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Datasheet
HTM502

Digital Humidity and Temperature Module

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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^2C 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

- Exchangeable RH/T module
- High accuracy
- Easy handling

- Robust sensor head

- E+E proprietary coating

- I^2C interface

Technical Data

Measurands

Relative humidity (RH)

Measuring range		0...100 %RH
Accuracy @ 23 °C	typ. max.	±(2.0 + 0.01*mv) %RH ±(2.7 + 0.01*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^2C
Max. CLK frequency		1 MHz
Internal pull-up resistor R_{PUPI} @ pin voltage = 0.7*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^2C 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^2C communication
4	SCL	I/O with pull-up	Serial data line for I^2C 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/$\overline{W}$ bit).

	I²C Address							R/$\overline{W}$	SLAVE Address (unshifted)	SLAVE Address (with W)	SLAVE Address (with R)
Bit #	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

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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	I²C 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
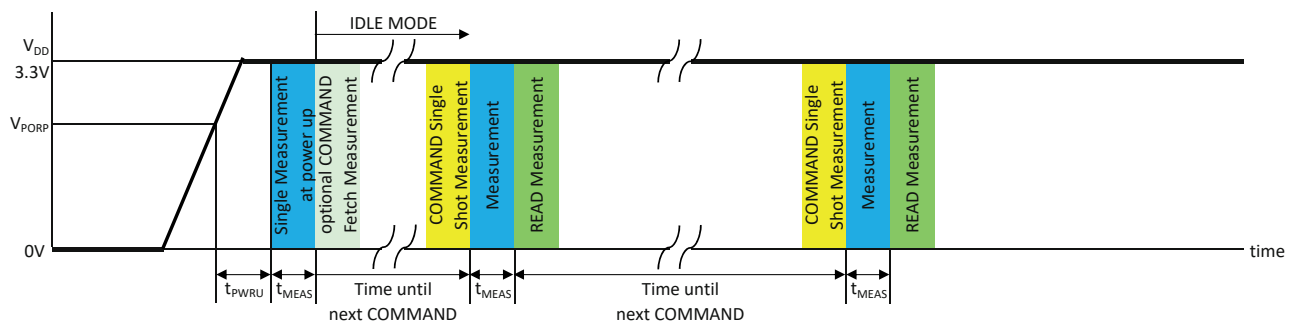
Figure 3: Single shot measurement

2. Periodic Measurement
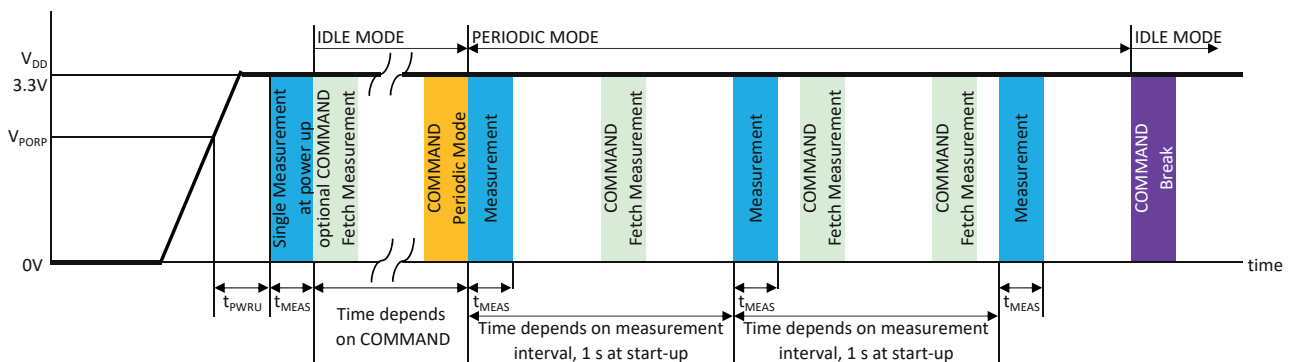
Figure 4: Periodic measurement

Single Shot Measurement (0x2C1B, 0x241D)

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

Condition	CMD Hex Code	
I^2C clock stretching	MSB	LSB
Enabled	0x2C	0x1B
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 I^2C address again in read mode:
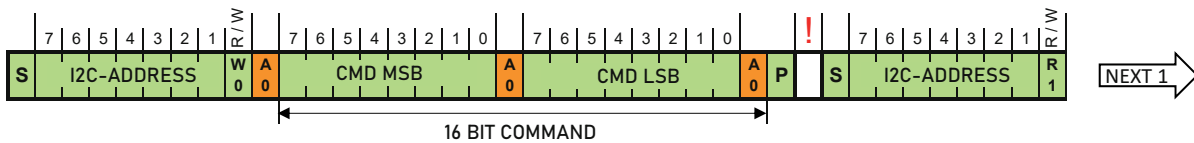
Figure 5: Start single shot measurement readout

