December 19, 2002 at 3:59 PM

International Space Station Data Retrieval On-the-Job Training Package

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1. Introduction

This package has been created for new employees of the Command and Data Handling (C&DH) branch of Payload Processing for the International Space Station (ISS) at Kennedy Space Center (KSC). However, it also serves as a refresher, when needed, for current employees. The intent of is to introduce the employees to the types of data retrievals performed by the branch and how to execute them.

To begin with, there is an overview of C&DH and its functions. The next two sections concern the format of data control (Military-Standard 1553) and data telemetry. Having a general understanding of these concepts is important in understanding projects within the branch.

The following sections relate to testing with which the branch is involved. The first of these sections distinguish which differences between the types of testing are relevant to the branch. The next section concerns Project Unique Identifier (PUI) Finder, which supplements programs described in the following two sections. These are data retrieval programs directly used by the branch in testing, Test, Control, and Monitor System (TCMS) and Protocol Analysis and Simulator System 1000 (PASS-1000). The sections concerning PUI Finder, TCMS, and PASS-1000 are written in a step-by-step format for procedures that would be performed by members of the branch.

In the event that further explanation of C&DH, the programs, or their functions is necessary, consult the appendix of this document. There references and their locations have been provided, along with an acronym list.

2. ISS C&DH

2.1. C&DH

Command and Data Handling (C&DH) is a distributed computer/data system made up of components that allows ground controllers and the crew to interface with and control systems and payloads for the ISS. The components are as follows: Mulitplexers/Demultiplexers (MDM), MDM Software (SW), Portable Laptop Computers, other computers, data buses, Caution & Warning (C&W, the alarm system for the ISS to notify ground and crew of off-nominal conditions and crew safety hazards) panel, automated payload switch, and payload Ethernet hub gateway.

2.2. General C&DH Functions

C&DH provides the capability to send commands to Space Station element end items. End items include the Remote Power Controller Module (RPCM), valves, fans, and many other items. C&DH also provides routing of data across Station computers from end items to Users. Users include Portable Computer System (PCS, for crew on orbit), and Mission Control Center Houston / Moscow (MCC-H / MCC-M) on Earth. Testing of the C&DH system includes data storage and distribution. Test Equipment include 1553 monitors (PASS-1000), high density ground recorders for ISPR 802.3 data, and Telemetry displays and recorders (TCMS). C&DH responsibilities cross all subsystems, since all systems must maintain communication.

2.3. Architecture

The client-server architecture of C&DH is a hierarchy of a master Bus Controller (BC, typical example is a MDM) controlling a Remote Terminal (RT, typical examples are MDM, Firmware Controller [FWC], sensors). The distribution system is Mil-Std-1553 B data bus architecture, explained in 3. Military-Standard 1553 protocols. The primary US computers are MDMs. The secondary computers are FWCs and are function unique (example RPCM). Some are microprocessor-based; some are state machines. Other computers (International Partners [IP], etc) are mostly microprocessor based; many are similar to or exactly like MDMs, though others have a completely unique platform.

2.4. MDM

2.4.1. Control

The basic architecture has three tiers for hardware and software: control, local, and user. The three tiers of control for MDM control: Command & Control (C&C) MDMs, Local Bus MDMs/FWCs, and Subsystem MDMs/FWCs.

Figure 2-1: Three Tiers of MDM Control

Figure 2-2: C&DH Architecture

C&C gets the data around the buses through various functions. They are:

- Telemetry
- Display Data (e.g. to PCS)
- Commands & Data between Processors
- Collect and distribute C&W
- Control / monitor audio, video, Command & Tracking (C&T)
- Acquire / distribute time
- Execute Automated Procedures
- Mass Storage Device Management

On the ISS, for C&C there are three Intel 80386 units: a primary, a backup, and a standby or off. They are all resident in U.S. Lab and have 2.2 MIPs and 1 Mbyte RAM.

2.4.2. Components

There are 2 types of MDMs: Standard Space Station (SS) MDM and Enhanced Space Station (ESS) MDM. The function of a SSMDM is to split one stream of data into several streams (and vice-versa) and provide the computing power of a personal computer. ESSMDM performs the same functions as a SSMDM, but with an added math coprocessor and more memory. The MDMs for the ISS are Intel 386SX machines built by Honeywell; they are unlike orbiter MDMs. Tiers 1 and 2 MDMs are ESS; Tier 3 MDMs are SS. MDMs have multiple configurations based on function.

Figure 2-3: MDM Component Architecture

2.4.3. Interfaces

Bus Interface Adapter (BIA) Interface has the MDM as a RT. It communicates with its BC via this card. Data processing is controlled by either an Input/Output Control Unit (IOCU) or Enhanced IOCU (EIOCU).

IOCU and EIOCU interfaces apply respectively to the SS MDMs and ESS MDMs and have the main differences between them. The IOCU/EIOCU contains the brains for control of the User Application Software, Input/Output (I/O) Backplane (User Card interface), SX Backplane (SPD Card Interface), and communication with the BC (via BIA card). IOCU/EIOCU Features:

- 12 MHz/16 MHz Intel 386SX Processor
- 1.2M/2.2M Instructions per second
- 1 M Byte of EEPROM
- Provides Analog to Digital (A/D) conversions
- Communicates with the Input/Output Card Control
- Interfaces with BIA Card

Serial/Parallel Digital (SPD) Interface provides high speed, digital 1553 communication for two 1553 buses and two serial 485 lines. A parallel port comes standard on the card but not utilized at this time. COTS product provides Bus Controller / Remote Terminal capabilities. SPD Interface has a maximum of 32 devices per bus. Each bus has 2 channels (A and B). Typical use is for station hardware with own processors – motor controllers, other MDMs.

High Rate Data Link (HRDL) Interface provides access for data storage and retrieval to the associated MDMs Mass Storage Device (MSD). HRDL also provides access to the Payload Network through the Automated Payload Switch (APS). It is part of the C&C MDM and P/L MDM Architecture only.

2.4.4. I/O Cards

The I/O cards provide an interface to the various sensors and effectors onboard.

- Low Level Analog (LLA) – sensors
- High Level Analog (HLA) – sensors
- Analog Input Output (AIO) – sensors and effectors
- Discrete Input Output (DIO) – sensors and effectors
- Solenoid Driver Output (SDO) – effectors

The uses of I/O (or User) Cards in Table 2-1: I/O Cards Uses. I/O Cards and their applications are listed in Table 2-2: I/O Card Applications.

2.4.5. Software Products

2.4.5.1. Software Developer Deliverables

User Application Software (UAS) is executable code for executing its software functionality and communicating with its BC/RTs. Pre Positioned Loads (PPLs) are software “updates” which are used to change things such as limits, set points, and configurations as needed throughout assembly and operations of ISS. Configuration Tables / Files are used to determine which RTs are active, which telemetry formats to use, or other unique functions. Other software “databases” used with the executable code to expedite commanding (ex. load shedding during emergency condition).

2.4.5.2. Honeywell Software

Honeywell has three main types of software for ISS C&DH:

- Boot Software for MDM initialization (separate version for Standard versus Enhanced)
- Diagnostic Software for maintaining stored information to determine root cause of problems
- HRDL Software for communication between it’s MSD and processors (for MDMs with Mass Storage Devices)

2.4.6. Memory Map

The two memory types of MDM Software are:

- Electrically Erasable Programmable Read-Only Memory (EEPROM) – Base Load used to activate Computer Software Control Interfaces (CSCI). Software changes to this area of memory remain after a power cycle, and will be used to reboot the system.
- Dynamic Random Access Memory (DRAM) – Dynamic Memory/Run time memory. Software changes made to this area of memory will be lost during a power cycle.

The layout of the Standard MDM Memory Map is Figure 2-4: Standard MDM Memory Map. The layout of the Enhanced MDM Memory Map is Figure 2-5: Enhanced MDM Memory Map.

2.4.7. States

- Startup **(**MDM is executing it's boot/UAS software after power up)
- Primary* (MDM is in control of its RTs)
- Backup/Secondary* (Will take over if Primary MDM stops communicating)
- Standby* (Will go to Backup if Backup MDM stops communicating)
- Failed (MDM may be in a degraded condition)
- Diagnostics (UAS software not running; MDM received box level errors; only low level commands accepted)

* Some software developers use different terminologies to describe these states.

2.5. Mass Storage Device

MSD is a non-volatile device that stores data (300M bytes) with a data transfer rate of 4Mbytes/sec, bi-directional; it providers an onboard hard disk drive for storing software. It is contained in selected ESSMDMs.

2.6. PCS

PCS is the Crew System Interface. Each computer is an IBM ThinkPad 760XD with UNIX based platform (Solaris). They have an external floppy, internal CD, and removable hard drive. They have COTS and custom software. Graphical displays are used for commanding and data display. There is also a C&W display. They support file transfers to/from MDMs and utilizes Recon Files (generated from Standard Out [STD OUT]). They have Mil-Std-1553 Interface and plug into Portable Computer Receptacles (PCRs) in modules. Prior to 5A activation, PCS interfaced w/Node MDMs. After 5A activation, PCS began interfacing with C&C MDMs. PCS can also interface with PL-MDMs.

2.7. Orbiter to Station Interface

Orbiter Interface Unit (OIU) to the ISS C&DH is used for commands and telemetry. It operates as a 'Bent-Pipe' / translator. It was the US controller prior to Node-1 MDM initiation on 2A. Controller interface is for Ultra High Frequency (UHF) Space to Space Communication System (SSCS). On-orbit/pre-assembly Interface (I/F) to activate the Multi-Purpose Logistics Module (MPLM, Mission UF-3), which is also known as ISS Resupply and Return (R&R).

2.8. Station Modes (as determined by C&C)

- Standard (nominal housekeeping, internal maintenance, and Payload operations)
- Microgravity* (needed during Microgravity payload operations)
- Reboost* (needed during reboost Operations)
- Proximity Operations (Ops)* (needed during docking and undocking of vehicles with ISS)
- External* (needed during assembly operations and with Robotics system Extra Vehicular Activity [EVA])
- Survival* (transitions in response to specific failures to ensure ISS survivability)
- Assured Safe Crew Return (ASCR)* (needed during emergency with unplanned vehicle undocking operations)
- Prop Transfer
- Gyrodine Spin-up
- Initial Attitude

* Software coordination between US Guidance, Navigation, and Control (GN&C) and USSR GN&C is required.

2.9. Standard Out

Standard Output is the electronic delivery mechanism for all the United States On-orbit Segment (USOS) generated and interfacing signals and all ISS flight software. Standard Out is used for configuring and providing tables for MDMs, PCS (reconfiguration tables), and ground systems, such as MCC (TCMS for KSC testing). Standard Out C&DH files define:

- Bus profile for all busses (except some user busses)
- BC and RT address assignments
- Command structures and templates
- Command instances
- Cyclic data
- Parameter definition, such as size, data type
- Conversion information for parameters
- Broadcast and payload ancillary data
- Telemetry formats

KSC uses Standard Out for developing procedures and troubleshooting flight/ground Hardware and Software problems. Standard Out:

- Provides command definition and data visibility
  - Broken commands can be identified
  - Commands can be developed on an alternate source (MATE, PASS, etc) and/or built into scripts for automatic execution.
- Tells where data is located during troubleshooting or nominal operations
  - Raw data can be used to verify flight statuses if there are no other ground systems available

   - Multiple locations of data can be verified (raw bus data, and CCS telemetry data)
- Allows ground system development for visibility into critical parameters
   - TCMS data base uses CDH file definitions for buildup
   - Real time flight vehicle monitoring is made simpler!

2.10. Flight Software

2.10.1. Documentation

- Command Description Document (CDD) – Describes the commands for a certain CSCI or FWC.
- Integrated Flight Load (IFL) Build Specification – Listing of all files to be released in an IFL. Most files delivered to KSC are released as part of an IFL. There are two types of IFLs.
   - Ready for Combined Training (RFCT) - The software supporting Space Station Training Facility's (SSTF) RFCT milestone for a Stage; it is not required for all flights.
   - Flight IFLs
      - Launch IFLs – The software loaded on all MDMs and /or MSDs prior to launch. Required for all flights that launch MDMs/MSDs and/or provide new PCS.
      - Stage Ops IFL – Software delivered to MCC at approximately launch – 3 months to enable transition from previous stage configuration to the new stage configuration. Required for all stages.
- Software Requirements Document (SRD) – Definition of operation and commands functions included in a revision of software.
- Telemetry Description Document (TDD) – Describes telemetry available for a certain CSCI or Firmware controller.
- Version Description Document (VDD) – Describes the configuration of a certain version of released software for a particular CSCI. A VDD contains:
   - Memory Maps (if provided by the software developers)
   - Load Instructions
   - File listings for specific CSCI
   - File build/Bundle instructions
   - Revision Levels and Checksum values.

2.10.2. Test and Verification

Flight Software (FSW) is tested at the Software Development and Integration Lab (SDIL) at the Sonny Carter Facility at Johnson Space Center (JSC). There are four different facilities testing different aspects of the software.

- Mission Build Facility (MBF) – Central software and data library; import/export SW products
- Software Verification Facility (SVF) - SVF is used for FSW Verification, C&DH Horizontal Integration, and C&DH Interface Verification. All MDMs (46) on Station

(including international MDMs and OIU will be present. It is used for software verification only; it is not an avionics simulator.
Figure 2-6: Three Tiers of MDM Flight Equivalent Unit (FEU)

- Prime Software Production Facility (PSPF) – C&C and Node 1 MDM SW development; CCS and NCS Formal Qualification Test (FQT).
- ISS System Integration Lab (ISIL) – Flight/ FEU MDMs & RT simulations; troubleshooting of SW problems; dry run procedures.

2.10.3. Maturity Levels

1. Engineering – Initial/development release; not placed under Configuration Management (CM) control by the ISS program.
2. Integration – Placed under CM Control.
3. Test Ready Release (TRR) – Preliminary testing complete; ready for formal testing; CM controlled release.
4. FQT – Formal qualification testing complete; CM controlled release.
5. Flight – FQT and/or Stage testing complete; ready for on-board use. CM controlled release.

2.10.4. Real-time Changes

- Data Load commands – A command that changes a specific location of memory without changing the corresponding checksums. It is usually loaded to DRAM memory.
- Pre-Position Program Load - Changes an area of memory. Usually at least 256 words plus the checksum associated with that area of memory. PPL files come in two formats:
  - Load Image Format (LIF) (final flight loads) – Contains information of what is to be changed in memory as well as routing information through a flight system.
  - Binary – It is loaded through the MATE to memory. It can be loaded to DRAM or EEPROM. It consists of a series of Data Load commands.

2.11. Software Verification Flow

1. Component Development
   a. Software – FSW (CSCI) and SW Simulators
   b. Hardware – MDM Development and Test. Supported by Generic MDM Software and MDM Application Test Environment (MATE) Development and Test. Done by Honeywell-AZ at the Bus Test Lab, Huntington Beach
2. Component Qualification and Acceptance
   a. Hardware and software combine and go to Software Developer/ Factory for Integration and FQT.
   b. When successful, software becomes Certified FSW.
3. Stage Testing and Beyond
   a. Components go to SVF for Stage Testing.
   b. Integrated Test (Acceptance Test/ Multiple Element Integration Test [MEIT]). Special approval is required when non-FQT Software is used for testing at KSC.
   c. Launch

2.12. Figures

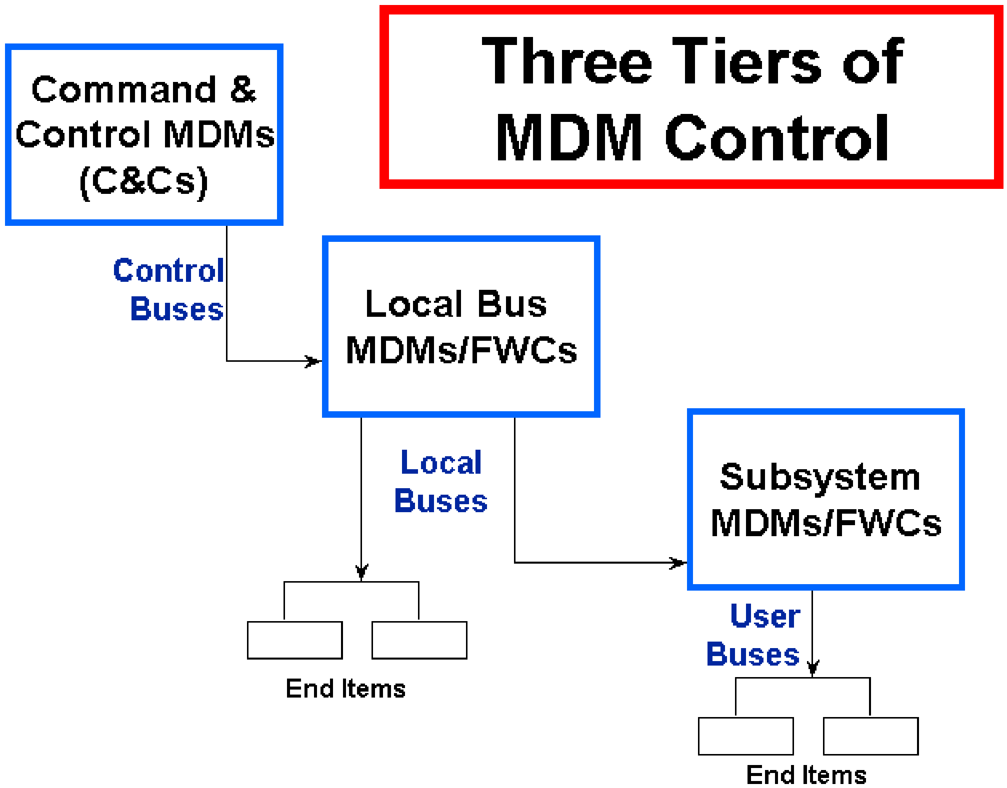


Figure 2-1: Three Tiers of MDM Control

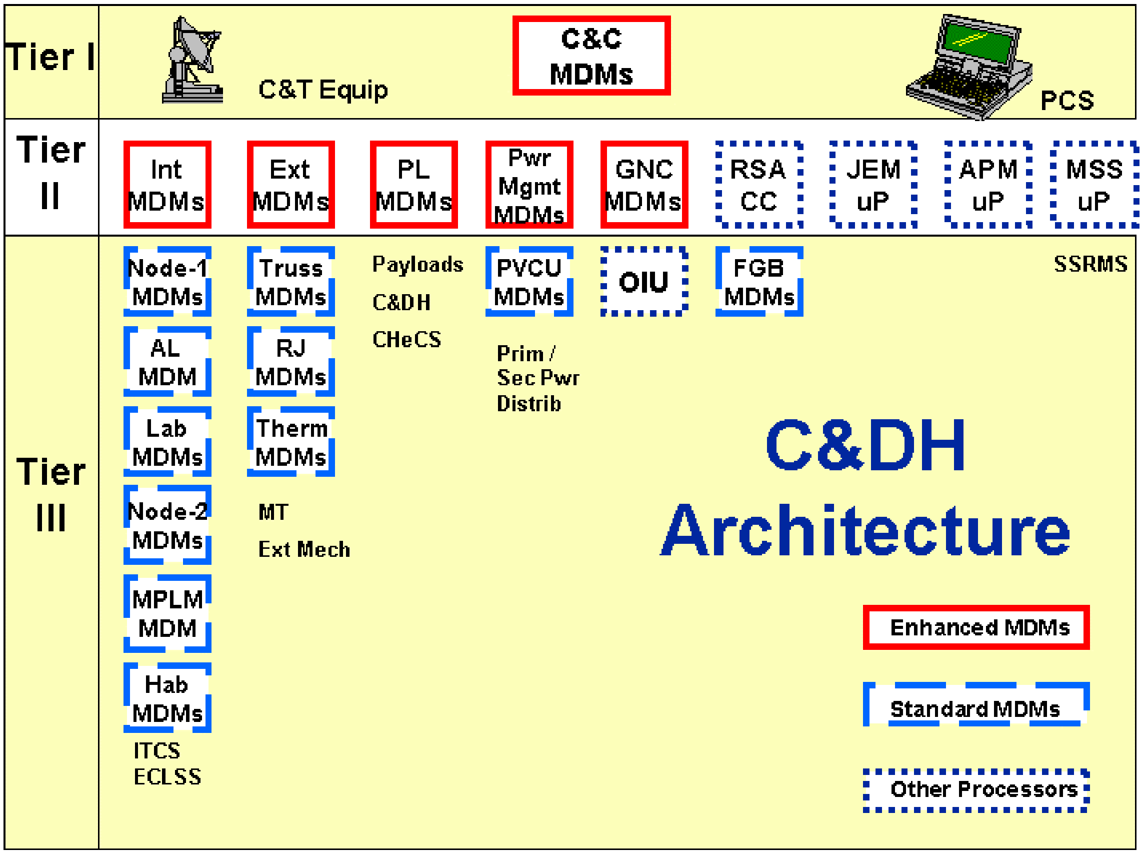


Figure 2-2: C&DH Architecture

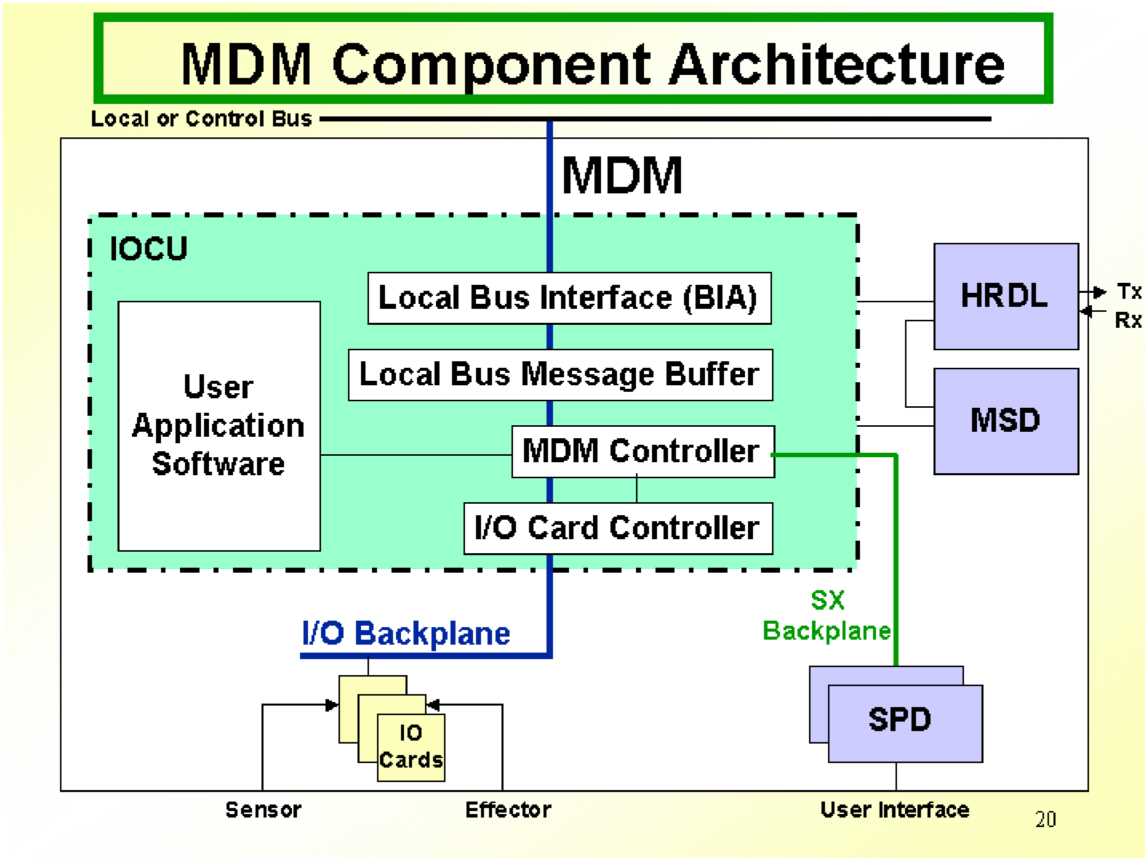


Figure 2-3: MDM Component Architecture

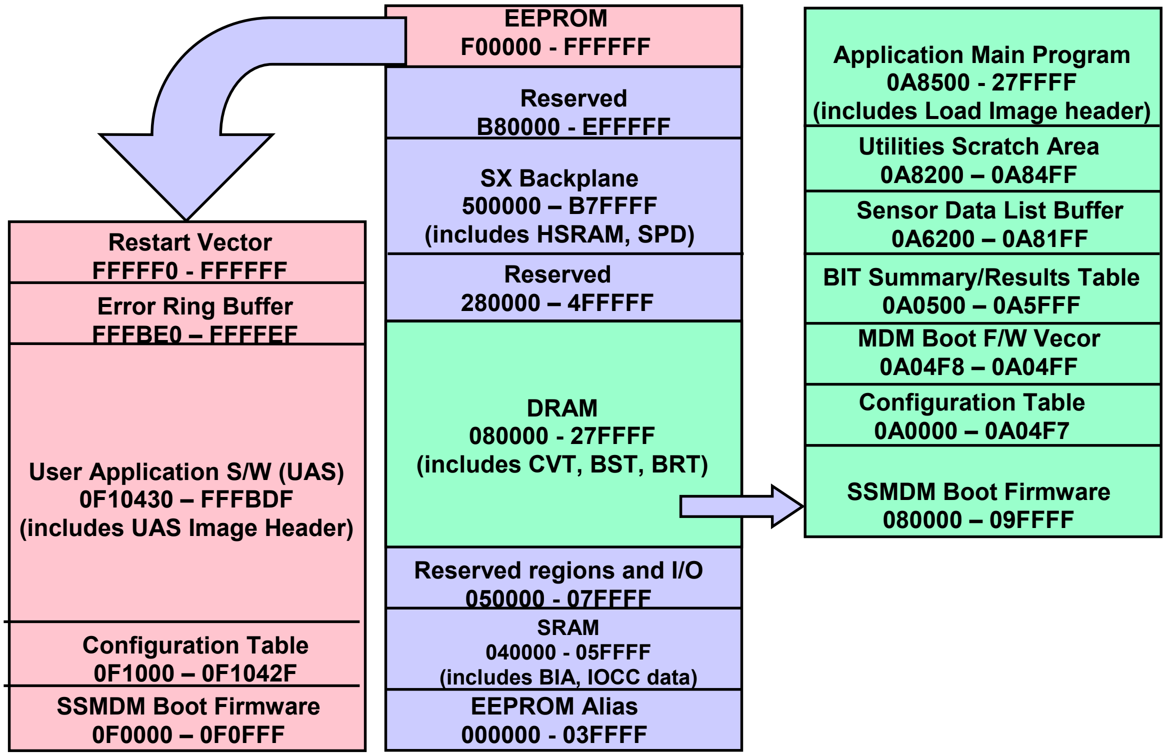


Figure 2-4: Standard MDM Memory Map

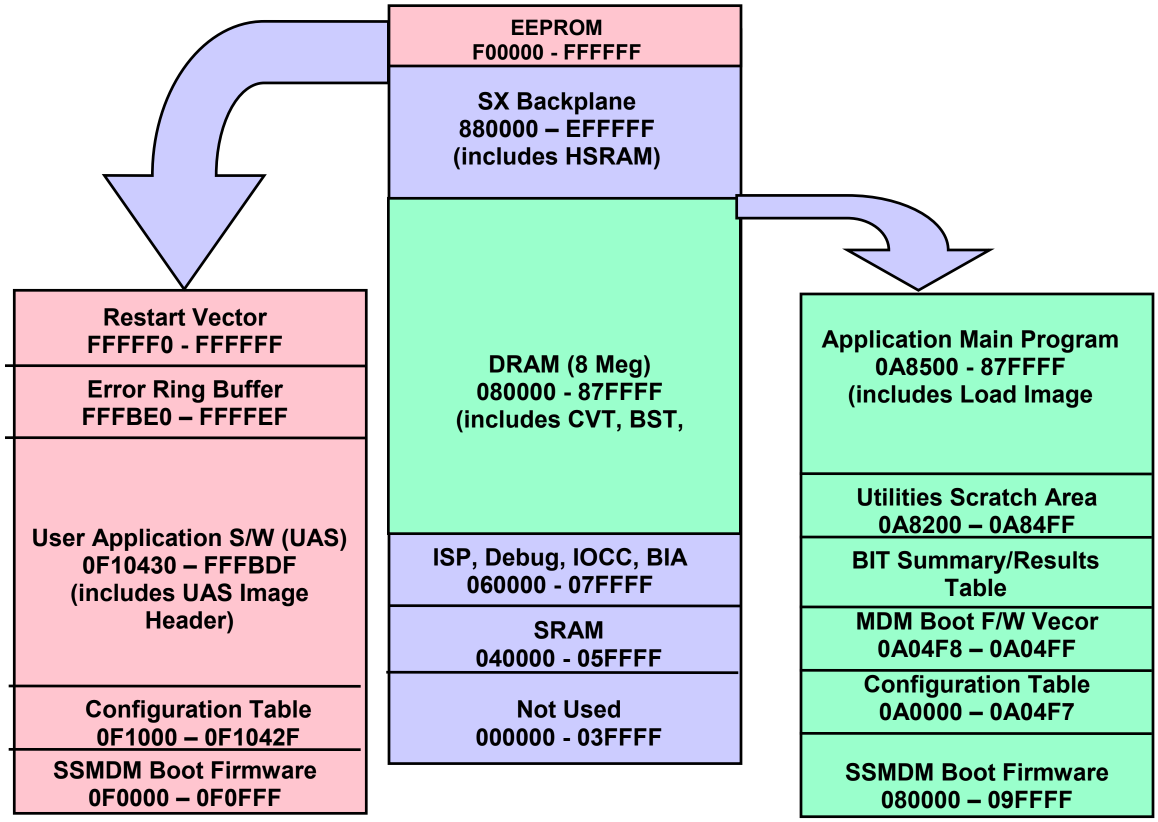


Figure 2-5: Enhanced MDM Memory Map

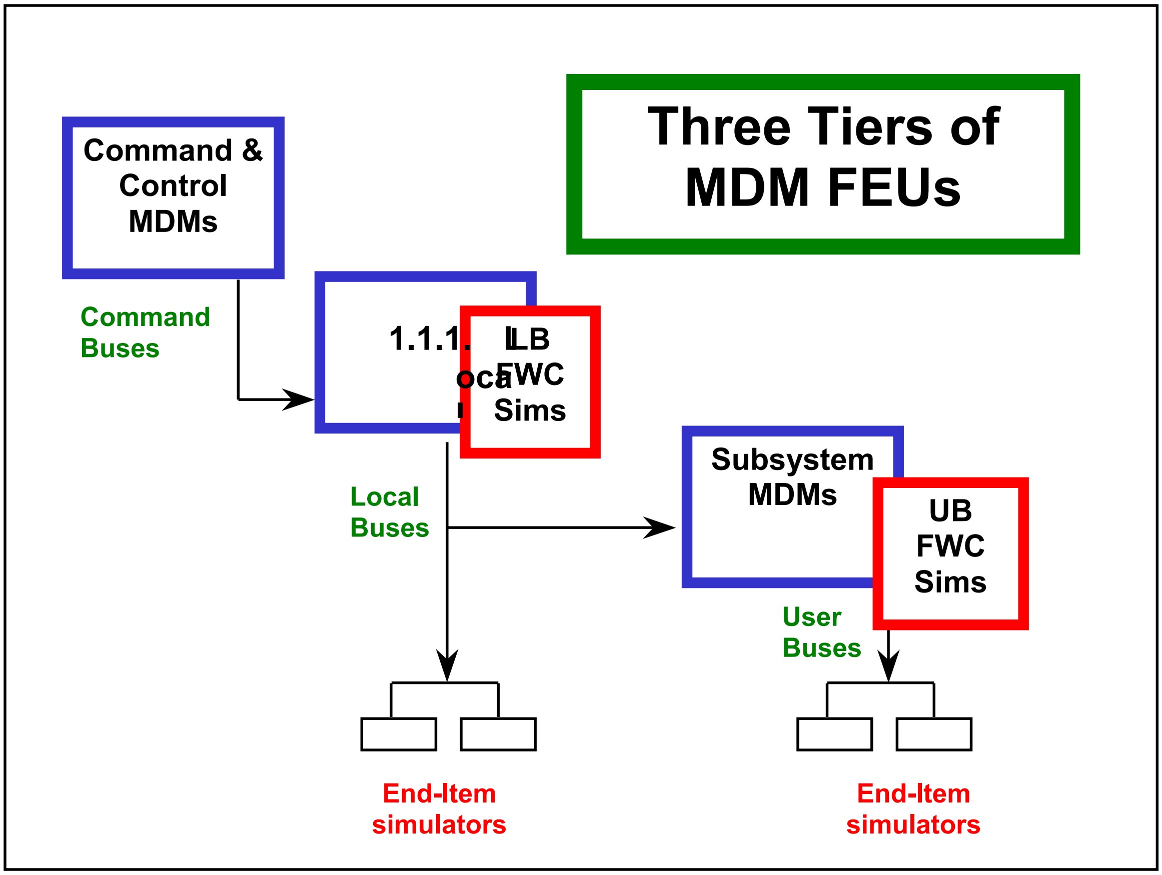


Figure 2-6: Three Tiers of MDM Flight Equivalent Unit (FEU)

2.13. Tables

I/O Card	Typical Use	# Ch	# of Cards on ISS
LLA - Low Level Analog	Reads analog voltage or supplies the current source to measure a voltage drop across a Resistive Temperature Device (RTD). Mainly used for precise temperatures measurements.	32	57
HLA - High Level Analog	Reads analog sensors (pressure, flow rate, speed) and supplies power for transducers.	32	24
AIO - Analog Input Output	Drives analog effectors (fan speeds, valve speeds) and reads analog sensor voltages.	16	22
DIO - Digital Input Output	Reads discrete sensors (valve/switch positions) and commands discrete effectors (valve / switch enable).	32	54

Table 2-1: I/O Card Uses

LLA	Fan Speed Indicator (Environmental Control and Life Support System [ECLSS]) Resistive Thermal Devices (Thermal Control System [TCS])
HLA	RFCA Inlet low and high flow range (TCS) A/L CL EMU1 voltage monitor (EVA)
AIO	RFCA FCV speed command (TCS) CCAA TCCV position command (ECLSS)
DIO	Fan Enable command (ECLSS) IMV Valve position (ECLSS)
SDO	C&W Panel lights (C&DH) LA FWD Port Value solenoid command (ECLSS)

Table 2-2: I/O Card Application

3. Military-Standard 1553 Protocol

3.1. General Information

Mil-Std-1553 was developed to define a communications bus to interconnect different subsystems which needed to share or exchange information. Information is transferred between bus terminals via a 1 Mbps digital serial communications channel. ISS uses version Mil-Std-1553B. C&DH uses it to transmit health and status information and commands and uses dual-redundant channels (channels "A" and "B"). The multiplex data bus system has the elementary configuration shown in Figure 3-1: Typical Data Bus Architecture. The data bus functions asynchronously in a command/response mode, and transmissions occur in a half-duplex manner. Only one of the data buses can be active at any given time; if a terminal receives a valid command from either bus, it will reset and respond to the new command on the data bus it was received.

