SKUTT CERAMIC PRODUCTS

Service Training Manual

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Electrical Theory and Safety

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Electrical Safety

A person receives an electric shock whenever any part of his / her body becomes part of an electric circuit. In this case injury can occur in two ways. One way is from nerve shock which, if great enough, will cause stoppage of the lungs or heart or both. Another form of injury is from the heating effect of the current which may cause severe burns where the current enters or leaves the body. For any given voltage the injury suffered depends upon on the amount of current, the course it takes through the body and the length of time the person is in the circuit. The amount of current flow will depend upon the voltage of the circuit contacted and the resistance of the circuit of which the victims' body is a part. The amount of current carried by the conductor that the person comes in contact with is of no importance provided it carries enough current to injure. Since one-tenth of an ampere or less may be fatal, all ordinary circuits have enough capacity to be dangerous. For example, the inherent hazard of a 10,000 ampere circuit is no greater than that of an ordinary lighting circuit if the voltages are identical.

The average reasonably dry, clean, non-metallic floor has enough resistance so that a person standing on it is not likely to receive a severe shock from a circuit of 220 volts or less. If the floor is wet, the person's clothing is wet, the person is sweaty, or on a metal floor, then the path of resistance through the body could be as low as 250 ohms. This 250 ohm circuit might allow a fatal shock to be received from only 30 volts. Deaths from circuits as low as 50 volts and less are on record.

Everyone is susceptible to electric shock, and if some people are more susceptible than others (for instance people with weak hearts) the difference is too small to be taken into consideration in applying safeguards. Electrical equipment should be made safe for all. Attributing a death or injury from low voltage to personal susceptibility is usually an explanation of ignorance or unwillingness to face the facts.

Protect yourself from injury. Don't be a path to ground for electricity. Do not work on live circuits. If you need to measure voltage or amperage of a circuit remove any watches or jewelry and wear proper shoes and clothing. Do not perform these measurements if you are drowsy or tired, a simple slip of your hand or meter lead could kill you. If possible use clips for one lead and measure with one hand guiding the other lead. Keep one hand behind your back if possible.

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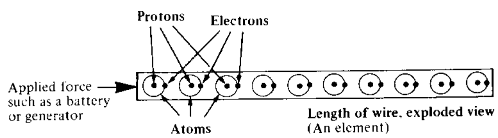
Electrical Theory

ELECTRICITY

Simply stated, electricity is nothing more than the process of moving electrons from one atom to another. These moving electrons are able to do a fair amount of work, because we don't move one at time.

Various materials have different abilities to let go of their electrons and accept new ones. That is referred to as conductivity. Good conductivity means the electrons can easily move from one atom to another. Well get into later.



Wire section with atoms

4 ingredients of electricity:

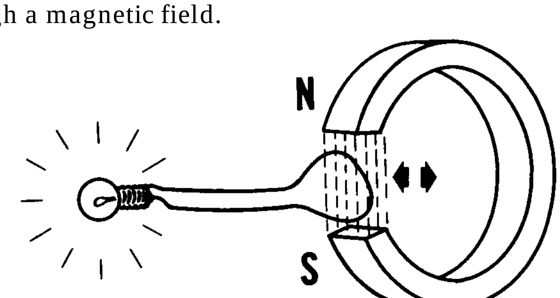
Before we look at the basic components in electricity it is helpful to think of electricity like water. In a water system we look at some form of **pressure**. When water is pumped up to a tower it has gravitational potential energy, which will release when the water is allowed to go downhill. The diameter and length of the pipe that carries the water to our home must be adequately sized so it doesn't introduce **resistance** for the flow of water we plan to move through the pipe. There is a certain **rate** at which the water will flow through this pipe and finally we have **gallons** of water as the product of the water flow.

Each of these elements to the water supply has a similar component in electricity.

Voltage (V) = pressure

Voltage is a term we are all pretty familiar with but may not really understand it. Voltage is the pressure, or force, the electrons feel which persuades them onto the next atom. It is also called electromotive force and is often shown in equations as E. We will keep things simple here and denote voltage with a V.

There are two basic types of voltage AC, alternating current, and DC, direct current. Virtually all power supplied to houses, schools and industrial is AC voltage. All of our kilns operate on AC. However we take some of that AC voltage potential and convert it into much lower DC voltage that is used for the circuit board on KM type kilns. AC voltage is generated by passing a large coil of wire through a magnetic field.



The unit of measure for voltage is a volt.

(continued)

Resistance (R or Ohms) = pipe diameter + distance

As electrons move through the wire it encounters resistance. The resistance is caused by 3 things:

1) The diameter of wire
2) The length of the wire
3) The material of the wire

1 and 2 will be discussed later in the section on wiring.

The electrons in some materials are very willing to move to another atom, while the electrons in other materials are extremely reluctant to allow an electron out of its grasp.

The materials that easily allow electron movement are said to have low resistance (or are good conductors of electrons).

The opposite of a good conductor is a material that allows no electron flow between the atoms. These materials are called insulators. The plastic wrapping on a piece of wire keeps the electron move contained to the metal inside the wire.

Somewhere in-between a good conductor and an insulator are materials that are specially designed to allow some electron movement. The benefit to this type of material is it will produce heat as the voltage moves the electrons through the material. Before the electrons move they encounter resistance. The force (V) must overcome resistance for electrons to move.

<u>Good Conductors</u>

Silver, copper, nickel & gold

<u>Insulators (poor conductors)</u>

Glass, wood, porcelain and rubber

Kanthal resistance wire is somewhere in between which is why it generates heat.

Resistance increases with temperature.

Resistance is measured in ohms (R) is it also abbreviated, R.

Amperage (A) = rate

In our water analogy amperage would be the rate the water flows through the pipe. It would be measured in gallons per minute or hour. Amperage is the rate electrons are moving in the conductor.

One way to limit the flow of water through a pipe would be to reduce the diameter of the pipe (increasing the resistance) and we would have fewer gallons of water coming out of the pipe in one minute than for a larger pipe.

This assumes the water pressure stays the same for both pipes. If we were to elevate the water tower the pressure would increase and we would be able to force more water through a pipe. So gallons per minute only means something when it is expressed relative to the water pressure. The same is true with amperage. <u>Amperage only has meaning when it is expressed relative to the voltage</u>. For example we would say a kiln draws “48 amps at 240 volts”.

The unit of measure of amperage is the ampere (A), sometimes shown as “I” (intensity of current) in electrical equations.

Wattage (W) = gallons

To complete the metaphor with flowing water, wattage would be like the number of gallons received while water was flowing.

In an electric kiln it is really the wattage (which is directly proportional to BTUs) that gets the heatwork done.

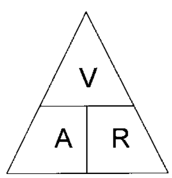
Just like with water flow an electric kiln needs a certain result (gallons or watts) in a given time. How frustrating is it to take a shower with just a trickle of water? All of these measures help us arrive at the wattage (also know as Power) the kiln is producing.

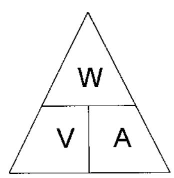
The Power Company will bill you on watts used for a given period of time, kilowatts (1000s of watts) used per hour. Example: a 11,500 watt load running for 1 hour would result in 11.5 kWh on your electric bill.

Ohms Law

Now that you have an understanding of the elements of electricity you probably guessed there must be a relationship between them that is predictable, and there is. It is called Ohm's Law and can be expressed simply as:

Amperage = Voltage / Resistance





These 2 equation triangles are helpful in determining the proper formula to use. For example: by placing your finger over "R" in triangle 1 the remaining symbols express the formula for calculating "R", V / A.

Voltage is the biggest factor in determining how fast a kiln with fresh heating elements will fire. It is difficult to increase the voltage we get from the Power Company, but it isn't difficult at all to lower the voltage getting to the kiln. We will discuss this more in the section on Wiring an Voltage Drops.

Resistance of the heating elements is something we can control, initially at least. As the elements age they provide more resistance to electron flow and reduce the current. Which in turn reduces the wattage of the kiln.

Amperage and Wattage are results and can only be influenced by changing the voltage or the resistance in the circuit.

Item	Water model	Electricity
Pressure or Force	Pounds per square inch (PSI)	Voltage (volts, V)
Resistance to flow	Pipe diameter & length of pipe	Resistance (ohms, R)
Rate of flow	Gallons per minute (GPM)	Amperage (amperes, A)
Work or result	Gallons	Wattage (watts, W)

Circuits

A circuit is simply an assembly of wires and components which allow current to flow (electrons to move). All circuits have these basic components:

1 voltage source

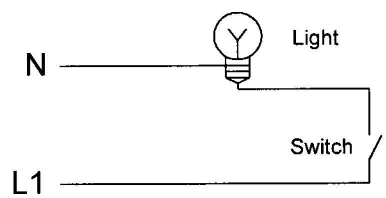
1 or more electrical loads (heaters, motors, something to consume power).

1 or more controls (switch, relay or actuator)

ELECTRICAL THEORY CONTINUED

Simple Circuit

A very common circuit which we all use everyday is a lightbulb and switch circuit. It looks like this when drawn as a schematic:



Multiple Load Circuits

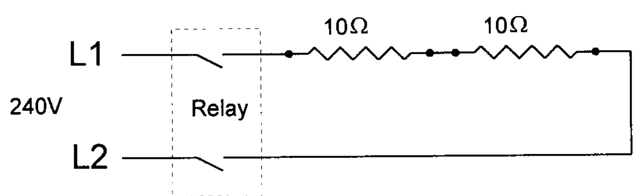
Now that we have a picture of a very simple circuit, there are 2 types of circuits that involve multiple loads. Simple circuits are easy to understand but most electrical circuits are some combination of components placed in series and parallel. The following will go into greater detail.

Series

A series circuit is one in which each load is lined up end to end. The current must flow through the first one then the next in a series to complete the circuit.

If a single component fails in a series circuit then power is lost to all components. And the entire circuit is de-energized. Remember those older style Christmas lights where 1 broken bulb would turn out all the lights?

An example of a series circuit in a Skutt kiln would be 2 818 elements going to 1 infinite switch or relay.

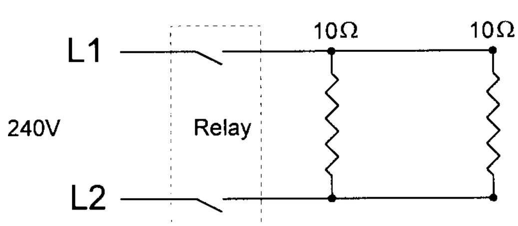


The working voltage is divided across each component in a series circuit. In the figure above if both resistors (heating elements) have the <u>same</u> resistance in ohms then the voltage would be consumed evenly between them. Specifically, if the applied voltage is 240 then each element would behave like a 120v element (240v / 2 elements = 120volts / element). Elements would be designed to operate on 120v instead of 240v when there are 2 elements in a series circuit.

If the 2 resistances are different, then the voltage drop across each would be proportional to the resistance.

Parallel

Unlike series circuits a parallel circuit applies the full line voltage to each load.



ELECTRICAL THEORY CONTINUED

One of the main benefits of a parallel circuit is apparent when a component fails. The damaged component doesn't effect the other loads in the circuit. The remaining load(s) will still operate as designed. This is how Christmas lights are manufactured now and it is a simple task to find the one bulb that is burned out because all the others are still illuminated.

Wiring & Voltage Drop

Every piece of wire has some resistance. The resistance is effected by 3 things:

1) The wire gauge or diameter.

2) The length of the run.

3) What the wire is made of. (A perfect conductor doesn't exist. Copper is a good conductor for the price thus explaining its popularity).

Let's take a closer look at each of these 3 factors individually before we look at the net effect.

Wire gauge

Every wire has a theoretical maximum flow it can take in amperes before it overheats. A wire size that is too small will limit the flow of current and create an unnecessary hazard. Oversizing wire for a circuit does not present any hazard what so ever.

The following table will give a few pieces of important information for discussion later.

American Wire Gauge AWG	Circular mils	Maximum amperage for copper 3 conductors in a cable at 86°F, 90°C wire National Electric Code.
0	325	170
2	258	130
4	204	95
6	162	75
8	128	55
10	102	40
12	81	30
14	64	25

Distance

Just as the diameter of the wire (pipe) can reduce or choke flow so can the length of the wire. As a general rule of thumb we recommend going to one size larger wire for each 50 feet of run from the circuit breaker panel to the wall outlet. These are calculations that electricians do all day long, but we have found this minimizes the effects of distance on kiln performance.

Wire type

Material	**Resistivity (Ω-circ.mil/foot)**
Silver	9.9
Copper	**10.4**
Aluminum	17.0
Iron	58.0
Kanthal A1	872.0

Bringing all 3 pieces together

There is an equation that will bring all 3 factors together into the resistance of a given length of wire of a certain distance and composition. The equation is:

Resistance (W) = Resistivity * (length of wire / diameter of wire^2)

Let's compare copper to aluminum in a 100 foot run with a diameter of 6 gauge.

