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NRX1B

Issue 1, 12 August 2025

Frequency Programmable 25kHz NBFM VHF Receiver

The NRX1B is a narrowband VHF receiver in a Radiometrix SIL standard pin out and foot print.

This makes the NRX1B ideally suited to those low power applications where existing single frequency wideband UHF modules have insufficient range

It is also frequency programmable via a serial port, supporting custom frequencies and increasing flexibility

Figure 1: NRX1B-169.4125-10

Features

- Conforms to ETSI EN 300 220-2 (radio) and EN 301 489-3 (EMC)
- Fully integrated sigma-delta PLL synthesizer based design
- Factory programmable custom frequency within 142-175MHz. No crystal lead-times
- Vibration resistant (negligible microphony)
- Data rates up to 10kbps
- Usable range over 500m
- 12.5kHz / 20kHz / 25kHz Channel spacing (factory set)
- Feature-rich interface (true analogue and/or digital baseband)
- Re-programmable via RS232 interface

Applications

- Industrial/Commercial Telemetry and Telecommand
- Non-specific Short Range Devices
- Asset Tracking and Tracing
- Remote Meter Reading
- In-building environmental monitoring and control
- High-end security and fire alarms

Technical Summary

- Operating frequency: 151.300MHz Australian LIPD
154.570MHz US MURS
169.4125MHz EU SRD
173.225MHz UK Fixed Alarm
173.250MHz UK Telemetry and Telecommand
- Fully integrated sigma-delta PLL synthesizer based design
- Supply range: 2.9V - 15V @ 17mA (internal 2.8V LDO voltage regulator)
- Data bit rate: 5kbps max.
- Receiver sensitivity: -120dBm (for 12dB SINAD) / -112dBm (for 1ppm BER)
- Dimensions 47 x 17 x 8mm (fully screened)

Evaluation platforms: Uni-Eval or NBEK + SIL carrier

NRX1B receiver

The NRX1B receiver consists of a highly integrated sigma delta (fractional N) synthesizer based Local Oscillator (LO), configured over an SPI serial bus by an on-board microcontroller. The primary frequency reference for the LO is a 26MHz TCXO. The remainder of the receiver is a conventional dual conversion super-heterodyne, using a wide dynamic range dual gate mosfet mixer and crystal / ceramic filter elements for optimum performance. The RF input is filtered using a multi-stage LC filter in the front end to provide image rejection and enhanced blocking performance. This reduces the user programmable frequency range to the filter passband, but can easily be re-banded (in the factory) to other frequencies.

