OMNEX
CONTROL SYSTEMS INC

Model OEM-900

Frequency-Hopping Spread Spectrum Radio Transceiver

Version 1.4

10/01 BK

Notices and Warnings

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 OMNEX will void the user's authority to operate the equipment.

This product is intended for fixed installation applications. In order to comply with FCC/IC adopted RF exposure requirements, installation of this transmitter system's antennas must be performed in a manner that will provide at least a 6 foot (2 meter) clearance from the front radiating aperture to any user or member of the public.

If this unit is installed in another device and the FCC ID label is not visible, then the outside of the device into which the module is installed must also display a label referring to the enclosed label. The exterior label should use wording such as "*Contains FCC ID: IA9FHOEM900*" or "*Contains Transmitter Module FCC ID: IA9FHOEM900*".

1. FEATURES AND SPECIFICATIONS

1.1 Description

The OEM-900 is a credit card sized, board-level 902-928 MHz radio platform specifically designed for industrial applications. Capable of accepting a wide range of input voltages, and able to operate across a broad temperature range, this radio's strength lies in its ability to withstand ISM band interference while ensuring the integrity of each data packet. This is accomplished via the OMNEX Iris data protocol that uses ARQ and Auto-Routing to move data accurately in hostile RF conditions. While supporting transparent data communications as well as MODBUS RTU and AB DF1 packet communications, the Auto-Routing feature allows the OEM-900 to build routing tables using Allen-Bradley and MODBUS addresses. This feature enables the radio to further 'assure' communications between PLC's and devices in a system for both inbound and outbound messages. Each unit is also capable of acting as a master, a slave and/or a store-and-forward repeater/slave.

1.2 HopLink Features

1.2.1 HopLink Technology

OMNEX HopLink devices employ frequency hopping spread spectrum technology to provide optimum performance under present FCC and ISC regulations. These devices are virtually immune to interference since they provide the interference and range benefits of a narrow band receiver while utilizing the entire 902 - 928 MHz band. The radio frequency hop pattern is pseudo random in nature and each transmission is 37 mSec in duration, after which it sits in the receive mode for 37 mSec waiting for a response. The hop sequence repeats approximately every 2.3 sec.

OMNEX devices are designed to operate specifically in the 902-928 MHz band. Many manufacturers have designed their ISM band equipment to operate in an ideal environment that the unlicensed bands are not. The OMNEX radios are designed to co-exist with all other radios legally allowed to operate in these bands and will generally outperform most other systems presently available.

Special hopping sequence codes allow systems to co-exist with no overlap in frequencies. Many more units can co-exist in one location with only a slight penalty in response time.

1.2.2 HopLink Data Integrity

HopLink products are designed for industrial applications. Every effort has been made to ensure that data over the link is secure and fail-safe. In addition to CRC-16 error checking, a number of self-checking features have been implemented. A special output on all HopLink Transceivers (LINK) indicates the status of the radio link and provides a fail-safe means of shutting down remote equipment in case of a failure in the link

1.2.3 HopLink Family

The HopLink telemetry product line (TEX-900, REX-900, HS-900, and DX-900MA) includes both simplex and duplex products incorporating a flexible array of Input and Output options. In addition, OMNEX provides packaged remote control products for controlling overhead cranes, conveyers and other construction equipment.

