

**DESCRIPTION**

VLA554-01R is a hybrid integrated circuit designed for driving n-channel IGBT modules in any gate-amplifier application. Electrical isolation voltage between input and output is 4000Vrms (for 1minute). This device include the isolated type DC-DC converter for a Gate drive. Therefore design of the gate power supply is not required.

The system of built-in short circuit protection provide a margin to time by function to maintain reverse bias for a predetermined time after the detection of short circuit.

Recommended IGBT modules:

$V_{CES} = 1200V$  series up to 3600A class

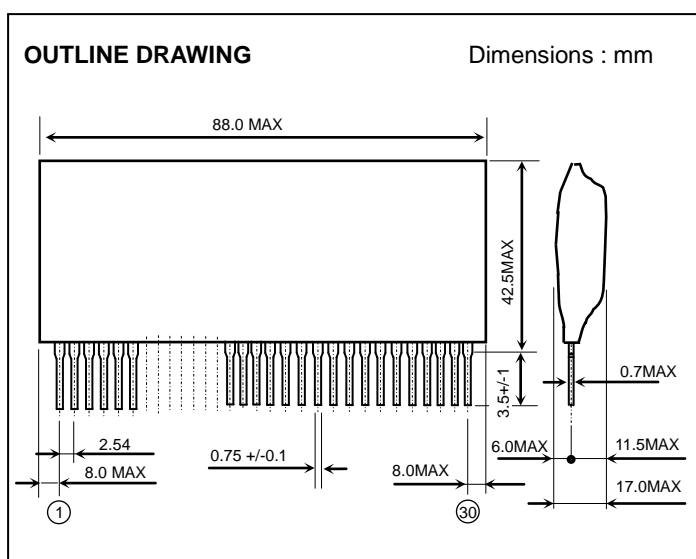
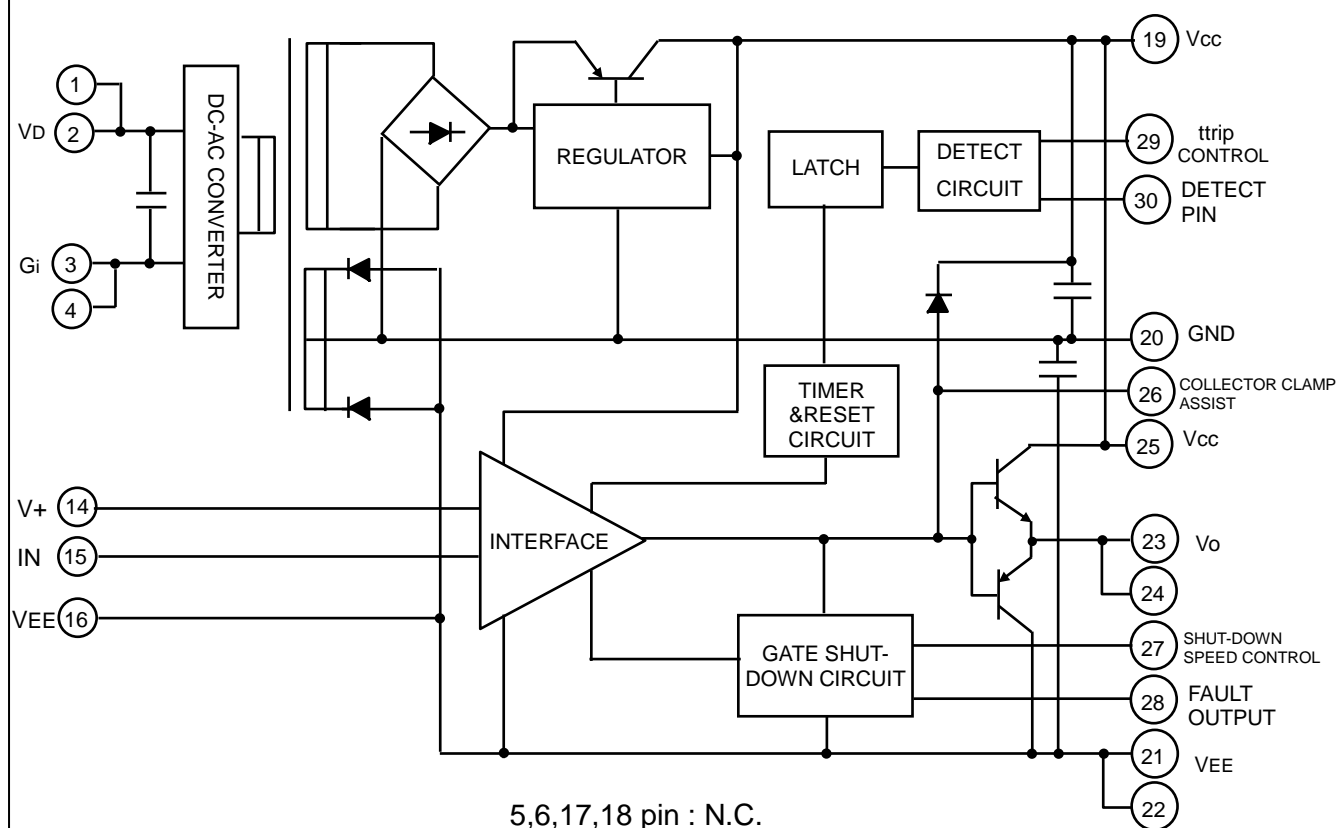
$V_{CES} = 1700V$  series up to 3600A class

**FEATURES**

- Built-in the isolated type DC-DC converter for gate drive
- SIP outline allows more space on mother board
- Built-in short circuit protection (With a pin for fault output)
- Possible to assist collector clamp circuit (pin 26)
- Variable fall time on activity of short circuit protection
- Electrical isolation voltage between input and output is 4000Vrms (for 1minute)
- Possible to optical interface for control signal input and fault signal output (by built fiber-optic connector in pin 14-16)

**APPLICATIONS**

To drive IGBT modules for general industrial use apparatus.

