RV-M8S Data Radio Modem
Technical Manual

Version B4

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Raveon Technologies Corporation

2320 Cousteau Court

Vista, CA 92081
www.raveontech.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

WARNING - DO NOT operate the RV-M8S radio modem when bystanders are near the antenna.

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. FCC /IC (or Regulatory Agency?) Compliance Information

a. FCC Compliance Notice

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

This product also complies with FCC Part 22, 90 and Part 95 Subpart J of the FCC rules and regulations.

The Federal Communications Commission (FCC), with its action in ET Docket 93-62, has adopted a safety standard for human exposure to Radio Frequency (RF) electromagnetic energy emitted by FCC-certified equipment. This product meets the uncontrolled environmental limits as stated in OET-65C (01-01) when operated in accordance with the operation guidelines described in this manual. Proper operation of this radio device according to the instructions in this publication will result in user exposure substantially below the FCC recommended limits.

This equipment generates, uses, and radiates radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference. However, there is no guarantee that interference will not occur. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.

- Increase separation between the equipment and receiver.

- Connect the equipment to an outlet on a circuit different from which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician.

b. ISED RSS-Gen Notice (in English and French?)

This device complies with Industry Canada RSS for unlicensed radio devices. Operation is permitted under both of the following conditions:
1) the device shall not cause interference;

2) the equipment must accept any interference received, even if the interference is likely to compromise its operation

 "Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1) l'appareil ne doit pas produire de brouillage;

c. ISED RF Exposure Guidance (in English and French?)

In order to comply with FCC/ISED RF Exposure requirements, this device must be installed to provide at least 100 cm separation from the human body at all times.

"Afin de se conformer aux exigences d'exposition RF FCC / ISED, cet appareil doit être installé pour fournir au moins 100 cm de séparation du corps humain en tout temps." In order to comply with the FCC / ISED RF exposure requirements, this device must be installed to provide at least 100 cm of separation from the human body at all times"

1.5. 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.

This module is not FCC approved. (Check if this statement is needed!(??))

2. Overview

The *M8S* RF data radio is a rugged high-performance, high-speed narrow-band data modem. 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.

For privacy and network versatility, the *M8S* incorporates a 16 bit identification code. Its protocol also uses a 16bit CRC to guarantee the integrity of the data. Perfect for SCADA and telemetry applications, the *M8S* can be used for simple point-to-point data communication applications, or for more sophisticated point-to-multipoint, peer-to-peer, or mesh networks.

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

2.1. Features

- *High-speed over the air data rates.*
- *Built-in radio transceiver with integrated modem*
- *Easy to use. Plug-in, Turn-on, and GO. Transmit data in = Receive data out.*
- *Lowest current draw in industry.*
- *Wide input voltage with high-efficiency switching voltage regulator.*
- *Integrated Packet data protocol <u>and</u> built-in Streaming Real-Time operation.*
- *ARQ error correction and retransmission capability. Totally transparent to the application.*
- *Capable of store-and-forward repeating operation.*
- *Small sized and very rugged extruded enclosure.*
- *16 bit addressing for up to 65,525 different unique device addresses per channel*
- *Supports group and broadcast transmissions. Network mask allows groups of any size.*
- *500-5000mW of RF output.   Other RF power levels available upon request.*
- *Easily configured using "AT" commands*
- *Very fast Transmit-to-Receive turn around time.*
- *RS-232 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.*

3. Specifications

3.1. General

Frequency Bands: RV-M8S-UC   *450-470*MHz

                                                RV-M8S-VB   150-174MHz

Serial Port Baud Rates   1.2k, 2.4k, 4.8k, 9.6k, 19.2k, 38.4k, 57.6k, 115.2k

Over-the-air baud rates   Narrow: 1200, 2400, 4800

                                                Wide: 1200, 2400, 4800, 9600

Operating Mode   Half-duplex

Full Spec Operating Temperature range   -30°C to +60°C

Extended Temp Range { extended temp specs}   -40°C to +60°C

TX-RX and RX-TX turn-around time   <3mS

Wake-up time   <500mS from OFF

Back-side LEDs   Power , Status

RF I/O Connector   SSMT

Digital signal levels   3.3V logic

Enable Input Low   400mV

Enable input High   1.40V

DC Input   10 – 30 VDC

3.2. DC Input

3.3V Input Specifications

DC Current Draw, RX mode   < 100mA

DC Current Draw, TX mode 100mW RF out   < 700mA {750mA}

Module disabled using pin 7 (?)   < 200uA

5.0V Input Specifications

DC Current Draw, RX mode   < 150mA

DC Current Draw, TX mode 100mW RF out   < 400mA {500mA}

DC Current Draw, TX mode 500mW RF out   < 800mA

Module disabled using pin 7 (?)   <200uA

3.3. Transmitter Specifications

RF Power Output .... 500mW –5W programmable

RF Frequency Range ……………….450-470 Mhz

Maximum Duty Cycle ....   *100% @ 100mW to 40C, 25% @600mW*

Frequency Deviation..........................*± 2.2kHz (-N) ± 3.5kHz (-W)*

RF Bandwidth....................................20 MHz no-tune

Occupied bandwidth.........................*8 kHz*

TX Spurious outputs..........................*< -70dBc*

Occupied Bandwidth.........................*Per FCC*

FCC Emissions Designator **8K20F1D**

Frequency Stability ....*Better than ±1.5ppm {2.5ppm}*

3.4. Receiver Specifications

RF Frequency Range ……………….. 450-470 Mhz
RX sensitivity (.1% BER).................... 9600bps   < -108dBm
                                                        4800bps   < -116dB {-110}
1200 & 2400baud .... Contact Factory
RF No-tune bandwidth 20MHz
Adjacent Channel Selectivity .... -65dB
Alternate Channel Selectivity .... -70dB
Blocking and spurious rejection .... -75dB
RX intermodulation rejection .... -70dB

3.5. Interface Specifications

Serial Interface Port	20-pin male header
IO Voltage Levels	3.3V digital logic. < 1000pF load capacitance.
RX and TX data	Transparent Async.
Word length	7 or 8 bits
Format	N, O, or E
RF Connector	MMCX

3.6. *LEDs*

The status LED visually show the current status of the radio.

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.

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.

3.7. *I/O Pinout*

The I/O connector is a 20-pin header. Pin-out and connector type to match MaxStream 9XTend.

I/O Pin Out

Pin #	Function	I/O	Function
1	GND	-	Ground
2	Vcc	I	DC Input
3	Carr Det	O	CD Out. High for carrier. Low for no carrier.
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 to shutdown the module. High to enable it.
8	Sleep	i	CPU Sleep input
9	CTS	O	Clear to send output. Indicates state of internal buffers.
10	RTS	I	RTS input for serial flow control.
11	RSSI	0	Receiver signal strength indicator
12		I	
13-20			To be determined. Raveon may use these pins for test functions and certain data-radio features.

