

## NTX2 / NRX2

Issue 1, 30 July 2012

## UHF Narrow Band FM TX & RX

**The NTX2 transmitter and NRX2 receiver offer a low power, reliable data link in a Radiometrix SIL standard pin out and foot print. This makes the NTX2/NRX2 pair ideally suited to those low power applications where existing single frequency wideband UHF modules have insufficient range. NTX2 HP (25mW) variant can be used in applications where greater radiated power is desired (for example when space limitations dictate the use of small and inefficient antenna, or in countries where the extra power is permitted)**



Figure 1: NRX2-434.650-10

NTX2-434.650-10

### Features

- Conforms to ETSI EN 300 220-3 (radio) and EN 301 489-3 (EMC)
- Standard frequencies: 434.075MHz, 434.650MHz and 458.700MHz
- Custom frequencies available in 433MHz (EU) and 458MHz (UK) band
- Data rates up to 10kbps
- Usable range over 500m
- 25kHz Channel spacing
- Longer range compared to Wide Band FM modules

Available for licence-exempt operation in the 433MHz (EU) and 458MHz (UK) bands, the NTX2 & NRX2 modules combine effective screening with internal filtering to minimise spurious radiation and susceptibility thereby ensuring EMC compliance. They can be used in existing low data rate (<10kbps) applications where the operating range of the system using TX2 transmitter and RX2 receiver need to be extended. They are particularly suitable for point-to-point and point-to-multipoint wireless links where longer ranges are required at low data rates.

### Technical Summary

#### Transmitter – NTX2

- 3 stage crystal controlled VCXO
- Supply 2.9V - 15V @ 18mA (internal 2.8V voltage regulator)
- Data bit rate: 10kbps max.
- Transmit power: +10dBm (10mW) or +14dBm (25mW HP variant)

#### Receiver – NRX2

- Double conversion FM superhet
- SAW band pass filter, image rejection: 50dB
- Intermediate Frequencies (IF): 21.4MHz, 455kHz
- Supply range: 2.9V - 15V @ 14mA (internal 2.8V voltage regulator)
- Data bit rate: 10kbps max.
- Receiver sensitivity: -118dBm (for 12dB SINAD) / -112dBm (for 1ppm BER)
- Local Oscillator (LO) re-radiation: <-60dBm
- Adjacent Channel: -70dBm
- Blocking: -84dB

**Evaluation platforms:** NBEK + SIL carrier

## Functional description

The NTX2 transmitter consists of a Frequency Modulated (FM) Voltage Controlled Crystal Oscillator (VCXO) feeding a frequency multiplier with two stage amplifier and RF filter. Operation can be controlled by the EN (Enable) line, the transmitter achieving full RF output typically within 5ms of this line being pulled high. The RF output is filtered to ensure compliance with the appropriate radio regulations and fed to the 50Ω antenna pin.

The NRX2 module is a double conversion NBFM superhet receiver capable of handling data rates of up to 10kbps. It will operate from a supply of 2.9V to 15V and draws 14mA when receiving. A signal strength (RSSI) output with greater than 60dB of range is provided. The SIL style NRX2 measures 47 x 17 x 8 mm excluding the pins.