Rc = 10.4 * (100 / 162^2) = 3.96 W

Ra = 17.0 * (100 / 162^2) = 6.48 W

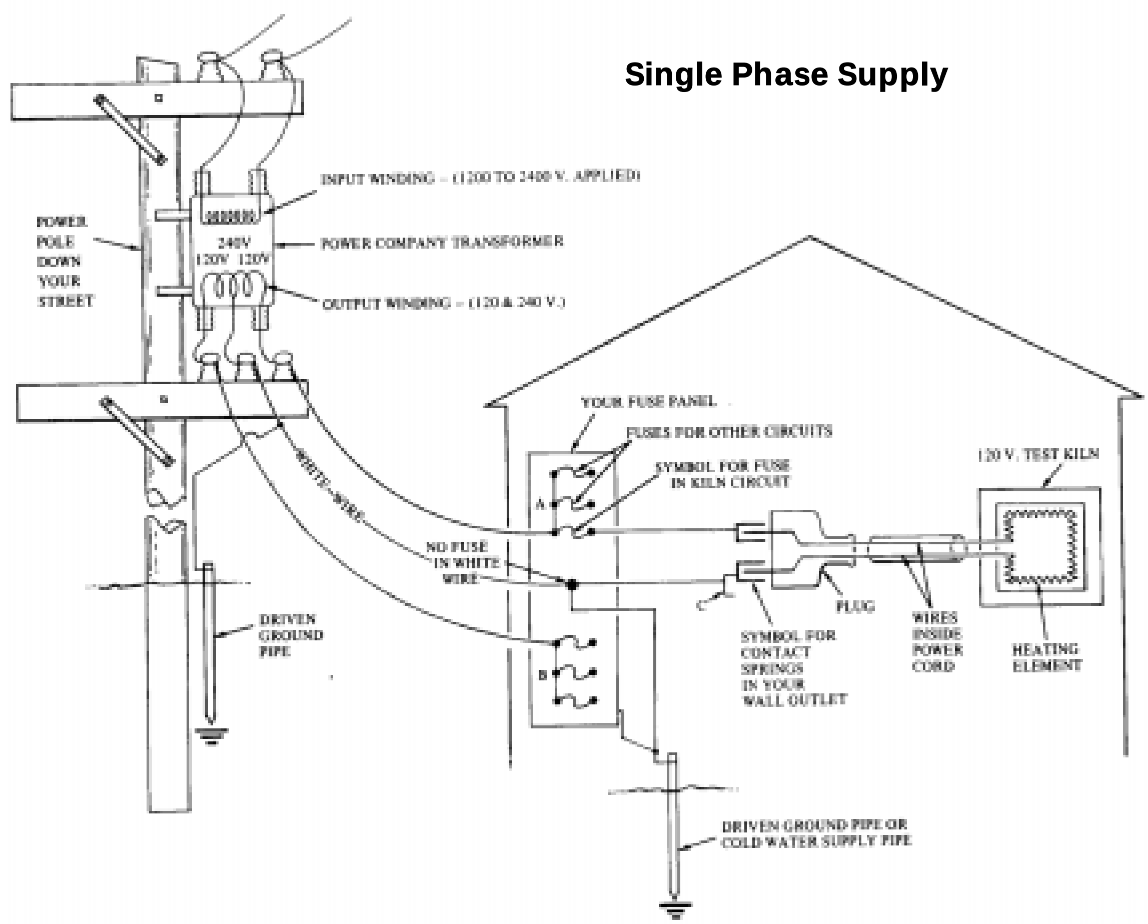
As you can see the Ra (aluminum) wire has much more resistance that the copper. This is why we recommend only working with copper wire when installing a kiln circuit.

Single and 3 Phase supplies

Electricity is generated at large facilities that spin turbines holding large coils of wire through magnetic fields. Depending on the geometry of the magnets and coils, various frequency and phase configurations are generated.

That voltage travels down main distribution lines at very high voltage (pressure) and is transformed down to working voltages on the power pole outside your house.

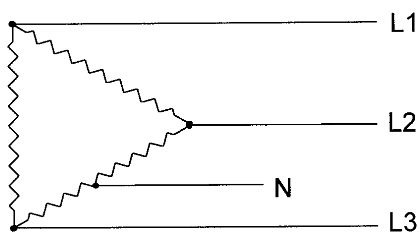
Single Phase Supply



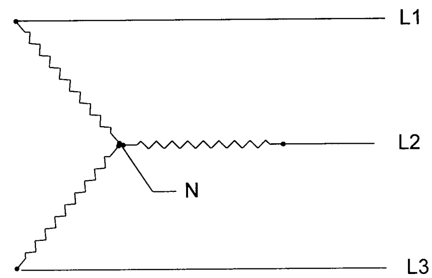
ELECTRICAL THEORY CONTINUED

You have heard the term “Hot wire” referring to a wire that has voltage potential present. We may use this term interchangeably with Phase wire. In the following diagrams we will label the phase wires with the standard convention of L1, L2 and L3 for Lines 1, 2 or 3.

The two most common types of power distribution are “Delta” and “Y”.

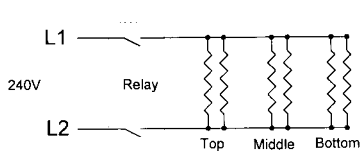


120/240 = DELTA

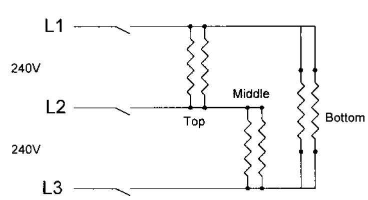


120/208 = WYE OR “Y”

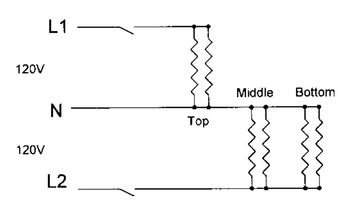
Typical Kiln Circuits



1 Phase 3 Section Kiln



3 Phase 3 Section Kiln



714 Kiln

CIRCUIT BREAKERS

Circuit breakers are over current protection devices. The purpose is to interrupt voltage to a circuit when the circuit has too much current flowing through it.

Breaker Facts

- The breaker will trip (open up) when it gets too hot.
- It is very normal for a circuit breaker to get warm when the kiln is operating, but not hot.
- Must be sized to 125% of the continuous load in Amperes.
- A 50A breaker will not run a 48A kiln.

Phase (or “Hot”) wires

As you open the front cover of a circuit breaker panel you will usually see 2 columns of switches or poles. Each pole will have a rating on stamped on it. This rating will be in amperes.

Each pole is a phase wire and must be protected from overcurrent.

To get 120v we combine 1 pole with a Neutral wire. Neutral wires are usually color-coded white.

Breaker Interlocks

2 poles that are connected with small rods, make up a 208 or 240v circuit (depending on the power distribution). If we are working with a 2 pole circuit you don’t add the values of each pole. The capacity of the circuit is still the stamped amperage, but it is now 208-240 instead of 120. Example: 30A bridged to another 30A is <u>not</u> 60A single phase, it is only 30 amps single phase.

3 phase circuits will have 3 poles all connected (i.e. 2,4 & 6 on panel)

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Electronic Theory

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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.

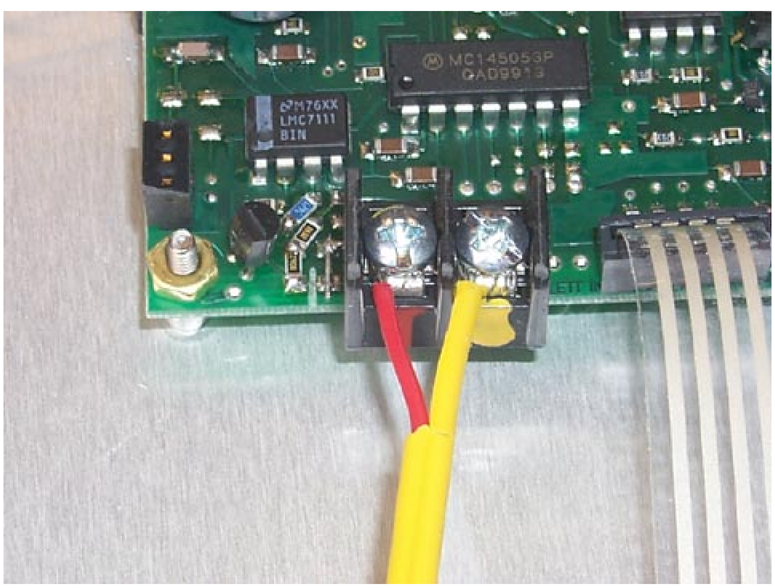
Precautions with electronic components

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.



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Troubleshooting

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Trouble Shooting Theory

METHODOLOGY OF TROUBLESHOOTING

Before you jump into performing a repair on a kiln it is very important to have reasonable certainty you are going to fix the right thing. If you are certain you've already identified the problem and solution this formalized process is probably and extra step, but if you aren't certain or have a particularly complicate problem this procedure will assist you.

It starts by identifying the correct symptom, then performing tests to help you form the right diagnosis. If this all sound like a medical process that is because it is very similiar. Now the human body is infinitely more complicated than a kiln, but the steps hold true.

Medical example:

You call your doctor and tell her you are tired a lot lately (the symptom), she will ask more questions to clarify the symptom list, the will probably do a blood work up next. The results indicate you are anemic (diagnosis) and she will prescribe an iron supplement (repair). Call her if the problem doesn't get any better in a few weeks (re-test).

Kiln example:

A customer calls you and says my kiln isn't making it to temperature (symptom), you will probably run a mental checklist of possible tests you'd like to run ranging from a visual inspection of the glowing elements to a chart recorded voltage test by the Power Company. But the element resistance test (see Module 9) indicates the elements have exceeded their useful life (diagnosis). The repair is pretty obvious, change the elements. Then after the kiln is put back together again you fire and test to make sure it can make temperature.

The reason this process is critical is that some of the repairs on a kiln are quite expensive and no one wants to spend a lot of time and money repairing something that "ain't broke".

Flowcharts

The remainder of this Module contains some very useful flowcharts to assist you in the troubleshooting process. We have attempted to put the most revealing test toward the top of the chart so you can hopefully find the most common problems quickly. Most of the common problems are covered well in these flowcharts, but there are a few things that a just too obscure to document well.

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Diagnostic Tests

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Testing Voltage

VOLTAGE MEASUREMENTS:

1. No load voltage measurement.

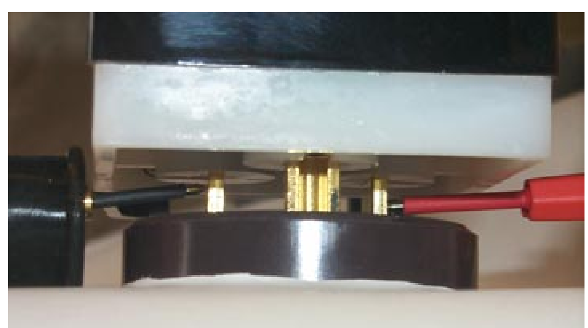
1 ph Outlet

3 ph Outlet

Measure the voltage across the rectangular holes with your meter. Set the meter to a voltage setting that will handle the voltage you are measuring. The meter leads must make contact with the metal part of the receptacle in the rectangular holes. If the voltage is only 110-120 volts on a 208 or 240 volt supply then the ground wire may be hot. Measure the voltage from each hot to ground. You should find approximately 120 volts in both cases. If the voltage is 208/240 to ground then you have a hot ground wire.

Write down the exact voltage you measure for future reference. Ideally your no load voltage should be within 1% or 2% of the nominal voltage.

2. Voltage measurement under load.



Measure the voltage at the receptacle while the plug end is in the receptacle far enough to make contact but out far enough to get your meter leads on the flat blades of the plug. Be careful, this is live voltage and it is very easy to slip your meter leads and short them together or touch one of them to the metal receptacle plate which is ground. Grounding a hot lead will cause large sparks and probably trip your breaker!

(continued)

TESTING VOLTAGE

While you are measuring this voltage the kiln should be on. This voltage is the voltage under load and it is normally slightly lower than the voltage with no load. A 1% to 2% voltage drop is normal. A 3% drop in voltage is OK. More than 3% drop may cause problems with the kiln firing to the rated temperature. More than 5% drop and you may want to call your power company.

Three phase kilns.

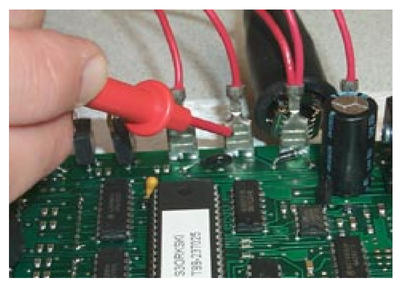
Three phase kilns have three hot flat blades L1, L2, L3 and one ground. Measure the voltage across all combinations of flat blades L1 to L2, L1 to L3 and L2 to L3. All of these combinations should read the nominal 208 or 240 volts.

3. Measure the voltage at the elements.

On KilnMaster (KM) controlled kilns you can measure the voltage at the pigtails of the elements by unscrewing and swinging open the red control box. Program the kiln and carefully measure the voltage at the pigtails while the relays click on and off. See the RAMP / HOLD 9999 program to keep the relays on.

On the KS kilns manufactured after 1998 it is easy to unscrew the top and bottom boxes and swing them open to measure the voltage at the pigtails while the kiln is on. Otherwise it is very difficult and not recommended to measure the voltage at the elements.

4. Measure the voltage to the controller.



Measuring Controller Voltage

Unplug the kiln before performing this test. [See back side of a touchpad]

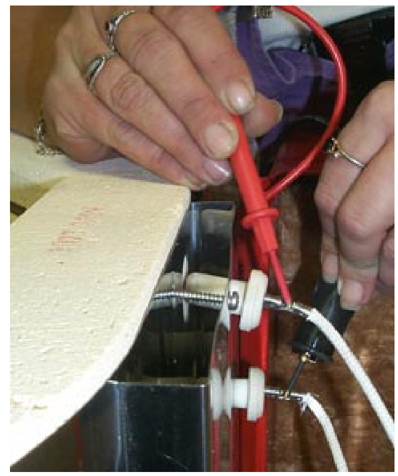
On KilnMaster controlled kilns manufactured after 1994 it is easy to unscrew the sheet metal screws that hold the touchpad to the red control box. On older models the screws are machine screws and require removing the insulating baffle to remove the nuts on the back side of the touchpad. There are 4 red wires connected to the back of the touchpad and two thermocouple wires. Number the red wires #1 through #4 starting at the connector closest to the top of the touchpad and going down. The #1 red wire connection is the 12 volts DC output to the relays. The voltage measured across #2 and #4 will be 24 volts AC. The #3 connector is the center tap of the transformer and will measure 0 volts AC or DC with reference to the chassis ground. If you do not find 24 volts AC measured from #2 to #4 then the transformer is defective or the red wires from the power cord to the bottom of the transformer is broken, disconnected or the fuse has blown.

