H(T)U(F)3500 SERIES

Analog Relative Humidity module with Temperature output

SPECIFICATIONS

- **Compact plug and play module with no external component required**
- **Can operate under 5VDC or 3VDC**
- **Relative Humidity and Temperature Analog Output**
- **Full interchangeability. No calibration required**
- **Can operate under 5VDC or 3VDC**
- **Low power consumption**
- **Fast response time**

Based on the new humidity sensor HTU21P, HTU3500 Series are dedicated humidity and temperature plug and play transducer designed for OEM applications where reliable and accurate measurements are needed. Direct interface with a micro-controller is made possible with the modules humidity linear voltage and direct NTC outputs. The HTU3500 Series are designed for high volume and demanding applications where power consumption is critical.

Optional PTFE filter/membrane (F) protects HTU3500 Series modules analog humidity modules with temperature output against dust, water immersion as well as against contamination by particles. PTFE filter/membrane preserves a high response time. Several connectors are proposed. 5VDC or 3VDC power supply products are available.

HU3500 – analog Humidity sensor only – can be proposed

FEATURES

- Full interchangeability with no calibration required in standard conditions
- Instantaneous desaturation after long periods in saturation phase
- Analog output
- Demonstrated reliability and long term stability
- Reliability not affected by repeated condensation
- HU3500 – analog humidity sensor only – can be proposed

APPLICATIONS

- Home appliance
- Medical
- Printers
- Humidifier

NOMENCLATURE

H(T)U(F)3X3Yzzz

Connector Type:

zzz = PVBM (Samtec connector)

= WxxGyy (wiring) with xx: cable length in mm

yy: from 24 to 30 (AWG)

Voltage supply :

Y = 3: Vcc=3VDC

= 5: Vcc=5VDC

Output Sensor:

X = 5 for Analog (voltage output for RH, resistor for Temp)

= 8 for Digital, I2C protocol

*With optional embedded PTFE filter: HTU**F**3X3Yyyy*

*With optional temperature measurement : H**T**UF3X3Yyyy*

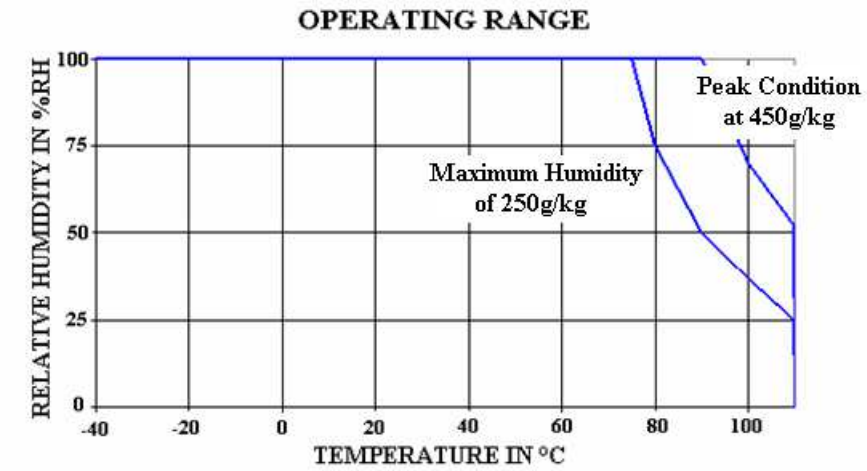
PERFORMANCE SPECS

MAXIMUM RATINGS

Ratings		Symbol	Value	Unit
Storage Temperature		T_{stg}	-40 to 125	°C
Supply Voltage (Peak)	HTU3533 products	V_{cc}	16V	V_{dc}
	HTU3535 products	Vcc	16V	V_{dc}
Humidity Operating Range		RH	0 to 100	%RH
Temperature Operating Range		T_a	-40 to +85	°C
VDD to GND	HTU3533 products		-0.3 to 3.6V	V
	HTU3535 products		-16 to 16V	V
Input current on any pin			-10 to +10	mA

Peak conditions: less than 10% of the operating time

Exposure to absolute maximum rating conditions for extended periods may affect the sensor reliability.



