SKUTT CERAMIC PRODUCTS

Electronic Theory

Electronic systems

All electronic systems do 3 main things: sense some kind of signal, decide what to do as a result of that signal and finally take action. In a KM kiln the steps are: read the signal from the thermocouple (Sense); make a decision about the state of the firing chamber based on that data (decide) and change the state of the relays if necessary (Act).

Thermocouples

A thermocouple is a device that takes advantage of a metallurgical property called the Seebeck Effect. Simply stated when 2 dissimilar metals are welded to form a junction then heated a DC-voltage is generated.

This DC-voltage is very small. It is measured in 1/1000ths of a volt, called millivolts. To give you an idea how small the full signal received from a Type K thermocouple at 2350°F is only 51.982 millivolts (mV). There is approximately 0.022mV change for each degree F.

The types of materials used will determine the linearity and magnitude of the signal. Various standards combinations exist. We use a Type K thermocouple for our kilns. The Negative wire is marked Red (unlike standard DC systems where + is red) and is made of a combination of Nickel-Chromium. The Positive wire is marked Yellow and is made of Nickel-Aluminum.

There are standard values for thermocouple output that are quite exacting. The table below summarizes that data in a range:

Temp°F	mV value	Temp°F	mV value	Temp°F	mV value
100	1.521	1100	24.622	2100	46.954
200	3.820	1200	26.978	2150	47.983
300	6.094	1300	29.315	2200	49.000
400	8.316	1400	31.628	2250	50.006
500	10.561	1500	33.912	2300	51.000
600	12.855	1600	36.166	2350	51.982
700	15.179	1700	38.389		
800	17.526	1800	40.581		
900	19.887	1900	42.741		
1000	22.255	2000	44.866		

(continued)

ELECTRONIC THEORY CONTINUED

The last point to make is that all mV values are referenced to 32°F (the freezing point of water) for 0.000mV output. This is called a cold junction reference point. Since our reference point is a voltmeter at room temperature we have understated the temperature by the difference between room temperature and 32°F.

Our circuit board and software automatically perform this cold junction compensation so the reading on a KM controller is very accurate.

Precautions with electronic components

The biggest enemy of semiconductor materials and solid state electronic components is static electricity. As you've just seen even a "large" signal from a thermocouple is only 52mV. Can you imagine what a 10,000-volt arc of static electricity would do to these sensitive parts? You got it. The part would be rendered useless.

Prevention: Before you touch a static sensitive part you should get in the habit of discharging your body of any static electric charge by touching a correctly grounded object. There are many ways that this simple suggestion can injure you so remember: Be careful and if you are not certain just avoid touching the components on the circuit board and you'll be OK.

Circuit boards also don't like heat. All the testing we performed gave way to a 110°F maximum operating temperature recommendation. If you notice a segment or two missing or growing dim in the display the chances are the heat in the kiln room is above 110°F and should be lowered somehow (usually that means some type of air conditioning). The display is the most temperature sensitive part on the controller so it the first component to be effected by heat.

The terminal block for the thermocouple on the controller doesn't have a great deal of mechanical strength. It is possible to over-tighten the screws and twist the terminal block off the circuit board. A snug connection is fine, don't get too aggressive with these screws.