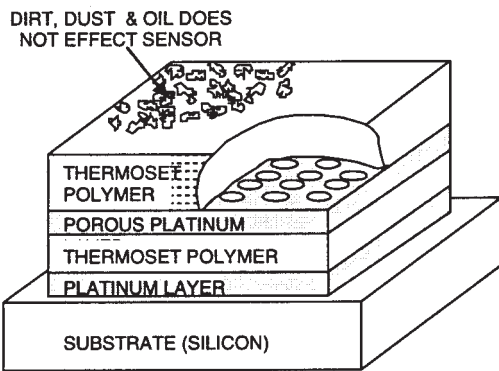


## HUMIDITY SENSOR THEORY AND BEHAVIOR

**SENSOR CONSTRUCTION:** Relative humidity sensors use an industrially proven thermoset polymer, three layer capacitance construction, platinum electrodes and except for high temperature versions (shown bottom), on-chip silicon integrated voltage output signal conditioning. (RHIC Sensor).

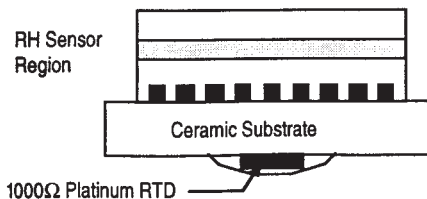
In operation, water vapor in the active capacitor's dielectric layer equilibrates with the surrounding gas. The porous platinum layer shields the dielectric response from external influences while the protective polymer over layer provides mechanical protection for the platinum layer from contaminants such as dirt, dust and oils. A heavy contaminant layer of dirt will slow down the sensor's response time because it will take longer for water vapor to equilibrate in the sensor.



**TEMPERATURE & HUMIDITY EFFECTS:** The output of all absorption based humidity sensors (capacitive, bulk resistive, conductive film, etc.) are affected by both temperature and %RH. Because of this, temperature compensation is used in applications which call for either higher accuracy or wider operating temperature ranges.

When temperature compensating a humidity sensor, it is best to make the temperature measurement as close as possible to the humidity sensor's active area, i.e. within the same moisture micro-environment. This is especially true when combining RH and temperature as a method for measuring dew point.

Industrial grade Humidity and Dew Point instruments incorporate a 1000 ohm Platinum RTD on the back of the ceramic sensor substrate for unmatched temperature compensation measurement integrity. No on-chip signal conditioning is provided in these high temperature sensors.



**VOLTAGE OUTPUT:** The RHIC sensor linear voltage output is a function of  $V_{supply}$ , %RH and temperature. The output is "ratio-metric," i.e. as the supply voltage rises, the output voltage rises in the same proportion. A surface plot of the sensor behavior for temperatures between 0°C and 85°C is shown in the graph below. This surface plot is well approximated by a combination of two equations:

1. A "Best Fit Line at 25°C," or a similar, sensor specific equation at 25°C. The sensor independent "typical" Best Fit Line at 25°C (bold line in graph) is:

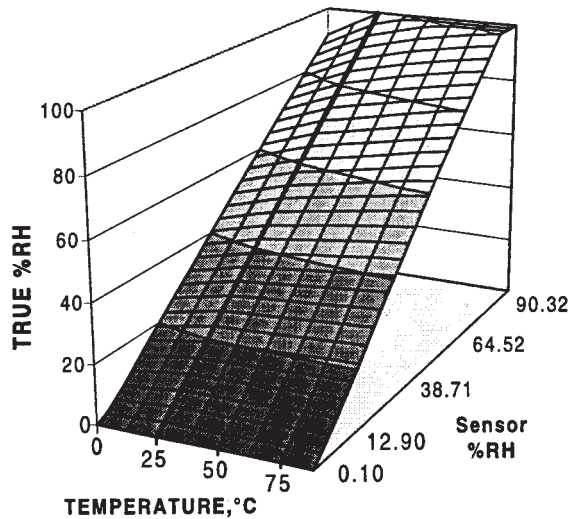
$$V_{out} = V_{supply} (0.0062 (\%RH) + 0.16)$$

A sensor specific equation can be obtained from an RH sensor printout. The printout equation assumes  $V_{supply} = 5VDC$  and is included or available as an option on every sensor.

