



FreeWave Technologies, Inc.

2.4 GHz Wireless Modem Installation Guide

This installation guide covers all models of the FreeWave Technologies 2.4 GHz spread spectrum transceiver sold under FCC ID KNY2920513513419 (Enclosed) and KNY209228624168 (Board Level).

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FCC Notification

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
- 2) this device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by FreeWave Technologies, Inc. Any changes or modifications made to the device without the express written approval of FreeWave Technologies may void the user's authority to operate the device.

CAUTION: This device has a maximum transmitted output power of 500mW. It is recommended that the transmit antenna be kept at least 36 cm away from nearby persons to satisfy FCC RF exposure requirements.

Note: 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. 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 to.
- ◆ Consult the dealer or an experienced radio/TV technician for help.

Note: Whenever any FreeWave Technologies module is placed inside an enclosure a label **must** be placed on the outside of that enclosure which includes the module's FCC ID.

ETSI:

"European Telecommunications Standards Institute" "Institut européen des normes de telecommunication"

This device must be operated as supplied by FreeWave Technologies, Inc. Any changes or modifications made to the device without the express written approval of FreeWave Technologies may void the user's authority to operate the device.

ETSI EMC standards EN 300 826 (common to – 328 and – 440 standards)

The device must be installed in a metal enclosure that is electrically grounded to meet safety requirements.

ETSI standards ETSI EN 300 328

This device complies under two conditions:

- (1) EN 300 328 operating mode is selected in the setup menu.
- (2) EIRP maximum limit of 100 mW (20 dBm) is met. A programmed maximum power setting of "10" results in device transmit output power of 100 mW (20 dBm). Under this condition the total gain including all cables and the antenna must not exceed 0 dB. If the total gain exceeds 0 dB, the device power setting must be reduced to meet the 100 mW (20 dBm) EIRP limit.

ETSI standards ETSI EN 300 440

Applicable definition: RFID as defined in the ERC/REC 70-03E, Annex 11:

"...radio frequency identification (RFID) applications including for example automatic article identification, asset tracking, alarm systems, waste management, personal identification, access control, proximity sensors, anti-theft systems, data transfer to handheld devices and wireless control systems."

This device complies under three conditions:

- (1) EN 300 440 operating mode is selected in the setup menu.
- (2) EIRP maximum limit of 500 mW (27 dBm) is met. A programmed maximum power setting of "10" results in device transmit output power of 500 mW (27 dBm). Under this condition the total gain including all cables and the antenna must not exceed 0 dB. If the total gain exceeds 0 dB, the device power setting must be reduced to meet the 500 mW (20 dBm) EIRP limit (see chart settings chart below).
- (3) Antenna requirements:
 - a. Beam-width equal or less than +/- 45 degrees horizontal.
 - b. Side-lobe attenuation equal or more than 15 dB.
 - c. Physical protection (e.g. antenna dome) with dimensions to limit the power transfer from the RFID antenna to a quarter wave matched dipole positioned at an extreme close proximity to less than or equal to + 15 dBm.
- (4) Outside use only.

A. Transceiver installation steps

To install the FreeWave 2.4GHz transceiver, follow the basic steps given below:

1. Mount the transceiver on a flat, stable surface using mounting holes in the corners of the transceiver. See section labeled *Hardware Mounting Instructions* for detailed installation instructions.
2. Install the antenna and connect the antenna feed line to the transceiver. If you are installing a directional antenna, preset the antenna's direction appropriately.
3. Connect a computer to the transceiver's RS232 port (please refer to the part C of this addendum for more information about the transceiver's pin assignment). This computer will be used to set the transceiver's configurations.
4. Connect the transceiver to a power supply.
5. Set the transceiver configuration according to the system topology and data terminal equipment requirements. Default transceiver settings allow user to do a quick installation without major changes in transceiver's configuration. But, there is one parameter that **must be considered for a new installation – transceiver's power output settings.**

Table with RF Xmit Power settings vs. RF Output Power of the transceiver is given below:

2.4 GHz (typical)		
Setting	mW	dBm
10	500	+27
9	450	+26.5
8	430	+26.3
7	400	+26
6	350	+25.4
5	300	+24.8
4	200	+23
3	125	+21
2	60	+18
1	20	+13
0	0.5	-3

Please, note that the output power in the table above may slightly vary from transceiver to transceiver, but it will never be above 27 dBm for the RF Xmit Power settings of 10.

