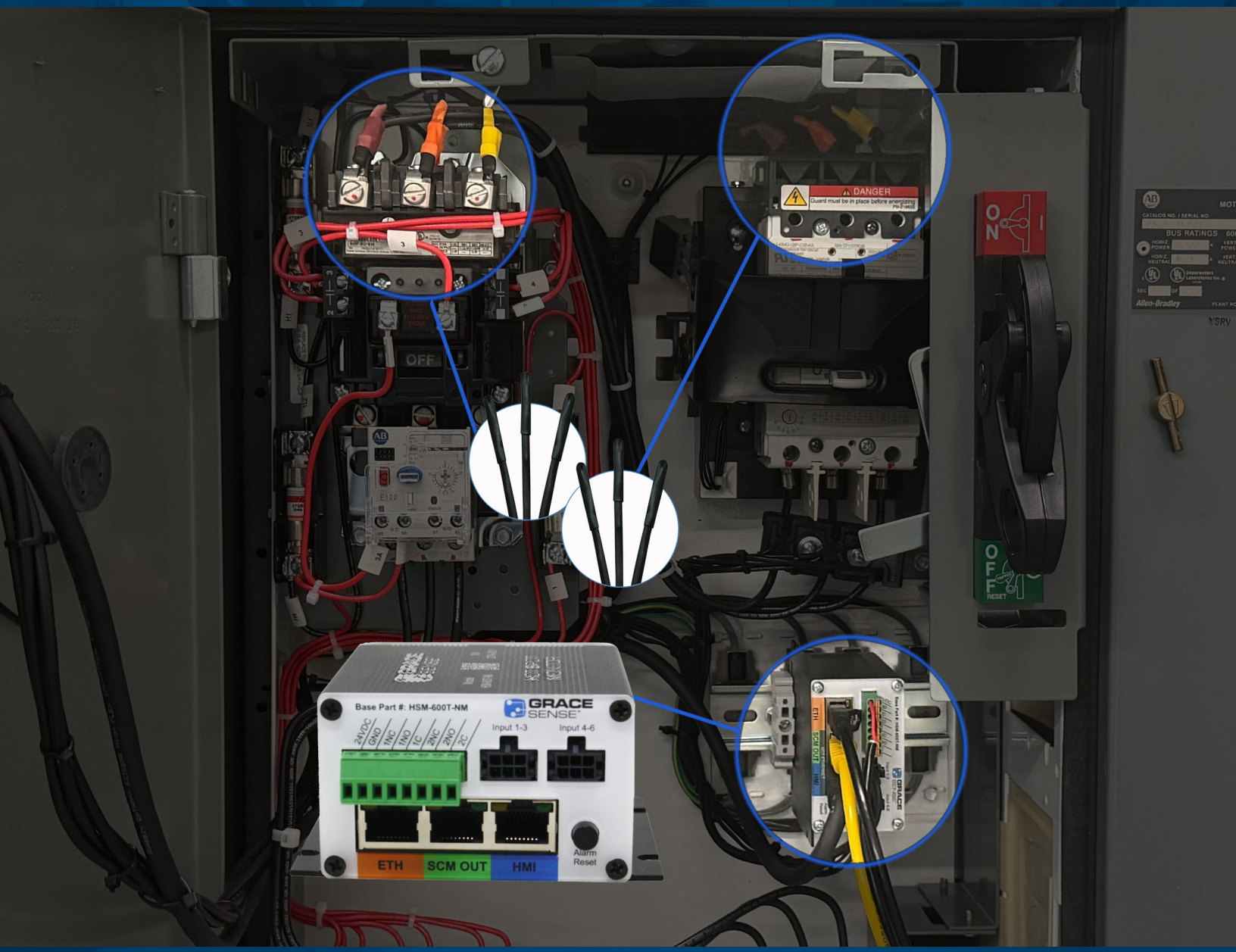
GRACE SENSE™



HOT SPOT MONITOR 600

(HSM 600)

INSTALLATION GUIDE

INSTRUCTION GUIDE: GS-HSM-IG-EN

Contact Information:

Grace Technologies, Inc.

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Davenport, IA 52807

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graceport.com/continuous-thermal-monitoring

Signal Words

As stated in ANSI Z535.4-2007, the signal word is a word that calls attention to the safety sign and designates a degree or level of hazard seriousness. The signal words for product safety signs are **"Danger"**, **"Warning"**, and **"Caution"**. These words are defined as:

DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, is used to address practices not related to personal injury.

NOTICE

NOTICE is used to address practices not related to personal injury.

Qualified Person

For the purposes of this manual, a qualified person, as stated in NFPA 70E®, is one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. In addition to the above qualifications, one must also be:

1. Trained and authorized to energize, de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

2. Trained in the proper care and use of personal protective equipment (PPE) such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

3. Trained in rendering first aid if necessary.

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Ch 1 General Information

The equipment is designed for use, installation, and maintenance by knowledgeable users of such equipment having experience and training in the field of high voltage electricity. This document and all other documentation shall be fully read, understood, and all warnings and cautions shall be abided by. If there are any discrepancies or questions, the user shall contact Grace Technologies, Inc. immediately at 1.800.280.9517.

⚠ WARNING

The equipment described in this document may contain high voltages and currents which can cause death or serious injury.

⚠ WARNING

Prior to adjustments, servicing, maintenance, or any act requiring the operator to make physical contact with the equipment, the power source must be disconnected and the equipment grounded. Failure to do so may result in death or serious injury.

NOTICE

The information in this instruction bulletin is not intended to explain all details or variations of the Grace equipment, nor to provide for every possible contingency or hazard to be met in connection with installation, testing, operation, and maintenance of the equipment. For additional information and instructions for particular problems, which are not presented sufficiently for the user's purposes, contact Grace Technologies at 1.800.280-9517.

NOTICE

Grace Technologies, Inc. reserves the right to discontinue and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

A. Scope

The information in this instruction bulletin describes the following 600 VAC thermistor-based temperature monitoring system:

- GraceSense™ Hot Spot Monitor 600 (HSM 600)

B. Purpose

The information in this instruction bulletin is intended to provide information required to properly operate and maintain the temperature monitoring system described in *Ch. 1 General Information, A. Scope*

This instruction bulletin provides:

1. Safety guidelines
2. General descriptions of the operation and maintenance of the Hot Spot Monitor 600
3. Information for ordering renewal parts
4. Illustrations, photographs, and description of the Hot Spot Monitor 600

The illustrations contained in this document may not represent the exact construction details of each Hot Spot Monitor 600 installation. The illustrations in this document are provided as general information to aid in showing component locations only.

All illustrations and photos are shown using de-energized equipment.

⚠ WARNING

Be sure to follow the appropriate safety precaution while handling any of the equipment. Failure to do so may result in serious injury or death.

C. Approvals and Certifications

1) **Safety Information**
Hot Spot Monitor 600 is UL Listed to UL 61010-1. Refer to product labeling for certification details.

2) **Radio Frequency Information**
This device contains digital circuitry and may generate radio frequency energy. Compliance with applicable FCC and international EMC regulations has not yet been formally evaluated.

3) **Electromagnetic Compatibility**
The Hot Spot Monitor 600 has been designed with consideration for electromagnetic compatibility. Formal testing to EN 61326-1 has not been completed.

D. Instruction Bulletins Availability

Instruction bulletins can be obtained by contacting: Grace Technologies, Inc., by calling 1.800.280.9517 or email: sales@gracetechnologies.com

NOTICE

Changes to the instruction bulletin may be implemented at any time and without notice. Go to: graceport.com/continuous-thermal-monitoring to ensure use of the current instruction bulletin for the GraceSense™ equipment.

Ch 2 Safety

A. Safe Work Condition

The information in Section A is quoted from NFPA 70E 2024 - Article 120, 120.6 Process for Establishing and Verifying an Electrically Safe Work Condition.

120.6 Process of Achieving an Electrically Safe Work Condition

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

2. After properly interrupting the load current, OPEN the disconnecting device(s) for each source.

3. Wherever possible, visually verify that all blades of the disconnecting devices are full open or that draw out-type circuit breakers are withdrawn to the test or fully disconnected position.

4. Release stored electrical energy.

5. Block or relieve stored nonelectrical energy in devices to the extent the circuit parts cannot be unintentionally energized by such devices.

6. Apply lockout/tagout devices in accordance with a documented and established procedure.

7. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Test each phase conductor or circuit part at each point of work to test for the absence of voltage. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

   Informational Note: See ANSI/ISA 61010-1 (82.02.01)/UL 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 V and below.

8. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

B. Safety Guidelines

Study this instruction bulletin and all other associated documentation before installing the Hot Spot Monitor 600.

Each user has the responsibility to instruct and supervise all personnel associated with usage, installation, operation, and maintenance of this equipment on all safety procedures. Furthermore, each user has the responsibility of establishing a safety program for each type of equipment encountered.

The safety rules in this instruction bulletin are not intended to be a complete safety program. The rules are intended to cover only some of the important aspects of personnel safety related to Hot Spot Monitor 600.

C. General

1. Only supervised and qualified personnel trained in the usage, installation, operation, and maintenance of the monitoring system shall be allowed to work on this equipment.

2. It is mandatory that this instruction bulletin, any supplements, and service advisories be studied, understood, and followed.

3. Maintenance programs must be consistent with both customer experience and manufacturers' recommendations, including service advisories and instruction bulletin(s).

4. Service conditions and equipment applications should also be considered in the development of safety programs. Variables include ambient temperature; humidity; actual continuous current; thermal cycling; number of operations; interrupting duty; and any adverse local conditions including excessive dust, ash, corrosive atmosphere, vermin and insect infestations.

D. Specific

1. **DO NOT WORK ON ENERGIZED EQUIPMENT.** If work must be performed on an energized circuit, appropriate PPE must be worn and NFPA 70E guidelines must be followed.

2. **DO NOT WORK ON EQUIPMENT WITH THE CONTROL CIRCUIT ENERGIZED.**

3. **ALL COMPONENTS SHALL BE DISCONNECTED BY MEANS OF A VISIBLE BREAK AND SECURELY GROUNDED FOR SAFETY OF PERSONNEL PERFORMING MAINTENANCE OPERATIONS ON THE EQUIPMENT.**

4. Interlocks are provided to ensure the proper operating sequences of the equipment and for the safety of the user. If for any reason an interlock does not function as described, do not make any adjustments, modification, or deform the parts. **DO NOT FORCE THE PARTS INTO POSITION. CONTACT GRACE TECHNOLOGIES FOR INSTRUCTIONS.**

E. Safety Labels

The equipment described in this document has DANGER, WARNING, CAUTION, and instruction labels attached to various locations. All equipment DANGER, WARNING, CAUTION, and instruction labels shall be observed when the circuit breaker is handled, operated, or maintained.

NOTICE

Warning and Caution labels are located in various places in and on the switchgear and on the circuit breaker's removable element. Always observe these Warnings and Caution labels. Do NOT remove or deface any of these Warning/Caution labels.

Ch 3 Equipment Description

A. General

The GraceSense™ Hot Spot Monitor 600 (HSM 600) is engineered for continuous thermal monitoring (CTM) in electrical environments and intended for use in low voltage and low current environments, where standard measurement methods like thermistors, RTD's and the like, are suitable. The sensor head has an insulated cap which can be strapped in place or otherwise attached on or near the source of heat. All components within the HSM 600 system are UL rated at 600 VAC.

