Information and
Communication Technology

Microwave Doppler Radar Motion Sensor

HB100

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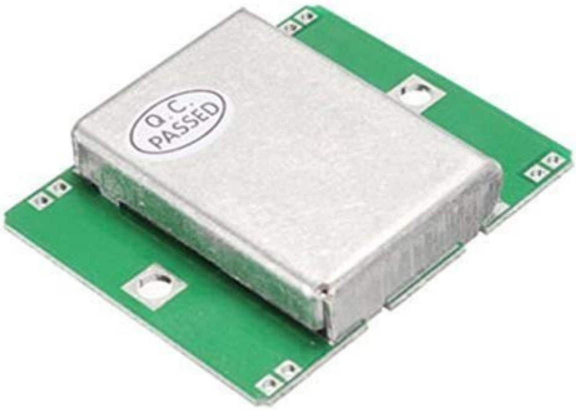
Documentation Index

01 INTRODUCTION

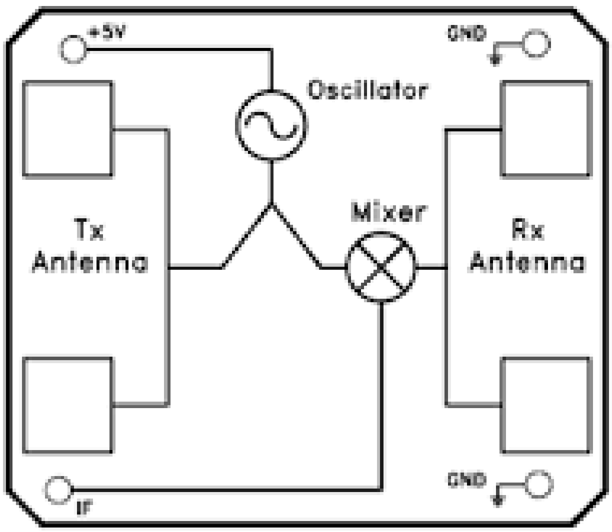


HB Series of microwave motion sensor module are X-Band
Mono-static DRO Doppler transceiver front-end module. These
modules are designed for movement detection, like intruder
alarms, occupancy modules and other innovative ideas.
The module consists of Dielectric Resonator Oscillator (DRO),
microwave mixer and patch antenna (see Diagram A).
This Application Note highlights some important points when
designing-in HB100 module. Most of the points are also
applicable to other models in this series.

MOUNTING :

Header Pins can be used to connected the terminals (+5V, IF, GND) to the amplifier circuit as well as
mounting support. Other mounting methods may be used.
Wave-solder the module onto PCBA is possible but processes has to be evaluated to prevent
deterioration. No-cleaning process is recommended.
Caution must be taken to avoid applying pressure or stresses to the chassis of the module. As it may
cause performance deterioration.

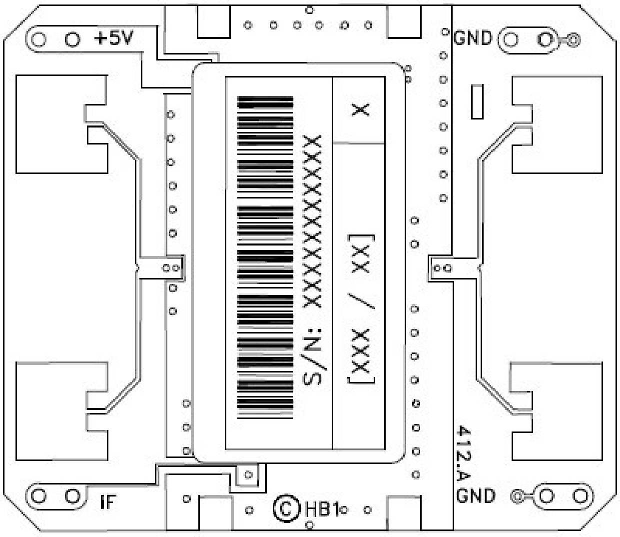
HB100 pinout



Power Supply 02

BEFORE POWER UP:

Connect the power supply, Ground and amplifier
circuitry at the designed terminals. Designation of
the connection terminals are printed on the PCB
as shown in Diagram