SKUTT CERAMIC PRODUCTS

Testing Resistance

RESISTANCE MEASUREMENTS:

First a little familiarity with your meter is helpful. Set the meter to the lowest ohms resistance position. Some meters will not accurately measure resistances less than 100 ohms. You will need a meter that can accurately measure ohms of resistance as low as 5 ohms. Some meters will allow you to zero the meter with an ohms adjustment dial on the meter while the leads are touching each other. If your meter does not have an ohms adjustment then touch the leads together and you should read 0.0 ohms. If your meter reads 0.1, 0.2, 0.3, 0.4 or something other than 0.0 then you will need to subtract that number from the your meter readings.



Testing Elements at Connector

Make sure you can identify a series or parallel circuit for your kiln elements. See the Basic Electricity section to help you with this distinction.

See the KM element resistance chart. These resistance readings can be done at the element pigtails. On kilns with elements in series like the model KM818, if an element is broken you will see infinite ohms of resistance. On kilns with elements in parallel like the KM1027, if one element is broken then you will be measuring the resistance of the unbroken element because the path for electricity still exists through the jumper wires. For example the KM1027 / 240 volt 1 phase kiln has 23.3 ohm top and bottom elements and 32.6 ohm center elements. If the top element is broken then you will be measuring the resistance of the other element in the top section which is a 32.6 ohm center element.

If your element readings are about 1.5 ohms more than the nominal readings then your elements are considered worn out and the kiln will not heat up to the rated temperature.

There are some cases where contamination will effect the actual resistance readings at room temperature. In this case it is possible to have fine resistance readings at room temperature but the elements don't behave properly at red hot temperatures. Sometimes contamination can cause elements resistance to be less than nominal.

Elements that are collapsing on themselves will also have resistance readings that are unreliable and the elements should be replaced.

Amperage readings can also be performed on the wiring to the kiln inside the circuit breaker box by qualified electricians.

SKUTT
CERAMIC PRODUCTS

Testing Amperage

AMPERAGE MEASUREMENTS:

Remember from ohms law that amperage readings are only meaningful when the voltage is known. 48 amps on a 240 volt circuit produce much more wattage than 48 amps on a 208 volt circuit. Watts = amps x volts and watts heat up your kiln!

Amperage readings can give you a very good indication of how your kiln is performing under load (with the kiln on). If the amperage is lower than the nominal kiln amperage then your kiln is not going to heat up properly to the rated temperatures. Low amperage is usually caused by low voltage to the kiln or elements resistance increasing but may also be a bad connection in the kiln wiring or at the element connectors.

Testing Amperage at Feeder Wires

On KilnMaster (KM) kilns the amperage readings can be done with a clamp on ammeter around the feeder wires and jumper wires going to the elements. The RAMP / HOLD 9999 program will be useful to keep the relays on during this measurement. On Kiln Sitter (KS) kilns manufactured after 1998 the readings can be made at the feeder wires to the elements after unscrewing and swinging open the top or bottom section boxes. You should always turn the kiln off until you plan where you will be taking your amperage readings, then turn the kiln on to make your readings.

Amperage readings can also be performed on the wiring to the kiln inside the circuit breaker box by qualified electricians.

SKUTT CERAMIC PRODUCTS

KM Visual Inspection

How can I check my KM kiln for proper operation?

One simple and quick test to determine that the relays and elements are working correctly is to visually inspect the kilns heating elements while the kiln is on. You can do this by entering the following Ramp / Hold program on an empty kiln and running it with the lid open so you can see the elements glowing. It will usually take anywhere from 10 to 30 minutes to see the elements glow depending on the model of the kiln and the age of the elements. While looking at the elements you might notice the following:

- **One section of the kiln is not going on.** This indicates a defective relay that is not turning on. There is usually one relay per section.
- **One element is not glowing at all.** This indicates a broken element.
- **There appears to be cool spots on some elements.** This indicates worn elements.
- **The TOP and BOTTOM elements are hotter than the center elements.** This is normal for all kilns except the KM714 and the KM614.

The following is the program for checking relays and elements in the kiln:

Step	*Press*	*Action*	*Display*
1	**Ramp/Hold**	Enters Ramp/Hold Mode	USEr1.
(Older version touchpads will not have USER numbers available.)			
2	**1**	Enters Program USER number	1
3	**Enter**	Stores the Program number selected	SEGS
(Older version touchpads will begin here.)			
4	**1**	Enters the number of segments in profile	1
5	**Enter**	Stores the number of segments	rA1
6	**9999**	Enters the firing rate per hour of seg. 1	9999
7	**Enter**	Stores segment 1 firing rate	^{0}F 1
8	**500**	Enters the ^{0}F temp. to reach before holding	0500
9	**Enter**	Stores the target temperature for segment 1	HLd1
10	**0**	Enters the time to hold at desired temp.	0000
11	**Enter**	Stores the hold time for segment 1	ALAr
12	**9999**	Enters the degrees to sound the alarm.	9999
13	**Enter**	Stores the alarm temperature	StOP

The display will flash StOP after programming is complete, then it will begin flashing the internal kiln temperature. This program will be stored as USEr #1 for future use or revisions. (USER numbers are available for newer model KM kilns manufactured after March of 1995).

SKUTT
CERAMIC PRODUCTS

Zone Control General Testing Procedure

POWER PLUG

1. Check ground on power plug for continuity to kiln jacket.
2. Check hot blades on power plug for short to kiln jacket.
3. Perform di-electric test on kiln.

PROGRAMING ZC KILNMASTER

1. Plug the unit into the appropriate power supply receptacle.
2. Ensure that the display reads “PF”.
3. Push the “ENTER” key and wait for the display to read idle conditions.

   The display should alternately read “tc2”, “idle” and the kiln temperature. (ambient)

   Ensure that the temperature reading is steady.
4. Push the “F/C” button and then the code 70. The display should read “rSEt”. Press “enter” to reset the kiln to default zone control values.

   Push the “F/C” button and then “Enter” to ensure the kiln reads in degrees C. The proper ambient reading should be around 20-25 degrees. Again the display will alternate between “tc2”, “idle” and the kiln temperature Set the temperature back to degrees Fahrenheit.
5. Push the “CONE FIRE” BUTTON. The display should indicate cone 018. Enter the code number “909” and push enter. The display should indicate cone 018 again. Change the cone value to cone 04 by Entering 04 and pushing enter again. The display should indicate an offset value of “9000”. Push enter again to accept this value. The display should now indicate cone 04. Push enter again and program the speed to medium. The display should now ask for a HOLD time of 00.00. Accept this holdtime by pressing enter. The display should now revert to the alternating tc, idle, and kiln temps. When programming is complete, push the review button and check the program for accuracy. The temperature value for cone 04 should be 1944 degrees. Press “review” and review the program.

Review should show:

ConE	04	
°F	1944	
°FOS	9000	
SPd	MEd	
HOLd	00.00	
dELA	00.00	
ALAr	9999	
tC1	°FOS	0000

(continued)

ZONE CONTROL GENERAL TESTING PROCEDURE

tC2	°FOS	0000
tC3	°FOS	0000
ErrS	ON	
°FLg	0005	
StOP		
tC2	idLE	70 (ambient) (display alternating these 3 values)

6. Using the "RAMP / HOLD" mode and user program #1, program the kiln for a single ramp to 300 degrees at 800 degrees / hour with a 15 minute hold. Set the alarm to 9999. Verify this program by pressing the "REVIEW" button. The review display should have similar values as step 5 above.

7. Close the kiln lid and push "START". Observe the kiln for the

   following while waiting for the temperature to <u>increase</u> to at least 200 degs.:

   *Push the button 1 and check tc1 temp. Do the same with 2 and 3. The temperatures should be in the same general range. (plus or minus 20 degrees or so).

   *Ensure the display is constant with no fluctuations

   *Check the amperage for proper correlation with kiln type and voltage

   *Check the nameplate for proper kiln type, voltage, etc.

   *The elements should begin to smoke

   *Look for anything unusual

   *On lid interlock models, open the lid latch during a "power on" cycle and ensure that the kiln shuts off. Close the lid latch and ensure that the kiln resumes normal operation.

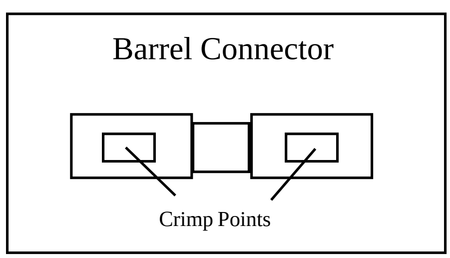
   *When the kiln reaches 200 degrees or buttons 1,2 and 3 show uniform temperature and heating, the test is complete.

SKUTT CERAMIC PRODUCTS

Replacing Elements

The correct element specifications are critical to the safe and efficient performance of your kiln. Elements can vary between models and within the same kiln, so be sure to order the factory recommended elements for your model and install them in the correct positions.

1. Unplug the kiln.
2. Remove attaching screws and swing open control box.
3. Label each feeder wire that leads to the elements you wish to replace to insure they will be reconnected in the correct position. You may wish to separate the kiln sections to give you easier access to the element you are replacing.
4. Cut the feeder wire as close to the crimped barrel connector as possible then cut the barrel connector off the element pigtail. This will allow the element pigtail to pass freely through the brick.
5. Remove all the pins which hold the element in the groove and **carefully** remove the element from the groove. Needle nose pliers can be very helpful.
6. Vacuum all debris from the element groove.
7. Elements from Skutt Ceramic Products are preformed with bends in the elements to match the angled joints of the brick. The pigtails on the new elements have loops that must be cut off prior to installation.
8. Install the new element by placing one of the pigtail ends through the terminal hole of the brick. As you feed the element into the groove be sure that the bends in the elements match the angled brick joints. Slight adjustments can be made if neccessary by slightly stretching or compressing the coils.
9. Once the element is in place, use the new pins which were included with your replacement element to secure the element into the groove. Using needle nose pliers, place the pins in a downward angle over the element in each corner. Only use element pins supplied by the factory to insure the elements will not be contaminated.
10. Place the porcelain insulators over the ends of the element pigtails on the outside of the kiln chamber. The pigtails can be at an angle so you may need to bend them so they are perpendicular to the kiln. Again be careful not to enlarge the existing hole.
11. Gently pull the element through the hole as far as it will go and cut the element 5/16” beyond the porcelain insulator using side cutters.



12. Strip 3/4” of insulation off the correct feeder wire bend the exposed wire over so it is doubled. This will allow for a tighter fit in the connector.

(continued)

REPLACING ELEMENTS

13. To attach connector:

    A. Grip one of the connectors that was supplied with your new element with a dimple crimping tool. Make sure the crimp point of the tool is lined up over place where you wish to make the crimp.

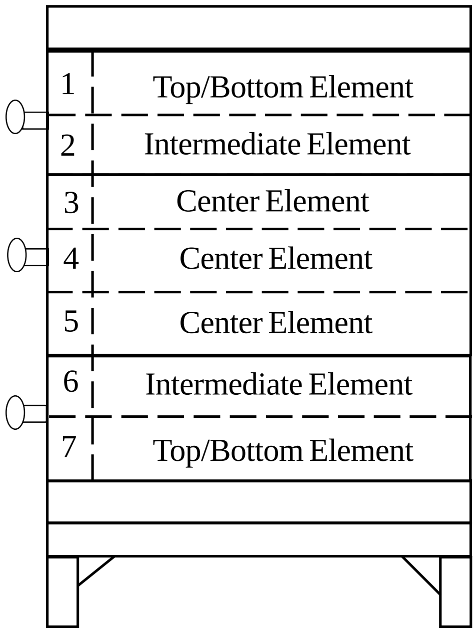
    B. Reach inside the kiln chamber and push the element through the hole as far as it will go and slide the connector over the pigtail so the end of the pigtail is in the center of the connector and crimp down hard. When you let go the connector and insulator should be pulled snug against the heat shield.

    C. Place the feeder wire into the other end of the connector and make a secure crimp.

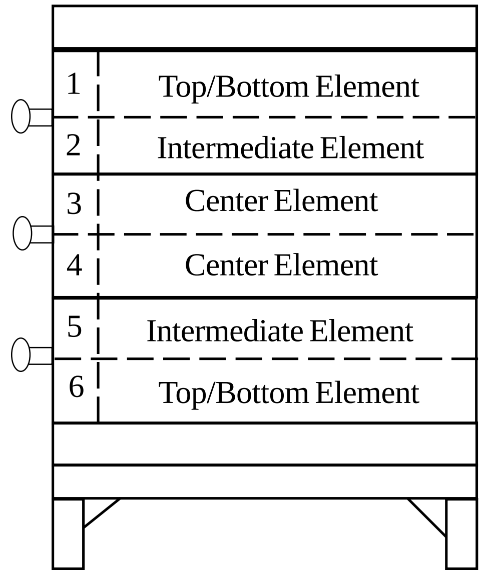
REPLACING ELEMENTS

The elements in many Skutt kilns are balanced therefore it is very important to place the correct element in the correct position. Below are diagrams that illustrate the correct placement.

