MEASUREMENT
SYSTEM
IDENTIFICATION

MSFC-SPEC-3274
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National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

PRESSURIZED CARRIERS GROUP
Multi Purpose Logistics Module

PROGRAMMABLE THERMOSTAT
END ITEM SPECIFICATION

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SIGNATURE PAGE

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DOCUMENT HISTORY LOG

Status (Baseline/Revision/ Cancelled)	Document Revision	Effective Date	Description
Baseline			Baseline Document
Revision	A	March, 2003	Editorial Changes
Revision	B	July, 2003	Revise Applicable Documents List, Update Figure 2, Correct control set point and span, revise testing procedures document callout, revise verification method of 3.3.2.4.1
Revision	C	August, 2003	Revised Random Vibration Loads Tables IV and V
Revision	D	April, 2004	Revised Verification 3.3.7.3 to Class H electrical bond per drawing 96M25121

Table of Contents

List of Tables

List of Figures

1.0 SCOPE

This specification establishes the performance, design, development, qualification and flight hardware requirements for the MPLM (Multi Purpose Logistics Module) programmable thermostat. These Programmable thermostats will replace the existing fixed temperature set point units in the Passive Thermal Control Subsystem (PTCS) 28 Vdc shell heater circuits.

1.1 Objectives

The objective of the thermostat development program is to replace current PTCS thermostats with improved state of the art programmable devices. This upgrade will improve the efficiency of the MPLM on-orbit shell heater operations by providing better shell temperature control through the use of programmable set points with closed loop feedback control capability. This feature results in more efficient STS heater power consumption, leading to increased cryogenic savings resulting from reduced fuel cell operations. The reduction in the cryogenic usage is needed to support future STS payload manifests, including the implementation of the MPLM active refrigeration cooling system. On-orbit shell heater operations are necessary in order to provide thermal conditioning to prevent condensation from forming inside the MPLM and to prevent the NPRA (negative pressure relief assembly) from opening upon de-orbit.

Additional benefits from the use of the programmable thermostats include more efficient pre and post launch operations. The need for warm air purges are no longer necessary since the programmable thermostats will allow the PTC heaters to more accurately control the internal MPLM environment. Other benefits include cost savings in future mission operations due to reduced engineering analytical services.

1.2 Description

The device is an electronic assembly used in conjunction with a Resistance Temperature Device (RTD) and heaters to provide temperature control for the exterior surface and interior environment of the MPLM. This device will consist of an electronic thermostat module and a mechanical interface assembly.

2.0 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown (or if no issue is specified, the issue in effect at the date of fabrication) form a part of this specification to the extent specified herein. In the event of conflict between documents the order of precedence for the design to requirements will be a follows:

a. This End Item Specification

b. National Aeronautics and Space Administration (NASA) documents
c. Other documents

MIL-STD-1285	Marking of Electrical and Electronic Parts
NHB 6000.1	Requirements for Packaging, Handling and Transportation
NASA-STD-6001	Flammability, Odor, Offgassing and Compatibility Requirements and Test Procedures for Materials in Environments that Support Combustion
MSFC-STD-2905	MSFC Tailoring Guide for NASA-STD-8739.4 Crimping, Interconnecting Cables, Harness, and Wiring
JSC-SP-R-0022	General Specification 0 Vacuum Stability Requirements of Polymeric Material for Spacecraft Application
MSFC-RQMT-2918	Requirements For Electrostatic Discharge Control
MSFC-SPEC-521	Electromagnetic Compatibility Requirements on Payload Equipment and Subsystems
NSTS-21000-IDD-ISS	International Space Station Interface Definition Document
ICD-A-21350	Shuttle Orbiter/MPLM Cargo Element Interfaces
ISS-MPLM-MAN-020	Programmable Thermostat Software User's Manual
MSFC-PLAN-PT PP001	MPLM Programmable Thermostat Hardware Development Plan
ASME Y14.5M-1982	Dimensioning and Tolerancing
NHB 5300.4 (3A-1)	Requirements for Soldered Electrical Connections
NHB 5300.4 (3G)	Requirements for Interconnecting Cables, Harnesses, and Wiring
NHB 5300.4 (3H)	Requirements for Crimping and Wire Wrap
NHB 5300.4 (3I) Change Notice 1	Change Notice 1 Requirements for Printed Wiring Board
NHB 5300.4 (3J)	Requirements for Conformal Coating and Staking of Printed Wiring Boards and Electronic Assemblies
NHB 5300.4 (3K)	Design Requirements for Rigid Printed Wiring Boards and Assemblies
SSP 41172	Qualification and Acceptance Environmental Test Requirements
ED17-MPLM-THERM-PROC-001	Full Functional Test Procedure for the Thermostat Assembly of the Multi Purpose Logistics Module (MPLM)
96M21937	Surface RTD
TIA/EIA-485-A	Electrical Characteristics of Generators and Receivers in Balanced Digital Multi-Point Systems

3.0 SYSTEM REQUIREMENTS

3.1 System Definition

This configuration will allow for closed loop control capability through the use of remote temperature sensors connected to each thermostat.

