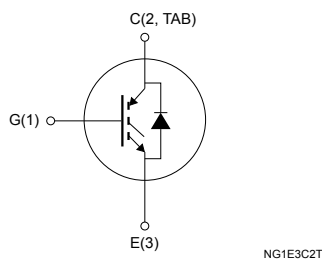
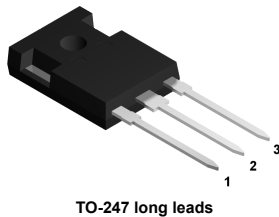


## Trench gate field-stop, 650 V, 20 A, high-speed HB2 series IGBT in a TO-247 long leads package



### Features

- Maximum junction temperature :  $T_J = 175\text{ }^{\circ}\text{C}$
- Low  $V_{CE(sat)} = 1.65\text{ V (typ.) @ } I_C = 20\text{ A}$
- 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 ( $V_{GE} = 0\text{ V}$ )                 | 650        | V    |
| $I_C$          | Continuous collector current at $T_C = 25\text{ °C}$                | 40         | A    |
|                | Continuous collector current at $T_C = 100\text{ °C}$               | 25         | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current                                            | 60         | A    |
| $V_{GE}$       | Gate-emitter voltage                                                | $\pm 20$   | V    |
|                | Transient gate-emitter voltage ( $t_p \leq 10\text{ }\mu\text{s}$ ) | $\pm 30$   |      |
| $I_F$          | Continuous forward current at $T_C = 25\text{ °C}$                  | 40         | A    |
|                | Continuous forward current at $T_C = 100\text{ °C}$                 | 23         |      |
| $I_{FP}^{(1)}$ | Pulsed forward current                                              | 60         | A    |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ °C}$                     | 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

$T_C = 25\text{ °C}$  unless otherwise specified

**Table 3. Static characteristics**

| Symbol        | Parameter                            | Test conditions                                                      | Min. | Typ. | Max.      | Unit          |
|---------------|--------------------------------------|----------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage  | $V_{GE} = 0\text{ V}$ , $I_C = 1\text{ mA}$                          | 650  |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$                         |      | 1.65 | 2.1       | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 125\text{ °C}$ |      | 1.95 |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 175\text{ °C}$ |      | 2.1  |           |               |
| $V_F$         | Forward on-voltage                   | $I_F = 20\text{ A}$                                                  |      | 1.65 | 2.55      | V             |
|               |                                      | $I_F = 20\text{ A}$ , $T_J = 125\text{ °C}$                          |      | 1.4  |           |               |
|               |                                      | $I_F = 20\text{ A}$ , $T_J = 175\text{ °C}$                          |      | 1.3  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$                              | 5    | 6    | 7         | V             |
| $I_{CES}$     | Collector cut-off current            | $V_{GE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$                      |      |      | 25        | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current         | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$                   |      |      | $\pm 250$ | nA            |

**Table 4. Dynamic characteristics**

| Symbol    | Parameter                    | Test conditions                                                                                                                 | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$                                                             | -    | 1010 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                 | -    | 81   | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                 | -    | 26   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 520\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$<br>(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        | $V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$<br>(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  | -    | $\mu\text{J}$ |
| $t_{d(off)}$    | Turn-off delay time       |                                                                                                                                                                                                  | -    | 78.8 | -    | ns            |
| $t_f$           | Current fall time         |                                                                                                                                                                                                  | -    | 35   | -    | ns            |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                                  | -    | 214  | -    | $\mu\text{J}$ |
| $t_{d(on)}$     | Turn-on delay time        | $V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$<br>(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  | -    | $\mu\text{J}$ |
| $t_{d(off)}$    | Turn-off delay time       |                                                                                                                                                                                                  | -    | 98   | -    | ns            |
| $t_f$           | Current fall time         |                                                                                                                                                                                                  | -    | 80   | -    | ns            |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                                  | -    | 378  | -    | $\mu\text{J}$ |

