



MDS-CPT

COMPASS TEMPERATURE MODULE

- 2D Compass with 1° resolution.
- Temperature with 0.1°C resolution.
- Integrated 8 bits MCU with 14 bits ADC.
- Integrated software for azimuth and temperature calculation.
- 3-wire synchronous serial interface.
- Low power, low voltage.

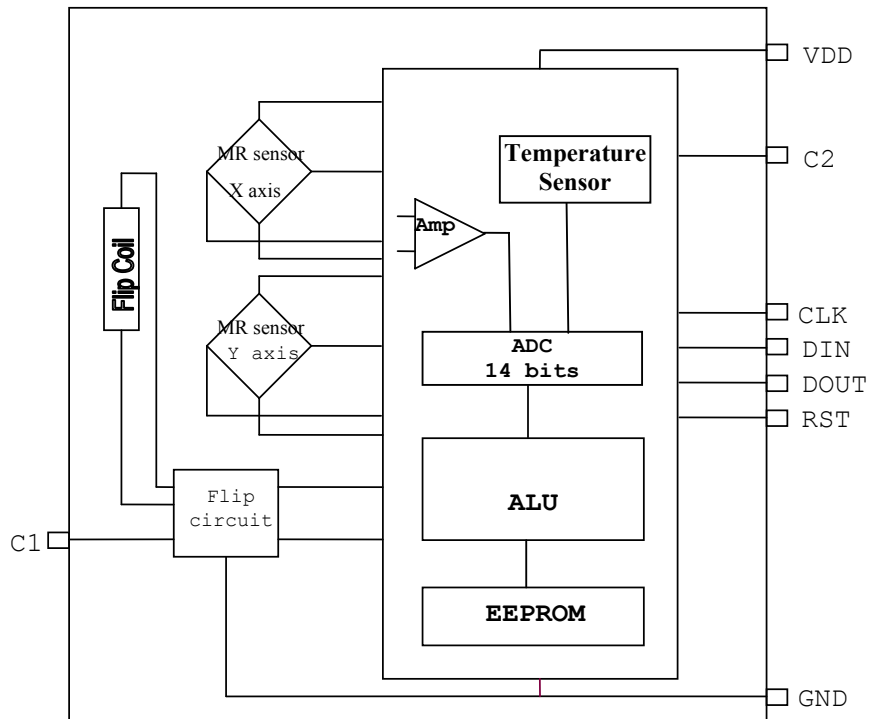
DESCRIPTION

The MDS-CPT is an SMD module including an 8 bit MCU with integrated 14 bits ADC and interface for a temperature sensor and 2 high sensitivity compass magneto resistive sensors. With its integrated firmware, this device supplies to designer the electronic compass heading and temperature measurement. This high integration level allows an easy access to sensor technology without any background in it. MDS-CPT is a low power, low voltage device that could be interfaced through its 3 wires synchronous interface to a low cost 8 bits MCU. Interfaces to 2D MR sensors and temperature sensor are also implemented. The small size of this module (7.62 x 12.7 x 2 mm) eases its integration in all watch applications.

APPLICATION

- Electronic compass with 1° resolution.
- Temperature devices with 0.1° resolution

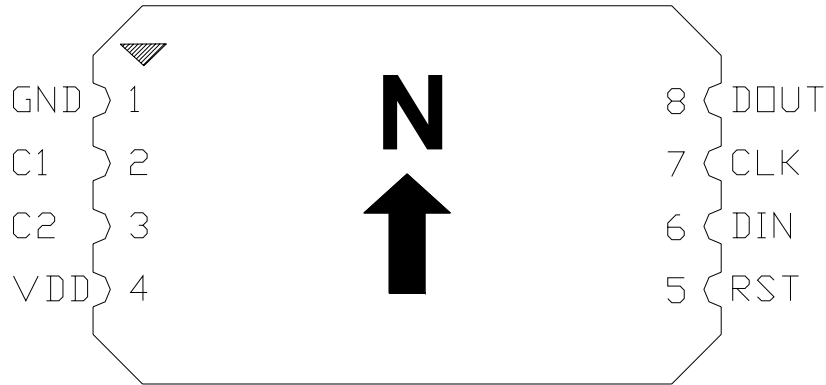
BLOCK DIAGRAM





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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 10 μ F connected to GND.
2. C2 should be 1 μ F connected to GND.
A 39ohm resistor must be connected between C1 and C2.
3. To reset MDS-CPT, RST pin must be applied low in 2ms and then delay as least 300ms before start communicating with MDS-CPT.



