



User Manual

RTcom-Universal, Global Max and Outback Radio Modems

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INTRODUCTION

The RTcom-range of radio modem is intended as a direct replacement for cables over short, medium and long distance, serial data links. They are suitable for part of point-to-point, master to slave or scanning telemetry links, where the modem is either used on its own or in conjunction with existing cables. The modems also operate transparent to many industry standard network protocols, such as Modbus and Eiba Bus and can be used with many manufacturers PLC communication protocols.

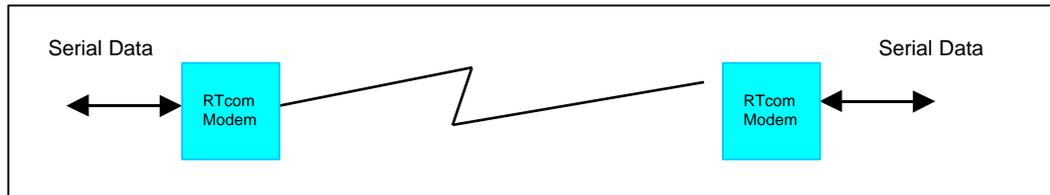
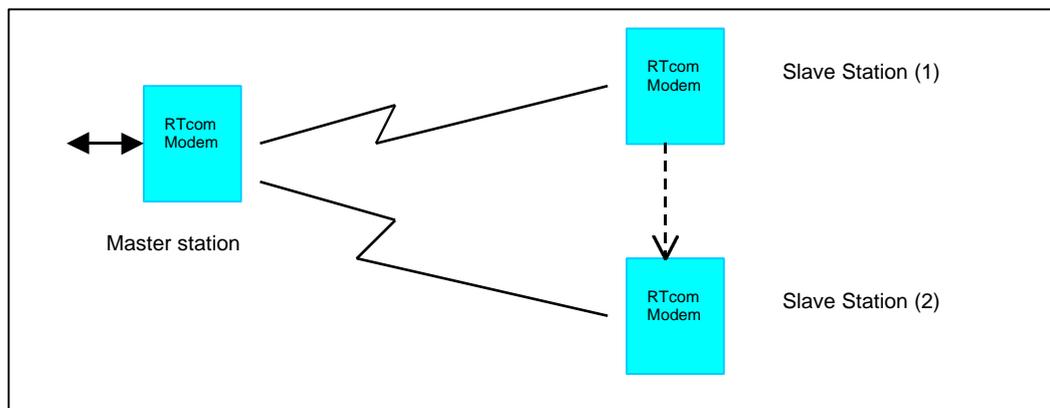


Fig 1: Simple point to point link

The advantages of wire free communication offered by Radio Modems such as Radio-Tech Universal, Global, Europa, Outback and Max are numerous. These include reduced installation cost, the ability to cross-awkward terrain, cross third parties lands, cross-rivers and operate from moving objects.



Polled Master to multiple slave system

Thousands of RTcom radio modems are now in service throughout the world, many operating 24hrs a day, all year round. However, for any radio communications system to be reliable care should be taken in the design of the whole system. Many countries impose restrictions on the frequency, power, channel power and occupied bandwidth of transmissions. Others in addition impose strict test and certification procedures on equipment while others permit a free for all!

In many countries it is quite legal to operate systems without need for operating licences. These countries include the United Kingdom, Australia, New Zealand, Korea, South Africa, Scandinavia and the majority of Europe. However, operation in these countries is normally subject to the equipment first being approved to a defined standard, such as the UK MPT1329 or the European ETS 300-220-1.

Other countries, such as the United States also permit unlicensed transmissions under FCC- Part 15, but both the power and duty cycle limits imposed make modem operation impractical for reliable operation over distance more than a few tens of meters.

Before using your RTcom Radio Modem please ensure that you have purchased the correct version and selected the correct frequency of operation. We have versions with many international approvals ranging from FCC-Part 90 through to Australia Standards and our European versions carry the CE mark. If in doubt please ask your local Radio-Tech Limited agent.

Frequency of operation

Often there is not a choice over operating frequency. In most countries frequency allocations are very limited, by way of example in Europe there is only 433-435MHz UHF or 868-870MHz SHF. While the UK and many others offer VHF, UHF and SHF allocations. However other frequencies may be used subject to local government licence.

