Application Notes

Featured Products: C60 and C61 Series

Description:
6 Pin Mini-DIP, Bi-Directional and DC Solid State Relay

Technical Profile describing the application and benefits of the following features:
- Low On-Resistance: 70 milliohms at 60 Vdc
- High Current Carrying Capability: Up too 2.5 Amps
- Optically Isolated: Free Floating output for high, low, or both side switching
- Switches: bi-directional, AC, and DC loads at 60, 100, 200, and 400 Volts
- Control: Broad input current range, 5 to 50 milliamps input for TTl control/customized switching speed.
- Small 6 pin mini-DIP package (SMT or THT).

Introduction:
Teledyne Relays C60 bi-directional solid state relay is the most versatile of our solid state relays. It is capable of switching AC, bi-directional, or DC loads. The loads can be switched from either the high side or the low side of the relay with an input of 5 to 50 mA. For DC applications, Teledyne Relays offers the C61 series, a DC only version of the C60 series. This Technical Brief describes how to use these relays and explains the benefits of the features offered.

Optical Isolation:
The C60 and C61 solid state relays are optically coupled to isolate control elements from load transients eliminating ground loops and signal noise. Optical isolation ensures the complete protection of signal lines, power and ground bus, and control circuits from switching noise and EMI. Optically isolated solid state relays use near IR light emitting diodes (LEDs) to generate light. The light then creates a drive voltage in light sensitive devices that powers the output switching devices. The drive requirement for an LED is current rather than voltage.

Input/Control:
The ideal drive for an optically isolated solid state relay is a constant current source. A schematic of this is shown in Figure 2.

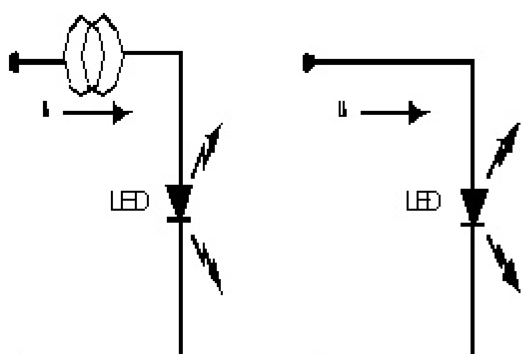
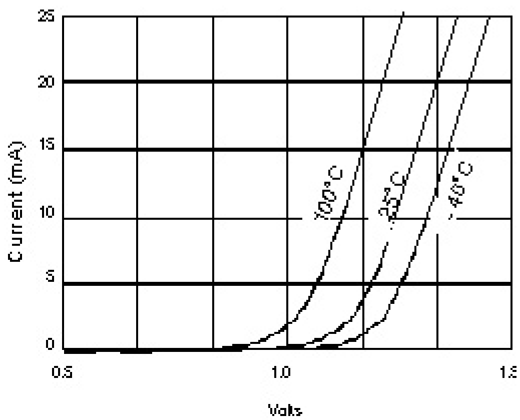


Figure 2

A constant current source offers the most predictable turn-on characteristics over temperature and consistent control of relay switching parameters. Another advantage of a constant current source relay input is it can be driven directly from most standard logic devices without the addition of external components. The LED characteristic curves with temperature effects are shown in Figure 3.



LED Current vs. Voltage

Figure 3

In some relay models an internal series resistor is included for compatibility with standard logic functions. When the relay does not contain an internal dropping resistor or a current source, then an external resistor is required in series with the control voltage to limit LED current to 10 mA typical. One benefit of the simple LED input/control configuration is flexibility to trade-off input drive current against turn-on characteristics.

Turn-On Control: The turn-on time specification parameters for the C60 and C61 series are based on switching the input at 10 mA input current. In order to operate the relay faster or to use a lower input current, then adjust the desired parameter by the equation shown below:

$$t_{on} = (t_{on}\text{-Specification})(10\text{ mA}) / I_{in}$$

Where ton is the new turn-on time and Iin is the required input current.
CALCULATION EXAMPLE using the C60-40 specification:
What is the required input current for a turn-on time of 0.5 ms?
Given:
Required turn-on: ton = 0.5 ms Iin = ?
Turn-on time(specification) = 3.0 ms
Soln:
Iin= (3 ms)(10 mA)/ 0.5ms = 15 mA

Turn-on time can also be improved (for a faster turn-on) with the addition of a current peaking circuit on the input of the solid state relay. Figure 4 shows a typical input drive circuit with a parallel RC peaking circuit.

