# STGW60H65DFB-4

## Trench gate field-stop IGBT, HB series 650 V, 60 A high speed

Datasheet - production data

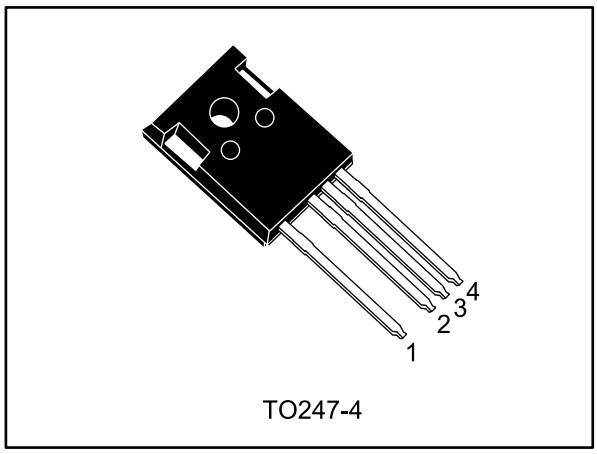
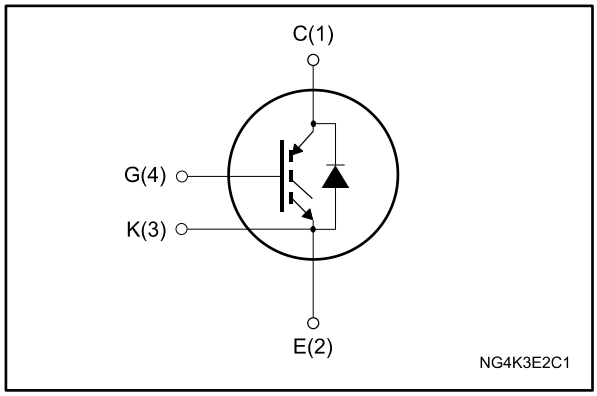



**Figure 1: Internal schematic diagram**




## Features

- Maximum junction temperature: $T_J$ = 175 °C
- Kelvin pin
- Low $V_{CE(sat)}$ = 1.6 V (typ.) @ $I_C$ = 60 A
- Minimized tail current
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode

## Applications

- Photovoltaic inverter
- High frequency converter

## Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the new HB series of IGBTs, which represents an optimum compromise between conduction and switching loss to maximize the efficiency of any frequency converter. A faster switching event can be achieved by the Kelvin pin, which separates power path from driving signal. Furthermore, the slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

**Table 1: Device summary**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STGW60H65DFB-4 | G60H65DFB | TO247-4 | Tube |

# Contents

# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0 V) | 650 | V |
| $I_C$ | 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 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 | |

**Notes:**

(1)Current level is limited by bond wires.

(2)Pulse width is 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 | 1.14 | |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50 | |

# 2 Electrical characteristics

$T_C$ = 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 V, $I_C$ = 2 mA | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 60 A | | 1.6 | 2.0 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 60 A, $T_J$ = 125 °C | | 1.75 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 60 A, $T_J$ = 175 °C | | 1.85 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 60 A | | 2 | 2.6 | V |
| | | $I_F$ = 60 A, $T_J$ = 125 °C | | 1.7 | | |
| | | $I_F$ = 60 A, $T_J$ = 175 °C | | 1.6 | | |
| $V_{GE(th)}$ | 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, $V_{CE}$ = 650 V | | | 25 | µA |
| $I_{GES}$ | Gate-emitter leakage current | $V_{CE}$ = 0 V, $V_{GE}$ = ±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 V | - | 7792 | - | nF |
| $C_{oes}$ | Output capacitance | | - | 262 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 158 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 60 A, $V_{GE}$ = 0 to 15 V (see *Figure 29: " Gate charge test circuit"* | - | 306 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 126 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 58 | - | |

**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 V, $I_C$ = 60 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω (see *Figure 28: " Test circuit for inductive load switching"* ) | - | 65 | - | ns |
| $t_r$ | Current rise time | | - | 26 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1846 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 261 | - | ns |
| $t_f$ | Current fall time | | - | 21 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | - | 346 | - | µJ |
| $E_{off}$(2) | Turn-off switching energy | | - | 1161 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 1507 | - | µJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 60 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω $T_J$ = 175 °C (see *Figure 28: " Test circuit for inductive load switching"* ) | - | 61 | - | ns |
| $t_r$ | Current rise time | | - | 30 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1640 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 284 | - | ns |
| $t_f$ | Current fall time | | - | 45 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | - | 644 | - | µJ |
| $E_{off}$(2) | Turn-off switching energy | | - | 1633 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 2277 | - | µJ |