In order to generalise the choice of frequency should be based upon the distance of intended operation, power supply constraints, data rate, duty cycle, attenuation, portability (antenna size) and the presence of other users. The following table is produced to assist your choice:-

	VHF (10mW)	UHF (10mW)	UHF (500mW)	SHF (5mW)	SHF (500mW)*
Free Space Transmission range	5-10km	3-5km	10-30km	100-200m	5 - 10km
Industrial installation In large buildings	50-700m	50-500m	50m-1km	10-30m	30-100m
Penetration through concrete walls	*****	****	*****	*	**
Ability to bend/ defract around obstructions	*****	*****	*****	**	**
Antenna size (dipole)	43cm	17cm	17cm	8cm	8cm
Potential users in adjacent channels	Message pagers Radio Microphones	Radio Amateur on 433MHz	Radio Amateurs on 433MHz Message Pages on 458MHz and TETRA on 410-430MHz	CT2 Mobile telephones	CT2 Mobile Telephone s
Transmission efficiency	*****	****	****	***	***
For battery operation	***	****	****	*****	*****
Relative cost	***	****	****	*****	*****

R.F path Surveys

The only certain way of determining the suitability of a communication channel is to conduct a radio path survey and spectrum scan.

The spectrum scan is something normally conducted prior to ordering a system. Normally this requires the use of a good quality scanning receiver such as an ICOM 8500 and a broadband antenna. Failure to use a quality scanner may result in signals being missed if channel resolution is too low and false signals being detected if co-channel and image rejection is poor.

When scanning, both the desired and adjacent channels should be checked for signals. As transmissions may be intermittent it is important to take time with the scan, stopping for as long as possible on each channel and looking for at least 15-minutes on the final chosen band.

If there is doubt over the signal reaching the receiver a path survey should be conducted. The outback modem includes a test mode that places the modems transmitter into constant transmit mode. This permits the measurement of signal strength at the receiver. Normally our modems will work satisfactorily with a signal level below 1uV (-107dBm).

INSTALLATION

Power Supplies:

As with any radio communications system, the RTcom modem should be connected to a clean and stable supply. Switch mode power supplies are rich in RF harmonics and should not be used. Please note that in many cases as CE sticker on a power supply is insufficient protection against potentially damaging harmonics. The reality is that the EMC pass limits are set at only -57dBm (316uV), whereas a radio is quite capable of operation down to an beyond -115 dBm (0.5uV). Hence, a power supply is capable of legally generating harmonics quite capable of blocking the modems operating channel. As a word of warning the frequency of the offending harmonics can shift with both ambient temperature, time and power supply load. Please do not be fooled into thinking that a system fine only to find that later it fails due to blocking from its own power supply. Hence as a rule of thumb we only recommend the use of linear power supplies. Similarly where supply interruption is to be protected against, we recommend the use of float charged (12V or 24V dc) batteries and not switching UPS's.

Location:

For indoor installations we recommend that the modem is located away from sources of heat and electrical apparatus such as inverters. Care has to be taken to minimise cable lengths both with respect to the antenna location and the attached terminal equipment. Generally RS232 should be used for short distance links < 30ft (10m) and RS422 / RS485 for long links of up to 1000ft (300m). In practice the maximum distance achievable will depend upon the combination of the drive capability of both the modem and data terminal.

The IP65 rating of the modem enclosure would to many imply that it could be operated outdoors in all weather conditions. Experience has shown this to be true, but operation can be jeopardised through long term exposure to rain, frost, direct sunlight, chemicals and blown sand. For these reasons we also recommend that where possible the modem should be mounted within a second enclosure of a similar IP rating and where the climate is variable a thermostatically controlled anti-condensation heater used. This practice has been used by our own field service engineers for many years and has proven very successful.

For battery powered operation in cold and damp climates the only reliable way to achieve long term operation is to use double IP65/7 enclosures, with both the outer and inner enclosure fitted with silica gel desiccant sachets.

Please be aware that solar heating and wind chill can take the modem beyond its designed operating temperature range. Further, thermal cycling can encourage moisture ingress due to pressure changes. Whenever necessary please fit your enclosure with wind deflectors and/or sunshades.

