Report 12735D
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Advanced Technology Microwave Sounder (ATMS) SysTE Operation and Maintenance Manual

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CDRL 051

Submitted To:

National Aeronautics and Space Administration (NASA)
Goddard Space Flight Center (GSFC)
Greenbelt, Maryland 20771

Submitted by:

Northrop Grumman
1100 West Hollyvale Street
Azusa, California 91702

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1 Introduction

1.1 Overview

The purpose of this document is to provide information necessary to operate the SysTE (System Test Equipment).

2 Documents

2.1 Government Documents

The following documents form a part of this manual to the extent specified herein. Unless otherwise specified, the latest issue that is approved on the contract shall apply.

GSFC 429-00-06-03	ATMS Performance and Operations Specification (POS)
GSFC 429-00-07-03	ATMS Mission Assurance Requirements
GSFC 429-00-06-05	Ground Support Equipment (GSE) Specification Attachment F

2.1.1 Non-Government Documents

CCSDS 203.0-B-1	CCSDS Recommendations for Space Data Systems Standards, Telecommand, Part 3: Data Management Service, Architectural Definition, Issue 1
CCSDS 701.0-B-2	CCSDS Recommendations for Advanced Orbiting Systems, Networks and Data Links, Architectural Specification

2.1.2 Northrop-Grumman Documents

RE-11862	ATMS Software Acquisition Management Plan (CDRL-080)
RE-12114	ATMS Command Description Document (CDRL-048)
RE-12115	ATMS Engineering Telemetry Description (CDRL-050)
AE-26835	ATMS Comprehensive Performance Test Procedure (CDRL-058)
AE-26841	ATMS EMI Test Procedure (CDRL-058)
AE-28132	ATMS SysTE Software Design Description
AE-28183	ATMS Memory Upload Procedure
AE-26842	ATMS System Calibration Test Procedure
AE-28100	Instrument Specification
Report 13942	Memory Interface User's Manual and Instrument Specific Data Load Procedure
Report 11996	ATMS Quality Manual (CDRL-088)
Report 11977	ATMS Configuration Management Plan (CDRL-005)
Report 1209412156	ATMS Contamination Control Plan (CDRL-006)
Report 11997	ATMS System Safety Program Plan (CDRL-089)
ES-I12-0025	Calibration System Description

2.2 Utilization

2.2.1 Utilization at Northrop Grumman

The System Test Equipment (SysTE) shall be used to operate the ATMS Instrument during performance verification and calibration testing by the instrument contractor. The SysTE can be used by the contractor to operate the instrument during system performance tests, both onsite and offsite, and whenever either a limited quick-look check or troubleshooting is required.

2.2.2 Utilization at S/C Facility

The SysTE will also be used at the Spacecraft (S/C) contractor's facility for instrument functional testing prior to and after integration into the Spacecraft. The SysTE will also be used for incoming acceptance tests, and for any other system evaluation tests that might be required.

2.2.3 ATMS Instrument Prior to Spacecraft Integration

Prior to electrical integration with the spacecraft, the SysTE provides power, clock, command, and telemetry interfaces that are normally furnished by the spacecraft to the instrument. The SysTE controls the instrument and collects data in the same manner as when used at the instrument contractors facility.

2.2.4 After Spacecraft Integration

After electrical integration with the spacecraft, the spacecraft furnishes ATMS command and telemetry interfaces and the spacecraft Electrical GSE (EGSE) performs ATMS command and data collection. The SysTE interfaces with the spacecraft electrical GSE via a local area network for spacecraft level testing.

3 Description

3.1 SysTE Mechanical Description

The SysTE is fully contained within a doublewide 19-inch rack cabinet. The cabinet has 6 casters for easy mobility and eyebolts that provide for lifting when using the lifting fixture (T-1364166). The overall height of the SysTE is 210 cm. The width not including the side-mounted printer is 130 cm, while the depth is slightly less than 100 cm. The SysTE weight is 544 (TBR) kg. Figure 1 shows a picture of the SysTE. Figure 2 and Figure 3 show the SysTE components and rear views.

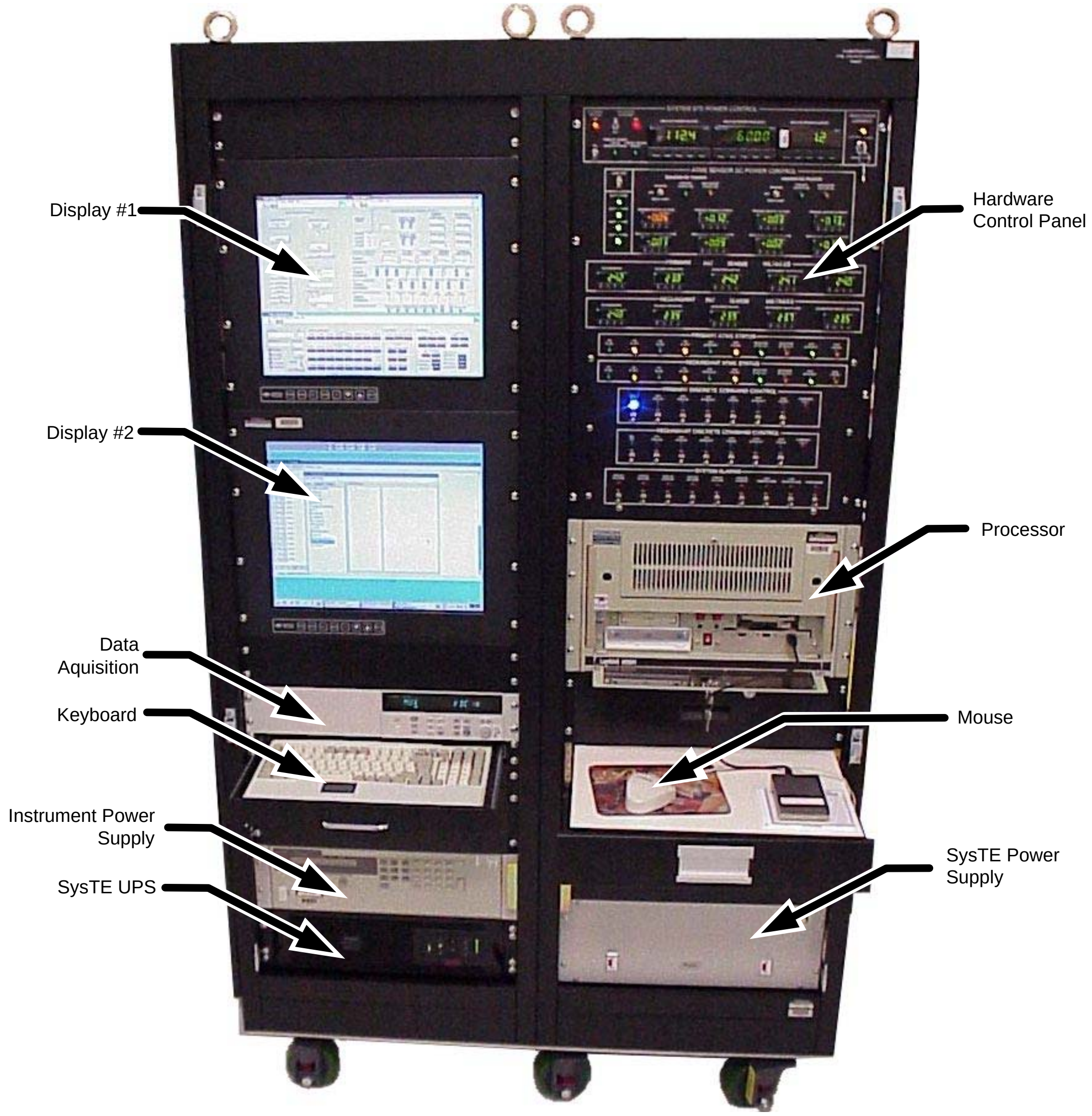


Figure 1: Front View of the ATMS System Test Equipment (SysTE)

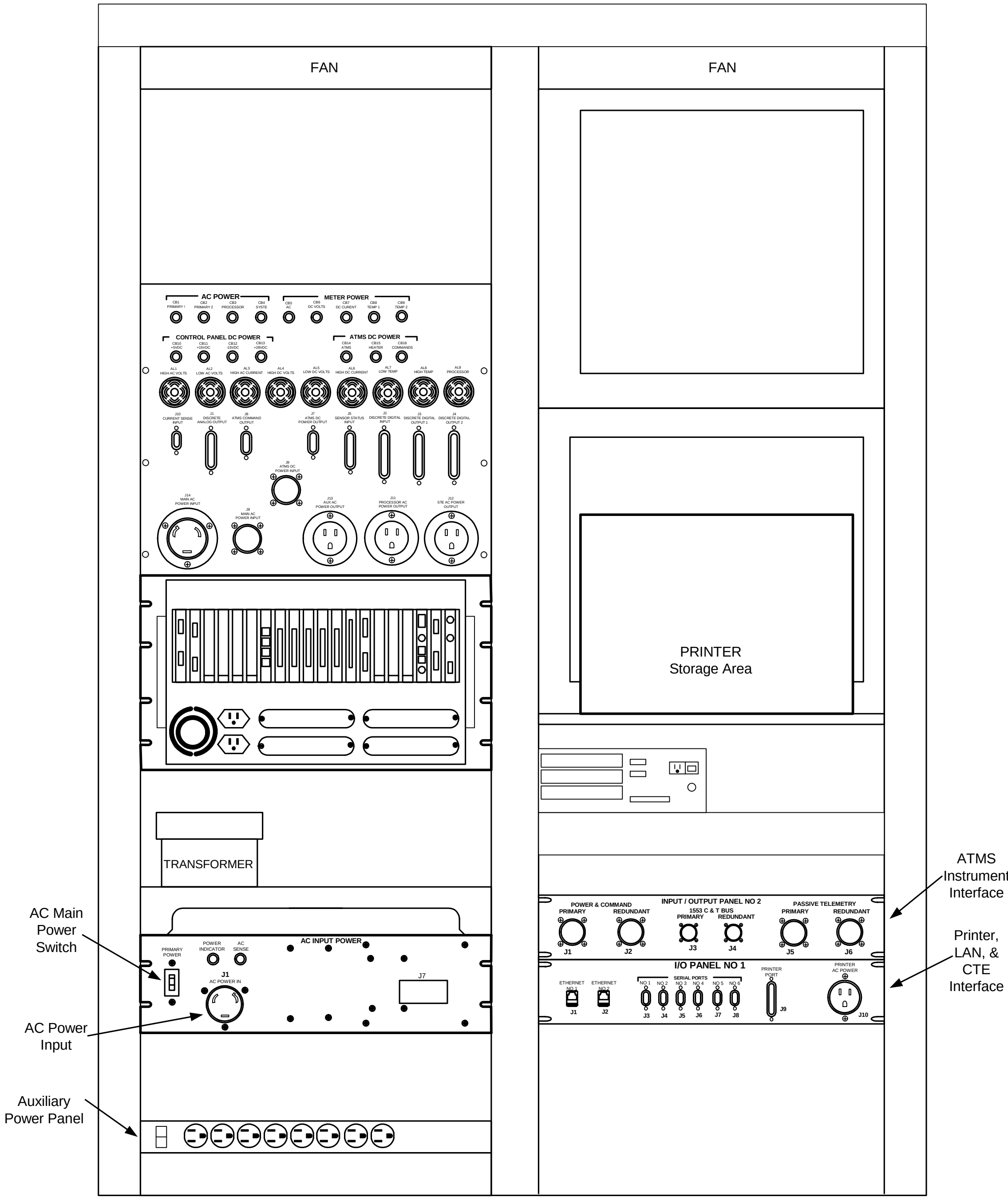


Figure 2: SysTE Components

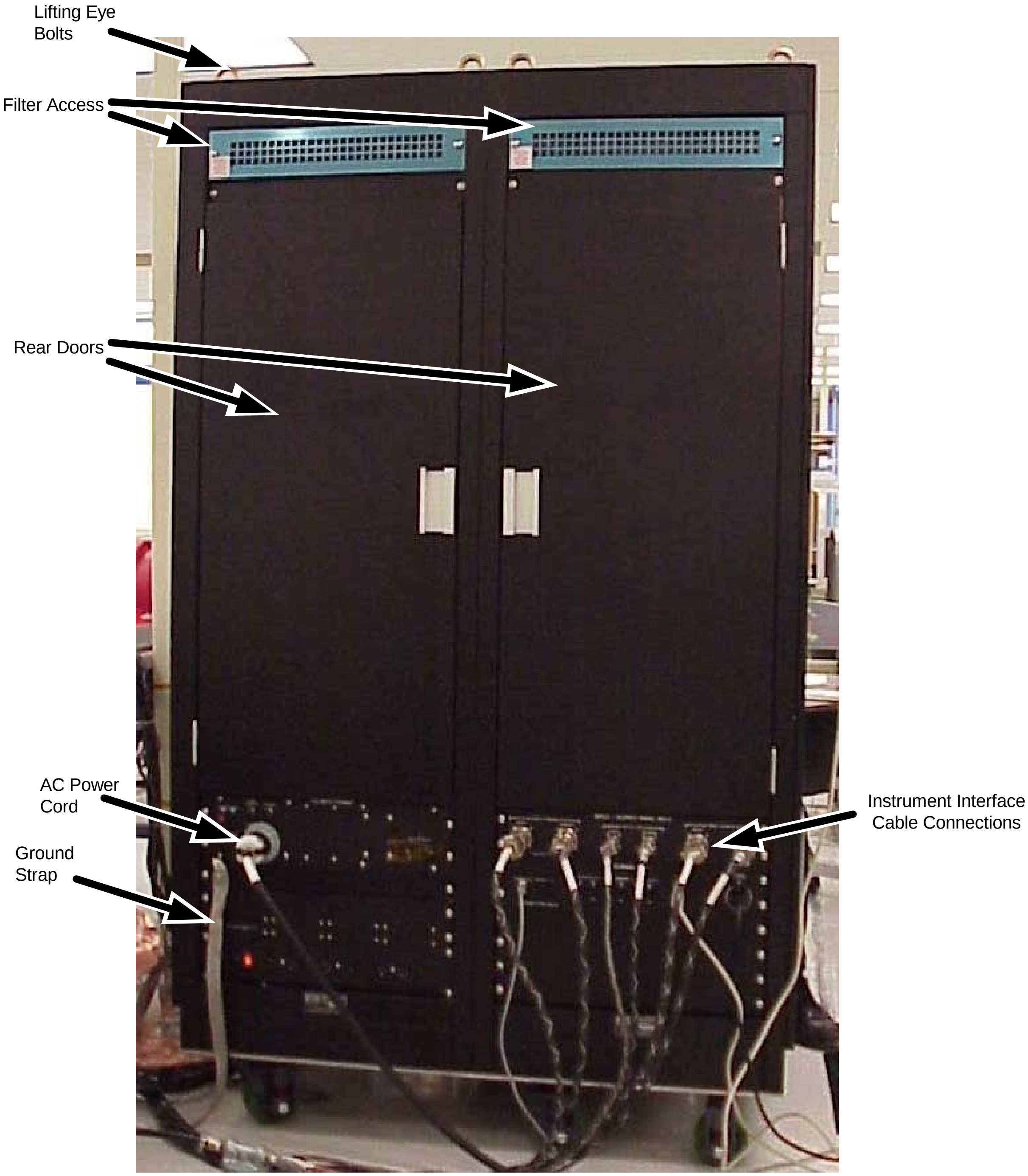


Figure 3: SysTE (Rear View)

3.2 SysTE Electrical Description

Figure 4 shows a block diagram of the SysTE and its interfaces to the CTE and ATMS instrument.

3.2.1 External Interfaces

External interfaces to the SysTE are made through I/O panel 1 and I/O panel 2. Figure 5 shows the connections that are located on I/O panels 1 and 2. Table I lists the connectors on I/O panel 1 with their descriptions. Table II lists the connectors for I/O panel 2 with their mating cables. Figure 6 shows the interconnections between the SysTE and CTE, and SysTE and ATMS instrument. Some testing may not require all connections shown. Refer to the test procedure for connections needed during specific tests.

3.2.2 Interface with the ATMS Instrument

The SysTE furnishes all power, timing signals, and commands needed by the ATMS and normally supplied by the spacecraft, through the connectors on I/O Panel 2.

Table I: Panel No. 1 Connectors

Ref.	Connector Name	Connector Type	Description / Use
J1	ETHERNET NO. 1	RJ-45	Intra-Net connection
J2	ETHERNET NO. 2	RJ-45	Interface to S/C STE
J3	SERIAL PORT NO. 1	DB-9	Not Used
J4	SERIAL PORT NO. 2	DB-9	Not Used
J5	SERIAL PORT NO. 3	DB-9	RS-232 Variable Target Control
J6	SERIAL PORT NO. 4	DB-9	RS-232 Fixed Target Control
J7	SERIAL PORT NO. 5	DB-9	Cold Plate Control
J8	SERIAL PORT NO. 6	DB-9	Not Used
J9	PRINTER PORT	DB-25	Parallel Printer Connection
J10	PRINTER AC POWER		115 VAC Receptacle for Printer

Table II: I/O Panel No. 2 Connectors and Mating Cables

Ref.	Connector Name	Mating Cable		
		4’	20’	25’ Thermal Vac
J1	Primary Power and Command	1364173-2	1364173-1	1365420-1
J2	Redundant Power and Command	1365444-2	1365444-1	1365447-1
J3	Primary 1553 C & T Bus	1364175-2	1364175-1	1365422-1
J4	Redundant 1553 C & T Bus	1365446-2	1365446-1	1365449-1
J5	Primary Passive Telemetry	1364174-2	1364174-1	1365421-1
J6	Redundant Passive Telemetry	1365445-2	1365445-1	1365448-1

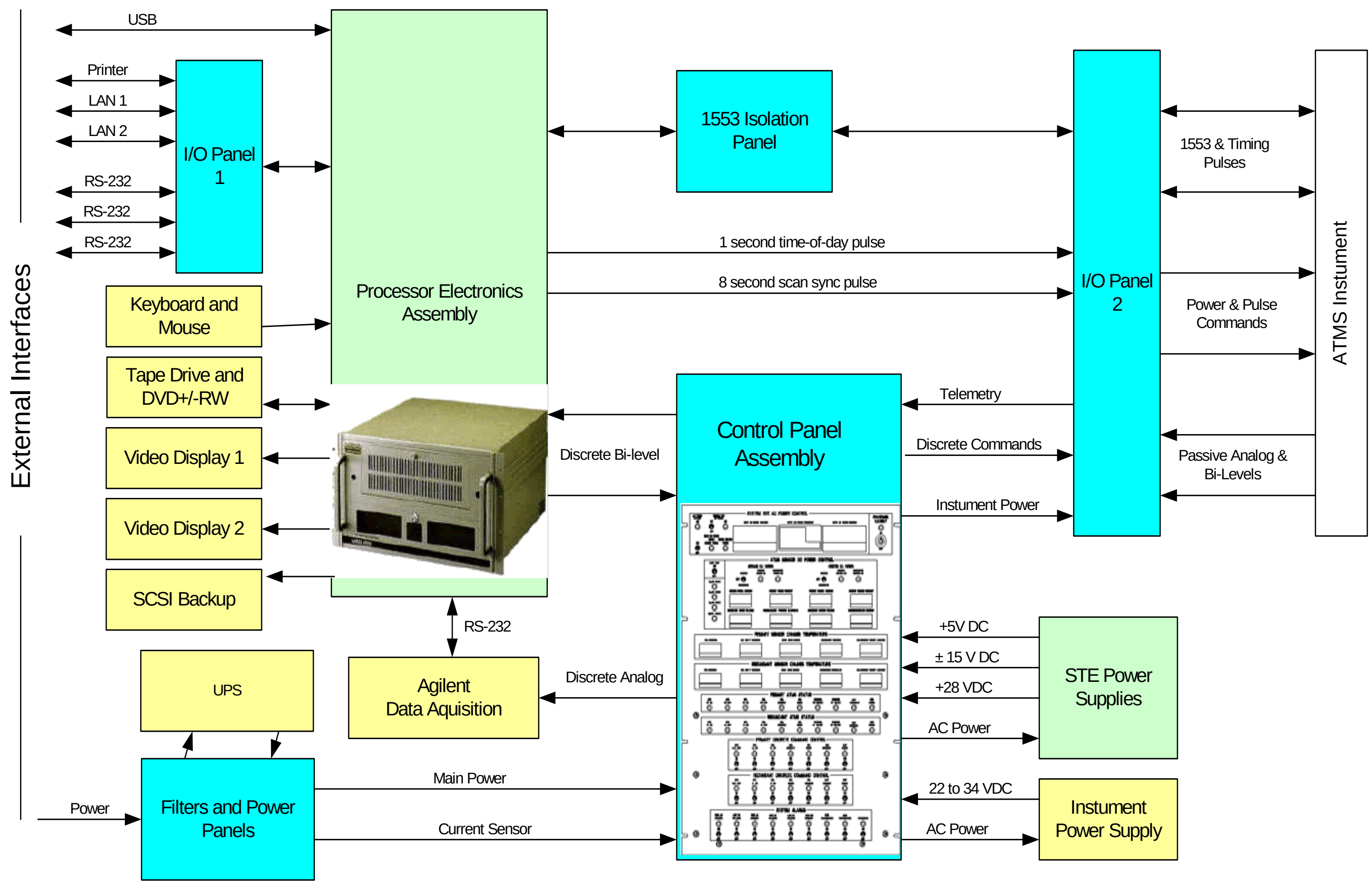


Figure 4: SysTE Block Diagram

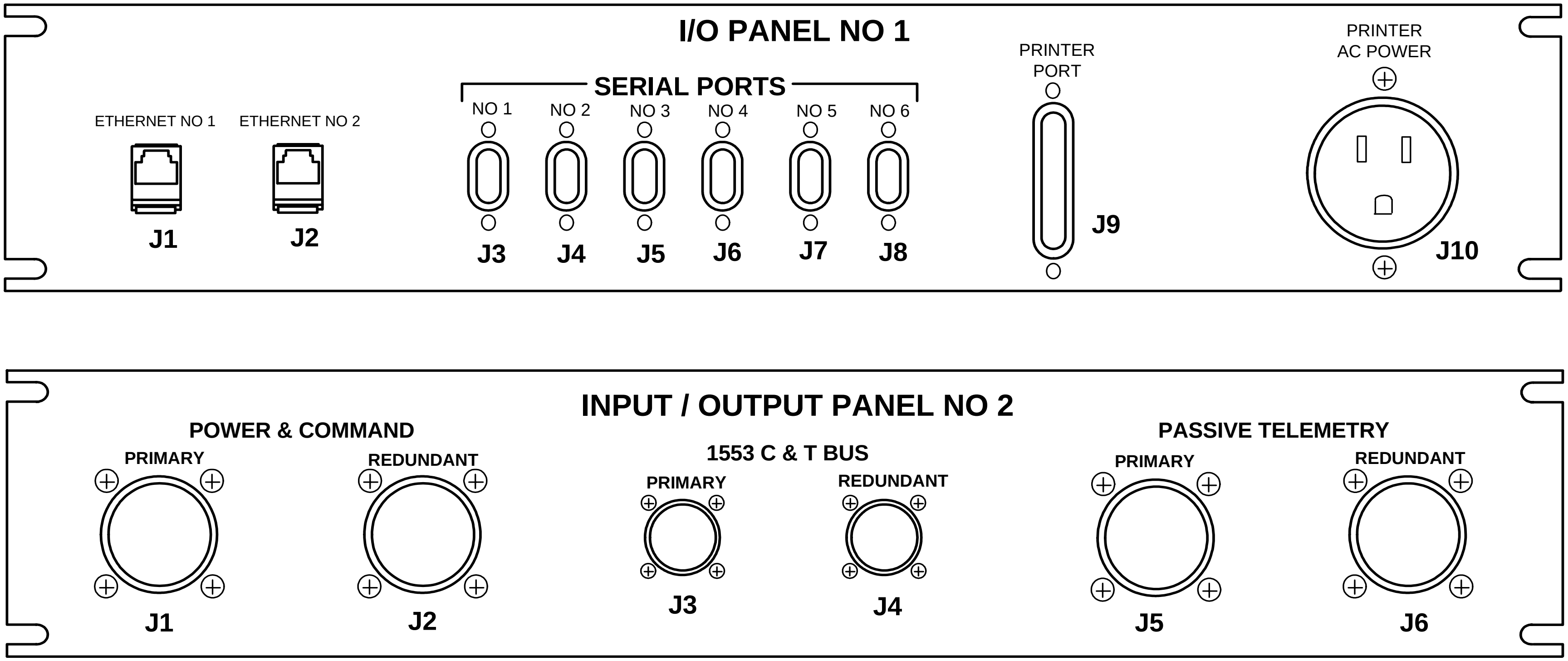


Figure 5: I/O Panels 1 & 2

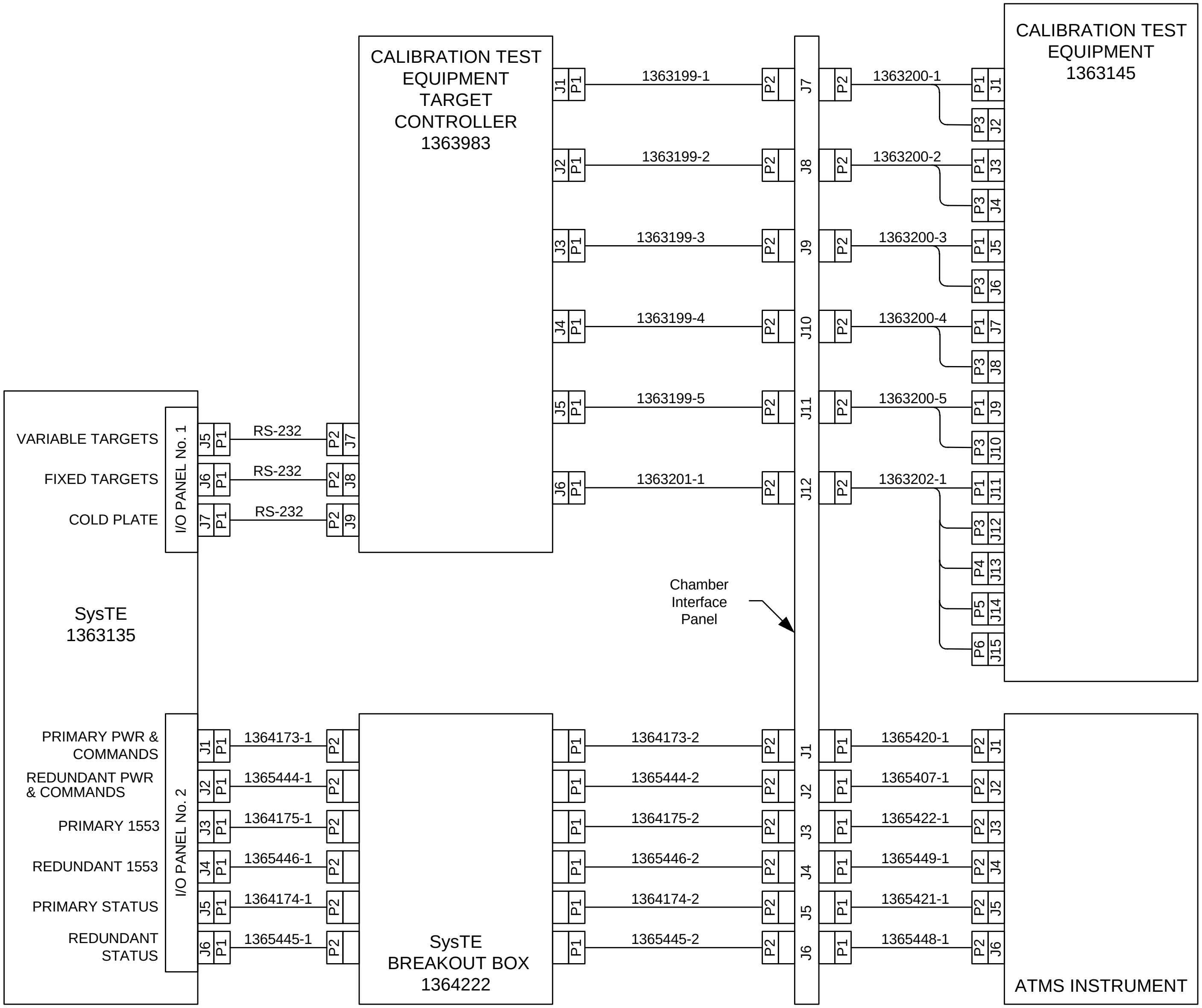


Figure 6: SysTE Interconnect

3.2.3 SysTE Characteristics

3.2.3.1 Gf Performance Characteristics

The SysTE comprises the hardware and software necessary to operate, test, and calibrate ATMS both by the instrument manufacturer and by the spacecraft integrator at their facilities and at the launch facility.

a. The hardware is workstation-based and augmented with any necessary electronics to provide all necessary interfaces.
b. The operating system of the software is LINUX.
c. Software programming has been done in C++ and Labview.
d. The SysTE has network capability with TCP/IP protocol.

3.2.3.2 Automated Data System

The SysTE includes an Automated Data System with the following capabilities:

a. The automated data system is capable of "real-time" data analysis during testing and will provide print outs of the results and a continuous recording of all processed data.
b. The automated data system is also capable of reading a S/C Contractor "History Tape" and performing data analysis of the ATMS data contained on the tape.
c. All data has the capability to be formatted in ASCII and delivered on standard CD ROM or DVD disk.

3.2.3.3 Data Received

The SysTE is capable of recording, displaying, and analyzing the data received from the ATMS and ground support equipment.

3.2.3.4 Instrument Telemetry

During ATMS performance and bench testing, the SysTE receives instrument telemetry via the normal spacecraft interfaces, as identified in Table II.

During testing at the spacecraft contractor’s facility, the SysTE receives instrument telemetry via the spacecraft electrical GSE, over a LAN interface.

3.2.3.5 Automatic Processing Equipment

The SysTE includes automatic processing equipment capable of:

a. Performing self-test
b. Issuing commands to the instrument
c. Sending and verifying programs, checks, etc;
d. Receiving and analyzing the data from the ATMS in real time
e. Controlling calibration equipment and other GSE
f. Interfacing with the S/C GSE.

3.2.3.6 Spacecraft Interface Monitoring

The SysTE provides the capability to monitor the spacecraft electrical interfaces.

3.2.4 Power and Signal Characteristics

3.2.4.1 Input Power to SysTE

The SysTE operates from a 115-volt, 60-Hertz (Hz) line and has capability to operate from 220-volt, 50 (Hz) line. The SysTE has a self contained UPS (Uninterruptible Power Supply) to maintain operation of the ATMS Instrument and the SysTE for a period of 15 minutes to allow graceful shutdown in the event of a power failure.

3.2.4.2 Power Supply to Instrument

SysTE power supply is capable of supplying 0 to 35 volts to the instrument at up to 15 A. The power supply should be set to current limit at 10.5 Amps with an over-voltage limit set to 34.5-volts.

3.2.4.3 Power Isolation

All power lines are physically isolated from signal lines, i.e., by shield and separate cables.

3.2.4.4 Short-Circuit and Voltage-Transient Protection

The power supplies have short-circuit protection and voltage-transient protection.

3.2.4.5 Power Line Filters

All power lines have feed through "L-type" filters with a minimum insertion loss of 20 dB at 30 kHz, 50 dB at 1 MHz, and 70 dB from 10 MHz to 1 GHz.

3.2.4.6 Signal Line Filters

All signal lines have a feed through "C-type" filters with a minimum insertion loss of 15 dB at 10 MHz and 55 dB at 1 GHz.

3.2.4.7 Signal Filter

The filter does not interfere with normal operation of the signal line.

3.2.5 SysTE Software

This software supports instrument verification, integration, monitoring of performance, ground operations, as well as supporting evaluation of data acquired during spacecraft integration, spacecraft (S/C) environmental tests, and launch activities.

All ground support software necessary to operate, test, and calibrate the instrument has been included with the SysTE.

3.2.5.1 Software for Test and Calibration

The SysTE includes all required computer programs that will be used in the processing and interpretation of the test and calibration data. These include, but are not necessarily limited to the following programs:

a. An instrument calibration program.

b. A limits program.

The SysTE capabilities include:

a. Performing a self-test
b. Sending commands to the instrument
c. Controlling the simulated S/C interfaces and external calibration GSE
d. Receiving data from the ATMS and CTE.
e. Performing health and safety checks to guarantee the safety of the instrument (in all states)
f. Analyzing the data in real time and in an off-line mode.

3.2.5.2 Data Analysis

The SysTE automated data system is capable of real-time data analysis during testing and provides printouts of the results and continuous recording of all data. The data analysis software includes engineering and instrument data trending software and sensor data analysis software necessary to determine the performance characteristics of the instrument. The system has been designed to permit the analysis of previously captured instrument data while still operating the instrument. The SysTE provides analysis routines (section 3.2.5.2) for the following tests:

1. CPT
2. EMI
3. Thermal Vacuum Calibration.

3.2.5.3 Limit Checking

The SysTE provides and maintains software to monitor all command states, selected voltages, currents, temperatures, and other monitored and derived (STE computed) parameters of the ATMS and CTE telemetry in a real-time basis.

The software has been designed to support verification of all operational modes of the ATMS and record and alert the operator of any user defined out-of-tolerance items as they occur.

3.2.5.3.1 ATMS Telemetry Limits

The instrument limits program is used at all time that the SysTE detects telemetry from the Instrument

ATMS voltages and currents, Housekeeping and Passive telemetry are monitored and checked against the limits specified in the SysTE limits table. Science data counts are also monitored against user-defined limits for specific tests. The numeric display of the telemetry item will be highlighted yellow or red to indicate that the limit has been exceeded. For red limits an audio alarm will sound, if activated. If a yellow or red limit is exceeded an entry is made to the text error log file and a SysTE error packet is added to the logfile. If the ‘Er Msg’ switch on the Health and Status display is set a message box, requiring operator intervention to clear will also be displayed.

3.2.5.3.2 Critical Fault

The SysTE software will generate a visual and audio alarm if a critical fault occurs.

3.2.5.4 Automatic Sequences (scripts)

The SysTE provides scripting capability that allows the user to send a predefined sequence of commands to the instrument and specific SysTE functions. This scripting capability is further defined in 4.7.

All automatic sequences (scripts) resident in the SysTE are capable of being bypassed by manual commands using the command generator.

3.2.5.5 Archival (Data Log)

All instrument data is continuously recorded in the data log as long as SysTE S/W is in either “ATMS” mode or in “S/C GSE” mode. The data log also continuously records all commands sent to the instrument or CTE, any errors generated by the SysTE, and CTE telemetry. The data log file consists of all CCSDS formatted packets generated by the instrument and internally by the STE. The log file is a stream of 16-bit words (PC standard little endian format).

The data log may be archived to external media (e.g. CD or DVD or to Magnetic Tape). The SysTE also has a USB port that can be connected to an external Drive for data backup.

Logged data may be used in post-processing analysis or on playback mode.

3.2.5.6 Run Time Log

The SysTE maintains an operational time log that documents the total instrument run-time, as well as total run time for each instrument redundancy path. The log also contains the run times of each assembly of the ATMS instrument. The operational time log is further discussed in section 4.2.

3.2.6 User Interface

The following sections describe the essentials of the user’s interface to the ATMS STE.

3.2.6.1 Data Display

The SysTE continuously displays instrument engineering Health and Status data. Upon user selection, the SysTE displays instrument science, diagnostic, hot cal, and dwell data, as well as CTE data.

3.2.6.2 Templates

The operator can select information to be displayed from a set of pre-stored display templates. These templates are discussed in section 4.1.3.2.

3.2.6.3 Converted Values

Displayed items are available in "converted values" (engineering units) as well as raw counts.

3.2.6.4 Calibration Targets Interface

The SysTE provides an interface with the ATMS calibration blackbodies so that the blackbody temperature data will be entered into the automated data system and correlated with the ATMS brightness temperature data.

The SysTE interfaces to the CTE controller through RS-232 serial ports. The user can set the temperature set points for the CTE variable targets, cold targets, and cold plate. The SysTE transmits the set points to the Azonix temperature controllers. The SysTE monitors, logs, and displays all CTE temperature data.

3.2.7 Self-test

The SysTE includes a self-test feature to verify proper operation of the test equipment and processor.

3.2.8 Short/Quick-Look Tests

The SysTE is capable conducting short electrical performance tests on the instrument that form the basis of the bench checkout tests. These tests are implemented as user defined scripts that are controlled as part of test procedures.

3.2.9 Break-out boxes

A breakout box (1364222) is provided with the STE to aid in diagnostics. The breakout box is shown in Figure 7.

Connection of the breakout box is shown in Figure 6. If the Breakout Box is not connected, the shorter 4-foot cables are not required.

