

**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 ( $V_{iso} = 2500V_{rms}$  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:**

$V_{CES} = 600V$  Series up to 600A Class

$V_{CES} = 1200V$  Series up to 400A Class

**Circuit Diagram**

Dimensions	Inches	Millimeters
A	1.73 Max.	44.0 Max.
B	1.02 Max.	26.0 Max.
C	0.31 Max.	8.0 Max.
D	0.21 Max.	5.5 Max.
E	0.1	2.54
F	0.02+0.006/-0.004	0.5+0.15/-0.1
G	0.17±0.06	4.5±1.5
H	0.01+0.008/-0.004	0.25+0.2/-0.1
J	0.21 Max.	5.5 Max.
K	0.12 Max.	3.0 Max.

**VLA542-01R**  
**IGBT Gate Driver**
**Absolute Maximum Ratings,  $T_a = 25^\circ\text{C}$  unless otherwise specified**

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

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

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Supply Voltage	$V_{CC}$	Recommended Range	14	15	17	V
Supply Voltage	$V_{EE}$	Recommended Range	-7	—	-12	V
Pull-up Voltage on Primary Side	$V_{IN}$	Recommended Range	4.75	5	5.25	V
"H" Input Signal Current	$I_{IH}$	Recommended Range	10	13	16	mA
		$V_{IN} = 5\text{V}$	—	13	—	mA
Switching Frequency	f	Recommended Range	—	—	20	kHz
Gate Resistance	$R_G$	Recommended Range	2	—	—	$\Omega$
"H" Output Voltage	$V_{OH}$	—	13	14	—	V
"L" Output Voltage	$V_{OL}$	—	-8	-9	—	V
"L-H" Propagation Time	$t_{PLH}$	$I_{IH} = 13\text{mA}$	0.2	0.4	1	$\mu\text{s}$
"L-H" Rise Time	$t_r$	$I_{IH} = 13\text{mA}$	—	0.4	1	$\mu\text{s}$
"H-L" Propagation Time	$t_{PHL}$	$I_{IH} = 13\text{mA}$	0.2	0.4	1	$\mu\text{s}$
"H-L" Fall Time	$t_f$	$I_{IH} = 13\text{mA}$	—	0.3	1	$\mu\text{s}$
Timer	$t_{timer}$	Between Start and Cancel (Under Input Sign "OFF")	1	—	2	ms
Fault Output Current	$I_{FO}$	Applied at Pin 8, $R = 4.7\text{k}\Omega$	—	5	—	mA
Controlled Time Detect Short-Circuit 1	$t_{trip1}$	Pin 1: 15V or more, Pin 2: Open	—	2.6	—	$\mu\text{s}$
Controlled Time Detect Short-Circuit 2 <sup>*2</sup>	$t_{trip2}$	Pin 1: 15V or more, Pins 2-4: 10pF (Connective Capacitance)	—	3	—	$\mu\text{s}$
SC Detect Voltage	$V_{SC}$	Collector Voltage of IGBT	15	—	—	V

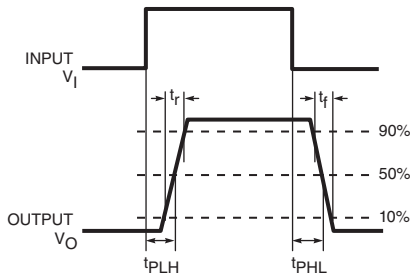
\*1 Differs from H/C condition.

\*2 The length of the capacitor from Pin 2 to Pin 4 should be less than 5cm.

