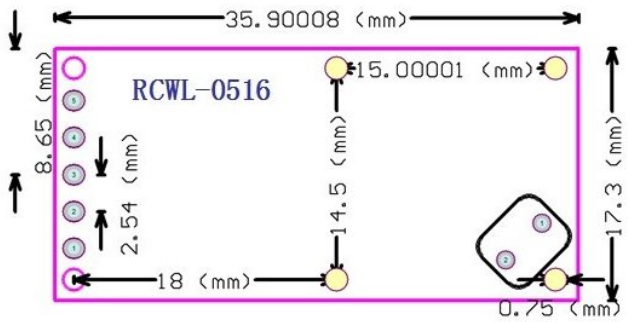
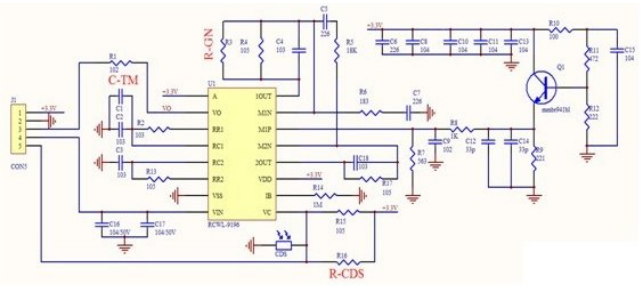
RCWL-0516

RCWL-0516 microwave radar sensor module Human body induction switch module Intelligent sensor
Features:

1, transmission signal processing control chip ***RCWL-9196***
2, wide operating voltage range: 4.0-28.0V
3, compared with the traditional infrared feeling PIR, with the penetrating detection capability
4, block time, distance adjustable
5, output 3.3V power supply

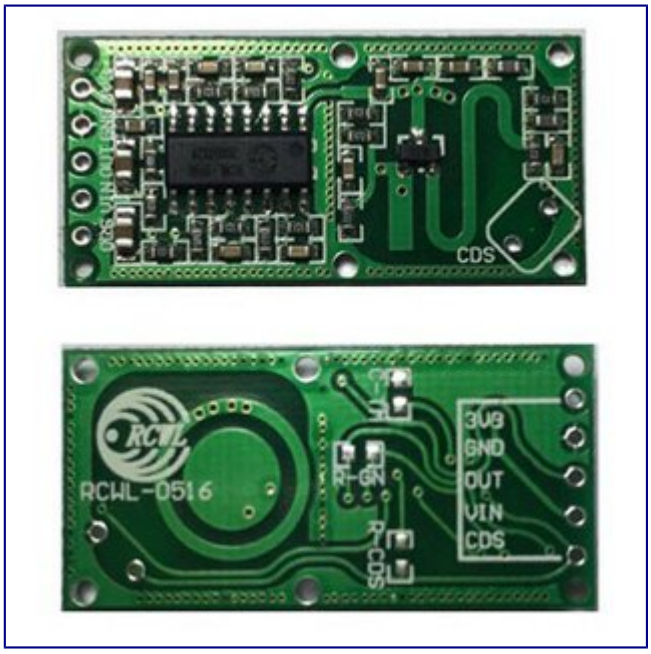




Application Design Note:

1, the sensing face in front of the gold without any shelter.
2, front and rear sensing surface space to set aside more than 1CM
3, the module carrier plane and install as flat line
4, a certain application of effective detection area
5, the component side of the module is positive sensing face, the opposite is negative sensing surface. Negative sensing surface sensing less effective
6, microwave modules can not be large-scale applications in the same area, otherwise there will be mutual interference. Between single individuals over distance greater than 1M

RCWL-0516 is a doppler radar microwave motion sensor module which can act as an alternative to a PIR motion sensor. This git repository is an attempt to collect the rather scant information on this board in one place.



