Craig Henry
J P Tech, Inc.
P.O. Box 863
East Troy, WI 53120
Phone: 262/642-7671
E-mail: craigh@jptechinc.com
Website: www.drrectiver.com

Firing Boards

As SCR rectifiers become more prevalent in the industry, finishers need to be aware of how the firing systems operate. This knowledge is beneficial in selecting the best rectifier for a particular application.

Because all manufacturers have different designs and configurations, we will discuss the basic operations of most firing systems.

Function

An SCR rectifier controls output by sending a signal to a phase-control thyristor (SCR) to turn itself on and then off, depending on the amount of voltage output desired. This typically involves a pair of SCRs on each phase of a three phase rectifier for a total of six SCRs. Some manufacturers use SCRs that are already paired, which are referred to as SCR modules. Additional SCRs may be paralleled for higher amperage requirements.

Phasing

Because three-phase power is propogated with individual AC sine waves, it is important that the SCRs are fired in the same sequence (A, B, and C) as the incoming power. The different combinations are: ABC, ACB, BCA, BAC, CAB, and CBA. Anytime an SCR rectifier is installed, it is imperative that the incoming phasing is correct. If this is a replacement, then duplicating the phasing on the previous installation will normally be sufficient. If this is a new installation, the electrician or rectifier service person will need to pay attention to initial phasing.

Board Inputs

The firing boards will pick up timing from the incoming power lines so that they will fire the SCRs at the start of the sine wave for each cycle. Some firing systems require three separate wires for each phase, while others phase in with only one or two:

DC Voltage—Firing boards must monitor the rectifier's output voltage to hold the preset level. The firing pattern of the SCR is adjusted based on this voltage feedback.

Pot Feedback—The potentiometers (pots) in the remote control enclosure take the signal from the firing board and send from 0–100% of that signal back to the board. The firing board then modifies the rectifier output proportionately.

DC Amperage—This input is taken from the shunt, which generates a millivolt signal (typically 0–50 mv) proportionate to the amperage output of the rectifier. This feedback is also used to adjust the SCR firing pattern.

Board Power—Most firing boards of domestic manufacture use 120 VAC to provide the operating power for the board. Some designs will run at lower voltage provided by a step-down transformer. Multi board systems may loop power from one board to the next.

Remote I/O—Some firing boards have isolated input/output channels so that the rectifier can be controlled remotely from a PLC. These inputs may differ depending on the manufacturer. Some may use 4–20 ma, others 0–5 VDC, yet another 0–12 VDC. Other manufacturers may require a separate isolation board to convert their data transfer signal to a form that their firing board can use.

Board Outputs

Potentiometer Output—Most firing systems provide the power to the voltage and amperage potentiometers (pots) in the remote control enclosures. The pot will then divide the signal from the firing board and return it to the board as the pot feedback. That tells the board how much output is desired.

SCR Firing—Firing boards send signals to each SCR (normally six) via a separate pair of wires to each SCR. The gate wire transmits a low voltage signal to turn the SCR on. When this signal is removed, the SCR turns itself off. Many manufacturers use a combination of a resistor and a capacitor in parallel to prevent these signals from crossing between phases and causing voltage on the gate wire by "snubbing" the signals.

Additional Features

Some manufacturers include additional features, either as a standard or optional feature:

Ramping—This feature allows the finisher to start at a low voltage and raise it at a controlled rate to the desired level. This approach is very beneficial in some processes, because it optimizes deposition without burning or rupturing.

Phasing—Some boards will monitor the oncoming three-phase power to make sure that all phases are present, and that they are in the correct sequence. If the phasing is incorrect or missing, the board will shut the rectifier down before damage can occur.

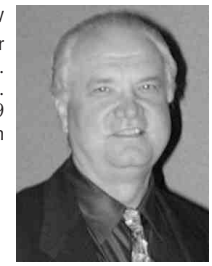
Over-Voltage or Over-Current—Many board systems have a protective circuit that will shut the rectifier down if it exceeds the maximum rated voltage or amperage outputs.

