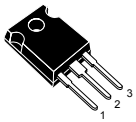
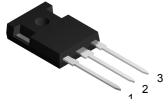


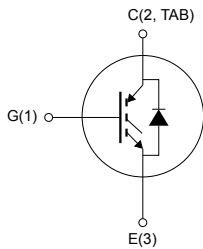
Trench gate field-stop 650 V, 60 A high speed V series IGBT in a TO-247 and TO-247 long leads packages



TO-247



TO-247 long leads



NG1E3C2T



Features

- Maximum junction temperature: $T_J = 175\text{ }^\circ\text{C}$
- 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
- Very fast soft recovery antiparallel diode

Applications

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

Description

These devices are IGBTs 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 links

[STGW60V60DF](#)

[STGWA60V60DF](#)

Product summary

| | |
|------------|-------------------|
| Order code | STGW60V60DF |
| Marking | GW60V60DF |
| Package | TO-247 |
| Packing | Tube |
| Order code | STGWA60V60DF |
| Marking | G60V60DF |
| Package | TO-247 long leads |
| 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 |
| I_F | Continuous forward current at $T_C = 25$ °C | 80 ⁽¹⁾ | A |
| | Continuous forward current at $T_C = 100$ °C | 60 | |
| $I_{FP}^{(2)}$ | Pulsed forward current | 240 | A |
| P_{TOT} | Total power 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 | |

1. Limited by bonding wires.

2. Pulse width limited by maximum junction temperature.

Table 2. Thermal data

| Symbol | Parameter | Value | Unit |
|------------|---|-------|------|
| R_{thJC} | Thermal resistance, junction-to-case IGBT. | 0.4 | °C/W |
| | Thermal resistance, junction-to-case diode. | 1.14 | |
| R_{thJA} | Thermal resistance, junction-to-ambient. | 50 | °C/W |

2 Electrical characteristics

$T_C = 25\text{ °C}$ 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 | 2.30 | 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 | 6 | 7 | V |
| V_F | Forward on-voltage | $I_F = 60\text{ A}$ | | 2 | 2.6 | V |
| | | $I_F = 60\text{ A}$, $T_J = 125\text{ °C}$ | | 1.7 | | |
| | | $I_F = 60\text{ A}$, $T_J = 175\text{ °C}$ | | 1.6 | | |
| 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 28) | - | 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 |
|-----------------|---------------------------|--|------|------|------|------------|
| $t_{d(on)}$ | 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 27) | - | 60 | - | ns |
| t_r | Current rise time | | - | 20 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 2365 | - | A/ μ s |
| $t_{d(off)}$ | 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 | |
| $t_{d(on)}$ | 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 27) | - | 57 | - | ns |
| t_r | Current rise time | | - | 23 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 2191 | - | A/ μ s |
| $t_{d(off)}$ | 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. Including the reverse recovery of the diode.

2. Including the tail of the collector current.

Table 6. Diode switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--|--|------|------|------|------------|
| t_{rr} | Reverse recovery time | $I_F = 60\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 27) | - | 74 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 703 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 19 | - | A |
| dI_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 714 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 184 | - | μ J |
| t_{rr} | Reverse recovery time | $I_F = 60\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27) | - | 131 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 2816 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 43 | - | A |
| dI_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 404 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 821 | - | μ J |

2.1 Electrical characteristics (curves)

Figure 1. Power dissipation vs case temperature

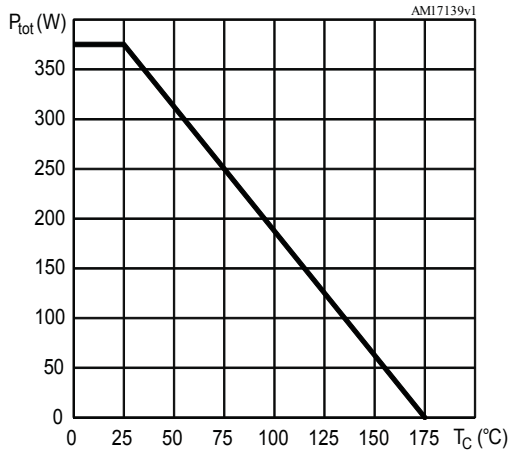


Figure 2. Collector current vs case temperature

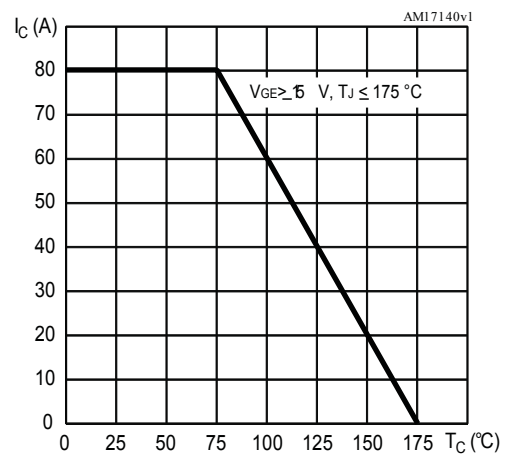


Figure 3. Output characteristics ($T_J = 25 \text{ }^\circ\text{C}$)

