# STGW80H65DFB, STGWT80H65DFB

## Trench gate field-stop IGBT, HB series 650 V, 80 A high speed

Datasheet - production data

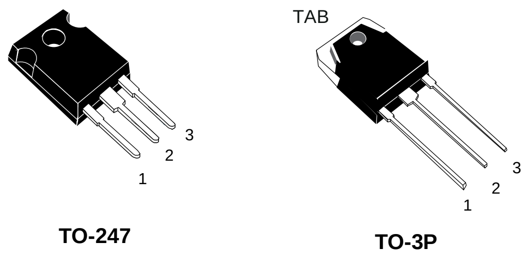
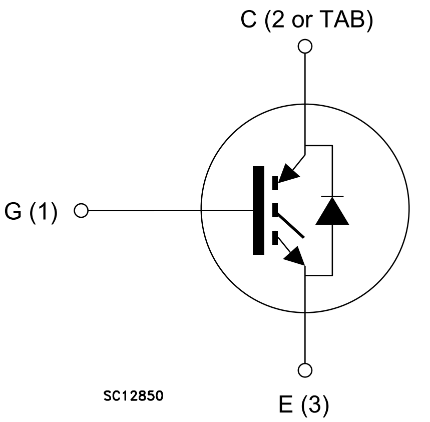



**Figure 1: Internal schematic diagram**




## Features

- Maximum junction temperature: $T_J$ = 175 °C
- High speed switching series
- Minimized tail current
- $V_{CE(sat)}$ = 1.6 V(typ) @ $I_C$ = 80 A
- Safe paralleling
- Tight parameter distribution
- 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.

**Table 1: Device summary**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STGW80H65DFB | GW80H65DFB | TO-247 | Tube |
| STGWT80H65DFB | GWT80H65DFB | TO-3P | 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 | 120(1) | A |
| | Continuous collector current at $T_C$ = 100 °C | 80 | |
| $I_{CP}$(2)(3) | Pulsed collector current | 300 | A |
| $V_{GE}$ | Gate-emitter voltage | ± 20 | V |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C | 120(1) | A |
| | Continuous forward current at $T_C$ = 100 °C | 80 | |
| $I_{FP}$(2)(3) | Pulsed forward current | 300 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 469 | 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 limited by maximum junction temperature. ($t_p$ < 1ms , $T_J$ < 175 °C)

(3)Defined by design, not tested.

**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 | 0.66 | |
| $R_{thJA}$ | 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, $I_C$ = 80 A | | 1.6 | 2 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 80 A, $T_J$ = 125 °C | | 1.8 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 80 A, $T_J$ = 175 °C | | 1.9 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 80 A | | 1.9 | 2.3 | V |
| | | $I_F$ = 80 A, $T_J$ = 125 °C | | 1.6 | | |
| | | $I_F$ = 80 A, $T_J$ = 175 °C | | 1.5 | | |
| $V_{GE(th)}$ | 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 | | | 100 | 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 | - | 10524 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 385 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 215 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 80 A, $V_{GE}$ = 15 V (see *Figure 29: " Gate charge test circuit"*) | - | 414 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 78 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 170 | - | |

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, $I_C$ = 80 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω (see *Figure 28: " Test circuit for inductive load switching"* ) | - | 84 | - | ns |
| $t_r$ | Current rise time | | - | 52 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1270 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 280 | - | ns |
| $t_f$ | Current fall time | | - | 31 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | - | 2.1 | - | mJ |
| $E_{off}$(2) | Turn-off switching energy | | - | 1.5 | - | mJ |
| $E_{ts}$ | Total switching energy | | - | 3.6 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 80 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω , $T_J$ = 175 °C (see *Figure 28: " Test circuit for inductive load switching"*) | - | 77 | - | ns |
| $t_r$ | Current rise time | | - | 51 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1270 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 328 | - | ns |
| $t_f$ | Current fall time | | - | 30 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | - | 4.4 | - | mJ |
| $E_{off}$(2) | Turn-off switching energy | | - | 2.1 | - | mJ |
| $E_{ts}$ | Total switching energy | | - | 6.5 | - | mJ |

**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 | $I_F$ = 80 A, $V_R$ = 400 V, di/dt = 1000 A/µs $V_{GE}$ = 15 V, (see *Figure 28: " Test circuit for inductive load switching"*) | - | 85 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 1105 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 26 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 722 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 267 | - | µJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 80 A, $V_R$ = 400 V, $V_{GE}$ = 15 V ,$T_J$ = 175 °C di/dt = 1000 A/µs (see *Figure 28: " Test circuit for inductive load switching"*) | - | 149 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 4920 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 66 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 546 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 1172 | - | µJ |

