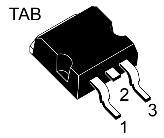
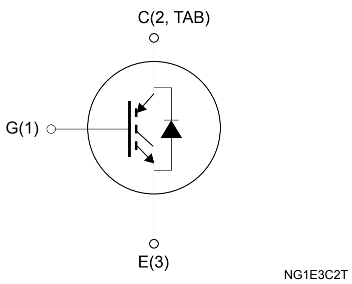
# Trench gate field-stop, 650 V, 20 A, M series low-loss IGBT




D²PAK




## Features

- High short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ $I_C$ = 20 A
- Tight parameters distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

## Applications

- Motor control
- UPS
- PFC
- General-purpose inverters

## Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where the low-loss and the short-circuit functionality is essential. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and the tight parameter distribution result in safer paralleling operation.

| Product status link |
|---|
| STGB20M65DF2 |

| Product summary | |
|---|---|
| **Order code** | STGB20M65DF2 |
| **Marking** | G20M65DF2 |
| **Package** | D²PAK |
| **Packing** | Tape and reel |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0) | 650 | V |
| $I_C$ | Continuous collector current at $T_C$ = 25 °C | 40 | A |
| | Continuous collector current at $T_C$ = 100 °C | 20 | A |
| $I_{CP}$ (1) | Pulsed collector current | 80 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C | 40 | A |
| | Continuous forward current at $T_C$ = 100 °C | 20 | A |
| $I_{FP}$ (1) | Pulsed forward current | 80 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 166 | W |
| $T_{STG}$ | Storage temperature range | -55 to 150 | °C |
| $T_J$ | Operating junction temperature range | -55 to 175 | °C |

1. *Pulse width limited by maximum junction temperature.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case IGBT | 0.9 | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 2.08 | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 62.5 | °C/W |

# 2 Electrical characteristics

$T_C$ = 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, $I_C$ = 250 µA | 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 | | 1.95 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 175 °C | | 2.1 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 20 A | | 1.85 | | V |
| | | $I_F$ = 20 A, $T_J$ = 125 °C | | 1.65 | | |
| | | $I_F$ = 20 A, $T_J$ = 175 °C | | 1.55 | | |
| $V_{GE(th)}$ | 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 | 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 | - | 1688 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 95 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 35 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 20 A, $V_{GE}$ = 0 to 15 V (see Figure 29. Gate charge test circuit) | - | 63 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 15 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 26 | - | |

**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, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 12 Ω (see Figure 28. Test circuit for inductive load switching) | | 26 | - | ns |
| $t_r$ | Current rise time | | | 10.8 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1409 | - | A/μs |
| $t_{d(off)}$ | Turn-off delay time | | | 108 | - | ns |
| $t_f$ | Current fall time | | | 65 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | | 0.14 | - | mJ |
| $E_{off}$(2) | Turn-off switching energy | | | 0.56 | - | mJ |
| $E_{ts}$ | Total switching energy | | | 0.7 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 12 Ω, $T_J$ = 175 °C (see Figure 28. Test circuit for inductive load switching) | | 28.4 | - | ns |
| $t_r$ | Current rise time | | | 11.2 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | 1393 | - | A/μs |
| $t_{d(off)}$ | Turn-off delay time | | | 107 | - | ns |
| $t_f$ | Current fall time | | | 145 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | | 0.3 | - | mJ |
| $E_{off}$(2) | Turn-off switching energy | | | 0.85 | - | mJ |
| $E_{ts}$ | Total switching energy | | | 1.15 | - | 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 | | - | |

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 | $I_F$ = 20 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/μs (see Figure 28. Test circuit for inductive load switching) | - | 166 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 690 | | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 13.2 | | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 769 | | A/μs |
| $E_{rr}$ | Reverse recovery energy | | - | 81 | | μJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 20 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) | - | 281 | | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 2010 | | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 19.6 | | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 370 | | A/μs |
| $E_{rr}$ | Reverse recovery energy | | - | 215 | | μJ |

