Wireless Temperature Monitoring System

Utility

Tie Plant

F4 F5 F6 M2

2500 kVA
2470 / 480

PC
Standalone
System

RECEIVER

Network
Web Server

Wireless Sensor
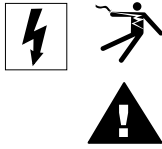
SQUARE D™

by Schneider Electric

HAZARD CATEGORIES AND SPECIAL SYMBOLS

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 potential 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 potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

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

⚠ WARNING

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

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result** in property damage.

Provides additional information to clarify or simplify a procedure.

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.

FCC NOTICE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. This Class A digital apparatus complies with Canadian ICES-003.

FCC RADIO FREQUENCY INTERFERENCE STATEMENT

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna;
- Increase the separation between the equipment and receiver;
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

NOTE: Consult the dealer or an experienced radio/TV technician for help.

TABLE OF CONTENTS

SECTION 1

SAFETY PRECAUTIONS

In this section:

This section contains important safety precautions that must be followed before attempting to install, service, or maintain electrical equipment. Carefully read and follow the safety precautions outlined below

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⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- The hardware of Wireless Temperature Monitoring System, the sensors, may be installed only on completely de-energized and removed out-of-service electrical equipment, such as circuit breakers or switches. To de-energize apply appropriate personal protective equipment (PPE) and follow safe electrical work practices. See NFPA 70E

- Only qualified personnel familiar with electrical equipment are to perform work described in this set of instructions.

- Perform such work only after reading and understanding all of the instructions contained in this manual.

- The circuit breaker must be in the open (O) position.

- All circuit breaker springs must be discharged.

- Switchgear primary conductors should be grounded.

- 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 electrical or other property.

- Carefully inspect your work area and remove any tools and objects left inside the equipment.

- All instructions in this manual are written with the assumption that the customer has taken these measures before performing the installation of wireless sensors inside electrical equipment.

Failure to follow this instruction will result in death or serious injury.

SECTION 2

RECEIVING

Upon receipt, check the packing list against the equipment received to ensure the order and shipment are complete. Claims for shortages or errors must be made in writing to Schneider Electric within 60 days after delivery. Failure to give such notice will constitute unqualified acceptance and a waiver of all such claims by the purchaser.

Immediately inspect the equipment for any damage which may have occurred in transit. If damage is found or suspected, file a claim with the carrier immediately and notify Schneider Electric. Delivery of equipment to a carrier at any of the Schneider Electric plants or other shipping points constitutes delivery to the purchaser regardless of freight payment and title. All risk of loss or damage pass to purchaser at that time.

For details concerning claims for equipment shortages and other errors, refer to Schneider Electric "Terms and Conditions of Sale."

HANDLING

Use care when handling the wireless temperature monitoring hardware.

STORAGE

When the parts are not in use keep them in a clean, dry, heated corrosion-free area where it is protected from damage. When the monitoring system hardware is stored for prolonged periods, inspect it regularly for overall condition.

SECTION 3

**APPLICATION NOTES AND
SPECIFICATIONS**

3.1. System Description

The Wireless Temperature Monitoring System (WTMS) monitors temperatures of the surfaces of energized electrical equipment (see Section 6, Ref [1], Product Specifications 16090-10).
The system consists of three components:

- Sensors (wireless transmitters)
- Receivers (signal receiving units)
- Software (processing, alarming and reporting software)

Square D High Temperature Sensors are designed to actively measure the temperature of the strategically important points on metal or insulating surfaces of current carrying parts. The Sensor design allows measuring the temperature in wide range, from 0 to 150° C. The Receiver receives the RF signals from the Sensors with temperature, time stamp and identification information from the Sensors and relays this information to PC.

Software processes the sensor information and records it into a textual log file. Two versions of software are available: one providing the system working in standalone mode (TempAssure), another in conjunction with power monitoring system. A version of the Receiver is also available for integration into SCADA and BMS systems.

3.2. How WTMS Works

WTMS is quickly and easily installed in any facility by deploying multiple Sensors in positions throughout energized equipment to continuously monitor surface temperature. The Sensors transmit a packet every twelve minutes, or, if the temperature is increasing fast, every six minutes.

The packet is picked up by a near Receiver/Receiver. Receivers have a typical indoor range of 100 feet with sensors mounted in equipment. The Receiver (antenna) is centrally installed in the control room (a single Receiver can receive information from 100 sensors). However, it is recommended to utilize at least 2 Receivers for a given area to maximize reception of the RF signals from the Sensors.

Depending on number of the Sensors in the system and the size of facility, a series of the Receivers can be connected in daisy chain. Once the data is picked up by the Receiver the data is placed on the Receiver network. The Receiver network uses standard category 5 Ethernet Cable to daisy chain the Receivers supplying power and a way to communicate back to the PC. Another option is to transfer the data to PC via multiple ethernet ports.

A PC installed at the facility or the existing facility network is used. In standalone mode of WTMS the TempAssure Software is installed on local PC and sensing parameters are set (WTMS allows adjusting alert conditions to Customer specific needs). Temperature information may be reviewed by the Customer or by Square D Engineering Support (see Section 6, Ref [2], Product Specifications 16090-11- WTMS Consulting Services) via modem or Internet. Alerts or reports can be sent to the customer in numerous ways such as by cell phone, two-way pager, or email. Web monitoring is also an option.

3.3. System Features

Easy Installation - Installation of software and Receiver is simple. Affix the receiver to conduit or strut and provide power. The software is also easy to install.

Monitoring - Software allows monitoring of the temperature readings from all active Sensors.

Range - Antenna receives Sensor signals up to 100 feet (30 meters) away (tested successfully up to 1000 ft.).

Population - The system can monitor an unlimited number of Sensors without interfering with one another or loss of identification.

Supervision - Sensors transmit a signal every 6-12 minutes depending of thermal condition, so you can respond quickly to any problems.

3.4. Square D High Temp Sensors Features

The Sensors are all-in-one temperature sensors and identification tags (Fig 1). The Sensors detect ambient temperature and continuously send radio frequency information to the Receiver. The device transmits the information it has collected using a low power RF transmission. The Sensors are calibrated accordingly to application to give accurate temperature readings. Re-calibration is not required.

Figure 1:   Wireless Square D High Temperature Sensor

Low Cost Installation - The Sensors are wireless and can be placed almost anywhere by using a high temperature adhesive.

Operation - In direct contact with the surface.

Long Battery Life - Sensors utilize a High Temperature 3V lithium battery that lasts up to 5 years.

3.4.1 Application Sensors

Wireless sensors can be applied to any type of new or used LV and MV electrical equipment such as switchgear, circuit breakers, capacitor banks, transformers, motors, busways and cables. The Sensors can be also used on HV and EHV electrical equipment.

