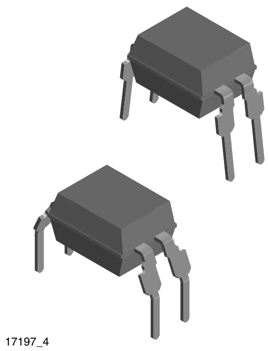
# Optocoupler, Phototransistor Output, AC Input



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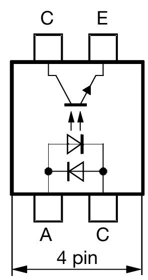



## LINKS TO ADDITIONAL RESOURCES

Product Page

Related Documents

Ultra Librarian EDA / CAD

## VDE STANDARDS

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

- **DIN EN 60747-5-5 (VDE 0884-5)**
  Optocoupler for electrical safety requirements
- **IEC 60950 / EN 60950**
  Office machines (applied for reinforced isolation for mains voltage ≤ 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

## DESCRIPTION

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

## FEATURES

Pb-free

e3

RoHS COMPLIANT

- Isolation materials according to UL 94 V-0
- 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 $kV_{peak}$
- Isolation test voltage (partial discharge test voltage) $V_{pd}$ = 1.6 $kV_{peak}$
- Rated isolation voltage (RMS includes DC) $V_{IOWM}$ = 600 $V_{RMS}$
- Rated recurring peak voltage (repetitive) $V_{IORM}$ = 890 $V_{peak}$
- Thickness though insulation ≥ 0.75 mm
- Creepage current resistance according to VDE 0303 / IEC 60112 comparative tracking index: CTI ≥ 175
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

## AGENCY APPROVALS

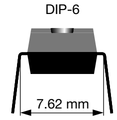
- UL
- cUL
- DIN EN 60747-5-5 (VDE 0884-5)
- FIMKO
- CQC GB4943.1
- CQC GB8898

## ORDERING INFORMATION

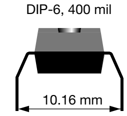
| T | C | E | T | 1 | 6 | 0 | 0 | # |
|---|---|---|---|---|---|---|---|---|

PART NUMBER

DIP-6




DIP-6, 400 mil




| AGENCY CERTIFIED / PACKAGE | CTR (%) |
|---|---|
| | ± 5 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



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

**Notes**

- 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.

(1) Refer to wave profile for soldering conditions for through hole devices (DIP)

| **ELECTRICAL CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **INPUT** | | | | | | |
| Forward voltage | $I_F$ = ± 50 mA | $V_F$ | - | 1.25 | 1.6 | V |
| Junction capacitance | $V_R$ = 0 V, f = 1 MHz | $C_j$ | - | 50 | - | pF |
| **OUTPUT** | | | | | | |
| Collector emitter voltage | $I_C$ = 100 μA | $V_{CEO}$ | 70 | - | - | V |
| Emitter collector voltage | $I_E$ = 100 μA | $V_{ECO}$ | 7 | - | - | V |
| Collector dark current | $V_{CE}$ = 20 V, $I_F$ = 0, E = 0 | $I_{CEO}$ | - | - | 100 | nA |
| **COUPLER** | | | | | | |
| Collector emitter saturation voltage | $I_F$ = 10 mA, $I_C$ = 1 mA | $V_{CEsat}$ | - | - | 0.3 | V |
| Cut-off frequency | $V_{CE}$ = 5 V, $I_F$ = 10 mA, $R_L$ = 100 Ω | $f_c$ | - | 100 | - | kHz |
| Coupling capacitance | f = 1 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 V, $I_F$ = ± 5 mA | CTR | 20 | - | 300 | % |


