

# STK554U392C-E

## Intelligent Power Module (IPM)

600 V, 15 A

The STK554U392C-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 with separate emitter connections for the lower legs for maximum flexibility in the choice of control algorithm.

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 15 A/600 V IGBT Module with Integrated Drivers
- Typical Values:  $V_{CE(sat)} = 1.7 \text{ V}$ ,  $V_F = 1.9 \text{ V}$
- 62.0 mm  $\times$  21.8 mm Single In-line Package with Vertical LF Type
- Cross-conduction Protection
- Integrated Bootstrap Diodes and Resistors
- These Devices are Pb-Free and are RoHS Compliant

### Certification

- UL1557 (File number : E339285)

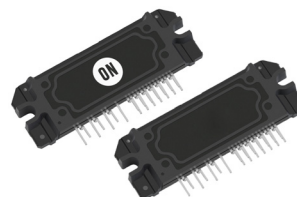
### Typical Applications

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



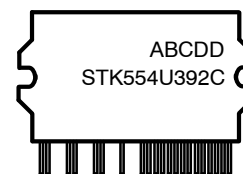
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SIP29 62 x 21.8FP-1  
CASE 127EZ

### MARKING DIAGRAM



STK554U392C = Specific Device Code

A = Year

B = Month

C = Production Site

DD = Factory Lot code

Device marking is on package underside

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 12 of this data sheet.

