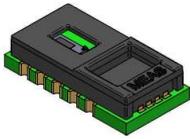


HTU1X Series – Miniature Temperature and Relative Humidity Sensor



- Miniature Surface mount SMD package
- Relative Humidity and Temperature Digital Output
- Fully calibrated
- Lead free component, reflow solderable
- Low power supply
- Fast response time and very low temperature coefficient

DESCRIPTION

Based on the rugged MEAS humidity sensor, the HTU1X(F) Series modules are dedicated humidity and temperature plug and play transducers for OEM applications where reliable and accurate measurements are needed. Direct interface with a micro-controller is made possible with the module humidity and temperature digital outputs. The HTU1X(F) Series modules are low power consumption designed for high volume and **cost sensitive applications with tight space constraints.**

FEATURES

- Full interchangeability with no calibration required in standard conditions
- Instantaneous desaturation after long periods in saturation phase
- Compatible with automatized assembly processes, including Pb free and reflow processes
- Individual marking for compliance to stringent traceability requirements

APPLICATIONS

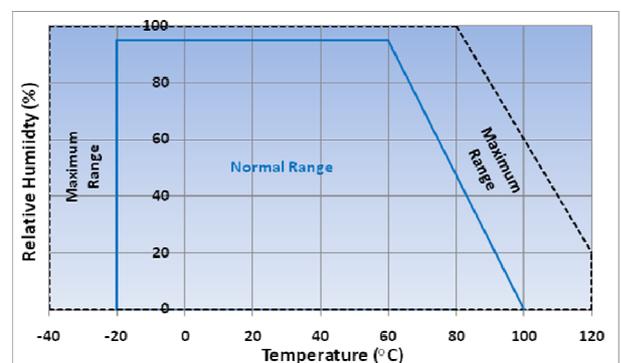
- Home Appliance
- Medical
- Printers
- Humidifier

PERFORMANCE SPECS

MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
Storage Temperature	T_{stg}	-40 to 125	°C
Supply Voltage (Peak)	V_{cc}	3.6	V_{dc}
Humidity Operating Range	RH	0 to 100	%RH
Temperature Operating Range	T_a	-40 to +105	°C
Maximum Power	P_d	2.5	mW

Peak conditions: less than 10% of the operating time



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HTU1X Series – Miniature Temperature and Relative Humidity Module

ELECTRICAL AND GENERAL ITEMS

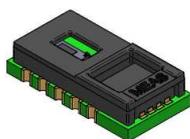
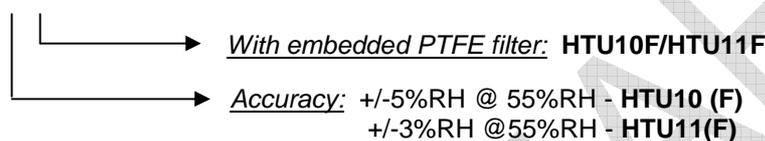
(@T = 25°C, @Vdd = 3.3V)

Characteristics	Symbol	Min	Typ	Max	Unit
Voltage Supply	VDD	3.2	3.3	3.4	V
Current consumption ⁽¹⁾	idd		250	700	μA
Communication	Digital (2-wire interface)				
Storage	10-50°C (-40°C / 125°C peak), 20 -60%RH				

⁽¹⁾ Conditions: V_{dd} = 3.3V, SCK= 1 MHz at 25°C

NOMENCLATURE

HTU1X(F) Series Modules



HTU10 and HTU11 Modules



HTU10F and HTU11F Modules

SENSOR PERFORMANCE

RELATIVE HUMIDITY

(@T = 25°C, @Vdd = 3.3V)

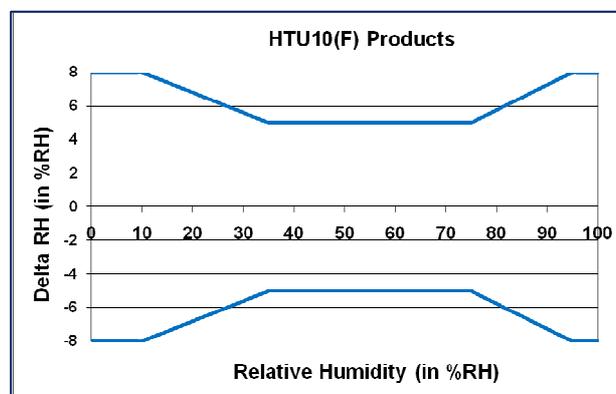
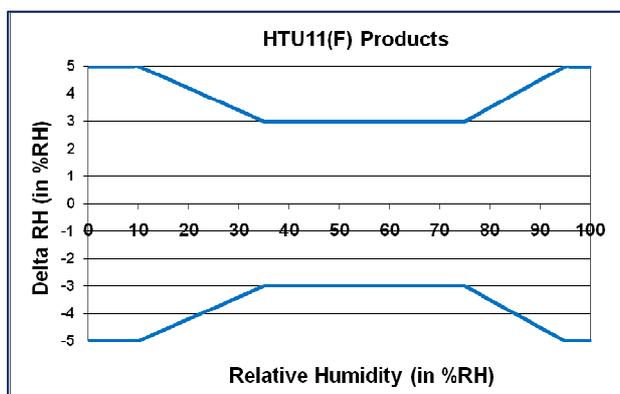
Characteristics	Symbol	Min	Typ	Max	Unit
Resolution			12		bits
			0.05		%RH
Humidity Measuring Range	RH	0		100	%RH
Relative Humidity Accuracy (10%RH to 95%RH)	HTU11(F) products		±3	±5	%RH
	HTU10(F) products		±5	±8	%RH
Replacement	fully interchangeable				
Temperature Coefficient (10°C to 50°C)	T _{cc}		+0.1		%RH/°C
Humidity Hysteresis				±1	%RH
Measuring Time (12 bits)			110		ms
Recovery time after 150 hours of condensation	t		10		s
Long term drift			- 0.5		%RH/yr
Response Time (at 63% of signal) from 33 to 75%RH ⁽¹⁾	T _{RH}		5	10	s