Antenna Feeders:

The basic rule of thumb is the longer the cable the greater the loss. Always attempt to keep cable runs to a minimum and whenever possible uses the lowest loss cable available. Both cables and terminations should always be 50-Ohm impedance. Cable bends should no be too tight i.e. the radius of the bend should be greater that 10 x the diameter of the cable.

It is important to remember that coaxial cables have losses proportional to their length and quality.

The following table gives loss figures from typical popular 50-Ohm coaxial cables: -

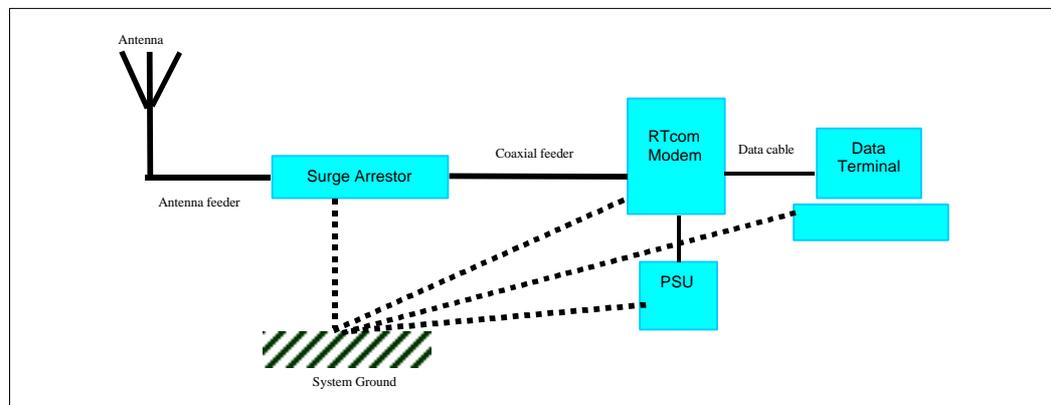
dB Loss per 10m length			
Cable Type	Dia	100MHz	1000MHz
RG58	5.0	2.0	7.6
URM67	10.3	0.68	2.52
URM76	5.0	1.6	5.3

Our modems are normally supplied with N-Type terminations (sockets). Other terminations (BNC or TNC) can be supplied to customer specific orders. Generally we find the N-Type to be the most reliable, robust and readily available connector that can accommodate low loss cables such as URM67.

Lightning Surge Protection:

A direct lightning strike can never be totally protected against or predicted. Currents exceeding 10,000A can flow vaporising antenna, feeders, towers and other such structures. Lightning conductors will give a degree of protection to the building but not always to the electronic apparatus within.

Generally the probability of a direct strike is very small, but a nearby strike with for example a 1km radius can be quite a regular occurrence in many locations. Nearby strikes or "strokes" can lead to the creation of large EM waves that can induce large voltages into antenna, feeders, signal wires and power supplies.



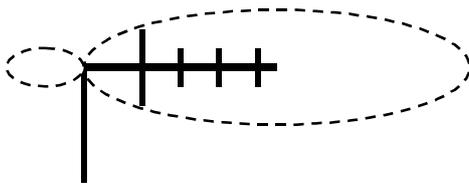
The best form of protection is to use a surge arrester. The arrester is connected in series with the antenna and the modem and is intended to safely limit the induced voltage. However a surge arrester can only be effective the impedance of the cable connecting it to ground is lower or equal to that of the modem and the other connected apparatus and secondly they are all connected to a common Earth point.

Note: Failure to connect the data terminal to the same Earth point compromises the protection of the apparatus. If however is not practical to implement, then a second surge protection device should be connected in series with the data and/or power connections, again bonded to the common Earth point.

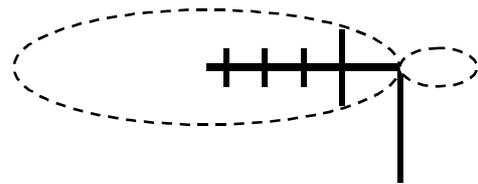
Antenna Installation

The type and location of the antenna used can have a profound effect on your overall system performance and its legality.