## 2.1 Electrical characteristics (curves)

**Figure 1. Power dissipation vs case temperature**

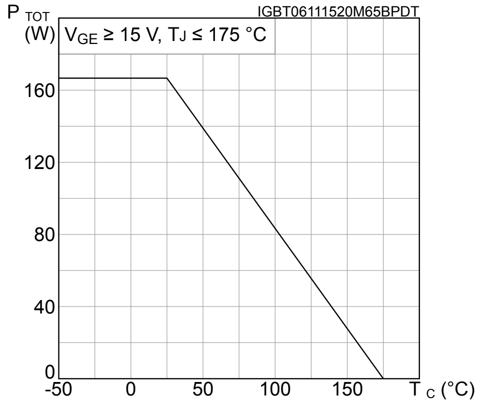



**Figure 2. Collector current vs case temperature**

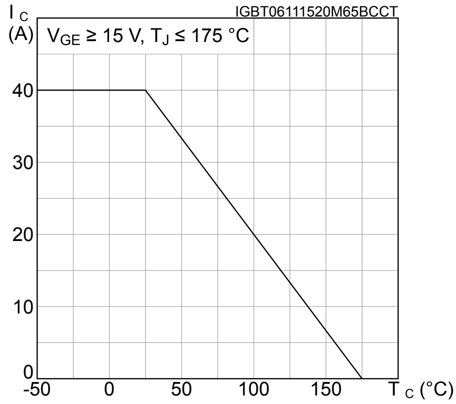



**Figure 3. Output characteristics ($T_J$ = 25 °C)**

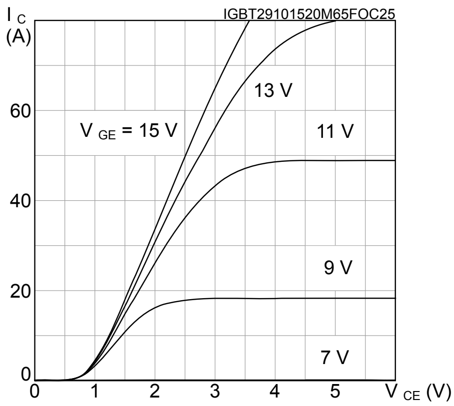



**Figure 4. Output characteristics ($T_J$ = 175 °C)**

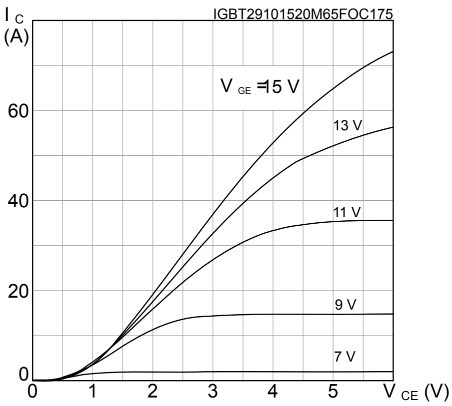



**Figure 5. $V_{CE}$(sat) vs junction temperature**

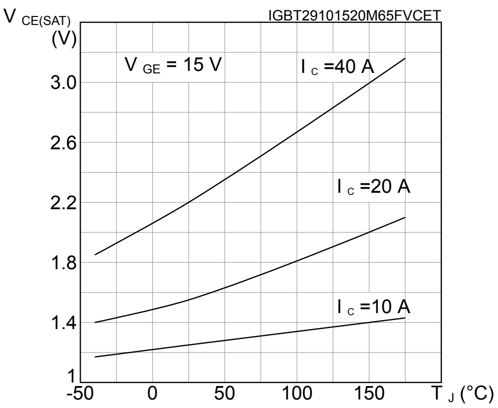



**Figure 6. $V_{CE}$(sat) vs collector current**

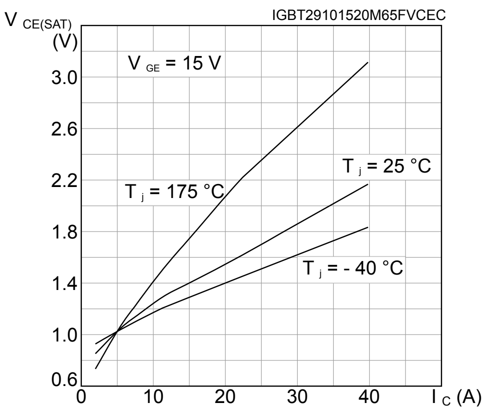


