

# STK541UC62A-E

## Advance Information Intelligent Power Module (IPM) 600 V, 10 A

The STK541UC62A-E is a fully-integrated inverter power stage consisting of a high-voltage driver, six IGBT's and a thermistor, suitable for driving permanent magnet synchronous (PMSM) motors, brushless-DC (BLDC) motors and AC asynchronous motors. The IGBT's are configured in a 3-phase bridge.

The power stage has a full range of protection functions including cross-conduction protection, external shutdown and under-voltage lockout functions. Output stage uses IGBT/FRD technology and implements Under Voltage Protection (UVP) and Over Current Protection with a Fault Detection output flag. Internal Boost diodes are provided for high side gate boost drive.

### Features

- Three-Phase 10 A / 600 V IGBT Module With Integrated Drivers
- Typical Values (Upper Side at 10 A):  $V_{CE(sat)} = 1.4$  V,  $V_F = 1.3$  V
- 62.0 mm x 21.8 mm Single In-line Package
- Cross-Conduction Protection
- Integrated Bootstrap Diodes and Resistors
- These Devices are Pb-Free and are RoHS Compliant

### Certification

- UL1557 (File Number: E339285)

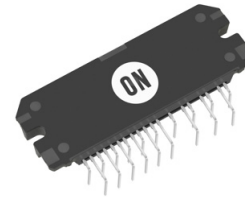
### Typical Applications

- Industrial Pumps
- Industrial Fans
- Industrial Automation
- Heat Pumps, Home Appliances



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SIP23 62x21.8  
CASE 127VB

### MARKING DIAGRAM



STK541UC62A = Specific Device Code

A = Year

B = Month

C = Production Plant

D = Ordering Number

Device Marking in on Package Underside

### ORDERING INFORMATION

See detailed ordering, marking and shipping information in the package dimensions section on page 13 of this data sheet.