## NTX2 Transmitter

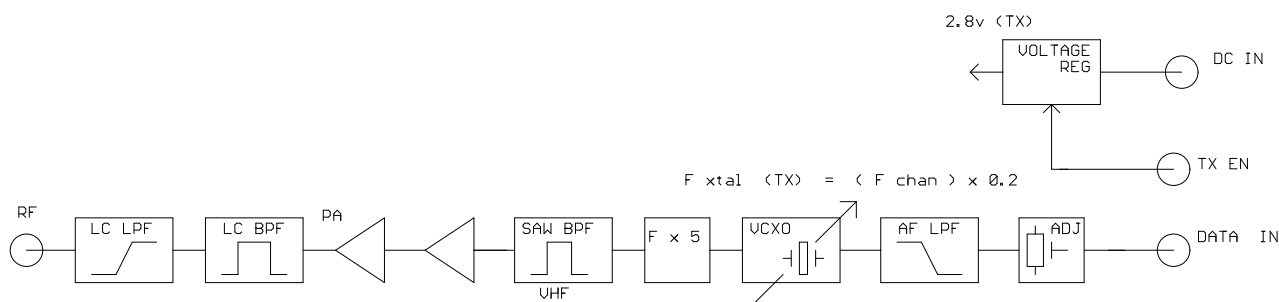


Figure 2: NTX2 block diagram

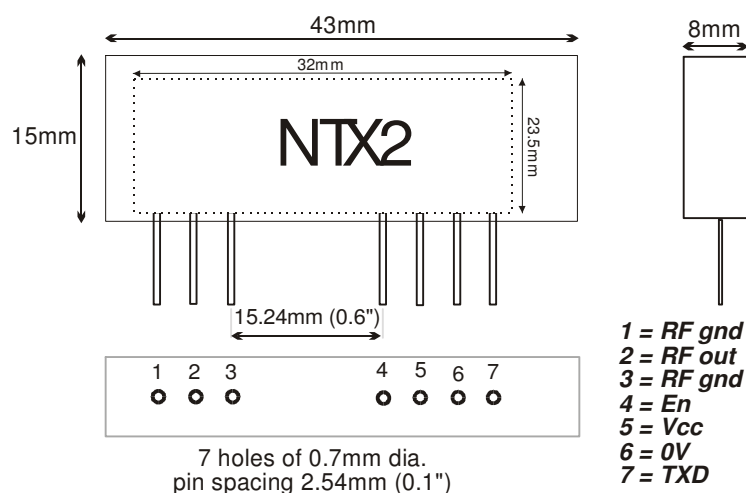


Figure 3: NTX2 pin-out and dimension

## User interface

| NTX2 pin | Name   | Function                                                                                                                                                                           |
|----------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1, 3     | RF gnd | RF ground is internally connected to the module screen and pin 6 (0V). These pins should be directly connected to the RF return path - e.g. coax braid, main PCB ground plane etc. |
| 2        | RF out | 50Ω RF output to the antenna                                                                                                                                                       |
| 4        | EN     | Pull high to enable Transmitter (3V CMOS logic)                                                                                                                                    |
| 5        | Vcc    | 2.9 – 15V DC power supply                                                                                                                                                          |
| 6        | 0V     | Ground                                                                                                                                                                             |
| 7        | TXD    | DC coupled input for 3V CMOS logic. $R_{in} = 100k\Omega$                                                                                                                          |

