Test circuit checks optical isolators

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When you add your own voltmeter to this test circuit, you can accurately measure the current-transfer efficiency of an optically coupled isolator that has a phototransistor output. The test circuit also enables you to evaluate the current gain (h_{FE}) of the coupler's phototransistor. Both parameters, which are measured to within ±3%, can be read directly from the voltmeter's display over the useful current range of most couplers.

The test circuit employs an operational amplifier (A_1) as a voltage-to-current converter to supply a maximum drive current of 10 milliamperes for the coupler's input light-emitting diode for the transfer-efficiency test. A pnp transistor is also wired as a voltage-to-current converter for providing a maximum base current of 10 microamperes to the coupler's phototransistor for the h_{FE} measurement. Another op amp (A_2) acts as a current-to-voltage converter during both tests.

The coupler's transfer efficiency can be defined as:

$$efficiency = \left| (I_C/I_D) \times 100\% \right|_{I_B=0}$$

where I_C is the phototransistor's collector current, and I_D is the LED's forward current. The transfer function of the voltage-to-current converter is expressed by:

$$I_D = E_i/100$$

and the transfer function of the current-to-voltage converter is:

$$E_o = I_C R_{FB}$$

The coupler's transfer efficiency can now be written as:

$$efficiency = (100E_o/E_i R_{FB}) \times 100\%$$

For the circuit to provide direct reading, a ganged switch is used to control both voltage E_i and resistance R_{FB}. The product of E_i and R_{FB} is always 100, regardless of switch position. The transfer efficiency, therefore, simply becomes $E_o \times 100\%$—so that a 1-volt output indicates an efficiency of 100%.

A similar relationship exists for phototransistor h_{FE}, which is defined as:

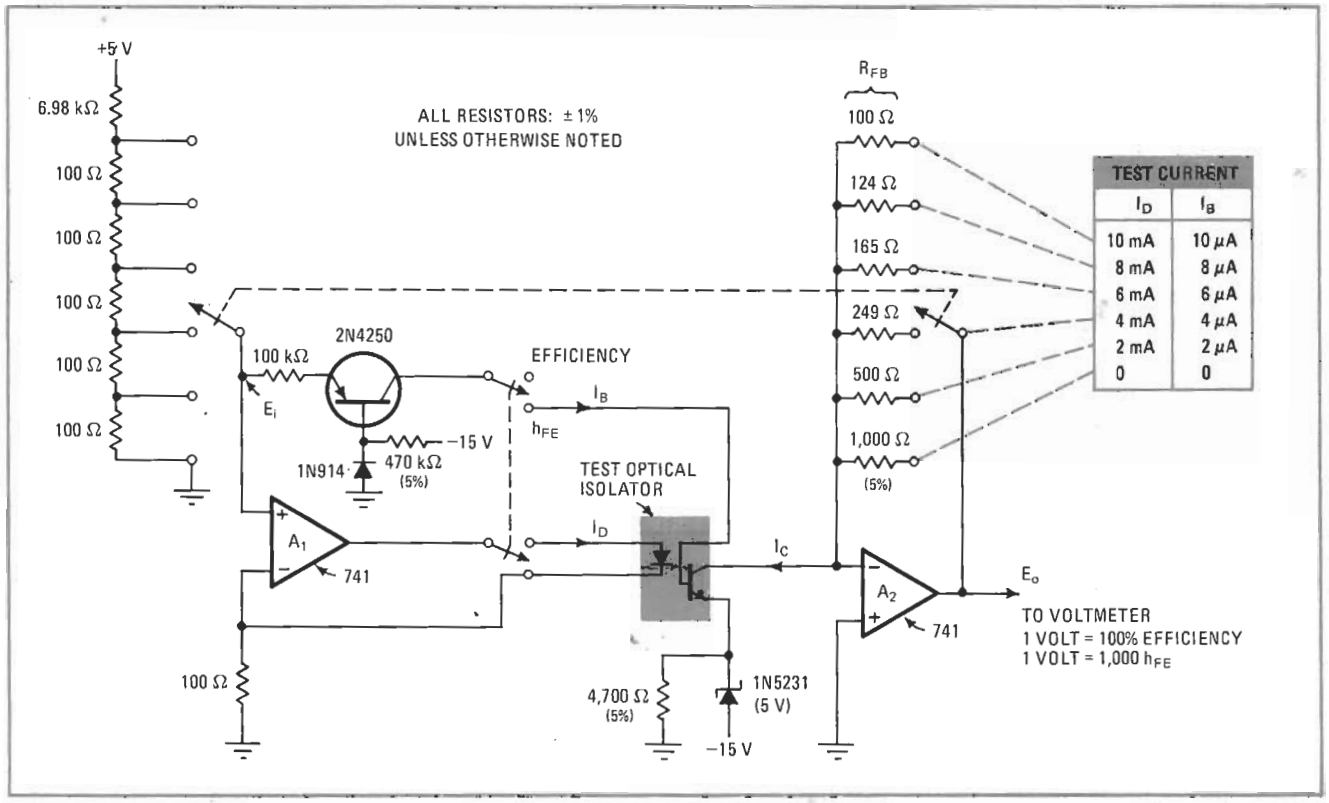
$$h_{FE} = \left| I_C/I_B \right|_{I_D=0}$$

where I_B is the phototransistor's base current. In terms of the transfer functions of the test circuit, phototransistor h_{FE} can be written as:

$$h_{FE} = E_o(10^5)/E_i R_{FB}$$

Since the product of E_i and R_{FB} is 100, then h_{FE} equals $1{,}000E_i$—so that a 1-v output corresponds to an h_{FE} of 1,000.

If you use general-purpose 741-type op amps in the test circuit, you will be able to measure transfer efficiency to about 300% and h_{FE} to about 3,000. □



Optical coupler checkout. This test circuit, together with a voltmeter, provides a direct readout of the current-transfer efficiency of an optical coupler. The h_{FE} of the coupler's phototransistor can also be measured. Amplifier A_1 and the transistor operate as voltage-to-current converters, while amplifier A_2 is a current-to-voltage converter. A ganged switch acts as a range control for the test current.