RFM96W
Spread Spectrum
Radio Modem

User's Guide

Revision 1.0
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Cautions and Warnings

Throughout this manual this symbol is used to indicate caution or warning. Please pay particular attention to these items to assure safe and reliable operation of your radio modem product.

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Getting Acquainted

Introduction

Radio modems provide wireless data communication between remote systems in situations where wireline communication is difficult or impossible. For field operations such as remote monitoring and control, DGPS, and data telemetry, the radio modem provides the ideal link between remote computers, instruments and other RS-232-devices.

The RFM96W Spread Spectrum is a high-speed, radio modem designed for field operation. At the heart of the RFM96W Spread Spectrum is a high quality, spread spectrum radio engineered specifically for field data communications. Using a simple 3-wire RS232 interface, the RFM96W Spread Spectrum can easily be connected to most computers and instruments to provide an efficient and reliable data link.

To meet the needs of a variety of applications, the RFM96W Spread Spectrum can be configured with an IBM-PC compatible computer. Operating parameters such as data transmission rate, mode, and others can be configured quickly without having to modify the modem hardware.

Pacific Crest Corporation stands behind its products by providing comprehensive customer support with quick and efficient service. We understand that your success in using our products is key. For this reason, our toll-free number is available for sales and service questions (U.S. and Canada). Additional customer service options are available to assure that your radio modem products are properly maintained, and to assure minimum downtime should a problem occur.

Monday through Friday - 8:00 a.m. to 5:00 p.m. (PST)
1-800-795-1001 (Toll-free U.S. and Canada)
(408) 653-2070 (International/Local)
(408) 748-9984 (Fax)
sales@paccrst.com (Internet)
support@paccrst.com
http://www.paccrst.com

Thanks

Thank you for purchasing the RFM96W Spread Spectrum radio modem. We are confident that with the care and maintenance outlined in this manual, your RFM96W Spread Spectrum will provide years of trouble free service.

Features and Benefits

The RFM96W Spread Spectrum provides maximum flexibility for a variety of radio frequency data communication applications. Some of the features and benefits include:

- Spread Spectrum - Unlicensed operation in the Industrial, Scientific and Medical (ISM) 900 MHz band.
- High Speed - Data rates up to 19.2 kbits per second, including sustained full-duplex data to meet the requirements of most field data applications.
- Rugged - The extruded aluminum enclosure is designed for superior protection against shock and vibration. The RFM96W Spread Spectrum provides waterproof operation as per IEC 144/855420 I.P. 66.
- Multi-protocol - point-to-point for simple wireline replacement and multidrop for multiple users sharing the same frequency.
- RS-232 Interface - A simple three-wire interface provides compatibility with many computers, instruments, and other devices with an RS-232 serial port.
- Factory Support - Pacific Crest Corporation offers a number of support and extended warranty plans. The responsive support and repair center provides quick and efficient service.

Main Components

The RFM96W Spread Spectrum radio modem is available in a watertight enclosure with rugged and dependable circular LEMO brand connectors. This section will acquaint you with the physical attributes of the RFM96W Spread Spectrum radio modem. Please refer to Figure 1 as you read the discussion below.

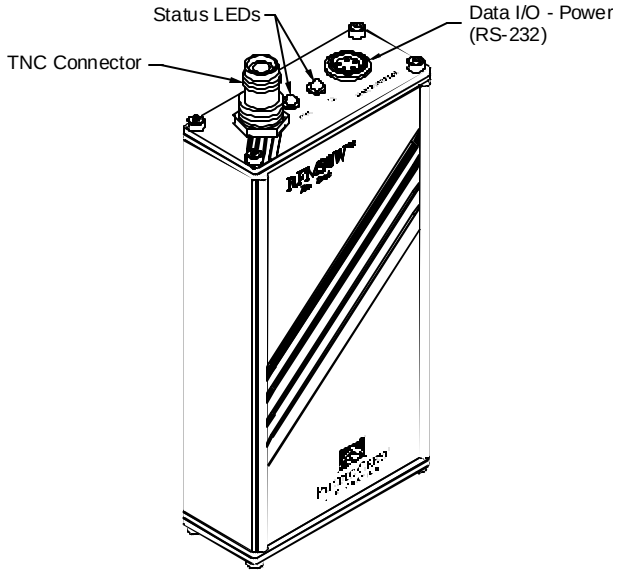

Figure 1 - RFM96W Spread Spectrum

Antenna Connector - A reverse TNC connector mates with the supplied antenna. The FCC limits the use of gained antennas and requires a "non-standard" type connector. The reverse TNC connector meets this requirement.