3.8. *Low Power Mode (LPM)*

The *M8* modem, has the ability to be put into a low power mode (LPM). In LPM the modem draws much less current from the DC input. In LPM, the internal radio in the M8 is disabled, as well as certain current-consuming hardware circuits. The ability of the *M8* to go into LPM is set with a configuration bit, using the **ATSM 1** command. **ATSM 1** configures the M8 to monitor the DTR input line, and enter the LPM mode whenever DTR is negated.   If the DTR signal is asserted, the M8 modem will operate normally.

The **ATSM 2** command forces the M8 modem into the low-power mode. In the Low Power mode, the M8's radio circuits are off, but it will still respond to

serial commands and it will still transmit characters over the air, albeit with some latency as it has to power-up the radio each time it wishes to transmit.

The **ATSM 0** command returns the M8 modem into the normal-operating mode with the receiver and transmitter operational.

The factory default value for the **ATSM** setting is **0**. When **ATSM** is a zero, the *M8* will not ever enter the LPM mode, and the DTR input signal is ignored.

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 *M8* modem.

There is also a "Command Mode" used to program and configure the *M8*. In the Command Mode, the *M8* modem accepts commands via the serial port TxD pin. The commands can be used to change certain internal parameters of the *M8* modem as well as to read-out the current configuration and diagnostic statistics.

4.2. Command Mode

The *M8* 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 *M8* modem first enters the Command Mode, it sends the phrase "*M8*" out it 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 *M8* 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 *M8* 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**.

4.5. Radio Manager

Radio Manager is a Windows XP/Vista software application that is used to configure Raveon's data radio products. It is compatible with all Raveon radio models, and provides configuration management, as well as programming assistance, diagnostic information, and a helpful "band scope" feature.

Radio Manager features:

- Supports all Raveon Radios (M3, M5, M8 and M8 GX series)
- An easy to use graphical interface
- Simplified editing of a radio's configuration
- Configurations may be stored to a file or retrieved from a file
- Intelligent parameter verification to help configure technical parameters
- On-line help
- Built-in terminal mode
- "Auto-Detect Radio" feature searches through possible serial port settings
- Band Scope feature graphically displays on and off channel signal levels

You can use Radio Manager in lieu of learning all of the M8's commands and programming protocol. In most situations, it is very useful for configuring the M8. There are certain very advanced configurations that will require manual

programming, but in most cases Radio Manger will be the easiest way to setup your radio.
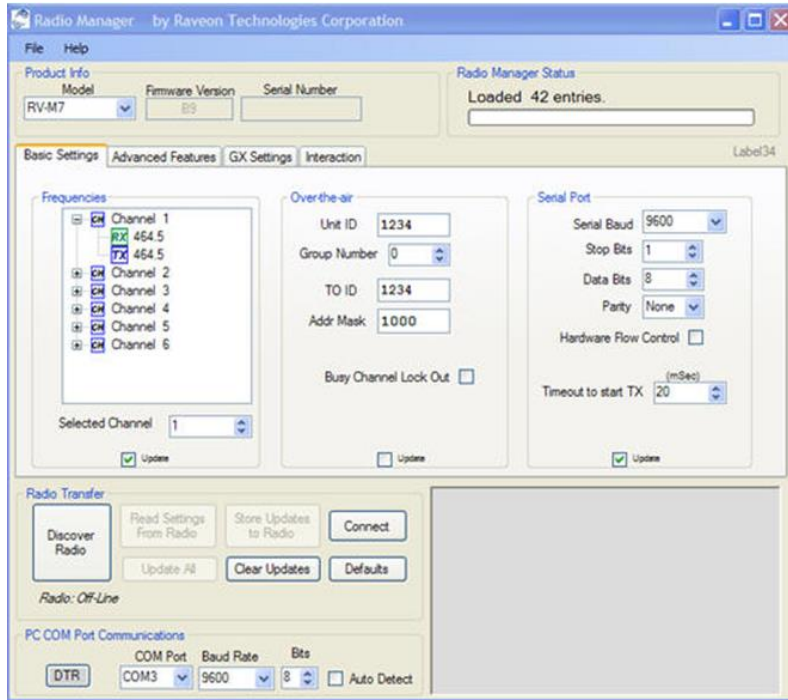
4.6. CONFIG Button

If certain parameters within the modem are modified in a manor that causes the modem to cease functioning or if the user cannot enter the command mode via the "+++" method described above, there is a small push button internal to the *M8* 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 *M8* modem once the Command Mode is exited.

Note: If the user-interface is password protected, and the Config button on the M8 is pressed, for security reasons, the encryption phrase is automatically erased.

4.7.   *Exiting the Command Mode*

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

1. **ATCN**   Issuing the **ATCN**. The M8 radio will exit the command mode, and begin normal operation.

2. **EXIT**   Issuing the **EXIT**. The M8 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.

4.8.   *Password Protection*

On M8 series products with firmware version C0 or higher, the user interface may be password protected. If it is password protected, the radio will output a "password:" prompt when entering the command mode.

When in the command mode, to enable the use of a password enter:

Password xxxx <CR>

Where xxxx is the 2-7 digit password you would like to protect the user interface with.

To disable password protection, enter:

Password 0 <CR>

Note: If the user-interface is password protected, and the Config button on the M8 is pressed, for security reasons, the encryption phrase is automatically erased.

4.9. Command Mode Commands

AT Command	Command Description	Parameters	Factory Default
AK	**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)
AT	**Silence AFTER Sequence** - Sets period of silence after the command sequence characters in mS.	Range:0 – 1000 (mS)	500
BD	**Baud Rate** – Sets serial com port baud rate (bps). Over-the-air (throughput) baud rate is set with ATR2 command. If a PC's serial baud rate is set higher than the fixed over-the-air baud rate of the module, hardware handshaking may be required.	Range: 0 – 7 0 = 1200 5= 38400 1 = 2400 6=57600 2 = 4800 7=115200 3 = 9600 4 = 19200	3
BC	**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
BT	**Silence BEFORE Sequence** – Sets period of silence before the command sequence character in mS.	Range: 0-1000 mS	500
BW	**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. This command is only used on the VHF version of the product. The UHF does not support w	N	N or W
CD	**Carrier Detect Threshold** – Read/set the carrier detect threshold, in dBm. -113 means -113dBm. Version firmware and higher.	-113	-120 to -60
CH	**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 characters.	1 = Enable 0 = Disable	0
CT	**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 *M8* is pressed, this parameter will be automatically set to 60000.	Range: 100-60000mS	60000
DCD	**Invert DCD line.** Use in conjunction with ATR1 to set DCD line functionality	0-1	0
DT	**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
E	**Echo** – Character echo set on (E1) or off (E0). This applies to the Command Mode only.	Range: 0 , 1	1 (echo)
F	**Display frequencies** – Display all of the frequencies programmed into all of the channel memories.		N/A
FT	**Transmit Frequency** – Program the transmit frequency for this channel. Enter in Hz or in MHz. The frequency will	Range: See product sheet. For MURS products,	See product data sheet.

