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BiM2/BiM3G

Issue 2, 7 March 2013

433 / 868MHz FM Data Transceiver

The BIM2/3G data radio module is a PLL synthesiser based miniature PCB mounting UHF radio transceiver which enable the simple implementation of a wireless data link at up to 128 kbps at distances up to 75 metres in-building and 300 metres open ground.

Figure 1: BIM3G-869.85-64-5V

Features

- Data rates up to 128 kbps
- Usable range up to 300 m
- Versions available on 433.92MHz, 434.42MHz, 868.30 or 869.85MHz
- Fully screened
- Low profile with small footprint
- Designed for compliance with EN 300 220-3 (radio) and EN 301 489-3 (EMC) standards

Available for operation at 433.05-434.79MHz, 868-870MHz band in the UK and Europe, these modules combine full screening with extensive internal filtering to ensure EMC compliance by minimising spurious radiations and susceptibilities. The BIM2/3G module will suit one-to-one and multi-node wireless links in applications. Because of their small size and low power requirements, the module is ideal for use in portable, battery-powered applications such as hand-held terminals.

Applications

- Data loggers
- EPOS equipment, barcode scanners, belt clip printers
- Audience response systems
- In-building environmental monitoring and control
- Security and fire alarms
- Restaurant ordering systems
- Vehicle data up/download

Technical Summary

- Crystal-locked PLL, FM modulated at up to 128 Kbps
- +10dBm on 433.92MHz and 869MHz (Dependent on version)
- High efficiency, >30%, DC to RF
- 2nd harmonic, > -60dBc
- Single conversion FM superhet receiver
- SAW front end filter gives >50dB image rejection
- Sensitivity: -102dBm sensitivity @ 1ppm BER, 64kbps version
  -108dBm sensitivity @ 1ppm BER, 15kbps version
  TBA dBm sensitivity @ 1ppm BER, 128kbps version
- RSSI output with 60dB range
- Extremely low LO leakage, -125dBm typical
- Supply: +5V (± 10%)
- Current consumption: 10mA (typ.)
- Size: 33 x 23 x 5mm

***Evaluation platforms**: Universal Evaluation Kit, NBEK + DIL carrier*

Functional overview

The transmit section of the BiM2/3G consists of a frequency modulated crystal locked PLL feeding a buffer amplifier and RF filter. A Tx select line controls operation. The transmitter achieves full RF output typically within 1ms 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 5V (digital drive) or a high level analogue waveform with the same peak limits (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. A version of BiM2/3G featuring a fast acting Carrier Detect (CD) output on the same RSSI pin is also available. The CD output will indicate the presence of any RF signals on the carrier frequency.

