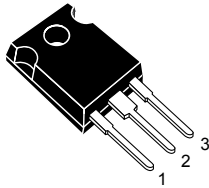
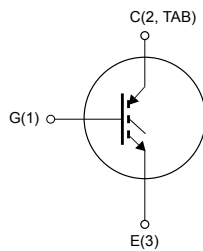


Trench gate field-stop, 600 V, 60 A, very high speed, V series IGBT in a TO-247 package


TO-247


G1C2TE3

Features

- Maximum junction temperature: $T_J = 175\text{ °C}$
- Tail-less switching off
- $V_{CE(sat)} = 1.85\text{ V (typ.) @ } I_C = 60\text{ A}$
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance

Applications

- Photovoltaic inverters
- Uninterruptible power supply
- Welding
- Power factor correction
- Very high frequency converters

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the V series IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of very high frequency converters. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Product status link

[STGW60V60F](#)

Product summary

| | |
|-------------------|------------|
| Order code | STGW60V60F |
| Marking | GW60V60F |
| Package | TO-247 |
| Packing | Tube |

1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|--|-------------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$ V) | 600 | V |
| I_C | Continuous collector current at $T_C = 25$ °C | 80 ⁽¹⁾ | A |
| | Continuous collector current at $T_C = 100$ °C | 60 | |
| $I_{CP}^{(2)}$ | Pulsed collector current | 240 | A |
| V_{GE} | Gate-emitter voltage | ±20 | V |
| P_{TOT} | Total dissipation at $T_C = 25$ °C | 375 | W |
| T_{STG} | Storage temperature range | -55 to 150 | °C |
| T_J | Operating junction temperature range | -55 to 175 | °C |

1. Current level is limited by bond wires.

2. Pulse width limited by maximum junction temperature and turn-off within RBSOA

Table 2. Thermal data

| Symbol | Parameter | Value | Unit |
|------------|---------------------------------------|-------|------|
| R_{thJC} | Thermal resistance junction-case IGBT | 0.4 | °C/W |
| R_{thJA} | Thermal resistance junction-ambient | 50 | °C/W |

2 Electrical characteristics

$T_J = 25\text{ °C}$ unless otherwise specified

Table 3. Static characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--------------------------------------|---|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage | $V_{GE} = 0\text{ V}$, $I_C = 2\text{ mA}$ | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$, $I_C = 60\text{ A}$ | | 1.85 | 2.3 | V |
| | | $V_{GE} = 15\text{ V}$, $I_C = 60\text{ A}$, $T_J = 125\text{ °C}$ | | 2.15 | | |
| | | $V_{GE} = 15\text{ V}$, $I_C = 60\text{ A}$, $T_J = 175\text{ °C}$ | | 2.35 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$ | 5.0 | 6.0 | 7.0 | V |
| I_{CES} | Collector cut-off current | $V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$ | | | 25 | μA |
| I_{GES} | Gate-emitter leakage current | $V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$ | | | ± 250 | nA |

Table 4. Dynamic characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$ | - | 8000 | - | pF |
| C_{oes} | Output capacitance | | - | 280 | - | pF |
| C_{res} | Reverse transfer capacitance | | - | 170 | - | pF |
| Q_g | Total gate charge | $V_{CC} = 480\text{ V}$, $I_C = 60\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 22. Gate charge test circuit) | - | 334 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 130 | - | nC |
| Q_{gc} | Gate-collector charge | | - | 58 | - | nC |

Table 5. IGBT switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------|---------------------------|---|------|------|------|------------------|
| $t_{d(on)}^{(1)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 60\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 21. Test circuit for inductive load switching) | - | 60 | - | ns |
| $t_r^{(1)}$ | Current rise time | | - | 20 | - | ns |
| $(di/dt)_{on}^{(1)}$ | Turn-on current slope | | - | 2365 | - | A/ μs |
| $t_{d(off)}$ | Turn-off delay time | | - | 208 | - | ns |
| t_f | Current fall time | | - | 14 | - | ns |
| $E_{on}^{(1)}$ | Turn-on switching energy | | - | 0.75 | - | mJ |
| $E_{off}^{(2)}$ | Turn-off switching energy | | - | 0.55 | - | mJ |
| E_{ts} | Total switching energy | | - | 1.3 | - | mJ |