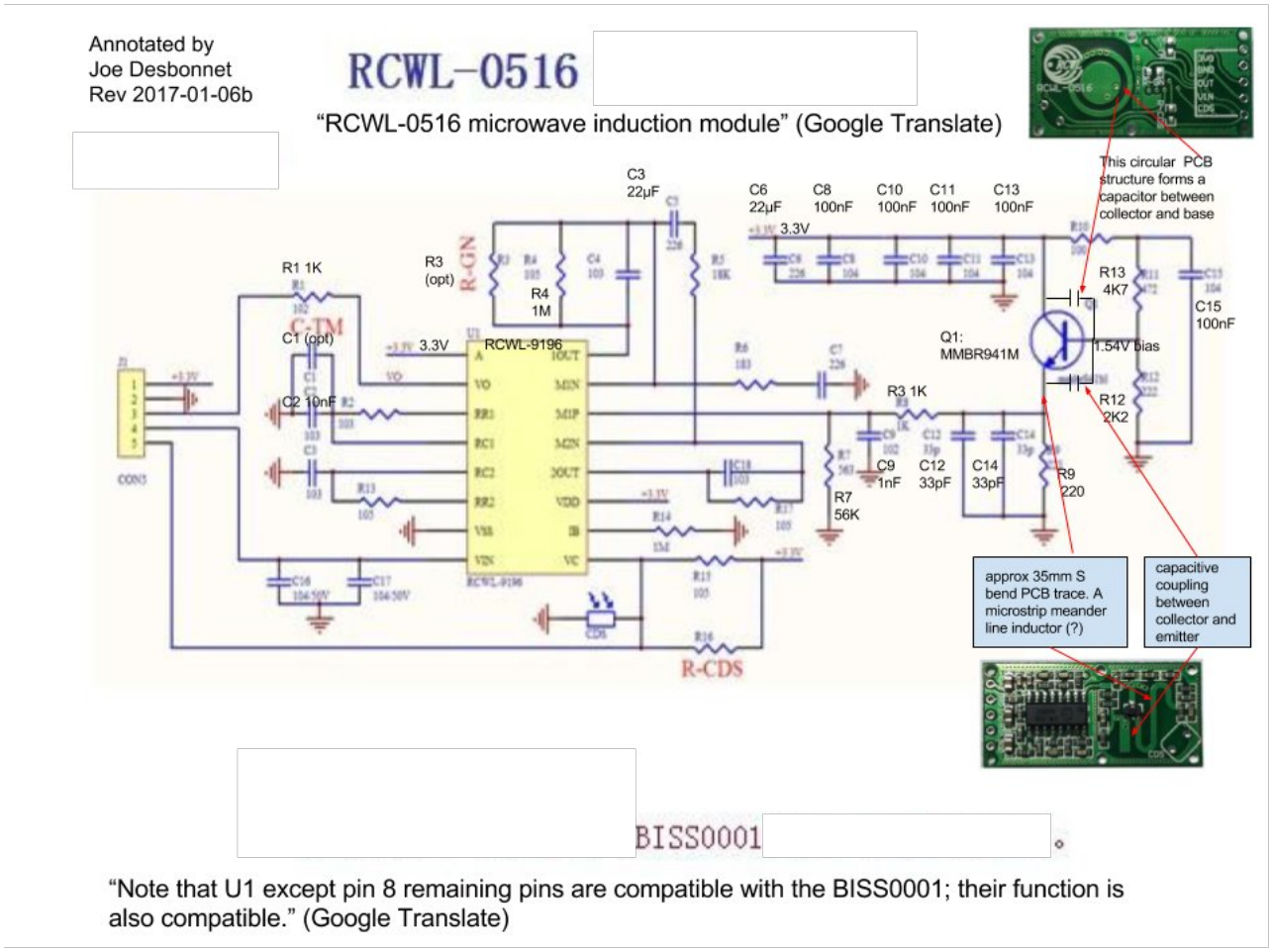
Operating frequency: The product specification omits the operating frequncy. I found a carrier at 3.181GHz on my unit using a HackRF One SDR radio (see spectrum plot below). I suspect this frequency will vary from device to device: it would be difficult to have a tight specification with such a simple RF circuit on FR4 PCB.

Working voltage: 4 - 28V. It provides a convenient 3.3V output to drive a MCU (good for 100mA ?).

