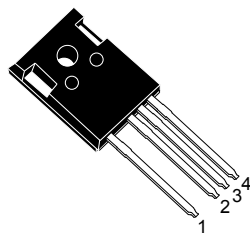
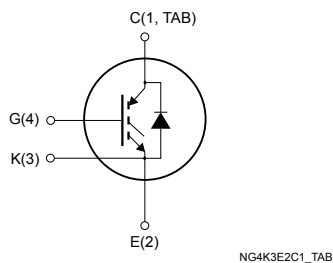


## Trench gate field-stop, 650 V, 50 A, high-speed HB2 series IGBT in a TO247-4 package



TO247-4



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^{\circ}\text{C}$
- Low  $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 50\text{ A}$
- Very fast and soft recovery co-packaged diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive  $V_{CE(sat)}$  temperature coefficient
- Excellent switching performance thanks to the extra driving kelvin pin

### Applications

- Welding
- Power factor correction
- UPS
- Solar inverters
- Chargers

### 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

[STGW50H65DFB2-4](#)

#### Product summary

|            |                 |
|------------|-----------------|
| Order code | STGW50H65DFB2-4 |
| Marking    | G50H65DFB2      |
| Package    | TO247-4         |
| 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             | 86         | A    |
|                   | Continuous collector current at $T_C = 100$ °C            | 53         |      |
| $I_{CP}^{(1)(2)}$ | Pulsed collector current                                  | 150        |      |
| $V_{GE}$          | Gate-emitter voltage                                      | ±20        | V    |
|                   | Transient gate-emitter voltage ( $t_p \leq 10$ µs)        | ±30        |      |
| $I_F$             | Continuous forward current at $T_C = 25$ °C               | 60         | A    |
|                   | Continuous forward current at $T_C = 100$ °C              | 38         |      |
| $I_{FP}^{(1)}$    | Pulsed forward current ( $t_p \leq 1$ µs, $T_J < 175$ °C) | 150        |      |
| $P_{TOT}$         | Total power dissipation at $T_C = 25$ °C                  | 272        | W    |
| $T_{STG}$         | Storage temperature range                                 | -55 to 150 | °C   |
| $T_J$             | Operating junction temperature range                      | -55 to 175 |      |

1. Defined by design, not subject to production test.
2. Pulse width is limited by maximum junction temperature.

**Table 2. Thermal data**

| Symbol     | Parameter                              | Value | Unit |
|------------|----------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case IGBT  | 0.55  | °C/W |
|            | Thermal resistance junction-case diode | 1.14  |      |
| $R_{thJA}$ | 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 | $V_{GE} = 15\text{ V}$ , $I_C = 50\text{ A}$                            |      | 1.55 | 2         | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 50\text{ A}$ ,<br>$T_J = 125\text{ °C}$ |      | 1.8  |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 50\text{ A}$ ,<br>$T_J = 175\text{ °C}$ |      | 1.9  |           |               |
| $V_F$         | Forward on-voltage                   | $I_F = 50\text{ A}$                                                     |      | 1.85 | 2.45      | V             |
|               |                                      | $I_F = 50\text{ A}$ , $T_J = 125\text{ °C}$                             |      | 1.65 |           |               |
|               |                                      | $I_F = 50\text{ A}$ , $T_J = 175\text{ °C}$                             |      | 1.45 |           |               |
| $V_{GE(th)}$  | 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            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0\text{ V}$                | -    | 2928 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                       | -    | 162  | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                       | -    | 78   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 520\text{ V}$ , $I_C = 50\text{ A}$ ,<br>$V_{GE} = 0\text{ to }15\text{ V}$ | -    | 151  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          | (see Figure 29. Gate charge test circuit)                                             | -    | 30   | -    |      |
| $Q_{gc}$  | Gate-collector charge        |                                                                                       | -    | 63   | -    |      |

