FireLine Data Radio Modem
Technical Manual

Version C9

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1. General Information about the FireLine

1.1. Congratulations!

Congratulations on your purchase of a FireLine radio modem.

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 jobs must be referred to your Authorized Service Center or Raveon Technologies Service Department.

1.3. Safety / Warning Information

WARNING - DO NOT operate theRV-M5-U radio modem when bystanders are within 2 feet (.6 meters) of the antenna.

Safety Training information:

Antennas used for this transmitter must not exceed an antenna gain of 0 dBd. The radio modem must be used in fixed vehicle-mount configurations or at fixed base-station sites. It is not intended for portable applications.

This radio is restricted to occupational use, work related operations only where the radio operator must have the knowledge to control the exposure conditions of its passengers and bystanders by maintaining the minimum separation distance of following range.

Failure to observe these restrictions may result in exceeding the FCC RF exposure limits.

Antenna Installation:

For rear deck trunk installation, the antenna must be located at least the following range away from rear seat passengers and bystanders in order to comply with the FCC RF exposure requirements.

For roof top installation, the antenna must be placed in the center of the roof.

Radiated frequency and Distance
RV-M5-UC
1.97 Feet (0.6 m)
FCC ID: SRS-RV-M5-UC
Raveon Technologies Corporation

1.4. FCC Compliance Information

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 and Part 90 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.

2. Overview

The *FireLine* 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 *FireLine's* user interface is asynchronous RS-232 data into and out of the *FireLine* (CMOS level optional). Modem operation is virtually transparent to the user and the configuration of the modem is via the user serial port.

Unlike all other modems, the FireLine may be operated in either a "*Packetized Mode*" or a "*Streaming Real-Time Mode*". There are advantages to each approach, and your depending upon how your system operates, you may choose one over the other.

For privacy and network versatility, the *FireLine* 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 *FireLine* 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 *FireLine* 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. 19200bps in 25kHz channel.*
- *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 regulator.*
- *Integrated Packet data protocol and built-in Streaming Real-Time operation.*
- *ARQ error correction and retransmission capability. Totally transparent to the application.*
- *Refarming-compliant modem 9600bps in a 12.5kHz channel*
- *Small sized and rugged extruded aluminum 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.*
- *2 watts of RF output Other RF power levels available upon request.*
- *Operating temperature range of –30 to +60 degrees C*
- *Easily configured using "AT" commands*
- *User interface is asynchronous serial data for TX, RX, and configuration.*
- *RS-232 serial input and output. Programmable serial baud rates up to 57600. CMOS levels optional.*
- *Programmable over-the-air data rates for long-range or high-speed*
- *Data activation of transmitter for automatic operation.*
- *Carrier-detect not required receiving. No squelch setting required.*

- *Synthesized receive and transmit frequencies*
- *SkyLine compatibility mode for use in older Sonik radio systems.*
- *Automatic AGC and polarity detection of received signals.*
- *Internal data buffers to allow the serial port data rate to be different than the over-the-air data rate.*

3. Specifications

3.1. General

All measurements made per TIA-603-B

Frequency: Model RV-M5-VA ..... 136 - 150MHz
Model RV-M5-VB ..... 150 - 174MHz
Model RV-M5-UC ..... 450 – 480MHz
Model RV-M5-UA (export only) ..... 403 – 434MHz

Size (inches) ..... 3.0D X 3.76W X 1.40H

DC input voltage ..... 8-16V DC

Typical current draw, receiving, over-the-air rates < 4800bps ..... <80mA

Typical current draw, receiving, over-the-air rates >= 4800bps ..... <110mA

Current draw when transmitting data ..... <1.7A max, 1.3A typical at 2watts

Frequency stability ..... ±1.5ppm

Over-the-air baud rates (programmable) 800, 2400, 4800, 8000, 9600, 19200

Internal data buffers (transmit and receive) ..... >2000 bytes

Operating temperature range ..... -30ºC to +60ºC (-30ºC to +80ºC storage)

TX-RX and RX-TX turn-around time ..... <10mS

Power on time to operational ..... <250mS

FCC ID Model RV-M5-UC SRS-RV-M5-UC
All other models for export or OEM use

3.2. Transmitter

Maximum RF power output ..... 2.0 watts, 5 watts optional

Maximum duty cycle ..... 20% at full power

Maximum transmit frequency deviation ..... ± 2.25kHz

Occupied bandwidth ..... 11 kHz (12.5kHz channels)
..... 16kHz (25kHz channels)

TX spurious outputs ..... < -70dBc

Emissions designator ..... 11K0F1D (12.5kHz channels)
..... 16K0F1D (25kHz channels)

3.3. Receiver

Typical RX sensitivity (1% BER)
19200bps, 4-level, 25kHz channel ..... -108dBm
9600bps, 4-level, 12.5kHz channel ..... -109dBm
4800bps, 2-level ..... -113dBm
2400bps ..... -116dBm
800bps ..... -118dBm

RX selectivity ..... -50dB (12.5kHz channel spacing)
..... -60dB (25kHz channel spacing)

Spurious and image rejection ..... -60dB

RX intermodulation rejection ..... -60dB at 2400bps

Conducted spurious emissions ..... <-20dBm

3.4. User Input and Output Signals

Serial port baud rates 1200, 2400, 4800, 9600, 19200, 38400, 57600*
(57600* not usable when over-the-air baud rates is 4800 baud or less)

Maximum baud-rate error ..... <0.5% 38400bps and lower, <2.5% at 57600bps.

Voltage levels ..... RS-232 complaint levels

Modem handshake signals ..... RTS, CTS, DTR, DSR, CD

RF I/O ..... 50 ohm BNC

Power .....B+ input and Ground

3.5. Model Numbers

The model number of the FireLine modem identifies its operating frequency band and bandwidth. The models are:

RV-M5-*ab-cd* where:

a = The band (V=136-174MHz, U=406-512MHz)
b = Sub band (A,B,C,…)
c = Channel Spacing (N=12.5kHz, W=25kHz, S=25kHz SkyLine compatible)
d = Power output (2=2 watts, 5=5 watts, 1=500mW)

Other frequency bands and channel spacings are available. Contact the factory for your specific needs.

