

BiM3D / BiM3DH

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Frequency Programmable FM UHF Transceiver

The BiM3D is a frequency programmable wideband FM transceiver module, which is an enhanced replacement for the BiM3B.

The BiM3DH is a higher power version, offering 25mW transmit power, specifically for the 25mW sub band allocation with in the 868MHz UK/EU license exempt band.

A lower power (0.75mW, compliant with FCC part 15 limits) version is available for US customers, operating in the 915MHz band

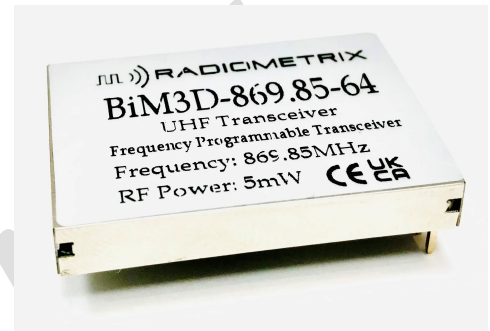


Figure 1: BiM3D-869-64

Features

- RF power output: +7dBm (5mW) for BiM3D
- RF power output: +14dBm (25mW) for BiM3DH
- Data rates: up to 10kbps or 64kbps
- Crystal controlled PLL Frequency Synthesiser based FM circuitry for both Tx and Rx
- SAW front end filter and full screening
- 869.85MHz and 868.30 MHz (EU) or 914.50MHz (North America) as standard
- Receiver Sensitivity: -111dBm for 12dB SINAD @64kbps,
-114dBm for 12dB SINAD @10kbps
- Supply: 2.9V - 16V @ 18mA TX (5mW), 39mA TX (25mW), 18mA Rx
- Conforms to European ETSI EN 301 489-3 and EN 300 220-2 (ERP @ 5mW)
- Usable range up to 300 metres external, 75 metres in building
- Received Signal Strength Indicator (RSSI) or Carrier Detect (CD)
- Analogue and digital baseband
- Low profile with small footprint
- 33 x 23 x 5mm

Applications

- Industrial or Commercial Telemetry and Telecommand
- Wireless Queue Management System
- Wheel Balancing
- Sports Scoreboard Display
- Wireless Battery Monitor.
- Temperature & Pressure Monitoring in Industrial process

Evaluation platforms: Narrow Band Evaluation Kit (NBEK) + BiM3D carrier board

Functional overview

The transmit section of the BiM3D consists of a frequency modulated crystal locked PLL feeding a LC match and RF filter. A TX select line 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. The RF output is filtered to ensure compliance with the appropriate regulations and fed via a Tx/Rx changeover switch to the antenna pin.

The receive section is a single conversion FM superhet with an IF of 10.7MHz. A SAW bandpass filter in the receiver front-end provides image rejection and suppression of other unwanted out-of-band signals. Like the transmitter, the receiver is controlled by its own active low RX select line. A post-detection lowpass filter establishes the signal bandwidth and ensures clean operation of the subsequent adaptive data slicer. The slicer is optimised for balanced data such as bi-phase code. A received signal strength (RSSI) output with 60dB of range is provided.