ELECTRICAL AND GENERAL ITEMS

- **HTU35Y3**

Characteristics	Symbol	Min	Typ	Max	Unit
Voltage Supply (1) (2)	V_{cc}	2.85	3.0	3.15	V_{dc}
Nominal Output @55%RH	V_{out}		1.490		V
Humidity Average Sensitivity	ΔmV/RH	-	+16	-	mV/%RH
Current consumption	I_{cc}	-	1.0	1.2	mA dc

(1) Module is ratiometric to voltage supply
(2) Maximum power supply ramp up time to VCC should be less than 20ms

HTU35Y5

Characteristics	Symbol	Min	Typ	Max	Unit
Voltage Supply (1) (2)	V_{cc}	4.75	5	5.25	V_{dc}
Nominal Output @55%RH	V_{out}	2.401	2.480	2.559	V
Humidity Average Sensitivity	ΔmV/RH	-	+26	-	mV/%RH
Current consumption	I_{cc}	-	1.2	1.5	mA dc

(1) Module is ratiometric to voltage supply

Maximum power supply ramp up time to VCC should be less than 20ms

SENSOR PERFORMANCE

ELECTRICAL CHARACTERISTICS

(@T=23°C, R_L>1MΩ unless otherwise noted)

Humidity Characteristics	Symbol	Min	Typ	Max	Unit
Humidity Measuring Range	RH	0		100	%RH
Relative Humidity Accuracy (20% to 80%RH)			±2	See graph	%RH
Temperature coefficient (10°C to 50°C)	T_{cc}			-0.15	%RH/°C
Recovery time after 150 hours of condensation	t		10		s
Humidity hysteresis			+/-1		%RH
Output impedance	Z			50	Ω
Sink current capability (R_{L_Min} = 8 kOhms) (1)	I			1	mA
Warm up time (90% of signal)	t_w		150		ms
Time Constant (at 63% of signal) 33%RH to 75%RH (2)	τ		5	10	s

(1) Conditions of sink current: Vout + 0.054V (3%RH) at Vout = 0.600 V (Vout min)
(2) At 1m/s air flow

Temperature Characteristics*	Symbol	Min	Typ	Max	Unit
Nominal resistance @ 25°C	R	9.9	10	10.1	kΩ
Beta value : B25/50	B	3346	3380	3414	K
Temperature measuring range	T_a	-40		+80	°C
Nominal Resistance Tolerance at 25°C	R_n		1		%
B value tolerance	B		1		%
Time Constant	τ		10		s

** Except for low temperatures*

POWER SUPPLY OPTION OF HTU3500 SERIES AT $3V_{DC}$ OR AT $5V_{DC}$

At $3V_{DC}$ or at $5V_{DC}$ power supply, there is no measurable impact of type of powering on temperature and RH accuracy.

HUMIDITY LOOK-UP TABLES

HTU3535 Modeled Voltage Output

Reference Output Values (Vcc = 5V)

0	Vout (mV)	RH (%)	Vout (mV)
10	1235	**55**	2480
15	1390	**60**	2605
20	1540	**65**	2730
25	1685	**70**	2860
30	1825	**75**	2990
35	1960	**80**	3125
40	2090	**85**	3260
45	2220	**90**	3400
50	2350	**95**	3530

POLYNOMIAL EQUATIONS

$V_{out} = 8.43E^{-4}\ RH^3 - 0.1485\ RH^2 + 34.16\ RH + 909$

$RH = -1.564E^{-9}V_{out}^3 + 1.205E^{-5}V_{out}^2 + 8.22E^{-3}V_{out} - 15.6$

with V_{out} in mV and RH in %

LINEAR EQUATIONS

$V_{out} = 26.23\ RH + 1032$

$RH = 0.03812\ V_{out} - 39.36$

with V_{out} in mV and RH in %

HTU3533 Modeled Voltage Output

Reference Output Values (Vcc = 3V)

RH (%)	Vout (mV)	RH (%)	Vout (mV)
10	740	**55**	1490
15	835	**60**	1565
20	925	**65**	1640
25	1010	**70**	1715
30	1095	**75**	1795
35	1175	**80**	1875
40	1255	**85**	1955
45	1330	**90**	2040
50	1410	**95**	2120

POLYNOMIAL EQUATIONS

$V_{out} = 5.05E^{-4}\ RH^3 - 8.91\ E^{-2}\ RH^2 + 2.05\ E^{1}\ RH + 5.45\ E^{2}$

