

## Measurement Techniques

### INTRODUCTION

The characteristics given in the optocoupler's data sheets are verified either by 100 % production tests followed by statistic evaluation or by sample tests on typical specimens. Possible tests are the following:

- Measurements on emitter chip
- Measurements on detector chip
- Static measurements on optocoupler
- Measurement of switching characteristics, cut-off frequency and capacitance
- Thermal measurements

The basic circuits used for the most important measurements are shown in the following sections, although these circuits may be modified slightly to cater for special measurement requirements.

### MEASUREMENTS ON EMITTER CHIP

#### Forward- and Reverse Voltage Measurements

The forward voltage,  $V_F$ , is measured either on a curve tracer or statically using the circuit shown in figure 1.

A specified forward current (from a constant current source) is passed through the device and the voltage developed across it is measured.

To measure the reverse voltage,  $V_R$ , a  $10 \mu\text{A}$  reverse current from a constant current source is applied to the diode (figure 2) and the voltage developed across it is measured on a voltmeter of extremely high input impedance ( $\geq 10 \text{ M}\Omega$ ).

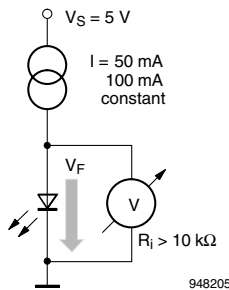


Fig. 1

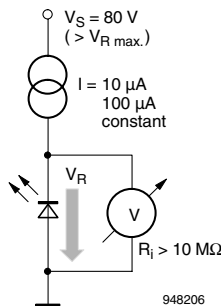


Fig. 2

### MEASUREMENTS ON DETECTOR CHIP

#### $V_{CE0}$ and $I_{CE0}$ Measurements

The collector emitter voltage,  $V_{CE0}$ , is measured either on a transistor curve tracer or statically using the circuit shown in figure 3.

The collector dark current,  $I_{CE0}$ , must be measured in complete darkness (figure 4). Even ordinary daylight illumination might cause wrong measurement results.

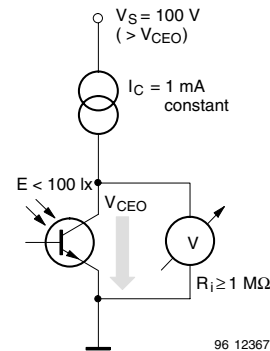


Fig. 3

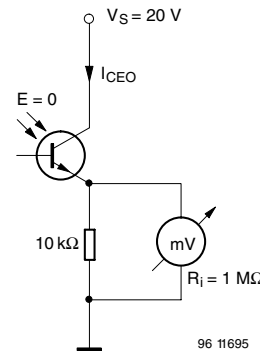


Fig. 4

#### Static Measurements

To measure the collector current,  $I_C$  (figure 5), a specified forward current,  $I_F$ , is applied to the  $I_R$  diode.

Voltage drop is then measured across a low emitter resistance.

In the case of collector emitter saturation voltage,  $V_{CEsat}$  (figure 6), a forward current,  $I_F$ , is applied to the  $I_R$  diode and a low collector current,  $I_C$ , in the phototransistor.  $V_{CEsat}$  is then measured across collector and emitter terminals

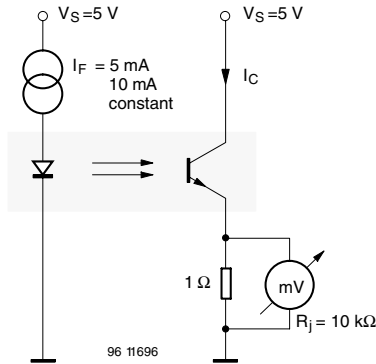


Fig. 5

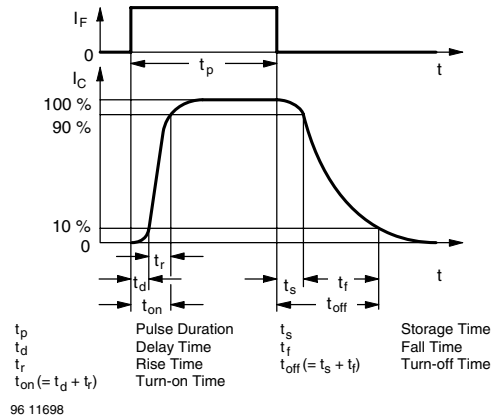


Fig. 8 -

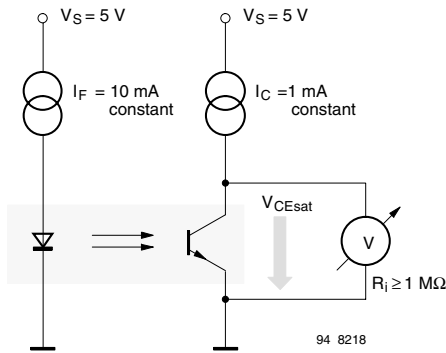


Fig. 6

## IMPROVEMENTS OF SWITCHING CHARACTERISTICS OF PHOTOTRANSISTORS AND DARLINGTON PHOTOTRANSISTORS

With normal transistors, switching times can be reduced if the drive signal level and hence the collector current is increased. Another time reduction (especially in fall time  $t_f$ ) can be achieved by using a suitable base resistor. However, this can only be done at the expense of a decreasing CTR.

## CUT-OFF FREQUENCY MEASUREMENT

The cut-off frequency is the frequency at which the coupler of the small signal current transfer ratio has decreased to  $\frac{1}{\sqrt{2}}$  of its lowest frequency value.

