

# Insulated Gate Bipolar Transistor (Ultrafast IGBT), 106 A


**SOT-227**

## FEATURES

- Trench IGBT technology
- Square RBSOA
- Positive  $V_{CE(on)}$  temperature coefficient
- Fully isolated package
- Very low internal inductance ( $\leq 5$  nH typical)
- Industry standard outline
- UL approved file E78996 
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


**RoHS**  
COMPLIANT

## PRIMARY CHARACTERISTICS

|                                     |                        |
|-------------------------------------|------------------------|
| $V_{CES}$                           | 1200 V                 |
| $I_C$ DC                            | 106 A at 90 °C         |
| $V_{CE(on)}$ typical at 75 A, 25 °C | 2.17 V                 |
| Speed                               | 8 kHz to 30 kHz        |
| Package                             | SOT-227                |
| Circuit configuration               | Single switch no diode |

## BENEFITS

- Designed for increased operating efficiency in power conversion: UPS, SMPS, welding, induction heating
- Easy to assemble and parallel
- Direct mounting on heatsink
- Plug-in compatible with other SOT-227 packages
- Low EMI, requires less snubbing

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                      | SYMBOL     | TEST CONDITIONS                               | MAX.     | UNITS |
|--------------------------------|------------|-----------------------------------------------|----------|-------|
| Collector to emitter voltage   | $V_{CES}$  |                                               | 1200     | V     |
| Continuous collector current   | $I_C$      | $T_C = 25$ °C                                 | 169      | A     |
|                                |            | $T_C = 90$ °C                                 | 106      |       |
| Pulsed collector current       | $I_{CM}$   | $T_J = 150$ °C, $t_p = 6$ ms, $V_{GE} = 15$ V | 350      |       |
| Clamped inductive load current | $I_{LM}$   |                                               | 250      |       |
| Gate to emitter voltage        | $V_{GE}$   |                                               | $\pm 20$ | V     |
| Power dissipation              | $P_D$      | $T_C = 25$ °C                                 | 781      | W     |
|                                |            | $T_C = 90$ °C                                 | 375      |       |
| Isolation voltage              | $V_{ISOL}$ | Any terminal to case, $t = 1$ min             | 2500     | V     |

## ELECTRICAL SPECIFICATIONS ( $T_J = 25$ °C unless otherwise specified)

| PARAMETER                                    | SYMBOL                  | TEST CONDITIONS                                    | MIN. | TYP. | MAX.      | UNITS   |
|----------------------------------------------|-------------------------|----------------------------------------------------|------|------|-----------|---------|
| Collector to emitter breakdown voltage       | $V_{BR(CES)}$           | $V_{GE} = 0$ V, $I_C = 4$ mA                       | 1200 | -    | -         | V       |
| Collector to emitter voltage                 | $V_{CE(on)}$            | $V_{GE} = 15$ V, $I_C = 75$ A                      | -    | 2.17 | 2.60      |         |
|                                              |                         | $V_{GE} = 15$ V, $I_C = 75$ A, $T_J = 125$ °C      | -    | 2.44 | -         |         |
|                                              |                         | $V_{GE} = 15$ V, $I_C = 75$ A, $T_J = 150$ °C      | -    | 2.49 | -         |         |
| Gate threshold voltage                       | $V_{GE(th)}$            | $V_{CE} = V_{GE}$ , $I_C = 4$ mA                   | 4.6  | 5.9  | 7.6       |         |
|                                              |                         | $V_{CE} = V_{GE}$ , $I_C = 4$ mA, $T_J = 125$ °C   | -    | 4.63 | -         |         |
| Temperature coefficient of threshold voltage | $V_{GE(th)}/\Delta T_J$ | $V_{CE} = V_{GE}$ , $I_C = 4$ mA (25 °C to 125 °C) | -    | -13  | -         | mV/°C   |
| Collector to emitter leakage current         | $I_{CES}$               | $V_{GE} = 0$ V, $V_{CE} = 1200$ V                  | -    | 0.9  | 100       | $\mu$ A |
|                                              |                         | $V_{GE} = 0$ V, $V_{CE} = 1200$ V, $T_J = 125$ °C  | -    | 750  | -         |         |
|                                              |                         | $V_{GE} = 0$ V, $V_{CE} = 1200$ V, $T_J = 150$ °C  | -    | 2.7  | -         | mA      |
| Gate to emitter leakage current              | $I_{GES}$               | $V_{GE} = \pm 20$ V                                | -    | -    | $\pm 250$ | nA      |