$RH = -7{,}23\ E^{-9}V_{out}^3 + 3{,}34\ E^{-5}V_{out}^2 + 1{,}37\ E^{-2}V_{out} - 15.6$

with V_{out} in mV and RH in %

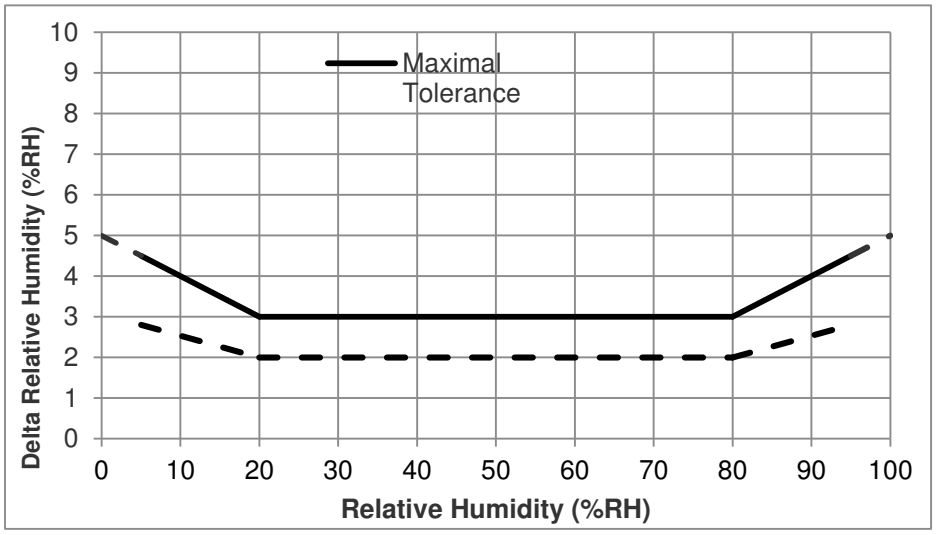
LINEAR EQUATIONS

$V_{out} = 15.94\ RH + 606$

$RH = 0{,}0627\ V_{out} - 37{,}969$

with V_{out} in mV and RH in %

RELATIVE HUMIDITY ERROR BUDGET CONDITIONS AT 25°C



TEMPERATURE COEFFICIENT COMPENSATION EQUATION

For other temperatures than 25°C, the following temperature coefficient compensation equation can be used and will guarantee Relative Humidity accuracy given in table1, from 0°C to 80°C:

$$RH_{compensatedT} = RH_{actualT} + f(T)$$

RHactualT	Ambient humidity in %RH, computed from HTU21D(F) sensor
Tactual	Humidity cell temperature in °C, computed from HTU21D(F) sensor
$f(T)$	RH correction (in %RH) is a linear function of the temperature T (°C) as described below: $f(T) = -0.15 * (25 - T)$

TEMPERATURE

Temperature Characteristics	Symbol	Min	Typ	Max	Unit
Nominal resistance @ 25°C	R	9.9	10	10.1	kΩ
Beta value : B25/50	B	3346	3380	3414	K
Temperature measuring range	T_a	-40		110	°C
Nominal Resistance Tolerance at 25°C	R_n		1		%
B value tolerance	B		1		%
Time Constant	τ		10		s

TYPICAL TEMPERATURE OUTPUT

Depending on the needed temperature measurement range and associated accuracy, we suggest two methods to access to the NTC resistance values.

$$R_T = R_N \times e^{\beta\left(\frac{1}{T} - \frac{1}{T_N}\right)}$$

R_T	NTC resistance in Ω at temperature T in K
R_N	NTC resistance in Ω at rated temperature T in K
T, T_N	Temperature in K
β	Beta value, material specific constant of NTC
e	Base of natural logarithm (e=2.71828)

① The exponential relation only roughly describes the actual characteristic of an NTC thermistor can, however, as the material parameter β in reality also depend on temperature. So this approach is suitable for describing a restricted range around the rated temperature or resistance with sufficient accuracy.

② For practical applications, a more precise description of the real R/T curve may be required. Either more complicated approaches (e.g. the Steinhart-Hart equation) are used or the resistance/temperature relation as given in tabulation form. The below table has been experimentally determined with utmost accuracy for temperature increments of 1 degree.