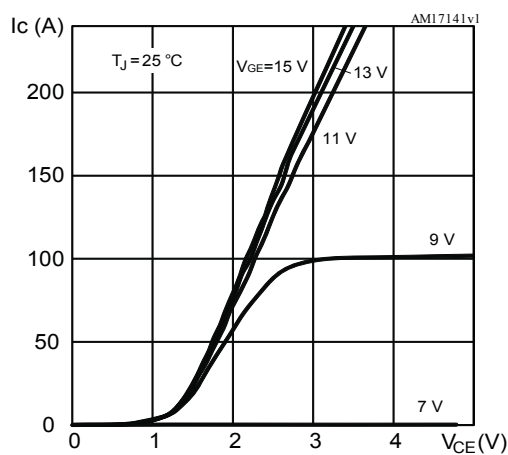


Figure 4. Output characteristics ($T_J = 175 \text{ }^\circ\text{C}$)

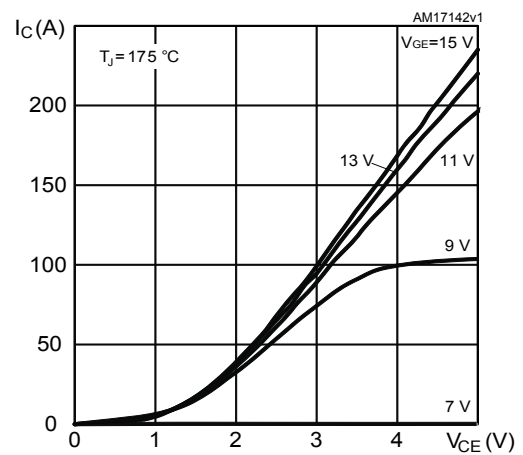


Figure 5. $V_{CE(sat)}$ vs junction temperature

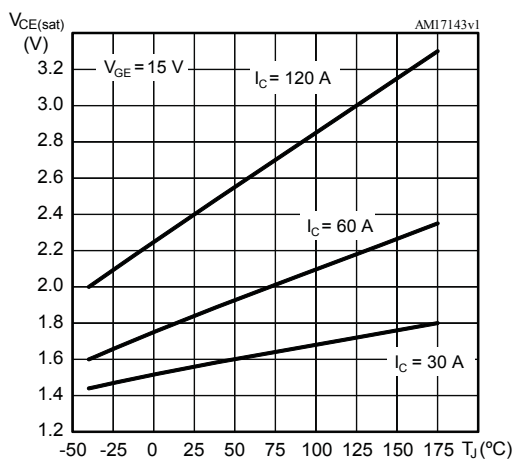


Figure 6. $V_{CE(sat)}$ vs collector current

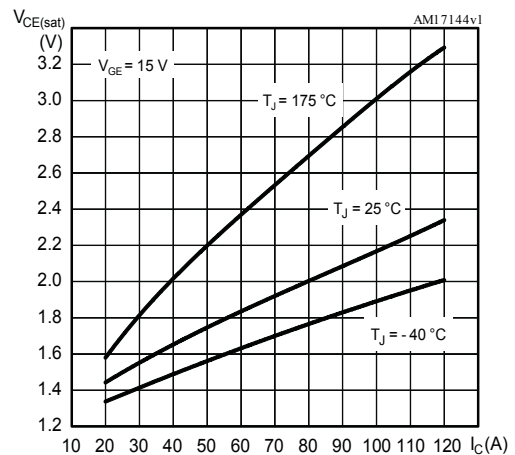


Figure 7. Collector current vs. switching frequency

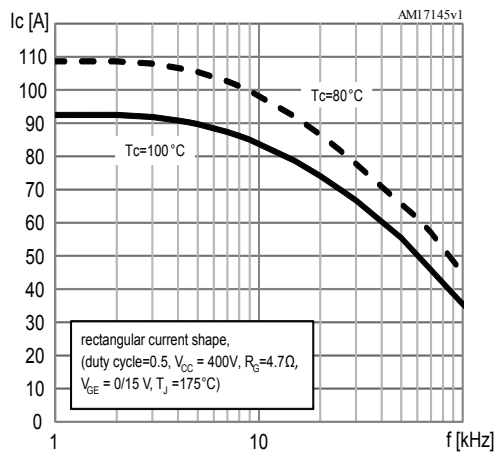


Figure 8. Safe operating area

