

# Hybrid ICs for Driving IGBTs

## VLA517-11R APPLICATION MANUAL



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## 1 Introduction

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The insulated gate bipolar transistor (IGBT) is increasingly being used in small, low-noise, high-performance power supplies, inverters, uninterruptable power supplies (UPS), and motor speed controls.

## 2 Features

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- High speed response for up to 40kHz operation
- **Built-in photocoupler for high isolation voltage:** 2500V AC for one minute
- **Single supply operation**
- **Built-in overcurrent protection circuit**
- **Overcurrent detection output**
- **SIL package for high-density mounting**

## 3 Application

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- General-purpose inverter and motor control
- NC machine tools
- Uninterruptable power supplies (UPS)
- Welding machines

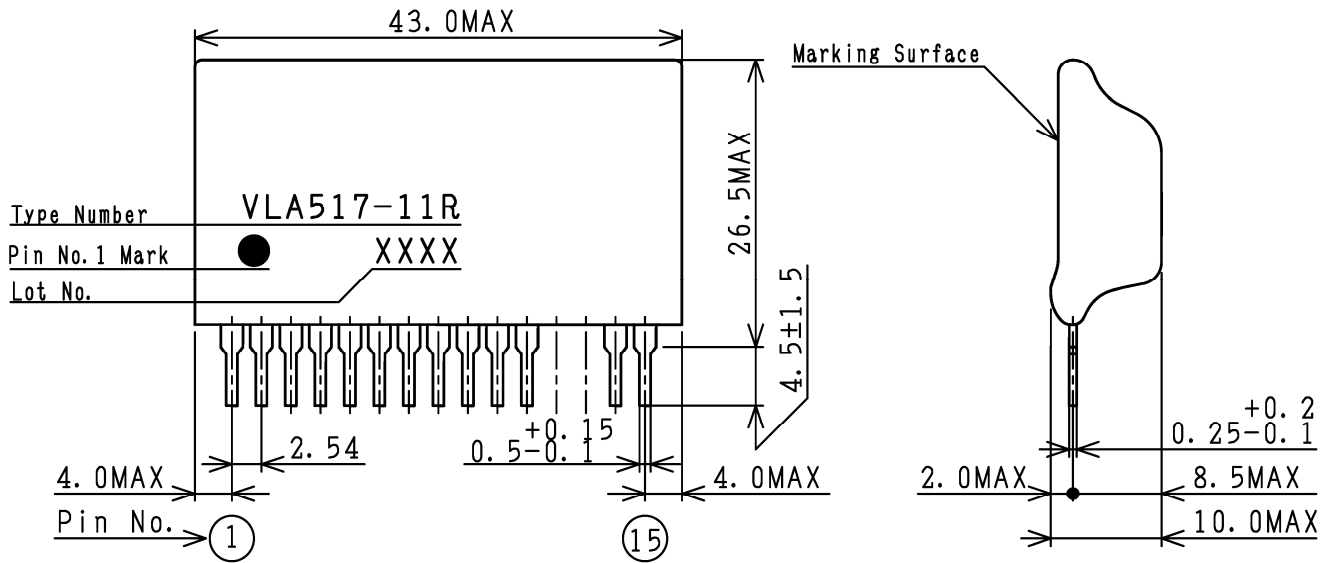
## 4 Comprehensive Chart

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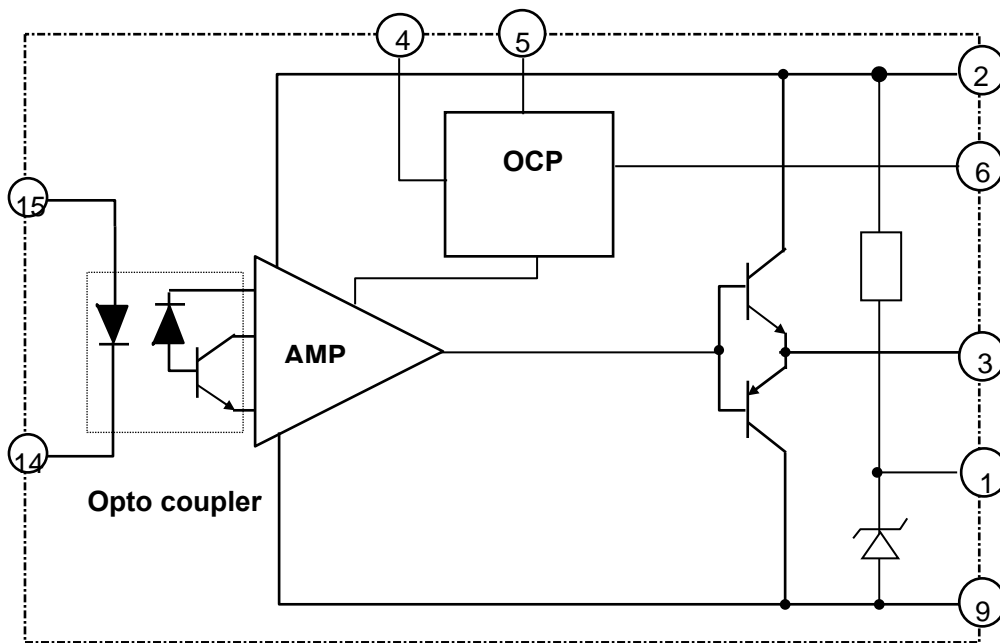
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| Fuji IGBT modules | V <sub>CES</sub> | I <sub>CP</sub> |
|-------------------|------------------|-----------------|
|                   | 600V             | up to 400A      |
|                   | 1200V            | up to 300A      |

## 5 Dimensions, mm



## 6 Functional Block Diagrams



| Pin number | Description   |
|------------|---|
| ①          | Connected to smoothing capacitor for reverse bias power supply  |
| ②          | Power supply (+20V)   |
| ③          | Drive output  |
| ④          | For connecting an external capacitor to protect against malfunction of the overcurrent protection circuit<br>(The capacitor is not needed in most cases.) |
| ⑤          | Overcurrent detection output  |
| ⑥          | Collector voltage monitoring  |
| ⑦ ⑧        | Not connected   |
| ⑨          | Power supply (0V)   |
| ⑩ ⑪        | Not connected   |
| ⑭          | Drive signal input (-)  |
| ⑮          | Drive signal input (+)  |