Status and Power Indicators - Two indicator lights are provided to indicate the operating status of the radio modem. See Indicator Lights later in this section for a description of how to interpret the indicators.

Data I/O - Power Connector - The environmentally sealed receptacle contains contacts for the three-wire RS-232 serial bus and the power connections. See Appendix A for pin-out diagrams.

Enclosure - The RFM96W Spread Spectrum has a lightweight extruded aluminum enclosure that provides protection against damage from exposure to water, dust, and corrosion as per IEC 144/855420 I.P. 66. The enclosure is powder coated with a blue salt-water resistant paint.

Antenna (not shown) - A rubber-duck style antenna is provided with the RFM96W Spread Spectrum. This antenna is tuned to the operating frequency band of the modem and is compliant with FCC regulations.

Data/Power Cable (not shown) - A two meter data/power cable is supplied with the RFM96W Spread Spectrum. This cable plugs into the circular connector on the unit and has a DE-9 female DTE connector for plugging into a computer or instrument. Power is connected through an SAE style connector that exits the base of the circular connector's strain relief.

See Appendix A for detailed cable and connector information, including pin-outs.

Indicator Lights

Two Light Emitting Diodes (LEDs) are used to indicate the modem status. The PWR LED is lit when power is supplied to the unit and the unit is operational. The red STAT LED provides radio transmit, receive or idle status information. Table 1 shows the interpretation of the STAT LED.

LED Flash Pattern	Description
Off	Command or standby mode and during configuration of the unit using RFMSSCNF.
Flickering Low Intensity	Searching or synchronization between the master and slave modems.
On Steady Low Intensity	Units are synchronized and in receive mode.
On Steady High Intensity	Units are synchronized and in transmit mode.

Table 1 - Status light interpretation

Caution: Only operate the radio modem with the antenna, or appropriate antenna substitute (dummy load) connected. Damage may occur to the radio if operated without an antenna. Never operate the RFM96W Spread Spectrum without a proper antenna connection!

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Rules and Regulations

Part 15 Compliance (for U.S.)

The RFM96W Spread Spectrum complies with Part 15 of Title 47 of the Code of Federal Regulations. Operation is subject to the condition that this device does not cause harmful interference.

Licensing

Licensing is not required for operation of the RFM96W Spread Spectrum in the United States and many countries worldwide.

Caution: Be aware that operation of the RFM96W Spread Spectrum 900 MHz radio transceiver is regulated on a country by country basis. Before operating your RFM96W Spread Spectrum, be sure to ascertain the conformity with local regulations. You may be subject to fines and other penalties if you operate a radio transmitter without proper authorization. In general, spread-spectrum radio operation at 900 MHz in Europe or other countries that use GSM telephones in the 900 MHz band is prohibited.

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How the Radio Modem Works

DTE or DCE?

Throughout this user's manual, the acronyms DCE and DTE are used to differentiate between the data terminal equipment (DTE), and the data communication equipment (DCE). The DTE represents the source and/or destination of the data, while the DCE facilitates the communication of data from its source to destination.

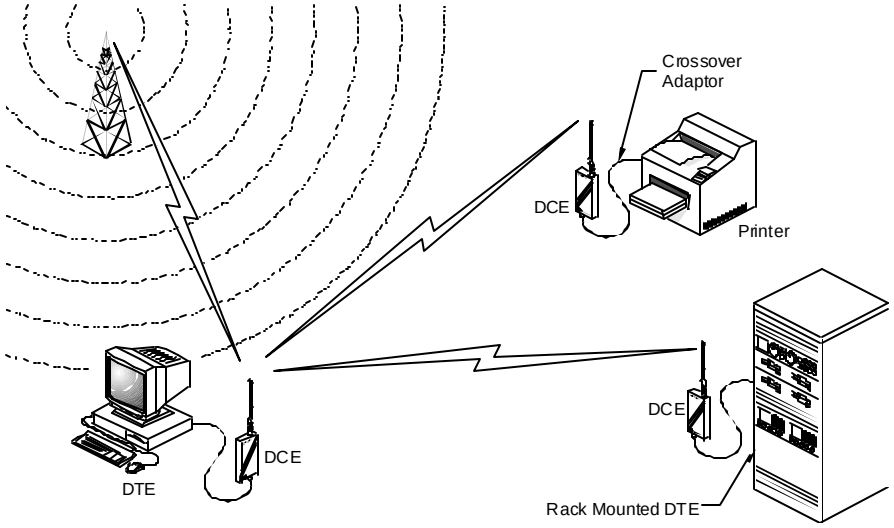

Figure 2 - RF Data Communication network

Radio modems, such as the RFM96W Spread Spectrum, are classified as DCEs. Most portable terminals and computers, such as the popular IBM-PC, are classified as DTEs. Figure 6 shows the flow of data in a typical communication circuit. In this example, two IBM-PC compatible computers (DTEs) communicate using a pair of RFM96W Spread Spectrum radio modems (DCEs).

