1 Form A Solid-State Relay

FEATURES
- Maximum $R_{ON} \leq 5 \Omega$
- Load voltage 60 V
- Load current 100 mA
- Isolation test voltage $3750 \, V_{RMS}$
- Small 4 pin SOP package
- Clean bounce free switching
- TTL / CMOS compatible input
- High reliability hybrid receptor
- Available on tape and reel

AGENCY APPROVALS
- UL 1577
- cUL
- DIN EN 60747-5-5 (VDE 0884-5)
- CQC
- FIMKO

DESCRIPTION
The VO1400AEF is an optically isolated 1 form A solid-state relay in a surface mount 4 pin SOP package.

APPLICATIONS
- Security systems
- Instrumentation
- Industrial controls

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PACKAGE</th>
<th>TAPE AND REEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP-4, tape and reel</td>
<td>VO1400AEFTR</td>
</tr>
<tr>
<td>SOP-4, tape and reel (product rotated in tape)</td>
<td>VO1400AEFT1</td>
</tr>
</tbody>
</table>
ABSOLUTE MAXIMUM RATINGS (T<sub>amb</sub> = 25 °C, unless otherwise specified)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONDITIONS</th>
<th>SYMBOL</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>INPUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED continuous forward current</td>
<td></td>
<td>I&lt;sub&gt;F&lt;/sub&gt;</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>LED reverse voltage</td>
<td></td>
<td>V&lt;sub&gt;R&lt;/sub&gt;</td>
<td>5</td>
<td>V</td>
</tr>
<tr>
<td>OUTPUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC or peak AC load voltage</td>
<td></td>
<td>V&lt;sub&gt;L&lt;/sub&gt;</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>Load current AC peak</td>
<td></td>
<td>I&lt;sub&gt;L&lt;/sub&gt;</td>
<td>100</td>
<td>mA</td>
</tr>
<tr>
<td>Peak load current</td>
<td>t = 10 ms</td>
<td>I&lt;sub&gt;LPK&lt;/sub&gt;</td>
<td>350</td>
<td>mA</td>
</tr>
<tr>
<td>SSR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total power dissipation</td>
<td></td>
<td>P&lt;sub&gt;diss&lt;/sub&gt;</td>
<td>120</td>
<td>mW</td>
</tr>
<tr>
<td>Ambient temperature range</td>
<td></td>
<td>T&lt;sub&gt;amb&lt;/sub&gt;</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td></td>
<td>T&lt;sub&gt;stg&lt;/sub&gt;</td>
<td>-40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Soldering temperature</td>
<td>t ≤ 10 s max.</td>
<td>T&lt;sub&gt;sld&lt;/sub&gt;</td>
<td>260</td>
<td>°C</td>
</tr>
</tbody>
</table>

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.

ABSOLUTE MAXIMUM RATING CURVE

- Fig. 1 - Input Safety Current vs. Ambient Temperature
- Fig. 2 - Output Safety Power vs. Ambient Temperature
- Fig. 3 - Load Current vs. Ambient Temperature
ELECTRICAL CHARACTERISTICS (T_{amb} = 25 °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>INPUT</td>
<td>LED forward current, switch turn-on</td>
<td>I_L = 100 mA, V_L ≤ 0.5 V, t = 10 ms</td>
<td>I_{Fon}</td>
<td>0.15</td>
<td>0.8</td>
<td>3.2</td>
</tr>
<tr>
<td></td>
<td>LED forward current, switch turn-off</td>
<td>V_L = 60 V</td>
<td>I_{Foff}</td>
<td>100</td>
<td>400</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>LED reverse current</td>
<td>V_R = 5 V</td>
<td>I_R</td>
<td>0.001</td>
<td>10</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td>LED forward voltage</td>
<td>I_F = 5 mA</td>
<td>V_F</td>
<td>0.8</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>LED reverse voltage</td>
<td>I_R = 10 μA</td>
<td>V_R</td>
<td>5</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>OUTPUT</td>
<td>On-resistance</td>
<td>I_F = 10 mA, I_L = 100 mA</td>
<td>R_{ON}</td>
<td>2.3</td>
<td>5</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td>Off-state leakage current</td>
<td>I_F = 0 mA, V_L = 60 V</td>
<td>I_{LEAK}</td>
<td>0.002</td>
<td>1</td>
<td>μA</td>
</tr>
</tbody>
</table>

Note
- Minimum and maximum values are testing 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.