A block diagram of the new MPLM PTCS heater system is shown in Figure 1. Each heater circuit will contain a programmable thermostat connected to an external temperature sensor (RTD), used to provide continuous temperature monitoring capability. The capability shall exist such that all of the MPLM thermostats' set points and control spans can be programmed remotely during ground processing through the communication cable using a Ground Support Equipment (GSE) computer.

Each thermostat will have programmable temperature set points and control spans. The data acquisition system will use a 485 serial interface communications cable to provide digital control capability. The electronic thermostat will be capable of cycling +28 V dc power (maximum 5 amperes) to the heater element/elements based on the control temperature set point, the control span, and an external temperature sensor.

The installed programmable thermostat and RTD sensor is shown in Figure 2. The mounting assembly consists of an Aluminum bracket bonded to the MPLM external pressure shell. The programmable thermostat will be secured to the mounting bracket via mounting screws (bolts, etc). The RTD will be mounted no more than 36 inches from the thermostat electronics module and near the existing thermostats. This installation design allows for easy replacement of failed units.

3.1.1 Design Mission Life Requirements

The MPLM Programmable Thermostat shall be designed for 25 missions.

3.2 Design, Construction, and Physical Dimensions

The general and individual item requirements shall be in accordance with NASA and MSFC handbooks and standards.

3.2.1 Thermostat Envelope

The envelope dimensions shall be 2.00 in. X 2.50 in. maximum footprint and .75 in. maximum height. Dimensioning and tolerancing shall be per ASME Y14.5M-1982. Mounting surface of the carrier shall be flat.