Some instruments and devices do not fall clearly into a DTE or DCE classification. The manufacturer determines the configuration of these devices. Generally, if the device is normally connected directly to a computer or terminal using a straight through cable, then the manufacturer will configure the device as a DCE. If you need to connect a DCE configured device to the radio modem, you will need to use a crossover cable or adapter between the modem and the device. See Appendix A for connector pin-outs and information about DCE to DCE connections.

Radio Frequency Data Communication

The RFM96W Spread Spectrum radio modem functions by taking digital information, transforming it into an analog wave form, and transmitting this signal via radio waves to a receiving radio modem. The receiving modem takes the signal, converts it back into digital information, and presents the digital information to the serial port of the receiving DTE.

Topics discussed in this section include spread spectrum technology overview, the causes and effects of signal fading, and an overview of factors which influence the range of transmission.

Spread Spectrum

Spread spectrum technology makes use of principle called spreading to provide communication that is relatively free from interference from traditional "narrow-band" and spurious noise. Narrow-band radio transmission, used in most land-mobile radios and cellular phones, makes use of a single frequency when broadcasting. Spread spectrum radios spread the information to be transmitted over a wide range of frequencies using one of two techniques - Frequency Hopping or Direct Sequence.

Frequency hopping spread spectrum radio modems jump from frequency to frequency in a systematic, though pseudo random pattern. The transmitter and receiver each follow the same pattern in a coordinated manner allowing the communication to occur. Because the radio modems only dwell for an instant on any single frequency, a source of interference on one frequency can be compensated for, resulting in generally reliable communication.

Direct Sequence techniques also spread the information over a wide band of frequencies, but do it using a wide-band mixing process where the data is multiplied by a higher frequency data stream and then broadcast. Through correlation circuitry, the receiving radio modem aligns itself with the high frequency data stream and is able to recover the original data.

The RFM96W Spread Spectrum makes use of frequency hopping technology to provide the spreading of the signal.

Note that no radio technology is immune to interference. Performance of the RFM96W Spread Spectrum may be affected in areas of high wide-band noise due to other spread spectrum systems in the area.

Signal Fade

Signal fade is the change in signal power arising from natural or man-made phenomena that degrades the performance of the radio system. In mobile radio environments, fade occurs as the signal level is changed because of RF path obstructions or multi-path (interference to the direct-path signal from signals reflected off of nearby objects.) The radio communication equipment must be

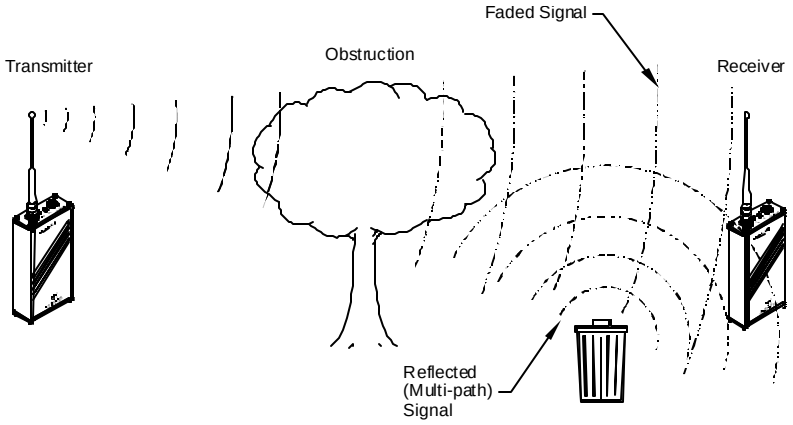

Figure 3 - Signal Fade and Multipath

able to quickly adjust to the changes in signal level to provide a consistent quality of data output that is not dependent on the signal strength.

By paying close attention to antenna placement and orientation, fading can be reduced. The most important consideration in antenna placement is maintaining the best possible line-of-sight orientation between transmitting and receiving antennas.

Multi-Path

The reflection of radio waves off of obstructions in the path between the transmitter and the receiver can cause multi-path interference. Destructive interference occurs as the out-of-phase reflected signals combine with the direct path signal. This type of fade condition is most apparent in mobile applications where the receiving radio modem is constantly moving through areas of multi-path interference.

