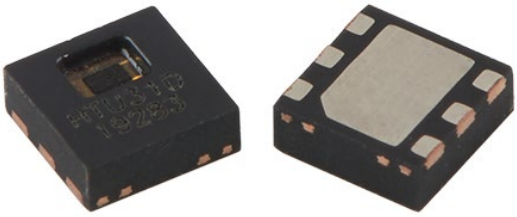


HTU31V RH/T SENSOR IC

Analog Relative Humidity & Temperature Sensor

Characteristics

- Fully calibrated, temperature compensated
- High accuracy: ±2%RH and ±0.2°C
- Fast humidity response time: 5s
- Wide supply voltage range from 3V to 5.5V
- Low average current: 161µA typical
- Compact 6-Pin DFN package: 2.5x2.5x0.9mm
- Ratiometric voltage output
- Fully RoHS and REACH compliant

Features

- High Reliability and Robustness
- Fast Recovery after Saturation
- Fully Compatible with Reflow Process
- Fully Interchangeable without Calibration
- Serial Individual Marking for Traceability
- Lead Free
- Low Power Consumption

Applications

- Home Appliance
- Medical
- Printers
- Humidifiers
- Automotive
- Meteorology
- Environmental Monitoring & Trackers

General Description

The HTU31 is one of the smallest and most accurate humidity sensors on the market. TE Connectivity precision engineering and 20+ years of experience in humidity and temperature combination sensors, enabled this new product with fast response time, precision measurement, low hysteresis, robustness to reflow assembly process and sustained performance even when exposed to extreme temperature [-40° to 125°C] and humidity [0%RH to 100%RH] environments.

HTU31 humidity & temperature sensor includes both digital (D) and analog (V) versions and combines multiple functions with an application-friendly operating supply voltage range from 3V to 5.5V.

HTU31 sensor is available in small and large volumes to meet the ever-changing demands of our customers.

PERFORMANCE SPECIFICATIONS

Relative Humidity Specifications

V_{dd} = 5V 25°C

Characteristics	Condition	Value	Units	Notes / Conditions
Humidity Operating Range	Max[1]	0 to 100	%RH	
Relative Humidity Accuracy	Typical	±2	%RH	*Figure 1 Humidity Sensor Rating @25°C*
Resolution	Typical	0.01	%RH	*Table 11 Humidity and Temperature Conversion Parameters*
Hysteresis	@25°C	±0.7	%RH	
Response Time[2]	$\tau_{63\%}$	5	s	
Recovery Time after Condensation[3]	Typical	10	s	
Long Term Drift[4]	Typical	<0.25	%RH / year	

Table 1 Humidity Specifications

Temperature Specifications

V_{dd} = 5V 25°C

Characteristics	Condition	Value	Units	Notes / Conditions
Temperature Operating Range		-40 to 125	°C	
Temperature Accuracy	Typical	±0.2	°C	*Figure 2 Temperature Sensor Rating*
Resolution	Typical	0.016	°C	*Table 11 Humidity and Temperature Conversion Parameters*
Response Time[2]	$\tau_{63\%}$	10	s	
Long Term Drift	Typical	0.04	°C / year	

Table 2 Temperature Specifications

[1] Cf. Figure 3 Humidity and Temperature Operating Range
[2] With 1m.s^{-1} air flow
[3] Measured according to AFNOR standard NFX 15-113, with 3 m.s^{-1} air flow
[4] Typical application in regular environmental variation within optimum measurement range

