1 Form A Solid-State Relay (Normally Open)

DESCRIPTION
The LH1546AEF (4 pin SOP) is robust, ideal for telecom and ground fault applications. It is an SPST normally open switch (1 Form A) that replaces electromechanical relays in many applications. It is constructed using a GaAlAs LED for actuation control and MOSFETs for the switch output.

FEATURES
- Isolation test voltage 3750 VRMS
- Typical $R_{ON}$ 22 Ω
- Load voltage 350 V
- Load current 120 mA
- High surge capability
- Clean bounce free switching
- Low power consumption
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS
- General telecom switching
- Instrumentation
- Industrial controls

AGENCY APPROVALS
- UL
- cUL
- BSI
- VDE
- FIMKO

LINKS TO ADDITIONAL RESOURCES
Related Documents Design Tools Models

ORDERING INFORMATION

<table>
<thead>
<tr>
<th>PACKAGE</th>
<th>UL, cUL, BSI, VDE, FIMKO</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOP-4, tape and reel</td>
<td>LH1546AEFTR</td>
</tr>
<tr>
<td>SOP-4, tubes</td>
<td>LH1546AEF</td>
</tr>
</tbody>
</table>
**Note**
- 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 RATINGS (T\text{amb} = 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>IRED continuous forward current</td>
<td>I\text{F}</td>
<td>50</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>IRED reverse voltage</td>
<td>V\text{R}</td>
<td>5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input power dissipation</td>
<td>P\text{diss}</td>
<td>80</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>DC or peak AC load voltage</td>
<td>V\text{L}</td>
<td>350</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Continuous DC load current</td>
<td>I\text{L}</td>
<td>120</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>SSR output power dissipation</td>
<td>P\text{diss}</td>
<td>550</td>
<td>mW</td>
<td></td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS (T\text{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>IRED forward current, switch turn-on</td>
<td>I\text{L} = 100 mA, t = 10 ms</td>
<td>I\text{Fon}</td>
<td>-</td>
<td>0.3</td>
<td>2</td>
<td>mA</td>
</tr>
<tr>
<td>IRED forward current, switch turn-off</td>
<td>V\text{L} = ± 350 V, I\text{L} &lt; 1 μA</td>
<td>I\text{Foff}</td>
<td>0.05</td>
<td>0.2</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>IRED forward voltage</td>
<td>I\text{F} = 10 mA</td>
<td>V\text{F}</td>
<td>-</td>
<td>1.4</td>
<td>1.6</td>
<td>V</td>
</tr>
<tr>
<td>On-resistance</td>
<td>I\text{F} = 5 mA, I\text{L} = 50 mA</td>
<td>R\text{ON}</td>
<td>-</td>
<td>22</td>
<td>27</td>
<td>Ω</td>
</tr>
<tr>
<td>Off-resistance</td>
<td>I\text{F} = 0 mA, V\text{L} = ± 100 V</td>
<td>R\text{OFF}</td>
<td>0.5</td>
<td>850</td>
<td>-</td>
<td>GΩ</td>
</tr>
<tr>
<td>Off-state leakage current</td>
<td>I\text{F} = 0 mA, V\text{L} = ± 100 V</td>
<td>I\text{leak}</td>
<td>-</td>
<td>&lt; 1</td>
<td>200</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td>I\text{F} = 0 mA, V\text{L} = ± 350 V</td>
<td>I\text{leak}</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>μA</td>
</tr>
<tr>
<td>Output capacitance</td>
<td>I\text{F} = 0 mA, V\text{L} = 1 V, 1 MHz</td>
<td>C\text{O}</td>
<td>-</td>
<td>39</td>
<td>-</td>
<td>pF</td>
</tr>
<tr>
<td></td>
<td>I\text{F} = 0 mA, V\text{L} = 50 V, 1 MHz</td>
<td>C\text{O}</td>
<td>-</td>
<td>6</td>
<td>-</td>
<td>pF</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**  
(T<sub>amb</sub> = 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>Turn-on time</td>
<td>I&lt;sub&gt;F&lt;/sub&gt; = 5 mA, I&lt;sub&gt;L&lt;/sub&gt; = 50 mA</td>
<td>t&lt;sub&gt;on&lt;/sub&gt;</td>
<td>0.2</td>
<td>3</td>
<td>ms</td>
<td></td>
</tr>
<tr>
<td>Turn-off time</td>
<td>I&lt;sub&gt;F&lt;/sub&gt; = 5 mA, I&lt;sub&gt;L&lt;/sub&gt; = 50 mA</td>
<td>t&lt;sub&gt;off&lt;/sub&gt;</td>
<td>0.05</td>
<td>3</td>
<td>ms</td>
<td></td>
</tr>
</tbody>
</table>

