

ASSEMBLING TEMP. & HUMIDITY SENSORS

*Will fog form tonight?
Keep track of the dew point with
Temperature & Humidity Sensors.*

Have Fun!

When finished you will have a sensitive temperature and relative humidity sensor **that you have built yourself!** Take your time, work carefully, and enjoy the project!

Check (✓) the Parts List

Before you start construction, match parts with the list below. If any parts are missing or if you have any questions you may contact us toll-free at **1.800.683.5487 (503.296.8579)**, email **Ron@FascinatingElectronics.com** or visit our website at **www.FascinatingElectronics.com**.

- (1) Humidity sensor
- (1) LM334Z current output temperature sensor
- (1) 555 timer IC
- (1) RH/Temp mini circuit board
- (2) 1.00 M Ω 1% 1/4W resistors
- (1) 2.26 K Ω 1% 1/4W resistor
- (1) 100 Ω 5% 1/4W resistor
- (2) 0.1 μ F axial capacitors
- (2") Clear heat shrink tube, 1/2" diameter
- (.7") Heat shrink tube, adhesive lined, 3/16" diameter
- (2) #4-1/4" stainless steel machine screws
- (2) #4 stainless steel hex nuts

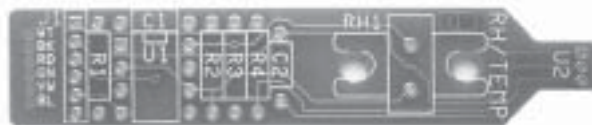
Also available from Fascinating Electronics (not included in WEA-THKIT):

- CAB-TH50: 50' six conductor cable with modular plug.

Electrical Assembly

Be sure to install the components on the component side and solder on the solder side of the board! The **solder side** is the side has the **copyright notice**.

COMPONENT SIDE



SOLDER SIDE



Install humidity sensor components:

- Make sure you don't install components on the solder side of the board. Solder = Copyright Notice.
- R1, 100 Ω 5% resistor (brown-black-brown).
- C1, 0.1 μ F axial capacitor.
- U1, 555 timer IC (NE555, LM555,...).
- R2, 1 M Ω 1% resistor (brown-black-black-yellow).
- R3, 1 M Ω 1% resistor (brown-black-black-yellow).

Install temperature sensor components:

- C2, 0.1 μ F bead capacitor (labelled "104").
- R4, 2.26 K Ω 1% resistor (red-red-blue-brown).
- U2, LM334Z temperature sensor. Slide the LM334 into the circuit board, with the flat side facing toward the installed components. Push the LM334Z down until the widened part of the leads reaches the circuit board (about 1/8" from the case). Bend the LM334Z back until it is horizontal and extends out from the end of the circuit board. Solder in place.

Installing the Cable

The following instructions are written for the six conductor flat cable kit (CAB-TH50).

Attach sensor circuit boards to cables:

- Trim about 1/2" to 3/4" of the silver jacket from the cable.
- Take the 2" long piece of 1/2" diameter clear heat shrink tubing and slip it up the cable so it is out of the way. Later this heat shrink will cover the circuit board.
- Slip the wires, with insulation intact, through the six individual strain relief circuit board holes. The holes are labelled with the wire colors. If a wire does not slip through the hole, try cutting the wire at an angle. If that still does not work enlarge the hole slightly with a small pointed tool (like a small nail) or drill bit.
- Using plenty of fresh solder, melt back the insulation and tin about 1/16" of each wire.
- In sequence, solder each wire to a J1 pad. Make sure you have a solid solder connection.
- Clean the soldering flux residue from the circuit board using a cleaner that is appropriate for the type of flux you are using. **It is important for the board to be very clean. Leakage current through the flux could cause drift of the readings.**

Test & Final Assembly

- ❑ **Temporarily** partially install the humidity sensor. Insert the component leads only part way into the holes, enough so that the sensor leads make reliable contact, but not so tight that they would be difficult to remove. **DO NOT solder in place!**
- ❑ Plug the sensor cable into the measurement electronics. Verify that the temperature and humidity sensors are working properly. Once the shrink tubing is installed it is difficult to make changes!
- ❑ **Remove the humidity sensor from the circuit board!** Otherwise the sensor would likely be damaged when installing the heat shrink tubing.

