Spang Power Electronics

Application Note

851 Series - Solution of Choice for Fiberglass Bushing Applications

OVERVIEW

The 851 Digital SCR Power Controller offered by Spang Power Electronics was designed specifically for the fiberglass application, including electric melt / boost, forehearth, and bushing power control. It has advanced features that have made it the unit of choice for the industry. They include:

- On-board diagnostics
- Computerized setup and calibration
- Process and fault monitoring
- Touch-proof mechanical design
- Network communications
- Advanced local digital control

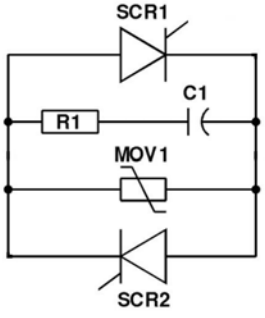
The fiberglass bushing application has traditionally been implemented with analog SCR power controllers coupled with step-down transformers and high current secondaries. Many fiberglass manufactures have become accustomed to the poor performance and production downtime associated with the outdated analog SCR controllers and lack of process information to understand problems and make improvements.

The Spang 851 Solution

The Spang line of 851 Digital SCR Power Controllers addresses many of these issues and allows for future improvements through automation. The 851 Digital SCR Power Controller offered by Spang Power Electronics was designed specifically for the fiberglass manufacturing application. Its features are tailored for the application and offer proven solutions for traditional problems. The purpose of this application note is to identify the key issues and describe how the 851 addresses them.

Issue: Voltage Transients

As with the nature of the application, the SCR controllers must be capable of handling voltage transients. These transients come from the upstream distribution system and from the load side of the bushing transformer. SCR controllers generally have two lines of defense against these transients. The first is the voltage rating of the SCR, generally known as the PRV or Peak Reverse Voltage rating. For analog 600V class controllers, the PRV rating is typically 1200V. Exceeding the 1200V rating may damage the SCR, allowing full current flow and SCR shorting.



The second line of defense is a snubber circuit typically referred to as an RCMOV circuit. This consists of a resistor and capacitor in series connected across the SCR set and a Metal Oxide Varistor (MOV) across the anode and cathode of the SCR (as shown). The purpose of this circuit is to absorb the energy of the transient and limit the voltage at the SCR below its PRV rating. The circuit is acting as shock absorber, absorbing the dangerous shock of the transient.

The typical failure mode of the circuit is the explosion of the MOV. MOVs

are rated by voltage and their capability to store energy, generally in Joules. When the energy absorption rating is exceeded, the MOV fails in a catastrophic fashion, blowing apart. Once this occurs, it is common that the arcing causes damage to the control amplifier and in some cases the SCRs themselves.

The Spang 851 Solution

The 851 uses SCRs with PRV ratings 33% above the industry standard, 1,600 V instead 1,200V. This allows the SCRs to survive a much higher voltage spike then the traditional design. Because of the rugged SCR, the MOV has been eliminated, removing the potential for a physical explosion and associated catastrophic damage.

Issue: SCR Misfiring

When the SCR controller "fires" into the primary of the bushing transformer, the wave form must be symmetric with respect to positive and negative axis. A non-symmetric waveform causes the transformer core to saturate and creates a high current pulse, as much as 10X the maximum current rating of the transformer. An SCR misfire supplies such a waveform to the transformer, saturating the core and initiating a high current pulse that damages the SCR modules or opens the I^2t fuse. The actual misfire itself occurs when the SCR module receives a gate pulse (i.e. signal to turn on) when it was not supposed to. Therefore one of the two SCRs "fires" while the other one does not, creating the non-symmetric waveform.

There are two analog SCR controller design factors that affect misfiring. They include the electrical noise immunity of the circuit design and the age of the circuit boards. High electrical noise in the industrial environment can cause the circuitry to misfire the SCRs. This noise may come from switching transients on the incoming line or from "noisy" equipment such as variable frequency drives within the plant. The design of the specific circuit boards for controlling the SCRs should be suitable for such an industrial environment and include the appropriate filtering.