⁽¹⁾ At 1m/s air flow

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HTU1X Series – Miniature Temperature and Relative Humidity Module

HUMIDITY ERROR BUDGET CONDITIONS AT 25°C



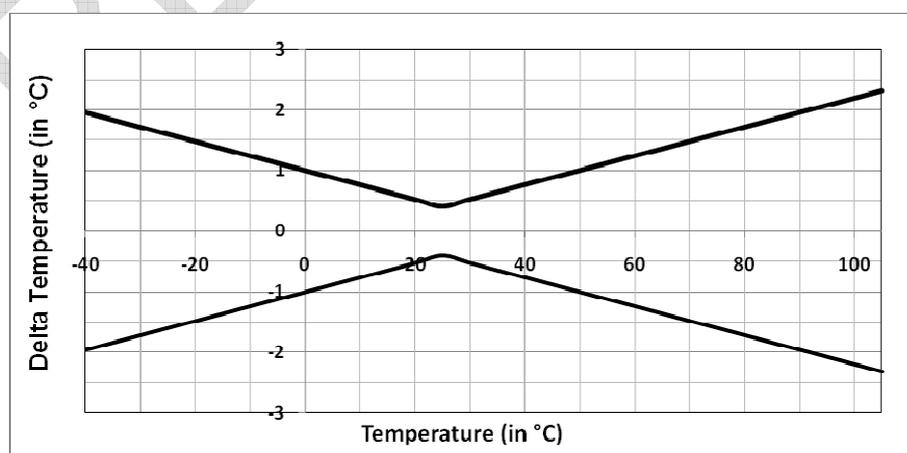
- HTU1X(F) Series modules are specified for optimum accuracy measurements within 10 to 95 %RH.
- Excursion out of this range (< 10% or > 95% RH, including condensation) does not affect the reliability of HTU1X(F) Series modules characteristics.

TEMPERATURE

Characteristics	Symbol	Min	Typ	Max	Unit
Resolution			14		bits
			0.01		°C
Temperature Measuring Range	T	-40		+105	°C
Accuracy @25°C			+/-0.4		°C
Replacement		fully interchangeable			
Operating range		-40		105	°C
		-40		221	°F
Measuring time (14 bits)			210		ms
Response Time (at 63% of signal) from 15°C to 45°C ⁽¹⁾	T _r		10		s

⁽¹⁾ At 1m/s air flow

TEMPERATURE ERROR BUDGET



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HTU1X Series – Miniature Temperature and Relative Humidity Module

USER GUIDE HTU1X

APPLICATION INFORMATION

- **Soldering instructions: Lead free reflow soldering recommended process.**

For soldering HTU1X(F) series modules standard reflow soldering ovens may be used. The sensor is qualified to withstand lead free reflow soldering recommended process profile below.

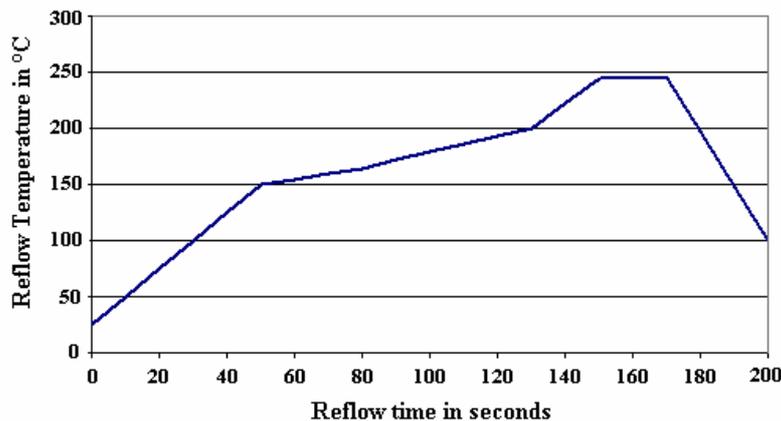
Typical composition of the solder paste Sn95.5 / Ag 3.9 / Cu0.6 as per JIS Z 3282:1999

- Melting point of 216 / 221°C
- Particle size: 20 to 38 micrometer
- Flux content: 11.8 +/- 0.3% as per JIS Z 3284:1994
- Chlorine content: 0% as per JIS Z 3197:1986
- Viscosity: 210 Pa. as per JIS Z 3284:1994 Annex 6
- Conditions for printing:
- Metal mask laser machined
- Squeegee type: metal or urethane / Hardness 80 to 90°
- Squeegee angle: 50 to 70°
- Squeegee speed: 20 to 80mm / s
- Printing pressure: 0.1 to 0.2 MPa

Mount parts within 24 hours after printing solder paste to avoid potential dry up.