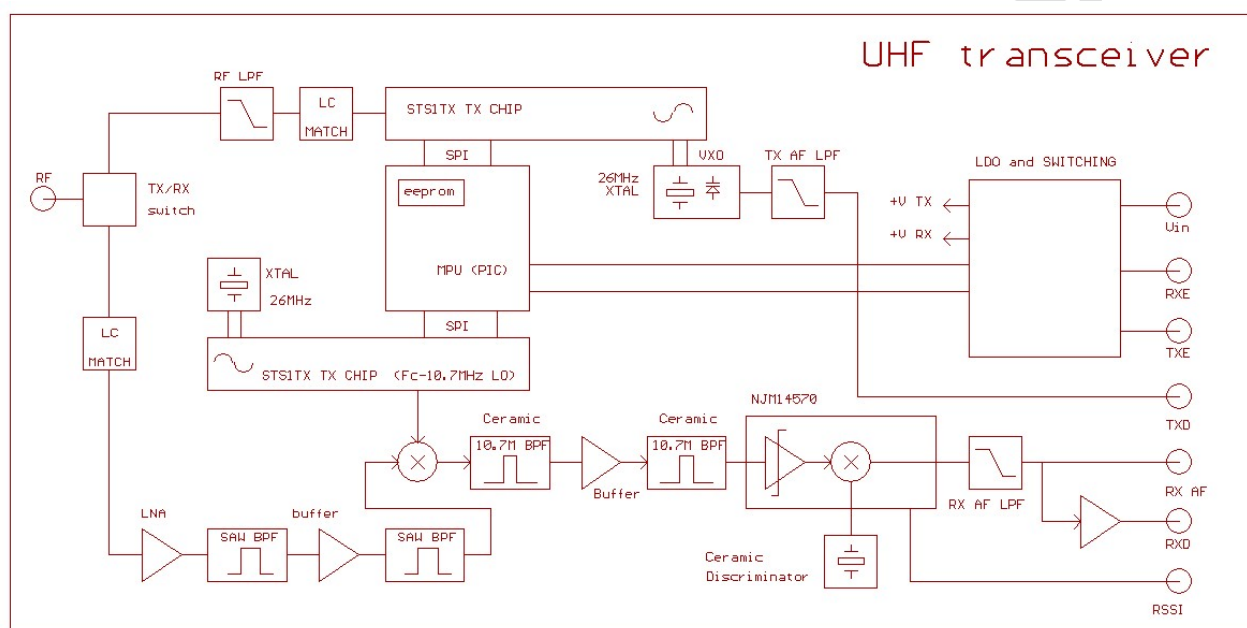


Fig. 2: Block diagram

Pin description

RF GND pins 1 & 3

RF ground pins, internally connected to the module screen and to pins 10 & 18 (0V). These pins should be connected directly to the RF return path (e.g. coax braid, main PCB ground plane etc).

Antenna pin 2

50Ω RF connection to the antenna, DC-isolated. See pages 7 & 8 for details of suitable antennas and feeds.

0V (GND) pins 10 & 18

Supply ground connection and screen.

RSSI pin 11

Received Signal Strength Indicator with 60dB range, operational when Rx is enabled. Output voltage nominally 0.05V (no RF signal), 1.30V (maximum). See page.6 for typical characteristics.

CD pin 11

Carrier Detect - When the receiver is enabled, a low indicates a signal above the detection threshold is being received. The output is high impedance (50kΩ) and should only be used to drive a CMOS logic input.

RXD pin 12

Digital output from internal data slicer. The output is a squared version of the signal on pin 13 (AF) and may be used to drive a decoder directly. The data is true data, i.e. as fed to the transmitter. Output is "open-collector" format with internal 10kΩ pullup to VCC (pin 17).

AF *pin 13*

Buffered & filtered analogue output from FM demodulator. Standing DC bias of 0.8V approx. Useful for test purposes or for driving external decoders. External load should be $>10k\Omega$ // $<100pF$

TXD *pin 14*

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 5 for suggested drive methods. Input impedance $>50k\Omega$.

TX select *pin 15*

Active-low Transmit select. $47k\Omega$ internal pull-up to 2.8V.

RX select *pin 16*

Active-low Receive select. $47k\Omega$ internal pull-up to 2.8V.

Pin 15 TX	Pin 16 RX	Function
1	1	Power down ($<3\mu A$)
1	0	Receiver enabled
0	1	Transmitter enabled
0	0	Invalid Operating Mode

Vcc *pin 17*

DC +ve supply pin. +2.9 to +16.0 volts. The supply should be clean, $<20mV_{P-P}$ ripple.

