



—
your partner
in sensor
technology.

+ 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 I²C 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



Technical Data

Measurands

Relative humidity (RH)

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

Temperature (T)

| | | | |
|---|------|--------------|--|
| Measuring range | | 5...60 °C | |
| Accuracy @ 15...60 °C | | ± 0.3 °C | |
| Response time t_{63} @ 1 m/s | typ. | 55 s | |
| Resolution | | 0.01 °C | |

Outputs

Digital

| | | |
|--|--|----------------------------------|
| Digital interface | | I ² C |
| Max. CLK frequency | | 1 MHz |
| Internal pull-up resistor R_{PUP1} @ 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 |
| External pull-up resistor R_{PUPE} on I ² C lines pull-up current ≤ 4.0 mA @ 3.3 V | min. typ. | 0.725 kΩ 4.7 kΩ |
| Capacitive bus load C_B, max. | Standard Fast mode Fast mode plus | 400 pF 400 pF 177 pF |

General

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

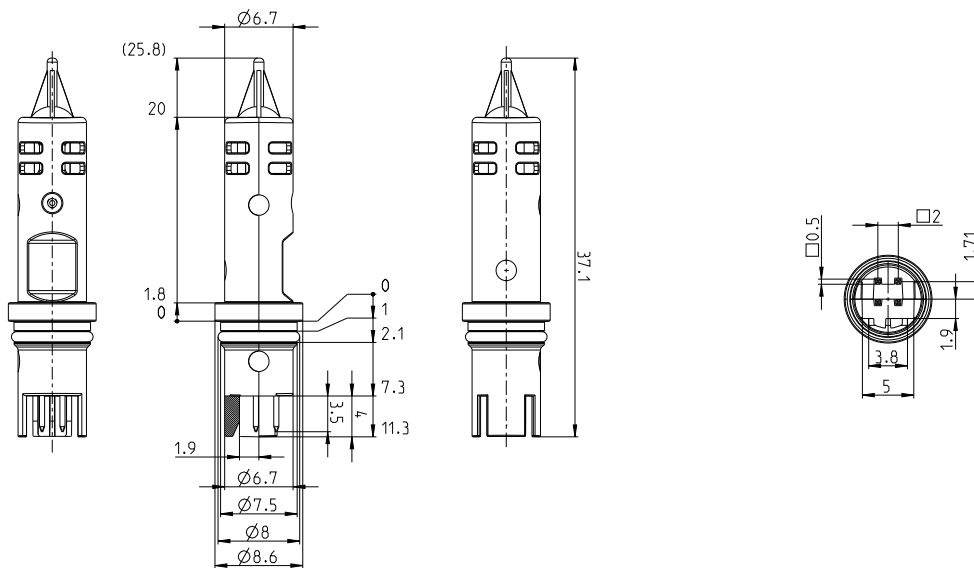
Pin Configuration



| Pin # | Name | Pin Type | Description |
|-------|------|------------------|---|
| 1 | V+ | 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 ² C communication |
| 4 | SCL | I/O with pull-up | Serial data line for I ² C communication |

Dimensions

Values in mm



Interface

Pin Configuration, Assignment and Description

Please refer to the Pin Configuration section above.

Supply Pins (V_{DD}, GND)

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

When using the constant current heater, a current change in the heater must not lead to a voltage drop below the minimum V_{DD} value (refer to Table 6). This means the bypass capacitor needs to be dimensioned sufficiently large so that the voltage controller is supplied adequately.

Sensor Power-up

As soon as V_{DD} exceeds the POR voltage V_{PORP}, the device gets initialized. After t_{PWRU}, 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 I²C interface.

I²C Communication

The I²C communication is based on the [NXP UM10204 I2C bus specification and user manual](#)¹⁾. 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_PU 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

I²C Address

The sensor’s I²C base address is 0x40 (without R/ \bar{W} bit).

| Bit # | I ² 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 1: I²C address structure

1) Revision 7, 1 October 2021, download from <https://www.nxp.com/docs/en/user-guide/UM10204.pdf>.

