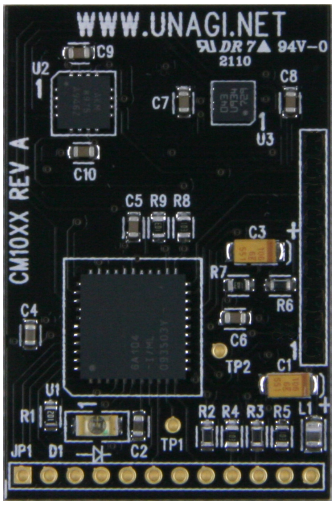
CM1020 ELECTRONIC COMPASS MODULE

COMPLETE DIRECTION DETECTION MODULE WITH MAGNETOMETER AND ACCELEROMETER

UNAGI NET LLC



General Description

The CM1020 is a complete electronic compass module, that outputs accurate directional data without the need for manual calibration or additional components. Utilizing a 3 axis magnetometer along with a highly sensitive triaxial accelerometer, the CM1020 calculates it's position relative to terrestrial magnetism, and outputs it's direction in degrees. Gyroscopic output data is also available.

With it's built-in microprocessor core, the CM1020 automatically calibrates itself using patented algorithms, so that the module is always ready to operate correctly. Simply apply DC power to the module, and then read the appropriate registers to find it's direction. The module does all the detection and heavy calculations.

The CM1020 communicates via a simple serial communication port. The CM1020 only requires a single 3.3VDC power supply and is very low in power consumption (< 350mW).

The CM1020 module is very small in size, 1.0" x 1.5" x 0.13". This allows the module to be easily incorporated into handheld or other portable devices. The module contains a single 12-pin header which contains all the power and interface signals.

The CM1020 module is built with high-volume manufacturing techniques, to keep quality high and costs low. Each module is 100% tested with accuracy guaranteed.

Features

• Completely tested self-contained module
No additional circuits or components required

• Patented Auto-Calibration
No special equipment or methods required to calibrate for accurate direction detection

• Highly accurate direction detection
Direction values from 0.0 to 359.9 degrees
Includes Gyro data: Inclination, Pitch, Roll, Yaw

•Low-power consumption
Ideal for battery operation

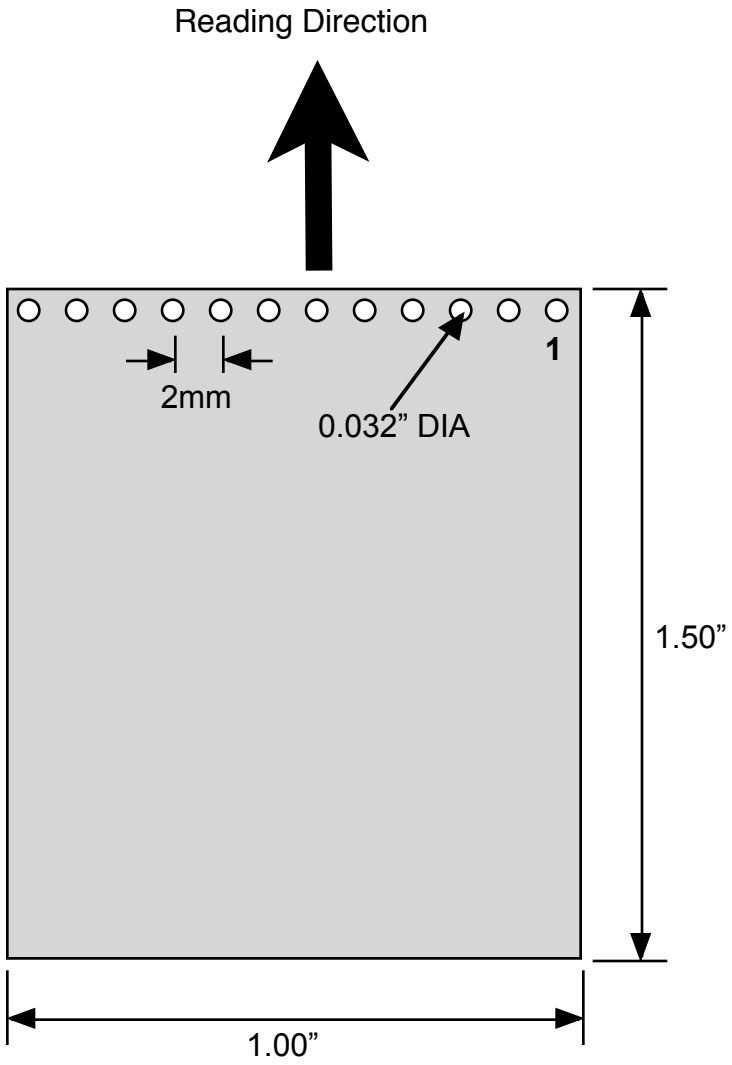
• Easy to interface
Single DC supply and a simple serial interface.

