SPT0001

SPT0001 - DIGITAL COMPASS MODULE (Preliminary 1.9)

● **DESCRIPTION**

SPT0001 is a digital compass module for use in navigation and guidance system. This compass solution can be easily integrated into systems using a digital interface. The SPT0001 consists of a Honeywell HMC1052 two-axis magneto-resistive sensor with integrated 12-bit ADC to provide resolution of 1° and accuracy of ± 5°. All compass calculation and Hard Iron compensation routines are included in the integrated microcontroller.

● **FEATURES**

- 0° ~359° range
- ± 5° accuracy
- 1° resolution
- Hard Iron Compensation
- Integrated MCU for heading calculation and compass calibration
- Low power consumption (STOP mode, <1uA)
- Easy to use digital interface
- Backup of calibration data to EEPROM (optional)
- Wide operating voltage (2.4V to 3.3V)

● **APPLICATIONS**

- Handheld digital compass
- Digital Navigation System (DNS)
- Vehicle Compass
- PDA Compass
- Mobile Phone Compass

● **TECHNICAL SPECIFICATIONS**

Parameter	Specification
Range	0° ~359°
Accuracy	± 5°
Resolution	1°
Supply voltage	2.4 V to 3.3 V
Current consumption (Stop Mode)	<1uA
Current consumption (Operating)	<200uA MAX
Current consumption (Calibration)	<1.5mA MAX
Operating temperature	−10°C ~ +60°C

Table 1: Specification

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- **PIN DESCRIPTION**

Pin	Name	I/O	Function
1	VDD	Power	Supply voltage, connect to VDD
2	MOSI	Input	Master output salve input
3	MISO	Output	Master input salve output
4	MSCL	Input	Clock generated by master
5	RST	Input	Module reset pin
6	GND	Power	Ground

Table 2: Pin Description

- **TABLE OF COMMANDS**

Command	Option	Data	Description
0101	0001	12 bits	Get compass heading (12 bits BCD values)
0101	0010	/	Calibration
0011	0001	/	Turn on EL
0011	0010	/	Turn off EL
0111	0011	12 bits	Check if calibration data recovered from EEPROM (if any) after system reset

Table 3: Table of Commands

- **COMPASS HEADING**

The compass module operates as a slave device. On power up, the compass module enters sleep mode which consumes negligible current. To enable the compass and to acquire the compass heading follows the protocol in the next section. After the compass heading is acquired, the compass module enters sleep mode to reduce current consumption.

- **CALIBRATION**

Digital compasses consist of sensing device to detect the earth's magnetic field. This magnetic field is weak and can be distorted by nearby ferrous objects or magnet. Calibration has to be done to compensate the distortion in magnetic field for accurate heading.

The calibration procedure is simple. The compass has to be placed on a horizontal plane and it enters calibration mode. The user is requested to rotate the compass slowly for one circle. After all, the user informs the system completion of calibration.

It should be noticed that calibration is necessary whenever the compass is relocated. A good practice is to avoid placing the compass near ferrous objects and strong magnetic field.

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- **EEPROM**

SPT0001 supports the backup of calibration data to EEPROM, this feature is optional and is selected by a jumper option.

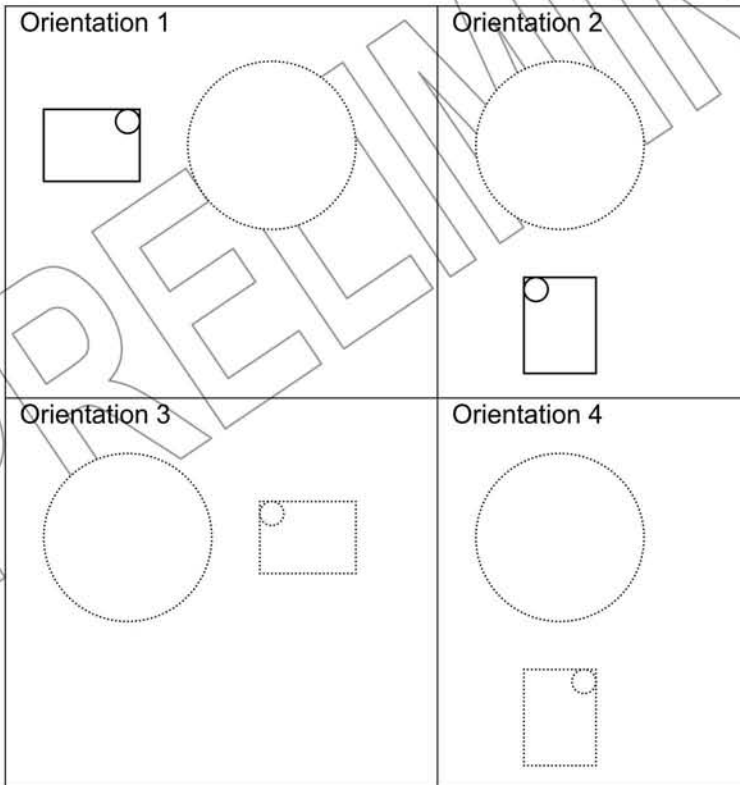| Bond Option 1	Description
Left open	No EEPROM (default)
Connect to VDD	With EEPROM

Table 4: EEPROM Option

EEPROM is a 93LC46 or compatible device and must support sequential read command.

