Switchgear Temperature Monitor

Increase safety by knowing more

System Solution

Antenna

Panel-mount Display

USER GUIDE - RFM5117

APPLICATIONS

Low-voltage switchgear
Medium-voltage switchgear
UPS battery stacks
Power distribution busbars
Critical electrical breakers

KEY FEATURES

Improves worker safety
Flags failing equipment
Reduces out-of-service time
Wireless on-metal sensors
Battery-free
Maintenance-free

What's in the system?

The RFM5117 Switchgear Temperature Monitor allows maintenance teams to track the status of low-voltage and medium voltage switchgear. The system alerts maintenance teams to temperature rises in switchgear components and busbars, which indicate deterioration and potentially dangerous arcing situations. The system is particularly useful for protecting workers and equipment from the catastrophic consequences of switchgear failure.

How is it used?

The system employs a family of rugged sensors. A four-port fixed reader monitors sensor status as it cycles through four antennas. Temperature data and control can be accessed via the USB or via a MODBUS/RS-485 interface using SCADA monitoring software.

Sensors sold separately

The rugged temperature sensor family is designed for use in harsh environments. The sensors attach directly to the metal components being monitored and are battery-free, maintenance-free.

Part numbers

The RFM5117-AF system includes a reader conforming to FCC frequency ranges. The RFM5117-AE system includes a reader conforming to EU/ETSI frequency ranges. Antennas and displays are provided. Sensors can be purchased separately.

Contents

RFM3260 Lug-mounted Temperature Sensor
Sold separately

RFM5117 Magnetic-mount antenna suitable for mounting inside switchgear enclosures

RFM5117 Panel-mount display with built-in alarms and temperature reporting

RFM5117 Fixed Reader for Switchgear Sensors

1. INTRODUCTION

Thank you for purchasing the RFM5117 Switchgear Temperature Monitor system. The system enables temperature monitoring of medium and low-voltage switchgear equipment used in the distribution and control of electricity. The temperature monitoring process employs radio frequency signals to wirelessly power and communicate with sensors and it does not require any wiring to the sensors. Sensors are purchased separately or as part of a completed system such as the RFM5107. The sensors are either placed directly on components using an adhesive backing or bolted directly to switchgear components using an integrated metal lug. A radio-enabled fixed reader is used to read sensor status. Because most switchgear is protected by a metal enclosure, one RF antenna should be placed inside each chamber of the cabinet.

1.1. RFM5107-Ax System Components:

Industrial Fixed Reader: The reader is used to communicate with the sensors and retrieve their temperature data/status. The reader includes internal firmware to monitor sensor data. The reader can be accessed via the USB or the MODBUS/RS-485 interfaces. A separate utility, which runs on the Windows® operating system, is provided to access reader data. The reader mounts directly to standard DIN rails and is secured with the built-in spring-loaded clip.

Panel-mount display: The display is preprogrammed to report current sensor temperatures. It can be configured to cycle through all active sensors, or to continuously report the sensor with the highest temperature.

Reader and display power source: The reader and display are powered by an external power source: 80-265V AC or DC.

Antennas: The system includes four antennas that can be mounted inside of switchgear enclosures. RF signals are not able to penetrate metal enclosures; this requires that one antenna be placed inside of each chamber of the enclosure. There is no limitation on the number of sensors that can be read by a single antenna, although the current version of the software will only report on a total of 12 sensors per reader.

Bidirectional power splitter: A bidirectional power splitter allows a single reader antenna port to support two or more antennas that can be placed in separate metal switchgear chambers. Power splitters reduce the power to individual antennas and may require increased reader output power. Splitting a single reader antenna port between more than four antennas is not recommended. Power splitters are not included with the RFM5117 system.

RF cables: The four antennas are connected to the reader using the four ANT1..4 antenna ports on the reader. Four cables are provided.

Temperature sensors: The RFM3240, RFM3250 and RFM3254 are wireless temperature sensors with adhesive backing. The RFM3260 is a wireless lug-mounted temperature sensor. All sensors employ RFMicron Smart Passive Sensing™ technology. These sensors are designed to be mounted directly to switchgear components.

Software: The software includes two components: firmware that is preinstalled on the reader, and a Windows®-compatible READER UTILITY that should be installed on a computer. The reader can be accessed via the USB or MODBUS/RS-485 interfaces. Use of a standard PLC-type industrial controller is also possible.

RFM3250 Rugged Temperature Sensors

Sold separately

2. THE READER

The fixed reader is used to communicate with the sensors and retrieve their temperature readings. This wireless reader does not include an integrated antenna; antennas must be connected to the reader using separate cables. The reader can operate from a range of external power sources.

2.1. Powering the reader

The reader can operate from ac or dc electrical power ranging from 80 V to 265 V. The system includes an appropriate connector for the power connection. When power is applied, the PWR LED on the reader unit will flash green.

2.2. Connecting the reader to a PC

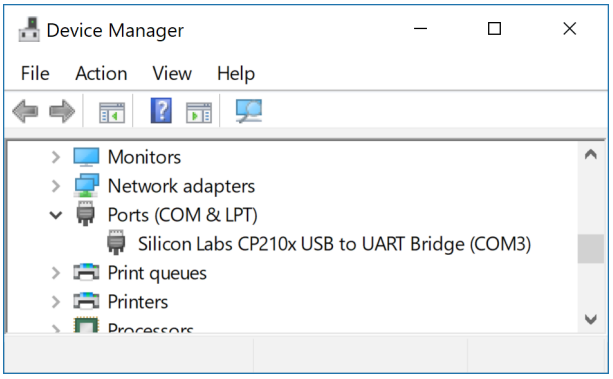
The reader can be configured over USB using the included READER UTILITY application. The READER UTILITY software files should be copied to a folder in the program directory of a Windows® computer. Clicking on the “Reader Utility.exe” file will open the application. Click the OPE(N) button in the PORT control at the bottom of the SENSOR INFORMATION tab to begin communicating with the reader. Once the communication link to the reader is successfully established, a “Reader Connection Successful” message will be displayed in the READER DIALOG window.

If the PC connection is not recognized, it may be helpful to cycle the reader power before connecting the USB cable, and then opening the READER UTILITY as the last step.

2.3. USB connection debugging

The USB connection to the RF reader may have failed if the Power LED is not blinking. The process below can be used to correct the issue.

1. Power the RF reader and connect the USB cable.
2. Open the Windows Device Manager by clicking through the Windows Control Panel, or by searching at the start menu.
3. Ensure that the Silicon Labs CP210x USB driver is visible.



4. If the driver is not present, please install it from the CP210x driver from the directory on the flash drive.

   \reader-utility-setup-software\

3. USING THE SYSTEM

3.1. Identifying and Organizing Sensors

As part of an installation process, each sensor must be registered with the reader using the READER UTILITY. Each sensor includes a personalization code in its EPC memory location. The reader uses this personalization code to identify individual sensors. Using sensors as they are shipped from the factory is acceptable. When initiated, the reader will interrogate each registered sensor and report temperature readings. Additional information is contained in section 7, the SENSOR SETTING Tab discussion.