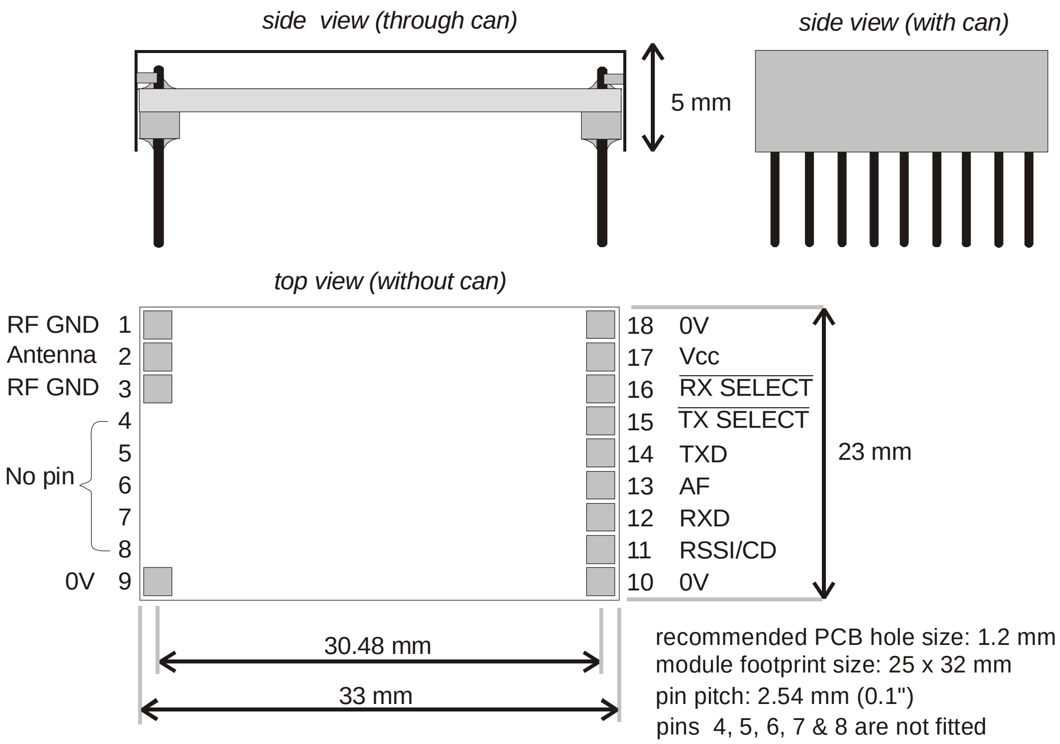


Fig. 2: Physical dimensions

Pin description

RF GND pins 1 & 3
RF ground pins, internally connected to the module screen and to pins 9, 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 9, 10 & 18
Supply ground connection and screen.

RSSI /CD pin 11
RSSI variant: Received Signal Strength Indicator with 60dB range, operational when Rx is enabled. Output voltage nominally 0.50Vdc (no signal), 1.0Vdc (maximum strength). See page.6 for typical characteristics.

Carrier Detect variant: When the receiver is enabled, a low indicates a signal above the detection threshold is being received. The output is high impedance 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 1V approx. Useful for test purposes or for driving external decoders. External load should be >10kΩ // <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, 5V max. See page 7 for suggested drive methods. Input impedance >50kΩ.

TX select pin 15
Active-low Transmit select. 47kΩ internal pull-up to Vcc.

RX select pin 16
Active-low Receive select. 47kΩ internal pull-up to Vcc.

Pin 15 TX	Pin 16 RX	Function
1	1	Power down (<10µA)
1	0	Receiver enabled
0	1	Transmitter enabled
0	0	Self test loop-back*

* Loop-back allows the receiver to monitor the transmitted signal. Under these conditions the Tx radiated signal level will be reduced to approximately -10dBm).

Vcc pin 17

+5V DC +ve supply pin. The supply should be clean, <20mVP-P ripple.

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(Dependant on version)*
TX, RX select (pins 15, 16)	*-9V to +5.5V*
All other pins	*-0.3V to +Vcc*
Antenna (pin 2)	*±50V DC, +10dBm RF*

Performance specifications

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

General	**pin**	**min.**	**typ.**	**max.**	**units**	**notes**
Supply voltage	17	4.5	5.0	5.5	V	Note 9
Tx supply current	17	-	14	-	mA	Note 9
Rx supply current	17	10	11	17	mA	Note 1
RF centre frequency	-	-		-	MHz	Note 9
Antenna port impedance	2	-	50	-	Ω	Tx or Rx
TX & RX select: high *(deselect)*	15, 16	Vcc-0.5		Vcc	V	
low *(select)*	15, 16	0		0.5	V	
Internal select pull-ups	15,16	-	47	-	kΩ	To Vcc (pin 17)
Balanced code bit rate	12	-	-	128	kbps	-128 version
Balanced code bit rate	12	-	-	64	kbps	-64 version
Balanced code bit rate	12	-	-	15	kbps	-15 version