**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 | $I_F$ = 60 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs (see *Figure 28: " Test circuit for inductive load switching"*) | - | 60 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 99 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 3.3 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 187 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 68 | - | µJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 60 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs, $T_J$ = 175 °C (see *Figure 28: " Test circuit for inductive load switching"*) | - | 310 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 1550 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 10 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 59 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 674 | - | µJ |

## 2.1 Electrical characteristics (curves)

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

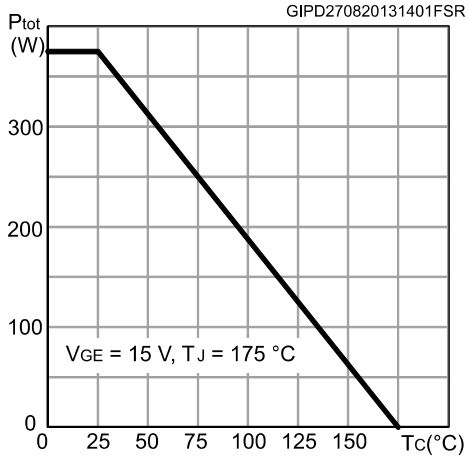



**Figure 3: Collector current vs. case temperature**

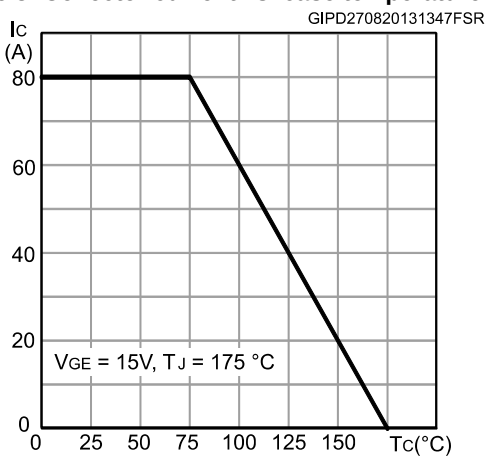



**Figure 4: Output characteristics ($T_J$ = 25 °C)**

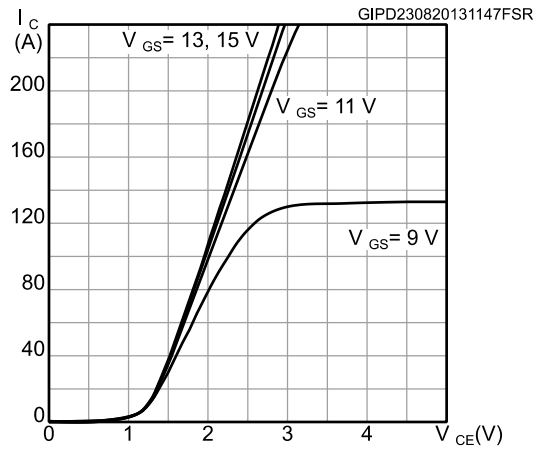



**Figure 5: Output characteristics ($T_J$ = 175 °C)**

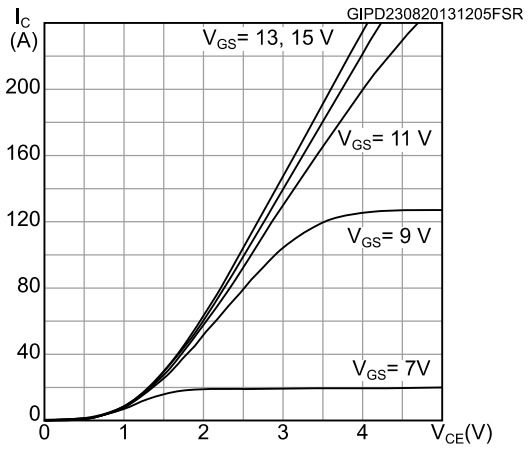



**Figure 6: $V_{CE(sat)}$ vs. junction temperature**

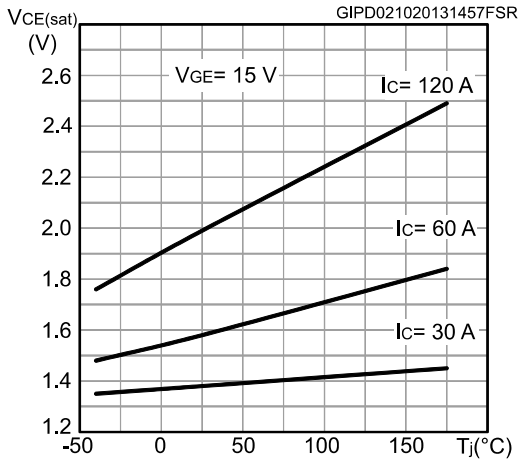



