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TESTING OPTOISOLATORS

Application Note

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Optoisolators are finding widespread use in digital applications to isolate data lines. They offer high electrical isolation and are easy to interface with other semiconductor circuitry. Testing these devices before they are installed can save many costly hours of troubleshooting in the prototype, production, and test stages of manufacturing.

A standard transistor curve tracer can be used to check most of the important optoisolator device specifications. Some of the measurements are:

Input Diode

Forward Voltage	V_F
Reverse Breakdown	BV_R
Reverse Leakage Current	I_R

Output Transistor*

* Dc Forward Current Gain	h_{FE}
Collector-to-Emitter Breakdown Voltage	BV_{CEO}
* Collector-to-Base Breakdown Voltage	BV_{CBO}
Emitter-to-Collector Breakdown Voltage	BV_{ECO}
Collector-to-Emitter Leakage Current	I_{CEO}
* Collector-to-Base Leakage Current	I_{CBO}

Isolator

Dc Collector Current Transfer Ratio	I_C/I_F
* Dc Base Current Transfer Ratio	I_B/I_F
Isolation Voltage (up to 1,600 V)	

TESTING THE OPTOISOLATOR

The device to be tested is connected to the curve tracer just as a standard transistor or diode. Since many optoisolators are packaged in a 6-pin mini-dip flatpack, an extremely handy accessory is the Integrated Circuit Adapter, Tektronix part number 013-0124-00, and a 14-pin dual-in-line socket for the adapter, Tektronix part number 136-0443-00 (see Fig. 1). This allows for easy connection of any of the device pins to the curve tracer DUT terminals. As an alternative, a standard dual-in-line IC socket, with banana plugs wired to the terminals can be used to connect the socket to the instrument.

* When Optoisolators do not provide access to the base lead of the output transistor, the measurements noted cannot be made.

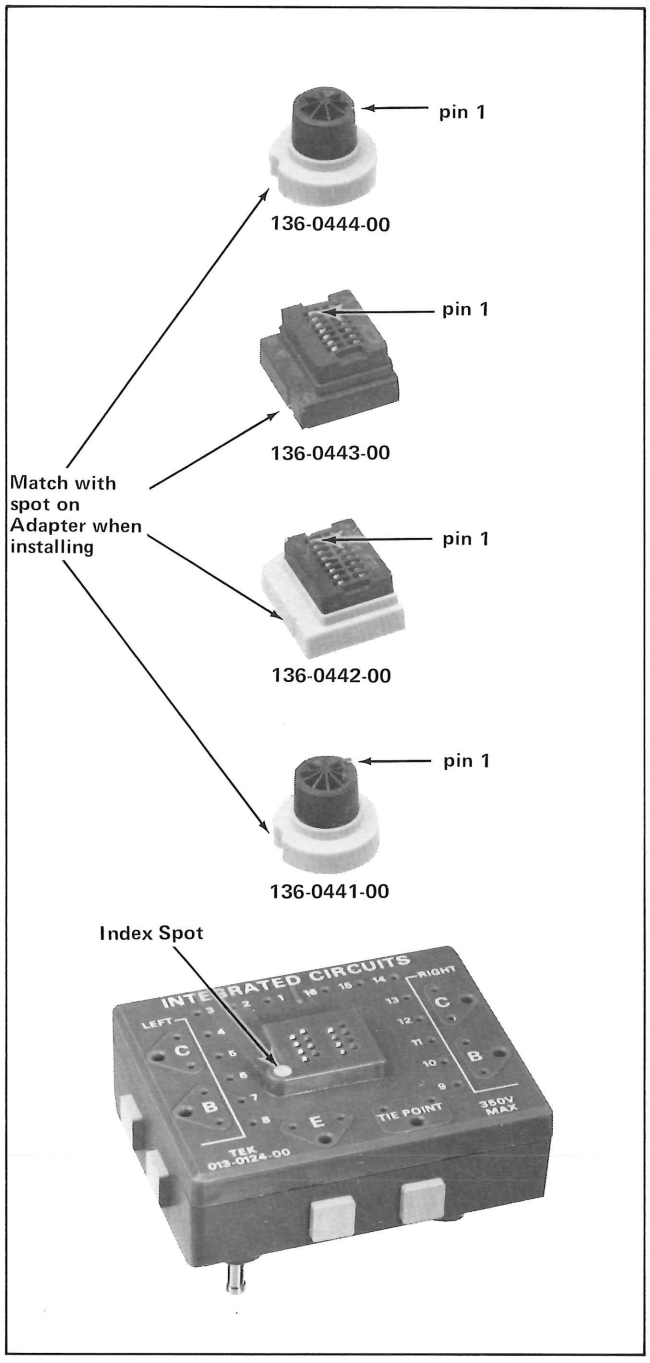

FIGURE 1.

