MDS-CP COMPASS MODULE

- 2D Compass with 1° resolution.
- Integrated 8 bits MCU with14 bits ADC.
- Integrated magnetic sensors and software for azimuth calculation
- 3-wire synchronous serial interface.
- Low power, low voltage.

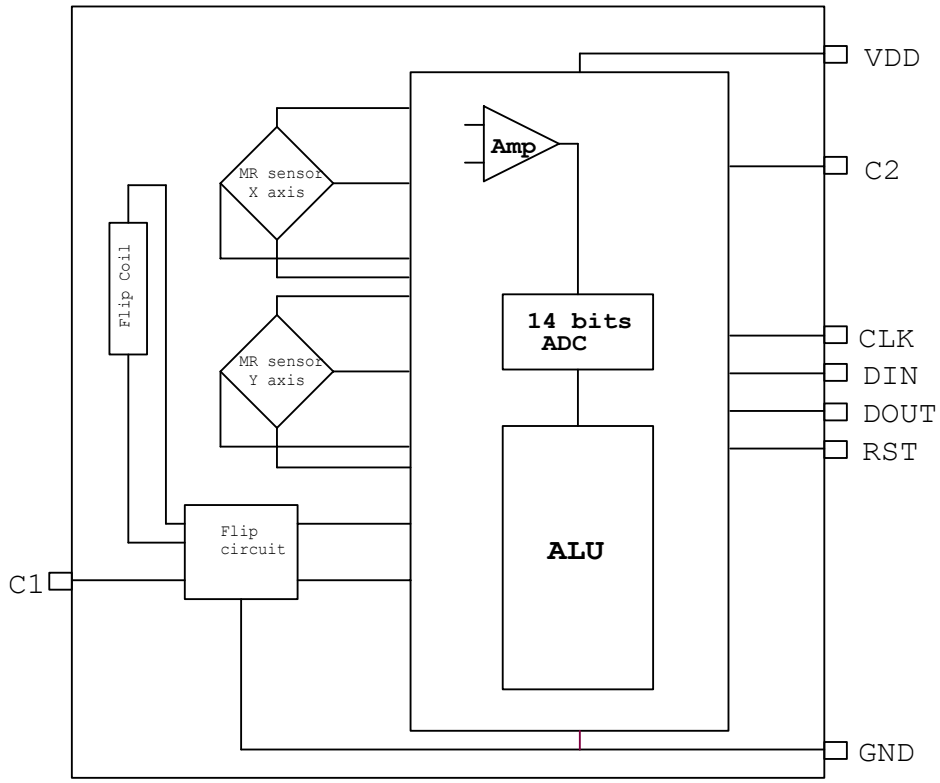
DESCRIPTION

MDS-CP is an SMD module including an 8 bits MCU with integrated 14 bits ADC and 2 high sensitivity compass magneto resistive sensors. With its integrated firmware, this device supplies to designer the electronic compass heading. This high integration level allows an easy access to sensor technology without any background in it.
MDS-CP is a low power, low voltage device that could be interfaced through its 3 wires synchronous interface to a low cost 8 bits MCU.
The small size of this module (7.62 x 12.70 x 2 mm) easies its integration in all watch applications.

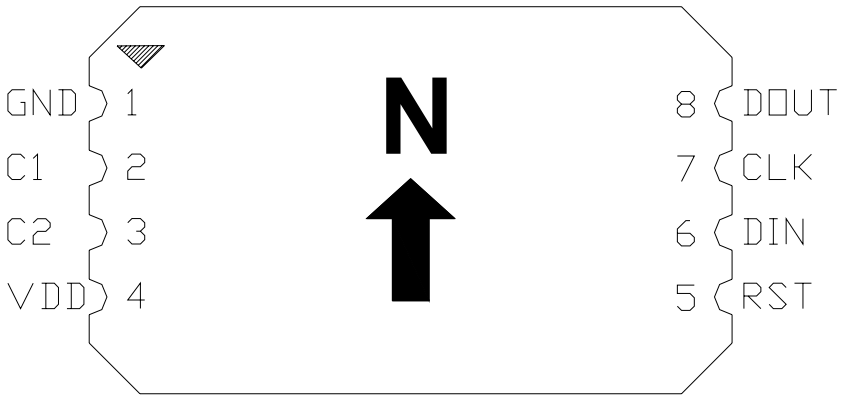
APPLICATION

- Electronic compass with 1° resolution.
- High added-value sensor watches.