In point to point links it is good practice to make efficient use of the radio spectrum by selecting an antenna that will project the R.F energy into the direction of desired operation and similarly at the receiver to collect transmissions only from the location of the transmitter.

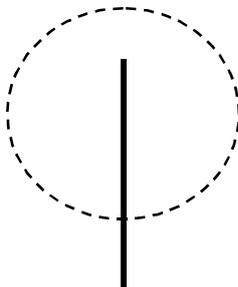


(Directional yagi antenna (vertically polarised))

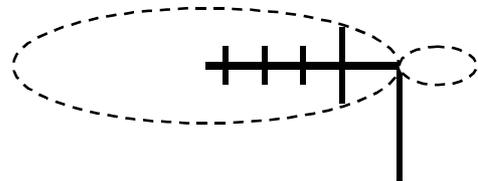


(Directional yagi antenna (vertically polarised))

In polled systems, where there is a central base station, the base station will need an omni-directional antenna. However, the outstations may still employ a directional antenna pointing back to the base station.



(Omni-directional antenna (vertically polarised))



(Directional yagi antenna (vertically polarised))

For mobile systems the only practical choice is to use omni-directional antenna at all stations.

It is very important that all antennas in a system share the same polarisation otherwise losses of up to 30dB may be encountered.

Note: Polarisation can be put to good use when it is desirable to reject an unwanted transmission on the same or a similar frequency.

Warning: The use of gain antenna in some countries is not permitted. Similarly where ERP (transmitted power limits) are imposed the actual transmitted power must not exceed the limit stated. This means that the transmitter output power, less any coaxial feeder losses, plus the antenna gain must not exceed the specified maximum ERP. Before installing your system please check!

Antenna Types

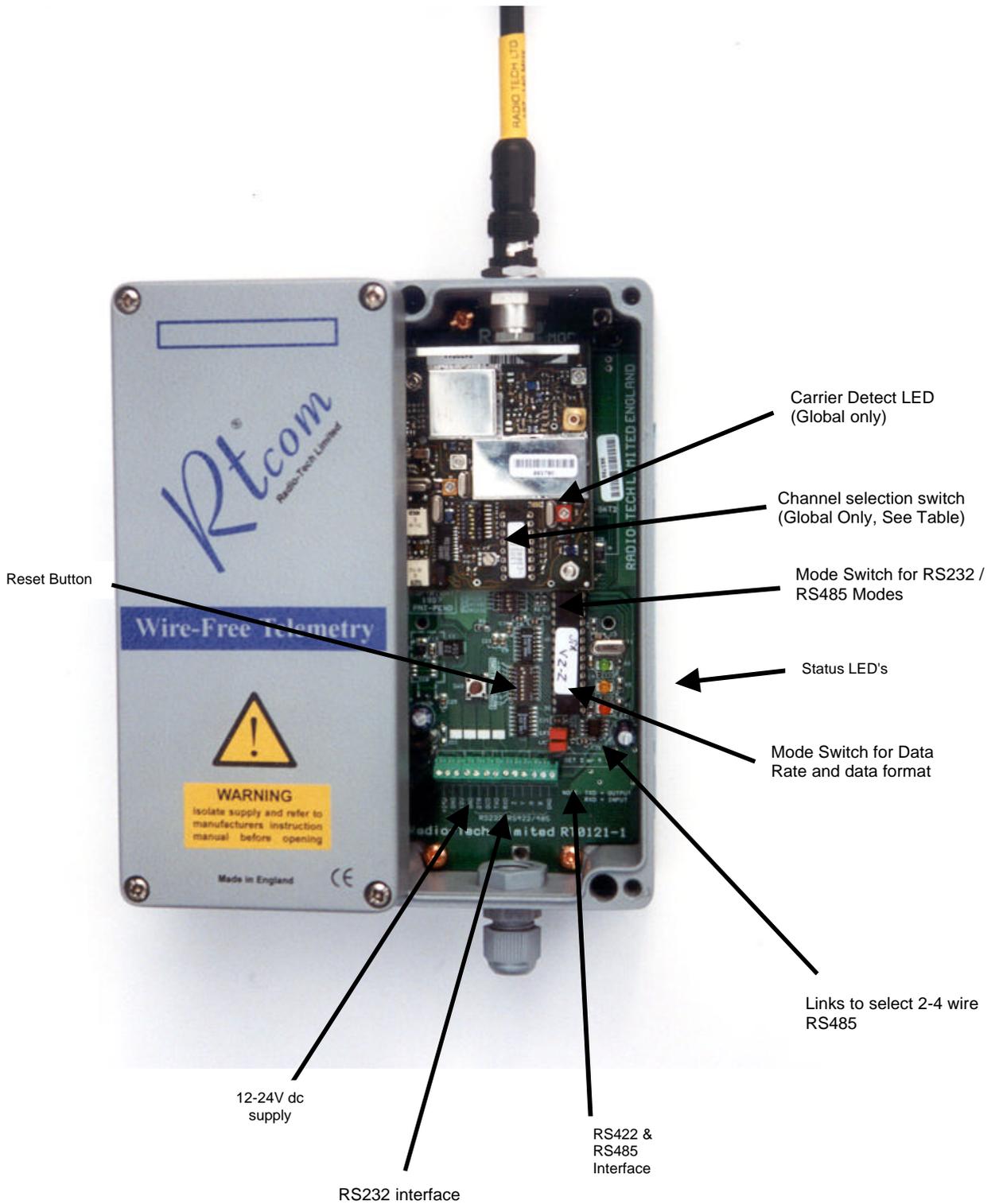
Antenna types fall into a number of categories. For the majority of applications the choice lies between portable, fixed, omni-directional and those with gain and directional properties.