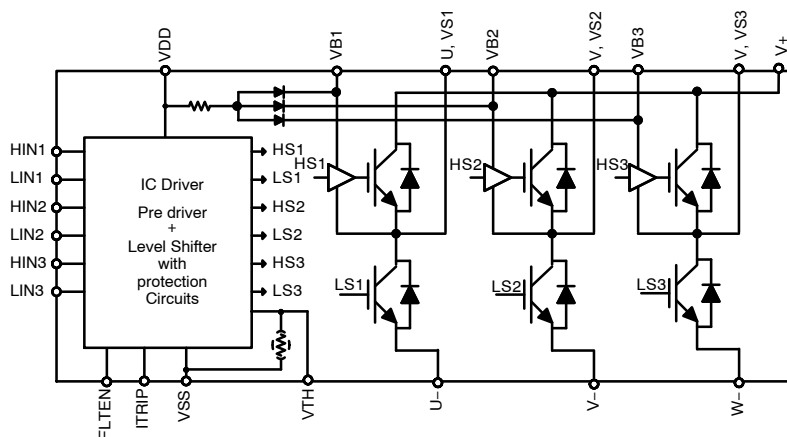


Figure 1. Functional Diagram

## STK554U392C-E

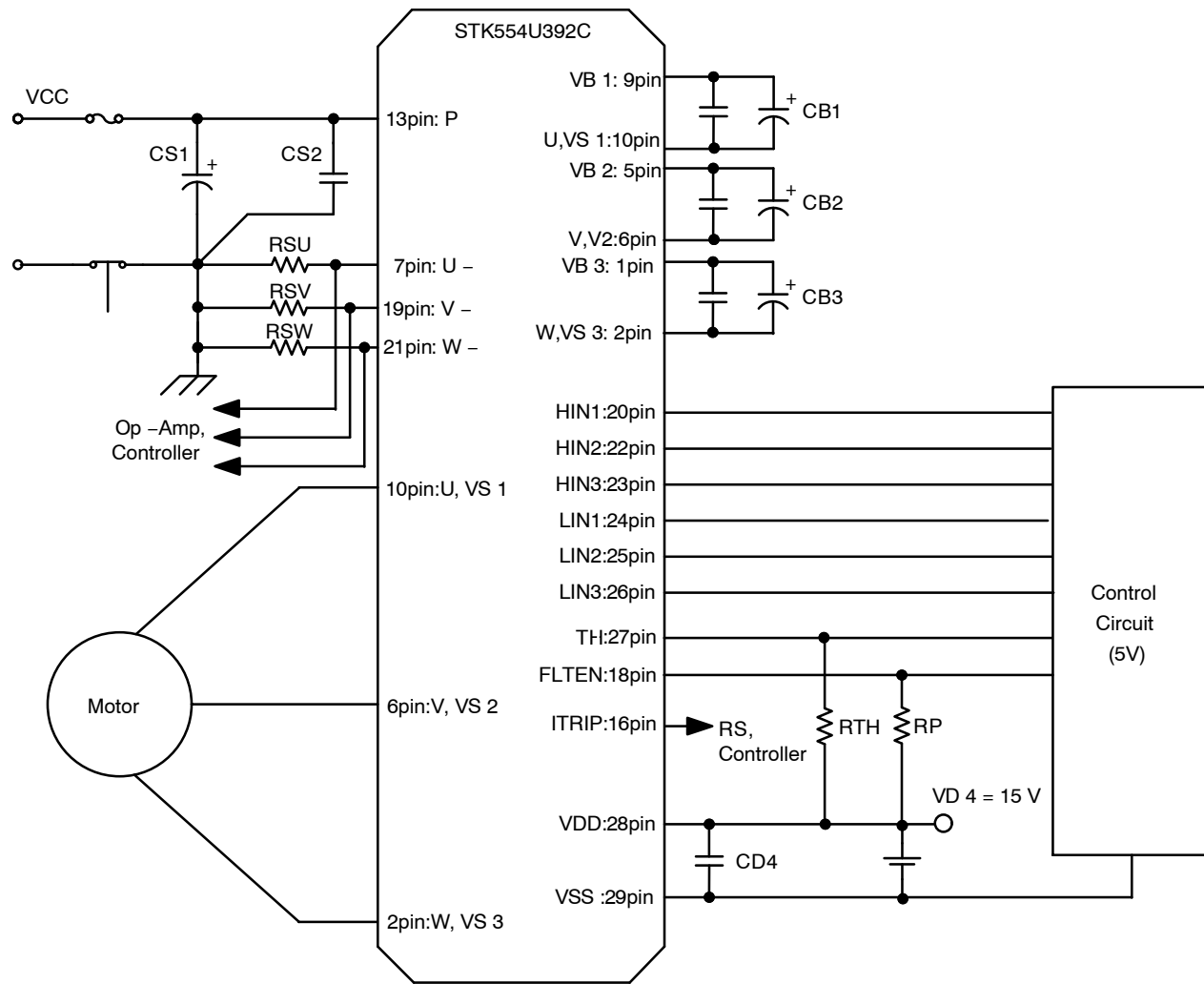


Figure 2. Application Schematic

### Usage Precaution

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  $\mu\text{F}$
2. The "FLTEN" terminal (Pin 18) 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 pull-down resistor (:33 k $\Omega$ (typ)) is connected with the inside of the signal input terminal, but

please connect the pull-down resistor(about 2.2 to 3.3 k $\Omega$ ) outside to decrease the influence of the noise by wiring etc

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  $\mu\text{s}$ , 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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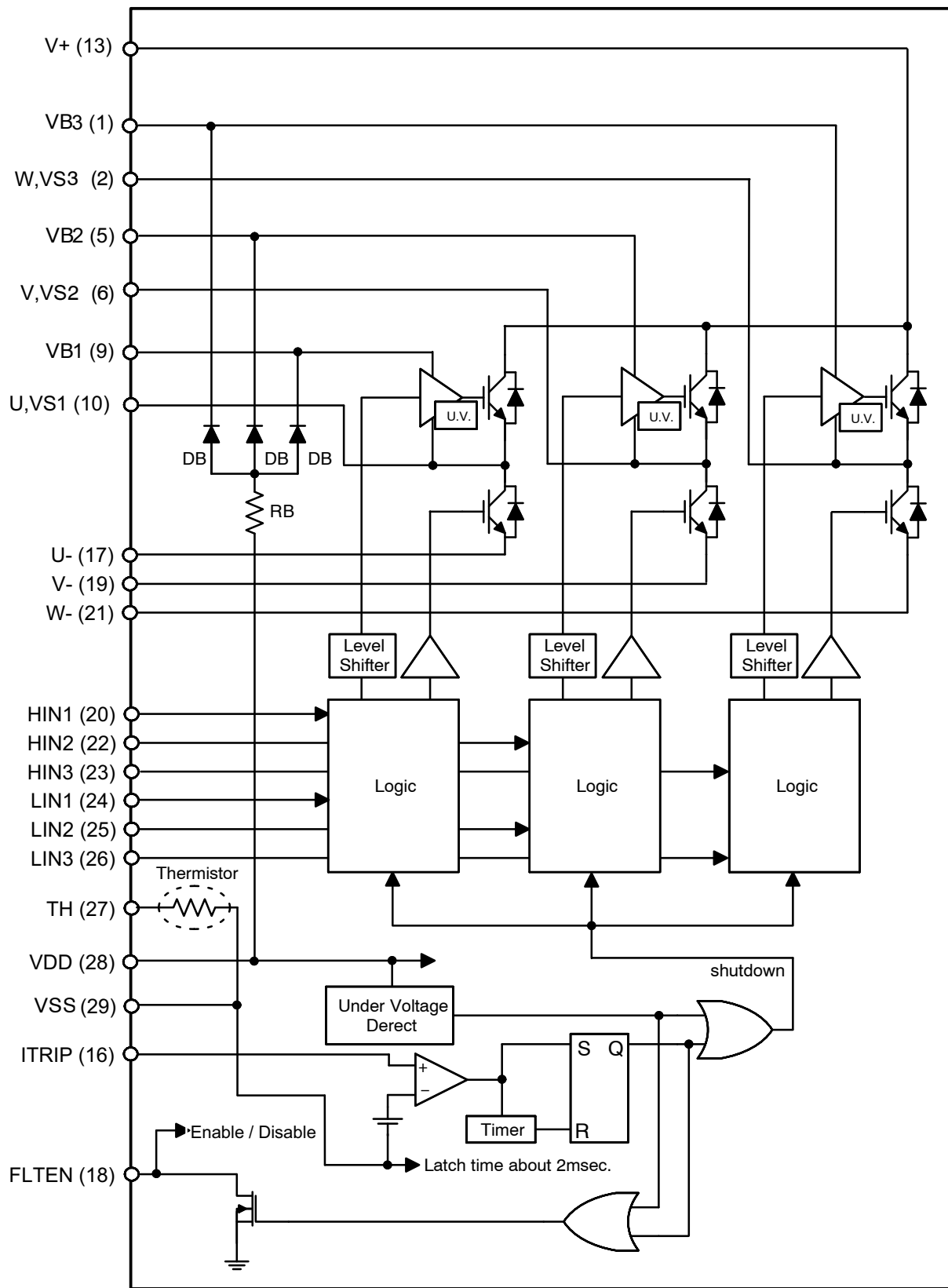