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

| Symbol          | Parameter                 | Test conditions                                                                                                                                                                                                                         | Min. | Typ. | Max. | Unit          |
|-----------------|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $t_{d(on)}$     | Turn-on delay time        | $V_{CC} = 400\text{ V}$ , $I_C = 50\text{ A}$ ,<br>$V_{GK} = 15\text{ V}$ , $R_{G(on)} = 12\ \Omega$ ,<br>$R_{G(off)} = 6.8\ \Omega$<br>(see Figure 28. Test circuit for inductive load switching)                                      | -    | 18   | -    | ns            |
| $t_r$           | Current rise time         |                                                                                                                                                                                                                                         | -    | 20   | -    | ns            |
| $E_{on}^{(1)}$  | Turn-on switching energy  |                                                                                                                                                                                                                                         | -    | 629  | -    | $\mu\text{J}$ |
| $t_{d(off)}$    | Turn-off delay time       |                                                                                                                                                                                                                                         | -    | 128  | -    | ns            |
| $t_f$           | Current fall time         |                                                                                                                                                                                                                                         | -    | 32   | -    | ns            |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                                                                         | -    | 478  | -    | $\mu\text{J}$ |
| $t_{d(on)}$     | Turn-on delay time        | $V_{CC} = 400\text{ V}$ , $I_C = 50\text{ A}$ ,<br>$V_{GK} = 15\text{ V}$ , $R_{G(on)} = 12\ \Omega$ ,<br>$R_{G(off)} = 6.8\ \Omega$<br>$T_J = 175\text{ }^\circ\text{C}$<br>(see Figure 28. Test circuit for inductive load switching) | -    | 12   | -    | ns            |
| $t_r$           | Current rise time         |                                                                                                                                                                                                                                         | -    | 22   | -    | ns            |
| $E_{on}^{(1)}$  | Turn-on switching energy  |                                                                                                                                                                                                                                         | -    | 1215 | -    | $\mu\text{J}$ |
| $t_{d(off)}$    | Turn-off delay time       |                                                                                                                                                                                                                                         | -    | 161  | -    | ns            |
| $t_f$           | Current fall time         |                                                                                                                                                                                                                                         | -    | 86   | -    | ns            |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                                                                         | -    | 983  | -    | $\mu\text{J}$ |

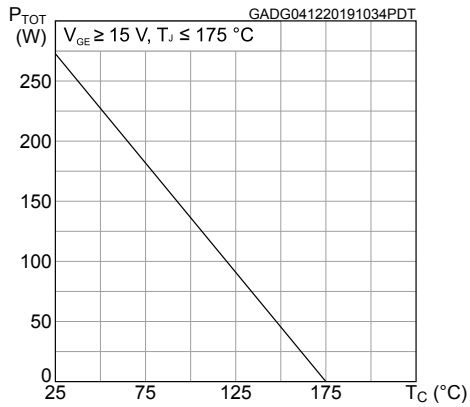
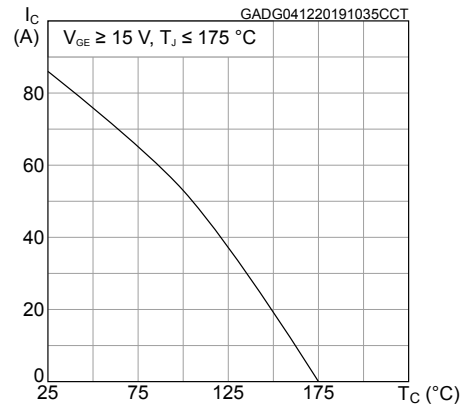
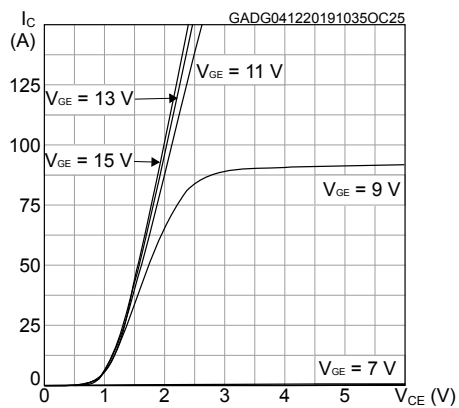
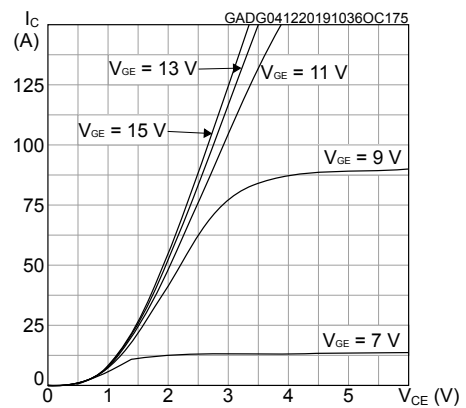
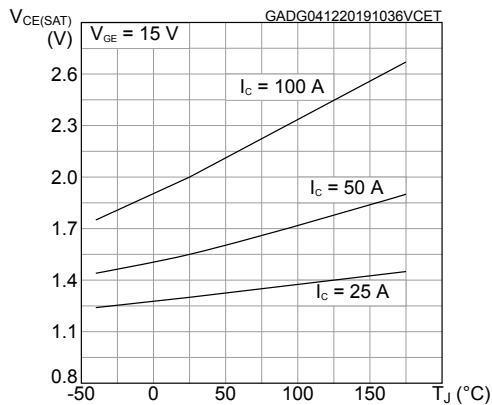
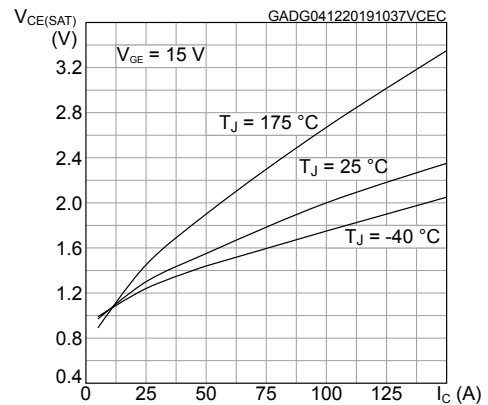
1. Including the reverse recovery of the diode.