**Figure 7. Collector current vs switching frequency**

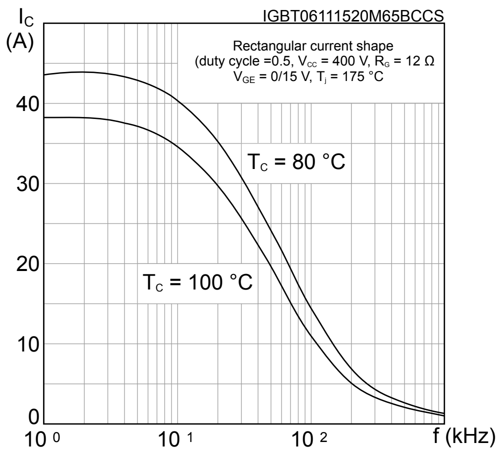



**Figure 8. Forward bias safe operating area**

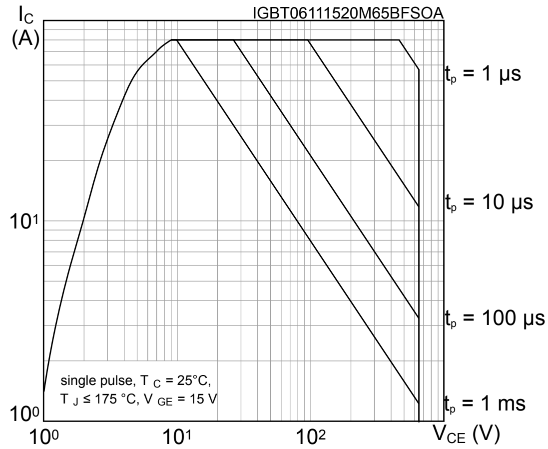



**Figure 9. Transfer characteristics**

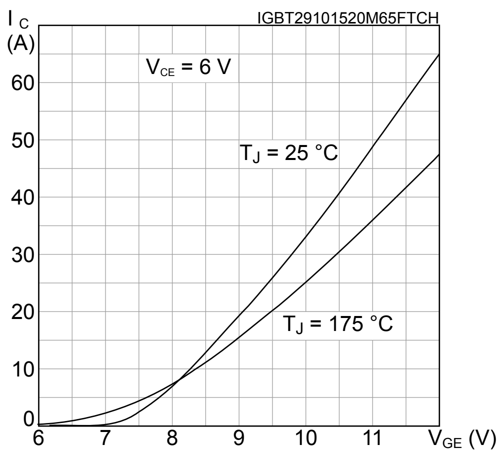



**Figure 10. Diode $V_F$ vs forward current**

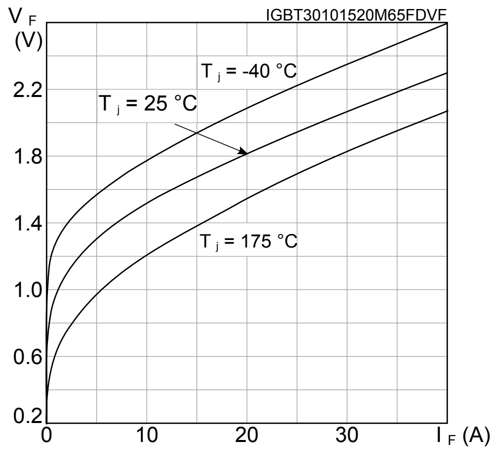



**Figure 11. Normalized $V_{GE(th)}$ vs junction temperature**

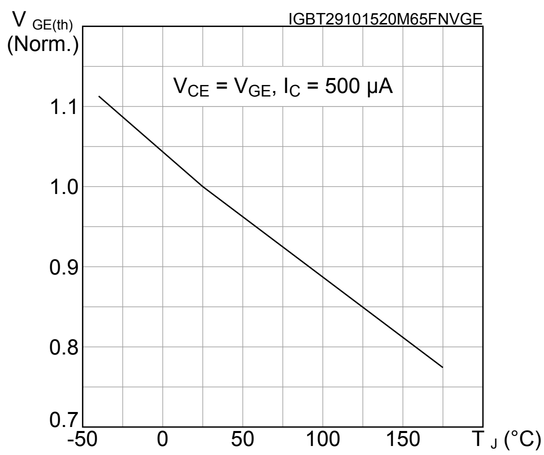



**Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature**

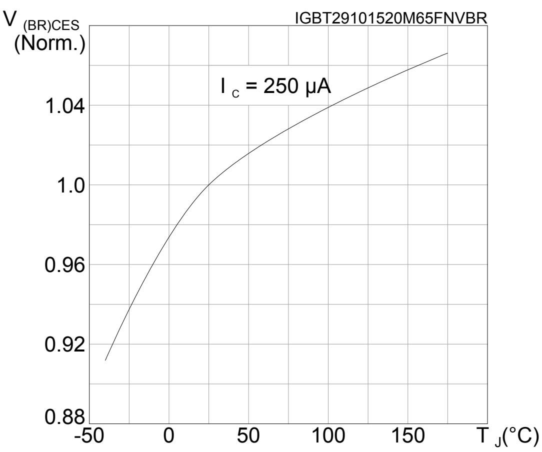


Figure 13. **Capacitance variations**

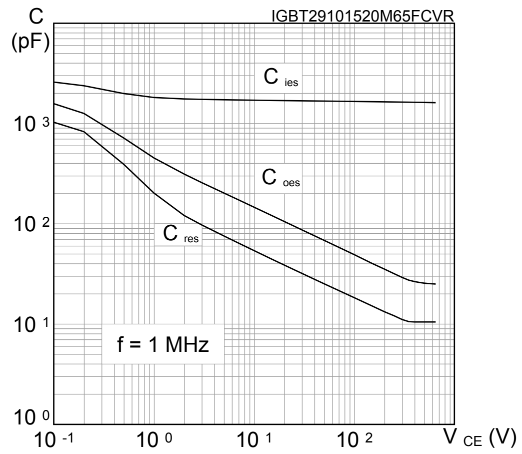



