# Digital Compass

Technical Manual Rev 1r0

**Robot Navigation Instrument**

Autonomous mobile robots needs a direction sensor if it is desired that it moves from one location to another without human help. Two popular technologies are readily available for this purpose, and both are feasible for hobby and professional use: GPS and the Electronic Compass.

With GPS, the robot can determine its absolute position and headings. But there is a couple of caveat attached to it that may severely limits its usefulness to autonomous robots: GPS is accurate to within +/- 5 meters at best, and does not work indoors.

Electronic Compass, on the other hand, won't give your robot its absolute location, but it can accurately guide your robot to a known target location relative to its present position. It will work both indoors and outdoors. This usually matters more than the robot absolute position. If a location fix is essential, GPS and electronic compass maybe installed to work together.

E Gizmo electronic compass is designed primarily to serve as navigational aid for autonomous robot systems. It can be used as well for other navigation applications with no or little additional hardware circuit. It has a 1 degree output resolution, serial I/O interface, and small footprint.

**About the circuit**

Figure 2 shows the complete schematic of the electronic compass. At the heart of the circuit is the magnetic field sensor itself, KMZ52 U2. This sensor consists of two sensing element internally arranged to generate a pair of voltage corresponding to its headings. This voltage is amplified by a low drift OPAMP amplifier circuit formed by U3. A low drift OPAMP ensures a reading that stays to its true value.

Voltage from U2 is then fed to a zilog encore XP! MCU ADC port. This is where the analog voltage from the magnetic field sensor circuit is processed to be converted into a digital heading direction value. The heading is continuously send to the SIO port, this is where your robot controller gets the heading direction.

The MCU also keeps the field sensor magnetically neutral by periodically demagnetizing it through the sensor internal flip coils. This is performed by the MCU by sending short pulses driving the flip coils through transistors Q1 and Q2.

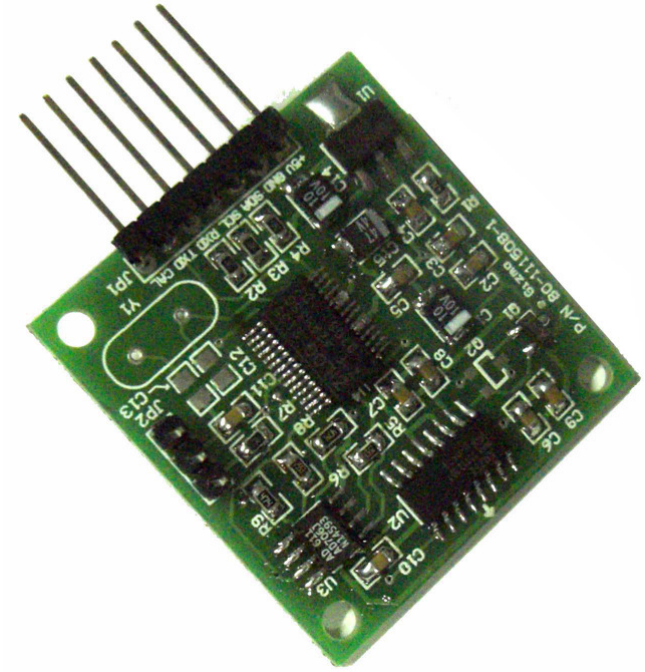


**Figure 1.** *e-Gizmo electronic compass is assembled using SMD components resulting in a subsystem with a small foorprint.*