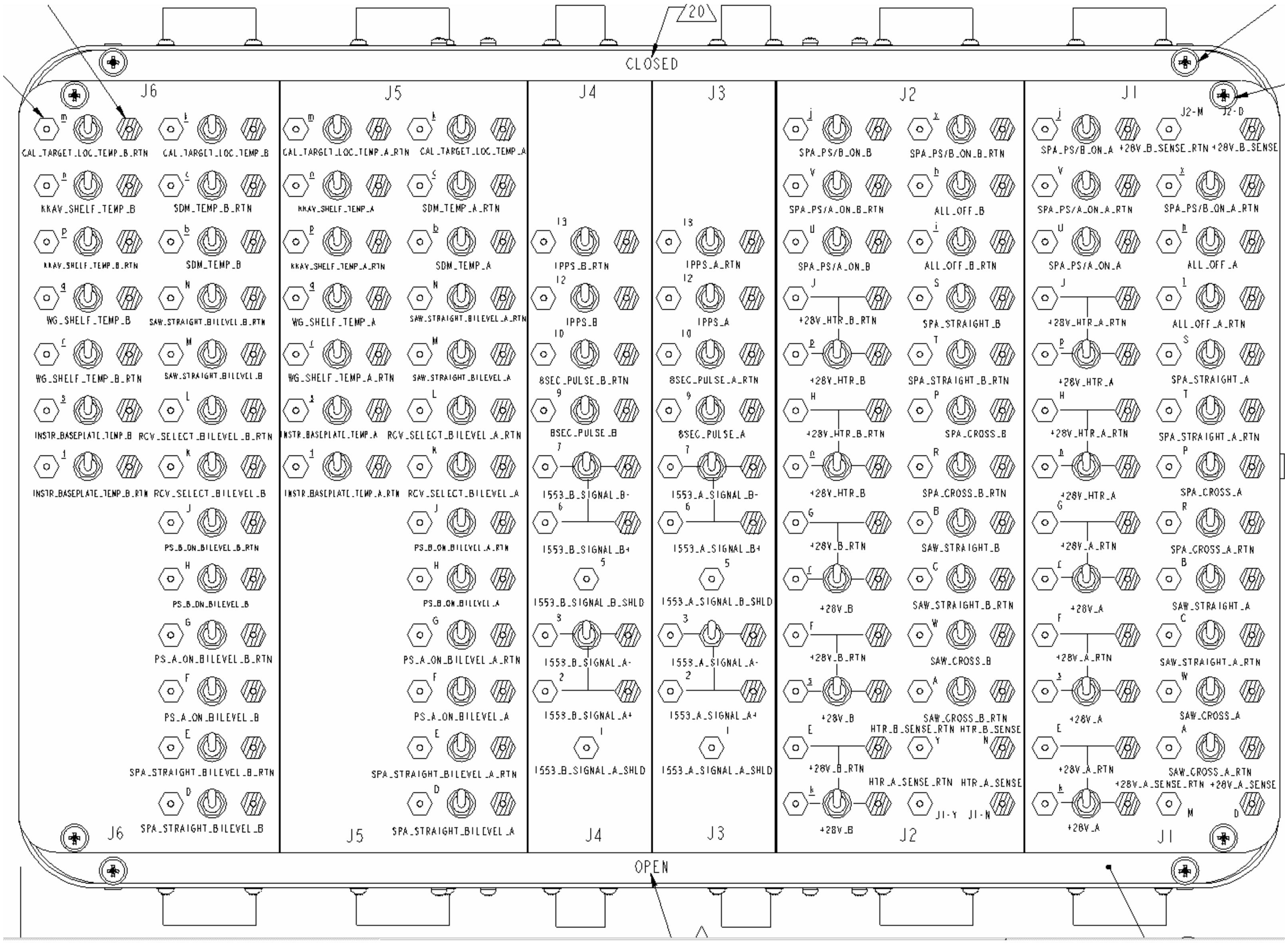


Figure 7: SysTE Breakout Box

3.3 Operability

The SysTE will facilitate test procedures and technician monitoring of equipment displays.

3.3.1 Environmental Conditions

3.3.1.1 General Conditions

The SysTE has been designed to be used in controlled environments typical of instrument manufacturer test and integration facilities.

3.3.1.2 Seismic Loading

The SysTE has been designed for a seismic loading of 0.5g lateral.

3.3.2 Transportability

Test equipment has been designed with wheels to facilitate mobility within test and integration facilities of the instrument manufacturer. Eyebolts located on the top of the rack provide the ability to lift the SysTE. The wheels shall be locked or chocked after moving to prevent unwanted movement of the SysTE during operation.

3.3.3 Storage/Shipping Container

A reusable storage/shipping container is provided for the SysTE. See section 7 for further information.

This container is suitable for use in the clean room after wiping with alcohol and removing air filters.

3.3.4 Grounding

The SysTE chassis is grounded to the third wire facility AC power ground through the AC power cord. The SysTE must also be grounded using a ground strap connected to the rear of the SysTE as shown in Figure **8**. This ground strap shall be connected to a facility ground point nearby.

The SysTE has separate and isolated grounds for DC power, telemetry, and facility AC power. The Instrument power return can be connected to chassis ground by means of a ground wire located within the rear door of the SysTE.

3.3.5 Design and Construction

3.3.5.1 Parts, Materials and Processes

Selection of parts, materials, and processes has been consistent with good commercial practice.

3.3.6 Contamination Control

3.3.6.1 Clean Room

The SysTE shall be cleaned to a visibly clean condition prior to entry in a clean-room. Also the two filters located at the top rear of the SysTE, and the filter located at the rear of the processor shall be removed before entry into a class 10Kclean room. The air filters are not required when operating in a class 100K or better environment. Only a mouse pad certified for use in a clean room shall be used with the SysTE. It is recommended to operate a printer outside the clean room over the network connection, or to use a printer and cartridge suitable for clean room operation.

3.3.6.2 Vacuum Chamber

The SysTE test cables used within the thermal vacuum chamber shall be cleaned to a visibly clean condition and baked out prior to the first exposure to vacuum testing in order to remove surface volatile condensable materials. See Table II for cable part numbers.

3.3.7 Electromagnetic Interference

The SysTE has been designed such that it will not generate electromagnetic interference (EMI) that would interfere with the instrument or that would prevent the instrument from meeting the EMI requirements.

3.3.8 Marking

All assemblies are marked with the assembly name, part number, and connector reference designations.

3.3.9 Documentation of Tests and Calibrations

All recorded Special Test Equipment (STE) data can be archived at the contractor's facility for a period of 3 years post-launch for each instrument. The recorded data can be delivered on standard DVD in PC compatible ASCII format. Data on the media will include: all temperature sensor calibration values; all calibration curves for temperature sensors; calibration curves for all voltage monitors; and all telemetry, and housekeeping data recorded during the calibration test runs.

3.4 Operation

3.4.1 Set-up

3.4.1.1 AC Power Input

AC power to the SysTE is from a standard 125V / 20-amp service, or from a standard 230V / 15-amp service.

For 115V operation, cable W20 is connected to the jack J1 labeled "AC POWER IN" on the AC power Panel. The plug end of W20 (PN 1363140-1) should be connected to a 125V / 20 Amp service (NEMA Style 5-20). For 230V operation, an appropriately designed cable (not supplied) must be connected to jack J7 on the AC power panel. Refer to **Figure 13** for the locations of these jacks.

3.4.1.2 Grounding

The SysTE chassis is grounded to the third wire facility AC power ground through the AC power cord. The SysTE must also be grounded using a ground strap connected to the rear of the SysTE as shown in Figure **8**. This ground strap shall be connected to a facility ground point nearby.

The SysTE has separate and isolated grounds for DC power, telemetry, and facility AC power. The Instrument power return can be connected to chassis ground by means of a ground wire located within the rear door of the SysTE.

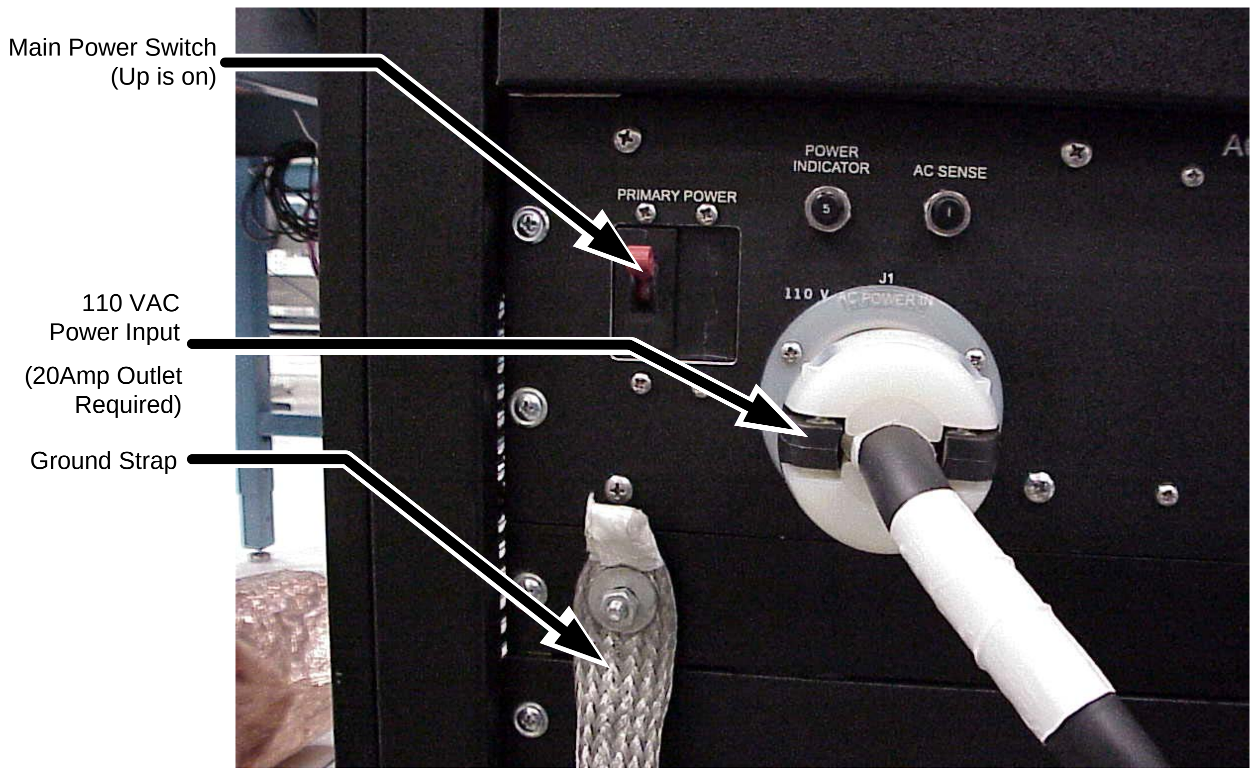


Figure 8: AC Power and Grounding Strap

3.4.1.3 Uninterruptible Power Supply (UPS)

The APC Smart-UPS has been included within the SysTE to prevent blackouts, brownouts, sags and surges from reaching the test equipment. The UPS will provide continuous power from its internal batteries until the utility line returns to safe levels. The batteries will last for 15 to 20 minutes when completely charged.

The UPS has the power control and operating indicators located on the front panel (Figure 9). The UPS will have power as soon as the SysTE power plug is connected to the AC power outlet. Pressing the button on the front panel labeled “Test” turns on the UPS. To turn off the UPS press the button labeled “0”. The five-LED display on the left indicates the percent load. The five-LED display on the right indicates the state of battery charge. For further information about the UPS, refer to the APC Smart-UPS User’s manual. When the AC power is lost, the UPS will sound a short beep every few seconds. The UPS will sound an alarm when the batteries are low.

Figure 9: SysTE Uninterruptible Power Supply (UPS)

3.4.1.4 SysTE Acopian Power Supply

The Acopian power supply supplies the SysTE with DC power to operate internal circuitry. The Acopian power supply is turned on using the two switches located on the front panel (Figure 10). These switches should be on at all times.

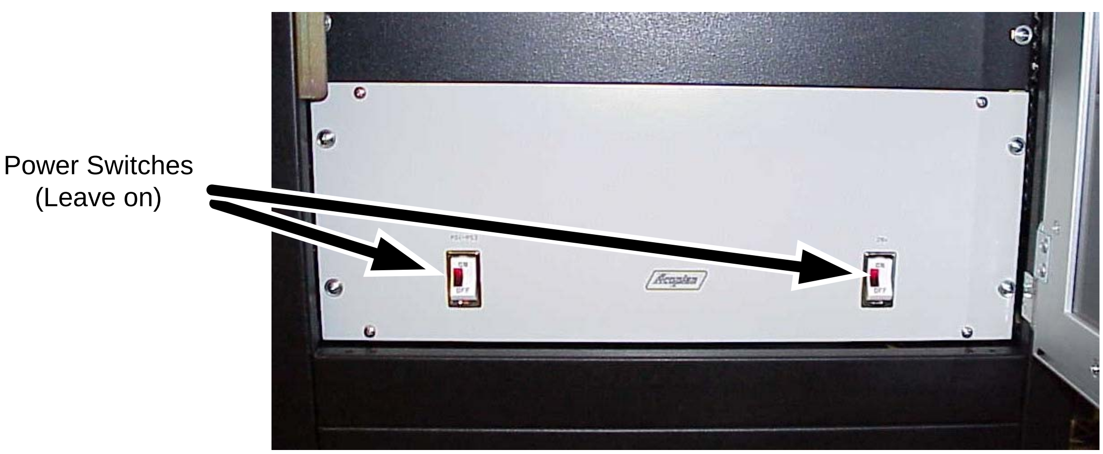


Figure 10: SysTE Acopian Power Supply

3.4.1.5 ATMS Instrument DC Power Supply

The ATMS Instrument is powered from an Agilent 6543A Programmable DC Power Supply. The voltage, current limit, and over-voltage must be set prior to applying power to the ATMS

Instrument. Refer to the Power Up procedure in section 3.5 of this manual. To change the voltage output, use the voltage control on the front panel (Figure 11). During normal operation, no other change should be necessary. For further information on the set-up of the power supply refer to the Agilent 6543A operating manual.

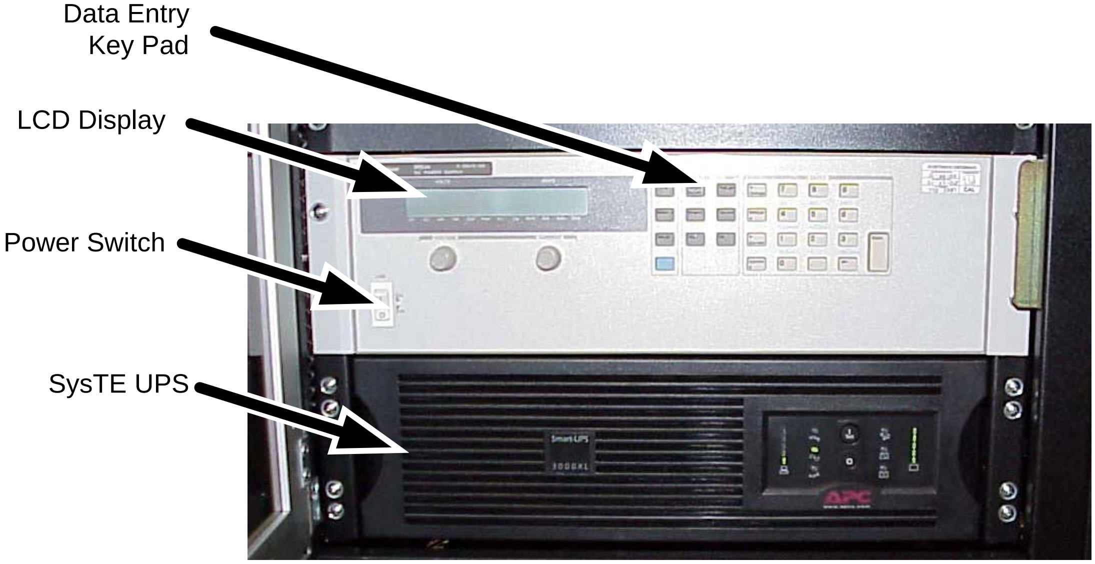


Figure 11: Agilent 6543A Power Supply

3.4.2 Circuit Breakers

The circuit breaker for the SysTE main power is on the AC Control Panel (Figure 12). The circuit breaker is on in the "up" position. Two circuit breakers for the front panel AC meters are located on the AC Power Panel (Figure 8 and 13).Circuit breakers for AC Power, Meter Power, Control Panel DC Power, and ATMS DC Power are on the back of the control panel (Figure 12).

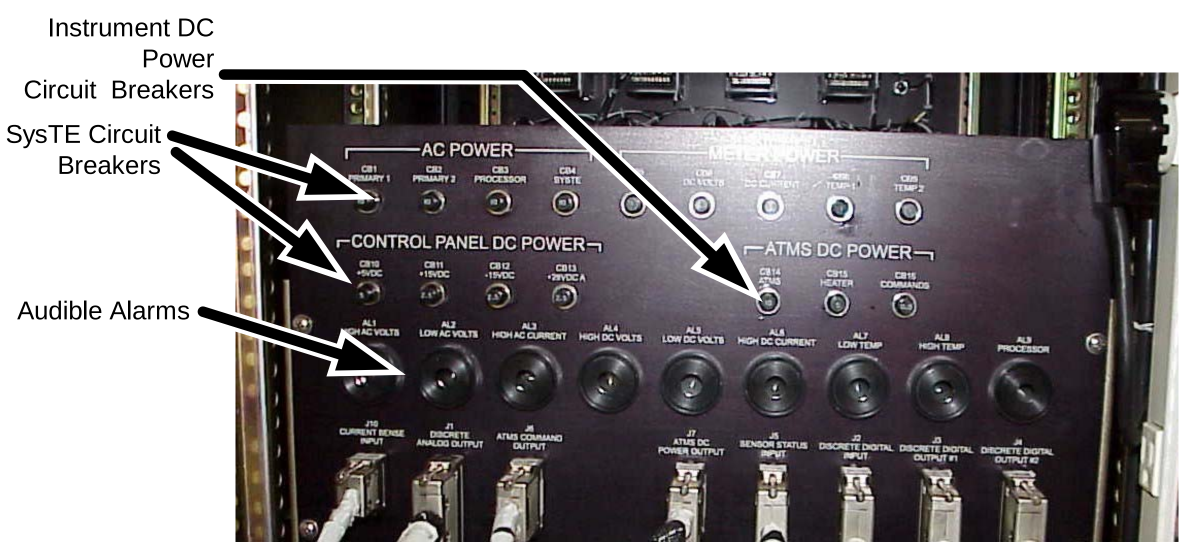


Figure 12: Rear Panel Circuit Breakers and Alarms

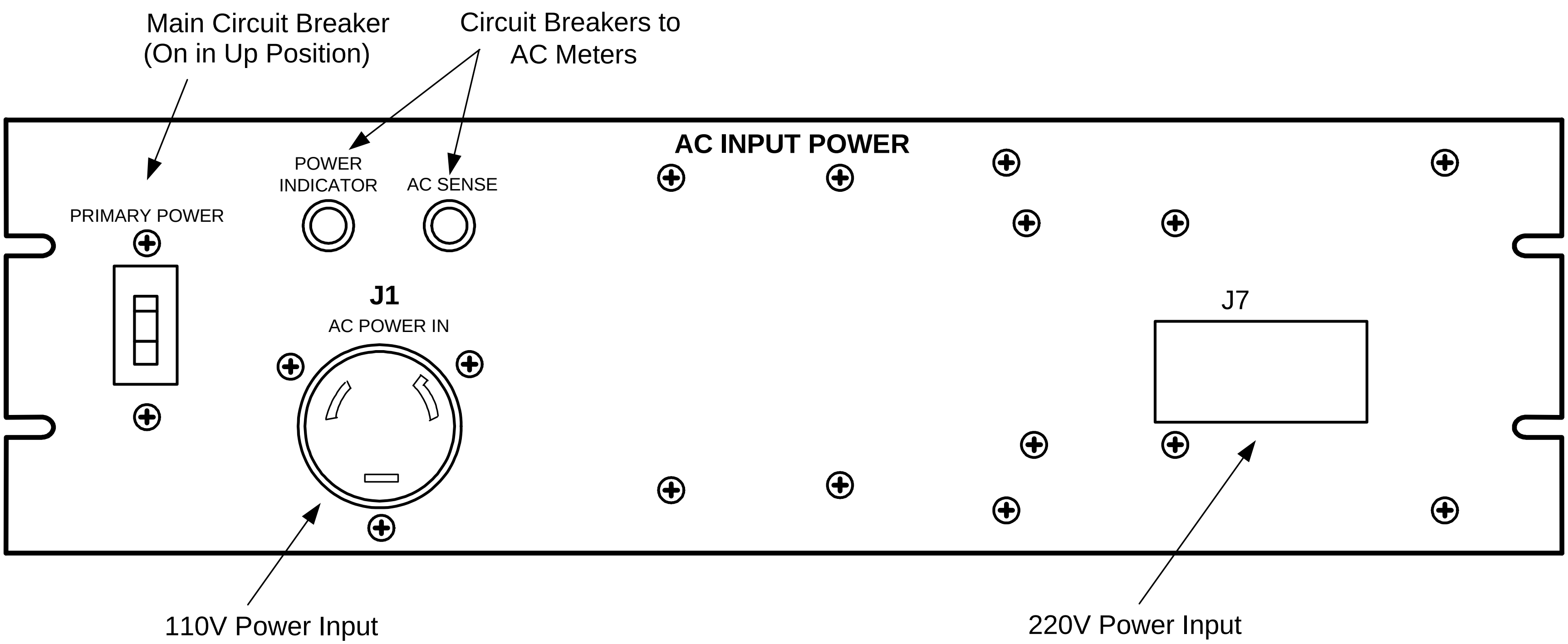


Figure 13: AC Power Panel

Table III: AC Input Power Panel Description (refer to Figure 13 for locations)

AC Input Power Panel Component	Component Type	Description of Operation
PRIMARY POWER	Circuit Breaker	Main 20 Amp circuit breaker for the entire SysTE.
AC POWER IN (J1)	110V Input Connector	110 volt SysTE input connector. Mates with cable W20 (part number 1363140-1)
AC POWER IN (J7)	220V Input Connector	220 volt SysTE input connector.
POWER INDICATOR	Circuit Breaker	5 Amp circuit breaker to AC input power meters on Control Panel.
AC SENSE	Circuit Breaker	1 Amp circuit breaker to AC current meter on Control Panel.
AC POWER SENSE (J4)	Connector	9 pin D connector supplying AC sense information to control panel meters
AC PWR OUT (J2)	Connector	110-volt AC power to control panel (power strips within rear door)
UPS AC POWER IN (J5)	Connector	110-volts AC Power to UPS (internal connection)
UPS AC POWER OUT (J6)	Connector	110-volt AC Power from UPS (internal connection)

3.4.3 Instrument Cable Connections

Figure 20 shows a photo of the Instrument interface cables connected to the SysTE. There are 6 cables, each of which having a unique keying to prevent connection to the wrong mating connector either at the SysTE or at the ATMS Instrument. Both ends of each of the 6 cables have identical connectors and it is possible to connect either end to the SysTE. However, the connections shown in Figure 6 should be followed in order to comply with all test procedures and other documentation.

Figure 14 and Table IV show further detail as to connector and cable descriptions and part numbers.

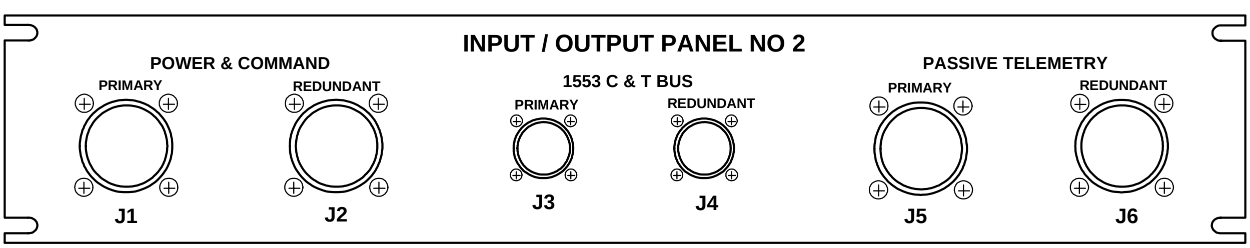


Figure 14: Input/Output Panel No. 2 Connector Locations

Table IV: I/O Panel No. 2 Connectors and Mating Cables

Ref.	Connector Name	Mating Cable		
		4’	20’	25’ Thermal Vac
J1	Primary Power and Command	1364173-2	1364173-1	1365420-1
J2	Redundant Power and Command	1365444-2	1365444-1	1365447-1
J3	Primary 1553 C & T Bus	1364175-2	1364175-1	1365422-1
J4	Redundant 1553 C & T Bus	1365446-2	1365446-1	1365449-1
J5	Primary Passive Telemetry	1364174-2	1364174-1	1365421-1
J6	Redundant Passive Telemetry	1365445-2	1365445-1	1365448-1

3.4.4 Printer Set-up

The printer can be set on the printer rack as shown in Figure 15 (see Section 3.3.6.1 for precautions when operating within a clean room). If using the HP 3800N USB printer the cable is to be connected to the USB port on the rear of the processor.. If using the Lexmark printer the parallel interface cable is to be connected to the 25 pin Printer Port connection on the I/O Panel No. 1 shown in Figure 16. Printer power is obtained from the Printer AC Power receptacle on I/O Panel No. 1 shown in Figure 16.

Figure 15: External Printer Rack

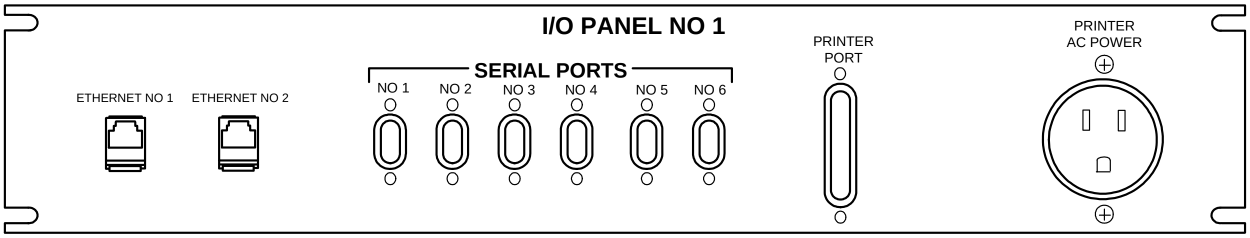


Figure 16: I/O Panel No. 1 connector locations

Table V: Panel No. 1 Connectors

Ref.	Connector Name	Connector Type	Description / Use
J1	ETHERNET NO. 1	RJ-45	Internal Intra-Net connection
J2	ETHERNET NO. 2	RJ-45	Interface to S/C STE
J3	SERIAL PORT NO. 1	DB-9	Not Used
J4	SERIAL PORT NO. 2	DB-9	Not Used
J5	SERIAL PORT NO. 3	DB-9	RS-232 Variable Target Control
J6	SERIAL PORT NO. 4	DB-9	RS-232 Fixed Target Control
J7	SERIAL PORT NO. 5	DB-9	Cold Plate Control
J8	SERIAL PORT NO. 6	DB-9	Not Used

J9	PRINTER PORT	DB-25	Parallel Printer Connection
J10	PRINTER AC POWER		115 VAC Receptacle for Printer

3.4.5 CTE Connections

The CTE connections Figure 16 are made using standard 9 pin serial cables connected to J5, J6, and J7 of the I/O Panel No. 2. Table V identifies which connector is used for each of the three target controllers.

3.4.6 LAN Set-up

The ATMS SysTE Processor incorporates two LAN connections. One LAN connection is used over the company's intranet for transferring data files. The second LAN connection is implemented during testing using a local hub at the spacecraft contractor's facility. The SysTE receives instrument telemetry over this interface via the spacecraft electrical GSE. Configuring the LAN interface is performed as follows:

1. Click on the "Start Application" icon on the panel menu.
2. From the pop-up menu, Select "YaST"
3. The "YaST Control Menu" will now appear and the screen.
4. Select "Network Devices" and click on "Network Card".
5. Select the desired network card to setup and click on "Configuration"
6. Click on "Static address setup" and enter the IP address and Subnet mask and click on "Next"
7. Click on "Finish" to complete the configuration
8. Repeat steps 1-7 for each of the network cards to be configured.

When the network cards have been configured, connect an Ethernet cable between "Ethernet NO 1" on "I/O Panel NO 1" and the intranet LAN. Connect the spacecraft electrical GSE interface to "Ethernet NO 2" on "I/O Panel NO 1". See and Table V for Ethernet cable types and Figure 16 for connector locations.

3.5 Turn -ON Procedure

When using the SysTE, it is important to use the following sequence to power up the system. Figure 17 and Figure 18 show details of the controls for the power supplies and UPS system.

STEP	SysTE POWER ON PROCEDURE
1	Visually inspect all cable connections to the SysTE (refer to Figure 6). The AC power cord is connected in step 11 if it is not already connected.
2	Verify that the processor is OFF. If it is not follow the Processor Shutdown Procedure.
3	Verify the power switch to the Agilent Variable power supply is in the OFF position.
4	Verify the switch on the Hardware Control panel labeled “SYSTEM STE AC POWER” is in the OFF position.
5	Verify the SENSOR POWER switch on the Hardware Control panel is in the OFF position.
6	Verify the “SENSOR DC POWER” switch on the Hardware Control panel is in the OFF position.
7	Verify the “HEATER DC POWER” switch on the Hardware Control panel is in the OFF position.
8	Set the “PROCESSOR LOCKOUT” key switch on the Hardware Control panel to the CONTROL PANEL position.
9	Verify the two switches on the Acopian power supply are in the ON position.
10	Turn on all System Alarm switches (nine switches located at the bottom of the Control Panel).
11	Connect the AC power cable from the rear of the SysTE to the mains power (see section 3.4.1). Turn on the Primary Power Switch/Circuit Breaker to the “up”, On position.
12	Verify The “AC POWER APPLIED” Lamp on the control panel is lit.
13	Set the “SYSTEM STE AC POWER” switch on the control panel to the ON position.
14	Verify the SYSTEM STE AC POWER lamp on the control panel is lit.
15	Verify a voltage between 100V and 126V on the INPUT AC POWER VOLTAGE meter on the control panel.
16	Verify the correct frequency on the INPUT AC POWER FREQUENCY meter on the control panel (60Hz ± 2 Hz in U.S.).
17	Depress the “TEST” button on the UPS system.
18	Verify the “On-Line” indicator on the UPS is illuminated.
19	Verify the two red lights on the Acopian Power supply are lit.

20 Verify the four green SysTE power lamps on the control panel are illuminated.

21 Turn on the processor power.

22 Verify Processor is operating.

The processor will run through a series of checks. All should say "OK"
A log-in window will appear after several seconds

23 Log into Computer by entering the Username and Password and click on "GO". The Desk-top will appear on the screen.

24 Click on the SysTE Software icon on the desk-top.

25 Check the INPUT AC POWER CURRENT meter to ensure the SysTE is drawing current.

26 Turn on Agilent 6553A power supply. <u>Do not enable output at this time.</u>

27 Set the voltage to the desired value. (Operating range is 28 ± 6 volts)

28 Verify the current reading on the Agilent 6553A is zero.

29 Set the current limit on the Agilent 6553A to 10.5 Amps.

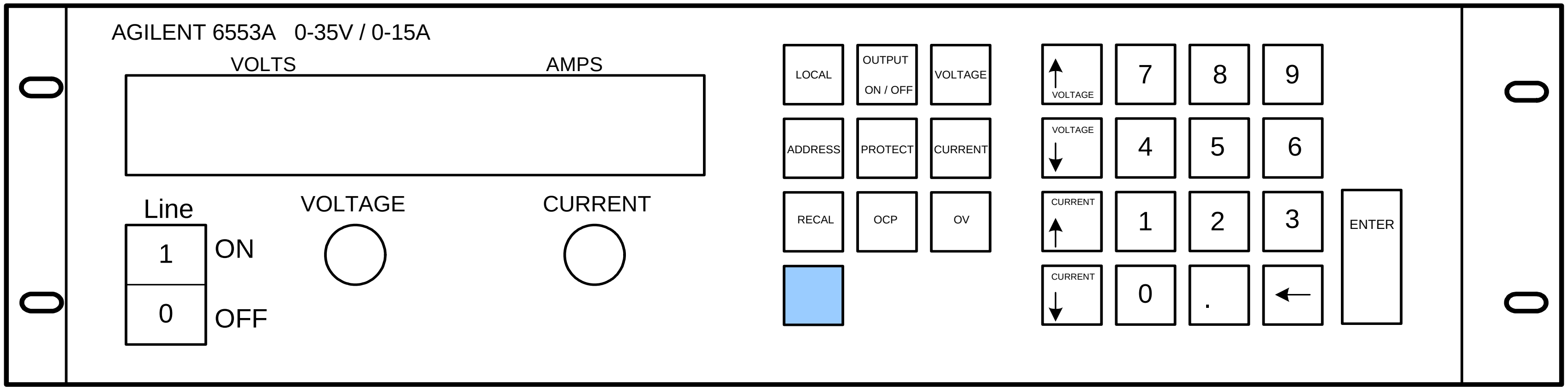
30 Set the over-voltage protection on the Agilent 6553A to 34.5-volts.

31 Press the Output ON/OFF button on the Agilent 6553A power supply to enable the output.

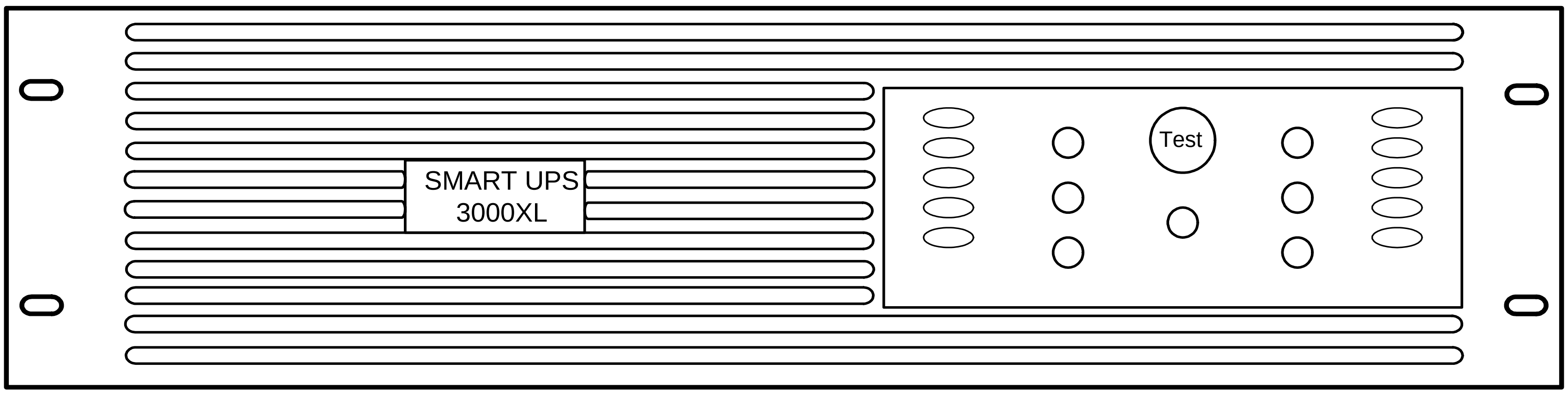
32 Refer to the Test Procedure or the Instrument Operating Procedure for further instructions.

3.5.1 Agilent 6553A Operation

1. Turn the Power switch to "ON" (Figure 11).
2. Press the "VOLTAGE" button.
3. Enter the desired voltage (within 28 ± 6 volts) using the numeric keypad.
4. Press the "ENTER" button.
5. Press the "CURRENT " button.
6. Enter a current of 10.5 using the numeric keypad.
7. Press the "ENTER" button.
8. Press the "OV" (over-voltage) button.
9. Enter an over-voltage setting of 34.5 using the numeric keypad.
10. Press the "ENTER" button.
11. When ready to apply voltage from the Agilent 6553A, press the "OUTPUT ON/OFF" button.



Agilent 6553A, Instrument 28-V Power Supply



Uninterruptable Power Supply

Figure 17: Instrument and Uninterruptible Power Supplies

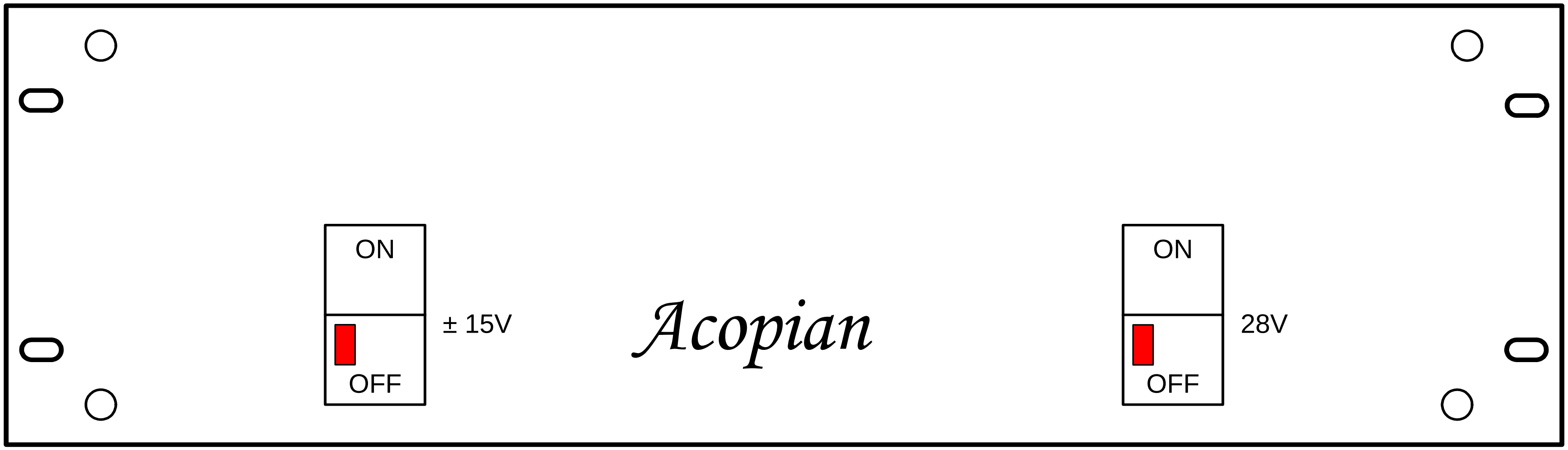


Figure 18: SysTE Acopian Power Supply

3.6 SysTE Operational Procedure

3.6.1 SysTE Control Panel

The SysTE Control Panel provides control and monitoring functions for the ATMS instrument. An illustration of the Control Panel is shown in Figure 19 and Figure 20. Further description is provided in the following paragraphs. Table VIII provide a brief description of each Control Panel component. The Control Panel provides 6 functions as listed below.

