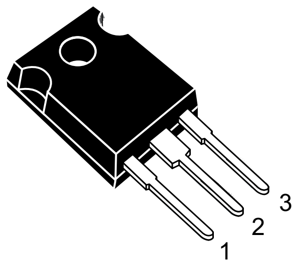
life.augmented

# STGW25M120DF3
# STGWA25M120DF3

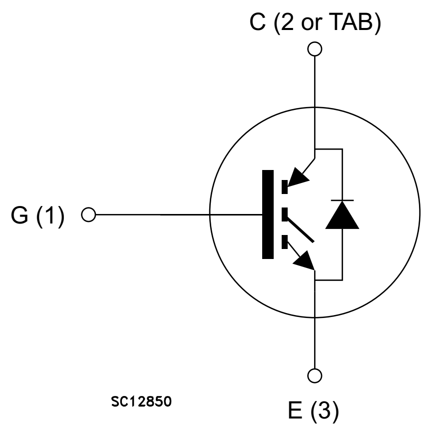
## Trench gate field-stop IGBT, M series 1200 V, 25 A low loss

**Datasheet - production data**




**TO-247**
**TO-247 long leads**

**Figure 1.Internal schematic diagram**




## Features

- 10 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.85 V (typ.) @ $I_C$ = 25 A
- Tight parameters distribution
- Safer paralleling
- Low thermal resistance
- Soft and fast recovery antiparallel diode

## Applications

- Industrial drives
- UPS
- Solar
- Welding

## Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series of IGBTs, which represent an optimum compromise in performance to maximize the efficiency of inverter systems where low-loss and short circuit capability are essential. Furthermore, a positive $V_{CE(sat)}$ temperature coefficient and tight parameter distribution result in safer paralleling operation.

**Table 1. Device summary**

| Order code | Marking | Package | Packaging |
|---|---|---|---|
| STGW25M120DF3 | G25M120DF3 | TO-247 | Tube |
| STGWA25M120DF3 | G25M120DF3 | TO-247 long leads | Tube |

# Contents

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0) | 1200 | V |
| $I_C$ | Continuous collector current at $T_C$ = 25 °C | 50 | A |
| $I_C$ | Continuous collector current at $T_C$ = 100 °C | 25 | A |
| $I_{CP}$ (1) | Pulsed collector current | 100 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C | 50 | A |
| $I_F$ | Continuous forward current at $T_C$ = 100 °C | 25 | A |
| $I_{FP}$ (1) | Pulsed forward current | 100 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 375 | W |
| $T_{STG}$ | Storage temperature range | - 55 to 150 | °C |
| $T_J$ | Operating junction temperature | - 55 to 175 | °C |

1. Pulse width limited by maximum junction temperature.

**Table 3. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case IGBT | 0.4 | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 0.96 | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50 | °C/W |

# 2 Electrical characteristics

$T_J$ = 25 °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) | $I_C$ = 2 mA | 1200 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 25 A | | 1.85 | 2.3 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 25 A, $T_J$ = 125 °C | | 2.1 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 25 A $T_J$ = 175 °C | | 2.2 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 25 A | | 2.95 | 4.1 | V |
| | | $I_F$ = 25 A $T_J$ = 125 °C | | 2.25 | | V |
| | | $I_F$ = 25 A $T_J$ = 175 °C | | 1.9 | | V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA | 5 | 6 | 7 | V |
| $I_{CES}$ | Collector cut-off current ($V_{GE}$ = 0) | $V_{CE}$ = 1200 V | | | 25 | µA |
| $I_{GES}$ | Gate-emitter leakage current ($V_{CE}$ = 0) | $V_{GE}$ = ± 20 V | | | 250 | nA |

**Table 5. Dynamic characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input capacitance | $V_{CE}$ = 25 V, f = 1 MHz, $V_{GE}$ = 0 | - | 1550 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 180 | - | pF |
| $C_{res}$ | Reverse transfer capacitance | | - | 65 | - | pF |
| $Q_g$ | Total gate charge | $V_{CC}$ = 960 V, $I_C$ =25 A, $V_{GE}$ = 15 V, see *Figure 30* | - | 85 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 11.5 | - | nC |
| $Q_{gc}$ | Gate-collector charge | | - | 45.5 | - | nC |

**Table 6. IGBT switching characteristics (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 600 V, $I_C$ = 25 A, $V_{GE}$ = 15 V, $R_G$= 15 Ω see *Figure 29* | - | 28 | - | ns |
| $t_r$ | Current rise time | | - | 15 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1370 | - | A/µs |
| $t_{d(off)}$ | Turn-off delay time | | - | 150 | - | ns |
| $t_f$ | Current fall time | | - | 155 | - | ns |
| $E_{on}$(1) | Turn-on switching losses | | - | 0.85 | - | mJ |
| $E_{off}$(2) | Turn-off switching losses | | - | 1.3 | - | mJ |
| $E_{ts}$ | Total switching losses | | - | 2.15 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 600 V, $I_C$ = 25 A, $R_G$= 15 Ω, $V_{GE}$ = 15 V, $T_J$ = 175 °C, see *Figure 29* | - | 28 | - | ns |
| $t_r$ | Current rise time | | - | 17 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1270 | - | A/µs |
| $t_{d(off)}$ | Turn-off delay time | | - | 155 | - | ns |
| $t_f$ | Current fall time | | - | 240 | - | ns |
| $E_{on}$(1) | Turn-on switching losses | | - | 1.6 | - | mJ |
| $E_{off}$(2) | Turn-off switching losses | | - | 1.9 | - | mJ |
| $E_{ts}$ | Total switching losses | | - | 3.5 | - | mJ |
| $t_{sc}$ | Short-circuit withstand time | $V_{CC}$ ≤ 600V, $V_{GE}$= 15V, $T_{Jstart}$ ≤ 150°C | 10 | | - | µs |

1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also 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 | $I_F$ = 25 A, $V_R$ = 600 V, $V_{GE}$ = 15 V, see *Figure 29* di/dt = 1000 A/µs | - | 265 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 1.2 | - | µC |
| $I_{rrm}$ | Reverse recovery current | | - | 19 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 1090 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 0.22 | - | mJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 25 A, $V_R$ = 600 V, $V_{GE}$ = 15 V, $T_J$ = 175 °C, see *Figure 29* di/dt = 1000 A/µs | - | 585 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 5 | - | µC |
| $I_{rrm}$ | Reverse recovery current | | - | 30 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 270 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 0.75 | - | mJ |

