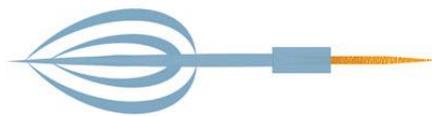




RV-M80-EA2
DART 896/940MHz Data Modem
Technical Manual

Version A2

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1. General Information about the RV-M8-EA2

1.1. Congratulations!

Congratulations on your purchase of a *RV-M80-EA2* OEM radio.

Please take a few minutes to read this manual carefully. The information presented here will allow you to derive maximum performance from your radio modem. After reading it, keep the manual handy for quick reference, in case questions arise later on.

1.2. NOTICE

There are no user-serviceable points inside this transceiver. All service work must be referred to your Authorized Service Center or Raveon Technologies Service Department.

IMPORTANT NOTICE !

Because of the nature of wireless communication, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors), or be totally lost. Significant delays or losses of data are rare when wireless devices, such as the Viper SC, are used in a normal manner with a well-constructed network.

This radio should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property.

Raveon accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using Viper SC, or for the failure of Viper SC to transmit or receive such data.

1.3. Safety / Warning Information

Service

This equipment should be serviced by qualified technicians only.

Blasting Caps and Blasting Areas

To avoid possible interference with blasting operations, turn off this radio or remove the DC power when you are near electrical blasting caps, in a blasting area, or in areas posted: **“Turn off two-way radio.”** Obey all signs and instructions.

Potentially Explosive Atmospheres

Turn off your radio prior to entering any area with a potentially explosive atmosphere. Do not install this product for use in areas with potentially explosive atmospheres. Do not remove, install, or charge batteries in such areas. Sparks in a potentially explosive atmosphere can cause an explosion or fire resulting in bodily injury or even death.

Note: The areas with potentially explosive atmospheres referred to above include fueling areas such as below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles, such as grain, dust or metal powders, and any other area where you would normally be advised to turn off your vehicle engine. Areas with potentially explosive atmospheres are often but not always posted.

FCC MPE Regulations:

WARNING: It is the responsibility of the user to guarantee compliance with the FCC MPE regulations when operating this device in a way other than described in this manual.

Human body Exposure:

This equipment is approved only for mobile and base station transmitting devices, separation distances of

- (i) 49 centimeters or more for antennas with gains of 0 dBi or less or
- (ii) 1 meters or more for antennas with gains 0 to 6 dBi should be maintained between the antenna of this device and nearby persons during operation. To ensure compliance, operation at distances closer than this is not recommended and the EUT has not been approved for operation with antennas having a gain that exceeds 6 dBi.

1.4. Part 15 Note:



This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

2. Overview

The *RV-M80-EA2* RF DART compliant Data radio modem is capable of high-speed narrow-band data communications. It contains a receiver, a transmitter, and modem, creating an easy-to-use transparent data radio link. The built-in DART protocol is compatible with Raveon's DART data radio protocol. (www.raveon.com/DART) This radio modem is not compatible with Raveon's M7 series of data radio modems.

The *RV-M80-EA2*'s user interface is asynchronous digital data into and out of the *RV-M80-EA2*. Modem operation is virtually transparent to the user and the configuration of the modem is via the user serial port.

The command-line interface is similar to Raveon's other data radio products, and configuring the mode is very easy. The *RV-M80-EA2* is an easy to use and its re-programmability makes it extremely versatile. Most parameters within the modem may be re-configured to optimize it for specialized operations, extended range, or higher data throughput.

2.1. Features

General Features

- *Serial input and output. Programmable serial baud rates up to 57600.*
- *Small sized and single-board construction.*
- *Very efficient circuitry. (< 700mW receiving, < 8W transmitting)*
- *Easy to use. Transmit data in = Receive data out.*
- *Easily configured using "AT" commands*
- *Extensive diagnostic capabilities*
- *WMX serial protocol may be enabled on the serial port..*
- *Wide input voltage with high-efficiency switching voltage regulator.*
-