The Sensors can be applied for measuring temperature of any strategically important points inside energized apparatus, such as stationary contacts, finger clusters, stabs, bolted connections, as well as any other important locations where temperature should be controlled. The number of points to monitor inside the unit is not limited. It is considered important to install the Sensors on each phase of the apparatus both on load and line side. Sometimes it is possible to detect a problem based on lesser number of the Sensors, for example only on load side, but this decision should be made based on design and application features. The only limitation is applying the Sensors would be the dimension of the space available at the point of interest, which should be not less than 1.5 x 1.5 x 1.5 inch^3 (4 x 4 x 4 cm^3). The Sensors can be attached to either metallic or insulating surfaces and in any position using installation technique and adhesives recommended in section 4.1.1.

Examples of Sensor installation points are shown in Fig. 2 for LV and MV circuit breakers. Fig. 3 and Fig. 4 show positions of the Sensors on the bus stabs and cable connections inside LV switchgear, and MV switchgear, as well as suggested positions of the sensors for measuring temperature of ambient air inside the cells.

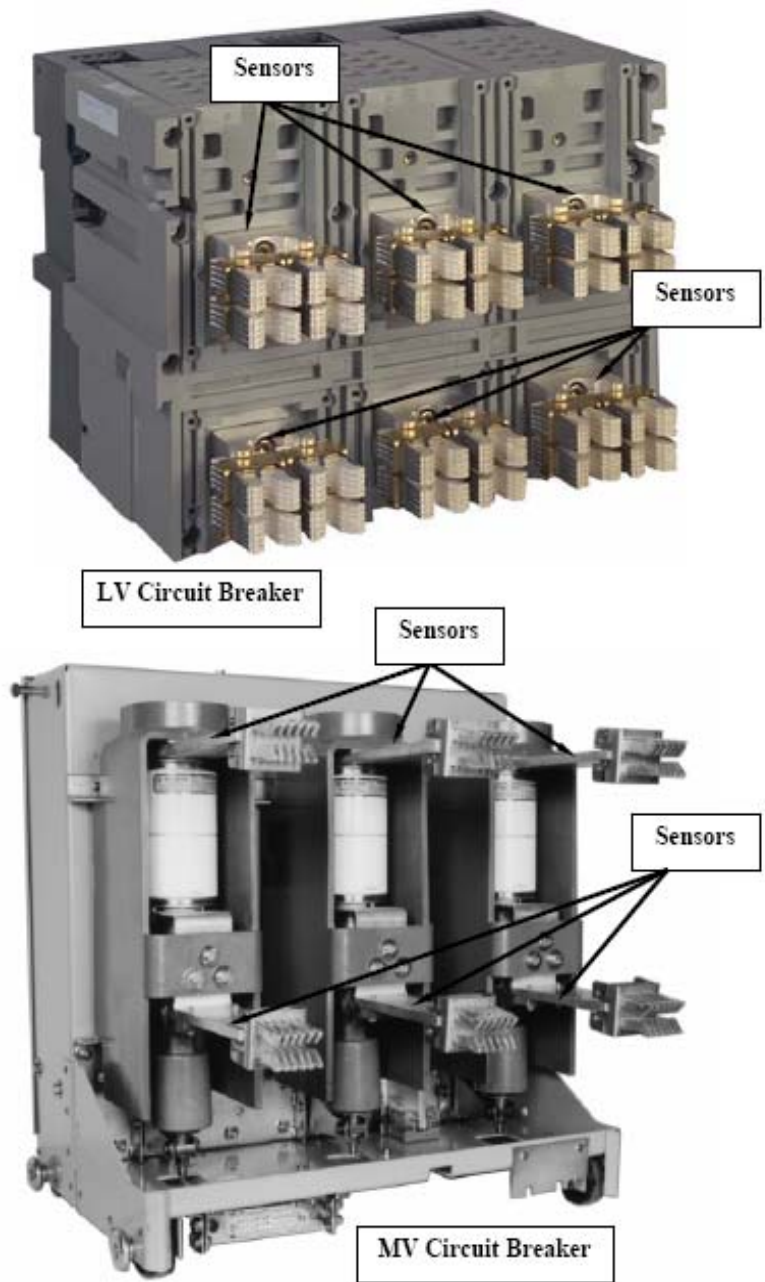**Figure 2:** **Wireless temperatures sensors on finger clusters of LV and MV Circuit Breakers.**

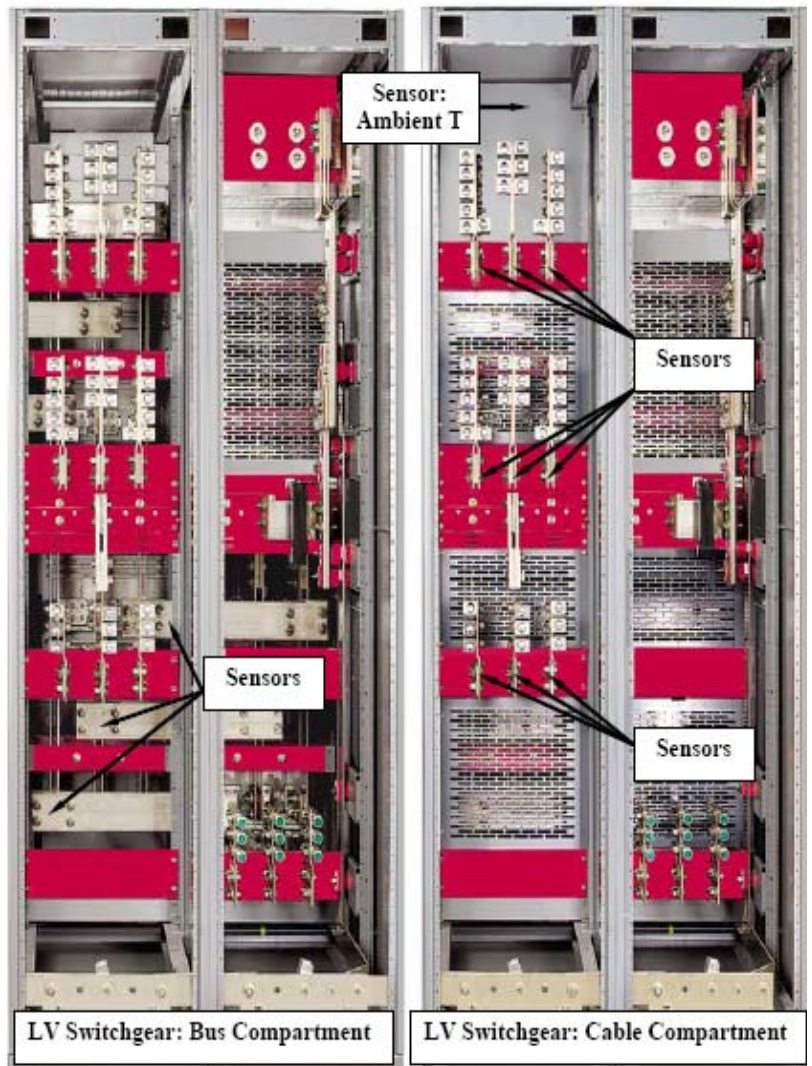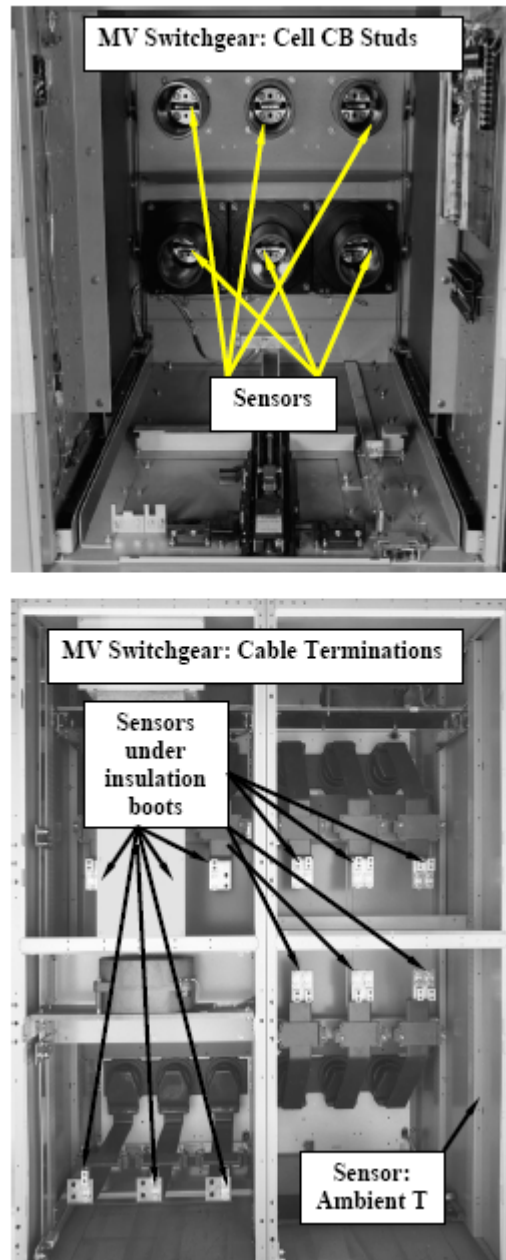**Figure 3:** **Wireless temperature sensors on buses and bolted cable connections inside LV switchgear.**

