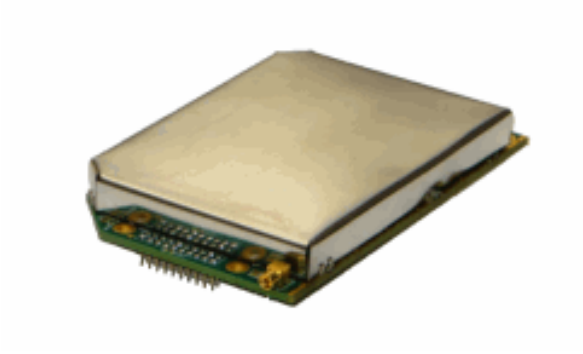
RV-M8S / RV-M8R

Data/Tracking/Paging Radio Modem
Technical Manual

Version D1

June 2019



Raveon Technologies Corporation
2320 Cousteau Court
Vista, CA 92081
www.raveon.com

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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.

1.3. Safety / Warning Information

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.

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.

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.

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.

Unlike any other radio modem on the market, the M8 may be operated in either a "Packetized Mode" or a "Streaming Real-Time Mode". There are advantages to each approach, and your choice depends upon how your system operates. Packet mode is the default in in most all cases, it is the best way to use a radio modem.

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.

It is also available in a receive-only version called the M8R. The M8R is the same electrical design and has the same features as the M8S except the transmit circuits are not populated.

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. (< 700mW receiving, < 8W transmitting)*
- *Lowest current draw in industry.*
- *Easy to use. Transmit data in = Receive data out.*
- *Receive-only version available*
- *Easily configured using "AT" commands*
- *Extensive diagnostic capabilities*
- *Serial communication may be 7 or 8 bit ASCII, or WMX*
- *Audio pass-through mode*

Data Radio Modem Features

- *High-speed over the air data rates.*
- *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 broadcast transmissions. Network mask allows groups of any size.*
- *Up to 5 watts of RF output. –VM MURS band version is 2 watt limited. Other RF power levels available upon request.*
- *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.*
- *Integrated Packet data protocol and built-in Streaming real-time operation.*

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.*

2.2. Firmware Updating

The M8S is a software based radio and modem. There are times an existing unit needs to get updated with a new feature, and this can often be done by loading the new firmware into the older radio modem. In firmware program called the “Boot Loader” is permanently installed inside the M8S’s microcontroller. During power up, it checks to see if the user wants to update the application program in the microcontroller. The STAT2 pin is used to trigger the Boot Loader. See application note AN186 for details on how to boat load new firmware into the M8S.

3. Electrical Inputs and Outputs

3.1. 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.

3.2. 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 of outbound serial data. Enable with In audio pass-through mod: functions as PTT. 0=TX, 1=RX.
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.

3.3. 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.

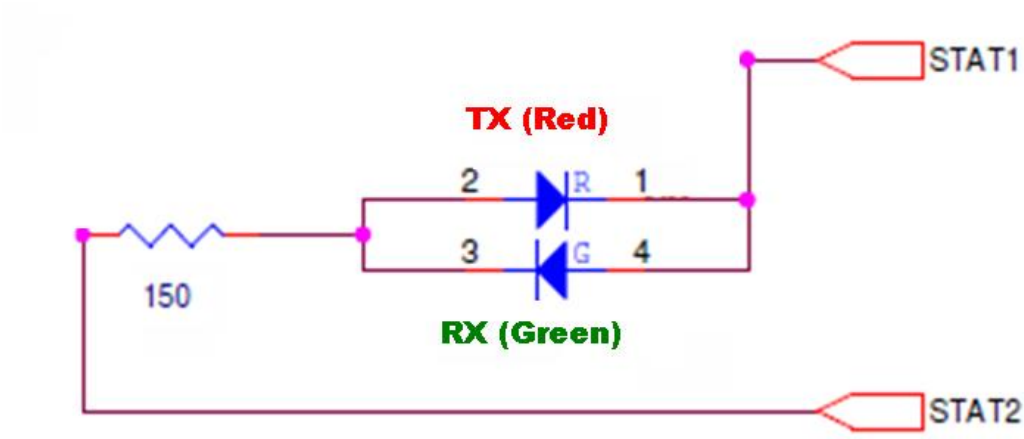
If an external heat sink presses against the “GND PAD” on the PCB, the RF power transistor will run cooler, and allow higher duty cycles.

3.4. 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.

3.5. 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.

4. User Serial Port Commands

4.1. 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*. 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.

4.2. 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 (transceiver version)

or

Raveon M8R (receive only version)

out of its serial port, and then an "OK" sequence. The "OK" sequence is a sequence of 4 characters:

An "**O**", "**K**", <**CR**>, and <**LF**> characters
(**<CR>** = ASCII 0D, **<LF>** = ASCII 0A)

4.3. 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.

4.4. 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.

4.5. CONFIG Button

If certain parameters within the modem are modified in a manner 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.

4.6. 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.

5. Command Mode Commands

5.1. General Command

These commands apply to the general configuration of the M8S, and are applicable in both the data modem mode and paging mode.

Command	Command Description	Parameters	Factory Default
ATAK	**Enable/Disable ARQ** – When ARQ is enabled, this modem will automatically send an ACK packet back to a modem that sends it data. 0=off, 1=on.	Range: 0 – 1	0 (no AKCs sent)
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
AFDC	**Audio input DC ofset** – The DC bias level on the audio input in millivolt. Adjust this setting so the audio transmissions are on the center of the channel. Set to 0 to have the M8S auto-detect the average.	Range: 0-3300 mV	1650
AFLVL	**Audio input level gain** – internal gain of the audio input signal, in % . Adjust this setting for the audio input deviation level.	Range: 0-2000% mV	100
AFLIM	**Audio deviation limit** – Sets the peak audio deviation limit for TX audio in the audio pass-through mode. In % of data deviation 100% limits audio to same as data. .	Range: 0-300%	100
ATBT	**Silence BEFORE Sequence** – Sets period of silence before the command sequence character in mS.	Range: 0-1000 mS	500
ATBW	**Set/Read IF Bandwidth -** Sets the IF bandwidth to narrow (N) or wide (W). Narrow is for 12.5kHz channels, and wide is for 25 or 30kHz spaced channels.	N or W	N
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 serial data characters.	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
ATCM	**Command Mode –** This command sets the way command mode can be entered. ATCM 1 will follow the RTS line – ATCT and EXIT command are still intact	0 = "+++" mode 1 = RTS line	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)

