

LMT1/LMR1

3 November 2011

VHF Narrow Band FM Low Cost multi channel radio modules

The LMT1 transmitter and LMR1 receiver modules offer a multi channel, low power, and reliable VHF data link. This makes the LMT1/LMR1 pair ideally suited to those low power applications where existing wideband modules have insufficient range, or where low cost multi-channel operation is needed without compromising on RF specification or regulatory requirement.



Figure 1: LMT1 transmitter and LMR1 receiver

Features

- Conforms to EN 300 220-3 and EN 301 489-3
- Conforms to FCC Part 90, Part 15B
- High performance double superhet. PLL synthesizer with TCXO
- quasi-dc (peak sampling) data recovery circuit (for enhanced performance on unbalanced datastreams)
- Data rates up to 5 kbps for standard module
- Usable range over 1km
- Fully screened. Low profile
- Feature-rich interface (RSSI, analogue and digital baseband)
- Re-programmable via RS232 interface
- Low power requirements

Applications

- Non-specific Short Range Devices (SRD)
- Industrial/Commercial Telemetry and Telecommand
- Medical and Biological Applications
- Mobile, Transportable and Lone Worker Safety Alarms
- Fixed Alarms
- Private Land Mobile Radio Services (PLMRS) in USA
- Public Safety, Industrial/Business Radio Pool systems in USA
- High-end security and fire alarms
- DGPS systems

Technical Summary

- Operating frequency: 173.200 - 173.325MHz (UK SRD band)
 150.825 - 152.450MHz (Australian LIPD Band)
 150-174MHz (US FCC CFR 47 Part 90 VHF PLMR band)
- 32 frequency channels
- Transmit power: +10dBm (10mW) nominal @ 3.1V (Adjustable 1 - 25mW)
 +20dBm (100mW) nominal @ 4.1V (Adjustable 25 - 100mW)
- Supply range: 3.1 – 15V (@10mW) transmitter and receiver
- Current consumption: 34mA @ 10mW, 90mA @ 100mW (transmit) and 20mA (receive)
- Data bit rate: 5kbps max. (Standard module)
- Receiver sensitivity: -118dBm (for 12 dB SINAD)
- Serial configuration by inverted RS232 (UART) at 3V CMOS level

