

Optocoupler with Phototransistor Output

Description

The TCET1600/ TCET2600/ TCET4600 consists of a phototransistor optically coupled to 2 gallium arsenide infrared-emitting diodes in a 4-lead up to 16-lead plastic dual inline package.

The elements are mounted on one leadframe using a **coplanar technique**, providing a fixed distance between input and output for highest safety requirements.

Applications

Circuits for safe protective separation against electrical shock according to safety class II (reinforced isolation):

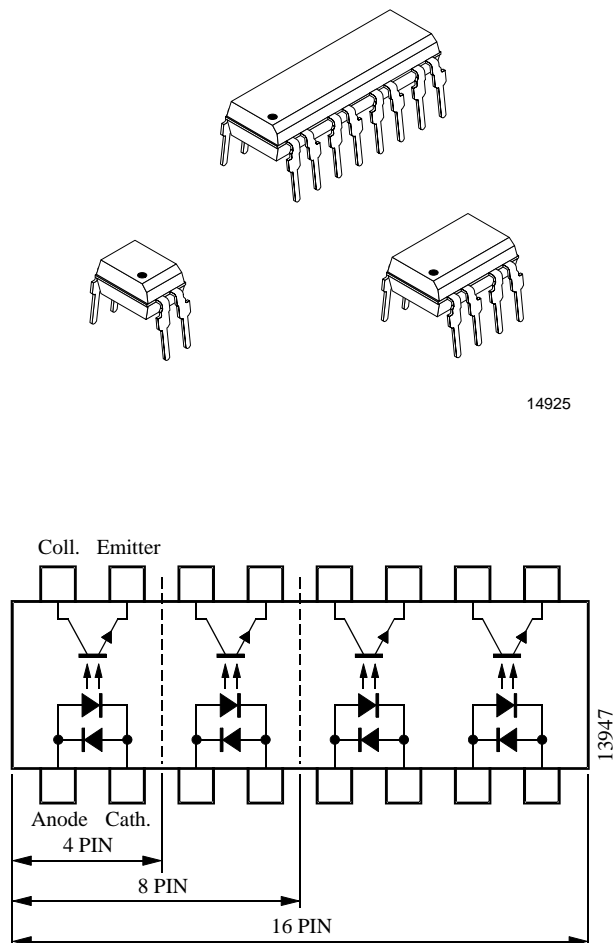
- For appl. class I – IV at mains voltage ≤ 300 V
- For appl. class I – III at mains voltage ≤ 600 V according to VDE 0884, table 2, suitable for:

Computer peripheral interface, microprocessor system interface, telecom equipment.

VDE Standards

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

- **VDE 0884**
Optocoupler for electrical safety requirements
- **IEC 950/EN 60950**
Office machines (applied for reinforced isolation for mains voltage ≤ 400 V_{RMS})
- **VDE 0804**
Telecommunication apparatus and data processing
- **IEC 65**
Safety for mains-operated electronic and related household apparatus



Order Instruction

Ordering Code	CTR Ranking	Remarks
TCET1600/ TCET1600G ¹⁾	>20%	4 Pin = Single channel
TCET2600	>20%	8 Pin = Dual channel
TCET4600	>20%	16 Pin = Quad channel

¹⁾ G = Leadform 10.16 mm; G is not market on the body



Features

Approvals:

- **BSI:** BS EN 41003, BS EN 60095 (BS 415), BS EN 60950 (BS 7002), Certificate number 7081 and 7402
- **FIMKO (SETI):** EN 60950, Certificate number 11027
- **Underwriters Laboratory (UL)** 1577 recognized, file number E-76222 – Double Protection
- **CSA (C-UL)** 1577 recognized, file number E-76222 – Double Protection
- **VDE** 0884, Certificate number 115667

VDE 0884 related features:

- Rated impulse voltage (transient overvoltage) $V_{IOTM} = 8$ 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} (848 V peak)
- Rated recurring peak voltage (repetitive) $V_{IORM} = 600$ V_{RMS}

