Optocoupler, Phototransistor Output, with Base Connection

DESCRIPTION
This datasheet presents five families of Vishay industry standard single channel phototransistor couplers. These families include the 4N35, 4N36, 4N37, 4N38 couplers.
Each optocoupler consists of gallium arsenide infrared LED and a silicon NPN phototransistor.
These couplers are Underwriters Laboratories (UL) listed to comply with a 5000 VRMS isolation test voltage.
This isolation performance is accomplished through Vishay double molding isolation manufacturing process. Compliance to DIN EN 60747-5-5 partial discharge isolation specification is available for these families by ordering option 1.
These isolation processes and the Vishay ISO9001 quality program results in the highest isolation performance available for a commercial plastic phototransistor optocoupler.
The devices are available in lead formed configuration suitable for surface mounting and are available either on tape and reel, or in standard tube shipping containers.

Note
• For additional design information see application note 45 normalized curves

FEATURES
• Isolation test voltage 5000 V_RMS
• Interfaces with common logic families
• Input-output coupling capacitance < 0.5 pF
• Industry standard dual-in-line 6 pin package
• Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

APPLICATIONS
• AC mains detection
• Reed relay driving
• Switch mode power supply feedback
• Telephone ring detection
• Logic ground isolation
• Logic coupling with high frequency noise rejection

AGENCY APPROVALS
• UL file no. E52744 (pending)
• cUL tested to CSA 22.2 bulletin 5A
• DIN EN 60747-5-2 (VDE 0884)/DIN EN 60747-5-5 (pending), available with option 1
• BSI: EN 60065, EN 60950-1
• FIMKO
• CQC

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PACKAGE OPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>4N35-X000</td>
<td>DIP-6</td>
</tr>
<tr>
<td>4N36-X000</td>
<td>Option 6</td>
</tr>
<tr>
<td>4N37-X000</td>
<td>Option 7</td>
</tr>
<tr>
<td>4N38</td>
<td>Option 9</td>
</tr>
<tr>
<td>4N35-X007</td>
<td>SMD-6, option 7</td>
</tr>
<tr>
<td>4N36-X007</td>
<td>SMD-6, option 9</td>
</tr>
<tr>
<td>4N37-X007</td>
<td>VDE, UL, cUL, BSI, FIMKO</td>
</tr>
<tr>
<td>4N38-X007</td>
<td></td>
</tr>
</tbody>
</table>

Notes
• Additional options may be possible, please contact sales office.
• Also available in tubes; do not put T on end.

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### Absolute Maximum Ratings

**PARAMETER** | **TEST CONDITION** | **SYMBOL** | **VALUE** | **UNIT**  
--- | --- | --- | --- | ---  
**INPUT** | | | |  
Reverse voltage | | \( V_R \) | 6 | V  
Forward current | | \( I_F \) | 60 | mA  
Surge current | \( t \leq 10 \mu s \) | \( I_{FSM} \) | 2.5 | A  
Power dissipation | | \( P_{diss} \) | 70 | mW  
**OUTPUT** | | | |  
Collector emitter breakdown voltage | | \( V_{CEO} \) | 70 | V  
Emitter base breakdown voltage | | \( V_{EBO} \) | 7 | V  
Collector current | | \( I_C \) | 50 | mA  
Collector peak current | \( I_P/T = 0.5, t_P \leq 10 \text{ ms} \) | \( I_{CM} \) | 100 | mA  
Output power dissipation | | \( P_{diss} \) | 150 | mW  
**COUPLER** | | | |  
Isolation test voltage | \( t = 1 \text{ s} \) | \( V_{ISO} \) | 5000 | \( V_{RMS} \)  
Creepage distance | | | \( \geq 7 \) | mm  
Clearance distance | | | \( \geq 7 \) | mm  
Isolation thickness between emitter and detector | | | \( \geq 0.4 \) | mm  
Comparative tracking index | | | \( \geq 175 \) |  
Isolation resistance | \( V_{IO} = 500 \text{ V}, T_{amb} = 25 \degree C \) | \( R_{IO} \) | \( \geq 10^{12} \) | \( \text{\Omega} \)  
| \( V_{IO} = 500 \text{ V}, T_{amb} = 100 \degree C \) | \( R_{IO} \) | \( \geq 10^{11} \) | \( \text{\Omega} \)  
Storage temperature | | \( T_{stg} \) | -55 to +150 | \( \degree C \)  
Operating temperature | | \( T_{amb} \) | -55 to +100 | \( \degree C \)  
Soldering temperature (1) | 2 mm from case, \( \leq 10 \text{ s} \) | \( T_{sld} \) | 260 | \( \degree C \)  
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**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 reflow profile for soldering conditions for surface mounted devices (SMD). Refer to wave profile for soldering conditions for through hole devices (DIP).