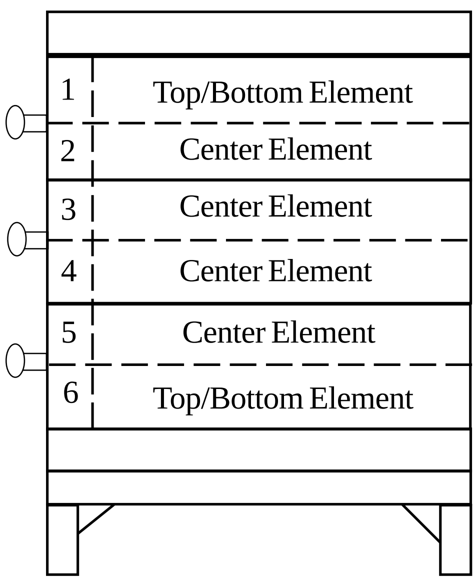
KM1231-PK



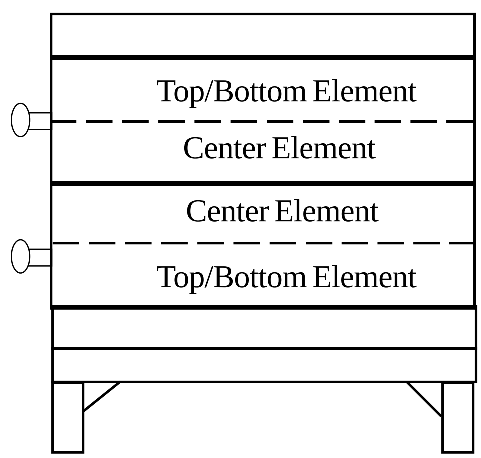
KM1227-PK



KM1227,KS1227,KS1027, 280, 235, 230, and 231



KM818, KM818-30A, 231-18 KM1018, and KS1018



<u>PLEASE NOTE</u>: The elements for all other kiln models are the same from top to bottom for each model. **This includes models 609, 614, 714, KS818, KS818P, KS818WR, KS818PWR, 181, 180, 145, 183, 185, the Pinto, and Octagon Fuser. Element positioning is not effected by phase or brick size.**

SKUTT
CERAMIC PRODUCTS

Repairs

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SKUTT CERAMIC PRODUCTS

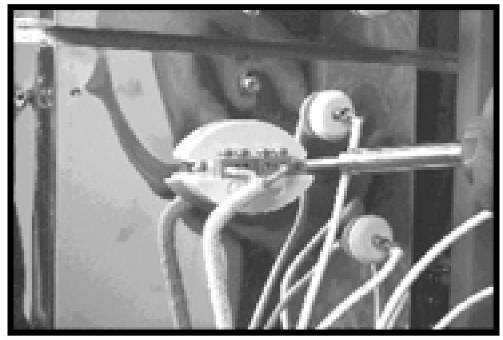
Brick Replacement

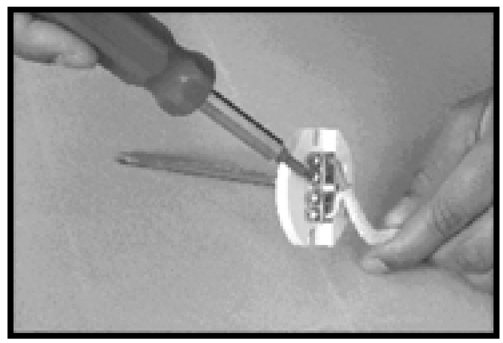
Always Unplug The Kiln Before Working On It!

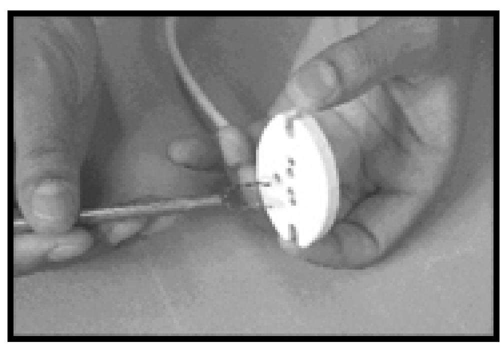
1. Order needed bricks from the parts list available from your Skutt dealer. Replacement of terminal bricks involves cutting and renewing element connectors and should normally be postponed until it's necessary to replace that element.
2. If repairing a top ring, disconnect the lid and remove all fittings from the jacket.
3. Remove the screws that hold the control panel to the kiln. Swing the panel open. Slide the connectors off the terminal strip (they are pre-numbered for easy identification). Unplug the thermocouple tabs which are marked positive and negative. Lift the box straight up to remove it. Place on a clean flat surface.
4. Place the ring, damaged side up, on a perfectly flat surface such as the kiln lid.
5. Pull out the straight element pins at the ends of the damaged brick.
6. Gently lift elements from troughs with a pick or long-nose pliers and gently lift them out into firing chamber just far enough to allow damaged brick to be slipped out. Remember that the elements are brittle.
7. Loosen the worm-type jacket fasteners equally, 1/2” to 3/4”.
8. Make sure element troughs in the brick are proper side up. Insert the new brick. This is easiest if a helper holds the adjoining bricks away.
9. Hold the worm-type jacket fastener housings with pliers and tighten them evenly until they meet resistance. Slip elements into new grooves and pin down.
10. Use sandpaper over a wood block to sand the edges of new brick down flush with its neighbors. Vacuum thoroughly when sanding is completed.
11. Replace hinges and hardware, and position the kiln so you can finish tightening the jacket just before the kiln shuts off on your next Cone 06 or hotter firing.

SKUTT CERAMIC PRODUCTS

MI Cable Thermocouple Replacement







1. Unplug the kiln from the power source to avoid electrical shock.
2. Remove the sheet metal screws from the left side of the KM control box.
3. Swing the control box open to expose the thermocouple wiring. This wiring is the yellow and red wiring with a yellow covering. Remove the two spade connectors attaching the wiring to the bottom of the terminal block.
4. Remove the two sheet metal screws attaching the white porcelain thermocouple block to the stainless steel heat shield. Carefully slide the thermocouple assembly out of the kiln taking care not to damage the kiln brick.
5. Remove the old thermocouple from the porcelain thermocouple block by loosening the two center screws on the block and sliding out the old thermocouple element.
6. Install the new MI Cable thermocouple leads into the thermocouple block taking care to insert the negative thermocouple lead into the negative side hole of the block. The lead wires must be slightly bent to align with the holes in the thermocouple block. Red will always be negative, so line up all red wires with any negative connection points. One lead of the thermocouple will be dyed red. Tighten the center screws on the block to hold the wires in place. Do not overtighten the screws as the wires may be cut off.
7. If your kiln was previously equipped with a 1/2" diameter thermocouple, the 2 1/2" long ceramic thermocouple adapter tube must now be inserted into the existing 1/2" thermocouple hole of your kiln. The ceramic adapter tube is slightly larger than 1/2" hole in your kiln in order to ensure a snug fit. Install the tube by slowly twisting the adapter tube into the kiln hole. Continue this process until the tube is inserted as far as the heat shield will allow. Now gently push or tap the ceramic tube the rest of the way into the kiln hole until it is flush with the outer skin of the kiln. The adapter tube may be inserted from the inside of the kiln if desired using this same procedure. The 2 1/2" ceramic tube is suitable for use with 2 1/2" and 3" kilns.

(continued)

MI CABLE THERMOCOUPLE REPLACEMENT

8. Slide the new MI Cable thermocouple and block assembly into the kiln and fasten in place on the heat shield using the two sheet metal screws you removed during disassembly.
9. Fasten the yellow and red thermocouple lead wire spade connectors back up to the terminal block of the control box. Ensure the negative (red) and positive leads are properly fastened.
10. Close the control box and check to ensure that lead wires are not pinched. If pinching occurs, reroute the wires and close the control box. Reinstall the sheet metal screws to hold the control box shut. Do not overtighten the sheet metal screws as stripping can occur.
11. Plug the kiln in. If a “PF” message appears in the display window, clear it by pressing “ENTER”. Observe the display and ensure that the room temperature is displayed. If the proper room temperature is displayed, go to step 12. If the message “FAIL” appears in the display window, the thermocouple has been connected improperly or a lead wire is not connected. Inspect all thermocouple connections and repeat step 11.
12. Program the kiln and start the kiln firing. Observe the temperature long enough to ensure that it is <u>increasing</u> and that the display is steady. If the temperature decreases, the thermocouple leads have been installed in reverse and must be correctly installed. If the display is jumpy, a loose connection may be present.

DO NOT FIRE WARE UNTIL STEP 12 IS COMPLETED AND A TEST FIRING USING PYROMETRIC CONES HAS BEEN PERFORMED!

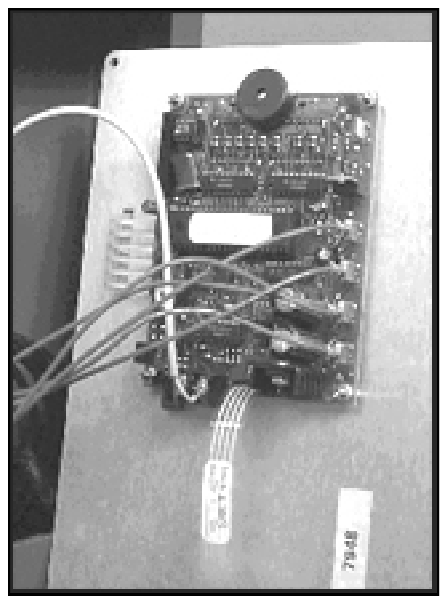
SKUTT CERAMIC PRODUCTS

Touchpad Replacement

The touchpad and circuit board of your automatic kiln are combined into one modular unit. Replacement of a faulty or upgraded unit is an easy operation.

To remove the touchpad from your automatic kiln, follow these instructions:

1. Unplug your kiln from the wall receptacle. Make absolutely certain that there is no power to your kiln.
2. Remove the four, black screws that attach the touchpad to the control box. (on older models it may be necessary to remove the control box from the kiln and remove the heat baffle from the control box in order to change the touchpad. Nuts and bolts were used on these units instead of sheet metal screws.) The lower right hand screw on the touchpad holds a small "star" washer in place on some models. This washer is located between the touchpad and the metal control box and serves as a grounding aid. Do not lose this washer. It must be replaced when the unit is reassembled. If you are receiving a new, replacement touchpad the star washer should be attached.



3. Carefully pull the touchpad away from the control box, exposing the internal wiring. Do not pull the wiring too hard as the leads to the transformer may be damaged. Identify and label the four control leads (red wires) attached to the circuit board. Number these leads 1 thru 4 using masking tape or other labeling means.
4. Identify the thermocouple wire (yellow wire) and note where this wire is connected to the circuit board.
5. Remove the red wires from the circuit board by pulling on the connectors and using a rocking motion. Now remove the yellow thermocouple wire using a Phillips screw-driver. Note that the yellow wire has a red lead and a yellow lead. These colored leads correspond to yellow and red marks on the terminal block to which they are attached.
6. Put your touchpad in a safe place. Some touchpads have a small metal switch in the upper left hand corner. Do not damage this switch.

(continued)

TOUCHPAD REPLACEMENT

To install your new touchpad follow these instructions:

1. Examine your new touchpad. Check it for any shipping damage. Your new touchpad will not have the small metal switch (this switch was removed due to an equipment upgrade). If everything looks okay, proceed.
2. Follow the steps 1 thru 5 on the previous page in reverse order. Be certain the yellow thermocouple wiring is properly attached to the circuit board terminal block, yellow wire in yellow spot and red wire in red spot. Hold the black terminal block with your fingers when tightening the attachment screws. It is possible to twist the terminal block loose from the circuit board if the terminal block is not securely held in the fingers. [When you re-mount the touchpad be sure to properly replace the star washer or install the one supplied. Scrape the paint from the control box if necessary to ensure the star washer seats against bare metal.] Do not overtighten the screws holding the touchpad in place. The screws should only be snug.
3. When the touchpad is replaced, plug your kiln in to the power supply and check for proper operation.
4. Your installation is complete.

SKUTT
CERAMIC PRODUCTS

KM Relay Replacement

1. Unplug the kiln from the wall receptacle.
2. Remove the 6 (or 4) sheet metal screws attaching the control box to the kiln body.
3. Swing the control box open to expose the internal wiring.
4. Remove the wires from the terminal strip by pulling gently. You should remove the white, numbered element feeder wires and the two thermocouple wires.
5. Remove the control box from the kiln by lifting the box upward off the hinges.
6. Cradle the control box upside down on a soft flat surface. Be careful not to break off the touchpad switch if present on your model. If necessary elevate one end of the control box with a pillow or rolled up towel to keep the switch from hitting any hard surfaces.
7. Remove the sheet metal screws that hold the fiberglass lined heat baffle in place. Remove the heat baffle and swing it to one side taking care not to damage the attached wiring.

8. Inspect the screws holding the relays in place. If sheet metal screws are used, proceed to step 11. If machine screws and nuts are used, proceed to step 9.
9. Remove the power cord wiring from the terminal block. It may be necessary to loosen the power cord strain relief to gain access to the relay chassis. Remove the power cord from the control box.
10. Remove the two machine screws and nuts holding the relay chassis in place.
11. Identify and tag the wiring to the faulty relay. Remove the wires to the relay by loosening and removing the push on connectors.
12. Remove the two screws holding the relay in place. It is only necessary to lift up the chassis far enough to gain access to the nuts securing the machine screws in place if machine screws are used. If sheet metal screws are used, simply remove them and the relay. Do not loosen or remove the relay chassis.
13. Remove the faulty relay.
14. Install the new relay by reversing the above directions.

KM RELAY REPLACEMENT

Body copy information starts here. You get some text going for a while, and then pretty soon you'll need a subhead. Why look here:

SUBHEAD GOES HERE

Then your next paragraph starts. And on it goes.