**Figure 7: $V_{CE(sat)}$ vs. collector current**

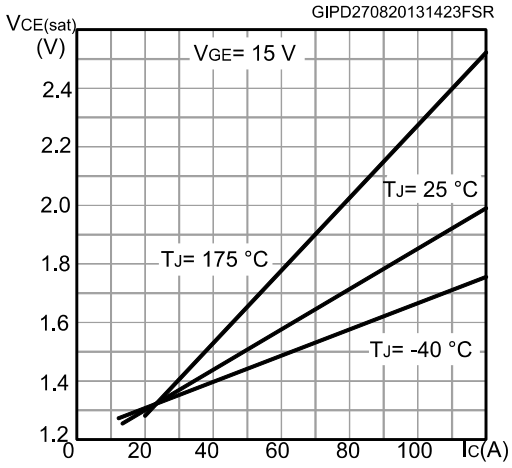


**Figure 8: Collector current vs. switching frequency**

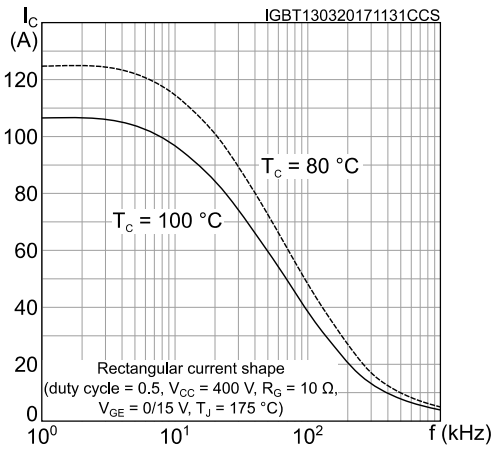



**Figure 9: Forward bias safe operating area**

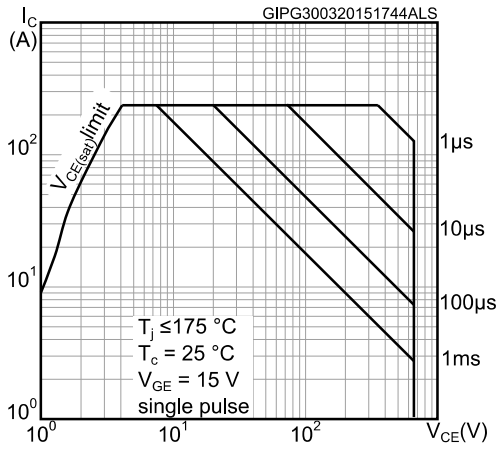



**Figure 10: Transfer characteristics**

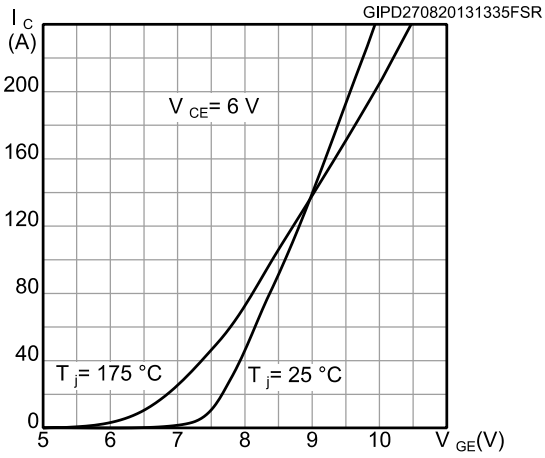



**Figure 11: Diode $V_F$ vs. forward current**

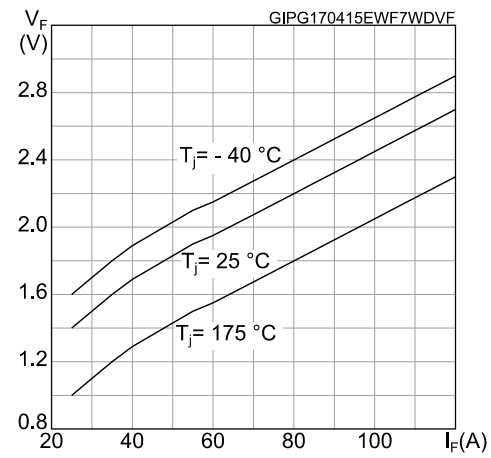



**Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature**

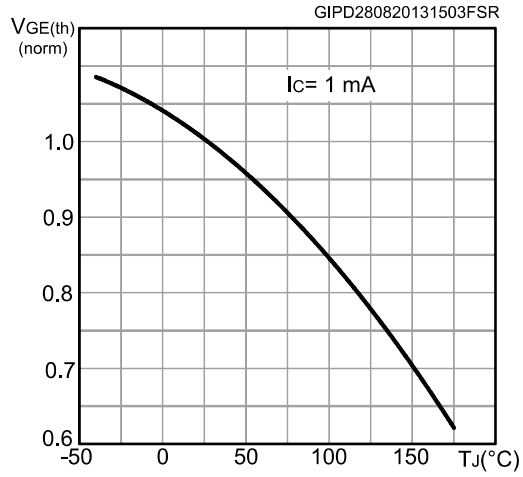



**Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature**

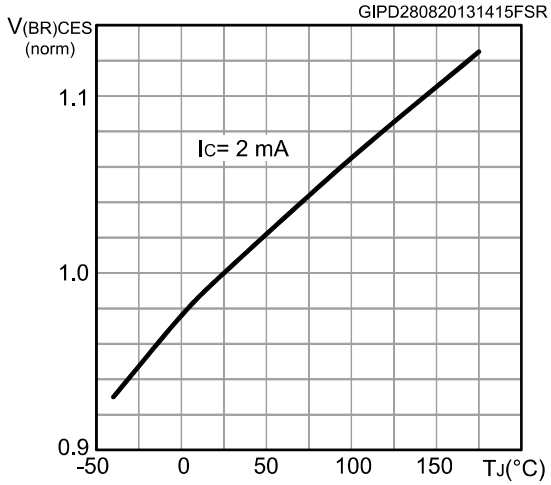