Humidity Sensor Rating

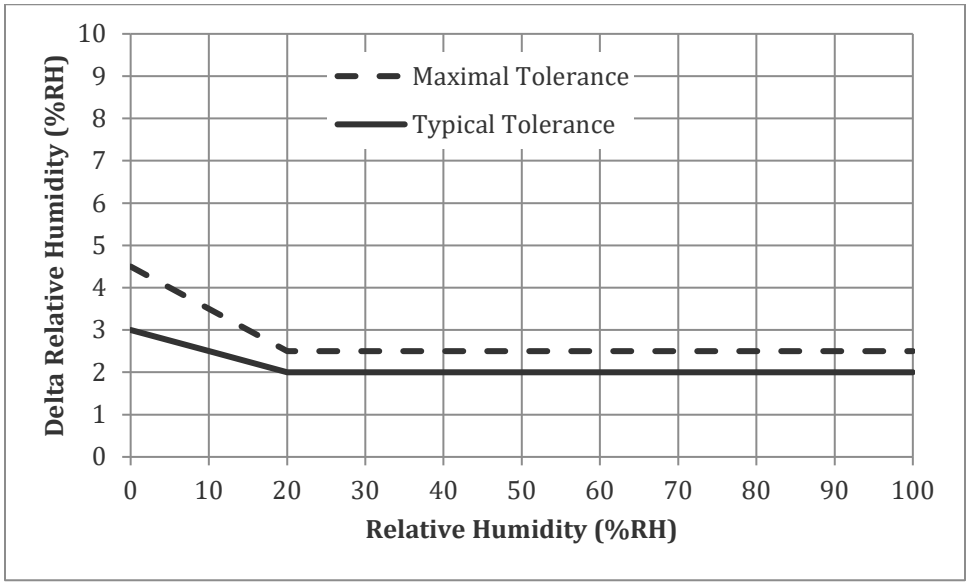


Figure 1 Humidity Sensor Rating @25°C

Temperature Sensor Rating

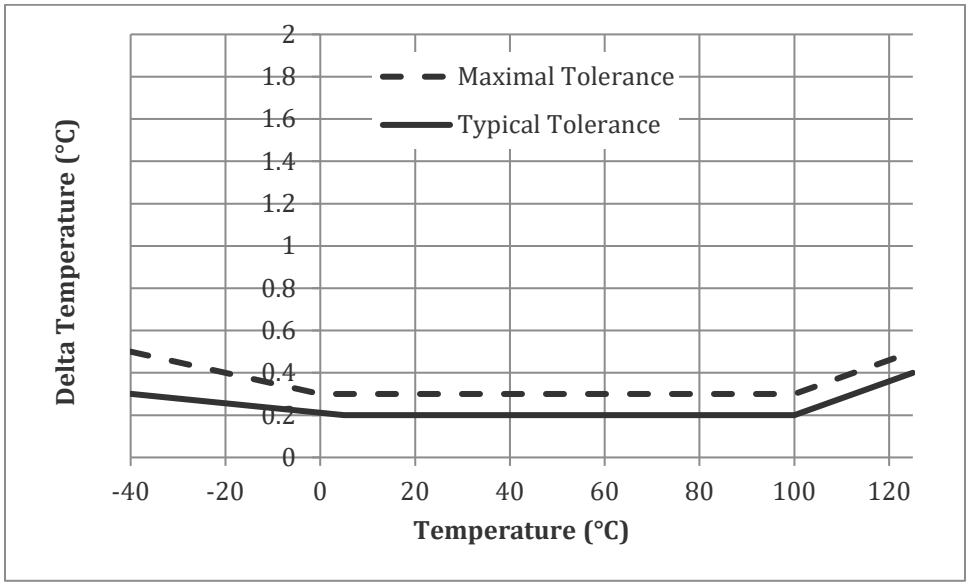


Figure 2 Temperature Sensor Rating

SENSOR INTEGRATION

Absolute Maximum Operating Conditions

Ratings	Symbol	Value	Unit	Notes / Conditions
Storage Temperature[5]	Tstg	-40 to 150	°C	
Supply Voltage (Peak)	Vcc	5.5	Vdc	
Humidity Operating Range	RH	0 to 100	%RH	
Temperature Operating Range	Ta	-40 to +125	°C	
VDD to GND		-0.3 to 5.5	V	
ESD HBM (Human Body Model)[6]		±4	kV	
ESD CDM (Charged Device Model)[7]		750	V	
Latch Up Sensitivity[8]		±300	mA	

