

## MTX3

Issue 1, 26 June 2014

## 868MHz band Narrow Band FM sub-miniature TX

*The MTX3 transmitter module adds a totally new sub-miniature form factor to the existing range of Radiometrix ISM band devices. Using cutting edge integrated RF devices, it offers multi channel, low power narrowband operation in a previously unobtainable size. It is ideally suited to applications where existing wideband modules have insufficient range and where traditional narrowband modules would physically be too big to fit in.*



Figure 1: MTX3-869-10-SAL

### Features

- Conforms to EN 300 220-2 and EN 301 489-3
- High performance Fractional N (Sigma-Delta) Synthesizer with TCXO
- Vibration resistant (negligible microphony)
- Data rates up to 10 kbps for standard module
- Usable range over 500m (with suitable aerials and matching receiver)
- Fully screened. Very low profile
- Feature-rich interface (analogue and digital baseband)
- Re-programmable via RS232 interface
- Low power requirements

### Applications

- Keyfobs and other hand held terminals
- Small form factor data loggers
- Industrial telemetry and telecommand
- In-building environmental monitoring and control
- Covert, high-end security devices
- Unobtrusive fire alarm sensors
- Heavy vehicle/machinery controls

### Technical Summary

- Operating frequency: 869.2125 and 869.2375MHz (Social alarms)  
(Design will cover 850 - 880MHz)
- 915MHz band version available
- Other custom UHF bands
- 850-950MHz version (MTX3) also available
- 4 parallel channels (also fully controllable via serial port)
- Transmit power: +10dBm (10mW)
- Supply range: 3.1 – 15V (will operate down to 2.9V)
- Current consumption: 24mA @ 10mW
- Data bit rate: 10kbps max. (standard module)
- Serial configuration by inverted RS232 at 3V CMOS level
- Size: 23 x 12.5 x 7 mm