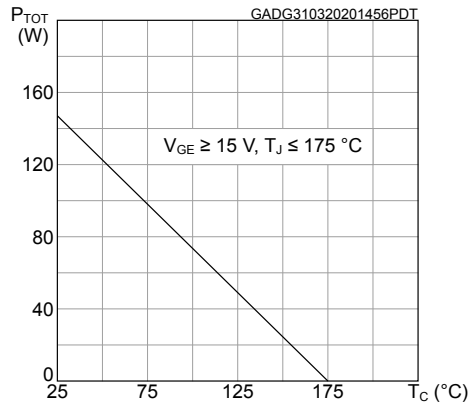
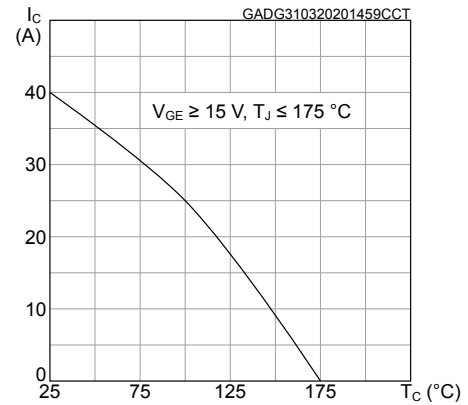
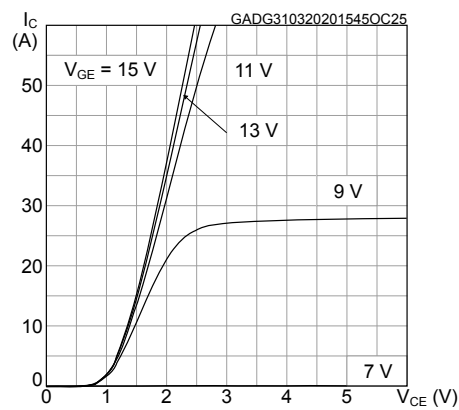
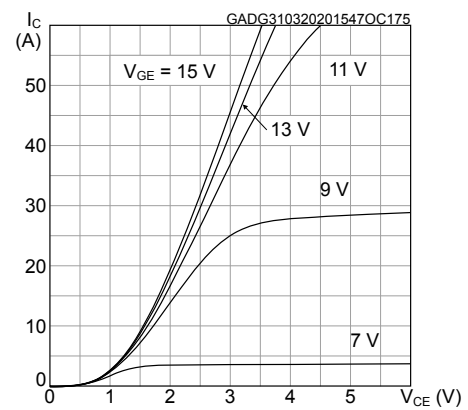
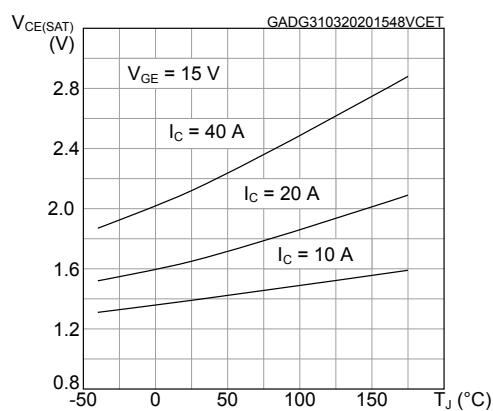
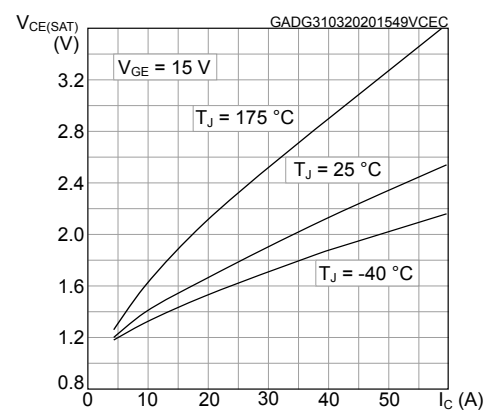
1. Including the reverse recovery of the diode.