## 2.1 Electrical characteristics (curves)

**Figure 2: Output characteristics (TJ= 25 °C)**

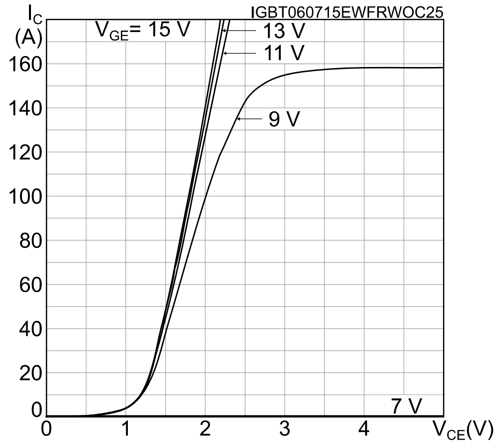



**Figure 3: Output characteristics (TJ= 175 °C)**

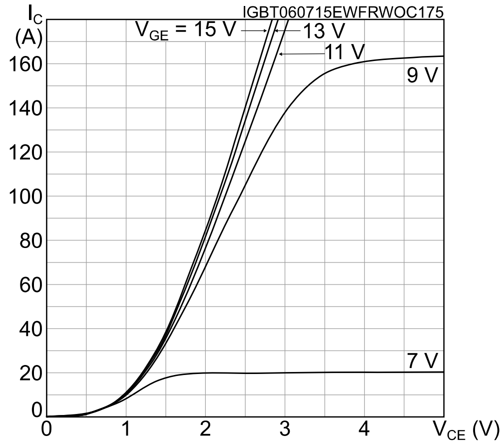



**Figure 4: Transfer characteristics**

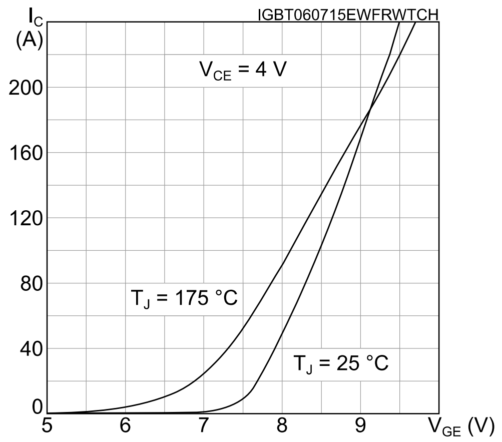



**Figure 5: Collector current vs. case temperature**

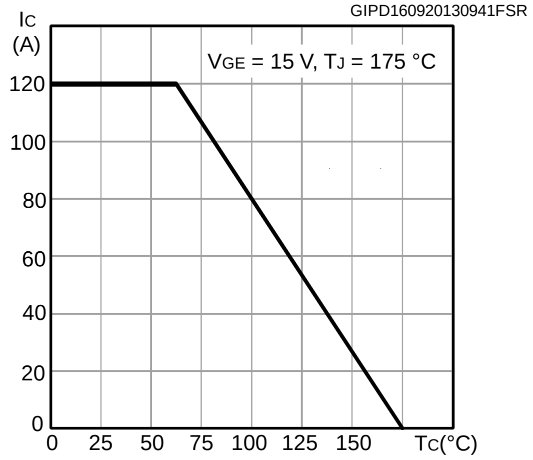



**Figure 6: Power dissipation vs. case temperature**

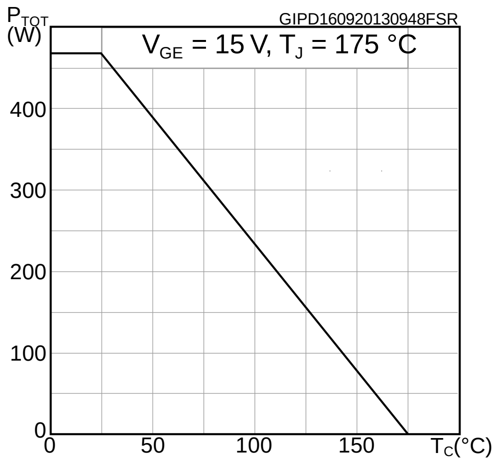



**Figure 7: VCE(sat) vs. junction temperature**

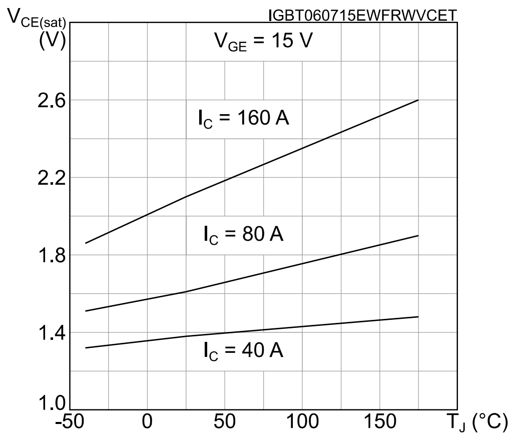