Figure 14. **Gate charge vs gate-emitter voltage**

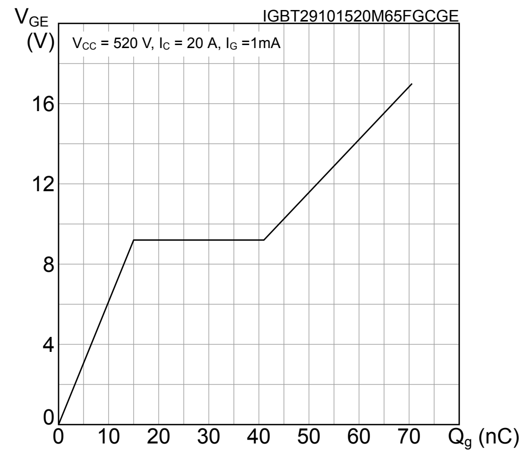



Figure 15. **Switching energy vs collector current**

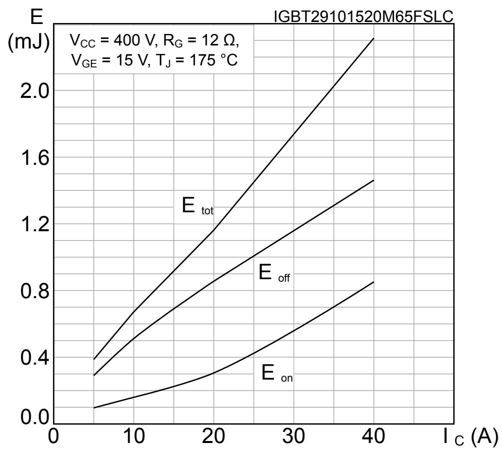



Figure 16. **Switching energy vs gate resistance**

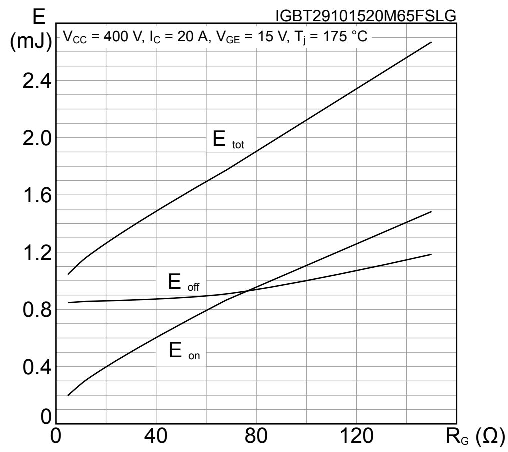



Figure 17. **Switching energy vs temperature**

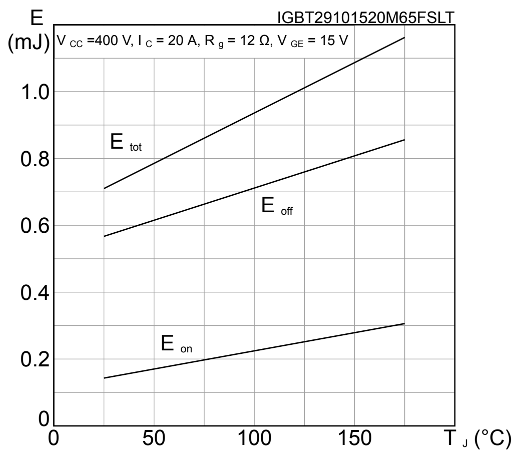



Figure 18. **Switching energy vs collector emitter voltage**

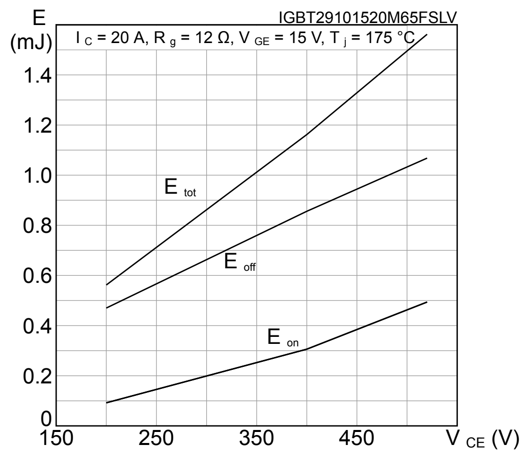


**Figure 19. Short-circuit time and current vs $V_{GE}$**

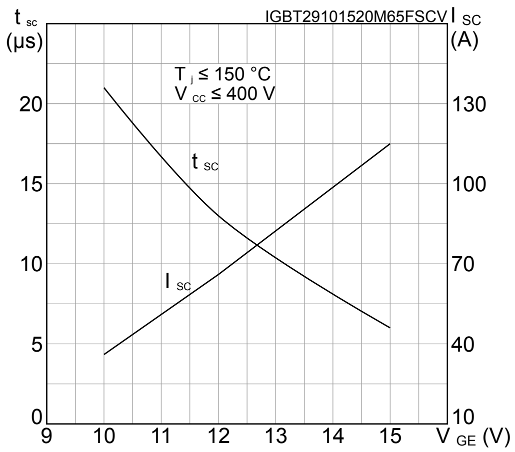



**Figure 20. Switching times vs collector current**

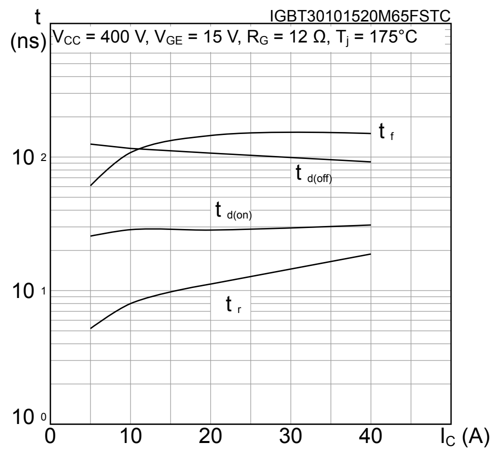