True omni-directional antenna in reality do not exist, i.e. those with equal gain in all directions. However the nearest practical equivalent is the 1/2 or 1/4 wave dipole. The 1/4 wave dipole is by far the most popular of all antennas and is found in use on most portable apparatus. Where the frequency is too low and the dipole can become cumbersome and a compressed dipole (helical) antenna has to be used.

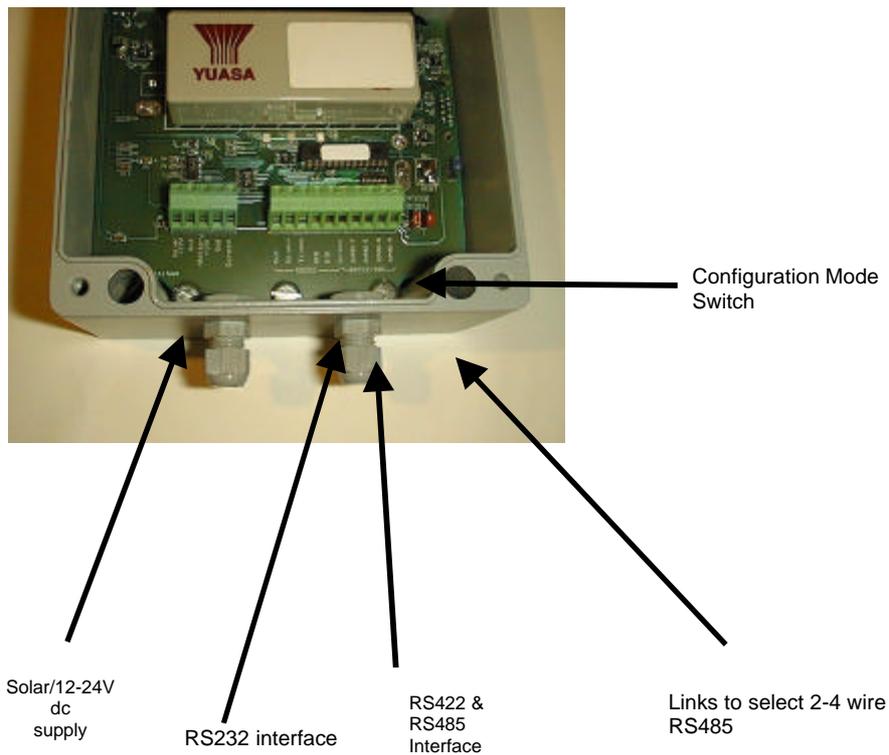
Whatever antenna types you choose please ensure that its impedance is 50 Ohms.