BLOCK DIAGRAM



PIN CONFIGURATION



Note: The arrow indicates North direction.

PIN DESCRIPTION

Name	In/Out	Pin No	Description
GND	I	1	Negative Power supply (Ground)
C1	I	2	Flip circuit capacitor (1)
C2	I/O	3	Charge Pump Capacitor (2)
VDD	I	4	Positive Power supply
RST	I	5	CPU Reset (3)
DIN	I	6	Synchronous Serial Interface Data Input
CLK	I	7	Synchronous Serial Interface Clock Input
DOUT	O	8	Synchronous Serial Interface Data Output

Note:

1. C1 should be 10μF connected to GND.
2. C2 should be 1μF connected to GND.
3. To reset MDS-CP, RST pin must be applied low in 2ms and then delay as least 300ms before start communicating with MDS-CP.

ABSOLUTE MAXIMUM RATINGS

Description	Value
Maximum voltage applied between VDD and VSS	3.6V
Voltage applied to any pin (but VDD)	VSS - 0.3V to VDD + 0.3V
Storage temperature	-20 to +85°C
Operating temperature	-10 to +60°C

NORMAL OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typical	Max	Unit
Power supply	V_{DD}		2.5	3.0	3.3	V
Current consumption Average current during AD conversion	I_{avgC}	V_{DD} = 3V		2.5	3	mA
Power down in sleep mode	I_{slp}			1.5	2.5	μA
Synchronous serial clock	Clk				5	kHz

COMPASS OUTPUT CHARACTERISTICS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit	Note
Resolution		VDD = 3V		1		°	1
Heading accuracy		VDD = 3V	-3		+3	°	1
Conversion time		VDD = 3V		200	300	ms	

Notes: 1. The accuracy is defined by rotating the compass at horizontal level on the 360° gabarit.

SERIAL COMMUNICATION COMMANDS

- For each byte, MSB is sent first and LSB at the end. Data is in hexadecimal format.
- The host MCU has to send 17clock pulses to read data from the module. The first 16 clocks is to read 2 bytes of data, the last clock is dummy clock.
- The module will enter sleep mode after executing a command or by expiring the communication timeout.
- In Sleep Mode, the oscillator stops, all internal registers and RAM keep values before Sleep Mode.
- To wake up the module from sleep mode, the host MCU just writes the first clock to the CLK pin. The module will wake up automatically and DOUT will go high within 6ms. The host MCU can then send out the new command.

The information supplied by the MDS-CP module could be sent to the host MCU on request. Hereunder, the list of commands issued by the host MCU to the compass module.

Commands name	Note	Code	Host MCU	MDS-CP
COMMUNICATION TEST	1	40H	Send 1 byte code and 4 bytes data	Send 4 bytes data
AZIMUTH 2D	2	4Ch	Send 1 byte code	Send 2 bytes data
COMPASS USER CALIBRATION	3			
Start calibration		4Ah	Send 1 byte code	Send 2 bytes data 4Ah
Calibration		4Bh	Send 1 byte code	Send 2 bytes data 4Bh
End calibration		49h	Send 1 byte code	Send 2 bytes data 49h