**Figure 21. Switching times vs gate resistance**

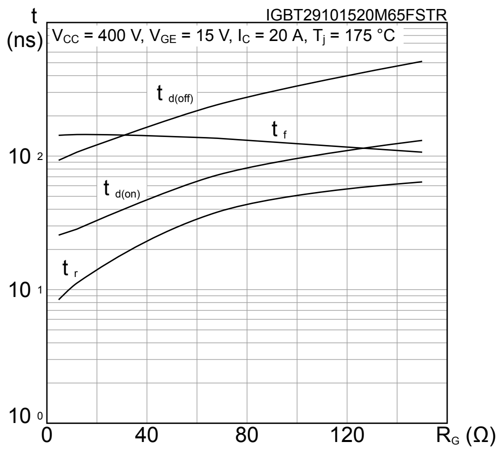



**Figure 22. Reverse recovery current vs diode current slope**

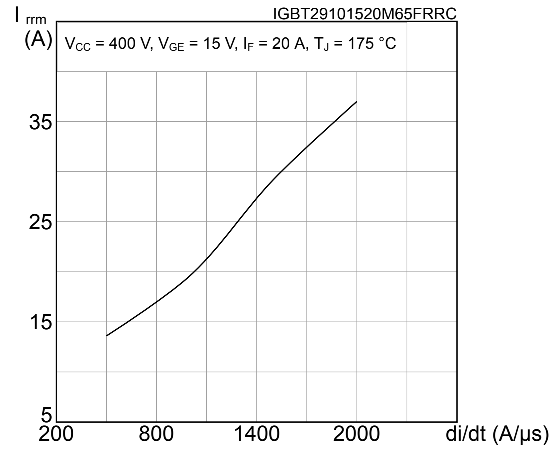



**Figure 23. Reverse recovery time vs diode current slope**

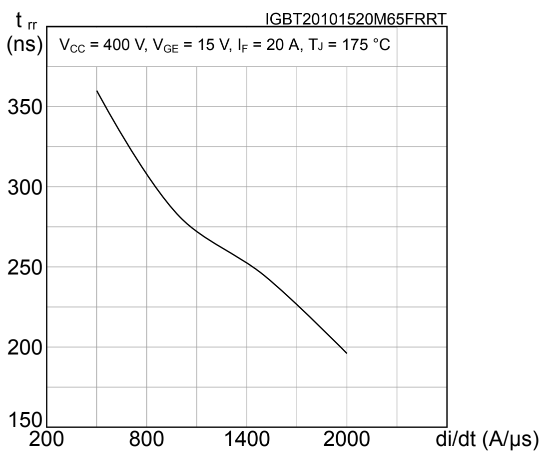



**Figure 24. Reverse recovery charge vs diode current slope**

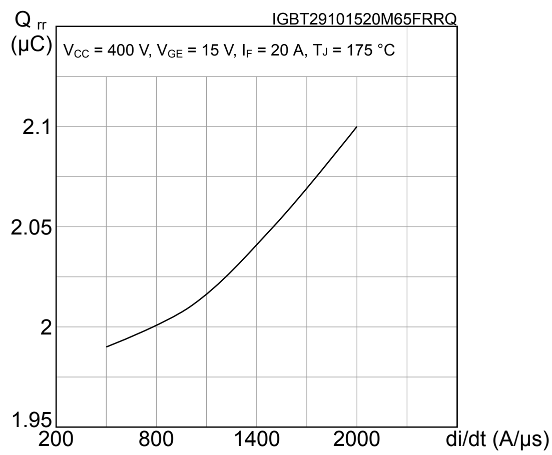


**Figure 25. Reverse recovery energy vs diode current slope**

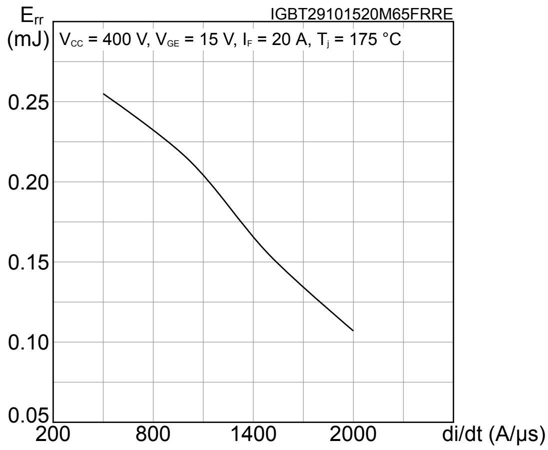



**Figure 26. Thermal impedance for IGBT**

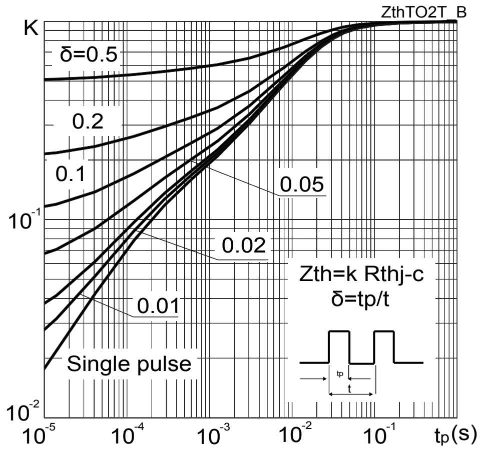
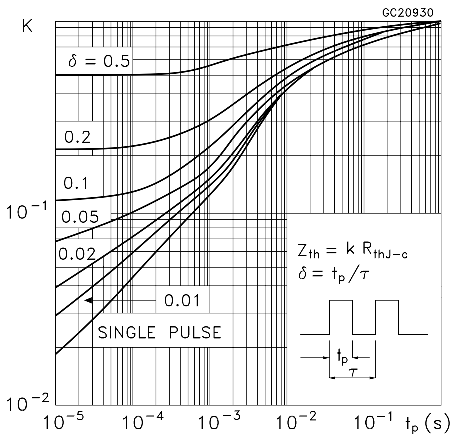



