BLACK BOX®
NETWORK SERVICES

MDR210A-485

900 MHz. Frequency Hopping RS-485 Master/Slave auto-sensing radio interface.

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Description

The MDR210A-485 uses an embedded 100-milliwatt, frequency-hopping wireless modem that provides communication between a local RS485 network and a remote network of RS485 connected devices. The MDR210A-485 will automatically sense the direction of data flow and switch the RS485 and Radio devices accordingly. The MDR210A-485 can be placed in a network of RS485 devices and appear as a slave repeater of remote RS485 devices or it can be placed in a network of one or many RS485 slaves and act as the RS485 repeater of a remote master. The radio operates within the 900 MHz ISM Band under Part 15 of the FCC Rules and Regulations.

The MDR210A-485 operates at 19200 Baud at either odd parity or no parity. Dipswitches select parity and one of 7 radio networks. Radios operating together must have the same radio network address (1-7 set by switches labeled A0-A2). Select a different radio network address to prevent interference from nearby networks that are not sharing information. The default radio network for Rooftop applications is 5. The user may choose another network address (1-7) if desired. While all radios in a network must have the same network address, they do not have to have the same parity. The parity is local to the RS485 serial port on the MDR210A-485 only. Parity information is not transmitted or received.

Radio network selection 0 (A0, A1, A2 all set to 0) selects a special network setup. When network address setting 0 is selected, the pre-programmed radio network parameters are used. These parameters are user and application specific and must be set at the factory for specific OEM applications.

The MDR210A-485 can also be used as a general purpose RS485 half duplex radio interface operating at 19200 Baud at either odd or no parity (dip switch selectable).

PARAMETER	MIN	TYP	MAX	UNITS
Supply Voltage	6.0	12	24	Volts
Supply Current	70	-	200	mA
Baud Rate	-	19200	-	Baud

PIN	SIGNAL	DESCRIPTION
1	TR-	RS485 transmit/receive negative I/O
2	TR+	RS485 transmit/receive positive I/O
3	GND	Common

Features

- **RS485 Master/Slave auto-sensing radio interface.**
- **Built in 900MHz frequency hopping radio for long-range wireless interface.**
- **Provides remote capability to RS485 Modbus networks.**
- **Automatically senses Master or Slave data flow.**
- **Multiple radios allow many remote RS485 networks to coexist logically.**
- **Provides means to connect legacy RS485 devices to wireless.**
- **Range Indoor: 600' to 1300'**
- **Range Outdoor: 7mi. with dipole, >20 mi. w/high gain antenna.**
- **LED power and activity indicator.**
- **Configuration parameters set by dipswitch.**
- **Low power, 6-24 VDC at 200 milliamp transmitting, 70 milliamp receiving.**
- **Astron AXH900RP SMA R Reverse Polarity SMA 6.5" Antenna.**

General	**MDR210A-485**
Frequency Range	902 to 928 MHz., unlicensed ISM Band
Type	Frequency Hopping Spread Spectrum Transceiver
Frequency Control	Direct FM
Transport Protocol	Transparent networking
Channel Capacity	Hops through 25 channels. Up to 65,000 network identifiers.
Serial Data Interface	Asynchronous RS232 levels. CMOS (TTL) Signals, 5V, 3.3V Tolerant
Serial Interface Baud Rate	Configurable from 2400-57600 bps
Data Throughput	9600 bps
Network Topology	Point – multipoint, point-to-point multi-drop transparent networking

Performance	
Channel Data Rate	10k or 20k bps respectively (vary with data rate)
Transmit Power Output	100mW
Rx Sensitivity	-110dBm or –107dBm Respectively
Range*	Indoor: 600' to 1500' Outdoor: 7 mi. with dipole, over 20 mi. with high gain antenna
Interface Rejection	70 dB at pager and cellular phone frequencies

*Range calculations are for 9600 baud line of sight. Actual range will vary based upon specific antenna selection and environment

9XSTREAM-192/96 Radio

Introduction

The 9XSTREAM-192/96 radio is a 100-milliwatt frequency hopping wireless modem that communicates with other equipment using a standard 19200 or 9600-baud asynchronous serial data stream. The radio is half-duplex and can sustain a continuous data stream at the specified data rate. The 9XSTREAM operates within the 900 MHz ISM Band under Part 15 of the FCC Rules and Regulations.