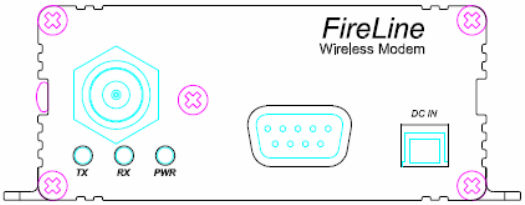
Sub-Bands

Sub-Band Letter	VHF (RV-M5-V…)	UHF (RV-M5-U…)
A	*132-150MHz*	*403-434MHz*
B	*150-174MHz*	*435-451MHz*
C		*450-480MHz*

4. Electrical Inputs and Outputs

The front panel of the FireLine modem has these features:

1. **BNC RF connector**
2. **Transmit LED (TX)**
3. **Receive LED (RX)**
4. **Power LED (PWR)**
5. **9-Pin serial I/O connector**
6. **DC Power Jack**



4.1. LEDs

The three status LEDs visually show the current status of the radio.

Transmit LED (TX) This LED blinks red when the transmitter keys and is putting out RF power.

Receive LED (RX) This LED glows red when there is an RF signal on the radio's receive frequency. This LED will indicate the presence of any signal, even one from other sources or radios, data, or voice. If it glows steadily at all times, there is probably some other user on the radio channel. The RF threshold level where this LED illuminates is programmable.

Power LED (PWR) This has 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. In the normal operating mode, this led will also glow red when data is received over the air.

4.2. DC Power

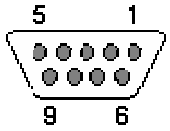
DC power for the modem is connected to the 2-pin DC power input jack labeled **DC IN**. Use the supplied cable to connect the DC power. The **red wire is positive (+)** and the **black wire is negative (-).**

Its connection is optional, as the user may alternately apply power to Pin 9 and ground to pin 5 of the 9-pin I/O connector.

The FireLine modem is supplied with a DC power cable, Raveon part number 4C660. The connector housing on the DC power cable is a MOLEX 50-57-9402. The pins used in the housing are MOLEX 16-02-1125. The crimp tool for the connector pins is a Molex part number 11-01-0209.

4.3. User I/O Connector

The User I/O is via a female 9-p D-subminiature connector. The following pins are defined.



Front-view of DB-9 connector on modem (female)

Pin #	Name	Dir	Function	Level / Specification
1	CD	out	Carrier detect	If enabled, indicates presence of carrier. 0 means carrier is present. If disabled, it is asserted (0) whenever the modem is operational, and not in the configuration mode. It will be a 1 when the modem is in the configuration mode.
2	RxD	out	Receive data	Data out of the modem.
3	TxD	in	Transmit data	Data into the modem.
4	DTR	in	Data terminal ready	Normally ignored by the *FireLine* modem.
5	GND		Ground connection	Signal and power ground
6	DSR	out	Data Set Ready	Normally is set to 0 when modem is powered on.
7	RTS	in	Request to send	Used to stop/start the flow of data coming out of the modem TxD pin. 0 = OK to send, 1 = don't send. Leave disconnected if not used.
8	CTS	out	Clear to send	Used to stop the flow of data going into the RxD pin from the device connected to the *FireLine*. 0 = OK to send, 1 = don't send. If the FireLine cannot accept more data, it will negate this signal (set to a 1).
9	Power	In/out	DC power (not Ring signal)	User may supply the DC power to the modem on this pin.

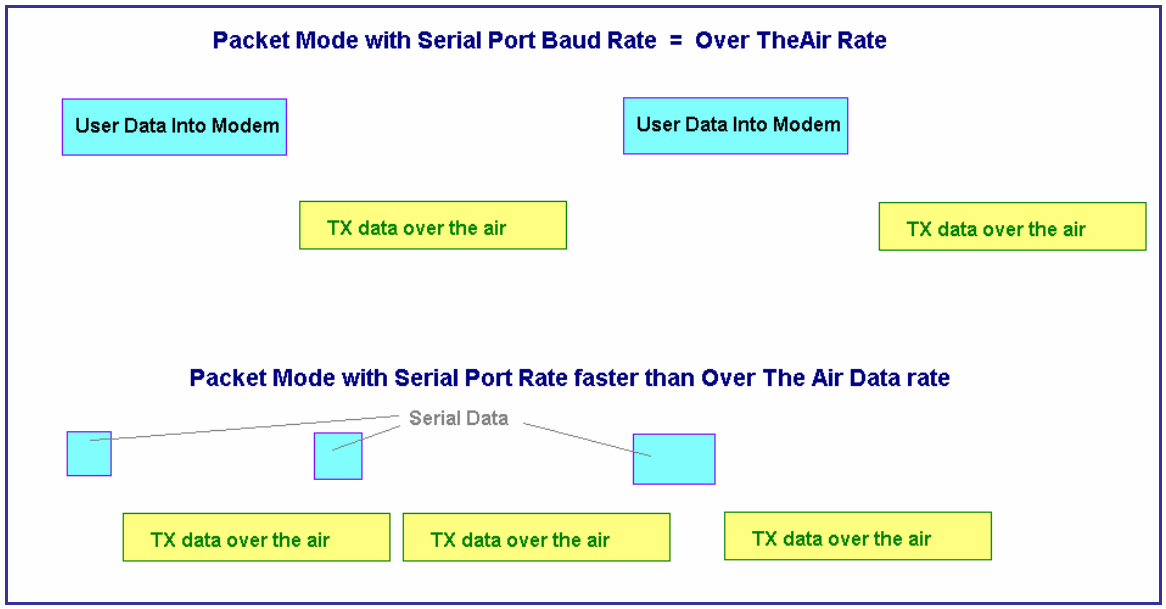
Note: RS-232 signals use positive and negative voltages to represent digital 1s and 0s. A positive voltage is a 0, and a negative voltage is a digital 1.

This pin-out allows it to be directly plugged into a computer's 9-pin serial port using a conventional serial cable. To connect it to a modem, or computer peripheral that has a serial port, you will need a "null-modem" cable. See Appendix A for more information on wiring a null-modem cable.

5. Using the FireLine Modem – Packet Mode

This section describes the operation of the when it is in the *Packetized Mode* of operation. This mode is selected with the command **ATMT0**. It is the easiest and most reliable mode of operation for a modem.

In Packetized Mode, all transmissions are sent in bursts or packets, and contain address, error detection, and error correction information. ARQ may also be used in this mode.



For operation of the modem in the streaming data, non-pacektized mode, see the section entitled "*Using the FireLine Modem – Streaming Mode".* Note, addressing and ARQ are not supported in streaming mode.

In Packetized Mode, selection of the serial port baud-rate is very important. From the diagram above, it is obvious that 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%. If the serial port baud rate is set much higher, say 2-8X the over-the air rate, the channel utilization becomes near 100%.

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.