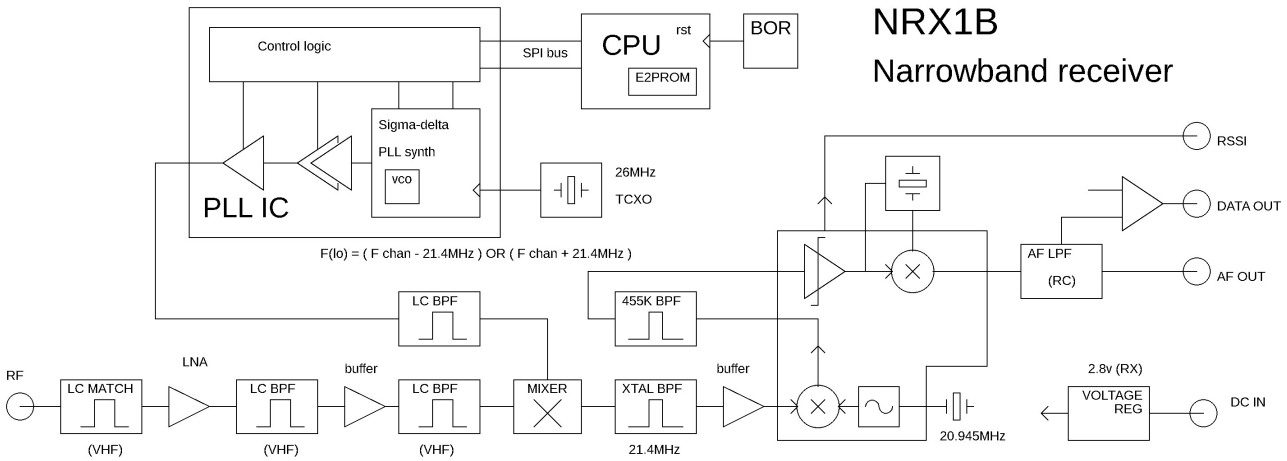

Figure 1: NRX1B block diagram

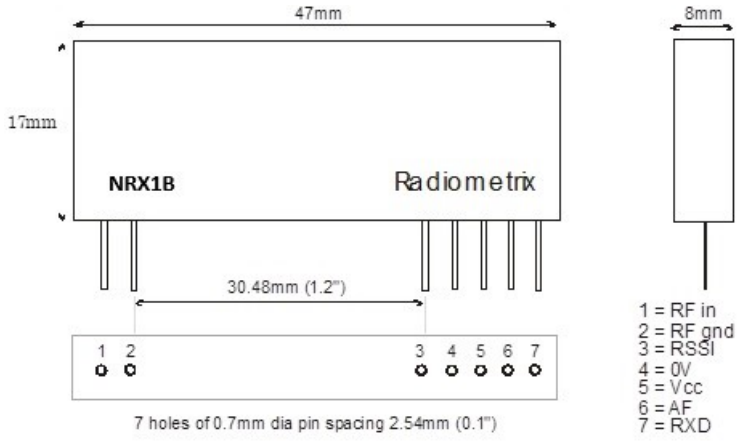

Figure 2: NRX1B pin-out and dimension

User interface – NRX1B

NRX1B 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	2.9V – 15V DC power supply
6	AF/PGM	500mV$_{pk-pk}$ audio. DC coupled, approx 1.5V bias 9600 baud 0V-5V RS232 (inverted UART) Programming command input
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 10kΩpull-up to VCC (pin 5). Suitable for bi-phase or Manchester codes

Notes:

1. Pinout is as our wideband RX2G receiver, or older NRX1
2. Unit is reprogrammed by applying a 0V-5V level RS232 (inverted UART) polarity command stream into AF/PGM pin 6

Absolute maximum ratings

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

Operating temperature	-20°C to +70°C
Storage temperature	-30°C to +85°C
RF in (pin 1)	±50V @ <10MHz, +13dBm @ >10MHz
All other pins	-0.3V to +15.0V

Performance specifications:
(Vcc = 5V / temperature = 20°C unless stated)

General	pin	min.	typ.	max.	units	notes
DC supply						
Supply voltage	5	2.9	-	15	V	
Supply current	5		17		mA	
Antenna pin impedance	1		50		Ω	
RF centre frequency			169.4125		MHz	1
Channel spacing			25		kHz	
Number of channels			1			
RF/IF						
RF sensitivity @ 12dB SINAD	1, 6		-120		dBm	
RF sensitivity @ 1ppm BER	1, 7		-112		dBm	
RSSI range	1, 3	50	50		dB	4
Blocking	1		84		dB	2
Image rejection	1		70		dB	2
Adjacent channel rejection	1	63			dB	2
Spurious response rejection	1		70		dB	2
LO leakage, radiated				-70	dBm	2
Baseband						
Baseband bandwidth @ -3dB	6		5		kHz	
AF level	6		500		mV_{P-P}	4
DC offset on AF out	6		1.5		V	
Distortion on recovered AF	6		5		%	
Dynamic timing						
Power up with signal present						
Power up to valid RSSI	5, 3		25		ms	
Power up to valid AF	5, 6		25		ms	
Power up to stable data	5, 7		50		ms	
Signal applied with supply on						
Signal to valid RSSI	1, 3		2.5		ms	
Signal to valid AF	1, 6		2.5		ms	
Signal to stable data	1, 7		10		ms	5

Notes:

1. Programs to any 169Hz EU/UK SRD band 25kHz bandwidth frequencies
2. Exceeds EN/EMC requirements at all frequencies.
3. See applications information for further details.
4. For received signal with ±3kHz FM deviation.
5. For 50:50 mark to space ratio (i.e. square-wave).

Channel Programming

At the heart of the device is a fractional N synthesizer locked to a high stability 26MHz TCXO.
The minimum step size of this PLL is 4.133Hz.