Figure 8: VCE (sat) vs. collector current

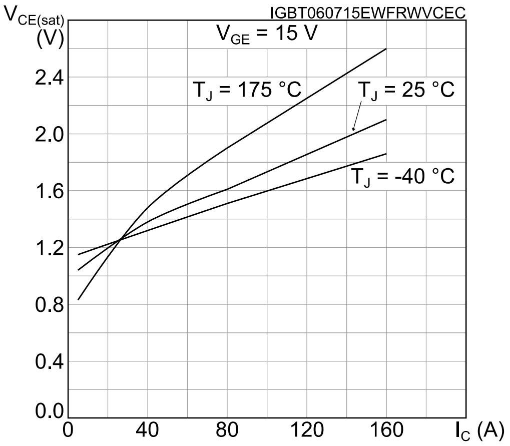



Figure 9: Forward bias safe operating area

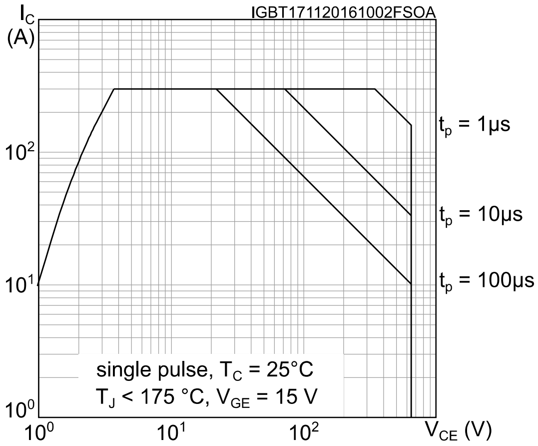



Figure 10: Diode VF vs. forward current

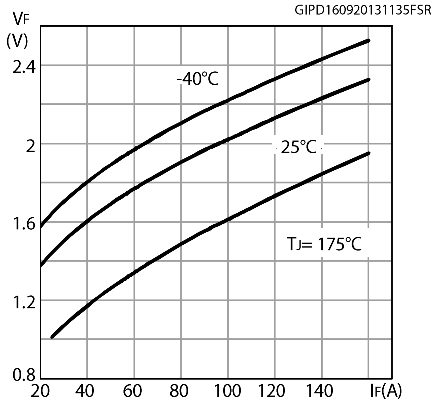



Figure 11: Normalized V(BR)CES vs. junction temperature

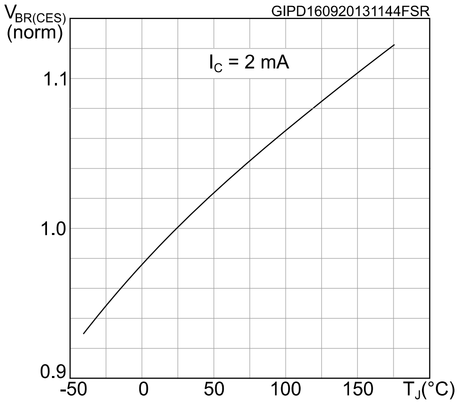



Figure 12: Normalized VGE(th) vs. junction temperature

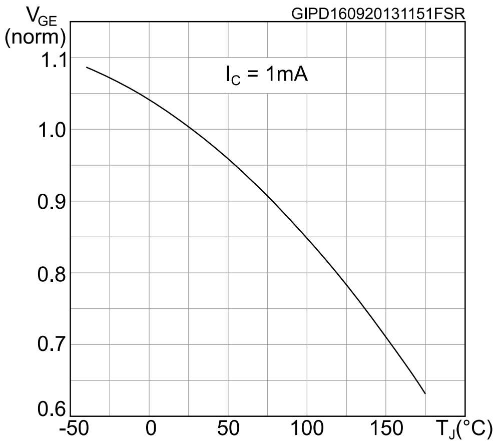



Figure 13: Gate charge vs. gate-emitter voltage

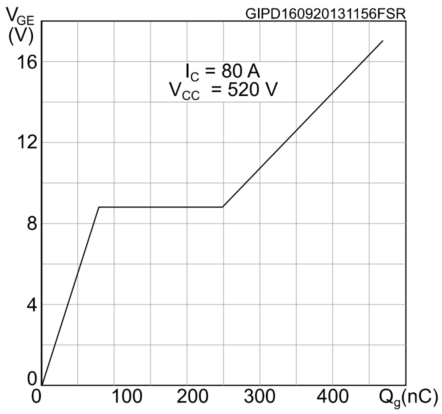