Transmitter section	**pin**	**min.**	**typ.**	**max.**	**units**	**notes**
RF power output	2	-	+10	-	dBm	Note 9
TX harmonics/spurious emission	2	-	-55	-40	dBm	
Initial centre frequency accuracy	-	-10	0	+10	kHz	
FM deviation	-	±20	±27	±35	kHz	Peak
Modulation bandwidth	-	0	-	65	kHz	@ -3db
Modulation distortion	-	-	5	10	%	Note 2
TX spectral bandwidth @-40dBc	2	-	-	250	kHz	worst case
TXD input level: high	14	2.8	5		V	Note 3
low	14	0	-	0.2	V	Note 3
TX power up to full RF	2	-	1	1.5	ms	Note 4

Receiver section	**pin**	**min.**	**typ.**	**max.**	**units**	**notes**
RF sensitivity, 10dB S/N	2, 13	-	-113	-	dBm	
RF sensitivity, 1ppm BER	2, 12	-	-TBA	-	dBm	-128 version
RF sensitivity, 1ppm BER	2, 12	-	-102	-	dBm	-64 version
RF sensitivity, 1ppm BER	2, 12	-	-108	-	dBm	-15 version
RSSI range	2, 11	-	60	-	dB	
IF bandwidth	-	-	180	-	kHz	
Image rejection (f_{RF}-21.4MHz)	2	50	54	-	dB	
IF rejection (10.7MHz)	2	100	-	-	dB	
Local osc. leakage, conducted	2	-	-125	-110	dBm	
Baseband bandwidth @ -3dB	13	0	-	65	kHz	-128 version
Baseband bandwidth @ -3dB	13	0	-	50	kHz	-64 version
Baseband bandwidth @ -3dB	13	0	-	7.8	kHz	-15 version
AF output signal level	13	200	250	350	mV p-p	Note 5
DC offset on AF output	13	1.5	2.0	2.5	V	Note 6
Distortion on recovered AF	13	-	1	5	%	Note 7
Load capacitance, AF & RXD	12, 13	-	-	100	pF	

Receiver section	pin	min.	typ.	max.	units	notes
Dynamic Timing						
Rx power up with signal present						
Power up to valid RSSI, $t_{PU-RSSI}$	11	-	0.5	1	ms	
Power up to stable data, $t_{PU-data}$	12	-	2	10	ms	-15 version
Power up to stable data, $t_{PU-data}$	12	-	10			-15-DS version
Power up to stable data, $t_{PU-data}$	12	-	2	10	ms	-64 version
Power up to stable data, $t_{PU-data}$	12	-	10		ms	-64-DS version
Power up to stable data, $t_{PU-data}$	12	-	3		ms	-128 version
Signal applied with Rx on						
RSSI response time (rise/fall)	11	-	0.1	-	ms	
Signal to stable data, $t_{sig-data}$	12	-	0.5	1	ms	-15 version
Signal to stable data, $t_{sig-data}$	12	-	5		ms	-15-DS version
Signal to stable data, $t_{sig-data}$	12	-	0.2	0.5	ms	-64 version
Signal to stable data, $t_{sig-data}$	12	-	1.5		ms	-64-DS version
Signal to stable data, $t_{sig-data}$	12	-	0.75		ms	-128 version
Time between data transitions	14	70	-	5000	µs	-15 version
Time between data transitions	14	15.6	-	1500	µs	-64 version
Averaged code mark:space	14	20	50	80	%	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 –15 and –64 versions on;y
6. Min/max at ±50kHz offset
7. Max at ±50kHz offset
8. Average, at max. data rate
9. Dependant on version

Power supply requirement

The power supply ripple/noise should be below 10mVp-p to avoid problems. If the quality of the supply is in doubt, it is recommended that a 10µF low-ESR tantalum or similar capacitor be added between the module supply pin (Vcc) and ground, together with a 10Ω series feed resistor between the Vcc pin and the supply rail.

The BIM2/3G incorporates a low voltage shutoff circuit, which prevents any possibility of erratic operation by disabling the RF output of the transmitter if the supply voltage drops below 2.2V (±5%). This feature is self-resetting, i.e. restoring the supply to greater than 2.2V will immediately restore full RF output from the module.

