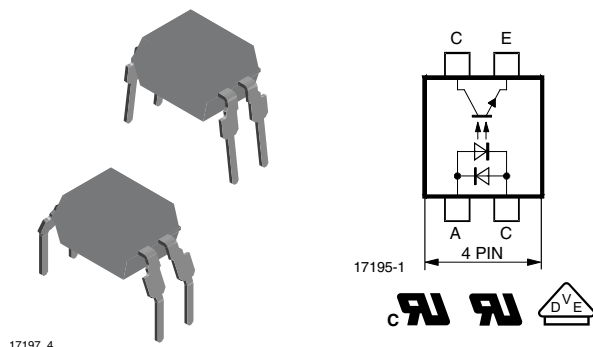


## Optocoupler, Phototransistor Output, AC Input



### DESCRIPTION

The TCET1600, TCET1600G consists of a phototransistor optically coupled to 2 gallium arsenide infrared-emitting diodes in a single (4 pin) package.

### VDE STANDARDS

These couplers perform safety functions according to the following equipment standards:

- **DIN EN 60747-5-2 (VDE 0884)**  
Optocoupler for electrical safety requirements
- **IEC 60950/EN 60950**  
Office machines (applied for reinforced isolation for mains voltage  $\leq 400 V_{RMS}$ )
- **VDE 0804**  
Telecommunication apparatus and data processing
- **IEC 60065**  
Safety for mains-operated electronic and related household apparatus
- **VDE 0700/IEC 335**  
Household equipment
- **VDE 0160**  
Electronic equipment for electrical power installation
- **VDE 0750/IEC 60601**  
Medical equipment

### FEATURES

- Isolation materials according to UL94 V-O
- Pollution degree 2 (DIN/VDE 0110 /resp. IEC 60664)
- Climatic classification 55/100/21 (IEC 60068 part 1)
- Special construction: therefore, extra low coupling capacity of typical 0.2 pF, high common mode rejection
- Low temperature coefficient of CTR
- Rated impulse voltage (transient overvoltage)  $V_{IOTM} = 10 \text{ kV peak}$
- Isolation test voltage (partial discharge test voltage)  $V_{pd} = 1.6 \text{ kV peak}$
- Rated isolation voltage (RMS includes DC)  $V_{IOWM} = 600 V_{RMS}$
- Rated recurring peak voltage (repetitive)  $V_{IORM} = 890 V_{peak}$
- Thickness though insulation  $\geq 0.75 \text{ mm}$
- Creepage current resistance according to VDE 0303/ IEC 60112 comparative tracking index:  $CTI \geq 175$
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC



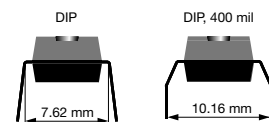
**RoHS**  
COMPLIANT

### AGENCY APPROVALS

- UL1577, file no. E52744 system code H, double protection
- CSA 22.2 bulletin 5A
- DIN EN 60747-5-2 (VDE 0884)
- DIN EN 60747-5-5 (pending)
- FIMKO

### ORDERING INFORMATION

|             |   |   |   |   |   |   |   |   |
|-------------|---|---|---|---|---|---|---|---|
| T           | C | E | T | 1 | 6 | 0 | 0 | # |
| PART NUMBER |   |   |   |   |   |   |   |   |



| AGENCY CERTIFIED/PACKAGE       | CTR (%)            |
|--------------------------------|--------------------|
|                                | $\pm 5 \text{ mA}$ |
| UL, cUL, VDE, FIMKO            | 20 to 300          |
| DIP-4, single channel          | TCET1600           |
| DIP-4, single channel, 400 mil | TCET1600G          |

### Note

- G = leadform 10.16 mm; G is not marked on the body.