**Figure 14: Switching energy vs. temperature**

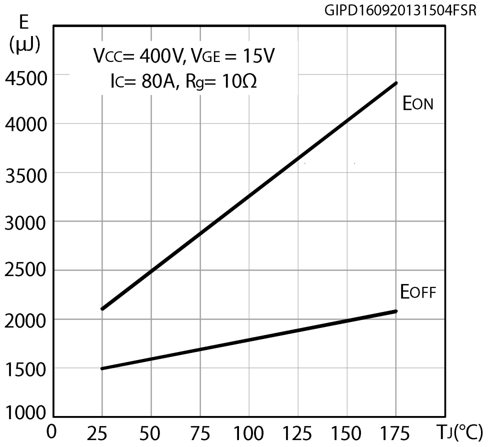



**Figure 15: Switching energy vs. gate resistance**

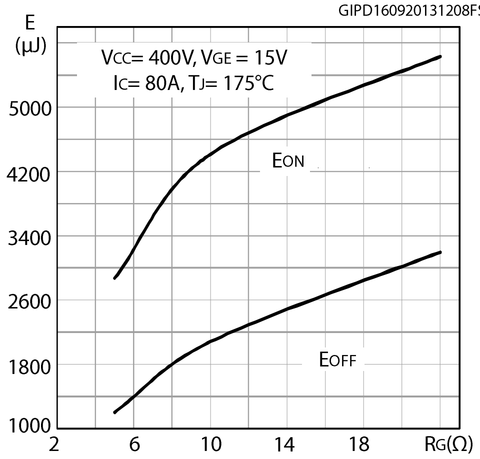



**Figure 16: Switching energy vs. collector current**

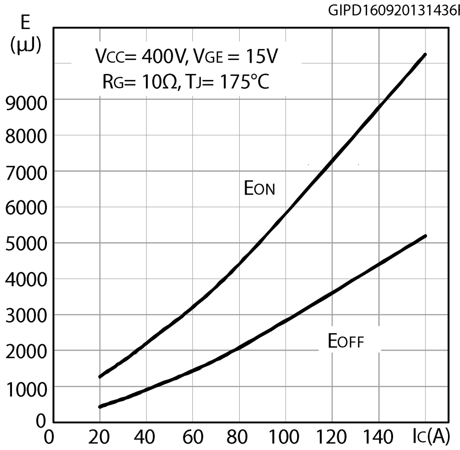



**Figure 17: Switching energy vs. collector emitter voltage**

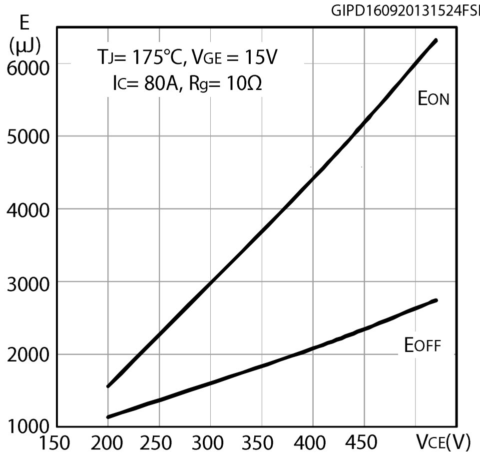



**Figure 18: Switching time vs. collector temperature**

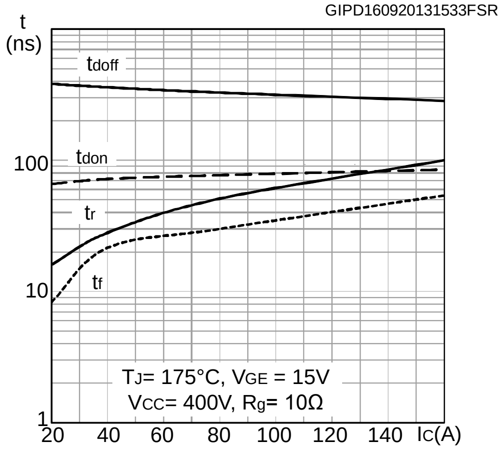



**Figure 19: Switching time vs. gate resistance**

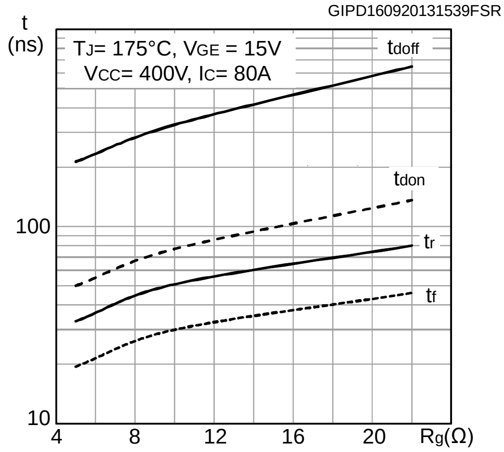