ATEN	**Data Encryption –** 0:disable. 1:AES128 GPS messages 2:AES128 Data and GPS messages. If not disabled, the transmitted data is encrypted with the selected encryption method using the **KEYPHRASE**.	Range: 0, 1, 2	0 (off)
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
ATI0	**Read/Set IO Mode** Normal digital serial mode is 5. If plugged into Tech Series enclosure (M21, M22), set this parameter to 8. Cycle Power to radio after changing ATIO mode.	Range: 0-8	5
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	**Modem Protocol Select** – The over-the-air communication protocol. 0=Packetized mode, 2=streaming, 3=POCSAG paging receiver. 8=Audio pass-through.	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

ATS120	**Set Data Framing Pre-Data Time** – When enabled (set to anything but 255), sets the pre-data time for CD Data Framing (See **Error! Reference source not found.**for more information)	0-254 = Enabled 255 = Disabled	255
ATS121	**Set Data Framing Post-Data Time** – Enabled by ATS120. Sets the post-data time for CD Data Framing (See **Error! Reference source not found.**for more information)	0-254 = Enabled 255 = Disabled	255
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. When set to 4, the receiver is off. The transmitter will still send data.	Range: 0, 1, 2, 4	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. Entering a <CR> will terminate the transmission.	0 = Go back to normal 1 = Random 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
MIMIC	**MIMIC mode.** MIMIC X Y X number of seconds to TX if input is low. Y is number of seconds between transmissions when the input is high.	None	
MODEL	**Read Model number. Read the model number of the unit.**	None	M8S or M8R
QSIZE	**Read the number of queued WMX frames in the WMX queue.**	None	-

QCLR	**Remove all WMX frames from the WMX frame queue.**	None	-
SHOW	**Show/display an overview of the radio's configuration.**	None	-
WMX	**Read/set the WMX serial port protocol. 0=off, 1= enabled.**	0, 1	0
WMXVR	**Read the WMX version**	None	
WMXINFO	**Read WMX information.** Returns: **Aa, bb, ccc, dd** where AA = Number of WMX message buffers in the product's WMX queue. bb = Number of WMX messaged queued up in the product's WMX frame queue. ccd = Total size of WMX message buffers in bytes. dd = WMX version implemented in the product.		

** 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.

5.2. 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
ATHS	**Show History** – Show a table of listing the most recent receptions, and the IDs that the data was sent from. The time shown is time in seconds since the reception, 2mS resolution.	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 **9.6** 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	3 narrow
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
ATGP	**Group Number** – Set or read the unit's Group Number. 0 means this feature is not used. If GP is set to any number other than 0, then all radios communicating with this unit must have the same group number programmed into them.	Range 0-255	0
ATTT	**Max Packet Size –** Set the maximum number of bytes in an over-the-air packet.	1 - 512	80
TXHOLD	**TX Hold ON –** Will hold the transmitter on between transmissions for x amount of milliseconds waiting for more data		0
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 TX delay –** Read or set the repeater/ACK delay in mS. This is the time between receiving a data packet, and the time the repeater will re-send it. If ACK feature is enabled, the delay in the ACK will also use this value. Default is 0, no delay.	*0 – 2000 milliseconds*	*0 (No Delay)*
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*	-
REPEAT	**Turn Repeater feature on/off. If 1, a quick way to enable repeating all packets. I f 0, disables the repeat feature.**	*0 (off) or 1 (on)*	*0*
RPR	**Remote Procedure Request.** Used to request execution of a command on a remote mode (over the air). See *M8S System Protocol* manual for information on using this feature.		

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

5.3. 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*

5.4. Factory Default Settings

RV-M8S-xx (Transceiver)

For the UHF M8S, model RV-M8S-UC, the main factory defaults are:

General Settings

Primary Protocol: (ATMT 0)..... Packet Data
Alternate Protocol: (ATMA 3) ..... POCSAG
WMX (WMX 0) ..... OFF

Paging Settings

Over-the-air paging baud rate: ..... 512 baud
Alternate protocol (pin 15 = 1)..... POCSAG 512
Paging data format (DF)..... Auto detect
Paging Cap Code 1 (CC 1 279001) 279001

Data Modem Settings:

Over-the-air data modem baud rate: ..... 4800 baud, 2-level
Serial port..... 9600baud, N/8/1
Hardware flow control ..... Off
RF Power Output 100% (2watts)
Channel number selected 1
ID (ATMY) 1234
Address Mask (ATMK) ..... FFFF
Frequencies
Ch 1.....462.2125 MHz

RV-M8R-xx (Receive Only)

For the UHF M8R receiver, model RV-M8R-xx, the main factory defaults are:

General Settings

Primary Protocol: (ATMT 0)..... Packet Data
Alternate Protocol: (ATMA 3) ..... POCSAG
Channel number selected 1
WMX (WMX 0) ..... OFF

Paging Settings

Over-the-air paging baud rate: ..... 512 baud

Alternate protocol (pin 15 = 1) ..... POCSAG 512
Paging data format (DF) ..... Auto detect
Paging Cap Code 1 (CC 1 279001) 279001

Data Modem Settings:

Over-the-air data modem baud rate: ..... 4800 baud, 2-level
Serial port 9600baud, N/8/1
Hardware flow control ..... Off
ID (ATMY) 1234
Address Mask (ATMK) ..... FFFF
Frequencies
Ch 1 .....462.2125 MHz

6. Using the M8S-VM MURS version

This section describes the operation of the M8S MURS version.

The five MURS authorized frequencies (47 CFR 95.632) and associated channel emission bandwidths (47 CFR 95.633) are:

1: 151.820 MHz	(11.25 KHz bandwidth)
2: 151.880 MHz	(11.25 KHz bandwidth)
3: 151.940 MHz	(11.25 KHz bandwidth)
4: 154.570 MHz	(20 KHz bandwidth)
5: 154.600 MHz	(20 KHz bandwidth)

The ATHP command can be used to change between these 5 frequencies.

The M8S-VM MURS band transmit power is limited to 2 watts maximum.

The ATFX and ATFT commands do not change frequencies in the M8S-VM MURS radio modem.

When using the narrow channels (1, 2, 3) set the over-the-air baud rate to 2-level 4800 baud (**ATR2 3**) or slower if desired.