**Figure 14: Capacitance variations**

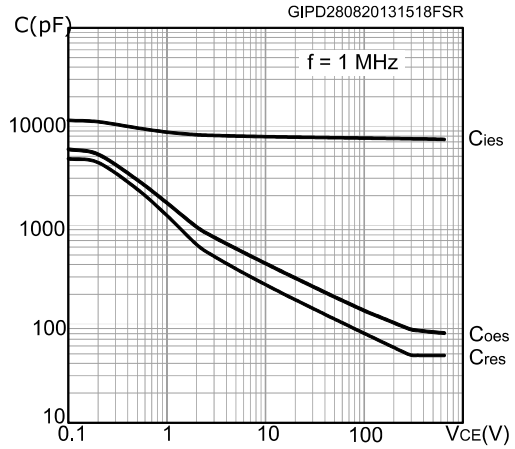



**Figure 15: Gate charge vs. gate-emitter voltage**

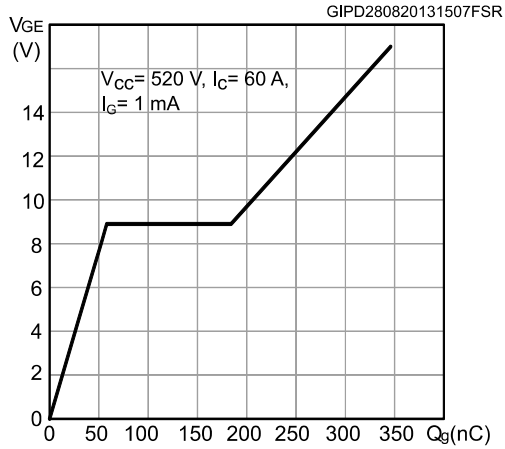



**Figure 16: Switching energy vs. collector current**

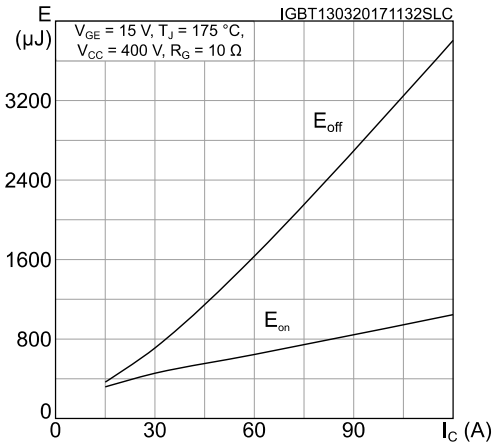



**Figure 17: Switching energy vs. gate resistance**

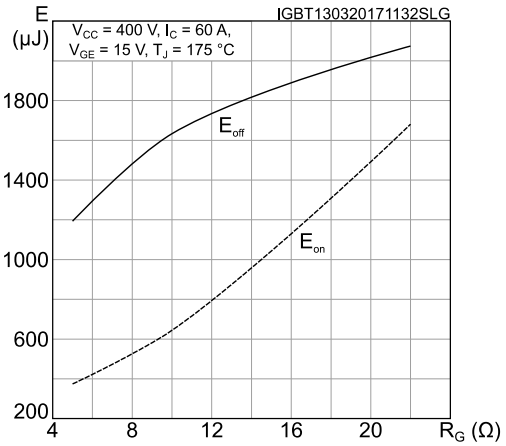



**Figure 18: Switching energy vs. temperature**

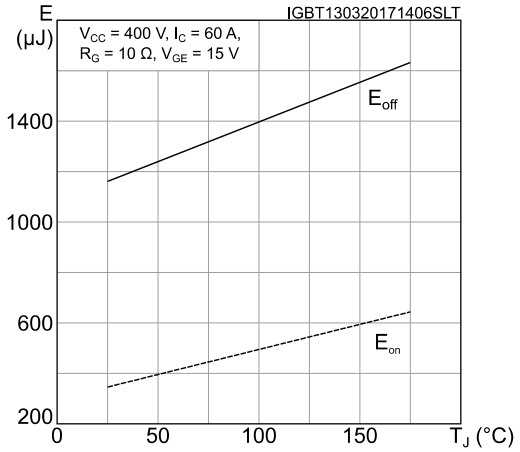



**Figure 19: Switching energy vs. collector emitter voltage**

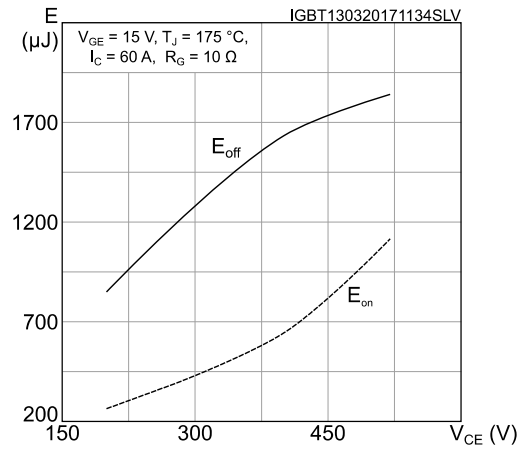


**Figure 20: Switching times vs. collector current**

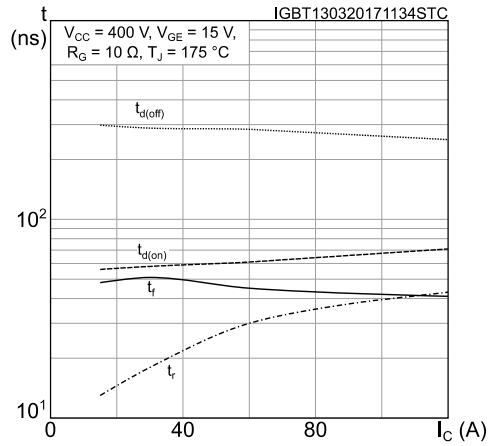