RFMicron wireless, battery-free sensors are also uniquely identifiable by a Tag Identification (TID) number stored in each sensor's memory. The TID is a fixed and unique value that cannot be changed. The Reader Utility does not currently access the sensor TID value.

3.2. Setting the SENSOR Description

The SENSOR description can be changed on the SENSOR SETTING tab of the Reader Utility. The SENSOR entry box will accept a 12-character alphanumeric string including { a..z, A..Z, 1..0, !@#$%^&*()_+-*\/=-<>?~{}[]<>? }. Click the SET button for the specific sensor to load this value into to the reader.

3.3. Entering SENSOR ID Codes

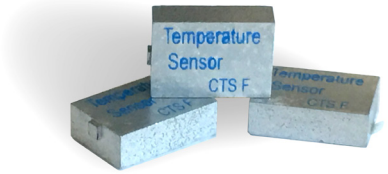
Sensor EPC values can be programmed with a distinct code or identifier number as needed by the maintenance team. Please see the SENSOR SETTING Tab description for additional details.

3.4. Sensor Handling and Placement

RFMicron sensors can be touched with no worry about affecting their operation. The RFM3250 and the RFM3260 temperature sensors are constructed with rugged materials designed to operate in harsh environments. In normal use, the RFM3250 protective backing is peeled from the sensor's adhesive layer before affixing it to the switchgear component. The RFM3260 lug-mounted sensor is bolted into place. Existing bolts can be used for this purpose if there is sufficient thread length available on the bolt. Other bolt options are possible as well.

Epoxy mounting of the sensors is allowable, but it is not recommended. The epoxy can act as a thermal insulator which reduces the flow of heat to the sensor; this means that the sensor will be somewhat closer to the ambient temperature, rather than at the temperature of the switchgear component being monitored.

If insulation materials are used over the sensor, the preference is to leave an air gap above the sensor so that it is not in direct contact with



RFM3254 Small-Format Rugged Temperature Sensor. Small enough to be placed directly on contact assemblies. Sold separately

protective materials. The thermal impedance of air is likely higher in most cases. Heat transfer from protective coatings and covers can cause the sensor temperature to be somewhat closer to the ambient temperature, rather than at the temperature of the switchgear component being monitored. A small air gap results in the sensor temperature being closer to the monitored component's temperature.

3.5. Launching the Application

The reader firmware is preinstalled on the reader. The READER UTILITY application must be loaded on a Windows® PC compatible system. The utility is launched by double-clicking on the application icon or the "Reader Utility.exe" file.

3.6. Measuring Sensor Temperature Values

The RFM5107 wireless reader is used to interrogate and display sensor values. The devices will report sensor data to the READER UTILITY software for display. Assuming the sensors are properly registered with the reader, the sequence to read sensor values requires that the reader is connected to a PC via USB, and that OPE(N) button should be pressed in PORT control seen on the SENSOR INFORMATION tab of the Reader Utility software, and that the START button should be pressed. The reader will update the SENSOR1..12 display values on the SENSOR INFORMATION tab.

RFM3240 High-Sensitivity Temperature Sensor.
Delivers a 19 meter read range is and is suitable for busbars and other large components.
Sold separately

3.7. Maximum Read Range

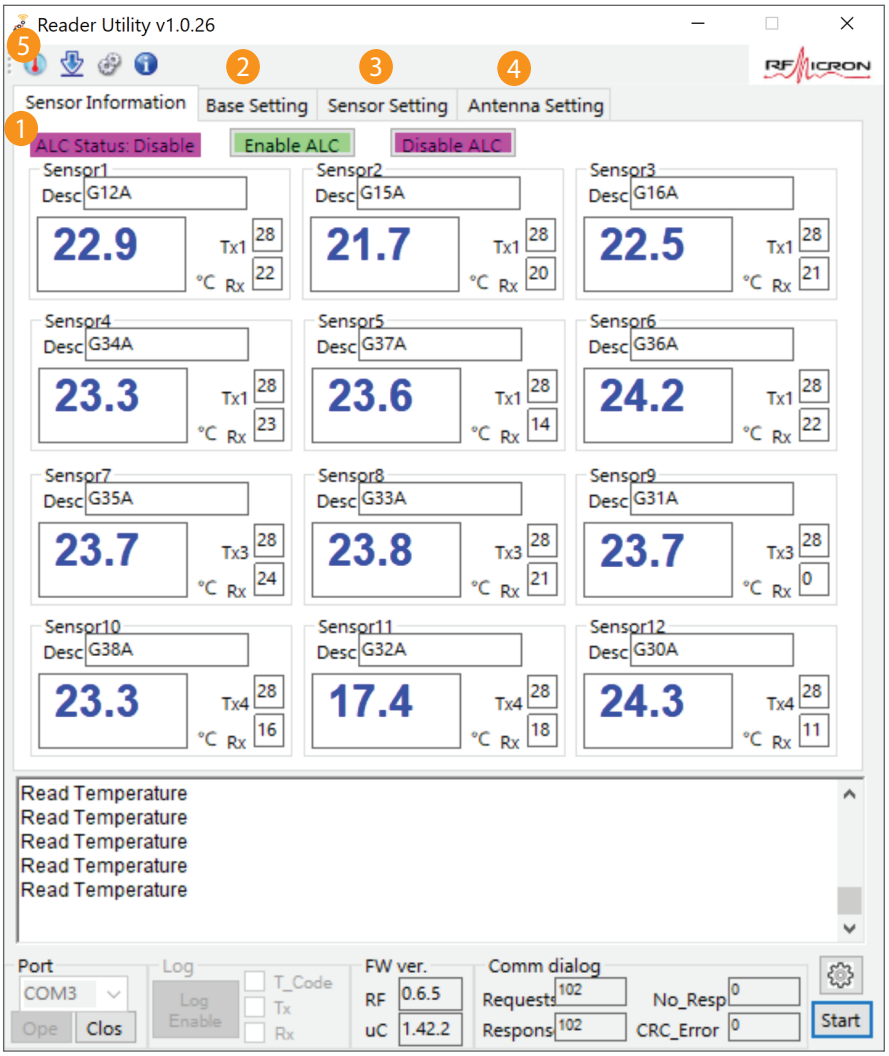
The maximum read range for the RFM3250 is approximately 5 to 7.5 meters in a free air environment depending on the antenna used. The maximum read range for the RFM3260 is approximately 13 meters in a free air environment. Inside of a metal enclosure with complex mechanical structures, the read range for both sensor types may be reduced to 2-3 meters.

Metal enclosures tend to reflect the RF signal throughout the enclosure. It is possible for these reflected signals to combine to create nulls or shadows, where the RF signal cancels itself. These nulls are usually only a few inches or centimeters wide. Moving sensors in any direction will often correct for any weak signal strength issues. Read range can also be improved by adding a second antenna to the enclosure. The second antenna may still have RF nulls and shadows, but these are generally located in different locations than the original antenna's nulls.