Transceiver output power level *must be* set according to the tables given below to satisfy FCC maximum EIRP requirement. Per FCC regulations, any antenna used with FreeWave transceivers must either be one of the approved antennas shown below or an antenna with comparable performance parameters. FreeWave Technologies offers a variety of omnidirectional and directional external antennas with both bracket and magnetic mounts. The complete list of antennas available from FreeWave Technologies including antenna gains, antenna manufacturer's information, and antenna's characteristics is shown below:

The following antennas are approved for use with FreeWave 2.4GHz transceivers:

2.4GH Directional Antennas

Gain	Manufacturer	Manufacturer Model Number	FreeWave Model Number
14dB	Mobile Mark	SCR14-2400	EAN2414CR

2.4 GHz Omni-directional Antennas

Gain	Manufacturer	Manufacturer Model Number	FreeWave Model Number
5dB	Maxrad	MAXC24505	EAN2405WC
2.5dB	Mobile Mark	PSTN3-2400N	EAN2400NH

WARNING: Any antennas placed outdoors must be properly grounded. Use extreme caution when installing antennas and follow all instructions included with the antennas.

Table 1 below provides the maximum output power settings for FreeWave 2.4GHz transceivers at given antenna gain (14 dB and 5 dB antennas are given as an example in Point to Point and Point to Multipoint systems) and cable loss combinations. Please note that **it is installer's responsibility to assure that the emission limits are not exceeded.**

Table 1: Output Power Settings at given Antenna Gain & Cable Loss combination.

		Cable Loss			
		1dB	2dB	3dB	4dB
Antenna Gain	14dB, Point-to-Point	6	8	9	9
	14 dB, Point-to-Multipoint	5	5	6	8
	5dB	9	9	9	9

Table 2 below shows how the RF Xmit Power settings on the transceiver correspond to the EIRP of the transceiver-cable-antenna combination for the 14 dB Yagi antenna at different cable loss values for the Point-to-Point system architecture.

Table 2: FreeWave Technologies 2.4GHz EIRP for 14dB Corner Reflector Antenna, Point-to-Point system architecture, Cable loss vs. RF Xmit Power Setting.

		Cable Loss			
		1dB	2dB	3dB	4dB
RF Xmit Power	9	39.43	38.43	37.43	36.43
	8	38.98	37.98	36.98	35.98
	7	38.17	37.17	36.17	35.17
	6	36.93	35.93	34.93	33.93
	5	34.96	33.96	32.96	31.96

Shaded area indicates combinations where EIRP limitations exceed FCC regulations and RF Xmit Power must be reduced.

Table 3 below shows how the RF Xmit Power settings on the radio correspond to the EIRP of the transceiver-cable-antenna combination for the 14 dB Yagi antenna at different cable loss values for Point-to-Multipoint systems.

Table 3: FreeWave Technologies 2.4GHz EIRP for 14dB Corner Reflector Antenna, Point-to-MultiPoint systems, Cable loss vs. RF XmitPower Setting.

		Cable Loss			
		1dB	2dB	3dB	4dB
RF Xmit Power	9	39.43	38.43	37.43	36.43
	8	38.98	37.98	36.98	35.98
	7	38.17	37.17	36.17	35.17
	6	37.93	36.93	35.93	34.93
	5	34.96	33.96	32.96	31.96

Shaded area indicates combinations where EIRP limitations exceed FCC regulations and RF Xmit Power must be reduced.

The table below shows the RF loss at various cable lengths at 2.4GHz.

