

TX3D

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Frequency Programmable FM UHF Transmitter/Receiver

The TX3D is a PLL synthesiser-based frequency programmable miniature PCB mounting UHF radio transmitter which enable the simple implementation of a wireless data link at up to 64 kbps at distances up to 75 metres in-building and 300 metres open ground.

Unlike legacy crystal-controlled TX/RX modules, the frequency programmable feature enables TX3D to be offered in number of custom frequencies within a given UHF band without requiring long lead time or MOQ.

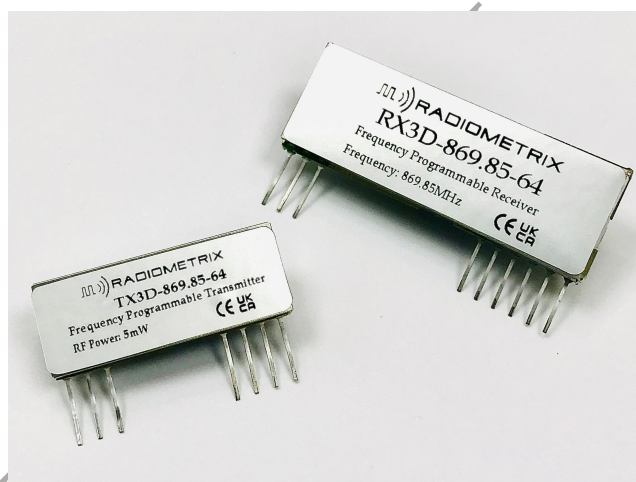


Fig 1: TX3D-869.85-64 & RXD-868.85-65

Features

- Conforms to European ETSI EN 301 489-3 and EN 300 220-2 (ERP @ 5mW and @ 10mW)
- North American version conforms to FCC part 15.249
- Data rates: up to 64kbps
- 869.85MHz and 868.30 MHz (EU) or 914.50MHz (North America) as standard

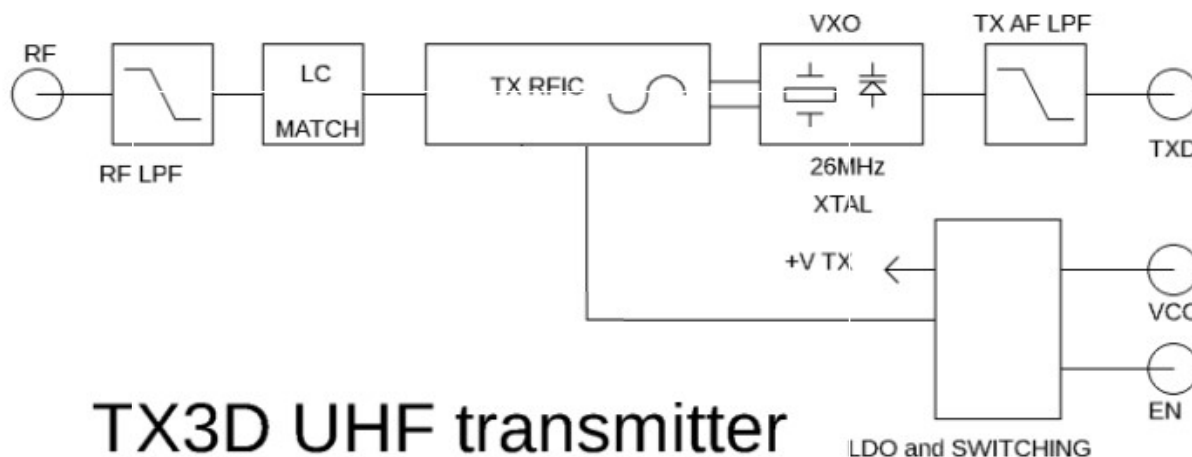
Technical Summary

- Crystal-locked PLL, FM modulated at up to 64 Kbps
- Supply: 2.9V - 16V @ 23mA TX (5mW), 30mA TX (10mW)
- Improved frequency accuracy

Applications

- Industrial or Commercial Telemetry and Telecommand
- Wireless Queue Management System
- Wheel Balancing
- Sports Scoreboard Display
- Security and fire alarms
- Wireless Battery Monitor.

