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# **+** Datasheet HTM502

**Digital Humidity and Temperature Module**



# HTM502

## Digital Humidity and Temperature Module

The new HTM502 digital RH/T module combines simple implementation, accuracy and reliability to meet current and future market requirements. The easy interchangeability and integration via I<sup>2</sup>C allow fast design-in and short project implementation times. The integrated sensor protection and the mechanically robust housing allow a wide range of use for applications from +5 °C to +60 °C.

## Features



**Inspection certificate**  
according to DIN EN 10204-3.1



Please note:  
The inspection certificate according to DIN EN 10204-3.1 is available online only from <https://certificates.epluse.com/>.  
The serial number is lasered onto the module as a 2D bar code.

# Technical Data

## Measurands

### Relative humidity (RH)

<b>Measuring range</b>	0...100 %RH	
<b>Accuracy</b> @ 23 °C	typ. max.	$\pm(2.0 + 0.01 \cdot mv)$ %RH $\pm(2.7 + 0.01 \cdot mv)$ %RH
<b>Temperature dependency</b>	typ.	$\pm 0.03$ %RH/°C
<b>Response time <math>t_{63}</math></b> @ 20 °C, RH jump 0 to 80 %RH	typ.	14 s
<b>Resolution</b>	0.01 %RH	

mv = measured value

### Temperature (T)

<b>Measuring range</b>	5...60 °C	
<b>Accuracy</b> @ 15...60 °C	$\pm 0.3$ °C	
<b>Response time <math>t_{63}</math></b> @ 1 m/s	typ.	55 s
<b>Resolution</b>	0.01 °C	

## Outputs

### Digital

<b>Digital interface</b>	I <sup>2</sup> C	
<b>Max. CLK frequency</b>	1 MHz	
<b>Internal pull-up resistor <math>R_{PUP1}</math></b> @ pin voltage = $0.7 \cdot V_{DD}$	$V_{DD} = 3.60$ V $V_{DD} = 3.30$ V $V_{DD} = 3.00$ V $V_{DD} = 2.35$ V	25 kΩ 27 kΩ 30 kΩ 34 kΩ
<b>External pull-up resistor <math>R_{PUPE}</math></b> on I <sup>2</sup> C lines pull-up current $\leq 4.0$ mA @ 3.3 V	min. typ.	0.725 kΩ 4.7 kΩ
<b>Capacitive bus load <math>C_B</math>, max.</b>	<b>Standard</b> <b>Fast mode</b> <b>Fast mode plus</b>	400 pF 400 pF 177 pF

## General

<b>Supply voltage <math>V_{DD}</math></b>	2.35 - 3.60 V	
<b>Current consumption, typ.</b>	<b>Idle</b> <b>Average, measurement interval 1 s</b> <b>Measurement peak</b>	6 μA 19 μA 900 μA
<b>Electrical connection</b>	4 pole connector acc. to drawings in sections "Dimensions" and "Pin Configuration"	
<b>Storage conditions</b>	5...45 °C 0...80 %RH, non-condensing	
<b>Enclosure Material</b>	Polycarbonate (PC)	

