RV-M50-EC

Daisy ISM-NA Wireless Modem and GPS Transponder

Technical Manual

Revision A1 (November 2015)

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1. Overview

The Daisy Wireless Modem is a secure, high-performance, long-range wireless access card and GPS transponder. Two data interfaces are available, transparent-link mode and Raveon's WMX Wireless Packet Format. Modem operation is virtually transparent to the user and the configuration of the modem is done easily through the user serial port.

As a GPS transponder, configuration is as simple as setting a report rate. Many options are available to create a customized GPS transponder by adjusting reporting rules and detail levels of GPS reports.

For security, AES-128 encryption is available.

While easy to use out-of-the-box, the Daisy Modem's programmability makes it extremely versatile. Most parameters may be reconfigured to optimize for specialized operations, extended range or higher data throughput.

1.1 Input and Output

Universal Wireless Radio Connector

TODO: Get that pinout chart

The primary connector is fully pin-for-pin compatible with

LED

By default, the LED will indicate the following:

Green: Radio has received a packet

Red: Radio is transmitting a packet

Flashing Orange: GPS is locking (flashing will cease when GPS has locked)

Many commands modify the operation of the LED, including disabling it entirely.

RF Antenna Connection

The RF Antenna Connection is an MMCX

GPS Antenna Connection

If installed, the GPS Antenna Connection is a u.FL (sometimes known as IPEX)

2. Configuring the Daisy ISM

2.1 Overview

The UART serial port on the unit is used to send and receive data over the air, as well as to configure the RF modem. In standard transparent-link operation, the user sends serial 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. No special characters, hardware control lines, or timing is required to operate the Daisy Modem.

By default, the serial port is set to 38400 baud, 8 data bits, 1 stop bit, no parity bit.

If the Daisy is configured as a GPS transponder, the serial port need not be connected to anything. The internal GPS will initiate the transmissions of position and status. The serial port may be connected to receive other GPS reports or send and receive additional data.

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

The modem also supports Raveon's Wireless Modem Exchange (WMX) protocol for commanding and messaging. WMX is ideal for fully automated control and tighter integration. For more information, see the WMX Protocol Description document and the Raveon Tech Note "Rapid Radio Configuration using WMX".

2.2 Command Mode

Command Mode is used to program and configure the modem. This mode is separate from data mode and will not transmit received data over-the-air, instead executing commands detailed in this manual.

Command Mode Encoding and Line Format

In Command Mode, all characters are ASCII encoded. All output lines will use the standard network line ending, CR+LF (ASCII 0x0D followed by ASCII 0x0A).

Inputs lines may use either CR, LF or CR+LF line endings.

Entering Command Mode

The modem may be put into a Command Mode, by entering a sequence of three plus characters (**+++**), called the Entry Sequence**.** To keep the modem from unintentionally entering the Command Mode because of the Entry Sequence occurring in a stream of data entering the modem, there must be a pause in the data stream before the Entry Sequence as well as a pause afterwards. If either pause is missing, the modem will not enter the command mode. The pause length is configurable, by default it is 500ms.

When the modem first enters the Command Mode, it will output the base model number along with the OK sequence:

RV-M50-EC
OK

Once in command mode, the instructions in the following sections can be followed to continue radio configuration.

Exiting Command Mode

To exit command mode and return to data mode, the command EXIT may be used.

Alternatively, command mode will timeout after a configurable amount of time, by default 60 seconds.

2.3 Using Commands

To execute a command, send the command name and any parameters separated by spaces, followed by a line ending. For example, to use the ATDT command to set the destination address to 1234, send:

ATDT 1234<LF>

Some commands may output result information on lines following the command, but the output will always terminate with either the OK sequence (introduced in the previous section) or the ERROR sequence (ERROR<CR><LF>).

Some commands may have different results depending on the number of parameters. In general, a command that sets a parameter(s) can read back its values by issuing the command with no parameters.

To get on-line help with a command, enter the command with a question mark at the end.

To see a list of all commands, use the HELP command.

2.4 Configuration Commands

The following commands are standard Raveon commands implemented by the modem.