- Creepage current resistance according to VDE 0303/IEC 112
Comparative Tracking Index: **CTI** ≥ 175
- Thickness through insulation ≥ 0.75 mm
- Internal creepage distance > 4 mm

General features:

- Isolation materials according to UL94-VO
- Pollution degree 2 (DIN/VDE 0110 /resp. IEC 664)
- Climatic classification 55/100/21 (IEC 68 part 1)
- Special construction:
Therefore, extra low coupling capacity of typical 0.2 pF, high **Common Mode Rejection**
- Low temperature coefficient of CTR
- **G** = Leadform 10.16 mm;
provides creepage distance > 8 mm, for TCET2600/ TCET4600 optional; suffix letter 'G' is not marked on the optocoupler
- Coupling System U

Absolute Maximum Ratings

Input (Emitter)

Parameter	Test Conditions	Symbol	Value	Unit
Reverse voltage		V_R	6	V
Forward current		I_F	±60	mA
Forward surge current	$t_p \leq 10 \mu s$	I_{FSM}	±1.5	A
Power dissipation	$T_{amb} \leq 25^\circ C$	P_V	100	mW
Junction temperature		T_j	125	°C

Output (Detector)

Parameter	Test Conditions	Symbol	Value	Unit
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	$T_{amb} \leq 25^\circ C$	P_V	150	mW
Junction temperature		T_j	125	°C

Coupler

Parameter	Test Conditions	Symbol	Value	Unit
Isolation test voltage (RMS)	$t = 1$ min	V_{IO}	5	kV
Total power dissipation	$T_{amb} \leq 25^\circ C$	P_{tot}	250	mW
Operating ambient temperature range		T_{amb}	−40 to +100	°C
Storage temperature range		T_{stg}	−55 to +125	°C
Soldering temperature	2 mm from case $t \leq 10$ s	T_{sd}	260	°C

**Electrical Characteristics** ($T_{\text{amb}} = 25^{\circ}\text{C}$)**Input (Emitter)**

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
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

Output (Detector)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
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_{CEO}	7			V
Collector dark current	$V_{\text{CE}} = 20 \text{ V}$, $I_F = 0$, $E = 0$	I_{CEO}			100	nA

Coupler

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Collector emitter saturation voltage	$I_F \pm 10 \text{ mA}$, $I_C = 1 \text{ mA}$	V_{CEsat}			0.3	V
Cut-off frequency	$V_{\text{CE}} = 5 \text{ V}$, $I_F \pm 10 \text{ mA}$, $R_L = 100 \text{ }\Omega$	f_c		100		kHz
Coupling capacitance	$f = 1 \text{ MHz}$	C_k		0.3		pF

Current Transfer Ratio (CTR)

Parameter	Test Conditions	Type	Symbol	Min.	Typ.	Max.	Unit
I_C/I_F	$V_{\text{CE}} = 5 \text{ V}$, $I_F = \pm 5 \text{ mA}$	TCET1600 up to TCET4600	CTR	0.20		3.0	

Maximum Safety Ratings (according to VDE 0884) see figure 1

This device is used for protective separation against electrical shock only within the maximum safety ratings. This must be ensured by using protective circuits in the applications.

Input (Emitter)

Parameters	Test Conditions	Symbol	Value	Unit
Forward current		I_{si}	130	mA

Output (Detector)

Parameters	Test Conditions	Symbol	Value	Unit
Power dissipation	$T_{amb} \leq 25^\circ\text{C}$	P_{si}	265	mW

Coupler

Parameters	Test Conditions	Symbol	Value	Unit
Rated impulse voltage		V_{IOTM}	8	kV
Safety temperature		T_{si}	150	$^\circ\text{C}$

Insulation Rated Parameters (according to VDE 0884)

