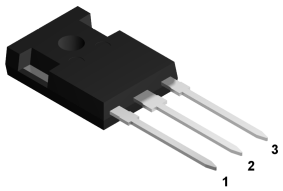
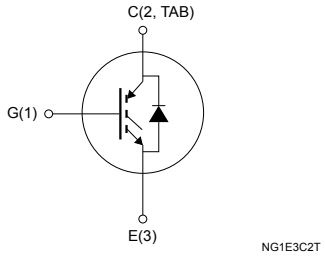
# STGWA20H65DFB2

Datasheet

## Trench gate field-stop, 650 V, 20 A, high-speed HB2 series IGBT in a TO-247 long leads package




TO-247 long leads




## Features

- Maximum junction temperature : $T_J$ = 175 °C
- Low $V_{CE(sat)}$ = 1.65 V (typ.) @ $I_C$ = 20 A
- Very fast and soft recovery co-packaged diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive $V_{CE(sat)}$ temperature coefficient

## Applications

- Welding
- PFC converters - single phase input
- Solar inverters (string and central)
- Uninterruptable power supplies (UPS)
- EV charging - DC fast charging stations

## Description

The newest IGBT 650 V HB2 series represents an evolution of the advanced proprietary trench gate field-stop structure. The performance of the HB2 series is optimized in terms of conduction, thanks to a better $V_{CE(sat)}$ behavior at low current values, as well as in terms of reduced switching energy. A very fast soft recovery diode is co-packaged in antiparallel with the IGBT. The result is a product specifically designed to maximize efficiency for a wide range of fast applications.

| Product status link |
|---|
| STGWA20H65DFB2 |

| Product summary | |
|---|---|
| **Order code** | STGWA20H65DFB2 |
| **Marking** | G20H65DFB2 |
| **Package** | TO-247 long leads |
| **Packing** | Tube |

# 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 | 40 | A |
| | Continuous collector current at $T_C$ = 100 °C | 25 | A |
| $I_{CP}$(1) | Pulsed collector current | 60 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| | Transient gate-emitter voltage ($t_p$ ≤ 10 µs) | ±30 | |
| $I_F$ | Continuous forward current at $T_C$ = 25 °C | 40 | A |
| | Continuous forward current at $T_C$ = 100 °C | 23 | |
| $I_{FP}$(1) | Pulsed forward current | 60 | A |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °C | 147 | W |
| $T_{STG}$ | Storage temperature range | -55 to 150 | °C |
| $T_J$ | Operating junction temperature range | -55 to 175 | °C |

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

**Table 2. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance junction-case IGBT | 1.02 | °C/W |
| | Thermal resistance junction-case diode | 1.47 | |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50 | |

# 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, $I_C$ = 1 mA | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 20 A | | 1.65 | 2.1 | 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 | | 1.65 | 2.55 | V |
| | | $I_F$ = 20 A, $T_J$ = 125 °C | | 1.4 | | |
| | | $I_F$ = 20 A, $T_J$ = 175 °C | | 1.3 | | |
| $V_{GE(th)}$ | 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 | - | 1010 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 81 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 26 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 20 A, $V_{GE}$ = 0 to 15 V (see Figure 28. Gate charge test circuit) | - | 56 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 9.4 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 27.8 | - | |

**Table 5. Switching characteristics (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 400 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω (see Figure 27. Test circuit for inductive load switching) | - | 16 | - | ns |
| $t_r$ | Current rise time | | - | 8 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 265 | - | µJ |
| $t_{d(off)}$ | Turn-off delay time | | - | 78.8 | - | ns |
| $t_f$ | Current fall time | | - | 35 | - | ns |
| $E_{off}$ (2) | Turn-off switching energy | | - | 214 | - | µJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 400 V, $I_C$ = 20 A, $V_{GE}$ = 15 V, $R_G$ = 10 Ω, $T_J$ = 175 °C (see Figure 27. Test circuit for inductive load switching) | - | 17 | - | ns |
| $t_r$ | Current rise time | | - | 9 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 556 | - | µJ |
| $t_{d(off)}$ | Turn-off delay time | | - | 98 | - | ns |
| $t_f$ | Current fall time | | - | 80 | - | ns |
| $E_{off}$ (2) | Turn-off switching energy | | - | 378 | - | 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 | $I_F$ = 20 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs (see Figure 30. Diode reverse recovery waveform) | - | 215 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 970 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 17 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 303 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 293 | - | µJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 20 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs, $T_J$ = 175 °C (see Figure 30. Diode reverse recovery waveform) | - | 330 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 2772 | - | nC |
| $I_{rrm}$ | Reverse recovery current | | - | 30 | - | A |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 244 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 866 | - | µJ |

