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USER'S GUIDE

RF SENSOR SYSTEM

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VERSION A

Safetran Systems Corporation, California Division
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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.

WARNING TO USERS

The user that changes, or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

NOTES, CAUTIONS, AND WARNINGS

Throughout this manual, notes, cautions, and warnings are frequently used to direct the reader's attention to specific information. Use of the three terms is defined as follows:

NOTE

Generally used to highlight certain information relating to the topic under discussion.

CAUTION

REFERS TO PROPER PROCEDURES OR PRACTICES WHICH IF NOT STRICTLY OBSERVED, COULD RESULT IN A POTENTIALLY HAZARDOUS SITUATION AND/OR POSSIBLE DAMAGE TO EQUIPMENT. CAUTIONS TAKE PRECEDENCE OVER NOTES AND ALL OTHER INFORMATION, EXCEPT WARNINGS.

WARNING

INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY. WARNINGS ALWAYS TAKE PRECEDENCE OVER NOTES, CAUTIONS, AND ALL OTHER INFORMATION.

If there are any questions, contact Safetran Application Engineering.

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SECTION I
INTRODUCTION

1.0 INTRODUCTION

1.1 SCOPE

This manual describes the installation and operation of the Safetran RF Sensor System consisting of an RF Sensor Base (RFSB) and a Gate Tip Transmitter (GTT).

1.2 DEFINITIONS AND ACRONYMS

RF Sensor System (RFSS) – General term for a base and sensor combination. For this specification, the sensor is the GTT and the base (RFSB) monitors the gate arm position and reports "down" and "up" events to the MTSS

RF Sensor Base (RFSB) – A device that receives the sensor information transmissions and may determine events and report to a monitoring system.

Gate Tip Transmitter (GTT) – A device that attaches near the end of a crossing gate arm and transmits position information. This tip sensor uses a low power RF radio to communicate with a base device.

Industrial, Scientific and Medical Band (ISM) – Radio frequencies available for use by unlicensed devices governed by Part 18 of the FCC rules. The RFSS uses a low power radio communicating on several frequencies in the 902-928 MHz band.

Safetran Mini Trackside Sensor (MTSS) – A device for collecting various sensor data and reporting to a centralized device.

Up/Vertical/Clear – Position of a Gate Arm that allows traffic to cross a railway. Due to overhead clearance, many gate arms are not vertical when they are stopped and locked in their raised position. The "Up" condition is indicated when the gate arm is within 10° of the established reference position.

Down/Horizontal/Level – Position of a Gate Arm that prevents traffic from crossing a railway. The "Down" condition is indicated when the gate arm is within 3° of the established reference position.

Beacon – A signal that is broadcast for synchronization or notification. For the RFSS, the RF Sensor Base broadcasts a beacon packet to indicate the start of a communication period on a frequency. The beacon also contains a list of the successive frequencies that the RFSB will use.

Discovery – Procedure used by a base and a tip to uniquely distinguish each other and exchange configuration information. After a successful Discovery, the base and tip will remain "paired" until the next Discovery.

1.3 SYSTEM COMPONENTS

The RFSS has two components: the GTT, as shown in Figure 1-1, which gathers and transmits gate arm position information

Figure 1-1 Gate Tip Transmitter (GTT)

The RFSB, as shown in Figure 1-2, which receives and analyzes the position information and provides the output signals to the recording equipment.

Figure 1-2 RF Sensor Base

Both components use PC-boards which have a microcontroller and radio; in addition, the GTT has an accelerometer.

1-2

1.4 THEORY OF OPERATION

The RFSS uses an RF Sensor Base (RFSB) and a Gate Tip Transmitter (GTT) to sense the position of the grade crossing barrier arm and provide event signals to reporting equipment (MTSS).
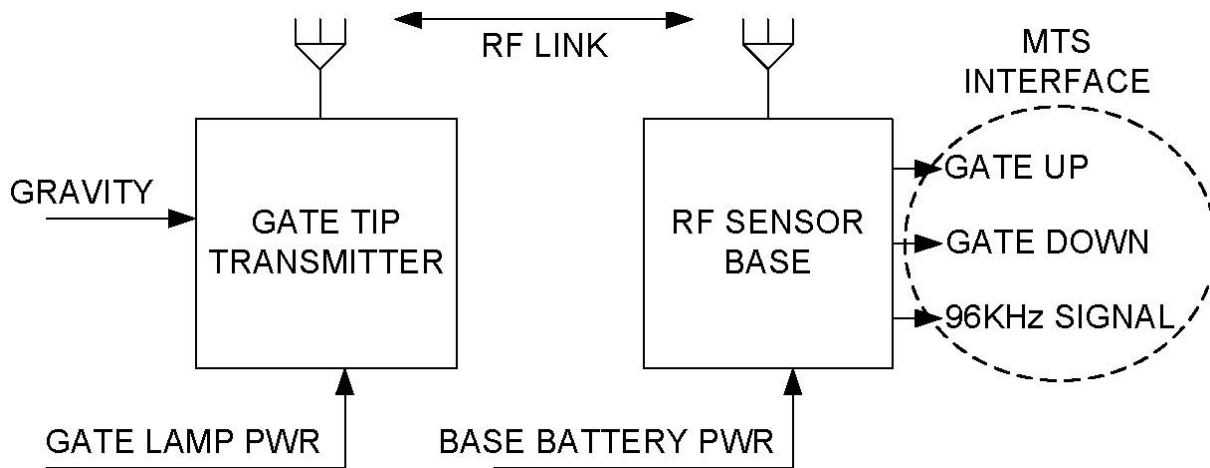

Figure 1-3   System Block Diagram

The GTT continually senses orientation and movement of the gate arm using an accelerometer and transmits the 3-axis acceleration values to the RFSB using a low power radio. The RFSB receives the radio packets from the GTT, analyzes the data and sets the output signals to indicate the position of the gate arm.

The RF Sensor System interface to the reporting equipment (MTSS) is provided by the RF Sensor Base. The Gate Tip Transmitter communicates with the RFSB; but has no direct interface to the MTSS.

For compatibility with the existing 80282 Gate Tip Sensor, the RFSB provides a 96 KHz signal to the MTSS to indicate Gate-Down. In addition to the current 96 KHz signal, the RFSB provides independent Gate-Down and Gate-Up position indications (both LED and digital output) and allows switching the 96 KHz carrier to be presented on either Gate-Down or Gate-Up condition.

Note that the digital signals are independent; Gate Down and Gate Up are asserted or de-asserted independently. Since the position of the gate arm is actually down, up or somewhere in between, the indications are Down-asserted, Up-asserted or both de-asserted. While Down and Up are exclusive events, they are not opposites.