**Evaluation platforms:** NBEK + matching carrier board

# MTX3

# Multi-channel narrowband transmitter

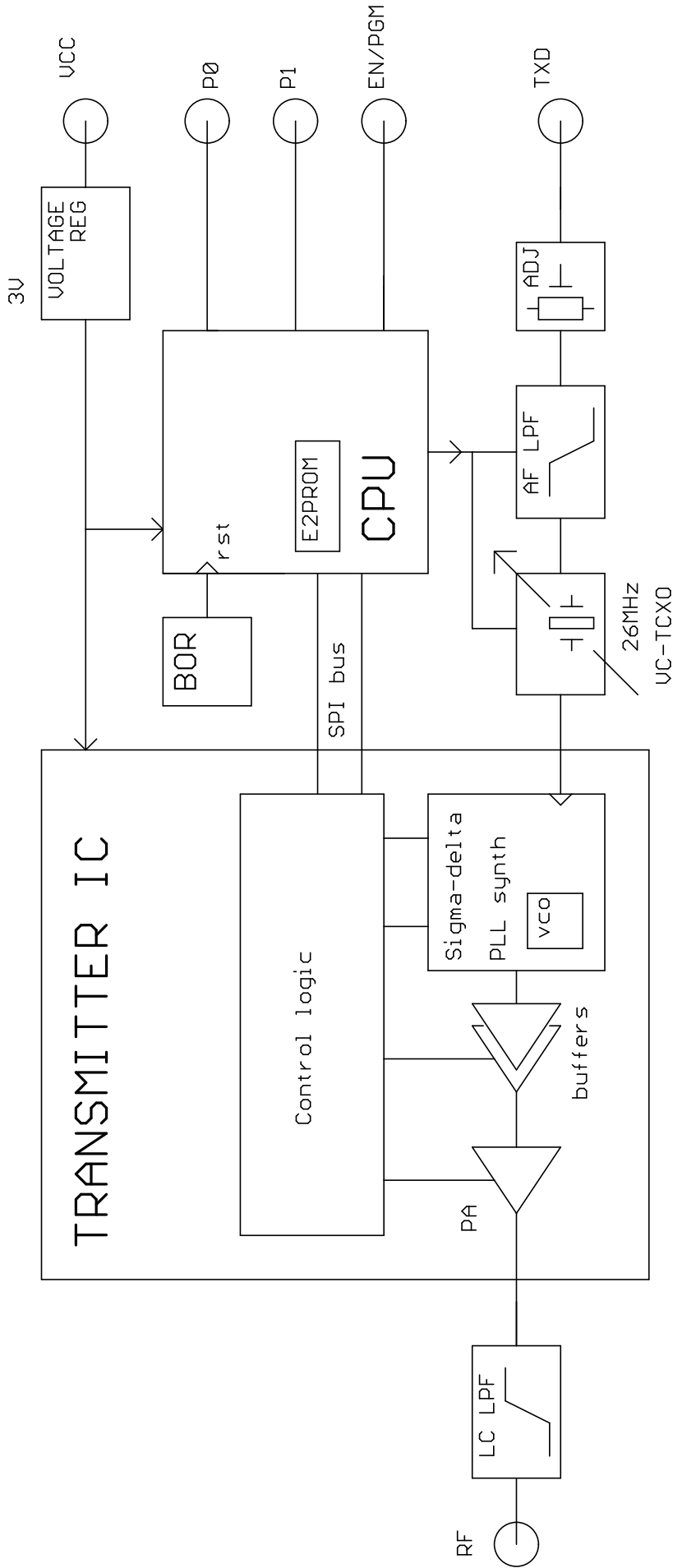


Figure 2: MTX3 block diagram

# Footprint (view from above)

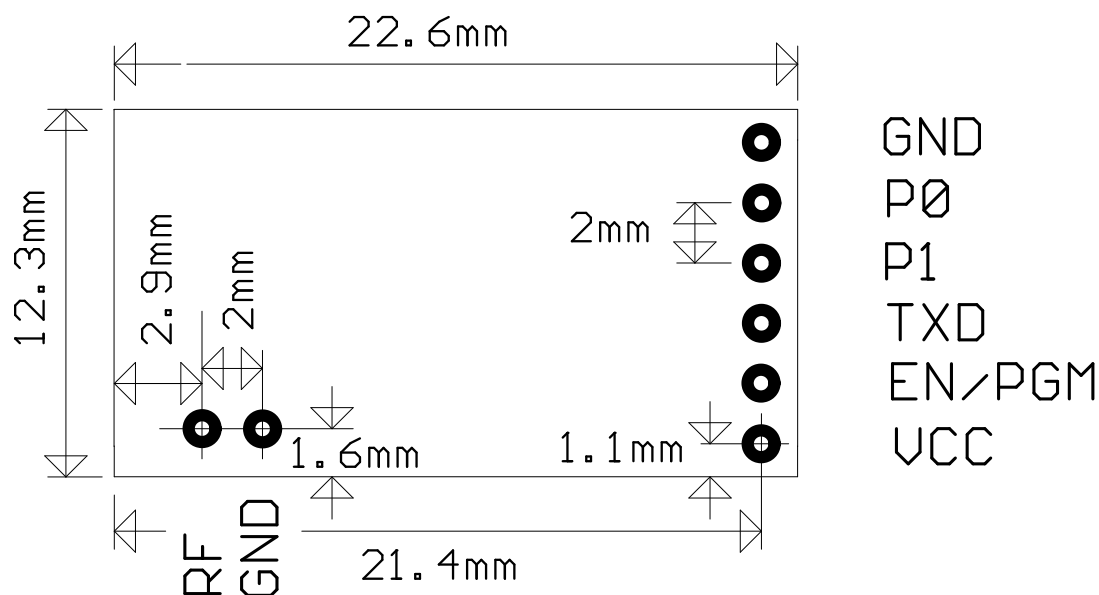


Figure 3: MTX3 footprint (top view)

## Pin description – MTX3

Pin	Name	Function
1	RF	RF output (to antenna)
2	GND	Ground
3	VCC	2.9V – 15V DC power supply (@ 10mW)
4	EN/PGM	Transmit Enable (active high) Serial frequency programming / configuration <sup>1</sup>
5	TXD	DC coupled input for 3V CMOS logic. $R_{in}=47k\Omega$
6	P1	Parallel Channel select
7	P0	Parallel Channel select LSB
8	GND	Ground