Parameter	Test Conditions	Symbol	Min.	Typ.	Max.	Unit
Partial discharge test voltage – Routine test	100%, $t_{test} = 1\text{ s}$	V_{pd}	1.6			kV
Partial discharge test voltage – Lot test (sample test)	$t_{Tr} = 60\text{ s}$, $t_{test} = 10\text{ s}$, (see figure 2)	V_{IOTM}	8			kV
		V_{pd}	1.3			kV
Insulation resistance	$V_{IO} = 500\text{ V}$	R_{IO}	10^{12}			Ω
	$V_{IO} = 500\text{ V}$, $T_{amb} = 100^\circ\text{C}$	R_{IO}	10^{11}			Ω
	$V_{IO} = 500\text{ V}$, $T_{amb} = 150^\circ\text{C}$	R_{IO}	10^9			Ω
	(construction test only)					

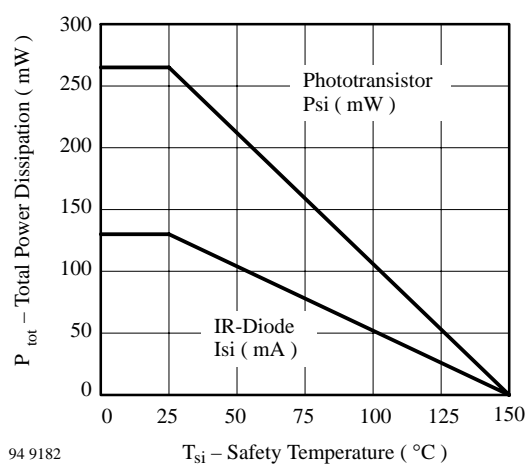


Figure 1. Derating diagram

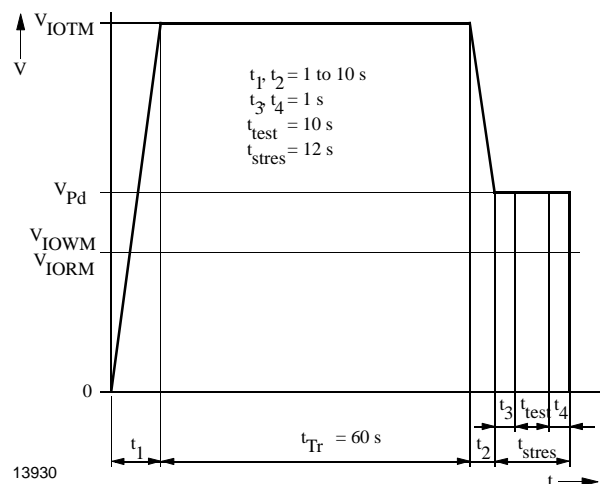


Figure 2. Test pulse diagram for sample test according to DIN VDE 0884

Switching Characteristics

Parameter	Test Conditions	Symbol	Typ.	Unit
Delay time	$V_S = 5\text{ V}$, $I_C = 2\text{ mA}$, $R_L = 100\ \Omega$ (see figure 3)	t_d	3.0	μs
Rise time		t_r	3.0	μs
Turn-on time		t_{on}	6.0	μs
Storage time		t_s	0.3	μs
Fall time		t_f	4.7	μs
Turn-off time		t_{off}	5.0	μs
Turn-on time	$V_S = 5\text{ V}$, $I_F = 10\text{ mA}$, $R_L = 1\text{ k}\Omega$ (see figure 4)	t_{on}	9.0	μs
Turn-off time		t_{off}	10.0	μs