Standard reflow soldering profile:

Lead Free Suggested Reflow Profile



Tests have been successfully performed with Lead Free TAMURA TLF-206-19A solder paste.

- **Hand soldering**

In special cases, where it is not practical to use such automated methods (such as for prototyping) hand soldering is used instead.

Hand or iron soldering may be applied to MEAS products, provided that the following precautions are taken:

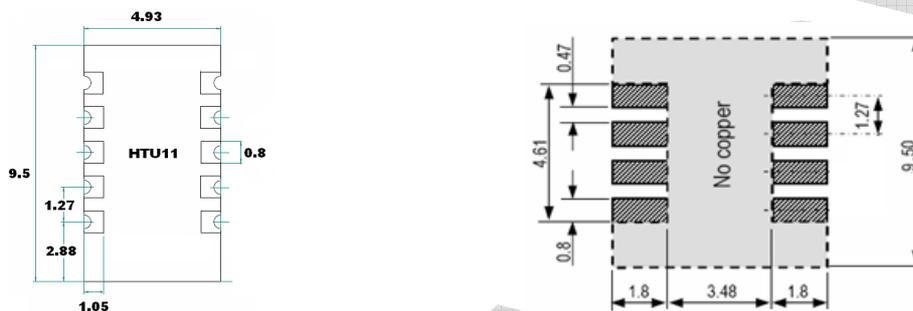
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HTU1X Series – Miniature Temperature and Relative Humidity Module

Temperature of the CMS soldering iron must be set up at 370°C. Total duration of the soldering operation must be kept below 5 seconds per contact.

Comment: visual aspect of the solder point is lustreless as for all Lead Free solder. This is normal and does not affect the Quality of the soldering point. Tests have been successfully performed with MULTICORE SOLDER LEAD FREE Sn/Ag/Cu Diam. 0.7mm / Ref 96SC.

For the design of the HTU1X(F) Series modules footprint it is recommended to use dimensions according to figure below.



Recommended footprint for HTU1X(F) Series Modules. Values in mm.

- **Storage Conditions and Handling Instructions**

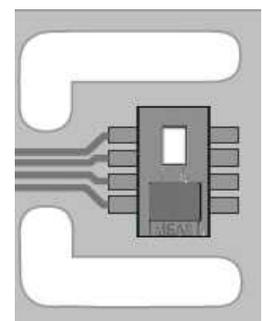
It is recommended to store HTU1X(F) Series modules in original packaging at following conditions: Temperature shall be in the range of 10°C – 50°C (-40°C – 125°C for limited time) and humidity at 20%RH – 60%RH.

- **Temperature effect**

Relative humidity reading strongly depends on temperature. Therefore, it is essential to keep humidity sensors at the same temperature as the air of which the relative humidity is to be measured.

In case of testing or qualification the reference sensor and test sensor must show equal temperature to allow for comparing humidity readings.

If the HTU1X(F) Series modules should be mounted in a way that prevents heat transfer from electronic component or keeps it as low as possible. Advices can be ventilation, reduction of copper layers between the HTU1X(F) Series and the rest of the PCB or milling a slit into the PCB around the sensor.



Example of HTU1X(F) Series Modules mounting with slits mills to minimize heat transfer.

- **Light**

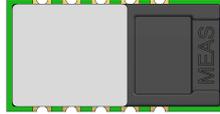
HTU1X(F) Series modules are not light sensitive.

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HTU1X Series – Miniature Temperature and Relative Humidity Module

- **Membrane**

HTU1XF modules housing integrates a PTFE filter at the sensor opening. This membrane prevents dirt and droplets from entering the housing.



Integrated PTFE filter for HTU10F and HTU11F products

- **Materials Used for Sealing / Mounting**

For sealing and gluing (use sparingly), use high filled epoxy for electronic packaging and silicone.

- **Wiring Considerations and Signal Integrity**

Carrying the SCK and DATA signal parallel and in close proximity (e.g. in wires) for more than 10cm may result in cross talk and loss of communication.

This may be resolved by routing VDD and/or GND between the two data signals and/or using shielded cables. Furthermore, slowing down SCK frequency will possibly improve signal integrity.

Power supply pins (VDD, GND) must be decoupled with a 100nF capacitor if wires are used. Capacitor should be placed as close as possible to the sensor.

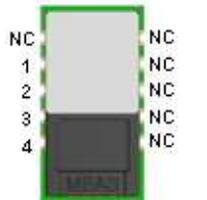
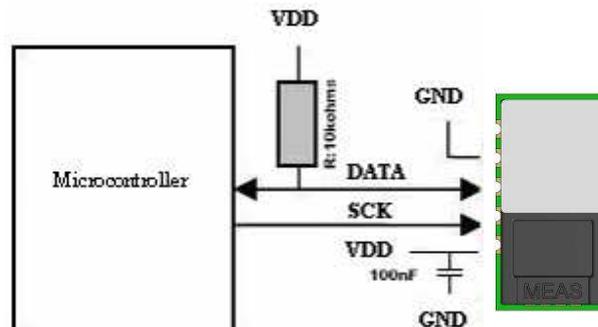
- **ESD (Electrostatic Discharge)**

ESD immunity is qualified according to IEC-61000-4-2:

- Human Body Model at +/- 2 kV (class A)
- Human Body Model at +/- 5 kV (class B)

INTERFACE SPECIFICATION

N°	Function	Comment
1	GND	Ground
2	DATA	Serial Data, bidirectional
3	SCK	Serial Clock, input only
4	VDD	Source Voltage
NC	NC	Must be left unconnected

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HTU1X Series – Miniature Temperature and Relative Humidity Module

- **Power Pins (VDD, GND)**

The supply voltage of HTU1X(F) Series modules must be in the range of 3.2VDC - 3.4VDC, recommended supply voltage is 3.3VDC (regulated).