SKUTT CERAMIC PRODUCTS

Phase Conversions

THE KM1227 / KM1027 CONVERSION PARTS:

3-Phase to 1-Phase Conversion

1. 6 gauge power cord with ring tongue connectors and plug end.
2. 1-phase terminal block
3. 1-phase strain relief (hole for power cord must be enlarged to 1 5/16")
4. 1-set primary harness wires (connects terminal block to relays) consisting of:
   a. Six 14 gauge wires, eight inches long with push on connectors
   b. two 18 gauge transformer wires twelve inches long with push on connectors

1-Phase to 3-Phase Conversion

1. 3-phase power cord with plug end and 10 gauge wires
2. 3-phase terminal block
3. 3-phase strain relief with two large and two small reducing washers. (hole for power cord must be reduced from 1 5/16" to 0.812").
4. 1-set primary harness wires (connects terminal block to relays) consisting of:
   a. Six 14 gauge wires, eight inches long with push on connectors
   b. two 18 gauge transformer wires twelve inches long with push on connectors

3-Phase to 1-Phase Conversion

1. 6 gauge power cord with ring tongue connectors and plug end
2. 1-phase strain relief (hole for power cord must be enlarged to 1 5/16")
3. 1-set primary harness wires (connects porcelain block to all switches, timer, and pilot light)nversion

1. 3-phase power cord with plug end.
2. Crimp connectors for 3 phase wires
3. Insulating cover for crimp connectors
4. Pilot cord with 4 prong plug.
5. 3 phase contactor box.
5. 3-phase strain relief with two large and two small reducing washers. (hole for power cord must be reduced from 1 5/16" to 0.812").
6. 1-set primary harness wires (connects phase wires to switches).

Element replacement guidelines for all phase conversions. (3 to 1,1 to3, KM or KS kilns)
240 v. to 240v.…….. No element change is necessary.
240 v. to 208 v……... All elements must be changed.
208 v. to 240 v……... All elements must be changed.
208 v. to 208 v……... Center elements must be changed

SKUTT
CERAMIC PRODUCTS

Preventative Maintainance

All Kilns:

1. Vacuum floor and element grooves regularly.Carefully vacuum around thermocouple and elements. Leave KM kilns plugged in when you are vacuuming to ground any static charges that may occur at the nozzle tip of the vacuum. Try to keep the vacuum away from the touchpad area.
2. Inspect Plug and Wall receptacle for any indication of excessive heat. Replace both plug and receptacle if necessary.

KM Kilns

1. Inspect the thermocouple for cracks or bends which could cause failure. Check and tighten thermocouple screw connections at the porcelain block. The thermocouple electronic circuitry may drift out of calibration. You can monitor the performance of your kiln with witness cone placed in the kiln. If the controller needs adjustment to fire hotter or cooler you can program a cone fire offset adjustment on the controller.

2. Inspect connections at the terminal strip. If any feeder wire or thermocouple connections are loose you can tighten the screws that hold the tabs with the tabs in the most counter-clockwise position possible. If the connectors are loose do not pinch the female connectors with a pliers replace them. Pinching can distort and minimize the electrical contact area in the connector.

3. KM1231-3PK and KM1227-3PK have screw type element connectors at the element ends that may need tightening periodically.

Kiln Sitter (KS) kilns

1. The tube assembly should be inspected and cleaned of any debris in the tube. The sensing rod should move freely in the tube.
2. The sensing rod should be replaced if the tip is worn too thin or otherwise damaged.
3. The falling weight and claw adjustments should be checked with the gauge washer periodically.

SKUTT CERAMIC PRODUCTS

KM Offset Instructions

Steps for changing the KM offset values.
For the message: oFOS (degrees F Offset) for each cone value.

ACTION	DISPLAY
1. Press CONE FIRE mode button. ------------------------------------ The display is alternating with ConE and the current cone value.	ConE / 04
2. Enter 909 to get cone offset mode ----------------------------------	909
3. Press ENTER. ---	ConE / 04
4. Enter the cone number you wish to offset...(for example 06) --	ConE / 06
Press ENTER --	**oF0S** / 0000

The display shows the degrees **F offset** alternating with the current value.

NOTE: the negative sign is not available on the keypad so we use a 9 to denote negative.

Example: 9015 subtracts 15 degrees F from the program for a cooler firing.
0015 adds15 degrees F to the program for a hotter firing.
0000 indicates no offset for a given cone.

ACTION	DISPLAY
5. Enter the number of degrees you want offset ----------------------	0025
Press ENTER --	Cone / 06
6. Enter the cone number again --	06
Press ENTER --	Spd / Med
7. Enter the rate you want SLo, MEd, FASt -------------------------	Med
Press ENTER --	HOLd / 00.00
8. Enter the hold time you want (ten minutes = 00.10) -------------- (1 hour and 30 minutes = 01.30)	00.10
Press ENTER --	StOP

The offset is done and the display should read the ambient temperature in the kiln now.
<u>The offset only applies to the specified cone in the Cone Fire Mode</u>.
This adjustment will not change the CONE TABLE values in the controller.
The offset adjustment will remain in memory even if the power is turned off.

SKUTT
CERAMIC PRODUCTS

Specifications

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SKUTT CERAMIC PRODUCTS

KM Kiln Specification Sheet

Electrical requirements for Skutt Automatic Kilns and KilnMaster Controller

Model	Volts	Amps	Watts	Copper Wire Size*	Fuse or Breaker Size	NEMA Receptacle Configuration
KM-614-3	115	20	2300	10	30	(Canada) 5-30
KM-614-3	115	20	2300	10	30	5-20
KM-714	240-208	20	3600	10	30	14-30
KM-818	240	26.7	6400	8	40	6-50
KM-818	208	26.7	6400	8	40	6-50
KM-818-30A	240	21.7	5200	10	30	6-30
KM-818-30A	208	24.0	4900	10	30	6-30
KM-1018	240	38.5	9250	6	50	6-50
KM-1018	208	40	8320	6	50	6-50
KM-1027	240	48	11520	6	60	6-50
KM-1027	208	48	9984	6	60	6-50
KM-1027 3ph	240	29.3	11520	8	40	15-50**
KM-1027 3ph	208	31.3	11000	8	45	15-50**
KM-1227	240	48	11520	6	60	6-50
KM-1227	208	48	9984	6	60	6-50
KM-1227 3ph	240	29.3	11520	8	40	15-50**
KM-1227 3ph	208	31.7	11000	8	45	15-50**
KM-1	240-208	Switching Capacity			48	6-50
KM-1 3ph	240-208	Switching Capacity			40	15-50

Model	Volts	Amps	Watts	Max. Cone	Copper Wire Size*	Fuse or Breaker Size
KM-1231PK	240	72	17300	10	2	90
KM-1231PK	208	80	16640	10	2	100
KM-1231PK-3ph	240	44.5	17300	10	6	60
KM-1231PK-3ph	208	51.5	17300	10	6	60
KM-1227PK	240	60	14300	10	4	80
KM-1227PK	208	69	14300	10	2	90
KM-1227PK-3ph	240	40	14300	10	6	50
KM-1227PK-3ph	208	46.7	14300	10	6	60

***An electrician will need to make the electrical connection.** The kilns are "hard wired" to allow for greater amperage. For each additional 50 feet use heavier wire, numerically two numbers lower—for example, instead of #6, use #4. If you anticipate installing any larger kiln in the future, use the heavier wire.*

**For runs longer than 50 feet use heavier wire, numerically two numbers lower—for example, instead of #10, use #8. If you anticipate installing any larger kiln in the future, use the heavier wire. **See special instructions and wiring diagram.*

(continued)

SPECIFICATIONS

KM KILN SPECIFICATION SHEET

Additional Power Notes

Three-phase operation. Only special order Model KM-1027 and KM-1227 will operate on a three-phase supply. However, any Skutt kiln can be properly powered via unbalanced connection to two of the three hot wires of a three-phase supply. Of course, the green safety ground connection provided in all Skutt power cords is also used.

Three-phase installation. Three-phase Models KM-1027 and KM-1227 can be plugged directly into a three-phase (15-50R) wall receptacle.

208 versus 240 supplies. As you can see from the chart, most Skutt models are available in either 208 or 240 volt versions. The exception is Model KM-714 which is universal, and will fire with 240V or 208V power.

The "120/208V" supply is increasingly encountered in schools and newly-built communities, because it's more efficient for heavy 120V loads. This affects Models KM-818, KM-1018, KM-1027 and KM-1227 because their elements receive the full 208 (or 240) applied volts. The 208V versions should never be fired on a 240V supply without first installing a full set of 240V elements. Otherwise, all components will be seriously overtaxed.

Important! Connecting and testing Model KM-714. The wall outlets for Model KM-714 must be powered by 3-wire 120/240-208V solid neutral supply—as for an electric range. Only No. 10 wire is required (or No. 8 for runs over 50 feet). 30 Amp fuses or circuit breakers only—no larger or smaller—are recommended. The U-shaped fourth blade of the 4W30 Amp grounding plug is for the pure green wire grounding of the kiln case. The blade opposite this U-shaped one takes the white solid neutral wire. See the photo below and refer to the wiring diagram in Appendix 5 for the 714 plug diagram.

SKUTT CERAMIC PRODUCTS

Old Style Kiln Conversion

KS MODELS	A SERIES MODEL #	OLD STYLE MODEL #
KS1227-3	1227-3	280-3
KS1027	1027	235 / 231
KS1027-3	1027-3	N / A
KS1018	1018	231-18
KS1018-3	1018-3	N / A
KS818	818	185
KS818-3	818-3	N / A
KS818WR	818 / WR	185 / WR
N / A	818P	181 (3-ht. sw.)
KS818P	818P	183 (inf. sw)
KS818P-3	818P-3	N / A
KS714	714	145
KS714-3	N / A	N / A
KS614-3	614-3	N / A
KS609	609	N / A
KS609-3	609-3	N / A

SKUTT CERAMIC PRODUCTS

PK Kiln Specification Sheet

Model	Volts	Amps	Watts	Max. Cone	Copper Wire Size*	Fuse or Breaker Size
KM-1231PK	240	72	17300	10	2	90
KM-1231PK	208	80	16640	10	2	100
KM-1231PK-3ph	240	44.5	17300	10	6	60
KM-1231PK-3ph	208	51.5	17300	10	6	60
KM-1227PK	240	60	14300	10	4	80
KM-1227PK	208	69	14300	10	2	90
KM-1227PK-3ph	240	40	14300	10	6	50
KM-1227PK-3ph	208	46.7	14300	10	6	60

***An electrician will need to make the electrical connection.** The kilns are "hard wired" to allow for greater amperage. For each additional 50 feet use heavier wire, numerically two numbers lower—for example, instead of #6, use #4. If you anticipate installing any larger kiln in the future, use the heavier wire.*

SPECIFICATIONS

SKUTT
CERAMIC PRODUCTS

KM Kiln
Element Resistance

MODEL	VOLT	PHASE	#1	#2	#3	#4	#5	#6
KM1227	240	1	13.6	13.6	16.3	16.3	13.6	13.6
KM1227	240	3	13.6	13.6	16.3	16.3	13.6	13.6
KM1227	208	1	11.7	11.7	14.4	14.4	11.7	11.7
KM1227	208	3	10.9	10.9	12.2	12.2	10.9	10.9
KM1027	240	1	13.6	13.6	16.3	16.3	13.6	13.6
KM1027	240	3	13.6	13.6	16.3	16.3	13.6	13.6
KM1027	208	1	11.7	11.7	14.4	14.4	11.7	11.7
KM1027	208	3	10.9	10.9	12.2	12.2	10.9	10.9
KM1018	240	1	11.7	11.7	11.7	11.7		
KM1018	208	3	9.7	9.7	9.7	9.7		
KM818	240	1	10.3	6.9	6.9	10.3		
KM818	208	1	8.9	6	6	8.9		
KM818-30A	240	1	12.7	8.5	8.5	12.7		
KM818-30A	208	1	9.9	6.7	6.7	9.9		
KM714	240	1	11.4	5.7	5.7			
KM714	208	1	11.4	5.7	5.7			
KM614	115	1	5.5	5.5	5.5			

SKUTT CERAMIC PRODUCTS

KilnSitter Kilns Element Resistance (TESTED THROUGH THE PLUG)

How to measure element resistance through the power cord on Kiln Sitter type kilns.

1. Unplug the kiln.
2. Turn all the switches to OFF.
3. Lift the falling weight and press the main plunger button ON. Gently lower the falling weight so it will not turn off the kiln or place a cone in the sitter to allow the claw to hold the weight in the upright position.
4. Turn the desired section switch to LOW, MED, then HIGH settings and measure the ohms of resistance across the 2 flat blades on the power cord for each setting. Compare your ohm meter readings to the ohm reading chart for kiln sitter type kilns.

NOTE: On three phase kilns you will have 3 flat blades on your power cord and you will have to try all three combinations of flat blades to determine which 2 blades are connected to the switch you are testing.

5. If your resistance readings are 1.5 ohms more than the listing in the chart then the section you are testing is considered to have worn out elements. Worn out elements will not allow the kiln to reach the rated temperature for the kiln.