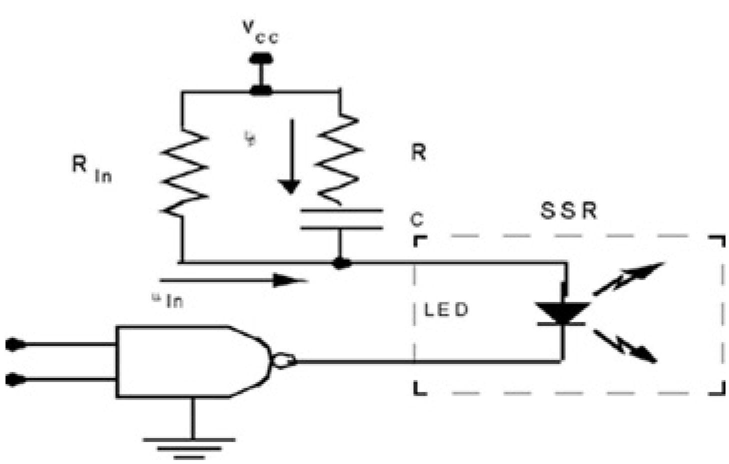


Figure 4

Rin is determined by calculating the required input drive current as shown below:

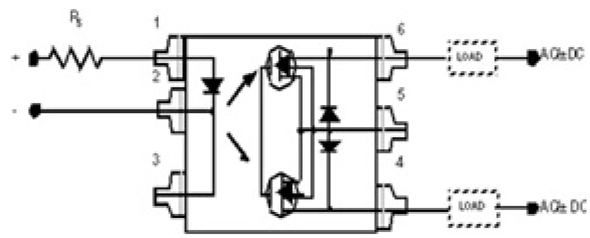
Rin = (VCC - VLED - VGate) / Iin

The value of R is set so the instantaneous input current from the RIn path and the RC path does not exceed 50 mA. The instantaneous sum of I p + I in should always be less than 50 mA.

Rmin = (VCC - VLED - VGate) / (50 - Iin)

DC Loads:

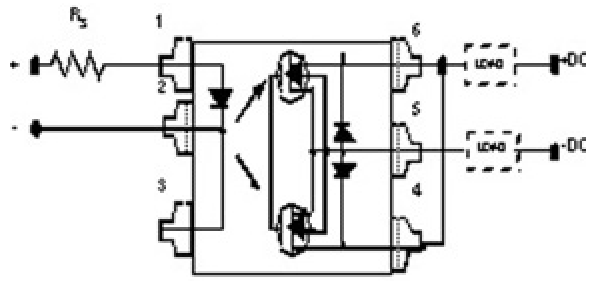
DC loads can be switched from several different configurations of the C60 series bi-directional relays. The diodes in parallel with the power FETs in the following figures are shown for clarity of information. They are inherent to the power FETs and cannot be removed. In the AC or bi-directional mode (Figure 5), the C60 series solid state relay is connected to switch plus/minus or minus/plus loads in either direction (bi-directional). This is also the same configuration for AC loads that will be discussed later. The load current for this configuration is determined by the junction to ambient thermal resistance and the on-resistance of the solid state relay in bi-directional mode. In the DC mode for the C60 series (Figure 6), the relay is shown with the output FETs connected in parallel. In this configuration the load current rating is double the Figure 5 level. The on-resistance of the Figure 6 circuit is one fourth of the Figure 5 circuit. The resistances of the power FETs in Figure 5 are in series while in Figure 6 they are in parallel.



C60 Series AC CONFIGURATION

Figure 5

The C60-10 can switch a continuous load of up to 2.5 amps with only 0.07 ohms on-resistance when used in the DC mode. The C61 series which consists of the C61-20 and C61-40 are DC only versions and are pin-for-pin compatible with the C60-20 and C60-40 solid state relays. The C61-20 can switch up to 1.0 amps with 0.3 ohms on-resistance. Table 1 below shows the current ratings for the C60 and C61 series.



C60 Series DC CONFIGURATION

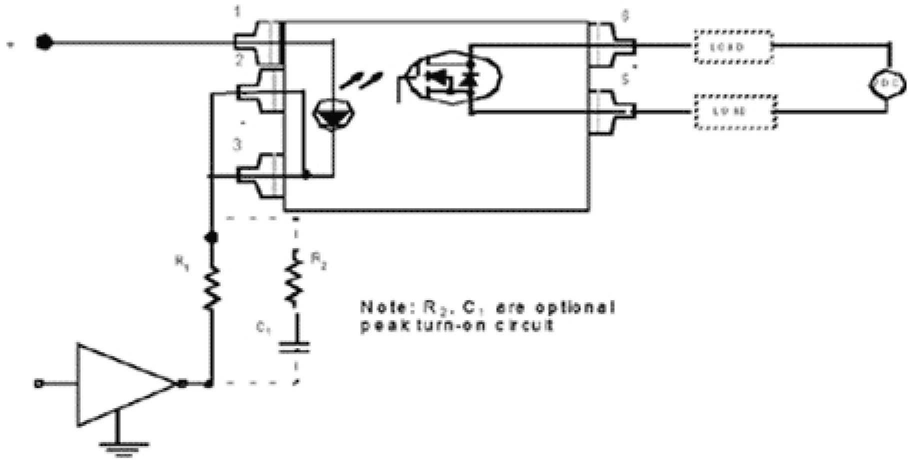
Figure 6

Note: Load can be connected to either side of the power supply

C60 and C61 Current Ratings and On-Resistance Values

Relay Part Number	C60-10	C60-20	C60-30	C60-40	C61-20	C61-40	Units
On-Resistance: DC	0.07	0.2	0.45	1.0	0.3	2.0	Ohms
Max Load Current: DC	2.5	1.5	1.0	0.5	1.0	0.4 Adc	
On-Resistance: Bi-Directional	0.28	0.7	1.8	4.0	N/A	N/A	Ohms
Max Load Current: Bi-Directional	±1.25	±0.75	±0.50	±0.25	N/A	N/A	Amps

Figures 7 shows the typical wiring configuration for a C61-20 solid state relay.