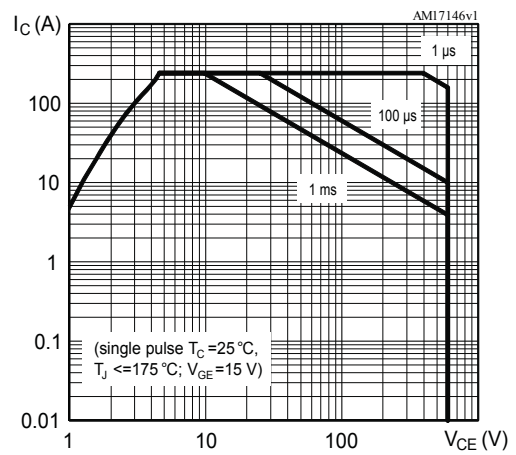


Figure 9. Transfer characteristics

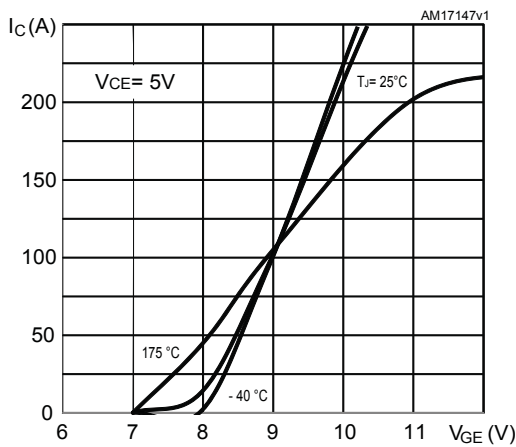


Figure 10. Diode V_F vs. forward current

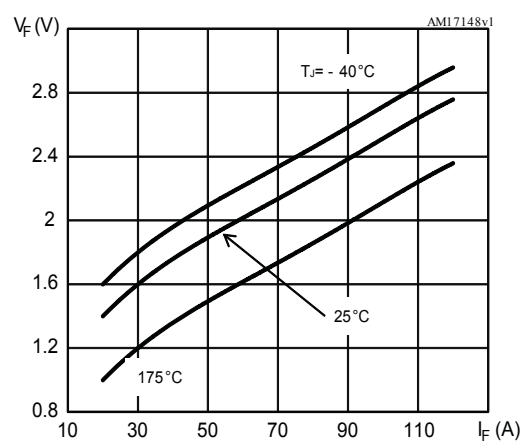


Figure 11. Normalized V_{GE(th)} vs junction temperature

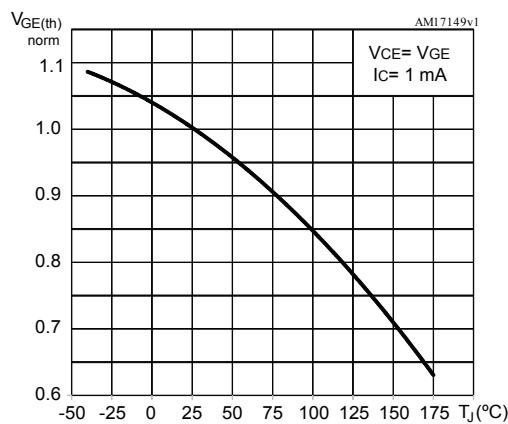


Figure 12. Normalized V_{(BR)CES} vs junction temperature

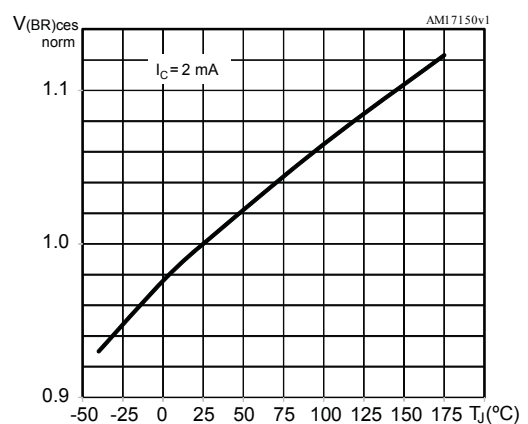


Figure 13. Capacitance variations