In case a command with clock stretching enabled has been issued, the slave holds SCL low until the calculation has been finished:
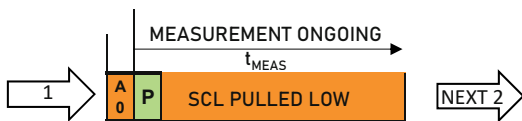
Figure 6: Clock stretching during measurement

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:
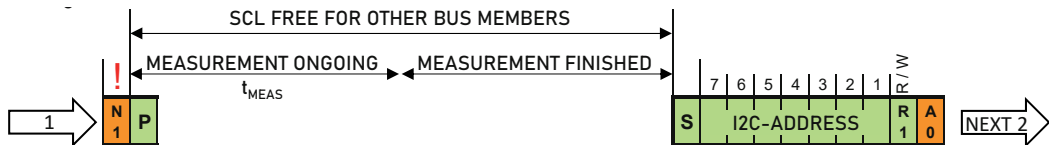

Figure 7: Poll for meauring values until ACK

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):

Data Bit From Master to Slave
Data Bit From Slave to Master

! = Note the deviation!

S = Start condition   **R** = Read Bit
P = Stop condition   **W** = Write Bit

A = Acknowledge (SDA low)
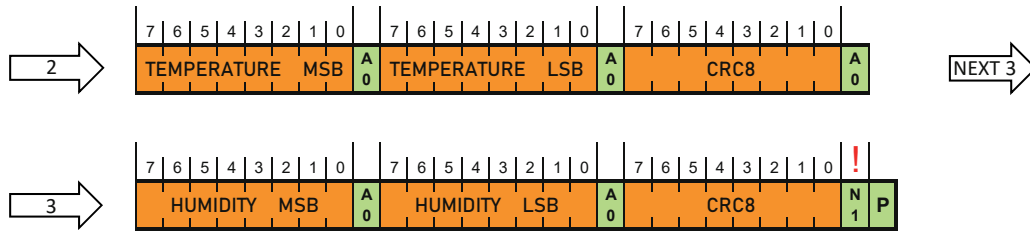**N** = Not Acknowledge (SDA high)

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.

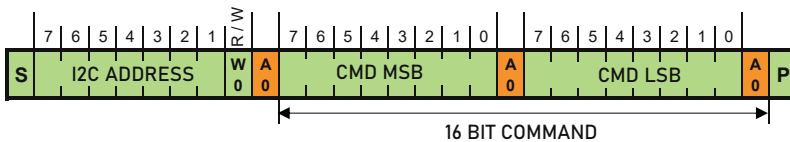| Command	CMD Hex Code
Periodic measurement	201E

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.

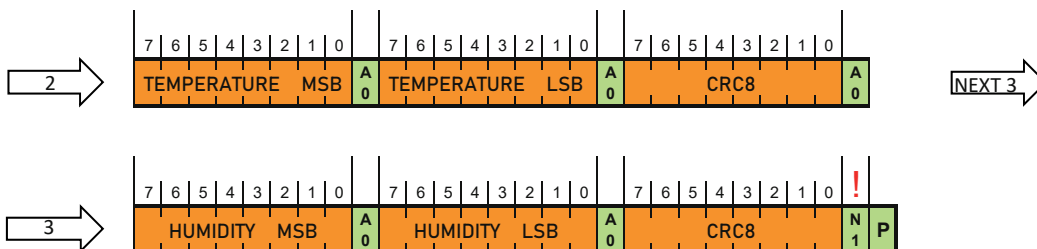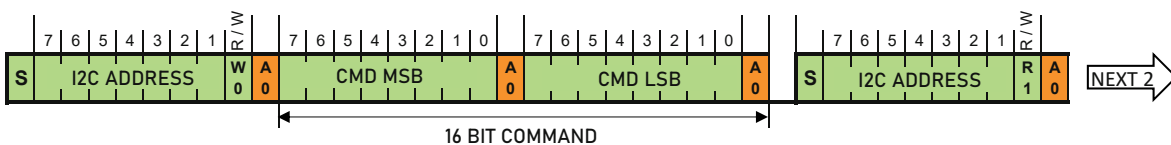| Command	CMD Hex Code
Fetch data	E000

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.