- **COMPASS SENSOR ORIENTATION**

SPT0001 supports 4 different placements of the compass sensor, following pictures show the orientation of the sensor as well as its relative location from the coin type battery (for watch application), all pictures below are viewing from the top, sensor in orientation 1 & 2 is placed on the upper side of the PCB; whereas sensor in orientation 3 & 4 is placed on the back side of the PCB. In orientation 1 & 2, the sensor and battery are on different side of the PCB, orientation 1 is the default settings and it is the recommended option.

Sensor orientation is selected by 2 jumper options.

Bond Option 2	Bond Option 3	Description
Left open	Left open	Orientation 1 (default)
Left open	Connect to VDD	Orientation 2
Connect to VDD	Left open	Orientation 3
Connect to VDD	Connect to VDD	Orientation 4

Table 5: Sensor Orientation Option

● INTERNAL/EXTERNAL OPAMP

The on board ADC has built-in operational amplifier for signal amplification, however, SPT0001 supports the option to use external operational amplifier.

Bond Option 4	Description
Left open	Use ADC built-in operational amplifier (default)
Connect to VDD	Use external operational amplifier

Table 6: Internal/External Operational Amplifier Option
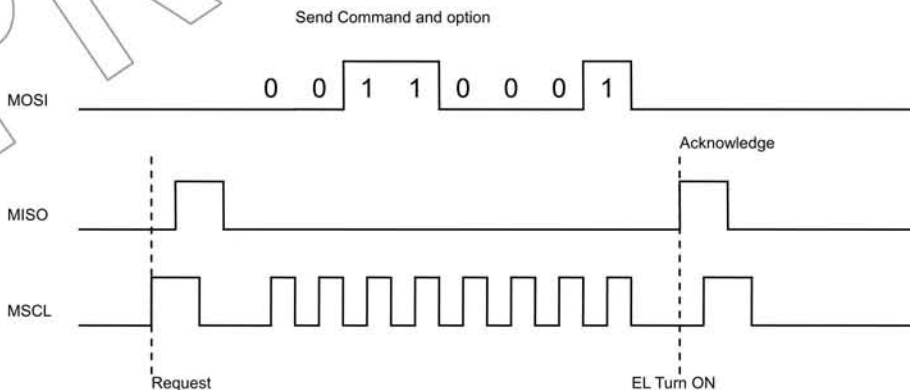
● TIMING DIAGRAMS