Actual values may also be influenced by inherent self-heating properties of NTCs. Please refer to MEAS-France Application Note HPC106 “Low power NTC measurement

TEMPERATURE LOOK-UP TABLE

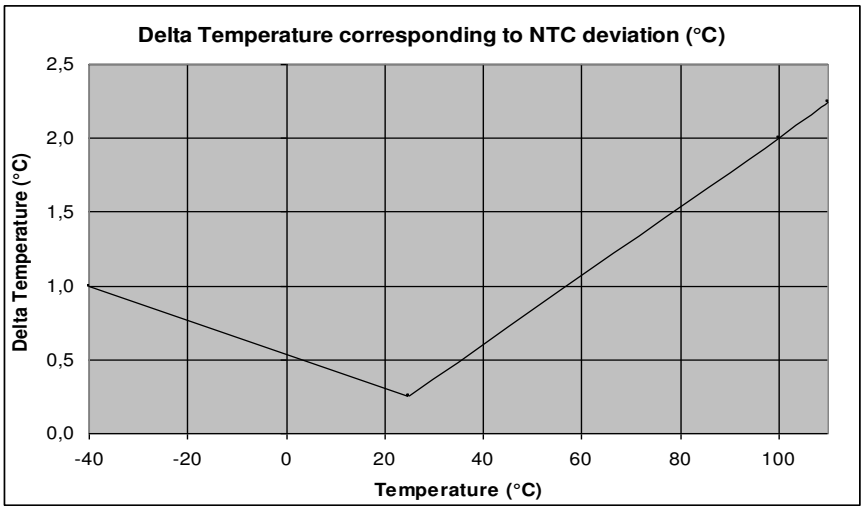
Temp (°C)	R (Ω)
-40	195652
-39	184917
-38	174845
-37	165391
-36	156513
-35	148171
-34	140330
-33	132958
-32	126022
-31	119494
-30	113347
-29	107565
-28	102116
-27	96978
-26	92132
-25	87559
-24	83242
-23	79166
-22	75316
-21	71677
-20	68237
-19	64991
-18	61919
-17	59011
-16	56258
-15	53650
-14	51178
-13	48835
-12	46613
-11	44506
-10	42506
-9	40600
-8	38791
-7	37073
-6	35442
-5	33892
-4	32420
-3	31020
-2	29689
-1	28423

Temp (°C)	R (Ω)
0	27219
1	26076
2	24988
3	23951
4	22963
5	22021
6	21123
7	20267
8	19450
9	18670
10	17926
11	17214
12	16534
13	15886
14	15266
15	14674
16	14108
17	13566
18	13049
19	12554
20	12081
21	11628
22	11195
23	10780
24	10382
25	10000
26	9634
27	9284
28	8947
29	8624
30	8315
31	8018
32	7734
33	7461
34	7199
35	6948
36	6707
37	6475
38	6253
39	6039

Temp (°C)	R (Ω)
40	5834
41	5636
42	5445
43	5262
44	5086
45	4917
46	4754
47	4597
48	4446
49	4301
50	4161
51	4026
52	3896
53	3771
54	3651
55	3535
56	3423
57	3315
58	3211
59	3111
60	3014
61	2922
62	2834
63	2748
64	2666
65	2586
66	2509
67	2435
68	2364
69	2294
70	2228
71	2163
72	2100
73	2040
74	1981
75	1925
76	1870
77	1817
78	1766
79	1716

Temp (°C)	R (Ω)
80	1669
81	1622
82	1578
83	1535
84	1493
85	1452
86	1413
87	1375
88	1338
89	1303
90	1268
91	1234
92	1202
93	1170
94	1139
95	1110
96	1081
97	1053
98	1026
99	999
100	974
101	949
102	925
103	902
104	880
105	858
106	837
107	816
108	796
109	777
110	758

