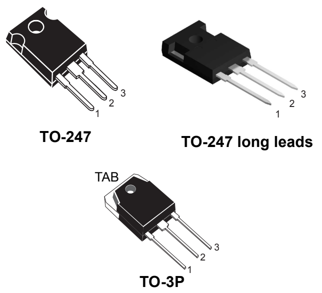
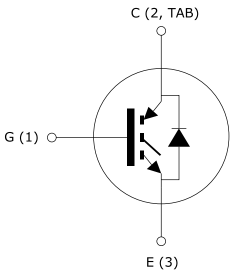
# STGW60H65DFB, STGWA60H65DFB, STGWT60H65DFB

Datasheet

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




| Product status link |
| --- |
| STGW60H65DFB |
| STGWT60H65DFB |
| STGWA60H65DFB |

## Features

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

## Applications

- Photovoltaic inverters
- High-frequency converters

## Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the new HB series of IGBTs, which represent an optimum compromise between conduction and switching loss to maximize the efficiency of any frequency converter. Furthermore, the slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

# 1 Electrical ratings

**Table 1. 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 | A |
| $I_{CP}$ (2)(3) | Pulsed collector current | 240 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| | Transient gate-emitter voltage ($t_P$ ≤ 10 μs) | ±30 | V |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C | 80 (1) | A |
| | Continuous forward current at $T_C$ = 100 °C | 60 | A |
| $I_{FP}$ (2)(3) | 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 | °C |

1. *Current level is limited by bond wires.*
2. *Pulse width is limited by maximum junction temperature.*
3. *Defined by design, not subject to production test.*

**Table 2. 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 | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50 | °C/W |

# 2 Electrical characteristics

$T_J$ = 25 °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 V, $I_C$ = 2 mA | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 60 A | | 1.60 | 2 | 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 4. 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 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 262 | - | pF |
| $C_{res}$ | Reverse transfer capacitance | | - | 158 | - | pF |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 60 A, $V_{GE}$ = 0 to 15 V (see Figure 28. Gate charge test circuit) | - | 306 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 126 | - | 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 V, $I_C$ = 60 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V (see Figure 27. Test circuit for inductive load switching) | - | 66 | - | ns |
| $t_r$ | Current rise time | | - | 38 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1216 | - | A/μs |
| $t_{d(off)}$ | Turn-off delay time | | - | 210 | - | ns |
| $t_f$ | Current fall time | | - | 20 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 1590 | - | μJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 900 | - | μJ |
| $E_{ts}$ | Total switching energy | | - | 2490 | - | μJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 60 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V, $T_J$ = 175 °C (see Figure 27. Test circuit for inductive load switching) | - | 59 | - | ns |
| $t_r$ | Current rise time | | - | 40 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1230 | - | A/μs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 242 | - | ns |
| $t_f$ | Current fall time | | - | 147 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 2860 | - | μJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 1255 | - | μJ |
| $E_{ts}$ | Total switching energy | | - | 4115 | - | μJ |

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 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 100 A/μs (see Figure 27. 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 = 100 A/μs, $T_J$ = 175 °C (see Figure 27. 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 1. Output characteristics ($T_J$ = 25 °C)**