![Timing Schematic](image)

**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></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&lt;sub&gt;ISO&lt;/sub&gt;</td>
<td>3750</td>
<td>V&lt;sub&gt;RMS&lt;/sub&gt;</td>
</tr>
<tr>
<td>Maximum transient isolation voltage</td>
<td>According to DIN EN 60747-5-5</td>
<td>V&lt;sub&gt;ITM&lt;/sub&gt;</td>
<td>6000</td>
<td>V&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>Maximum repetitive peak isolation voltage</td>
<td>According to DIN EN 60747-5-5</td>
<td>V&lt;sub&gt;IRM&lt;/sub&gt;</td>
<td>707</td>
<td>V&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>Isolation resistance</td>
<td>T&lt;sub&gt;amb&lt;/sub&gt; = 25 °C, V&lt;sub&gt;IO&lt;/sub&gt; = 500 V</td>
<td>R&lt;sub&gt;IO&lt;/sub&gt;</td>
<td>≥ 10&lt;sup&gt;12&lt;/sup&gt;</td>
<td>Ω</td>
</tr>
<tr>
<td></td>
<td>T&lt;sub&gt;amb&lt;/sub&gt; = 100 °C, V&lt;sub&gt;IO&lt;/sub&gt; = 500 V</td>
<td>R&lt;sub&gt;IO&lt;/sub&gt;</td>
<td>≥ 10&lt;sup&gt;11&lt;/sup&gt;</td>
<td>Ω</td>
</tr>
<tr>
<td>Output safety power</td>
<td></td>
<td>P&lt;sub&gt;SO&lt;/sub&gt;</td>
<td>350</td>
<td>mW</td>
</tr>
<tr>
<td>Input safety current</td>
<td></td>
<td>I&lt;sub&gt;SI&lt;/sub&gt;</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>Input safety temperature</td>
<td></td>
<td>T&lt;sub&gt;S&lt;/sub&gt;</td>
<td>165</td>
<td>°C</td>
</tr>
<tr>
<td>Clearance distance</td>
<td>SOP-4</td>
<td></td>
<td>≥ 5</td>
<td>mm</td>
</tr>
<tr>
<td>Creepage distance</td>
<td>SOP-4</td>
<td></td>
<td>≥ 5</td>
<td>mm</td>
</tr>
<tr>
<td>Input to output test voltage, method B</td>
<td>V&lt;sub&gt;ORM&lt;/sub&gt; x 1.875 = V&lt;sub&gt;PR&lt;/sub&gt;, 100 % production test with t&lt;sub&gt;M&lt;/sub&gt; = 1 s, partial discharge &lt; 5 pC</td>
<td>V&lt;sub&gt;PR&lt;/sub&gt;</td>
<td>1326</td>
<td>V&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>Input to output test voltage, method A</td>
<td>V&lt;sub&gt;ORM&lt;/sub&gt; x 1.6 = V&lt;sub&gt;PR&lt;/sub&gt;, sample test with t&lt;sub&gt;M&lt;/sub&gt; = 10 s, partial discharge &lt; 5 pC</td>
<td>V&lt;sub&gt;PR&lt;/sub&gt;</td>
<td>1131</td>
<td>V&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

