

System Monitor with Instrumentation-Grade Accuracy Used to Measure Relative Humidity

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The LTC2991 is designed to measure supply voltages, currents and temperatures on large circuit boards when used in system monitor applications. It is also capable of delivering $\pm 1^\circ\text{C}$ accuracy when using a 1-cent MMBT3904 transistor as a temperature sensor, making it suitable for many instrumentation applications. Temperature is the most measured physical parameter, with sensor selection a function of accuracy requirements, durability, cost and compatibility with the medium being measured. An inexpensive NPN transistor is an ideal sensor for applications calling for disposable sensors, or those that require a large number of sensors.

A PSYCHROMETER: NOT NEARLY AS OMINOUS AS IT SOUNDS

A psychrometer is a type of hygrometer, a device that measures relative humidity. It uses two thermometers, one dry (dry bulb) and one covered in a fabric saturated with distilled water (wet bulb). Air is passed over both thermometers, either by a fan or by swinging the instrument, as in a “sling psychrometer.” A psychrometric chart is then used to calculate humidity from the dry and wet bulb temperatures. Alternatively, a number of equations exist for this purpose. The following equations are used in testing this circuit.

WET = wet bulb temperature in Celcius
 DRY = dry bulb temperature in Celcius
 p = pressure in kPa

$$A = 6.6 \cdot 10^{-4} \cdot (1 + 1.115 \cdot 10^{-3} \cdot \text{WET})$$

$$\text{ESWB} = e^{\left(\frac{16.78 \cdot \text{WET} - 116.9}{\text{WET} + 273.3} \right)}$$

$$\text{ED} = \text{ESWB} - A \cdot p \cdot (\text{DRY} - \text{WET})$$

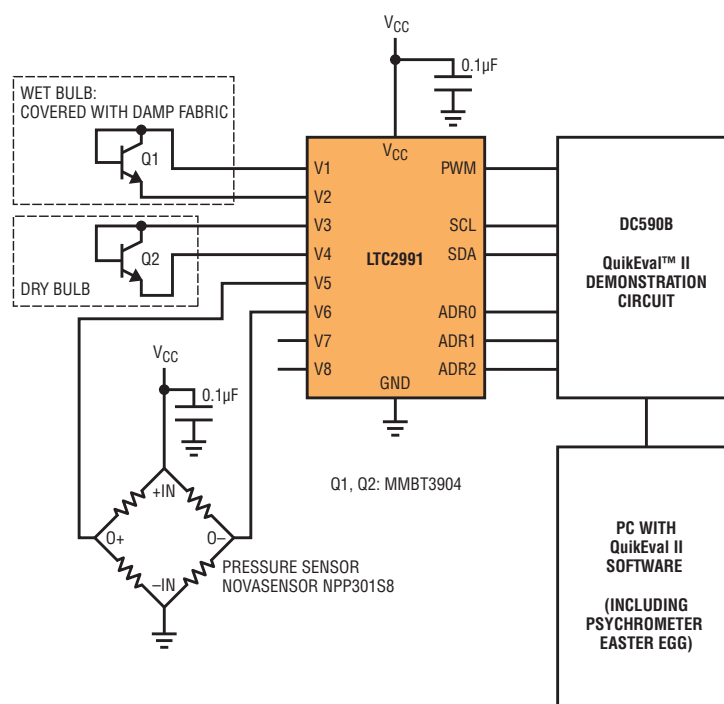
$$\text{EDSB} = e^{\left(\frac{16.78 \cdot \text{DRY} - 116.9}{\text{DRY} + 273.3} \right)}$$

$$\text{HUMIDITY} = \frac{\text{ED}}{\text{EDSB}}$$

Figure 1 shows the LTC2991-based psychrometer. The two transistors provide the wet bulb and dry bulb temperature readings when connected to the appropriate inputs of the LTC2991.

The equations include atmospheric pressure as a variable, which is determined here via a Novasensor NPP301-100

Figure 1. Simple psychrometer using the LTC2991



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barometric pressure sensor measured by channel x configured for a differential input. Full-scale output is 20mV per volt of excitation voltage, at 100kPa barometric pressure (pressure at sea level is approximately 101.325kPa).

The LTC2991 can also measure its own supply voltage (which in our circuit is the same supply rail used to excite the pressure sensor). Thus it is easy to calculate a ratiometric result from the pressure sensor, removing the error contribution of the excitation voltage.

ERROR BUDGET

The LTC2991 remote temperature measurements are guaranteed to be accurate to $\pm 1^\circ\text{C}$. Figure 2 shows the error in indicated humidity that results from a 0.7°C error in the worst-case direction, and the error in indicated humidity that results from a 0.7°C error in the worst-case direction combined with worst-case error from the pressure sensor. This error falls within the range of accuracy of the psychrometric equations themselves. Should higher accuracy be required, a lookup table with the psychrometric charts would need to be implemented.

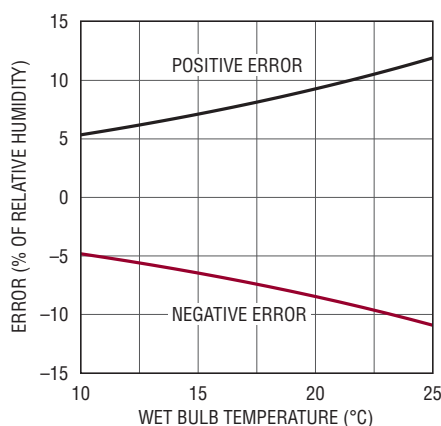


Figure 2. Worst-case error

TRY IT OUT!

A psychrometer readout is implemented as an Easter egg in the LTC2991 (DC1785A) demonstration software, available as part of the Linear Technology QuikEval™ software suite.

The demo board should be connected as shown in Figure 1. To access the readout, simply add a file named “tester.txt” (without the quotes) in the install directory of your DC1785A software. The contents of this file do not matter. On software start-up, the message “Test mode enabled” should be shown in the status bar, and a Humidity option will appear in the Tools menu. Relative humidity readings can then be compared to sensors of similar accuracy grade, such as resistive and capacitive film. ■

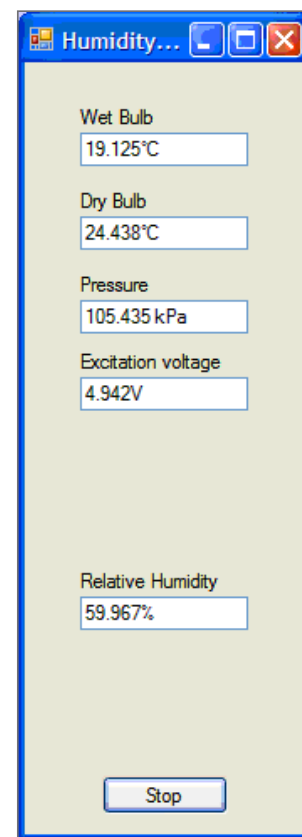


Figure 3. A psychrometer readout is implemented as an Easter egg in the LTC2991 (DC1785A) demonstration software, available as part of Linear's QuikEval software suite.