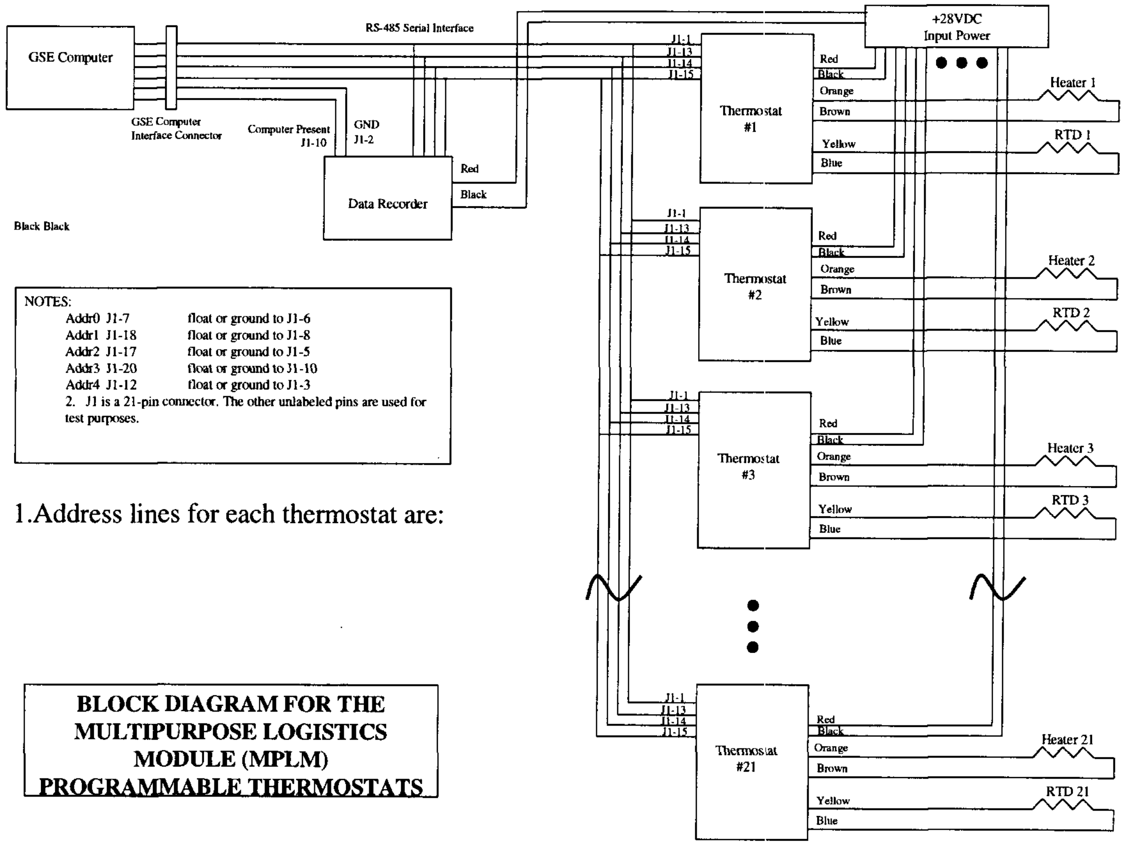
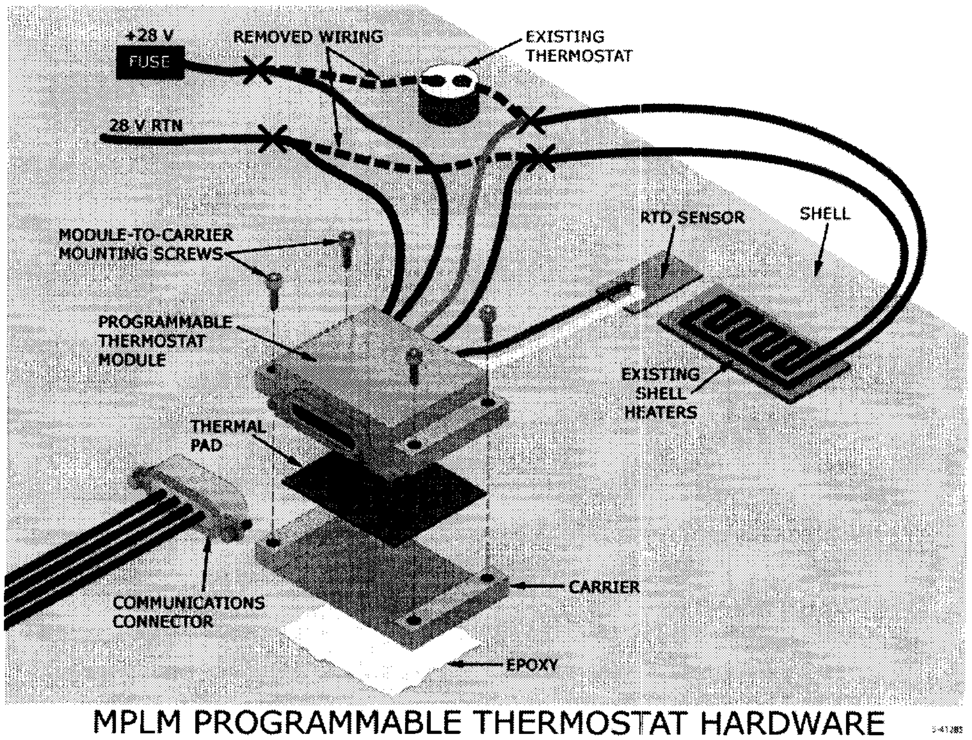


Figure 1: MPLM Programmable Thermostat Heater System Block Diagram

3.2.2 Functional Design

A representative thermostat system layout is shown in Figure 2.



Note: Delete thermal pad and add green ground wire from one of 4 module-to-carrier mounting screw locations to structure. This figure is representative of the thermostat configuration and is not the actual configuration.

Figure 2: Programmable Thermostat Unit w/Mounting Bracket

3.2.3 Input/Output Interface

3.2.3.1 Wire Terminal Interface

The power input, power output, and temperature sensor interfaces shall be pigtail leads. The power input pigtails shall be 20 AWG (American Wire Gauge) twisted pair. The power output pigtails shall be 20 AWG twisted pair. The temperature sensor pigtails shall be 24 AWG twisted pair. The twisted pairs shall be twisted per NHB 5300.4. The wire terminal function shall be in accordance with Table I. MSFC-STD-2905 shall be followed.