## 7 Ratings and Characteristics

### Absolute Maximum Ratings (at Tc=25degree unless otherwise specified)

| Items                       | Symbol | Conditions               | Rated value |
|-----------------------------|--------|--------------------------|-------------|
| Power supply voltage        | Vcc    |                          | 25V         |
| Photo coupler input current | Iin    |                          | 25mA        |
| Forward bias output current | Ig1    | PW=2μs、duty=0.05 or less | 4.0A        |
| Reverse bias output current | Ig2    | PW=2μs、duty=0.05 or less | 4.0A        |
| Isolation voltage           | VISO   | AC50Hz/60Hz,1min         | 2500V       |
| Operation temperature       | Tc     |                          | -25 +85°C   |
| Storage temperature         | Tstg   |                          | -25 +125°C  |

### Recommended Operations Conditions

| Items                       | Symbol | Recommended condition |
|-----------------------------|--------|-----------------------|
| Power supply voltage        | Vcc    | 20~22V                |
| Photo Coupler Input Current | Iin    | 10mA+/-10%            |

### Electrical Characteristics (Ta=25°C, Vcc=20V, IF=10mA)

| Items                                       | Symbol | Conditions | Rated value         |       |
|---|--------|------------|---------------------|-------|
|   |        |            | Typ.                | Max.  |
| Switching time 1                            | ton    |            |                     | 1.5μs |
| Switching time 2                            | toff   |            |                     | 1.5μs |
| OCP operating voltage                       | Vocp   |            | 8.5V                |       |
| OCP delay time                              | tocp   |            |                     | 10μs  |
| Alarm delay time                            | tARM   |            |                     | 1.5μs |
| Reverse bias power supply voltage           | VRB    | IF=0A      | 5V                  |       |
| Opto coupler Common mode transient immunity | dv/dt  |            | P-P, 1000V-5000V/μs |       |