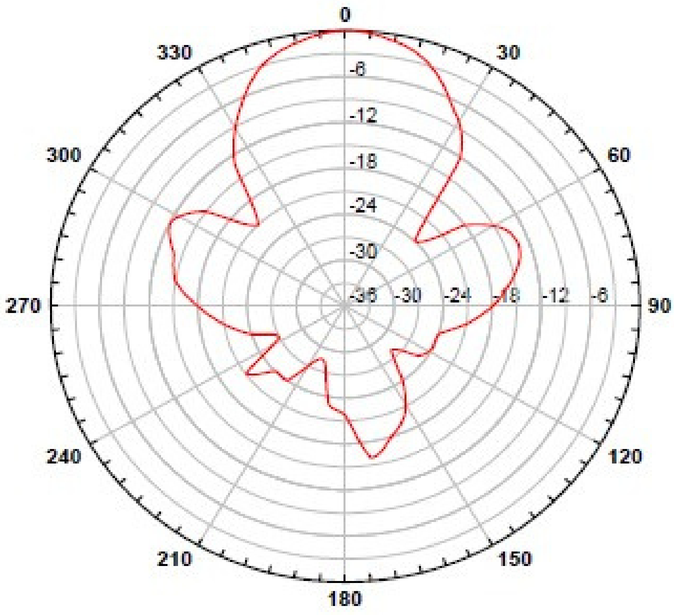


DIAGRAM

POWER SUPPLY:

- The module operates at +5 Vdc for Continious wave (CW) operation (see Annex 1).
- The module can be powered by +5V low duty cycle pulsed trains in order to reduce its power
- consumption. Sample & Hold circuit at the IF output is required for pulse operation (see Annex 2).

03 Transmission & Radiation



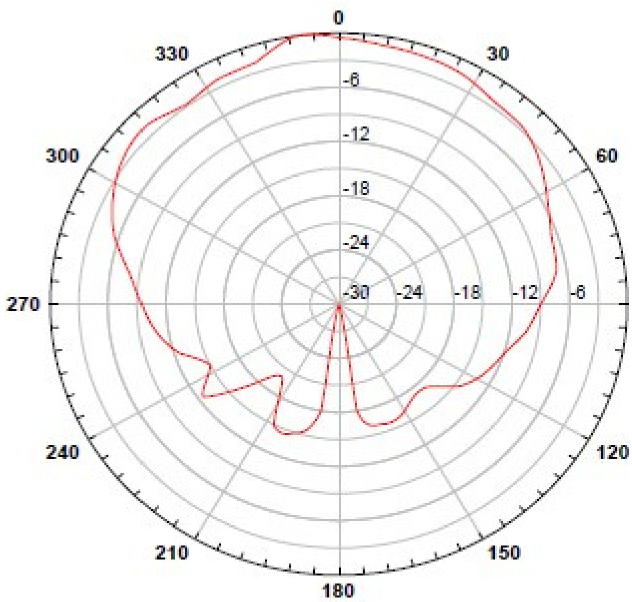
Elevation

TRANSMIT FREQUENCY:

The transmit frequency and power of the module is set by 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.
Annex 3 shown the allocated frequency in some countries.

RADIATION PATTERN:

The module 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.



Azimuth

OUTPUT SIGNALS 04

DOPPLER SHIFT:

Doppler shift - Doppler shift output from IF terminal when movement is detected. The magnitude of the Doppler Shift is proportional to reflection of transmitted energy and is in the range of microvolts (μV). A high gain low frequency amplifier is usually connected to the IF terminal in order to amplify the Doppler shift to a processable level (see Annex 1). 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 4. The Received Signal Strength (RSS) is the voltage measured of the Doppler shift at the IF output. The RSS figure specified in the technical data sheet is level of a 25 Hz Doppler shift, generate from the modulated microwave signal received at the received 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 less and absorption loss of the target, as well as other losses. This RSS figure can be view 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 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.