3.1.1. Terminals

- Bus Monitor (BM) - receives bus traffic and extracts selected information to be used at a later time. It is "listen only." Its information can be used for off-line applications and as an information source for Backup Bus Controller. Figure 3-2: Bus Monitor Functional Elements
- Bus Controller (BC) - initiates all information transfers on the data bus. It participates in all data transfers, receives status responses, monitors systems status. There can only be one active controller on a bus, though it can be an RT on another bus. Figure 3-3: Bus Controller Functional Elements
- Remote Terminal (RT) - any terminal not acting as a BC or BM. Up to 30 RTs can be on a 1553 bus. RTs have two sets of 32 message "buffers" of 32 words each. One set is "receive" subaddresses, and the other set are "transmit" subaddresses. Messages are addressed to the applicable RT address and subaddress. RT address 31 is used for messages to be broadcast to all RTs. The RT responds to the last valid command received. Figure 3-4: Remote Terminal Functional Elements

3.1.2. Message Transfer Formats

The terms "transmit" and "receive" are with respect to the RT. The transfers are illustrated in Figure 3-5: Information Transfer Formats.

- BC to RT transfer (Receive)
- RT to BC transfer (Transmit)
- RT to RT transfer (not used for ISS)
- Mode Command (can be transmit or receive, with or without data)

3.1.3. Word Formats

The data flows in three types of words: command, data, and status, illustrated in Figure 3-6: Word Formats. All 1553 words are 20 bits long and encoded in biphase (Manchester II) coding. Figure 3-7: Data Encoding. Each word contains a synchronization signal (sync) that is 3 bits long, 16 data/command/status bits, and 1 parity bit. The sync and parity bits are required by the 1553 hardware in determining 1553 message formats and data errors. Command and status words use a positive sync; data words use a negative sync. Figure 3-8: Word Syncs. Odd parity is used for 1553.

- Command – consists of a sync, RT address, transmit/receive bit, subaddress/mode, data word count/mode code, and parity bit.
  - Sent only by the BC.
  - Subaddresses 0 and 31 (00000 and 11111) are used to indicate a mode command.Mode code is a means by which the Bus Controller can communicate with the multiplex bus related hardware, in order to assist in the management of information flow. Table 3-1: Assigned Mode Codes
- Data – consists of a sync waveform, data bits, and a parity bit.
- Status – consists of a sync waveform, RT address, message error bit, instrumentation bit, service request bit, three reserved bits, broadcast command received bit, busy bit, subsystem flag bit, dynamic bus control acceptance bit, terminal flag bit, and a parity bit.
  - Sent only by an RT.
  - Status bits are reset on receipt of a valid command, with the exception of the following two mode commands: transmit status and transmit last command.
  - The message error bit indicates an error in the previous message with word validation, transmission continuity, proper word count, or (optional) illegal command detection. The RT sets the bit and ignores the command completely, waiting to send status when next contacted by the BC. If the error was in the command word, the RT does not set the message error bit and ignores the command. Valid commands have good word form. An illegal command is a user-defined valid command whose bit combination is not used by the user.

3.2. ISS Transaction

Figure 3-9: ISS C&DH 1553 Data Bus Architecture

Table 3-2: 1553 Subaddress Assignment Example

3.2.1. Types of ISS 1553 Messages

The following are types of ISS 1553 messages. There can be other types of messages on local or user busses.

- Broadcast sync - The bus controller's current processing frame is the first transaction of each processing frame. Broadcasts on all busses to let the RTs know what processing frame is active. RTs may be command to "sync" to BIA (BC).

- Broadcast time - Time is broadcast once a second
- Ancillary (BAD: RT31 Receive subaddresses 13,14; and PSAD: PL-MDM Receive subaddresses 22, 23,24):
  - Broadcast Ancillary Data (BAD) - Status information from station components gathered by the C&C and broadcast back. This is how one MDM finds out the status of a component that it does not control. Some other systems also use the term "Broadcast Ancillary," but the data set would be different unless they are propagating the BAD.
  - Payload Specific Ancillary Data (PSAD) - Goes from the C&C to the Payload MDM. The Payload MDM may then pass on all or part of the data to the payloads. It is a similar to BAD, but tailored to the Payload needs.
- Cyclic data - Heath and status data from the RT (transmit subaddresses, number of messages varies)
- Standard commands - Receive subaddresses; For MDMs, usually subaddresses 27 and 28)
- Memory load commands - Data packets to the RT (For MDMs and PCS, receive subaddresses 15 through 23)
- Memory dump (normal and extended) - Data packets from the RT. (For MDMs, transmit subaddresses 14, 15, 16)
- Pass through from another bus (cyclic data, commands)
- Command polls – Command requests from an RT to the BC
- Binary Data Transfers - S-Band Telemetry and RPCMs

Figure 3-10: ISS Link Layer Supported Communications Pipes

3.2.2. Common Status Bits

The RT responds to the 1553 transfer with a status word, and then data words if any were requested. The most significant bits are transferred first with the less significant bits following in descending order of value in data word. The following status bits are most commonly used for ISS.

- Most significant 5 bits are the RT address.
- Message error (message not supported, such as cyclic data when an MDM is in diagnostic mode).
- Service request bit (used by C&T RTs).
- Busy bit (set when the RT doesn't have time to respond to the request. Not used by most ISS RTs).
- Subsystem flag (used by MDMs to indicate diagnostic mode, used by C&T).

3.2.3. Command

Commands have a header, which follows the CCSDS definition.
Figure 3-11: Command Headers.

Three types of commands are utilized on board the ISS: Standard Commands, Data Load/File Transfer Commands and Non CCSDS Firmware Commands

- Standard Commands are used to instruct or command a function at the destination of a command and consist of one or two CMSG_CON 1553 messages of which the first message always contains the CCSDS protocol.
- Data Load/File Transfer commands are used to transfer data from the source to the destination and consists of up to 9 CMSG_CON messages of which the first message always contain the CCSDS protocol.
- Non CCSDS Firmware Commands do not contain CCSDS headers and are used to transmit.

The Command Structure provides a shell for the types of commands that are available to be transmitted to a particular destination. Actual transmitted commands to the onboard system is identified as 'Instantiated Commands.' The instantiated command provides the unique values for the parameters established by the Command Structure. In some cases, commands will be available as ‘Template Commands’, which again is based on the Command Structure; however, the actual values for the parameters will be inserted at the command source.

A Command Structure Signal is defined as a structure of digitized Command Primitive Signals that could originate from the ground, the PCS, or a MDM/Processor CSCI and is transmitted on a 1553 bus via the C&C MDM to the target MDM/FC/Processor for the purpose of initiating an action within the target MDM/FC/Processor CSCI. The purpose for MDM/FC/Processor Command Structure signals is to identify the existence of commands to each unique CSCI without identifying the specific physical MDM/FC/Processor receiving the command.

3.2.3.1. Command Routing

Most flight elements have one or more Application Identifiers (APID), which are routing IDs.

- The APID is a source destination pair.
- Many MDMs have a pair (or three in the case of the C&C) of MDMs where one functions in the “Primary” mode and the other in a “Backup” or “Secondary” mode. For these MDMs, “Logical” APIDs are assigned, so the actual MDM that will receive the command depends on what modes the MDMs are in.
- Most MDMs also have a physical APID which is specifically for that MDM so that commands will be routed to that MDM regardless of the mode of the MDM. Not all MDMs have physical APIDs for uplink, such as the GNC and the C&C MDMs.
- An additional bit is associated with the APID (“TYPE” in word 1 in the previous table). 0 = CORE, which applies to most of the MDMs, including the payload MDM. 1 = Payload, which is for applies to payloads such as the Human Research Facility (HRF)
- In addition to command APIDs, each MDM has an APID for routing data to the ground, such as for dump data, so that the ground can tell where the data originated.
- When an MDM receives a command, the APID is checked to see if the command destination is that MDM. If not, then the MDM will check the APID table and route

the command accordingly. If the APID is not found in the MDMs APID table, then the command will be rejected.

3.2.3.2. Command Fields

- For each APID, a sequence count is maintained so that the MDM will know whether the command that was received is new or was previously processed. If the sequence count for the particular APID has not changed, then the command will be ignored.
- There is a time ID which indicates what type of time, if any, is included in the header. Time is calculated from midnight, January 5/6, 1980 (This time is related to the GPS satellite.)
- Sequential count which expresses the length of the remainder of the packet including checkword if present. The value is the number of bytes (octets) following this field minus 1. (An easy way to calculate the number of words in the command is to take the packet length, convert from hex to decimal if necessary, add 1, divide by 2 and add 3.)
- All commands that have CCSDS headers should include a checksum. The checksum is a 16 bit add without carry of all command words (including the header) up to but not including the checksum itself.
- Standard commands on the control busses are transmitted in two 32 word 1553 messages. The unused words (based on the packet length field) may be zero filled or residual data.
- For some lower tier RTs the CCSDS header and fill words are stripped off, such as for the C&T equipment and RPCMs.

3.2.3.3. Command Response

MDMs provide a command response in cyclic data. The command response consists of:

- ➢ Words 1 and 2 of the command (which provides the APID and sequence count)
- ➢ Command response (0 = good response)
  Figure 3-12: Command Response

Some MDMs also provide an application layer response, since the standard command response is often just a transfer layer response. An example application layer response would be if the MDM is in the wrong state to perform the command.

3.3. Figures

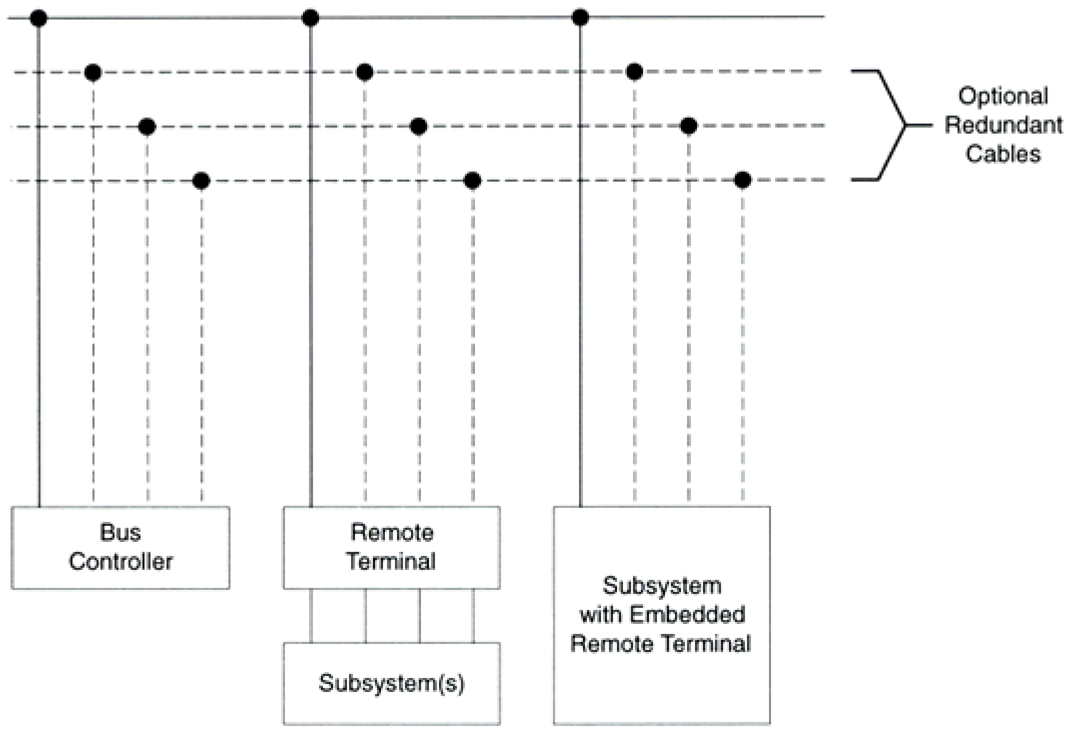
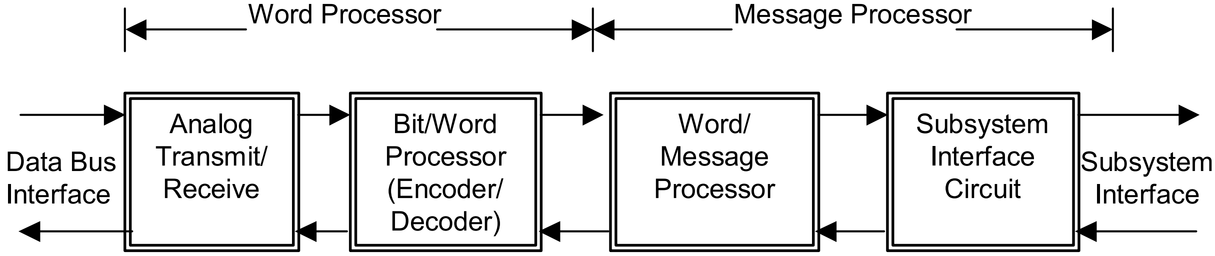


Figure 3-1: Typical Data Bus Architecture



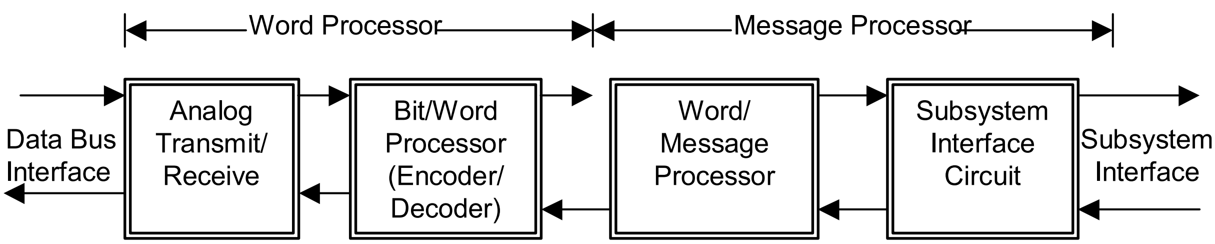
RECEIVE
•Signal Limiting
•Filter
•Threshold Detect
COMMON
•Bus Coupling

RECEIVE
•Receiver
•Sync Detection
•Data Detection
•Manchester Error Detection
•Parity Check
•Bits/Word Count
CLOCK GENERATION

RECEIVE
•Common Word Decode
•Address Recognition
•Mode Execution
•Word Count Detection
•Message Error Detect
BUILT-IN-TEST
INTERFACE CONTROL
•Data Address
•Control Registers
MEMORY BUFFERS

•Direct Memory Access

Figure 3-2: Bus Monitor Functional Elements



RECEIVE
•Signal Limiting
•Filter
•Threshold Detect
TRANSMIT
•Driver
•Transmitter Control
COMMON
•Bus Coupling

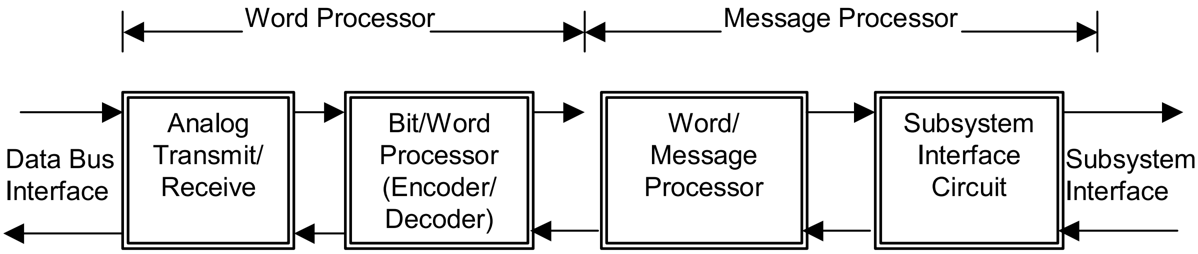
RECEIVE
•Receiver
•Sync Detection
•Data Detection
•Manchester Error Detection
•Parity Check
•Bits/Word Count
TRANSMIT
•Transmit Control
•Sync/Data Encode
•Parity Generation
CLOCK GENERATION

RECEIVE
•Word Count Detection
•Message Error Detect
TRANSMIT
•Word Count
BUILT-IN-TEST
INTERFACE CONTROL
•Data Address
•Control Registers
MEMORY BUFFERS

•Conversion
•Calibration
•Self Test

•Direct Memory Access

Figure 3-3: Bus Controller Functional Elements



RECEIVE
•Signal Limiting
•Filter
•Threshold Detect
TRANSMIT
•Driver
•Transmitter Control
COMMON
•Bus Coupling

RECEIVE
•Receiver
•Sync Detection
•Data Detection
•Manchester Error Detection
•Parity Check
•Bits/Word Count
TRANSMIT
•Transmit Control
•Sync/Data Encode
•Parity Generation
CLOCK GENERATION

RECEIVE
•Common Word Decode
•Address Recognition
•Mode Execution
•Word Count Detection
•Message Error Detect
TRANSMIT
•Word Count
•Status Register
BUILT-IN-TEST
INTERFACE CONTROL
•Data Address
•Control Registers
MEMORY BUFFERS

•Channel Selection
•Data Sampling
•Conversion
•Subsystem Timing
•Buffer Registers
•Calibration
•Self Test

•Direct Memory Access

Figure 3-4: Remote Terminal Functional Elements

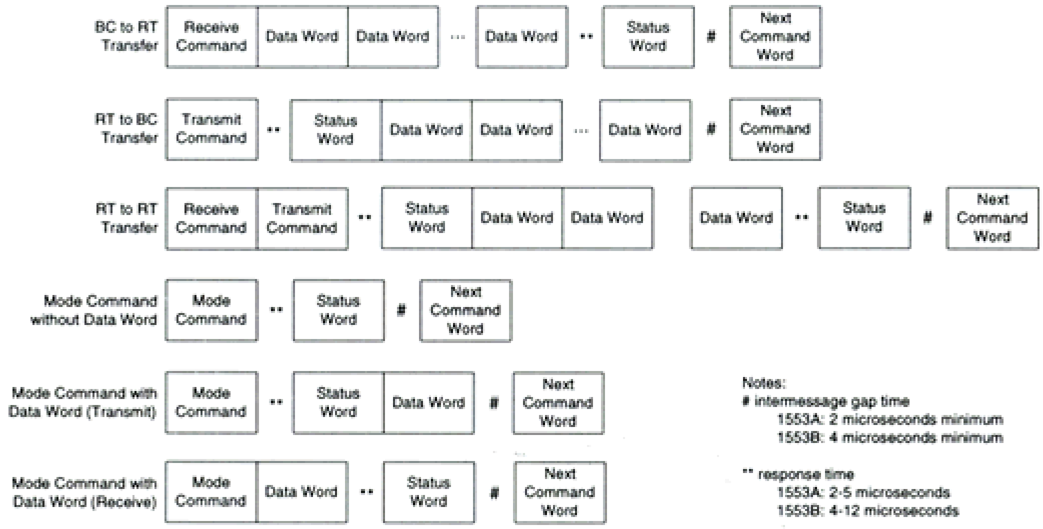


Figure 3-5: Information Transfer Formats

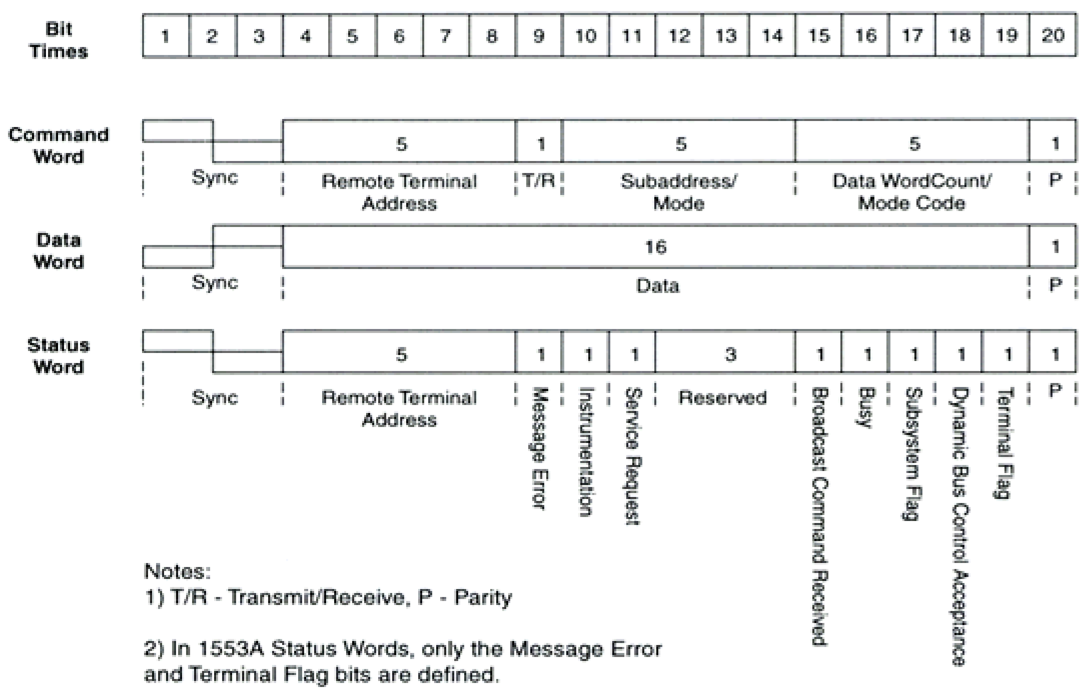


Figure 3-6: Word Formats

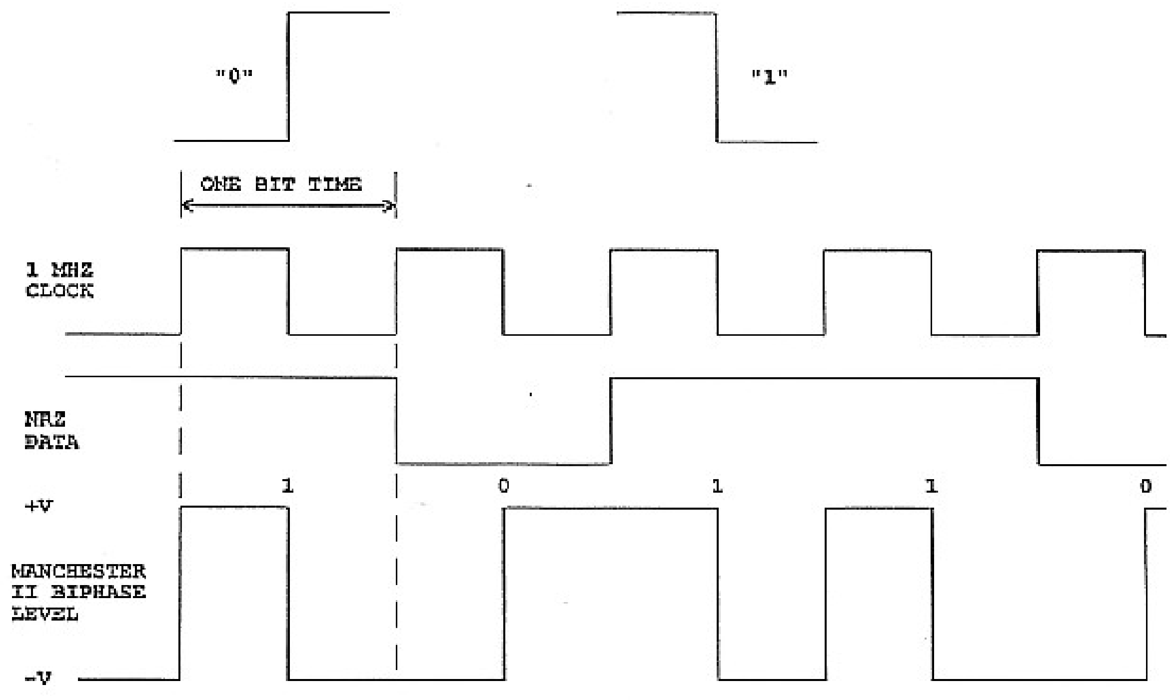


Figure 3-7: Data Encoding

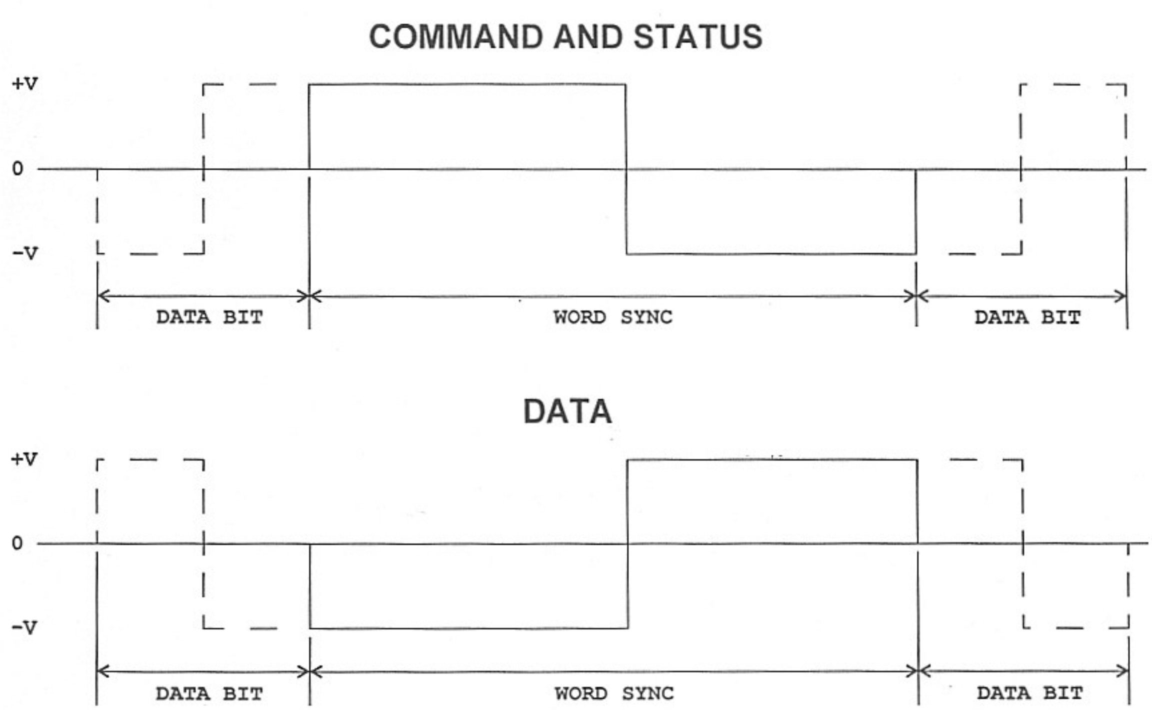


Figure 3-8: Word Syncs

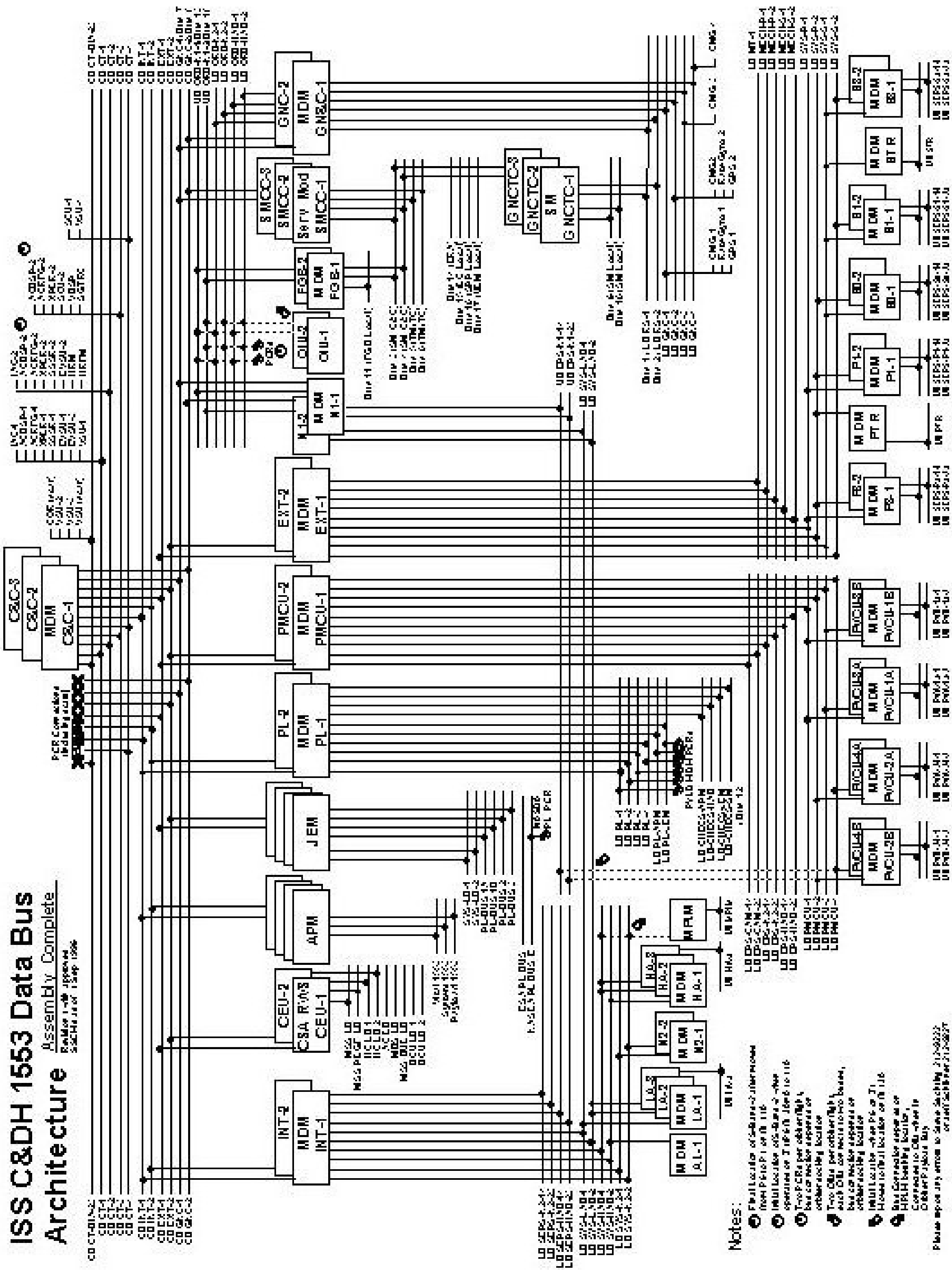


Figure 3-9: ISS C&DH 1553 Data Bus Architecture

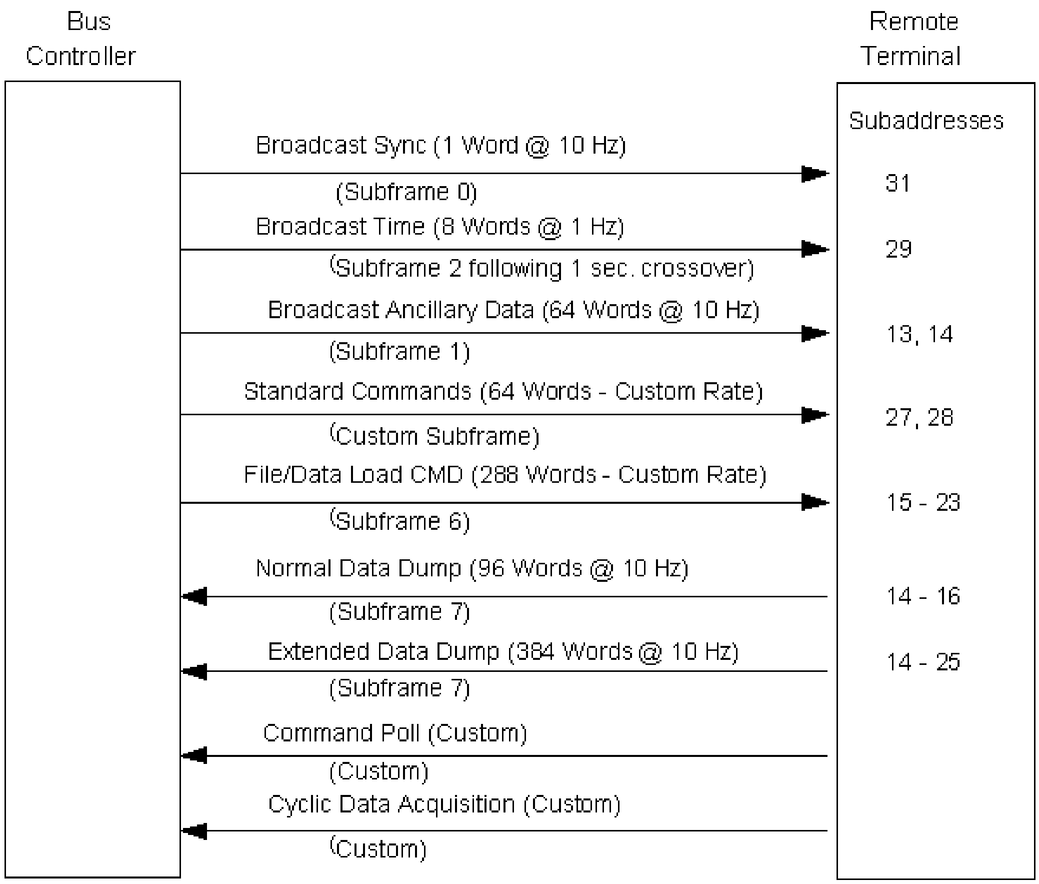


Figure 3-10: ISS Link Layer Supported Communications Pipes

<table>
<tr><th>Field</th><th>Wd #</th><th>MSB</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th>LSB</th></tr>
<tr><td rowspan="3">Primary Header</td><td>1</td><td colspan="3">Version ID (000)</td><td>Type</td><td>Sec Hdr Flag (1)</td><td colspan="11">Application Process ID (APID)</td></tr>
<tr><td>2</td><td colspan="2">Seq Flags</td><td colspan="14">Packet Sequence Count</td></tr>
<tr><td>3</td><td colspan="16">Packet Length (# octets - 1 following this field)</td></tr>
<tr><td rowspan="5">Second-Header</td><td>4</td><td colspan="16">Time (MSBs of Coarse Time)</td></tr>
<tr><td>5</td><td colspan="16">Time (LSBs of Coarse Time, LSB = 1 second)</td></tr>
<tr><td>6</td><td colspan="8">Fine Time</td><td colspan="2">Time ID</td><td>Chk wrd</td><td>ZOE TLM</td><td colspan="4">Packet Type</td></tr>
<tr><td>7</td><td>Spare</td><td colspan="4">Element ID</td><td colspan="11">Packet ID Word #1 (Element and Usage Dependent)</td></tr>
<tr><td>8</td><td colspan="16">Packet ID Word #2 (Element and Usage Dependent)</td></tr>
<tr><td rowspan="2"></td><td>9</td><td colspan="16">User Data Word #1</td></tr>
<tr><td>n-1</td><td colspan="16">User Data Word #n-1</td></tr>
<tr><td></td><td>n</td><td colspan="16">User Data Word #n - Checkword (optional depending on the value in the Checkword bit in word 6)</td></tr>
</table>