The System devices (RFSB and GTT) rely on a local power source, but they do not require signal wiring or use the power wiring for signaling. The devices use low power radios for wireless communication.

1.5   SYSTEM DESCRIPTION

The GTT has a single Green/Red LED that is illuminated on request to indicate Health (Green) or Discovery (Red).   There is a single pushbutton to request LED illumination or a Discovery sequence. The GTT is in an exposed location (on the gate arm), so the LED is normally off to avoid drawing attention to the device.
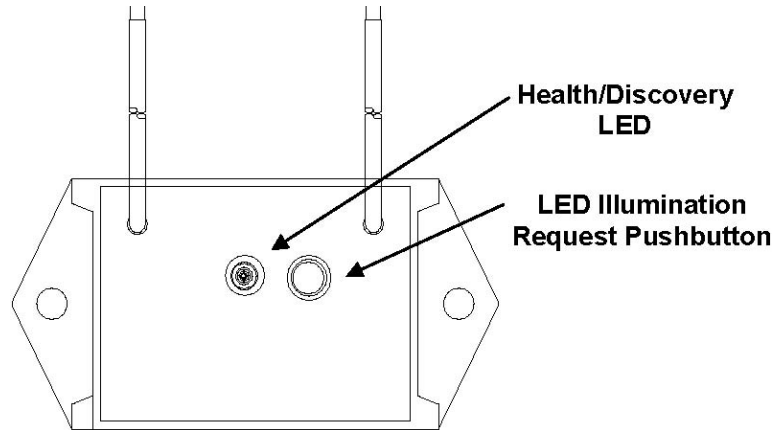
Figure 1-4   GTT Indicator and Control

The RFSB has LEDs to indicate POWER, HEALTH, DOWN position, UP position and COM (Discovery); these LEDs are illuminated whenever appropriate. The RFSB has a SYNC pushbutton that is used to request Remote LED illumination, establish Gate-Up reference, or Discovery sequence. The RFSB has two configuration switches: LONG/SHORT for different length gate arms and MOD to activate the 96 KHz carrier signal (Gate-Down or Gate-Up).

Figure 1-5   RFSB Indicators and Controls

1-4

1.6   SPECIFICATIONS

Gate Tip Transceiver

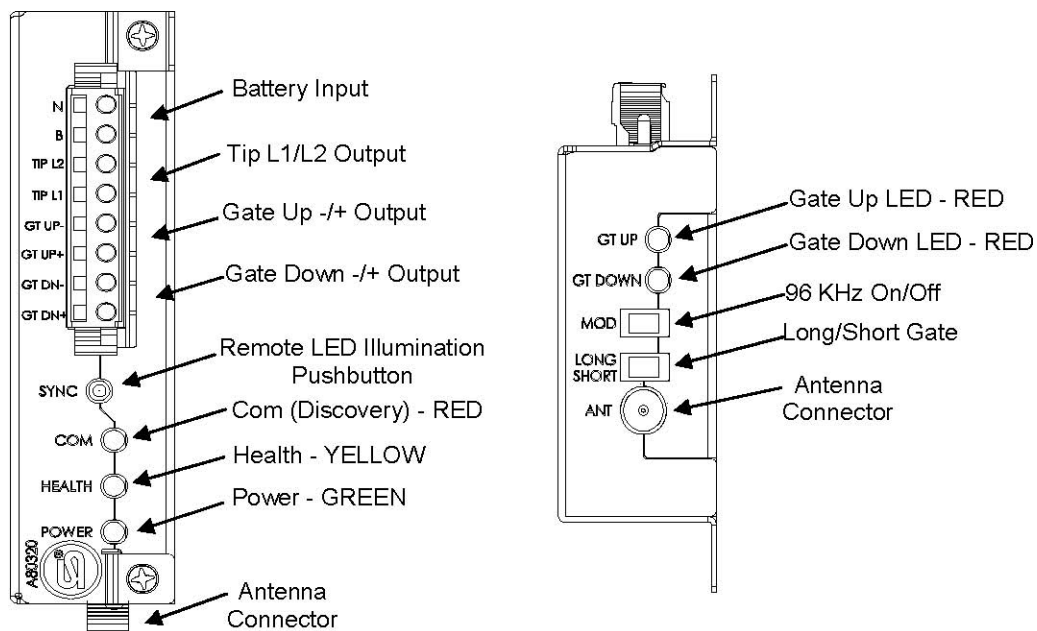|	
Input Voltage	9.0 – 20.0 VAC - VDC (13.2 V Nominal) Any Polarity
Input Current	0.2A @ Nominal Voltage
Environmental:	
Temperature:	-40° F - +160° F (-40° C - +71° C)
Humidity:	Hermetically Sealed
Dimensions:	
Length:	3.0 inches (7.6 cm)
Width:	1.5 inches (3.8 cm)
Depth:	1.625 inches (4.1 cm)
Weight::	2 ounces (56.7 g)
FCC ID:	LTY80319
IC:	2347A-80319
	FCC CFR Part 15.247 and 15.109 Class B compliant
Frequency Range:	902 MHz – 928 MHz ISM Band
Number of Channels:	10
Channel Separation:	325 KHz
RF Output Power:	+10 dBm
Modulation:	FSK, OOK, MSK, GFSK
Differential Load Impedance:	86.5 + j43 Ω
FSK Data Rate:	500 kbps Maximum
RSSI Output:	Digital
Receiver Sensitivity (FSK):	-94 dBm
Spurious Emissions:	-57 dBm
Antenna Connection	Differential

RF Sensor Base

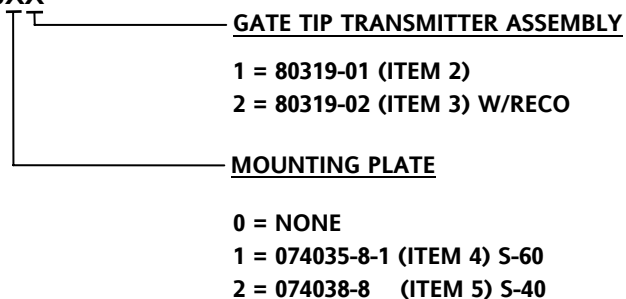|	
Input Voltage	8.0 – 34.5 VDC (13.2 V Nominal)
Input Current	0.2A @ Nominal Voltage
Environmental:	
Temperature:	-40° F - +160° F (-40° C - +71° C)
Humidity:	95% non-condensing
Dimensions:	
Length:	3.50 inches (8.9 cm)
Width:	6.00 inches (15.2 cm)
Depth:	1.15 inches (2.9 cm)
Weight::	1.25 lbs (567 g)
FCC ID:	LTY80319
IC:	2347A-80319