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

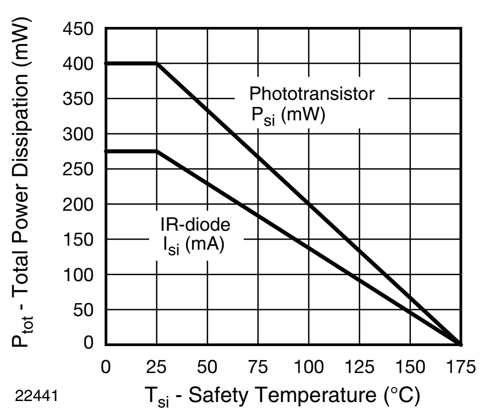


Fig. 1 - Derating Diagram

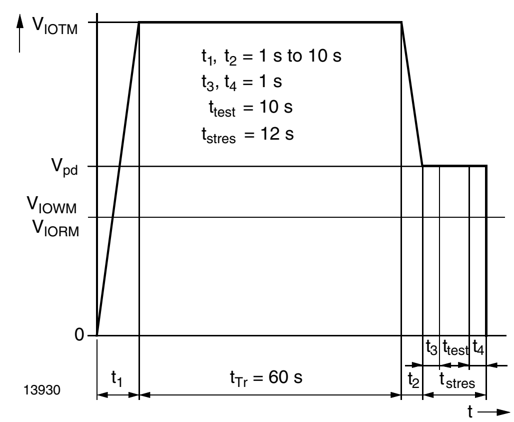


Fig. 2 - Test Pulse Diagram for Sample Test according to DIN EN 60747-5-2 (VDE 0884); IEC60747-5-5

| SWITHCING CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| Delay time | $V_S$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω, (see Fig. 3) | $t_d$ | - | 3 | - | μs |
| Rise time | $V_S$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω, (see Fig. 3) | $t_r$ | - | 3 | - | μs |
| Turn-on time | $V_S$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω, (see Fig. 3) | $t_{on}$ | - | 6 | - | μs |
| Storage time | $V_S$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω, (see Fig. 3) | $t_s$ | - | 0.3 | - | μs |
| Fall time | $V_S$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω, (see Fig. 3) | $t_f$ | - | 4.7 | - | μs |
| Turn-off time | $V_S$ = 5 V, $I_C$ = 2 mA, $R_L$ = 100 Ω, (see Fig. 3) | $t_{off}$ | - | 5 | - | μs |
| Turn-on time | $V_S$ = 5 V, $I_F$ = 10 mA, $R_L$ = 1 kΩ, (see Fig. 4) | $t_{on}$ | - | 9 | - | μs |
| Turn-off time | $V_S$ = 5 V, $I_F$ = 10 mA, $R_L$ = 1 kΩ, (see Fig. 4) | $t_{off}$ | - | 10 | - | μs |


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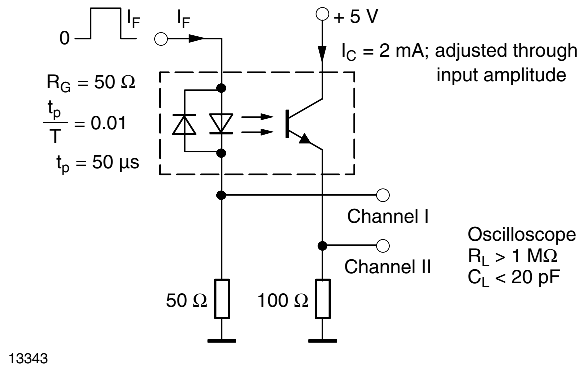


