# STGWT20HP65FB

## Trench gate field-stop IGBT, HB series 650 V, 20 A high speed

Datasheet - production data

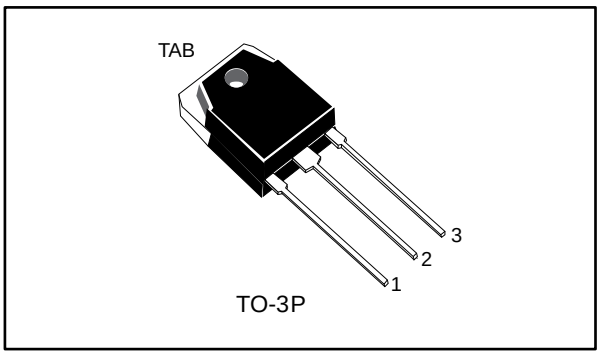
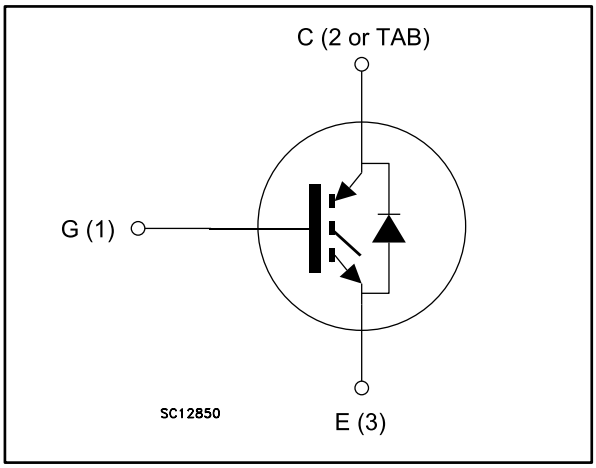



**Figure 1: Internal schematic diagram**




## Features

- Maximum junction temperature: $T_J$ = 175 °C
- Minimized tail current
- $V_{CE(sat)}$ = 1.55 V (typ.) @ $I_C$ = 20 A
- Tight parameter distribution
- Co-packed diode for protection
- Safe paralleling
- Low thermal resistance

## Applications

- Power factor corrector (PFC)

## 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. 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 |
|---|---|---|---|
| STGWT20HP65FB | GWT20HP65FB | 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 | 40 | A |
| | Continuous collector current at $T_C$ = 100 °C | 20 | |
| $I_{CP}$(1) | Pulsed collector current | 80 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C(2) | 5 | A |
| | Continuous forward current at $T_C$ = 100 °C | 5 | |
| $I_{FP}$(3) | Pulsed forward current | 10 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 168 | W |
| $T_{STG}$ | Storage temperature range | -55 to 150 | °C |
| $T_J$ | Operating junction temperature range | -55 to 175 | |

**Notes:**

(1)Pulse width limited by maximum junction temperature

(2)Limited by wires

(3)Pulsed forward current

**Table 3: Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case IGBT | 0.9 | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 5 | |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50 | |

# 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 V, $I_C$ = 2 mA | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 20 A | | 1.55 | 2.0 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 125 °C | | 1.65 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 175 °C | | 1.75 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 5 A | | 2 | | V |
| | | $I_F$ = 5 A, $T_J$ = 125 °C | | 1.85 | | |
| | | $I_F$ = 5 A, $T_J$ = 175 °C | | 1.75 | | |
| $V_{GE(th)}$ | 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 | - | 2764 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 80 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 60 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 20 A, $V_{GE}$ = 15 V (see *Figure 27: "Gate charge test circuit"*) | - | 120 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 20 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 50 | - | |

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

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(off)}$ | Turn-off delay time | $V_{CE}$ = 400 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω (see *Figure 26: "Test circuit for inductive load switching"*) | - | 139 | - | ns |
| $t_f$ | Current fall time | | - | 20 | - | ns |
| $E_{off}$(1) | Turn-off switching energy | | - | 170 | - | µJ |
| $t_{d(off)}$ | Turn-off-delay time | $V_{CE}$ = 400 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω, $T_J$ = 175 °C (see *Figure 26: "Test circuit for inductive load switching"*) | - | 147 | - | ns |
| $t_f$ | Current fall time | | - | 38 | - | ns |
| $E_{off}$(1) | Turn-off switching energy | | - | 353 | - | µJ |

