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Ewave Radio Modem Technical Manual

Version 1.02

Ewave Radio Modems covered in this manual:

SuperSCREAMER
BaseWAVE
SCREAMER 422
STAMPER

1 Overview

The Ewave family of wireless radio-frequency data modems are designed for systems requiring the full-duplex transmission and reception of wireless data. All Ewave family members are based on the RF10K™ core. The RF10K™ core uses our 900 MHz full-duplex transceiver, coupled with our proprietary dual RISC processor modulation/demodulation engine. Ewave Radio Modems are available in several supply voltages and support standard serial interfaces using RS232, RS422, or TTL voltage levels. An Ewave Radio Modem can be used in any application where a wireless data link is needed -- the full duplex design allows the modem to be a drop-in replacement for an existing wired serial link. The Ewave Radio Modem's low power requirements also makes it an ideal solution for battery-powered applications.

Features of the Ewave Radio Modem:

- FCC certified; no user license required.
- Full duplex, allowing simultaneous transmission and reception of data.
- Programmable baud rates, up to 38.4K.
- 9600 bps sustained data throughput (higher data rate available if transparent 16-bit CRC is disabled).
- Up to 40 channels, software selectable.
- Transparent, simple operation: Looks like a serial cable to your application.
- Transparent protection from errors and interference via 16-bit CRC (Cyclic Redundancy Code; optional).
- High data reliability via transparent, automatic Retry/Acknowledge (optional).
- Dynamic packetization of data, providing low latency while maintaining high throughput.
- Packetization configurable via software parameters: Maximum Packet-Size Threshold and Next-Byte Wait Time.
- Commands may be sent on-the-fly (e.g., Transmit Power On/Off, Channel) or modem may be configured once and "locked" in the Data state for maximum transparency to your application.
- Fully integrated antenna.
- Operation from regulated 5V or unregulated ~7.2-10VDC (in which case the modem can supply 5V to another device). 3.3V also available – see Ordering Information at end of document.
- Non-volatile storage of user parameters (e.g., Channel, Baud Rate).
- Status LEDs indicating Transmit and Receive Activity, Transmitter Power On/Off and Command/Data Mode.
- Support for RS232 "Break" conditions and RTS/CTS control signals.

Ewave Radio Modems are available in the following configurations:

- Data Interface:
  - RS232
  - RS422
  - TTL
- Protocol Support:
  - Normal transparent data mode (fastest data throughput)
  - High-reliability mode with CRC and automatic retry/acknowledgement
  - Parallax PBASIC mode (for remote-debugging/remote-download with Parallax's Basic Stamp)
  - RM2000 mode (for use with Innovation First Robot Controller System; see http://www.innovationfirst.com)

- An Enhanced Modem is also available which includes all the above Protocol features *in one Modem*, and allows software feature selection on-the-fly.
- Supply Voltage:
  - +5VDC supply voltage (3.3VDC also available) 140mA.
  - +7.2-10VDC supply voltage (unregulated) 140mA.
- Packaging:
  - Industrial-strength ABS case
  - OEM module (without case)

2 Installation

There are no special installation requirements for the Ewave Radio Modems, however, for best performance, the modems' antennae should be oriented parallel to each other and perpendicular to the ground.

Please refer to Ewave's On-line Support Center at http://www.electrowave.com/support.shtml for help with installation or troubleshooting problems.

3 Theory of Operation

3.1 Anatomy of an Ewave Radio Modem

The picture below shows one of the two types of Ewave packet radio modems, which are arbitrarily referred to as *Mobile* (short flexible black antenna) and *Base* (longer swiveling chrome antenna). The "Mobile" or "Base" units are interchangeable -- in any system either or both units can be fixed or portable (though the Mobile's short flexible antenna lends itself to portable use). However, it is important to note that a Mobile unit will not communicate directly with another Mobile and likewise a Base unit will not communicate directly with another Base. This is a necessary consequence of the fact that the modems are *full-duplex* (meaning data may be transmitted and received simultaneously): To allow full-duplex operation, the Base and Mobile units contain matched pairs of the Ewave RF transceiver module which are optimized to transmit on a different range of frequencies (e.g., the Base units transmit on 926-928 MHz while the Mobile units transmit on 902-904 MHz. The exact frequencies for each channel are listed in the appendix.)