LV Switchgear: Bus Compartment   LV Switchgear: Cable Compartment

Figure 4: **Wireless temperature sensors on stabs and bolted cable connections inside MV switchgear.**

3.5. Sensor Specifications

Type: Sensor and Radio Frequency Transmitter .

Physical Dimensions: Sensor casing: D=1.5 in. (40 mm), H =1 in. (25 mm)

Weight: < 20 g (0.7oz.)
Enclosure: Non-conductive, High T and UL tested, waterproofed for humid and corrosive environment

Operating Temperature: Low: 0º C (32º F); High: 150º C (300º F)

Transmission Range: 100 ft. (sensors installed in switchgear).

Mounting Location: On flat clean surface using High T adhesive.

Transmission Frequency: Transmittance intervals change based on the rate of the temperature change: Signal is transmitted by the Sensor every 12 minutes. However, in case of a temperature rise of 3º C per minute the Sensor will transmit every 6 minutes.

Battery: High temperature 3V lithium battery, easily replaceable in the field.

3.6. WTMS Receiver Features

The WTMS monitors all Sensors, actively measuring temperatures in a selected area. The Receiver constantly monitors and listens for transmissions. The Receiver determines if a signal is valid or if it is noise to be filtered out, then mark the transmissions with the proper packet and send it via a network to a computer for processing.

The Receiver utilizes **S**pread **S**pectrum **T**echnology (SST). It is available in three different versions (Fig.5), plus a repeater version.

- — Serial SST Receiver receives transmissions and sends them to a PC via RS-485 using a Connection Kit (RS-485 to RS-232 Converter). Serial REceivers to be connected, in series, for large coverage areas.
- — SST Receiver with wired Ethernet Connection (802.3).
- — Wireless Extension SST Receiver, which provides wireless transmission of the RF signals to a wired SST Receiver thus doubling the distance between the transmitters and receiving units.
- — Ethernet SST Receiver with Modbus TCP communication protocol.

Power must be supplied to the Receiver by using the power transformer supplied with the Receiver. For the Serial SST Receiver, another option is to supply power via the RS--485 network using power from the Connection Kit. This option is ideal for a Receiver mounted in an area that does not have a convenient power source.

Either the Serial or 802.3 Ethernet type of wired Receiver accepts temperature and identification information from the Sensors and relays the information to the TempAssure Software (see section 4.2), which displays the activity of all wireless Sensors and logs their temperature readings into a text file for future reference and analysis. A diagnostic screen allows the user to monitor the system for any problems in the sensory network.

Figure 5:   SST Receivers: Serial, Wired Ethernet, and Wireless/Extension versions.

3.7. Receiver Specifications

3.7.1 SST Receiver Specifications

Type: Spread Spectrum Technology

Frequency Range: 902-928 MHz

Physical Dimensions: 6in. x 4in. x 1.25in. (15cm x 10.2cm x 3.2cm)

Weight: 1/2 lb.

Minimum Reception Range: Omni-directional 300 ft. line-of-site. Range reduced by obstructions.

Connection/Communications:

  — *Serial SST Receiver:* RJ-45/RS-485 link to computer. 115,200 baud, no parity, 8 bits, one stop bit, asynchronous link to computer.
  — *Ethernet SST Receiver:* RJ45 Power (2.1mm)

Power Requirements: 6VDC, 500 mA

Mounting Location: Hanging on a pole, or attached to a flat, clean surface using adhesive

Operating Temperature: -28ºC to 85ºC (-18ºF to 185ºF)

Accessories: Square D High Temp Sensors.

Bus Adapter Kit: *Serial SST Receiver:* Connection Kit - RS232 TO RS485 Converter; 7ft. CAT5 RJ45 Cord; and 485PS - Power Supply

Bus Protocol:

— *Serial SST Receiver*: Proprietary

— *Ethernet SST Receiver (802.3):* Proprietary

— Ethernet SST Receiver (Modbus): Modbus® TCP

Certifications: Part 15 FCC approved, CE certified

3.7.2 Ethernet SST Modbus® Receiver Connectivity

Ethernet SST Receiver with Modbus® TCP Protocol is equipped with both an Ethernet port and an RS-485 Serial port, which allows using it as a Serial SST Receiver. This function is provided to facilitate WTMS setup preparatory procedure. This option could be utilized in optimization of sensing and receiving units' positions, while using a simple standalone version of the system software. This version may be also used prior to WTMS integrations into a customized monitoring system.

In Fig. 6, position of the ports for Ethernet cable and DC power input for utilization of the Modbus® module are shown. The third port is designated for connecting the Receiver to PC via connection kit (shown in Fig.10) directly or using an optional Ethernet Serial Server. The use of Serial module would require a connection kit and TempAssure software installed on local PC. When the Serial module is utilized, the receiver will be powered via a power supply that is included in the connection kit (the power input on the receiver will not be utilized).

Figure 6: Positions of the Ports on the Ethernet SST Receiver with Modbus® TCP.