### Notes:

1. Serial programming is by the application of a logic level inverted RS232 datastream at 9600 baud to the EN/PGM pin. The unit must be fully enabled (5mS after the rising edge of the EN signal) before a programming burst can be properly decoded.
2. Channel select inputs have pull-ups (50k $\Omega$ ) to 3V internal rail. Do not exceed 3V logic levels on this port. Do not drive pins high when unit is turned off
3. Channel select inputs are active low. If unused, allow them to remain unconnected
4. EN has a 100k $\Omega$  pulldown resistor
5. All pins are on a 2mm grid
6. In the 'off' state there are no transmit state spuri
7. The unit will operate (with marginally reduced specifications and lower (6-8mW) output power) from a 2.9 – 3.0V rail. This must be well regulated and without noise or ripple, as in this state the unit's internal regulator no longer operates, and provides no supply rejection.
8. Switching time as controlled by the EN pin is <5ms, but when power is first applied to the unit there is a 20ms long "calibration" period before the transmitter becomes active

## Condensed specifications

<b>Frequency</b>	Social alarms: 869.2125 and 869.2375MHz (design will cover 850-880MHz) 915MHz band version available
<i>Frequency stability</i>	±1.5kHz
<i>Channel spacing</i>	25kHz, 20KHz
<i>Number of channels</i>	4 channels controlled by parallel port, or 256 sequential, or direct control of PLL device via RS232 interface
Operating temperature	-20 °C to +70 °C (Storage -30 °C to +70 °C)
Spurious radiations	Compliant with ETSI EN 300 220-3 and EN 301 489-3
<b>Transmitter</b>	
Output power	+10dBm (10mW) ±1dB 5mW/7dBm version available
Peak deviation	±3kHz
TX on switching time	5ms from EN transition
Modulation type	FSK (F3D)
TX modulation bandwidth	DC – 5kHz (3V CMOS compatible)
Adjacent channel TX power	<-37dBm
TX spurious	<-45dBm (no RF output in Standby)
<i>Supply</i>	
Voltage	3.1V – 15V (usable down to 2.9v)
Current	24mA @ 10mW (nominal) <3µA standby (EN low or floating)
Inputs	data (CMOS/TTL compatible)
Size	23 x 12.5 x 7mm
Interface	<i>User</i> 6 pin, 2mm pitch header
	<i>RF</i> 2pin 2mm pitch header
Recommended PCB hole size	1mm

# Channel Programming

It is useful at this point to describe how an MTX3 defines its operating frequency:

At the heart of the device is a fractional N synthesizer locked to a high stability VCXO. The minimum step size of this PLL is (approximately) 24.8Hz

The data required by the PLL consists of two coefficients: the integer and the fraction. Output frequency relates to these values thus:

**Output frequency (in MHz) = 13 x (integer + (fraction / 2<sup>19</sup>))**

For correct operation, the component (fraction / 2<sup>19</sup>) must have a value between 1 and 2 (in other words, the "fraction" coefficient varies between 524288 and 1048576) while the value of "integer" is limited by the operating frequency range of the device (850 to 890MHz) so will lie between 64 and 79

So how do you calculate it by hand ?

Take the frequency, divide it by 13

Take the whole number part remaining, **subtract one** from it, and that's "integer"

Take everything right of the decimal point, add one and multiply by 524288, and that's "fraction"

**Example:** 869MHz divide by 13 equals 66.84615384

Subtract one from whole number, i.e. 66 - 1

so "integer" = 65

and fraction = (0.84615384 + 1) x 524288 = 967916

and to confirm: 13 x (65 + (967916/524288)) does indeed equal 869MHz (minus 7.6Hz)

In interface terms, these coefficients are expressed as a 32 bit binary word (eight hexadecimal digits) where the most significant byte comprises the integer value, and the remaining three bytes (24 bits) make up "fraction"

When programming the MTX3, keep in mind that the unit maintains (in RAM) the current values of all programmable values (current frequency, band of operation, RF power and frequency offset adjustments and the sequential table values) and that toggling the EN pin does NOT erase or corrupt them.