Figure 3. Simplified Block Diagram

Table 1. PIN FUNCTION DESCRIPTION

| Pin | Name   | Description                                         |
|-----|--------|-----------------------------------------------------|
| 1   | VB3    | High Side Floating Supply Voltage 3                 |
| 2   | W, VS3 | Output 3 – High Side Floating Supply Offset Voltage |
| 5   | VB2    | High Side Floating Supply voltage 2                 |
| 6   | V, VS2 | Output 2 – High Side Floating Supply Offset Voltage |
| 9   | VB1    | High Side Floating Supply voltage 1                 |
| 10  | U, VS1 | Output 1 – High Side Floating Supply Offset Voltage |
| 13  | V+     | Positive Bus Input Voltage                          |
| 16  | ITRIP  | Current protection pin                              |
| 17  | U–     | Low Side Emitter Connection – Phase U               |
| 18  | FLTEN  | Enable input / Fault output                         |
| 19  | V–     | Low Side Emitter Connection – Phase V               |
| 20  | HIN1   | Logic Input High Side Gate Driver – Phase U         |
| 21  | W–     | Low Side Emitter Connection – Phase W               |
| 22  | HIN2   | Logic Input High Side Gate Driver – Phase V         |
| 23  | HIN3   | Logic Input High Side Gate Driver – Phase W         |
| 24  | LIN1   | Logic Input Low Side Gate Driver – Phase U          |
| 25  | LIN2   | Logic Input Low Side Gate Driver – Phase V          |
| 26  | LIN3   | Logic Input Low Side Gate Driver – Phase W          |
| 27  | TH     | Thermistor output                                   |
| 28  | VDD    | +15 V Main Supply                                   |
| 29  | VSS    | Negative Main Supply                                |

NOTE: Pins 3, 4, 7, 8, 11, 12, 14, 15 are not present.

Table 2. ABSOLUTE MAXIMUM RATINGS at T<sub>C</sub> = 25°C (Note 1, 2)

| Rating                     | Symbol       | Conditions                                                       | Value       | Unit |
|----------------------------|--------------|------------------------------------------------------------------|-------------|------|
| Supply Voltage             | VCC          | V+ to U–, V–, W–, surge < 500 V (Note 3)                         | 450         | V    |
| Collector–emitter Voltage  | VCE          | V+ to U, V, W or U, V, W, to U–, V–, W–                          | 600         | V    |
| Output Current             | Io           | V+, U–, V–, W–, U, V, W terminal current                         | +15         | A    |
|                            |              | V+, U–, V–, W–, U, V, W terminal current, T <sub>c</sub> = 100°C | ±8          | A    |
| Output Peak Current        | Iop          | V+, U–, V–, W–, U, V, W terminal current, P.W. = 1 ms            | +30         | A    |
| Pre–driver Voltage         | VD1, 2, 3, 4 | VB1 to U, VB2 to V, VB3 to W, VDD to VSS (Note 4)                | 20          | V    |
| Input Signal Voltage       | VIN          | HIN1, 2, 3, LIN1, 2, 3                                           | –0.3 to VDD | V    |
| FLTEN Terminal Voltage     | VFLTEN       | FLTEN terminal                                                   | –0.3 to VDD | V    |
| Maximum Power Dissipation  | Pd           | IGBT per 1 channel                                               | 35          | 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 (Note 5)                                            | 0.9         | Nm   |
| Withstand Voltage          | Vis          | 50 Hz sine wave AC 1 minute (Note 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.

1. 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 + and U–(V–, W–) 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 µm to +100 µm.
6. Test conditions : AC2500V, 1 second

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**Table 3. RECOMMENDED OPERATING RANGES** at  $T_c = 25^\circ\text{C}$  (Note 7)

| Rating                      | Symbol    | Conditions                            | Min  | Typ | Max  | Unit          |
|-----------------------------|-----------|---------------------------------------|------|-----|------|---------------|
| Supply Voltage              | $V_{CC}$  | $V_+$ to $U-(V-,W-)$                  | 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 7)         | 13.5 | 15  | 16.5 | V             |
| ON-state Input Voltage      | VIN(ON)   | HIN1, HIN2, HIN3,<br>LIN1, LIN2, LIN3 | 3.0  | –   | 5.0  | V             |
| OFF-state Input Voltage     | VIN(OFF)  |                                       | 0    | –   | 0.3  |               |
| PWM Frequency               | fPWM      |                                       | 1.0  | –   | 20   | kHz           |
| Dead Time                   | DT        | Turn-off to turn-on (external)        | 0.5  | –   | –    | $\mu\text{s}$ |
| Allowable Input Pulse Width | PWIN      | ON and OFF                            | 1.0  | –   | –    | $\mu\text{s}$ |
| Package Mounting Torque     |           | 'M3' type screw                       | 0.6  | –   | 0.9  | Nm            |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

7. 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** at  $T_c = 25^\circ\text{C}$ , VD1, VD2, VD3, VD4 = 15 V

| Parameter                               | Test Conditions                         | Symbol            | 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         | $VR(BD) = 600$ V                        | $IR(BD)$          | –   | –   | 100 | $\mu\text{A}$      |
| Collector to Emitter Saturation Voltage | $I_c = 15$ A, $T_j = 25^\circ\text{C}$  | $V_{CE(sat)}$     | –   | 1.7 | 2.4 | V                  |
|                                         | $I_c = 8$ A, $T_j = 100^\circ\text{C}$  |                   | –   | 1.4 | –   | V                  |
| Diode Forward Voltage                   | $I_F = -15$ A, $T_j = 25^\circ\text{C}$ | $V_F$             | –   | 1.9 | 2.6 | V                  |
|                                         | $I_F = -8$ A, $T_j = 100^\circ\text{C}$ |                   | –   | 1.4 | –   | V                  |
| Junction to Case Thermal Resistance     | IGBT                                    | $\theta_{j-c}(T)$ | –   | –   | 3.5 | $^\circ\text{C/W}$ |
|                                         | FRD                                     | $\theta_{j-c}(D)$ | –   | –   | 5.0 |                    |

