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MTX2

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UHF Narrow Band FM sub-miniature transmitter

The MTX2 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: MTX2-434.650-10

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: 433.875-434.650MHz (EU band)
                              458.525 - 459.1MHz (UK band)
- 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: 20mA @ 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
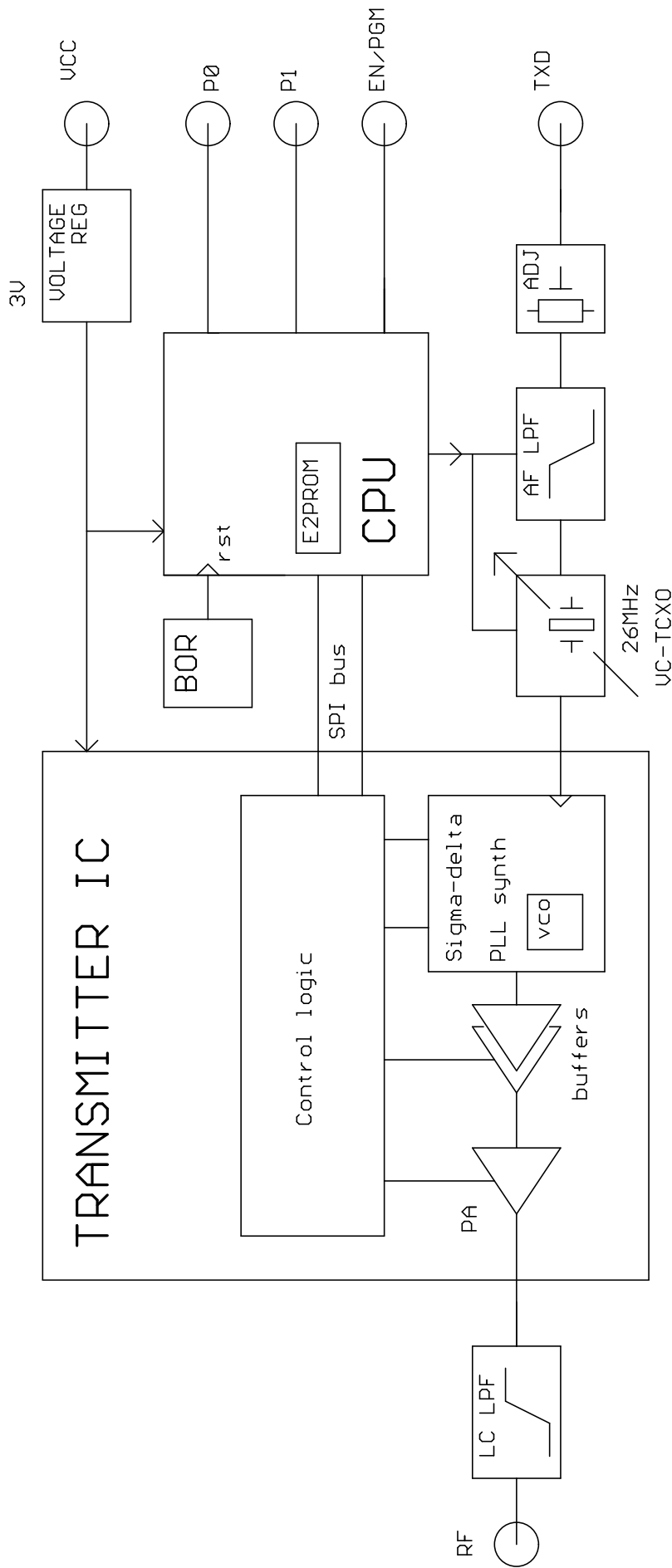
MTX2   Multi-channel narrowband transmitter