However the typical application circuit includes a pull-up resistor R on data wire and a 100nF decoupling capacitor between VDD and GND.

- **Serial clock input (SCK)**

SCK is used to synchronize the communication between microcontroller and HTU1X(F) Series modules. Since the interface consists of fully static logic there is no minimum SCK frequency.

- **Serial data (DATA)**

The DATA tri-state pin is used to transfer data in and out of the device. Data changes after the falling edge and is valid on the rising edge of the serial clock SCK. During transmission the DATA line must remain stable while SCK is high. An external pull-up resistor (e.g. 10kΩ) on SCK is required to pull the signal high only for open collector or open drain technology microcontrollers. In most of the cases, pull-up resistors are internally included in I/O circuits of microcontrollers.

ELECTRICAL CHARACTERISTICS

(VDD=3.3V, Temperature=25°C unless otherwise noted)

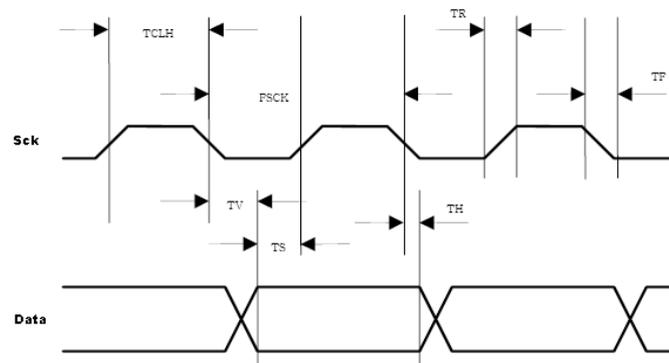
Characteristics	Symbol	Min	Typ	Max	Unit	Condition
Voltage Supply	VDD	3.2	3.3	3.4	V	
Current consumption ⁽¹⁾	idd		250	700*	μA	*Measuring
High level input voltage	VIH	70%			VDD	
Low level input voltage	VIL			30%	VDD	
High level output voltage	VOH	80%			VDD	
Low level output voltage	VOL			20%	VDD	
Leakage current	IL			1	μA	

DC CHARACTERISTICS

Characteristics	Symbol	Min	Typ	Max	Unit	Condition
SCK Frequency	FSCK			1	MHz	VDD>3.0V
DATA Fall time	TRFO	3	10	20	ns	Output Load 5pF
SCK Hi/Low time	TCLx	200			ns	
DATA valid time	TV		250		ns	
DATA setup time	TS	100			ns	
DATA hold time	TH	0	10		ns	
SCK rise/fall time	TR/TF		10		ns	

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HTU1X Series – Miniature Temperature and Relative Humidity Module



COMMUNICATION PROTOCOL WITH SENSOR

- **Power pins**

The HTU1X(F) Series modules require a voltage supply between 3.2 VDC and 3.4 VDC. After power up, the device needs 10ms to reach its “stand-by” state. No commands should be sent before that time.

- **Start symbol**

To initiate transmission, a start bit has to be issued. It consists of a lowering of the DATA line while SCK is high followed by lowering SCK.

- **Stop symbol**

To stop transmission, a stop bit has to be issued. It consists of a heightening of the DATA line while SCK is high followed by lowering SCK.

- **Restart symbol**

To restart transmission, a restart bit has to be issued between write and read commands including a start symbol.

- **Interface**

The serial interface of the HTU1X(F) Series modules is optimized for sensor readout and power consumption. HTU1X(F) Series modules communication bus is very close to I2C bus for wiring and voltage levels. Start and stop signals are I2C compliant but:

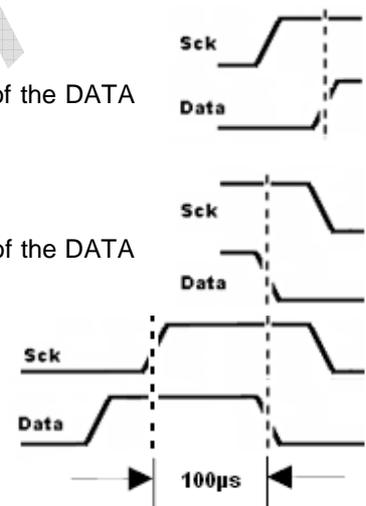
The sensor (slave) has no address. To avoid any communication conflict with other slaves on a standard I2C bus, you need to check is none of the other slave addresses is 0x80, 0x81, 0x82, 0x83.

The sensor answers only to specific commands (requests).