When using the wide channels (4, 5) set the over-the-air baud rate to 2-level 9600 baud (**ATR2 5**) or slower if desired.

The M8S-VM radio modems are exclusively MURS frequencies radios. These devices also comply with FCC Rules Part 15.

Operation is subject to the following two conditions:

1. This device does not cause harmful interference.

2. This device does accept any interference received, including interference that may cause undesired operation. FCC License is not required.

This device operates on frequencies authorized for use in the Multi-Use Radio Service (MURS). MURS frequencies are available for unlicensed business or personal use.

To comply with FCC requirements, transmitter adjustments should be made only by or under the supervision of a person certified as technically qualified to perform transmitter maintenance and repairs in the private land mobile and fixed services as certified by an organization representative of the user of those services.

Do not Replace any transmitter component (capacitor, semiconductor, etc.).

7. Using the M8S in Paging Mode

This section describes the operation of the M8S when it is in the *paging receive mode.*

There are two ways to configure the M8S to operate as a paging receiver. The M8S may be configured to use just one protocol 100% of the time as defined by the **ATMT** command. Or, the M8S may be configured with a second “Alternate Protocol”, that may be selected using the input pin 15.

1. ***Configured by Command***. *With ATMA set to -1 to disable the alternate protocol, the ATMT command will select the current operating mode, either data modem or paging.* ***ATMT 0*** *selects data modem*

*mode, and **ATMT 3** selects POCSAG paging receiver command. With **ATMA** set to -1, the **ATMT** command will always determine the protocol the M8S is using.*

2. ***Hardware Select:*** *Issue the **ATMA 3** command to set the Alternate Protocol to paging decode. When **ATMA** is set to any number other than -1, the M8S will use input pin number 15 to select between two possible protocols. Protocol numbers are: 0=data radio, 3= POCSAG decode. Pull input pin 15 high, enabling the alternate protocol. The factory default configuration is ATMA 3 and ATMT 0.*

7.1. Setting Cap Codes

Cap Codes are the "ID" of the paging receiver. When a paging message is receive dover-the-air with a cap code that matches any one of the M8S's configured cap code registers, the M8S will receive the paging message. The M8S has multiple cap code registers. To configure a cap code register, use the CC x command, where x is the cap code register number. Setting a cap code to -1 or 0 disables the particular cap code.

For example, to configure the M8S to receive pages sent to cap code 12345, issue the following command:

CC 1 12345

By factory default, the cap code is set to 12345, and all other cap code registers are disabled. If you issue the AT&F command, the cap codes will be reset to factory defaults.

*For test purposes, the promiscuous receive mode may be enabled using the PM x command. If **PM** is set to PM 1, then the cap codes are ignored, and the M8S will receive all paging messages.*

7.2. Setting Paging Data Format

Pagers are generally either numeric, alpha-numeric, or tone. Most paging transmitters specify the type of pager message they are sending, by setting the function bits in the pager message. If they do, then the M8S can be set to automatically select paging format.

If the user wishes to force the M8S to decode messages in a particular format, then set the data format manually using the DF command.

DF 0 *(numeric),* ***DF 1*** *(alphanumeric),* ***DF 2*** *(tone),* ***DF 3*** *(auto select).*

7.3. Numeric Messages

When the pager receives a numeric page, it outputs the numeric digits via its RXD output pin on the I/o connector. The baud rate of the serial port is set with the **ATBD** command. The outputted characters are ACSII representations of the BCD numeric digits.

BCD numeric encoding packs 4 bit BCD symbols 5 to a message code word into bits 30-11. 0-9 are encoded as ASCII 0-9. Values beyond 9 in each nibble (i.e. 0xA through 0xF) are encoded as follows:

- 0xA Reserved (possibly used for address extension)
- 0xB Character U (urgency)
- 0xC " ", Space (blank)
- 0xD "-", Hyphen (or dash)
- 0xE ")", Left bracket
- 0xF "(", Right bracket

Over the air, BCD messages are normally space padded with trailing 0xC's to fill the code word. The M8S output ASCII characters representing the numeric digits as shown in this table:

Numeric Digit	ASCII	ASCII Code		Numeric Digit	ASCII	ASCII Code
0x0	0	0x30		0x8	8	0x38
0x1	1	0x31		0x9	9	0x39
0x2	2	0x32		0xA	*	0x2A
0x3	3	0x33		0xB	U	0x55
0x4	4	0x34		0xC	*space*	0x20
0x5	5	0x35		0xD	-	0x2D
0x6	6	0x36		0xE	)	0x29
0x7	7	0x37		0xF	(	0x28

7.4. Alphanumeric Messages

When the pager receives an alphanumeric page, it outputs the charactors via its RXD output pin on the I/o connector. The baud rate of the serial port is set with the **ATBD** command.

Alphanumeric messages are comprised of a sequence of numbers and letters, using 7-bit ASCII characters. Characters are encoded in 7 bit ASCII format and assembled into the 20 bit message bits area of a message code word (bits 30-11). Three seven bit ASCII characters use 21 bits so if the message is 3 or more ASICC characters long, the first 20 bits of an ASCII message are in the first code word, the next 20 bits of a alphanumeric message are transmitted in the next code word, and so on. The 7-bit ASCII code is used for alpha-numeric messages. There are 20 bits in each codeword for message data, however, in this format each character is 7 bits. Characters are split between codewords and the last codeword is filled with unprintable characters such as *end of message* , *end of text,* or *null*. Null is the only character which can be

incomplete.
The maximum length for a standard alpha-numeric message is 40 characters.

ASCII				b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	1	0	1	0	1
b4	b3	b2	b1		↓							
0	0	0	0	→	NUL	DLE	SP	0		P		p
0	0	0	1		SOH	DC	!	1	A	Q	a	q
0	0	1	0		STX	DC	"	2	B	R	b	r
0	0	1	1		ETX	DC	#	3	C	S	c	s
0	1	0	0		EOT	DC	$	4	D	T	d	t
0	1	0	1		ENQ	NAK	%	5	E	U	e	u
0	1	1	0		ACK	SYN	&	6	F		f	v
0	1	1	1		BEL	ETB	'	7	G	W	g	w
1	0	0	0		BS	CAN	(	8	H	X	h	x
1	0	0	1		HT	EM	)	9	I	Y	i	y
1	0	1	0		LF	SUB	*	:	J	Z	j	z
1	0	1	1		VT	ESC	+	;	K		k	
1	1	0	0		FF	FS	,	<	L		l	
1	1	0	1		CR	GS	-	=	M		m	
1	1	1	0		SO	RS	.	>	N	^	n	
1	1	1	1		SI	US	/	?	O	_	o	DEL

7.5. WMX and POCSAG Decoding

The WMX protocol may be enabled with the modem in the POCSAG mode. This allows the user to easily read the ID that was decoded by the POCSAG receiver.