| <b>ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup></b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified) |                                      |            |               |                    |
|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------|------------|---------------|--------------------|
| PARAMETER                                                                                                             | TEST CONDITION                       | SYMBOL     | VALUE         | UNIT               |
| <b>INPUT</b>                                                                                                          |                                      |            |               |                    |
| Reverse voltage                                                                                                       |                                      | $V_R$      | 6             | V                  |
| Forward current                                                                                                       |                                      | $I_F$      | $\pm 60$      | mA                 |
| Forward surge current                                                                                                 | $t_p \leq 10\text{ }\mu\text{s}$     | $I_{FSM}$  | $\pm 1.5$     | A                  |
| Power dissipation                                                                                                     |                                      | $P_{diss}$ | 100           | mW                 |
| Junction temperature                                                                                                  |                                      | $T_j$      | 125           | $^{\circ}\text{C}$ |
| <b>OUTPUT</b>                                                                                                         |                                      |            |               |                    |
| Collector emitter voltage                                                                                             |                                      | $V_{CEO}$  | 70            | V                  |
| Emitter collector voltage                                                                                             |                                      | $V_{ECO}$  | 7             | V                  |
| Collector current                                                                                                     |                                      | $I_C$      | 50            | mA                 |
| Collector peak current                                                                                                | $t_p/T = 0.5, t_p \leq 10\text{ ms}$ | $I_{CM}$   | 100           | mA                 |
| Power dissipation                                                                                                     |                                      | $P_{diss}$ | 150           | mW                 |
| Junction temperature                                                                                                  |                                      | $T_j$      | 125           | $^{\circ}\text{C}$ |
| <b>COUPLER</b>                                                                                                        |                                      |            |               |                    |
| Isolation test voltage (RMS)                                                                                          | $t = 1\text{ s}$                     | $V_{ISO}$  | 5300          | $V_{RMS}$          |
| Isolation voltage                                                                                                     |                                      | $V_{IORM}$ | 890           | $V_P$              |
| Total power dissipation                                                                                               |                                      | $P_{tot}$  | 250           | mW                 |
| Operating ambient temperature range                                                                                   |                                      | $T_{amb}$  | - 55 to + 100 | $^{\circ}\text{C}$ |
| Storage temperature range                                                                                             |                                      | $T_{stg}$  | - 55 to + 150 | $^{\circ}\text{C}$ |
| Soldering temperature <sup>(2)</sup>                                                                                  | 2 mm from case, $t \leq 10\text{ s}$ | $T_{sld}$  | 260           | $^{\circ}\text{C}$ |

## Notes

- (1) Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of this document. Exposure to absolute maximum ratings for extended periods of the time can adversely affect reliability.
- (2) Refer to wave profile for soldering conditions for through hole devices (DIP).

| <b>ELECTRICAL CHARACTERISTICS</b> ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ , unless otherwise specified) |                                                                    |             |      |      |      |      |
|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|-------------|------|------|------|------|
| PARAMETER                                                                                                | TEST CONDITION                                                     | SYMBOL      | MIN. | TYP. | MAX. | UNIT |
| <b>INPUT</b>                                                                                             |                                                                    |             |      |      |      |      |
| Forward voltage                                                                                          | $I_F = \pm 50\text{ mA}$                                           | $V_F$       |      | 1.25 | 1.6  | V    |
| Junction capacitance                                                                                     | $V_R = 0\text{ V}, f = 1\text{ MHz}$                               | $C_j$       |      | 50   |      | pF   |
| <b>OUTPUT</b>                                                                                            |                                                                    |             |      |      |      |      |
| Collector emitter voltage                                                                                | $I_C = 100\text{ }\mu\text{A}$                                     | $V_{CEO}$   | 70   |      |      | V    |
| Emitter collector voltage                                                                                | $I_E = 100\text{ }\mu\text{A}$                                     | $V_{ECO}$   | 7    |      |      | V    |
| Collector dark current                                                                                   | $V_{CE} = 20\text{ V}, I_F = 0, E = 0$                             | $I_{CEO}$   |      |      | 100  | nA   |
| <b>COUPLER</b>                                                                                           |                                                                    |             |      |      |      |      |
| Collector emitter saturation voltage                                                                     | $I_F = 10\text{ mA}, I_C = 1\text{ mA}$                            | $V_{CEsat}$ |      |      | 0.3  | V    |
| Cut-off frequency                                                                                        | $V_{CE} = 5\text{ V}, I_F = 10\text{ mA}, R_L = 100\text{ }\Omega$ | $f_c$       |      | 100  |      | kHz  |
| Coupling capacitance                                                                                     | $f = 1\text{ MHz}$                                                 | $C_k$       |      | 0.3  |      | pF   |

## Note

- Minimum and maximum values were tested requirements. Typical values are characteristics of the device and are the result of engineering evaluations. Typical values are for information only and are not part of the testing requirements.