Effective Board Life

This is often difficult to predict. Most manufacturers make upgrades to their firing boards either through revisions of

(Continued on page 33)

Frank Altmayer, MSF, AESF Fellow
AESF Technical Director
Scientific Control Laboratories, Inc.
3158 Kolin Ave.
Chicago, IL 60623-4889
E-mail: faltmayer@sclweb.com



Adhesion to Plastic Substrates Depends on Type of Plastic

Dear Advice & Counsel,

I am a purchasing manager and I don't know much about plating, especially when the substrate is plastic. I have been told that some plastics, such as something called ABS, is easier to plate than others. What happens if you have a plastic that is a blend? We had a blend of ABS and Polystyrene plated and it failed miserably in service. The plating peeled from the plastic.

Signed,
A.B. Simon

Dear Ms. Simon,

Adhesion of plated metal deposits to plastic is produced by processing the plastic through numerous steps that are designed to create surface porosity that acts as anchor points for the plated metal. Adhesion is benefited by use of a plastic material that is easily etched by the chemical process steps. The plastic considered to be the most easily plated (yields the highest level of adhesion) is ABS (acrylonitrile-butadiene-styrene). The plastic that you provided us is a blend of ABS and polycarbonate (PC). Such plastics are typically 40-60 percent ABS, and it has been reported that ABS-PC blends yield a lower level of plating adhesion than ABS, and that the higher the polycarbonate of the blend, the more difficult it is to obtain an adequate level of adhesion.

The key to obtaining adhesion of the plated metal is to obtain a highly porous etch of the plastic. Some proprietary preparation processes employ a "conditioning" step ahead of the etch, which swells the plastic, causing cracks to form on the surface when the plastic shrinks back down in the subsequent process steps. The etch step dissolves the butadiene from the acrylonitrile-styrene-polycarbonate matrix, leaving surface pores. The butadiene particles present in the plastic should be numerous and oblong in shape to enhance the number and shape of anchor points. Ideally, the surface of the etched plastic is "tufted."

If the butadiene particles are round instead of oblong, the etch on this plastic may be only what is considered to be marginal. Such etches can result in service failure, because of thermal cycling and corrosion that results from exposure of plated parts to the elements.

Typical adhesion failures may be caused by:

a. An inadequate amount of plating thickness resulting in premature corrosion.
b. A weak etch obtained, caused by the plastic having a low (and in some cases poorly shaped) butadiene content.
c. Failure to neutralize/reduce leftover hexavalent chromium after etching
d. Use of electroless nickel instead of electroless copper as the first metallic layer

You may wish to look up "On the Mechanism of Plating on Plastics" by N.V. Mandich and G.A. Krulik, in the December, 1993 issue of *P&SF* for a highly detailed explanation of what goes on when plastic is processed for plating. Dr. Richard Wedel researched blistered plastics and authored an article in January 1975 titled "Characteristics of Corrosion-Associated Blisters on Plated Plastics." ***P&SF***

Rectifier Clinic

(Continued from page 31)

the existing design or a complete redesign, which may add reliability or features.

Certain components (often capacitors or some micro-chips) have a shorter working life than others and may, therefore, require replacement. The frequency of the need for replacement will depend on the manufacturer's design, the components themselves, and the ambient conditions where they operate. A board that is housed in a clean, moderate temperature environment will have a longer operating life.

Generally speaking, the older a circuit board gets, the shorter the mean time between failure. Because repairing a board is less expensive than replacement, it will require tracking the frequency of repair to determine when replacement is warranted. Because replacement will increase reliability, requirements for operating without interruption may influence a decision.

Board Replacement

Many finishers will have more than one brand of rectifiers in their shop. Consequently, when the decision to replace a firing board system is made, the finisher may opt to have his repair service replace the old firing boards with those made by a different manufacturer. This decision may be warranted by cost, competitive advantages of one brand over another, or a desire to have all of the firing boards in the shop to be from one manufacturer. Your internal or external rectifier technician can help you make this decision.

Although electronic components are very reliable, failures will occur over time. Knowing the design and operating tendencies of your equipment will allow you to manage your operation with greater confidence and less downtime. ***P&SF***