RF signals within a complex mechanical structure might also combine to reinforce signal strength. If readings from a sensor appear erratic and the reported power at that sensor is above 25 in the RX INDICATOR dialog as reported in the SENSOR1..12 displays on the SENSOR INFORMATION tab of the Reader Utility, then the use of the ALC (AUTOMATIC LEVEL CONTROL) is recommended. The ALC will modulate the power to the sensor to compensate for situations where the RF power is too strong.

4. READER UTILITY SOFTWARE

The READER UTILITY application provides access to sensor data values. The READER UTILITY is also used to configure and register sensor settings on the reader.



1	SENSOR INFORMATION Tab	Primary access to sensor data
2	BASE SETTING Tab	Communication and data filtering controls
3	SENSOR SETTING Tab	Sensor configuration settings
4	ANTENNA SETTING Tab	Antenna configuration settings
6	Menu Items	Individual menu controls for calibration, firmware updates, etc.

5. SENSOR INFORMATION Tab

Once launched, the READER UTILITY application displays the main SENSOR INFORMATION tab. This is the primary sensor output display.

1.1	SENSOR1..12	Sensor display windows	1.7	PORT	Communications port
1.2	DESC	Sensor text description	1.8	LOG ENABLE	Data logging enable
1.3	SENSOR VALUE	Sensor value display	1.9	FW VER	Firmware version
1.4	TX1..4	Transmitter power and antenna ID	1.10	COMM DIALOG	Communications technical dialog
1.5	RX	Receive power at the sensor	1.11	START/STOP	START/STOP button
1.6	READER DIALOG	Reader dialog box	1.12	ALC ENABLE/DISABLE	Auto Level Control Enable/Disable

SENSOR1..12 displays report sensor values, status and error messages for each sensor.

Display	Message
28.6	Example normal temperature reading in degrees centigrade
Read Fail	Failure to read sensor with specified EPC code
No Setting	Sensor identification information is not present
Disable	The sensor is disabled
----	Temperature has not been read yet
ANT Disable	The specified antenna(s) are not enabled

DESC indicator displays a description for each of the twelve sensor displays. The text description entered in the SENSOR entry on the SENSOR SETTING tab for each sensor is displayed in this dialog.

SENSOR VALUE display reports the current sensor temperature if the read is successful, or an error message on the twelve SENSOR1..12 displays.

TX1..4 indicator reports the reader output power used when interrogating each of the twelve sensors. The indicator number in the TX1..4 label identifies which of the four antennas is listed as the primary antenna for the specified sensor. The first "enabled" antenna {1..4} is typically displayed.

RX indicator reports the RSSI receive power seen by each of the twelve sensors during the read operation.

READER DIALOG window displays communication messages between the reader and the READER UTILITY application.

PORT control selects the COM port used by the USB or serial communication channel. Once the COM port is specified, the OPE(N) button should be pressed to initiate communication with the reader. The STOP button should be pressed to end communication with the reader.

LOG ENABLE in the LOG control selects the file name and storage location used to record data logging information. The TEMP_CODE, TX, and RX checkboxes determine if these values are stored in addition to the temperature readings for each sensor. A TEMP_CODE is a raw data value from the sensor prior to being converted into a temperature in °C. The TX and RX values are the sames as described in this section.

FW VER indicates which RF radio firmware version and which UC program control firmware version are loaded on the reader.

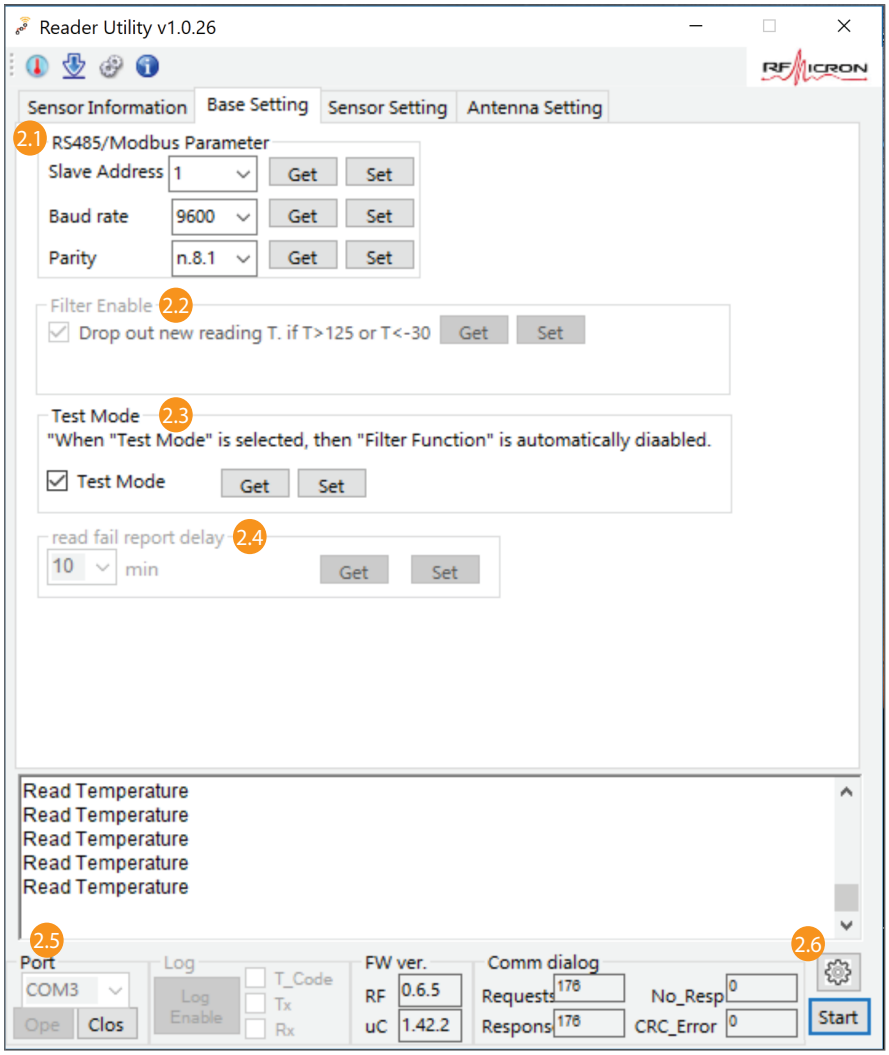
COMM DIALOG displays communication-related status and error messages.

START/STOP button causes the reader to start reading sensor values. These values will be displayed and updated in the SENSOR1..12 displays as each reading is captured. If data logging is enabled using the LOG ENABLE, sensor values will be recorded to the log file.

ALC ENABLE/DISABLE Automatic Level Control (ALC) button manages the automatic RF power level control for the reader. The ALC strives to increase RF output power when reading sensors located at some distance from the reader antenna, where there may be too little power for the sensor. The ALC also reduces the RF output power for sensors located near the reader antenna, where there may be too much power for the sensor. Once enabled, ALC will automatically adjust to find optimum transmit power levels. The ALC adjustment time can be 10s of minutes.

