



DCP3011 Digital Compass Module User Manual

Dr Robot[®]

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Table of Contents

I. Introduction	2
II. Operations	2
II.1. Connections of compass module	2
II.2. Connect to WiRobot System	3
II.3. Configure the WFS802b/g module	3
III. Packet Format	4
IV. Calibrating the compass module	6
V. FAQ	7

I. Introduction

The DCP3011 compass module has been specifically designed for use in robots as an aid to navigation. The aim was to produce a unique number to represent the direction the robot is facing. The compass uses the Philips KMZ51 magnetic field sensor, which is sensitive enough to detect the Earth's magnetic field. The output from two of them mounted at right angles to each other is used to compute the direction of the horizontal component of the Earth's magnetic field.

Features

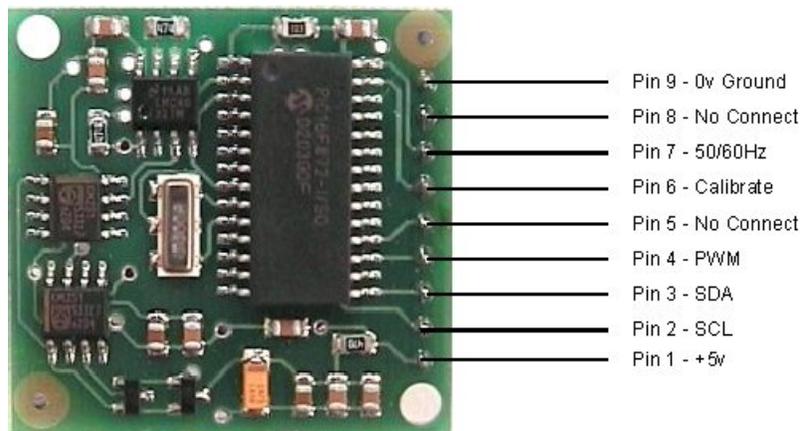
- High Resolution: 0.1 Degree
- Voltage : 5v only required
- Current: 20mA Typical
- Accuracy: 3-4 degrees approx. after calibration
- Plug-and-play in the WiRobot system