Evaluation platforms: Universal Evaluation Kit, NBEK + SIL carrier



TX3D UHF transmitter

. Fig. 2: TX3D block diagram

Functional overview

The TX3D transmitter consists of a frequency modulated crystal locked PLL feeding a LC match and RF filter. An Enable pin controls operation. The transmitter achieves full RF output typically within 2ms of this line being pulled low. Modulation is applied at the TXD input and may be either a serial digital stream toggling between 0V and 3V (digital drive) or a high level of ac coupled analogue waveform up to 1.7V peak-to-peak (linear drive). Modulation shaping is performed internally by a 2nd order lowpass filter, which minimises spectral spreading.

Pin description:

RF GND (pins 1 & 3)

RF ground, 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.

RF OUT (pin 2)

50Ω RF output to the antenna. Internally DC-isolated. See antenna section of apps notes for details of suitable antennas.

En (pin 4)

Tx enable. <0.15V shuts down module (current <3μA). >1.7V enables the transmitter. Impedance ~1MΩ. Observe slew rate requirements (see apps notes).

Vcc (pin 5)

DC +ve supply pin. +2.9 to +16.0 volts. The supply should be clean, <20mVpp ripple.

0V (pin 6)

DC supply ground. Internally connected to pins 1 & 3 and module screen.

TXD (pin 7)

This DC-coupled transmitter modulation input will accept either serial digital data or high level linear signals. Drive signal must be limited to 0V min, 3V max. See page 4 for suggested drive methods. Input impedance >50kΩ.

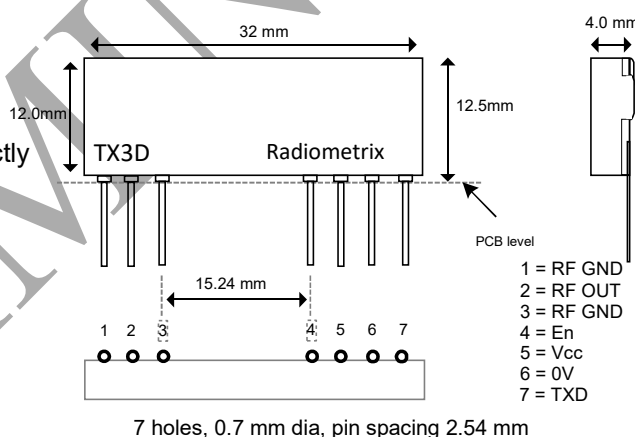


Fig 3: TX3D Dimension and Pinout

Absolute maximum ratings

Survival Maximums:

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

Operating temperature	-20°C to +70°C
Storage temperature	-40°C to +100°C

TX3D, all variants

Vcc (pin 5)	-0.3V to +16.0V
Data input (pin 7)	-0.3V to +16.0V
En (pin 4)	-9V to +16V
RF out (pin 2)	±50V DC 10dBm RF

Performance Specifications: TX3D

Figures apply to standard version @ Vcc=5.0V, temperature +20 °C, unless stated.

General	pin	min.	typ.	max.	units	notes
Supply voltage	5	2.9	3.0	16	V	
Idle current	4, 5			3	µA	
Tx supply current @0.75mW	5	-	13	-	mA	914.50MHz
@5mW	5	-	23	-	mA	869.85 MHz
@10mW	5	-	30	-	mA	868.30MHz
RF centre frequency (EU)	-	-	869.85/ 868.30	-	MHz	
RF centre frequency (N-America)	-	-	914.50	-	MHz	
Antenna port impedance	2	-	50	-	Ω	
TX Enable: high (<i>select</i>)	4	1.7		16	V	
low (<i>deselect</i>)	4	0		0.5	V	
Balanced code bit rate	7	-	-	64	kbps	
RF power output 0.75mW	2	-1	+0	+1	dBm	914.50MHz, 1
5mW	2	+6	+7	+8	dBm	869.85 MHz, 1
10mW	2	+9	+10	+11	dBm	868.30MHz 1
TX harmonics/spurious emission	2			-40	dBm	
Initial centre frequency accuracy	-	-5	0	+5	kHz	
FM deviation	-	±20	±30		kHz	Peak
Modulation bandwidth	-	0		35	kHz	@ -3db
TX spectral bandwidth @-40dBc	2			250	kHz	worst case
TXD input level: high	7	2.8		3.0	V	2
low	7	0		0.2	V	2
TX power up to full RF	2			2	ms	3

