



458MHz RF SYNTHESISED TRANSCEIVER

X7000

FEATURES

- MINIATURE SYNTEHSISED MODULE
- DATA RATE UP TO 9600bps
- NO OPERATING LICENCE REQUIRED
- 5 - 500mW OUTPUT POWER
- 10 - 20km RANGE (Direct Line of Sight)
- 1-3km RANGE (Within Buildings)
- 32 RF CHANNELS SET BY 6 DIL SWITCHES OR SERIAL PORT OR BY INCREMENTAL LPULSE
- WIDE Tx VOLTAGE RANGE 8.5 - 14V DC
- TYPE APPROVED TO MPT1329 & ETSI300-220
- FREQUENCY RANGE 458.525 - 458.925MHz
- SIZE 93 X 60 X 17mm
- ANTENNA CONNECTION: MCX



DESCRIPTION

The R.F. Solutions 458MHz FM Transceiver Module is a compact frequency synthesised module capable of transmitting data up to 20 kilometres in direct line of sight, up to 1-3km within buildings. The units are suitable for general purpose telemetry applications where small size and high data rates are needed. The module can transmit digital or analogue (GMSK, or FSK) data at up to 9600baud rate.

The output power and frequency channel is user selectable, to ensure that an open channel may be employed.

Supplied as a completed module, no modification or pre tuning is necessary. Connections to the module are via a 26 way connector on the module base. The transmitter has three data inputs, Digital, Analogue, and direct modulation. Two data outputs are provided one digital and one analogue. The transmitter and receiver sections may be switched independently via external signal lines.

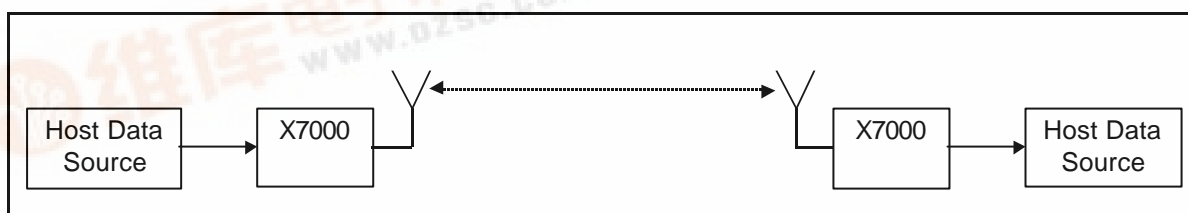
The transmitter section has three data inputs: one for Analogue Data (AIN), one for Digital Data (DIN) and one for Direct Modulation (MIN). Two data outputs are provided from the receiver section, these are: Digital Data Out (DOUT) and Analogue Data Out (AOUT).

The transmitter and receiver can be switched independently by signals (TXON) and (RXON). Additional signals are provided such as relative signal strength indication (RSSI), RF Carrier Direct (CD), Synthesiser Locked (RDY) and Out of Lock (OOL).

The RF frequency can be set in three ways. The 6 DIL switches located at the front of the module set the default RF frequency. This can be incremented or decremented by pulsing the input (FINC) in conjunction with the clock input (FCLK). In addition a Serial Data Stream can be used to set the RF frequency directly and interrogate the status of the radio. Other output signals provided are Relative Signal strength, Carrier Detect, Synthesiser Locked, Out of Lock. The RF output power can be set between 5mW and 500mW by the (RFADJ) signal.

This transceiver requires no licence to operate and is type approved to MPT1329 and ETSI300-220.

TYPICAL OPERATION



Frequency of Operation

The transceiver operate on the 458.500MHz to 458.950MHz telemetry band. There are 32 channels within this band at 12.5KHz or 15 channels at 25KHz bandwidth.