| SWITCHING CHARACTERISTICS (T <sub>J</sub> = 25 °C unless otherwise specified) |                     |                                                                                                                                                                    |                                                                        |                                                                                                                                   |      |            |      |   |    |
|-------------------------------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|------|------------|------|---|----|
| PARAMETER                                                                     | SYMBOL              | TEST CONDITIONS                                                                                                                                                    |                                                                        | MIN.                                                                                                                              | TYP. | MAX. UNITS |      |   |    |
| Total gate charge (turn-on)                                                   | Q <sub>g</sub>      | I <sub>C</sub> = 90 A, V <sub>CC</sub> = 960 V, V <sub>GE</sub> = 15 V                                                                                             |                                                                        | -                                                                                                                                 | 307  | -          | nC   |   |    |
| Gate to emitter charge (turn-on)                                              | Q <sub>ge</sub>     |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 33   | -          |      |   |    |
| Gate to collector charge (turn-on)                                            | Q <sub>gc</sub>     |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 160  | -          |      |   |    |
| Turn-on switching loss                                                        | E <sub>on</sub>     | I <sub>C</sub> = 75 A, V <sub>CC</sub> = 600 V, V <sub>GE</sub> = 15 V, R <sub>g</sub> = 5 Ω, L = 500 μH, T <sub>J</sub> = 25 °C                                   | Energy losses include tail and diode recovery<br>Diode used HFA16PB120 | -                                                                                                                                 | 2.15 | -          | mJ   |   |    |
| Turn-off switching loss                                                       | E <sub>off</sub>    |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 2.59 | -          |      |   |    |
| Total switching loss                                                          | E <sub>tot</sub>    |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 4.74 | -          |      |   |    |
| Turn-on delay time                                                            | t <sub>d(on)</sub>  |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 36   | -          | ns   |   |    |
| Rise time                                                                     | t <sub>r</sub>      |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 26   | -          |      |   |    |
| Turn-off delay time                                                           | t <sub>d(off)</sub> |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 116  | -          |      |   |    |
| Fall time                                                                     | t <sub>f</sub>      |                                                                                                                                                                    |                                                                        | -                                                                                                                                 | 82   | -          |      |   |    |
| Turn-on switching loss                                                        | E <sub>on</sub>     |                                                                                                                                                                    |                                                                        | I <sub>C</sub> = 75 A, V <sub>CC</sub> = 600 V, V <sub>GE</sub> = 15 V, R <sub>g</sub> = 5 Ω, L = 500 μH, T <sub>J</sub> = 125 °C |      | -          | 2.23 | - | mJ |
| Turn-off switching loss                                                       | E <sub>off</sub>    |                                                                                                                                                                    |                                                                        |                                                                                                                                   |      | -          | 3.87 | - |    |
| Total switching loss                                                          | E <sub>tot</sub>    |                                                                                                                                                                    |                                                                        |                                                                                                                                   |      | -          | 6.1  | - |    |
| Turn-on delay time                                                            | t <sub>d(on)</sub>  | -                                                                                                                                                                  | 34                                                                     |                                                                                                                                   |      | -          | ns   |   |    |
| Rise time                                                                     | t <sub>r</sub>      | -                                                                                                                                                                  | 27                                                                     |                                                                                                                                   |      | -          |      |   |    |
| Turn-off delay time                                                           | t <sub>d(off)</sub> | -                                                                                                                                                                  | 123                                                                    |                                                                                                                                   |      | -          |      |   |    |
| Fall time                                                                     | t <sub>f</sub>      | -                                                                                                                                                                  | 147                                                                    |                                                                                                                                   |      | -          |      |   |    |
| Reverse bias safe operating area                                              | RBSOA               | T <sub>J</sub> = 150 °C, I <sub>C</sub> = 250, R <sub>g</sub> = 4.7 Ω, V <sub>GE</sub> = 15 V to 0 V, V <sub>CC</sub> = 800 V, V <sub>P</sub> = 1200 V, L = 500 μH |                                                                        |                                                                                                                                   |      | Fullsquare |      |   |    |