Note that it is possible to implement various "multi-drop" or "multi-node networks" schemes with the Ewave Radio Modems – a single modem of one type communicating with several of the opposite type. For example, this can be done through on-the-fly control of Transmit Power.

The picture at left shows a Mobile Ewave Radio Modem unit.

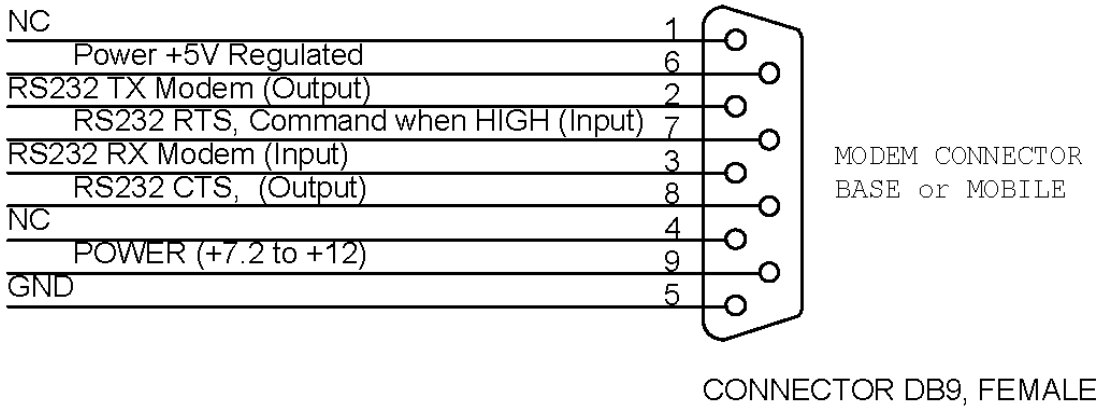
The DB9 connector supplies standard RS232 or RS422 signals.

5V 140mA regulated power may also be supplied via the DB9, or the modem may be powered by unregulated DC (7.2-10V, 140mA) supplied via the side plug. If this is done, regulated 5V will be available via the DB9 and may be used to power an external 5 Volt device.

3.2 Connector Pin-outs

There are two different pin-outs for the Ewave Radio Modems. The pin out for the SuperScreamer, BaseWave and Stamper is as follows:

The pin-out for the modem's RS232 DB9 connector (either model, Base or Mobile) is as follows:



Both the Base and Mobile types of Ewave Radio Modems configured for RS232 have Female DB9 connectors. This allows direct connection to a standard PC DB9 serial port via a straight-thru cable. When connecting the Ewave Radio Modem to a PC-peripheral device (e.g., a mouse, trackball, digitizer) as a drop-in wire replacement, a gender-changer and null-modem is usually required.

Please consult our web site www.electrowave.com for the pin out for the SCREAMER 422.

3.3 LEDs

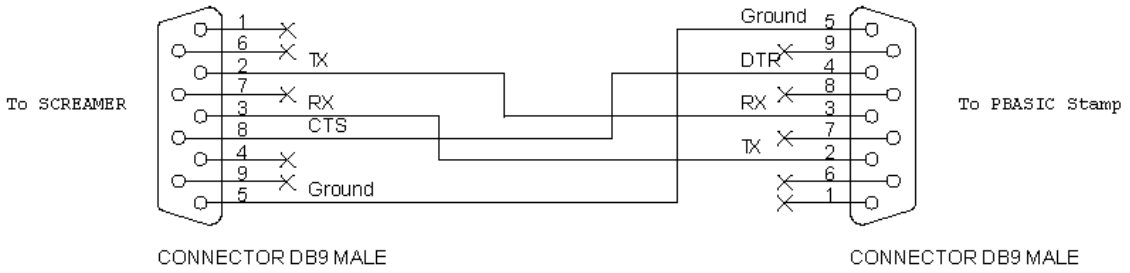
The table below summarizes the meaning of the Ewave Radio Modem's LEDs:

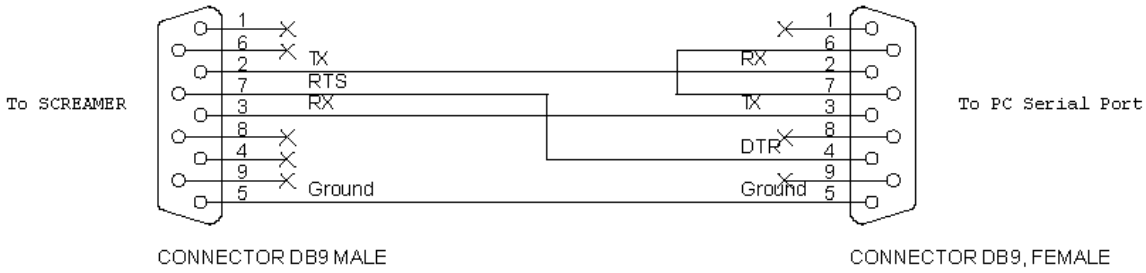
What it means…	*Status LED*	*Transmit LED*	*Receive LED*
Modem is in Command state	Rapid Blink *	---	---
TX Power is On	---	ON	
TX Power is Off, Modem in command state	Rapid Blink *	OFF	
TX Power is Off, Modem in data state	ON	OFF	---
Modem is Actively Transmitting Data	OFF	FLASHING	---
Modem is Actively Receiving Data	---	---	FLASHING
California Brownout	OFF	OFF	OFF

* Rapid blink indication added for code version V1.39 or higher. Older versions LED is on solid.

3.4 Connection to Parallax Basic Stamp for Remote-Debugging & Remote-Programming

In addition to providing a standard wireless link, the Ewave's Stamper and SuperSCREAMER versions of the Radio Modems may be used for remote-programming/remote-debugging of the Parallax Basic Stamp Processors.
The diagram below shows how the two Ewave Radio Modems should be connected between the PC and the PBASIC part:





3.5 Characteristics of Packet Radio Communication

The Ewave packet radio modem has been designed to be a transparent, drop-in replacement for a serial connection, and employs a number of automatic optimizations for this purpose. Nevertheless, a basic understanding of the underlying characteristics of radio packet communication will help the application developer:

- properly configure the Ewave Radio Modem for optimal performance in a particular application;
- rapidly diagnose problems; and
- improve the design of future applications for maximum performance or reliability within the limits of radio communication imposed by Nature.

The Ewave Radio Modem provides a ***"****full-duplex"* communications channel (meaning data may flow in either direction simultaneously) for 8-bit asynchronous serial data. In comparison to a hard-wired connection, there are several important issues to be aware of when using the Ewave Radio Modems: Latency, bandwidth, and errors.

3.5.1 Latency

Latency (or delay) is the time between an action and a response – e.g., the time between when a byte is sent and when it is received by the other modem. With a hard-wired electrical connection, the latency is very small (i.e., close to the speed of light.) With a Radio Modem latency is much greater for several reasons:

- A packet modem will typically transmit a "pre-amble" signal before transmitting the actual data, to allow the receiver to synchronize to the data stream (or re-synchronize after an error). The length of this "pre-amble" sets a lower limit on the delay between outputting a byte to the transmitter and that same byte being output by the receiving modem.
- A packet modem will also typically attempt to transmit multiple bytes together as a unit, following a single "pre-amble". This is more efficient than generating a pre-amble for *each* data byte – in

fact, as the number of data bytes per packet increases, the time devoted to the pre-amble becomes less significant, and overall efficiency increases. While this efficiency may not matter in some applications (e.g., a sensor transmitting a few bytes once per second), it sets an upper limit on the bandwidth of the channel and therefore is very important in some applications. So, a modem may attempt to transmit "large" packet sizes – but this means the transmitting modem may need to queue the first few data bytes until it has received a full packet's worth of data instead of beginning to transmit immediately. This adds to the latency on top of that due to the length of the "pre-amble".

- Finally, the internal design of the packet modem may add additional latency as data bytes are moved from one internal FIFO to another. A quality packet modem, such as the Ewave Radio Modem, will attempt to overlap or "pipeline" as many of these internal operations as possible to minimize latency.

3.5.2 Bandwidth

Bandwidth is the rate of data bits transferred per unit time (e.g., bits per second). Typically, a radio modem imposes a certain overhead due to the necessity of transmitting a "pre-amble" for synchronization, command or "framing" bytes used to encode the data in packets, error checking codes or checksums for error detection and/or correction, etc. Also, features such as retry/acknowledge (which may be enabled on some Ewave Radio Modem models), while improving reliability, reduce the effective bandwidth when errors or interference are present – because the modem must use some bandwidth to re-transmit already-sent data or to transmit acknowledgements. In order to provide 9600 bps of data throughput, a radio modem will typically transfer data "over-the-air" at a higher rate to compensate for the aforementioned overhead. The Ewave Radio Modem transfers data "over-the-air" at approximately 10,000 bits / second.