Details about WMX and code examples are on the Raveon website at www.raveon.com/wmx

When a POCSAG message is received, and the WMX feature is enabled in the unit (**WMX 1** command), then the M8S will output the decoded message wrapped in the WMX frame format as shown below.

WMX Frame Format

WMX Frames are used to pass data into and out of a radio modem. The bytes in the data field of the frame, field 6, contains the data that is transferred.

WMX Data Frame Format for Paging Reception

Field Number	Bytes	Field Name	ASCII Code	Function
	1	Start of Header (SOH)	1 (0x01)	Indicates beginning of a frame
1	1	Control Field[*1]	0x42	Indicates a Receive Data WMX message
2	0-6	Destination Address	ID in ASCII hex, 0000-FFFFFF	6 ASCII HEX representation of the decoded CAP code. For example, cap code 279001 will be represented in the field as 441D9.
	1	Separator 1 (**!**)	33 (0x21)	Field separator character 1.
3	0-4	Source Address (Optional when transmitting)	Null (no byte)	This field is unused in POCSAG Decoder. It may contain the ID of the radio that sent this WMX message.
	1	Separator 3 (#)	35 (0x23)	Field separator character 3 (when transmitting, may be left out if sequence field is not used)
5	0-4	Sequence	ASCII number 0-255	A sequence number for this reception to uniquely identify it. Increments every reception.
	1	Separator 4 (**$**)	36 (0x24)	Field separator character 4

6	0-16	RSSI Field	ASCII digits	RSSI Information about this reception. Units in negative dBm.
	1	Start of Text (SOT)	2 (0x02)	Indicates beginning of data
7	1-500	Data Field		The data bytes sent/received by the user. May be any binary data bytes except the DLE ETX sequence. *See Binary Encoding* section on how to send 8-bit binary data.
	2	End of Text (DLE ETX)	16 (0x10) 3 (0x03)	ETX end of the data frame
8	0 - 4	ASCII hex Checksum (Optional)	Variable 0-FFFF	The 16-bit checksum of all the previous bytes, starting with the SOH through the end of the data bytes, not including DLE/ETX. Most significant digit first.
	1	End of Transmission (EOT)	4 (0x04)	Indicates end of the frame

8. Using the M8S – Packet Data Mode

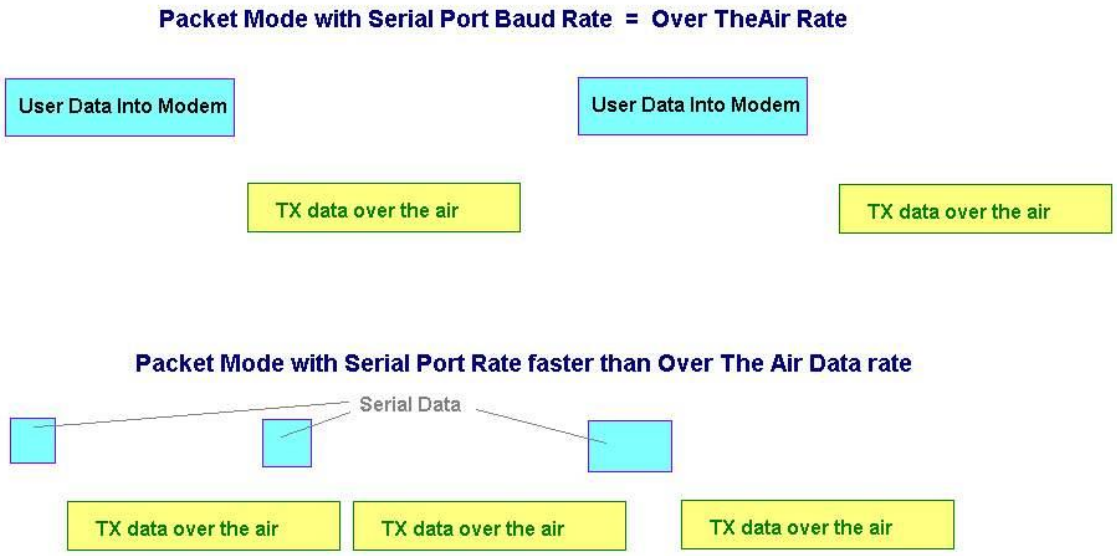
This section describes the operation of the M8S when it is in the *Packet Mode* of operation. It is the easiest and most reliable mode of operation for a data modem.

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.

8.1. 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, and 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.

Streaming Mode Advantages

1. ***Low Latency:*** The transmitter will key-up immediately upon the user's first byte of data entering the modem. Packetized operation waits until a packet has been loaded before keying. (Although high serial-port data rates can minimize this packet latency to a negligible level). When receiving, data comes out the serial port as it is received. In packet mode, data output starts at the end of the packet once the CRC is verified and any decryption is complete.

2. ***Data with Errors:*** Packet mode does not output corrupted data. But when a streaming mode radio is receiving data, it works down into the noise-floor of the radio. If the channel is noisy or the signal is weak, there will be bit-errors in the data. At the end of a transmissions, the modem may output additional noise data. User applications must (and often do), take this into account.

8.2. 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.

8.3. 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 **ATCD** command. This is factory calibrated to an equivalent RF level of approximately -110dBm.

8.4. 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.

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.

