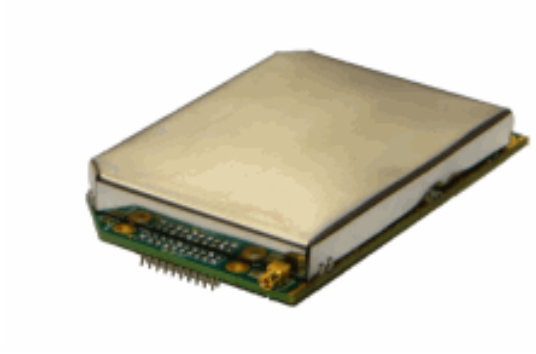
RV-M8S

Data/Paging Radio Modem
Technical Manual

Version B6

May 2014



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1. General Information about the RV-M8

1.1. Congratulations!

Congratulations on your purchase of an *M8S* OEM radio modem – the most advanced radio modem of its kind available today.

Please take a few minutes to read this manual carefully. The information presented here will allow you to derive maximum performance from your radio modem. After reading it, keep the manual handy for quick reference, in case questions arise later on.

1.2. NOTICE

There are no user-serviceable points inside this transceiver. All service work must be referred to your Authorized Service Center or Raveon Technologies Service Department.

IMPORTANT NOTICE !

Because of the nature of wireless communication, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors), or be totally lost. Significant delays or losses of data are rare when wireless devices, such as the Viper SC, are used in a normal manner with a well-constructed network.

This radio should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property.

Raveon accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using Viper SC, or for the failure of Viper SC to transmit or receive such data.

1.3. Safety / Warning Information

1> This equipment should be serviced by qualified technicians only.

2> Blasting Caps and Blasting Areas

To avoid possible interference with blasting operations, turn off this radio or remove the DC power when you are near electrical blasting caps, in a blasting area, or in areas posted: "**Turn off two-way radio**." Obey all signs and instructions.

3> ***Potentially Explosive Atmospheres***

Turn off your radio prior to entering any area with a potentially explosive atmosphere. Do not install this product for use in areas with potentially explosive atmospheres. Do not remove, install, or charge batteries in such areas. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death.

Note: The areas with potentially explosive atmospheres referred to above include fueling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles, such as grain, dust or metal powders, and any other area where you would normally be advised to turn off your vehicle engine. Areas with potentially explosive atmospheres are often but not always posted.

4> FCC MPE Regulations

WARNING: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described in this manual.

5> Human body Exposure:

This equipment is approved only for mobile and base station transmitting devices, separation distances of
(i) 36 centimeters or more for antennas with gains of 0 dBi or less or
(ii) 1 meters or more for antennas with gains 0 to 6 dBi should be maintained between the antenna of this device and nearby persons during operation. To ensure compliance, operation at distances closer than this is not recommended.

The preceding statement must be included as a CAUTION statement in manuals for OEM products to alert users on FCC RF Exposure compliance.

1.4. OEM Use

This radio module is for OEM use, and it is the responsibility of the OEM user to notify the end-users of RF and electrical safety issues.

It is the user's responsibility to check his/her FCC license to determine the correct parameters and settings for the channel frequencies, power level, and bandwidth.

It is the responsibility of the OEM implementing this product to ensure the suer is aware of this.

1.5. Part 15 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 and, 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.
- Consult the dealer or an experienced radio/TV technician for help.

2. Overview

The *M8S* RF Paging/Data radio modem is capable of high-speed narrow-band data communications and POCSAG paging decoding. Its powerful microprocessor enables it to perform as both a data radio modem and a paging receiver. It contains a receiver, a transmitter, and modem, creating an easy-to-use transparent data radio link. The *M8S's* user interface is asynchronous digital data into and out of the *M8S.* Modem operation is virtually transparent to the user and the configuration of the modem is via the user serial port.

The M8S can be configured in either a paging decoder mode or a data modem mode. The command-line interface is similar to Raveon's other data radio products, and configuring the mode is very easy. The M8S also has a digital input pin that may be used to electrically change modem types between data modem and paging modes.

The *M8S* is an easy to use and its re-programmability makes it extremely versatile. Most parameters within the modem may be re-configured to optimize it for specialized operations, extended range, or higher data throughput.

2.1. Features

General Features

- *Serial input and output. Programmable serial baud rates up to 57600.*
- *Small sized and single-board construction.*
- *Very efficient circuitry.*
- *Lowest current draw in industry.*
- *Easy to use. Transmit data in = Receive data out.*
- *Receive-only version available*
- *Extensive diagnostic capabilities*
- *Serial communication may be 7 or 8 bit ASCII, or WMX*

Data Radio Modem Features

- *High-speed over the air data rates. Meets FCC spectral efficiency standards.*
- *Built-in radio transceiver with integrated modem*
- *Wide input voltage with high-efficiency switching voltage regulator.*
- *Capable of store-and-forward repeating operation.*
- *16 bit addressing for up to 65,525 different unique device addresses per channel*
- *Supports group and broadcast transmissions. Network mask allows groups of any size.*
- *Very fast Transmit-to-Receive turn-around time.*
- *Serial input and output. Programmable serial baud rates up to 57600.*
- *Programmable over-the-air data rates for long-range or high-speed*
- *Automatic key of transmitter on data.*
- *RF carrier-detect is not required receiving. No squelch setting required.*

Paging Receiver Features

- *POCSAG decoder mode operates at 512, 1200, and 2400 baud.*
- *1-3 programmable cap codes.*
- *Promiscuous mode to receive all pages on the air.*
- *Automatic and manual switching between numeric and alpha-numeric modes.*
- *Small sized and very rugged extruded enclosure.*

3. Specifications

3.1. General

Model Number, transceiver:.....RV-M8S-xx
Frequency Bands:.....-VC 216-220MHz
Serial Port Baud Rates 1.2k, 2.4k, 4.8k, 9.6k, 19.2k, 38.4k, 57.6k, 115.2k
Over-the-air baud rates ..... 1200, 2400, 4800, 9600 (default)
Operating Mode.....Simplex or Half-duplex
Full Spec Operating Temperature range.....-30°C to +60°C
TX-RX and RX-TX turn-around time.....<3mS
Wake-up time .....<700mS from OFF
On-board LEDs .....Power , Status
RF I/O Connector .....MMCX female
Digital signal levels.....3.3V logic
Enable Input Low.....400mV
Digital Output High (1K load) .....3.0 - 3.3V
Digital Output Low (1K load) .....0 - 0.2V
Digital Input High .....> 3.0V
Digital Input Low .....< 0.3V
Enable input High.....1.40V
DC Input .....10-15 volts DC

3.2. Transmitter Specifications (RV-M8S-xx)

RF Power Output .....2.0-*3.0 W*
Maximum Duty Cycle (2W, measured over 60 seconds).....*10% to 50C, 5% to 60C*
Frequency Deviation .....*± 2.2kHz*
Channel spacing.....12.5kHz, 25kHz
Occupied bandwidth.....*11 kHz narrow, 16kHz wide*
TX Spurious outputs.....*< -70dBc*
Occupied Bandwidth.....*Per FCC part 90*
FCC Emissions Designator *11K0F1D*, 16K0F2D
Frequency Stability .....*Better than ±1.5ppm*

3.3. Receiver Specifications

Data RX sensitivity (.1% BER), 19200, 9600, ...< -106dBm
1200 & 2400baud .....< -112dBm
RF No-tune bandwidth 20MHz
Adjacent Channel Selectivity.....-50dB
Alternate Channel Selectivity.....-65dB
Blocking and spurious rejection.....-75dB
RX intermodulation rejection .....-70dB

3.4. Interface Specifications

Connector Type..... 20-pin 2mm header
DC Input 8-13V
DC power draw, RX mode ..... < 600mW
DC power draw, TX mode, 2W..... < 8W
DC power draw, TX mode, 3W..... < 12W

DC current draw, standby mode ..... < 150uA
IO Voltage Levels..... 3.3V digital logic
RX and TX data ..... Transparent Async
Word length..... 8 bits
Format ..... N, O, or E
Modem handshake signals ..... RTS, CTS, CD

4. Electrical Inputs and Outputs

4.1. LEDs

Status LED (TX) This LED blinks red when the transmitter keys and is putting out RF power. It blinks green upon the reception of data or RF carrier. It turns orange when decoding a paging message.

Power LED (PWR) This LED does a short blink, once every two seconds, indicating to the user that the power to the modem is ON and the modem is working. When the modem is in the command mode, this LED will blink on and off, once per second.

4.2. I/O Pinout

The I/O connector is a 20-pin header, 2mm pin spacing.

