

## NRX1

Issue 1, 30 July 2012

### Low cost VHF Narrow Band FM receiver

**The NRX1 is a narrow band FM VHF receiver and it offers a low power, reliable data link in a Radiometrix SIL standard pin out and footprint.**

**It is an enhanced, low cost version of the Radiometrix RX1, but in a slightly larger dimension.**

**NRX1 is compatible with the TX1, TX1H, HX1 transmitters, and the BiM1 transceiver.**



Figure 1: NRX1-173.225-10

NRX1 is a VHF equivalent of Radiometrix UHF NRX2 receiver and it is available for licence exempt operation in the UK 173MHz bands and European 169MHz band. NRX1 modules combine effective screening with internal filtering to minimise spurious radiation and susceptibility thereby ensuring EMC compliance. They are particularly suitable for one-to-one and multi-node wireless links where longer ranges are required at low to moderate data rates. Because of their small size and low power consumption, these modules are ideal for use in battery-powered portable applications such as handheld terminals.

#### Features

- Designed to comply with harmonised radio standard EN 300 220-2 and EMC standard EN 301 489-3
- Frequencies available as standard: 144.390, 144.800, 151.300, 161.975, 162.025, 169.4125, 173.225 and 173.250MHz
- Other custom frequencies from 120MHz to 180MHz available to order
- Data rates up to 10 kbps with 25kHz channel spacing
- Usable range to 10km+ with matching transmitter
- Fully screened

#### Applications

- EPOS equipment, barcode scanners
- Data loggers
- Industrial telemetry and telecommand
- In-building environmental monitoring and control
- High-end security and fire alarms
- DGPS systems
- Vehicle data up/download

#### Technical Summary

- Double conversion FM superhet
- Supply range: 2.9V - 15V @ 10mA (internal 2.8V voltage regulator)
- Data bit rate: 10kbps max.
- Receiver sensitivity: -120dBm (for 12dB SINAD)
- Local Oscillator (LO) re-radiation: <-60dBm
- Adjacent Channel: -70dBm
- Blocking: -86dB