The 5 DIL switches accessed from the top of the module set the RF frequency after power is applied or a RST has occurred. The following frequencies will be set on the standard UK version:

| Ch No (Hex) | Frequency (MHz) | SW5 | SW4 | SW3 | SW2 | SW1 |
|-------------|-----------------|-----|-----|-----|-----|-----|
| 02 | 458.525 | ON | ON | ON | ON | OFF |
| 04 | 458.550 | ON | ON | ON | OFF | ON |
| 06 | 458.575 | ON | ON | ON | OFF | OFF |
| 08 | 458.600 | ON | ON | OFF | ON | ON |
| 0A | 458.625 | ON | ON | OFF | ON | OFF |
| 0C | 458.650 | ON | ON | OFF | OFF | ON |
| 0E | 458.675 | ON | ON | OFF | OFF | OFF |
| 10 | 458.700 | ON | OFF | ON | ON | ON |
| 12 | 458.725 | ON | OFF | ON | ON | OFF |
| 14 | 458.750 | ON | OFF | ON | OFF | ON |
| 16 | 458.775 | ON | OFF | ON | OFF | OFF |
| 18 | 458.800 | ON | OFF | OFF | ON | ON |
| 1A* | 458.825* | ON | OFF | OFF | ON | OFF |
| 1C | 458.850 | ON | OFF | OFF | OFF | ON |
| 1E | 458.875 | ON | OFF | OFF | OFF | OFF |
| 20* | 458.900* | OFF | ON | ON | ON | ON |
| 22 | 458.925 | OFF | ON | ON | ON | OFF |

* Excluded from MPT1329 approval and cannot be used for transmission.

Radio Propagation

With any radio system, there are a number of factors affecting the system performance. These are

- Transmitter power output
- Height of transmitter and receiver antenna
- Length of feeder cables to the antenna
- Type and efficiency of antenna
- Surrounding topography
- The weather

Antennas

The types of antenna we recommend for this Modem are;

Helical : The smallest, most compact antenna, has a gain of 0.5, designed for short ranges up to 2km

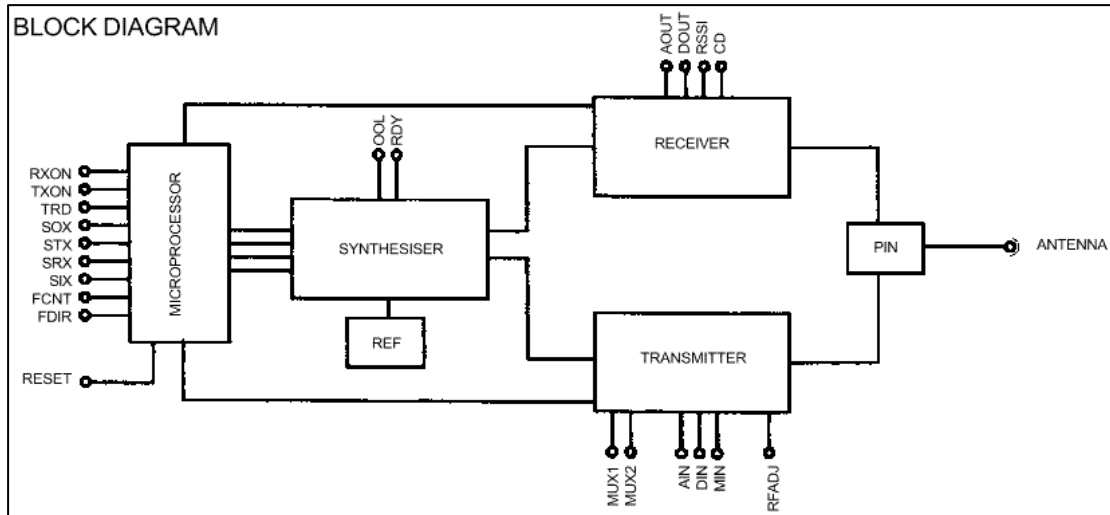
1/4 Wave Flexi : General purpose antenna with gain <1 gives slightly better range than Helical

Yagi : A highly directional antenna (Looks similar to a standard TV aerial). Typically has a gain of >2dB. The output power of a transmitter connected to a Yagi must be reduced in order to comply to the DTI specifications. This does however have the advantage of reducing the power consumed by the transmitter to achieve the same range. By connecting a Yagi to a receiver, the system range may be extended to 20km.

Note : Try to keep the feed wire to the antenna as short as possible, If the antenna is to be mounted some distance away 50Ω low loss co-axial cable should be used as the interconnection.