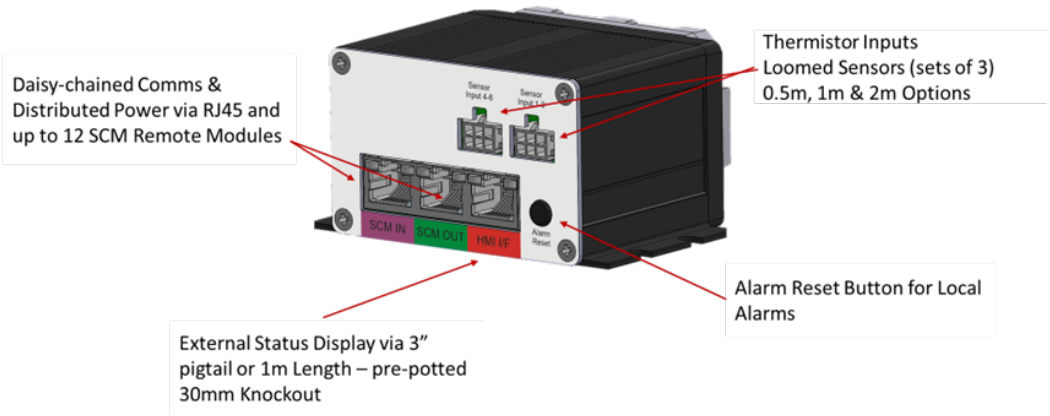
The Hot Spot Monitor 600 system is comprised of, at a minimum, one Sensor Conditioning Network Module (SCM-NM), six temperature sensors, and an external ambient temperature reference. The system captures real-time temperature data across all sensing points, enabling dynamic calculations of differential temperature (ΔT), also known as Rise Over Ambient (RoA), and dew point. Warning and alarm conditions are logged with time-stamped entries to support traceability and diagnostics. All raw data measurements and derived values are accessible via MODBUS TCP/IP or EtherNet/IP protocols, ensuring compatibility with supervisory control and data acquisition (SCADA) systems and predictive maintenance platforms. This architecture supports compliance with industry standards (NFPA 70B, IEEE 2969) relating to continuous thermal monitoring which encourages integration into broader asset reliability frameworks.

B. Sensing System Overview

The GraceSense™ Hot Spot Monitor 600 system consists of four major components:

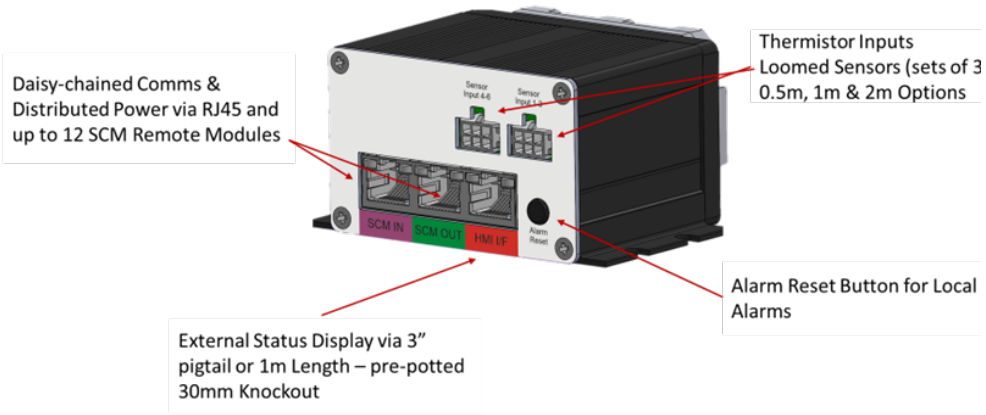
1. The Sensor Conditioning Network Module (SCM-NM) serves as the foundational communications interface for the Hot Spot Monitor 600 system. It supports a remote Status Display, six temperature inputs, and two relay latching alarm contacts, and has onboard ambient temperature and humidity sensors for calculating dew point values. The SCM-NM is capable of operating as a stand-alone system but can support up to twelve SCM Remote Modules (SCM-RM) using daisy-chained RJ45 cables. The SCM-NM distributes 24 VDC power and provides two-way communication to all SCM-RMs.

Figure 1 - SCM-NM Network Module



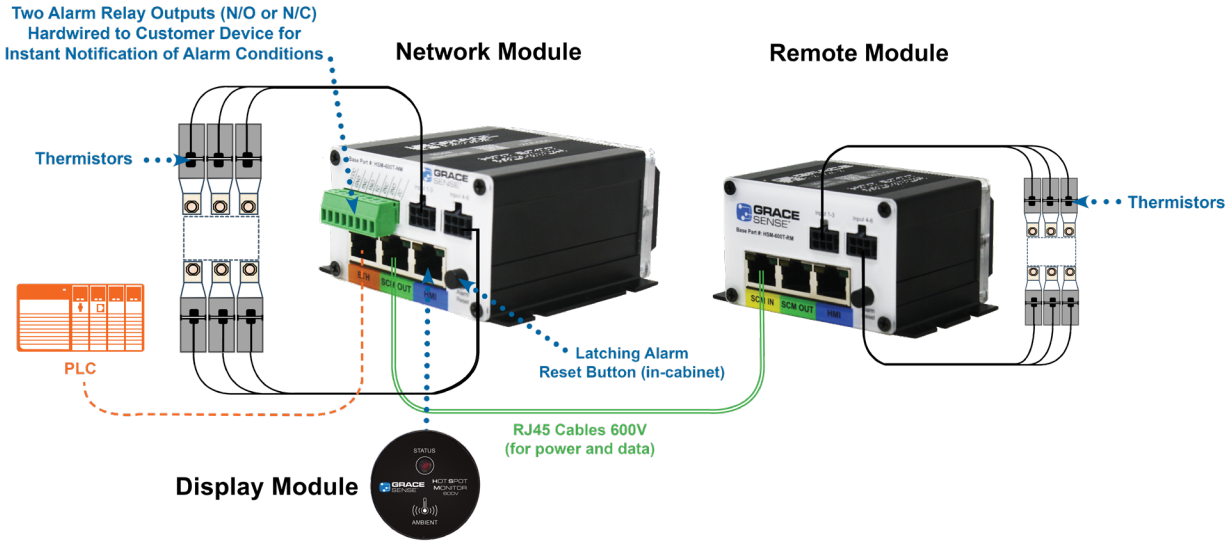
2. The Sensor Conditioning Remote Module (SCM-RM) serves as a local temperature monitoring interface with support for an external Status Display module and six temperature inputs and has onboard ambient temperature and humidity sensors for calculating dew point values. There must be one SCM-NM to support up to 12 SCM-RMs through daisy-chained 600V rated RJ45 cables, so the SCM-RM may receive power and communication messages, as well as transmit alarming details.

Figure 2 - SCM-RM Remote Module



Networking the primary components are as shown in Figure 3 below interconnected with a single RJ45, 600V rated, shielded cable (sold separately).

Figure 3 - Overall System Configuration



3. The Thermistor Temperature Sensors have insulated tips and provide SCM module(s) with the localized temperature information necessary to evaluate Potential Failure Points (PFP) within monitored electrical equipment. These sensors are harnessed in sets of three and available in several lengths (see HSM 600 Ordering Guide for options). The sensors and associated cabling are UL listed rated at 600 VAC, and therefore, can route safely within a low voltage electrical environment.

Figure 4 - Insulated Thermistor Design

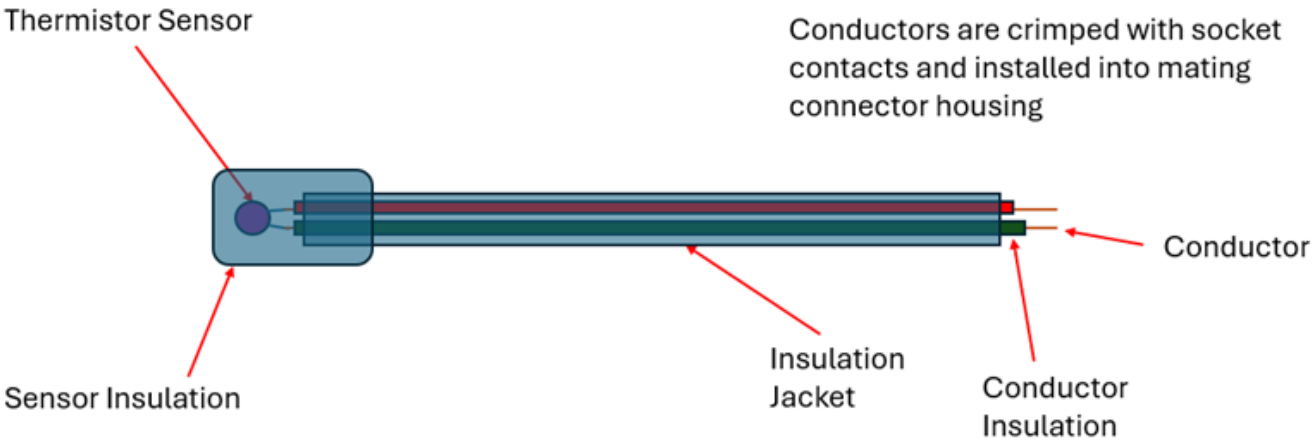
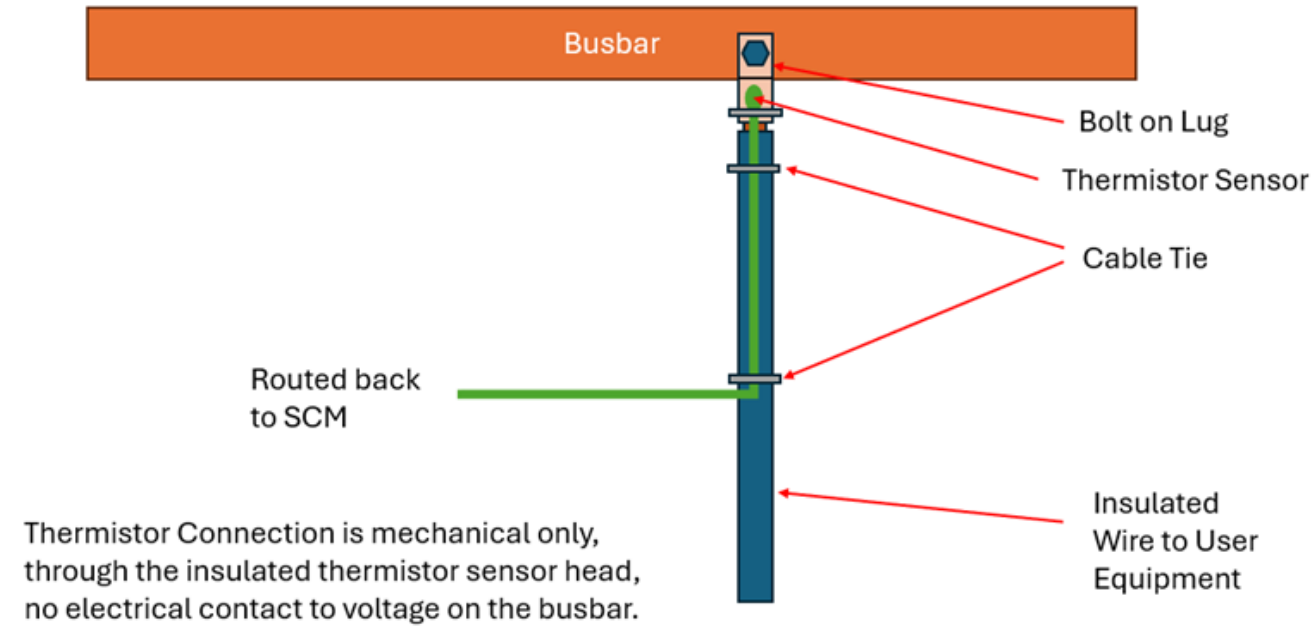


Figure 5 - Clamp-On Cable Mounting of Thermistor



Thermistor Attachment on Busbar or Insulated Cable

Sensors are rated to attach directly to the busbar or to be clamped to a load-carrying insulated cable using one or more of the following methods:

- Plastic cable ties, 600V rated
- Electrical thermal tape or rubber tape
- Hook and loop (Velcro®)
- Thermal-rated epoxy

⚠ WARNING

Be sure to follow the appropriate safety precaution while handling any of the equipment. Failure to do so may result in serious injury or death.