## 2.1 Electrical characteristics (curves)

**Figure 2. Power dissipation vs. case temperature**

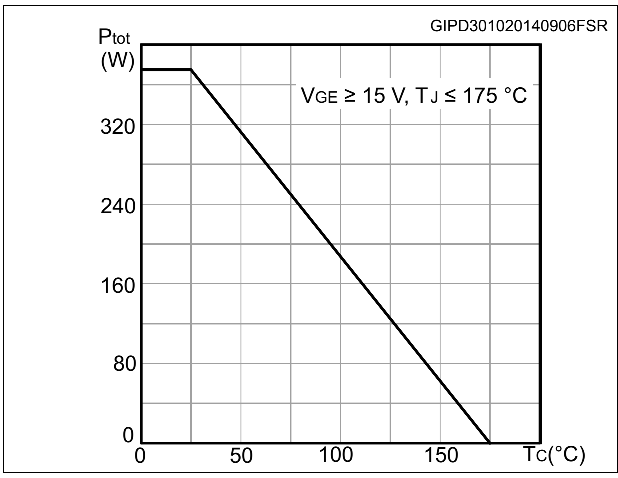



**Figure 3. Collector current vs. case temperature**

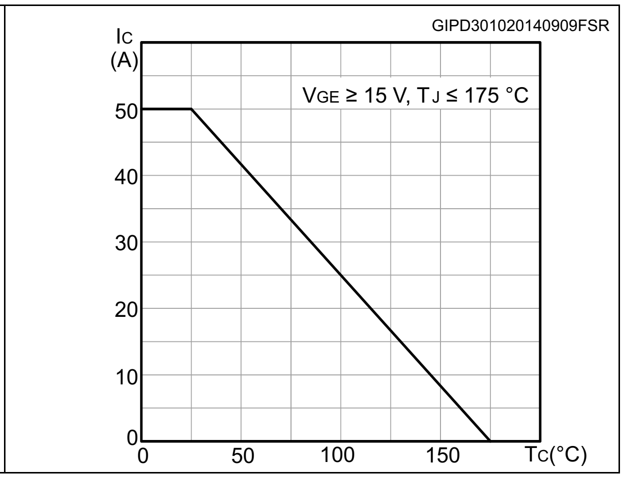



**Figure 4. Output characteristics ($T_J$=25°C)**

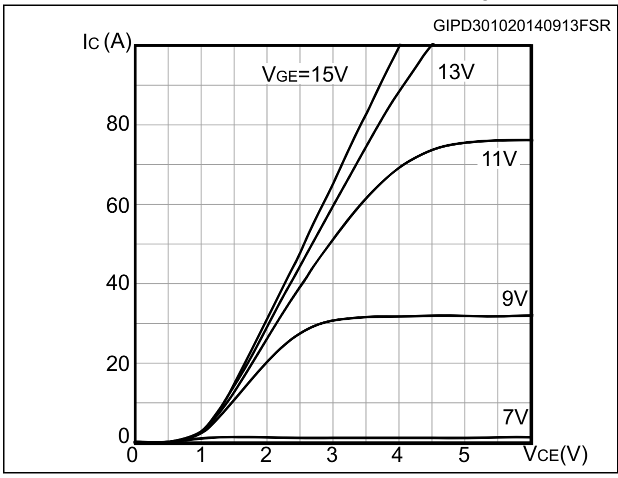



**Figure 5. Output characteristics ($T_J$=175°C)**

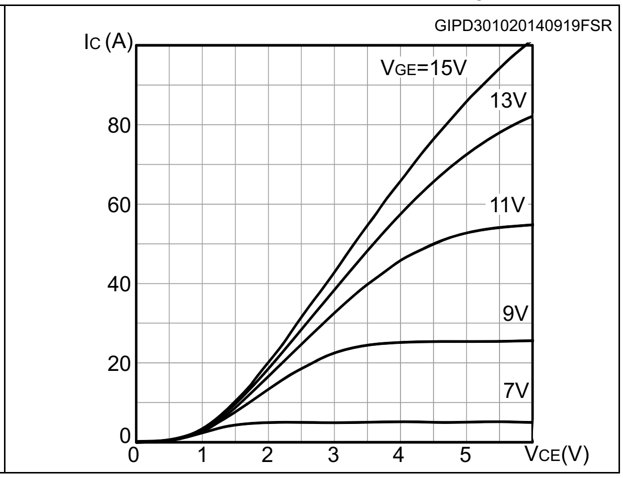



**Figure 6. $V_{CE(sat)}$ vs. junction temperature**

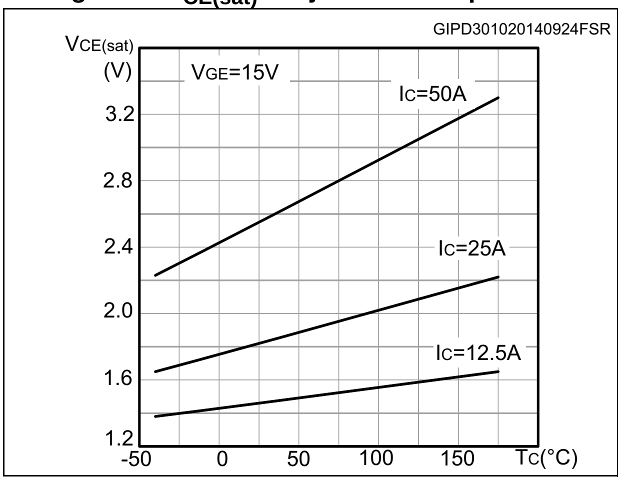