### Notes:

1. EN pin should not be left floating
2. Pinout footprint is as TX1H.
3. Compatible with RX2M, RLC2 and NRX2

## NRX2 receiver

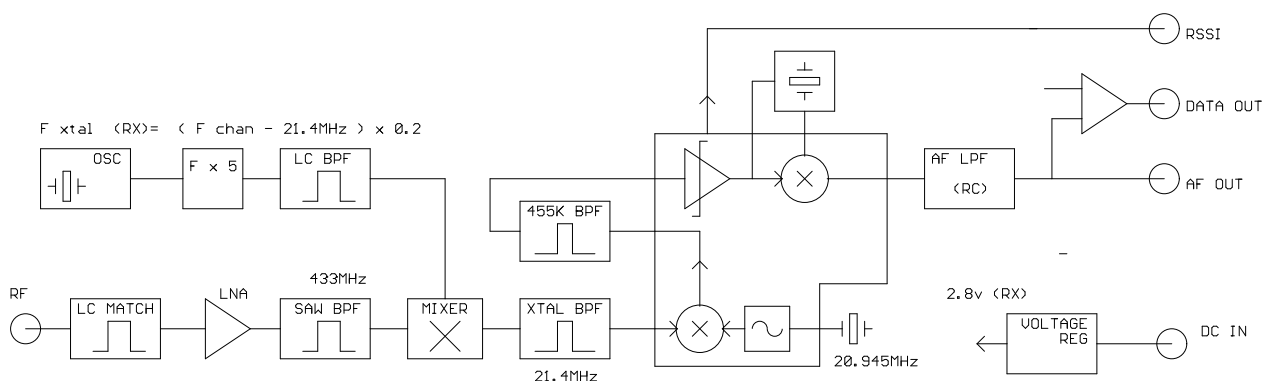


Figure 4: NRX2 block diagram

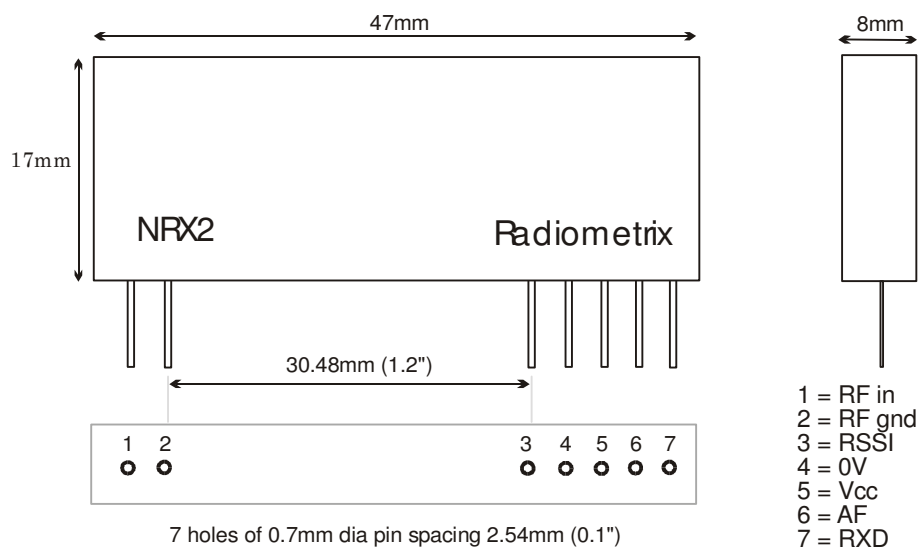


Figure 5: NRX2 pin-out and dimension

## User interface – NRX2

| NRX2 pin | Name   | Function                                                                                                                                                                                                                                                                |
|----------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | RF in  | 50Ω RF input from the antenna                                                                                                                                                                                                                                           |
| 2        | RF gnd | RF Ground is internally connected to the module screen and pin 4 (0V). These pins should be directly connected to the RF return path - e.g. coax braid, main PCB ground plane etc.                                                                                      |
| 3        | RSSI   | Received Signal Strength Indicator with >60dB range. DC level between 0.5V and 2V                                                                                                                                                                                       |
| 4        | 0V     | Ground                                                                                                                                                                                                                                                                  |
| 5        | Vcc    | 2.9 – 15V DC power supply                                                                                                                                                                                                                                               |
| 6        | AF     | 500mV <sub>pk-pk</sub> audio. DC coupled, approx 0.8V bias                                                                                                                                                                                                              |
| 7        | RXD    | Received Data output from the internal data slicer. The data is squared version of the Audio signal on pin 6 and is true data, i.e. as fed to the transmitter. Output is "open-collector" format with internal 10kΩ pull-up to Vcc (pin 5). Suitable for bi-phase codes |

### Notes:

1. Pinout is as our wideband RX2A receiver

## Absolute maximum ratings

Exceeding the values given below may cause permanent damage to the module.

|                       |                |
|-----------------------|----------------|
| Operating temperature | -10°C to +60°C |
| Storage temperature   | -30°C to +70°C |

### NTX2

|                     |                                |
|---------------------|--------------------------------|
| Vcc, TXD (pins 5,7) | -0.3V to +16.0V                |
| En (pin 4)          | -0.3V to +Vcc V                |
| RF out (pin 2)      | ±50V @ <10MHz, +20dBm @ >10MHz |