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> # CAUTION
>
> **HAZARD OF EQUIPMENT DAMAGE**
>
> • Wireless Temperature Monitoring for use with Low Voltage and Medium Voltage electrical equipment.
>
> **Failure to follow this instruction can result in equipment damage and void the warranty.**

> # ⚠ DANGER
>
> **HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**
>
> • Install and remove Wireless Sensors only on de-energized equipment and removed out of service electrical equipment. To remove or take out of service any circuit breaker or switch refer to OEM manual for these devices.
>
> • To de-energize electrical equipment apply appropriate personal protective equipment (PPE) and follow safe work practices. See NFPA 70E.
>
> **Failure to follow to follow these instructions will result in death or serious injury**

SECTION 4

WTMS INSTALLATION

4.1. Installation of Temperature Monitoring Hardware

Hardware of Wireless Temperature Monitoring System consists of the set of temperature monitoring devices (wireless temperature sensors), signal receiving devices (Receivers) and connecting kit for connecting the Receiver to PC and supplying power to the Receiver.

4.1.1. Installation of the Sensors

Use the following procedure to attach wireless Sensor to the part for which the temperature is to be measured. The Sensor can be installed on any flat surface made of metallic materials. The Sensor cannot be installed on any movable contacts or lubricated areas.

Surface preparation note: If Sensors are installed on metallic surfaces on current carrying part, on insulation, or on compartment doors, the surface should be cleaned from any dust, particulate matter and moisture with a clean dry cloth. If needed, use a mild cleaner to remove grease or dirt from the surface.

Adhesives:

1. RTV Silicone Adhesive (requires about 24 hours curing at room temperature), such as GE Silicone II Premium Waterproof Silicone, stock number GE500 90642.
2. Instant adhesive ("super glue") should hold the sensor in place long enough for the silicon to cure. It is rated for about 125ºC (~260º F), so

the bus bar should be kept below this temperature during the curing process.

The application procedure should be as follows:

Different views of the sensor are shown in Fig.7. It is pictured from the top (left) and from the bottom (right), and the sensor case is shown in the center. For installation, the units should be disassembled by removing the lid and the sensor assembly (Fig.7) from the case. The case should be glued onto the equipment surface with the bottom facing the surface. After the sensor case is attached to the surface, the sensor assembly should be inserted into the case with the copper enclosure getting into the opening in the case bottom and the lid should be snapped in to close the case.

1. Apply a ring of silicone in the area between the outer edge of the small elevated ring located at the opening in the case center and the edge of case. The silicone ring should be about 2.5mm wide, enough to seep around the case outside edges when applied (Fig.8, left)

2. Apply four drops of "super glue" equidistantly on the surface of small elevated ring in the center to the case (Fig.8, right). As soon as the case is pressed to the surface, the glue will spread and cover ~100% of the ring surface area.

3. Attach the case bottom in the position on the surface of the part for which the temperature is to be measured as soon as possible to avoid an early hardening of the instant glue. Press the sensor to the surface for 2 minutes, after which it is safe to leave the case for the next 24 hours to let the silicone cure. Super glue is strong enough to hold the weight of the sensor in any position.

4. Make sure the silicone seeps around the edge of the sensor to prevent airflow. After the cure is complete, the RTV silicone adhesive takes over.

Figure 7: **The sensor: the top of the sensor with RFID label seen through the transparent lid and the label attached to the side of the case (left), the empty case of the sensor bottom up (center), the bottom of the assembled sensor with the sensing element in copper enclosure inserted into the opening in the bottom of the case (right).**

Figure 8:   Sensor assembly with sensing element within copper enclosure.

Figure 9:   RTV Adhesive ring on the bottom of the case (left); drops of super glue on the inner elevated ring (right).

4.1.2. Installation of the Receiver

Finding the best location for the Receivers:

The key factor in a successful install, is finding the best possible location for the Receiver. The plant walk-through will provide best opportunity to search for a location based on the sensor array. Place readers in open areas to receive as many signals as possible. Here are a few guidelines to help when placing the Receiver**:**

- **Install the Receiver as high as possible**

- **Position the Receiver in a central location**

Place the Receiver as close to the center of the location as possible to maximize the reception of the antenna. If a central location is unavailable, look for the best possible sit in relationship to the sensors.

- **Keep the Receiver away from Interference.**

The receiver is designed to work in noisy environments but it is hindered if placed near (within 5 feet) the following devices:

— Florescent Lighting Fixtures

— Computers and Monitors

— TV's and Radios

— Large Metal Objects

— Telephone and Network (Ethernet) equipment

— Other items that may block or absorb RF signals which may cause blind spots to Receivers, such as thick concrete walls, air-conditioning units.

Suggested mounting methods for Receivers: the Receivers should be mounted with a minimum of 1 in. separation from flat surfaces such as walls, rafters, etc. Steel walls and rafters especially require separation to get good reception.

4.1. 3. Assembly of Connection Kit (Serial Receiver to PC connection)

Parts in Connection Kit:

1. DB25M-DB9F converter
2. RS-232 to RS-485 B&B converter
3. RJ45-DB25F converter
4. Transformer 120 VAC to 12 VDC
5. RJ45 cable (CAT5)

Assembly of Connection Kit

1. Attach the 9-pin connector of the DB25M-DB9F converter to Com port 1 (9-pin) on the back of the computer. If PC does not have 9-pin port use one of USB ports with USB to RS-232 DB9 converter (not included).

2. Attach another end of DB25M-DB9F converter to the RS232 side of the B&B converter. Connect the RJ45-DB25F converter to the RS485 end of the B&B adapter. Connect the Receiver to RJ45-DB25F converter with RJ45 cable (use any of two lines on the bottom of the Receiver).

Assembled WTMS is shown in Fig. 10. If PC is located at significant distance from the Receiver, use as long as needed RJ45 cord to connect the Receiver to RJ45-DB25F converter. Otherwise use the cable included in the kit.
To energize the Receiver, connect the pin of power supply (transformer 120 VAC to 12 VDC) into the side of the RS485-RS232 converter and plug transformer into power jack. As soon as connection is made, the LEDs towards the bottom of chassis of the Receiver begin flashing signalizing that the unit receives RF signals from the sensors.

Figure 10:   Long Range Connection Kit with Serial Receiver..

4.2. Installation of Software for Standalone WTMS

4.2.1. TempAssure installation

There are two versions of TempAssure Software; one for the Serial Receiver and one for the Ethernet Receiver. It is installed by using TempAssure Software on CD. The installation is supported by Installation Wizard. The software and log file will be saved on the PC hard drive in the folder C:/Freshloc. For technical support on downloading and installation of TempAssure Software contact Square D Services Engineering.
After installing TempAssure, open the file tassure.cfg in the Freshlock folder. In the section of text, starting with minTime=425, make the following edits:

   — At the end of the section, add the line: See TwiceWithin=7200.

   — Change the value after "NotSeenDisplay" to 7200.

