

Trench gate field-stop IGBT, M series 650 V, 75 A low-loss in TO-247 and TO-247 long leads packages

Datasheet - production data

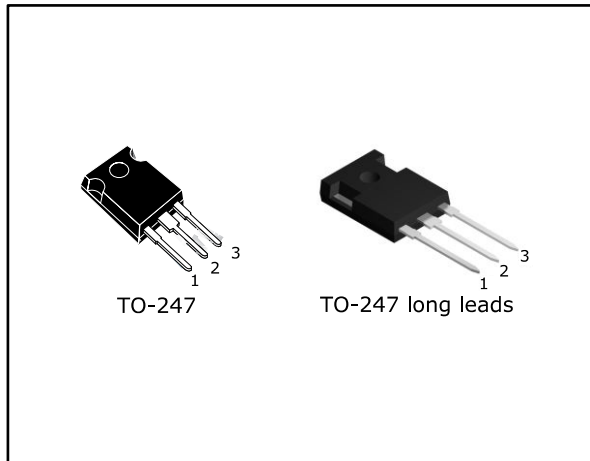
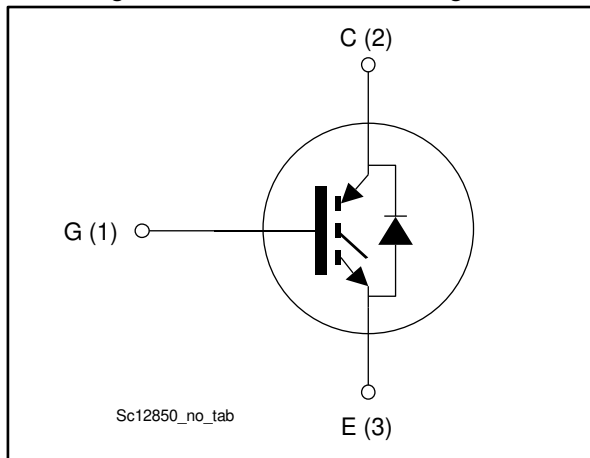


Figure 1: Internal schematic diagram



Features

- 6 μs of short-circuit withstand time
- $V_{CE(sat)} = 1.65 \text{ V (typ.) @ } I_c = 75 \text{ A}$
- Tight parameter distribution
- Safer paralleling
- Positive $V_{CE(sat)}$ temperature coefficient
- Low thermal resistance
- Soft and very fast recovery antiparallel diode
- Maximum junction temperature: $T_J = 175 \text{ }^\circ\text{C}$

Applications

- Motor control
- UPS
- PFC
- General purpose inverter

Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. The devices are part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where low-loss and short-circuit functionality are essential. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

| Order code | Marking | Package | Packing |
|---------------|-----------|-------------------|---------|
| STGW75M65DF2 | G75M65DF2 | TO-247 | Tube |
| STGWA75M65DF2 | | TO-247 long leads | |

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1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|--|-------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$ V) | 650 | V |
| $I_C^{(1)}$ | Continuous collector current at $T_C = 25$ °C | 120 | A |
| I_C | Continuous collector current at $T_C = 100$ °C | 75 | A |
| $I_{CP}^{(2)}$ | Pulsed collector current | 225 | A |
| V_{GE} | Gate-emitter voltage | ±20 | V |
| $I_F^{(1)}$ | Continuous forward current at $T_C = 25$ °C | 120 | A |
| I_F | Continuous forward current at $T_C = 100$ °C | 75 | A |
| $I_{FP}^{(2)}$ | Pulsed forward current | 225 | A |
| P_{TOT} | Total dissipation at $T_C = 25$ °C | 468 | W |
| T_{STG} | Storage temperature range | - 55 to 150 | °C |
| T_J | Operating junction temperature range | - 55 to 175 | °C |

Notes:

(1)Current level is limited by bond wires

(2)Pulse width limited by maximum junction temperature.

Table 3: Thermal data

| Symbol | Parameter | Value | Unit |
|------------|--|-------|------|
| R_{thJC} | Thermal resistance junction-case IGBT | 0.32 | °C/W |
| R_{thJC} | Thermal resistance junction-case diode | 0.74 | °C/W |
| R_{thJA} | Thermal resistance junction-ambient | 50 | °C/W |

2 Electrical characteristics

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

Table 4: Static characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--------------------------------------|---|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage | $V_{GE} = 0\text{ V}$, $I_C = 250\text{ }\mu\text{A}$ | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$, $I_C = 75\text{ A}$ | | 1.65 | 2.1 | V |
| | | $V_{GE} = 15\text{ V}$, $I_C = 75\text{ A}$, $T_J = 125\text{ °C}$ | | 1.95 | | |
| | | $V_{GE} = 15\text{ V}$, $I_C = 75\text{ A}$, $T_J = 175\text{ °C}$ | | 2.1 | | |
| V_F | Forward on-voltage | $I_F = 75\text{ A}$ | | 2 | 2.85 | V |
| | | $I_F = 75\text{ A}$, $T_J = 125\text{ °C}$ | | 1.75 | | |
| | | $I_F = 75\text{ A}$, $T_J = 175\text{ °C}$ | | 1.6 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}$, $I_C = 2\text{ mA}$ | 5 | 6 | 7 | V |
| I_{CES} | Collector cut-off current | $V_{GE} = 0\text{ V}$, $V_{CE} = 650\text{ V}$ | | | 25 | μA |
| I_{GES} | Gate-emitter leakage current | $V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$ | | | ± 250 | μA |

Table 5: Dynamic characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$ | - | 6290 | - | pF |
| C_{oes} | Output capacitance | | - | 390 | - | |
| C_{res} | Reverse transfer capacitance | | - | 136 | - | |
| Q_g | Total gate charge | $V_{CC} = 520\text{ V}$, $I_C = 75\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 30: "Gate charge test circuit") | - | 225 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 53 | - | |
| Q_{gc} | Gate-collector charge | | - | 87 | - | |