## SWITCHING CHARACTERISTICS

### Definition

Each electronic device generates a certain delay between input and output signals as well as a certain amount of amplitude distortion. A simplified circuit (figure 7) shows how the input and output signals of optocouplers can be displayed on a dual-trace oscilloscope.

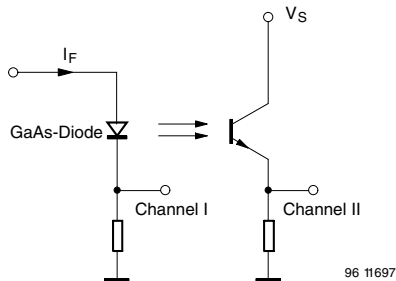


Fig. 7

The following switching characteristics can be determined by comparing the timing of the output current waveform to that of the input current waveform (figure 8).

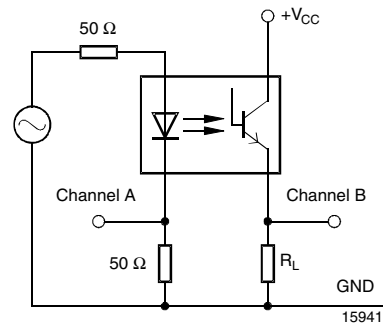


Fig. 9 - Test Circuit for Cut-off Frequency

Before applying an AC test signal to the coupler input terminals, the IR diode has to be biased with a DC current in order to establish a work-point in the linear region of the phototransistor's output diagram. Then a small sinusoidal current signal of 1000 Hz is superimposed to the DC bias current. The output to input AC signal ratio  $I_C/I_F$  is measured and set to 0 dB. After this the frequency of the input signal is increased and the  $I_C/I_F$  ratio is recorded and plotted. Depending on the coupler's DC current transfer ratio and the test conditions, the AC signal ratio will drop at higher frequency levels. The frequency value at - 3 dB signal level

is called the cut-off frequency.

### TEST CIRCUIT FOR CUT-OFF FREQUENCY

Coplanar 6 PIN e.g.: TCDT1100 Series

Coplanar 4 PIN e.g.: TCET1100 Series

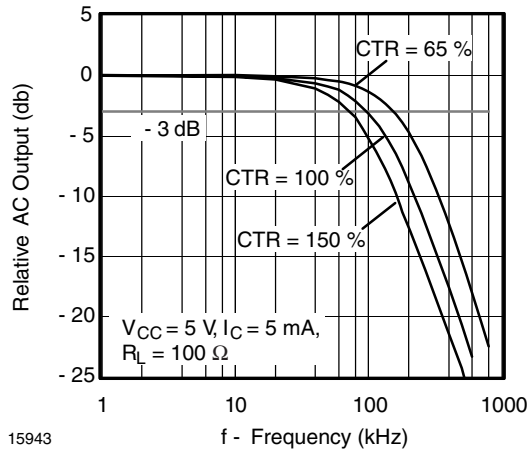


Fig. 10

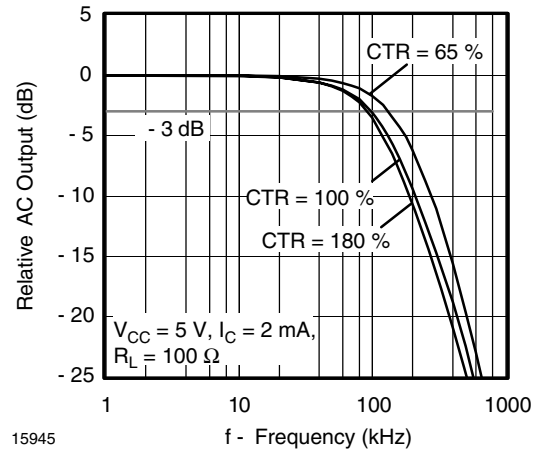


Fig. 12

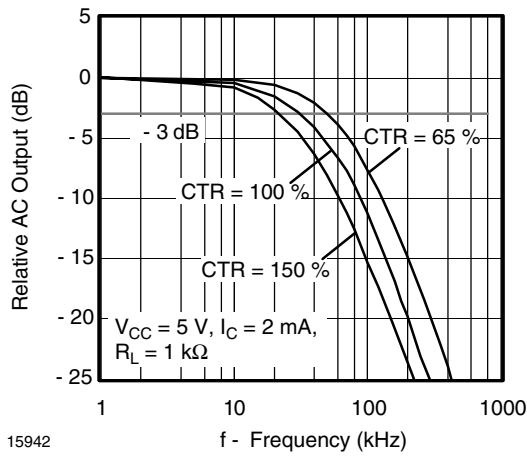


Fig. 11

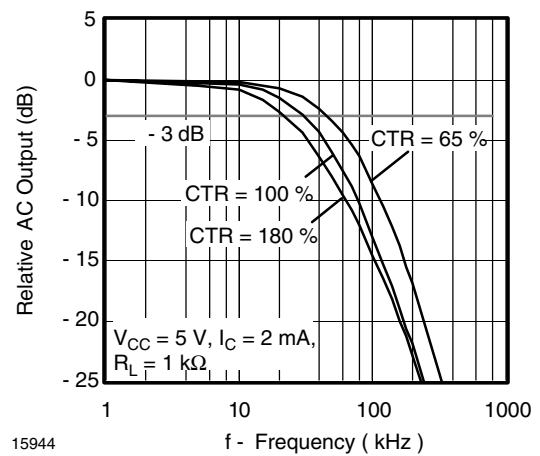


Fig. 13