Figure 3-11: Command Headers

Response Code	Definition	Response Code	Definition
0	Command Accepted	14	Invalid Dump Address
1	Sequence Error (1)	15	Command Routing Error
2	Checksum Fail	16 – 50	Spare (2)
3	Invalid APID	51	Command Inhibited
4	Spare	52	Illegal Command Code
5	Time Authentication Failure (1)	53	Command Parameter Error (e.g., out of range, missing.)
6	Time Tag error : Execution too far in future (1)	54	Improper command sequence
7	Time Tag error : Execution too far in past (1)	55-60	Spare
8	Time Tag error : Time Tagged Command Queue Full (1)	61	Command Function not available
9	Time tag command error: Duplicate Command (1)	62	Incompatible Operational State
10	Invalid Station Mode (1)	63	Commanded device or process busy
11	Command Routing Queue Full	64	Commanded ORU unavailable
12	Spare	65	Commanded ORU Failed
13	Application Queue Full	66-100	Spare
		101 +	reserved for applications

Figure 3-12: Command Response

3.4. Tables

Transmit or Receive	Mode Code	Function	Associated Data Word	Broadcast Command Allowed	Notes
T	00000	Dynamic Bus Control	No	No	1
T	00001	Synchronize	No	Yes	
T	00010	Transmit Status Word	No	No	2, 3
T	00011	Initiate Self-test	No	Yes	
T	00100	Transmitter Shutdown	No	Yes	2
T	00101	Override Transmitter Shutdown	No	Yes	2
T	00110	Inhibit Terminal Flag Bit	No	Yes	1
T	00111	Override Inhibit Terminal Flad Bit	No	Yes	
T	01000	Reset Remote Terminal	No	Yes	2
T	01001	Reserved	No	TBD	
⇑	⇑	⇑	⇑	⇑	
⇓	⇓	⇓	⇓	⇓	
T	01111	Reserved	No	TBD	
T	10000	Transmit Vector Word	Yes	No	
R	10001	Synchronize	Yes	Yes	
T	10010	Transmit Last Command	Yes	No	3
T	10011	Transmit Bit Word	Yes	No	
R	10100	Selected Transmitter Shutdown	Yes	Yes	
R	10101	Override Selected Transmitter Shutdown	Yes	Yes	
T or R	10110	Reserved	Yes	TBD	
⇑	⇑	⇑	⇑	⇑	
⇓	⇓	⇓	⇓	⇓	
T or R	11111	Reserved	Yes	TBD	

Notes:

1 Not Allowed for Broadcast Use by the USAF
2 Required by Mil-Std 1553
3 Remote Terminal does not reset Status Word upon recipient of this Command

Table 3-1: Assigned Mode Codes

Primary INT Subaddress Assignments

S/A	Receive	Transmit
00	Mode Code	Mode Code
01	LA-2 C&W Panel Control Command	INT Cyclic Data (1)
02	N2-1 C&W Panel Control Command	INT Cyclic Data (2)
03	N2-2 C&W Panel Control Command	INT Cyclic Data (3)
04	Not Used	CBM Cyclic Data (1)
05	Not Used	LA-1 Cyclic Data (1)
06	Not Used	LA-1 Cyclic Data (2)
07	Not Used	LA-2 Cyclic Data (1)
08	Not Used	LA-2 Cyclic Data (2)
09	Not Used	LA-3 Cyclic Data (1)
10	Not Used	LA-3 Cyclic Data (2)
11	Not Used	AL-1 Cyclic Data (1)
12	Not Used	MPLM Cyclic Data (1)
13	Broadcast Ancillary Data (1)	MPLM Cyclic Data (2)
14	Broadcast Ancillary Data (2)	Data Dump (1)
15	Data Load (1)	Data Dump (2)
16	Data Load (2)	Data Dump (3)
17	Data Load (3)	N2-1 Cyclic Data (1)
18	Data Load (4)	Not Used
19	Data Load (5)	N2-1 Cyclic Data (1)
20	Data Load (6)	N2-1 Cyclic Data (2)
21	Data Load (7)	N3 SDS Valve Command Poll
22	Data Load (8)	Not Used
23	Data Load (9)	Not Used
24	Not Used	Not Used
25	Not Used	Not Used
26	Not Used	CAM -1 Data Acquisition - (reserved)
27	Standard Command (1)	CAM -2 Data Acquisition - (reserved)
28	Standard Command (2)	BIT Summary Table A
29	Broadcast Time	BIT Summary Table B
30	Reserved (Data Wrap Write)	Reserved (Data Wrap Read)

Table 3-2: 1553 Subaddress Assignment Example

4. Data Telemetry

4.1. Cyclic Data

Cyclic Data is health and status data from the RT (transmit subaddresses, number of messages varies).

4.2. Telemetry

Telemetry is the process of collection, preparation, and transmission of digitized information from one point to another via an established communication medium. The ISS employs several technologies to accomplish this task, each requiring different conventions of description.

4.2.1. Normal S-Band Telemetry Definition

ISS S-Band Telemetry Definition is the process of packaging data acquired by the functioning C&C MDMs from lower-tier devices and making it available for transmission to various signal sinks. Routing varies with the sink and ISS configuration. Basic telemetry constructs vary with the targeted ISS functional coverage. In the ISS nominal telemetry sink and routing scheme, the C&C MDMs receive the accumulated signal data via sets of MDM-unique 1553B data acquisition messages. Predefined Telemetry Format tables are utilized by the C&C MDM to build S-band telemetry packets. Packet content and content rate assignments are predicated on data acquisition availability and ISS functional status-reporting requirements. There is a predetermined set of telemetry packet types, each containing a unique CCSDS header and a set maximum number of words of data. The data contained in each packet is allocated to discrete rate groups (10Hz, 1Hz and .1 Hz). Each rate group contains primitive signal data that is stored either in words, double words or individually depending on its bit size. Packets are combined by the C&C MDM into a processing frame transfer of telemetry data, which is transmitted every 100 milliseconds at high rate or less often at low rate.

4.2.2. Data Organization

These are the levels of organization for telemetry data. Each unique telemetry version is assigned a group PUI as the highest level group identifier, with subgroup and signal SPUI content assignments made as necessary to fully define its specific version construct and content. For identification and organization, each level below version are assigned a group PUI, with subgroup and signal SPUI content assignments made as necessary to establish telemetry construct definition within the level above it.

1. Telemetry Version - that total set of potential telemetry content which is collected and organized for transmittal within the largest basic processing increment. For the ISS, that increment is termed a major frame and is composed of 100 units called processing frames, each of equal construct. The C&DH has defined a fixed task-scheduling environment based on a 10Hz processing frame from which the telemetry task receives its cyclic organization. Telemetry major frames and processing frames may be of a different time base than the C&DH processor task scheduling and I/O frames. Each specific telemetry version is defined to the program to enable interim and end-user consumption of the telemetry data.
2. Processing Frame -that total set of potential telemetry content, which is collected and organized for transmittal within one telemetry transmission increment. ISS C&DH design defines 100 such transmissions within each C&DH telemetry major frame.
3. Packet -a CCSDS compliant construct of information with predefined content that has been assembled for transmission, one or more of which compose a telemetry processing frame transfer of information.
4. Rate Group - a contiguous set of words within a telemetry packet which have been assigned to contain information refreshed at a specified frequency.
5. CCSDS Header Group - that set of contiguous words within each telemetry packet necessary to establish the ISS adopted CCSDS packet protocol for telemetry transmissions.

4.2.3. Word and Double Word Groups

- The Telemetry Word and Double Word Groups that are contained in a full telemetry rate group of data are identified by unique group SPUIs. The telemetry content definition inherits these SPUIs, and their attributes, from the data acquisition bus messaging definition process necessary to make signals available for the telemetry definition process.
- The Telemetry Signals that are full-length primitives, or contained in telemetry word and double word groups of data, are identified by unique signal SPUIs. The telemetry content definition inherits these SPUIs, and their attributes, from the established ISS primitive signal definition process.

4.3. Broadcast Ancillary Data (BAD)

BAD EXT Data (BED) uses data outputting to command (one MDM outputs and changes a bit and this cycles through and is treated as a command by another MDM). Status information from station components gathered by the C&C and broadcast back. This is how one MDM finds out the status of a component that it does not control. Some other systems also use the term “Broadcast Ancillary,” but the data set would be different unless they are propagating the BAD. It is broadcast to RT address 31.

4.4. Payload Ancillary Data

Payload Ancillary Data (PAD) is system-related data that goes from the C&C to the Payload MDM via the 1553B Control Bus. Selected parameters within the PAD are then provided to payloads by the Payload MDM. Since the PAD contains system data, the PUIs for the parameters to be included in the PAD are already defined.

The requirements for the parameters contained in PAD come from Payload Developers (PD), Payload Integrators (PI), MSFC Payload Operations Personnel, etc. The PAD potentially can change on a per-flight basis because of new requirements being received from PDs/PIs, or in response to anomaly resolution.

It is the responsibility of the Payload Utilization Office to collect the requirements for the data that must be contained in the PAD, and to provide the necessary IP&CL inputs to the MBF to ensure that the required parameters are contained in the PAD.

Requirements for the parameters (PUIs) contained in PAD will be provided to the MBF during the Engineering Cycle (approx. 90% complete) and during the Flight Cycle (100% complete) for each flight with new payloads or subrack payloads.

PAD is a similar to BAD, but tailored to the Payload needs.

5. Test Type Variance in Simulated Data

For more test configurations in addition to those in this package, go to TCMS Simulation Configurations.

5.1. Utilization

For Utilization testing, ancillary data is simulated. This is due to the TCMS emulating the C&C. The cyclic data from the PL-MDM is real.

5.1.1. Payload Rack Checkout Unit (PRCU)

PRCU is the distributed verification of payload interfaces to the ISS ICDs. KSC PRCU is used for re-verification of payload interfaces as required, verification of ISPR/EXPRESS rack or attached payloads required by Payloads Office to undergo verification in PRCU prior to testing in PTCS, and offline post-delivery check. For PRCU, the C&DH system is capable of LRDL, MRDL, and HRDL emulation and simulating C&C MDM.

5.1.2. Payload Test and Checkout System (PTCS)

For PTCS, the C&DH system provides high fidelity compliment of on-orbit interfaces through the use of Program FEUs (PL MDM, PEHGs) and services to verify command and data pathways/interfaces. TCMS simulates C&C and APS RT. TCMS also does S-Band Uplink commanding and system control/monitoring. The following equipment is unique to this testing: MATE 3, PDA, and PDG.

PDSS-KSC provides payload telemetry routing and distribution to EHS-KSC and User GSE. EHS-KSC provides a user interface for uplinking data to ISPR/AP and accepting health and status data from the ISPR/AP. PDSS-KSC is a subset of the MSFC PDSS system (H/W and S/W) and EHS-KSC is a subset of the MSFC EHS system (H/W and S/W)

Figure 5-1: Utilization Payload Test and Checkout System (PTCS) Design

5.2. MPLM

For MPLM testing, TCMS simulates INT-MDM and Orbiter Interface Unit (OIU).

Figure 5-2: MPLM Post-Rack Installation Test (PRIT) Configuration

Figure 5-3: MPLM - TCMS Design Certification Review

5.3. MEIT 3

Figure 5-4: MEIT3 with Node 2 (JEM-PM/Node 2/US Lab Emulator)

Figure 5-5: MEIT 3 Caution and Warning Mode

5.4. Figures

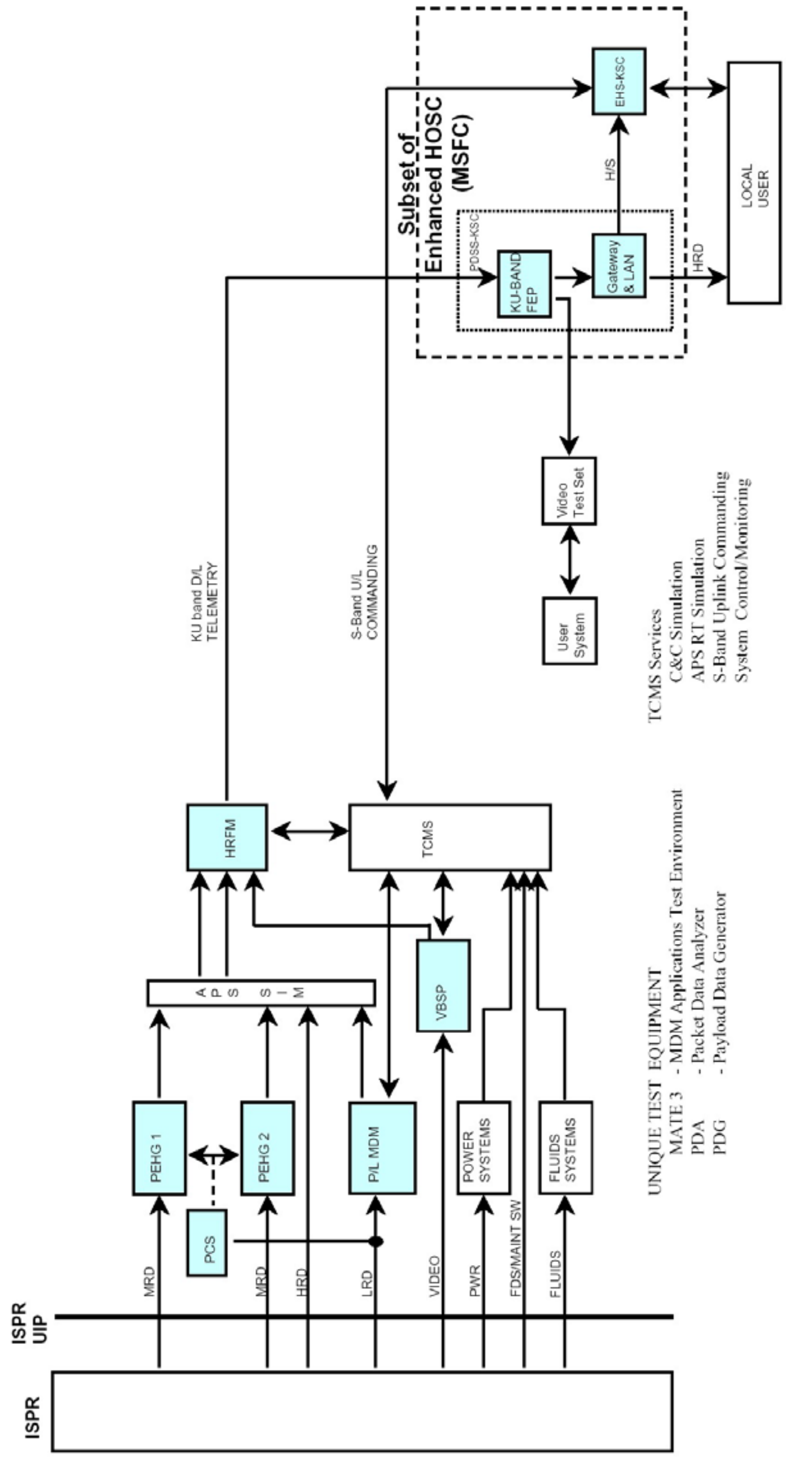


Figure 5-1: Utilization Payload Test and Checkout System (PTCS) Design

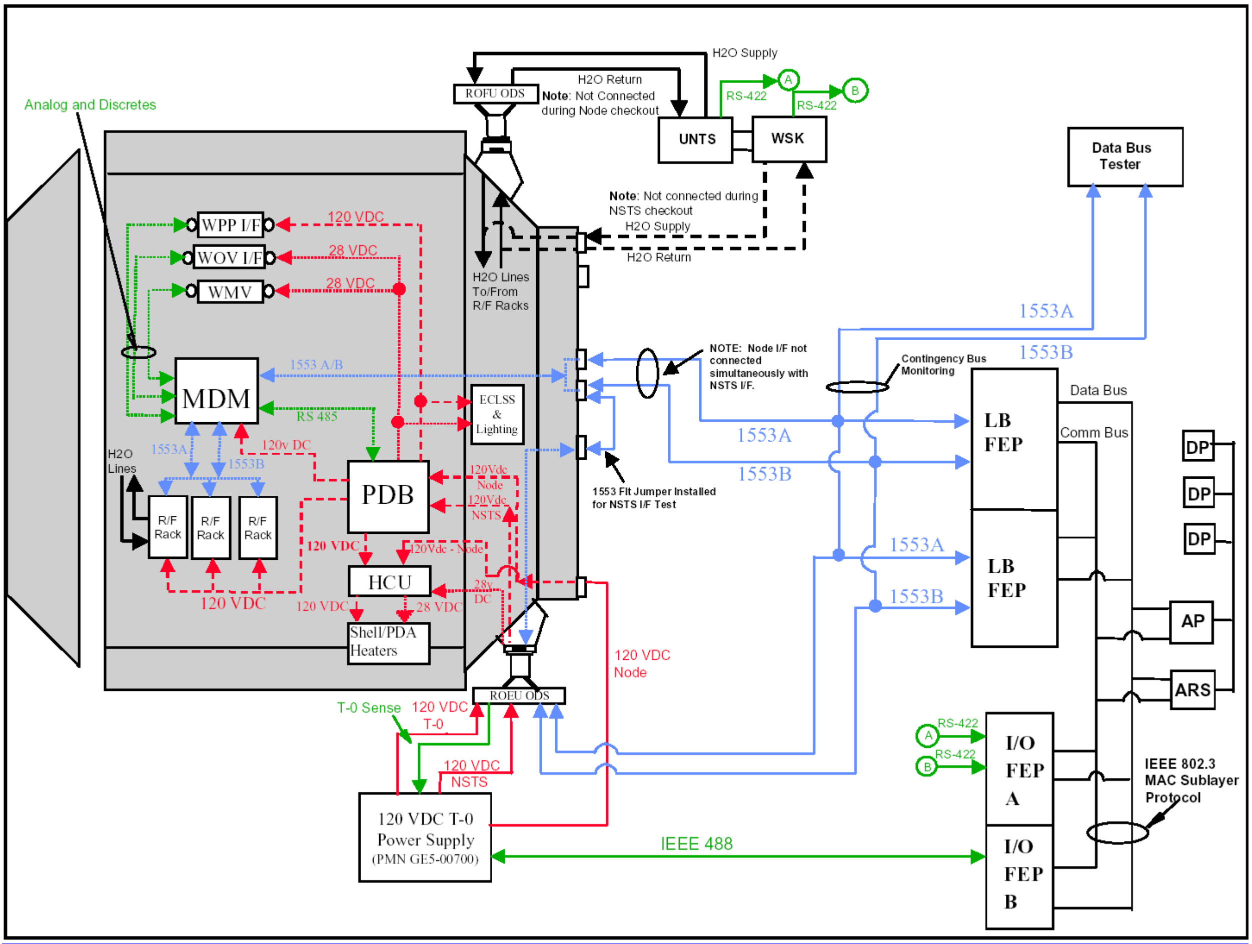


Figure 5-2: MPLM Post-Rack Installation Test (PRIT) Configuration

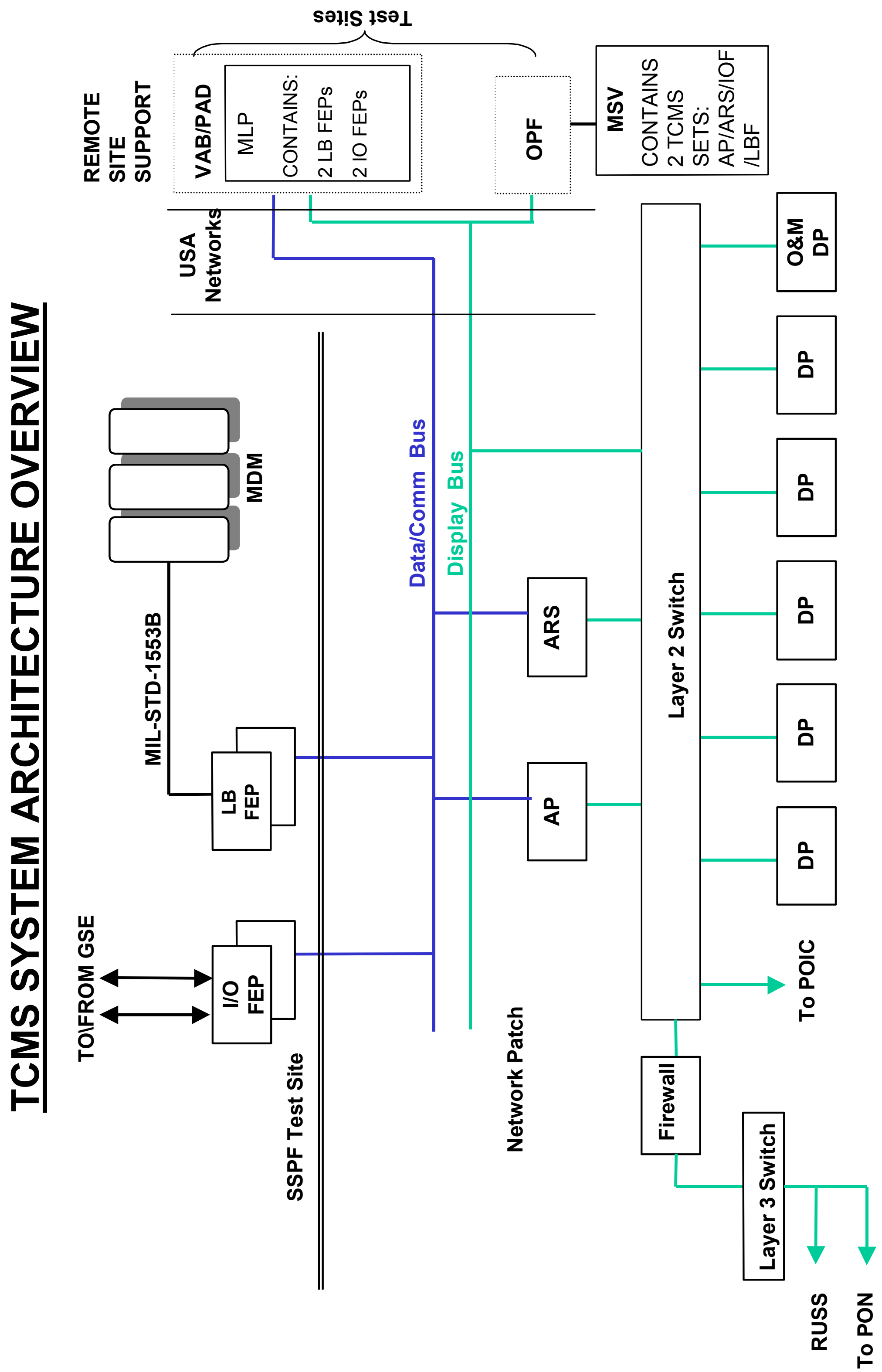


Figure 5-3: MPLM - TCMS Design Certification Review

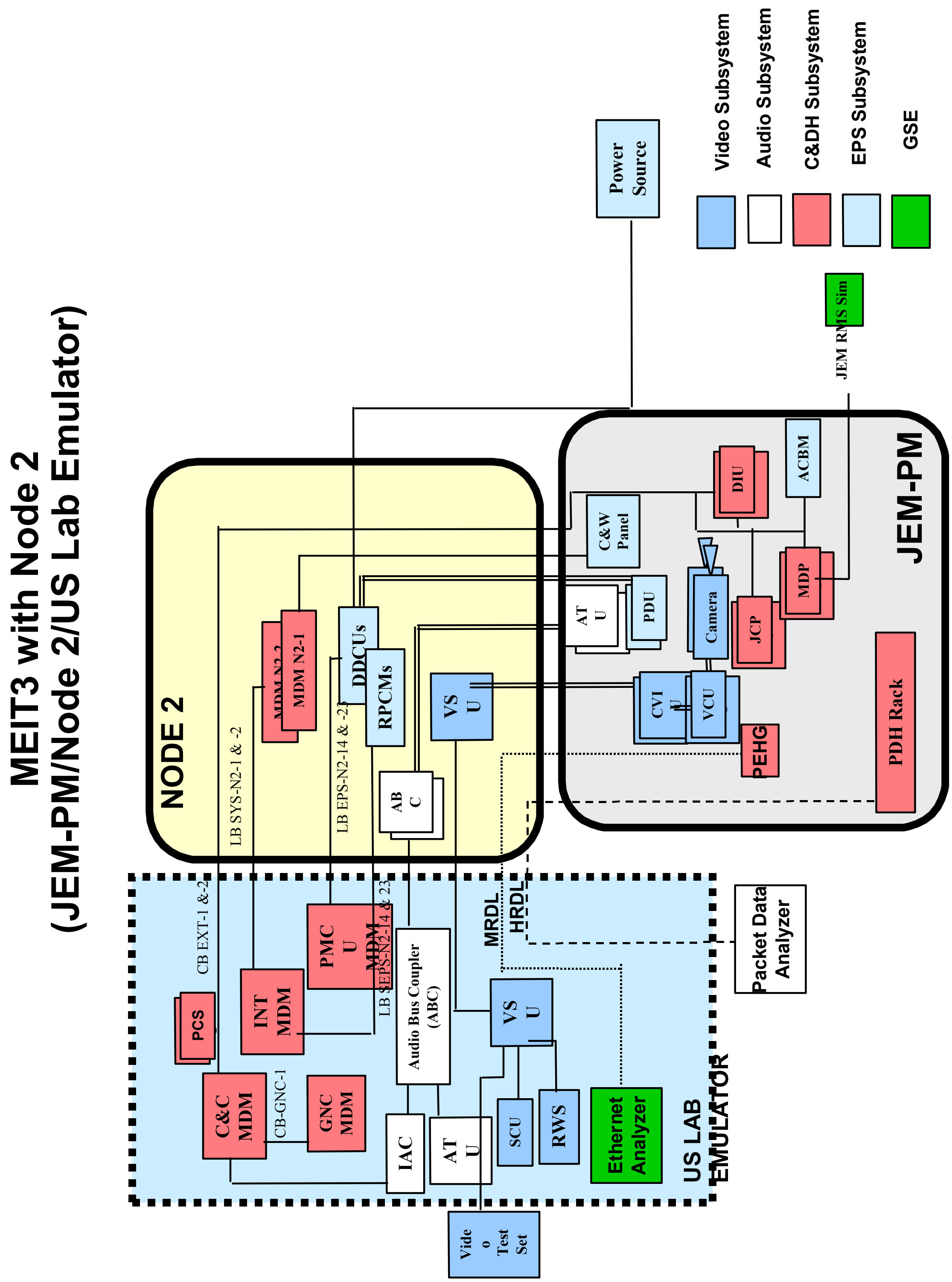


Figure 5-4: MEIT3 with Node 2 (JEM-PM/Node 2/US Lab Emulator)

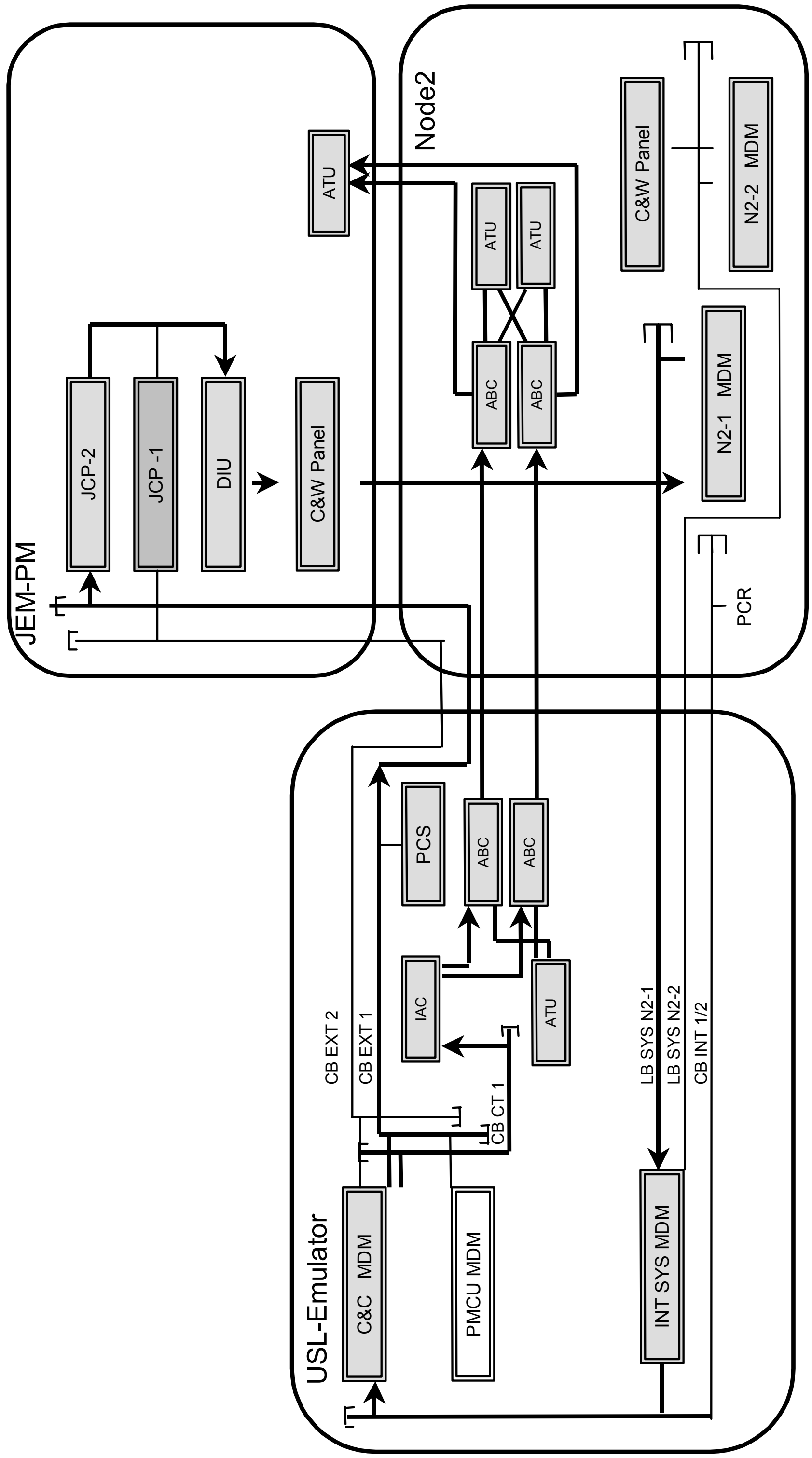


Figure 5-5: MEIT 3 Caution and Warning Mode

6. PUI Finder

6.1. PUI Types

Program Uniquie Identifiers (PUIs) are used to identify ISS command and data. The following is a list of types of PUIs. A description of some of the PUI types is in Table 6-1: Types of PUIs.

- Signal
- Conversion
- Word
- Group (usually rate group, such as 10 Hz, 1Hz, 0.1 Hz)
- Command Template
- Command Instance
- Bus
- Device (6 characters)
- Requirement

6.2. Signal PUIs

Signal Program Unique Identifiers (SPUIs) are used to identify all ISS signals. An ISS signal is defined as data needed/provided by the flight crew, ground crew, ISS hardware elements, ISS firmware controllers, ISS PCS, or ISS MDM CSCI. ISS Signals are those signals that traverse (in either direction) the wiring between sensor devices, effectors, and the on-board processors, which are used by ground or onboard operations for command and control of the Station.

Figure 6-1: ISS Signal Data Domain
Figure 6-2: ISS Signal Data Domain Detail

The name given to a signal PUI is based on its following qualities:

- Functional System Data Provider: RT device, generic group device, or logical MDM device generating (source) or receiving (destination) the Message Content Group Signal (6 characters)
  1. Element (2)
  2. Functional system (1)
  3. Subsystem/assembly/CSCI (3)
- Generic Device Code (2 characters)
- Sequence Number (4 characters)
- Signal Type (1 character)

Figure 6-3: Signal PUI Format

There are five categories of SPUIs:

- Hardware Primitive
- Firmware Primitive
- Software Primitive

- Groups
- Command Instantiations

6.3. Group Signals

The concept of signal grouping is utilized throughout the signal data definition and capture discipline and is the identifying of instances of physical hierarchical containment structures for signals. These structures are given the name "groups". They may consist of a grouping of signal information as it appears on a 1553B or non-1553 data bus, or a grouping of signal information as it appears within an air-to-ground telemetry transmission, or a grouping of signal information as it appears within a CCSDS header, etc. Group identifiers (SPUIs) are assigned as an abstract method of identifying these structures that are inherent in the designed C&DH signal management system.