Fig. 3 - Test Circuit, Non-Saturated Operation

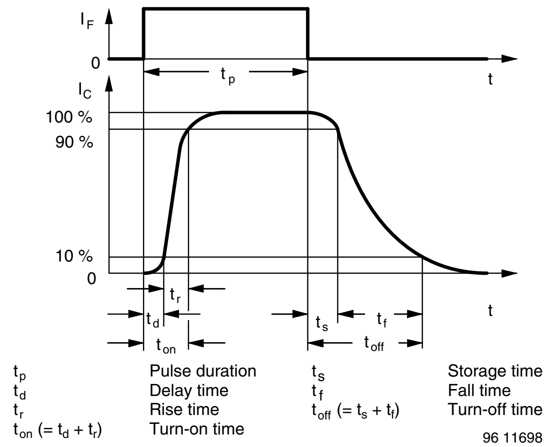


Fig. 5 - Switching Times

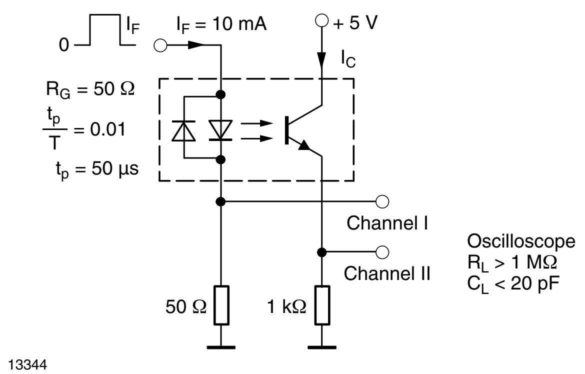


Fig. 4 - Test Circuit, Saturated Operation

| SAFETY AND INSULATION RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **TEST CONDITION** | **SYMBOL** | **VALUE** | **UNIT** |
| Climatic classification | According to IEC 68 part 1 | | 55 / 100 / 21 | |
| Comparative tracking index | | CTI | 175 | |
| Maximum rated withstanding isolation voltage | t = 1 min | $V_{ISO}$ | 4420 | $V_{RMS}$ |
| Maximum transient isolation voltage | | $V_{IOTM}$ | 10 000 | $V_{peak}$ |
| Maximum repetitive peak isolation voltage | | $V_{IORM}$ | 890 | $V_{peak}$ |
| Isolation resistance | $V_{IO}$ = 500 V, $T_{amb}$ = 25 °C | $R_{IO}$ | $\geq 10^{12}$ | Ω |
| | $V_{IO}$ = 500 V, $T_{amb}$ = 100 °C | $R_{IO}$ | $\geq 10^{11}$ | Ω |
| Output safety power | | $P_{SO}$ | 400 | mW |
| Input safety current | | $I_{SI}$ | 275 | mA |
| Safety temperature | | $T_S$ | 175 | °C |
| Creepage distance | | | ≥ 7 | mm |
| Clearance distance | | | ≥ 7 | mm |
| Insulation thickness | | DTI | ≥ 0.4 | mm |

**Note**

- As per IEC 60747-5-5, § 7.4.3.8.2, this optocoupler is suitable for “safe electrical insulation” only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits.


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**TYPICAL CHARACTERISTICS** ($T_{amb}$ = 25 °C, unless otherwise specified)

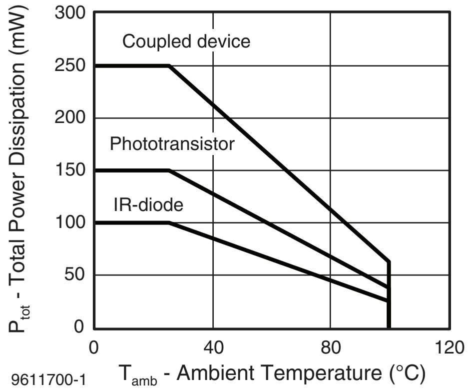


Fig. 6 - Total Power Dissipation vs. Ambient Temperature

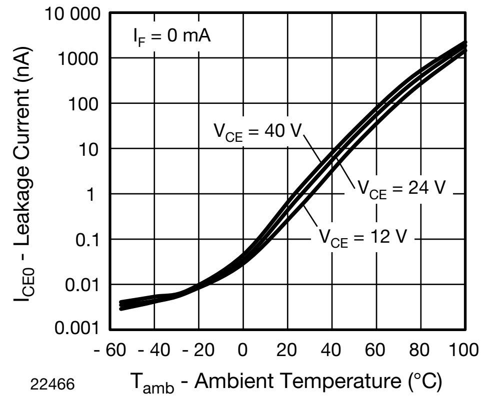


Fig. 9 - Leakage Current vs. Ambient Temperature

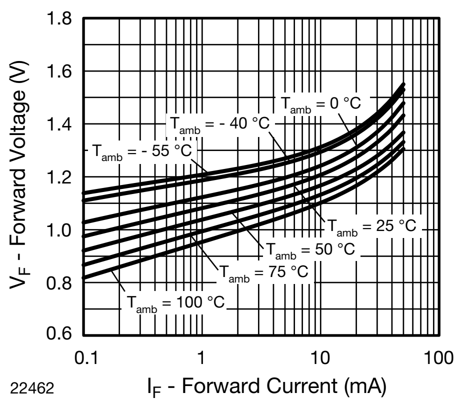


Fig. 7 - Forward Current vs. Forward Voltage

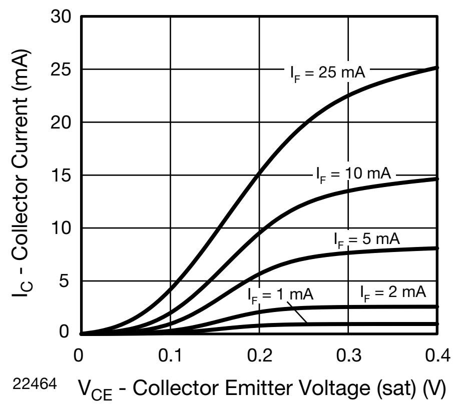


Fig. 10 - Collector Current vs. Collector Emitter Voltage (saturated)

