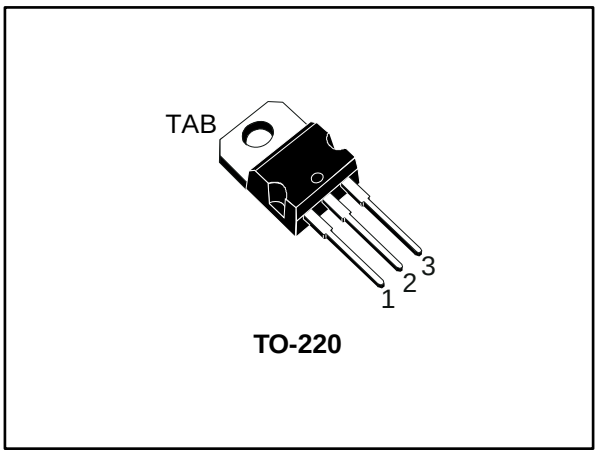
# STGP30M65DF2

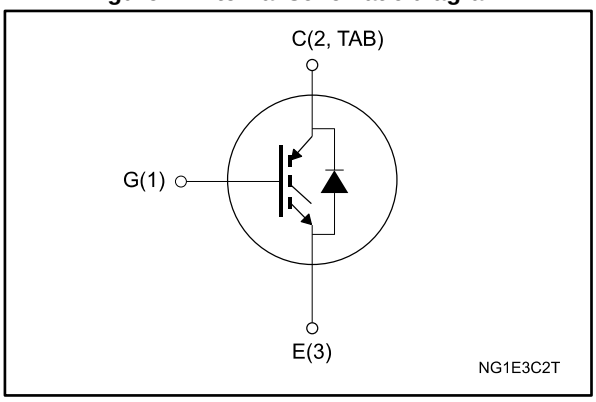
## Trench gate field-stop IGBT, M series 650 V, 30 A low-loss in a TO-220 package

Datasheet - production data




**TO-220**

**Figure 1: Internal schematic diagram**




## Features

- 6 µs of minimum short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ $I_C$ = 30 A
- Tight parameters distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

## Applications

- Motor control
- UPS
- PFC

## 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 |
|---|---|---|---|
| STGP30M65DF2 | G30M65DF2 | TO-220 | Tube |



This is information on a product in full production.

# 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 | 60 | A |
| $I_C$ | Continuous collector current at $T_C$ = 100 °C | 30 | A |
| $I_{CP}$(1) | Pulsed collector current | 120 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C | 60 | A |
| $I_F$ | Continuous forward current at $T_C$ = 100 °C | 30 | A |
| $I_{FP}$(1) | Pulsed forward current | 120 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 258 | W |
| $T_{STG}$ | Storage temperature range | -55 to 150 | °C |
| $T_J$ | Operating junction temperature range | -55 to 175 | °C |

**Notes:**

(1)Pulse width limited by maximum junction temperature.

**Table 3: Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case IGBT | 0.58 | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 1.47 | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 62.5 | °C/W |

# 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, $I_C$ = 250 µA | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 30 A | | 1.55 | 2.0 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 30 A, $T_J$ = 125 °C | | 1.95 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 30 A, $T_J$ = 175 °C | | 2.1 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 30 A | | 1.85 | 2.65 | V |
| | | $I_F$ = 30 A, $T_J$ = 125 °C | | 1.6 | | |
| | | $I_F$ = 30 A, $T_J$ = 175 °C | | 1.5 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$ = $V_{GE}$, $I_C$ = 500 µA | 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 | µA |

**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 | - | 2490 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 143 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 46 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 30 A, $V_{GE}$ = 0 to 15 V (see *Figure 30: "Gate charge test circuit"*) | - | 80 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 18 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 32 | - | |

**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, $I_C$ = 30 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω (see *Figure 29: "Test circuit for inductive load switching"*) | | 31.6 | - | ns |
| $t_r$ | Current rise time | | | 13.4 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1791 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | | 115 | - | ns |
| $t_f$ | Current fall time | | | 110 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | | 0.3 | - | mJ |
| $E_{off}$(2) | Turn-off switching energy | | | 0.96 | - | mJ |
| $E_{ts}$ | Total switching energy | | | 1.26 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 30 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω, $T_J$ = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*) | | 30 | - | ns |
| $t_r$ | Current rise time | | | 17 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1435 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | | 116 | - | ns |
| $t_f$ | Current fall time | | | 194 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | | 0.67 | - | mJ |
| $E_{off}$(2) | Turn-off switching energy | | | 1.36 | - | mJ |
| $E_{ts}$ | Total switching energy | | | 2.03 | - | mJ |
| $t_{sc}$ | Short-circuit withstand time | $V_{CC}$ ≤ 400 V, $V_{GE}$ = 13 V, $T_{Jstart}$ = 150 °C | 10 | | - | µs |
| | | $V_{CC}$ ≤ 400 V, $V_{GE}$ = 15 V, $T_{Jstart}$ = 150 °C | 6 | | - | |