05 NOISE

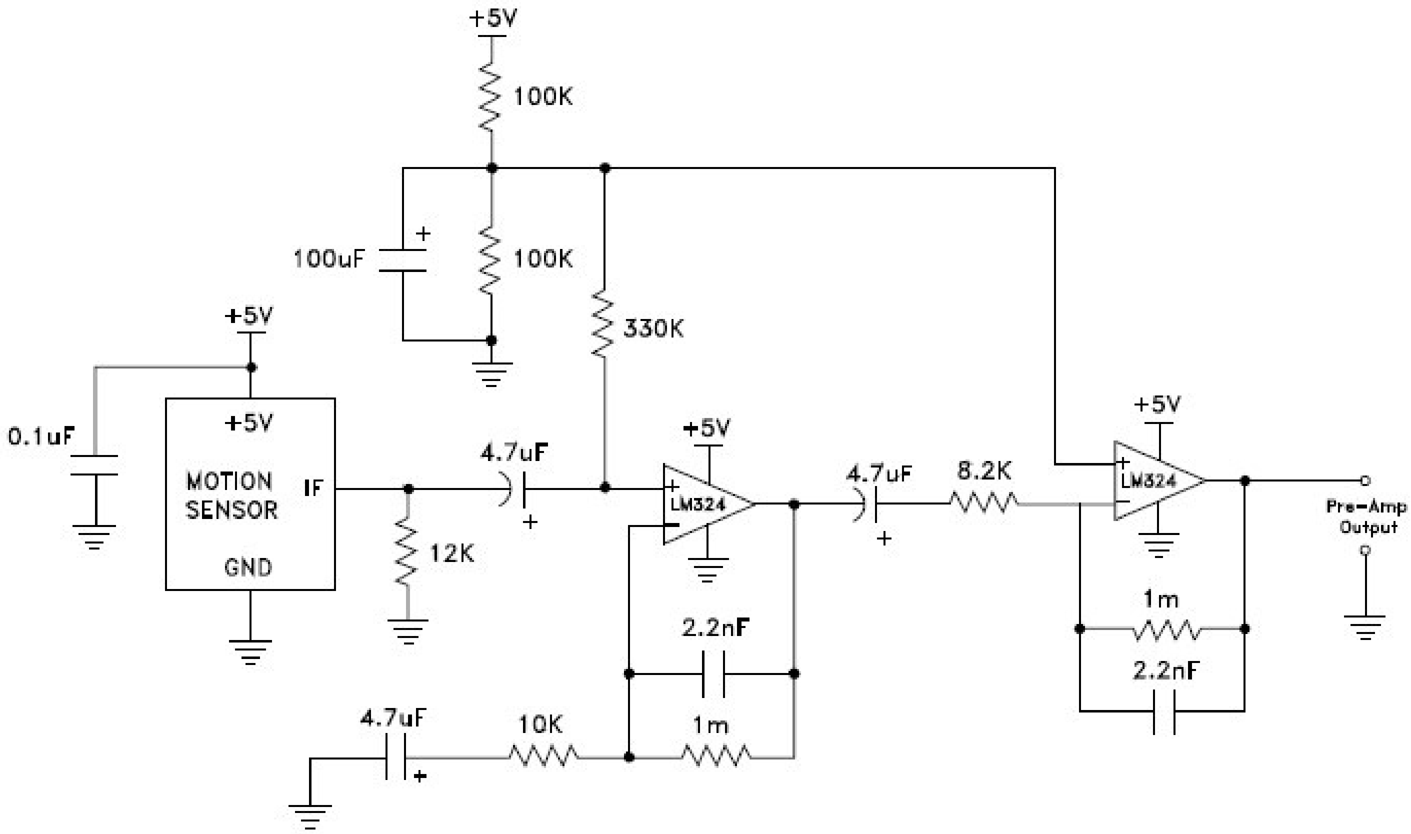
Noise - The noise figure specified in the technical data sheet is the noise measured in an Anechoic
chamber, that shield the unit-under-test from external interference, as well as reflection from surfaces.
Hence, the figure is only presenting the noise generated by the internal circuit itself.
Other 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.
Specially attention has to be given to the interference pick up from fluorescent light, as the 100/120 Hz
noise is closed to the Doppler frequency generated by human movement
On and off switching of certain devices (relay, LED, motor, etc.) may generated 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 - DC level (0.01 to 0.2 Vdc) exists at the IF terminal and its polarity can be positive Va1n.0d2
negative. Its magnitude may vary over temperature. AC coupling is recommended for IF terminal
connection.