6.4. Downloading PUI Finder

Before using PUI Finder, it is necessary to have PUI Finder and special MS Access databases downloaded or linked. The program and databases can be found through links on the Command & Telemetry Certification & Operations website at http://hsi.jsc.nasa.gov/c&t/index.htm.

6.5. Using PUI Finder

6.5.1. Opening PUI

1. Select the **Database** from which to view the PUIs.
   Figure 6-4: Selecting Database
2. Select the **PUI** text box and enter the name of the PUI. Select **Find**.
   Figure 6-5: Entering PUI

6.5.2. General Retrieval Data

1. Select the **F01 FW/SW** tab. Relevant data: Data Type. For data type, the numbers represent the number of relevant bits; the letters represent what form of data the numbers are in. Full explanations of all the data types can be found in Appendix J of the Prime Contractors Software Standards and Procedures Specifications. The common forms and how to find their meaning are as follows:
   Figure 6-6: F01 FW/SW (Firmware/Software)
   a. E is enumerated; each value represents a state conversion. Select the **F21SC** tab. The Code column lists the possible data values and the corresponding definition is under the Definition column.
      Figure 6-7: F21 SC (State Conversion)
   b. UI is unsigned integer; it needs to be converted from hexadecimal to decimal.
   c. SI is signed magnitude; the sign of the unit needs to be figured out and the value of the other 15 bits needs to be converted from hexadecimal to decimal. Select the **F22PC** tab. The first bit of the data determined the sign of the data; 0 value for positive, 1 value for negative. Therefore, for a value of 800A, your 16 bit signed integer value is Negative 10; for a value of 000A, your 16 bit

signed integer value is Positive 10. The Conversion Units column lists the unit the data is to represent. When there is a curve, it is necessary to convert the data to reach its proper value. To convert to the required unit, assign the given data to be the unit x and use the formula $A_0 + A_1x + A_2x^2 + A_3x^3 + A_4x^4 + A_5x^5$. There may be different coefficients based on certain restrictions on the data, such as if it is + or -, or if it is with in a certain range.
Figure 6-8: F22 PC (Polynomial Calibration)

d. F is floating point; it is a real number represented by a three-field binary format as required by IEEE standard 754 for floating point numerics. It needs to be converted from hexadecimal to IEEE. There is a converter on TCMS at location/HexToIeee ######## and on the web at http://babbage.cs.qc.edu/courses/cs341/IEEE-754hex32.html. There also is a converter for IEEE to hexadecimal on TCMS at location/IeeeToHex ################################## and on the web at http://babbage.cs.qc.edu/courses/cs341/IEEE-754.html.

6.5.3. Message Retrieval Data

1. Select the **Msg Ref** tab. Relevant data (in the same row(s) as the bus from which data is required): Source PUI, Processing Frame(s), Subaddress(es), Word Offset, Bit Offset, and Word Order.
   Figure 6-9: Message Reference
2. RT Address:
   a. Select the **PUI** text box and enter the name of the Source PUI.
   b. Select Device in the **PUI Type** box. Select **Find.**
   c. Select the **CDH ADD** tab. Go to the row with the relevant bus name. Relevant data: Bus address (RT address). This is not always dependable and the CDH Architecture Design Document (ADD) is where to find the exact information.
   Figure 6-10: Command & Data Handling Architecture Design Document
3. Select the **Pipe Ref** tab. Relevant data: Rate. This information concerns how many times a second the data is updated (1 Hz: updates once a second; 10 Hz: updates ten times a second)
   Figure 6-11: Pipe Reference

6.5.4. Telemetry Retrieval Data

1. Select the **Tlm Ref** tab. Relevant data (in the same row as the telemetry version used during the required time period): Telemetry Group PUI, Telemetry Group Name, Tlm Frame, Tlm Group, Word Offset, Bit Offset, and Word Order.
   Figure 6-12: Telemetry Reference
2. Open the Telemetry Group PUI found under the Signal PUI's Tlm Ref tab.
   a. Select the **PUI** text box and enter the name of the Telemetry Group PUI. Select **Find**.
   b. Select the **F03 GD** tab. Relevant Data: Content Offset.
   Figure 6-13: F03 GD (Group Records)

Notes:

1. In the event that the relevant subaddress(es) does not display the processing frames, there is always at least one subaddress with a frame counter to reference for that subaddress(es). This can be found in the
2. PUI finder expresses all numbers in decimal. The raw data is expressed in hexadecimal, including the processing frames. If need help to convert from decimal to hexadecimal and vice versa, use the Calculator program found under Accessories under Programs on the Start menu in Windows. Select Views, and then select Scientific. Use the radio buttons to go from one format to the other.

6.5.5. Using Find

1. Select the relevant tab.
2. Select **Edit** > **Find**.
   Figure 6-14: Edit > Find
3. Enter the information needed (i.e. PUI, number, word) and change options as necessary.
   Figure 6-15: Find Box
4. Select **Find**. If necessary, select **Find Next** to go to the next occurrence of information needed.
5. Select **Cancel** to exit Find.

6.6. Unroll

Unroll is a tool used to navigate from lower groups to higher groups. The Unroll tab recursively decomposes groups into their lowest contents. The information extracted is from entered PUI's definition in the F03 table of the database.

6.6.1. Unroll Modes

Unroll has in two basic modes: Normal Unroll and Telemetry Unroll. The mode is automatically determined based upon the Group Type of the PUI being unrolled.

6.6.1.1. Normal Unroll

The following information is shown: Word PUI; Signal PUI; Data Type; Name; Word Offset; Bit Offset. Group PUIs go under Word PUI and Signal PUIs go under Signal PUI. Both Group PUIs and Signal PUIs have their data types and word offsets displayed; only Signal PUIs display bit offsets.

6.6.1.2. Telemetry Unroll

The following information is shown: Word PUI; Signal PUI; Data Type; Name; TLM_PROF (telemetry processing frame number); TLM_GRP (telemetry group number); Word Offset; Bit Offset. The telemetry processing frame column is only displayed when unrolling telemetry versions. For larger telemetry streams, Custom Unroll may be necessary, as the computer will most likely run out of memory before all records are displayed.

6.6.2. Default Unroll

1. Select the **Unroll** tab.
2. Select the **PUI** text box and enter the name of the PUI (must be a group PUI).
3. Select **Unroll**.
   Figure 6-16: Default Unroll

6.6.3. Customized Unroll

1. Select the **Unroll** tab.
2. Select the **PUI** text box and enter the name of the PUI (must be a group PUI).
3. Select **Customize**.
   Figure 6-17: Customize Unroll
   Figure 6-18: Customize Unroll Settings
   Note: In any box, select **Cancel** to leave the box without any changes made taking effect. In the Customized Unroll Settings box, select the **Restore Default Settings** to undo all customized settings and close the Customized Unroll box.
4. Select the **Set Group Columns** box and make any necessary changes. Select **OK**.
   Figure 6-19: Set Group Columns
5. Select the **Set Signal Columns** box and make any necessary changes. Select **OK**.
   Figure 6-20: Set Signal Columns
6. Select the radio button next to the desired Output Setting. To view in the PUI Finder Screen, select **Screen**. To save to a file, select **File (Tab Indent)** or **File (No Tab Indent)**. For many group PUIs, it will be necessary to save the unroll to a file. The unroll will be too big to be outputted to the screen.
7. To save the current configuration to a file for later use, select **Save A Configuration To A File**. Select the folder the file is to be saved to, type the name of the configuration file in the text box and select **Save**.
   Figure 6-21: Save a Configuration to a File
8. To load a preset configuration from a file for later use, select **Load A Configuration From A File**. Select the folder the file is saved in, select the name of the configuration file in the text box and select **Open**.
   Figure 6-22: Load a Configuration from a File
9. Select **Use Custom Settings**.
10. Select **Unroll**
11. If the Output Setting is to a file, select the folder the file is to be saved to, type the name of the configuration file in the text box and select **Save**.
    Figure 6-23: Save an Unroll to File
    Note: To view a saved unroll, open the file using Internet Explorer or Notepad.

6.7. Figures

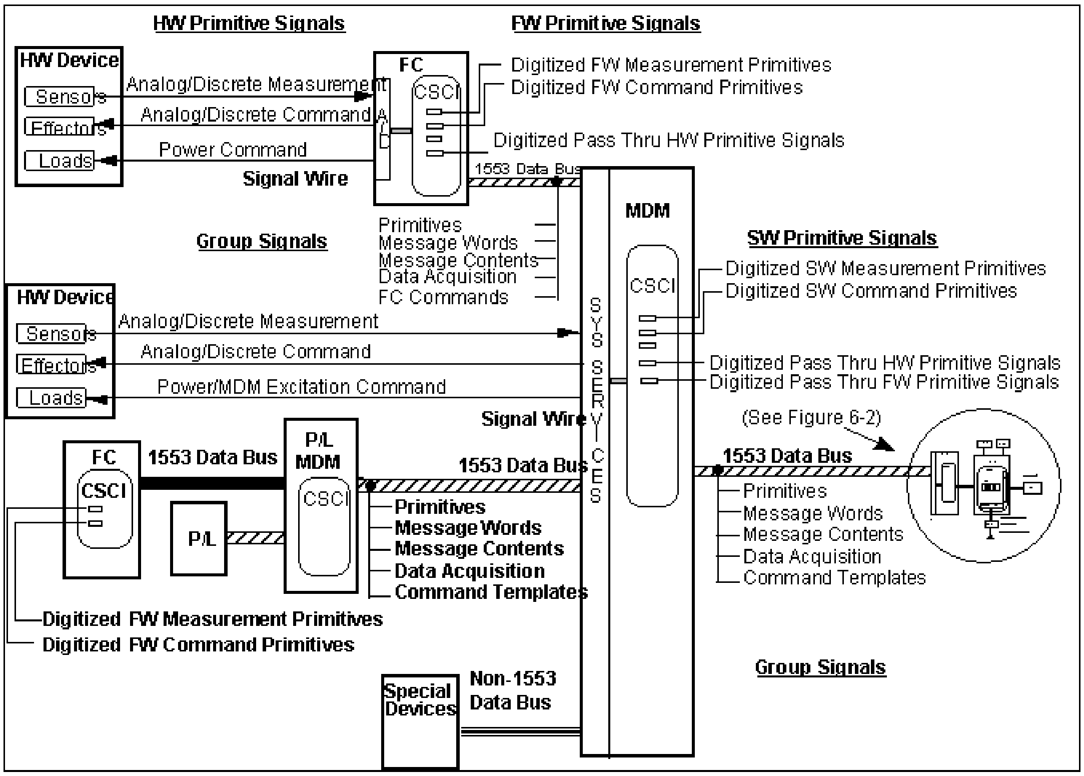


Figure 6-1: ISS Signal Data Domain

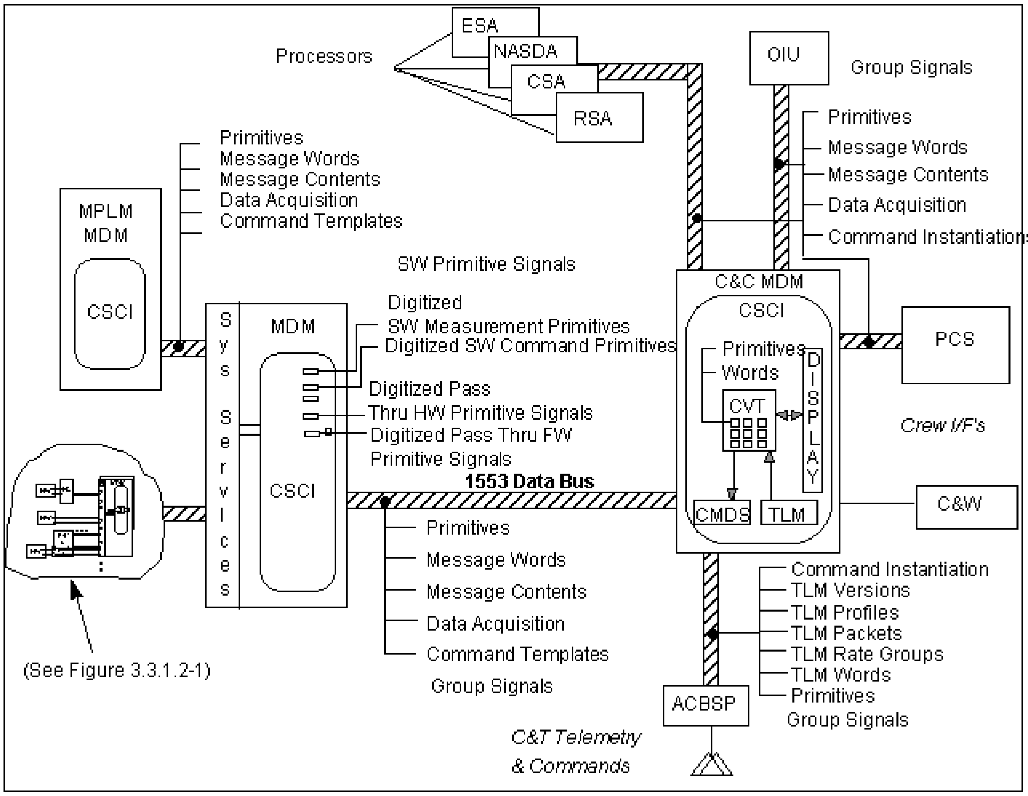


Figure 6-2: ISS Signal Data Domain Detail

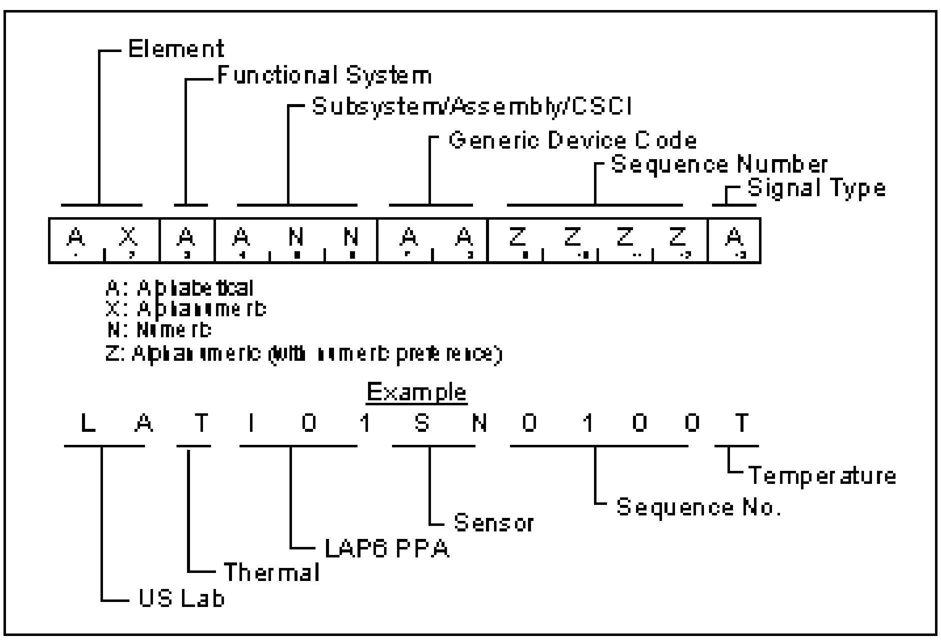


Figure 6-3: Signal PUI Format

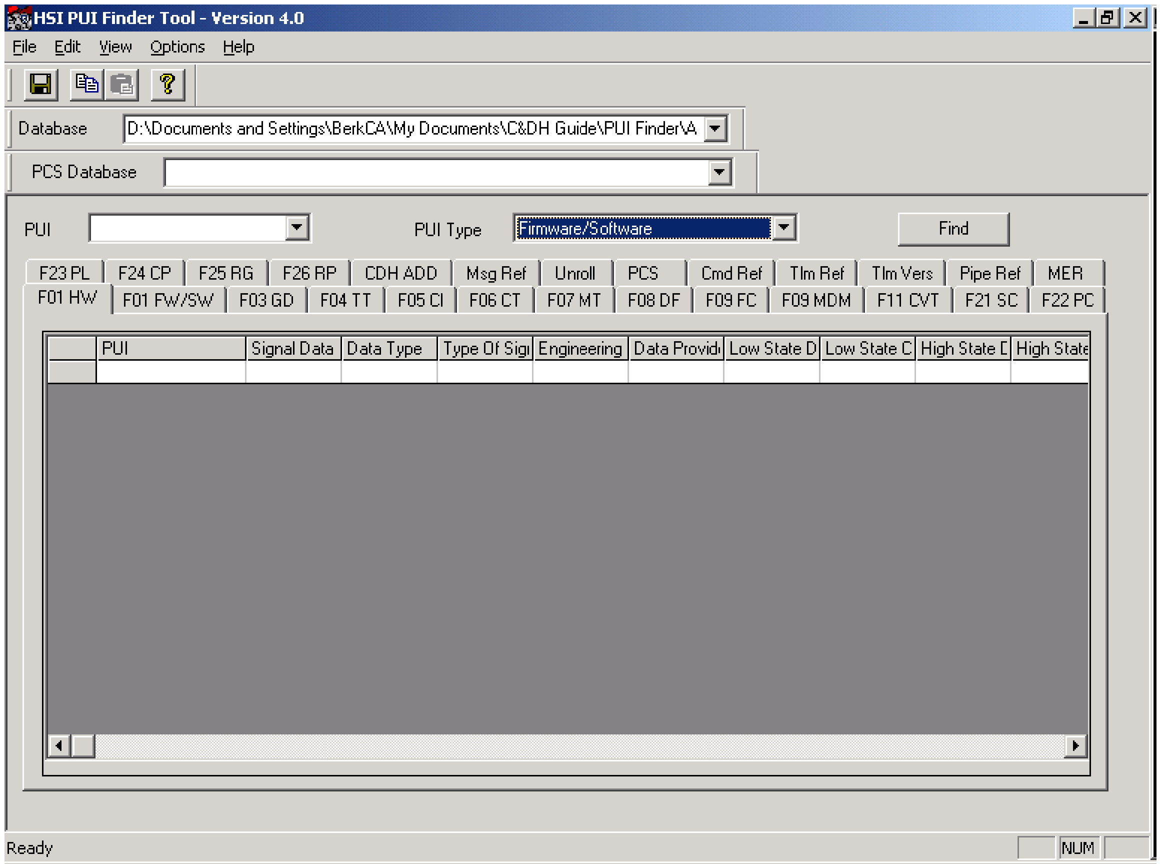
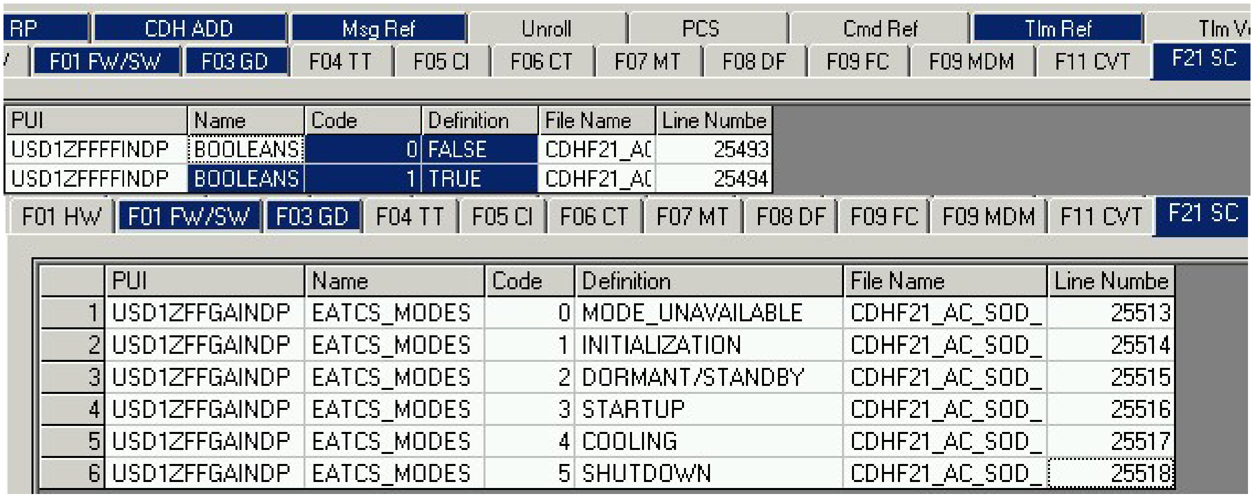


Figure 6-4: Selecting Database

Figure 6-5: Entering PUI

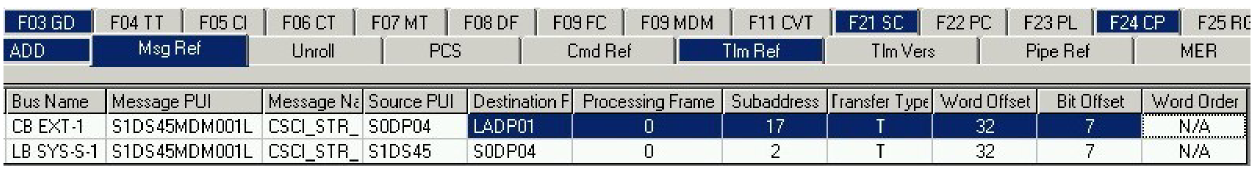
Figure 6-6: F01 Firmware/Software



PUI	Name	Code	Definition	File Name	Line Numbe
USD1ZFFFFINDP	BOOLEANS	0	FALSE	CDHF21_AC	25493
USD1ZFFFFINDP	BOOLEANS	1	TRUE	CDHF21_AC	25494

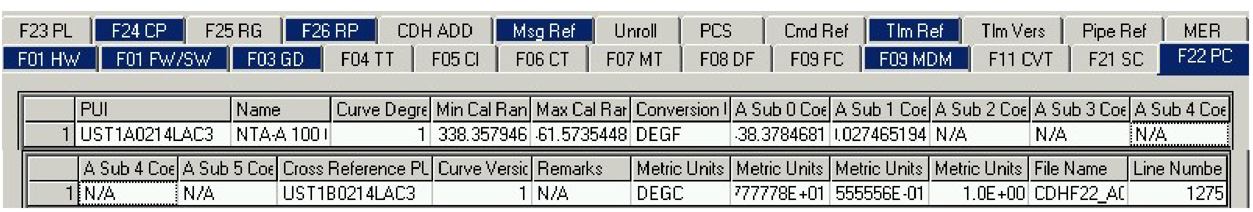
	PUI	Name	Code	Definition	File Name	Line Numbe
1	USD1ZFFGAINDP	EATCS_MODES	0	MODE_UNAVAILABLE	CDHF21_AC_SOD_	25513
2	USD1ZFFGAINDP	EATCS_MODES	1	INITIALIZATION	CDHF21_AC_SOD_	25514
3	USD1ZFFGAINDP	EATCS_MODES	2	DORMANT/STANDBY	CDHF21_AC_SOD_	25515
4	USD1ZFFGAINDP	EATCS_MODES	3	STARTUP	CDHF21_AC_SOD_	25516
5	USD1ZFFGAINDP	EATCS_MODES	4	COOLING	CDHF21_AC_SOD_	25517
6	USD1ZFFGAINDP	EATCS_MODES	5	SHUTDOWN	CDHF21_AC_SOD_	25518

Figure 6-7: F21 SC



Bus Name	Message PUI	Message Na	Source PUI	Destination F	Processing Frame	Subaddress	Transfer Type	Word Offset	Bit Offset	Word Order
CB EXT-1	S1DS45MDM001L	CSCI_STR_	S0DP04	LADP01	0	17	T	32	7	N/A
LB SYS-S-1	S1DS45MDM001L	CSCI_STR_	S1DS45	S0DP04	0	2	T	32	7	N/A

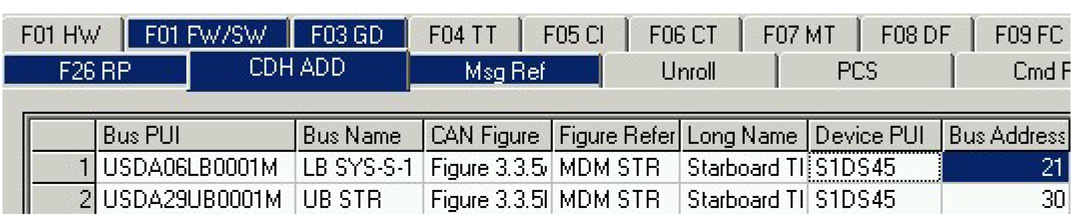
Figure 6-8: Message Reference



	PUI	Name	Curve Degre	Min Cal Ran	Max Cal Rar	Conversion I	A Sub 0 Coe	A Sub 1 Coe	A Sub 2 Coe	A Sub 3 Coe	A Sub 4 Coe
1	UST1A0214LAC3	NTA-A 100 I	1	338.357946	-61.5735448	DEGF	-38.3784681	I.027465194	N/A	N/A	N/A

	A Sub 4 Coe	A Sub 5 Coe	Cross Reference PL	Curve Versic	Remarks	Metric Units	Metric Units	Metric Units	Metric Units	File Name	Line Numbe
1	N/A	N/A	UST1B0214LAC3	1	N/A	DEGC	777778E+01	555556E-01	1.0E+00	CDHF22_AC	1275

Figure 6-9: F22 PC



	Bus PUI	Bus Name	CAN Figure	Figure Refer	Long Name	Device PUI	Bus Address
1	USDA06LB0001M	LB SYS-S-1	Figure 3.3.5	MDM STR	Starboard TI	S1DS45	21
2	USDA29UB0001M	UB STR	Figure 3.3.5I	MDM STR	Starboard TI	S1DS45	30

Figure 6-10: Command & Data Handling Architecture Design Document

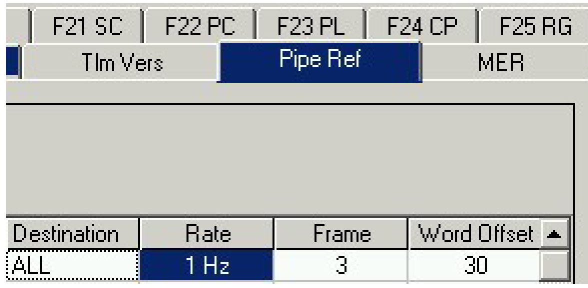


Figure 6-11: Pipe Reference

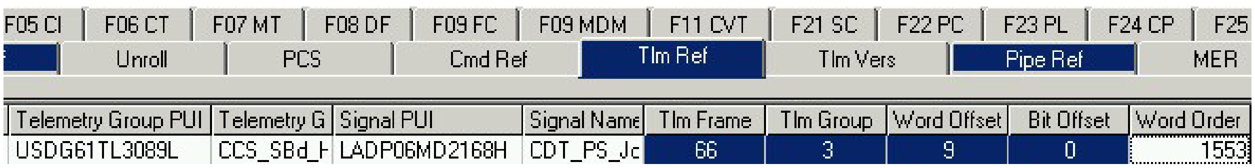


Figure 6-12: Telemetry Reference

Figure 6-13: F03 GD (Group Records)