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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	Note
Power supply	V _{DD}		2.5	3.0	3.3	V	
Current consumption		V _{DD} = 3V					
Average current during compass reading	I _{avgC}			300		μA	1
Average current during temperature reading	I _{avgT}			60		μA	1
Power down in sleep mode	I _{slp}			1.5	2.5		
Synchronous serial clock	Clk				5	KHz	

Note:

1. Average current consumptions are calculated for 1 reading per second

OUTPUT CHARACTERISTICS (Unless otherwise specified VDD=3V, Ta=25°C)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit	Note
Temperature resolution		T= 0°C ... + 50°C		0.1		°C	
Temperature accuracy		T= 0°C ... + 50°C	-1		1	°C	
Compass resolution				1		°	1
Heading accuracy			-3		+3	°	1
Conversion time							
Temperature mode				50	80	ms	
Compass mode				200	300	ms	

Notes:

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



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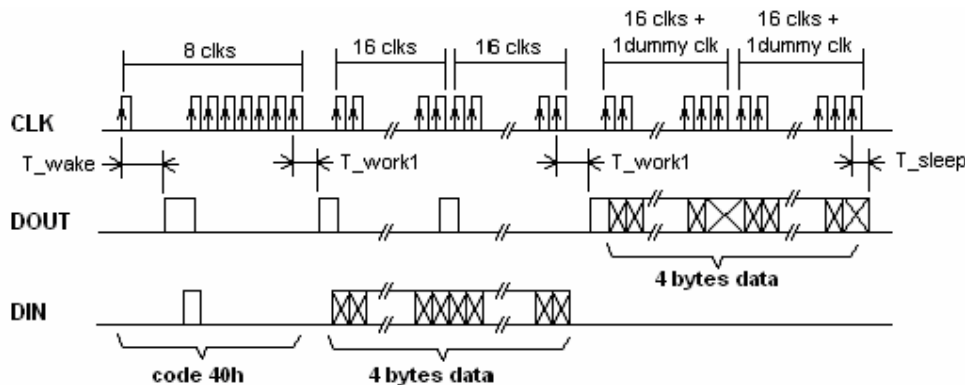
SERIAL COMMUNICATION COMMANDS

- 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-CPT 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	Code	Host MCU	MDS-CPT
COMMUNICATION TEST	40H	Send 1 byte code and 4 bytes data	Send 4 bytes data
AZIMUTH 2D	4Ch	Send 1 byte code	Send 2 bytes compass data
COMPASS CALIBRATION			
Start calibration			
Calibration	4Ah	Send 1 byte code	Send 2 bytes data 004Ah
End calibration	4Bh	Send 1 byte code	Send 2 bytes data 004Bh
	49h	Send 1 byte code	Send 2 bytes data 0049h
TEMP in C degree	44h	Send 1 byte code	Send 2 bytes temperature data

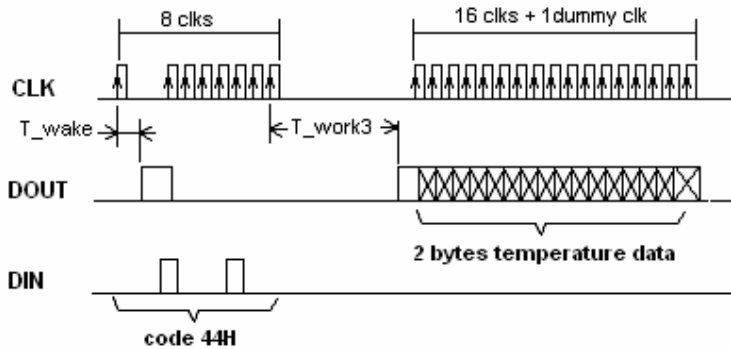
COMMUNICATION TEST



- The Host MCU sends 1 byte code and 4 bytes data, then receives these 4 bytes data returned from MDS-CPT. The host compares sent and received data to test the communication.