## 2.1 Electrical characteristics (curves)

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

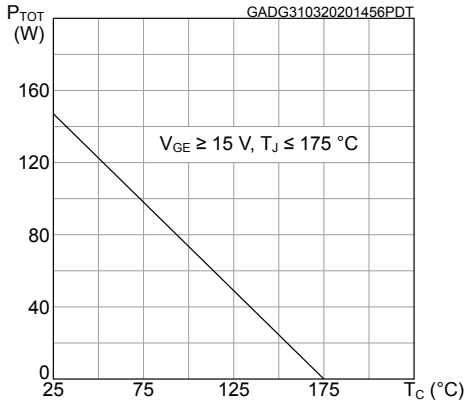



**Figure 2. Collector current vs case temperature**

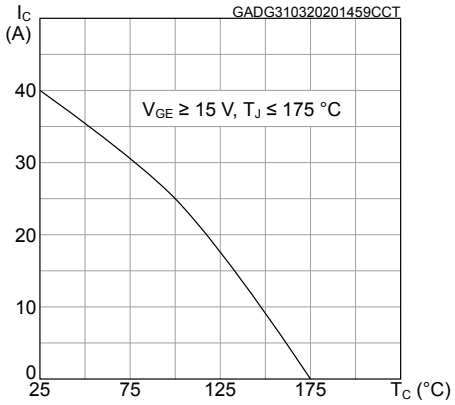



**Figure 3. Output characteristics ($T_J$ = 25 °C)**

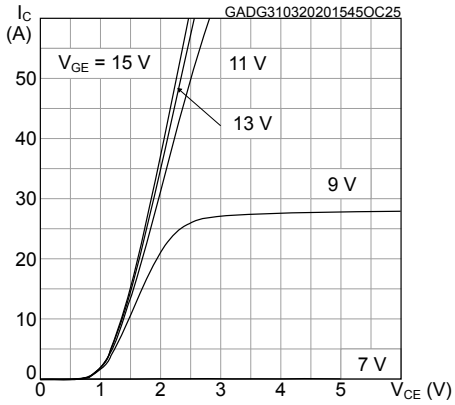



**Figure 4. Output characteristics ($T_J$ = 175 °C)**

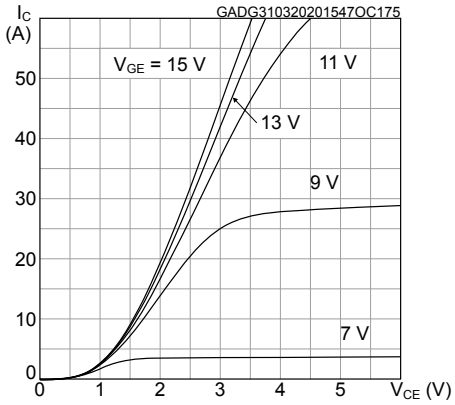



**Figure 5. $V_{CE(sat)}$ vs junction temperature**

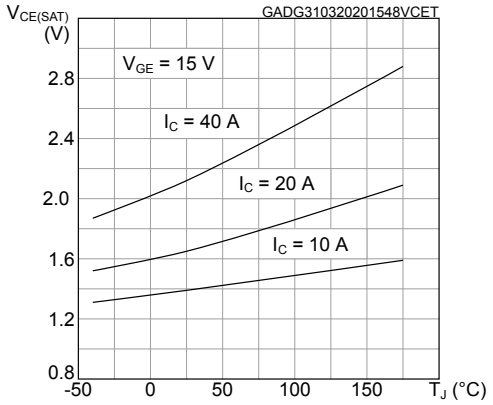