	automatically be saved in non-volatile memory (flash) for this current channel number.	frequency cannot be changed.	
FR	**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.
FX	**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
GP	**Group Number –** Set/read the group number for this unit. 0 means ignore the group number. 1-255 is a group identifier. Only M8s with the same Group Number will communicate together.	0-255	0 (ignore group numbers)
HP	**Channel Number –** Select separate channels to minimize interference between multiple sets of modules operating in the same vicinity. The channel number is stored in EEPROM memory.	Range: 1 – 6	1
HS	**Show History –** Show a table of listing the most recent receptions, and the IDs that the data was sent from	No parameter	
HX	**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)*
IO	**Configure the I/O** The proper hardware option must be installed in the modem. All *M8* modems support RS-232 mode.	Range: 0 – 5 0=RS232 1=Ethernet 2=RS485 dup 3=RS485 simplx 4=RS422 5=GPS	0
IC	**Read Current Draw** Read the current draw in mA. Accuracy is within 20% of actual current draw.	Range: 0-9999	N/A
JF	**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
L	**Enable/Disable the LEDs –** 1 = LEDs always off. This reduces some power consumption. 0 = LED operate normally.	0 or 1	0
MK	**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
MT	**Protocol Select –** The over-the-air communication protocol. 0=Packetized mode, 2=Streaming data.	Range: 0-2	0
MY	**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
NB	**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
ND	**Number of Data Bits –** Set/read the number of data bits.	Range: 5 – 8	8
NS	**Stop Bits –** Selects the number of stop bits.	Range: 1-2	1
PE	**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
PO	**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

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 may be RF carrier detect, or modem data detect.	Range : 0 – 3 3 = Framing 2 = Always assert CD 1 = Data CD 0 = RF CD	0
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**. Refer to section 6.6 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)
R3	**Serial Port Time Out** – The time in milliseconds for the serial port to time out. When data is entering the serial port, and this amo0unt of time passes with no more data, the M8 will begin to transmit the data over the air.	Range: 1 – 999	20 20mS is the default.
R5	**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)
R8	**Frequency Offset.** Used to set the radio on the center of the radio channel.	Range: -500 to +500	0**
RB	**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)
RF	**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)
RQ	**Receiver Signal Level** – Reads the Receiver Signal strength this instant, and returns the level in dBm.	Range: -40 to –130 (dBm)	-
RS	**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
RV	**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
S120	**Data Framing Pre-time (mS)** 255 is data framing off. Use with **ATR1** 3. See section 9.6	0-255	255
S121	**Data Framing Post-time (mS)** 255 is data framing off. Use with **ATR1** 3. See section 9.6	0-255	255
SL	**Serial Number** – Reads and returns a unique serial number for thjs unit.	Read Only 1 - 999999999	unique
SH	**Show –** Display the configuration of the modem. This will return a page of ASCII characters, showing the main configuration parameters.	none	None
SM	**LPM Operation Enable** – When set to 1, the DTR input line controls the M8's low-power operation. When set to 0, the M8 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	Range: 0, 1, 2	0

	mode, disabling the receiver.		
ST	**Statistics –** Show the unit's operational statistics. See Statistics section of user manual.	0, 1,2, 3, 4, or 5	None
TD	**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…	
TE	**Read product temperature –** Read the internal temperature of the unit's circuit board in degrees Celsius.	-40 to +99	-
TT	**Max Packet Size –** Set the maximum number of bytes in an over-the-air packet.	1 - 512	80
VB	**Read DC input Voltage**– Returns the DC input voltage reading, in mV (12500 = 12.5VDC input).	None	none
VR	**Firmware Version** – Returns firmware version currently loaded on the module.	Read Only, 3 characters	none
Xn	**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	
XR	**Enable/Disable Store and Forward Repeating –** 0=disabled, 1 – enabled.	*0 or 1*	*0 (Off)*
XT	**Read/set repeater delay –** Read or set the repeater delay. This is the time between receiving a data packet, and the time the repeater will re-send it.		
&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

** 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.

4.10. Other non-AT commands

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	-
MODEL	**Read Model number.** Read the model number.	None	-
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 *M8 System Protocol* manual for information on using this feature.		
SHOW	**Show/display** *an overview of the radio's configuration.*	None	-

4.11. Factory Default Settings

For the UHF M8S, model RV-MS8-Ux, the main factory defaults are:

Channel 1   (-UC model) .... 464.500 MHz
Channel 1   (-UA model) .... 413.100 MHz
Over-the-air baud rate: .... 4800 baud, 2-level
Serial port 9600baud, N/8/1
Hardware flow control .... Off
RF Power Output 20% (1W)
Channel number selected 1
ID (ATMY) 1234

5. Using the M8S Modem – Packet Mode

This section describes the operation of the when it is in the *Packet Mode* of operation. Packet Mode is the factory-default operating mode.   It is the easiest and most reliable mode of operation for a modem.   Note: The configuration of the *M8S* is done when the *M8S* is in the "Command Mode". Refer to Section 1 on page 12 for details on all of the available commands and programmable features.

In Packet Mode, all transmissions are sent in bursts or packets, and contain address, error detection, and error correction information. Date enters the M8 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. *M8* 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. M8 uses a 16-bit address to identify data packets.

4. *No Dribble Data* Even in the presence of noise, the M8 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 M8 in its Packet Mode.

6. *Repeatable and Routable.* M8 packets are structured so that they may be repeated using a store-and-forward repeater, and/or routed using specialized hardware.

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).

2. *Data with Errors* The M8 will continue to receive data, down into the noise-floor of the radio. If the channel is noisy or the signal is weak, there may be bit-errors in the data, or the M8 may output additional noise data. User

applications must (and often do), take this into account, and thus can operate with weaker signals and have longer communication range.

Figure 1 (Packet Mode of Operation)
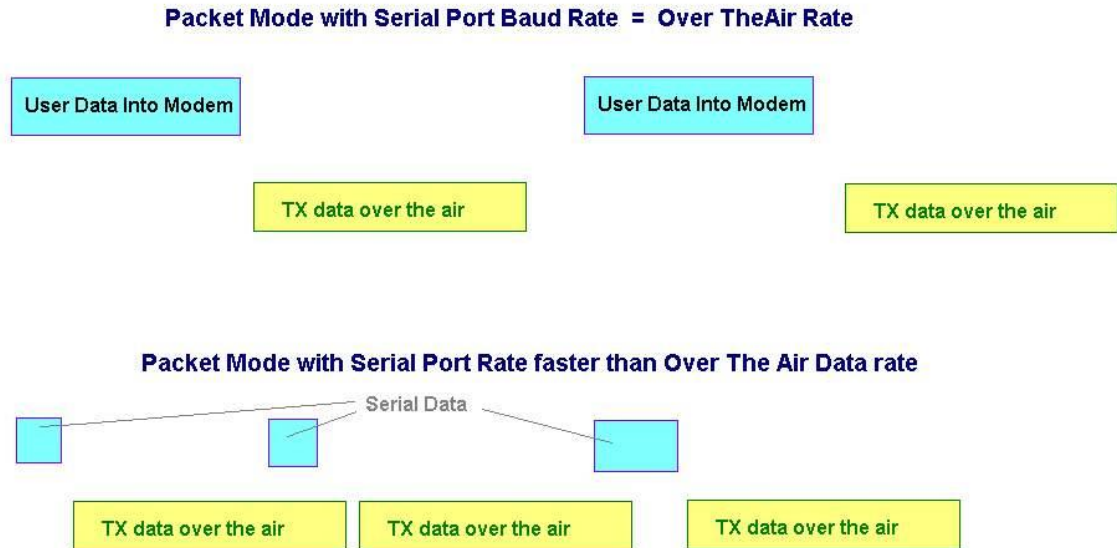
For operation of the modem in the streaming data, non-packetized mode, see the section **Streaming Mode** on page 32. The Packet or Streaming operation is configured using the **ATMT** command, with Packet Mode being the factory default.

