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SCR Contactors Vital to Resistance Welding Controllers

Despite Problems with overheating, SCRs are here to stay

by David Darrah
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When purchasing a new resistance welding controller, most of us would rather check out the various features and schedules the new controllers offer rather than the silicon controlled rectifier or SCR contactor. The SCR is hardly the most interesting part, but it's undoubtedly the most important. Although those who service and keep SCR contactors operating have found them to be a bit of a nuisance because of the need for water to cool them and the resultant leaks that sometimes occur, still, SCR contactors are crucial, and it is necessary to fully understand their intricacies and peculiarities.

Dependable and Precise but Keep Them Cool

SCRs, introduced in the early 1960s, have proven to be dependable, and they offer precise control for resistance welding. Two SCRs are used for single-phase lines and are connected in inverse parallel: one to pass current during the positive half cycle and the other during the negative half cycle. When connected in this way (Fig. 1) and used in resistance welding controllers, SCRs are typically called a contactor or A.C. switch.

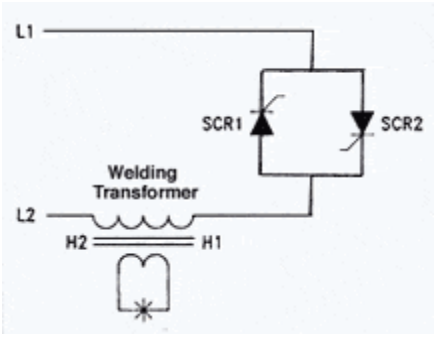

Fig. 1 - Simplified diagram of SCR contactor and welding transformer.

While the efficiency of the SCR is very high when conducting current, there is a problem of losses that produce heat. Excessive heat is one cause of damage to SCRs; therefore, they must be operated below damage temperature, describes by SCR manufacturers as "junction temperature." The junction is the internal region between the positive and negative layers of the silicon wafers.

These wafers are connected to the anode and cathode terminals of the SCR. Maximum junction temperatures of typical SCRs used for resistance welding are below 135°C (275°F). Since SCRs are used to control high currents, they can heat up and exceed the maximum junction temperature within milliseconds.

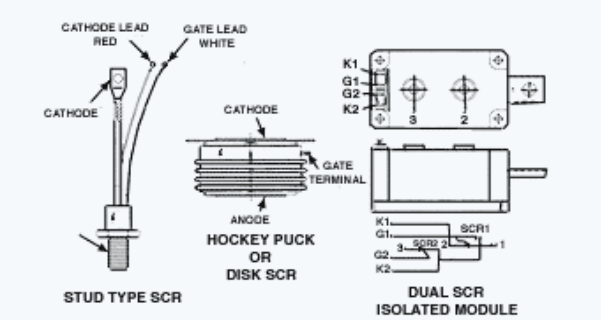

Fig. 2 - The three types of SCR packages: stud, disk, and module.

How to Dissipate the Heat

Therefore, the SCR requires a heat exchanger, or heat sink, to dissipate the heat. SCR's are typically kept cool by either air or water cooling methods. To understand the methods of cooling SCRs, it is important to know how they are packaged. Most control manufacturers use one of three types of SCR packages or outlines: stud type, "hockey puck" or disk type, and modules - Fig. 2.

Stud outlines for SCRs have 1/4 - 28, 1/2 - 20 and 3/4 - 16 threads. The stud is the anode connection of the SCR and used to mount the SCR to its heat sink. The cathode connection of the SCR is usually a ring terminal or flexible lead. The larger the size of the stud, the higher the current capacity of the SCR. The anode heat sink, however, must be isolated.

Hockey puck, or disk designs, are typically named because of their physical size: 1/2 in. high by 1-1/2 in. diameter, 1 by 2 in., 1 by 3 in. or larger. Puck-type SCRs are mounted between heat sinks or bus bars with some method of clamping. The heat sinks must then be isolated.

A third package gaining in popularity for use in resistance welding is often called a SCR module. Modules are housed in a plastic enclosure containing two or more SCRs and are mounted on a copper mounting base. Modules are available in a variety of current ratings from 25 through 1200 A when water cooled.

SCR modules offer several advantages over individual stud or hockey puck packages. For one, they are offered in convenient, small packages and are internally wired with two SCRs. Additionally, module based are electrically isolated from the line voltage and offer increased flexibility in both air and water cooled systems.

All three types of SCR packages require some method of cooling and can be cooled by water or air methods. Therefore, contactors are classified by the method by which they are cooled.

Classifying Contactors by Cooling Method

Natural convection cooling is used for lighter kVa (kilovolt-ampere) welding controls, usually below 60 kVa and duty cycles under 10%.

SCRs are mounted to aluminum or copper heat sinks and use fins to add surface area for radiating heat from the SCR (Fig. 3). Ambient air flows through the cabinet, passing over the heat sinks and SCRs keeping the device below critical temperature. The rating of an air-cooled contactor can be increased by adding a fan or blower to force air over the heat sink and SCR.

Fig. 3 - Fins add surface area to help convect heat away from the natural convection - cooled SCR contactor.

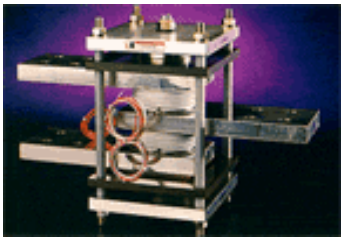

Fig. 4 –
This double- sided direct water cooled SCR contactor offers cooling efficiency improvements of 50%

Direct water-cooled SCR contactors are found in controls from 50 to 1500 kVa systems. In this method, SCRs are mounted or clamped to water-cooled heat sinks. The heat sinks are at line voltage potential and must be isolated from the cabinet walls. Direct water cooling methods can be either single or double-sided cooled. Double-sided cooling (Fig. 4) is about 50% more efficient than single - sided cooling.

Indirect water-cooled SCR contactors (Fig. 5) can be single or double-sided cooled. In this method, heat sinks are electrically isolated from the SCR, giving them zero voltage potential. Indirect cooling is possible with the stud-type SCR packages, but is more common with hockey puck or module designs.

Fig. 5 –
The indirect water - cooled SCR module contactor has electrically isolated heat sinks

Indirect cooling methods offer several advantages over direct methods. Indirect-cooled controllers have fewer or no water hoses, meaning less potential for leaks or bursting hoses. Finally, heat sinks for indirect-cooled contactors do not require isolation from control cabinets.

Here to Stay

When all the variables are figured in with SCR contactors, the bottom line is clear: SCRs have been around for more than 30 years, and they are here to stay. They're precise and effective and despite their inherent problems with