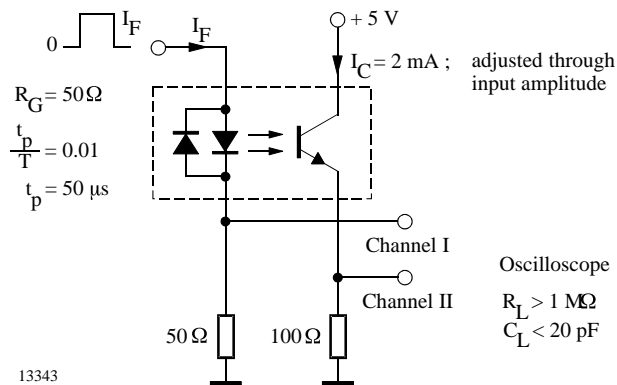


Figure 3. Test circuit, non-saturated operation

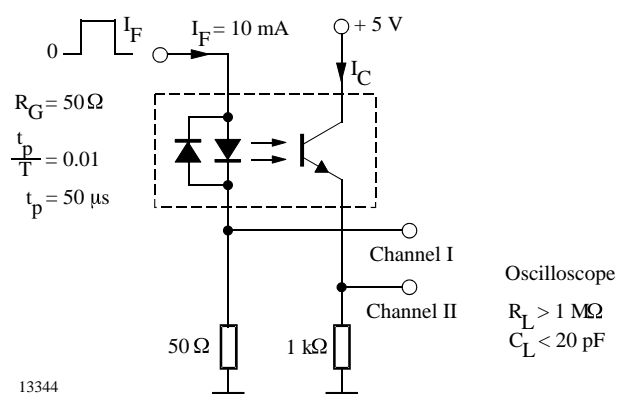


Figure 4. Test circuit, saturated operation

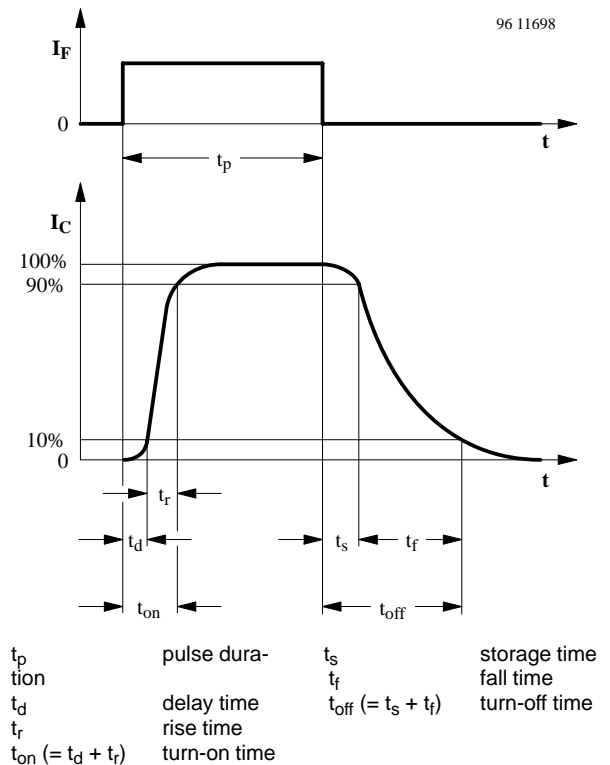


Figure 5. Switching times

Typical Characteristics ($T_{amb} = 25^{\circ}\text{C}$, unless otherwise specified)