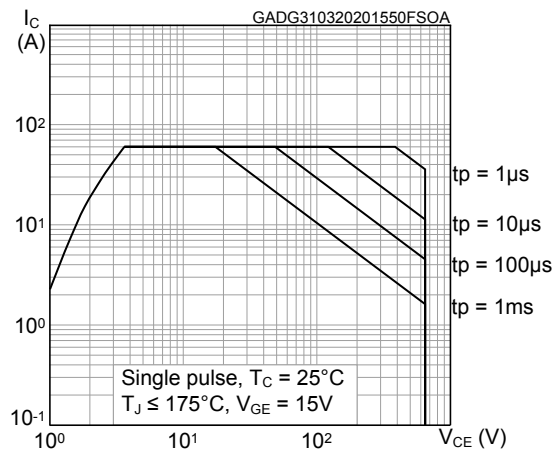
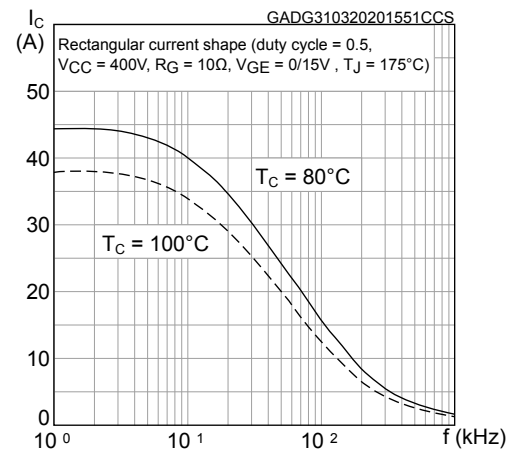
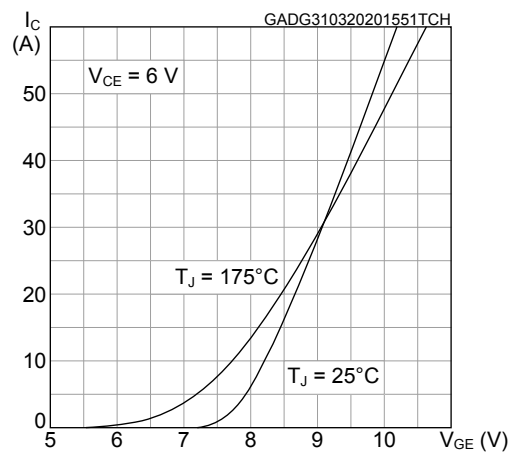
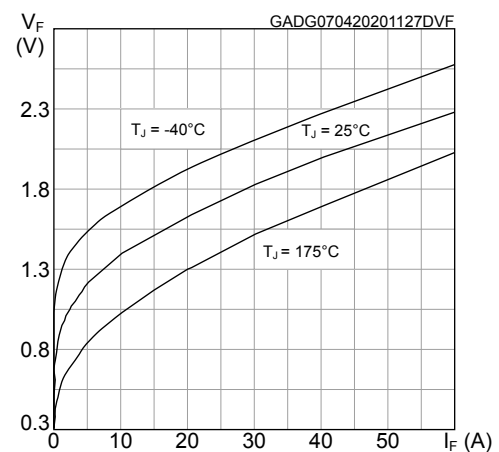
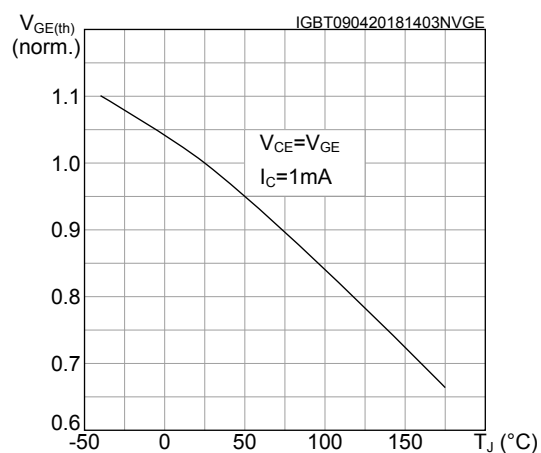
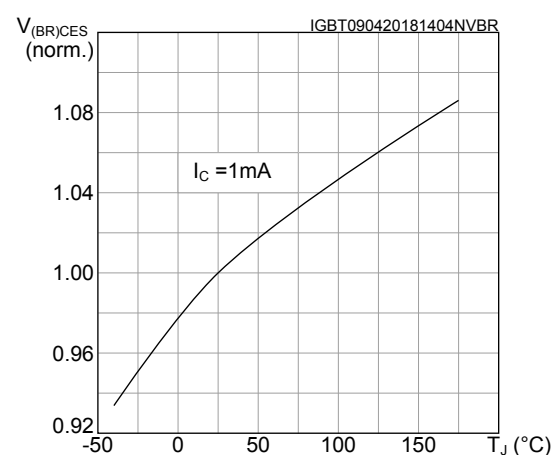
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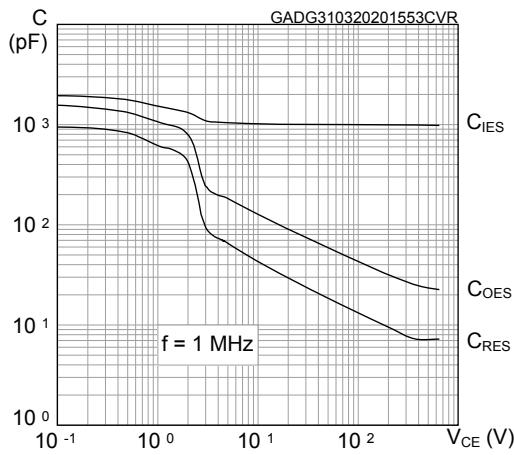