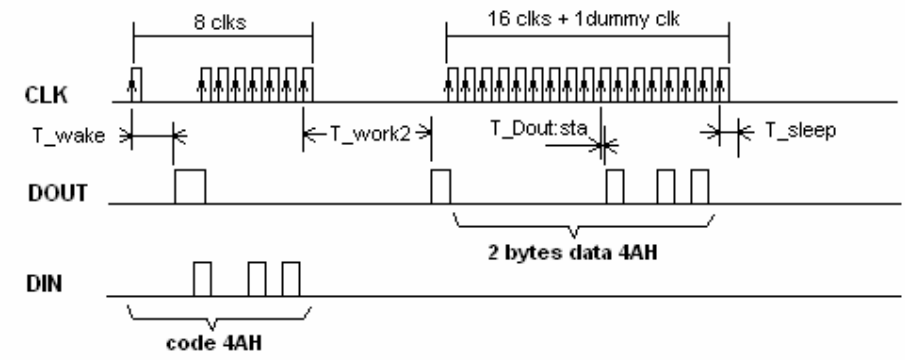
Notes:

1. **Communication Test**: the Host MCU sends 1 byte code and 4 bytes data, then receives these 4 bytes data from MDS-CP. The host compares sent and received data to test the communication. Data sent could be any 4 bytes hex number, except the string 13 12 14 22h, MDS-CP uses this string for testing.
2. **Read Compass Azimuth**: the Host MCU sends 1 byte code and then receives 2 bytes data from MDS-CP module. At 2 bytes data: 12 bits LSB for azimuth (AZI), 3 bits LSB of 4 bits MSB for cardinal and semi cardinal points (CP), and 1 bit MSB for error due to strong magnetic field (Err).
   - AZI : 0^{o}…359^{o}
   - CP = 0 : North
   - CP = 1 : North - East
   - CP = 2 : East
   - CP = 3 : South - East
   - CP = 4 : South
   - CP = 5 : South - West
   - CP = 6 : West
   - CP = 7 : North - West
   - Err = 1: error strong magnetic field.
   - Err = 0: normal magnetic field.

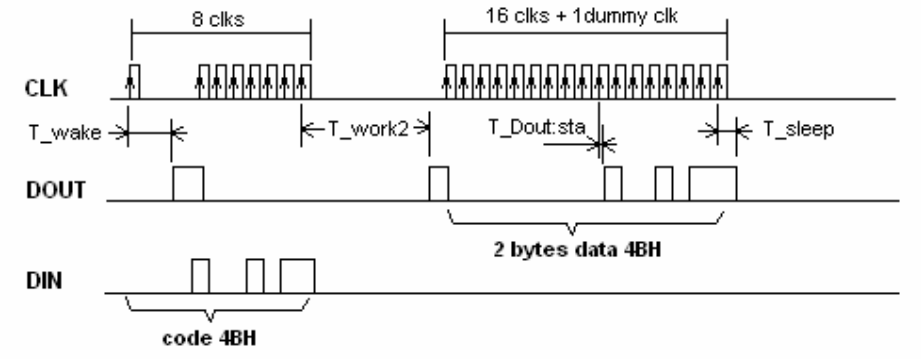
   There will be error if the read values of MR sensors are 50% more than the maximum values or 50% less than the minimum values. Maximum and minimum values are those got during calibration.
3. **User calibration for compass**: the Host MCU must follow this order of commands: **START calib, CALIB and END calib**. START command is sent once at start calibration and END command once at the end of calibration, CALIB command must be sent continuously (i.e. every 300ms + communication time) during calibration and the compass must be turned very slowly at horizontal level for at least 360^{o}. Each time, CALIB Code is sent by the MCU, the module will acknowledge the Host MCU order by returning 2 bytes data (4Bh).

