Triple Channel Transmissive Optical Sensor With Phototransistor Outputs for “Turn and Push” Encoding

DESCRIPTION
The TCUT1630X01 is a compact transmissive sensor that includes an infrared emitter and three phototransistor detectors, located face-to-face in a surface-mount package. The tall dome design supports an additional transistor and additional mechanical room for vertical signal encoding.

FEATURES
- Package type: surface-mount
- Detector type: phototransistor
- Dimensions (L x W x H in mm): 5.7 x 5.9 x 7.1
- AEC-Q101 qualified
- Gap (in mm): 3
- Aperture (in mm): 0.3
- Typical output current under test: I_C = 1.3 mA
- Emitter wavelength: 950 nm
- Lead (Pb)-free soldering released
- Moisture sensitivity level (MSL): 1
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS
- Automotive optical sensors
- Accurate position sensor for encoder
- Sensor for motion, speed, and direction
- Sensor for “turn and push” encoding

PRODUCT SUMMARY

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>GAP WIDTH (mm)</th>
<th>APERTURE WIDTH (mm)</th>
<th>TYPICAL OUTPUT CURRENT UNDER TEST (mA)</th>
<th>DAYLIGHT BLOCKING FILTER INTEGRATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCUT1630X01</td>
<td>3</td>
<td>0.3</td>
<td>1.3</td>
<td>No</td>
</tr>
</tbody>
</table>

Note
(1) Conditions like in table basic characteristics / coupler

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>ORDER CODE</th>
<th>PACKAGING</th>
<th>VOLUME (1)</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCUT1630X01</td>
<td>Tape and reel</td>
<td>MOQ: 1100 pcs, 1100pcs/reel</td>
<td>Drypack, MSL 1</td>
</tr>
</tbody>
</table>

Note
(1) MOQ: minimum order quantity
### ABSOLUTE MAXIMUM RATINGS \((T_{\text{amb}} = 25 \, ^{\circ}\text{C}, \text{unless otherwise specified})\)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITION</th>
<th>SYMBOL</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUPLER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction temperature</td>
<td>(T_J)</td>
<td>110</td>
<td>(^{\circ}\text{C})</td>
<td></td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td>(T_{\text{amb}})</td>
<td>-40 to +105</td>
<td>(^{\circ}\text{C})</td>
<td></td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>(T_{\text{stg}})</td>
<td>-40 to +125</td>
<td>(^{\circ}\text{C})</td>
<td></td>
</tr>
<tr>
<td>Soldering temperature</td>
<td>In accordance with Fig. 17</td>
<td>(T_{sd})</td>
<td>260</td>
<td>(^{\circ}\text{C})</td>
</tr>
<tr>
<td>INPUT (EMITTER)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reverse voltage</td>
<td>(V_R)</td>
<td>5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Forward current (T_{\text{amb}} \leq 95 , ^{\circ}\text{C})</td>
<td>(I_F)</td>
<td>25</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Forward surge current (t_p \leq 10 , \mu\text{s})</td>
<td>(I_{\text{FSM}})</td>
<td>200</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation (T_{\text{amb}} \leq 95 , ^{\circ}\text{C})</td>
<td>(P_V)</td>
<td>37.5</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>OUTPUT (DETECTOR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector emitter voltage</td>
<td>(V_{\text{CEO}})</td>
<td>20</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Emitter collector voltage</td>
<td>(V_{\text{ECO}})</td>
<td>7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Collector current</td>
<td>(I_C)</td>
<td>20</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Collector dark current (T_{\text{amb}} = 85 , ^{\circ}\text{C}, , V_{\text{CE}} = 5 , \text{V})</td>
<td>(I_{\text{CEO}})</td>
<td>3.3</td>
<td>(\mu\text{A})</td>
<td></td>
</tr>
<tr>
<td>Total power dissipation (T_{\text{amb}} \leq 95 , ^{\circ}\text{C})</td>
<td>(P_V)</td>
<td>37.5</td>
<td>mW</td>
<td></td>
</tr>
</tbody>
</table>

### ABSOLUTE MAXIMUM RATINGS

![Fig. 1 - Power Dissipation Limit vs. Ambient Temperature](22460)

![Fig. 2 - Forward Current Limit vs. Ambient Temperature](22461)
**ELECTRICAL CHARACTERISTICS** \[ (T_{\text{amb}} = 25 \, ^{\circ}\mathrm{C}, \text{unless otherwise specified}) \]

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITION</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COUPLER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector current per channel</td>
<td>( V_{\text{CE}} = 5 , \text{V}, I_F = 15 , \text{mA} )</td>
<td>( I_C )</td>
<td>0.45</td>
<td>1.3</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Collector emitter saturation voltage</td>
<td>( I_F = 15 , \text{mA}, I_C = 0.2 , \text{mA} )</td>
<td>( V_{\text{CEsat}} )</td>
<td>-</td>
<td>-</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td><strong>INPUT (EMITTER)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward voltage</td>
<td>( I_C = 15 , \text{mA} )</td>
<td>( V_F )</td>
<td>1</td>
<td>1.2</td>
<td>1.4</td>
<td>V</td>
</tr>
<tr>
<td>Reverse current</td>
<td>( V_R = 5 , \text{V} )</td>
<td>( I_R )</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>μA</td>
</tr>
<tr>
<td>Junction capacitance</td>
<td>( V_R = 0 , \text{V}, f = 1 , \text{MHz} )</td>
<td>( C_J )</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td><strong>OUTPUT (DETECTOR)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector emitter voltage ( I_C )</td>
<td>( I_C = 1 , \text{mA} )</td>
<td>( V_{\text{CEO}} )</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Emitter collector voltage</td>
<td>( I_C = 100 , \mu\text{A} )</td>
<td>( V_{\text{EEO}} )</td>
<td>7</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Collector dark current</td>
<td>( V_{\text{CE}} = 25 , \text{V}, I_F = 0 , \text{A}, E = 0 , \text{lx} )</td>
<td>( I_{\text{CEO}} )</td>
<td>-</td>
<td>1</td>
<td>100</td>
<td>nA</td>
</tr>
</tbody>
</table>

