Technical Brief
AN245 Rev A1

VUF/UHF Data Radio Modem Guidelines

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Summary

Raveon's ***RV-M7*** data radio modems work on narrow-band VHF and UHF channels. Our other narrow-band data radio modems such as ***RV-M6, RV-M8***, and "*Tech Series*" data radios ***RV-M21*** and ***RV-M22*** are over-the air compatible and have all the same features descried in this Guideline document.

The Raveon data radios are designed for remote data transmission in industrial and commercial industries.

This Modem Guideline describes the general features and operational procedures to utilize Raveon's data radio technology in private long-range wireless networks.

This list of guidelines for our RV-M7 and other Radio Modems includes:

- Setting up a Radio Modem
- Utilizing a Radio Modem for high quality performance.
- Testing a system to verify it is working as expected.

Setting up a Radio Modem

The most important thing to do is Read the Data Radio Technical manual for the model you are using. These links on Raveon's website have the data sheets and technical manuals. RV-M7, Tech Series RV-M2xs, RV-M6, RV-M8.

Note that the M6 and M8 models are radio modules, often operating with the M21/M22 tech series enclosure. Should your product be used in the enclosure it is best to read both the M21/M22 manual in conjunction with either the M6 or M8 manual as appropriate.

At the end of each radio technical manual, there is a list of ***Troubleshooting*** topics to help you figure out what is not working correctly in your system. This section has been updated repeatedly with solutions as gathered from real life experiences..

Raveon's factory default settings always setup to default modes and features, and brand new radios from Raveon will communicate reliably without any other settings. However to use them in your system, you often must setup specific features you need or want. The most common parameters to setup on a new radio for your system are listed here:

1. *Frequency*. Set the frequency of the radio to your frequency. ATFX command will set the transmit and receive frequencies identically in one command.
2. *Bandwidth.* Many radios have programmable IF bandwidths such as 6.25kHz, 12.5kHz, and 25kHz. The default on most are narrow-band 12.5kHz. ATBW

command will read the bandwidth, and in some models can be set to 'N' (narrowband) or "W" (wideband) values. All radios in your system must use a common bandwidth.

3. *Over-*the-Air (OTA) baud rate. The ATR2 parameter sets this baud rate, with the most common (and typically stock) setting being ATR2 = 3, which is an OTA rate of 4800 baud using 2-level modulation. All radios in your system must use a common OTA rate.
4. *RF Power.* Factory default is full power, so if you need lower power, the ATPO command will adjust it, and you must read the power and adjust the TX power with ATPO command to set the power to the level you want.
5. *ID Codes.* Every radio has a 16-bit ID code. 0001 – FFFF. Should you wish to use the diagnostic PING feature ensure each system radio has a unique ID. Often ID's may be set to represent nodes in your system. For instance ID 1000 may be used at a 'master' system radio while remote radio ID's can be incremented (e.g.1001, 1002…) to represent node 1, node 2, etc, in your system.

If you want Raveon to setup your radios when you acquire them from Raveon, you can work with the sales team to create a Tech Note specific to your requirements, and then any orders can reference that Tech Note and the production team will configure the radios per your Tech Note. Use care to differentiate new systems from new radios adding to existing systems.

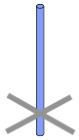
System Design

Application note AN119 describes RF System Design to help you figure out what type of antennas to use, where to locate them, and how to improve system reliability.

AN119 explains how antennas work in your system. Antennas are designed in many different ways, so the antenna you use, must be used in the way the antenna company intended.

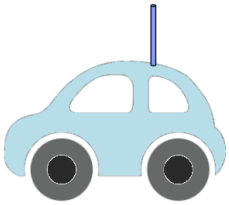
Antennas

Some directional antennas propagate RF in strong ways in certain directions, and receive best in that same direction. Using them can reduce noise from other areas, and strengthens the signal strength in the direction you point them. Their range is long, but they are directional, so in some other directions, they cannot communicate very well.



Omni-directional antennas radiate and receive RF signals 360 degrees all around them, getting weaker towards each of the two points. To obtain strong RF, the ground plane area around the base of the antenna must be near ¼ the wavelength of RF.