2. Including the tail of the collector current.

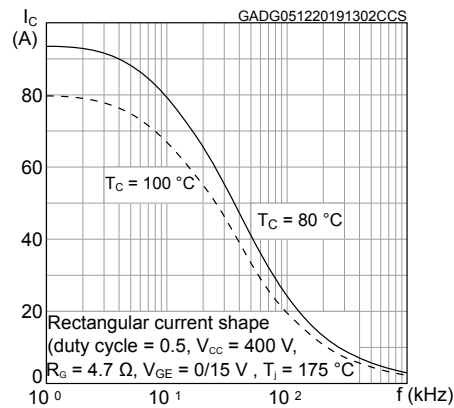
**Table 6. Diode switching characteristics (inductive load)**

| Symbol       | Parameter                                                  | Test conditions                                                                                                                                                                                         | Min. | Typ. | Max. | Unit             |
|--------------|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------------|
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 50\text{ A}$ , $V_R = 400\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$<br>(see Figure 31. Diode reverse recovery waveform)                                        | -    | 92   | -    | ns               |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                         | -    | 673  | -    | nC               |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                         | -    | 20.9 | -    | A                |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                         | -    | 675  | -    | A/ $\mu\text{s}$ |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                         | -    | 138  | -    | $\mu\text{J}$    |
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 50\text{ A}$ , $V_R = 400\text{ V}$ ,<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 31. Diode reverse recovery waveform) | -    | 209  | -    | ns               |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                         | -    | 3500 | -    | nC               |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                         | -    | 45.8 | -    | A                |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                         | -    | 600  | -    | A/ $\mu\text{s}$ |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                         | -    | 841  | -    | $\mu\text{J}$    |

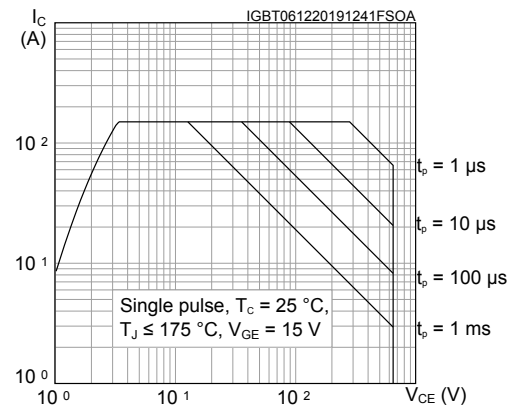
## 2.1 Electrical characteristics (curves)