**Notes:**

(1)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 | $I_F$ = 5 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs (see *Figure 26: "Test circuit for inductive load switching"*) | - | 140 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 21 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 6.6 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 430 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 1.6 | - | µJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 5 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, $T_J$ = 175 °C, di/dt = 1000 A/µs (see *Figure 26: "Test circuit for inductive load switching"*) | - | 200 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 47.3 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 9.6 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 428 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 3.2 | - | µJ |

## 2.1 Electrical characteristics (curves)

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

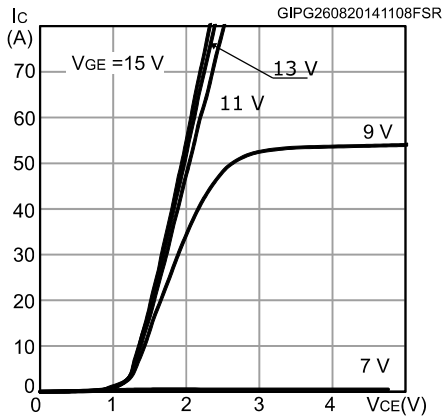



**Figure 3: Output characteristics ($T_J$ = 175 °C)**

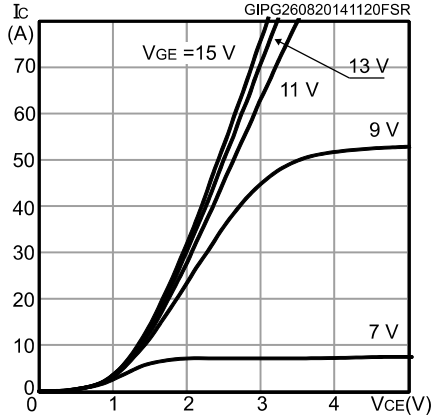



**Figure 4: Transfer characteristics**

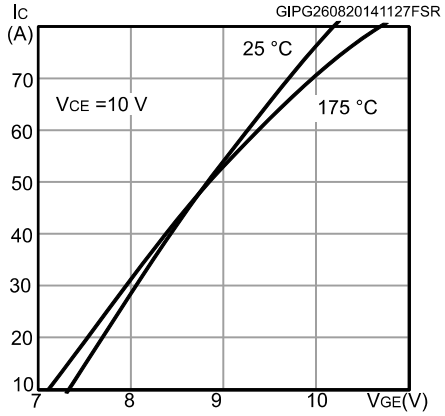



**Figure 5: Collector current vs. case temperature**

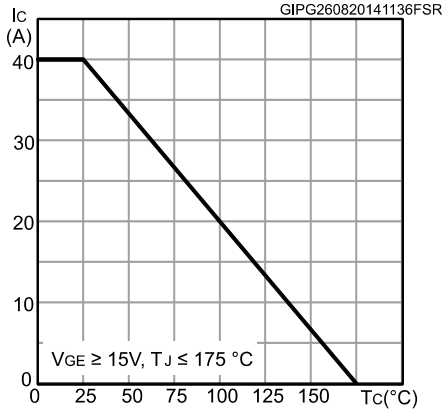



**Figure 6: $V_{CE(sat)}$ vs. junction temperature**

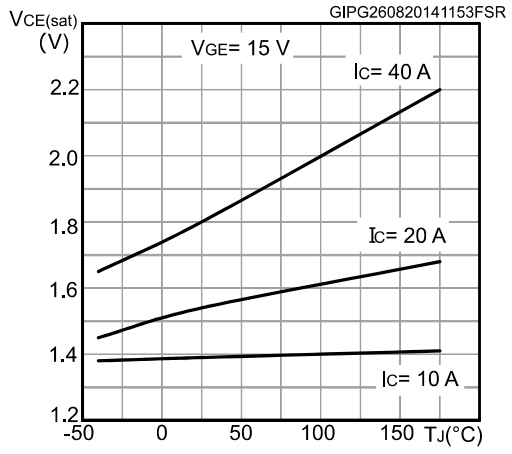