**Figure 27. Thermal impedance for diode**



# 3 Test circuits

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

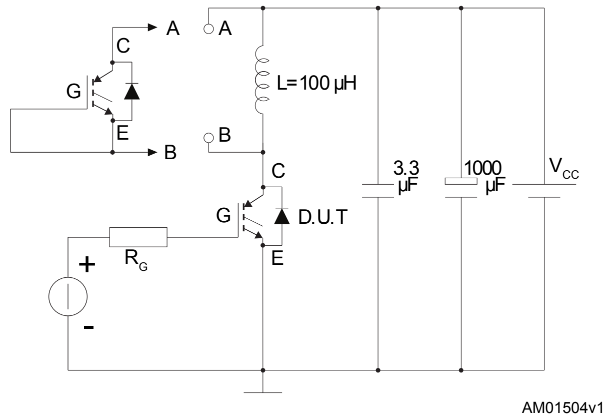



**Figure 29. Gate charge test circuit**

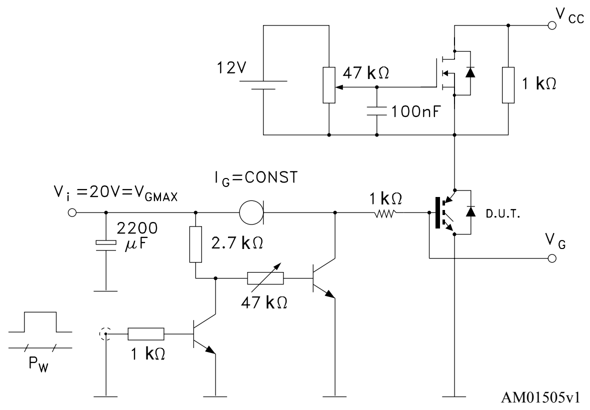



**Figure 30. Switching waveform**

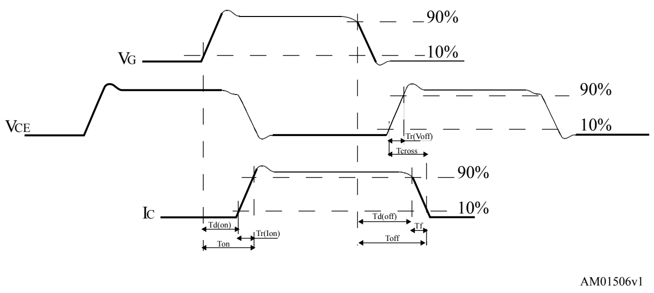
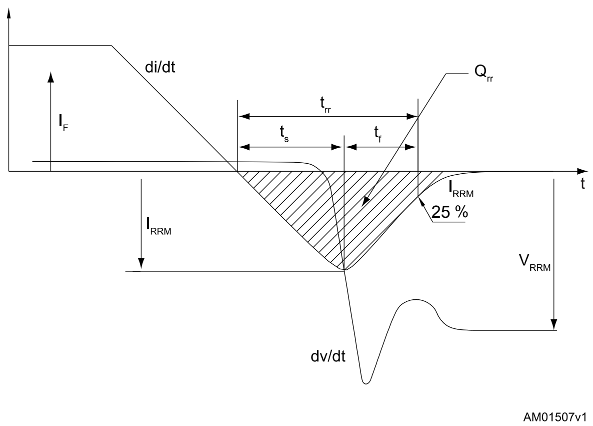