The standard BiM2/3G requires a regulated 5V supply with ripple content <100mVpk-pk.

Received Signal Strength Indicator (RSSI)

The BIM2/3G module 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 5 of the module has a standing DC bias in the region of 0.5V with no signal, rising to around 1V at maximum indication. The RSSI output source impedance is high (~100kΩ) and external loading should therefore be kept to a minimum.

To ensure a fast response the RSSI has limited internal decoupling of 1nF to ground. This may result in a small amount of ripple on the DC output at pin 5 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 5 to ground. For example, adding 10nF here will increase RSSI response time from 100µs to around 1ms. The value of this capacitor may be increased without limit.

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

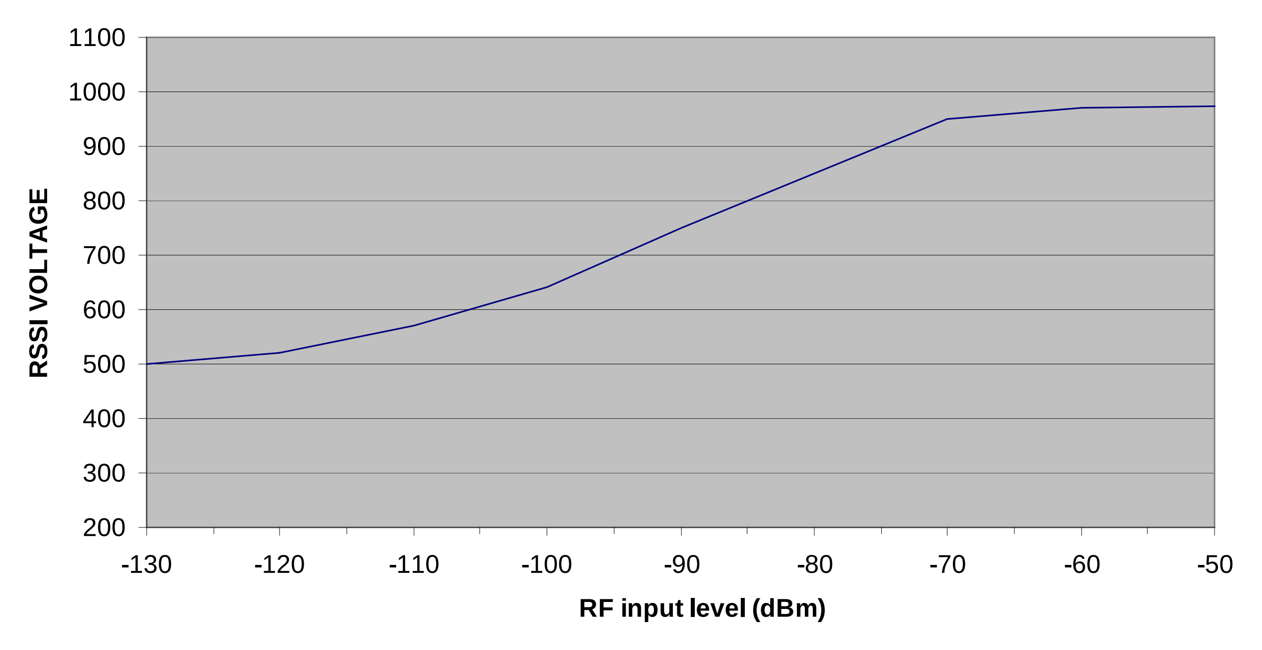


Figure 3: Typical RSSI

Module mounting considerations

Good RF layout practice should be observed – in particular, any ground return required by the antenna or feed should be connected directly to the RF GND pin at the antenna end of the module, and not to the OV pin which is intended as a DC ground only. All connecting tracks should be kept as short as possible to avoid any problems with stray RF pickup.

If the connection between module and antenna does not form part of the antenna itself, it should be made using 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.