**Figure 7: Power dissipation vs. case temperature**

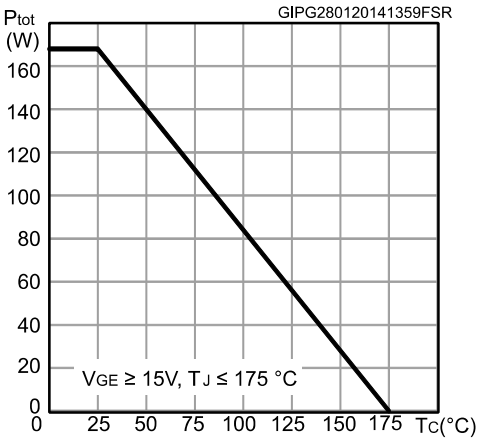


**Figure 8: Forward bias safe operating area**

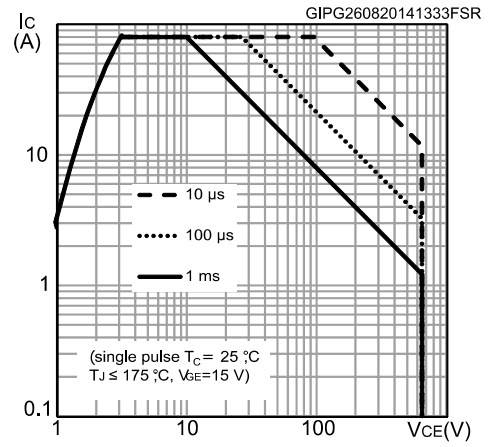



**Figure 9: Collector current vs. switching frequency**

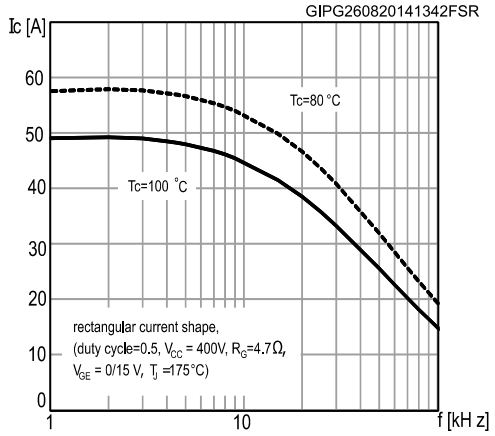



**Figure 10: Normalized $V_{GE(th)}$ vs. junction temperature**

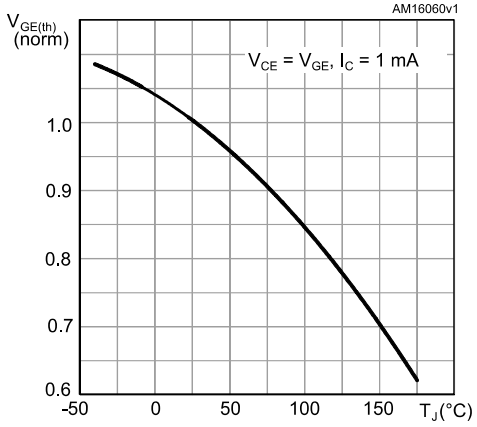



**Figure 11: Normalized $V_{(BR)CES}$ vs. junction temperature**

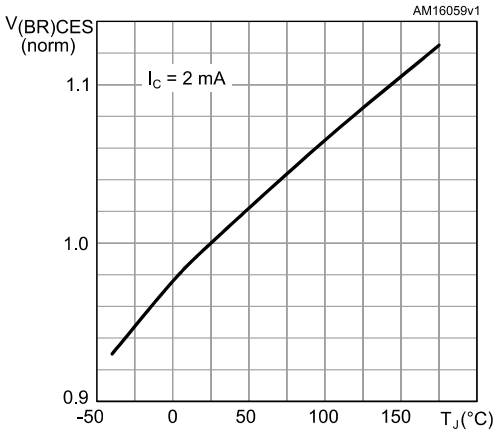



**Figure 12: Switching energy vs. collector current**

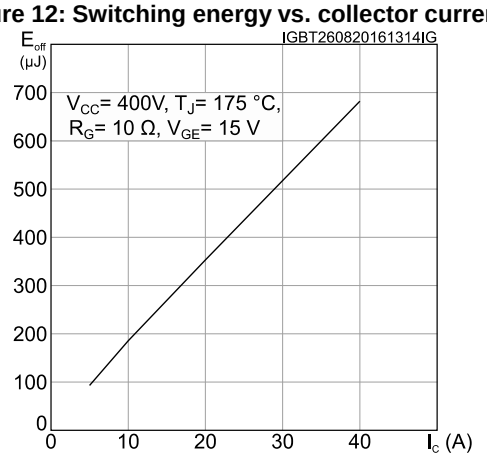



**Figure 13: Switching energy vs. gate resistance**

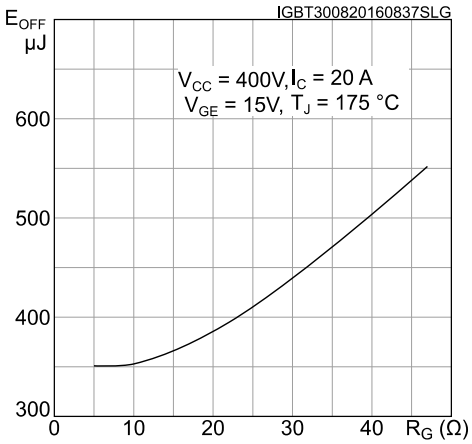