Applications

- Robotic system

II. Operations

II.1. Connections of compass module

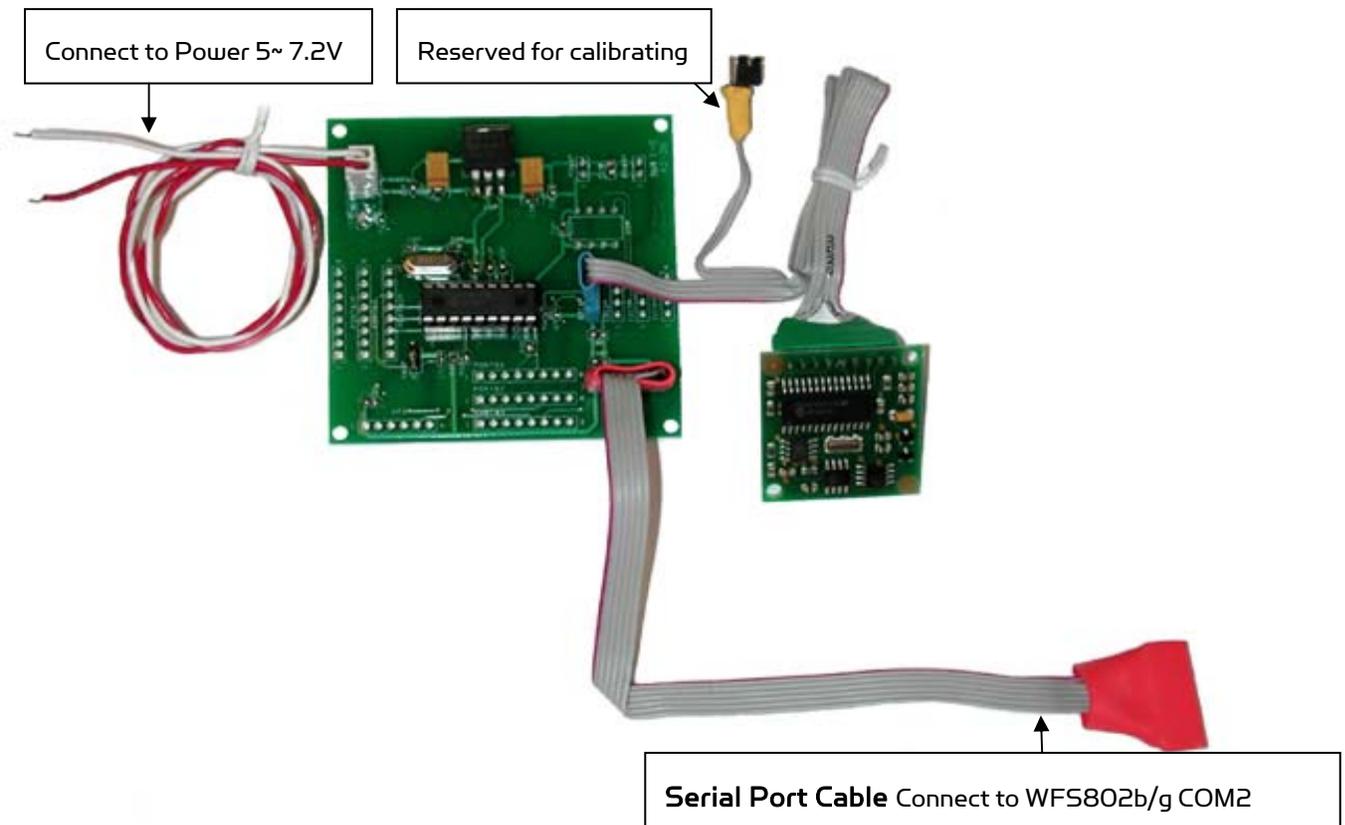


The compass module requires a 5v power supply at a nominal 15mA.

There are two ways of getting the bearing from the module. A PWM signal is available on pin 4, or an I2C interface is provided on pins 2,3.

The PWM signal is a pulse width modulated signal with the positive width of the pulse representing the angle. The pulse width varies from 1mS (0°) to 36.99mS (359.9°) – in other words 100µS/° with a +1mS offset. The signal goes low for 65mS between pulses, so the cycle time is 65mS + the pulse width - ie. 66ms-102ms. The pulse is generated by a 16 bit timer in the processor giving a 1µS resolution, however I would not recommend measuring this to anything better than 0.1° (10µS). Make sure you connect the I2C pins, SCL and SDA, to the 5v supply if you are using the PWM, as there are no pull-up resistors on these pins.

II.2. Connect to WiRobot System



II.3. Configure the WFS802b/g module

IMPORTANT: The serial port cable must be connected with WFS802b/g COM2.

Because the Serial Port Cable PIN 1 carries 5V but the WFS802b/g only need 3.3.V, if you plug Serial Port Cable into WFS802b/g's COM1, the WFS802b/g module should be damage.

Please reconfigure WFS802b/g COM2 setting via WFS802b/g web management page:

115200, 8, N, 1, no flow control,

TCP connection with accept incoming

Port : 10002

III. Packet Format

Each data packet consists of the following basic components:

1. Start-of-transmission indicator (STX)
2. Robot ID (RID)
3. Reserved byte for future use
4. Data ID (DID)
5. A Length field to specify the total number of byte in the Data field
6. Data, if any
7. A checksum
8. An end-of-transmission indicator (ETX)

The format of the frame is illustrated as follows:

STX	RID	SEQ	DID	LENGTH	DATA	CHECKSUM	ETX
-----	-----	-----	-----	--------	------	----------	-----

STX = 94 | 02 (0x5E | 0x02)

RID = 5

SEQ = package sequence (not used now)

DID = 128 (for constellation package)

LENGTH = 22

DATA

1-20 reserved for Constellation

21,22 for compass

21 – high byte

22 - lower byte

The data should be in 0 -3599 to display the direction 0 -359.9 degree.

CHECKSUM

Checksum is calculated over all the fields of each data packet, except the STX and ETX. This checksum is used to determine any packet transmission error. The sender is required to append the checksum in each packet and the receiver is required to verify the checksum to see if any transmission error. Note that any value can be used in the reserved byte for calculation purpose but please make sure that this value will be stored in the reserved field of the packet.

The following is a C sample code that is used i for calculating the checksum. The variable lpBuffer stores the content of a data packet excluding the STX and ETX in an array and the variable nSize stores the size of the data (from RID to DATA fields) in the lpBuffer array.