Range

Reliable communication range is the parameter by which radio communication links are judged. 900 MHz spread spectrum radios are limited to short range applications with generally good line-of-sight conditions. Radio waves in these frequencies propagate in a straight path and are susceptible to attenuation through foliage and other obstructions. The FCC mandates maximum power output of spread spectrum to be 1 Watt or less. Also, the FCC limits the use of high gain antennas. The intent of the FCC is to maximize the reuse of the radio spectrum by limiting the power output of unlicensed transmitters. For longer range applications, we recommend licensed narrow-band versions of the RFM96W that are permitted to operate with higher output powers.

Modes of Operation

The RFM96W Spread Spectrum offers two modes of operation that define the DTE-DCE interface. Each of these modes have three protocols that define the over-the-air communication parameters. The two modes of operation are point-to-point and multidrop.

Point to point

This mode is used to closely approximate a standard wired connection between two serial devices (such as a computer and a printer.) The RFM96W Spread Spectrum operates transparently with full-duplex communication. Address fields are used to determine the source and recipient of the data in point-to-point mode. See Configuring the Radio Modem section for a description of the over-the-air communication parameters that are available in this mode.

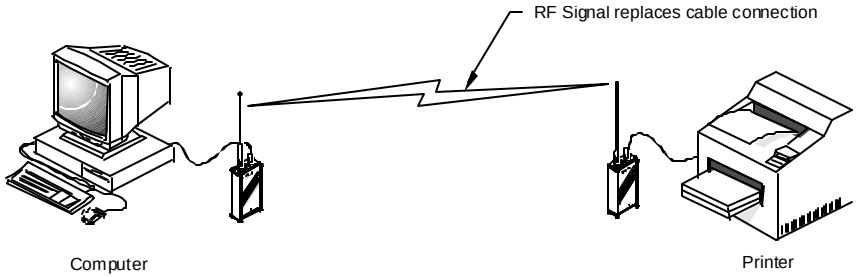

Figure 4 - Point-to-point application

Multidrop

This mode is used to allow several RFM96W Spread Spectrum radio modems to communicate in a polled-response network configuration. In traditional multidrop environments, one or more devices are used to send information to a master device, usually in response to a poll from the master. The master device synchronizes the timing of the slave devices and enables all the units to communicate with each other. Most GPS and SCADA applications use multidrop mode to allow flexibility and multiple unit operation. See Configuring the Radio Modem section for a description of the over-the-air communication parameters that are available in this mode.

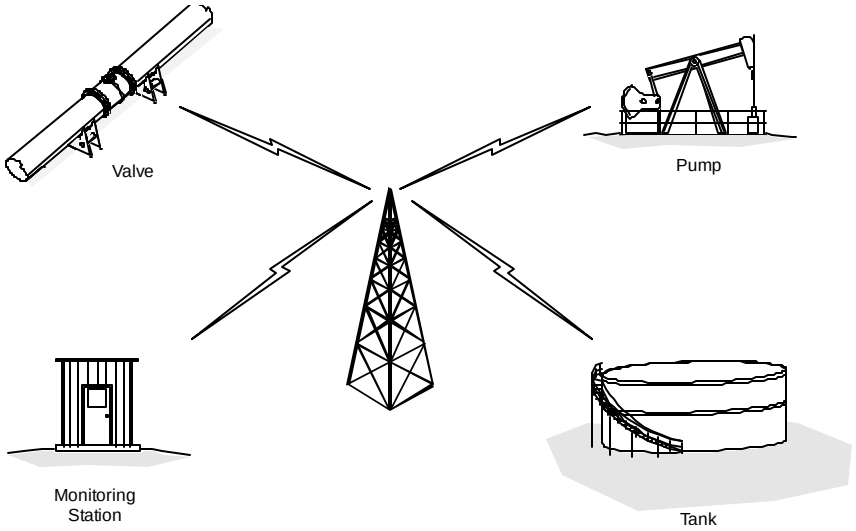

Figure 5 - Multidrop Application

Preparing the Radio Modem for Use

General Considerations

Before connecting the radio modem to your computer or power source, please review this section. Setting up the radio modem for best performance requires a basic understanding of radio fundamentals covered in the last section.

Connecting the Antenna

A flexible 1/2 wave rubber duck antenna is supplied with the RFM96W Spread Spectrum. The antenna is equipped with a reverse TNC style connector. The TNC screws onto the connector on the RFM96W Spread Spectrum.