Pin #	Function	I/O	Function
1	GND	-	Ground
2	Vcc	I	DC Input
3	CD	O	Carrier Detect Out. Low for carrier. Logic high for no carrier. *RF* or *DATA* carrier detect set with ATR1 command. Default: RF.
4	TX On	O	Pin is High when module is transmitting. Low when off, receiving, or sleeping.
5	Data In (TXD)	I	Transmit data input.
6	Data Out (RXD)	O	Receive data output.
7	Enable	I	Low (<.7V) to shut down the module. High (>2.5V) to enable it.
8	Sleep	i	CPU Sleep input
9	CTS	O	Clear to send output. Indicates state of internal input buffer. ATJF command sets the threshold where CTS is negated.
10	RTS	I	RTS input for serial flow control.
11	RSSI	0	Receiver signal strength indicator
12	3.3V out	O	3.3V out of the M8 module. 50mA max current draw.
13	IOA AUDIO IN	I/O	General purpose digital I/O. 3V digital logic from CPU on M8. If the Audio option is used, this pin is used to input transmit audio.
14	IOB	I/O	General purpose I/O. 3V digital logic from CPU on M8. By default functions as DSR. 0= ready&running. 1=sleeping. If enable=0, this line will =0.
15	Decode Mode	I	3V digital logic with 10k pull-up. High/open = POCSAG paging receive mode, Low/ground=data modem mode. This feature enabled by setting the alternate protocol with the ATMA command.
16	STAT1	O	Output to drive external dual-color LED. Connect led between STAT1 and STAT2.
17	RX Audio	O	Receive and transmit audio output for factory test. Do not connect to anything. If the AUDIO option is used, this pin is the receive audio output.
18	STAT2	O	Output to drive external dual-color LED. Do not connect the LED to ground or DC voltage.
19	GND	-	System Ground to M8
20	Vbu	I	Backup battery input to CPU to retain memory. Not required to be connected to anything.

4.3. Heatsinking

The M8S operates at up to 10% transmit duty cycle at ambient temperatures up to 50°C. For duty cycles up to 50%, the module requires additional heat sinking.

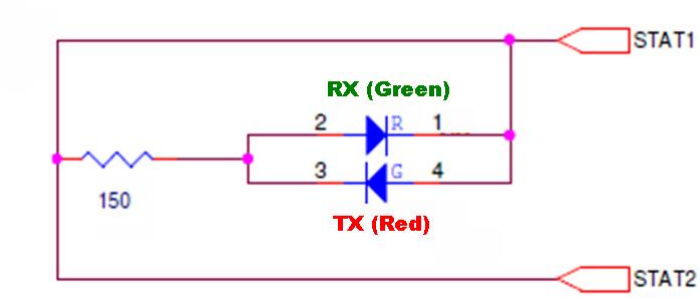
If an external heat sink presses against the “GND PAD” are of the PCB, the RF power transistor will run cooler, and allow higher duty cycles.

4.4. Mounting Holes

6 mounting holes are provided on the module. For best RF performance, the M8S module should be mounted to the system ground, using metal stand-offs.

4.5. STAT LED Outputs

An external dual-color LED may be connected to STAT1 and STAT2 pins to show the status of the modem. Do not connect the LED to power or ground! Connect the LED as show below.



Because the STAT2 signal is also used to put the modem into the “bootloader’ mode, the led must be wired as shown above to ensure a reliable start-up. The Red LED will blink when the modem transmits, and the green LED will blink on receive of data. It will also blink orange when decoding a POCSAG message.

5. User Serial Port Commands

5.1. Overview

The serial portion the RF modem is used to send and receive data over the air, as well as to configure the RF modem. In normal operation, the user sends data into the TXD pin of the IO connector, and this data is transmitted over the air. Received data from another RF modem is output to the user via the RXD pin of the IO connector. This is the default operating condition of the RF modem. No special characters, hardware control lines, or timing is required to operate the *M8S* modem.

There is also a "Command Mode" used to program and configure the *M8*. The command mode is for use by qualified technicians, or OEM applications that manage the configuration of the device. It is the responsibility of the OEM user, system integrator, or dealer to ensure the device is configured in compliance with FCC regulations and requirements specified in this manual.

In the Command Mode, the *M8S* modem accepts commands via the serial port TxD pin. The commands can be used to change certain internal parameters of the *M8S* modem as well as to read-out the current configuration and diagnostic statistics.

5.2. Command Mode

The *M8S* modem may be put into a "Command Mode", by entering a sequence of three plus characters (+++). To keep the *M8S* modem from unintentionally entering the Command Mode because of the +++ pattern occurring in a stream of data entering the modem, there must be a pause in the data stream before the +++ as well as a pause after the +++ is sent. If either pause is missing, the modem will not enter the command mode.

Using serial communications software such as *HypterTerminal*, send the 3-character command sequence "+++" while observing times of silence before [BT (Silence Before Sequence) Command] and after [AT (Silence After Sequence) Command] the command characters. The default BT and AT times are 500mS.

The default sequence for entering into AT Command Mode:

1. No characters sent for ½ a second.

2. Input three (3) plus characters ("+++") within ½ of a second.

3. No characters sent for ½ a second.

When the *M8S* modem first enters the Command Mode, it sends the phrase

Raveon M8S

5.3. Setting a Parameter

To set a parameter in the *M8S* modem, enter the Command Mode as described above. Then enter the proper AT command, a space, the

parameter, and then a carriage return. For Example, to set the address of the *M8S* modem to 1234, enter the following command:

ATDT 1234 <CR>

Once a Parameter is changed, the modem will begin using the new parameter and the new parameter is saved to non-volatile.

5.4. Reading a Parameter

To read the value of a particular setting, issue the command, with no parameter. The modem will return the value followed by an "OK". The modem's OK response is:

The value in ASCII decimal format.

A <CR> <LF> (<CD> = ASCII 0D, <LF> = ASCII 0A).

An "O", "K", <CR>, and <LF> sequence.

For example, if the user enters the command to read the *M8's* modem address and its address was 1234, the user would issue the following command:

ATDT<cr>

and the modem will respond with:

1234 <CR> <LF> **OK** <CR> <LF>

To get on-line help with a command, enter the command and put a question mark in for the parameter. For example, to see what the ATDT command is for, type:

ATDT ?

The modem will respond by listing a brief description of the command. To see a list of all commands, type **HELP**.

Many commands support the "**MIN**" and "**MAX**" parameters to read the minimum and maximum allowable settings. For example, type **ATJF MAX** to find the maximum value the CTS negation threshold may be set to.

5.5. CONFIG Button

If certain parameters within the modem are modified in a manor that causes the modem to cease functioning or if the user cannot enter the command mode via the "+++" method described above, there is a small push button internal to the *M8S* modem to assist in this case. This CONFIG button may be pressed at any time, and forces the modem into a known operational state. The CONFIG button is located inside the modem. Remove the rear cover, exposing the two circuit boards. The button is in the front edge of the radio module's circuit board.

The default settings that the modem will revert to when the CONFIG button is pressed are:

1. *Serial port 9600 baud, 8 data bits 1 stop, no parity*
2. *ATCT setting set to 60000 (60 second time-out)*
3. *Serial port on the front of the unit in RS232 mode, 9600bps, N/8/1.*

Even though the serial baud rate reverts to 9600 baud when the CONFIG button is pressed and the IO port is RS232, it will revert back to the settings programmed into the *M8S* modem once the Command Mode is exited.

5.6. Exiting the Command Mode

There are three ways to exit the command mode. They are:

1. **ATCN** Issuing the **ATCN**. The M8S radio will exit the command mode, and begin normal operation.

2. **EXIT** Issuing the **EXIT**. The M8S radio will exit the command mode, and begin normal operation.

3. **Time Out**. After a pre-set amount of time (60 seconds is the factory default time), the modem will automatically exit the Command Mode, and continue normal operation. Changes will not automatically be saved. This time-out duration may be set with the **ATCT** command.

6. Command Mode Commands

6.1. General Command Common to Data Mode and Paging Mode

These commands apply to the general configuration of the M8S, and are applicable in both the data modem mode and paging mode.
These commands are for use by qualified service technicians.