**BLOCK DIAGRAM**

**MAXIMUM RATINGS** (Unless otherwise noted, Ta=25°C)

Symbol	Parameter	Conditions	Ratings	Unit
VD	Supply voltage	DC	-1 ~ 16.5	V
VO	Output voltage	"H" output voltage	Vcc	V
I <sub>N(PULSE)</sub>	Input current (PULSE)	PW 10msec, Duty cycle 50%, Applied pin 1,2	4	A
I <sub>OHP</sub>	Output current	Pulse width 3μs	-24	A
I <sub>OLP</sub>			24	A
Viso	Isolation voltage	Sine wave voltage 60Hz, for 1min. , R.H.<60%	4000	Vrms
T <sub>C</sub>	Case temperature	Surface temperature	100	°C
Topr	Operating temperature	No condensation allowable	-30 ~ +70	°C
Tstg	Storage temperature	No condensation allowable	-40 ~ +100 (*1)	°C
I <sub>FO</sub>	Fault output current	Applied pin 28	20	mA
V <sub>R30</sub>	Input voltage to pin 30	Applied pin 30	60	V
I <sub>drive</sub>	Gate drive current	Gate average current	210 (*2)	mA

(\*1) Differs from H/C condition

(\*2) Refer to I<sub>drive</sub>-Ta CHARACTERISTICS.**ELECTRICAL CHARACTERISTICS** (Unless otherwise noted, Ta=25°C, VD=15V, R<sub>G</sub>=1 ohm, C<sub>L</sub>=1.6μF, f=3kHz)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
VD	Supply voltage	Recommended range	14.2	15	15.8	V
f	Switching frequency	Recommended range	-	-	10	kHz
R <sub>G</sub>	Gate resistance	Recommended range	0.33	-	-	Ω
Vcc	Gate positive supply voltage	-	15.2	16.5	17.5	V
VEE	Gate negative supply voltage	-	-6	-8	-11.5	V
η	Gate supply efficiency	Load current = 210mA η = (Vcc+IV <sub>EE</sub> I) x 0.21 / (15 x I <sub>D</sub> ) x 100	60	72	-	%
V <sub>OH</sub>	"H" output voltage	10k ohm connected between pin 23-20	14	15.3	16.5	V
V <sub>OL</sub>	"L" output voltage	10k ohm connected between pin 23-20	-5.5	-7	-11	V
t <sub>PLH</sub>	"L-H" propagation time	I <sub>IH</sub> =30mA(*3), propagation time from pin 15	0.3	0.5	1.0	μs
t <sub>r</sub>	"L-H" rise time	I <sub>IH</sub> =30mA(*3)	-	0.6	1.2	μs
t <sub>PHL</sub>	"H-L" propagation time	I <sub>IH</sub> =30mA(*3), propagation time from pin 15	0.2	0.4	1.0	μs
t <sub>f</sub>	"H-L" fall time	I <sub>IH</sub> =30mA(*3)	-	0.3	1.2	μs
t <sub>timer</sub>	Timer	Between start and cancel (under input signal "OFF")	1	-	2	ms
I <sub>FO</sub>	Fault output current	Applied pin 28, R = 2.4k ohm	-	10	-	mA
t <sub>trip1</sub>	Controlled time detect short circuit 1	Pin 30 : 15V and more, pin 29 : open	-	3.5	-	μs
t <sub>trip2</sub>	Controlled time detect short circuit 2 (*4)	Pin 30 : 15V and more, pin 29-21,22 : 10pF (connective capacitance)	-	3.9	-	μs
V <sub>SC</sub>	SC detect voltage	Collector voltage of IGBT	15	-	-	V

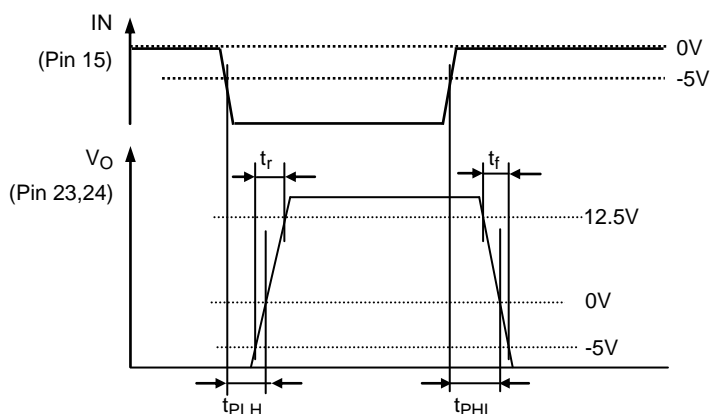
(\*3) It is current which flows through LED of the optical link element of an input interface circuit.

Refer to 'MEASUREMENT CIRCUIT' for an input interface circuit.

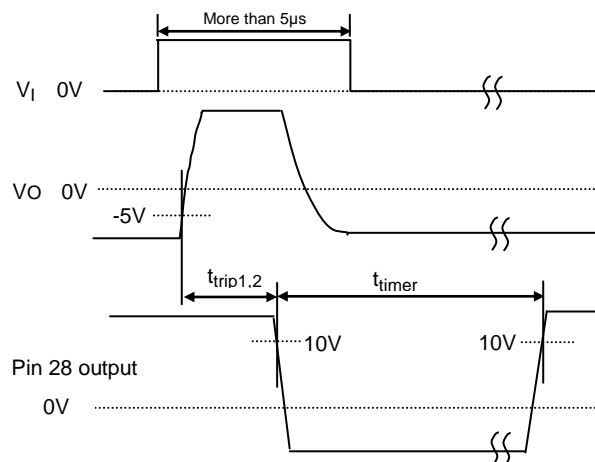
(\*4) Length of wiring of condenser controlled time detect short-circuit is within 5cm from pin 21,22 and 29 coming and going.