It is a 2 wires bus (1 clock and 1 data). The clock signal is unidirectional signal from master (MCU) to slave (sensor). This signal is managed by the master. The slave is only listening. The data signal is bidirectional. The idle level is Vcc.

Two suggested options are:

- To use another port dedicated for communication with our sensor (recommended option).
- To rename other slave addresses different from 0x80, 0x81, 0x82, 0x83 values as they are parametrable to avoid any potential communication conflict.



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HTU1X Series – Miniature Temperature and Relative Humidity Module

HTU1X SERIES MODULES LIST OF COMMANDS AND REGISTER ADDRESSES

Command	Code
Write Command	0x80
Read Command	0x81
Measure Temperature	0x82
Measure Humidity	0x83
Read OTP command	0x13

OTP Command	Code
Read Command	0x13

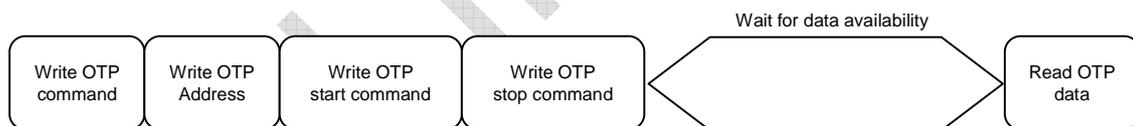
Register	Address
Humidity MSB	0x10
Humidity LSB	0x11
Temperature MSB	0x12
Temperature LSB	0x13
OTP command	0x0B
OTP address	0x0C
OTP start command	0x0D
OTP stop command	0x0E
OTP data	0x0F

OTP mapping	Address
Coeff Temp MSB	0x0A
Coeff Temp LSB	0x0B

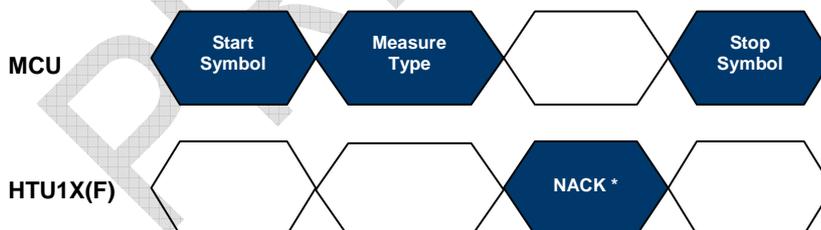
MEASUREMENT SEQUENCE OVERVIEW



READ OTP SEQUENCE OVERVIEW: MSB OR LSB TEMPERATURE COEFFICIENT



MEASURE COMMAND: RH OR TEMP

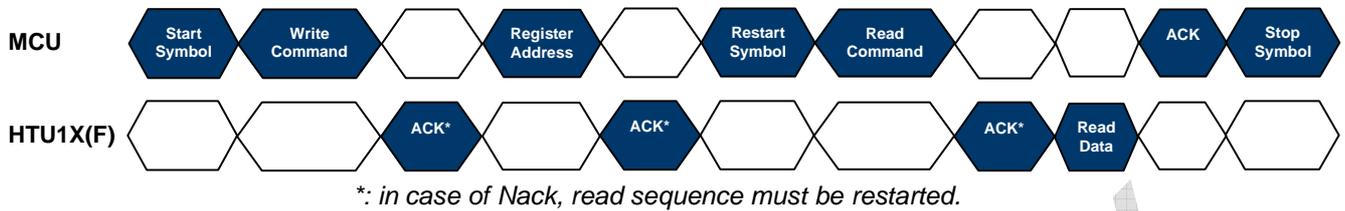


*: Measure commands will be NACKed. Read and Write commands will be ACKed.

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HTU1X Series – Miniature Temperature and Relative Humidity Module

READ SEQUENCE



WRITE SEQUENCE



MEASUREMENT OF RH AND TEMPERATURE

After issuing a measurement command ('0x83' for Humidity, '0x82' for Temperature) the controller has to wait for the measurement to complete. This takes approximately 110/210 ms for 12/14bit-measurement. The exact time varies by up to ±15% with the speed of the internal oscillator.

To signal the completion of a measurement, the HTU1X(F) Series modules pull up the data line and enter idle mode. The controller must wait for this "data ready" signal before restarting SCK to readout the data. Measurement data is stored HTU1X(F) Series modules internal register ('0x10', '0x11' for Humidity, '0x12', '0x13' for Temperature), therefore the controller can continue with other tasks and readout as convenient. Two bytes register value of measurement data will then be readout. The MCU must acknowledge each byte by pulling the DATA line low for measurement data readout.

14-bit Temp & 12-bit RH Configuration – Valid data																
Temperature	0x12 register (MSB)								0x13 register (LSB)							
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	T13	T12	T11	T10	T9	T8	T7	T6	T5	T4	T3	T2	T1	T0	X	X
Relative Humidity	0x10 register (MSB)								0x11 register (LSB)							
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
	X	X	X	X	H11	H10	H9	H8	H7	H6	H5	H4	H3	H2	H1	H0

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HTU1X Series – Miniature Temperature and Relative Humidity Module

READ OF TEMPERATURE COEFFICIENT – TC

To compute the temperature, customer need to get temperature output from 0x12 and 0x13 registers and from temperature coefficient. To get the temperature coefficient unique for each module, here is the process described to be followed.