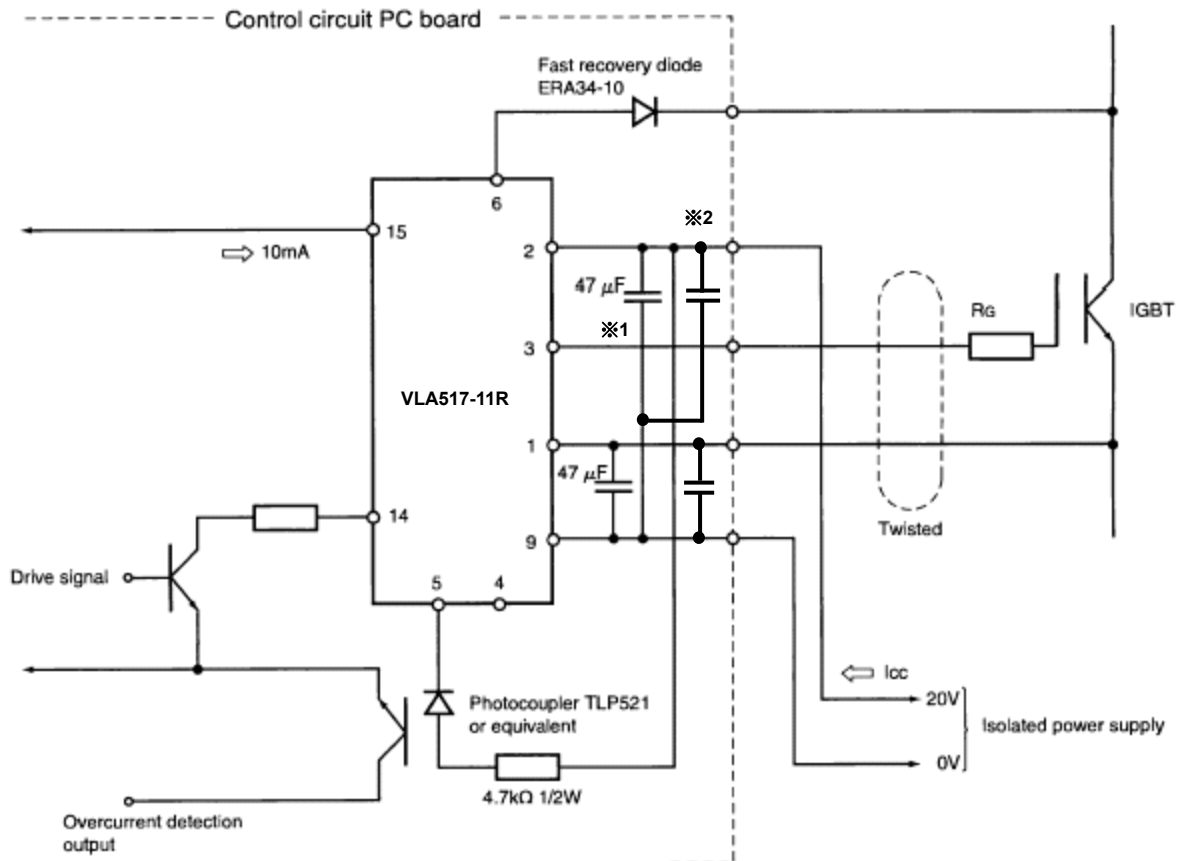
## 8 Application Circuits

### VLA517-11R application circuits

VLA517-11R is a hybrid IC capable of driving up to 400A for a 600V IGBT and up to 300A for a 1200V IGBT. Since the signal delay in the drive circuit is 1.5 $\mu$ s or less, the hybrid IC is suitable for switching at up to about 40kHz.

Note the following when using the hybrid IC:

- The IGBT's gate-emitter drive loop wiring must be shorter than one meter.
- The IGBT's gate-emitter drive wiring should be twisted.
- If a large voltage spike is generated at the collector of the IGBT, increase the IGBT's gate series resistor ( $R_G$ ).



※ The capacitor absorbs changes in the supply voltage caused by the power supply wiring impedance. It is not a power supply filter capacitor.

※ Opto-coupler might malfunction after the turn off on the IGBTs when  $V_{PN}$  is high voltage or  $R_G$  is small value. The problem will be solved to connect the film capacitor or the ceramic capacitor of about 1.5 $\mu$ F.

## 9 Operation

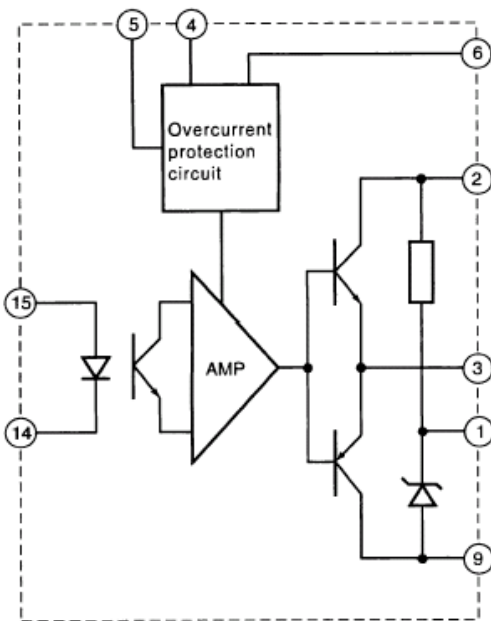
### 1. Outline

The following built-in functions make the fullest use of the IGBT.