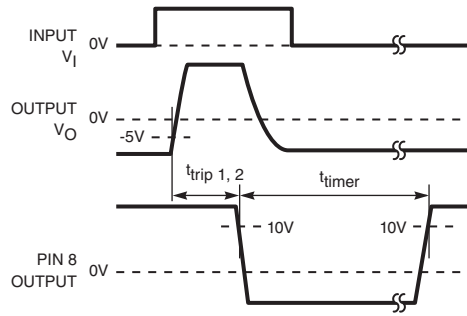
**VLA542-01R**  
IGBT Gate Driver

**Definition of Characteristics**

**SWITCHING OPERATION**

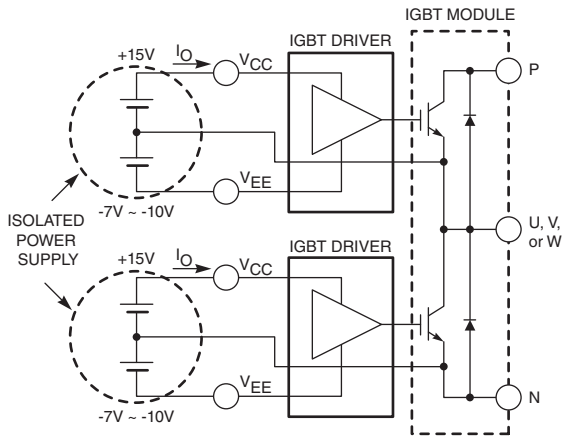


**OPERATION OF SHORT CIRCUIT PROTECTION**



**Power Supply for IGBT Driver**

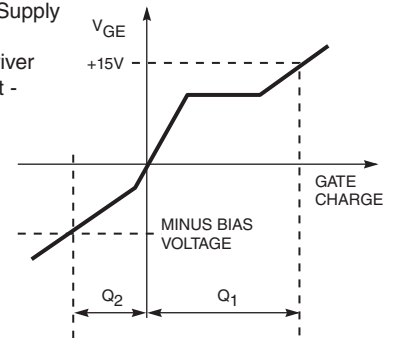
For IGBT driving, an isolated power supply (+15V and approximately -10V) is necessary for every IGBT driver.



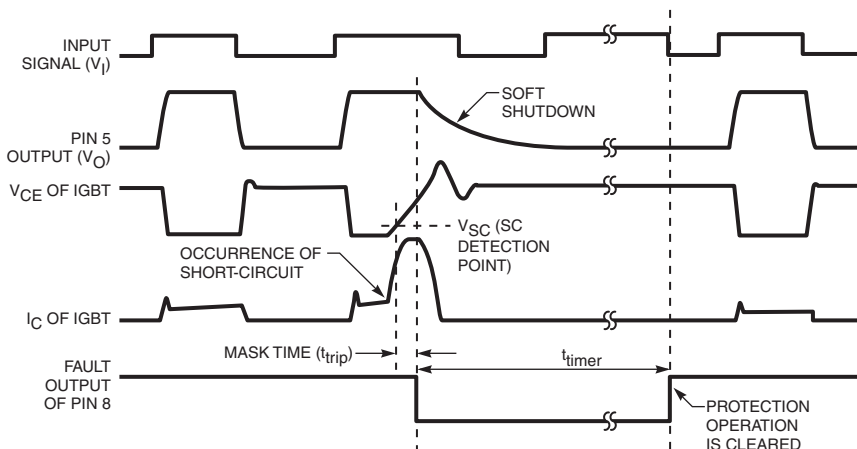
**Gate Charge Characteristic of IGBT**

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

- $I_O = (I_{drive} + I_{CC}) \times (1 + \text{Margin})$
- $I_O$  : Output Current of Gate Power Supply
- $I_{drive}$  : Gate Average Current
- $I_{CC}$  : Stable Bias Current of IGBT Driver (Refer to the dissipation current - supply voltage characteristics of this datasheet.)
- Margin : Over 0.3
- $I_{drive}$  :  $(Q_1 + IQ_2) \times f$
- $Q_1$  : 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