Figure 6-14: Edit > Find

Figure 6-15: Find Box

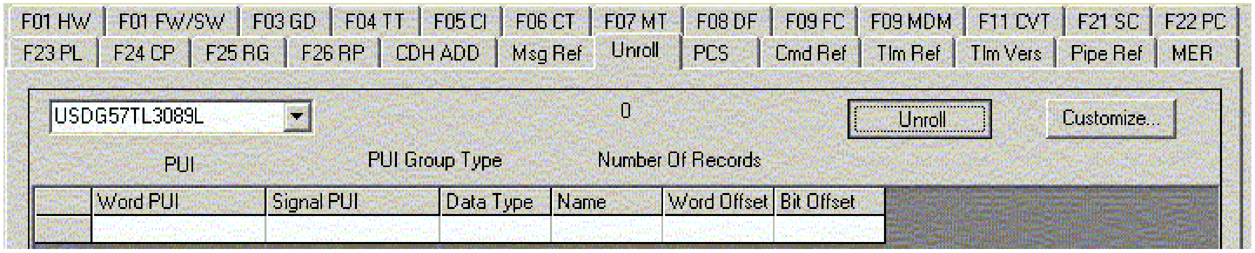


Figure 6-16: Default Unroll

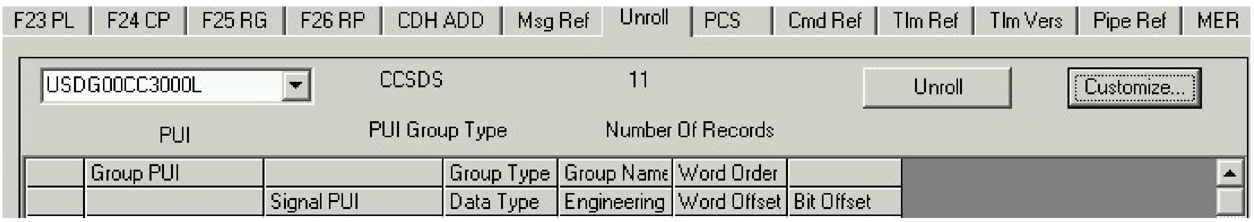


Figure 6-17: Customize Unroll

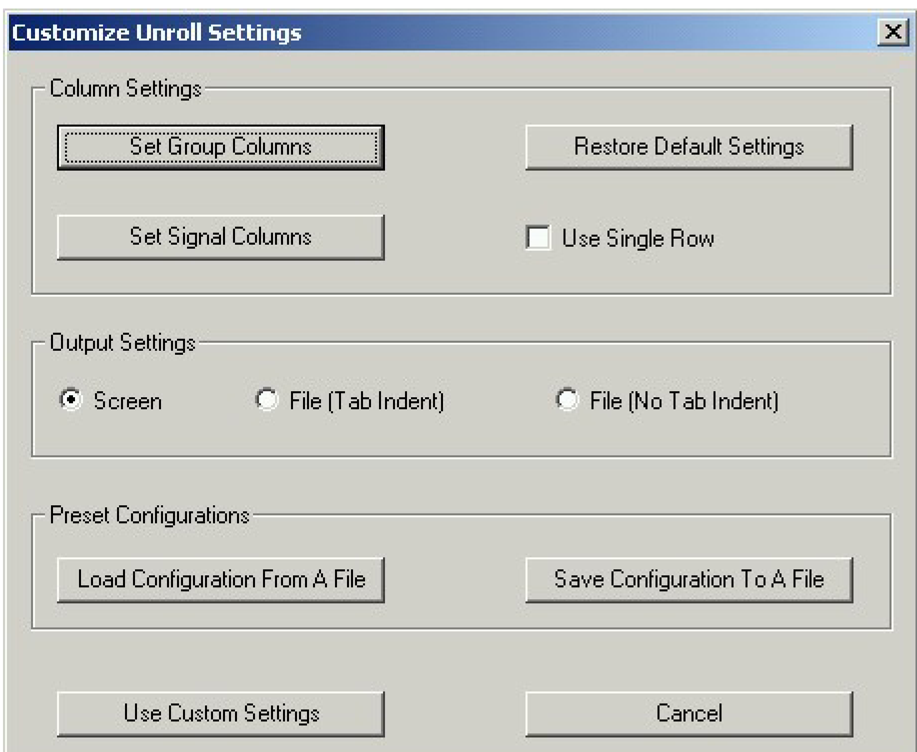


Figure 6-18: Customize Unroll Settings

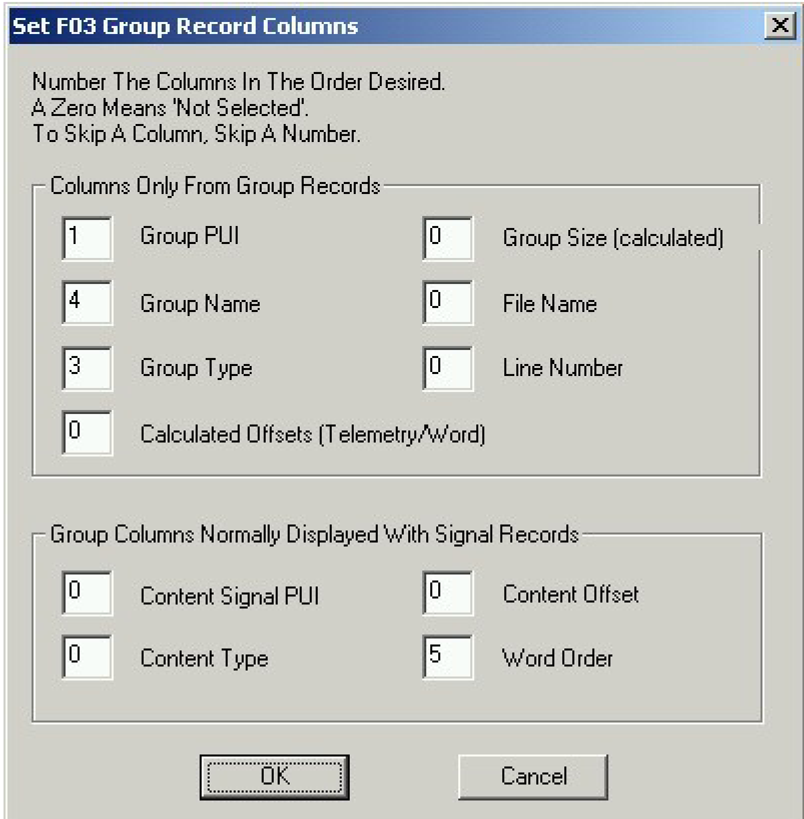


Figure 6-19: Set Group Columns

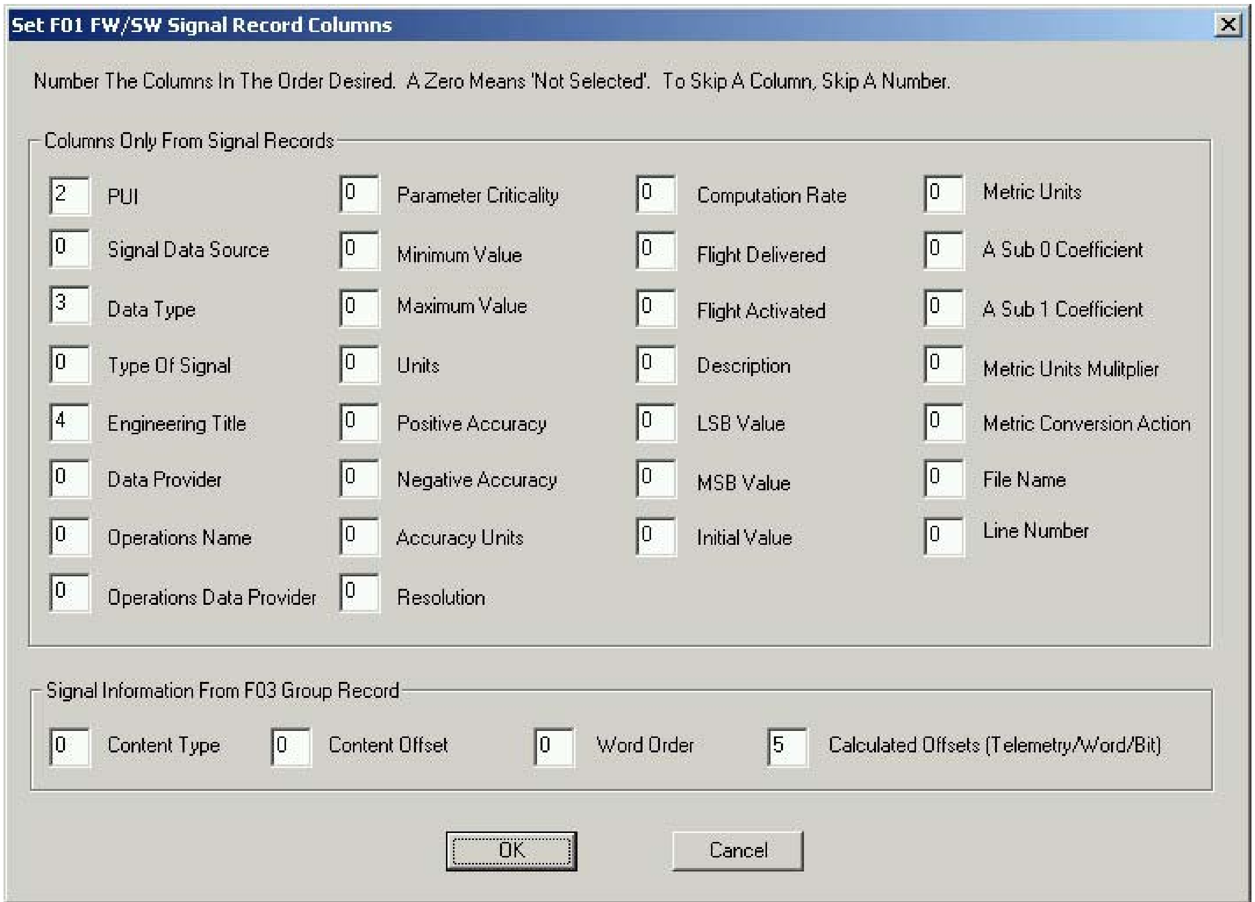


Figure 6-20: Set Signal Columns

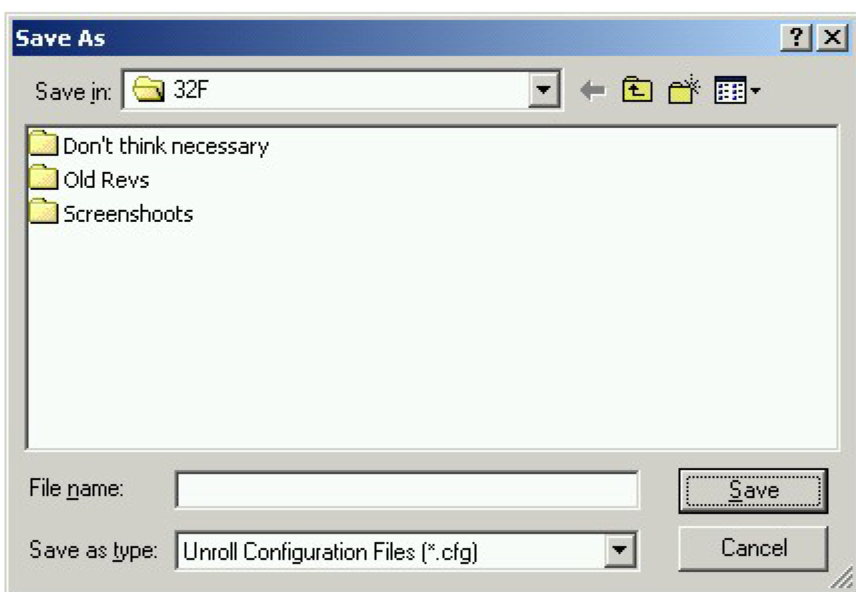


Figure 6-21: Save a Configuration to a File

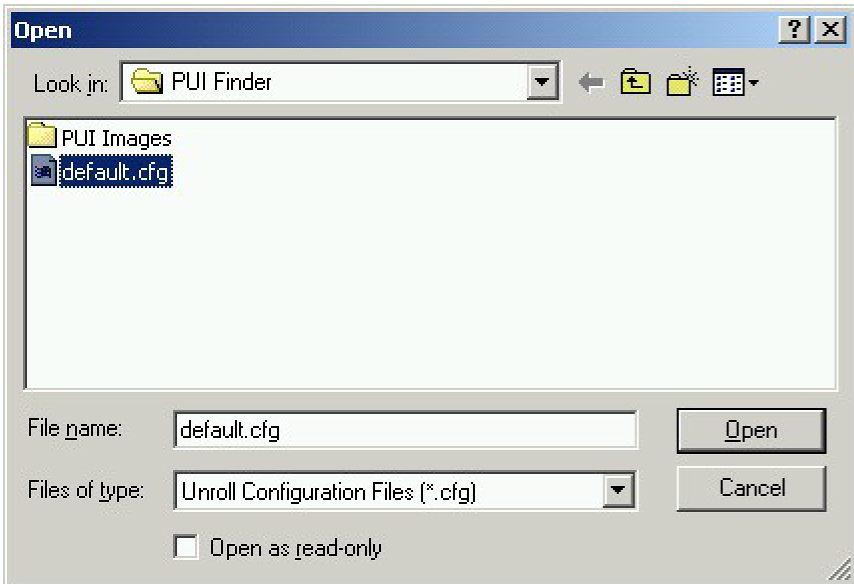


Figure 6-22: Load a Configuration from a File

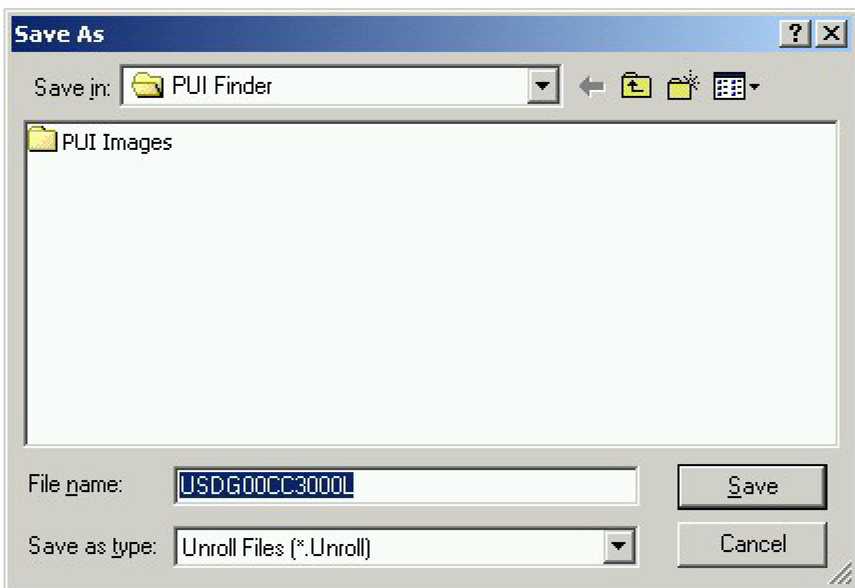


Figure 6-23: Save an Unroll to File

6.8. Tables

Type of PUI	Paragraph/General Description	Usage
Requirement PUI (RPUI)	Seven(7) character fixed format identifiers assigned to uniquely identify each software requirement in the Part 1 Interface Control Documents (ICDs).	1) Part 1 SW ICD 2) Part 2 SW ICD
Signal PUI (SPUI)	Thirteen(13) character fixed format identifiers assigned to uniquely identify each and all ISS signals generated, or utilized by, the design elements defined in the Part 2 ICDs and IP&CL. The SPUI also will be used to identify RPCM channels in the Resource Management area of the VMDB.	1) Part 2 SW ICD 2) IP&CL 3) Resource Mgmt
Device PUI (DPUI)	Six(6) character fixed format identifiers assigned to uniquely identify Hardware Devices, Firmware Controllers, MDMs, and Special Software Devices (Logical and Groups) which will be the IP&CL source for all ISS signals. The DPUI also will be used to identify sources and loads in the Resource Management area of the VMDB.	1) IP&CL 2) Resource Mgmt
Bus PUI (BPUI)	Thirteen(13) character fixed format identifiers assigned to uniquely identify all the Data Buses utilized by the ISS MDMs and Firmware Controllers.	IP&CL
Conversion PUI (CPUI)	Thirteen(13) character fixed format identifiers assigned to uniquely identify all the State Conversion and Calibration Curve tables required to interpret ISS discrete signals (i.e. state conversion) and analog signals (i.e. calibration curves).	IP&CL

Table 6-1: Types of PUIs

7. TCMS

7.1. General Retrieval Parameters

1. In TCMS Main Screen, select **Retrieve Session** with the mouse.
   Figure 7-1: TCMS Main Screen > Retrieve Session
2. Select **New** (if past retrieval is required, select that particular retrieval). Select **OK**.
   Figure 7-2: Retrieval List
3. The Retrieve Label Prompt appears. Select the default name, and type in required name of the retrieval session (the cursor does not have to be in the text box for this entry). Select **OK**.
   Figure 7-3: Retrieval Label Prompt
4. In the Retrieve Session, select **Test ID**.
   Figure 7-4: Retrieval Session > Test ID
   Scroll the available choices and select the one you require. If the test you wish to view data from is currently occurring, the **Test ID** will be the same as in **Test** in the main menu. Select **OK**.
   Figure 7-5: Test ID Selection
   Note: **DB Name** is automatically given the same value.
5. Select **Retrieval Times** > **All Times**.
   Figure 7-6: Retrieval Times > All Times
   The disk type (magnetic or optical), disk label, and time period for each disk appear for the entire length of time of the test; the disks are sorted by disk type (magnetic first) and then earliest start time. This is useful if the time of an event, but not the Test ID, is known; it helps determine if a Test ID(s) contains the required time period.
   Figure 7-7: Retrieval Times
6. Move the cursor into the **UTC start time**. The format for the time is the last two digits of the year followed by GMT. To modify the time, place the cursor in front of the first digit that you wish to modify and select. Begin typing in time. Though cannot see where cursor currently located, it writes over the next digit and backspace can be used. When the required time is displayed, place the cursor in the text box and press **Enter**. A message in the Retrieval Message Area will confirm that the new **UTC start time** has been accepted.
   Figure 7-8: Retrieval Message Area
   Figure 7-9: UTC Start Time Acceptance
   In there is an invalid action (such as entering a time incorrectly) or the attention of the user is required, a yellow message will appear in the Retrieval Message Area. The retrieval will not execute until invalid actions have been rectified.
   Figure 7-10: UTC Start Time Rejection
   Note: **Duration** will automatically calculate and display the amount of time between the entered **UTC start time** and **UTC stop time**. If without a value, **UTC stop time** will automatically update to the time at which the **UTC start time** was entered. If **Duration** is changed, the **UTC stop time**

will automatically update and vice versa. If all three have a value and either **UTC start** or **stop time** are changed, Duration will change to accommodate their difference.

7. Move the cursor into **Duration**. The format for the amount of time is in GMT. To modify the time, place the cursor in front of the first digit that you wish to modify and select. Begin typing in time. Though cannot see where cursor currently located, it writes over the next digit and backspace can be used. When the required time is displayed, place the cursor in the text box and press **Enter**. A message in the Retrieval Message Area will confirm that the new **Duration** has been accepted.
   Figure 7-11: Duration Acceptance

   OR

   Move the cursor into the **UTC stop time**. The format for the time is the last two digits of the year followed by GMT. To modify the time, place the cursor in front of the first digit that you wish to modify and select. Begin typing in time. Though cannot see where cursor currently located, it writes over the next digit and backspace can be used. When the required time is displayed, place the cursor in the text box and press **Enter**. A message in the Retrieval Message Area will confirm that the new **UTC stop time** has been accepted.
   Figure 7-12: UTC Stop Time Acceptance
   Note (for processed retrievals only): Unless a PUI is enabled or experiences a change in status, the status is displayed every twenty minutes. If a time period of less than twenty minutes falls between the times when the status is updated and there is no enabling or change in status during that time period, no data is displayed.
   Figure 7-13: Processed Retrieval Time
8. Select **Retrieval Times** > **Defined Times**.
   Figure 7-14: Retrieval Times > Defined Times
   The disk type (magnetic or optical), disk label, and time period for each disk appear only for the time between the UTC start and stop times; the disks are sorted by disk type (magnetic first) and then earliest start time.
   Figure 7-15: Defined Times
   If all of the listed disks are on magnetic (immediate, temporary storage), retrieval can be executed without problems. If some or all of the listed disks are optical (permanent storage), call the TCMS Control Room (7-6629) and inform them of which disks need to be inserted in which drives. In the event that there are more disks than available drives, have the disks from the beginning of the time period put in first. A yellow message appears in the Retrieval Message Area when switching from one disk to another during retrieval.
   Figure 7-16: Switching Disks
   At this point, call the TCMS Control Room inform them to remove the disk that is no longer being used and put in the next disk that is not already in a drive.
9. Select **Ret Dest** Figure 7-17: Retrieval Destination
   and enter the filename you want the retrieved data saved to in the text box. Select **OK**.
   Figure 7-18: File Manager

7.2. Raw-1553 Retrieval

7.2.1. Raw-1553 Message Retrieval

7.2.1.1. Raw Retrieval Definition Parameters

1. Select **Retrieval Definition** > **Raw-1553**.
   Figure 7-19: Retrieval Definition > Raw-1553
2. Select **Raw-1553 Msg Ret**.
   Figure 7-20: Raw-1553 Message Retrieval
3. Select the required **bus** and select **OK**.
   Figure 7-21: Bus PUI Selection
4. Select **Command Words**.
   Figure 7-22: Raw-1553 Filter Parameter Definition
5. Select **RT** > required **RT Address** (while holding down left mouse button).
   Figure 7-23: RT Selection in Command Words
   Select **T/R** > required **R** or **T** or ***** if both are required (while holding down left mouse button).
   Figure 7-24: T/R Selection in Command Words
   Select the text box under **Subaddress** and enter the required **Subaddress(es)** (there can be multiple ones, entered individually or as a series)(ex: 2, 5-9, 20, 31). Repeat for all required RT Addresses.
   Figure 7-25: Subaddress Selection in Command Words
   Select **Done**.
6. Select **Done**.
   Note: To modify parameters after selecting done, simply select Raw-1553 Msg Ret. The Retrieval Definition Confirmation window will appear, giving the options to **Modify**, **Remove**, or **Cancel** the retrieval parameters. Select the option that applies.
   Figure 7-26: Retrieval Definition Confirmation

7.2.1.2. Executing Retrieval

1. Select **Retrieval Control** > **Execute**.
   Figure 7-27: Retrieval Control > Execute
2. When one or more retrievals are already occurring, a window will appear with two options. On Queue delays the retrieval until the retrievals ahead of it are done; Concurrent executes the retrieval concurrent with the other retrievals. Unless there is a reason to wait for the other retrievals to finish (e.g. eight retrievals already occurring), select **Concurrent** and select **OK**.
   Figure 7-28: Concurrent/On Queue
   Figure 7-29: Retrieval Executing
   Note: If ever need to abort retrieval after executing, select **Retrieval Control** > **Abort**.
   Figure 7-30: Retrieval Control >Abort

A window will appear, giving the options to **Abort With Save** or **Abort Without Save**. The Abort With Save saves data from the retrieval up to the point that abort was selected. Select the option that applies.
Figure 7-31: Abort Retrieval
If ever need to pause a retrieval, select **Retrieval Control** > **Pause**.
Figure 7-32: Retrieval Control > Pause
To resume the retrieval, select **Retrieval Control** > **Resume**.
Figure 7-33: Retrieval Control > Resume
If the disk with the necessary data is not inserted into the proper drive, the Load Disk/Tape Dialog window will appear informing you of which disk needs to be inserted into which drive.
Figure 7-34: Load Disk/Tape Dialog
Call TCMS Control Room (7-6629) and ask them to do this for you, then select **OK**. If the disk is still not in the proper drive, the window will reappear.

3. Wait until **Retrieval Complete** appears in the Retrieval Message Area.
   Figure 7-35: Retrieval Complete

7.2.1.3. Viewing Raw Data

Note: Some of these steps concern viewing the data during testing. If you are able to view the file in Notepad or a similar program, ignore steps 1-3 and 10.

1. To view the file containing the raw data, select **Rlog in DBS** from the TCMS main screen.
   Figure 7-36: Rlog in DBS
2. Making sure the cursor is in the window, enter pwd to confirm that you are in the same directory as the data file.
3. Enter **pg filename.txt** is to view the data file.
   Figure 7-37: Viewing Data File
   Note: A shortcut is to enter **ls –latr** to view most recently updated files in directory. Select the data file to view, the type **pg** , making sure to include the space after pg. The select with the middle button of the mouse and press **Enter**. Also, to reuse previous commands, press the **Esc** key. Then press the **K** and **J** keys to scroll backward and forward, respectively, through previous commands. When required command found, press **Enter** to execute.
4. The raw data is displayed in sets of data. Each set of data is for an individual subaddress for each processing frame. The sets of data are separated by a row with the following information: GMT, Bus, Channel, RT address, subaddress and R/T. Each set of data contains 32 words in two rows, four characters per word.
   Figure 7-38: Raw-1553 Message Data File
5. Find the processing frame(s) (which are in hexadecimal) relevant to PUI. For cyclic data, it will be in the first word of first subaddress of the cyclic data packet. For broadcast ancillary data, it will primarily be in the eighth word of subaddress 13. The processing frame is seven least significant bits of its word and is an

unsigned integer. There are several ways to scroll through the document. The enter key scrolls forward 16 lines. +### moves forward ### lines, -### moves back ### lines. By moving the mouse and holding down with the middle button, it is possible to scroll up or down through data already revealed by moving the mouse in that respective direction. Entering a forward slash followed by characters (ex. /0A03) skips forward to the next occurrence of that sequence of characters. If the first occurrence of the sequence is not the required one, entering only a forward slash (/) will repeat the search for the same sequence. Figure 7-39: Moving in Data File

6. If the processing frame counter is not in the subaddress relevant to the PUI, go to the relevant subaddress in the same processing frame (if the relevant subaddress is greater than the processing frame counter, then the next relevant subaddress; if the relevant subaddress less than the processing frame counter, then the previous relevant subaddress).
7. Find the word corresponding to the word offset. The first row contains words 1-16; the second row contains words 17-32. The word offset ranges from 1-32 (e.g. a word offset of 10 would by the tenth word from the left in the first row; a word offset of 20 would by the fourth word from the left in the second row). If the word order is Intel (only applicable with data types of two or four words), the extracted words need to be word swapped. This is because Intel transmits the least significant word first instead of the most significant word first as required by Mil-Std-1553. Examples: if the extracted words are 43ab 78c9, then the data is 78c9 43ab; if the extracted words are 43ab 78c9 56f4 d12e, then the data is d12e 56f4 43ab 78c9.
8. Once in the required word, find the first bit of the data for the required PUI. Each word contains 16 bits, 4 bits per character. The bits in a word are labeled 0-15. |0 1 2 3|4 5 6 7|8 9 10 11|12 13 14 15| The bit offset is the first bit in the data. The required bit is that labeled bit (ex. if the bit offset is 7, then the first bit is bit 7, which is the eighth bit from the left).
9. Once beginning with required bit, the amount of data corresponding the PUI is the data type (ex. if the bit offset is 7 and the data type is 3 bits, then the data relevant to the PUI is bits 7-9, the eighth, ninth, and tenth bits from the left).
10. Enter **q** to exit viewing file (or press **Enter** at the end of file). Figure 7-40: Exiting Data File

7.2.2. Raw-1553 Telemetry Retrieval

7.2.2.1. Raw Retrieval Definition Parameters

1. Select **Retrieval Definition** > **Raw-1553**. Figure 7-19: Retrieval Definition > Raw-1553
2. Select **Raw-1553 Tlm Ret**. Figure 7-41: Raw-1553 Telemetry Retrieval
3. Select the required **bus** (the S-BAND one) and select **OK**. Figure 7-42: S-Band Bus PUI Selection
4. Select the text box under **FMT ID**. Figure 7-43: Raw-1553 Telemetry Formats

5. Select the required **Format** (Telemetry Group from PUI Finder) and select **OK.** An asterisk or a zero indicates a wild card selection. Up to eight formats may be selected, each in a different row and each having all columns filled in.
6. Figure 7-44: Format ID SelectionSelect the text box under **PROC FRAME** and enter the required **Processing Frame(s)** (Telemetry Frame from PUI Finder)**.** There can be multiple ones, entered individually or as a series (ex: 2, 5-9, 20, 31) and range from 0 to 99 inclusive, depending on the format.
   Figure 7-45: Processing Frame Selection
7. Select the text box under **RATE.** Select the required **Rate** (the Rate, which appears right before the word Rate, is found within the Telemetry Group Name from PUI Finder) and select **OK**.
   Figure 7-46: Rate Selection
8. Select the text box under **START WD** and enter the required **Start Word.** To determine Start Word: use Table 7-1: Start Word Determination or Content Offset + Word Offset – 1 = Start Word (e.g. for Content Offset = 57 and Word Offset = 9, Start Word = 65)
   Figure 7-47: Start Word Selection
9. Select the text box under **NMBR WDS** and enter the required **Number of Words.** Number of words will be as follows: 1 for 16 bits and less, 2 for 16-32 bits, and 4 for 64 bits. An asterisk indicates a wild card selection.
   Figure 7-48: Number of Words Selection
   Select **Done**.
10. Select **Done**.

    Note: To modify parameters after selecting done, simply select Raw-1553 Tlm Ret. The Retrieval Definition Confirmation window will appear, giving the options to **Modify**, **Remove**, or **Cancel** the retrieval parameters. Select the option that applies.
    Figure 7-26: Retrieval Definition Confirmation

7.2.2.2. Executing Retrieval

1. Select **Retrieval Control** > **Execute**.
   Figure 7-27: Retrieval Control > Execute
2. When one or more retrievals are already occurring, a window will appear with two options. On Queue delays the retrieval until the retrievals ahead of it are done; Concurrent executes the retrieval concurrent with the other retrievals. Unless there is a reason to wait for the other retrievals to finish (e.g. eight retrievals already occurring), select **Concurrent** and select **OK**.
   Figure 7-28: Concurrent/On Queue
   Figure 7-29: Retrieval Executing

   Note: If ever need to abort retrieval after executing, select **Retrieval Control** > **Abort**.
   Figure 7-30: Retrieval Control >Abort
   A window will appear, giving the options to **Abort With Save** or **Abort Without Save**. The Abort With Save saves data from the retrieval up to the point that abort was selected. Select the option that applies.

Figure 7-31: Abort Retrieval
If ever need to pause a retrieval, select **Retrieval Control** > **Pause**.
Figure 7-32: Retrieval Control > Pause
To resume the retrieval, select **Retrieval Control** > **Resume**.
Figure 7-33: Retrieval Control > Resume
If the disk with the necessary data is not inserted into the proper drive, the Load Disk/Tape Dialog window will appear informing you of which disk needs to be inserted into which drive.
Figure 7-34: Load Disk/Tape Dialog
Call TCMS Control Room (7-6629) and ask them to do this for you, then select **OK**. If the disk is still not in the proper drive, the window will reappear.

3. Wait until **Retrieval Complete** appears in the Retrieval Message Area.
   Figure 7-35: Retrieval Complete

7.2.2.3. Viewing Raw Data

Note: Some of these steps concern viewing the data during testing. If you are able to view the file in Notepad or a similar program, ignore steps 1-3 and 10.

1. To view the file containing the raw data, select **Rlog in DBS** from the TCMS main screen.
   Figure 7-36: Rlog in DBS
2. Making sure the cursor is in the window, enter pwd to confirm that you are in the same directory as the data file.
3. Enter **pg filename.txt** is to view the data file.
   Figure 7-37: Viewing Data File
   Note: A shortcut is to enter **ls –latr** to view most recently updated files in directory. Select the data file to view, the type **pg** , making sure to include the space after pg. The select with the middle button of the mouse and press **Enter**. Also, to reuse previous commands, press the **Esc** key. Then press the **K** and **J** keys to scroll backward and forward, respectively, through previous commands. When required command found, press **Enter** to execute.
4. The raw data is displayed in sets of data. Each set of data is for an individual subaddress for each processing frame. The sets of data are separated by a row with the following information: GMT, Bus, Channel, Format Number and ID, Version, and Processing Frame. Each set of data contains the first row of 16 data words, followed by the row in which the start word appears and any other rows containing requested data.
   Figure 7-49: Raw-1553 Telemetry Data File
5. Find the relevant GMT. There are several ways to scroll through the document. The enter key scrolls forward 16 lines. +### moves forward ### lines, -### moves back ### lines. By moving the mouse and holding down with the middle button, it is possible to scroll up or down through data already revealed by moving the mouse in that respective direction. Entering a forward slash followed

by characters (ex. /0A03) skips forward to the next occurrence of that sequence of characters. If the first occurrence of the sequence is not the required one, entering only a forward slash (/) will repeat the search for the same sequence.
Figure 7-39: Moving in Data File

6. Find the start word. Each row has a number to the left of it indicating the word number of the first word in the row. The row 1 contains words 1-16; the row 49 contains words 49-64. The start word row has the words preceding the start word in that row and the corresponding number of words following the start word that was requested. If the number of words is not specified, then all words following the start word for that data set are displayed (maximum word 99). The start word ranges in location depending on its position from the first word of the row (e.g. a start word of 30 would by the fourteenth word from the left in row 17; a start word of 67 would by the third word from the left in row 65).
7. Once at the start word, the data required is the start word plus the words following totaling the number of words (e.g. if the start word is word 45 and number of words is two, than the data required is words 45 and 46). If the word order is Intel (only applicable with data types of two or four words), the extracted words need to be word swapped. This is because Intel transmits the least significant word first instead of the most significant word first as required by Mil-Std-1553. Examples: if the extracted words are 43ab 78c9, then the data is 78c9 43ab; if the extracted words are 43ab 78c9 56f4 d12e, then the data is d12e 56f4 43ab 78c9.
8. Once in the required word, find the first bit of the data for the required PUI. Each word contains 16 bits, 4 bits per character. The bits in a word are labeled 0-15. |0 1 2 3|4 5 6 7|8 9 10 11|12 13 14 15| The bit offset is the first bit in the data. The required bit is that labeled bit (ex. if the bit offset is 7, then the first bit is bit 7, which is the eighth bit from the left).
9. Once beginning with required bit, the amount of data corresponding the PUI is the data type (ex. if the bit offset is 7 and the data type is 3 bits, then the data relevant to the PUI is bits 7-9, the eighth, ninth, and tenth bits from the left).
10. Enter **q** to exit viewing file (or press **Enter** at the end of file).
Figure 7-40: Exiting Data File

7.3. Processed Retrieval

Only PUIs that have been previously designated so are processed and can be retrieved as such. This is mainly an issue for MEIT testing, which, due to the very large number of PUIs for this type of testing, needs to be limited in selecting which PUIs are processed.

A limitation of processed PUIs is that for enumerated data types, only 16 states (values) can be processed. However, the raw data will still be received and the description can be used to express the state.

7.3.1. Processed Retrieval Definition Parameters

1. Select **Retrieval Definition** > **Proc**.
Figure 7-50: Retrieval Definition > Proc
2. Select **Processed Meas**.

Figure 7-51: Processed Meas

3. Move the cursor into the **Wildcard** box and select. Enter the information about the required PUI(s), using the asterisk to represent zero, one, or multiple characters. Multiple asterisks can be used anywhere in the PUI. With the cursor still in the text box, press **Enter**.
   Figure 7-52: Displaying PUI's with Wildcard
   Note: If PUI information entered does not find any PUIs, then nothing will be displayed and a red error message will appear in the Retrieval Message Area.
   Figure 7-53: MSID Error
4. Scroll PUIs meeting parameters and select desired **PUI(s)**. Multiple PUIs can be selected/deselected by utilizing the Control and Shift keys. Select **Add**.
   Figure 7-54: Selecting PUIs with Wildcard
   OR
   Move the cursor into the **Manual** box and select. Enter the exact name of the required PUI, place the cursor in the text box, and press **Enter**.
   Figure 7-5546: Selecting PUIs by Manual Entry
5. To remove PUI(s) mistakenly added to list, select unnecessary **PUI(s)** and select **Delete**.
   Figure 7-56: Deselecting PUIs
6. Select **Done**.

7.3.2. Executing Retrieval

1. Select **Retrieval Control** > **Execute**.
   Figure 7-27: Retrieval Control > Execute
2. When one or more retrievals are already occurring, a window will appear with two options. On Queue delays the retrieval until the retrievals ahead of it are done; Concurrent executes the retrieval concurrent with the other retrievals. Unless there is a reason to wait for the other retrievals to finish (e.g. eight retrievals already occurring), select **Concurrent** and select **OK**.
   Figure 7-28: Concurrent/On Queue
   Figure 7-29: Retrieval Executing
   Note: If ever need to abort retrieval after executing, select **Retrieval Control** > **Abort**.
   Figure 7-30: Retrieval Control >Abort
   A window will appear, giving the options to **Abort With Save** or **Abort Without Save**. The Abort With Save saves data from the retrieval up to the point that abort was selected. Select the option that applies.
   Figure 7-31: Abort Retrieval
   If ever need to pause a retrieval, select **Retrieval Control** > **Pause**.
   Figure 7-32: Retrieval Control > Pause
   To resume the retrieval, select **Retrieval Control** > **Resume**.
   Figure 7-33: Retrieval Control > Resume

If the disk with the necessary data is not inserted into the proper drive, the Load Disk/Tape Dialog window will appear informing you of which disk needs to be inserted into which drive.
Figure 7-34: Load Disk/Tape Dialog
Call TCMS Control Room (76629) and ask them to do this for you, then select **OK**. If the disk is still not in the proper drive, the window will reappear.

3. Wait until **Retrieval Complete** appears in the Retrieval Message Area.
   Figure 7-35: Retrieval Complete

7.3.3. Viewing Processed Data

Note: Some of these steps concern viewing the data during testing. If you are able to view the file in Notepad or a similar program, use only step 4.