1. AC Power Control and monitoring
2. DC Power control and monitoring
3. Monitoring of Instrument passive telemetry temperatures
4. Monitoring of ATMS Instrument bi-level status
5. Discrete pulse commands
6. Alarms for out-of-limit conditions

3.6.1.1 Control Panel AC power operation

The upper portion of the SysTE Control Panel has a series of meters, LED indicators, and switches that control power to both the instrument and the STE. The three meters at the top of the control panel indicate the AC voltage, AC frequency, and AC current. These meters will take measurements at all time when the SysTE is connected to AC power. The AC voltage and frequency meters indicate the voltage into the SysTE, and not the output of the UPS. The current meter indicates the current out of the UPS. A description of the operation of the LED Indicators and toggle switches is given in Table VI.

Table VI: Control Panel AC Power Description

Control Panel Component	Component Type	Description of Operation
AC POWER APPLIED	LED Indicator	Indicates the presence of AC power to the SysTE from the power cord.
SYSTEM STE AC POWER	Toggle Switch	Main power switch to all SysTE components except instrument power supply.
SYSTEM STE AC POWER	LED Indicator	Indicates power is on to all SysTE components.
SENSOR POWER	Toggle Switch	Applies power to the Instrument DC Power Supply (Agilent 6543A)
SENSOR POWER	LED Indicator	Indicates 28VDC power is being supplied to the instrument from the SysTE
HEATER POWER	LED Indicator	Indicates 28VDC power is being supplied to the instrument Heaters from the SysTE

INPUT AC POWER VOLTAGE	Meter	Displays the AC voltage supplied to the SysTE. This meter does not read the output of the UPS
INPUT AC POWER FREQUENCY	Meter	This meter displays the power line frequency
INPUT AC POWER CURRENT	Meter	This meter displays the total current being supplied to the STE

Note: When operating the SysTE on 230VAC, the AC voltage meter will read half the supplied voltage.

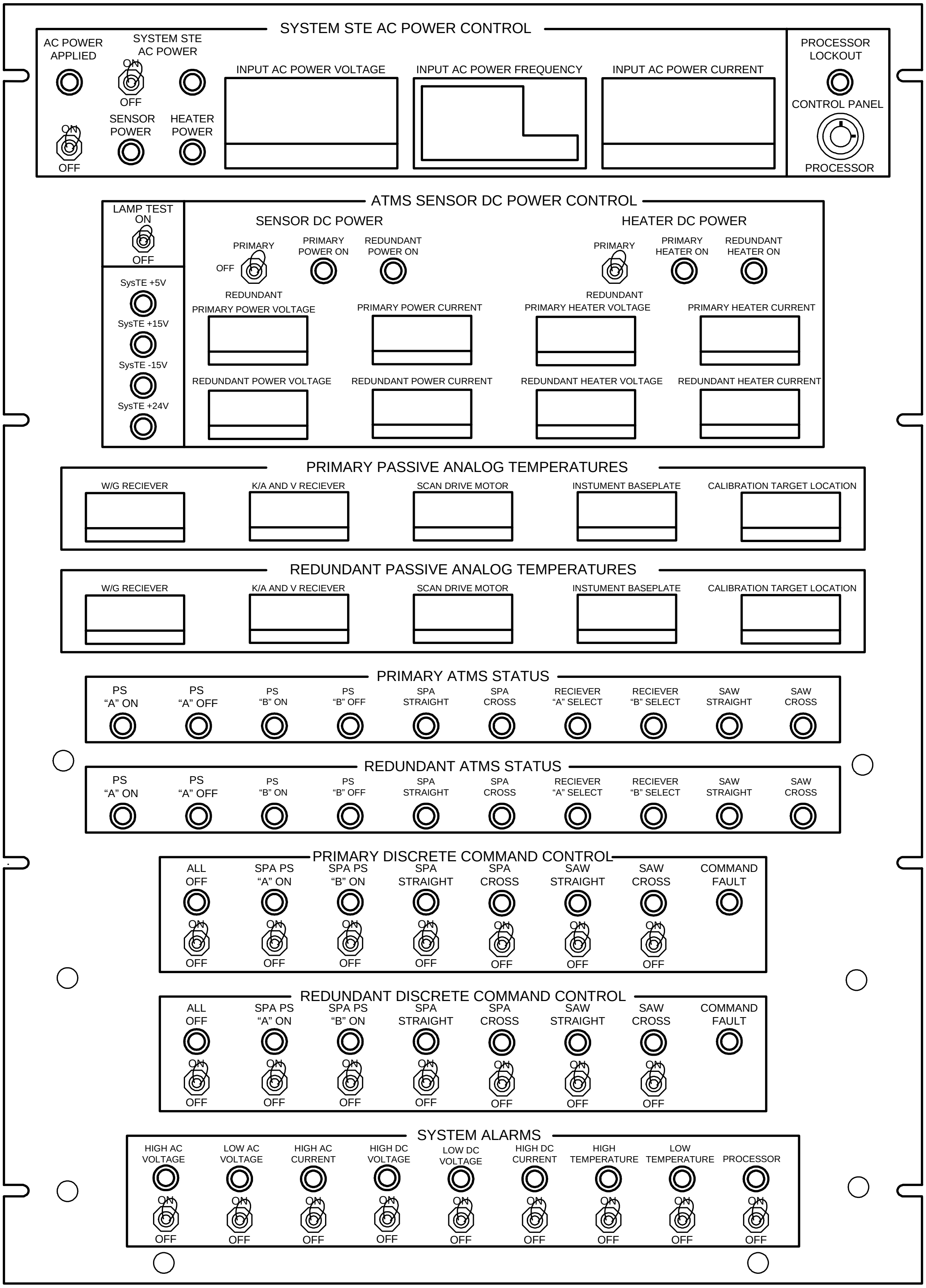


Figure 19: SysTE Control Panel Front

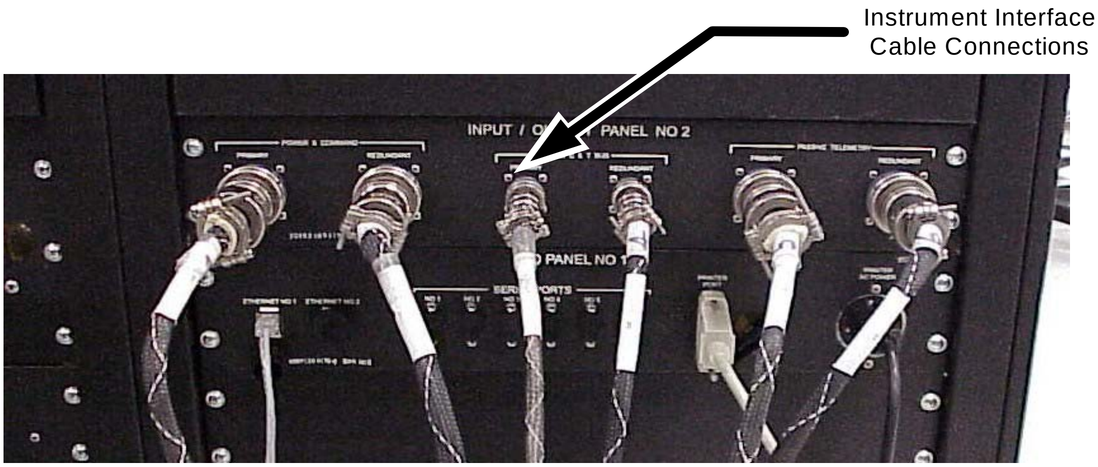


Figure 20: SysTE Control Panel, Rear

3.6.1.2 Control Panel DC Power Operation

This section of the control panel controls and monitors the DC power to the instrument. This section also provides an indication of the individual SysTE voltages, and provides a switch for testing all the lamps (LED indicators) on the SysTE control panel. Table VII provides a description of the operation of each of these functions. In addition to the meters providing the function described in the table, the meters provide out-of-limits checks, which will sound an audible alarm when something is out of limit. The limits, which are programmed into the meters, are shown in Table X.

Table VII: Control Panel DC power operation

Control Panel Component	Component Type	Description of Operation
LAMP TEST	Toggle Switch	Illuminates the lamps on the control panel in sequence for verification of lamp operation.
SysTE +5V	LED Indicator	Illuminated when +5-volts is being supplied to the SysTE
SysTE +15V	LED Indicator	Illuminated when +15-volts is being supplied to the SysTE
SysTE -5V	LED Indicator	Illuminated when -15-volts is being supplied to the SysTE
SysTE +24V	LED Indicator	Illuminated when +24-volts is being supplied to the SysTE
SENSOR DC POWER	Toggle Switch	Switches the 28V DC supply to PRIMARY, REDUNDANT, or OFF
PRIMARY POWER ON	LED Indicator	Illuminated when power is being supplied to the Primary input to the ATMS Instrument

Control Panel Component	Component Type	Description of Operation
REDUNDANT POWER ON	LED Indicator	Illuminated when power is being supplied to the Redundant input to the ATMS Instrument
HEATER DC POWER	Toggle Switch	Switches the 28V DC Heater supply to PRIMARY, REDUNDANT, or OFF
PRIMARY HEATER ON	LED Indicator	Illuminated when power is being supplied to the Primary input to the ATMS Instrument Heaters
REDUNDANT HEATER ON	LED Indicator	Illuminated when power is being supplied to the Redundant input to the ATMS Instrument Heaters
PRIMARY POWER VOLTAGE	Meter	Provides a display of the voltage being supplied to the instrument primary voltage connector terminals.
REDUNDANT POWER VOLTAGE	Meter	Provides a display of the voltage being supplied to the instrument redundant voltage connector terminals.
PRIMARY POWER CURRENT	Meter	Provides a display of the current being supplied to the instrument primary side.
REDUNDANT POWER CURRENT	Meter	Provides a display of the current being supplied to the instrument redundant side.
PRIMARY HEATER VOLTAGE	Meter	Provides a display of the voltage being supplied to the instrument primary heater voltage connector terminals.
REDUNDANT HEATER VOLTAGE	Meter	Provides a display of the voltage being supplied to the instrument redundant heater voltage connector terminals.
PRIMARY HEATER CURRENT	Meter	Provides a display of the current being supplied to the instrument primary heaters.
REDUNDANT HEATER CURRENT	Meter	Provides a display of the current being supplied to the instrument redundant heaters.

3.6.1.3 Analog Passive Temperatures

The analog passive temperatures are displayed on individual meters. A list of the meters is shown below. All meters read in degrees centigrade.

1. Primary W/G Receiver Temperature
2. Primary K/A and V Receiver temperature
3. Primary Scan Drive Motor Temperature
4. Primary Instrument Baseplate Temperature
5. Primary Calibration Target Location Temperature
6. Redundant W/G Receiver Temperature

7. Redundant K/A and V Receiver temperature
8. Redundant Scan Drive Motor Temperature
9. Redundant Instrument Baseplate Temperature
10. Redundant Calibration Target Location Temperature

3.6.1.4 ATMS Status

The ATMS Status lamps located on the front panel are indication of the bi-level telemetry signals from the instrument. A description of each lamp is given in Table VIII below.

Table VIII: Control Panel Status Description

STATUS LAMP	COLOR	DESCRIPTION
PS “A” ON	GREEN	Primary power supply is on
PS “A” OFF	YELLOW	Primary power supply is off
PS “B” ON	GREEN	Redundant power supply is on
PS” B” OFF	YELLOW	Redundant power supply is off
SPA STRAIGHT	GREEN	Primary Power Supply will power Primary SPA Redundant Power Supply will power Redundant SPA
SPA CROSS	YELLOW	Primary Power Supply will power Redundant SPA Redundant Power Supply will power Primary SPA
RECIEVER “A” SELECT	GREEN	Primary Receiver Power Supply is on
RECIEVER “B” SELECT	YELLOW	Redundant Receiver Power Supply in on
SAW STRAIGHT	GREEN	Primary Power Supply will power Primary SAW Filter Redundant Power Supply will power Redundant SAW Filter
SAW CROSS	YELLOW	Primary Power Supply will power Redundant SAW Filter Redundant Power Supply will power Primary SAW Filter

When the cables from the SysTE to the Instrument are not connected the following Primary and Redundant STATUS LAMPS will be illuminated.

1. PS “A” ON (Green)
2. PS “B” ON (Green)
3. SPA CROSS (Yellow)
4. RCEIVER “A” SELECT (Green)
5. SAW STRAIGHT (Green)

3.6.1.5 Discrete Pulse Commands

The Control Panel can send Discrete Pulse Commands to the ATMS Instrument. There are seven primary commands and seven redundant commands. These commands are sent by moving one of the 14 momentary toggle switches to the ON position and then releasing it. The switch is a locking type switch. To move the switch position it is necessary to carefully pull the handle out before moving it to either the up or down position. The pulse commands are 28-volts in amplitude and last for 70 mS. Table IX shows the commands and their descriptions. The blue lamps above the command switches indicate the last sent command. The Command Fault lamp will illuminate if the command logic fails on. The SysTE has a safety mechanism that will shut off the command voltage in the event of a failure.

Table IX: Discrete Pulse Commands

Command	Description
ALL OFF	Commands off all power supplies within the instrument
SPA PS “A” ON	Commands on the primary power supply within the instrument
SPA PS “B” ON	Commands on the redundant power supply within the instrument
SPA STRAIGHT	Commands the “A” power supply to power the “A” SPA, or the “B” power supply to power the “B” SPA
SPA CROSS	Commands the “A” power supply to power the “B” SPA, or the “B” power supply to power the “A” SPA
SAW STRAIGHT	Commands the “A” power supply to power the “A” SAW filter, or the “B” power supply to power the “B” SAW filter
SAW CROSS	Commands the “A” power supply to power the “B” SAW filter, or the “B” power supply to power the “A” SAW filter

3.6.2 Primary & Redundant Pulse Command

The Primary Discrete Pulse Commands and the Redundant Discrete Pulse Commands operate entirely independent within the SysTE. Any one Discrete Pulse Command, either Primary or Redundant will yield the same result in the ATMS Instrument.

3.6.2.1 System Alarms

The SysTE has nine audible alarms that will sound in the event of an out-of-limit condition on one of the control panel meters or from parameters measured in the SysTE Processor (see section 4.10 for further information on processor initiated alarms). Table X shows the control panel meters, and the high and low alarm conditions for each. In the event of an alarm condition, a corresponding lamp will light in addition to the sounding of the audible alarm. The audible alarm may be shut off with the corresponding toggle switch. Refer to Figure 19 for locations of System Alarm indicators and switches.

Table X: Limits for alarms

Ref.	Panel Meter			Alarm Setting	
				Low	High
M1	AC Power Voltage			90V	130V
M2	AC Power Frequency			-----	-----
M3	AC Power Current			-----	8A
M4	Primary W/G Receiver Temperature			-25°C	65°C
M5	Primary K/A & V Receiver Temperature			-25°C	65°C
M6	Primary Scan Drive Motor Temperature			-45°C	80°C
M7	Primary Baseplate Temperature			-32°C	70°C
M8	Primary Cal. Target Temperature			-25°C	65°C
M9	Redundant W/G Receiver Temperature			-25°C	65°C
M10	Redundant K/A & V Receiver Temperature			-25°C	65°C
M11	Redundant Scan Drive Motor Temperature			-45°C	80°C
M12	Redundant Baseplate Temperature			-32°C	70°C
M13	Redundant Cal. Target Temperature			-25°C	65°C
M14	Primary ATMS Voltage			22V	35V
M15	Primary ATMS Current			-----	4.5A
M16	Primary Heater Voltage			22V	35V
M17	Primary Heater Current			-----	1.0A
M18	Redundant ATMS Voltage			22V	35V
M19	Redundant ATMS Current			-----	4.5A
M20	Redundant Heater Voltage			22V	35V
M21	Redundant Heater Current			-----	1.0A

3.6.3 ATMS SysTE Processor

The ATMS SysTE Processor consists of a rack mounted 2.4GHz Pentium IV with the following hardware.

1. 20 Slot Active Backplane 17 PCI, 2 CPU, 2 ISA
2. 2.4GHz Intel Pentium 4 CPU
3. Optical Mouse
4. 101 Key Keyboard for Rack Drawer
5. Qty. 2 500GB Hard Drives
6. DVD+RW/TR DVD-RW/R 4.7GB 24x/10x/32x CDRW Drive
7. 10/20GB Tape Backup
8. 2GB RAM
9. Two LAN connections
10. Six RS-232 Serial Ports
11. Dual Redundant Mil-STD 1553 Bus
12. Two 16 channel, 16 bit A/D cards
13. Two 32-bit Digital Input cards
14. One 32-bit Digital Output card
15. One Timing & Sync. card
16. Two 17-inch flat panel Color Displays
17. 8 USB Ports (4 Front/4Rear)
18. 2 Fire Wire Ports (1 Front / 1 Rear)

The ATMS SysTE Processor uses the Red Hat LINUX operating system version 7.2. The SysTE Processor runs National Instruments' LAB VIEW software to implement most software functions. Figure 21 shows the basic front panel of the SysTE Processor.

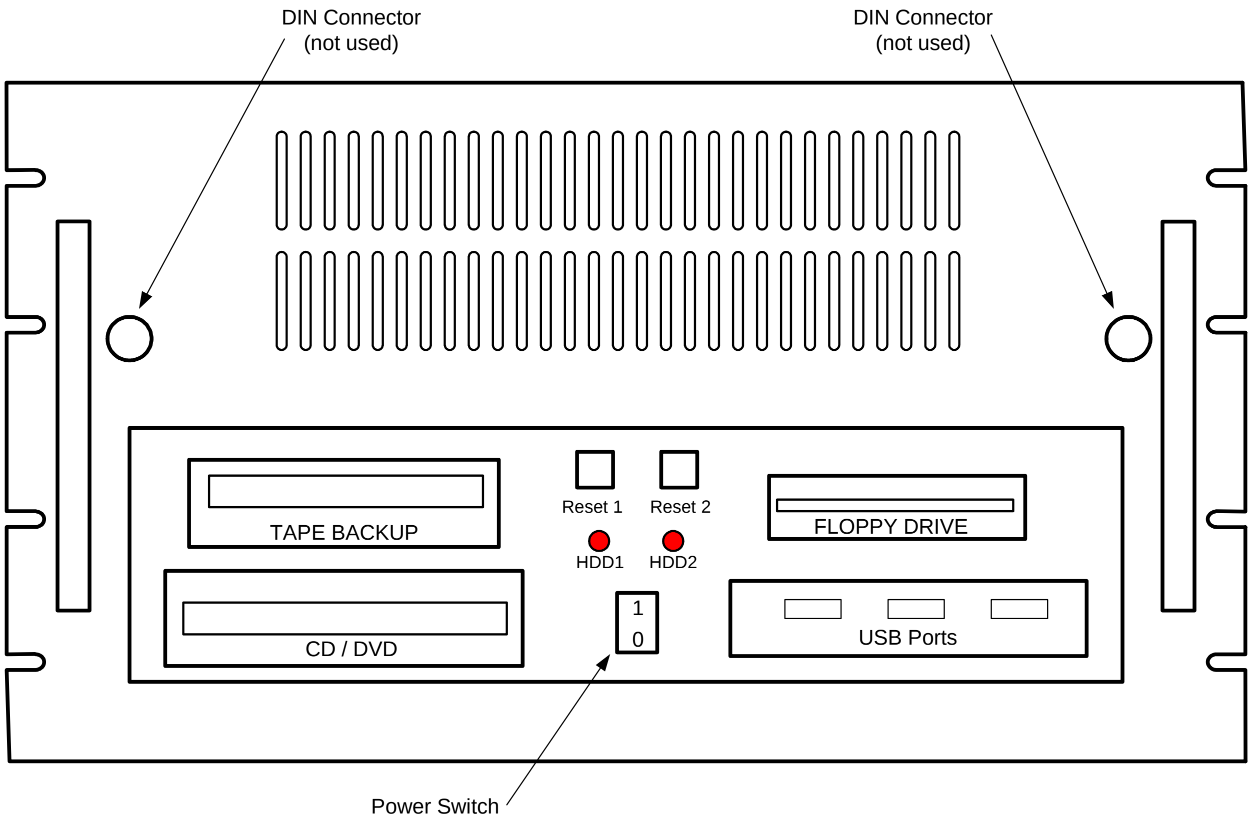


Figure 21: SysTE Processor

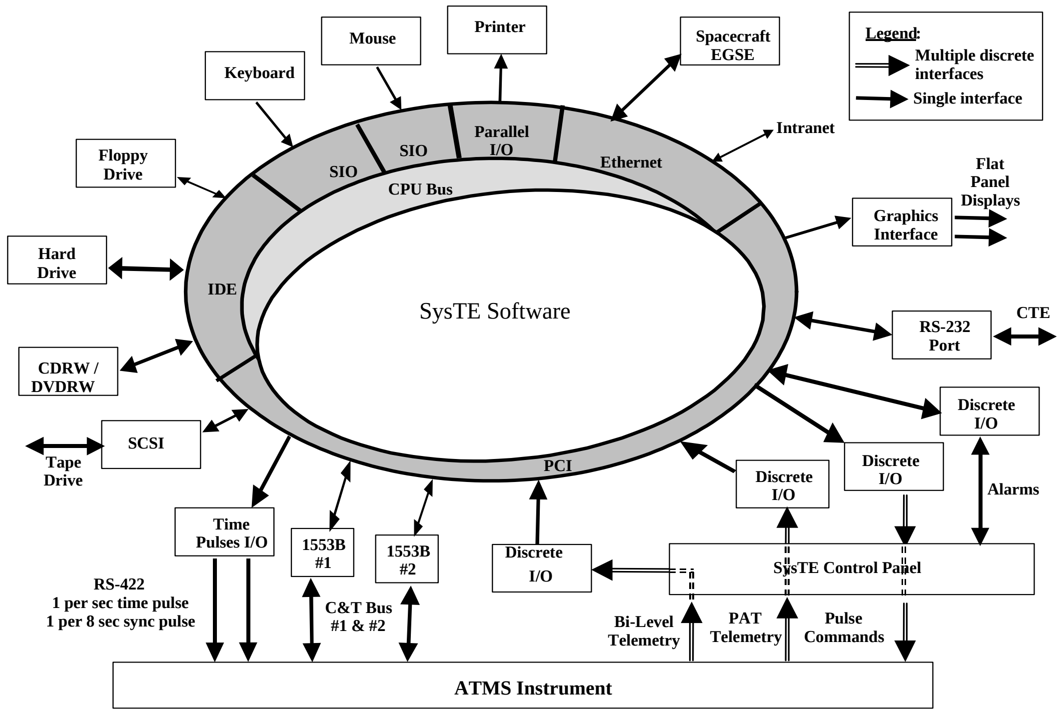


Figure 22: Software / Hardware Interface Diagram

3.6.4 Processor Display

The Two 17 inch Displays on the Processor are for providing a graphical interface to the operator. The top display shows three screens: 1. Main Panel; 2. Control Panel; 3. Health & Status Panel. The bottom Display is for more specific control and monitoring functions. A detailed description of all screens will be given in the following sections.

3.6.4.1 Processor Interface

The Processor interfaces to the SysTE Control Panel and the ATMS Instrument as illustrated in Figure 23:.

3.6.4.2 Communications

All external communications with the SysTE is via:

1. An ISO 802.3 Ethernet interface utilizing TCP/IP protocol. This interface is used to communicate with the S/C GSE. The capacity of the interface is 10/100 Mbps, however the bandwidth used by the SysTE software is expected to be only a small fraction of the link's capability.
2. RS232 Serial communication port used to communicate with the Azonix devices. The devices are connected on dedicated lines at 9600 baud. The commanding and receipt of data is expected to only utilize a fraction of the available bandwidth.
3. Dual Condor Engineering 1553B (PCI1553-SS) interface PCI card is used to communicate with the ATMS instrument. This interface operates at 1 Mbps.

The maximum bus utilization is calculated to be about 5% for the bi-directional interface between the SysTE and a single ATMS instrument.

4 SysTE Software Operation

The SysTE software is used to collect data from the ATMS instrument and SysTE hardware as well as analyze data collected from the ATMS instrument. Data collection, or logging, is active whenever ATMS is in either Instrument Mode or Spacecraft Mode. Data analysis routines read data from either the active log, real time, or can process previously logged data. Analysis functions are completely separate from the data collection function enabling the analysis of data other than that being collected.

The SysTE software enters the Standby Mode as soon as the test operator launches the application. In Standby Mode, the SysTE software immediately prompts the user for login and password (this is in addition to the normal operating system login). Upon successful login, the SysTE performs initialization tasks for both SysTE hardware and software and performs a calibration of the analog voltage input channels and does a self-test. At successful completion of self-test, the SysTE displays the Input Selection Panel. The Control Panel and health and Status displays are not visible in Standby Mode.

In addition to SysTE system's user account, the SysTE S/W will provide a user login to prevent unauthorized personnel to enter and to execute the application. The SysTE S/W also provides the capability of monitoring critical parameters of the ATMS Instrument. In the event any of the critical parameters are out of specified tolerances, the SysTE S/W will automatically, in conjunction with SysTE H/W, disconnect power to the Instrument to prevent the instrument from possible damage. The upper monitor display consists of the Main Window (Upper left), Software Control Panel (upper right) and the Health and Status display (lower). See Figure 23:.

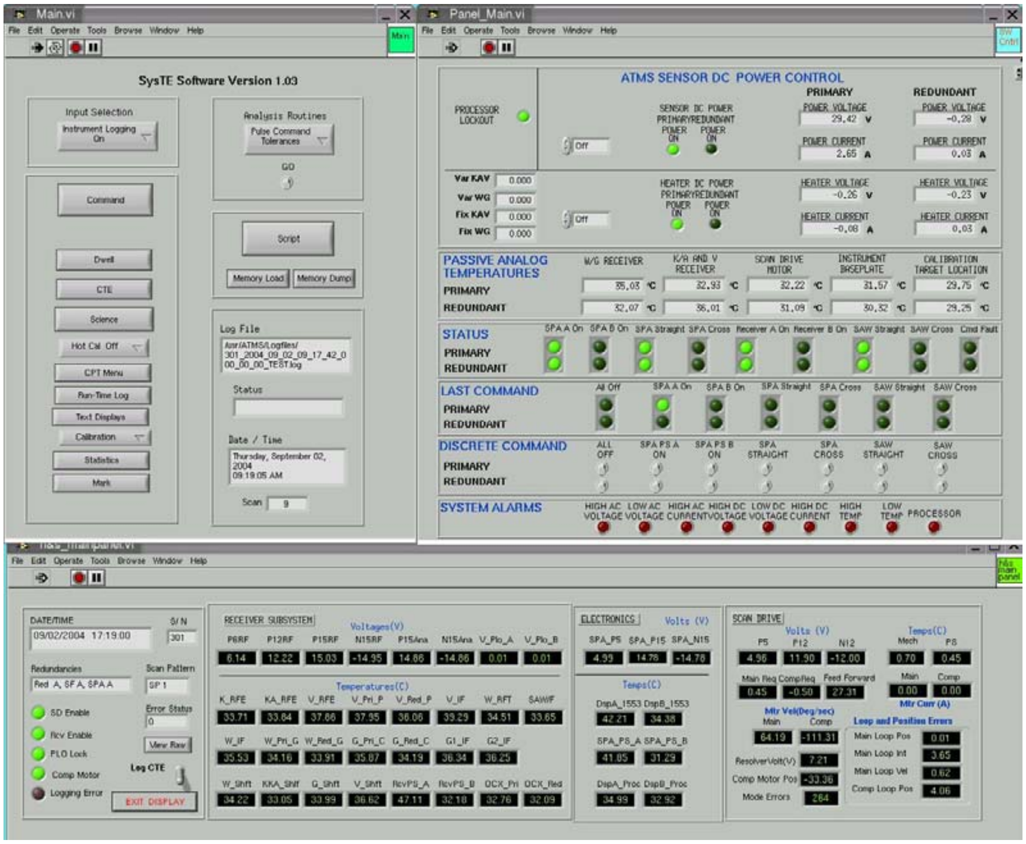


Figure 23: Upper Video Display

4.1 Operational Modes

The SysTE software has an initial startup mode (Standby) and 3 functional modes of operation. The software's initial state is "Standby". The test operator then chooses one of the 3 operational modes, namely *Instrument Logging On Mode*, *Playback Mode*, or *Spacecraft Mode*. Transition to *Instrument Logging On*, *Playback* or *Spacecraft STE mode* is accomplished by using the Input Selection control located on the upper left of the Input Selection Panel (see Figure 25). A fifth option *Instrument Logging Restart* is available when the SysTE software is in the *Instrument Logging On* or *Spacecraft* Mode. This function closes the existing data log file and creates a new data file for further data collection.

4.1.1 Instrument Logging On Mode

Instrument Logging On Mode is the major mode of operation. In this mode the Control Panel and Health and Status displays are visible. Optionally, the Science, Hot Calibration Temperatures and Calibration Test Equipment displays may be activated. When this mode is selected the operator is prompted for the instrument serial number. By default the serial number selected the previous time the software was used will be selected. A new data log is then started and the 1553 Command and Telemetry process is initiated. Timing pulses and Time-of-Day messages are also sent to the ATMS instrument while in this mode. The steps required to enter the Instrument Logging On Mode are provided below. Once in Instrument Logging On Mode, it is possible to command the instrument using either the command generator (4.1.3.4) or the script processor (4.7).

1. Login to the SysTE Software
2. At the Main Display, Select "Instrument Logging On Mode" from the Input Selection button
3. When prompted, enter the instrument's serial number
4. Confirm the Data Log File name from the Log File Box.

4.1.2 Playback Mode

Playback Mode is used to read an existing log file and update the data displays. All or part of an existing log file may be displayed. CCSDS and pulse commands are disallowed while in Playback mode. Data viewing and analysis functions may be executed while in Playback mode.

1. Login to the SysTE Software
2. At the Main Display, Select "Playback Mode" from the Input Selection button
3. When prompted, select the data log file to use for playback.

4.1.3 Spacecraft STE Mode

The ATMS instrument is connected to the spacecraft STE. The user is presented with the Spacecraft STE connection window which the user can change the IP address and select either HMD (default) or SMD links. A test button can also be used to check the ethernet interface before operation. See Figure 24:. A process called netClient, similar to the Command and Telemetry (CmdTelem) used in Instrument Logging Mode is started and connects with the server via an ethernet interface. All telemetry packets received are routed to the SysTE via an Ethernet interface. The Calibration Test Equipment (CTE) may still be controlled by the SysTE manually or via commands from the spacecraft STE.

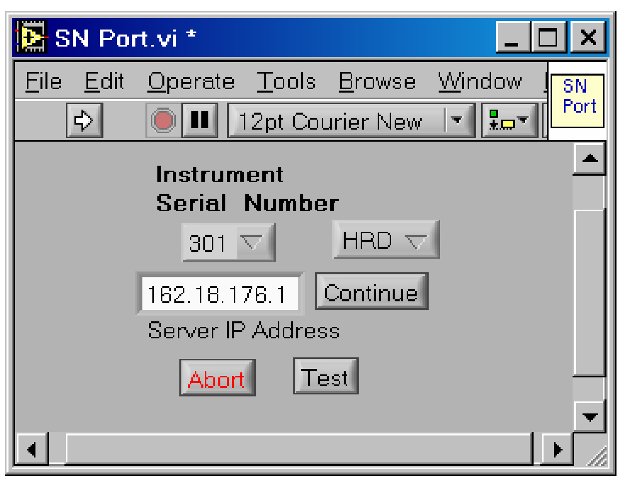


Figure 24: Spacecraft STE User Interface

The Spacecraft STE mode is selected to display and process data sent to the SysTE from the Spacecraft STE via an Ethernet connection. The SysTE logs data, in this mode, identically to Instrument Logging On Mode. Instrument pulse and CCSDS commands are disabled, however, Calibration Test Equipment (CTE) commands may be sent manually or commanded by the Spacecraft STE.

1. Login to the SysTE Software
2. At the Main Display, Select “Spacecraft STE Mode” from the Input Selection button
3. Verify the Spacecraft STE IP address and select either HMD (default)or SMD links.
4. Confirm the Data Log File name

4.1.3.1 Instrument Logging Restart

When the SysTE software is in the *Instrument Logging On* or *Spacecraft* Mode, the test operator has the option closing the existing data log file and create a new data file

1. At the Main Display, Select “Instrument Logging Restart” from the Input Selection button
2. Confirm the Data Log File name from the Log File Box.
3. Confirm the scan reset from the “Scan” count box

4.1.3.2 Main Panel

1. The Main Panel is shown in Figure 25, and has the following functions.
2. Input Selection
3. Command
4. Dwell
5. CTE
6. Science
7. Hot Cal
8. CPT Menu
9. Run Time Log
10. Text Displays
11. Calibration
12. Statistics
13. Mark
14. Analysis Routines
15. Scripts
16. Log File
17. Status
18. Date / Time

4.1.3.3 Input Selection

The input selection selects the source of the input data. The data source may be either the ATMS Instrument or stored data. The monitoring and analysis routines will operate with either data source. Refer to section 3.2.6 for further description.

4.1.3.4 Send 1553 Commands

Clicking on the Command button will open the CCSDS Command Generator Window. The CCSDS Command Generator screen is shown in Figure 26. A list of commands that can be sent using the command generator is given in Table XI. All CCSDS/1553B operations are controlled through a separate Linux process, which is initiated upon the selection of Instrument Logging On Mode. The ATMS instrument must be polled every 125 milliseconds (8 Hz) for any pending telemetry. The telemetry must then be verified for content and logged. CCSDS commands and time-of-day messages must also be sent to the instrument via this same interface. For further information refer Report No. 12114 (Command List and Description). The following steps are used to send a 1553 command to the instrument:

1. On the Main Display, click the Command Button.
2. On the Command Generator screen, in the command type field, select the Function Code of the command to send.
3. On the Command Generator screen, in the parameters field, select the bits corresponding to the command parameters defined in Report No. 12114B.
4. On the Command Generator screen, click on the Send button.

Note: The remaining fields on the Command Generator screen are used for diagnostic purposes, to confirm that the SysTE is generating the correct CCSDS packet (per Report No. 12114B) based on the use- defined command to be sent.