Table I Wire Terminal Function Table

Terminal No Wire Color	Function	Description	Wire Size
1: Red	Power	28Vdc Input Power	AWG 20
2: Black	Power Return	28 V dc Input Power Return	AWG 20
3: Orange	Heater Power (+)	28 V dc Output to Heater	AWG 20
4: Brown	Heater Return (-)	28 V dc Output Return	AWG 20
5: Blue	RTD (+)	Temperature Sensor, Signal (+)	AWG 24
6: Yellow	RTD Return (-)	Temperature Sensor, Signal Return	AWG 24

3.2.3.2 Connector Interface

The RS-485, address, Program/Run, and Reset interfaces shall be provided in a connector. The connector part number and pin-out shall be as defined in Table II

Table II Connector Pin Function Table

J1: MS-262-021-435-22OS

Pin Number	Function	Description
1	RS-485 RXD H	Receive hi
2	Ground	Ground
3	Ground	Ground
4	Load/Program	Programming control bit
5	Ground	Ground
6	Signal Ground	Ground
7	Address Bit 0	Address bit 0
8	Ground	Ground
9	TP2	Test Point 2
10	Ground	Ground
11	+28 V dc	Input power
12	Address Bit 4	Address bit 4
13	RS-485 RXD L	Receive lo
14	RS-485 TXD L	Transmit lo
15	RS-485 TXD H	Transmit hi
16	TP1	Test Point 1
17	Address B:+2	Address bit 2
18	Address B: +1	Address bit 1
19	TP3	Test Point 3
20	Address Bit: +3	Address bit 3
21	Reset	Reset

3.2.4 EEE Parts

The use of commercial and industrial grade EEE (Electrical, Electronic, Electro-mechanical) parts is permitted in the design and fabrication of the electronics assembly. In particular, Plastic Encapsulated Microcircuits (PEMs) are allowed. Established reliability parts are encouraged where available. All EEE parts will be procured with Certificate of Compliance and identify manufacturer and lot/date code. There will be no additional testing performed at the piece part level and burn-in will be performed at the assembled unit level per SSP 41172 paragraph 5.1.8. The parts shall be verified by functional testing of the completed electronics assembly after required burn-in.

3.2.5 Materials

All materials shall meet outgassing and flammability requirements per NASA-STD-6001.

3.2.6 Ionizing Radiation

N/A

3.2.7 Temperature and Thermal Design

The thermostat shall be capable of operation within the temperature range of -20°C to 58°C in a vacuum. The thermal design shall insure thermal conduction through the wiring and the mounting surface for operation at these temperatures.

3.2.8 Weight

The combined weight of the electronics module and mounting bracket shall not exceed 100 grams (3.53 oz). The weight of the pigtail wires are not included in this mass allotment.

3.3 Performance Characteristics

Unless otherwise specified, the electrical performance characteristics are as specified herein and apply over the full-recommended case operating temperature range specified in 3.2.7 herein.

3.3.1 Electrical Performance Characteristics

Electrical characteristics shall be as specified in Table III.

3.3.2 Electrical Function

The thermostat shall provide on/off control of 28 Vdc power to resistive heaters based on feedback from an RTD. The thermostat on/off control shall be based on programmable control set point and span. The control set point is the desired control temperature, and the span is defined as the temperature difference between the on and off temperatures about the control set point. The control set point shall be selectable from 5 to 45°C in 1 °C increments. The span shall be selectable from 1 °C to 10 °C in 1.0 °C increments.

The thermostat shall provide a 4 wire RS-485 serial interface to allow the control set point and span to be modified via remote command on the ground only. The reference is through the 28V return. The thermostat shall also provide, as a minimum, the following feedback when requested by command via the RS-485 interface: current control set point and span settings, temperature measurement via RTD, and results of self-test command. The thermostat shall incorporate a default control set point and span to be used if programmable control set point or span is corrupted.

Table III Electrical Performance Characteristics

Test	Conditions unless Otherwise specified Input Voltage = 28 Vdc	Min	Max	Unit
Quiescent Power Supply Current	Input power = 32Vdc, Ih = 0A	--	25	mA
Maximum Output Current I_h	Input power = 32Vdc	5.0		A
Maximum Voltage drop from input power to output power	Ih = 5 Adc		2.0	Vdc
Turn on time	Ih = 0 to 5.0 Adc $T_R = T_{0.9 \times Ih} - T_{0.1 \times Ih}$		100	milli-second
Turn off time	Ih = 5.0 to 0 Adc $T_F = T_{0.1 \times Ih} - T_{0.9 \times Ih}$		100	milli-second

3.3.2.1 Sensors

The design shall be such that when connected per Figure 1 the thermostat shall meet the system functional requirements as outlined herein. The sensor will be a Resistive Thermal Device (RTD) manufactured in accordance with 96M21937. The RTD to be used is calibrated for 1.0 milliampere (mA) operation.