1. To view the file containing the processed data, select **Rlog in DBS** from the TCMS main screen.
   Figure 7-36: Rlog in DBS
2. Making sure the cursor is in the window, enter **pwd** to confirm that you are in the same directory as the data file.
3. Enter **pg filename.txt** is to view the data file.
   Figure 7-37: Viewing Data File
   Note: A shortcut is to enter **ls –latr** to view most recently updated files in directory. Select the data file to view, the type **pg** , making sure to include the space after pg. The select with the middle button of the mouse and press **Enter**. Also, to reuse previous commands, press the **Esc** key. Then press the **K** and **J** keys to scroll backward and forward, respectively, through previous commands. When required command found, press **Enter** to execute.
4. The data is displayed in a table; the columns are the UTC, M/SID, command description, status, and value. The data is only displayed for the times in which there is a status or measurement change or a status check, which occur on a twenty-minute interval.
   Figure 7-57: Processed Data File
5. There are several ways to scroll through the document. The enter key scrolls forward 16 lines. +### moves forward ### lines, -### moves back ### lines. By moving the mouse and holding down with the middle button, it is possible to scroll up or down through data already revealed by moving the mouse in that respective direction. Entering a forward slash followed by characters (ex. /0A03) skips forward to the next occurrence of that sequence of characters. If the first occurrence of the sequence is not the required one, entering only a forward slash (/) will repeat the search for the same sequence.
   Figure 7-39: Moving in Data File
6. Enter **q** to exit viewing file (or press **Enter** at the end of file).
   Figure 7-40: Exiting Data File

7.4. Figures

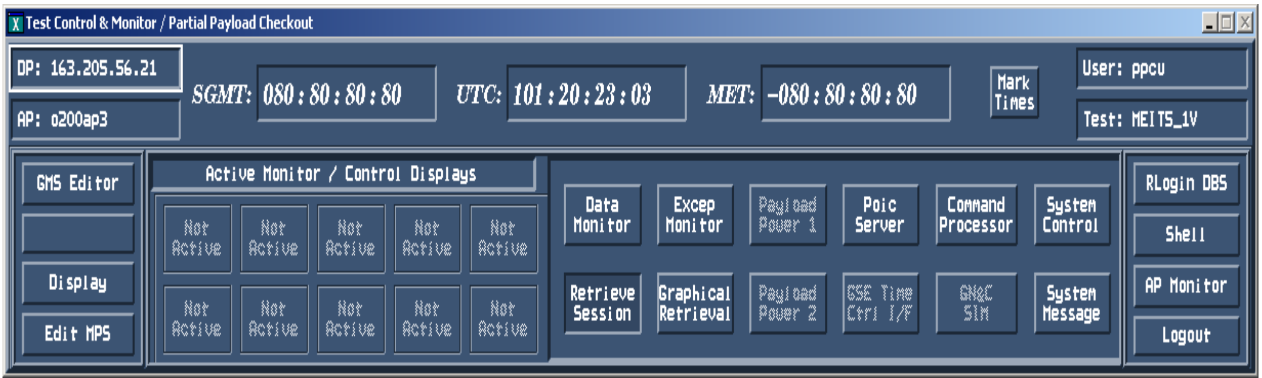


Figure 7-1: TCMS Main Screen > Retrieve Session

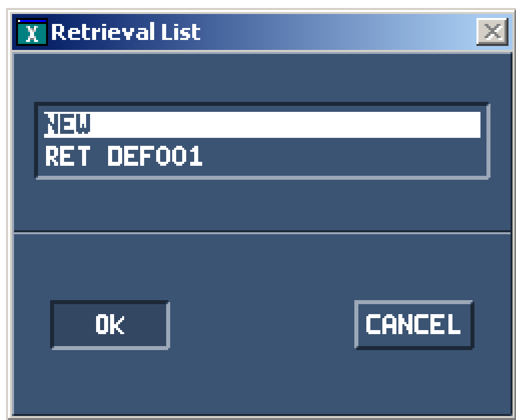


Figure 7-2: Retrieval List

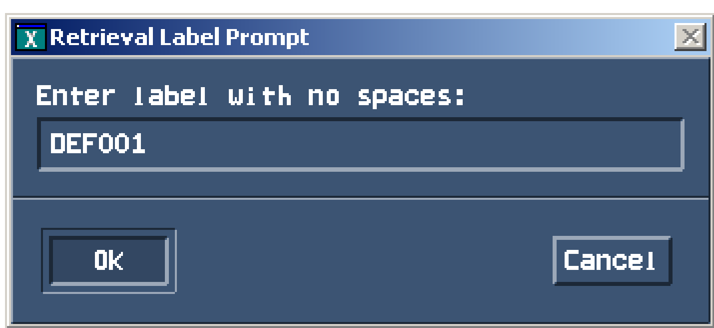


Figure 7-3: Retrieval Label Prompt

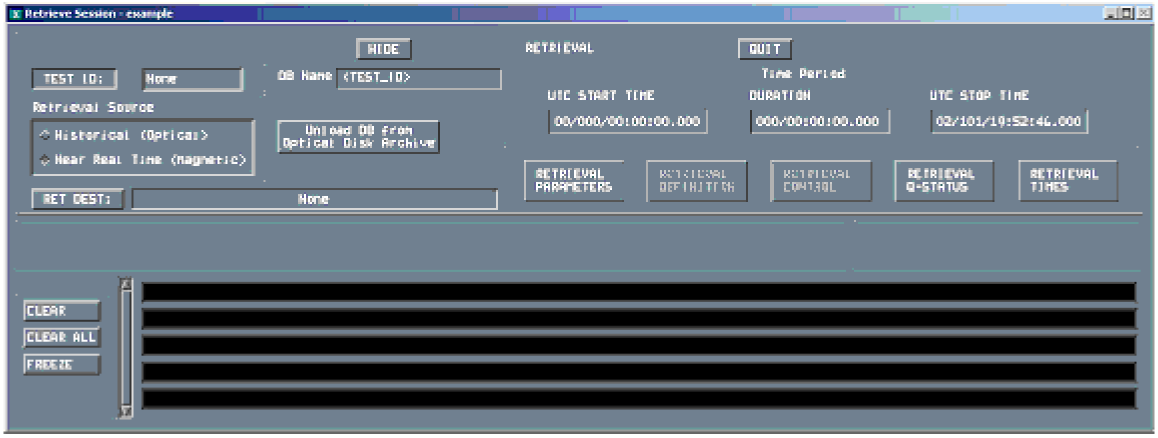


Figure 7-4: Retrieval Session > Test ID

Figure 7-5: Test ID Selection

Figure 7-6: Retrieval Times > All Times

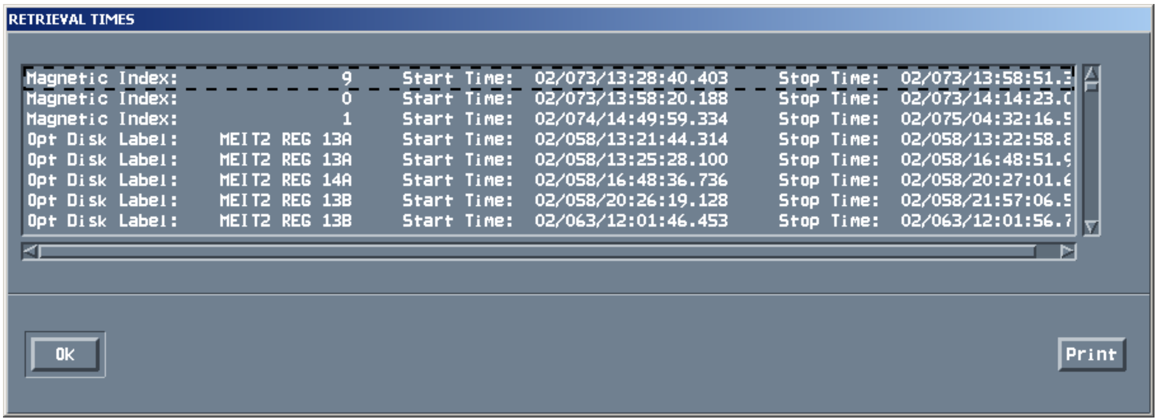


Figure 7-7: Retrieval Times

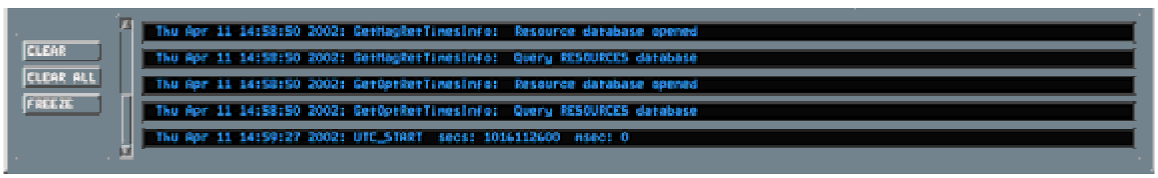


Figure 7-8: Retrieval Message Area

Figure 7-9: UTC Start Time Acceptance

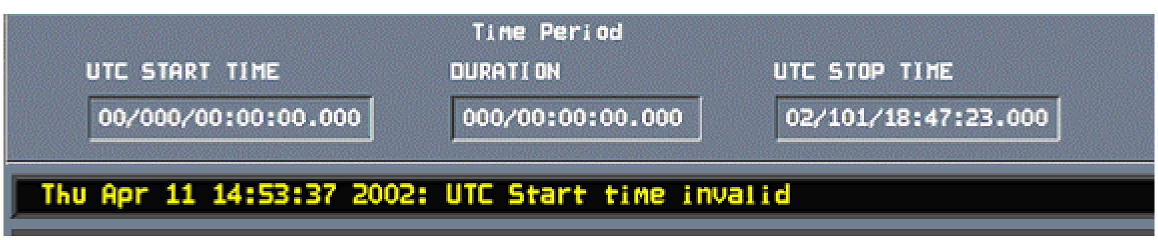


Figure 7-10: UTC Start Time Rejection

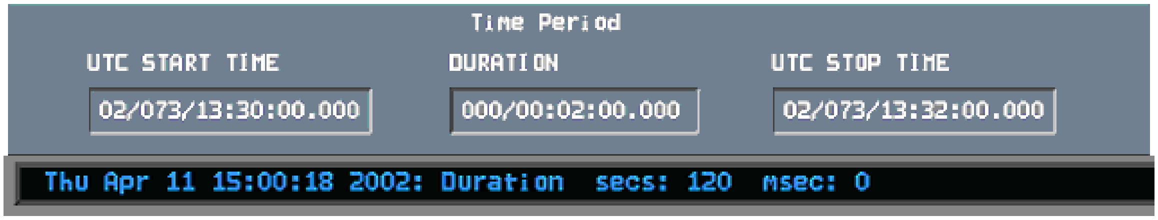


Figure 7-11: Duration Acceptance

Figure 7-12: UTC Stop Time Acceptance

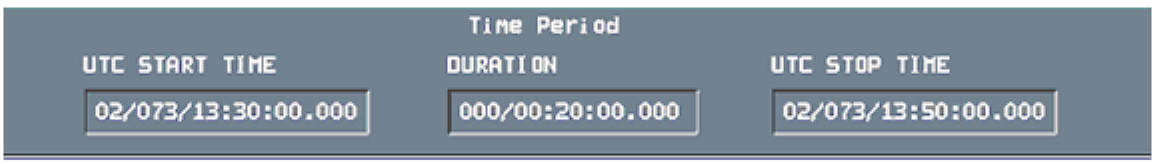


Figure 7-13: Processed Retrieval Time

Figure 7-14: Retrieval Times > Defined Times

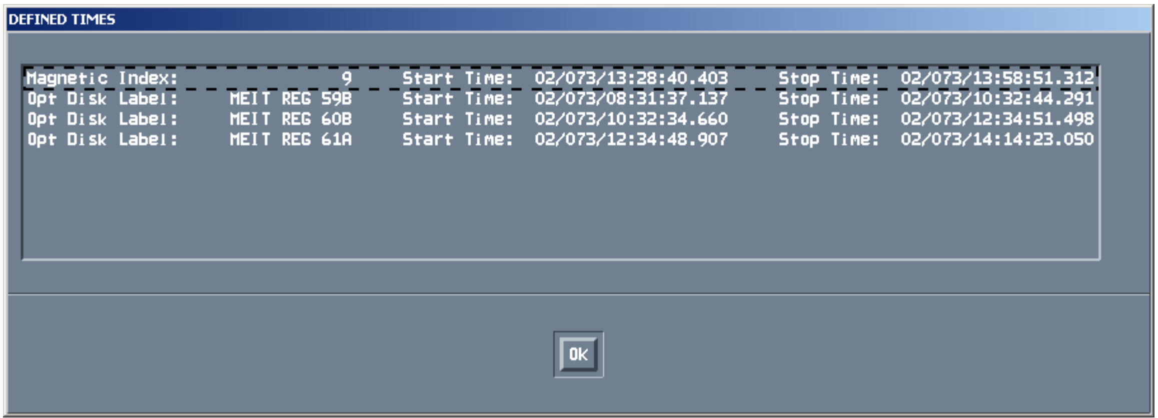


Figure 7-15: Defined Times

Figure 7-16: Switching Disks

Figure 7-17: Retrieval Destination

Figure 7-18: File Manager

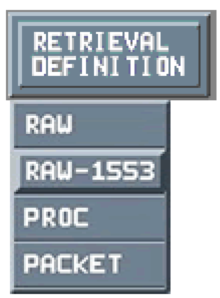


Figure 7-19: Retrieval Definition > Raw-1553

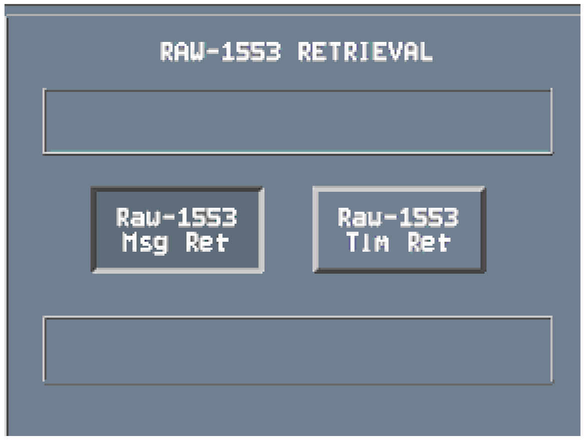


Figure 7-20: Raw-1553 Message Retrieval

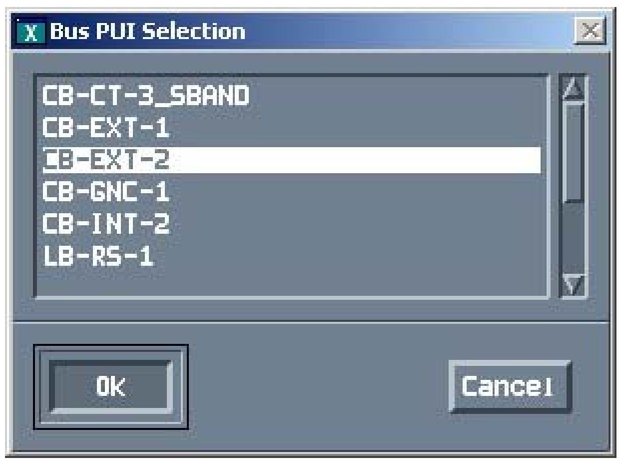


Figure 7-21: Bus PUI Selection

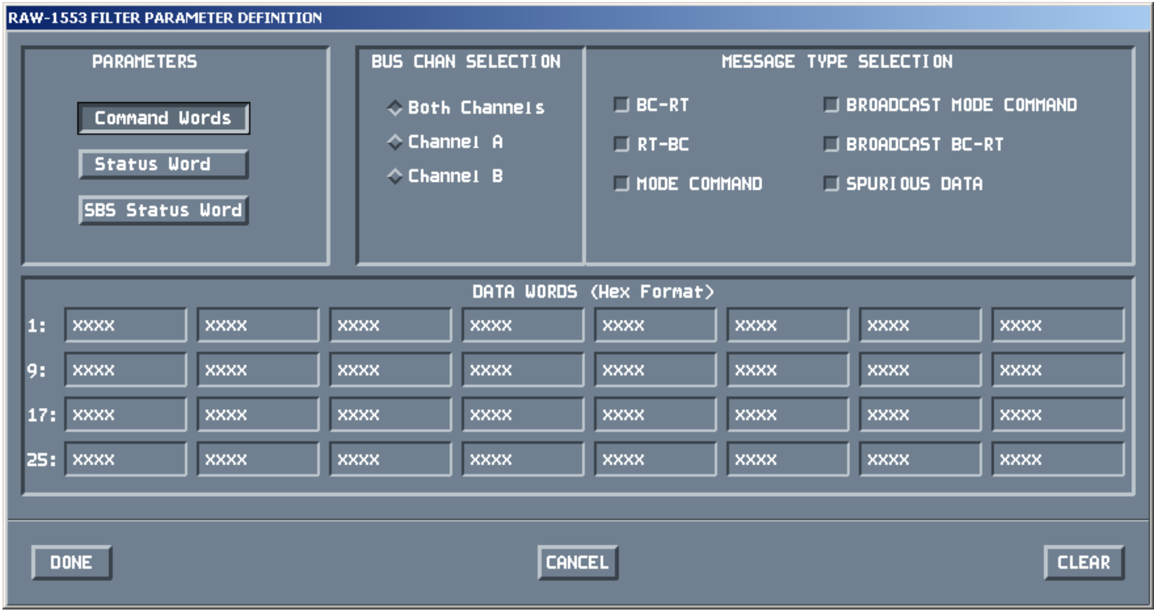


Figure 7-22: Raw-1553 Filter Parameter Definition

Figure 7-23: RT Selection in Command Words

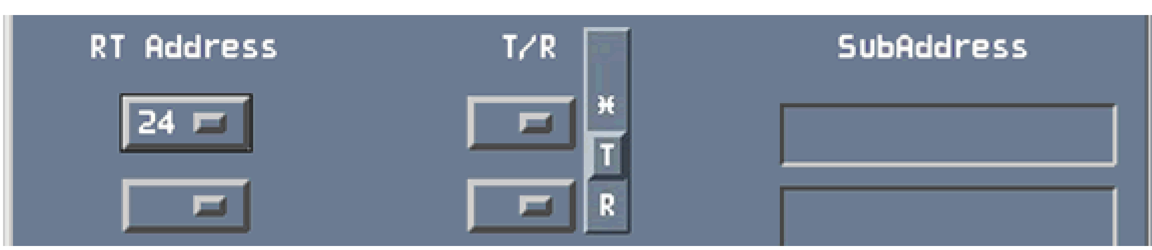


Figure 7-24: T/R Selection in Command Words

Figure 7-25: Subaddress Selection in Command Words

Figure 7-26: Retrieval Definition Confirmation

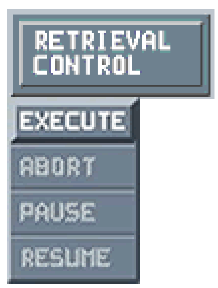


Figure 7-27: Retrieval Control > Execute

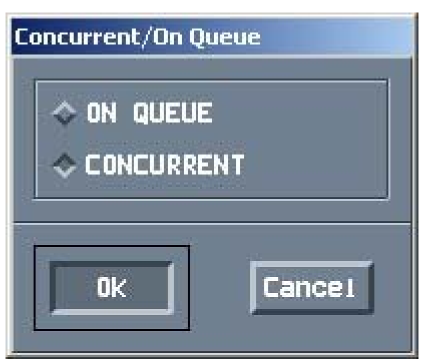


Figure 7-28: Concurrent/On Queue

Figure 7-29: Retrieval Executing

Figure 7-30: Retrieval Control >Abort

Figure 7-31: Abort Retrieval

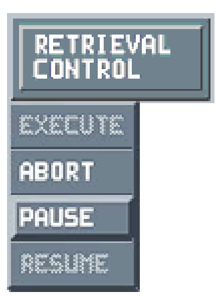


Figure 7-32: Retrieval Control > Pause

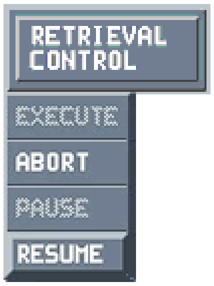
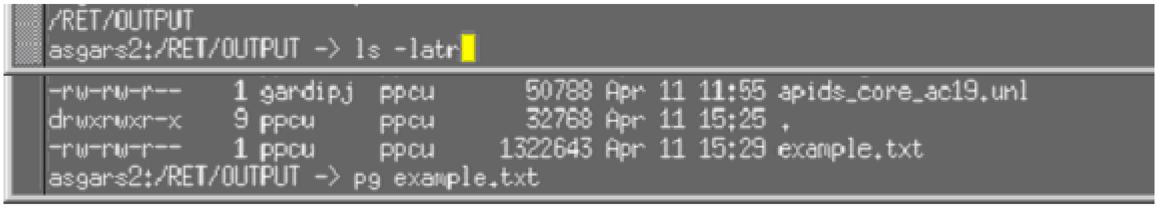


Figure 7-33: Retrieval Control > Resume

Figure 7-34: Load Disk/Tape Dialog

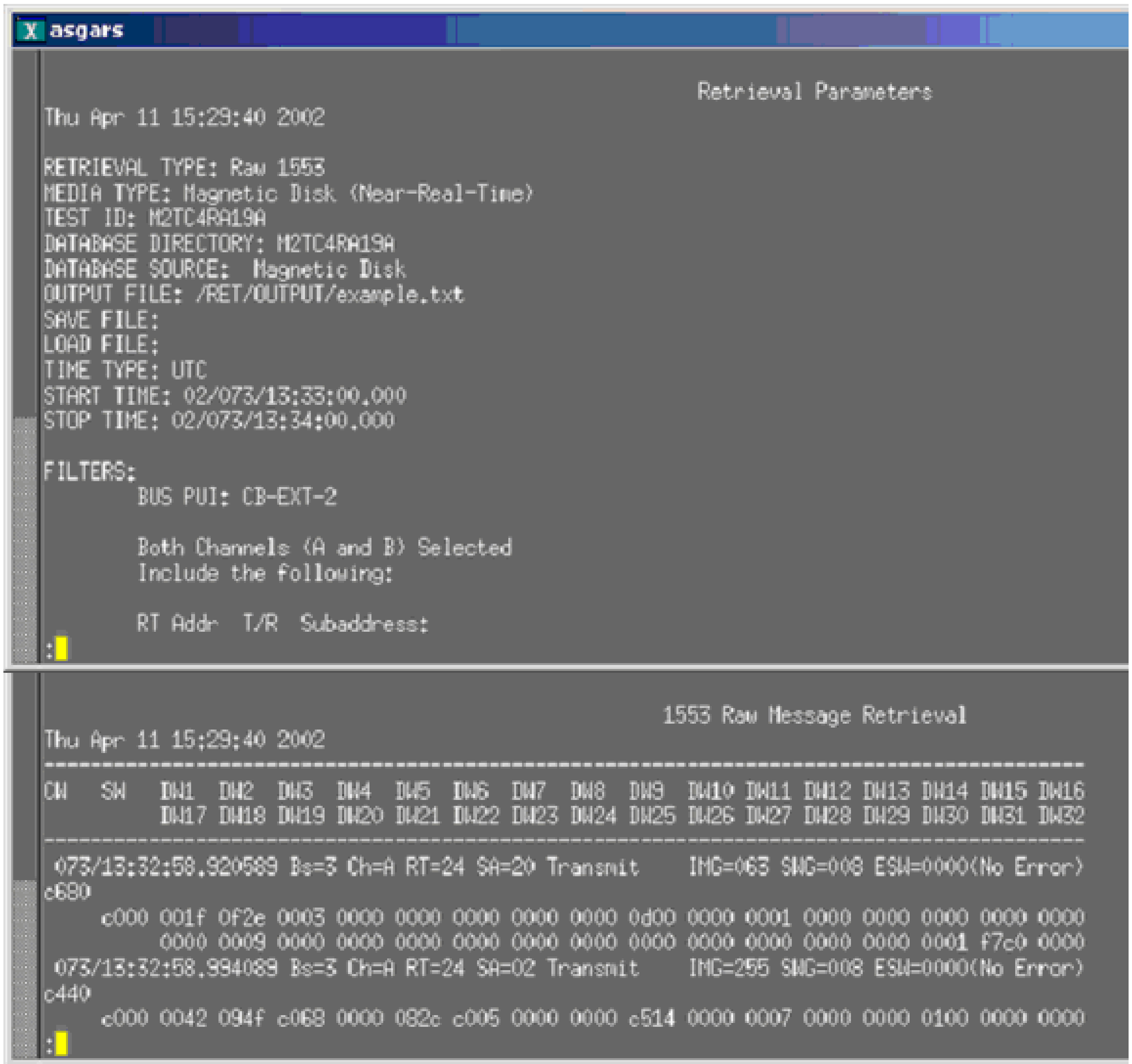
Figure 7-35: Retrieval Complete

Figure 7-36: Rlog in DBS



```
/RET/OUTPUT
asgars2:/RET/OUTPUT -> ls -latr
-rw-rw-r--    1 gardipj  ppcu      50788 Apr 11 11:55 apids_core_ac19.unl
drwxrwxr-x    9 ppcu     ppcu      32768 Apr 11 15:25 .
-rw-rw-r--    1 ppcu     ppcu    1322643 Apr 11 15:29 example.txt
asgars2:/RET/OUTPUT -> pg example.txt
```

Figure 7-37: Viewing Data File



```
asgars

                                                     Retrieval Parameters
Thu Apr 11 15:29:40 2002

RETRIEVAL TYPE: Raw 1553
MEDIA TYPE: Magnetic Disk (Near-Real-Time)
TEST ID: M2TC4RA19A
DATABASE DIRECTORY: M2TC4RA19A
DATABASE SOURCE:  Magnetic Disk
OUTPUT FILE: /RET/OUTPUT/example.txt
SAVE FILE:
LOAD FILE:
TIME TYPE: UTC
START TIME: 02/073/13:33:00.000
STOP TIME: 02/073/13:34:00.000

FILTERS:
        BUS PUI: CB-EXT-2

        Both Channels (A and B) Selected
        Include the following:

        RT Addr  T/R  Subaddress:
:

                                                   1553 Raw Message Retrieval
Thu Apr 11 15:29:40 2002
-----------------------------------------------------------------------------------------
CW   SW   DW1  DW2  DW3  DW4  DW5  DW6  DW7  DW8  DW9  DW10 DW11 DW12 DW13 DW14 DW15 DW16
          DW17 DW18 DW19 DW20 DW21 DW22 DW23 DW24 DW25 DW26 DW27 DW28 DW29 DW30 DW31 DW32
-----------------------------------------------------------------------------------------
 073/13:32:58.920589 Bs=3 Ch=A RT=24 SA=20 Transmit     IMG=063 SWG=008 ESW=0000(No Error)
c680
     c000 001f 0f2e 0003 0000 0000 0000 0000 0000 0d00 0000 0001 0000 0000 0000 0000 0000
          0000 0009 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0001 f7c0 0000
 073/13:32:58.994089 Bs=3 Ch=A RT=24 SA=02 Transmit     IMG=255 SWG=008 ESW=0000(No Error)
c440
     c000 0042 094f c068 0000 082c c005 0000 0000 c514 0000 0007 0000 0000 0100 0000 0000
:
```

Figure 7-38: Raw-1553 Message Data File

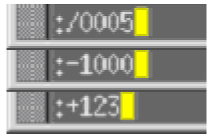


Figure 7-39: Moving in Data File

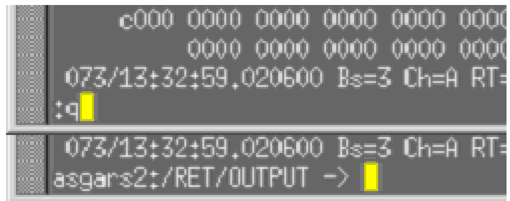


Figure 7-40: Exiting Data File

Figure 7-41: Raw-1553 Telemetry Retrieval

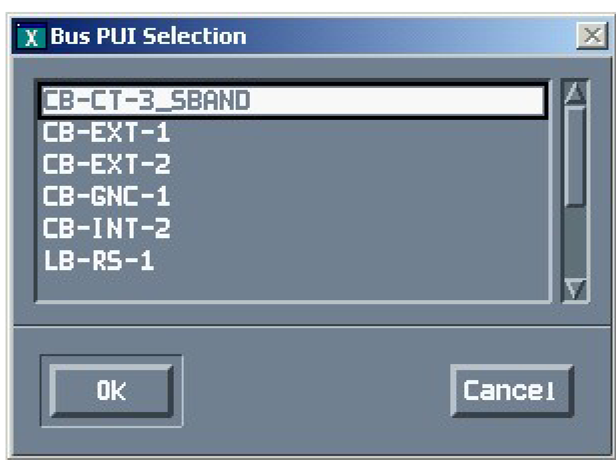


Figure 7-42: S-Band Bus PUI Selection

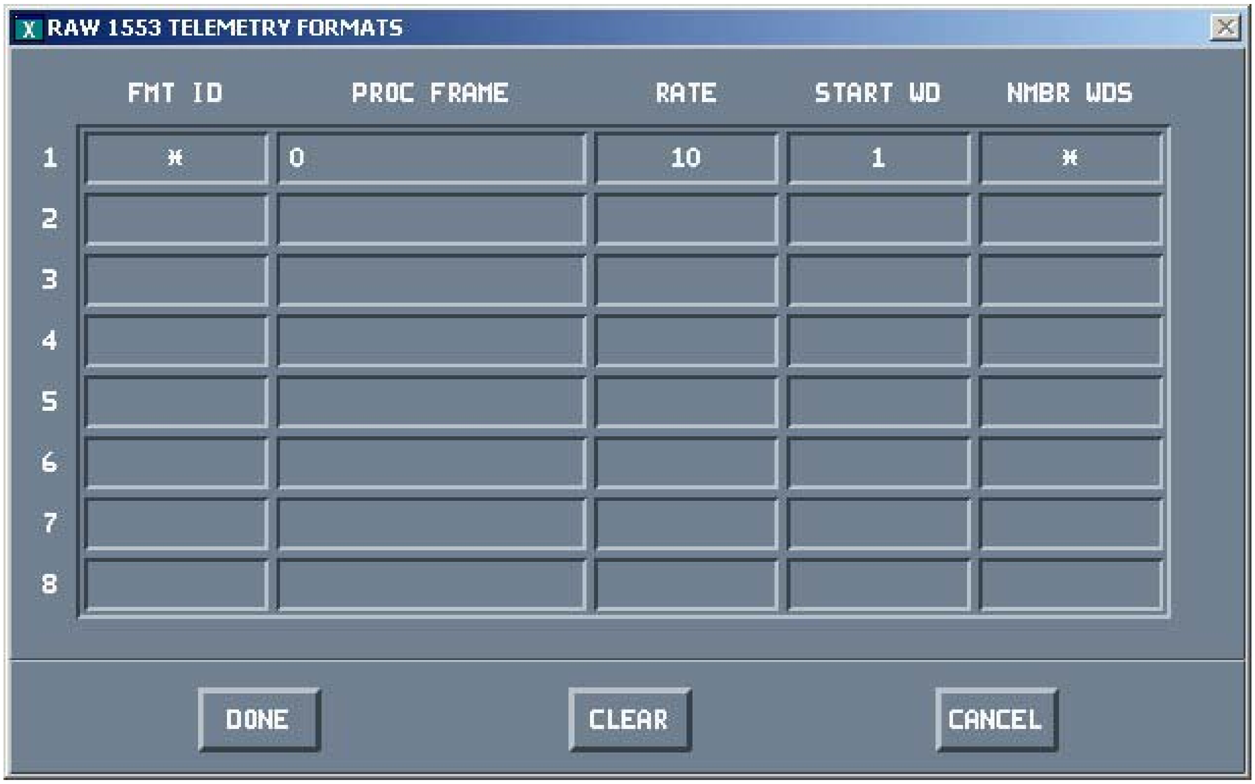


Figure 7-43: Raw-1553 Telemetry Formats

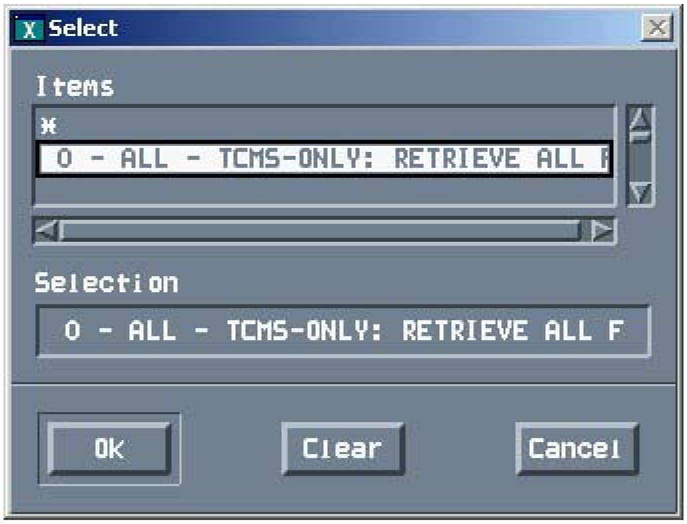


Figure 7-44: Format ID Selection

Figure 7-45: Processing Frame Selection

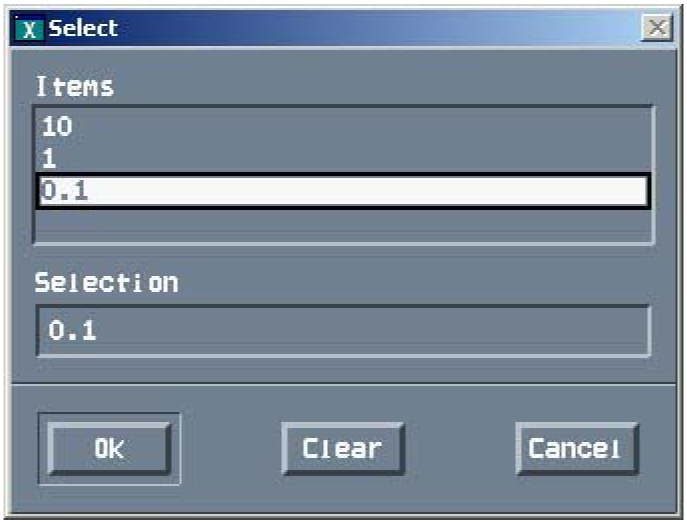


Figure 7-46: Rate Selection

Figure 7-47: Start Word Selection

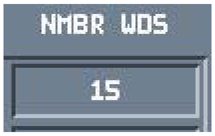


Figure 7-48: Number of Words Selection

```
                              Retrieval Parameters
Fri Aug  9 15:44:26 2002                                              Page 1

RETRIEVAL TYPE: Filtered 1553 Telemetry
MEDIA TYPE: Optical Disk (Historical)
TEST ID: M2TC4RA19A
DATABASE DIRECTORY: M2TC4RA19A
DATABASE SOURCE:  Magnetic Disk
OUTPUT FILE: /RET/OUTPUT/2002_069_sband_raw.txt
SAVE FILE:
LOAD FILE:
TIME TYPE: UTC
START TIME: 02/069/12:46:58.000
STOP TIME: 02/069/12:47:58.000

FILTERS:
        BUS PUI: CB-CT-3_SBAND
        BDT CONTROL COMMAND = 0x8840
        FILTER COMMAND      = 0x8860
        Format: 3(0x03) HK2     Frames: 66(0x42)
                Rate: 0.1 Start Wd: 65 Num Wds: 2
□
                      1553 Telemetry Filtered Message Retrieval
Fri Aug  9 15:44:29 2002                                              Page 1
-------------------------------------------------------------------------------------
CW   WD# DW1  DW2  DW3  DW4  DW5  DW6  DW7  DW8  DW9  DW10 DW11 DW12 DW13 DW14 DW15 DW16
-------------------------------------------------------------------------------------
 069/12:47:01.658613 Bs=2 Ch=A SBAND   Format=03 HK2 Version=11 Processing Frame=66
8860   1  0be8 dd0a 00b9 29b6 1844 3344 0ec3 0042 0000 0000 0000 0000 0000 0000 0000 0000

     65  4396 ac31

 069/12:47:11.658732 Bs=2 Ch=A SBAND   Format=03 HK2 Version=11 Processing Frame=66
8860   1  0be8 de36 00b9 29b6 184e 3344 0ec3 0042 0000 0000 0000 0000 0000 0000 0000 0000
```