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------|---------------------------|---|------|------|------|------------------|
| $t_{d(on)}^{(1)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 60\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 21. Test circuit for inductive load switching) | - | 57 | - | ns |
| $t_r^{(1)}$ | Current rise time | | - | 23 | - | ns |
| $(di/dt)_{on}^{(1)}$ | Turn-on current slope | | - | 2191 | - | A/ μs |
| $t_{d(off)}$ | Turn-off delay time | | - | 216 | - | ns |
| t_f | Current fall time | | - | 27 | - | ns |
| $E_{on}^{(1)}$ | Turn-on switching energy | | - | 1.5 | - | mJ |
| $E_{off}^{(2)}$ | Turn-off switching energy | | - | 0.8 | - | mJ |
| E_{ts} | Total switching energy | | - | 2.3 | - | mJ |

1. Switching-on times and energy have been calculated applying the STGW60V60DF's co-pack diode in the high side of the test circuit shown in [Figure 21. Test circuit for inductive load switching](#). Both the IGBT and the diode are at the same temperature. The turn-on switching energies include the reverse recovery of the diode.
2. Including the tail of the collector current.

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

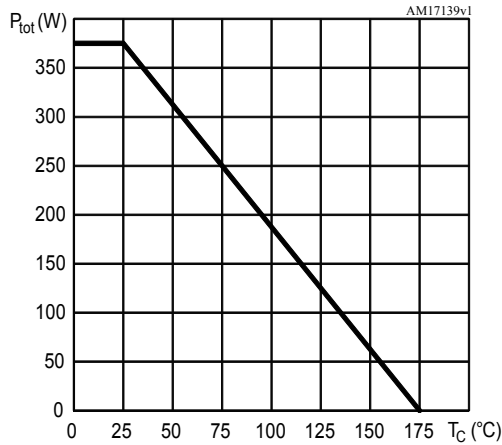


Figure 2. Collector current vs case temperature

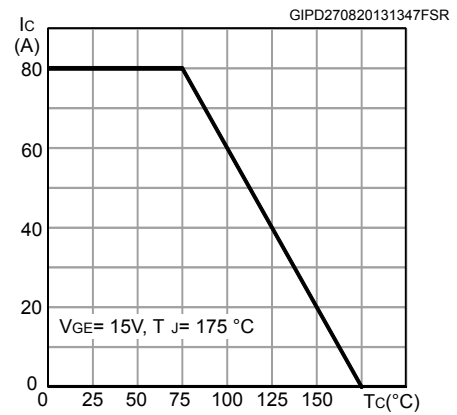


Figure 3. Output characteristics ($T_J = 25^\circ\text{C}$)

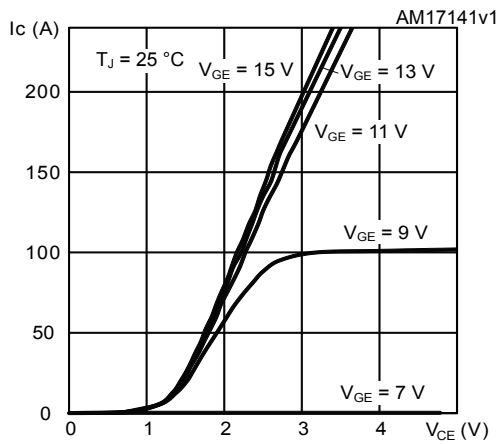


Figure 4. Output characteristics ($T_J = 175^\circ\text{C}$)