3.3.2.2 Output Switch

The output switch shall be capable of directly operating external heaters from the thermostat internal 28Vdc line. The heater load will be a resistive low inductance design. The switch shall be capable of conducting 5.0 amperes continuously.

3.3.2.3 Voltage Operation

The thermostat shall be designed for operation from 22 to 32 Vdc, and shall not be damaged by voltages less than 22 Vdc. Operating within this range, the thermostat shall meet the specifications of Table III.

3.3.2.3.1 Input Reverse Polarity Protection

None, care must be made in connecting input power.

3.3.2.4 Serial Interface

The thermostat shall incorporate an RS-485 serial link to allow control set point and span to be selected.

3.3.2.4.1 Electrical Characteristics

The serial interface shall meet the driver/receiver electrical characteristics as defined in TIA/EIA-485-A.

3.3.2.4.2 Serial Bus Address

The RS-485 address shall be selected via five address lines and signal ground lines in the J1 data interface connector backshell as defined in Table II. An open circuit shall be interpreted as a '1'. If the resistance between an address pin and a signal ground pin shall be $\leq$1 ohm then that signal shall be interpreted as a '0'.

3.3.2.4.3 Software Interface Definition

Software interface shall be in accordance with Programmable Thermostat Software User's Manual, ISS-MPLM-MAN-020.

3.3.2.5 Default Set Points

The thermostat shall incorporate a back-up, default control set point and span in the event that either the programmed set point or span become corrupted in memory. The default control set point and span shall be selectable within the same ranges and increments as the programmed set point and span. Definition of the default set point implementation shall be 23° C. The default span shall be 1° C.

3.3.3 Instrumentation

The following instrumentation shall be provided and be available upon request via the RS-485 serial interface.

- RTD temperature with a minimum range of 0°C to 50 °C with an accuracy of ± 0.5°C

3.3.4 Program/Run Function

During programming and software testing the capability to modify the thermostat program code or default control set point or span shall be provided by pulling the Program/Run line low.

3.3.5 Reset Function

During programming and software testing the capability to reset the thermostat microcontroller shall be provided by pulling the Reset line low.

3.3.6 Self-test Function

The capability to perform a self-test on the thermostat via RS-485 command shall be provided. The description of the command and response of the thermostat shall be as defined in ISS-MPLM-MAN-020.

3.3.7 Environments

3.3.7.1 Vibration Loads

The thermostat shall meet the random vibration loads as specified in Tables IV and V.

Table IV Thermostat Design Vibration Levels

Frequency (Hz)	Design Level
20	0.04 g^2/Hz
20 to 65	+7.6 dB/Octave
65 to 180	0.8 g^2/Hz
180 to 360	-7.0 dB/Octave
360	0.16 g^2/Hz
360 to 1400	-2.6 dB/Octave
1400	0.05 g^2/Hz
1400 to 2000	-4.9 dB/Octave
2000	0.028 g^2/Hz
Composite	16.8 g_{rms}

Duration: 810 seconds (25 Missions)
Three mutually perpendicular axes

Table V Thermostat Acceptance Vibration Levels

Frequency (Hz)	Level
20	0.01 g^2/Hz
20 to 65	+7.6 dB/Octave
65 to 180	0.2 g^2/Hz
180 to 360	-7.0 dB/Octave
360	0.04 g^2/Hz
360 to 1400	-2.6 dB/Octave
1400	0.0125 g^2/Hz
1400 to 2000	-4.9 dB/Octave
2000	0.007 g^2/Hz
Composite	8.4 g_{rms}

Duration: 60 seconds
Three mutually perpendicular axes

3.3.7.2 Electromagnetic Interference (EMI)

The thermostat shall meet the emissions and susceptibility requirements of MSFC-SPEC-521. The thermostat shall also be compatible with transients produced by the Orbiter hydraulic circulation pump start-up as defined in section 7.3.4.2.2 of ICD-A-21350.

3.3.7.3 Grounding and Isolation

+28 V dc return shall be isolated from chassis at each thermostat by greater than 1 mega ohm. The thermostat chassis shall be electrically bonded to the MPLM structure and shall meet a Class H bond in accordance with NSTS 21000-IDD-ISS.

3.3.7.4 Electrostatic Discharge (ESD)

The thermostat shall be designed to comply with Class 2 minimum requirements in accordance with MSFC-RQMT-2918.

3.3.7.5 Thermal Requirements

The thermostat shall be designed to operate between -20° C and +58° C. Component qualification levels for thermal vacuum/cycle tests shall be -31°C and +69°C, while component flight acceptance test levels shall be -20°C and +58°C.