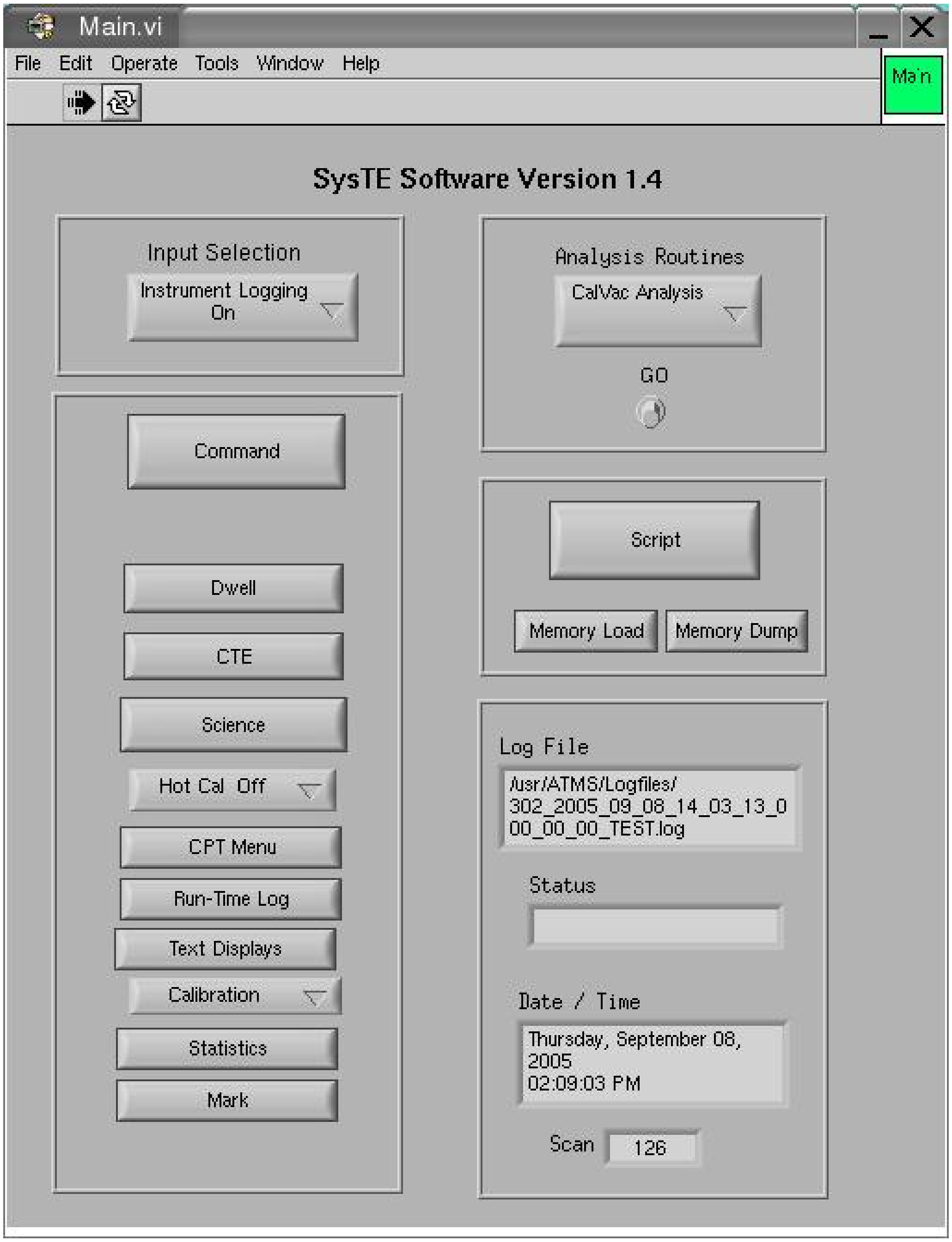


Figure 25: Main Screen

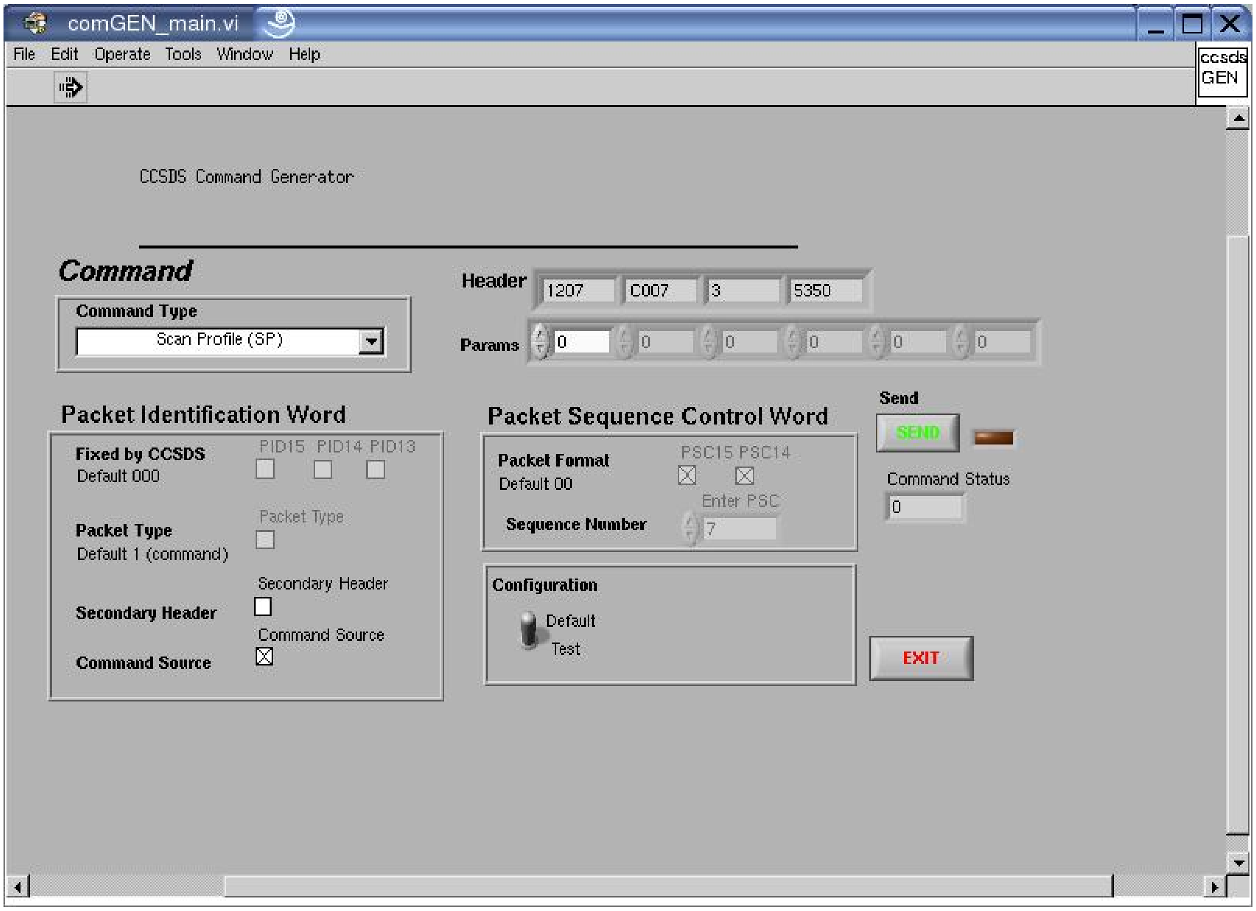


Figure 26: CCSDS Command Window

Table XI: CCSDS Commands

Function Name	Description
Subsystem Enable	Enables or disables the receiver subsystem, the scan drive subsystem, and the scan drive compensator
Data Collection Mode	Selects which data packets will be available for transmission to the spacecraft (1553B data bus). Housekeeping and LEO&A are always available while instrument is ON.
Scan Profile	Scan Profile Select loads one of four (1-4) 592 word profiles from processor RAM to SDE RAM. This is used for selection of cold calibration angle position. Zero(0) is used to execute from SDE PROM.
Point and Stare	This command points the scan drive reflector to a specified angle. 0 = zero angle, Bit 15 = 180°
Telemetry Dwell	Parameter = $FFFF_{16}$ is used to turn off Telemetry Dwell. The upper 2 bits are used to select the telemetry type:
Continuous Sampling	This command causes radiometric mission data to be collected continuously over the 8/3 second scan period (instead of tlhe nominal 104 earth view and calibration beam positions). It is intended primarily to support point & stare diagnostics and ground testing.
Safe-Hold	Commands ATMS into Safe-Hold
RAM-Load	Loads software into RAM memory.

Function Name	Description
RAM-Start	Used for ground diagnostics or for code restart
Memory Dump	
Memory Checksum	See format for memory loads for start address. The Command Status response will contain the checksum
Ground Test	The command's parameter field is a fixed 32 words. If less than 32 addresses are required the list of addresses can be terminated by $FFFF_{16}$ following the last desired address. To turn off Ground Test telemetry a Ground Test command is sent with $FFFF_{16}$ in the first parameter location.

4.1.4 Dwell

The Dwell Data Display Screen displays a single channel of telemetry data contained in the dwell data packet. The Dwell Data Display is shown in Figure 27. The dwell index channel being displayed is identified in the lower left of the screen. The maximum, minimum, and mean value is also displayed at the bottom of the screen. Refer to the Engineering Telemetry Description document (Report No. 12115F) for further details on telemetry data.

1. At the Main Display, Click the Dwell button
2. If no data is displayed, send the dwell command to the instrument per Section 4.1.3.4.

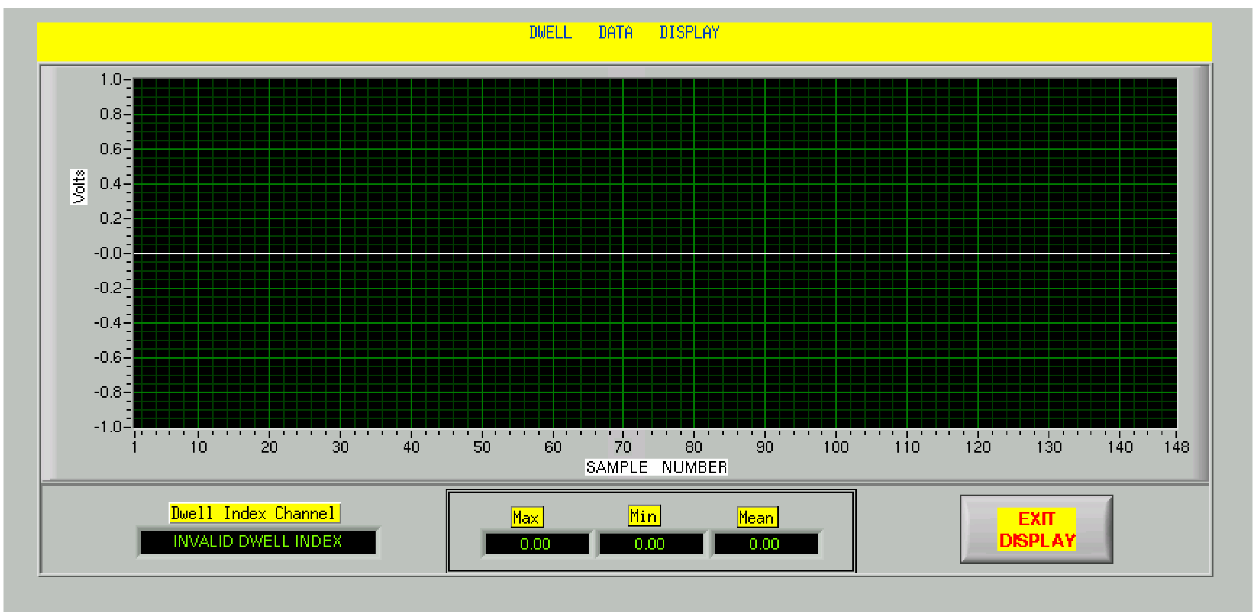


Figure 27: Dwell Data Display

4.1.5 CTE Data

The CTE Data Display will show the data from one of the calibration target PRTs. The CTE channel can be selected using the control on the lower left of the screen. Maximum, minimum, and mean data are also displayed. Figure 28shows the CTE Data Display. Table XII shows a list of CTE channels.

1. At the Main Display, Click the CTE button
2. On the CTE Data Display, select the CTE channel from the scroll field on the bottom left of the screen.
3. If no data is shown, confirm that the CTE controller is connected to the SysTE and powered-on.

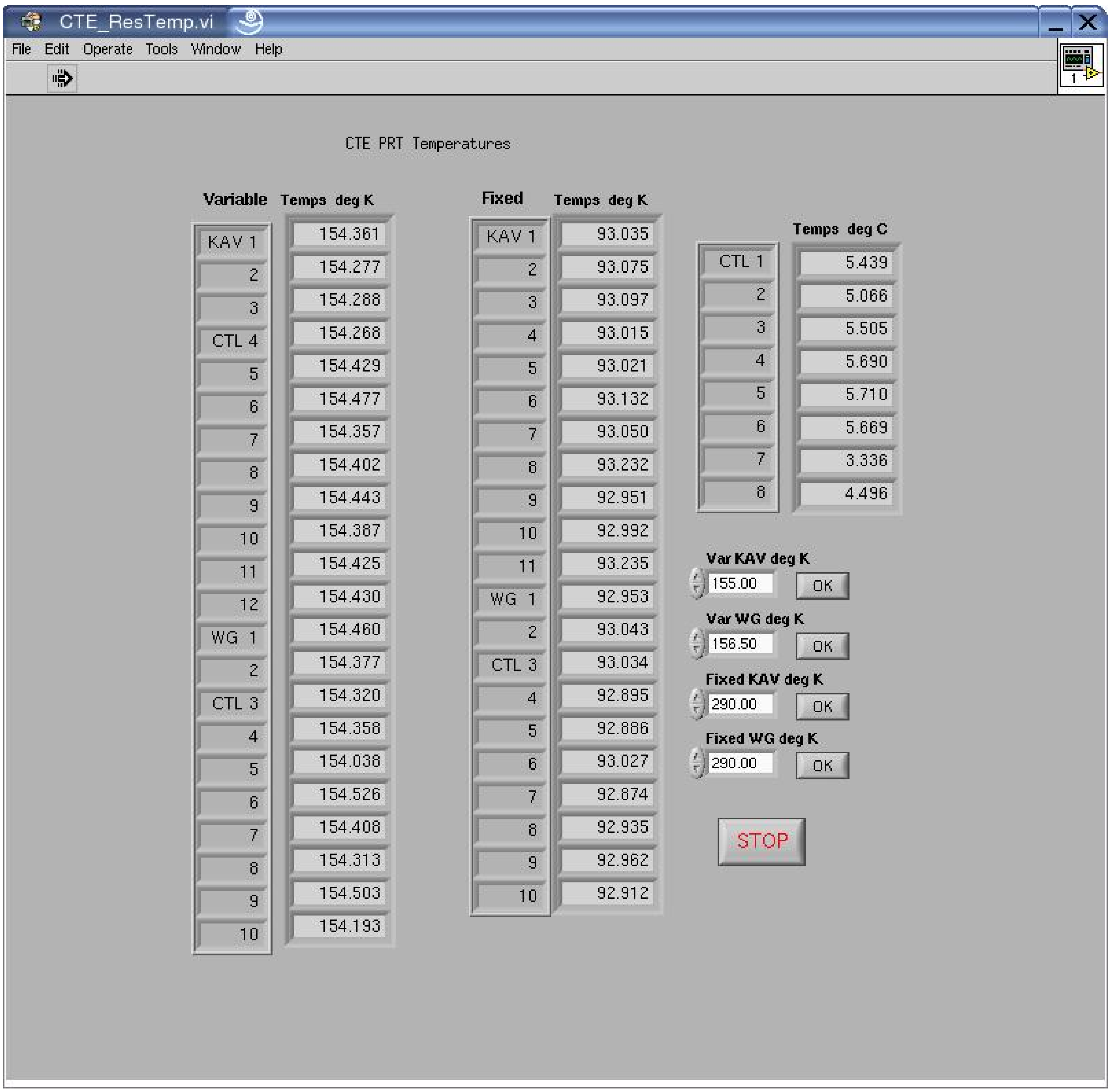


Figure 28: CTE Data Display

Table XII: CTE Channels

1	KAV Variable Targets
2	W/G Variable Targets
3	KAV Fixed Targets
3	W/G Fixed Targets
4	Colt Plate Targets

4.1.6 Science Data

All 22 channels of science data can be viewed simultaneously. The maximum, minimum, mean, and standard deviation can be displayed for any one channel at a time. Figure 29 shows the Science Data Display.

1. At the Main Display, Click the Science button
2. On the Science Data Display, select the channel from the scroll bar on the left to choose which channel's statistics to display.
3. If no data is displayed, command the instrument to transmit science data per Section 4.1.3.4.

Figure 29: Science Data Display

4.1.7 Hot Cal Data

The Hot Cal Data Display shows all 15 four-wire PRT data for the warm Loads. The maximum, minimum, mean, and standard deviation can be displayed for any one channel at a time. Figure 30 shows the Hot Cal Data Display.

1. At the Main Display, Click the Hot Cal button
2. On the Hot Cal Data Display, select the 4-wire PRT from the scroll bar on the left to choose which statistics to display.
3. If no data is displayed, command the instrument to transmit hot cal data per Section 4.1.3.4.

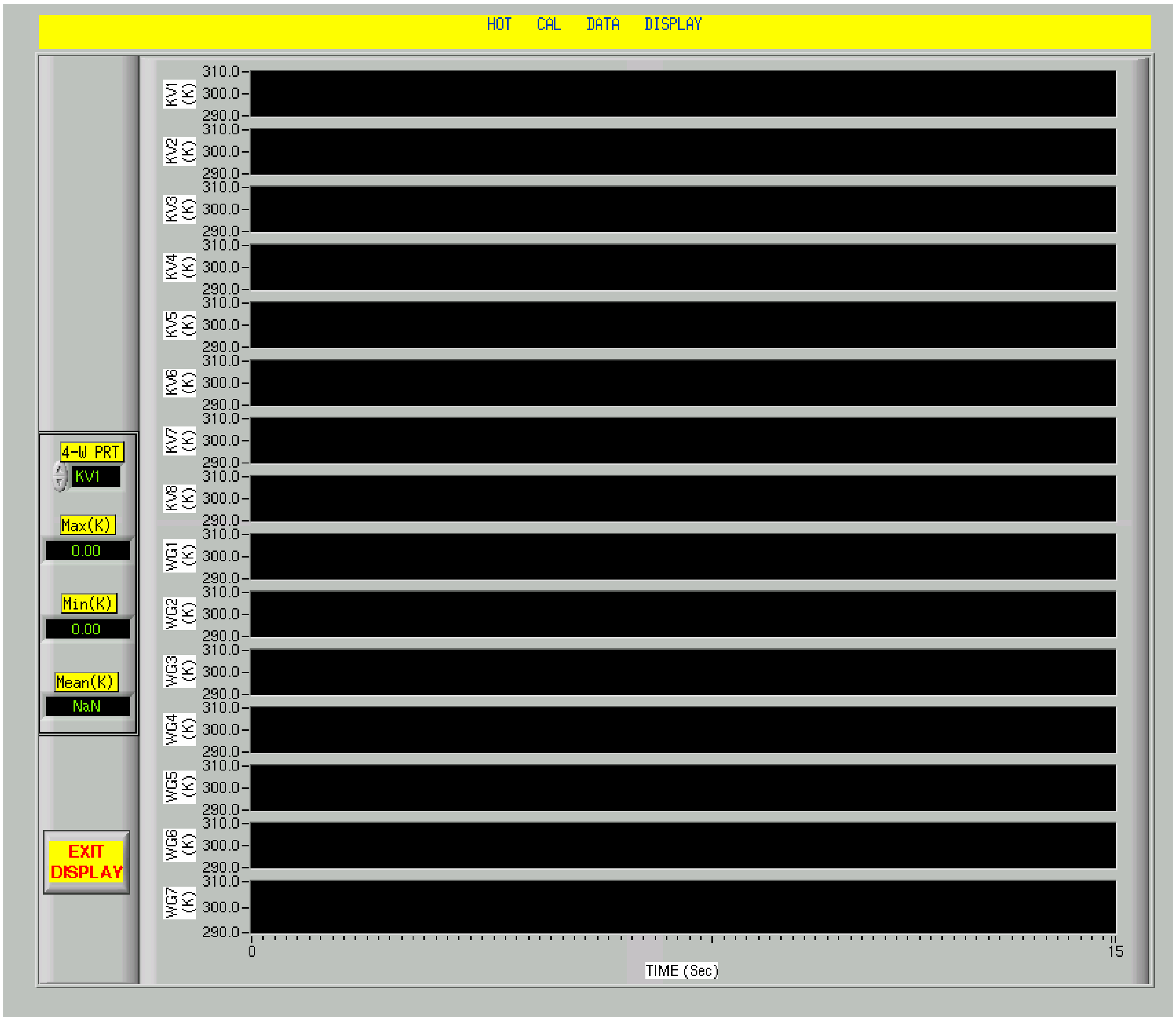


Figure 30: Hot Cal Data Display

4.1.8 CPT Menu

The ‘CPT Menu’ button brings up the Calibration Performance Test selection window. See Figure 31: CPT Menu Window below. The user can then select a test from the list and execute it by hitting the Run button (partially cancelled by the selection list). The Calibration Performance Tests are described in the following sections.

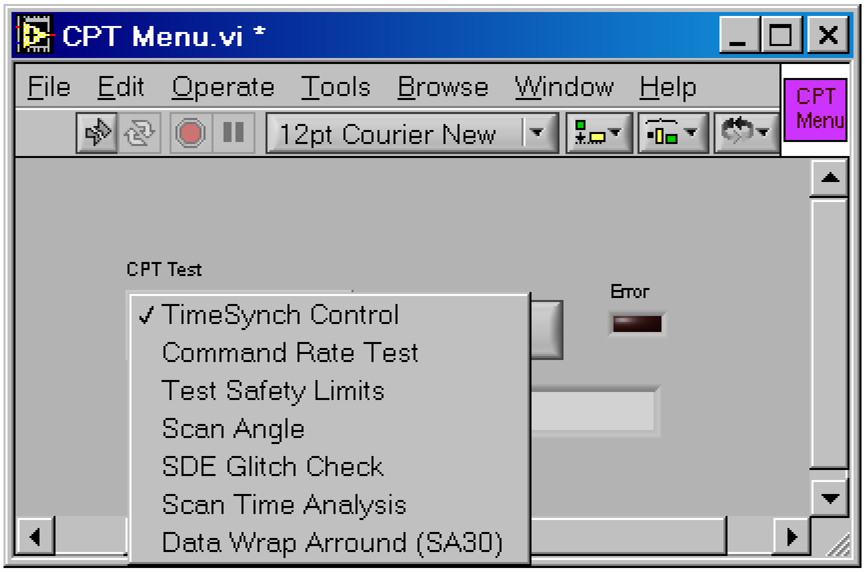


Figure 31: CPT Menu Window

4.1.8.1 Time Synch Control

The Time Synch Control is used to test the features of the Timing and Synchronization CCA within the STE and the ATMS flight software's capability to respond to missing timing pulses and messages. The control brings up the Time Synch Control window. See Figure 32: Time Synch Control Window.

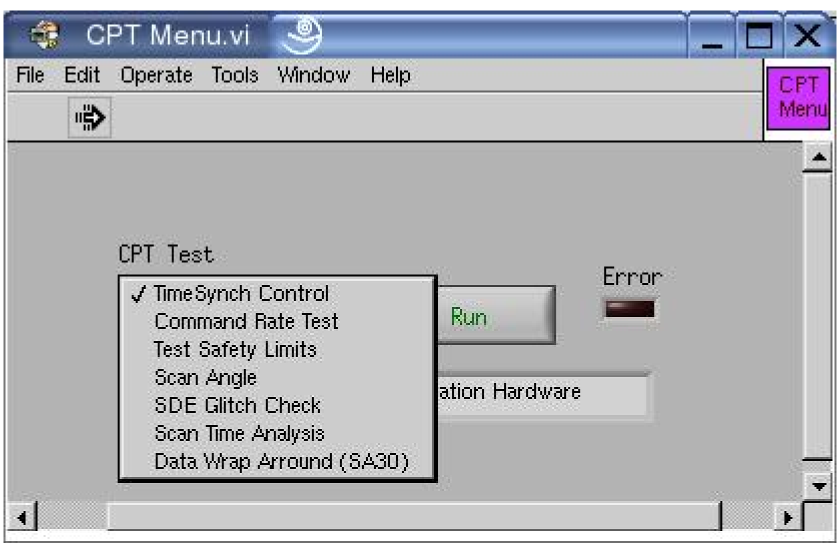


Figure 32: Time Synch Control Window

Theoperator can select the number of one second or eight second pulses or one second 1553 TOD messages to skip. When ATMS detects each missing one second pulse or message it responds with a Hardware Error packet (21F) with the status word (Word 3) indicating the type of error. The STE software counts the returning error packets and increments the skip count whenever it detects a valid error packet. For 8 second pulses there is no error response.

4.1.8.2 Command Rate Test

The Command Rate test is used to send 32 commands/sec to ATMS and verify the returning Command Status packets. See Figure 33:. The user can choose which packets to send by editing the packet contents. Illegal packets can also be sent to check for proper handling of bad commands

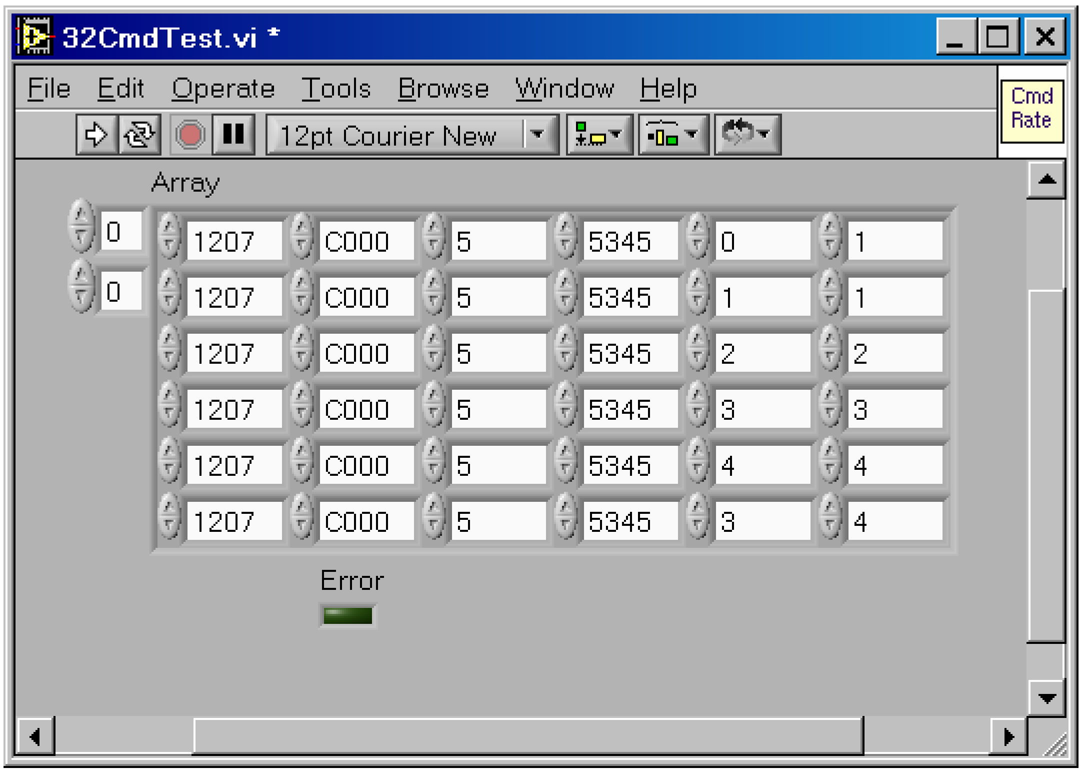


Figure 33: Command Rate Test

4.1.8.3 Test Safety Limits

The Safety Linits test is used to cause the limit checking, performed by the ATMS instrument, to activate, causing ATMS to enter Safe-hold. Memory loads are sent to the ATMS instrument to enable limit checking and reduce the limits below normal operating values. Once the limit has been exceeded for the defined time, ATMS will enter Safe-Hold. The Safety Limit to check is selected and the memory load commands sent when the value changes. The operator will verify that ATMS enters Safe-Hold within the appropriate number of scans.

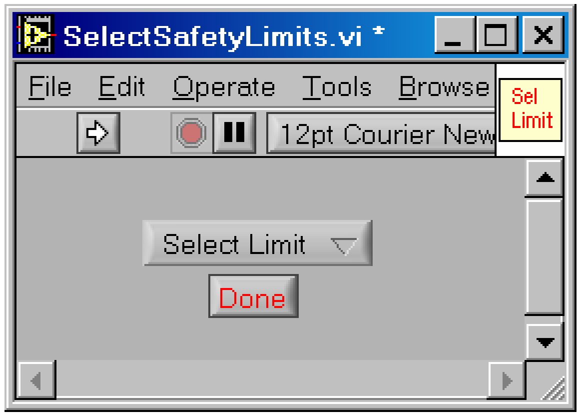
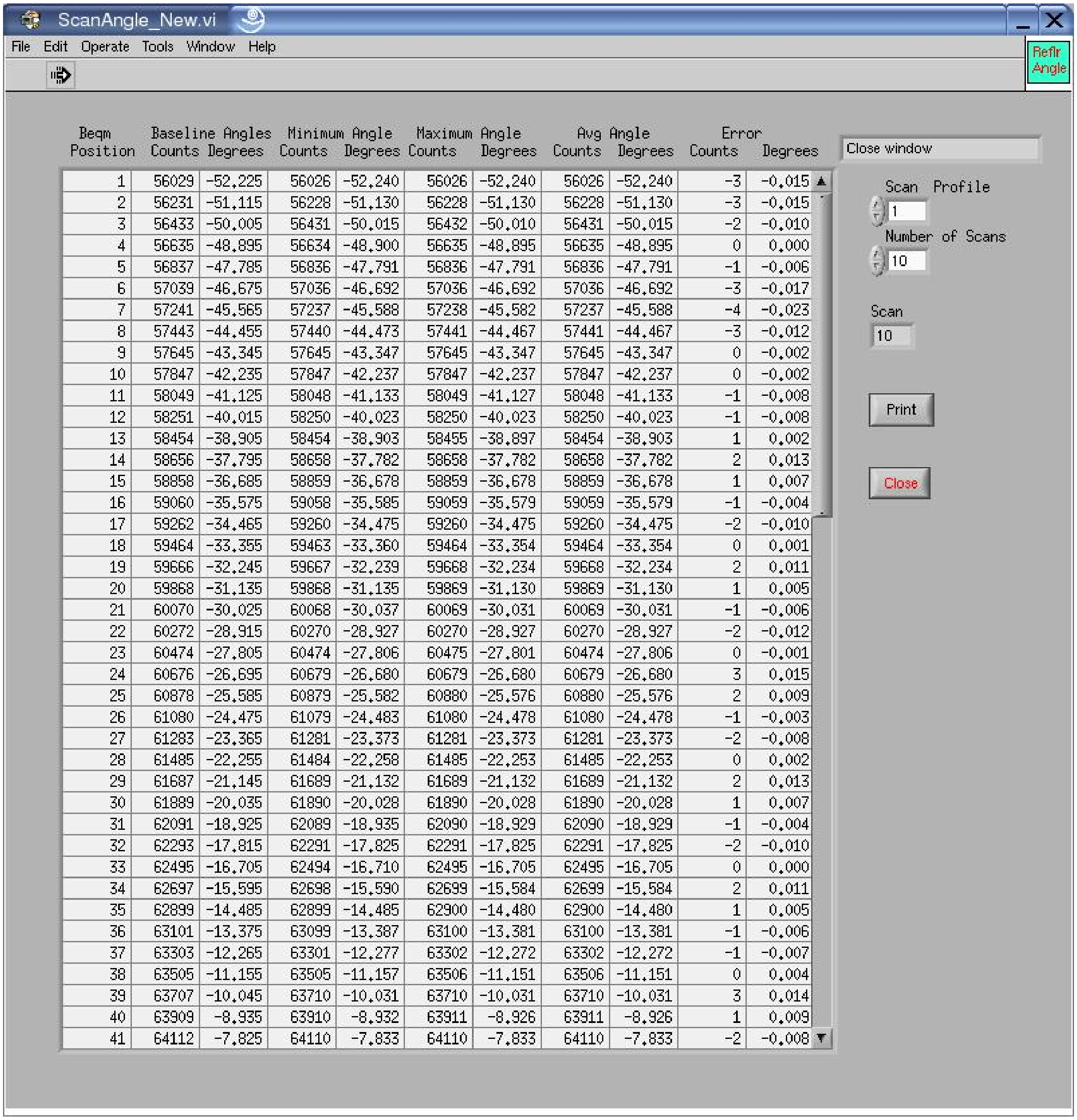


Figure 34: Safety Limit Test

4.1.8.4 Scan Angle

The San Angle test verifies that the scan drive is positioned at the correct position for the 96 earth, 4 cold calibration and 4 hot calibration epochs for 10 scans. See Figure 35:. Each beam position angle is compared with truth data in counts as well as an angle in degrees. The maximum, minimum and mean values are calculated and an error generated in counts and degrees.



Beam Position	Baseline Angles Counts	Baseline Angles Degrees	Minimum Angle Counts	Minimum Angle Degrees	Maximum Angle Counts	Maximum Angle Degrees	Avg Angle Counts	Avg Angle Degrees	Error Counts	Error Degrees
1	56029	-52.225	56026	-52.240	56026	-52.240	56026	-52.240	-3	-0.015
2	56231	-51.115	56228	-51.130	56228	-51.130	56228	-51.130	-3	-0.015
3	56433	-50.005	56431	-50.015	56432	-50.010	56431	-50.015	-2	-0.010
4	56635	-48.895	56634	-48.900	56635	-48.895	56635	-48.895	0	0.000
5	56837	-47.785	56836	-47.791	56836	-47.791	56836	-47.791	-1	-0.006
6	57039	-46.675	57036	-46.692	57036	-46.692	57036	-46.692	-3	-0.017
7	57241	-45.565	57237	-45.588	57238	-45.582	57237	-45.588	-4	-0.023
8	57443	-44.455	57440	-44.473	57441	-44.467	57441	-44.467	-3	-0.012
9	57645	-43.345	57645	-43.347	57645	-43.347	57645	-43.347	0	-0.002
10	57847	-42.235	57847	-42.237	57847	-42.237	57847	-42.237	0	-0.002
11	58049	-41.125	58048	-41.133	58049	-41.127	58048	-41.133	-1	-0.008
12	58251	-40.015	58250	-40.023	58250	-40.023	58250	-40.023	-1	-0.008
13	58454	-38.905	58454	-38.903	58455	-38.897	58454	-38.903	1	0.002
14	58656	-37.795	58658	-37.782	58658	-37.782	58658	-37.782	2	0.013
15	58858	-36.685	58859	-36.678	58859	-36.678	58859	-36.678	1	0.007
16	59060	-35.575	59058	-35.585	59059	-35.579	59059	-35.579	-1	-0.004
17	59262	-34.465	59260	-34.475	59260	-34.475	59260	-34.475	-2	-0.010
18	59464	-33.355	59463	-33.360	59464	-33.354	59464	-33.354	0	0.001
19	59666	-32.245	59667	-32.239	59668	-32.234	59668	-32.234	2	0.011
20	59868	-31.135	59868	-31.135	59869	-31.130	59869	-31.130	1	0.005
21	60070	-30.025	60068	-30.037	60069	-30.031	60069	-30.031	-1	-0.006
22	60272	-28.915	60270	-28.927	60270	-28.927	60270	-28.927	-2	-0.012
23	60474	-27.805	60474	-27.806	60475	-27.801	60474	-27.806	0	-0.001
24	60676	-26.695	60679	-26.680	60679	-26.680	60679	-26.680	3	0.015
25	60878	-25.585	60879	-25.582	60880	-25.576	60880	-25.576	2	0.009
26	61080	-24.475	61079	-24.483	61080	-24.478	61080	-24.478	-1	-0.003
27	61283	-23.365	61281	-23.373	61281	-23.373	61281	-23.373	-2	-0.008
28	61485	-22.255	61484	-22.258	61485	-22.253	61485	-22.253	0	0.002
29	61687	-21.145	61689	-21.132	61689	-21.132	61689	-21.132	2	0.013
30	61889	-20.035	61890	-20.028	61890	-20.028	61890	-20.028	1	0.007
31	62091	-18.925	62089	-18.935	62090	-18.929	62090	-18.929	-1	-0.004
32	62293	-17.815	62291	-17.825	62291	-17.825	62291	-17.825	-2	-0.010
33	62495	-16.705	62494	-16.710	62495	-16.705	62495	-16.705	0	0.000
34	62697	-15.595	62698	-15.590	62699	-15.584	62699	-15.584	2	0.011
35	62899	-14.485	62899	-14.485	62900	-14.480	62900	-14.480	1	0.005
36	63101	-13.375	63099	-13.387	63100	-13.381	63100	-13.381	-1	-0.006
37	63303	-12.265	63301	-12.277	63302	-12.272	63302	-12.272	-1	-0.007
38	63505	-11.155	63505	-11.157	63506	-11.151	63506	-11.151	0	0.004
39	63707	-10.045	63710	-10.031	63710	-10.031	63710	-10.031	3	0.014
40	63909	-8.935	63910	-8.932	63911	-8.926	63911	-8.926	1	0.009
41	64112	-7.825	64110	-7.833	64110	-7.833	64110	-7.833	-2	-0.008

Figure 35: Scan Angle

4.1.8.5 SDE Glitch Check

The SDE Glitch check checks angle errors real-time. It is used to see each angle error graphically to determine patterns in angle error.

4.1.8.6 Scan Time Analysis

The Scan Time Analysis calculates the scan times of 30 scans and displays the times between each scan. See Figure 36:.