**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 | $I_F$ = 30 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs (see *Figure 29: "Test circuit for inductive load switching"*) | - | 140 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 880 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 17 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 650 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 115 | - | µJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 30 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs, $T_J$ = 175 °C (see *Figure 29: "Test circuit for inductive load switching"*) | - | 244 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 2743 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 25 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 220 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 320 | - | µJ |

## 2.1 Electrical characteristics (curves)

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

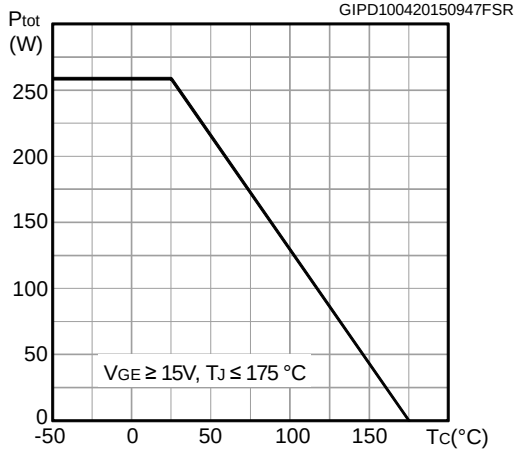



**Figure 3: Collector current vs. case temperature**

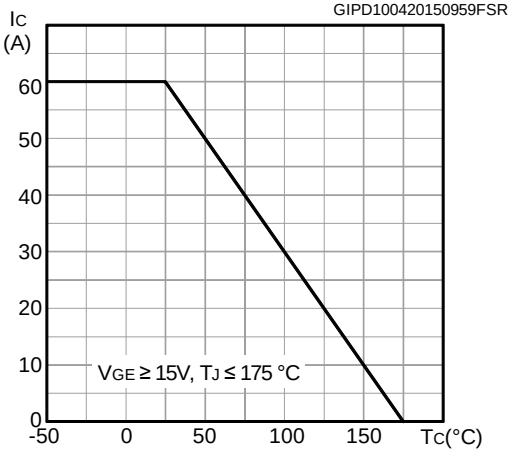



**Figure 4: Output characteristics ($T_J$ = 25 °C)**

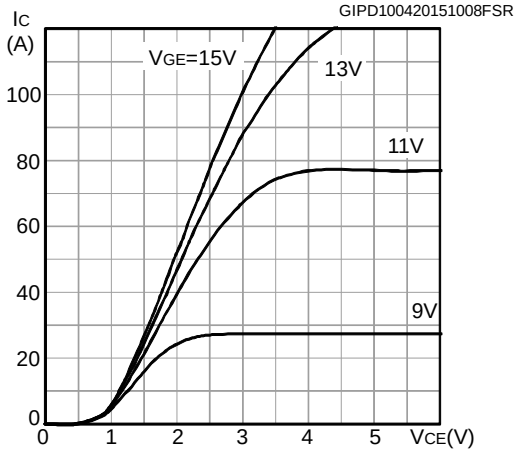



**Figure 5: Output characteristics ($T_J$ = 175 °C)**

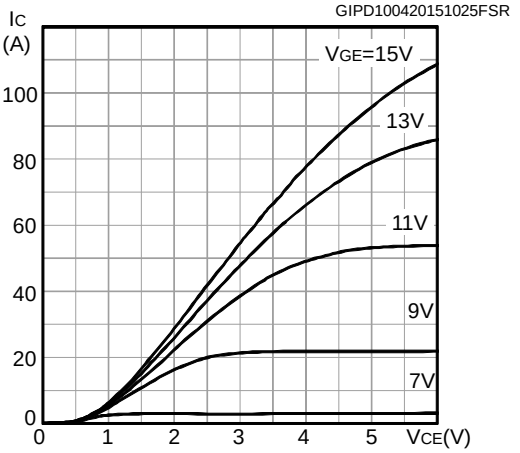



