

# Messenger RMX Radio / Leased-Line Modem Reference Manual



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## Overview

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The Messenger RMX modem is a multi-functional communication device. It is designed for the remote telemetry system with multiple sites communicating via audio radio or “dry” (no PBX) telephone leased-line in a multi-drop configuration.

The Messenger RMX has the following features:

- 1200, 2400 or 4800 baud modem operation.
- 115200, 38400, 19200, 9600, 4800, 2400 or 1200 baud RS-232/RS-485 port operation.
- USB Host interface
- Separate diagnostic port – live real-time monitoring of communications operation
- Leased-line or radio audio interface.
- 1 mV<sub>RMS</sub> – 1.6 V<sub>RMS</sub> audio input and output. (Data Input and output)
- Built-in Push To Talk capability (active low).
- User configurable lead delay and trail delay in 1mS increments.
- User configurable packetizing character gap detection.
- Internal or external carrier detect (active-high and active-low configurable), or data stream detection.
- Software configurable (no trim pots).
- Non-volatile EEPROM memory.
- Built-in intelligent error detection and encryption.
- Built-in tone test generator.
- Built-in loopback testing.
- Small footprint and rugged design.
- 10 – 30 Vdc power supply.

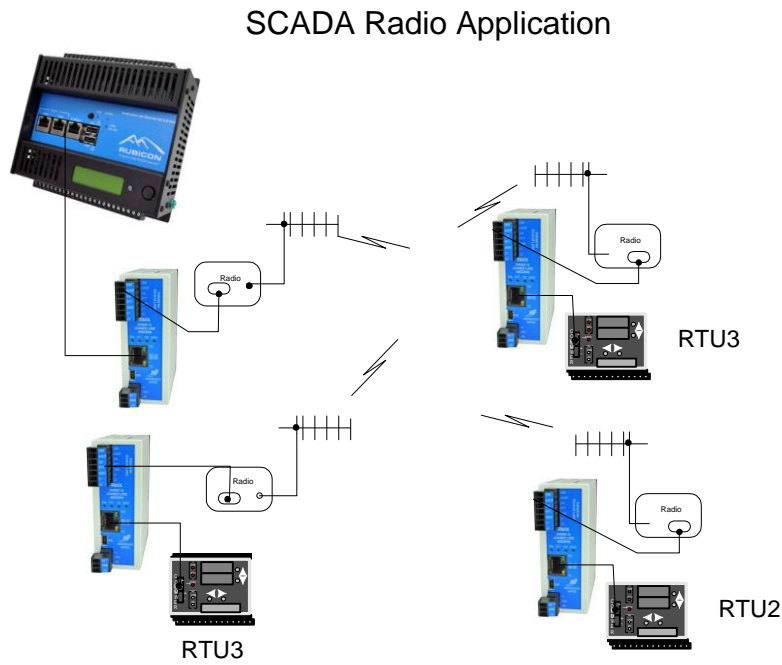
## Operation and Configuration Considerations:

The Messenger RMX modem is a packetizing device that uses a micro-controller to transfer data between the DCE (Data Communications Equipment) port and modem port. This offers several advantages over a conventional serial device:

- Automatic Lead and Trail Delay for Push To Talk (PTT) control.
- Lower audio baud rates for equipment with limited bandwidth.
- Data packetizing for better error rejection.
- Serial hardware handshaking independent.
- Collision control at modem level.
- Fully software configurable.
- Configuration can be carried out at startup by DTE.
- Rejects messages from other types of systems and modems.
- CRC Error checking and AES-128 Security Encryption

## Example of a Typical SCADA Application.

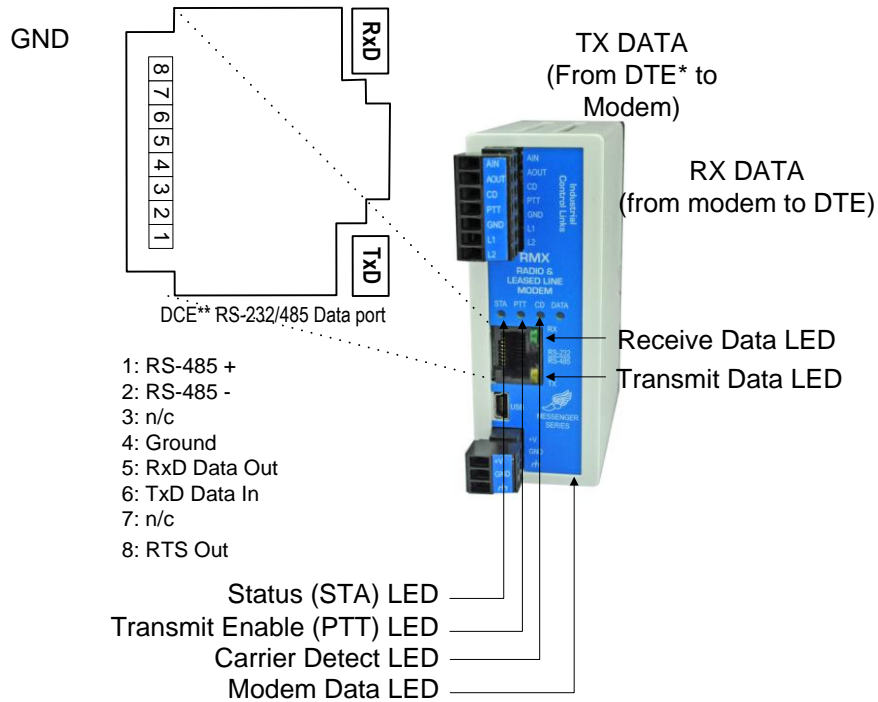
Figure 1 illustrates a typical SCADA system with a Master communicating to three slave RTU's via the MESSENGER RMX's radio interface. A leased-line configuration differs only in the medium used to communicate to other modems. In a leased line configuration, a "Dry Pair" of wires would be used in a multi-drop configuration.



**Figure 1**

A leased-line configuration differs only in the medium used to communicate to other modems. In a leased line configuration, a "Dry Pair" of wires would be used in a multi-drop configuration.

## Front Panel



\*\*DCE = Data Communication Equipment.

## Front Panel LED's

The Status LED (ST) is used as a status indicator. It has three states:

Status LED Condition	Meaning
Flashing Slowly (500ms)	Normal operation
Steady On	Configuration Mode

**Table 1**

The Push-to-Talk (PTT) LED lights just before a packetized message is sent “over the air” by the modem and lights while the message is being sent.

The Carrier Detect LED (CD) signals the detection of either an internal carrier generated from modem discriminator or an external carrier detect from a radio or both. This is configuration dependent.

The Modem Data LED (DATA) lights whenever any data is moving in or out of the modem.

The Transmit Data LED (TX) on the RJ-45 jack indicates that a message is being received and packetized by the modem via the RS-232/485 data port. The Transmit Data LED (TX) is tied directly to the serial receive line of the modem. This may be difficult to see at times due to short message packets and fast data baud rates. ([See Block Diagram section for details.](#))

The Receive Data LED (RX) on the RJ-45 jack indicates that a message was received by the modem and is being sent out the normal serial data port (RS-232/485). The Receive Data LED (RX) is tied directly to the serial transmit line of the modem. It indicates data

flowing from the DCE port connector (Pin 3) to the modem. This may be difficult to see due to short packets and fast data rates. ([See Block Diagram section for details](#)).