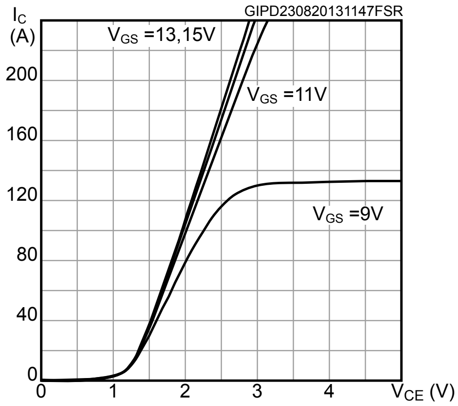



**Figure 2. Output characteristics ($T_J$ = 175 °C)**

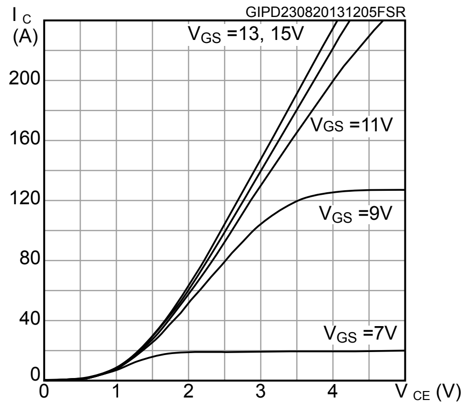



**Figure 3. Transfer characteristics**

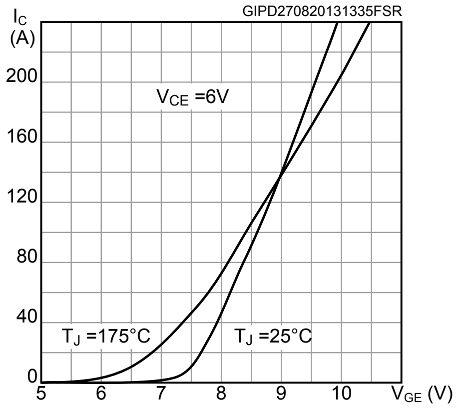



**Figure 4. Collector current vs case temperature**

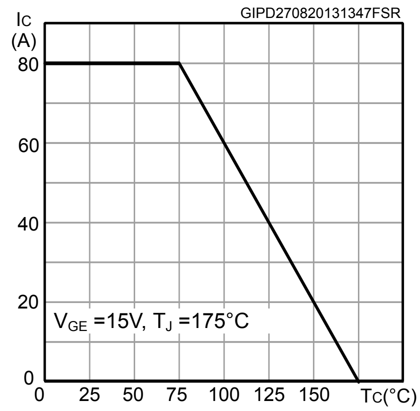



**Figure 5. Power dissipation vs case temperature**

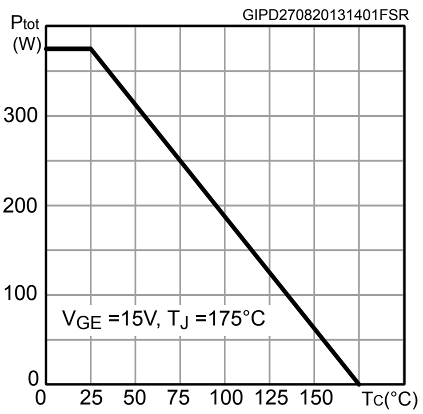



**Figure 6. $V_{CE(sat)}$ vs junction temperature**

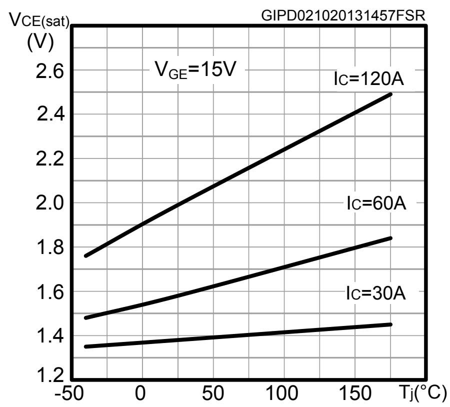


**Figure 7.** $V_{CE(sat)}$ **vs collector current**

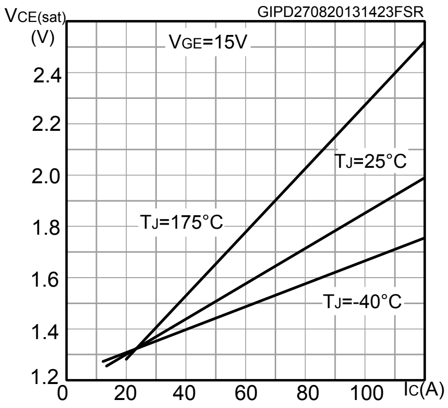



**Figure 8.** **Forward bias safe operating area**

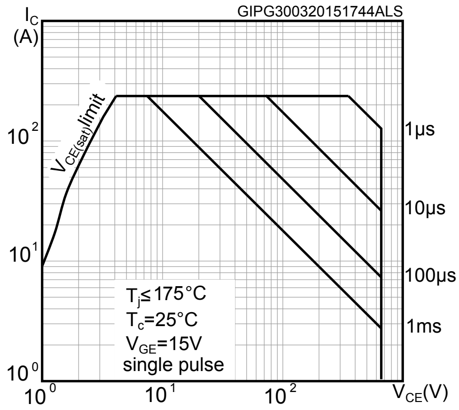