3.4 Electrical Test Requirements

The electrical test requirements shall be in accordance with ED17-MPLM-THERM-PROC-001, Full Functional Test Procedure for the Thermostat Assembly of the Multi Purpose Logistics Module (MPLM) . These test procedures shall identify procedures to verify the electronics at printed wiring assembly, complete functional test to verify all operational modes, and a monitoring test procedure to verify performance during system functional and environmental testing.

3.5 Marking

Part marking shall be in accordance with MIL-STD-1285 and shall include the following, in the order of precedence shown:

a. Part identification number per section 1.2.1.
b. Serial Number.
c. Tags showing the terminal numbers defined in Table 1 except the shield need not be marked.
d. Electrostatic discharge sensitivity (ESDS) identifier.
e. Other information at the manufacturer's option.

3.6 External Non Metallic Materials

External nonmetallic materials, including those used for device marking, shall be flame resistant, odor free and non-toxic in accordance with NASA-STD-6001. All materials shall meet the thermal vacuum stability requirements as specified in JSC-SP-R-0022A. Nonmetallic materials shall be approved by the design activity.

3.7 Rework

Rework shall be in accordance with NHB 5300.4.

3.8 Handling

This device shall be handled in accordance with NHB 6000.1 and MSFC-RQMT-2918.

3.9 Ground Support Equipment

3.9.1 Computer Interface Cable

The GSE computer interface cable shall be fabricated with standard industry practices and supplied by MSFC.

3.9.2 GSE Computer

The GSE Computer shall be a standard IBM compatible computer.

4.0 VERIFICATION

This section contains the requirements for formal qualification of the programmable thermostat to be used on MPLM. The qualifications consist of:

a. Data for the reliability analysis will be collected and recorded during qualification.

b. Qualification requirements are specified in sections 4.2 and 4.3. Qualification represents the broadest scope of verification within design tolerances to which a configuration/end item is subjected. It encompasses the entire range of activity to verify that the design conforms to requirements when subjected to environmental life-cycle conditions. Flight-like hardware is normally used for qualification testing. If actual flight hardware is used for qualification testing, it shall be in accordance with SSP 41172. If development test data is intended to be used to qualify hardware, its intent shall be predeclared. Environmental models shall be used to represent environments that cannot be achieved under the conditions of ground testing. Simulators, used for verifying requirements, require validation so that the item undergoing qualification cannot distinguish between the simulator and actual operational hardware/software.

c. Integration testing and checkout shall be conducted during end item buildup. Activities such as continuity checking and interface mating will be performed. Activities such as major component operation in the installed environment, support equipment compatibility, and documentation verification will be proven during qualification.

d. Formal verification of performance characteristics occurs for the full range of performance requirements during qualification and for normal operational and critical physical requirements during acceptance.

4.1 General

Programmable thermostat qualification will be conducted by inspection, analysis, demonstration, or test. Test is chosen as the verification method to verify performance requirements that are not readily observable.

These methods are defined as follows:

a. Inspection. Engineering inspection, hereafter referred to as inspection, is a method of verification that determines conformance to requirements by the use of standard quality control methods to ensure compliance by review of drawings and data. This method is used wherever documents or data can be visually used to verify the physical characteristics of the product instead of the performance of the product.

b. Analysis. Analysis is a process used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may be used when it can be determined that: (1) rigorous and accurate analysis is possible, (2) test is not cost effective, and (3) inspection is not adequate.

Verification by similarity is the process of analyzing the specification criteria for hardware configuration and application for an article to determine if it is similar or identical in design, manufacturing process, and quality control to an existing article that has previously been qualified to equivalent or more stringent specification criteria. Special effort will be made to avoid duplication of previous test from this or similar programs. If the previous, application is considered to be similar, but not equal to or greater in severity, additional qualification tests shall concentrate on the areas of new or increased requirements.

c. Demonstration. Demonstration consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics such as human engineering features, services, access features, and transportability. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedures.

d. Test. Test is a method in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test shall be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist which could compromise personnel safety, adversely affect flight systems or payload operation, or result in a loss of mission objectives; or for any components directly associated with Space Station and Orbiter interfaces. The analysis of data derived from tests is an integral part of the test program, and should not be confused with analysis as defined above.

4.1.1 Responsibility for Verifications

Unless otherwise specified in the contracts, FD24 is responsible for assuring the closure of all verification activities as specified herein.