TEMPERATURE ERROR BUDGET



0.1°C tolerance on Resistance Measurement

STEINHART-HART COEFFICIENTS

According to the equation below, the Steinhart-Hart coefficients for the operating temperature range for HTU3500 products thermistor are:

$$\frac{1}{T} = a + b * \ln(R) + C * \ln(R) * \ln(R) * \ln(R)$$

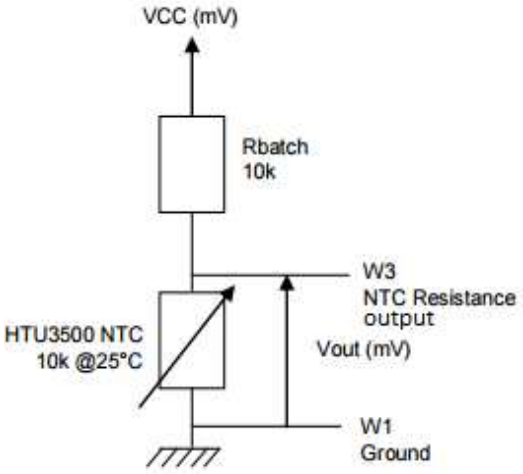
R	NTC resistance in Ω at temperature T in K
T	Temperature in K
a	Constant value (a= 8.61393E-04)
b	Constant value (b= 2.56377E-04)
c	Constant value (c= 1.68055E-07)

TEMPERATURE INTERFACE CIRCUIT

Concerning the temperature sensor of the HTU3500 Series products, the following measuring method described below is based on a voltage bridge divider circuit. It uses only one resistor component (Rbatch) at 1% to design HTU3500 temperature sensor interfacing circuit.

Rbatch is chosen to be equal to NTC @25°C to get: Vout = Vcc/2 @25°C.

The proposal method connects Rbatch to Vcc and NTC to Ground. It leads to a negative slope characteristic (Pull-Up Configuration).



$$V_{OUT}(mV) = \frac{Vcc(mV) * NTC_{HTU\,3500}(\Omega)}{R_{batch}(\Omega) + NTC_{HTU\,3500}(\Omega)}$$

Temperature (°C)	Resistance (Ω)	For HTU3533 products (VCC=3VDC) Pull-Up Configuration Vout (mV)	For HTU3535 products (VCC=5VDC) Pull-Up Configuration Vout (mV)
-40	195652	2854	4757
-30	113347	2757	4595
-20	68237	2617	4361
-10	42506	2429	4048
0	27219	2194	3657
10	17926	1926	3210
20	12081	1641	2736
25	10000	1500	2500
30	8315	1362	2270
40	5834	1105	1842
50	4161	882	1469
60	3014	695	1158
70	2228	547	911
80	1669	429	665
85	1452	380	634

- **Storage Conditions and Handling Instructions**

It is recommended to store HTU3500 Series sensor in its original packaging at following conditions: Temperature shall be in the range of -40°C – 125°C

APPLICATION: DEW POINT TEMPERATURE MEASUREMENT

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.

Dew point temperature of the air is calculated using Ambient Relative Humidity and Temperature measurements from HTU3500 Series sensor with following formulas given below

Partial Pressure (PP_{Tamb}) formula from Ambient Temperature:

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

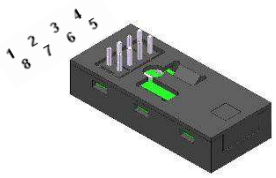
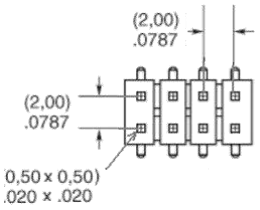
Dew point Temperature (T_d) formula from Partial Pressure (PP_{Tamb}):

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

PP_{Tamb}	Partial Pressure in mmHg at ambient temperature (T_{amb})
RH_{amb}	Ambient humidity in %RH, computed from HTU3500 Series sensor
T_{amb}	Humidity cell temperature in °C, computed from HTU3500 Series sensor
T_d	Calculated Dew Point in °C
A, B, C	Constants: A=8.1332; B=1762.39; C=235.66

CONNECTING AND MECHANICAL CHARACTERISTICS

CONNECTING CHARACTERISTICS

Connector Type*	Symbol	Overview	Connector Pitch	Mating Connector
Medium Male Connector (1) (2) (1.91 mm – 0.075 in long)	**PVBM**			Direct Soldering (through hole)

** For alternate connector type, please contact factory.*

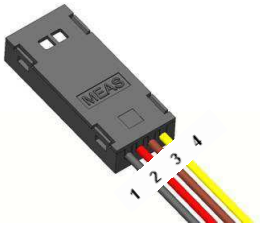
(1) For board-to-board mounting, we suggest wave soldering.

(2) Pins are connected by twos.