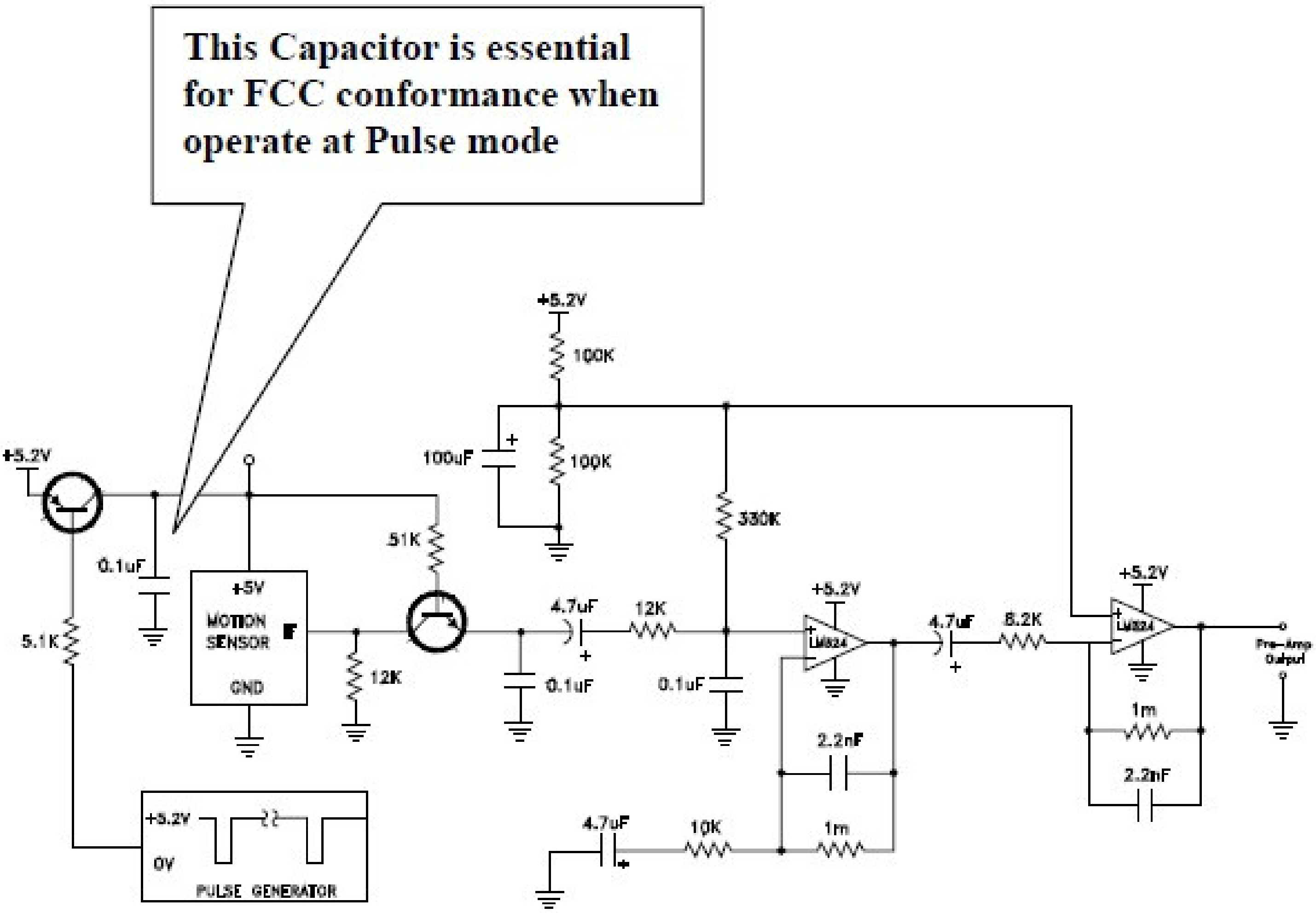
06

ANNEX 1: Amplifier Circuit (CW operation)



07

ANNEX 2: Amplifier Circuit (Pulse operation, PRF =2 KHz, Duty Cycle = 4%)



08 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.