Caution: The FCC regulates the types of antennas and their associated gains for use in the 900 MHz ISM band. Only use antennas that are designed specifically for the RFM96W Spread Spectrum.

Connecting the Data Cable

The RFM96W Spread Spectrum comes with a serial interface cable. The DTE side of the cable is a DE-9 style connector compatible with the 9-pin serial interface on a personal computer. Depending on the interface on your equipment, you may need a serial gender adapter or crossover adapter to make the proper connections.

The plug side of the adapter cable matches the receptacle on the RFM96W Spread Spectrum. The plug is keyed and can only be inserted into the plug with the proper orientation. The adapter cable also provides an SAE style connector for making the power connection.

Connecting Power

The RFM96W Spread Spectrum is powered by an external DC power supply. An AC/DC wall power adapter is supplied with the unit for configuration and table-top operation where power is available. A power cable is provided to help you connect a battery or other power source to the data/power cable for modem operation. The supplied power cable has an in-line fuse for protection against over-voltage or reverse polarity connection.

Caution: Misapplication of power may damage the RFM96W Spread Spectrum. When connecting to an external power supply, verify voltage polarity and level prior to applying power.

All power leads are color-coded. The RED banded lead is to be connected to the positive supply and the BLACK lead is to be connected to ground. Before applying power, check polarity and power supply voltage level.

General Safety Information

The United States Department of Labor, through the provisions of the Occupational Safety and Health Act of 1970 (OSHA), has established an electromagnetic energy safety standard that applies to the use of this equipment. Proper use of this radio will result in exposure below the OSHA limit. The following precautions are recommended:

DO NOT operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.

DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.

All equipment should be serviced only by a Pacific Crest Corporation qualified service center. Do not open the enclosure or attempt to adjust or repair your units.

Configuring the Radio Modem

BEFORE ATTEMPTING COMMUNICATION, YOU MUST ASSIGN ONE MODEM TO BE THE MASTER. ALL OTHERS SHOULD BE SET UP AS SLAVES. PLEASE SEE THE READ-ME-FIRST LITERATURE PACKAGED WITH THIS UNIT FOR HELP IN DOING THIS CONFIGURATION.

The RFMSSCNF Program

The RFM96W Spread Spectrum is configured with a software program called RFMSSCNF that is supplied with the modem. RFMSSCNF runs under Windows 3.1, Windows-95 or Windows-NT. The program allows you to view, edit, and save configuration parameters quickly and efficiently.

An installation utility is provided to install RFMSSCNF on your computer. Insert the supplied floppy diskette into your computer and run the install program. In Windows-96 or Windows-NT, press Start and select Run. In Windows 3.1, from the program manager select File and then Run. Enter in the Open field a:setup (substitute b: for a: if using the b: drive).

At this point, the configuration program will guide you through the operation of setting-up the RFM96W Spread Spectrum. Don't worry about making a mistake - the program allows you to restore the factory default values at any time.

We suggest that you familiarize yourself with the operation of the RFM96W Spread Spectrum using the default settings before attempting other configurations.

Configuration Parameters

This section fully defines the configuration parameters that you can modify with the RFMSSCNF program. Understanding these parameters will allow you to configure your RFM96W Spread Spectrum so that it operates as required by your application.

Baud Rate

Select the baud rate used for communication with the local DTE device. The RFM96W Spread Spectrum supports all common baud rates from 1200 to 19,200. Note that interleaved FEC protocol will not work for full duplex data transfers at 19200 baud. (Factory default is 9600 baud.)

Channel

Sets the channel of operation. 440 channels are available. All units must be set to operate on the same channel. (Factory default is channel 0.)

Local Address

Sets the address of the local unit. In point-to-point applications this address should be unique among all units at a particular site. In multi-drop (factory default) operation, this address should be the same for all units at a particular site. Addresses can be any number from 0 to 16,000. (Factory default is 0.)

Remote Address

The remote address is used in point-to-point applications only. The remote address specifies the address to which information from the local modem will be delivered. Remote address can be any number from 0 to 16,000. (Factory default is 256.)

Protocol

Three protocols are supported in each of the two operating modes - point-to-point and multidrop. In all cases, the protocol chosen must be programmed into all units at a particular site.

Point-to-point Operating Mode

Protocol	Description
ARQ	In this protocol, a 16-bit CRC is sent with the data and verified by the receiving modem. If the 16-bit CRC does not match, then the transmitting modem automatically retransmits the data. Because the retransmitted data is sent on the next hop, a different frequency is used. This reduces the impact of interference from a narrow-band source.
FEC Low Latency	FEC low latency minimizes the period of time between the receipt of data by the transmitting modem and the delivery of the data to the DTE connected to the receiving modem. Low latency FEC provides moderate data correction, but does not correct across frequency hops.
FEC Interleaved	FEC interleaved makes best use of the error correction technology that allows data from a completely jammed hop to be reconstructed in the receiving modem. Note that FEC interleaved is not available for full-duplex operation at 19,200 baud.