**Figure 31. Diode reverse recovery waveform**



# 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 D²PAK (TO-263) type A2 package information

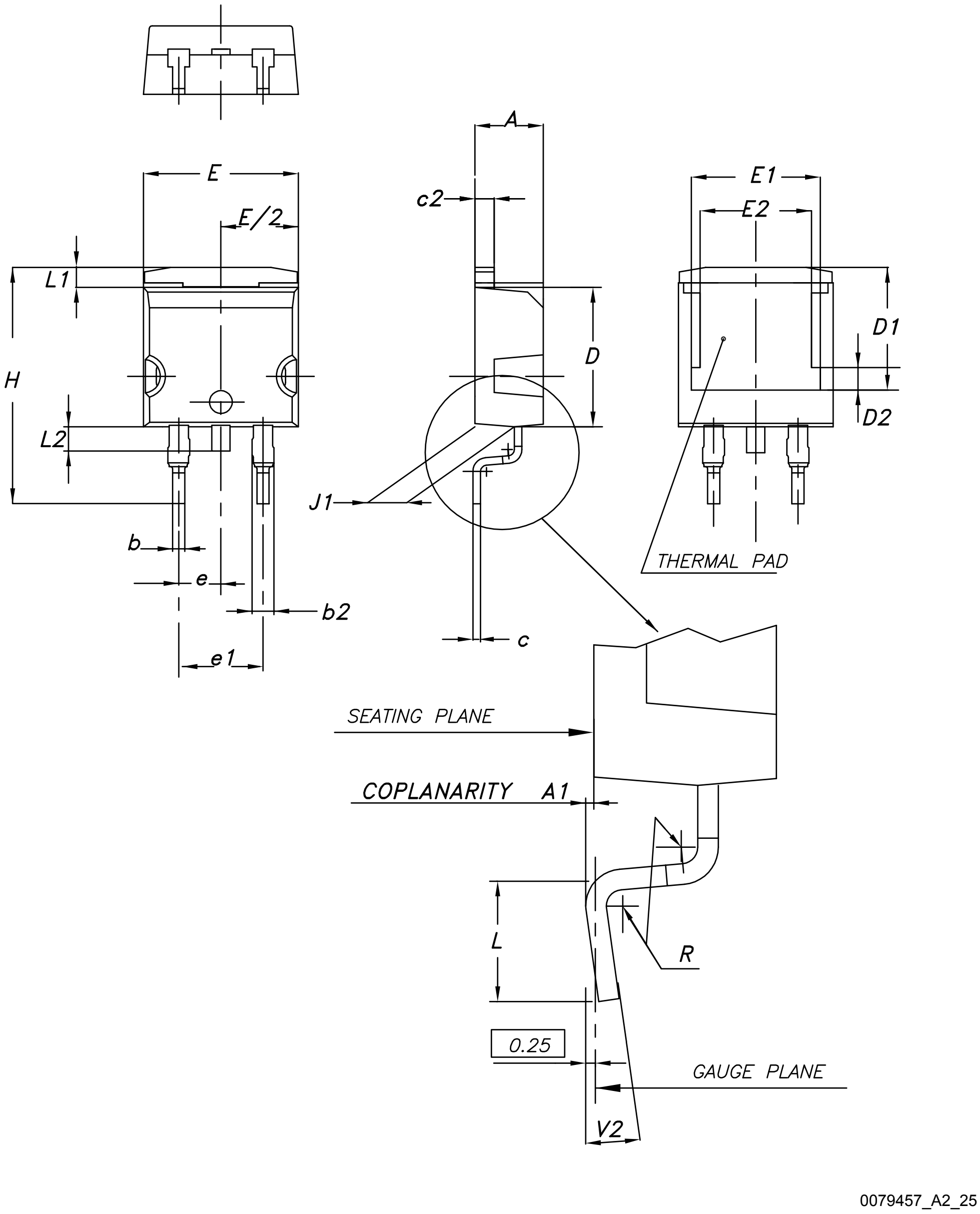
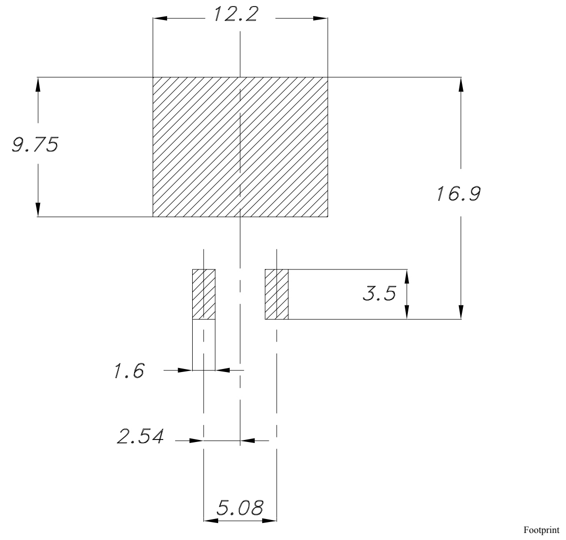



