WARWICK WIRELESS
LIMITED

X7200/X7200HP SYNTHESISED RADIO MODEM

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X7200/X7200HP RADIO MODEM

1.0 FEATURES

- Type approved for licence free use.
- 17 selectable radio channels.
- Range 10Km to 20Km line of sight and 1Km to 3Km in buildings
- Serial Interface with baud rates of 1200 to 19200.
- RS232 flow control for duplex operation
- Two data transmission speeds.
- 4K of buffer memory.
- Two data repeater modes to extend range.
- Addressable individually and globally
- On-line AT commands for modem dial-up operation and RF channel change.
- Predictor/Corrector error checking mode
- Transmitter keying for site surveys and antenna alignment.
- Low power mode

The X7200 Radio Modem transmits and receives half duplex serial data at baud rates of 1200 to 19200 by means of a FM Radio Transceiver operating on the UK licence except 458.500MHZ to 458.950MHZ band and most other world wide data frequencies - The radio conforms to MPT1329 and the European ETSI 300-220 standards.

A 4K buffer memory is provided so that data can be passed asynchronously between the host and modem without the need for handshaking. The CTS output signal can be used for flow control in duplex applications. It indicates to the host that the RF channel is in use or that the buffer memory is full. The X7203 interface unit is available if large computer files need to be transferred with full duplex operation. This add-on unit will provide data packeting, data encryption and data packet retries.

The over air data speed can be configured at either 5K bits/sec or 10K bits/sec. This is independent of the baud rate and should be set to a lower value were possible for the best results.

All the parameters on the X7200 radio modem can be set by an internal menu selected by connecting pin 6 on the 9 way D Connector to 0v or typing $ ESC directly after the power has been applied. The menu configuration is permanently stored on EEPROM.

A modem can be used in an open configuration in the same way as a RS485 bus or given a unique transmitter and receiver address. If the address mode is selected only modems with the same address can communicate with each other. In addition “AT” commands can be sent to the modem to change the address configuration during normal operation so that any modem can “dial up” any other modem. These commands are used in specific ways and do not restrict the use of any data strings or combinations of data.

A forward error correcting algorithm can be configured to increase the integrity of the data transmission at high speed or over long distances.

The modem can be configured in two repeater modes. The first mode will command any modem in range to repeat back the data it has just received thereby testing data integrity and radio range. The second repeater mode uses the address mode to form repeater chains thereby extending the range of a transmission over physical obstacles or in shaded areas.

The RF frequency is set by the menu, or DIL switches located inside the modem, or by an

"AT" command sent to the serial port. The RF power output can be set from 5mW to 500mW by a potentiometer also located inside the case. The modem can be configured to transmit a continues RF carrier so that a site can be surveyed to find the best reception locations and antenna installations can be correctly aligned and tested.

The X7200 radio modem is powered from a regulated DC source of between 8.5v to 14V. In receive mode it will take 80mA and in transmit 330mA. Taking DTR low will switch the modem into a power saving stand-by mode. In this state it will consume approximately 0.1 mA. It will take approximately 20mSec for the modem to become fully operational after DTR is taken high or power is applied. The modem is protected by an internal resetable fuse.

The modem is housed in a robust, lightweight aluminium enclosure measuring 114mm by 65mm by 26 mm.

Additional options include:

X7201 12V power supply.
X7202 PC to Modem cable.
X7204 IP67 enclosure.
X7205 Leather carrying case.
X7206 Belt mounted battery packs.
X7207 600 ohm line interface module.