• Compact size 1.0" x 1.5" x 0.13"
Ideal for hand-held or other portable products

Applications

• Automobile navigators
• Portable GPS mapping equipment
• Weather station loggers
• Construction equipment
• Marine mapping displays

MODULE OUTLINE



PIN DESCRIPTIONS

PIN #	NAME	DIRECTION	FUNCTION
1	I2CDAT	Open Collector	I2C Data connection. Requires 2.2K pull up resistor.
2	12CCLK	Open Collector	I2C Clock connection. Requires 2.2K pull up resistor.
3	---	---	Non functional pin. Do not connect.
4	---	---	Non functional pin. Do not connect.
5	---	---	Non functional pin. Do not connect.
6	---	---	Non functional pin. Do not connect.
7	---	---	Non functional pin. Do not connect.
8	---	---	Non functional pin. Do not connect.
9	---	---	Non functional pin. Do not connect.
10	---	---	Non functional pin. Do not connect.
11	VDD	POWER	MAIN VOLTAGE CONNECTION. 3.3VDC TYPICAL.
12	GND	POWER	MAIN GROUND CONNECTION.

VDD, GND – These pins are the main module power connections. VDD typically is 3.3V. Bypass capacitors should be connected as close to these pins as possible.

Absolute Maximum Ratings

Supply Voltage	-0.3V to 6V
Input Voltage	-0.3V to 6V
Voltage at all other pins	-0.3V to 5.5V
T_{MAX}	100 C

Recommended Operating Conditions

Voltages referenced to GND; GND = 0 V

Parameter	Symbol	Pin	Min	Typ	Max	Unit
Supply Voltage (1)	VDD	11	2.7	3.3	4.0	V
Input Voltage	V_{IN}	2, 4, 5, 8, 9, 10	0.0	-	VDD	V
Output Current	I_O	3, 7	-	-	3.0	mA
Temperature	T_A		-30		+85	°C

(Note 1) Maximum supply voltage ramp-up time is 200uS.

DC Characteristics

Voltages referenced to GND; GND = 0 V, VDD = 3.3V

Parameter	Symbol	Pins	Min	Typ	Max	Unit
Input Voltage Low	V_{IL}		GND	–	0.2 VDD	V
Input Voltage High	V_{IH}		0.8 VDD	–	VDD	V
Output Voltage Low	V_{OL}		–	–	0.4	V
Output Voltage High	V_{OH}		2.7	–	–	V
Open Collector Voltage – Low	V_{OCL}	1,2	–	–	0.2 VDD	V
Open Collector Voltage – High	V_{OCH}	1,2	0.8 VDD	–	–	V
Open Collector Resistance	V_{OCR}	1,2	–	2.2 K	–	Ohm
Module Power Consumption	I_{DD}	11	–	30	–	mA

Applications Information

Power On

The CM1020 only requires power to begin operation. The module has a built-in reset and watchdog function, therefore all that is required is proper VDD to begin operation.

The maximum power ramp-up is 200uS. If power is applied at a slower ramp-up than 200uS, proper module initialization is not guaranteed and operations may be erratic.

Serial Communication

The CM1020 communicates over a serial port with various control signals. Please refer to the Serial Communication section for additional information on the exact timing signals required.

Direction North

The module facing direction is from the top edge of the module.

Automatic Calibration

The CM1020 has an automatic self-calibration function that operates once the power is applied, and continuously thereafter on a regular basis. The magnetic axis self-calibration is performed when the module is rotated through positions during normal use. No other action is necessary for the module to calibrate to the terrestrial magnetism of the surrounding environment.

Serial Communication

The CM1020 module uses the simple 2-wire serial communication protocol I2C. There are only two pins required for all communications in both directions. The CM1020 module acts as a slave device on the I2C databus. In other words, the module does not initiate any data transactions, but only responds to data requests.

PIN	NAME	DIRECTION	FUNCTION
1	I2CDAT	Open Collector	I2C Data connection.
2	I2CCLK	Open Collector	I2C Clock connection.

I2CDAT, I2C Data Connection – This is the communication data pin. It requires a resistor pull up to VDD. The value of the resistor is listed in the DC Characteristics table.

I2CCLK, I2C Clock Connection – This is the communication clock pin. It requires a resistor pull up to VDD. The value of the resistor is listed in the DC Characteristics table.