**DEFINITION OF CHARACTERISTICS**

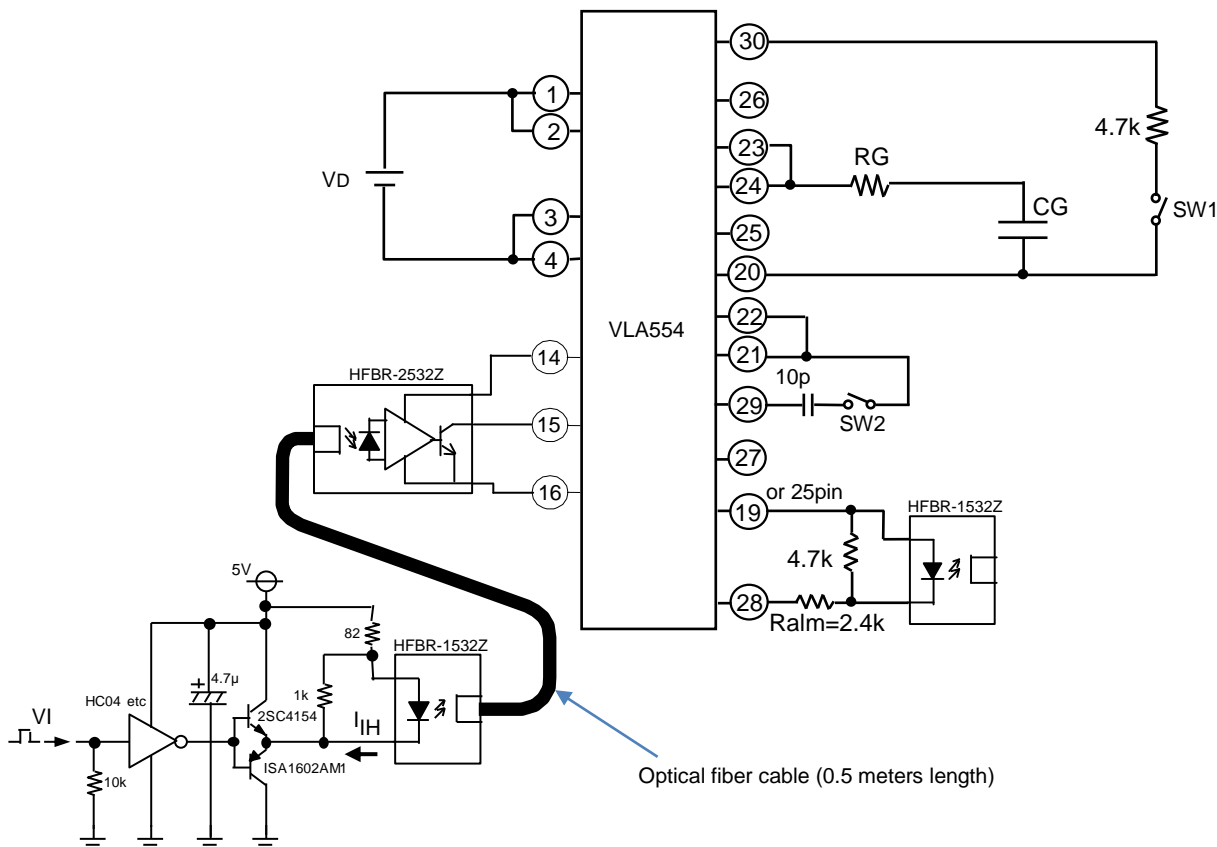
(1) SWITCHING OPERATION



(2) OPERATION OF SHORT CIRCUIT PROTECTION



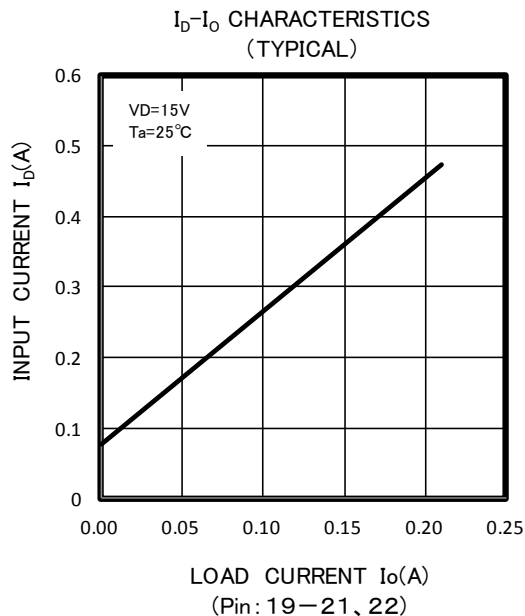
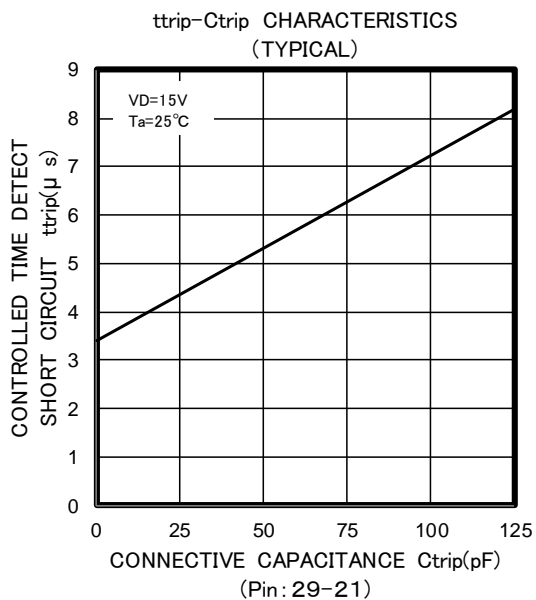
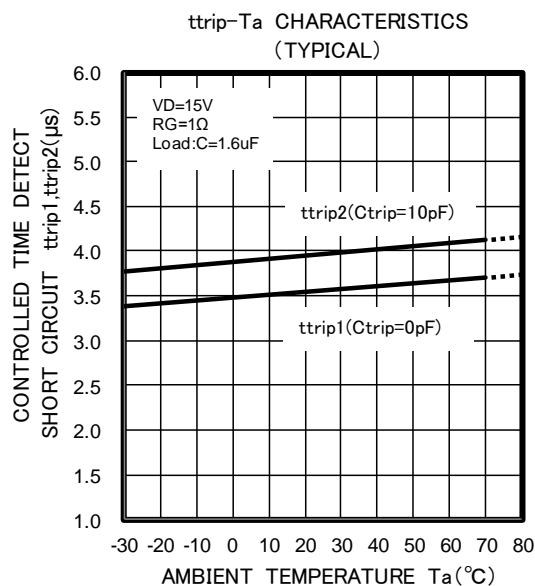
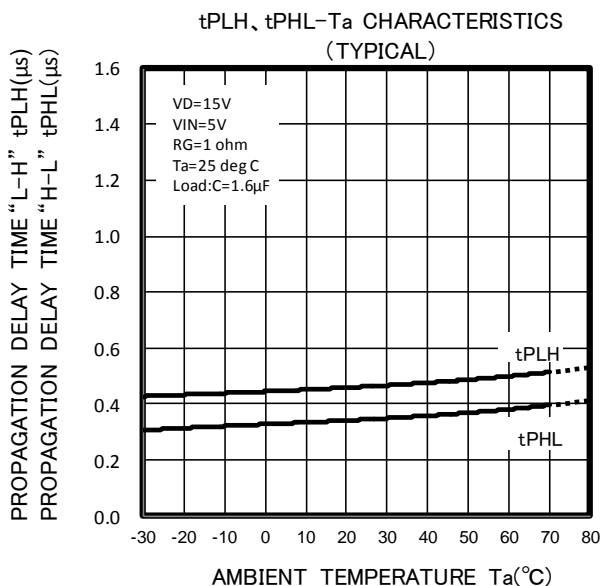