	FCC CFR Part 15.247 and 15.109 Class B compliant
Frequency Range:	902 MHz – 928 MHz ISM Band
Number of Channels:	10
Channel Separation:	325 KHz
RF Output Power:	+10 dBm
Modulation:	FSK, OOK, MSK, GFSK
Differential Load Impedance:	86.5 + j43 Ω
FSK Data Rate:	500 kbps Maximum
RSSI Output:	Digital
Receiver Sensitivity (FSK):	-111 dBm
Spurious Emissions:	-57 dBm
Antenna Connection:	RP - SMA
Antenna:	½ Wave Center-fed Dipole
Frequencies Used:	903.4 – 903.6 MHz
	905.8 – 906.0 MHz
	908.2 – 908.4 MHz
	910.6 – 910.8 MHz
	913.0 – 913.2 MHz
	915.4 – 915.6 MHz
	917.8 – 918.0 MHz
	920.2 – 920.4 MHz
	922.6 – 922.8 MHz
	925.0 – 925.2 MHz

1.7 ORDERING INFORMATION

CONFIGURATION CHART

8000-80314-00XX

GATE TIP TRANSMITTER ASSEMBLY

1 = 80319-01 (ITEM 2)
2 = 80319-02 (ITEM 3) W/RECO

MOUNTING PLATE

0 = NONE
1 = 074035-8-1 (ITEM 4) S-60
2 = 074038-8   (ITEM 5) S-40

SECTION II
INSTALLATION

2.0   INSTALLATION

2.1   GTT INSTALLATION

The GTT installs in the lamp assembly on the gate arm. Wires are attached in parallel to existing Tip Light power wires using wire nuts. The GTT is mounted inside the cover of the Tip Light junction box using two #10 self tapping sheet metal screws included with the unit. The GTT should be mounted as near to the end of the gate as possible. The long surface is parallel to the edge of the gate arm.
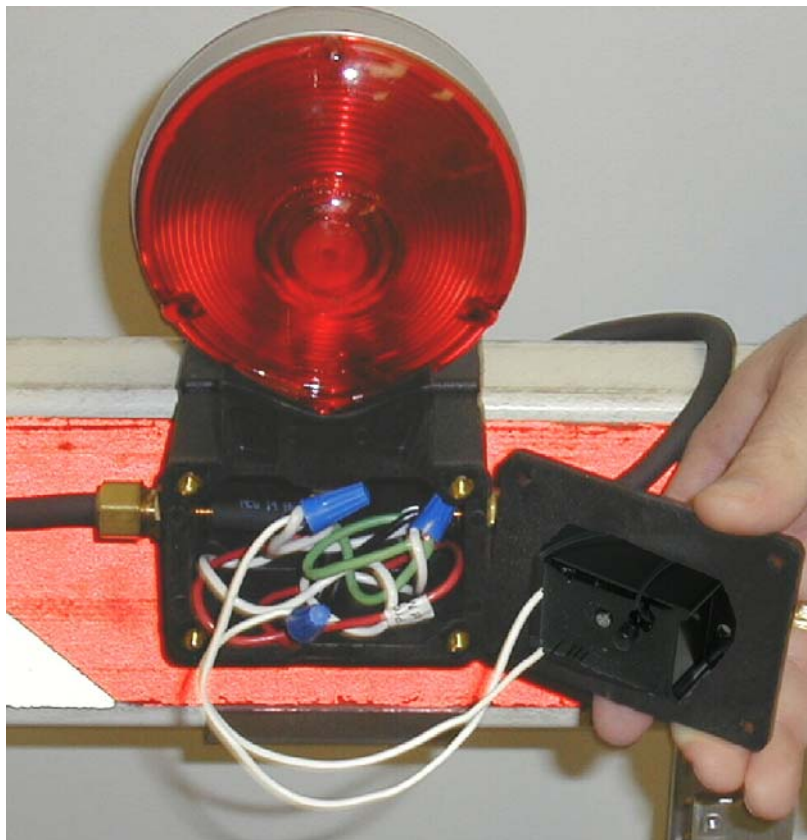

Figure 2-1   Mounting GTT

2-1

Crossing gates using the Reco Tip Lights will require the use of the 80319-02 GTT shown in Figure 2-1, which includes a cable and plug.

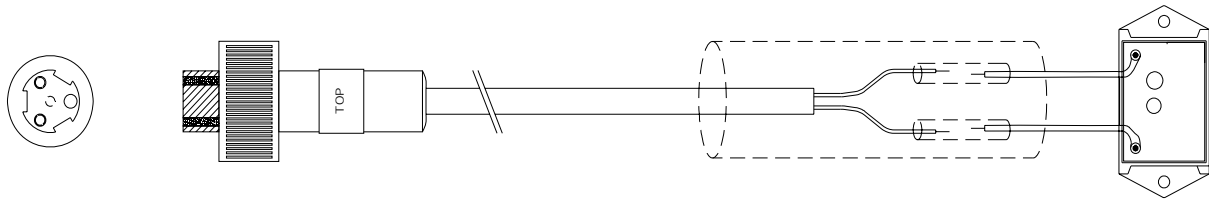**Figure 2-2   80319-02 GTT and RECO Light Harness**

The GTT RECO Light Harness connects to the Exit Connector on the Tip Light. as shown in Figure 2-3.

TIP LIGHT

EXIT CONNECTOR ON
TIP LIGHT

TOP PIN IN LAMP HOUSING CONNECTOR
MUST BE ALIGNED WITH THE WORD "TOP"
MARKED ON GATE-TIP SENSOR CABLE PLUG

FRONT VIEW
(SHOWS MISSING TOP
CONTACT)