### CURRENT TRANSFER RATIO

| PARAMETER | TEST CONDITION                                  | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|-----------|-------------------------------------------------|--------|------|------|------|------|
| $I_C/I_F$ | $V_{CE} = 5\text{ V}$ , $I_F = \pm 5\text{ mA}$ | CTR    | 20   |      | 300  | %    |

### MAXIMUM SAFETY RATINGS

| PARAMETER             | TEST CONDITION | SYMBOL     | MIN. | TYP. | MAX. | UNIT |
|-----------------------|----------------|------------|------|------|------|------|
| <b>INPUT</b>          |                |            |      |      |      |      |
| Forward current       |                | $I_F$      |      |      | 275  | mA   |
| <b>OUTPUT</b>         |                |            |      |      |      |      |
| Power dissipation     |                | $P_{diss}$ |      |      | 400  | mW   |
| <b>COUPLER</b>        |                |            |      |      |      |      |
| Rated impulse voltage |                | $V_{IOTM}$ |      |      | 10   | kV   |
| Safety temperature    |                | $T_{si}$   |      |      | 175  | °C   |

#### Note

- According to DIN EN 60747-5-2 (VDE 0884) (see figure 1). This optocoupler is suitable for safe electrical isolation only within the safety ratings. Compliance with the safety ratings shall be ensured by means of suitable protective circuits.

### INSULATION RATED PARAMETERS

| PARAMETER                                               | TEST CONDITION                                                                  | SYMBOL     | MIN.      | TYP. | MAX. | UNIT     |
|---------------------------------------------------------|---------------------------------------------------------------------------------|------------|-----------|------|------|----------|
| Partial discharge test voltage - routine test           | 100 %, $t_{test} = 1\text{ s}$                                                  | $V_{pd}$   | 1.669     |      |      | kV       |
| Partial discharge test voltage - lot test (sample test) | $t_{Tr} = 60\text{ s}$ , $t_{test} = 10\text{ s}$ ,<br>(see figure 2)           | $V_{IOTM}$ | 10        |      |      | kV       |
|                                                         |                                                                                 | $V_{pd}$   | 1.424     |      |      | kV       |
| Insulation resistance                                   | $V_{IO} = 500\text{ V}$                                                         | $R_{IO}$   | $10^{12}$ |      |      | $\Omega$ |
|                                                         | $V_{IO} = 500\text{ V}$ , $T_{amb} = 100\text{ °C}$                             | $R_{IO}$   | $10^{11}$ |      |      | $\Omega$ |
|                                                         | $V_{IO} = 500\text{ V}$ , $T_{amb} = 150\text{ °C}$<br>(construction test only) | $R_{IO}$   | $10^9$    |      |      | $\Omega$ |