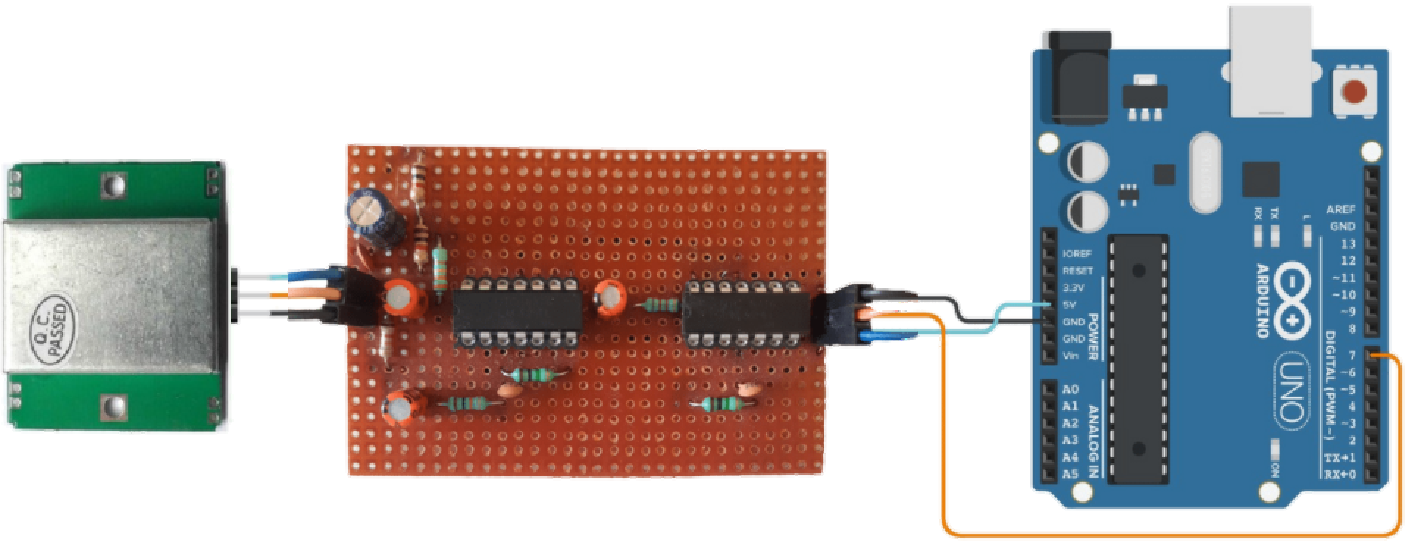
If a target is moving straight toward or away from HB100 (F_t = 10.525 GHz) The formula is simplified to:

F_d = 19.49V (Velocity in km/hour) or 31.36V (V in mile per hour)

Conversion factor for other frequencies are shown as below:

Frequency	**Fd (V in Km/hr)**	**Fd (*V* in mph)**
9.35 GHz	17.31V	27.85*V*
9.9 GHz	18.33V	29.49*V*
10.525 GHz	19.49V	31.36*V*
10.587 GHz	19.60V	31.54*V*
10.687 GHz	19.79V	31.84*V*
24.125 GHz	44.68V	71.89*V*

Interfacing with Arduino 09



INTERFACING WITH ARDUINO

- Now its time to interface the HB100 with the Arduino UNO. As we studied earlier the signal came out from the HB100 is very weak so now we have to amplify the signal using the annex 1 circuit in the final configuration.
- So to faithfully amplify the signal came out of the HB100 we have to follow the Annex 1 as given above.
- Here I created the PCB of the Annex 1 and you need to do the same. Here I pasted the image of the Circuit and all the connections are as above.
- Here the blue colored represent the positive power supply. Here it carries the +5V Power supply consumed from the Arduino UNO.
- Now the orange colored cable represents the IF Terminal of the HB100 and on the other end connect the same with the digital pin D7 of the Arduino UNO.
- Now connect the ground terminal of the HB100 with the PCB and the other end of the PCB with the ground of the Arduino UNO.
- Now your setup is complete and now its time to code the Arduino UNO.