6. BASE SETTINGS Tab

The BASE SETTING tab includes test and configuration controls covering the serial communication protocol, data filtering, and a test mode used during installation.



2.1	RS-485	Serial communication settings
2.2	FILTER ENABLE	Data reporting filter controls
2.3	TEST MODE	Disables filter during installation
2.4	OTHER SETTINGS	Other control display area
2.5	FAST MODE BUTTON	Speeds the reading process up for installation

RS-485 control manages settings for the RS-485 serial communication port. ADDRESS, BAUD RATE, and PARITY can all be set via the pull-down entry options. The SET button for each modified entry should be pressed to update the reader settings. The GET button will cause the current reader settings to be displayed in the READER DIALOG window.

FILTER ENABLE manages filtering that excludes temperature readings that are below -30°C or above 125°C. Readings below 30°C are considered erroneous and therefore uninteresting. Readings above 125°C are considered highly abnormal, and therefore do not add additional value beyond the initial 125°C alarm report.

TEST MODE control disables any active data filters. The SET button should be pressed to update the reader settings. The GET button will cause the current reader TEST MODE setting to be displayed in the READER DIALOG window.

READ FAIL REPORT DELAY sets the number minutes after a sensor read failure before the alarm is triggered. Common values are between 1 and 10 minutes. The RFM5117 system applies strict digital communication protocols to ensure that false alarms are not triggered. This may mean that a scheduled read will be discarded, which triggers the local read failure notice. The READ FAIL REPORT DELAY setting does not affect which readings are validated and which are discarded. This setting only delays the reporting of these alarms outside of the reader.

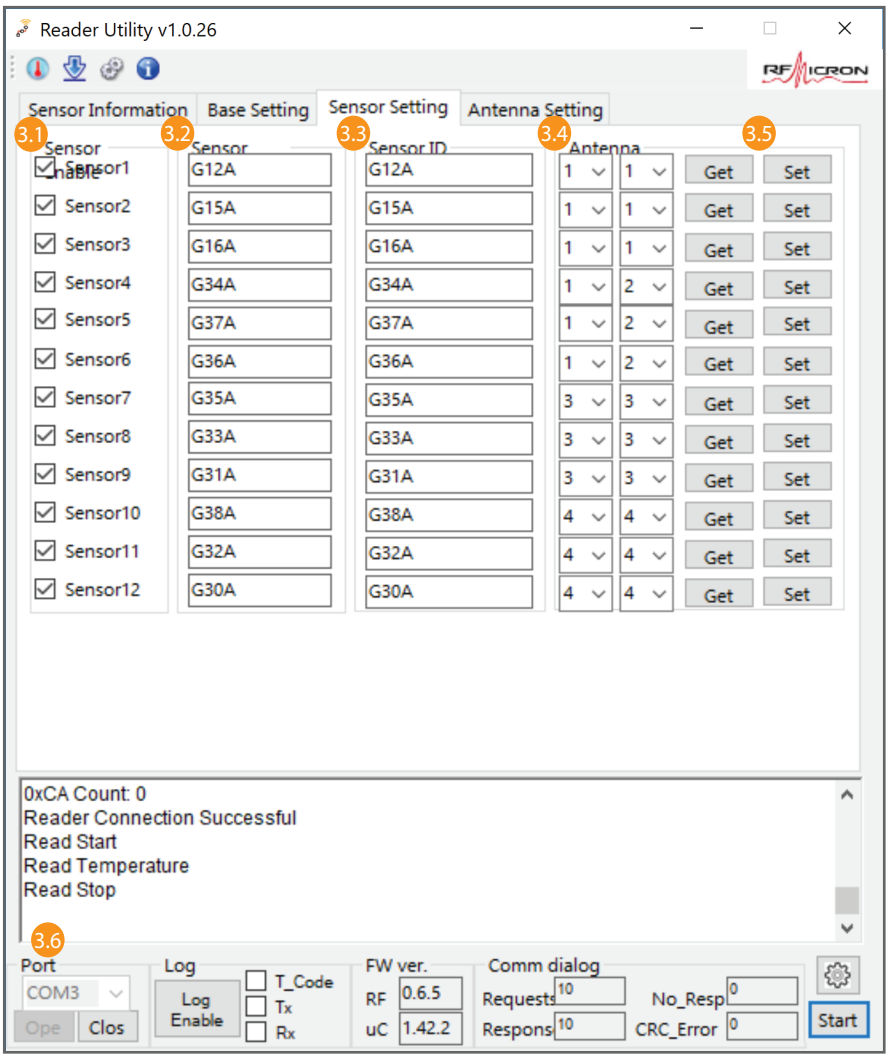
OTHER SETTINGS displayed at the bottom of the BASE SETTING tab are described with the SENSOR INFORMATION tab controls.

FAST MODE BUTTON displayed at the bottom of all tabs. The Fast Mode is enabled to speed the read process up for sensor placement and installation.

CAUTION: The FAST MODE is not designed to be used for extended periods of time. Use beyond 10 minutes will likely overrun the reader with data. If the reader is overrun with data in FAST MODE, it can be reset by power cycling. The FAST MODE should not be enabled for more than 10 minute periods.

7. SENSOR SETTING Tab

Displays individual sensor configuration data and controls. The sensor controls are only active when the reader is not monitoring temperatures. If the reader is actively monitoring temperatures, the sensor data and controls will be grayed out. Pressing the STOP button at the bottom right of the screen will terminate active temperature measurements and enable the sensor controls.



3.1	SENSOR ENABLE	Sensor enable/disable controls	3.4	ANTENNA	Selects antenna(s) for a sensor
3.2	SENSOR	Sensor text description	3.5	GET/SET	Sets and gets settings from reader
3.3	SENSOR ID	Sensor ID code	3.6	OTHER SETTINGS	Other control display area

SENSOR ENABLE checkboxes enable or disable individual sensors. Read data for enabled sensors will be displayed on the SENSOR1..12 displays on the SENSOR INFORMATION tab. The "Disabled" message will be displayed in the SENSOR1..12 displays if a sensor is disabled.

SENSOR is a text entry box to give each sensor a meaningful descriptive name. This name can be the sensor identification code, or it can be the name of the component being monitored. Only 12 characters will be displayed on SENSOR1..12 displays on the SENSOR INFORMATION tab.

SENSOR ID is a 128-bit numeric code that is loaded into the sensor EPC storage location. 128-bits is equivalent to 16 ASCII characters or 32 hex characters. Sensors provided with the system are preprogrammed with suitable EPC codes.

OPTION 1 NOTE: Only the 64 lower order bits, or the lower order 8 ASCII characters will be recognized by the system. All 128-bits of the sensor EPC will need to be written in order for the reader and the sensor communicate.