   — change the value after "MustSeeEveryTime" to 7200.
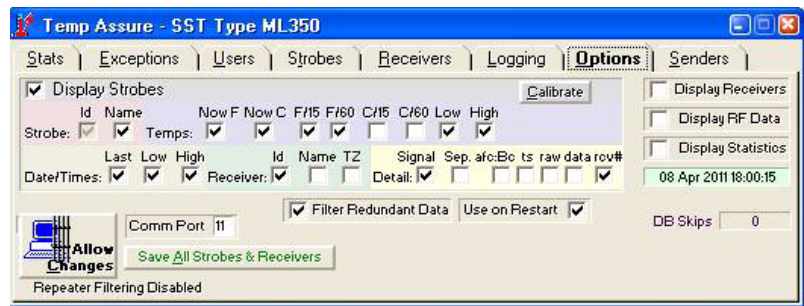
4.2.2. TempAssure Software Setup for Serial Receiver

When TempAssure launches, the window shown in Fig.11 will appear. If the computer cable is plugged into Com 1 it will show "Serial Port 1". If you need to change your com port, click on the Options Tab. You will then see the screen shown in Fig. 12.

Figure 11:   TempAssure main screen

Figure 12:   "Option" Tab


To change the com port:

(1) Type in the com port number in the box next to "Comm Port," and press enter.
(2) Click the box next to "Use on Restart" to place a checkmark.
(3) Click on the **X** to close TAssure.
(4) Restart TAssure

Receiver(s) Setup. You will now be back at the main TAssure screen (**Stats**). A blinking green box (directly under "Stats") means your Receiver is connected and working. Once you start seeing numbers under **Serial Receives**, you know you are receiving data. Now that you know that everything is working, click on the **Receivers** Tab (Fig.13). If the "Auto Adds" is checked all receiving units will be automatically added.

Figure 13:   "Receiver Tab"
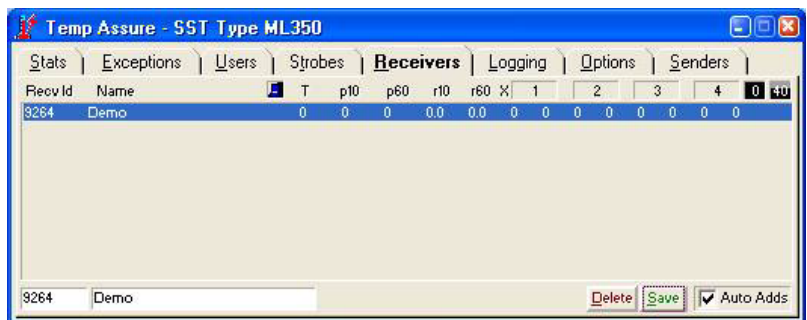
This is where you type in the information for the receiver(s) you have:
(1) In the first box, type in the number (ID) of your receiver or choose one of
it is automatically added.
(2) In the second box, type in a name for your receiver (i.e. control room,
etc.).
(3) Click Save.
(4) Repeat for additional Receivers.
Note: You must type a name for the receiver in order to run Local Reports
(discussed later in this document).

Strobe(s) setup: Click on the **Strobes** tab (Fig.14).
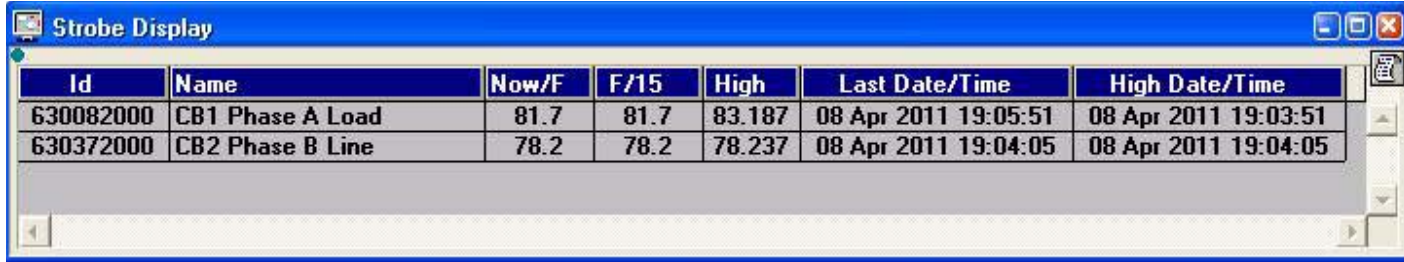
Figure 14:   "Strobe" Tab
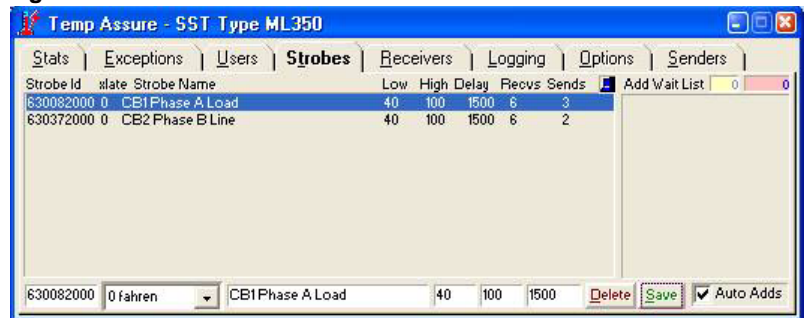
You will need to input the strobe ID's on this screen in order to view the tem-
peratures of your strobes.
(1) In the first box, enter in the number of your strobe (RFID) or click on "Auto
Adds."
(2) The second box "xlate" is a pull down menu, select **"O Fahren."**
(3) In the third box "Strobe Name," enter in exact location the Sensor will be
placed.
(4) In the fourth box "Low", enter in the **low alert temperature in Celsius**.
For high temperature application this value may be as high as maximum am-
bient temperature according to electrical standards (40 degree C).
(5) In the fifth box "High", enter in the **high alert temperature in Celsius**. For
example, if it is an electrical contact, and you would not want it to go above
100 degree C, then you enter in 100 in this box.
(6) The sixth box is "Delay." You may enter in a time interval for a sensor to
alert. The value needs to be entered in seconds. For example, if you set a
delay of 0 seconds, and your contact temperature rises up to 100 degree C,
the line with the sensor in this location would turn red on the strobe display
screen, indicating a high alert alarm.
(7) Click "Save." You should now see your strobes (sensors) on both the
TempAssure strobe window and on the strobe display screen.

Strobe Display utility (Fig. 15) displays which sensors are installed and in
which locations, and all other information chosen in Option Tab, such as Tem-
peratures in Fahrenheit or Celsius degree, average temperatures for 15 or
60 minutes, the time stamp of last measurements, and so on.

Figure 15:   Strobe Display Utility

4.2.3 TempAssure Software Setup for Ethernet 802.3 Receiver

There is a specific version of TempAsure for the Ethernet Receiver. First, you will need to run the Digi Device Discovery program to configure the Ethernet Receiver to point to your TempAssure application. Lastly refer to section 4.2.2. for the remainder of the setup, as most information still applies to the Ethernet version.