4.2 Segment Quality Conformance Inspections

Mandatory qualification test requirements for test setup, methodology, and conditions are as specified in SSP 41172. Demonstrations, analyses, inspections, and any additional test requirements are specified herein. Individual verification requirements do not require a standalone verification to be performed but may be combined with the satisfaction of other verification requirements to prevent unnecessary redundancy and optimize commonality.

4.3 System Requirement

No verification required.

4.3.1 System Definition

No verification required.

4.3.1.1 Design Mission Life Requirements

This requirement shall be verified by analysis.

4.3.2 Design, Construction and Physical Dimensions

This requirement shall be verified by inspection and test. The mechanical piece parts will be inspected by MSFC S&MA personnel.

4.3.2.1 Thermostat Envelope

This requirement shall be verified by analysis.

4.3.2.2 Functional Design

No verification required.

4.3.2.3 Input/Output Interface

No verification required.

4.3.2.3.1 Wire Terminal Interface

This requirement shall be verified by inspection.

4.3.2.3.2 Connector Interface

This requirement shall be verified by inspection.

4.3.2.4 EEE Parts

This requirement shall be verified by demonstration.

4.3.2.5 Materials

This requirement shall be verified by analysis and inspection.

4.3.2.6 Ionizing Radiation

N/A

4.3.2.7 Temperature and Thermal Design

This requirement shall be verified by qualification and acceptance thermal vacuum and thermal cycle testing per SSP 41172 and by system level analysis.

4.3.2.8 Weight

This requirement shall be verified by test.

4.3.3 Performance Characteristics

4.3.3.1 Electrical Performance Characteristics

This requirement shall be verified by test.

4.3.3.2 Electrical Function

4.3.3.2.1 Sensors

Sensors will be delivered with calibration data and shall be verified by analysis of calibration data versus requirement.

4.3.3.2.2 Output Switch

This requirement shall be verified by test.

4.3.3.2.3 Voltage Operation

This requirement shall be verified by test.

4.3.3.2.3.1 Input Reverse Polarity Protection

N/A

4.3.3.2.4 Serial Interface

This requirement shall be verified by test.

4.3.3.2.4.1 Electrical Characteristics

This requirement shall be verified by analysis.

4.3.3.2.4.2 Serial Bus Address

This requirement shall be verified by test.

4.3.3.2.4.3 Software Interface Definition

This requirement shall be verified by test.

4.3.3.2.5 Default Set Points

This requirement shall be verified by test.

4.3.3.3 Instrumentation

This requirement shall be verified by test.

4.3.3.4 Program/Run Function

This requirement shall be verified by test.

4.3.3.5 Reset Function

This requirement shall be verified by test.

4.3.3.6 Self-test Function

This requirement shall be verified by test.

4.3.3.7 Environments

This requirement shall be verified by test.

4.3.3.7.1 Vibration Loads

This requirement shall be verified by test.

4. 3.3.7.2 Electromagnetic Interference (EMI)

This requirement shall be verified by test.

4.3.3.7.3 Grounding and Isolation

This requirement shall be verified by test.

4.3.3.7.4 Electrostatic Discharge (ESD)

This requirement shall be verified by inspection.

4.3.3.7.5 Thermal Requirements

This requirement shall be verified by test.

4.3.4 Electrical Test Requirements

This requirement shall be verified by analysis.

4.3.5 Marking

This requirement shall be verified by inspection.

4.3.6 External Non Metallic Materials

This requirement shall be verified by analysis.

4.3.7 Rework

This requirement shall be verified by inspection.

4.3.8 Handling

This requirement shall be verified by inspection.

4.3.9 Ground Support Equipment

4.3.9.1 Computer Interface Cables

This requirement shall be verified by inspection.

4.3.9.2 GSE Computer

This requirement shall be verified by inspection.

5.0 PACKAGING

5.1 Packing, Packaging and Preservation

The Thermostat shall be preserved, packaged, packed, marked, labeled, handled, stored, and transported as specified in NHB 6000.1. Level C preservation, packing and packaging shall be used unless otherwise specified on the purchase contract.

5.2 Unit Packaging

Each thermostat shall be packaged in a manner so that the individual thermostat may be handled and stored without bending or strain on the wire terminals. The unit package shall be capable of reuse after opening.

