

## BiM1H

Issue 3, 27 July 2012

### VHF Narrow Band FM 500mW transceiver

*The BiM1H transceiver modules offer a 500mW RF output VHF data link in Radiometrix transceiver standard pin-out and footprint. This makes the BiM1H ideally suited to those low power applications where existing wideband transceivers provide insufficient range.*



Figure 1: BiM1H-169.4125-5

#### Features

- Conforms to EN 300 220-3 and EN 301 489-3
- Standard frequencies: 144.390, 144.800, 145.825, 149.250, 155.725 or 169.4125MHz
- Other frequencies from 120MHz to 180MHz
- Data rates of up to 5kbps (standard) or 10kbps (APRS)
- Usable range over 10km
- Fully screened
- Feature-rich interface (RSSI, analogue and digital baseband)
- Low power requirements

The BiM1H is a half duplex radio transceiver module for use in long range bi-directional data transfer applications at ranges up to 10kilometres. The module is available for operation on the 169MHz European licence exempt frequency band as standard.

#### Applications

- Asset Tracking and Tracing
- Automatic remote Meter Reading (AMR)
- Automatic Packet Reporting System (APRS) frequencies: 144.390MHz (EU), 144.800MHz (USA)

#### Technical Summary

- RF Power output: +27dBm (500mW)
- Receive sensitivity: -120dBm for 12 dB SINAD
- Operating frequency: 144.390, 144.800, 145.825, 149.250, 155.725 or 169.4125MHz
- Channel spacing: 25kHz
- Peak FM Deviation:  $\pm 3$ kHz
- Supply range: +5V regulated supply
- Current consumption: 290mA transmit, 8mA receive
- Data bit rate: 5kbps max. (standard module)
- RSSI output with >60dBm range
- Size: 33 x 23 x 12mm

