Web Site: www.parallax.com
Forums: forums.parallax.com
Sales: sales@parallax.com
Technical: support@parallax.com

Office: (916) 624-8333
Fax: (916) 624-8003
Sales: (888) 512-1024
Tech Support: (888) 997-8267

HS1101 Relative Humidity Sensor (#27920)

The HS1101 humidity sensor is a cost-effective solution for measuring relative humidity within ±5% accuracy. The sensor's design is based on a unique capacitive cell; therefore, by using simple RC circuit wiring it is easy to interface with any Parallax microcontroller, including the BASIC Stamp® and Propeller chip.

Features

- Simple calibration required when operating in standard conditions
- Fast response time
- Simple, RCTIME output corresponds to relative humidity when directly connected to BASIC Stamp
- Compatible with automatized assembly processes, including wave soldering, reflow and water immersion

Key Specifications

- Power requirements: 5 to 10 VDC
- Communication: Analog output of varying capacitance in response to change in relative humidity
- Humidity Measuring Range: 1 to 99% RH
- Operating temperature: -40 to 212 °F (-40 to 100 °C)

Application Ideas

- Home and office automation
- Humidity component for weather station applications
- Industrial process control systems

Specifications

Symbol	Quantity	Minimum	Typical	Maximum	Units
Vs	Supply Voltage †		5.0	10	V
RH	Measuring Range †	1		99	%
Ta	Operating Temperature †	-40		100	°C
Tcc	Temperature Coefficient		0.23		T_{Decay}/°C
ta	Response time (33 – 76 % RH) †		5		S

† Information obtained from the Humirel HS1101 Manufacturer Datasheet Rev 7.

Connecting and Testing

Connecting the HS1101 to a microcontroller is demonstrated here with a BASIC Stamp module. It is a straightforward application, requiring only one I/O pin. Since the HS 1101 is based on a unique capacitive cell, relative humidity can be obtained using a simple RC wiring diagram, as shown in Figure 1.

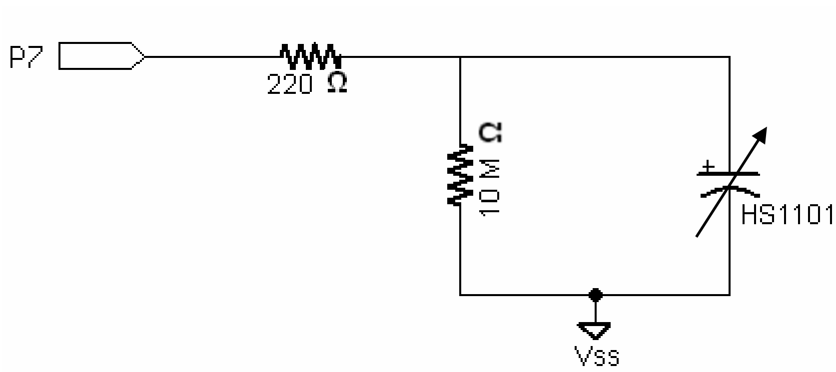


Figure 1: Sample RC Application Circuit

BASIC Stamp 2 Series Example

Below are the steps required to obtain relative humidity readings from the HS1101:

√ Build the circuit shown in Figure 1. Be sure the negative side of the sensor is connected to ground as shown in Figure 2!

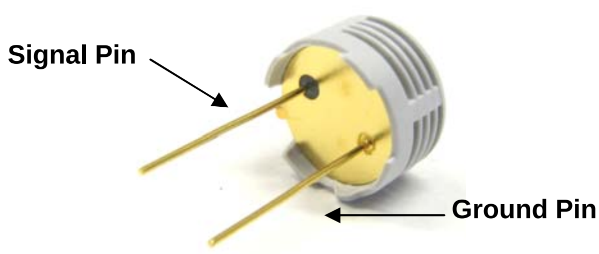


Figure 2: Signal and Ground Pins

√ Enter and run the test program RelativeHumidityReading.bs2 included in the source code section on page 4. All of the source code is also available from the Downloads section of the HS1101 Relative Humidity Sensor product page at www.parallax.com.