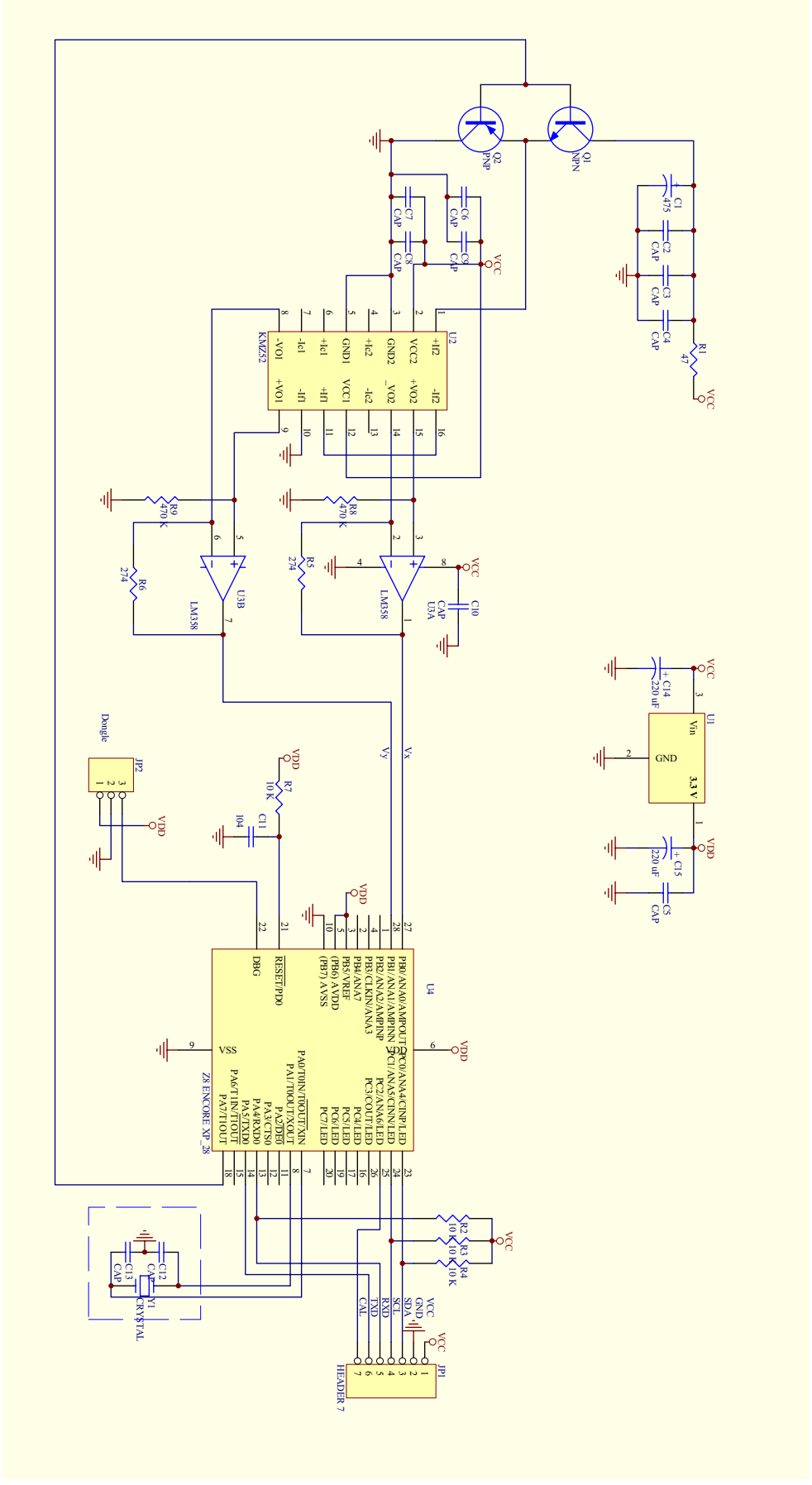
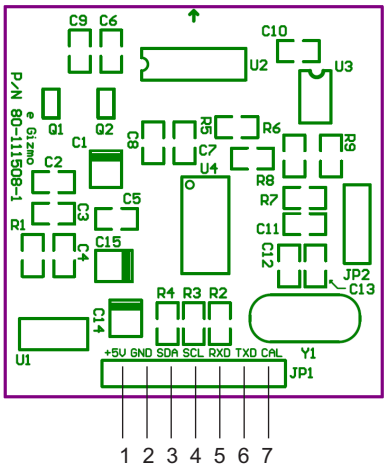



**Figure 2.** *Complete schematic diagram of e Gizmo electronic compass.*

## Pin Description




| Pin No | ID | Function |
|---|---|---|
| 1 | +5V | 5V DC power input |
| 2 | GND | Ground |
| 3 | SCA | Reserved for future enhancement |
| 4 | SCL | Reserved for future enhancement |
| 5 | RXD | Reserved for future enhancement |
| 6 | TXD | Transmit Data |
| 7 | CAL | Calibration (see text) |

* Reserved pins are for future enhancements and do not have useful function for this current version.

### Connecting the Electronic Compass

The electronic compass requires a stable and well filtered 5V DC source for its operation. Although it draws an average of 18mA (typical), during operation, it periodically drives the current hungry internal flip coil of the sensor, producing a current that is somewhat spiky. An inadequate 5V source will result in substantial error in the compass readings.

The electronic compass Tx pin outputs a 3.3V logic signal. It is directly compatible with any 3.3V MCU. Most 5V MCUs will work at this logic level without the need for a level translator. It is a good idea though, to check the MCU datasheet first. The parameter to check is the logic high input voltage of the target MCU UART rx input. If its minimum value indicates a voltage lower than 3.0V, your circuit is good without a translator. Most 5V TTL logic has a guaranteed high level of 2.0V, these should work without any problem with the electronic compass.