**Evaluation platforms:** NBEK + BiM / SMX carrier

# BiM1H

## Single channel 500mW transceiver

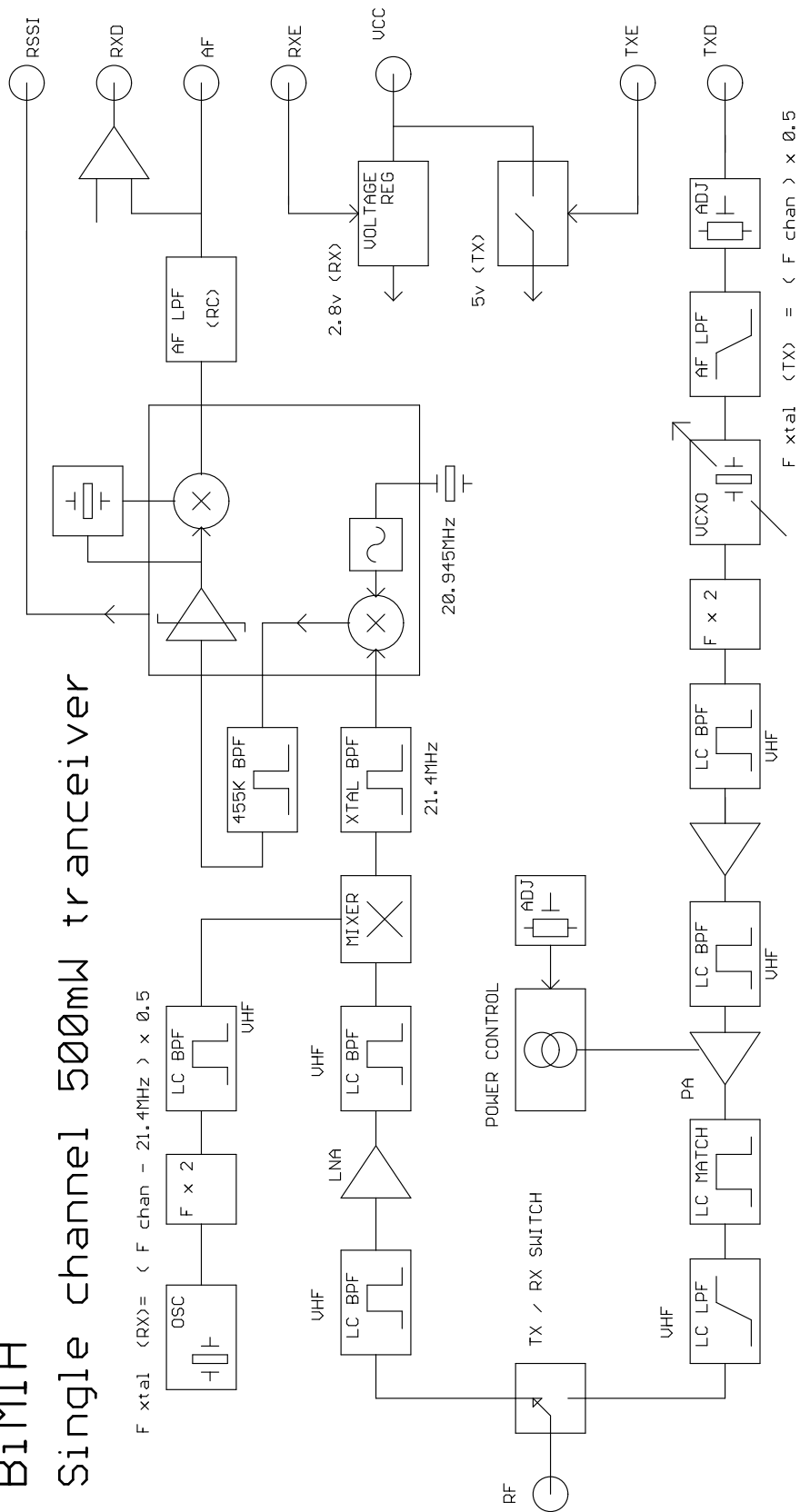


Figure 2: BiM1H block diagram

BiM1H transceiver contains a 500mW BiM1HT transmitter circuit and BiM1R receiver circuit with their RF output and input connected to a common RF pin via an internal RF switch.

## Functional description

The transmit section of the BiM1H 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. A Tx Select line controls the operation; the transmitter achieves full RF output typically within 8ms 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