LMT1 VHF multi-channel transmitter

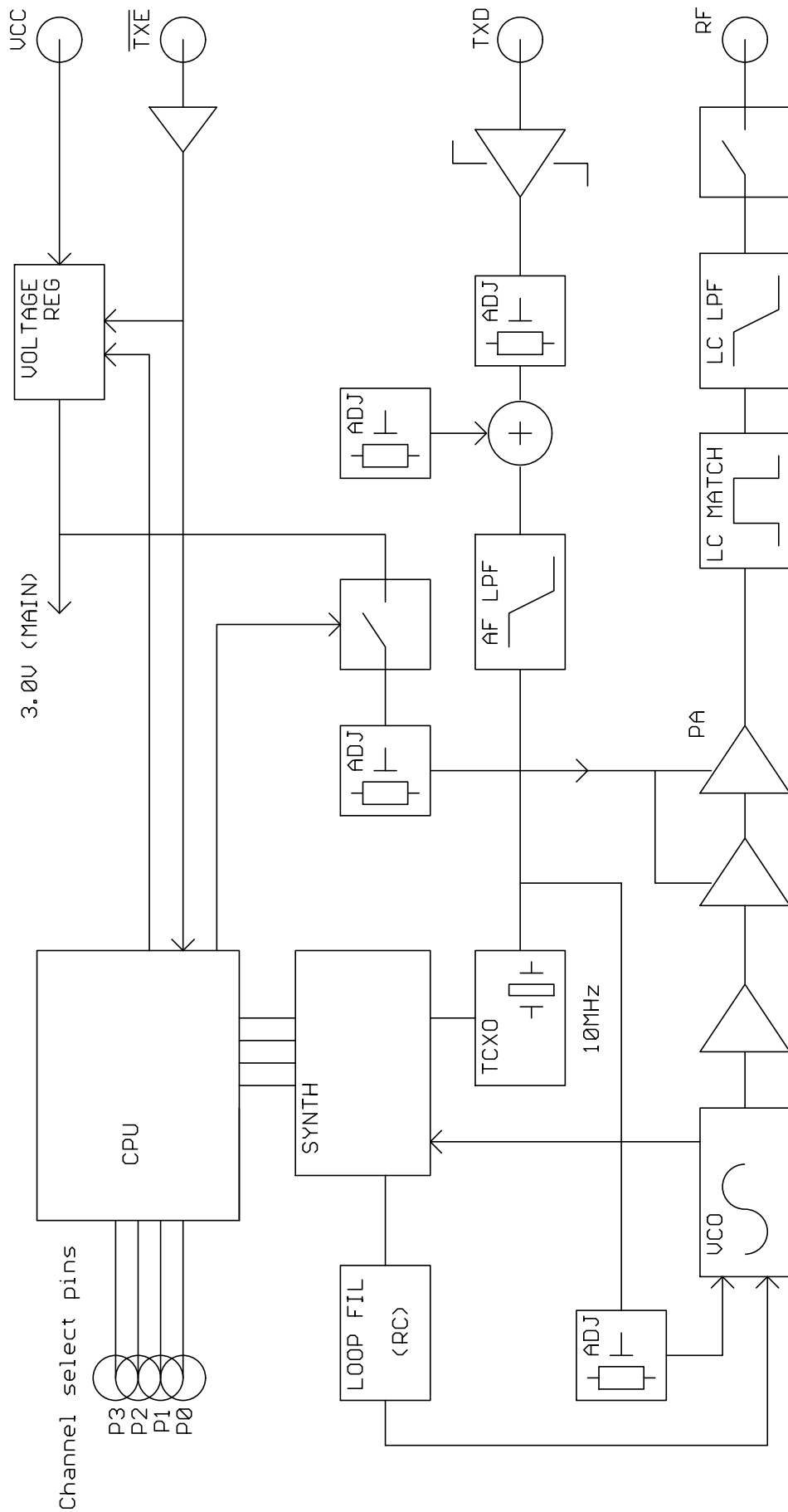


Figure 2: LMT1 block diagram

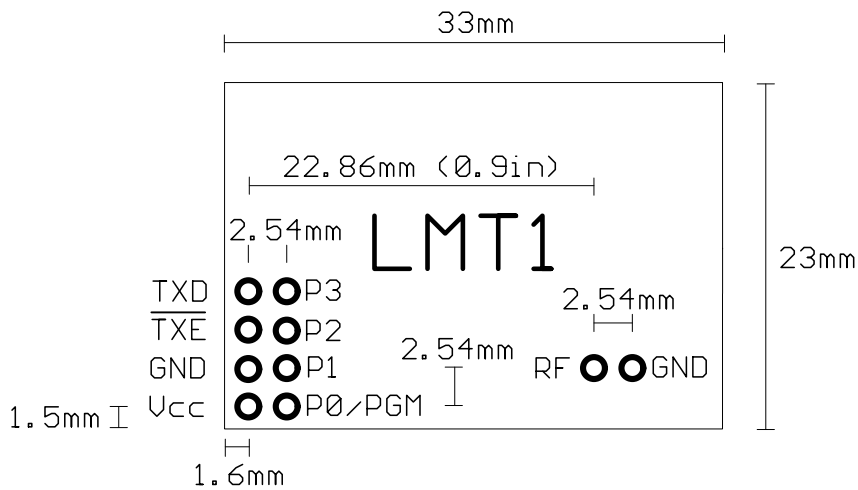


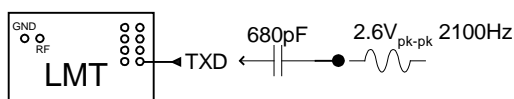
Figure 3: LMT1 footprint (top view)

Pin description – LMT1

Pin	Name	Function
1a	Vcc	3.1 – 15V power supply (10mW) 4.1V – 15V power supply (100mW)
2a	0V	Ground
3a	TXE	Transmit Enable (active low)
4a	TXD	DC coupled input for 3V CMOS logic. $R_{in}=47k\Omega$ See note 10 below for phase modulation (-PM) version
5a	No pin	Not present in LMT1
1b	P0/PGM	Parallel Channel select LSB Serial frequency programming / configuration ¹
2b	P1	Parallel Channel select
3b	P2	Parallel Channel select
4b	P3	Parallel Channel select MSB
5b	No pin	Not present in LMT1