### Electrical Characteristics

**PARAMETER** | **TEST CONDITION** | **PART** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNIT**  
--- | --- | --- | --- | --- | --- | --- | ---  
**INPUT** | \( I_F = 10 \text{ mA} \) |  | \( V_F \) | 1.2 | 1.5 | V  
| \( I_F = 10 \text{ mA}, T_{amb} = -55 \degree C \) |  | \( V_F \) | 0.9 | 1.3 | 1.7 | V  
Reverse current (1) | \( V_R = 6 \text{ V} \) |  | \( I_R \) | 0.1 | 10 | \( \mu \text{A} \)  
Capacitance | \( V_R = 0 \text{ V}, f = 1 \text{ MHz} \) |  | \( C_O \) | 25 | | pF  
**OUTPUT** | \( I_C = 1 \text{ mA} \) | 4N35 | \( B_{VCEO} \) | 30 | | V  
| 4N36 | \( B_{VCEO} \) | 30 | V  
| 4N37 | \( B_{VCEO} \) | 30 | V  
| 4N38 | \( B_{VCEO} \) | 80 | V  
Collector emitter breakdown voltage (1) | \( I_C = 1 \text{ mA} \) | 4N35 | \( B_{VCEO} \) | 70 | | V  
| 4N36 | \( B_{VCEO} \) | 70 | V  
| 4N37 | \( B_{VCEO} \) | 70 | V  
| 4N38 | \( B_{VCEO} \) | 80 | V  
Emitter collector breakdown voltage (1) | \( I_C = 100 \text{ \mu A} \) | 4N35 | \( B_{VCEO} \) | 70 | | V  
| 4N36 | \( B_{VCEO} \) | 70 | V  
| 4N37 | \( B_{VCEO} \) | 70 | V  
| 4N38 | \( B_{VCEO} \) | 80 | V  
Collector base breakdown voltage (1) | \( I_C = 100 \text{ \mu A}, I_B = 1 \text{ \mu A} \) | 4N35 | \( B_{VCEO} \) | 70 | | V  
| 4N36 | \( B_{VCEO} \) | 70 | V  
| 4N37 | \( B_{VCEO} \) | 70 | V  
| 4N38 | \( B_{VCEO} \) | 80 | V  

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Document Number: 83717
ELECTRICAL CHARACTERISTICS (T_{amb} = 25 ^\circ C, unless otherwise specified)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITION</th>
<th>PART</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector emitter leakage current (1)</td>
<td>V_{CE} = 10 V, I_{F} = 0</td>
<td>4N35</td>
<td>I_{CEO}</td>
<td>5</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N36</td>
<td>I_{CEO}</td>
<td>5</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N37</td>
<td>I_{CEO}</td>
<td>5</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N38</td>
<td>I_{CEO}</td>
<td>50</td>
<td></td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_{CE} = 30 V, I_{F} = 0, T_{amb} = 100 ^\circ C</td>
<td>4N35</td>
<td>I_{CEO}</td>
<td>500</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N36</td>
<td>I_{CEO}</td>
<td>500</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N37</td>
<td>I_{CEO}</td>
<td>500</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Collector emitter capacitance</td>
<td>V_{CE} = 0</td>
<td>4N38</td>
<td>C_{CE}</td>
<td>6</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>coupler</td>
<td>Resistance, input output (1)</td>
<td>V_{IO} = 500 V</td>
<td>R_{IO}</td>
<td>10^{11}</td>
<td></td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacitance, input output</td>
<td>f = 1 MHz</td>
<td>C_{IO}</td>
<td>0.5</td>
<td></td>
<td>pF</td>
<td></td>
</tr>
</tbody>
</table>