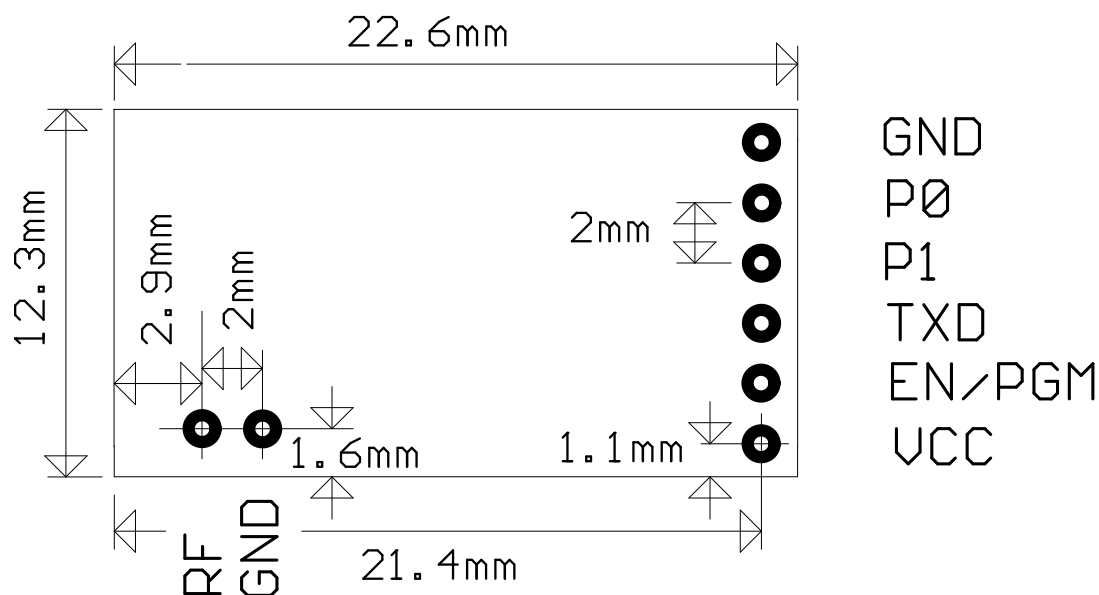Figure 2: MTX2 block diagram

Footprint (view from above)

Figure 3: MTX2 footpint (top view)

Pin description – MTX2

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[1]
5	TXD	DC coupled input for 3V CMOS logic. R_{in}=47kΩ
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 (50kΩ) 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 100kΩ pulldown resistor
5. All pins are on a 2mm grid
6. In the 'off' state there are no transmit state spurii
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
9. 25mW version uses 3v3 internal rail (not 3v0), but is otherwise identical

Condensed specifications

Frequency	433MHz EU band, and 458MHz UK band Other custom UHF bands
Frequency stability	±1.5kHz
Channel spacing	25kHz, 20KHz or 12.5KHz (to order)
Number of channels	4 channels controlled by parallel port, or 256 sequential, or direct control of PLL device via RS232 interface
Operating temperature	-20 ºC to +70 ºC (Storage -30 ºC to +70 ºC)
Spurious radiations	Compliant with ETSI EN 300 220-3 and EN 301 489-3
Transmitter	
Output power	+10dBm (10mW) ±1dB +14dBm (25mW) 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)
Supply	
Voltage	3.1V – 15V (usable down to 2.9v)
Current	20mA @ 10mW (nominal) <3µA standby (EN low or floating)
Inputs	data (CMOS/TTL compatible)
Size	23 x 12.5 x 7mm
Interface User	6 pin, 2mm pitch header
RF	2pin 2mm pitch header
Recommended PCB hole size	1mm

Channel Programming

It is useful at this point to describe how an MTX2 defines it's 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) 12.4Hz

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) = 6.5 x (integer + (fraction / 2^19))

For correct operation, the component (fraction / 2^19) 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 (422.5 to 525MHz) so will lie between 64 and 79

So how do you calculate it by hand ?

Take the frequency, divide it by 6.5

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: 430MHz divide by 6.5 equals 66.15384615

so "integer" = 65

and fraction = (0.15384615 +1) x 524288 = 604948

and to confirm: 6.5 x (65+(604948/524288)) does indeed equal 430MHz (plus 3.9Hz)

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 MTX2, 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 MTX2 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 MTX2 has three different modes of operation:

1. Parallel. By default the MTX2 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

MTX2 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 ffffff is the 3 byte "fraction" coefficient
Frequency (in MHz) = 6.5 x integer + 6.5 x (fraction/2^19) The component (fraction/2^19) 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 MTX2 commands

Commands	Function
@PRG_iiffffff <cr>	sets the current operating frequency (in RAM) (ii is never zero, ffffff is in the range 080000 - 0FFFFF)
@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 O8,0A,0B or 0D)
@PRG_POWER 00 <cr>	turn unit off
@PRG_POWER FF <cr>	turn unit back on

Antenna requirements

Three types of integral antenna are recommended and approved for use with the module:

A) **Whip**   This is a wire, rod ,PCB track or combination connected directly to RF pin of the module. Optimum total length is 16.4cm (1/4 wave @ 433MHz). Keep the open circuit (hot) end well away from metal components to prevent serious de-tuning. Whips are ground plane sensitive and will benefit from internal 1/4 wave earthed radial(s) if the product is small and plastic cased

B) **Helical**   Wire coil, connected directly to RF pin, open circuit at other end. This antenna is very efficient given it's small size (20mm x 4mm dia.). The helical is a high Q antenna, trim the wire length or expand the coil for optimum results. The helical de-tunes badly with proximity to other conductive objects.

