Substation Monitoring Device for Medium Voltage Switchgear

ENGLISH

Operation Manual

Instruction Bulletin

This instruction bulletin describes the monitoring, tracking, and measuring functions of the Substation Monitoring Device for Medium Voltage Switchgear.

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Section 1— Safety Information

Important Information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this bulletin or on the equipment to warn of hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury. The safety alert symbol is not used with this signal word.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

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Section 2— List of Acronyms

Refer to Table 1 for a list of acronyms used in this instruction bulletin.

Table 1 – List of Acronyms

Acronym	Stands for:
BMS	Building Management System
GSM	Global System for Mobile communications
HMI	Human Machine Interface
IED	Intelligent Electronic Device
I/O	Input/Output
LV	Low Voltage
MV	Medium Voltage
SCADA	Supervisory Control and Data Acquisition
SL	Serial Line
SLD	Single Line Diagram
SMD	Substation Monitoring Device
SMS	Short Message Service
TCP/IP	Transmission Control Protocol/Internet Protocol

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Section 3— Introduction

This document provides monitoring instructions using the Substation Monitoring Device (SMD) from Schneider Electric.

The signaling information provided by the monitoring system described in this manual is intended to be informational only. The SMD monitors temperature and humidity conditions in specific locations within the switchgear and provides indication signals when thresholds are surpassed. When temperature and humidity conditions are outside of the pre-established parameters, consider taking action to assess the equipment condition. Contact your local Schneider Electric representative or Field Services team to obtain the appropriate information.

SMD General Description

Substation monitoring can be achieved through substation alarming via:

- Local and remote monitoring
- Nearby control

The SMD provides several tracking and measuring functions, as well as monitoring features, for:

- Thermal monitoring
- Environmental monitoring
- Dry transformer monitoring
- Circuit breaker monitoring

Substation Alarming

The SMD collects all alarming indications available in the substation using digital input (for example, blown fuse or Watchdog relay) information. The SMD also collects the information using Modbus™ protocol over Ethernet or Serial Line (SL) communication.The collected alarms are then presented on the Human Machine Interface (HMI) locally and made available remotely.

Local and Remote Monitoring

The SMD can be used for local and/or remote monitoring.

Local monitoring includes a single-line diagram (SLD) representation of the lineup with temperature values and alarm logs on a color display.

- If no pre-alarm or alarm is activated, the general status is operating normally (green display).
- If at least one pre-alarm is activated, but no alarm, the general status is pre-alarm (yellow display).
- If at least one alarm is activated, the general status is alarm (red display).

Local monitoring also includes summarized information on the global status of the substation from the digital contact outputs. This information can be used for signaling with lights (typically green, yellow, and red) or with any equipment accepting contact output.

- Digital Contact Output 1: Closed when global status is green
- Digital Contact Output 2: Closed when global status is yellow
- Digital Contact Output 3: Closed when global status is red
- Digital Contact Output 4: Always Open

Remote monitoring can be achieved through:

- Short Message Service (SMS) associated to the alarms.
- Connection to remote SCADA, Building Management System (BMS), or Schneider Electric service platform using Modbus™ TCP/IP link.

Nearby Control

⚠ WARNING

LOSS OF SYSTEM CONTROL PATHS

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Example: Emergency Stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death or serious injury.

The Nearby Control function allows you to operate the circuit breaker or lead break switch without being in front of the cubicle through mobile devices like tablets and smart phones. A local Harmony HMI is required for using Nearby Control.

Nearby control uses a password to limit access to authorized users. In addition:

- The local HMI allows for the opening and closing of the switchgear switching devices through the SMD only when connected to the protective relay or other Intelligent Electronic Device (IED) through Modbus™. The switching devices' status is available in the SLD.
- The nearby HMI allows switchgear operation through a mobile device (for example, a tablet or smart phone) when connected to the SMD.

Thermal Monitoring

Aging electrical connections are a common cause of medium voltage switchboard issues. The purpose of Thermal Monitoring is to monitor the temperature of the connections to detect deterioration before damage occurs. Thermal monitoring of cable, busbar, and circuit breaker connections in the cubicle, as well as transformer connections, is achieved using a ZigBee concentrator with TH110 wireless sensors from Schneider Electric.

Different temperature measurement algorithms are available for indicating alarms:

- Standard absolute monitoring: An alarm is indicated when the temperature exceeds a fixed threshold.
- Advanced absolute monitoring: An alarm is indicated when the temperature exceeds the threshold adapted permanently to the load current of the feeder.
- Discrepancy monitoring: An alarm is indicated when the differences between phase temperatures exceed a fixed threshold.

Common specifications can be selected to apply the same temperature thresholds to all connections.

Environmental Monitoring

Environmental monitoring is achieved using a Zigbee concentrator with CL110 wireless sensors from Schneider Electric. The sensors measure the humidity and temperature inside cubicles to estimate the health of the cubicle's environment based on the frequency of condensation and pollution. A severity indicator is assigned to the detected environmental condition and is used to calculate when the next inspection of the cubicle is recommended. An alarm can be set for temperature or humidity conditions.

Common specifications can be selected to apply the same environmental thresholds to all cubicles.

Dry Type Transformer Monitoring

PT100 sensors from Schneider Electric installed in the windings monitor dry type transformers. Ageing of the transformer is determined as defined in standard IEC 60076-12. An alarm can also be set for detected hot spot temperature.

Circuit Breaker Monitoring

The SMD monitors the health of the circuit breakers based on information collected in the protection relays. Alarms are indicated when maintenance is needed according to equipment wear thresholds. Alarms can also be set for abnormal operating or charging times.

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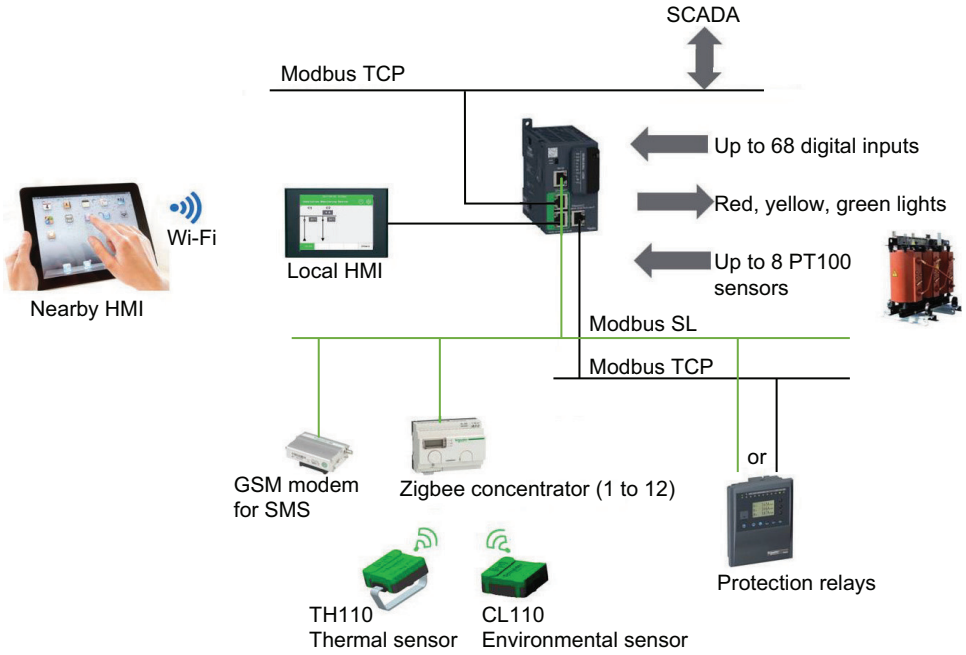
Section 4— SMD Architecture

The SMD consists of a Modicon™ TM251 Programmable Logic Controller (PLC), called the “main control unit” in this document, connected to various optional components (Figure 1). Components include:

- Input/Output (I/O) boards for digital and analog input acquisition
  - — Digital inputs connect switchgear auxiliary contacts for status monitoring (for example, circuit breaker monitoring) and are used for any digital information collected as an alarm.
  - — Analog inputs monitor dry transformer internal windings temperature using an embedded PT100 probe.
- Up to 12 ZigBee concentrators to interface sensors with the main control unit. Three concentrators are dedicated to monitoring cubicle sensors and nine are dedicated to monitoring transformer sensors. The sensors include:
  - — TH110 thermal sensors
  - — CL110 environmental sensors
- A local Harmony™ HMI
- Nearby HMI on a mobile devices is also possible when a Wi-Fi access point is available.
- Protection relays or other Modbus devices for monitoring and controlling medium voltage switchgears
- A GSM modem for SMS transmission

Figure 1 – Typical System Architecture



Section 5— Safety Precautions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E or CSA Z462.
- This equipment must be installed and serviced only by qualified personnel.
- Perform such work only after reading and understanding all of the instructions contained in this bulletin.
- Turn off all power supplying this equipment before working on or inside equipment.
- Before performing visual inspections, tests, or maintenance on this equipment, disconnect all sources of electric power. Assume all circuits are live until they are de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of backfeeding.
- Always use a properly rated voltage sensing device to confirm power is off.
- Practice lock-out/tag-out procedures according to OSHA requirements.
- Handle this equipment carefully and install, operate, and maintain it correctly in order for it to function properly. Neglecting fundamental installation and maintenance requirements may lead to personal injury, as well as damage to equipment or other property.
- Operate the equipment, such as the tablet that supports the SMD, within the specified electrical and environmental limits.
- Carefully inspect your work area and remove any tools and objects left inside the equipment.
- Replace all devices, doors, and covers before turning on power to this equipment.
- All instructions in this manual are written with the assumption that the customer has taken these measures before performing maintenance or testing.

Failure to follow these instructions will result in death or serious injury.