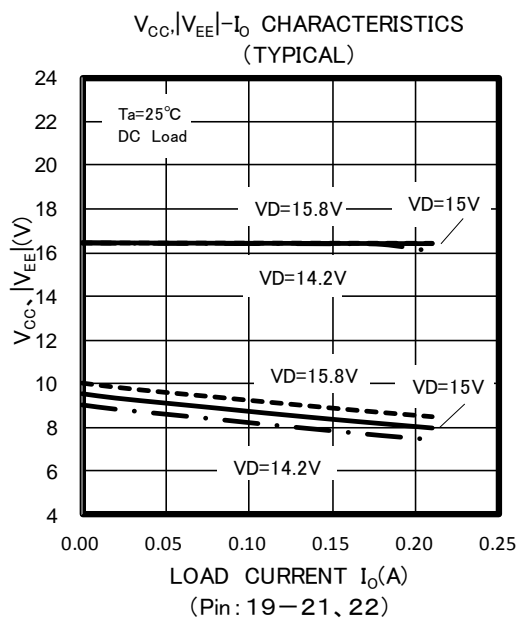
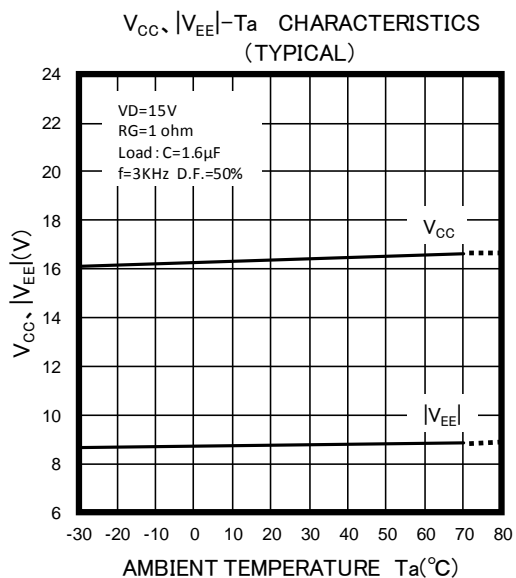
**MEASUREMENT CIRCUIT**



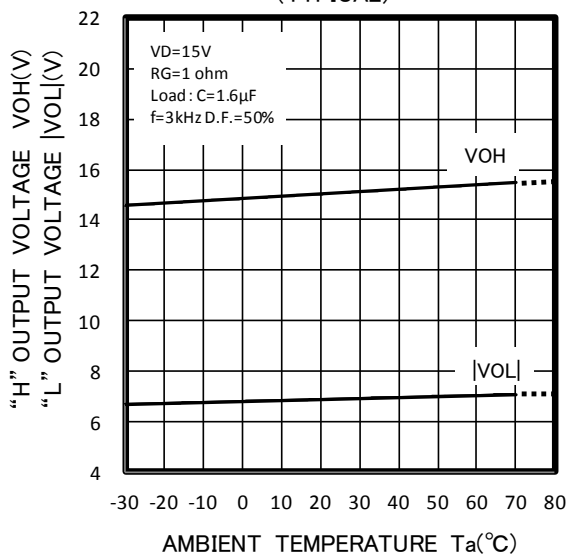
**MEASUREMENT CONDITION**

- Ta=25 deg C
- VD=15V
- RG=1ohm
- CG=1.6µF
- SW1:ON→Switching Mode
- SW1:OFF→Short Circuit Protect Mode
- SW2:OFF→Measurement of ttrip1
- SW2:ON→Measurement of ttrip2