**Figure 14: Switching energy vs. temperature**

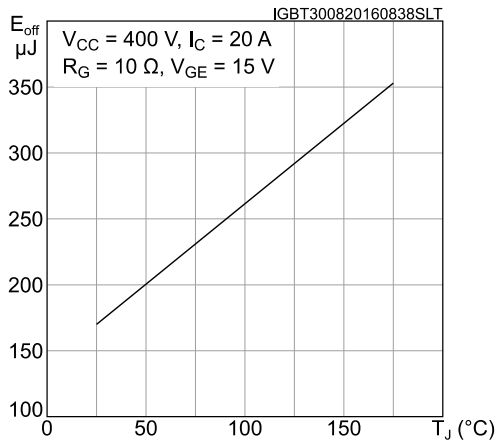



**Figure 15: Switching energy vs. collector emitter voltage**

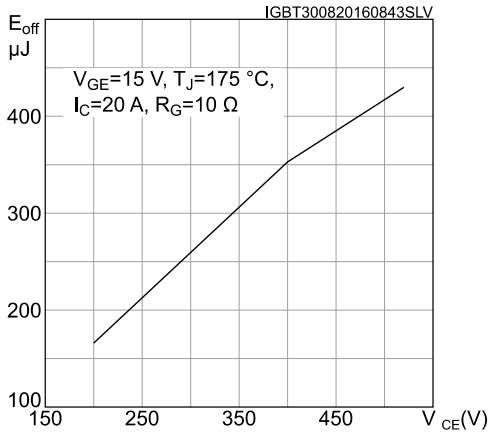



**Figure 16: Switching times vs. collector current**

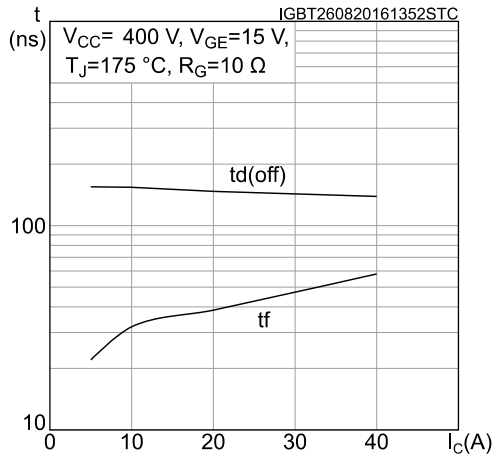



**Figure 17: Switching time vs. gate resistance**

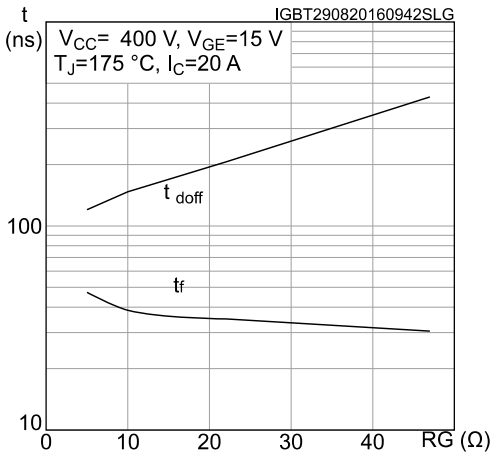



**Figure 18: Capacitance variations**

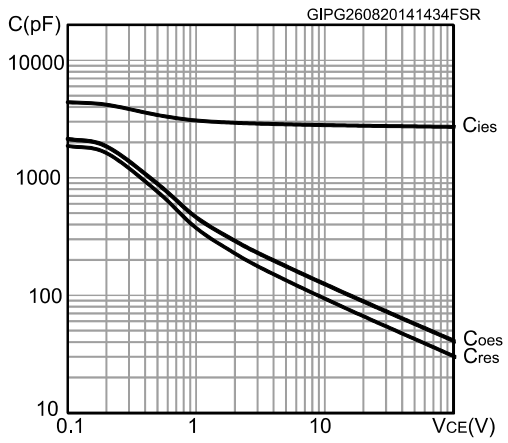



**Figure 19: Gate charge vs. gate-emitter voltage**

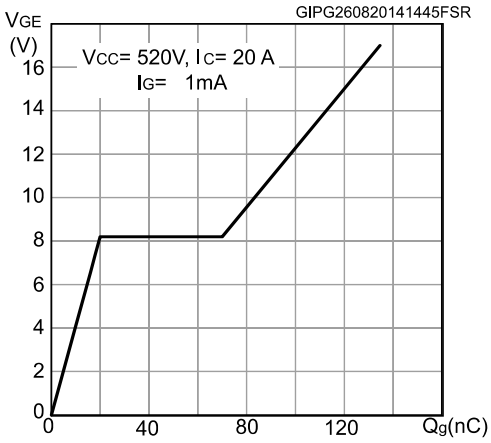


**Figure 20: Diode $V_F$ vs. forward current**

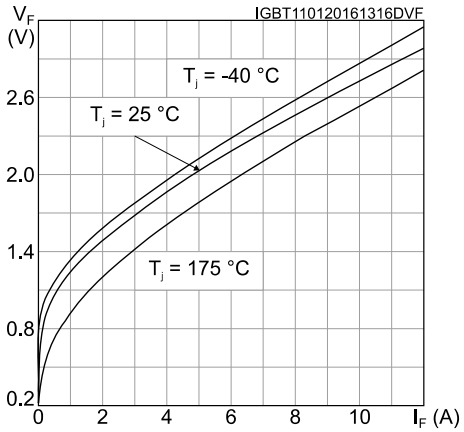