**Figure 21: Switching times vs. gate resistance**

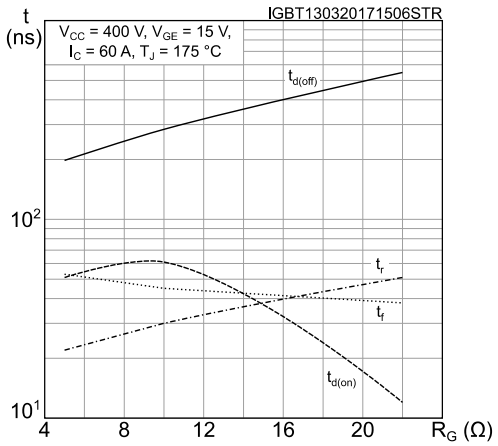



**Figure 22: Reverse recovery current vs. diode current slope**

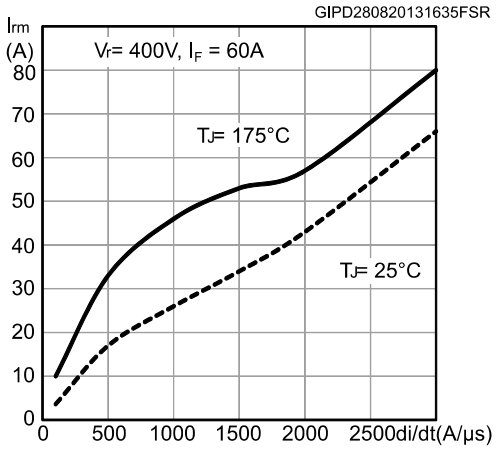



**Figure 23: Reverse recovery time vs. diode current slope**

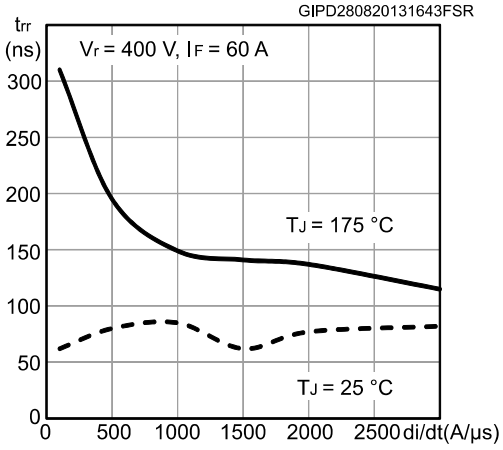



**Figure 24: Reverse recovery charge vs. diode current slope**

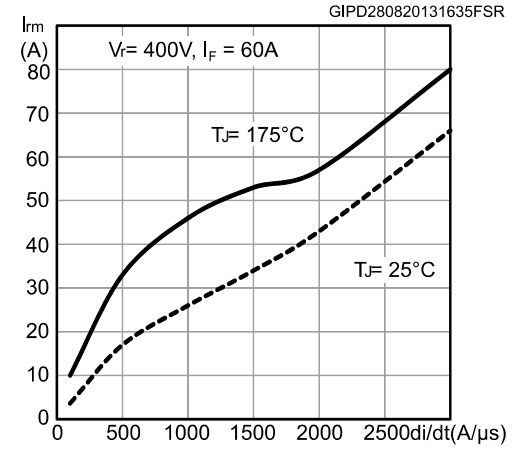



**Figure 25: Reverse recovery energy vs. diode current slope**

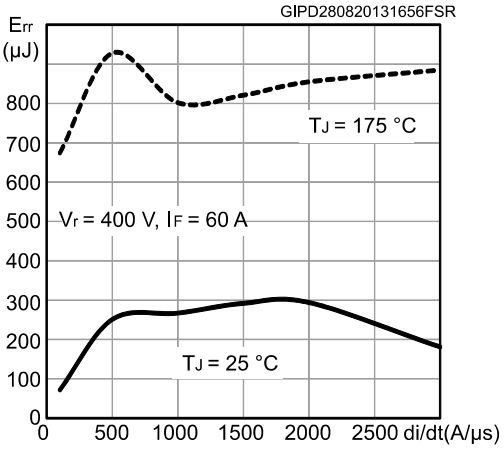


**Figure 26: Thermal impedance for IGBT**

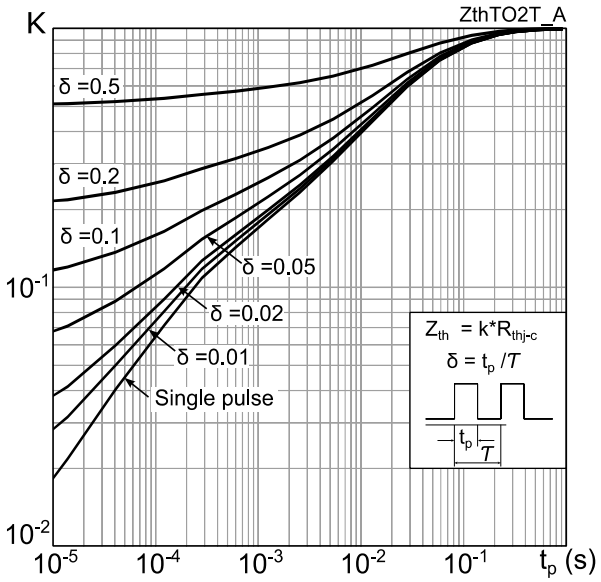
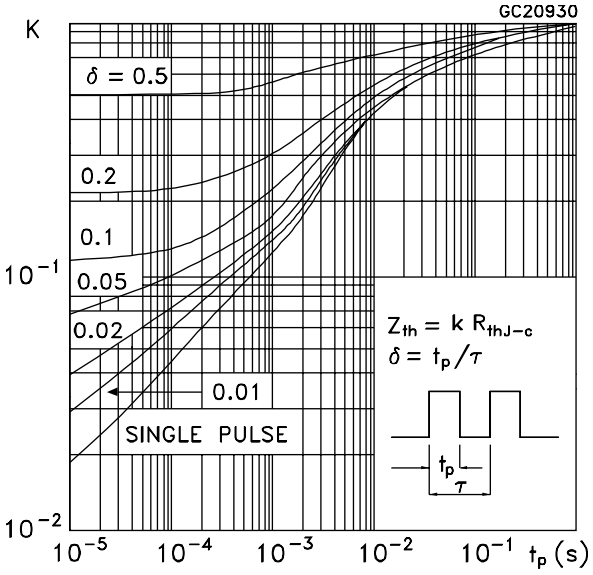



