

VHF Narrow Band FM transceiver

The BiM1 transceiver modules offer a 100mW RF output VHF data link in Radiometrix transceiver standard pin-out and footprint. This makes the BiM1 ideally suited to those low power applications where existing wideband transceivers provide insufficient range.



Figure 1: BiM1-151.300-10

Features

- Conforms to EN 300 220-3 and EN 301 489-3 (10mW version only)
- Standard frequency 151.300MHz
- Other frequencies from 120MHz to 180MHz
- Available separately as BiM1T transmitter and BiM1R receiver
- TX1H is a BiM1T in TX1 pin-out
- Data rates up to 10kbps for standard module
- Usable range over 10km
- Fully screened
- Feature-rich interface (RSSI, analogue and digital baseband)
- Low power requirements

The BiM1 is a half duplex radio transceiver module for use in long range bi-directional data transfer applications at ranges up to 10kilometres. The module operates on the UK licence exempt frequency of 173.225/173.250MHz with 10mW RF output and Australian frequency of 151.300MHz with 100mW RF output. The small footprint of 23 x 33mm and low profile of 10mm together with low power requirements of <80mA (for 100mW) at 3.8V enables convenient PCB installation. BiM1 is also available as separate BiM1T transmitter and BiM1R receiver which can be used as dual-in-line equivalents of TX1 transmitter and RX1 receiver respectively.

Applications

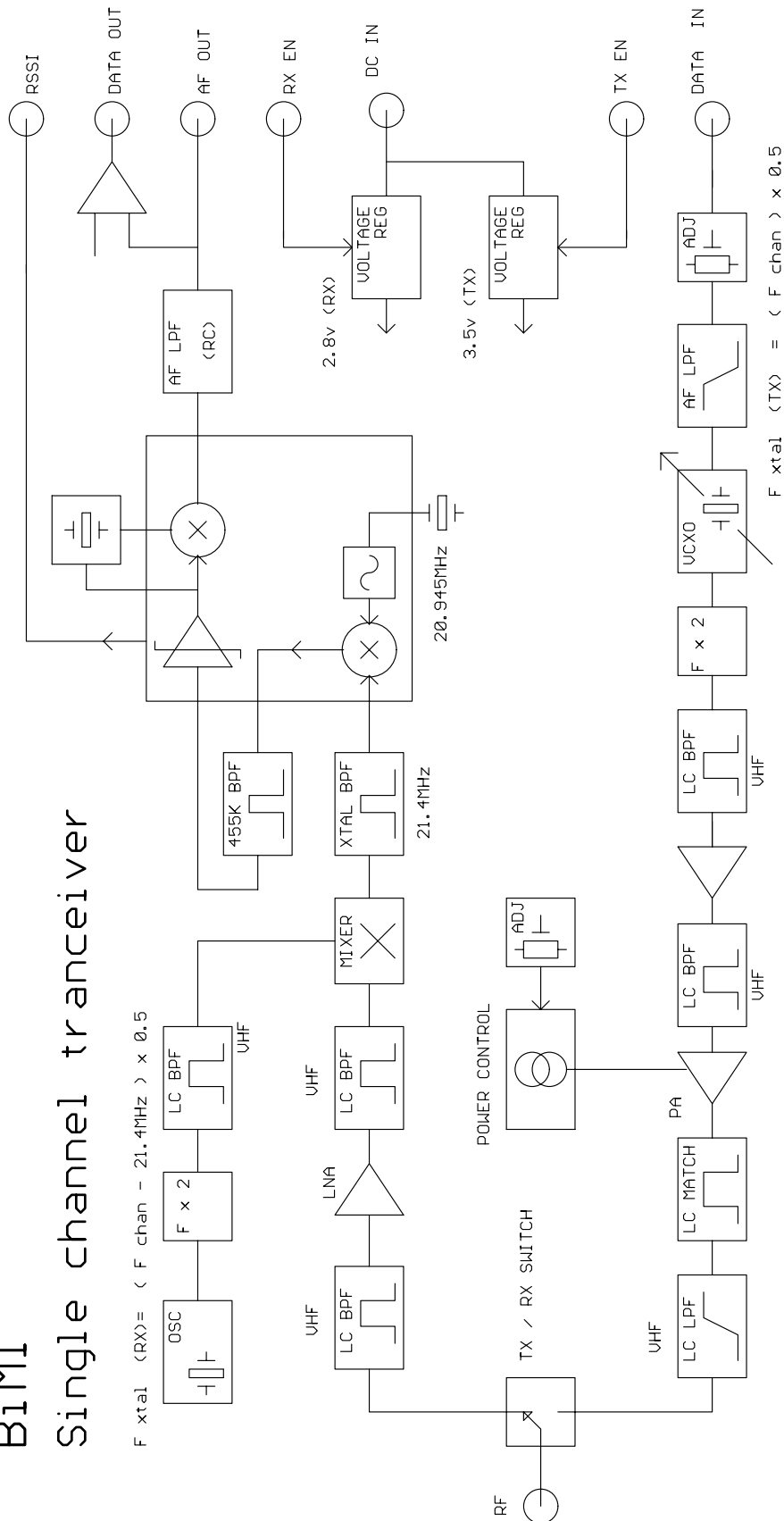
- EPOS equipment, barcode scanners
- Data loggers
- Industrial telemetry and telecommand
- In-building environmental monitoring and control
- High-end security and fire alarms
- DGPS systems
- Vehicle data up/download