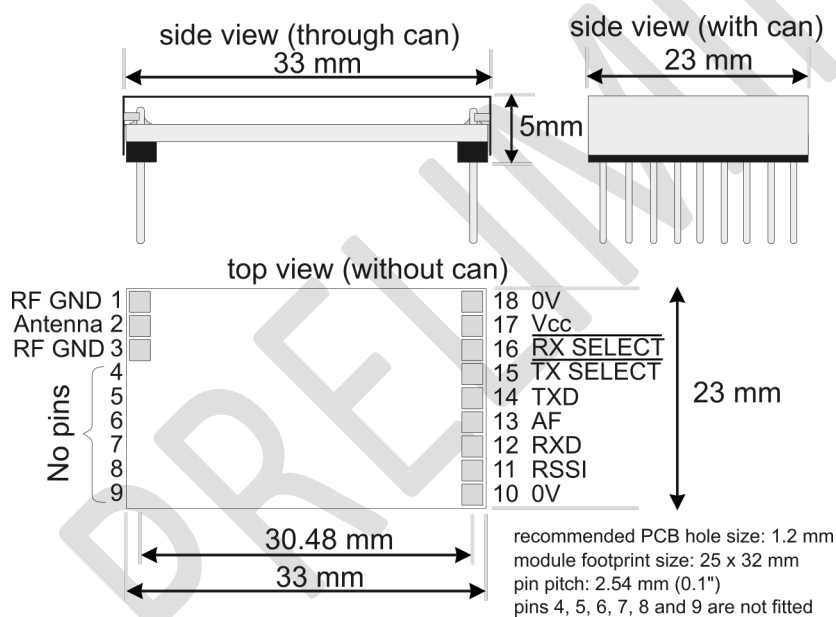


Fig. 3: Physical dimensions

Weight: 7g (typ.)

Absolute maximum ratings

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

Operating temperature	-20°C to +70°C
Storage temperature	-40°C to +100°C
Vcc (pin 17)	-0.3V to +16V
TX, RX select (pins 15, 16)	-9V to +16V
All other pins	-0.3V to +Vcc
Antenna (pin 2)	±50V DC, +10dBm RF

Performance specifications

Figures apply to standard version @ Vcc=3.0V, temperature +20 °C, unless stated.

General	pin	min.	typ.	max.	units	notes
Supply voltage	17	2.9	3.0	16	V	
Idele current	17			3	µA	
Tx supply current @0.75mW	17	-	13	-	mA	914.50MHz
Tx supply current @5mW	17	-	18	-	mA	869.85 MHz
Tx supply current @10mW	17	-	21	-	mA	
Tx supply current @25mW	17		39		mA	868.30MHz
Rx supply current	17		17		mA	Note 1
RF centre frequency (EU)	-	-	869.85/ 868.30	-	MHz	
RF centre frequency (N-America)	-	-	914.50	-	MHz	
Antenna port impedance	2	-	50	-	Ω	Tx or Rx
TX & RX select: high (<i>deselect</i>)	15, 16	2.0		2.8	V	
low (<i>select</i>)	15, 16	0		0.5	V	
Internal select pull-ups	15,16	-	20	-	kΩ	To internal 2.8V reference
Balanced code bit rate	12	-	-	64	kbps	-64 version
Balanced code bit rate	12	-	-	10	kbps	-10 version

Transmitter section	pin	min.	typ.	max.	units	notes
RF power output 0.75mW	2	-1	+0	+1	dBm	914.50MHz
RF power output 5mW	2	+6	+7	+8	dBm	869.85 MHz
RF power output 10mW	2	+9	+10	+11	dBm	
RF power output 25mW	2	+13	+14	+15	dBm	868.30 MHz
TX harmonics/spurious emission	2			-40	dBm	
Initial centre frequency accuracy	-	-10	0	+10	kHz	
FM deviation	-	±20	±30		kHz	Peak
Modulation bandwidth	-	0		35	kHz	@ -3db
Modulation distortion	-		5	10	%	Note 2
TX spectral bandwidth @-40dBc	2			250	kHz	worst case
TXD input level: high	14	2.8		3.0	V	Note 3
low	14	0		0.2	V	Note 3
TX power up to full RF	2			2	ms	Note 4