Data entered into the SENSOR ID should be in hex format. If an ASCII code is used, each 8-bit ASCII code should be split into the two equivalent hex characters. For example, the letter 'A' has a decimal value of 65 and a hex value of 0x41. The value '41' should be entered in the SENSOR ID to represent the letter 'A'. If fewer than 16 ASCII characters are used to identify a sensor, the entered code should be padded with 0's so that a total of 32 hex characters are entered to support the 128-bit format.

OPTION 2 NOTE: To simplify data entry, a four-character ASCII code can be entered into the SENOR ID entry box. The reader will append the needed zeros to the left of the four-character ASCII code before writing the setting to the reader using the SET control for that sensor. Example codes printed on the sensors are S03B, or F27S, etc. Use of the four-character ASCII code is highly recommended.

For example, an ASCII code of F27S will translate to a hex code of 46 32 37 53_{HEX} which is then padded with zeros to create the EPC code programmed into the sensor. Sensors that have been preprogrammed at the factory do not need to be reprogrammed, but use if the four-character ASCII code is highly recommended to simplify sensor registration on the system.

Example: Upper-order EPC bits	Example: Lower-order EPC bits
$0000\ 0000\ 0000\ 0000_{HEX}$	$0000\ 0000_{HEX}$ $F27S_{ASCII}$
$0000\ 0000\ 0000\ 0000_{HEX}$	$0000\ 0000\ 4632\ 3753_{HEX}$

ANTENNA entry pull-downs indicate which antenna(s) the reader will use to communicate with each sensor. Both entries can reference the same antenna. If there is only one antenna within the enclosure, both pull-downs should reference that antenna.

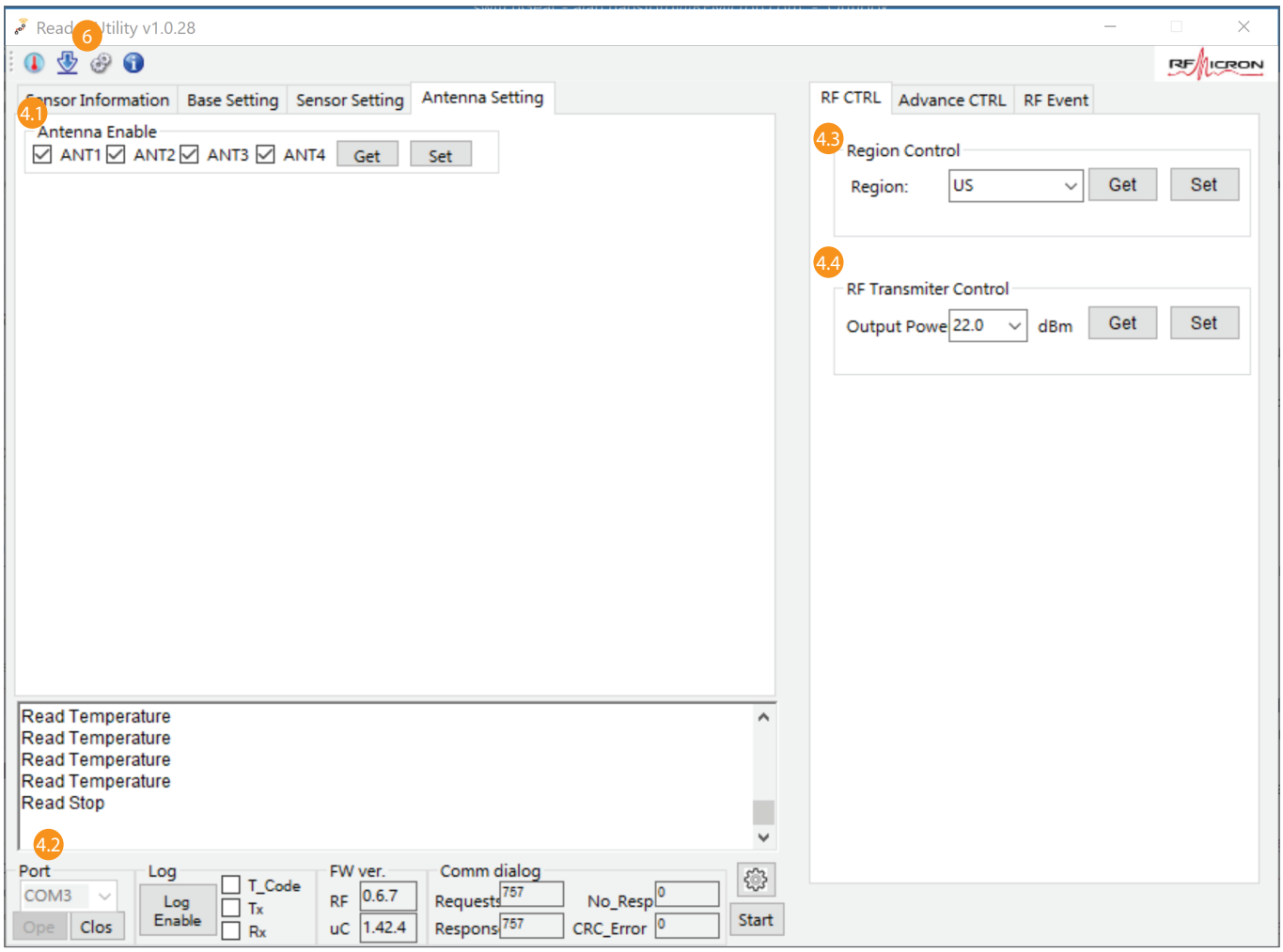
In cases where two antennas are present within the enclosure, those two antennas should be referenced by the ANTENNA entry pull-downs.

GET/SET buttons control updates to the reader. The SET button should be pressed to update the reader settings for each modified sensor. The GET button will cause the current sensor settings stored on the reader to be displayed in the READER DIALOG window.

OTHER SETTINGS displayed at the bottom of the SENSOR SETTING tab are described with the SENSOR INFORMATION tab controls.

8. ANTENNA SETTING Tab

Displays individual antenna configuration data and controls. The RF CTRL fly-out manages RF radio controls and is opened with using the Menu Items control (6).



4.1	ANTENNA ENABLE	Antenna port enables
4.2	OTHER SETTINGS	Other control display area
4.3	FREQUENCY CONTROL	Region and channel controls
4.4	RF TRANSMITTER CONTROL	Maximum RF power limit

ANTENNA ENABLE displays the antenna enable/disable status. If all four antennas are attached to the reader, then all antennas should be listed as enabled. If a reader antenna port ANT1..4 is not used, that antenna should be unchecked. The SET button should be pressed to update the reader settings. The GET button will cause the current antenna settings stored on the reader to be displayed in the READER DIALOG window.

If a sensor is not assigned to at least one enabled antenna, the "ANT disabled" message will be displayed in the SENSOR1..12 displays.

OTHER SETTINGS displayed at the bottom of the ANTENNA SETTING tab are described with the SENSOR INFORMATION tab controls.

FREQUENCY CONTROL sets the output frequency range of the reader. The allowable output frequency range is typically mandated by government regulation. Use of frequencies disallowed for a given geographic region can cause interference with other radio devices and is specifically disallowed. Please select the appropriate frequency range to match your geographic region.