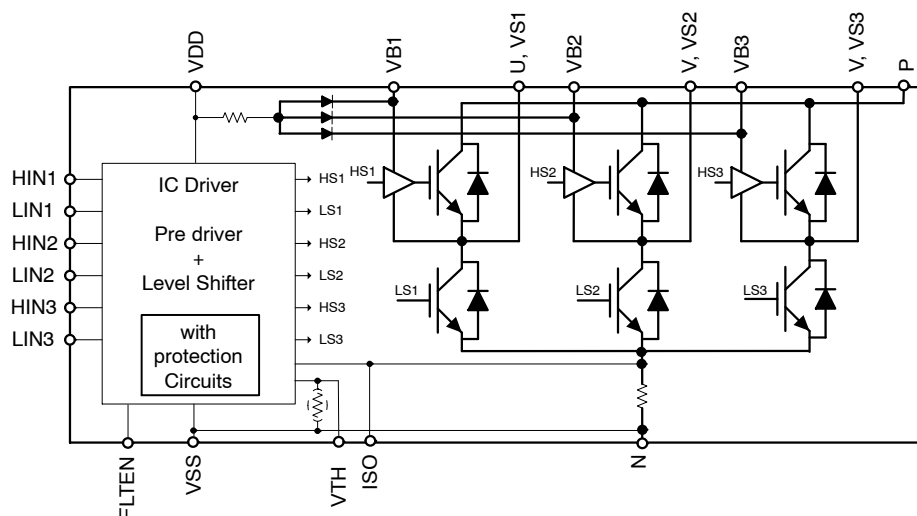


Figure 1. Functional Diagram

## STK541UC62A-E

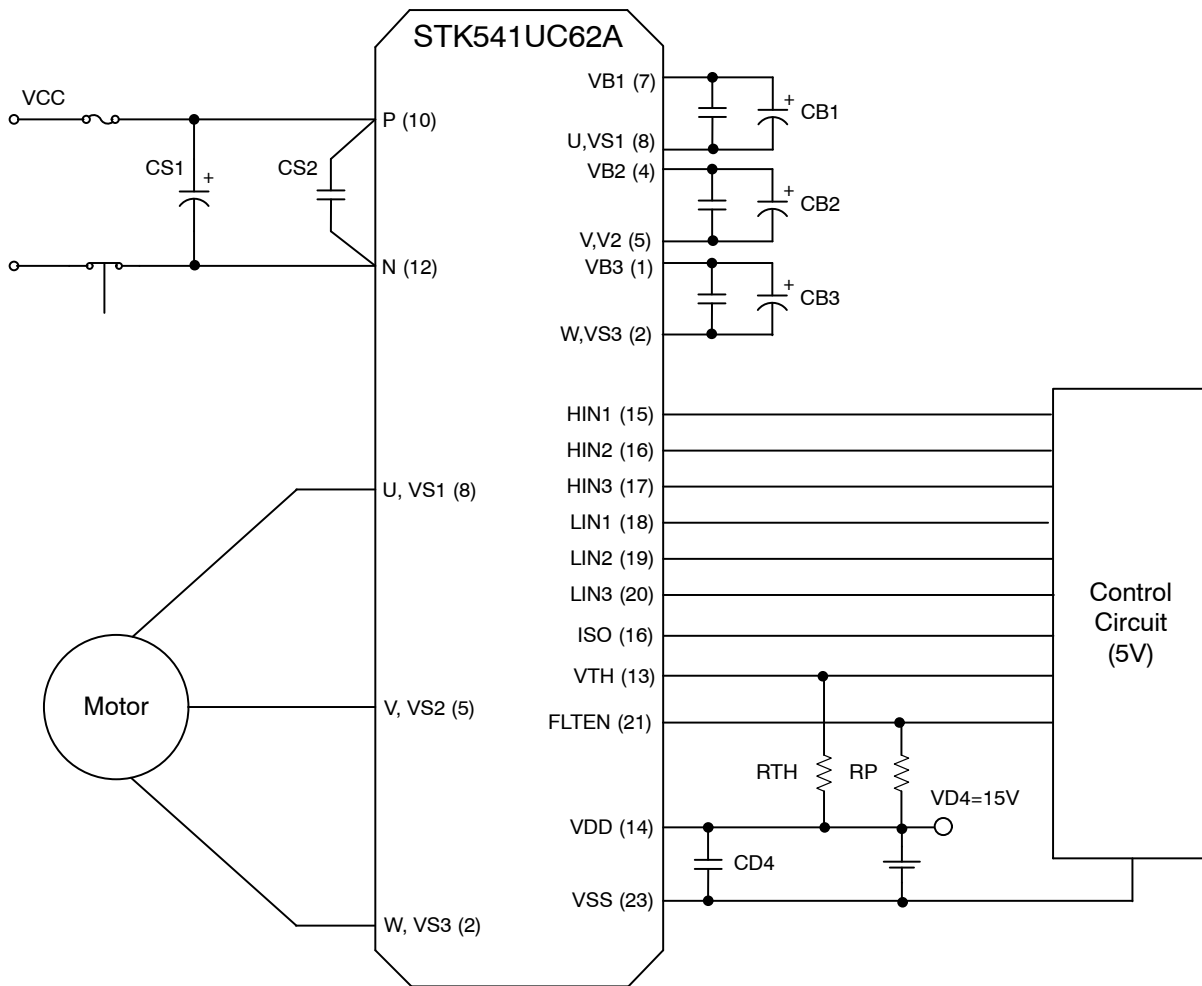


Figure 2. Application Schematic

### Function Description

1. It is essential that wiring length between terminals in the snubber circuit be kept as short as possible to reduce the effect of surge voltages. Recommended value of "CS" is in the range of 0.1 to 10  $\mu$ F.
2. The "FLTEN" terminal (Pin 21) is I/O terminal; Fault output / Enable input. It is used to indicate an internal fault condition of the module and also can be used to disable the module operation.
3. Inside the IPM, a thermistor used as the temperature monitor for internal substrate is connected between VSS terminal and TH terminal therefore, an external pull up resistor connected between the TH terminal and an external power supply should be used.

4. The "ISO" terminal (Pin 22) is current monitor terminal. When the pull-down resistor is used, please select it more than 5.6 k $\Omega$
5. As protection of IPM to the unusual current by a short circuit etc. it recommends installing shunt resistors and an over-current protection circuit outside. Moreover, for safety, a fuse on Vcc line is recommended.
6. Disconnection of terminals U, V, or W during normal motor operation will cause damage to IPM, use caution with this connection.
7. When input pulse width is less than 1  $\mu$ s, an output may not react to the pulse. (Both ON signal and OFF signal)

This data shows the example of the application circuit, does not guarantee a design as the mass production set.

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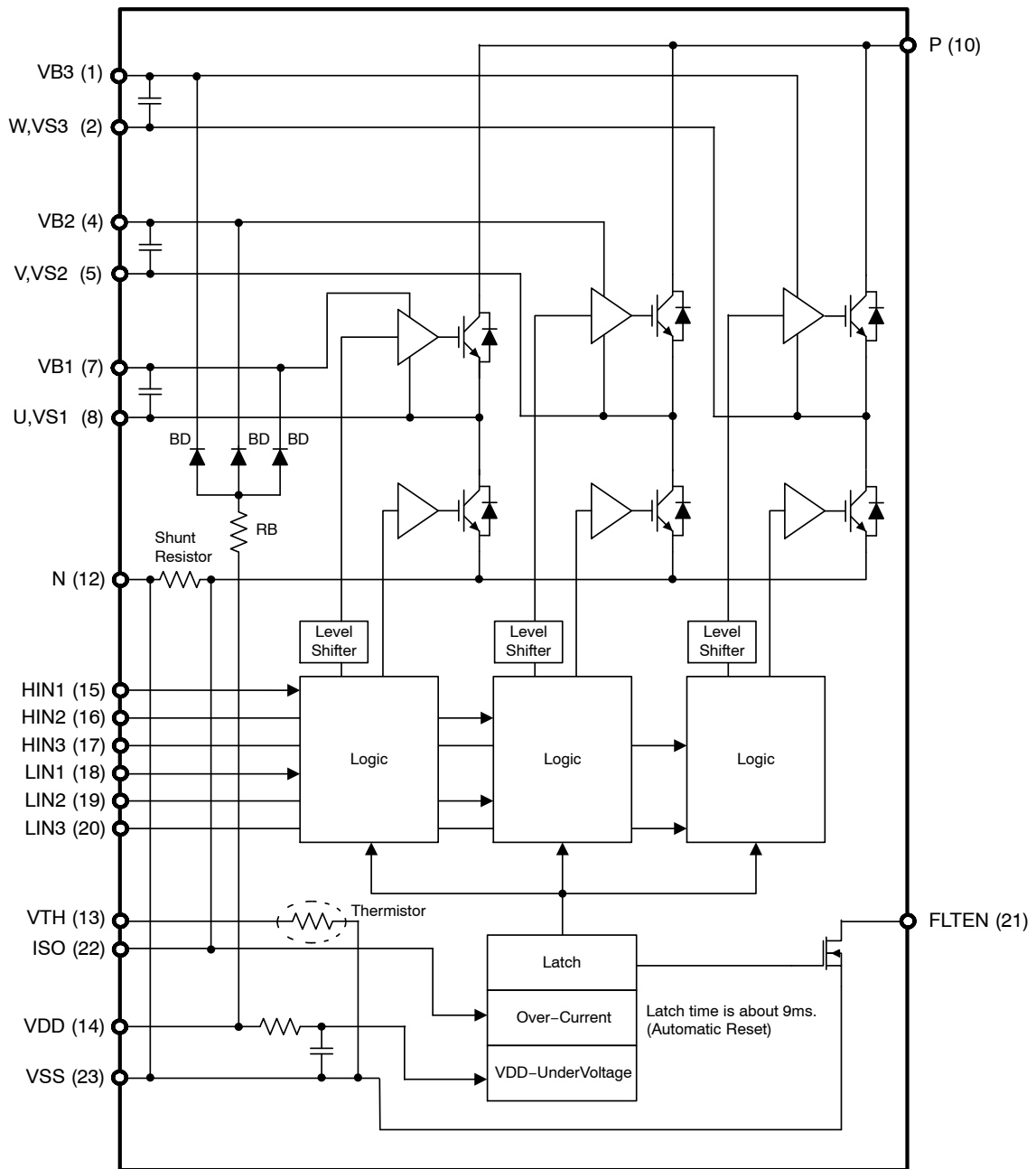


Figure 3. Simplified Block Diagram

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**Table 1. PIN FUNCTION DESCRIPTION**

| Pin # | Label  | Description                                         |
|-------|--------|-----------------------------------------------------|
| 1     | VB3    | High Side Floating Supply Voltage 3                 |
| 2     | W, VS3 | Output 3 – High Side Floating Supply Offset Voltage |
| 4     | VB2    | High Side Floating Supply Voltage 2                 |
| 5     | V, VS2 | Output 2 – High Side Floating Supply Offset Voltage |
| 7     | VB1    | High Side Floating Supply Voltage 1                 |
| 8     | U, VS1 | Output 1 – High Side Floating Supply Offset Voltage |
| 10    | P      | Positive Bus Input Voltage                          |
| 12    | N      | Negative Bus Input Voltage                          |
| 13    | VTH    | Temperature Feedback                                |
| 14    | VDD    | +15 V Main Supply                                   |
| 15    | HIN1   | Logic Input High Side Gate Driver – Phase U         |
| 16    | HIN2   | Logic Input High Side Gate Driver – Phase V         |
| 17    | HIN3   | Logic Input High Side Gate Driver – Phase W         |
| 18    | LIN1   | Logic Input Low Side Gate Driver – Phase U          |
| 19    | LIN2   | Logic Input Low Side Gate Driver – Phase V          |
| 20    | LIN3   | Logic Input Low Side Gate Driver – Phase W          |
| 21    | FLTEN  | Fault output and Enable                             |
| 22    | ISO    | Current monitor output                              |
| 23    | VSS    | Negative Main Supply                                |