# Pin Configuration

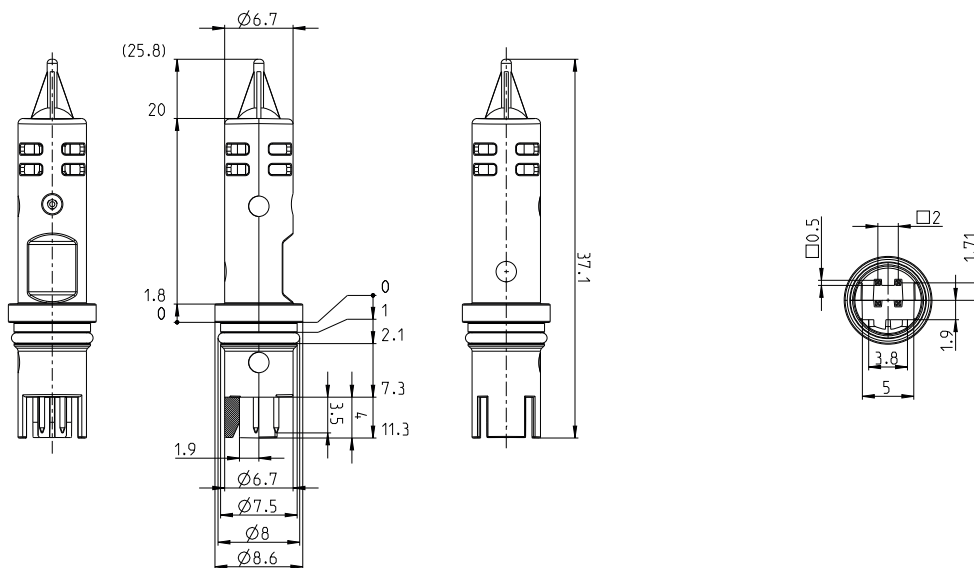


Pin #	Name	Pin Type	Description
1	V <sub>DD</sub>	Power	Positive supply pin
2	GND	Power	Ground (internally connected to thermal pad)
3	SDA	I/O with pull-up	Serial data line for I <sup>2</sup> C communication
4	SCL	I/O with pull-up	Serial data line for I <sup>2</sup> C communication

Table 1: HTM502 pin configuration

# Dimensions

Values in mm



# Interface

## Pin Configuration, Assignment and Description

Please refer to the Pin configuration section above.

## Supply Pins (V<sub>DD</sub>, GND)

The supply pins must be equipped with a bypass ceramic capacitor of at least 100 nF.

### Sensor Power-up

As soon as V<sub>DD</sub> exceeds the POR voltage V<sub>PORP</sub>, the device gets initialized. After t<sub>PWRU</sub>, the initialization procedure is completed and a single shot measurement is carried out automatically. After the measurement time, the measured values are available at the I<sup>2</sup>C interface.

## I<sup>2</sup>C Communication

The I<sup>2</sup>C communication is based on the NXP UM10204 I<sup>2</sup>C bus specification and user manual<sup>1)</sup>. The HTM502 supports the modes “standard” (100 kHz), “fast mode” (400 kHz) and “fast mode plus” (1 000 kHz).

The sensor works as SLAVE and needs to be queried by a MASTER.

Please consider self-heating due to a low R<sub>P<sub>U</sub></sub> when the sensor has to sink the pull-up current. In this case, the residual voltage on the SCL or SDA pin briefly generates a power loss in the sensor.

Example: 4 mA \* 0.4 V = 1.6 mW

## I<sup>2</sup>C Address

The sensor’s I<sup>2</sup>C base address is 0x40 (without R/ $\bar{W}$  bit).

Bit #	I <sup>2</sup> C Address							R/ $\bar{W}$	SLAVE Address (unshifted)	SLAVE Address (with W)	SLAVE Address (with R)
	7	6	5	4	3	2	1	0			
	1	0	0	0	0	0	0	0/1	0x40	0x80	0x81

**Table 2:** I<sup>2</sup>C address structure

1) Revision 7, 1 October 2021, download from <https://www.nxp.com/webapp/Download?colCode=UM10204&location=null>.

The document is located behind a login access barrier.

# Sensor Communication

## Command Overview

Command	Description
0x2C1B	Measurement, single shot, I <sup>2</sup> C clock stretching enabled
0x241D	Measurement, single shot, I <sup>2</sup> C clock stretching disabled
0x201E	Measurement, periodic with 1s measurement interval
0xE000	Fetch periodic measurement data
0x30A2	Soft Reset
0x3093	Break (end periodic measurement)
0x3041	Clear Status Register 1
0xF32D	Readout of Status Register 1
0x7029	Read Identification
0x06	I <sup>2</sup> C Reset at general call address 0x0

Table 3: HTM502 commands

## Measured Data Format

Humidity [%RH] = (Humidity MSB x 256 + Humidity LSB)/100

Temperature [°C] = (Temperature MSB x 256 + Temperature LSB)/100

## Measurement Modes

There are two different operation modes to communicate with the sensor:

1. Single Shot Measurement

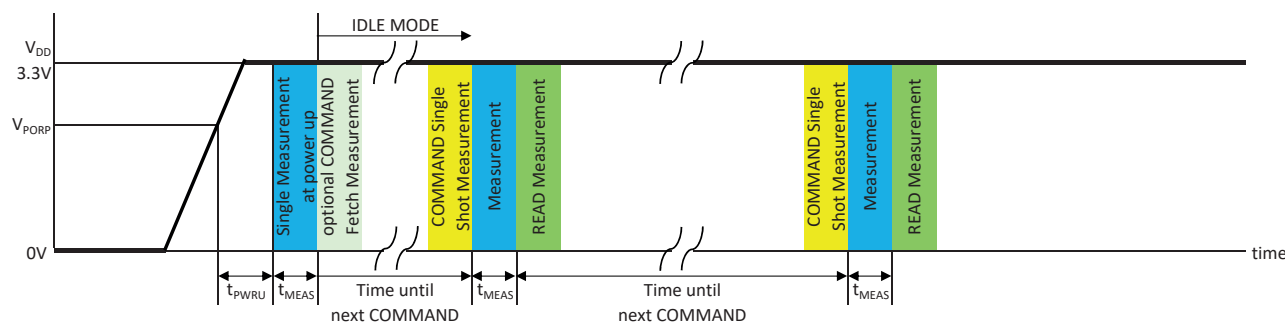


Figure 1: Single shot measurement

2. Periodic Measurement

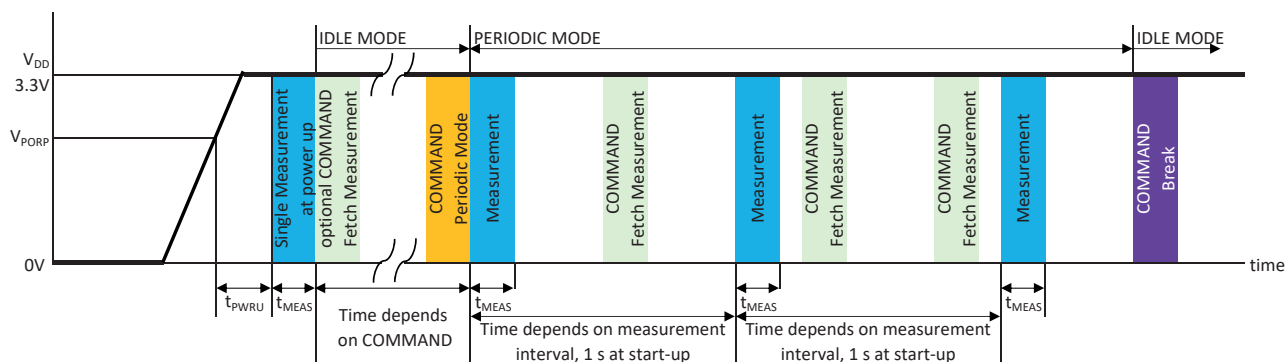


Figure 2: Periodic measurement

### Single Shot Measurement (0x2C1B, 0x241D)

The command initiates a single measurement, the measured data is available for query after  $t_{MEAS}$ . I<sup>2</sup>C clock stretching enabled: waiting for the end of the measurement during command execution.

Condition	CMD Hex Code	
	MSB	LSB
I <sup>2</sup> C clock stretching Enabled	0x2C	0x1B
I <sup>2</sup> C clock stretching Disabled	0x24	0x1D

Table 4: Single shot measurement with or without clock stretching

A single-shot measurement is started after the command has been received successfully. The readout of the calculated values RH and T is started by sending the I<sup>2</sup>C address again in read mode:

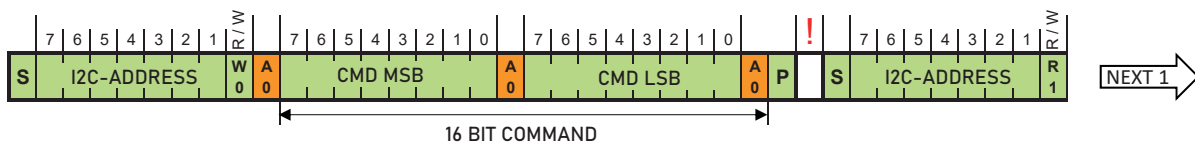


Figure 3: Start single shot measurement readout

In case a command with clock stretching enabled has been issued, the slave holds SCL low until the calculation has been finished:

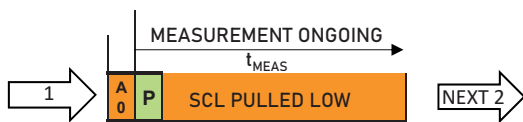


Figure 4: Clock stretching during measurement

In case a command without clock stretching has been issued, the slave does not acknowledge (NACK) a read header as long as the calculation has not been finished:

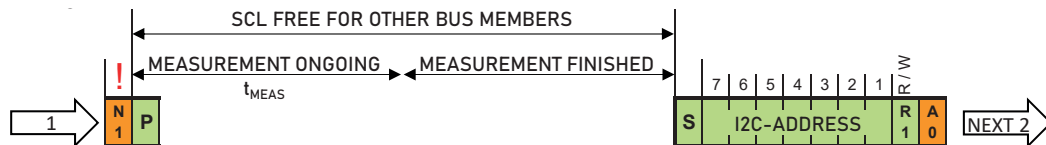


Figure 5: Poll for measuring values until ACK

After the calculation is finished, the slave responds to a read header with a pair of data words, each of them is followed by an 8 bit checksum (CRC8). The first data word contains the temperature value while the second word contains the relative humidity value. The master has to acknowledge each single data byte by an acknowledge (ACK), otherwise the slave will stop sending any further data and wait for a stop condition (P):

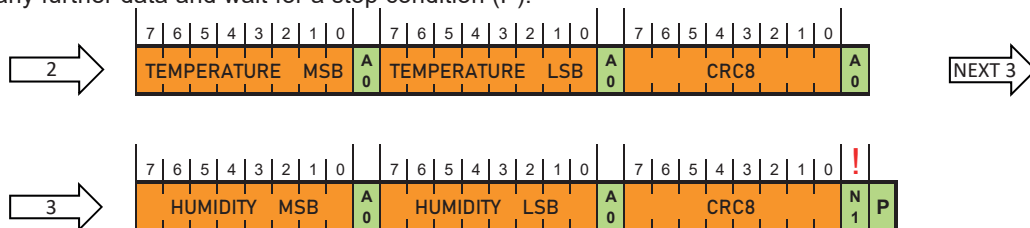


Figure 6: Measured value readout

- Data Bit From Master to Slave
- Data Bit From Slave to Master
- ! = Note the deviation!
- S = Start condition
- P = Stop condition
- R = Read Bit
- W = Write Bit
- A = Acknowledge (SDA low)
- N = Not Acknowledge (SDA high)

### Periodic Measurement (0x201E)

Once issued, measurements and calculations are started automatically with a given measuring interval and resolution. The standard measurement interval is 1 s and the resolution is 13 bit for RH and T. This mode does not support clock stretching.

Command	CMD Hex Code
Periodic measurement	201E

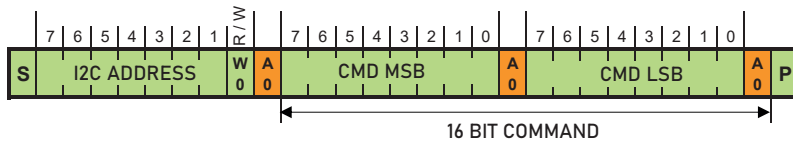


Figure 7: Periodic measurement commands

### Fetch Periodic RH&T Measurement Results (0xE000)

Readout of calculation results in periodic measurement mode can be performed using the fetch command. This is similar to the readout of measurement results in single-shot mode, except that clock stretching is always disabled. The slave will answer with NACK if no measurement results are available.

Command	CMD Hex Code
Fetch data	E000

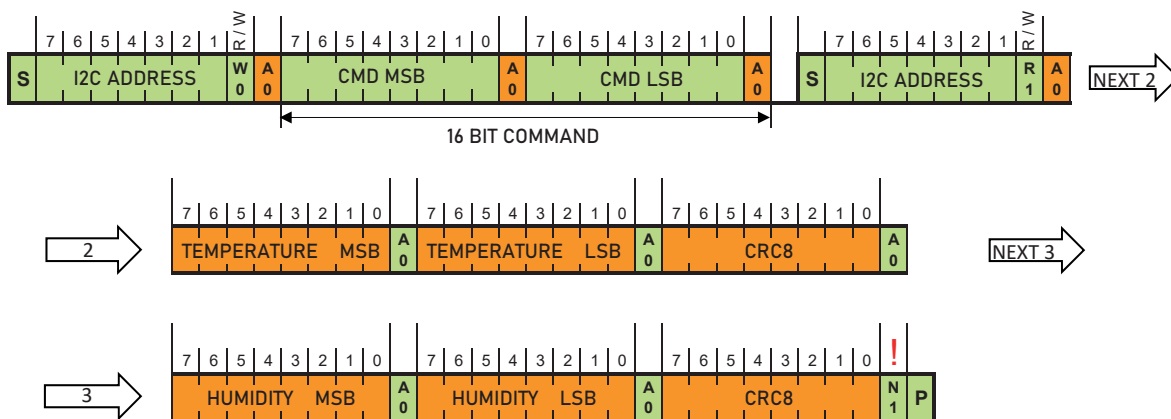


Figure 8: Fetch command

This command is also suitable for reading out the measured data generated by the power-up procedure.