1.3 Specifications

General	
Frequency Band	902-928 MHz
Frequency Hopping Sequence	4 selectable groups, each containing 63 frequencies
Operation	Half duplex
Radio Addresses	65,000+
Radio Modes	Master, Slave, Repeater/Slave
Data Characteristics	
Serial Port	RS-232 and TTL (3V logic)
Serial Connector	14-pin dual header
Antenna Connector	MCX female
Data Port Rates	1200, 2400, 4800, 9600, 19200, 38400 baud (Asynchronous)
Data Rate in RF Channel	9600 bps
Flow Control	Selectable between Hardware or None
Typical Latency	70ms
Auto-Routing	MODBUS RTU, AB DF1 protocols
Error Correction/Detection	ARQ with CRC-16
RF Channel Protocol	Iris
Transmitter	
Power Output	1 Watt (30dBm) nominal
Duty Cycle	50%
Output Impedance	50 ohms
Transmitter Keying	Data activated
Maximum SWR (with no damage)	Infinite at all phase angles
Receiver	
Type	Double conversion superheterodyne
Data Threshold	Less than –110dBm
Acquisition Threshold	Less than –113dBm
Primary Power	
Voltage	9 to 30 VDC, reverse voltage protected
Transmitter Supply Current	400mA at 12 VDC; 170mA at 24 VDC
Receiver Supply Current	25mA at 12 VDC; 16mA at 24 VDC
Fuse	0.75A polyfuse
Reverse Polarity Protection	YES
Environmental	
Humidity	0% - 95% at 40°C, non-condensing
Temperature	Operating: -40° to 158°F (-40° to 70°C)
	Storage: -40° to 185°F (-40° to 85°C)
Size	2.2” x 3.1” x 0.75” (55mm x 78mm x 17mm)
Weight	1.6 oz (45 g)
Case	Open Printed Circuit Board (PCB)
Mounting	4 corner 4 – 40 threaded mounting post (1/4” standoff)
Diagnostics	
Indicators	External LED’s, Link status, Good receive status, Receive error status
Agency Approvals	
FCC	Part 15.247
Industry Canada	RSS 210
CSA/C & US	Class 1 Div 2; Groups A, B, C, D (pending)

Table 1.3.1 (Specifications)

2. CONFIGURATION

2.1 Introduction

The RS-232 serial communications interface to the OEM-900 is intended to provide the means of communication with the radio. Data may be passed through this interface normally or the radio may be configured using a specialized subset of the industry standard modem AT command set.

2.2 Data Transfers

Data may be sent to or read from the radio link by using this communications interface as one would a regular RS-232 serial port. A write to the port will cause the data to be sent through the radio link, whereas the arrival of any data from the radio link will automatically be sent to the host via this port. By default, the radio will power up into the **data transfer mode** of operation.

2.3 Commands

The host may modify the configuration of the radio by issuing commands via this communications interface using a specialized subset of the industry standard modem AT commands.

To enable the radio to respond to these commands, it must first be switched from data to configuration mode. This is achieved by observing two seconds of silence on the transmitter line, followed by sending the ASCII escape code sequence: '+++' and then followed by an additional two seconds of silence. Upon completion, the radio will then accept a stream of configuration data.

Configuration information is sent to the radio in the form of one or more command strings. Each string is sent to the port prefixed with the ASCII 'AT' attention code. The radio will acknowledge each command string received with the ASCII 'OK' string. Those commands requiring the radio to return configuration information to the host will first be answered with the data followed by the acknowledgement string.

EXAMPLE: Following power up, the host places the radio into configuration mode

Host: <2 seconds silence> +++ <2 seconds silence>
Radio: OK<CR><LF>

EXAMPLE: The host sets the radio's ID code.

Host: ATS1=25<CR><LF>
Radio: OK<CR><LF>

EXAMPLE: The host reads back the radio's ID code.

Host: ATS1?<CR><LF>
Radio: 25<CR><LF>OK<CR><LF>

EXAMPLE: After the configuration procedure has been completed, the radio is returned to the data mode.

Host: ATD<CR><LF>
Radio: no response (enters data mode immediately)

The complete command set for the radio is defined in Table 2.3-1.

Command	Description
AT	Attention. Returns 'OK' when the radio is in configuration mode.
ATE0	Disable echoing of characters when in configuration mode. Default.
ATE1	Enable echoing of characters when in configuration mode.
ATI	Display software revision information.
ATSn=V	S register n is changed to value V. (n is a decimal number)
ATSn?	The value is S register n is output.
ATD	Data mode. Used to exit configuration mode and enter data transfer mode.
ATZ	The configuration is loaded from EEPROM.
AT&Z	The configuration is reset to factory defaults.
AT&W	The configuration is written to EEPROM.

Table 2.3-1 (OEM-900 Command Set)

Command Notes:

- The command line may not exceed forty characters in length.
- Multiple commands are allowed on a single command line.
- All command line entries must be terminated with a carriage return (0x0d). The linefeed character (0x0a) is optional and will be ignored.
- All whitespace characters (0x20, 0x09) within commands will be ignored.
- All commands will return "OK<CR,LF>" (0x4f, 0x4b, 0x0d, 0x0a) upon completion (**Note**: The "ATD" command is the only exception to this).