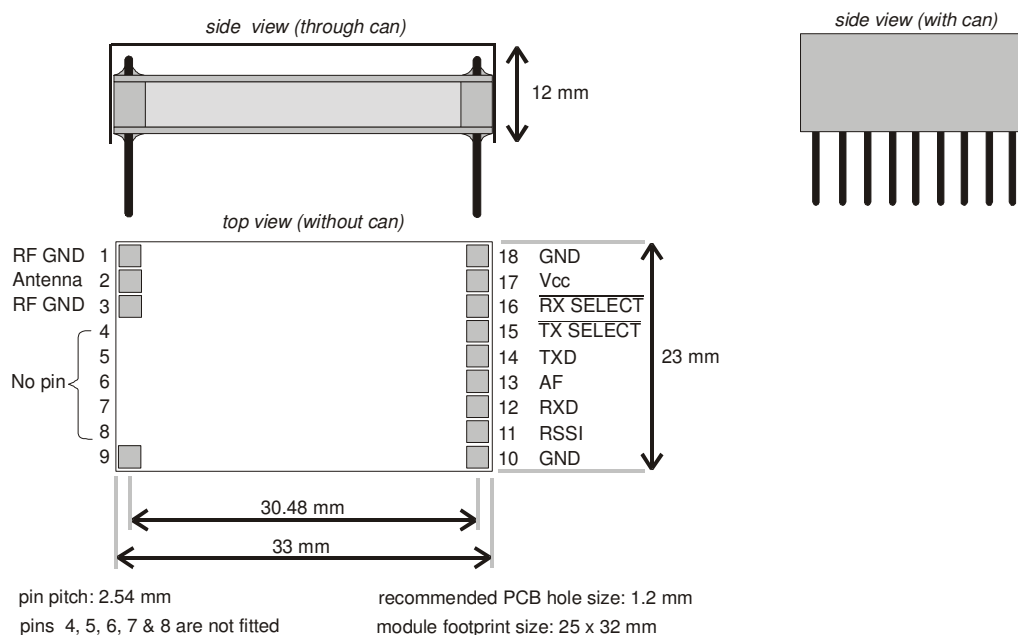


Figure 3: BiM1H pin-out and dimension

BiM1H Pin	Name	Function
1, 3	RF GND	RF ground pin, internally connected to the module screen and pin 5, 9, 10, 18 (0 Volt).
2	RF IN/OUT	50Ω RF input/output from the antenna
17	VCC	+5V regulated DC power supply
16	RX SELECT	Pull low to enable Receiver
15	TX SELECT	Pull low to enable Transmitter
14	TXD	DC coupled input for 5V CMOS logic. $R_{in} = 100k\Omega$
13	AF	500mV <sub>pk-pk</sub> audio. DC coupled, approx 0.8V bias
12	RXD	2.5V <sub>pk-pk</sub> logic output of data slicer. Suitable for Biphase codes
11	RSSI	DC level between 0.5V and 2.4V. 60dB dynamic range
9, 10, 18	0V	Supply ground connection

### NOTES:

1. RX SELECT and TX SELECT have internal (10kΩ approx.) pull-up to Vcc
2. Avoid RX SELECT and TX SELECT both low: undefined module operation (but damage will not result)
3. A regulated +5v rail must be used
4. Pin out is as standard BiM1 and 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)	±50V @ <10MHz, +13dBm @ >10MHz
All other pins	-0.3V to +16.0V

## Performance specifications:

(Vcc = 5V / temperature = 20°C unless stated)

General	pin	min.	typ.	max.	units	notes
<b>DC supply</b>						
Supply voltage	17		5.0		V	
TX Supply current	17		290		mA	
RX Supply current	17		8		mA	
Antenna pin impedance	2		50		Ω	
RF centre frequency			169.4125		MHz	
Channel spacing			25		kHz	
Number of channels			1			
<b>Transmitter</b>						
<b>RF</b>						
RF power output	2	+26	+27	+28	dBm	1
Spurious emissions	2			-36	dBm	
Adjacent channel TX power (500mW)			-37		dBm	
Frequency accuracy		-2.5	0	+2.5	kHz	2
FM deviation (peak)		±2.5	±3.0	±3.5	kHz	3
<b>Baseband</b>						
Modulation type			FSK			
Modulation bandwidth @ -3dB		0		2.5	kHz	8
TXD input level (logic low)	14		0		V	4
TXD input level (logic high)	14		5		V	4
<b>Dynamic timing</b>						
TX select to full RF			8		ms	

General	pin	min.	typ.	max.	units	notes
<b>Receiver</b>						
<b>RF/IF</b>						
RF sensitivity @ 12dB SINAD	2, 13		-120		dBm	
RF sensitivity @ 1ppm BER	2, 12		-115		dBm	
RSSI threshold	2, 11		-127		dBm	5
RSSI range	2, 11		60		dB	5
Blocking	2		88		dB	
Image and other Spurious emission	2		-70		dBm	
Adjacent channel	2		-70		dBm	
LO re-radiated			-60		dBm	
<b>Baseband</b>						
Baseband bandwidth @ -3dB	13		5		kHz	
AF level	13		500		mV <sub>P-P</sub>	6
DC offset on AF out	13		0.8		V	
Distortion on recovered AF	12		5		%	
<b>Dynamic timing</b>						
<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			0.3	ms	7
Mark : space ratio	12	20	50	80	%	7

**Notes:**

1. Measured into 50Ω resistive load.
2. Total over full supply and temperature range.
3. With 0V – 5.0V modulation input.
4. To achieve specified FM deviation.
5. See applications information for further details.
6. For received signal with ±3kHz FM deviation.
7. For 50:50 mark to space ratio (i.e. squarewave).
8. A Wide bandwidth (0-5kHz) version, which supports 10kbps data rate, is also available as special.

## Applications information

### ***RX Received Signal Strength Indicator (RSSI)***

The BiM1H 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.

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 of up to 0.5V with no signal, rising to 2.4V at maximum indication.  $\Delta V_{\text{min-max}}$  is typically 1.5V and is largely independent of standing bias variations. Output impedance is 56k $\Omega$ . Pin 11 can drive a 100 $\mu$ A meter directly, for simple monitoring.