Table 6: IGBT switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|------------------------------|---|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 75\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 3.3\ \Omega$ (see Figure 29: "Test circuit for inductive load switching") | | 47 | - | ns |
| t_r | Current rise time | | | 22.4 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 2680 | - | A/ μ s |
| $t_{d(off)}$ | Turn-off-delay time | | | 125 | - | ns |
| t_f | Current fall time | | | 93 | - | ns |
| $E_{on}^{(1)}$ | Turn-on switching energy | | | 0.69 | - | mJ |
| $E_{off}^{(2)}$ | Turn-off switching energy | | | 2.54 | - | mJ |
| E_{ts} | Total switching energy | | | 3.23 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 75\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 3.3\ \Omega$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 29: "Test circuit for inductive load switching") | | 48 | - | ns |
| t_r | Current rise time | | | 25 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 2420 | - | A/ μ s |
| $t_{d(off)}$ | Turn-off-delay time | | | 125 | - | ns |
| t_f | Current fall time | | | 167 | - | ns |
| $E_{on}^{(1)}$ | Turn-on switching energy | | | 2.17 | - | mJ |
| $E_{off}^{(2)}$ | Turn-off switching energy | | | 3.45 | - | mJ |
| E_{ts} | Total switching energy | | | 5.62 | - | mJ |
| t_{sc} | Short-circuit withstand time | $V_{CC} \leq 400\text{ V}$, $V_{GE} = 13\text{ V}$, $T_{Jstart} \leq 150\text{ }^\circ\text{C}$ | 10 | | - | μ s |
| | | $V_{CC} \leq 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} \leq 150\text{ }^\circ\text{C}$ | 6 | | | |

Notes:

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

Table 7: Diode switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--|---|------|------|------|------------|
| t_{rr} | Reverse recovery time | $I_F = 75\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 29: "Test circuit for inductive load switching") | - | 165 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 1.72 | - | μ C |
| I_{rrm} | Reverse recovery current | | - | 25 | - | A |
| dl_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 750 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 289 | - | μ J |
| t_{rr} | Reverse recovery time | $I_F = 75\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 29: "Test circuit for inductive load switching") | - | 256 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 6.85 | - | μ C |
| I_{rrm} | Reverse recovery current | | - | 48 | - | A |
| dl_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 300 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 1033 | - | μ J |

2.1 Electrical characteristics (curves)

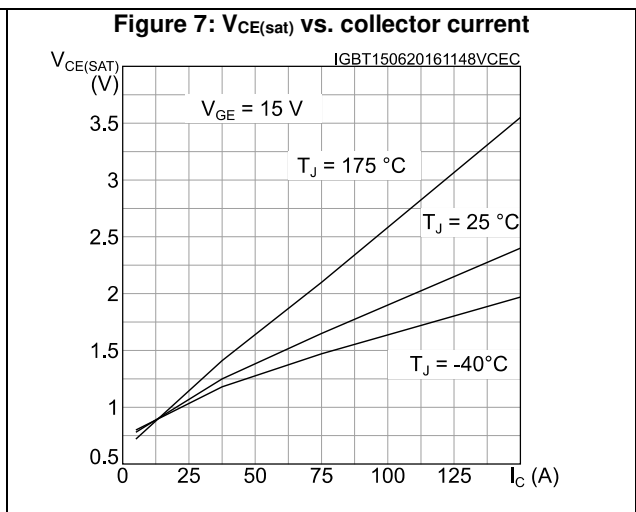
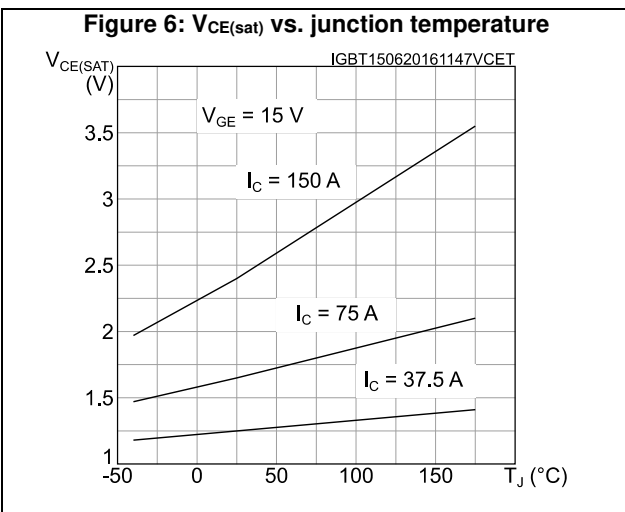
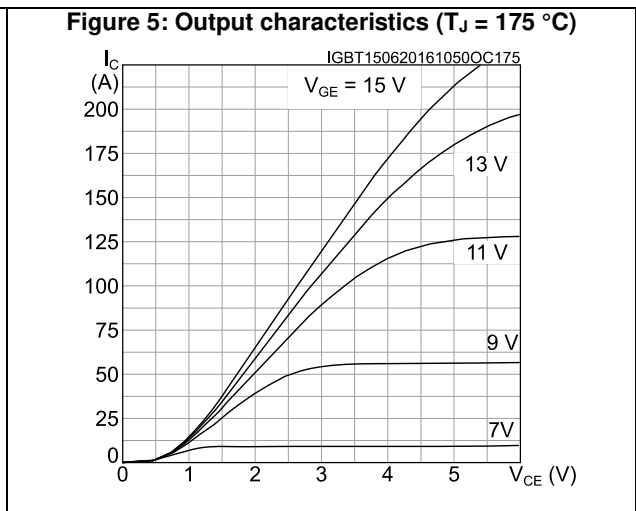
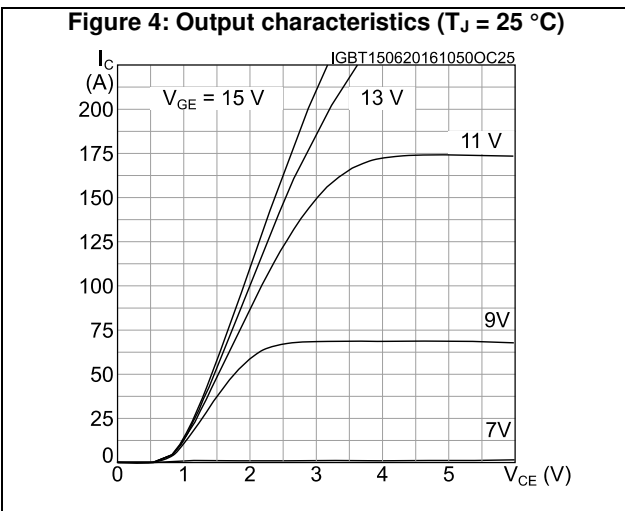
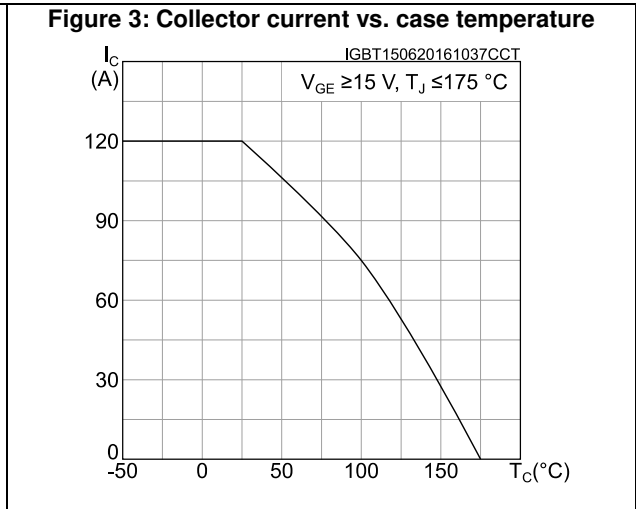
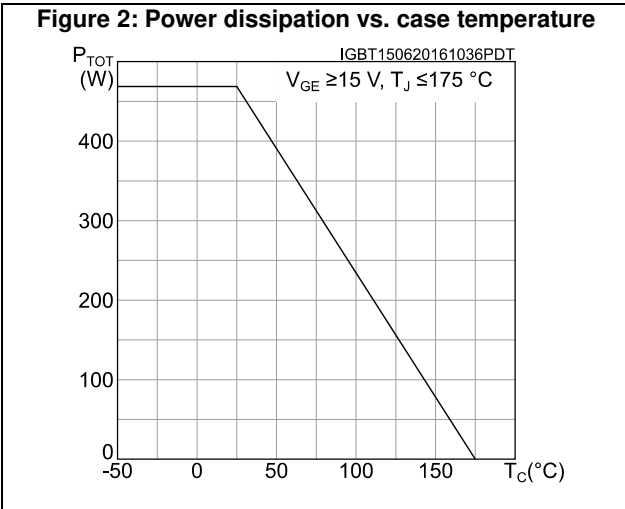