- Signal isolation circuit
- Drive amplifier
- Overcurrent detector
- Low speed overcurrent cut-off circuit
- Gate turn-off power supply

### 2. Signal isolation circuit

A photocoupler with a high isolation voltage is used for signal isolation. Therefore, this hybrid IC can be used in devices powered from 480V AC.



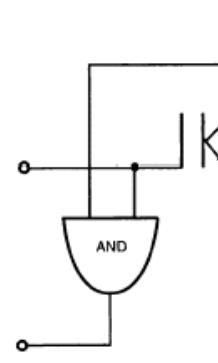
### 3. Overcurrent detector

The IGBT can withstand an overcurrent of only 10 $\mu$ s duration when short-circuited. An extremely fast protection circuit is necessary for this reason.

This hybrid IC incorporates an overcurrent protection circuit. An overcurrent is detected according to the relationship between the drive signal and the collector voltage.

The principle of overcurrent detection is shown below. An overcurrent is considered present when the collector voltage is high although an on-signal is inputted.

|            | VCE low | VCE high    |
|------------|---------|-------------|
| On-signal  | Normal  | Overcurrent |
| Off-signal | -       | Normal      |



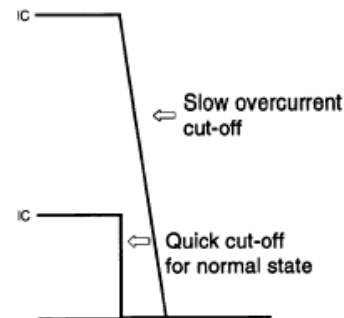
### 4. Low-speed overcurrent cut-off circuit

A low-speed cut-off circuit slowly turns off the IGBT in response to an overcurrent.

When an overcurrent is cut off at normal drive speed, the collector voltage spike generated is large enough to damage the IGBT.

The low-speed cut-off circuit protects the IGBT against damage.

(The low-speed cut-off circuit does not operate for overcurrents of 10 $\mu$ s or less duration.)

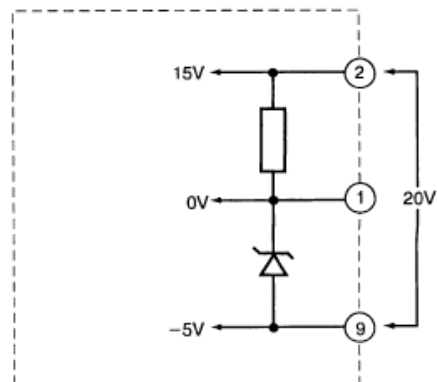


### 5. Gate turn-off power supply

The IGBT needs a +15V on-gate voltage to get a low on-voltage and -5V off-gate voltage to protect against malfunction in the off state.

This is a built-in circuit which generates a constant-voltage supply from the 20V supply for IGBT gate turn-off.

Do not apply external voltage to pin 1.