name	Gain and Directional Properties	Comments
1/4 wave dipole	< -0.8dB near omni in the vertical plane only.	For portable apparatus operating above 400MHz Requires a ground plane for operation
Helical	< -4 to -10dB near omni in the vertical plane only.	For portable apparatus < 400MHz Requires a ground plane for operation
1/2 wave dipole	+ 1.2 to + 1.8dB near omni-directional in the vertical plane.	For portable and fixed apparatus looking for a low cost antenna that does not require a ground plane
End fed dipole	0db, near omni in vertical plane	For fixed apparatus that does not require a ground plane
Colinear	+3dB to +9dB , near omni-directional in vertical plane	For fixed apparatus that does not require a ground plane
Yagi	+3dB to +28dB . Beam width proportional to gain	For point to point links. Where an unwanted signal needs to be blocked from the opposite direction choose an antenna with a high front to back ratio

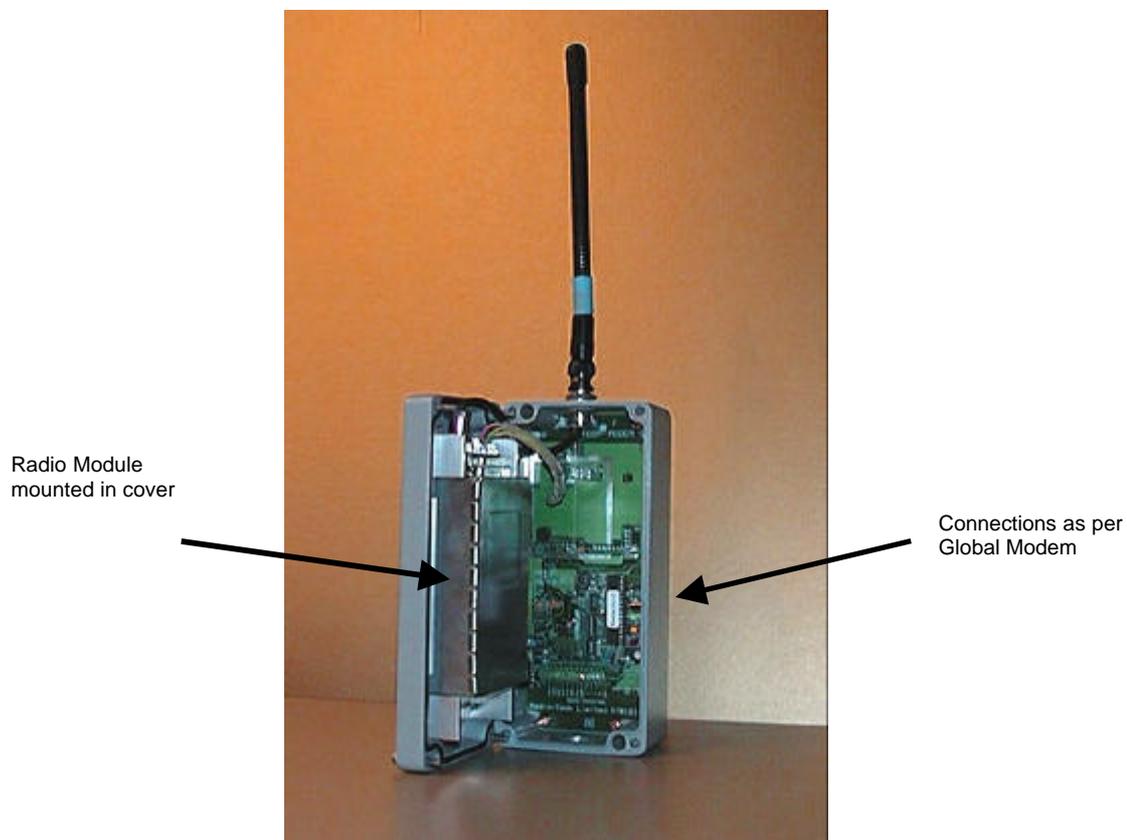
Guide to your RTcom-Global & Max Modem



Guide to your RTcom-Outback



Guide to your RTcom-Max (Please take care when opening cover)



CONNECTIONS

Data connections should always be made using screened cable. This will insure maximum rejection of interference from outside sources. Always use a common ground point.