DART Radio Modem Features

- *Quickly deploy new radios into complex systems*
- *Configures radio modems dynamically, based upon current system needs and settings.*
- *Over-the-air channel/frequency assignments*
- *Data transmission bandwidth allocation*
- *Assigns channel bandwidth dynamically to devices needing to communicate*
- *Retry interval and duration is managed by local base station based on loading and QOS*
- *Wireless Devices (WDs) automatically find the a local base station to link-up to when they power on.*
- *Balance the data communication loads based upon device priorities, system configuration and minimum QOS*
- *WDs may be assigned to groups. Single messages may be sent to groups of WDs. Messages may be routed to/from groups.*

2.2. Firmware Updating

The RV-M80-EA2 is a software based radio and modem. There are times an existing unit needs to get updated with a new feature, and this can often be done by loading the new firmware into the older radio modem. In firmware program called the “Boot Loader” is permanently installed inside the RV-M80-EA2’s microcontroller. During power up, it checks to see if the user wants to update the application program in the microcontroller.

Specifications

2.3. General

Model Number, transceiver:.....	RV-M80-EA2-X
RF Power Output	1.0W – 3.0 W (programmable)
IF Bandwidth.....	12.5kHz standard, 25kHz optional (-W)
Serial Port Baud Rates	1.2k, 2.4k, 4.8k, 9.6k, 19.2k, 38.4k, 57.6k, 115.2k
Over-the-air baud rates	1200, 2400, 4800, 9600
Operating Mode.....	DART over-the-air protocol
Full Spec Operating Temperature range.....	-30°C to +60°C
Wake-up time	<700mS from OFF
RF I/O Connector	MMCX female
Enable Input Low.....	400mV
Digital Output High (1K load)	3.0 - 3.3V
Digital Output Low (1K load)	0 - 0.2V
Digital Input High	> 3.0V
Digital Input Low	< 0.3V
Enable input High.....	1.40V

2.4. Transmitter Specifications (RV-M80-EA2-xx)

RF Power Output	1W – 3 W (programmable)
Frequency Range (-EA2).....	854-862MHz
Frequency Range (-EB).....	896-901MHz
Frequency Range (-TB).....	935-940MHz
Maximum Duty Cycle (1W)	50% to 40C, 20% to 60C
Maximum Duty Cycle (5W, measured over 60 seconds).....	10% to 50C, 5% to 60C
Frequency Deviation	± 2.2kHz
Channel spacing.....	12.5kHz
TX Spurious outputs.....	< -70dBc
Occupied Bandwidth.....	Per FCC
FCC Emissions Designator	8K0F1D & 13K2F1D
Frequency Stability	Better than ±1.0ppm

2.5. Receiver Specifications

Frequency Range (-EA2).....	809-817MHz
Frequency Range (-EB).....	935-940MHz
Frequency Range (-RB).....	896-901MHz
Data RX sensitivity (.1% BER), 19200bps Wideband.....	< -110dBm
Data RX sensitivity (.1% BER), 9600bps Narrowband	< -110dBm
Data RX sensitivity (.1% BER), 1200bps	< -116dBm
Current Consumption	<120mA at 12.5V DC input
Channel spacing.....	12.5kHz or 25kHz (-N or -N)
Adjacent Channel Selectivity 12.5kHz	-50dB
Alternate Channel Selectivity	-60dB
Blocking and spurious rejection.....	-70dB
RX intermodulation rejection	-70dB

2.6. Interface Specifications

DC Input

Connector on front panel 3-pin M8 type
Raveon P/N

Serial Port

Serial connector type DB9 RS 232 serial
IO Voltage Levels..... RS232
RX and TX data Transparent Async
Word length..... 8 bits
Format N, O, or Even parity, 1 stop

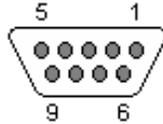
Other

RF connector TNC Female

3. Electrical Inputs and Outputs

3.1. RS-232/EIA232 Serial I/O Connector

The RS-232 9-pin serial I/O connector is a female 9-pin D-subminiature connector having the following pins configuration. It is pinned out so that it may be plugged directly into a computer or PC's 9-pin COM port.



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. Logical 0 (+ voltage on RS-232) 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. Configured with the ATR1 setting.
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 M7 modem. May control the power-state of the modem in low-power mode if this feature is enabled.
5	GND		Ground connection	Signal and power ground
6	DSR	out	Data Set Ready	Normally is set to 0 when modem is powered on and running. Modem sets to a 1 when in low-power mode or in command mode.
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 M7. 0 = OK to send, 1 = don't send. If the M7 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.