**Figure 20: Reverse recovery current vs. diode current slope**

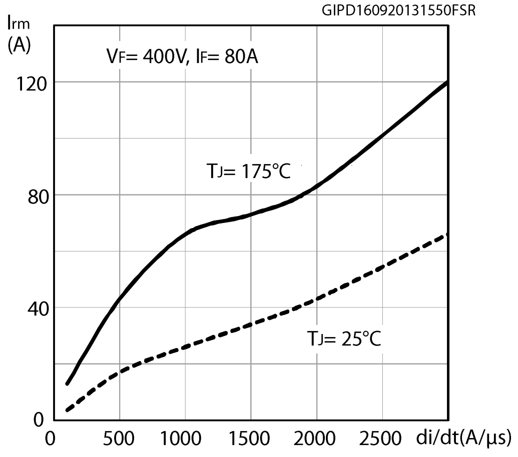



**Figure 21: Reverse recovery time vs. diode current slope**

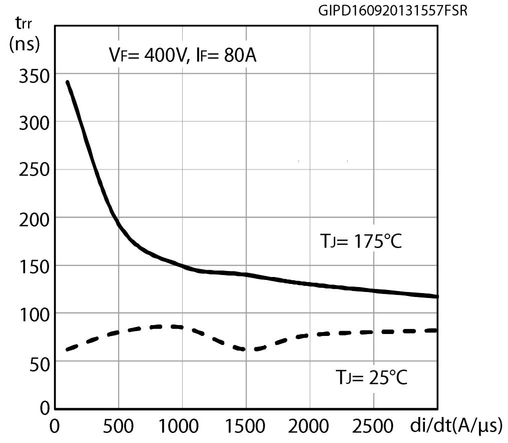



**Figure 22: Reverse recovery charge vs. diode current slope**

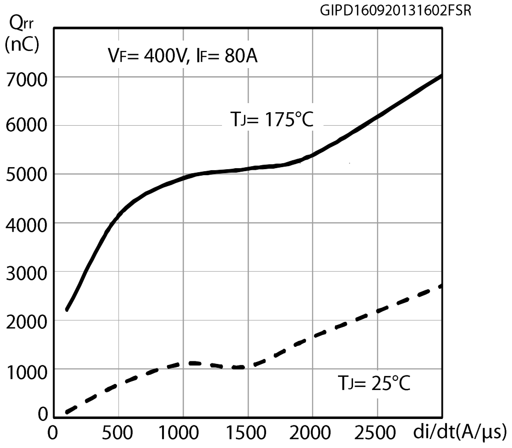



**Figure 23: Reverse recovery energy vs. diode current slope**

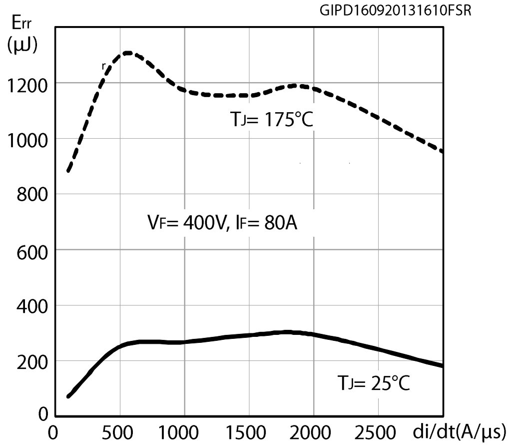



**Figure 24: Capacitance variations**

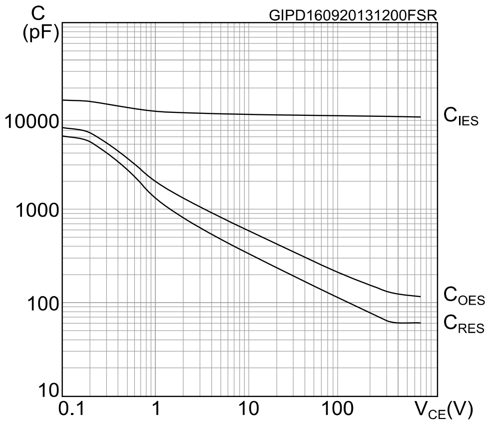