5.1. Setup

1. Connect a DC power source to the DC IN connection on the front of the modem.

2. Connect a good quality antenna, cut to the operating frequency, to the BNC connector on the front of the modem. Use a good antenna, and place is at high-above obstructions as possible.

3. Connect a computer terminal, or PC computer running HyperTerminal, to the 9-pin I/O connector. The factory default serial ports settings are 9600 bps, 8 data bits, 1 stop, no parity.

4. Program the modem's operating frequency to your desired operating frequency. This is done with the **ATFX xxx.xxxxx** command. See the section "**Serial Port Commands**" for information describing the various parameters that may be modified in the modem. In most applications, the default settings from the factory will work fine.

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 9-pin connector on the front of the modem.

The radio 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 *M8* 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.

5.2.   *Programming Channels and Frequencies*

The M8 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.

5.3.   *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 M8 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 M8 can handle serial-port data rate far in excess of the over-the-air rate, the efficiency of the M8 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.

Note that many Windows applications which use the serial port, such as HyperTerminal, put large gaps between the bytes of data they send out the serial port. If an application is not getting the desired throughput, verify that it is not an artifact of the Operating System or the computer.

Flow Control

If large amounts of data will be sent with the *M8*, 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.

You can modify this CTS threshold with the ATJF xx command. If you would like CTS negated when there is 1or more bytes in the M8's buffers, set **ATJF** to 1 (**ATJF** 1).

Packet Size

The over-the-air packet size may be set with the **ATTT xx** command. Once the modem receives one full packet of data into via the serial port, it will automatically key the transmitter and send the data. Factory default is 80 bytes. The M8 will also automatically send all of the data in its buffer when there is a pause in the incoming data stream, regardless of the ATTT setting.

Key-On_Data

When serial data is entering the *M8*'s RS-232 port, the *M8* looks for pauses in the data as indication that it is time to send a packet of data over the air. The

factory default duration of the pause it looks for is 20mS, but the user may change this to over values using the **ATR3 xxx** command, where xxx is in milliseconds. **ATR3 2** (2mS) is a good setting if you are configuring the M8 for use in a polled SCADA system.

Busy-Channel Lock Out

If your system operation require the M8 modem to monitor-before-transmit, of if you do not want the M8 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 M8 senses RF carrier, and determines that the channel is busy is set by the **ATRA** command. This is factory calibrated to an equivalent RF level of approximately -110dBm.

5.4. Addressing (Packetized Mode only)

Addressing Basics

One of the more powerful aspects of the *M8* 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 *M8* contains a 16 bit address, called its Unit Address, and is represented as a 4 digit hexadecimal number. *M8* address may be any number between 0000 and FFFF, which is effectively 65,535 different addresses. Every *M8* 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 *M8* 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 M8 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 M8 radio modems.

Group Numbers

By default the M8's Group Number is 0. Group 0 means ignore the group numbering. The Group Number is set with the **ATGP xx** command, where xx is the group number. **ATGP 0** disables group numbering and is the default way the M8 radio modem works. If the Group Number is set to any non-zero number

from 1-255, then the group feature is enabled, and the group number will be the group specified in the **ATGP** command. When enabled, the M8 will only communicate with other M8s that have the same Group Number.

Hexadecimal Numbers

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

Hexadecimal Table

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

When communicating over the air, *M8* 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 M8 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.

An alternate way to disable addressing altogether, is set the Address Mask to 0000 (**ATMK** 0000 command). This tells the M8 to ignore the address, and receive every transmission. The disadvantage to this method is the adjacent-system problem. If there is another M8 system on the same channel, all modems with the 0000 mask will receive them also.

A good idea is to start numbering all of your M8 with a Unit Address of 0001, 0002, 0003, etc… Set the address Mask to F000. This will let all M8s with ID's 0001-0999 talk to each other. If you want a separate group, start numbering them 1000, 1001, 1002, etc… Then the 1000 series group will only hear 1000 series M8's and the units that have IDs starting with 0xxx will only hear other radios with IDs that start with 0xxx.

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.
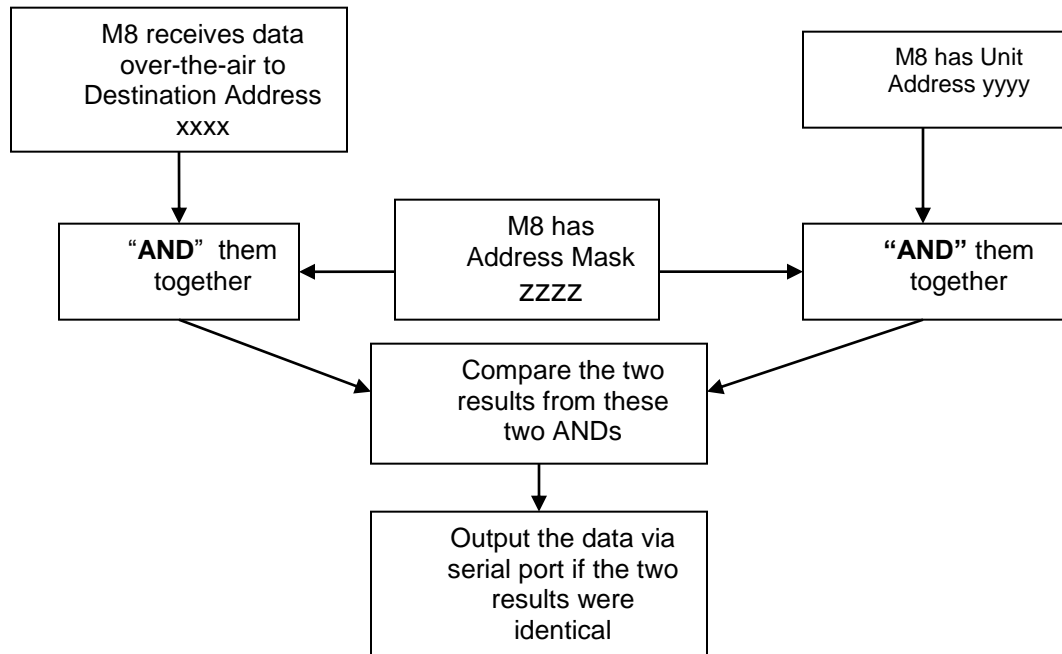
The Address Mask

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. For most applications, where one modem talks to one modem, or where all modems in the system communicate with all other modems in the system, the Address Mask should stay set to FFFF.