## SWITCHING CHARACTER

|                                    |                                                                                           |       |             |      |    |               |
|------------------------------------|-------------------------------------------------------------------------------------------|-------|-------------|------|----|---------------|
| Switching Time                     | $I_o = 15$ A<br>Inductive load                                                            | t ON  | –           | 0.45 | –  | $\mu\text{s}$ |
|                                    |                                                                                           | t OFF | –           | 0.55 | –  | $\mu\text{s}$ |
| Turn-on Switching Loss             | $I_c = 15$ A, $V^+ = 300$ V,<br>$V_{DD} = 15$ V, $L = 3.9$ mH<br>$T_c = 25^\circ\text{C}$ | Eon   | –           | 410  | –  | $\mu\text{J}$ |
| Turn-off Switching Loss            |                                                                                           | Eoff  | –           | 390  | –  | $\mu\text{J}$ |
| Total Switching Loss               |                                                                                           | Etot  | –           | 800  | –  | $\mu\text{J}$ |
| Turn-on Switching Loss             |                                                                                           | Eon   | –           | 270  | –  | $\mu\text{J}$ |
| Turn-off Switching Loss            | $V_{DD} = 15$ V, $L = 3.9$ mH<br>$T_c = 100^\circ\text{C}$                                | Eoff  | –           | 280  | –  | $\mu\text{J}$ |
| Total Switching Loss               |                                                                                           | Etot  | –           | 550  | –  | $\mu\text{J}$ |
| Diode Reverse Recovery Energy      | $I_F = 8$ A, $V^+ = 400$ V, $V_{DD} = 15$ V,<br>$L = 3.9$ mH, $T_c = 100^\circ\text{C}$   | Erec  | –           | 12   | –  | $\mu\text{J}$ |
| Diode Reverse Recovery Time        |                                                                                           | Trr   | –           | 54   | –  | 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         | –    | –  | $\mu\text{s}$ |
| Allowable Offset Voltage Slew Rate | Between $U(V,W)$ to $U-(V-,W-)$                                                           | dv/dt | –50         | –    | 50 | V/ns          |

## 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 |               |
| High level Input Voltage      | HIN1, HIN2, HIN3,       | Vin H     | 2.5 | –    | –   | V             |
| Low level Input Voltage       | LIN1, LIN2, LIN3 to VSS | Vin L     | –   | –    | 0.8 | V             |
| Logic 1 input Leakage Current | VIN = +3.3 V            | $I_{IN+}$ | –   | 100  | 143 | $\mu\text{A}$ |

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**Table 4. ELECTRICAL CHARACTERISTICS** at Tc = 25°C, VD1, VD2, VD3, VD4 = 15 V (continued)

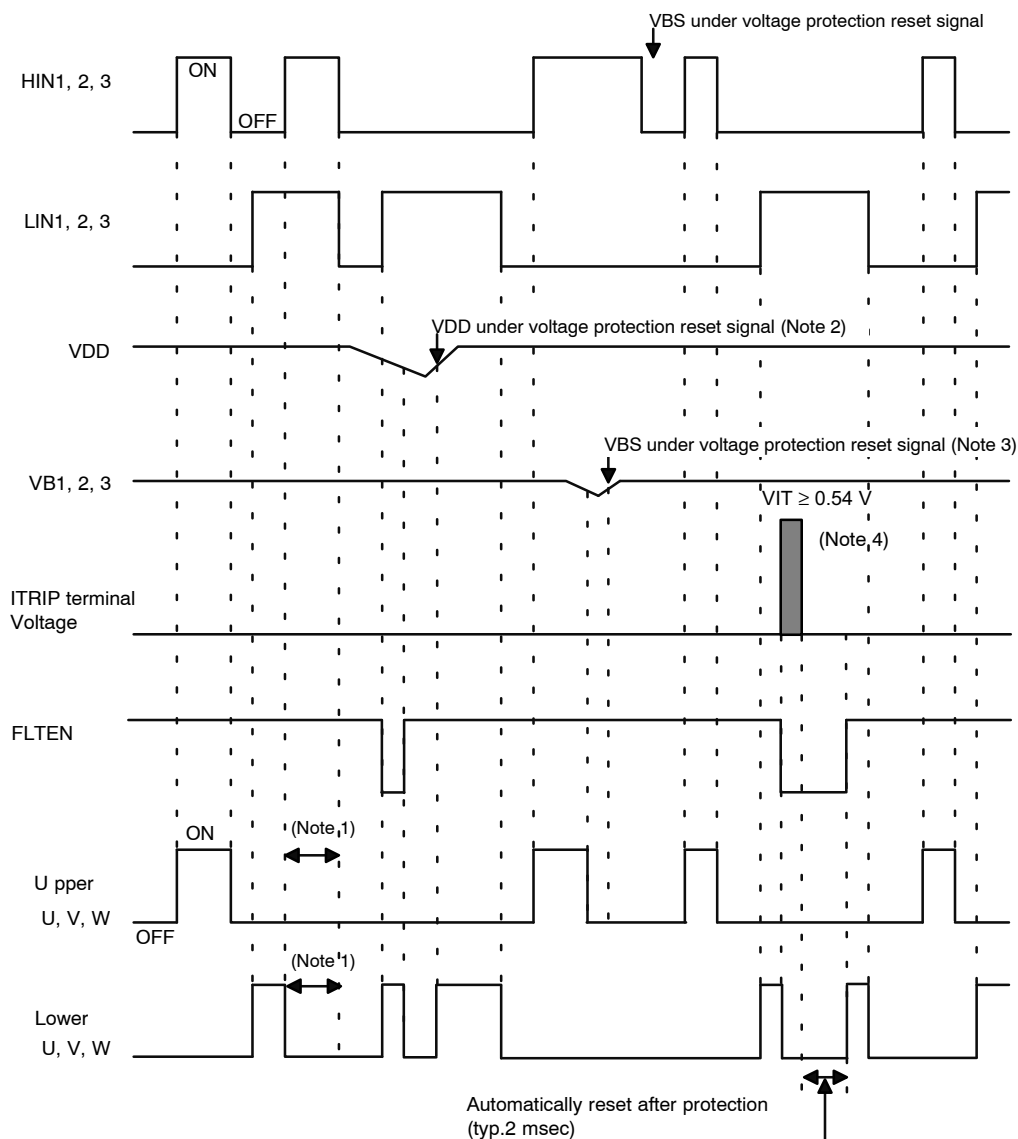
| Parameter                                        | Test Conditions                       | Symbol           | Min  | Typ  | Max  | Unit |
|--------------------------------------------------|---------------------------------------|------------------|------|------|------|------|
| Logic 0 input Leakage Current                    | VIN = 0 V                             | IIIN-            | –    | –    | 2.0  | μA   |
| FLTEN Terminal Sink Current                      | FAULT: ON / VFLTEN = 0.1 V            | IoSD             | –    | 2.0  | –    | mA   |
| FLTEN Clearance Delay Time                       | From time fault condition clear       | FLTCLR           | 1.55 | 1.9  | 2.25 | ms   |
| FLTEN Threshold                                  | VEN rising                            | VEN+             | –    | –    | 2.5  | V    |
|                                                  | VEN falling                           | VEN–             | 0.8  | –    | –    | V    |
| ITRIP Threshold Voltage                          | ITRIP(16) to VSS(29)                  | VITRIP           | 0.44 | 0.49 | 0.54 | V    |
| ITRIP to Shutdown Propagation Delay              |                                       | tITRIP           | 340  | 550  | 800  | ns   |
| ITRIP Blanking Time                              |                                       | tITRIPBL         | 250  | 350  |      | ns   |
| VCC and VBS Supply Undervoltage Protection Reset |                                       | VCCUV+<br>VBSUV+ | 10.5 | 11.1 | 11.7 | V    |
| VCC and VBS Supply Undervoltage Protection set   |                                       | VCCUV–<br>VBSUV– | 10.3 | 10.9 | 11.5 | V    |
| VCC and VBS Supply Undervoltage Hysteresis       |                                       | VCCUVH<br>VBSUVH | 0.14 | 0.2  | –    | V    |
| Thermistor for Substrate Temperature Monitor     | Resistance between TH(27) and VSS(29) | Rt               | 42.3 | 47   | 51.7 | kΩ   |