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. In general, the parameters you may want to modify will be:

ATFT, ATFR	Frequency for this channel
ATMT 0	0 for normal Packetized operation.
ATAK	0 for no ARQ, 1 if this unit sends ACKs
ATRB	Set the number of retries if ARQ is used
ATBD	Serial port baud rate
ATMY	The ID of this unit
ATMK	The network address mask
ATDT	The address of the unit this modem will talk to
ATBC	Enable/disable busy channel lock-out

6. Connect your serial data device to the 9-pin connector on the front of the modem. The default serial port default settings are 9600bps, 8 data bits, 1 stop bit, no parity.

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 FireLine 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.

5.2. Data Transmission

To transmit data, simply 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 it has over the air.

While the modem is transmitting, the user may continue to send more data into the FireLine, as its buffers are full-duplex, and operate independently of the over-the-air activity. The serial port baud-rates may be set slow to accommodate legacy equipment, or set at high-speed to minimize latency.

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

When serial data is entering the FireLine's RS-232 port, the FireLine 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.

5.3. Data Reception

When the modem receives data over the radio, it checks it for errors, and if it is error-free, it will send it out the serial port. Again, the serial port may be set to any baud rate the user wishes, and the radio receiver and transmitter will continue to operate independently of the baud rate.

When the modem receives a signal, it will assert the CD hardware signal on the RS-232 serial port if it was configured to do so.

5.4. Addressing (Packetized Mode only)

Addressing Basics

One of the more powerful aspects of the *FireLine* modem is its addressing scheme. Each FireLine contains a 16 bit address, called its Unit Address, and is represented as a 4 digit hexadecimal number. *FireLine* address may be any number between 0000 and FFFF, which is 65,535 different addresses. Every FireLine has a unit id programmed into it, as well as the ID of the unit it will send data to. The unit ID is programmed with the **ATMY xxxx** command, and the ID of the destination modem to send data to is configured with the **ATDT xxxx** command. The defaults ID is 1234 for the unit ID, and FFFF for the destination ID.

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, *FireLine* modems transmit their Unit Address along with the data. Receiving modems check the received Unit Address, and see if it matches their 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.

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 *FireLine*, there is an "Address Mask" programmed into it. The default mask is FFFF. The address mask is also 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, will you want to change the address mask. Whenever data is received over the air, the Unit Address of the device that sent the data is logically "ANDed" with the Address Mask in the receiving modem. This is the Effective Transmission Address. The receiving *FireLine* 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 Transmission 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

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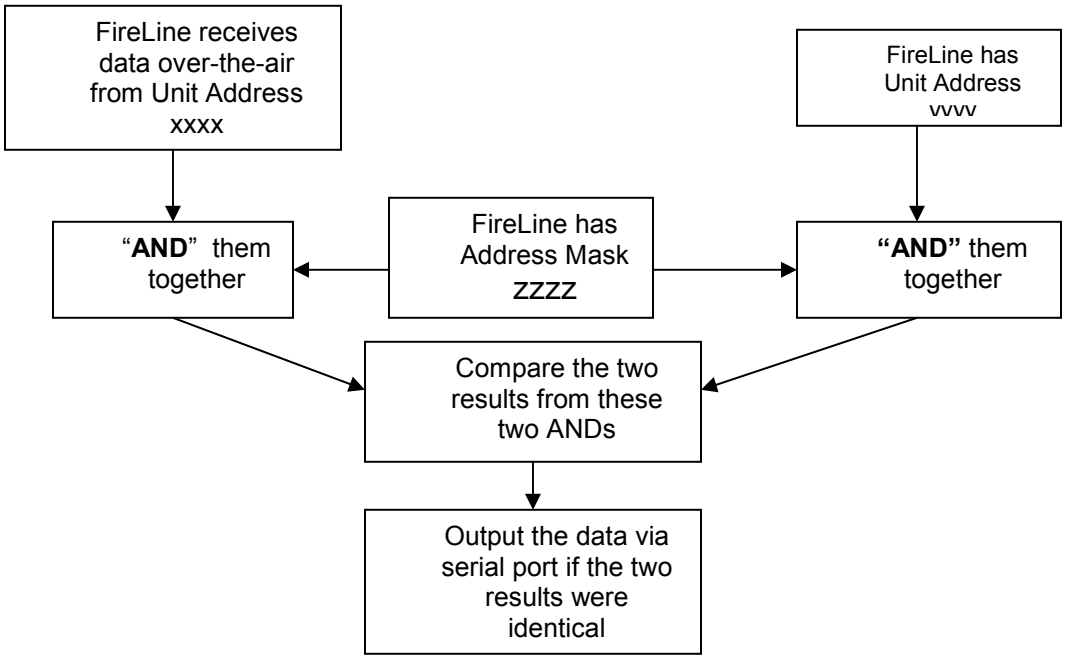


One effect of this is that an address mask of 0000 will cause the FireLine modem to received any data from any unit that transmits. The Unit Address will effectively be ignored if the mask is set to 0000.

Addressing Examples:

Example 1 (default configuration)

Sending Unit 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 Unit 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 Unit Address = **1236**

Receiving Unit Address = **1234**

Receiving Unit's 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 Unit Address = **2234**

Receiving Unit Address = **1234**

Receiving Unit'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 FireLine 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 FireLine 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:

1) 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.