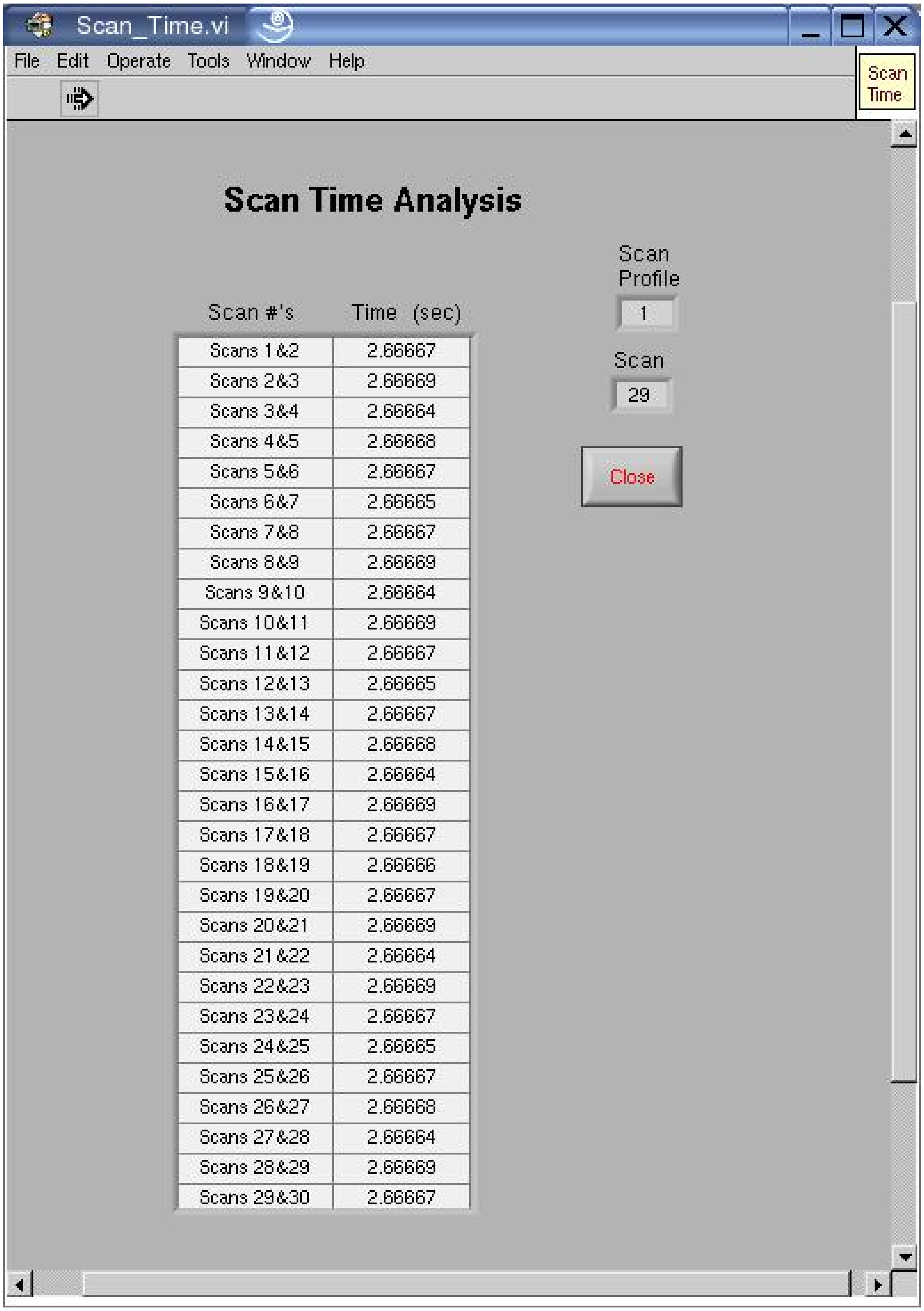
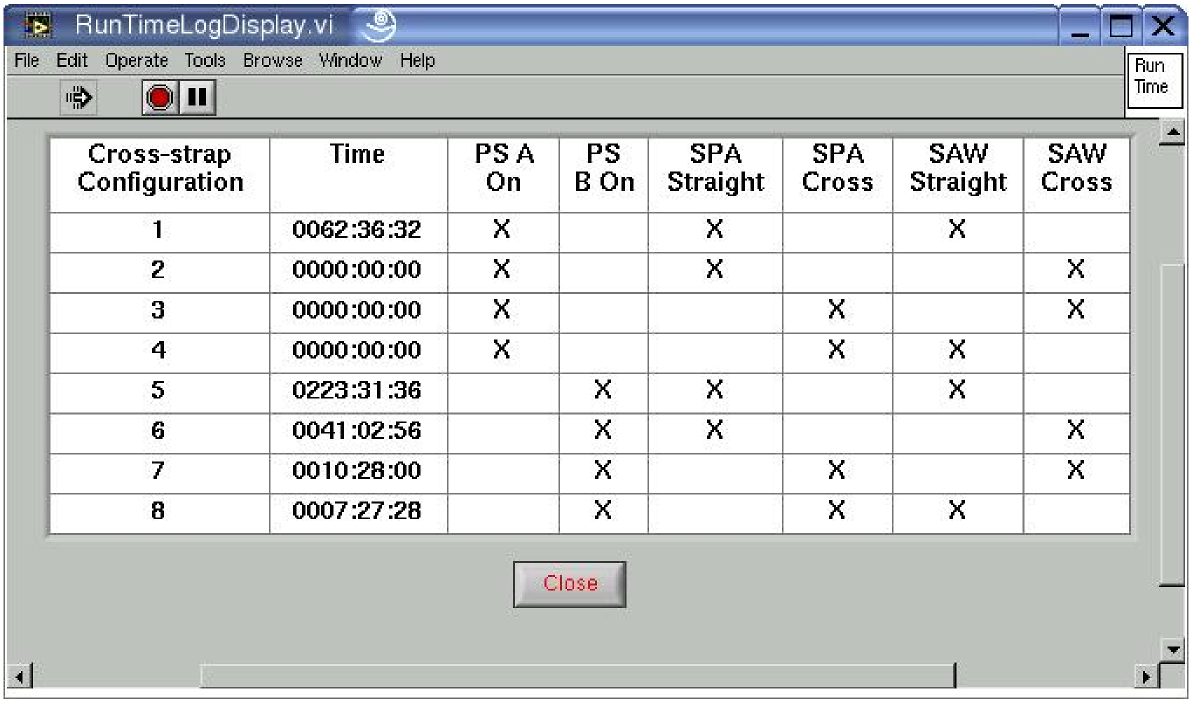


Figure 36: Scan Time Analysis

4.2 Run-Time Log

The Run-Time Log display is used to display the instrument's run-times in each of the 8 redundancy configurations. See Figure 37: below.



Cross-strap Configuration	Time	PS A On	PS B On	SPA Straight	SPA Cross	SAW Straight	SAW Cross
1	0062:36:32	X		X		X	
2	0000:00:00	X		X			X
3	0000:00:00	X			X		X
4	0000:00:00	X			X	X	
5	0223:31:36		X	X		X	
6	0041:02:56		X	X			X
7	0010:28:00		X		X		X
8	0007:27:28		X		X	X	

Figure 37: Run Time Log

4.3 Text Displays

Text display allows the user to select and print instrument telemetry packets. Telemetry which can be displayed are:

1. Science
2. HotCal
3. Calibration
4. Dwell
5. Diagnostic
6. Housekeeping

The data can also be saved as a formatted text file (Save button). When the Housekeeping display is selected the displayed data is also sent to a formatted Excel '.csv' file which is used to trend housekeeping telemetry during Thermal Cycling and Thermal Vacuum Calibration tests.

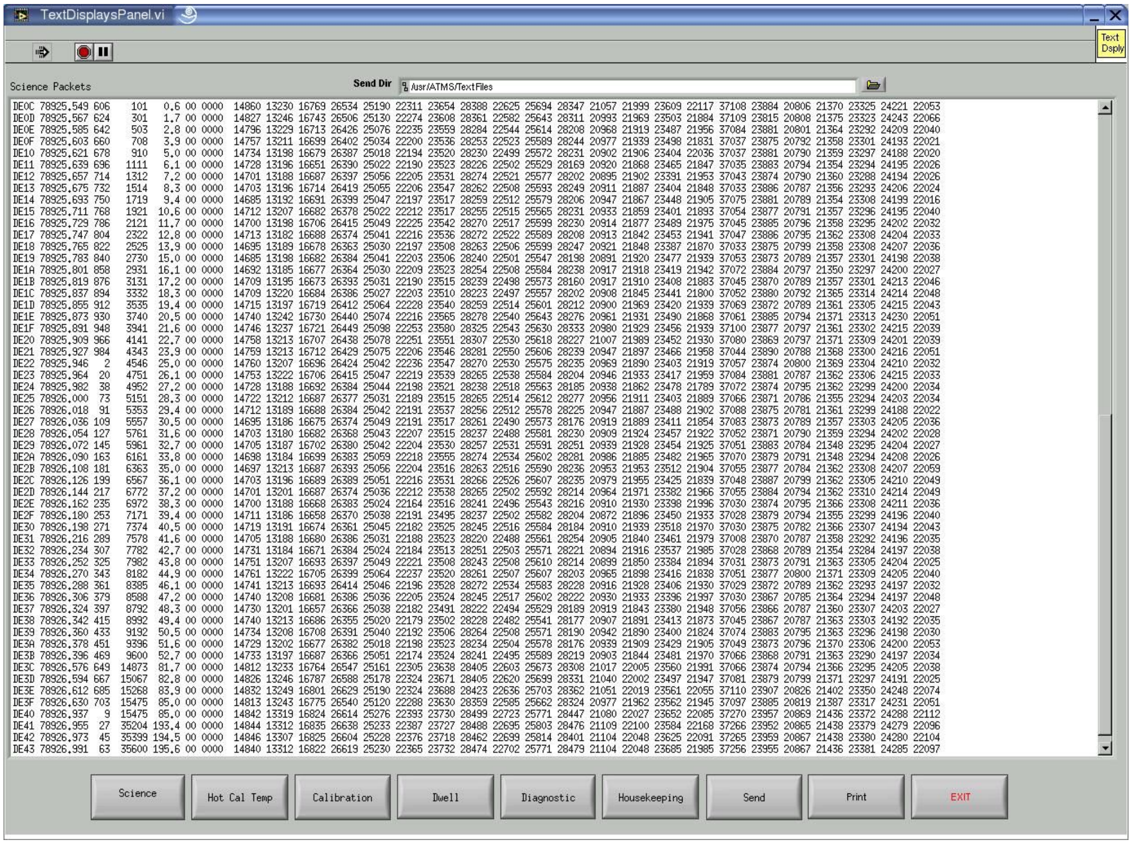


Figure 38: Text Display Example (Science Data)

4.4 Calibration

The calibration button allows the user to select 3 routines:

1. Ambient Calibration – Used to give a rough calculation of Gain and NEΔT
2. CalVac Collection – Collects data to be analyzed by CalVac Analysis and validates science and temperature data over the time of collection.
3. CalVac Analysis – Performs Gain, NEΔT and Accuracy calculations to evaluate instrument performance over the required range of baseplate and target temperatures

4.4.1 Ambient Calibration

The Ambient Calibration routine is normally run for 111 scans using a cold bucket filled with LN_2 . It is used to get a rough performance measurements. It is also run hourly during Thermal Cycle and Thermal Vacuum Calibration testing to acquire trending data. The Ambient Calibration screen is illustrated in Figure 39:.

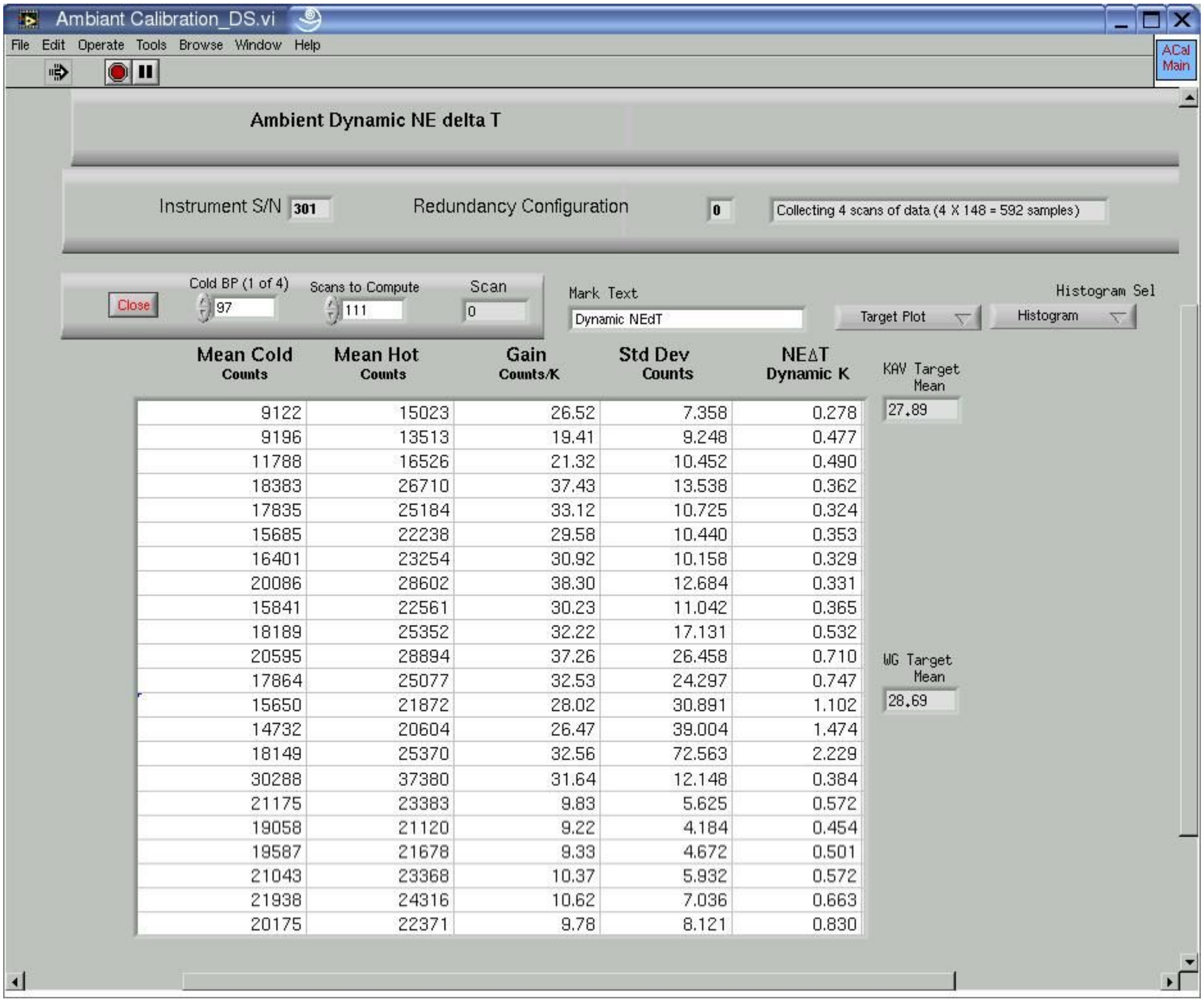


Figure 39: Ambient Calibration Display

4.4.2 CalVac Collection

The CalVac Collection routine collects data to be analyzed by CalVac Analysis and validates science and temperature data over the time of collection. For normal operation 278 full scans are required. Because CTE and Housekeeping data are logged only once in 9 seconds (3 scans) another 3 scans are collected (281) to make sure enough data is available to analyze. The display shows the CTE PRT temperatures along with the variance of the worst PRT and its identification.

See Figure 40.

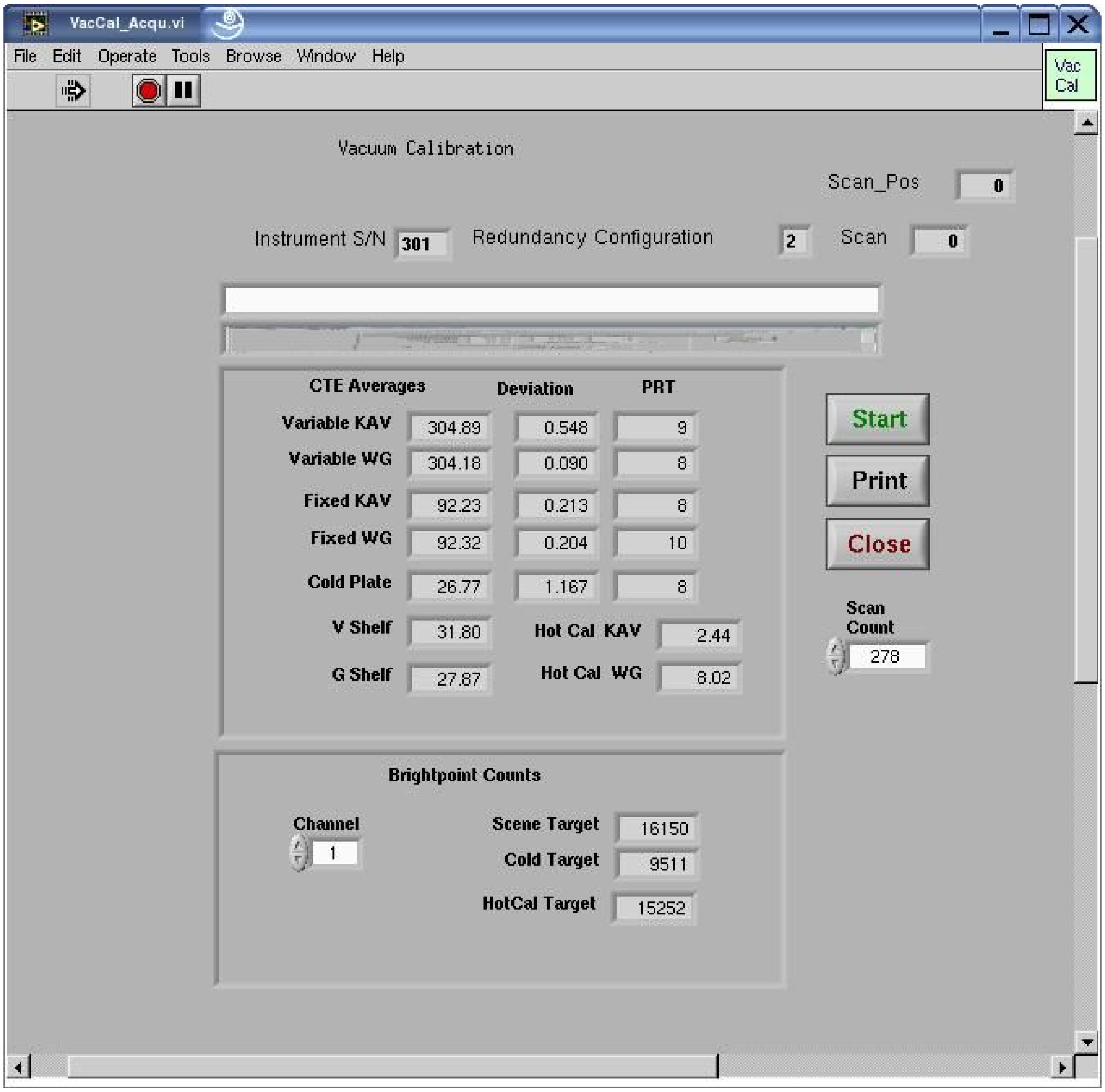


Figure 40: CalVac Collecton

4.4.3 CalVac Analysis

The CalVac Analysis performs Gain, NEΔT and Accuracy calculations to evaluate instrument performance over the required range of baseplate and target temperatures. Refer to Appendix A for a detailed explanation of the processing algorithms. Refer to ***AE-26842C System Calibration Test Procedure*** for a detailed description of the test procedures.

This routine, although run as part of the STE software is a separate routine which can be run by itself with the STE in any mode, even Off mode. When run the user is prompted for a logfile. If the CalVac Collection routine was used to acquire the data there will be displayed marks in the file where the specific data starts and ends. Once the software is given a place to start it will process 278 scans of data and generate an HTML formatted report. The report is automatically saved in the logfile directory and can be printed on the SysTE printer.

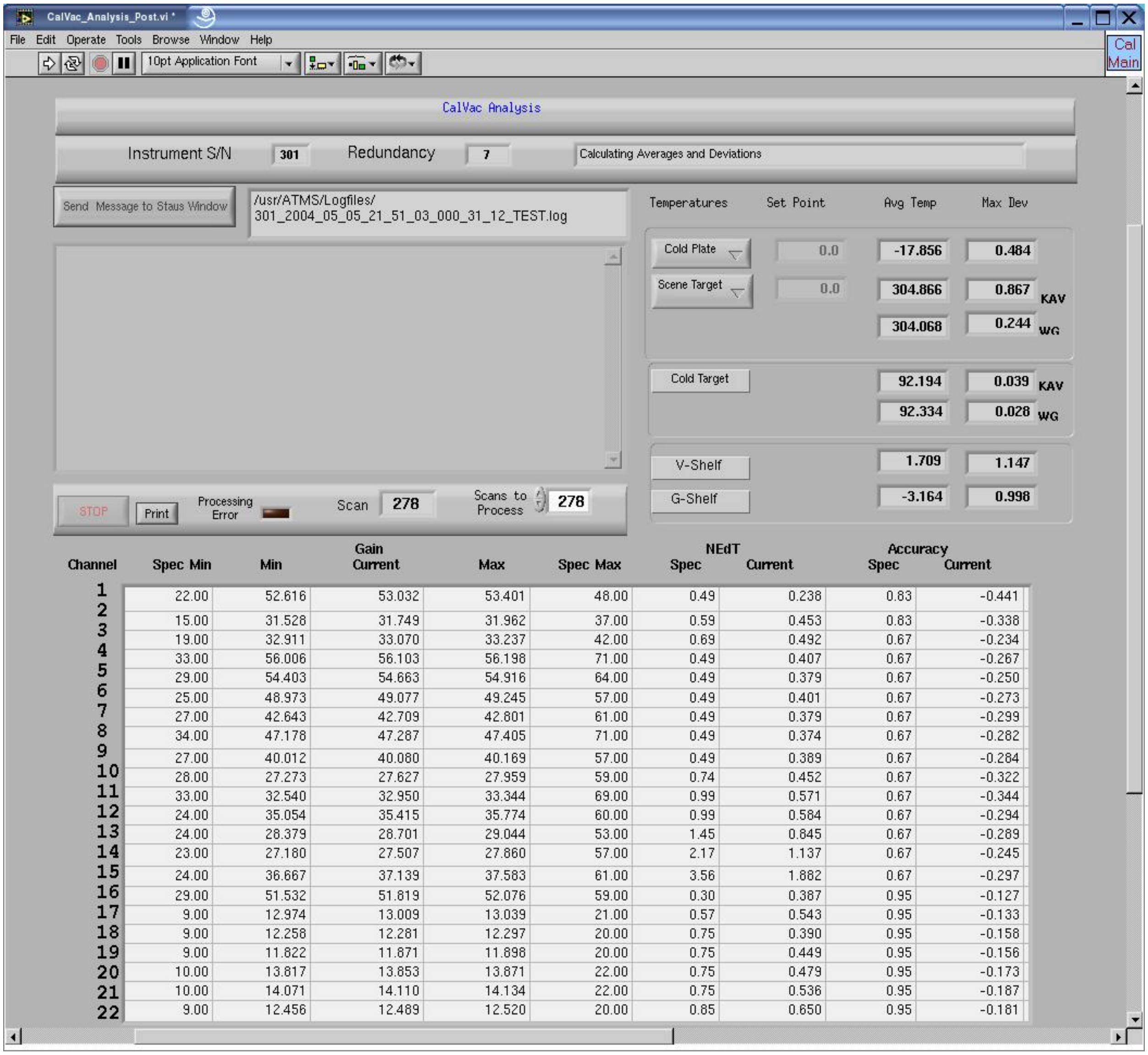


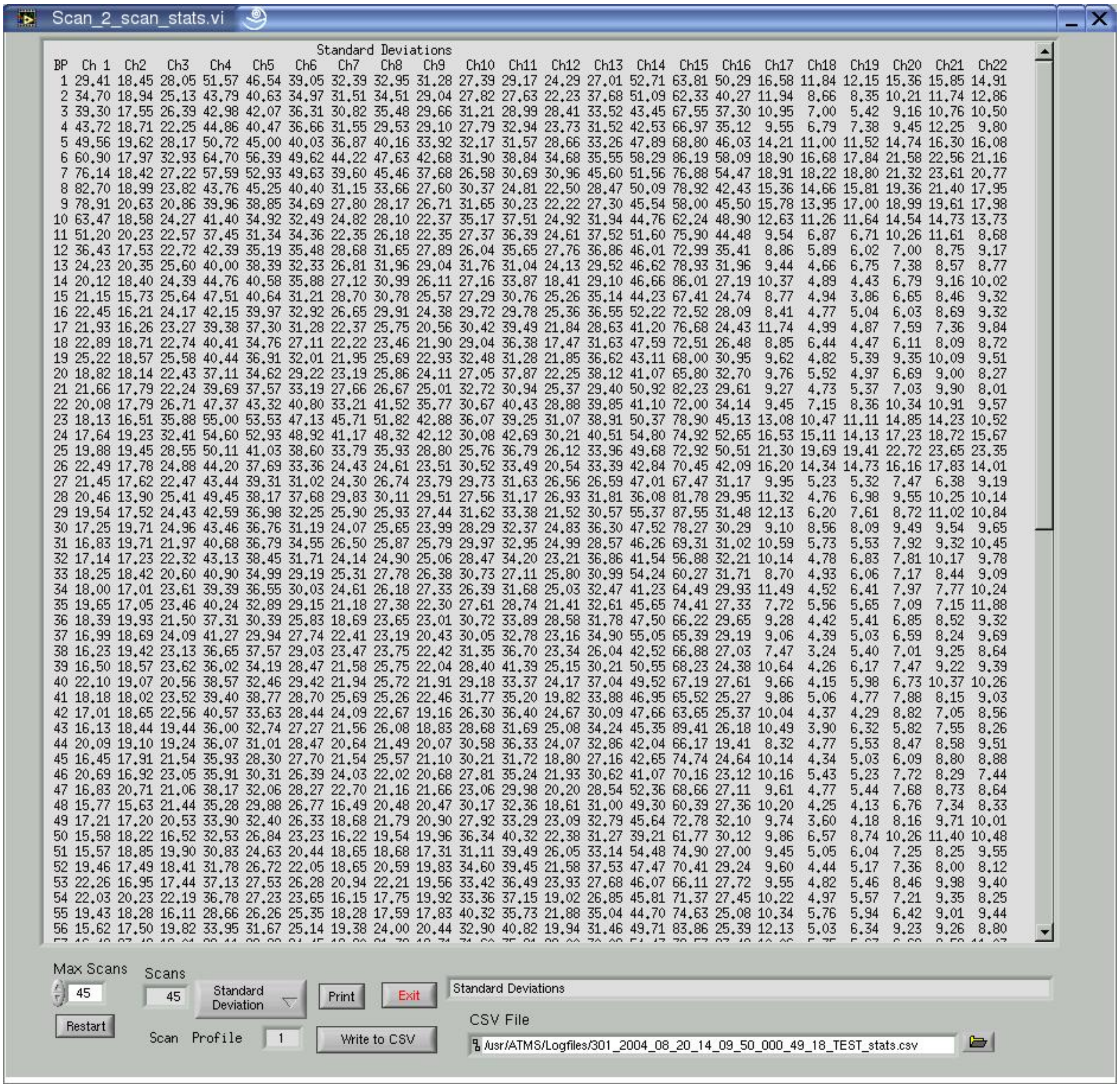
Figure 41: CalVac Analysis

4.5 Statistics

The Statistics routine is used to perform calculations on real-time data or data read in Playback mode. There are four displays:

1. Standard Deviation – Calculates and displays the standard deviation of each of the 22 channels at 104 beam positions over the variable sampling interval. See Figure 42: Statistics Display Example (Standard Deviation)
2. Scan to Scan Differences – Calculates and displays the difference in counts from one scan to the next for all 22 channels at 104 beam positions over the variable sampling interval.

3. Mean Counts – Calculates and displays the mean counts of each of the 22 channels at 104 beam positions over the variable sampling interval.
4. Scan Angle Analysis – Performs a scan angle analysis, similar to the analysis described in section 4.1.8.4.



BP	Ch 1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15	Ch16	Ch17	Ch18	Ch19	Ch20	Ch21	Ch22
1	29.41	18.45	28.05	51.57	46.54	39.05	32.39	32.95	31.28	27.39	29.17	24.29	27.01	52.71	63.81	50.29	16.58	11.84	12.15	15.36	15.85	14.91
2	34.70	18.94	25.13	43.79	40.63	34.97	31.51	34.51	29.04	27.82	27.63	22.23	37.68	51.09	62.33	40.27	11.94	8.66	8.35	10.21	11.74	12.86
3	39.30	17.55	26.39	42.98	42.07	36.31	30.82	35.48	29.66	31.21	28.99	28.41	33.52	43.45	67.55	37.30	10.95	7.00	5.42	9.16	10.76	10.50
4	43.72	18.71	22.25	44.86	40.47	36.66	31.55	29.53	29.10	27.79	32.94	23.73	31.52	42.53	66.97	35.12	9.55	6.79	7.38	9.45	12.25	9.80
5	49.56	19.62	28.17	50.72	45.00	40.03	36.87	40.16	33.92	32.17	31.57	28.66	33.26	47.89	68.80	46.03	14.21	11.00	11.52	14.74	16.30	16.08
6	60.90	17.97	32.93	64.70	56.39	49.62	44.22	47.63	42.68	31.90	38.84	34.68	35.55	58.29	86.19	58.09	18.90	16.68	17.84	21.58	22.56	21.16
7	76.14	18.42	27.22	57.59	52.93	49.63	39.60	45.46	37.68	26.58	30.69	30.96	45.60	51.56	76.88	54.47	18.91	18.22	18.80	21.32	23.61	20.77
8	82.70	18.99	23.82	43.76	45.25	40.40	31.15	33.66	27.60	30.37	24.81	22.50	28.47	50.09	78.92	42.43	15.36	14.66	15.81	19.36	21.40	17.95
9	78.91	20.63	20.86	39.96	38.85	34.69	27.80	28.17	26.71	31.65	30.23	22.22	27.30	45.54	58.00	45.50	15.78	13.95	17.00	18.99	19.61	17.98
10	63.47	18.58	24.27	41.40	34.92	32.49	24.82	28.10	22.37	35.17	37.51	24.92	31.94	44.76	62.24	48.90	12.63	11.26	11.64	14.54	14.73	13.73
11	51.20	20.23	22.57	37.45	31.34	34.36	22.35	26.18	22.35	27.37	36.39	24.61	37.52	51.60	75.90	44.48	9.54	6.87	6.71	10.26	11.61	8.68
12	36.43	17.53	22.72	42.39	35.19	35.48	28.68	31.65	27.89	26.04	35.65	27.76	36.86	46.01	72.99	35.41	8.86	5.89	6.02	7.00	8.75	9.17
13	24.23	20.35	25.60	40.00	38.39	32.33	26.81	31.96	29.04	31.76	31.04	24.13	29.52	46.62	78.93	31.96	9.44	4.66	6.75	7.38	8.57	8.77
14	20.12	18.40	24.39	44.76	40.58	35.88	27.12	30.99	26.11	27.16	33.87	18.41	29.10	46.66	86.01	27.19	10.37	4.89	4.43	6.79	9.16	10.02
15	21.15	15.73	25.64	47.51	40.64	31.21	28.70	30.78	25.57	27.29	30.76	25.26	35.14	44.23	67.41	24.74	8.77	4.94	3.86	6.65	8.46	9.32
16	22.45	16.21	24.17	42.15	39.97	32.92	26.65	29.91	24.38	29.72	29.78	25.36	36.55	52.22	72.52	28.09	8.41	4.77	5.04	6.03	8.69	9.32
17	21.93	16.26	23.27	39.38	37.30	31.28	22.37	25.75	20.56	30.42	39.49	21.84	28.63	41.20	76.68	24.43	11.74	4.99	4.87	7.59	7.36	9.84
18	22.89	18.71	22.74	40.41	34.76	27.11	22.22	23.46	21.90	29.04	36.38	17.47	31.63	47.59	72.51	26.48	8.85	6.44	4.47	6.11	8.09	8.72
19	25.22	18.57	25.58	40.44	36.91	32.01	21.95	25.69	22.93	32.48	31.28	21.85	36.62	43.11	68.00	30.95	9.62	4.82	5.39	9.35	10.09	9.51
20	18.82	18.14	22.43	37.11	34.62	29.22	23.19	25.86	24.11	27.05	37.87	22.25	38.12	41.07	65.80	32.70	9.76	5.52	4.97	6.69	9.00	8.27
21	21.66	17.79	22.24	39.69	37.57	33.19	27.66	26.67	25.01	32.72	30.94	25.37	29.40	50.92	82.23	29.61	9.27	4.73	5.37	7.03	9.90	8.01
22	20.08	17.79	26.71	47.37	43.32	40.80	33.21	41.52	35.77	30.67	40.43	28.88	39.85	41.10	72.00	34.14	9.45	7.15	8.36	10.34	10.91	9.57
23	18.13	16.51	35.88	55.00	53.53	47.13	45.71	51.82	42.88	36.07	39.25	31.07	38.91	50.37	78.90	45.13	13.08	10.47	11.11	14.85	14.23	10.52
24	17.64	19.23	32.41	54.60	52.93	48.92	41.17	48.32	42.12	30.08	42.69	30.21	40.51	54.80	74.92	52.65	16.53	15.11	14.13	17.23	18.72	15.67
25	19.88	19.45	28.55	50.11	41.03	38.60	33.79	35.93	28.80	25.76	36.79	26.12	33.96	49.68	72.92	50.51	21.30	19.69	19.41	22.72	23.65	23.35
26	22.49	17.78	24.88	44.20	37.69	33.36	24.43	24.61	23.51	30.52	33.49	20.54	33.39	42.84	70.45	42.09	16.20	14.34	14.73	16.16	17.83	14.01
27	21.45	17.62	22.47	43.44	39.31	31.02	24.30	26.74	23.79	29.73	31.63	26.56	26.59	47.01	67.47	31.17	9.95	5.23	5.32	7.47	6.38	9.19
28	20.46	13.90	25.41	49.45	38.17	37.68	29.83	30.11	29.51	27.56	31.17	26.93	31.81	36.08	81.78	29.95	11.32	4.76	6.98	9.55	10.25	10.14
29	19.54	17.52	24.43	42.59	36.98	32.25	25.90	25.93	27.44	31.62	33.38	21.52	30.57	55.37	87.55	31.48	12.13	6.20	7.61	8.72	11.02	10.84
30	17.25	19.71	24.96	43.46	36.76	31.19	24.07	25.65	23.99	28.29	32.37	24.83	36.30	47.52	78.27	30.29	9.10	8.56	8.09	9.49	9.54	9.65
31	16.83	19.71	21.97	40.68	36.79	34.55	26.50	25.87	25.79	29.97	32.95	24.99	28.57	46.26	69.31	31.02	10.59	5.73	5.53	7.92	9.32	10.45
32	17.14	17.23	22.32	43.13	38.45	31.71	24.14	24.90	25.06	28.47	34.20	23.21	36.86	41.54	56.88	32.21	10.14	4.78	6.83	7.81	10.17	9.78
33	18.25	18.42	20.60	40.90	34.99	29.19	25.31	27.78	26.38	30.73	27.11	25.80	30.99	54.24	60.27	31.71	8.70	4.93	6.06	7.17	8.44	9.09
34	18.00	17.01	23.61	39.39	36.55	30.03	24.61	26.18	27.33	26.39	31.68	25.03	32.47	41.23	64.49	29.93	11.49	4.52	6.41	7.97	7.77	10.24
35	19.65	17.05	23.46	40.24	32.89	29.15	21.18	27.38	22.30	27.61	28.74	21.41	32.61	45.65	74.41	27.33	7.72	5.56	5.65	7.09	7.15	11.88
36	18.39	19.93	21.50	37.31	30.39	25.83	18.69	23.65	23.01	30.72	33.89	28.58	31.78	47.50	66.22	29.65	9.28	4.42	5.41	6.85	8.52	9.32
37	16.99	18.69	24.09	41.27	29.94	27.74	22.41	23.19	20.43	30.05	32.78	23.16	34.90	55.05	65.39	29.19	9.06	4.39	5.03	6.59	8.24	9.69
38	16.23	19.42	23.13	36.65	37.57	29.03	23.47	23.75	22.42	31.35	36.70	23.34	26.04	42.52	66.88	27.03	7.47	3.24	5.40	7.01	9.25	8.64
39	16.50	18.57	23.62	36.02	34.19	28.47	21.58	25.75	22.04	28.40	41.39	25.15	30.21	50.55	68.23	24.38	10.64	4.26	6.17	7.47	9.22	9.39
40	22.10	19.07	20.56	38.57	32.46	29.42	21.94	25.72	21.91	29.18	33.37	24.17	37.04	49.52	67.19	27.61	9.66	4.15	5.98	6.73	10.37	10.26
41	18.18	18.02	23.52	39.40	38.77	28.70	25.69	25.26	22.46	31.77	35.20	19.82	33.88	46.95	65.52	25.27	9.86	5.06	4.77	7.88	8.15	9.03
42	17.01	18.65	22.56	40.57	33.63	28.44	24.09	22.67	19.16	26.30	36.40	24.67	30.09	47.66	63.65	25.37	10.04	4.37	4.29	8.82	7.05	8.56
43	16.13	18.44	19.44	36.00	32.74	27.27	21.56	26.08	18.83	28.68	31.69	25.08	34.24	45.35	89.41	26.18	10.49	3.90	6.32	5.82	7.55	8.26
44	20.09	19.10	19.24	36.07	31.01	28.47	20.64	21.49	20.07	30.58	36.33	24.07	32.86	42.04	66.17	19.41	8.32	4.77	5.53	8.47	8.58	9.51
45	16.45	17.91	21.54	35.93	28.30	27.70	21.54	25.57	21.10	30.21	31.72	18.80	27.16	42.65	74.74	24.64	10.14	4.34	5.03	6.09	8.80	8.88
46	20.69	16.92	23.05	35.91	30.31	26.39	24.03	22.02	20.68	27.81	35.24	21.93	30.62	41.07	70.16	23.12	10.16	5.43	5.23	7.72	8.29	7.44
47	16.83	20.71	21.06	38.17	32.06	28.27	22.70	21.16	21.66	23.06	29.98	20.20	28.54	52.36	68.66	27.11	9.61	4.77	5.44	7.68	8.73	8.64
48	15.77	15.63	21.44	35.28	29.88	26.77	16.49	20.48	20.47	30.17	32.36	18.61	31.00	49.30	60.39	27.36	10.20	4.25	4.13	6.76	7.34	8.33
49	17.21	17.20	20.53	33.90	32.40	26.33	18.68	21.79	20.90	27.92	33.29	23.09	32.79	45.64	72.78	32.10	9.74	3.60	4.18	8.16	9.71	10.01
50	15.58	18.22	16.52	32.53	26.84	23.23	16.22	19.54	19.96	36.34	40.32	22.38	31.27	39.21	61.77	30.12	9.86	6.57	8.74	10.26	11.40	10.48
51	15.57	18.85	19.90	30.83	24.63	20.44	18.65	18.68	17.31	31.11	39.49	26.05	33.14	54.48	74.90	27.00	9.45	5.05	6.04	7.25	8.25	9.55
52	19.46	17.49	18.41	31.78	26.72	22.05	18.65	20.59	19.83	34.60	39.45	21.58	37.53	47.47	70.41	29.24	9.60	4.44	5.17	7.36	8.00	8.12
53	22.26	16.95	17.44	37.13	27.53	26.28	20.94	22.21	19.56	33.42	36.49	23.93	27.68	46.07	66.11	27.72	9.55	4.82	5.46	8.46	9.98	9.40
54	22.03	20.23	22.19	36.78	27.23	23.65	16.15	17.75	19.92	33.36	37.15	19.02	26.85	45.81	71.37	27.45	10.22	4.97	5.57	7.21	9.35	8.25
55	19.43	18.28	16.11	28.66	26.26	25.35	18.28	17.59	17.83	40.32	35.73	21.88	35.04	44.70	74.63	25.08	10.34	5.76	5.94	6.42	9.01	9.44
56	15.62	17.50	19.82	33.95	31.67	25.14	19.38	24.00	20.44	32.90	40.82	19.94	31.46	49.71	83.86	25.39	12.13	5.03	6.34	9.23	9.26	8.80

Figure 42: Statistics Display Example (Standard Deviation)

4.6 Mark

The Mark button simply allows the operator to insert a 'Mark' in the logfile. A 'mark' consists of a mark packet and an entry in the '.idx' file pointing to the inserted packet.