IMPORTANT: The 9XSTREAM radio has been certified as a module by the FCC for integration into OEM products without further certification being necessary (as per FCC section 2.1091.) The OEM must satisfy the following requirements in order to comply with FCC regulations:

The system integrator must ensure that the external label provided with this device is placed on the outside of the final product.

In order to comply with the FCC RF exposure requirements, the 9XSTREAM may be used only with approved antennas that have been tested with this radio and a minimum separation distance of 20 cm must be maintained from the antenna to any near by persons. The OEM must also include a statement in the final product manual, informing users of the requirement to maintain 20 cm separation from the antenna to any near by persons. If the OEM integrates the 9XStream into their final product, where the final product utilizes a non-approved antenna or is classified as a portable device per FCC Section 2.1093 (less than 20 cm separation distance between the antenna to any near by persons,) the OEM is responsible for obtaining a separate authorization on the final product.

The 9XSTREAM radio requires a regulated 5-volt, 200mA supply for operation. Any voltage higher than 5.5 volts will damage the radio.

Approved Antennas

Mfr Model	Freq	Gain Type	Connector
Dimensions			
Astron AXQ900 PTL	902-928	2dBi Omni	MMCX 3”
Astron AXH900RP SMA R	902-928	2dBi Omni	Reverse Polarity SMA 6.5”
MaxStream 900CDAN	902-928	2dBi Omni	Integrated 3”

External Label:

This device contains transmitter module FCC ID:OUR9XTREAM. The enclosed 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.

9XStream Frequency Hopping Data Radio

FCC Compliance Warning:

Changes or modifications to the 9XStream Data Radio not expressly approved by MaxStream, Inc. could
void the user's authority to operate this product.

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.

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.

Antenna
Antenna Connector MMCX Female
Antenna Impedance 50 Ohms unbalanced
Approved Antennas Integral wire antenna (factory installed)
Astron AXQ9PRLMMCX – 1/4 wave flexible whip
Astron AXH900 RP SMAR – 1/2 wave flexible whip, SMA

Serial Port Scanning

The Scan Function is provided to assist the user when they are unsure which communication port the MDR210A-485 is attached to or what baud rate it has been set to. The Scan Function will attempt to communicate with the MDR210A-485 over every port installed on the PC at every allowed baud rate. While this is not a fast process, it does allow the recovery of a device whose configuration is unknown. If the Scan Function is unable to determine the port which the MDR210A-485 is attached to, the user will be notified. The user should then ensure that no other application has the communication port in use before re-attempting the Scan.

Application Fields

COM Port - Specifies which PC communication port the MDR210A-485 to be configured is attached.

Scan - The scan function iterates each available PC communication port looking for an attached MDR210A-485. If an MDR210A-485 is found, its COM Port and current Baud Rate values are provided.

Network ID - All communicating MDR210A-485s must be programmed to the same Network ID. The valid values are from hexadecimal 1 to FFF.

Hop Table - All communicating MDR210A-485s must be programmed to the same Hop Table. The valid values are 0 to 6. Independent networks in the same vicinity should use different Hop Tables to minimize packet collisions.

Baud Rate - This is the desired communication Baud Rate between the host and the MDR210A-485.

Setup - Send the currently selected values to the MDR210A-485 attached to the specified communication port.

Close - Exits the Application.

Networks

There are seven available **networks (Hop Tables)**. Each network utilizes a different pseudo-random hopping sequence to navigate through the shared hopping channels. In the event that two modules from different networks collide on a channel (because they

hop in a different sequence) the two modules will jump to separate channels on the next hop. Using networks, multiple module pairs can operate in the same vicinity with minimal interference from each other. The network parameter is user-definable using the MDR210A-485 Set-up Hop Table.

Module Address

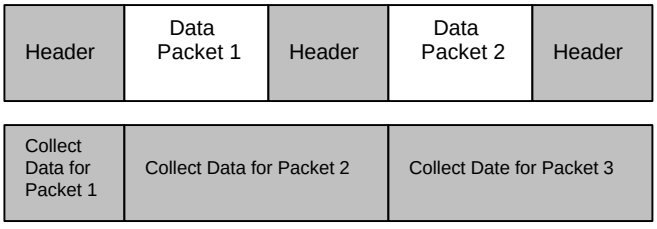
Module Addresses provide another level of addressing among the MDR210A-485 modules. Each module in a network can be configured with a 16-bit Module Address to establish selective communications within a network. This address is set to 65535 values using the MDR210A-485 Set-up Hop Table command.