CONNECTIONS

| Pin | Signal | Direction | Description |
|-------|-----------------------|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | GND | IN | 0V Power Supply |
| 3 | NU | | Not Used |
| 5 | OOL | OUT | Out of Lock Signal. Output set low if synthesiser has not locked within 70mSec of TXON or RXON being applied. |
| 7 | SOX | OUT | Serial status Data Out. Used in conjunction with SRX |
| 9 | STX | OUT | Serial status data; TTL Level 9600baud no parity |
| 11 | SRX | IN | Serial set-up data; TTL Level 9600baud no parity |
| 13 | TXON | IN | Set low to switch on the transmitter |
| 15 | RSSI | OUT | Voltage logarithmically proportional to signal strength 0V=No signal, 0.7V = 0.1mV, 1.6V = 10 mV, 2.4V = 100 mV |
| 17 | DIN | IN | Digital Signal : 100k Ω input impedance DC - 9600bps 2.5V threshold |
| 19 | MIN | IN | Direct Modulation : 10k Ω input impedance DC - 9600bps + / - 3Vpk-pk for full deviation |
| 21 | AOUT | OUT | Receiver Analogue Signal : Bias Voltage = 2.8V Max Deviation = 1.8V pk-pk |
| 23 | NU | | Not Used |
| 25 | DOUT | OUT | Receiver Digital Signal. The ANOUT signal is processed and presented in digital form. |
| 2 | RFADJ | IN | Sets the output Power. Floating input = Max RF Power 0.4 - 0.5V = 5 – 500mW |
| 4 | SIX | OUT | Low when serial status data is present on STX |
| 6 | RST | IN | Held low to reset module |
| 8 | RXON | IN | Set Low to switch the receiver on. Used in conjunction with TXON: TXON RXON FUNCTION Low Low Transmit Low High Transmit High Low Receive High High Power Down |
| 10 | FCNT | IN | High to low transition increments or decrements the RF channel. |
| 12 | FDIR | IN | HIGH sets FCNT to increment channel LOW sets FCNT to decrement channel |
| 14/16 | MUX1/M UX2 | IN | MUX1 and MUX2 connect one of the three data inputs to the transmitter in the following way: MUX1 Mux2 INPUT High High DIN Low High AIN High Low MIN |
| 18 | AIN | IN | Analogue Signal : Maximum deviation at 1Vpk-pk, bandwidth 6Hz to 4KHz, 3K Ω input impedance |
| 20 | RDY | OUT | Set low when synthesiser has locked |
| 22 | TRD | OUT | Set high when in transmit or receive |
| 24 | +VE | IN | Power Supply +ve, regulated 8.5 - 14V supply. |
| 26 | CD | OUT | Carrier Detect; high when an RF signal of sufficient strength is present |
| A | GND | IN | 0 Volts |
| B | +Ve | IN | Power Supply +ve, regulated 8.5 - 14V supply. |



OPERATION

OOL The Out of Lock signal is set low by two radio module if the synthesiser has not locked within 70mSec of ,either TXON or RXON being asserted

SOX The SOX input can be used to send serial commands to the module or pass serial data to the transmitter.

The command character 02H sent to SRX will divert all following serial data to the SOX output. This output can be connected to the DIN digital input hence only one serial port is needed to control the radio module status and transmit serial data over the air.

STX/SRX The STX output and the SRX input can be used to interrogate the X7000 Radio Module via a serial port and set the following parameters.

- RF Channel Change
- Power Down Mode
- Transmit Mode
- Receive Mode
- Initialise Mode
- Status Report

The SRX port receives serial data from an external source and the STX transmits serial data from the X7000 radio module Both operate at half duplex, TTL levels, 9600 baud 8 data bits. 1 stop bit, and no parity. A start bit is defined as a transition from 5V to 0V

Serial Protocol

The X7000 Module is interrogated on the SRX pin by the host sending 05H. The module will send an acknowledge byte from STX of 06H.