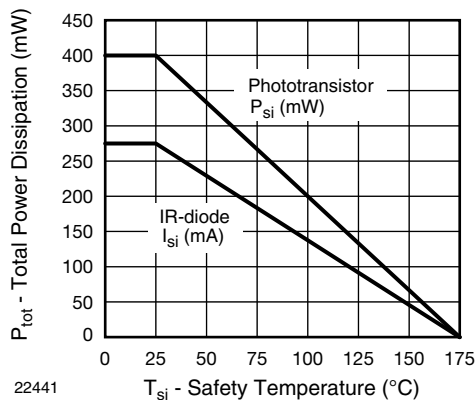


Fig. 1 - Derating Diagram

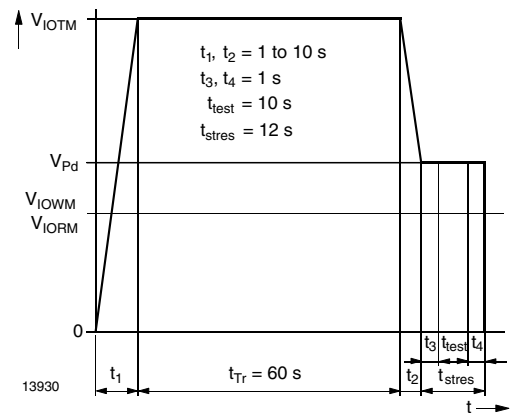


Fig. 2 - Test Pulse Diagram for Sample Test acc. to  
DIN EN 60747-5-2 (VDE 0884); IEC60747-5-5

| SWITCHING CHARACTERISTICS |                                                                                       |           |      |      |      |               |
|---------------------------|---------------------------------------------------------------------------------------|-----------|------|------|------|---------------|
| PARAMETER                 | TEST CONDITION                                                                        | SYMBOL    | MIN. | TYP. | MAX. | UNIT          |
| Delay time                | $V_S = 5\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$ , (see figure 3)       | $t_d$     |      | 3    |      | $\mu\text{s}$ |
| Rise time                 | $V_S = 5\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$ , (see figure 3)       | $t_r$     |      | 3    |      | $\mu\text{s}$ |
| Turn-on time              | $V_S = 5\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$ , (see figure 3)       | $t_{on}$  |      | 6    |      | $\mu\text{s}$ |
| Storage time              | $V_S = 5\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$ , (see figure 3)       | $t_s$     |      | 0.3  |      | $\mu\text{s}$ |
| Fall time                 | $V_S = 5\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$ , (see figure 3)       | $t_f$     |      | 4.7  |      | $\mu\text{s}$ |
| Turn-off time             | $V_S = 5\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$ , (see figure 3)       | $t_{off}$ |      | 5    |      | $\mu\text{s}$ |
| Turn-on time              | $V_S = 5\text{ V}$ , $I_F = 10\text{ mA}$ , $R_L = 1\text{ k}\Omega$ , (see figure 4) | $t_{on}$  |      | 9    |      | $\mu\text{s}$ |
| Turn-off time             | $V_S = 5\text{ V}$ , $I_F = 10\text{ mA}$ , $R_L = 1\text{ k}\Omega$ , (see figure 4) | $t_{off}$ |      | 10   |      | $\mu\text{s}$ |