Figure 32. D²PAK (TO-263) type A2 package outline

Table 7. $D^2PAK$ (TO-263) type A2 package mechanical data

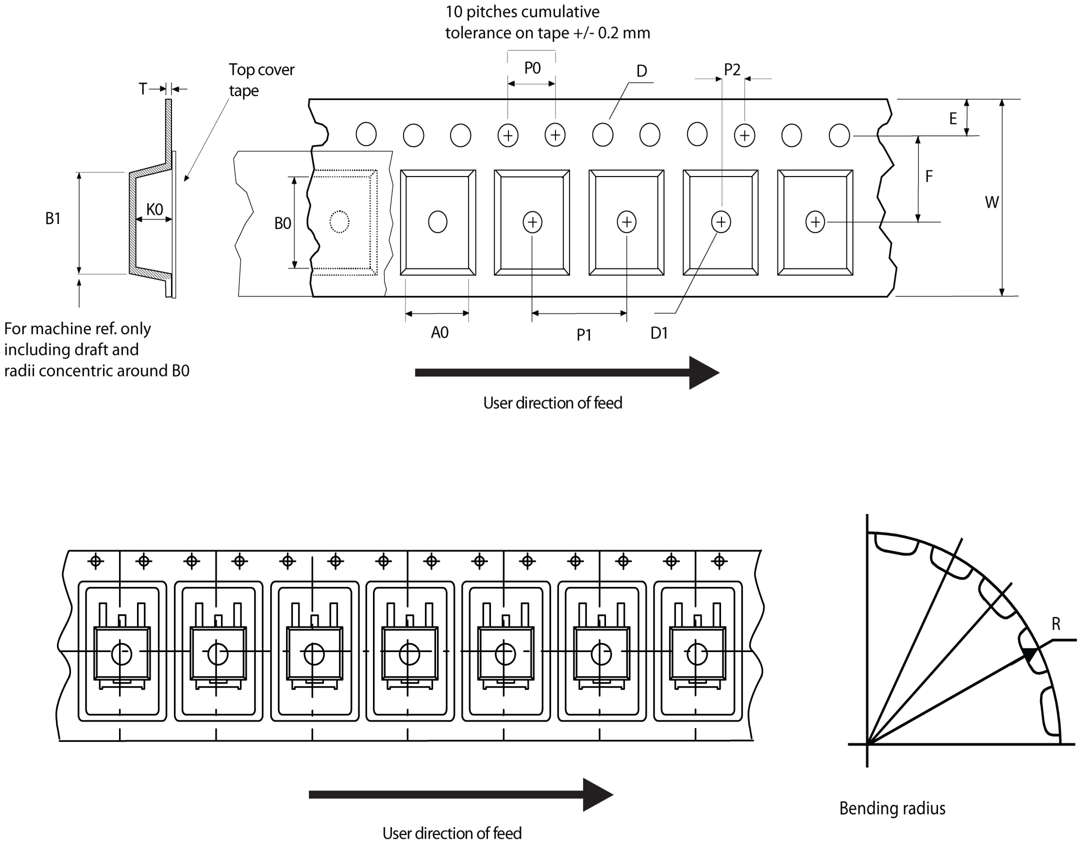
| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| A1 | 0.03 | | 0.23 |
| b | 0.70 | | 0.93 |
| b2 | 1.14 | | 1.70 |
| c | 0.45 | | 0.60 |
| c2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | 7.50 | 7.75 | 8.00 |
| D2 | 1.10 | 1.30 | 1.50 |
| E | 10.00 | | 10.40 |
| E1 | 8.70 | 8.90 | 9.10 |
| E2 | 7.30 | 7.50 | 7.70 |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15.00 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.40 | |
| V2 | 0° | | 8° |

Figure 33. $D^2PAK$ (TO-263) recommended footprint (dimensions are in mm)



## 4.2 D²PAK packing information

Figure 34. D²PAK tape outline




AM08852v1

Figure 35. D²PAK reel outline

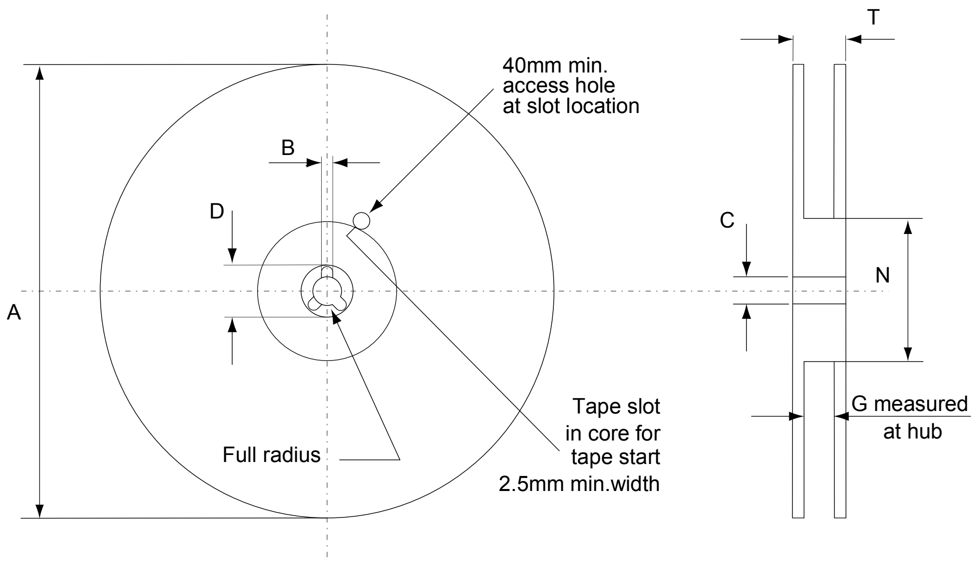



Table 8. D²PAK tape and reel mechanical data

| Tape | | | Reel | | |
|---|---|---|---|---|---|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 26.4 |
| F | 11.4 | 11.6 | N | 100 | |
| K0 | 4.8 | 5.0 | T | | 30.4 |
| P0 | 3.9 | 4.1 | | | |
| P1 | 11.9 | 12.1 | Base quantity | | 1000 |
| P2 | 1.9 | 2.1 | Bulk quantity | | 1000 |
| R | 50 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 23.7 | 24.3 | | | |

## Revision history

**Table 9. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 05-Nov-2015 | 1 | First release. |
| 14-Apr-2016 | 2 | Updated *Figure 13: "Normalized V(BR)CES vs. junction temperature"*.<br>Minor text changes. |
| 08-Oct-2018 | 3 | Updated Table 3. Static characteristics.<br>Minor text changes |

# Contents

单击下面可查看定价，库存，交付和生命周期等信息

>>STMicro(意法半导体)