RF TRANSMITTER CONTROL manages the maximum output power of the reader. The maximum output power at the antenna is typically mandated by government regulation. Use of maximum output power above the allowed limits for a given geographic region can cause interference with other radio devices and is specifically disallowed. Please select the appropriate maximum output power to match your geographic region. The reader output power should be adjusted to deliver power at the sensor in the 15 to 25 range as indicated by the sensor RX receive power indicator shown on the sensor display window of the READER UTILITY.

Region	Frequency Range
Brazil	902.128 to 907.234 MHz, 915.128 to 927.82 MHz
China1/China2	920.125 to 924.875 MHz
Europe	865.70 to 867.5 MHz
Japan	920.6 MHz to 923.4 MHz
Korea	917.10 to 923.30 MHz
North America	902.75 to 927.25 MHz
United States	917.10 to 926.90 MHz

CAUTION: Use of the North America setting is not recommended. Please use the US setting.

ADVANCE CONTROL manages several engineering mode settings. The SUCCESS READ RATIO control on this fly-out is important for sensor setup. The ADVANCED CONTROL fly-out panel is made visible by double-clicking the RF CTRL fly-out. The RF CTRL fly-out is made visible by clicking the gear above the menu tabs.

SUCCESS READ RATIO enables calculation of the percentage of successful reads in the last 30 reads. Read ratios below 50% are good candidates for re-optimizing sensor placement. Located on the ADVANCED CONTROL fly-out

MAIN MENU Items

The MAIN MENU items provide access to utility functions including sensor calibration, firmware updates, RF controls for the reader radio and about information.

CALIBRATE TEMPERATURE menu opens the SENSOR CALIBRATION dialog. Calibrating a sensor at a known temperature improves the temperature monitoring accuracy of that sensor near the calibration temperature.

WARNING: Sensors MUST be at a known temperature to perform a calibration. Otherwise, significant errors will be injected into the temperature monitoring process. Use of the calibration process in not recommended.

CALIBRATE TEMPERATURE specifies the current temperature of the sensor. It is essential that the sensor's actual temperature be known before attempting any calibration. Typically, sensors are placed in a controlled temperature environment and allowed to soak for an extended period of time before attempting a calibration.

CALIBRATE ALL SENSORS will update the calibration data on all sensors registered with the Reader Utility application when the OK button is pressed.

CALIBRATE A SINGLE SENSOR will calibrate a single sensor registered with the Reader Utility application according to the sensor number {1..12}.

CANCEL terminates the calibration process without taking action.

WARNING: Use of the calibration process in not recommended.

RF FIRMWARE DOWNLOAD opens the firmware update dialog.

OPEN allows the user to specify the file and directory location of the file that will be used to update the reader firmware.

UPDATE button loads the specified file on to the reader.

RF CTRL fly-out panel manages RF interrogation parameters. Please see the ANTENNA SETTING Tab description for additional details

ABOUT indicates the firmware version and release date.

9. MODBUS Interface

The reader data can be accessed over the RS-485 serial interface using the industry standard MODBUS protocol. This interface is typically manged by SCADA (Supervisory Control And Data Acquisition) software running in the control center. The RFM5117 reader is compatible with most of the common SCADA software solutions.

SERIAL COMMUNICATION settings are adjusted using the USB interface and the READER UTILITY. Please see the BASE SETTING tab.

BASE ADDRESS of the reader should be set using the USB interface and the READER UTILITY. Please see the BASE SETTING tab.

9.1. Reader register map

These registers are accessible over the RS-485 using MODBUS protocol from SCADA software.

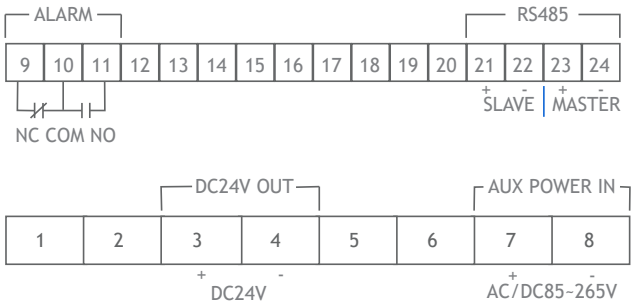
Register	Name	Type	Units	Range	Description
1000-1002	Reserved	R			Do not modify
1004-1015	Temperature[1..12]	R	0.1 °C	-300 °C to 1,250 °C	**Current SENSOR VALUE temperature** Error codes: -999: Read failure -998: SENSOR ID code does not match -997: Sensor is disabled -996: Initial value -995: Antenna selected for this sensor is not enabled
1016-1051	Reserved	R			
1052-1063	RX[1..12]	R	Rx	[0..31]	RSSI Power level seen at the sensor. Unit-less. Larger values indicate higher power. Used with placing sensors.
1064-1099	Reserved	R			Do not modify
1100-1111	TEMPERATURE CODE[1..12]	R	Codes	[0..4095]	Raw temperature code from the sensors. Not used in normal operation.
1200	Address	R/W		[1-255]	MODBUS address of the reader.
1201	Baud Rate	R/W	bps	[0..5]	0: 1200 1: 2400 2: 4800 3: 9600 4: 19,200 5: 38,400
1202	Parity	R/W	N/A	[0..3]	0: N.8.1 1: N.8.2 2: O.8.1 3: E.8.1
1203-1480	Reserved				Do not modify

10. Panel-Mount Display

The display is preprogrammed to report current sensor temperatures. It can be configured to cycle through all active sensors, or to continuously report the sensor with the highest temperature.

10.1. Display Connections

The display incorporates two removable connectors on the back that facilitate external connections. The display supports power input, 24V output power, a normally open (NO) alarm connection as well as a normally closed (NC) alarm connection. RS-485 slave and master serial ports allow the reader and the display to be daisy-chained to simplify operation.