**Timing Chart**

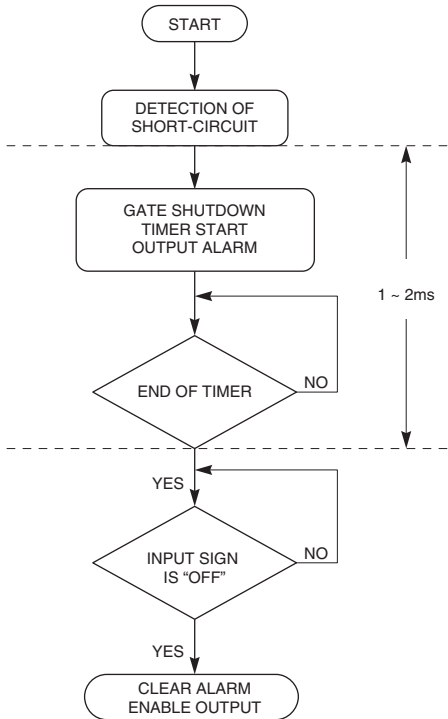


**VLA542-01R**  
IGBT Gate Driver

### Operation of Protection Circuit

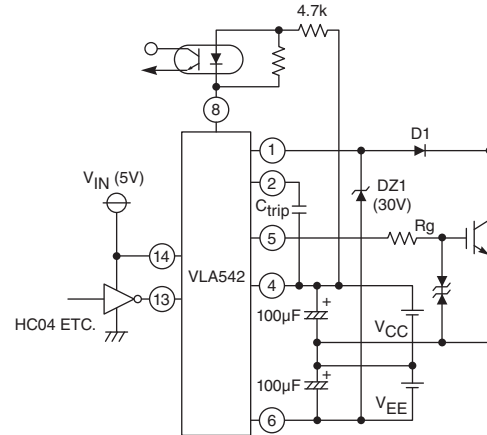
1. In the case where the gate voltage is "H" and the collector voltage is high, the hybrid IC will recognize a short-circuit condition and immediately reduce the gate voltage. Additionally, it will output an error signal ("L") which indicates that the protection circuit is operating at the same time from Pin 8.
2. The protection circuit resets if the input signal is "OFF" when the premised 1~2msec passed. ("OFF" period needs 10 $\mu$ m or more.)
3. When the output rises, the controlled time detect short-circuit (typically 2.6 $\mu$ s) 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.

### Operation Flow on Detecting Short Circuit



NOTE: Output voltage with protection circuit operating is about  $-|V_{EE}| + 2V$

### Application Circuit Example

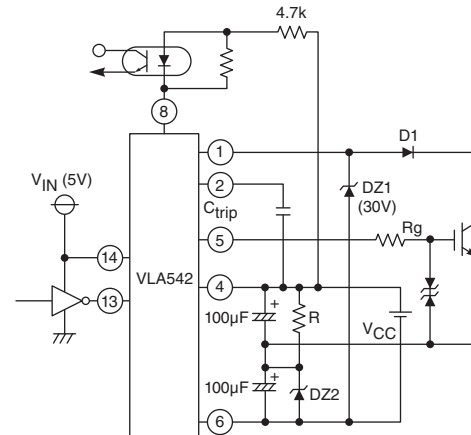


$V_{CC} = 15V$   
 $V_{EE} = 10V$   
 $C_{trip} = 0 \sim 47pF$  (Rough Guide, 50V, Ceramic)  
D1 : Fast Recovery Diode ( $t_{rr} \leq 0.2\mu s$ )  
RP1H (SanKen) etc.

### Precaution

1. Voltage compensation capacitors are expected to be located as close as possible to the hybrid IC.
2. D<sub>1</sub> requires approximately the same voltage rating as the power modules.
3. If reverse recovery time of D<sub>1</sub> 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).

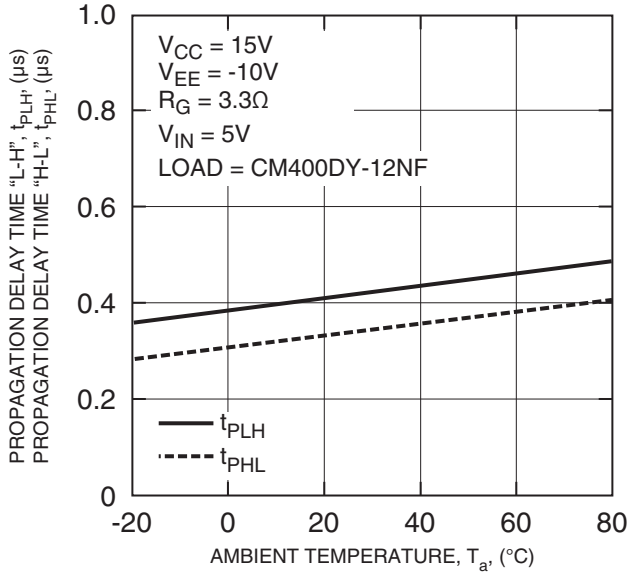
### Application Example of Single Power Supply



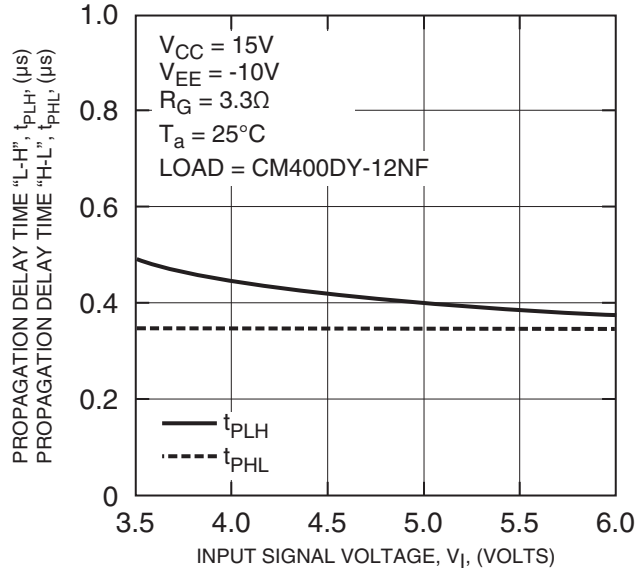
$V_{CC} = 24V$   
DZ2 : 8.2V, 1/2W  
R : 2.7k ~ 3.3k $\Omega$