**Figure 6: $V_{CE(sat)}$ vs. junction temperature**

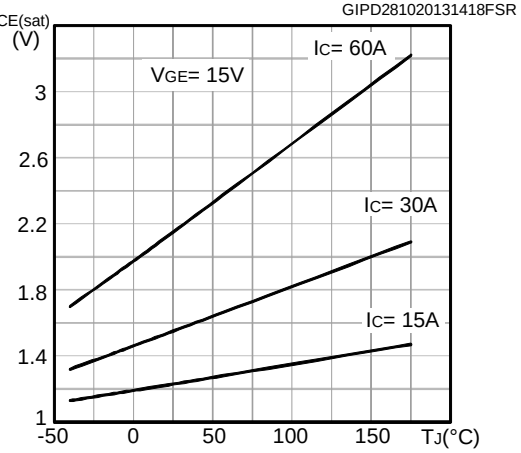



**Figure 7: $V_{CE(sat)}$ vs. collector current**

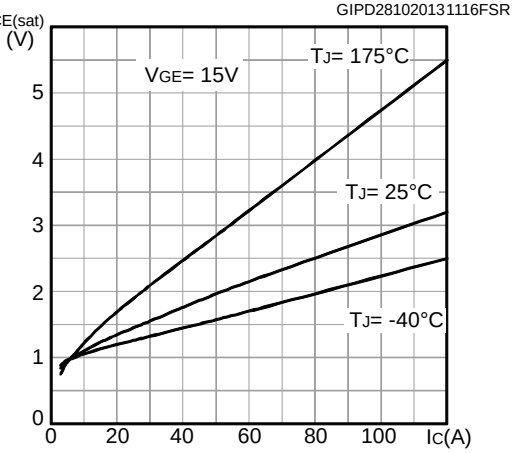


**Figure 8: Collector current vs. switching frequency**

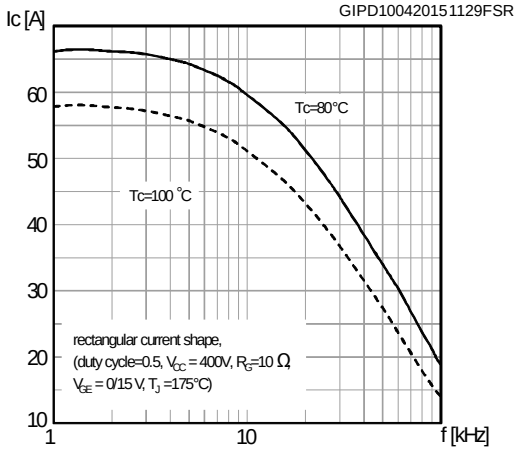



**Figure 9: Forward bias safe operating area**

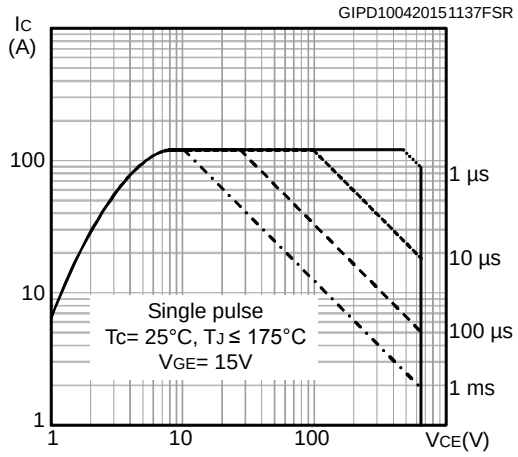



**Figure 10: Transfer characteristics**

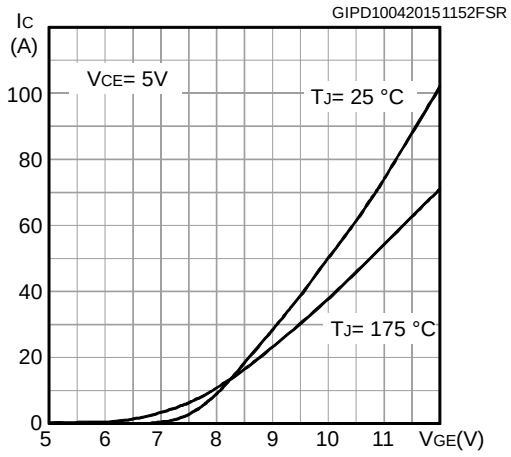



**Figure 11: Diode $V_F$ vs. forward current**

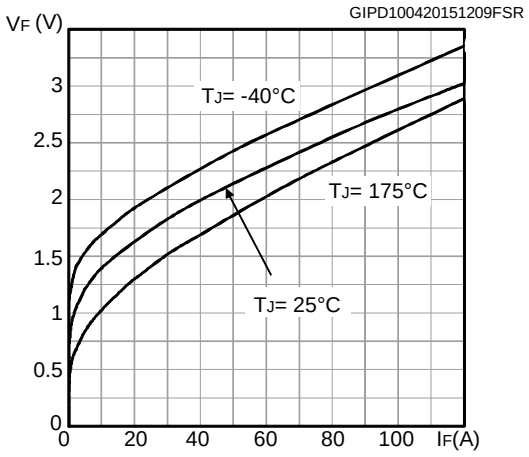



**Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature**

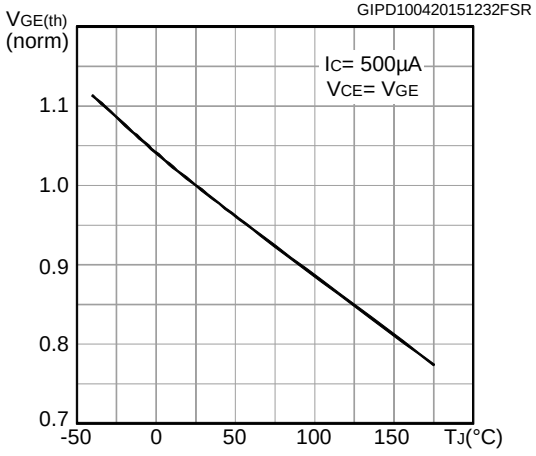



**Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature**

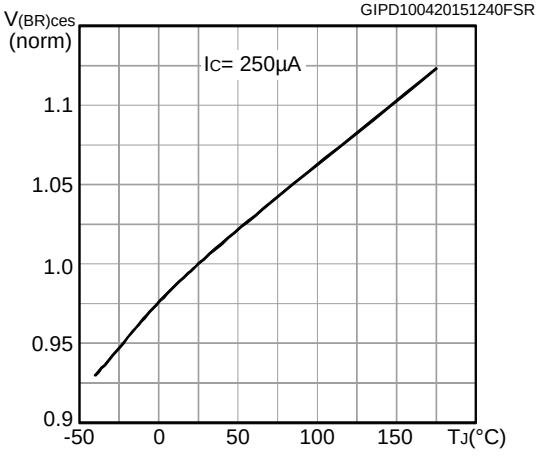


**Figure 14: Capacitance variations**

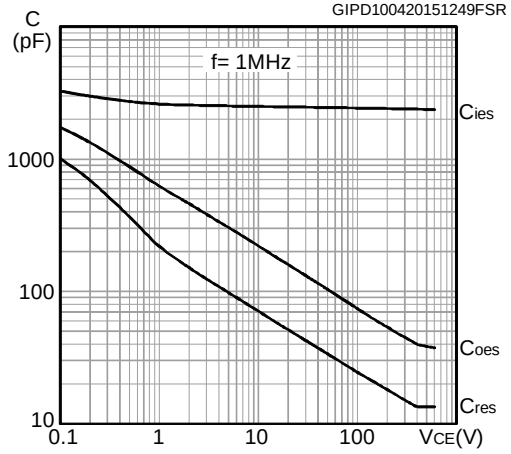



**Figure 15: Gate charge vs. gate-emitter voltage**

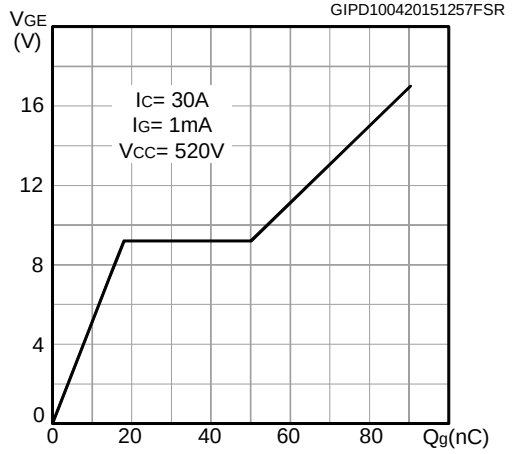



**Figure 16: Switching energy vs. collector current**

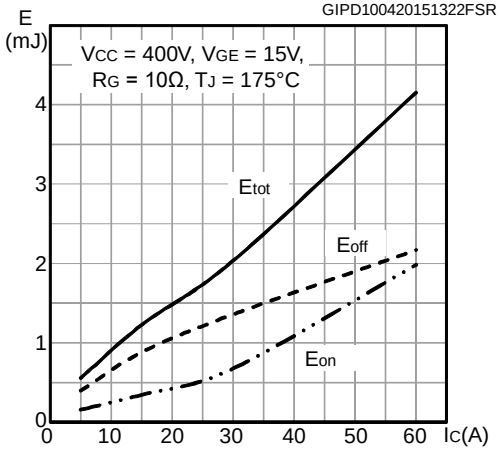



**Figure 17: Switching energy vs. gate resistance**

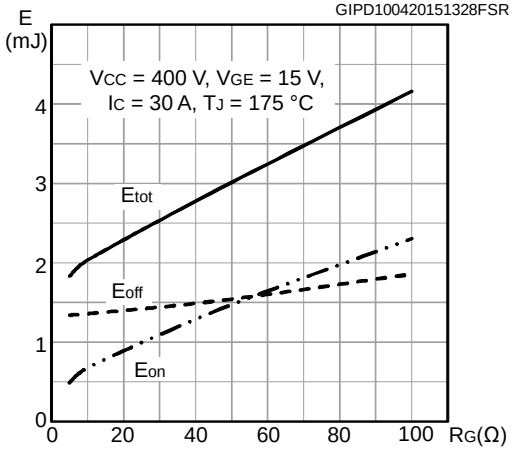



**Figure 18: Switching energy vs. temperature**

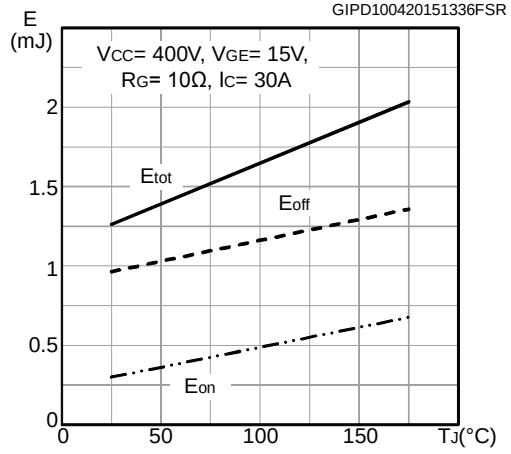