MEAS recommend to get the temperature coefficient one time at start of the product and to record it on the MCU.

Parameter	OTP Address															
	0x0A register (MSB)							0x0B register (LSB)								
	b15	b14	b13	b12	b11	b10	b9	b8	b7	b6	b5	b4	b3	b2	b1	b0
Temperature Coefficient - TC	C13	C12	C11	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0	X	X

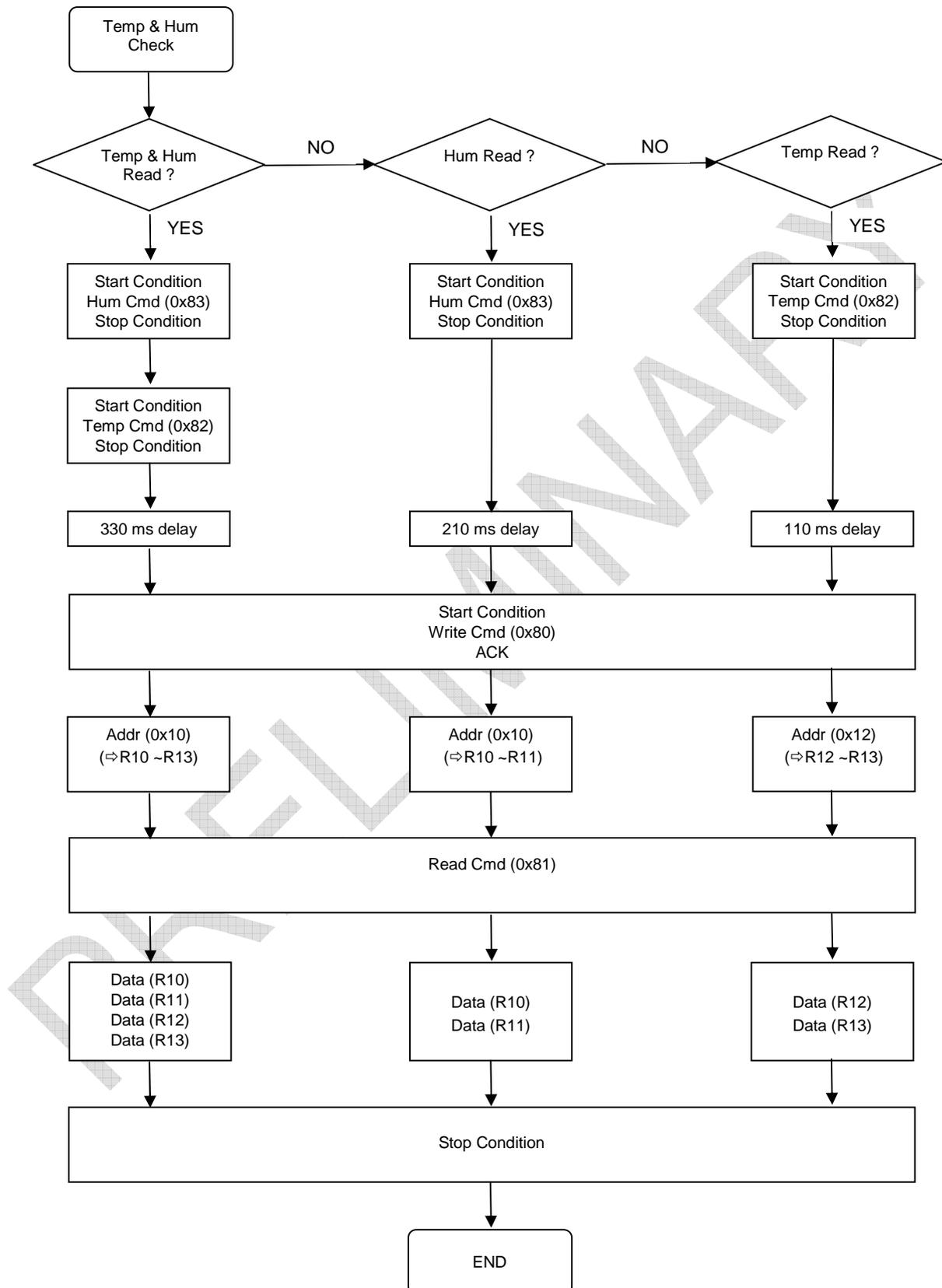
To get Temperature Coefficient MSB or LSB value:

1. Write 'Read OTP command' to 'OTP command' register
2. Write 'OTP address' to 'OTP address' register
 - a. 0x0A for MSB Temperature Coefficient
 - b. 0x0B for LSB Temperature Coefficient
3. Write '0x00' to 'OTP start command' register
4. Write '0x00' to 'OTP stop command' register
5. Setting stand-by mode of OTP
 - a. Write '0x10' to 'OTP command' register
 - b. Write '0x00' to 'OTP address' register
 - c. Write '0xFF' to 'OTP start command' register
 - d. Write '0x00' to 'OTP stop command' register
6. Read data from 'OTP data' register

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HTU1X Series – Miniature Temperature and Relative Humidity Module

MEASUREMENT DIAGRAM



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HTU1X Series – Miniature Temperature and Relative Humidity Module