Sensor Communication

Command Overview

| Command | Description |
|---------|---|
| 0x2C1B | Measurement, single shot, I2C clock stretching enabled |
| 0x241D | Measurement, single shot, I2C 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 ² C Reset at general call address 0x0 |

Table 4: HTM502 commands

Measured Data Format

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

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

Measurement Modes

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

1. Single Shot Measurement

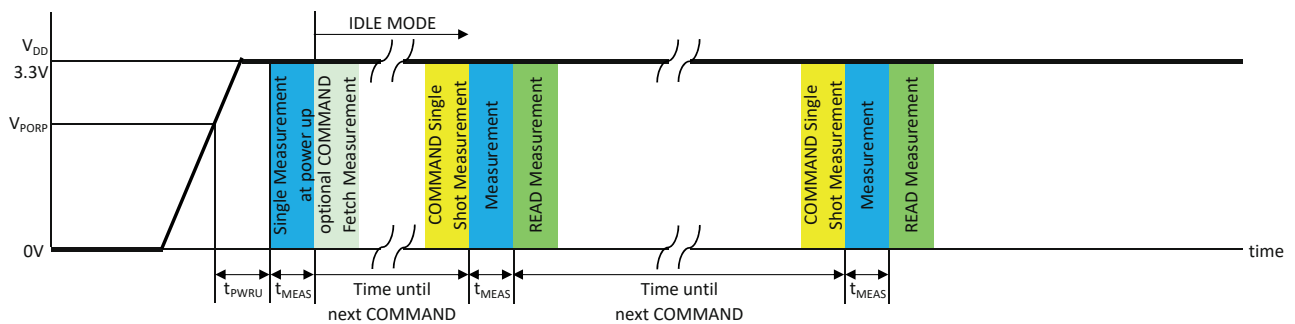


Figure 3: Single shot measurement

2. Periodic Measurement

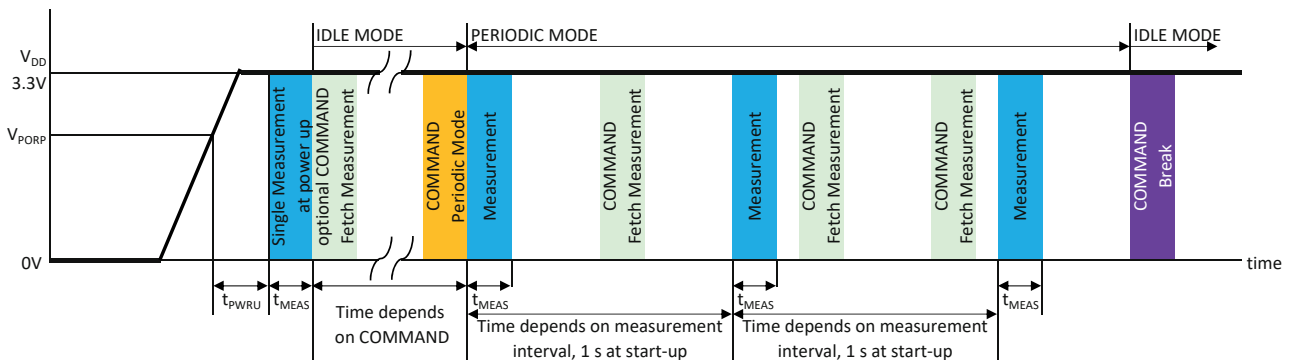


Figure 4: Periodic measurement

Single Shot Measurement (0x2C1B, 0x241D)

The command initiates a single measurement, the measured data is available for query after t_{MEAS} . I²C clock stretching enabled: waiting for the end of the measurement during command execution.

| Condition | CMD Hex Code | |
|--|--------------|------|
| | MSB | LSB |
| I ² C clock stretching Enabled | 0x2C | 0x1B |
| I ² C clock stretching Disabled | 0x24 | 0x1D |