### NRX2

|                           |                                |
|---------------------------|--------------------------------|
| Vcc, RXD (pins 7,9)       | -0.3V to +16.0V                |
| En, RSSI, AF (pins 4,5,8) | -0.3V to +Vcc V                |
| RF in (pin 1)             | ±50V @ <10MHz, +13dBm @ >10MHz |

## Performance specifications: NTX2 transmitter

(Vcc = 3V / temperature = 20°C unless stated)

| General                      | pin | min. | typ.    | max. | units | notes |
|------------------------------|-----|------|---------|------|-------|-------|
| <b>DC supply</b>             |     |      |         |      |       |       |
| Supply voltage               | 5   | 2.9  | 3.0     | 15   | V     |       |
| TX Supply current (10mW)     | 5   |      | 18      | -    | mA    |       |
| TX Supply current (25mW HP)  | 5   |      | 28      |      | mA    |       |
| Antenna pin impedance        | 2   | -    | 50      | -    | □     |       |
| <b>RF</b>                    |     |      |         |      |       |       |
| RF centre frequency          |     | -    |         | -    | MHz   | 1     |
| NTX2-434.650-10(-HP)         |     |      | 434.650 |      |       |       |
| NTX2-434.075-10(-HP)         |     |      | 434.075 |      |       |       |
| NTX2-458.700-10(-HP)         |     |      | 458.700 |      |       |       |
| Channel spacing              |     | -    | 25      | -    | kHz   |       |
| Number of channels           |     | -    | 1       | -    |       |       |
| RF power output (10mW)       | 2   | 9    | 10      | 11   | dBm   | 2     |
| RF power output (25mW HP)    | 2   |      | 14      |      |       | 2     |
| Spurious emissions           | 2   | -    | -       | -40  | dBm   | 7     |
| Adjacent channel TX power    |     | -    | -37     | -    | dBm   |       |
| Frequency accuracy           |     | -    | -       | ±2.5 | kHz   | 3     |
| FM deviation (peak)          |     | ±2.5 | ±3.0    | ±3.5 | kHz   | 4     |
| <b>Baseband</b>              |     |      |         |      |       |       |
| Modulation type              |     | -    | FSK     | -    |       | F3D   |
| Modulation bandwidth @ -3dB  |     | 0    | -       | 5    | kHz   |       |
| TXD input level (logic low)  | 7   | -    | 0       | -    | V     | 5     |
| TXD input level (logic high) | 7   | -    | 3.0     | -    | V     | 5     |
| Distortion                   |     |      | TBA     |      | %     | 6     |
| <b>Dynamic timing</b>        |     |      |         |      |       |       |
| TX Enable to full RF         |     | -    | -       | 5    | ms    |       |

### Notes:

1. Available in 25kHz channel steps on other custom frequencies in 433MHz/458MHz band
2. Measured into 50Ω resistive load.
3. Total over full supply and temperature range.
4. With 0V – 3.0V modulation input.
5. To achieve specified FM deviation.
6. For 1V<sub>pk-pk</sub> signal biased at 1.4V
7. Complies with spurious emission limits of ETSI EN 300 220-1 (SRD) and ACMA (LIPD)