Figure 8: Collector current vs. switching frequency

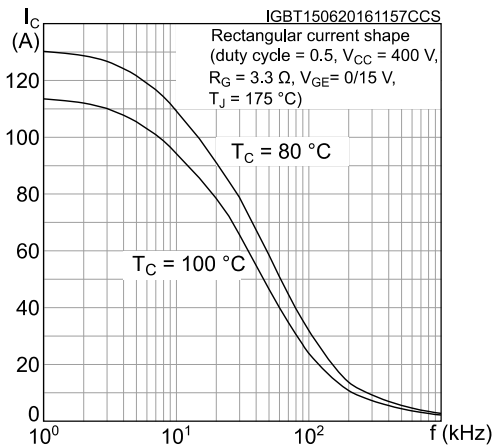


Figure 9: Forward bias safe operating area

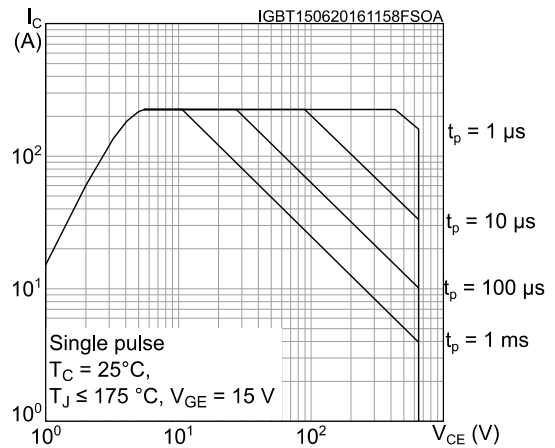


Figure 10: Transfer characteristics

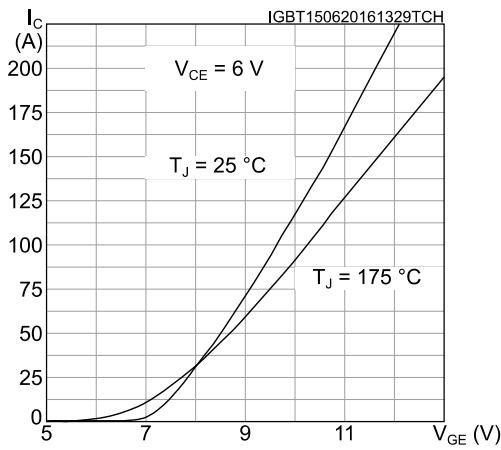


Figure 11: Diode V_F vs. forward current

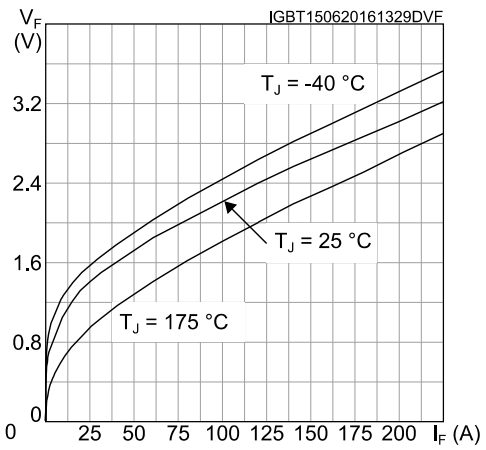