⚠ WARNING

POTENTIAL COMPROMISE OF SYSTEM AVAILABILITY, INTEGRITY, AND CONFIDENTIALITY

- Change default passwords to help prevent unauthorized access to device settings and information.
- Disable unused ports/services and default accounts, where possible, to minimize pathways for malicious attacks.
- Place networked devices behind multiple layers of cyber defenses (such as firewalls, network segmentation, and network intrusion detection and protection).
- Use cyber security best practices (for example: least privilege, separation of duties) to help prevent unauthorized exposure, loss, modification of data and logs, interruption of services, or unintended operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

⚠ **WARNING:** This product can expose you to chemicals including Nickel compounds, which are known to the State of California to cause cancer, and Bisphenol A (BPA), which is known to the State of California to cause birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

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Section 6— SMD Communication (Indications)

The main processor unit TM251 and related accessory components are described in their specific product data sheets or manuals.

Local indicating information includes, but is not limited to, the main processor unit, digital and analog inputs/outputs (I/Os), and the Ethernet switch.

Main Control Unit TM251

When the Substation Monitoring Device (SMD) starts correctly and is fully operational:

- The two green LEDs RUN and PWR are on, and
- All red LEDs are off.

NOTE: Refer to Table 9 on page 41 for additional system status LED labels, function types, colors, statuses, and descriptions.

NOTE: When the red LED BAT is on, the battery must be replaced to save the date and time in case of loss of power supply.

Refer to the TM251 instruction bulletin (HRB5960404) that was shipped with your equipment for battery replacement instructions, or download the current version at: https://www.schneider-electric.us/en/download/document/HRB59604/.

All SMD information is stored in the main processor unit, but the persistent data related to thermal monitoring and all applicable functions are stored in non-volatile memory. They do not rely on the battery.

TM3DM8R or TM3DI16 Digital I/O Modules

Digital inputs/outputs TM3DM8R or TM3DI16 indicate:

One green LED for each digital input or output for the status.

TM3TI4 Analog Input Module or TM4ES4 Ethernet Switch Module

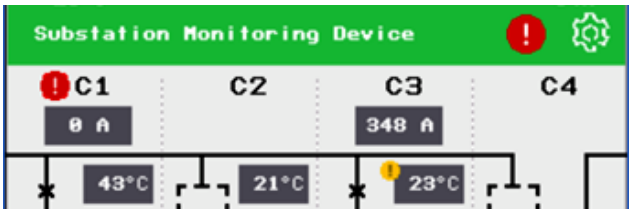
Analog input TM3TI4 or Ethernet switch TM4ES4 indicate:

One green LED for power.

Harmony™ Local HMI

Any red or yellow **status indication !** icon reports an alarm or pre-alarm on the SMD (Figure 2).

Figure 2 – Alarm or Pre-alarm Status Indication Icon



Disable Buzzer / Configure Backlight

The buzzer can be disabled and the backlight can be configured in the Harmony configuration screen (Figure 3).

1. Press two opposite corners of the screen quickly and successively.

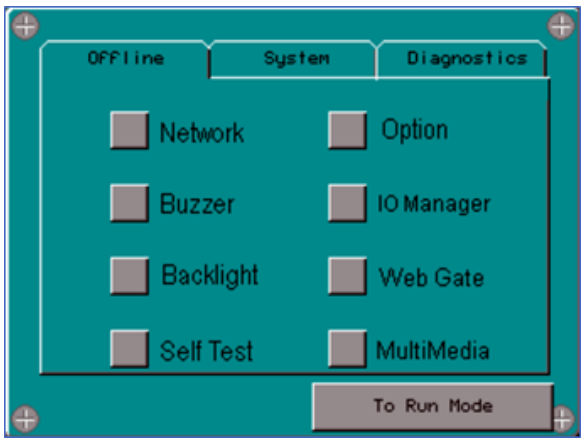
   RESULT: The Harmony configuration screen opens.

2. Click the Offline tab.

   a. Click the Buzzer box to enable or disable the buzzer.

   b. Click the Backlight box to configure the backlight.

Figure 3 – Harmony Local HMI Configuration Screen



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Section 7— Substation Monitoring System Device Usage

Human Machine Interface (HMI) Screen Descriptions

Active areas include buttons and status **indication icons !**

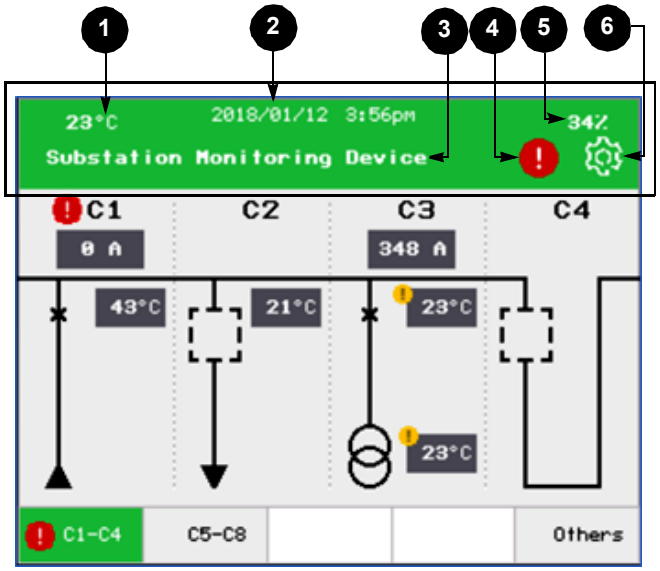
- Green or blue: Indicates normal conditions
- Yellow: Indicates a pre-alarm
- Red: Indicates an alarm (A temperature or humidity threshold has been exceeded.)

Navigation through the SMD HMI screens is achieved by touching active areas on the screen (Figure 4).

The HMI main screen is divided into different sections. The upper green area contains command buttons and general status indications (icons).

The white background is the main part of the screen and displays the function information. This area is organized into different screens that display general and/or detailed information.

Figure 4 – HMI Screen Descriptions



1	Room Temperature Display: Measured by the CL110 sensor and displayed when the active screen is the Home screen. Click on the temperature to access the Substation Environment screen (Figure 10 on page 22).
2	Date and Time Display: Click to set the date and time (Figure 16 on page 26).
3	Active Page Display: — In the HMI screen, the name “Substation Monitoring Device” is displayed. — For other pages, text is screen-dependent. The SMD screen menu name appears after the Home icon. — Click the Home screen icon (not shown here) to go back to the SMD Home screen (Figure 6 on page 19). — Click on the name of the menu to go back to previous screen.
4	Notifications Icon: Click to see the list of active and inactive alarms, and pre-alarms (Figure 9 on page 21).
5	Room Humidity Display: Measured by the CL110 sensor and displayed when the Home screen is active. Click on the temperature to access the Substation Environment screen (Figure 10 on page 22).
6	Settings Icon: Click the icon to configure the SMD or check the System Setup (Figure 12 on page 23).

Human Machine Interface (HMI) Screens and Organization

The HMI screens consist of the following organization levels (Figure 5). Refer to Table 2 for additional information regarding the screens listed below.

Table 2 – List of screens

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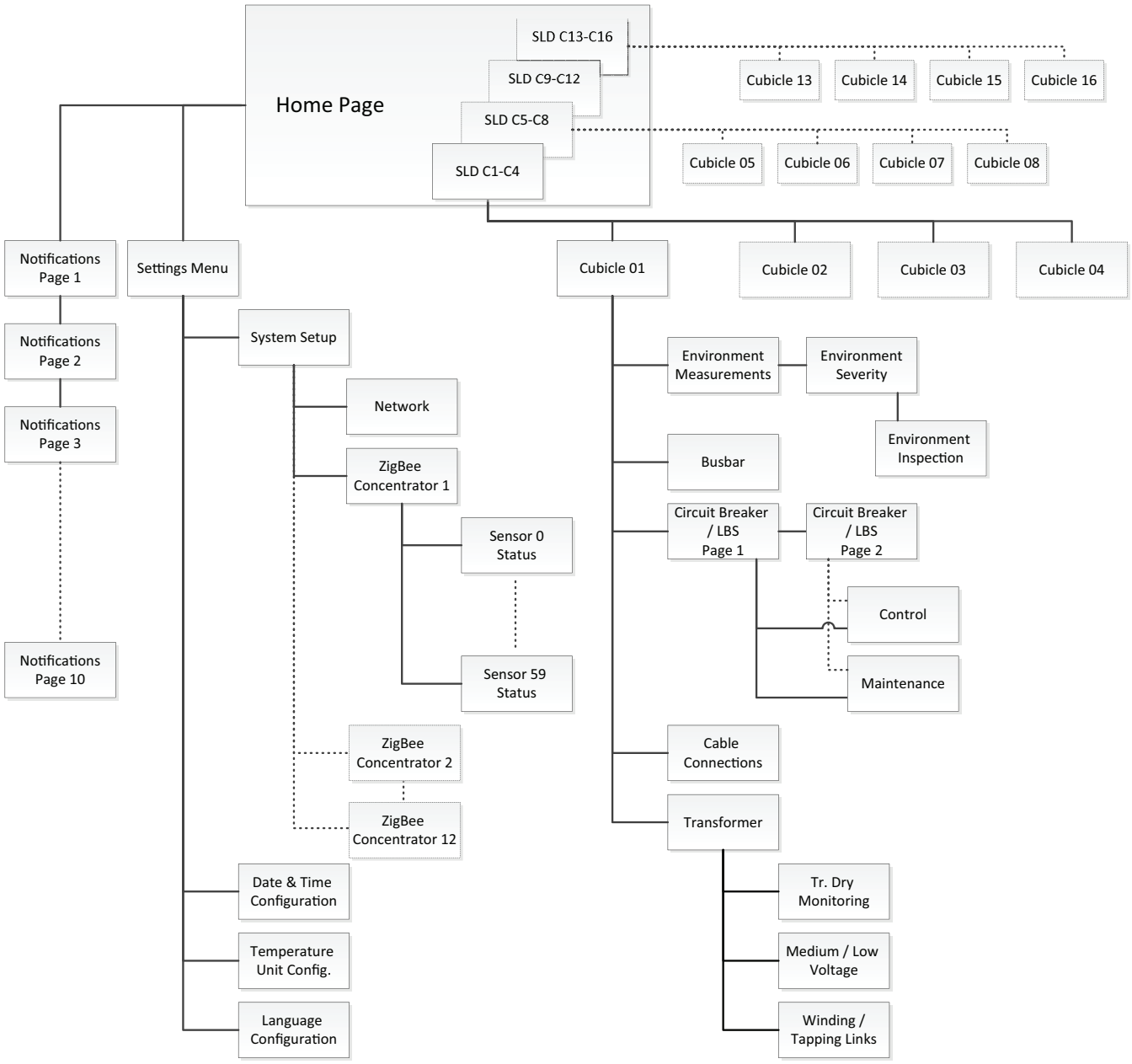
Figure 5 – HMI Screens and Organization



Home Screen

The Home screen is displayed by default after start-up.