4. The Status Display is an externally-mounted display designed as a through-panel, visible indicator of alarm status within the system. This Display also serves as an ambient input value for the differential temperature (ΔT) - Rise Over Ambient (RoA) calculations.

   It is important that ambient be captured externally to the electrical equipment to ensure an accurate baseline for thermal rise-over-ambient calculation ΔT as defined in the IEEE C37.20.1 standard. Internal placement near hot components can distort readings due to localized heating and temperature gradients, resulting in a lower ΔT and under-reporting of true rise over ambient and potentially masking critical thermal risks.

   This through-door option, using a 30mm knockout, supports these critical features by enabling an immediate alert indication while maintaining a reliable ΔT measurement, giving both responsiveness and precision in one solution.

   A single Status Display can be connected to an SCM-NM and used as the ambient reference for the entire CTM network, allowing all units to calculate in compartment ΔT from a single reference. In this setup, this Display's LEDs will indicate the worst-case status for the entire network. Alternatively, separate Status Displays can also be connected to each SCM-RM, allowing status to be independently indicated in each monitored compartment

   The multi-color status LED provides immediate visual feedback by displaying distinct colors—either solid, flashing, or both—to indicate various system conditions. This intuitive signaling enhances situational awareness and enables rapid diagnostics without the need for external tools or interfaces.

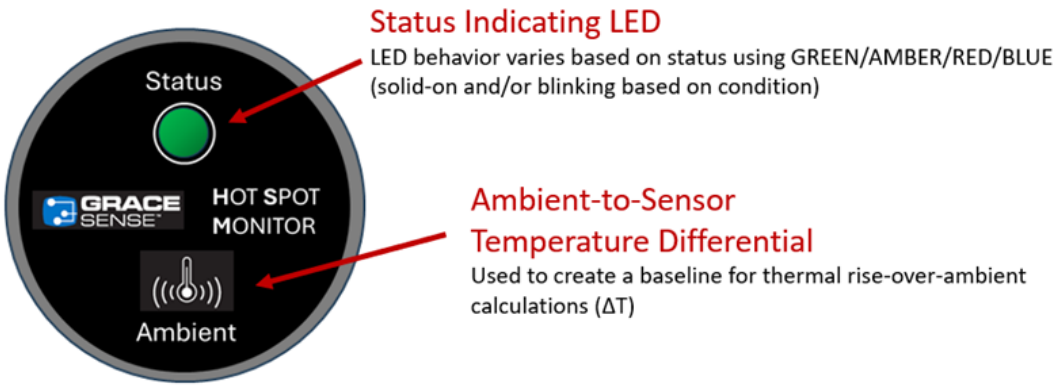
Figure 6 - Status Display w/ 1m male cable

Figure 7 - Status Display with 3" female cable

It is recommended that at least one Status Display be used for each section/lineup of equipment.

Alternatively, an external ambient input may be used if available and referenced in the HSM 600 Web-server for the ΔT calculation. Note: Without the Grace-supplied Status Display, there will be no visible alarm indication, unless another form of indicator is configured via one of the Output Relay contacts on the SCM-NM device, or other external communication interface.

Figure 8 - Status Display Faceplate



Status Display LED Behavior

LED Indication	Status	Definition	Action
Solid GREEN 	All Sensor Temps GOOD	All Temps are actively below defined WARNING and ALARM thresholds, and all previous WARNING and ALARM events have been acknowledged.	No action needed.
Flashing AMBER 	Active Temp WARNING	One or more Temp is actively exceeding its defined WARNING threshold.	Investigate reasons for elevated temperature levels and mitigate if able. Watch closely for any further temperature escalation. If set up in the HSM 600 Webserver, this WARNING can latch an output relay.
Solid AMBER 	Previous Temp WARNING Not Acknowledged	One or more Temp has previously exceeded its defined WARNING threshold but has not yet been acknowledged.	Investigate reasons for elevated temperature levels and acknowledge WARNING. Watch closely for any further temperature escalation.
Flashing RED 	Active Temp ALARM	One or more Temp is actively exceeding its defined ALARM threshold.	Immediately investigate reasons for elevated temperature levels and mitigate if able. Watch closely for any further temperature escalation. If set up in the HSM 600 Webserver, this ALARM can latch a relay.
Solid RED 	Previous Temp ALARM Not Acknowledged	One or more Temp has previously exceeded its defined ALARM threshold but has not yet been acknowledged.	Immediately investigate reasons for elevated temperature levels and acknowledge ALARM. Watch closely for any further temperature escalation.
Flashing BLUE 	Active Dew Point WARNING or ALARM	One or more calculated dew point level is actively exceeding its defined WARNING or ALARM threshold	Immediately investigate and take action to reduce dew point levels at the elevated locations. These ALARMS can trigger a SCM-NM relay.

**Note 1: Temperature (GREEN, YELLOW, RED) and Dew Point (BLUE) Indication Can Occur Simultaneously*
***Note 2: See Section C.1 for Alarm Acknowledgement Instructions*

C. General Specifications

Model	SCM-NM	SCM-RM
Feature	Network Module Sensor Conditioning	Remote Module Sensor Conditioning
Input Power	24 VDC Input, 1A max, Class 2 or Limited Power Source	24 VDC - Powered over RJ45 from SCM-NM or SCM-RM
Output Power	24 VDC, 18W Max	24 VDC - Powered over RJ45 from SCM-NM or SCM-RM
Power Consumption	Approx 1.50 Watts	Approx 1.50 Watts
Dimensions	3.62"L x 3.61"W x 1.84"H	3.62"L x 2.64"W x 1.84"H
Mounting	Surface Mount or DIN Rail	Surface Mount or DIN Rail
Communications	Ethernet I/P, Modbus TCP/IP	DNP3 directly to SCM-NM via RJ45
Temperatures	Operate: -20ºC to +75ºC	Operate: -20ºC to +75ºC
System Isolation	Power: DC/DC Converter Comms: Digital Isolation IC	Power: DC/DC Converter Comms: Digital Isolation IC
Cabling between SCM Devices	RJ45, 600 VAC Rated, Shielded *(sold separately)*	RJ45, 600 VAC Rated, Shielded *(sold separately)*
Onboard Sensors	Temperature & Humidity used for Dew Point Calculations	Temperature & Humidity used for Dew Point Calculations
Onboard Memory	8Mb (up to 50 years of backup)	8Mb (up to 50 years of backup)
Latching Alarm Reset	Mechanical Push button or SCM-NM Webserver	
Relay Contact Outputs	Two Form-C Relay Contacts (NO/NC)	None. Relay Contacts are located only on the SCM-NM
Extruded Aluminum Housing	Length: 92.1mm (3.62 in) Height: 46mm (1.85 in) Width: 91.8mm (3.61 in)	Length: 67.1mm (2.64 in) Height: 46mm (1.85 in) Width: 91.8mm (3.61 in)
Webserver for System Setup	User interface for status viewing, threshold setup, data download	Setup originates in SCM-NM

Table A - Sensor Conditioning Modules (SCM)

Standard Thermistor Sensor Specifications

Feature	G-HSM-ACC-T3-XXYY
Type	NTC Thermistor
Sensor length	Sensor length: 0.5m, 1m, 2m
Grouping	Loomed in Sets of 3
Voltage Rating	Conductor Insulation & Insulated Sheath rated at 600 VAC
Flame Rating	VW-1
Resistance	Ohms @ 25°C: 10,000Ω
Resistance Tolerance	+/-% @ 25°C:1%
R-T Curve	J
Temp. Coefficient	(% / °C) @ 25°C: -4.4, Beta (K) 0-50°C (preferred): 3892
Operating Temp	-40°C to +105°C
UL CAT Ratings	CATIII, 600V - Thermistor evaluated in end-product 61010-1 certification
Type & IP Ratings	Type Ratings 1, 2, 4X indoor, 5, 12, 12K, & 13 and Ingress Protection Ratings IP6X, IPX6, IPX9, IPX9K
Relative Humidity	95%
Pollution Degree	2

Table B - Standard Thermistor Sensor Specifications

Status Display Specifications

Model Numbers	Status Display 1 (-SD1)	Status Display 2 (-SD2)
Description	3” Female Pigtail	1m Cable with Male Connector
Operating Voltage	5 VDC Switched Power Distribution	5 VDC Switched Power Distribution
Maximum Voltage	5 VDC Switched Power Distribution	5 VDC Switched Power Distribution
Mounting	30mm Knockout with Gasket and Locknut to secure to equipment	30mm Knockout with Gasket and Locknut to secure to equipment
Communication	DNP3 directly to SCM-NM or SCM-RM via RJ45	
LED	Multi-color Status LEDs (See Chap 3, Sec B.5.a for LED Behavior)	Multi-color Status LEDs (See Chap 3, Sec B.5.a for LED Behavior)

Table C - Status Display Specifications

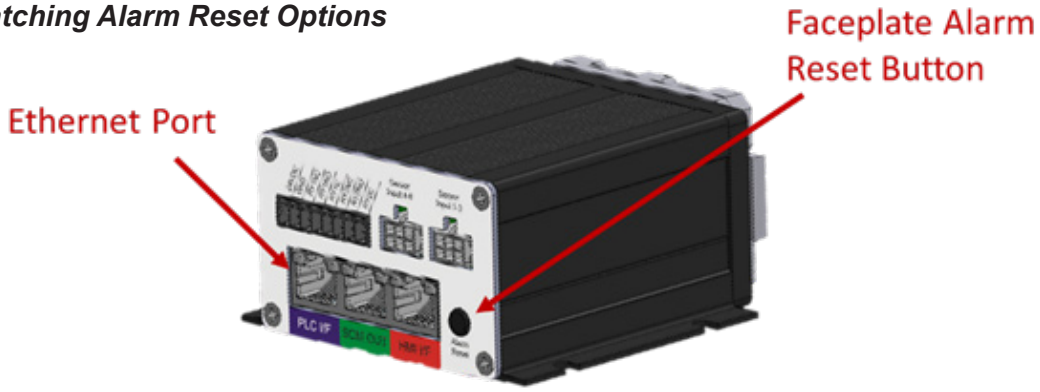
1. **Latching Alarm Feature**

   Both SCM models include a faceplate RESET push button to acknowledge latched alarms. An alarm latches when any SCM reaches a warning or alarm threshold value set in the HSM Webserver. Once latched, this warning or alarm will remain active until it is manually acknowledged and reset. The intent is to drive investigation of elevated temperatures and assess the failure risk at the monitored point.