Figure 12: Normalized V_GE(th) vs. junction temperature

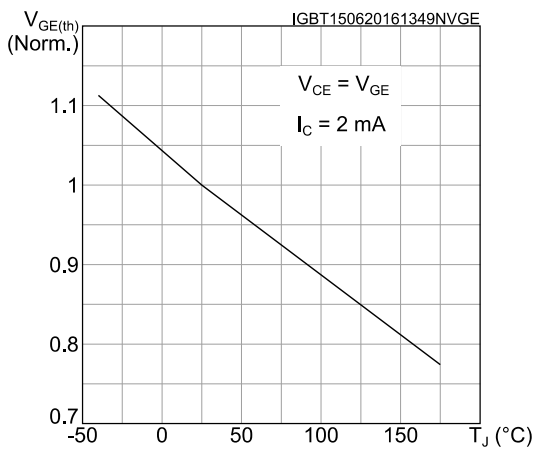
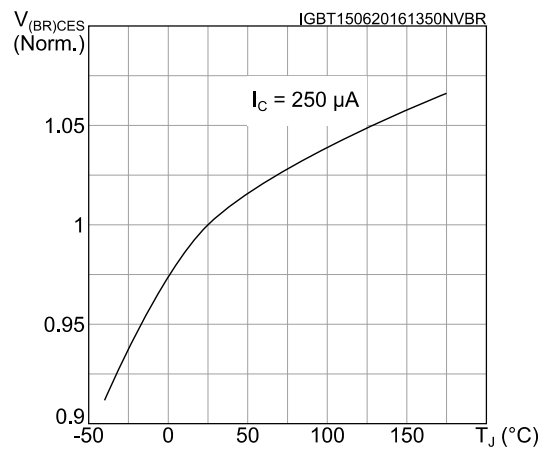
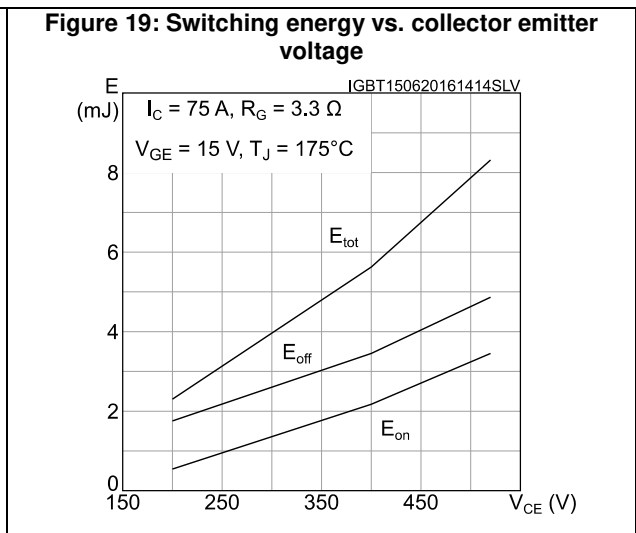
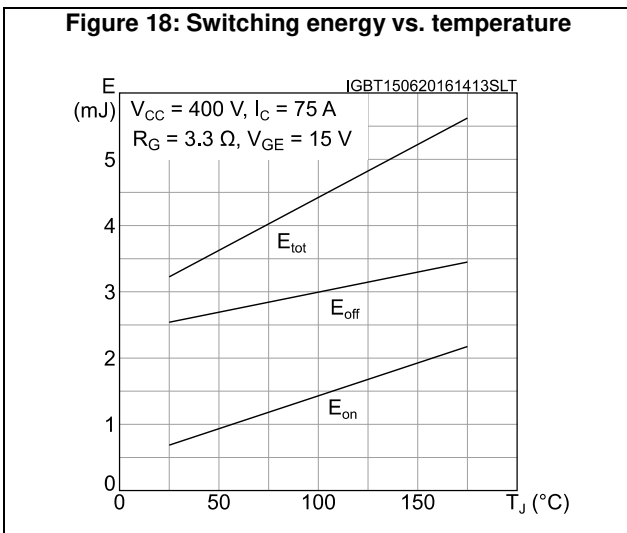
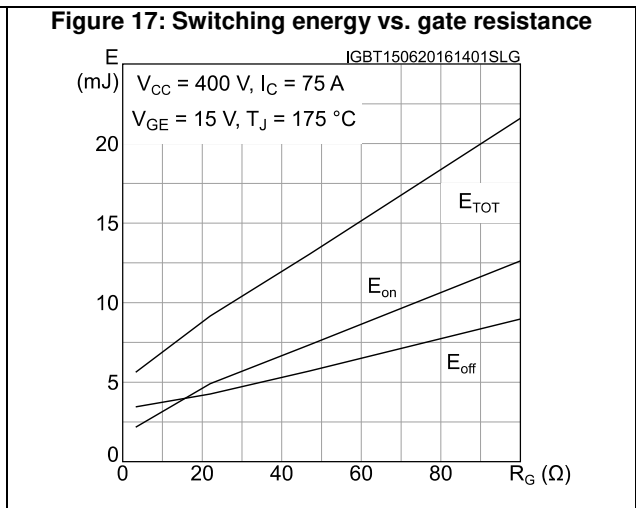
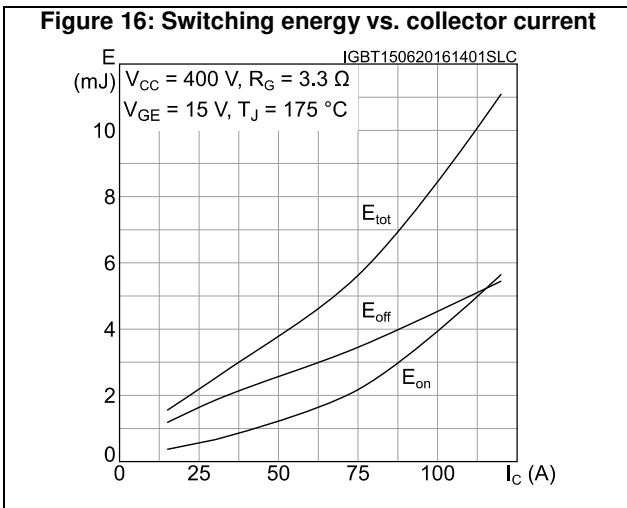
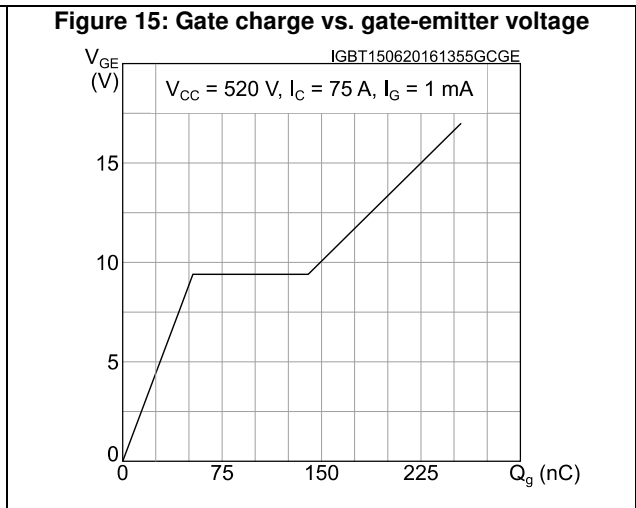
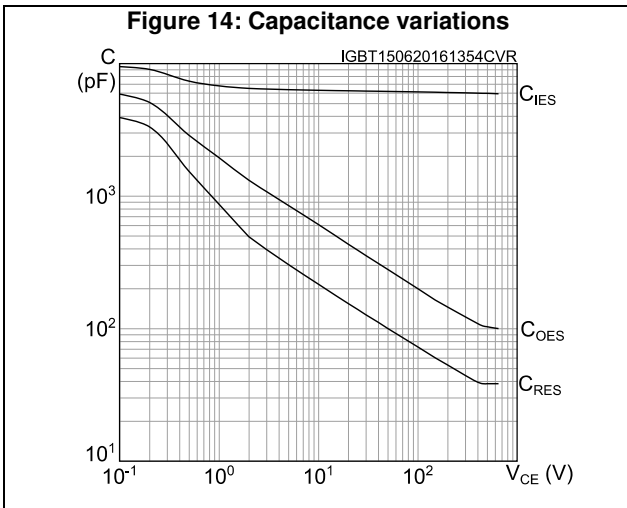