Isolator Tests

The MCT-2 optoisolator is used as the DUT in this application note, since it is fast becoming the most widely used isolator. All tests are made with the TEKTRONIX 577 Curve Tracer. Other curve tracer instruments can be used in a similar manner.

The tests described are those of the optoisolator as a whole, rather than of its individual components. The individual component measurements are not included as they are the same as standard diode and transistor measurements, and have been described in many other publications. The curve tracer makes these isolator tests easy, and displays instantly almost all characteristics of optoisolators.

Initial Setup

1. Set the LEFT-RIGHT switch on the front porch to the center position, to ensure that no voltages exist at the DUT terminals.
2. Connect four patch cables to the integrated circuit socket adapter as shown in Figure 2.

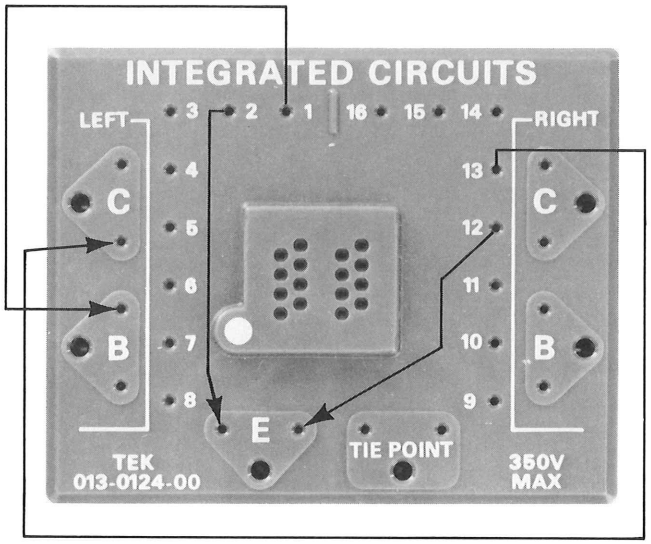

FIGURE 2.

3. Install the dual-in-line socket in the adapter with the MCT-2 optoisolator in the socket. Note: Pins 12, 13, and 14 on the IC adapter correspond to pins 4, 5, and 6 respectively on the device.
4. Install the adapter on the curve tracer front porch and set the controls as follows:

COLLECTOR SUPPLY	
Max Peak Volts	25 V
Max Peak Power	0.6 W
Variable Collector	0%
Collector Supply Polarity	+ (not + dc)
STEP GENERATOR	
Step/Offset AMPL	5 mA
Offset Mult	000 (fully ccw)
Number of Steps	Midrange
**All Dark Grey Buttons	Pushed IN
**All White Buttons	OUT
HORIZ VOLTS/DIV	2 Collector Volts
Both POSITION Controls	Midrange
VERTICAL CURRENT/DIV	5 mA

5. Adjust the INTENSITY, FOCUS, and POSITION controls for a well defined spot in the lower left corner of the crt graticule.

** The effect of these procedures is to place the step generator and the display in the conventional mode of operation.

6. Set the LEFT-RIGHT switch on the front porch to LEFT and rotate the VARIABLE COLLECTOR % clockwise to between 60% and 80%.

The display obtained should be similar to that shown in Figure 3—a family of curves from which the dc collector current transfer ratio of the device can be computed. The number of curves displayed depends on the setting of the NUMBER OF STEPS control on the curve tracer.

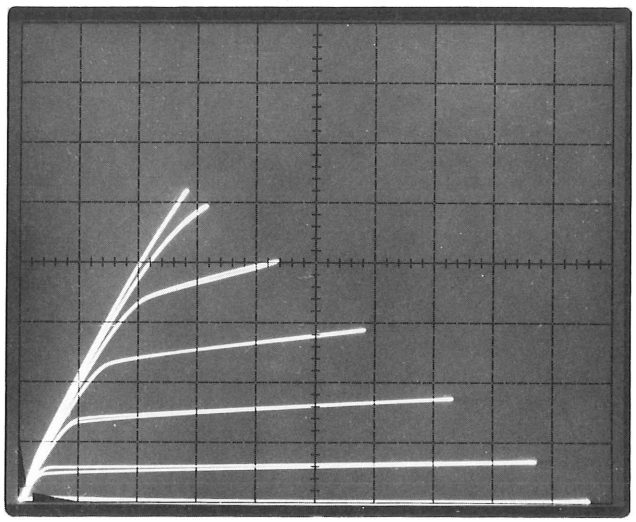

FIGURE 3.