C 61 SERIES DC CONFIGURATION

Figure 7

Note: Load can be connected to either side of the power supply

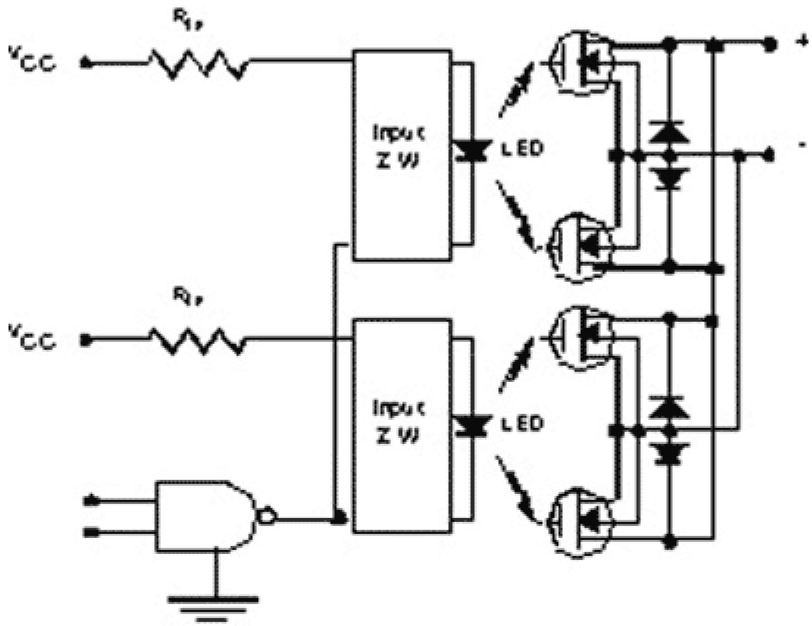
AC or Bi-Directional Loads:

AC loads can also be switched with the C60 series solid state relays as shown in Figure 5. The C60 solid state relays switch AC loads on and off without waiting for output waveform zero crossing to occur. When compared to AC solid state relays with SCRs or Triacs, the output capacitance of power FET bi-directional solid state relays is higher. For an SCR switch, an expected output capacitance is in the range of 10pF. An equivalent power FET output switch would have several hundred pF of junction capacitance which can restrict applications switching high frequencies.

Relay Parallel Operation:

The C60 and the C61 solid state relays can also be connected in parallel to increase load current switching capability. The Ron for a MOSFET has a positive temperature coefficient. When connected in a parallel configuration (as shown in Figure 8), if one MOSFET carries an unequal current share, the Ron will increase causing more current to be carried by the other parallel switch. This inherent characteristic of power FETs ensures current sharing and reasonable thermal characteristics.

When two relays are connected in parallel several important characteristics are improved. The Ron is decreased by the parallel combination, so the on-state voltage drop is decreased by the same ratio for an equivalent current. The parallel configuration also shares power and heat between two packages for better thermal characteristics.



C60 SERIES PARALLEL CONFIGURATION

Figure 8

C60 and C61 Applications:

Computer Driven Loads:
These relays are well suited for computer controlled power switching applications. Optical isolation prevents transient noise from coupling into the computer interface circuitry and power systems even when driving reactive loads (diode suppression is required on the relay output for inductive loads). The power FET output allows linear control of large and small voltage and current with no offset. The high current surge rating and the ability to control large power levels in a very small package make these relays the choice for a variety of applications.

Typical Switched Functions:
Ground Start, Instrumentation, Data Acquisition Systems, Interface Break Switch, E & M Signaling, On/Off Control, Test Equipment, Battery Switch, Parallel Equipment/Line Interface, Servo Systems, Automated Test Equipment, Robotics, Industrial Security Systems, Audio/Visual Control, Factory Automation, Instrumentation, Thermal Control Systems, Light Control Systems, Programmable Controllers, Control Panels, Industrial Controls, Peripherals (Printers/FAX), Medical Monitor/Control, Auxiliary I/O.

Typical Loads:
Motors AC or DC*
Lights
Heaters
Triac/SCR drivers
Audio Switching
Transducer Signals
Relays/Solenoids *
Small Loads (millivolt) power FET output allows switching low level signals without distortion or offset.
* A suppression diode is required for inductive loads