4.7 Scripts

The script processor is used in conjunction with the various analysis routines to perform the required instrument tests. The main functions of the script processor is to set the instrument into a required state, mark the log file at various points during the test and collect data for the required periods of time. Figure 43 illustrates the script operator display. Table XIII identifies the commands available for scripting and

Table XIV shows a sample script. To access the script processor, perform the following steps:

1. At the Main Display, Click the Script button.
2. At the Script Processor Display, select the script to run.
3. Click the Run button to initiate the script.
4. Click the Abort button to immediately terminate the script.
5. Click the Pause button to temporarily stop the script. Click the Run button to proceed.

Table XIII: Script Commands

Verb	Noun	Parameters	Comments
Command	CCSDS Command	See CDRL-048 Command List and Description	Commands sent over 1553B bus
Pulse	Pulse Command Name	None	Sends a Pulse command to digital output for a period of 70 ms.
Mark	Comment String	None	Adds a Mark CCSDS packet to the log file and adds a mark index to the index file. Marks are used to locate the results of test data quickly during playback.
Delay	Count	Optional Scan	Delays script execution for Count milliseconds. If the parameter Scan is entered Count is the number of scan times (8/3 seconds/scan) to delay
Verify	Signal Name	State 0 or 1	Verify the state of a digital input
Set	Digital Signal Name	State 0 or 1	Sets the state of a digital output. Note the Pulse command is equal to Set *name* 1 Delay 70 Set *name* 0
Pause	Comment String	None	Displays a Message Box containing the Comment String and stops the script execution until the operator mouse clicks on the message Box's Continue button
Compare	Telemetry	Word #, Value, Mask | Tolerance	Telemetry is the name of the packet to check, Housekeeping, Health&Status, etc. Word# is the index into the packet's data field, Value is the expected result. The Mask | Tolerance field is optional. Mask is a value to be ANDed with the telemetry word and consists of a hexadecimal constant in C hex format i.e. 0xabcd. Tolerance must be a positive decimal number. If the field to compare is an integer (ADC count values or reflector position, for example) Tolerance is assumed to be the number of counts the sampled value can be above or below Value. If Word# refers to a packet containing a field consisting of a voltage or temperature 4 word 'double', Tolerance should be a 'double' constant containing a decimal point. i.e. 0.1. If the

Verb	Noun	Parameters	Comments
			Mask | Tolerance field is not present Value must match exactly.
Wait	Telemetry	Word#, Value, Mask | Tolerance	Same as ‘Compare’ but the script execution pauses until the telemetry sample compares with Value applying the Mask or Tolerance.
TimeSynch	Function: OneSecPeriod EightSecPeriod OneSecMiss EightSecMiss TODMsgMiss Delay	Value: Period values in milliseconds Delay in milliseconds Miss refers to the number of consecutive pulses or TOD messages not to send.	Value is a decimal integer of milliseconds. One second corresponds to 1000 ms. Delay is defined as the nominal time between the TOD message and its corresponding time pulse and is only accurate to the defined poll period of the Time & Synchronization card. Pulse periods are accurate to the accuracy of the Time & Synchronization card’s crystal oscillator.
MemLoad	Filename		A predefined memory load file is transmitted to the instrument and its checksum verified.
GroundTest		Up to 32 16-bit hexadecimal addresses of the form 0xabcd	The addresses are sent to the instrument and the instrument will respond with the data at the provided addresses. The results are displayed in the status window in hexadecimal format
CTE	Target	Temperature	Sets a target temperature

Table XIV: Sample Script

Requirements for Script: Trend Data Collection	
This script commands the instrument to transmit science, hot cal temps, and diagnostic telemetry packets and scan using scan profile #1 for 112 scans.	
Script Trend_Data_Collection	
Mark "Trend Data Collection"	Marks data log to indicate start of test
Command CM 15 63 & hot	Command inst. to transmit science, cal, diagnostic, cal packets
Command SP 2	Select scan profile #1
Wait Command Status 2 SP	Waits until command status on scan profile selection is received
Compare Command Status 3 0	Confirm that the command status is "successful" before proceeding
Command SP 3	Execute scan profile #1
Delay 3 scans pulse	Allow scan to sync to new profile and 8-second
Mark "The data"	Marks data log to indicate good data for analysis
Delay 111 scans minutes)	Collect data for 112 scans (approximately 4.9
Mark "End Trend Data Collection"	Marks data log to indicate end of test

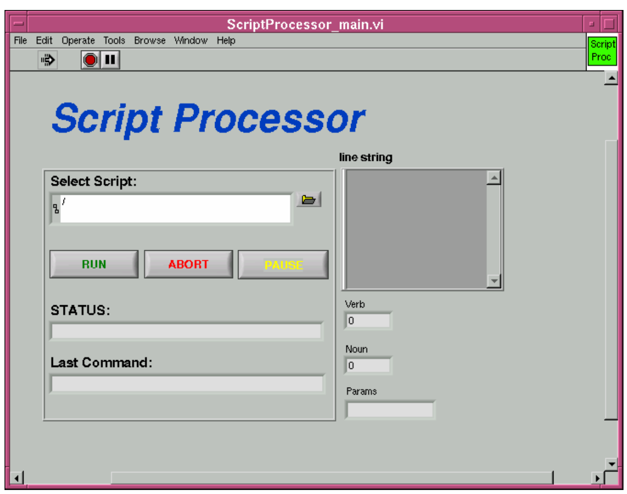


Figure 43: Script Processor Screen

4.8 Memory Load

The Memory Load button is used to load formatted memory load files to the ATMS instrument. The ATMS instrument has four memory types:

1. SPA Program RAM
2. SPA Data RAM
3. SPA EEPROM
4. Scan Drive Electronics (SDE) RAM

Memory Load files and detailed upload procedure can be found in ***AE-28183 Memory Upload Procedure for the Advanced Technology Microwave Sounder (ATMS)*** and ***Report 13942 Memory Interface User's Manual and Instrument Specific Data Load Procedure***. See Figure 44: Memory Load Display for an illustration of the user interface.

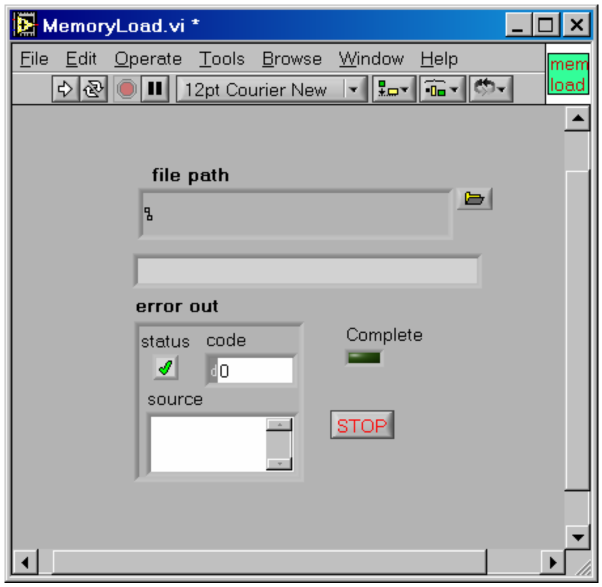


Figure 44: Memory Load Display

4.9 Memory Dump

The Memory Dump display is used to view internal ATMS memory. All four types of memory can be displayed by selecting one of the four memory types. An address and length must also be provided. The memory dump is shown as a 2 dimensional array with eight 16-bit words/row. See Figure 45: Memory Dump Display for an illustration of the user interface. Aditional information can be found in ***Report 13942 Memory Interface User's Manual and Instrument Specific Data Load Procedure***.

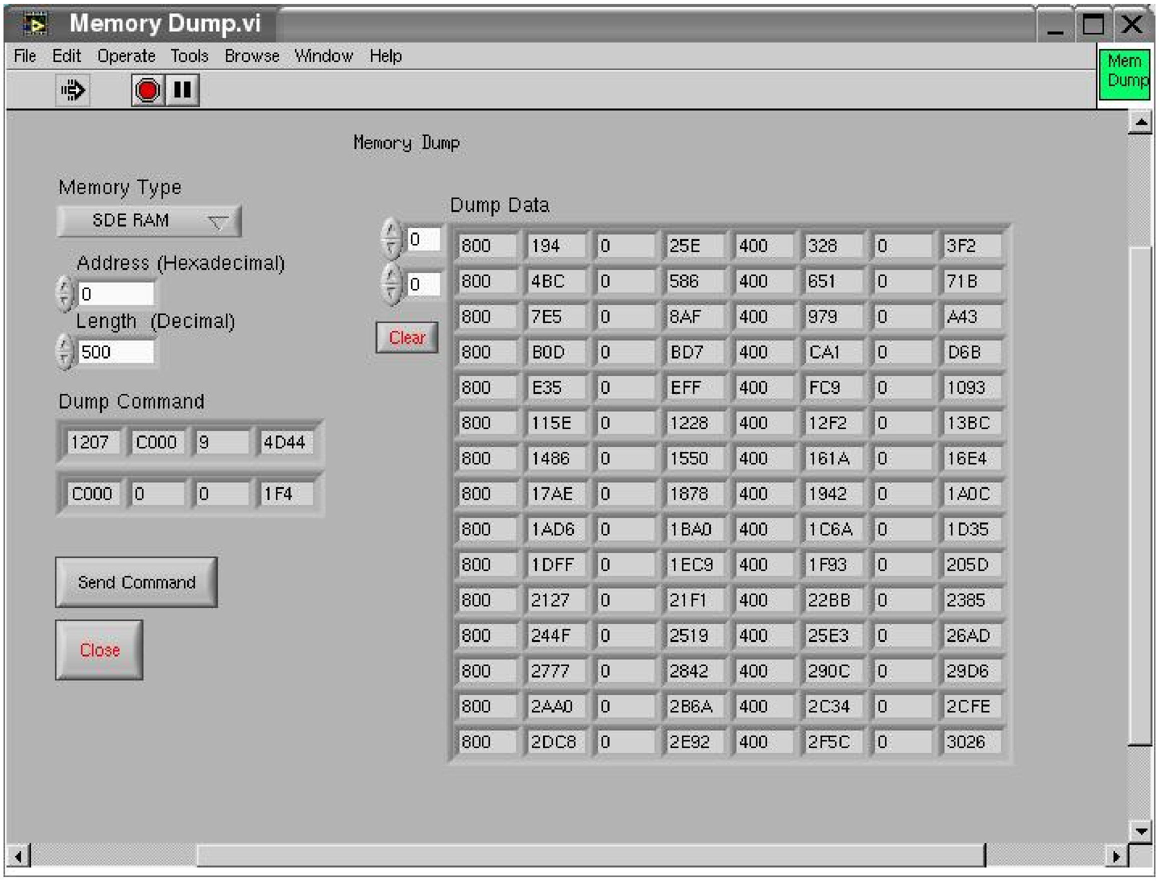


Figure 45: Memory Dump Display

4.10 Health and Status

Housekeeping data is displayed on the Health and Status Display. See Figure 46: Health and Status Screen . The operator is provided with the current state of the Receiver, Electronics and Scan Drive subsystems every eight seconds (3 scans). The telemetry values may be displayed in either ADC counts or engineering units. Instrument mode along with the date and time of the data is also displayed. The Health and Status window is displayed when the SysTE software is in any operational mode. The display is updated on the receipt of Housekeeping data packets read real-time from the instrument, relayed through the Spacecraft STE or read from a previously logged data file. If any telemetry values exceed the safety limits in the SysTE limits table, they will be highlighted either yellow, or red. If the value has exceeded the red limit, it will also sound an audible alarm.

1. The Health and Status display is automatically displayed on the screen upon entering instrument, playback, or spacecraft mode.
2. Engineering units are provided on the Health and Status display. To view the raw ADC counts use the ‘View Raw’ button to bring up the Raw Telemetry screen.
3. CTE data logging is enabled by using the ‘Log CTE’ switch

4. The Err Msg switch is used to display a Message box to the operator whenever a limit is exceeded. The operator must close all message boxes by manually hitting the OK button. All messages are logged to the ATMS logfile as well as error text sent to the text log file regardless of the state of the Err Msg switch..

Figure 46: Health and Status Screen

4.11 Control Panel

When Processor Lockout has been deselected, the SysTE software controls control panel operations. The software control panel becomes active and will accept inputs to send pulse commands to the instrument. Temperatures, voltages, bi-level statuses and alarms will also be displayed on the software control panel. The software control panel is illustrated in Figure 47. The software control panel is displayed in all modes except Idle, but it can be used to send pulse commands only during Instrument Logging On Mode. The Software Control Panel is similar to the hardware Control Panel described in section 3.2. The function of each control panel component is identical to its hardware counterpart.

1. To apply or remove operational power to the ATMS instrument, click on the Sensor DC power switch in the upper right section and slide to the desired position.
2. To apply or remove heater power to the ATMS instrument, click on the Heater DC power switch in the upper right section and slide to the desired position.
3. To send a pulse command to the ATMS instrument, click on the button next to the desired command.
4. To turn off an audible alarm, click on the STOP button at the bottom of the display.

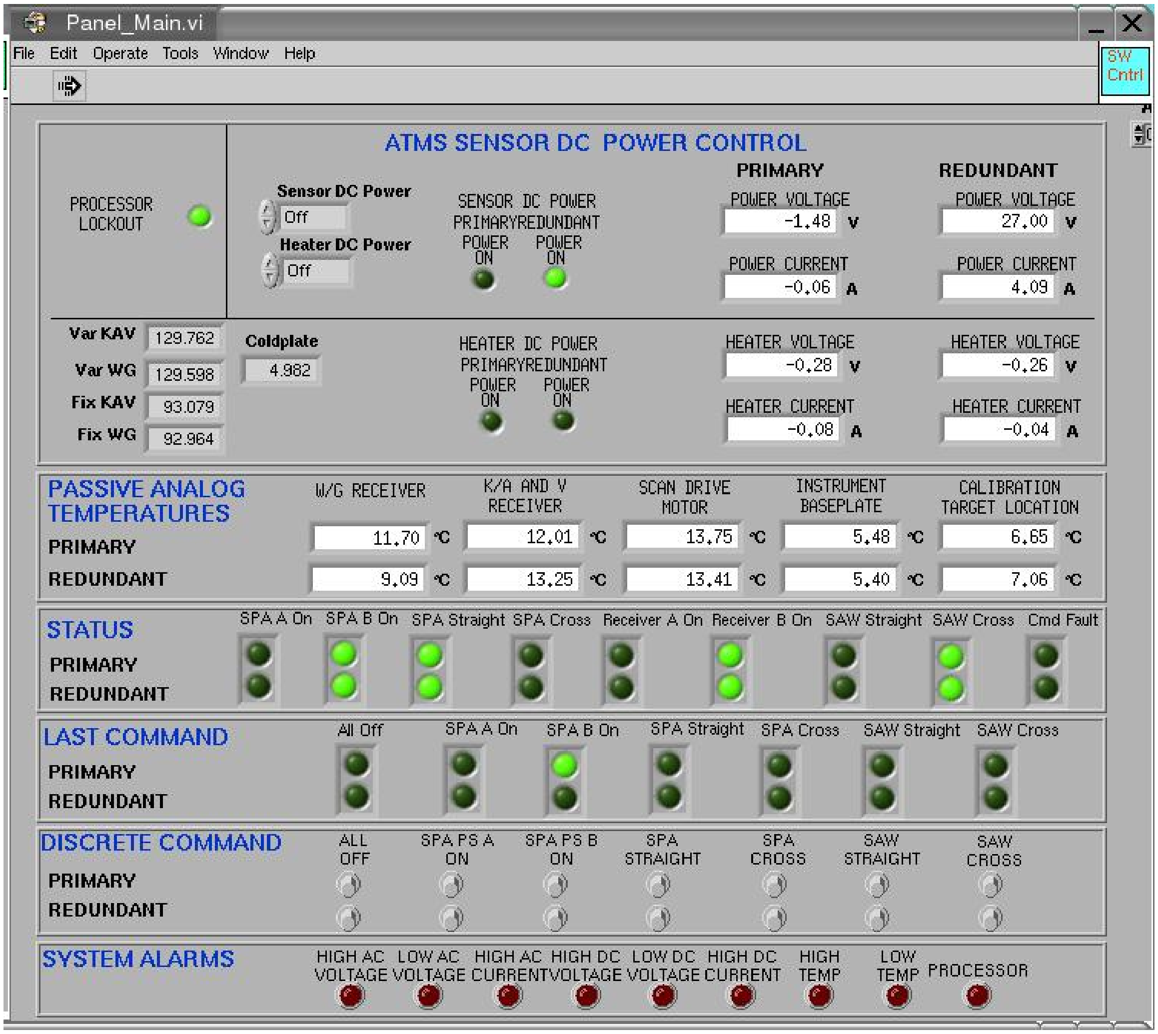


Figure 47: Software Control Panel

While the Software Control Panel is being displayed the STE logs ‘Passive Telemetry’ (214) and ‘Voltages and Currents’ (219) packets.

4.12 Data Logging

The major purpose of the Instrument Logging On Mode (and Spacecraft STE Mode) of operation is data collection. As soon as the operator selects the instrument serial number, all data received from and sent to the ATMS instrument and SysTE hardware components will be logged. If ‘Processor Lockout’ is selected from the hardwired Control Panel when a log file is active data CCSDS packets from the instrument will continue to be logged, however, pulse commands sent via the hardwired Control Panel will not be logged as ‘Pulse Command’ packets.

4.12.1 Command and Telemetry Process

For efficiency, all CCSDS/1553B telemetry is collected and logged via a separate Linux process. This process communicates with the main LabView software using a form of Inter-Process Communication (IPC) called a message queue. CCSDS/1553B commands and time-of-day messages are passed through to the command and telemetry process using the same message queue.

4.12.2 Command and Telemetry Logging

All data going to and coming from the ATMS Instrument, SysTE control panel and CTE equipment is logged. The logged data consists of CCSDS packets containing, in the secondary header, the time of the data's creation as a segmented UTC time. The vast majority of the data to be logged (ATMS CCSDS commands and telemetry) is received as CCSDS data. Other data such as pulse commands, SysTE status, CTE data, etc, are converted to CCSDS format prior to logging.

4.12.3 Time and Synchronization

The ATMS Instrument requires a one-second pulse (Time-of-Day or TOD) and eight-second pulse (Scan Synchronization). These pulses are generated by the custom Time and Synchronization PCI interface within the SysTE processor assembly. The Time and Synchronization hardware is monitored by the Command and Telemetry Process, which sends the Time-of-Day CCSDS broadcast message at the user defined time before the TOD pulse. It also monitors the 8-second pulse transmission and logs the eight-second pulse time.

4.13 Uploading Software

4.13.1 Memory Load

Data can be transferred to the ATMS instrument by issuing a Memory Load. Memory Loads are accomplished by sending a series of Memory Load CCSDS packets to the ATMS instrument. Memory Load commands have a different format from normal ATMS commands. Refer to ***Report 12114 CDRL-048 Advanced Technology Microwave Sounder (ATMS) Command List and Description*** for the format of the Memory Load command. Four areas of memory are capable of being loaded:

1. Data RAM
2. Program RAM
3. EEPROM
4. SDE RAM

4.13.2 Memory Dump

Data can be transferred from the ATMS instrument by issuing a Memory Dump command (opcode 'MD'). Refer to ***Report 12114 CDRL-048 Advanced Technology Microwave Sounder (ATMS) Command List and Description*** for the format of the Memory Dump command. Memory from any of the four memory areas listed above may be dumped. Memory Dump data is returned in 'Memory Dump' telemetry packets. Refer to ***Report 12115 CDRL-050 Advanced Technology Microwave Sounder (ATMS) Engineering Telemetry Description*** for the format of the Memory Dump telemetry packets. If science data collection is enabled, memory dumps may require more time due to the fact that the outgoing data must be throttled to conform with bandwidth limitations. The memory dump data packets will be logged in the data log file.

4.13.3 Memory Load Files

To simplify memory loads, a memory load file (MLF) will be used to perform memory loads to the ATMS instrument. Each MLF consists of one or more sets containing a memory load packet, a corresponding memory checksum command and a corresponding 16-bit checksum. The SysTE reads the files and sends each set's memory load packet, waits for a command status response, sends the memory checksum command, waits for the command status response and then verifies the checksum command's status response with the checksum read from the file. If an error is detected at any point, the operator will be notified by a standard error message box. A utility routine has been written to take a formatted Microsoft Excel 'CSV' file and construct a MLF file.

4.13.3.1 Utility Routines

4.13.4 BuildML

BuildML is used to build memory load files (MLF) having a '.ml' extension from CSV files containing the information to load. Refer to ***Report 13942 Memory Interface User's Manual and Instrument Specific Data Load Procedure*** for details. This routine exists in both a STE and PC versions. The STE version does not have a user interface. The program is run at the UNIX command prompt and just takes a single argument (the CSV file to convert):

buildml *csvfile*

The PC version is a windows program with a user interface as shown in Figure 48:.

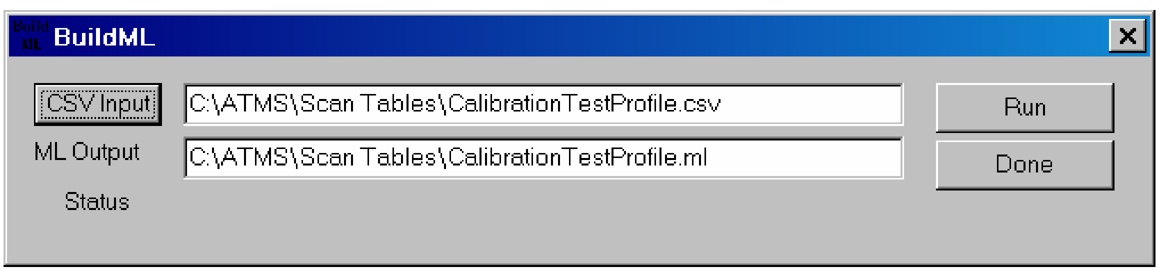


Figure 48: BuildML Display

Both routines create a '.ml' file in the same directory as the CSV source.

4.13.4.1.1 Displog

Displog is used to convert an ATMS logfile to a CSV file capable of being processed by EXCEL. As with BuildML there is a STE as well as a PC version. The STE version is executed from the UNIX command line:

displog *logfile*

The PC version of displog is shown in Figure 49:.

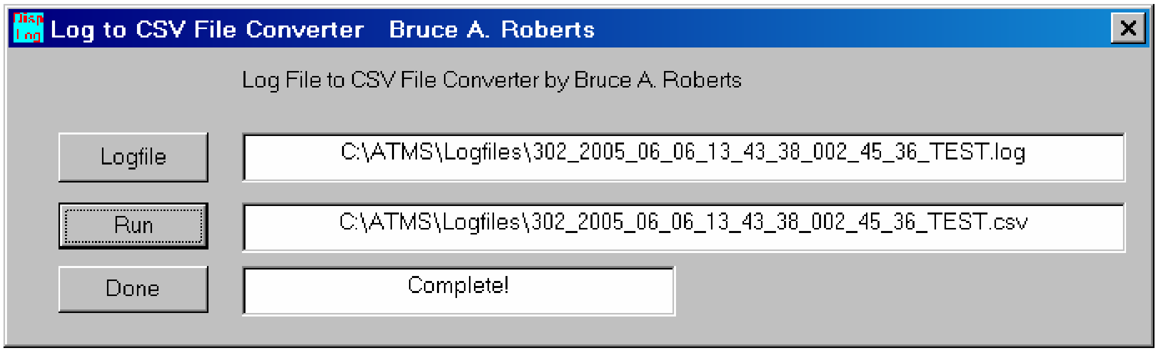


Figure 49: Displog Display

4.13.5 Plot Telemetry

Plot Telemetry is used to plot and analyze up to 2 hours worth of science and housekeeping telemetry. The operator first enters a logfile. If the logfile contains more that 2 hours (2700 scans) only the first 2700 scans will be read, otherwise the entire file will be processed.

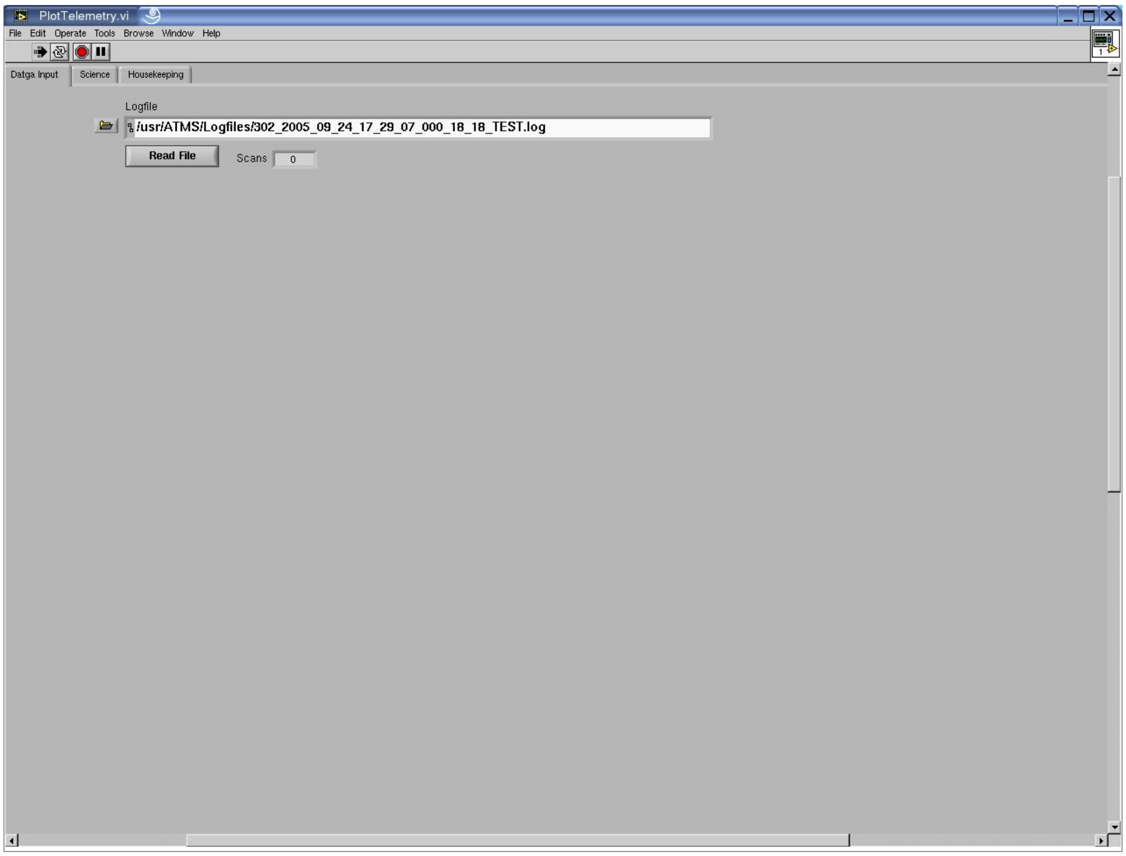


Figure 50: Plot Telemetry Logfile Selection Tab

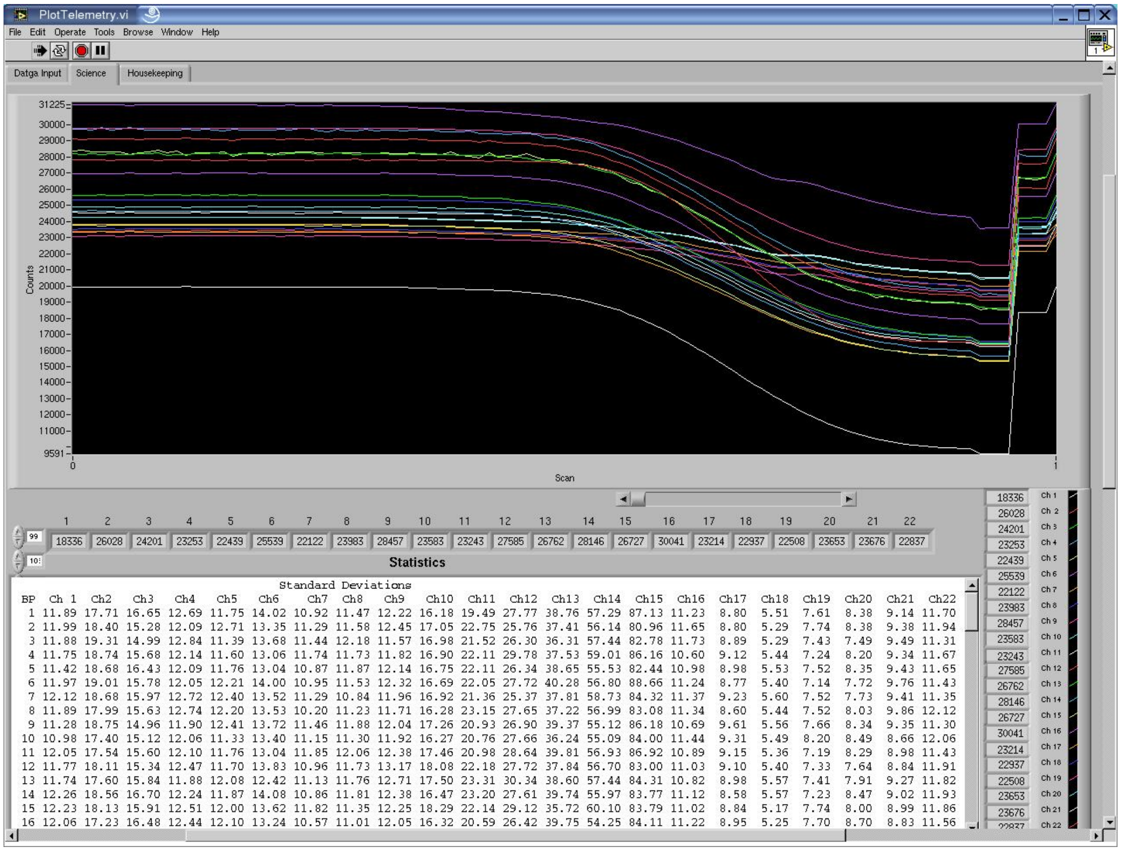


Figure 51: PlotTelemetry Science Display

From the Science display the operator can select either Standard Deviation, Scan to Scan Differences or Mean Counts. The graphic display can be zoomed or scrolled by changing the numbers on the scale limits. The values of any raw science can also be displayed.

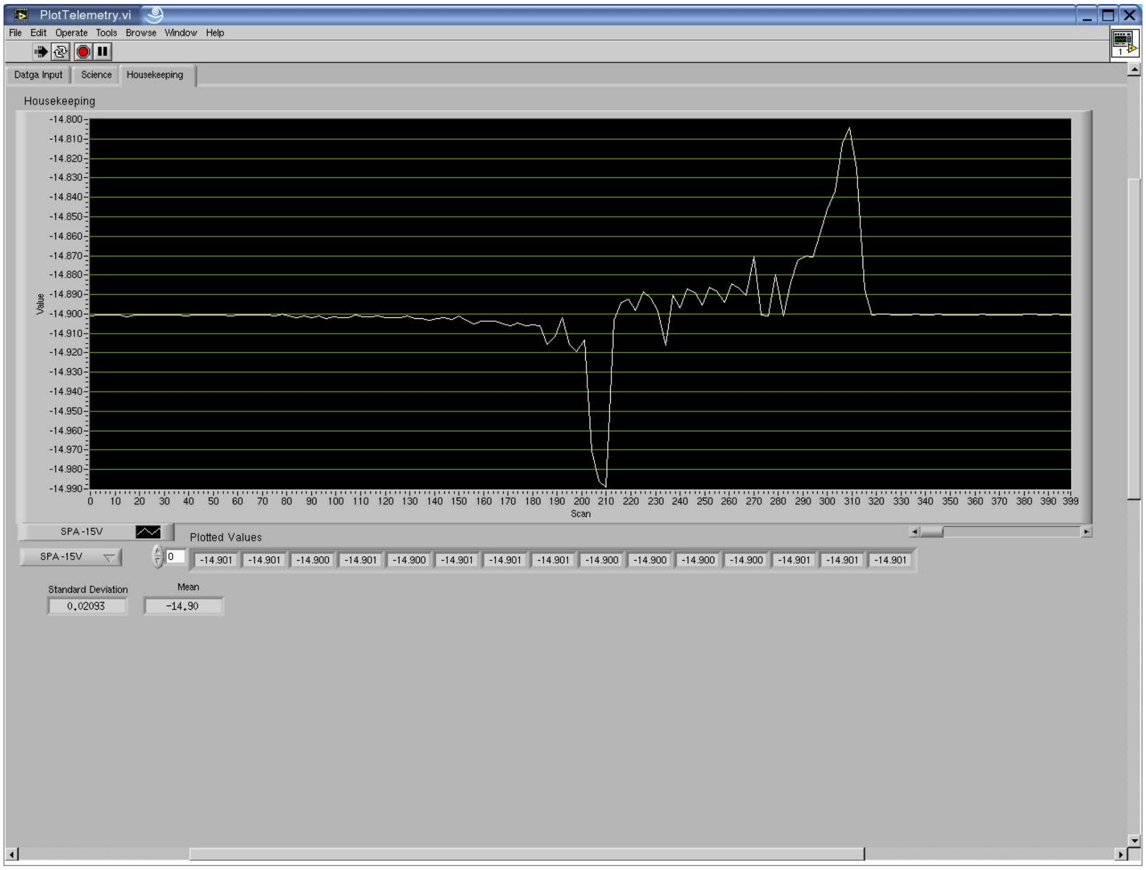


Figure 52: PlotTelemetry Housekeeping Display

Up to 2 hours of Housekeeping telemetry data can be plotted. As with the science data the display can be panned, scrolled, and zoomed. The standard deviation and mean of the data is also displayed.

4.13.6 Data Analysis Utility

The *Data Analysis Utility* was designed to function separately from the STE software. Due to its large memory and processing requirements it is not advised to operate it while the STE is collecting data. The *Data Analysis Utility* has been written as a stand-alone LabVIEW routine using ATMS log files as its primary input. The LabVIEW code acts as the user interface, plot and report generator. For optimization a C++/QT routine, *AnalysisExtract*, has been written to extract the specific log file[1] data requested. The *Data Analysis Utility* consists of a *DataAnalysisSelection* component, which selects science and housekeeping items to plot and/or report, plotting routines and report generation routines.

---

[1] The data requested can span one or several log files.

4.13.6.1 DataAnalysisSelection

The *DataAnalysisSelection* interface is shown in Figure 53:, Figure 54: andFigure 55:. It consists of a 'tab' area where Science or Housekeeping data can be added to the selection and a common area where selections are accumulated, log files and times are selected.

4.13.6.1.1 DataAnalysisSelection – Start Logfile

The *Start Logfile* control is used to provide an initial file for data analysis. Use the folder icon to the right of the text entry box to bring up a file selection dialog. Once a file is selected the default *Start Time* and *End Time* are set to the start and end times of the file. These times can be changed by the operator.

4.13.6.1.2 DataAnalysisSelection – Log File

The *Log File* indicator is used to display the log file (without the corresponding path information). When the *Start Logfile* option is used it is just the file name part of the selected file.

4.13.6.1.3 DataAnalysisSelection – Axes Types

The program is capable of plotting data with up to 5 different axes. While selecting data to plot/report this indicator is used to provide the operator feedback on the number of axes currently used. The axes define the Y-axis type, for example, Counts, Temperature, Volts or Amps. The Clear button can be used to clear all current selections.

4.13.6.1.4 DataAnalysisSelection – Start Time

The *Start Time* timestamp control is used to define the time of the beginning to the data to be plotted. It is usually initialized by selecting a *Start Logfile*, but can be changed by the operator.

4.13.6.1.5 DataAnalysisSelection – Duration

The *Duration* timestamp control is used to define the time range of the data to be plotted. It is usually initialized by selecting a *Start Logfile*. It is updated automatically to be equal to *End Time* minus *Start Time*. If it is manually changed by the operator the *End Time* is automatically updated to reflect the change in duration.

4.13.6.1.6 DataAnalysisSelection – End Time

The *End Time* timestamp control is used to define the time of the end to the data to be plotted. It is usually initialized by selecting a Start *Logfile*, but can be changed by the operator. If manually changed the Duration is automatically updated to reflect the change.

4.13.6.1.7 DataAnalysisSelection – Plot Data

The *Plot Data* button will initiate the data extraction and plotting functions.

4.13.6.1.8 DataAnalysisSelection – 2 Channel Difference

The *2 Cnannel Differences* checkbox is active when 2 science or 2 housekeeping selections are active. When selected it causes a difference plot to be generated.

4.13.6.1.9 DataAnalysisSelection – Exit

The *Exit* button exits the application.