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 *M8* 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 2 (Address Filtering)*

```
┌─────────────────────┐                              ┌─────────────────────┐
│  M8 receives data   │                              │                     │
│  over-the-air to    │                              │    M8 has Unit      │
│ Destination Address │                              │   Address yyyy      │
│        xxxx         │                              │                     │
└─────────────────────┘                              └─────────────────────┘
          │                                                     │
          ▼                                                     ▼
┌─────────────────┐    ┌─────────────────┐          ┌─────────────────┐
│  "AND" them     │◄───│    M8 has       │─────────►│  "AND" them     │
│   together      │    │ Address Mask    │          │   together      │
│                 │    │     zzzz        │          │                 │
└─────────────────┘    └─────────────────┘          └─────────────────┘
          │                                                     │
          └──────────►┌─────────────────┐◄───────────────────┘
                      │  Compare the two │
                      │ results from these│
                      │    two ANDs      │
                      └─────────────────┘
                                │
                                ▼
                      ┌─────────────────┐
                      │ Output the data via│
                      │ serial port if the two│
                      │   results were   │
                      │    identical     │
                      └─────────────────┘
```

One effect of this is that an address mask of 0000 will cause the *M8* modem to received any data from any unit that transmits. 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 *M8* Unit Address = **1234**
>
> Receiving *M8* 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.

5.5. *Error Correction*

The *M8* modem has a built-in error correction mode, commonly referred to as *Automatic Repeat request (ARQ)*. It works by checking each reception for errors, and if the data is OK, it sends a short "*ACK*" packet back over the air telling the sending station the data was OK.

The *M8* modem uses a traditional Carrier Sense Multiple-Access (CSMA) algorithm with randomized re-try time slots to determine when to re-transmit packets that must be re-sent. The duration between re-tries increases as the number of attempts increases.

If received data has an error in it or if the receiving modem does not get the data due to interference, the receiving modem does not send the ACK back, and the sending station will automatically re-send the data. There are two aspects to configuring ARQ:

a. Enable the ARQ mode in the modem to allow it to transmit ACKs (**ATAK 1** command). This command enables the modem to transmit ACK packets.

b. Configure the number of retries the modem should attempt if an ACK packet is not received back when it sends data (**ATRB xx** command). For example, if you set **ATRB** to 5 with the **ATRB 5** command, the modem will wait for an ACK whenever it sends data. If it receives and ACK back from the modem that it sent data to, it will do nothing more. But if it does not receive an ACK, it will resend the same data, trying up to 5 more times.

The factory default condition is not to send or require ACK packets, so if you wish to use this mode, program the *M8* to transmit ACKs with the **ATAK 1** command. This will cause the modem to send an ACK anytime it receives data from another modem. Note: If the destination address was a broadcast (FFFF, FFxx, or xxFF), it will not wait for an ACK.

The number of times it retries to send data that does not get through (does not get an ACK) is up to the user, but a number of 5 is usually a good compromise. If after 5 times, the data does not get through, then there probably is something seriously wrong with the channel or system.

The retried-transmissions are randomly spaced at intervals between approximately 200mS and 400mS, increasing by 50mS for each attempted

transmission. Once the modem has sent its data the number of times the user specified in the **ATRB xx** command, the data is discarded, and the modem will continue to operate as normal.

It is very important that if one modem is configured to send ACK packets (**ATAK 1**) that all other modems communicating with it are also set to expect ACK packets using the **ATRB xx** command.

To disable ARQ (the default condition of the modem), disable ARQ with the **ATAK 0** <u>and</u> set retries to zero with the **ATRB 0** command.

5.6. *Store-and-Forward Repeating*

The *M8* modem has a built-in wireless repeater. Each M8 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 M8 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 M8 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 M8 that sent the data and the Destination ID of the unit that the data is intended for.

Figure 3   Overview of Repeater Operation
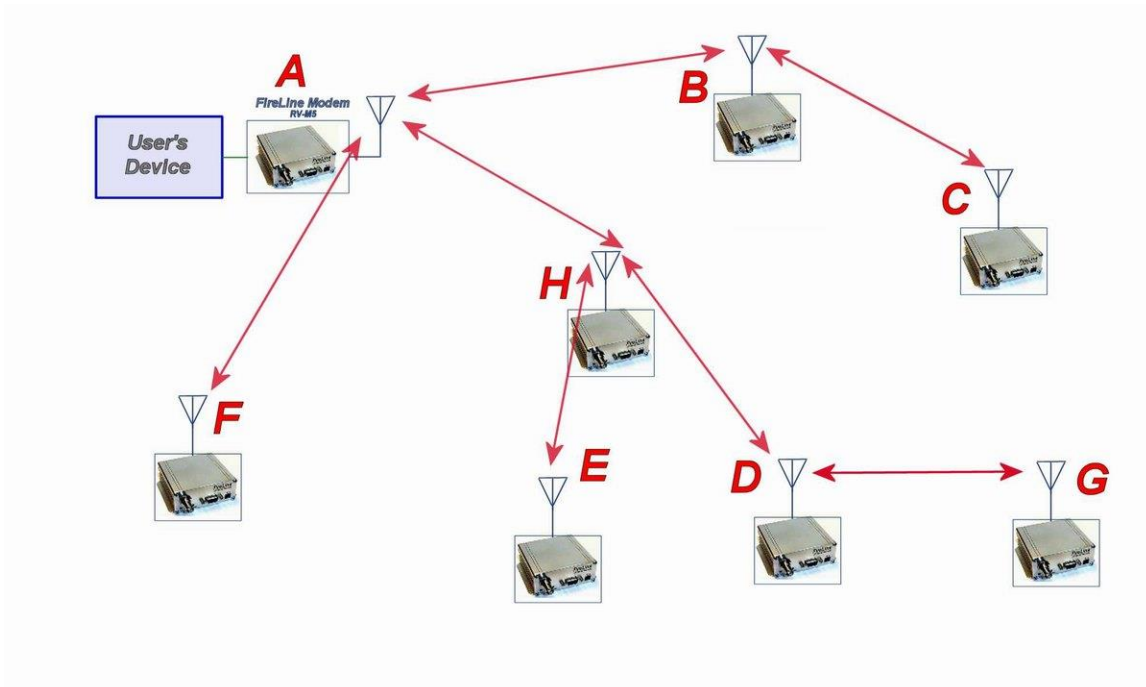
In the example shown in Figure 3 above, *M8* **A** is will communicate with all other modems in the system. It can directly communicate with **B, H**, and **F**.   Because of propagation limits, it cannot communicate reliable to **E, D, C,** and **G**.