The RTcom Global, Eurpoa, MAX and Outback modems support RS232, RS422 and RS485 communications, both 2 and 4-wire. The RS232 port should be used for short cable runs of up to 10m and the RS422 and RS485 can be used for over 100m. The modems support various data rates from 1200 to 9600bps depending upon version. All units support 7 and 8-bit ASCII even an odd parity and 1 or 2 stop bits.

Terminal Number	Designation WRT Modem	Notes
1	+24V dc supply	
2	GND	Ground
3	+12V dc supply	
4	GND	Ground
5	DTR**	Optional not normally needed
6	DCD	Optional not normally needed
7	TXD (RS232)	Output data from modem
8	RXD (RS232)	Input data to modem
9	Z = TX (-)	RS485/ RS422
10	Y = TX (+)	"
11	A = RX (+)	"
12	B = (RX(-)	"
13	GND	Ground

Connections for the Global and Max modems

Terminal Number	Designation WRT Modem	Notes
1	+24V dc supply	
2	GND	Ground
3	+12V dc supply	
4	GND	Ground
5	TXD (RS232)	Output data from modem
6	RXD (RS232)	Input data to modem
7	Y TX(+)	RS485/ RS422
8	Z TX(-)	"
9	B RX (-)	"
10	A (RX(+)	"
11	GND	Ground

Connections for the RTcom-Europa Modem

Pin Number	Designation WRT Modem	Notes
1	DCD	Optional not normally needed
2	RX (data)	RS232 input data to modem
3	TX(data)	RS232 output data from modem
4	RTS	Optional not normally needed
5	GND	Ground
6	B RX(-)	RS485/RS422
7	A RX(+)	"
8	+Vs	Supply 7.5 to 15V dc
9	N/C	
10	GND	Ground
11	Z = TX(-)	RS485/RS422
12	Y = TX(+)	"
13	+Vs	Optional supply connection.
14	GND	Optional
15	+ Vs	Optional supply connection

Connections for the Universal & Plastic Housed Global Modem

Note with RS422 & RS485 connections it is the responsibility of the system builder to ensure that the connections are correctly terminated. Normally cables with an impedance > 100 Ohms should be used and terminating resistors (120R bwtween A-B and Z-Y) may aslo be required.

CONFIGURATION:-

Depending upon the model of the modem you will be able to select one of the communication configurations listed below:-

VHF : MPT1328 RTcom-Outback	UHF: MPT1329 RTcom-Outback	VHF/UHF RTcom-Max	UHF: MPT1329 RTcom-Global
1200-2400bps	1200-4800bps	2400 fixed	2400-9600bps
7 & 8 bit ASCII	7 & 8 bit ASCII	7 & 8 bit ASCII	7 & 8 bit ASCII
Even & odd parity	Even & odd parity	Even & odd Parity	Even & odd parity
1 or 2 Stop bits	1 or 2 stop bits	1 or 2 stop bits	1 or 2 stop bits

Operating Modes available with the Global, Max and Outback Modems

On the Global and Max modems two dip switches are provided for the selection of the desired operating mode and two plug links are provided from the selection of 2 or 4 wire RS485 operation. A further DIP switch is provided on the Global modem for frequency Channel selection.

Switch Number	Function
1	Baud Rate (See Table)
2	Baud Rate (See Table)
3	8 or 9 bit data (Off = 8-bit, on = 9-bit) (excluding 1 start and stop bit)
4	Spare
5	Spare
6	Spare
7	Spare
8	Test Mode (Off = Run, on = Test mode)

Data Format Mode switch function SW1

Switch Number	Function
1	Spare
2	Spare
3	On = RS485 / RS422
4	On = RS232

Interface Mode switch SW2

Note: The Europa is fully electronically programmable. Europa users should consult the programming toll on the disk provided with the modem.

Mode SW1,1	Mode SW1,2	Data Rate
Off	Off	2400 bps
On	Off	4800 bps
Off	On	9600bps
On	On	19200bps

Date rate setting table subject to version constraints listed above.

Test mode is provided exclusively to assist installation. Whenever test mode is selected the modem will produce a test transmission to aid both antenna alignment and propagation tests. Effectively the modem transmits a string of data at your desired data rate. This data message usually " Radio-Tech RTcom Modem" can be used during commissioning to prove the link both with respect to the radio and cable paths.