## RS-232/RS-485 COM Port Connection

The Messenger RMX can be connected to any DTE (Data Terminal Equipment) that is capable of baud rates of 1200 baud to 115200 baud. No 'handshaking signals are required or generated.

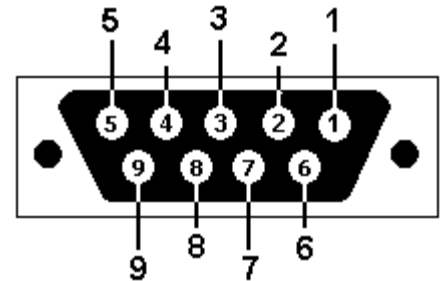
If the DTE port requires handshaking, this will need to be supplied with a special connector modification to "fake out" the DTE port.

The DTE connector wiring is designed to be directly compatible (using standard Ethernet cables) with ICLs Pinnacle controller line. A simple Ethernet cable may be connected directly from a pinnacle controller serial port to the modem RS-232/485 port. Adapters may be used with standard Ethernet cables to provide standard DB-9 serial port wiring.

Pin/Color Coding:

1 BLUE	2 ORANGE	3 BLACK	4 RED
5 GREEN	6 YELLOW	7 BROWN	8 WHITE

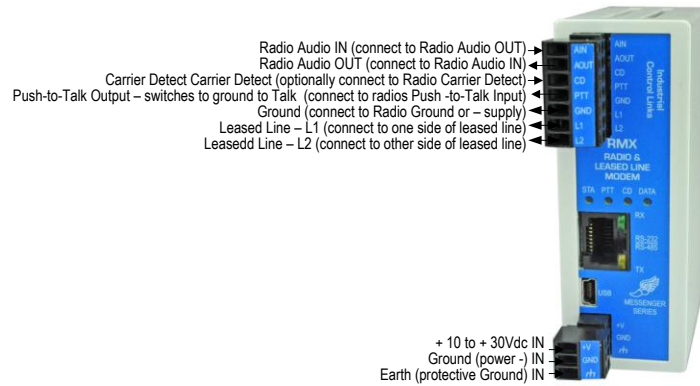
DB9F	Color	RJ45	Signal Name (Controller)
1	Blue	1	RS-485+
2	Yellow	6	TXD In (Data to be sent comes into this pin)
3	Green	5	RXD out (Data received comes out of this pin)
4	Orange	2	RS-485-
5	Red	4	Ground
6	---	7	No connect
8	White	8	RTS Out (for external rs-485 control)
9	---	--	No connect



View looking into front face of female connector

The Messenger RMX does not care about handshaking lines coming from the DTE port. The Messenger RMX modem looks for a character gap (time of no data flow) to signal it is time to send a message. This will be discussed in detail later in this manual (see [Character Gap section](#)).

## Modem Radio/Leased Line Wiring



**Figure 2 – Radio / Leased Line Wiring**

The Messenger RMX is DC powered and will accept any DC voltage from **10 – 30 VDC**.

The Audio In, Audio Out, Push To Talk, and Carrier Detect all get referenced to the DC negative input and are used for radio communication only. The two ground pins (on the modem and power connectors) are internally connected.

The L1 and L2 pins are transformer coupled and reference only each other.

## Wiring The Messenger RMX

### Radio Wiring

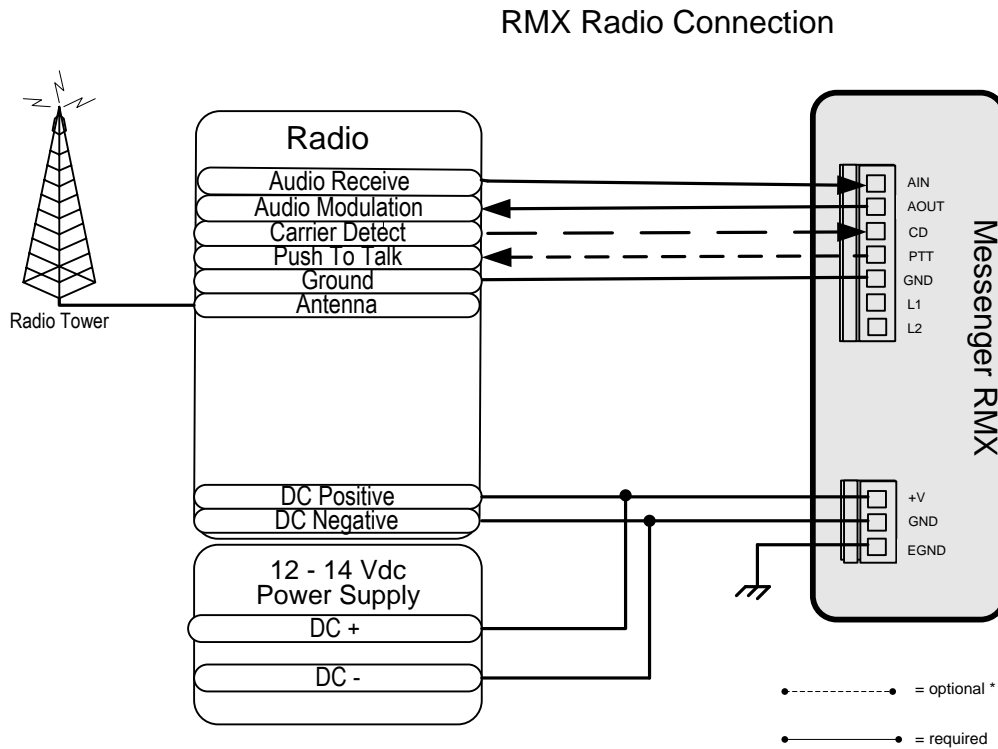


Figure 3

Notice that Carrier Detect is an optional signal. It can be configured to either active-high (1) or active-low (0) mode. The Messenger RMX does not need this signal to operate. It can also internally detect a carrier from modem audio coming from the radio.



