Description:
VLA542-01R is a hybrid integrated circuit designed for driving n-channel IGBT modules in any gate-amplifier application. This device is a fully isolated gate drive circuit with an optically isolated gate drive amplifier that provides an over-current protection function based on desaturation detection.

Features:
- Electrical Isolation Between Input and Output via an Opto-coupler (V_{iso} = 2500\text{V}_{\text{rms}} for 1 Minute)
- Two Supply Drive Topology
- Built in Short-Circuit Protection with a pin for Fault Output
- CMOS Compatible Input Interface

Applications:
- To Drive IGBT Modules for Inverter or AC Servo Systems Application.

Recommended IGBT Modules:
- \( V_{CES} = 600\text{V} \) Series up to 600A Class
- \( V_{CES} = 1200\text{V} \) Series up to 400A Class

Circuit Diagram

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Inches</th>
<th>Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.73 Max.</td>
<td>44.0 Max.</td>
</tr>
<tr>
<td>B</td>
<td>1.02 Max.</td>
<td>26.0 Max.</td>
</tr>
<tr>
<td>C</td>
<td>0.31 Max.</td>
<td>8.0 Max.</td>
</tr>
<tr>
<td>D</td>
<td>0.21 Max.</td>
<td>5.5 Max.</td>
</tr>
<tr>
<td>E</td>
<td>0.1</td>
<td>2.54</td>
</tr>
<tr>
<td>F</td>
<td>0.02+0.006/-0.004 0.5+0.15/-0.1</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>0.17±0.06 4.5±1.5</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>0.01+0.008/-0.004 0.25+0.2/-0.1</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>0.21 Max.</td>
<td>5.5 Max.</td>
</tr>
<tr>
<td>K</td>
<td>0.12 Max.</td>
<td>3.0 Max.</td>
</tr>
</tbody>
</table>
### Absolute Maximum Ratings, $T_a = 25^\circ C$ unless otherwise specified

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Symbol</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage (DC)</td>
<td>$V_{CC}$</td>
<td>18</td>
<td>V</td>
</tr>
<tr>
<td>Supply Voltage (DC)</td>
<td>$V_{EE}$</td>
<td>-15</td>
<td>V</td>
</tr>
<tr>
<td>Input Signal Voltage (Applied Between; Pin 13 and Pin 14, 50% Duty Cycle, Pulse Width 1ms)</td>
<td>$V_I$</td>
<td>-1 ~ +7</td>
<td>V</td>
</tr>
<tr>
<td>Output Voltage (When Output Voltage is &quot;H&quot;)</td>
<td>$V_O$</td>
<td>$V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Output Peak Current (Pulse Width 2μs)</td>
<td>$I_{OHP}$</td>
<td>-5</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>$I_{OLP}$</td>
<td>5</td>
<td>A</td>
</tr>
<tr>
<td>Isolation Voltage (Sine Wave Voltage 60Hz, for 1 min.)</td>
<td>$V_{iso}$</td>
<td>2500</td>
<td>$V_{rms}$</td>
</tr>
<tr>
<td>Case Temperature</td>
<td>$T_C$</td>
<td>95</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature (No Condensation Allowable)</td>
<td>$T_{opr}$</td>
<td>-20 ~ +70</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature (No Condensation Allowable)</td>
<td>$T_{stg}$</td>
<td>-40 ~ 100(^1)</td>
<td>°C</td>
</tr>
<tr>
<td>Fault Output Current (Applied at Pin 8)</td>
<td>$I_{FO}$</td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>Input Voltage at Pin 1 (Applied at Pin 1)</td>
<td>$V_{R1}$</td>
<td>50</td>
<td>V</td>
</tr>
</tbody>
</table>