√ You should obtain results similar to those shown in Figure 3.

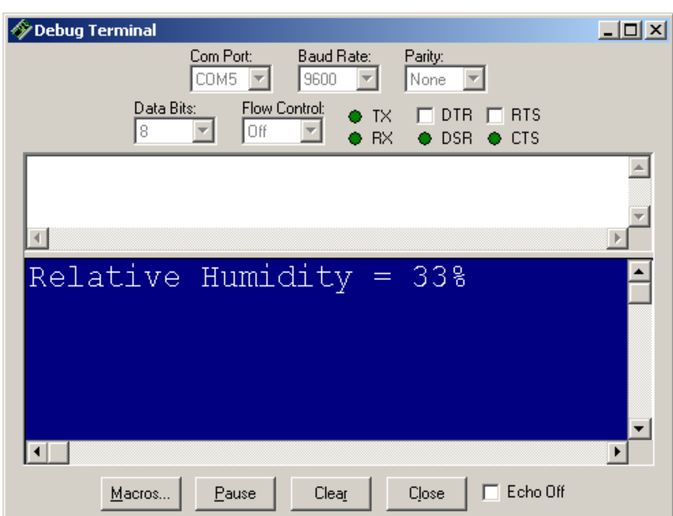


Figure 3: Typical Debug Output

Device Information

Linear approximation was used to obtain relative humidity readings for this application. Therefore, the results can have up to a ±5% RH error. In addition, when operating in temperatures 25° higher or lower than room temperature, the RH error can increase by ±2%. If more precise results are desired, additional calibration is required.

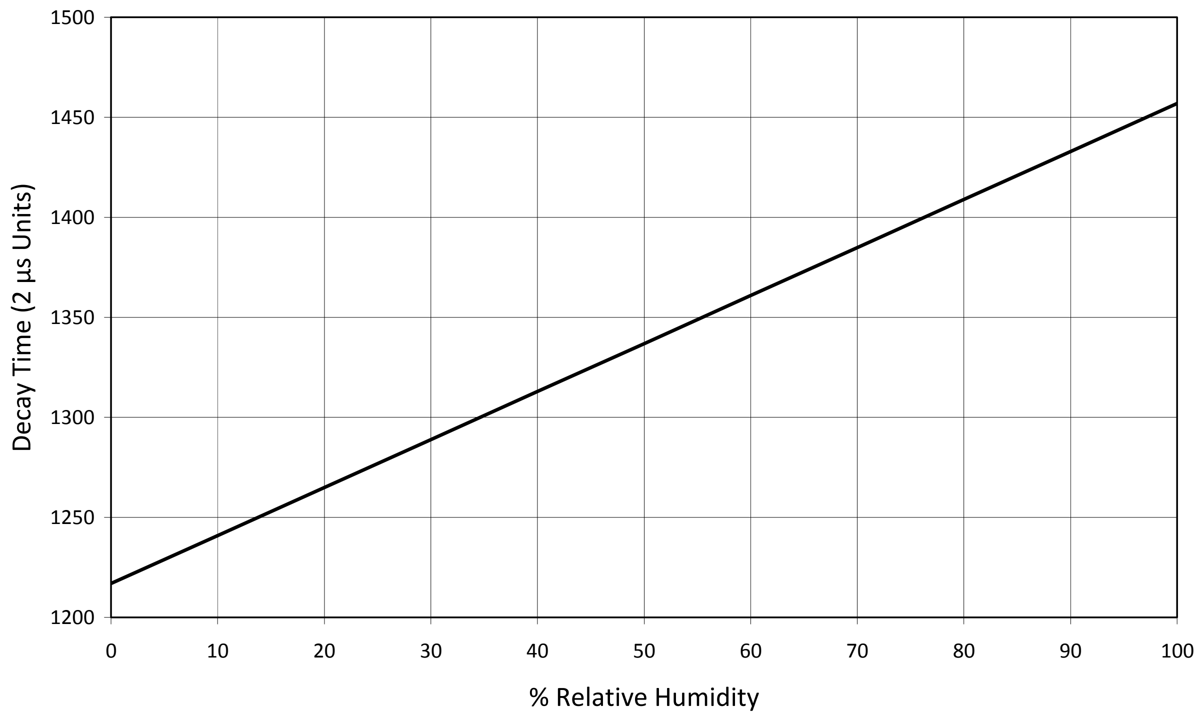
The linear approximation constant used to determine relative humidity can vary if operating in different environments. For more precise measurements, use a known humidity meter and adjust the RHconstant value in RelativeHumidityReading.bs2 until the Debug Terminal output matches the known humidity reading.