### Leased Line Wiring

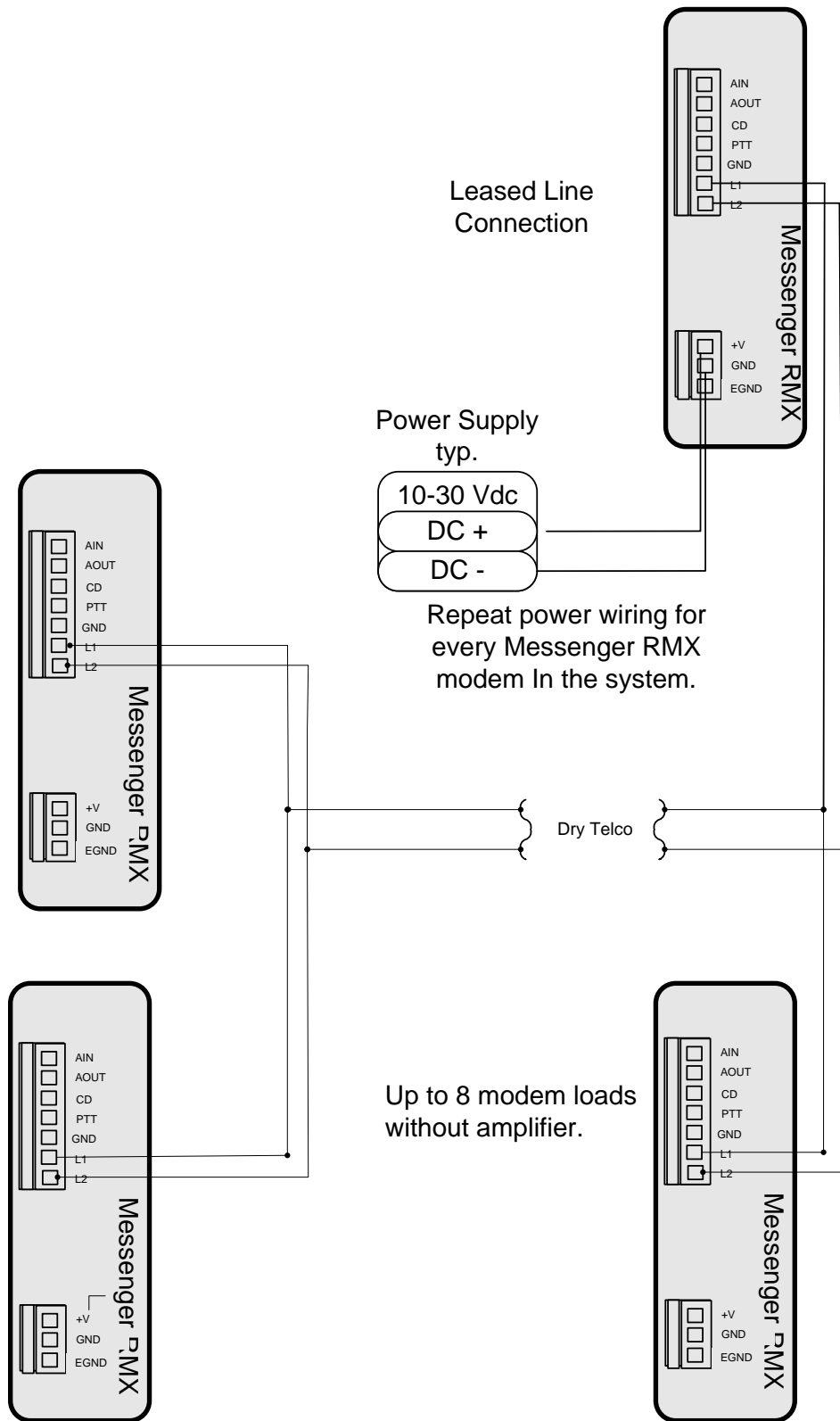


Figure 4

The Messenger RMX modem can be used as a Leased Line modem and can be wired into “dry” telephone wiring to cover long distances or into twisted pair to handle inter-building or inter-plant telemetry. The distance specification is difficult to predict due to the following variables.

- Condition and type of wiring.
- Number of modems or nodes. (Each is an additional load).
- Layout of system.
- Impedance of protection devices. (Lightning arrestors, MOV, and transorbs).
- Routing of telephone company wires. \*\*

If communication is accomplished over telephone Leased-Line, the use of lightning arrestors is highly recommended.

Each modem presents a 600 ohm load (AC Impedance) to the system. Each modem you add reduces the system audio level proportionately. The Messenger RMX modem can be automatically compensate for a large variability in signal amplitude. Built-in transformer coupling rejects a high degree of common-mode noise.

\*\* Telephone companies are notorious for having bad lines and often route around problems leaving the bad lines in place. It is sometimes hard to find a good pair in a buried cable. Configuration

### **Radio or Leased Line Hardware Configuration**

The Messenger RMX modem comes configured as a radio modem from the factory. To use in leased-line mode, the modem is simply software configured using the diagnostic port. There are no user settable jumpers or switches inside the modem. To change the Messenger RMX operating mode, please see the **MM** command.

## Software Configuration

Most of the configuration of the Messenger RMX is accomplished via a terminal and the configuration interface. By factory default, the USB connector is the configuration interface.

### Equipment Required:

1. Terminal or PC with Terminal Emulation Program Software.
2. Straight Through Modem Cable. ([See Figure 2](#)).
3. RMS or Average AC Meter or Multi-meter.
4. RF FM Deviation Meter (optional for radio)

### Setting up a Terminal Emulation Link

For this example HyperTerminal from Hilgrave Corporation will be used. This is the standard terminal program that ships with Windows NT / 98 / 95 and is available when the Communications option is installed from Microsoft.

### Terminal Setup Procedure:

- Click on the Start Menu on the PC and select *Programs, Accessories, Communications* and open *HyperTerminal* folder
- Double click on *Hypertrm.exe* to make a new connection.
- Give the connection a name such as “RMX” and click *OK*.
- Select an available COM port on your computer. Most computers have COM1 and COM2 available. For this example we will select “Direct to COM1”. Unfortunately, Windows remembers comm. port settings, so the Comm port assigned to a USB interface may be a larger number (such as Comm 30, etc.)
- Set up the Port Settings Window to the following parameters (This step can be bypassed if you are using the USB connector, since USB does not require conventional comm settings). The default baud rate is 115200.

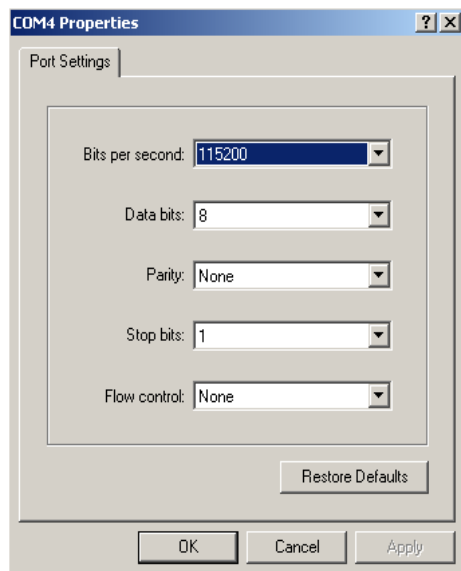


Figure 5

- There is no need to set up the `Advanced` parameters. They do not affect operation.
- Click `OK` to continue to the terminal.
- Connect the PC COM port you specified to the Messenger RMX COM port using a USB cable or a Serial Cable.
- By default the USB port is designated as the command port, and if you are using a USB cable just press Enter on your keyboard to see the main configuration screen.
- If that doesn't work then you are probably connected to the data port, pressing keys at the computer keyboard should cause the DATA and the PTT LED to flash on the Messenger RMX. If not, try a jumper from pin 2 to 3 on the computer COM port. This is called a "loop-back" connection. Whatever is typed at the keyboard should be "looped back" or echoed on the terminal screen. If this works, check the cable connection to the Messenger RMX. If not, try a different COM port on the PC. There may be a hardware configuration problem on the PC or another program using the port.