The host has 3.6sec to send one Of the following command bytes:

- | | | |
|-----|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 49H | Initialise Channels. | Forces both receive and transmit channels to the channel set on the DIL switches. |
| 4CH | Change Channel. | If this character is sent the module will expect two further bytes of data. The first byte will set the RF transmission frequency The second byte will set the RF receive frequency. The channel bytes are shown in the DIL Switch Table |

| | | |
|------|-----------------|---------------------------------------------------------------------------------------------------------------------|
| 50 H | Power Down Mode | The module will disable the transmitter and receiver thereby reducing the current consumption to approximately 2mA. |
| 54H | Transmit Mode. | Enables the transmitter. Data on DIN, AIN or MIN will be broadcast. |
| 52H | Receiver Mode. | Enables the Receiver. Received data will appear on AOUT and DOUT |
| 53H | Status Report. | Four bytes will be transmitted by the module indicating the current status: |
| | 1st Byte | Acknowledge 53H |
| | 2nd Byte | Transmission channel number |
| | 3rd Byte | Receiver channel number |
| | 4th Byte | Module Status: |
| | | 00H Module powered down |
| | | 02H Receive mode |
| | | 04H Transmit mode |
| | | 22H Receiver synthesiser not locked |
| | | 32H Transmitter synthesiser not locked |

TXON
RSSI

The TXON input is set low to switch on the transmitter stage.
The relative signal strength indication provides a voltage which is logarithmically proportional to the RF signal strength:

- 0.0V = No RF signal strength
- 0.7V = 1µV RF signal strength
- 1.6V = 10µV RF signal strength
- 2.4V = 100µV RF signal strength
- 2.7V = 1mV RF signal strength

DIN

The digital modulation input accepts digital serial data from DC to 10kbps. It has a threshold of 2.5V with an input impedance of 100kΩ.

MIN

The MIN input can be used to directly modulate the transmitter. A 3V p-p signal on a 2.5V bias voltage will produce full deviation of ± 3KHz. There is no filtering on the input therefore care must be taken not to infringe the MPT1 329 specification on adjacent channel power limits. If this input is used the equipment might have to be type approved again.

AOUT

A demodulated analogue signal is presented. A full deviation of +1-3KHz will produce a 1.8Vp-p signal on a 2.8V DC bias.

DOUT

The DOUT output signal is a digitised version of the AOUT analogue signal. The peak and trough limits of AOUT are measured and a midway level is generated. A comparator compares the level with AOUT and the digitised DOUT signal is produced.

When transmitting a long data stream it is important to transmit an equal mark and space ratio if possible. A long stream of either marks (FFH) or spaces (00H) can cause problems. In addition a preamble such as 55H, AA or CCH is required at the start of each data stream so that the midway level can be established before the data is received.

RFADJ

The RF output level can be regulated from this input. An open circuit will produce the maximum output power or 500mW. If 0V is applied to RFADJ then the minimum output power of 5mW will be set.

The RF output power can be adjusted between the maximum and minimum by setting a voltage of between 0.4V to 0.5V. This adjustment will be affected by both component tolerance and temperature.

SIX

The SIX output is set low when data is present on the STX output.

RST The RST input when held low will reset the internal microprocessor.
RXON The RXON input is used in conjunction with the TXON input to switch the module into the receive mode, the transmit mode or the standby mode in the following way:

| TXON | RXON | FUNCTION |
|------|------|------------|
| Low | Low | Transmit |
| High | Low | Receive |
| Low | High | Transmit |
| High | High | Power Down |

FCNT The FCNT input is used in conjunction with the FDIR input to increment or decrement the RF channel by means of an external switch closure. The input has internal switch debounce and a transition from high to low will cause the RF channel to change.

FDIR The FDIR input sets the direction in which the RF channel will change. If FDIR is high then when FCNT is changed from high to low the RF channel will be incremented. If FDIR is low then when FCNT is changed from high to low the RF channel will be decremented.

MUX1/MUX2 MUX1 and MUX2 are used to connect one of the three data inputs to the transmitter in the following way:

| MUX1 | MUX2 | INPUT |
|------|------|-------|
| High | High | DIN |
| Low | High | AIN |
| High | Low | MIN |

AIN The AIN input accepts analogue modulation data. A 1Vp-p signal will cause maximum frequency deviation of +/- 3kHz. The Input has a bandwidth of 6Hz to 5KHz with an input Impedance of 3kΩ.

RDY The RDY output is set low when the synthesiser has locked. In the transmit mode RDY can be used to give an indication that the module is ready to transmit data. If the module is switched on or from the standby mode to the receive mode, RDY can be used to indicate that the receiver is operational.