To solve this problem, some of the M8 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 *M8* **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, M8 **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 M8 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 M8 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. M8 check 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.

6. Using the M8S Modem – Streaming Mode

This section describes the operation of the Streaming Mode of operation. This mode is selected with the command **ATMT 2**.

6.1. Streaming Mode Operation

In Streaming Mode, radio transmissions will begin whenever data enters the mode, 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 4 (Streaming Mode of Operation)

.
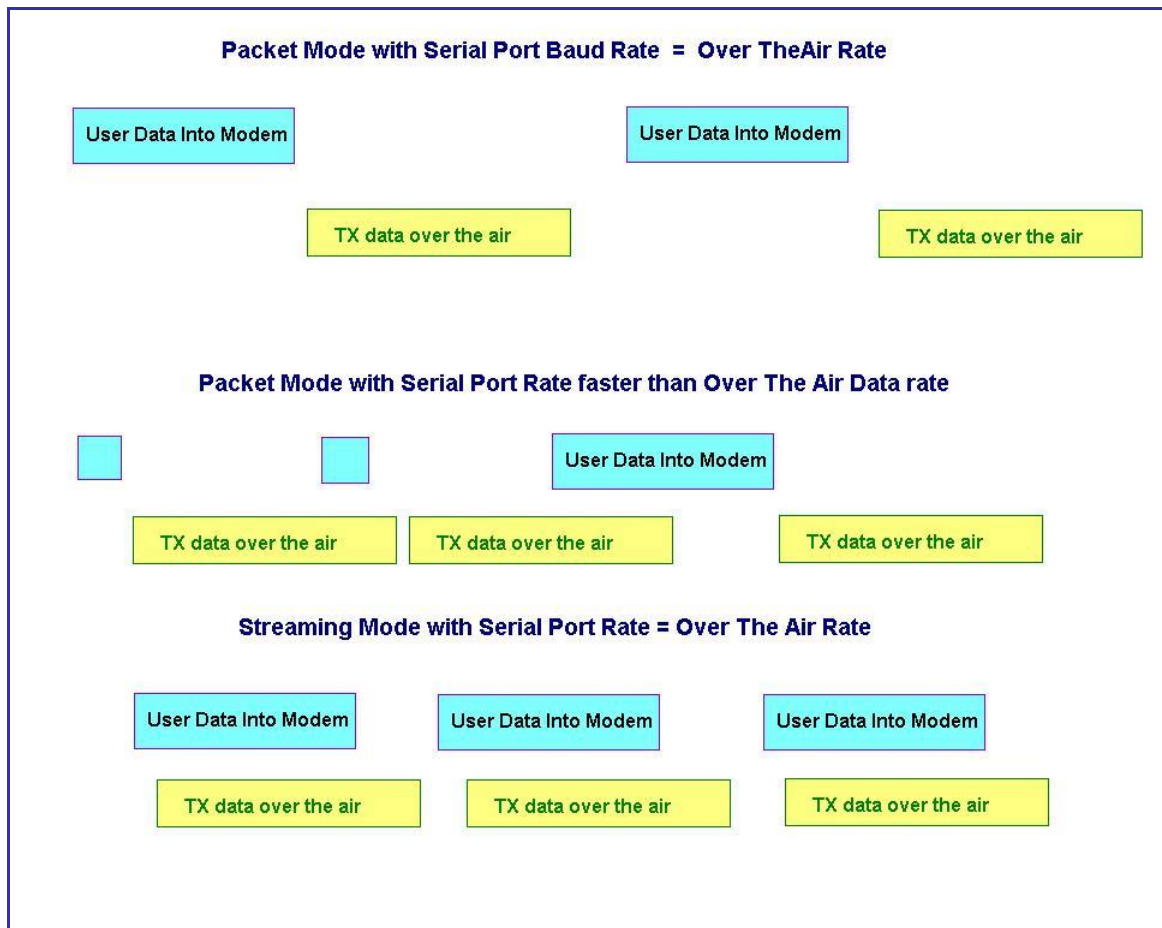
6.2. Baud Rate Selection

In Streaming Mode, the user data may still enter the modem at any baud rate, as set with the **ATBD x** command. The *M8* 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 M8 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 M8. 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 *M8* modem will hold the data as it is sent out the serial port.

6.3. 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. 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 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 noise. This may take a byte or two of time, and during this time period, the receiving modem may output random noise bytes.

6.4. Carrier Detect

To reduce bit errors and additional noise bytes, the user may configure the M8 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.

6.5. Serial Data Flow Control

If large amounts of data will be sent with the *M8*, 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.

6.6. *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.   The 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	M8 Modem Models that support the rates
800bps (R2=0)	12.5kHz or 25kHz	2	RV-M8-UC-N, RV-M8-UC-W
1200bps (R2=1)	12.5kHz or 25kHz	2	RV-M8-UC-N, RV-M8-UC-W
2400bps (R2=2)	12.5kHz or 25kHz	2	RV-M8-UC-N, RV-M8-UC-W
4800bps (R2=3) Default setting	12.5kHz or 25kHz	2	RV-M8-UC-N, RV-M8-UC-W
8000bps (R2=4)	12.5kHz or 25kHz	4	RV-M8-UC-N, RV-M8-UC-W
9600bps (R2=5)	25kHz	2	RV-M8-UC-W only
19200bps (R2=6)	25kHz	4	RV-M8-UC-W (will not work with Radio Type 5)
5142bps (R2=7)	12.5kHz or 25kHz	2	RV-M8-UC-N, RV-M8-UC-W, RV-M8-UC-S
9600bps (R2=8)	12.5kHz or 25kHz	4	RV-M8-UC-N, RV-M8-UC-W

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.

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-M8S-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.

1.

7. 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.

STAT 1   Display statistics of how the modem's GPS is working (if installed).

AT$5   Display RSSI. It will scroll the reading until another character comes in the serial port.

Packet Counter

The packet counter mode will output packet count statistics once per minute. It will output the number of packets received in the last minute as well as the running total. T

ATPE   Begin counting and displaying the packet counters every minute

ATPE 1   Reset the packet counters back to zero

ATPE 2   Stop counting and displaying packet counters

Upon power up, the packet counter feature is always disabled.

8. M8S Diagnostic Provisions

8.1. Overview of Diagnostics

Internal to the *M8* 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 *M8* radio network.

8.2. Reading the Diagnostic Information

M8 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 *M8* 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.

8.3. Status and Statistics Command

AT Command	Command Description	Response
ST	**General Communication Statistics** – This command will cause the *M8* to output a table of various operational statistics.	Statistics overview screen
ST1	**GPS Statistics** – Statistics related to the GPS operation, if installed.	GPS Statistics overview screen
ST2	**Low-level internal statistics** – Returns various low-level statistics. These are subject to change in various firmware revisions.	Low-level statistics screen
ST3	**Compile date and time** – Returns the data and the time that the firmware was compiled.	Date and time
ST4	**Run Time** – Returns the amount of time that the modem has been powered up and running.	Run time display screen
ST9	**Reset all statistics counters**	OK

| ST10 | **Statistic Read** – Returns numeric values, comma separated, of all statistics as described in the ST command. | Run time display screen |

9. 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.