Sending command (by master)
1. Master make a request by setting MSCL to H and waiting for response from slave
2. After detecting the request from master, slave respond by setting MISO to H
3. After detecting the response from slave, master set MSCL to L
4. After detecting MSCL become L, slave set MISO to L
5. Slave is now ready and master could send out the command, slave will read data on each rising edge of MSCL
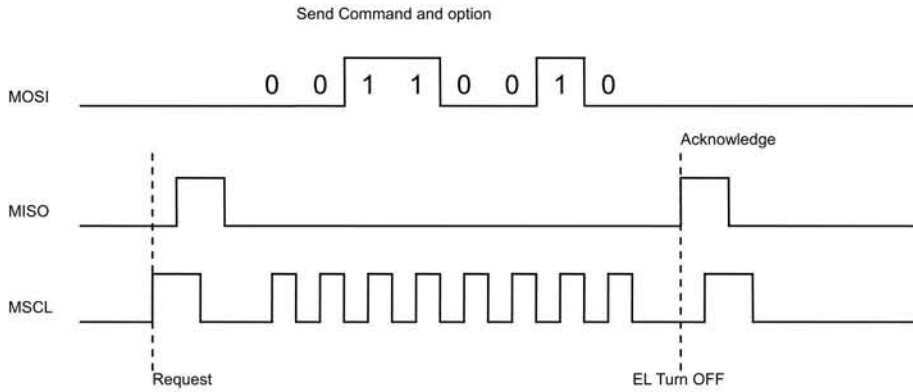
Sending acknowledge (by slave)
1. Slave acknowledge by setting MISO to H and waiting for response from master
2. After detecting the ack signal from slave, master respond by setting MSCL TO H
3. After detecting the response from master, slave set MISO to L
4. After detecting MISO become L, master set MSCL to L
5. If there is no data to send out from slave, communication is complete; If there is any data from slave, the first bit data will be sent out now and the rest will be clocked out on each falling edge of MSCL, master should read data on each rising edge of MSCL
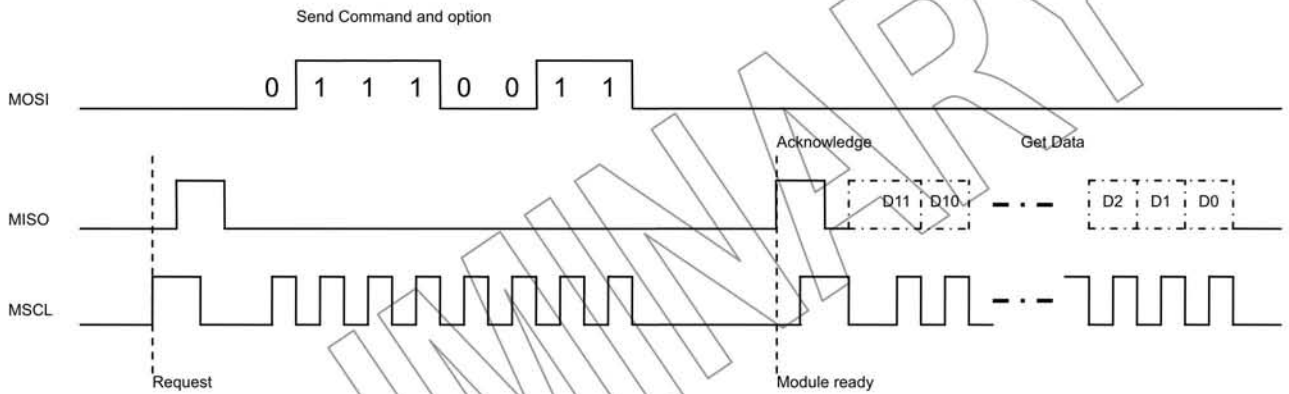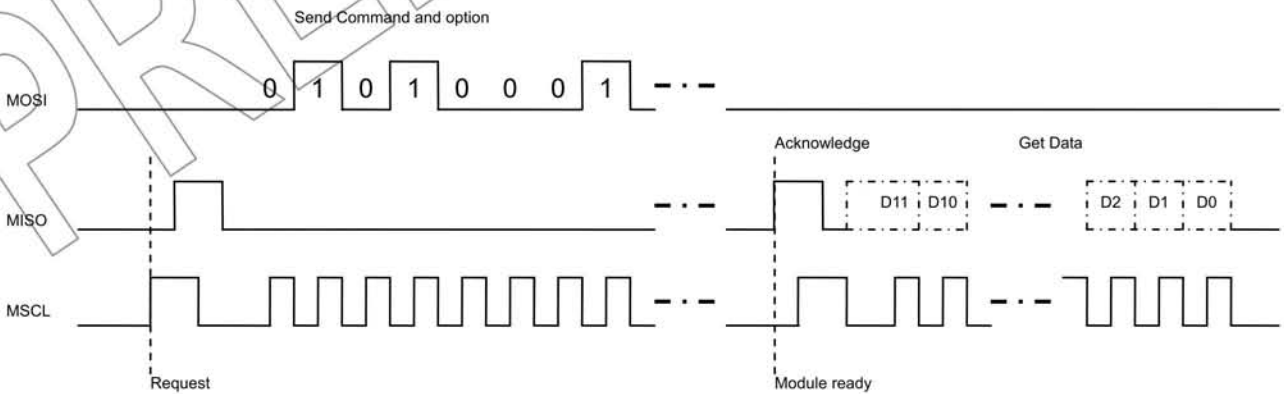
■ EL Turn On

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■ **EL Turn Off**

Send Command and option

MOSI   0   0   1   1   0   0   1   0

Acknowledge

MISO

MSCL

Request   EL Turn OFF

■ **Calibration Data Recovery Check**

Send Command and option

MOSI   0   1   1   1   0   0   1   1

Acknowledge   Get Data

MISO   D11   D10   — · —   D2   D1   D0

MSCL

Request   Module ready

Data formatting

D11~D1	Reserved
D0	H: calibration data is recovered from EEPROM; L: no calibration data recovered