Command Line Editing:

Typing the Escape key (0x1b) discards the input line and restarts the command. Typing the Backspace (0x08) or the Delete (0x7f) key discards the previous character.

Register	Name (Attributes)	Description
S0	Group ID (read/write)	Each group of radios that are to communicate with each other must have the same group ID. Valid Range: 1..63 Default Value: 1
S1	Radio ID (read/write)	Each radio within a network must have a unique ID. Valid Range: 0..254 (**Note**: 255 is reserved as the broadcast ID) Default Value: 1
S2	Security ID (read/write)	Each group of radios must be assigned a unique security ID code. Each radio within the group must utilize the same code. Valid Range: 0..65534 Default Value: 0
S3	Radio Mode (read/write)	This register contains the operating mode of the radio. Valid Modes: M, S, R (Master, Slave, Repeater). Default: S. (Slave)
S4	Point-to-Point Mode (read/write)	Only two radios may operate together in point-to-point mode and both share the same ID code (**Note**: This mode will not work with repeaters in the network) Valid Modes: Y, N (Yes, No) Default: N (No)
S5	Repeaters in Network (read/write)	Setting this register causes the master radio to repeat every packet that is to be sent by the radio. It is to be utilized whenever repeater/slave units are present in the network. The radio will communicate on a four-hop cycle. Valid Modes: Y, N (Yes, No) Default: N (No)

Register	Name (Attributes)	Description
S6	Retransmit Broadcasts (read/write)	Setting this register causes the master radio to repeat every packet that is to be sent by unassured (broadcast) delivery. The radio will communicate on a four-hop cycle. Valid Modes: Y, N (Yes, No) Default: N (No)
S7	RF Band (read/write)	This register determines which frequency band the radio will use while hopping. Valid Range: 1..4 Default Value: 1
S8..S9	Reserved	
S10	RSSI (read only)	This register contains the average signal strength of all packets received by the radio (**Note**: Units are **TBD**)
S11	Link Status (read only)	This register will contain a value of 1 if the radio has received a good RF packet within the last 2 seconds, otherwise the value will be 0.
S12	Master ID (read only)	This register contains the ID code of the master for the radio (**Note**: This applies to repeater/slave radio units only)
S13	Retries (read/write)	This register contains the number of communication retries a frame may undergo before it is discarded. Default: 50
S14	Maximum Message Wait (read/write)	This register contains the maximum period of time (in tenths of a second) that packetized data may be buffered without being transmitted before the chain is flushed. Valid Range: 0..255 (tenths of a second) Default: 10 (one second)
S15	Network Table Flush Timeout (read/write)	This register contains the maximum period of time (in tenths of a second) that the network table is to be kept before flushing. Valid Range: 0..65535 (tenths of a second) Default: 12,000 (twenty minutes)
S16..S19	Reserved	
S20	Baud Rate (read/write)	Serial port baud rate. Changes to this register will take effect on next power up of the radio. Allowable Values: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 Default Value: 9600
S21	Data Bits (read/write)	Serial port data bits per character. Changes to this register will take effect on next power up of the radio. Allowable Values: 7, 8 Default Value: 8
S22	Stop Bits (read/write)	Serial port stop bits per character. Changes to this register will take effect on next power up of the radio. Allowable Values: 1, 2 Default Value: 1
S23	Parity (read/write)	Serial port parity configuration. Changes to this register will take effect on next power up of the radio. Allowable Values: E, O, N. (Even, Odd, None) Default Value: N (None)
S24	Handshaking (read/write)	This register indicates whether the serial port is utilizing hardware handshaking. Changes to this register will take effect on the next power up of the radio. Allowable Values: 0, 1, 2 (No handshake, HW Control, Xon/Xoff) Default Value: 0 (No handshake)
S25	Port Protocol (read/write)	Serial port protocol configuration. Changes to this register will take effect on the next power up of the radio. Allowable Values: 0, 1, 2, 3 (None, MODBUS, Allen Bradley, Custom1)