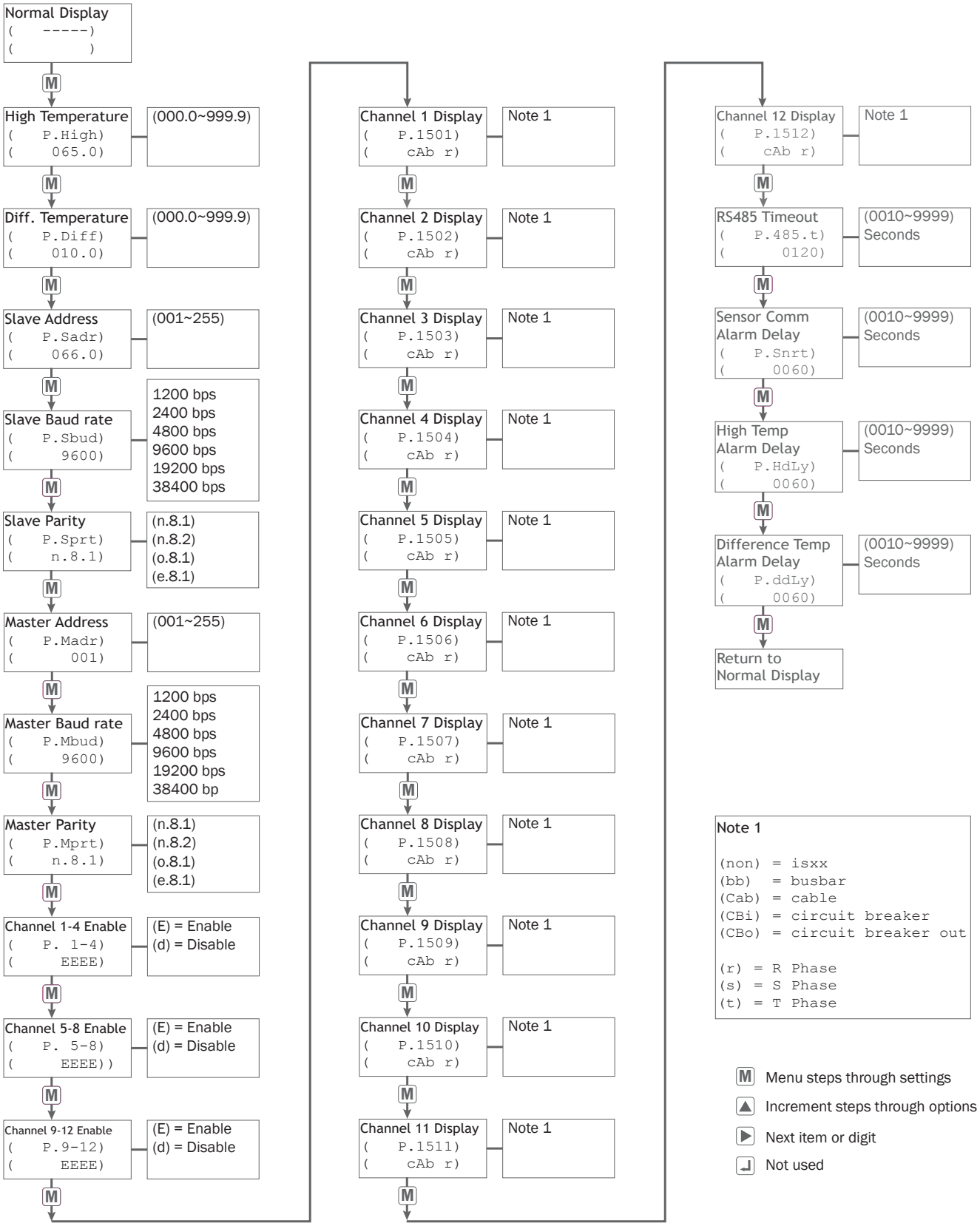
10.2. Display Menu Structure

Display settings are managed using the four buttons on the front panel. The M menu button cycles through the various menu items, while the arrow buttons cycle through the setting options. Pressing the arrow buttons repeatedly will cycle through the options in a loop. The return button can be used to acknowledge and clear blinking alarms.

10.3. Display Master Slave RS-485 Interfaces

The display unit incorporates two RS-485 interfaces. The master is used to communicate with the reader unit. The slave interface us used to communicate with the monitoring system. The display can be installed between the monitoring system and the reader, or the reader can be connected directly to the monitoring system using the display.

10.4. Panel-Mount Display Menu Structure



10.5. Panel-Mount Display MODBUS registers

These registers are accessible over the RS-485 using MODBUS protocol from SCADA software.

Register	Name	Type	Units	Range	Description
88-99	ISO Display[1..12]	R/W		[1..12]	0 = non (Display ISxx) 1 = bb r (bus bar R Phase) 2 = bb s (bus bar S Phase) 3 = bb t (bus bar T Phase) 4 = CAb r (cable R Phase) 5 = CAb s (cable S Phase) 6 = CAb t (cable T Phase) 7 = Cbi r (circuit breaker in R Phase) 8 = Cbi s (circuit breaker in S Phase) 9 = Cbi t (circuit breaker in T Phase) 10 = Cbo r (circuit breaker out R Phase) 11 = Cbo s (circuit breaker out S Phase) 12 = Cbo t (circuit breaker out T Phase)
100	Product Code	R			
101	Firmware Version	R			
102	Alarm State	R			Bit0: 1 = High Temp. Alarm; 0 = None Bit1: 1 = Diff. Temp. Alarm; 0 = None Bit2: 1 = Comm. Alarm; 0 = None
103-114	Sensor Temperature [1..12]	R	0.1 °C	-200 °C to 1,250 °C	**Current SENSOR VALUE temperature**
1052-1063	Signal Strength [1..12]	R	0.1	[0..500]	RSSI Power level seen at the sensor. Unit-less. Larger values indicate higher power. Used with placing sensors.
127	Master Address	R/W	0.1 °C	[1-255]	Used to collect temperature data from RF reader
128	Master Baud Rate	R/W	bps		0=1200 1=2400 2=4800 3=9600 4=19200 5=38400
129	Master Parity, Data, Stop	R/W			0 = n.8.1 1 = n.8.2 2 = o.8.1 3 = e.8.1

Continued from prior page

Register	Name	Type	Units	Range	Description
130	Slave Address	R/W		[1-255]	Used to communicate to SCADA/DCS to send back data to monitoring systems
131	Slave Baud Rate	R/W	bps	[0..5]	0: 1200 1: 2400 2: 4800 3: 9600 4: 19,200 5: 38,400
132	Slave Parity, Data, Stop	R/W	N/A	[0..3]	0: N.8.1 1: N.8.2 2: O.8.1 3: E.8.1
133	High Temp Alarm setting	R/W	0.1	0~1999	
134	Diff Temp. Alarm setting	R/W	0.1	0~1999	
135	Time Out	R/W	1 sec	10~9999	
136	Single Time Out	R/W	1 sec	10~9999	
137	Channel Enable	R/W	Bit	0=Disable 1=Enable	Bit0 = channel1 Bit1 = channel2 Bit2 = channel3 Bit3 = channel4 Bit4 = channel5 Bit5 = channel6 Bit6 = channel7 Bit7 = channel8 Bit8 = channel9 Bit9 = channel10 Bit10 = channel11 Bit11 = channel12
147	High Temp Alarm delay	R/W	1 sec	0~9999	
148	Diff Temp. Alarm delay	R/W	1 sec	0~9999	

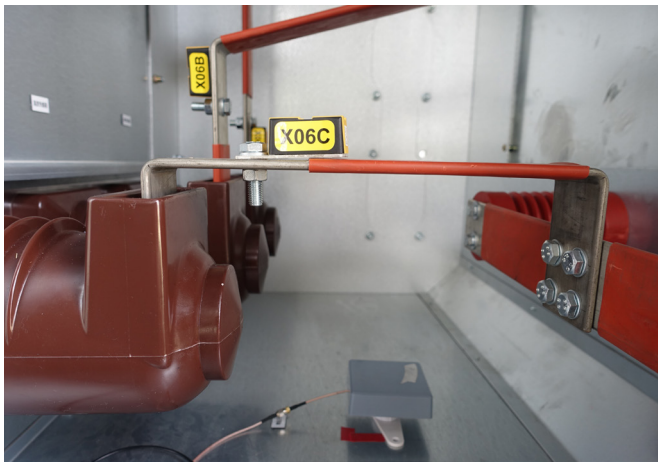
11. BEST PRACTICES

11.1. RFM3260 Lug-mounted Temp. Sensor

• The RFM3260 is designed to be bolted directly to switchgear components and mechanical joints, with at least 10 cm separation between sensors.