1. Pins 3, 6, 9, 11 are not present.

**Table 2. ABSOLUTE MAXIMUM RATINGS** at  $T_C = 25^\circ\text{C}$ , (Note 2)

| Symbol                     | Parameter | Min                                                      | Max         | Unit |
|----------------------------|-----------|----------------------------------------------------------|-------------|------|
| Supply voltage             | VCC       | P to N, surge < 500 V (Notes 3)                          | 450         | V    |
| Collector–emitter voltage  | VCE       | P to U, V, W or U, V, W, to N                            | 600         | V    |
| Output current             | Io        | P,N,U,V,W terminal current                               | ±10         | A    |
|                            |           | P,N,U,V,W terminal current,<br>$T_c = 100^\circ\text{C}$ | ±5          | A    |
| Output peak current        | Iop       | P,N,U,V,W terminal current, P.W. = 1ms                   | ±20         | A    |
| Pre–driver voltage         | VD1,2,3,4 | VB1 to U, VB2 to V, VB3 to W, VDD to VSS (Notes 4)       | 20          | V    |
| Input signal voltage       | VIN       | HIN1, 2, 3, LIN1, 2, 3                                   | –0.3 to 7   | V    |
| FLTEN terminal voltage     | VFLTEN    | FLTEN terminal                                           | –0.3 to VDD | V    |
| Maximum power dissipation  | Pd        | IGBT per 1 channel                                       | 22          | W    |
| Junction temperature       | Tj        | IGBT, FRD, Pre–Driver IC                                 | 150         | °C   |
| Storage temperature        | Tstg      |                                                          | –40 to +125 | °C   |
| Operating case temperature | Tc        | IPM case                                                 | –40 to +100 | °C   |
| Tightening torque          |           | A screw part (Notes 5)                                   | 0.9         | Nm   |
| Withstand voltage          | Vis       | 50 Hz sine wave AC 1 minute (Notes 6)                    | 2000        | VRMS |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

2. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.

3. Surge voltage developed by the switching operation due to the wiring inductance between P and N terminal.

4. VD1=VB1 to U, VD2=VB2 to V, VD3=VB3 to W, VD4=VDD to VSS terminal voltage.

5. Flatness of the heat–sink should be less than –50  $\mu\text{m}$  to +100  $\mu\text{m}$ .

6. Test conditions : AC2500V, 1 second

7. Reference voltage is “VSS” terminal voltage unless otherwise specified.

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**Table 3. RECOMMENDED OPERATING RANGES** (at  $T_C = 25^\circ\text{C}$ )

| Characteristic              | Symbol    | Conditions                     | Min  | Typ | Max  | Unit          |
|-----------------------------|-----------|--------------------------------|------|-----|------|---------------|
| Supply voltage              | $V_{CC}$  | P to N                         | 0    | 280 | 450  | V             |
| Pre-driver supply voltage   | VD1, 2, 3 | VB1 to U, VB2 to V, VB3 to W   | 12.5 | 15  | 17.5 | V             |
|                             | VD4       | $V_{DD}$ to $V_{SS}$ (Note 8)  | 13.5 | 15  | 16.5 | V             |
| ON-state input voltage      | VIN(ON)   | HIN1,HIN2,HIN3,                | 0    | –   | 0.3  | V             |
| OFF-state input voltage     | VIN(OFF)  | LIN1,LIN2,LIN3                 | 3.0  | –   | 5.0  |               |
| PWM frequency               | fPWM      |                                | 1.0  |     | 20   | kHz           |
| Dead time                   | DT        | Turn-off to turn-on (external) | 2.0  | –   | –    | $\mu\text{s}$ |
| Allowable input pulse width | PWIN      | ON and OFF                     | 1.0  | –   | –    | $\mu\text{s}$ |
| Package mounting torque     |           | 'M3' type screw                | 0.6  |     | 0.9  | Nm            |

8. Pre-drive power supply (VD4 =  $15 \pm 1.5$  V) must have the capacity of  $I_o = 20$  mA (DC), 0.5 A (Peak).

**Table 4. ELECTRICAL CHARACTERISTICS**  $T_C = 25^\circ\text{C}$ , VD1, VD2, VD3, VD4 = 15 V (Note 9)

| Parameter                               | Symbol                                 | Test Condition      | Min | Typ | Max | Unit               |
|-----------------------------------------|----------------------------------------|---------------------|-----|-----|-----|--------------------|
| <b>Power output section</b>             |                                        |                     |     |     |     |                    |
| Collector-emitter leakage current       | $V_{CE} = 600$ V                       | $I_{CE}$            | –   | –   | 100 | $\mu\text{A}$      |
| Bootstrap diode reverse current         | $V_{R(BD)} = 600$ V                    | $I_{R(BD)}$         | –   | –   | 100 | $\mu\text{A}$      |
| Collector to emitter saturation voltage | $I_c = 10$ A, $T_j = 25^\circ\text{C}$ | Upper side          | –   | 1.4 | 2.3 | V                  |
|                                         |                                        | Lower side (Note 9) | –   | 1.7 | 2.6 | V                  |
|                                         | $I_c = 5$ A, $T_j = 100^\circ\text{C}$ | Upper side          | –   | 1.3 | –   | V                  |
|                                         |                                        | Lower side (Note 9) | –   | 1.6 | –   | V                  |
| Diode forward voltage                   | $I_F = 10$ A, $T_j = 25^\circ\text{C}$ | Upper side          | –   | 1.3 | 2.2 | V                  |
|                                         |                                        | Lower side (Note 9) | –   | 1.6 | 2.5 | V                  |
|                                         | $I_F = 5$ A, $T_j = 100^\circ\text{C}$ | Upper side          | –   | 1.2 | –   | V                  |
|                                         |                                        | Lower side (Note 9) | –   | 1.5 | –   | V                  |
| Junction to case thermal resistance     | IGBT                                   | $\theta_{j-c}(T)$   | –   | –   | 5.5 | $^\circ\text{C/W}$ |
|                                         | FRD                                    | $\theta_{j-c}(D)$   | –   | –   | 6.5 |                    |