## The Messenger RMX Configuration Interface

### Getting Into Configuration Mode on the Data Port

1. Wait 1 second.
2. Hit the "+" key three times in quick succession (within one second) but separated by 200mS.
3. You should see the "OK>" prompt of the Messenger RMX user interface.
4. The "STA" LED will change to steady on if configuration mode has been entered.

### Troubleshooting Modem Connection

If this does not work check some of these items:

- Using the "+" located on the "+" / "=" key, be sure that you pressing the "Shift" key at the same time.
- Using the "+" key on the keypad is okay. Most keyboards have this key and it does not require the "Num Lock" to be on to use it. But the key is not used often and is sometimes bad.
- Be absolutely sure you hit nothing for one second, enter "+" small pause "+" small pause "+". This is the way the Messenger RMX knows that this data is not part of an actual message.
- If using a serial cable and the "TX" LED does not flash momentarily, communication to the modem is not working from the terminal.
- If the modem's "STA" light changes to steady on and the "OK>" prompt does not appear the RX pin is probably disconnected in the cable or the cable is the wrong type.
- If all else fails try `Call Disconnect` and `Call Reconnect` menu options in HyperTerminal. Do this several times with a new connection until the modem responds with an "OK>" prompt. Once this works, save the HyperTerminal session and open that HyperTerminal session **EVERY** time you use HyperTerminal to configure RMX modems.
- Try a different terminal emulation program (such as PutTTY).
- Be sure that another program is not using the COM port.

At the “OK>” prompt, hit the “Enter” key to get to the Configuration Screen: You should see the following :

```
RMX II v1.00.10
Up Time  0 days   00:00:08  Level In:   0mV
Packets: TX=0 RX=0  crc Err=0  Incomplete=0

PT=0      Data Port Type: 0 = RS-232, 1 = RS-485, 2 = USB
PB=115    Port Baud Rate: 12/24/48/96/19/38/115
PG=5      Packetizing Character Gap (Characters)

MM=0      Modem Radio/Leased Line Mode: 0 = Radio, 1 = Leased Line
MB=24     Modem Baud Rate 12/24/48 for 1200,/2400/4800 bps
CD=2      Carrier Detect: 0=Ext. Low, 1 = Ext Hi, 2 = Internal, 3 = Ignore
RO=1000   Data Out Audio Level, 10 to 1600 (mVrms) in Radio mode

MT=1      Mode Type: 0=Original RMX, 1=Messenger RMX
AC        Show Advanced Configurations
EX        Exit out of command mode

OK>
```

\* The parameters and their values seen here are the factory defaults as set by the DE command

\*\* If MM=1 then the RO Parameter is replaced with LO (Lease Line Data Out)

### Entering Modem Examination Commands

To enter commands that examine settings, simply type in the command and hit the <Enter> key. Examples:

```
MM <Enter>
```

```
MB <Enter>
```

### Modifying Modem Configuration Parameters

To modify a configuration value, type the parameter desired followed by the “=” character, a space and/or the value desired. Examples:

```
LD=20 <Enter>
```

```
MM 1 <Enter>
```

```
PT2 <Enter>
```

### Advanced Parameters

At the "OK>" prompt, type "AC" and press the "Enter" key to get to the Advanced Configuration Screen: You should see the following :

```
RMX II v1.00.10  Advanced Configuration

L4=5      RS-485 Lead Delay (Characters)
T4=2      RS-485 Trail Delay (Characters)
LM=200    Modem Lead Delay (mS)
TM=20     Modem Trail Delay (mS)
CF=5      Carrier Detect Filter (mS)
SH=10     Serial Tx HoldOff - Quiet Time Between Messages Sent (Characters)
UH=50     USB Tx HoldOff - Quiet Time Between Messages Sent (mS)
MH=10     Modem Tx HoldOff - Quiet Time Between Messages Sent (Characters)

EK=Messenger RMX II      AES-128 Key (1 to 16 Chars)

FD        Display Factory Defaults
DE        Change all settings to factory defaults

TH        Trace Hex - Press ESC to exit mode
TTx       Test Tone (S)- Press ESC to exit mode
LTx       Loopback Test (S) - Press ESC to exit mode

OK>
```

## Factory Defaults

Entering a command of “FD” displays the factory default settings. The “DE” command sets all settings back to the factory defaults.

```
OK>FD

RMX II v1.00.10   Factory Defaults

PT=0      Data Port Type: 0=RS-232, 1= RS-485, 2= USB
PB=115    Port Baud Rate: 12/24/48/96/19/38/115
PG=5      Packetizing Character Gap (Characters)

MM=0      Modem Radio/Leased Line Mode:  0 = Radio, 1 = Leased Line
MB=24     Modem Baud Rate 12/24/48 for 1200,/2400/4800 bps
CD=2      Carrier Detect: 0 = Ext. Low, 1 = Ext. Hi, 2 = Internal, 3 = Ignore
LO=0      Data Out Audio Level, 6 to -40 (dBm) in Leased Line mode
RO=1000   Data Out Audio Level, 10 to 1600 (mVrms) in Radio mode

MT=1      Mode Type: 0=Original RMX, 1=Messenger RMX
L4=5      RS-485 Lead Delay (characters)
T4=2      RS-485 Trail Delay (characters)
LM=200    Modem Lead Delay (mS)
TM=20     Modem Trail Delay (mS)
CF=5      Carrier Detect Filter (mS)
SH=10     Serial Tx HoldOff - Quiet Time Between Messages Sent (Characters)
UH=50     USB Tx HoldOff - Quiet Time Between Messages Sent (mS)
MH=10     Modem Tx HoldOff - Quiet Time Between Messages Sent (Characters)

EK=Messenger RMX II      AES-128 Key (1 to 16 characters)

OK>
```

## Commands

- PT Data Port Type: 0 = RS-232, 1 = RS-485, 2 = USB**  
 If DP = 0 or 1 then the command/diagnostic port is USB else the command port is RS-232.  
 There is no command port function on RS-485 port. The user can enter +++ on the data port to set it as the temporary command port, the other port is disabled during this mode.
- PB Port Baud rate : 12 = 1200, 24 = 2400, 48 = 4800, 96 = 9600, 19=19200, 38=38400, 115=115200**  
 This command sets the baud rate of the RS-232 and RS-485 port.
- PG Character Gap before sending to the modem (Characters).**  
 The modem gathers characters together and transmits them as a packet. This time instructs the modem on how long to wait before declaring a packet complete and sending it. The time is specified in character times (depends on the port baud rate).
- MM Modem Radio/Leased Line Mode: 0 = Radio, 1 = Leased line**  
 This command sets the operating mode and interface of the modem.
- CD Carrier Detect: 0 = External Low, 1 = External High, 2 = Internal, 3 = Ignore**  
 This command sets how the modem determines that there is a carrier signal to parse incoming messages. The choices are high or low true from the external radio, or internal detection by their modem receive circuitry, or Ignore. The Ignore selection depends on the synchronization bytes built into the packet sent/received in the header of each message.
- CF Carrier Detect Filter (mS)**  
 This command sets how much filtering is applied to the Carrier Detect. The signal must be stable for the number of mS specified.
- MB Modem baud: 12 = 1200, 24 = 2400, 48 = 4800**  
 This command sets the "over the air" data rate.
- MT Modem type :0 = Old RMX, 1 = Messenger RMX**  
 Mode 0: max packet size is 232 bytes fully compatible with older RMX2400  
 Mode 1: Packet length is 1024 bytes, CRC and AES encrypted data  
 This command is provided to ensure compatibility with the older RMX modem. If this compatibility is not required, Mode 1 should be used.
- RO Data Out Audio Level, 1 to 1600 (mVrms) in Radio mode.**  
 This command sets the signal output level in the Radio Mode. Most radios require a 1Vrms signal (1000mV).
- LO Data Out Audio Level, 6 to -40 (dBm) in Leased Line mode.**  
 This command sets the signal output level in the Leased Line Mode. Most leased lines expect to be driven with a 0dB level (into 600ohms).
- FD Display factory defaults.**
- DE Set all parameters to factory defaults.** The defaults are different for MT0 verses MT1 Mode
- EX Exit from command mode on Data port.** This has no effect on the Command Port.