**Figure 7. $V_{CE(sat)}$ vs. collector current**

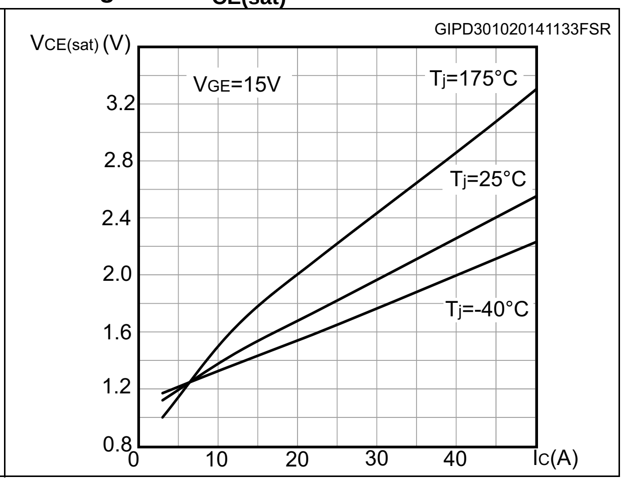


**Figure 8. Collector current vs. switching frequency**

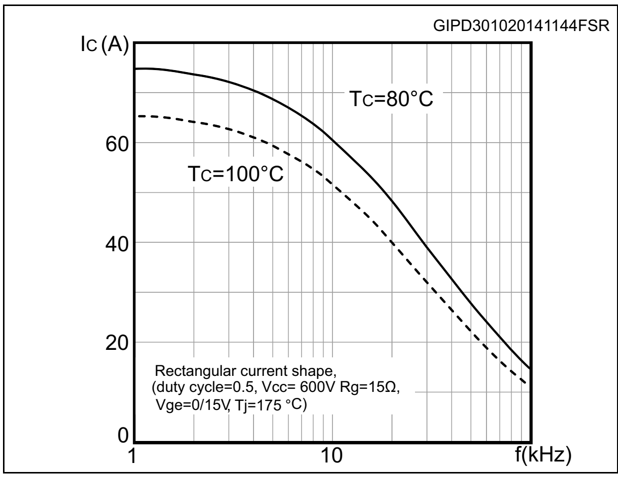



**Figure 9. Safe operating area**

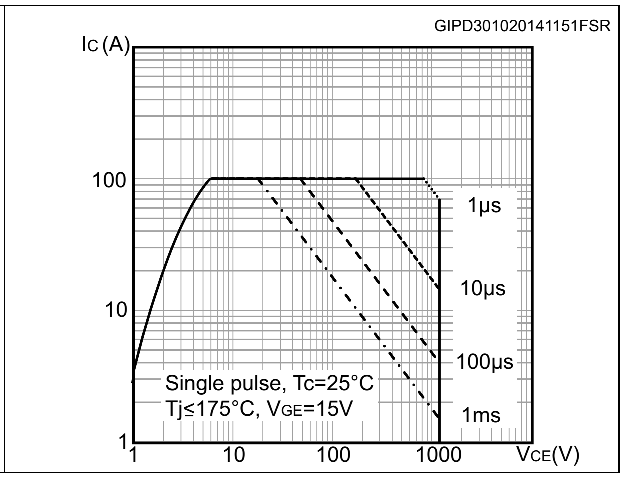



**Figure 10. Transfer characteristics**

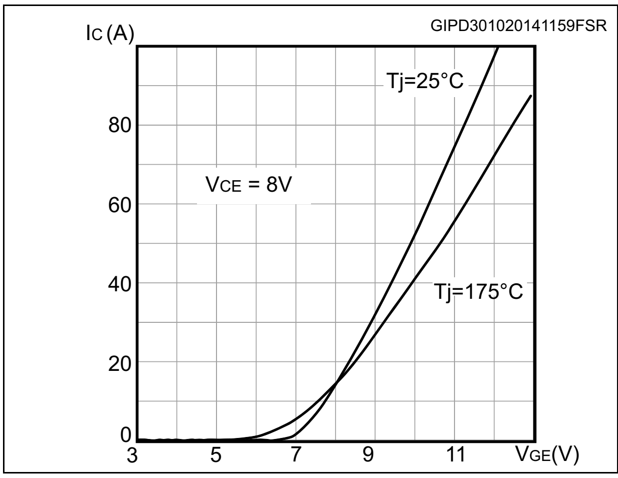



**Figure 11. Diode $V_F$ vs forward current**

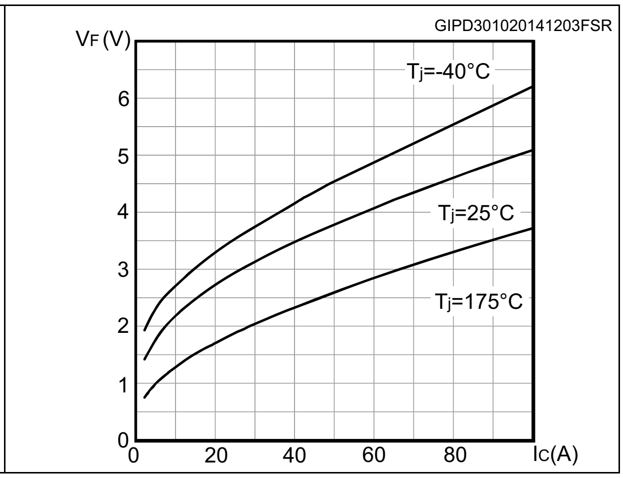



**Figure 12. Normalized $V_{GE(th)}$ vs junction temperature**

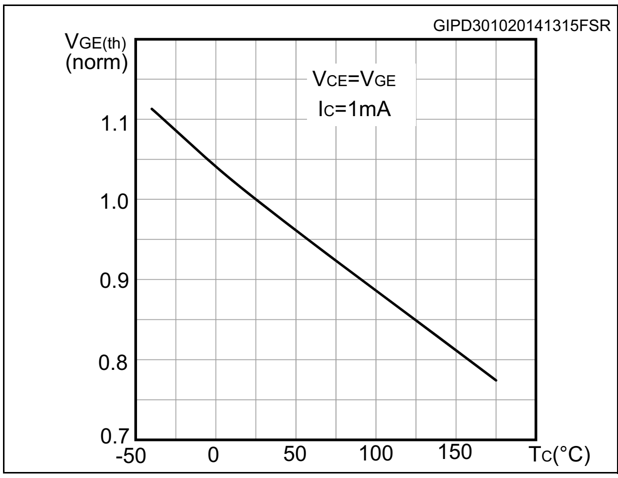