## Switching Character

|                                   |                                                                                         |       |             |     |     |               |
|-----------------------------------|-----------------------------------------------------------------------------------------|-------|-------------|-----|-----|---------------|
| Switching time                    | $I_o = 10$ A<br>Inductive load                                                          | t ON  | 0.2         | 0.4 | 1.1 | $\mu\text{s}$ |
|                                   |                                                                                         | t OFF | –           | 0.5 | 1.2 | $\mu\text{s}$ |
| Turn-on switching loss            | $I_c = 5$ A, $P = 300$ V,<br>$V_{DD} = 15$ V, $L = 3.9$ mH<br>$T_c = 25^\circ\text{C}$  | Eon   | –           | 200 | –   | $\mu\text{J}$ |
| Turn-off switching loss           |                                                                                         | Eoff  | –           | 130 | –   | $\mu\text{J}$ |
| Total switching loss              |                                                                                         | Etot  | –           | 330 | –   | $\mu\text{J}$ |
| Turn-on switching loss            | $I_c = 5$ A, $P = 300$ V,<br>$V_{DD} = 15$ V, $L = 3.9$ mH<br>$T_c = 100^\circ\text{C}$ | Eon   | –           | 240 | –   | $\mu\text{J}$ |
| Turn-off switching loss           |                                                                                         | Eoff  | –           | 160 | –   | $\mu\text{J}$ |
| Total switching loss              |                                                                                         | Etot  | –           | 400 | –   | $\mu\text{J}$ |
| Diode reverse recovery energy     | $I_F = 5$ A, $P = 400$ V, $V_{DD} = 15$ V,<br>$L = 0.5$ mH, $T_c = 100^\circ\text{C}$   | Erec  | –           | 17  | –   | $\mu\text{J}$ |
| Diode reverse recovery time       |                                                                                         | Trr   | –           | 62  | –   | ns            |
| Reverse bias safe operating area  | $I_o = 20^\circ$ , $V_{CE} = 450$ V                                                     | RBSOA | Full Square |     |     |               |
| Short circuit safe operating area | $V_{CE} = 400$ V, $T_c = 100^\circ\text{C}$                                             | SCSOA | 4.0         | –   | –   | $\mu\text{s}$ |

## Control (Pre-driver) section

|                              |                |    |   |      |     |    |
|------------------------------|----------------|----|---|------|-----|----|
| Pre-driver power dissipation | VD1,2,3 = 15 V | ID | – | 0.08 | 0.4 | mA |
|                              | VD4 = 15 V     |    | – | 1.6  | 4.0 |    |

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**Table 4. ELECTRICAL CHARACTERISTICS**  $T_C = 25^\circ\text{C}$ , VD1, VD2, VD3, VD4 = 15 V (Note 9)

|                                                            |                                          |                            |      |      |      |               |
|------------------------------------------------------------|------------------------------------------|----------------------------|------|------|------|---------------|
| High level Input voltage                                   | HIN1,HIN2,HIN3,<br>LIN1,LIN2,LIN3 to VSS | Vin H                      | 2.5  | –    |      | V             |
| Low level Input voltage                                    |                                          | Vin L                      | –    | –    | 0.8  | V             |
| Input threshold voltage hysteresis                         |                                          | Vinth(hys)                 | 0.5  | 0.8  | –    | V             |
| Logic 1 input leakage current                              | VIN = +3.3V                              | $I_{IN+}$                  | 76   | 118  | 160  | $\mu\text{A}$ |
| Logic 0 input leakage current                              | VIN = 0 V                                | $I_{IN-}$                  | 97   | 150  | 203  | $\mu\text{A}$ |
| FLTEN terminal sink current                                | FAULT:ON / VFLTEN = 0.1 V                | $I_{oSD}$                  | –    | 2.0  | –    | mA            |
| FLTEN clearance delay time                                 | From time fault condition clear          | FLTCLR                     | 6.0  | 9.0  | 12.0 | ms            |
| FLTEN Threshold                                            | VEN rising                               | VEN+                       | 2.5  |      | –    | V             |
|                                                            | VEN falling                              | VEN–                       | –    | –    | 0.8  | V             |
| $V_{CC}$ and $V_{BS}$ supply undervoltage protection reset |                                          | $V_{CCUV+}$<br>$V_{BSUV+}$ | 10.5 | 11.1 | 11.7 | V             |
| $V_{CC}$ and $V_{BS}$ supply undervoltage protection set   |                                          | $V_{CCUV-}$<br>$V_{BSUV-}$ | 10.3 | 10.9 | 11.5 | V             |
| $V_{CC}$ and $V_{BS}$ supply undervoltage hysteresis       |                                          | $V_{CCUVH}$<br>$V_{BSUVH}$ | 0.14 | 0.2  |      | V             |
| Output level for current monitor                           | $I_o = 10\text{ A}$                      | ISO                        | 0.30 | 0.33 | 0.36 | V             |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