**Figure 9.** **Diode** $V_F$ **vs forward current**

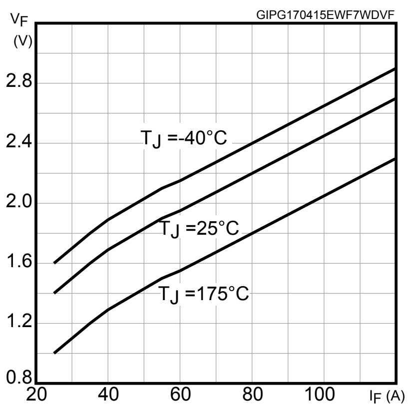



**Figure 10.** **Normalized** $V_{(BR)CES}$ **vs junction temperature**

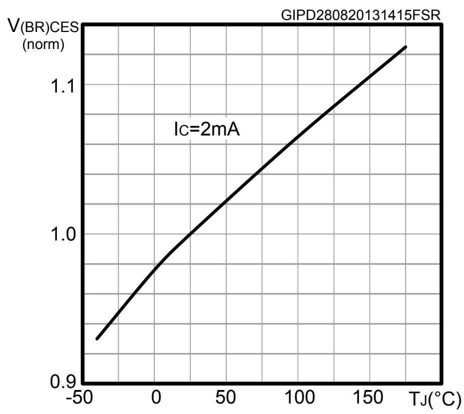



**Figure 11.** **Normalized** $V_{GE(th)}$ **vs junction temperature**

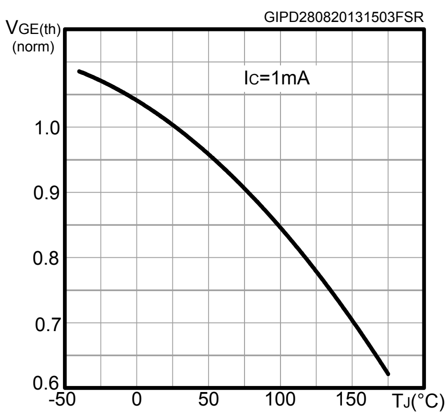



**Figure 12.** **Gate charge vs gate-emitter voltage**

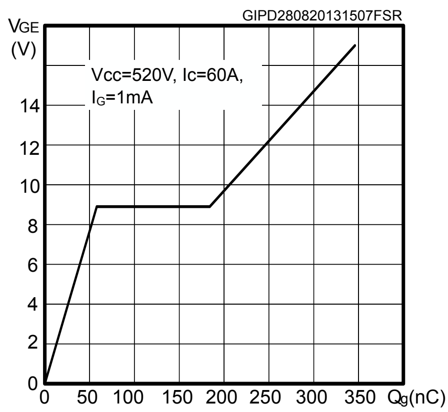


**Figure 13.** Switching energy vs temperature

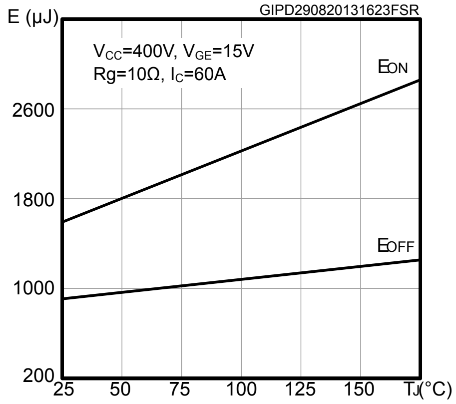



**Figure 14.** Switching energy vs gate resistance

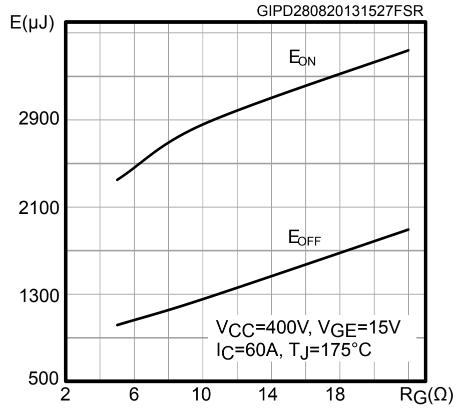



**Figure 15.** Switching energy vs collector current

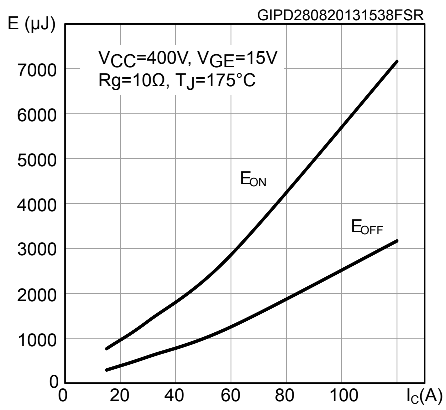