### Break Command (0x3093)

The periodic measurement mode can be stopped using the break command. After finishing an ongoing measurement, the sensor will enter the idle mode. An ongoing measurement can delay the transition into the idle mode.

Command	CMD Hex Code
Break	3093

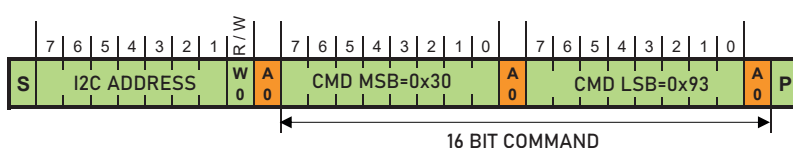


Figure 9: Break command

A single measurement (command) or a reset (command or power-up) both stop the periodic measurement, too.



### Reset Commands (0x30A2, 0x06)

The slave supports multiple commands to reset the device. Once a reset command is received, the device is completely reset, like a reset during power-up. During the reset time, the device will not respond to any request on the I<sup>2</sup>C interface. In order to execute the reset on a specific device, the command “Soft Reset” can be used. This forces the system to execute the startup procedure without the need to remove the power supply. The protection will be re-established with the “Soft Reset”.

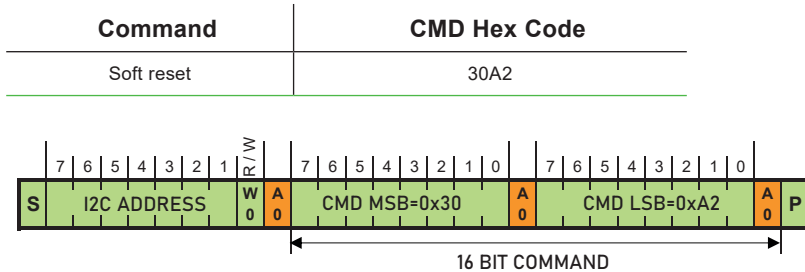


Figure 10: Soft reset

In order to reset all devices on the bus, the master can use the “General call” mode. This generates a reset (system startup) in all devices on the bus which support this function. The effect is the same as for the “Soft Reset” command.



Figure 11: Reset through general call

In order to reset the I<sup>2</sup>C interface only, keep SDA high while toggling SCL nine times or more. This must be followed by a start condition preceding the next command. This sequence does not affect any configuration, status register or system status.

### Status Register (0xF32D)

The sensor implements a 16 bit status register. Their contents can be read using the following command:

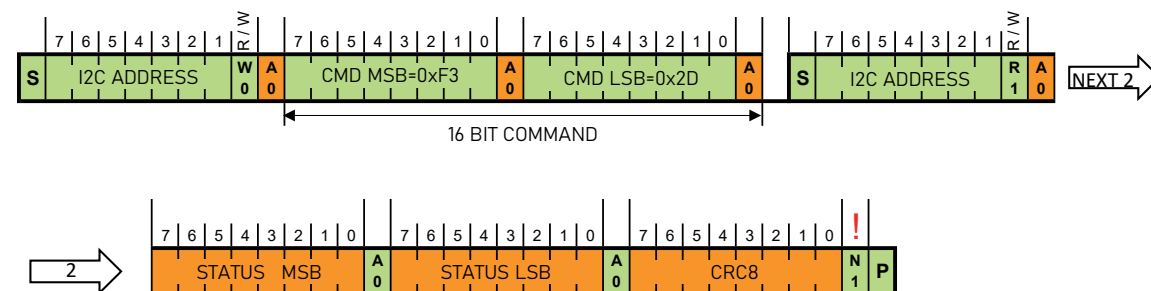


Figure 12: Read out status register

Upon receipt of the following clear command, bits 15, 4 and 3 are cleared in the status register. All other bits remain unaffected:

Command	CMD Hex Code
Clear Status Register	3041

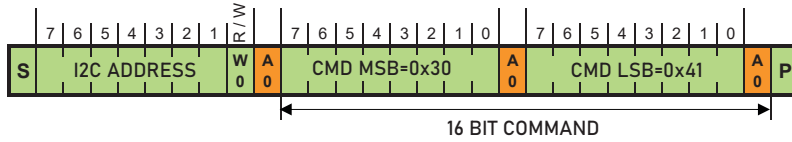


Figure 13: Clear status register

Bit	Name	Description
15	OVERALL_ERROR	0: none of bits [11:0] set 1: at least one of bits [11:0] set This bit is cleared upon the Clear Status Register command
14	Reserved	-
13	Reserved	-
12	Reserved	-
11	Reserved	-
10	Reserved	-
9	Reserved	-
8	Reserved	-
7	Reserved	-
6	Reserved	-
5	Reserved	-
4	System Reset	0: no reset since status 1 clear 1: POR or I <sup>2</sup> C reset This bit is cleared upon the Clear Status Register command
3	POR	0: no POR since status 1 clear 1: POR occurred This bit is cleared upon the Clear Status Register command
2	Reserved	-
1	Reserved	-
0	CRC	1: checksum of the latest write transfer failed

Table 5: Status register

### Read Identification (0x7029)

Each sensor device has a specific 8-byte identification. This Identification allows a factory backtracking of each device. When the following command is issued, the I<sup>2</sup>C slave sends all 8 bytes consecutively, followed by a CRC8 checksum (see chapter CRC Calculation).

Command	CMD Hex Code
Read Identification	7029

**i Please note:** During the I<sup>2</sup>C communication before the I<sup>2</sup>C address read, a repeated start sequence must be executed, the sequence “stop + start” is not sufficient.

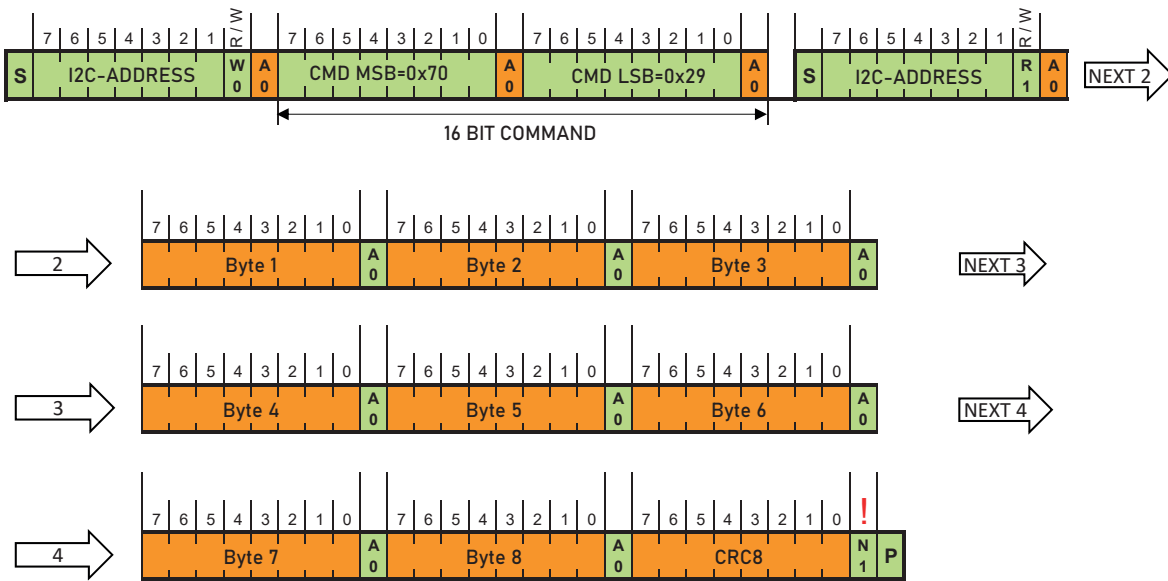


Figure 14: Read Identification

Example:

“1C4606026156553C” (Hexadecimal)

### CRC Calculation

Response data words/memory write data are protected by a CRC8 checksum:

Property	Value
Name	CRC8
Width	8 bit
Polynomial	0x31 ( $x^8 + x^5 + x^4 + 1$ )
XOR input	0xFF
Reflect input	False
Reflect output	False
XOR output	0x00

Table 6: CRC checksum calculation

# Ordering Guide

Feature	Description	Code
Packaging		HTM502-
	Single packed	PK4
	Multipackage (Tray) <sup>1)</sup>	PK6