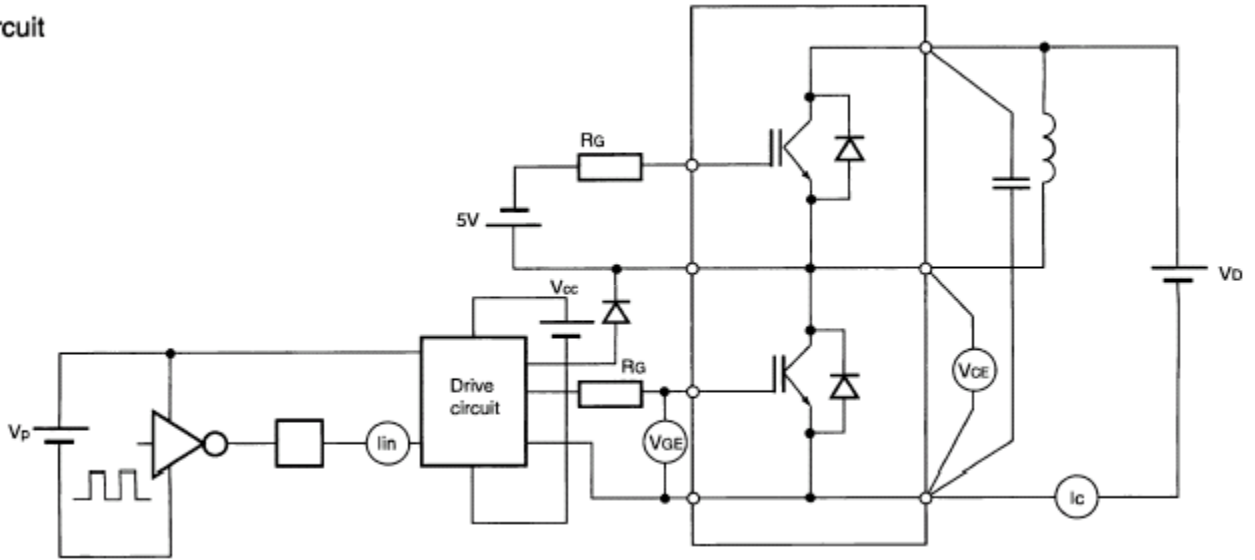


# 10 Operating Waveforms

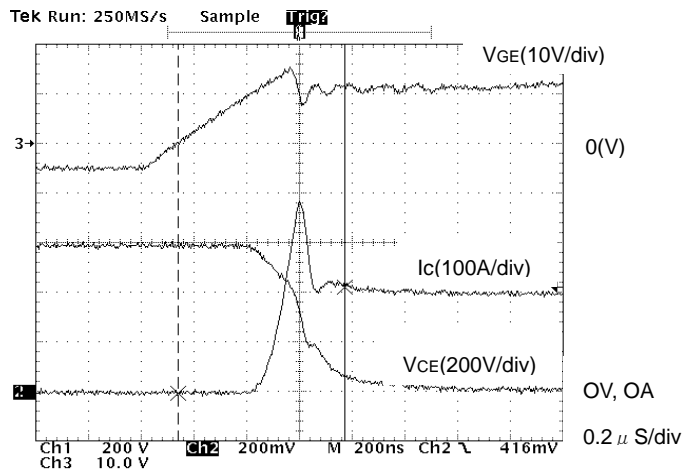
## 2. VLA517-11R

- Input-output waveforms

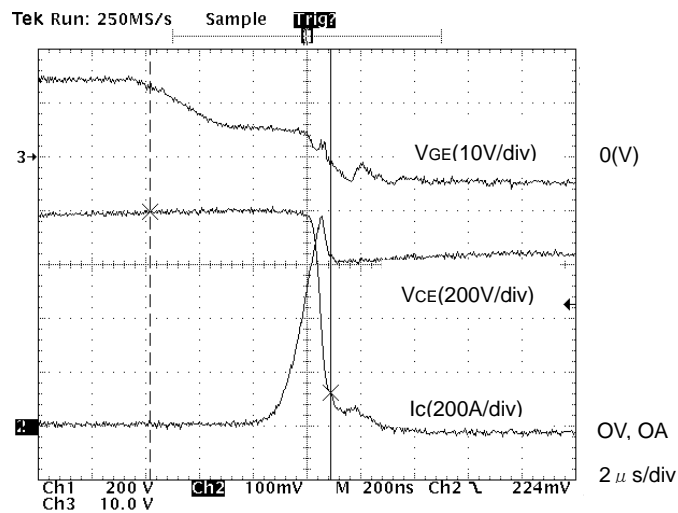
Test circuit



Operating conditions:  $V_{cc}=20V$ ,  $V_d=600V$ ,  $I_c=200A$ , IGBT module: 2MBI200U4B120,  $R_g=6.2\Omega$