**Figure 16.** Switching energy vs collector emitter voltage

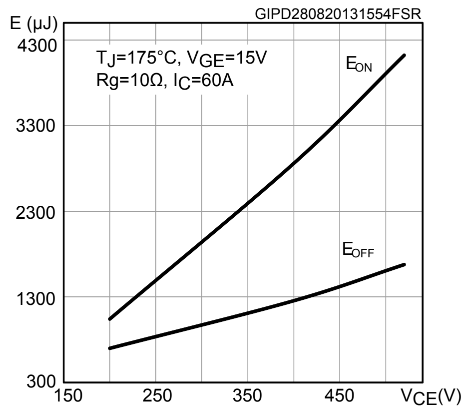



**Figure 17.** Switching times vs collector current

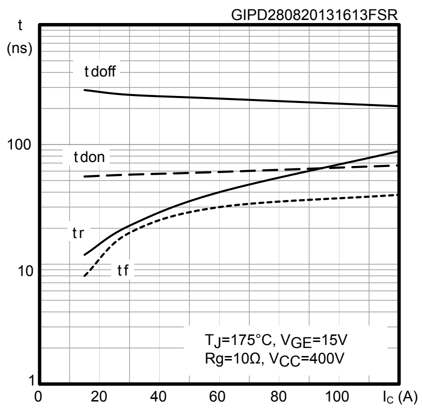



**Figure 18.** Switching times vs gate resistance

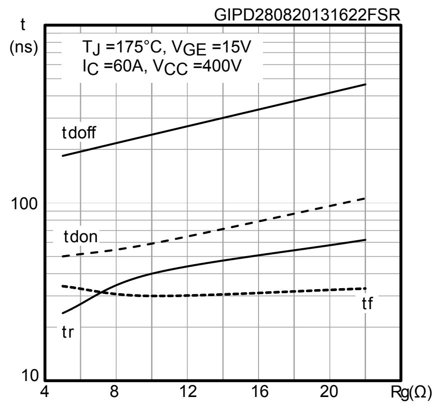


**Figure 19.** Reverse recovery current vs diode current slope

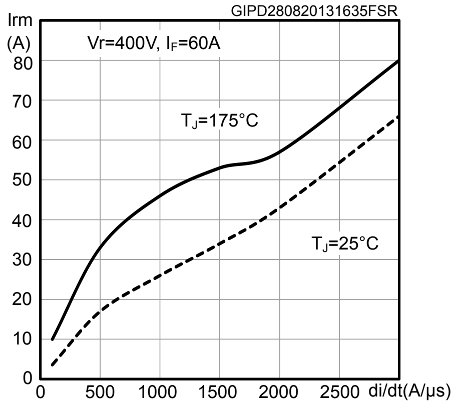



**Figure 20.** Reverse recovery time vs diode current slope

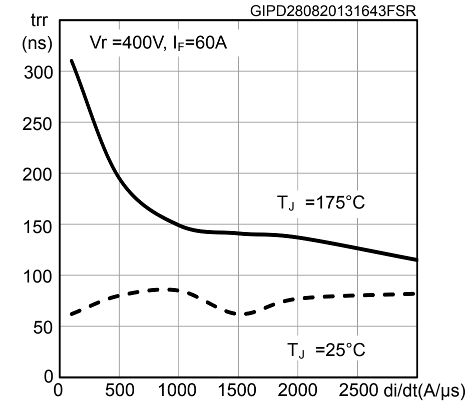



**Figure 21.** Reverse recovery charge vs diode current slope

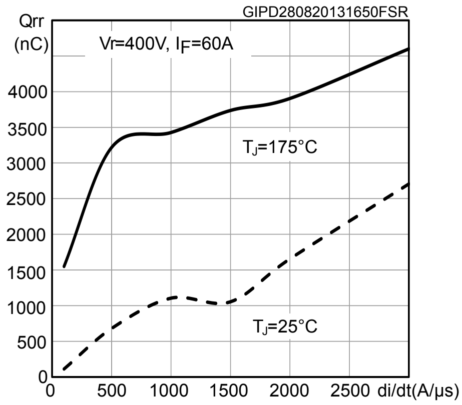



**Figure 22.** Reverse recovery energy vs diode current slope

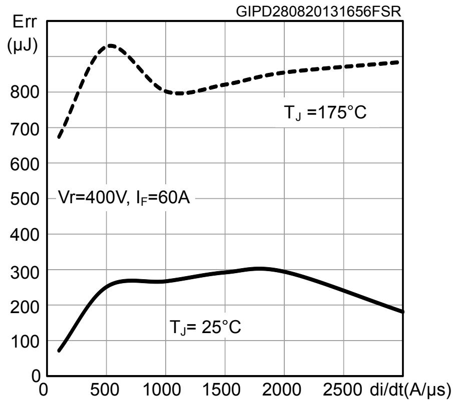