3.2. GPS (-GX option)

GPS receiver for position tracking utilizes a MAX-7 GPS receiver.

MAX 7 Product description

The MAX-7 series is the newest family of standalone GPS/GNSS modules from u-blox. With the exceptional performance of the u-blox 7 multi-GNSS (GPS, GLONASS, Galileo, QZSS and SBAS) engine, the MAX-7 series delivers high sensitivity and minimal acquisition times in the ultra compact MAX form factor.

The MAX-7 series provides maximum sensitivity while maintaining low system power. The MAX-7C is optimized for cost sensitive applications. The MAX-7Q provides best performance

and lowest power, while the MAX-7W provides best performance and is optimized for active antennas. The industry proven MAX form factor allows easy migration from MAX-6 modules. Sophisticated RF-architecture and interference suppression ensure maximum performance even in GPS-hostile environments.

The MAX-7 series combines a high level of integration capability with flexible connectivity options in a miniature package. This makes it perfectly suited for industrial and mass-market end products with strict size and cost requirements. The DDC (I2C compliant) interface provides connectivity and enables synergies with u-blox SARA, LEON and LISA wireless modules. u-blox 7 modules use GPS/GNSS chips qualified according to AEC-Q100

4. User Serial Port Commands

4.1. Overview

The serial portion the RF modem is used to send and receive data over the air, as well as to configure the RF modem. In normal operation, the user sends data into the TXD pin of the IO connector, and this data is transmitted over the air. Received data from another RF modem is output to the user via the RXD pin of the IO connector. This is the default operating condition of the RF modem. No special characters, hardware control lines, or timing is required to operate the *RV-M80-EA2* modem.

There is also a “Command Mode” used to program and configure the *M8*. In the Command Mode, the *RV-M80-EA2* modem accepts commands via the serial port TxD pin. The commands can be used to change certain internal parameters of the *RV-M80-EA2* modem as well as to read-out the current configuration and diagnostic statistics.

4.2. Command Mode

The *RV-M80-EA2* modem may be put into a “Command Mode”, by entering a sequence of three plus characters (+++). To keep the *RV-M80-EA2* modem from unintentionally entering the Command Mode because of the +++ pattern occurring in a stream of data entering the modem, there must be a pause in the data stream before the +++ as well as a pause after the +++ is sent. If either pause is missing, the modem will not enter the command mode.

Using serial communications software such as *HypterTerminal*, send the 3-character command sequence “+++” while observing times of silence before [BT (Silence Before Sequence) Command] and after [AT (Silence After Sequence) Command] the command characters. The default BT and AT times are 500mS.

The default sequence for entering into AT Command Mode:

1. No characters sent for ½ a second.
2. Input three (3) plus characters (“+++”) within ½ of a second.
3. No characters sent for ½ a second.

When the *RV-M80-EA2* modem first enters the Command Mode, it sends the phrase

Raveon RV-M80-EA2 (transceiver version)

or

Raveon M8R (receive only version)

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

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

4.3. Setting a Parameter

To set a parameter in the *RV-M80-EA2* modem, enter the Command Mode as described above. Then enter the proper AT command, a space, the parameter, and then a carriage return. For Example, to set the address of the *RV-M80-EA2* modem to 1234, enter the following command:

ATDT 1234 <CR>

Once a Parameter is changed, the modem will begin using the new parameter and the new parameter is saved to non-volatile.

4.4. Reading a Parameter

To read the value of a particular setting, issue the command, with no parameter. The modem will return the value followed by an "OK". The modem's OK response is:

The value in ASCII decimal format.

A <CR> <LF> (<CD> = ASCII 0D, <LF> = ASCII 0A).

An "O", "K", <CR>, and <LF> sequence.

For example, if the user enters the command to read the *M8*'s modem address and its address was 1234, the user would issue the following command:

ATDT<cr>

and the modem will respond with:

1234 <CR> <LF> OK <CR> <LF>

To get on-line help with a command, enter the command and put a question mark in for the parameter. For example, to see what the ATDT command is for, type:

ATDT ?

The modem will respond by listing a brief description of the command. To see a list of all commands, type **HELP**.