Technical Summary

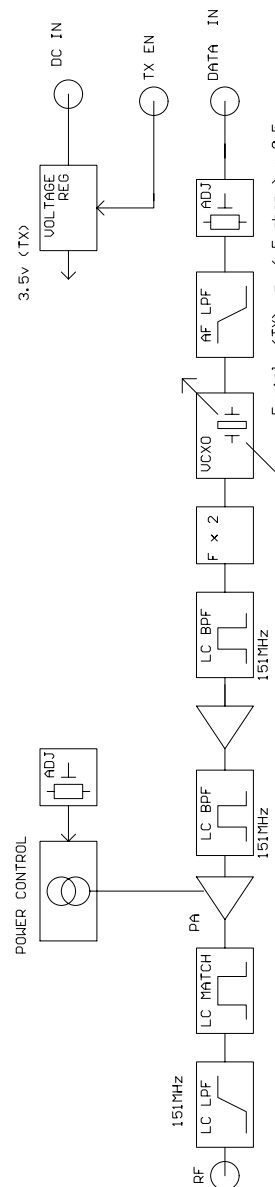
- Size: 33 x 23 x 10mm
- Operating frequency: 151.300MHz
- Supply range: 100mW Transmitter 3.8V - 15V, Receiver: 3.0V-15V
- Supply range: 10mW Transmitter 3.0V - 15V, Receiver: 3.0V-15V
- Current consumption: 80mA transmit @ 100mW, 8mA receive
- Data bit rate: 10kbps max. (standard module)
- RSSI output with >60dBm range
- 10kbps, -120dBm sensitivity (for 12 dB SINAD)

BiM1

Single channel transceiver



TX1H Single channel 100mW UHF transmitter



BiM1 transceiver contains BiM1T transmitter circuit and BiM1R receiver circuit with their RF output and input connected to a common RF pin via an internal RF switch.

TX1H transmitter circuit is the BiM1T transmitter circuit in the TX1 pin-out with slightly enlarged dimension to accommodate extra Power Amplifier circuit to produce 100mW RF output.

Functional description

The transmit section of the BiM1 consists of a frequency modulated Voltage Controlled Crystal Oscillator (VCXO) feeding a frequency doubler with two stage amplifier and RF filter. Final Power Amplifier stage is factory pre-set to appropriate band power level. Operation is controlled by a Tx Select line, the transmitter achieving full RF output typically within 5ms of this line being pulled low. The RF output is filtered to ensure compliance with the appropriate radio regulations and fed via a fast Tx/Rx changeover switch to the 50Ω antenna pin.

The receive section is a double conversion FM superhet with IF at 21.4MHz and 455kHz fed by a Low Noise Amplifier (LNA) on the RF front-end. The receiver is controlled by RX Select line and will power up typically <2ms. Quadrature detector output is available as Audio Frequency (AF) output and transmitted digital data is regenerated from AF using adaptive data slicer. A Received Signal Strength Indicator (RSSI) output with some 60dB of range is provided.