**Figure 13. Normalized $V_{(BR)CES}$ vs. junction temperature**

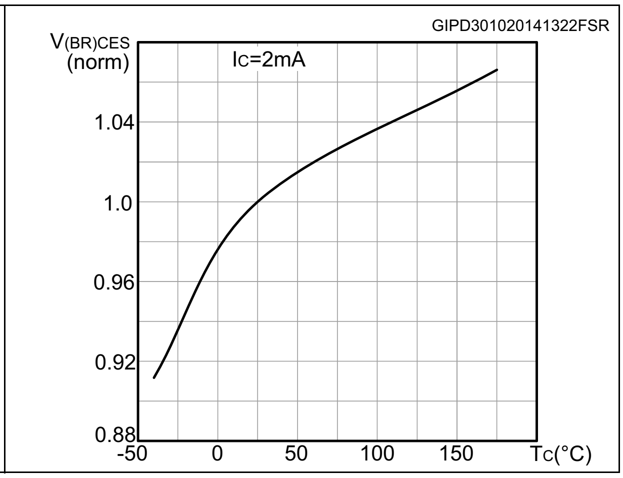


**Figure 14. Capacitance variations**

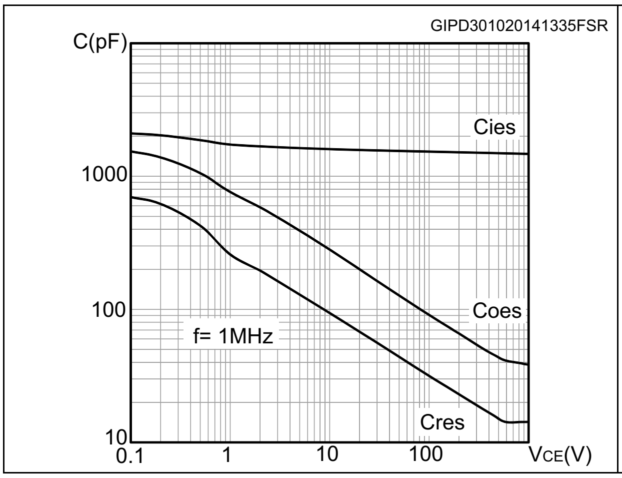



**Figure 15. Gate charge vs. gate-emitter voltage**

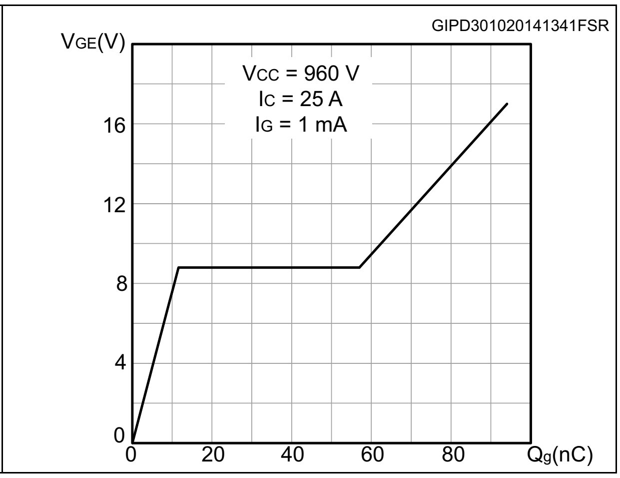



**Figure 16. Switching losses vs. collector current**

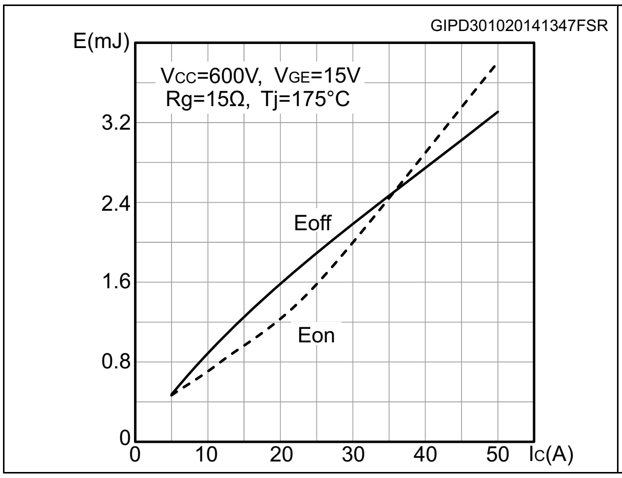



**Figure 17. Switching losses vs. gate resistance**

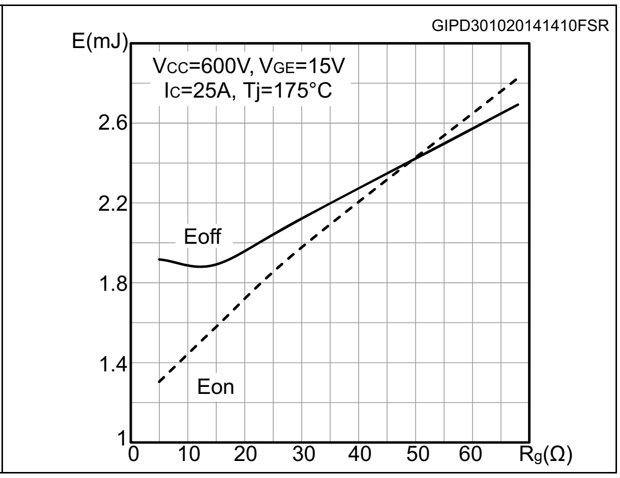