Command	Command Description	Parameters	Factory Default
ATAT	**Silence AFTER Sequence** - Sets period of silence after the command sequence characters in mS.	Range:0 – 1000 (mS)	500
ATBD	**Baud Rate** – Sets serial com port baud rate (bps). 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	5

ATBT	**Silence BEFORE Sequence** – Sets period of silence before the command sequence character in mS.	Range: 0-1000 mS	500
ATBW	**Set/Read Channel Bandwidth**	See section 3	
ATCT	**Command Time Out** – If no valid commands have been received via the serial port within this time period (in milliseconds), modem returns to normal operation mode from Command mode. If the CONFIG button inside the *M8* is pressed, this parameter will be automatically set to 60000.	Range: 100-60000mS	60000
ATDT	**Destination Address**– Sets address of the modem to send data to.	Range: 0-FFFF	0001
ATF	**Display frequencies** – Display all of the frequencies programmed into all of the channel memories.		N/A
ATFX	**Frequency**	See section 3	
ATHP	**Channel Number** – Select channel number to configure	See section 3	
ATIC	**Read Current Draw** Read the current draw in mA. Accuracy is within 20% of actual current draw.	Range: 0-9999	N/A
ATL	**Enable/Disable the LEDs** – 1 = LEDs always off. This reduces some power consumption. 0 = LED operate normally.	0 or 1	0
ATMK	**Address Mask** – Configures local and global address space. Each digit may be a 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,or F. In most applications, this is kept at FFFF.	Range: 0000 - FFFF	FFFF
ATMY	**Unit Address** – Configures the individual; address for this unit. Each digit may be a 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,or F. Note: FF is interpreted as a group. See addressing section.	Range: 0000 - FFFF	1234
ATPC	**Read TX Current**. Read the device's current draw during the last transmission, in mA	0-9999	-
ATR2	**Over-The-Air bit rate**	See section 3	
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 modem will begin to transmit the data over the air.	Range: 1 - 999	20 20mS is the default.
ATRQ	**Receiver Signal Level –** Reads the Receiver Signal strength this instant, and returns the level in dBm.	Range: -40 to –130 (dBm)	-
ATRS	**RSSI** (Receive Signal Strength Indicator) – Returns the signal level of last received packet. The reading is in dBm. Usable for relative comparison of signals, but absolute value is within10dB at -90dBm.	No parameters. Returns a number: -50 to –140 (dBm) varies by model.	none
ATSL	**Serial Number –** Reads and returns a unique serial number for this unit.	Read Only 1 - 999999999	unique
ATSH	**Show –** Display the configuration of the modem. This will return a page of ASCII characters, showing the main configuration parameters.	none	None
ATST	**Statistics –** Show the unit's operational statistics. See Statistics section of user manual.		None

ATTE	**Read product temperature –** Read the internal temperature of the unit's circuit board in degrees Celsius.	-40 to +99	-
ATVB	**Read DC input Voltage**– Returns the DC input voltage reading, in mV (12500 = 12.5VDC input).	None	None
ATVR	**Firmware Version** – Returns firmware version currently loaded on the module.	Read Only, 3 characters	none
AT&F	**Restore Factory** – Restore to the factory configuration		None
PING	**Ping another modem.** Format is PING xxxx, where xxxx is the ID of the modem to ping.	XXXX	-
SHOW	**Show/display *an overview of the radio's configuration.***	None	-
MODEL	**Read Model number.** Read the model number.	None	-
BAND	**Show/display *the radio band.*** Displays the frequency band that the radio is configured for, along with the upper and lower frequency, in MHz. BB is the band code, lll is the lower frequency in MHz, and uuu is the upper frequency in MHz.	None	BB, lll, uuu
CONFIG	**Show Configuration.** Display the settings of every parameter in the unit. If the parameter is 1, then the help text is not displayed, If the parameter is 2, the configuration is output in strictly the format used to program another unit.	None, 1, 2	-
AESKEY	**Set the AES encryption key**		

2.5 GPS Commands

The following commands are available if the GPS option is installed.