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

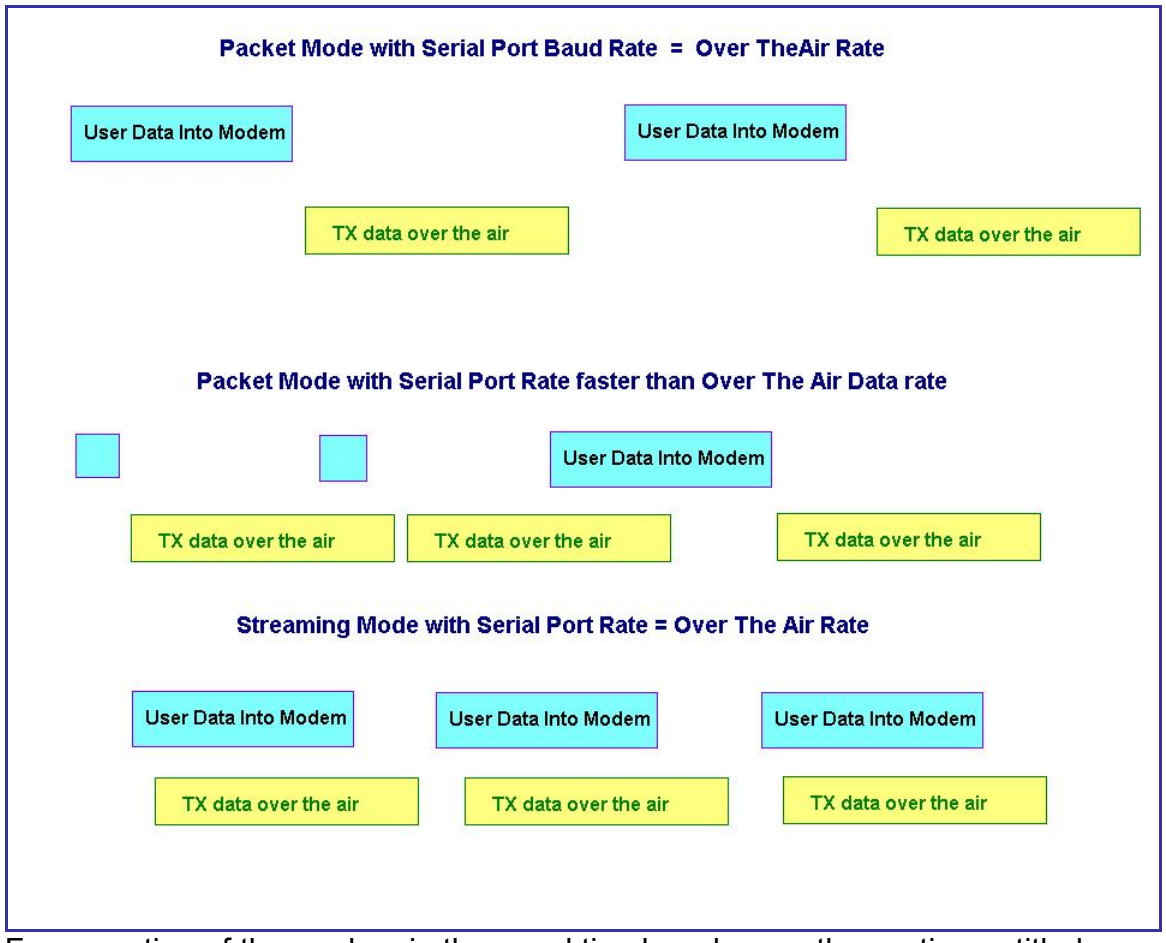
The number of times it retries to send data that does not get through (does not get an ACK) is up to the user, but a number of 5 is usually a good compromise. If after 5 times, the data does not get through, then there probably is something seriously wrong with the channel or system.

The retried-transmission 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.

6. Using the FireLine Modem – Streaming Mode

This section describes the operation of the when it is in the streaming mode of operation. This mode is selected with the command **ATMT2**.

In streaming mode, all transmissions begin whenever data enters the mode, and 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.



For operation of the modem in the pacektized mode, see the section entitled "*Using the FireLine Modem – Packet Mode".*

In Streaming mode, the user data may still enter the modem at any baud rate, as set with the **ATBD x** command. The FireLine 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 unkey the radio and go back into the receive mode.

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

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 FireLine modem will hold the data as it is sent out the serial port.

7. Installation

1. Secure the *FireLine* modem using the four mounting holes on the side flanges of the unit.
2. Connect a DC power source to the DC IN connection on the front of the modem. Use the supplied cable, and connect the RED wire to +, and the black wire to – (ground). The black wire and the case of the FireLine should be connected to earth ground.
3. 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.
4. A separation distance of at least 20 centimeters must be maintained between the transmitter's radiating structures and the body of the user or nearby persons.
5. Connect a computer terminal, or PC computer running HyperTerminal, to the 9-pin I/O connector.
6. If the antenna is mounted out doors, us a lighting arrestor in-line with the antenna, and properly ground the antenna and the *FireLine* chassis to an earth ground.

8. FCC Licensing Information

FireLine radio modems operate on radio frequencies that are regulated by the Federal Communications Commission (FCC). In order to transmit on these frequencies, you are required to have a license issued by the FCC.

Almost everyone engaged in public safety activities - as well as private organizations, are required, to obtain a radio station license from the Federal Communications Commission if they wish to use a radio transmitter.

The FCC will help you through the licensing process.

You can find the basic information you need to begin the process at the FCC website. If you are engaged in public safety activities, you can go directly to:

http://wireless.fcc.gov/publicsafety

If you are a business, commercial, or institutional organization, you can go directly to:

http://wireless.fcc.gov/services/ind&bus

In either case, you will be shown the regulations and the information you will need to gather before you get started - your desired operating frequencies, wideband/narrowband, antenna type and size, power/wattage, etc. You'll also

get information on how to obtain the necessary application forms - either in hard-copy or electronic format - and how to proceed.

The FCC website also offers a list of Frequency Coordinators. These are private organizations officially certified by the FCC to help you through the process, and who in most cases will handle the actual filing of your application. With few exceptions, you must apply for an FCC license through a Frequency Coordinator. They are located throughout the country, making it easy for you to find one that is familiar with radio operations in your area.

There are companies who specialize in assisting with licensing radio modems. You may consider contacting one of the following:

Atlas License Company and Data Services
1-800-252-0529
http://www.alcds.com

Airwaves Licensing
1-717-334-0910
http://www.airwaveslicensing.com

9. User Serial Port Commands

9.1. Overview

The asynchronous 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 user port, 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 user port. This is the default operating condition of the RF modem.

There also is a "Command Mode". In the Command Mode, the *FireLine* modem accepts commands via the serial port TxD pin. The commands can be used to change certain internal parameters of the *FireLine* modem.

9.2. Command Mode

The *FireLine* modem may be put into a "Command Mode", by entering a sequence of three plus characters (+++). To keep the *FireLine* modem from accidentally 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 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 1 second.

2. Input three (3) plus characters ("+++") within one (1) second.

3. No characters sent for one (1) second.

When the *FireLine* modem first enters the Command Mode, it sends the phrase "FireLine" 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)

9.3. Setting a Parameter

To set a parameter in the FireLine modem, enter the configuration 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 *FireLine* modem to 1234, enter the following command:

ATDT 1234 <CR>.

9.4. 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 *FireLine's* modem address and its address was 1234, the user would issue the following command:

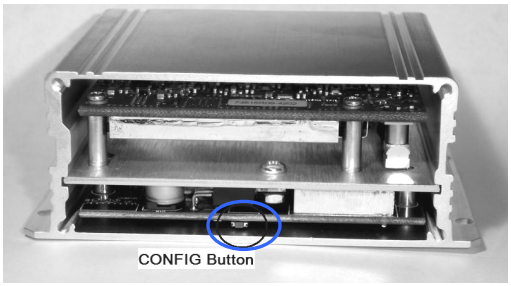
ATDT<cr>

and the modem will respond with:

1234<CR> <LF>

9.5. CONFIG Button

If certain parameters within the modem are modified in a manor that causes the modem to cease functioning or if the user cannot enter the command mode via the "+++" method described above, there is a small push button internal to the *FireLine* modem to assist. This CONFIG button may be pressed at any time, and forces the modem into a know operational state. The CONFIG button is located inside the modem. Remove the rear cover, exposing the two circuit boards. The button is in the center of the lower circuit board as shown below.