1. Click the Home icon from any screen to return to the Home screen.

   RESULT: A single line diagram (SLD) with all status information summarized is displayed on the Home screen (Figure 6).

The SLD is split into four screens with four cubicles each. Refer to the area at the bottom of the screen to view the number of available screens (Figure 6).

2. Click the Others button (Figure 6).

   RESULT: The screen opens to display the temperature at locations “other” than cubicles if other locations are defined in the configuration.

Only two screens, C1–C4 and C5–C8, are available to navigate when six cubicles are defined in the SMD configuration (Figure 6). If 16 cubicles were defined, then buttons C9–C12 and C13–C16 would appear, too.

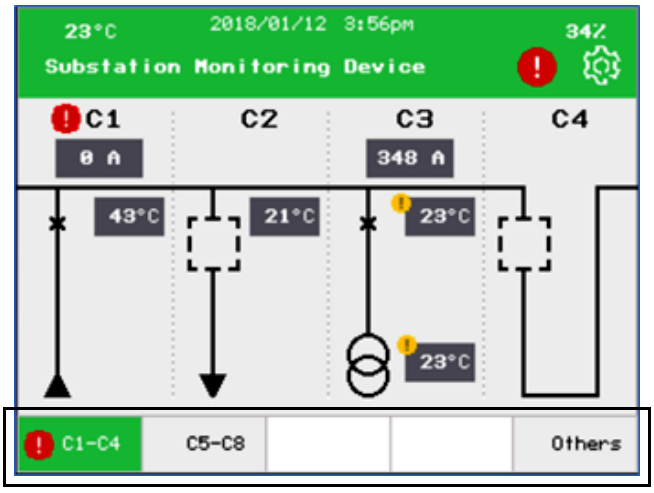
Figure 6 – Home Screen and Navigation Bar

Available screens include:

- Page C1–C4 for cubicle 1 up to cubicle 4
- Page C5–C8 for cubicle 5 up to cubicle 8
- Page C9–C12 for cubicle 9 up to cubicle 12
- Page C13–C16 for cubicle 13 up to cubicle 16

The Navigation bar provides access to:

- The buttons C1–C4 up to C13–C16 to scroll between the four screens
- The Others button to open the screen and display the temperature at “other” locations
- The active screen (shown with a green background).The inactive screens are shown with a light gray background
- Notification alarms and pre-alarms. The **status indication icon !** appears in yellow or red near the C1–C4 up to C13–C16 label or near the Others button to report an alarm or pre-alarm in this part of the SMD.



Home screen navigation bar

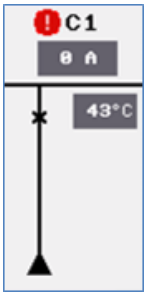
The SLD shows up to four cubicles in each Home screen page.

3. Click on the cubicle area (Figure 6).

   RESULT: Detail information for each cubicle is displayed (Figure 7 on page 20). In a transformer cubicle, a second temperature is displayed (Figure 8 on page 20).

   NOTE: The SLD does not show sections—only cubicles. Sections with more than one circuit breaker or switch are represented by showing two cubicles.

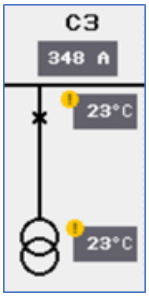
Figure 7 – Example: Cubicle without a Transformer



Displays:

- The cubicle reference C1, C2, etc.,
- The **status indication icon !** in yellow or red near the reference if an alarm or pre-alarm exists in this cubicle related to the application (thermal, environmental, or circuit breaker monitoring)
- The current measurement in the cubicle, if configured
- The switchgear position, if configured
- The connection temperature with:
  - Only the highest temperature from different phases and from all positions (cable, circuit breaker, busbar, transformer) is displayed
  - The **status indication icon !** in yellow or red in case of inoperative sensor

Figure 8 – Example: Cubicle with a Transformer



Displays:

- The highest temperature from different phases related to transformer monitoring
- The **status indication icon !** in yellow or red in case of an inoperative sensor

Table 3 shows the rules that are applied when digital inputs indicate the circuit breaker position.

Table 3 – Circuit Breaker Positions Indicated from Digital Input Information

Auxiliary contact 52B - Open	Auxiliary contact 52A - Closed	CB position calculated by SMD	IEC Icon displayed on HMI	ANSI Icon displayed on HMI
ON	ON	Unknown		
ON	OFF	Open		
OFF	ON	Closed		
OFF	OFF	Unknown		

NOTE: A dashed line appears when a circuit breaker position is unknown or when a protective relay (or other Intelligent Electronic Device (IED)) is inoperable. The circuit breaker can be either open or closed when the status is unknown.

Notifications Screen

The Notifications screen records and displays status changes related to alarms or pre-alarms within the Substation Monitoring Device (SMD).

Status indications are shown as notification icons at the beginning of the line where alarms or pre-alarms are active or inactive. The alarm or pre-alarm time stamp is shown on the second line of the status change (Figure 9).

1. Click on the **status indication icon !** in the header from any Substation Monitoring Device (SMD) screen.

   RESULT: A Notifications screen appears with SMD status information displayed and time stamped.

The Notifications screen shows five events per page. Up to 10 pages of events are available to view.

2. Click the up and down arrows at the bottom of the screen to navigate to the previous and next event pages.

Figure 9 – Notifications Screen and Icons

	Pre-alarm or alarm is inactive: Status: Operating normally (green)
	Pre-alarm has been activated, but no alarm: Status: Pre-alarm (yellow)
	Alarm has been activated: Status: Alarm (red) A temperature or humidity threshold has been exceeded.

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Substation Environment Screen

The Environment screen shows temperature and humidity values.

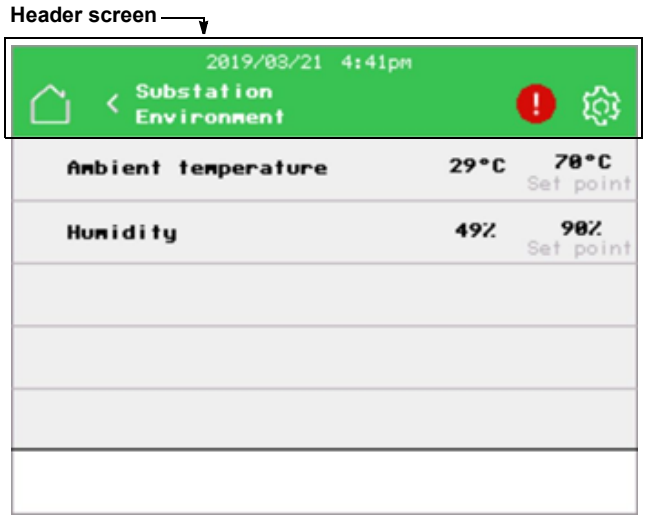
Click on the Temperature or Humidity value in the header screen (Figure 10).

RESULT: The substation room's Ambient temperature and Humidity are displayed.

Figure 10 – Substation Environment Screen

Within the Substation Environment screen, there are two lines:

- Actual Ambient temperature and its alarm trigger point
- Actual ambient Humidity and its alarm trigger point



Settings Screen

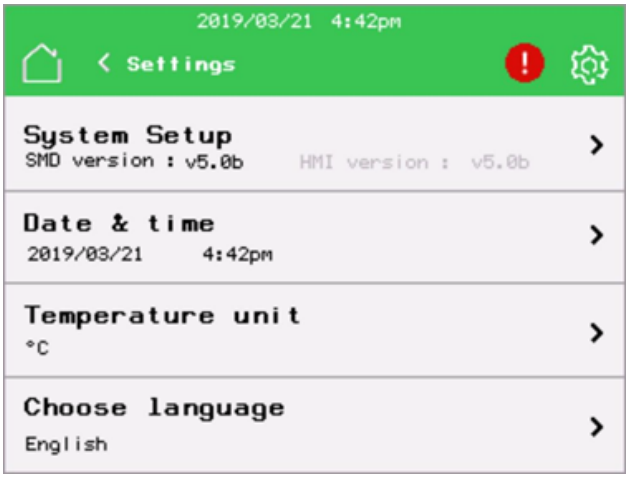
Click the Settings icon from any screen to access the Settings screen.

RESULT: The Settings screen opens and allows access to the menu function lines (Figure 11).

Figure 11 – Settings Screen

Within the Settings screen, there are four function lines:

- System Setup: Click to check the status of the communication between main processing unit, ZigBee concentrators, and sensors. Displays:
  - The version of the SMD and the HMI in the System Setup label.
  - The HMI and PLC versions. If they are different, then a notification message appears instead of the HMI version.
- Date & time: Click to set the date and time and to choose the format.
- Temperature unit: Click to select the temperature unit (°C or °F).
- Choose language: Click to set the language.



System Setup Screen

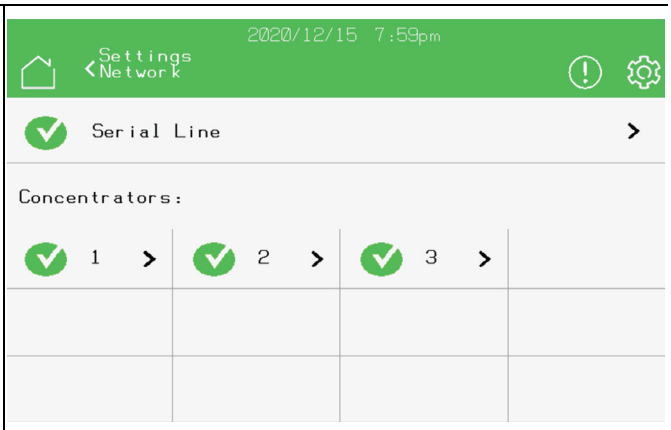
Click on System Setup line of the Settings screen.