Figure 7-49: Telemetry Data File

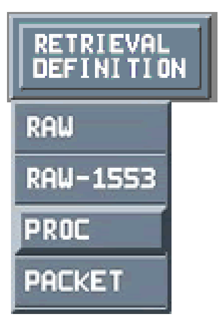


Figure 7-50: Retrieval Definition > Proc

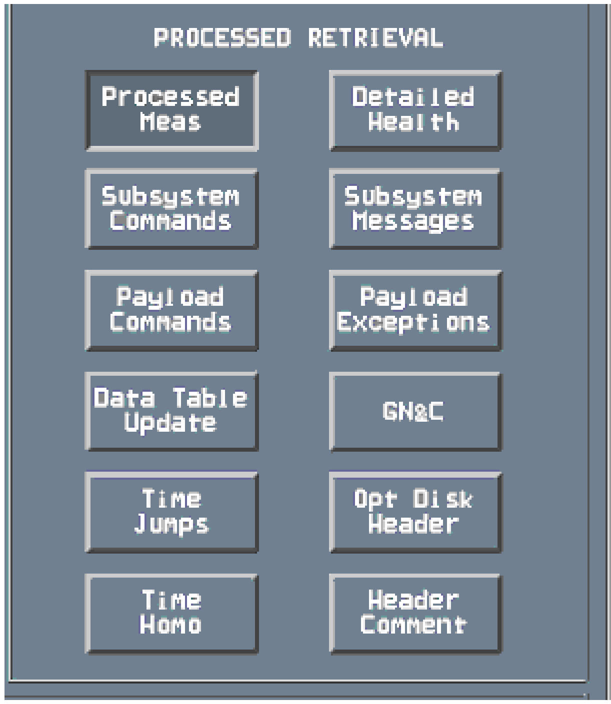


Figure 7-51: Processed Meas

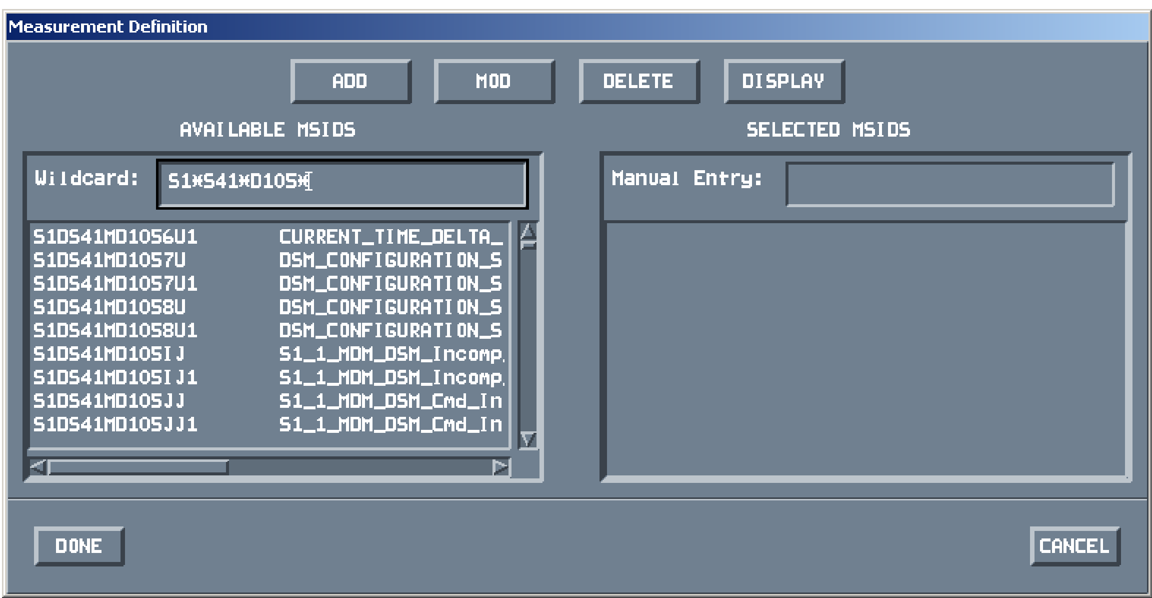


Figure 7-52: Displaying PUIs with Wildcard

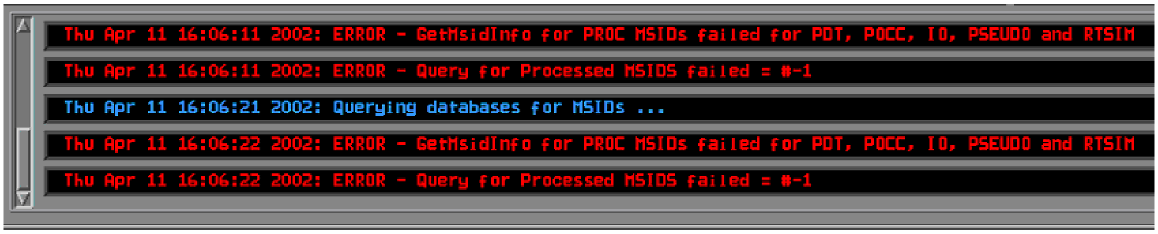


Figure 7-53: MSID Error

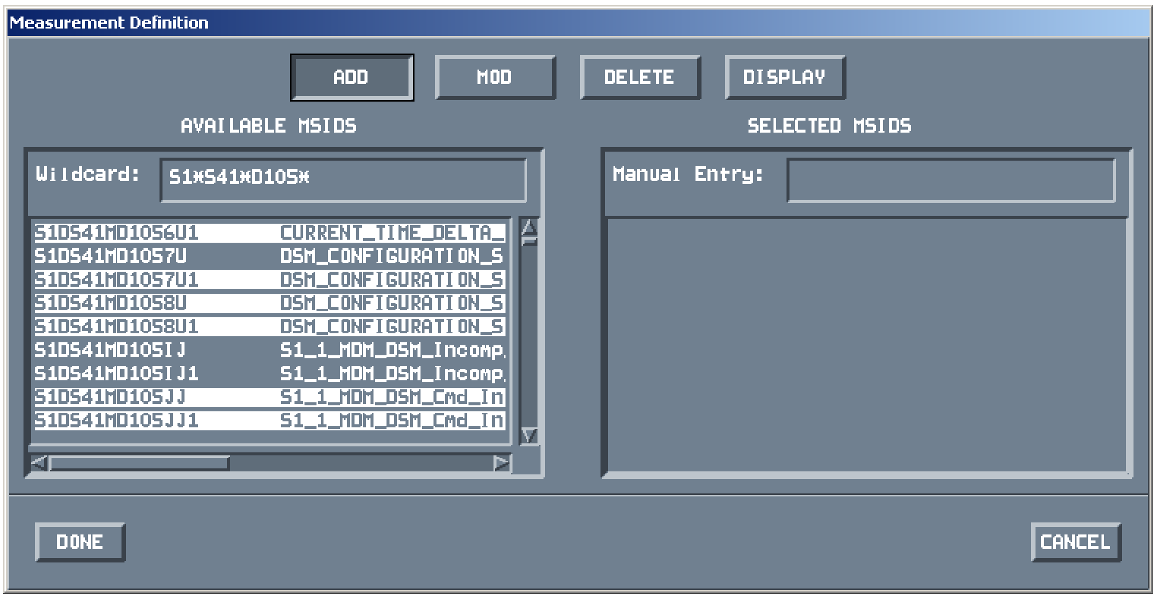


Figure 7-54: Selecting PUIs with Wildcard

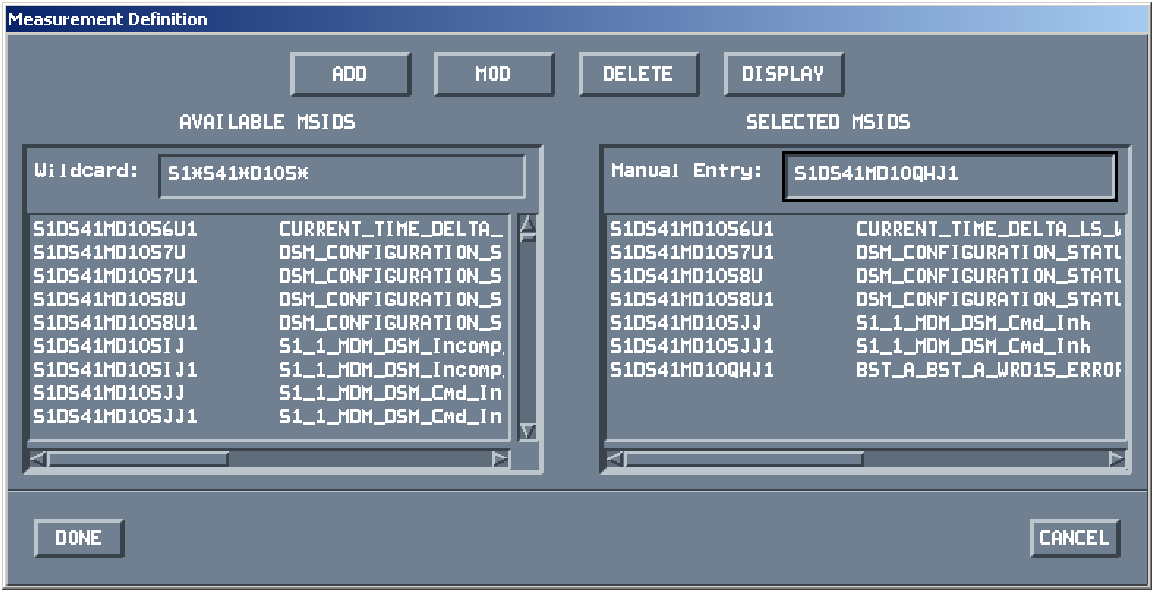


Figure 7-55: Selecting PUIs by Manual Entry

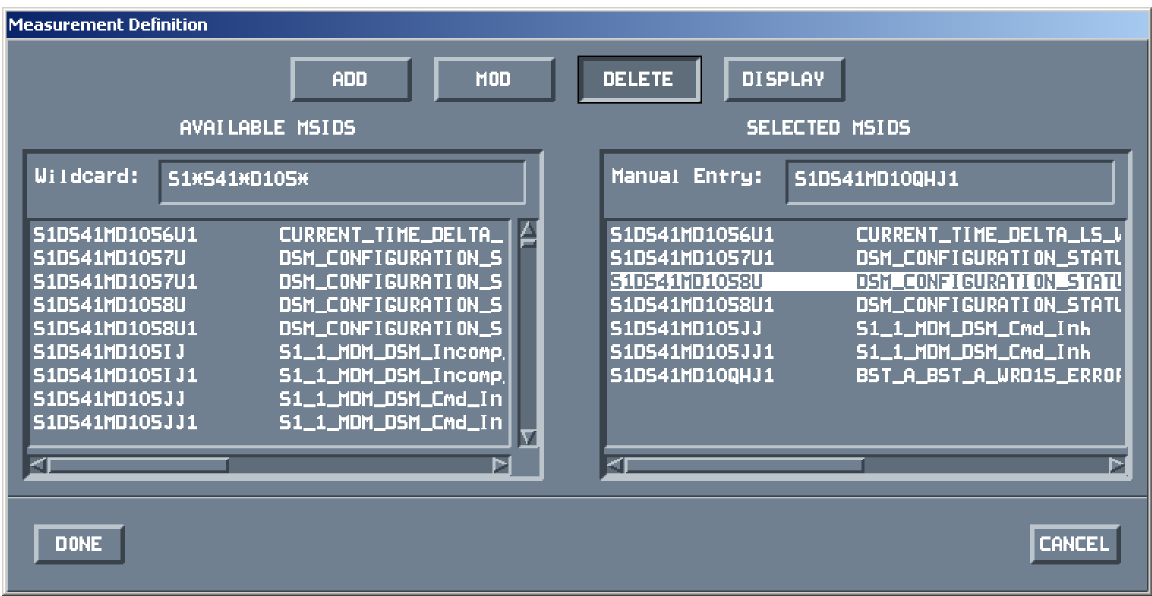


Figure 7-56: Deselecting PUIs

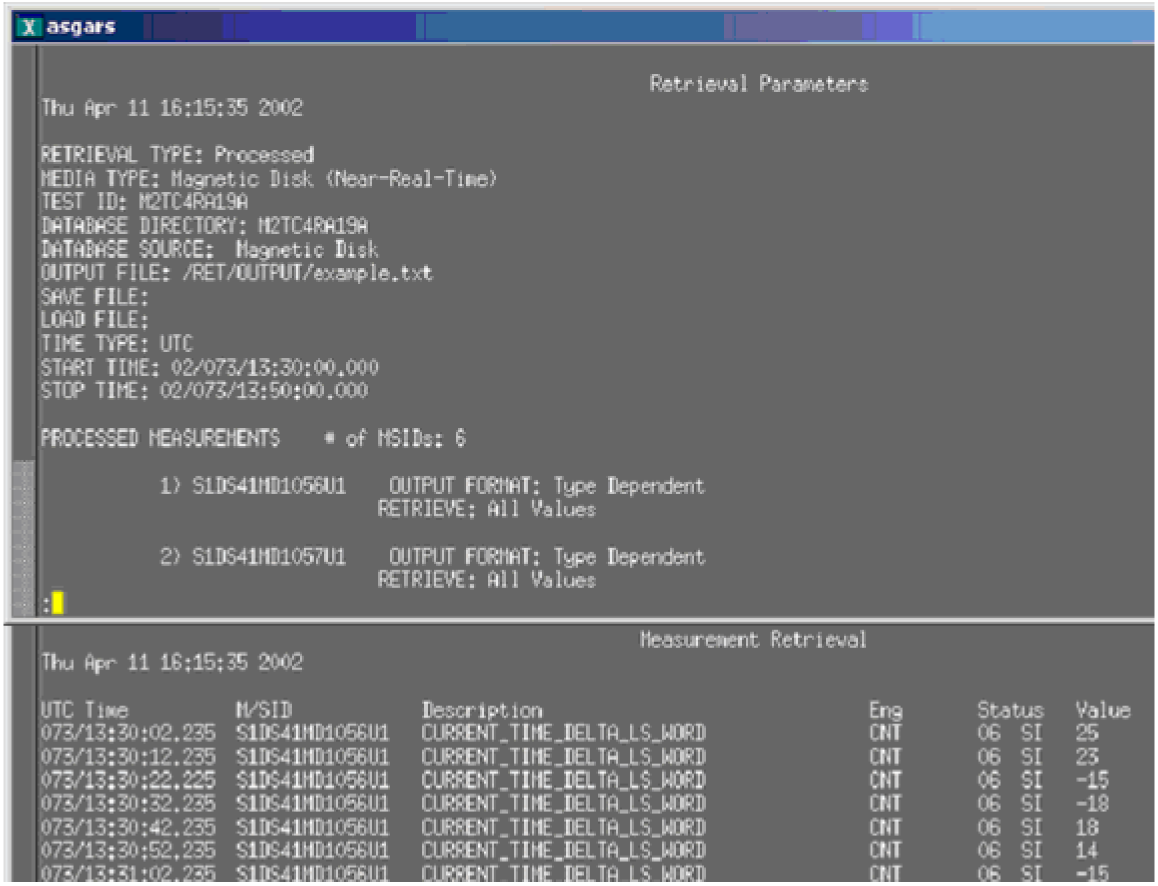


Figure 7-57: Processed Data File

7.5. Tables

Rate (Hz)	Format	Format Name	Start Word
0.1	1	Essential	Word Offset + 236
	2	Housekeeping I	Word Offset + 188
	3	Housekeeping II	Word Offset + 56
1	1 2 3	Essential Housekeeping I Housekeeping II	Word Offset + 8
10	1 2 3	Essential Housekeeping I Housekeeping II	N/A

Table 7-1: Start Word Determination

8. PASS-1000

8.1. Snapshot Mode Retrieval

1. Select **Monitor** > **Snapshot Mode**.
   Figure 8-1: Monitor > Snapshot Mode
   Figure 8-2: Snapshot Mode Screen

8.2. Data Logging Mode Retrieval

1. Select **Monitor** > **Data Logging Mode**.
   Figure 8-3: Monitor > Data Logging Mode
   a. To create new files: Select the **Filename** text box and enter the required filename. There is a seven-character filename limit. The default file extension is .arc; however, in the event the file needs to be zipped, change the extension to .sbs, as Winzip will think .arc is already zipped.
      Figure 8-4: File Open New File
   b. To view existing files: Select the required **directory** in the right column. Select the required **filename** in the left column.
      Figure 8-5: File Open Old File
2. Select **OK**.
   Figure 8-6: Data Logging Mode Screen

8.3. Executing Retrieval

1. Select **Log Devices**. Select/deselect the Log Devices such that only the required Log Devices have a checkmark to their left.
   Figure 8-7: Log Devices
2. Select **Log Filters**. Select the required Log Filter.
   Figure 8-8: Log Filters
3. In the RT Filter Control Panel, the available RTs are displayed. Green highlight of an RT means all of the subaddresses in that RT are selected; yellow highlight of an RT means some of the subaddresses in that RT are selected; gray highlight of an RT means none of the subaddresses in that RT are selected.
   Figure 8-9: RT Filter Control Panel
   a. To select all of the subaddresses for all of the RTs, select **All**.
   b. To select none of the subaddresses for all of the RTs, select **None**.
   c. To select all or none of the subaddresses for an individual RT, select the **RT** until it has the respective green or gray highlight.
   d. To individually select/deselect subaddresses for an RT, select **Edit** from beneath that particular RT. In the SA Filter Definition Panel, the available subaddresses are displayed in two separate tables: Receive Buffers and Transmit Buffers. Green highlight of a subaddresses means it is selected for the respective receive or transmit; gray highlight of a subaddresses means it is not selected for the respective receive or transmit.
      Figure 8-10: SA Filter Definition Panel
      i. To select all of the subaddresses for both receive and transmit, select **All**.

   ii. To select none of the subaddresses for both receive and transmit, select **None**.
   iii. To select/deselect a subaddress, select the **subaddress** from the respective receive or transmit table until it has the respective green or gray highlight.
4. Select **Triggers**. Select the name of **database** monitoring below the Simple heading.
   Figure 8-11: Trigger > Database
5. Select the pull down menu and select the **trigger** required. If no specific trigger required, select **Trig on any msg** for all messages.
   Figure 8-12: Trigger Selection
6. Select the **Filesize** text box. Enter the size or greater that you want the file to be in bytes. If Stop is selected while the monitoring is occurring, the file size will be that of the file at the time Stop is selected. Otherwise, the file size will be that which was entered.
   Figure 8-13: Filesize
7. Select **Run**.
   Figure 8-14: Monitor Control
8. To stop the monitoring, select **Stop** or wait for the buffer.
9. Scroll to data or use **Find**.

8.4. Using Find

1. Select **Find**. The search goes down from whatever buffer currently at in the file.
   Figure 8-15: Display
2. Select **type** of find. Most commonly used is the **Find msg=MSGID when MASKed data word NN=VALUE**. An explanation of all search types is available in Table 3.5.10 of the PASS-1000 Users Manual.
   Figure 8-16: Find
3. Enter the required **MSGID** in the four text boxes. Each box respectively represents the RT address, whether receiving or transmitting (R/T), the subaddress, and the word count (usually 32 words, since most 1553 data in Space Station uses the 32 word "boxcar" data transmission). "X" can be used in the above fields as a wildcard. If the required subaddress does not have a processing frame counter, use a subaddress that has a relevant processing frame counter.
4. Enter the **Mask** value in hexadecimal. This specifies the value of a mask that will be logically anded with the current word. This allows for a bit to be out of sync in the bits that are not significant and not interfere. If searching for a processing frame, only 0-99 are used, so only the seven least significant bits are used. The Mask value would then be 007F. The Mask value FFFF can be used to find all bits.
5. Enter the **Value** in hexadecimal. This can be a processing frame or other type of data word.
6. Enter the word offset for the data word in **NN**.
7. Select **OK**.

Note: To find the next message meeting the search pattern, select **Next**.
To find the last message meeting the search pattern, select **Last**.
Figure 8-15: Display

8.5. Finding Data

1. The raw data is displayed in sets of data. Each set of data is for an individual subaddress for each processing frame. A horizontal line separates the sets of data. Each data set has a message number to its left, in the order card:: buffer: message number, followed by the gap, absolute, and delta times.
   Figure 8-17: Message Number
2. If the processing frame counter is not in the subaddress relevant to the PUI, go to the relevant subaddress in the same processing frame (if the relevant subaddress is greater than the processing frame counter, then the next relevant subaddress; if the relevant subaddress less than the processing frame counter, then the previous relevant subaddress).
3. Each set of data for each subaddress for the different times contains 32 words in four rows, four characters per word. The first row contains words 1-8; the second row contains words 9-16; the third row contains words 17-24; the fourth row contains words 25-32. The word offset ranges from 1-32. Find the word corresponding to the word offset (e.g. a word offset of 10 would by the second word from the left in the second row; a word offset of 30 would by the sixth word from the left in the fourth row). If the word order is Intel (only applicable with data types of two or four words), the extracted words need to be word swapped. This is because Intel transmits the least significant word first instead of the most significant word first as required by Mil-Std-1553. Examples: if the extracted words are 43ab 78c9, then the data is 78c9 43ab; if the extracted words are 43ab 78c9 56f4 d12e, then the data is d12e 56f4 43ab 78c9.
4. Once in the required word, find the first bit of the data for the required PUI. Each word contains 16 bits, 4 bits per character. The bits in a word are labeled 0-15. |0 1 2 3|4 5 6 7|8 9 10 11|12 13 14 15| The bit offset is the first bit in the data. The required bit is that labeled bit (ex. if the bit offset is 7, then the first bit is bit 7, which is the eighth bit from the left).
5. Once beginning with required bit, the amount of data corresponding the PUI is the data type (ex. if the bit offset is 7 and the data type is 3 bits, then the data relevant to the PUI is bits 7-9, the eighth, ninth, and tenth bits from the left).

8.6. Saving as ASCII file

1. Select **File** > **Save as ASCII File**.
   Figure 8-18: File > Save as ASCII File
2. If all of the data is in the current buffer, select **OK**. However, if the required data is in more than one buffer, select the diamond next to **Message Range**. Then enter the **first** and the **last messages** that you want saved in their respective text boxes (message information found to the left of the data sets).
   Figure 8-19: ASCII Save

Note: To find the last message in the data set, select **Last** in the Monitor Control Panel. If a **Find** has been performed before this, select **Find** and enter X for all values and then select **Last**.
Figure 8-15: Display

3. Select the **Filename** text box and enter the required filename. There is a seven-character filename limit. Use the extension .txt for text files. Select **OK**.
Figure 8-4: File Open New File

8.7. Monitoring a Subaddress

1. Select **RT** > **View**.
Figure 8-20: RT > View
2. Select **Sel** under the required RT address.
Figure 8-21: View RT Select
3. Select **Sel** under the required subaddress.
Figure 8-22: View Subaddress Select
A screen displaying the current 32 words of data for the respective subaddress appears. The screen continuously updates itself.
Figure 8-23: Subaddress Monitoring

8.8. Monitoring Bus Activity

8.8.1. Percent Display

1. Select **Bus Activity** > **Percent Display**.
Figure 8-24: Bus Activity > Percent Display
A screen displaying a box for each RT address appears. Each RT address has a percentage amount (also represented by a bar) next to an R and a T (receiving and transmitting data, respectively), representing the percentage of the bus's total activity it is using. The receiving and transmitting percentages represent percentage of bus bandwidth. Green means that the MDM is polling for and receiving information from the Remote Terminal; yellow means that the MDM is polling for the Remote Terminal, but is not getting a response. Red means that there is an error on the bus (Parity error, Manchester error, etc) and you can left click on the RT to determine the specific errors that are being generated. The screen continuously updates itself.
Figure 8-25: Percent Bus Activity by RT
2. Hold the **Left mouse button** on the required RT address. The error summary for that RT address appears so long as the Left Mouse button is depressed.
Figure 8-26: Bus Activity by RT Error summary
3. **Right-click** the required RT address. A screen displaying a box for each subaddress appears. Each subaddress has a percentage amount (also represented by a bar) next to an R and a T (receiving and transmitting data, respectively), representing the percentage of the RT address's total activity it is using. The receiving and transmitting percentages represent percentage of bus bandwidth. Green means that the MDM is polling for and receiving information from the Remote Terminal; yellow means that the MDM is polling for the Remote Terminal, but is not getting a response. Red means that there

is an error on the bus (Parity error, Manchester error, etc) and you can left click on the RT to determine the specific errors that are being generated. The screen continuously updates itself.
Figure 8-27: Bus Activity by Subaddress

a. Hold the **Left Mouse Button** on the required **subaddress**. The error summary for that subaddress appears so long as the Left Mouse button is depressed.
Figure 8-28: Bus Activity by Subaddress Error Summary
b. **Right-click** anywhere on the screen to return to the screen displaying all the RT addresses.

4. Select **OK** to close the screen.

8.8.2. Count Analysis

1. Select **Bus Activity** > **Count Analysis**.
Figure 8-29: Bus Activity > Count Analysis
A screen appears with each RT address in a row. In each RT's row, there is a row for the total count of the RT, the A bus, and the B bus; in each column, the sum of the A and B bus counts should equal the total count for the RT address. There are columns for the Command Count, No Response, Error Count, and Error. At the end of each RT row, there is the status word for that RT address. The screen continuously updates itself.
Figure 8-30: Bus Activity by Count

Notes:

1. If the MDM is out of sync, most MDMs will have the MSB of the first word as set; thus PF 1 would be found as "8001", PF10 would be found as "800A", etc. Thus the use of Masking in Find.