		240 VOLTS			208 VOLTS		
MODEL		HIGH	MED.	LOW	HIGH	MED.	LOW
1227, 280	Bottom	13	23	55	11	19	48
	Center	16	33	65	14	28	57
	Top	13	33	55	11	28	48
1227 3ph, 280 3ph	Bottom	13	23	55	11	19	45
	Center	16	33	65	12	24	48
	Top	13	33	55	11	24	45
1027, 231, 235	Bottom	13	23	55	11	19	48
	Center	16	33	65	13	28	56
	Top	13	33	55	11	28	48
1027 3ph, 231 3ph, 235 3ph	Bottom	13	23	55	11	19	45
	Center	16	33	65	12	24	48
	Top	13	33	55	11	24	45
1018, 231-18	Bottom	12	19	48	9	16	40
	Top	12	29	48	9	24	40
818	Bottom	16			15		
	Top	16			15		

(continued)

KILNSITTER KILN ELEMENT RESISTANCE

		240 VOLTS			208 VOLTS		
MODEL		HIGH	MED.	LOW	HIGH	MED.	LOW
818 WR	Bottom	16			15		
	Center	16			15		
	Top	16			15		
818 P	Bottom	21			16		
	Top	21			16		
818 P WR	Bottom	21			16		
	Center	21			16		
	Top	21			16		
181, 180	Bottom	5.5	11	22			
	Top	5.5	11	22			
181-13	Bottom	23	23	23	19		
181-27	Bottom	19.8			17		
	Center	19.8			17		
	Top	19.8			17		
183	Bottom	22			17		
	Top	22			17		
183-27	Bottom	22			18		
	Center	22			18		
	Top	22			18		
185	Bottom	18			16		
	Top	18			16		
714, 145	Bottom	6	12	24			
	Top	11	11	0			
614	Bottom	8.5					
	Top	16					
129	Bottom	8.6	8.6	17			
	Top	8.6					
10F		8					
12F		8					
Pinto		7.5					
Octagon Fuser		15					

SKUTT CERAMIC PRODUCTS

Wiring Diagrams

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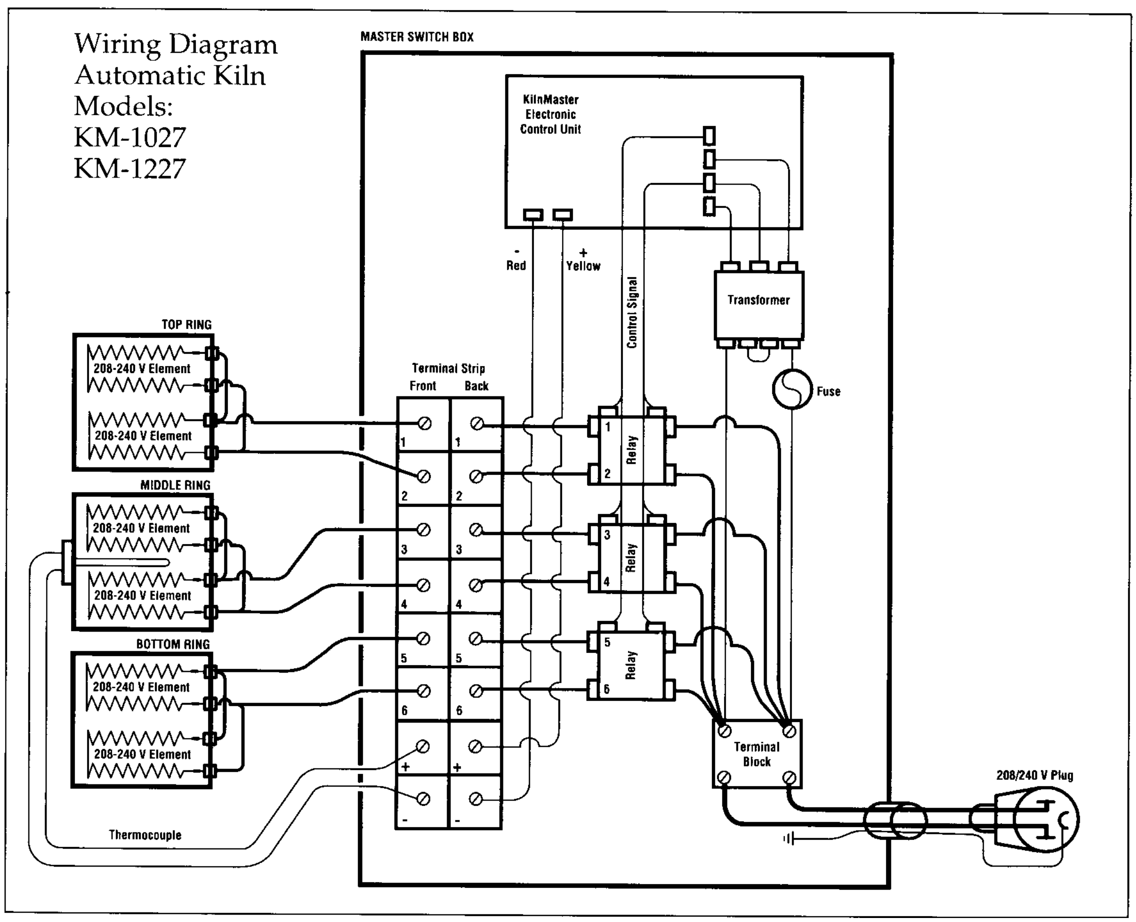
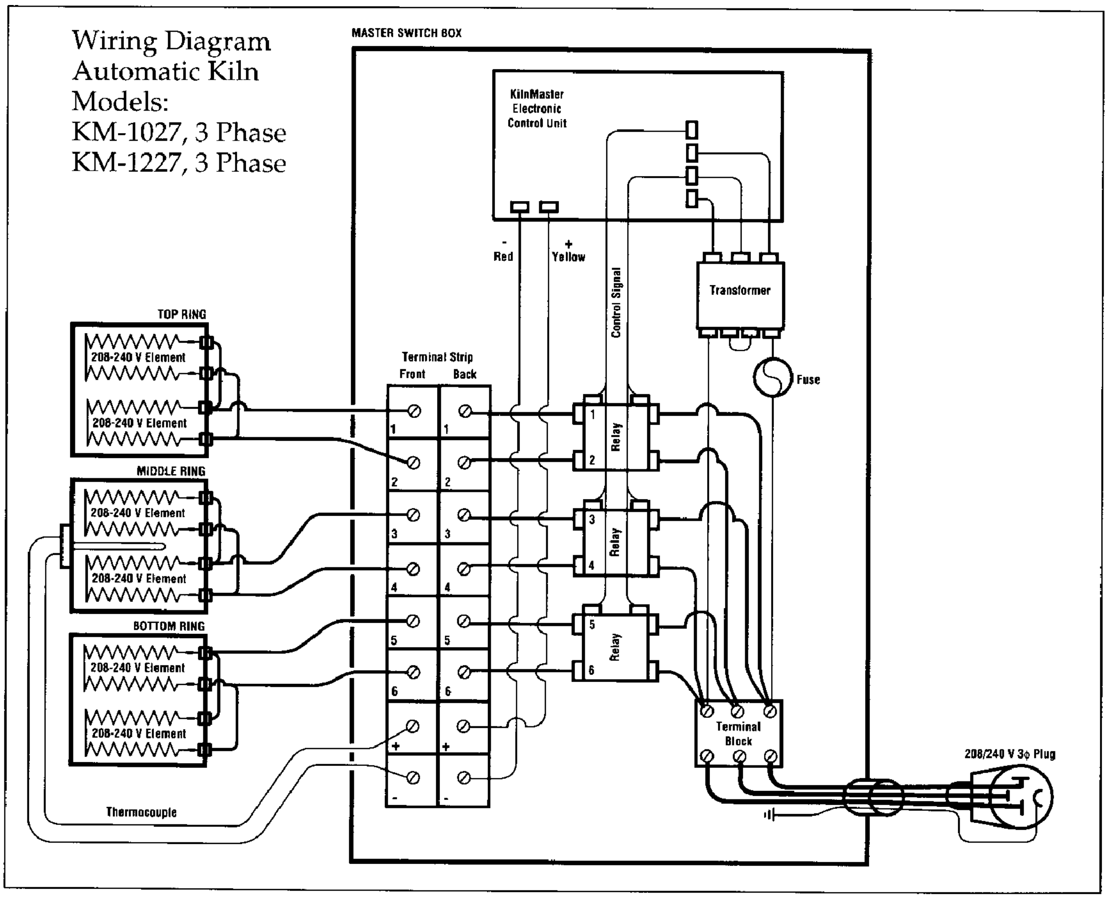
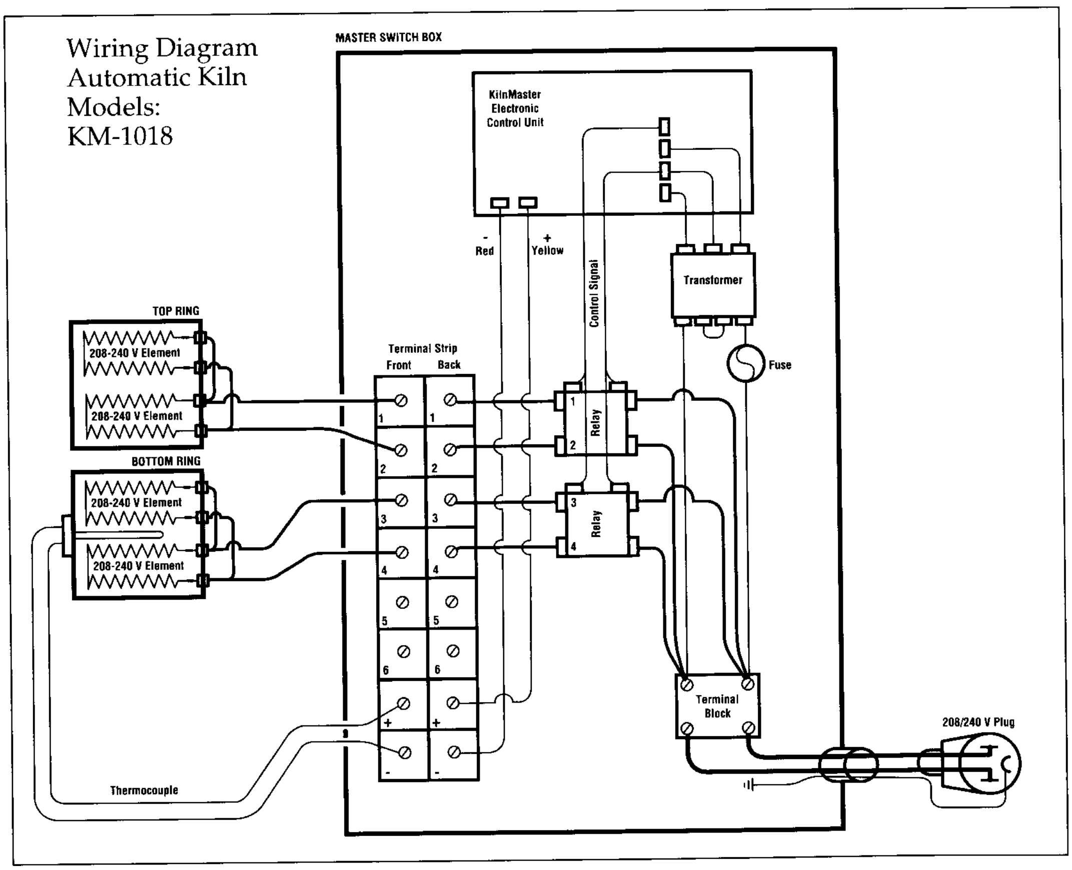
KM1227/KM1027 Wiring Diagram