9. Reference voltage is “VSS” terminal voltage unless otherwise specified.

APPLICATIONS INFORMATION

Input / Output Timing Chart

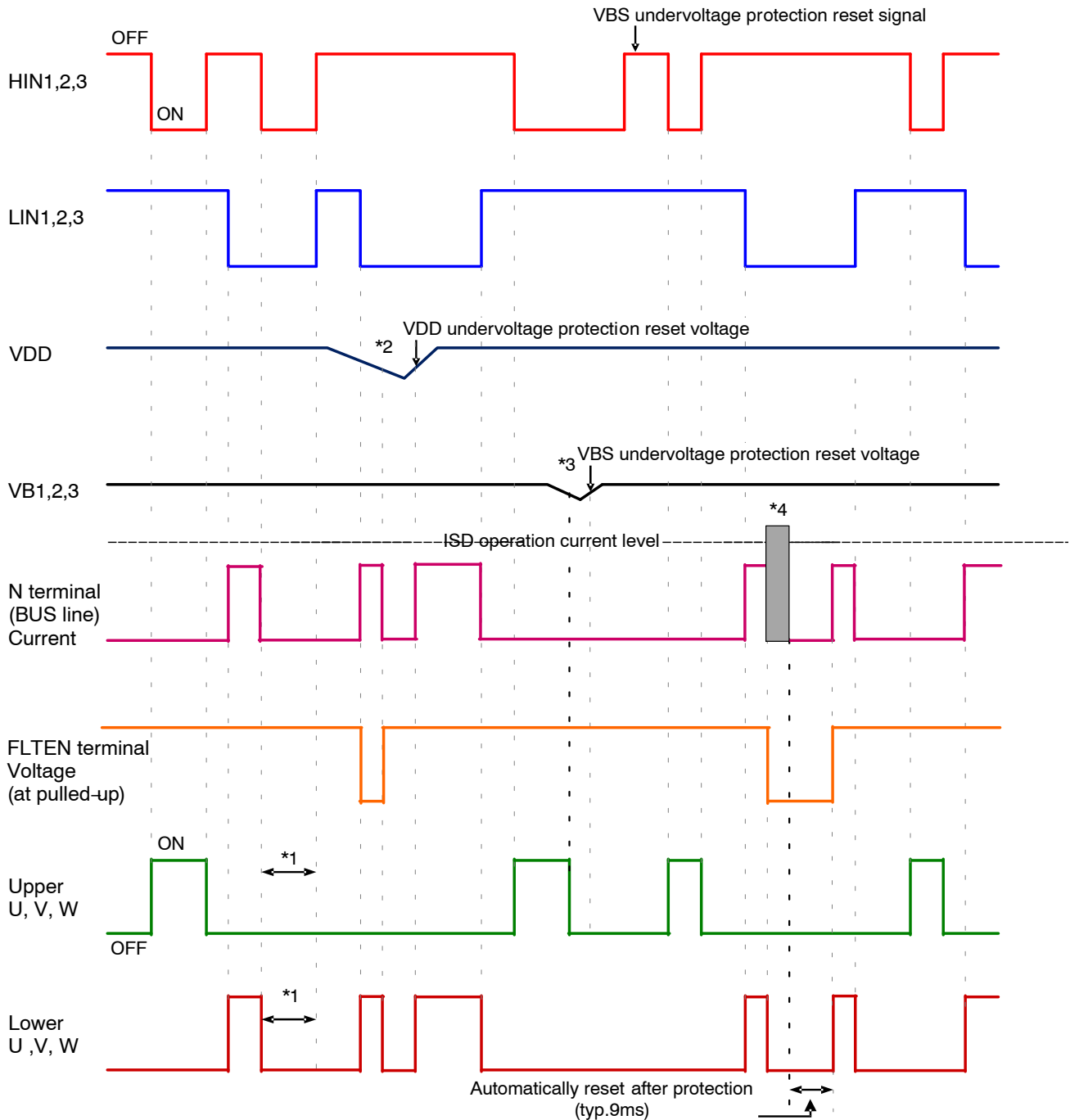


Figure 4. Input/Output Timing Chart

NOTES:

1. Shows the prevention of shoot-thru via control logic, however, more dead time must be added to account for switching delay externally.
2. When VDD decreases all gate output signals will go low and cut off all 6 IGBT outputs. When VDD rises the operation will resume immediately.
3. When the upper side voltage at VB1, VB2 and VB3 drops only the corresponding upper side output is turned off. The outputs return to normal operation immediately after the upper side gate voltage rises.
4. In case of over current detection, all IGBT's are turned off and the FAULT output is asserted. Normal operation resumes in typ. 9ms after the over current condition is removed.

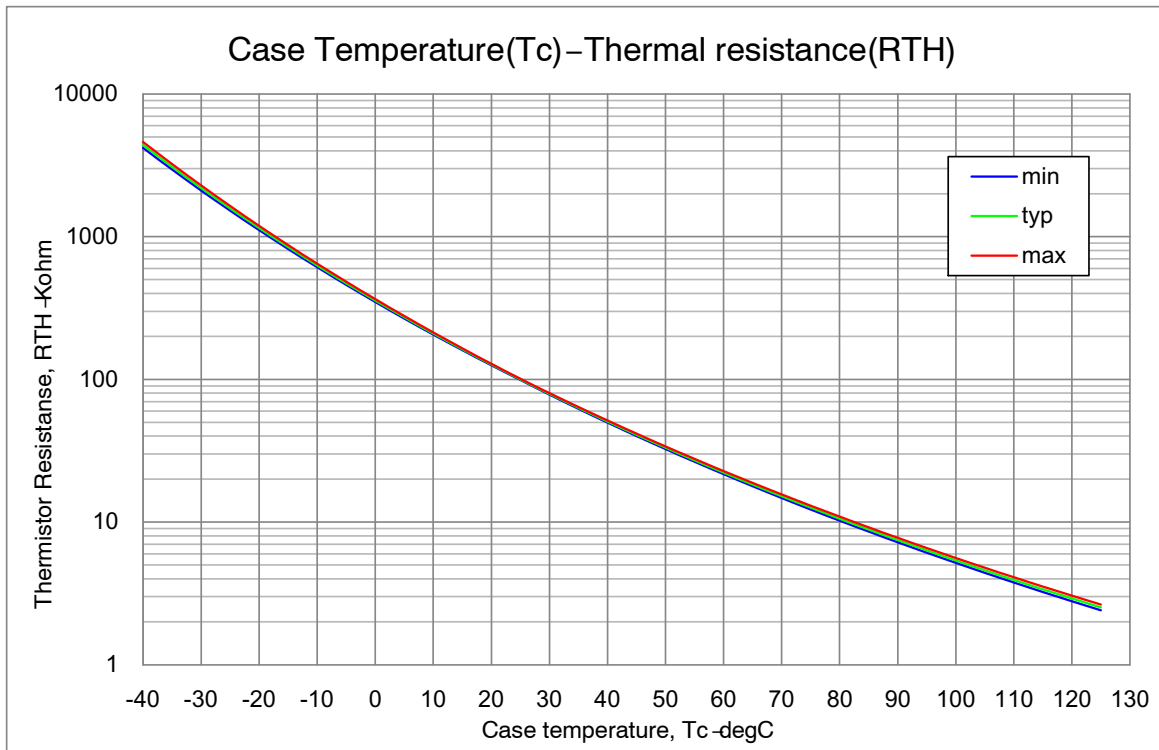
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**Table 5. LOGIC LEVEL TABLE**