**Figure 27: Thermal impedance for diode**



# 3 Test circuits

**Figure 28: Test circuit for inductive load switching**

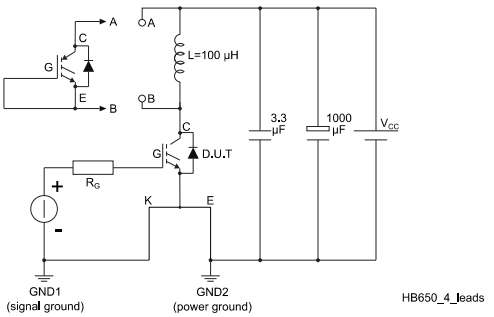



**Figure 29: Gate charge test circuit**

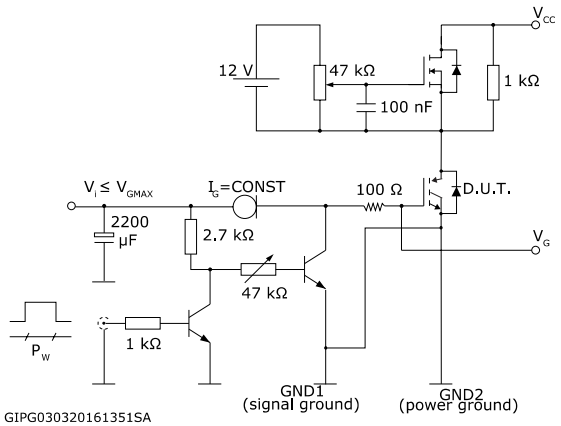



**Figure 30: Switching waveform**

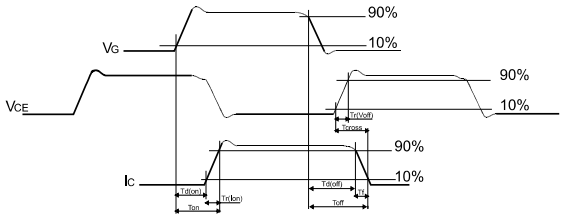
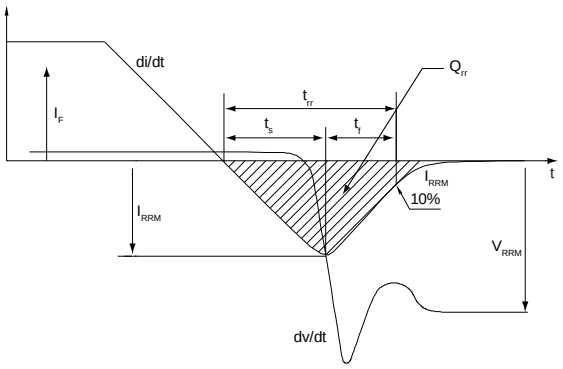