All modules with the same Module Address can transmit and receive data among themselves. Any modules on a network with different Module Addresses will still detect and listen to the data in order to maintain network synchronization. However, they will not send the data to their serial ports if their Module Addresses do not match the Module Addresses of the transmitter.

Data Validity

The first data packet transmitted contains all bytes that accumulated in the data buffer while the header (see Figure 2a below) was being sent. After the first data packet is sent, another header will be sent if data is available in the buffer. The header is followed by another data packet. The second data packet (and all subsequent data packets) will consist of data that accumulated in the buffer while the previous data packet and header were being sent (see Figure 2a). The size of each data packet can vary up to 64 bytes. This progression can be seen in Figure 2b.

Sent Data:



Group Data into Packets:

Figure 2a – Generation of Data Packets

Data Validity (Cont.)

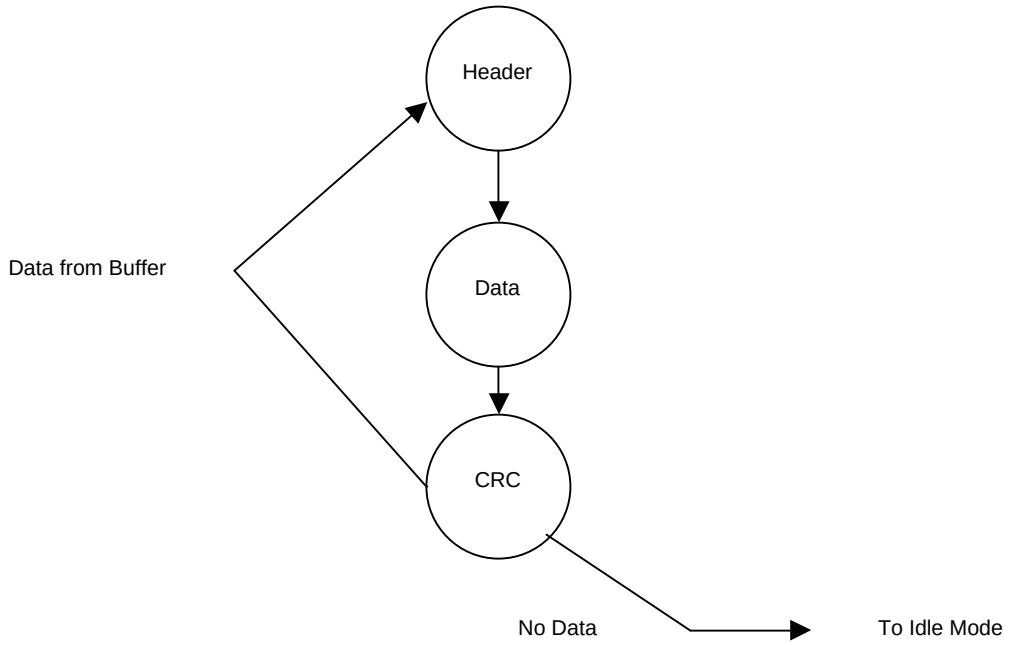


Figure 2b – Transmit Mode Description

To verify data integrity, a 16-bit cyclic redundancy check (CRC) is computed for the transmitted data and attached to the end of each data packet before transmission. The receiver will then compute the CRC on all incoming data. Any received data that has an invalid CRC is discarded.

Glossary

Data Buffer – Collects incoming serial data prior to over-the-air data transmission. The data buffer can hold up to 132 bytes at a given time.

Data Packets – A grouping of data to be sent over-the-air. Each data packet contains a header and data that is collected from the data buffer. The size of the packets varies up to 64 bytes depending on how many bytes of data are in the data buffer.

Glossary (cont.)

Frequency Hopping Spread Spectrum (FHSS) – Method employed by the MDR210A-485 module which involves transmitting data over several different channels in a specific channel hopping sequence known by the transmitter and the receiver(s).

Half-duplex – A mode for radio operations. Radios that operate in half-duplex are able to either transmit data or receive data at a given time, but cannot do both simultaneously. When one module is transmitting, all modules within range listen to the transmission and will only transmit when the transmission is complete.

Module Addresses – Provides a layer of addressing among modules. Modules with the same Module Addresses can communicate together.

Networks – Provides a layer above Module Addresses for communicating between modules. Each network has a unique hopping sequence that allows modules on the same network to remain synchronized together.

RS-232 logic – Standard logic levels implemented in devices using the RS-232 communication protocol.

Sensitivity – A measurement specification that describes how weak a signal can be (in dBm) and still be detected by the receiver.