Many commands support the "**MIN**" and "**MAX**" parameters to read the minimum and maximum allowable settings. For example, type **ATJF MAX** to find the maximum value the CTS negation threshold may be set to.

4.5. CONFIG Button

If certain parameters within the modem are modified in a manner that causes the modem to cease functioning or if the user cannot enter the command mode via the "+++" method described above, there is a small push button internal to the *RV-M80-EA2* modem to assist in this case. This CONFIG button may be pressed at any time, and forces the modem into a known operational state. The CONFIG button is located inside the modem. Remove

the rear cover, exposing the two circuit boards. The button is in the front edge of the radio module's circuit board.

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

1. *Serial port 9600 baud, 8 data bits 1 stop, no parity*
2. *ATCT setting set to 60000 (60 second time-out)*
3. *Serial port on the front of the unit in RS232 mode, 9600bps, N/8/1.*

Even though the serial baud rate reverts to 9600 baud when the CONFIG button is pressed and the IO port is RS232, it will revert back to the settings programmed into the *RV-M80-EA2* modem once the Command Mode is exited.

4.6. Exiting the Command Mode

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

1. **ATCN** Issuing the **ATCN**. The RV-M80-EA2 radio will exit the command mode, and begin normal operation.
2. **EXIT** Issuing the **EXIT**. The RV-M80-EA2 radio will exit the command mode, and begin normal operation.
3. **Time Out**. After a pre-set amount of time (60 seconds is the factory default time), the modem will automatically exit the Command Mode, and continue normal operation. Changes will not automatically be saved. This time-out duration may be set with the **ATCT** command.

5. Command Mode Commands

5.1. General Common Commands

These commands apply to the general configuration of the RV-M80-EA2, and are applicable in both the data modem mode and paging mode.

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). Type the range index (0-7) or the actual desired baud rate.	Range: 0 – 7 0 = 1200 5=38400 1 = 2400 6=57600 2 = 4800 7=115200 3 = 9600 4 = 19200	3
ATBT	Silence BEFORE Sequence – Sets period of silence before the command sequence character in mS.	Range: 0-1000 mS	500
ATCD	Carrier Detect Threshold – Read/set the carrier detect threshold, in dBm. -113 means -113dBm.	-113	-120 to -60
ATCH	Configure Hardware Flow Control – Enable (1) or disable (0) flow control. When enabled, the modem will monitor the RTS line, and if it is negated, stop sending data out the serial port. If disabled, the modem will ignore the state of RTS, and always send out characters.	1 = Enable 0 = Disable	0
ATCT	Command Time Out – If no valid commands have been received via the serial port within this time period (in milliseconds), modem returns to normal operation mode from Command mode. If the CONFIG button inside the <i>RV-M80-EA2</i> is pressed, this parameter will be automatically set to 60000.	Range: 100-60000mS	60000
ATE	Echo – Character echo set on (E1) or off (E0). This applies to the Command Mode only.	Range: 0 , 1	1 (echo)
ATFC	Set/read channel – Program the transmit frequency for this channel. Enter in Hz or in MHz. ATFC cc tt rr oo Where cc is the channel number, tt is the TX frequency, rr is the RX frequency, oo is optional. If oo is included, it is stored as the channel option bits. oo is a two digit HEX parameter. Enter ATFC ALL to display all channels.		
ATFS	Show frequencies – Display all of the frequencies programmed into all of the channel memories.		N/A
ATFT	Transmit Frequency – Program the transmit frequency for this channel. Enter in Hz or in MHz. The frequency will automatically be saved in non-volatile memory (flash) for this current channel number.	Range: See product data sheet. For MURS products, frequency cannot be changed.	See product data sheet.
ATFR	Receive Frequency – Program the receive frequency for this channel. Enter in Hz or MHz. The frequency will automatically be saved in non-volatile memory (flash) for this current channel number.	Range: See product data sheet. For MURS products, frequency cannot be changed.	See product data sheet.