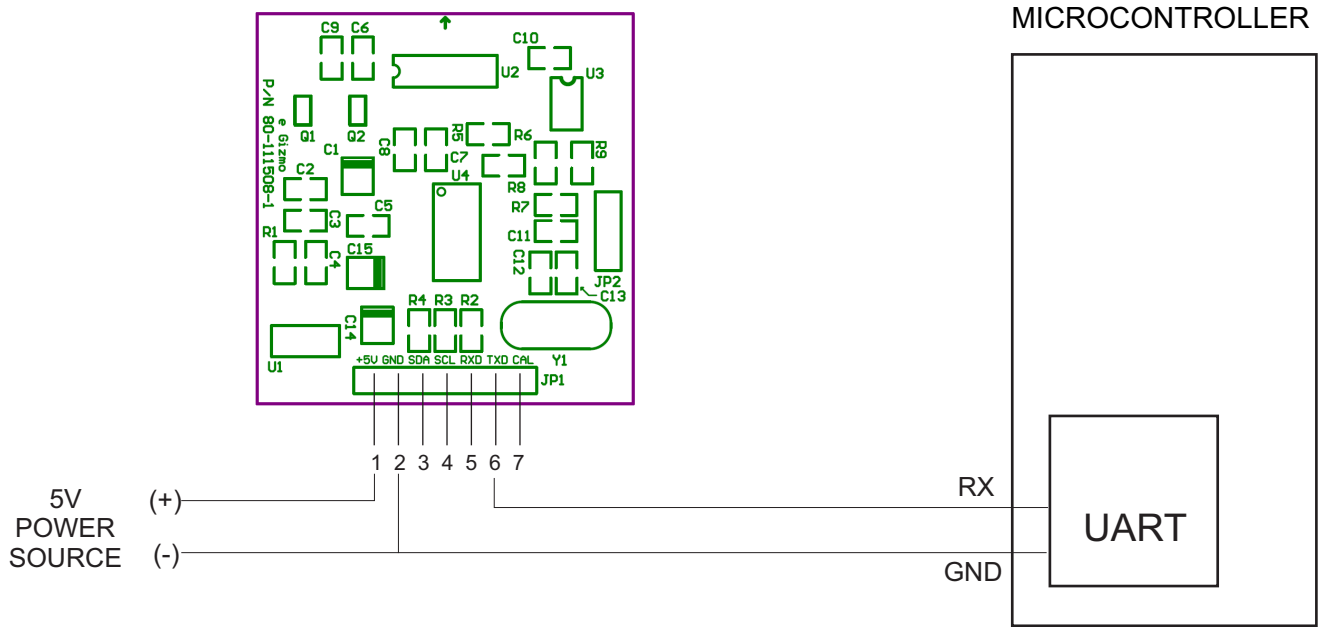



**Figure 4.** *The electronic compass connects directly to your MCU UART port. Only the MCU RX pin is used for the transfer of headings data, leaving the TX pin available for other uses.*

**Setup and Calibration**

The electronic compass is factory calibrated, but there are several instances where recalibration may become necessary. If you think your electronic compass gives inaccurate readings and need to be recalibrated, perform the following procedure:

1. Select a horizontally leveled non metallic surface away from any object that may may result in false reading (e.g. Transformer, motor, large metal, magnet, etc)
2. Connect CAL pin 7 to GND
3. Turn ON power.
4. Rotate with care the electronic compass two full rotations (any direction).
5. Disconnect CAL pin from GND.
6. Verify electronic compass readings to complete the calibration.

**Usage Precautions**

The electronic compass is sensitive to both the earth magnetic field, and to magnetic field generated by other objects. Large metal object, motors, transformers, nearby can disrupt the magnetic field causing the electronic compass give a false reading.

The electronic compass is not tilt compensated. It must be mounted on a level surface to get accurate headings. External tilt compensation may be required (e.g. using tilt sensors or accelerometers) if maximum accuracy is required under tilted conditions.