Since the HS1101 relative humidity sensor is based on a capacitive cell, relative humidity can be related to the decay time of the sensor. Using several measurements taken in a humidity controlled environment, a simple line equation can be calculated using linear approximation to define the relationship between the decay time of the sensor and the percent of relative humidity:

$$T_{Decay} = 2.4 \bullet \%RH + RHconstant$$

Using this equation, a typical response curve can be derived when applying this equation to different percents of relative humidity.

Typical Response Curve for RCTIME Application



Example Source Code

While this sensor is compatible with all Parallax microcontrollers, the included source code is solely for BASIC Stamp® 2 microcontroller. When working with other BASIC Stamp models, a scale factor will have to be applied to your code to account for different clock speeds. (For more information see the RCTIME command in the BASIC Stamp Syntax and Reference Manual.)

Additional calculations and coding techniques will be required when interfacing with any other Parallax microcontroller, since RCTIME is specific to the PBASIC programming language for BASIC Stamp microcontroller modules.

Additional Spin programs have been developed to measure decay time and capacitance with the Propeller chip. Use these programs in conjunction with performing additional control tests to develop Propeller applications. Go to *forums.parallax.com* -> *Propeller Chip* -> *Propeller Education Kit Labs* for more information.

BASIC Stamp® 2 Program

```
' {$STAMP BS2}
' {$PBASIC 2.5}
' RelativeHumidityReading.bs2
' Displays relative humidity in the Debug Terminal or the Parallax Serial LCD.

LCD             PIN     0               ' Serial output to LCD

time            VAR     Word
humidity        VAR     Word

LcdBaud         CON     84              ' Baud rate of LCD
RHconstant      CON     12169           ' Relative Humidity Constant * 10

LcdCls          CON     $0C             ' Clear LCD (use PAUSE 5 after)
LcdCR           CON     $0D             ' Move pos 0 of next line
LcdBLon         CON     $11             ' Backlight on
LcdBLoff        CON     $12             ' Backlight off
LcdOff          CON     $15             ' LCD off
LcdOn1          CON     $16             ' LCD on; cursor off, blink off
LcdLine1        CON     $80             ' Move to line 0, position 0
LcdLine2        CON     $9A             ' Move to line 1, position 5

HIGH Lcd                                ' Setup serial output pin
PAUSE 100

SEROUT Lcd, LcdBaud, [LcdOn1]           ' Initialize LCD
PAUSE 250
SEROUT Lcd, LcdBaud, [LcdBLon]          ' Turn Backlight on
PAUSE 5
SEROUT Lcd, LcdBaud, [LcdCls]           ' Clear LCD
PAUSE 5

DO
  HIGH 7
  PAUSE 1
  RCTIME 7, 1, time
  time = time * 10
  humidity = (time – RHconstant) / 24

  ' Debug Display:
  DEBUG HOME, "Relative Humidity = ", DEC humidity, "%"

  ' LCD Display:
  SEROUT Lcd, LcdBaud, [LcdLine1, "RelativeHumidity",
                        LcdLine2, DEC humidity, "%" ]
  PAUSE 100
LOOP
```