**Figure 19: Switching energy vs. collector emitter voltage**

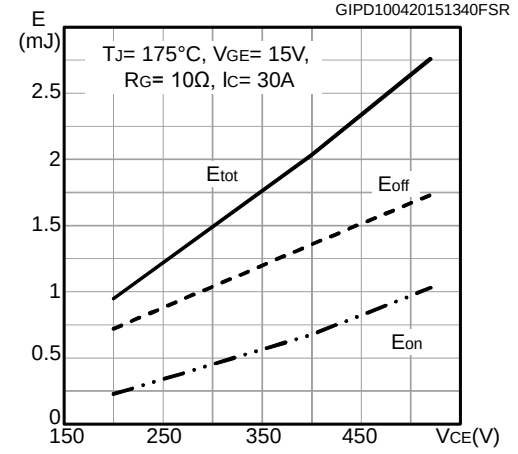


**Figure 20: Short-circuit time and current vs. $V_{GE}$**

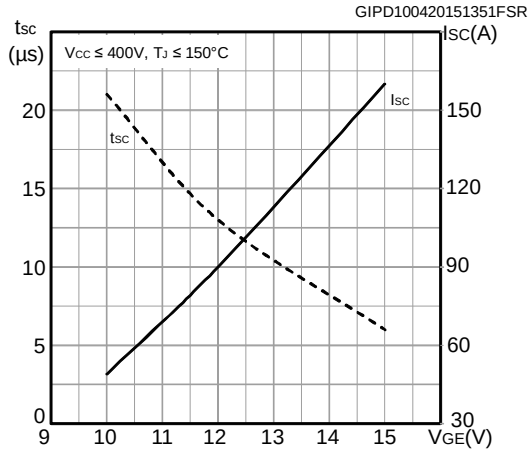



**Figure 21: Switching times vs. collector current**

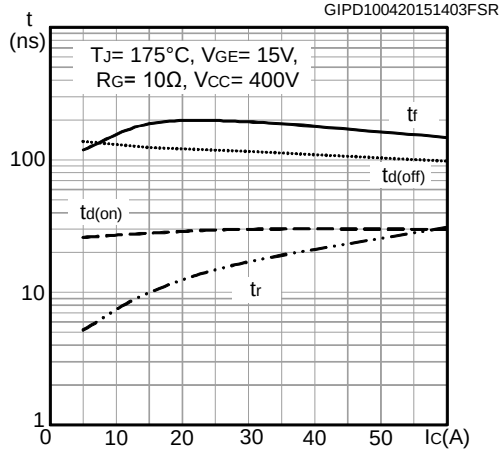



**Figure 22: Switching times vs. gate resistance**

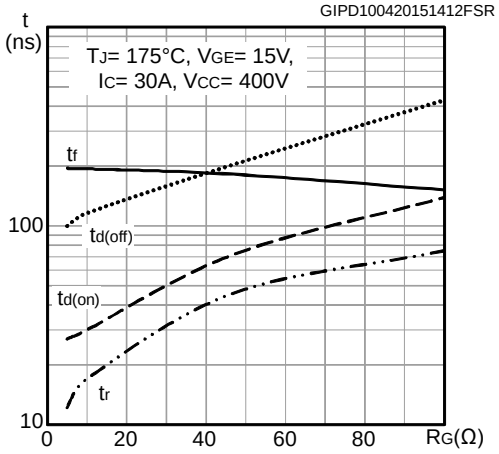



**Figure 23: Reverse recovery current vs. diode current slope**

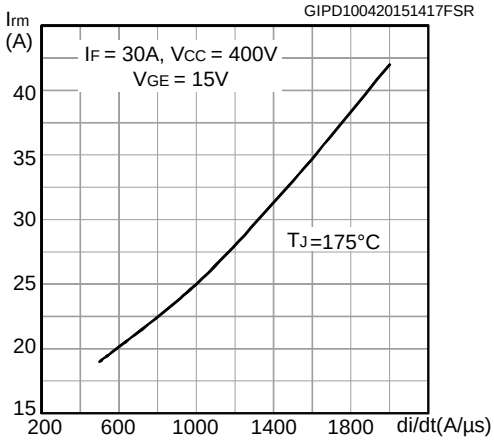



**Figure 24: Reverse recovery time vs. diode current slope**

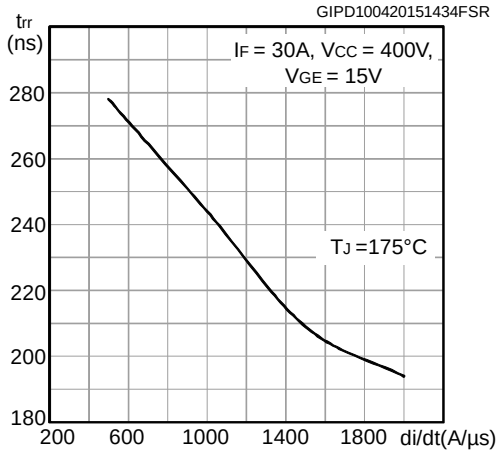



**Figure 25: Reverse recovery charge vs. diode current slope**

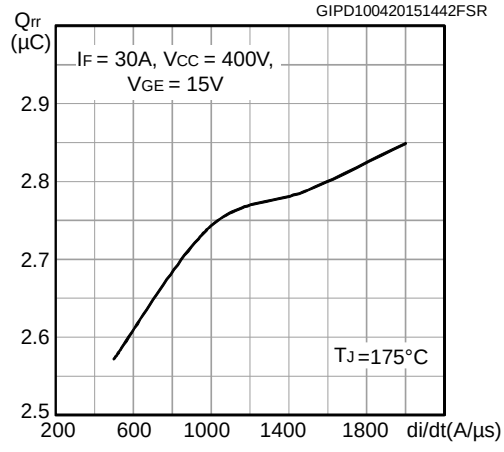