TIMMING DIAGRAMS

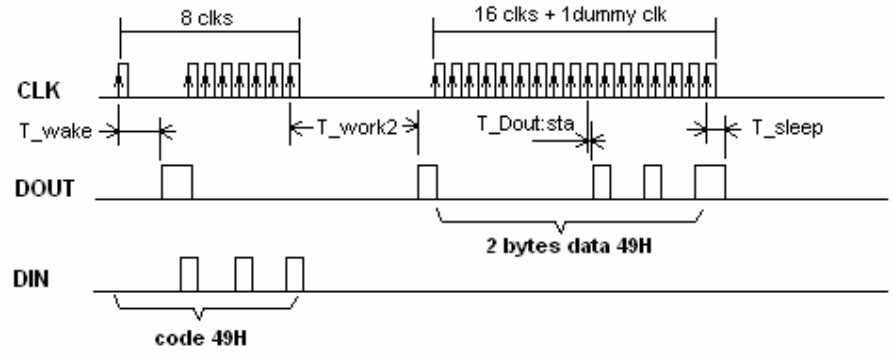
START CALIBRATION



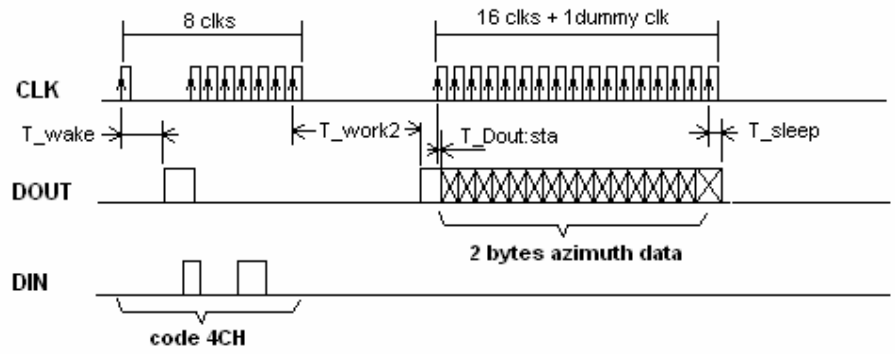
CALIBRATION



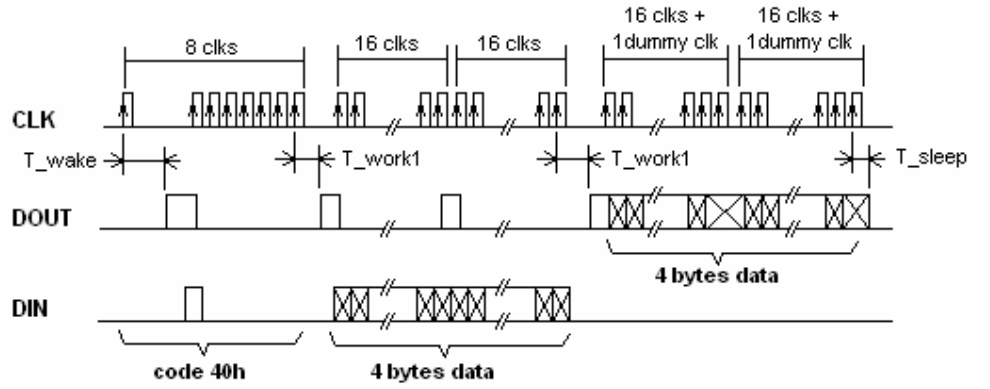
END CALIBRATION



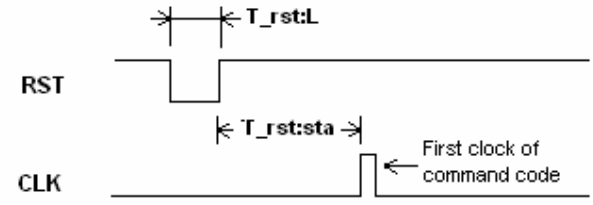
READ AZIMUTH



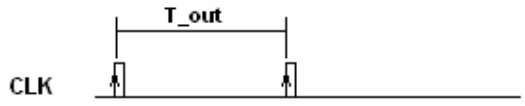
COMMUNICATION TEST



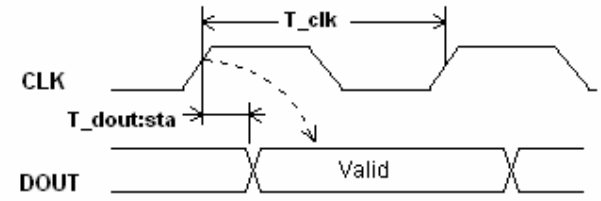
RESET TIMING



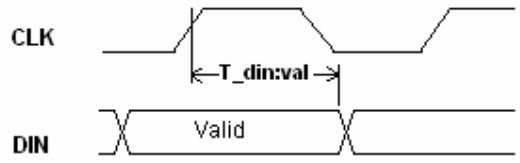
TIME OUT



DATA OUT TIMING



DATA IN TIMING



Symbol	Descriptions	Notes	Min	Typical	Max	Units
T_rst:L	Active low reset time		2			ms
T_rst:sta	Stable time after reset				300	ms
T_clk	Clock cycle	1	0.2		1000	ms
T_out	Communication time out	1	900	1000	1100	ms
T_din:sta	Hold time for valid input data from rising edge of clk	2	100			μs
T_dout:val	Output valid from rising edge of clk	3			100	μs
T_wake	Wake up time from sleep mode	4			6	ms
T_work1	Delay time for executing the communication command	5		150	200	μs
T_work2	Delay time for executing the AD conversion and Azimuth command	5		200	300	ms
T_sleep	Hold time for the module return to sleep mode	6			200	μs