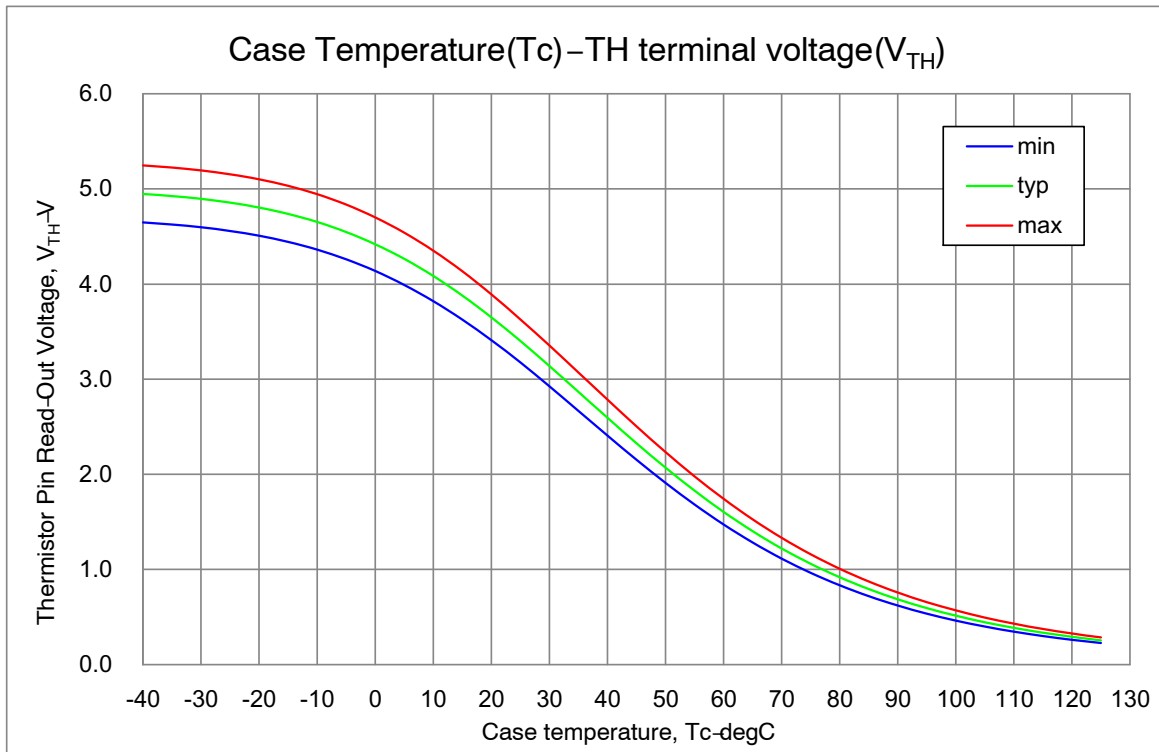
| INPUT |     |     | OUTPUT         |               |                |       |
|-------|-----|-----|----------------|---------------|----------------|-------|
| HIN   | LIN | OCP | High side IGBT | Low side IGBT | U,V,W          | FLTEN |
| H     | L   | OFF | OFF            | ON            | P              | OFF   |
| L     | H   | OFF | ON             | OFF           | N              | OFF   |
| L     | L   | OFF | OFF            | OFF           | High Impedance | OFF   |
| H     | H   | OFF | OFF            | OFF           | High Impedance | OFF   |
| X     | X   | ON  | OFF            | OFF           | High Impedance | ON    |

**Table 6. THERMISTOR CHARACTERISTICS**

| Parameter               | Symbol           | Condition              | Min  | Typ  | Max  | Unit |
|-------------------------|------------------|------------------------|------|------|------|------|
| Resistance              | R <sub>25</sub>  | T <sub>c</sub> = 25°C  | 99   | 100  | 101  | kΩ   |
|                         | R <sub>100</sub> | T <sub>c</sub> = 100°C | 5.12 | 5.38 | 5.66 | kΩ   |
| B-Constant (25 to 50°C) | B                |                        | 4160 | 4250 | 4335 | K    |
| Temperature Range       |                  |                        | -40  | -    | +125 | °C   |



**Figure 5. Thermistor Resistance versus Case Temperature**



**Figure 6. Thermistor Voltage versus Case Temperature Condition: Pull-up resistor = 4.7 kphm, Pull-up voltage of TH = 5 V**

#### Fault Output

The FLTEN terminal is an open drain output requiring a pull-up resistor. If the pull-up voltage is 5 V, use a pull-up resistor with a value of 6.8 kΩ or higher. If the pull-up voltage is 15 V, use a pull-up resistor with a value of 20 kΩ or higher. The FAULT output is triggered if there is a VDD under voltage or an overcurrent condition.

The terminal has a function of enable output, this pin is used to enable or shut down the built-in driver. If the voltage on the FLTEN pin rises above the ENABLE ON-state voltage, the output drivers are enabled. If the voltage on the FLTEN pin falls below the ENABLE OFF-state voltage, the drivers are disabled.

#### Under Voltage Lockout Protection.

If VDD goes below the VDD supply under voltage lockout falling threshold, the FAULT output is switched on. The FAULT output stays on until VDD rises above the VDD supply under voltage lockout rising threshold. After VDD has risen above the threshold to enable normal operation, the driver waits to receive an input signal on the LIN input before enabling the driver for the HIN signal.

#### Overcurrent Protection

Over current protection is implemented by measuring the voltage across a shunt resistor to negative supply terminal. In case of an OCP fault the gate drivers are shut down internally and the external Fault signal becomes active (low).

Once activated by a fault condition the FAULT signal output returns to inactive (and is pulled high by the external resistor) when the fault condition is over and the fault clear time (FLTCLR) has passed. This implies that the system microcontroller needs to disable all input signals to the module by driving them low upon detection of a fault condition. An additional fuse is recommended to protect against system level or abnormal over-current fault conditions.

#### Capacitors on High Voltage and V<sub>DD</sub> supplies

Both the high voltage and V<sub>DD</sub> supplies require an electrolytic capacitor and an additional high frequency capacitor.

#### Minimum input pulse width

When input pulse width is less than 1.0 μs, an output may not react to the pulse. (Both ON signal and OFF signal)

#### Calculation of bootstrap capacitor value

The bootstrap capacitor value CB is calculated using the following approach. The following parameters influence the choice of bootstrap capacitor:

- VBS : Bootstrap power supply.  
15 V is recommended.
- QG : Total gate charge of IGBT at VBS = 15 V.  
89nC

- UVLO : Falling threshold for UVLO.  
Specified as 12 V.
- ID<sub>MAX</sub> : High side drive consumption current.  
Specified as 400 µA
- t<sub>ONMAX</sub> : Maximum ON pulse width of high side IGBT.

#### Capacitance calculation formula

$$CB = (QG + ID_{MAX} * t_{ONMAX}) / (VBS - UVLO)$$

CB is recommended to be approximately 3 times the value calculated above. The recommended value of CB is in the range of 1 to 47 µF, however, the value needs to be verified prior to production. When not using the bootstrap circuit, each high side driver power supply requires an external independent power supply.

The internal bootstrap circuit uses a MOSFET. The turn on time of this MOSFET is synchronized with the turn on of the low side IGBT. The bootstrap capacitor is charged by turning on the low side IGBT.