2.0 SPECIFICATION

2.1 Radio

RF Frequency		400MHz - 480MHz
RF Power:	X7400	5mW
	X7200	5mw – 500mW
	X7200HP	1W – 12W
Channels		17
Channel Separation		25KHz / 12.5KHz
Modulation		F3D. F1D
Receiver Sensitivity		0.3µV for 10dB SINAD
Antenna Connector		BNC/TNC

2.2 Modem

Interface Baud Rate	
(standard)	19200, 9600; 4800, 2400, 1200
(extended)	600, 300, 150
Data Word	8 bits
Parity	Odd, even, None
Stop Bits	1
Modulation	Gaussian Minimum Shift Keying
Interface	RS232/RS422
Transmission speed	10Kbits/sec, 5Kbits/sec

2.3 Power Supply

DC Supply Voltage	8.5V to 14V (12V nominal)
DC Supply Current	
X7200	
Transmitting	330 mA
Receiving	80 mA
Stand By	0.l mA

X7200HP	
Transmitting @ 1W	870 mA
Transmitting @ 5W	2.8A
Receiving	120 mA

2.4 Mechanical and Environmental

Size without base plate	114mm by 65mm by 26mm
Size overall	140mm by 65mm by 26mm
Operating Temperature Range	-10 to +55 deg C

3.0 CONNECTIONS

3.1.1 9 Way D Type Connector RS232

1		+12V		INPUT
	6	CONFIGURATION MODE		INPUT
2		RD	DATA	INPUT
	7	RTS	REQUEST TO SEND	INPUT
3		TD	DATA	OUTPUT
	8	CTS	CLEAR TO SEND	OUTPUT
4		DTR	(STANDBY)	INPUT
	9	RSSI		OUTPUT
5		0v		INPUT

PIN 1+VE 12V regulated power supply, capable of supplying 0.3Amps and an inrush current of 0.7Amps for 20mSec. It is not advisable to use a switched mode power supply either to drive the X7200 radio modem or in close proximity to it. This type of power supply can produce high energy radio frequencies over a broad spectrum thereby causing interference to the received signal.

PIN 2 RD Receive serial data from host

PIN 3 TD Transmit serial data to host.

PIN 4 DTR A signal of between 0v to -15v will switch the modem into standby power mode. The input has an impedance of 22Kohms. Open circuit for normal operation.

PIN 5 OV Power supply and common for host.

PIN 6 CON Configuration input. Connecting 0V to this input will send the configuration menu to the host when the power is applied. It is left open circuit for normal operation

PIN 7 RTS Used in curtain applications to inhibit data from the TD output of the modem.

PIN 8 CTS Brought low by the modem when a RF carrier is detected or the receiver buffer memory is full. This can be connected to RTS on the host to inhibit data from the host in duplex operations.

PIN 9 RSSI The relative signal strength indication provides a voltage which is logarithmically proportional to the receiver signal strength.

0V	=	No RF signal strength
0.7V	=	1µV " " "
1.6V	=	10µV " " "
2.4V	=	100µV " " "
2.7V	=	1mv " " "

3.1.2 9 Way D Type Connector RS485

1		+12V		INPUT
	6	CONFIGURATION MODE		INPUT
2		DATA IN	RS485 IN	INPUT
	7	DATA IN	RS485 IN	INPUT
3		DATA OUT	RS485 OUT	OUTPUT
	8	DATA OUT	RS485 OUT	OUTPUT
4		DTR (STANDBY)		INPUT
	9	CD	CARRIER DETECT	OUTPUT
5		0v		INPUT

3.2 LED Indicators

Three LEDS on the front of the modem indicate the following states:

TX	Green	On when modem is transmitting data.
RX	Green	On when a RF carrier of greater than 0.9uV is detected by the modem. This threshold can be adjusted by a potentiometer inside the modem.
POWER	Red	On when power is applied to the modem

4.0 OPERATION

A transmission is started by sending data to RD (pin 2) on the serial port. The radio modem places this data in the transmitter buffer memory while it checks to see if the RF. channel is free. If it is not then the data is stored in the buffer until the channel becomes free. If it is free then a preamble message will be transmitted so that the receiving modems can align to the incoming data.

The modem will then transmit a repeater command byte, if set, and a transmitter address byte followed by the data that has been placed in the buffer memory. The transmission is terminated when a gap of two data bytes is detected in the incoming data stream.