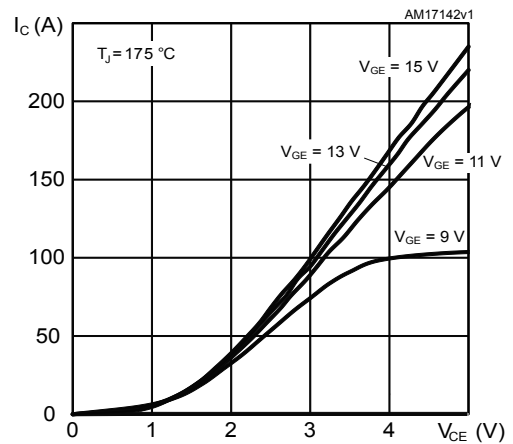


Figure 5. $V_{CE(sat)}$ vs junction temperature

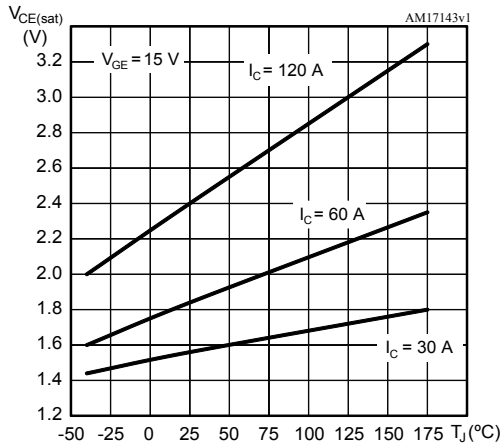


Figure 6. $V_{CE(sat)}$ vs collector current

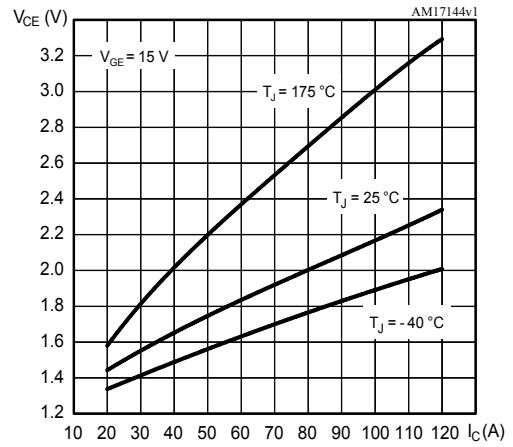


Figure 7. Collector current vs switching frequency

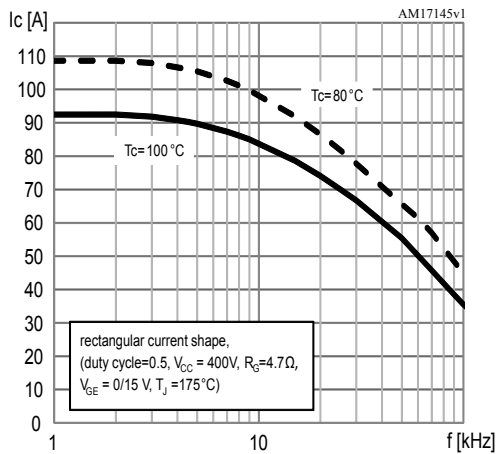


Figure 8. Forward bias safe operating area

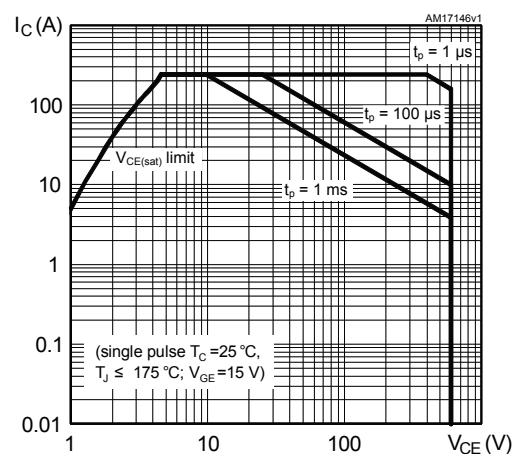