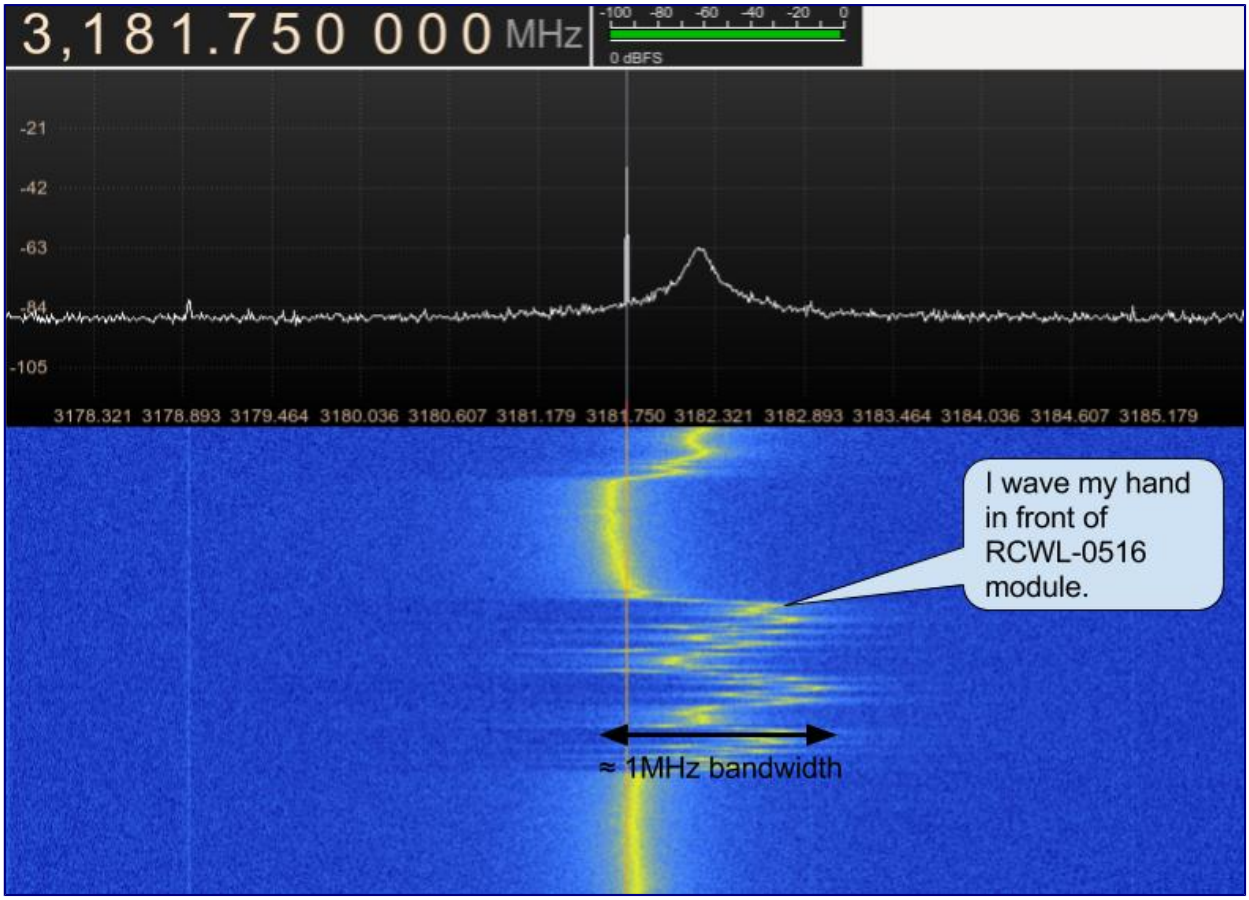
The forward side of the board is the side with components. This side should face the objects being detected. Do not obstruct forward side with anything metalic. The back side should have clearance of more than 1cm from any metal.

Board header

Pin	Function
3V3	3.3V regulated output. Max 100mA (?)
GND	Ground
OUT	Trigger: high (3.3V) if motion detected. 0V normally.
VIN	4 - 28V supply voltage
CDS	(light sensor related.. TODO)



I used spice simulations to verify that small changes to transistor base bias causes changes in oscillation frequency. By running a few simulations I estimate that 1µV change in bias will change oscillation frequncy by 1.4MHz.



The low frequncy part

The core of the low frequncy signal processing is an IC marked RCWL-9196. The schematic says (in chinese) that it's similar to a BISS0001 PIR IC. But there are differences. Unfortunately I can't find any hard information (eg datasheet) on this.
Now can I find any information on the brand/company name "RCWL".