The module may be potted if required in a viscous compound which cannot enter the screen can.

Warning: *DO NOT wash the module. It is not hermetically sealed.*

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 5V. Reducing the amplitude of the data input from this value reduces the transmitted FM deviation, typically to ±20-22kHz minimum at 0 - 2.8V. The receiver will cope with this quite happily and no significant degradation of link performance should be observed.

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 DC-biased to 1.5V with the modulation AC-coupled and limited to a maximum of 3V 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.
Although the module baseband response extends down to DC, data formats containing a DC component are unsuitable and should not be used. This is because frequency errors and drifts between the transmitter and receiver occur in normal operation resulting in DC offset errors on the AF output.

The time constant of the adaptive data slicer in the BiM2/3G 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.

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 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 or 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. 433MHz 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.

Three types of integral antenna are recommended:

A) ***Helical*** Wire coil, connected directly to pin 2, 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.

B) ***Loop*** A loop of PCB track tuned by a fixed or variable capacitor to ground at the 'hot' end and fed from pin 2 at a point 20% from the ground end. Loops have high immunity to proximity de-tuning.

C) ***Whip*** This is a wire, rod, PCB track or combination connected directly to pin 2 of the module. Optimum total length is 15.5cm (1/4 wave @ 433MHz). 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

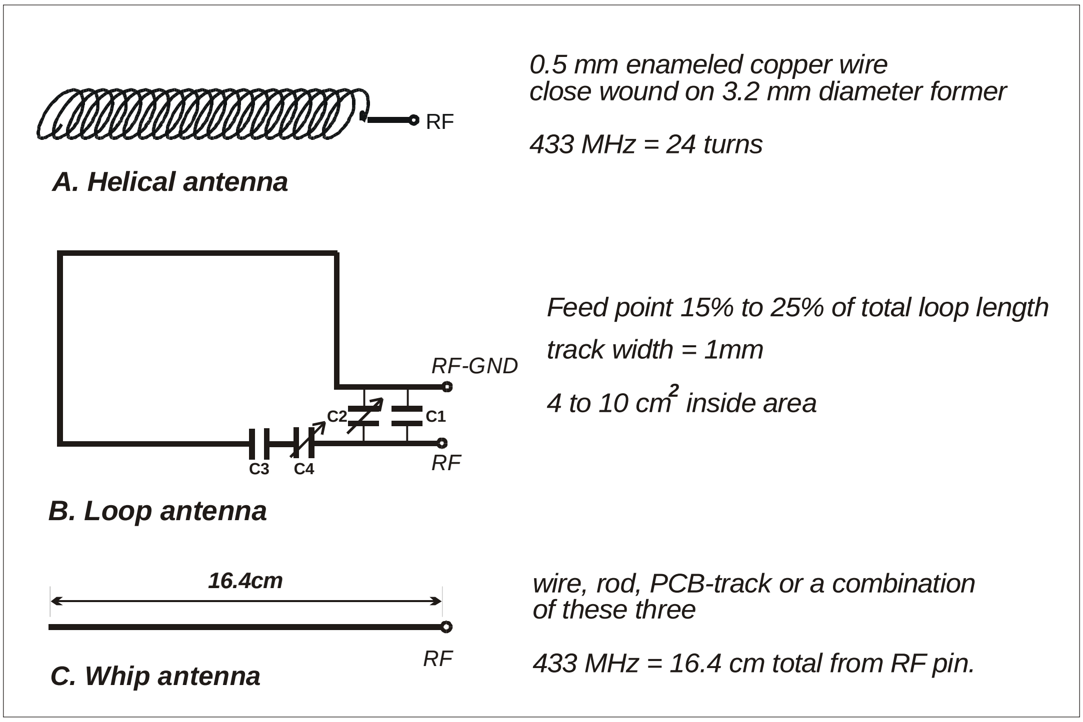


Fig.4: Antenna configuration (BiM2G @ 433.92MHz)

	helical	*loop*	*whip*
Ultimate performance	**	*	***
Easy of design set-up	**	*	***
Size	***	**	*
Immunity proximity effects	**	***	*
Range open ground to similar antenna (for BiM2G-433-15)	200m	100m	300m

Antenna selection chart

Duty Cycle requirements

The duty cycle is defined as the ratio, expressed as a percentage, of the maximum transmitter "on" time on one or more carrier frequencies, relative to a one hour period. Where an acknowledgement message is required, the additional transmitter "on" time shall be included.