| THERMAL AND MECHANICAL SPECIFICATIONS  |                   |                       |      |      |            |                      |
|----------------------------------------|-------------------|-----------------------|------|------|------------|----------------------|
| PARAMETER                              | SYMBOL            | TEST CONDITIONS       | MIN. | TYP. | MAX.       | UNITS                |
| Junction and storage temperature range | $T_J$ , $T_{Stg}$ |                       | -40  | -    | 150        | $^{\circ}\text{C}$   |
| Junction to case                       | $R_{thJC}$        |                       | -    | -    | 0.16       | $^{\circ}\text{C/W}$ |
| Case to heatsink                       | $R_{thCS}$        | Flat, greased surface | -    | 0.05 | -          |                      |
| Weight                                 |                   |                       | -    | 30   | -          | g                    |
| Mounting torque                        |                   | Torque to terminal    | -    | -    | 1.1 (9.7)  | Nm (lbf.in)          |
|                                        |                   | Torque to heatsink    | -    | -    | 1.8 (15.9) | Nm (lbf.in)          |
| Case style                             | SOT-227           |                       |      |      |            |                      |

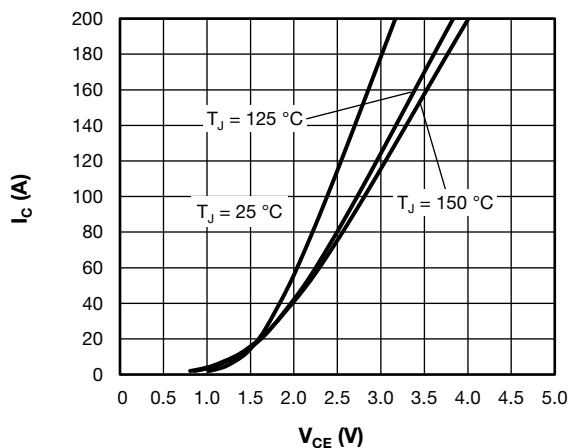
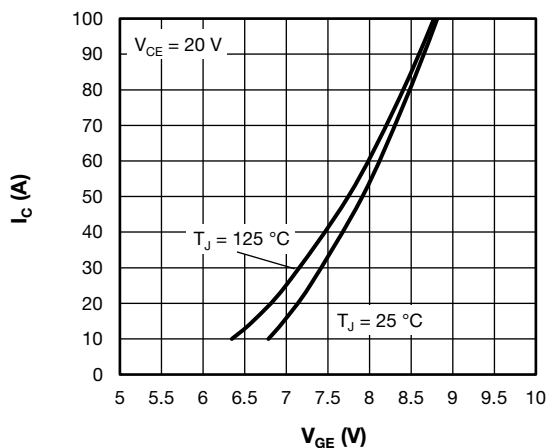

