fireright

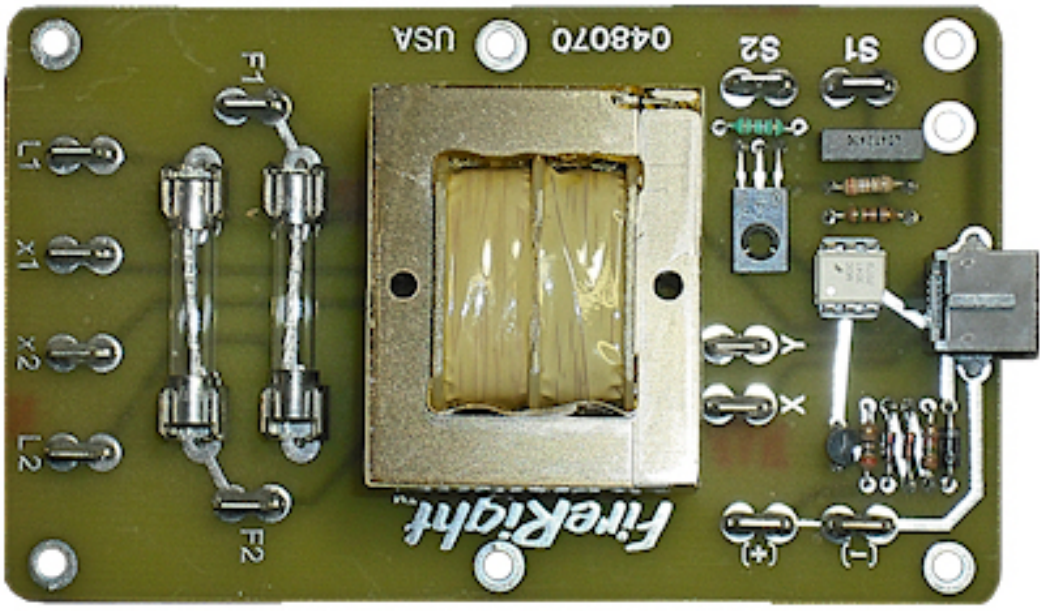
Troubleshooting Help for Power Controllers

What the Power Controller Does

Various models of *KilnTronics* ® and *FireRight* kiln temperature controllers use separate power controller boxes or panels to interface the high-voltage circuitry of the kiln with the low-voltage controller. These separate components provide low voltage power for the temperature controller, and accept low-level switching signals from the temperature controller, converting them to high-level power switching for the kiln's electric heaters. They also isolate the temperature controller from the kiln's high voltage electrical system.

Power Controller Circuit Boards

All but the very oldest FireRight *Power Controllers* and *Interface Panels* have a printed circuit board like the one shown here.[1] This board can work with either 110-120vac or 280-240vac, depending on the connections at its input terminals. (A wiring diagram is provided below.)



The two fuses are connected in series with both sides of the AC input power line. These are fractional amp time-delay, or "slow blow" type fuses, rated 1/8-Amp. The low level current rating is designed to protect the

[1] An earlier version of this board, part number 048025, is electrically identical, differing only in mechanical layout.

solenoid coils of mechanical power relays used to switch the kiln's heaters on and off. When these big relays, or "contactors," attempt to close, their solenoid coil draws up to ten times as much current as it will once the contacts are closed; upwards of one amp. The time-delay fuses and the solenoid coil will tolerate that momentary surge. If something prevents the big relay from closing successfully, that high "inrush current" will persist, and the fuses will blow, thus protecting the relay's solenoid coil from overheating, which blisters its plastic bobbin, thereby rendering it forever non-serviceable. Things that cause this are:

- contact chattering; sometimes caused by electrical interference disturbing the controller, loose connections, or a defective optical isolator ("MOC-3041," the small six-pin white chip on the power controller circuit board,)
- dust build-up or other foreign matter in the relay, which prevents its pole pieces from coming together completely, and
- low power line voltage at the kiln.

The large rectangular component is the middle of the circuit board is a small power transformer used to provide low-level power for the temperature controller. It converts the AC input voltage to a low, safe, level of 24-volts. The transformer has two failure modes.

- cracked pins – resulting from shock and vibration. For unknown reasons, the pins that crack are #1 or #4 on the input side (the left side in the above image) of the transformer. The intermittent connection results in arcing, which eventually results in carbon deposits at the crack, which is usually near the connection on the circuit board, which makes is easy to find this problem by visual inspection. The arcing causes electrical interference at the controller, which is likely to produce chattering.
- burn out – which causes discoloration the transformer's windings and usually an offensive order which results from burned varnish. This is always the result of incorrect power input connections; usually the 110-volt connections used for a 220-volt system.