3.5.3 Errors

Errors and interference are much more common in a wireless communications system compared to a wired one. The effect of this is to increase latency and decrease bandwidth. For instance, if the Ewave Radio Modem is programmed for automatic retry/acknowledge of data, a sufficient level of radio interference may in effect increase the latency to infinity and decrease the bandwidth to zero. This is unavoidable, and depending on the environment may even be common, so applications should be designed with appropriate fail-safes, error checking and user-feedback.

3.6 Fine-Tuning the Ewave Radio Modem for your Application

This section discusses the features of the Ewave Radio Modem which may be used to fine-tune the modem to your application.

3.6.1 CRCs – Protection from Interference

CRC's (Cyclic Redundancy Codes) are a widely-used mechanism for detecting errors in communication systems. Some Ewave Radio Modem models include automatic, transparent CRC generation and checking. Without this feature, the Radio Modem may interpret random radio interference as valid received data – which can confuse your application if it does not implement its own error checking. With this feature, the Ewave Radio Modem automatically filters out radio interference. The corrupted packets will be silently discarded. In many applications this is acceptable, but if it is not, the application may either implement its own retry scheme or use the Ewave Radio Modem's transparent Retry/Acknowledge (if the particular Ewave Radio Modem model includes this feature.)

3.6.2 Packet Size Threshold

The packet size threshold parameter determines the number of bytes the Radio Modem will attempt to assemble into a "packet." Some applications tend to send fixed sized blocks of data and are sensitive to the time between bytes within a single application-defined block. This parameter allows the application

developer to tell the Ewave Radio Modem what size data blocks to expect so that the modem may packetize them as a unit and deliver them at the receiver with minimal and consistent delay between bytes.

For maximum throughput, the largest possible packet size threshold should be selected.

The Ewave Radio Modem also implements a partial packet timeout to automatically re-synchronize with the application's data block boundaries – if the packet size threshold is not reached within the Wait Time (discussed below), the modem will transmit a smaller packet.

3.6.3 Wait Time before Transmittal

The Wait Time before Transmittal parameter determines how long the Ewave Radio Modem will wait for the next byte before packetizing and transmitting the current data in its queue. This allows the application developer to adjust the modem to the timing characteristics of the application.

This parameter should be set to zero to minimize latency – in this case, the Ewave Radio Modem will begin transmitting as soon as a single byte is sent to the modem.

3.6.4 Retry/Acknowledge

The Ewave Radio Modems can implement an automatic Retry / Acknowledge scheme which is transparent to the application. This, combined with CRCs for error detection, greatly improves the reliability of data transfer without requiring any changes to the application. However, note that in this mode, depending on the level of interference, data may be delayed for arbitrarily long times. Applications which implement their own protocol time-outs may need to be modified.

If the Ewave Radio Modem model implements Retries, each data packet will be automatically re-transmitted until either an Acknowledgement packet is received from the other modem, or until the application sends additional data to the transmitting modem, in which case the modem will give up re-transmitting the old data and begin (re-)transmitting the new data in the same way.

The Ewave Radio Modem guards against duplication of data packets – from the application's point-of-view, any data sent will be output from the other modem at most once.

3.7 Ewave Radio Modem Protocol Configurations

Ewave Radio Modems are available optimized for several different application protocols and characteristics. Alternately, the Enhanced SuperSCREAMER™ is available which includes support for all protocol features and allows the user to dynamically re-configure the modem on-the-fly.