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.

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

# APPLICATIONS INFORMATION

## Input / Output Timing Chart



### NOTES:

- Shows the prevention of shoot-through via control logic, however, more dead time must be added to account for switching delay externally.
- 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.
- 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.
- When VITRIP exceeds threshold all IGBT's are turned off and normal operation resumes 2 ms (typ) after over current condition is removed.

Figure 4. Input / Output Timing Chart

Table 5. LOGIC LEVEL TABLE

| INPUT |     |       | OUTPUT         |               |                |       |
|-------|-----|-------|----------------|---------------|----------------|-------|
| HIN   | LIN | Itrip | High side IGBT | Low side IGBT | U,V,W          | FLTEN |
| H     | L   | L     | ON             | OFF           | VP             | OFF   |
| L     | H   | L     | OFF            | ON            | NU, NV, NW     | OFF   |
| L     | L   | L     | OFF            | OFF           | High Impedance | OFF   |
| H     | H   | L     | OFF            | OFF           | High Impedance | OFF   |
| X     | X   | H     | 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  | 44.6 | 47.0 | 49.4 | kΩ   |
|                         | R <sub>125</sub> | T <sub>c</sub> = 125°C | 1.28 | 1.41 | 1.53 | kΩ   |
| B-Constant (25 to 50°C) | B                | –                      | 4010 | 4050 | 4091 | K    |
| Temperature Range       | –                | –                      | –40  | –    | +125 | °C   |

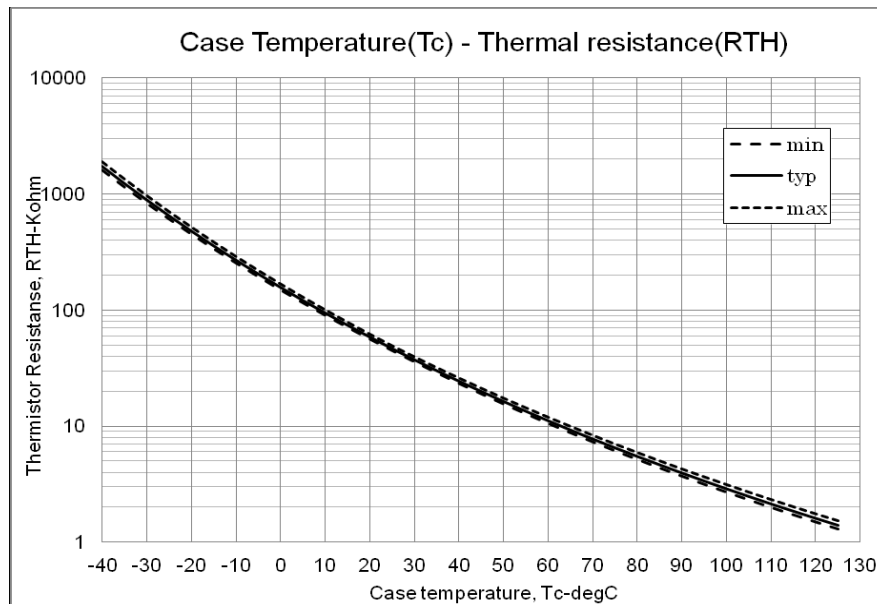
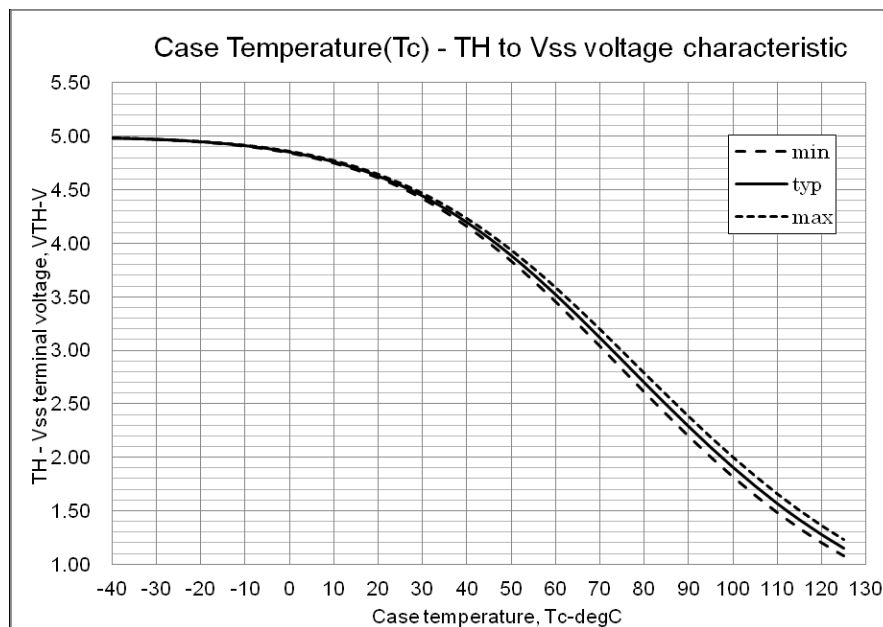