**Figure 31: Diode reverse recovery waveform**



# 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 TO247-4 package information

**Figure 32: TO247-4 package outline**

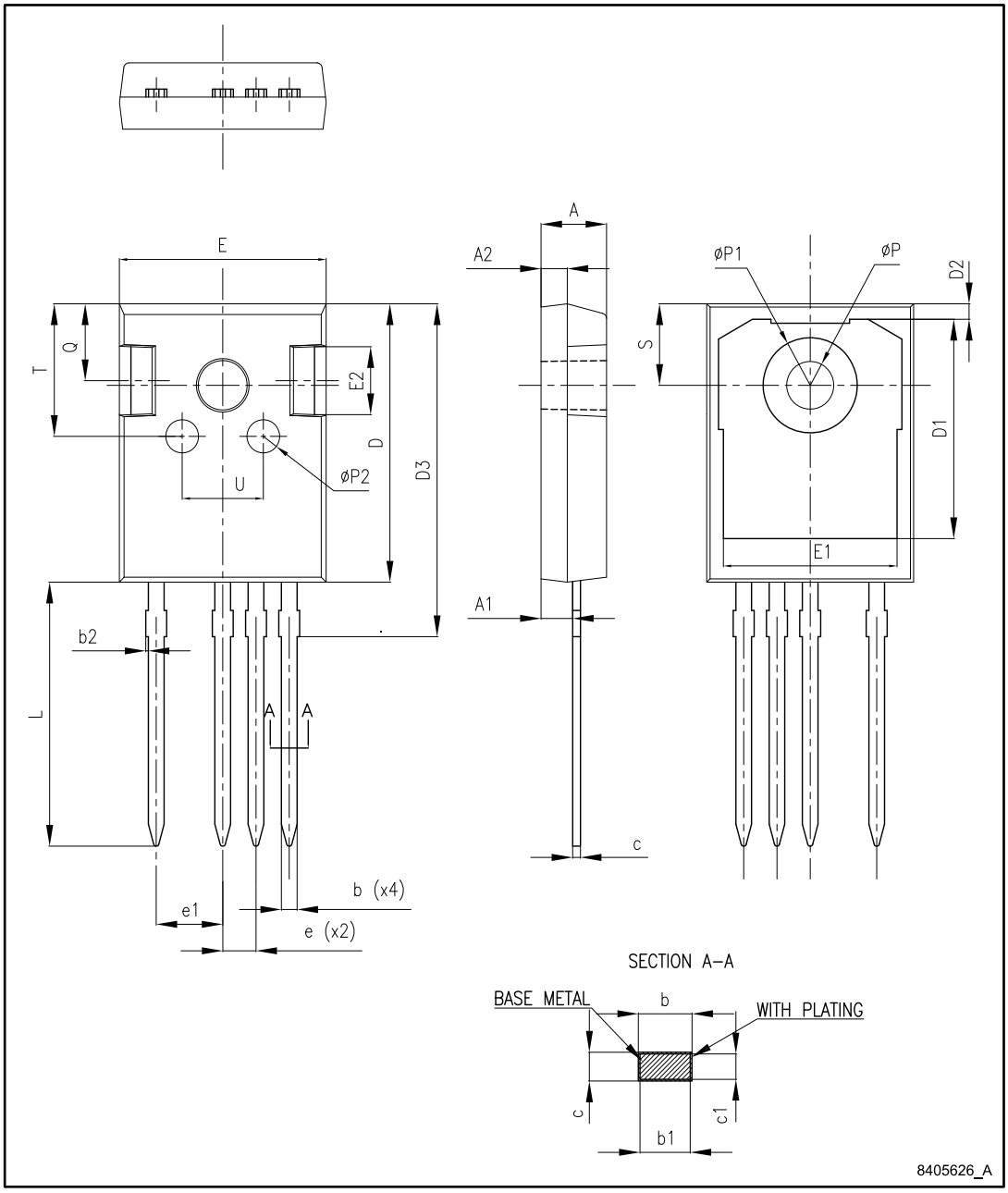


Table 8: TO247-4 mechanical data

| 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 | | 1.29 |
| b1 | 1.15 | 1.20 | 1.25 |
| b2 | 0 | | 0.20 |
| c | 0.59 | | 0.66 |
| c1 | 0.58 | 0.60 | 0.62 |
| D | 20.90 | 21.00 | 21.10 |
| D1 | 16.25 | 16.55 | 16.85 |
| D2 | 1.05 | 1.20 | 1.35 |
| D3 | 24.97 | 25.12 | 25.27 |
| E | 15.70 | 15.80 | 15.90 |
| E1 | 13.10 | 13.30 | 13.50 |
| E2 | 4.90 | 5.00 | 5.10 |
| E3 | 2.40 | 2.50 | 2.60 |
| e | 2.44 | 2.54 | 2.64 |
| e1 | 4.98 | 5.08 | 5.18 |
| L | 19.80 | 19.92 | 20.10 |
| P | 3.50 | 3.60 | 3.70 |
| P1 | | | 7.40 |
| P2 | 2.40 | 2.50 | 2.60 |
| Q | 5.60 | | 6.00 |
| S | | 6.15 | |
| T | 9.80 | | 10.20 |
| U | 6.00 | | 6.40 |

# 5 Revision history

Table 9: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 30-May-2016 | 1 | First release |
| 21-Mar-2017 | 2 | Updated *Table 2: "Absolute maximum ratings"* and *Table 6: "IGBT switching characteristics (inductive load)"*.<br>Updated *Section 2.1: "Electrical characteristics (curves)"*.<br>Minor text changes |

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