Command	Command Description	Parameters	Factory Default
ATAT	**Silence AFTER Sequence** - Sets period of silence after the command sequence characters in mS.	Range:0 – 1000 (mS)	500
ATBD	**Baud Rate** – Sets serial com port baud rate (bps). Type the range index (0-7) or the actual desired baud rate.	Range: 0 – 7 0 = 1200 5= 38400 1 = 2400 6=57600 2 = 4800 7=115200 3 = 9600 4 = 19200	3
ATBT	**Silence BEFORE Sequence** – Sets period of silence before the command sequence character in mS.	Range: 0-1000 mS	500
ATCD	**Carrier Detect Threshold** – Read/set the carrier detect threshold, in dBm. -113 means -113dBm.	-113	-120 to -60
ATCH	**Configure Hardware Flow Control** – Enable (1) or disable (0) flow control. When enabled, the modem will monitor the RTS line, and if it is negated, stop sending data out the serial port. If disabled, the modem will ignore the state of RTS, and always send out charators.	1 = Enable 0 = Disable	0
ATCI	**Handshaking Invert** – Used to invert the RTS handshaking signal. 0=normal, 1 = inverted.	1 = Invert 0 = Normal active low.	0
ATCT	**Command Time Out** – If no valid commands have been received via the serial port within this time period (in milliseconds), modem returns to normal operation mode from Command mode. If the CONFIG button inside the *M8S* is pressed, this parameter will be automatically set to 60000.	Range: 100-60000mS	60000
ATE	**Echo –** Character echo set on (E1) or off (E0). This applies to the Command Mode only.	Range: 0 , 1	1 (echo)
ATF	**Display frequencies** – Display all of the frequencies programmed into all of the channel memories.		N/A
ATFT	**Transmit Frequency –** Program the transmit frequency for this channel. Enter in Hz or in MHz. The frequency will automatically be saved in non-volatile memory (flash) for this current channel number.	Range: See product data sheet. For MURS products, frequency cannot be changed.	See product data sheet.
ATFR	**Receive Frequency –** Program the receive frequency for this channel. Enter in Hz or MHz. The frequency will automatically be saved in non-volatile memory (flash) for this current channel number.	Range: See product data sheet. For MURS products, frequency cannot be changed.	See product data sheet.
ATFX	**TX and RX Frequency –** Program the receive and transmit frequency for this channel. Enter in Hz or MHz. Same as issuing an ATFR and an ATFT command. The frequency will automatically be saved in non-volatile memory (flash) for this current channel number.	Range: See product data sheet.	N/A

ATHN	**Channel Number** Select current radio channel number. This command does not store the channel number into EEPROM,	Range: 1 - 6	1
ATHP	**Channel Number** – Select current radio channel number. The channel number is stored in EEPROM memory.	Range: 1 - 6	1
ATIC	**Read Current Draw** Read the current draw in mA. Accuracy is within 20% of actual current draw.	Range: 0-9999	N/A
ATJF	**Read/set the CTS threshold** – Set the serial buffer threshold where the CTS line is negated. By default the ATJF level is at 80% of the internal buffer size.	1 - 2000	3800
ATL	**Enable/Disable the LEDs** – 1 = LEDs always off. This reduces some power consumption. 0 = LED operate normally.	0 or 1	0
ATMT	**Protocol Select** – The over-the-air communication protocol. 0=Packetized mode, 3=POCSAG paging receiver.	Range: 0 or 3	0
ATMA	**Alternate Protocol** – If enabled, the alternate protocol is selected with the Decode Mode input pin, 15.	Range: -1, 0, or 3	3
ATNB	**Parity** – Selects parity format. Settings 0-4 transfer 8-bits over antenna port and generate the parity bit on the RF receiving side.	Range: 0 – 5 0 = none 1 = Odd 2 = Even 3 = Mark (1) 4 = Space (0)	0
ATND	**Number of Data Bits** – Set/read the number of data bits.	Range: 5 - 8	8
ATNS	**Stop Bits –** Selects the number of stop bits.	Range: 1-2	1
ATR1	**Select CD pin output signal** – CD may be RF carrier detect, or modem data detect.	Range : 0 - 4 4 = Data Framing 3= Always negate CD 2 = Always assert CD 1 = Data CD 0 = RF CD	0
ATR3	**Serial Port Time Out** – The time in milliseconds for the serial port to time out. When data is entering the serial port, and this amo0unt of time passes with no more data, the M8S will begin to transmit the data over the air.	Range: 1 - 999	20 20mS is the default.
ATR8	**Frequency Offset.** Used to set the radio on the center of the radio channel.	Range: -500 to +500	0**
ATRQ	**Receiver Signal Level** – Reads the Receiver Signal strength this instant, and returns the level in dBm.	Range: -40 to –130 (dBm)	-
ATRS	**RSSI** (Receive Signal Strength Indicator) – Returns the signal level of last received packet. The reading is in dBm. Usable for relative comparison of signals, but absolute value is within10dB at -90dBm.	No parameters. Returns a number : -50 to –140 (dBm) varies by model.	none
ATSL	**Serial Number** – Reads and returns a unique serial number for thjs unit.	Read Only 1 - 999999999	unique
ATSM	**LPM Operation Enable** – When set to 1, the DTR input line controls the M8's low-power operation. When set to 0, the M8S will not go into LPM, regardless of the state of the DTR pin. When set to 2, the modem is forced into a low-power mode, disabling the receiver.	Range: 0, 1, 2	0
ATST	**Statistics –** Show the unit's operational statistics. See Statistics section of user manual.	0, 1,2, 3, 4, or 5	None
ATTD	**Transmit Test Data** – When issued, the modem will begin transmitting data. The type of data sent is set in the parameter.	0 = Go back to normal 1 = Random	

	Entering a <CR> will terminate the transmission.	3 = 1010… at ¼ baud rate 4 = TX all 0s 5 = TX all 1s 6 = Test Points ON 7 = Transmit CW 8 = Transmit 1010101…	
ATTE	**Read product temperature –** Read the internal temperature of the unit's circuit board in degrees Celsius.	-40 to +99	-
ATVB	**Read DC input Voltage**– Returns the DC input voltage reading, in mV (12500 = 12.5VDC input).	None	none
ATVR	**Firmware Version** – Returns firmware version currently loaded on the module.	Read Only, 3 characters	none
AT&F	**Restore Factory** – Restore the factory default values. This command will not erase the calibration values. After this command executes, the modem will still be in the CONFIG mode.		none
BAND	**Read the Band – Reads the frequency band of the radio. First parameter is the text version (UA, UC, VB, …), second parameter is the lower limit, and the third parameter is the upper limit in MHz. Use to read the band that the radio is tuned to cover.**	None	-
CONFIG	**Display the M8's configuration.**	0, 1, or 2	-
CHNUM	**Read number of channels.** This command will return the number of channels this product has.		6
MODEL	**Read Model number. Read the model number of the unit.**	None	M8S
SHOW	**Show/display an overview of the radio's configuration.**	None	-

** indicates values that are calibrated in the factory and are unit-specific. If the "Radio Type" is changed, these will need to be re-calibrated.

6.2. Data Modem Mode Related Commands

These commands apply to the operation of the M8S when it is in the data modem communication mode.

Command	Command Description	Parameters	Factory Default
ATBC	**Busy Channel Lock Out** – Enable/disable the BCL. If enabled, the modem will not transmit on a radio channel that is busy (has RF on if). 0-OFF, 1=ON.	Range: 0-1	0
ATDT	**Destination Address to call**– Sets address of the modem to send data to. Note, this parameter is entered in HEX format. Each digit may be a 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,or an F.	Range: 0-FFFF	1234
ATGP	**Group Number** – Set/read the group number for this unit. 0 means ignore the group number. 1-255 is a group identifier. Only M8s with the same Group Number will communicate together.	0-255	0 (ignore group numbers)
ATHS	**Show History** – Show a table of listing the most recent receptions, and the IDs that the data was sent from	No parameter	
ATHX	**Enable/Disable single-hop repeating –** 0=any number of repeats, 1 – unit will not repeat a packet that was already repeated.	*0 or 1*	*0 (multi-hop OK)*
ATLA	**Listen Address** – Configures the listen address for this unit. The unit will receive data if this listen address matches the destination address in a data transmission. FFFF to disable it.	Range: 0000 - FFFF	1234
ATMK	**Address Mask** – Configures local and global address space. Each digit may be a 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,or F. In most applications, this is kept at FFFF.	Range: 0000 - FFFF	FFFF