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>Turn-on time</td>
<td>I_F = 10 mA, V_L = 20 V, I_L = 100 mA</td>
<td>t_{on}</td>
<td>-</td>
<td>20</td>
<td>500</td>
<td>μs</td>
</tr>
<tr>
<td>Turn-off time</td>
<td>I_F = 10 mA, V_L = 20 V, I_L = 100 mA</td>
<td>t_{off}</td>
<td>-</td>
<td>80</td>
<td>500</td>
<td>μs</td>
</tr>
</tbody>
</table>

Fig. 4 - Timing Test Circuit and Waveforms
### SAFETY AND INSULATION RATINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITION</th>
<th>SYMBOL</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climatic classification</td>
<td>According to IEC 68 part 1</td>
<td></td>
<td>40 / 85 / 21</td>
<td></td>
</tr>
<tr>
<td>Pollution degree</td>
<td>According to DIN VDE 0109</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Comparative tracking index</td>
<td>Insulation group IIIa</td>
<td>CTI</td>
<td>175</td>
<td></td>
</tr>
<tr>
<td>Maximum rated withstanding isolation voltage</td>
<td>According to UL1577, t = 1 min</td>
<td>V_ISO</td>
<td>3750</td>
<td>V_RMS</td>
</tr>
<tr>
<td>Maximum transient isolation voltage</td>
<td>According to DIN EN 60747-5-5</td>
<td>V_IDTM</td>
<td>6000</td>
<td>V_peak</td>
</tr>
<tr>
<td>Maximum repetitive peak isolation voltage</td>
<td>According to DIN EN 60747-5-5</td>
<td>V_IORM</td>
<td>707</td>
<td>V_peak</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Tamb = 25 °C, V_IO = 500 V</td>
<td>R_IO</td>
<td>≥ 10^{12}</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td>Tamb = 100 °C, V_IO = 500 V</td>
<td>R_IO</td>
<td>≥ 10^{11}</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td>Tamb = TS, V_IO = 500 V</td>
<td>R_IO</td>
<td>≥ 10^9</td>
<td>Ω</td>
</tr>
<tr>
<td>Output safety power</td>
<td></td>
<td>P_SO</td>
<td>400</td>
<td>mW</td>
</tr>
<tr>
<td>Input safety current</td>
<td></td>
<td>I_SI</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>Input safety temperature</td>
<td></td>
<td>T_S</td>
<td>165</td>
<td>°C</td>
</tr>
<tr>
<td>Clearance distance</td>
<td>Measured from input terminals to output terminals, shortest distance through air</td>
<td></td>
<td>≥ 5</td>
<td>mm</td>
</tr>
<tr>
<td>Creepage distance</td>
<td>Measured from input terminals to output terminals, shortest distance path along body</td>
<td></td>
<td>≥ 5</td>
<td>mm</td>
</tr>
<tr>
<td>Input to output test voltage, method B</td>
<td>V_IORM x 1.875 = V_PR, 100 % production test with t_M = 1 s, partial discharge &lt; 5 pC</td>
<td>V_PR</td>
<td>1326</td>
<td>V_peak</td>
</tr>
<tr>
<td>Input to output test voltage, method A</td>
<td>V_IORM x 1.6 = V_PR, 100 % sample test with t_M = 10 s, partial discharge &lt; 5 pC</td>
<td>V_PR</td>
<td>1131</td>
<td>V_peak</td>
</tr>
</tbody>
</table>

**Note**

- This SSR is suitable for “safe electrical insulation” only within the safety ratings. Compliance with the safety ratings shall be ensured by means of protective circuits.
TYPICAL CHARACTERISTICS \( (T_{\text{amb}} = 25 \, ^{\circ}\text{C}, \text{unless otherwise specified}) \)