Multidrop Operating Mode

Protocol	Description
Fast Hop	Fast hop reduces data latency but increases the protocol overhead and results in overall lower data throughput. Typical data latency is 7.5 milliseconds. A 1K data transfer takes approximately 0.914 seconds.
Normal Hop	Normal hop is a good compromise between data latency and data throughput. Typical data latency is 25 milliseconds. A 1K data transfer takes approximately 0.582 seconds.
Normal Hop with FEC	Normal hop with FEC includes the ability for the receiver to correct errors in the received data. Typical data latency is 37.5 milliseconds. A 1K data transfer takes approximately 0.640 seconds.

(Factory default is Multidrop mode and Normal Hop with FEC.)

Unit type

The unit type is not used in point-to-point protocols. In multidrop mode, a single master must be designated. The master device controls the synchronization of all data in the network and should be located at a central point. In DGPS applications, the master device should be associated with the GPS base station. (Factory default is Slave.)

Warning: All units shipped from the factory are programmed to Multidrop mode and unit type Slave. Before attempting communication, one unit must be programmed as a Master.

TX timeout

The TX timeout value specifies the amount of time the transmit buffer may remain full before it is reset. If a link is dropped during data transfer, the transmitters buffer will fill up. Once the buffer is full, additional characters will be lost. This parameter provides a safety net allowing the buffer to be automatically cleared and control to be returned to the DTE. (Factory default is 0 - no flow timer.)

Echo

When used with some PC terminal emulation programs, the modem is expected to echo the serial data to the local DTE. Note that echo does not affect communications between the units during data transfer. (Factory default is off.)

Programming the Radio Modem

Programming the radio modem is the action of taking the modifications to the modem configuration that you did using RFMSSCNF and sending them to the radio modem where they are stored for subsequent use. If you have modified the settings, and wish to program the settings into your radio modem, then select Save from the Settings pull-down menu.

Printing your Configuration

You may print the current configuration of the radio modem by selecting Print from the Settings pull-down menu. If you have modified any settings, the print feature will not be available until you program your modem.

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Operating the Radio Modem

Operating Environment

The RFM96W Spread Spectrum is designed for field, mobile or fixed location operation. Care should be taken to assure that the device is operated within the factory specifications.

Shock and Vibration

Normal shock and vibration encountered in mobile/portable use will not affect the RFM96W Spread Spectrum. The tough aluminum enclosure provides protection against damage in most circumstances. Care must be taken, however, against unnecessarily rough handling that could damage the RFM96W Spread Spectrum. The RFM96W Spread Spectrum has been tested and qualified for protection against shock and vibration as per IEC 68-2-55.

Water and Dust

The RFM96W Spread Spectrum is suitable for outdoor and marine applications where protection from the environment is required. The RFM96W Spread Spectrum has been tested and provides protection as per IEC 144/855420 I.P. 66.

Temperature

Temperature should be maintained between the specified limits during operation. Operation of the radio modem beyond either temperature extreme may damage the unit or cause it to be non-compliant with local or federal regulations.

Power Supply

An external DC power source of between 10 and 15 volts capable of supplying sufficient current is required for operation. The radio modem can be directly wired to vehicle power systems that use lead-acid batteries with a nominal DC voltage of 12 volts (negative ground).

Caution: Connection of power that is outside of the recommended voltage range or reverse polarity connection may damage the unit. Always check voltage and polarity prior to applying power to the unit. Damage due to incorrect power connection is not covered under the warranty.

TX Duty Cycle

The RFM96W Spread Spectrum supports 100% duty cycle operation with full-duplex communication.

Service and Support

Philosophy

Pacific Crest Corporation is dedicated to providing the very best service and support possible. We recognize that the success of our business is directly related to the success our customers have in using our products. For this reason, we provide easy access with our toll free number, which we encourage our customers to use if they are experiencing difficulties or problems with the equipment we supply.

Let us know what you think. A cornerstone of our business philosophy is to evolve our product lines to match the needs of our customers. Your input allows us to better determine what we need to do to keep our product and support offerings in alignment with your needs.