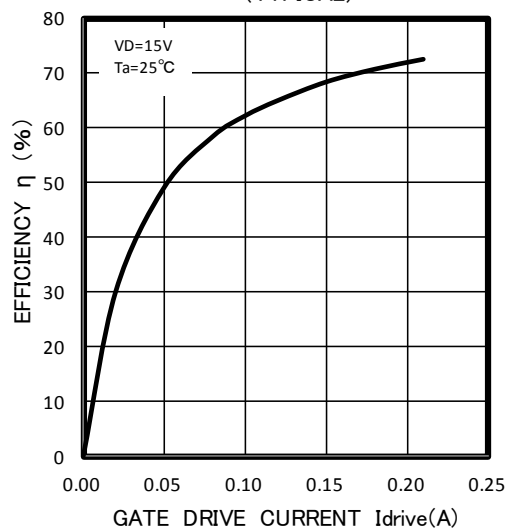
PERFORMANCE CURVES



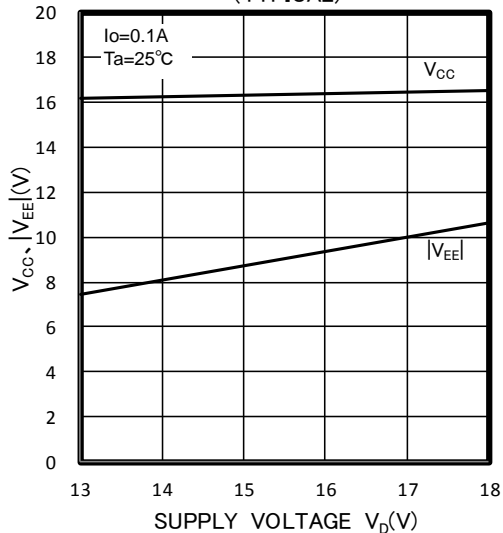
VOH,|VOL|-Ta CHARACTERISTICS (TYPICAL)



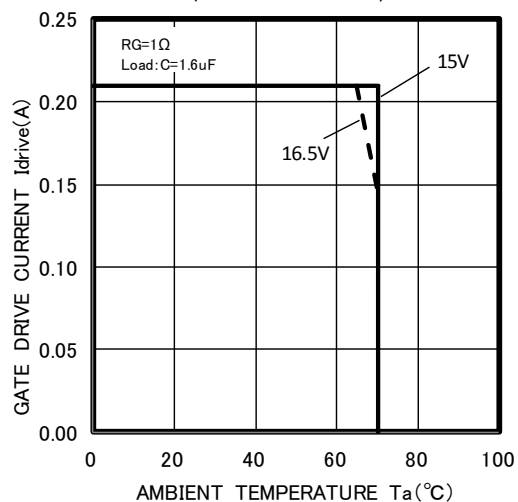
η -Idrive CHARACTERISTICS (TYPICAL)



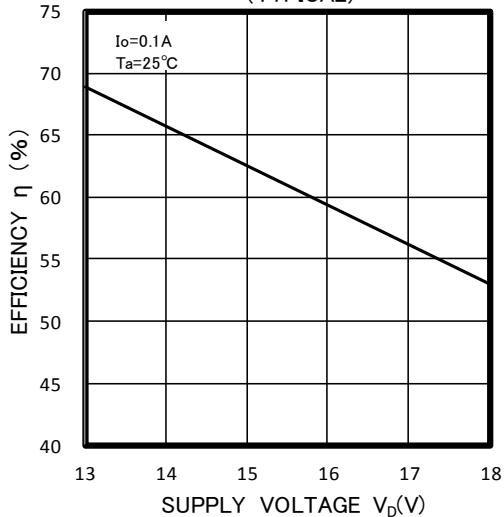
VCC, |VEE|-VD CHARACTERISTICS (TYPICAL)