**Figure 25: Collector current vs. switching frequency**

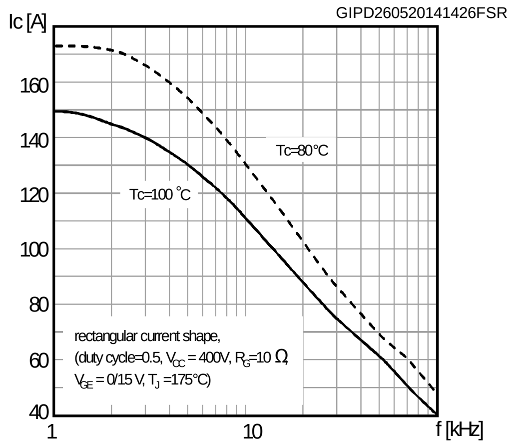


**Figure 26: Thermal impedance for IGBT**

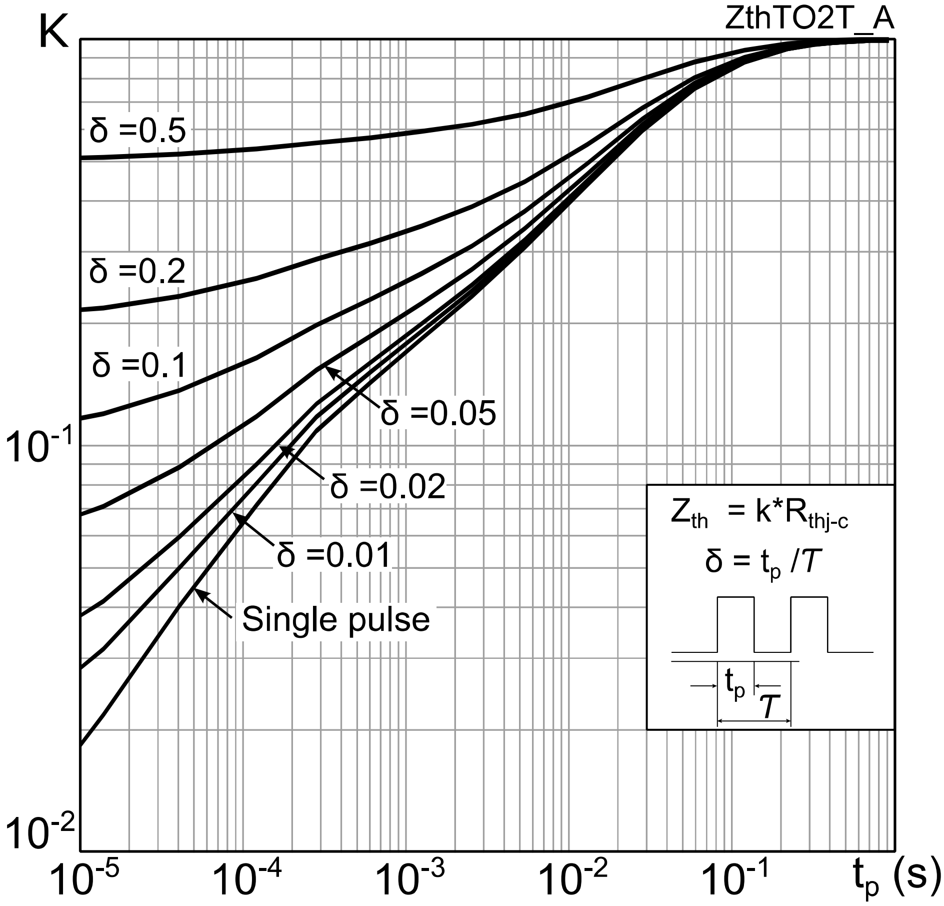
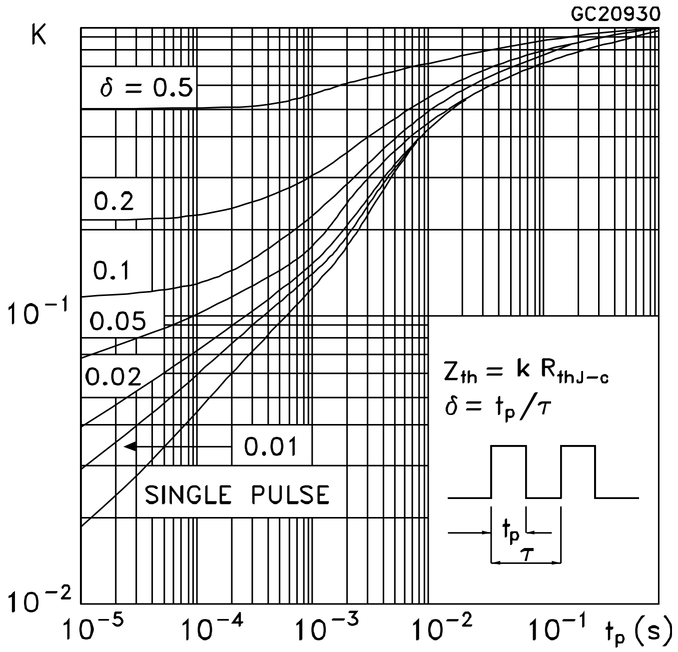


**Figure 27: Thermal impedance for diode**



# 3 Test circuits

Figure 28: Test circuit for inductive load switching

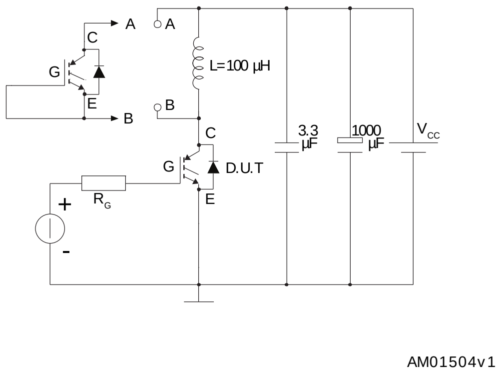



Figure 29: Gate charge test circuit

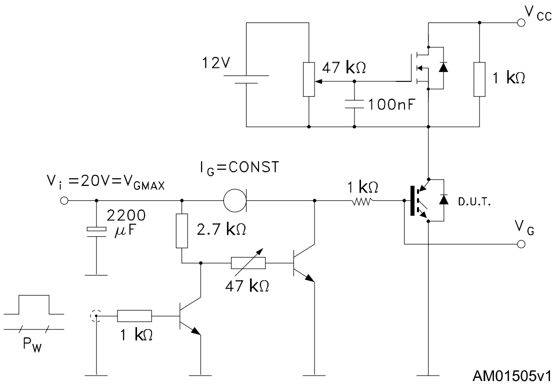



Figure 30: Switching waveform

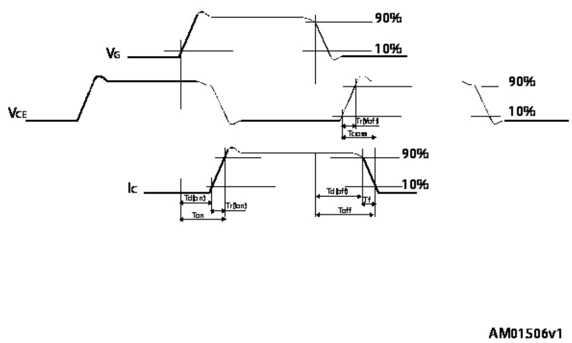
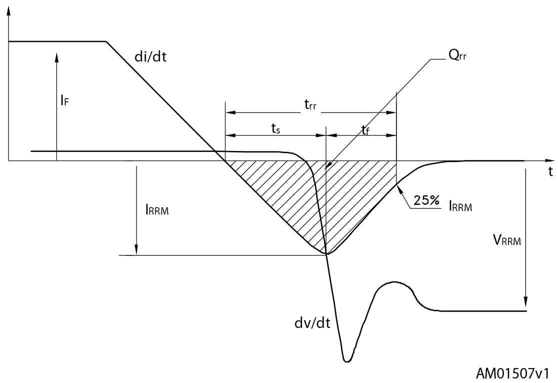