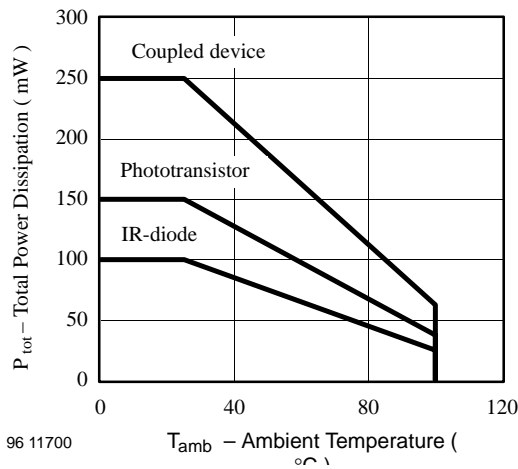


Figure 6. Total Power Dissipation vs. Ambient Temperature

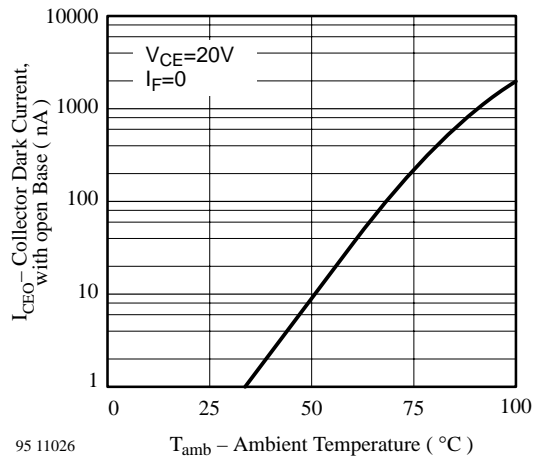


Figure 9. Collector Dark Current vs. Ambient Temperature

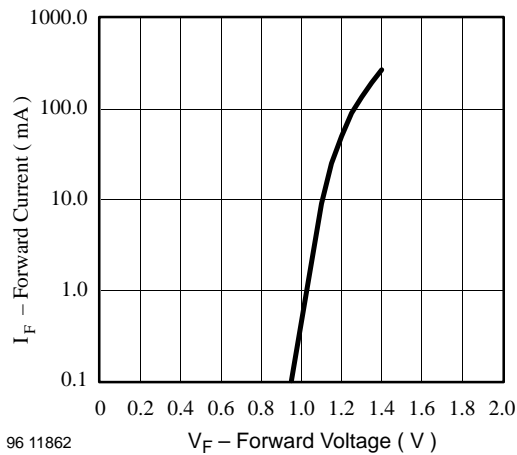


Figure 7. Forward Current vs. Forward Voltage

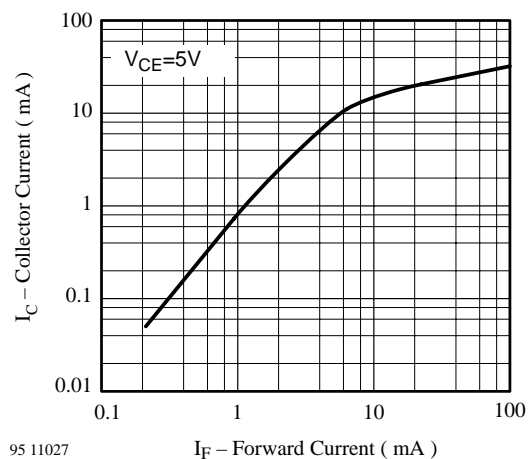


Figure 10. Collector Current vs. Forward Current