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

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

**Figure 3. Output characteristics (T<sub>J</sub> = 25 °C)**

**Figure 4. Output characteristics (T<sub>J</sub> = 175 °C)**

**Figure 5. V<sub>CE(sat)</sub> vs junction temperature**

**Figure 6. V<sub>CE(sat)</sub> vs collector current**


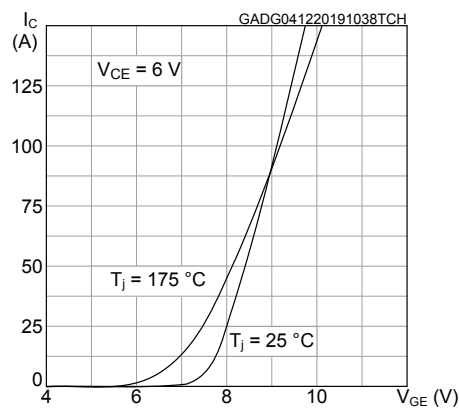
**Figure 7. Collector current vs switching frequency**



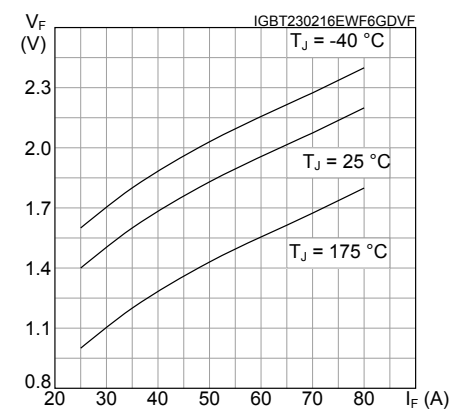
**Figure 8. Forward bias safe operating area**



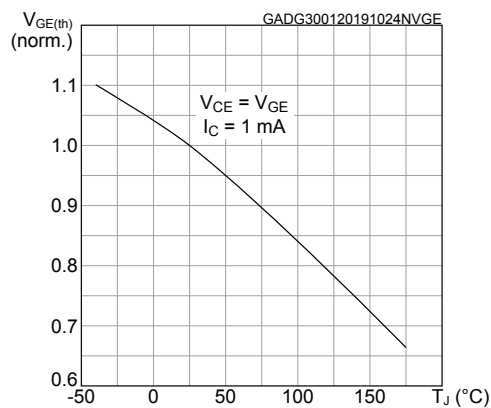
**Figure 9. Transfer characteristics**



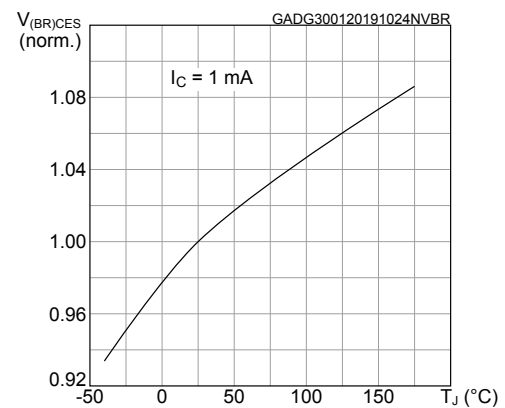
**Figure 10. Diode V\_F vs forward current**



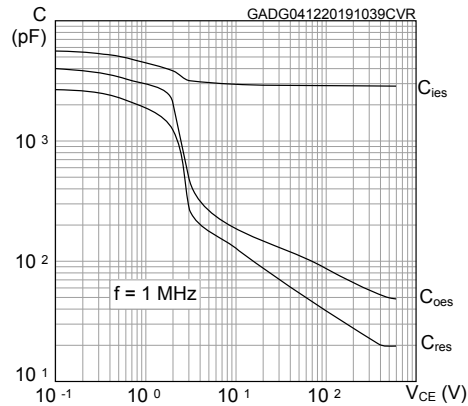
**Figure 11. Normalized V\_GE(th) vs junction temperature**