RESULT: The System Setup screen opens and allows access to the communication status between the PLC, ZigBee concentrators, and sensors (Figure 12).

Figure 12 – Network Setup Screen

Within the System Setup screen, there are 13 function lines:

- Serial Line: Click to access the network and Modbus configurations and the ZigBee concentrator addresses. Icon displayed at the beginning of the line:
  - Red icon: Indicates non-communication between the PLC and one of the ZigBee concentrators.
- Concentrator 1, 2, and up to 12: Click to check the status of the communication between the ZigBee concentrator and the sensors. Icon displayed before each ZigBee concentrator:
  - Red icon: Indicates the PLC cannot communicate with the ZigBee concentrator. Possible causes are the ZigBee concentrator is not energized, not connected to PLC, or has an invalid address.
  - Yellow icon: Indicates communication between the PLC and ZigBee concentrator is established. One or more sensors are not connected to the ZigBee concentrator.



Network Screen

The Network screen shows the Modbus configuration for the communication between the PLC and ZigBee concentrators.

Click on the Network screen line of the System Setup screen (Figure 12).

RESULT: The Network screen opens and displays the communication settings between the PLC and ZigBee concentrators (Figure 13).

Figure 13 – Serial Line Setup Screen

NOTE: The communication settings between the PLC and ZigBee concentrators must not be modified. The SMD will work only with these settings:

- Baud rate: 38400 bps
- Frame Setting: 8e1
  - Number of bits: 8
  - Parity: even
  - Number of stop bit: 1
- Automatic Detection (of Modbus communication parameter): No
- ZigBee Concentrators Modbus addresses shown: click on the arrow to open a new screen and modify it.

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ZigBee Concentrator Screen / Sensor Status Screen

The ZigBee Concentrator screen shows the status of up to 60 sensors that can be connected to each ZigBee concentrator.

1. Click on one of the concentrator lines of the System Setup screen (Figure 12 on page 23).

   RESULT: The ZigBee Concentrator screen displays the status icons for the sensors (Figure 14).

Figure 14 – ZigBee Concentrator Screen, Sensor Configurations/Connections, and Status Icons

9	Sensor is not configured in the SMD
7	Sensor is paired to and actively communicating with the ZigBee concentrator
6	Sensor is not paired to the ZigBee concentrator, but is defined in the SMD configuration
!	Sensor is inoperable: Sensor is paired with the ZigBee concentrator and is defined in the SMD configuration, but the sensor does not communicate with the ZigBee concentrator
!	Non-communicating sensor or unexpected sensor type: Sensor is paired with the ZigBee concentrator and is defined in the SMD configuration, but is inoperable

See Figure 15 and refer to Table 4 on page 25 for detailed Sensor Status screen and icon information.

2. Click on one of the sensors of the ZigBee Concentrator screen (Figure 14).

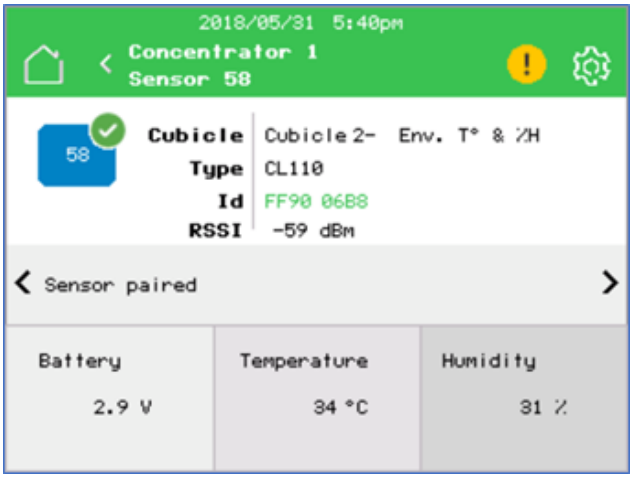
   RESULT: The Sensor Status screen opens and displays the detailed information and measured values for the sensors (Figure 15).

Figure 15 – Sensor Status Screen

Detailed sensor information is shown in the top part of the screen.

- Cubicle: Reference of the cubicle where the sensor is used, including the name defined by the user
- Type: Type of sensor: TH110 or CL110
- Id: Unique sensor ID:
  - Indicated on the sensor itself, and
  - Referenced by the ZigBee concentrator to identify it
- RSSI: Received signal strength indicator (power measurement received by the ZigBee concentrator)
  - Indicates the quality of the communication between the sensor and the concentrator
  - Should be above -75 dBm (a lower reception level results in a communication error.)

Measured sensor values are shown in the bottom part of the screen. Displays: Temperature, Humidity (if applicable), and Battery voltage (if applicable)



Sensor status is indicated as an icon in the middle of the screen, as well as in the top left part of the screen.

Refer to Table 4 for sensor status icon indications.

Click the left and right arrows in the middle of the screen to navigate to the previous and next sensors.

Table 4 – Sensor Status Icon Indications, Troubleshooting, and Solutions

	Sensor is paired to and actively communicating with the ZigBee concentrator.	
	Sensor is not paired to the ZigBee concentrator, but is defined in the SMD configuration.	Sensor or the ZigBee concentrator is operable, but pairing is not complete: Possible cause: Commissioning is not finished.
	Sensor is inoperable: Sensor is paired with the ZigBee concentrator and is defined in the SMD configuration, but the sensor does not communicate with the concentrator.	Yellow indicates that the sensor is not available either because the: — Current flowing is null or too low to energize the sensor, or — Sensor isn't communicating or sensor type is unexpected. These indications may result in a loss of signal reception or communication.
	Non-communicating sensor or unexpected sensor type: Sensor is paired with the ZigBee concentrator and is defined in the SMD configuration, but is inoperable.	Red indicates: — **Unexpected sensor type:** Example: Sensor CL110 is paired, but sensor TH110 is defined in the configuration. Solution: Identify sensor types accurately and check that they are paired and defined correctly within the SMD configuration. — **Non-communicating sensor CL110:** Example: The battery in sensor CL110 is too low. Solution: Replace sensor CL110. — **Non-communicating sensor TH110:** Example: A different TH110 sensor communicates correctly within the same connection, but at another phase. Solution: Verify the line and sensor TH110 are energized properly. Check that the value of the current flowing through each of the three (3) phases is correct. These indications could lead to finding inoperable sensor(s).

ENGLISH

Date & Time Configuration Screen

The Programmable Logic Controller (PLC) stores the Substation Monitoring Device (SMD) date and time values in a non-volatile memory using the battery.

NOTE: Refer to *Main Control Unit TM251* on page 14 for battery replacement information.

1. Click on Date & time menu line of the Settings screen.

   RESULT: The Date & time screen opens and allows access to set the date and time (Figure 16).

   NOTE: The Substation Monitoring Device (SMD) is operable, even when the date and time stamps are inaccurate. However, the date and time should be set correctly to receive accurate operation and alarming information from the environmental monitoring function. Refer to *Environmental Monitoring* on page 11 and Figure 10 on page 22.
2. Click on the down arrows to modify the date, time, and format values.
3. Check that the values are correct and click the Update button to validate the Year, Month, Day, Hour, Minute, or AM/PM values.

   RESULT: The screen displays a message communicating that the operation is in progress. The HMI displays the new date and time when the PLC update is complete.

Figure 16 – Date & Time Configuration Screen

The Date & time screen is split into three parts:

— Date:

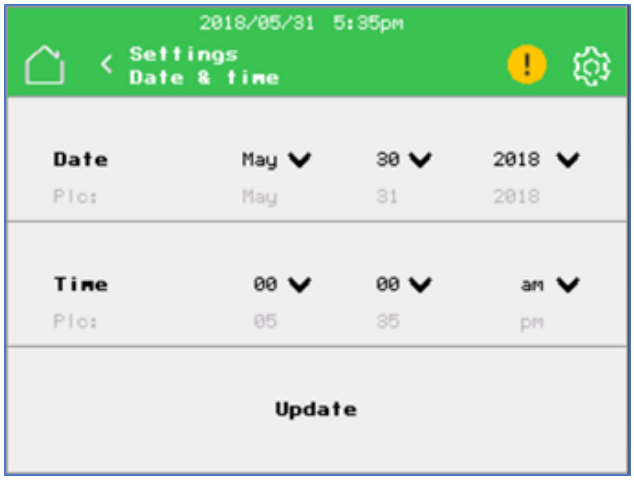
New value in black and current date in gray (second line)

— Time:

New value in black and current time in gray (second line)

— Update button:

Button used to apply changes



Temperature Unit Configuration Screen

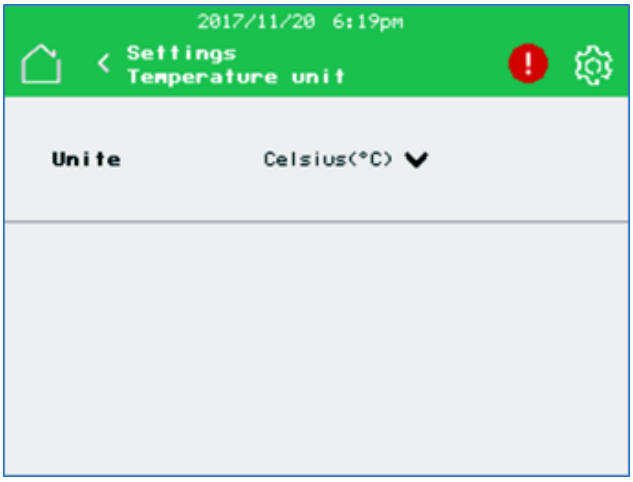
The Temperature Unit Configuration screen allows modification to the unit measurement used to display the temperature.

1. Click on the Temperature Unit menu line of the Settings screen.

   RESULT: The active temperature unit is displayed (Figure 17).