If more data is sent after a gap of two data bytes then the above sequence will be repeated.

When the receiving modem detects the presence of incoming data it takes CTS (pin 8) low. The repeater command byte is decoded and the transmitter address compared to the receiver address. If they are the same or if the global address of 00 is decoded or if the address mode is switched off then the data will be presented at the serial output port TD (pin 3). At the end of the message CTS is taken high.

If the repeater command is decoded or the repeater mode set in the configuration menu then the data will be stored and then re-transmitted.

The best results are obtained from the radio modem by setting the transmission speed to the slow setting and the baud rate to either 4800 or 9600.

5.0 GETTING STARTED

5.1 Basic Connection

TRANSMIT	(TD)	ON HOST TO RECEIVE (RD) ON MODEM PIN 2
RECEIVE	(RD)	ON HOST TO TRANSMIT (TD) ON MODEM PIN 3
GROUND	(0V)	ON HOST TO 0V ON MODEM PIN 5

5.2 Power Connection

PIN 1 = POSITIVE 12V
PIN 5 = NEGATIVE 0V

5.3 Factory Setting

The radio modem is supplied with the following settings

Baud Rate	9600
Parity	OFF
Repeater mode	OFF
Error Correction	OFF
Address Mode	OFF
Transmitter Address	0 0
Receiver Address	0 0
Transmitter Test Mode	OFF
Transmission speed	SLOW (5K bits/sec)
RF Frequency (UK)	458.925MHz
RF Power	500mW

5.4 Plug and Play

Connect three wires to the RS232 serial port of the host terminal (0V, TD and RD) as described above. Connect a regulated 12V, 1Amp power supply to the radio modem. X7202 PC to Modem cables can be used along with a X7201 power supply.

Configure a PC in Microsoft Windows Terminal, Data Talk or any other terminal package with the following settings:

9600 Baud
No Parity
1 Stop Bit
Local Echo
XON/XOFF to OFF
RTS/CTS to OFF (no handshaking)

Connect up a second modem in the same way.

Pressing a key on one PC will transmit the character to the other. Refer to the Section 8.0 Trouble Shooting if this does not happen.

If a second PC is not available simply power up the second modem. Configure the modem connected to the PC in the repeater mode with the address mode switched off. This will command the distant modem to repeat back the characters sent to it.

Fig 1 shows how an open network using the above configuration would work. All the data transmitted from one modem will be received by all of the others. This is similar to an RS485 network but instead of connecting the equipment by wire a radio modem is used.

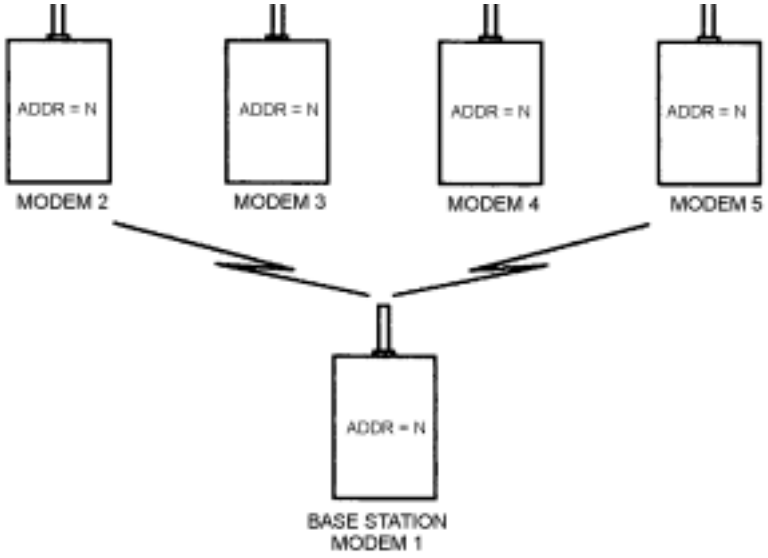

FIGURE 1 OPEN NETWORK

6.0 CONFIGURATION

6.1 Configuration by Hard Wire Link

The modem can be configured by connecting a dumb terminal to the modem with following settings:

9600 Baud
No Parity
1 Stop Bit
Local Echo
XON/XOFF to OFF
RTS/CTS to OFF (no handshaking)

Remove the power from the modem and connect 0v to pin 6 on the modem D Connector. When the power is reconnected the following will appear on the screen:

WARWICK IND ELEC
X7200 MODEM *.*

BAUD	PARY	O/E	REPT	ERR	DDR	TXAD	RXAD	RFC	TXON	FX	?
B	N	O	N	N	N	OO	OO	Q	N	F	Y/N

6.2 Configuration by Terminal Access

If the current configuration is known then the modem can be configured without the use of a link between pin 6 and 0V.

Connect a dumb terminal to the D connector with the same baud rate and parity as that already configured in the modem.
Switch the modem off and then on again.

Press the $ key and then the ESC key. The following will appear on the screen:

WARWICK IND ELEC
X7200 MODEM *.*

BAUD	PARY	O/E	REPT	ERR	DDR	TXAD	RXAD	RFC	TXON	FX	?
B	N	O	N	N	N	OO	OO	Q	N	F	Y/N

To reconfigure the modem type N.
The pointer will then be placed under the baud rate setting.

6.3 Baud Rate Settings BAUD

A baud rate is entered by typing a letter A to E as follows

BAUD RATE	LETTER
19200	A
9600	B
4800	C
2400	D
1200	E

The pointer then moves to the parity setting.

6.4 Parity On/Off parity

If a parity bit is required then type Y.

The parity bit is only used too and from the modem. It is not transmitted by the radio modem. If over air parity is required then set the hosts at both ends to 7 bits plus a parity bit. This will then transmit data plus parity over air.

6.5 Odd or Even Parity O/E

If parity is required either O for Odd or E for Even parity must be entered next. A letter must be entered to proceed to the next setting.

6.6 Repeater Mode REPT

A modem can be set in two different repeater modes by typing Y.

6.6.1 Open Repeater (Echo Back Mode)

Any transmitting modem can command a receiving modem to repeat the data steam. This is done by setting the Repeater Mode but not the Address Mode on the transmitting modem.

The repeater mode on the receiving modem does not have to be set.

Hence data can be automatically echoed back from any distant modem. This can be used to test radio range and data integrity.

FIGURE 2 ECHO BACK MODE (OPEN REPEATER)

6.6.2 Chain Repeaters

If the Repeater Mode is used in conjunction with the Address Mode then a chain of modems can be set up.

Each modem in the chain is given a receiving address and a transmitting address. The transmitting address must be the same as the receiving address of the next modem in the chain. The transmitting address and receiving address on each modem must be different.

	MODEM 1	MODEM 2	MODEM 3	MODEM 4
REC ADD	22	33	22	33
TRANS ADD	33	22	33	22

The repeating modems can be used to send and receive data via their serial ports. Alternatively they can be stand alone units just with power connected to them

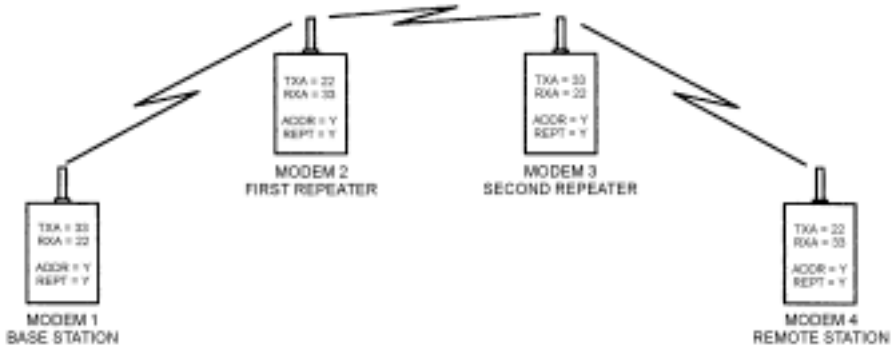

FIGURE 3 REPEATER MODE

6.7 Error Correction Mode ERR

By selecting this option with a Y, a forward error correcting algorithm is brought into operation. Redundant data bits are then inserted in the transmitted data.