Dc Collector Current Transfer Ratio

The manufacturer specifies the dc collector current transfer ratio of the MCT-2 with a forward current (I_F) of 10 mA, and with a 10 V collector to emitter voltage (V_{CE}). To establish these values, rotate the VARIABLE COLLECTOR % control until the second curve lies at the horizontal center of the screen (see Figure 4; disregard the bottom curve representing zero drive current). This represents 10 V V_{CE} (5 divisions X 2 V/division) at 10 mA I_F (5 mA/step X 2 steps). Figure 4 shows the same curves as Figure 3, however, the vertical scale factor has been changed to 2 mA/div for increased resolution.

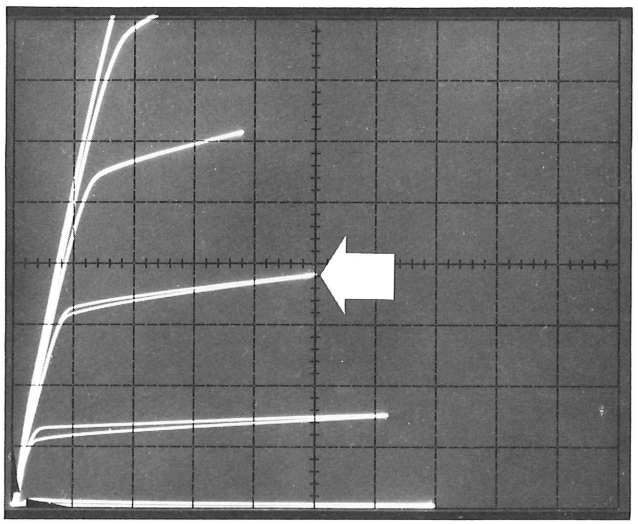

FIGURE 4.

To obtain the current transfer ratio, measure the collector current (I_C) for the second curve at V_{CE} of 10 V (indicated by the arrow in Figure 4).

Divide this amount by the diode forward current (I_F) of 10 mA, and multiply the result by 100. In the example shown, the I_C is approximately 7.7 mA. Thus, $I_C/I_F = 7.7/10 \times 100 =$ 77%. The manufacturer's specifications guarantee a minimum of 20%, with a typical value of 50%.

Dc Base Current Transfer Ratio

To measure the base current transfer ratio, the setup must be changed slightly. Remove the cable connected to the emitter (Pin 4) of the isolator, and connect it to the base (Pin 6). This now 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 that shown in Figure 5.

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 forward current (I_F) of 10 mA. There is no guaranteed minimum or maximum value specified for this measurement. The second step displayed (again, disregard the baseline) represents 10 mA (I_F), and center screen horizontally represents 10 V V_{CB}.

The base current, I_B, is 9.8 μA (with vertical scale set at 5 μA/div), which gives a base current transfer ratio of 0.1%.

$$I_B/I_F = 9.8\ \mu A/10\ mA \times 100 \simeq 0.1\%$$

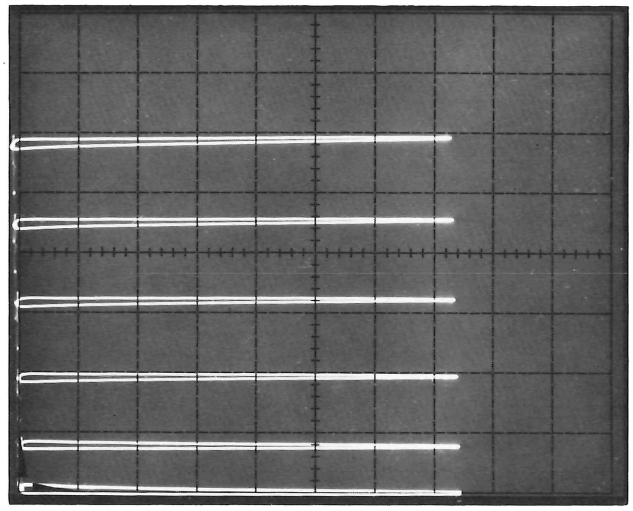

FIGURE 5.

Isolation Voltage

Isolation voltage should only be tested up to the guaranteed minimum rating. If the devices are tested to their maximum rating their isolation voltage must be exceeded. This is destructive testing and results in failure of the device.

To test the optoisolator isolation voltage, 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 other element (the transistor). Then apply the specified voltage and check for any leakage current, which will cause an upward shift of the baseline from the zero-current position.