is designated for and determines how the cables are routed. The Standard Switch Panels (SSPs) provide switching, circuit breaking, fusing and statusing for cargo element use, limited capability for controlling conduct of experiments and power control for pallets.

ACRONYMS

A/D	Analog Input Differential
AOPL	Advance Order Parts List
ABCL	As Built Configuration List
ACPCA	AC Power Control Assembly
AFD	Aft Flight Deck
AGE	Avionics Ground Equipment
APCU	Assembly Power Converter
ASE	Airborne Support Equipment
BAC	Buffer Access Card
BTU	Bus Terminal Unit
C&W	Caution Warning
CD-ROM	Compact Disk Read Only Memory
CAS	CITE Augmentation System
CCB	Configuration Control Board
CCBD	Configuration Control Board Directive
CCMS	Control, Checkout and Monitor Subsystem
CCN	Cost Charge Number
CCTV	Close Circuit Television
CDBFR	Common Data Buffer
CDS	Central Data System
CITE	Cargo Integrated Test Equipment
CMTS	Configuration Management Tracking System
COTS	Commercial Off the Shelf
CPI	CITE POCC Interface
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DAM	Data Acquisition Module
DAS	Data Acquisition System
DBC	Data Bus Coupler
DBES	Data Bus Element Simulator
DBESMIF	DBES Manchester Interface
DCPCA	DC Power Control Assembly
DEU	Display Electronic Unit
DG	Display Generator
DIO	Digital Input/Output
DPS	Data Processing System
DRA	Document Release Authorization
DRAM	Dynamic Random Access Memory
DU	Display Unit
E/E	Electrical/Electronic
EAR	Engineering Action Request
ECS	Environmental Control System
ECP	Engineering Change Proposal

ECR	Engineering Change Request
EFT	Electronic File Transfer
EI	Engineering Instruction
EO	Engineering Order
ESA	Engineering Support Area
ESR	Engineering Support Request
EACE	Engineering Assessment and Cost Estimate
FEC	Field Engineering Change
FEP	Front End Processor
FIFO	First In First Out
FP	Foot Print
FF	Flight Forward
GMMCA	GPC/Mass Memory Control Assembly
GMT	Greenwich Mean Time
GN&C	Guidance, Navigation and Control
GPC	General Purpose Computer
GPIB	General Purpose Interface Bus
GSD	Ground Systems Development
GSE	Ground Support Equipment
HIM	Hardware Interface Module
HPF	Horizontal Processing Facility
Hz	Hertz
I/F	Interface
I/F TD	Interface Terminal Distributor
I/O	Input/Output
IBM	International Business Machines
ICC	Intercomputer Communication
IEEE	Institute of Electrical and Electronic Engineers
INC	Installation Notice Card
IRIG-B	Interrange Instrumentation Group - B
IOP	Input/Output Processor
IPL	Initial Program Load
IPLed	Initial Program Loaded
JSC	Johnson Space Center
KU	Keyboard Unit
LDB	Launch Data Bus
LOE	Level of Effort
LPIS	Launch Package Integration Stand
LPS	Launch Processing System
LRU	Line Replacement Unit
MS-DOS	Microsoft Disk Operating System
MB	Megabyte
MCDS	Multifunction CRT Display System
MET	Mission Elapsed Time
MDM	Multiplexer/Demultiplexer

MLP	Mobile Launch Platform
MM	Mass Memory
MMU	Mass Memory Unit
MMS	Mass Memory Simulator
MRL	Material Instructions and Parts/Spares Requirements List
Mod Kit	Modification Kit
MSS	Mission Specialist Station
MTU	Master Timing Unit
NDM	Network Data Mover
NRZ	Non Return to Zero
NSP	Network Signal Processor
O&C	Operations and Checkout Building
OD	Orbiter Downlink
OFA	Outfitting Assembly
OI	Operational Instrumentation
OI/PL	Operational Instrumentation and Payload
OIS-D	Operational Intercommunication System Digital
OIU	Orbiter Interface Unit
OOS	On-Orbit Station
OPS	Operations
OTS	Off the Shelf
P	Page
P/L	Payload
P/P	Printer Plotter
PDR/SPA	Processed Data Recorder/Shared Peripheral Area
PC-NFS	Personal Computer Network File System
PC	Personal Computer
PCM	Pulse Code Modulation
PCMMU	PCM Master Unit
PDR	Processed Data Recorder
PDI	Payload Data Interleaver
PED	Product Engineering Definition
PFP	Programmable Function Panel
PHES	Payload Heat Exchanger Simulator
PI/RF	Payload Interrogator/Radio Frequency
PLMDM	Payload Multiplexer/Demultiplexer
POCC	Payload Operations Control Center
PPIH	Payload Pallet Integrated Hardware
PR	Purchase Request
PS	Power Supply
PSA	Power Supply Assembly
PSS	Payload Specialist Station
PWA	Private Write Area
RAM	Random Access Memory
RDR	Raw Data Recorder

RMS	Remote Manipulator System
ROEU	Remotely Operated Electrical Umbilical
ROFU	Remotely Operated Fluid Umbilical
RPA	Record and Playback
RSP	Retention System Power
RTP	Retransmission Processor
S/M	Structural/Mechanical
SBC	Single Board Computer
SCRS	Strip Chart Recorder Subsystem
SCSI	Small Computer Systems Interface
SDLC	Synchronous Data Link Control
SIP	Standard Interface Panel
SM	Systems Management
SMCH	Standard Mixed Cargo Harness
SP	Safing Panel
SPA	Shared Data Area
SPF	Software Production Facility
SSP	Standard Switch Panel
SSPF	Space Station Processing Facility
T-0	Time Minus Zero
T&CD	Timing and Countdown
TCP/IP	Transmission Control Protocol/Internet Protocol
TCGs	Time Code Generators
TIA	Task Implementation Authorization
TLCE	Transmission Line Conditioning Equipment
TSS	Task Summary Sheet
TCTI	Time Compliance Technical Instruction
UPLK	Uplink
USS	Umbilical Separation Simulator
V	Volt/Volts
VA	VoltAmps
V&DA	Video and Data Assembly
VGI	VME/GMMCA Interface
VME	Versa Module European
VPF	Vertical Processing Facility
VSB	VME Subsystem Bus
VU	Vehicle Utility
WAN	Wide Area Network
WBFO	Wide Band Terminal System
WBTS	Wide Band Terminal System
∅	Phase