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

1. *Serial port 9600 baud, 8 data bits 1 stop, no parity*
2. *ATCT setting set to 60000 (60 second time-out)*

Even though the serial baud rate reverts to 9600 baud when the CONFIG button is pressed, it will revert back to the ATBD setting programmed into the modem once the Command Mode is exited.

9.6. Exiting the Command Mode

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

1. ATSV Issuing the ATSV command saves they current configuration to non-volitile memory, and then returns to the normal operation mode.

2. ATCN Issuing the ATCN command does not save the current configuration, but it does cause the modem to continue to operate. If changes to the configuration were done in the Command mode, these changes will be used in operation, but they will not be saved to non-volatile memory.

3. Time Out. After a pre-set amount of time (60 seconds is the factory default time), the modem will continue normal operation. Changes will not automatically be saved.

9.7. 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 factory-set only. If a PC's serial baud rate is set higher than the fixed over-the-air baud rate of the module, may need to be implemented.	Range: 0 – 6 0 = 1200 bps 1 = 2400 2 = 4800 3 = 9600 4 = 19200 5 = 38400 6 = 57600	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
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 charators.	1 = Enable 0 = Disable	0
CN or **O**	**Exit AT Command Mode** – Exits module from AT Command Mode and returns it to Idle Mode. Parameters are not saved in EEPROM.	none	none
CT	**Time Out from AT Command Mode** – If no valid commands have been received within this time period (in milliseconds), modem returns to normal operation mode from Command mode.	Range: 100-60000mS	60000
DT	**Unit 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 F.	Range: 0-FFFF	1234
E0 , E1	**Echo – Set Echo on (E1) or off (E0)**	Range: 0 , 1	0
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 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.
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	Range: See product data sheet.	N/A

	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.		
HP	**Channel Number** – Select separate channels to minimize interference between multiple sets of modules operating in the same vicinity.	Range: 1 - 5	1
K2	**Disable LEDs** – When 1, LEDs are always off to conserve power. When 0, LEDs work normally.	0, 1	0
L	**Enable/Disable the LEDs** – 0=LEDs always off. This reduces some power consumption. 1=LED operate normally.	0 or 1	1
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=FireLine packetized, 1=SkyLine packetized. 2=non-packetized 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
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
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	-133**
R1	**Select CD pin output signal** – CD may be RF carrier detect, or modem data detect.	Range : 0, 1 2 = Always assert CD 1 = Data CD 0 = RF CD	1
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 4 = 8000 4L 1 = 1200 5 = 9600 2L 2 = 2400 6 = 19200 3 = 4800 7 = 5142 8 = 9600 4L	3
R3	**Serial Port time out** – Number of mS of no activity before transmitting.	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)
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 : 0-999	300**
RB	**Number of retries**. If this modem does not get an ACK back when it sends data, this is the number of	Range: 0-99	0 (ACKs are not

	times it will re-transmit the packet and wait for an ACK. 0=disabled feature.		used)
RD	**Stream-mode TX method** – When the modem is configured for streaming (non-packet) operation, this bit sets how the transmitter is Keyed. 0=RTS line. 1-data.	Range: 0, 1	1 (data)
RE	**Default Configuration** – Restores radio module parameters (R0 – RA registers) to factory default configuration.	none	none
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)
RG	**Transmit Time-Out-Timer** – Sets the transmitter time-out-timer in seconds. This is a fail-safe timer for improper configuration or operation of the modem. In normal operation, the TOT setting is not changed.	Range: 0-999	60
RS	**RSSI** (Receive Signal Strength Indicator) – Returns the signal level of last received packet. This is DAC reading of the RSSI in the radio. It is not calibrated, but gives a relative signal strength indication.	No parameters. Returns a number 0-1024.	none
RT	**Radio Type –** Select the type of radio module installed within the modem. ***If this parameter is changed, you must fully recalibrate the modem.*** The type of radio module installed is listed on the serial number. Various	Range: 1-9 2 = RV-M5-UC(DM3473) 3 = RV-M6-UC(DM3475) 5 = RV-M5-UC-W	2**
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
SV	**Save –** Save all the parameters to EEPROM. This command must be used if changed parameters are to be stored in non-volatile memory, and used next time the modem is powered up. Modem exits configuration mode after this command is executed. It saves all parameters except the frequency (The frequency is automatically saved when an ATFT, ATFR, or ATFX command is executed)	none	None
TD	**Transmit Random Data** – When issued, the modem will begin sending random data. Entering a <CR> will terminate the transmission.	0 = Go back to normal 1 = Random 2 = Hop up/dn one channel 3 = Force PLL to fast 4 = TX all 0s 5 = TX all 1s 6 = Test Points ON 7 = Transmit CW 8 = Transmit 1010101…	
TT	**Max Packet Size –** Set the maximum number of bytes in an over-the-air packet.	1 - 512	240
VR or **I0**	**Firmware Version** – Returns firmware version currently loaded on the module.	Read Only, 3 characters	none
&F	**Restore Factory** – Restore the factory default values. This command will not erase the calibration values in the flash unless the parameter is the three-digit string "123". After this command executes, the modem will still be in the CONFIG mode.	None to maintain calibration, "123" to erase everything.	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.

9.8. Default Frequencies

Channel 1 464.55 MHz

9.9. Setting the Over-The-Air Data Rate

The SkyLine 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 8 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*	*FireLine Modem Models that support the rates*
800bps (R2=0)	12.5kHz or 25kHz	2	RV-M5-UC-N, RV-M5-UC-W
1200bps (R2=1)	12.5kHz or 25kHz	2	RV-M5-UC-N, RV-M5-UC-W
2400bps (R2=2)	12.5kHz or 25kHz	2	RV-M5-UC-N, RV-M5-UC-W
4800bps (R2=3) Default setting	12.5kHz or 25kHz	2	RV-M5-UC-N, RV-M5-UC-W
8000bps (R2=4)	12.5kHz or 25kHz	4	RV-M5-UC-N, RV-M5-UC-W
9600bps (R2=5)	25kHz	2	RV-M5-UC-W
19200bps (R2=6)	25kHz	4	RV-M5-UC-W (will not work with Radio Type 5)
5142bps (R2=7)	12.5kHz or 25kHz	2	RV-M5-UC-N, RV-M5-UC-W, RV-M5-UC-S
9600bps (R2=7)	12.5kHz or 25kHz	2	RV-M5-UC-N, RV-M5-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 FireLine radio modems is 4800 baud for narrow-band versions, and 9600 baud for wide-band versions.