**[Enter] Show normal help and status of command settings for current Mode**

**AC Show Advanced Settings** This command displays the Advanced Settings (see below).

### Advanced Commands

**L4 RS-485 Lead Delay (Characters)**

This value sets the delay from turning ON the RS-485 transmitter to starting to actually send out data on the RS-485 line. The value is in character times, so it's absolute value in mS will change depending on the interface baud rate.

**T4 RS-485 Trail Delay (Characters)**

This value sets the delay from turning OFF the RS-485 transmitter once all of the characters have gone out on the out data on the RS-485 line. The value is in character times, so it's absolute value in mS will change depending on the interface baud rate.

**EK AES-128 Encryption Key (1 to 16 Chars)**, This command set the value of the AES encryption key. This key must match between all modems in the same network. If the key is set to less than 16 characters, the key will be padded with spaces.

**LM Modem Lead Delay (mS)**

This value sets the delay from turning ON the modem (radio or leased line) transmitter to starting to actually send out data.

**TM Modem Trail Delay (mS)**

This value sets the delay from turning OFF the modem transmitter once all of the characters have gone out on the radio or leased line.

**SH Serial Tx HoldOff - Quiet Time between Messages Sent (Characters)**

This value ensures that there is a minimum gap between messages on the Serial line.

**MH Modem Tx HoldOff - Quiet Time between Messages Sent/Received (Characters)**

This value ensures that there is a minimum gap between messages on the radio or leased line. It also ensures that two messages on the radio or leased line do not "step" on each other by checking that no other messages are being sent on the line before sending a message out.

**UH USB Tx HoldOff - Quiet Time between Messages Sent(mS)**

This value ensures that there is a minimum gap between messages on the USB line

**TH Trace Hex; Display the Data passing through the modem in Hex.**

This is a diagnostic function to trace message activity in real time on the radio or leased line. The data coming in is first decrypted and then copied to a holding buffer to be sent out the command port in a Hexidecimal display. Press [Esc] to exit this command.

**TT Transmit Test tone.**

Send a High tone, then low tone, and then pause for 3 seconds each. The default timing of 3 seconds can be changed by adding a timing parameter after the TT ( i.e. TT5). Press [Esc] to exit this command.

**LT Loopback Test.**

This is a diagnostic loopback function. This will send a special packet to another Messenger RMX every 2 seconds. The other unit will reply to the loopback request. The default timing of 2 seconds can be changed by adding a timing parameter after the LT. If MT=1 then the loopback is internal and the slave RMX doesn't need a loopback

plug. If MT=0 then the Loopback is external and you will need to connect the TX to the RX on the other units serial connector. Press [Esc] to exit this command.

Original Mode RMX-2400 Commands (Supported for compatibility)

- EC External Carrier Detect.**  
Will set CD to the value of CL below
- IC Internal Carrier Detect.**  
Will set CD = 2
- CL Carrier Detect Level:** 0 = External Low, 1 = External High.  
if CD is NOT in external mode then CD will equal CL
- DI Data In Audio Level –**  
Not Supported in Messenger RMX
- DO Data Out Audio Level,** 1 to 160 (0.01Vrms).  
Both RO and LO will be calculated from this value.
- SA Save –**  
Not Supported in Messenger RMX
- CG Character Gap before sending to the modem in 10mS increments.**  
Will be converted to GP using the current baud rate.
- LD Modem Lead Delay (10mS).**  
The value will be multiplied by 10 and stored in LM.
- TD Modem Trail Delay (10mS)**  
The value will be multiplied by 10 and stored in LM.

## Message Tracing

Entering a command of “TH” will cause all message traffic to be traced (displayed in hex format). The transmit data is displayed in bright purple with a leading “O” and the receive data is displayed in green with the appropriate receive data level and leading “I”.

Trace mode is exited by pressing the [ESC] key.

```
OK>
TH

Starting Trace Hex mode.

          0 01 01 00 00 08 30 CC
928mV    I 01 01 01 00 51 88
          0 01 01 00 00 08 30 CC
908mV    I 01 01 01 00 51 88
          0 01 01 00 00 08 30 CC
917mV    I 01 01 01 00 51 88
          0 01 01 00 00 08 30 CC
920mV    I 01 01 01 00 51 88
          0 01 01 00 00 08 30 CC
```

## Loopback Testing

Loopback testing tests the data link (Radio or Leased Line). The far unit receives the loop test message and sends it back to the “Master” site automatically. Running a loopback test is automatic with Messenger RMX modems, but requires a Transmit to Receive connection on older RMX-2400 modems (at the Slave site only). Entering a command of “LT” at a Master site will cause a loopback test to be initiated.

The loopback test is exited by pressing the [ESC] key.

```
RMX II v1.00.10
Up Time 0 days 00:00:08 Level In: 0mV
Packets: TX=0 RX=0 crc Err=0 Incomplete=0

PT=0 Data Port Type: 0 = RS-232, 1 = RS-485, 2 = USB
PB=115 Port Baud Rate: 12/24/48/96/19/38/115
PG=5 Packetizing Character Gap (Characters)

MM=0 Modem Radio/Leased Line Mode: 0 = Radio, 1 = Leased Line
MB=24 Modem Baud Rate 12/24/48 for 1200,/2400/4800 bps
CD=2 Carrier Detect: 0=Ext. Low, 1 = Ext Hi, 2 = Internal, 3 = Ignore
RO=1000 Data Out Audio Level, 10 to 1600 (mVrms) in Radio mode

MT=1 Mode Type: 0=Original RMX, 1=Messenger RMX
AC Show Advanced Configurations
EX Exit out of command mode

OK>LT
Starting Loop Test mode.

TestString=ABCDEFGHIJKLMNPOQRSTUVWXYZ1234567890

Good: 15 Bad 0 (100%) Receive Levels - Local 920mV Remote: 977mV
```

## Audio Configuration

### Radio Configuration

#### Equipment Needed:

- RMS or Average AC Meter.
- Terminal Emulator.
- RF Dummy Loads.
- FM Deviation Meter (optional)

#### Procedure

This procedure is intended as a pre-installation configuration. It is not recommended that this procedure be done in the field unless absolutely necessary. Use the following diagram to setup the test on the “bench”. Please refer to the [Radio Wiring](#) section for details. Note that this may also be an ideal time to set up the “LM” and “TM” Lead and trail delay parameters if necessary. See [Advanced Topics](#) section.