**Figure 23.** Capacitance variations

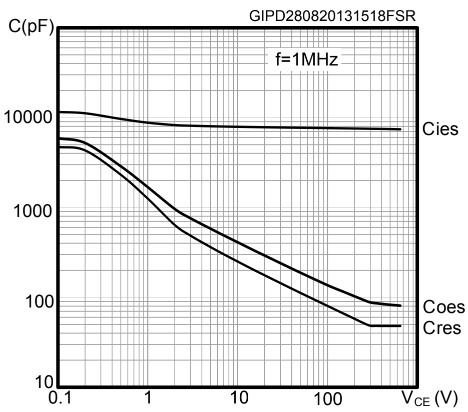



**Figure 24.** Collector current vs switching frequency

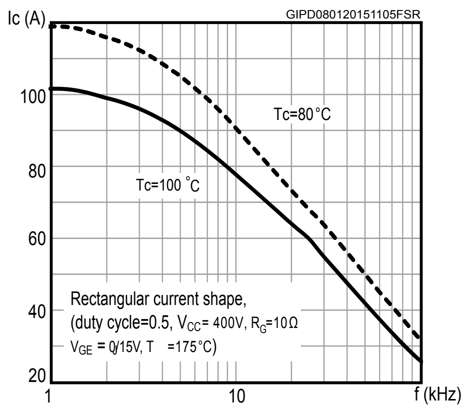


**Figure 25.** **Thermal impedance for IGBT**

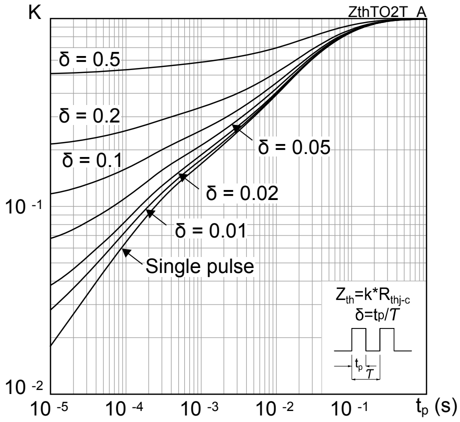
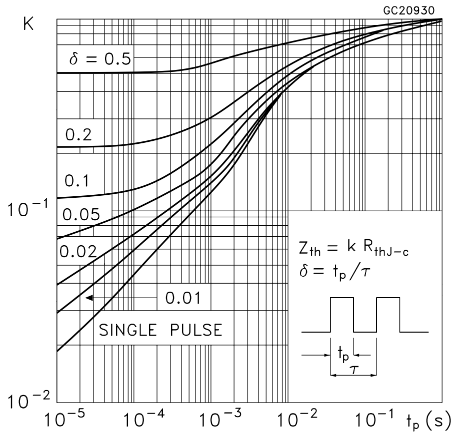



**Figure 26.** **Thermal impedance for diode**



# 3 Test circuits

**Figure 27. Test circuit for inductive load switching**

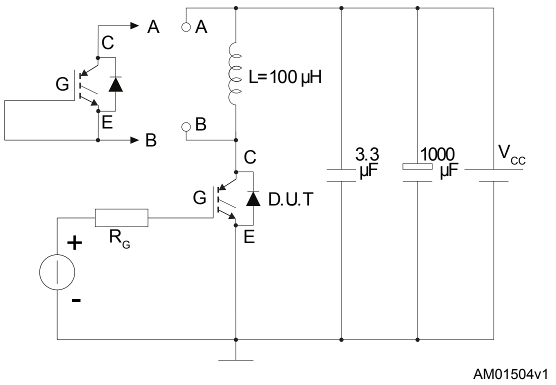



**Figure 28. Gate charge test circuit**

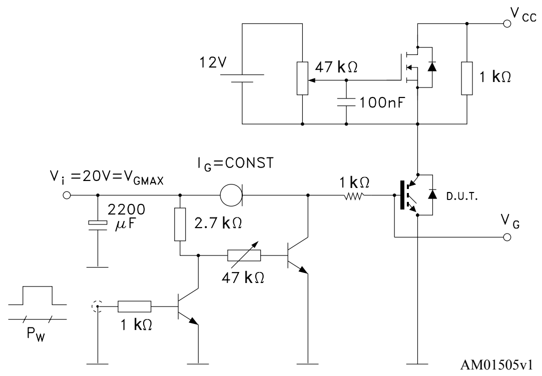



**Figure 29. Switching waveform**

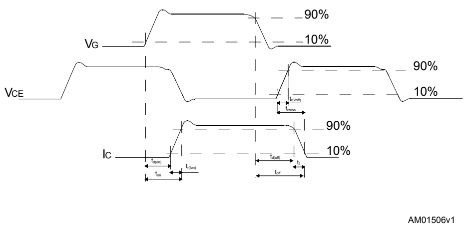
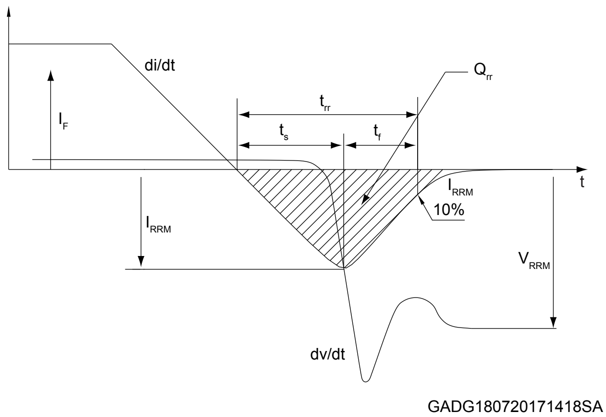