RV-M5-UC (narrow-band version)

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

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

For **best range** (longest distance), set R2=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-M5-UC-W (wide-band version)

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

For **best range** (longest distance), set R2=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.

9.10. 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

SHOW Display an overview of the configuration.

STAT Display statistics of how the modem is working.

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.

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

10. Tune-up and Alignment

Do not key the transmitter for more than 30 seconds out of every 300 seconds. The transmitter is rated at 10% duty cycle maximum.

The following table lists the parameters in the modem that are calibrated at the factory. Calibration values are stored in registers R0 – R9. The *FireLine* radio modem has the capability of incorporating a variety of different radios modules. Each different radio model is considered a different "radio type". The radio type is read and set with the ATRT command.

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 value, and it is easy to unintentionally modify the wrong register.

Typical Register Settings

R Register	R0	R5	R8	R9
Function	Peak Deviation	Preamble Length	Frequency Offset	Modulation Balance
Radio Type 2 (DM3473 Module)	100	5	0	20
Radio Type 3 (DM3475 Module)	120	5	0	20
Radio Type 5 (DM3472 Module)	175	9	50	NA

The type of radio module installed in the radio is shown on the serial number label attached to the FireLine modem's rear cover.

10.1. Center Frequency

1. Set the VCO balance setting to its nominal value. Use this command:
   ATR9 20
2. Key the transmitter with CW output using this command:
   ATTD 7

3. The modem will now put out CW on the center of the channel.
4. Read the frequency offset with the **ATR8** command.
5. 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.
6. Set the deviation back to the value you read in step 1, using the **ATR0** command.

10.2. TX Deviation

1. Switch to channel 1.
2. Key the transmitter into a 50 ohm load using the ATTD 5 command. The unit will now transmit, and send a digital 0 continuously. This should be +2.0kHz in frequency for narrow-band radios (12.5kHz spaced channels) and +4.0kHz for wide-band (25kHz channels).
3. Adjust the deviation register setting so that the frequency deviation is correct. The deviation is set with a digital adjustment. Use the ATR0 command to read or set the deviation level.

10.3. TX Modulation Balance

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

1. Transmit an alternating 10101.. pattern using the ATTD 8 command.
2. While monitoring the modulation using an FM demodulator, adjust the balance digital pot value, by setting it with the ATR9 xx command. xx = 0 - 127, and is typically around 40 for good modulation and a deviation of 2.0kHz.
3. Transmit random data, using the ATDT 1 command. Verify the DC center of the demodulated data is stable.
4. If necessary, change the ATR9 setting so that the long data bit have the same amplitude and DC value as the shorter ones.

10.4. RX DC Offset Verification

To verify that the DC center of the received signal is near the nominal value, perform the following steps:

1. Generate a test signal, 1kHz tone, 1.5kHz deviation, on the receive frequency. Connect the signal generator to the antenna input. Set the RF level to -90dBm.
2. Measure the average voltage at TPRX1 on the modem circuit board.
3. The DC voltage should be between 1.0 and 2.0 volts, and the p-p voltage of the sine wave should be greater than 50mV and less than 2 volts.

10.5. 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 **ATRA** command.

When the modem is used in the streaming mode (non-pacetized operation, you may wish to configure the modem to require RF carrier detect to be active for the modem to receive data. Use the **ATRF** command to enable/disable this feature.

To set the RF carrier detect level, perform the following steps:

1. Generate a test signal, 1kHz tone, 1.5kHz deviation, on the receive frequency. Connect the signal generator to the antenna input. Turn the RF level off.
2. Watch the RSSI value by issuing the **AT$5** command. The current reading will be sent out the serial port.
3. Adjust the RF level to a point where you would like the RSSI to trigger the CD signal. This is factory-set to -110dBm.
4. Send the **ATRA nnn** command. Set **nnn** to be equal to the RSSI setting you would like the CD signal to trip at. The BUSY LED will also indicate an RF carrier when the RF carrier is above the threshold set with the ATRA command.
5. Generate an RF signal on-channel with a level of -110dBm. Verify the Power/BUSY LED stays on. If it does not, repeat step 4, adjusting in increments of 10.

11. SkyLine Compatibility

11.1. General

The *FireLine* RF modem has built-in compatibility with a radio modem made by Sonik Technologies, Vytek Wireless, and Cal Amp called the *SkyLine*. In most applications, Raveon's *FireLine* modem can communicate with *SkyLine* modems, provided the *FireLine* is properly configured. There are two versions of the Skyline, a wide-band version running at 9600 bps over the air, and a narrow-band version running at 5142bps over the air.

Following is a list of SkyLine features that are fully supported by Raveon's FireLine wireless modem.

Transparent Operation. The FireLine can operate using the same over-the-air packet protocol as the SkyLine, so users of the SkyLine will see no difference between data transmission, reception, and timing.

Addressing. The FireLine uses a 16bit address in the same way as the SkyLine addressing operated. All SkyLine address modes and techniques work with the FireLine modem. Along with the SkyLine's xxFF and FFxx group calls, the FireLine also has a net mask for an even more versatile addressing scheme.

ARQ. The FireLine has an ARQ (Automatic ReQuest) mode, functionally the same as SkyLine's ACK mode. The FireLine modem will send and receive ACK packets in the same way that the SkyLine modem does.

11.2. SkyLine Compatibility Issues

Certain features of the SkyLine modem are not currently implemented in the *FireLine* modem. They are:

Repeater Function	No store and forward repeating is implemented.
Over-the-air rates	The SkyLine is fixed at 9600baud over the air for wide-band modems, and 5142baud for anrrow-band modems. The FireLine can use these data rates, as well as many others that the SkyLine does not support.

11.3. Configuring FireLine to Communicate with a SkyLine

To configure the *FireLine* modem to talk to an old *SkyLine* modem, the user must configure the *FireLine* with these commands:

ATR2 7 This command tells the *FireLine* modem to operate with an over-the-air baud rate of 5124 bits per second. This is the baud-rate of all narrow-band (12.5Khz spaced) SkyLine radio modems. Wide-band SkyLine radios operated at 9600 baud over the air. The command to set the *FireLine* to 9600 baud over the air is ATR2 5.

ATR5 7	This command tells the *FireLine* modem to send 7 bytes of preamble before every transmission.
MYID 1234	The MYID of the *FireLine* modem is set with the ATDT command or the MYID command. The default MYID of the SkyLine was 1234.
TOID FFFF	The TOID of the *FireLine* modem is set with the ATMK command or the TOID command. The default TOID of the SkyLine was FFFF (broadcast address).