**Figure 18. Switching losses vs. junction temperature**

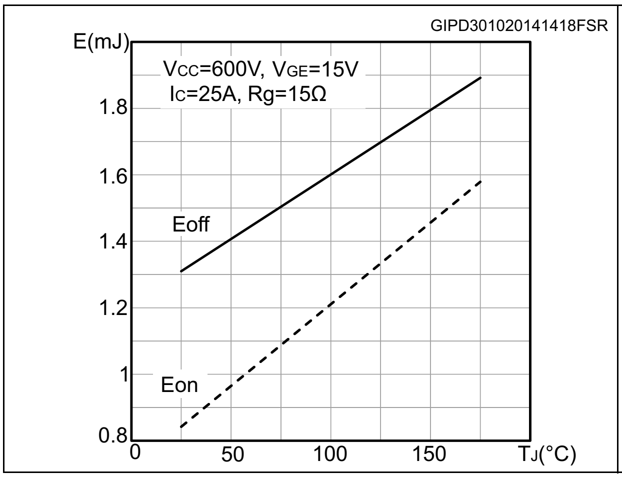



**Figure 19. Switching losses vs. collector emitter voltage**

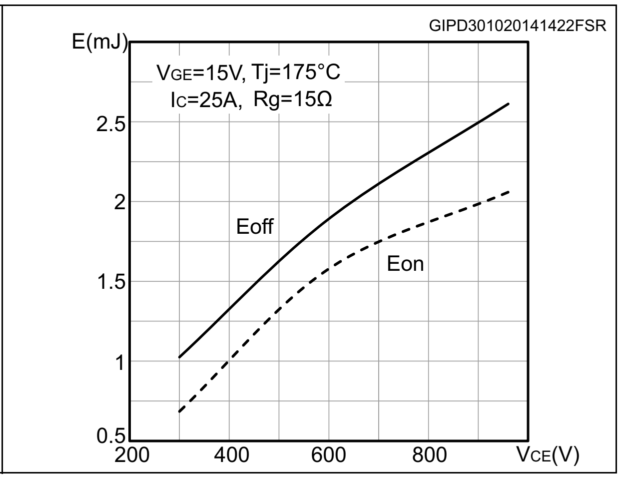


Figure 20. Short-circuit time and current vs. $V_{GE}$

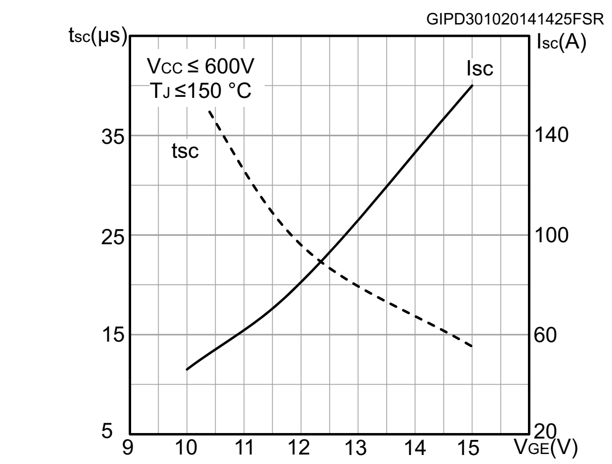



Figure 21. Switching times vs. collector current

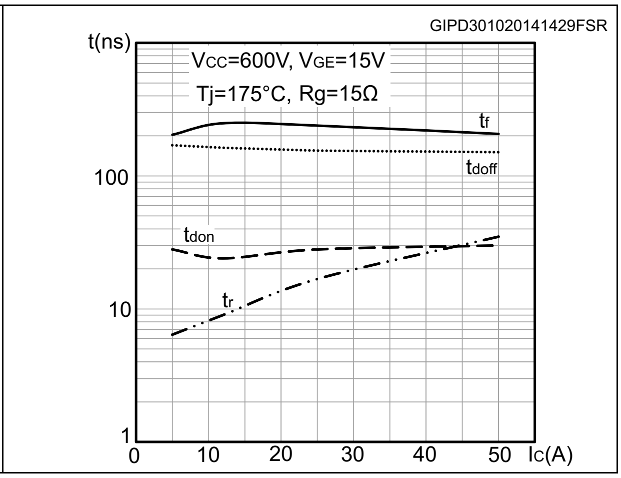



Figure 22. Switching times vs. gate resistance

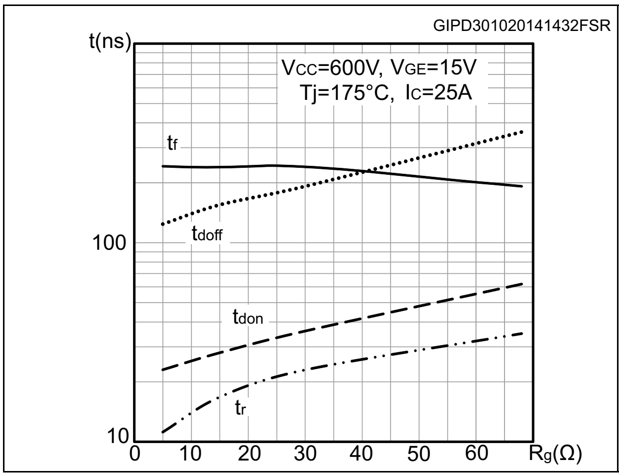