The components on the front and the solder connections on the back of the circuit board must be coated with hot-melt glue and then sealed with heat shrink tubing. This forms a moisture proof seal. You can get a hot-melt glue gun and glue sticks at your local hardware or crafts store. **Never use anything other than a hot air gun to shrink the tubing.**

- ❑ Using a hot-melt glue gun, inject glue around the resistors, capacitors, 555 timer and cables on the component side of the board. Also apply glue to the solder side and edges of the board under these components. Put a bit of glue on the temperature sensor leads on both sides of the board. **Do not apply glue where the humidity sensor mounts.**
- ❑ Move the 2" long piece of 1/2" diameter clear heat shrink tubing (which had been slid up the cable earlier) so that it covers the circuit board up to **but not over** the outline of the humidity sensor. Shrink the tubing over the board and onto the cable. Excess hot-melt adhesive will be squeezed out by the heatshrink. A few toothpicks work great to remove this excess. **Do not use excessive heat! Be careful not to melt the cable's plastic jacket.**
- ❑ Take the 0.7" long piece of 3/16" diameter adhesive lined heat shrink tubing. Slip it over the temperature sensor so that it fits snugly against the circuit board. Shrink the tubing over the sensor and onto the circuit board. If the tube does not seal completely closed, while the glue is still molten use a pair of pliers to gently squeeze it shut.
- ❑ Permanently install RH1, the capacitive relative humidity sensor. Carefully align the leads with the holes, and press straight down. Install the #4 stainless steel mounting screws through the circuit board. Secure with #4 hex nuts. After the sensor is secure, solder the leads to their pads. Swab away the flux with an appropriate cleaner. **Caution: Do not get cleaner on the humidity sensor.**

Your sensor is ready to calibrate!

Calibration

The accuracy of your thermometer and relative humidity sensor depends on careful calibration.

The easiest and most accurate way to calibrate the thermometer is to put in water baths at two known temperatures. The sensor is quite linear, so you should be able to interpolate and extrapolate your readings.

Caution: Do not immerse the humidity sensor! When putting the temperature sensor in a water bath during calibration, enclose the assembly in a plastic bag to prevent the humidity sensor from being immersed.

The humidity sensor may be calibrated based on a 100% relative humidity reading. Take a small plastic container, like a margarine tub, and cut a slit in the lid large enough for the sensor cable to exit. Saturate a sponge with cool water and put it in the bottom of the container. Suspend the humidity sensor boards above the sponge. When the readings have stabilized, measure the period for your 100% calibration point. The period of the signal coming from the humidity sensor will decrease as it dries out. At 0% relative humidity the period should be about 72.7% of the period you measured at 100% relative humidity. Other points may be extrapolated from the following table:

Correspondence of Humidity to Signal Period
Normalized to the 100%RH Period

<u>%RH</u>	<u>Period</u>
100	100.0
90	95.2
80	91.4
70	88.0
60	85.0
50	82.5
40	80.3
30	78.2
20	76.4
10	74.7
0	72.7

Cable Signal Configuration

<u>Wire Color</u>	<u>Signal</u>	<u>Modular Pin</u>
White	Temperature Signal	1
Black	Temperature +5 Volts	2
Red	Humidity +5 Volts	3
Green	Humidity Frequency	4
Yellow	Enable	5
Blue	Humidity Ground	6

Protect the Humidity Sensor

The sensing element is a very thin (like Saran Wrap) membrane of plastic gently held by gold plated contacts. Moisture in the air is absorbed by this plastic, changing its dielectric constant. Electronics sense the capacitance, which controls the period of the output signal. For accurate measurements and long operating life your humidity sensor must be mounted properly.

1. Do not expose the sensor to direct wind and rain.

Keep the sensor in a sheltered location where wind and rain will never hit the sensor. The thin plastic membrane can be dislodged by the stress of wind, or windblown rain. An exposed sensor element can be destroyed by just one strong blast of wind. Some protection may be afforded by siting the sensor on a covered porch or patio where the overhanging roof protects the sensor. Although this is not foolproof and the sensor may be damaged by a wind gust. We suggest you shield the sensor with a can, jar, or capped section of pipe (as shown in the drawing). A piece of fiberglass filter material (from an inexpensive furnace filter, available at hardware stores) placed over the mouth of the jar will increase protection.

2. Avoid getting the sensor sopping wet.

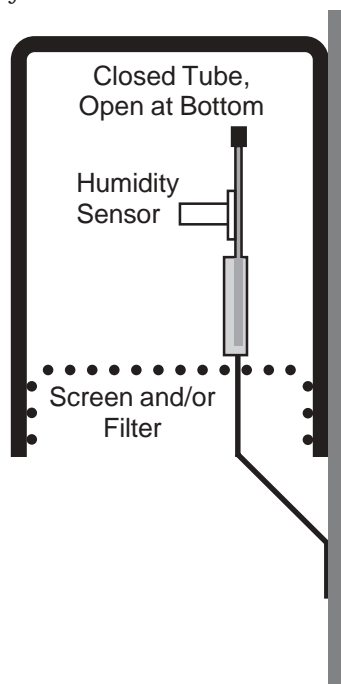
The sensor element can also be destroyed by getting it wet. Mineral or salt-laden water on the sensor element may leave a conductive residue that would short it out. Even clean water can destroy the sensor element by promoting the growth of mildew. Keep the sensor out of contact with all water, except for water vapor.