Table 4: Cable loss at 2.4GHz

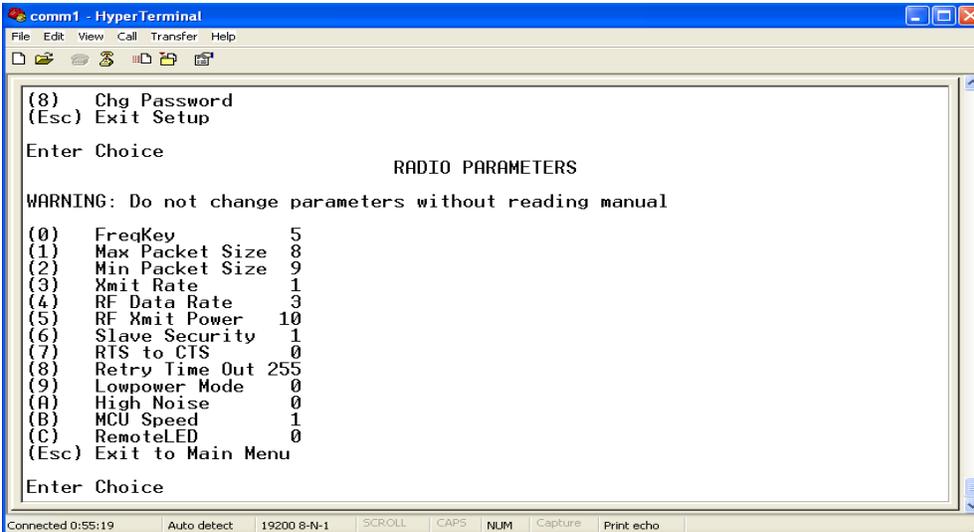
Length in Feet	LMR240	LMR400
10	1.3dB	.7dB
20	2.6dB	1.4dB
25	3.2dB	1.7dB
30	3.9dB	2.1dB
50	6.5dB	3.4dB
100	12.9dB	6.8dB

Follow the steps below to configure the Power Output Level:

- ✓ Start HyperTerminal or any other terminal emulation program on the computer connected to the transceiver's RS232 port (refer to the User Manual for the HyperTerminal setup instructions).
- ✓ Invoke the Setup menu on the transceiver.
- ✓ Choose option number **3** from the Main Menu on the HyperTerminal window.
- ✓ Choose option number **5** from the Radio Parameters menu followed by the settings an appropriate RF Xmit Power value, which is defined in the previous transceiver installation procedure.

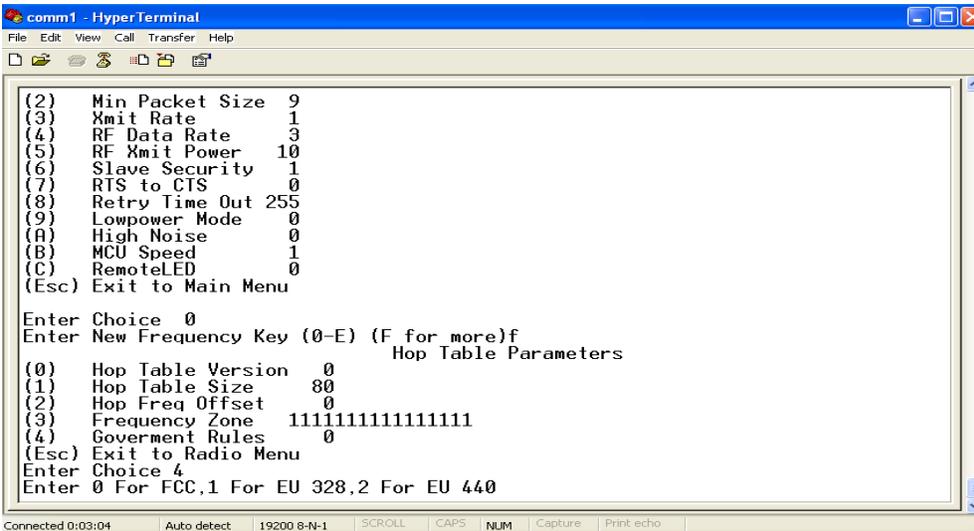
WARNING: In Transceivers with firmware version 3.36 and above, Government Rules must be set to 0 to comply with FCC regulations.
Note: All Frequency Zone settings must be set to "1".

To access the Government Rules option, press **3** at the Main menu to get to the Radio Parameters menu. Press **0** to get into the **FreqKey** submenu.



```
comm1 - HyperTerminal
File Edit View Call Transfer Help
(8) Chg Password
(Esc) Exit Setup
Enter Choice
                                RADIO PARAMETERS
WARNING: Do not change parameters without reading manual
(0) FreqKey          5
(1) Max Packet Size 8
(2) Min Packet Size 9
(3) Xmit Rate        1
(4) RF Data Rate     3
(5) RF Xmit Power    10
(6) Slave Security   1
(7) RTS to CTS       0
(8) Retry Time Out  255
(9) Lowpower Mode    0
(A) High Noise       0
(B) MCU Speed        1
(C) RemoteLED        0
(Esc) Exit to Main Menu
Enter Choice
```

