Venstar RF Remote Sensor

System Specification

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1. Scope

The purpose of this document is to provide the specifications of the Venstar RF Remote Sensors. These sensors will work with existing Venstar thermostats, specifically the T-71, T-250, and T-200.

2. Overview

The Venstar RF Remote Sensor is made of two components: the Transmitter Assembly and the Receiver Assembly. **Figure 1** illustrates the interconnection of the Transmitter Assemblies, Receiver Assembly and the Venstar T-XXX thermostats. The Receiver Assembly and thermostat are connected via a standard terminal strip using three wires. The Receiver Assembly and Transmitter Assembly are connected using an RF link at 418 MHz with unidirectional transmission.

Up to 16 Transmitter Assemblies may be used at the same time with the Receiver Assembly. When more than one Transmitter Assembly is installed all must provide a unique identifier. The Receiver Assembly averages all signals received and reports the averaged temperature to the Venstar T-XXX thermostat upon interrogation.

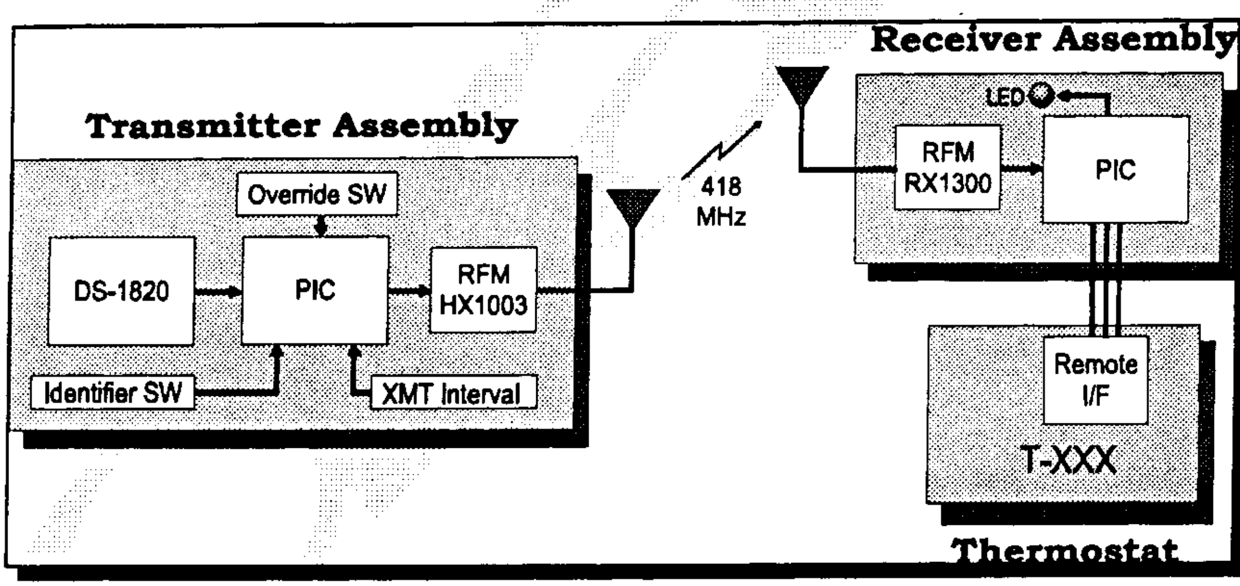

Figure 1 RF Remote System Block Diagram

15
2
2

3. System Requirements

The Venstar RF Remote Sensor shall be comprised of two functional units:

i. Transmitter Assembly/Assemblies

ii. Receiver Assembly.

The RF Remote Sensor shall function with the existing Venstar thermostat, also known as the "T-XXX".

3.1 Transmitter Assembly

The Venstar RF Remote Sensor System will provide up to 16 transmitters which report local temperature to a remote receiver. Transmissions are made periodically at a set interval regardless of change in temperature. The user may override this interval using the front panel button to transmit a signal upon pressing.

The RF Remote Sensor Transmitter Assembly shall reside within five-hundred (500) feet of the Receiver Assembly.

The Transmitter Assembly shall transmit a unit identifier with each transmission. The unit identification shall include 4 bits of house code and 4 bits of unit number. The identifier code shall be determined from jumper settings.

The Transmitter Assembly shall transmit temperature in degrees Celsius. Temperature data shall be collected from a digital temperature sensor. The temperature value shall be scaled for 7 bits plus 1 bit for sign. In addition to unit identifier and temperature, each transmission shall include indication of override button action and checksum.

Accommodations shall be made for the future inclusion of a battery low indication in the data transmitted. Until such inclusion, this indicator shall report zero.

The format for the transmitted data is shown in Table 1 below.