KM1227 3PH/KM1027 3PH Wiring Diagram

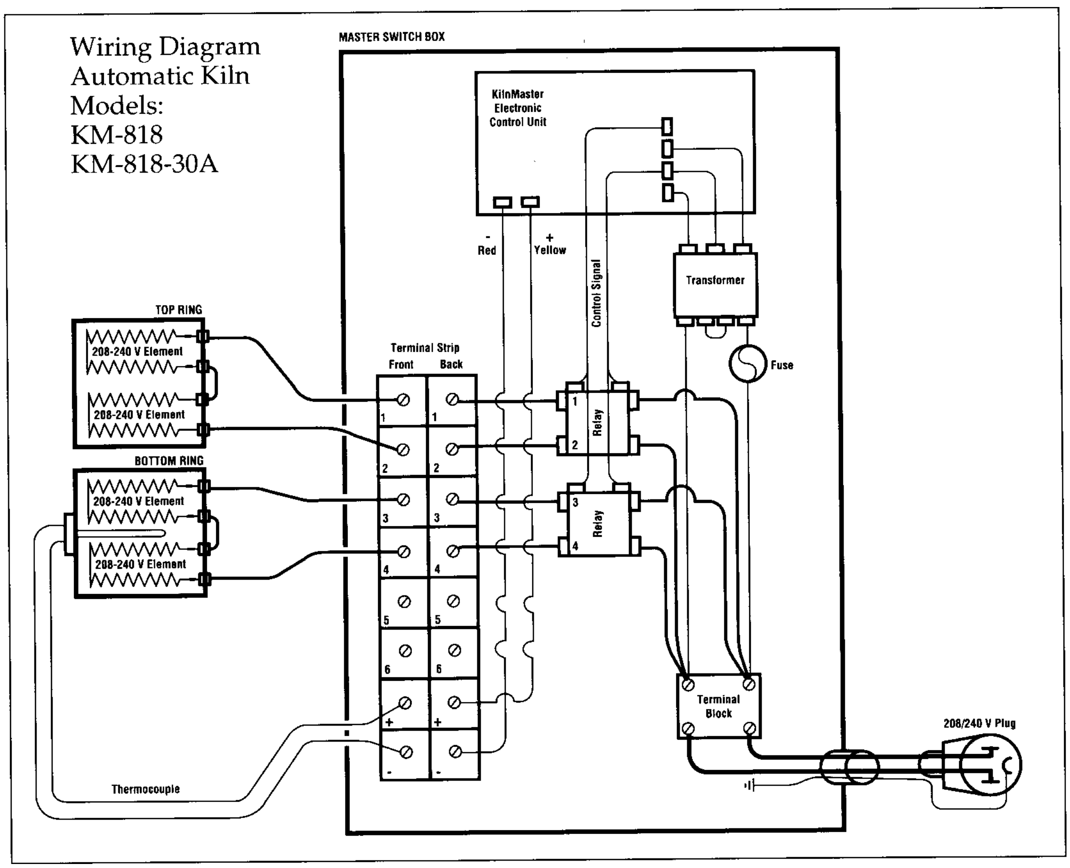


KM1018 Wiring Diagram

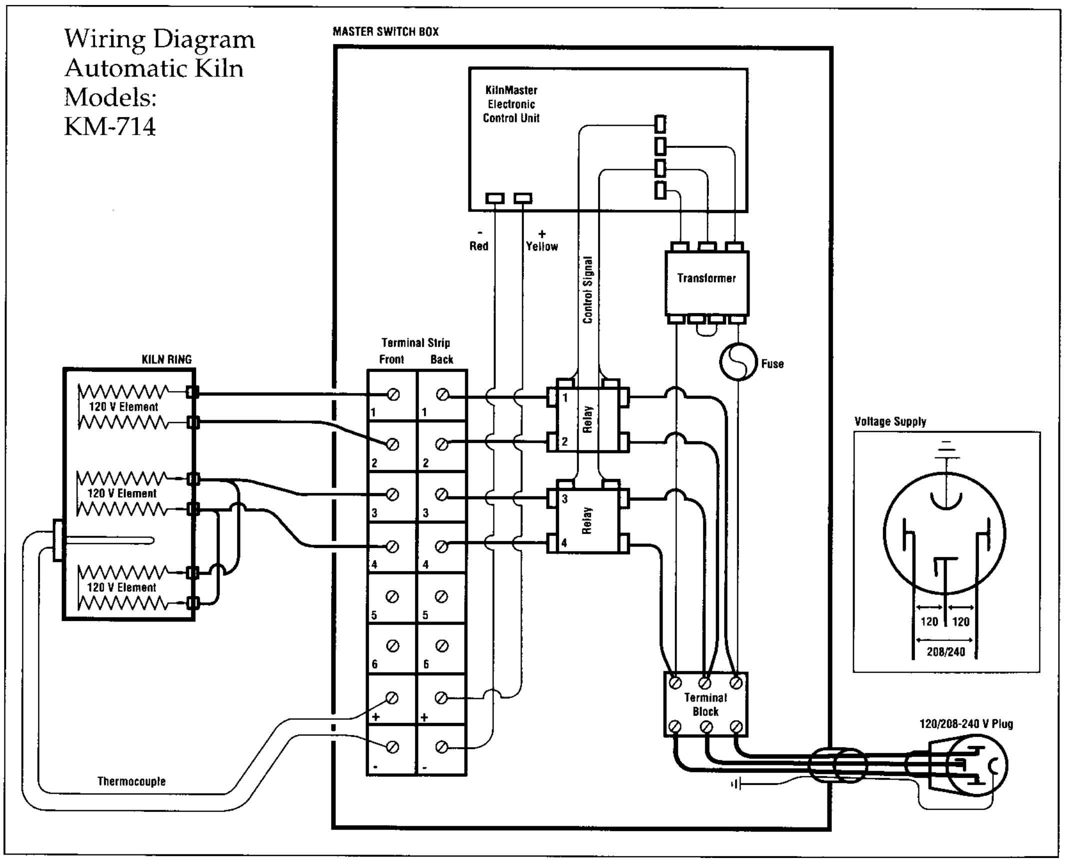


SKUTT
CERAMIC PRODUCTS

KM818
Wiring Diagram

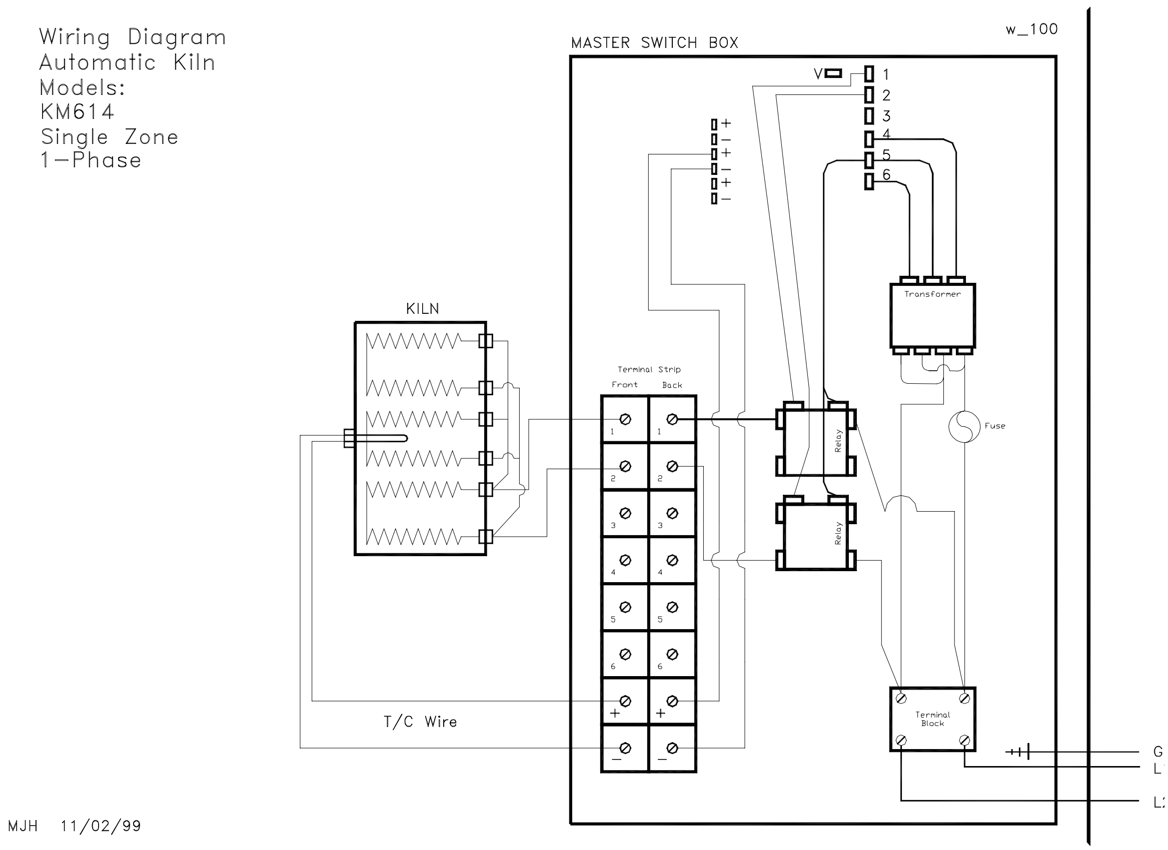


KM714 Wiring Diagram



SKUTT CERAMIC PRODUCTS

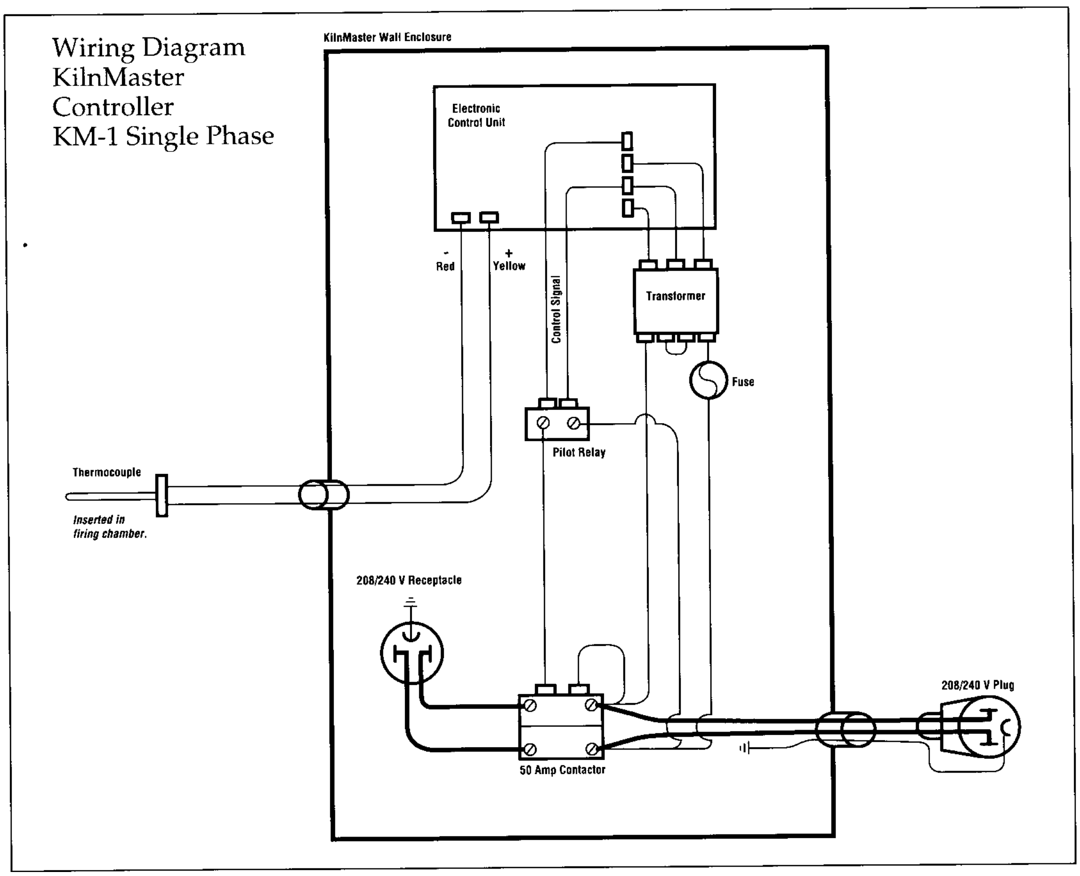
KM614 Wiring Diagram



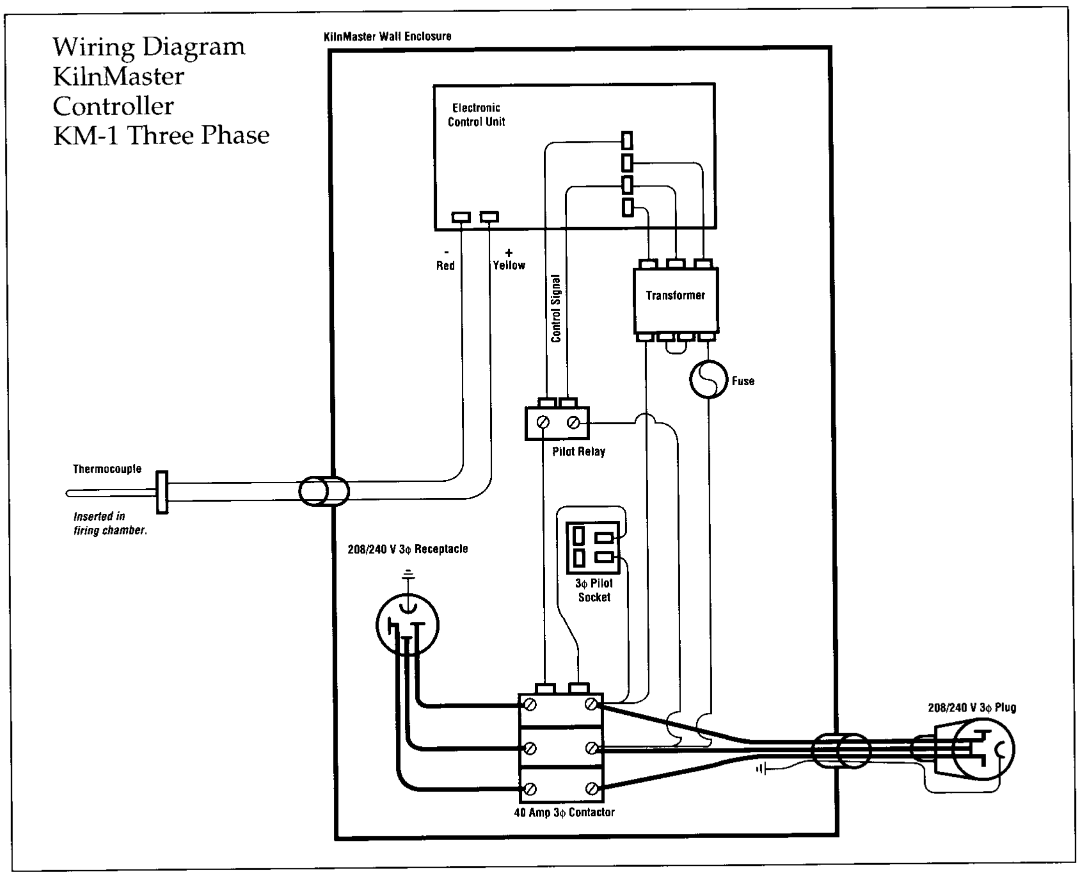
(continued)