Notes:

- Serial programming is by an inverted, CMOS logic level, 2400 baud RS232 datastream applied to the P0 pin.
- Channel select inputs have pullups (50k Ω) to 3v internal rail. Do not exceed 3V logic levels on this port.
- Channel select inputs are active low
- TXE has a 100k Ω pullup to Vcc
- All pins are on an 0.1" grid
- The pins 5a/b are not present, but are included in footprint for compatibility with other units in this family
- In the 'off' state a PIN switch open circuits the RF output pin. There are no 'off' state spuri.
- Unit will operate (with marginally reduced specifications and lower (6-8mW) output power) from a 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.
- 100mW versions should not be run continuously from supply voltages > 9v
- Phase Modulation (-PM) version LMT1:** 2.6V peak-to-peak level 2100Hz sinewave tone via an external 680pF series capacitor will produce FM deviation of 4.2kHz.



The external 680pF series capacitor on LMT1 TXD input provides a defined 6dB per octave pre emphasis response, to mimic the behavior of a Phase Modulated transmitter.

LMR1 VHF multichannel receiver

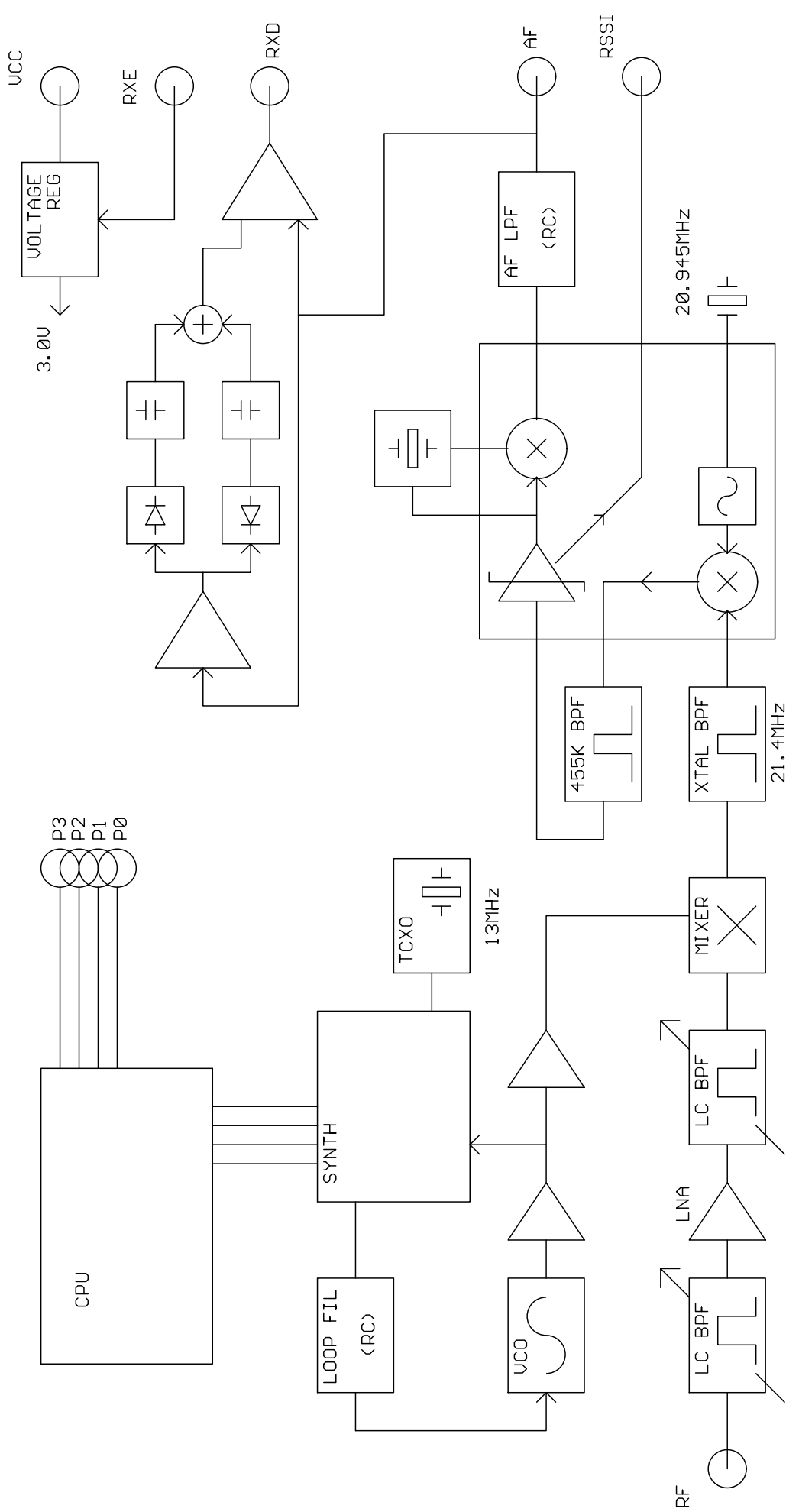


Figure 4: LMR1 block diagram

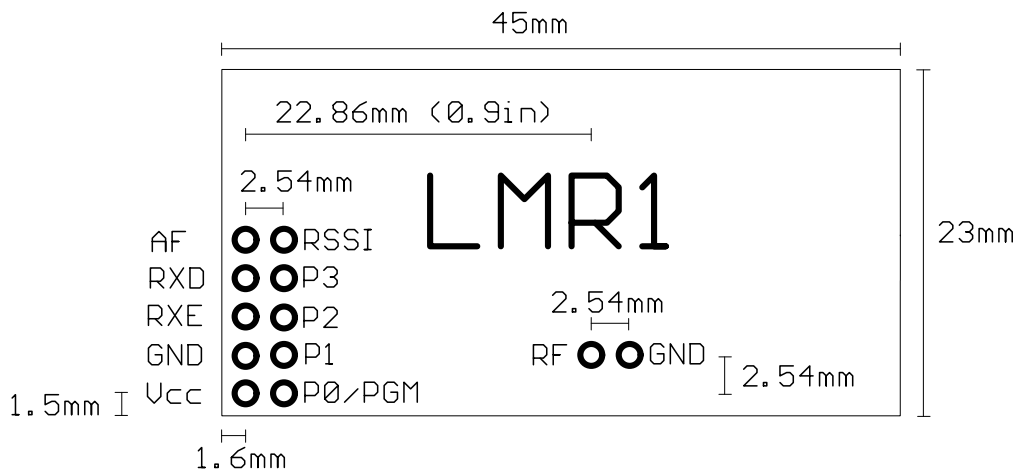