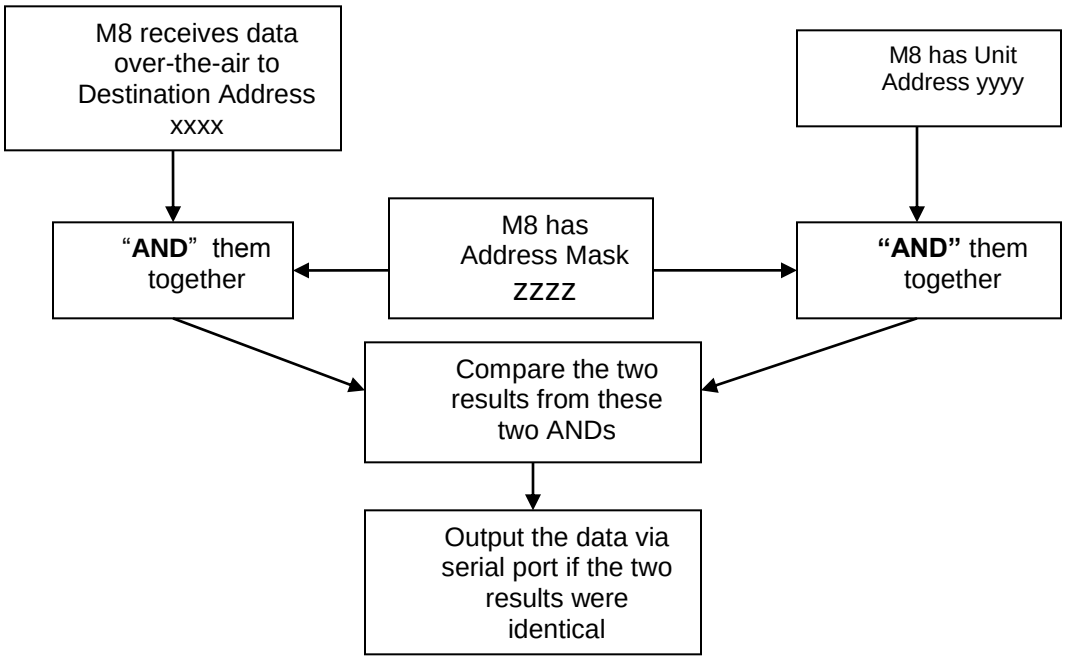
The Address Mask

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.

8.5. 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.

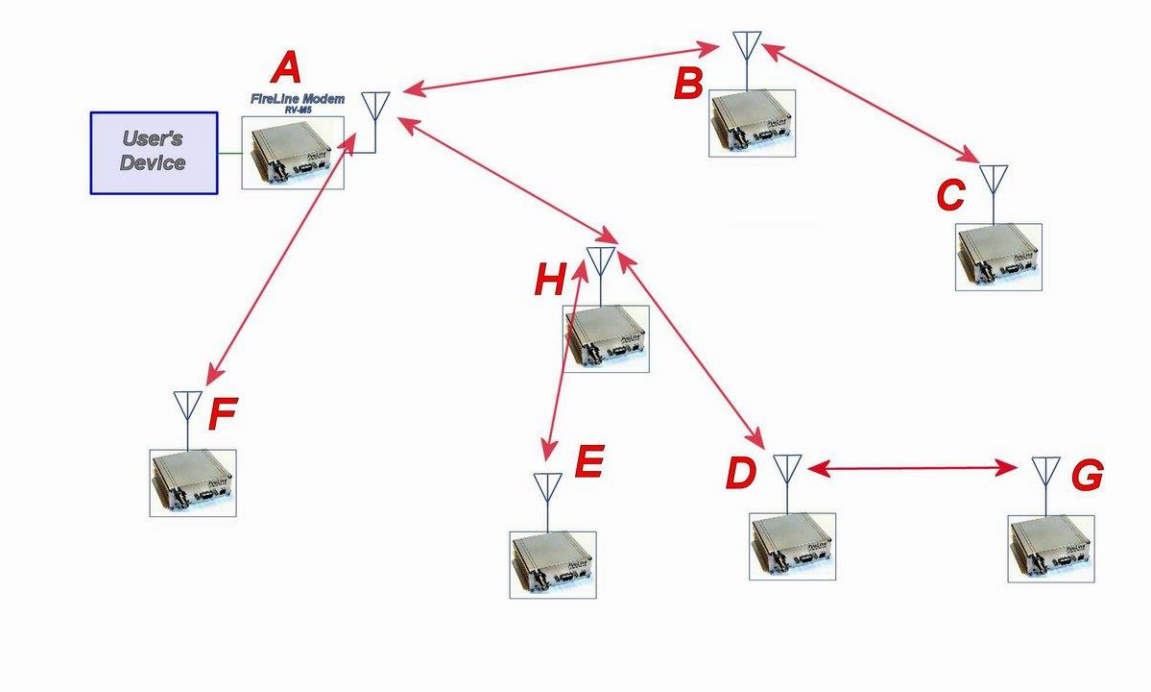
Manual Configuration of the Repeat Feature

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.

9. Using the ***Streaming Mode***

This section describes the Streaming Mode of operation. This mode is selected with the command **ATMT 2**. Streaming mode transmissions are transmissions of raw data, no error correction, no device address, no byte count, no encryption,

