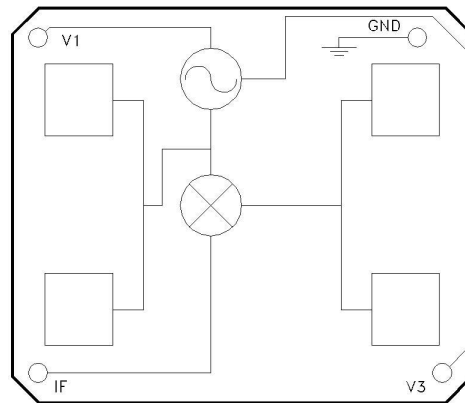


1. Introduction

HB180 miniature microwave motion sensor is a X-Band Bi-Static FM Doppler transceiver module. It has built-in voltage tuned Dielectric Resonator Oscillator (VT-DRO) and a pair of micro-strip patch antenna array, making them ideal for OEM usage as FM transceiver or FSK ranging motion detectors.

This User Manual highlights some important points for application with HB 180 module.

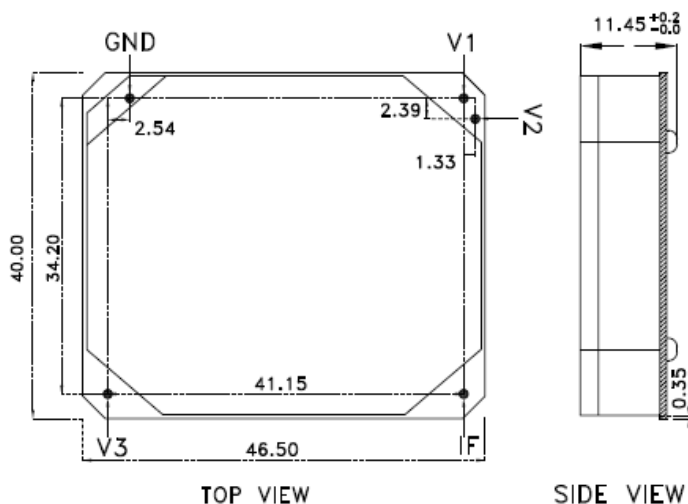


Block Diagram and Connection

Figure1: Block Diagram

2. Mounting

Header pins can be used to connect the terminals (V1, V3, IF, GND) to the power supply, FM signal generator and the amplifier circuits to serve as mounting support. Other mounting methods may be used. Caution must be taken to avoid pressure or stress being applied to the chassis of the module as it may cause performance deterioration.



(All dimension in mm)

CONNECTION PIN DEFINITION		
1	GND	GROUND
2	V1	+5V DC (CW OR PULSE MODE)
3	V2	NC (NOT CONNECTED)
4	V3	Tuning Voltage: 0~5VDC, <=1Kohm
5	IF	IF

Figure2: Outline Diagram

3. Connection

Connection Hole Definition:

1. GND: Ground;
2. V1: +5VDC (See section 4);
3. V2: NC (NOT CONNECTED);
4. V3: Tuning voltage :0~5VDC, Res<=1Kohm; (See section 4);
5. IF: Doppler Shift Output.

4. Pulse Operation

The Pulse operation of transmitter (V1) uses +5Vdc pulsed at up to 2kHz repetition frequency at a duty cycle of 5% for lower power consumption. FM modulation signal V3 uses pulse, sinewave, sawwave , etc , the FM modulation signal frequency at up to 2KHz.