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

$$Freq = \left(INTE + \frac{FRAC}{2^{19}} \right) \times \frac{2 \times VCTCXO}{Outdiv} \qquad \text{where} \quad \frac{2 \times 26\,MHz}{24} = 2.1666667$$

Output Divider (Outdiv) value for 142MHz-175MHz band is 24.
For correct operation, the component (FRAC / 2^{19}) must have a value between 1 and 2

However, the frequency programmed into the receiver section is the LOCAL OSCILLATOR (LO) frequency, not the actual channel frequency, which puts an offset into the frequency calculations

For unit operating on a channel frequency of 163MHz or higher, the local oscillator is 21.4MHz below the carrier (so subtract 21.4MHz). AF output will be inverted on higher receive frequency units.

$$LO = RF - IF = 173.250\,MHz - 21.4\,MHz = 151.85\,MHz \; for \; RF \geq 163\,MHz$$

For units operating on frequencies below 163MHz, the local oscillator is 21.4MHz above the channel.

$$LO = RF + IF = 154.700\,MHz + 21.4\,MHz = 175.970\,MHz \; for \; RF < 163\,MHz$$

Receivers operating between 156 and 163MHz (and transmitters below 142MHz) are a special case. These are fitted with a different PLL IC, which has a coverage of 119 to 159MHz, allowing conventional low side injection to be maintained. Contact tech support for further details

RX Example:

$$\frac{154.570\,MHz + 21.4\,MHz}{2.166666} = 81.216923 \; where \; \frac{2 \times 26\,MHz}{24} = 2.166666$$

INTE = 81-1 = 80 (0x50)
FRAC = (0.216923 +1) × 524288 = 638,018 (0x09BC42)
FRAC2 = 0x09
FRAC1 = 0xBC
FRAC0 = 0x42

$$Freq = \left(80 + \frac{638018}{524288} \right) \times 2.166666\,MHz = 175.969999\,MHz + 0.69\,Hz$$

When programming the NRX1B, keep in mind that the unit maintains in SRAM the current values of all programmable values (frequency, band of operation, RF power and frequency offset adjustments values)

These values are only loaded from EEPROM at cold start power-on

There is one "write all values to EEPROM" command. 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.

NRX1B EEPROM stores Frequency coefficients, RF Power level, Frequency Offset and the Band select constants. As this is a receiver, power level should always be set to 3 (or left alone!)

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.
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.

Serial interface commands

NRX1B PGM serial interface consists of an 9600bps, 8 data bits, No Parity, 1 Stop bit, 0V-5V level RS232 (Inverted UART) datastream applied to the AF/PGM pin (if a PNP open collector driver is used then the idle state of the interface will not affect the AF output levels)

Every command string starts with the phrase "@PRG_" and terminated with Carriage Return <cr>.

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)

User commands

Commands	Function
@PRG_iif2f1f0<cr>	sets the transmitter frequency iif2f1f0 is an 8 digit hexadecimal number, coding 4 bytes: ii is the "integer" value f2 most significant FRAC2 byte in the 24 bit FRAC word f1 bits 8 through 15 of the fraction word (FRAC1) f0 least significant FRAC0 byte
@PRG_BURN_ROM<cr>	write current setup into EEPROM
@PRG_POWER 00<cr> @PRG_POWER FF<cr>	Turn the LO PLL circuit OFF (50% power reduction) Turn the PLL back ON
@PRG_00000000<cr>	Re-sets itself to the values currently stored in EEPROM (this usually only otherwise happens at power-up)

Factory alignment commands

Commands	Function
@PRG_POWER pp <cr> Do not use this command	Sets the LO PLL power output pp is a 2 digit hexadecimal number (in the range 00 to 3F) e.g. @PRG_POWER **03**<cr>
@PRG_TRIM+ aa <cr>	set an "up" offset aa is 00 (0Hz) to 7F at 4.133Hz per bit @PRG_TRIM+1E<cr>
@PRG_TRIM- aa <cr>	sets a "down" offset aa is 00 (0Hz) to 7F at 4.133Hz per bit
@PRG_BAND# bb For a VHF receiver only 0D is valid	band divider value (bb) 08 850-1050MHz 0A 425-520MHz 0B 280-350MHz **0D 140-175MHz**
@PRG_BURN_ROM<cr>	write current setup into EEPROM

Applications information

Power supply requirements

NRX1B receiver module has a built-in regulator 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.