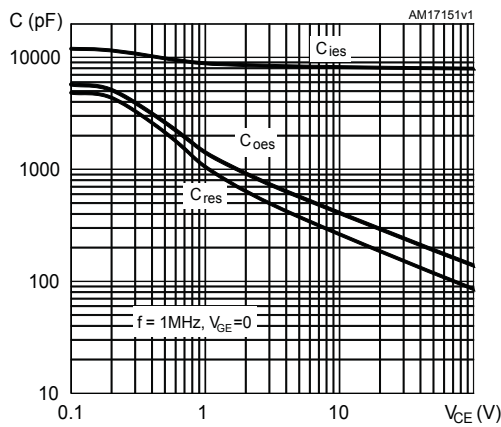


Figure 14. Gate charge vs gate-emitter voltage

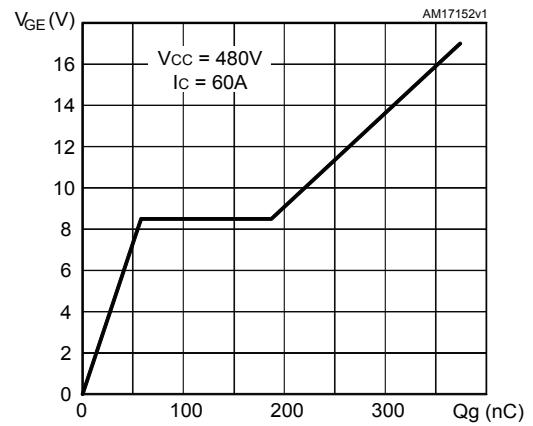


Figure 15. Switching energy vs collector current

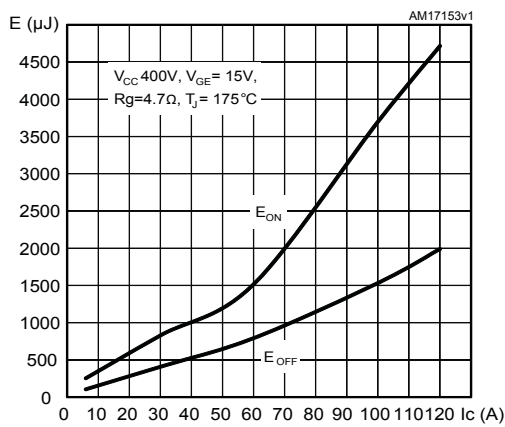


Figure 16. Switching energy vs gate resistance

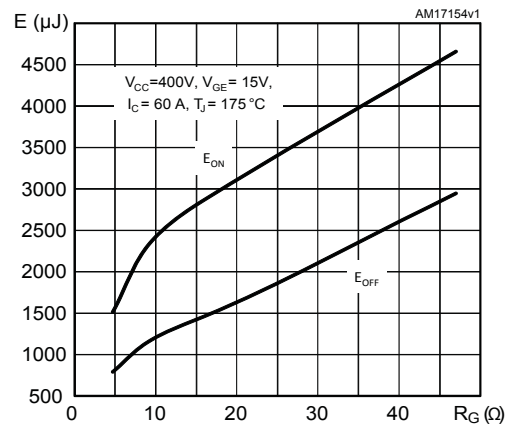


Figure 17. Switching energy vs junction temperature

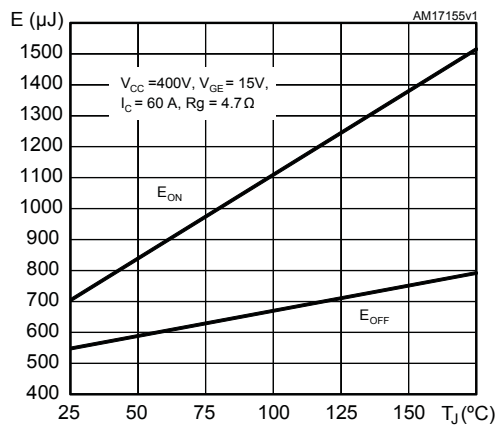


Figure 18. Switching energy vs collector-emitter voltage