User interface

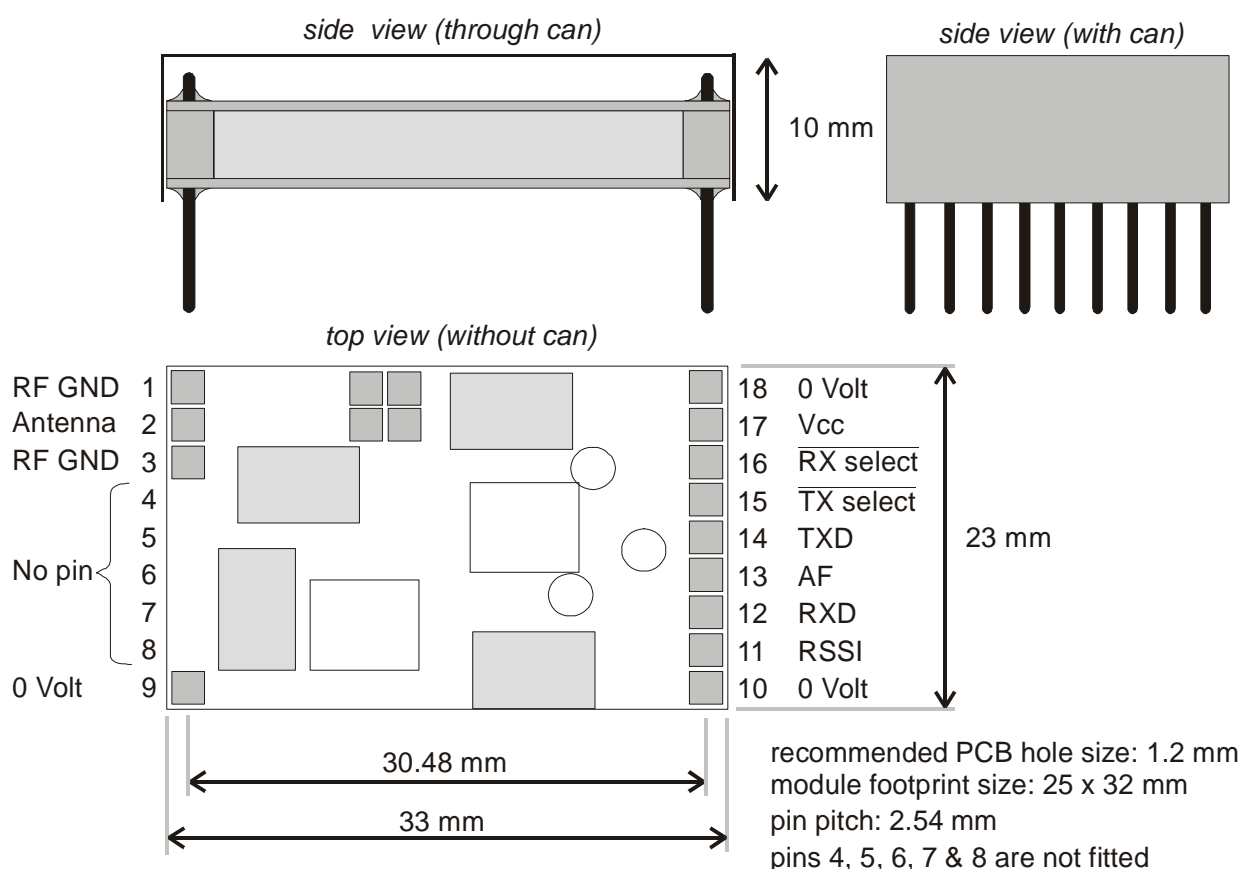


Figure 4: BiM1 pin-out and dimension

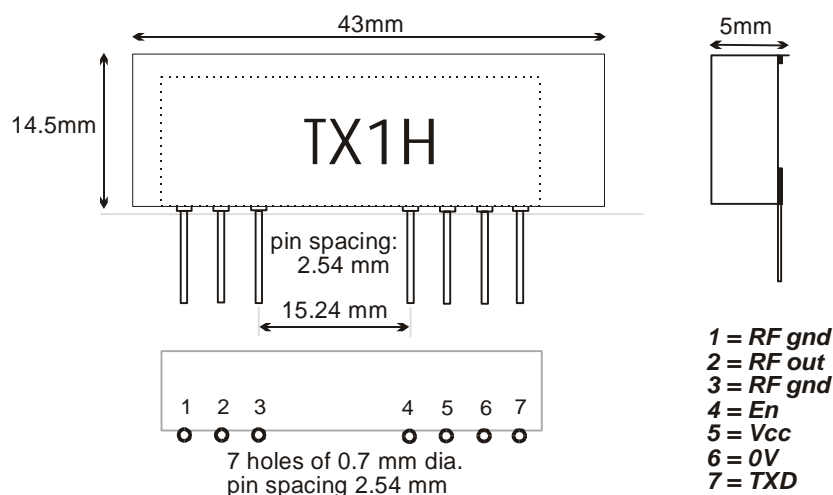


Figure 5: TX1H pin-out and dimension

BiM1 Pin	TX1H pin	Name	Function
1, 3, 9, 10, 18	1, 3, 6	0V	Ground
17	5	VCC	3.8 – 15V DC power supply
16	-	$\overline{\text{RX}}$	Pull low to enable Receiver
15	4	$\overline{\text{TX}}$ EN	Pull low to enable Transmitter Pull high to enable Transmitter
14	7	TXD	DC coupled input for 3V CMOS logic. $R_{in} = 100k\Omega$
13	-	AF	500mV _{pk-pk} audio. DC coupled, approx 0.8V bias
12	-	RXD	2.5V _{pk-pk} logic output of data slicer. Suitable for Biphase codes
11	-	RSSI	DC level between 0.5V and 2V. 60dB dynamic range

NOTES:

1. $\overline{\text{RX}}$ and $\overline{\text{TX}}$ have internal (10k Ω approx.) pull-up to Vcc
2. EN pin should not be left floating
3. For Vcc greater than 9V, transmit duty cycle must be limited to 25% or less
4. Avoid $\overline{\text{RX}}$ and $\overline{\text{TX}}$ both low: undefined module operation (but damage will not result)
5. A 10mW UK version is available on 173.225MHz. (3-16V operation, 10mA TX)
6. Pin out is as BiM2. On RF connector end only pins 1, 2, 3, 9 are present.

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

RF in (pin 1) $\pm 50V @ <10MHz$, +13dBm @ >10MHz

All other pins -0.3V to +16.0V

Performance specifications:

(Vcc = 3.8V / temperature = 20 °C unless stated)

General	pin	min.	typ.	max.	units	notes
DC supply						
Supply voltage (100mW BiM1T)	17	3.8	-	15	V	
Supply voltage (10mW BiM1T, BiM1R)	17	3.0	-	16	V	
TX Supply current (100mW)	17		80		mA	
TX Supply current (10mW)	17		25		mA	
RX Supply current	17		8		mA	
Antenna pin impedance	2		50		Ω	
RF centre frequency (100mW)			151.300		MHz	
RF centre frequency (10mW)			173.225		MHz	
Channel spacing			25		kHz	
Number of channels			1			
Transmitter						
RF						
RF power output (100mW)	2	+19	+20	+21	dBm	1