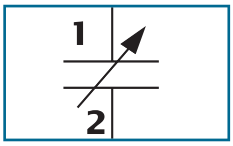

HUMIREL

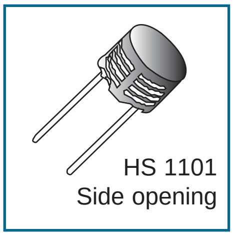
TECHNICAL 1 DATA

RELATIVE HUMIDITY SENSOR

HS 1100 / HS 1101

Based on a unique capacitive cell, these relative humidity sensors are designed for high volume, cost sensitive applications such as ***office automation, automotive cabin air control, home appliances, and industrial process control systems****. They are also useful in all applications where humidity compensation is needed.*





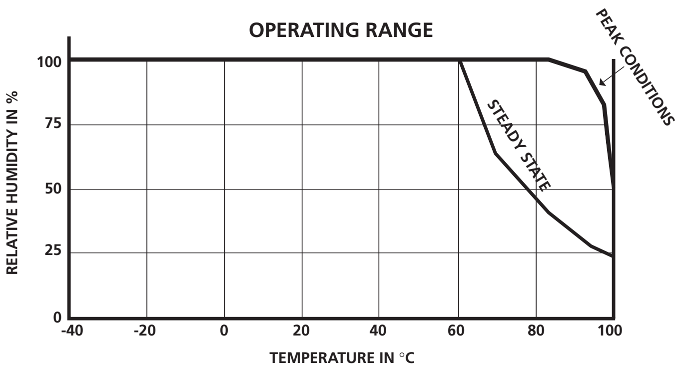
FEATURES

- **Full interchangeability** with no calibration required in standard conditions
- **Instantaneous desaturation** after long periods in saturation phase
- Compatible with automatized assembly processes, **including wave soldering, reflow and water immersion** (1)
- High reliability and long term stability
- Patented solid polymer structure
- Suitable for linear voltage or frequency output circuitry
- Fast response time
- Individual marking for compliance to stringent traceability requirements

(1) soldering temperature profiles available on request

MAXIMUM RATINGS (Ta= 25°C unless otherwise noted)

Ratings	Symbol	Value	Unit
Operating Temperature	Ta	-40 to 100	°C
Storage Temperature	Tstg	-40 to 125	°C
Supply Voltage	Vs	10	Vac
Humidity Operating Range	RH	0 to 100	% RH
Soldering @ T = 260°C	t	10	s



CHARACTERISTICS

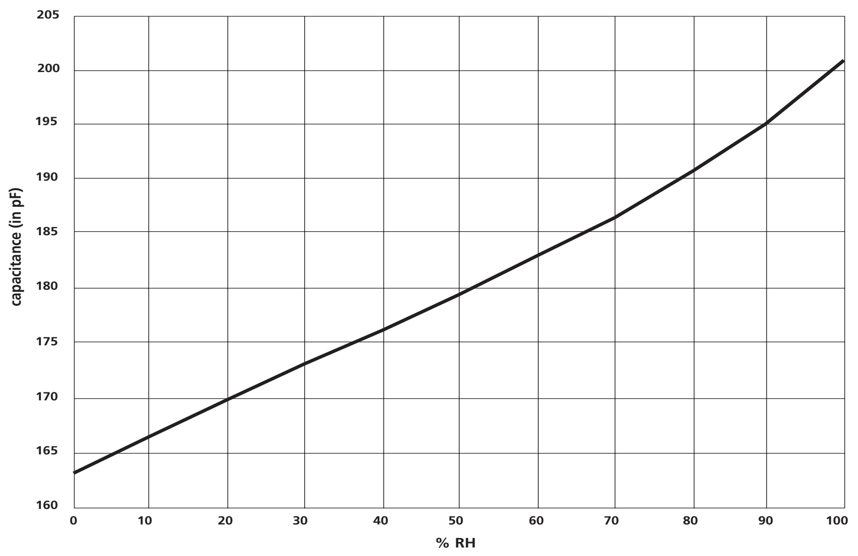
(Ta = 25°C, measurement frequency @ 10kHz unless otherwise noted)