TRD The TRD output is set high when the module is in the transmit mode or the receive mode

+VE The +VE input is the second of two directly connected supply inputs. A regulated 8.5V to 14V power supply capable of supplying the following current:

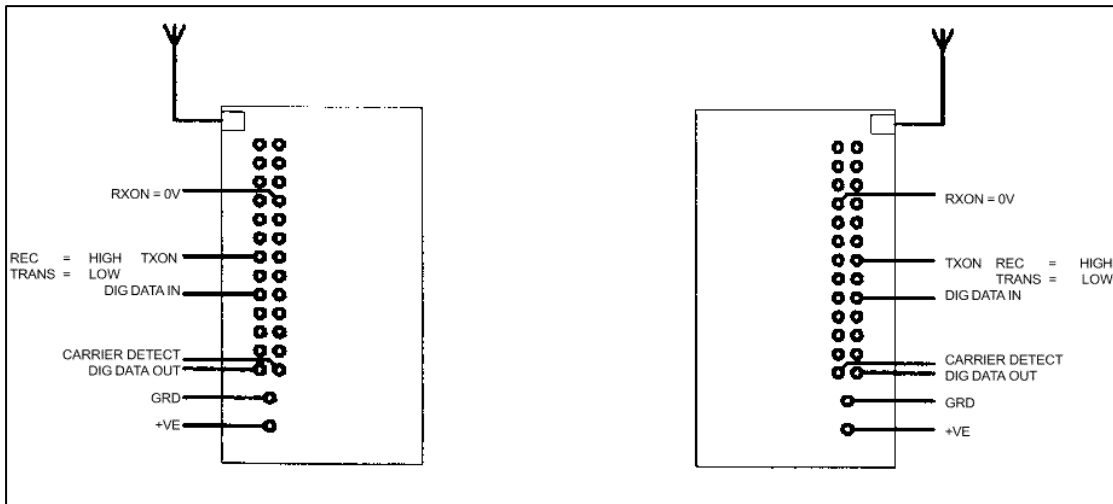
- Transmit Mode 350mA (inrush Current = 700mA for 20msec.)
- Receive Mode 70mA
- Standby Mode 2mA

The power supply should have a ripple voltage of <50mV on load. Some switch mode power supplies can produce RF frequencies which will cause interference to the receiver signal.

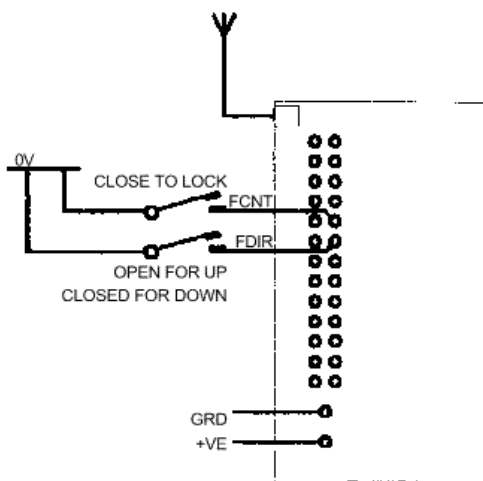
CD The CD output is set high when the receiver detects an RF carrier. The threshold is factory set to 2µV but this can be adjusted to be more or less sensitive by a potentiometer on the underside of the module.

NOTE: All digital inputs are pulled up via 100kΩ resistors. They should not be connected directly to the power rail

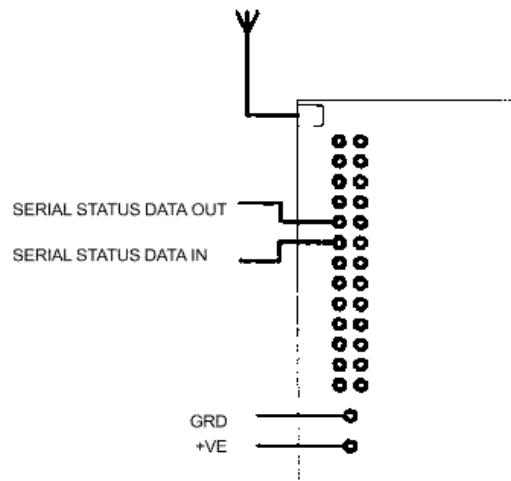
BASIC TRANSCEIVER



SERIAL CONTROL



SWITCH CONTROL



ABSOLUTE MAXIMUM RATINGS

Storage Temperature.....-30 to +85° Celsius.
 Operating Temperature..... -10 to +55° Celsius.