The standard protocol configurations are:

Configuration Name	*Description*	*Packet Size Threshold (bytes)?*	*Wait before Transmittal (millisec.)?*	*CRC ?*	*Retry ?*	*Typical Use*
"Fast"	Maximum Data Throughput with Minimum Latency	1	0	OFF	OFF	
"Checksum"	High Reliability	set by user	set by user	ON	user	
"Break"	High Reliability with RS232 "Break" and RTS/CTS Signalling	set by user	set by user	ON	ON	Remote Debugging & Remote Download of Parallax Basic Stamps
"RM2000"	Fixed-Length Packets with CRC but no Retries	26 (fixed size)	complete packet	OFF	OFF	Robot Control & Telemetry

3.8 Command state vs. Data state

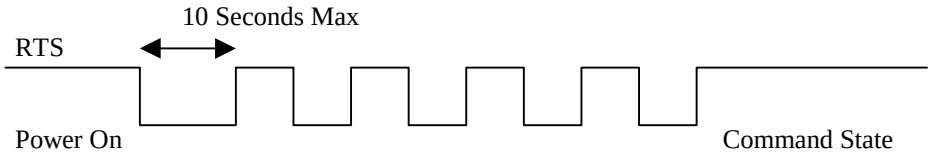
Normally the Ewave Radio Modem is in the *Data state*, in which all bytes sent to the modem via its serial port are treated as user data and transmitted.

Depending on the configuration of the Ewave Radio Modem, it may also be possible to place the modem in *Command state*. In this state, bytes sent to the modem via its serial port are interpreted as commands, allowing on-the-fly reconfiguration of some or all modem settings and saving of modified settings in EEPROM. The settings, which may be changed, depend on the protocol configuration of the Ewave Radio Modem. The default factory Baud Rate is set to 9600 N81.

Whenever the modem enters Command state, or whenever the modem processes a valid Command, it sends a response of "OK" followed by a <CR><LF>. While in command state, Radio Data reception is disabled. Invalid commands result in a response of "ER"<CR><LF>.

Depending on the type of Radio Modem, different commands are available to the end user.

Exactly how or if Command state can be accessed depends on the modem's protocol configuration and the setting of the Attention flag. If the Attention flag is OFF, then regardless of protocol configuration the modem can only enter Command state immediately after power is applied. The modem must be powered-up with RTS asserted, and then RTS must be toggled five times with less then 10 seconds between toggles. See diagram below:



If any bytes are received on the modem's serial port during this toggling sequence, the modem will immediately enter Data state (the received byte will be lost). To re-enter Command state, the modem must once again be power cycled, with RTS asserted and the toggling sequence repeated.

For "Break"-configured modems with Attention ON, to enter Command state, apply power to the modem with RTS asserted, then send a single byte to the serial port. The modem will enter Command state and interpret the bytes received on the serial port as commands until RTS is de-asserted.

For all other configurations of modems with Attention ON, Command state may be entered by simply asserting RTS. De-asserting RTS returns the modem to Data mode, and Command state may be re-entered any number of times by re-asserting RTS.

3.9 The SuperSCREAMER™ with Dynamic Protocol Support

Regular Ewave Radio Modems are pre-programmed at the factory with firmware specific to their expected use.

The Enhanced SuperSCREAMER includes support for all protocol capabilities in one unit, and may be dynamically re-configured by the user. This is done using the MODE command (described below) which is only available with the Enhanced SuperSCREAMER model.

4 Commands

This section describes the format of all Ewave Radio Modem commands. It assumes the modem has already been placed in Command state as described above.

Commands consist of a single "command byte", all of which are printable ASCII characters, followed by zero or more "argument bytes". In most cases, the argument bytes are also printable ASCII (for instance, channel #'s are offset by 0x30 hexadecimal to make them printable), however in some cases this is not possible because all 256 values are needed. All bytes which are not valid commands result in an "ER" response from the modem.

The modem will respond with either "OK"<CR><LF> or "ER"<CR><LF> when it processes a command.

All commands except the "D**x**" commands which update EEPROM should execute within 5 milliseconds plus whatever time is required to transfer any response (in the case of the QUERY commands), which varies depending on the current modem baud rate setting. The "D**x**" commands should execute within 25 milliseconds.

4.1 QUERY SETTINGS

Send:	
?	Modem responds with a human-readable summary of its current settings. Every line ends with a <CR><LF> and the entire output is terminated with a final "OK"<CR><LF> to acknowledge the "?" command.

Example:

(user sends command… Note: no line-terminator is needed.)

```
?
```

(modem responds…)

```
www.electrowave.com, Ewave Inc.<CR><LF>
Ver 1.33<CR><LF>
Mobl<CR><LF>
TX Power ON<CR><LF>
Attention OFF<CR><LF>
Retry ON<CR><LF>
Break Mode<CR><LF>
0x16 (F) Channel List<CR><LF>
0x00 (0) Packet Size<CR><LF>
0x30 Wait Time<CR><LF>
OK<CR><LF>
```

4.2 QUERY VERSION

Send:	
V	Modem responds with its firmware version number.