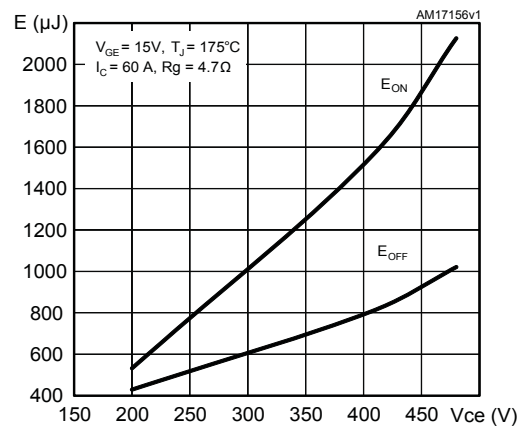


Figure 19. Switching times vs collector current

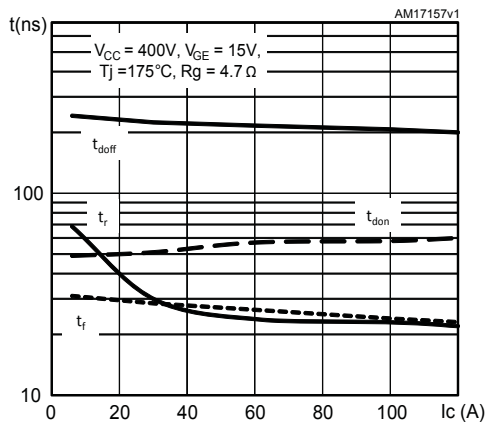


Figure 20. Switching times vs gate resistance

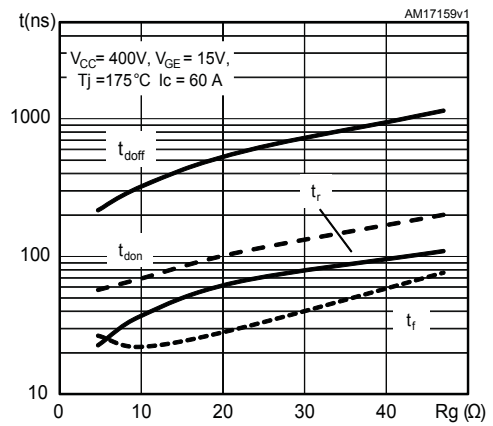


Figure 21. Reverse recovery current vs. diode current slope

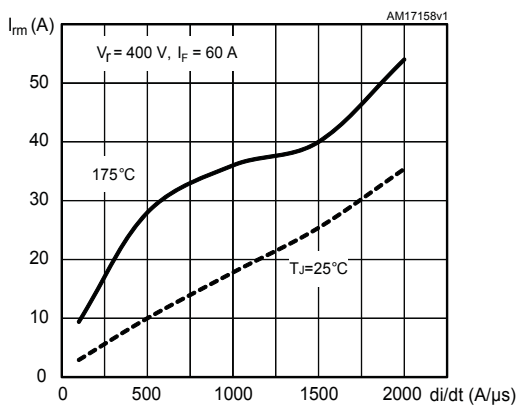


Figure 22. Reverse recovery time vs. diode current slope

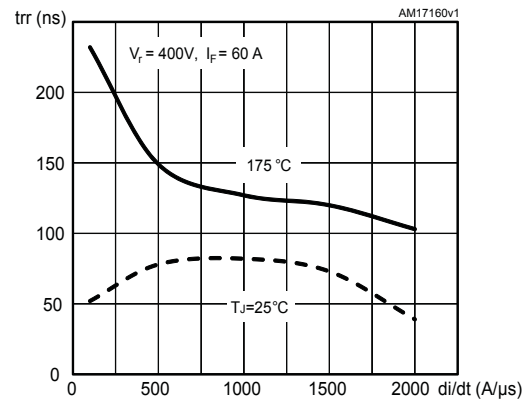


Figure 23. Reverse recovery charge vs. diode current slope