WARNING: Improper antenna load can cause damage to the final stage of the transmitter. Always use a 50Ω impedance antenna.

TECHNICAL SPECIFICATION

Ambient temperature = 25° Celsius.

| ELECTRICAL CHARACTERISTICS | MIN | TYPICAL | MAX | DIMENSION | NOTE |
|----------------------------|---------|---------|---------|-----------|------------------|
| Transmission Frequency | 458.525 | | 458.925 | MHz | UK |
| Transmission Frequency | 400 | | 480 | MHz | World-Wide |
| Weight | | | 30 | grams | |
| Supply Voltage | 8.5 | 12 | 14 | V | |
| Supply Current | | | 5 | mA | Standby Mode |
| Channels | | 17 | | | |
| Channel Separation | 12.5 | 25 | 25 | KHz | |
| Start up Time | 5 | 10 | 30 | mSecs | |
| Modulation | | F3D | | | |
| TRANSMITTER | | | | | |
| RF Power Output | 5 | | 500 | mW | |
| Supply Current | 290 | 320 | 350 | mA | @ 500mW |
| Frequency Deviation | | +/-3 | | KHz | @25KHz Channel |
| Frequency Deviation | | +/-1.5 | | KHz | @12.5KHz Channel |
| Analogue Input (AIN) | | 1 | | Vp-p | + /- 3KHz Dev |
| Digital Input (DIN) | 0 | 5 | 10 | V | DC to 10Kbps |
| Modulation Input (MIN) | | 3 | | Vp-p | + /- 3KHz Dev |
| Modulation Rate | DC | | 10 | Kbps | |
| RECEIVER | | | | | |
| Supply current | 55 | 65 | 70 | mA | |
| Standby mA | 1 | 2 | 3 | mA | |
| IF Frequencies | | 45/455 | | MHz | |
| Sensitivity | | 0.3 | | mV | 10dB SINAD |
| Bandwidth | | +/- 7.5 | | KHz | |
| Analogue Output (AOUT) | 1.8 | | | Vp-p | 2K impedance |
| Digital Output (DOUT) | 0 | 5 | 5 | V | |
| RSSI | 0 | 2.7 | | V | 2.7v = 1mVFS |

Power Supply

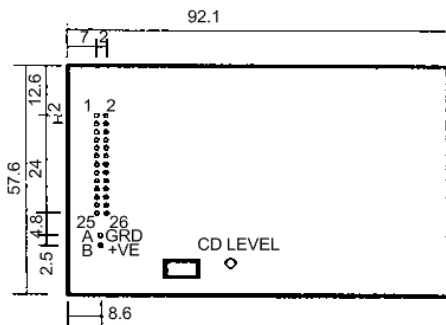
Must be regulated and ripple free. It is not advisable to use a switched mode power supply, either to drive the X7000 Modem or within close proximity to it. Switched mode power supplies can produce high energy radio frequencies over a broad spectrum potentially causing interference with the operation of the Modem.

Note : If the direct modulation input is used (MIN) then the radio and the users modulation circuit must be submitted for MPT1329 type approval.

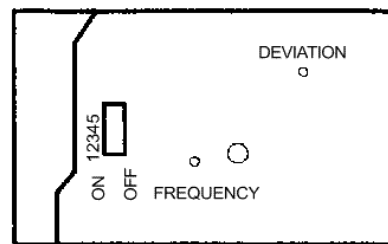
Channel Selection

Channel selection may be effected by either the 5DIL switches, Single step, or via the serial data communication.

MECHANICAL DIMENSIONS



BOTTOM VIEW



TOP VIEW

ORDERING INFORMATION

| PART No | DESCRIPTION |
|---------|--------------------------------|
| X7000 | Synthesised Transceiver 458MHz |

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RF Solutions is a member of the Low Power Radio Association.