RF power output (10mW)	2	+9	+10	+11	dBm	1
Spurious emissions (100mW)	2		-40		dBm	
Spurious emissions (10mW)	2		EN 300 220-3		dBm	2
Adjacent channel TX power (100mW)			-37		dBm	
Adjacent channel TX power (10mW)			TBD			2
Frequency accuracy		-2.5	0	+2.5	kHz	3
FM deviation (peak)		± 2.5	± 3.0	± 3.5	kHz	4
Baseband						
Modulation bandwidth @ -3dB		0		5	kHz	
TXD input level (logic low)	14		0		V	5
TXD input level (logic high)	14		3.0		V	5
Dynamic timing						
TX select to full RF			5		ms	

General	pin	min.	typ.	max.	units	notes
Receiver						
RF/IF						
RF sensitivity @ 12dB SINAD	2, 13		-120		dBm	
RF sensitivity @ 1ppm BER	2, 12		-115		dBm	
RSSI threshold	2, 11		-127		dBm	
RSSI range	2, 11		60		dB	
IF bandwidth					kHz	
Blocking	2		85		dB	
Image rejection	2		60		dB	
Adjacent channel rejection	2		70		dB	2
Spurious response rejection	2		65		dB	
LO leakage, conducted			-70		dBm	3
LO leakage, radiated			-60		dBm	3
Baseband						
Baseband bandwidth @ -3dB	13		5		kHz	
AF level	13		400		mV _{P-P}	7
DC offset on AF out	13		0.8		V	
Distortion on recovered AF	12		TBD		%	
Load capacitance, AF / RXD	12,13		TBD		pF	
Dynamic timing						
<i>Power up with signal present</i>						
Power up to valid RSSI	16, 11		TBD		ms	
Power up to stable AF output	16, 13		2			
Power up to stable RXD output	16, 12		10		ms	
<i>Signal applied with supply on</i>						
Signal to valid AF	2, 11		TBD		ms	
Signal to stable data	2, 12		TBD		ms	
Time between data transitions	12			0.1	ms	8
Mark : space ratio	12	20	50	80	%	8

Notes:

1. Measured into 50Ω resistive load.
2. Exceeds EN/EMC requirements at all frequencies.
3. Total over full supply and temperature range.
4. With 0V – 3.0V modulation input.
5. To achieve specified FM deviation.
6. See applications information for further details.
7. For received signal with ±3kHz FM deviation.
8. For 50:50 mark to space ratio (i.e. squarewave).