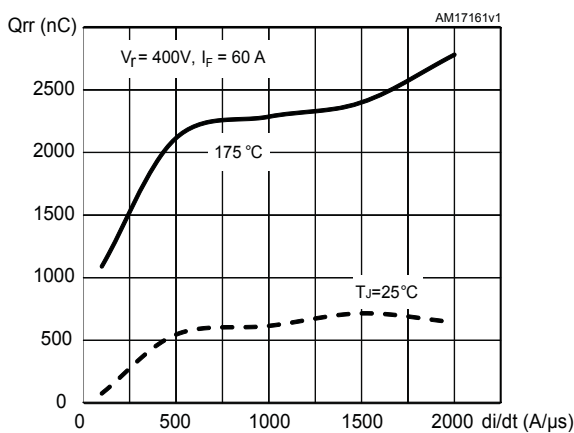


Figure 24. Reverse recovery current vs. energy current slope

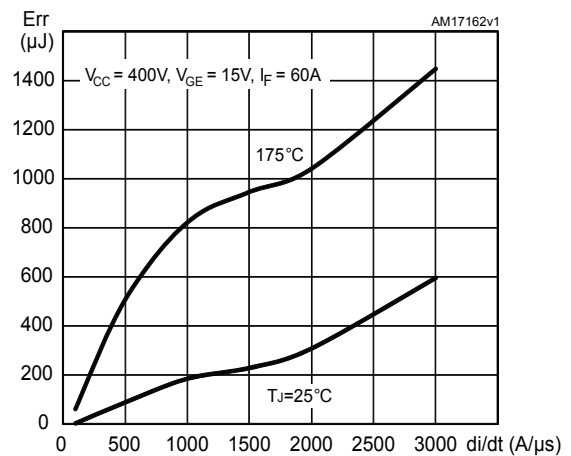


Figure 25. Thermal impedance for IGBT

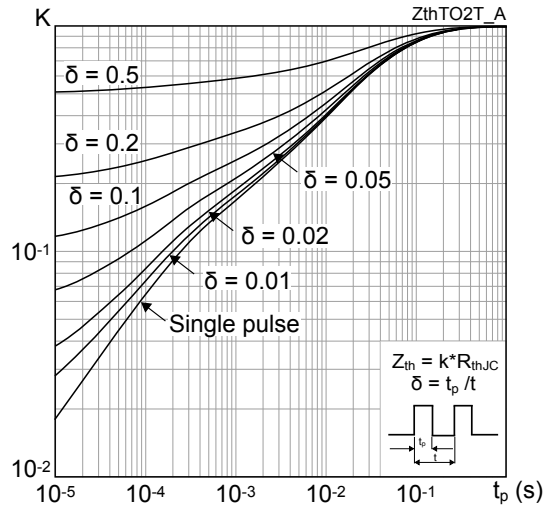
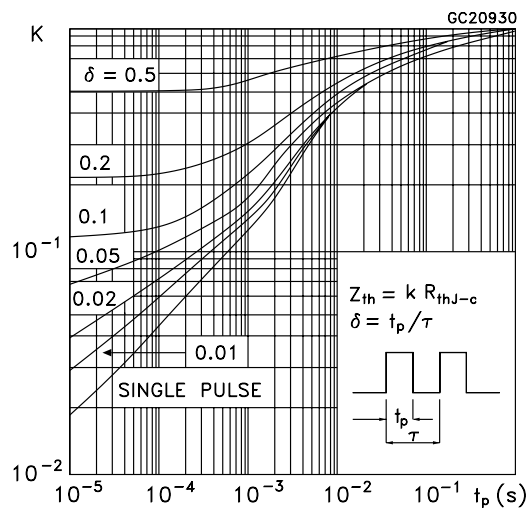
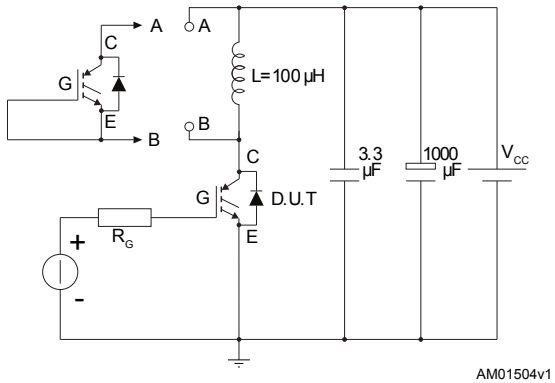
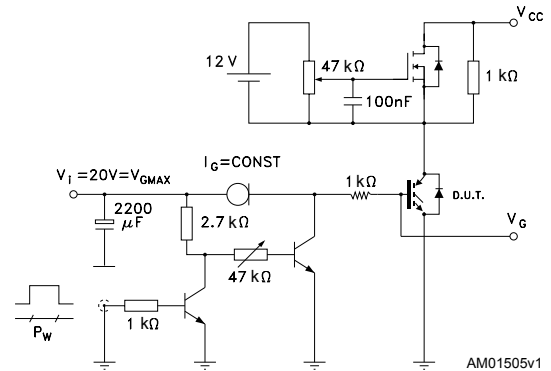
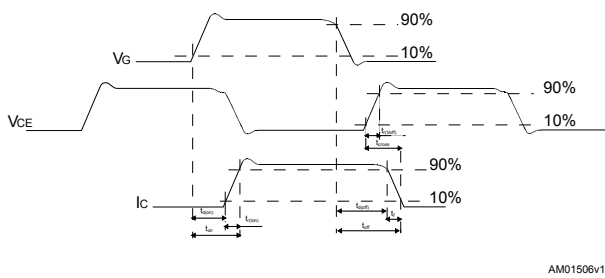
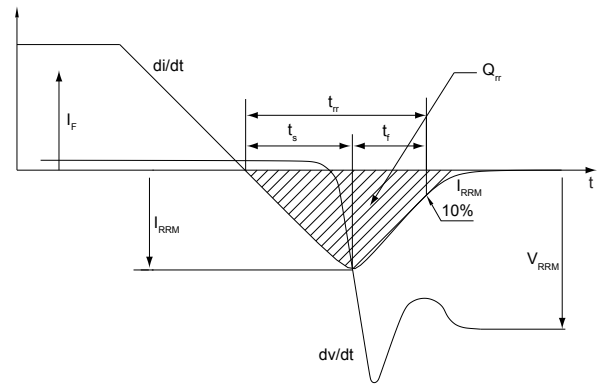