ATFX	TX and RX Frequency – Program the receive and transmit frequency for this channel. Enter in Hz or MHz. Same as issuing an ATFR and an ATFT command. The frequency will automatically be saved in non-volatile memory (flash) for this current channel number.	Range: See product data sheet.	N/A
ATHP	Channel Number – Select current radio channel number. The channel number is stored in EEPROM memory.	Range: 1 - 6	1
ATIC	Read Current Draw Read the current draw in mA. Accuracy is within 20% of actual current draw.	Range: 0-9999	N/A
ATL	Enable/Disable the LEDs – 1 = LEDs always off. This reduces some power consumption. 0 = LED operate normally.	0 or 1	0
ATMT	Protocol Select – The over-the-air communication protocol. 0=Packetized mode, 5=DART	Range: 0 or 5	5
ATNB	Parity – Selects parity format. Settings 0-4 transfer 8-bits over antenna port and generate the parity bit on the RF receiving side.	Range: 0 – 5 0 = none 1 = Odd 2 = Even 3 = Mark (1) 4 = Space (0)	0
ATR3	Serial Port Time Out – The time in milliseconds for the serial port to time out. When data is entering the serial port, and this amount of time passes with no more data, the RV-M80-EA2 will begin to transmit the data over the air.	Range: 1 - 999	20 20mS is the default.
ATR8	Frequency Offset. Used to set the radio on the center of the radio channel.	Range: -500 to +500	0**
ATRQ	Receiver Signal Level – Reads the Receiver Signal strength this instant, and returns the level in dBm.	Range: -40 to – 130 (dBm)	-
ATRS	RSSI (Receive Signal Strength Indicator) – Returns the signal level of last received packet. The reading is in dBm. Usable for relative comparison of signals, but absolute value is within 10dB 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
ATSM	LPM Operation Enable – When set to 1, the DTR input line controls the M8's low-power operation. When set to 0, the RV-M80-EA2 will not go into LPM, regardless of the state of the DTR pin. When set to 2, the modem is forced into a low-power mode, disabling the receiver.	Range: 0, 1, 2	0
ATST	Statistics – Show the unit's operational statistics. See Statistics section of user manual.	0, 1,2, 3, 4, or 5	None
ATTD	Transmit Test Data – When issued, the modem will begin transmitting data. The type of data sent is set in the parameter. Entering a <CR> will terminate the transmission.	0 = Go back to normal 1 = Random 3 = 1010... at ¼ baud rate 4 = TX all 0s 5 = TX all 1s 6 = Test Points ON 7 = Transmit CW 8 = Transmit 1010101...	
ATTE	Read product temperature – Read the internal temperature of the unit's circuit board in degrees Celsius.	-40 to +99	-
ATVB	Read DC input Voltage – Returns the DC input voltage reading, in mV (12500 = 12.5VDC input).	None	none
ATVR	Firmware Version – Returns firmware version currently loaded on the module.	Read Only, 3 characters	none
AT&F	Restore Factory – Restore the factory default values. This command will not erase the calibration values. After this		none

	command executes, the modem will still be in the CONFIG mode.		
BAND	Read the Band – Reads the frequency band of the radio. First parameter is the text version (UA, UC, VC, ...), second parameter is the lower limit, and the third parameter is the upper limit in MHz. Use to read the band that the radio is tuned to cover.	None	-
CONFIG	Display configuration. Displays most all variables.	0, 1, or 2	-
CHNUM	Read number of channels. This command will return the number of channels this product has.		6
RTC	Read the Real Time Clock value. Returns value in V hh:mm:ss format where V is synchronization valid flag Y for yes, N for NO. hh is hours, mm is minutes, ss is seconds. If not valid, the RTC time is free-running and not synchronized to UTC time.	<i>none</i>	<i>N/A</i>
MODEL	Read Model number. Read the model number of the unit.	None	RV-M80-EA2 or M8R
SHOW	Show/display an overview of the radio's configuration.	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.

5.2. Data Modem Mode Related Commands

These commands apply to the operation of the RV-M80-EA2 when it is in the data modem communication mode.

Command	Command Description	Parameters	Factory Default
ATPO	RF Power Output. Set or show the RF power output setting. Value is in percent, from 0% to 100%. Use and RF wattmeter to confirm the power setting, and adjust the % accordingly to obtain the desired RF power level.	0-100	100
ATRO	Symbol Peak Deviation – Set the peak FM deviation of the transmit symbols. Note: This can be a negative number to invert the modulation.	Range: -1000 – 1000	120**
ATRV	Disable Remote Access – When enabled (set to a 0), the modem will respond to over-the-air RPR requests, Pings, and over-the-air commands. Default is OFF (1).	0 = Remote Access on 1 = Remote Access off	1
ATTT	Max Packet Size – Set the maximum number of bytes in an over-the-air packet.	1 - 512	80
ATXT	Read/set repeater delay – Read or set the repeater delay. This is the time between receiving a data packet, and the time the repeater will re-send it.		