Figure 5. Thermistor Resistance versus Case Temperature





Condition: Pull-up resistor = 4.7 kphm, Pull-up voltage of TH = 5 V

**Figure 6. Thermistor Voltage versus Case Temperature**

#### 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 k $\Omega$  or higher. If the pull-up voltage is 15 V, use a pull-up resistor with a value of 20 k $\Omega$  or higher. The FAULT output is triggered if there is a VDD undervoltage 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 ELTEN pin falls below the ENABLE OFF-state voltage, the drivers are disabled.

#### UnderVoltage Lockout Protection

If VDD goes below the VDD supply undervoltage lockout falling threshold, the FAULT output is switched on. The FAULT output stays on until VDD rises above the VDD supply undervoltage 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

An over-current condition is detected if the voltage on the ITRIP pin is larger than the reference voltage. There is a blanking time of typically 350 ns to improve noise immunity. After a shutdown propagation delay of typically 550ns, the FAULT output is switched on.

The over-current protection threshold should be set to be equal or lower to 2 times the module rated current (IO).

An additional fuse is recommended to protect against system level or abnormal over-current fault conditions.

#### Capacitors on High Voltage and VDD Supplies

Both the high voltage and VDD supplies require an electrolytic capacitor and an additional high frequency capacitor.

#### Minimum Input Pulse Width

When input pulse width is less than 1.0  $\mu$ s, 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.  
132 nC
- UVLO : Falling threshold for UVLO.  
Specified as 12 V
- IDMAX : High side drive consumption current.  
Specified as 400  $\mu$ A
- tONMAX : Maximum ON pulse width of high side IGBT

#### Capacitance calculation formula

$$CB = (QG + IDMAX \times tONMAX) / (VBS - UVLO)$$

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  $\mu$ F, 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.

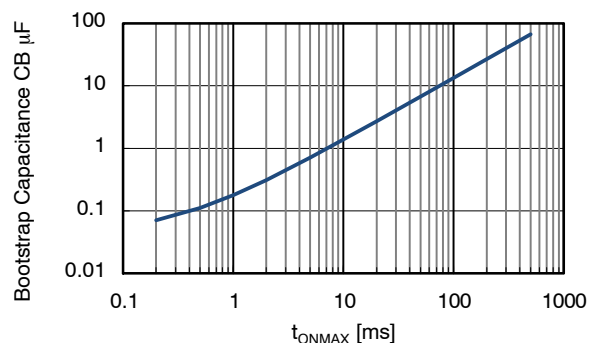


Figure 7. Bootstrap Capacitance versus  $t_{ONMAX}$

Table 7. MOUNTING INSTRUCTIONS

| Item      | Recommended Condition                                                                                                                                                                           |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pitch     | 56.0 $\pm$ 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 $\mu$ m<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 $\mu$ m<br>Uniformly apply silicone grease to whole back                                                                                              |