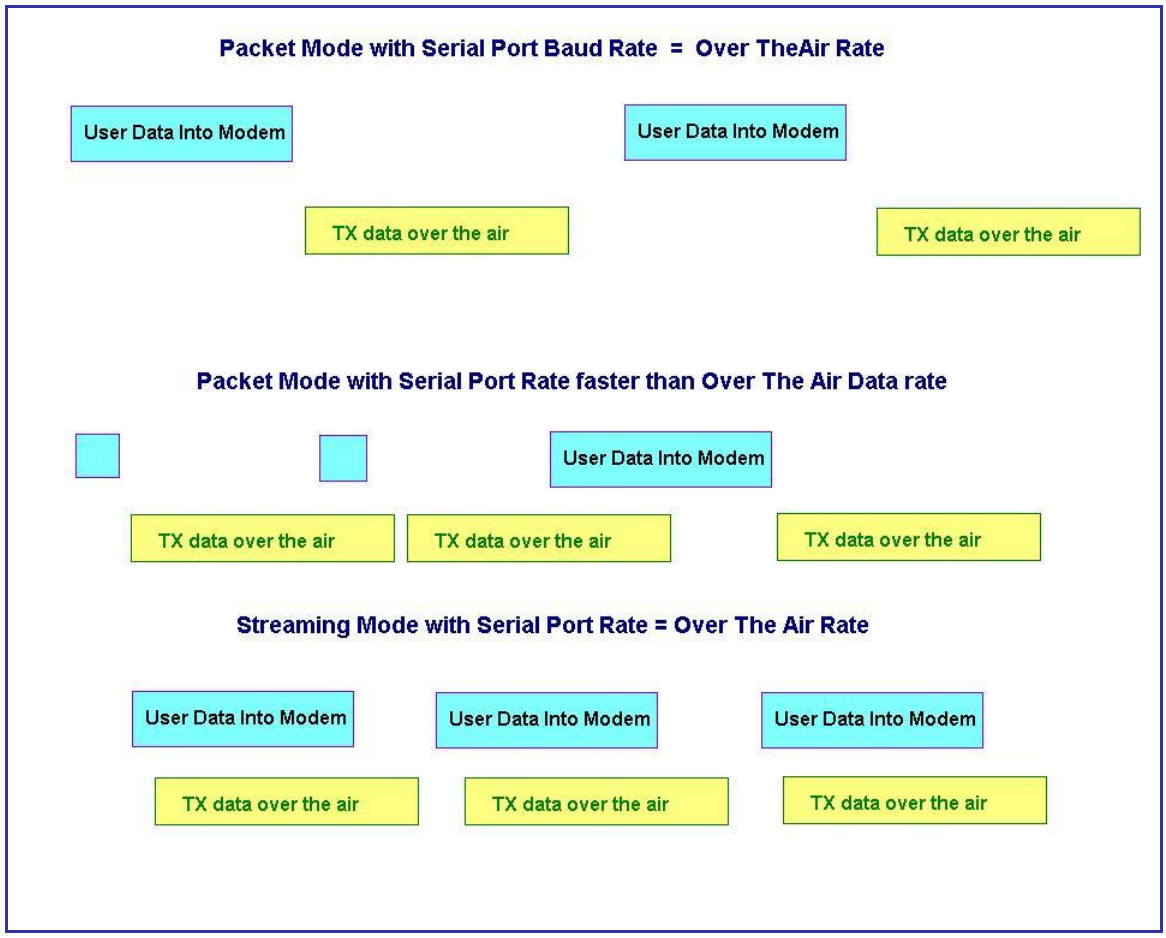
no checksum,…The Streaming Mode over-the-air transmissions are much shorter because they do not have the features and reliability of the *Packet Mode*. In most situations, we recommend that the *Packet Mode* be used because of its error detection, and strong features.

9.1. Streaming Mode Operation

In Streaming Mode, radio transmissions will begin whenever data enters the modem, and the transmission will continue as long as there is data to send. The transmitter will automatically key when data enters the modem, and there is no need to assert any control lines. It will automatically de-key when there is no more data to send.

Figure 3 illustrates the difference between the Packet Mode and the Streaming Mode of operation.

` Figure 3 (Streaming Mode of Operation)



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9.2. Baud Rate Selection

In Streaming Mode, the user data may still enter the modem at any baud rate, as set with the **ATBD x** command. The modem will buffer the data and send it out

over the air in the same order as it enters the modem. When the buffer is empty and there is no more data coming into the modem, it will automatically de-key the radio and go back into the receive mode. The modem will send a hidden end-of-message signal to the receiving modem, thus avoiding any extra data bytes "*dribble bytes*" from coming out of the user serial port. When the modem is operating with very weak signals, the end-of-message signal may be obscured, and missed by the receiving radio modem. In this case, additional noise bytes may come out of the user serial port.

While receiving, the modem will also output the receive data out the serial port at the rate set by the **ATBD** command. If the serial port baud-rate is slower than the over-the-air rate, an internal buffer in the modem will hold the data as it is sent out the serial port.

9.3. Bit Errors

Unlike Packet Mode operation, there is no error-detection nor error-correction in the Streaming Mode, so user data may contain bit errors. The user's application must be able to handle these errors or additional bytes of noise data.

If the application that is using the M8 cannot tolerate have erroneous data when the channel is noisy, the modem should be operated in the Packet Mode instead of Streaming mode (In Packet Mode, data is always first checked for bit-errors, and never outputted if it detects any errors).

The end of a transmission is detected by the receiving modem by the presence of a special end-of-message signal send over-the-air. The end-of-message over-air signal is a CW carrier signal sent at the end of data. Transmitting M8S automatically put the end-of-message signal out after the user's data has been transmitted. If the receiving modem does not receive this CW signal (due to noise or interference), the receiving modem may continue to output some more data, until it detects that the RF carrier is gone, or the received signal is actually very noisy. This may take a byte or two of time, and during this time period, the receiving modem may output random noise bytes.

9.4. Carrier Detect

To reduce bit errors and additional noise bytes, the user may configure the modem to require and RF carrier Detect before receiving any data. Because the RF carrier Detect Threshold is set above the noise-floor of the receiver, bit-errors will be rare if RF carrier is required to receive. By default, the M8 does not require RF carrier detect to receive. To enable it, use the **ATRF 1** command. To disable the need for RF carrier detect, us the **ATRF 0** command (Factory default).

When **ATRF** is **0**, the modem will be more sensitive, and be able to receive weak signals, but there is more likely to be many bit errors when the signals are weak.

9.5. Serial Data Flow Control

If large amounts of data will be transmitted, and the serial port is operated at a faster data rate than the over-the-air rate, it may be possible to overflow the internal data buffer. To ensure the transmit buffer does not overflow, enable and use hardware flow control. Hardware flow control is enabled with the **ATCH 1** command. Note that the *M8* modem will always indicate the status of its internal buffer using the CTS signal on the DB-9 serial connector. When CTS is negated, the internal buffers are more than 80% full. When it is asserted and it is "Clear to Send", the buffers are less than 80% full. The ATCH command enables or disables the RTS input signal.

9.6. Setting the Over-The-Air Data Rate

The M8 has programmable over-the-air baud rates. The over-the-air rate is stored in register R2, and is programmed with the **ATR2 x** command, where **x** is a number corresponding to the rate. There are many possible baud rates, but not all rates may be used with all radio modem models. Consult the following table.

Over-the-air rate	***Radio Bandwidth***	***Number of Modulation Levels***	***Modem Channel Bandwidths that support the rates***
800bps (R2=0)	12.5kHz or 25kHz	2	W and N
1200bps (R2=1)	12.5kHz or 25kHz	2	W and N
2400bps (R2=2)	12.5kHz or 25kHz	2	W and N
4800bps (R2=3) Default setting	12.5kHz or 25kHz	2	W and N
8000bps (R2=4)	12.5kHz or 25kHz	4	W and N
9600bps (R2=5)	25kHz	2	W
19200bps (R2=6)	25kHz	4	W
5142bps (R2=7)	12.5kHz or 25kHz	2	W and N
9600bps (R2=8)	12.5kHz or 25kHz	4	W and N

Changing the over-the-air data rate will change the sensitivity of the receiver. Higher-data rates require a stronger signal at the receiver to be properly received. The default over-the-air data rate for *M8* radio modems is 4800 baud for narrow-band versions, and 9600 baud for wide-band versions. These are the optimal data rates for radio modems on wide and narrow radio channels.