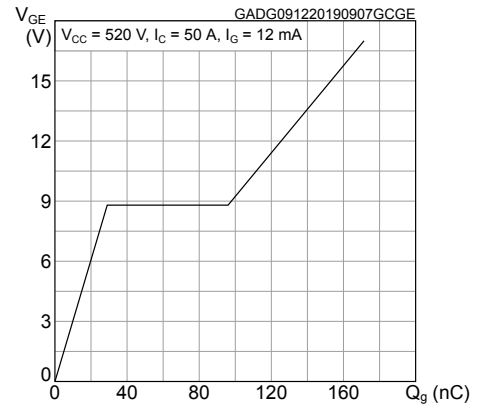
**Figure 12. Normalized V\_(BR)CES vs junction temperature**



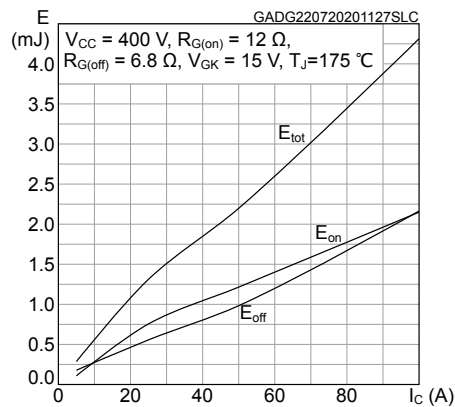
**Figure 13. Capacitance variations**



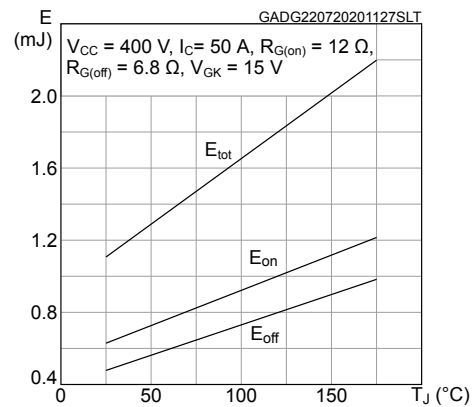
**Figure 14. Gate charge vs gate-emitter voltage**



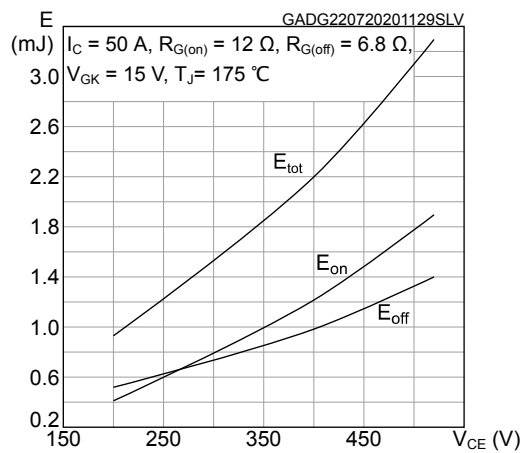
**Figure 15. Switching energy vs collector current**



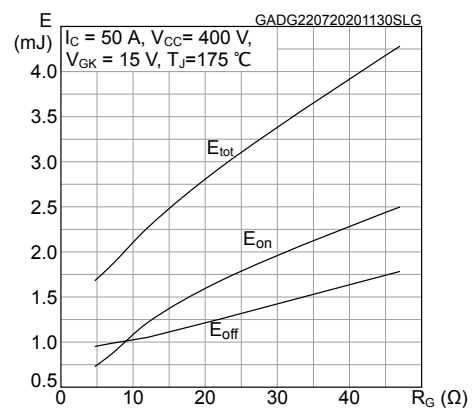
**Figure 16. Switching energy vs temperature**