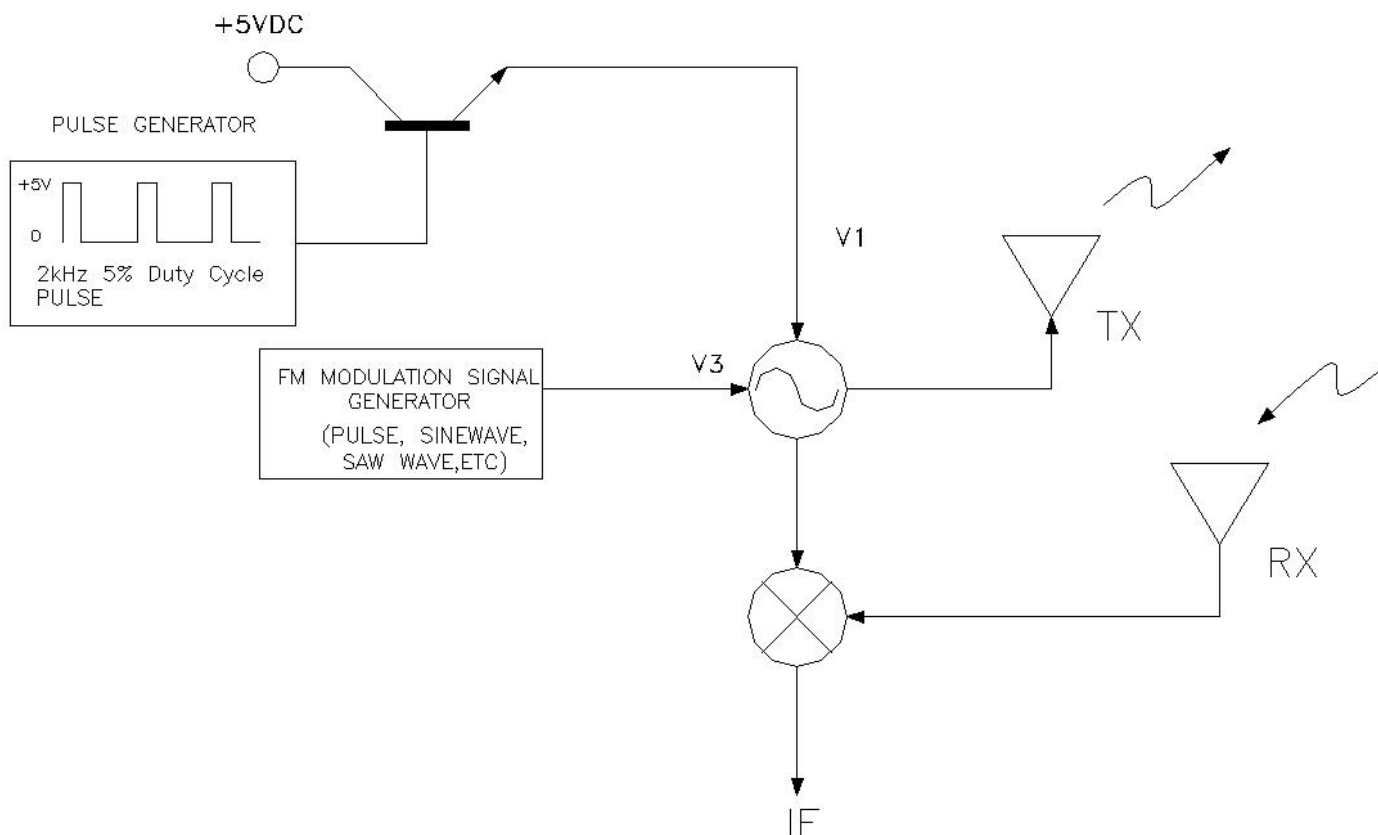


Figure3: Pulse Operation & FM Modulation Block Diagram

5. Transmit Frequency

The transmitter’s center frequency and power of the module are set by the factory. There is no user adjustable part in this device.

The module is a low power radio device (LPRD) or intended radiator. Local radio communication authority regulates use of such a device. Though user license may be exempted, type approval of equipment or other regulation compliance may be required.

6. FM Characteristics

The HB180 module’s electric tuning voltage range: +0.5~5V, and the typical electric tuning sensitivity (avg.) is -1MHz/V. The typical FM linearity is ±10%.