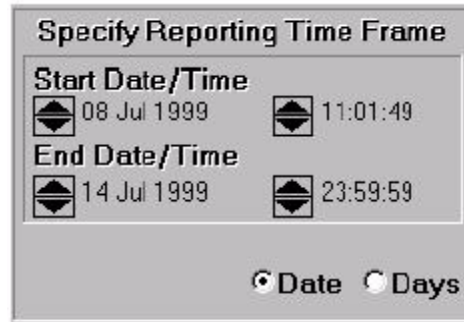### 4.2.4 TempAssure Reporting Software

The data from temperature monitoring system is transferred from the sensors via the Receiver to TempAssure database. Standalone WTM System is working with TempAssure Software. The data collected by WTMS may be view and analyzed using TAssure Local Report Program. LocalRpt is a reporting tool used with the TAssure program to print a report and graph changes in strobe temperature. LocalRpt also supports graphing of multiple Strobes for easy comparisons between strobes. The Local Report requires that Sensors and Receivers have names. Make sure that this has been done before starting Local Report. The first step in using the reporting program is to select the sensor locations for the report. Click on the Show Item selection button (Fig. 16). This will display a list of sensor locations (items) to choose from. Local-Rpt automatically selects
all of the items on the list by default. If you don't want all items included on the report, click on the Select None button and choose the specific items. When making your selection you may select multiple strobes by holding down the *Ctrl* key and clicking on each item. Then click on the Hide Item Selection Button.

Figure 16:   Local Report: choosing the sensors for display
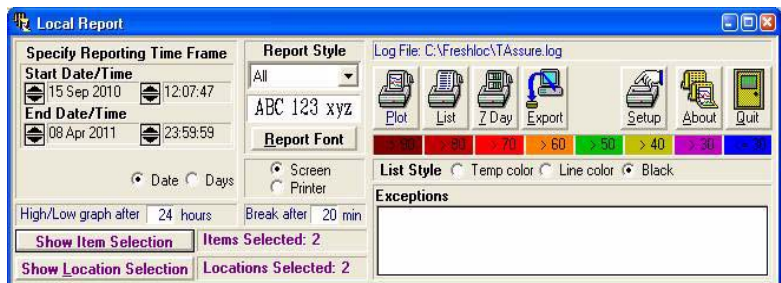
The next step is selecting the time frame for the report (Fig.17). Use the Date/Time markers to select the starting and ending point. To increase or decrease the Date/Time use the arrow buttons next to the Date/Time you wish to change.

Figure 17:   Local Report: selecting time frame

To run a report for an allotted number of days you may click the *Days* button and Input a value in the *Report for Last ___ Days* Blank.

The report is now ready to be created. Select the type of report to use. Select the *List* button and LocalRpt will gather a list of strobe entries and display them in a report format. To create a graph select the *Plot* button and LocalRpt will create a line graph from the data recorded in the TAssure.log file. Listed below are examples of the two types of reports. Shown in Fig. 18 is an example of the *Plot* type report, it creates a graph of the temperature for chosen strobes.

Figure 18:   Local Report Plot
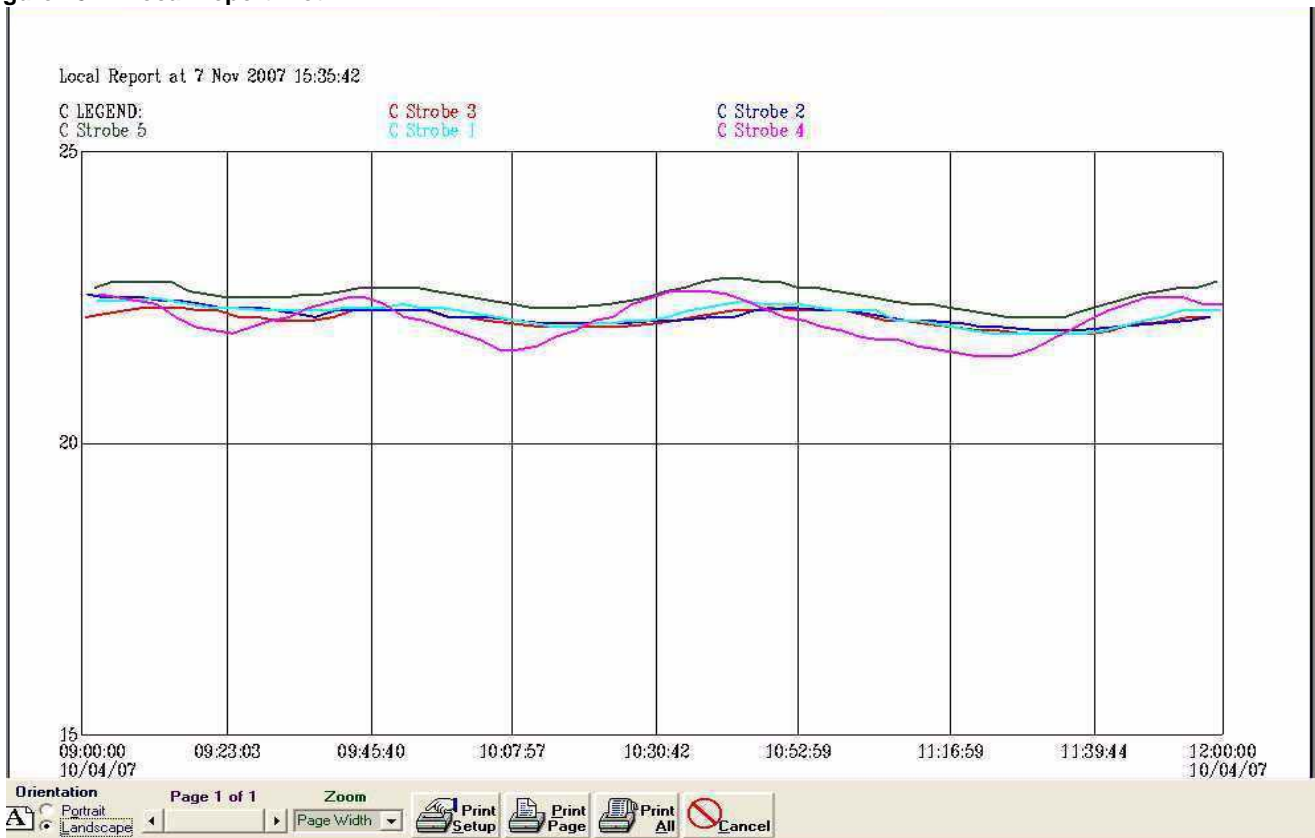
The data may be listed if the option "List" is chosen, then the data may be averaged for any selected time period and presented in tabular format. The data may be exported into text file, which is easily converted into Excel format for further analysis.

4.3. SCADA Software Integration

Most Supervisory Control and Data Acquisition (SCADA) and other monitoring software package have a Modbus driver either "built-in" or available as an option. In order to connect the Wireless Temperature monitoring system via Modbus to a software package, the Modbus TCP WTMS receiver will need to be utilized. The following steps should be followed to establish communications with the receiver and create a device tag within the SCADA software.

1. The WTMS receiver will need a static IP address. The unit comes preset with a default of 192.168.0.100.

    a. To configure the IP on the receiver, put your computer on the same subnet as the receiver (via the IP configuration of your PC). **Important:** Write down your settings before making the change. (Fig.19)

    b. Change the IP information on the receiver to work with your network, by going to the receiver website and clicking "Edit" under network settings. (See screen capture below) The website is located at http://<IP address of the reciever>, and can only be reached if your computer is on the same subnet as the device.

    c. Change your PC IP settings back to the original settings you documented in step (a).