ATMY	**Unit Address** – Configures the individual; address for this unit. Each digit may be a 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,or F. Note: FF is interpreted as a group. See addressing section.	Range: 0000 - FFFF	1234
ATPE	**Packet Error Display –** Shows statistics to compute packet-error rate. Displays Packets Per Minute (PPM) and a running total.	None (display PER) 1 = reset counters 2 = Stop PER display	None
ATPO	**RF Power Output**. Set or show the RF power output setting. Value is in percent, from 0% to 100%. Use and RF wattmeter to confirm the power setting, and adjust the % accordingly to obtain the desired RF power level.	0-100	100
ATR0	**Symbol Peak Deviation** – Set the peak FM deviation of the transmit symbols. Note: This can be a negative number to invert the modulation.	Range: -1000 – 1000	120**
ATR2	**Over-The-Air bit rate** - This is the data rate the radio uses to send data over the air. **All RF modems in the network must use the same over-the-air baud rate**. Refer to section **Error! Reference source not found.** for information on how to set the OTA baud rate.	Range: 0 = 800 5 = 9600 2L 1 = 1200 6 = 19200 4L 2 = 2400 7 = 5142 2L 3 = 4800 8 = 9600 4L 4 = 8000 4L 9 = 2000 2L	5 (600)
ATR5	**Preamble length** – The number of bytes to send over-the-air in the pre-amble.	Range: 3 - 255	5** (Varies based on data rate and radio type. 7 typical)
ATRB	**Number of retries**. If this modem does not get an ACK back when it sends data, this is the number of times it will re-transmit the packet and wait for an ACK. 0=disabled feature.	Range: 0-99	0 (ACKs are not used)
ATRF	**RF Carrier Required** – When enabled, there must be RF energy on the channel for the modem to output data. Streaming data mode only. 1-RF required. 0=ignore RF energy when receiving.	Range: 0, 1	0 (no RF required)
ATRV	**Disable Remote Access** – When enabled (set to a 0), the modem will respond to over-the-air RPR requests, Pings, and over-the-air commands. Default is OFF (1).	0 = Remote Access on 1 = Remote Access off	1
ATTT	**Max Packet Size –** Set the maximum number of bytes in an over-the-air packet.	1 - 512	80
ATXn	**Show or Configure the Repeat Table** – Set the addresses that this unit will store-and-forward data to/from. n = 1, 2, 3, or 4 designating the entry in the table to show or edit..	*Four parameters* aaaa bbbb cccc dddd where aaaa=Source Address bbbb = S.A. Mask cccc = Destination Address dddd = D.A. Mask	
ATXR	**Enable/Disable Store and Forward Repeating –** 0=disabled, 1 – enabled.	*0 or 1*	*0 (Off)*
ATXT	**Read/set repeater delay –** Read or set the repeater delay. This is the time between receiving a data packet, and the time the repeater will re-send it.		
PING	**Ping another modem. Format is PING xxxx, where xxxx is the ID of the modem to ping. If remote access is enabled on xxxx, it will respond.**	*XXXX*	-

** indicates values that are calibrated in the factory and are unit-specific.

6.3. Paging Receiver Related Commands

The following commands are specific to the operation of the M8S in the paging decoder mode. The ATMT and ATMA commands configure the M8S to operate in the paging decoder mode.

DF	**Data Format**. 0=Numeric, 1= Alpha-numeric, 2=tone, 3=voice, 4=auto detect based on function bits.	*0, 1, 2, 3, or 4*	*4*
CC x	**Set/Read Cap Code.** Two parameters, CC x yyyy x= 1,2 or 3 which is the cap code number. yyyy is the pager code 1 – 2097152. -1 to disable the particular cap code. Enter "CC" to see a list of all pager cap codes.		*CC 1 12345* *CC 2 -1* *CC 3 -1*
PM	**Promiscuous Mode.** Enable/disable promiscuous mode. 0 = off, 1 = ON (receive all paging messages).	*0 or 1*	*0*
PR	**Pager Data Rate.** Parameter is 512, 1200, or 2400	*512, 1200, 2400*	*512*

7. Using the M8S – Packet Data Mode

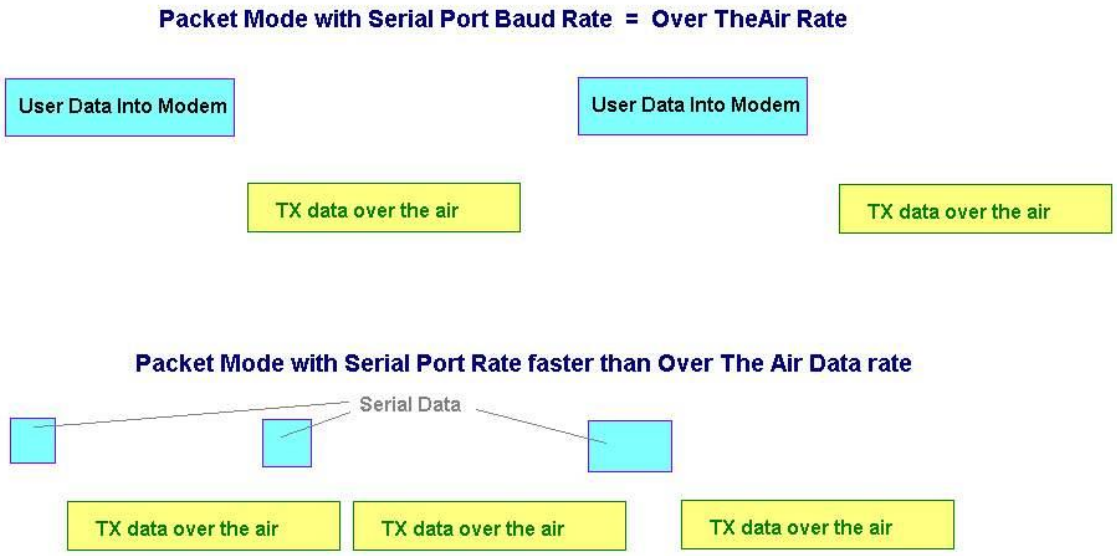
This section describes the operation of the M8S when it is in the *Packet Mode* of operation. It is the easiest and most reliable mode of operation for a data modem.

In Packet Mode, all transmissions are sent in bursts or packets, and contain address, error detection, and error correction information. Date enters the M8S modem's serial I/O port, and is stored in a buffer within the modem until it is ready to be transmitted. Packetized operation has these advantages over non-packet modems:

Packet Mode Advantages

1. ***Error Detection*** The modem uses a 16-bit CRC at the end of every packet of data. The CRC is used to check the data for errors, and if there are any errors, the data will not be passed onto the user.
2. ***Error Correction*** Automatic error correction may be used. *M8S* modems incorporate an optional ARQ method to re-transmit packets with error, to ensure the user's data is delivered error-free.
3. ***Addressing*** Packetized operation allows for a more versatile network architecture, with source, destination, and network addresses. M8S uses a 16-bit address to identify data packets.
4. ***No Dribble Data*** Even in the presence of noise, the M8S modem will not output extra data or have random bit errors. Modems without packet operation generally do not work well with weak noisy signals.
5. ***Transparent Operation*** Because of the high-reliability and error-free operation the Packet Mode offers the user, most user applications will seamlessly work using the M8S in its Packet Mode.
6. ***Repeatable and Routable.*** M8S packets are structured so that they may be repeated using a store-and-forward repeater, and/or routed using specialized hardware.

(Packet Mode of Operation)



The packet or paging mode of operation is configured using the **ATMT** command.

7.1. Setup

1. Connect a DC power source to the M8S.
2. Connect a good quality antenna, cut to the operating frequency, to the BNC connector on the front of the modem. Use a good antenna, and place is at high-above obstructions as possible.
3. Connect a computer terminal, or PC computer running HyperTerminal, to the 9-pin I/O connector. The factory default serial ports settings are 9600 bps, 8 data bits, 1 stop, no parity.
4. Program the modem's operating frequency to your desired operating frequency. This is done with the **ATFX xxx.xxxxx** command.
5. Using the AT commands, change any of the default operating parameters that must be modified. From the factory, the modems are configured and shipped ready-to-use. Out of the box, they will communicate on the default radio channel using the factory defaults. In general, the parameters you may want to modify will be:

ATFX	Frequency for this channel. Set to your frequency.
ATBD	Serial port baud rate
ATMY	The ID of this unit. Default is 1234.
ATMK	The network address mask. Default is FFFF.
ATDT	The address of the unit this modem will talk to. Default is 1234.

6. Connect your serial data device to the TXD and RXD pins of the I/O connector. To connect the M8S to an RS232 serial port, you will need an external digital to serial level converter.

The M8S is now ready to use. Any serial data going into the modem will be transmitted over the air, and any data received over the air will be sent out the serial port.

Remember, that from the factory, all *M8S* modems are configured to simply work. Plug in power and connect to the serial port at 9600 baud, and the modems will communicate on the default channel. Change the channel frequency to your specific frequency, and they will be ready to work on your channel.

7.2. Programming Channels and Frequencies

The M8S modem has memory for up to 6 channels. A channel is a pair of frequencies, one for transmit and one for receive. They may be different or they may be the same. You may program any valid frequency into any channel number. To program a channel, perform the following steps.

1. Change to the channel you wish to program, using the **ATHP x** command, where x is the channel number.
2. Program the frequency for this channel x, using the **ATFT**, **ATFR**, or **ATFX** command. Note that the frequency my be entered in MHz as long as you use a decimal point. For Example, enter **ATFX 450.1** to set the channel frequency to 450.100MHz. Alternately, you may enter the frequency in hertz by entering **ATFX 450100000**. You must enter all of the zeros if you enter the frequency in hertz.
3. Review the frequency setting with the **ATFT**, **ATFR**, or **ATFX** command. To see a list of all of the channels , enter **ATF**.
4. To change the radio channel, use the **ATHP x** command while the modem is in the command mode.

7.3. Data Transmission

To transmit data, send one or more bytes of data into the serial port of the modem. When a full packet of data has been collected into the internal buffer of the modem, or when there is a pause in the data, the modem will automatically key its transmitter, and send the data over the air.