OPERATION

The RTcom protocol permits 100% transparent operation and direct cable emulation. Simply what goes in comes out! R.F. packet framing, code balancing, encryption and preambles etc are taken care of automatically within the modem.

Standard industrial communications protocols such as Modbus include a secure CRC 16 or 32 error check code on data transfers and will probably already be in use over your link, particularly if you are linking PLC's. Rather than duplicate the CRC and risk increasing the overall bit error rate the RTcom protocol leaves your protocol 100% intact and does not add any further error checking and subsequent time delay to your messages.

LED's

Status LED's are provided to aid use. On the Global, Universal and Max, the top, green LED indicates power and the CPU status. If all is well this LED will blink at a regular interval.

The centre amber LED is for received data communications (message received or sent to the data terminal) by cable.

The bottom red LED indicates the transmission of data.

All LED's Blink

If all LED's should blink together this indicates a data configuration error. This is normally caused by the data rate, parity etc being incorrect at the transmitting end. The data configuration error mode is normally triggered by the occurrence of a framing error.

Manual intervention, i.e. changing the dip switches and/or the data terminal will be required. Note both ends of the link must share the same configuration.

Only after pressing and releasing the reset button will the configuration become effective.

COMMISSIONING

The data rate, parity and number of data bits are set using the dual in line switch located above. If a scanner is available the chosen channels and the adjacent channels should be scanned for activity.

With frequency agile products such as the Max and Global a free channel should be selected as far away as possible from the channel/s in use.

The antenna should be positioned and one modem connected and set to test mode. The scanner should be used to measure the received signal strength. If the strength is > 1uv the link will normally work however a "fade margin" of >10dB is preferable.

If a scanner is not available than once the link has been established plug in attenuators may be used to determine the fade margin.

Finally, once the installation is complete it should be tested for conformance the EMC, Health and Safety and Wiring Regulations etc. Exposed joints should be sealed using self-amalgamating tape and screw threads coated with rust proofing compound.

COMMUNICATION PROTOCOLS

RTcom Protocol

The RTcom™ Communication protocol does not make any attempt to correct communication errors. From experience the latency (delay) caused by error correction techniques is prohibitive for the majority of applications. Further the use of a "transmit" buffer imposes a finite file size on the system and hence introduces the need for flow control lines such as DTR. Further, errors can occur in cabling due to induced switching surges, nullifying any error protection on the radio link.

Proprietary Protocols

The majority of our customers use a cable protocol that already employs error checking. This normally comes in the form of a check sum appended to the end of the message. Similarly addressing can be appended to the message giving the destination of the data. Protocols such as Modbus and Eiba Bus handle these functions automatically.

Windows™ TERMINAL.EXE and HYPER TERMINAL.EXE

Windows™ depending upon its version contains terminal (Terminal.EXE or Hyper Terminal.EXE) programs that can be used to transfer files between two platforms. From experience we have found the Windows™ 3.11 version of Terminal.exe to be more reliable than the Windows™ 95 version. The 98 version has however been improved but performance will vary from machine to machine. The problem we believe with these programmes is the low priority placed on communications by the

system. This results in the messages becoming fragmented, thus confusing the modem into thinking the end of file has been detected.

The other common problem, in particular with Windows™ Hyper Terminal, is the way in which it deals with errors. Should an error occur it attempts to re-establish the link from both ends simultaneously, something of course that cannot be supported on a half duplex link.

Windows is a registered Trade Mark of the Microsoft Corporation

In summary, the best communication packages are those specifically written for a specific task. Packages such as Visual Basic can be used to great effect as they give you control over the priorities.

We are able to write customer specific programmes and/or assist you own software engineers.

EMC CONFORMATY

Finished products placed on the market with the EU must be EMC Type Examined. Where applicable the RTcom-Modems have been Type examined in their own right or contain a Type Examined radio transceiver module.

Where applicable a Type Examination/ EMC Declaration of Conformity will be attached to this manual.

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All information is given in good faith. Equipment should not be used where failure could result in loss of life or damage to the environment. No losses can be accepted for errors or omissions contained in this document. It is the responsibility of the user to confirm licensing and other legal issues.

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