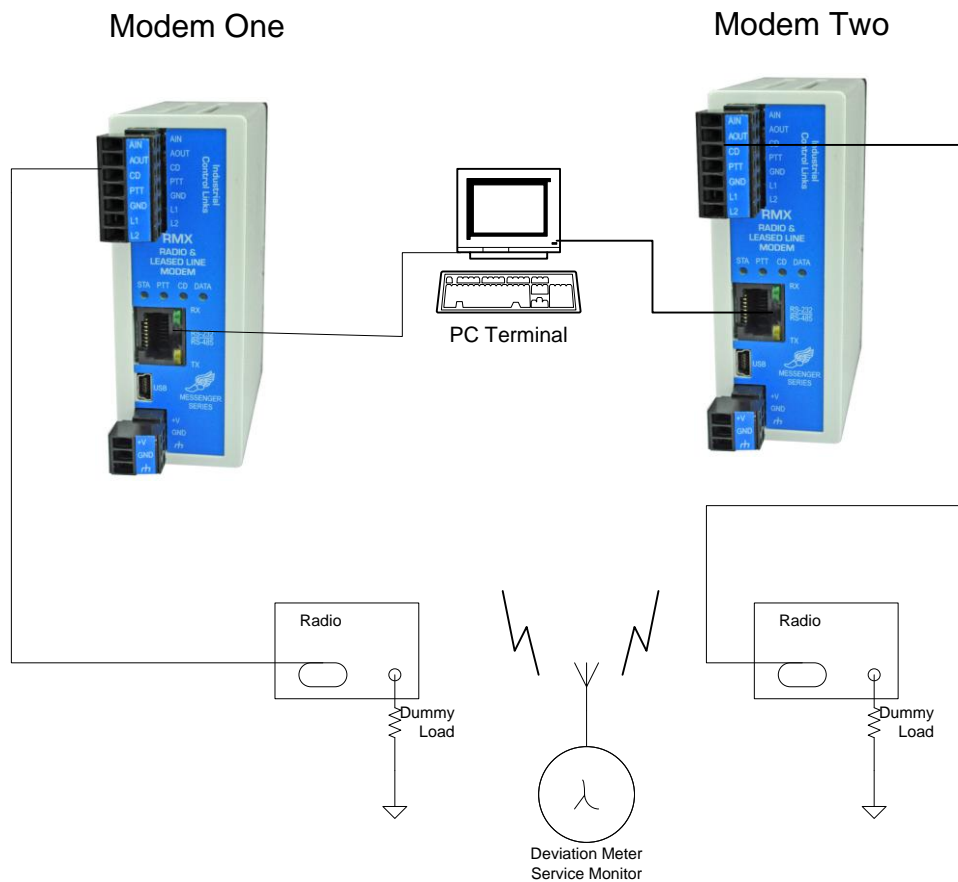


Figure 6

1. Attach AC meter to the “AIN” (Audio In) connector on the back of the Modem Two. “AIN” should be connected to the radio’s audio output. Ensure that Input signal does not exceed 1.6Vrms.
2. Plug the Terminal Emulator into configuration port of Modem One (refer to [Getting Into Configuration Mode](#) section).
3. At the “OK>” prompt type “TT [enter]”.
4. If possible, take a deviation reading to insure FCC compliance. Proper specifications can be found in the FCC license or the radio manual.
5. Adjust the modem output level with the “RO” command for Modem One so that the deviation falls within the radio and license specification. Some adjustment of the radio volume control may be required.
6. Repeat the setup for the Modem two and it’s radio equipment.
7. Perform a loopback test with the “LT” command to verify there are no communication faults.

## Leased Line Configuration

### Equipment Needed:

- Two RMS or Average AC Meters.
- Two Terminal Emulators. (Laptops with two USB ports work well).
- Two Communication Devices.

### Procedure

Most Leased lines require a 0dB input for a -17dB output. The automatic gain adjustment feature of the Messenger RMX modem eliminates the manual setup process required by the older RMX modems.

1. Plug the Terminal Emulator into configuration port of Modem One (refer to [Getting Into Configuration Mode](#) section).
2. If this is a new unit then enter MM1 to put the Messenger RMX into Leased Line Mode.
3. Adjust the modem output level with the “LO” command for Modem One to 0dB or the level recommended by the telephone company.
4. Repeat the setup for Modem Two.
5. Perform a loopback test with the “LT” command to verify there are no communication faults.

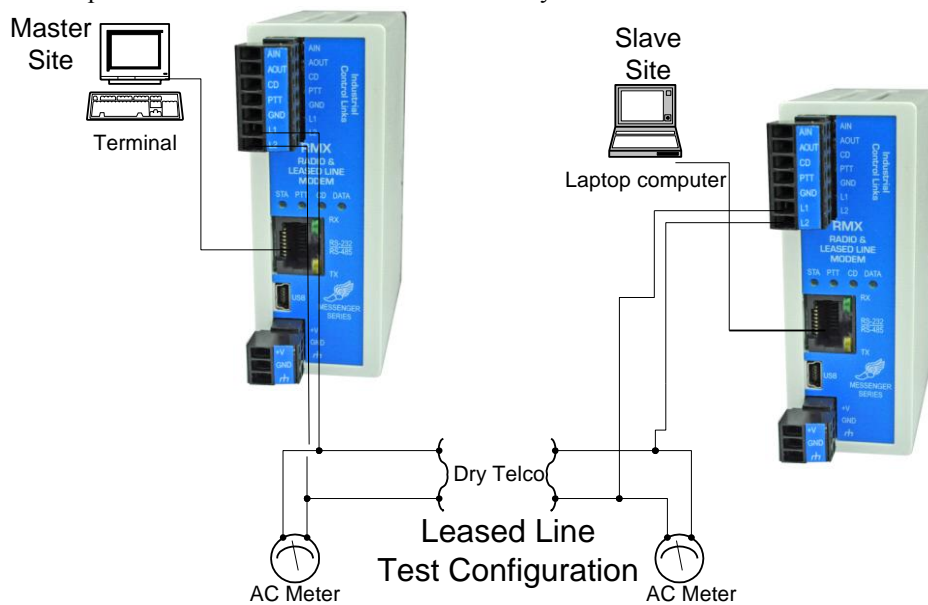


Figure 7





## Advanced Topics

### Lead Delay and Trail Delay

The Lead Delay parameter is the time between asserting Push To Talk before transmitting a message packet. It allows slow radios time to key up the transmitter carrier before the actual data is transmitted. This keeps the data from being clipped off at the front end or leading edge of the message thus corrupting it. The timing parameters needed vary from radio to radio and are usually proportional to the output power of the radio. This time is often referred to as “key time” or “transmitter attack time”. This specification can be found in the radio’s manual technical specification section.

The Trail Delay does exactly the same but for the end of the message. This keeps the end of the message from being clipped off which would corrupt it also. Please keep in mind that Trail Delay is ALMOST NEVER needed.