**Figure 21: Reverse recovery current vs. diode current slope**

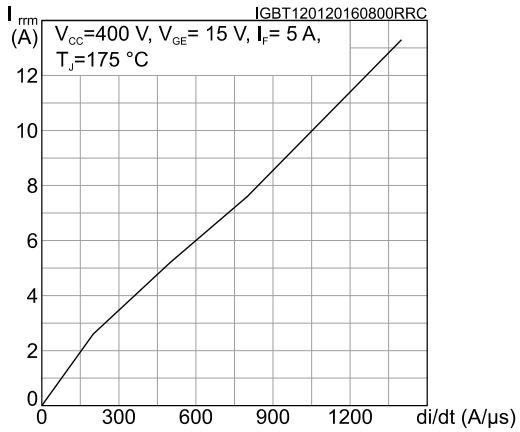



**Figure 22: Reverse recovery time vs. diode current slope**

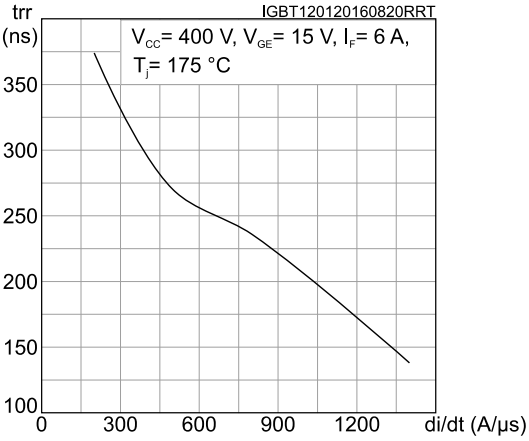



**Figure 23: Reverse recovery charge vs. diode current slope**

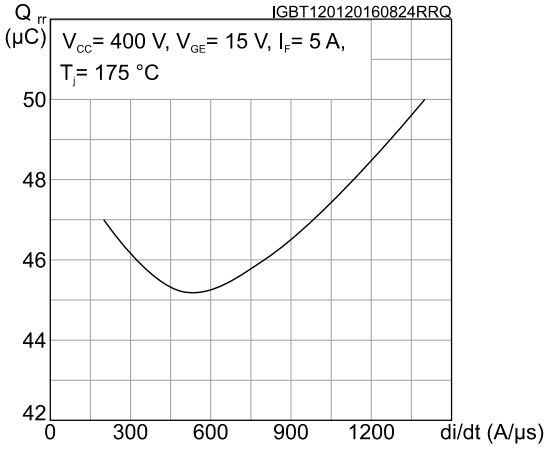



**Figure 24: Reverse recovery energy vs. diode current slope**

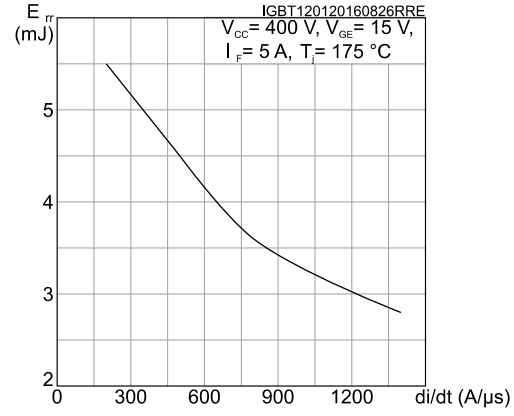
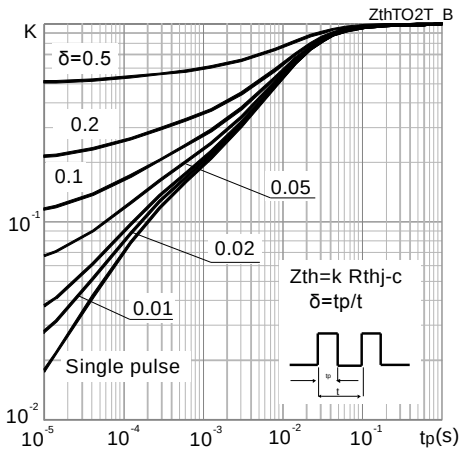



**Figure 25: Thermal impedance**



# 3 Test circuits

**Figure 26: Test circuit for inductive load switching**

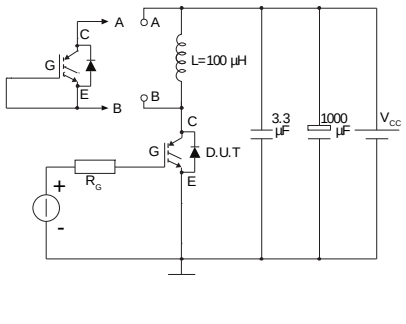



**Figure 27: Gate charge test circuit**

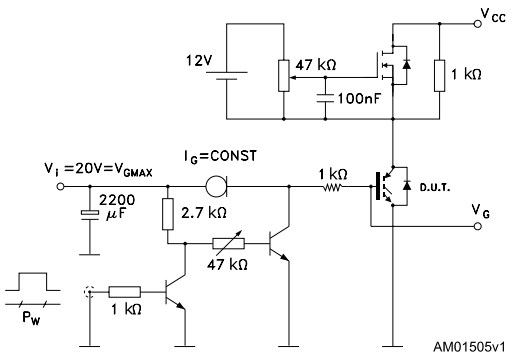
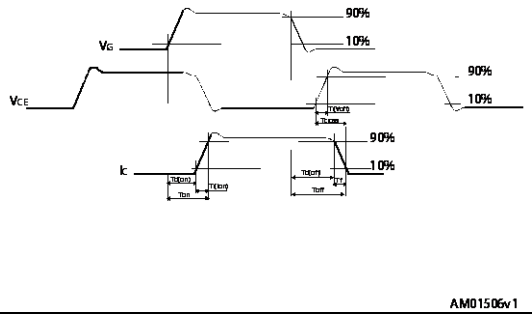