These values are only loaded from eeprom at cold start power-up (but not when the EN pin is cycled) or when the unit is commanded to execute eeprom reads by certain serial functions (such as the "@PRG\_00000000" command)

There are no (or very few) "write a value to eeprom" commands. It is usually necessary to load the relevant current operating RAM value(s) and THEN issue a suitable command to write the RAM value to eeprom.

The MTX3 eeprom stores a set of frequency coefficients for each parallel channel plus a fifth set for the sequential table start. It also stores power level, frequency offset, sequential table step size and sequential channel, and the band select constant

Programming a value or coefficient over the serial bus over-writes the previous value and implements this change on the PLL immediately, but does not change the eeprom contents until a relevant "program eeprom" command is issued

In general, the most recent stimulus received by the unit will decide the operating frequency and mode (although if sequential mode has been selected (serial channel not equal to zero) a change to the parallel port or a direct frequency program command will not initiate a frequency change).

## Operation Modes

The MTX3 has three different modes of operation:

**1. Parallel.** By default the MTX3 operates on one of the four channels selected by the parallel input pins. At power up, or when a change of parallel input is detected, the current frequency coefficients are loaded from the eeprom stores corresponding to parallel channels 0-3. The parallel input consists of an inverted 2 bit binary number applied to P0/P1 (often from a 2 pole switch)

**2. Sequential.** If a (sequential) channel is programmed over the serial port, the unit sets it's operating frequency according to this channel number, the programmed table start frequency and the currently programmed table step size. If the channel is set to zero, the unit returns to default parallel operation.

If the (sequential) channel is programmed into eeprom, the unit will default to this channel at power up

The table can be considered to be a 255 entry table, starting at channel 1, with the frequency incrementing by the programmed step size for each increment in channel number (it can be seen that, if a 256 entry table starting with channel zero is desired then programming all the parallel channels to the ch0 frequency, and the sequential table start value to ch1 will achieve this)

**3. Direct.** Whenever a frequency coefficient is programmed into the unit, the frequency will change immediately to this new value regardless of other modes or operation. This is the simplest and most flexible means of controlling the unit.

If a unit is set in sequential table mode (ie: channel value isn't zero), then direct programming cannot be used to over-ride the selected channel (executing an @PRG\_iiffffff will just set up a set of frequency coefficients ready to be written to rom. It won't change the actual operating frequency)

## Serial interface commands

MTX3 serial interface consists of an inverted RS232 datastream (9600 baud, 1+8+1, no parity) applied to the EN pin (the idle state of the interface will turn the transmitter on)

Every command string starts with the phrase "@PRG\_"

The characters in a command string must not be separated by more than 5mS (so typing individual characters on a terminal keyboard will NOT work), but a pause of at least 10mS is required between commands (more following a BURN\_ROM command. In this case a much longer idle period, of 50mS at least, is needed for eeprom programming)

## Frequency setting commands

Commands	Function
@PRG_iiffffff <cr>	sets the current (temporary) frequency  iiffffff is an 8 digit hexadecimal number (4 bytes): ii is the 1 byte "integer" coefficient fffff is the 3 byte "fraction" coefficient
Frequency (in MHz) = 13 x integer + 13 x (fraction/2 <sup>19</sup> ) The component (fraction/2 <sup>19</sup> ) must be in the range 1-2	
@PRG_BURN_CH0 <cr>	write current frequency into channel 0 eeprom
@PRG_BURN_CH1 <cr>	write current frequency into channel 1 eeprom
@PRG_BURN_CH2 <cr>	write current frequency into channel 2 eeprom
@PRG_BURN_CH3 <cr>	write current frequency into channel 3 eeprom
(these functions do NOT program band/power/offset values)	

## Sequential table operations

Commands	Function
@PRG_0001zzzz <cr>	program zzzz as the sequential table step size
@PRG_BURN_CHC <cr>	sets the current frequency coefficients as the sequential table start frequency and programs this, and the step size, into eeprom
@PRG_000000 cc <cr>	set cc as sequential channel number
@PRG_0000FF cc <cr>	set cc as above AND program it into eeprom
@PRG_0000AA nn <cr>	set a maximum channel limit (nn) for the table Setting channel to zero disables sequential table operation