Figure 9. Transfer characteristics

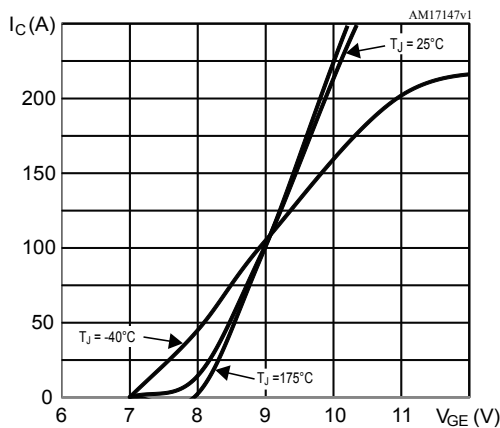


Figure 10. Normalized $V_{GE(th)}$ vs junction temperature

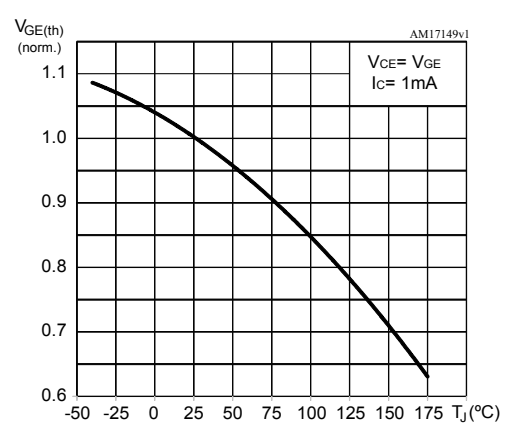


Figure 11. Normalized $V_{(BR)CES}$ vs junction temperature

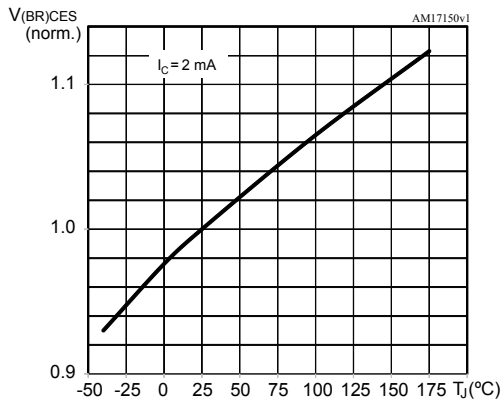


Figure 12. Capacitance variation

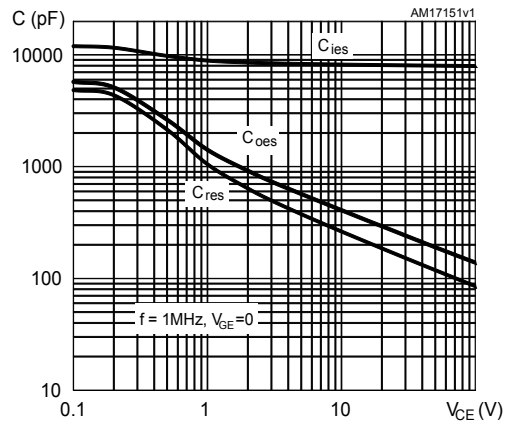