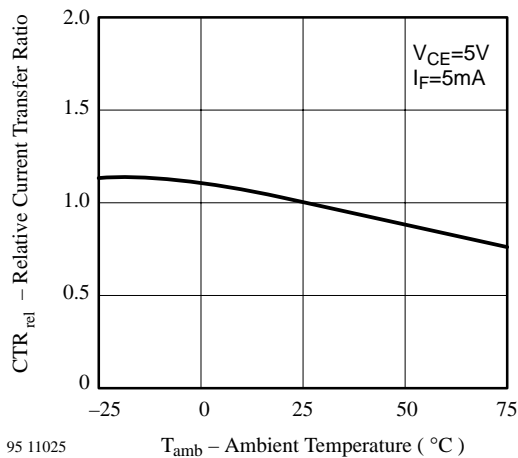


Figure 8. Relative Current Transfer Ratio vs. Ambient Temperature

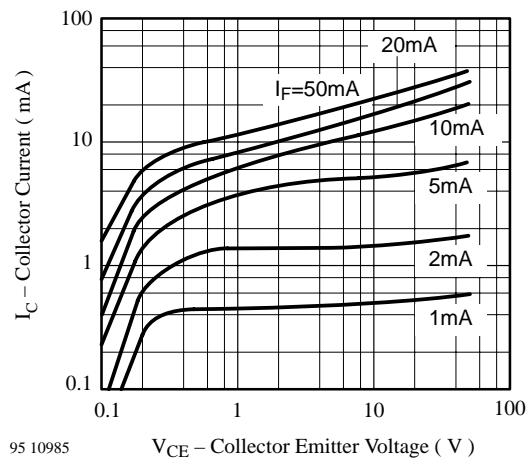


Figure 11. Collector Current vs. Collector Emitter Voltage

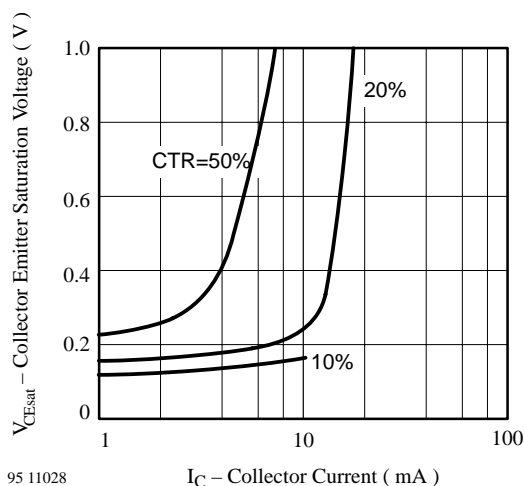


Figure 12. Collector Emitter Saturation Voltage vs. Collector Current

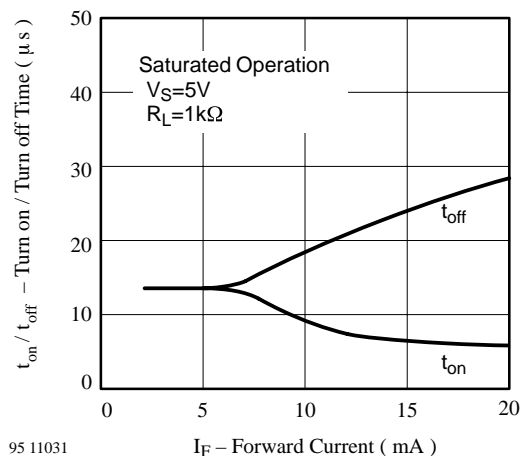