Characteristics	Symbol	Min.	Typ.	Max.	Unit.
Humidity measuring range	RH	1		99	%
Supply voltage	Vs		5	10	V
Nominal capacitance @ 55% RH*	C	177	180	183	pF
Temperature coefficient	Tcc		0.04		pF/°C
Averaged Sensitivity from 33% to 75% RH	ΔC/%RH		0.34		pF/%RH
Leakage current (Vcc = 5 Volts)	Ix		1		nA
Recovery time after 150 hours of condensation	tr		10		s
Humidity Hysteresis			+/-1.5		%
Long term stability			0.5		%RH/yr
Response time (33 to 76 % RH, still air @ 63%)	ta		5		s
Deviation to typical response curve (10% to 90% RH)			+/-2		% RH

** Tighter specification available on request*

CHARACTERISTICS (CONT'D)

Typical response curve of HS 1100/HS 1101 in humidity



Calibration data are traceable to NIST standards through CETIAT laboratory.

Measurement frequency : 10kHz
Ta = 25°C

Polynomial response : $C(pf)=C@55\%*(1.25 10^{-7}RH^{3}-1.36 10^{-5}RH^{2}+2.19 10^{-3}RH+9.0 10^{-1})$

RH in % RH

Measurement frequency influence

In this data sheet, all capacitance measurements are @ 10kHz. However, the sensor can operate without restriction from 5kHz to 100kHz. To calculate the influence of frequency on capacitance measurements :

$$C@fkHz=C@10kHz(1.027-0.01185Ln(fkHz))$$

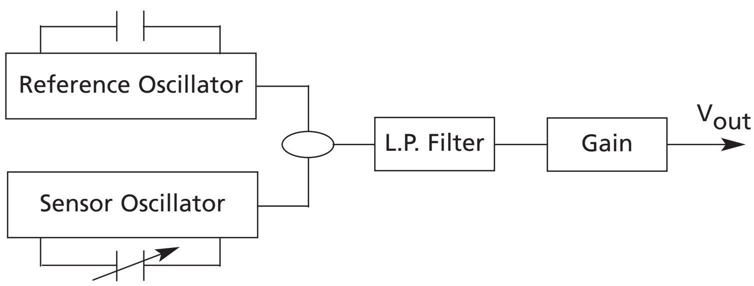
Polarization

In order to get a better reproducibility during measurements, always connect the case of the header (pin 2) to the ground of the circuit.
The case of the header is located on the opposite side of the tab.

Soldering instructions : see the Application Note HPC007

PROPORTIONAL VOLTAGE OUTPUT CIRCUIT

Internal Block Diagram



$$V_{out}=V_{cc}*(0.00474*\%RH+0.2354)$$

for 5 - 99% RH

Typical temperature coefficient :
+0.1% RH/°C - From 10 to 60°C

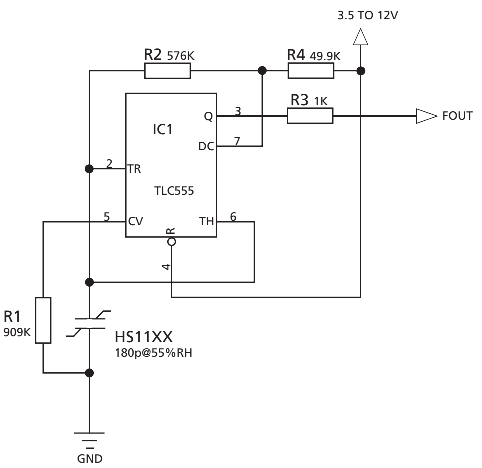
DEMO BOARD AVAILABLE ON REQUEST (REF HM1510)