Register	Name (Attributes)	Description
		Default Value: 0 (None)
S26	Buffer Mode (read/write)	This register indicates whether the radio buffers data as individual characters or in packets. Allowable Values: 0, 1 (Character, Packet) Default Value: 0 (Character)
S27..S29	Reserved	
S30..S42	Blocked Frequencies (read/write)	These registers specify frequencies (in hundreds of kHz) that the radio is not permitted to utilize. Valid Range: 9022..9277 (100Khz multiples) Default Value: All transmission frequencies are permissible
S43..S49	Reserved	
S50	Rx Frames Started Diagnostic (read only)	This register contains a count of the total number of identifiable frames that the radio attempted to receive. Valid Range: 0..65535
S51	Rx Frames Received Diagnostic (read only)	This register contains a count of the total number of frames that were correctly received by the radio. Valid Range: 0..65535
S52	Rx CRC Errors Diagnostic (read only)	This register contains a count of the total number of frames that were received with an invalid CRC. Valid Range: 0..65535
S53	Tx Frames Sent Diagnostic (read only)	This register contains a count of the total number of frames that were sent by the radio. Valid Range: 0..65535
S54	Tx Heartbeat Frames Diagnostic (read only)	This register contains a count of the total number of heartbeat frames that were sent by the radio. Applicable to a master or repeater only. Valid Range: 0..65535
S55	Tx Data Frames Diagnostic (read only)	This register contains a count of the total number of data frames that were sent by the radio. Valid Range: 0..65535
S56..S59	Reserved	
S60, S80	Tx Retries Diagnostic (read only)	This register contains the total number of times the radio tried to retransmit a frame. Valid Range: 0..65535
S61, S81	Rx Repeated Diagnostic (read only)	This register contains the total number of repeated frames of data that were received by the radio. Valid Range: 0..65535
S62, S82	Rx Sync Frames Diagnostic (read only)	This register contains the total number of synchronization frames that were received by the radio. Valid Range: 0..65535
S63, S83	Tx Sync Frames Diagnostic (read only)	This register contains the total number of synchronization frames that were sent by the radio. Valid Range: 0..65535
S64, S84	Rx Resend Bit Diagnostic (read only)	This register contains the total number of acknowledgement, synchronization and/or data frames received with the resend bit set. Valid Range: 0..65535
S65, S85	Rx ACK Frames Diagnostic (read only)	This register contains the total number of acknowledgement frames received by the radio. Valid Range: 0..65535
S66, S86	Tx ACK Frames Diagnostic (read only)	This register contains the total number of acknowledgement frames sent by the radio. Valid Range: 0..65535
S67, S87	Rx Assured Frames Diagnostic (read only)	This register contains the total number of data frames received by the radio via assured delivery. Valid Range: 0..65535
S68, S88	Tx Assured Frames Diagnostic	This register contains the total number of data frames sent by the radio via assured delivery.

Register	Name (Attributes)	Description
	(read only)	Valid Range: 0..65535
S69, S89	Rx Broadcast Frames Diagnostic (read only)	This register contains the total number of frames the radio received by unassured (broadcast) delivery. Valid Range: 0..65535
S70, S90	Tx Broadcast Frames Diagnostic (read only)	This register contains the total number of frames sent by the radio via unassured (broadcast) delivery. Valid Range: 0..65535
S71, S91	Tx Dropped Frames Diagnostic (read only)	This register contains the total number of frames that had been discarded by the radio during transmission. Occurs when a synchronization frame could not be allocated or on a failed attempt to synchronize this radio with the intended recipient radio. Valid Range: 0..65535
S72, S92	Rx Response Frames Diagnostic (read only)	This register contains the total number of 'request for sync' frames that had been received by the radio during transmission. Valid Range: 0..65535
S73, S93	Max. Tx Retries Diagnostic (read only)	This register is used as a "high-water" marker for measuring the maximum number of transmission retries encountered by the radio since power up. Valid Range: 0..49
S74..S79 S94..S98	Reserved	
S99	Test Mode (read/write)	Writing to this register causes the radio to immediately enter into a test mode. (See table 3, Test Mode Summary below). Default: 0 (OFF) ***NOTE**: This mode is intended for internal use only*
S100..S127	Reserved	

Table 2.3-2 (Configuration S-Register Summary)

Configuration Register Notes:

- All values will be displayed as printable decimal ASCII characters (i.e. the value 45D (0x2d) will be displayed and entered as 0x34, 0x35).
- S-registers 60 – 73 and 80 – 93 are diagnostic counters, which are set to zero upon power up only. Prolonged use of the radio equipment will eventually result in the overflow of some of these counters, which will wrap them back to zero. As a result, the relationship between these counters, as detailed in the discussion below, will not be preserved.
- S-registers 60 – 73 are implemented by the network master radio and repeater units as diagnostic counters used to monitor communication in the "downstream" (repeater/slave's) direction. Whereas slave radio units use these diagnostics to monitor communication in the "upstream" (master's) direction
- S-registers 80 – 93 are implemented in repeater radio units alone and are the diagnostic counters used to monitor communication in the "upstream" (master's) direction only.