### Electrical Characteristics, $T_a = 25^\circ C$, $V_{CC} = 15V$, $V_{EE} = -10V$, $R_G = 3.3\Omega$

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{CC}$</td>
<td>Recommended Range</td>
<td>14</td>
<td>15</td>
<td>17</td>
<td>V</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>$V_{EE}$</td>
<td>Recommended Range</td>
<td>-7</td>
<td>—</td>
<td>-12</td>
<td>V</td>
</tr>
<tr>
<td>Pull-up Voltage on Primary Side</td>
<td>$V_{IN}$</td>
<td>Recommended Range</td>
<td>4.75</td>
<td>5</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>&quot;H&quot; Input Signal Current</td>
<td>$I_{IH}$</td>
<td>Recommended Range ((V_{IN} = 5V))</td>
<td>10</td>
<td>13</td>
<td>16</td>
<td>mA</td>
</tr>
<tr>
<td>&quot;H&quot; Output Voltage</td>
<td>$V_{OH}$</td>
<td>—</td>
<td>13</td>
<td>14</td>
<td>—</td>
<td>V</td>
</tr>
<tr>
<td>&quot;L&quot; Output Voltage</td>
<td>$V_{OL}$</td>
<td>—</td>
<td>—</td>
<td>-8</td>
<td>-9</td>
<td>V</td>
</tr>
<tr>
<td>&quot;L-H&quot; Propagation Time</td>
<td>$t_{PLH}$</td>
<td>$I_{IH} = 13mA$</td>
<td>0.2</td>
<td>0.4</td>
<td>1</td>
<td>μs</td>
</tr>
<tr>
<td>&quot;L-H&quot; Rise Time</td>
<td>$t_{r}$</td>
<td>$I_{IH} = 13mA$</td>
<td>—</td>
<td>0.4</td>
<td>1</td>
<td>μs</td>
</tr>
<tr>
<td>&quot;H-L&quot; Propagation Time</td>
<td>$t_{PHL}$</td>
<td>$I_{IH} = 13mA$</td>
<td>0.2</td>
<td>0.4</td>
<td>1</td>
<td>μs</td>
</tr>
<tr>
<td>&quot;H-L&quot; Fall Time</td>
<td>$t_{f}$</td>
<td>$I_{IH} = 13mA$</td>
<td>—</td>
<td>0.3</td>
<td>1</td>
<td>μs</td>
</tr>
<tr>
<td>Timer</td>
<td>$t_{timer}$</td>
<td>Between Start and Cancel (Under Input Sign &quot;OFF&quot;)</td>
<td>1</td>
<td>—</td>
<td>2</td>
<td>ms</td>
</tr>
<tr>
<td>Fault Output Current</td>
<td>$I_{FO}$</td>
<td>Applied at Pin 8, $R = 4.7k\Omega$</td>
<td>—</td>
<td>5</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>Controlled Time Detect Short-Circuit 1</td>
<td>$t_{trip1}$</td>
<td>Pin 1: 15V or more, Pin 2: Open</td>
<td>—</td>
<td>2.6</td>
<td>—</td>
<td>μs</td>
</tr>
<tr>
<td>Controlled Time Detect Short-Circuit 2(^2)</td>
<td>$t_{trip2}$</td>
<td>Pin 1: 15V or more, Pins 2-4: 10pF (Connective Capacitance)</td>
<td>—</td>
<td>3</td>
<td>—</td>
<td>μs</td>
</tr>
<tr>
<td>SC Detect Voltage</td>
<td>$V_{SC}$</td>
<td>Collector Voltage of IGBT</td>
<td>15</td>
<td>—</td>
<td>—</td>
<td>V</td>
</tr>
</tbody>
</table>

\(^1\) Differs from H/C condition.
\(^2\) The length of the capacitor from Pin 2 to Pin 4 should be less than 5cm.
Definition of Characteristics

**SWITCHING OPERATION**

- INPUT: $V_I$
- OUTPUT: $V_O$
- PIN 8

- Gate Charge Characteristic of IGBT

When choosing the gate power supply, choose a product that can supply the current capacity provided by the following calculation.

\[
I_O = (I_{\text{drive}} + I_{\text{CC}}) \times (1 + \text{Margin})
\]

- $I_O$: Output Current of Gate Power Supply
- $I_{\text{drive}}$: Gate Average Current
- $I_{\text{CC}}$: Stable Bias Current of IGBT Driver

(Refer to the dissipation current - supply voltage characteristics of this datasheet.)