(TOP TERMINAL DOES NOT HAVE A METAL
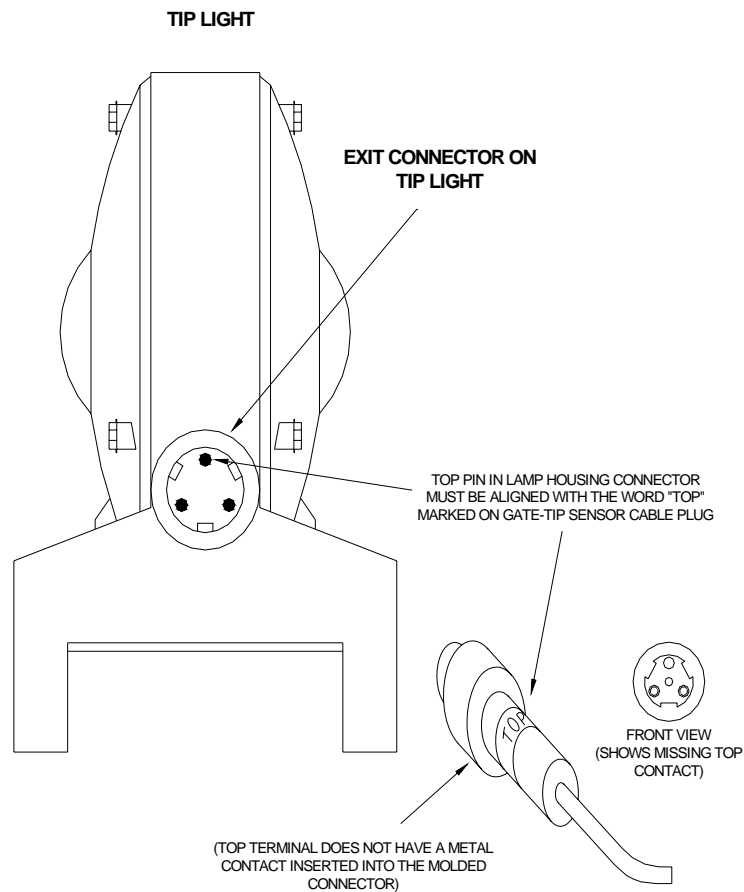CONTACT INSERTED INTO THE MOLDED
CONNECTOR)

Figure 2-3   GTT installation with RECO Light

2-2

The GTT is mounted on the tip of the gate arm using the two #10 self tapping screws included with the GTT. A typical installation is shown in Figure 2-4.
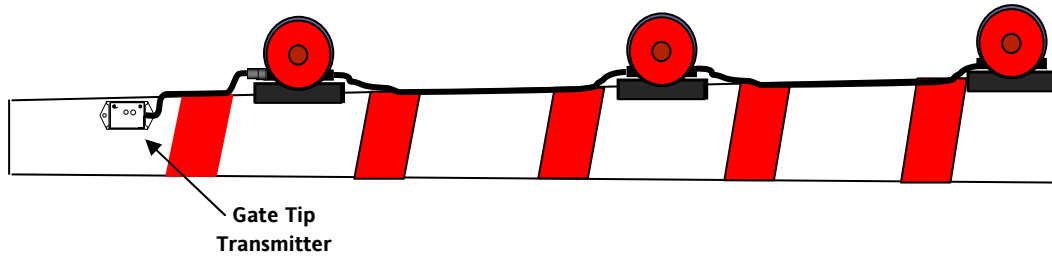

Gate Tip
Transmitter

Figure 2-4   Typical GTT Installation on Gate Arm

2.2   RFSB INSTALLATION

The RFSB module installs inside the crossing gear box. A mounting plate is provided to mount the RFSB inside the gear box compartment as shown in Figure 2-5. Arrange the swivel antenna away from any gears or moving parts.