Figure 23.Reverse recovery current vs. diode current slope

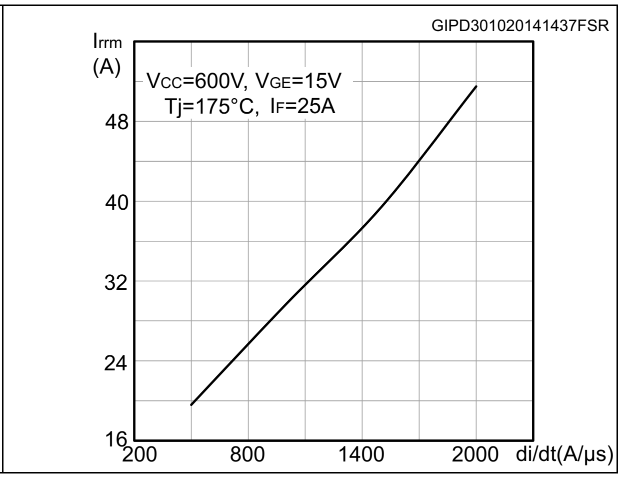



Figure 24. Reverse recovery time vs. diode current slope

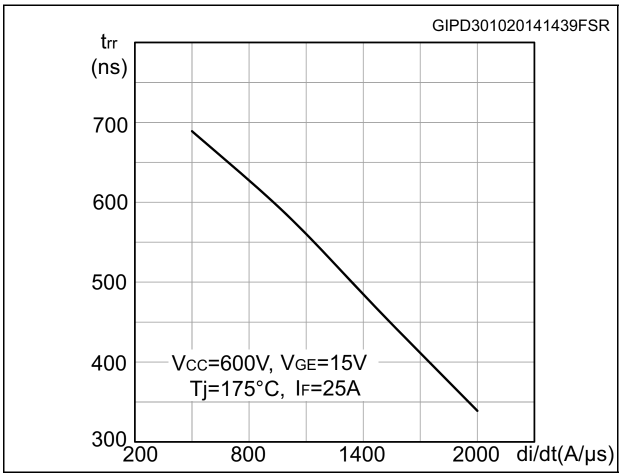



Figure 25.Reverse recovery charge vs. diode current slope

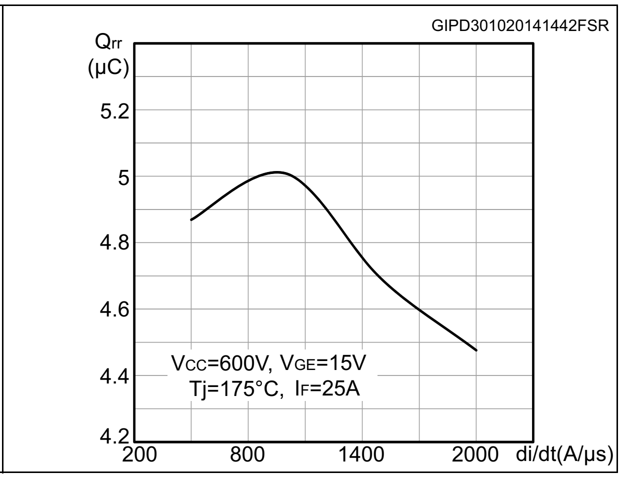


**Figure 26. Reverse recovery energy vs. diode current slope**

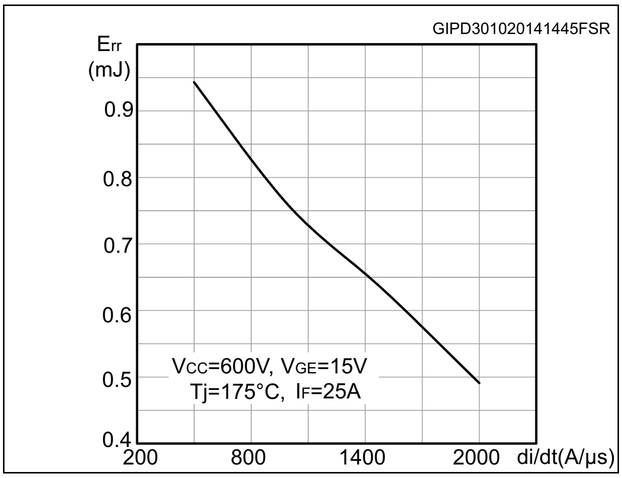


Figure 27.Thermal impedance for IGBT

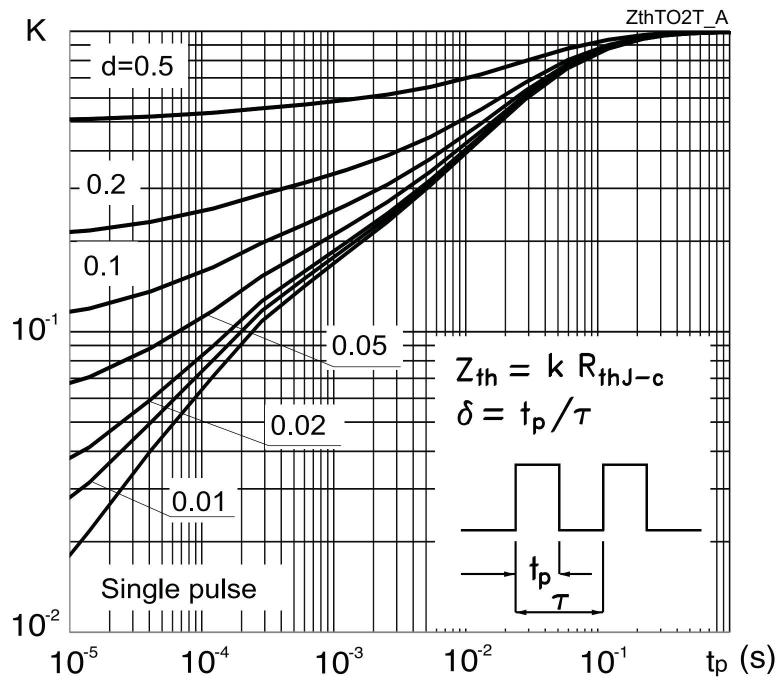
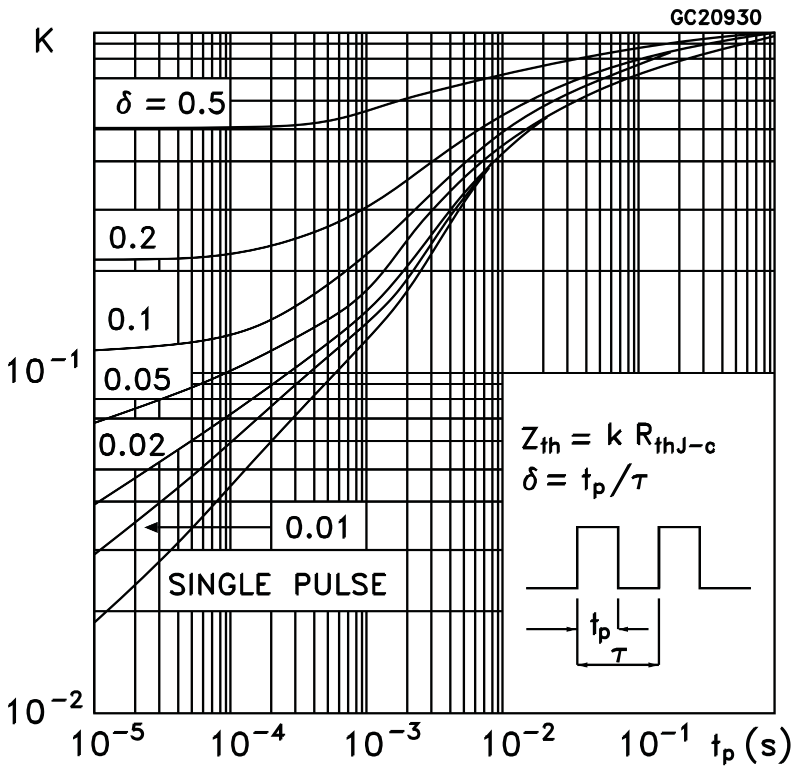