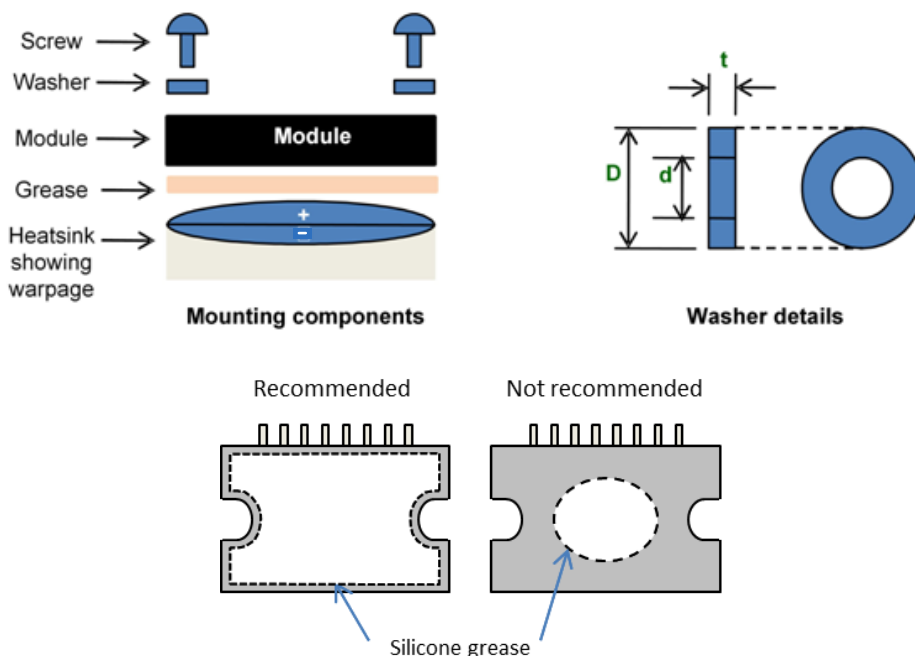


Figure 8. Module Mounting Details: Components; Washer Drawing; Need for Even Spreading of Thermal Grease

TEST CIRCUITS

•  $I_{CE}$

|   | U+ | V+ | W+ | U- | V- | W- |
|---|----|----|----|----|----|----|
| M | 13 | 13 | 13 | 10 | 6  | 2  |
| N | 10 | 6  | 2  | 17 | 19 | 21 |

|   | U(DB) | V(DB) | W(DB) |
|---|-------|-------|-------|
| M | 9     | 5     | 1     |
| N | 29    | 29    | 29    |

NOTE: U+, V+, W+ : High side phase  
U-, V-, W- : Low side phase

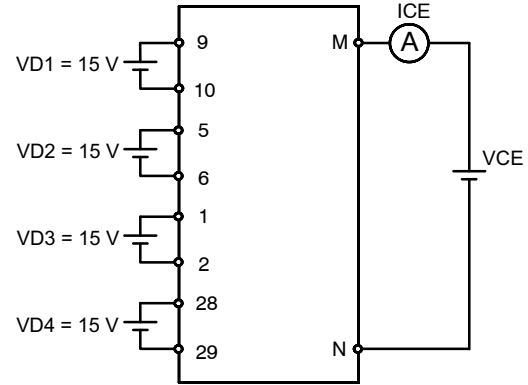


Figure 9. Test Circuit for  $I_{CE}$

•  $V_{CE(sat)}$  (Test by pulse)

|   | U+ | V+ | W+ | U- | V- | W- |
|---|----|----|----|----|----|----|
| M | 13 | 13 | 13 | 10 | 6  | 2  |
| N | 10 | 6  | 2  | 17 | 19 | 21 |
| m | 20 | 22 | 23 | 24 | 25 | 26 |

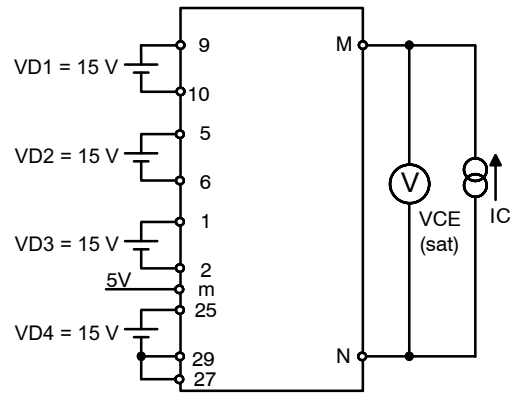


Figure 10. Test Circuit for  $V_{CE(sat)}$

•  $V_F$  (Test by pulse)

|   | U+ | V+ | W+ | U- | V- | W- |
|---|----|----|----|----|----|----|
| M | 13 | 13 | 13 | 10 | 6  | 2  |
| N | 10 | 6  | 2  | 17 | 19 | 21 |

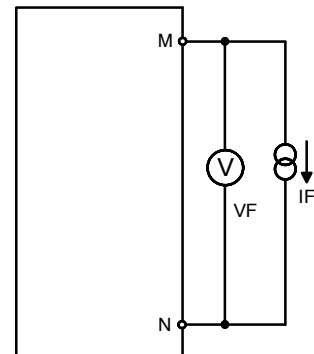


Figure 11. Test Circuit for  $V_F$

## STK554U392C-E

- ID

|   | VD1 | VD2 | VD3 | VD4 |
|---|-----|-----|-----|-----|
| M | 9   | 5   | 1   | 28  |
| N | 10  | 6   | 2   | 29  |

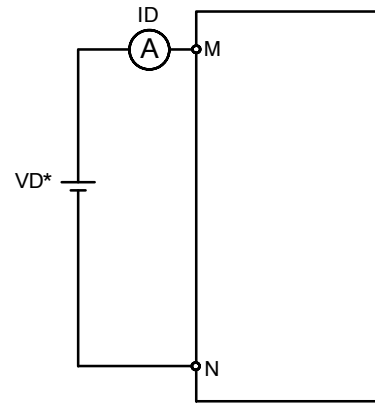


Figure 12. Test Circuit for ID

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

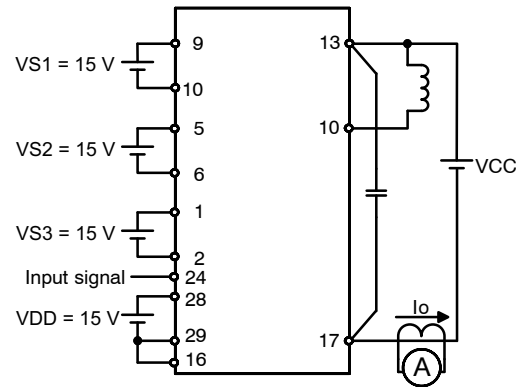
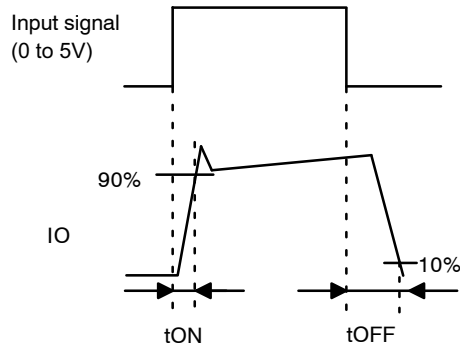


Figure 13. Switching Time Test Circuit

- RB-SOA (The circuit is a representative example of the lower side U phase.)