   The following data can be used to generate a latched warning or alarm:
   - Largest difference between thermistor temperature and ambient temperature
   - Actual thermistor temperature
   - Largest difference between two thermistor temperatures
   - Dew Point (Temperature at which condensation is likely to occur)

   There are several ways in which latched alarm can be reset/cleared:
   - Local SCM-NM – Faceplate Reset Button (single push) will reset alarms for this unit
   - Local SCM-RM – Faceplate Reset Button (single push) will reset alarms for this unit
   - System Reset – SCM-NM Faceplate Reset Button (push and hold) will reset all alarms on the HSM network
   - Embedded Webserver accessible via Ethernet (left most port on the SCM-NM) – will reset all alarms on the HSM network

Figure 9 - Latching Alarm Reset Options



2. **Dew Point Monitoring**
   Each SCM module includes both an embedded ambient temperature sensor and a humidity sensor. The HSM 600 uses these inputs to calculate the dew point value within the compartment in which it is located, providing the ability to issue a warning or alarm related to condensation risk.

   While relative humidity provides an indication of air moisture content, it does not directly indicate when condensation will occur. Dew point, by contrast, represents the temperature at which moisture in the air will condense on surfaces inside the electrical apparatus. Monitoring dew point is more effective than humidity alone, as it provides a clear warning to the risk of corrosion, insulation failure, and electrical faults.

   The warning indication of dew point is defined within the SCM-NM Webserver. The user can indicate how far in advance of the dew point they desire a warning or alarm, in °F or °C.

Dew Point Example 1:
Warm Environment:

- Internal air temperature inside enclosure: 95°F
- Relative humidity inside enclosure: 70%
- Dew point: about 84°F
- Relative Dew Point Alarm Threshold: 5°F
- If a busbar, door surface, or cable shield drops to 84°F or lower (maybe during a cool night, or from air conditioning in adjacent areas), moisture can form right on the conductive surface. In this case, the Relative Dew Point Alarm would trigger when the temperature drops below 89°F.

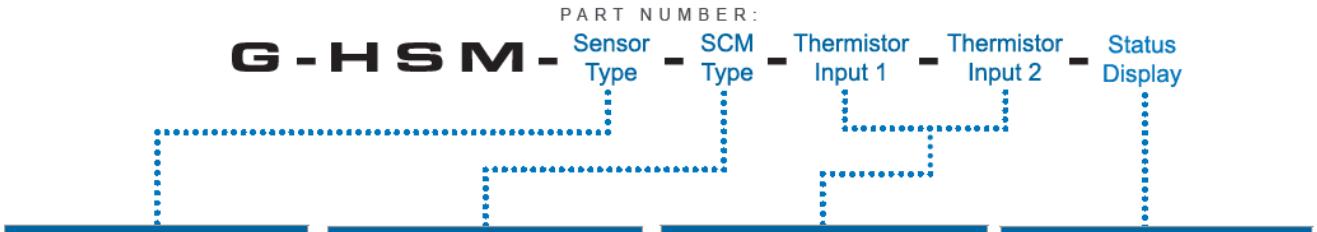
Dew Point Example 2:
Cool Environment:

- Internal air temperature inside enclosure: 60°F
- Relative humidity inside enclosure: 80%
- Dew point: about 54°F
- Relative Dew Point Alarm Threshold: 5°F
- In this case, early morning temperature swings or outside cold air infiltration can push the metal surface temperature below 54°F and cause condensation droplets. That is exactly the condition that corrodes terminals or leads to partial discharge and tracking. In this case, the Relative Dew Point Alarm would trigger when the temperature drops below 59°F.

	Humidity	Dew Point
What is it	% of moisture in air relative to max it can hold at given temp	Temperature at which moisture condenses into liquid water
Depends on	Ambient temperature	Ambient and humidity
Condensation Risk	Indirect - high %RH doesn't always mean condensation	Direct - Shows exactly when condensation will occur
Reliability Value	May overstate or understate risk	Clear, actionable measure of condensation risk
Maintenance Impact	Reactive - requires interpretation	Proactive - enables alarms and preventative actions

Table D - Humidity and Dew Point

3. **System Part Number Buildout**
   a. Material: Nylon
   A complete HSM 600 part number follows this structure:



Sensor Type	
CODE	DESCRIPTION
600T	HSM 600 Series Thermistor

Sensor Conditioning Module (SCM) Type	
CODE	DESCRIPTION
XX	No Module
NM	Network Module *(Required for ALL systems)*
RM	Remote Module *(No more than 12 additional units – each defined)*

Thermistor Inputs *(Loomed in sets of 3)*	
CODE	DESCRIPTION
XXX	No Thermistor
0605	Thermistors, 600V Rated, 0.5m Length
0610	Thermistors, 600V Rated, 1.0m Length
0620	Thermistors, 600V Rated, 2.0m Length

Status Display with Ambient	
CODE	DESCRIPTION
XXX	No Display
SD1	Status Display, Potted Male with 1.0m Cable
SD2	Status Display, Potted Female with 3.0" Pigtail

4. **Parts Sold Separately**
   - RJ-45 Daisy-Chain Cable, 600 VAC, Shielded
   - 24 VDC Universal Power Supply, 15W, 25W

Ch 4 Installation

The installation of the GraceSense™ Hot Spot Monitor 600 (HSM 600) systems begins with identifying the equipment to be monitored. At a minimum, the system is comprised of the SCM Network Module, thermistor sensors, and the Status Display module which are installed within an industrial control panel or similar enclosure as a complete system.

Images 1 and 2 below depict an installation example on low voltage switchgear. However, the principles of installation can be carried over to many other applications where temperature monitoring is needed. Other examples include wiring splices, motor control centers, bus duct, dry-type transformers and so on.

A. Selecting a Location

The HSM 600 can measure temperatures on any equipment within its operational range. The project starts by identifying Potential Failure Points (PFP). Sensor tips may be placed on or near these locations and secured in place. Ensure each thermistor is flush to the heat surface with no potential for air gaps. Thermistors are not intended to be routed through conduit and are only intended to be mounted within the same panel as the busbar or conductor to be monitored.

The sensor components are 600 VAC rated and can be mounted directly to the bus with the appropriate means, e.g., Scotch® Rubber Splicing Tape 23 (0.030 in), Velcro® straps, or other thermal, non-conductive products, to ensure a secure connection.

Figure 10 - Sensors attached directly to insulated cables

Figure 11 - Sensors attached directly to 600VAC busbar with rubber tape

B. Mounting the HSM 600 SCM Modules

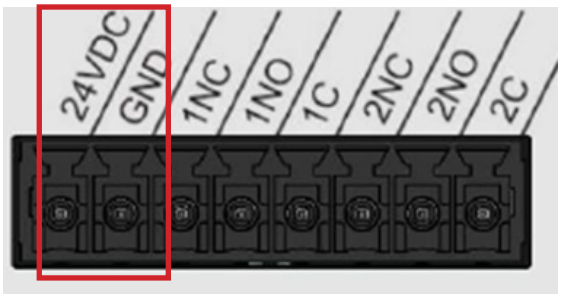
It is recommended that the SCM modules be located within the compartment they are monitoring. There are two standard mounting designs available depending on the mounting type desired: surface mount, and DIN rail mount.

Surface Mount		DIN Rail Mount	
Network Module	Yes	Network Module	Yes
Remote Module	Yes	Remote Module	Yes

Table E - SCM Mounting

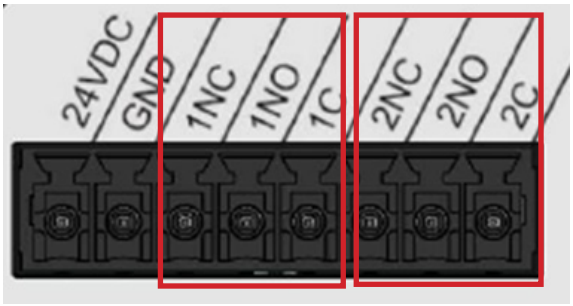
C. Powering the HSM 600 SCM Modules

The HSM 600 Networking Module (SCM-NM) operates from a 24 VDC external UL listed power source (Class 2 or Limited Power Source output) and distributes power and communications to all connected network devices. Any industrial DC power supply rated for 24 VDC may be used provided it can deliver sufficient power for all networked devices. Each unit requires ≈ 1.5 watts each under maximum load conditions. For proper installation, connect the input power to the SCM-NM terminal block through fused terminal blocks on both the positive and negative (+/–) DC lines. When using Grace-supplied 600 VAC RJ45 cables—or cables of equivalent rating—power and communications are automatically distributed to all remote SCM devices, eliminating the need for additional power supplies or wiring throughout the electrical equipment.



D. Relay Alarm Contacts

Each SCM model includes two (2) Form C interposing relay output contacts for hardwired general alarm notifications. These relays are intended to interface a PLC input to an alarm condition and they provide for signal isolation and alarm switching via their NO/NC contacts. They do not deliver alarm power. With both NO and NC relay options available, users can configure the alarm for either an alarm-open (normally-closed contact) or alarm-closed (normally-open contact) condition. These outputs are intended to be wired to a PLC or other external device or monitoring system to provide immediate notification of any alarming event.



E. Terminal Connector

The SCM-NM module utilizes a screw-down terminal connector. Ensure that all wires are fully inserted and verified secure by performing an individual wire pull test.

Note: All wiring to the terminal connector should be rated 90°C or higher.

F. Grounding

Grounding of the unit will automatically be achieved if the devices are surface mounted on a grounded apparatus. If using the DIN rail option, use the grounding plate located on the DIN rail clip.

G. HSM 600 Webserver Interface

An embedded webserver within the SCM-NM allows for a full view of all conditional information for devices in the network. It also allows for customization of warning and alarm levels, as well as other setup parameters. In many cases, hovering the mouse will display a pop-up, defining the text or describing an expected action for that location.

1. Connection to the SCM-NM Webserver

   On initial bootup, the embedded webserver can be accessed through the units' default static IP:

   a) Attach an Ethernet cable from a laptop to the ETH port on the SCM-NM.

   b) From a web browser, use the factory default static IP 192.168.1.50 to connect to the embedded HSM 600 Webserver.