Table 3 Maximum Operating Conditions

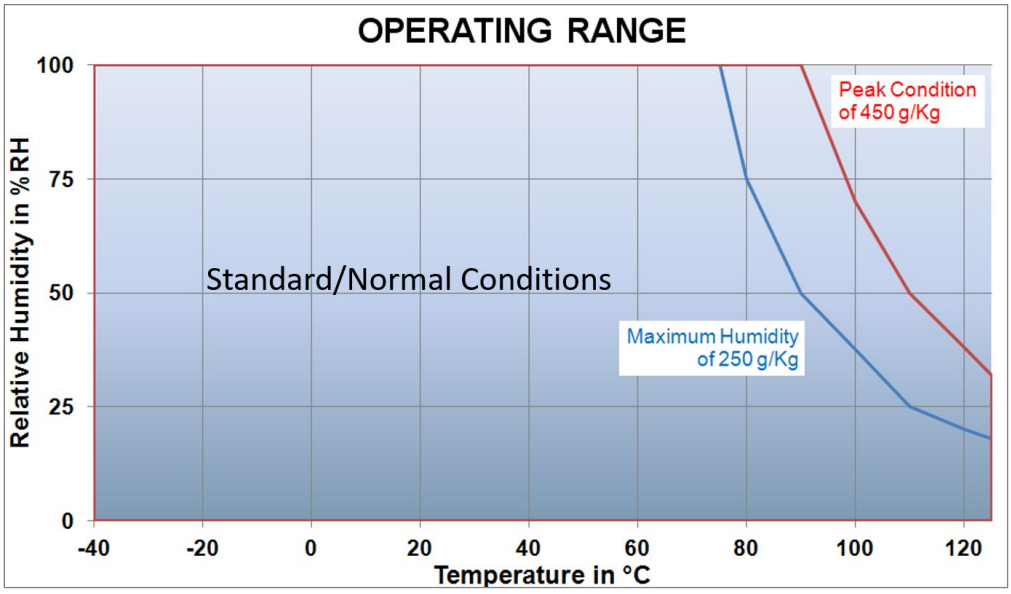


Figure 3 Humidity and Temperature Operating Range

The sensor should operate at peak condition less than 10% of the operating life. Exposure to absolute maximum humidity/temperature conditions for extended periods may temporarily induce an offset on RH measurement (+5%RH above accuracy specifications, which will recover over time) and accelerate its ageing.

[5] Sensor in specifications after 1000h storage @150°C
[6] According to ANSI/ESDA/JEDEC JS-001-2017, AEC-Q100-002.
[7] According to JESD22-C101, AEC-Q100-011
[8] According to JESD78

Electrical Specifications

V_{dd} = 5V 25°C

Characteristics	Symbol	Min	Typ	Max	Unit	Notes / Conditions
Supply Voltage	V_{dd}	3.0	5.0	5.5	V	
Current Consumption	i_{dd}		161		µA	Typical
			511		µA	Peak
Power Dissipation			805		µW	Typical
			2.55		mW	Peak
Buffer Output Current				±200	µA	
Buffer Capacitive Load		0.0		5.0	nF	

Table 4 Electrical Specifications

Timing Specifications

V_{dd} = 5V 25°C

Characteristics	Symbol	Min	Typ	Max	Unit	Notes / Conditions
Power Up Time				10	ms	

Table 5 Timing Specifications

INTERFACES

Pin Assignment

N°	Function	Description
1	RH	RH Ratiometric Voltage Output
2	GND	Ground
3	BUF	Buffer Off Control
4	RST	Reset
5	VDD	Supply Voltage
6	TEMP	Temp. Ratiometric Voltage Output

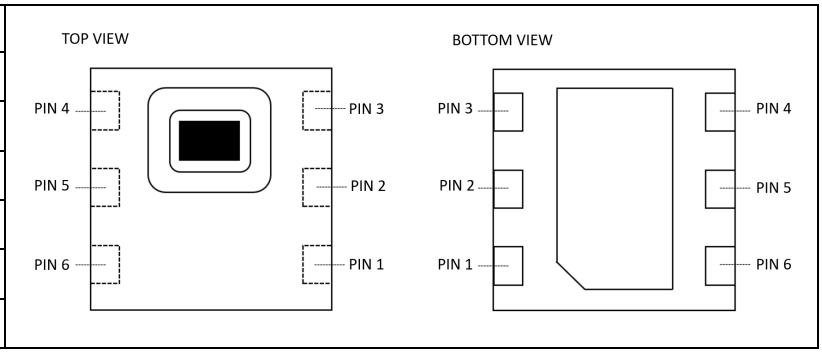


Table 6 Pin Assignment

Relative Humidity and Temperature Ratiometric Voltage Output Pins (RH / TEMP)

Relative humidity voltage output is directly provided via RH pin. Temperature voltage output is directly provided via TEMP pin.