**Evaluation platforms:** NBEK + BiM / SMX carrier

# NRX1

## Single channel VHF receiver

$$F_{xtal} (RX) = \langle F_{chan} - 21.4MHz \rangle \times 0.5$$

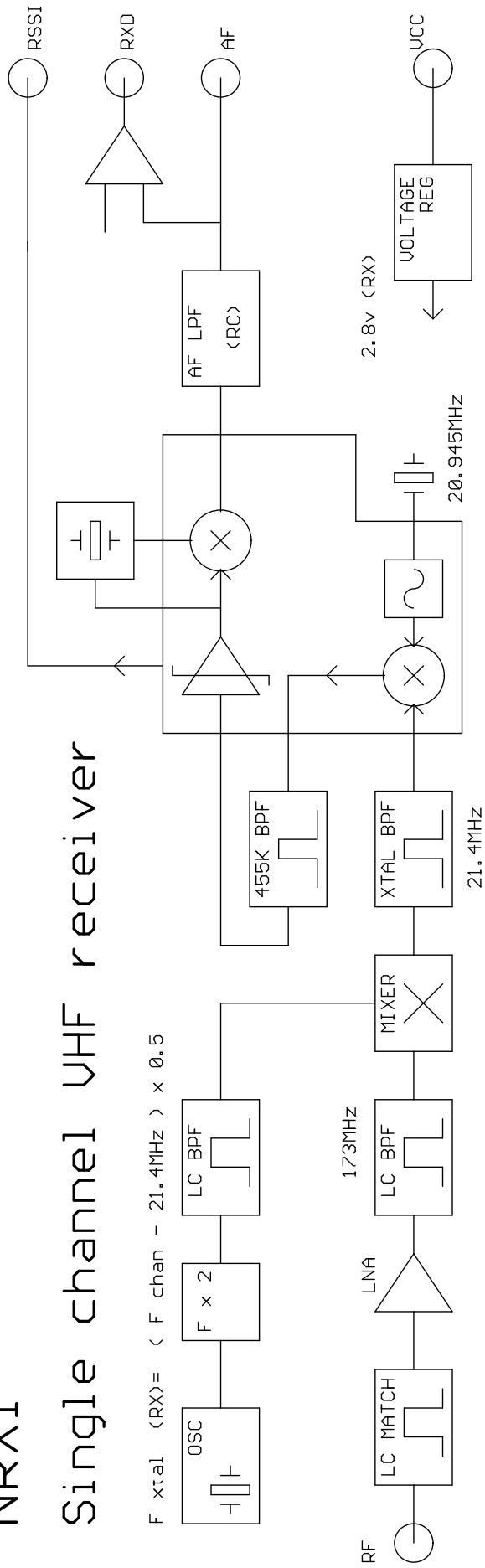


Figure 2: NRX1 block diagram

## User interface

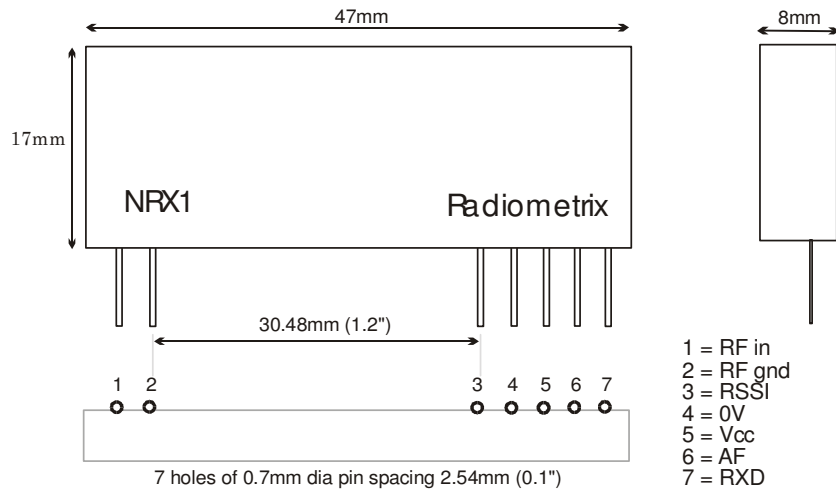


Figure 3: NRX1 pin-out and dimension

NRX1pin	Name	Function
1	RF in	50Ω RF output to the antenna
2	RF gnd	RF ground
3	RSSI	DC level between 0.5V and 2V; 60dB dynamic range
4	0V	Ground
5	Vcc	5V regulated DC power supply
6	AF	500mVp-p audio. DC coupled, approx 0.8V bias
7	RXD	.5Vp-p logic output of data slicer. Suitable for Biphase codes

**Note:** Pinout and footprint as RX1 (but larger dimension and lacks Enable pin) and UHF NRX2.

## Condensed specifications

Frequency	144.390MHz North American APRS 144.800MHz European APRS 151.300MHz Australian LIPD 161.975MHz Automatic Identification System (AIS 1) 162.025MHz Automatic Identification System (AIS 2) 169.4125MHz European Meter Reading, Asset Tracking and Tracing 173.225MHz UK Fixed Alarm 173.250MHz UK Industrial/Commercial Telemetry and Telecommand Other VHF 120-180MHz by special order subject to MOQ, lead-time
Frequency stability	±2.5kHz
Channel spacing	25kHz
Number of channels	1
Supply voltage	2.9 – 15V DC
Current	10mA
Operating temperature	-10 to +60 °C (Storage -30 to +70 °C)
Size	47 x 17 x 8 mm
Spurious radiations	Compliant with ETSI EN 300 220-3 and EN 301 489-3
Interface User	5 pin 0.1" pitch SIL
RF	2 pin 0.1" pitch SIL
<b>Receiver</b>	
Sensitivity	-120dBm for 12dB SINAD
image / spurious	-60dB (or better)
blocking	-86dB (or better)
adjacent channel	-70dB
LO re-radiation	<-65dBm
Outputs	RSSI, Audio, Data
Power on to valid audio	2ms
Power on to stable data out	10ms (for 50:50 mark / space)

## Applications information

### RX Received Signal Strength Indicator (RSSI)

The NRX1 has a wide range RSSI which measures the strength of an incoming signal over a range of 60dB or more. This allows assessment of link quality and available margin and is useful when performing range tests.

The output on pin 11 of the module has a standing DC bias of up to 0.5V with no signal, rising to 2.4V at maximum indication.  $\Delta V_{\text{min-max}}$  is typically 1V and is largely independent of standing bias variations. Output impedance is 56k $\Omega$ . Pin 11 can drive a 100 $\mu$ A meter directly, for simple monitoring.