Example:

(user sends command… Note: no line-terminator is needed.)

```
V
```

(modem responds…)

```
Ver 1.33<CR><LF>
OK<CR><LF>
```


4.3 QUERY STATION TYPE

Send:	
S?	Modem responds with its station type, either "**Base**" or "**Mobl**", followed by a <CR><LF>.

Example:

(user sends command… Note: no line-terminator is needed.)
S?
(modem responds…)
Mobl<CR><LF>
OK<CR><LF>

4.4 SET MODE OF MODEM (SuperSCREAMER Only)

Send:	
Mf	"Fast" mode, used for normal wireless link. Auto packetizes data, with dynamic packet sizes. "Fast" mode is used when the highest speed data link possible is required. Data packets are sent without internal checksums. The maximum data throughput of the modem when it is in fast mode is 1035 bytes/second.
Mc	"Checksum" mode, adds an 16 bit CRC to packets. Packets with invalid CRC are discarded. "Checksum" mode adds an internal CRC (cyclic redundancy code) to each data packet. The receiving modem rejects packets with invalid CRCs. The maximum data throughput when using Checksum mode is 964 bytes/second.
Mb	"Break" mode. Used with Parallax parts, generates RS232 Break and RTS to CTS outputs. Break mode is used in applications that need to be able to send a serial Break signal, and also send and receive RTS/CTS hardware handshake signals. This mode is useful when using the Radio Modem to program and debug the Parallax PBASIC products.
Mr	RM2000 mode, used for the FIRST COMPETITION ROBOT "RM2000" mode uses fixed-length datagrams to get maximum data throughput. In this mode the data packets must follow a specific format. This mode is currently used for the data link with the Innovation First Robotics Controller. The maximum data throughput in this mode is 1071 bytes/second.

4.5 ATTENTION ON/OFF

Send:	
An	Set Attention On; modem responds to RTS-assertion by entering Command state.
Af	Set Attention Off; modem ignores RTS-assertion and treats RTS as a data signal. Command state may only be entered at power-up.

4.6 TX POWER ON/OFF

Send:	
Tn	Transmitter Power On.
Tf	Transmitter Power Off. Radio Modem can still receive incoming radio packets while Tx Power is Off.

4.7 RETRY ON/OFF

Send:	
Rn	Retry/Ack. On; The modem will automatically re-send the data packet until it is acknowledged by the other modem. If new data is sent to the modem before the current data packet has been acknowledged, the retry-attempt is aborted and the new data is processed.
Rf	Retry/Ack. Off; Each data packet is transmitted exactly once.

4.8 SET CHANNEL

Send:	
C**x**, where **x** is [0x31-0x58]	Sets the current channel to (**x** – 0x30.)

While the modem is capable of using 40 channels, only 5 channels are available to the user in the standard modems:

Channel # (1-40)	Channel # (in hex.)	Channel Command	Channel Char. in Decimal	Channel Char. in Hex
4	0x04	C4	52	0x34
13	0x0D	C=	61	0x3D
22	0x16	CF	70	0x46
31	0x1F	CO *("See-letter-Oh")*	79	0x4F
40	0x28	CX	88	0x58

Both modems must be on the same channel to communicate.

4.9 SET PACKET SIZE THRESHOLD

Send:	
P**x**, where **x** is [0x31-0x58]	Set the size threshold for data packets. How this parameter is interpreted depends on the modem's protocol configuration.

For "RM2000"-configured modems, (which uses fixed-length data packets), this parameter sets the length of the data packets. In this case, **x** is 48 + the desired fixed-length packet size. Example: For a fixed-length packet size of 20 bytes, **x** would be 48 + 20 = 68, which in ASCII is "D". Therefore the command "PD" will set the fixed-length packet size to 20 bytes.

For "Checksum"- or "Break"-configured modem's, (which send variable-sized data packets), this parameter sets the **maximum** length – once this length is reached (or the Wait Time is exceeded) the packet is transmitted. In this case, **x** is interpreted as a Boolean-mask as follows:

Desired Packet Size Threshold (in bytes)	Value of **x** (hex)	Value of **x** (decimal)	Command to send
1	0x4F	79	PO (letter Oh)
2	0x4E	78	PN
4	0x4C	76	PL
8	0x48	72	PH
16	0x40	64	P@
32 (internal FIFO limits this to 29)	0x30	48	P0 (numeral zero)

In nearly all circumstances the user will want to set the Packet Size Threshold to the maximum value (e.g., 29, via the command "P0").