Fig. 1 - Typical Trench IGBT Output Characteristics,  $V_{GE} = 15\text{ V}$ 


Fig. 4 - Typical Trench IGBT Transfer Characteristics

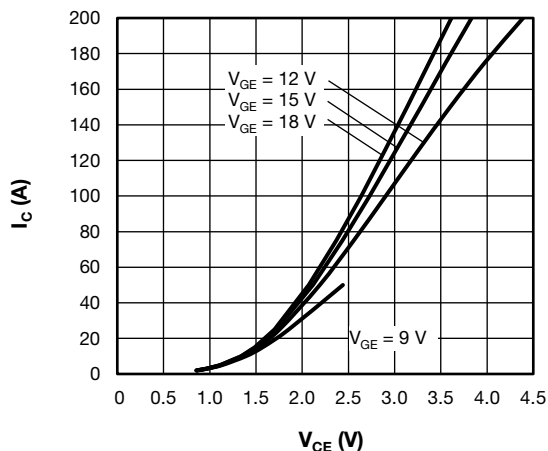
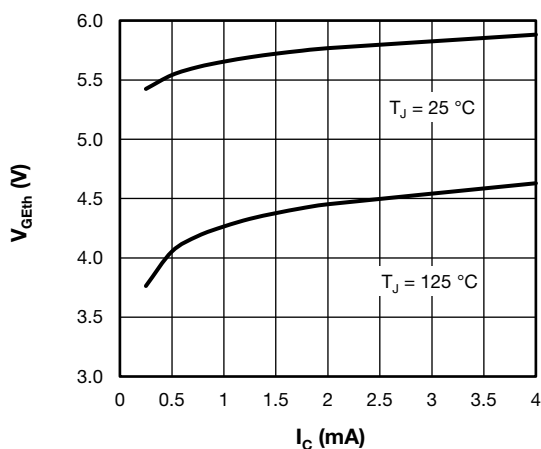

Fig. 2 - Typical Trench IGBT Output Characteristics,  $T_J = 125\text{ °C}$ 


Fig. 5 - Typical Trench IGBT Gate Threshold Voltage

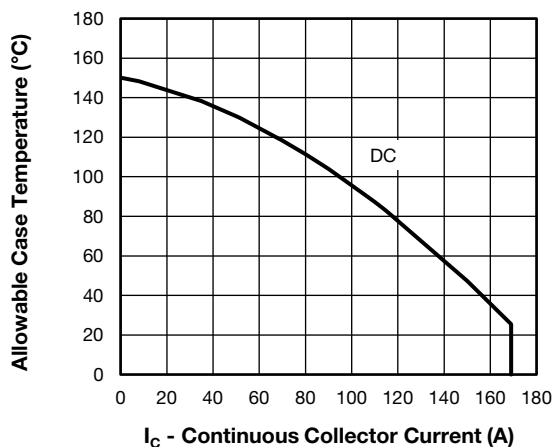


Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature

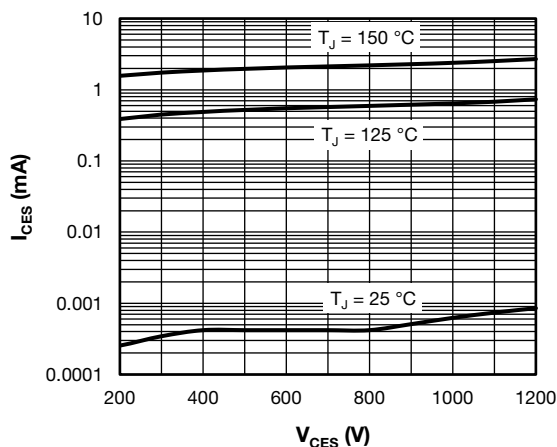


Fig. 6 - Typical Trench IGBT Zero Gate Voltage Collector Current

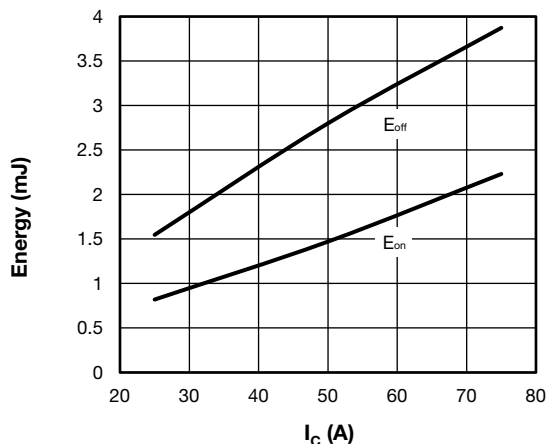


Fig. 7 - Typical Trench IGBT Energy Loss vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