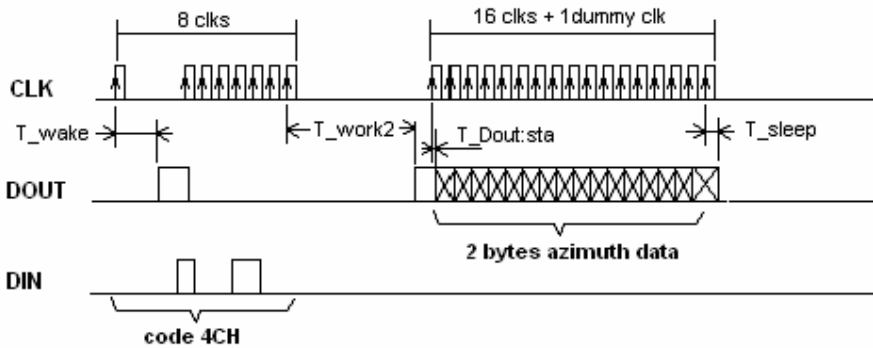


TEMPERATURE READING IN °C



- To read temperature from MDS-CPT, the host MCU sends code 44H and read 2 bytes temperature data returned from MDS-CPT. Data must be divided by 10 to get the real temperature.
- Temperature range is from -10°C to 60°C and resolution is 0.1°C .

AZIMUTH READING



- The Host MCU sends 1 byte code and then receives 2 compass bytes data from MDS-CPT module.
- Hereunder is the data formation of 2 compass bytes data:

Byte1						Byte2					
MSB					LSB	MSB					LSB
ERR	CP [2..0]			AZI[11..8]			AZI[7..0]				

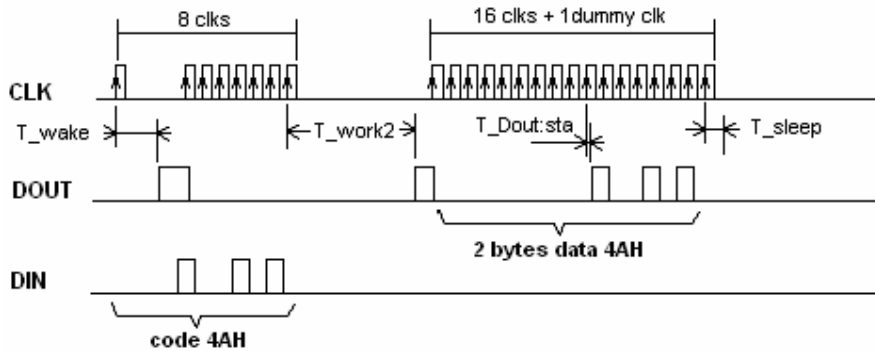
- ERR: error bit.
ERR=0: no error.
ERR=1: there is an error due to a strong magnetic field applied to the sensor since the calibration finished.
- CP [2..0]: cardinal point
 - CP = 0 : North
 - CP = 1 : North - East
 - CP = 2 : East
 - CP = 3 : South - East
 - CP = 4 : South
 - CP = 5 : South - West
 - CP = 6 : West
 - CP = 7 : North - West
- AZI [11..0]: azimuth data, $0^{\circ}\dots359^{\circ}$



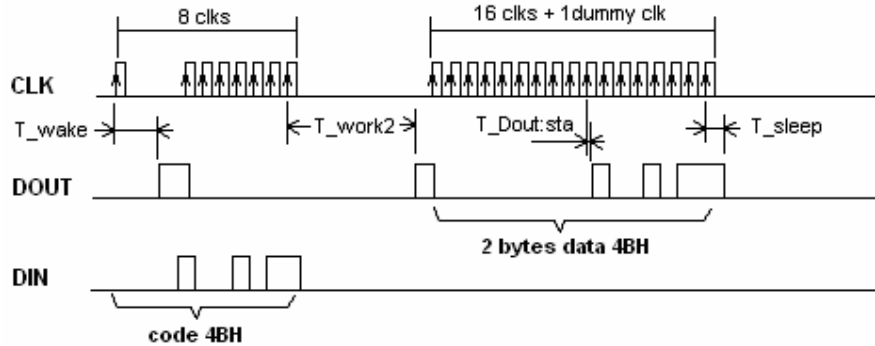
CALIBRATION FOR COMPASS

The Host MCU must follow this sequence:

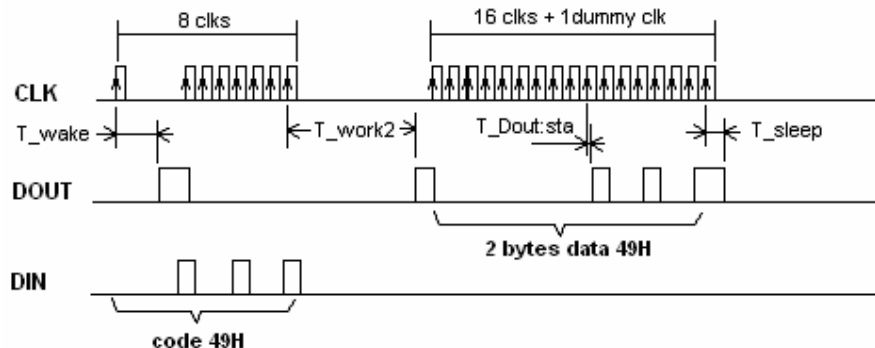
1. **START command** is sent once at start calibration. The host MCU sends code 4AH and receives 2 acknowledge bytes data 004Ah from MDS-CPT.



2. **CALIB command** must be sent continuously (i.e. every 300ms + communication time) while the compass must be turn very slowly at horizontal level for at least 360° during calibration. Each time, the host MCU sends code 4BH and 2 acknowledge bytes data 004BH returned from MDS-CPT.

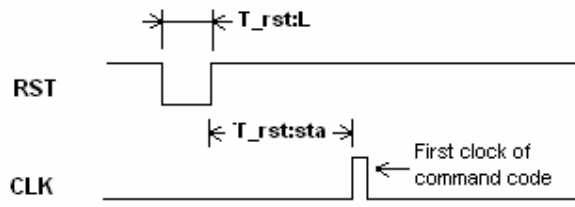


3. **END command** must be sent once to stop the calibration. The host MCU sends code 49H and receives 2 acknowledge bytes data 004BH returned from MDS-CPT.

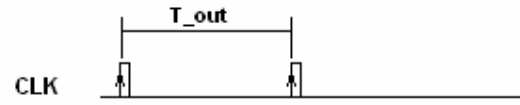




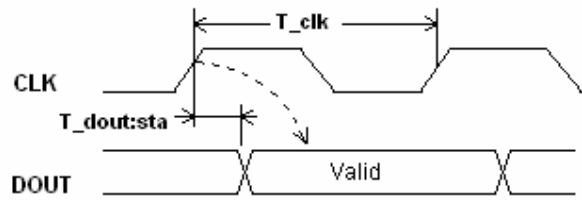
RESET TIMING



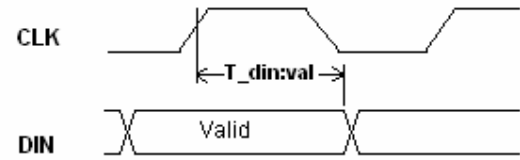
TIME OUT



DATA OUT TIMING



DATA IN TIMING





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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 in compass mode	5		200	300	ms
T_work3	Delay time for executing the AD conversion in Temperature mode			50	80	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 entire 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, T_work2, T_work3 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

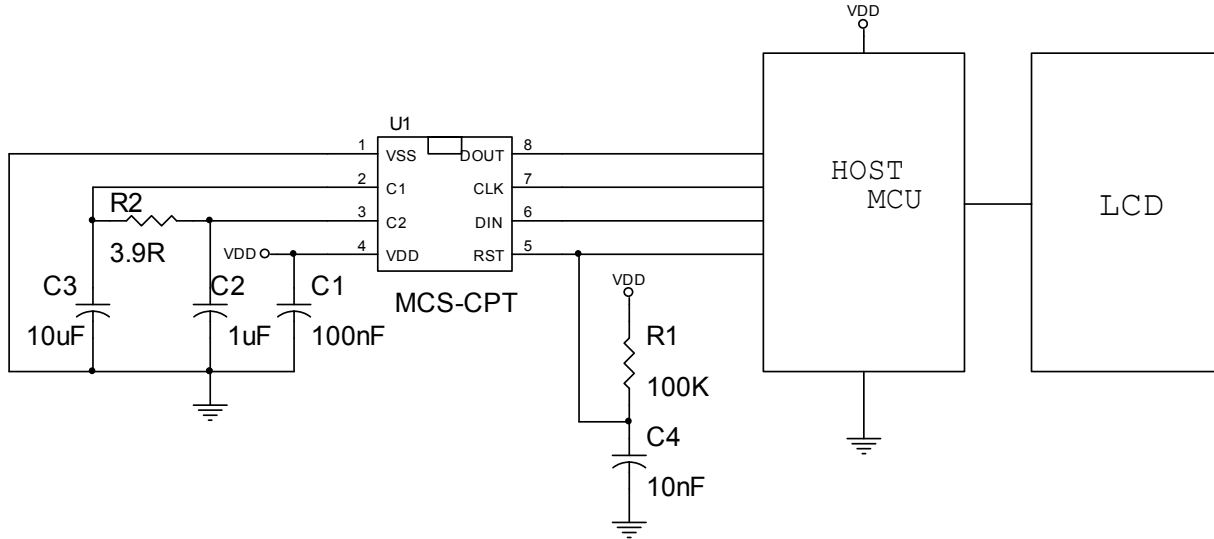
- After executing a command, the module goes to sleep mode automatically. In order to save the power, the host MCU ports have to be set compatible with the settings of the module's ports.