Figure 5: LMR1 footprint (top view)

Pin description – LMR1

Pin	Name	Function
1a	Vcc	3.1 – 15V power supply
2a	0V	Ground
3a	RXE	Receiver Enable (active high)
4a	RXD	Data out (open collector, no pullup)
5a	AF out	700mV p-p audio. DC coupled, approx 0.8v bias.
1b	P0/PGM	Parallel Channel select LSB Serial frequency programming / configuration ¹
2b	P1	Parallel Channel select
3b	P2	Parallel Channel select
4b	P3	Parallel Channel select MSB
5b	RSSI	DC level between 0.5v and 2.2v. 60dB dynamic range

NOTES:

1. Serial programming is by an inverted, cmos logic level, 2400 baud RS232 datastream applied to the P0 pin.
2. Channel select inputs have pullups (50k Ω) to 3v internal rail. Do not exceed 3v logic levels on this port.
3. Channel select inputs are active low
4. All pins are on an 0.1" grid
5. Data recovery circuit used for RXD is not a simple 'average and compare' type. It is a peak sampling quasi-DC coupled design, allowing a greater than usual flexibility in data format.
6. Unit will operate (with marginally reduced specifications) from a 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.

Serial interface commands

2400 baud RS232. 8 bit data, no parity, 1 start bit, 1 or 2 stop bits.