Table 2: 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 I²C address again in read mode:

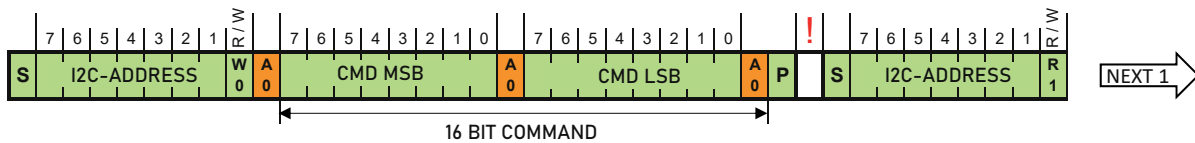


Figure 5: Start single shot measurement readout

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

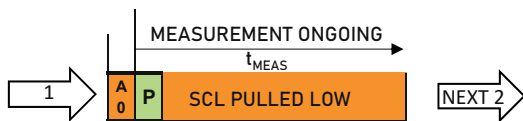


Figure 6: Clock stretching during measurement

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:

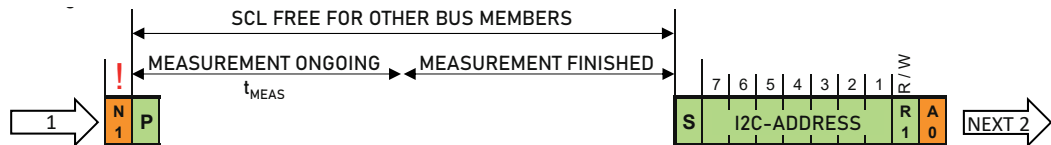


Figure 7: Poll for measuring values until ACK

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 A 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):

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

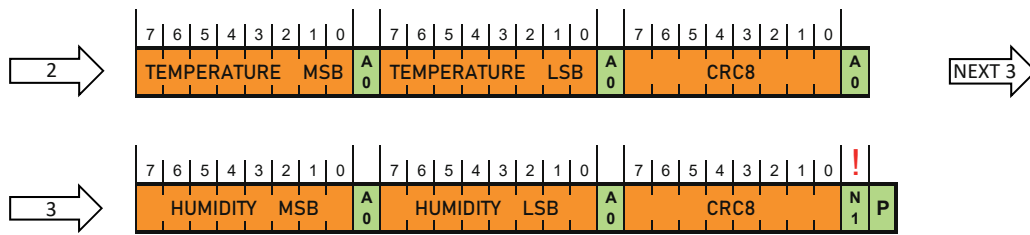


Figure 8: Measured value readout

Periodic Measurement (0x201E)

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

| Command | CMD Hex Code |
|----------------------|--------------|
| Periodic measurement | 201E |