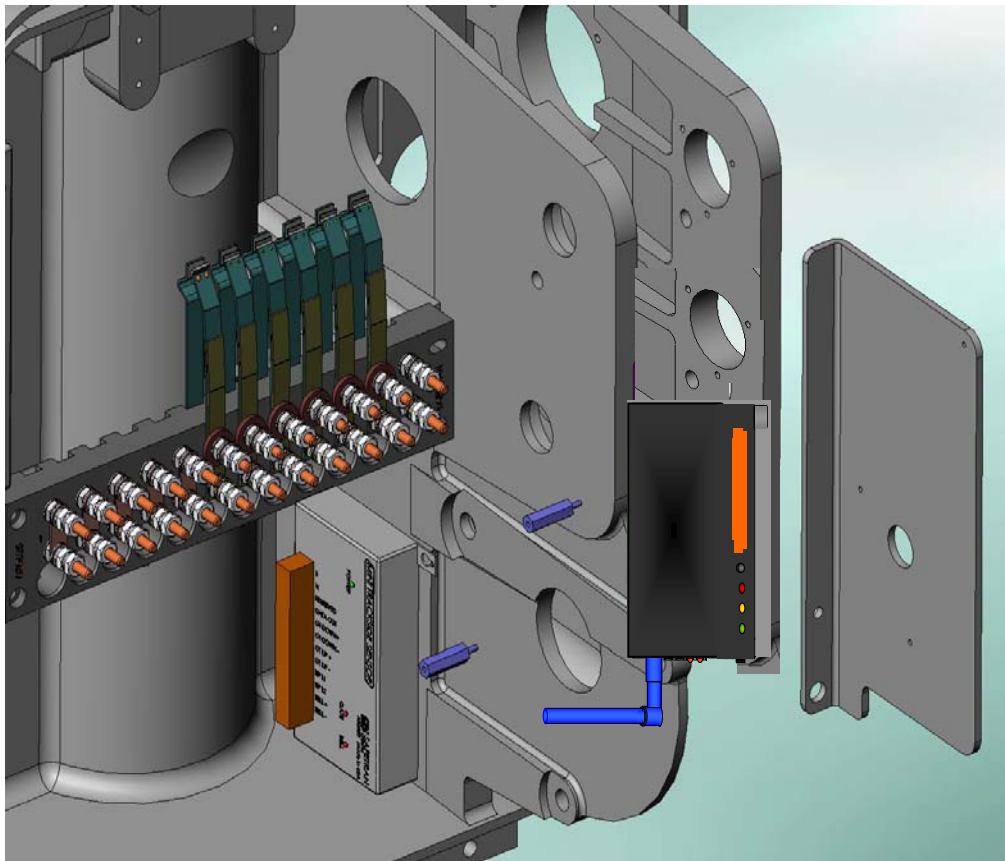**Figure 2-5   Mounting RFSB Component**

2-3

2.2.1   RFSB Interconnect

The output of the RFSB is connected to the MTSS as shown in Figure 2-6. The RFSB and the MTSS must be connected to the same power source.
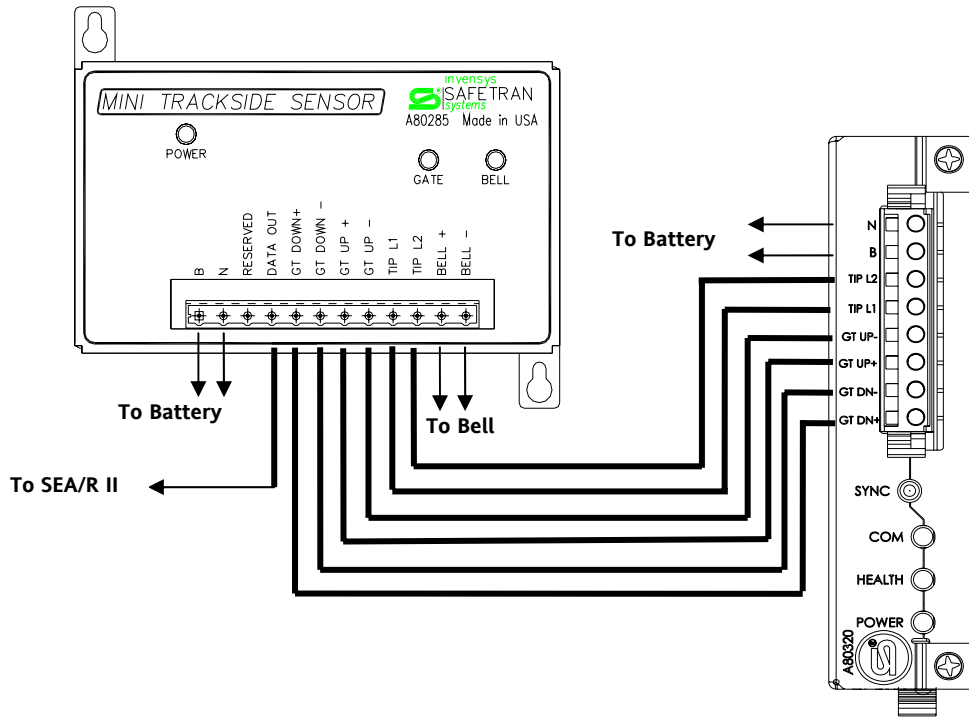

Figure 2-6   RFSB Interconnect

SECTION III
SET UP PROCEDURE

3.0   SET UP

3.1   RFSS SYSTEM SET UP

The RF Sensor System set up procedure a simple operation. The procedure requires the crossing be powered up and the crossing gate in the down position. The appropriate measures will be required to secure vehicular traffic as well as pedestrian and worker safety.

WARNING

SET UP OF THE RF SENSOR SYSTEM REQUIRES THE CROSSING BE POWERED AND THE GATE IN THE DOWN POSITION. DELOY THE APPRORIATE RAILROAD SAFETY PROCEDURES TO SECURE VEHICULAR TRAFFIC AS WELL AS PEDESTRIAN AND WORKER SAFETY.

3.2   DISCOVERY PROCESS

It is necessary to pair a GTT and RFSB together using the Discovery Process. Only one GTT and RFSB can be powered during the Discovery Process.
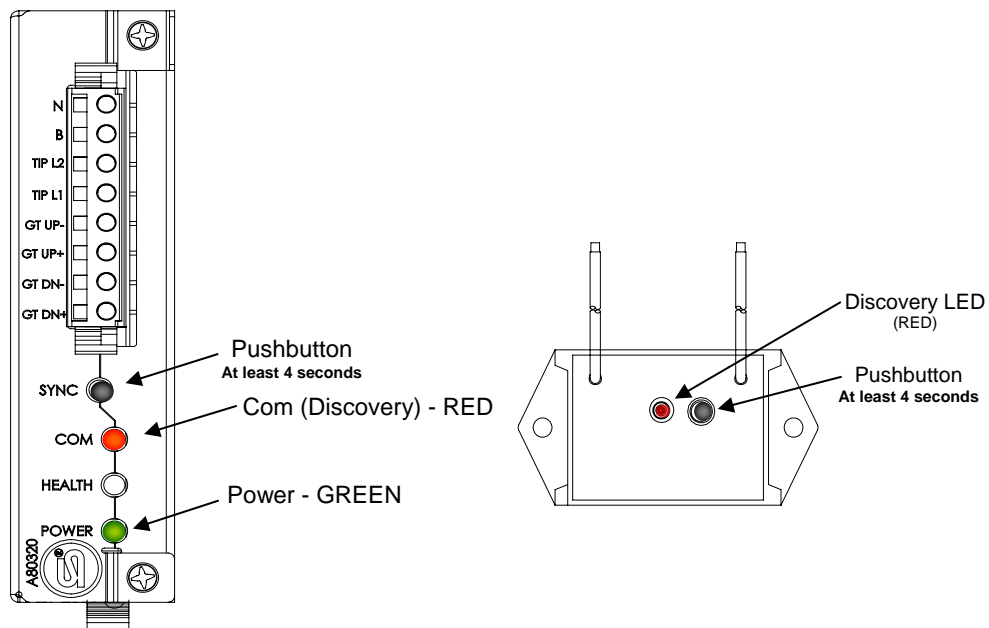
Figure 3-1   Discovery Process

3-1

Perform the following procedure to pair the GTT and RFSB:

1.) Verify power is applied to the RFSB and the Power LED is illuminated.
2.) Verify Crossing Gate is powered and gate lamp power is on.
3.) Lower Crossing Gate
4.) Press Pushbutton of GTT for one second and verify LED is illuminated GREEN.
5.) Press GTT Pushbutton and hold for at least 4 seconds and verify LED is RED.
6.) Press RFSB Pushbutton and verify COM (Discovery) LED is illuminated solid.
7.) The GTT LED and RFSB COM LED will be lit during the Discovery Process.
8.) When GTT and RFSB LEDs extinguish the Discovery Process is complete.

3.3   RFSB SET UP

The RFSB has two slide switch adjustments to configure the unit to the crossing gate as shown in Figure 3-2.
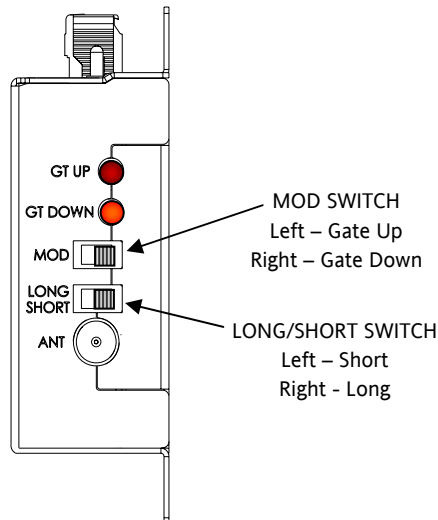
Figure 3-2   RFSB Set Up

3.3.1   MOD Switch

The MOD switch on the RFSB selects the gate arm position that will activate the 96 KHz carrier. With the switch set to the left (towards the silkscreen) the output is set for activation in the gate arm up position. With the switch to the right (away from the silkscreen) the activation will be when the gate arm is down. For compatibility to the 80282 Gate Tip Sensor, the switch should be set to provide carrier when the gate arm is down.