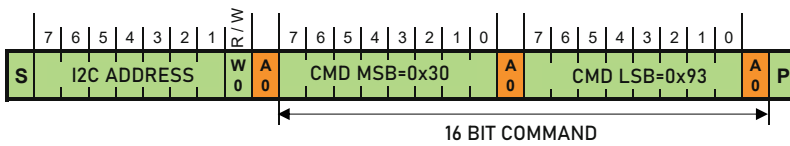| Command	CMD Hex Code
Break	3093

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 I^2C 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".

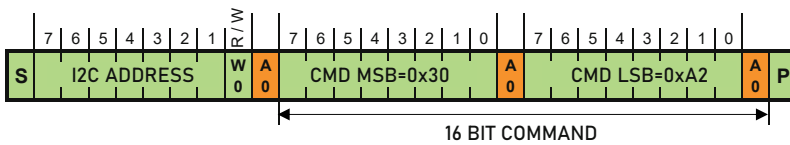| Command	CMD Hex Code
Soft reset	30A2

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.

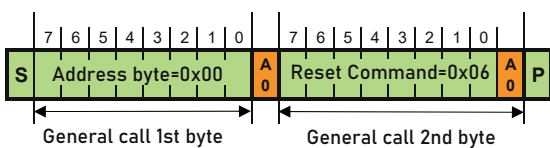| Command	CMD Hex Code
Address byte	00
Second byte	06

Figure 13: Reset through general call

In order to reset the I^2C 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:

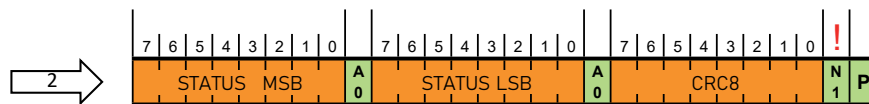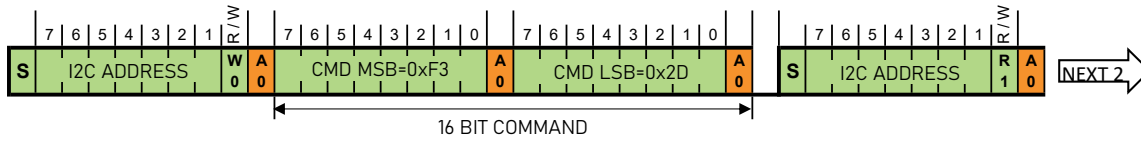| Command	CMD Hex Code
Read out Status Register	F32D

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:

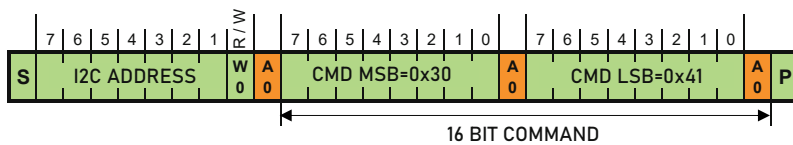| Command	CMD Hex Code
Clear Status Register	3041

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 I^2C slave sends all 8 bytes consecutively, followed by a CRC8 checksum (see chapter 6.14 (CRC Calculation)).

Command	CMD Hex Code
Read Identification	7029

> **i** **Please note:** During the I^2C communication before the I^2C address read, a repeated start sequence must be executed, the sequence "stop + start" is not sufficient.
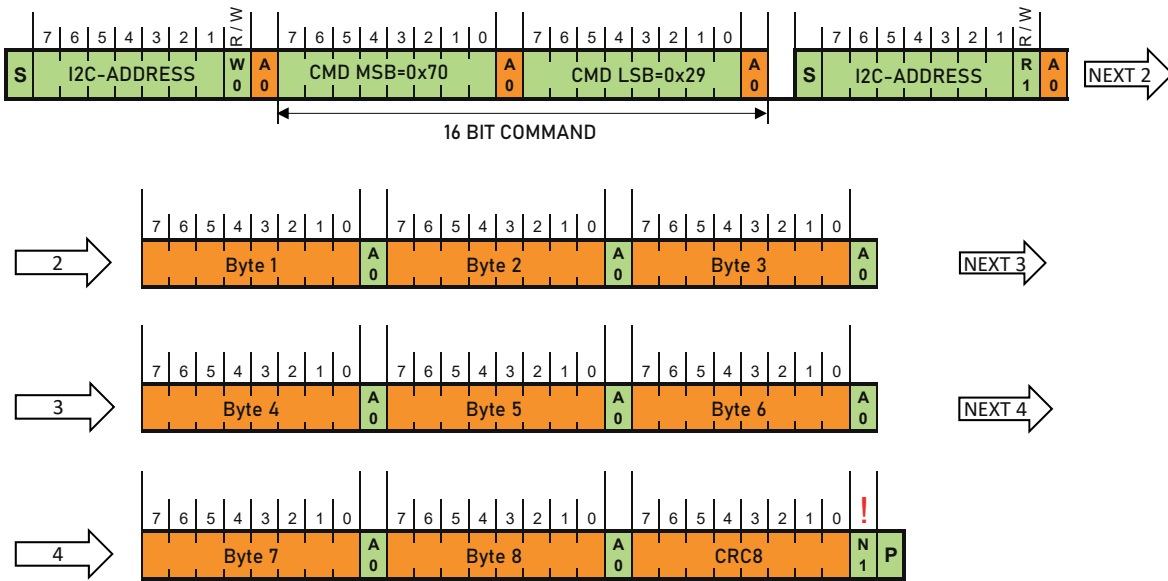
Figure 16: Read Identification