2. System Status Screen

   This screen is an at-a-glance view of all current alarms by module and alarm type. These are labeled based on condition. There are three primary actions to this page:

   - STATUS OVERVIEW displays the current status of all networked devices
   - SYNC UTC TIME will sync the PC time to the SCM-NM for time-stamping alignment
   - CLEAR ALL LATCHED ALARMS is the alarm reset for all latched alarms within the network

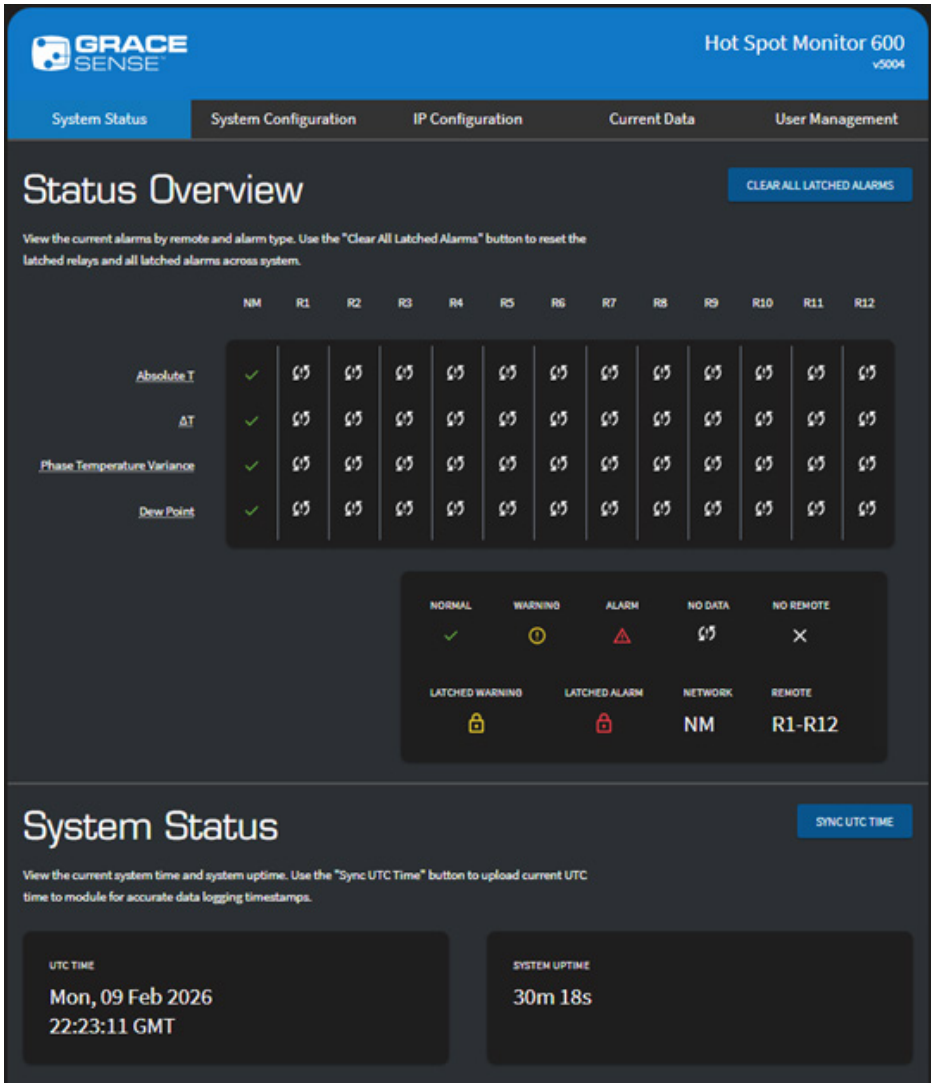


Figure 14 - Status Overview Screen

3. System Configuration Screen

   This screen allows the user to configure the HSM 600 network. These configurations can be saved locally to a SCM-NM by using the SAVE CONFIGURATION button or exported to an AOP or MODBUS configuration file by using the EXPORT button. Saved configurations may also be uploaded to a SCM-NM module using the IMPORT button. This can help save time when configuring multiple similar systems. The System Configuration screen is made up of 5 separate configuration sections.

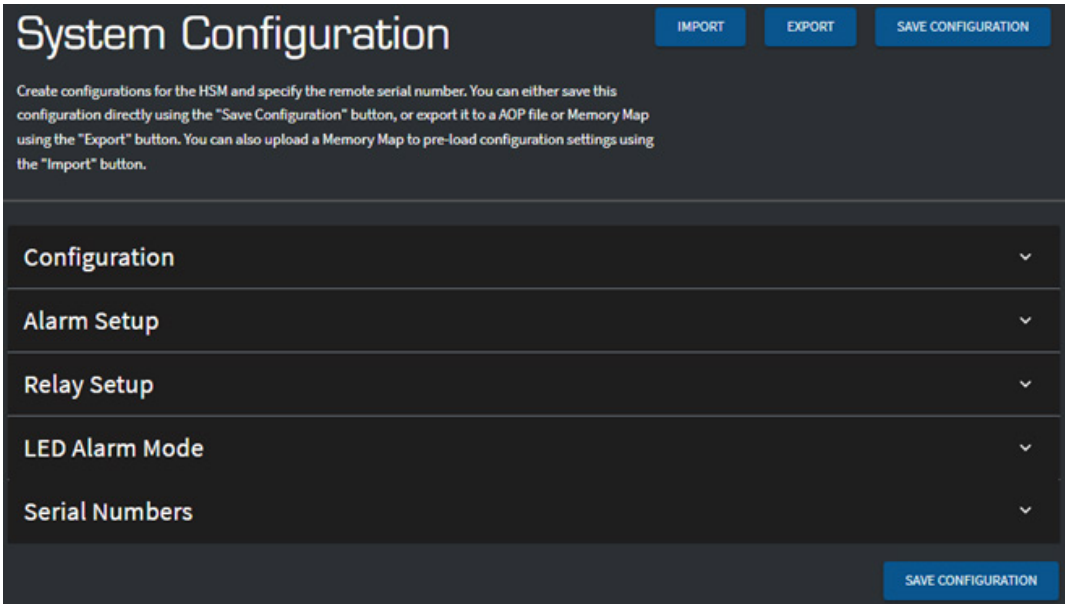


Figure 15 - System Configuration Screen

b. Grounding via dedicated PE terminal and grounding conductor. The HSM unit is equipped with a dedicated PE terminal (Terminal 8). This terminal is internally connected to grounding DIN clip contact plate. Use this contact to ground the unit if grounded DIN rail is not available.

Configuration Section

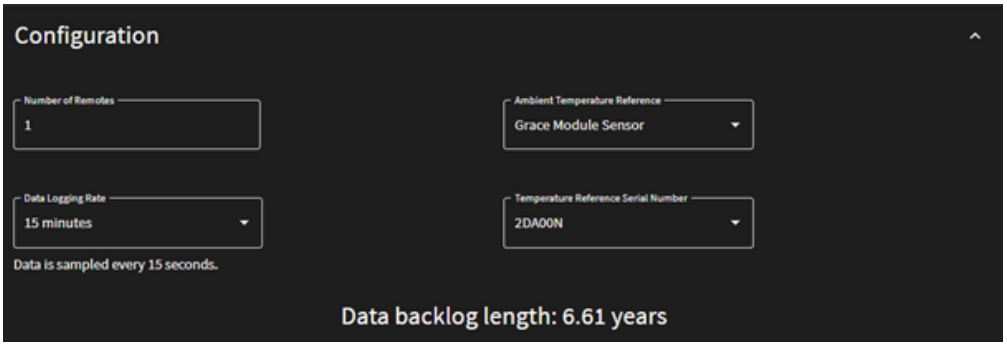


Figure 16 - Configuration Section

- Specify the number of remote SCM-RM modules in the network, if any.
- Specify the ambient temperature reference source and its serial number. Options are:
  - o An onboard temperature sensor from inside a SCM module
  - o An external temperature sensor from a Status Display unit
  - o An external source exposed through a PLC (coming soon)
    - Specify the data logging interval rate. This rate combines with the number of remote SCM-RM modules to define the available data backlog length.

Alarm Setup Section

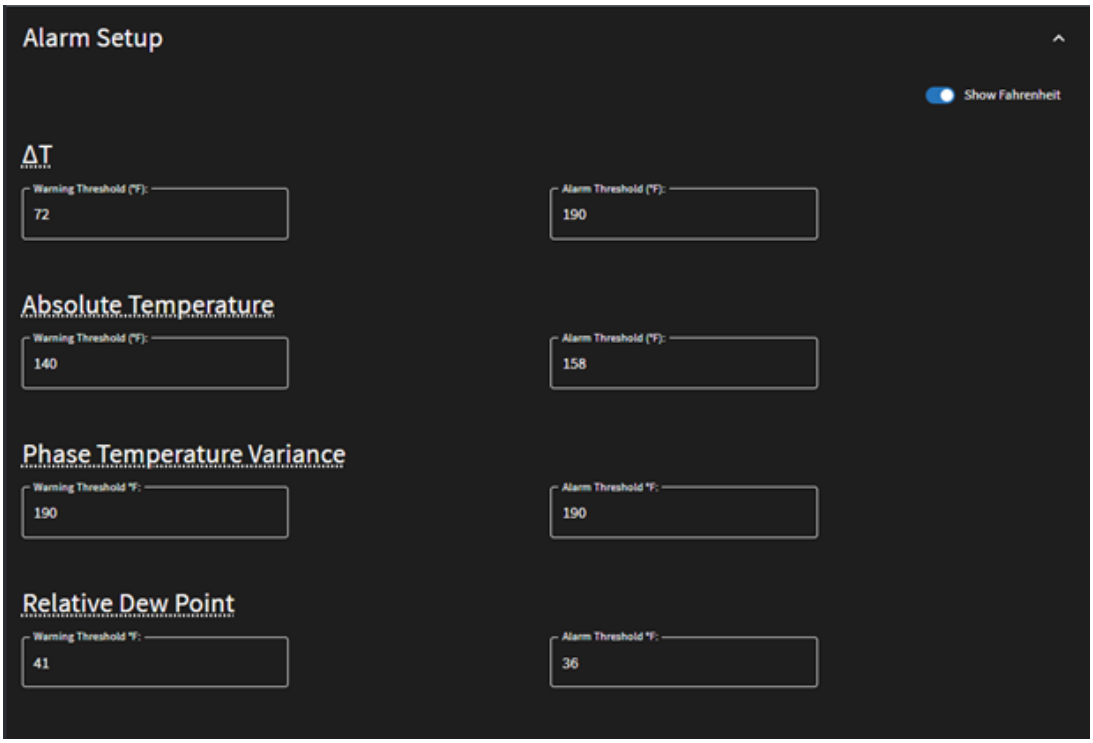


Figure 17 - Alarm Setup Section

- Specify temperature display units in Celsius (°C) or Fahrenheit (°F) via toggle switch
- Define ΔT (to ambient) Warning & Alarm thresholds
- Define Absolute Temperature (thermistor) Warning & Alarm thresholds
- Define Phase Variance (between thermistors) Warning & Alarm thresholds
- Define Relative Dew Point Warning & Alarm thresholds