Figure 13: Normalized V_BR(CES) vs. junction temperature



Electrical characteristics

STGW75M65DF2, STGWA75M65DF2



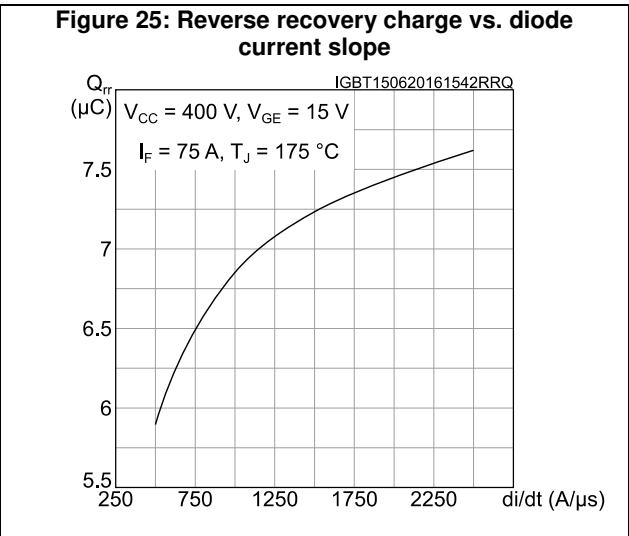
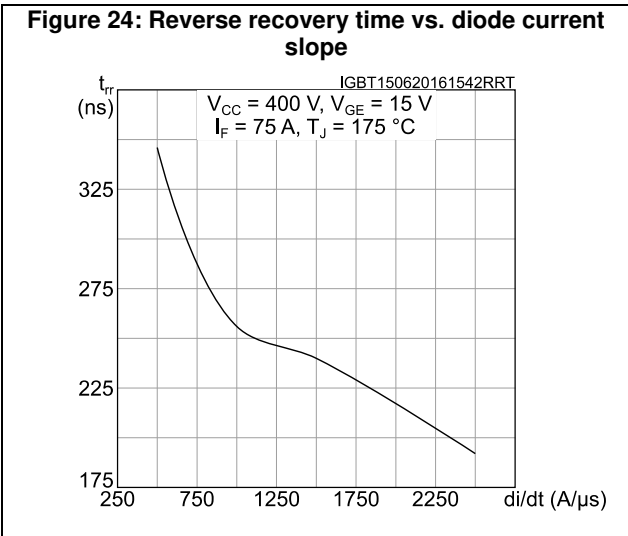
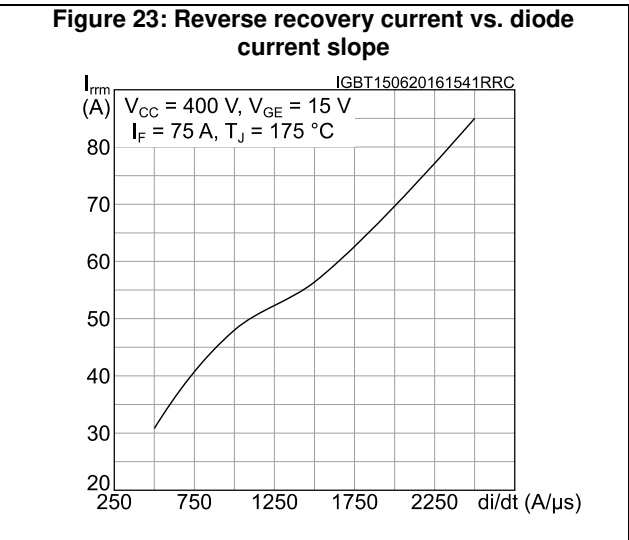
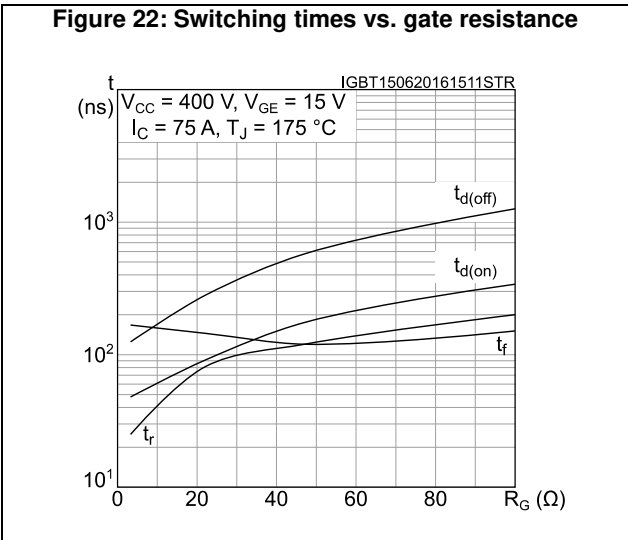
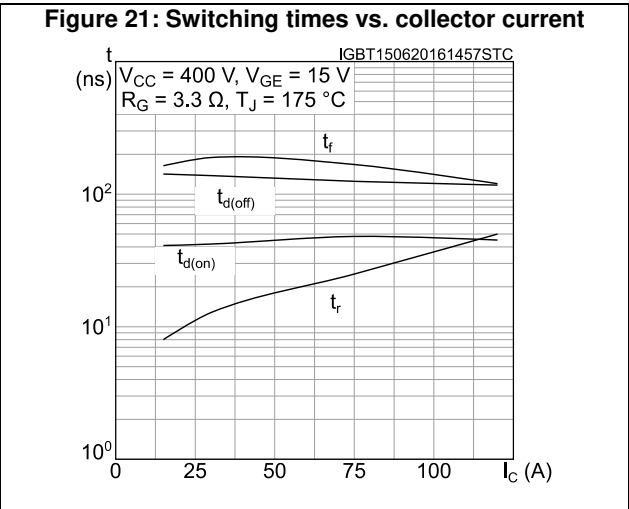
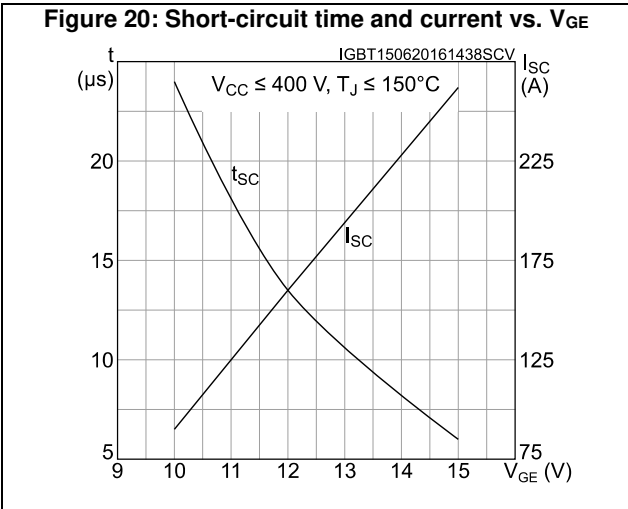