Figure 28.Thermal impedance for diode



# 3 Test circuits

**Figure 29. Test circuit for inductive load switching**

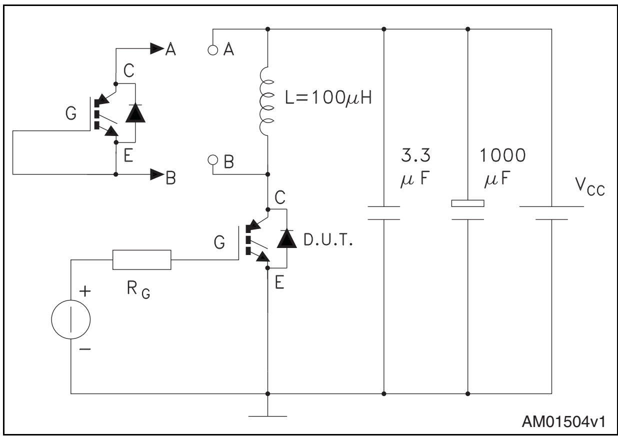



**Figure 30. Gate charge test**

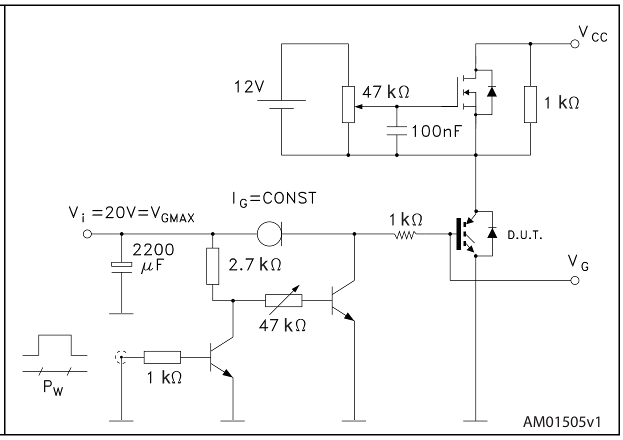



**Figure 31. Switching waveform**

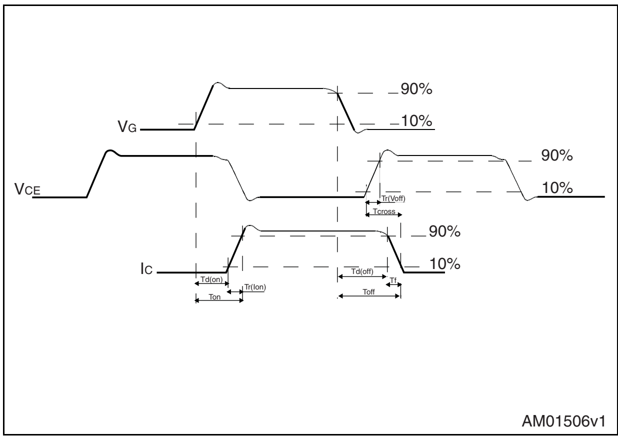
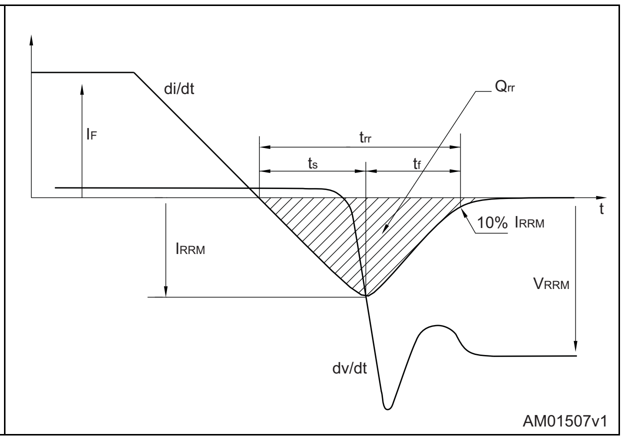