3. TROUBLESHOOTING

3.1 Diagnostic Registers

The S-register diagnostic counters are intended for use in troubleshooting a live communications link in the field. As a result, many of these S-registers are quantitatively inter-related to indicate just how well communication is progressing. As these relationships tend to be mathematical in nature, they are presented thus as follows:

MAC Layer Specifics

Transmission

Slave:	Tx Frames Sent (S53) = Tx Data Frames (S55)
Master[1]:	Tx Frames Sent (S53) = Tx Heartbeat Frames (S54) + Tx Data Frames (S55)
Repeater[2]:	Tx Frames Sent (S53) = Tx Heartbeat Frames (S54) + Tx Data Frames (S55)
Master[3]:	Tx Frames Sent (S53) = (Tx Heartbeat Frames (S54) + Tx Data Frames (S55)) * 2

Reception

All Radios:	Rx Frames Started (S50) = Rx Frames Recv'd (S51) + Rx CRC Errors (S52)

LLC Layer Specifics

Transmission

Tx Assured Frames (S68) = Tx Data Frames (S55) + Tx Retries (S60)
Tx Ack Frames (S66) = Rx Sync Frames (S62) + Rx Resend Bit (S64) + Rx Assured Frames (S67)

Reception

Rx ACK Frames (S65) = Tx Sync Frames (S63) + Tx Assured Frames (S68)

[1] S-register S3, Point-to-point mode is set; S-register S4, Repeaters in Network is clear; S-register S5, Retransmit Broadcasts is clear
[2] S-register S4, Repeaters in Network is set and S-register S5, Retransmit Broadcasts is either set or clear
[3] S-register S4, Repeaters in Network is set and S-register S5, Retransmit Broadcasts is either set or clear

3.2 Test Modes

The various test modes are intended as a means of testing the radio for FCC approval and are not normally available for use by the end-user. Entering into a test mode is to be accomplished by writing the eight-bit test number to S-register S99, as shown below:

EXAMPLE: The host sets the radio's test mode.

Host: ATS99=2<CR><LF>
Radio: OK<CR><LF>

Exiting from test mode may only be accomplished by the cycling of power to the radio.

Table 3.2-1 below provides a complete summary of all the test modes currently available within the OEM-900 radio board.

Mode Number	Description
0	Off. No test mode selected.
1	Sends continuous data at the test transmit frequency with the power amplifier on
2	Sends steady carrier at the test transmit frequency with the power amplifier on
3	Receives steady carrier at the test receive frequency
4	Sends continuous data at the test transmit frequency with the power amplifier off
5	Sends steady carrier at the test transmit frequency with the power amplifier off

Table 3.2-1 (Test Mode Summary)

3.3 RF Band Interleaving

The OEM-900 radio has a frequency range that spans from 902.2MHz to 927.7Mhz. This is further decomposed into four interleaved bands, each of which is comprised of up to 63 discrete frequency channels.

The radio may be configured to block the use of frequencies that would cause interference with other in-field equipment. Up to thirteen frequencies may be blocked from use by entering their values in any of S-registers S30 through S42.

EXAMPLE: The host instructs the radio not to use the 925.2MHz frequency channel.
Host: AT30=9252
Radio: OK<CR><LF>

4. ANTENNAS

NOTE: The FCC and ISC require that the antenna be restricted to that supplied by the manufacturer and approved for use with this product. A 0dB quarter-wave omni antenna is normally supplied. For other antenna options, please contact OMNEX Control Systems Inc.

! Caution

It is important for proper operation of the OEM-900 that when multiple systems are to be installed, there is ample space between the antennas. There must be a minimum of 3 feet (1 meter) vertical and 10 feet (3 meters) horizontal separation between the transmitter of one system and the receiver of another. As well, when these units are used in a repeater fashion, the 3 foot (1 meter) vertical separation must also be adhered to.