Relay Setup Section

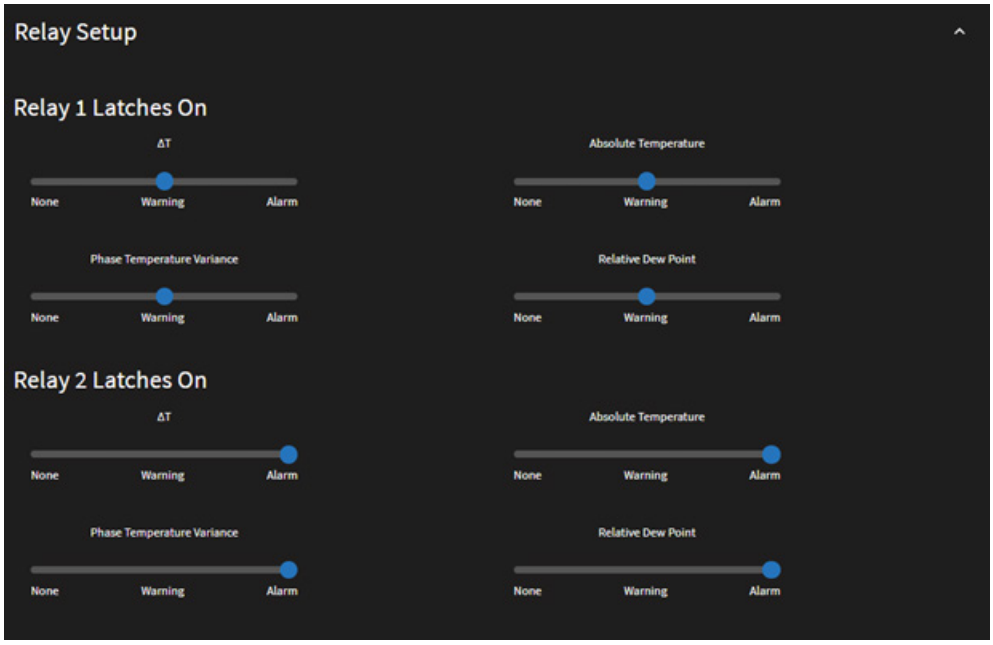


Figure 18 - Relay Setup Section

- For each of the SCM-NM relay outputs, define which of the warning or alarm values will engage the latching relay: ΔT (to ambient), absolute temperature (thermistor), phase variance (between thermistors), and/or relative dew point.
- For each of the SCM-NM relay outputs, define how a latched relay output is to be cleared. Options:
  - o Auto clear will automatically clear latched relay output when all latched trigger values drop below the corresponding warning/alarm levels.
  - o Button Clear will allow latched relay output to be cleared upon depression of the cor-responding SCM faceplate alarm reset button.
  - o Webserver Clear will allow latched relay output to be cleared using the SCM-NM webserver “Clear All Latched Alarms” button (on the Status Overview screen).

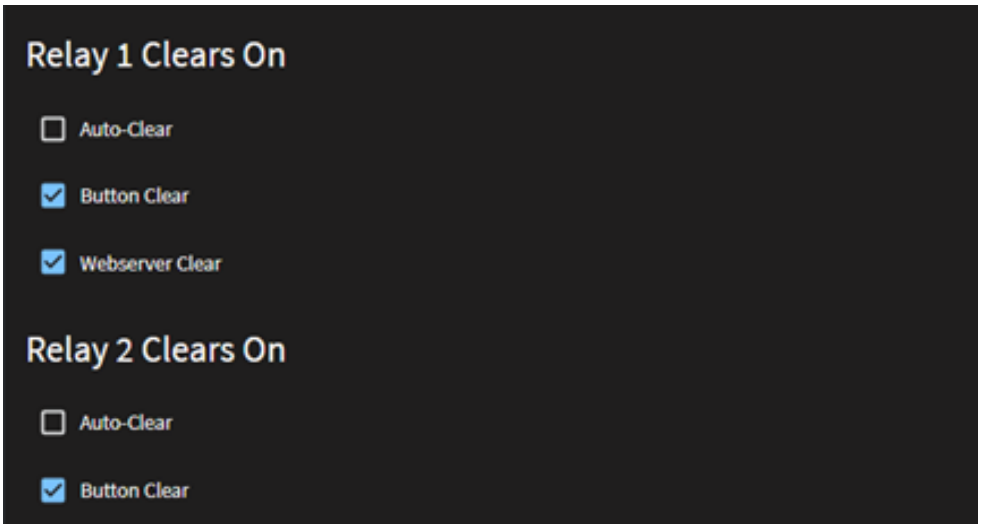


Figure 19 - Relay Clear Options

It is important to note that depending on settings, latched alarms and latched LED indicators may not be directly coupled. Thus, it is possible to configure a system so that the physical reset button is required for latched relays, but latched LEDs must be cleared through the webserver.

LED Alarm Mode Section

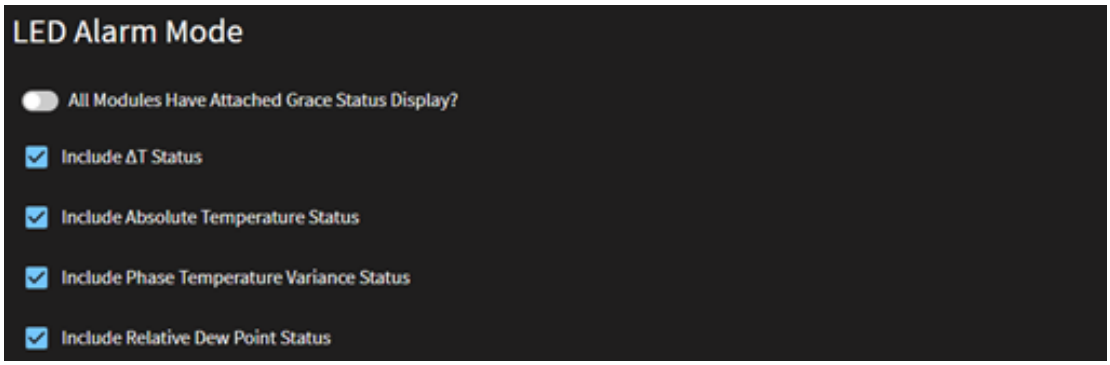


Figure 20 - LED Alarm Mode Section

- Define whether all remote SCM-RM modules have an attached Status Display. If they do, each SCM Status Display will indicate worst case status for the attached SCM. If they do not, the singular SCM-NM Status Display will indicate worst case status for the network as a whole.
- Define which of the warning or alarm values will be indicated on the Status Display LEDs: ΔT, absolute temperature, phase variance (between thermistors), and/or relative dew point.

Serial Numbers Section

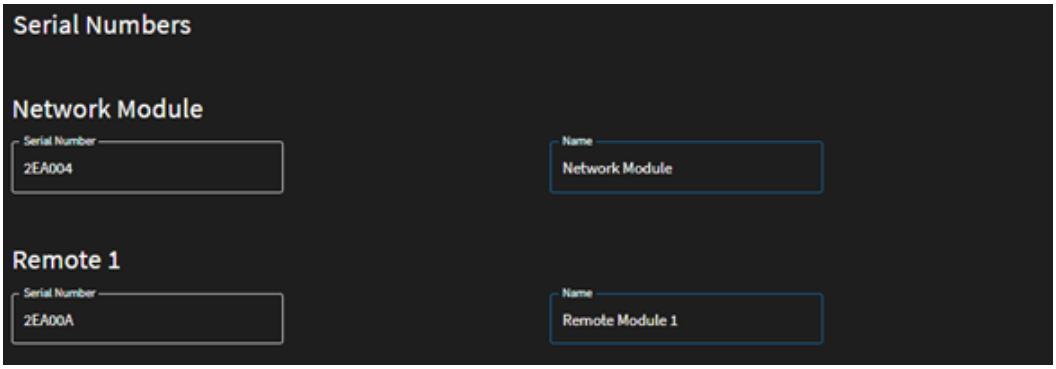


Figure 21 - Serial Numbers Section

- The SCM-NM serial number is automatically populated, as this is the device in which the HSM Webserver resides. For easier identification, an optional NAME field is provided to assign an equipment tag or custom label associated with the serial number.
- Similarly, in this section each SCM-RM must be defined. A NAME field is available for easier identification.

4. IP Configuration Screen

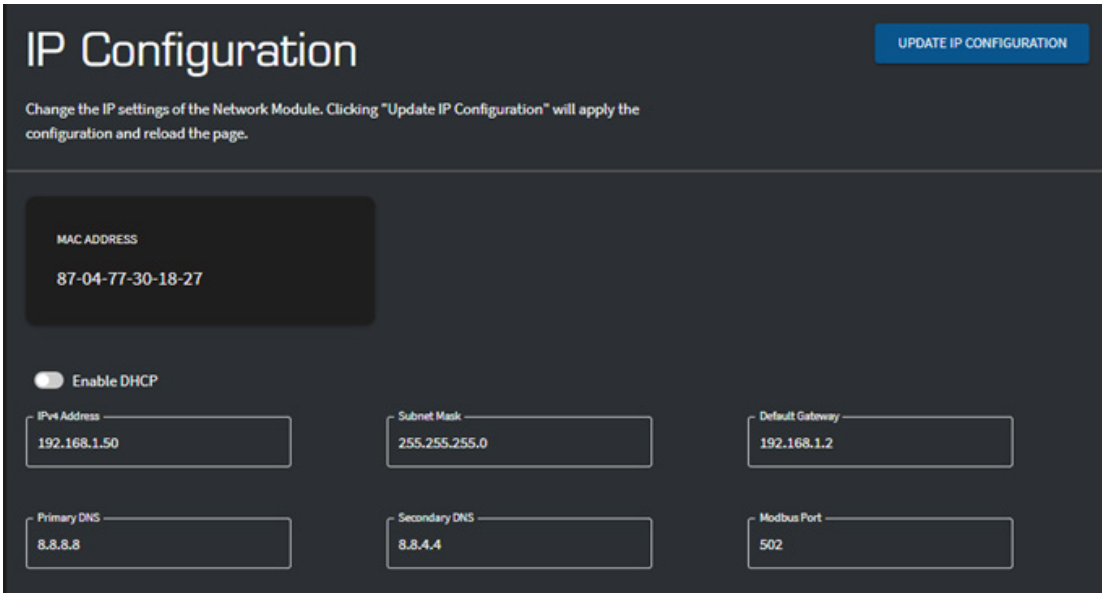


Figure 22 - IP Configuration Screen

This screen identifies and allows for custom IP addressing. Once the IPv4 address has been de-fined, the UPDATE IP CONFIGURATION button will save the input settings. It is important to note that upon pressing this button, the unit will reboot with the new settings (and will thus become in-accessible at the previous IP address).

The toggle button labeled ENABLE DHCP allows the SCM-NM to receive the IP configurations automatically in lieu of manual configuration. This screen also lets the user customize a port for Modbus TCP/IP communications.