TYPICAL PERFORMANCE CURVES

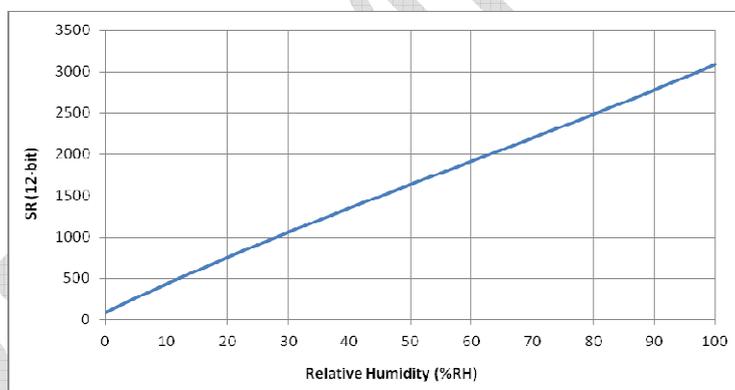
HUMIDITY SENSOR

(VDD=3.3V, Temperature=25°C unless otherwise noted)

- Humidity Look-up Table

%RH	SR 12bits	%RH	SR 12bits
5	265	55	1776
10	433	60	1916
15	596	65	2056
20	755	70	2197
25	909	75	2339
30	1059	80	2483
35	1206	85	2630
40	1351	90	2779
45	1494	95	2931
50	1636	100	3088

- Humidity Curve



- Humidity Polynomial Equations

RH in %RH

$$SR = a \cdot RH^3 + b \cdot RH^2 + c \cdot RH + d$$

SR	a	b	c	d
12-bit	7.186×10^{-4}	-1.26×10^{-1}	35.40	91.30

$$RH = a \cdot SR^3 + b \cdot SR^2 + c \cdot SR + d$$

SR	a	b	c	d
12-bit	-8.80×10^{-10}	4.96×10^{-6}	2.63×10^{-2}	-2.33

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HTU1X Series – Miniature Temperature and Relative Humidity Module

- Humidity Linear Equations

RH in %RH

$$SR = a \cdot RH + b$$

SR	a	b
12-bit	29.35	151.19

$$RH = a \cdot SR + b$$

SR	a	b
12-bit	3.41×10^{-2}	-5.12

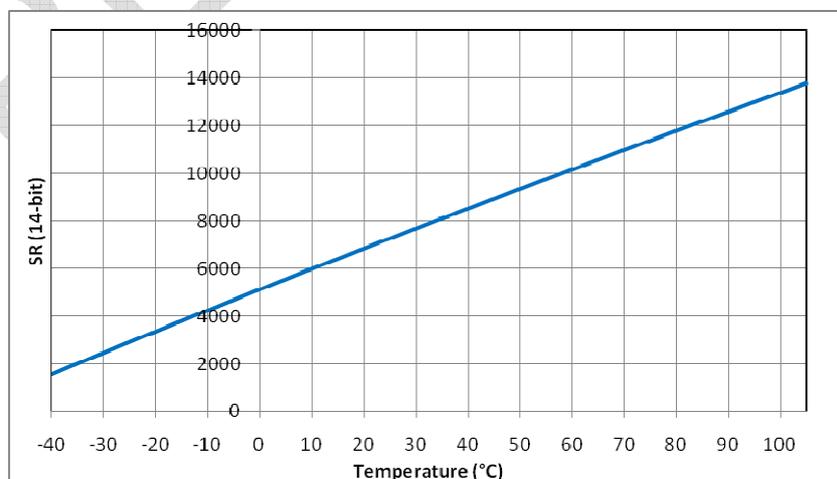
TEMPERATURE SENSOR

(VDD=3.3V, Temperature=25°C unless otherwise noted)

- Temperature Look-up Table

T (°C)	SR 14bits	T (°C)	SR 14bits
-40	1553	35	8089
-35	2008	40	8506
-30	2461	45	8920
-25	2910	50	9333
-20	3356	55	9744
-15	3799	60	10153
-10	4239	65	10560
-5	4677	70	10966
0	5112	75	11370
5	5544	80	11772
10	5974	85	12174
15	6402	90	12574
20	6827	95	12973
25	7250	100	13370
30	7671	105	13767

- Temperature Curve



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HTU1X Series – Miniature Temperature and Relative Humidity Module

- **Compensated Temperature Linear Equation (using temperature coefficient TC)**

T in SR (14-bit)
TC in SR (14-bit)
Temp in °C

$$Temp_{corrected} = \frac{40}{TC} * (T - 7250) + 25$$

- **Compensated Temperature Polynomial Equation (using temperature coefficient TC)**

T in SR (14-bit)
TC in SR (14-bit)
Temp in °C

$$Temp_{corrected} = \frac{40}{TC} * (a * T^2 + b * T + c - 7250) + 25$$

with	a	b	c
	6.052x10 ⁻⁰⁶	0.891	475.92

- **Inversed Compensated Temperature Linear Equation (using temperature coefficient TC)**

T in SR (14-bit)
TC in SR (14-bit)
Temp in °C

$$T = \frac{TC}{40} * (Temp - 25) + 7250$$

PROCESS

HTU1X(F) Series modules have been tested through a complete sequence process taking in account many of the requirements of the JEDEC standard including:

- Solder heat and solderability including lead free process
- Pb free wave soldering and reflow soldering processes (260°C) + DI water clean at 45°C
- Salt Atmosphere JESD22-A107-A
- Temperature Cycling - 40°C / +125°C for 168 hours
- High Temperature / Humidity Operating Life - 93%RH / 60°C for 168 hours
- Low Humidity storage life - RH < 10%/23°C for 168 hours
- Resistance to immersion in water at ambient temperature and 80°C
- High temperature storage 120°C for 168 hours
- Resistance to many chemicals linked to home appliances/automotive or consumer applications

Additional tests under harsh chemical conditions demonstrate good operation in presence of salt atmosphere, SO₂ (0.5%), H₂S (0.5%), O₃, NO_x, NO, CO, CO₂, Softener, Soap, Toluene, acids (H₂SO₄, HNO₃, HCl), HMDS, Insecticide, Cigarette smoke, a non-exhaustive list.

ENVIRONMENTAL AND RECYCLING

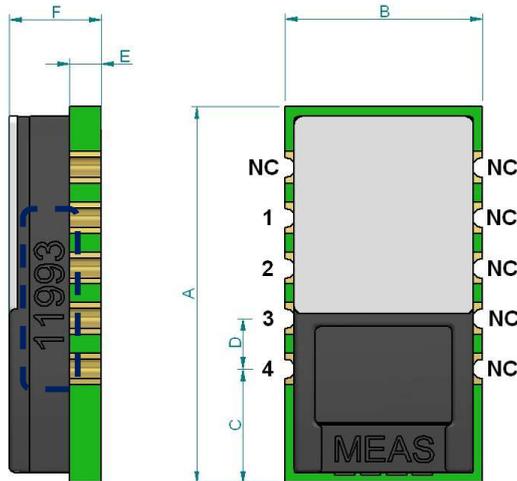
HTU1X(F) Series modules are lead free components and are compatible with Pb Free soldering processes.

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HTU1X Series – Miniature Temperature and Relative Humidity Module

HTU1X(F) Series modules are free from Cr (6+), Cd and Hg.

PACKAGE OUTLINE



Dim	Typ (mm)
A	9.50 ± 0.40
B	4.93 ± 0.40
C	2.88 ± 0.30
D	1.27 ± 0.20
E	0.80 ± 0.20
F	2.60 ± 0.40

Pin Out Assignment

N°	Function
1	GND
2	DATA
3	SCK
4	VDD

- Marking information - YDDDZ

YDDD: Date Code

Y: Last digit of the year eg 2011 = 1

DDD: Day of the year

Z: Product identification

= 1 for HTU10

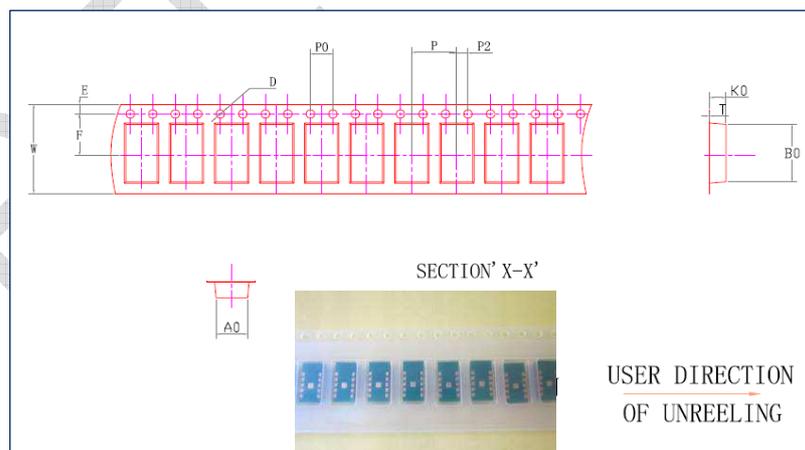
= 2 for HTU10F

= 3 for HTU11

= 4 for HTU11F

Example: For a batch of HTU11 assembled on 18-07-2011 => 11993

- Tape and reel information



Item	W	A0	B0	D	E	F	K0	P0	P2	P	T
Dimension	24.00	5.30	10.10	1.5	1.75	11.50	2.80	4.0	2.0	8.0	0.30
Tolerance	±0.3	±0.1	±0.1	+0.1 -0.0	±0.1	±0.1	±0.1	±0.1	±0.1	±0.1	±0.05

深圳市新世联科技有限公司

HTU1X Series – Miniature Temperature and Relative Humidity Module

ORDERING INFORMATION

- HPP828C031: HTU10 - DIGITAL TEMPERATURE AND RELATIVE HUMIDITY MODULE
- HPP828D031: HTU11 - DIGITAL TEMPERATURE AND RELATIVE HUMIDITY MODULE
- HPP828C131: HTU10F - DIGITAL TEMPERATURE AND RELATIVE HUMIDITY MODULE
- HPP828D131: HTU11F - DIGITAL TEMPERATURE AND RELATIVE HUMIDITY MODULE

PACKAGE: TAPE AND REEL M.P.Q OF 1400 PIECES

Revision	Comments	Who	Date
0	Creation	B.SICARD	January 10
A	General update	D. LE GALL	August 11
B	New MEAS Template, commands and registers values updated, RH equations and LUT updated, added orientation of the HTU1X in tape packaging	D. LE GALL	January 12

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