9.1. 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.

9.2. 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**
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**. Refer to section 6.6 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
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

9.3. 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.

9.4. TX Deviation

1. Switch to channel 1.

2. Key the transmitter into a 50 ohm load using the **ATTD 3** command. The unit will now transmit, and send a digital 0 continuously. This should be +2.0kHz in frequency for narrow-band radios (12.5kHz spaced channels) and +4.0kHz for wide-band (25kHz channels).

3. Adjust the deviation register setting so that the frequency deviation is correct. The deviation is set with a digital adjustment.   Use the ATR0 command to read or set the deviation level.
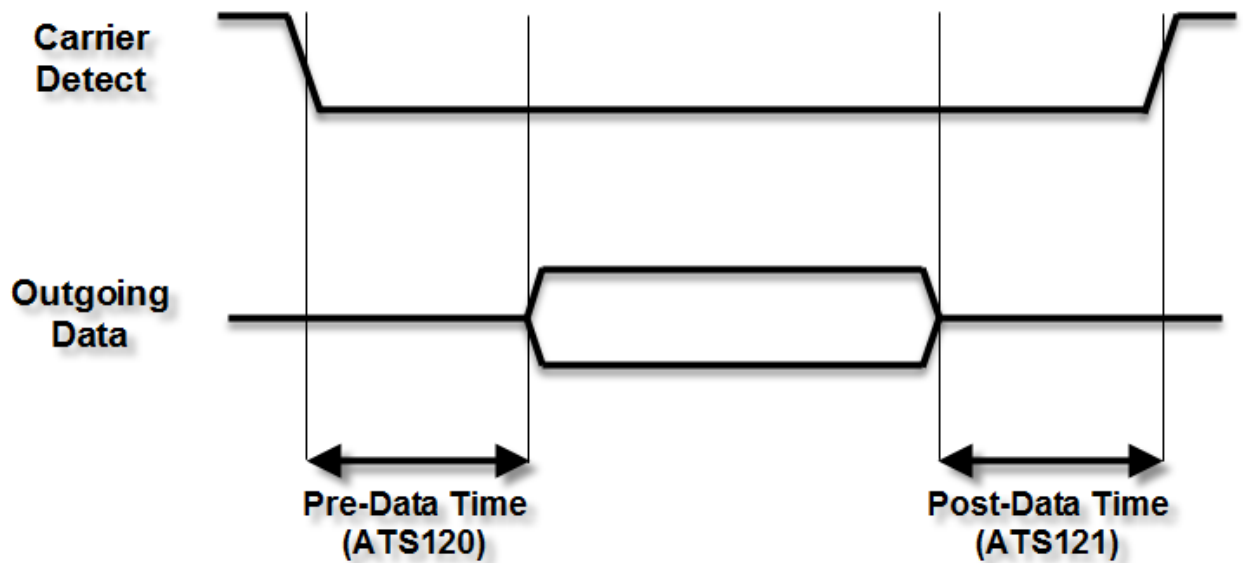
9.5. RX Carrier Detect

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

CD Output Data Framing

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 high and only goes low 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 polarity of the carrier detect signal can be inverted with the **ATDCD** command.

1. Data Framing

- If Data Framing is enabled, any other Carrier Detect and flow control output configuration is ignored. Set **ATR1 3** to enable. Set **ATS120** and **ATS121** to set the number of milliseconds for pre and post data time. This feature is available in firmware version A31 and later.

Unused Page??

10.   *Troubleshooting*

Symptom: Unit will not receive

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

Soultion #2. If the addresses match, and RX LED blinks but still no reception of data, verify that the RTS signal is asserted. The *M8* will not output data if the RTS signal on the DB-9 I/O connector is not asserted. If the user's hardware cannot assert the RTS hardware line, disable hardware flow control in the *M8* modem, using the **ATCH 0** command.

Solution #3. If the RX LED blinks, 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 M8 has an optional Low Power Mode (LPM). If LPM is enabled, the M8 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 M8 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 *M8* will require the CTS signal to be asserted. The *M8* 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 *M8* 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 *M8* will look for in the serial input data stream. If a pause greater than this value happens, the modem will transmit. If the ATG0 paramter is set very large, say 2000000, this means 2 seconds, and the modem may simply be waiting a long time

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

Solution #4. Verify Low Power Mode. The M8 has an optional Low Power Mode (LPM). If LPM is enabled, the M8 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 M8 will turn off when the DTR line is off, or the program connected to the serial port is closed, or the RS-232 connector is un plugged.

Symptom: Receive light blinks, but no data is received

Solution #1. Verify Input/Output Configuration. The *M8* has numerous I/O options. RS232 is standard, but Ethernet, RS485 or RS422 may be configured also. Use the ATIO command to view how the I/O is configured. ATIO 0 is the default (RS232 mode).

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

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

Symptom: Long delay before transmitting

Solution #1. <u>Verify that serial port timeout is OK.</u> The ATR3 command sets the number of milliseconds that the *M8* 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. <u>Verify the serial port baud rate.</u> 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, <u>verify the AT, BT and CT times,</u> that they are long enough for you to enter the +++ string.

Solution #2. <u>Handshaking.</u> 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. <u>Verify the power is on.</u> 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. <u>Verify the internal fuse OK.</u> There is an internal fuse in the RV-M8, protecting it from reverse-voltage and electrical failures. If the power LED does not blink or come on when DC is applied, check the fuse and replace it with the same type 3-amp mini fuse, and try again. If you replace the fuse, the unit must be carefully check for damage and proper operation before being installed. If you replace the fuse, you must use a *Littlefuse* brand fuse, part number 0297003 or Raveon part, number 1X726-3 to maintain calibration of your unit.

Solution #3. <u>Verify Low Power Mode.</u> The M8 has an optional Low Power Mode (LPM). If LPM is enabled, the M8 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 M8 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. <u>Verify the repeater's Unit ID is unique.</u> An RV-M8 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 that it originated the transmission. Set the MTID of the repeater to a unique ID number.

11.   Antenna information

Key to a successful installation is the choice and installation of a good antenna system. A good quality antenna can more than double the range of a radio

system. Properly locating the antenna is vital to creating a quality radio link, and a poor installation can decrease the range of the system by as much at 90%.

Use these guidelines to evaluate your antenna system design, and be sure contact a quality radio communication equipment distributor such as *Talley Electronics* (http://www.talleycom.com) to help choose the proper antenna for your system.

To increase your communications range, locate the antenna high as needed, practical, safe, and allowed by your license. On fixed base-station applications, you may utilize an antenna with gain. *Note: The maximum Permissible Exposure (MPE) for this product was computed using a 0dB gain antenna, and must be recalculated if a gain antenna is used.*

Height   Try to locate the antenna as high above obstructions, vehicle, and buildings as possible. UHF radio channels require a clear "line-of-sight" between the transmitter and the receiver. Radio waves will penetrate buildings, and reflect off and around obstacles, but the fewer obstacles between stations the better the signal quality.