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
		HTM502-
Packaging	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
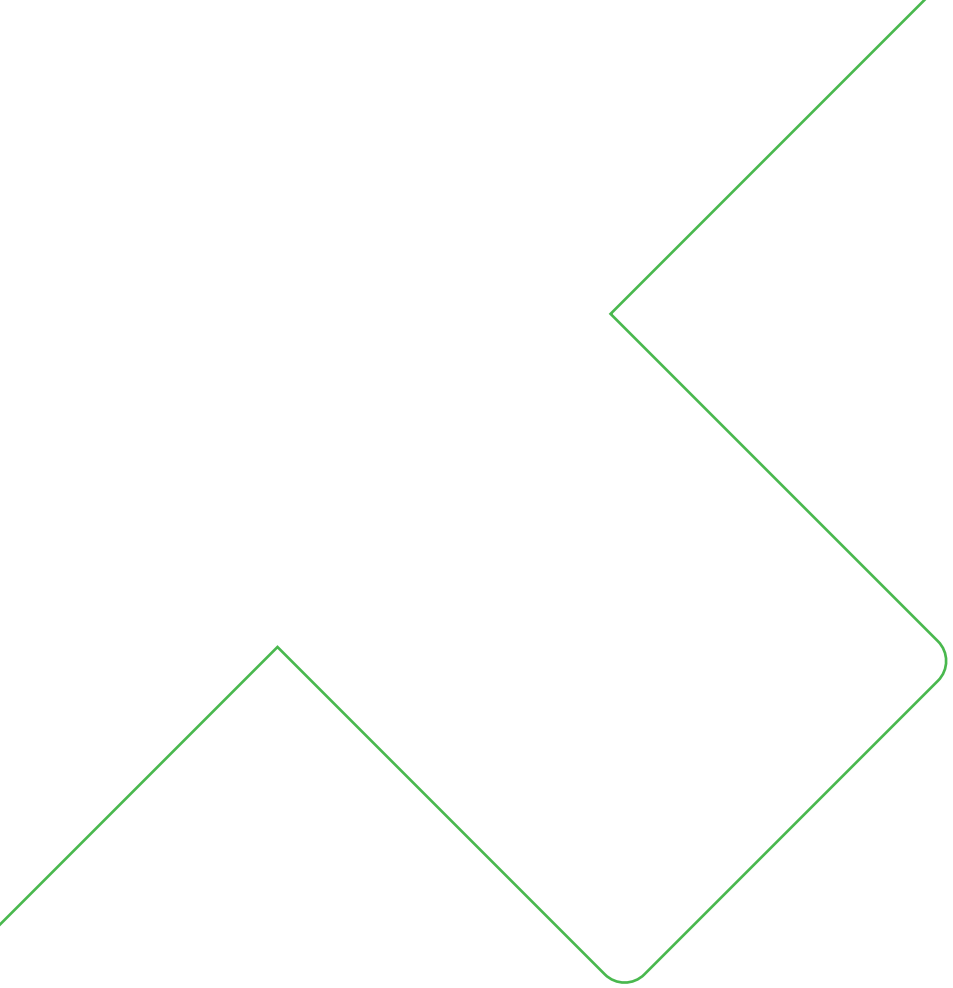
Accessories	Code
Probe tube, including flex cable	**HA060201**

Protection cap for 12 mm probe, see also datasheet Accessories	
Membrane, polycarbonate body	**010118**
Metal grid, polycarbonate body	**010119**
Stainless steel sintered	**010103**

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

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www.epluse.com/htm502

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