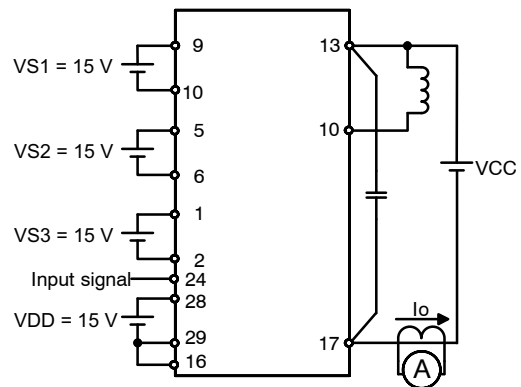
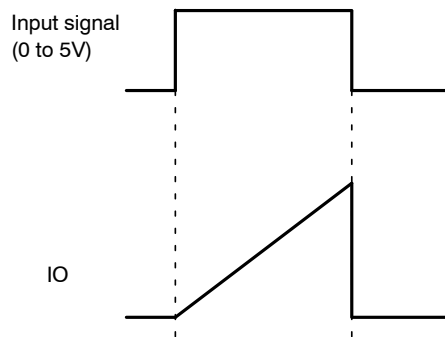


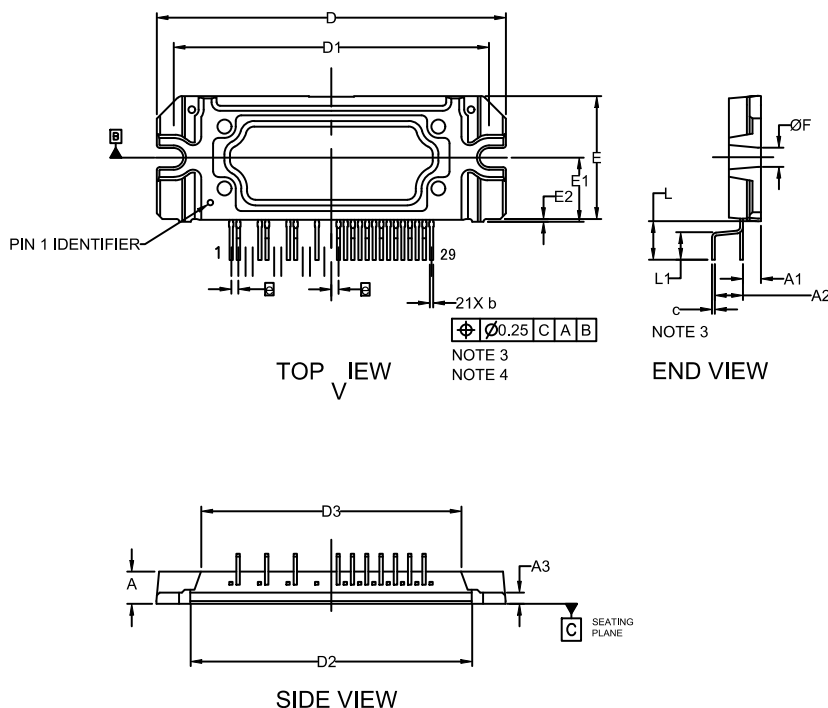
Figure 14. RB-SOA Test Circuit

### ORDERING INFORMATION

| Device        | Package                                                | Shipping       |
|---------------|--------------------------------------------------------|----------------|
| STK554U392C-E | MODULE<br>SIP29 62x21.8FP-1<br>Vertical Type (Pb-Free) | 8 Units / Tube |

**SIP29 62x21.8FP-1**  
**CASE 127EZ**  
**ISSUE O**

DATE 07 MAY 2018



NOTES:

1. DIMENSIONING AND TOLERANCING PER. ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b and c APPLY TO THE PLATED LEADS AND ARE MEASURED BETWEEN 1.00 AND 2.00 FROM THE LEAD TIP.
4. POSITION OF THE LEAD IS DETERMINED AT THE ROOT OF THE LEAD WHERE IT EXITS THE PACKAGE BODY.
5. MISSING PINS ARE 3,4,7,8,11,12,14 AND 15.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN.        | NOM.  | MAX.  |
| A   | 5.20        | 5.70  | 6.20  |
| A1  | 2.70        | 3.20  | 3.70  |
| A2  | 4.50        | 5.00  | 5.50  |
| A3  | 1.50        | 2.00  | 2.50  |
| b   | 0.55        | 0.60  | 0.80  |
| c   | 0.45        | 0.50  | 0.70  |
| D   | 61.50       | 62.00 | 62.50 |
| D1  | 55.50       | 56.00 | 56.50 |
| D2  | 49.50       | 50.00 | 50.50 |
| D3  | 45.70       | 46.20 | 46.70 |
| E   | 21.8 REF    |       |       |
| E1  | 11.4 REF    |       |       |
| E2  | 0.00        | 0.50  | 1.00  |
| e   | 1.27 BSC    |       |       |
| F   | 2.90        | 3.40  | 3.90  |
| L   | 6.30        | 6.80  | 7.30  |
| L1  | 3.80        | 4.30  | 4.80  |

|                         |                          |                                                                                                                                                                                     |
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