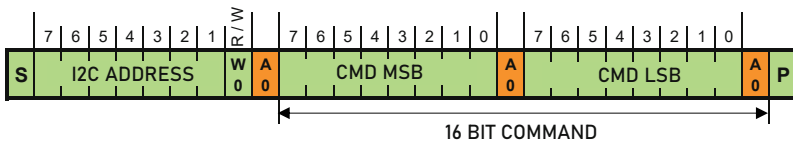


Figure 9: Periodic measurement commands

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 |

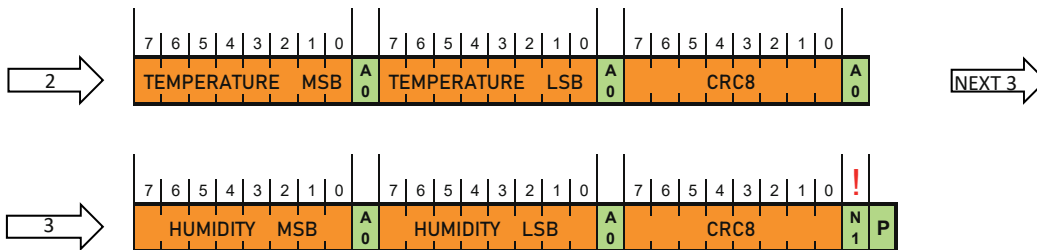
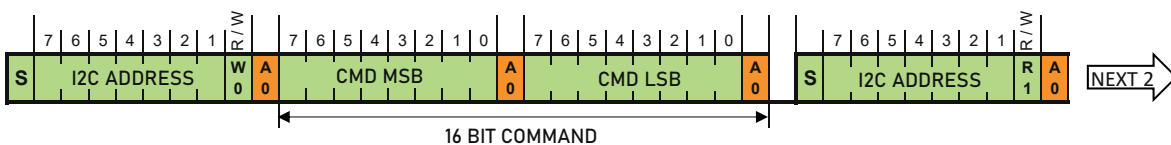


Figure 10: Fetch command

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 |

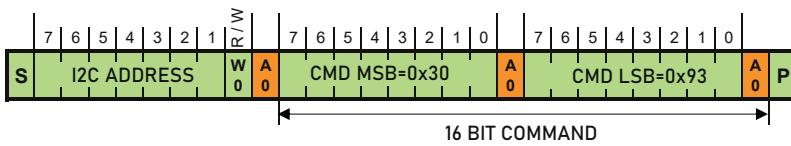


Figure 11: Break command

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 I²C 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”.

| Command | CMD Hex Code |
|------------|--------------|
| Soft reset | 30A2 |

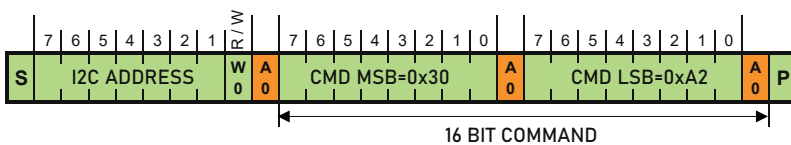


Figure 12: Soft reset

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.

| Command | CMD Hex Code |
|--------------|--------------|
| Address byte | 00 |
| Second byte | 06 |

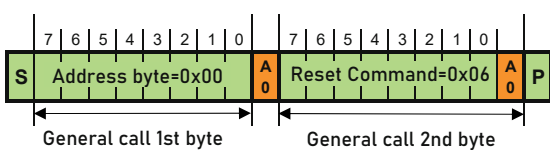


Figure 13: Reset through general call

In order to reset the I²C 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:

| Command | CMD Hex Code |
|--------------------------|--------------|
| Read out Status Register | F32D |

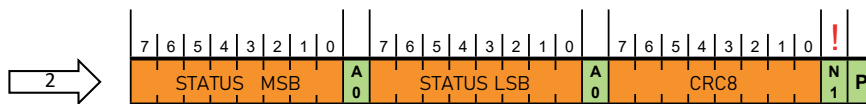
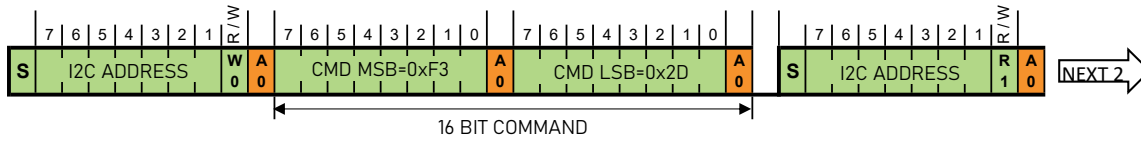


Figure 14: Read out status register

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 |

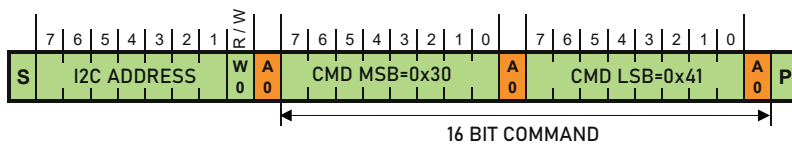


Figure 15: Clear status register

| 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 I2C 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 3: 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 I²C slave sends all 8 bytes consecutively, followed by a CRC8 checksum (see chapter 6.14 (CRC Calculation)).

| Command | CMD Hex Code |
|---------------------|--------------|
| Read Identification | 7029 |



Please note: During the I²C communication before the I²C address read, a repeated start sequence must be executed, the sequence “stop + start” is not sufficient.