Serial Port Baud Rate

While the modem is transmitting, the user may continue to send more data into the *M8.* Because the buffers in the M8S are full-duplex, the serial port data rate and the over-the-air data rates are independent. The serial port baud-rates may be set slow to accommodate legacy equipment, or set at high-speed to minimize latency. The over-the-air data rate us usually 4800 baud for narrow-band channels, and 9600 baud for wide-band, although faster or slower rates may be used.

In Packet Mode, selection of the serial port baud-rate is important. As shown above, if the serial port baud-rate is the same as the over-the-air baud rate and the packets are short, the channel utilization is only about 50%. But, if the serial port baud rate is set much higher, say 2-8X the over-the air rate, the channel utilization becomes near 100%.

Because the M8S can handle serial-port data rate far in excess of the over-the-air rate, the efficiency of the M8S in Packet Mode is approximately the same as other brand modems that cannot operate in a Packet Mode — with the added benefit or ARQ, error-free data, and addressing.

Busy-Channel Lock Out

If your system operation require the M8S modem to monitor-before-transmit, of if you do not want the M8S to transmit on a channel that is busy, you can enable "Busy-Channel-Lockout", using the **ATBC 1** command. **ATBC 0** disables BCL, and thus the modem will transmit whenever it has data to send out.

The factory-default is BCL disabled. Use caution when enabling it, as a CW interferer, PC with poor shielding, or some other source of RF can stop the modem from transmitting. The threshold where the M8S senses RF carrier, and determines that the channel is busy is set by the **ATRA** command. This is factory calibrated to an equivalent RF level of approximately -110dBm.

7.4. Addressing (Packetized Mode only)

Addressing Basics

One of the more powerful aspects of the *M8S* modem is its addressing scheme. Incorporating addressing in the modem allows multiple radio systems on the same frequency to co-exist, and not interfere with each other. Also, some user application cannot tolerate receiving data that was not intended for it, and by setting the addresses in the modems properly, the system can be configured to allow reception of only data intended for the recipient.

If addressing is not needed or desired, it can be turned off so that all modems receive data from all other modems, and all modems can talk to all other modems.

Each *M8S* contains a 16 bit address, called its Unit Address, and is represented as a 4 digit hexadecimal number. *M8S* address may be any number between 0000 and FFFF, which is effectively 65,535 different addresses. Every *M8S* has a Unit Address programmed into it, as well as the ID of the unit it will send data to. The Unit Address is programmed with the **ATMY xxxx** command, and the Unit Address of the destination modem (the Destination Address) is configured with the **ATDT xxxx** command.

The defaults UNIT ID in al *M8S* modems is 1234, and 1234 is the default for the destination ID. An Address Mask is used to select which digits of the address will be used to determine if a particular reception was intended for the M8S modem. The default Address Mask is FFFF, which means all digits will be used. With

these settings, by default all M8s will talk to and hear all other M8S radio modems.

Group Numbers

By default the M8's Group Number is 0. Group 0 means ignore the group numbering. The Group Number is set with the **ATGP xx** command, where xx is the group number. **ATGP 0** disables group numbering and is the default way the M8S radio modem works. If the Group Number is set to any non-zero number from 1-255, then the group feature is enabled, and the group number will be the group specified in the **ATGP** command. When enabled, the M8S will only communicate with other M8s that have the same Group Number.

Hexadecimal Numbers

For those not familiar with hexadecimal numbers, a hexadecimal digit represents a 4-bit binary pattern. There are 16 possible values (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,and F). These 16 values represent 4 bits of information, thus 4 hexadecimal digits can represent 16 bits of information. The hexadecimal numbers represent 4 bit data in the following way:

Hexadecimal Table

Hex #	*Binary*		*Hex #*	*Binary*		*Hex #*	*Binary*		*Hex #*	*Binary*
0	0000		**5**	0100		**8**	1000		**C**	1100
1	0001		**6**	0101		**9**	1001		**D**	1101
2	0010		**7**	0110		**A**	1010		**E**	1110
3	0011		**8**	0111		**B**	1011		**F**	1111

When communicating over the air, *M8S* modems transmit their Unit Address and the Destination Address along with the data. Receiving modems check the received Destination Address, and see if it matches their Unit Address. If it does match, the receiving modem outputs the data it received via its serial port. If it does not match, the receiving modem discards the data, and does not send it out the serial port.

Setting A System-Wide Address

If individual addressing is not needed in your system, there are two ways to ensure it is not used. One way is to set all modems in the system with the same Unit Address and Destination Address. From the factory, these are both set to 1234, and thus, all modems can communicate with all other modems, using the address 1234. The advantage of using this system-wide address, is that if there are other M8S modems on the channel, but in some other system, they probably will not have the same Unit Address, and thus will not interfere with your system. To reduce the possibility of data cross-talk, the system implementer may wish to use a different system-wide address for the Unit Address instead of 1234. There are over 65,000 addresses available.

The **ATLA** command can be used to set an additional address that the M8S will listen for.

An alternate way to disable addressing altogether, is set the Address Mask to 0000 (**ATMK** 0000 command). This tells the M8S to ignore the address, and receive every transmission.

Broadcast Transmissions

The double FF is used to identify a broadcast packet. A transmission with a two digit FF in the first two positions of the destination ID, or in the last two positions of the destination ID, will be interpreted as a broadcast, and any modem with an ID that matches the two non-FF digits will receive the data. For example, sending data with a destination ID of 12FF will be received by any modem with a unit ID 1200 through 12FF. Sending data with a destination ID of FF34 will be received by any modem with a unit ID of 0034 through FF34.

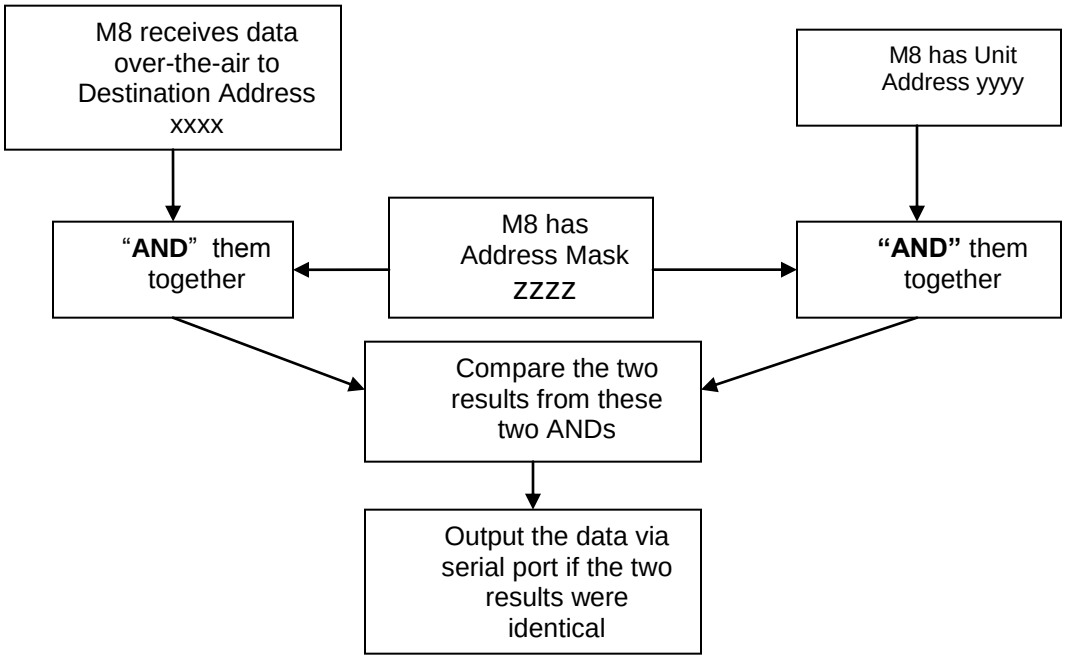
The Address Mask

The reason to use hexadecimal digits to represent the unit address, is that along with the Unit Address programmed into the *M8*, there is an "Address Mask" programmed into it. The default mask is FFFF. The address mask is used to determine if a particular data transmission should be received by the modem.

Only in systems where some modems should only talk to certain other modems, might you want to change the address mask. Whenever data is received over the air, the Destination Address of the transmission is logically "ANDed" with the Address Mask in the receiving modem. This is the *Effective Destination Address*. The receiving *M8S* also ANDs its own Unit Address with its Address Mask. The result is the *Effective Unit Address*. The *Effective Unit Address* is compared to the *Effective Destination Address*, and if the two are identical, the data will be received.

Note: Logically 1 AND 1 = 1, 0 AND 0 = 0, 1 AND 0 = 0, 0 AND 1 = 0

` ***Figure 1 (Address Filtering)***



One effect of this is that an address mask of 0000 will cause the *M8S* modem to receive all data from all units that transmit data messages. The Destination Address will effectively be ignored if the mask is set to 0000.