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

5.3. DART Related Commands

The following commands are specific to the operation of the RV-M80-EA2 when used on a DART Dynamic Automatic Radio Transmission system. DART features are enabled when the Modem type (ATMT) parameter is set to DART, which is type 5.

ATEN	Set the Security Level ATEN X Where X is the security level 1-3.	1-3	1
DCB	Display Channel Bank DCB X Display channel bank X frequencies and settings.	1-10	1

SCB	Set Channel Bank. Configure a channel bank or read a channel bank. SCB B Y C P B: bank number 1-10, Y: Entry Number C: Channel Number a(optional): P is optional. Set to “C” if this entry is a control channel. SCB X to read and display a bank’s settings. SCB X ERASE will erase all entries in bank X. SCB X Y DELETE will delete channel Y from bank X.		
SYSKEY	SET the encryption key. Set the SYSTEM encryption key. This is an ASCII hex representation of the 128 bit key. It must contain 32 hex characters. SYSKEY DEFAULT sets the factory default key.	<i>Key, 32 hex characters.</i>	
NETKEY	SET the encryption key. Set the NET encryption key. This is an ASCII hex representation of the 128 bit key. It must contain 32 hex characters. NETKEY DEFAULT sets the factory default key.	<i>Key, 32 hex characters.</i>	
SID	Read Set the System ID. Normally, this setting should not be changed.	0-255	1
RDP	Read Dart Parameter. RDP X where X is an index specifying which internal parameter to read. This command is used for system testing and diagnosis by the factory and technical support. 1 (DNA) 2 (authorization status) 3 (connection status) 4 (base station ID) 5 (sequence) 6 (system ID) 7 (device class) 8 (LNA) 9 (home) 10 (communication state) 20 (GPS mode) 21 (1PPS count) 22 (GPS status) 23 (GPS features) 24 (TX Rate)		
TABLE	Read the channel table version information. Returns two integers, comma separated. X, Y where X is the band code and Y is the version of this band’s table.		

5.4. GPS Related Commands

The following commands are specific to the operation of the RV-M80-EA2 when the device has the GPS option installed.

GXF	Display/Set Feature GXF X Y Display, set, or disable various GPS features. X is numeric feature code: 1 = Periodic GPS position reporting. Y = 0 for off, 1 for on.	1-10	1

5.5. Diagnostic Related Commands

The following commands may be helpful in diagnosing communication problems or system performance.

GXF	Display/Set Feature GXF X Y Display, set, or disable various GPS features. X is numeric feature code: 1 = Periodic GPS position reporting. Y = 0 for off, 1 for on.	1-10	1

5.6. Factory Default Settings

(DART Data Transceiver)

For the UHF RV-M80-EA2, model RV-M80-EA2-UC, the main factory defaults are:

General Settings

Primary Protocol: (ATMT 0)..... Packet Data
WMX (WMX 0) OFF

Data Modem Settings:

Over-the-air data modem baud rate: 4800 baud, 2-level
Serial port..... 9600baud, N/8/1
Hardware flow control Off
RF Power Output 100% (2watts)
Channel number selected 1
ID (ATMY) 1234
Address Mask (ATMK) FFFF
Frequencies
Ch 1462.2125 MHz

6. Programming Channels and Frequencies

The RV-M80-EA2 modem has memory for up to 100 channels. A channel is a pair of frequencies, one for transmit and one for receive. They may be different or they may be the same. You may program any valid frequency into any channel number. To program a channel, perform the following steps.