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

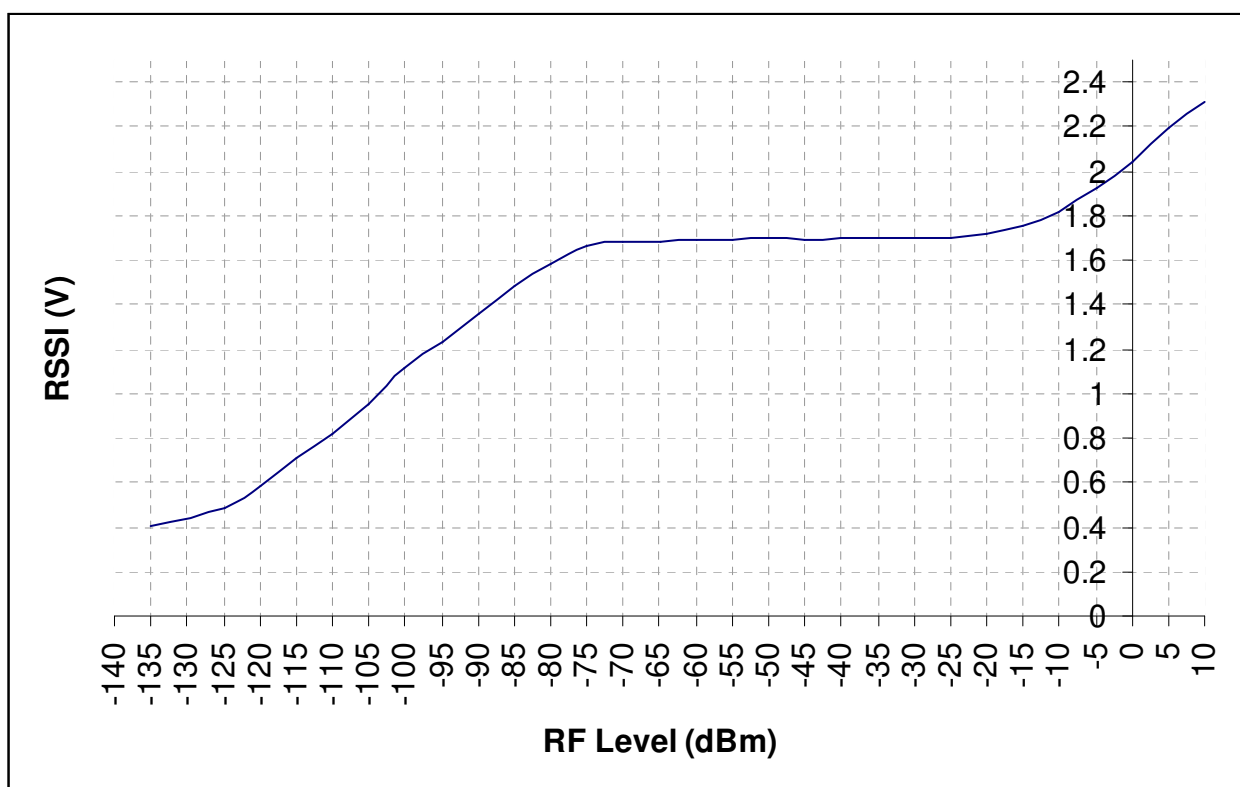


Figure 4: Typical RSSI level with respect to received RF level at BiM1H antenna pin

## ***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

## **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.
2. 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. The problem becomes worse as logic speeds increase, because fast logic edges generate harmonics across the VHF range which are then radiated effectively by the PCB tracking. In extreme cases system range may be reduced by a factor of 5 or more. To minimise any adverse effects situate 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.

*The following types of integral antenna are in common use:*

**Quarter-wave whip.** This consists simply of a piece of wire or rod connected to the module at one end. At 169MHz the total length should be 421mm from module pin to antenna tip including any interconnecting wire or tracking. Because of the length of this antenna it is almost always external to the product casing.