**Performance specifications: NRX2 receiver***(V<sub>cc</sub> = 3V / temperature = 20°C unless stated)*

|                                      | pin  | min. | typ.    | max. | units             | notes |
|--------------------------------------|------|------|---------|------|-------------------|-------|
| <b>DC supply</b>                     |      |      |         |      |                   |       |
| Supply voltage                       | 7    | 2.9  | 3.0     | 15   | V                 |       |
| Supply current                       | 7    | -    | 14      | -    | mA                |       |
| <b>RF/IF</b>                         |      |      |         |      |                   |       |
| RF centre frequency                  | 1, 6 |      |         |      | MHz               |       |
| NRX2-434.650-10                      |      |      | 434.650 |      |                   |       |
| NRX2-434.075-10                      |      |      | 434.075 |      |                   |       |
| NRX2-458.700-10                      |      |      | 458.700 |      |                   |       |
| RF sensitivity @ 12dB SINAD          | 1, 6 | -    | -118    | -    | dBm               |       |
| RF sensitivity @ 1ppm BER            | 1, 7 | -    | -112    | -    | dBm               |       |
| RSSI threshold                       | 1, 3 | -    | -125    | -    | dBm               | 1     |
| RSSI range                           | 1, 4 | -    | 55      | -    | dB                | 1     |
| IF bandwidth                         |      | -    | TBA     | -    | kHz               |       |
| Blocking                             | 1    | -    | 84      | -    | dB                |       |
| Image rejection                      | 1    | -    | 55      | -    | dB                |       |
| Adjacent channel rejection           | 1    | -    | 70      | -    | dB                |       |
| Spurious response rejection          | 1    | -    | 55      | -    | dB                |       |
| LO re-radiation                      | 1    | -    | -       | -60  | dBm               | 2     |
| <b>Baseband</b>                      |      |      |         |      |                   |       |
| Baseband bandwidth @ -3dB            | 6    | 0    | -       | 5    | kHz               | 1     |
| AF level                             | 6    | -    | 500     | -    | mV <sub>P-P</sub> | 3     |
| DC offset on AF out                  | 6    | -    | 0.8     | -    | V                 |       |
| Distortion on recovered AF           | 6    | -    | TBA     | -    | %                 |       |
| <b>Dynamic timing</b>                |      |      |         |      |                   |       |
| <i>Power up with signal present</i>  |      |      |         |      |                   |       |
| Power up to valid RSSI               | 5, 3 | -    | 3       | -    | ms                |       |
| Power up to valid AF                 | 5, 6 | -    | 2       | -    | ms                |       |
| Power up to stable data              | 5, 7 | -    | TBA     | 10   | ms                |       |
| <i>Signal applied with supply on</i> |      |      |         |      |                   |       |
| Signal to valid RSSI                 | 1, 3 | -    | 2       | -    | ms                |       |
| Signal to valid AF                   | 1, 6 | -    | 1       | -    | ms                |       |
| Signal to stable data                | 1, 7 | -    | TBA     | 5    | ms                | 4     |
| Time between data transitions        | 7    | 0.1  | -       | TBA  | ms                |       |

**Notes:**

1. See applications information for further details.
2. Exceeds EN/EMC requirements at all frequencies.
3. For received signal with  $\pm 3$ kHz FM deviation. AF output is inverted with respect to TXD input.
4. For 50:50 mark to space ratio (i.e. squarewave).

## Applications information

### Power supply requirements

Both modules have built-in regulators which deliver a constant 2.8V to the module circuitry when the external supply voltage is 2.9V or greater, with 40dB or more of supply ripple rejection. This ensures constant performance up to the maximum permitted rail, and removes the need for external supply decoupling except in cases where the supply rail is extremely poor (ripple/noise content  $>100\text{mV}_{\text{pk-pk}}$ ).

The Enable pin allows the TX module to be turned on or off under 3V logic control with a constant DC supply to the Vcc pin. The module current in power-down mode is less than  $1\mu\text{A}$ .

The Enable pin should be tied directly to the Vcc pin if this facility is not required.

### TX modulation requirements

The module is factory-set to produce the specified FM deviation with a TXD input to pin 7 of 3V amplitude, i.e. 0V "low", 3V "high".

If the data input level is greater than 3V, a resistor must be added in series with the TXD input to limit the modulating input voltage to a maximum of 3V on pin 7. TXD input resistance is  $100\text{k}\Omega$  to ground, giving typical required resistor values as follows:

| Vcc              | Series resistor      |
|------------------|----------------------|
| $\leq 3\text{V}$ | -                    |
| 3.3V             | $10\text{ k}\Omega$  |
| 5V               | $68\text{ k}\Omega$  |
| 9V               | $220\text{ k}\Omega$ |

### NRX2 Received Signal Strength Indicator (RSSI)

The NRX2 receiver incorporates a wide range RSSI which measures the strength of an incoming signal over a range of 55dB or more. This allows assessment of link quality and available margin and is useful when performing range tests.