1. Change to the channel you wish to program, using the **ATFC** command.
ATFC x tt rr c ab
where x is the channel number,
tt is the TX frequency in HZ or MHz,
rr is the Rx frequency in Hz or MHz
c is 4 for control channel, 0 for non-control channels,
ab are the over-the air modulation options.
 - a. **a** is the bit rate index corresponding to the over-the-air bit rate to use:
0=4800 2L, 5=9600 2L, 6=19200 4L, 8=9600 4L, 0=4800 2L,
 - b. **b** is the channel bandwidth. 0=12.5kHz, 1=25kHz.
2. For Example, enter **ATFC 3 217.425 219.425 4 00** to set the channel 3 TX frequency to 217.425MHz and RX frequency to 219.425MHz, 4800 bps, two-level modulation, narrow band channel.
3. Review the frequency setting with the **ATFC x** where x is the channel number to display.
4. To display all channel's, use the **ATFC ALL** command.
5. Some data rates are not suitable for use on certain channel bandwidths. For example, 19200 4-level modulation will not work on a 12.5kHz narrow-band radio channel.

6.1. Initializing a new RV-M80-EA2 to factory defaults

Warning, this will erase all parameters, and may cause your RV-M80-EA2 to stop working on your network.

AT&F	Loads defaults
ATRT 0 CONFIRM	Radio Type 0 for RV-M80-EA2 Radio modem
ATFC INITIALIZE ALL	Loads factory defaults into channel table
SCB INITIALIZE	Loads the channel banks with default channels
ATIO 5	Digital I/O mode
HWMODE 0	Hardware mode 0

Once the RV-M80-EA2 is ready to be used on a DART network, make sure all of these settings are set.

ATMT 5	Hyper/DART modem type
SID xx	Set the system ID

On RV-M80-EA2, the periodic reporting must be enabled. This command is set at the factory to enable GPS periodic reporting.

GXF 1 1	Enable periodic GPS tracking reporting
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7. Data Transmission

To transmit data, send one or more bytes of data into the serial port of the modem. When a full packet of data has been collected into the internal buffer of the modem, or when there is a pause in the data, the modem will automatically key its transmitter, and send the data over the air if the modem is within range of a base station.

Serial Port Baud Rate

While the RV-M80-EA2 modem is transmitting and receiving data on the DART network, the user may continue to send more data into the RV-M80-EA2. Because the buffers in the RV-M80-EA2 are full-duplex, the serial port data rate and the over-the-air data rates are independent. The serial port baud-rates may be set slow to accommodate legacy equipment, or set at high-speed to minimize latency.

8. 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.
- 3 = Force PLL to fast lock mode
- 4 = Transmit all 0s
- 5 = Transmit all 1s
- 7 = Transmit CW on center of channel
- 8 = Transmit preamble (101010 pattern)

- ML x** Debug Message Level. By default and at power on, this level is set to 0 (no debug messages).
0 = no debug or diagnostic messages
1 = DART, and data reception related message will come out serial port
2 = Verbose messages, Mostly used for factory and engineering purposes.
- SHOW** Display an overview of the configuration.
- STAT** Display statistics of how the modem is working.

9. Diagnostic Provisions

9.1. Overview of Diagnostics

Internal to the *RV-M80-EA2* radio modem, is a powerful 32-bit microprocessor. Along with handling all aspects of radio modulation and demodulation, the microprocessor also maintains an extensive array of diagnostic information.

This section details the diagnostic information available, and describes how to use the information to optimize or troubleshoot a *RV-M80-EA2* radio network.

9.2. Reading the Diagnostic Information

RV-M80-EA2 diagnostic information is read using AT commands, while the unit is in the Command Mode. Refer to the section “User Serial Port Commands” to learn how to put the *RV-M80-EA2* modem into the Command Mode.

To see a general overview of how the modem has been operating, use the **ATST** command (status request command), without any parameter. The radio modem will respond with a list of certain operation statistics that it maintains. All statistics start counting at 0. The **ATST 1** command can be used to reset all statistics back to 0, except the run-time timers.

Other operation and configuration statistics are available using the ATST command, with a parameter to specify the desired statistic. The following table describes the various statistics available.

9.3. Status and Statistics Command

AT Command	Command Description	Response
ST	General Communication Statistics – This command will cause the <i>RV-M80-EA2</i> to output a table of various operational statistics.	Statistics overview screen
ST2	Low-level internal statistics – Returns various low-level statistics. These are subject to change in various firmware revisions.	Low-level statistics screen
ST3	Compile date and time – Returns the data and the time that the firmware was compiled.	Date and time
ST4	Run Time – Returns the amount of time that the modem has been powered up and running.	Run time display screen
ST9	Reset all statistics counters	OK

10. Tune-up and Alignment

The *RV-M80-EA2* modem has been factory calibrated, in should not require any re-calibration when installed, or when changing frequency or channel. Unless the user is trained in radio test and calibration, the values stored in the R registers should not be modified. Radio calibration and alignment is performed using the **ATRx** commands.