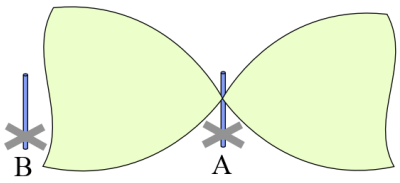
If the antenna is the same length, but does not have the grounded base wires on it, the RF energy it transmits and receives will be lower. The metal of the product the radio is installed in can be used as the antenna ground plane base. For example, an antenna on a car does not need



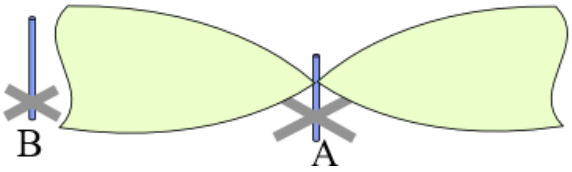
ground wires, because the roof of the car can be used as the RF ground plane.

Antennas are ratet with “Antenna Gain”. An antenna that says is it a 3dB antenna, has 2X more gain than a similar 0dB antenna. 6dB is 4X gain, 9dB is 8X more gain. So an antenna that is 3dB, may be anticipated to 2X as well as a normal Omni-directional antenna. To get gain, the antenna radiates RF energy in certain directions at the sacrifice of other directions. Here are some examples.

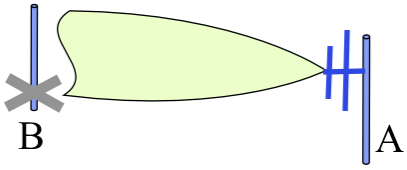
A normal 0dB Omni Antenna: TX Energy from A goes to B. You see some energy goes over the top of B and B gets some, and misses some.



A 3dB higher gain Omni Antenna: TX Energy from A goes to B and A antenna with some gain keeps 50% more energy lower, so B gets to receive more of it. You see less energy goes over the top of B so it gets 2X more energy (3dB more)



6dB higher gain directional Antenna: TX Energy from A goes to B and A antenna with some gain keeps 2X more energy lower and 2X more directly at B instead of radiating away from B. So B gets to receive much more RF energy. You see energy goes straight to B so it gets 4X more energy (6dB more).



For optimal results all antennas in a system should share the same ‘polarity’. For example, when using most omni-directional antennas each antenna should be mounted in an upright position or posture.

Antenna Distance for Multiple Radios

Point-to point radio modems work very reliably. It is important to know that if a transmitter is transmitting in an area, the local receivers near it can receive it, but if another remote radio sends a weak signal, a local receiver near the transmitter may not receive very well if the competing transmitting radio is on a frequency very near the system.

If two transmitters transmit at the same time, then no receiver can actually receive the signal because the two transmissions will “interfere” with each other, and the RF signals become muddled.

It is very important on RF radio systems to make sure transmitters always transmit on their own, one at a time. Raveon can provide TDMA systems to guarantee this works, assigning unique time slots for each transmitting device to use. Most communication systems design their data messaging to ensure that each transmission is done on its own time. A good way to do this is:

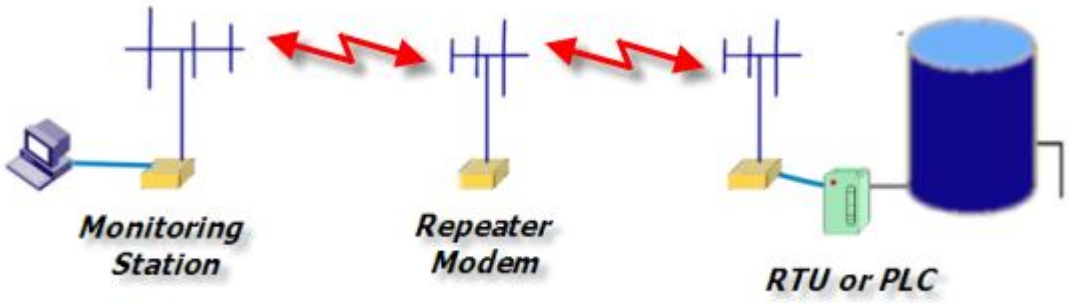
A. Have one master station POLL each remote one, so when one is polled, it transmits as required all by itself.

B. Have a master station tell each remote unit when to transmit (at different times). So each remote station transmits all by itself at its own time.

C. Some system use random transmissions, and infrequent transmissions normally don’t interfere, but as transmissions become more frequent the likelihood of interference rises dramatically. Raveon radios can often reduce this likelihood by the user implementing a ‘listen before speaking’ feature, to avoid transmitting if an interferer is on the air, and/or message receipt acknowledgements (ACKs). Systems will often use the ACK feature to have the receiver acknowledge that it received the message, and if the ACK is not returned the transmitter will re-send the message again in a random time.