Figure 13. Gate charge vs gate-emitter voltage

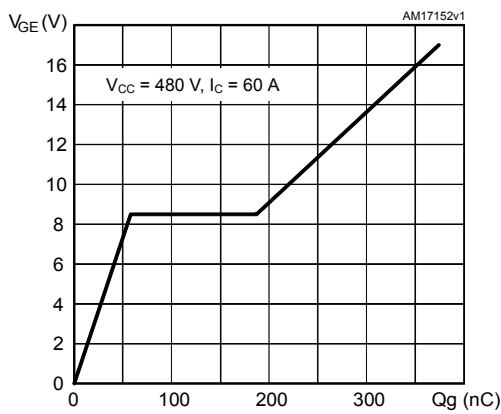


Figure 14. Switching energy vs collector current

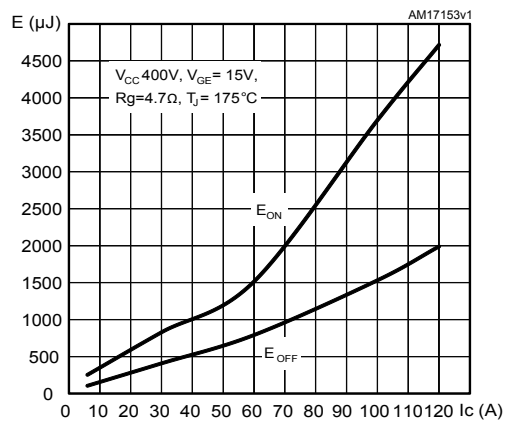


Figure 15. Switching energy vs gate resistance

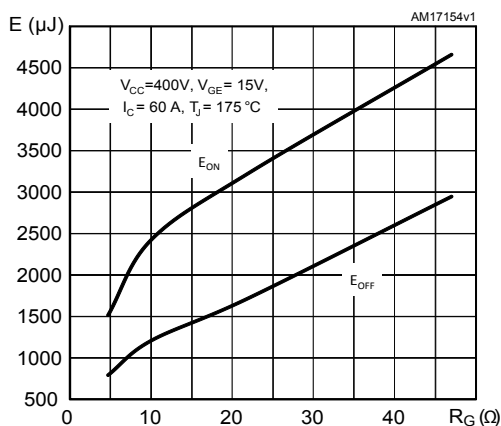


Figure 16. Switching energy vs temperature

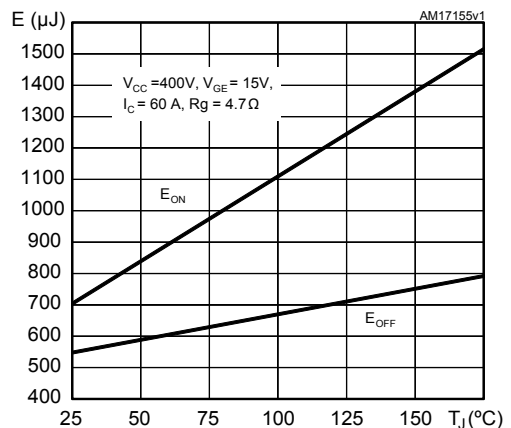


Figure 17. Switching energy vs collector-emitter voltage