If the receiving station also has the option selected, corrupt data will be detected and corrected by means of the redundant bits. If the data is completely incoherent then the ASCII character “CONTL E” (05h) will be loaded into the Rx serial port at the end of the message.

The algorithm has the effect of reducing the data transmission speed by one third but extending the effective range.

6.8 Address Mode ADDR

Typing Y to this option will enable the Address Mode. The modem will transmit its TXAD at the start of each data string. It will not pass receiver data to the serial port unless the transmitter address of the incoming data string coincides with its receiver address RXAD.

The transmitter address 00 is used as a global address. Hence all radio modems in range regardless of its receiver address will pass the data string to its serial port.

An “AT” (Attention) instruction can be sent from the host to change both the receiver address RXAD and the transmitter address TXAD.

6.8.1 Basic Configuration

When the address option is selected, two modems with the following address will pass data to their Hosts.

TXAD Modem 1 = RXAD Modem 2
RXAD Modem 1 = TXAD Modem 2

No other modems in the network will be able to communicate with them. This is useful for high security data is transfer.

6.8.2 Station Addressing

The ATRnn and ATTnn instruction can be used to “dial up” distant modems as shown in fig 4. The base station modern has its receiver address set to 01. The four distant stations, modem 2 to modem 5, have their transmitter address set to 01. Therefore any distant modem can transmit data to the base station but not to each other.

The base station can dial up modem 2 by inserting the following instruction string at the start of the data:

ATT02

In Hexadecimal code this will be:

A	T	T	0	2
41	54	54	30	32

Modem 3 can be dialled up in the same way with the instruction:

ATT03

The instruction string will not be transmitted over the air as long as it is sent to the modem without any breaks.

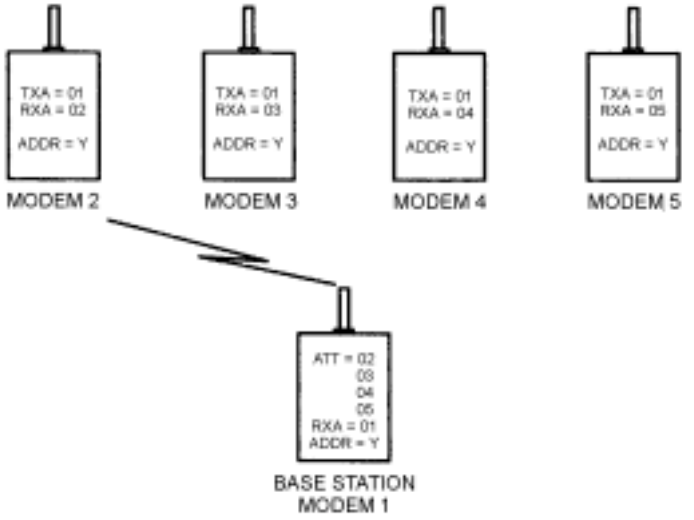

FIGURE 4 STATION ADDRESSING

6.8.3 Global Addressing

The base station can send the same data to all the modems by using the Global Address 00 (Fig 5). The following instruction would be inserted before the data by the base station host:

ATT00

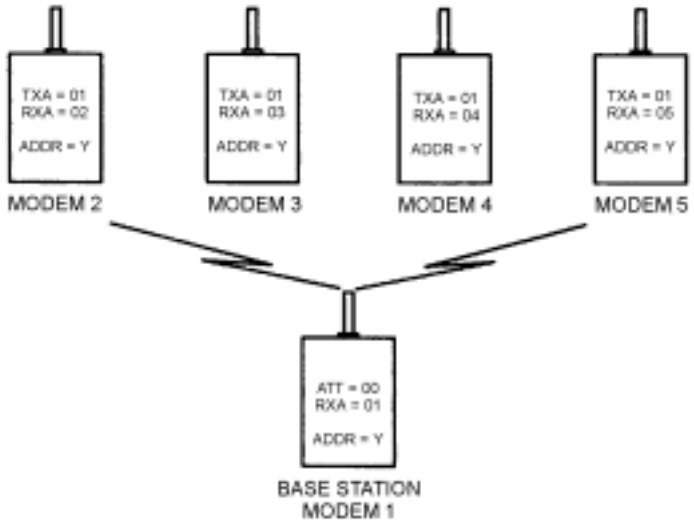

FIGURE 5 GLOBAL ADDRESSING

6.9 RF Channel RFC

One of the 17 RF channels can be set by typing a letter from A to Q as shown in Table 7.1.1. This frequency will be stored in the EEPROM and set every time the modem is switched on.

This function can be disabled by typing $ instead of a letter A to Q. The modem will then use the DIL switches to set the RF frequency. The initial response will be faster when power is applied or when the stand-by mode (DTR) is used. In addition the RF channel can be selected on site without the need for a terminal.

6.10 Transmitter Key TXON

Typing Y to this option will switch on the Transmitter. It will then act as a radio beacon so that any of the following installation and test procedures can be carried out using a RF power meter, the RX LED, the RSSI output or a scanning receiver.

6.10.1 RF Power Output

The power output of the transmitter can be adjusted using the RF power potentiometer and a RF power meter connected to the antenna socket.

6.10.2 ERP and SWR

The Standing Wave Ratio (SWR) of an antenna, and the antenna feeder loses can be measured using a RF Power Meter.

A maximum transmitter power (ERP) of 500mW is allowed for the UK, MPT1329 licence except band. Some of this power is lost in the coaxial cable between the radio modem and the antenna. It is possible to compensate for feeder losses by using a high gain, directional, Yagi antenna. Care must be taken not to transmit more than 500mW therefore the RF power must be reduced to compensate for the gain of the antenna minus the losses of the antenna feeder. The RF power potentiometer can be set so that the ERP does not exceed the legal limit.

6.10.3 Antenna Alignment

If directional yagi antenna are used it is important to aligned them correctly. This can be done using a compass and ordinance survey maps. The alignment can be checked by attaching a radio modem to the yagi antenna feeder, rotating the antenna and measuring the peak signal strength using the RSSI output with a voltmeter connected to it. This will be in the direction of the transmitter beacon.

6.10.4 Site Survey

A site can be surveyed for the best reception conditions using a scanning receiver set to the same RF frequency or observing the RX LED on the radio modem.

A radio modem set in the TXON mode is placed at the base station site. A second radio modem powered from a 12V battery can be moved around the site. If the RX LED remains lit there is sufficient signal for good data reception. The RX LED will go out if the signal becomes too weak.

6.11 Transmission Speed

Transmission speeds can be configured to either 5K Bits/sec or 10K Bits/Sec by typing F for fast or S for slow. This speed is independent of the baud rate. It is recommended that the baud rate and transmission speed should be as close to each other as possible.

F = 10K Bits/Sec
S = 5K Bits/Sec

A transmission rate of 5K bits/sec is recommended if maximum range is required.