The main module I2C address is 0x89 Hex for Read Data, 0x88 for Write Data. Single register reads are available, along with block reads with register number auto increment. Typical access sequence is listed below.

Set Register Number to access:
- START
- 0x88 (Chip address, Write)
- ACK
- 0x03 (Set Register Number to 03)
- ACK
- STOP

Read Register Data:
- START
- 0x89 (Chip address, Read)
- ACK
- 0xnn (Read Register 03 data)
- ACK (increments Register Number)
- 0xnn (Read Register 04 data)
- ACK (increments Register Number)
- 0xnn (Read Register 05 data)
- No ACK
- STOP Condition

Applications Information

Data Format

The registers of the CM1020 are grouped into two byte words. The Heading data is in hex, with the actual direction degrees multiplied by 10. In other words, a reading of 1376 would mean that the heading is 137.6 degrees. The remaining data registers are in 2's complement format.

Name	Register #	Description	Bits	Info
HEADU	0x00	Heading	8	Upper byte of the calculated heading
HEADL	0x01	Heading	8	Lower byte of the calculated heading
INCU	0x02	Inclination	8	Upper byte of the calculated inclination
INCL	0x03	Inclination	8	Lower byte of the calculated inclination
MAGU	0x04	Magnitude	8	Upper byte of the calculated magnitude
MAGL	0x05	Magnitude	8	Lower byte of the calculated magnitude
IDIRU	0x06	Initial Direction	8	Upper byte of the calculated initial direction
IDIRL	0x07	Initial Direction	8	Lower byte of the calculated initial direction
PITU	0x08	Pitch	8	Upper byte of the calculated pitch
PITL	0x09	Pitch	8	Lower byte of the calculated pitch
ROLU	0x0A	Roll	8	Upper byte of the calculated roll
ROLL	0x0B	Roll	8	Lower byte of the calculated roll
YAWU	0x0C	Yaw	8	Upper byte of the calculated yaw
YAWL	0x0D	Yaw	8	Lower byte of the calculated yaw

- **Register 0x00 - HEADU (Calculated Heading, Upper byte)**
- **Register 0x01 - HEADL (Calculated Heading, Lower byte)**

HEADU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 HEADU (7:0) : Upper byte of the calculated heading

HEADL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 HEADL (7:0) : Lower byte of the calculated heading

HEADU & HEADL combine to show the pointed direction in degrees x 10.

For example, a value of hex 055F, which is decimal 1375, indicates a heading of 137.5 degrees.

- **Register 0x02 - INCU (Calculated Inclination, Upper byte)**
- **Register 0x03 - INCL (Calculated Inclination, Lower byte)**

INCU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 INCU (7:0) : Upper byte of the calculated inclination

INCL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 INCL (7:0) : Lower byte of the calculated inclination

Inclination is the path of the terrestrial magnetic field, which varies depending on your location.

- **Register 0x04 – MAGU (Calculated Magnitude, Upper byte)**
- **Register 0x05 – MAGL (Calculated Magnitude, Lower byte)**

MAGU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 MAGU (7:0) : Upper byte of the calculated magnitude

MAGL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 MAGL (7:0) : Lower byte of the calculated magnitude

Magnitude is the amount of magnetic flux being detected by the module. This will vary depending on the module's position and the operating environment.

- **Register 0x06 – IDIRU (Calculated Initial Direction, Upper byte)**
- **Register 0x07 – IDIRL (Calculated Initial Direction, Lower byte)**

IDIRU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 IDIRU (7:0) : Upper byte of the calculated initial direction

IDIRL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 IDIRL (7:0) : Lower byte of the calculated initial direction

Initial direction shows the position the module was pointing when power was applied.

- **Register 0x08 – PITU (Calculated Pitch, Upper byte)**
- **Register 0x09 – PITL (Calculated Pitch, Lower byte)**

PITU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 PITU (7:0) : Upper byte of the calculated pitch

PITL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 PITL (7:0) : Lower byte of the calculated pitch

- **Register 0x0A – ROLU (Calculated Roll, Upper byte)**
- **Register 0x0B – ROLL (Calculated Roll, Lower byte)**

ROLU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 ROLU (7:0) : Upper byte of the calculated roll

ROLL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 ROLL (7:0) : Lower byte of the calculated roll

- **Register 0x0C – YAWU (Calculated Yaw, Upper byte)**
- **Register 0x0D – YAWL (Calculated Yaw, Lower byte)**

YAWU							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 YAWU (7:0) : Upper byte of the calculated yaw

YAWL							
7	6	5	4	3	2	1	0
n	n	n	n	n	n	n	n

BITS 7-0 YAWL (7:0) : Lower byte of the calculated yaw

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