**Helical.** This is a more compact but slightly less effective antenna formed from a coil of wire. It is very efficient for its size, but because of its high Q it suffers badly from detuning caused by proximity to nearby conductive objects and needs to be carefully trimmed for best performance in a given situation. The size shown is about the maximum commonly used at 169MHz and appropriate scaling of length, diameter and number of turns can make individual designs much smaller.

### Integral antenna summary:

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

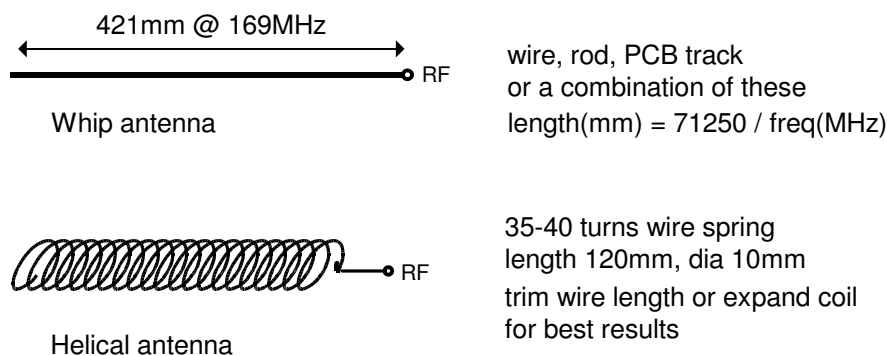


Figure 5: integral antenna configurations

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

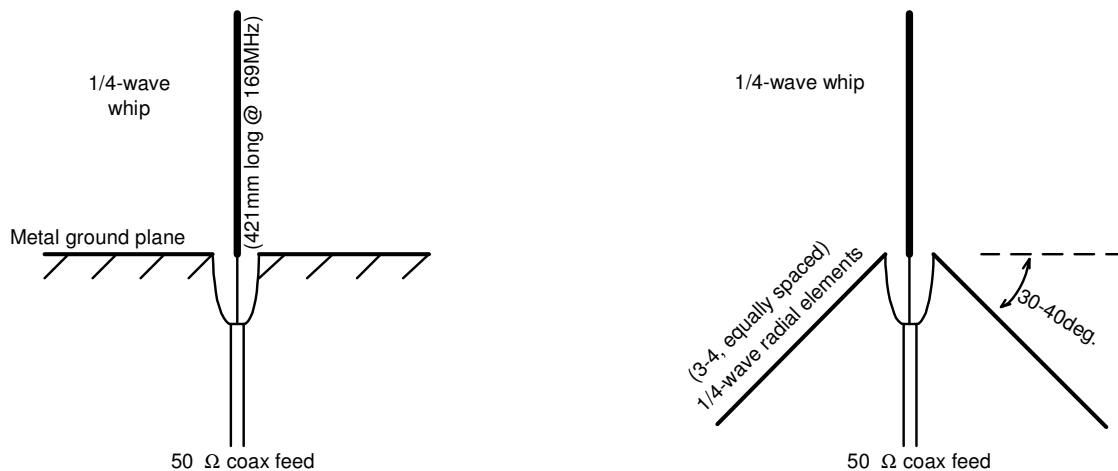


Figure 6: Quarter wave antenna / ground plane configurations

**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 BiM1H will exceed the maximum radiated power permitted by UK type approval regulations.

### **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 BiM1H transceiver is manufactured in the following variants as standard:

BiM1H-149.250-5	Czech Republic
BiM1H-155.725-5	Czech Republic
BiM1H-169.4125-5	EU Meter Reading, Tracking & Tracing
BiM1H-169.5625-5	EU Meter Reading, Tracking & Tracing
BiM1H-144.390-10	US APRS
BiM1H-144.800-10	EU APRS
BiM1H-145.825-10	Amateur Radio on the International Space Station (ARISS)

The special 10kbps version is not suitable for licence exempt application as the adjacent channel power exceeds the European Harmonised standard requirement.

Other variants can be supplied to individual customer requirements at frequencies from 120MHz to 180MHz.

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The Intrastat commodity code for all our modules is: 8542 6000

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Further details are available on The Office of Communications (Ofcom) web site:

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