Name of port	Module MDS-CPT	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



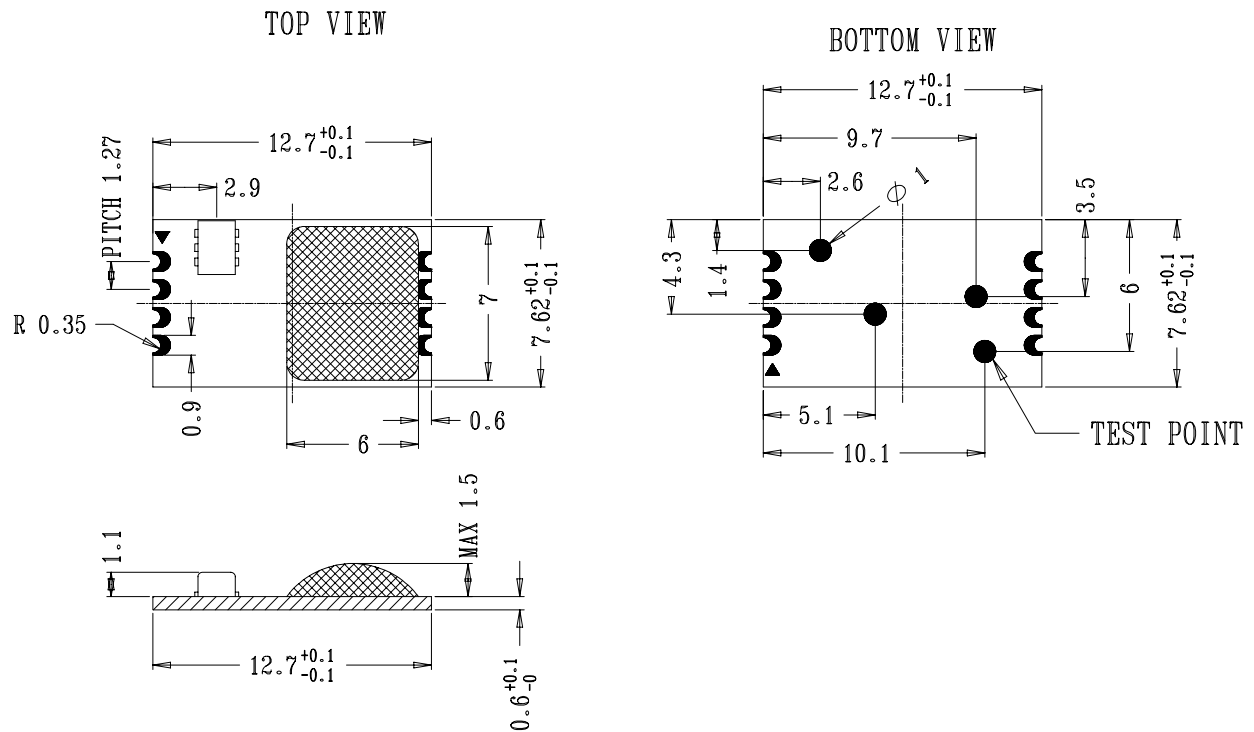
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APPLICATION SCHEMATIC



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

PACKAGE DIMENSIONS





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ORDERING INFORMATION

PRODUCT CODE: MDS-CPT

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REVISION HISTORY

- **Rev 0.1:** 19 November 2007
 - Change the package outline.
 - Change max conversion time T_{work2} from 250ms to 300ms
- **Rev 0.2:** 29 February 2008
 - Correct the package dimension at 1st page.
 - Change company's address.