4.1 Height

For maximum transmission effectiveness, several factors must be taken into account. Obviously, distances between antennas are important, as radio signals dissipate as they travel. The Fresnel Zone, or the space occupied by the propagating radio signal, changes shape as it travels across the earth, and must be relatively clear of obstacles. For distances greater than 7 miles (11 kilometers), the curvature of the earth can adversely affect the radio link. As a result, the overall formula for calculating approximate total antenna heights is:

$$H = 13.7\sqrt{D} + \frac{D^2}{8}$$

Where:

H = antenna height in **feet**
D = distance between radios in **miles**

To simplify this, refer to Figure 4.1-1 to find the suitable minimum height of the antennas at each end of the link.

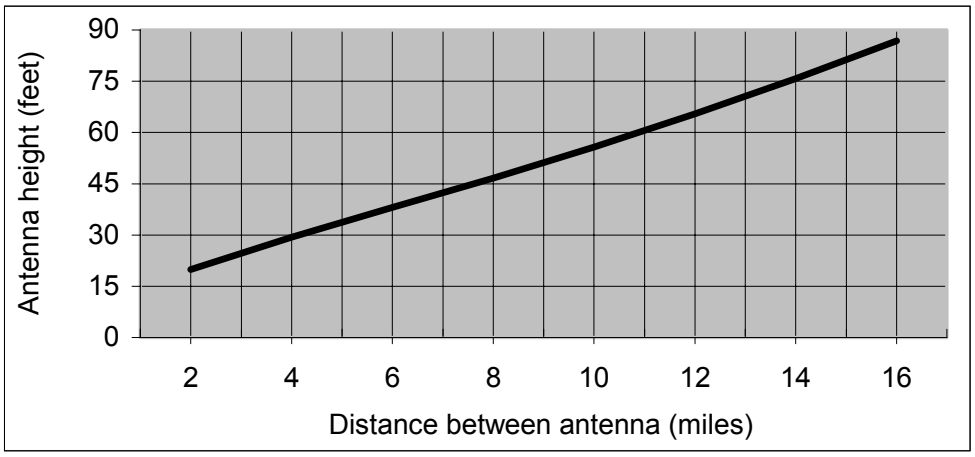


Figure 4.1-1 (Antenna height calculation)

4.2 Mounting

The OEM-900 operates at 902 - 928 MHz. Radio signals at these frequencies do not bend around objects but they do bounce and reflect off objects. However, each reflection robs the signal of some of its energy. To maximize the received power, the transmitter antenna should be mounted within line of sight of the receiver antenna.

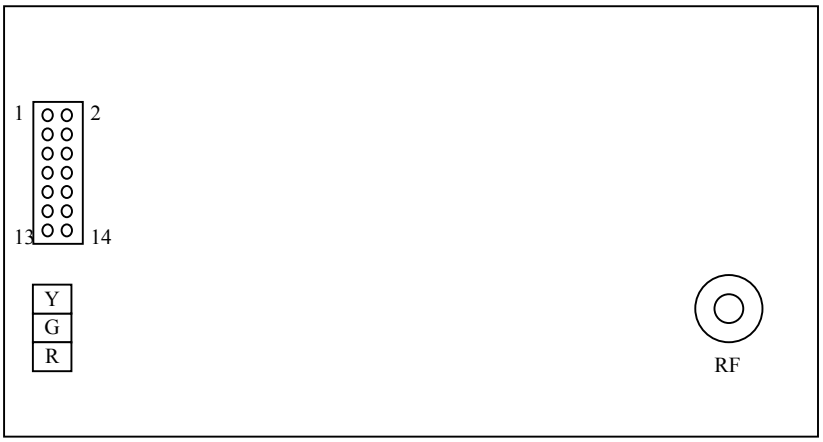
Warning

For safety reasons, it is important that the antenna mast be grounded to earth. It is also a good idea to use a coaxial cable lightning suppressor between the antenna and the OEM-900

4.3 Connection

The omni antenna attaches directly to a 6 foot (2 meter) length of RG-174 cable with an MCX male connector at the end. This fits into the MCX female connector on the end of the Transceiver.