**Figure 30. Diode reverse recovery waveform**



# 4 Package information

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 31. TO-247 package outline

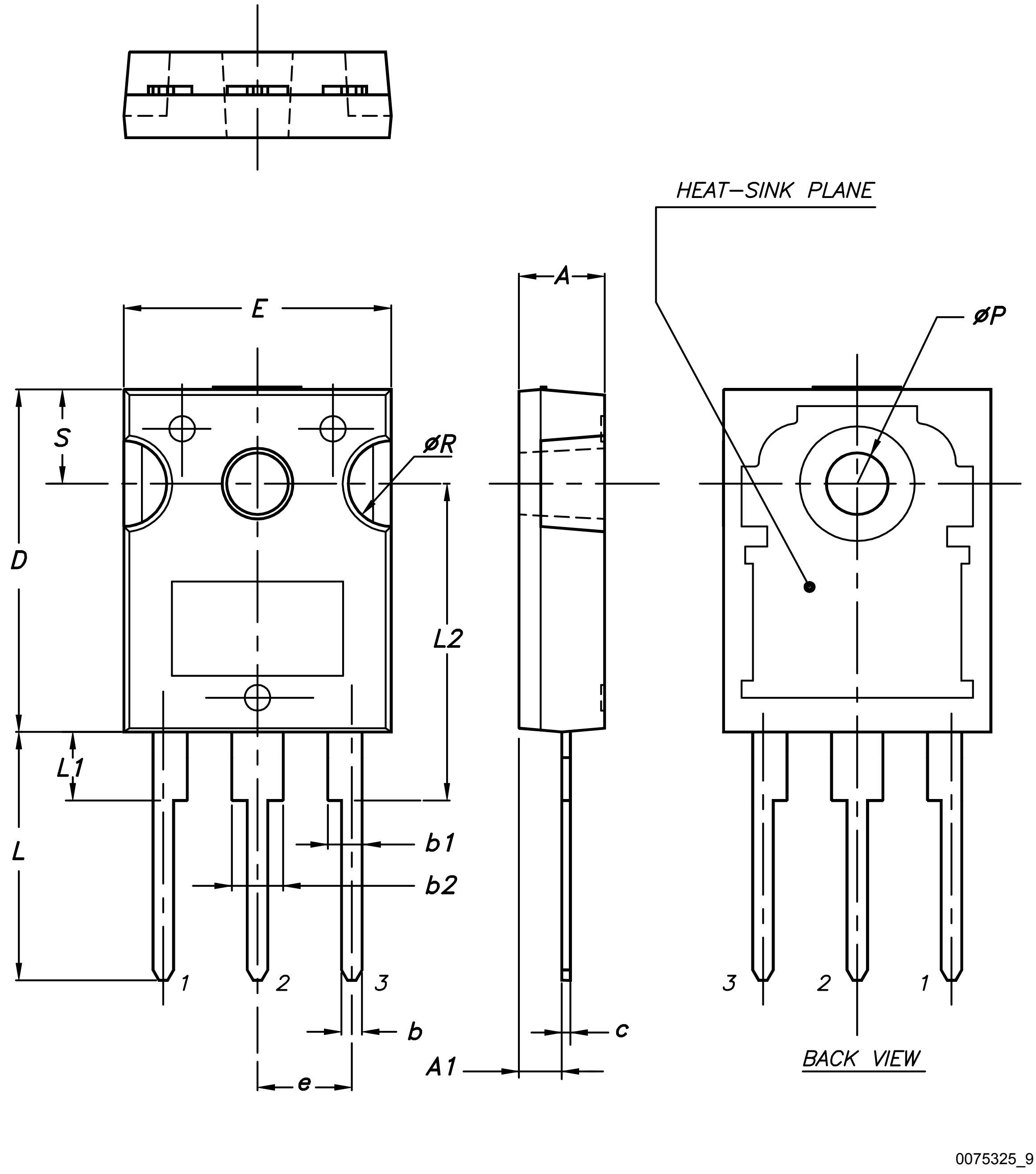


Table 7. **TO-247 package mechanical data**

| 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 |

## 4.2 TO-247 long leads package information

Figure 32. **TO-247 long leads package outline**

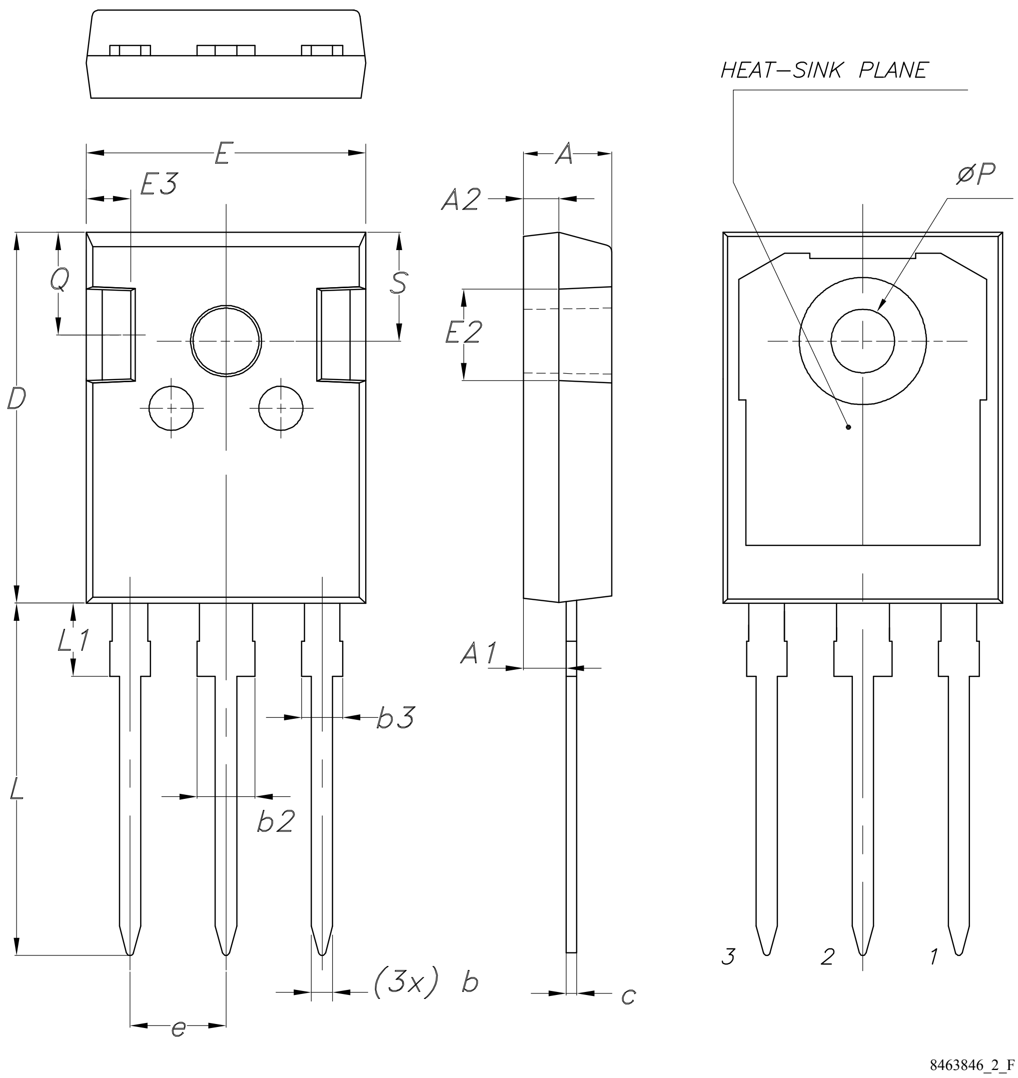


**Table 8.** **TO-247 long leads package mechanical data**

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

## 4.3 TO-3P package information

Figure 33. TO-3P package outline

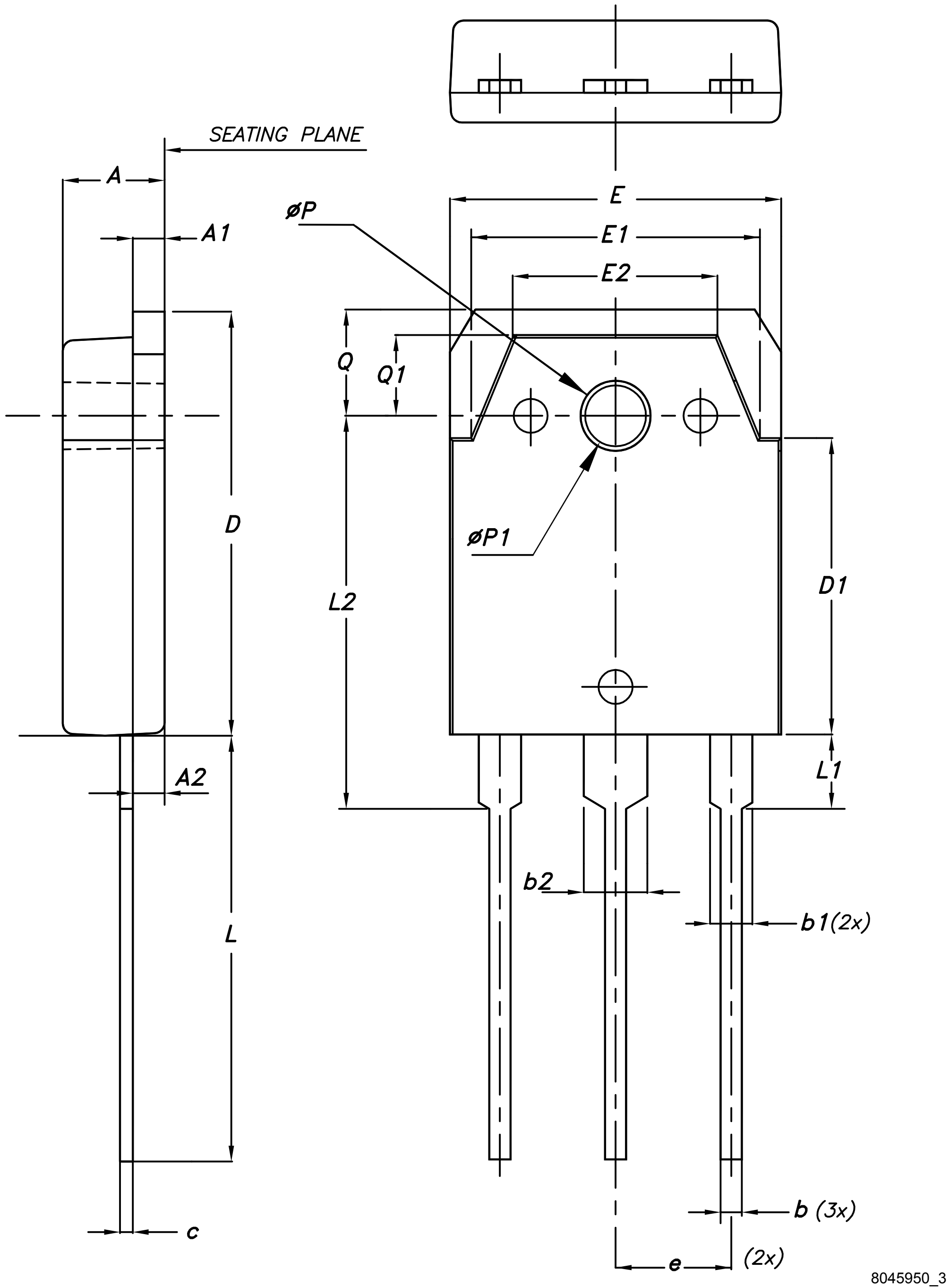


Table 9. **TO-3P package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.60 | 4.80 | 5.00 |
| A1 | 1.45 | 1.50 | 1.65 |
| A2 | 1.20 | 1.40 | 1.60 |
| b | 0.80 | 1.00 | 1.20 |
| b1 | 1.80 | 2.00 | 2.20 |
| b2 | 2.80 | 3.00 | 3.20 |
| c | 0.55 | 0.60 | 0.75 |
| D | 19.70 | 19.90 | 20.10 |
| D1 | 13.70 | 13.90 | 14.10 |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 13.40 | 13.60 | 13.80 |
| E2 | 9.40 | 9.60 | 9.90 |
| e | 5.15 | 5.45 | 5.75 |