5. Current Data Screen

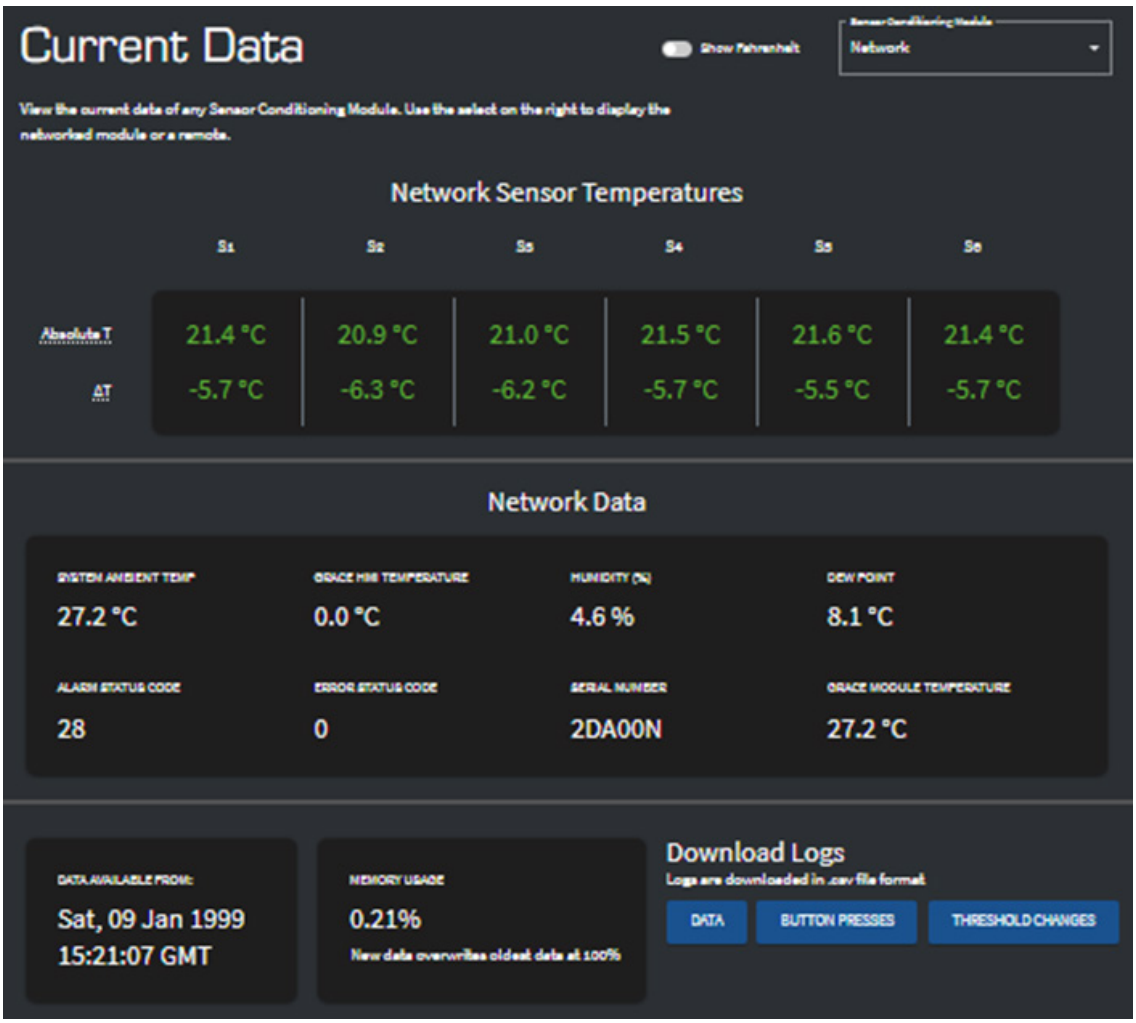


Figure 23 - Current Data Screen

This important screen allows viewing of all the current data being monitored in the network. This includes all networked thermistors, onboard humidity and temperature sensors, status display temperature sensors, and other network data.

- The list box in the upper right corner of the screen identifies the SCM module whose data is being displayed on the screen.
- Specify data display units in Celsius (°C) or Fahrenheit (°F) via toggle switch
- The DATA AVAILABLE FROM display box displays the first historical logged data point, and the MEMORY USAGE box lets the user know how much memory has been used.

Once MEMORY USAGE reaches 100%, the oldest data is overwritten. If the network unit has not been time synchronized to a PC, the oldest data will be marked as starting on January 1, 1970.

- DOWNLOAD LOGS is the section allowing the external extraction of the full data log file in .csv file format. There are 3 different files available for download:
  - o DATA – all logged sensor data values
  - o BUTTON PRESSES – identifies the day and time of all button depressions. This allows a user to identify the exact day and time a physical RESET button or CLEAR ALL LATCHED ALARM button was depressed.
  - o THRESHOLD CHANGES – identifies the day and time when any threshold values were changed.

6. User Management Screen

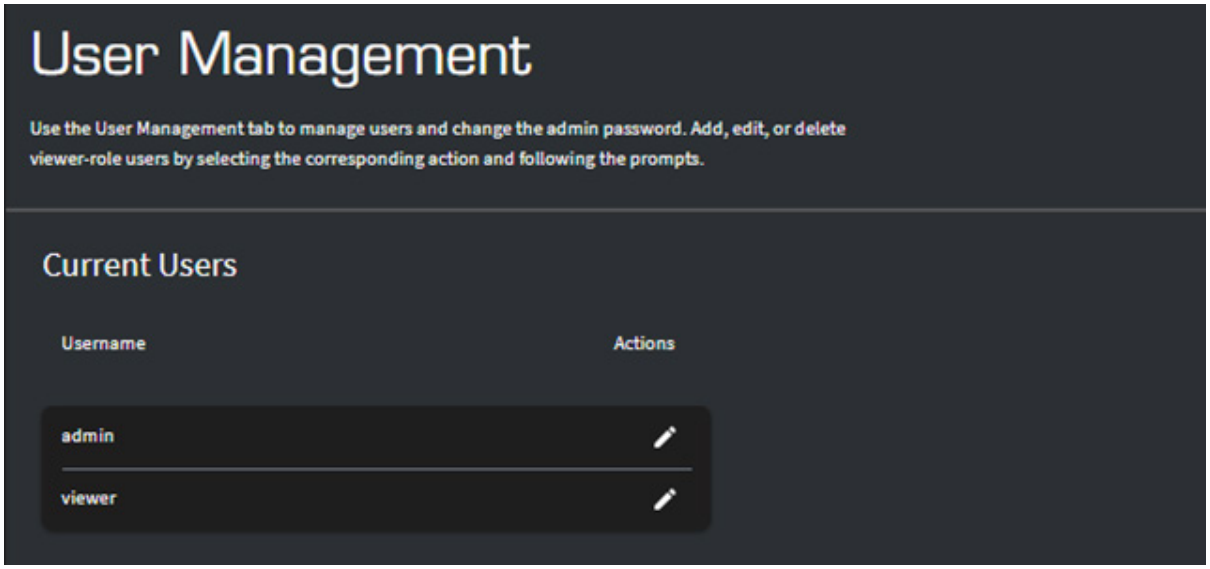


Figure 24 - User Management Screen

By default, 2 user roles exist within the HSM 600 Network:

- Administrator (all admin rights)
- Viewer (view-only rights)

This screen allows the Administrator (admin) to add, edit, or delete viewer-role users by selecting the corresponding action and following the prompts.

Ch 5 Troubleshooting Tips

1. Temperature readings look incorrect or unstable
   - Check sensor mounting. Any air gap between the thermistor tip and the conductor/bus will cause inaccurate readings. Re secure using cable ties, thermal tape, Velcro®, or epoxy.
   - Verify ambient sensor placement. If the Status Display is mounted inside a hot compartment, ΔT will be artificially low. Ambient must be external to the enclosure.
   - Confirm correct sensor grouping. Sensors are loomed in sets of three; ensure each set is routed to the correct SCM input.
   - Inspect for damaged or pinched sensor cables. All thermistor cables are 600 VAC rated but can still be compromised by sharp edges or tight bends.

2. No communication between SCM-NM and SCM-RM
   - Check SCM-NM port usage. On the SCM-NM, ensure that only a Status Display is connected to the SD port. Ensure that the control network (if attached) is connected to the ETH port. Ensure that the downstream SCM-RM is connected to the SCM OUT port.
   - Check SCM-RM port usage. On each SCM-RM, ensure that only a Status Display is con-nected to the SD port. Ensure that only an upstream SCM-RM or SCM-NM is connected to the SCM IN port. Ensure that only a downstream SCM-RM is connected to the SCM OUT port.
   - Inspect for damaged or pinched network cables. All network cables are 600 VAC rated but can still be compromised by sharp edges or tight bends.

3. Alarms not clearing
   - Confirm whether the alarm is latched. Latched alarms require manual reset.
   - Try the correct reset method (availability depends on configuration):
     - SCM-NM faceplate button (single press)
     - SCM-RM faceplate button (single press)
     - System-wide reset (SCM-NM press and hold for 5 seconds)
     - Webserver reset via Ethernet
   - Check if the condition still exists. A latched alarm will re-trigger immediately if the temperature or dew point threshold is still exceeded.

4. Status Display not illuminating
   - Verify 5 VDC switched power from the SCM.
   - Check the RJ45 connection.
   - Confirm the Status Display is connected to the correct SCM. If only one is installed, it will display alarms for the entire network.

5. Dew point warning appears unexpectedly
   - Review dew point threshold settings in the HSM 600 Webserver.
   - Check humidity sensor location. Internal humidity spikes can occur in sealed compartments.
   - Inspect for environmental changes. Cooling airflow, night temperature drops, or adjacent HVAC systems can cause condensation risk.

6. Relay outputs not triggering
   - Confirm relay wiring. The SCM-NM provides two Form-C contacts; ensure NO/NC wiring matches your alarm logic.
   - Verify relay configuration in the Webserver.

7. System not powering up
   - Verify the 24 VDC Class 2 or LPS power supply.
   - Check fused terminal blocks on both + and – lines.
   - Inspect for loose terminal connections at the SCM-NM.

8. Static IP address is forgotten
   - Use the IP reset procedure to restore factory defaults. The IP address settings will revert to the default static IP address of 192.168.1.50 if this procedure is followed:
     1. Press the SCM-NM mechanical reset button and hold for 15 seconds.
     2. Release the button
     3. Within the next 30 seconds, press and hold the button for an additional 5 seconds.

9. User password is forgotten
   - If it is a non-admin password, Admin can reset using SCM-NM Webserver.
   - If it is an admin password, reach out to Grace Technologies for the reset procedure at 1.800.280.9517 or sales@gracetechnologies.com

Ch 6 Frequently Asked Questions (FAQ's)

1. What is the maximum number of SCM modules I can connect together?

Up to 12 SCM-RMs can be daisy-chained to a single SCM-NM using the 600 VAC rated RJ45 cable.

2. Can I use standard Ethernet cables for networking the modules?

No. The system requires a 600 VAC rated, shielded RJ45 cable designed for power and communication in electrical environments. These are sold separately from Grace or can be supplied by others.

3. Do I need a Status Display module for each SCM?

Not required, but recommended. Note:

- *One Status Display provides visibility for alarms in network.*
- *Multiple Status Displays improve compartment-level visibility.*

4. Can the HSM 600 operate as a stand-alone device?

Yes — the SCM-NM can operate independently, but the SCM-RM cannot; it requires an SCM-NM for power and communication.