Applications information

Power supply requirements

The BiM1 have built-in regulators which deliver a constant 3.5V to the transmitter and 2.8V to the receiver.circuitry when the external supply voltage is 3.5V or greater. 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 $>0.1V_{p-p}$).

TX modulation requirements

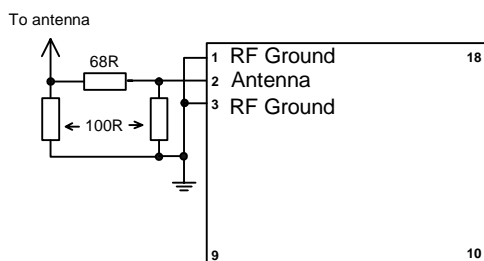
The module is factory-set to produce the specified FM deviation with a TXD input to pin 14 of 3V amplitude, i.e. 0V “low”, 3V “high

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 100k Ω to ground, giving typical required resistor values as follows:

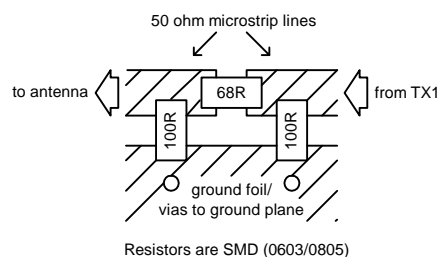
Vcc	Series resistor
$\leq 3V$	-
3.3V	10 k Ω
5V	68k Ω
9V	220k Ω

Reducing the output power of the BiM1

If the BiM1 is to be used for applications for which the regulatory Effective Radiated Power (ERP) limit is lower than 100mW its output power can be reduced to comply with relevant regulatory requirements. This is done by inserting a 10dB attenuator network between the module and the antenna or feed, as follows:



schematic diagram



physical arrangement

Figure 6: 10dB attenuator for BiM1 transceiver, BiM1T transmitter

Keep all tracking around the attenuator network as short as possible, particularly ground paths, and use matched 50 Ω microstrip lines for input and output connections (track width of 2.5mm if using 1.6mm thick FR4 PCB).

However, this 10dB attenuator will also reduce the sensitivity of the BiM1 transceiver by 10dB.

RF output can also be factory set from +5dBm (3mW) to +20dBm (100mW) depending on minimum order quantity.

RX Received Signal Strength Indicator (RSSI)

The BiM1 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 Ω . Pin 11 can drive a 100 μ A meter directly, for simple monitoring.

Typical RSSI characteristic is as shown below:

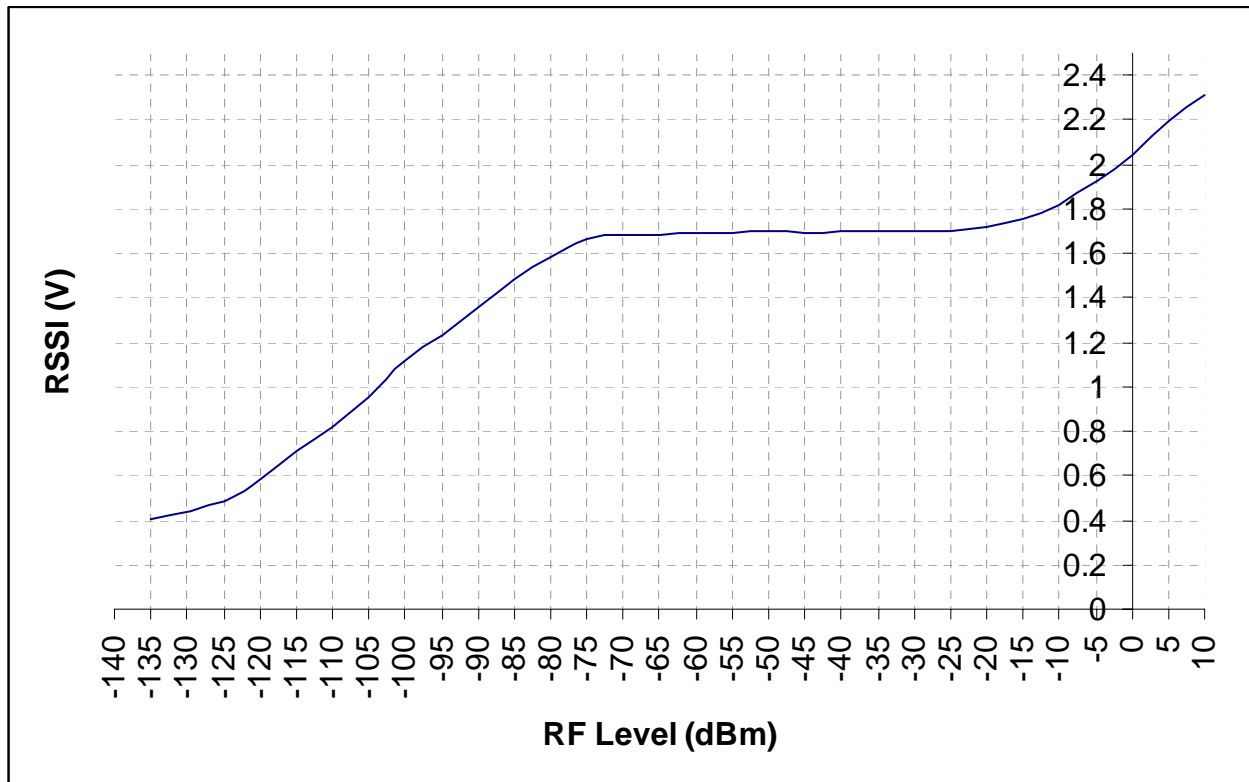


Figure 7: RSSI level with respect to received RF level at BiM1 antenna pin

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 BiM1 to stabilise. The BiM1 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.

Networks

BiM1's may be used in many different configurations from simple pair's to multi-node random access networks. The BiM1 is a single frequency device thus in a multi node system the signalling protocol must use Time Division Multiple Access (TDMA). In a TDMA network only one transmitter may be on at a time, 'clash' occurs when two or more transmitters are on at the same time and will often cause data loss at the receivers. TDMA networks may be configured in several ways - Synchronous (time slots), Polling (master-slave) or Random access (async packet switching e.g. X25). Networked BiM1's allow several techniques for range / reliability enhancement:

- Store and forward Repeaters:** If the operating protocol of the network is designed to allow data path control then data may be routed via intermediate nodes. The inclusion of a repeating function in the network protocol either via dedicated repeater/router nodes or simply utilising existing nodes allows limitless network expansion.
- Spatial Diversity:** In buildings multi-path signals create null spots in the coverage pattern as a result of signal cancellation. In master-slave networks it is cost effective to provide 2 BiM1's with separate antenna at the master station. The null spot patterns will be different for the two BiM1's . This technique 'fills in' the null spots, i.e. a handshake failure on the first BiM1 due to a signal null is likely to succeed on the 2nd BiM1.

"RS232" Serial data

It is possible to transmit "RS232" serial data directly at 600 to 9600bps baud between a pair of BiM1 transceivers in half duplex mode. The data must be "packetised" with no gaps between bytes. i.e. The data must be preceded by >10ms of preamble (55h or AAh) to allow the data slicer in the BiM1 to settle, followed by one 00h and one FFh bytes to allow the receive UART to lock, followed by a unique start of message byte, (01h), then the data bytes and finally terminated by a CRC or check sum. The receiver data slicer provides the best bit error rate performance on codes with a 50:50 mark:space average over a 5ms period, a string of FFh or 00h is a very asymmetric code and will give poor error rates where reception is marginal. Only 50:50 codes may be used at data rates above 1kbps.

We recommend 3 methods of improving mark:space ratio of serial codes, all 3 coding methods are suitable for transmission at 10kbps:-

- **Method 1 - Bit coding**

Bit rate , Max 10kbps , Min 250bps
Redundancy (per bit) 100% (Bi-phase)

Each bit to be sent is divided in half, the first half is the bit to be sent and the second half, it's compliment. Thus each bit has a guaranteed transition in the centre and a mark:space of 50:50 . This is Bi-phase or Manchester coding and gives good results, however the 100% redundancy will give a true throughput of 5kbps.