**Using the Electronic Compass**

The electronic compass sends SIO (UART) data using the following communications settings:

| | |
|---|---|
| Data Rate: | 9600 baud |
| Data width: | 8 bits |
| Stop Bits: | 1 |
| Parity: | None |
| Handshake: | None |

The electronic compass sends the heading informations using fixed 6 bytes transmission format:

ETX + Data1 + Data2 + Data3 + Data4 + STX

Where:

ETX – Start of transmission, character code 02
STX – End of transmission, character code 03
Data1 to Data4 – 4 digit direction heading data in ASCII format

**Note:** Data4 is the 1 digit decimal fraction part of the readings.

Example Readings:

Data1 = 1
Data2 = 0
Data3 = 7
Data4 = 5

This is data is translated as 107.5 degrees

Direction headings can be any value between 0 to 359.5 degrees, with 0.5 degree resolution. Heading values corresponds to the following cardinal directions:

0 – Magnetic North
90 – East
180 – South
270 – West

Likewise, ordinal directions correspond to the following readings:

45 – Northeast NE
135 – Southeast SE
225 – Southwest SW
315 - Northwest NW

## General Specifications:

| | |
|---|---|
| Sensing Element: | KMZ52 |
| MCU: | Zilog Z8F042AP |
| Range: | 0-359.5 degrees |
| Resolution: | 0.5 degree |
| Power Supply: | 5VDC |
| Current: | 18mA average (typical) |
| Board Dimensions: | 38L x 36.5W mm |

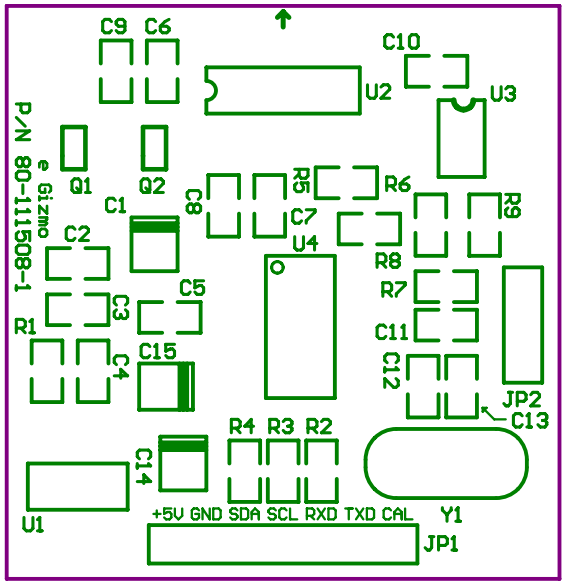



**Figure 5.** *e Gizmo electronic compass PCB component layout.*

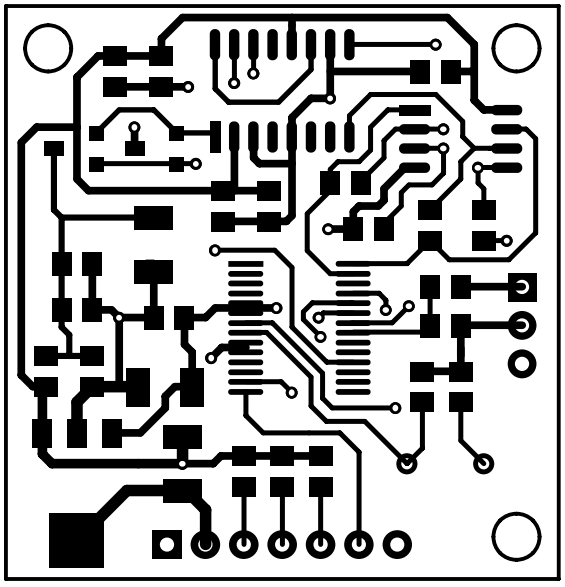


**Figure 6.** *e Gizmo electronic compass PCB top layer copper layout.*

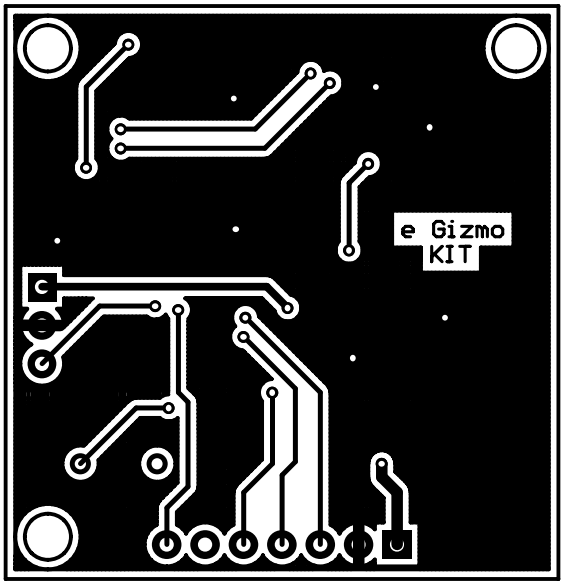



**Figure 7.** *e Gizmo electronic compass PCB bottom layer layout.*