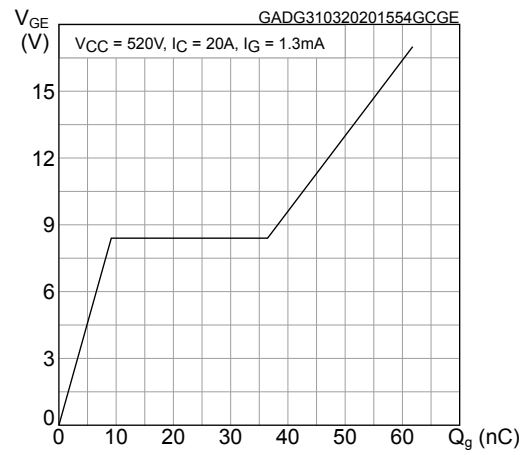
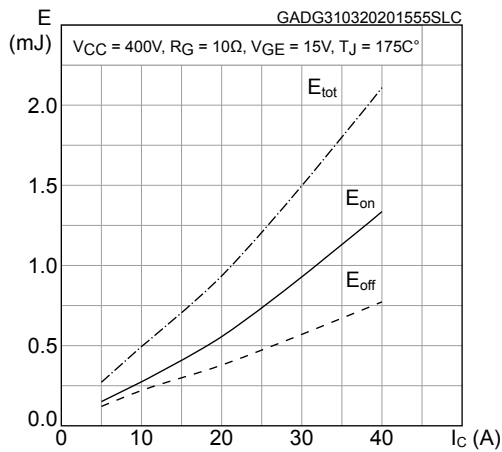
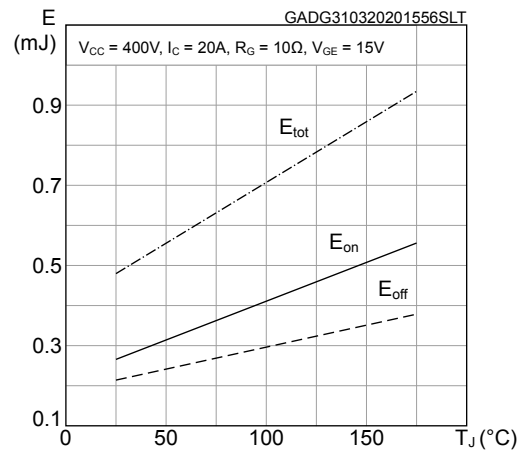
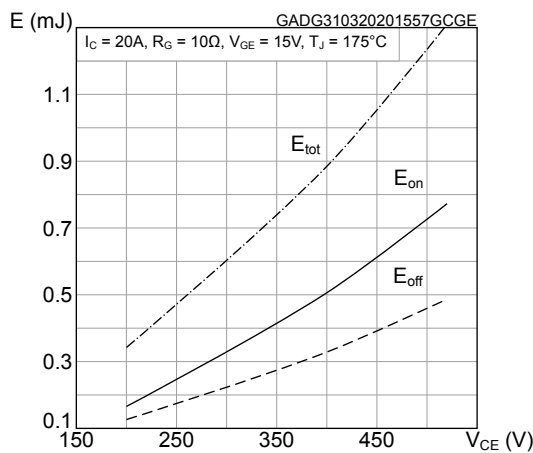
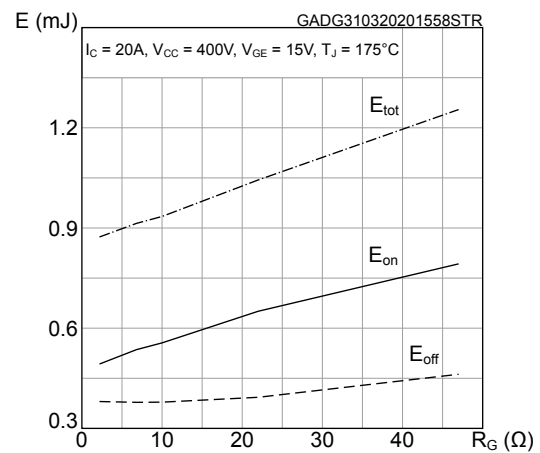
**Table 6. Diode switching characteristics (inductive load)**