Improper adjustment of the radio calibration (R0-R9 and RA registers), can result in failure of the radio modem.

Calibration and alignment values are stored internal to the modem in the “R” registers. (R0-R9 and RA). For example, to read R5, issue the **ATR8** command without any parameter. To change the setting, issue the **ATR8 nn** command, where nn is the new value you would like to store.

Once you read a register using an ATRx command, you may modify its value by entering a “U” for up or a “D” for down. U or D will change the value by one. Use this trick carefully, because it modifies the last R register that was read, and it is easy to unintentionally modify the wrong register.

10.1. Periodic Calibration

The only setting that may require adjustment is the center frequency. After years of operation, all crystals will age and change frequency slightly. The ATR8 command is used to adjust the center frequency. Like all narrow-band radios, semi-annual checks and adjustment of frequency is recommended.

10.2. Calibration Commands

The following AT commands are used to calibrate the M8. Do not ever change these unless you have been factory trained to do so.

AT Command	Command Description	Parameters	Factory Default
R0	Symbol Peak Deviation – Set the peak FM deviation of the transmit symbols. Note: This can be a negative number to invert the modulation.	Range: -1000 – 1000	120**
R1	Select CD pin output signal – CD pin may be RF carrier detect, or modem data detect, off, on, or RX data framing, or on-line status. Line status mode asserts CD when on-line in normal modem operation and it negates CD when in the command mode.	Range : 0 - 5 5 = RX data framing. Assert when outputting data 4 = Line stat. 3 = Always negate CD 2 = Always assert CD 1 = Data CD 0 = RF CD	0 (RF Carrier)
R2	Over-The-Air bit rate - This is the data rate the radio uses to send data over the air. All RF modems in the network must use the same over-the-air baud rate.	Range: 0 = 800 5 = 9600 2L 1 = 1200 6 = 19200 4L 2 = 2400 7 = 5142 2L 3 = 4800 8 = 9600 4L 4 = 8000 4L 9 = 2000 2L	3

R3	Serial Port time out – Number of mS of no activity on the serial port before transmitting the data in its buffer.	Range: 1 - 5000	20 (mS)
R5	Preamble length – The number of bytes to send over-the-air in the pre-amble.	Range: 3 - 255	4** (Varies based on data rate and radio type. 7 typical)
R8	Frequency Offset. Used to set the radio on the center of the radio channel.	Range: -500 to +500	0**
R9	Modulation Balance.	Range: 0-100	20**
RA	Select RF CD output threshold – This value is the RSSI threshold where the carrier detect is asserted. Note: To force CD always on, set this to 0, and R1 to RF Carrier Detect.	Range : 0 thru -127	-110

10.3. Center Frequency

1. Key the transmitter with CW output using this command:
ATTD 7
2. The modem will now put out CW on the center of the channel.
3. Read the frequency offset with the **ATR8** command.
4. Adjust the frequency to the center of the channel with the **ATR8** command. You can use the “U” key and the “D” key to change the settings up and down one value in real time.

10.4. TX Deviation

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

10.5. TX Modulation Balance

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

1. Set-up a service monitor to monitor the FM deviation of the transmitted signal on an oscilloscope. The frequency response of the demodulated FM signal must be greater than 10Hz to 5kHz without any de-emphasis.
2. Transmit random data on the center of the band, using the **ATTD 1** command. This command will cause the *RV-M80-EA2* to automatically key up, and send random data for one minute.

3. Verify the DC center of the demodulated data is stable. The random data should be randomly timed 1s and 0s, and have little to no AC component on them. See pictures below for details.
4. If necessary, change the **ATR9** setting so that the long data bit have the same amplitude and DC value as the shorter ones.
5. On the low end of the band, adjust **ATRL** so that the modulation is proper.
6. On the high end of the band, adjust **ATRH** so that the modulation is proper.

11. Mechanical

11.1. DC Input

A. Change to locking / waterproof type