Addressing Examples:

Example 1 (default configuration)

Sending Destination Address = 1234

Receiving Unit Address = 1234

Receiving Unit's Address Mask = FFFF

Result: Unit will receive the data, because the addresses identically match. When the addresses are identical, the value of the mask is not important.

Notes: This is the default configuration. All units have address 1234, and all modems will talk to all other modems with address 1234.

Example 2 (a configuration that won't work)

Sending to Destination Address = **1236**

Receiving Unit Address = **1234**

Receiving Unit's Address Mask = **FFFF**

Result: No data will be received, because the address do not match, and the address mask of FFFF requires that all digits in the address match. .

Example 3 (able to receive a data from a group, 1230 – 123F)

Sending to Destination Address = **1236**

Receiving *M8S* Unit Address = **1234**

Receiving *M8S* Address Mask = **FFF0**

Result: Data will be received. 1236 ANDed with FFF0 is 1230. 1234 ANDed with FFF0 is 1230. The results of the ANDing match, and thus the data will be received.

Example 4 (able to receive from a group, xx34 where xx is any two digits)

Sending Destination Address = **2234**

Receiving *M8*'s Unit Address = **1234**

Receiving *M8*'s Address Mask = **00FF**

Result: Data will be received. 2234 AND 00FF equals 0034. 1234 AND 00FF equals 0034, therefore they match. The results of the ANDing match, and thus the data will be received.

7.5. Store-and-Forward Repeating

The *M8S* modem has a built-in wireless repeater. Each M8S is capable of not only sending and receiving data from/to its serial port, but also re-transmitting data packets it receives over-the-air data.

Automatic Repeater Configuration

The easiest way to enable store-and-forward repeating is the use the **REPEAT 1** command. **REPEAT 1** will turn on the store-and-forward feature, and configure it to repeat all packets the radio can hear on the air. **REPEAT 0** disables store-and-forward repeating.

It is highly recommended that you use this method to configure your M8S as a repeater.

Important: The Unit ID of the repeater must be unique in the system. No other radio modem in the system can have the ID of the repeater.

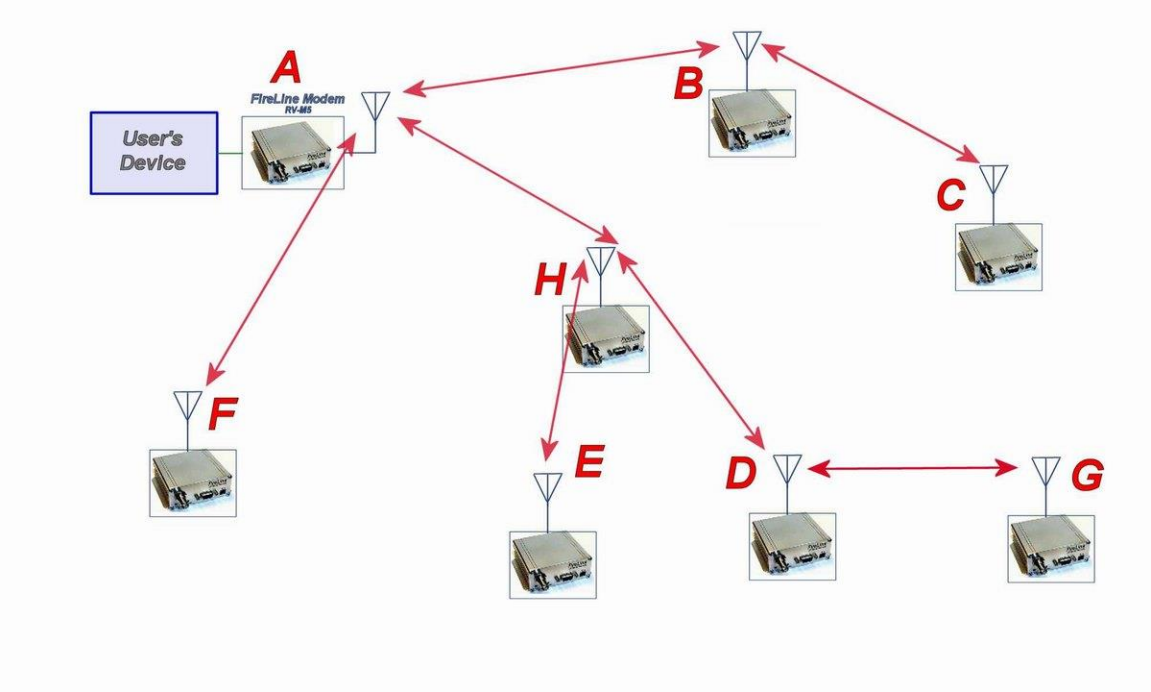
Manual Configuration of the Repeat Feature

There is a sophisticated packet repeating algorithm in the M8, and it may be manually configured for more complex repeating scenarios. In most cases this is not needed. Simply use the **REPEAT 1** command. But, if you do not wish the repeater to repeat all packets, you may manually configure the Repeater Table within the M8. The Repeater Table is a table of IDs that the M8S should repeat. It contains a range of IDs and a mask. There may be up to 4 entries in the Repeater Table, each with a different range of IDs that should be repeated.

Important: The Unit ID of the repeater must be unique in the system. No other radio modem in the system can have the ID of the repeater.

Data is transmitted over-the-air in bursts called packets, and each packet has the Unit ID of the M8S that sent the data and the Destination ID of the unit that the data is intended for.

Figure 2 Overview of Repeater Operation



In the example shown in Figure 3 above, *M8S* **A** is will communicate with all other modems in the system. It can directly communicate with **B, H**, and **F**. Because of propagation limits, it cannot communicate reliable to **E, D, C,** and **G**.

To solve this problem, some of the M8S modems are configured as repeaters. The still are able to send and receive data, but they also will repeat data out to the modems that are out of range of *M8S* **A**.

H is configured to repeat all messages to/from **E, D**, and **G**. **B** is configured to repeat all messages to/from **C**, and **D** is configured to repeat all messages to/from **G**.

The following table illustrates one possible way the M8s could be programmed to accomplish this type of system.

M8	Unit ID (ATMY)	Destination (ATDT)	Network Mask (ATMK)	Repeat Source	Repeat Source Mask	Repeat Destination	Repeat Destination Mask
	Addresses programmed into unit			Repeater table programmed into unit			
A	1000	1000	FF00	-	-	-	-
B	1010	1000	FF00	1020	FFFF	1000	FFFF
				1000	FFFF	1000	FFFF
C	1020	1000	FF00	-	-	-	-
D	1030	1000	FF00	1031	FFFF	1000	FFFF
				1000	FFFF	1000	FFFF
E	1032	1000	FF00	-	-	-	-
F	1021	1000	FF00	-	-	-	-
G	1031	1000	FF00	-	-	-	-
H	1022	1000	FF00	1030	FFFF	1000	FFFF
				1000	FFF0	1000	FFFF

Store-and-forward repeating is manually enabled with the ATXR command. **ATXR 1** enables repeating. **ATXR 0** disables it. Unlike the **REPEAT** x command which configures the repeater table to repeat all packets, the **ATXR 1** enables the feature but does not configure the Repeater Table.

The *Repeat Source*, *Repeat Source Mask*, and the *Repeat Destination* are programmed into a Repeater Table in the M8. The ATX command is used to program the Repeater Table. The Repeater Table may have up to 4 entries.

For example, M8S **B** in the above example will have two entries in its Repeater Table. The command to set the two entries is:

ATX1 1020 FFFF 1000 FFFF
ARX2 1000 FFFF 1000 FFFF

The first command above sets the Repeat Source to 1020 and the Repeat Destination to 1000, both with a Mask of FFFF. The FFFF mask means all digits of the source and destination are used to determine if the transmission should be repeated. All packets from units with MYID 1020 (**C**) sent to 1000 will be repeated by this unit. It will not repeat messages from **D, E, F, G,** or **H** because their Unit IDs are not in the *Repeat Source* repeater table.

The second command above sets the Repeat Source to 1000 and the Repeat Destination to 1000, both with a Mask of FFFF. The FFFF mask means all digits of the source and destination are used to determine if the transmission should be repeated. All packets from units with MYID 1000 (**A**)sent 1000 will be repeated by this unit. In other words, all transmissions from **A** will be repeated by **B**.

To view the Repeater Table, use the **ATX** command, with no parameter. To view a single entry in the table, use the **ATXn**, where n=1, 2, 3, or 4.

To delete an entry in the table so it has no effect on the operation, set the fields to 0. For example, to disable entry 1, use the **ATX1 0 0 0 0** command.

There can be an issue with regard to store-and-forward repeating and busy channels, particularly on polled systems. Raveon's M8S wireless modem has a number of provisions in it to make store-and-forward repeating work smoothly.