**Figure 26: Reverse recovery energy vs. diode current slope**

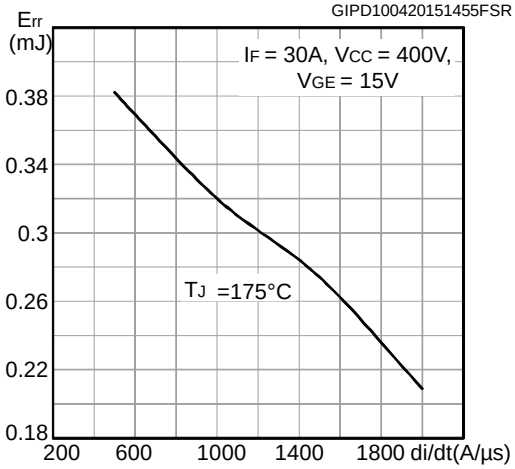



**Figure 27: Thermal impedance for IGBT**

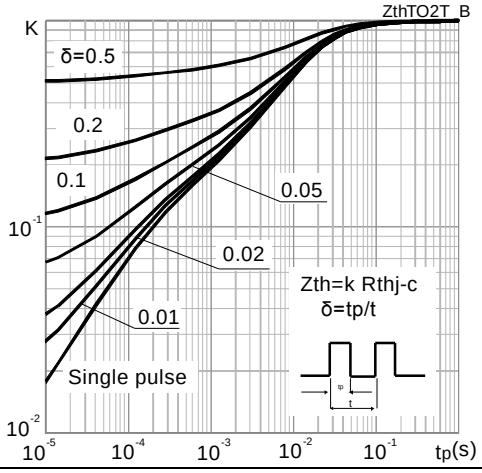
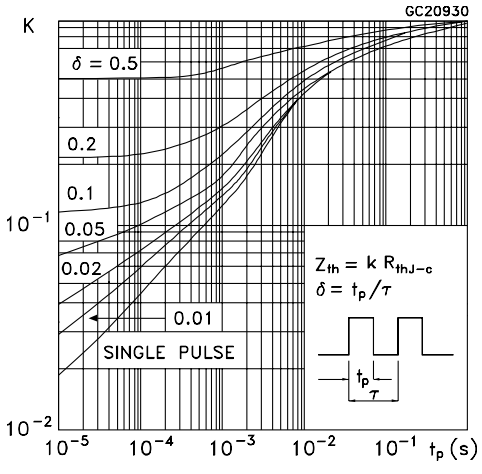



**Figure 28: Thermal impedance for diode**



# 3 Test circuits

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

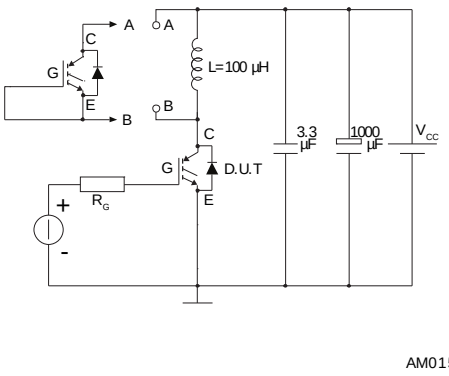



**Figure 30: Gate charge test circuit**

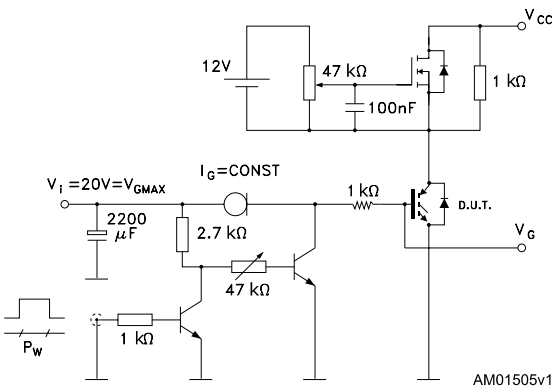



**Figure 31: Switching waveform**

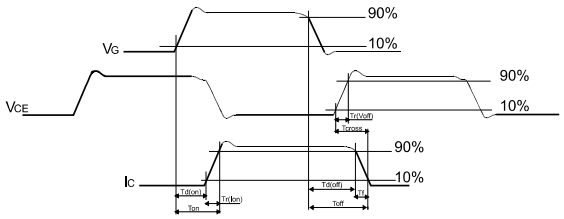
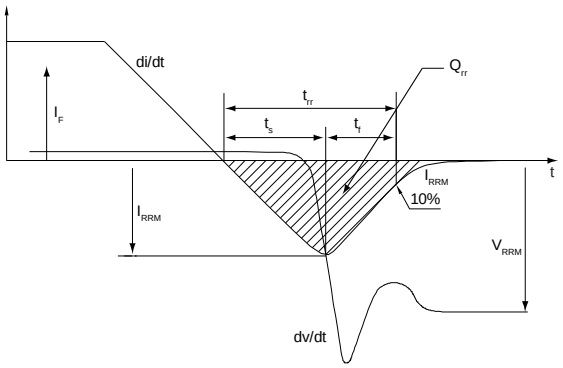