C) **Loop**   A loop of PCB track tuned by a fixed or variable capacitor to ground at the 'hot' end and fed from RF pin at a point 20% from the ground end. Loops have high immunity to proximity de-tuning.

Feature	A	B	C
	whip	*helical*	*loop*
Ultimate performance	***	**	*
Easy of design set-up	***	**	*
Size	*	***	**
Immunity proximity effects	*	**	***
Range open ground to similar antenna	500m	200	100

The antenna choice and position directly controls the system range. Keep it clear of other metal in the system, particularly the 'hot' end. The best position by far, is sticking out the top of the product. This is often not desirable for practical/ergonomic reasons thus a compromise may need to be reached. If an internal antenna must be used, try to keep it away from other metal components, particularly large ones like transformers, batteries and PCB tracks/earth plane. The space around the antenna is as important as the antenna itself.
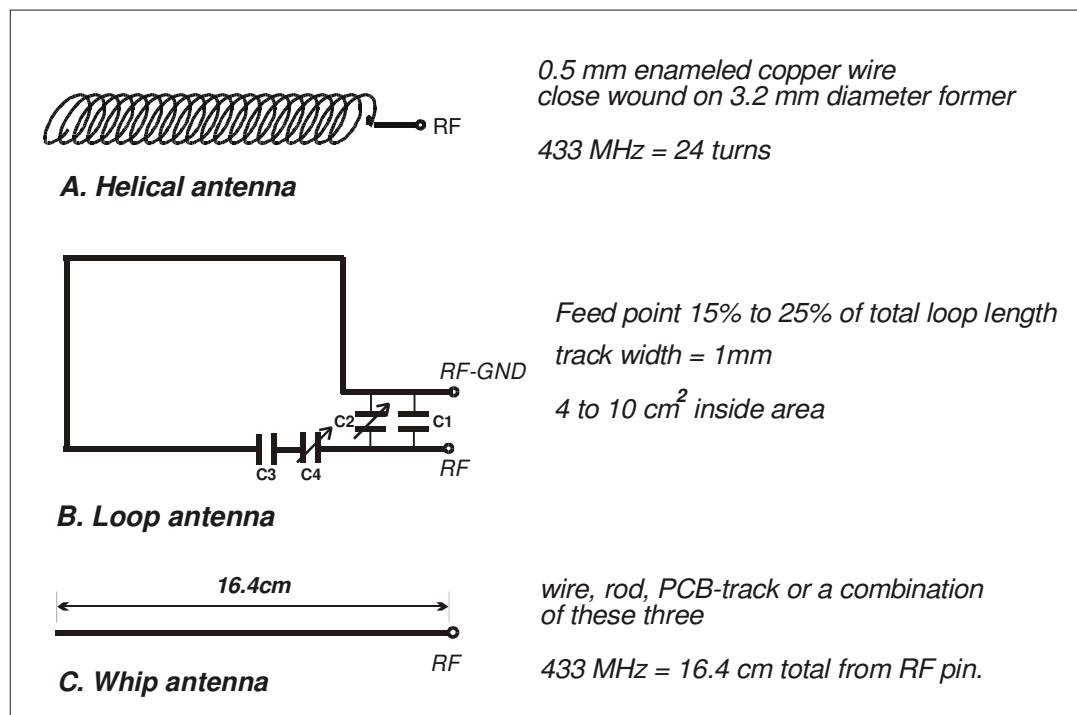

0.5 mm enameled copper wire
close wound on 3.2 mm diameter former

433 MHz = 24 turns

A. Helical antenna

Feed point 15% to 25% of total loop length

track width = 1mm

4 to 10 cm^2 inside area

B. Loop antenna

wire, rod, PCB-track or a combination of these three

433 MHz = 16.4 cm total from RF pin.

C. Whip antenna

Figure 7: Antenna types

Ordering Information

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

Part no.	Frequency
MTX2-433-10	CH0: 434.650, CH1: 434.075, CH2: 434.500, CH3: 434.275MHz
MTX2-458-10	CH0: 458.700, CH1: 458.525, CH2: 458.600, CH3: 458.750MHz
MTX3-869-10-SAL	CH0: 869.2125, CH1-3: 869.2375MHz (for Social Alarm use)

Alternatively, the MTX2 can be supplied as a single frequency module with factory set channel (like the NTX2B or similar unit). In this case all channels are supplied programmed to the same frequency.

Part no.	Frequency
MTX2-434.650-10	CH0 - 3: 434.650MHz
MTX2-434.075-10	CH0 - 3: 434.075MHz
MTX2-458.700-10	CH0 - 3: 458.700MHz

Note: Also available on the other UHF band frequencies, including 869 or 915MHz (MTX3).

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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/***

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