**Figure 6. $V_{CE(sat)}$ vs collector current**

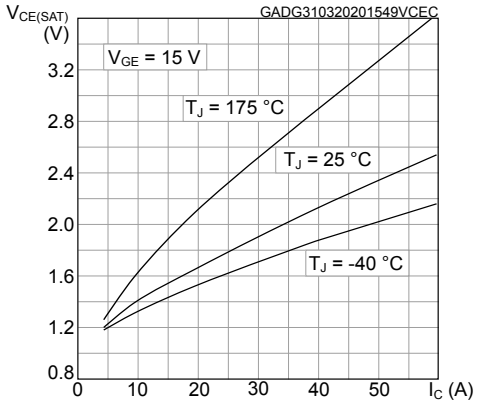


**Figure 7. Forward bias safe operating area**

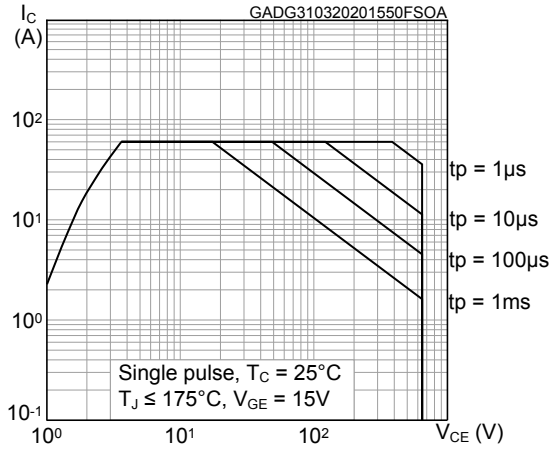



**Figure 8. Collector current vs switching frequency**

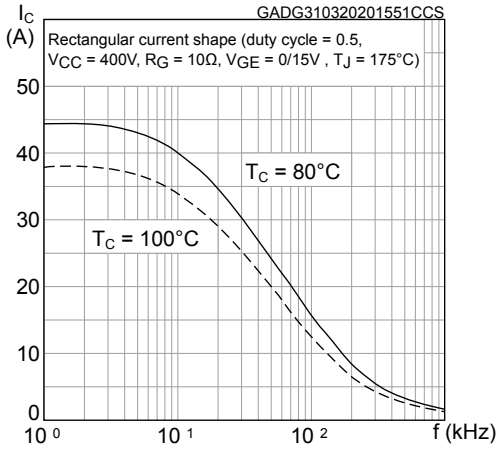



**Figure 9. Transfer characteristics**

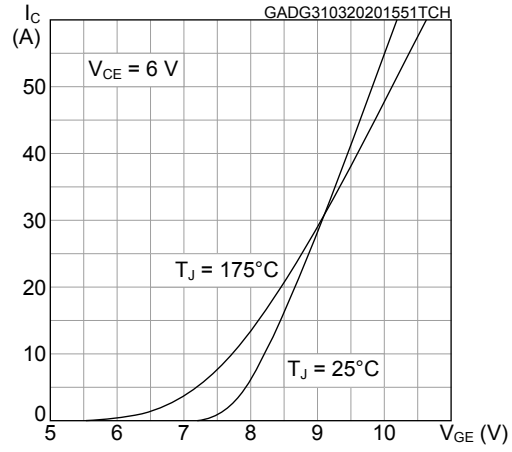



**Figure 10. Diode $V_F$ vs forward current**

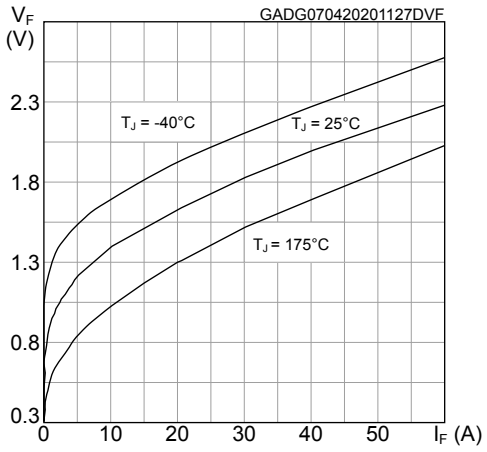



