THINK TANK

By John J. Yacono

Controlling Power

Well, another month is upon us and with it a batch of new circuits. As always, all the circuit creators whose work appears in this month's column will receive a *Think Tank II* book. Send your submissions to *Think Tank*, **Popular Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

My topic for this month, optoisolators, was prompted by a comment made by John Caywood (*Think Tank*, August 1991) who expressed an interest in power-control devices, and by a request made in our first letter for this month. After we deal with optoisolators, I'll answer a couple of other letters.

A CHRISTMAS DISPLAY

Every year, I set up a large animated Christmas-light display in my front yard. How big? Well one of the displays is shaped like a 6 by 7-foot present complete with a large bow on top. The lights are sequenced so that the bow goes out and the next set of lights, shaped like an open lid, comes on. When the lid turns on, a 4-foot rabbit complete with a drum and trumpet appears. As the rabbit waves and beats the drum, musical notes appear around the instruments. There is also a boy riding a rocking horse and next to that, there's a wagon and a tricycle.

After 3 years, the cars keep coming from all over and line up outside to watch and film the display. It does get somewhat embarrassing, what with all the traffic and jokes about the drain on the electricity, but kids of all ages like what they see.

Up to now I have been using 555 timers with relays and Triacs to sequentially supply power to the lights. The circuit is so large that it takes up two circuit boards that contain a total of eleven 555's with their support components, relays, etc. I've wanted to replace the relays with solid-state components and reduce the overall number of components. Well, your "Multiplexing with Counters" circuits (*Think Tank*, May 1991) are just what I need, I think. My question is what would be the best way to control AC with the 4017 counters?

—*Bill J. Stern, Sistersville, WV*

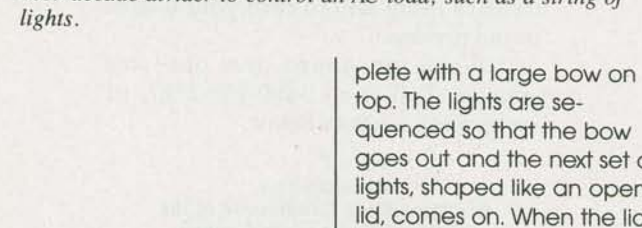

Fig. 1. A Triac-output optoisolator used with a Triac will allow a 4017 decade divider to control an AC load, such as a string of lights.

It's really pretty simple to control the lights in your display. What you need to do is connect an optoisolator at each output of each 4017. Then connect the optoisolator to a Triac that will actually control each light circuit.

To see exactly how that should be done, take a look at Fig. 1. Since the 4017 is a CMOS chip, any one of its outputs can supply enough current to light an LED in an optoisolator. The optoisolator contains a light-activated Triac driver, so when the LED turns on, the Triac driver conducts a little current. That current flows through the gate of the Triac, turning it on. The Triac then allows current to pass from the AC source to your light display.

A couple of technical tips are in order at this point. First, be sure that you power the 4017's from a 10-volt source to ensure that the optoisolators will activate good and hard. Second, be sure not to confuse the two main terminals on the Triac (the terminals that go to the AC source and the lamps) with one another: The main terminal drawn near the gate should always go to the power source, the other terminal should go to the load. Third, select Triacs that can handle the current required for your displays (use heat sinks if necessary). Last, whenever working with AC-power circuits observe extreme (make that obsessive) caution. Never work on such circuits while they are under power and use heavy-gauge Romex wire for all power connections. Use wire nuts wherever possible in the AC circuit; solder melts when passing high current.

The optoisolator circuit presented in Fig. 1 will not work well with highly inductive loads. That's because an inductive load will not permit the current and voltage flowing through the Triac to fall to zero at the same time. That prevents the Triac from turning off once the LED turns off. For those of you that would like to use such optoisolators to power inductive loads, try the circuit in Fig. 2. The extra capacitor and resistor help to overcome the effects of the inductive load, allowing the Triac to turn off.

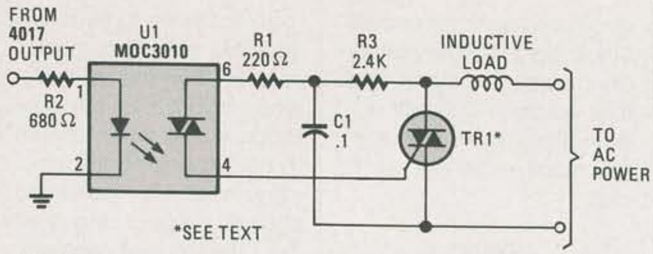

Fig. 2. For controlling an inductive load, the basic circuit in Fig. 1 needs to be augmented with an additional resistor and capacitor. Without the extra components, the Triac may not turn off.