Table 1 Byte Pattern

Byte 1	UN.3	UN.2	UN.1	UN.0	HC.3	HC.2	HC.1	HC.0
Byte 2	SIGN	T.6	T.5	T.4	T.3	T.2	T.1	T.0
Byte 3	CS.5	CS.4	CS.3	CS.2	CS.1	CS.0	OVR	BAT
Bit	7	6	5	4	3	2	1	0

The Transmitter Assembly shall provide self synchronization for the Receiver Assembly. Each transmission will utilize a 10 bit training sequence, '1101100010'.

The Transmitter Assembly shall read the transmit interval jumper settings and provide a 5 second, 2, 5, or 10 minute transmission interval. It is intended that the 5 second interval be used for installation only as this interval would unnecessarily diminish battery life. The assembly shall transmit data any time the override button is depressed. After the button is depressed current data shall be transmitted and the transmission interval re-initialized.

Transmissions shall occur twice for each temperature sample. This is used to reduce data errors. The second transmission shall be delayed by 256 ms multiplied by 1 plus the decimal value of the lower 3 bits of the unit number.

Each bit transmitted shall be 1.024 milliseconds in duration. Each byte transmitted shall be expanded to 12 bits to accommodate DC balancing. DC balancing is the action of matching the number of zeroes to ones transmitted per byte. Thus after each nibble, the data is expanded with filler which "equalizes" the bit pattern.

Terry,

I propose that we use an Error Correction Code instead of or in addition to the transmit twice approach. The proposed Error Correction Code uses a (7,4) Hamming code, which produces three bits of ECC data for each four bits of user data. The code can correct any one-bit error in the resulting seven bits of data. Two bit errors can be detected, but not corrected, while larger errors can neither be detected nor corrected by the ECC itself.

The proposed implementation will use a checksum on each packet, with ECC applied to the entire packet, including checksum. This will allow full correction of errors in a transmitted packet with a bit error rate as high as 14.2%. Larger error rates will not be detected by the ECC, but will be detected by checksum *verification, which will cause the packet to be rejected. The reliability of the ECC method remains constant with larger packet sizes, while the reliability of the retransmission method falls linearly.*

Each byte of user data will generate six bits of ECC data, which will be transmitted as a byte. Thus the total amount of data transmitted will be twice the packet size – identical to the retransmission method.

A preliminary implementation of the encoding (transmitter) side of the (7,4) Hamming code used 48 words of ROM for instructions and lookup tables. The receiver side (decoding) will require slightly more than 48 words. However, the receiver should have more ROM space.

The real question is, what type of noise do we expect? The ECC won't help us with long bursts which wipe out an entire byte. My guess is that the simple ECC approach I propose will help in most instances and is certainly easily removed if you are unhappy with the results. You implied in your memo that RFM will be "blessing" your protocol. Would you like to submit this scheme to them as well?

3.1.1 Interfaces

The Transmitter Assembly shall provide the following interfaces:

a. Digital Temperature Sensor
b. Identifier Jumpers
c. Transmit interval jumpers
d. Override Button
e. DC Power
f. RF (418 MHz).

3.1.2 Physical Dimensions

The Transmitter Assembly dimensions are the responsibility of Venstar and not provided in this specification.

3.1.3 Power

Power for the Transmitter Assembly shall be provided from an on board battery. The battery shall be of TBD type and size.

3.2 Receiver Assembly

The Venstar RF Remote Sensor Receiver Assembly receives the data transmitted from up to 16 Transmitter assemblies and averages all signals received. The averaged temperature is reported to the Venstar T-XXX thermostat upon interrogation. The Receive Assembly includes an LED for indication of proper packet receipt.

The Receiver Assembly shall compress the 12 transmit format back to an 8 bit representation. The checksum shall be calculated for each packet received and compared with the included checksum. Each packet received from the transmitter shall be decoded for house code and unit number. Upon receipt of valid identifier code and valid checksum, the Receiver Assembly shall illuminate the LED for 250 milliseconds.

Temperature data received shall be signed degrees Celsius. Temperatures from each zone shall be stored until replacement data is received. The Receiver Assembly shall average the received data across all valid zones. If data is not received within 10 minutes of the previous data, the zone shall be considered invalid.

Upon interrogation from the T-XXX, the Receive Assembly shall send average temperature data to the T-XXX. The data sent from the Receiver Assembly to the T-XXX shall be in the format provided by the DS-1820 specification. When valid average data is unavailable, the Receiver Assembly shall not respond to the T-XXX interrogation.

3.2.1 Interfaces

The Receiver Assembly shall provide the following interfaces:

a. RF (418 MHz)
b. Remote Sensor 3-wire bus
c. DC Power
d. LED

3.2.2 Physical Dimensions

The Receiver Assembly dimensions are the responsibility of Venstar and not provided in this specification.

3.2.3 Power

The Receiver Assembly shall receive power from the Venstar T-XXX Thermostat. Voltage shall be 5 Volts DC, +/- TBD.