Notes
- Minimum and maximum values are testing requirements. Typical values are characteristics of the device and are the result of engineering evaluation. Typical values are for information only and are not part of the testing requirements.
- (1) Indicates JEDEC registered values.

CURRENT TRANSFER RATIO (T_{amb} = 25 ^\circ C, unless otherwise specified)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITION</th>
<th>PART</th>
<th>SYMBOL</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{C}/I_{F} (1)</td>
<td>V_{CE} = 10 V, I_{F} = 10 mA</td>
<td>4N35</td>
<td>CTRDC</td>
<td>100</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N36</td>
<td>CTRDC</td>
<td>100</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N37</td>
<td>CTRDC</td>
<td>100</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_{CE} = 10 V, I_{F} = 20 mA</td>
<td>4N38</td>
<td>CTRDC</td>
<td>20</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N35</td>
<td>CTRDC</td>
<td>40</td>
<td>50</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N36</td>
<td>CTRDC</td>
<td>40</td>
<td>50</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4N37</td>
<td>CTRDC</td>
<td>40</td>
<td>50</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V_{CE} = 10 V, I_{F} = 10 mA, T_{A} = - 55 ^\circ C to + 100 ^\circ C</td>
<td>4N38</td>
<td>CTRDC</td>
<td>30</td>
<td></td>
<td>%</td>
<td></td>
</tr>
</tbody>
</table>

Note
- (1) Indicates JEDEC registered values.

SWITCHING CHARACTERISTICS (T_{amb} = 25 ^\circ C, 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>Turn-on time (1)</td>
<td>V_{CC} = 5 V, I_{C} = 2 mA, R_{L} = 100 Ω</td>
<td>t_{on}</td>
<td>10</td>
<td></td>
<td>µs</td>
<td></td>
</tr>
<tr>
<td>Turn-off time (1)</td>
<td>V_{CC} = 5 V, I_{C} = 2 mA, R_{L} = 100 Ω</td>
<td>t_{off}</td>
<td>10</td>
<td></td>
<td>µs</td>
<td></td>
</tr>
</tbody>
</table>

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

Fig. 3 - Forward Voltage vs. Forward Current

Fig. 4 - Collector Current vs. Collector Emitter Voltage (NS)

Fig. 5 - Collector Current vs. Collector Emitter Voltage (sat)

Fig. 6 - Leakage Current vs. Ambient Temperature

Fig. 7 - Normalized CTR (NS) vs. Ambient Temperature

Fig. 8 - Normalized CTR (sat) vs. Ambient Temperature
Fig. 9 - Normalized CTR (NS) vs. Forward Current

Fig. 10 - Normalized CTR (sat) vs. Forward Current

Fig. 12 - CTR Frequency vs. Collector Current

Fig. 13 - Switching Time vs. Load Resistance

Fig. 11 - CTR Frequency vs. Phase Angle
**PACKAGE DIMENSIONS** in millimeters

![Diagram of package dimensions with dimensions labeled]

**PACKAGE MARKING**

![Image of package marking]

**Notes**
- VDE logo is only marked on option 1 parts. Option information is not marked on the part.
- Tape and reel suffix (T) is not part of the package marking.
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