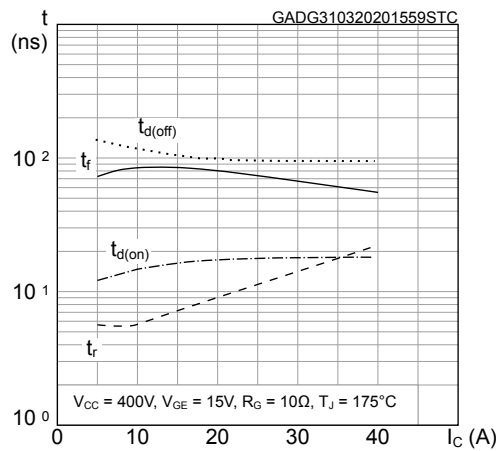
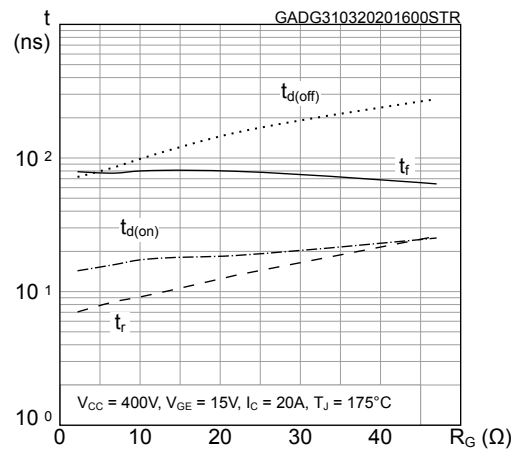
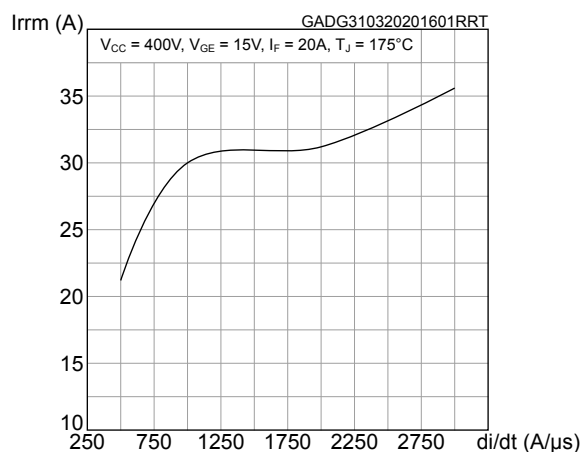
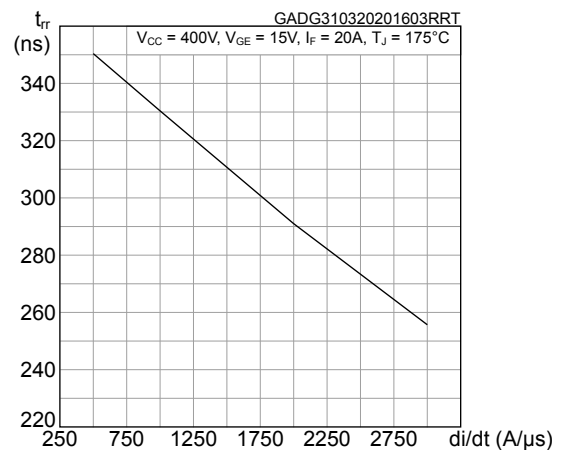
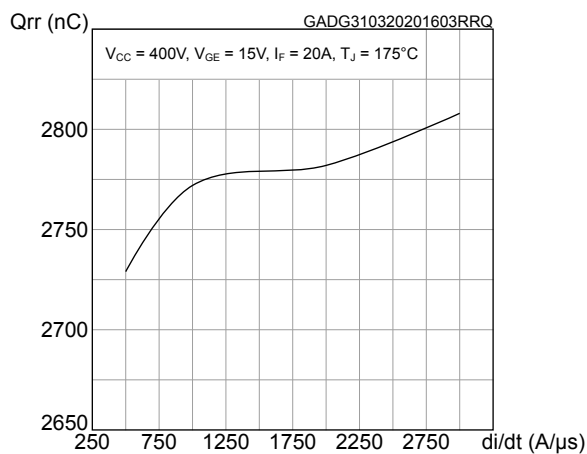
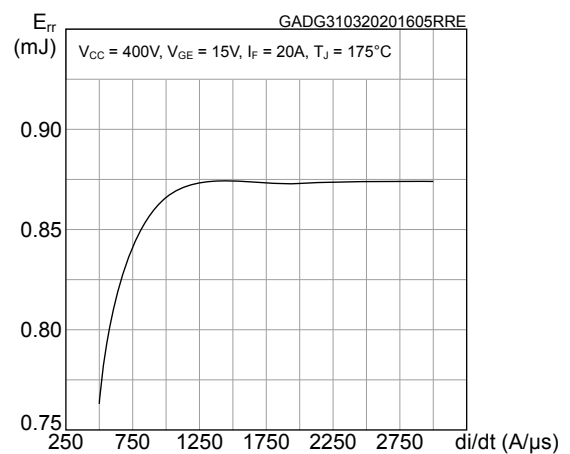
| Symbol       | Parameter                                                  | Test conditions                                                                                                                                                                                         | Min. | Typ. | Max. | Unit                   |
|--------------|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------------------|
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 20\text{ A}$ , $V_R = 400\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$<br>(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  | -    | $\text{A}/\mu\text{s}$ |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                         | -    | 293  | -    | $\mu\text{J}$          |
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 20\text{ A}$ , $V_R = 400\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ ,<br>$T_J = 175\text{ }^\circ\text{C}$<br>(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  | -    | $\text{A}/\mu\text{s}$ |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                         | -    | 866  | -    | $\mu\text{J}$          |