7.0 RADIO TRANSMISSION

7.1 Radio Frequency

7.1.1 DIL Switch Settings X7200HP

DIL	RF Frequency	RF Power
0	173.175MHZ	1W
1	173.150MHZ	1W
2	173.125MHZ	1W
3	173.100MHZ	1W
4	173.075MHZ	1W
5	173.050MHZ	1W
6	173.025MHZ	1W
7	173.000MHZ	1W
8	173.175MHZ	5W
9	173.150MHZ	5W
A	173.125MHZ	5W
B	173.100MHZ	5W
C	173.075MHZ	5W
D	173.050MHZ	5W
E	173.025MHZ	5W
F	173.000MHZ	5W

7.3 Radio Propagation

When installing a X7200 Radio Modem there are a number of factors that should be considered as they will affect the performance of the radio link. These are:

Transmitter power output.
Sensitivity of the receiver.
Height of transmitter and receiver antenna.
Length and type of the coaxial feeder cables to the antenna. These should be low loss RU67 type and kept as short as possible. As a rule of thumb the RF power is halved every 10m of antenna feeder. It is better to keep the signal wire long and the antenna feeder short.
Type of Antenna used.
Surrounding Topography.
Interference for other networks operating on the same frequency.
The Weather.

7.4 Antennas

The main types of antenna used in telemetry applications are as follows:

Helical
End Fed Dipole
Yagi

7.4.1 Helical Antenna

The helical stub antenna is robust, low cost and physically small. It has a gain less than unity.

Range of up to 2Km.

7.4.2 End Fed Dipole

The end fed dipole antenna has a unity gain. Its main application is to provide cost effective omni-directional radiation.

Range 10 to 20 Km

7.4.3 Yagi

This antenna has a high gain typically twice (3dB) to ten times (10dB) the input power in the direction of orientation. It is the type of aerial commonly used in domestic televisions.

The output power of a transmitter connected to a Yagi antenna has to be reduced to conform to the DTI specification. This has the advantage of reducing the overall power consumed by the transmitter without effecting the range in the direction of orientation. It also reduces interference from other users.

The receiver signal is also amplified if a Yagi antenna is used thereby extended range in the direction of orientation to around 20 Km line of sight.

8.0 TROUBLE SHOOTING

8.1 No Data Transmission

Check that TD and RD are connected to the 9 way D Connector correctly. This can be checked by using a voltmeter:

a) Connect the Host to the Modem.
b) With no signal present, measure the voltage between:
   0V (Pin 5) and TD (Pin 3)
   0V (Pin 5) and RD (Pin 2)
c) Both should be between -5V to -15V.

If only one is at a negative voltage then the RD and TD connections are reversed.

8.2 No Data Reception

If the RX LED on the receiver is not lighting at the same time as the TX LED on the transmitter then check the RF frequency DIL switches on both modems to see if they are set to the same RF frequency.

If the RX LED is lit when no data is being transmitted then there might be another user on the channel. Select an RF channel on the DIL switches were the RX LED is not lit. Remember to switch the power off and then on again when you make a change in the DIL switch settings to load the new value.

If RX LED is flickering on all RF channels then look for a source of local interference such as a switch mode power supply or a computer in close proximity.

If there are other radio modems or radio telemetry systems operating on adjacent frequencies on the same site then the antenna on your system must be mounted at least 3m away from the antenna of the other systems. This will prevent the transmitter of one system interfering with the receiver of the other.

8.3 Corrupted Data

Corrupted data can be caused by poor power supplies.

Check that the power supply is regulated at 12V and has a ripple of less than 50mV on load. It must also be capable of delivering an inrush current of 0.7Amps for 20mSec. when the radio modem starts its transmit cycle.

The ripple voltage can be measured with a voltmeter set on A.C. volts.

8.4 Radio Path

The radio path can be tested by configuring the transmitting modem to the Repeater Mode.

Exit the configuration menu and transmit a character from the dumb terminal

This will be echoed back from the distant modem if there is a good transmission path.

8.5 HELP LINE NUMBER 01455 233616

9.0 WARNING

Warwick Wireless Limited reserve the right to change the design or specification of the X7200 Radio Modem without notification. In addition Warwick Wireless Limited take no responsibility for the installation and operation of the radio modem.

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