The migration from electromecha

By Alfonso Camacho-Carrillo and Geoff Garcia, ON Semiconductor

Driven by the need to reduce their customers' utility bills and comply with energy saving directives (such as Energy Star) electronics manufacturers are under pressure to make their designs as energy efficient as possible. In many cases TRIACs have replaced electromechanical relays, as these solid state devices offer greater power efficiency levels, and higher degrees of reliability.

Migrating to system designs based on solid state technology allows OEMs to create more compact, reliable, environmentally-friendly products.

GFCI systems

Silicon controlled rectifiers (SCRs) were one of the first generation of devices to evolve out of the thyristor family. These single direction power switching devices have been utilised in system designs for many decades. One of the modern applications now making use of them is ground fault circuit interrupters (GFCIs). These can be employed in household branch circuits to produce resettable outlets for implementing in certain environments, such as bathrooms, to protect users from harmful electrical shocks. SCRs that are used here have current handling capabilities of 0.8A to 25A. They are generally implemented as shown in Figure 1. Before the presence of ground fault is detected, the line is connected to the load, allowing the appliance (hair dryer, shaver, etc) to be plugged into the wall. Inside the GFCI, coils are used to monitor the current on the neutral wire and what is commonly called the "hot" wire. These coils allow the controller to determine if there is an imbalance between the current on the hot wire and the one o, the neutral wire. Should there be an imbalance, this would indicate that the hot wire has found another path to ground, which in many cases could mean it is passing through the body of the user. The controller monitors the currents and if an imbalance is detected, it will send a gate trigger to the SCR. The SCR will then