CODE 10

```
#include "FreqPeriod.h"

double lfrq;
long int pp;

void setup() {
Serial.begin(9600);
  FreqPeriod::begin();
  Serial.println("FreqPeriod Library Test");
}

void loop() {
  pp = FreqPeriod::getPeriod();
  if (pp) {
    Serial.print ("period: ");
    Serial.print(pp);
    Serial.print(" 1/16us / frequency: ");

  lfrq = 16000400.0 /pp;
  Serial.print(lfrq);
  Serial.print(" Hz ");
  Serial.print(lfrq/31.36);
  Serial.println(" Mph ");
  delay(200);
}
}
```

11 Line Comment

```
#include<FreqPeriod.h>
```

This line means...
We are including the FreqPeriod library to our code. This library is specially used for the measuring of the Frequencies and show the exact output in the Serial Monitor.

Link for Library Download:
https://drive.google.com/file/d/1LKV5j84LYQXjzxAgz1P0HibcpGzLQexY/view?usp=sharing

```
double lfrq;
long int pp;
```

This two lines means...
We are declaring one double variable lfrq and one long int pp.

Line Comment 11

Now moving to the Void Setup()

Serial.begin(9600);

This line means...
We are determining the board rate to 9600. So now we have to select 9600 in the serial monitor. After that we are able to see well synchronized output of the HB100

FreqPeriod::begin();

This line means...
We are calling the begin function from the included library.

Serial.println("FreqPeriod Library Test");

This line means...
We are declaring text which is going to display on the Serial Monitor. Here as you can see println is written which means it will be printed in a new line everytime when the board rate refreshes.

Line Comment 11

Now moving to the Void loop()

```
pp = FreqPeriod::getPeriod();
```

This line means...
We are declaring or we can say allotting the long int pp with the value that we get in the library function called getPeriod.

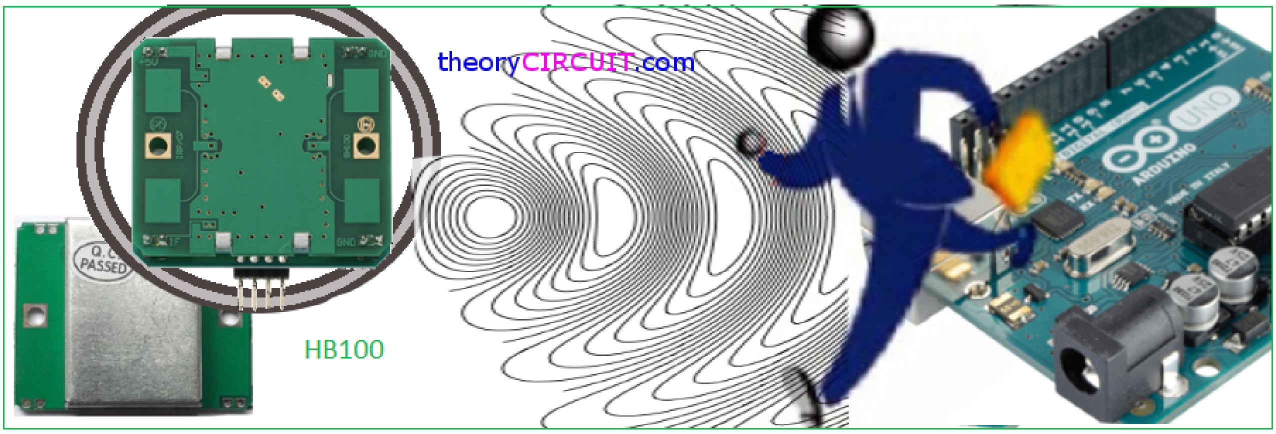
```
if (pp) {
Serial.print ("period: ");
Serial.print(pp);
Serial.print(" 1/16us / frequency: ");

lfrq = 16000400.0 /pp;
Serial.print(lfrq);
Serial.print(" Hz ");
Serial.print(lfrq/31.36);
Serial.println(" Mph ");
delay(200);
}
```

Here we are creating a loop in which we are printing the text on the serial monitor like period and then we will print the value of period which is pp. After that we will print the frequency lfrq on the serial monitor whose equation is 16000400.0/pp. Now after that moving to the last part of the code in which we going to display the frequency in Hz. In next line they have shown the equation of the Hz = lfrq/31.36 which is in Mph.
After that we are giving a delay of 200 micro seconds and after that the loop breaks and again follow the loop part contineously.