The output on pin 3 of the module has a standing DC bias of  $<0.5\text{V}$  with no signal, rising to 2V at maximum indication.

Typical RSSI characteristic is as shown below:

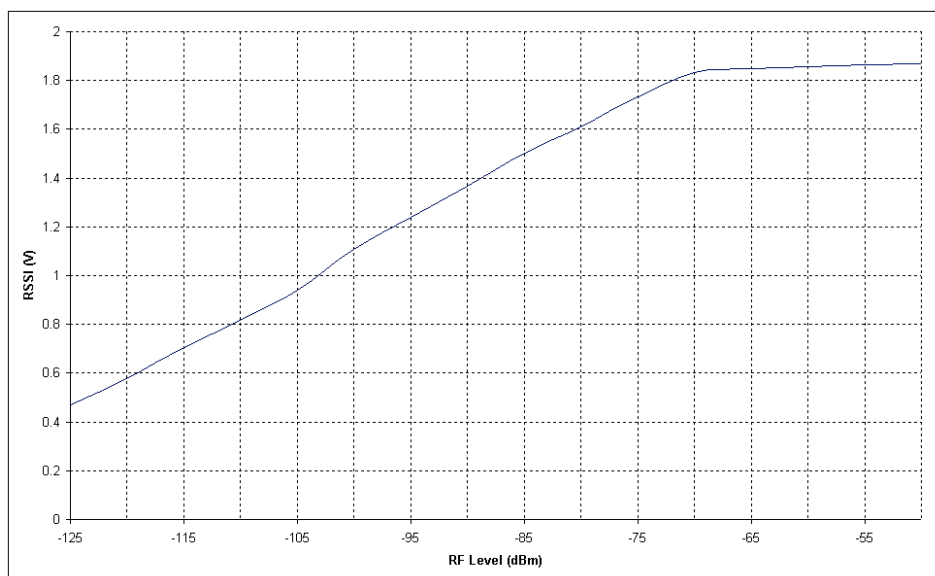


Figure 6: RSSI response curve

### ***Expected range***

Predicting the range obtainable in any given situation is notoriously difficult since there are many factors involved. The main ones to consider are as follows:

- Type and location of antennas in use
- Type of terrain and degree of obstruction of the link path
- Sources of interference affecting the receiver
- “Dead” spots caused by signal reflections from nearby conductive objects
- Data rate and degree of filtering employed

The following are typical examples – but range tests should always be performed before assuming that a particular range can be achieved in a given situation:

| <b>Data rate</b> | <b>Tx antenna</b> | <b>Rx antenna</b> | <b>Environment</b> | <b>Range</b> |
|------------------|-------------------|-------------------|--------------------|--------------|
| 10kbps           | ¼ wave            | ¼ wave            | urban/obstructed   | 300m         |
| 10kbps           | ¼ wave            | ¼ wave            | Rural/open         | 500m         |
| 10kbps           | helical           | helical           | in-building        | 100m         |

### ***Data formats and range extension***

The NTX2's TXD input is normally driven directly by logic levels but will also accept analogue drive (e.g. 2-tone signalling). In this case it is recommended that TXD (pin 7) be DC-biased to 1.2V approx. with the modulation ac-coupled and limited to a maximum of  $2V_{p-p}$  to minimise distortion over the link. The varactor modulator in the NTX2 introduces some 2<sup>nd</sup> harmonic distortion which may be reduced if necessary by predistortion of the analogue waveform.

Although the modulation bandwidth of the NTX2 extends down to DC as does the NRX2 it is not advisable to use data containing a DC component. This is because frequency errors and drifts between the transmitter and receiver occur in normal operation, resulting in DC offset errors on the NRX2's audio output.

The NRX2 in standard form incorporates a low pass filter with a 5kHz nominal bandwidth. In conjunction with similar filtering in the NTX2 an overall system bandwidth of 5kHz is obtained. This is suitable for transmission of data at raw bit rates up to 10kbps.

## Antennas

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 antenna type for any given application.