Serial data is sent to the unit on one of the parallel channel select pins (P0). It is very important that the unit does not 'decode' switch bounce in ordinary operation as a command string, or spurious re-writing of the e2prom will result. For this reason the user must send the 16 character string ENABLESERIALMODE (followed by a carriage return) to activate the serial command mode before sending any of the command strings listed below. Command mode is disabled on power down, or on reception of a # character. To successfully program the unit, it must be enabled ('RXE high (rx) or TXE low (tx)).

GOCHAN aa	Serially select channel aa, where aa is ch0 to ch31
LOAD aa nnnnn	Set value of N register for channel aa, where aa is Channels 0 to 31
SETPAR	Channel selected by 4 bit parallel inputs (ch0 to ch15 only)
SETSER	Channel selected by most recent GOCHAN operation
RVALUE rrrr	Set value for R register
SINGLE nnnnn	Set value of N for single channel operation. N value NOT stored in EEPROM
<cr>	Process entry
/	Clear all buffers
#	Disable command mode

aa = a two digit channel number from 00 to 31

nnnnn = synthesizer N register value (up to 65535)

rrrr = synthesizer R register value (up to 16383)

For LMT1 Transmitter:

$$R = \frac{f_{Xtal}}{f_{channelspacing}} = \frac{10MHz}{25kHz}, \text{ So } R=400$$

$$N_{TX} = \frac{f_{RF}}{f_{Channelspacing}} = \frac{173.250MHz}{25kHz} = 6930$$

For LMR1 Receiver:

$$R = \frac{f_{Xtal}}{f_{channelspacing}} = \frac{13MHz}{25kHz}, \text{ So } R=520$$

$$N_{RX} = \frac{f_{RF} - 21.4MHz}{f_{Channelspacing}} = \frac{173.250MHz - 21.4}{25kHz} = 6074$$

Notes: 1. A pause of at least 50ms must be allowed between command strings (EEPROM programming time).

2. SINGLE mode does not store the N value in EEPROM. Therefore the unit is inoperative after a power down until either another valid SINGLE command is received, or mode is changed by a GOCHAN, SETPAR or SETSER command. SINGLE mode is intended for frequency agile applications.

3. For UK version (173.200 - 173.325MHz band) the following channel assignment is supplied:

CH0: 173.250MHz

CH1: 173.275MHz

CH2: 173.300MHz

CH3: 173.325MHz

CH4 - CH7: 173.225MHz (only used for alarm applications)

CH8 - CH31: 173.325MHz

Condensed specifications

Frequency	Any frequency in the 173MHz and 151MHz bands In UK band, only 173.250, 173.275, 173.300 and 173.325 MHz are used as standard 150.825 - 152.450MHz (Australian LIPD Band) 150-174MHz US licensed Private Land Mobile Radio (PLMR) band Other custom variants from 130 - 180MHz on any 2MHz band
<i>Frequency stability</i>	±1.5kHz
<i>Channel spacing</i>	12.5kHz, 20kHz or 25kHz
<i>Number of channels</i>	16 channels controlled by parallel port or 32 via serial RS232 interface
Operating temperature	-20 °C to +70 °C (Storage -30 °C to +70 °C)
Spurious radiations	Compliant with ETSI EN 300 220-3 and EN 301 489-3 Compliant with FCC Part 90 (LMT1), Part 15B (LMR1)
Transmitter	
Output power	+10dBm (10mW) ±1dB nominal (factory adjustable 1 - 25mW) and +20dBm (100mW) ±1dB nominal (factory adjustable 25 - 100mW)
Peak deviation	±3kHz (±1.5kHz @ 12.5kHz channel spacing) -PM version: ±4.2kHz (for 2.6V pk-pk 2100Hz)
TX on switching time	30ms from TXE transition
Modulation type	FSK (F3D) Phase modulation (-PM version)
TX modulation bandwidth	DC – 5kHz (3V CMOS compatible)
Adjacent channel TX power	<-37dBm
TX spurious	<-40dBm (no RF output in Standby)
Supply	
Voltage	3.1V – 15V (10 – 25mW) 4.1V – 15V (25 – 100mW);
Current	34mA nominal transmit (@10mW) 90mA nominal transmit (@100mW) <8µA standby (TXE high or floating)
Inputs	data (CMOS/TTL compatible)
Size	33 x 23 x 9mm
Interface	<i>User</i> 10 (8) pin 0.1" pitch dual row (5+5) header <i>RF</i> 2pin 0.1" pitch
Recommended PCB hole size	1.2mm
Receiver	
Sensitivity	-118dBm for 12dB SINAD
S/N ratio	35dB (min), 40dB (typ) on AF output
AF bandwidth (-3dB)	4kHz
image	<-60db
Othr spurious	<-70dbm
Blocking	Better than 84dB
Adjacent channel	<-60dB
LO re-radiation	-70dBm
Supply	
Voltage	3.1V – 15V
Current	20mA receive <1µA standby (RXE low)
Outputs	RSSI, audio, data (quasi DC data recovery circuit)
Size	46 x 23 x 9 mm
Interface	<i>User</i> 10 pin 0.1" pitch dual row (5+5) header <i>RF</i> 2pin 0.1" pitch
Recommended PCB hole size	1.2mm

