Tech Talk
With Bob Dolph

Taming Relays for Real World Integration

The scene is one you know well: As you pull up to the home you say to yourself, "This is the second service call I've made on this system this year." The problem is an automatic timer control designed to switch a bank of external floodlights. "I have had it with this panel," says the voice in your head. "On the first repair call, I had to replace the main circuit board. On the second call, I had to replace the external control relay. What can I do in the future to help reduce service expenses on these types of applications?"

None of the equipment was defective. However, there are several design precautions that could have been taken to make this system operate more reliably. Let's take a closer look.

Find the Root of the Problem to Find a Solution

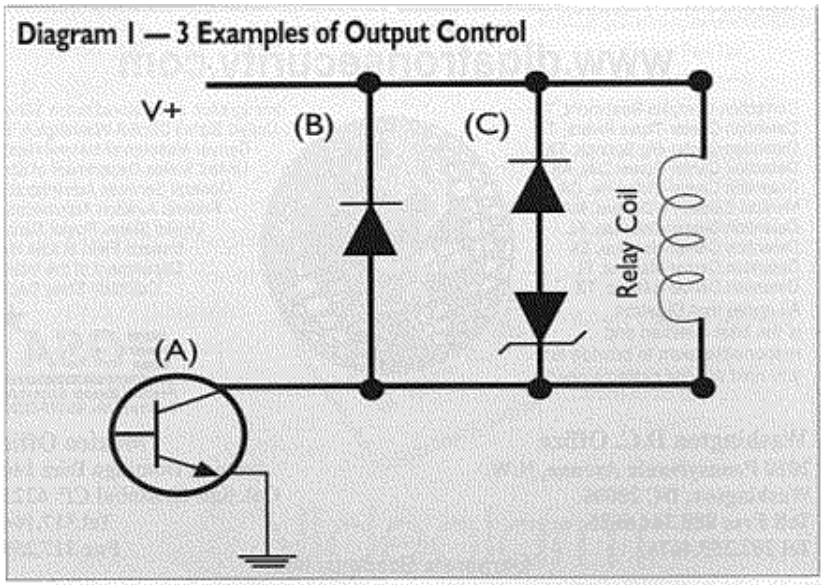
The output control is commonly known as an "open collector" transistor output (*see example A in Diagram 1*). In this case, the switched, 12VDC output was limited to handling 50mA current maximum. A 12VDC/5A relay that draws only 30mA was specified. The relay appears to be in the specified load range of the transistor output. What could be the problem?

Inductive devices, such as the coil of a relay, a solenoid in a door strike, or a motor winding, create a large "inductive kick-back" voltage spike when voltage has been applied and then quickly removed. This voltage spike can often be 10 times to 20 times that of the original supply voltage, and can destroy a transistor output. An add-on semiconductor device can help suppress this kick-back voltage spike and protect the transistor output.

One of the most common and popular suppression configurations is a clamping diode (1N4xxx) connected in reverse across the relay coil (*see example B in Diagram 1*). Use a diode with a reverse breakdown voltage of at least 10 times the source voltage and a forward current at least as large as the coil current. The diode will clamp the kick-back voltage spike and protect it form damaging the transistor output.

However, a less-known configuration of using a zener diode and diode-in-series across the coil (*see example C in Diagram* 1) may work better. A single diode configuration can cause a relay's normally open contacts to open slower than usual when power is turned off to the relay. This slower action can cause burning of the relay contacts, especially from an incandescent load, such as flood lamps. The zener diode configuration has also been recommended by several relay manufacturers.

Other suppression devices can be specified; they are a metal-oxide varistor (MOV), and a Tranzsorb®. When using an MOV, one must remember that this device weakens during a period of hits and eventually could fail. If selected, a protection voltage of 1.414 times the source voltage should be used. The Tranzsorb could be used, as it is basically a bilateral zener diode, and is good for AC circuit suppression.



This illustration shows three possible output control configurations: (A) open collector relay driver output; (B) single diode clamp; and (C) diode and zener diode combination.