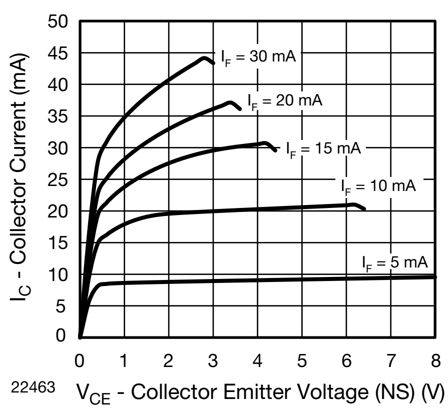


Fig. 8 - Collector Current vs. Collector Emitter Voltage (non-saturated)

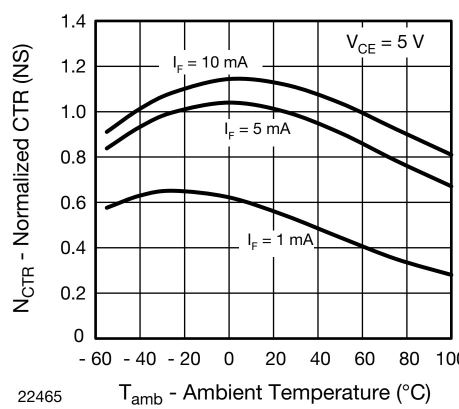


Fig. 11 - Normalized CTR (non-saturated) vs. Ambient Temperature


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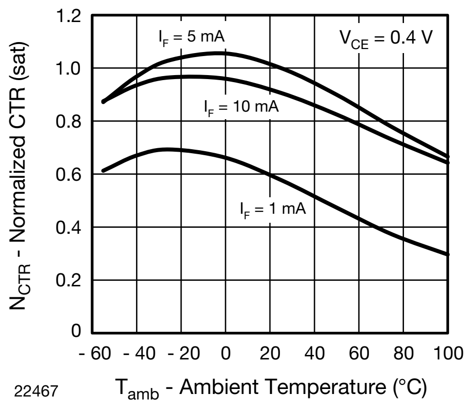