The maximum over-the-air baud-rate for a narrow-band radio (12.5kHz channel-spacing) is 9600bps. Due to IF filter limitations, the *M8* does not work as well at 9600 baud as some other rates. Its performance is optimized for 4800 baud 2-level modulation and 8000 baud 4-level modulation.

The maximum over-the-air baud-rate for a wide-band model (25kHz channel spacing) is 19200bps. Due to IF filter limitations, it does not work as well at 19200 baud as lower data rates. Its performance is optimized for 9600 baud 2-level modulation.

RV-M8-UC (narrow-band version)

Factory default, set R2 to 3 (4800 baud).

For **high-speed operation**, set R2 to 4 (8000 baud).

For **best range** (longest distance), set R2 to 1 (1200 baud)

Other data rates of 0(800bps), 2(2400bps), 3(4800bps), and 7(9600bps) will work, but have a less optimal bit-error-rate vs. receive sensitivity.

RV-M8-UC-W (wide-band version)

For **high-speed operation**, set R2 to 5 (9600 baud).

For **best range** (longest distance), set R2 to 1 (1200 baud)

Other data rates of 0(800bps), 2(2400bps), 3(4800bps), 7(9600bps), and 6(19,200bps) will work, but have a less optimal bit-error-rate vs. receive sensitivity.

10. Power Management

The RV-M8S has two ways to allow external devices to manage its power consumption.

1. A digital input to control the DC power on or off.
2. The ATSM command to tell the device to change operational features putting the device into a low-power mode (LPM).

10.1. A digital input

The IO pin 7 (Enable Pin) can be used to turn the device on or off. There is an internal pull-up resistor that enables the RV-M8S if this pin is not connected to anything.

If the Enable pin is pulled down to 0 volts, or at least below 0.7V, the Internal DC power supplies in the device will turn off, and the device power consumption will get very low. Typically below 1mA. The serial port an all device features will be disabled. This is very similar to turning the DC power on or off, but for many digital controllers, an open collector driver to digital out pin can be used to turn the radio on or off without switching the DC, which save cost, time, and current spikes.

10.2. The ATSM command

The ATSM command manages sleep modes and power modes. When the ***ATSM x*** command parameter ***x*** is set to:

0: The M8S will not go into LPM, regardless of the state of the DTR pin. This is the normal full-on mode.

1: Enables the DTR input line controls the M8's low-power operation. DTR can put the product into LPM mode.

2: The modem is forced into a low-power mode (LPM), disabling the receiver and transmitter.

4: The receiver is off, reducing current draw. The transmitter will still transmit the data as it normally does.

The LPM mode is a low-power mode, usually in the 20-30mA current range. The CPU is still running, serial data still monitored, the GPS is still running if this feature is used, but the receiver circuits are off, and the transmitter circuits are off. This command can be issued to the device in the command mode or using WMX messages to the device. Even in the LPM, the RV-M8S will process commands and WMX messages.

11. Audio Pass-Through Mode

The *M8S* modem may be configured to pass the receive audio out its I/O connection and when keyed, pass the audio on pin

The IO pins on the 20-pin I/O header related to the audio pass-through mode are:

Pin #	Function	I/O	Function
1	GND	-	Ground
2	Vcc	I	DC Input
7	Enable	I	Low (<.7V) to shut down the module. High (>2.5V) to enable it.
11	RSSI	0	Receiver signal strength indicator
13	TX 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.
10	PTT	I/O	In audio pass-through mode, functions as PTT. 0=TX, 1=RX.
17	RX Audio Out	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.
19	GND	-	System Ground to M8

Pin 12 is the Push To Talk (PTT) input. It has a pull-up resistor of about 10K on it. When PTT is low, the transmitter in the M8T will turn on, and output the audio signal that is on pin 13.

When PTT is high, the M8T is in the receive mode, and the receive audio will be output on pin 17.

There are a few commands designed specifically for use in configuring the operation of the M8S in audio pass-through mode.

AFDC	**Audio input DC ofset** – The DC bias level on the audio input in millivolt. Adjust this setting so the audio transmissions are on the center of the channel. Set to 0 to have the M8S auto-detect the average.	Range: 0-3300 mV	1650
AFLVL	**Audio input level gain** – internal gain of the audio input signal, in % . Adjust this setting for the audio input deviation level.	Range: 0-2000% mV	100
AFLIM	**Audio deviation limit** – Sets the peak audio deviation limit for TX audio in the audio pass-through mode. In % of data deviation 100% limits audio to same as data. .	Range: 0-300%	100
TXTOT	**Transmit Time-Out-Timer** – Sets the maximum number of seconds that the M8S will stay transmitting when the PTT input is asserted.	Range: 0-500 seconds	10

The transmit audio input pin 13 is designed to have audio sent in with a 1.66 V DC bias. If the audio input has a different DC bias voltage, the M8T can be reconfigured to use the different DC bias offset. The **AFDC** sets the nominal DC boas voltage. Note, the analog input range of the M8S is 0-3.3V. Ideally bias the DC input to 1.66V or AC couple it with a capacitor and add two bias resistor to ground and 3.3V. To have the M8S determine the DC bias input automatically

and use the measured DC level as the DC input, set **AFDC** to 0 to have the M8S automatically find the DC input bias and compensate for it.

The **AFLVL** command sets the DC gain of the TX audio input. With it set to 100%, an audio signal with a peak-to-peak value of 500mV will produce +/- 2kHz of FM deviation. With **AFLVL** set to 200, 250mV p-p input will give 2kHz p-p of FM deviation.

The **AFLIM** command sets a hard FM deviation limit, which will stop the M8S from deviating the FM carrier beyond the preset limit with the input TX audio exceeds a threshold that would have cause the M8S or over-deviate.

Raveon suggests the **AFDC**, **AFLVL**, and **AFLIM** always be adjusted and calibrated by trained radio technicians familiar with setting FM deviation gain and FM limiters.