Repeating For Extended Range

For longer communication ranges, high RF noise environments or obstructed line of sight applications it may be necessary to use a repeater to establish a reliable communications link.



Incorporated in the radio is a built in store-and-forward repeater function. The repeater function works only in the Packet Mode, and will not repeat streaming messages. A repeater can extend the range of a system by 2-20X, depending upon how high-up above the average terrain the repeater is mounted.

The following table shows a typical repeater system configuration in packetized mode.

AT Command	Monitoring Modem	Repeater Modem	Remote Modem	Notes
ATMY	1000	2000	0001-0999	Individual unit address for this particular modem. Each remote modem should get a unique ID.
ATDT	0001	N/A	1000	Destination address to send data to.
ATMK	F000	0000	F000	Address mask. F000 means that to receive, the first digit of the MYID must match the first digit of the TOID.
ATXR	0	1	0	Enable/Disable repeater function. Only enable it on the particular radio that will be the repeater.
ATX1	N/A	1000 0000 1000 0000	N/A	In the repeater, set the addresses this unit will store-and-repeat to/from. By leaving the repeater table untouched, or by setting the repeater address masks in the repeater table entries to 0000, this repeater will repeat any and all data packets .

Serial Data In and Out of the Modem

Buffer Status

Tech Series radios have a command ATJF that will allow the user to set the CTS threshold. By default, this is set to 80% of the buffer's size. When the internal data buffer of the M21 reaches this threshold, the CTS hardware handshake line is negated.

The user may change this threshold. If you want the modem's CTS line to indicate when the buffer is empty (all data has been transmitted), then set the **ATJF** parameter to 1 (**ATJF 1**). This will have the effect of negating CTS whenever there is any data in the M21's data buffer. When all data has been transmitted over-the-air, the CTS line will be asserted again. It is a handy way to receive a hardware indication that a transmission has gone out, and the radio is ready for more data.

Regardless of the ATJF setting, the radio modem's data buffer can hold thousands of bytes of data, queuing them up to be sent over the air. The ATJF command only affects the threshold where CTS is asserted, not the size of the internal data buffer.

RF Performance

Application note AN206 describes RF Radio coverage technology.

Application note AN119 describes RF System Design to help you figure out what type of antennas to use, where to locate them, and how to make your system reliable.

All Raveon application notes are on this Web Page: https://www.raveon.com/wireless-data-radio-application-notes/

Testing Your System

Here is a list of ways to verify the wireless data communications in your system are working correct.

LEDs

The STAT LED on the data radio is a Status LED. It will blink Green when it receives. Looking at it when a transmission comes in, it should blink green if the receiver is working and the system is configured correctly. If the system is not working, it won't blink. (Wrong frequency, no antenna, radio off, wring ID, wrong encryption key,…)

If the LED is on when there is no apparent transmission, this indicates that there is RF noise near that radio. Sometimes personal computers spew RF noise and activate the Stat LED. Antennas should not be near a PC or any electrical thing that radiates RF noise.

PING

The PING command can be sent from a radio to PING another radio. This command is typed in the command mode, or send using the WMX communication protocol.

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. For example, if you send PING 1234 radio 1234 should receive it, and if radio 1234 receives this PING message, it will send a message back to the PINGer. And if the PING receives the response, that will show:

1. The communication works.
2. The ID is correct.
3. The response will show the RSSI signal strength the radio 1234 saw, and 1234 send that RSSI information. You can use the RSSI's to roughly determine if a remote signal may be marginally too weak.

Another great use of PING is to adjust power, adjust antennas, or adjust whatever you want, and you can PING to make sure the system still works. To PING, the radios must be in packet mode (ATMT = 0), must have unique ID's with appropriate TOID and ATMK settings, and must have remote access enabled (ATRV = 0).

WMX Wireless Message Exchange

WMX is the communication protocol used in Raveon's wireless modems, to allow a user to have full control over the sending and receiving of data. It enables the user of a Raveon modem to specify the destination ID when sending data. It also allows the user to identify the source of data when data is received.

To embed a data radio within your product, this WMX protocol has great features to improve system reliability. You can execute commands without going into command mode. You can also send WMX PING messages without going into command mode. Furthermore, you can specify each individual message be sent to a unique radio ID (or group of ID's) and when you receive, you will know the ID of the radio that sent the data.

https://www.raveon.com/raveon-radio-protocol-wmx/

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