Command	Command Description	Parameters	Factory Default
GPS	**GPS Operation Mode.** Set the Operating mode.	1 – 9	1
GPS&F	**Reset all GPS parameters**	-	-
IDLERATE	**IDLE TX Interval.** Set the number of seconds between position transmissions when the unit is idle (has not moved more than TRIGDX meters).	0-9999 seconds	10
NMEAOUT	**Enable/Disable NMEA messages.** Configures output standard NMEA messages (GGA, GLL, RMC) out its serial port. **NMEAOUT 0** disables the messages**. NMEAOUT 1** enables them.	0, 1	1
NMEAMASK	**Set/Read NMEA message bit mask.** The NMEAMASK register contains configuration bits to enable various NMEA standard messages from the internal GPS receiver that will be sent out the serial port. The parameter is the decimal integer value of the mask.	0-9999	258 (RMC, GLL, GAA)
NMEARATE	**Set/Read NMEA message rate.** Set/read the number f seconds between NMEA messages from the internal local GPS.	1-99	5
TRIGDX	**Distance trigger.** Set a distance (in meters) threshold beyond-which the unit will transmit its position and status. If set to 0, the unit always reports at the TXRATE. If set to an distance greater than zero, then the unit reports at the TXRATE intervals if it has moved this distance since the last report. If it has not moved, it will still report its position, but at the rate set by IDLERATE. If IDLERATE is set t 0, then the unit will not report its position when not moving.	0-999	0
TRIGSPEED	**Speeding Report.** Set a speed (in kilometers/hour) threshold above-which the unit will begin reporting its position and status. Set to 0 to disable this feature.	0-999	0
TXRATE	**GPS Report Rate.** Set number of seconds between GPS reports. This is also the rate at which the internal GPS will measure position, speed, etc. Even if the unit is not moving, the GPS periodically measures position and speed to determine if it has triggered a speed or position transmission.	1 - 9999	10
TRIGSLEEP	**Set up sleep/wake triggers for GPS**	0-15	0

2.6 Factory Default Settings

Standard Factory Settings

Channel	Center Frequency	Bandwidth	Symbol Rate
1	916.3	500kHz	37.50 kbps
2	919.6	500kHz	37.50 kbps
3	922.9	500kHz	37.50 kbps

Serial port ..... 38400 baud, N/8/1
ID (ATMY)..... 1234

GPS Option Factory Settings

Report Interval..... 30 s
Trigger Distance..... 9998

3. Operational Modes and Configuration

3.1 Channel Configuration and Virtual Channelization

About Virtual Channelization

With Virtual Channelization, the RV-M50-EC will operate in a proprietary, decentralized, 1-3 channel frequency-agile manner. This unique feature allows networks of RV-M50-EC radios to operate with no central network controller and no requirement that all radios are in range of each other. This enables the reliability of multiple channels in the ISM band while allowing free-form network architectures as required.

General Configuration

Under Virtual Channelization, a number of configuration options are selectable:

1. Channel frequencies
2. Channel bandwidth
3. Channel data rate

To configure any individual channel, issue **ATHP <channel>**, where **<channel>** ranges from 1-3 to select the channel. **ATH** will list the configuration of all channels. Once a channel to configure is selected, the commands below will modify the parameters of the channel.

FCC regulations require that the RV-M50-EC not allow certain modes of operation. If the radio is placed in a non-compliant configuration, this will be indicated upon entering Command Mode or when issuing the **SHOW** command. The **SHOW** or **ATH** commands will detail what action was taken to correct the non-compliant configuration.

3.2 Channel Center Frequency

Channel frequency is set with **ATFX <frequency>**, where **<frequency>** is expressed in MHz, e.g. 915.5. In North America, channel center frequency may be set between 902.3 - 927.8MHz for 125kHz channels and between 902.7 - 927.5MHz for 500kHz channels.

To completely disable a channel, set **ATFX 0**. Note that disabling a channel will cause non-compliant configurations if 125kHz channels are in use. All three channels must be enabled if 125kHz channels are in use, and exactly two channels must be 125kHz.

Note also that a frequency separation of 600kHz is enforced for 500kHz channels and 200kHz for 125kHz channels.

3.3 Channel Bandwidth and Transmit Power

Channel bandwidth is set with **ATBW <bandwidth>**, where **<bandwidth>** is set according to the table below:

ATBW Setting	Channel Bandwidth	Transmit Power
0	125kHz	21dBm

2	500kHz	26dBm

To comply with FCC regulations, 125kHz channels may only be used if exactly one 500kHz channel and exactly two 125kHz channels are in use.

