Engineer's notebook

Curve tracer can check optoisolator performance

by Ken Lindsay
Tektronix Inc., Beaverton, Ore.

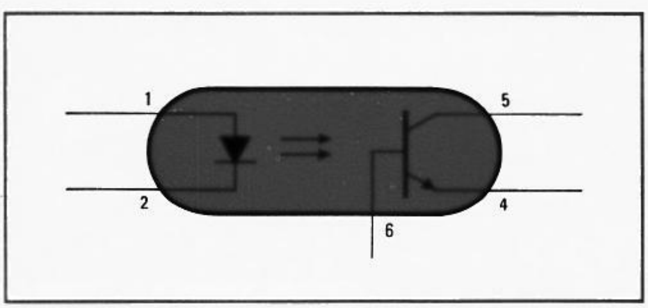
A conventional transistor curve tracer can be used to check the performance of optoisolators against the manufacturer's specifications. These tests, performed before the component is installed, can save many costly hours of troubleshooting in the prototype, production, and test stages of manufacturing.

An optoisolator consists of a light-emitting diode and a phototransistor in a single package, as shown in Fig. 1. The characteristics of the diode and the characteristics of the transistor can be measured in the same way as for any other diode or transistor. The two optical-coupling characteristics—ratios of transistor collector current and base current to diode forward current—and the isolation can be checked by three procedures.

In the examples, the MCT-2 optoisolator is used as the device under test because it is probably the most widely used isolator. A Tektronix 577 curve tracer was used to perform the tests; however, other instruments can be used in a similar manner.

The isolator may be connected to the curve tracer in the same way as a standard diode or transistor. Since many optoisolators are packaged in a six-pin mini-DIP flatpack, a dual in-line socket and adapter allows easy connection of the device to the curve-tracer terminals. As an alternative, a standard dual in-line IC socket, with banana plugs wired to the terminals, can be used.

The first coupling test is a measurement of the dc collector current-transfer ratio, which is the ratio of dc collector current, I_C, to diode forward current, I_F. The manufacturer specifies a value for this ratio under conditions of I_F of 10 milliamperes and collector-to-emitter voltage V_{CE} of 10 volts. To check this value, connect pin 5 of the device to the collector terminal of the curve tracer, pins 2 and 4 to the emitter terminal, and pin 1 to the base terminal of the curve tracer so that the step generator drives current through the diode. With no voltage at the terminals, set the controls of the curve tracer as follows:



1. Optoisolator. Characteristics of the input diode and the output transistor can be checked with a curve tracer, and so can isolation and signal-coupling between the diode and transistor. (Some optoisolators do not provide access to the transistor base lead.)

Collector supply	
Max peak voltage	25 V
Max peak power	0.6 W
Variable collector	0%
Collector-supply polarity	+ (not +dc)
Step generator	
Step offset amplitude	5 mA
Offset multiplier	000 (fully ccw)
Number of steps	Midrange
Any other adjustments	Set for conventional operation
Horizontal volts/division	2 V
Vertical current/division	2 mA
Intensity, Focus, and Position	Set for well-defined spot in the lower left corner of the CRT graticule.

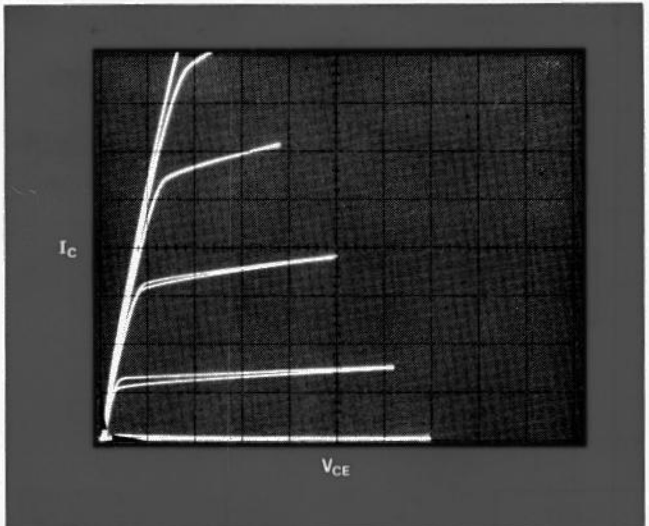
Switch on the voltages at the curve-tracer terminals and set the VARIABLE COLLECTOR % between 60% and 80%. The display obtained should be similar to that shown in Fig. 2. The number of curves displayed depends on the setting of the NUMBER OF STEPS control on the curve tracer.