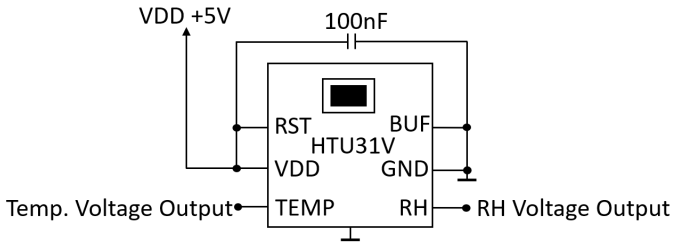


Figure 4 HTU31V Typical Application Circuit

Power Pins (VDD / GND)

Typical circuit includes a 100nF decoupling capacitor between VDD and GND, located as close as possible to the sensor.

BUF Pin

The HTU31V includes a built-in output buffer for the two voltage RH and temperature outputs.

The BUF pin is used to enable or disable this output buffer.

- When BUF pin is connected to GND, as represented in *Figure 4 HTU31V Typical Application Circuit*, voltage output buffer is on, this is the recommended configuration for most applications.
- When BUF pin is connected to VDD, analog output buffer is off, the voltage outputs will be at high impedance, an external buffer is then highly recommended. Loading on RH and TEMP pins must be higher than 1GΩ to avoid nonlinear effects.

RST Pin

The RST pin can be used to generate a reset of the sensor. A minimum pulse of 1µs is required to reliably trigger a sensor reset.

- When RST pin is connected to GND, chip in reset / power down mode.
- When RST pin is connected to VDD, chip is in operating mode.

If reset feature is not used, RST pin must be connected to VDD, as represented in *Figure 4 HTU31V Typical Application Circuit*.

COMMUNICATION AND OPERATION

Conversion of Ratiometric Voltage Outputs

Relative Humidity Conversion

From the voltage output V_{RH}, updated each 250ms, the relative humidity in %RH is obtained by the following formula:

$$RH(\%) = -12{,}5 + 125 \cdot \frac{V_{RH}}{V_{DD}} = -\frac{10}{0{,}8} + \frac{100}{0{,}8} \cdot \frac{V_{RH}}{V_{DD}}$$

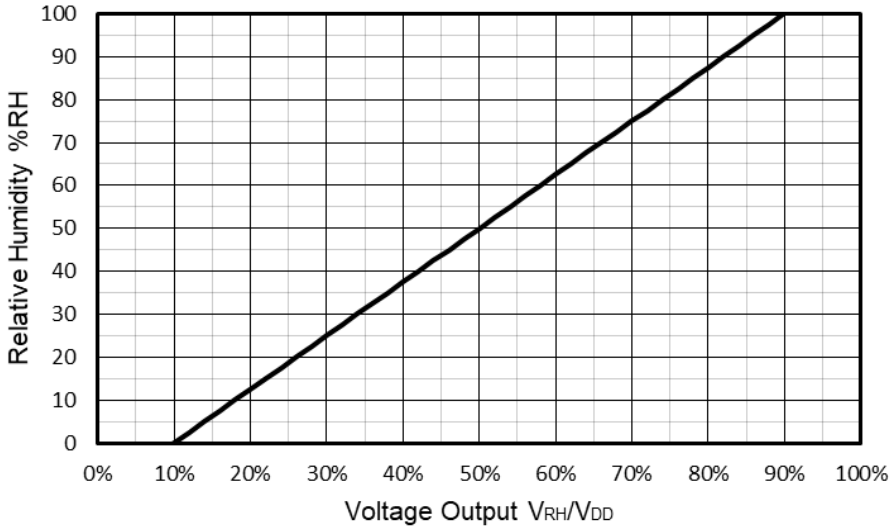


Figure 5 Relationship between ratiometric voltage output and measured relative humidity in %RH

Temperature Conversion

From the voltage output V_T, updated each 250ms, the temperature T in °C or in °F is obtained by the following formulas:

$$T(°C) = -60{,}625 + 206{,}25 \cdot \frac{V_T}{V_{DD}} = -40 - \frac{16{,}5}{0{,}8} + \frac{165}{0{,}8} \cdot \frac{V_T}{V_{DD}}$$

$$T(°F) = -77{,}125 + 371{,}25 \cdot \frac{V_T}{V_{DD}} = -40 - \frac{29{,}7}{0{,}8} + \frac{297}{0{,}8} \cdot \frac{V_T}{V_{DD}}$$