① Turn-on waveforms

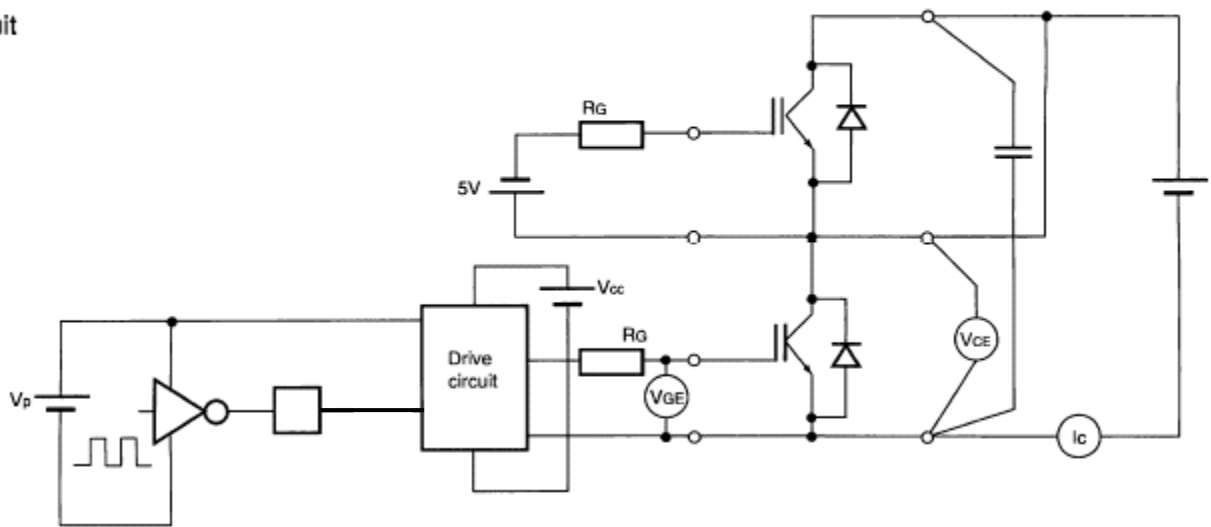


② Turn-off waveforms

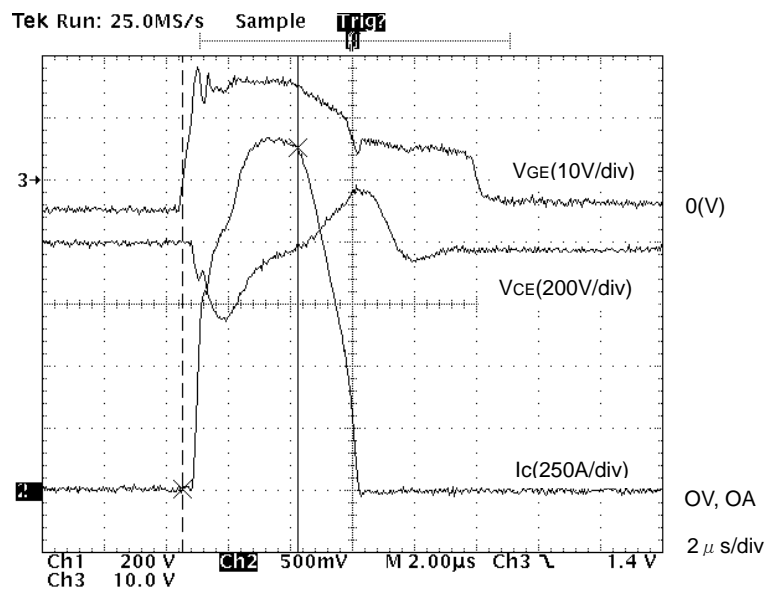


● Waveforms at short circuit

Test circuit



Operating conditions:  $V_{cc}=20V$ ,  $V_d=800V$ , IGBT module: 2MBI200U4B120,  $R_g=6.2\Omega$

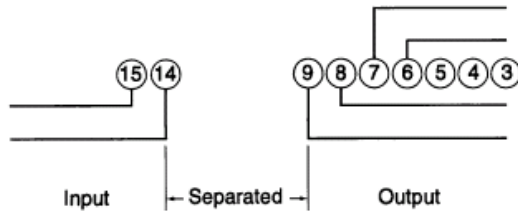


③ Turn-on waveforms (At short circuit)

## 11 Notes

### 1. Separation of input circuit from output circuit

Keep the wiring of the input circuit (Photocoupler) away from the output circuit wiring to assure that the proper dielectric strength and high noise resistance are maintained.



### 2. Use under recommended operating conditions

The IGBT works best if the recommended operating conditions driven in Section 7 are observed.

- Note that excessive drive supply voltage could damage the IGBT due to excess IGBT gate voltage, and that an insufficient drive voltage could abnormally increase the IGBT's ON voltage.
- Note that an excessive input current could increase the signal delay in the drive circuit, and that an insufficient input current could cause unstable operation of the drive circuit.
- Note that an insufficient gate resistance can increase the switching noise of the IGBT and freewheeling diode.
- Note the points above where the recommended operating conditions cannot be observed.

## 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 deteriorate. 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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