Fig. 5 - Forward Current vs. Forward Voltage

Fig. 6 - Forward Current for Switch Turn-On vs. Ambient Temperature

Fig. 7 - On-Resistance vs. Ambient Temperature

Fig. 8 - Leakage Current vs. Ambient Temperature

Fig. 9 - Turn-On Time vs. Forward Current

Fig. 10 - Turn-Off Time vs. Forward Current
PACKAGE DIMENSIONS (in millimeters)

![Package Dimensions Diagram]

PACKAGE MARKING

![Package Marking Diagram]

Notes
- XXXX = LMC (lot marking code)
- Tape and reel suffix (TR) is not part of the package marking
TAPE AND REEL INFORMATION (in millimeters)

**Fig. 13 - VO1400AEFT (2000 pieces on reel)**

- Pin 1: 2.0 ± 0.1
- 2.0 ± 0.1
- 4.0 ± 0.1
- 4.0 ± 0.1
- 1.5 ± 0.1
- 1.5 ± 0.1
- 1.75 ± 0.1
- 1.75 ± 0.1
- 0.35 ± 0.05
- 0.35 ± 0.05
- 7.33 ± 0.1
- 7.33 ± 0.1
- 12.0 ± 0.3
- 12.0 ± 0.3
- 5.5 ± 0.1
- 5.5 ± 0.1
- 2.36 ± 0.1
- 2.36 ± 0.1
- 2.66 ± 0.1
- 2.66 ± 0.1
- 4.72 ± 0.1
- 4.72 ± 0.1
- 0.35 ± 0.05
- 0.35 ± 0.05
- LC
- LC

**Note:**
- Cumulative tolerance of 10 spocket holes is 0.20

**Fig. 14 - VO1400AEFT1 (1000 pieces on reel)**

- Pin 1: 2.0 ± 0.1
- 2.0 ± 0.1
- 4.0 ± 0.1
- 4.0 ± 0.1
- 1.5 ± 0.1
- 1.5 ± 0.1
- 1.75 ± 0.1
- 1.75 ± 0.1
- 0.32 ± 0.05
- 0.32 ± 0.05
- 7.33 ± 0.1
- 7.33 ± 0.1
- 12.0 ± 0.1
- 12.0 ± 0.1
- 1.5 ± 0.1
- 1.5 ± 0.1
- 2.36 ± 0.1
- 2.36 ± 0.1
- 2.66 ± 0.1
- 2.66 ± 0.1
- 4.72 ± 0.1
- 4.72 ± 0.1
- 0.35 ± 0.05
- 0.35 ± 0.05
- LC
- LC

**Note:**
- Cumulative tolerance of 10 spocket holes is 0.20
**SOLDER PROFILES**

![Solder Profile Diagram](image1.png)

**HANDLING AND STORAGE CONDITIONS**

ESD level: HBM class 2

Floor life: unlimited

Conditions: $T_{amb} < 30 \, ^\circ C$, RH < 85%

Moisture sensitivity level 1, according to J-STD-020

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**Fig. 15 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020 for SMD Devices**
Footprint and Schematic Information for VO1400AEF

The footprint and schematic symbols for the following parts can be accessed using the associated links. They are available in Eagle, Altium, KiCad, OrCAD / Allegro, Pulsonix, and PADS.

Note that the 3D models for these parts can be found on the Vishay product page.

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>FOOTPRINT / SCHEMATIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO1400AEFT1</td>
<td><a href="http://www.snapeda.com/parts/VO1400AEFT1/Vishay/view-part">www.snapeda.com/parts/VO1400AEFT1/Vishay/view-part</a></td>
</tr>
<tr>
<td>VO1400AEFT2</td>
<td><a href="http://www.snapeda.com/parts/VO1400AEFT2/Vishay/view-part">www.snapeda.com/parts/VO1400AEFT2/Vishay/view-part</a></td>
</tr>
<tr>
<td>VO1400AEFTR</td>
<td><a href="http://www.snapeda.com/parts/VO1400AEFTR/Vishay/view-part">www.snapeda.com/parts/VO1400AEFTR/Vishay/view-part</a></td>
</tr>
</tbody>
</table>

For technical issues and product support, please contact optocoupleranswers@vishay.com.
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