Typical Characteristics for Voltage Output Circuit

At V_{CC} 5V - 25°C

RH	0	10	20	30	40	50	60	70	80	90	100
Voltage (V)	-	1.41	1.65	1.89	2.12	2.36	2.60	2.83	3.07	3.31	3.55

FREQUENCY OUTPUT CIRCUITS



BILL OF MATERIAL AVAILABLE ON REQUEST

COMMENTS

This circuit is the typical astable design for 555. The HS1100/HS1101, used as variable capacitor, is connected to the TRIG and THRES pin. Pin 7 is used as a short circuit pin for resistor R4.
The HS1100/HS1101 equivalent capacitor is charged through R2 and R4 to the threshold voltage (approximately 0.67Vcc) and discharged through R2 only to the trigger level (approximately 0.33Vcc) since R4 is shorten to ground by pin 7.
Since the charge and discharge of the sensor run through different resistors, R2 and R4, the duty cycle is determined by :

$$t_{high} = C@\%RH*(R2+R4)*ln2$$
$$t_{low} = C@\%RH*R2*ln2$$
$$F = 1/(t_{high}+t_{low}) = 1/(C@\%RH*(R4+2*R2)*ln2)$$
$$\text{Output duty cycle} = t_{high}*F = R2/(R4+2*R2)$$

To provide an output duty cycle close to 50%, R4 should be very low compared to R2 but never under a minimum value.
Resistor R3 is a short circuit protection. 555 must be a CMOS version.

REMARK

R1 unbalances the internal temperature compensation scheme of the 555 in order to introduce a temperature coefficient that matches the HS1100/HS1101 temperature coefficient. In all cases, R1 should be a 1% resistor with a maximum of 100ppm coefficient temperature like all other R-C timer resistors. Since 555 internal temperature compensation changes from one trademark to one other, R1 value should be adapted to the specific chip. To keep the nominal frequency of 6660Hz at 55%RH, R2 also needs slight adjustment as shown in the table.

555 Type	R1	R2
TLC555 (Texas)	909kΩ	576kΩ
TS555 (STM)	100nF capacitor	523kΩ
7555 (Harris)	1732kΩ	549kΩ
LMC555 (National)	1238kΩ	562kΩ

For a frequency of 6660Hz at 55%RH

Typical Characteristics for Frequency Output Circuits

REFERENCE POINT AT 6660Hz FOR 55%RH / 25°C

RH	0	10	20	30	40	50	60	70	80	90	100
Frequency	7351	7224	7100	6976	6853	6728	6600	6468	6330	6186	6033

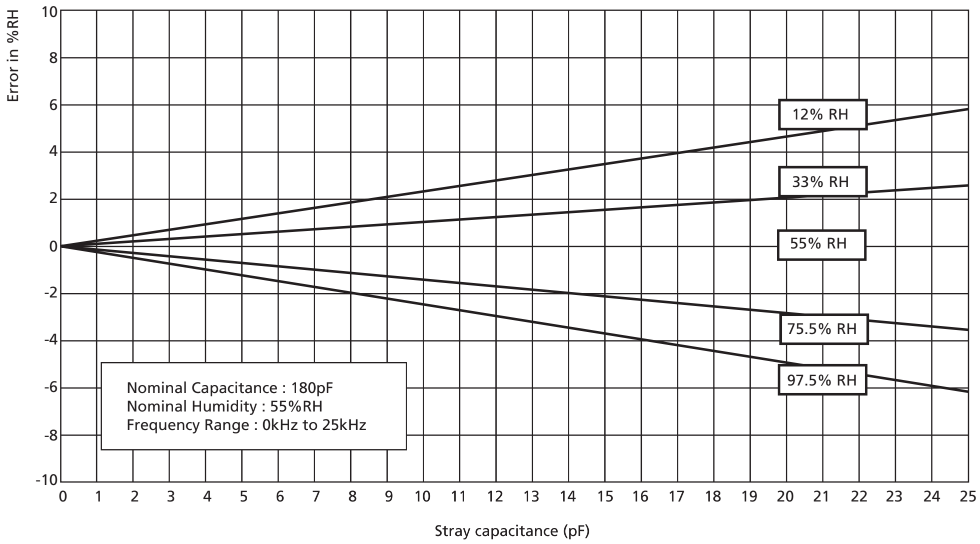
Typical for a 555 Cmos type. TLC555 (RH : Relative Humidity in %, F : Frequency in Hz)