**Figure 11. Normalized $V_{GE(th)}$ vs junction temperature**

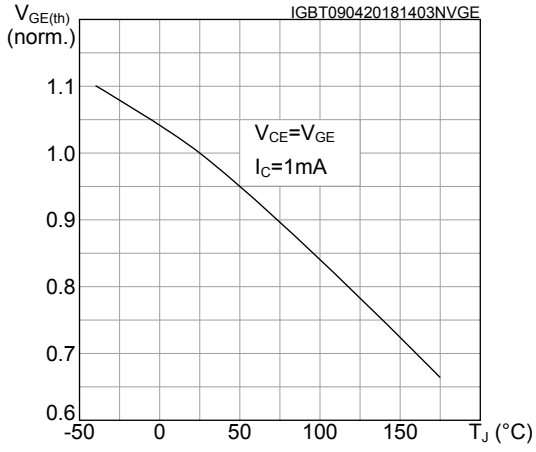



**Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature**

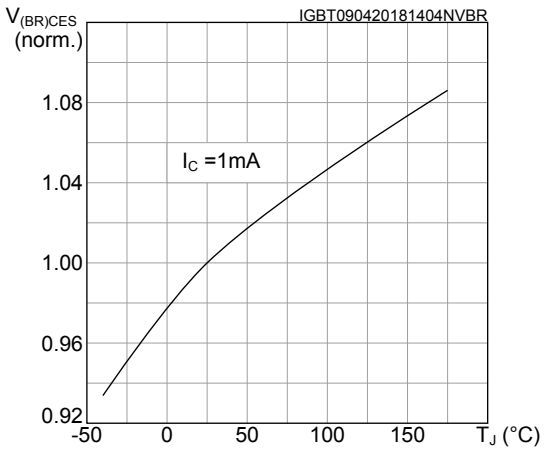


**Figure 13. Capacitance variations**

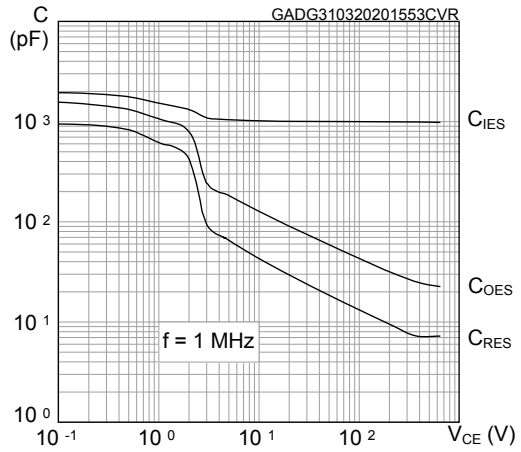



**Figure 14. Gate charge vs gate-emitter voltage**

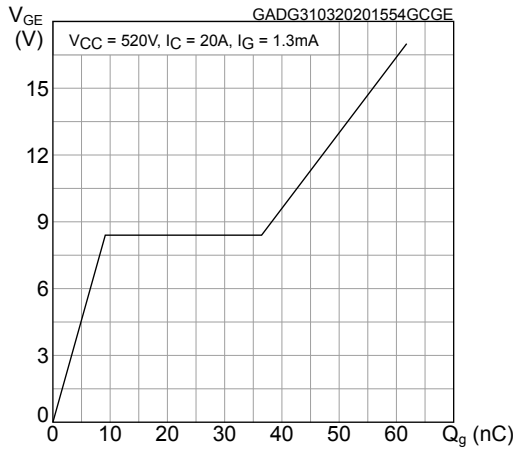



**Figure 15. Switching energy vs collector current**

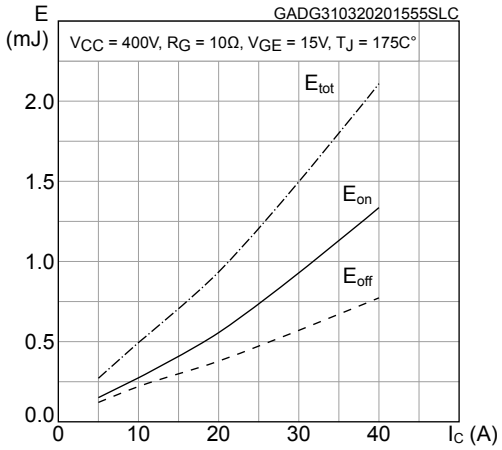