3-2

3.3.2 LONG/SHORT SWITCH

The Long/Short Switch on the RFSB configures the Gate Arm length. Short Gates are less than 25 feet in length. Long Gates are 25 feet or longer in length. Set the switch to the left for Short gate arms and to the right for Long gate arms.

3.3.3 GATE UP REFERENCE

To establish a "Gate UP" reference in the RFSB, perform the following procedure:

NOTE

To perform the "Gate Up" reference procedure, power must be applied to the GTT with the Gate Arm in the "Up" position.

1.) With the Gate Arm Up and power applied to the GTT, press the SYNC pushbutton on the RFSB three (3) times.
2.) Verify the RFSB COM LED is illuminated.
3.) When the RFSB COM LED extinguishes, the reference procedure is completed.
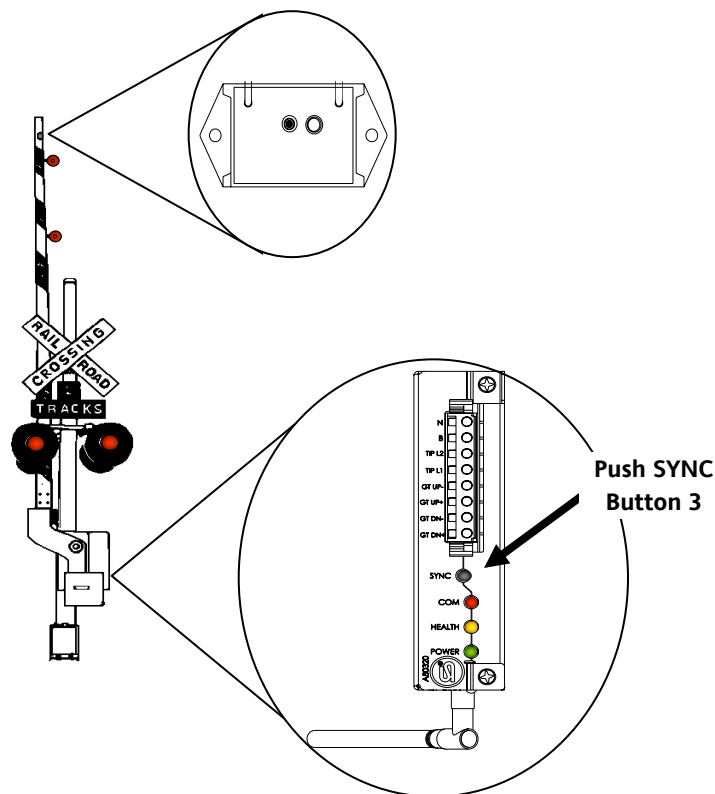4.) Restore normal signal operation.

Figure 3-3   Gate Up Reference

3-3

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SECTION IV
OPERATION

4.0 OPERATION

4.1 RFSS SYSTEM OPERATION

The RF Sensor System operation is relatively transparent, once the set up procedure is complete. The RFSS components have indicators to provide system status. The GTT LED will illuminate on demand but remains extinguished during normal operation to not attract unwanted attention.

4.2 RF SENSOR BASE OPERATION

The RF Sensor Base (RFSB) senses the Gate Arm position from the Gate Tip Transmitter (GTT). The RFSB is wired to the Mini Trackside Sensor (MTSS), which collects the data and sends it to a recorder life the Safetran SEA/R II.

4.2.1 RFSB Indicators and Controls

The RFSB has several indicators to provide status and operational health as shown in Figure 4-1.
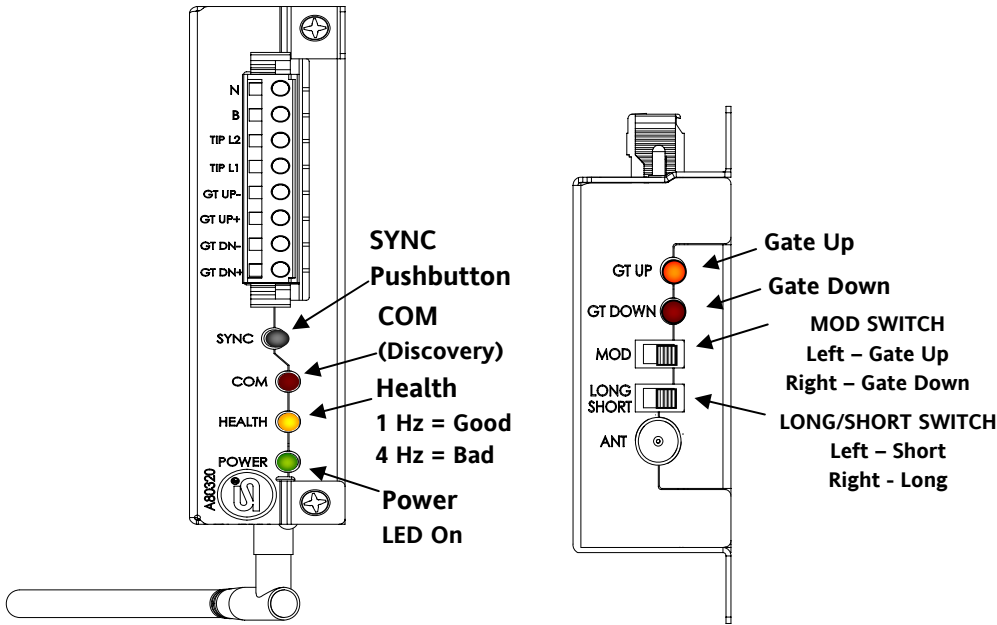

Figure 4-1   RFSB Indicators

4.2.1.1   Power Indicator

The Power indicator LED (Green) illuminates when power is applied to the RFSB.

4-1

4.2.1.2 Health Indicator

The Health indicator (Amber) is illuminated when power is applied to the RFSB and provides the Health status of the module. A 1 Hz flash rate indicates Good health. A 4 Hz flash rate indicates Bad Health and the module requires service.

4.2.1.3 COM (Discovery) Indicator

The COM indicator (Red) illuminates during the Discovery operation while establishing a link with the GTT. The COM indicator also illuminates during the Gate Up Reference operation as the RFSB communicates with the GTT and records the Gate Up information.

4.2.1.4 Gate Up Indicator

The Gate Up Indicator (Red) illuminates when the crossing gate arm is in the up position. In most installations, the GTT will be powered from the tip light power and only active while the gate lamps are on. Once the gate is in the up position and the power to the lamps and the GTT is removed, the Gate Up LED will extinguish until the GTT is repowered and the gate becomes active. Supplying continuous power to the GTT will provide an indication at all times.

4.2.1.5 Gate Down Indicator

The Gate Down indicator (Red) illuminates when the gate arm is in the down position.