The age of the circuit board also impacts the unit's performance. As the electrolytic capacitors age, they lose their original capacitance, changing the characteristics of the circuit. Generally used on the power supply circuit, the capacitors may cause instability and SCR misfiring.

The Spang 851 Solution

With more then 35 years of application experience, Spang understands the operating conditions and application requirements. The 851 controller and microprocessor circuit was designed for the highest degree of noise immunity and precise SCR firing, eliminating unwanted misfires.

Issue: I^2t Fuse Failure

Most analog SCR controllers use an I^2t fuse as the line of defense for short circuits. The fuse is sized to open before the SCRs are damaged in the case of a short circuit. These short circuits are caused by an SCR misfire, phase to phase shorts, or ground faults on the bushing transformer secondary. Having the fuse to protect the SCR is good, but when it opens, it takes time and money to replace the fuse, loosing valuable production from the zone.

The Spang 851 Solution

The 851 allows for a "fuseless" design. The I^2t fuse has been eliminated. The unit utilizes fast acting over current protection that shuts the SCRs off in the event of a short circuit at the load. The response is fast enough to turn the SCRs off before they are damaged. This feature saves the SCRs plus eliminates the need to replace fuses. Once the short circuit is fixed, simply turn the unit back on.

Issue: "Over driving" Bushing Current

The expensive and sensitive platinum bushings can be adversely affected, even damaged, by excessive current. This is sometimes referred to as “over driving” the bushing. This risk is prevalent in controllers that are not equipped with current feedback loops in the control circuitry.

The Spang 851 Solution

The 851 controller is furnished with precise current feedback sensors. This allows the User to accurately set a current limit level for the bushing application. This eliminates the risk of “over driving” the bushing. When this limit is exceeded during normal operation, the output voltage is reduced to maintain acceptable current and an alarm is annunciated to alert the operator that a potential problem may exist.

Issue: Bushing “Ear” Connections

Over time, the connections from the bushing transformer secondary to the busing transformer, commonly called the “ears”, loosen. When they become loose, the voltage drop across the connection increases creating additional heat and energy loss. If the connection is loose enough, the excessive heat may melt the connection or prevent the bushing itself from receiving enough voltage to meet the process requirements.

The Spang 851 Solution

In addition to monitoring the primary of the bushing transformer, the 851 is capable of monitoring the secondary voltage and current through an external current transformer and potential transformer. By connecting the voltage feedback at the “ears”, the 851 is capable of continuously monitoring and actually regulating this voltage. With this data and trending, changes in the load and connection impedance will be evident and useful for preventative maintenance.

Issue: Lack of Information

With the analog SCR controller, very little information is fed back to the process controller. In some cases there can be an SCR fault. With only feedback for the actual output voltage via a 4 – 20 mA signal, it is very difficult to understand the problem that caused the failure of the unit. Was it high voltage or high current? Did we lose the input voltage? Was there a short circuit? It takes a good deal of time and in some cases trial and error to figure these things out, all the while you are loosing valuable production.

The Spang 851 Solution

The 851 continuously monitors a multitude of parameters and offers configurable alarms and faults for unit and process protection. Acting as a data collector, once coupled with an industrial network, the valuable process data is available instantaneously for remote database collection, HMI display, or advanced trending and analysis. Through trending, predictive and preventative maintenance becomes possible. Failure mode analysis is also now possible to review the tracked data to determine what went wrong and when.

Multiple communication options are available including MODBUS RTU, DeviceNet, Profibus, and Ethernet MODBUS TCP. This flexibility allows the customer to select the network solution that matches each specific plant’s automation architecture.

CONCLUSIONS

The 851 Digital SCR Power Controller is the solution of choice for fiberglass manufacturing. It provides dramatic improvements over traditional analog controllers and addresses many of their shortcomings.

To learn more about the 851 Digital SCR Power Controller and all other Spang Power Electronics' products please visit our Web site at www.spangpower.com or contact us by phone / fax at the numbers listed below.

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