### *Integral antennas*

These are relatively inefficient compared to the larger externally-mounted types and hence tend to be effective only over limited ranges. They do however result in physically compact equipment and for this reason are often preferred for portable applications. Particular care is required with this type of antenna to achieve optimum results and the following should be taken into account:

1. 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/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.
2. Microprocessors and microcontrollers tend to radiate significant amounts of radio frequency hash which can cause desensitisation of the receiver if its antenna is in close proximity. The problem becomes worse as logic speeds increase, because fast logic edges generate harmonics across the UHF range which are then radiated effectively by the PCB tracking. In extreme cases system range may be reduced by a factor of 5 or more. To minimise any adverse effects situate antenna and module as far as possible from any such circuitry and keep PCB track lengths to the minimum possible. A ground plane can be highly effective in cutting radiated interference and its use is strongly recommended.

A simple test for interference is to monitor the receiver RSSI output voltage, which should be the same regardless of whether the microcontroller or other logic circuitry is running or in reset.

*The following types of integral antenna are in common use:*

**Quarter-wave whip.** This consists simply of a piece of wire or rod connected to the module at one end. At 434MHz the total length should be 164mm from module pin to antenna tip including any interconnecting wire or tracking. Because of the length of this antenna it is almost always external to the product casing.

**Helical.** This is a more compact but slightly less effective antenna formed from a coil of wire. It is very efficient for its size, but because of its high Q it suffers badly from detuning caused by proximity to nearby conductive objects and needs to be carefully trimmed for best performance in a given situation. The size shown is about the maximum commonly used at 434MHz and appropriate scaling of length, diameter and number of turns can make individual designs much smaller.

**Loop.** A loop of PCB track having an inside area as large as possible (minimum about 4cm<sup>2</sup>), tuned and matched with 2 capacitors. Loops are relatively inefficient but have good immunity to proximity detuning, so may be preferred in shorter range applications where high component packing density is necessary.

*Integral antenna summary:*

| Feature                       | whip | helical | loop |
|-------------------------------|------|---------|------|
| Ultimate performance          | ***  | **      | *    |
| Ease of design set-up         | ***  | **      | *    |
| Size                          | *    | ***     | **   |
| Immunity to proximity effects | **   | *       | ***  |