1) Minimum order quantity 10 pcs

# Order Example

## HTM502-PK4

Feature	Code	Description
Model	HTM502	RH/T module
Packaging	PK4	Single packed

# Accessories

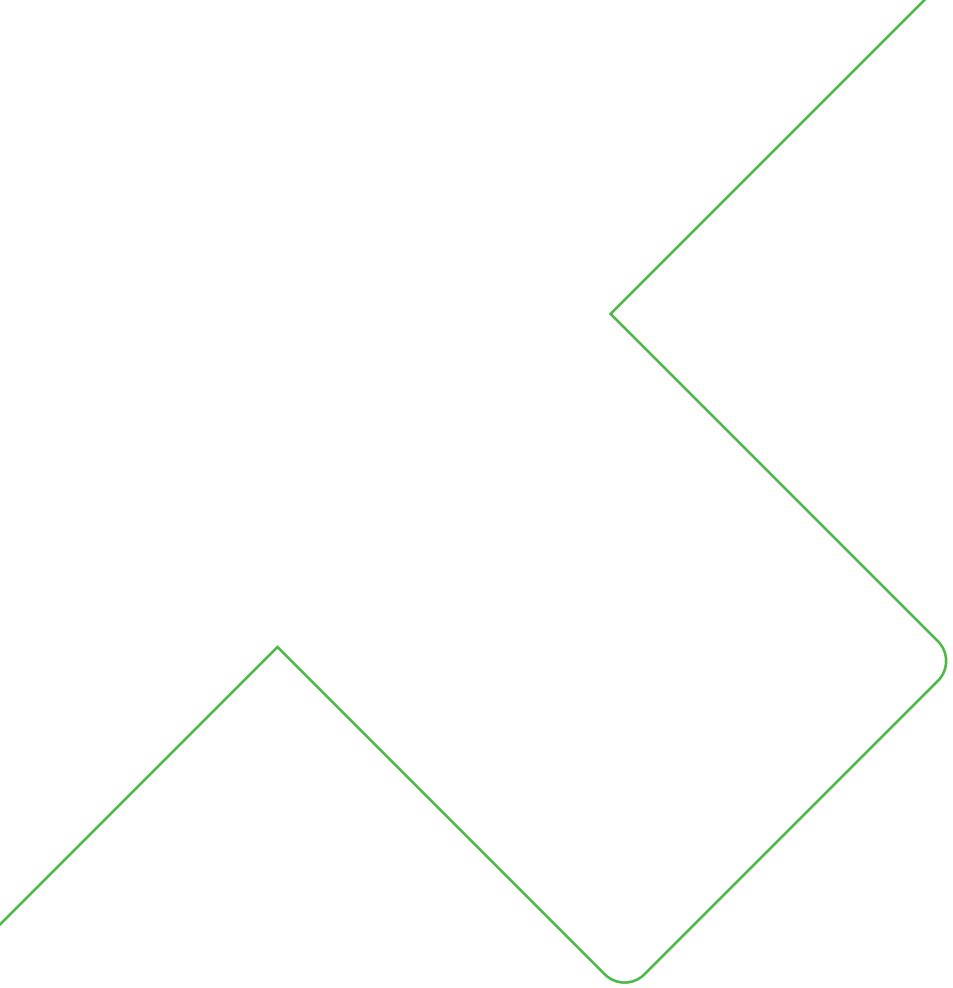
Accessories	Code
<p>Probe tube, including flex cable</p>	HA060201
<p>Protection cap for 12 mm probe, see also datasheet <a href="#">Accessories</a></p> <p>Filter cap with membrane, polycarbonate body</p> <p>Filter cap with metal grid, polycarbonate body</p> <p>Stainless steel sintered filter cap</p>	<p>HA010118</p> <p>HA010119</p> <p>HA010103</p>

# Acronyms

Acronym	Meaning
A	Ambient
B	Bus
CDM	Charged Device Model
ESD	Electrostatic Discharge
HBM	Human Body Model
MEAS	Measurement, Measuring
PORI	Power On Reset, Idle Mode
PORP	Power On Reset, Periodic Mode
POR	Power On Reset
PU	Pull-up
PUPE	Pull-up external
PUPI	Pull-up internal
PWRU	Power Up
RH	Relative Humidity
T	Temperature

## Support Literature

[www.epluse.com/htm502](http://www.epluse.com/htm502)



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