RX Received Signal Strength Indicator (RSSI)

The LMR1 has wide range RSSI that 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 5b of the module has a standing DC bias of up to 0.5V with no signal, rising to 2.5V at maximum indication (RF input levels of -40dBm and above). $\Delta V_{\text{min-max}}$ is typically 2V and is largely independent of standing bias variations. Output impedance is 40k Ω . Pin 5b can drive a 100 μA meter directly, for simple monitoring.

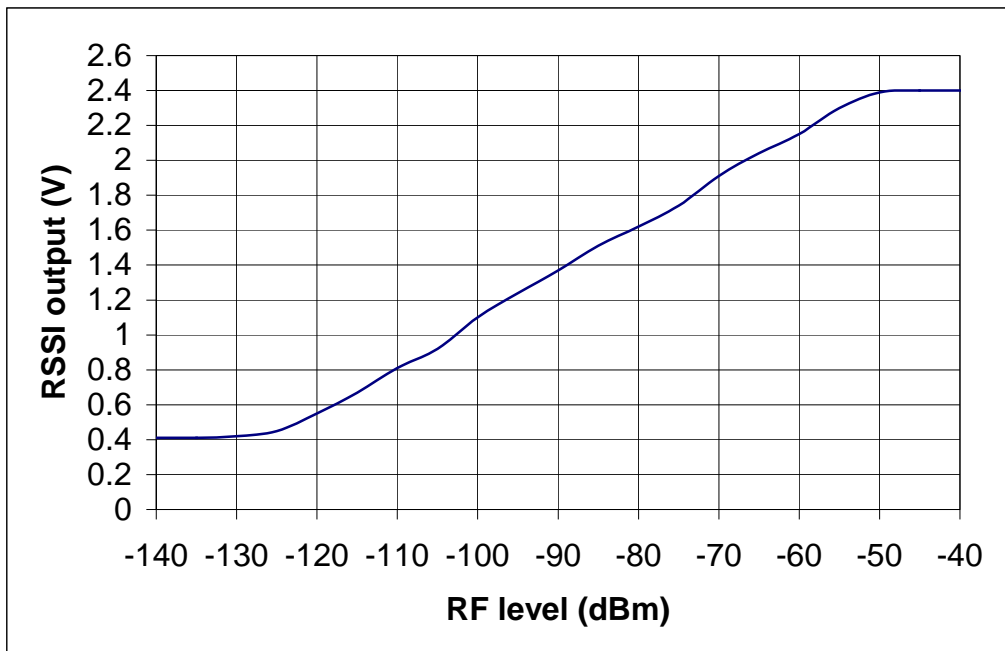


Figure 6: typical RSSI level with respect to received RF level at LMR1 antenna pin

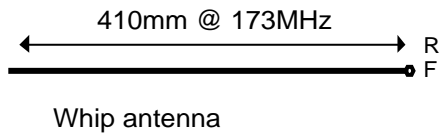
Antenna requirements

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 410mm (1/4 wave @ 173MHz). 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.

	A	B	C
	<i>whip</i>	<i>helical</i>	<i>loop</i>
Ultimate performance	***	**	*
Easy of design set-up	***	**	*
Size	*	***	**
Immunity proximity effects	*	**	***

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.