Notes:

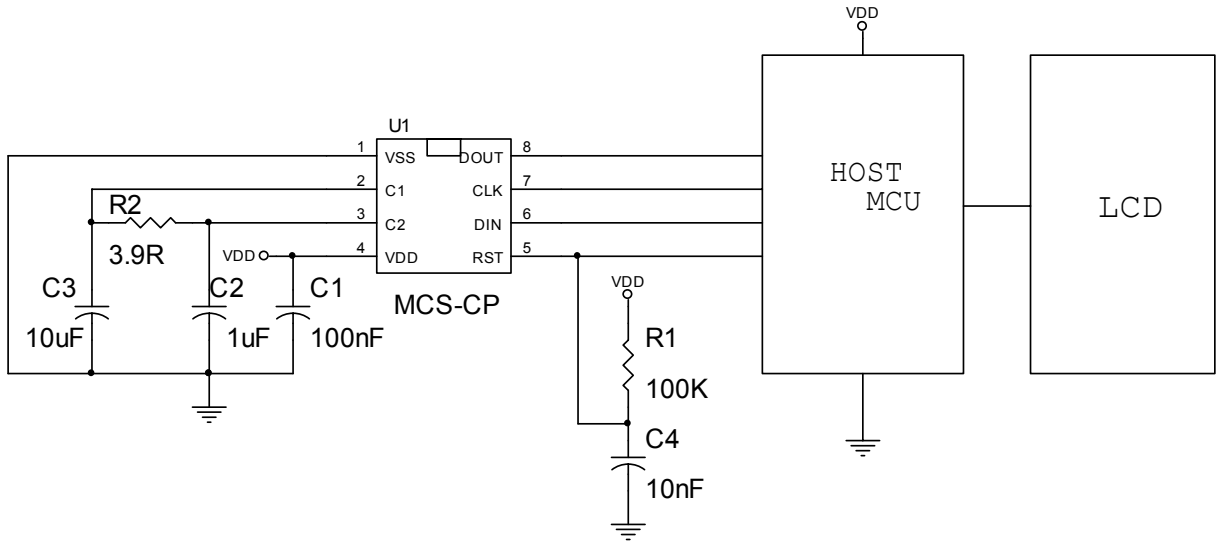
1. The maximum clock cycle is 1s, it is the Time-out of clock. If the interval between 2 clocks is more than 1s, the module will return to sleep mode and reset its entired serial interface, the host MCU has to restart the communication.
2. DIN should be set before rising edge of clock and hold at least 100 μs since this rising edge.
3. DOUT have to be read at least 100 μs after the rising edge of clock. For safety, the host MCU could read it at the falling edge of clock.
4. After sending the first clock of code, the host MCU waits T_wake for the module waking up from sleep mode and check Dout high before sending the next clocks.
5. The host MCU waits for DOUT high before processing the next step of communication test command. Dout will go high within T_work1 or T_work2 after the last clock of code.
6. After finishing a command, the module needs 200 μs to return to sleep mode. The host MCU has to delay T_sleep since the last clock of the previous command before sending new code.