Figure 14. Turn on / off Time vs. Forward Current

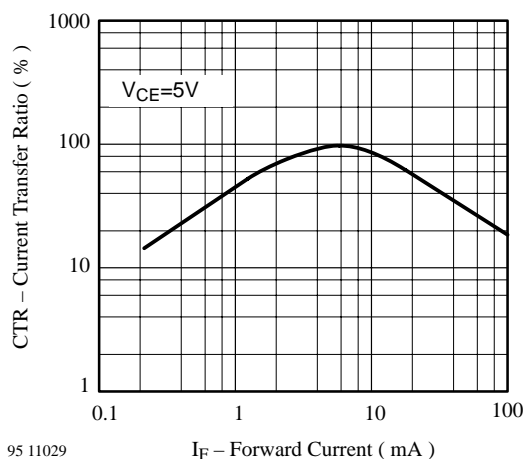


Figure 13. Current Transfer Ratio vs. Forward Current

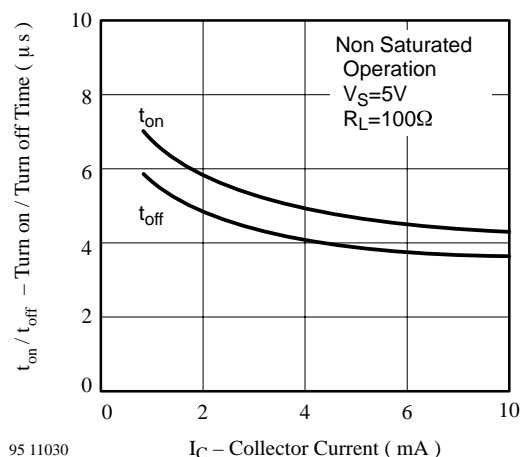


Figure 15. Turn on / off Time vs. Collector Current

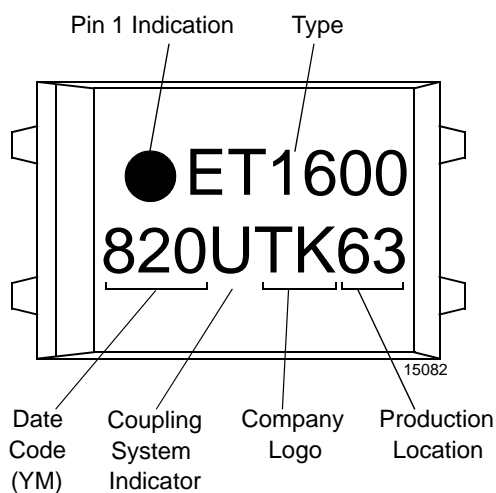
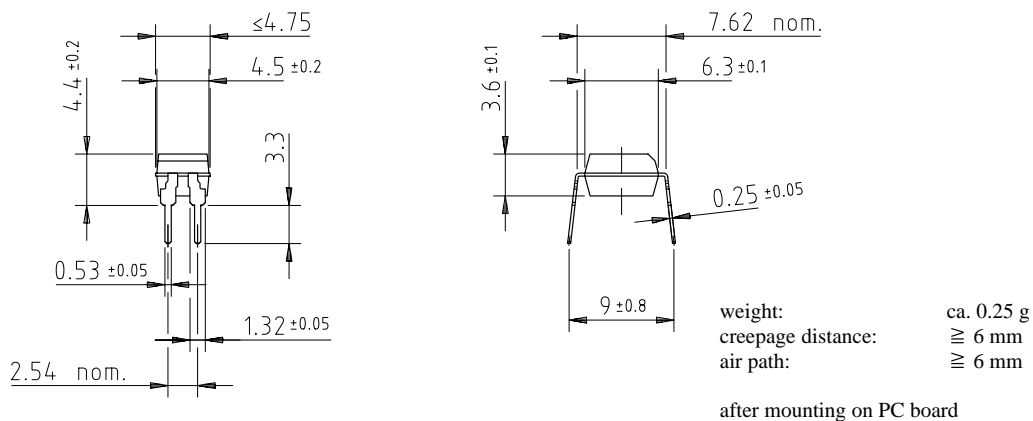
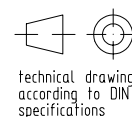
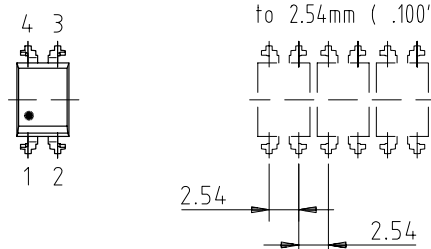