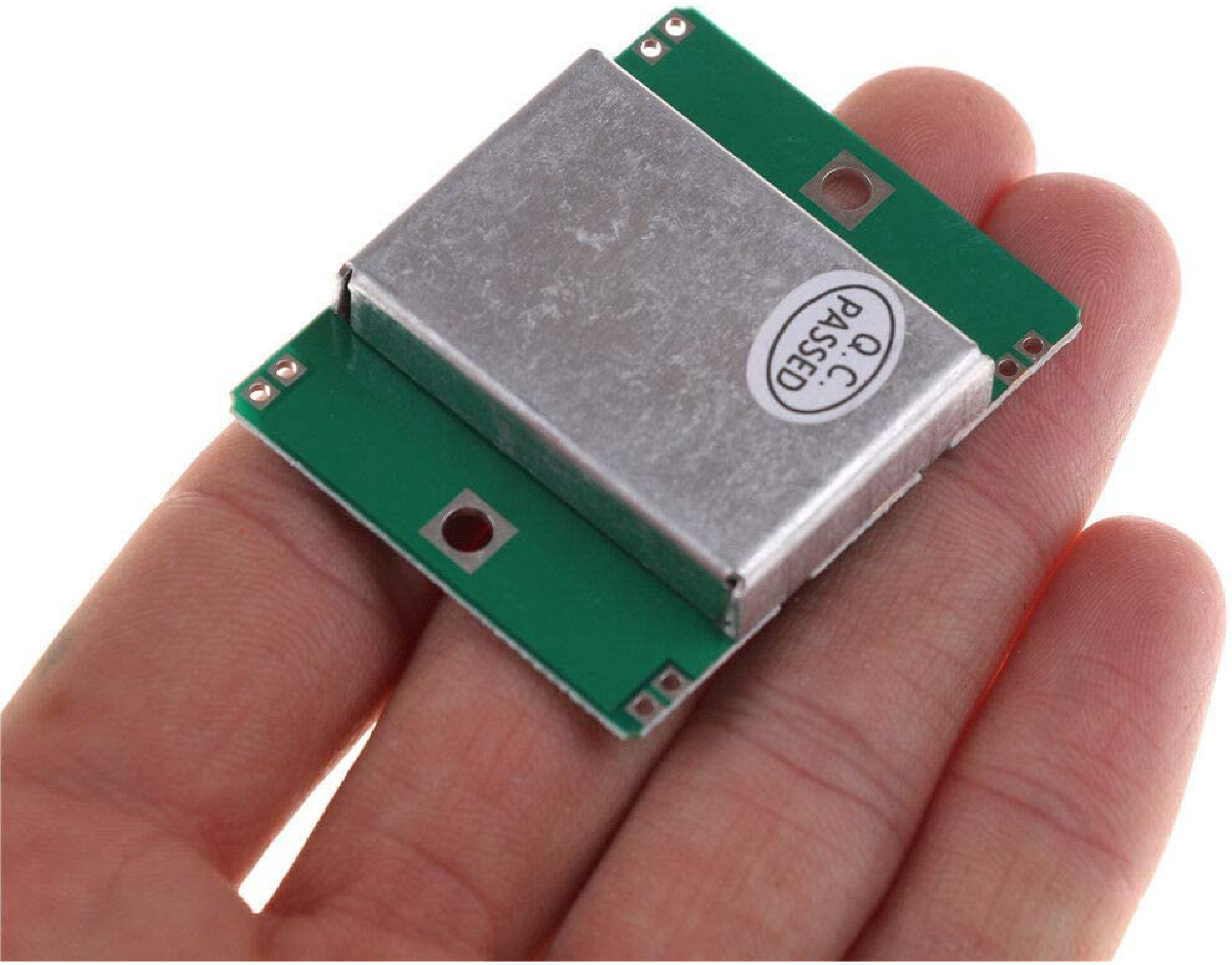
12 Applications and Uses

- HB100 Miniature Microwave Motion Sensor is an X-Band Bi-Static Doppler transceiver module.
- It has a built-in Dielectric Resonator Oscillator (DRO) and a pair of Microstrip patch antenna array, making it ideal for usage in motion detection equipment.
- This module is ideal for...

1. Alarms
2. Motion detectors
3. Lighting control
4. Vehicle speed measurement
5. Automatic doors.



MICROWAVE RADAR DOPPLER SENSOR



Thank You