**Figure 32. Diode reverse recovery waveform**



# 4 Package mechanical data

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, STGW25M120DF3

**Figure 33. TO-247 drawing**

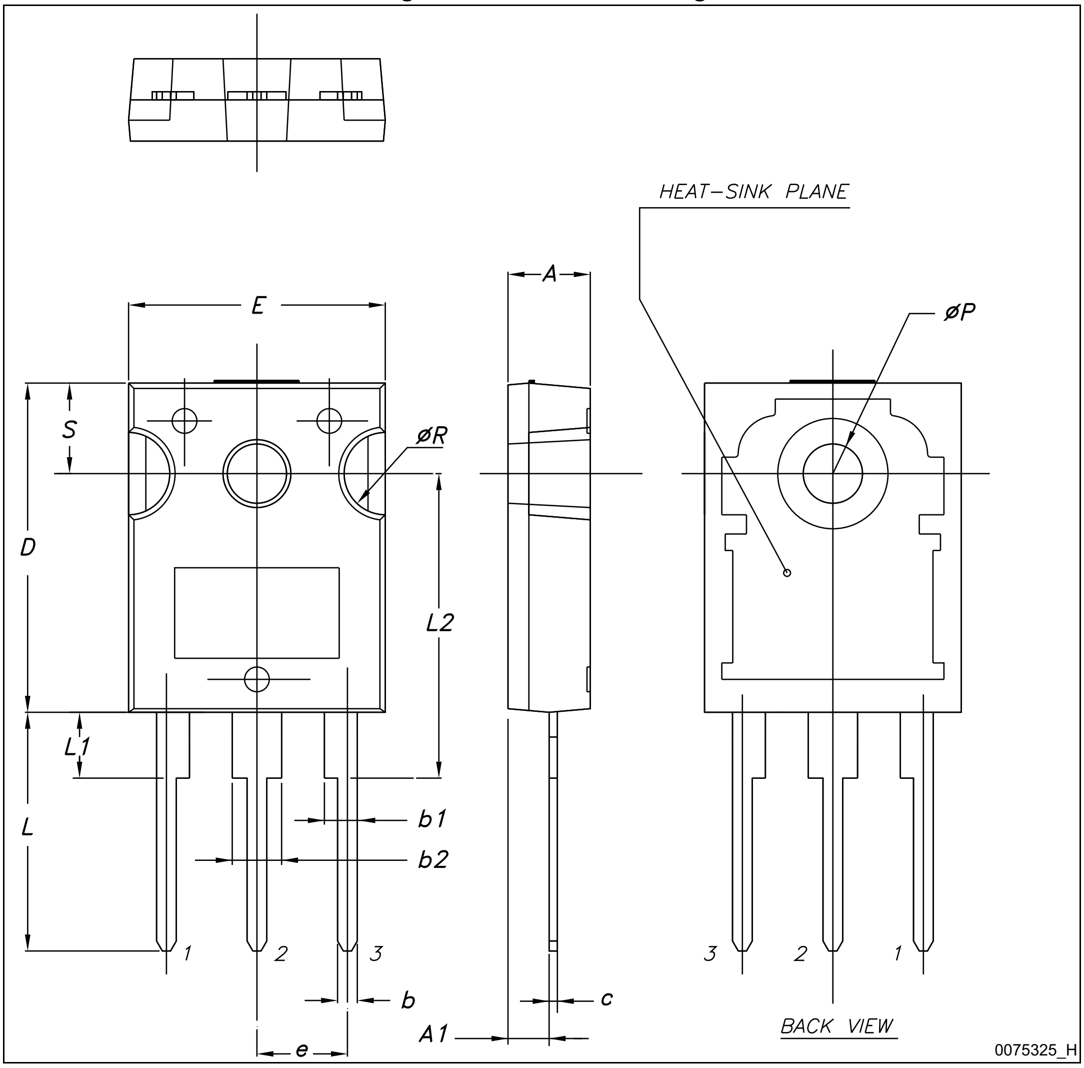


**Table 8. TO-247 mechanical data**

| 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 | |
| ∅P | 3.55 | | 3.65 |
| ∅R | 4.50 | | 5.50 |
| S | 5.30 | 5.50 | 5.70 |

## 4.2 TO-247 long leads, STGWA25M120DF3

**Figure 34. TO-247 long leads drawing**

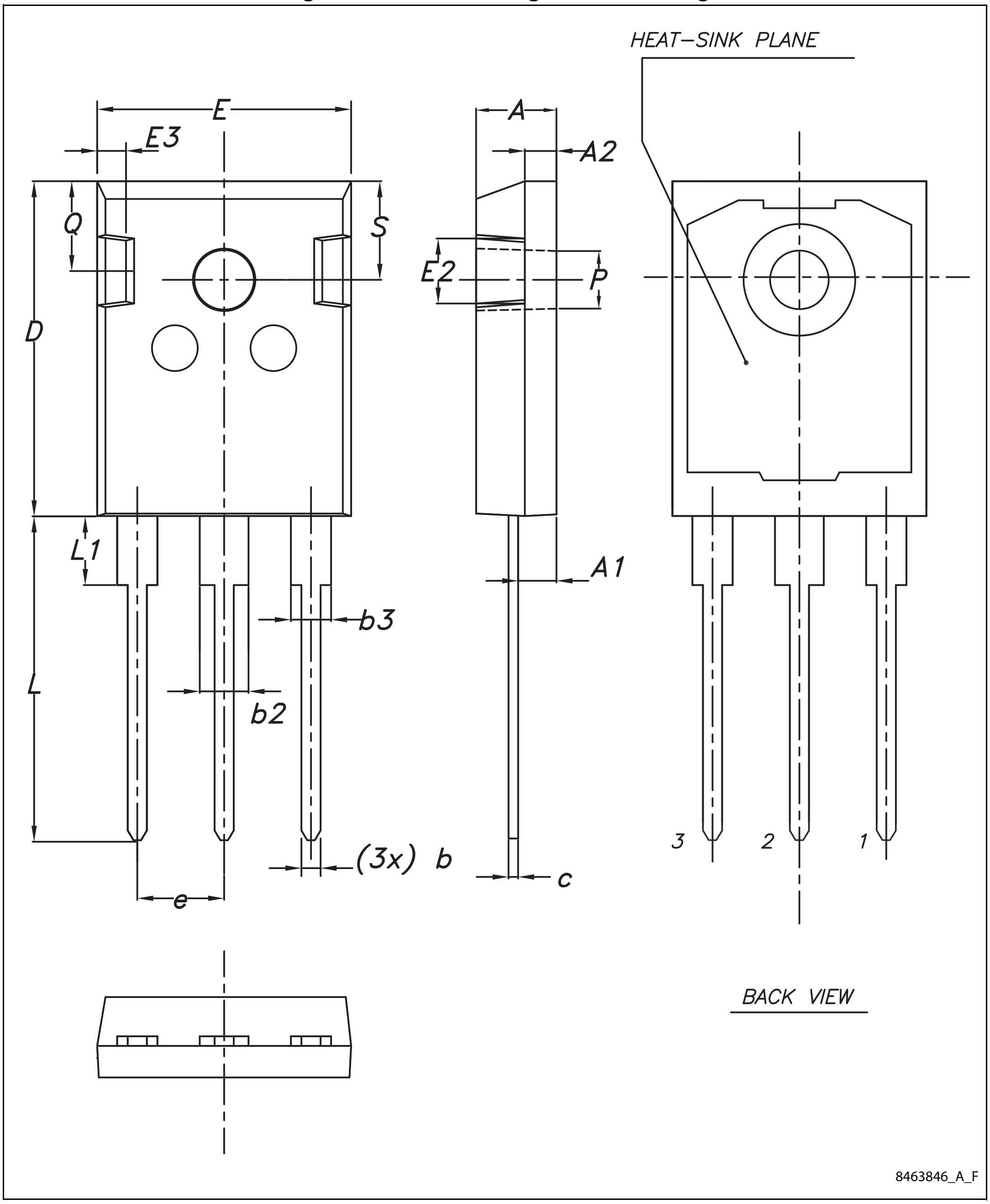


**Table 9. TO-247 long leads mechanical data**

| 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 |
|---|---|---|
| 22-Apr-2014 | 1 | Initial release. |
| 31-Oct-2014 | 2 | Document status promoted from preliminary to production data.<br>Updated all the document accordingly.<br>Added *Section 2.1: Electrical characteristics (curves)*.<br>Updated *Section 4: Package mechanical data*. |