8.9. Figures

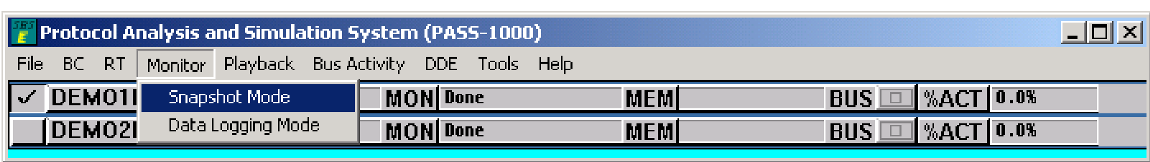


Figure 8-1: Monitor > Snapshot Mode

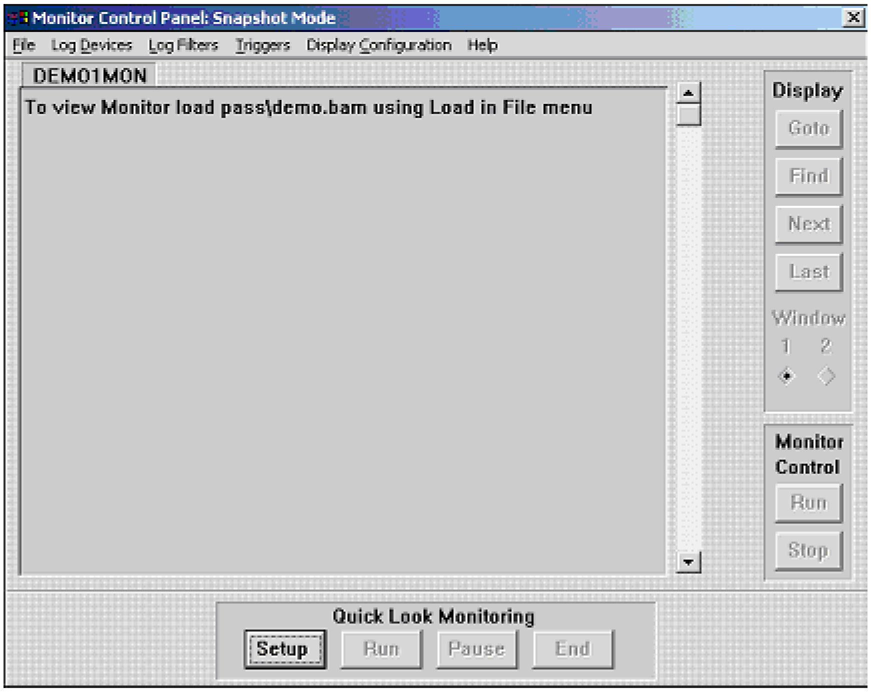


Figure 8-2: Snapshot Mode Screen

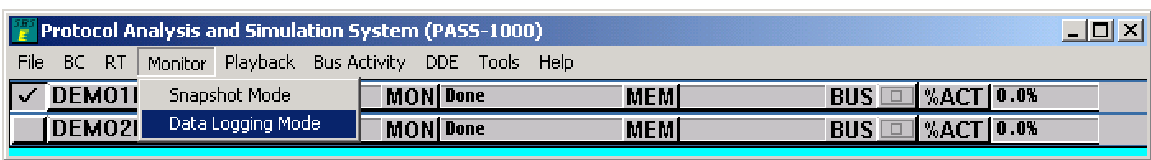


Figure 8-3: Monitor > Data Logging Mode

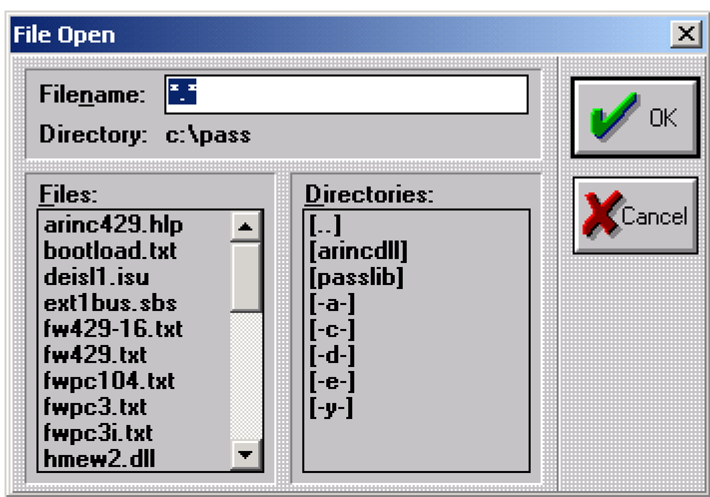


Figure 8-4: File Open New File

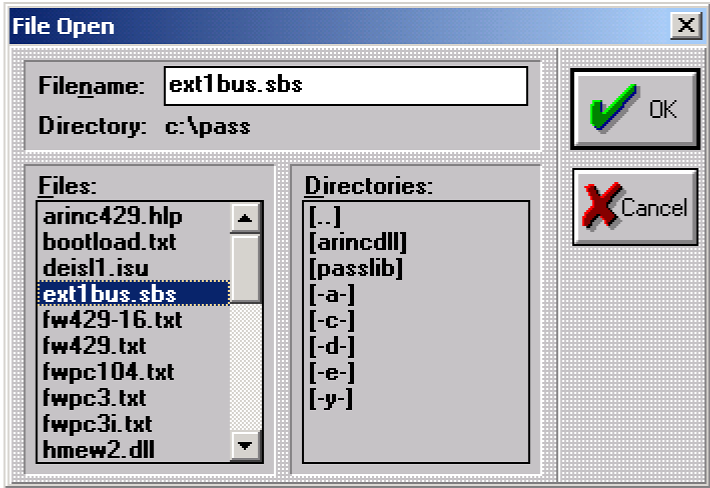


Figure 8-5: File Open Old File

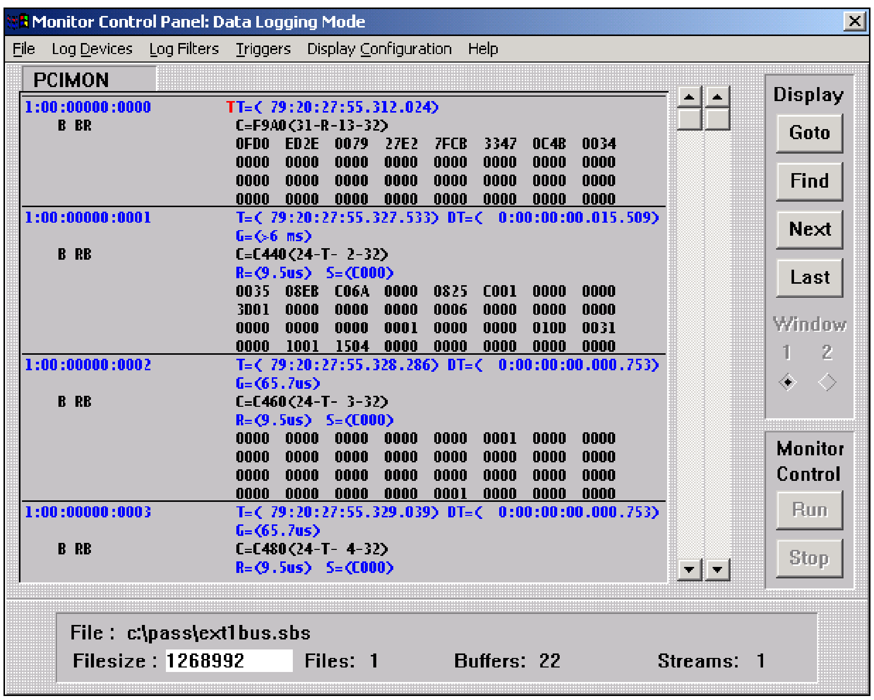


Figure 8-6: Data Logging Mode Screen

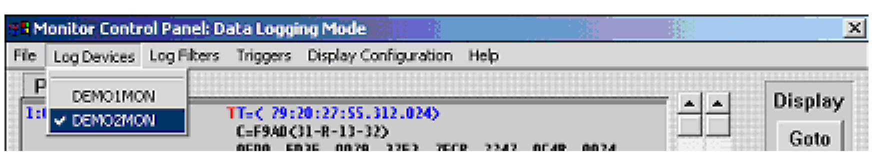


Figure 8-7: Log Devices

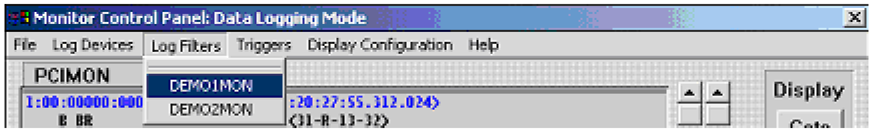


Figure 8-8: Log Filters

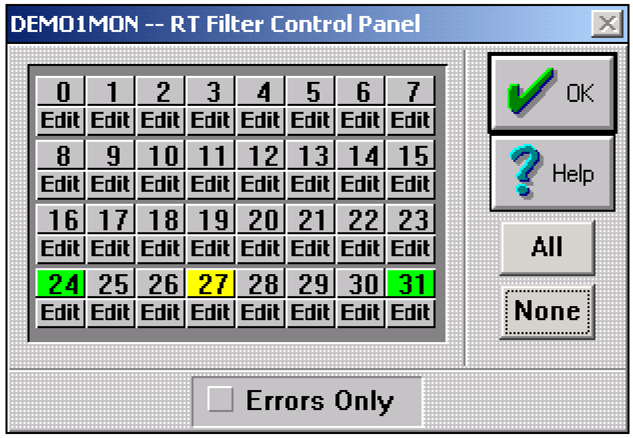


Figure 8-9: RT Filter Control Panel

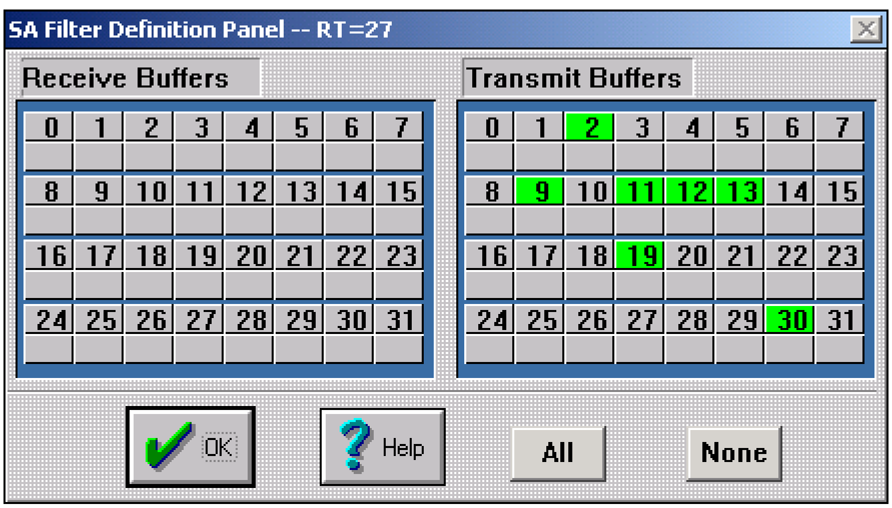


Figure 8-10: SA Filter Definition Panel

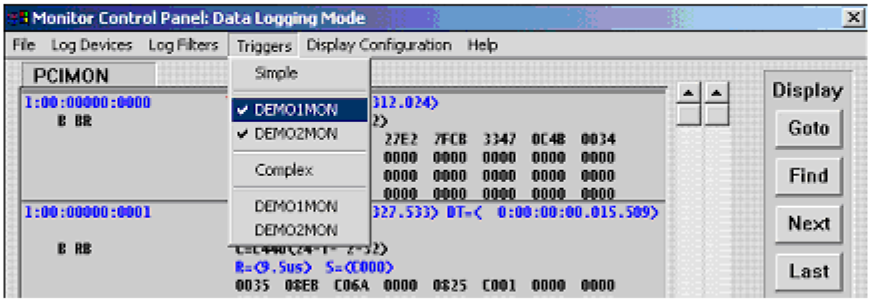


Figure 8-11: Trigger > Database

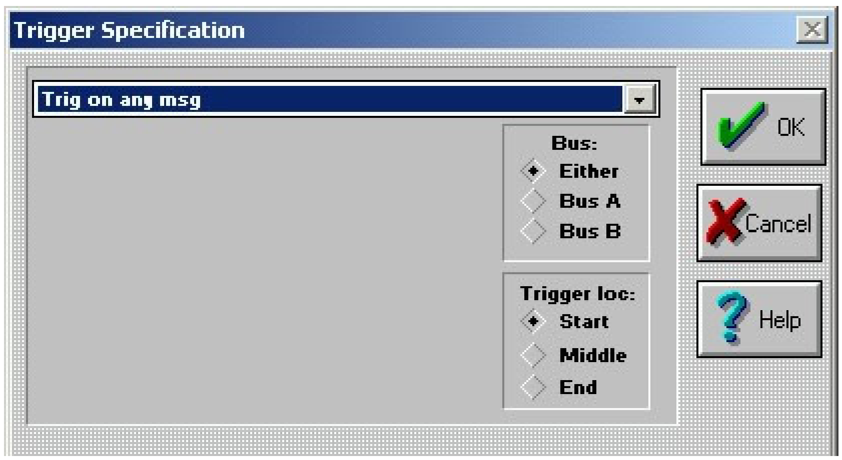


Figure 8-12: Trigger Selection

Figure 8-13: Filesize

Figure 8-14: Monitor Control

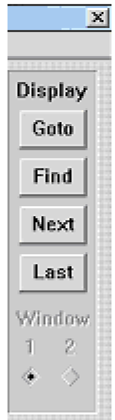


Figure 8-15: Display

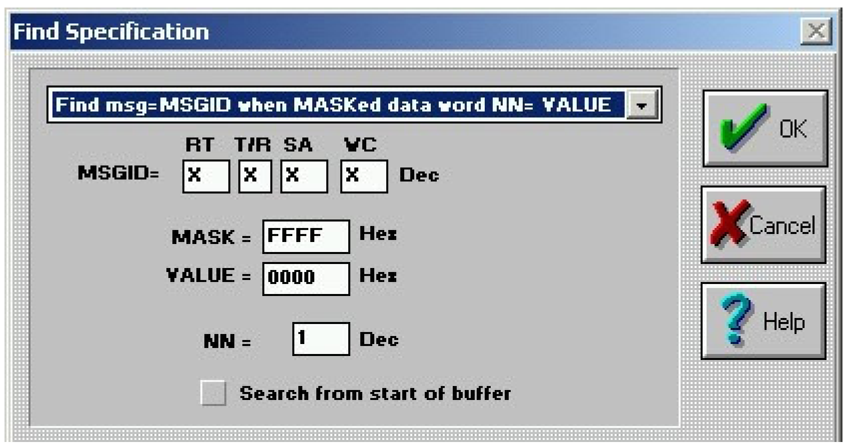


Figure 8-16: Find

Figure 8-17: Message Number

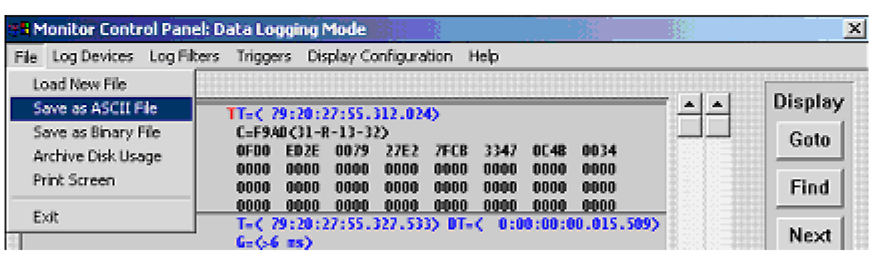


Figure 8-18: File > Save as ASCII File

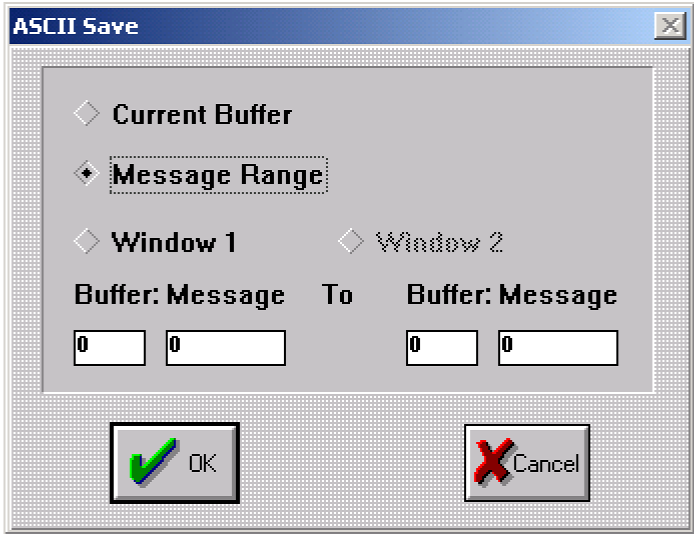


Figure 8-19: ASCII Save

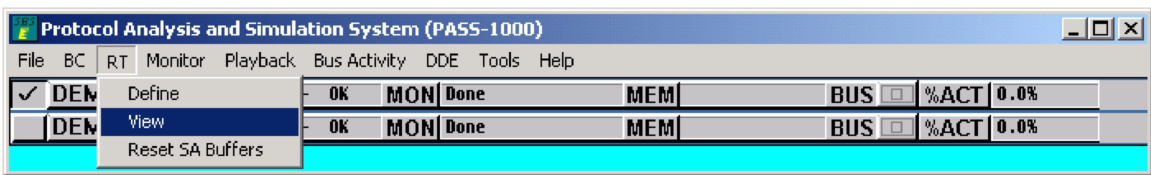


Figure 8-20: RT > View

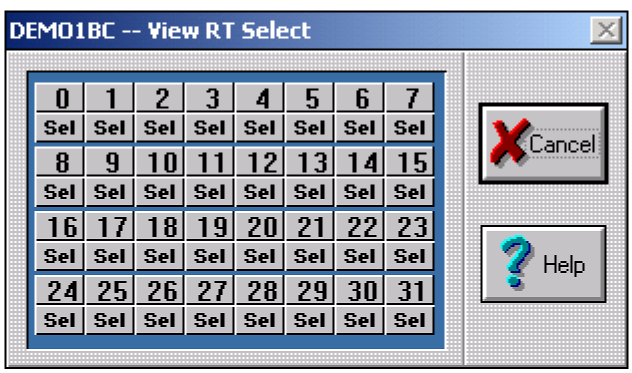


Figure 8-21: View RT Select

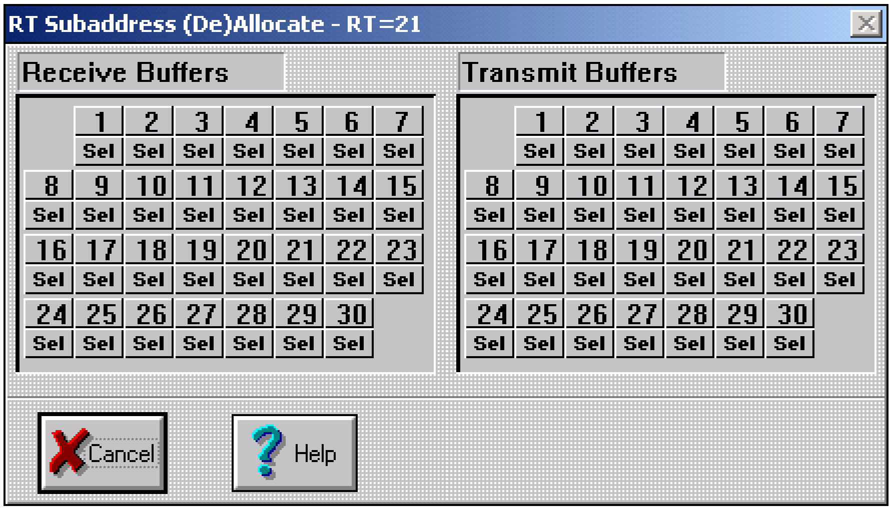


Figure 8-22: View Subaddress Select

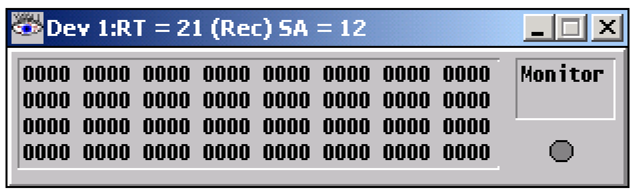


Figure 8-23: Subaddress Monitoring

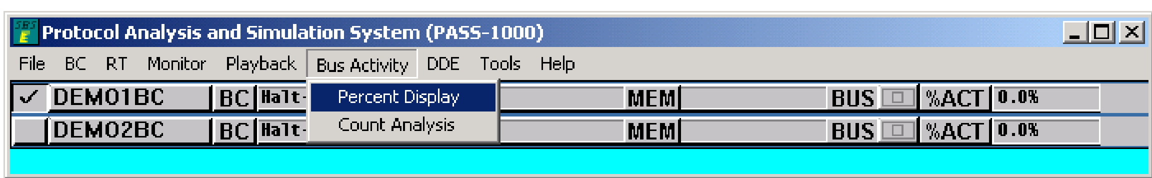


Figure 8-24: Bus Activity > Percent Display

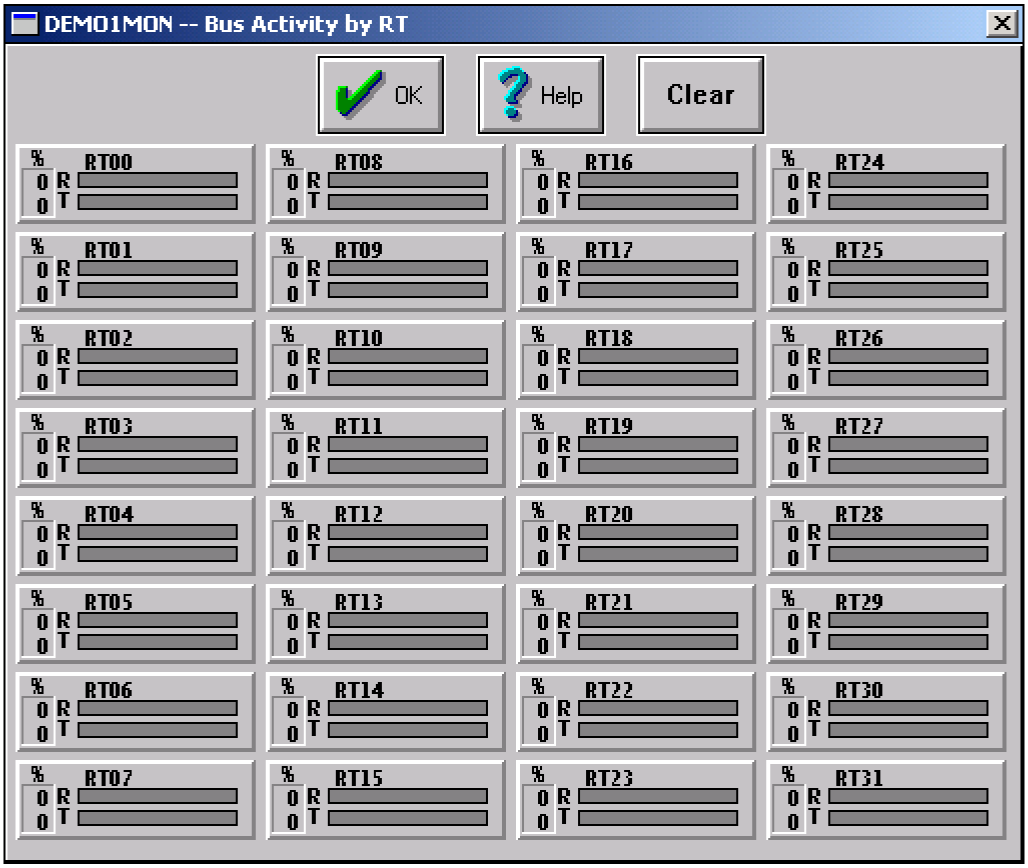


Figure 8-25: Percent Bus Activity by RT

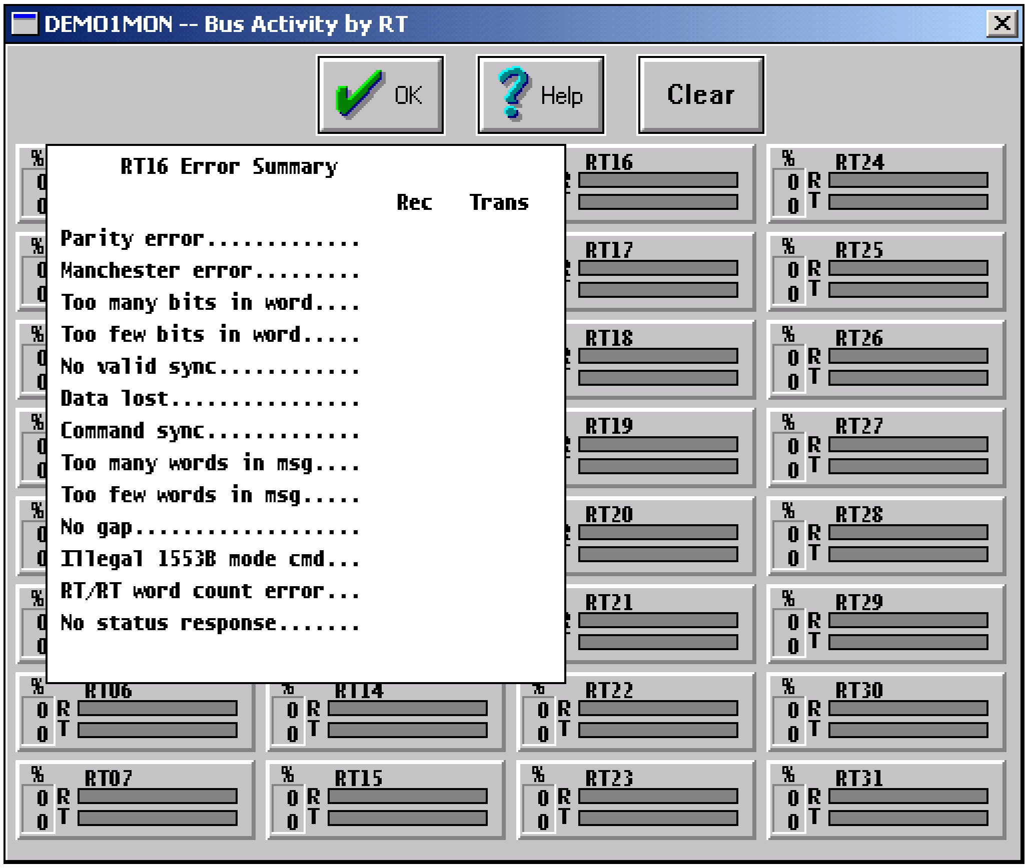


Figure 8-26: Bus Activity by RT Error summary

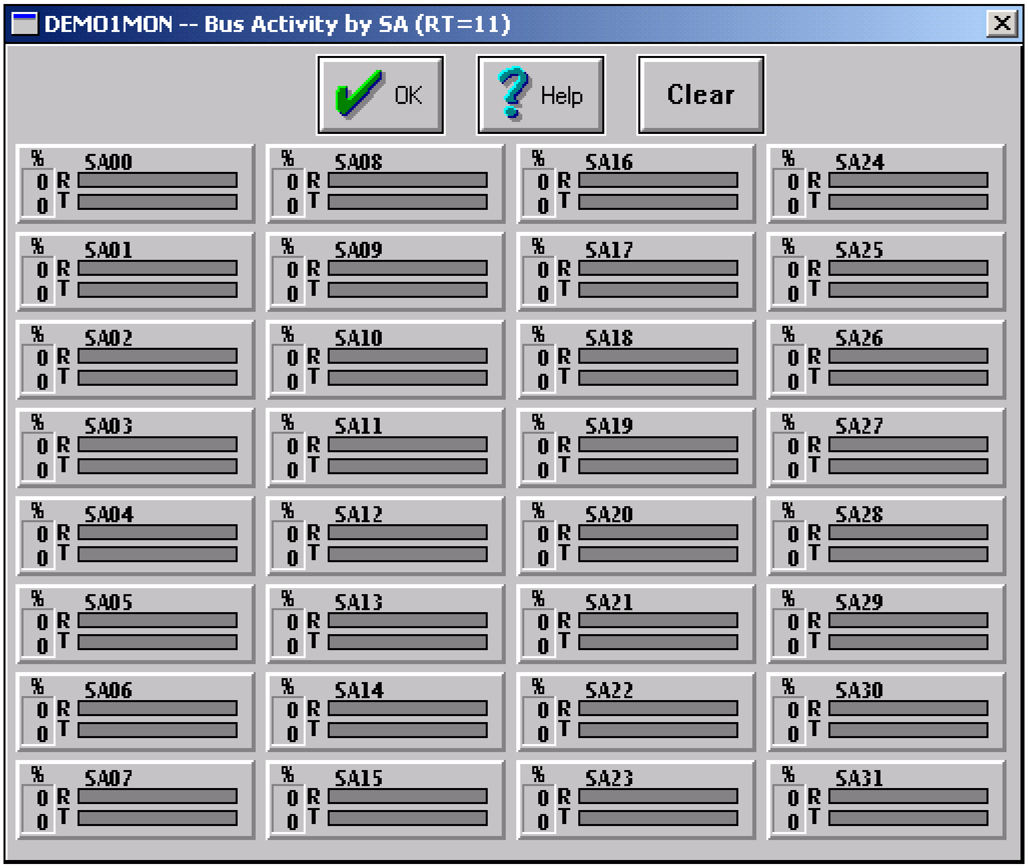


Figure 8-27: Bus Activity by Subaddress

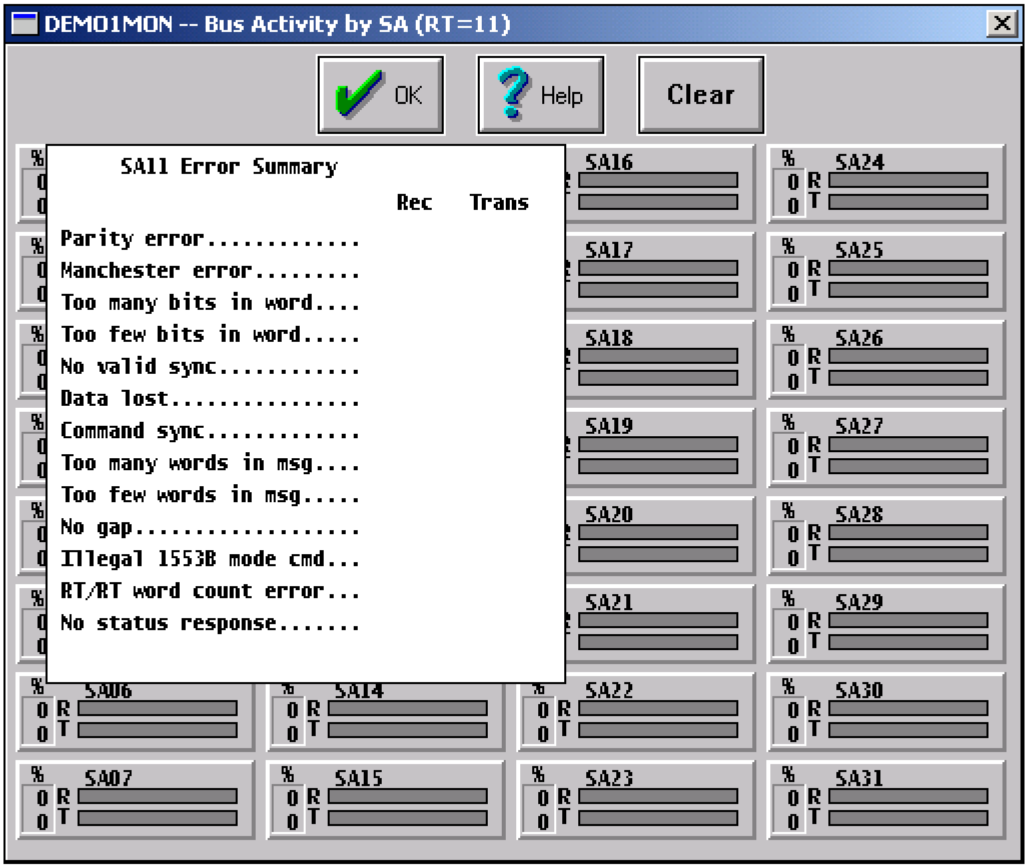


Figure 8-28: Bus Activity by Subaddress Error Summary

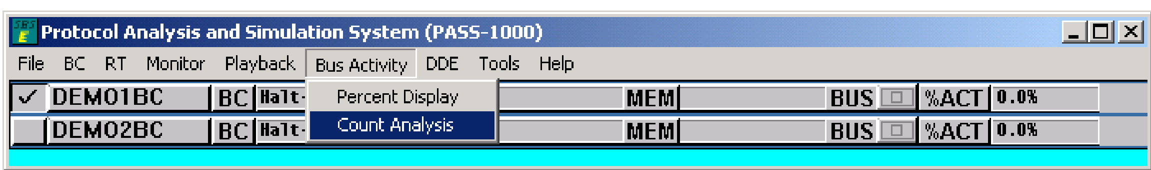


Figure 8-29: Bus Activity > Count Analysis

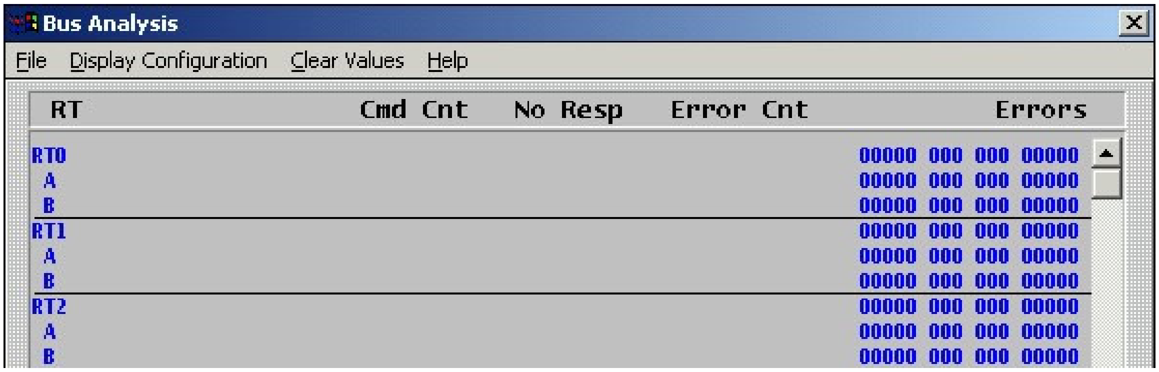


Figure 8-30: Bus Analysis by Count

Appendices

Appendix A ISS C&DH Sources

ISS C&DH Overview
ISS C&DH Overview Packet
ISS Flight Software Overview
Standard Out Overview (D684-10177-01 Mission Build Facility Standard Output Definition)
MOD JSC C&DH overviews
Space Station Multiplexer/Demultiplexer (SSMDM) Standard Interface Control Document (SSP 30261-002, Rev L)
Enhanced Space Station Multiplexer/Demultiplexer (ESSMDM) Standard Interface Control Document (SSP 30261-004, Rev F)

Appendix B Military-Standard 1553 Protocol Sources

MIL-STD-1553B
An Interpretation of MIL-STD-1553B
ISS 1553 Command and Data Overview
ISS 1553 Command and Data Handling Protocol Overview
ICD Subaddress Assignments Multiplexer/Demultiplexer (MDM) Hardware and Software

Appendix C Data Telemetry Sources

Prime Contractors Software Standards and Procedures Specifications
D684-10056-01 Revision K

Appendix D Test Variance Sources

KSC Payload Processing Utilization Pitches
Integration PRCU Overview
Integration PTCS Overview

MPLM Ground Processing Plan (K-SS-09.5.1-BASIC)
KSC MEIT 3 Homepage
  MEIT 3 Planned LAB Emulator Block Diagram
  ISS Flight Emulator Line Drawing
  MEIT 3 Reassessment Charts
TCMS Simulation Configurations

Appendix E PUI Finder Sources

PUI 101
PUI Overview
PUI Finder Users Manual
PUI Finder Overview
Reading and Converting Data Overview
Prime Contractors Software Standards and Procedures Specifications D684-10056-01 Revision K
Software Interface Control Document Part 1 United States On-Orbit Segment to United States Ground Segment Command and Telemetry SPP-411454 Revision G
Frame Counting PUIs

Appendix F TCMS Sources

TCMS Users Manual
TCMS Retrieval Instructions
TCMS/PPCU Data Definition Document (DDD) KSCM-PEDE-0063:
Section 3 – System Data Passing Philosophy
Section 4 – DBS Databases
TCMS/PPCU Software O&M Volume 7 KSCM-PEDE-0051-O&M:
Section 2 – System Overview
Section 3 – System Orientation
Section 6 – Data Monitor
Section 10 – Retrieval

Appendix G PASS-1000 Sources

PASS-1000 Users Manual
Retrieval to PASS-1000 Conversion Test Procedure
Retrieval to PASS-1000 Conversion Instructions

Appendix H Acronym List

A/D	Analog to Digital
A/L	Airlock
ABC	Audio Bus Coupler
ACBSP	Assembly Contingency Baseband Signal Processor
ADD	Architecture Design Document
AIO	Analog Input Output
AP	Application Processor

AP	Attached Payload
APID	Application Identifier
APM	Advanced Pressurized Module
APS	Automated Payload Switch
ASCR	Assured Safe Crew Return
ATU	Audio Terminal Unit
BAD	Broadcast Ancillary Data
BED	BAD EXT Data
BC	Bus Controller
BIA	Bus Interface Adapter
BM	Bus Monitor
BPUI	Bus PUI
C&C	Command and Control
C&DH	Command and Data Handling
C&T	Communication and Tracking
C&W	Caution and Warning
CCSDS	Consultive Committee for Space Data Systems
CDD	Command Description Document
CM	Configuration Management
CMSG_CON	Command 1553 Message Content
COTS	Commercial Off the Shelf
CPUI	Conversion PUI
CSCI	Computer Software Control Interface
DDCU	DC to DC Converter Unit
DIO	Discrete Input Output
DIU	Data Interface Unit
DP	Data Package/Processing
DPUI	Device PUI
DRAM	Dynamic Random Access Memory
ECLSS	Environmental Control and Life Support System
EEPROM	Electrically Erasable Programmable Read-Only Memory
EHS	Enhanced HOSC System
EIOCU	Enhanced Input/Output Control Unit
EPS	Electrical Power System
ESS	Enhanced
EVA	Extra Vehicular Activity
EXPRESS	EXpediting the Process of Experiments to the Space Station
EXT	External
FC	Firmware Controller
FDS	Flight Design Systems
FEP	Front-End Processor
FEU	Flight Equivalent Unit
FGB	Functional Cargo Block (Functionalui Germaticheskii Block)

FQT	Formal Qualification Test
FSW	Flight Software
FWC	Firmware Controller
GMT	Greenwich Mean Time
GN&C	Guidance, Navigation, and Control
GSE	Ground Support Equipment
H/W	Hardware
HLA	High Level Analog
HOSC	Huntsville Operations Support Center
HRDL	High Rate Data Link
HRF	Human Research Facility
HRFM	High-Rate Frame Multiplexer
HRM	High Rate Modem
I/F	Interface
I/O	Input/Output
IAC	Integrated Assembly & Checkout
ICD	Interface Control Document
IFL	Integrated Flight Load
INT	Internal
IOCU	Input/Output Control Unit
IP	International Partner
IP&CL	Instrumentation Program and Command List
ISIL	ISS System Integration Lab
ISRP	International Standard Payload Rack
ISS	International Space Station
JCS	Johnson Space Center
JEM	Japanese Experiment Module
KSC	Kennedy Space Center
Ku	Frequency Sub-Band
LA	Lab
LAN	Local Area Network
LB	Local Bus
LIF	Load Image Format
LLA	Low Level Analog
LRDL	Low Rate Data Link
MATE	MDM Application Test Environment
MBF	Mission Build Facility
Mbps	Mega bit per second
MCC-H	Mission Control Center-Houston
MCC-M	Mission Control Center-Moscow
MDM	Multiplexer/Demultiplexer
MEIT	Multiple Element Integration Test
Mil-Std 1553	Military-Standard 1553
MIP	Minimum Impulse Pulse
MPLM	Multi-Purpose Logistics Module

MRDL	Medium Rate Data Link
MSD	Mass Storage Device
MSFC	Marshall Space Flight Center
Msg Ref	Message Reference
Msg Ret	Message Retrieval
MSID	Measurement Stimulus ID
MSS	Mobile Servicing System
N#	Node #
O&M	Operations and Maintenance
OIU	Orbiter Interface Unit
OPF	Orbiter Processing Facility
Ops	Operations
PASS	Protocol Analysis and Simulator System
PCR	Portable Computer Receptacle
PCS	Portable Computer System
PD	Payload Developers
PDA	Packet Data Analyzer
PDG	Payload Data Generator
PDDS	Payload Data Services System
PEHG	Payload Ethernet Hub Gateway
PI	Payload Integrators
PL	Payload
PMA	Pressurized Mating Adapter
PMCU	Power Management Controller Unit
POIC	Payload Operations Integration Center
PPL	Pre Positioned Load
PRCU	Payload Rack Checkout Unit
PSAD	Payload Specific Ancillary Data
PSPF	Prime Software Production Facility
PTCS	Payload Test and Checkout System
PUI	Project Unique Identifier
PVCU	Photovoltaic Controller Unit
pwd	Present working directory
q	Quit
R&R	Resupply and Return
RAM	Random Access Memory
RF	Radio Frequency
RFCT	Ready for Combined Training
RJ	Rotary Joint
RPCM	Remote Power Controller Module
RPUI	Requirement PUI
RSA	Russian Space Agency
R/T	Receiver/Transmitter
RT	Remote Terminal
RTD	Resistive Temperature Device

RWS	Remote Workstation
SCU	Sync Control Unit
SDIL	Software Development and Integration Lab
SDO	Solenoid Driver Output
SM	Service Module
SPD	Serial/Parallel Digital
SPUI	Signal PUI
SRD	Software Requirements Document
SSCC	Space Station Control Center
SSCS	Space to Space Communication System
SSTF	Space Station Training Facility
STD OUT	Standard Out
SVF	Software Verification Facility
SW	Software
Sync	Synchronization signal
TBD	To Be Determined
TCS	Thermal Control System
TCMS	Test, Control, and Monitor System
TDD	Telemetry Description Document
TDRSS	Tracking and Data Relay Satellite System
Tlm	Telemetry
Tlm Ret	Telemetry Retrieval
TRR	Test Ready Release
UAS	User Application Software
UHF	Ultra High Frequency (system)
USAF	United States Air Force
USICU	United States ISPR Check-out Unit
USL	United States Lab
USOS	United States On-orbit Segment
UTC	Coordinate Universal Time
VAB	Vehicle Assembly Building
VBSP	Video Baseband Signal Processor
VDD	Version Description Document
VSU	Video Switch Unit
WD	Word