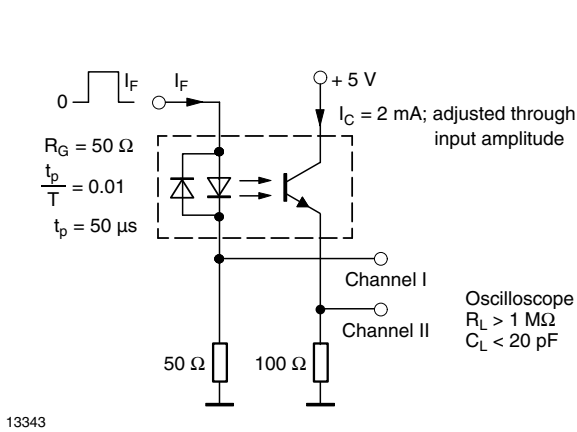


Fig. 3 - Test Circuit, Non-Saturated Operation

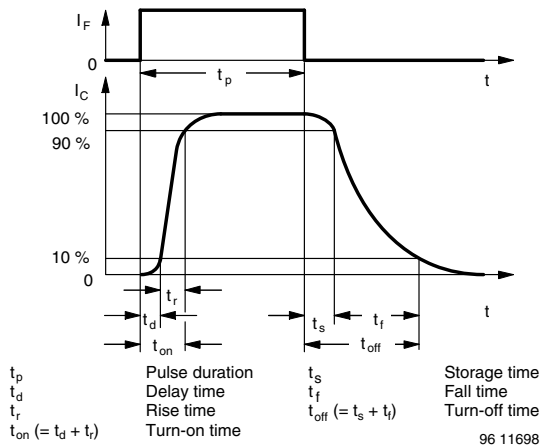


Fig. 5 - Switching Times

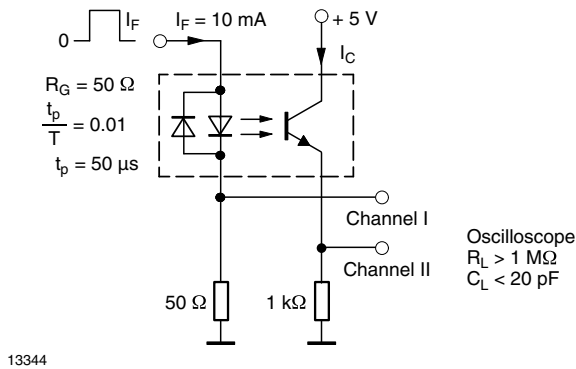


Fig. 4 - Test Circuit, Saturated Operation

### TYPICAL CHARACTERISTICS ( $T_{amb} = 25^{\circ}\text{C}$ , unless otherwise specified)

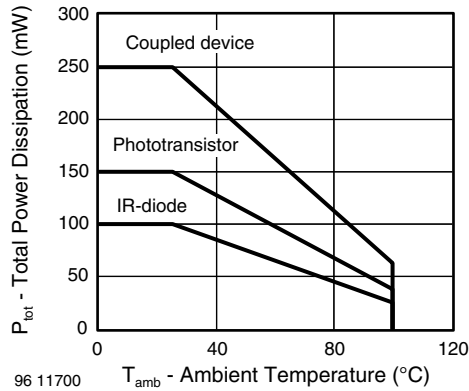


Fig. 6 - Total Power Dissipation vs. Ambient Temperature

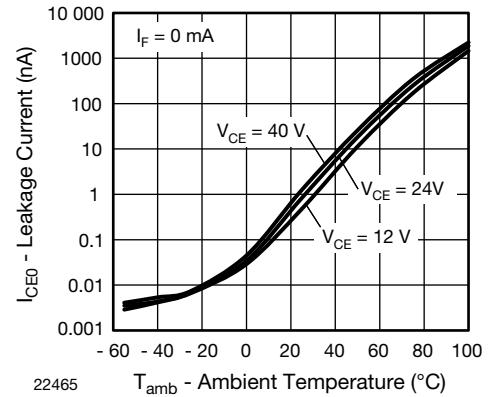


Fig. 9 - Leakage Current vs. Ambient Temperature

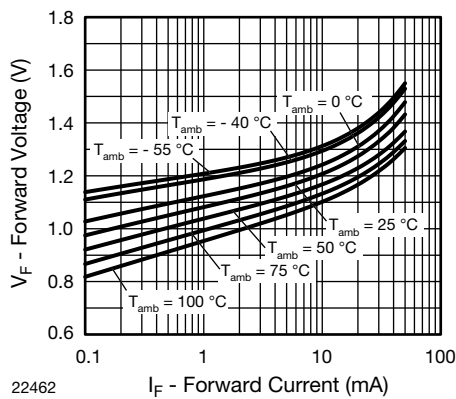


Fig. 7 - Forward Current vs. Forward Voltage

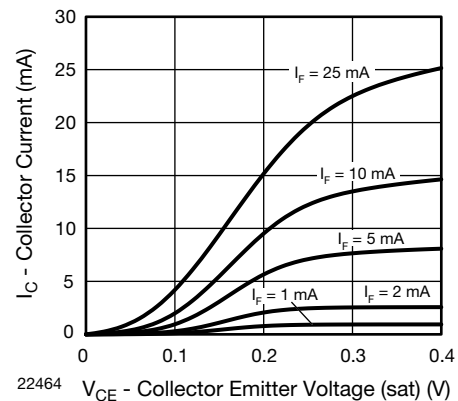


Fig. 10 - Collector Current vs. Collector Emitter Voltage (sat)