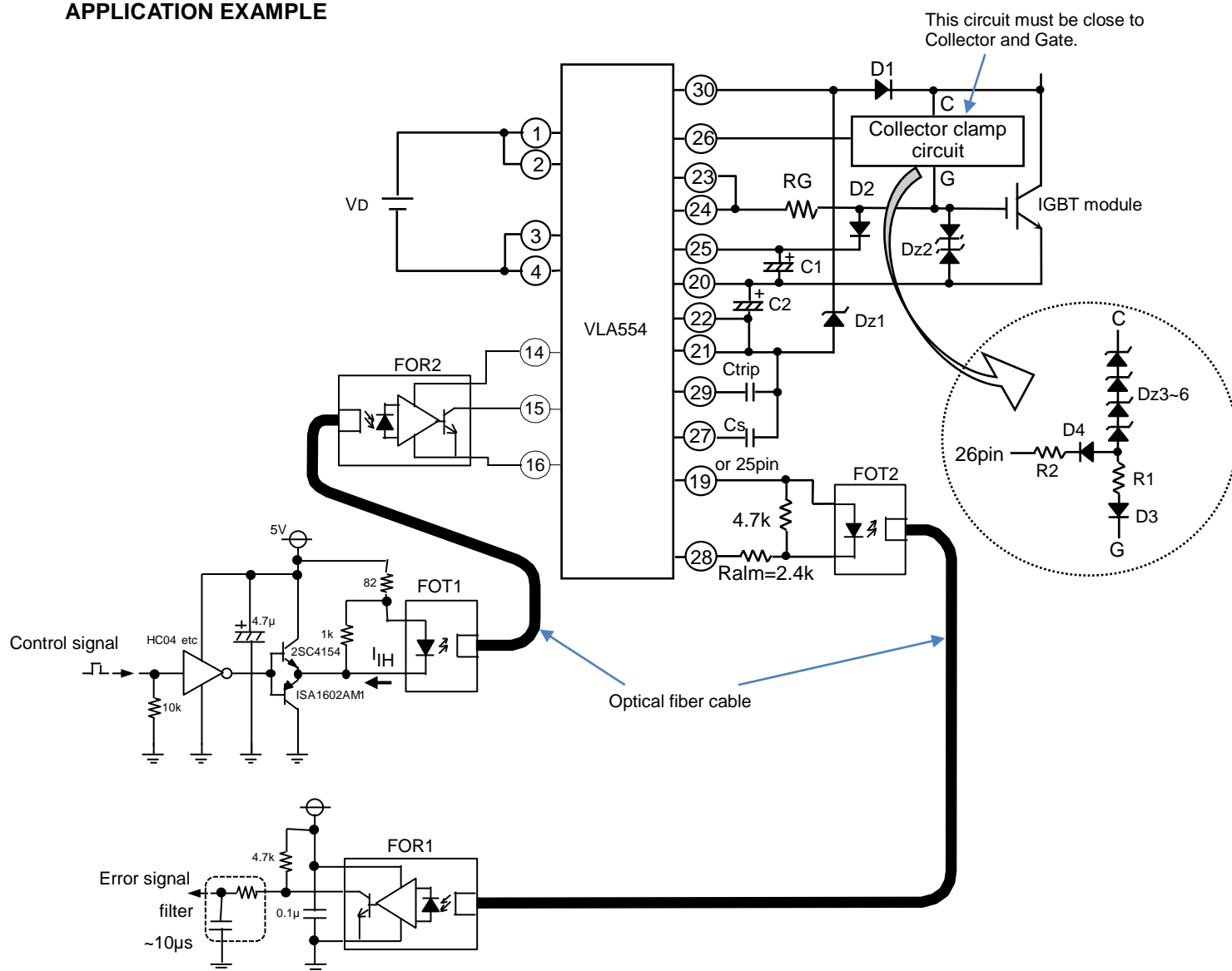
Idrive-Ta CHARACTERISTICS (MAXIMUM RATING)



η -VD CHARACTERISTICS (TYPICAL)



## APPLICATION EXAMPLE



VD=15V +/-5%  
 FOT1,2 : HFBR-1532Z (AVAGO)etc.  
 FOR1,2 : HFBR-2532Z (AVAGO)etc.  
 Ctrip : Depend on RG  
 Cs : Depend on surge voltage  
 Dz1 : 30V, 0.5W~1W  
 Dz2 : 18V, Bidirectional  
 D1 : Fast recovery diode (trr : 200ns Max)  
 RP1H(Sanken) etc.  
 C1,C2 : 470uF, 35V(Low impedance)

D2~4 : SBD VRM=60V, IFSM>60A class  
 R1 : 1 ohm, 1W class  
 R2 : 10 ohm, 1/4W class  
 Dz3~6 :  $V_{pn} < \text{Total } V_z < V_{CES}$  of IGBT  
 Rough guide of total  $V_z$  is as follows  
 For  $V_{CES}$  1200V series → 900~1000V  
 For  $V_{CES}$  1700V series → 1300~1400V  
 It depends on  $V_{pn}$ ,  $I_C(\text{max})$ , RG, snubber circuit,  
 Inductance of power main circuit, and kind  
 of main condenser.

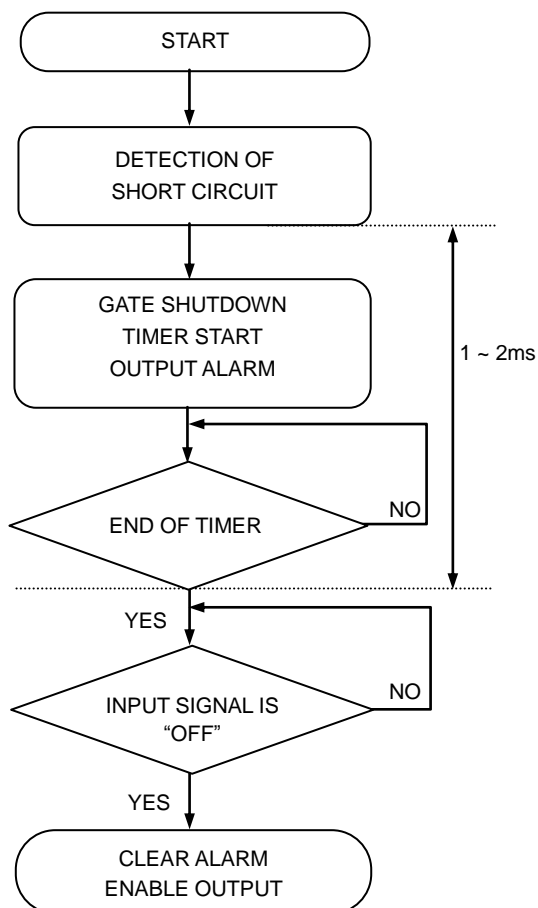
## PRECAUTION

- (1) Voltage compensate capacitors are expected to be located as close as possible to the Hybrid IC.
- (2) Minimize the area of closed circuit of gate circuit so as not to be affected by induction noise.
- (3) D1 requires approximately the same voltage of IGBT modules.
- (4) When recovery current flow in D1, pin 30 is applied high voltage.  
In that case, counterplan for protection which insert a zener diode between pin21 and 30 are necessary like above diagram.
- (5) When you make late speed of reverse bias at the time of short circuit protection operation,  
please adjust and connect a capacitor between pin 21 and 27.
- (6) When the built in short-circuit protection circuit need not be used, please connect resistance of 4.7k ohm between pin 30 and 20.  
(D1 and Dz1 are not required.)
- (7) **When the collector clamp circuit operates repeatedly, it may be destroyed for heat. That is why the confirmation of calorific value is necessary for zener diode by actual inverter test.**