A quick-configure command is included in the *FireLine*, to allow it to be easily switch to the *FireLine* mode. The command is "SKYLINE". When in the configuration mode, enter **SKYLINE**, and the modem will reconfigure itself as a narrow-band SkyLine modem, with **TOID = FFFF**, **MYID=1234**, 80 byte packets, 20mS serial port time out, channel 1 frequency, over-the-air baud rate 5142.

11.4. Use of the DM3472 Wide-band Module

The FireLine modem may be configured with a DM3472 wide-band radio module to communicate with the Sonik SL-UC wide-band SkyLine radio modem at 9600bps. To do so, the following parameters must be set. All other configurations will stay the same as a standard FireLine.

The FireLine radio modem must he a wideband configuration, with a –S on the end of the part number.

Note: This requires that the radio type be changed to 5, and the peak deviation set to 3.0 kHz.

ATRT 5	Set the radio type to 5. This must be the first parameter that is configured.
SKYLINE	Set the SkyLine protocol mode.
ATR2 5	Set the over-the-air baud rate to 9600 baud.
ATR0 180	Set the peak deviation to +/-3.0kHz. You will probably have to adjust this setting to achieve the exact deviation.
ATR0 175	This is the nominal deviation level for this module.
ATR1 1	Use data CD
ATR5 9	SkyLine modems required 9 bytes of preamble.

12. 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, located 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

13. Internal Radio Connection

Internal to the *FireLine*, the modem circuit board interfaces to a radio transceiver module via a 14 pin single in-line connector. The following table describes the function of each pin.

Pin #	Function
1	System ground
2	+7.5V regulated output, ±5%. 1.5amp maximum current source.
3	+7.5V transmit, ±5%. 100mA maximum current source.
4	RX ON. +5.0V in RX mode 0V TX mode. 10mA maximum current source.
5	Radio ON. +5.0V DC to radio. Digital output. 10mA maximum current source.
6	Transmit modulation. 2.5V DC RX, 2.5V DC with 2V p-p Gaussian filtered 9600bps data during transmit.
7	Synthesizer lock detect input. Low=unlocked. High = locked.
8	PLL enable signal. Latch enable signal for serial interface to PLL.
9	PLL data signal. Data to PLL chip via three wire interface, pins 8,9, and 10.
10	PLL clock for three wire interface.
11	No connect
12	RSSI input from radio. Optional input signal.
13	Receiver discriminator input from radio. On-board AGC for signals with amplitude of .1V-2Vp-p and a DC bias of 1V-2.5V.
14	Modulation balance output. Adjustable DC voltage, set with the ATR9 command.

14. Appendix A. Serial Port Hardware

14.1. Serial Port Data and Handshaking

In computer terminology, the RF modem is considered a “Data Communications Equipment” device, or DCE. The user’s hardware that the modem is connected to is considered “Data Terminal Equipment”, or DTE.

Following is a description of how data and control is communicated over the various serial port signals between the modem (DCE) and another device (DTE) that the modem’s I/O port is connected to.

TxD (INPUT)

This line is used to transmit data from the DTE to the DCE. It is maintained at a logical 1 state when nothing is transmitted. If Hardware Flow Control is enabled in the modem, the terminal will start to transmit data to the modem when a logical 1 is present on all of the following lines:

- Clear To Send (output from modem)
- Request to Send (output from the DTE)

RxD (OUTPUT)

This circuit is used to receive data from the DCE to the DTE. The modem will start to transmit data to the DTE when a logical 1 is present on all of the following lines:

- Data Terminal Ready (reply that it is OK to send)
- Data Set Ready (asserted by the modem)

RTS

On this line, the DTE will send a signal when it wants to receive data from the *FireLine* modem. The *FireLine* modem will not output data unless this pin is low, or “Flow Control” has been disabled in the modem set-up. When a DTE (such as a PC or microcontroller) wants to stop the flow into it, it negates RTS. Negated "Request To Send" (digital 1) means "request NOT to send to me" (stop sending). When the DTE is ready for more bytes it asserts RTS (digital 0) and the flow of bytes to it resumes. DCE equipment works the same way but sends the stop signal out the CTS pin. Thus it's RTS/CTS flow control using 2 lines. The user may turn this feature off or on, using the **ATCH** command. The default is OFF. To turn it on, issue an **ATCH 1** command.

CTS

This signal is an output from the FireLine, and it indicates the *FireLine’s* ability to send more data. If the user tries to send more data into the *FireLine* than the *FireLine* can transmit over the air, it will negate the signal on this pin. The CTS may be asserted when the serial-port data rate is greater to or equal to the over-the-air rate. For example, if the over-the-air data rate is set to 2400

baud, and the user is send data into the modem at 9600 baud, the modem will negate the CTS signal once the *FireLine's* internal data buffers become full.

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 FireLine data is detected on the radio receiver).

DTR

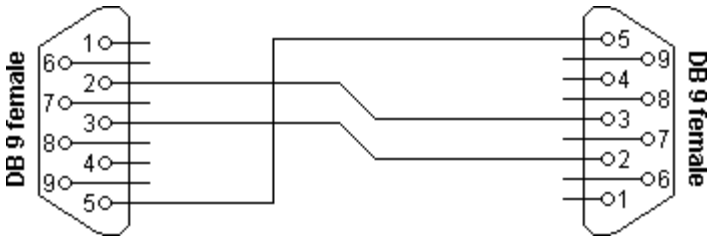
This line is an input to the FireLine. It is normally ignored because the default configuration of the FireLine modem is to ignore this signal. If the DTR line is enabled for use, using the **ATK5 1** command, the DTR input line can be used to put the FireLine modem into its SLEEP mode. With DTR enabled, anytime the DTR line is a logic 0, the FireLine will be operating normally. With DTR enabled, anytime the DTR line is a logic 1, the FireLine will go into a SLEEP mode, drawing much less DC power.

14.2. Null modem without handshaking

Sometimes, a "*Null Modem*" cable may be required to connect the FireLine modem to another device. The specific connections are very dependent upon the type of hardware and handshaking used, but the following sections should help in configuring a null-modem cable.

How to use the handshaking lines in a null modem configuration? The simplest way is to don't use them at all. In that situation, only the data lines and signal ground are cross connected in the null modem communication cable. All other pins have no connection. An example of such a null modem cable without handshaking can be seen in the figure below.