**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.
TYPICAL CHARACTERISTICS ($T_{\text{amb}} = 25 ^\circ \text{C}$, unless otherwise specified)

Fig. 2 - Safety Input Current vs. Ambient Temperature

Fig. 3 - Safety Power Dissipation vs. Ambient Temperature

Fig. 4 - Maximum Load Current vs. Ambient Temperature

Fig. 5 - Forward Voltage vs. Ambient Temperature

Fig. 6 - Forward Current vs. Forward Voltage

Fig. 7 - Normalized Forward Current for Switch Turn-On vs. Ambient Temperature
Fig. 8 - Normalized On-Resistance vs. Ambient Temperature

![Normalized On-Resistance vs. Ambient Temperature](image)

Normalized to $T_{amb} = 25 \, ^\circ\text{C}$

$I_F = 5.0 \, \text{mA}$
$I_L = 50 \, \text{mA}$

Fig. 9 - Output Capacitance vs. Load Voltage

![Output Capacitance vs. Load Voltage](image)

Switch Capacitance (pf)

Applied Voltage (V)

$I_F = 0 \, \text{mA}$
$f = 1 \, \text{MHz}$

Fig. 10 - Off-State Leakage Current vs. Load Voltage

![Off-State Leakage Current vs. Load Voltage](image)

Off-State Leakage Current (nA)

$V_L$ - Load Voltage (V)

$I_F = 0 \, \text{mA}$

$T = -40 \, ^\circ\text{C}$

$T = 25 \, ^\circ\text{C}$

$T = 85 \, ^\circ\text{C}$

Fig. 11 - Turn-On Time vs. Forward Current

![Turn-On Time vs. Forward Current](image)

Turn-On Time (ms)

Forward Current (mA)

$I_F = 5 \, \text{mA}$

T = 85 °C

T = 25 °C

T = -40 °C

Fig. 12 - Normalized Turn-On Time vs. Ambient Temperature

![Normalized Turn-On Time vs. Ambient Temperature](image)

Normalized Turn-On Time

Normalized to $T_{amb} = 25 \, ^\circ\text{C}$

Fig. 13 - Turn-Off Time vs. Forward Current

![Turn-Off Time vs. Forward Current](image)

Turn-Off Time (ms)

Forward Current (mA)

$I_F = 50 \, \text{mA}$

T = 85 °C

T = 25 °C

T = -40 °C

Fig. 8 - Normalized On-Resistance vs. Ambient Temperature

![Normalized On-Resistance vs. Ambient Temperature](image)

Normalized On-Resistance

Ambient Temperature ($^\circ\text{C}$)

$T_{amb}$

Normalized to $T_{amb} = 25 \, ^\circ\text{C}$

$I_F = 5.0 \, \text{mA}$

$I_L = 50 \, \text{mA}$
Fig. 14 - Normalized Turn-Off Time vs. Ambient Temperature

**PACKAGE DIMENSIONS** (in millimeters)

![Package Dimensions Diagram]

Fig. 15 - Package Drawing
PACKAGE MARKING (example)

![Package Marking Example](image)

Notes
- XXXX = LMC (lot marking code)
- Tape and reel suffix (TR) is not part of the package marking

PACKAGING INFORMATION (in millimeters)

![Packaging Information Diagram](image)

Notes
- Cumulative tolerance of 10 sprocket holes is 0.20 mm
- Applicable orientation as below:

<table>
<thead>
<tr>
<th>DEVICES PER REEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE</td>
</tr>
<tr>
<td>SOP-4</td>
</tr>
</tbody>
</table>

For technical questions, contact: optocoupleranswers@vishay.com

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SOLDER PROFILES

Fig. 19 - Lead (Pb)-free Reflow Solder Profile According to J-STD-020 for SMD Devices

HANDLING AND STORAGE CONDITIONS

ESD level: HBM class 2
Floor life: unlimited
Conditions: $T_{amb} < 30 \, ^\circ C$, RH < 60 %
Moisture sensitivity level 1, according to J-STD-020
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