2. Click on the active temperature unit (down arrow) to modify it and choose between Celsius (°C) and Fahrenheit (°F).

Figure 17 – Temperature Unit Configuration Screen



Language Configuration Screen

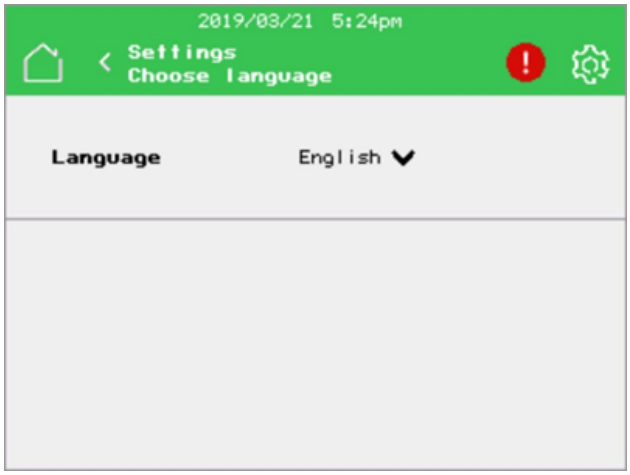
The Language Configuration screen allows modification modification to the language used in the HMI.

1. Click on the Choose Language menu line of the Settings screen.

   RESULT: The active language is displayed with a label (Figure 18).

2. Click on the active language (down arrow) to modify it and choose the preferred language from the list. Available languages are: English, French, Spanish, Italian, and Portuguese.

Figure 18 – Language Configuration Screen



ENGLISH

Cubicle Screen

1. Click on the cubicle in the Home screen to show the Cubicle screen (Figure 6 on page 19).

   RESULT: The Cubicle screen opens and allows access to the function lines and details information (Figure 19).

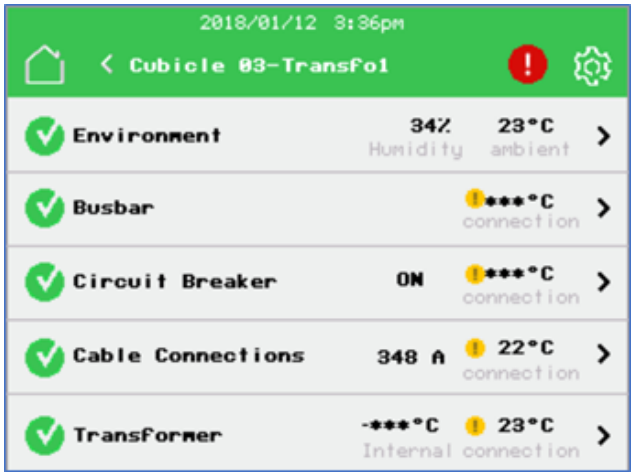
Figure 19 – Cubicle Screen

Within the Cubicle screen, there are five function lines:

- Environment
- Busbar
- Circuit Breaker
- Cable Connections
- Transformer

Functions that are not available in the cubicle are displayed in light gray.

Configured functions are displayed in black.

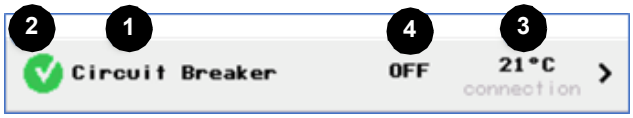


2. Click on the configured equipment function line.

   RESULT: More details about the selected configured function are displayed. Refer to Table 5 for Cubicle screen descriptions.

Table 5 – Cubicle Screen Descriptions

1	Function Description
2	**Status Indication Icon !**: Appears in yellow or red when an alarm or pre-alarm related to this function in the cubicle exists
3	Connection Temperature Measurement: — Displays the maximum temperature measured by all sensors — **Status indication icon !** appears in yellow or red near the temperature if an alarm or pre-alarm threshold is reached
4	Additional information related to the function: — Circuit breaker status (determined by reading the Modbus address of the protective relay (or other Intelligent Electronic Device (IED)) — Current flowing in the cubicle — Humidity — Transformer internal temperature



Environment Screen

The Environment screen is split into two function screens that show:

- The temperature and humidity measurements, as well as the estimated severity indicator (Figure 20).
- The Environment Severity history since the last declared inspection (Figure 21).

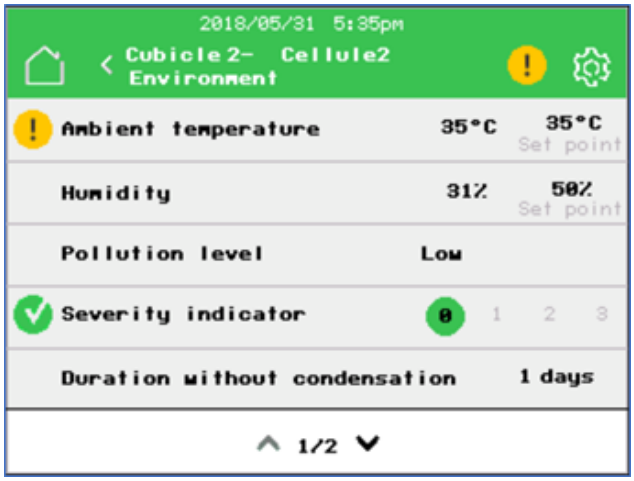
Click on the Environment line of the Cubicle screen.

RESULT: The temperatures, alarms, temperature thresholds, and history of severity levels are displayed on the screen (Environment Screen Functions Page 1 and Page 2).

Environment Screen Functions Page 1 measurements shown are:

- Ambient temperature of the cubicle: Measured by the CL110 sensor and the pre-alarm threshold (and defined by the SMD). The **status indication icon !** appears in yellow at the beginning of the line when the measurement is above the threshold.
- Humidity: Measured by the CL110 sensor and the related pre-alarm threshold (and defined by the SMD). The **status indication icon** ! appears in yellow at the beginning of the line when the measurement is above the threshold.
- Pollution level of the substation: Is shown as the same setting in all cubicle environment screens (and defined by the SMD). Indicated as Low or High.
- Severity indicator: Calculated by the SMD from the humidity, temperatures and pollution level defined in the configuration. Indicated as levels 0, 1, 2, or 3.
- Duration without condensation: Measured as the number of days without condensation.

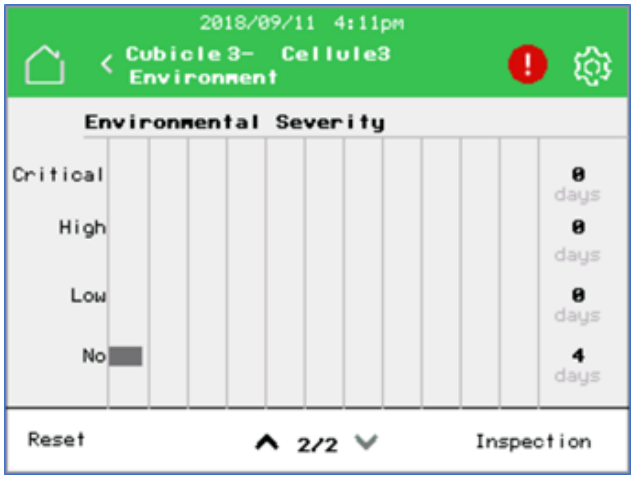
Figure 20 – Environment Screen Functions Page 1: Measurements



Environment Screen Functions Page 2 shows four severity indicator levels of climatic conditions and the number of days in them since the last inspection. The severity levels are:

- Critical (indicates level 3)
- High (indicates level 2)
- Low (indicates level 1)
- No (indicates level 0)

Figure 21 – Environment Screen Functions Page 2: Environmental Severity History



Severity Indicator

Based on standard IEC 62271-304, the SMD indicates four severity levels of equipment aging that are determined by the cumulative days the equipment spends in condensation and pollution conditions.

The indicators are shown in degrees and are as follows (Table 6):

- Degree 0 (indicated in green)
- Degree 1 (indicated in yellow)
- Degree 2 (indicated in orange)
- Degree 3 (indicated in red)

These indicators are used to determine an acceleration factor and when addressed in time, can lead to a reduction in maintenance time. The degree of severity of service condition is determined daily based on the measured condensation and pollution level declared (Figure 20 on page 29 and Table 6).

NOTE: Follow the switchgear maintenance plan that is specific to your equipment. Contact your local Schneider Electric representative or Field Services team to obtain the appropriate information.

Table 6 – Environmental Monitoring: Degree of Severity

The SMD measures the condensation level from the relative humidity and ambient temperatures, as well as the cold point temperature.

Ambient temperature is the air temperature inside the cubicle. Cold point temperature is the temperature of the walls of the cubicle. These two temperatures, along with humidity are used to calculate the condensation levels.

The possible condensation levels are:

— **Co**: Normally nonrecurring condensation: (not more than twice a year)
— **CL**: Infrequent condensation: (not more than twice a month)
— **CH**: Frequent condensation: (more than twice a month)
— **CH+**: Very frequent condensation: (more than twice a week)

The pollution levels defined in the configuration are:

— **PL**: Low pollution
— **PH**: High pollution

		Pollution	
		PL	PH
Condensation	Co	Degree 0	Degree 1
	CL	Degree 1	Degree 2
	CH	Degree 2	Degree 3
	CH+	Degree 3	

The severity degree is displayed in green, yellow, orange, and red depending of its value.

The Environment condition alarm is generated for pollution levels:

— Pollution Level Low
  — Degree 1 or 2: Pre-alarm
  — Degree 3: Alarm
— Pollution Level High
  — Degree 2: Pre-alarm
  — Degree 3: Alarm

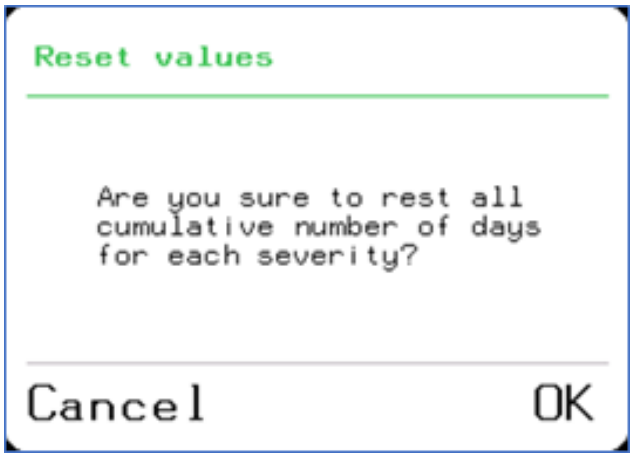
Degree of Severity History and Reset

The Substation Monitoring Device (SMD) cumulates the days for each severity level and represents them in a bar graph (Figure 21 on page 29).