## 2.1 Electrical characteristics (curves)

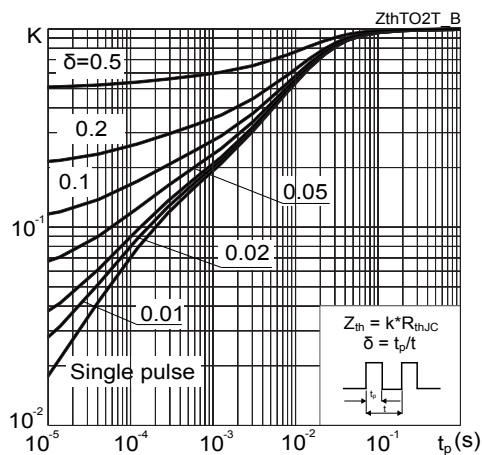
**Figure 1. Power dissipation vs case temperature**

**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**


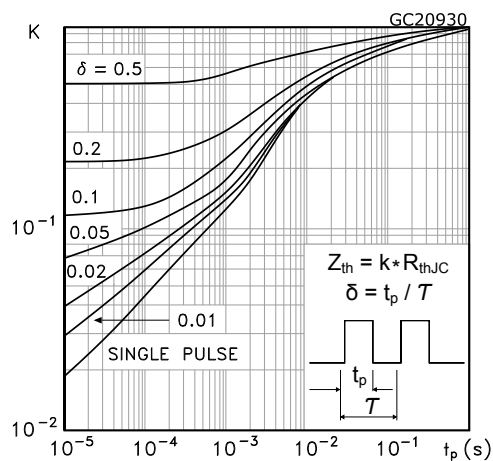
**Figure 13. Capacitance variations**

**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**


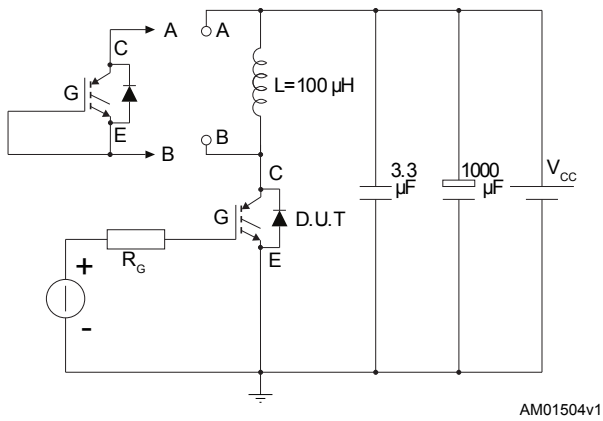
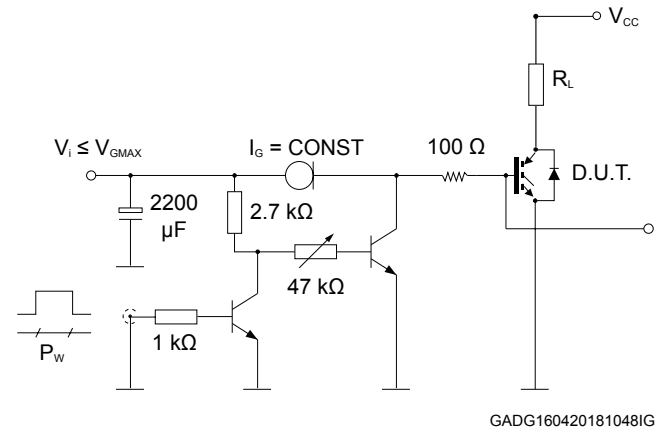
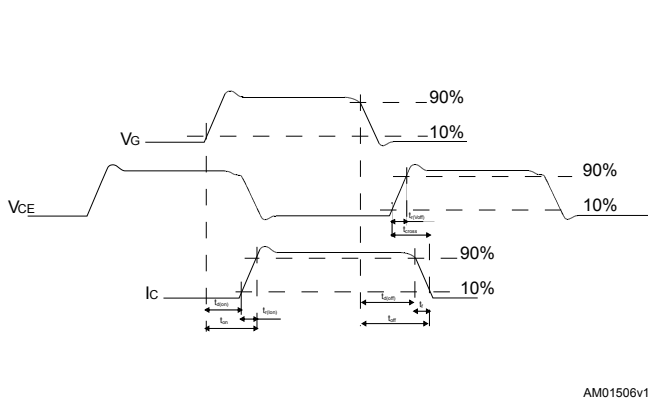
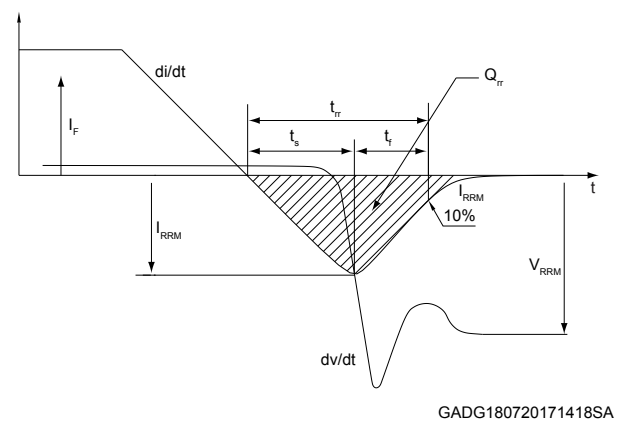
**Figure 25. Thermal impedance for IGBT**