**Figure 28: Switching waveform**



# 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-3P package information

**Figure 29: TO-3P package outline**

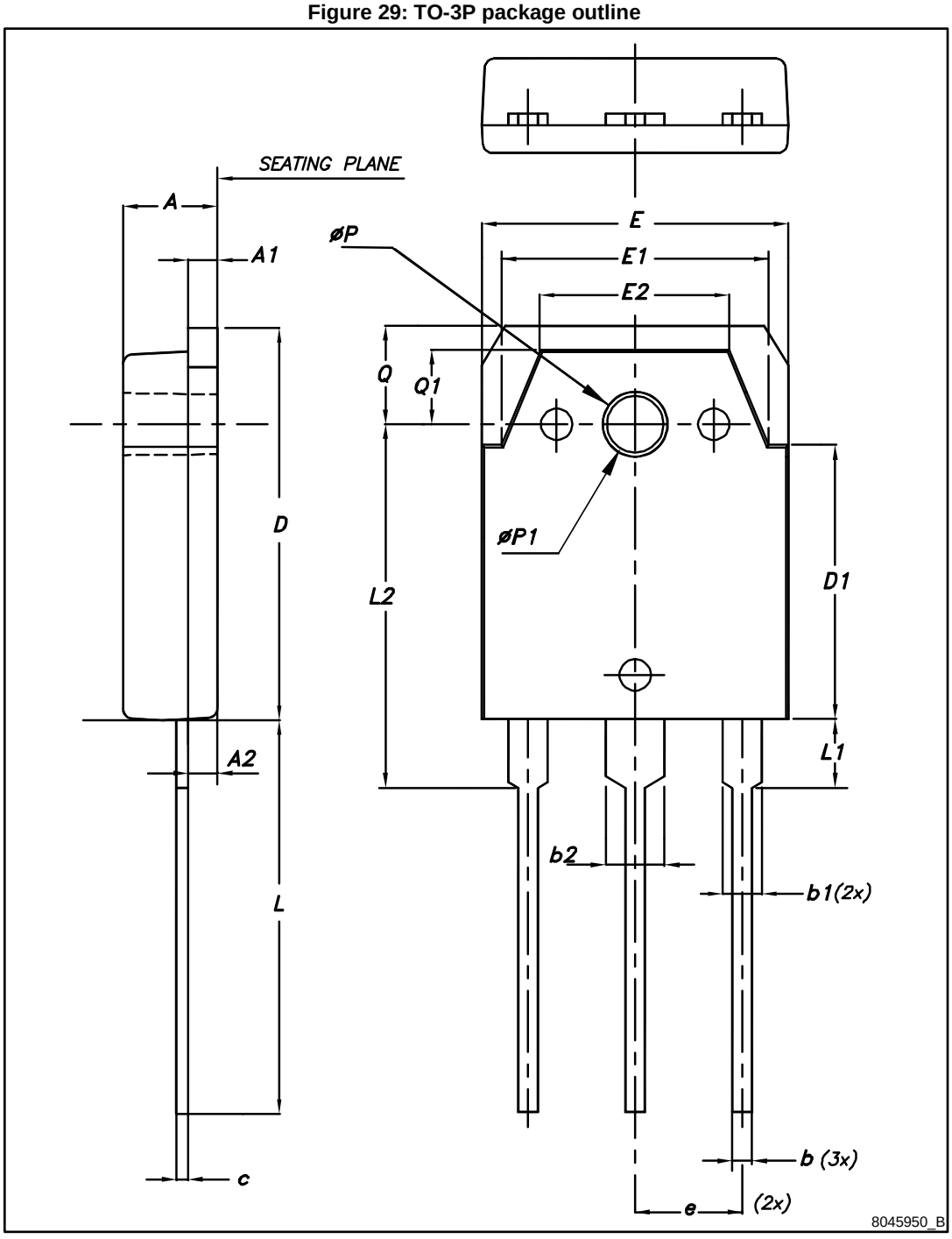


Table 8: TO-3P package mechanical data

| 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 9: Document revision history

| Date | Revision | Changes |
|---|---|---|
| 31-Aug-2016 | 1 | First release. |
| 28-Sep-2016 | 2 | Datasheet promoted from preliminary to production data. |
| 13-Dec-2016 | 3 | Updated *Figure 1: "Internal schematic diagram"*.<br>Updated *Table 4: "Static characteristics"* and *Table 7: "Diode switching characteristics (inductive load)"*.<br>Added *Figure 20: "Diode VF vs. forward current"*, *Figure 21: "Reverse recovery current vs. diode current slope"*, *Figure 22: "Reverse recovery time vs. diode current slope"*, *Figure 23: "Reverse recovery charge vs. diode current slope"* and *Figure 24: "Reverse recovery energy vs. diode current slope"*.<br>Updated *Figure 2: "Output characteristics (TJ = 25 °C)"*, *Figure 12: "Switching energy vs. collector current"* and *Figure 17: "Switching time vs. gate resistance"*.<br>Minor text changes |

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- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

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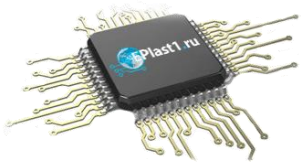
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.




**Как с нами связаться**

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