Typical RSSI characteristic is as shown below:

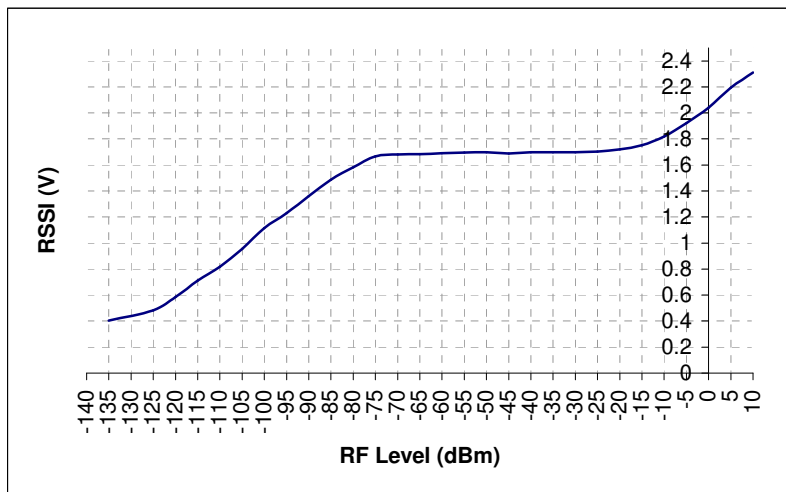


Figure 4: RSSI level with respect to received RF level at NRX1 antenna pin

### Packet data

In general, data to be sent via a radio link is formed into a serial "packet" of the form :-

#### **Preamble - Control - Address - Data - CRC**

Where: **Preamble:** This is mandatory for the adaptive data slicer in the receiver in the NRX1 to stabilise. The NRX1 will be stable after 10ms. Additional preamble time may be desired for decoder bit synchronisation, firmware carrier detection or receiver wake up.

**Control:** The minimum requirement is a single bit or unique bit pattern to indicate the start of message (frame sync.). Additionally, decoder information is often placed here such as: packet count, byte count, flow control bits (e.g. ACK, repeat count), repeater control, scrambler information etc.

**Address:** This information is used for identification purposes and would at least contain a 16/24 bit source address, additionally - destination address, site / system code, unit number and repeater address's may be placed here.

**Data:** User data, generally limited to 256 bytes or less (very long packets should be avoided to minimise repeat overheads on CRC failure and channel hogging).

**CRC:** 16/24 Bit CRC or Checksum of control-address-data fields used by the decoder to verify the integrity of the packet.

The exact makeup of the packet depends upon the system requirements and may involve some complex air-traffic density statistics to optimise through-put in large networked systems.

## 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 VHF 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 173MHz the total length should be 410mm 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 173MHz 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 5cm<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	**	*	***

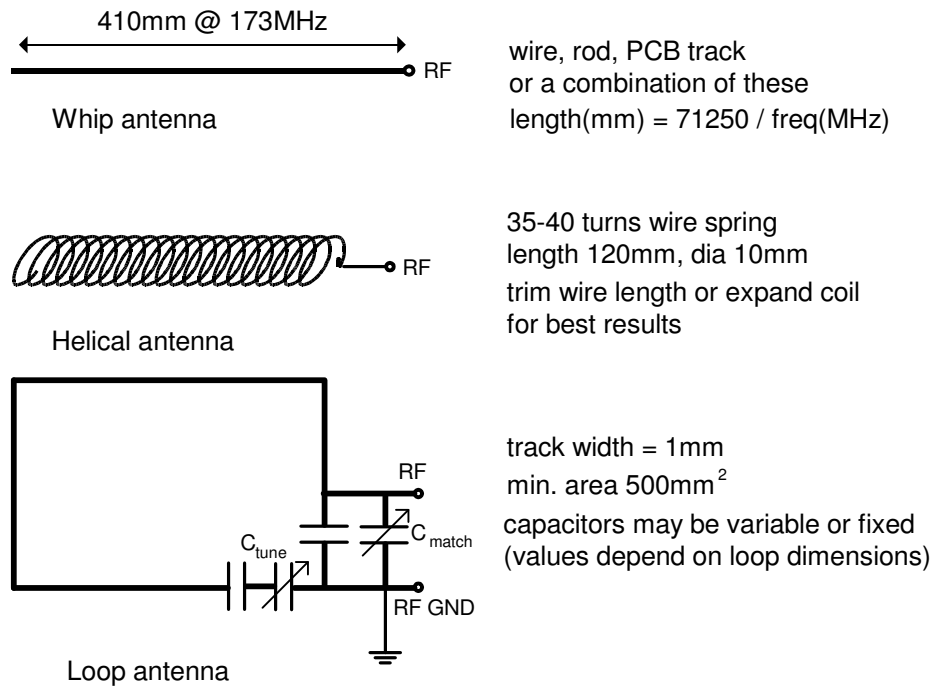


Figure 5: integral antenna configurations

### 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 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 connector to wall brackets, through-panel fixings and magnetic mounts for temporary attachment to steel surfaces.