| L | 19.80 | 20.00 | 20.20 |
| L1 | 3.30 | 3.50 | 3.70 |
| L2 | 18.20 | 18.40 | 18.60 |
| ØP | 3.30 | 3.40 | 3.50 |
| ØP1 | 3.10 | 3.20 | 3.30 |
| Q | 4.80 | 5.00 | 5.20 |
| Q1 | 3.60 | 3.80 | 4.00 |

# 5 Ordering information

Table 10. Order codes

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STGW60H65DFB | GW60H65DFB | TO-247 | Tube |
| STGWA60H65DFB | G60H65DFB | TO-247 long leads | Tube |
| STGWT60H65DFB | GWT60H65DFB | TO-3P | Tube |

## Revision history

**Table 11. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 12-Mar-2013 | 1 | Initial release. |
| 30-Aug-2013 | 2 | Document status promoted from preliminary to production data.<br>Added *Section 2.1: Electrical characteristics (curves)*. |
| 31-Oct-2013 | 3 | Updated $V_{CE(sat)}$ in *Table 4: Static characteristics.* |
| 24-Feb-2014 | 4 | Updated title and description in cover page. |
| 09-Jan-2015 | 5 | Updated features in cover page, *Table 2: Absolute maximum ratings*, and *Table 6: IGBT switching characteristics (inductive load)*.