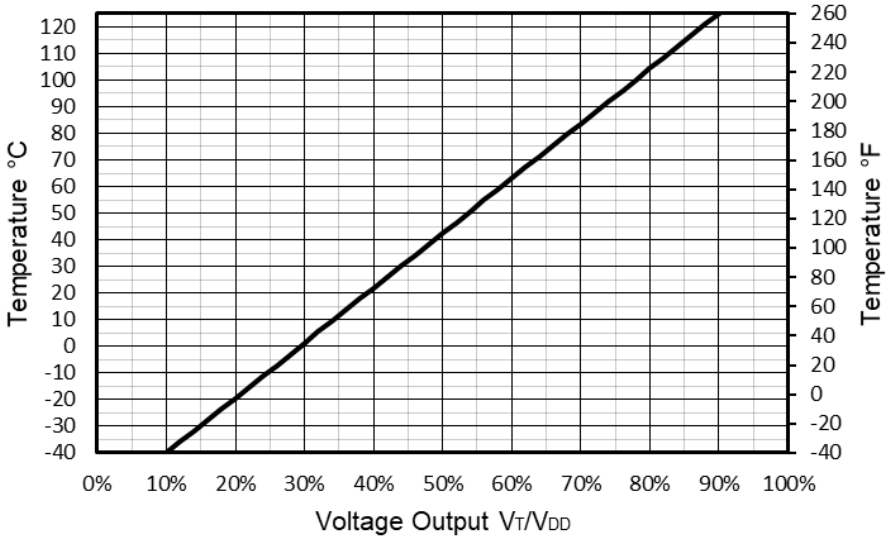


Figure 6 Relationship between ratiometric voltage output and measured temperature in °C and °F

Error Codes

Relative Humidity

In case of abnormal open circuit, the voltage output V_{RH} will provide an error code : V_{RH}=0V.
In case of abnormal short circuit, the voltage output V_{RH} will provide an error code : V_{RH}=V_{DD}.

Temperature

In case of abnormal open circuit or values below -50°C, the voltage output V_T will provide an error code : V_T=0V.
In case of values between -50°C and -40°C, the voltage output V_T will provide a clamping : $V_T = \frac{V_T}{V_{DD}}$ = 10%.
In case of values between 125°C and 150°C, the voltage output V_T will provide a clamping : $V_T = \frac{V_T}{V_{DD}}$ = 90%.
In case of abnormal short circuit or values above 150°C, the voltage output V_T will provide an error code : V_T=V_{DD}.

Dew Point Temperature Calculation

The dew point is the temperature at which the water vapor in the air becomes saturated and condensation begins.

The dew point is associated with relative humidity. A high relative humidity indicates that the dew point is closer to the current air temperature. Relative humidity of 100% indicates that the dew point is equal to the current temperature (and the air is maximally saturated with water). When the dew point stays constant and temperature increases, relative humidity will decrease.

Partial Pressure (PP_{Tamb}) Calculation from Ambient Temperature

Partial Pressure (PP_{Tamb}) is calculated using temperature measurement from HTU31 sensor with the following formula:

$$PP_{Tamb} = 10^{\left[A - \frac{B}{(Tamb+C)}\right]}$$

PP_{Tamb}	Partial Pressure in mmHg at Ambient Temperature
T_{amb}	Ambient Temperature in °C, from HTU31
A, B, C	Constants: A=8.1332; B=1762.39; C=235.66

Dew Point Temperature (T_d) Calculation from Partial Pressure (PP_{Tamb})

Dew point temperature (T_d) of the air is calculated using ambient relative humidity and temperature measurements from HTU31 sensor with the following formula:

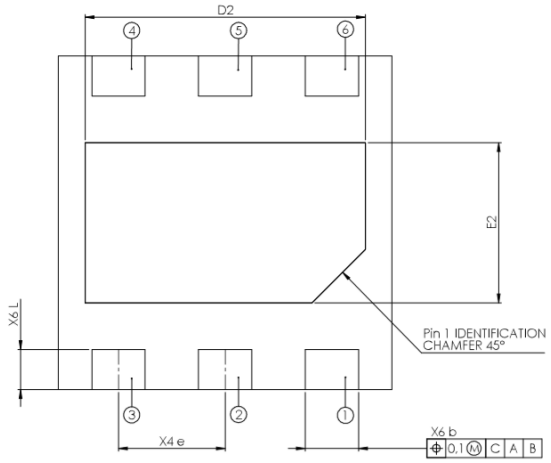
$$T_d = -\left[\frac{B}{\log_{10}\left(RH_{amb} \times \frac{PP_{Tamb}}{100}\right) - A} + C\right]$$