Another variation of this code is to encode a '1' as a long bit with one transition and '0' as a short bit with two transition or vice versa. Each encoded bit starts with a guaranteed transition to reverse the voltage level even if stream of 00h/FFh is encoded. This is called Differential Manchester Encoding. This encoding method is easier to decode as the decoder has to sample encoded bit several times and if the sample value is more than 75% of a long bit period, then it is decoded as '1' and if there was transition then it is decoded as '0' or vice versa.

- **Method 2 - FEC coding**

Bit rate , Max 10kbps, Min 2.4kbps
Redundancy (per byte) 100%

Each byte is sent twice; true then it's logical compliment. e.g. even bytes are true and odd bytes are inverted. This preserves a 50:50 balance.

A refinement of this simple balancing method is to increase the stagger between the true and the inverted data streams and add parity to each byte. Thus the decoder may determine the integrity of each even byte received and on a parity failure select the subsequent inverted odd byte. The greater the stagger the higher the immunity to isolated burst errors.

Digitised analogue data

Linear operation of BiM1 transceivers will allow direct transfer of analogue data, however in many applications the distortion and low frequency roll off are too high (e.g. bio-medical data such as ECG). The use of delta modulation is an excellent solution for analogue data in the range 1Hz up to 4kHz with less than 1% distortion. A number of proprietary IC's such as Motorola's MC3517/8 provide CVSD Delta mod/demod on a single chip.

Where the signal bandwidth extends down to DC , such as strain gauges, level sensing, load cells etc. then Voltage to Frequency / Frequency to Voltage chips (such as Nat Semi LM331) provide a simple means of digitising.

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:

Data rate	Tx antenna	Rx antenna	Environment	Range
1.2kbps	half-wave	half-wave	rural/open	10-15km
10kbps	half-wave	half-wave	rural/open	3-4km
10kbps	helical	half-wave	urban/obstructed	500m-1km
10kbps	helical	helical	in-building	100-200m

Note: The figure for 1.2kbps assumes that the receiver bandwidth has been suitably reduced by utilising an outboard sallen-key active audio filter and data slicer or similar arrangement.

The BiM1 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 14) 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 BiM1 introduces some 2nd harmonic distortion which may be reduced if necessary by predistortion of the analogue waveform. At the other end of the link the BiM1 RXD output is used to drive an external decoder directly.

Although the modulation bandwidth of the BiM1 extends down to DC 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 BiM1 audio output.

The BiM1 in standard form incorporates a low pass filter with a 5kHz nominal bandwidth. This is suitable for transmission of data at raw bit rates up to 10kbps.

In applications such as long range fixed links where data speed is not of prime concern, a considerable increase in range can be obtained by using the slowest possible data rate together with filtering to reduce the receiver bandwidth to the minimum necessary.

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.

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.

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.

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 50 Ω coax feed can be achieved if the elements are angled downwards at approximately 30-40° to the horizontal.

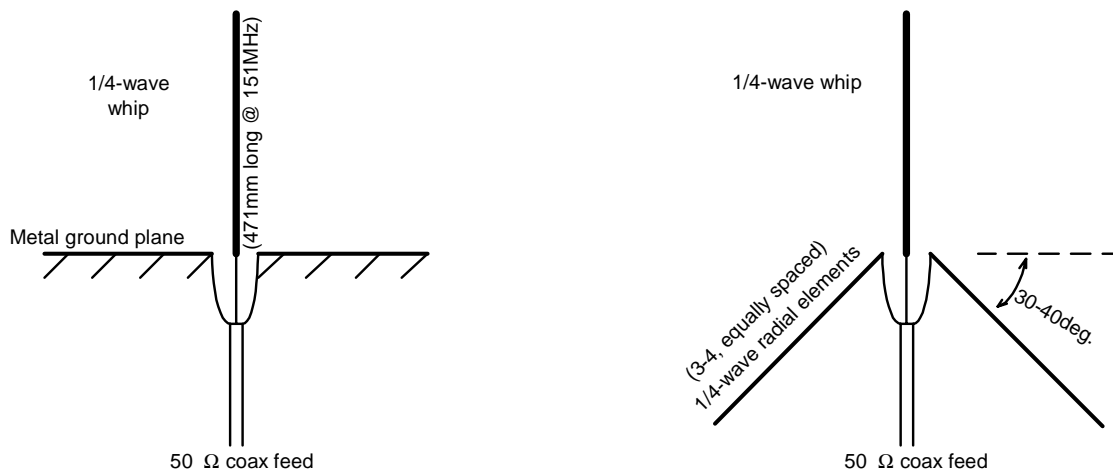


Fig.9: Quarter wave antenna / ground plane configurations

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.