If the low side IGBT is held on for a long period of time (more than one second for example), the bootstrap voltage on the high side MOSFET will slowly discharge.

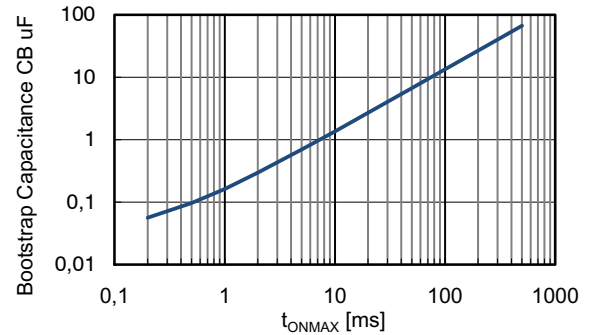


Figure 7. Bootstrap capacitance versus t<sub>ONMAX</sub>

Table 7. MOUNTING INSTRUCTIONS

| Item      | Recommended Condition                                                                                                                                                                      |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pitch     | 56.0 ± 0.1 mm (Please refer to Package Outline Diagram)                                                                                                                                    |
| Screw     | Diameter : M3<br>Screw head types: pan head, truss head, binding head                                                                                                                      |
| Washer    | Plane washer<br>The size is D : 7 mm, d : 3.2 mm and t : 0.5 mm JIS B 1256                                                                                                                 |
| Heat sink | Material: Aluminum or Copper<br>Warpage (the surface that contacts IPM) : -50 to +100 µm<br>Screw holes must be countersunk<br>No contamination on the heat sink surface that contacts IPM |
| Torque    | Final tightening : 0.6 to 0.9 Nm<br>Temporary tightening : 20 to 30 % of final tightening                                                                                                  |
| Grease    | Silicone grease<br>Thickness : 100 to 200 µm<br>Uniformly apply silicone grease to whole back                                                                                              |

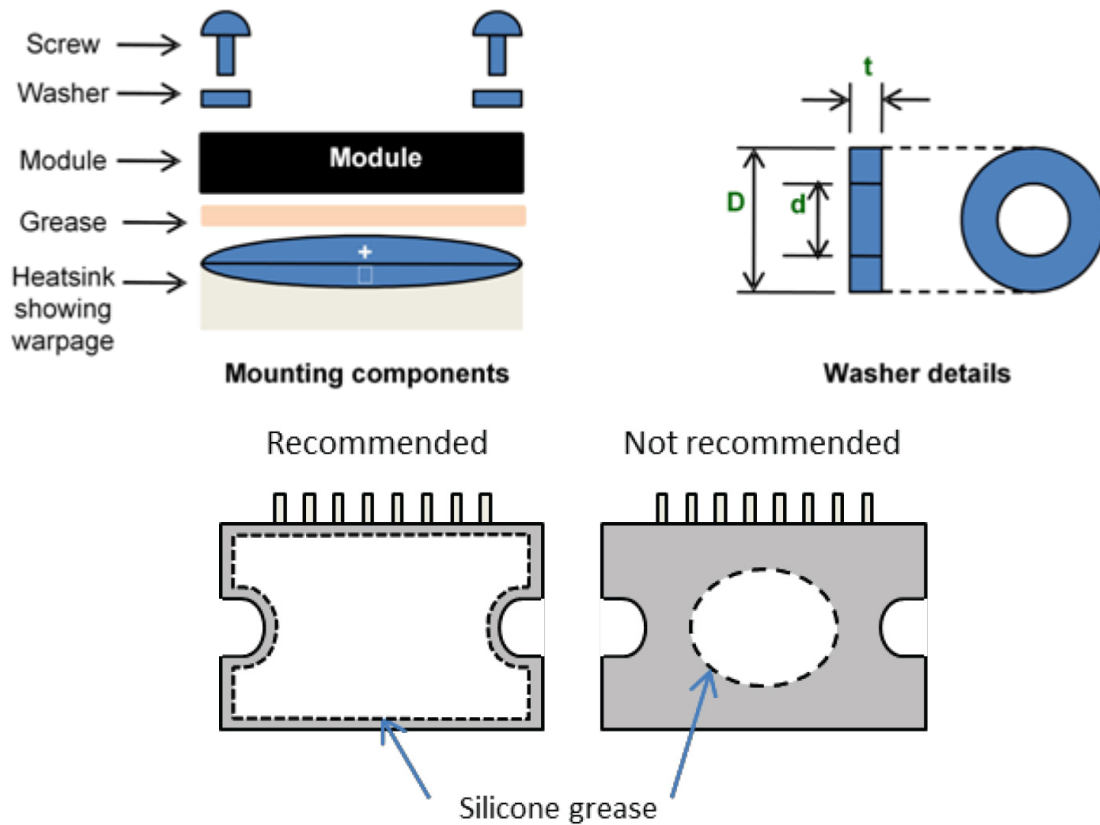


Figure 8. Module Mounting Details: Components; Washer Drawing; Need for Even Spreading of Thermal Grease

- $V_{CE(sat)}$  (Test by pulse)

- $I_{CE}$

|   | U+ | V+ | W+ | U- | V- | W- |
|---|----|----|----|----|----|----|
| M | 10 | 10 | 10 | 8  | 5  | 2  |
| N | 8  | 5  | 2  | 12 | 12 | 12 |

|   | U(DB) | V(DB) | W(DB) |
|---|-------|-------|-------|
| M | 7     | 4     | 1     |
| N | 23    | 23    | 23    |

U+, V+, W+ : High side phase

U-, V-, W- : Low side phase

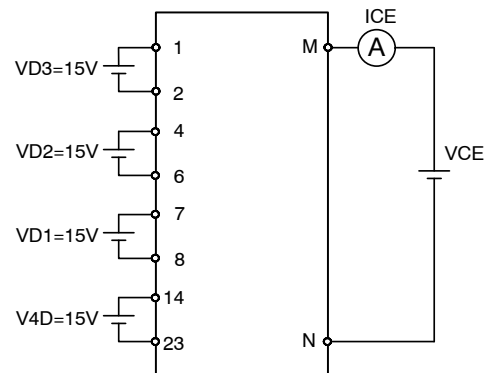


Figure 9. Test Circuit for ICE

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## • $V_{CE(sat)}$ (Test by pulse)

|   | U+ | V+ | W+ | U- | V- | W- |
|---|----|----|----|----|----|----|
| M | 10 | 10 | 10 | 8  | 5  | 2  |
| N | 8  | 5  | 2  | 12 | 12 | 12 |
| m | 15 | 16 | 17 | 18 | 19 |    |