■ **Compass Heading**

Send Command and option

MOSI   0   1   0   1   0   0   0   1   — · —

Acknowledge   Get Data

MISO   — · —   D11   D10   — · —   D2   D1   D0

MSCL   — · —

Request   Module ready

Compass angle data formatting

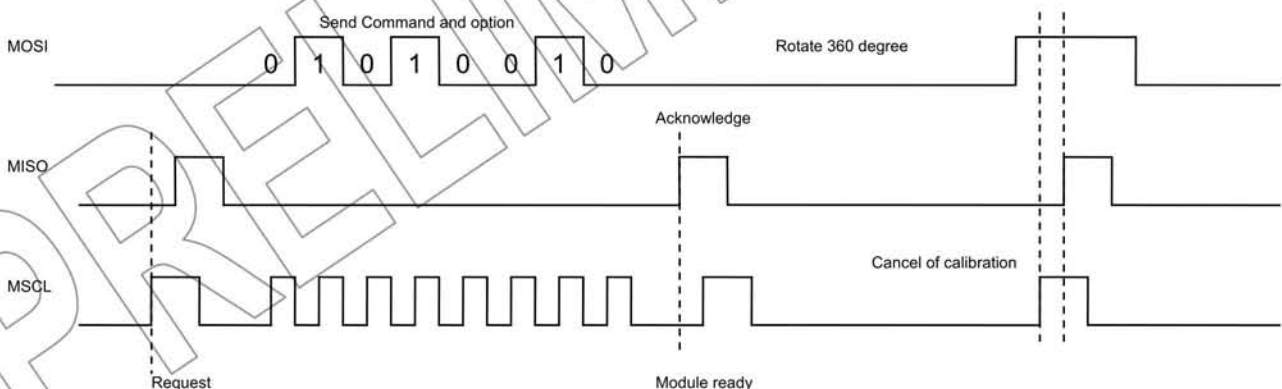| Digit 1 (BCD) (most significant digit)	Digit 2 (BCD)	Digit 3 (BCD)
D11~D8	D7~D4	D3~D0
e.g. digit 1 = 3, digit 2 = 5, digit 3 = 9 => angle = 359°		

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■ Start Calibration and Normal Ending

End of calibration
1. Master set MSCL to H while keeping MOSI L
2. After detecting MSCL become H and MOSI is L, calibration mode is terminated, the compass module then analyses the collected calibration data, when complete, slave will set MISO to H
3. After detecting the response from slave, master set MSCL to L
4. After detecting MSCL become L, slave set MISO to L
5. Slave is now ready for master to clock out the calibration status, slave will output the status on the rising edge of MSCL, master should wait for at least 100us before reading the data, a L means calibration is ok, fail otherwise. Compass module will keep the old calibration data if calibration is fail. Compass module will save the new calibration data to EEPROM (if present) if calibration is ok. After reading the calibration status, master should set MSCL to L
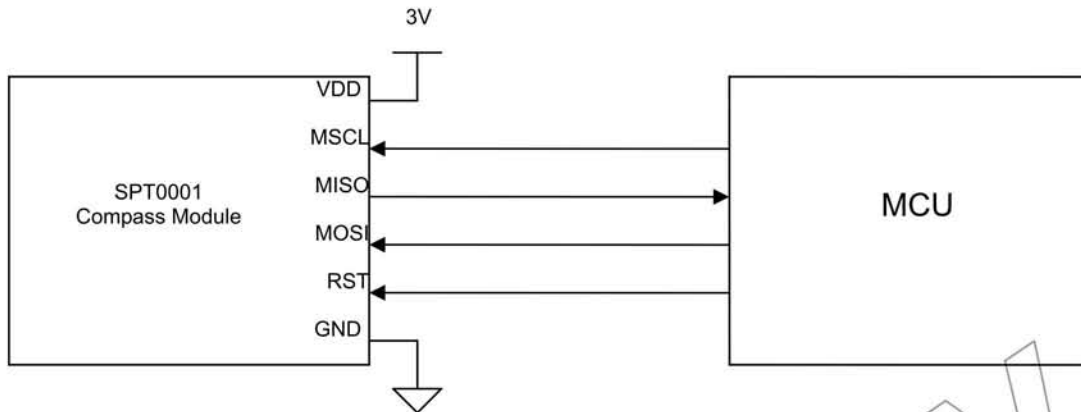
■ Start Calibration and Abort

Cancel of calibration
1. Master set MOSI to H and then set MSCL to H
2. After detecting MSCL become H and MOSI is H, calibration is cancelled and the compass module will keep the old calibration data, slave respond by setting MISO to H
3. After detecting the response from slave, master set MSCL to L
4. After detecting MSCL become L, slave set MISO to L
5. Communication is complete and master set MOSI to L

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● **APPLICATION CIRCUIT**

● **BONDING OPTIONS**

Bond Option	Jumper (PCB)
Bond Option 1	J11
Bond Option 2	J12
Bond Option 3	J13
Bond Option 4	J14

Table 6: Bond option and the corresponding jumper (PCB)

● **MECHANICAL**