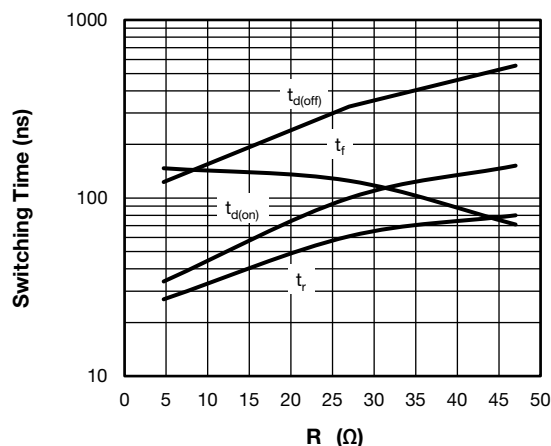


Fig. 10 - Typical Trench IGBT Switching Time vs.  $R_g$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 75\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

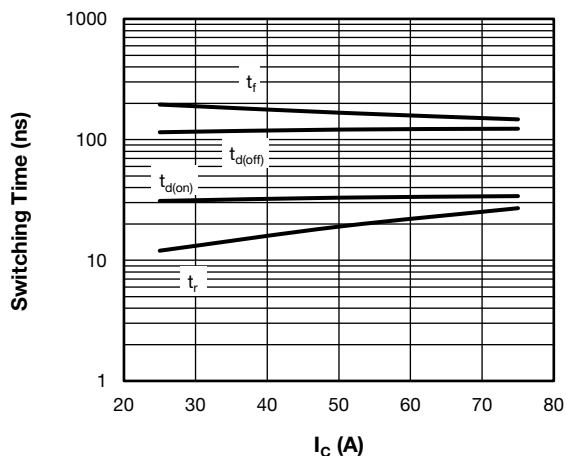


Fig. 8 - Typical Trench IGBT Switching Time vs.  $I_C$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

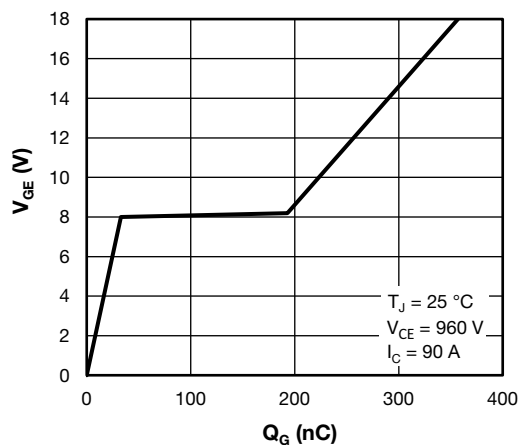


Fig. 11 - Typical Trench IGBT Gate Charge vs. Gate to Emitter Voltage

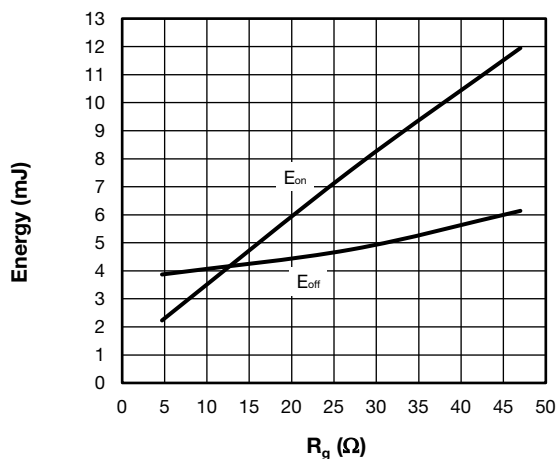


Fig. 9 - Typical Trench IGBT Energy Loss vs.  $R_g$   
 $T_J = 125^\circ\text{C}$ ,  $V_{CC} = 600\text{ V}$ ,  $I_C = 75\text{ A}$ ,  $V_{GE} = +15\text{ V}/-15\text{ V}$ ,  $L = 500\ \mu\text{H}$