3. Protect the electronics.

The electronics use very small currents that can be easily shorted by water condensation. Here is where your careful work with the hot melt adhesive and heat shrink pays off.

4. Shade from direct or reflected sunlight.

Direct or reflected sunlight will warm the sensors, resulting in temperature readings higher than the actual and relative humidity readings lower than actual. In addition, the ultraviolet light in sunlight will degrade the plastic element in the humidity sensor. We recommend the sensor be sited in a shady area, preferably on the north side of a building.



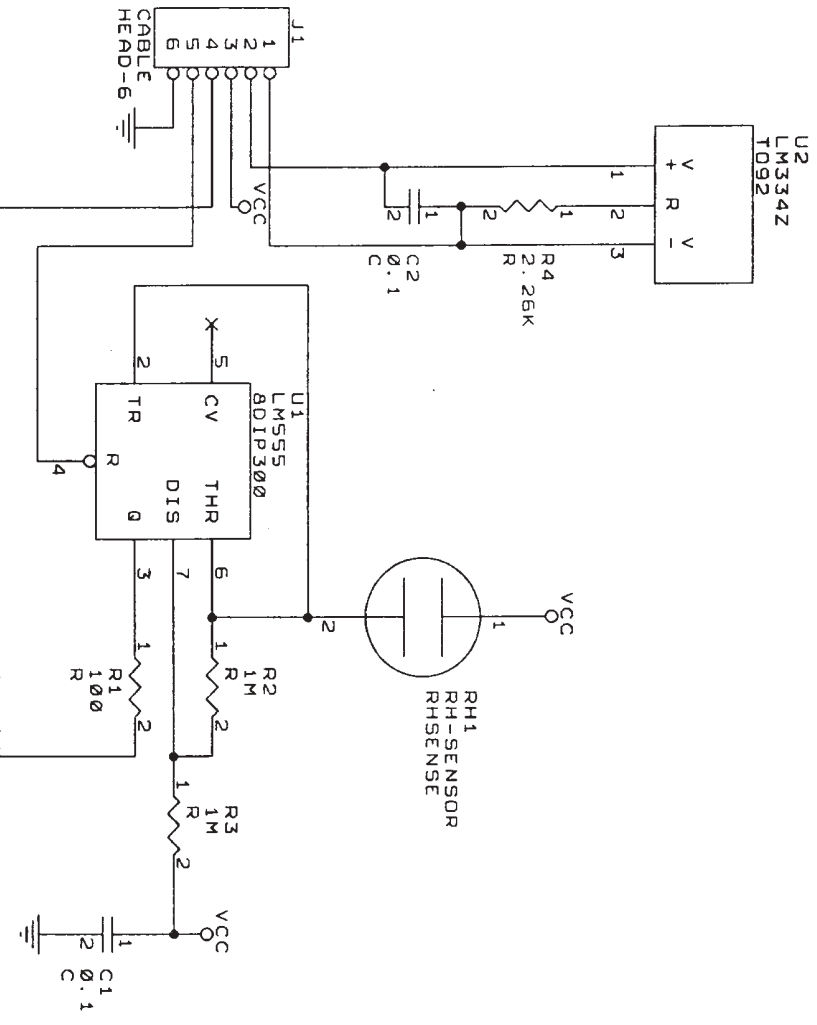
Circuit Description

Temperature sensing is performed by the LM334Z. The LM334Z is a two terminal current source, whose output current is linearly proportional to the **absolute** temperature. The 2.26 K Ω resistor sets the nominal current level through the device to 0.1 microamp per degree kelvin. This tiny current flow prevents any significant self-heating of the sensor. To convert from kelvin to centigrade subtract 273.15 from the kelvin value. Absolute zero is at 0°K or -273.15 °C.

Sending this signal through a 100 Kohm 1% resistor to ground results in a voltage signal, at 10 millivolts per °K, or about 2.73 volts at 0 °C. You may wish to include an opamp circuit in your electronics to provide both offset and gain to this signal to expand the temperature range of interest to match the voltage range of the A/D convertor you are using. You may also want to include a low pass filter, as this high impedance circuit is susceptible to picking up 60 Hz noise.

The humidity sensor is a capacitor whose value varies slightly with changes in relative humidity. The 555 timer, along with R2 and R3, convert this capacitance into a frequency for measurement by the Experimenter. To avoid crosstalk with the temperature sensor, you should shut down the 555 timer during temperature measurements by using the reset input. But if you are not doing this, don't just leave the reset input floating or your humidity readings will be erratic. For best signal integrity, the 555 timer's output is back terminated by a 100 ohm resistor (approximately the characteristic impedance of a typical wire) by R1.

We have found dividing the 555 timer's output by 16 (by using a 74HC393 or similar) provides a more stable period for measurement. To determine the current relative humidity divide the current period by the period that was measured at 100% relative humidity, then use the table on page 2. You may interpolate within the table to determine relative humidity with finer resolution. ■



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