The six-pin white chip is a "MOC3041" optical isolator. It actually has a small LED inside, optically coupled to a light-sensitive TRIAC switch. The temperature controller's output switches this tiny light source on and off to regulate as needed to control electric power to the kiln's heating elements. The output side of the optical isolator is used to trigger a larger TRIAC which, in turn, switches the large power relay on and off. Thus there is no electrical connection between the high-voltage sections in the power controller, and the output of the temperature controller.

- The MOC3041 has only one failure mode, which results in power relay chattering. Firings typically begin normally, but then the power

relay begins to click on and off randomly, with the frequency of this random switching gradually increasing until the relay is chattering almost constantly.

The MOC3041 is a low cost, commonly available component, which can be obtained from most distributors of electronic components.[2] It is socket-mounted, so easy to remove and replace. Observe polarity by paying attention to the dimple atop the chip, which identifies its pin #1. Make sure that is oriented as shown in the above image.

The 3-pin black component that looks like a power transistor is actually a "2N6073A" low-power TRIAC ... sort of an AC-capable transistor. It is controlled by the optical isolator, and switches current to the power relay's solenoid coil on and off.

- The 2N6073A rarely fails, but when it does it is usually in a mode that results in "half-waving," meaning that it switches only during half of the AC cycle. This is essentially the same as applying half the needed voltage to the power relay's coil, which results in constant chattering.

The 2N6073A is also a low cost, commonly available component, which can be obtained from most distributors of electronic components.[3] It is soldered into the circuit board, however, so its replacement requires removal of the board. Observe polarity by paying attention to the metal side of the plastic package, which must be resting against the surface of the circuit board. .

The gray, box-like component standing up adjacent to terminal "S1" is a 0.047µF metal film capacitor. It is used with its adjacent 39Ω resistor to provide a "snubber network" which helps to ensure that the 2N6073A TRIAC will always be able to turn-off successfully (i.e., will not occasionally latch up.) This capacitor has a rated "dc working voltage" of 400-volts. Electrical surges, such as are sometimes caused by nearby lightning strikes, can exceed that, causing the capacitor to break down internally and "explode," which also often burns out the 39Ω resistor.

- This is often an isolated type of failure, so the system might appear to be working properly, even though these components are obviously damaged. In that case, replacement of the snubber capacitor and resistor is all that is required.
- When the system is not working properly, and this sort of damage is found, a power line surge can be assumed to have also damaged the 2N6073A TRIAC, and possibly the MOC3041 optical isolator.

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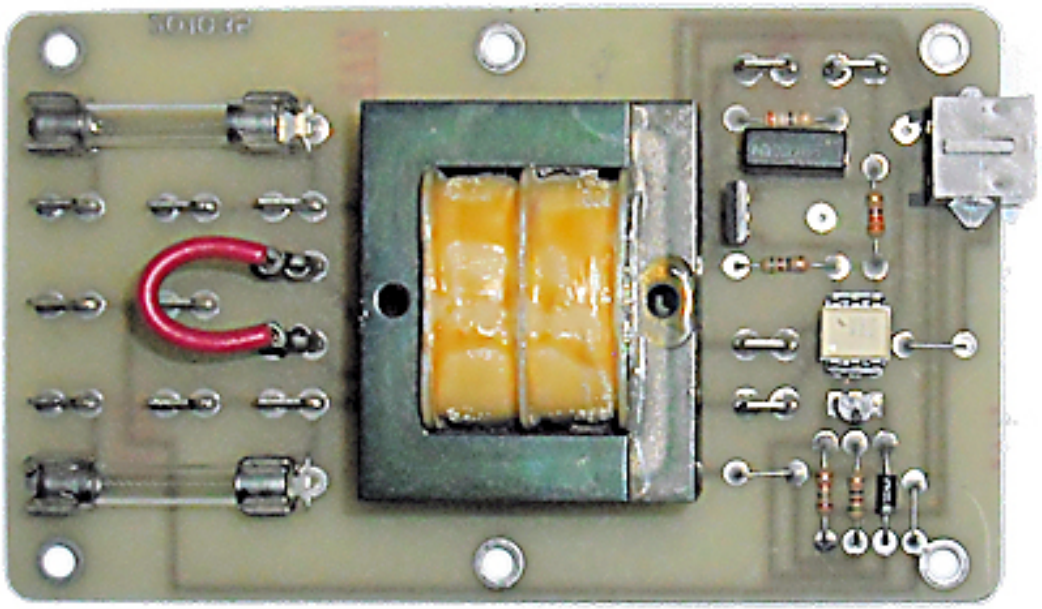
[2] Locally, or on the Internet: Digi-Key Corp of Thief River Falls, MN, Mouser Electronics of Fort Worth, TX.