Figure 19:
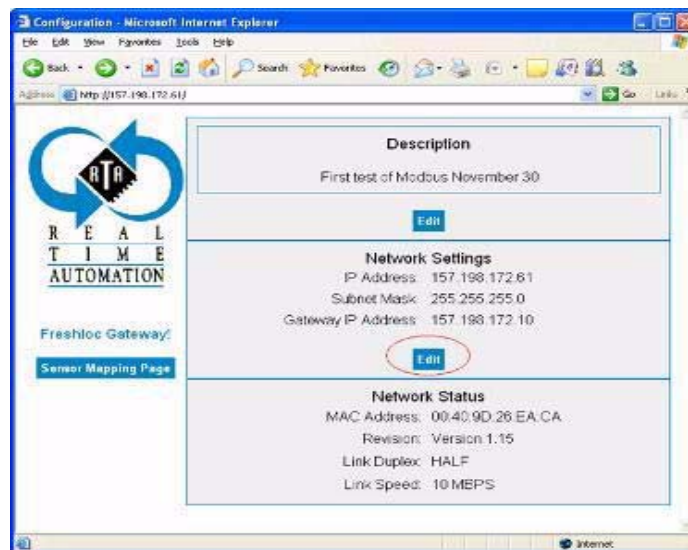
2. The receiver has a range of registers that store the information for each sensor. The range starts at register 3801 and goes until 19800, with 20 registers allocated to each sensor.

Determine the sensor information that is stored at a specific register range by going to the Sensor Mapping Page from the link on the main page of the

receiver. The table will only show entries for discovered sensors up to a maximum of 800 entries.

A sample mapping page is displayed in the screen capture below (Fig.20). The sensors are assigned a range by the receiver, as it detects them. The first range of 290 registers is referred to as Table 1, and so forth.

Figure 20:
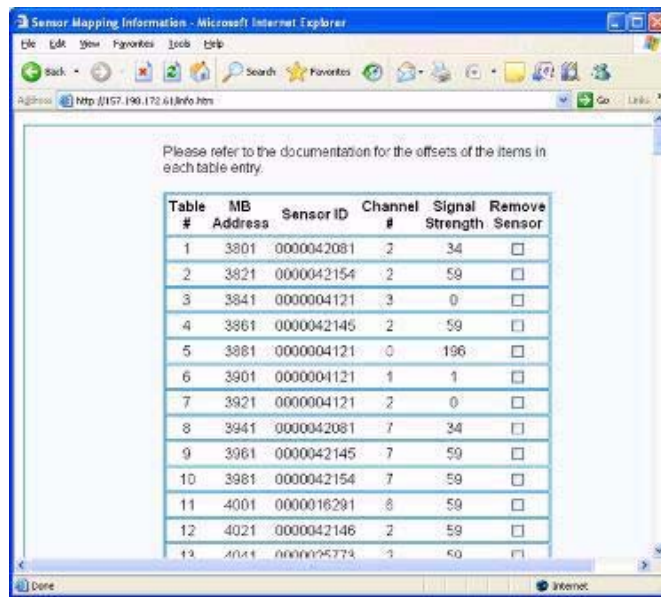
Following is a list of useful quantities and their offsets within the range of registers assigned to each sensor:

Quantity	Offset
Sensor ID (two registers)	1 and 2
Celsius Reading in Hundredths of degree C	4
Fahrenheit Reading in Hundredths of degree F	14

Example:

To read the temperature in Celsius for Sensor ID 42154 displayed in the above diagram, you would send a ModBus read request to address 157.198.172.61, specifying the 3825 (3821 + 4), as the register number from which to read.

In the response packet you will get the temperature in hundreths of a degree Celsius. So if the temperature is 25 degrees Celsius you will get a ModBus response with the number 2500.

3. Clear the current sensor table by writing one to Modbus address 50000. This will also clear the flash tables.

4. Acquire sensor channels.

5. When all channels have been acquired (verify the sensor mapping as described in Step 2), write the sensor directory to flash by writing the value "2" to Modbus address 50001.

   NOTE: the flash write operation could take up to a minute depending on the number of channels acquired, so leave the unit powered up.

6. Setup the Modbus application to reference the sensor table locations acquired above.

4.4. Modbus Specifications for WTMS Modbus TCP Receiver

A. Configuration - The TCP/IP Address, Subnet Mask and Default Gateway Address can all be addressed over the Modbus TCP network starting at Modbus location 60,000 for 12 registers. Each octet is a separate word. These parameters can also be configured via the configuration web page located at http://192.168.0.100/index.htm. The web page also allows an application name to be programmed into the device.

B. A maximum of 800 Sensor ID packets (Sensor ID/Channel) can be addresses through the Modbus Server Interface at device id1. Only sensor packets starting with 0x02 0x01 are decoded; all others are ignored

C. Modbus TCP Data Space Mapping

Table 1:

Modbus Address Holding Register	
1- 2	Sensor ID for table 1
3	Channel # for table 1
4	Reserved
5 - 6	Sensor ID for table 2
7	Channel # for table 2
8	Reserved
3113 - 3120	Sensor ID/Channel for table 800
3201 - 3250	Status Bit array
3251 - 3800	Reserved
3801 - 3830	Sensor Data Packet (table 800)
50000 (Write 1)	Clear Sensor Tables (a write of any value
50001 (Write 2)	Write Current Sensor Directory (a write of any value)
50002 - 50003 (read)	Master TIck count - reset when power cycled
60000	IP Address MSB
60001	IP Address
60002	IP Address
60003	IP Address LSB
60004	Subnet Mask MSB
60005	Subnet Mask
60006	Subnet Mask
60007	Subnet Mask LSB
60008	Gateway Address MSB
60009	Gateway Address
60010	Gateway Address
60011	Gateway Address LSB

D. Status Data starting at 3201 is a set of registers that provide packet arrival status. Each bit of the status data registers maps to a Sensor ID/channel combination. There are 800 bits (1 per Sensor ID/Channel Packet) in this structure (50 Modbus words). The bit will be set to a 1 to indicate that the table entry has data.

Status Bits:

First word of status (3201) 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

table entry 16 -----------------^

table entry 15 ---------------------^

table entry 14 ------------------------^

table entry 1 --^

Second word of status (3202) 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

table entry 17 ---^

E. Sensor Data Packet Mapping (starting at Word 3801)

    1. Offset 0: SS Channel

    2. Offset 1: Sensor ISD (Two Words)

    3. Offset 3: Channel and Type

    4. Offset 4: Measurement (Celsius)

    5. Offset 5: Reserved

    6. Offset 6: Sequence Count

    7. Offset 7: Signal Strength

    8. Offset 8: Pre-correction

    9. Offset 9: Post-correction

    10. Offset 10: SSTID (2 Words)

    11. Offset 12: Delta Tick Count (2 Words)

    12. Offset 14: Measurement (Fahrenheit)

    13. Offset 15: Reserved (Four Words)

F. Sensor Data Packets are filled in the order that packets arrive. A Sensor ID/Channel block is assigned to a Sensor ID when the first packet for that Sensor ID is received.