APPENDIX A - OEM-900 RS232 Pin-Out Connection Diagram



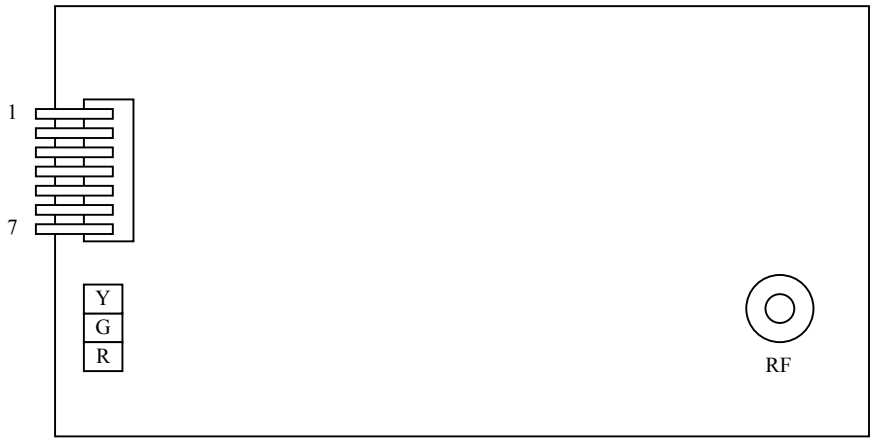
Power Connector

Pin Number	Description
1	Ground
2	Positive Power (9-30VDC)
3	RF LED indicator
4	RS232 CTS (in)
5	TX LED indicator
6	RS232 RTS (out)
7	I/O #1
8	RS232 Receive (in)
9	I/O #2
10	RS232 Transmit (out)
11	Auxiliary In/Out #2
12	Auxiliary In/Out #1 (RSSI)
13	+4VDC Out
14	Ground

Indicator Lights

Light Color	Description
Yellow	On solid if connected to another radio, otherwise flashes.
Green	Blinks when transmitting serial data out the serial port.
Red	Blinks when receiving serial data from the serial port.

APPENDIX B – OEM-900 TTL Connection Diagram



Power Connector

Pin Number	Description
1	Positive Power (9-30VDC)
2	TTL level RTS (out)
3	TTL level CTS (in)
4	TTL level Receive (in)
5	TTL level Transmit (out)
6	Auxiliary In/Out #1 (RSSI)

Indicator Lights

Light Color	Description
Yellow	On solid if connected to another radio, otherwise flashes.
Green	Blinks when transmitting serial data out the serial port.
Red	Blinks when receiving serial data from the serial port.

NOTE: All TTL levels use 3.3VDC logic levels (but will tolerate 5V levels)

Warranty

OMNEX Control Systems Inc. Warrants to the original purchaser that the OMNEX products are free from defects in materials and workmanship under normal use and service for a period of **ONE YEAR,** parts (EXCLUDING: SWITCHES, CRYSTALS, OR PARTS SUBJECT TO UNAUTHORIZED REPAIR OR MODIFICATION) and labor from the date of delivery as evidenced by a copy of the receipt. OMNEX's entire liability and your exclusive remedy shall be, at OMNEX's option, either the (a) repair or (b) replacement of the OMNEX product which is returned within the warranty period to OMNEX freight ***collect*** by the OMNEX **APPROVED** carrier with a copy of the purchase receipt and with the **return authorization** of OMNEX. If failure has resulted from accident, abuse or misapplication, OMNEX shall have no responsibility to repair or replace the product under warranty. In no event shall OMNEX be responsible for incidental or consequential damage caused by defects in its products, whether such damage occurs or is discovered before or after replacement or repair and whether or not such damage is caused by the negligence of OMNEX Control Systems Inc.

Neither OMNEX nor its Distributors shall be liable for any delay or failure of the performance of any of its obligations under this agreement caused by acts of God, labor disputes, embargoes, boycotts, shortage of parts or any cause beyond its reasonable control.

Neither OMNEX nor its Distributors shall be responsible for incurred costs associated with border clearance or with the delay of the OMNEX products in transit to OMNEX. Any charges associated with the return of the OMNEX products may be subject to billing to the original purchaser in the event that the OMNEX products are NOT covered by the warranty as noted above.