- Margin: Over 0.3
- $Q_1$: Gate Charge on Plus Bias (Refer to the IGBT datasheet).
- $Q_2$: Gate Charge on Minus Bias (Refer to the IGBT datasheet).
- $f$: IGBT Switching Frequency

**OPERATION OF SHORT CIRCUIT PROTECTION**

- INPUT: $V_I$
- OUTPUT: $V_O$
- PIN 8

Power Supply for IGBT Driver

For IGBT driving, an isolated power supply (+15V and approximately -10V) is necessary for every IGBT driver.

- Isolated Power Supply
- IGBT Driver

Gate Charge Characteristic of IGBT

Timing Chart

- Soft Shutdown
- Occurrence of Short-Circuit
- Mask Time ($t_{\text{trip}}$)
- Protection Operation is Cleared
Operation of Protection Circuit

1. In the case where the gate voltage is "H" and the collector voltage is high, the hybrid IC will recognize a short-circuit condition and immediately reduce the gate voltage. Additionally, it will output an error signal ("L") which indicates that the protection circuit is operating at the same time from Pin 8.

2. The protection circuit resets if the input signal is "OFF" when the premised 1~2msec passed. ("OFF" period needs 10μm or more.)

3. When the output rises, the controlled time detect short-circuit (typically 2.6μs) is set up so that the on-time of the IGBT can be secured properly. It is possible to adjust this time by connecting the capacitor (C_{trip}) between Pin 2 and Pin 4.

Application Circuit Example

Application Example of Single Power Supply

Precaution

1. Voltage compensation capacitors are expected to be located as close as possible to the hybrid IC.

2. D_1 requires approximately the same voltage rating as the power modules.

3. If reverse recovery time of D_1 is long, Pin 1 is applied a high voltage. In that case, a zener diode between Pin 1 and Pin 6 is inserted for necessary protection as shown above.

4. In case Pin 2 is operating, the C_{trip} is expected to be wired as close as possible to Pin 2 and Pin 4 (less than 5cm).

Application Example of Single Power Supply

- VCC = 15V
- VEE = 10V
- C_{trip} = 0~47pF (Rough Guide, 50V, Ceramic)
- D_1: Fast Recovery Diode (trr ≤ 0.2μs)
- RP1H (SanKen) etc.
**VLA542-01R**

**IGBT Gate Driver**

**t_{PLH}, t_{PHL} - T_a CHARACTERISTICS (TYPICAL)**

- **VCC = 15V**
- **VEE = -10V**
- **R_G = 3.3Ω**
- **V_IN = 5V**
- **LOAD = CM400DY-12NF**

**Ambient Temperature, T_a (°C)**

**t_{PLH}, t_{PHL} - V_I CHARACTERISTICS (TYPICAL)**

- **VCC = 15V**
- **VEE = -10V**
- **R_G = 3.3Ω**
- **Ta = 25°C**
- **LOAD = CM400DY-12NF**

**Connective Capacitance, C_{trip} (pF)**

- **VCC = 15V**
- **VEE = -10V**
- **Ta = 25°C**
AMBIENT TEMPERATURE, $T_a$ (°C)

POWER DISSIPATION - AMBIENT TEMPERATURE CHARACTERISTICS (MAXIMUM RATING)

- $P_D = 5.0$ W
- $P_D = 4.0$ W
- $P_D = 3.0$ W
- $P_D = 2.0$ W
- $P_D = 1.0$ W

$R_g = 2\Omega$ (INCLUDING THE POWER DISSIPATION OF $R_g$)

SUPPLY VOLTAGE, (VOLTAGE) (PIN: 4-6)

DISSIPATION CURRENT - SUPPLY VOLTAGE (PIN: 4-6) INPUT SIGNAL “L” (TYPICAL)

$T_a = 25°C$

CONSUMPTION CURRENT, (mA)

0 10 20

0 20 40 60 80 100

AMBENT TEMPERATURE, $T_a$ (°C)

SUPPLY VOLTAGE, (VOLTAGE) (PIN: 4-6)