Gain   Antennas are specified by their gain. They actually do not have gain, but rather they can increase the strength of a signal in certain directions, at the expense of attenuating signals from other directions. Gain antennas always have "patterns" of gain. It is important you understand the pattern of your antenna. Omni directional antennas will receive from almost any angle, 360 degrees around them.
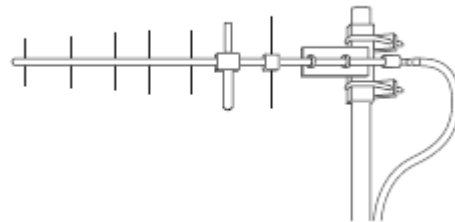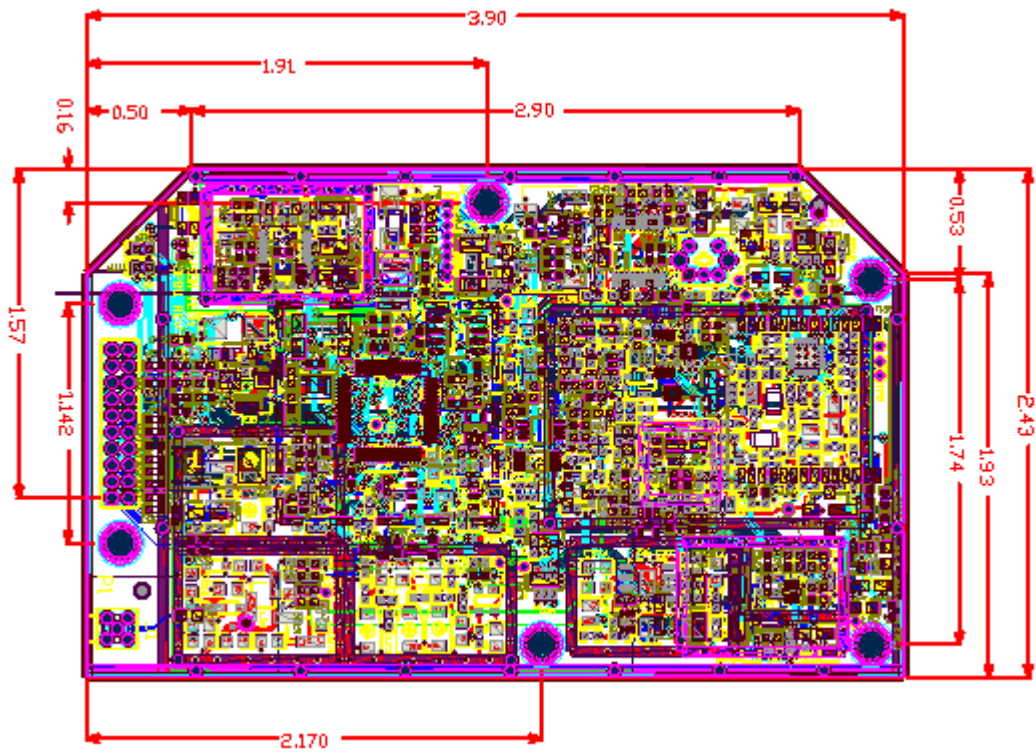
Omni Antenna   Directional Antenna

12. Mechanical

Limited Two Year Warranty

If within 24 months from date of purchase, this Product fails conforms to Raveon Technologies Corporation's (the Company) published specifications for the model purchased due to a defect in material or workmanship, Raveon Technologies Corporation will repair or replace it, at Raveon's sole discretion. This warranty is extended to the original purchasing end user only and is not transferable. Any claim for breach of warranty must be brought to the Company's attention within such twelve (24) month period and the Product must be returned for action on any such claim within twelve (24) months from the date of purchase Within a reasonable period of time after a claim, the Company will correct any failure of the Product to conform to specifications or any defect in materials or workmanship, or replace the Product, or at its option provide a full refund of the purchase price. A repaired or replaced Product is warranted for 90 days from the date of return shipment to the buyer, or for the balance of the original warranty period, whichever is longer. These remedies are the buyer's exclusive remedies for breach of warranty.

This warranty does not apply to: (a) product damage caused by accident, dropping or abuse in handling, acts of God or any negligent use; (b) units which have been subject to unauthorized repair, opened, taken apart or otherwise modified; (c) units not used in accordance with instructions; (d) damages exceeding the cost of the product; (e) batteries; (f) the finish on any portion of the product, such as surface and/or weathering, as this is considered normal wear and tear; (g) transit damage, initial installation costs, removal costs, or reinstallation costs; (h) damage due to lighting, floods, fire, or earthquakes (i) any product, components or parts not manufactured by the Company (j) defects caused by failure to provide a suitable installation environment for the Radio; (k) damage during shipment; (l) that the Product will be free from any claim for infringement of any patent, trademark, copyright or other proprietary right, including trade secrets.

RAVEON TECHNOLOGIES INCORPORATED WILL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING DIRECTLY OR INDIRECTLY OUT OF THE OWNERSHIP, USE OR OPERATION OF THE RADIO REGARDLESS OF WHETHER SUCH DAMAGES ARE PREDICATED OR BASED UPON BREACH OF WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, STRICT TORT, OR ANY OTHER LEGAL THEORY. SUCH DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, LOSS OF PROFITS, LOSS OF SAVINGS OR REVENUE, LOSS OF USE OF THE RADIO OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF ANY SUBSTITUTE EQUIPMENT, FACILITIES OR SERVICES, THE CLAIMS OF THIRD PARTIES, INCLUDING CUSTOMERS AND INJURY TO PROPERTY. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU. THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES. ALL IMPLIED WARRANTIES, INCLUDING THE WARRANTY OF MERCHANTABILITY AND THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY MODIFIED TO EXIST ONLY AS CONTAINED IN THIS LIMITED WARRANTY, AND SHALL BE OF THE SAME DURATION AS THE WARRANTY PERIOD STATED ABOVE. SOME STATES DO NOT ALLOW LIMITATIONS ON THE DURATION OF AN IMPLIED WARRANTY, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

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

No employee of the Company, or any other party is authorized to make any warranty in addition to those made in this document. This warranty limits the Company's risk and allocates the risks of product failure between the Company and the buyer. This allocation is recognized by both parties and is reflected in the price of the goods. The buyer acknowledges that it has read this warranty, understands it, and is bound by its terms. This limited warranty is governed by the laws of the State of California, without reference to its conflict of law provisions or the U.N. Convention on Contracts for the International Sale of Goods.

Warranty service is available by mailing postage prepaid to:

Raveon Technologies Corporation
2320 Cousteau Court
Vista, CA 92081 - USA

To obtain warranty service, include a copy of the original sales receipt or invoice showing the date, location, and price of purchase. Include a written description of the problem with the product, a phone number and name of person who may be contacted regarding the problem, and the address to where the product should be returned.

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