The following diagrams show both good and bad Lead and Trail Delay scenarios:

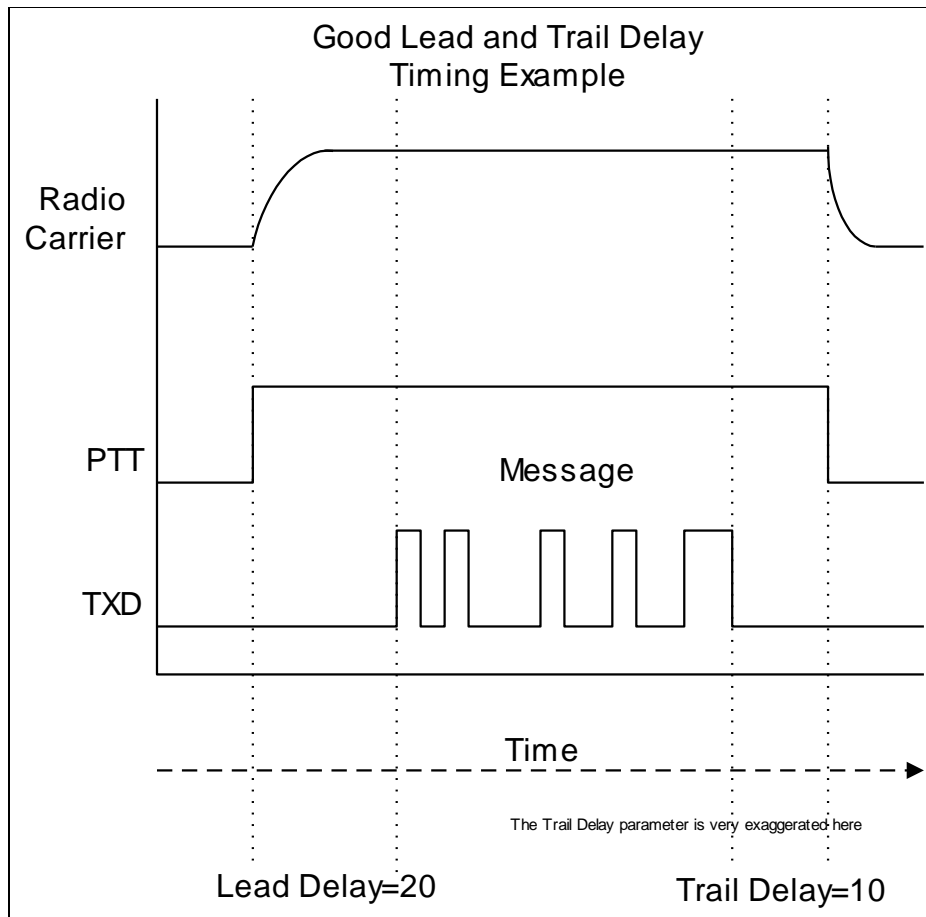


Figure 8

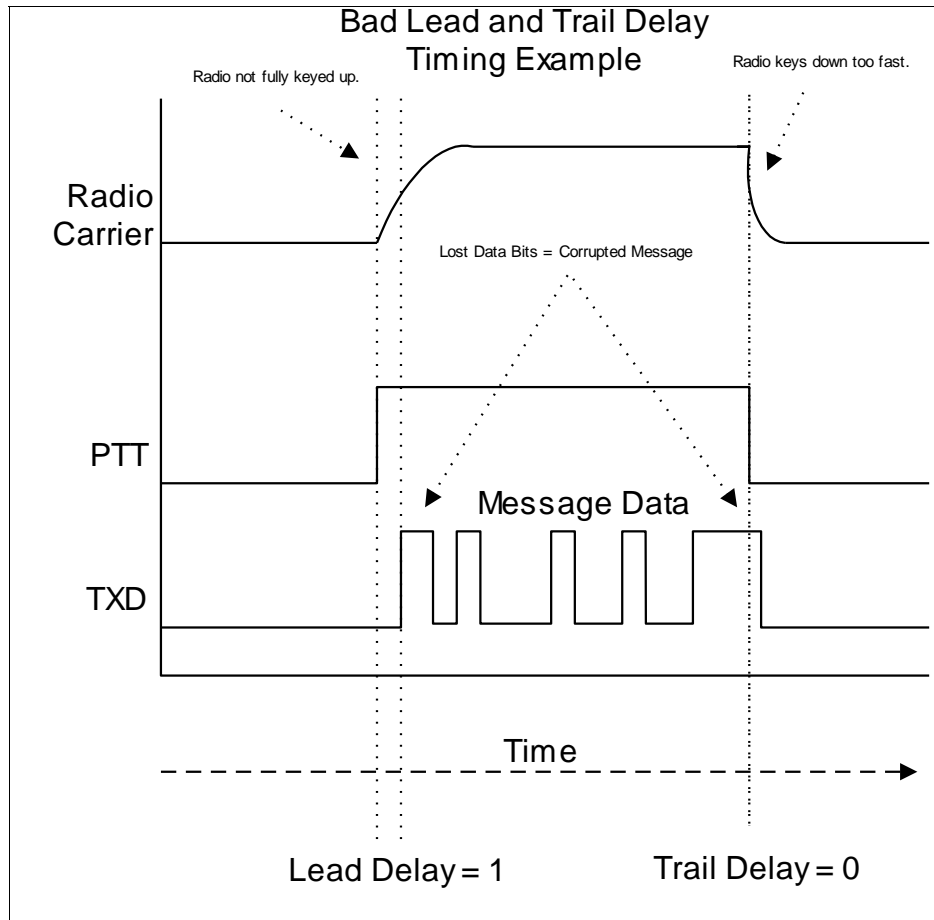


Figure 9

## Character Gap

The Character Gap parameter is the way the Messenger RMX knows where the end of a packet occurs as its transmitted from the DTE device. This method is used in place hardware or software handshaking. This Character Gap is rarely critical but may need adjustment under unusual circumstances.

## Data Packet Formatting

The MESSENGER RMX uses a proprietary data packet formatting. This formatting allows the modem to synchronize incoming audio to the modem's discriminator, verify the incoming header data is from another MESSENGER RMX and check the message length. The Message is AES-128 encrypted for security and has a 16bit checksum for validity.

## Message Format

The modem receives data asynchronously through the RS-232, RS-485 or USB port onboard. When a gap (the length of which is user definable) in the incoming data occurs, the modem transmits whatever data is currently in its transmit buffer. The data is sent as a

synchronous block or "packet". When a data packet is sent from one modem to another, the following bytes are what actually get transmitted:

```
SYNCH_BYTE, SYNCH_BYTE, BYTE1_PREAMBLE, BYTE2_PREAMBLE, BYTE3_PREAMBLE, BYTE4_PREAMBLE,  
<Expansion_Byte>, <packet size N>, <Eoffset>, <crc lsb>, <crc msb>, <byte1>, <byte2>, ...,  
<byteN>
```

The two SYNCH\_BYTES are simply two 0xAA characters. The receiving modem chip needs this alternating pattern of 0's and 1's so it can synchronize itself with the transmitting chip at the other end.