Channel Data Rate

Channel data rate is set with **ATR2 <rate>**, where **<rate>** is set according to the table below:

ATR2 Setting	Bit Rate for 125kHz Channels	Bit Rate for 500kHz Channels
6	9.37 kbps	37.50 kbps
7	5.46 kbps	21.87 kbps
8	3.12 kbps	12.50 kbps
9	1.75 kbps	7.03 kbps
10		3.90 kbps
11		2.14 kbps
12		1.17 kbps

Note that adjusting data rate will affect maximum allowable packet size.

Channel Occupancy

Regardless of the number of channels employed, a channel may not be used for longer than 400mS in a period of 400mS * channel count, to comply with FCC 15.247(f). The modem automatically enforces this, and may temporarily delay a transmission to comply as needed.

3.4 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; there is a pause in the data per ATR3; or the maximum packet size is reached, the modem will automatically key its transmitter, and send the data over the air.

3.5 Position Transmission

Position Transmission is enabled by setting either TXRATE or IDLERATE to a nonzero value.

When position transmission is enabled, the device will send its position and other status information over-the-air automatically, per the configurations below.

Idle Transmission Rate

IDLERATE sets the idle reporting interval. This should be set to the longest acceptable time between position reports. Conditions (detailed in the following sections) can cause the modem to transmit faster than the IDLERATE. Set to 0 will disable any idle reporting.

Active Transmission Rate

TXRATE sets the active transmission rate. This is the rate the modem will send its position when one of the conditions below arises, which can be enabled or disabled individually:

1. Motion
2. Distance Traveled

3. Speed

See the command section for details on how to configure these values.

Report Format

A number of output report formats are available, with the most common being $PRAVE, a customized format for wireless GPS transponders. See the OUTPUT command for more detail.

Local Position Information

The NMEAOUT, NMEARATE and NMEAMASK commands will configure the unit to output its GPS position locally over the user serial port.

Deep Sleep

Use the TRIGSLEEP command to configure deep sleeping of the radio.

3.6 Data Reception

Serial Port Data

When the modem receives data over the air, 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.

GPS Position and Status

When the modem receives a position report and status from another modem, it will send this information out the serial port, formatted in Raveon's $PRAVE message format.

Change the position report output format with the **OUTPUT x** command. Enable/disable the local GPS NMEA data with the **NMEAOUT x** command (0 off, 1 on)

The position/status messages that the modem is able to send out of its serial port are:

Message Format	Description	OUTPUT x Parameter/setting
$GPWPL	***NMEA WayPoint List.*** This message is commonly used to share waypoint locations among GPS units. The modem can output this message when it receives a position report. A GPS display connected to it, should put a waypoint on its screen, and in its database, at reported location.	OUTPUT 3
$PRAVE	***Raveon Position & Satus.*** This message is used by Raveon and third-party applications for tracking location and status information.	OUTPUT 1
$GPTLL	***NMEA Target Lat Long.*** This message is commonly sent by marine RADAR receivers to notify plotting devices of the	OUTPUT 2

	location of a RADAR target. A plotter or display connected to the modem that supports the TLL message should put an icon on its screen at the location specified. The icon name is the MYID of the modem that transmitted its position over the air.	
$GPGGA	***NMEA GPS Position Fix Data.*** This message is the standard position message from a GPS receiver.	NMEAOUT 1
$GPGSV	***NMEA Satellites in view.*** This message is the standard message to indicate the number of satellites in view, and their signal quality.	NMEAOUT 1

3.7 Device Addressing

ID Addressing Basics

ID addressing is used to differentiate one modem from another. Each must have a unique number programmed into them, so that when a position report is received, the modem that sent the message can be identified. This is called the MYID of the unit that sent the message.

Each modem has a MYID programmed into it, and is represented as a 4 digit hexadecimal number. Addresses between 0001-FFFF are valid. The Unit Address is programmed with the **MYID xxxx** command, and the ID of the destination modem it sends its messages to (the Destination Address) is configured with the **ATDT xxxx** command.