[3] ditto note [2].

All of the remaining parts on the power controller circuit board are “passive components” which, for all practical purposes, never fail. When they do, they are almost always physically damaged and thereby visibly defective, and that will have been a secondary result of some other catastrophic failure. All of these are commonly available electronic components.

Older PCB Versions

An earlier version of this board, part number 048025, is electrically identical, differing only in mechanical layout.



Older Power Controllers

The earliest power controllers had no such printed circuit board. They had a separate dual fuse-holder, and used a commercial “solid state relay” such as the one pictured here:

The only failure mode associated with these devices is the “half-wave” chattering problem. The only solution is to remove the old one and replace it with a new one. They were mounted in screw-type terminal blocks, so

are easy to replace. They are still commonly available through electrical and electronic distributors[4] , and over the years have become less pricey.

Power Contactors

The large heating relays used in power controllers (or sometimes on-board the kiln itself) are known in the trade as “Definite Purpose Contactors” (or “DPC’s”). The smaller relay on the right can handle kilns rated up to 48-amps on single-phase 208-240vac power. The larger relay is used for all bigger kilns, and kilns wired for three-phase power.

Contactors rarely wear out, or fail of their own accord. As explained above, chattering or low voltage may cause their solenoid coils to over-heat, and since the coils are wound on plastic bobbins, the plastic melts, deforming the channel through which the relay’s armature must travel in order to close its contacts, thereby making the relay inoperable. Replacement solenoid coils are available for the larger contactors, but often cost almost as much as a whole new unit. So the usual fix in either case is to replace the contactor.

A second cause of failure is loose connections at the power terminals; the large screw terminals shown in the above images. The loose connection results in arcing, which causes heat at the terminal. The abnormal heating and cooling going on at the terminal causes expansion and contraction, which further loosens the connection and corrodes the copper wire connected to it. This progressive failure eventually causes the terminal to become red hot, which burns its plastic supporting structure, ruining the relay. This can always be prevented by making it a practice to periodically remove power from the system, then making sure that the screw terminals are tight. Once damaged, the only fix is to replace the contactor.

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[4] see note [2]

Upon inspection, the contacts of these large power relays usually look burned and charred, prompting the unaware to think about cleaning them up with a file or emery board. That should never be done. The charred appearance is normal, resulting from the actual melting of small spots in the silver on the contact pads, which is necessary to form a low-resistance electrical connection. Polishing up the contacts will not fix anything; it merely removes good silver from the contact, thereby serving to shorten its useful life.

Slow Kiln? Check the Electrical Service

If all the heating elements appear to be good (they all light up,) the next question is the electrical service itself. The kiln is probably wired for 220-240-volts. Overloaded electrical systems, bad circuit breakers, loose connections, and undersized wiring often result in lower voltages at the kiln, preventing it from reaching higher heats. Your electrician can easily check this out, if needed. Before making the measurement, turn the kiln full on, allow the elements to heat up somewhat, then make the measurement *at the kiln itself* at some point within the kiln's switch box. If the voltage at the kiln is much lower than the service's rated voltage, the electrician will be able to work backwards, taking measurement progressively further back toward the power source to see where the problem (a voltage drop) is developing.

Got the Right Heating Elements?

Electric kilns are most commonly designed for 220/240-volt single-phase power. An older standard provides 208-volts, and large kilns are sometimes designed for three-phase power systems. The heating elements in your kiln must match the line power of your electrical service. A rather common error is to replace the elements in a kiln designed for 208-volt systems with elements calibrated for a 220/240-volt kiln. The result is essentially the same as low line voltage, with the kiln failing to achieve higher heats in a reasonable time, or at all.

More Help

Electric kilns are simple systems, so most problems are easy to diagnose. A sometimes complicating factor arises from the fact that the firing process is very slow, and problems occasionally happen during times while nobody is actually watching the kiln.

Effective troubleshooting involves starting at the logical beginning of a system (in this case the kiln's controls) and working methodically through it to the other end (the electric service.) With this approach, you are very likely to be able to discover the cause of your kiln's problems. Random guessing is almost always ineffective, and costly in terms of both time and money.

If you need additional advice or service assistance, we'll he happy to help. Contact us at by phone or email.

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