Please note: Using a Yagi or other gain antenna with the BiM1 will exceed the maximum radiated power permitted by UK type approval regulations. It can be used in the UK only in conjunction with the BiM1R receiver.

For best range in UK fixed link applications use a half-wave antenna on BiM1T transmitter and a half-wave or Yagi on BiM1R 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 BiM1 transceiver is manufactured in the following variants as standard:

For Australian general applications on 151.300MHz

TX1H-151.300-10	Transmitter
BiM1T-151.300-10	Transmitter
BiM1R-151.300-10	Receiver
BiM1-151.300-10	Transceiver

For UK alarm applications on 173.225MHz:

BiM1-173.225-10	Transmitter
BiM1-173.225-10	Receiver
BiM1-173.225-10	Transceiver

For UK general applications on 173.250MHz:

BiM1-173.250-10	Transmitter
BiM1-173.250-10	Receiver
BiM1-173.250-10	Transceiver

Other variants can be supplied to individual customer requirements at frequencies from 151.300MHz to 173.250MHz and/or optimised for specific data speeds and formats. However these are subject to minimum order quantity (MOQ) and long lead time. Please consult the Sales Department for further information.

Some of the non-standard frequencies readily available. i.e. no MOQ or long lead time, are as follows:

Part number: BiM1-xxx.xxx-10 (where xxx.xxx is the operating frequency)

Frequency (MHz)	Type approval	Note	Frequency (MHz)	Type approval	Note
138.125	-	1, 2, 3	157.420	Yes	1, 2
149.170	-	1, 2, 3	159.685	Yes	1, 2
151.275	-	1, 2, 3	159.6875	Yes	1, 2
151.300	Yes	1, 2	161.975	Yes	1, 2
151.775	Yes	1, 2	162.025	Yes	1, 2
152.175	Yes	1, 2	162.975	Yes	1, 2
152.500	Yes	1, 2	163.000	Yes	1, 2
152.575	Yes	1, 2	164.525	Yes	1, 2
152.650	Yes	1, 2	167.420	Yes	1, 2
152.850	Yes	1, 2	169.435	Yes	1, 2
153.8125	Yes	1, 2	169.41875	Yes	1, 2
153.9125	Yes	1, 2	172.420	Yes	1, 2
153.925	Yes	1, 2	173.075	Yes	1, 2
154.463	Yes	1, 2	173.175	Yes	1, 2

155.475	Yes	1, 2	173.200	Yes	1, 2
155.715	Yes	1, 2	173.960	Yes	1, 2, 3
155.725	Yes	1, 2	180.175	-	1, 2, 3

Note 1: Complies with the ETSI standards but NOT approved
2: For specialised application, NOT for general purpose
e.g: 121.500MHz is an international distress frequency
3: NOT a European Harmonised frequency. Consult local radio regulatory authority.

Type approval

The BiM1-173 module is meets European harmonised standard ETSI EN 300 220-3 for UK use within the following categories:

- (a) General applications in the band 173.2-173.35MHz but **excluding** 173.225MHz.
- (b) Industrial/commercial applications at the same frequencies as category (a).
- (c) Fixed/in-building alarm applications at 173.225MHz.
- (d) Medical/biological applications (including airborne use for the tracking of birds) in the band 173.7-174.0MHz.

REQUIREMENTS FOR CONFORMANCE TO ETSI EN 300 220-3:

1. Transmitted ERP (effective radiated power) must not exceed the limit of 1mW (0dBm) for category (a) or 10mW (+10dBm) for categories (b), (c) and (d). Equipment in category (a) must include a 10dB attenuator between the RF output pin and the antenna or feed, as specified on page 6 of this leaflet.
2. Any type of antenna system may be employed provided that the applicable ERP limit is not exceeded - i.e. transmitting antenna structures which exhibit ERP gain (such as yagis) are not permitted. See pages 10-13 of this leaflet for details of suitable antennas.
3. The module must not be modified or used outside its specification limits.
4. The module may only be used to transmit digital or digitised data. Speech and/or music are not permitted.

Breaching any of these conditions will invalidate type approval.

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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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