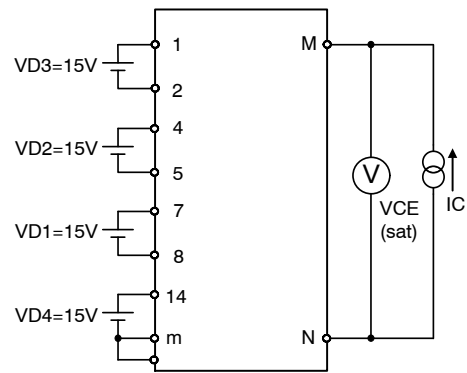


Figure 10. Test Circuit for  $V_{CE(sat)}$

## • $V_F$ (Test by pulse)

|   | U+ | V+ | W+ | U- | V- | W- |
|---|----|----|----|----|----|----|
| M | 10 | 10 | 10 | 8  | 5  | 2  |
| N | 8  | 5  | 2  | 12 | 12 | 12 |

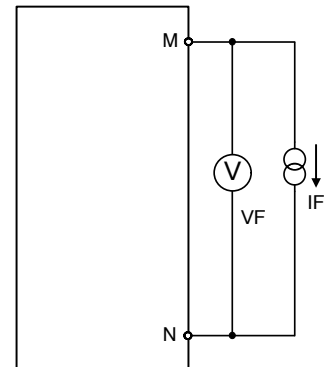


Figure 11. Test Circuit for  $V_{CE(sat)}$

## • $I_D$

|   | VD1 | VD2 | VD3 | VD4 |
|---|-----|-----|-----|-----|
| M | 7   | 4   | 1   | 14  |
| N | 8   | 5   | 2   | 23  |

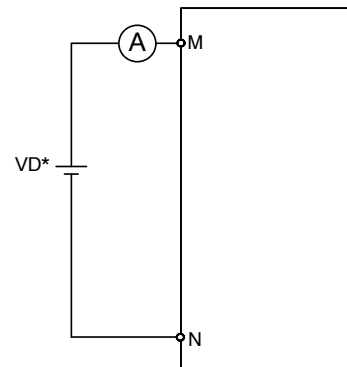


Figure 12. Test Circuit for  $I_D$

## STK541UC62A-E

- Switching time (The circuit is a representative example of the low side U phase)

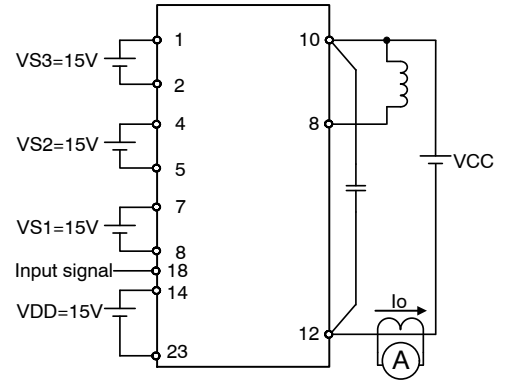
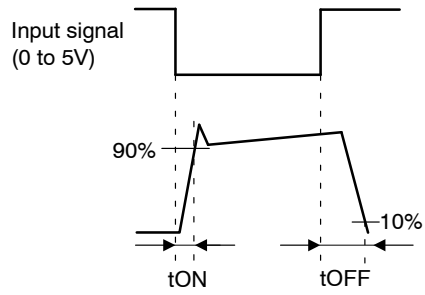


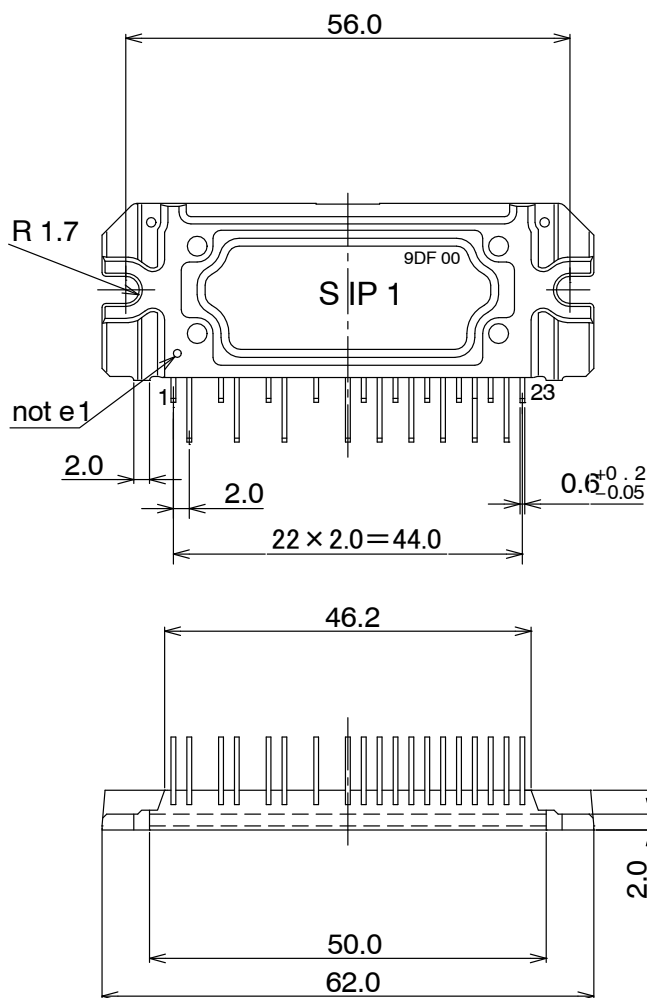
Figure 13. Switching Time Test Circuit

Table 8. ORDERING INFORMATION

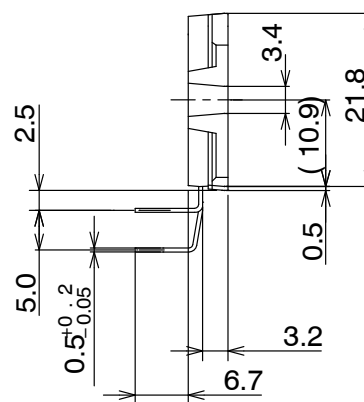
| Device        | Marking     | Package                    | Shipping      |
|---------------|-------------|----------------------------|---------------|
| STK541UC62A-E | STK541UC62A | SIP23 62x21.8<br>(Pb-Free) | 8 Unit / Tube |

**SIP23 56x21.8**  
**CASE 127BV**  
**ISSUE O**

DATE 30 APR 2012



missing pin : 3,6,9,11



|                         |                      |                                                                                                                                                                                     |
|-------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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