Press **f** for more options within the **FreqKey** menu and then press **4** to get into the Government Rules option. At the prompt, type **0** to set the radio to comply with FCC rules. Type **1** to set the radio to comply with 328 rules. Type **2** to set the radio to comply with 440 rules.



```
comm1 - HyperTerminal
File Edit View Call Transfer Help
(2) Min Packet Size 9
(3) Xmit Rate        1
(4) RF Data Rate     3
(5) RF Xmit Power    10
(6) Slave Security   1
(7) RTS to CTS       0
(8) Retry Time Out  255
(9) Lowpower Mode    0
(A) High Noise       0
(B) MCU Speed        1
(C) RemoteLED        0
(Esc) Exit to Main Menu
Enter Choice 0
Enter New Frequency Key (0-E) (F for more)f
                                Hop Table Parameters
(0) Hop Table Version 0
(1) Hop Table Size    80
(2) Hop Freq Offset   0
(3) Frequency Zone    1111111111111111
(4) Government Rules  0
(Esc) Exit to Radio Menu
Enter Choice 4
Enter 0 For FCC,1 For EU 328,2 For EU 440
```

6. Repeat the steps above for each transceiver in the network.

Networks using the FreeWave 2.4GHz transceiver that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

This excludes the use of Point-to-MultiPoint systems, omni-directional applications, and multiple co-located intentional radiators transmitting the same information. Either the operator or the installer of the FreeWave transceiver is responsible for ensuring that the system is used exclusively for fixed, Point-to-Point operations.

Please contact FreeWave Technologies at 303-444-3862 with any questions regarding this matter.

NOTE: Please, be advised that antennas other than listed in this section can potentially be used with the transceiver provided that:

- These antennas are of a similar type to the listed above;
- Antenna gain does not exceed 5 dB for omni-directional and 14 dB for directional antenna;
- Overall system EIRP does not exceed limits set forth by Part 15.247 of FCC Rules and Regulations.

WARNING: *Any antenna other than listed in this section needs to be approved by FreeWave Technologies before it is used to assure that the transceiver in combination with the new antenna meets FCC requirements.*

B. Transceiver Location

Placement of the FreeWave transceiver is likely to have a significant impact on its performance. In general the rule with FreeWave is that the higher the placement of the antenna the better the communication link - **height is everything**. In practice, you should also place the transceiver away from computers, telephones, answering machines, and other similar equipment. To improve the data link, FreeWave Technologies offers directional and omni-directional antennas with cable lengths ranging from 3 to 200 feet.

When using an external antenna, placement of that antenna is critical to a solid data link. Other antennas in close proximity are a potential source of interference; use the Radio Statistics or Diagnostics software to help identify potential problems. It is also possible that slight adjustments in antenna placement (as little as 2 feet) will solve noise problems.