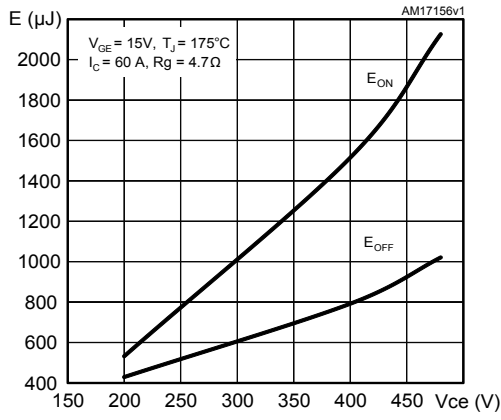


Figure 18. Switching times vs collector current

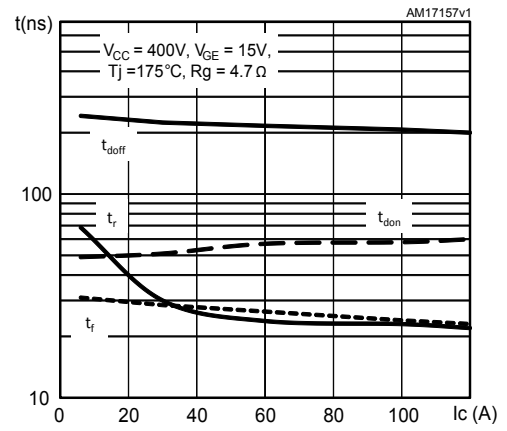


Figure 19. Switching times vs gate resistance

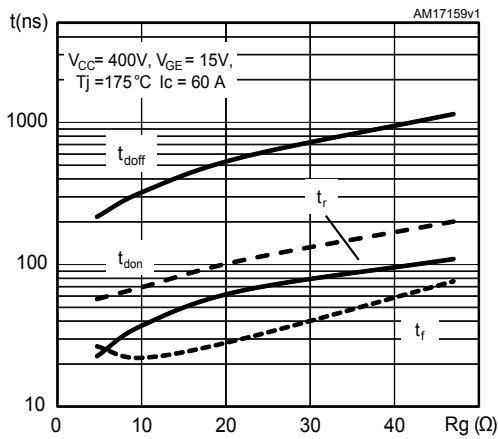
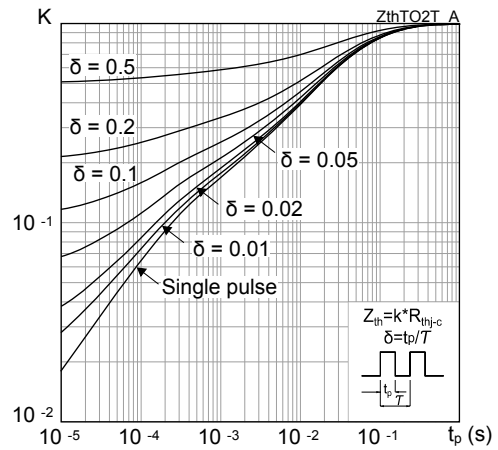
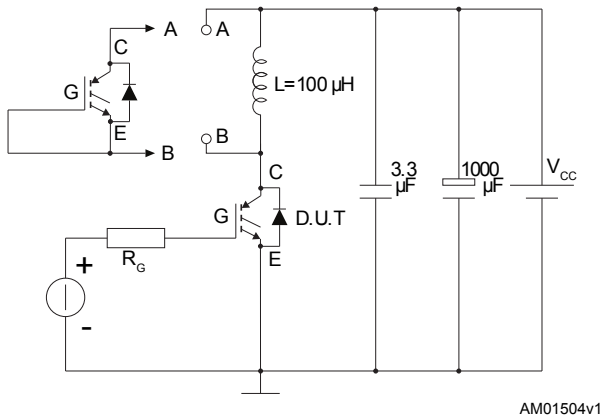
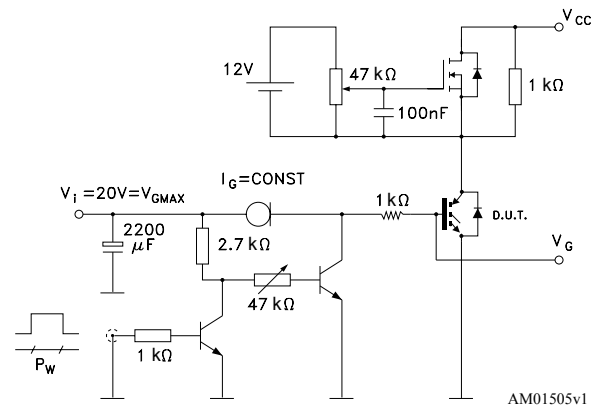
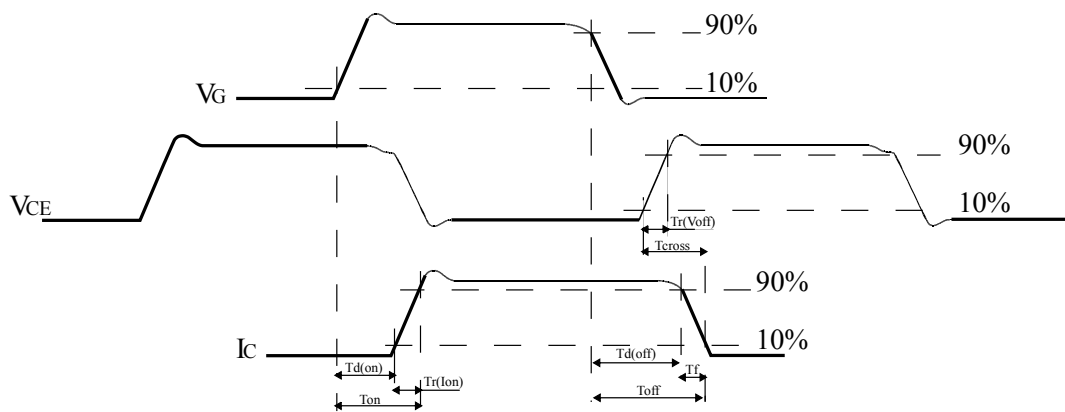