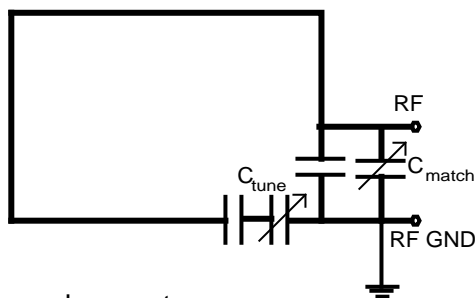
Whip antenna

wire, rod, PCB track
or a combination of these
length(mm) = 71250 / freq(MHz)



Helical antenna

35-40 turns wire spring
length 120mm, dia 10mm
trim wire length or expand coil for
best results



Loop antenna

track width = 1mm
min. area 500mm²
capacitors may be variable or fixed
(values depend on loop dimensions)

Figure 7: Antenna types

Ordering Information:

Part No.	Description	Frequency band (MHz)	RF power (mW)	Channel spacing (kHz)	Data rate kbps
LMT1-173-5	Transmitter	173.225 - 173.325	10	25	5
LMR1-173-5	Receiver	173.225 - 173.325		25	5
LMT1-151-5	Transmitter	150.825 - 152.450	100	25	5
LMR1-151-5	Receiver	150.825 - 152.450		25	5
LMT1-144-5	Transmitter	144.000 - 146.000	100	25	5
LMR1-144-5	Receiver	144.000 - 146.00		25	5
LMT1-173-5-12k5	Transmitter	173.225 - 173.325	10	12.5	5
LMR1-173-5-12k5	Receiver	173.225 - 173.325		12.5	5
LMT1-151-5-12k5	Transmitter	150.825 - 152.450	100	12.5	5
LMR1-151-5-12k5	Receiver	150.825 - 152.450		12.5	5
LMT1-173-10	Transmitter	173.225 - 173.325	10	25	10
LMR1-173-10	Receiver	173.225 - 173.325		25	10
LMT1-xxx-5	Where xxx is any 2MHz band from 130MHz to-180MHz		10/100	25	5
LMR1-xxx-5				25	5
LMT1-xxx-PM	Where xxx is any 2MHz band from 130MHz to-180MHz		10/100	25	2.6Vpk-pk 2100Hz

Federal Communications Commission (FCC) Labelling Requirement

LMT1 Transmitter module is labelled as follows:

LMR1 Receiver module is labelled as follows:

Radiometrix Ltd
LMT1-xxx.xxx-5-ccc
12.5kHz NBFM Transmitter
CH0:aaa.aaaa – CH31:zzz.zzzzMHz
FCC ID: TSK-LMT1

Radiometrix Ltd
LMR1-xxx.xxx-5-ccc
12.5kHz NBFM Receiver
CH0:aaa.aaaa – CH31:zzz.zzzzMHz
FCC ID: TSK-LMR1

xxx.xxxx is the middle frequency of the 2MHz sub-band within 150-174MHz
ccc is the Suffix to identify channel frequency table configuration specific to customer
aaa.aaaa is the Channel 0 Frequency
zzz.zzzz is the Channel 31 Frequency

The Original Equipment Manufacturer (OEM) must ensure a clearly visible label on the outside of the final product enclosure that displays the text shown below to comply with FCC requirement.

Contains LMT1-xxx.xxx-5-ccc
FCC ID: TSK-LMT1
This device complies with Part 90 of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

Contains LMR1-xxx.xxx-5-ccc
FCC ID: TSK-LMR1
This device complies with Part 15 subpart B of the FCC Rules. Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Label must be etched, engraved, stamped, indelibly printed, or permanently fixed on an exterior surface of the equipment and must be visible at the time of purchase (can be on the inside of the battery compartment of hand held equipment, but not on the battery cover. Battery cover must not require special tools for removal).

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This device has been designed to operate with following antennas with 0dB Gain to prevent usage of any prohibited antennas.

Helical Antenna

Radiometrix Part Number: ANT-xxx-H-BNC
Manufacturer Part Number: BNCVHFH
Data Sheet: <http://www.badland.co.uk/pdfs/HELICAL%20DATA%20SHEET.pdf>

It is a Helical VHF Antenna with BNC connector where xxx is the operating frequency of the LMT1/LMR1.