The **TXTOT** command sets the transmit time-out-timer (TOT). The TOT protects the radio and the system from damage and interference due to accidental over-keying of a transmitter. Set the **TXTOT** value to the maximum number of seconds a TX audio pass-through transmission should ever take. If the **TXTOT** times-out, the M8S will automatically un-key, and not re-key again until the PTT line is negated, and then some time re-asserted.

12. 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)

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.

13. Diagnostic Provisions

13.1. 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.

13.2. 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.

13.3. Status and Statistics Command

AT Command	Command Description	Response
STAT	**General Communication Statistics** – This command will cause the *M8S* to output a table of various operational statistics.	Statistics overview screen
STAT 1	**GPS Tracking statistics** – Returns variables and statistics related to the GPS tracking if this GPS option is in this device.	GPS Statistics
STAT 2	**Low-level internal statistics** – Returns various low-level statistics. These are subject to change in various firmware revisions.	Low-level statistics screen
STAT 3	**Compile date and time** – Returns the data and the time that the firmware was compiled.	Date and time
STAT 4	**Run Time** – Returns the amount of time that the modem has been powered up and running.	Run time display screen
STAT 9	**Reset all statistics counters**	OK

14. 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.

14.1. 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.

14.2. 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

14.3. 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.

14.4. 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 +2.2kHz 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.

14.5. 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 RSSI value may be change with the **ATCD** 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 *M8* data is detected on the radio receiver).

ATR1 1 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.

ATR1 2 Mode 2 - CD ON

In this mode, the CD pin is always asserted.

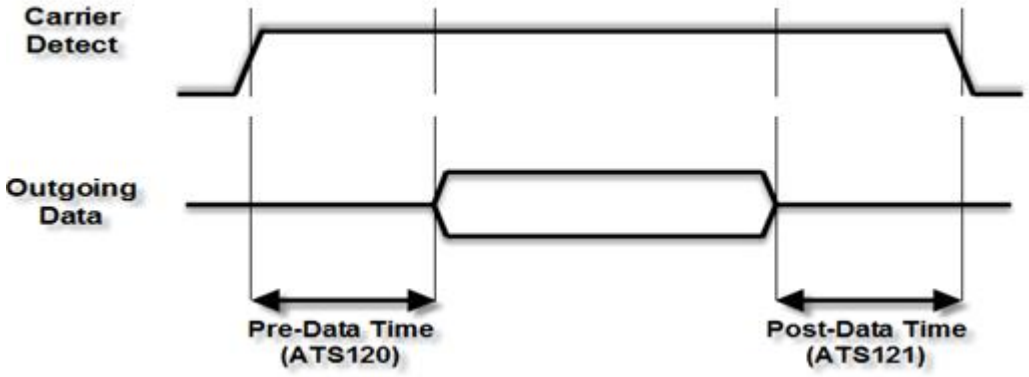
ATR1 3 Mode 3 - CD OFF

In this mode, the CD pin is always negated.

ATR1 4 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.

Output 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.

15. 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.

Solution #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 IO 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 parameter 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.

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.

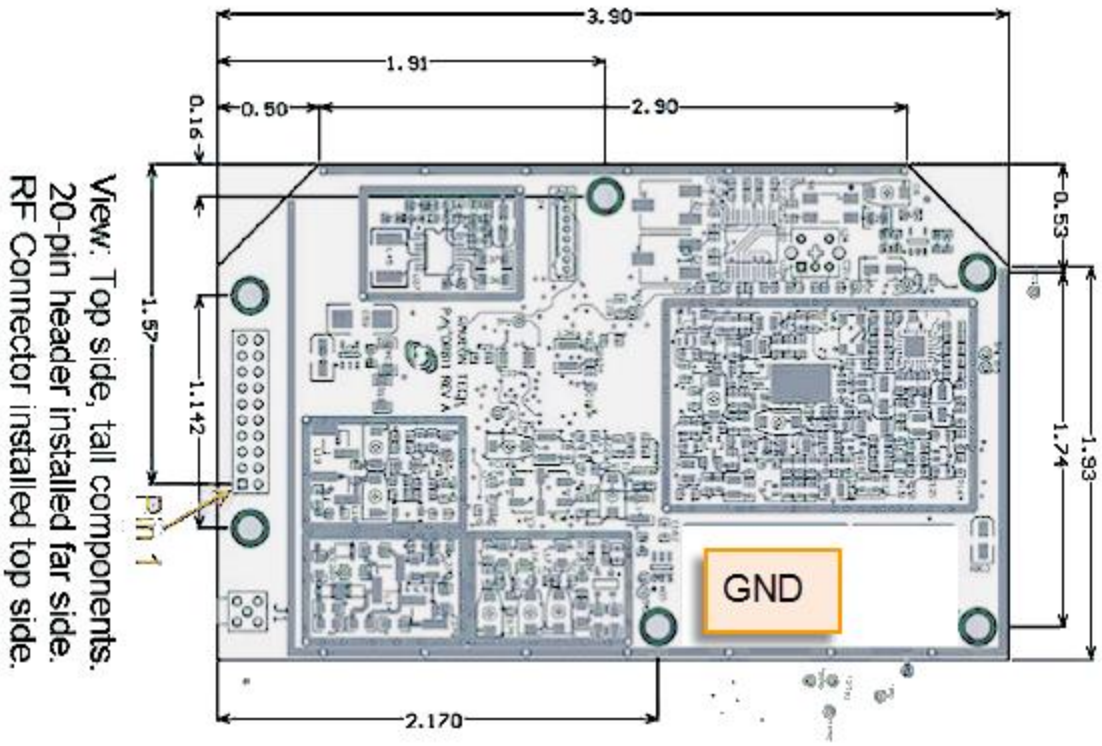
Solution #2. Verify Low Power Mode. The M8S has an optional Low Power Mode (LPM). If LPM is enabled, the M8S will power down whenever the DTR line of the serial port is turned off. The Power LED will blink once every 10 seconds in the LPM mode. The **ATSM** command is used to set or read the Low Power 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.

Symptom: Repeater will not repeat.

Solution #1. Verify the repeater's Unit ID is unique. An RV-M8S configured to be a repeater will not repeat messages it originated. If other units in the system have the same ID as the repeater, the repeater will not repeat them because it thinks the it originated the transmission. Set the MTID of the repeater to a unique ID number.

16. Mechanical

A drawing is shown below.



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Vista, CA 92081 - USA

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Products repaired under warranty will typically have their program memories erased and reset to factory default settings.