SKUTT CERAMIC PRODUCTS

KM-1
Wiring Diagram

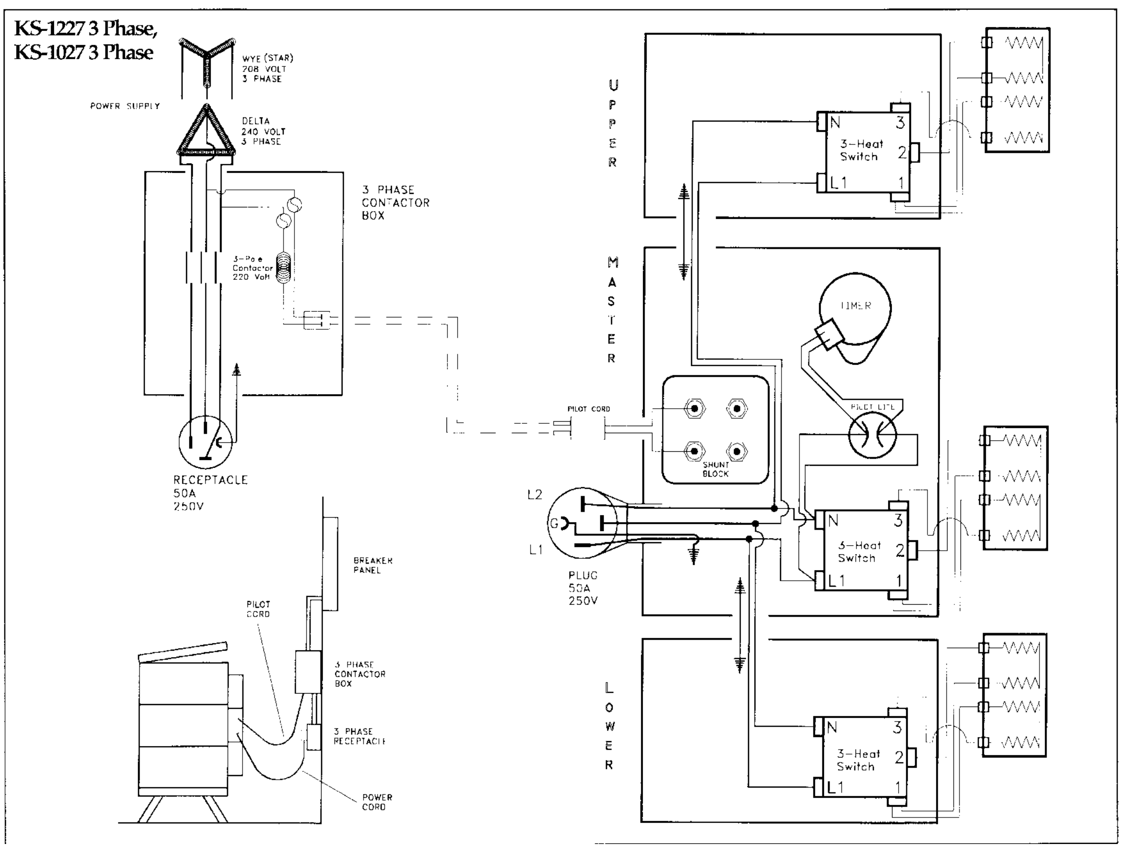


KM-1 3 PH Wiring Diagram

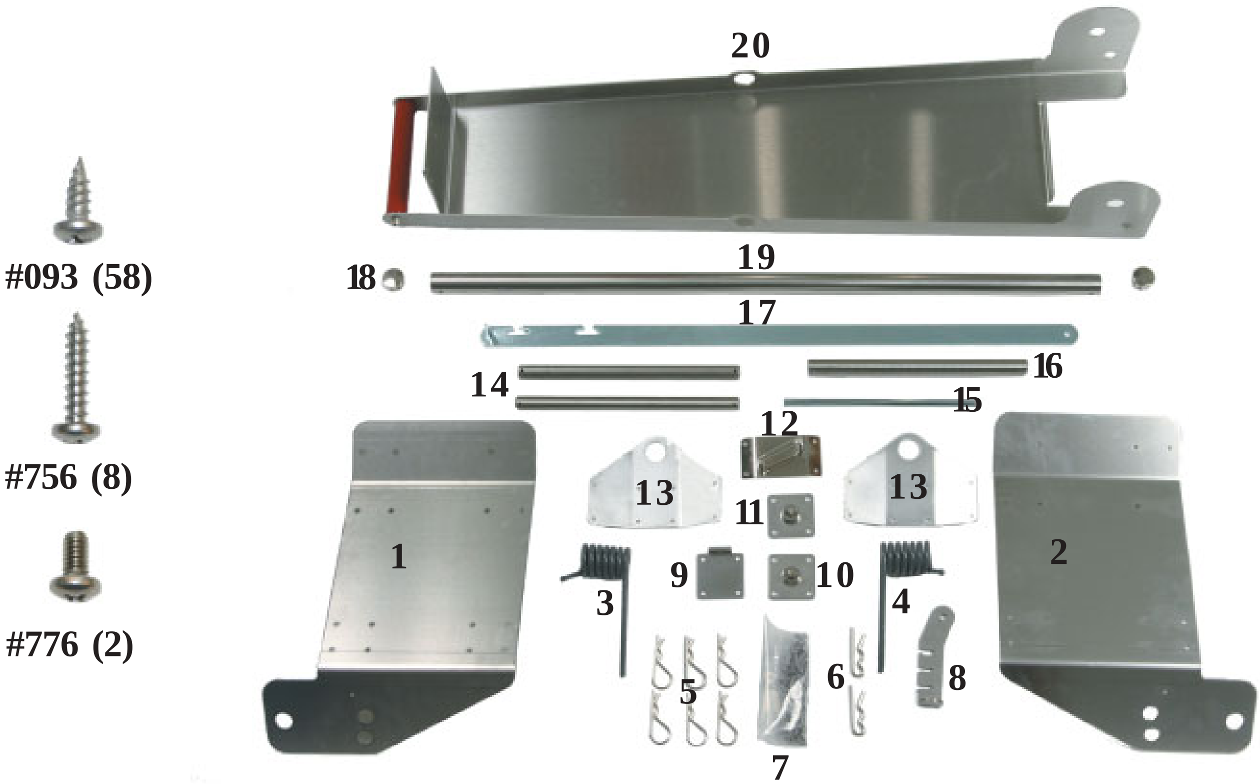


SKUTT
CERAMIC PRODUCTS

KS1227 3 PH/KS1027 3 PH Wiring Diagram



Lid Lifter Upgrade Kit



CONTENTS

1 Left Body Hinge
2 Right Body Hinge
3 Right Spring
4 Left Spring
5 Hitch Pins
6 Main Hinge Cotter Pins (2)
7 Bag of Screws (See detail)
8 Lid Prop Arm
9 Lid Prop Catch Plate
10 Lid Brace Pad
11 Prop Arm Pad (Threaded w/nut)
12 Lid Brace Bracket
13 Lid Pad Eye (2)
14 5/8” Spring Retainer Rod (2)
15 Strut Rod
16 3/4” Main Hinge Rod
17 Lid Brace
18 Metal Hole Plug (2)
19 Cross Bar
20 Lid Lifter Arm

(continued)

REQUIRED TOOLS

- 12 Volt or Higher Cordless Drill w/ #2 Phillips Head Bit

An underpowered cordless drill will make it difficult to set the screws into the band material. A Phillips screwdriver may also be used. If a screwdriver is used it will be necessary to set the screws by hitting the screwdriver with the butt of your hand before screwing them in.

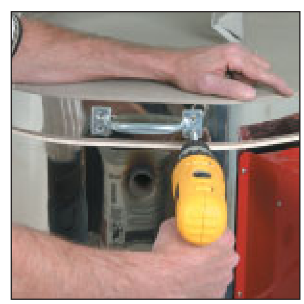
INSTALLATION INSTRUCTIONS

1. Open your Lid Lifter retrofit kit and examine the contents. Check to ensure you have all the items listed on the front page. A few items may look slightly different depending on the model you are upgrading but the number and general type will be the same.

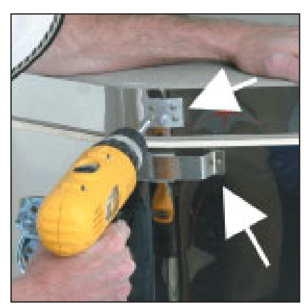
2. With your existing kiln lid closed, remove the following hardware from your kiln:

A. Remove Lid and Body Hinge Assemblies

B. Remove Lid Handle



C. Remove the Lid Brace, Lid Brace Pad, and Lid Brace Guide



LID LIFTER UPGRADE KIT CONTINUED

3. ***Tighten the lid band and upper section body band securely***. Use a little WD-40 or similar lubricant on the worm screws if they are corroded.

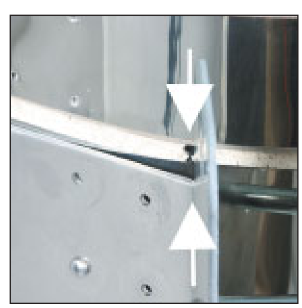
4. There will be sharp raised areas where the old sheet metal screws were on your lid and body band. These should be filed smooth or tapped flat gently with a small hammer to remove or flatten the burrs.

5. Attach the left and right lid lifter body hinges.

A. Attach the Strut Rod to the Left Body Hinge using a #776 machine screw.

B. Stand both body hinges up on a flat surface and attach the Right Body Hinge to the other end of the strut Rod

C. Slide the lid towards the front of the kiln so you can locate the seams on the rear brick The inside bends of the Body Hinges are going to align on these seams. Mark them with a pen so you can see them when the lid is slid back in position.

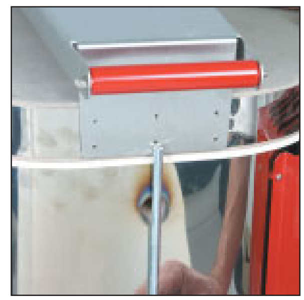


D. Align the Body Hinge Assembly so the edge is even with the top edge of the body band and the inside bend of the Body Hinges are in line with your marks. Secure with #093 screws beginning with the second column of holes in from the strut rod and working your way out. The first column of holes on each Body Hinge requires slightly longer screws so use the #756 screws.

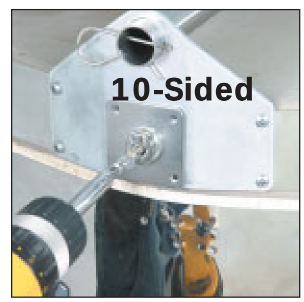
LID LIFTER UPGRADE KIT CONTINUED

6. Attach the Lid Lifter Arm

A. Ensure that the kiln lid is positioned and centered on the top section with the lid band buckles lined up with the body band buckles. Line up the 3/4" holes in the lid lifter arm with the 3/4" holes in the body hinges and pin in place using the 3/4" Main Hinge Rod. Placing something under the Arm helps prevent damaging the lid during this step. Lower the lid lifter arm so it rests on the kiln lid. Install the 2 Cotter Pins in the ends of the Main Hinge Rod, securing it in place.



B. Line up the bottom edge of the bent flange on the front of the lid lifter arm with the bottom edge of the lid band and center the flange on the lid band using the top peep plug hole as a reference. Secure the flange to the lid band using the #093 sheet metal screws.



C. Slide the 1" diameter Crossover Bar through the holes in the middle of the lid lifter arm and center the tube. Slide the two Pad Eyes over each end of the Crossover Bar and insert a Hitch pin on each end of the bar.

D. The Pad Eyes should be squared up with the lid band and fastened in place using the #093 sheet metal screws. The Lid Brace Pad mounts on top of the left Pad Eye. The position varies depending on the model. Check photos.

E. Insert the metal hole plugs into the ends of the Crossover Bar.

UPGRADES

LID LIFTER UPGRADE KIT CONTINUED

7. Install and Tension the Springs

A. With the lid closed, install the torsion springs on the main hinge rod as follows: Remove one hitch pin from the main hinge rod. Slide the main hinge rod out so that only one side of the hinge assembly is still hinged. Slide the torsion springs over the end of the main hinge rod taking care that the long ends of the springs are together and facing down. (See photo). Slide the main hinge rod back in place and reinstall the hitch pin.

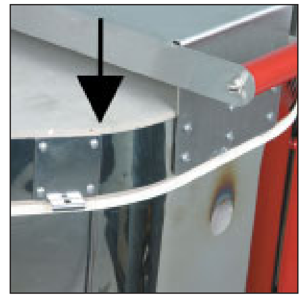
B. Slide the 5/8" upper spring retainer rod in place in the upper 5/8" holes ensuring that the upper ends of the torsion springs are behind the retainer rod. Install the hitch pins in the ends of the retainer rod.

C. Open the kiln lid fully about 10 degrees past vertical and allow the upper spring retainer rod to stop the lid movement. The lid should be stable and safe in this position. Install the 5/8" lower spring retainer rod in place using the outermost set of 5/8" holes in the body hinges. Ensure the lower ends of the torsion springs are behind the retainer rod. It may be necessary to push on the spring ends slightly to install the spring rod properly. Install the hitch pins in the ends of the spring retainer rod.

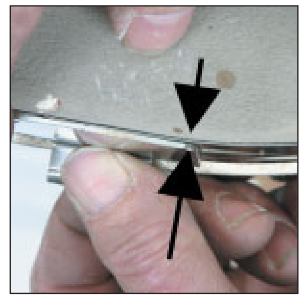
D. When the lid is carefully lowered, the torsion springs will be put in compression. Ensure that no one is standing behind the kiln when the lid is lowered until it is determined that all hinge parts are securely fastened and are working properly. Make a thorough inspection of all hinges, spring rods, etc. to ensure that nothing has worked loose.

LID LIFTER UPGRADE KIT CONTINUED

8. Install Lid Prop



A. The Lid Prop Plate should be located on the lid with the right edge of the plate flush with the first facet junction to the left of the handle. See photo.



B. To line it up position the Plate overlapping the facet junction and slide it back until there is no gap between the right edge of the Pate and the lid band. Line up the bottom edge of the Catch plate flush with the bottom edge of the lid band. Attach the Plate using #093 screws.

C. Position the Lid Prop Arm by placing the Prop Catch in the first notch and aligning the prop so it is perpendicular to the lid band. The Prop Arm should be able to rock back out of the closed position without catching on the Prop Catch. Secure the Prop Arm Pad with #093 screws.

8. Install Lid Brace

A. Attach the Lid Brace to the Lid Brace Pad. Be sure that 2 washers are used between the Lid Brace and Lid Brace Pad and 1 washer is used between the Lid Brace and the CotterPin

B. The Lid Brace Bracket position will be different depending on whether it is a 10-sided model or a 12-sided model. Use the photos to help position the bracket and then secure it with #093 screws.

LID LIFTER UPGRADE KIT CONTINUED

Congratulations! Your Lid Lifter Upgrade is now complete. Periodic checks should be made to the spring and hinge assembly to ensure all components are staying tight and in proper working order. A light lubricating oil may be applied to the main hinge rod if squeaking is present.

OPERATION

The lid prop and lid brace

The lid prop has several functions. The first notch in the Lid Prop holds the kiln lid down to ensure that the lid stays closed during the firing. Since the lid is extremely light there is a potential for the lid to be raised by the upward flow of heat radiation during the firing. ***Always be sure to fasten the Lid Prop before firing the kiln.***

The second to positions on the Lid Prop are used for venting. For normal venting use the second middle notch and for heavy venting use the top notch. After the kiln has reached 1000 F be sure to lower the lid and reset the Prop to the closed position for the remainder of the firing.

- ***Never use the venting positions if your kiln is equipped with a downdraft vent.***
- ***Always use gloves when operating the Lid Handle or Lid Prop when the kiln is hot.***

Your upgrade kit included a new style lid brace. This new lid brace has 2 positions. The first position is convenient for normal everyday use and the second opens the lid over 90 degrees so large objects can be lowered into the kiln without obstruction. The new brace also includes a safety stop to prevent the lid from opening too far.