Simple null modem without handshaking



(DB-9 Female shown. Same wiring for male-to-male cable)

Connector 1	Connector 2	Function
2	3	Rx ← Tx
3	2	Tx → Rx
5	5	Signal ground

14.3. Compatibility issues

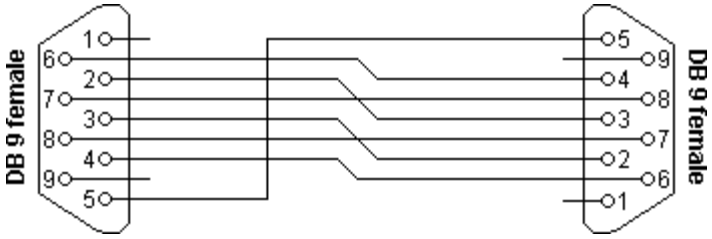
There is a problem, if either of the two devices checks the **DSR** or **CD** inputs. These signals normally define the ability of the other side to communicate. As they are not connected, their signal level will never go high. This might cause a problem.

The same holds for the **RTS**/**CTS** handshaking sequence. If the software on both sides is well structured, the **RTS** output is set high and then a waiting cycle is started until a ready signal is received on the **CTS** line. This causes the software to hang because no physical connection is present to either **CTS** line to make this possible. The only type of communication which is allowed on such a null modem line is data-only traffic on the cross connected **Rx**/**Tx** lines.

14.4. Null modem with full handshaking

In this null modem cable, seven wires are present. The cable is shown in the following figure.

Null modem with full handshaking



(DB-9 Female shown. Same wiring for male-to-male cable)

Connector 1	Connector 2	Function		
2	3	Rx	←	Tx
3	2	Tx	→	Rx
4	6	DTR	→	DSR
5	5	Signal ground		
6	4	DSR	←	DTR
7	8	RTS	→	CTS
8	7	CTS	←	RTS

14.5. Compatibility issues

The null modem cable with full handshaking does not permit the older way of flow control to take place. The main incompatibility is the cross connection of the **RTS** and **CTS** pins. Originally, these pins are used for a question/answer type of flow control. When the full handshaking null modem cable is used, there is no request anymore. The lines are purely used for telling the other side if communication is possible.

The main advantage of this cable is, that there are two signaling lines in each direction. Both the **RTS** and **DTR** outputs can be used to send flow control information to the other device. This makes it possible to achieve high communication speeds with this type of null modem cable, provided that the system has been designed for it.

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.

Soultion #2. If the addresses match, and RX LED blinks but still no reception of data, verify that the RTS signal is asserted. The FireLine 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 FireLine 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).

Symptom: Unit will not transmit

Solution #1. Verify that CTS is wired. Some devices that could be connected to the FireLine will require the CTS signal to be asserted. The *FireLine* does assert this signal, but if the wire is not connected, you device may not be outputting data to the *FireLine*. If the TX LED blinks, the FireLine 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 FireLine 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).

Symptom: Long delay before transmitting

Solution #1. Verify that serial port timeout is OK. The ATG0 command sets the number of microseconds that the FireLine 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. Typical settings for this parameter are 20000 (20mS).

Symptom: Modified parameters are lost at power-up

Solution #1. Issue an ATSV command. After any parameter is modified, the modem will operate with the new setting, but unless the ATSV command is issued, it will revert to the old setting upon turning power off and back on again. The ATSV command saves all parameters into EEPROM memory, and these saved parameters are restored upon power up.

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

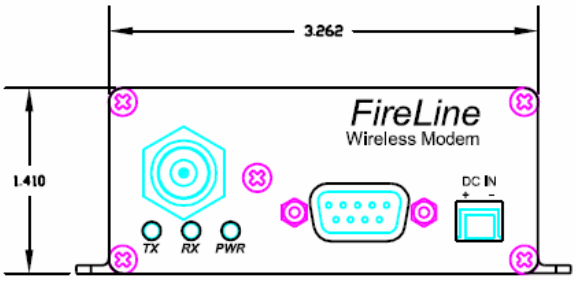
port to 9600 baud, 8 data bits, one stop, and no parity. If the baud-rate was OK, verify the AT, BT and CT times, that they are long enough for you to enter the +++ string.

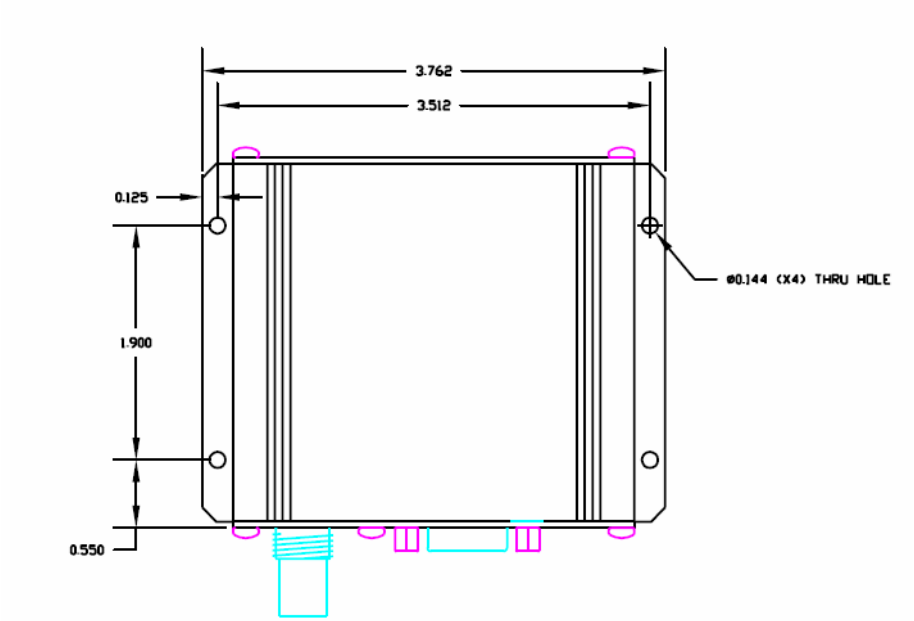
Solution #2. Handshaking. You may have hardware handshaking enabled on your terminal program, but the hardware or cable may not support it. Disable hardware handshaking on your terminal program to verify this is the issue.

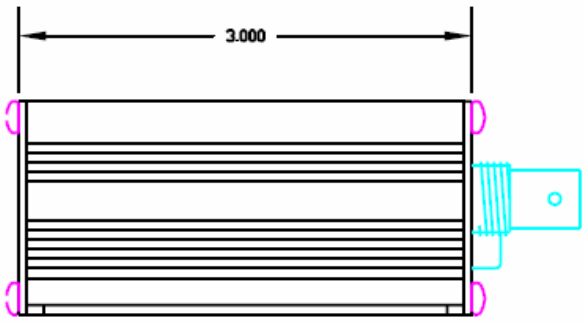
Symptom: Modem appears dead.

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 **ATJS2** command.

16. Mechanical







17. Limited One Year Warranty

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2722 Loker Avenue West
Suite D
Carlsbad, CA 92024

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.