Polynomial response :

$$F_{mes(Hz)} = F55_{(Hz)}(1.1038-1.9368 10^{-3}*RH+3.0114 10^{-6}*RH^2-3.4403 10^{-8}*RH^3)$$

Measurement Error vs Stray Capacitance

A special attention is required in order to minimize stray capacitance in the layout. The added capacitance will act as a parallel capacitance with the sensor and create a measurement error.



● Qualification process

- HS1100/HS1101 sensors have been qualified through a complete qualification process taking in account many of the requirements of the MIL STD750 including :

Solder heat and solderability
Wave soldering at 260°C + DI water clean at 45°C
Mechanical shock - 1500 g, 5 blows, 3 directions
Vibration - Variable (F = 100 - 2000Hz), fixed (F = 35Hz)
Constant acceleration
Marking permanency
ESD - Electrostatic Discharge - Human boby & Machine model
Salt Atmosphere MIL STD750/Method 1041/96 hours
Temperature Cycling - 40°C / +85°C
High Temperature / Humidity Operating Life - 93%RH / 60°C for 1000 hours
Low humidity storage life - RH < 10%/23°C - 1000 hours
Resistance to immersion in water at ambient temperature and 80°C - 160 hours
Resistance to acid vapors at 75000 ppm for nitric, sulfuric and chlorhydric acids
Resistance to many chemicals linked with home appliances/ automotive or consumer applications.

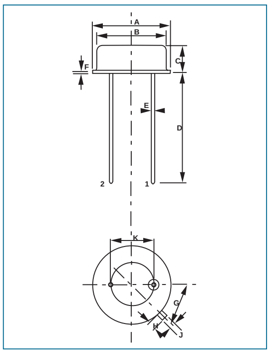
All these tests are regularly performed on different lots from production. ***More information are available on request***

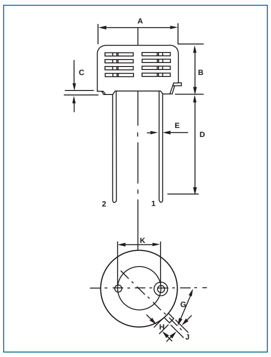
● Environmental and recycling information :

- HS1100/HS1101 sensors are lead free components
- HS1100/HS1101 sensors are free of Cr (VI), Cd and Hg.

PACKAGE OUTLINE HS1100

Dim	Min (mm)	Max (mm)
A	9.00	9.30
B	8.00	8.50
C	3.50	3.90
D	12.00	14.00
E	0.40	0.50
G	45° BCS	
H	0.70	1.10
J	0.70	0.90
K	4.83	5.33





Dim	Min (mm)	Max (mm)
A	9.70	10.20
B	5.70	6.20
C	0.40	0.60
D	12.00	14.00
E	0.40	0.50
G	45° BCS	
H	0.70	1.10
J	0.70	0.90
K	4.83	5.33

PACKAGE OUTLINE HS1101

ORDERING INFORMATION :
HS 1100 : HPP 800 A 001 (MULTIPLE PACKAGE QUANTITY OF 50 PIECES)
HS 1101 : HPP 801 A 001 (MULTIPLE PACKAGE QUANTITY OF 48 PIECES)
CAPACITIVE RELATIVE HUMIDITY SENSOR.

SAMPLE KIT OF HS1100-HS1101 IS AVAILABLE THROUGH HUMIREL WEB SITE

www.humirel.com

email : sales@humirel.com