PP_{Tamb}	Partial Pressure in mmHg at Ambient Temperature
RH_{amb}	Ambient Relative Humidity in %RH, from HTU31
T_{amb}	Ambient Temperature in °C, from HTU31
T_d	Calculated Dew Point in °C
A, B, C	Constants: A=8.1332; B=1762.39; C=235.66

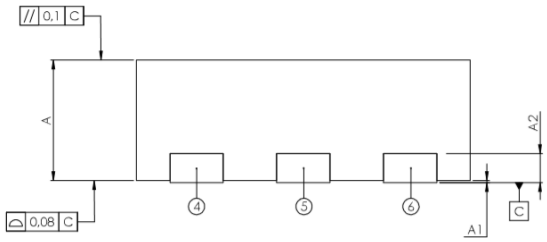
PACKAGING AND ASSEMBLY INFORMATION

Package Outline

Bottom View

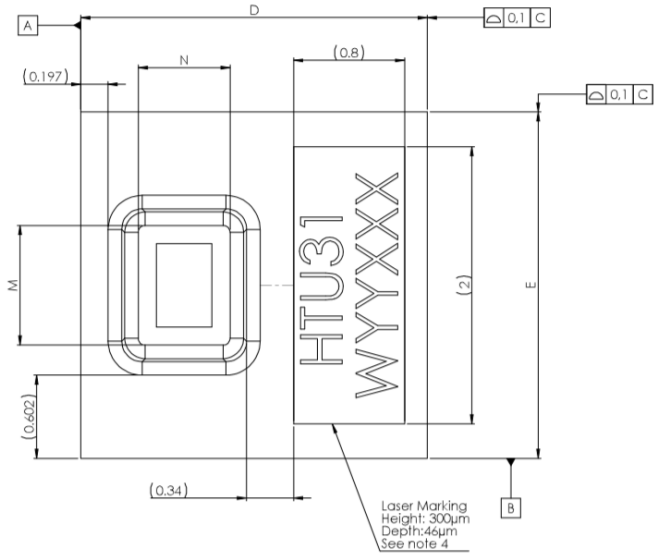


Side View



Description	"W" in the marking
HTU31 Digital	D
HTU31 Analog	V

Top View



SYMBOL	COMMON					
	DIMENSIONS MILLIMETER			DIMENSIONS INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.85	0.90	0.95	0.033	0.035	0.037
A1	0.00	0.02	0.05	0.000	0.001	0.002
A2	0.203 REF			0.008 REF		
b	0.35	0.40	0.45	0.014	0.016	0.018
D	2.45	2.50	2.55	0.096	0.098	0.100
D2	2.05	2.10	2.15	0.081	0.083	0.085
E	2.45	2.50	2.55	0.096	0.098	0.100
E2	1.15	1.20	1.25	0.045	0.047	0.049
e	0.80 BSC			0.031 BSC		
L	0.25	0.30	0.35	0.010	0.012	0.014
M	0.860 REF			0.034 REF		
N	0.660 REF			0.026 REF		

Packaging Type

HTU31 is provided in DFN type package (Dual Flat No leads).

The HTU31 sensor chip is mounted on a lead frame made of Cu and plated with Ni/Pd/Au.

Traceability Information

Every HTU31V is laser marked with an alphanumeric code. The marking consists of two lines of digits:

- The first line denotes the sensor type: HTU31.
- The second line denotes HTU31 output mode and Date Code as:
    - The first digit of the second line defines the HTU31 output mode:
        - D = Digital (I²C)
        - V = Analog
    - The second and third digits define the manufacturing year: 19=2019, 20=2020.
    - The last three digits represent the day of the year.

Reels are also labeled for lot identification and additional traceability information, as displayed below:

With:

3X:	Sensor Type (31 for HTU31)
Y:	Output mode (V = Analog)
TTTTTTTTT:	MEAS Traceability Code
QQQQ:	Quantity per reel (400, 1500 or 5000 units)
YY:	Last two digits of the year
DDD:	Day of the year

Tape & Reel Packaging

HTU31V sensors are delivered in tape & reel packaging, sealed into antistatic ESD bags.