Note:

1. Measured into a 50Ω load
2. For specified FM deviation
3. EN high to > full RF output

Power supply requirement

The standard TX3D module incorporates a built-in regulator which delivers 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 supply rail and removes the need for external supply decoupling except in cases where the supply rail is extremely poor (ripple/noise content >0.1Vp-p).

Note, however, that for supply voltages lower than 2.85V the regulator is effectively inoperative and supply ripple rejection is considerably reduced. Under these conditions the ripple/noise on the supply rail should be below 10mVp-p to avoid problems. If the quality of the supply is in doubt, it is recommended that a 10 μ F low-ESR tantalum or similar capacitor be added between the module supply pin (Vcc) and ground, together with a 10 Ω series feed resistor between the Vcc pin and the supply rail.

The Enable pin allows the module to be turned on or off under logic control with a constant DC supply to the Vcc pin. The module current in power-down mode is less than 3 μ A.

NOTE: If this facility is used, the logic control signal must have a slew rate of 40mV/ms or more. Slew rates less than this value may cause erratic operation of the on-board regulator and therefore the module itself.

TX3D modulation requirements

The module will produce the specified FM deviation with a TXD input to pin 7 of 3V amplitude, i.e. 0V "low" and 3V "high". Reducing the amplitude of the data input from this value (usually as a result of reducing the supply voltage) reduces the transmitted FM deviation to typically ± 25 kHz at the lower extreme of 2.9V. The receiver will cope with this quite happily and no significant degradation of link performance should be observed as a result.

Where standard 2-level digital data is employed with a logic "low" level of 0V ± 0.2 V, the logic "high" level applied to TXD may be any value between +2.5V and +3V for correct operation. However, if using multi-level or analogue signalling the maximum positive excursion of the modulation applied to TXD must not exceed +2.5V or waveform distortion will result. If the input waveform exceeds this level a resistive potential divider should be used at the TXD input to reduce the waveform amplitude accordingly. This input is high impedance (>100k Ω) and can usually be ignored when calculating required resistor values.

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 apply particularly to integral antennas and 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/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.

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. 900MHz region is generally less prone to this effect than lower frequencies, but problems can still arise. Things become worse as logic speeds increase, because fast logic edges are capable of generating harmonics across the UHF range which are then radiated effectively by the PCB tracking. In extreme cases system range can be reduced by a factor of 3 or more. To minimise any adverse effects, situate the 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.

Depending on the application and bearing in mind applicable legal requirements (see p.6), a variety of antenna types may be used with the TX3D and RX3D.

Integral antenna: generally, do not perform as well as externally mounted types, however they result in physically compact equipment and are the preferred choice for portable applications. The following can be recommended:

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. This antenna is quite simple and performs well, especially if used in conjunction with a ground plane. This will often be provided by the PCB on which the module is mounted, or by a metal case.

Base-loaded whip: This is a shortened whip, 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 if space is at a premium. The value must be carefully chosen to tune the particular length of whip in use, making this antenna more difficult to set up than a 1/4-wave whip.

Helical: This is a compact but slightly less effective antenna formed from a coil of wire. It is very efficient for its size, but has high Q and tends to suffer badly from detuning caused by proximity to nearby conductive objects. It needs to be carefully trimmed for best performance in a given situation and the required dimensional tolerances can be difficult to achieve repeatably, nevertheless it can provide a very compact solution.

Loop:. A loop of PCB track, 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 very high component packing density is necessary.