**Figure 26. Thermal impedance for diode**



### 3 Test circuits

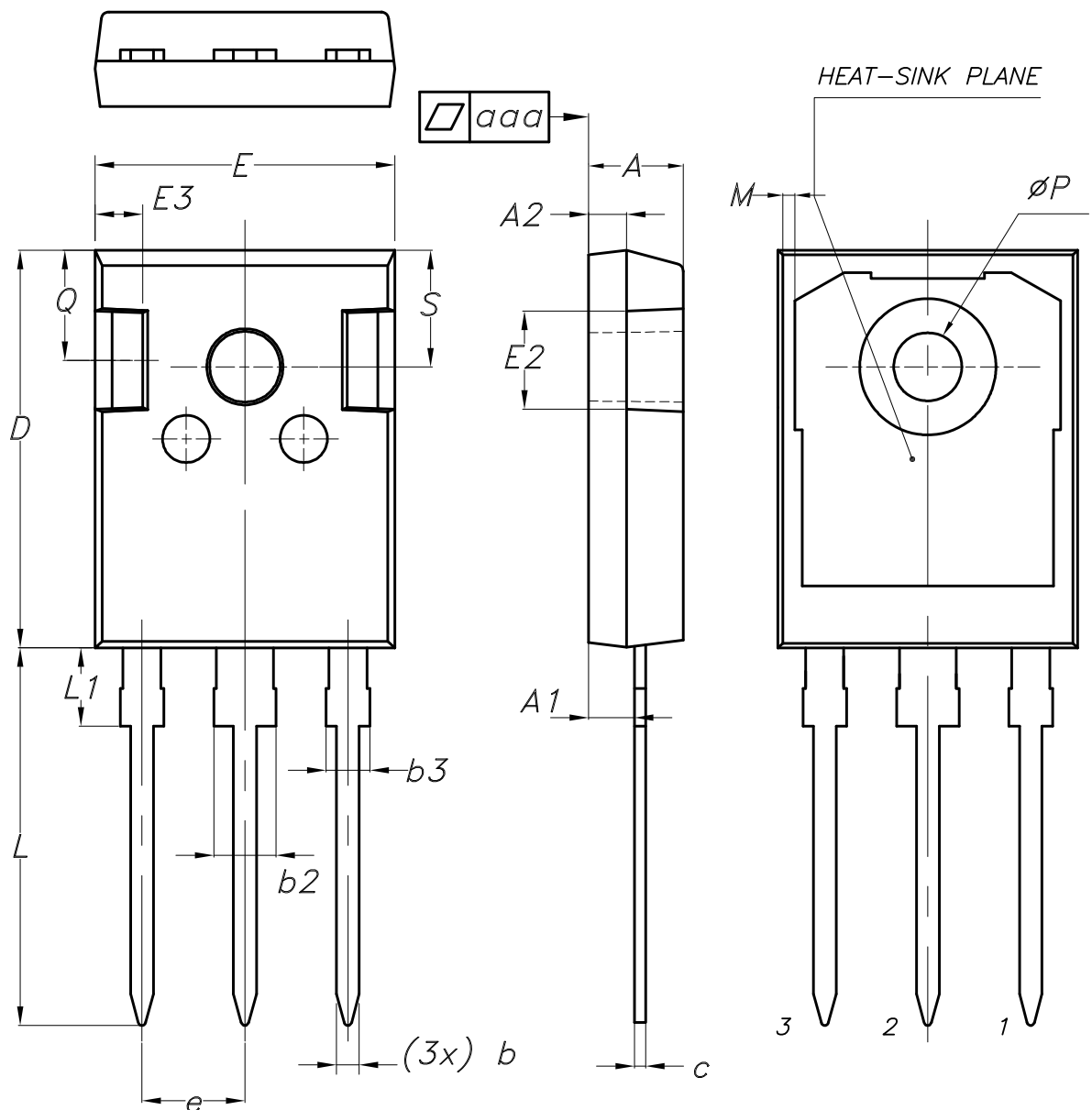
**Figure 27. Test circuit for inductive load switching**

**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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 TO-247 long leads package information

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



*BACK VIEW*

8463846\_5

**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 <a href="#">Section 4.1: TO-247 long leads package information</a> .<br>Minor text changes. |

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