Serial Data – Data that enters the MDR210A-485 module through its serial port.

Start bit – A low UART signal to signify the beginning of an eight-bit data sequence.

Stop bit – The last bit in a UART data sequence. The stop bit is high and indicates the end of an eight-bit data sequence.

Synchronization – Synchronization is used to ensure that the transmitter and receiver are communicating properly with each other and following the same channel hopping sequence.

Transmission Latency – Time required to send a packet of data. This value is dependent on the number of bytes being sent and the baud rate of the module.

Transmit Mode – Mode of operation in which over-the-air data can be transmitted from a module to other modules.

Application Notes

Why does Sensitivity Matter?

Receiver sensitivity is the lowest power level at which the receiver can detect a wave and demodulate data. Sensitivity is purely a receiver specification and is independent of the transmitter. As the wave propagates away from the transmitter, it attenuates as the distance increases. Lowering the sensitivity on the receiver (making it more negative) will allow the radio to detect weaker signals, and thus increase the transmission range. Sensitivity is vitally important since even slight differences in receiver sensitivity can account for large discrepancies in the range. To better understand this relationship, the following example is provided.

Example:

Compare the MDR210A-485 module (with –110dBm sensitivity) to a commercial radio receiver with a sensitivity of –90 dBm. The Friis transmission formula can be used to calculate received power (or signal strength) at any receiver location under line-of-sight conditions. This formula is given by

$$P(r) = \frac{P(t) \times G(t) \times G(r) \times \lambda^2}{F(s) \times 4\pi r^2}$$

P(r) = received power (mW)
P(t) = transmitted power (mW)
G(t) = gain of transmit antenna (linear)
G(r) = gain of receive antenna (linear)
F(s) = fading margin (linear)
λ = wavelength (meters)
r = distance between Transmitter and Receiver (meters)

The following values were used to compare the range limitations of these modules:

P(t) = 100mW
G(t) and G(r) = 2dB, or 1.585 linear
λ = 0.333 meters
F(s) = 21dB, or 125.89 (experimentally determined.

The table below demonstrates the power received at the receiver over the specified range between the TX and RX antennas, assuming line of sight conditions.

Application Notes **(cont.)**

Range (meters)	Received Power	Detectable by MDR210A-485	Detectable by Commercial Radio
100	-68.526 dBm	YES	YES
500	-82.506 dBm	YES	YES
1000	-88.526 dBm	YES	YES
3000	-92.048 dBm	YES	NO
5000	-102.506 dBm	YES	NO
8000	-106.588 dBm	YES	NO
10000	-108.526 dBm	YES	NO
11265 (7miles)	-109.559 dBm	YES	NO
12000	-110.805 dBm	NO	NO

Since the range doubles every 6dB, the 20dB sensitivity difference in radios corresponds to 2^(20/6) = 10.08 times the range using the MDR210A-485 radio!

Appendix A – Specifications

General	
Frequency Range	902 to 928 MHz, unlicensed ISM Band
Type	Frequency Hopping Spread Spectrum Transceiver
Frequency Control	Direct FM
Transport Protocol	Transparent Networking
Channel Capacity	Hops through 25 channels. Up to 65,000 NetIDs.
Serial Data Interface	Asynchronous RS-232 levels
Serial Interface Baud Rate	?????
Data Throughput	?????
Performance	
Channel Data Rate	10k or 20k bps Respectively (vary with data rate)
Transmit Power Output	100mW
Rx Sensitivity	-110 or –107 dBm Respectively
Range*	Indoor: 600' to 1500' Outdoor: 7mi. With dipole, over 20 mi. with high gain antenna
Interference Rejection	70 dB at pager and cellular phone frequencies
Power Requirements	
Supply Voltage	5 VDC +/-0.3V
Current Consumption	Tx - 170 mA nominal, Rx - 50 mA nominal
Physical Properties	
Board Size	1.6” x 2.7” x .35” (4.06 x 6.86 x .89)cm
Weight	8 oz. (24g)
Connectors	11 pin 0.1” spaced male berg type header
Operating Temperature	-40° to 85° C
Operating Humidity	10% to 90% (non-condensing)
Antennas	
Antenna Connector	MMCX Female
Approved Antennas	????

*Range calculations are for 9600 baud radio line of sight. Actual range will vary based upon specific board integration, antenna selection, environment and the OEM’s device.

Antenna

Antenna Connector MMCX Female

Antenna Impedance 50 Ohms unbalanced

Approved Antennas Integral wire antenna (factory installed)

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