Standard packaging sizes are 400, 1500 and 5000 units per reel.

Each reel contains 440mm (55 pockets) header tape and 200mm (25 pockets) trailer tape.

For 400 and 1500 units: outside diameter of 7” (178mm) and a 1/2” (13mm) diameter arbor hole.

For 5000 units: outside diameter of 13” (330mm) and a 1/2” (13mm) diameter arbor hole.

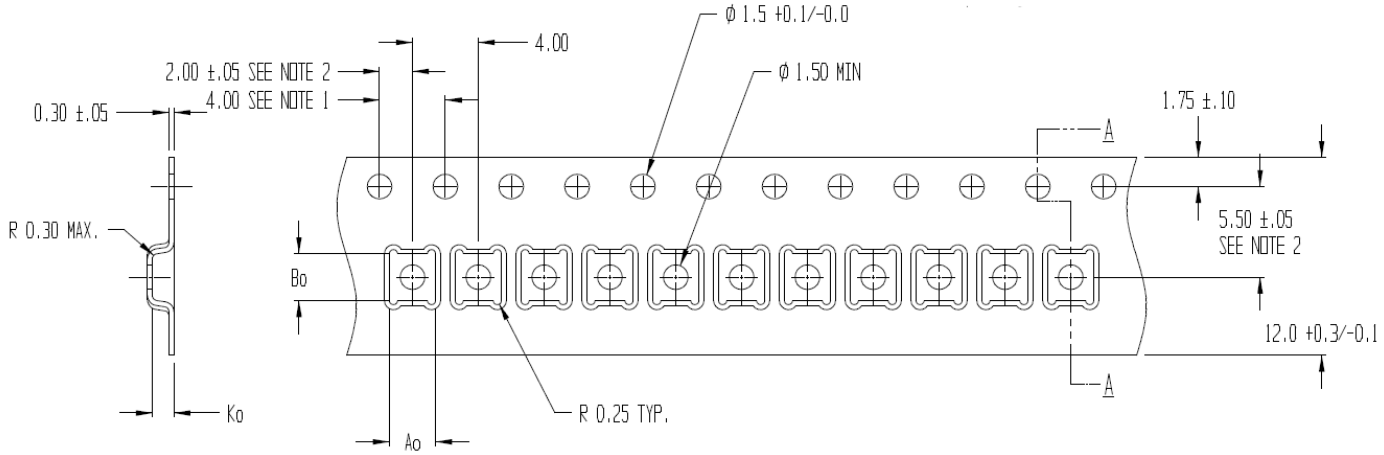


Figure 7 Tape and Reel Drawing

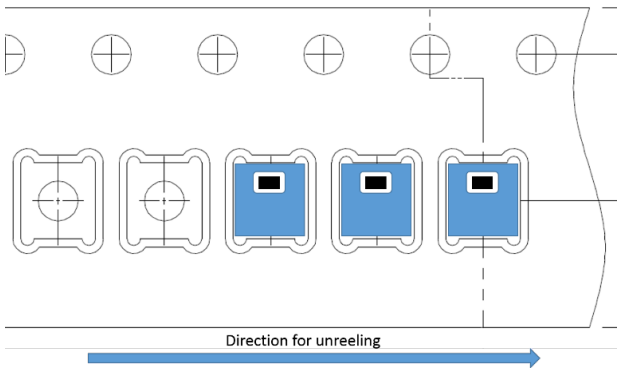


Figure 8 Product Orientation in Tape and Reel Packaging

Recommended Footprint for PCBa Assembly

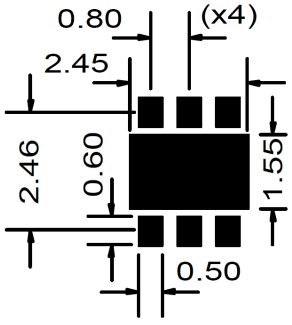


Figure 9 Recommended footprint (All dimensions are in mm)

Handling & Storage Recommendations

To guaranty and preserve the high-quality performance of the HTU31 sensor, the following recommendations shall be respected concerning storage and packaging:

Prior sensors use or assembly, it is recommended to store them in their original sealed anti ESD packaging. If sensors have been removed from their original packaging, it is recommended to keep them in anti-static shielded ESD bags.