Figure 16. Marking example

Dimensions of TCET1600 in mm

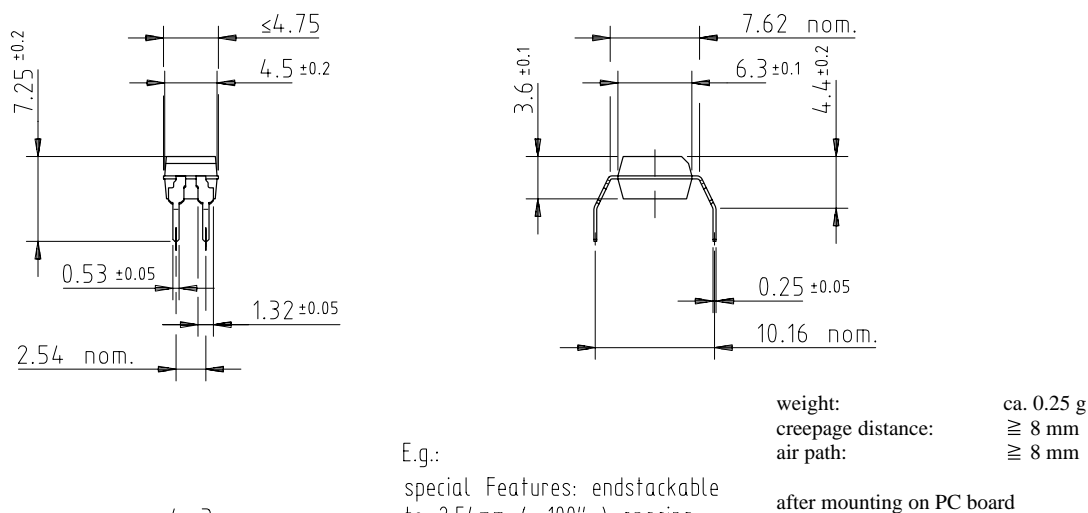


E.g.:
 special Features: endstackable
 to 2.54mm (.100") spacing

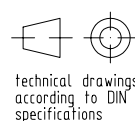
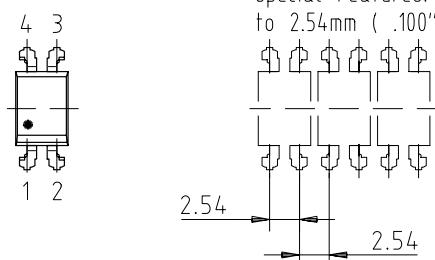


14789

Dimensions of TCET1600G in mm

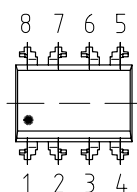
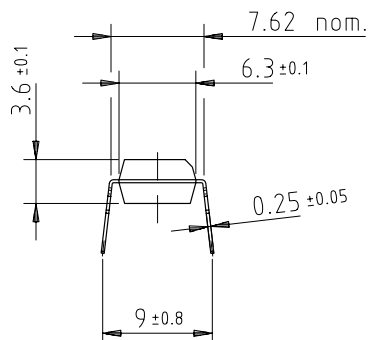
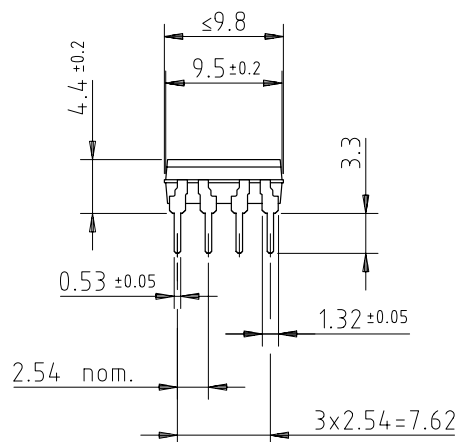


E.g.:
 special Features: endstackable
 to 2.54mm (.100") spacing



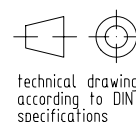
14792

Dimensions of TCET2600 in mm



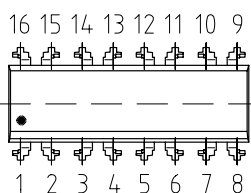
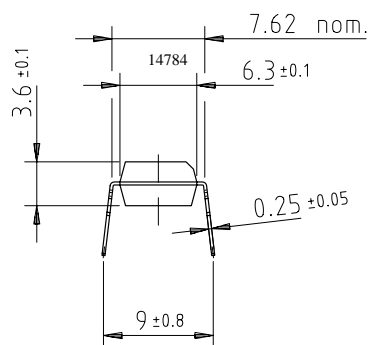
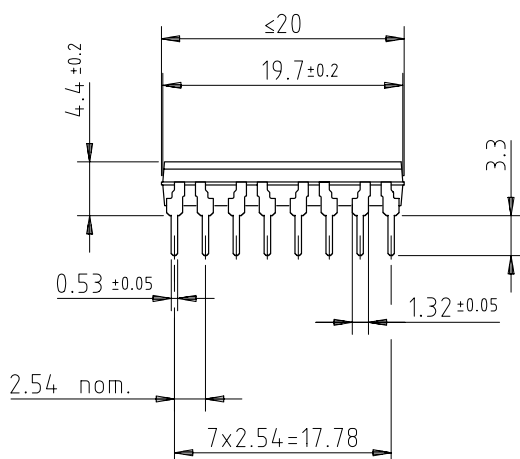
weight: ca. 0.55 g
 creepage distance: ≥ 6 mm
 air path: ≥ 6 mm

after mounting on PC board



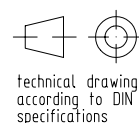
14784

Dimensions of TCET4600 in mm



weight: ca. 1.0 g
 creepage distance: ≥ 6 mm
 air path: ≥ 6 mm

after mounting on PC board



14783