2. A sensor independent equation which corrects the %RH reading (from the Best Fit Line Equation) for temperature, T:

$$\text{True RH} = (\%RH) / (1.0546 - .00216 T); T = ^\circ C$$

$$\text{Or True RH} = (\%RH) / (1.093 - .0012 T); T = ^\circ F$$



The equations above match the typical surface plot (Best Fit Line at 25°C) or the actual surface plot (sensor specific equation at 25°C) to within the following tolerances:

- ±1% for  $T > 20^\circ C$
- ±2% for  $10^\circ C < T < 20^\circ C$
- ±5% for  $T < 10^\circ C$

Our dewpoint instruments account for the sensor specific version of the surface plot directly via a look up table.

**NOTE:** Convert the observed output voltage to %RH values via the first equation before applying the second equation.

### CONDENSATION AND WETTING

CONDENSATION occurs whenever the surface temperature of the sensor's active area drops below the ambient dew point of the surrounding gas. Condensation forms on the sensor (or any surface) even if the surface temperature only momentarily drops below the ambient dew point. Small temperature fluctuations near the sensor can unknowingly cause condensation to form when operating at humidity levels above 95%.

While quick to condense, water is slow to evaporate in high humidity conditions (i.e. when the surface temperature of the sensor is only slightly above the ambient dew point.) Because of this, a sensor's recovery period from either condensation or wetting is much longer than its normal time response. During recovery, the sensor outputs a constant 100% RH signal regardless of the ambient RH.

When an application calls for continuous monitoring of RH at humidity levels of 90% and above, take steps to avoid intermittent condensation. Some strategies are:

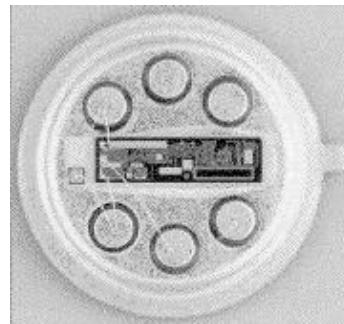
1. Maintain a good air mixing to minimize local temperature fluctuations.
2. The HIH-3602-A and -C use a sintered stainless steel filter to protect the sensor from splashing. A hydrophobic coating further suppresses condensation and wetting in rapidly saturating and de-saturating or splash prone environments.
3. Heat the RH sensor so that the active area is hotter than the local dew point. This can be done through an external heater or by self heating of the CMOS RH chip by operating it at a higher supply voltage.

**NOTE:** Heating an RH sensor above ambient temperature changes its calibration and makes it sensitive to thermal disturbances such as air flow. When contemplating such an approach, MICRO SWITCH recommends selecting an HIH-3602 type sensor and getting application technical support.

### INTEGRATED SIGNAL CONDITIONING

All RH sensors quickly recover from condensation or wetting with no shift in calibration. However, after 24 hour or longer exposures to either high >95% RH or continuous condensation, an upward shift of 2% to 3% RH may occur. This shift is repeatable and can be reversed by placing the sensor in a low 10% RH environment for a 10 hour period.

Silicon integrated humidity sensors (RHIC – relative humidity integrated circuit) incorporate signal conditioning circuitry on-chip with the sensing capacitor. These "RHIC" humidity sensors are laser trimmed so that at  $V_{supply} = 5 V$ , the output voltage typically spans 0.8V to 3.9V for the 0% RH to 100% RH range at 25°C. (Sensor specific calibration data printouts and best fit lines at 25°C are either included or available as an option on every sensor.)



The HIH-3602-C incorporates a RHIC humidity sensor, a 1000Ω platinum RTD and anti-static protection in a single TO-5 can.

RHIC based sensors are factory calibrated, micro-power devices with either individual calibration and/or good unit-to-unit interchangeability. These features help OEM manufacturers avoid in-house humidity calibration costs and extend battery life in portable instruments. Improved accuracy can be obtained by tuning system electronics to account an individual sensors Best Fit Line at 25°C.