¼ wavelength Monopole (Whip) Antenna

Radiometrix Part Number: ANT-xxx-W-SMA
Manufacturer Part Number: SMAWHIP
Data Sheet: <http://www.badland.co.uk/pdfs/uhf%20flexy%20data%20sheet.pdf>

It is a $\frac{1}{4}$ wavelength Monopole (Whip) VHF Antenna with SMA connector where xxx is the operating frequency of the LMT1/LMR1.



Figure 8: ANT-xxx-H-BNC



Figure 9: ANT-xxx-W-SMA

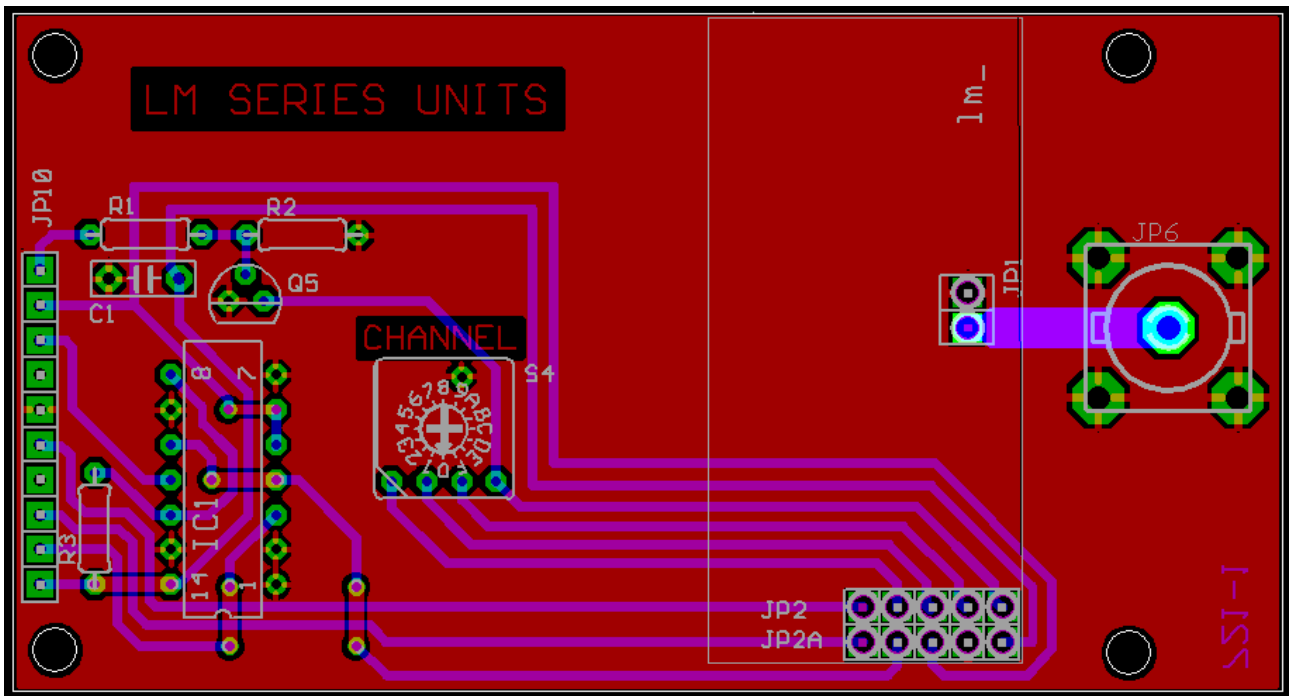


Figure 10: Narrow Band Evaluation Kit LM Carrier Board

A 50Ω Micro-strip trace layout should be constructed on host PCB between Antenna BNC/SMA connector (JP6) and the RF pin (JP1) of the LMT1/LMR1 module using a 2.8mm width copper track on one side (blue) and ground plane (red) on other side of a 1.6mm thick FR4 PCB.

LMT1, LMR1 modules were tested with above microstrip design used on Narrow Band Evaluation Kit (NBEK) LM Carrier Board during FCC certification process.

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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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