There is a 10% duty cycle restriction on 10mW 433.050-434.790 MHz band and 1% on 25mW 868.0-868.6MHz band in EU member states.

The BIM2G is a RF module intended to be incorporated into a wide variety of applications and finished products, Radiometrix has no control over the end use of the BIM2G.

Module users should, therefore, ensure that they comply with the stated Duty Cycle requirements of the version of CEPT/ERC Recommendation 70-03 in place at the time of incorporation of the BIM2G into their product.
http://www.erodocdb.dk/Docs/doc98/official/pdf/REC7003e.pdf

Please refer to Appendix A for duty cycle information on 868-870MHz band in which the BiM3G operates.

Variants and ordering information

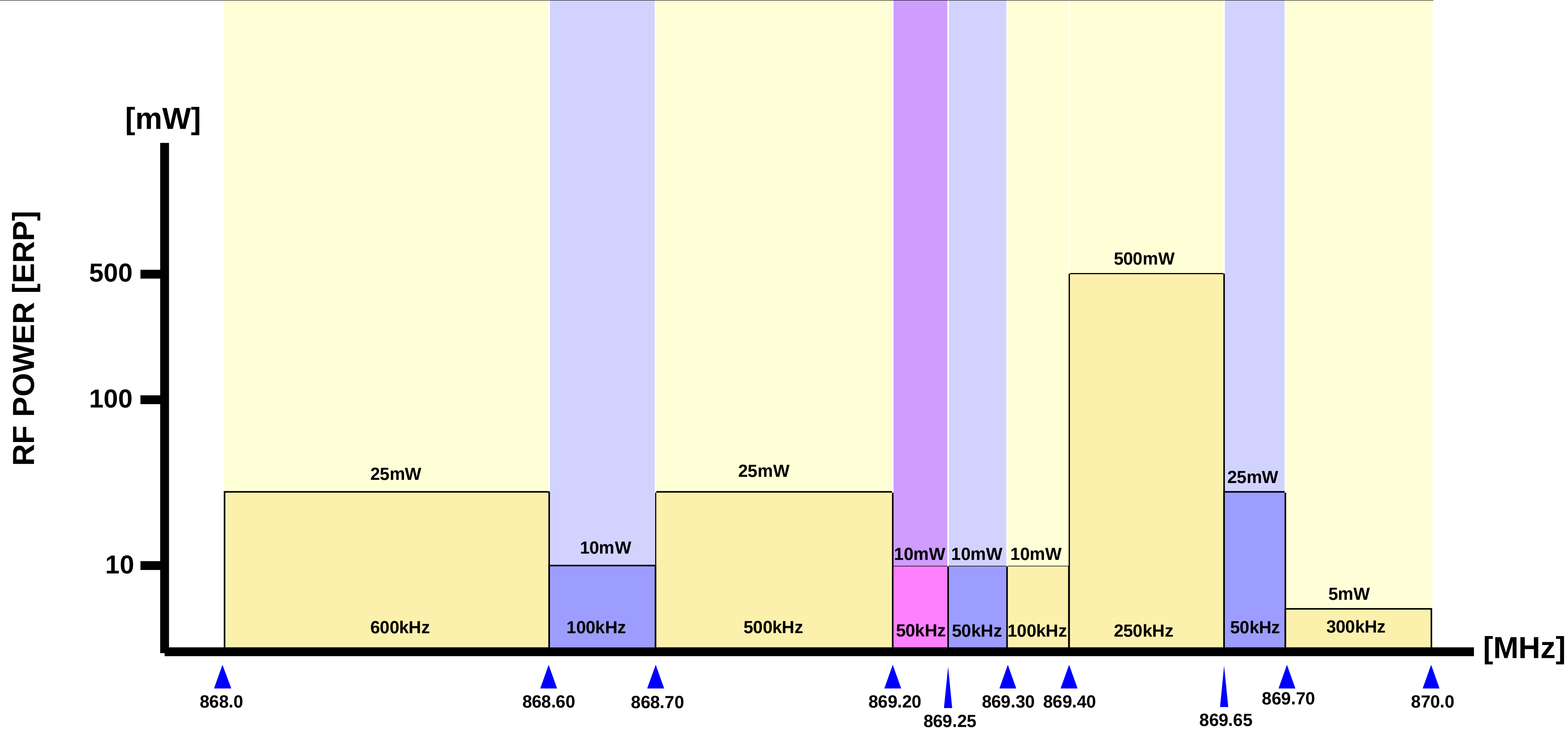
The following variants are standard:

Part number	RF power (mW)	Data rate (kbps)	Frequency (MHz)	
RSSI versions				
BIM2G-433-15-5V	10	15	433.92	Manchester Encoded data packet only
BIM2G-433-15-5V-DS	10			
BIM2G-433-64-5V	10	64	433.92	Manchester Encoded data packet only
BIM2G-433-64-5V-DS	10			
BIM2G-433-128-5V	10	128	433.92	
BIM2G-434-15-5V		15	434.42	Manchester Encoded data packet only
BIM2G-434-15-5V-DS	10			
BIM2G-434-64-5V	10	64	434.42	Manchester Encoded data packet only
BIM2G-434-64-5V-DS	10			
BIM2G-434-128-5V	10	128	434.42	
BIM3G-869.85-15-5V	5	15	869.85	Manchester Encoded data packet only
BIM3G-869.85-15-5V-DS	5			
BIM3G-869.85-64-5V	5	64	869.85	Manchester Encoded data packet only
BIM3G-869.85-64-5V-DS	5			
BIM3G-869.85-128-5V	5	128	869.85	
BIM3G-868.30-15-5V	10	15	868.30	Manchester Encoded data packet only
BIM3G-868.30-15-5V-DS				
BIM3G-868.30-64-5V	10	64	868.30	Manchester Encoded data packet only
BIM3G-868.30-64-5V-DS				
BIM3G-868.30-128-5V	10	128	868.30	
CD versions				
BIM2G-433-15-CD-5V-DS	10	15	433.92	
BIM2G-433-64-CD-5V-DS	10	64	433.92	
BIM2G-433-128-CD-5V	10	128	433.92	
BIM2G-434-15-CD-5V-DS	10	15	434.42	
BIM2G-434-64-CD-5V-DS	10	64	434.42	
BIM2G-434-128-CD-5V	10	128	434.42	
BIM3G-869.85-15-CD-5V-DS	5	15	869.85	
BIM3G-869.85-64-CD-5V-DS	5	64	869.85	
BIM3G-869.85-128-CD-5V	5	128	869.85	
BIM3G-868.30-15-CD-5V-DS	10	15	868.30	
BIM3G-868.30-64-CD-5V-DS	10	64	868.30	
BIM3G-868.30-128-CD-5V	10	128	868.30	

Appendix A

CEPT/ERC Rec 70-03, 868 MHz Band Plan

Applications	Non-specific SRD	Alarm	Non-specific SRD	Social Alarm	Alarm	Non-specific SRD		Alarm	Non-specific SRD
Channel Spacing	No Spacing	25kHz or WB	No Spacing	25kHz		25kHz	25kHz or Wide Band	25kHz	No Spacing
Duty Cycle	<1% or LBT	<1%	<0.1% or LBT	<0.1%		<1%	<10% or LBT	<10%	up to 100%



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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/

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