Click the Reset button at the bottom left of the screen to reset the graph and restart the calculation (Figure 21 on page 29).

RESULT: A pop-up window appears to confirm the operation (Figure 22).

Figure 22 – Environmental Severity: History Reset



Inspection Date

The date of the last inspection can be defined in the configuration during installation of the SMD. The number of cumulated days of each degree of severity is used to calculate an aging factor (Figure 23).

Click on the Inspection button in the Environment screen to declare a performed inspection (Figure 21 on page 29).

RESULT: The Environmental Inspection page opens and the algorithm is reset to restart the calculation of the next inspection date (Figure 23).

Figure 23 – Environment Inspection Screen

The SMD calculates the next inspection date using:

- The date of the last inspection.
- The period of the inspection defined in the configuration.
- The aging factor derived from the degree of severity.

NOTE: A pre-alarm occurs two months before the next inspection date. It is an on-screen notification that appears when the inspection date is reached or exceeded.

Busbar Screen

The Busbar screen displays the information related to the thermal monitoring temperature of the busbar connections.

Click on the Busbar line of the Cubicle screen to view thermal monitoring information related to the busbar.

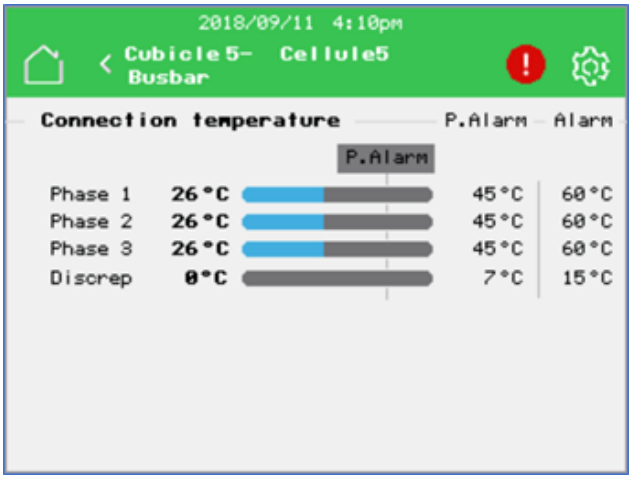
RESULT: The Busbar thermal monitoring information is displayed (Figure 24).

Figure 24 – Busbar Thermal Monitoring Screen

For each Busbar connection, there are four lines:

— One for each phase (shown on three separate lines)

— One for the discrepancy temperature algorithm result



Refer to *Thermal Monitoring Screens* on page 39 for additional pre-alarm and alarm thresholds, status indication, and bar graph information.

Circuit Breaker Screen / Load Break Switch Screen

⚠ WARNING

LOSS OF SYSTEM CONTROL PATHS

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Example: Emergency Stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death or serious injury.

The Circuit Breaker screen is split into two function screens that show:

— The information related to the circuit breaker thermal monitoring (Figure 25 on page 33).

— The information related to circuit breaker monitoring and control (Figure 26 on page 33).

Click on the Circuit Breaker line of the Cubicle screen to view the Circuit Breaker temperature and monitoring.

RESULT: The functions (thermal monitoring, circuit breaker monitoring, and circuit breaker Control button) are displayed on the screen (Figures 25 and 26 on page 33).

Circuit Breaker Screen Functions Page 1 allows access to screens that are related to four functions:

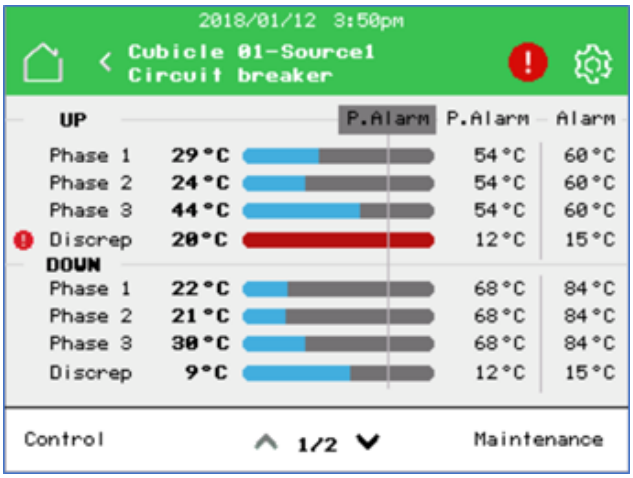
- Thermal monitoring (Page 1)
- Circuit breaker monitoring (Page 2)
- Circuit breaker control (Control button)
- Circuit breaker maintenance (Maintenance button)

When entering the Circuit Breaker screen, the Thermal Monitoring screen displays temperature information for the top and bottom of the circuit breaker (Figure 25).

For each circuit breaker connection, there are four lines:

- One for each phase (shown on three separate lines)
- One for the result of the discrepancy temperature algorithm

Figure 25 – Circuit Breaker Screen Functions Page 1: Thermal Monitoring Screen

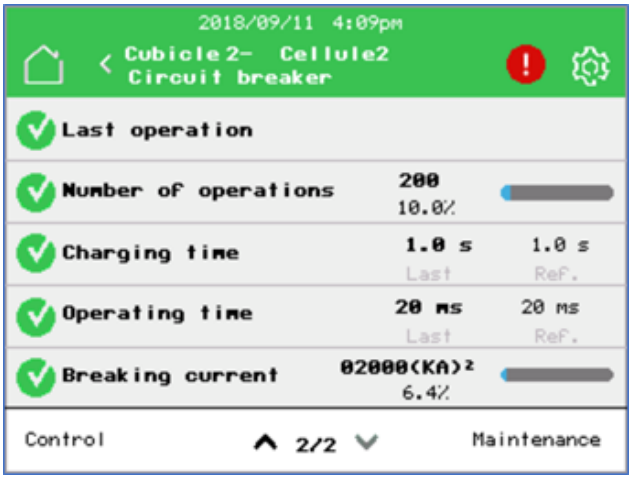


Refer to *Thermal Monitoring Screens* on page 39 for additional pre-alarm and alarm thresholds, status indication, and bar graph information.

Circuit Breaker Screen Functions Page 2 contains circuit breaker monitoring information that is used to perform circuit breaker health calculations, which helps detect equipment aging. The aging evaluation is executed using the information collected in the protection relay (Figure 26):

- Last operation: Displays the last date of operation
- Number of operations: Displays:
  - The number of operations read in the protection relay.
  - The **indication status icon !** (Appears in red or yellow at the beginning of the line when an alarm or pre-alarm exists)
- Charging time and Operating time: Displays:
  - The last value measured
  - The reference value (First value measured by the SMD)
  - The **indication status icon !** (Appears in red at the beginning of the line when time is abnormal)
- Breaking current: Displays:
  - The cumulated breaking current (kA)² read in protection relay and compares it to the maximum value specified for the circuit breaker
  - The **indication status icon !** (Appears in red or yellow at the beginning of the line when an alarm or pre-alarm exists)

Figure 26 – Circuit Breaker Screen Functions Page 2: Monitoring and Control



For additional information, refer to:

- *Circuit Breaker Mechanism Aging Evaluation: Number of Operations* on page 34.
- *Circuit Breaker Mechanism Aging Evaluation: Operating and Charging Times* on page 34.
- *Circuit Breaker Mechanism Aging Evaluation: Breaking Current* on page 35.

The bar at the bottom of the Circuit Breaker screen (Figure 27) allows you to navigate between Page 1 and Page 2 details, as well as to access Control (Figure 27) and Maintenance (Figure 28) functions within the Substation Monitoring Device (SMD).

Figure 27 – Circuit Breaker Screen Navigation Bar

- Click the down arrow to go to Page 2 circuit breaker monitoring.
- Click the up arrow to go to Page 1 thermal monitoring.
- Click on the Control button to operate the circuit breaker from Pages 1 and 2.
  - **RESULT:** The original page is displayed at the end of the control operation.

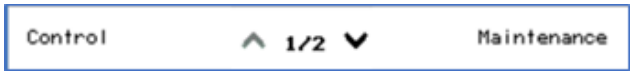


Figure 28 – Circuit Breaker Maintenance Screen

Click the Maintenance button to view the date of the last maintenance and to declare that a maintenance has been executed.

Circuit Breaker Mechanism Aging Evaluation: Number of Operations

Mechanism aging is linked directly to the Number of operations realized and correlated to the maximum Number of operations specified for the circuit breaker (Figure 26 on page 33).

A % bar graph shows the active value compared to the maximum value specified for the circuit breaker (Table 7).

Table 7 – Circuit Breaker Mechanism Number of Operations Value and Statuses

% Bar Graph	Color	Status
0–25%	Blue	OK
25%–50%	Yellow	Pre-alarm 25% mechanical aging
50%–80%	Yellow	Pre-alarm 50% mechanical aging
80%–100%	Red	Alarm 80% mechanical aging

Circuit Breaker Mechanism Aging Evaluation: Operating and Charging Times

The first operating and charging times that the SMD observes are stored as reference times (Figure 26 on page 33). The SMD indicates an alarm if the measured time is too long compared to the reference times based on the following time increases:

- Operating time is not normal if it increases by 30 ms compared to the reference time.
- Charging time is not normal if it increases by 3 s compared to the reference time.

Circuit Breaker Mechanism Aging Evaluation: Breaking Current

The algorithm is based on the wear of the electrical contact and is measured using the cumulated Breaking Current (kA)² stored by the protection relay (Figure 26 on page 33).