<br>Updated *Figure 5: Collector current vs. case temperature*, *Figure 6: Power dissipation vs. case temperature*, *Figure 8: VCE(sat) vs. collector current*, *Figure 18: Switching times vs collector current*, *Figure 19: Switching times vs gate resistance* and *Figure 20: Reverse recovery current vs. diode current slope*.<br>Added *Figure 25: Collector current vs. switching frequency*.<br>Updated *Section 4: Package information*.<br>Minor text changes. |
| 23-Mar-2015 | 6 | Text edits throughout document.<br>In document, added new order code STGWA60H65DFB in TO-247 long leads package, with accompanying information and data.<br>In *Section 2.1: Electrical characteristics (curves)*:<br>- updated *Figure 2, Figure 3, Figure 4, Figure 7, Figure 9* |
| 17-Apr-2015 | 7 | Text edits throughout document.<br>In *Section 2: Electrical characteristics:*<br>- updated *Table 4: Static characteristics*<br>- updated *Table 6: IGBT switching characteristics (inductive load)*<br>In *Section 2.1: Electrical characteristics (curves):*<br>- updated *Figure 3* and *Figure 9* |
| 22-Jul-2019 | 8 | Updated Table 1. Absolute maximum ratings.<br>Minor text changes. |

# Contents

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