Receiver section	pin	min.	typ.	max.	units	notes
RF sensitivity, 12dB SINAD	2, 13		-111		dBm	-64 version
RF sensitivity, 12dB SINAD	2, 13		-114		dBm	-10 version
RSSI output, no signal	11		200		mV	
RSSI output, max indication	11		1.25		V	-50dBm RF input
RSSI range	2, 11		60		dB	
IF bandwidth	13		180		kHz	
Adjacent channel @ ±300kHz	2		51		dB	
Blocking @ ±2MHz	2		65		dB	
Blocking @ ±10MHz	2		88		dB	
Image rejection	2		64		dB	
IF/2 rejection	2		50		dB	
IF rejection (10.7MHz)	2	better than 70dB			dB	

Receiver section	pin	min.	typ.	max.	units	notes
Local osc. leakage, conducted	2			-75	dBm	
Baseband bandwidth @ -3dB	13	0		50	kHz	-64 version
Baseband bandwidth @ -3dB	13	0		7	kHz	-10 version
AF output signal level	13		400		mV p-p	Note 5
DC offset on AF output	13		0.9		V	Note 6
Distortion on recovered AF	13	-		6	%	Note 7
Ultimate (S+N)/N	13	30		40	dB	-50dBm RF input
Load capacitance, AF & RXD	12, 13	-	-	100	pF	
Dynamic Timing						
Rx power up with signal present - 3kHz (= 6kbit/sec) modulation						
RXE active to stable RSSI, t _{PU-RSSI}	11	-	2.5	-	ms	-10 version
RXE active to stable RXD, t _{PU-data}	12	-	3		ms	-10 version
RXE active to good RX AF, t _{PU-AF}	13	-	2		ms	-10 version
Rx power up with signal present - 15kHz (= 30kbit/sec) modulation						
RXE active to stable RSSI, t _{PU-RSSI}	11	-	2.5	-	ms	-64 version
RXE active to stable RXD, t _{PU-data}	12	-	3		ms	-64 version
RXE active to good RX AF, t _{PU-AF}	13	-	2		ms	-64 version
Signal applied with Rx on						
Signal to stable data, t _{sig-data} 3kHz modulation (6kbit/sec NRZ)	12	-	1	-	ms	-10 version (Note 9)
Signal to stable data, t _{sig-data} 15kHz modulation (30kbit/sec NRZ)	12	-	200	-	μs	-64 version (Note 9)
Time between data transitions	12	15.6	-	1000	μs	-64 version
Time between data transitions	12	0.1	-	10	ms	-10 version
Averaged code mark:space	12	40	50	60	%	Note 8

Note:

1. Increases at high RF input level (>-20dBm)
2. See page 6 for further details
3. For specified FM deviation
4. Tx select low > full RF output
5. ±30kHz FM deviation
6. Min/max After stabilisation
7. Max at ±50kHz offset
8. Average, at max. data rate
9. for 50:50 mark space stable data

Application Information

Modulation formats and range extension

The module will produce the specified FM deviation with a 2-level digital input to TXD which toggles between 0V and 3V. Reducing the amplitude of the data input from this value (usually as a result of reducing the supply voltage) reduces the transmitted FM deviation.

TXD 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) should be AC-coupled with 100nF series capacitor and amplitude limited to a maximum of 1.7V peak-to-peak. The instantaneous modulation voltage must not swing below 0V or above 3V at any time if waveform distortion and excessive FM deviation is to be avoided – use a resistive potential divider and/or level shifter to accomplish this if necessary. The varactor modulator in the transmitter 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 AF output (pin 13) can be used to drive an external decoder directly.

Data formats containing a DC component are unsuitable and should not be used. The time constant of the data slicer in the BiM3D is set at a reasonable compromise to allow the use of low code speeds where necessary whilst keeping settling times acceptably fast for battery-economised operation. RXD output on pin 12 is “true” sense, i.e. as originally fed to the transmitter.

The AF output waveform on pin 13 is in the same sense as that originally fed to the transmitter, i.e. no inversion takes place but, it has a DC varying offset present at all times whilst the data slicer tracks any frequency errors.

Received Signal Strength Indicator (RSSI)

The BiM3D receiver incorporates a wide range RSSI which measures the strength of an incoming signal over a range of approximately 60dB. This allows assessment of link quality and available margin and is useful when performing range tests.

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.