5. What types of alarms can be generated?

The system can generate warnings or alarms for a variety of different sensed conditions:

- *Largest difference between thermistor temperature and ambient temperature*
- *Actual thermistor temperature*
- *Largest difference between two thermistor temperatures*
- *Dew Point (Temperature at which condensation is likely to occur)*

6. How is dew point calculated?

Each SCM includes onboard ambient temperature and humidity sensors. Dew point is calculated internally using these values and compared to a user-defined threshold.

7. Are the thermistor sensors safe to mount directly on busbars?

Yes. They are UL Listed and 600VAC rated, designed for direct mounting on busbars or insulated cables using tape, Velcro®, or epoxy.

8. Can the system integrate with SCADA or PLCs?

Yes. The SCM-NM supports control system integration via:

- *Modbus TCP/IP*
- *Ethernet/IP*
- *Hardwired relay outputs for alarm signaling*

9. What is the operating temperature range of the SCM modules?

Both SCM-NM and SCM-RM operate from –20°C to +75°C.

10. How do I download data or configure thresholds?

Use the embedded Webserver accessible through the left most Ethernet port on the SCM-NM, then navigate to the CURRENT DATA menu tab and in the lower right corner is the DOWNLOAD LOG section where (3) different files are available for download.

Chapter 7 | Modbus TCP/IP & EtherNet/IP Memory Map

	Modbus TCP/IP and EtherNet/IP Memory Map								
	Read/Write	Register Description	RegisterName	Default Value		Modbus TCP/IP		EtherNet/IP	
						Register	Offset	C/I	Offset
SCM-NM Network Module Configuration	W	Serial Number of SCM-NM Module	SerialNumber(LSW)	N/A		40001	0	C	0
			SerialNumber(MSW)			40002	1		
	W	Number of SCM-RM Modules in System	NumRemotes	0	0x0000	40003	2	C	4
	W	Time between samples in data log (min)	DataLoggingRateMin	30 mins	0x001E	40004	3	C	6
	W	Source for Ambient Temperature Reference	AmbientTemperatureReference	1	0x0001	40005	4	C	8
	W	RESERVED	RESERVED	N/A		40006	5	C	10
	W	Serial Number of Ambient Temperature Reference	TemperatureReferenceSN(LSW)	N/A		40007	6	C	12
			TemperatureReferenceSN(MSW)			40008	7		
	W	Threshold for ΔT Temperature Warnings (°C)	DeltaTWarningThreshold(LSW)	45°C	0x002D	40009	8	C	16
			DeltaTWarningThreshold(MSW)		0x0000	40010	9		
	W	Threshold for ΔT Temperature Alarms (°C)	DeltaTAlarmThreshold(LSW)	50°C	0x0032	40011	10	C	20
			DeltaTAlarmThreshold(MSW)		0x0000	40012	11		
	W	Threshold for Absolute Temperature Warnings (°C)	AbsoluteTWarningThreshold(LSW)	70°C	0x0046	40013	12	C	24
			AbsoluteTWarningThreshold(MSW)		0x0000	40014	13		
	W	Threshold for Absolute Temperature Alarms (°C)	AbsoluteTAlarmThreshold(LSW)	90°C	0x005A	40015	14	C	28
			AbsoluteTAlarmThreshold(MSW)		0x0000	40016	15		
	W	Threshold for Phase Temperature Warnings (°C)	PhaseTWarningThreshold(LSW)	15°C	0x000F	40017	16	C	32
			PhaseTWarningThreshold(MSW)		0x0000	40018	17		
	W	Threshold for Phase Temperature Alarms (°C)	PhaseTAlarmThreshold(LSW)	20°C	0x0014	40019	18	C	36
			PhaseTAlarmThreshold(MSW)		0x0000	40020	19		
	W	Threshold for Dew Point Warnings (°C)	DewPointWarningThreshold(LSW)	5°C	0x0005	40021	20	C	40
			DewPointWarningThreshold(MSW)		0x0000	40022	21		
	W	Threshold for Dew Point Alarms (°C)	DewPointAlarmThreshold(LSW)	2°C	0x0002	40023	22	C	44
			DewPointAlarmThreshold(MSW)		0x0000	40024	23		
	W	Alarm Mode Setting for Relay 1	Relay1AlarmMode	85	0x0055	40025	24	C	48
	W	Alarm Mode Setting for Relay 2	Relay2AlarmMode	170	0x00AA	40026	25	C	50
	W	Clear Mode Setting for Relay 1	Relay1ClearMode	7	0x07	40027	26	C	52
	W	Clear Mode Setting for Relay 2	Relay2ClearMode	6	0x06	40027	26	C	53
	W	Mode Setting for Attached Status Display	StatusDisplayMode	31	0x001F	40028	27	C	54

Table F - Network Module Configuration Memory Map

	Modbus TCP/IP and EtherNet/IP Memory Map								
	Read/Write	Register Description	RegisterName	Default Value		Modbus TCP/IP		EtherNet/IP	
						Register	Offset	C/I	Offset
SCM-RM Remote Module Configuration	W	Serial Number of First SCM-RM Module	SerialNumber(LSW)	N/A		40029	28	C	56
			SerialNumber(MSW)			40030	29		
	W	Serial Number of Second SCM-RM Module	SerialNumber(LSW)	N/A		40031	30	C	60
			SerialNumber(MSW)			40032	31		
	W	Serial Number of Third SCM-RM Module	SerialNumber(LSW)	N/A		40033	32	C	64
			SerialNumber(MSW)			40034	33		
	W	Serial Number of Fourth SCM-RM Module	SerialNumber(LSW)	N/A		40035	34	C	68
			SerialNumber(MSW)			40036	35		
	W	Serial Number of Fifth SCM-RM Module	SerialNumber(LSW)	N/A		40037	36	C	72
			SerialNumber(MSW)			40038	37		
	W	Serial Number of Sixth SCM-RM Module	SerialNumber(LSW)	N/A		40039	38	C	76
			SerialNumber(MSW)			40040	39		
	W	Serial Number of Seventh SCM-RM Module	SerialNumber(LSW)	N/A		40041	40	C	80
			SerialNumber(MSW)			40042	41		
	W	Serial Number of Eighth SCM-RM Module	SerialNumber(LSW)	N/A		40043	42	C	84
			SerialNumber(MSW)			40044	43		
	W	Serial Number of Ninth SCM-RM Module	SerialNumber(LSW)	N/A		40045	44	C	88
			SerialNumber(MSW)			40046	45		
	W	Serial Number of Tenth SCM-RM Module	SerialNumber(LSW)	N/A		40047	46	C	92
			SerialNumber(MSW)			40048	47		
	W	Serial Number of Eleventh SCM-RM Module	SerialNumber(LSW)	N/A		40049	48	C	96
			SerialNumber(MSW)			40050	49		
	W	Serial Number of Twelth SCM-RM Module	SerialNumber(LSW)	N/A		40051	50	C	100
			SerialNumber(MSW)			40052	51		

Table G - Remote Module Configuration Memory Map

	Modbus TCP/IP and EtherNet/IP Memory Map								
	Read/Write	Register Description	RegisterName	Default Value		Modbus TCP/IP		EtherNet/IP	
						Register	Offset	C/I	Offset
SCM-NM Network Module Data	R	Serial Number of SCM Module	SerialNumber(LSW)	N/A		30001	0	I1	0
			SerialNumber(MSW)			30002	1		
	R	UTC Timestamp (seconds since 1/1/1970)	CurrentTimestamp(LSW)	N/A		30003	2	I1	4
			CurrentTimestamp(MSW)			30004	3		
	R	Internal SCM Temperature (°C)	InBucketTemperature(LSW)	N/A		30005	4	I1	8
			InBucketTemperature(MSW)			30006	5		
	R	External Status Display Temperature (°C)	ExternalTemperature(LSW)	N/A		30007	6	I1	12
			ExternalTemperature(MSW)			30008	7		
	R	Alarm Status Code	AlarmStatusCode(LSW)	N/A		30009	8	I1	16
			AlarmStatusCode(MSW)			30010	9		
	R	Error Status Code	ErrorStatusCode(LSW)	N/A		30011	10	I1	20
			ErrorStatusCode(MSW)			30012	11		
	R	Status Register	StatusRegister3(LSW)	N/A		30013	12	I1	24
			StatusRegister3(MSW)			30014	13		
	R	Status Register	StatusRegister4(LSW)	N/A		30015	14	I1	28
			StatusRegister4(MSW)			30016	15		
	R	Thermistor Probe #1Temperature (°C)	Probe1Temperature(LSW)	N/A		30017	16	I1	32
			Probe1Temperature(MSW)			30018	17		
	R	Thermistor Probe #2Temperature (°C)	Probe2Temperature(LSW)	N/A		30019	18	I1	36
			Probe2Temperature(MSW)			30020	19		
	R	Thermistor Probe #3Temperature (°C)	Probe3Temperature(LSW)	N/A		30021	20	I1	40
			Probe3Temperature(MSW)			30022	21		
	R	Thermistor Probe #4Temperature (°C)	Probe4Temperature(LSW)	N/A		30023	22	I1	44
			Probe4Temperature(MSW)			30024	23		
	R	Thermistor Probe #5Temperature (°C)	Probe5Temperature(LSW)	N/A		30025	24	I1	48
			Probe5Temperature(MSW)			30026	25		
	R	Thermistor Probe #6Temperature (°C)	Probe6Temperature(LSW)	N/A		30027	26	I1	52
			Probe6Temperature(MSW)			30028	27		
	R	Internal SCM Humidity (%RH)	Humidity(LSW)	N/A		30029	28	I1	56
			Humidity(MSW)			30030	29		
	R	Calculated Dew Point (°C)	DewPoint(LSW)	N/A		30031	30	I1	60
			DewPoint(MSW)			30032	31		

Table H - Network Module Data Memory Map

	Modbus TCP/IP and EtherNet/IP Memory Map							
	Read/Write	Register Description	RegisterName	Default Value	Modbus TCP/IP		EtherNet/IP	
					Register	Offset	C/I	Offset
SCM-RM #1 Data	R	Identical to SCM-NM Network Module Data Structure			30033	32	I1	64
SCM-RM #2 Data	R	Identical to SCM-NM Network Module Data Structure			30065	64	I1	128
SCM-RM #3 Data	R	Identical to SCM-NM Network Module Data Structure			30097	96	I1	192
SCM-RM #4 Data	R	Identical to SCM-NM Network Module Data Structure			30129	128	I1	256
SCM-RM #5 Data	R	Identical to SCM-NM Network Module Data Structure			30161	160	I1	320
SCM-RM #6 Data	R	Identical to SCM-NM Network Module Data Structure			30193	192	I1	384
SCM-RM #7 Data	R	Identical to SCM-NM Network Module Data Structure			30225	224	I1	448
SCM-RM #8 Data	R	Identical to SCM-NM Network Module Data Structure			30257	0	I2	0
SCM-RM #9 Data	R	Identical to SCM-NM Network Module Data Structure			30289	32	I2	64
SCM-RM #10 Data	R	Identical to SCM-NM Network Module Data Structure			30321	64	I2	128
SCM-RM #11 Data	R	Identical to SCM-NM Network Module Data Structure			30353	96	I2	192
SCM-RM #12 Data	R	Identical to SCM-NM Network Module Data Structure			30385	128	I2	256

Table I - Remote Module Data Memory Map