The factory default **MYID** in all modems is 1234, and 1234 is also the default for the Destination ID also.

The default Address Mask is F000, which means the modem will receive a transmission from any other modem as long as the first digit of the destination address matches, in this case, is a 1.

Make sure you set the **MYID** of each modem in your system to a different number.

For example, to set the ID of your modem to 17, enter:

MYID 17 <enter>

To set your modem to send its position and status data to modem number 1, enter:

ATDT 1 <enter>

To set your address mask to receive all messages from units with IDs 1-999, and exclude 1000-9999, enter

ATMK F000 <enter>

3.8 Local NMEA data from the internal GPS

The modem may be configured to output standard NMEA 0183 GPS messages from its internal GPS receiver. For GPS tracking, these GPS transponders can receive GPS position reports from other radios, and they may also be configured to output their own GPS location via their serial port.

The following NMEA messages are available

NMEA Message	Bit Number (zero based)	Bit Mask (hex format / decimal)
GGA	0	0×001 / 1
GLL	1	0×002 / 2
RMC	9	0×100 / 256

You can change the NMEAMASK parameter to modify with of the NMEA sentences will come out the serial port.

For example, to have only the RMC sentence come out the serial port, use the following command"

NMEAMASK 256

To have the GGA and GLL come out the serial port use this command:

NMEAMASK 3

The NMEAMASK parameter is the sum of all of the decimal values of the individual bits corresponding to the NMEA messages.

4. Diagnostic Provisions

4.1 Status and Statistics Command

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

4.2 ATST Command

The ATST command will return the following information:

STATISTICS

`Good RX Packets:` `nnn` (packets received over the air with no bit-errors and correct address)

With Bad CRCs: nnn (over-the-air packets with bit errors that were discarded)

Bytes received: nnn (number of bytes this modem received, and sent out its serial port)

Bytes transmitted: nnn (number of bytes this modem received via the serial port, and transmitted over the air)

Packets send: nnn (number of packets this modem has transmitted over the air. Retransmissions in the ARQ mode are not counted)

Pkts last minute: nnn (Number of packets received during the last minute)

OK

If there is a hardware problem, there may be one or more hardware error messages listing the error types (CPU Exceptions, OS Rebooted, or Fatal OS failures). Consult the factory if any of these messages ever appear.)

4.3 ATST1 Command (GPS Statistics)

The ATST 1 command, will return various information regarding the operation of the GPS features.

4.4 ATST3 Command

The ATST3 command, will return the time and date the firmware was compiled.

4.5 ATST4 Command

The ATST4 command will return internal timers that tell how long the modem has been powered up and running. All of these timers restart a 0 upon power up.

Run time:

Years: nnn (number of years running)

Days: nnn (number of days running, resets to 0 after one year)

Hours: nnn (number of hours running, resets to 0 after 23 hours, 59 minutes, 59 seconds)

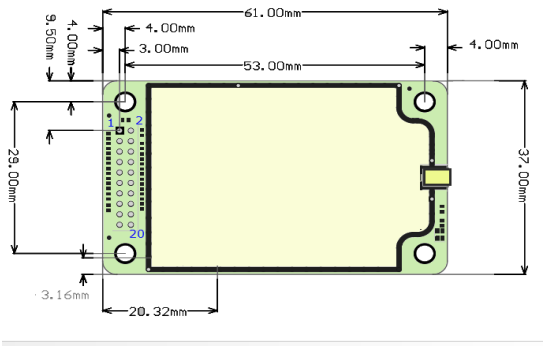
Min: nnn (number of minutes running, resets to 0 after 59 minutes, 59 seconds)

Sec: nnn (number of seconds running, resets to 0 after 59 seconds)

Uptime: nnn (number of seconds running. Does not reset.

OK

5. Mechanical



6. 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.

6.1 Safety Training information

Always use this radio with the antenna supplied with it. This radio is restricted to occupational use. Work related operations are permitted only when the radio operator has the knowledge to control the exposure conditions of its passengers and bystanders by maintaining the minimum separation distance. Failure to observe these restrictions may result in exceeding the FCC RF exposure limits.

7. 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.

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.