4.2.1.6 SYNC Pushbutton

The SYNC Pushbutton has three modes. Each mode uses a different sequence to initiate the function.

4.2.1.6.1 SYNC Pushbutton Discovery Mode

Pressing the SYNC pushbutton for 4 seconds or longer will start the Discovery Process. The Discovery process pairs the RFSB with a GTT as detailed in the Set Up Section.

4.2.1.6.2 SYNC Pushbutton Gate Up Reference Mode

Pressing the SYNC pushbutton 3 times with the crossing gate arm in the Up position, will establish the Gate Up Reference for the RFSB. This reference is sent from the GTT to the RFSB and stored as the Gate Up position.

4.2.1.6.3 SYNC Pushbutton GTT Health Mode

Pressing the SYNC pushbutton 1 time activates the GTT LED in the Health monitor mode for one minute.

4.2.1.7 MOD Switch

The MOD Switch sets the gate position that will activate the 96 KHz carrier. Left towards the silkscreen is Gate Up, and Right away from the silkscreen is Gate Down.

4.2.1.8 LONG/SHORT Switch

The LONG/SHORT Switch is used set the system for Long (25 ft or longer) or Short (24 ft or less) crossing gate arms.

4.2.2 GTT Indicator and Control

The GTT has an dual color (RED/GREEN) LED and a Pushbutton Control. The indicator will illuminate during set up processes and when manually activated. The LED will extinguish when the process is complete or one minute after manual activation. The LED is normally off to remain stealth on the crossing gate arm.

4.2.2.1 LED Indicator

The LED indicator illuminates Green to indicate module health. Flashing of 1 Hz indicates good health and 4Hz bad health. A Red indication will occur during the Discovery Process while the GTT is being paired with a RFSB.

4.2.2.2 GTT Pushbutton

The GTT pushbutton is used to activate the Discovery Process and the GTT Health status. Pressing the GTT Pushbutton for 4 seconds will start the Discovery Process with a RFSB. The pushbutton on the RFSB also mush be pressed for 4 seconds. Pressing the GTT Pushbutton for 1 second will start the GTT Health monitor for 1 minute.
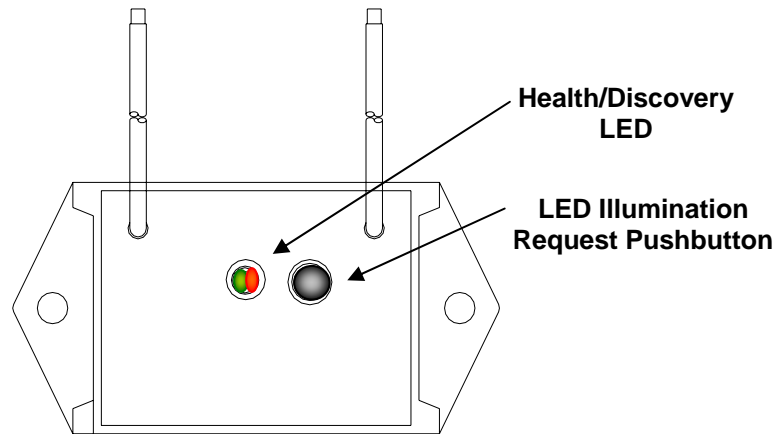

Figure 4-2   GTT Indicator and Control

4.2.3 Gate Arm Position Entry and Exit Range

The GTT has an entry and exit window in both the Gate Up and Gate Down position. Table 1 details the window parameters for Gate Up and Gate Down positions for Short and Long Gate Arms.

4-3

Table 4-1 Gate Arm Position Entry and Exit Windows

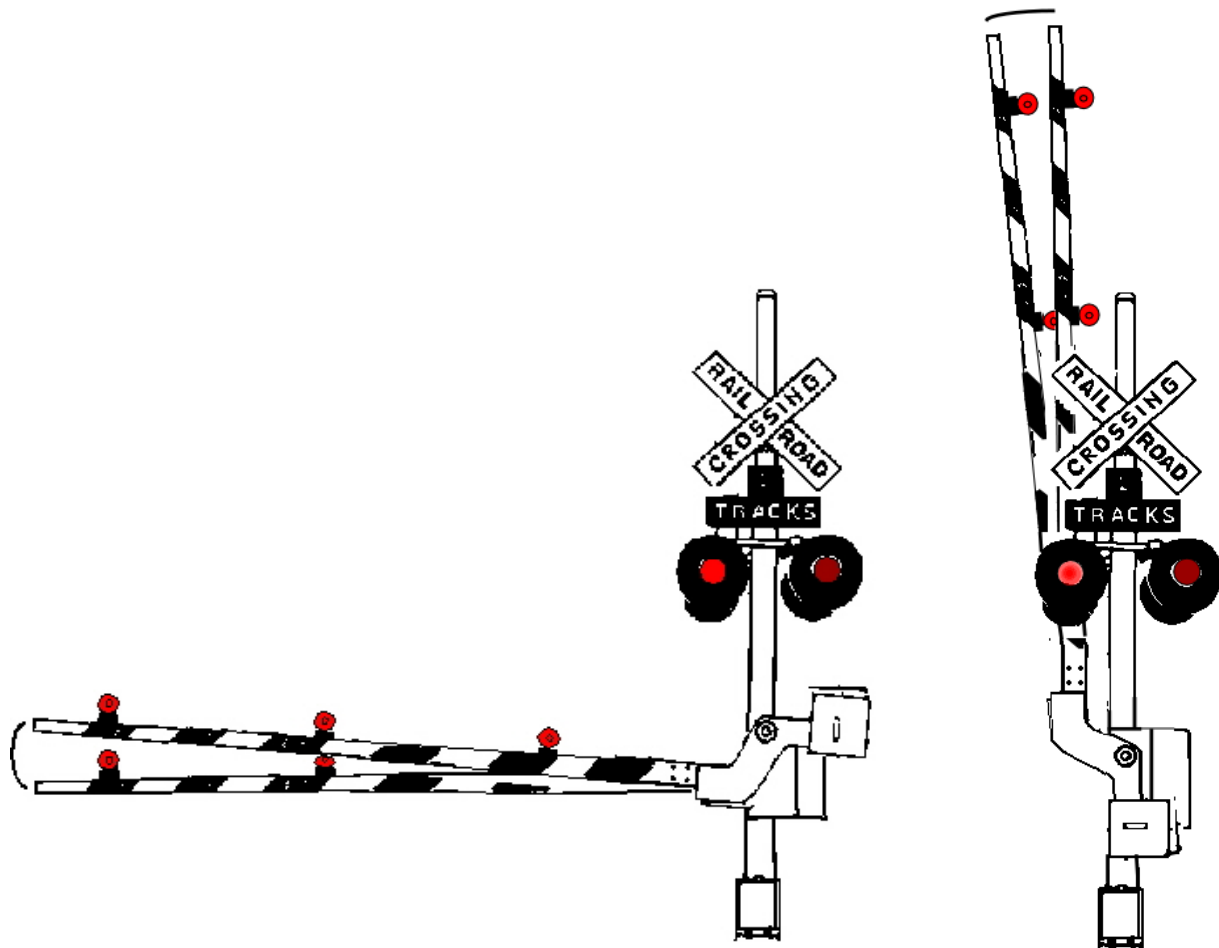|	Switch	
	SHORT	LONG
Down-Entry (GT DN On)	5º	3º
Down-Exit (GT DOWN Off)	8º	4º
Up-Exit (GT UP Off)	8º	4º
Up-Entry (GT UP On)	5º	3º