Pin number	BISS0001	RCWL-9196
1	A Retriggerable & non-retriggerable mode select (A=1 : re-triggerable)	3.3V regulated output (100mA max?)
2	VO Detector output pin (active high)	same
3	RR1 Output pulse width control (Tx)	same?
4	RC1 Output pulse width control (Tx)	same?
5	RC2 Trigger inhibit control (Ti)	same?
6	RR2 Trigger inhibit control (Ti)	same?
7	Vss Ground	same
8	VRF RESET & voltage reference input (Normally high. Low=reset)	Vin (4 - 28V)
9	VC Trigger disable input (VC > 0.2Vdd=enable; Vc < 0.2Vdd =disabled)	same
10	IB Op-amp input bias current setting	?
11	Vdd Supply voltage	3.3V regulated output (again?)
12	2OUT 2nd stage Op-amp output	same
13	2IN- 2nd stage Op-amp inverting input	same
14	1IN+ 1st stage Op-amp non-inverting input	same
15	1IN- 1st stage Op-amp inverting input	same
16	1OUT 1st stage Op-amp output	same

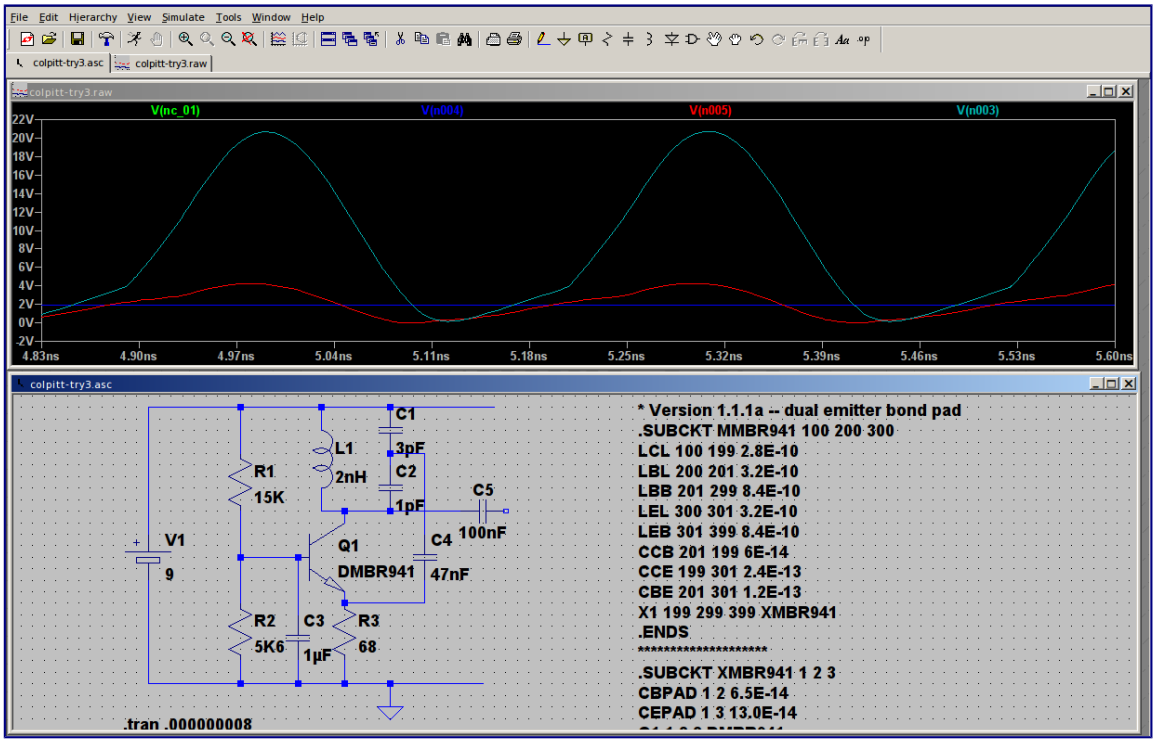
Adjustment components

On the back of the board (the side without components) are pads for 3 optional components (0805 dimensions).