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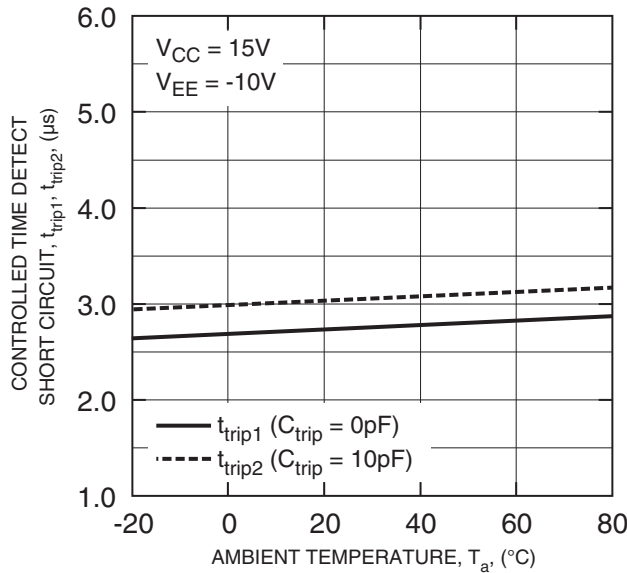
$t_{PLH}$ ,  $t_{PHL}$ - $T_a$  CHARACTERISTICS  
(TYPICAL)



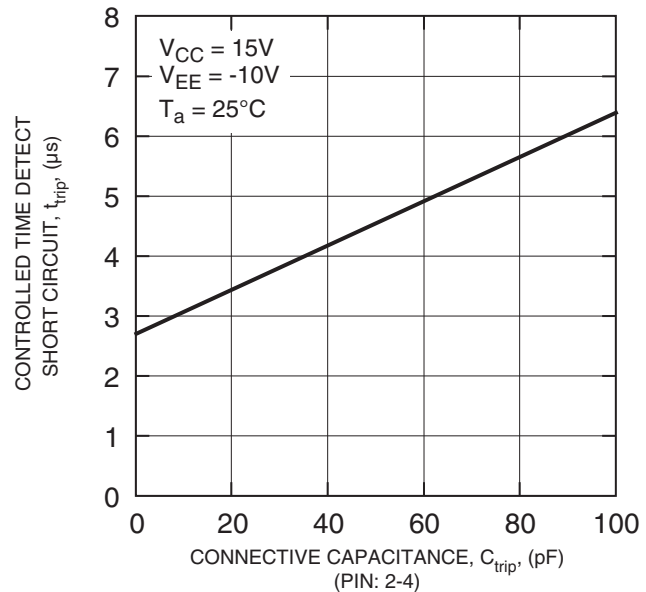
$t_{PLH}$ ,  $t_{PHL}$ - $V_I$  CHARACTERISTICS  
(TYPICAL)



$t_{trip1}$ ,  $t_{trip2}$ - $T_a$  CHARACTERISTICS  
(TYPICAL)

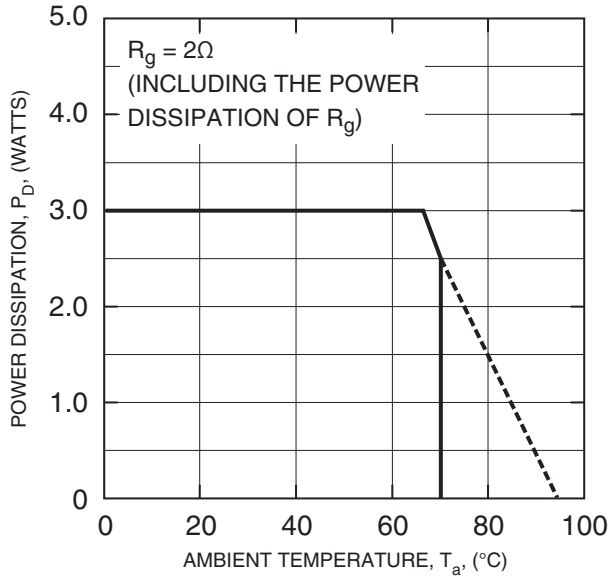


$t_{trip}$ - $C_{trip}$  CHARACTERISTICS  
(TYPICAL)



VLA542-01R  
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**POWER DISSIPATION - AMBIENT TEMPERATURE CHARACTERISTICS (MAXIMUM RATING)**



**DISSIPATION CURRENT - SUPPLY VOLTAGE (PIN: 4-6) INPUT SIGNAL "L" (TYPICAL)**