**SWITCHING CHARACTERISTICS**

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITION</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rise time</td>
<td>( I_C = 0.7 , \text{mA}, V_{\text{CE}} = 5 , \text{V}, \ R_L = 100 , \Omega ) (see Fig. 3)</td>
<td>( t_r )</td>
<td>-</td>
<td>9</td>
<td>150</td>
<td>μs</td>
</tr>
<tr>
<td>Fall time</td>
<td>( I_C = 0.7 , \text{mA}, V_{\text{CE}} = 5 , \text{V}, \ R_L = 100 , \Omega ) (see Fig. 3)</td>
<td>( t_f )</td>
<td>-</td>
<td>16</td>
<td>150</td>
<td>μs</td>
</tr>
</tbody>
</table>

**BASIC CHARACTERISTICS** \[ (T_{\text{amb}} = 25 \, ^{\circ}\mathrm{C}, \text{unless otherwise specified}) \]

- **Fig. 3 - Test Circuit for \( t_r \) and \( t_f \)**
- **Fig. 4 - Switching Times**
- **Fig. 5 - Forward Current vs. Forward Voltage**
- **Fig. 6 - Forward Voltage vs. Ambient Temperature**

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**REV. 1.2, 25-MAR-2020**

For technical questions, contact: sensorstechsupport@vishay.com

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Fig. 7 - Collector Current vs. Forward Current

Fig. 8 - Collector Current vs. Collector Emitter Voltage

Fig. 9 - Collector Emitter Saturation Voltage vs. Ambient Temperature

Fig. 10 - Collector Current vs. Ambient Temperature

Fig. 11 - Collector Dark Current vs. Ambient Temperature

Fig. 12 - Rise / Fall Time vs. Collector Current

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**Fig. 13 - Relative Collector Current vs. Horizontal Displacement**
Horizontal Shutter (0.25 mm thickness)

**Fig. 14 - Relative Collector Current vs. Vertical Displacement**
Vertical Shutter (0.25 mm thickness)

**Fig. 15 - Application example**

IF = 15 mA + V_C = 5 V

**Fig. 16 - Top View Sensor**
Channel Positions and Origin of Horizontal Shutter

**Fig. 17 - Top View Sensor**
Channel Positions and Origin of Vertical Shutter

**REFLOW SOLDER PROFILE**

Max. ramp up 3 °C/s
Max. ramp down 6 °C/s
Max. 120 s
Max. 100 s
Max. 30 s
Max. 260 °C
Max. 250 °C
Max. 240 °C
Max. 217 °C
Max. 205 °C
Max. 198 °C
Max. 195 °C
Max. 192 °C
Max. 189 °C
Max. 186 °C
Max. 183 °C
Max. 180 °C
Max. 177 °C
Max. 174 °C
Max. 171 °C
Max. 168 °C
Max. 165 °C
Max. 162 °C
Max. 159 °C
Max. 156 °C
Max. 153 °C
Max. 150 °C
Max. 147 °C
Max. 144 °C
Max. 141 °C
Max. 138 °C
Max. 135 °C
Max. 132 °C
Max. 129 °C
Max. 126 °C
Max. 123 °C
Max. 120 °C
Max. 117 °C
Max. 114 °C
Max. 111 °C
Max. 108 °C
Max. 105 °C
Max. 102 °C
Max. 99 °C
Max. 96 °C
Max. 93 °C
Max. 90 °C
Max. 87 °C
Max. 84 °C
Max. 81 °C
Max. 78 °C
Max. 75 °C
Max. 72 °C
Max. 69 °C
Max. 66 °C
Max. 63 °C
Max. 60 °C
Max. 57 °C
Max. 54 °C
Max. 51 °C
Max. 48 °C
Max. 45 °C
Max. 42 °C
Max. 39 °C
Max. 36 °C
Max. 33 °C
Max. 30 °C
Max. 27 °C
Max. 24 °C
Max. 21 °C
Max. 18 °C
Max. 15 °C
Max. 12 °C
Max. 9 °C
Max. 6 °C
Max. 3 °C
Max. 0 °C

Fig. 18 - Lead (Pb)-free Reflow Solder Profile
According to J-STD-020
**FLOOR LIFE**
Level 1, according to JEDEC®, J-STD-020. No time limit.

**PACKAGE DIMENSIONS** in millimeters

![Technical drawing](image)

- Not indicated tolerances ± 0.15 mm
- Material cut-outs
- Technical drawings according to DIN specification.
- Optical axes emitter
- Recommended Footprint

**Note**
- Do not connect n.c. pins to the circuit

**Material cut-outs**

![Material cut-outs](image)

**Top view**

![Top view](image)

**Recommended Footprint**

![Recommended Footprint](image)

Drawing No.: 6.541-5106.01-4
Issue: 1; 20.06.2016
PACKAGE DIMENSIONS in millimeters
Volume/reel = 1100 pcs

Unreel direction

Reel-design is representative for different types

Lable posted here

Emitter dome
Detector dome

Drawing-No.: 9.800-5133.01-4
Issue: 1; 29.06.2016
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