Hardware Mounting Instructions

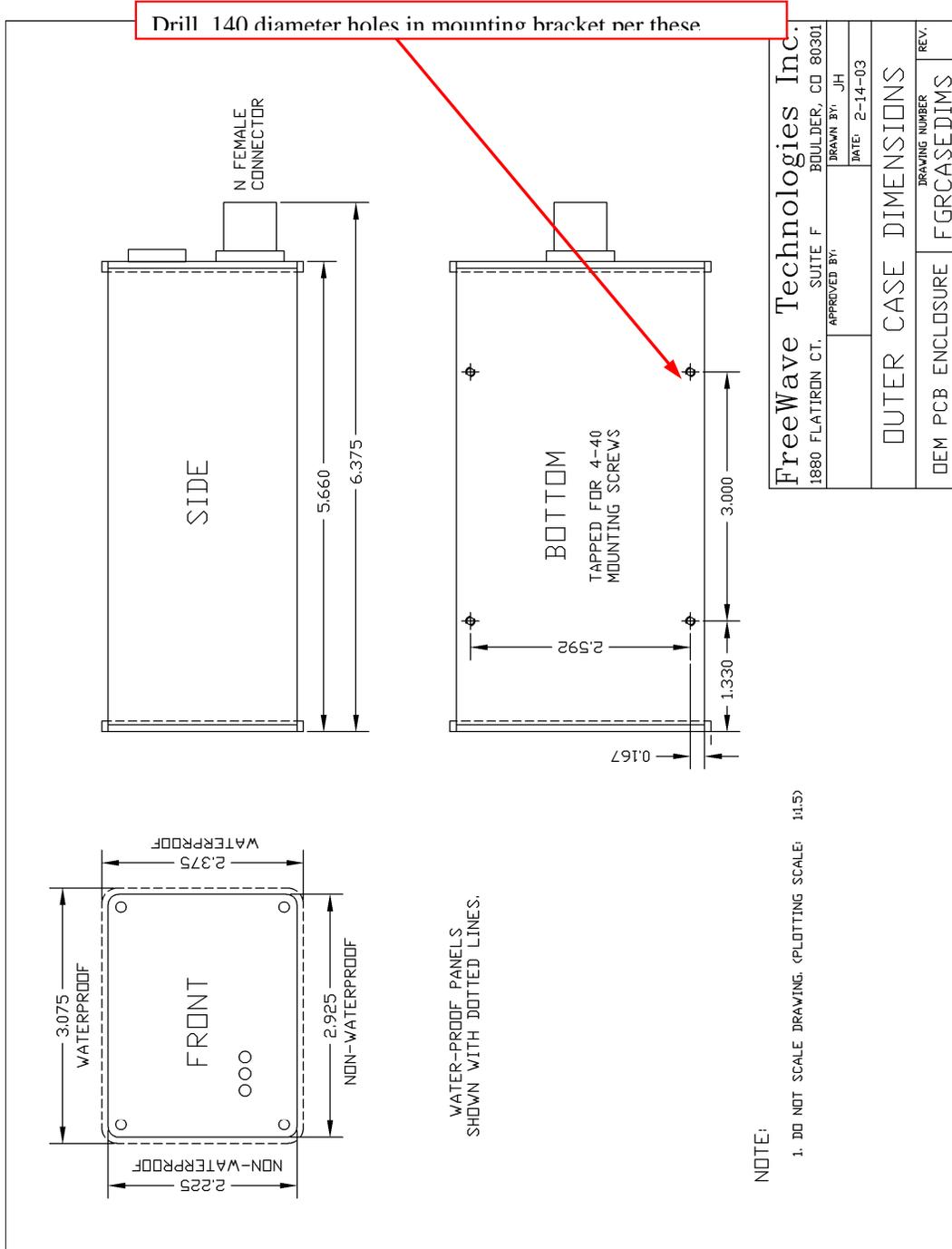


Mounting Instructions for I-Series Radio Transceiver in Ruggedized Enclosure

Qty Hardware required:

4	4-40 x 1/4 Pan Head Screw
4	#4 Split Lock Washers

1. Use a split lock washer on all four mounting screws.
2. Locate and drill .140 Diameter holes (see *Figure 1 - the Bottom view*) in the sheet metal (panel, bracket, etc.) that the enclosure will be mounted to.
3. From the backside of the sheet metal, insert screws through the holes and into the mounting holes on the enclosures bottom side.
4. Tighten firmly.



(Figure 1)

Mounting Instructions for I-Series Board Level Radio Transceiver

Qty	Hardware required:
4	4-40 x 3/4 Standoff
8	4-40 x 1/4 Pan Head Screw
8	#4 Split Lock Washers

1. Use a split lock washer on all eight mounting screws.
2. Locate and drill .140 Diameter holes (see *Figure 2 for Radio mounting hole dimensions*) in the sheet metal (panel, bracket, etc.) that the transceiver will be mounted to. Align the holes in accordance to the mounting holes in the transceiver.
3. From the backside insert screws through the holes and into a standoff for mounting the transceiver.
4. From the top of the transceiver, insert screws through the holes and into a mounted standoff.
5. Tighten firmly.