## Serial port on/off commands

Commands	Function
@PRG_POWER 00<cr>	will turn the unit completely off (this command does NOT also zero the power setting variable)
@PRG_POWER FF<cr>	Unit is turned back on (or by cycling the EN pin) If the unit is in "software off" it will still decode valid commands (although an invalid string will be interpreted as an EN pin cycle, and the unit will turn on). The parallel port will also be read, although not acted upon until the unit is re-activated
@PRG_00000000 <cr>	will cause the unit to re-set itself to the values currently stored in eeprom (just like what happens at power-up). This also zeros the stored serial channel and does a parallel channel read

**Note:** The characters in a command string must not be separated by more than 5mS, but a pause of at least 10mS is required between commands (more following a BURN\_ROM command a much longer idle period, of 50mS at least, is needed)

## The complete list of the MTX3 commands

Commands	Function
@PRG_iifffff <cr>	sets the current operating frequency (in RAM) (ii is never zero, fffff is in the range 080000 - 0FFFFFF)
@PRG_0001zzzz <cr>	will program zzzz as the sequential table step size
@PRG_00000000 <cr>	eeprom values to RAM (cold start-up) and channel = 0
@PRG_000000cc <cr>	will set cc as sequential channel number (in RAM)
@PRG_0000FFcc <cr>	will set cc as above AND program it into eeprom
@PRG_0000AAnn <cr>	will set (nn) as maximum channel limit for the table and program it into eeprom
@PRG_BURN_CH0 <cr>	write current frequency into channel 0 eeprom
@PRG_BURN_CH1 <cr>	write current frequency into channel 1 eeprom
@PRG_BURN_CH2 <cr>	write current frequency into channel 2 eeprom
@PRG_BURN_CH3 <cr>	write current frequency into channel 3 eeprom
@PRG_BURN_CHF <cr>	write band, power and offset into eeprom
@PRG_BURN_CHC <cr>	set table start to current frequency AND write both this and the current step size values to eeprom
@PRG_POWER pp <cr>	sets power variable
@PRG_TRIM+ aa <cr>	set a positive frequency trim offset
@PRG_TRIM- aa <cr>	set a negative frequency trim offset
@PRG_BAND# bb <cr>	set band divider code (bb is 08,0A,0B or 0D)
@PRG_POWER 00 <cr>	turn unit off
@PRG_POWER FF <cr>	turn unit back on

## Antenna considerations and options

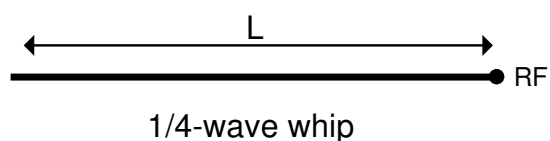
The choice and positioning of transmitter and receiver antennas is of the utmost importance and is the single most significant factor in determining system range. The following notes are intended to assist the user in choosing the most effective arrangement for a given application.

Nearby conducting objects such as a PCB or battery can cause detuning or screening of the antenna which severely reduces efficiency. Ideally the antenna should stick out from the top of the product and be entirely in the clear, however this is often not desirable for practical or ergonomic reasons and a compromise may need to be reached. If an internal antenna must be used, try to keep it away from other metal components and pay particular attention to the “hot” end (i.e. the far end), as this is generally the most susceptible to detuning. The space around the antenna is as important as the antenna itself.

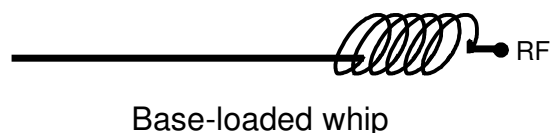
### **Two types of antenna are recommended for use with the MTX3**

**Whip (1/4-wave):** This consists simply of a piece of wire or rod connected to the module at one end. The lengths given below are from module pin to antenna tip including any interconnecting wire or tracking (but not including any 50Ω coax or microstrip connection). This antenna is simple, cheap, easy to set up and performs well. It is especially effective when used with a ground plane, which in practice is often provided by the main PCB or by a metal case.