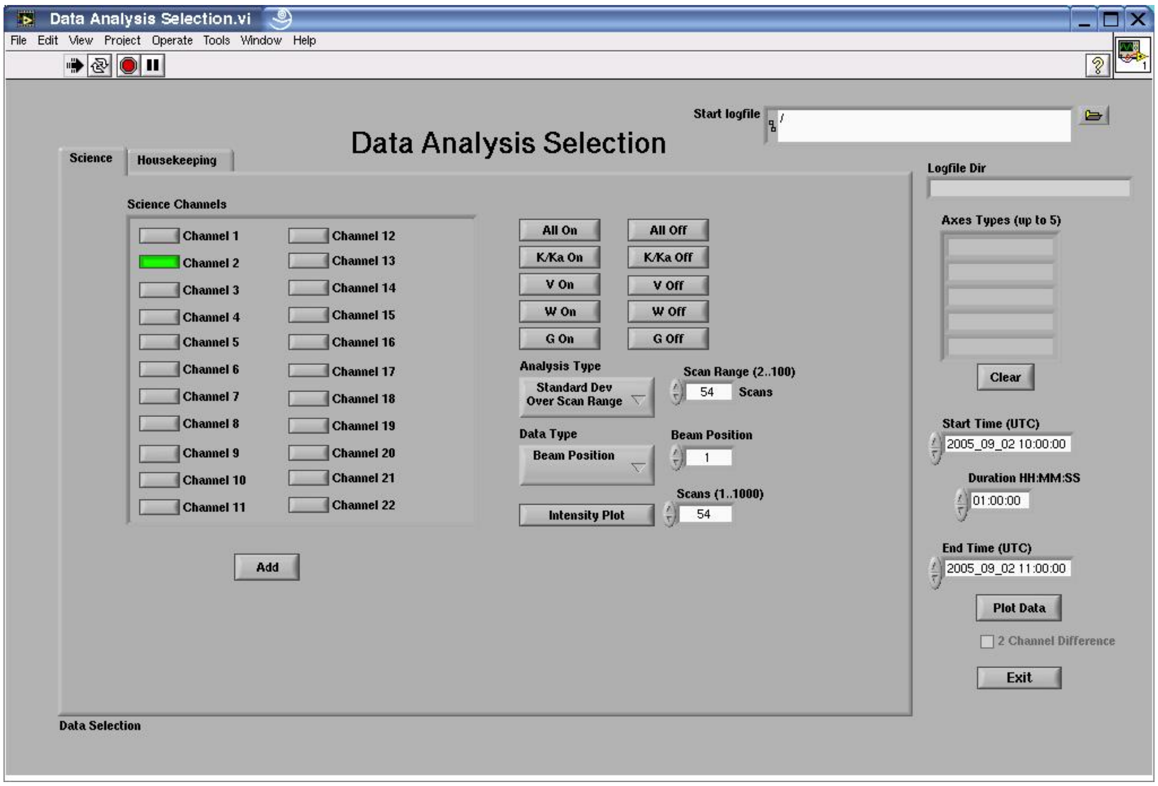


Figure 53: Science Data Selection User Interface

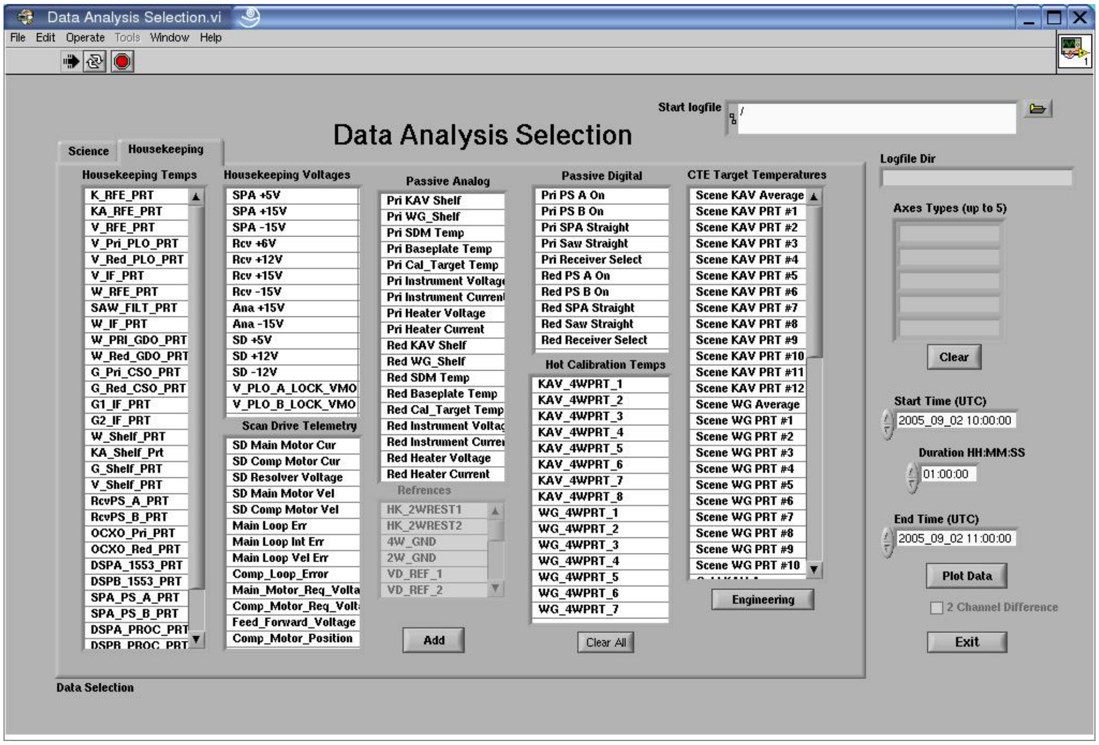


Figure 54: Housekeeping Data Selection (Engineering Units)

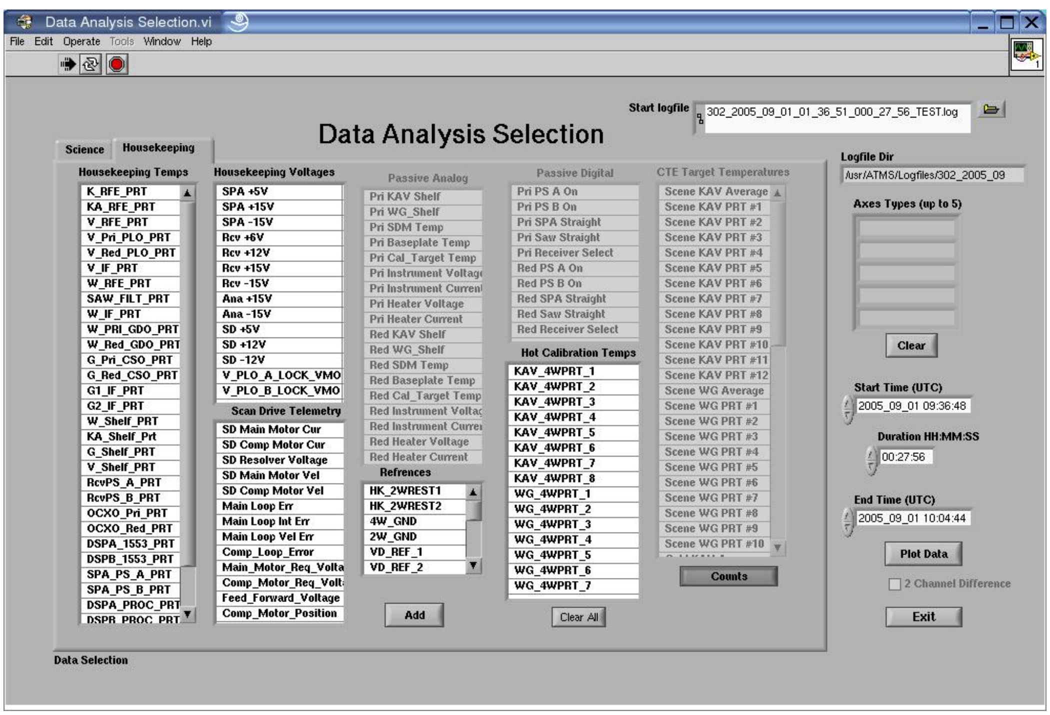


Figure 55: Housekeeping Data Selection (Counts)

4.13.6.2 DataAnalysisSelection – Science Data

Figure 53: Shows the interface for selecting science data to plot and/or report.

The Science Data tab contains buttons to allow the selection of science data channels, the Analysis Type and Data Type of the plots and/or reports. The is also a button to generate an Intensity plot[2] and a checkbox for 2 Channel Difference[3] plots. The *Add* button is used to add a selection to the list. Plots of different analysis and data types can be mixed in any combination by selecting new combinations and selecting *Add*.

4.13.6.2.1.1DataAnalysisSelection – Science Data – Channel

The individual channel buttons can be used to select channels in any combination. The buttons act as toggles and turn green when selected. There are also band selection buttons, which allow channels to be turned on and off by band as well as all on or all off.

4.13.6.2.1.1.1 DataAnalysisSelection – Science Data – Analysis Type

The Analysis Type can be one of the following:

1. Raw Counts – The data are displayed as counts received directly from the science data telemetry.
2. Scan to Scan Differences – Displays the difference in counts of each selected channel between the current scan and the one immediately preceding it.
3. Mean – Displays each channel’s mean over the required scan range.
4. Standard Deviation – Displays the standard deviation of each selected channel over the required scan range.
5. CSR Over Range – Displays the Column Scene Removed data for the selected channels over the required scan range.

4.13.6.2.1.1.2 DataAnalysisSelection – Science Data – Data Type

The Data Type is selected to be one of the following:

1. Beam Position – A single beam position 1 – 104.. (1-96 Earth, 97–100 Cold Calibration, 101-104 Hot Calibration)
2. Cold Calibration – For each scan the average of beam positions 97-100.
3. Hot Calibration – For each scan the average of beam positions 101-104
4. Hot – Cold – For each scan the average of 101-104 minus the average of 97-100.
5. All Beam Positions – This function is active when only a single channel is active and selects the plotting of a single channel over all beam positions 1-104.
6. All Earth Positions – Same as 5 but only positions 1-96

[2] Intensity plots can be selected when one and only one channel is selected.

[3] 2 Channel Difference plots can be generated when 2 channels or a single channel at 2 beam positions is selected.

7. All Cold Cal Positions – Same as 5 but only positons 97-100.
8. All Hot Cal Positions – Same as 5 but only positions 101-104
9. All Calibration Positions – Same as 5 but only positions 97-104.

4.13.6.2.1.1.3 DataAnalysisSelection – Science Data - Intensity Plot

When a single channel is selected the *Intensity Plot* button becomes active. The user can select the number of scans to plot. When the *Intensity Plot* is selected an intensity graph is displayed. See Figure 56:.

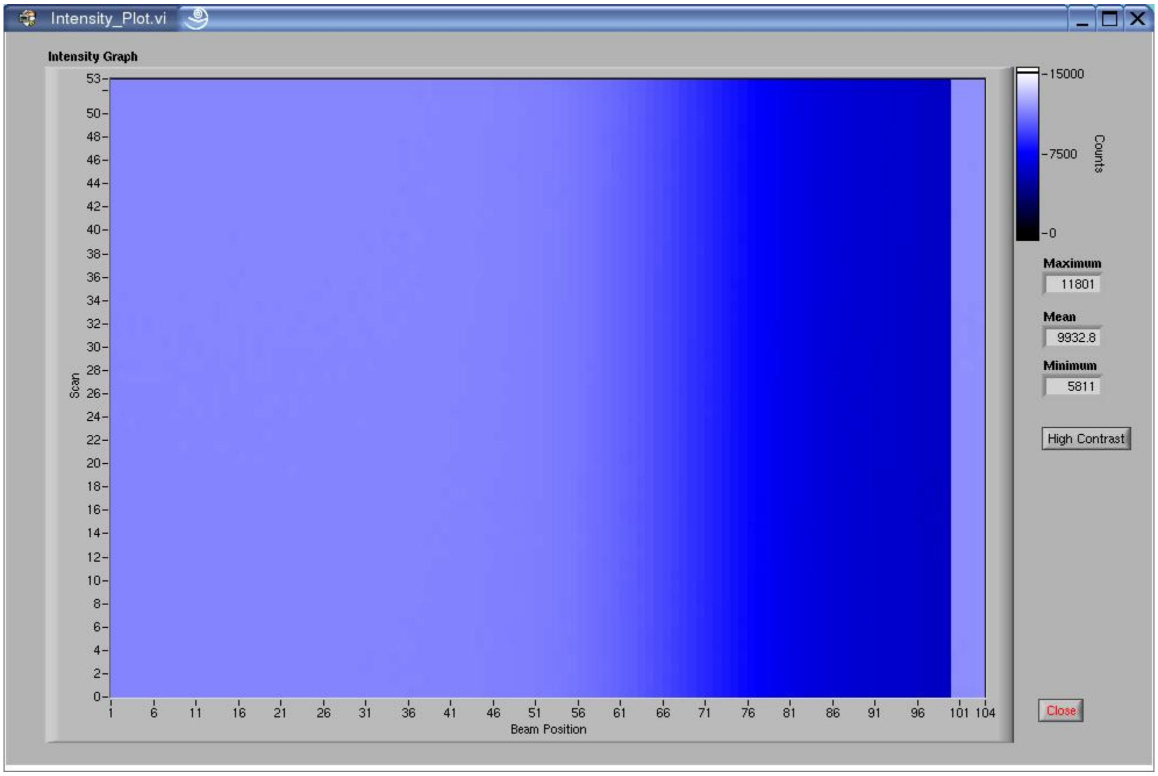


Figure 56: Intensity Plot

The plot shows a single channel's intensity at all beam positions, where the lighter the color the higher the intensity. The plot above shows data from thermal vacuum calibration session. The intensity scale can be changed by altering the upper and lower range in 'Counts' legend (upper right). The *High Contrast* button is used to set the minium and maximum of the scale to the minimum and maximum of the input data respectively creating a 'high contrast' image.

4.13.6.3 DataAnalysisSelection – Housekeeping Data

The Housekeeping Selection tab can be seen in Figure 54: and Figure 55:. Data can be selected from several groupings and added to existing plots (including science data plots).

Data can be displayed in either engineering units (temperatures, voltages, etc.) or ADC counts received from the instrument. If a data item is not available in the selected mode it will be disabled on the display. As with the Science tab, if two items are selected *the 2 Channel Difference* checkbox is enabled and the user can plot the difference between the two selections. A special feature has been added to allow a LabVIEW 'digital' plot to be generated if only digital data is displayed.

4.13.6.4 Plotting

The *Plot Data* button causes all selected data to be extracted[4] and passed to the plotting routines. There are separate plotting routines for each axis count, plus a separate ones for difference and digital plots.

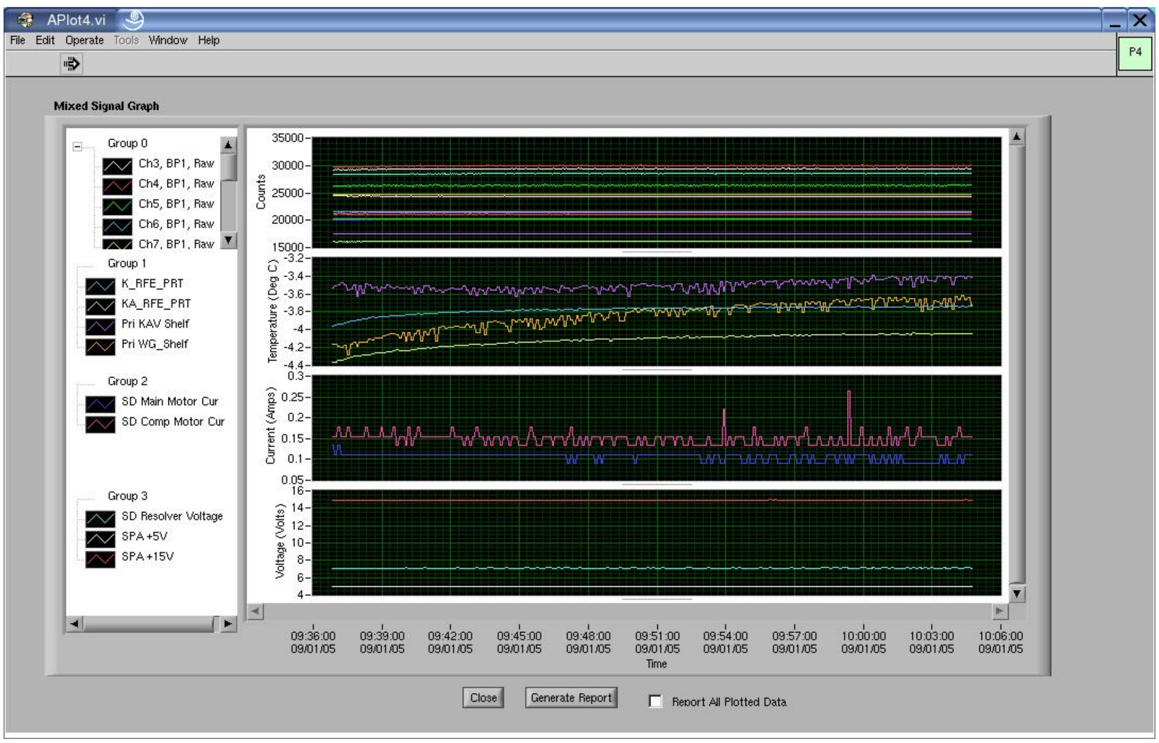


Figure 57: Example Plot with 4 Axes

[4] A C++/QT routine is used to extract and perform the analysis functions of the data from the log file(s).

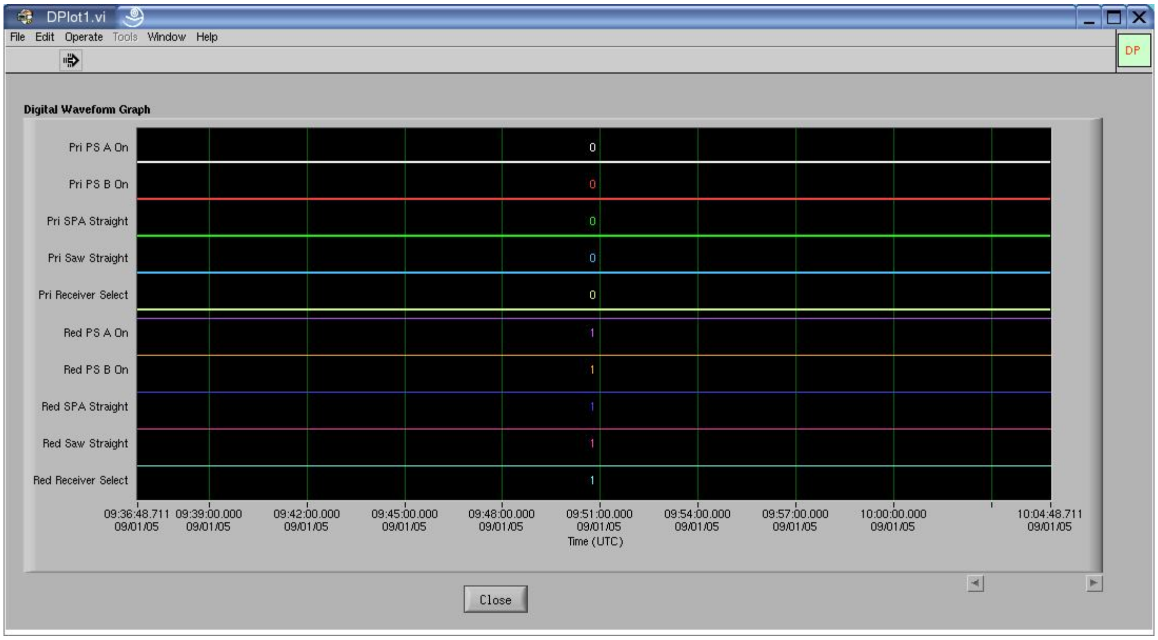


Figure 58: Example Digital Plot

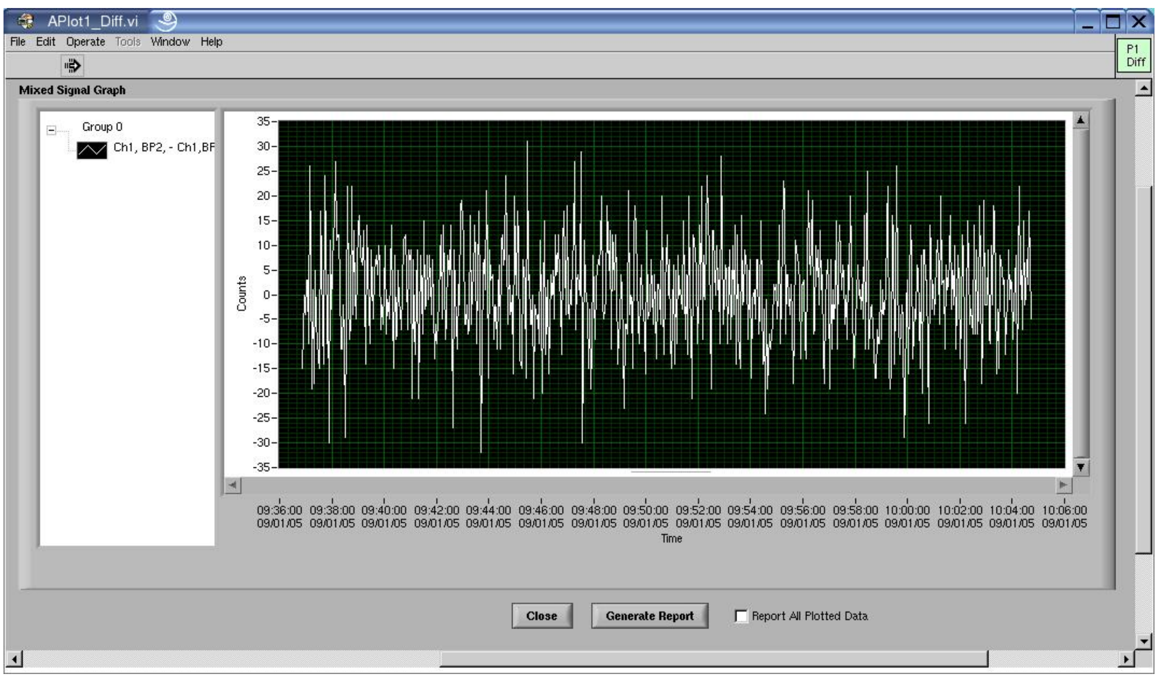
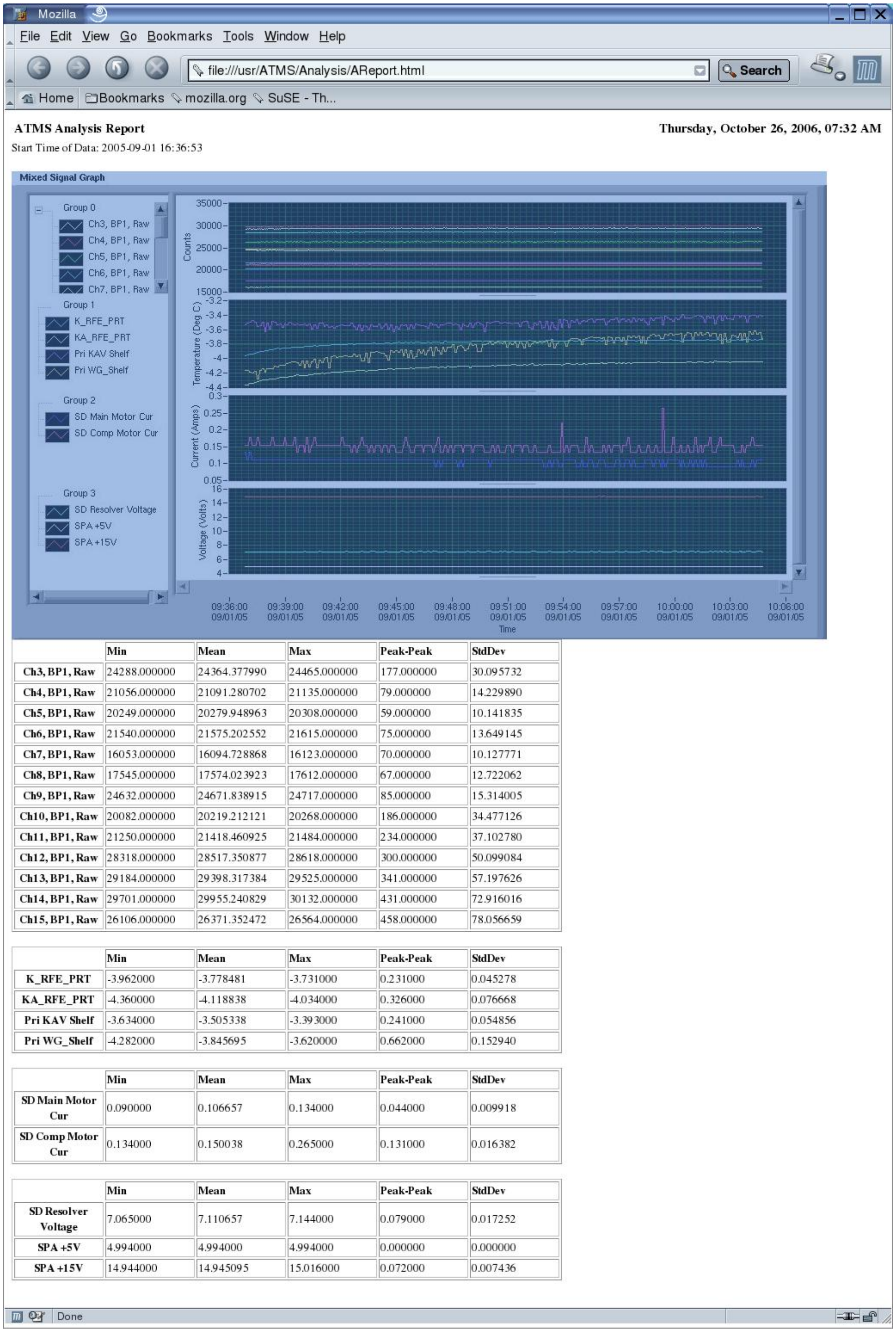


Figure 59: Example Difference Plot

4.13.6.4.1 Plotting – Report Generation

HTML formatted reports showing the graphical representation of the data along with values for the minimum, maximum, mean and standard deviation of each data item can be generated by selecting the *Generate Report* button. The raw data can also be placed on the report by checking the *Report All Plotted Data* box. An example report is provided in Figure 60:.



	Min	Mean	Max	Peak-Peak	StdDev
Ch3, BP1, Raw	24288.000000	24364.377990	24465.000000	177.000000	30.095732
Ch4, BP1, Raw	21056.000000	21091.280702	21135.000000	79.000000	14.229890
Ch5, BP1, Raw	20249.000000	20279.948963	20308.000000	59.000000	10.141835
Ch6, BP1, Raw	21540.000000	21575.202552	21615.000000	75.000000	13.649145
Ch7, BP1, Raw	16053.000000	16094.728868	16123.000000	70.000000	10.127771
Ch8, BP1, Raw	17545.000000	17574.023923	17612.000000	67.000000	12.722062
Ch9, BP1, Raw	24632.000000	24671.838915	24717.000000	85.000000	15.314005
Ch10, BP1, Raw	20082.000000	20219.212121	20268.000000	186.000000	34.477126
Ch11, BP1, Raw	21250.000000	21418.460925	21484.000000	234.000000	37.102780
Ch12, BP1, Raw	28318.000000	28517.350877	28618.000000	300.000000	50.099084
Ch13, BP1, Raw	29184.000000	29398.317384	29525.000000	341.000000	57.197626
Ch14, BP1, Raw	29701.000000	29955.240829	30132.000000	431.000000	72.916016
Ch15, BP1, Raw	26106.000000	26371.352472	26564.000000	458.000000	78.056659

	Min	Mean	Max	Peak-Peak	StdDev
K_RFE_PRT	-3.962000	-3.778481	-3.731000	0.231000	0.045278
KA_RFE_PRT	-4.360000	-4.118838	-4.034000	0.326000	0.076668
Pri KAV Shelf	-3.634000	-3.505338	-3.393000	0.241000	0.054856
Pri WG_Shelf	-4.282000	-3.845695	-3.620000	0.662000	0.152940

	Min	Mean	Max	Peak-Peak	StdDev
SD Main Motor Cur	0.090000	0.106657	0.134000	0.044000	0.009918
SD Comp Motor Cur	0.134000	0.150038	0.265000	0.131000	0.016382

	Min	Mean	Max	Peak-Peak	StdDev
SD Resolver Voltage	7.065000	7.110657	7.144000	0.079000	0.017252
SPA +5V	4.994000	4.994000	4.994000	0.000000	0.000000
SPA +15V	14.944000	14.945095	15.016000	0.072000	0.007436

Figure 60: Sample Analysis Report

4.13.6.5 Analysis of SMD data

When the ATMS SysTE logs telemetry via the SMD stream from the spacecraft it contains data only in raw counts form. In order to use the data analysis tool described in this section the raw counts in the Housekeeping packet must be converted to values with proper engineering units. This is accomplished by using the AdEngData routine to add the engineering data.

4.13.6.5.1 AdEngData software Instructions

1. Click the AdEngData icon on the desktop. The dialog box shown below will appear on the monitor.

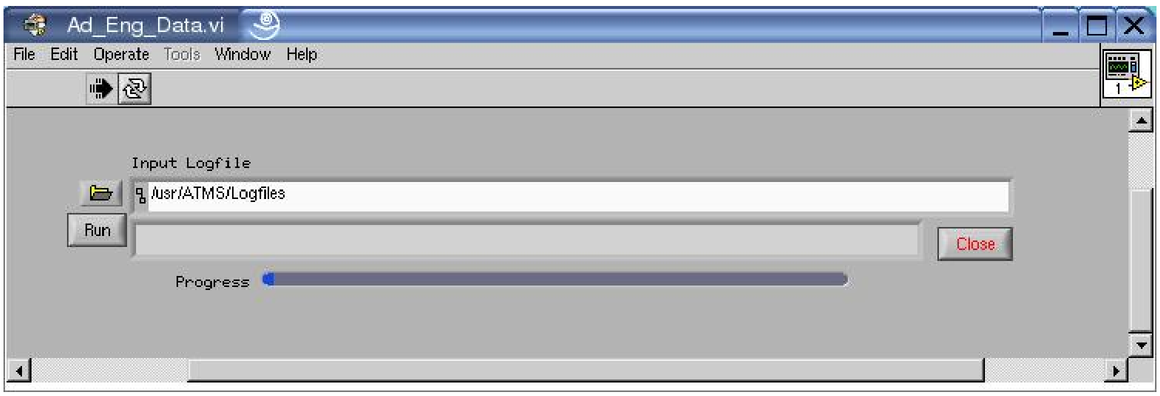


Figure 61: AdEngData Dialog Box

2. Click the folder icon.
3. Select the SMD file to be used from the dialog box. The files name and path will appear in the test box under Input Logfile.
4. Click the “Run” button to run the program
5. The progress bar along the bottom will indicate how far along the routine has progressed. A message will appear in the text box next to the “Run” button when the software is finished.
6. The modified log file will be in the same directory as the original. The file may now be used with the data analysis software. In the event the file is saved with the extension “.tmp” it must be renamed with the extension “.log”.
7. Click the “Close” button or select Quit from the file menu to exit the program.

5 Turn-OFF Procedure

Turning off of the Instrument and the SysTE shall follow the procedure outlined in order to have the Instrument in a known state, and to avoid loosing any data.

STEP	SysTE POWER OFF PROCEDURE
1	Confirm the instrument is in the OFF mode. Follow the procedure in the test procedure or the Instrument Operation Manual for correct turn-off procedure of the Instrument.
2	Verify the PRIMARY POWER CURRENT meter and REDUNDANT POWER CURRENT meters read less than 150mA
3	Turn the HEATER DC POWER to OFF.
4	Turn the SENSOR DC POWER to OFF.
5	Exit the ATMS program running in the SysTE processor. a. Select "OFF" from the Input Selection pull-down menu of the Main Software Display. b. All Software windows should close except the Main Software Window. c. .Click on the "**X**" in the upper right corner of the Main Software Window to exit the ATMS STE software.
6	Log out of the processor by performing the following: 9. Click on the icon labeled "K" on the lower left hand side of the monitor. 10. From the pop-up menu, Select logout "ATMS" 11. Select "Turn off computer" and click "OK". d. Wait for shut down procedures to complete.
7	Shut down the processor and printer.
8	Verify zero voltages and currents on all meters.
9	Verify zero current on the Agilent 6553A Power Supply meter.
10	Press the OUTPUT ON/OFF button on the Agilent 6553A Power Supply to disable the output.
11	Verify zero volts on the meter of the Agilent 6553A Power Supply.
12	Set the Agilent 6553A Power Supply power switch to OFF.
13	Set the SENSOR POWER switch on the Control Panel to OFF.
14	Verify SENSOR POWER and HEATER POWER lamps are off.
15	Set SYSTEM STE AC POWER switch to OFF.
16	Verify SYSTEM AC POWER lamp is off.
17	Verify zero current on INPUT AC POWER CURRENT meter.

6 Maintenance

6.1 Air Filters

Two air filters are located at the top of the SysTE at the rear. These filters should be changed every 6 months when under heavy use. The filters are standard 3-3/8 x 16-3/4 x 1/2" (8.57 cm x 42.55 cm x 1.27 cm).

A filter is also located at the rear of the processor. This filter should by changed every 12 months under heavy use.

All filters must be removed prior to entry into a class 10,000 clean-room.

6.2 Printer

The primary printer in the SysTE is a Hewlett Packard Color LaserJet 3800N. This is a color printer with a USB interface. The alternate printer in the Lexmark F320. This is a black & white printer with a parallel interface. Refer to the appropriate printer manual for maintenance information.

6.3 Software

The SysTE S/W application, with the exception of low-level device drivers that are written in C++, is written in LabView, a graphic programming language that is proven to take less effort to develop and to maintain than any other text based languages. The SysTE S/W application provides the capability to execute functions from scripts; therefore, provides the flexibility for the end user and as a result lowers the maintenance of the S/W.

6.4 Self Test

Upon execution, SysTE S/W performs a self-test on its test measurement devices to establish a initialization baseline. In the event any of the test devices fails the self-test, the test operator will be prompted to make appropriate actions based on the messaged window. The SysTE S/W maintains a corresponding execution status to all user inputs, including user GUI intervention, commands selections and etc. All calculations that could cause an "undefined" mathematically are checked prior to the operations.

6.5 Ground Test

The ‘Ground Test’ command is a special diagnostic command available to use for software debugging. A list of up to 32 addresses may be sent to the ATMS instrument using this command. In response, the ATMS instrument sends a ‘Ground Test’ telemetry packet containing the values at the desired locations.

6.6 Calibration

Calibration of the SysTE will be performed to the SysTE Calibration Procedure AE-28155. The SysTE must be calibrated once per year. A calibration sticker is located on the front of the SysTE.

7 Shipping and Handling

The shipping container is shown in Figure 61. The inside dimensions are 141.0 cm x 115.6 cm x 292.1 cm (55.5" x 45.5" x 115"). The base and lids are 58.4 cm (23") deep and the mid-section is 177.8 cm (70"). The weight of the packaged SysTE is 635 (TBR) kg. Refer to the ATMS Packaging, Handling, Storage, and Transportation Procedure, AE-26860 for shipping and handling details.

Figure 62: ATMS Shipping Container

8 List of Acronymns

ATMS	Advanced Technology Microwave Sounder
BP	Beam Position
Cal	Calibration
CCSDS	Consultative Committee for Space Data Systems
CTE	Calibration Test Equipment
FFT	Fast Fourier Transform
Hex	Hexadecimal
Hz	Hertz (frequency)
ID	Identification
I/O	Input/Output
K	Kelvin
kbps	Thousand Bits-Per-Second
N/A	Not Applicable
PAT	Passive Analog Temperature sensors
PRT	Platinum Resistance Temperature
RS-232	Serial Interface
SysTE	System Test Equipment
TMCS	Temperature Measurement and Control System (Azonix)
VDC	Volt Direct Current
VI	Virtual Instrument
DPA	Data Processing Application

9 Appendix A – data processing algorithms

9.1 Radiometric Temperature Computation

The inferred radiometric brightness temperature of the scene target, T_{BI}, will be computed as follows for each scan j:

$$\mathbf{T_{BI}(i, j)} = \overline{\mathbf{T_{CC}(j)}} + \frac{\left(\mathbf{C_S(i, j)} - \overline{\mathbf{C_{CC}(j)}}\right)}{\mathbf{G(j)}} \qquad (7\text{-}1)$$

$$\mathbf{G(j)} = \frac{\overline{\mathbf{C_{HC}(j)}} - \overline{\mathbf{C_{CC}(j)}}}{\overline{\mathbf{T_{HC}(j)}} - \overline{\mathbf{T_{CC}(j)}}}$$

where: $\overline{T_{HC}(j)}$ = Calibrated in-flight hot target brightness temperature as determined by linear fit data.

$\overline{T_{CC}(j)}$ = Fixed cold target brightness temperature as determined by linear fit data.

$C_S(i, j)$ = A/D counts corresponding to the variable scene target brightness temperature.

$\overline{C_{HC}(j)}$ = A/D counts corresponding to hot target brightness temperature as determined by linear fit data.

$\overline{C_{CC}(j)}$ = A/D counts corresponding to fixed cold target brightness temperatures determined by linear fit.

i = Sample number (1-6)

j = Scan number (5-275)

The 6 scene data samples are obtained at beam positions 13 - 18. In the above equation, a least square linear fit is applied to the following calibration data parameters: C_{HC} , C_{CC}, T_{HC}, T_{CC}. The equations for these linear-fit parameters are presented below:

$$\overline{C_{HC}(j)} = M_{HC} \bullet t_s + C_{HC0}$$

where:

t_s = τ_s + N(4/3) (seconds)

τ_s = Time displacement (seconds) from the start of a scan (beam position no. 1) to the midpoint of the scene target samples for that scan = 0.2703 second

$$\mathbf{M_{HC}} = \frac{\mathbf{N} \bullet \sum \left(\mathbf{C_{HC}(k)} \bullet \mathbf{t_{HC}(k)}\right) - \sum \mathbf{C_{HC}(k)} \bullet \sum \mathbf{t_{HC}(k)}}{\mathbf{N} \bullet \sum \left[\mathbf{t_{HC}(k)}\right]^2 - \left(\sum \mathbf{t_{HC}(k)}\right)^2}$$

$C_{HC}(k)$ = Average of hot target counts from the four samples of the k^{th} scan

$t_{HC}(k) = \tau_{HC} + (8/3)(k\text{-}j+N/2)$ (seconds)

τ_{HC} = Time displacement (seconds) from the start of a scan (beam position no. 1) to the midpoint of the hot target samples for that scan = 2.2883 second

$$\text{and } C_{HC0} = \frac{\sum C_{HC}(k) - M_{HC} \bullet \sum t_{HC}(k)}{N}$$

All summations are on k = j - N/2 to k= j + N/2 - 1, where N = 8 (no. of scans of calibration target data used in the computation of inferred brightness temperature).