Figure 20. Thermal impedance



3 Test circuits

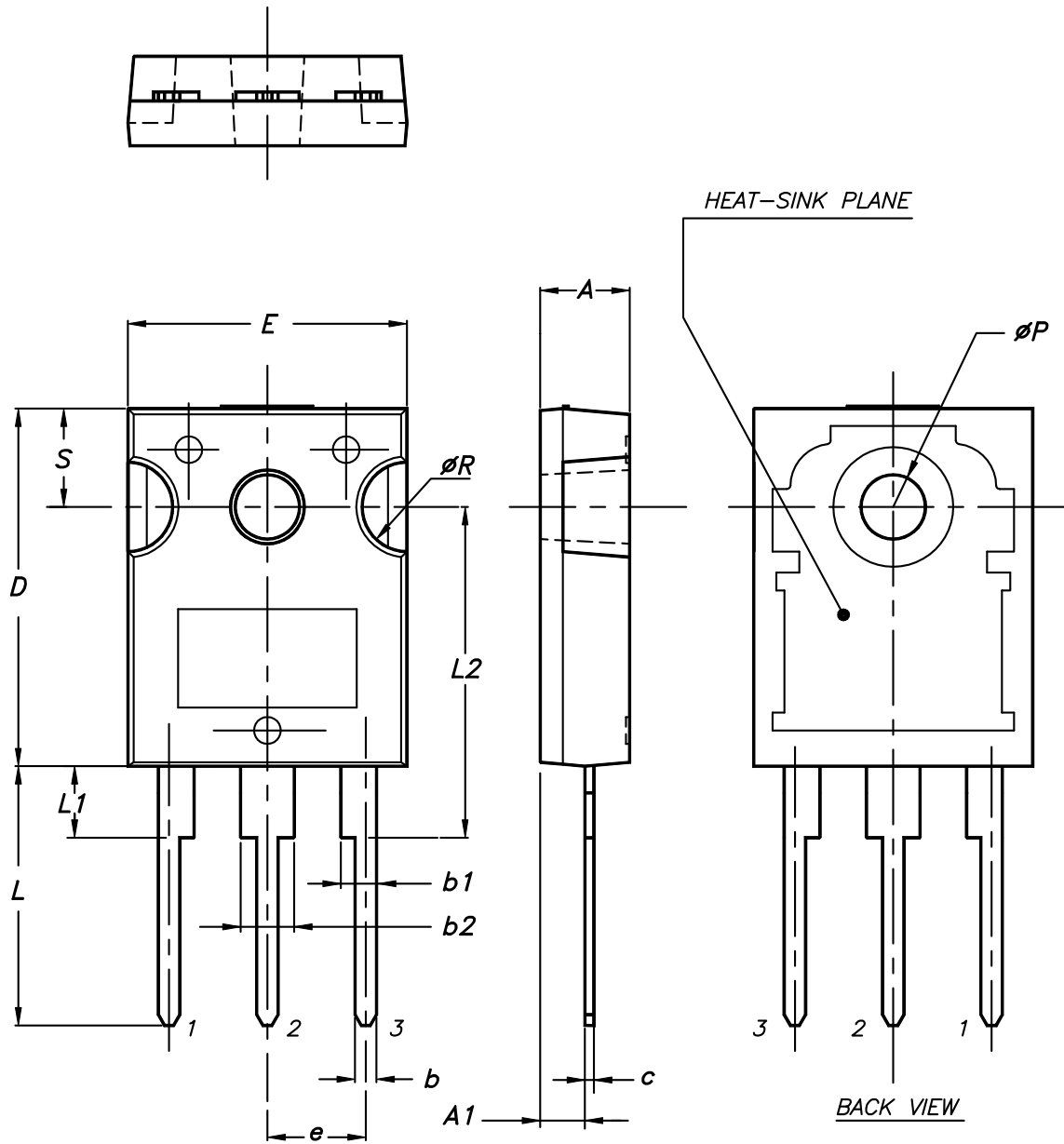
Figure 21. Test circuit for inductive load switching

Figure 22. Gate charge test circuit

Figure 23. Switching waveform


4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

4.1 TO-247 package information

Figure 24. TO-247 package outline



0075325_9

Table 6. TO-247 package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.85 | | 5.15 |
| A1 | 2.20 | | 2.60 |
| b | 1.0 | | 1.40 |
| b1 | 2.0 | | 2.40 |
| b2 | 3.0 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.85 | | 20.15 |
| E | 15.45 | | 15.75 |
| e | 5.30 | 5.45 | 5.60 |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| ØP | 3.55 | | 3.65 |
| ØR | 4.50 | | 5.50 |
| S | 5.30 | 5.50 | 5.70 |

Revision history

Table 7. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 04-Jun-2013 | 1 | First release |
| 06-Feb-2014 | 2 | Updated <i>Figure 1: Internal schematic diagram</i> . Updated title, features and description in cover page. Minor text changes. |
| 21-Jun-2017 | 3 | Modified title, features and internal schematic on cover page. Modified <i>Table 3. Static characteristics</i> and <i>Table 5. IGBT switching characteristics (inductive load)</i> . Updated Package information. Minor text changes. |
| 17-Sep-2018 | 4 | Updated Section 2.1 Electrical characteristics (curves) . Minor text changes |

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