Figure 31: Diode reverse recovery waveform



# 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 TO-247 package information

**Figure 32: TO-247 package outline**

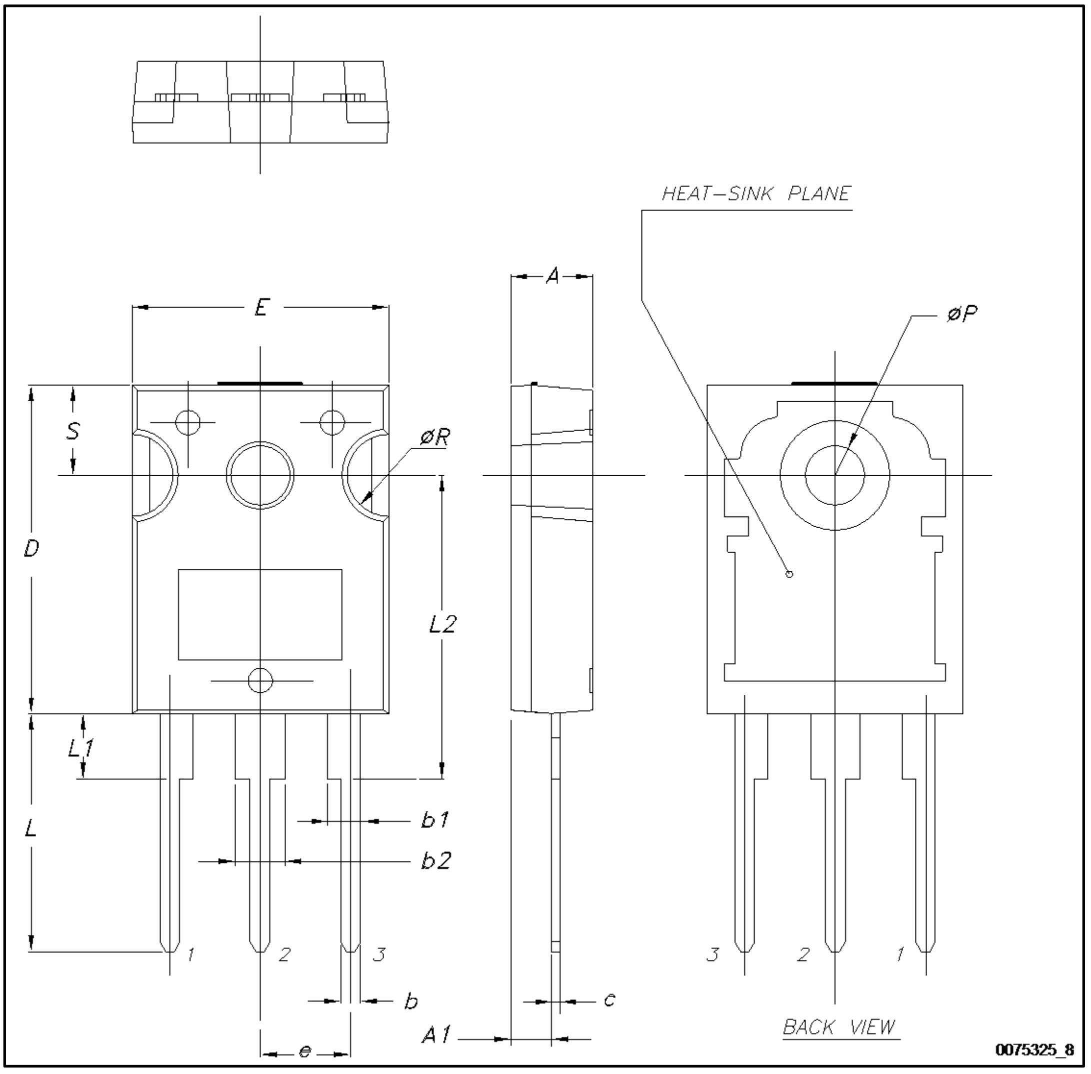


Table 8: TO-247 package mechanical data

| 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-3P package information

Figure 33: TO-3P package outline

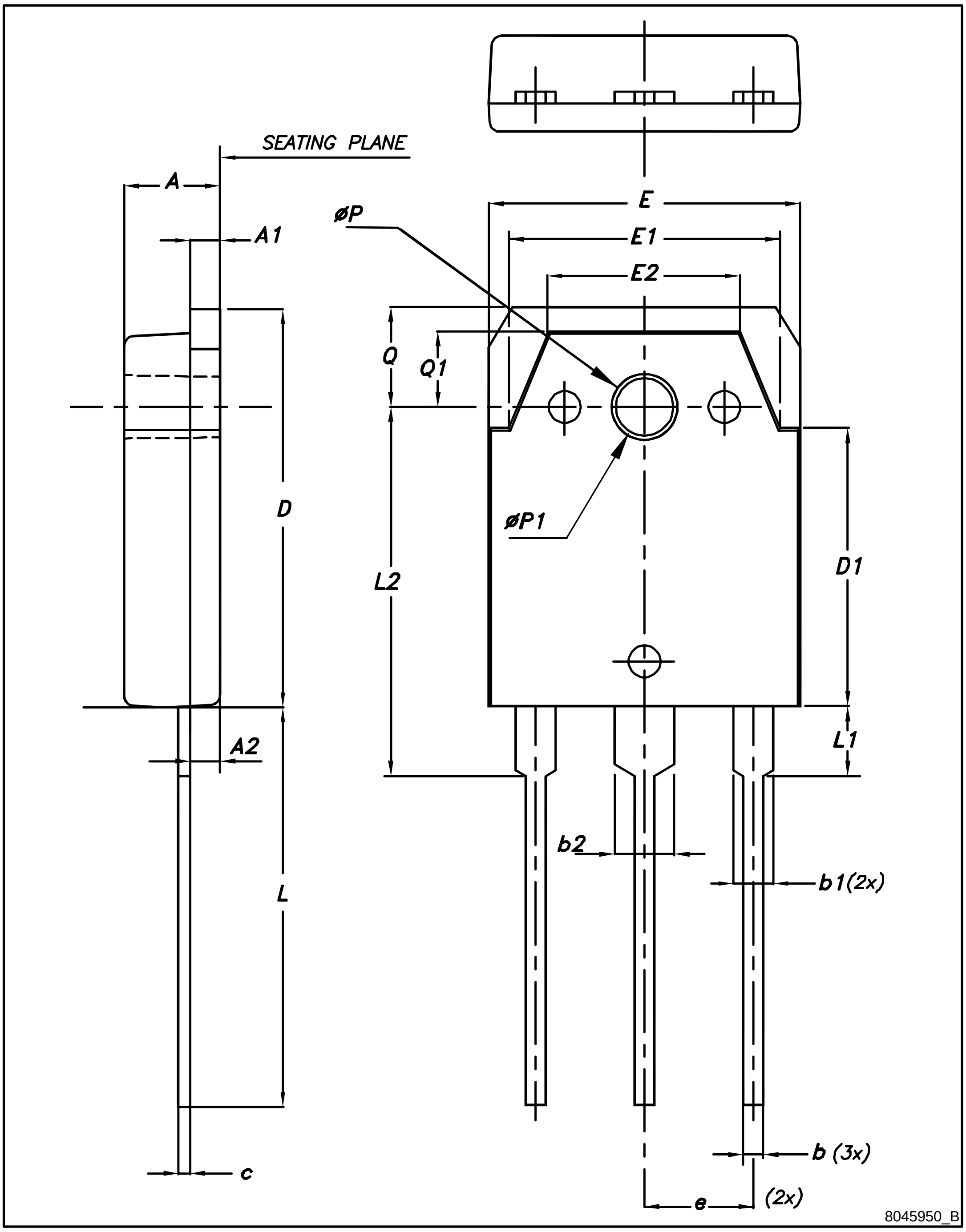


Table 9: TO-3P package mechanical data

| 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 |

# 5 Revision history

Table 10: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 12-Mar-2013 | 1 | First release. |
| 18-Sep-2013 | 2 | Document status promoted from preliminary to production data. Added Section *2.1: Electrical characteristics (curves)* |
| 20-Nov-2013 | 3 | Added device in Max247. Modified *Table 1* accordingly. Updated *Section 4: Package information.* Minor text changes in cover page. |
| 24-Jan-2014 | 4 | Updated title and description in cover page. Updated *Table 6: IGBT switching characteristics (inductive load), Table 7: Diode switching characteristics (inductive load)*, *Figure 9: Forward bias safe operating area* and*Figure 14: Switching energy vs. temperature.* |
| 13-Jun-2014 | 5 | Updated *Figure 5: Collector current vs. case temperature, Figure 6: Power dissipation vs. case temperature, Figure 18: Switching times vs. collector current, Figure 19: Switching times vs. gateresistance* and *Figure 24: Capacitance variations.* Added *Figure 25: Collector current vs. switching frequency*. Updated *Section 4: Package information*. Minor text changes. |
| 07-May-2015 | 6 | Added TO-247 long leads package information. |
| 21-Sep-2016 | 7 | Updated *Figure 2: "Output characteristics (TJ= 25 °C) "*, *Figure 3: "Output characteristics (TJ= 175 °C) "*, *Figure 4: "Transfer characteristics "*, *Figure 7: "VCE(sat) vs. junction temperature"* and *Figure 8: "VCE (sat) vs. collector current"*. The part number STGY80H65DFB has been moved to a separate datasheet. Minor text changes. |
| 17-Nov-2016 | 8 | Updated *Table 2: "Absolute maximum ratings"* and *Figure 9: "Forward bias safe operating area"*. The part number STGWA80H65DFB has been moved to a separate datasheet. Updated document accordingly. |