The four BYTE<sub>x</sub>\_PREAMBLE bytes make up a unique 32-bit pattern that the receiving modem looks for to determine if the data that follows is an actual packet or maybe just noise or garbage that is being received. The preamble bytes are:

```
BYTE1_PREAMBLE    0xC4  
BYTE2_PREAMBLE    0xD7  
BYTE3_PREAMBLE    0xAF  
BYTE4_PREAMBLE    0x71
```

After the proper sequence of four preamble bytes is received, the next byte is the Expansion Byte. This byte contains the 2 high bits to the size, a loopback flag bit, and an AES-128 flag bit. If the AES-128 flag is set then we are sending a Messenger RMX packet, if it is not set then we are sending an Original RMX2400 (MT0) packet. The loopback flag is used so that the receiving RMX knows to internally loop the data back.

After the expansion byte is received, the next byte is the lower 8 bits of the data packet size. It gets combined with the 2 bits in the expansion byte to make the 10 bit size. This gives a maximum packet size of 1024 bytes.

The Eoffset is used to tell us where the end of the actual message is within the AES-128 encrypted data. AES-128 encryption is always used on blocks of 16 characters, so if the message is not evenly divisible by 16 we will pad the message and use the Eoffset to tell us where the message ends and the padding begins.

Next is the 16 bit CRC, this is needed to validate the AES-128 data to follow.

When Communicating with an Original RMX in MT0 mode, the packet is similar except it doesn't have the Eoffset or CRC bytes. Also the Expansion Byte's value in the MT0 mode MUST be 0. This packet is NOT AES-128 encrypted and has no way to validate its data.

## Technical Data

### Block Diagram

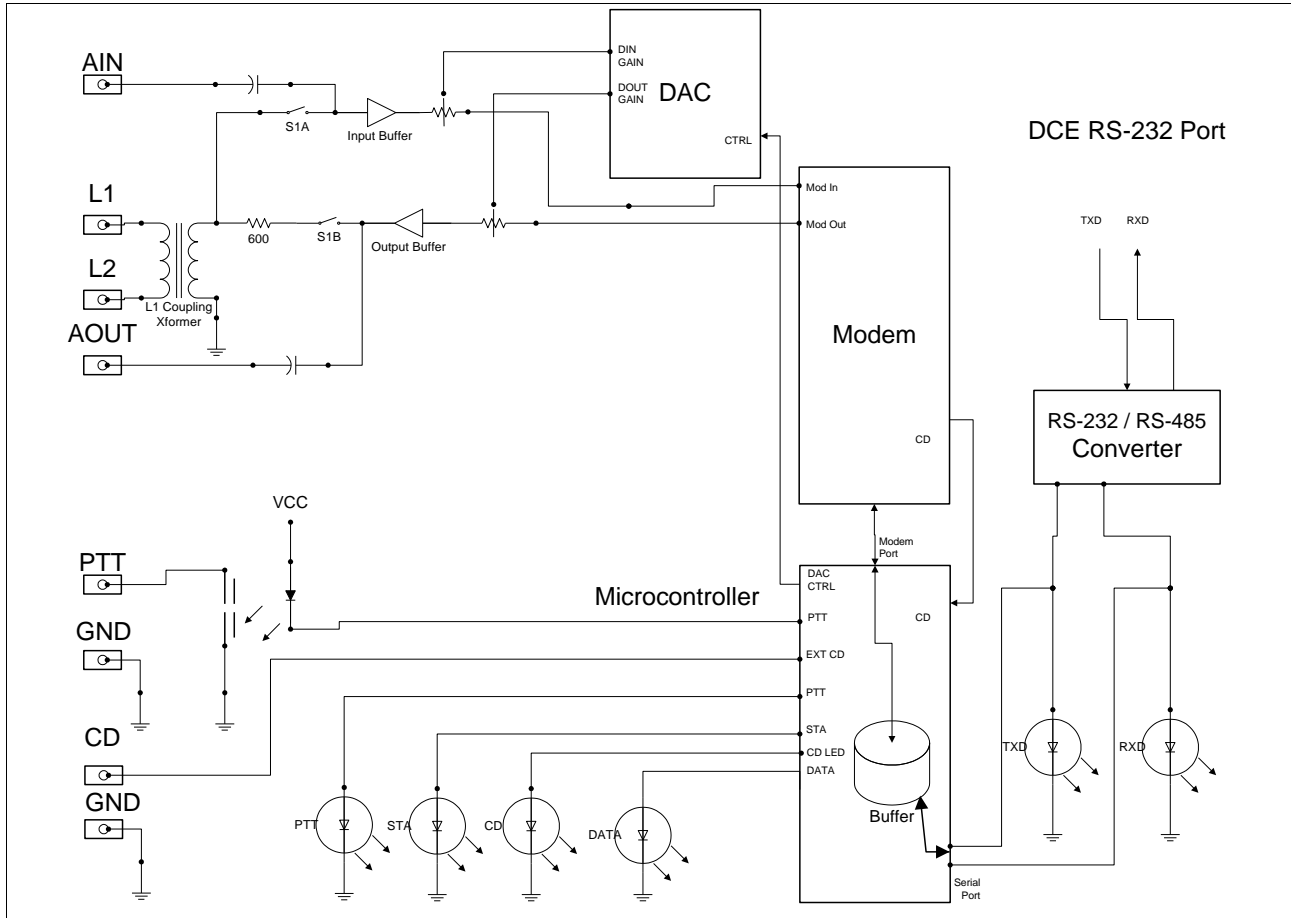


Figure 10

## **Specifications**

### **Output Level:**

#### **User Settable**

10 to 1600mVrms (radio Mode)  
-40dB to 6dB (Leased Line Mode)

### **Input Level:**

#### **Automatic Adjustmety**

10 to 1600mVrms (radio Mode)  
-40dB to 6dB (Leased Line Mode)

### **Bit Error Rate and Noise Immunity:**

$7 \times 10^{-4}$  @Signal to Noise Ratio of -12dB @ Bandwidth.

$1 \times 10^{-8}$  @Signal to Noise Ratio of -20dB @ Bandwidth.

Bandwidth = 1200Hz @ 1200 Baud.

Bandwidth = 2400Hz @ 2400 Baud.

### **DCE Port Baud Rates:**

115200, 38400, 19200, 9600, 4800, 2400 or 1200

### **Modem Port Baud Rates:**

4800, 2400 or 1200

### **Environmental:**

#### **Operating Temperature:**

-40 to 70 degree Celsius

#### **Humidity:**

10 to 95% Non-Condensing

### **Power Requirements:**

10 to 30 Vdc

0.3 Watts Maximum

## Modem Dimensions

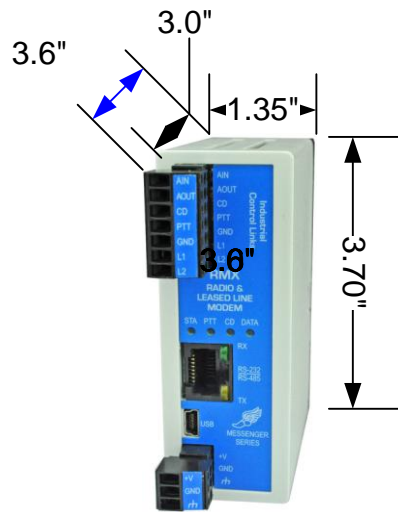


Figure 11