**Figure 16. Switching energy vs temperature**

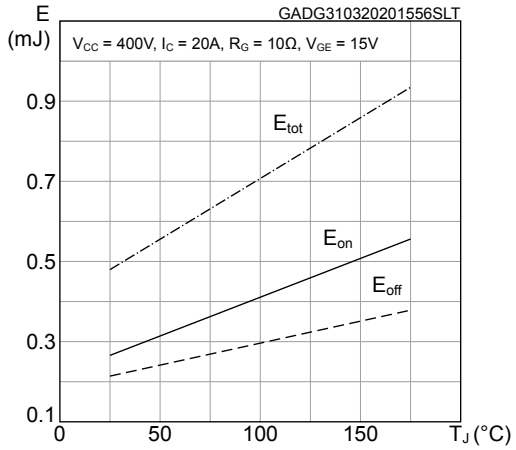



**Figure 17. Switching energy vs collector emitter voltage**

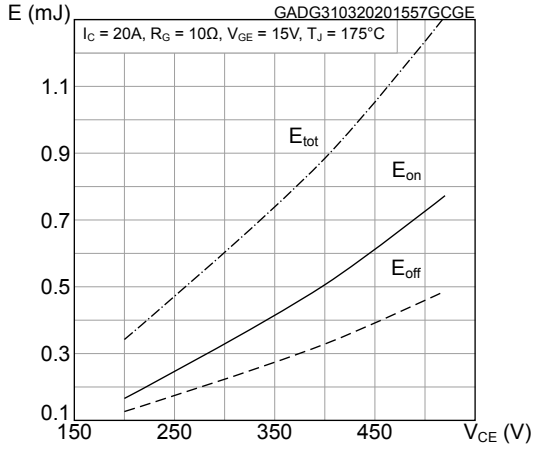



**Figure 18. Switching energy vs gate resistance**

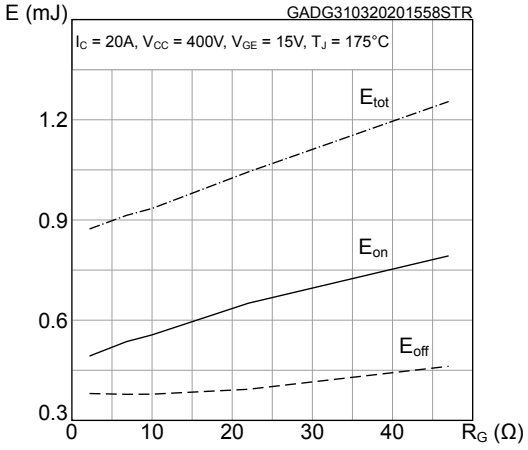


**Figure 19. Switching times vs collector current**

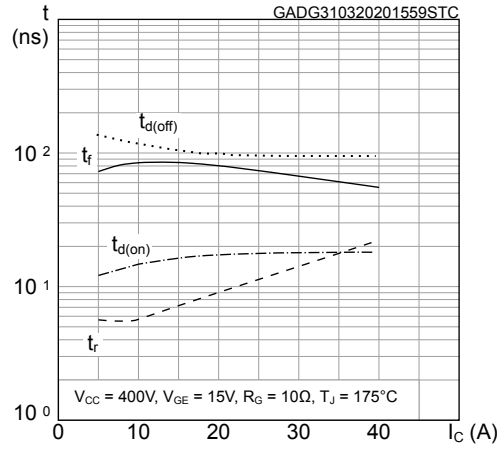



**Figure 20. Switching times vs gate resistance**

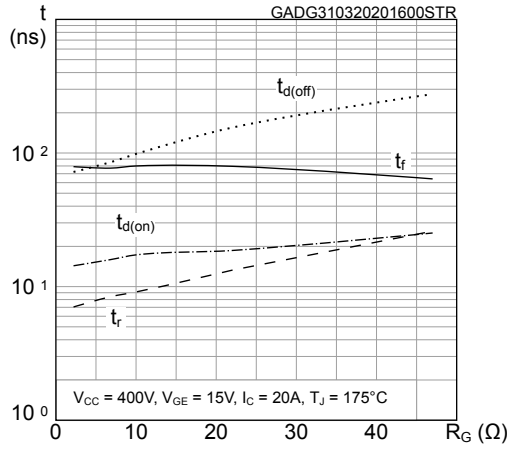