Figure 26. Thermal impedance for diode



3 Test circuits

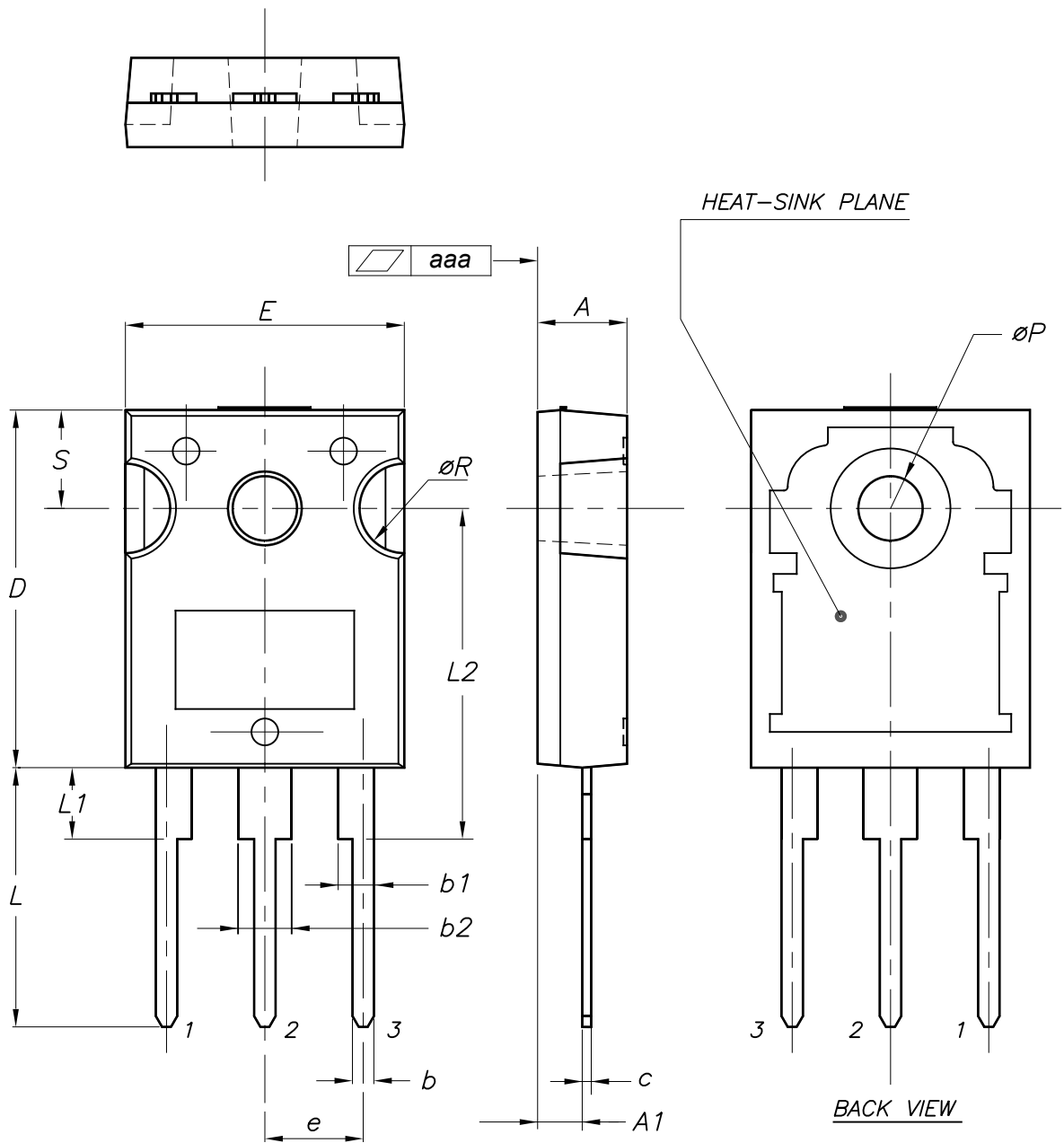
Figure 27. Test circuit for inductive load switching