These regulators ensure constant performance up to the maximum permitted rail, and remove the need for external supply decoupling except in cases where the supply rail is extremely poor (ripple/noise content >100mVpk-pk).

NRX1B Received Signal Strength Indicator (RSSI)

The NRX1B features wide range RSSI which measures the strength of an incoming signal over a range of 50dB 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 up to 0.5V (approx.) with no signal, rising to around 2.0V at maximum indication. DVmin-max is typically 1V and is largely independent of standing bias variations. Output impedance is 47kΩ. Pin 11 can drive a 100μA meter directly, for simple monitoring.

Please note that the actual RSSI voltage at any given RF input level varies somewhat between units. The RSSI facility is intended as a relative indicator only - it is not designed to be, or suitable as, an accurate and repeatable measure of absolute signal level or transmitter-receiver distance.
Typical RSSI characteristic is as shown below:

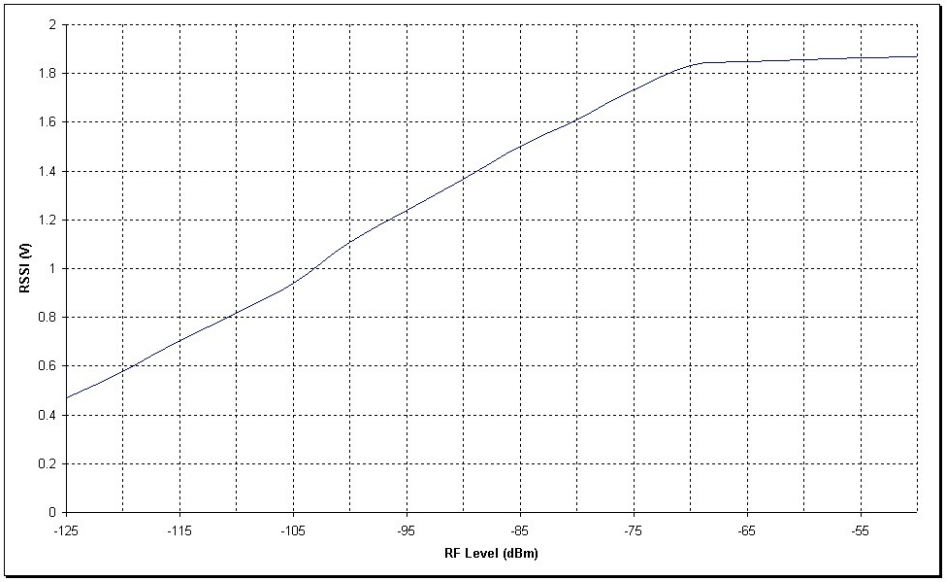

Figure 3: RSSI level with respect to received RF level at NiM1B antenna pin

Variants and ordering information

The NRX1B are manufactured in the following variants as standard:

Part No.	Frequency (MHz)	Country
NRX1B-144.390-5	144.390	EU
NRX1B-144.800-5	144.800	EU
NRX1B-151.300-5	151.300	Australia/ New Zealand
NRX1B-154.570-5	154.570	US
NRX1B-169.4125-5	169.4125	EU/UK
NRX1B-173.225-5	173.225	UK
NRX1B-173.250-5	173.250	UK

(Depending on the built state, NRX1B can be reprogrammed on any frequencies with in the 142 - 175MHz band)

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

Radio Equipment Directive (RED)

Before it can be placed on the UK market, radio control equipment must first comply with the provisions of the Radio Equipment Directive 2014/53/EU.

To comply, all equipment has to meet a set of Essential Requirements that are based on voluntary Harmonised European Standards. Manufacturers can meet the essential requirements by ensuring equipment meets the applicable harmonised standards or by seeking the opinion of an Radio Equipment Directive Notified Body. Once this assessment has been carried out, the manufacturer can declare compliance, affix the CE mark to the equipment and then place it on the market anywhere in the European Community.

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