A % bar graph shows the electrical aging in % bar graph = actual electrical wear / maximum permissible wear (Table 8).

Table 8 – Circuit Breaker Mechanism Breaking Current Value and Statuses

% Bar Graph	Color	Status
0–25%	Blue	OK
25%–50%	Yellow	Pre-alarm 25% electrical wear
50%–80%	Yellow	Pre-alarm 50% electrical wear
80%–100% or >65000 (kA)²	Red	Alarm 80% electrical wear

Circuit Breaker Control

⚠ WARNING

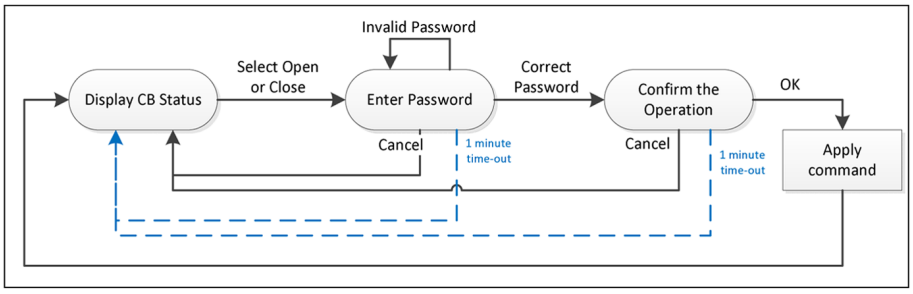
LOSS OF SYSTEM CONTROL PATHS

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Example: Emergency Stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of anticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death or serious injury.

1. Click the Control button to operate the circuit breaker (Figure 27 on page 34).
2. Follow the Circuit Breaker Control procedure (Figure 29).

Figure 29 – Circuit Breaker Control Procedure



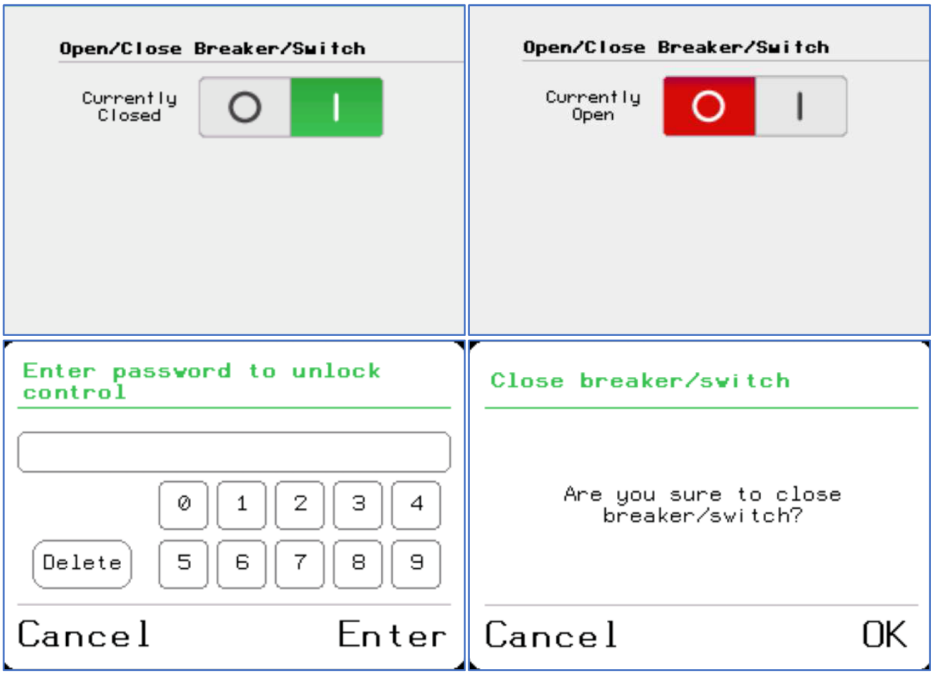
3. Enter the password to unlock the control (Figure 30 on page 36).

   NOTE: The default password is 123456 if it was not changed during the Substation Monitoring Device configuration.

   NOTE: The HMI returns to the Home page (canceling the password) after one (1) minute of inactivity within the password or confirmation screens.

ENGLISH

Figure 30 – Circuit Breaker Control Screens



Cable Connections Screen

The Cable Connections screen displays the information related to the thermal monitoring temperature of the cable connections.

Click on the Cable Connections line of the Cubicle screen to view thermal monitoring information related to the connections for Cables 1 and 2.

RESULT: The Cable Connections thermal monitoring information is displayed (Figure 31).

Figure 31 – Cable Connections Thermal Monitoring Screen

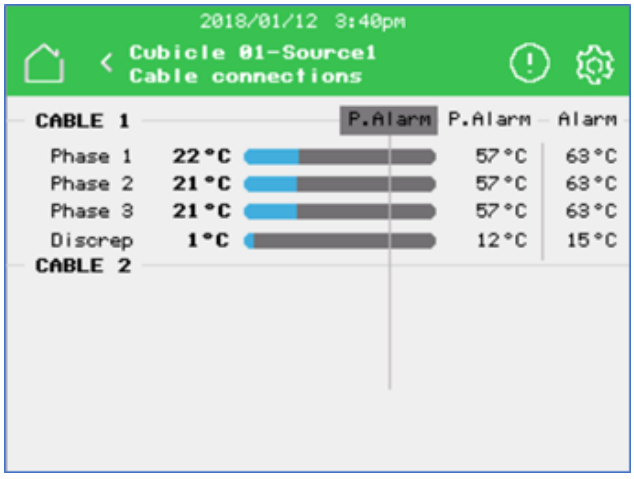
For each Cable connection, there are four lines:

— One for each phase (shown on three separate lines)

— One for the result of the discrepancy temperature algorithm

Refer to *Thermal Monitoring Screens* on page 39 for additional pre-alarm and alarm thresholds, status indication, and bar graph information.

NOTE: If the alarm values exceed the threshold values, contact your local Schneider Electric team for assistance. Equipment aging can be accelerated under these conditions.



Transformer Screen

1. Click on the Cubicle in the Home screen to access the Transformer screen.

   RESULT: The Cubicle screen opens and allows access to the function lines and details information (Figure 32).

Figure 32 – Transformer Screen

Within the Transformer screen, there are three configured function lines:

— Tr. Dry Monitoring: Allows access to dry transformer monitoring when a PT100 probe is configured

— Medium/Low Voltage: Allows access to the Thermal monitoring information related to the MV and LV part of the transformer

— Winding/Tapping Links: Allow access to the Thermal monitoring information related to the Winding and the Tapping Links

The **status indication icon !** appears in yellow or red at the beginning of the line where an alarm or pre-alarm exists.

2. Click on the configured function line.

   RESULT: More details about the selected function are displayed.

Thermal Monitoring Information of a Dry Transformer Screen Menu

The Thermal Monitoring Information of a Dry Transformer screen menu shows the thermal temperature of the transformer windings and the estimated age of the transformer.

Based on standard IEC 60076-12, the Substation Monitoring Device (SMD) monitors the transformer windings temperatures and thermal class information to determine the life duration (aging) of the transformer.

Click the Tr. Dry Monitoring line of the Transformer screen to view thermal monitoring information of a dry transformer.

RESULT: A window appears displaying the winding temperatures, aging information, thermal class, and alarm thresholds (Figure 33 on page 38).

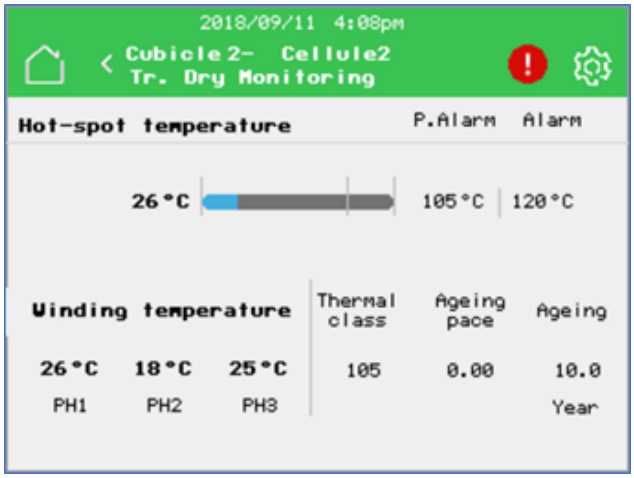
The transformer thermal class within the configuration is used to define the alarm thresholds for the hotspot temperature:

- Pre-alarm treshold: Is the insulation system temperature
- Alarm treshold: Is defined 10 °C (50 °F) below the maximum hotspot winding temperature

ENGLISH

Figure 33 – Thermal Monitoring Information of a Dry Transformer Screen

- The hot spot winding temperature is shown in the top half part of the screen. Displays:
  - A numerical value
  - A % Bar graph with color status: (blue by default, yellow if pre-alarm, or red if alarm)
- The three winding temperature measurements for three phases are displayed in the bottom left corner of the screen.
- The transformer thermal class and aging information is displayed in the bottom right corner of the screen.



Transformer Medium/Low Voltage Screen

The Medium/Low Voltage screen displays the thermal monitoring information related to the temperature of the MV (upper bushing) and LV transformer connections.

Click on the Medium/Low Voltage line of the Transformer screen to view thermal monitoring information related to the MV and LV connections.

RESULT: The MV and LV Connections thermal monitoring information is displayed (Figure 34).

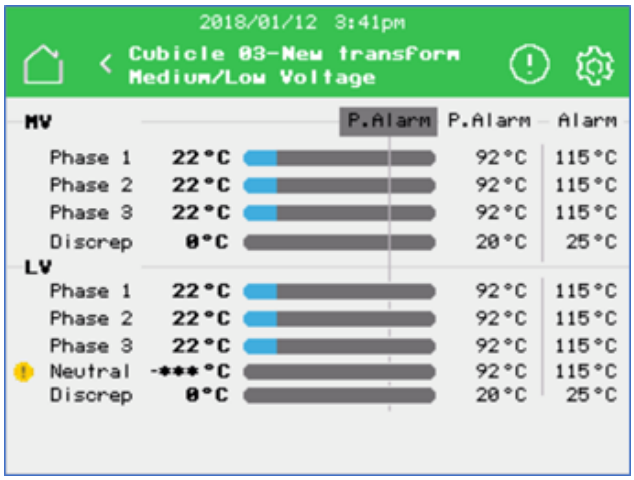
Figure 34 – Transformer Medium/Low Voltage Thermal Monitoring Screen

For each Transformer connection, there are four lines:

- One for each phase (shown on three separate lines)
- One for the result of the discrepancy temperature algorithm

NOTE: The LV transformer has an additional Neutral connection line.