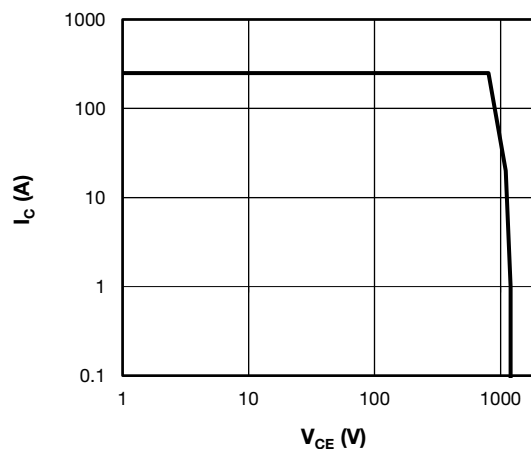
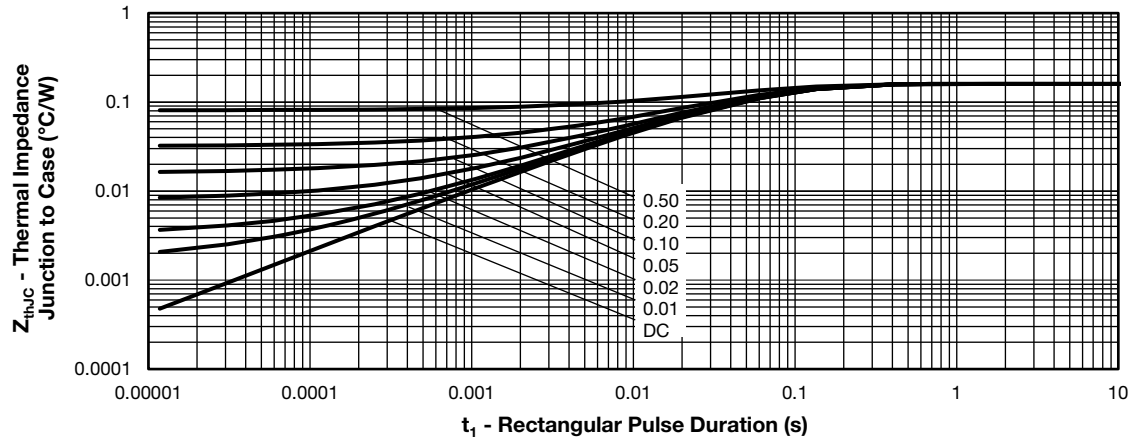
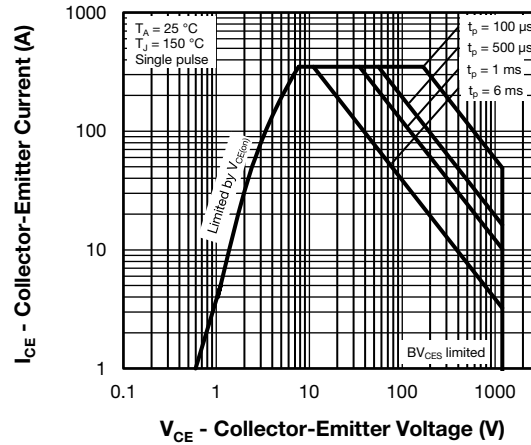
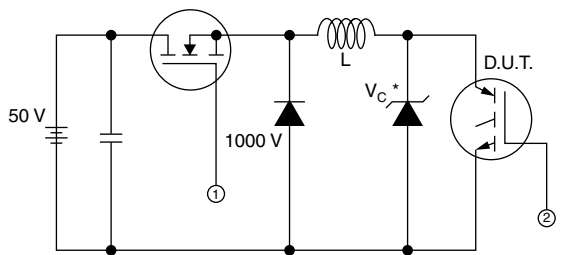


Fig. 12 - Trench IGBT Reverse BIAS SOA  
 $T_J = 150^\circ\text{C}$ ,  $I_C = 250\text{ A}$ ,  $R_g = 4.7\ \Omega$ ,  $V_{GE} = +15\text{ V}/0\text{ V}$ ,  
 $V_{CC} = 800\text{ V}$ ,  $V_p = 1200\text{ V}$





\* Driver same type as D.U.T.;  $V_C = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50 V power supply, pulse width and inductor will increase to obtain  $I_d$