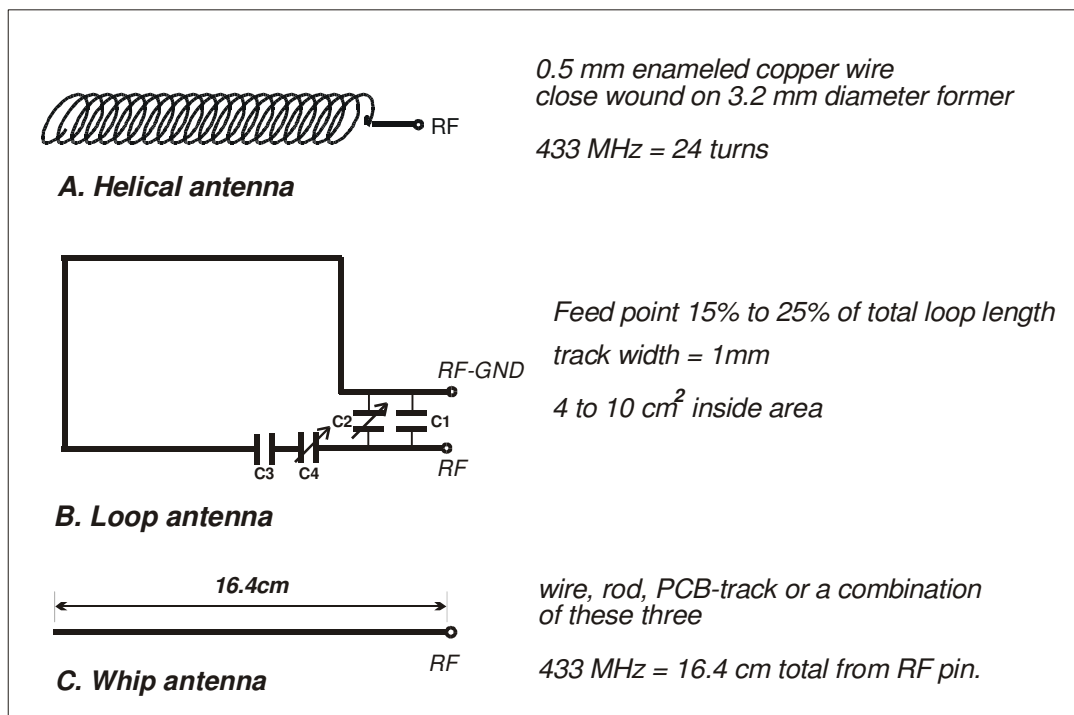


Figure 7: integral antenna configurations

### External antennas

These have several advantages if portability is not an issue, and are essential for long range links. External antennas can be optimised for individual circumstances and may be mounted in relatively good RF locations away from sources of interference, being connected to the equipment by coax feeder.

**Helical.** Of similar dimensions and performance to the integral type mentioned above, commercially-available helical antennas normally have the coil element protected by a plastic moulding or sleeve and incorporate a coax connector at one end (usually a straight or right-angle BNC/SMA type). These are compact and simple to use as they come pre-tuned for a given application, but are relatively inefficient and are best suited to shorter ranges.

**Quarter-wave whip.** Again similar to the integral type, the element usually consists of a stainless steel rod or a wire contained within a semi-flexible moulded plastic jacket. Various mounting options are available, from a simple BNC/SMA connector to wall brackets, through-panel fixings and magnetic mounts for temporary attachment to steel surfaces.

A significant improvement in performance is obtainable if the whip is used in conjunction with a metal ground plane. For best results this should extend all round the base of the whip out to a radius of the length of the whip used (under these conditions performance approaches that of a half-wave dipole) but even relatively small metal areas will produce a worthwhile improvement over the whip alone. The ground plane should be electrically connected to the coax outer at the base of the whip. Magnetic mounts are slightly different in that they rely on capacitance between the mount and the metal surface to achieve the same result.

A ground plane can also be simulated by using 3 or 4 quarter-wave radials equally spaced around the base of the whip, connected at their inner ends to the outer of the coax feed. A better match to a 50Ω coax feed can be achieved if the elements are angled downwards at approximately 30-40° to the horizontal.

## **Module mounting considerations**

The modules may be mounted vertically or bent horizontal to the motherboard. Note that the components mounted on the underside of the NTX2 and NRX2 are relatively fragile – avoid direct mechanical contact between these and other parts of the equipment if possible, particularly in situations where extreme mechanical stresses could routinely occur (as a result of equipment being dropped onto the floor, etc).

Good RF layout practice should be observed. 50Ω microstrip line or coax or a combination of both should be used to connect RF pin of the module to RF connector or antenna. It is desirable (but not essential) to fill all unused PCB area around the module with ground plane.

## **Variants and ordering information**

The NTX2 transmitters and NRX2 receivers are manufactured in the following variants as standard:

|                       |                    |      |             |
|-----------------------|--------------------|------|-------------|
| <i>At 434.650MHz:</i> | NTX2-434.650-10    | 10mW | Transmitter |
|                       | NTX2-434.650-10-HP | 25mW | Transmitter |
|                       | NRX2-434.650-10    |      | Receiver    |
| <i>At 434.075MHz:</i> | NTX2-434.075-10    | 10mW | Transmitter |
|                       | NTX2-434.650-10-HP | 25mW | Transmitter |
|                       | NRX2-434.075-10    |      | Receiver    |
| <i>At 458.700MHz:</i> | NTX2-458.700-10    | 10mW | Transmitter |
|                       | NTX2-458.700-10-HP | 25mW | Transmitter |
|                       | NRX2-458.700-10    |      | Receiver    |

***Other frequency variants can be supplied to individual customer requirements in the 433MHz (European) and 458MHz (UK) licence exempt bands***

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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/>***

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