There are many other types of optoisolators (in fact, too numerous to cover *all* of them here); each with its own special properties and uses. For example, some optoisolators are equipped with transistor outputs (or drivers), as shown in Fig. 3. They are useful when you want one DC circuit to control another. You may be wondering why one wouldn't just use a transistor. Well, there are times when the control circuit must have separate voltage-supply and ground lines from the circuit that it's controlling. A transistor-driver optoisolator allows the LED and the transistor drive to reside in completely separate circuits.

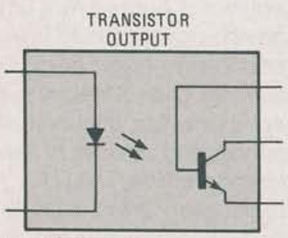

Fig. 3. Transistor-output optoisolators are useful to allow one DC circuit to control another. That allows you to separate the grounds of the two circuits.

Closely akin to the transistor-output optoisolator is the Darlington-output optoisolator (see Fig. 4). They are also useful when you want to isolate one DC circuit from another, but they provide "snappier" action. To put that another way, the output will snap on and

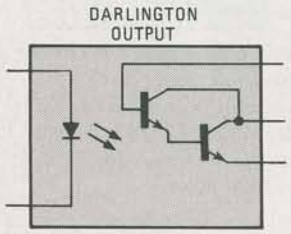

Fig. 4. A Darlington-output optoisolator has a harder action. It runs fully on even if the LED only glows dimly.

conduct at its maximum capability even if the LED only glows dimly. That's useful for applications that require high sensitivity and/or fast action.

Another common optoisolator sports an SCR output (See Fig. 5). That SCR acts like any other SCR, but it's a light-activated SCR (or LASCR). It turns on when the LED packaged with it glows. As you probably know, SCR's act like diodes that can be turned on. When turned on, they allow current to flow in only one direction. Once turned on, they latch—they will continue to allow current to flow until the current drops to a low value. That makes these optoisolators

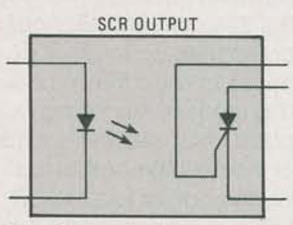

Fig. 5. Optoisolators with SCR outputs latch on. Once activated, the only way to turn them off is to prevent current from flowing through the SCR.

very nice for alarm circuits. Once triggered they latch on to sound an alarm, and they isolate any sensitive detection circuits from the electrically noisy annunciator.

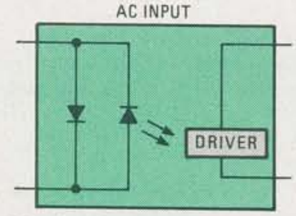

Fig. 6. AC-input optoisolator devices contain two oppositely oriented LED's. One of the LED's will light no matter which direction the current flows.

Some optoisolators have the ability to accept an AC control signal. Take a look at Fig. 6 to see how that is done. There are two LED's placed back-to-back at the input. One LED will be forward biased and glow when current flows in one direction, and the other LED will glow when the current reverses. This variety of optoisolator is useful when you don't know the polarity of the control signal, or when you want an AC signal (such as audio-controlled current) to activate a device.

A "BALANCED" PRESENTATION.

This is in regard to Mr. Grabosky's contribution (*Think Tank*, June 1991) and your reply thereto. Mr. Grabosky's use of a 500-ohm resistor in each line feeding power to his telephone (see Fig. 7) is correct. Telephone companies go to great expense to keep the tip and ring leads of the talking paths balanced through all of their equipment, including the cables leading up to the customers' premises. That is done to prevent crosstalk and noise from degrading the entire network. In that context, it behooves all experimenters and hobbyists to try to emulate their example. In that respect, that means that if you introduce an impedance in one side of the line, a corresponding impedance should be added to the other side. Along similar lines, the tip and ring lines should be opened by contacts in both lines simultaneously except at the terminal equipment.

Since the FCC has permitted private individuals to connect all sorts of equipment to telephone lines, there has been a gradual degradation of the total network by poorly designed equipment. A good example is to listen to the transmission of some portable telephones. The crosstalk and noise introduced by them affects all of the users of the network.

Both the 500-ohm resistors in each leg of Mr. Grabosky's circuit can be replaced by a small inductor, about 500-mH, in series with a 100-ohm resistor. That should improve the sound quality of the circuit.

—Ted LeBaron, Ft. Myers, FL

I applaud your defense of the telephone company standards. I agree that any device connected to the phone line should obey every FCC and telephone-company rule, and anyone connecting devices to the telephone lines should make every effort to study and adhere to the standards. However, Mr. Grabosky's circuit didn't connect to the phone line, and cannot be prone to crosstalk (it contained only one voice channel). Be that as it may, thank you for pointing out a very important issue. I hope everyone appreciates your point.

CLEARING UP SOME NOISE.

The April 1991 *Think Tank* featured a white-noise generator circuit from Bob