**OPERATION OF PROTECTION CIRCUIT**

- (1) In case the gate voltage is "H" and the collector voltage is high, this Hybrid IC will recognize the circuit as short circuit and immediately reduce the gate voltage. Besides, put out a fault sign ("L") which inform that protection circuit is operating at the same time from pin 28.
- (2) The protection circuit reset and return to ordinary condition if input signal is "L" when the predetermined time(1 ~ 2ms) passed. ("L" period needs 15us or more)
- (3) When the output rises, the controlled time detect short circuit (Typ 3.5us) is set up so that on-time of IGBT can be secured properly. It is possible to adjust that time by connecting the capacitor (Ctrip) between pin 21,22 and 29.

**OPERATION FLOW ON DETECTING SHORT CIRCUIT**



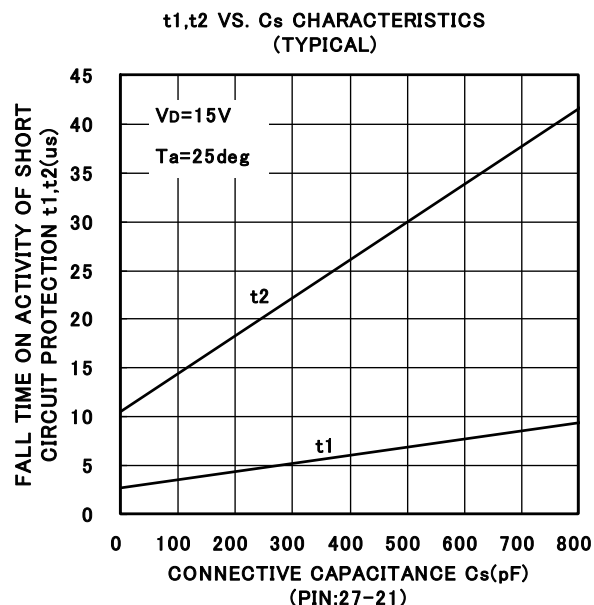
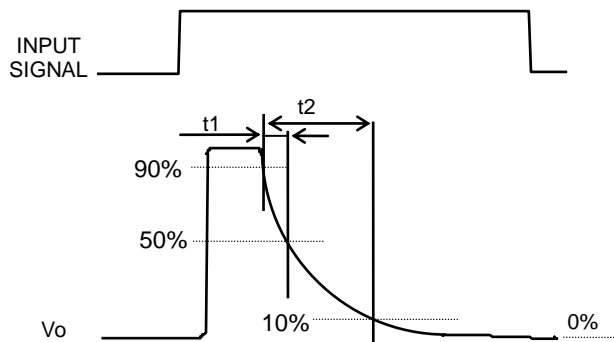
Note : Output voltage with protection circuit operating is about  $-|V_{EE1}| + 2V$ .

**ADJUSTMENT OF OUTPUT FALL TIME**

(When the protection circuit is operating)

In case you want to decrease the speed of reverse bias when the protection circuit is operating, you can adjust that speed by connecting the capacitor (Cs) between pin 21 and 27.

(Please refer to under figures.)



**CAPACITY FOR POWER SUPPLY ON INPUT SIDE**

This product has isolated DCDC converter built in for gate drive.  
 When you chose the power supply on input side,  
 please select the product that can supply the current capacity proven  
 by next 3steps.

1st step : Calculation for gate average current

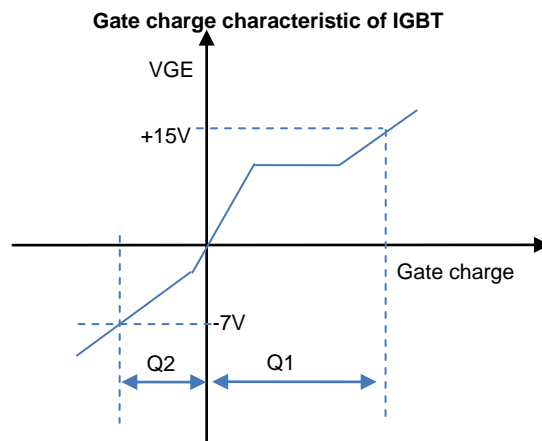
$$I_{drive} = (Q1 + IQ2) \times f$$

$I_{drive}$  : Gate average current

Q1 : Gate charge at +15V (Read from data sheet of IGBT)

Q2 : Gate charge at -7V (Read from data sheet of IGBT)

f : Switching frequency of IGBT



2nd step : Reading required current from performance curve

If the result of calculation for  $I_{drive}$  is 100mA

$I_D$  is about 270mA by right chart.