Fig. 12 - Normalized CTR (saturated) vs. Ambient Temperature

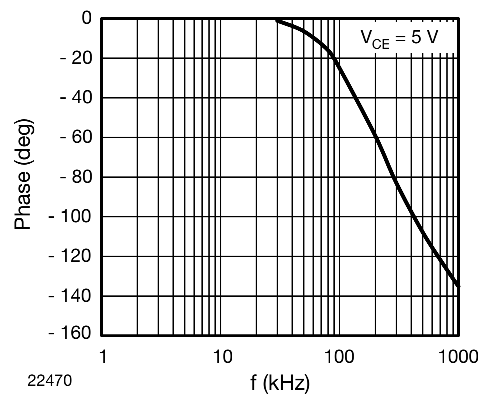


Fig. 15 - $F_{CTR}$ vs. Phase Angle

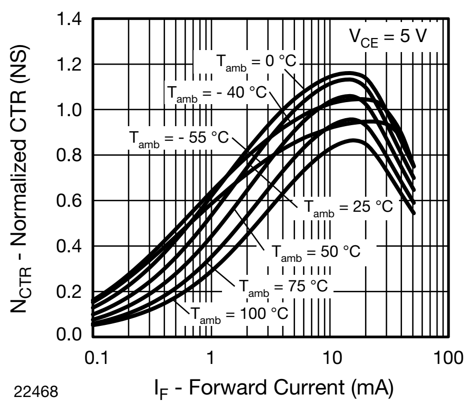


Fig. 13 - Normalized CTR (non-saturated) vs. Forward Current

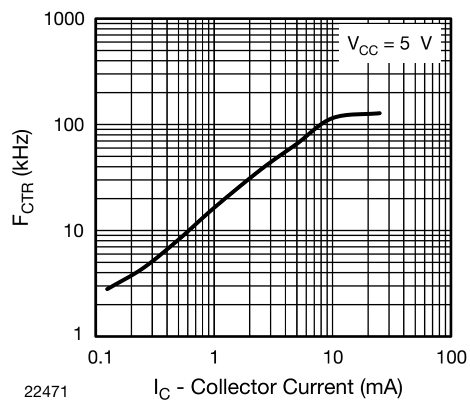


Fig. 16 - $F_{CTR}$ vs. $I_C$

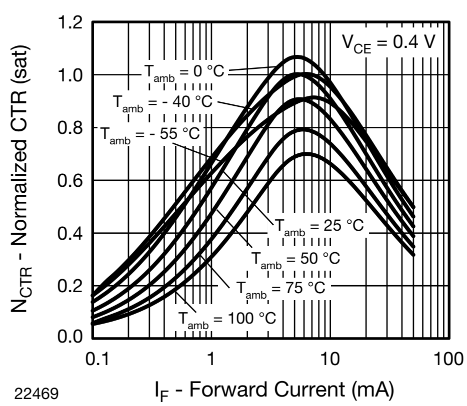


Fig. 14 - Normalized CTR (saturated) vs. Forward Current

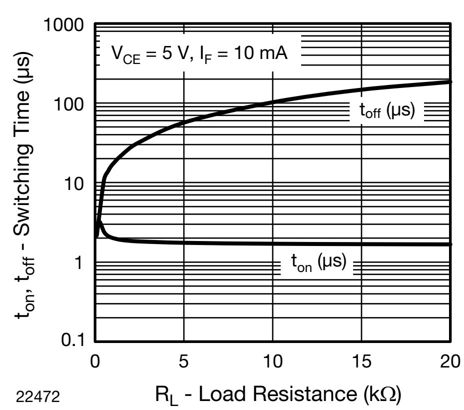


Fig. 17 - Switching Time vs. Load Resistance


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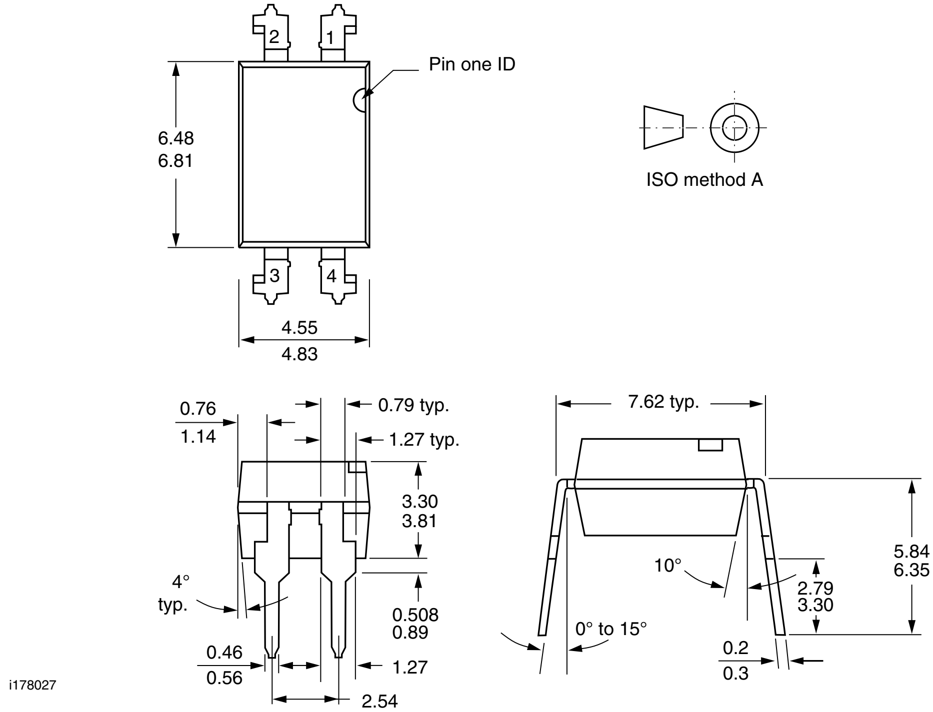
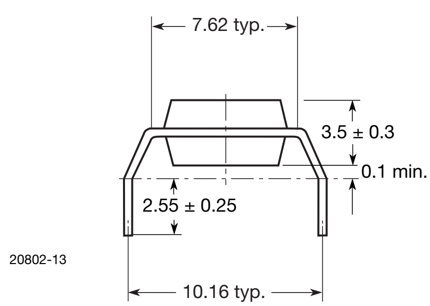
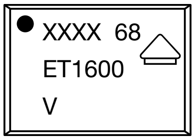
**PACKAGE DIMENSIONS** in millimeters




**Option 6**




**PACKAGE MARKING** (example)




**Note**

- XXXX = LMC (lot marking code)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