Rotate the control for VARIABLE COLLECTOR % until the end of the second curve lies at the horizontal center of the screen, as in Fig 2 (disregard the bottom curve representing zero drive current). This display represents a V_{CE} of 10 V (5 divisions × 2 V/division) and an I_F of 10 mA (5mA/step × 2 steps). In the example shown, the I_C is approximately 7.7 mA, so I_C/I_F is 7.7/10 or 77%. The manufacturer's specifications guarantee a minimum of 20%, with a typical value of 50%.

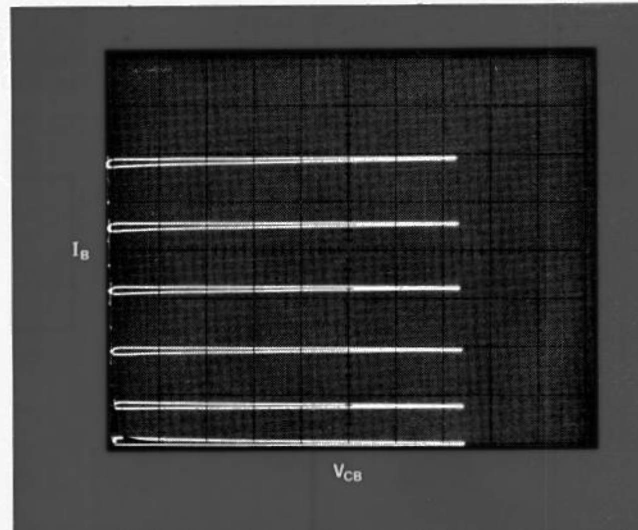
For the second test, which measures the base-current-transfer ratio, the setup must be changed slightly. Remove the cable connected to the emitter of the isolator, (pin 4) and connect it to the base (pin 6). This change grounds the base and opens the emitter, which allows the collector-base current to be measured. Change the VERTICAL CURRENT/DIV control to 5 μA and check that the display is similar to the one in Fig. 3.

According to the manufacturer's specifications, the typical value for dc-base-current transfer ratio is 0.2% with a voltage between collector and base (V_{CB}) of 10 V, and a diode forward current (I_F) of 10 mA. The second step displayed (again, disregard the baseline) represents an I_F of 10 mA, and center screen horizontally represents V_{CB} of 10 V. The base current, I_B, is 9.8 μA, so the base current transfer ratio I_B/I_F is about 0.1%.

The third and last test must be made with caution. Isolation voltage should be tested only up to the guaranteed minimum rating. If the devices are tested to their maximum, their isolation voltage would have to be



2. Tracer display. Collector current is displayed as function of collector-to-emitter voltage for diode forward currents of 0, 5, . . . 25 mA. Horizontal scale is 2 volts/division; vertical scale is 2 mA/division. Manufacturer rates I_C/I_F ratio at specified I_F and V_{CE}.



3. Base current. If optoisolator has base lead, base-current-transfer ratio I_B/I_F can be checked as in this curve-tracer pattern. I_F steps are 0, 5, . . . 25 mA; horizontal scale is 2 volts/division; and vertical scale is 5 μA/division.

exceeded, and it would destroy the device.

To test the isolation voltage of the optoisolator, simply connect the curve-tracer COLLECTOR SUPPLY terminal to any one point on an element of the optoisolator, such as the diode, and ground one point on the transistor. Then apply the specified voltage and check for any leakage current, which will cause an upward shift of the base line from the zero-current position. □