$I_D$  : Consumption current of DCDC converter in this HIC

3rd step : Securing the margin

$$I_{out} = I_D \times (1 + \text{margin})$$

$I_{out}$  : Output current of input power supply

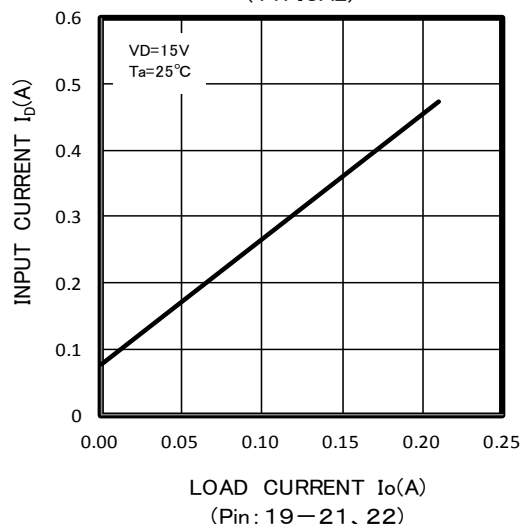
Margin : 0.4

If the result of  $I_D$  is 270mA, please prepare the power supply  
 that has the following spec.

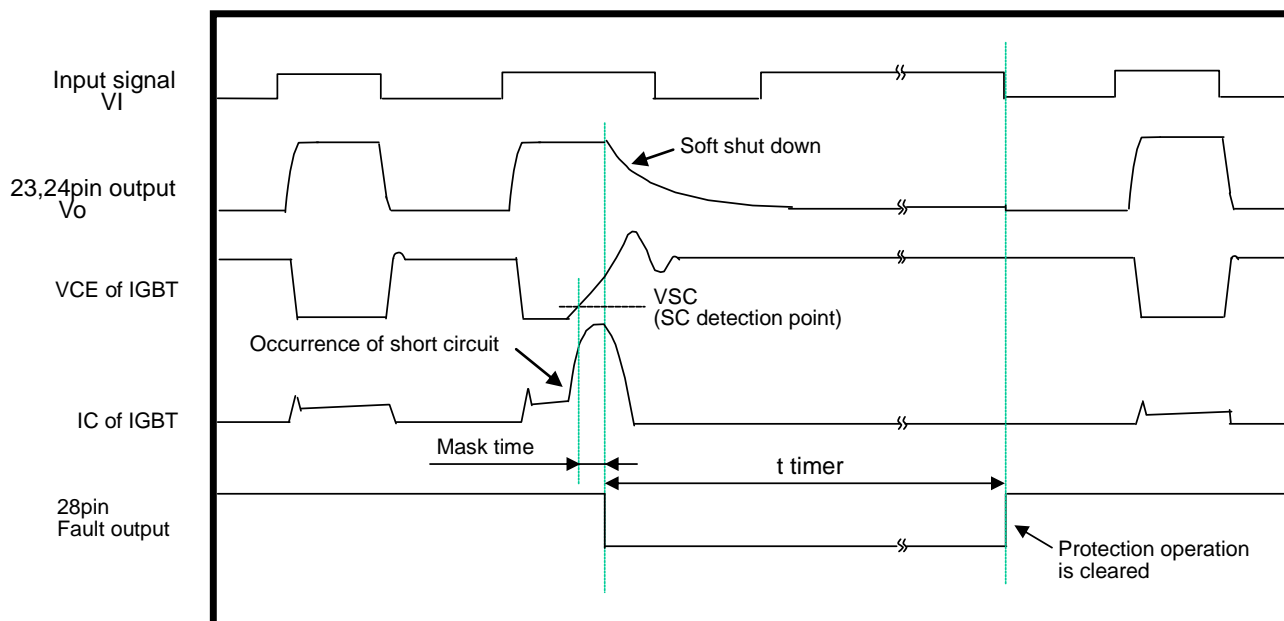
Output voltage : 15V

Output current : more than 350mA

$I_D$ - $I_o$  CHARACTERISTICS  
(TYPICAL)



**TIMING CHART**





## FOR SAFETY USING

Great detail and careful attention are given to the production activity of Hics, such as the development, the quality of production, and in its reliability. However the reliability of Hics depends not only on their own factors but also in their condition of usage. When handling Hics, please note the following cautions.

CAUTIONS	
Packing	<p>The materials used in packing Hics can only withstand normal external conditions. When exposed to outside shocks, rain and certain environmental contaminants, the packing materials will deteriorates. Please take care in handling.</p>
Carrying	<ol style="list-style-type: none"> <li>1) Don't stack boxes too high. Avoid placing heavy materials on boxes.</li> <li>2) Boxes must be positioned correctly during transportation to avoid breakage.</li> <li>3) Don't throw or drop boxes.</li> <li>4) Keep boxes dry. Avoid rain or snow.</li> <li>5) Minimal vibration and shock during transportation is desirable.</li> </ol>
Storage	<p>When storing Hics, please observe the following notices or possible deterioration of their electrical characteristics, risk of solder ability, and external damage may occur.</p> <ol style="list-style-type: none"> <li>1) Devices must be stored where fluctuation of temperature and humidity is minimal, and must not be exposed to direct sunlight. Store at the normal temperature of 5 to 30 degrees Celsius with humidity at 40 to 60%.</li> <li>2) Avoid locations where corrosive gasses are generated or where much dust accumulates.</li> <li>3) Storage cases must be static proof.</li> <li>4) Avoid putting weight on boxes.</li> </ol>
Extended storage	<p>When extended storage is necessary, Hics must be kept non-processed. When using Hics which have been stored for more than one year or under severe conditions, be sure to check that the exterior is free from flaw and other damages.</p>
Maximum ratings	<p>To prevent any electrical damages, use Hics within the maximum ratings. The temperature, current, voltage, etc. must not exceed these conditions.</p>
Polarity	<p>To protect Hics from destruction and deterioration due to wrong insertion, make sure of polarity in inserting leads into the board holes, conforming to the external view for the terminal arrangement.</p>

**Keep safety first in your circuit designs!**

- ISAHAYA Electronics Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (1) placement of substitutive, auxiliary circuits, (2) use of non-flammable material or (3) prevention against any malfunction or mishap.

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