Figure III.1 Sample C Code of Checksum Calculation

```
BYTE CalculateCRC(char *lpBuffer, int nSize)
{
    BYTE shift_reg, sr_lsb, data_bit, v;
    int i, j;
    BYTE fb_bit;

    shift_reg = 0; // initialize the shift register

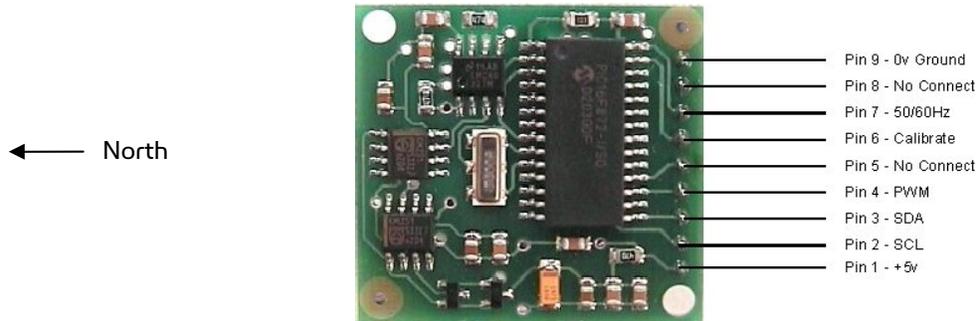
    for (i = 0 ; i < nSize ; i++)
    {
        v = (BYTE) (lpBuffer[i] & 0x0000FFFF);
        for (j = 0 ; j < 8 ; j++) // for each bit
        {
            data_bit = v & 0x01; // isolate least sign bit
            sr_lsb = shift_reg & 0x01;
            fb_bit = (data_bit ^ sr_lsb) & 0x01; // calculate the feed back bit
            shift_reg = shift_reg >> 1;
            if (fb_bit == 1)
                shift_reg = shift_reg ^ 0x8C;
            v = v >> 1;
        }
    }
    return shift_reg;
}
```

ETX = 94 | 13 (0x5E | 0x0D)

IV. Calibrating the compass module

Calibration only needs to be done once - the calibration data is stored in EEPROM on the PIC16F872 chip. You do not need to re-calibrate every time the module is powered up.

Compass module orientation to produce 0 degrees reading.



IMPORTANT: The compass module must be kept flat (horizontal and parallel to the earth's surface) with the components on top and for the DCP3011 the sensors underneath. Keep the module away from metallic - especially magnetic - objects.

Pin 6 is used to calibrate the compass. The calibrate input (pin 6) has an on-board pull-up resistor and can be left unconnected after calibration. To calibrate the compass you only have to take the calibrate pin low and then high again for each of the four major compass points North, East, South and West. A simple push switch wired from pin 6 to 0v (Ground) is OK for this. The compass points can be set in any order, but all four points must be calibrated. For example

1. Set the compass module flat, pointing North. Press and release the switch
2. Set the compass module flat, pointing East. Press and release the switch
3. Set the compass module flat, pointing South. Press and release the switch
4. Set the compass module flat, pointing West. Press and release the switch

V. FAQ

Q. Will your compass tell me which direction is north?

A. No.

Q. Ok, will your compass tell me which way the magnetic north pole is?

A. No.

Q. So what does it do?

A. It gives you the direction of the horizontal component of the prevailing magnetic flux. OK, so I'm making a point here and it's this: The magnetic field in a building can vary hugely. Don't expect it to be always pointing north. By walking around my workshop with a standard magnetic needle compass I can make it point in any direction I like by moving past various machines, and I can do the same thing at home by going near the fridge or even the central heating radiators. The compass module will give the same results. It can only provide information about the field at its current location.

Q. Is the Compass affected by Motors, Magnets, Ferrous objects etc?

A. Yes. Anything that affects the local magnetic field will affect the Compass module. Motors in particular contain strong magnets. The only solution is to mount the compass as far away from magnetic/ferrous objects as is practicable. Also see the previous questions and answers above

Q. If the accuracy of the compass is 3-4°, how can you provide a resolution of 0.1°?

A. Accuracy and resolution are not the same thing. A 3.5 digit multi-meter has a resolution of 1 in 2000 or 0.05%, yet the accuracy on some ranges can be 5% - a hundred times worse. A robot can use the resolution to detect small changes in direction even though there is uncertainty about the absolute direction. Also see previous answer.

Q. How many degrees can the module be tilted before the readings become inaccurate?

A. None. Moving the compass off horizontal will result in increasing error. The sensors are sensitive to the vertical component of the Earth's magnetic field as well. The angle of the Earth's field is not horizontal; it dives into the ground at an angle which varies according to location. It is this which produces an inherent error in the reading, and makes calibration of the compass required at the point where it is to be operated. After calibration you can expect 3-4° accuracy if you keep it horizontal.

Q. Which way up should the Compass be?

A. The Compass module should be horizontal, with the PCB parallel to the Earth's surface. The IC's should be on top and the Sensors underneath.

Q. Can the Compass be mounted near to the speaker?

A. The speaker magnet will affect the Compass. The effects reduce with distance and are negligible at 10-12 inches