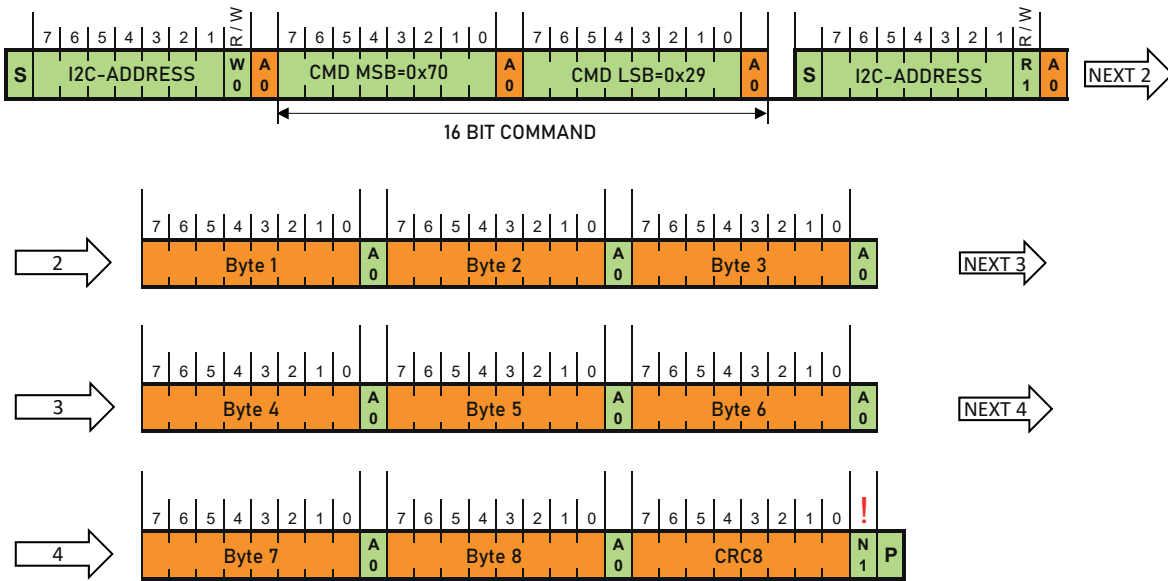


Figure 16: Read Identification

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 (x8 + x5 + x4 + 1) |
| XOR input | 0xFF |
| Reflect input | False |
| Reflect output | False |
| XOR output | 0x00 |

Figure 17: CRC checksum calculation

Ordering Guide

| Feature | Description | Code |
|-----------|-----------------------------------|---------|
| Packaging | | HTM502- |
| | Single packed | PK4 |
| | Multipackage (Tray) ¹⁾ | PK6 |