Table 4-2   Gate Arm Position Entry and Exit Windows

4-4

SECTION V
TROUBLESHOOTING

5.0   TROUBLESHOOTING

5.1   RFSS SYSTEM TROUBLESHOOTING

The RF Sensor System operation is relatively transparent. However, should a problem occur, the following troubleshooting procedures will aid in identifying the source of the problem.

WARNING

SERVICING THE RF SENSOR SYSTEM REQUIRES THE CROSSING BE POWERED AND THE GATE IN THE DOWN POSITION. DELOY THE APPRORIATE RAILROAD SAFETY PROCEDURES TO SECURE VEHICULAR TRAFFIC AS WELL AS PEDESTRIAN AND WORKER SAFETY.

5.2   OPERATIONAL CHECKS

Simple checks can be made to verify the system operation. Reviewing the indicator LEDs will provide the system's operational status.
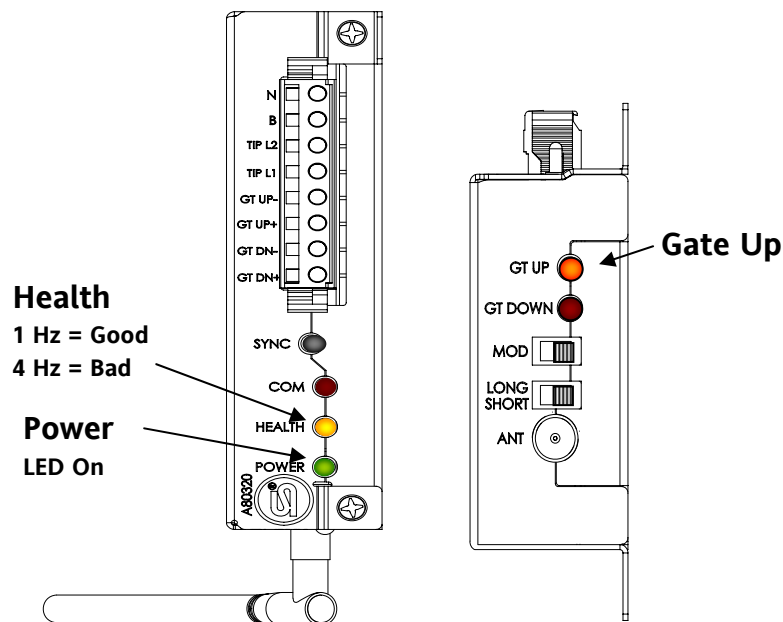
Figure 5-1   RFSB Indicators

5.2.1 RFSB CHECKS

Perform the following checks on the RFSB module:

1.) Verify the POWER LED is illuminated.
2.) Check the HEALTH LED. 1 Hz = GOOD, 4 Hz = Bad
3.) Check the GT UP (Gate Up) LED is illuminated (assuming the gate arm is up).
4.) Verify all wiring is properly terminated and secure.
5.) Verify the MOD and LONG/SHORT switches are in their proper positions.
6.) Verify antenna is securely mounted.

5.2.2 GTT CHECKS

Perform the following checks on the GTT module:

HEALTH
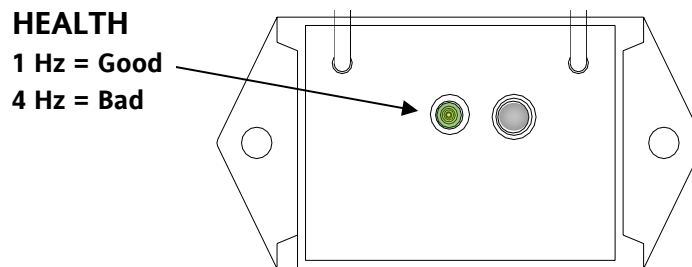**1 Hz = Good**
4 Hz = Bad

Figure 5-2   GTT Indicators

1.) Press the SYNC pushbutton on the RFSB module once and check the LED indicator on the GTT module. A 1 Hz flash rate indicates GOOD health a 4 Hz flash rate indicates bad health.
2.) If the LED is NOT flashing, press the pushbutton on the GTT once. If the LED is flashing verify is the flash rate is 1 Hz indicating GOOD health or 4 Hz BAD health.
3.) If no indication is observed on the GTT LED, verify power is available to the GTT module.
4.) If GTT LED did NOT illuminate after pressing the RFSB pushbutton and DID illuminate after pressing the GTT pushbutton, perform the Discovery Procedure and verify the GTT and RFSB are communicating as a pair.

5-2

Table 5-1 TROUBLESHOOTING CHART

GTT TROUBLESHOOTING	
LED Indicator will not illuminate	Verify power is available. Verify power is within specification, 9 – 20 VAC or VDC Verify power wires are not cut or broken Replace GTT Module
LED Indicates BAD Health	Replace GTT Module
LED will not illuminate when RFSB module pushbutton is pressed once	Perform Discovery Procedure Verify RFSB module is operational

RFSB TROUBLESHOOTING	
Power LED not illuminated	Verify power is available Verify power is within specification, 9 – 20 VAC or VDC Verify power wires are not cut or broken Replace RFSB Module
Health LED indicates BAD Health	Replace RFSB Module
RFSB Module will not communicate with GTT Module	Verify GTT Module is operational Perform Discovery Procedure Verify antenna is securely fastened
RFSB not communicating with MTSS	Verify RFSB is in good health Verify Cage Clamp connector is secure Verify wiring is properly terminated and secure

RF Sensor System Troubleshooting	
Gate Up LED not illuminated when Gate Arm is Up	Perform Gate Up Reference Procedure Verify GTT is mounted properly Verify MOD Switch is set for proper Gate Length Verify GTT is good health

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