Fig. 15 - Clamped Inductive Load Test Circuit

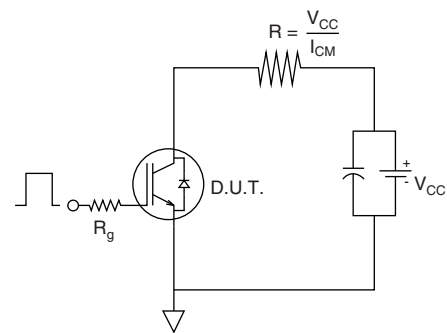


Fig. 16 - Pulsed Collector Current Test Circuit

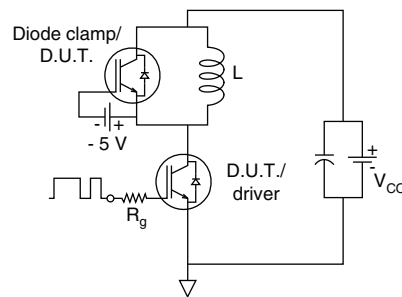


Fig. 17 - Switching Loss Test Circuit

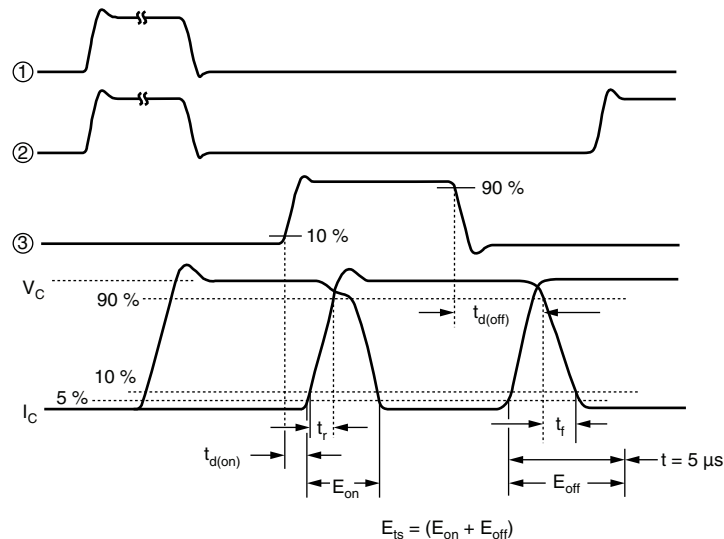


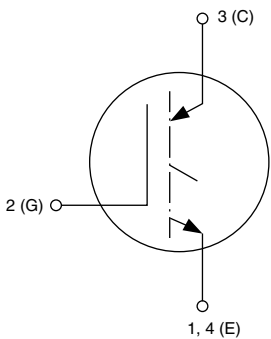
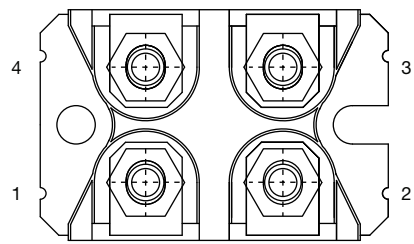
Fig. 18 - Switching Loss Waveforms Test Circuit

**ORDERING INFORMATION TABLE**

|             |            |          |          |           |          |          |            |          |
|-------------|------------|----------|----------|-----------|----------|----------|------------|----------|
| Device code | <b>VS-</b> | <b>G</b> | <b>T</b> | <b>90</b> | <b>S</b> | <b>A</b> | <b>120</b> | <b>U</b> |
|             | 1          | 2        | 3        | 4         | 5        | 6        | 7          | 8        |