Pin Out Assignment

N°	Function
1/8	Ground
2/7	Vcc – Voltage Supply
3/6	Tout – Temperature
4/5	RHout – Relative Humidity

WIRING CHARACTERISTICS

Connector Type	Symbol	Overview	More information*	Remote Mating Connector*
N/A	**WxxGyy**		Wxx: Wiring cable length* in mm Gyy: Wiring cable type* (from AWG 24 to 30):	N/A

** On request, please contact factory.*

Pin Out Assignment (with wires)

N°	Colour	Function
1	Black	Ground
2	Red	Vcc – Voltage Supply
3	Brown	Tout – Temperature
4	Yellow	RHout – Relative Humidity

RESISTANCE TO PHYSICAL AND CHEMICAL STRESSES

HTU3500 series modules have been tested according to table below:

Environment	Standard	Results
Salt atmosphere	JESD22-A107-A	Within specification
Temperature cycling	-20°C / +85°C, 168 hours	Within specification
Thermal shocks	-20°C / +85°C, 500 cycles	Within specification
High temperature / Humidity operating life	93%RH / +60°C, 168 hours	Within specification
Resistance to immersion into water	Ambient temperature	Within specification
Low temperature storage	-20°C, 500 hours	Within specification
High temperature storage	+85°C, 500 hours	Within specification
ESD immunity	JEDEC JESD22-A114 JEDEC JESD22-A115	Within specification* Within specification**

* JEDEC JESD22-A114 method for connections & open window (Human Body Model at ±8kV powered and unpowered)
**JEDEC JESD22-A115 method (Machine Model ±200V)

HTU3500 Series are protected against reverse polarity.

HTU3500 Series are not light sensitive

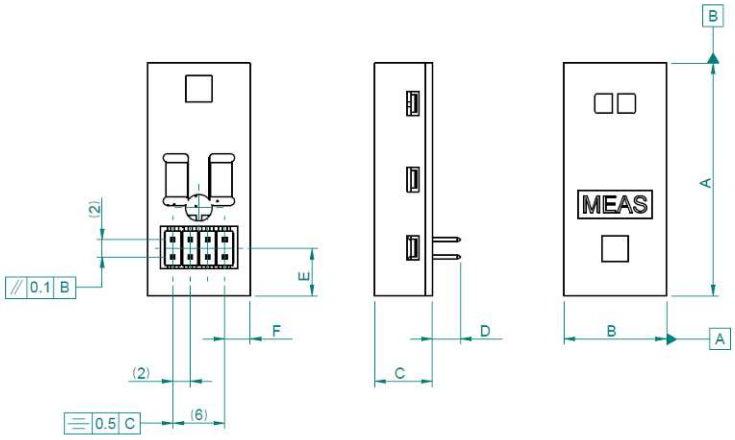
ENVIRONMENTAL AND RECYCLING

HTU3500 series modules are lead free components and are compatible with Pb Free soldering process.

HTU3500 series modules are free from Cr (6+), Cd and Hg.

PACKAGE OUTLINE

MECHANICAL CHARACTERISTICS: HTU3500 SERIES PACKAGE OUTLINE

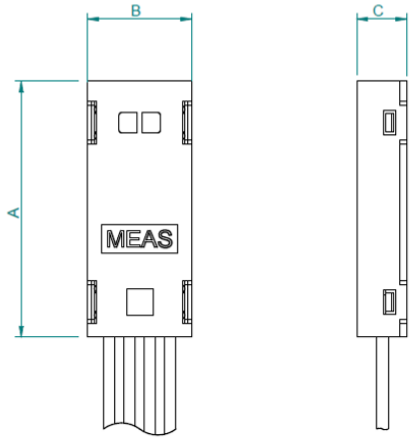


Package Outline with connector
(1.91 mm – 0.075 in long)

Dim	Typ (mm)
A	27 ± 0.5
B	11.9 ± 0.5
C	6.7 ± 0.5
D	3.25 ± 0.5
E	5.54 ± 0.5
F	2.95 ± 0.5

Color: Black

Weight: 1.8g



Package Outline with wiring

Dim	Typ (mm)
A	29 ± 0.5
B	11.9 ± 0.5
C	5.7 ± 0.7

Color: Black

Weight: 1.8g

Double coated adhesive tape could be used on plastic housing area (ref: 3M – 5925F) to fix parts