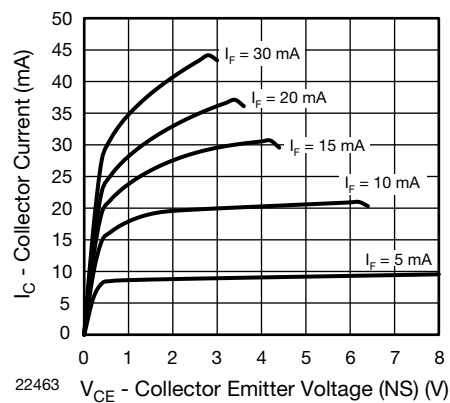


Fig. 8 - Collector Current vs. Collector Emitter Voltage (NS)

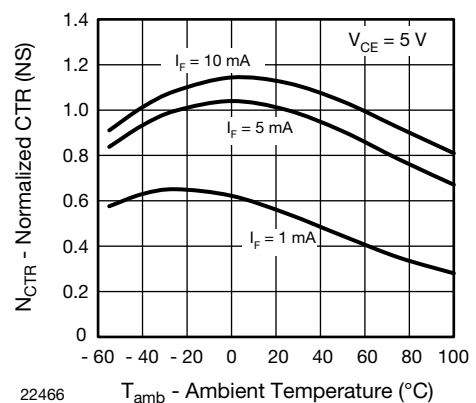


Fig. 11 - Normalized CTR (NS) vs. Ambient Temperature

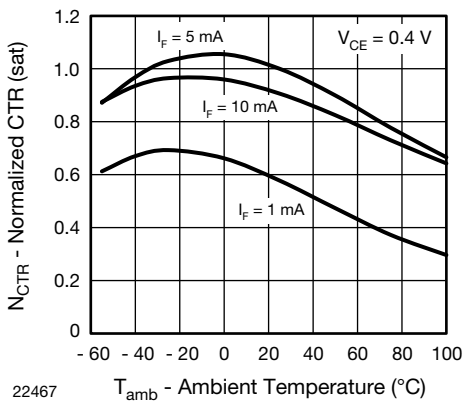


Fig. 12 - Normalized CTR (sat) vs. Ambient Temperature

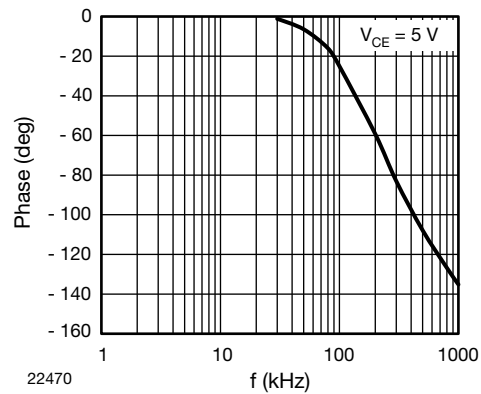


Fig. 15 -  $F_{CTR}$  vs. Phase Angle

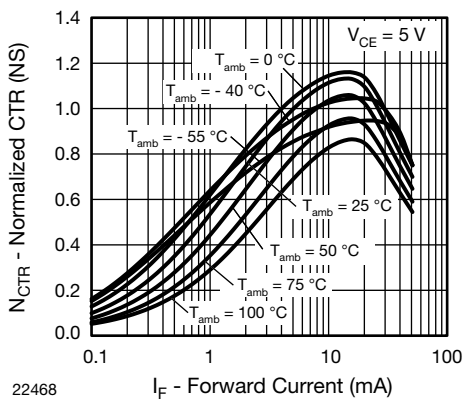


Fig. 13 - Normalized CTR (NS) vs. Forward Current

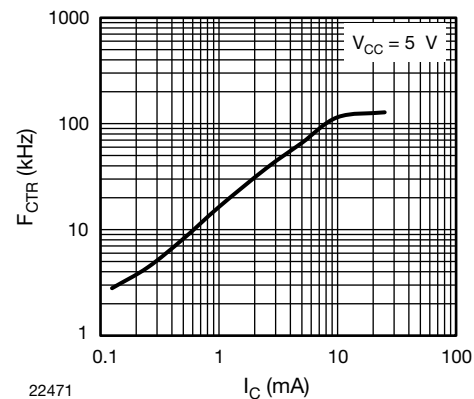