HTU31 sensor shall not be in contact with volatile chemicals such as solvents or other organic compounds that could induce a sensing element pollution or damage.

HTU31 sensor is classified MSL level 1 according to IPC/JEDEC J-STD-020.1 for storage, packaging and handling.

The typical shelf life is 1 year at temperature below 30°C and relative humidity below 85%RH.

HTU31 sensor shall be protected from ESD (Electrostatic Discharge) and shall be handled in ESD protected areas (EPA) under protected and standard controlled conditions (ground with wrist-straps, ground all non-insulating and conductive objects, operate only in grounded conductive floor.

Figure 10 Protection against ESD mandatory

Soldering and Assembly Instructions

HTU31 sensor is designed to withstand soldering profile according to IPC/JEDEC J-STD-020 with peak temperatures at 260°C during up to 30sec for Pb-free assembly in reflow ovens.

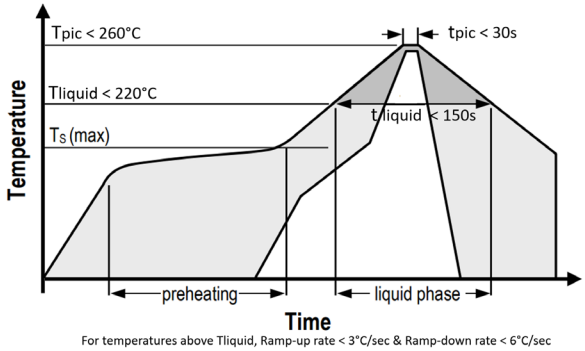


Figure 11 Reflow Soldering profile according to JEDEC standard

Standard pick & place equipment and vacuum nozzles for standard DFN packages may be used for assembly of HTU31 sensors.

For manual soldering contact time must be limited to 5 seconds at 350°C.

The use of “no clean” solder paste is recommended to avoid pollution or damage of RH sensing element.

In case of applications with exposure of the sensor to corrosive gases or condensed water (i.e. environments with high relative humidity) the soldering pads shall be sealed (e.g. conformal coating) to prevent loose contacts or short cuts.

No board wash shall be applied to HTU31 sensors without appropriate sensor upper surface adhesive tape protection.

No coating shall be applied to HTU31 sensors without appropriate sensor upper surface adhesive tape protection.

Immediately after soldering high thermal stress, HTU31 sensors may temporarily read a normal slight RH negative deviation (< 1%RH) corresponding to sensing element extreme drying. This slight normal deviation will disappear after one or two days.

ORDERING INFORMATION

Output Signal

D	I²C Digital
V	Ratiometric Voltage

Part Number

HTU31x

Description	Quantity	Part number
HTU31D RH/T IC DIGITAL R400 (New ESD 4kV)	400	10142048-20
HTU31D RH/T IC DIGITAL R1500 (New ESD 4kV)	1500	10142048-21
HTU31D RH/T IC DIGITAL R5000 (New ESD 4kV)	5000	10142048-22
HTU31D RH/T IC DIGITAL R400 (ESD 2kV)	400	10142048-00
HTU31D RH/T IC DIGITAL R1500 (ESD 2kV)	1500	10142048-01
HTU31D RH/T IC DIGITAL R5000 (ESD 2kV)	5000	10142048-02
HTU31V RH/T IC ANALOG R400 (New ESD 4kV)	400	10142048-30
HTU31V RH/T IC ANALOG R1500 (New ESD 4kV)	1500	10142048-31
HTU31V RH/T IC ANALOG R5000 (New ESD 4kV)	5000	10142048-32
HTU31V RH/T IC ANALOG R400 (ESD 2kV)	400	10142048-10
HTU31V RH/T IC ANALOG R1500 (ESD 2kV)	1500	10142048-11
HTU31V RH/T IC ANALOG R5000 (ESD 2kV)	5000	10142048-12
Demonstration Board HTU31D	1	10142605-10
Demonstration Board HTU31V	1	10142605-02

REVISION HISTORY

DATE	VERSION	PAGE(S)	CHANGES
January 2021	3	2 / 4 / 6 / 7 / 13	Update of Humidity Response Time, Long-Term Drift, and ESD. / Interfaces / Voltage Outputs / Part number updates