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BOB'S TIPS

- An add-on semiconductor device can help suppress kick-back voltage spikes and protect the transistor output.
- A popular suppression configuration is a clamping diode (1N4xxx), connected in reverse across the relay coil.
- The single diode configuration can cause a relay's normally open contacts to open slower than normal when power is truned off.
- The trun-on current for an incandescent load can be 10 to 15 times higher than normal.

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Make Sure the Current Is Correct for the Circuit

The second problem with replacing the relay may have been caused by not originally specifying the correct current handling capacity. A better understanding of various types of electrical loads and how to derate the relay current ratings will help.

An incandescent-type load has a very low resistance due to the cold lamp filament. The turn-on current can be 10 times to 15 times higher than normal. This can cause arcing and welding on the relay contacts if the correct relay type is not selected.

Looking at Table 1, a relay that has a standard (purely resistive) rating of 15A should only be used in a 1.5A incandescent-loaded circuit. On the other hand, an incandescent-loaded circuit with a steady current of 1A could have an inrush of 10A to 15A. Now we have a better idea of why the relay failed prematurely.

Table 1 — Guidelines for Specifying Electromechanical Relays in Switching Various Load Types

Load Type	Derated Value Guidelines	Inrush Current Multiplier
Resistive	75%	—
Comments: Standard rating of relay current. Industry practice is to still derate.		
Inductive	40%	10-20
Comments: Relay, transformer, and solenoid coils. Arcing on contacts breaking.		
Capacitive	75%	20-40
Comments: Long wire runs can add to capacitive load. Current can be very high and short on contacts making from a high capacitance load.		
Motor	20%	5-10
Comments: Can have very high startup current and shutdown voltages.		
Incandescent	10%	10-15
Comments: Lamps and heaters. Very high inrush current until filament warms up.		

Some final tips and comments:

-- Solid State Relays (SSR) can help when dealing with AC-type loads. They must have good heatsinks and can fail when shorted. Circuit fuse protection is suggested.

-- Measure the current inrush with a fast data hold clamp-on ammeter or oscilloscope before specifying a relay.

-- Don't use diodes to suppress an AC load. They only work on half the cycle.

-- Never make parallel contact connections to increase current capacity.

-- Explore other suppression configurations, such as resistor/capacitor (R/C) circuits or combinations of R/C, MOV, Transzorb, zener diodes and diodes to better fine-tune the circuits. The metal type in the relay contact can affect overall performance.

Touring Show Aisles Proves Worthwhile, Even Fascinating

Recently, I had the opportunity to attend two major trade shows: the ISC West in Las Vegas and the EHX Home Automation in Orlando, Fla. I will report, after each show I attend, on the products and services I find particularly interesting, unusual, or just plain handy.

Window Candles: Yes, window candles. This has to be the most unusual product I have seen displayed at ISC. We run wire to windows for alarm contacts; why not run an extra pair so customers can have low-voltage decorator candles in their windows? You might laugh, but your competition may be putting them in as we speak. Go to www.windowcandles.com for more information.

Handy Installation Aids: Are you tired of having to prepare the end of a wire for pulling? Check out the Fiberfish screw tip (FIB25) that allows you to simply push the end of jacketed cable onto your pull rod tip. Contact Service Warehouse at (800) 822-6004 for more information. Also, ask about its shoe covers (SHOE-50P) for cleaner residential installations.

Here are a couple of items from Roy Bowling's bag of tricks at Labor Saving Devices Inc. (LSD). A pulling sock tip (works like the old Chinese finger puzzle) called the PullSleeve is used for pulling preconnected cables such as BNC and Cat-5. Do you find yourself having to drill out a hole for a larger diameter contact that already has the wire pulled? Take a look at the LSD Rebore-Zit drill bit. Go to www.lsdinc.com.

Easy RJ-45 Connections: Do you ever pull your hair out trying to make a really tight, short RJ-45 connection on Cat-5 type twisted cable? Make the leads as long as you want, then push them up tight before crimping. Consider the EZ-RJ45 connector from Platinum Tools at www.calcentron.com.

Overhead (OH) Door Latch Switch: This supervises any metallic overhead door-rail latch. It is called the Quick-switch and you can find more information at www.quick-switch.com. The company also offers items to help reduce the detection gaps often found in OH alarm contact magnets.