Phone/BBS/Internet Support

Phone support is available during our business hours, Monday through Friday (8 a.m. to 5 p.m. Pacific Standard Time). Call 1-800-795-1001 (U.S. and Canada), (408) 653-2070 (International), or (408) 748-9984 (Fax). We have a 24-hour BBS available (9600 baud, no parity, 8 data bits, 1 stop bit) at (408) 748-9954. All software is available on the BBS. You can also contact the support group via the world-wide-web at http://www.paccrst.com or e-mail us at support@paccrst.com.

Service Contracts

We highly recommend that you take advantage of our annual service contracts, where we take responsibility for tuning, maintaining and repairing your RFM96W Spread Spectrum for a nominal annual fee. Call the factory for information on the Service and Extended Warranty agreements for details.

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Warranty

One-Year Limited Warranty

This warranty gives you specific legal rights. You may also have other rights which vary from state to state or province to province.

Pacific Crest Corporation warrants its radio modem products against defects in materials and workmanship for a period of one year from receipt by the end user. During the warranty period, Pacific Crest Corporation will, at its option, either repair or replace products that prove to be defective.

Exclusions

Should Pacific Crest Corporation be unable to repair or replace the product within a reasonable amount of time, a refund of purchase price may be given upon return of the product.

The warranty on your RFM96W Spread Spectrum radio modem shall not apply to defects resulting from:

- Improper or inadequate maintenance by the customer
- Unauthorized modification or misuse
- Operation outside of the environmental specifications for the product
- Negligence or misuse

Warranty Limitations

The warranty set forth above is exclusive and no other warranty, whether written or oral, is expressed or implied. Pacific Crest Corporation specifically disclaims the implied warranties of merchantability and fitness for a particular purpose.

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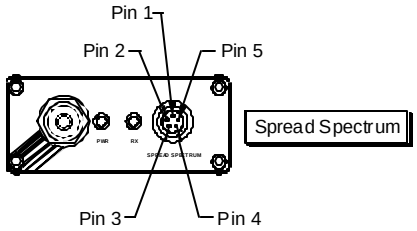
Appendix A - Cables and Connectors

RFM96W Spread Spectrum Data and Power Connectors

The RFM96W Spread Spectrum uses sealed circular connectors for the data and power ports. The connectors are manufactured by LEMO and distributed in the U.S. by LEMO U.S.A. (1-800-444-LEMO). A B-series 5-pin plug is designed to mate with the data/power receptacle of the RFM96W Spread Spectrum, use LEMO P/N FGG0B305CNAD52, See Figure A2 for pin-out information on the power and data ports of the RFM96W Spread Spectrum.

Power connection is made with an SAE type polarized DC power connector, commonly available at automotive supply outlets.



Pin #	Function
1	Power
2	Ground
3	RX Data (to DTE)
4	Signal Ground
5	TX Data (from DTE)

Figure A2 - RFM96W Spread Spectrum Data and Power Connectors

DCE-DCE Interface

On occasion, it will be necessary to connect an instrument configured as a DCE to the radio modem (also a DCE). In order to make this connection, a crossover adapter can be used. Because the RFM96W Spread Spectrum radio modem uses a simple 3-wire interface, the crossover adapter swaps the transmit and receive signals found on pins 2 and 3 of a standard serial port. Crossover adapters are available at most computer supply stores, and can be purchased directly from Pacific Crest Corporation.

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Appendix B - Mounting Instructions

Mounting Brackets (Optional)

Mounting brackets allow the mounting of the RFM96W Spread Spectrum onto any flat surface. Figure B1 provides mounting dimensions and placement.

Caution: Mounting the RFM96W Spread Spectrum on a surface subject to vibration may degrade the performance of the radio modem due to electromechanical interference.