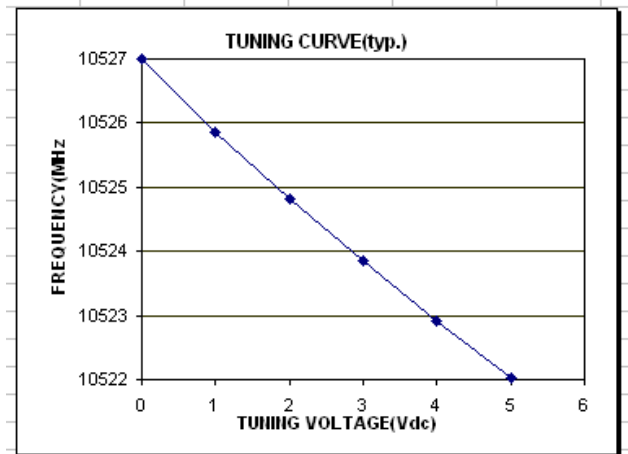
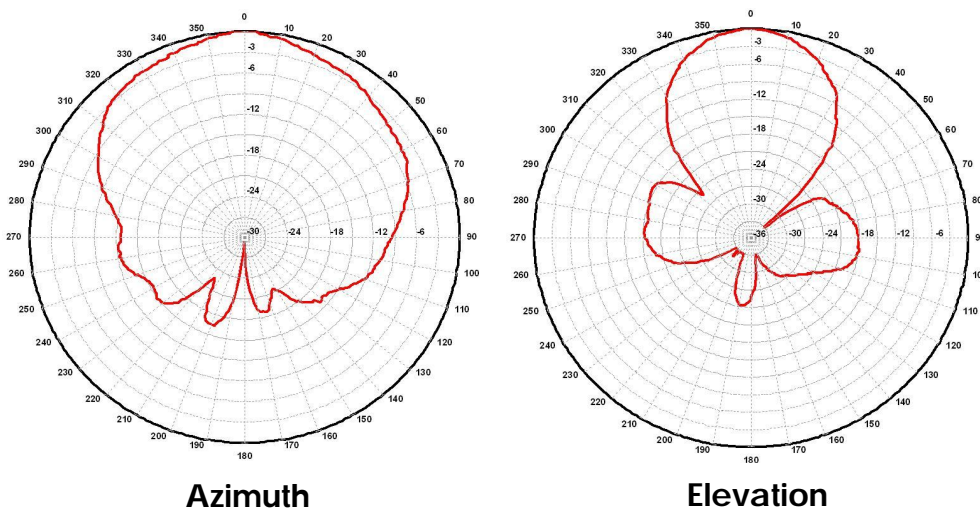


Figure4: Typical VCO characteristics

Annex 1 shows the allocated frequency in some countries.

7. Radiation Pattern

The module is to be mounted with the antenna patches facing to the desired detection zone. The user may vary the orientation of the module to get the best coverage. The radiation patterns of the antenna and their half power beam width (HPBW) are shown in below diagram.



8. Output Signals

FSK Doppler shift – The two-channel IF terminal outputs two Doppler shift signal when movement is detected. The magnitude of two-channel Doppler Shift is proportional to the reflection of the transmitted energy and is in the range of microvolts (μV). The phase difference between these two - channel signal included the distance information, basing on the phase difference can attain the distance between the target and the radar detector. The formula is as follows:

$$R = \frac{(\phi_1 - \phi_2) \cdot c_0}{2 \cdot (F_1 - F_2)}$$

It means:	F_1 und F_2	the two discrete transmit frequencies
	c_0	speed of light
	Φ_1 und Φ_2	the phase difference of the received IF signals at the mixer outputs (in radian)
	R	the range or distance

Two high gain low frequency amplifiers are usually connected to the IF terminals in order to amplify the Doppler shift to a processable level (see Annex 2). Frequency of Doppler shift is proportional to velocity of motion. Typical human walking generates Doppler shift below 100 Hz. Doppler frequency can be calculated by Doppler equation in Annex 2.

The Received Signal Strength (RSS) is the measured voltage of the Doppler shift at the IF output. The RSS figure specified in the technical data sheet is the level of a 25 Hz Doppler shift, generated from the modulated microwave signal received at the receiver antenna, The received microwave signal is attenuated to 93 dB below the transmit microwave signal from the transmit antenna of the same unit. The 93dB loss is the total losses combining two ways free space loss (82.4 dB for 30 meters at 10.525 GHz), reflection loss and absorption loss of the target, as well as other losses.

This RSS figure can be viewed as an approximation of the output signal strength for a human at 15 meters away walking straight to the module at 1.28 km/hour.