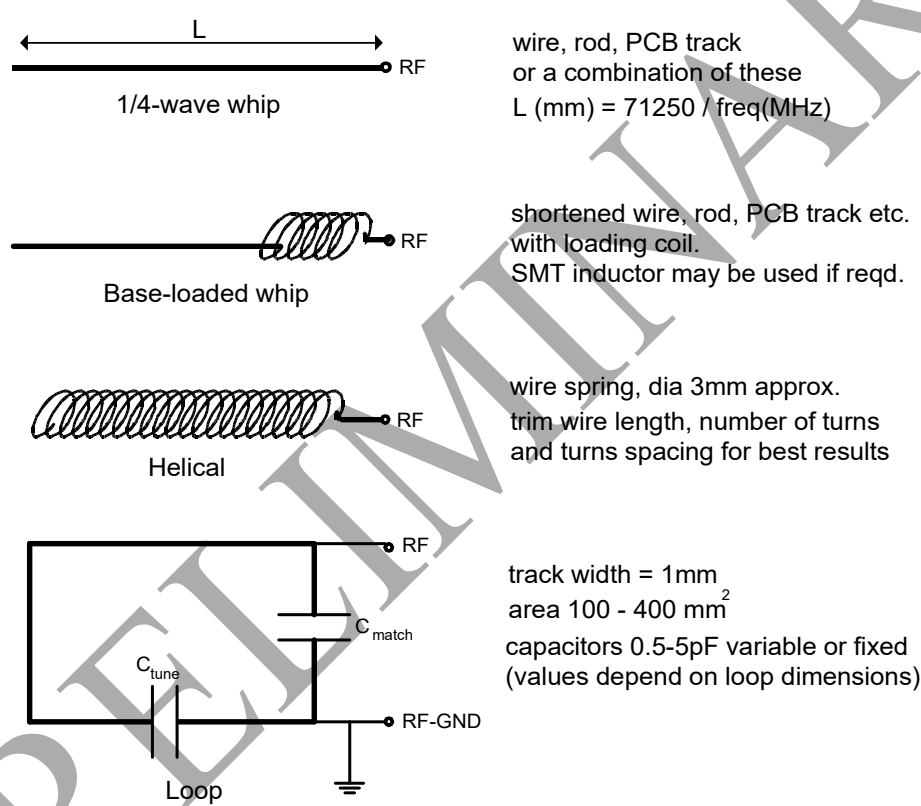


Fig.4: Integral antenna configurations

Integral antenna summary:

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

External antennas have several advantages if portability is not an issue. They 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. Apart from the usual whips, helicals etc, low-profile types such as microstrip patches can be very effective at these frequencies. Suitable antennas are available from many different sources and are generally supplied pre-tuned to the required frequency.

Type Approval requirements: USA

Radiometrix TX3D modules are sold as component devices which require external components and connections to function. They are designed to comply with FCC Part 15.249 regulations; however, they are not approved by the FCC. The purchaser understands that FCC approval will be required prior to the sale or operation of any device containing these modules.

- 1) Antennas must be either permanently attached (i.e. non-removable) or must use a connector which is unique or not commonly available to the public.*
- 2) The user must ensure that the TX3D/antenna combination does not radiate more than the maximum permitted level of 50mV/m at 3m distance (FCC Part 15.249).*
- 3) The appropriate FCC identifying mark and/or part 15 compliance statement must be clearly visible on the outside of the equipment containing the module(s).*

Variants and ordering information

TX3D modules are manufactured in the following variants as standard:

Part number	RF power mW	Frequency MHz	Data rate kbps
TX3D-869.85-64	5	869.85	64
TX3D-868.30-64	10	868.30	64
TX3D-914.50-64	0.75	914.50	64

Matching RX3D receiver modules are manufactured in the following variants as standard:

Part number	Frequency (MHz)	Data rate (kbps)
RX3D-869.85-64	869.85	64
RX3D-869.85-10	869.85	10
RX3D-868.30-64	868.30	64
RX3D-868.30-10	868.30	10
RX3D-914.30-64	914.50	64
RX3D-914.30-10	914.50	10

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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 must 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 a 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.

<https://www.ofcom.org.uk/spectrum/information>

<https://www.ofcom.org.uk/spectrum/rules/>

<https://ec.europa.eu/docsroom/documents/33162>