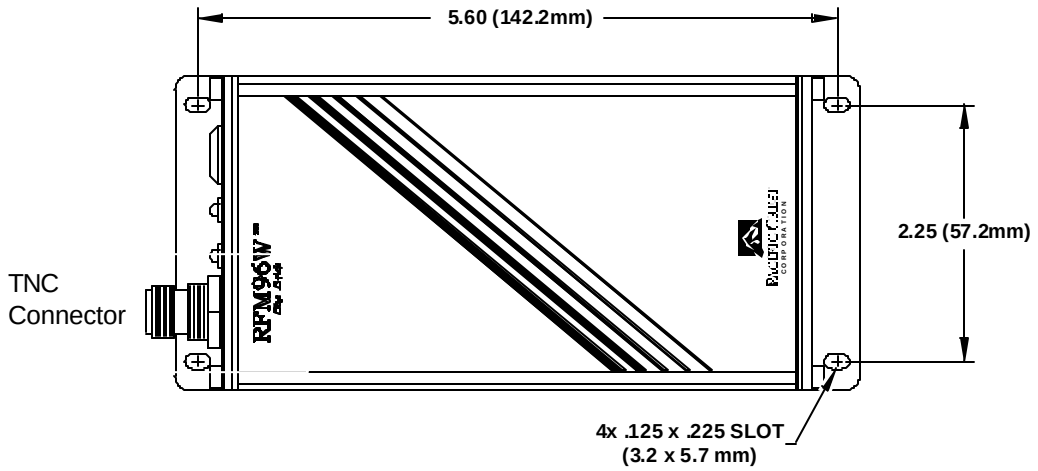

Figure B1 - Mounting hole dimensions

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Appendix C - ASCII Table

DEC	HEX	SYM	DEC	HEX	SYM	DEC	HEX	SYM
0	00	NUL	43	2B	+	86	56	V
1	01	SOH	44	2C	,	87	57	W
2	02	STX	45	2D	-	88	58	X
3	03	ETX	46	2E	.	89	59	Y
4	04	EOT	47	2F	/	90	5A	Z
5	05	ENQ	48	30	0	91	5B	[
6	06	ACL	49	31	1	92	5C	\
7	07	BEL	50	32	2	93	5D	]
8	08	BS	51	33	3	94	5E	^
9	09	HT	52	34	4	95	5F	_
10	0A	LF	53	35	5	96	60	`
11	0B	FT	54	36	6	97	61	a
12	0C	FF	55	37	7	98	62	b
13	0D	CR	56	38	8	99	63	c
14	0E	SO	57	39	9	100	64	d
15	0F	SI	58	3A	:	101	65	e
16	10	DLE	59	3B	;	102	66	f
17	11	DC1	60	3C	<	103	67	g
18	12	DC2	61	3D	=	104	68	h
19	13	DC3	62	3E	>	105	69	i
20	14	DC4	63	3F	?	106	6A	j
21	15	NAK	64	40	@	107	6B	k
22	16	SYN	65	41	A	108	6C	l
23	17	ETB	66	42	B	109	6D	m
24	18	CAN	67	43	C	110	6E	n
25	19	EM	68	44	D	111	6F	o
26	1A	SUB	69	45	E	112	70	p
27	1B	ESC	70	46	F	113	71	q
28	1C	FS	71	47	G	114	72	r
29	1D	GS	72	48	H	115	73	s
30	1E	RS	73	49	I	116	74	t
31	1F	US	74	4A	J	117	75	u
32	20	SP	75	4B	K	118	76	v
33	21	!	76	4C	L	119	77	w
34	22	“	77	4D	M	120	78	x
35	23	#	78	4E	N	121	79	y
36	24	$	79	4F	O	122	7A	z
37	25	%	80	50	P	123	7B	{
38	26	&	81	51	Q	124	7C	|
39	27	‘	82	52	R	125	7D	}

40	28	(	83	53	S	126	7E	~
41	29	)	84	54	T	127	7F	DEL
42	2A	*	85	55	U			

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Appendix D - Technical Specifications

General

Interface

RS-232 compatible interface configurable for 1200 to 19,200 baud operation with 1 start, 8 data, and one stop bit.

Power Supply

Power supplied externally through the power ports. Power supply range is 9-26 VDC. Power consumption during transmission is 3.8 Watts, during reception 0.5 Watts.

Radio

Frequency Ranges

902-928 MHz.

Spread Spectrum Method

Frequency hopping.

Modulation Rate

37.5 kbps

Transmitter

Carrier power 1-Watt

Receiver

Sensitivity -105 dBm. Dynamic range 95 dB. Image and spurious rejection > 70 dB. Adjacent channel rejection 40 dB at 100 kHz offset.

Modem

DTE Modes

Point-to-point (PTP) and Multidrop (MD).

Transmission Protocols

PTP ARQ, PTP FEC with low latency, PTP FEC interleaved (not available at 19,200 baud rate). MD fast hop rate, MD normal hop rate, and MD normal hop rate with FEC.

Environmental

Size

2.75" W x 1.15" H x 5.26" L (7.0cm x 2.9cm x 13.4cm)

Weight

11 ounces (0.32 kg)

Shock and Vibration

Per IEC 68-2-55.

Enclosure Protection

Per IEC 144/855420 I.P. 66 Dust tight and watertight (RFM96W Spread Spectrum only)

Temperature Range

-22° to 140° F (-30° to 60° C) Operating
-67° to 185° F (-55° to 85° C) Non-operating