SLEEP MODE SETTINGS

- After executing a command, the module goes to sleep mode automatically. In order to save the power, the host MCU ports have to be set compatible with the settings of the module's ports.

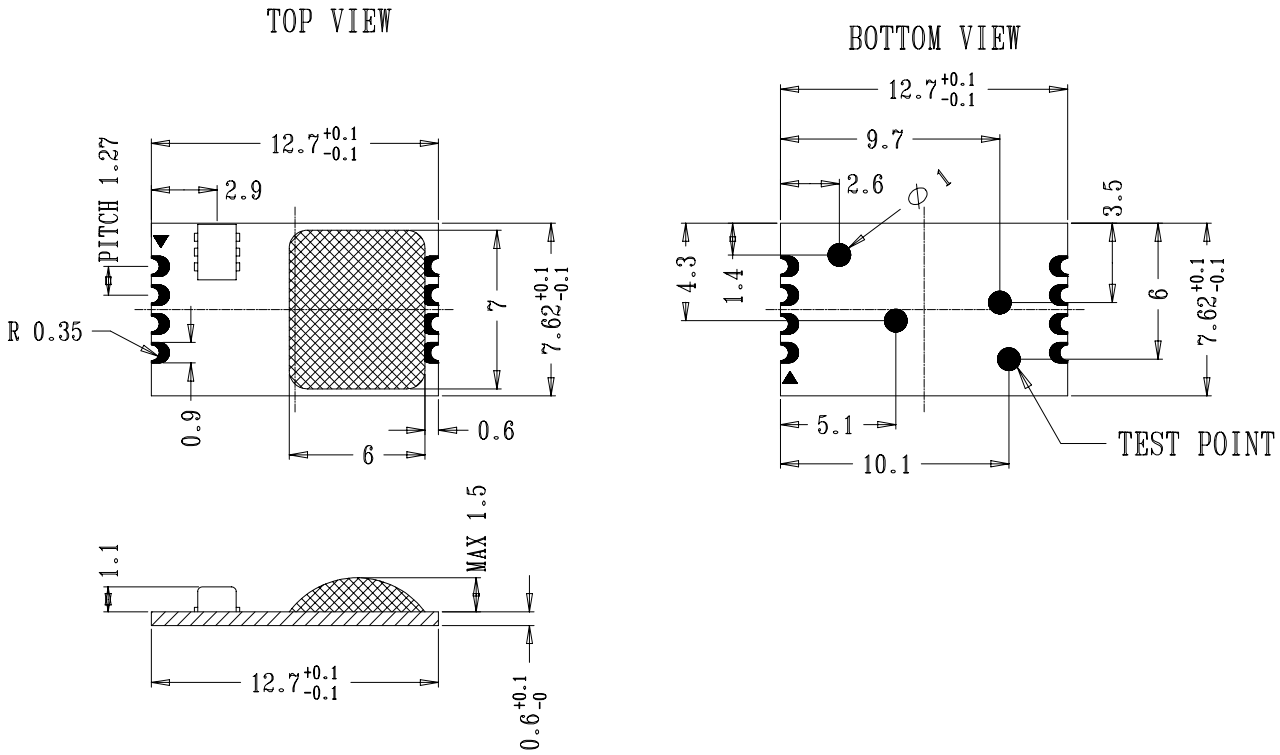
Name of port	Module MDS-CP	Recommended settings for host MCU
DIN	Input HiZ	Output low
DOUT	Output low	Output low or input HiZ
CLK	Input HiZ	Output low
RST	Input HiZ	Output high

APPLICATION SCHEMATIC



Note: The host mcu can reset MDS-CP when RST is connected to its output port.

PACKAGE DIMENSIONS



ORDERING INFORMATION

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REVISION HISTORY

- **Rev 3.1**: 19 November 2007
  - Change the package outline.
  - Change max conversion time T_work2 from 250ms to 300ms
- **Rev 3.2**: 31 January 2008
  - Correct the package dimension at 1st page.
  - Change company's address.