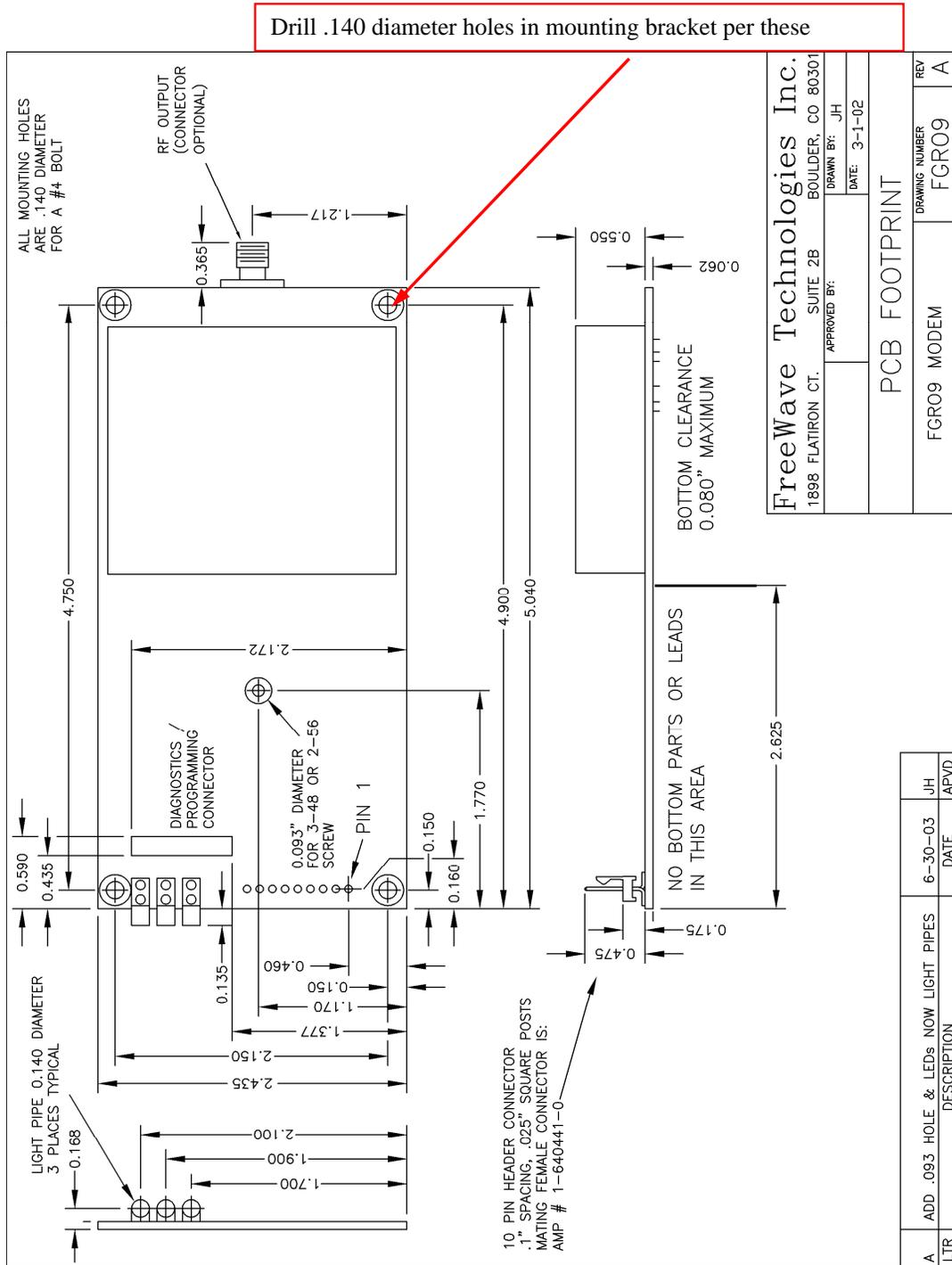
Mount the transceiver to the flat, stable surface using mounting holes in the corners of the transceiver. FreeWave recommends a minimum stand-off height of 1/4". The following mounting bracket solutions are available from FreeWave Technologies: Model #ONTWK-001 and Model #PMB-ENCL. Transceiver models sold under FCC ID KNY-6231812519 are to be installed professionally in NEMA enclosures.

Formatted: Bullets and Numbering

DO NOT USE VELCRO® TO MOUNT THE RADIO



- Attaching and detaching Velcro® pieces creates an ESD (Electro-static Discharge) hazard. ESD can damage the radio's circuitry. It also has the potential to damage other electronic devices close by.
 - Mounting a radio to a metal surface with Velcro® does not provide enough distance between the surfaces, and can result in an electrical short across the radio
- Velcro® is the registered trademark of Velcro Industries B.V.



(Figure 2)