For example, in the diagram above, assume A is the master station, and C is a remote station being polled. When the store-and-forward repeater B sees a packet it should repeat, immediately upon reception of the packet, it keys its transmitter and repeats the packet. The scenario that can cause problems is if the end receiving station C actually heard the original transmission from A. In a polled scenario, the end station C will typically then respond to the poll, and want to transmit. Station C's transmission can happen at the same time as the repeater B is trying to repeat the original transmission.

This contention can be reduced/eliminated in the following ways:

1. Turn busy-channel lock-out on (**ATBC 1**) on all modems. This stops them from transmitting on a busy channel (stops them from transmitting when the repeater is transmitting).
2. Set the serial port baud-rate on the end-stations to be fairly slow (**ATBD x**). Thus, when they receive a poll request, there is a delay as they send data in/out of their serial ports, and during this delay, the repeater can do its thing.
3. Increase the serial port time-out value from 20mS to say 250mS (**ATR3 250**). Then, when the polled station responds, there is a 250mS delay before the end station's data gets sent out over the air. This gives a little gap for the repeater to use for repeating messages.
4. Any combination of 1-3.

M8S radio modems will not repeat or receive duplicate versions of the same data packet. If two repeaters are used in the same system, each will repeat a transmission only one time, even if they are within communication range of each other. A repeater will not repeat a transmission if it was the originator of the transmission. If another M8S in the system has the same ID as the repeater, the repeater will not repeat data from that particular unit. The repeater's ID must be unique in the system.

If a M8S is configured as a repeater, and is also used to send and receive data, it will not repeat any transmission that it originated. M8S checks the ID of the station that originated the transmission to determine if the message should be repeated. If the transmission was originated by a station with the same Unit ID as the Unit ID in the receiving station, the data will not be repeated. This is why it is important to have a different ID for each M8S modem in a network that uses repeaters.

8. Debug Related Commands

Bench Testing

(Must be in command mode to test. Enter +++ at the keyboard to put unit into config/test mode.)

ATTD x Various transmit test routines.
0 = Go back to normal mode. Stops the test.
1 = Random data transmit.
2 = Hop up/down one channel
3 = Force PLL to fast lock mode
4 = Transmit all 0s
5 = Transmit all 1s
6 = Enable the test points on the PCB.
7 = Transmit CW on center of channel
8 = Transmit preamble (101010 pattern)

ML x Debug Message Level. By default and at power on, this level is set to 0 (no debug messages).
0 = no debug or diagnostic messages
1 = POCSAG and data reception realated message will come out serial port
2 = Verbose messages, Mostly used for factory and engineering puroises.

SHOW Display an overview of the configuration.

Ping xxxx Ping another modem over the air. Transmits a request to xxxx to see if xxxx can hear the sending station. If it does, it answers with a response transmission, containing its ID and the signal strength of the reception. .

STAT Display statistics of how the modem is working.

9. Diagnostic Provisions

9.1. Overview of Diagnostics

Internal to the *M8S* radio modem, is a powerful 32-bit microprocessor. Along with handing all aspects of radio modulation and demodulation, the microprocessor also maintains an extensive array of diagnostic information.

This section details the diagnostic information available, and describes how to us the information to optimize or troubleshoot a *M8S* radio network.

9.2. Reading the Diagnostic Information

M8S diagnostic information is read using AT commands, while the unit is in the Command Mode. Refer to the section "User Serial Port Commands" to learn how to put the *M8S* modem into the Command Mode.

To see a general overview of how the modem has been operating, us the **ATST** command (status request command), without any parameter. The radio modem will respond with a list of certain operation statistics that it maintains. All statistics start counting at 0. The **ATST 1** command can be used to reset all statistics back to 0, except the run-time timers.

Other operation and configuration statistics are available using the ATST command, with a parameter to specify the desired statistic. The following table describes the various statistics available.

9.3. Status and Statistics Command

AT Command	Command Description	Response
ST	**General Communication Statistics** – This command will cause the *M8S* to output a table of various operational statistics.	Statistics overview screen
ST2	**Low-level internal statistics** – Returns various low-level statistics. These are subject to change in various firmware revisions.	Low-level statistics screen
ST3	**Compile date and time** – Returns the data and the time that the firmware was compiled.	Date and time
ST4	**Run Time** – Returns the amount of time that the modem has been powered up and running.	Run time display screen
ST9	**Reset all statistics counters**	OK

10. Tune-up and Alignment

The *M8S* modem has been factory calibrated, in should not require any re-calibration when installed, or when changing frequency or channel. Unless the user is trained in radio test and calibration, the values stored in the R registers should not be modified. Radio calibration and alignment is performed using the **ATRx** commands.

Improper adjustment of the radio calibration (R0-R9 and RA registers), can result in failure of the radio modem.

Calibration and alignment values are stored internal to the modem in the "R" registers. (R0-R9 and RA). For example, to read R5, issue the **ATR8** command without any parameter. To change the setting, issue the **ATR8 nn** command, where nn is the new value you would like to store.

Once you read a register using an ATRx command, you may modify its value by entering a "U" for up or a "D" for down. U or D will change the value by one. Use this trick carefully, because it modifies the last R register that was read, and it is easy to unintentionally modify the wrong register.

10.1. Periodic Calibration

The only setting that may require adjustment is the center frequency. After years of operation, all crystals will age and change frequency slightly. The ATR8 command is used to adjust the center frequency. Like all narrow-band radios, semi-annual checks and adjustment of frequency is recommended.

10.2. Calibration Commands

The following AT commands are used to calibrate the M8. Do not ever change these unless you have been factory trained to do so.

AT Command	**Command Description**	**Parameters**	**Factory Default**
R0	**Symbol Peak Deviation** – Set the peak FM deviation of the transmit symbols. Note: This can be a negative number to invert the modulation.	Range: -1000 – 1000	120**
R1	**Select CD pin output signal** – CD pin may be RF carrier detect, or modem data detect, off, on, or RX data framing, or on-line status. Line status mode asserts CD when on-line in normal modem operation and it negates CD when in the command mode.	Range : 0 - 5 5 = RX data framing. Assert when outputting data 4 = Line stat. 3 = Always negate CD 2 = Always assert CD 1 = Data CD 0 = RF CD	0 (RF Carrier)
R2	**Over-The-Air bit rate** - This is the data rate the radio uses to send data over the air. **All RF modems in the network must use the same over-the-air baud rate**.	Range: 0 = 800 5 = 9600 2L 1 = 1200 6 = 19200 4L 2 = 2400 7 = 5142 2L 3 = 4800 8 = 9600 4L 4 = 8000 4L 9 = 2000 2L	3

R3	**Serial Port time out** – Number of mS of no activity on the serial port before transmitting the data in its buffer.	Range: 1 - 5000	20 (mS)
R5	**Preamble length** – The number of bytes to send over-the-air in the pre-amble.	Range: 3 - 255	4** (Varies based on data rate and radio type. 7 typical)
R8	**Frequency Offset.** Used to set the radio on the center of the radio channel.	Range: -500 to +500	0**
R9	**Modulation Balance.**	Range: 0-100	20**
RA	**Select RF CD output threshold** – This value is the RSSI threshold where the carrier detect is asserted. Note: To force CD always on, set this to 0, and R1 to RF Carrier Detect.	Range : 0 thru -127	-110

10.3. Center Frequency

1. Key the transmitter with CW output using this command:
   ATTD 7
2. The modem will now put out CW on the center of the channel.
3. Read the frequency offset with the **ATR8** command.
4. Adjust the frequency to the center of the channel with the **ATR8** command. You can use the "U" key and the "D" key to change the settings up and down one value in real time.

10.4. TX Deviation

1. Switch to channel 1.
2. Key the transmitter into a 50 ohm load using the **ATTD 3** command. The unit will now transmit, and send a digital 0 continuously. This should be +2.0kHz in frequency for narrow-band radios (12.5kHz spaced channels) and +4.0kHz for wide-band (25kHz channels).
3. Adjust the deviation register setting so that the frequency deviation is correct. The deviation is set with a digital adjustment. Use the ATR0 command to read or set the deviation level.

10.5. TX Modulation Balance

(*Note: This step is not performed on radios with Radio Type 5*)

1. Set-up a service monitor to monitor the FM deviation of the transmitted signal on an oscilloscope. The frequency response of the demodulated FM signal must be greater than 10Hz to 5kHz without any de-emphasis.

2. Transmit random data on the center of the band, using the **ATTD 1** command. This command will cause the *M8S* to automatically key up, and send random data for one minute.
3. Verify the DC center of the demodulated data is stable. The random data should be randomly timed 1s and 0s, and have little to no AC component on them. See pictures below for details.
4. If necessary, change the **ATR9** setting so that the long data bit have the same amplitude and DC value as the shorter ones.
5. On the low end of the band, adjust **ATRL** so that the modulation is proper.
6. On the high end of the bamd, adjust **ATRH** so that the modulation is proper.