**Figure 21. Reverse recovery current vs diode current slope**

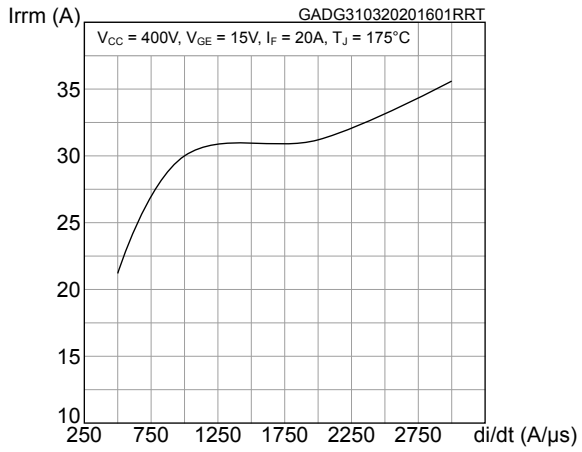



**Figure 22. Reverse recovery time vs diode current slope**

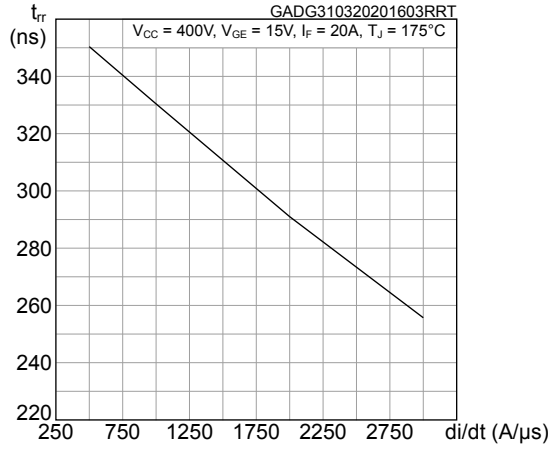



**Figure 23. Reverse recovery charge vs diode current slope**

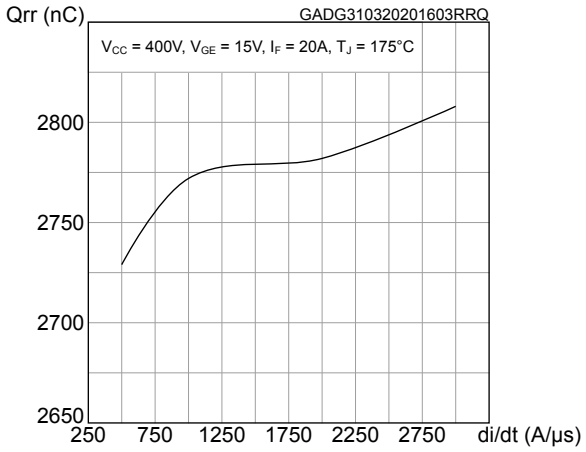



**Figure 24. Reverse recovery energy vs diode current slope**

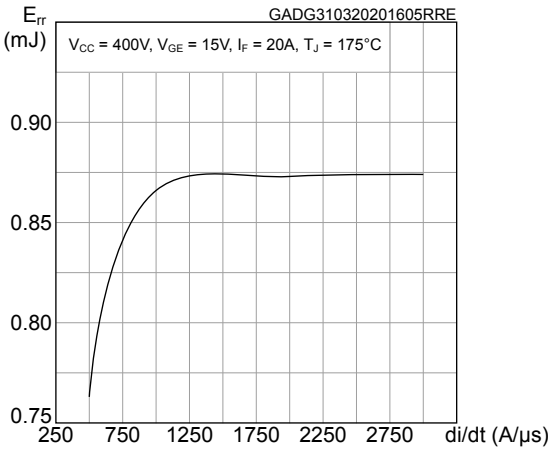


**Figure 25. Thermal impedance for IGBT**

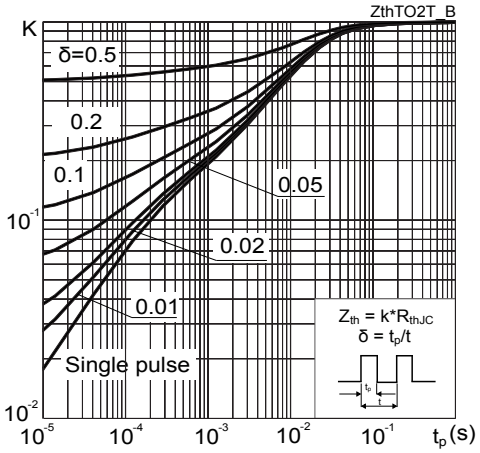
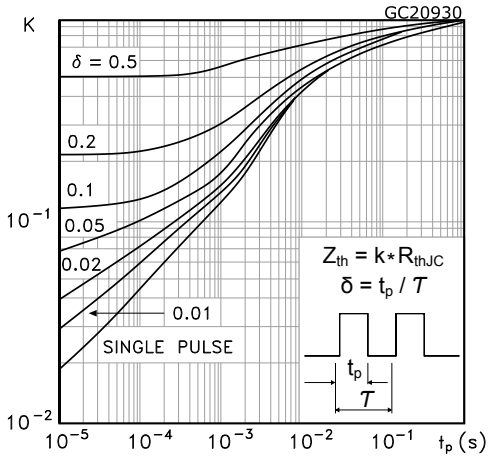