Reflection of a human body is varied with the size of the body, clothing, apparels and other environmental factors; RSS measured for two human bodies may vary by 50%.

Circuit designer must take note of the maximum and minimum Received Signal Strength (RSS) specified in technical data sheet, when designing the amplifier. Sensitive deviation between modules has to be considered when setting amplifier gain or alarm threshold. On-production-line gain adjustment may be necessary if a narrow window for triggering threshold is required.

Noise - The noise figure specified in the technical data sheet is the noise measured in an Anechoic chamber, that shields the unit-under-test from external interference, as well as reflections from surfaces. Hence, the figure is only representing the noise generated by the internal circuit itself.

Other than noises generate from internal electronic circuit, in actual applications, other noises may be picked up from surrounding, or other part of the electronic circuit.

Special attention has to be given to the interference picked up from fluorescent light, as the 100/120 Hz noise is closed at the Doppler frequency generated by human movement.

On and off switching of certain devices (relay, LED, motor, etc.) may generate a high magnitude of transient noise at the IF terminal. Careful PCB layout and time masking is necessary to prevent false triggering.

DC Level - DC level (0.01 to 0.2 Vdc) exists at the IF terminal and its polarity can be positive and negative. Its magnitude may vary over temperature. AC coupling is recommended for IF terminal connection.

9. Radiation Safety

Microwave radiation from the module is well below established safety standards for general public environment, like ANSI C95.1-1991 of USA and NRPB-G11 of United Kingdom.

10. Handling

The module has been fully tested to specifications. Upon opening, tighten or loosen the chassis will cause performance deterioration.

The module is an electrostatic sensitive device (ESD). Precautions shall be observed for handling and assembly.

11. Product Support

Please contact our product support engineers in the factory for technical assistance whenever necessary.

Product Support (Microwave Sensors)

Tel: (65) 6521 7948

Fax: (65) 6521 7801

e-mail: agilsense@stee.stengg.com

This device complies with part 15 of 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.

Any changes or modifications to ST Electronics equipment not expressly approved by ST Electronics could void the user authority to operate the equipment.

The system integrated the radio should have label indicated the FCC ID of approved Radio.
Such as putting a label on system as below: CONTAIN FCC ID: VECHB8

Warning : The radio does not allow to be installed and operated with other radio simultaneously when integrated in host system.

Installed in such configuration may subject to additional FCC testing and equipment authorization.

Annex 1: Transmission of RF

Allocated frequency for several countries listed below:

Frequency	Country	Remark
9.35 GHz	Germany	
10.525 GHz	USA, Belgium, Netherlands	
10.587 GHz	UK, France	Outdoor & Indoor applications

1. Though same frequency is allocated in some countries, national regulations may specify different EIRP, spurious emission or other requirements.
2. ETS EN300 440 is the recommended harmonized standard for European Community, member country may adopt their own national regulation. The HB180 transceivers meet the requirement of EN300 440
3. The HB180 is also designed to meet the FCC standard part 15.245 and is aimed for use in the America as well.
4. The regulations are subjected to change from time to time, please contact appropriate authorities for full and up-to-dated information.
5. Useful websites:

Agency	Website
The Code of Federal Regulations, USA	http://www.access.gpo.gov/cgi-bin/cfrassemble.cgi?title=199847
The European Radiocommunication Office	http://www.ero.dk/
Federal Communications Commission	http://www.fcc.gov/

Annex 2: Doppler Equation

$$F_d = 2V \left(\frac{F_t}{c} \right) \cos \theta$$

Where

F_d = Doppler frequency

V = Velocity of the target

F_t = Transmit frequency

c = Speed of light (3×10^8 m/sec)

θ = The angle between the target moving direction and the axis of the module.

If a target is moving straight toward or away from HB100 ($F_t = 10.525$ GHz) The formula is simplified to:

$$F_d = 19.49V \text{ (Velocity in km/hour) or } 31.36V \text{ (V in mile per hour)}$$

Conversion factors for other frequencies are shown below:

Frequency	Fd (V in Km/hr)	Fd (V in mph)
9.35 GHz	17.31V	27.85V
10.525 GHz	19.49V	31.36V
10.587 GHz	19.60V	31.54V