10.6. Carrier Detect

The Carrier Detect (CD) signal from the modem is output on pin 3. It may be asserted by the detection of RF, using an internal signal called RSSI (Receive Signal Strength Indication). The RSSI signal is an analog signal representing the strength of the RF carrier. It is compared with a pre-set value, and if it is above this value, Carrier Detect is asserted. The pre-set value may be change with the **ATRA** command.

Note: “Asserted” means low. “Negated” means high. The CD pin will sit at about 3.3V when CD is not asserted. A digital 1 (3.3V) on the CD pin is the standard convention used to indicate no carrier detect. This allows the digital signals like the CD pin to be connected to standard RS232 line driver circuits and operated with the correct polarity.

Mode 0 - RF CD

On this line the modem indicates to the DTE that it has received a carrier from a remote device. It will assert this signal any time there is a carrier detected. The modem may be configured to assert this when an RF carrier is detected (any on-channel RF, voice or data), assert it only when another RF modem signal is detected, or always assert it. The operation of this line is configured with the ATR1 command. The default is 1 (asserts when *M7* data is detected on the radio receiver).

Mode 1 - Data CD

In this mode, the CD pin is asserted whenever the modem detect a valid data modem signal on the air. If RF is present, but it is voice or some non-data single, then the CD pin is negated.

Mode 2 - CD ON

In this mode, the CD pin is always asserted.

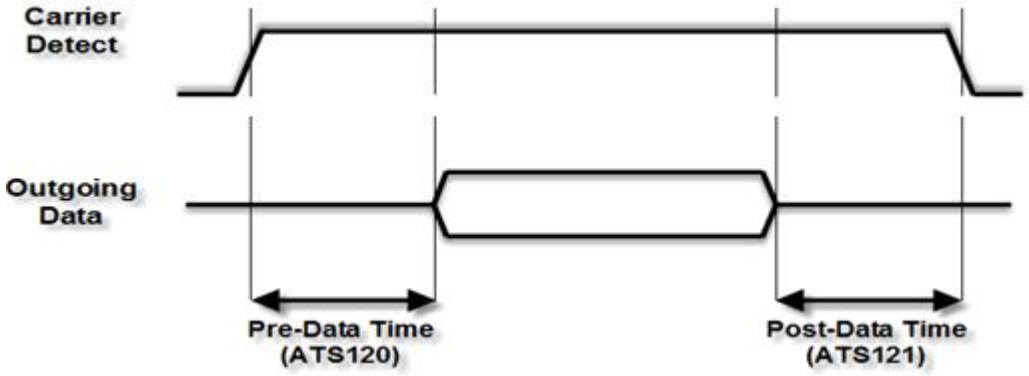
Mode 3 - CD OFF

In this mode, the CD pin is always negated.

Mode 4 - Output Data Framing

To enable the *Output Data Framing* feature, set **ATR1** to **4**, set **ATS120** to the number of mS for the Pre-Data Time, and **ATS121** to the number of mS for the Post-Data Time.

Ouput Data Framing is used when it is necessary for the serial terminal to wake from sleep or enter an appropriate mode to receive data. In this mode, the Carrier Detect handshaking line is nominally low and only goes high to signal that data is being output. The Pre-Data and Post-Data time can be set from 0-254ms, as indicated in the diagram below. The CD signal will normally stay low (near 0 volts), and when the Output Data Framing takes place, it will go high (about 3V).



If *Output Data Framing* is enabled, any other Carrier Detect and flow control output configuration is ignored.

11. Troubleshooting

Symptom: Unit will not receive

Solution #1. Verify that the modem is on the correct RF channel. If it is, the RX LED should blink every time another modem tries to transmit to it. If the RX LED does not blink when it should be receiving, it is on the wrong RF frequency.

Soultion #2. If the addresses match, and RX LED blinks but still no reception of data, verify that the RTS signal is asserted. The *M8S* will not output data if the RTS signal on the DB-9 I/O connector is not asserted. If the user's hardware cannot assert the RTS hardware line, disable hardware flow control in the *M8S* modem, using the **ATCH 0** command.

Solution #3. If the status RX LED blinks green when a different unit transmits, verify that the Unit Address of the sending modem matches the unit address of the receiving modem. If this is OK, verify that the over-the-air baud rate of all modems is the same (ATR2 command).

Solution #4. Verify Low Power Mode. The M8S has an optional Low Power Mode (LPM). If LPM is enabled, the M8S will power down whenever the DTR line of the serial port is turned off. The Power LED will blink once every 10 seconds in the LPM mode. The **ATSM** command is used to set or read the Low Power Mode. **ATSM 1** enables it, and **ATSM 0** disables it. If LPM is used (**ATSM 1**), then the M8S will turn off when the DTR line is off, or the program connected to the serial port is closed, or the RS-232 connector is un plugged.

Symptom: Unit will not transmit

Solution #1. Verify that CTS is wired. Some devices that could be connected to the *M8S* will require the CTS signal to be asserted. The *M8S* does assert this signal, but if the wire is not connected, you device may not be outputting data to the *M8*. If the TX LED blinks, the *M8S* is transmitting data. Every time data enters the modem, the TX LED should blink

Solution #2. Verify that serial port timeout is OK. The ATG0 command sets the number of microseconds that the *M8S* will look for in the serial input data stream. If a pause greater than this value happens, the modem will transmit. If the ATG0 paramter is set very large, say 2000000, this means 2 seconds, and the modem may simply be waiting a long time

Solution #3. Verify that the radio channel is clear or BCL is off. The **ATBC 1** command enables Busy Channel Lockout. If BCL is on, the modem will not transmit on a busy channel. The **ATBC 0** command turns it off, and thus the modem will transmit when it needs to, regardless if the channel is busy. The RX led on the front of the modem is illuminated whenever the radio channel is busy (RF present).

Solution #4. Verify Low Power Mode. The M8S has an optional Low Power Mode (LPM). If LPM is enabled, the M8S will power down whenever the DTR line of the serial port is turned off. The Power LED will blink once every 10 seconds in the LPM mode. The **ATSM** command is used to set or read the Low Power Mode. **ATSM 1** enables it, and **ATSM 0** disables it. If LPM is used (**ATSM 1**), then the M8S will turn off when the DTR line is off, or the program connected to the serial port is closed, or the RS-232 connector is un plugged.

Symptom: Receive light blinks, but no data is received

Solution #1. Verify Input/Output Configuration. The *M8S* has numerous I/O options. RS232 is standard, but Ethernet, RS485 or RS422 may be configured also. Use the ATIO command to view how the I/O is configured. ATIO 0 is the default (RS232 mode).

Solution #2. Verify the serial port baud rate. This is difficult if it is set wrong, because you cannot enter the command mode to check it. Try all possible baud rates, and see if one of them works with the modem. Alternately, remove the rear cover of the modem, and press the CONFIG

button. This will force the modem into the Command Mode, as well as set the serial port to 9600 baud, 8 data bits, one stop, and no parity. If the baud-rate was OK, verify the AT, BT and CT times, that they are long enough for you to enter the +++ string.

Symptom: Long delay before transmitting

Solution #1. Verify that serial port timeout is OK. The ATR3 command sets the number of milliseconds that the *M8S* will look for in the serial input data stream. If a pause greater than this value happens, the modem will transmit. If the ATG0 parameter is set very large, say 2000, this means 2 seconds, and the modem may simply be waiting a long time. Typical settings for this parameter are 20 (20mS).

Symptom: Cannot enter Command Mode

Solution #1. Verify the serial port baud rate. This is difficult if it is set wrong, because you cannot enter the command mode to check it. Try all possible baud rates, and see if one of them works with the modem. Alternately, remove the rear cover of the modem, and press the CONFIG button. This will force the modem into the Command Mode, as well as set the serial port to 9600 baud, 8 data bits, one stop, and no parity. If the baud-rate was OK, verify the AT, BT and CT times, that they are long enough for you to enter the +++ string.

Solution #2. Handshaking. You may have hardware handshaking enabled on your terminal program, but the hardware or cable may not support it. Disable hardware handshaking on your terminal program to verify this is the issue.

Symptom: Modem appears dead.

Solution #1. Verify the power is on. When the modem has good DC power, the PWR LED will blink once per second. If it is not blinking, either the modem does not have power, the modem is broken, or the LEDs have been disabled via the **ATL0** command.

Solution #2. Verify Low Power Mode. The M8S has an optional Low Power Mode (LPM). If LPM is enabled, the M8S will power down whenever the DTR line of the serial port is turned off. The Power LED will blink once every 10 seconds in the LPM mode. The **ATSM** command is used to set or read the Low Power Mode. **ATSM 1** enables it, and **ATSM 0** disables it. If LPM is used (**ATSM 1**), then the M8S will turn off when the DTR line is off, or the program connected to the serial port is closed, or the RS-232 connector is un plugged.

12. Mechanical

A drawing is shown below.