Pad	Function
C-TM	Regulate the repeat trigger time. The default (unpopulated) time is 2s. A SMD capacitor to extend the repeat trigger time. Pin 3 of the IC emits a frequency (f), and the tigger time in seconds is given by (1/f) * 32678
R-GN	The default detection range is 7m, adding a 1M resistor reduces it to 5m
R-CDS	the VCC is in parrel connection with CDS(RCWL-9196 pin 9) through R-CDS. Connect the LDR at the R-CDS to turn off the detecting function at night. (?? TODO: make sense of this)

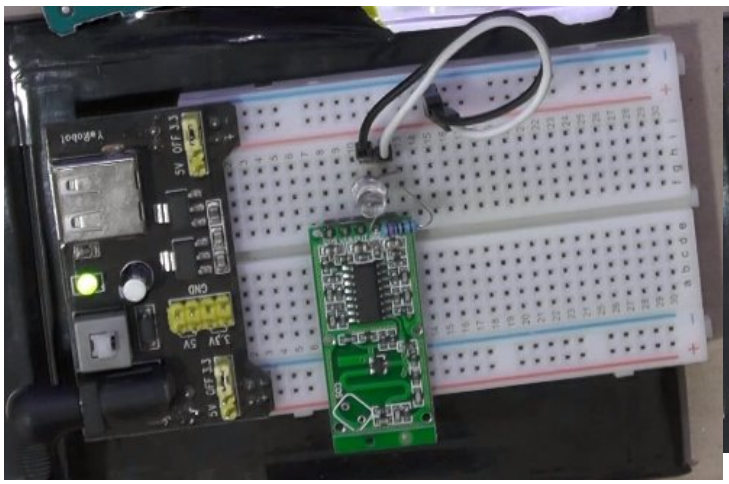
Spice simulation

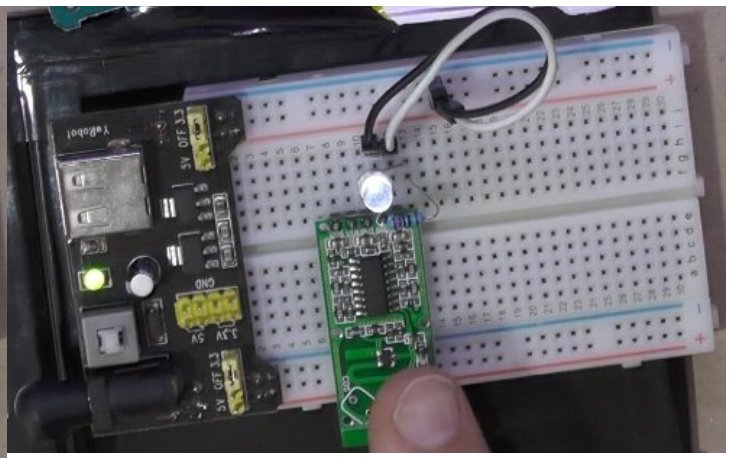
I started with an example Colpitt circuit [9] and substituted the 2N3904 NPN with a MMBR941 (Spice model from [10]).
I am using the Windows LTSpice from Linear Technologies (available as free download [11], also works with Linux under Wine emulator).
See colpitt.asc for a working Colpitt oscillator and rcwl-0516.asc for a model of the RCWL-0516 (however it does not oscillate!).



Doppler effect calculations

If ft is the transmitted frequency, fr is the reflected frequency (as measured by the common transmit/receive antenna on the sensor), v is the speed of the target relative to the sensor (negative if receeding, positive if advancing toward sensor), c is the speed of light and fd = (fr-fd) is the doppler shift, then:
fr = ft (c + v) / (c – v)
fd = fr - ft = 2v ft / (c – v)
If (c << v) then fd ≈ 2v ft / c
Assume typical human motion speed of v = 1 m/s. ft = 3.181GHz, c = 2.998E8 m/s, then fd = 10Hz.





/** Example NOT tested : Log the output pin of a RCWL-0516 radar module to a 433 MHz XY-FST transmitter. */

```
#include <VirtualWire.h>

#define PIN_RADAR 2
#define PIN_TX 9
#define PIN_LED 13

void setup() {
  Serial.begin(9600);
  pinMode(PIN_LED, OUTPUT);
  vw_set_tx_pin(PIN_TX);        // Arduino pin to connect the receiver data pin
  vw_setup(6000);               // bps connection speed
}
```