**Base-loaded whip:** In applications where space is at a premium a shortened whip may be used, tuned by means of a coil inserted at the base. This coil may be air-wound for maximum efficiency, or a small SMT inductor can be used. The value must be empirically chosen to tune the particular length of whip for best results “in situ”, making this antenna more difficult to set up. Radiated power will generally be slightly less than that obtained from a 1/4-wave whip.



wire, rod, PCB track  
or a combination of these  
 $L \text{ (mm)} = 71250 / \text{freq(MHz)}$



shortened wire, rod, PCB track etc.  
with loading coil.  
SMT inductor may be used if reqd.

Fig. 4: Antenna configurations

Other types of antennas are feasible but tend to have drawbacks at these frequencies. Helical and tuned loop antennas are both very compact but tricky to set up, and can be impractical at 868MHz because of their very small size. Microstrip patch antennas are relatively large in area, directional, and have gain.

**Note:** Where the specified antennas are mounted on the PCB and/or in close proximity to metalwork (module casing, components, PCB tracking etc), the antenna radiation pattern may be seriously affected. Radiated power may be significantly increased in some directions (sometimes by as much as 10dB) and correspondingly reduced in others. This may adversely affect system performance where good all-round coverage is desired.

Care should also be taken to ensure that this effect does not increase the radiated power in any direction beyond that allowed by type approval regulations. Where this occurs the antenna may need to be relocated. In extreme cases a resistive attenuator of appropriate value may be required between the module and antenna.



## Ordering Information

Standard frequency setup for 4 channel MTX3 radios uses these default channels:

Part no.	Frequency
MTX3-869-10-SAL	CH0: 869.2125, CH1-3: 869.2375MHz (for Social Alarm use)
MTX3-869-10	868 – 870 MHz
MTX3-869-10-5mW	868 – 870 MHz (with 5mW RF power)

Alternatively, the MTX3 can be supplied as a single frequency module with factory set channel (like the NTX3B or similar unit). In this case all channels are supplied programmed to the same frequency.

Part no.	Frequency
MTX3-869.2125-10	CH0 - 3: 869.2125MHz
MTX3-869.2375-10	CH0 - 3: 869.2375MHz

**Note:** Also available on the other UHF band frequencies, including 915MHz or 433 (MTX2)

### Matching COR3 receiver

Part no.	Frequency	Module mounting	Pins
COR3-869-5-SAL	CH0: 869.2125, CH1-3: 869.2375MHz	Vertical Mounting, Parallel pins	RF, RFGND, RSSI, GND, VCC, AF, RXD, P0/PGM
COR3-869-5-SAL-H	CH0: 869.2125, CH1-3: 869.2375MHz	Horizontal Mounting, Perpendicular pins	RF, RFGND, RSSI, GND, VCC, AF, RXD, P0/PGM
COR3-869-5	868-870MHz	Vertical Mounting, Parallel pins	RF, RFGND, RSSI, GND, VCC, AF, RXD, P3, P2, P1, P0/PGM

**Radiometrix Ltd**  
**Hartcran House**  
**231 Kenton Lane**  
**Harrow, Middlesex**  
**HA3 8RP**  
**ENGLAND**  
**Tel: +44 (0) 20 8909 9595**  
**Fax: +44 (0) 20 8909 2233**  
**sales@radiometrix.com**  
**www.radiometrix.com**

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The Intrastat commodity code for all our modules is: 8542 6000.

**R&TTE Directive**

After 7 April 2001 the manufacturer can only place finished product on the market under the provisions of the R&TTE Directive. Equipment within the scope of the R&TTE Directive may demonstrate compliance to the essential requirements specified in Article 3 of the Directive, as appropriate to the particular equipment.

Further details are available on The Office of Communications (Ofcom) web site:

**<http://www.ofcom.org.uk/radiocomms/ifi/>**

*Information Requests*

*Ofcom*

*Riverside House*

*2a Southwark Bridge Road*

*London SE1 9HA*

*Tel: +44 (0)845 456 3000 or 020 7981 3040*

*Fax: +44 (0)20 7783 4033*

*information.requests@ofcom.org.uk*

*European Radiocommunications Office (ERO)*

*Peblingehus*

*Nansensgade 19*

*DK 1366 Copenhagen*

*Tel. +45 33896300*

*Fax +45 33896330*

*ero@ero.dk*

*www.ero.dk*

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