Figure 26: Reverse recovery energy vs. diode current slope

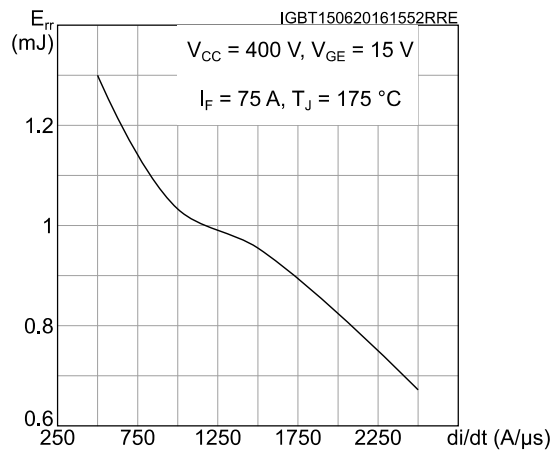


Figure 27: Thermal impedance for IGBT

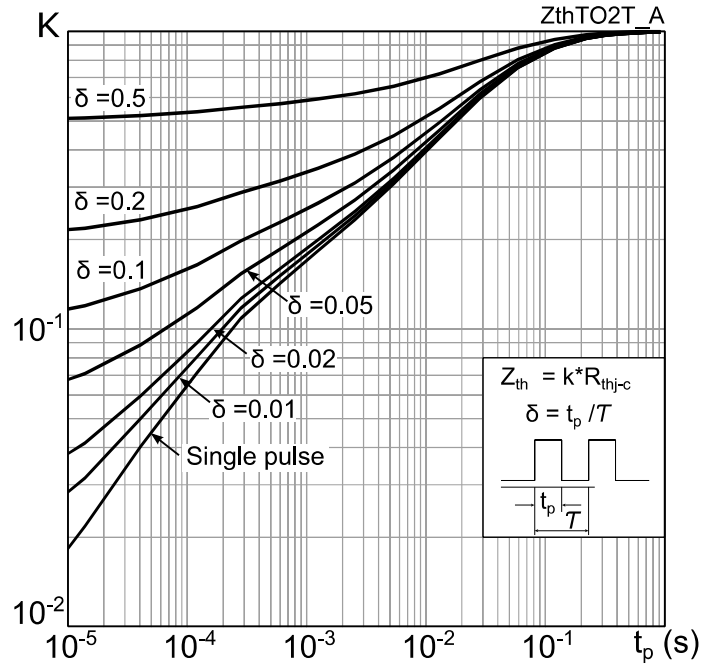
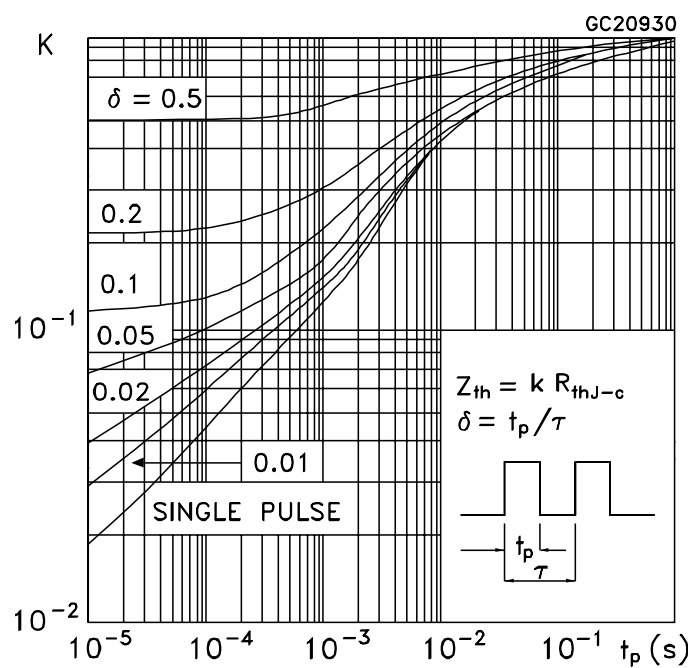
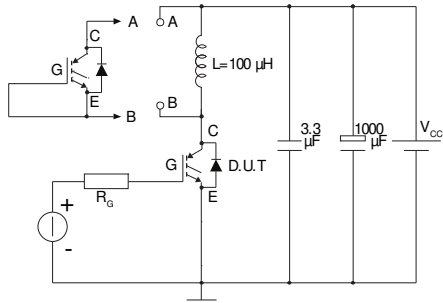