• If the RFM3260 is attached to components using existing bolts, please ensure that there is sufficient thread length to engage the nut fully.

• To improve antenna performance, the long axis of the RFM3260 sensors should be aligned with the long axis of busbars and other linear components.



• The RFM3260 incorporates an RF energy focusing element to improve read range when the antenna is located perpendicular to the plane on which the RFM3260 is mounted. In more common terms, the top of the sensor should be pointed toward the antenna if possible.

• The RFM3260 is not water tight. The sensor should not be submerged or positioned such that the plastic housing acts to contain water.

11.2. RFM3250 Rugged Temperature

• The RFM3250 is designed to be installed on a flat metal surface with at least 10 cm separation between sensors.

• To improve RF performance, the left end of the RFM3250, where a small bump can be felt, should not be placed directly against metal surfaces.

• For the best temperature accuracy, RFM3250 sensors should not be installed using epoxy. Epoxy on top of the sensor can increase thermal coupling to the ambient environment and undermine accurate measurement of the monitored component.

• The RFM3250 adhesive will adhere to most surfaces, but care should be taken to ensure the mounting surface is free of grease and dirt before attachment.

• The RFM3250 should not be placed with its long side against a 90-degree metal corner.

11.3. Antennas

• An antenna must be installed inside of each metal enclosure being monitored. The RF signal will not penetrate a metal enclosure.

• Antenna cable entry openings into the metal enclosure should be well sealed to prevent smoke and particulates from entering the enclosure.

• To improve RF performance, the antenna face should be perpendicular to most sensors if possible.

• Shorter RF cables connecting the antennas to the reader PORT1..4 ports results in better RF performance. As examples, 3 meter cables are “short”, while 10 meter cables are “long”.

12. TROUBLESHOOTING

Challenge: Reader cannot find an RFM3250 sensor when attempting to read:

Actions: Ensure that the sensor is installed on a metal surface. The metal surface is important for proper RFM3250 operation.

Challenge: The sensor reads temperatures with an offset.

Action: Ensure that additional materials such as epoxy are not placed over the sensor. These can affect the sensor's thermal coupling to the component being monitored.

Challenge: Multiple sensors are found when attempting to isolate a single sensor's EPC:

Actions: Cover all nearby sensors (other than the one to be assigned) with a layer of aluminum foil or your hand. Alternately, stack the other sensors on top of each other to minimize their communication strength.

Challenge: The SENSOR1..12 displays report one or more read errors, with a large TX transmit power above 25 or a large RX RSSI sensor receive power above 25.

Actions: Under these conditions, the sensor(s) might be receiving too much power from the reader. Reduce the RF TRANSMITTER CONTROL maximum power setting on the RF CTRL control panel fly-out, or enable the ALC controls accessible on the SENSOR INFORMATION tab. Please note that ALC can take 10s of minutes to settle to final values.

Challenge: The SENSOR1..12 displays report one or more read errors, with a low RX RSSI sensor power level in an open room environment.

Actions: Increase the RF TRANSMITTER CONTROL maximum power setting on the RF CTRL control panel fly-out, but do not violate the maximum output power allowed for your geographic region. Alternatively, enable the ALC control on the SENSOR INFORMATION Tab.

13. FURTHER INFORMATION

PB030 - RFM5117 Switchgear Temperature Monitoring System Product Brochure

IN030 - RFM5117 Switchgear Temperature Monitoring System User Guide (this document)

IN018 - RFM5117-A Switchgear Temperature Sensor Placement Guide

PB019 RFM3240-A Rigid PCB Temperature Sensor Product Brief

PB008 RFM3250-B Rugged Temperature Sensor Product brief

PB022 RFM3254-A Rugged Temperature Sensor Product Brief

PB018 RFM3260-A Lug-Mounted Temperature Sensor Product Brief

14. QUICK START PROCESS

STEP 1: CONNECT THE SYSTEM by following the instructions in section 2. THE READER.

STEP 2: LOAD READER UTILITY program as described in section 2.2. Connecting the reader to a PC.

STEP 3: SET RS-485 & MODBUS SETTINGS as described in section 11. MODBUS Interface.

STEP 4. CONFIGURE ANTENNAS as described in section 12.3 Antennas. For system checkout, the antennas and reader can be used on a desktop or bench prior to installation inside of switchgear.

STEP 5: REGISTER SENSORS as described in section 3. USING THE SYSTEM. Registering the sensors involves entering the required SENSOR ID code that is printed on the sensor. A text description of the sensor placement location (busbar A, etc.) can be added, but is not required. At least one antenna must be assigned to each enabled sensor. When placed inside of switchgear, the assigned antenna must be in the same chamber as the sensor. Please refer to section 8. ANTENNA SETTING TAB to verify that the antenna has been enabled.

STEP 6: VERIFY SENSOR COMMUNICATION as described in section 5. SENSOR INFORMATION TAB. Sensors are properly registered when temperature data is reported to the SENSOR DISPLAY WINDOW.

STEP 7. INSTALL SENSORS AND ANTENNAS in the switchgear. Please see IN018 RFM5107-A Switchgear Temperature Sensor Placement Guide for additional information. The RSSI values reported by the system can help identify optimum sensor locations when placing sensors.

OPTIONAL - SCADA SOFTWARE: Verify that the SCADA software can communicate with the reader. This may involve coordination with your SCADA software manager. Connection into a SCADA monitoring system is not required, but it provides a richer historical data set if historical data is captured. The RFM5117 does not capture historical sensor data on the reader itself.

If the digital display is used with the system, the SCADA software will access the reader data that is maintained on the digital display. The digital display will manage all direct communication with the reader itself.

Once the reader is communicating with the SCADA system, please verify that the SCADA software can communicate with the sensors.

OPTIONAL - PROGRAM SENSOR ID: Sensors shipping from RFMicron are preprogrammed with a four-character SENSOR ID to facilitate sensor registration on the system. The four-character SENSOR ID is described in section 7. SENSORS SETTING Tab, NOTE 2 is employed, only the four ASCII characters need to be entered in the SENSOR ID entry box.

If the four-character SENSOR ID is not used, then the full 128-bit SENSOR ID from the sensor must be entered in the SENSOR ID text entry box.

The RFM5117 does not provide the capability to reprogram or write the SENSOR ID for a sensor. A separate system like, the RFM5102 handheld, is needed.