The output on pin 11 of the module has a standing DC bias in the region of 200mV with no signal, rising to around 1.25V at maximum indication (RF input levels of -50dBm and above). For any given RF input level, absolute RSSI voltage is likely to vary somewhat between individual units - please refer to specifications table on p4.

Typical RSSI characteristic is shown below (this is for indicative purposes only and is not a guarantee of actual RSSI characteristics):

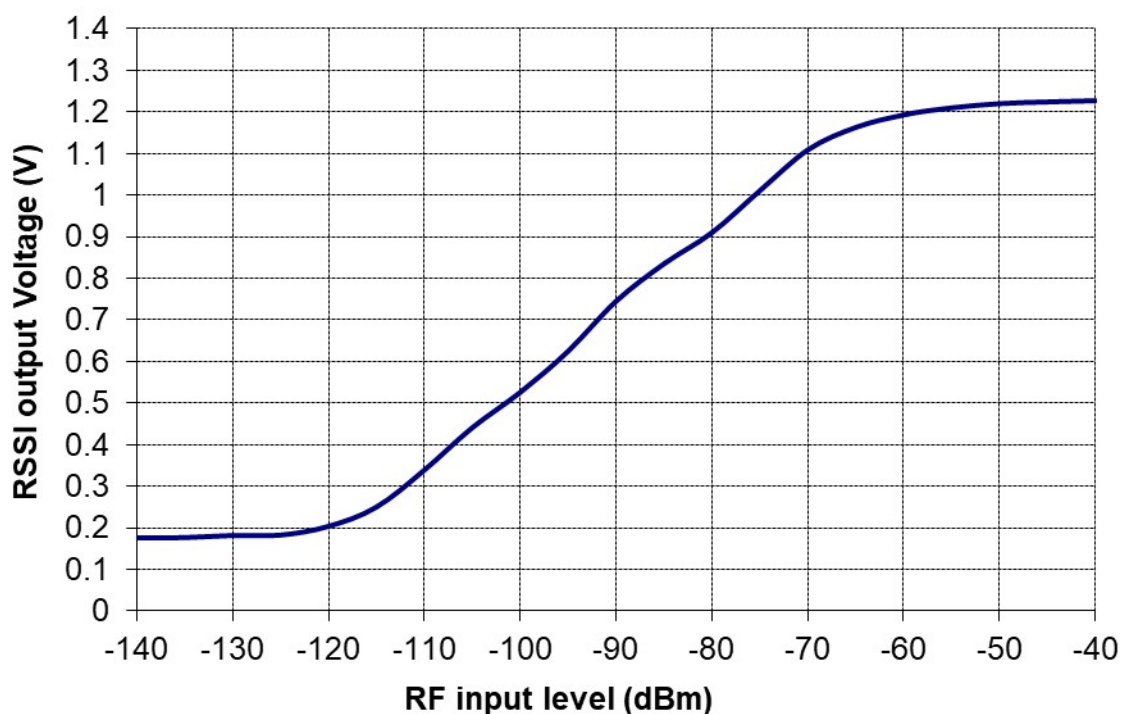


Fig.4: Typical RSSI response curve

To ensure a reasonably fast response the RSSI has limited internal decoupling of 10nF to ground. This may result in a small amount of audio ripple on the DC output at pin 11 of the module. If this is a problem further decoupling may be added at the expense of response speed, in the form of a capacitor from pin 11 to ground.

Variants and ordering information

BiM3D modules are manufactured in the following variants as standard:

Part number RSSI versions	RF power mW	Frequency MHz	Data rate kbps
BiM3D-869-64	5	869.85	64
BiM3D-869-10	5	869.85	10
BiM3DH-868-64	25	868.30	64
BiM3DH-868-10	25	868.30	10
BiM3D-914-64	0.75	914.50	64
BiM3D-914-10	0.75	914.50	10
CD version			
BiM3D-869-64-CD	5	869.85	64
BiM3D-869-10-CD	5	869.85	10
BiM3DH-868-64-CD	25	868.30	64
BiM3DH-868-10-CD	25	868.30	10
BiM3D-914-64-CD	0.75	914.50	64
BiM3D-914-10-CD	0.75	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/>

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