Fig. 16 -  $F_{CTR}$  vs.  $I_C$

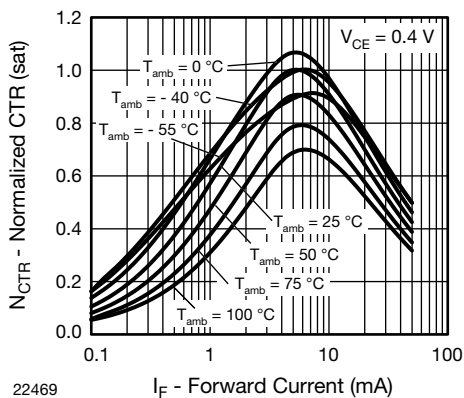


Fig. 14 - Normalized CTR (sat) vs. Forward Current

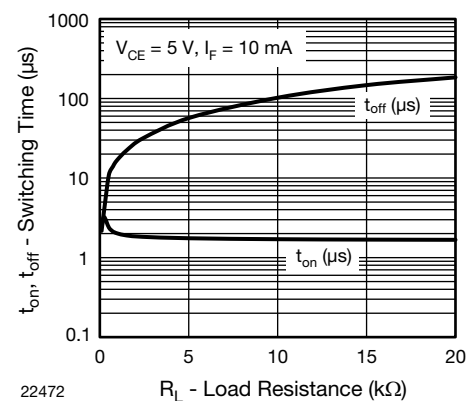


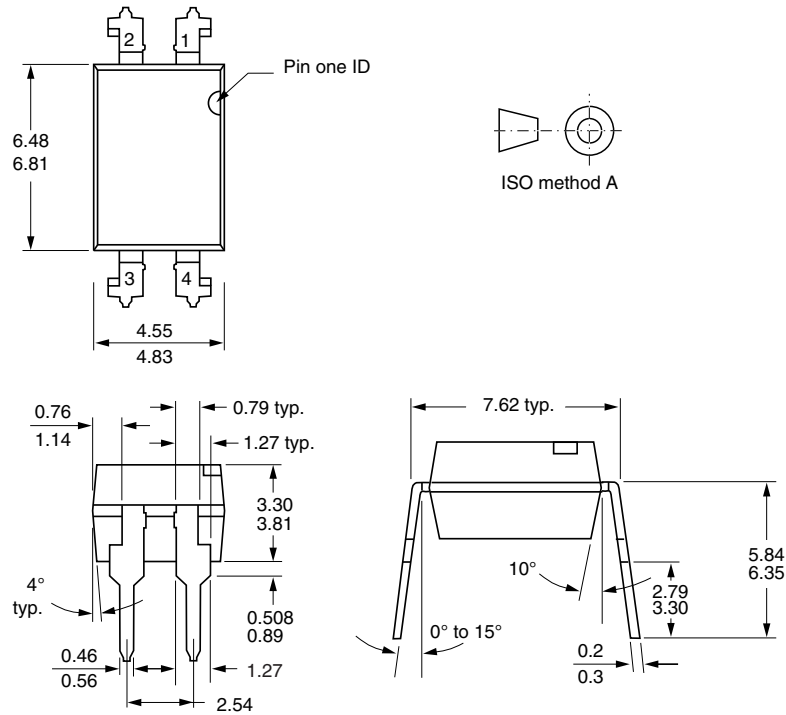
Fig. 17 - Switching Time vs. Load Resistance



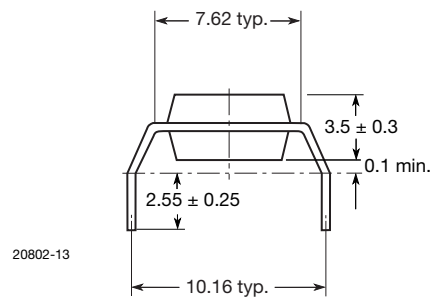
# TCET1600, TCET1600G

Optocoupler, Phototransistor Output, Vishay Semiconductors  
AC Input

## PACKAGE DIMENSIONS in millimeters



### Option 6



## PACKAGE MARKING (example)





## Disclaimer

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