**Figure 32: Diode reverse recovery waveform**



# 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-220 type A package information

**Figure 33: TO-220 type A package outline**

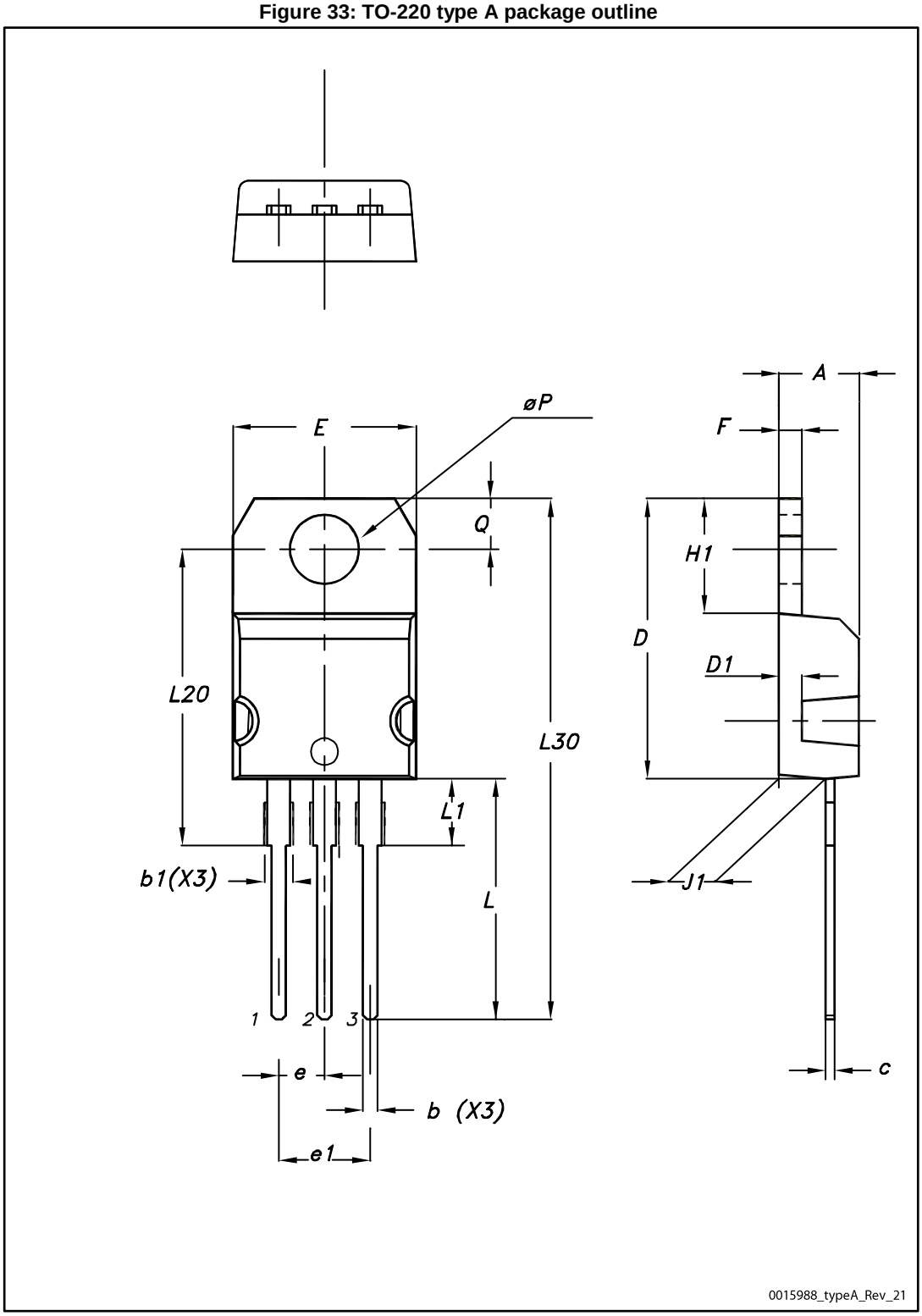


Table 8: TO-220 type A mechanical data

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.55 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10.00 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13.00 | | 14.00 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| øP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |

# 5 Revision history

**Table 9: Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 10-Feb-2015 | 1 | First release. |
| 13-Apr-2015 | 2 | Document status promoted from preliminary to production data.<br>Updated features in cover page.<br>Updated *Section 2: "Electrical characteristics"*<br>Added *Section 2.1: "Electrical characteristics (curves)"* |
| 11-Apr-2017 | 3 | Updated document title.<br>Updated *Table 4: "Static characteristics"*, *Table 6: "IGBT switching characteristics (inductive load)"* and *Table 7: "Diode switching characteristics (inductive load)"*.<br>Updated *Figure 13: "Normalized $V_{(BR)CES}$ vs. junction temperature "*.<br>Updated *Section 4.1: "TO-220 type A package information"*.<br>Minor text changes |

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