6.0 ABBREVIATIONS AND ACRONYMS

A	Amperes
AQL	Acceptable Quality Level
AWG	American Wire Gauge
CSI	Customer Source Inspection
°C	Degree(s) Celsius
dB	decibel
dc	direct current
DPA	Destructive Physical Analysis
EEE	Electrical, Electronic, Electromechanical
EMI	Electro magnetic Interference
ESD	Electrostatic Discharge
G	grams
GSE	Ground Support Equipment
Hz	Hertz (cycles per second)
Km	kilometer
mA	milliamperes
micro A	microampere
MPLM	Multi Purpose Logistics Module
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NPRA	Negative Pressure Relief Assembly
Oz	ounce
PTC	Passive Thermal Control
PTCS	Passive Thermal Control System
RAM	Random Access Memory
RTD	Resistance Temperature Device
Rtn	return
S&MA	Safety and Mission Assurance
S/N	Serial Number
STS	Space Transportation System
Vdc	Voltage, direct current

APPENDIX A: REQUIREMENTS VERIFICATION MATRIX

VERIFICTION TEST LEVEL
DEV DEVELOPMENT
QAL QUALIFICATION
ACC ACCEPTANCE
NR NOT REQUIRED

VERIFICATION ASSESSMENT METHOD
ANL ANALYSIS
INS INSPECTION
TST TEST
DEM DEMONSTRATION

Section 3 Requirements Paragraph	Verification Test Levels				Verification Assessment Method				Section 4 Verification Paragraph	Verification Responsibility
	NR	DEV	QAL	ACC	ANL	INS	DEM	TST		
3.1	X								4.3.1	
3.1.1					X				4.3.1.1	FD24
3.2						X		X	4.3.2	S&MA
3.2.1					X				4.3.2.1	S&MA
3.2.2	X								4.3.2.2	
3.2.3	X								4.3.2.3	
3.2.3.1						X			4.3.2.3.1	S&MA/ED17
3.2.3.2						X			4.3.2.3.2	S&MA/ED17
3.2.4							X		4.3.2.4	ED 17
3.2.5					X	X			4.3.2.5	ED35
3.2.6	X								4.3.2.6	
3.2.7			X	X				X	4.3.2.7	ED26
3.2.8								X	4.3.2.8	S&MA/ED17
3.3	X								4.3.3	
3.3.1								X	4.3.3.1	ED17
3.3.2									4.3.3.2	ED17
3.3.2.1					X				4.3.3.2.1	ED17
3.3.2.2								X	4.3.3.2.2	ED17
3.3.2.3								X	4.3.3.2.3	ED17
3.3.2.3.1	X								4.3.3.2.3.1	
3.3.2.4								X	4.3.3.2.4	ED17
3.3.2.4.1					X				4.3.3.2.4.1	ED17
3.3.2.4.2								X	4.3.3.2.4.2	ED17
3.3.2.4.3								X	4.3.3.2.4.3	ED17
3.3.2.5								X	4.3.3.2.5	ED17
3.3.3								X	4.3.3.3	ED17
3.3.4								X	4.3.3.4	ED17
3.3.5								X	4.3.3.5	ED17
3.3.6								X	4.3.3.6	ED17
3.3.7								X	4.3.3.7	S&MA/
3.3.7.1								X	4.3.3.7.1	S&MA/
3.3.7.2								X	4.3.3.7.2	S&MA/
3.3.7.3								X	4.3.3.7.3	ED17
3.3.7.4						X			4.3.3.7.4	S&MA
3.3.7.5			X	X				X	4.3.3.7.5	ED26
3.4					X				4.3.4	ED17
3.5						X			4.3.5	S&MA
3.6					X				4.3.6	ED35
3.7						X		X	4.3.7	S&MA
3.8						X			4.3.8	S&MA
3.9	X								4.3.9	
3.9.1						X			4.3.9.1	ED17
3.9.2						X			4.3.9.2	ED17
5.0	X								5.0	
5.1				X		X			5.1	FD24
5.2				X		X			5.2	FD24

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C H	DOCUMENT NUMBER	DRL DSH	DRL REV	TITLE	CCBD NO.	PCN	PC	EFFECTIVITY
*	MSFC-SPEC-3274	205	-	MULTI PURPOSE LOGISTICS MODULE THERMOSTAT END ITEM SPECIFICA TION	MP3-00-0074	MP00070	MP	1

	CHG NO.	CHG REV	CHG NOTICE	RESPONSIBLE ENGINEER	RESPONSIBLE ORGANIZATION	ACTION DATE	DESCRIPTION
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6. DOCUMENT/DRAWING TITLE:	7. REPORT TYPE:
Programmable Thermostat End Item Specification Rev. D	

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477-72-61	NA	NA

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30. ISSUE:	31. ANNEX:	32. SCN:	33. DCN:	34. AMENDMENT:

35. APPENDIX:	36. ADDENDUM:	37. CCBD:	38. CODE ID:	39. IRN:
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