1) Minimum order quantity 10 pcs

Order Example

HTM502-PK4

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

Accessories

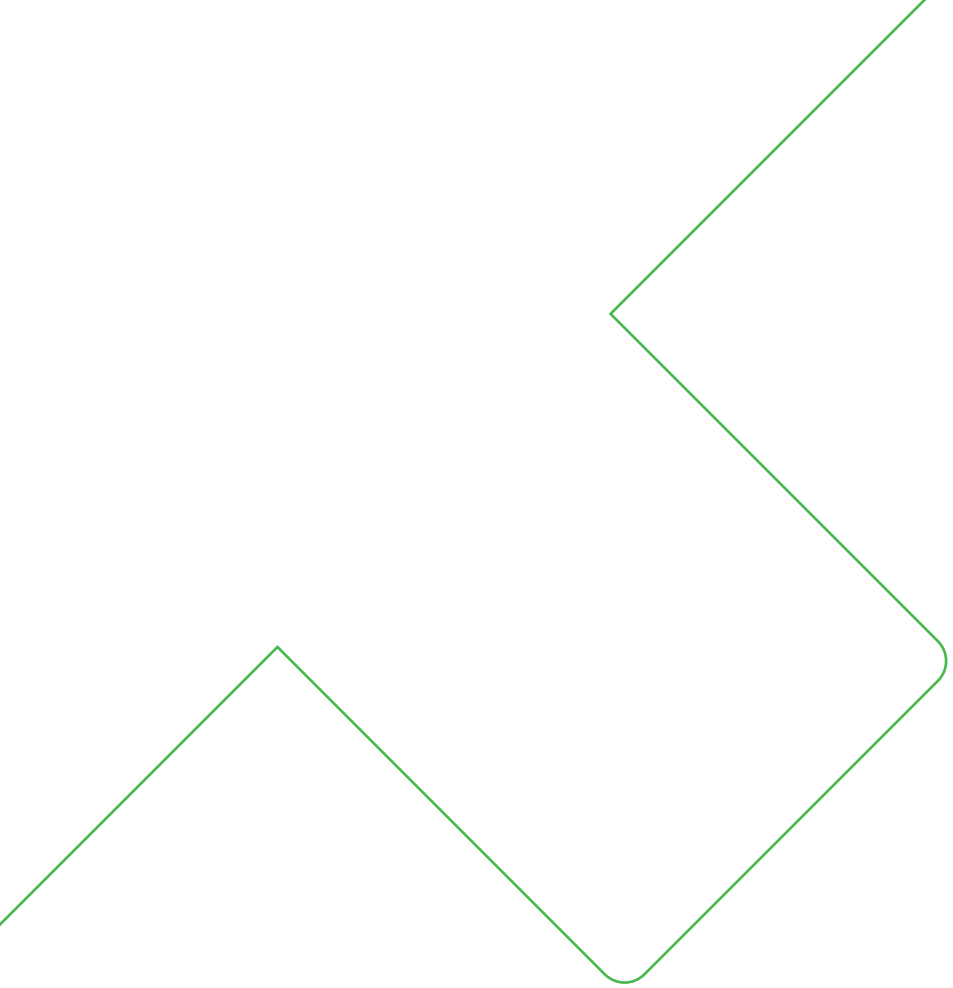
| Accessories | Code |
|---|---|
| <p>Probe tube, including flex cable</p> <p>Protection cap for 12 mm probe, see also datasheet Accessories Membrane, polycarbonate body Metal grid, polycarbonate body Stainless steel sintered</p> | <p>HA060201</p> <p>010118 010119 010103</p> |

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 |
| Td | Dew point temperature |
| T | Temperature |

Support Literature

www.epluse.com/htm502



Company Headquarters &
Production Site

E+E Elektronik Ges.m.b.H.
Langwiesen 7
4209 Engerwitzdorf | Austria
T +43 7235 605-0
F +43 7235 605-8
info@epluse.com
www.epluse.com

Subsidiaries

E+E Sensor Technology (Shanghai) Co., Ltd.
T +86 21 6117 6129
info@epluse.cn

E+E Elektronik France SARL
T +33 4 74 72 35 82
info.fr@epluse.com

E+E Elektronik Deutschland GmbH
T +49 6171 69411-0
info.de@epluse.com

E+E Elektronik India Private Limited
T +91 990 440 5400
info.in@epluse.com

E+E Elektronik Italia S.R.L.
T +39 02 2707 86 36
info.it@epluse.com

E+E Korea Co., Ltd.
T +82 31 732 6050
info.kr@epluse.com

E+E Elektronik Corporation
T +1 847 490 0520
info.us@epluse.com

Version v1.1 | 09-2022
Modification rights reserved



—
your partner
in sensor
technology.

www.epluse.com