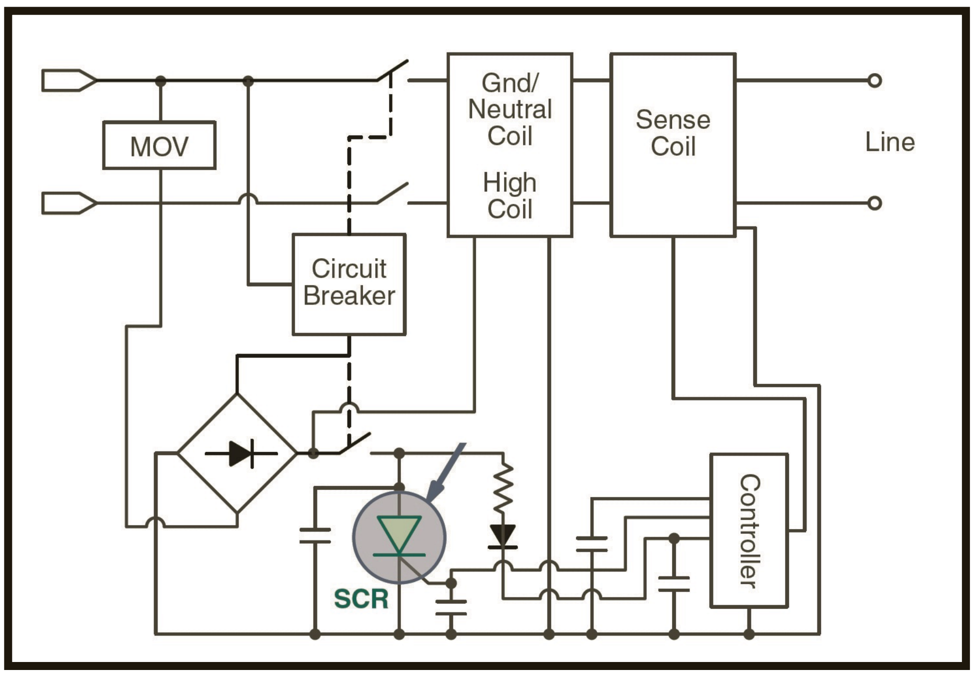

Figure 1: Example of a typical GFCI circuit

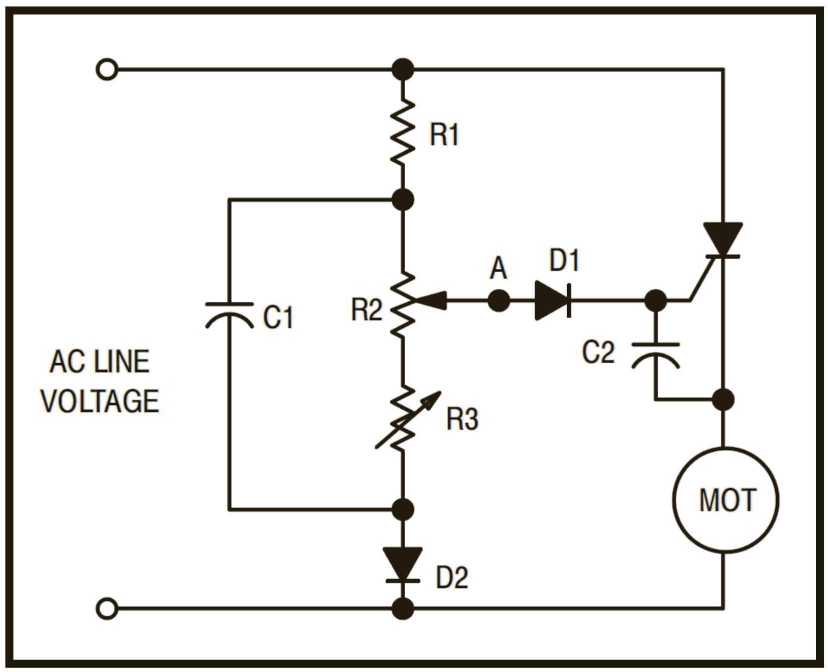

Figure 2: Example of a dimmer control circuit

anical to solid state switching

complete a path to ground, opening the circuit, and thus protecting the user from injury.

Compressor units

The TRIAC is essentially a two way derivative of the SCR, and can be thought of simply as a pair of SCRs placed in an anti-parallel arrangement, allowing current to flow in either direction. These devices are now being implemented increasingly into the domestic market, providing the switching functions for motors in various white goods and home appliances (from food blender motors right up to the compressor units in refrigerators). The three-phase motors in modern washing machines allow different speeds to be set to match the load. This means that energy is not wasted. Motor control systems generally employ TRIACs which are specified for currents of 8ARMS to 16ARMS. A standard circuit design for such systems would consist of three TRIACs for supplying the power to the three-phase 1HP motor once they are triggered. An optocoupler would supply the signal current to each of the TRIACs so the motor keeps the same phase shift between lines (as the optocouplers have zero crossing circuits within them). For washing machines, 0.8 A to16 A TRIACs are employed. These are generally connected to the line voltage. They drive the motor drive of the washing machine's drum, as well as driving smaller solenoid valves responsible for managing the water, allowing hot and cold water into the drum and also draining it at the end of the washing cycle. In addition, the TRIACs will control the valves for water softener and soap dispensing. Since these devices are connected to the line on the mains they can be driven directly from a microprocessor. Based on the cycle that the washing machine is going through, the microprocessor will trigger the appropriate TRIAC. With the TRIACs being connected to the mains, the AC signal inherently crosses the 0 V and this provides the means to have them return to their blocking state. The microprocessor then only needs to pulse the gate of each TRIAC when operation is once again required. These TRIACs generally have blocking voltages (VDRM/VRRM) of 800 V and IGTs ranging from 3 mA to 50 mA.

Dimming control

Dimming control systems for incandescent lamps usually utilise 8A to 25A TRIAC devices. The basic circuit will have a layout as described in Figure 2. Dimming is carried out by phase control. For the first part of each half cycle of the AC sine wave, an electronic switch is opened to prevent the current flow. At some specified phase angle (μ), the switch is closed, allowing the full line voltage to be applied to the load for the remainder of that half cycle. Altering μ will control how much of the total sine wave is applied to the load. The operational amplifier (LM339) performs a zero crossing function, and due to this, the integrated circuit (555) is activated each time a zero crossing condition occurs. Therefore, once the integrated circuit is activated (due to a zero crossing), it will wait a short delay time before it activates the transistor and in turn the TRIAC. Due to this delay time, the TRIAC can be activated at different phase angles of each half cycle (covering 5% to 95% of the total AC sine wave), and the load only receives the proportion of the current waveform that has been set.

The future for TRIACs

There are many industrial applications which need to deal with high currents (25A to 40A), but still require smaller packages. Future developments in TRIAC design should allow the marrying of these two requirements. Handheld industrial tools (such as power drills) will use the following type of circuit for speed control of the motor. The RC network is altered by use of a variable resistance activated by the SCR or TRIAC. The specified SCR/TRIAC device, since it is generally able to control conducting angles from 5% to 95% of the total cycle or half cycle in the case of the SCR, allows for accurate speed control of the motor. In many case the motors are inductive in power tools, and tend to require higher di/dt(c) values than those of other applications. This is due to the condition of the voltage and current being out of phase with each other.

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