Figure 28. Gate charge test circuit

Figure 29. Switching waveform

Figure 30. Diode reverse recovery waveform


4 Package information

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 31. TO-247 package outline



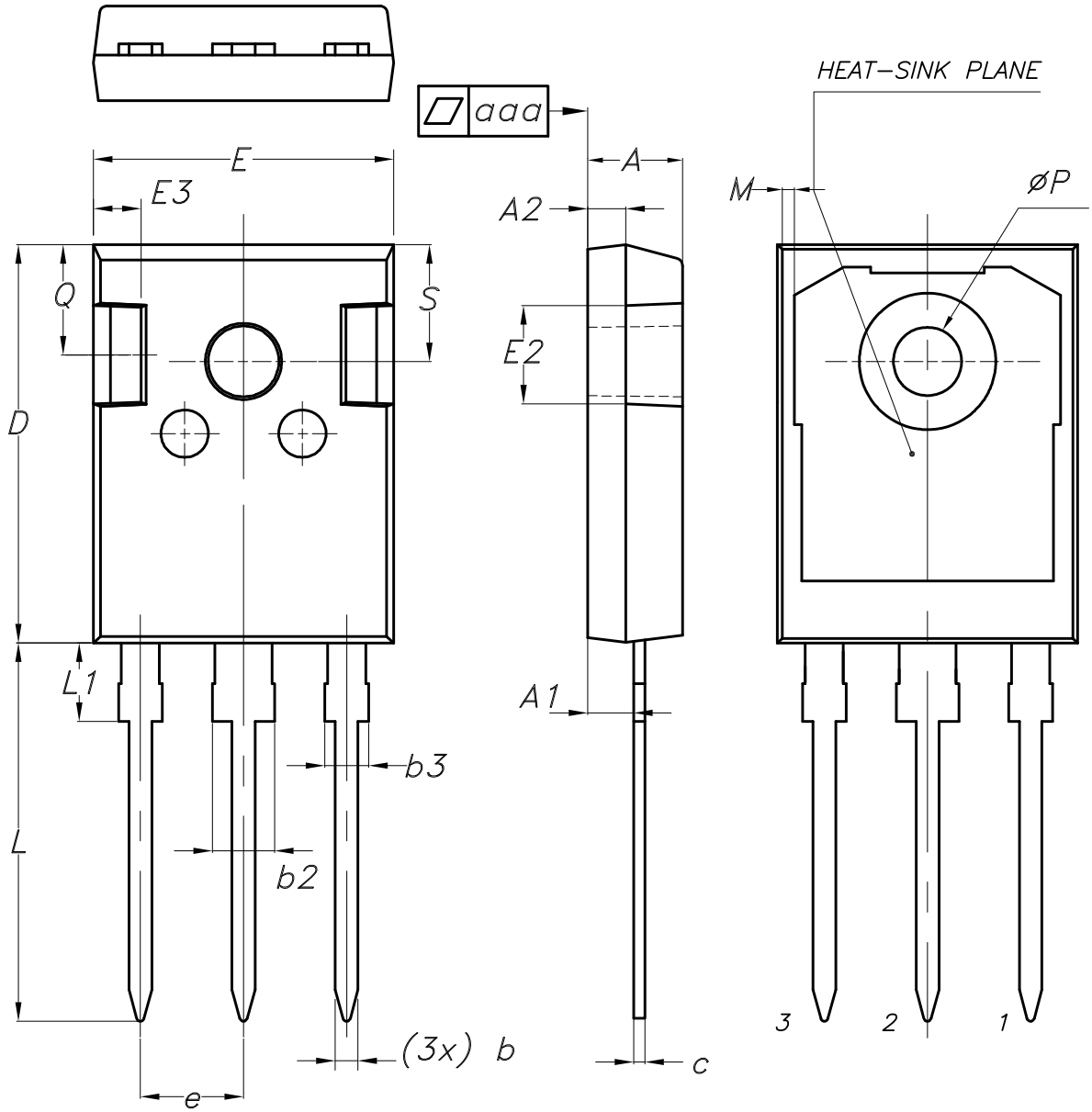
0075325_10

Table 7. 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 |
| aaa | | 0.04 | 0.10 |

4.2 TO-247 long leads package information

Figure 32. TO-247 long leads package outline



BACK VIEW

8463846_5

Table 8. TO-247 long leads package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.90 | 5.00 | 5.10 |
| A1 | 2.31 | 2.41 | 2.51 |
| A2 | 1.90 | 2.00 | 2.10 |
| b | 1.16 | | 1.26 |
| b2 | | | 3.25 |
| b3 | | | 2.25 |
| c | 0.59 | | 0.66 |
| D | 20.90 | 21.00 | 21.10 |
| E | 15.70 | 15.80 | 15.90 |
| E2 | 4.90 | 5.00 | 5.10 |
| E3 | 2.40 | 2.50 | 2.60 |
| e | 5.34 | 5.44 | 5.54 |
| L | 19.80 | 19.92 | 20.10 |
| L1 | | | 4.30 |
| M | 0.35 | | 0.95 |
| P | 3.50 | 3.60 | 3.70 |
| Q | 5.60 | | 6.00 |
| S | 6.05 | 6.15 | 6.25 |
| aaa | | 0.04 | 0.10 |

Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 15-Jan-2013 | 1 | Initial release. |
| 23-Apr-2013 | 2 | Added: – New order code STGWT60V60DF and new package mechanical data TO-3P Table 9 on page 16, Figure 33 on page 15. – Section 2.1: Electrical characteristics (curves) on page 6. |
| 04-Jun-2013 | 3 | Updated Table 4: Static characteristics and Figure 12 on page 7. Document status changed from preliminary to production data. |
| 21-Jun-2013 | 4 | Updated Figure 3: Collector current vs. temperature case. |
| 12-Jul-2013 | 5 | Updated R_{thJC} value for Diode in Table 3: Thermal data. |
| 21-Oct-2013 | 6 | Updated title, features and description in cover page. |
| 28-Sep-2016 | 7 | Added part number STGWA60V60DF and TO-247 long leads package information. Updated Table 2 Table 4 and Table 6. Updated Figure 10: Transfer characteristics. Minor text changes. |
| 20-Jan-2025 | 8 | Updated Section 4.1: TO-247 package information , and Section 4.2: TO-247 long leads package information . Removed TO-3P package information. Updated document title on cover page. Minor text changes. |



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| 3 | Test circuits | 10 |
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| 4.1 | TO-247 package information | 11 |
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