### Ground plane

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 300mm or more (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.

As shown on figure 9, 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.

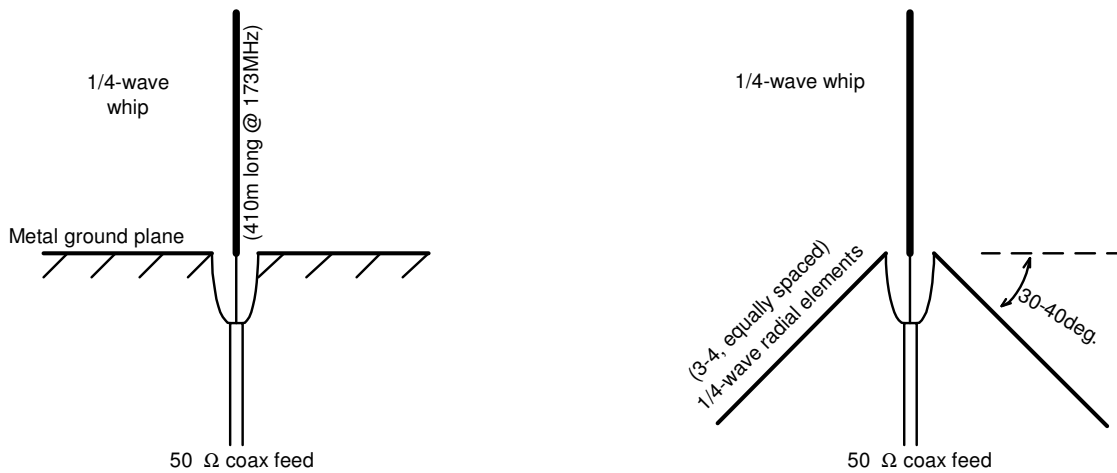


Figure 6: Quarter wave antenna / ground plane configurations

**Half-wave.** There are two main variants of this antenna, both of which are very effective and are recommended where long range and all-round coverage are required:

1. The half-wave dipole consists of two quarter-wave whips mounted in line vertically and fed in the centre with coaxial cable. The bottom whip takes the place of the ground plane described previously. A variant is available using a helical instead of a whip for the lower element, giving similar performance with reduced overall length. This antenna is suitable for mounting on walls etc. but for best results should be kept well clear of surrounding conductive objects and structures (ideally >1m separation).
2. The end-fed half wave is the same length as the dipole but consists of a single rod or whip fed at the bottom via a matching network. Mounting options are similar to those for the quarter-wave whip. A ground plane is sometimes used but is not essential. The end-fed arrangement is often preferred over the centre-fed dipole because it is easier to mount in the clear and above surrounding obstructions.

**Yagi.** This antenna consists of two or more elements mounted parallel to each other on a central boom. It is directional and exhibits gain but tends to be large and unwieldy – for these reasons the yagi is the ideal choice for links over fixed paths where maximum range is desired.

For best range in UK fixed link applications use a half-wave antenna on the matching transmitter (e.g. TX1, BiM1T) and a half-wave or Yagi on NRX1 receiver, both mounted as high as possible and clear of obstructions.

### Module mounting considerations

Good RF layout practice should be observed. If the connection between module and antenna is more than about 20mm long use 50Ω microstrip line or coax or a combination of both. It is desirable (but not essential) to fill all unused PCB area around the module with ground plane.

### Variants and ordering information

The NRX1 receiver is manufactured in the following variants as standard:

<b>NRX1-144.390-10</b>	North American Automatic Packet Reporting System (APRS)
<b>NRX1-144.800-10</b>	European APRS
<b>NRX1-161.975-10</b>	Automatic Identification System (AIS 1)
<b>NRX1-162.025-10</b>	Automatic Identification System (AIS 2)
<b>NRX1-151.300-10</b>	Australian Low Interference Potential Devices (LIPD)
<b>NRX1-169.4125-10</b>	European Meter Reading, Asset Tracking and Tracing
<b>NRX1-173.225-10</b>	UK Fixed Alarm
<b>NRX1-173.250-10</b>	UK Industrial/Commercial Telemetry and Telecommand

Matching transmitter: **TX1-xxx.xxx-10** (where xxx.xxx is the operating frequency)

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

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