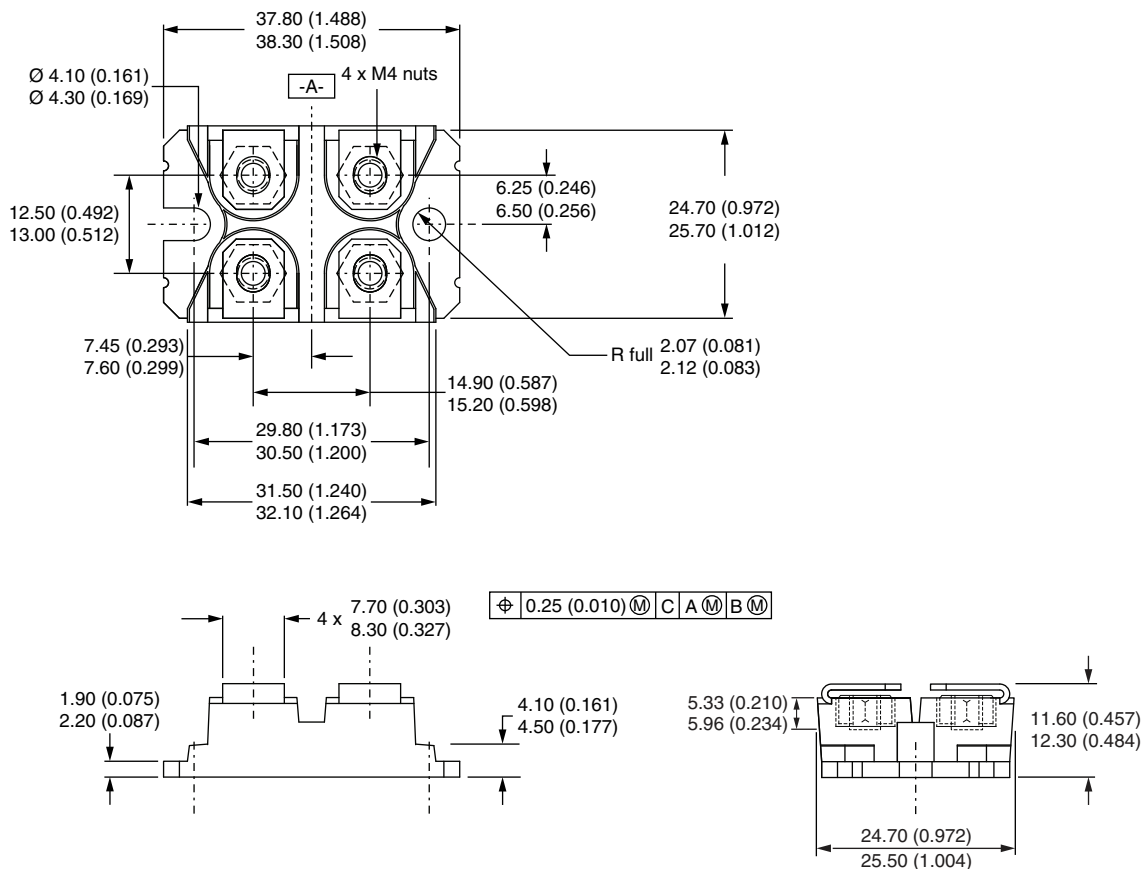
|          |                                                      |
|----------|------------------------------------------------------|
| <b>1</b> | - Vishay Semiconductors product                      |
| <b>2</b> | - Insulated gate bipolar transistor (IGBT)           |
| <b>3</b> | - T = Trench IGBT                                    |
| <b>4</b> | - Current rating (90 = 90 A)                         |
| <b>5</b> | - Circuit configuration (S = single switch no diode) |
| <b>6</b> | - Package indicator (A = SOT-227)                    |
| <b>7</b> | - Voltage rating (120 = 1200 V)                      |
| <b>8</b> | - Speed/type (U = ultrafast IGBT)                    |

| <b>CIRCUIT CONFIGURATION</b> |                                   |                                                                                                                                                                             |
|------------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CIRCUIT</b>               | <b>CIRCUIT CONFIGURATION CODE</b> | <b>CIRCUIT DRAWING</b>                                                                                                                                                      |
| Single switch<br>no diode    | S                                 | <br> |

| <b>LINKS TO RELATED DOCUMENTS</b> |                                                                        |
|-----------------------------------|------------------------------------------------------------------------|
| Dimensions                        | <a href="http://www.vishay.com/doc?95423">www.vishay.com/doc?95423</a> |
| Packaging information             | <a href="http://www.vishay.com/doc?95425">www.vishay.com/doc?95425</a> |

## SOT-227 Generation 2

**DIMENSIONS** in millimeters (inches)



### Note

- Controlling dimension: millimeter





## Disclaimer

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