Figure 28: Thermal impedance for diode



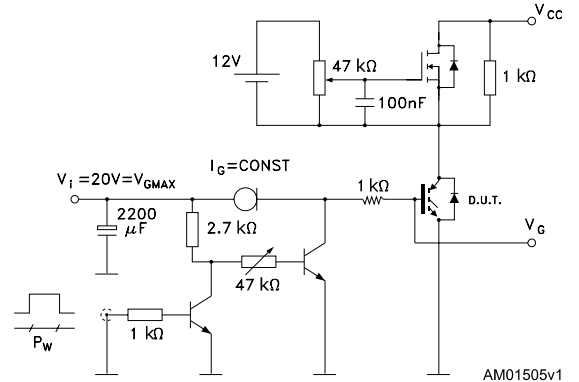
3 Test circuits

Figure 29: Test circuit for inductive load switching



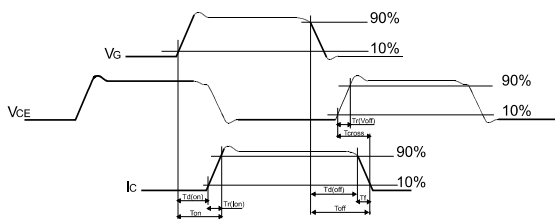
AM01504v1

Figure 30: Gate charge test circuit



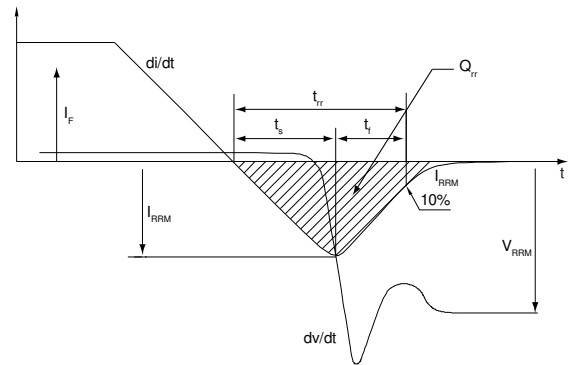
AM01505v1

Figure 31: Switching waveform



AM01506v1

Figure 32: Diode reverse recovery waveform



AM01507v1

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 33: TO-247 package outline

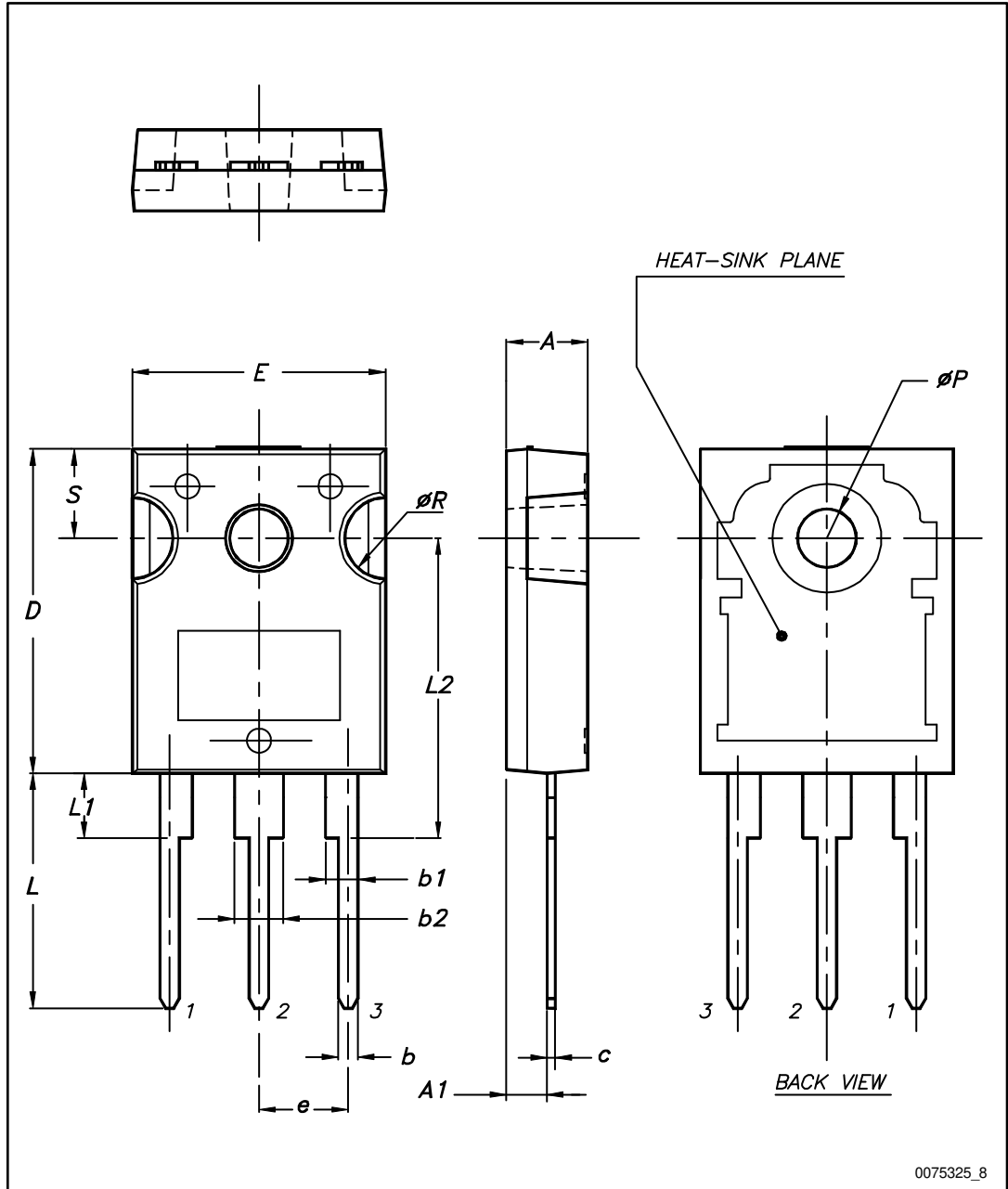


Table 8: TO-247 package mechanical data

| 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 |

4.2 TO-247 long leads package information

Figure 34: TO-247 long leads package outline

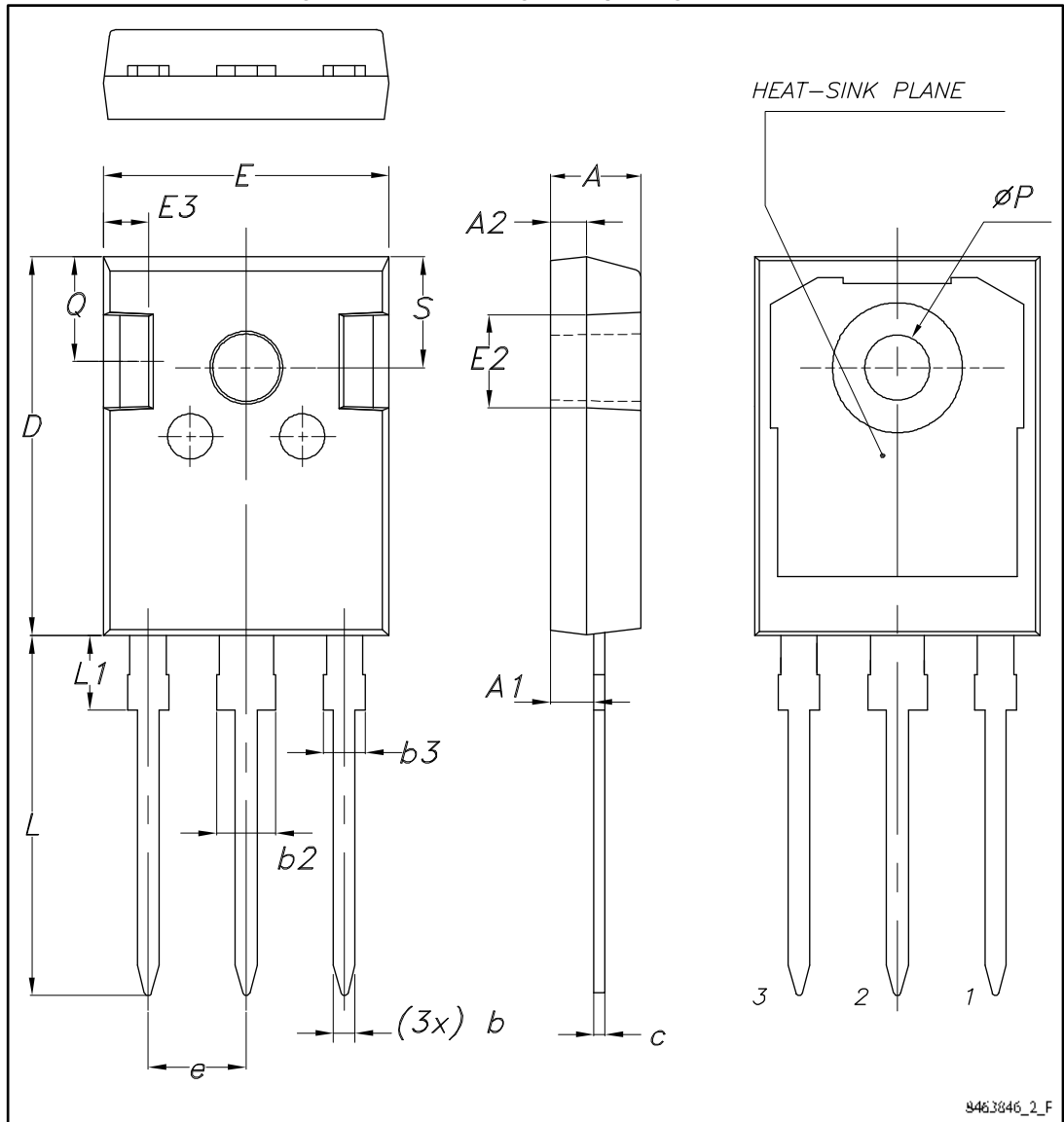


Table 9: TO-247 long leads package mechanical data

| 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 |
| P | 3.50 | 3.60 | 3.70 |
| Q | 5.60 | | 6.00 |
| S | 6.05 | 6.15 | 6.25 |

5 Revision history

Table 10: Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 02-Dec-2015 | 1 | First release. |
| 15-Jun-2016 | 2 | Inserted device in TO-247 and document updated accordingly. Inserted <i>Section 2.1: "Electrical characteristics (curves)"</i> . Document status promoted from preliminary to production data. Minor text changes. |
| 03-May-2017 | 3 | Modified: title, features and application on cover page. Modified <i>Table 4: "Static characteristics"</i> , <i>Table 7: "Diode switching characteristics (inductive load)"</i> and <i>Figure 13: "Normalized $V_{(BR)CES}$ vs. junction temperature"</i> . Minor text changes. |

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