4.10 SET WAIT-TIME BEFORE TRANSMITTAL

Send:	
W**x**, where **x** is [0x00-0xFF]	Sets the Wait Time before Transmittal in 0.10 millisecond increments. If the modem does not receive another byte within this time, the modem will packetize and transmit the currently queued bytes.

NOTE: Unlike most other commands, the argument **x** to the Wait Time command is NOT offset by 0x30, because all 256 possible values are valid wait times.

Example: If the modem's serial port is set to 9600 baud then it takes about 1.04 ms for a byte to be shifted into the modem's serial port. If the delay between bytes (being sent to the modem's serial port) is 5 ms, then setting a Wait Time greater than 5.0 ms + 1.04ms = 6.04 ms will result in these bytes being grouped together into maximally sized packets. Conversely, if the inter-byte delay is greater than this value, the modem will attempt to send each byte as a single packet.

4.11 SAVE DEFAULT SETTINGS TO EEPROM

Send:	
Ds	Save current settings as User Default.
Dr	Reload Factory Default as current settings, and save as new User Default.

4.12 SET BAUD RATE

Send:	
B2	2400 bps
B4	4800 bps
B9	9600 bps (Factory Default baud Rate)
B1 ("*Bee-Numeral-one*")	19200 bps
Bl**x** ("*Bee-Ell-***x**")	low speed, take "byte" **x** and save in the PIC SPBRG register, allows non-standard baud rates
Bh**x** *("Bee-Aitch-**x**")*	high speed, take "byte" **x** and save in the PIC SPBRG register, allows non-standard baud rates

5 Specifications

Voltage (V):	5.0 regulated, ***OR*** 7.2-10 unregulated	
Current (A)	140 mA TX power on	
Current (A)	100 mA TX Power off	
Sustained Data Rate:	9600 baud or 1071 bytes/sec	
Burst Data Rate:	38.4 K baud	
Channels:	1 to 40, depending on version	
Channel Spacing:	50 kHz	
Range:	300 feet typical	
Output Power:	50,000 uVolts/meter at 3 feet max.	
Frequency (MHz):	**Base**	**Mobile**
Tx	926-928	902-904
Rx	902-904	926-928
Modulation:	+/- 8.0kHz	
Temperature:	50-110 °F	

6 Transmit Frequencies

Channel #	Mobile (Short Ant)	Base (Long Ant)
	TX Freq (MHz)	TX Freq (MHz)
1	902.079	925.991
2	902.129	926.041
3	902.179	926.092
4	902.230	926.142
5	902.280	926.192
6	902.330	926.242
7	902.380	926.293
8	902.431	926.343
9	902.481	926.393
10	902.531	926.443
11	902.581	926.493
12	902.632	926.544
13	902.682	926.594
14	902.732	926.644
15	902.782	926.694
16	902.833	926.745
17	902.883	926.795
18	902.933	926.845
19	902.983	926.895
20	903.033	926.946
21	903.084	926.996
22	903.134	927.046
23	903.184	927.096
24	903.234	927.147
25	903.285	927.197
26	903.335	927.247
27	903.385	927.297
28	903.435	927.347
29	903.486	927.398
30	903.536	927.448
31	903.586	927.498
32	903.636	927.548
33	903.687	927.599
34	903.737	927.649
35	903.787	927.699
36	903.837	927.749
37	903.887	927.800
38	903.938	927.850
39	903.988	927.900
40	904.038	927.950

7 Ordering Information

Please consult our web site the latest pricing and ordering information:

http://www.electrowave.com/

8 OEM Options

Should our standard Ewave Radio Modem product line does not fit your needs, Ewave, Inc. can provide custom OEM solutions. We have the design capabilities to do unique board layouts, features and packaging.

Contact us at (972) 248-2931 or email oem@electrowave.com. We will be happy to discuss your design needs and provide a price quote.

9 Revision History

February 11, 2001 – M. Shepard -- Initial revision.
May 18, 2001-- PSA – Release V1.01
August 3, 2001 – MNS – Release V1.02: three typos