**Figure 26. Thermal impedance for diode**



# 3 Test circuits

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

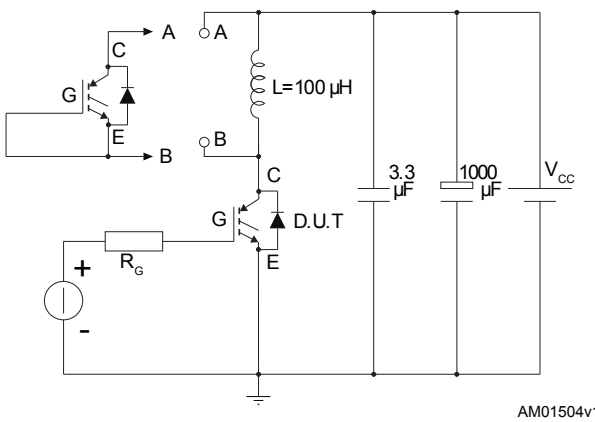



**Figure 28. Gate charge test circuit**

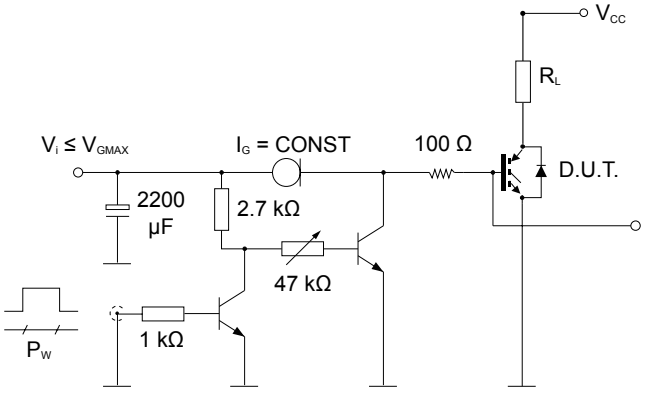



**Figure 29. Switching waveform**

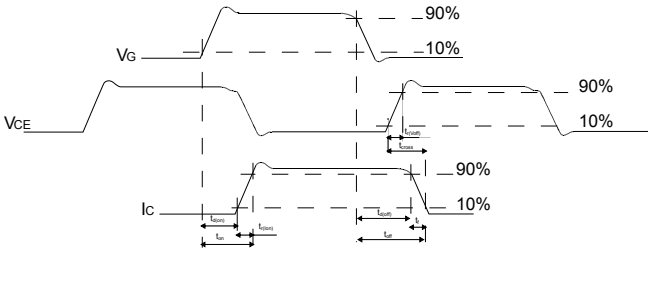
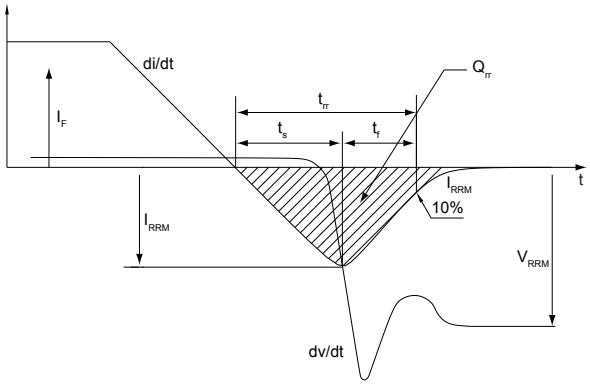



**Figure 30. Diode reverse recovery waveform**



# 4 Package information

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 long leads package information