G. Diagnostic packets are stored identically to Sensor ID packets.

H. Time Stamping - 100 msec tick count resolution measured from power on. This tick count is a double word. It resets on power on and rollover.

I. Diagnostics - If the Default Gateway IP Address has a non-zero value, diagnostic information will be broadcast in a UDP packet on port 45000. This packet will show the serial data received and the calculated checksum of the packet.

J. The Sensor Directory mapping will be saved to non-volatile flash memory when a value of <u>two</u> is written to the Modbus register 50001. This information will be restored when the Gateway powers up.

K. Temperature decoding - All temperatures for sensors are shown on Channel 12 and are two byte signed words. The values represent the temperature measured at the time received by the gateway (minus time to transmit which is well under 1 second). The measurement is a signed value in 100ths of a degree centigrade and the range is in excess of 150C.

L. Clear Sensor Tables - A write of <u>one</u> to Modbus address 50000 will clear the stored data tables (and write the directory to flash).

M. Write Sensor Directory - A write of two to Modbus 50001 will write the stored sensor directory to flash.

SECTION 5

VALIDATION TESTS FOR WTMS PARTS AND PERFORMANCE

Square D Services designed and arranged a set of validation tests at independent laboratories, and provided required documentation for the tests. Below is a listing of test providers and description of the tests' goals and results. Complete reports of all test listed are available upon request.

Testing Providers:

*   **Square D Services Engineering**
*   **Square D RF Laboratory**
*   **Freshloc Technologies**
*   **Independent Testing Services:**
    — Met Laboratories
    — Underwriters Laboratories
    — FCC
    — Nemco USA

5.1. Validation Tests provided by Square D Engineering Services

5.1.1. Calibration Technique for Square D High Temp Sensors (direct thermal contact with the surface)

Square D Engineering developed a new calibration technique providing sensor calibration in the conditions adequate to the system application. All sensors are calibrated within the oven with stabilized ambient temperature with the sensors installed on the surface of metal bus, which temperature is changing within the range of T from 0ºC to 150ºC and controlled with TCs.

5.1.2. Testing of Adhesion Quality of Silicone RTV as HT adhesive

Two different properties of high temperature adhesive have been tested to approve an adhesive for using it for attachment of wireless temperature sensors in energized electrical equipment: (1) chemical inertness at high temperatures towards metallic and insulating surfaces, and (2) an ability to hold the sensors in vertical or upside down position for the period in service. Testing of Silicon RTV sealant at high temperature proved that the product provides a good adhesion and is chemically inert towards the surface to which the sensors may be attached. This adhesive leaves no residue on metal surfaces of the bus or insulation after the sensors have been removed. Additional testing was provided by Freshloc technologies on Silicone adhesive strength. The preferred adhesive was placed on a test bus bar and allowed to cure for 24 hours. The bus bar was then heated to approximately 150ºC for two hours. At the end of two hours, the adhesive was tested to tolerate a load of up to 20 lbs. The bond strength measure proved that the silicone adhesive is sufficient to hold the weight of the sensor in vertical or upside down configuations.

5.1.3. Influence of High Voltage on Sensors Performance Signal Transmittance Test setup

The measurements have been conducted using HiPot Set providing high voltage on the metal part using a Step-up VT that allows raising the voltage up to 100 kV. Step-up VT is a source of corona by itself. Several Square D High Temp sensors were positioned on piece of copper bus bar, which was connected to Step-up transformer with the cable. The voltage has been raised from 5 kV to 50 kV and held for 10 minutes at each voltage. At the last stage of the test the voltage has been raised to 25 kV and was hold at this value for one hour. During the test the receiver was in close proximity to the Step-up transformer at the distance about 5 feet. During the runs with 50 kV applied to bus bar corona occurred, which produced very strong sound. Multiple sensors have been located close to energized piece of bus bar to determine if their functions as well as performance of Receiver are affected by HV corona.

Test Results
The effect of high Voltage and Corona in close proximity to the wireless sensors has been found insignificant.

5.2. WTMS Validation Tests Provided by Testing Services

The following tests (Table 2) have been provided by Met Laboratories, Underwriters Laboratories in Northbrook, IL and RF Laboratory of Square D in Raleigh, NC. and Nemco USA, Inc. Test reports are available upon request. FCC certification report has been received from Freshloc Technologies.

Table 2:

No.	Test	Standard, Level	Test Lab	Comments, Results
1	UL Test / installation Category	UL 3111-1, IEC 61010-1, UL 61010B-1 and IEC/EN1010 Level III	**UL Lab Northbrook**	Completed, Passed
2	Vibration Test	IEC61010-1 PMO SEP1001	**Met Lab**	Completed, Passed
3	Drop Test	PMO SEP 1002	**Met Lab**	Completed, Passed
4	EMC Tests	FCC Part 15, Class A/CE Heavy Industrial/Radiated/Conducted	**FCC**	Certified
5	EMI Tests	IEC 6100-4-4, Level 3; 4-3; 4-3; 4-8 4-2, level 3; 4-5 level 4	**Square D RF Lab**	Completed, Passed
6	EMI Tests (European Standards for CE Mark), Receivers	ETSI EN 300 220-3 V1.1.1 (2000-09); ETSI EN 301 489-1 V1.4.1 (2002-08); ETSI EN 301 489-17 V1.2.1 (2002-08); IEC 60950-1/EN 60950-1	**Nemco USA, Inc.**	Completed, Passed
7	EMI Tests (European Standards for CE Mark), Sensors	ETSI EN 301 489-1 V1.4.1 (2002-08); ETSI EN 301 489-17 V1.2.1 (2002-08); IEC 60950-1/EN 60950-1	**Nemco USA, Inc.**	Completed, Passed

SECTION 6

REFERENCES

1. "Technical Specification for Wireless Temperature Monitoring System," Square D Technical Library, Specification Number: 16090-10 (26 01 20.14). Product Name: Wireless Temperature Monitoring System [On-Line]. Available:
http://ecatalog.squared.com/pubs/Electrical%20Distribution/26%2001%2020.14.doc

2. "Technical Specification for Wireless Temperature Monitoring System - Consulting Services," Square D Technical Library, Specification Number: 16090-11 (26 01 20.15). Product Name:
WTMS - Consulting Services [On-Line]. Available:
http://ecatalog.squared.com/pubs/Electrical%20Distribution/26%2001%2020.15.doc

SECTION 7

FCC NOTE

1. This device complies with Part 15 of the FCC Rules.
   Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
2. THE MANUFACTURER IS NOT RESPONSIBLE FOR ANY RADIO OR TV INTERFERENCE CAUSED BY UNAUTHORIZED MODIFICATIONS TO THIS EQUIPMENT. SUCH MODIFICATIONS COULD VOID THE USER'S AUTHORITY TO OPERATE THE EQUIPMENT.