NOTE: If the alarm values exceed the threshold values, contact your local Schneider Electric team for assistance. Aging of the transformer core can be accelerated under these conditions.



Refer to *Thermal Monitoring Screens* on page 39 for additional pre-alarm and alarm thresholds, status indication, and bar graph information.

Transformer Winding/Tapping Links Screen

The Winding/Tapping Links screen displays the thermal monitoring information related to the temperature of the Winding (lower bushing) and Tapping Links transformer connections.

Click on the Winding/Tapping Links line of the Transformer screen to view thermal monitoring information related to the MV and LV connections.

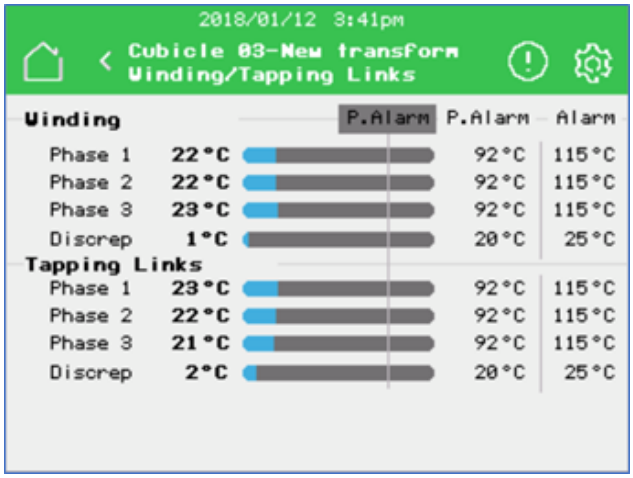
RESULT: The Winding/Tapping Links thermal monitoring information is displayed (Figure 35 on page 39).

Figure 35 – Transformer Winding/Tapping Links Thermal Monitoring Screen

For each Winding/Tapping Links connection, there are four lines:

— One for each phase (shown on three separate lines)

— One for the result of the discrepancy temperature algorithm



Refer to *Thermal Monitoring Screens* on page 39 for additional pre-alarm and alarm thresholds, status indication, and bar graph information.

Thermal Monitoring Screens

Thermal Monitoring screens are available within various screens (Figures 36 and 37 on page 40). For example, it can be accessed by:

- Clicking the Others button from the Home screen.
- Clicking the All functions menu from the Cubicle screen.

RESULT: The temperatures, alarms, and temperature thresholds are displayed on the screen.

NOTE: The following thermal monitoring screen descriptions are not specific for all Substation Monitoring Device (SMD) screens.

Example 1 displays the thermal temperatures for “Others” connections (locations) other than cubicles if some are defined in the configuration. Example 2 displays the thermal temperatures information for circuit breakers.

ENGLISH

The information related to a set of sensors is displayed in half the screen. The monitoring information of two connections can be displayed in the same screen.

For each connection, there are four lines:

— One for each phase (shown on three separate lines)
— One for the result of the discrepancy temperature algorithm

For each line:

— The measured or calculated value is displayed in numeric value. When no measurement exists, the text *** is displayed.
— The pre-alarm and alarm thresholds are displayed:
  — If the standard algorithm is used, then the thresholds are defined in configuration and are constant.
  — If the advanced algorithm is used, then the thresholds are variable and are changing depending on the current flowing in the conductor and the time constant defined in the configuration.
— The **status indication icon !** appears in yellow or red at the left of the line when an alarm or pre-alarm is active.
— A bar graph shows the temperature versus the thresholds. Color changing indicates the status:
  — Blue (default): Normal operation
  — Yellow: Pre-alarm
  — Red: Alarm
  — Grey: The SMD does not receive any measurement (sensor not communicating)

Figure 36 – Example 1: Thermal Monitoring Screen: Others Connections

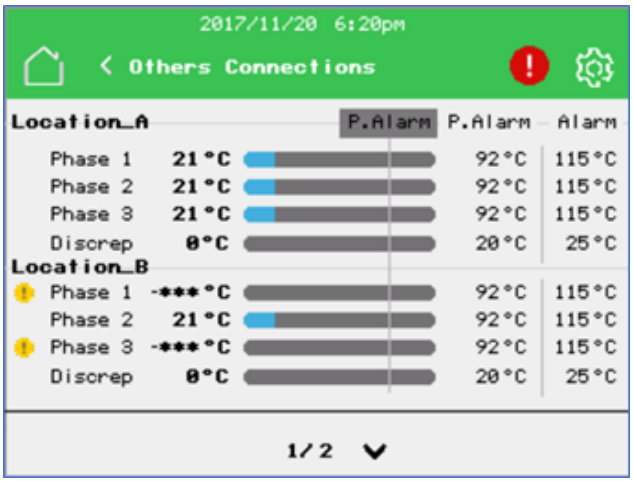
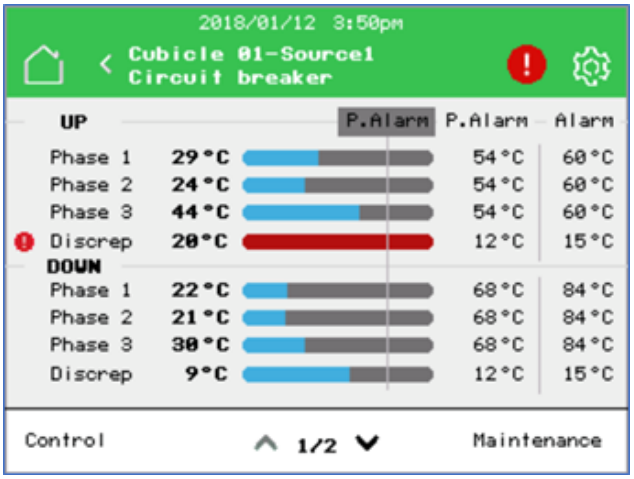


Figure 37 – Example 2: Thermal Monitoring Screen: Circuit Breakers



Section 8— Troubleshooting and Support

Main Control Unit TM251 System Status LEDs

Table 9 describes the system status LEDs for the main processor unit TM251:

Table 9 – Main Control Unit TM251 System Status LEDs

Label	Function Type	Color	Status	Description
PWR	Power	Green	On	Indicates that power is applied
			Off	Indicates that power is removed
RUN	Machine status	Green	On	Indicates that the main control unit is running a valid application
			Flashing	Indicates that the main control unit has a valid application that is stopped
			1 Flash	Indicates that the main control unit has paused at BREAKPOINT
			Off	Indicates that the main control unit is not programmed
ERR	Internal error	Red	On	Indicates that an operating system error has been detected
			Fast flashing	Indicates that the main control unit has detected an internal error
			Slow flashing	Indicates either that a minor error has been detected if RUN is ON or that no application has been detected
I/O	I/O error	Red	On	Indicates detected device errors on the serial line, SD card, TM4 bus, TM3 bus, Ethernet port(s) or CANopen port
SD	SD card access	Green	On	Indicates that the SD card is being accessed
BAT	Battery	Red	On	Indicates that the battery needs to be replaced
				Refer to document number HRB59604: https://www.schneider-electric.us/en/download/document/HRB59604/
			Flashing	Indicates that the battery charge is low
ETH	Ethernet port status	Green	On	Indicates that the Ethernet port is connected and the IP address is defined
			3 Flashes	Indicates that the Ethernet port is not connected
			4 Flashes	Indicates that the IP address is already in use
			5 Flashes	Indicates that the module is waiting for BOOTP or DHCP sequence
			6 Flashes	Indicates that the configured IP address is not valid
SL	Serial line	Green	On	Indicates the status of the serial line
			Off	Indicates no serial communication
TM4	Error on TM4 bus	Red	On	Indicates that an error has been detected on the TM4 bus
			Off	Indicates that no error has been detected on the TM4 bus
CAN-R	CANopen running status	Green	On	Indicates that the CANopen bus is operational
			Off	Indicates that the CANopen master is configured
			Flashing	Indicates that the CANopen bus is being initialized
			1 Flash per second	Indicates that the CANopen bus is stopped
CAN-E	CANopen error	Red	On	Indicates that the CANopen bus is stopped (BUS OFF)
			Off	Indicates no CANopen detected error
			Flashing	Indicates that the CANopen bus is not valid
			1 Flash per second	Indicates that the main control unit has detected that the maximum number of error frames has been reached or exceeded
			2 Flashes per second	Indicates that the main control unit has detected either a Node Guarding or a Heartbeat event

NEMA Reference Publications

Schneider Electric publications are available through your local representative. Refer to Schneider Electric support at http://www.se.com/CCC to locate contacts for your region. Also, refer to http://www.se.com to download technical publications and other technical information.

For information about obtaining NEMA documents, write to:

National Electrical Manufacturers Association (NEMA)
Attention: Customer Service
1300 North 17th Street
Suite 1847
Rosslyn, VA 22209

Table 10 – NEMA Reference Publications

Publication	Publication Number
General Instructions for Proper Installation, Operation, and Maintenance of Switchboards Rated 600 V or Less	NEMA Publication PB2.1
Application Guide for Ground-Fault Protective Devices for Equipment	NEMA Publication PB2.2
Circuit Breakers	NEMA Publication AB-4
Enclosed and Miscellaneous Distribution Switches	NEMA Publication KS-1
Electrical Equipment Maintenance	NFPA 70B-1999

Maintenance Log

Table 11 – Maintenance Log Description

Date	Initials	Maintenance Performed/Description

ENGLISH

Maintenance Log Description

Date	Initials	Maintenance Performed/Description

ENGLISH

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