**Figure 31. TO-247 long leads package outline**

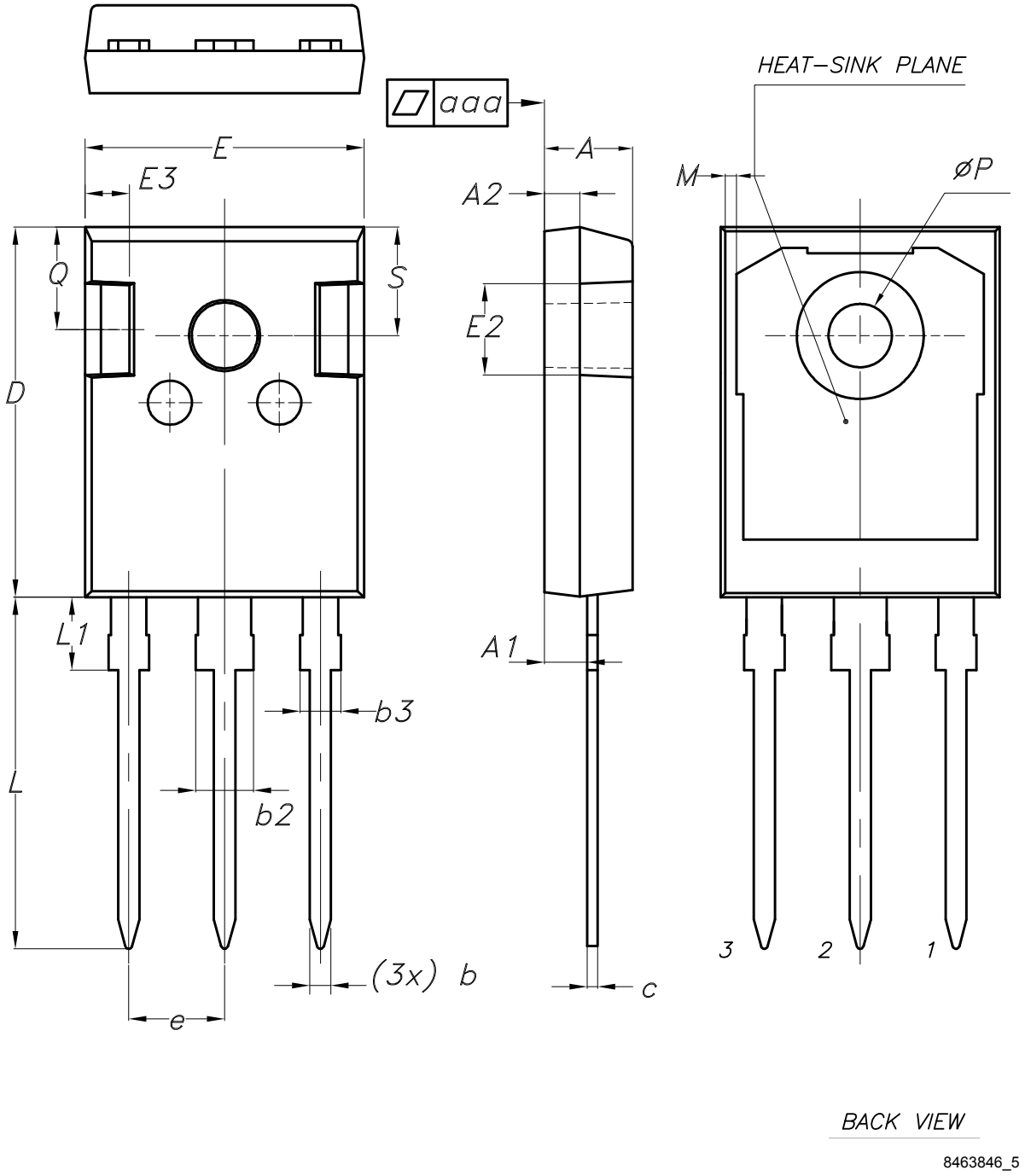


Table 7. **TO-247 long leads package mechanical data**

| 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 |
| M | 0.35 | | 0.95 |
| P | 3.50 | 3.60 | 3.70 |
| Q | 5.60 | | 6.00 |
| S | 6.05 | 6.15 | 6.25 |
| aaa | | 0.04 | 0.10 |

## Revision history

Table 8. **Document revision history**

| Date | Version | Changes |
|---|---|---|
| 07-Apr-2020 | 1 | First release. |
| 01-Oct-2024 | 2 | Updated Section 4.1: TO-247 long leads package information.<br>Minor text changes. |

# Contents