Similar equations apply for the parameters C_{CC} , T_{HC}, and T_{CC} , as below.

$$\overline{\mathbf{C_{CC}(j)}} = M_{CC} \bullet t_s + C_{CC0}$$

$$\mathbf{M_{CC}} = \frac{\mathbf{N \bullet \sum (C_{CC}(k) \bullet t_{CC}(k)) - \sum C_{CC}(k) \bullet \sum t_{CC}(k)}}{\mathbf{N \bullet \sum [t_{CC}(k)]^2 - \left(\sum t_{CC}(k)\right)^2}}$$

$C_{CC}(k)$ = Average of cold target counts from the four samples of the k^{th} scan

$t_{CC}(k) = \tau_{CC} + (8/3)(k\text{-}j+N/2)$ (seconds)

τ_{CC} = Time displacement (seconds) from the start of a scan (beam position no. 1) to the midpoint of the cold target samples for that scan = 1.9099 second

$$\text{and } \mathbf{C_{CC0}} = \frac{\mathbf{\sum C_{CC}(k) - M_{CC} \bullet \sum t_{CC}(k)}}{\mathbf{N}}$$

$$\overline{\mathbf{T_{HC}(j)}} = M_{HT} \bullet t_s + T_{HC0}$$

$$\mathbf{M_{HT}} = \frac{\mathbf{N \bullet \sum (T_{HC}(k) \bullet t_{HC}(k)) - \sum T_{HC}(k) \bullet \sum t_{HC}(k)}}{\mathbf{N \bullet \sum [t_{HC}(k)]^2 - \left(\sum t_{HC}(k)\right)^2}}$$

$T_{HC}(k)$ = Average of Hot target brightness temperatures derived from the PRT samples obtained on the k^{th} scan (see 7.2.1 and 7.2.2)

$$\text{and} \qquad \mathbf{T_{HC0}} = \frac{\mathbf{\sum T_{HC}(k) - M_{HT} \bullet \sum t_{HC}(k)}}{\mathbf{N}}$$

$\overline{\mathbf{T_{CC}(j)}} = M_{CT} \bullet t_s + T_{CC0}$

$$\mathbf{M_{CT}} = \frac{\mathbf{N \bullet \sum \left(T_{CC}(k) \bullet t_{CC}(k)\right) - \sum T_{CC}(k) \bullet \sum t_{CC}(k)}}{\mathbf{N \bullet \sum \left[t_{CC}(k)\right]^2 - \left(\sum t_{CC}(k)\right)^2}}$$

$T_{CC}(k)$ = Average of Cold target brightness temperatures derived from the PRT samples obtained on the k^{th} scan (see 7.2.1 and 7.2.2)

and $$\mathbf{T_{CC0}} = \frac{\mathbf{\sum T_{CC}(k) - M_{CT} \bullet \sum t_{CC}(k)}}{\mathbf{N}}$$

9.2 Target Temperature Computation

9.2.1 Physical temperature computation

The kinetic temperatures of the in-flight hot calibration target, the CTE cold target, and the CTE scene target are determined from the average of the temperatures derived from the Platinum Resistance Temperature (PRT) sensors. The signal from each PRT is digitized via an A-to-D converter, which provides a count from 0 to 65,535 representing the resistance of a given PRT, which is then converted to temperature using PRT calibration data.

9.2.1.1 Instrument Hot Calibration Target

In the ATMS instrument, a precision resistor, referred to as a Precision Analog Monitor (PAM), and a short circuit are sequentially sampled by the same multiplexer and A-to-D circuits as are used for the Hot Calibration Target PRTs, providing a calibration of the resistance-to-digital counts conversion. An algorithm will convert the PRT counts, C_i, to resistance values, R_i, using the following equation:

$$R_i = R_{ref}[C_i - C_{off}] / [C_{ref} - C_{off}]$$

Where:

C_i = the number of counts measured for the i^{th} PRT

C_{ref} = PAM counts

C_{off} = Multiplexer reference counts (shorted input)

R_{ref} = PAM resistance

The algorithm for converting the resistance R_i into the physical temperature of the i^{th} PRT will use the Callendar-Van Dusen equation:

$$R_i = R_{oi}[1+\alpha_i(T_c - \delta_i((T_c/100)-1)(T_c/100)-\beta((T_c/100)-1)(T_c/100)^3)]$$

T_c = the physical temperature, in degrees Centigrade
R_i = the resistance in ohms of the i^{th} PRT
R_{oi} = the resistance in ohms of the i^{th} PRT at the ice point
$\alpha_i, \delta_i, \beta_\iota$ = constants measured for the i^{th} PRT

The Newton-Raphson technique will be used to perform the inversion, to compute T_c from a given R_i.

9.2.1.2 Calibration Test Equipment (CTE) Targets

The CTE Controller provides the resistances of the PRTs of the Scene (variable) and Cold (fixed) targets to the SysTE. The SysTE then converts the resistances to temperatures using a 6^{th} order polynomial:

$$T = A_0 + A_1 R + A_2 R^2 + A_3 R^3 + A_4 R^4 + A_5 R^5 + A_6 R^6$$

The values of these coefficients are given below in Table VIII.

9.2.2 Brightness Temperature Computation

The radiometric brightness temperatures of the targets will be computed from Planck's equation for an ideal blackbody, using the following equation:

$$T_B = \varepsilon \frac{h\nu}{k} \left\{ \left[e^{\frac{h\nu}{kT_k}} - 1 \right]^{-1} + 0.5 \right\},$$

where:

h = Planck's constant = $6.626 \bullet 10^{-34}$ Joule-sec
ν = The electromagnetic frequency in Hz
k = Boltzmann's constant = $1.3807 \bullet 10^{-23}$ Joules/K
$\mathbf{T_k}$ = The kinetic temperature of the observed blackbody
ε = Measured emissivity of the target

9.3 Radiometric Accuracy Measurement

For each scene target data sample, equation 7-1 will be used to compute an inferred brightness temperature, T_{BI}. The Radiometric Accuracy, determined from n sample measurements, is then computed as:

$$A_R(T_{sc}, i_c) = (1/n)\Sigma\,(T_{BI} - T_{BT}), \quad (7\text{-}2)$$

where the T_{BT} values are the scene target brightness temperatures derived from the PRT measurements,

T_{sc} is the nominal scene temperature (one of eleven values)

i_c is the instrument temperature case (one of three cases)

n is the number of samples = 6 x 271 = 1626.

This Radiometric Accuracy does not represent actual instrument on-orbit Calibration Accuracy, because it includes the effects of a cold target error that is different from on-orbit cold calibration error, and it includes a scene target error. The purpose of these Radiometric Accuracy measurements is to obtain the transfer function non-linearity (see section 8.6), which can then be used in the Radiometric Math Model (RE-12110) to derive instrument on-orbit Calibration Accuracy.

Table XV: PRT Calibration Coefficients for CTE Scene Targets

Target	PRT No.	A_0	A_1	A_2	A_3	A_4	A_5	A_6
KAV Scene (used on EDU)	1	31.0873875466	0.240334737985	-5.72460934650E-05	1.62068509881E-07	-1.76020309193E-10	9.18317359787E-14	-1.86688153722E-17
	2	31.2036474283	0.237713367491	-4.30923885839E-05	1.27532976955E-07	-1.34313659870E-10	6.73902944428E-14	-1.31145336781E-17
	3	31.5964719461	0.234400356808	-2.83913467809E-05	9.28810380339E-08	-9.20597039058E-11	4.24119860270E-14	-7.44240222608E-18
	4	31.3588041655	0.237692821888	-4.51673724264E-05	1.34932024208E-07	-1.45168456306E-10	7.47103537489E-14	-1.49672911124E-17
	5	31.1573781847	0.238805140877	-5.05750756267E-05	1.47817055212E-07	-1.60564865894E-10	8.37527806097E-14	-1.70441028010E-17
	6	31.3676943690	0.235928729011	-3.55684824879E-05	1.09528334700E-07	-1.13953378654E-10	5.70281420679E-14	-1.12038471378E-17
	7	31.2645473555	0.239024101867	-5.07043618198E-05	1.45674152070E-07	-1.55966383034E-10	8.01874739584E-14	-1.60860274326E-17
	8	31.1408422266	0.240143779787	-5.70597757739E-05	1.62940760231E-07	-1.78696628943E-10	9.43845221110E-14	-1.94527149297E-17
	9	31.1785531818	0.238110444535	-4.58401009936E-05	1.32820093074E-07	-1.38556624002E-10	6.88672731573E-14	-1.32902136233E-17
	10	31.2450145661	0.237564024892	-4.36457335236E-05	1.28681220572E-07	-1.35915685728E-10	6.88354575003E-14	-1.35981263345E-17
	11	31.3987523112	0.235817200513	-3.50097602532E-05	1.09950681568E-07	-1.15265605119E-10	5.75026357351E-14	-1.11471079025E-17
KAV Scene (to be used on PFM)	1	31.7451669814	0.232658874027	-2.25224129013E-05	8.43315614918E-08	-8.654550454790E-11	4.11151231031E-14	-7.44957228206E-18
	2	31.5069591320	0.235353564984	-3.74753499569E-05	1.20611719276E-07	-1.302390917420E-10	6.68563912285E-14	-1.33574851284E-17
	3	31.5216695735	0.235103810188	-3.30149596822E-05	1.08289453454E-07	-1.14151936160E-10	5.66173671524E-14	-1.08261130516E-17
	4	31.6102771373	0.233717222235	-2.81338208290E-05	9.79110938389E-08	-1.02625830973E-10	5.02901457510E-14	-9.47049893785E-18
	5	31.6468416713	0.233463521234	-2.69690526011E-05	9.54725843293E-08	-1.00668045633E-10	4.98979239912E-14	-9.56177940869E-18
	6	31.5884685218	0.235290521068	-3.58418428569E-05	1.15561315915E-07	-1.24084791856E-10	6.32941549611E-14	-1.25449935415E-17
	7	31.5593505107	0.233572204087	-2.77259268875E-05	9.56109864120E-08	-9.90575135782E-11	4.82723409290E-14	-9.10431118729E-18
	8	31.3756825254	0.235350085649	-3.58038407994E-05	1.15797220854E-07	-1.23948846929E-10	6.28489584782E-14	-1.23566053300E-17
	9	31.5589584996	0.235241540817	-3.64807089139E-05	1.18366836622E-07	-1.28185709593E-10	6.59853027962E-14	-1.32113886247E-17
	10	31.6785579496	0.234622032704	-3.21681836613E-05	1.07910530051E-07	-1.14418459979E-10	5.69610477341E-14	-1.09106793203E-17
	11	31.6080128279	0.234845746568	-3.48659393381E-05	1.16466697600E-07	-1.27881158766E-10	6.68184545165E-14	-1.36048080179E-17

	12	31.5920834878	0.233649152867	-2.85460488775E-05	9.99251966739E-08	-1.06534673116E-10	5.37039324961E-14	-1.05200979180E-17
WG Scene	1	31.47884709910	0.234946252547	-3.1118869290E-05	1.015114364290E-07	-1.046387927220E-10	5.068668827560E-14	-9.454551618870E-18
	2	31.33851470080	0.235667396153	-3.3435965460E-05	1.057205884450E-07	-1.093418889080E-10	5.365464366280E-14	-1.021687550240E-17
	3	31.61120001410	0.232369225125	-1.7680540602E-05	6.876191238460E-08	-6.530340554400E-11	2.758511631620E-14	-4.152312585600E-18
	4	31.53488352480	0.235217608831	-3.1803307679E-05	1.006200250210E-07	-1.018944080440E-10	4.855890903410E-14	-8.909058863400E-18
	5	31.62688957010	0.233293355740	-2.5660480658E-05	8.988347968420E-08	-9.023387129930E-11	4.151710582140E-14	-7.171419100750E-18
	6	31.58106803080	0.233918833246	-2.5533637989E-05	8.685383022130E-08	-8.645196262210E-11	4.004106738330E-14	-7.074350584630E-18
	7	31.57914612220	0.234391805319	-3.0064478197E-05	1.004701718630E-07	-1.035940242510E-10	4.978710857820E-14	-9.147862851410E-18
	8	31.58335328460	0.234750376195	-2.9102671537E-05	9.373944802240E-08	-9.336281291790E-11	4.361077595270E-14	-7.826896529150E-18
	9	31.59173265390	0.234828807004	-2.9776950681E-05	9.578810135160E-08	-9.608242144950E-11	4.522840191090E-14	-8.182492724560E-18
	10	31.39691089730	0.236189789151	-3.6071426097E-05	1.110405176000E-07	-1.146440713280E-10	5.622283913550E-14	-1.070546347730E-17

Table XVI: PRT Calibration Coefficients for CTE Scene Targets

Target	PRT No.	A_0	A_1	A_2	A_3	A_4	A_5	A_6
KAV Cold	1	31.2256286992	0.237264919040	-4.11922222978E-05	1.23613710081E-07	-1.30676470096E-10	6.60622076143E-14	-1.30123427589E-17
	2	31.4918726944	0.236082215972	-3.29364874082E-05	1.03691618132E-07	-1.05848204327E-10	5.00794726436E-14	-8.92640413447E-18
	3	31.1196268895	0.239865788483	-5.61382237975E-05	1.60141126058E-07	-1.74854728279E-10	9.19931525400E-14	-1.89086729823E-17
	4	31.1024512070	0.239502801397	-5.58099656539E-05	1.61117823754E-07	-1.77352773964E-10	9.42025307064E-14	-1.95782577134E-17
	5	31.1996882786	0.237596585566	-4.26337877418E-05	1.25218715507E-07	-1.30195975296E-10	6.45060576269E-14	-1.24081766840E-17
	6	31.0511608793	0.240811325872	-6.18413124336E-05	1.75031507413E-07	-1.94492406820E-10	1.04741469404E-13	-2.21154035018E-17
	7	31.3902923628	0.236610166061	-3.93553512097E-05	1.18865691409E-07	-1.23933322023E-10	6.15986507846E-14	-1.19142498233E-17
	8	31.3072008498	0.237430179735	-4.48865263578E-05	1.35545704919E-07	-1.47612253646E-10	7.74096871803E-14	-1.58993425482E-17
	9	30.9900685704	0.239418187762	-5.49671411410E-05	1.59375334514E-07	-1.74520637284E-10	9.17885693039E-14	-1.88395542383E-17
	10	31.1940591544	0.238792518709	-5.03376674740E-05	1.46924700757E-07	-1.59554884171E-10	8.32912308292E-14	-1.69730584939E-17
	11	31.1275285189	0.239748064377	-5.63706958910E-05	1.62313575370E-07	-1.79711597639E-10	9.61947850575E-14	-2.01457100356E-17
WG Cold	1	30.9606243657	0.238908507103	-4.53809601668E-05	1.27150723418E-07	-1.288472490980E-10	6.21376112571E-14	-1.15885178652E-17
	2	31.0474468245	0.236511258249	-3.19562149665E-05	9.63453226854E-08	-9.436331327430E-11	4.34772052460E-14	-7.67576656271E-18
	3	31.0489959898	0.238424440465	-4.23260778152E-05	1.20308854094E-07	-1.224826417490E-10	5.98078022054E-14	-1.13921449142E-17
	4	31.1574558374	0.235466144978	-2.66263397818E-05	8.20136993548E-08	-7.597001332800E-11	3.24016939513E-14	-5.14356198452E-18
	5	30.9595874471	0.239149644269	-4.72535681107E-05	1.33852316703E-07	-1.397712981460E-10	7.02114868523E-14	-1.37881475513E-17
	6	31.1819920943	0.236925066467	-3.72658432090E-05	1.11416250505E-07	-1.137287512720E-10	5.52418560373E-14	-1.04150323677E-17
	7	31.0456629152	0.238636543676	-4.20987945409E-05	1.16266104552E-07	-1.153876632890E-10	5.53030969840E-14	-1.04413773456E-17
	8	31.3102261261	0.236445067412	-3.26061921373E-05	9.93830609514E-08	-1.00171842294E-10	4.82479050982E-14	-9.08019647525E-18
	9	31.4444755933	0.235418305478	-3.00812542825E-05	9.41776389180E-08	-9.39095421817E-11	4.43768179369E-14	-8.13416344473E-18
	10	31.3500651841	0.234434960988	-2.55562389609E-05	8.39661359700E-08	-8.24490984899E-11	3.83202040722E-14	-6.93312891930E-18

9.4 NEΔT Measurement

Temperature sensitivity (NEΔT) is defined in GSFC 429-00-06-03 as the standard deviation of the radiometer output temperature in degrees Kelvin (K) when the antenna is viewing a 300 K uniform and stable target.

For each scene target temperature step, the sensitivity (NEΔT) is computed from the standard deviation of the error values (T_{BI}-T_{BT}), given by the following equation:

$$NE\Delta T = \{[1/(n-1)][\Sigma\ (T_{BI} - T_{BT})^2 -\ nA_C{}^2]\}^{1/2}\ , \qquad (7\text{-}3)$$

where n is the number of samples, and Ac is the accuracy, defined in equation 7-2.

The sensitivity values obtained for scene target temperatures of 280 K and 305 K will be used to derive, by interpolation, the sensitivity for a 300 K scene. The pass/fail criteria for these measured NEΔT values are derived from the requirements that are applicable to worst-case on-orbit conditions, as described in the Radiometric Math Model.

9.5 Non-Linearity

For each instrument temperature case, the best-fit linear line is obtained for the Radiometric Accuracy (A_R) values versus scene temperatures. The best-fit line is given by:

$$A(T_S) = m[T_S - \overline{T_S}] + \overline{A_R}\ ,$$

where T_s is the true scene brightness temperature

$\overline{T_s}$ is the mean value of the scene temperatures,

and $$m = \frac{\overline{A_R T_S} - \overline{A_R}\ \overline{T_S}}{\overline{T_S{}^2} - \overline{T_S}^2}$$

The peak ground-test non-linearity error is half the peak-to-peak deviation from the linear regression:

$$NL_{meas} = 0.5 * \{\ Max[A_R(T_s,i_c) - A(T_s,i_c)] - Min[A_R(T_s,i_c) - A(T_s,i_c)]\ \}$$

The maximum on-orbit non-linearity error will be significantly larger than the non-linearity measured during thermal-vacuum calibration, however, since the specified on-orbit dynamic range (3 K to 330 K) is larger than that in the thermal-vacuum chamber (93 K to 330 K). The approach for deriving linearity over the on-orbit dynamic range is to compute a polynomial regression line for the Radiometric Accuracy (A_R versus T_S), and extrapolate down to 3 K. The peak difference is then computed between the polynomial regression curve and a straight line connecting the end points of the curve (at 3 K and 330 K). This peak difference occurs at the mid-temperature (166.5 K). The peak instrument on-orbit non-linearity is one half of this peak difference. This approach eliminates the effects of CTE target errors.

9.6 Dynamic Range

The dynamic range of the system is required to accommodate input brightness test temperatures from 3 K to 330 K, and gain fluctuations up to 4 dB (±2 dB). Monitoring the radiometric counts relative to the limits indicated in Table VII will assure satisfaction of dynamic range requirements.

9.7 Short-term Gain Fluctuation (ΔG/G)

An FFT will be computed on data collected from an extended dwell observation of the scene target, when set at 330K. This data will be used to derive short-term Gain Fluctuation (ΔG/G). During this test, the scanning will be implemented by the following sequence of point/stare commands while in continuous sampling (CS) data mode collection. This sequence will be repeated 10 times.

1. point to center of scene target, (scan angle = 323.37°); collect 512 samples
2. point to cold target, (scan angle = 83.34°); collect 16 samples
3. point to instrument hot target, (scan angle = 195.0°); collect 16 samples

The brightness temperature for each scene target sample will be computed from equation 7-1, using the average values of the preceding and succeeding cold and hot target samples as calibration references.

The scene target PRT measurements will be averaged, and a linear fit of these measurements versus time (see 7.1) will be used to derive interpolated target temperatures for each of the radiometric samples.

The measurement error, which is the difference between derived brightness temperature and the interpolated scene PRT temperature, will be computed for each sample. The FFT will then be performed on these 512 brightness temperature measurement errors.

Multiple FFT blocks of data will be taken and processed (from multiple scans), to determine a mean spectrum, and to assess the variability of the spectra.

The composite spectrum will then be filtered with a high-pass filter having a low-frequency cut-off corresponding to 1.73 seconds (the earth-viewing period of an operational scan). The ΔG/G will be the difference between the power in this filtered spectrum and the power of white-noise at a level equal to the high-frequency spectral density, normalized to the white-noise power.

9.8 CTE and Instrument Target Errors

Each of the three targets has a bias error, and the relative bias between the scene target and the instrument hot target, and between the scene target and the cold target, will introduce errors in the computed Radiometric Accuracy, A_R. These errors shall be determined by computing the values of the polynomial regression curve at the hot target and cold target temperatures. Since the procedure described above for deriving Instrument Calibration Accuracy (see 7.3 and 7.5) eliminates linear offsets, there is no need to explicitly apply corrections for these target errors. Their values are computed and reported only for engineering evaluation of the CTE targets.

9.9 Standard Deviation of Counts

As a part of the monitoring and limit-checking functions, described in 4.4, the standard deviation of counts is computed over a 100-scan interval. Since this is performed during temperature transitions, it is desirable to eliminate the effects of temperature-dependant gain variations, so that the computed standard deviation will be truly representative of receiver performance. It has been determined from ambient test data that a linear regression over a 100-scan interval will remove the temperature-dependant drift contribution to counts standard deviation.

The standard deviation is then computed as follows:

$$\sigma_i = \sqrt{\frac{1}{99}\sum_{j=i-99}^{i}(\Delta C_j)^2}$$

$$\Delta C_j = C_j - \overline{C_j}$$

where i = current sample (scan) index

j = index of prior samples, used for the regression

$\overline{C_j}$ = value of the linear regression line at sample j

The linear regression is performed using the following equation:

$$\overline{C_j} = M_i t_j + C_{0i}$$

$$M_i = \frac{100\sum_{j=i-99}^{i}\left(C_j t_j\right) - \sum_{j=i-99}^{i} C_j \sum_{j=i-99}^{i} t_j}{100\sum_{j=i-99}^{i} t_j^2 - \left(\sum_{j=i-99}^{i} t_j\right)^2}$$

$$C_{0i} = \left[\sum_{j=i-99}^{i} C_j - 100\sum_{j=i-99}^{i} t_j\right] / 100$$

$$t_j = j - i + 100$$

Evaluating the terms that are a function only of t_j results in the following:

$$\overline{C_j} = M_i \times (j - i + 100) + C_{0i}$$

$$M_i = 1.2 \times 10^{-5} \sum_{j=i-99}^{i} C_j (j - i + 100) - 0.05942 C_{Ai}$$

$$C_{0i} = C_{Ai} - 49.5 M_i$$

$$C_{Ai} = 0.01 \sum_{j=i-99}^{i} C_j$$

9.10 Effective Sensitivity

The effective sensitivity of the calibration measurements is defined in the SOW, 2.9.3.1, as the "standard deviation of the measured mean from the true mean". It is required to be ≤ 0.09 K. The effective sensitivity, S_E, is computed for each channel, and for each instrument temperature case. For the given channel and instrument temperature, the difference between each A_R value and the polynomial regression curve at the same scene temperature is computed, for all four redundancy configurations. The effective sensitivity is then the standard deviation of these differences:

$$S_E = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N} \left(A_{Ri} - A_{Pi} \right)^2}$$

where N = Total number of samples; nominally, N = 44

A_{Ri} = Radiometric accuracy of sample i, defined in equation 7-2

A_{Pi} = Value of the polynomial regression curve corresponding to the i^{th} sample

10 Appendix B SysTE Logged Telemetry

Packet Types and Headers

Telemetry to be transferred via the MIL-STD-1553B bus shall consist of data packets that use the Consultative Committee for Space Data Systems (CCSDS) Path Protocol Data Unit format described in CCSDS 701.0-B-2 (reference 1). Each packet shall have a primary header that contains 2 16-bit words (one 16-bit word = 2 octets) and a secondary header that contains a four-word UTC time code.

Reference Document 2 (*1553 Interface Requirements for NPOESS 09/26/2001)* defines the basic types of telemetry and initial application process identifier (APID) assignments.

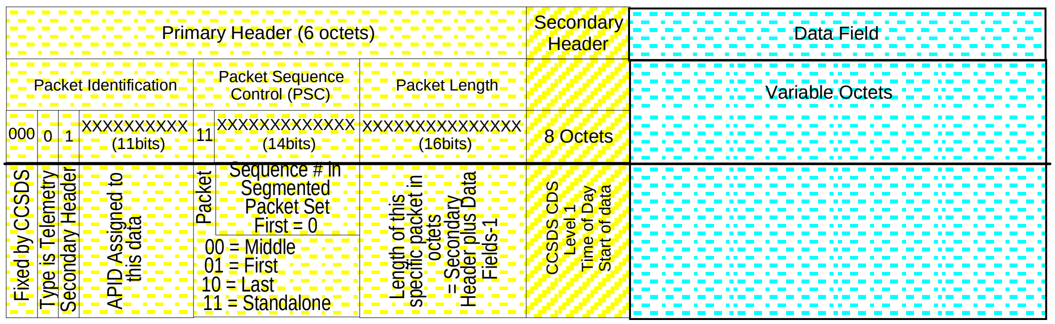


Figure 63: CCSDS Packet Format

Calibration Test Equipment (CTE) Packet Format

Each data field is 64 bits (8 bytes or 4 16-bit words) IEEE floating point little endian format.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
CTE	Calibration Test Equipment	21C(540)	1	Variable KAV Target PRT #1 Temperature ºK	Polled every 8 seconds using internal Labview timer
			2	Variable KAV Target PRT #2 Temperature ºK	
			3	Variable KAV Target PRT #3 Temperature ºK	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			4	Variable KAV Target PRT #4 Temperature ºK	
			5	Variable KAV Target PRT #5 Temperature ºK	
			6	Variable KAV Target PRT #6 Temperature ºK	
			7	Variable KAV Target PRT #7 Temperature ºK	
			8	Variable KAV Target PRT #8 Temperature ºK	
			9	Variable KAV Target PRT #9 Temperature ºK	
			10	Variable KAV Target PRT #10 Temperature ºK	
			11	Variable KAV Target PRT #11 Temperature ºK	
			12	Variable KAV Target PRT #12 Temperature ºK	
			13	Variable WG Target PRT #1 Temperature ºK	
			14	Variable WG Target PRT #2 Temperature ºK	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			15	Variable WG Target PRT #3 Temperature ºK	
			16	Variable WG Target PRT #4 Temperature ºK	
			17	Variable WG Target PRT #5 Temperature ºK	
			18	Variable WG Target PRT #6 Temperature ºK	
			19	Variable WG Target PRT #7 Temperature ºK	
			20	Variable WG Target PRT #8 Temperature ºK	
			21	Variable WG Target PRT #9 Temperature ºK	
			22	Variable WG Target PRT #10 Temperature ºK	
			23	Fixed KAV Target PRT #1 Temperature ºK	
			24	Fixed KAV Target PRT #2 Temperature ºK	
			25	Fixed KAV Target PRT #3 Temperature ºK	

Telemetry Type	**Telemetry Packet**	**APID: Hex(Decimal)**	**Data fields**		**Sampling**
			No.	**Content**	
			26	Fixed KAV Target PRT #4 Temperature ºK	
			27	Fixed KAV Target PRT #5 Temperature ºK	
			28	Fixed KAV Target PRT #6 Temperature ºK	
			29	Fixed KAV Target PRT #7 Temperature ºK	
			30	Fixed KAV Target PRT #8 Temperature ºK	
			31	Fixed KAV Target PRT #9 Temperature ºK	
			32	Fixed KAV Target PRT #10 Temperature ºK	
			33	Fixed KAV Target PRT #11	
			34	Fixed WG Target PRT #1 Temperature ºK	
			35	Fixed WG Target PRT #2 Temperature ºK	
			36	Fixed WG Target PRT #3 Temperature ºK	
			37	Fixed WG Target PRT #4 Temperature ºK	
			38	Fixed WG Target PRT #5 Temperature ºK	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			39	Fixed WG Target PRT #6 Temperature ºK	
			40	Fixed WG Target PRT #7 Temperature ºK	
			41	Fixed WG Target PRT #8 Temperature ºK	
			42	Fixed WG Target PRT #9 Temperature ºK	
			43	Fixed WG Target PRT #10 Temperature ºK	
			44	Coldplate Thermocouple #1 Temperature ºC	
			45	Coldplate Thermocouple #2 Temperature ºC	
			46	Coldplate Thermocouple #3 Temperature ºC	
			47	Coldplate Thermocouple #4 Temperature ºC	
			48	Coldplate Thermocouple #5 Temperature ºC	
			49	Coldplate Thermocouple #6 Temperature ºC	
			50	Coldplate Thermocouple #7 Temperature ºC	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			51	Coldplate Thermocouple #8 Temperature ºC	

Housekeeping Engineering Telemetry Packet Format

The ATMS STE as part of its normal operation converts Housekeeping (206) packet data to engineering units for display and limit checking. The converted data is then logged as Housekeeping Engineering (207) packets to aide in off-line analysis.

Each data field is 64 bits (8 bytes or 4 16-bit words) IEEE floating point little endian format.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
Housekeeping Eng	Housekeeping Engineering	207(519)	1	SPA_P5V_A_VMON or SPA_P5V_B_VMON	Polled every 8 seconds soon after Housekeeping packets are received
			2	SPA_P15V_A_VMON or SPA_P15V_B_VMON	
			3	SPA_N15V_A_VMON or SPA_N15V_B_VMON	
			4	RCV_P6V_RF_VMON	
			5	RCV_P12V_RF2_VMON	
			6	RCV_P15V_RF_VMON	
			7	RCV_N15V_RF_VMON	
			8	RCV_P15V_ANA_VMON	
			9	RCV_N15V_ANA_VMON	
			11	K_RFE_PRT [1]	
			12	KA_RFE_PRT [2]	
			13	V_RFE_PRT [1]	
			14	V_PRI_PLO_PRT [2]	
			15	V_RED_PLO_PRT [1]	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			16	V_IF_PRT [1]	
			17	W_RFE_PRT [2]	
			18	SAW_FILT_PRT [1]	
			19	W_IF_PRT [2]	
			20	W_PRI_GDO_PRT [1]	
			21	W_RED_GDO_PRT [2]	
			22	G_PRI_CSO_PRT [1]	
			23	G_RED_CSO_PRT [2]	
			24	G1_IF_PRT [2]	
			25	G2_IF_PRT [1]	
			26	W_SHELF_PRT	
			27	KKA_SHELF_PRT	
			28	G_SHELF_PRT	
			29	V_SHELF_PRT	
			30	RCVPS_A_PRT [1]	
			31	RCVPS_B_PRT [2]	
			32	OCXO_PRI_PRT [2]	
			33	OCXO_RED_PRT [2]	
			34	DSPA_1553_PRT [2]	
			35	DSPB_1553_PRT[1]	
			36	SPA_PS_A_PRT[2]	
			37	SPA_PS_B_PRT [1]	
			38	DSPA_PROC_PRT [1]	
			39	DSPB_PROC_PRT [2]	
			40	SD_P5V_VMON	
			41	SD_P12V_VMON	
			42	SD_N12V_VMON	
			43	MAIN_MOTOR_CUR	
			44	COMP_MOTOR_CUR	
			45	RESOLVER_VMON	
			46	SD_MAIN_MOTOR_VEL	
			47	SD_COMP_MOTOR_VEL	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			48	SD_MAIN_LOOP_ERROR	
			49	SD_MAIN_LOOP_INT_ERROR	
			50	SD_MAIN_LOOP_VEL_ERROR	
			51	SD_COMP_LOOP_ERROR	
			52	SD_MAIN_MOTOR_REQ_VOLTAGE	
			53	SD_COMP_MOTOR_REQ_VOLTAGE	
			54	SD_FEED_FORWARD_VOLTAGE	
			55	COMP_MOTOR_POS	
			56	SD_MECH_TEMP	
			57	SD_PS_PRT	
			58	V_PLO_A_LOCK_VMON	
			59	V_PLO_B_LOCK_VMON	

<u>HotCal Engineering Packet Format</u>

The ATMS STE as part of its normal operation converts Hot Calibration (212) packet data to engineering units for display and limit checking. The converted data is then logged as HotCal Engineering (208) packets to aide in off-line analysis.

Each data field is 64 bits (8 bytes or 4 16-bit words) IEEE floating point little endian format.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
HotCal Eng	HotCal Engineering	208(520)	1	KV_WL_4WPRT_1	Polled every 8/3 seconds soon after HotCal (212) packets are received
			2	KV_WL_4WPRT_2	
			3	KV_WL_4WPRT_3	
			4	KV_WL_4WPRT_4	
			5	KV_WL_4WPRT_5	
			6	KV_WL_4WPRT_6	
			7	KV_WL_4WPRT_7	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			8	KV_WL_4WPRT_8	
			9	WG_WL_4WPRT_1	
			10	WG_WL_4WPRT_2	
			11	WG_WL_4WPRT_3	
			12	WG_WL_4WPRT_4	
			13	WG_WL_4WPRT_5	
			14	WG_WL_4WPRT_6	
			15	WG_WL_4WPRT_7	

Passive Telemetry Packets

The ATMS STE as part of its normal operation converts data sampled from the Agilent Data Acquition unit to engineering units for display and limit checking. The converted data is then logged as Passive Telemetry (214) packets to aide in off-line analysis.

Each data field (except for the last, which is a 16-bit word) is 64 bits (8 bytes or 4 16-bit words) IEEE floating point little endian format.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
Passive Telemetry	Passive Telemetry	214(532)	1	PRIMARY SDM_TEMP	Logged roughly every 4 seconds
			2	PRIMARY CAL_TARGET_LOC_TEMP	
			3	PRIMARY KAV_SHELF_TEMP	
			4	PRIMARY WG_SHELF_TEMP	
			5	PRIMARY INSTR_BASEPLATE _TEMP	
			6	REDUNDANT SDM_TEMP	
			7	REDUNDANT CAL_TARGET_LOC_TEMP	
			8	REDUNDANT KAV_SHELF_TEMP	

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
			9	REDUNDANT WG_SHELF_TEMP	
			10	REDUNDANT INSTR_BASEPLATE _TEMP, Word 1	
			Word 41	PRIMARY PS_A_ON_BILEVEL	
				PRIMARYPS_B_ON_BILEV E	L
				PRIMARY SPA_STRAIGHT_BILEVEL	
				PRIMARY SAW_STRAIGHT_BILEVEL	
				PRIMARY RCV_SELECT_BILEVEL	
				N/A RESERVED	
				N/A RESERVED	
				N/A RESERVED	
				REDUNDANT PS_A_ON_BILEVEL	
				REDUNDANT PS_B_ON_BILEVEL	
				REDUNDANT SPA_STRAIGHT_BILEVEL	
				REDUNDANT SAW_STRAIGHT_BILEVEL	
				REDUNDANT RCV_SELECT_BILEVEL	
				N/A RESERVED	
				N/A RESERVED	
				N/A RESERVED	

Voltages and Currents Packets

The ATMS STE as part of its normal operation converts data sampled from the Agilent Data Acquition unit to engineering units for display and limit checking. The converted data is then logged as Voltages and Currents (219) packets to aide in off-line analysis.

Each data field is 64 bits (8 bytes or 4 16-bit words) IEEE floating point little endian format.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
Voltages and Currents	Voltages and Currents	219(537)	1	Primary ATMS Sensor Voltage	Logged roughly every 4 seconds
			2	Primary ATMS Sensor Current (amps)	
			3	Primary ATMS Heater Voltage (volts)	
			4	Primary ATMS Heater Current (amps)	
			5	Primary LOCAL GND (volts)	
			6	Redundant ATMS Sensor Voltage (volts)	
			7	Redundant ATMS Sensor Current (amps)	
			8	Redundant ATMS Heater Voltage (volts)	
			9	Redundant ATMS Heater Current (amps)	
			10	Redundant LOCAL GND (volts)	

STE Error Packet Format

STE Error Packets are logged by the STE when a error is detected such a limit going out of bounds, an alarm indicator, illegal packets detected, etc.

The body of the packet consists of ASCII text after the CCSDS header. These packets are variable length. The output text is always an even number of bytes.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
STE Error	STE Error	21E(542)		ASCII Text	When errors are detected

Mark Packet Format

Mark Packets are logged by the STE by operator request or automatically by data collection routines.

The body of the packet consists of ASCII text after the CCSDS header. These packets are variable length. The output text is always an even number of bytes.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
Mark	Mark	21A(538)		ASCII Text	Logged by the STE

Time of Day Packet Format

Time of Day (TOD) Packets are logged by the STE at one second intervals when the ATMS instrument is directly connected to the STE and the ATMS instrument is operational and accepting telemetry requests.

The packet contains no body. The secondary header (words 4-7, See Figure 62) consists of a segmented UTC time representing the current GMT time and used by the ATMS instrument to synchronize to spacecraft time and to generate telemetry packets with the correct time.

Telemetry Type	Telemetry Packet	APID: Hex(Decimal)	Data fields		Sampling
			No.	Content	
TOD	TOD	100(256)[5]		N/A	Sent to the ATMS instrument by the STE and then logged by the STE

[5] APID 100 is used by the STE because at the time of the software's development the spacecraft's value for the APID of TOD messages was not determined.

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