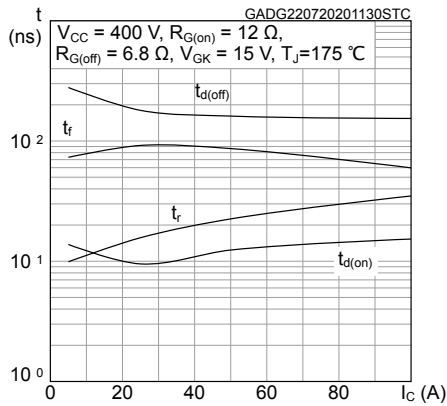
**Figure 17. Switching energy vs collector emitter voltage**



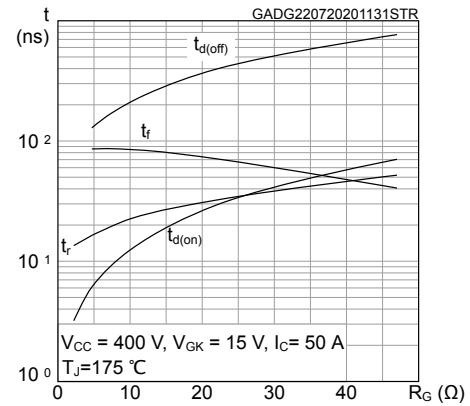
**Figure 18. Switching energy vs gate resistance**



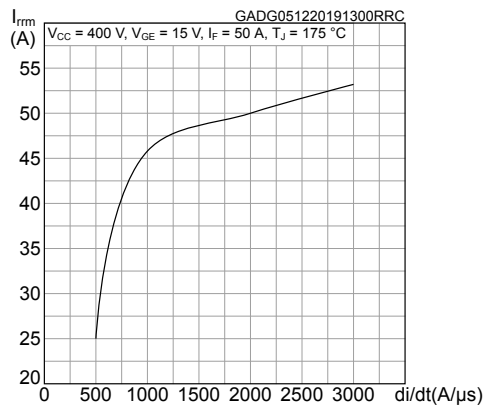
**Figure 19. Switching times vs collector current**



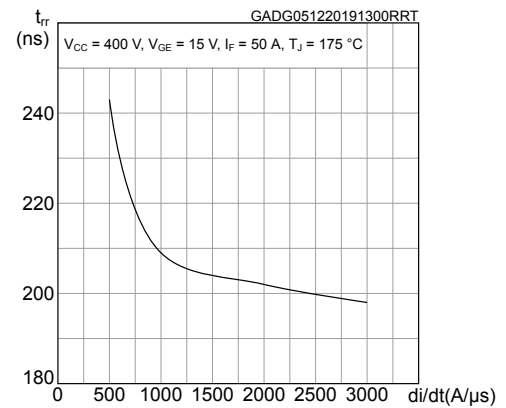
**Figure 20. Switching times vs gate resistance**



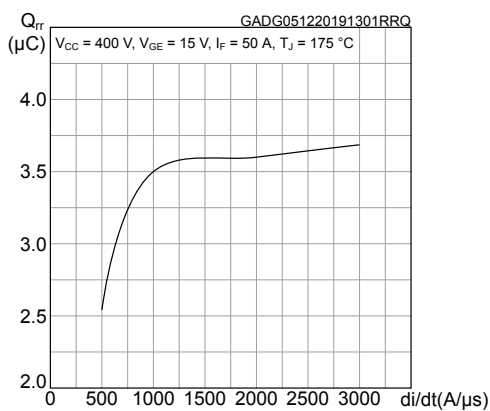
**Figure 21. Reverse recovery current vs diode current slope**



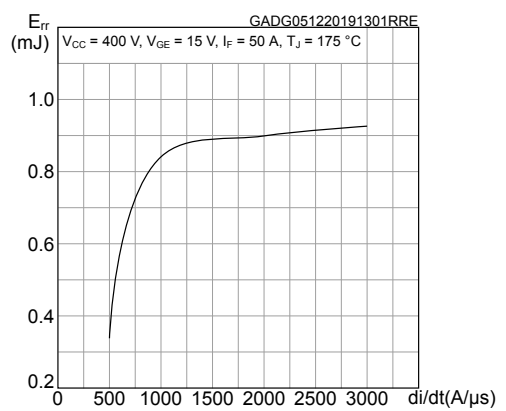
**Figure 22. Reverse recovery time vs diode current slope**



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

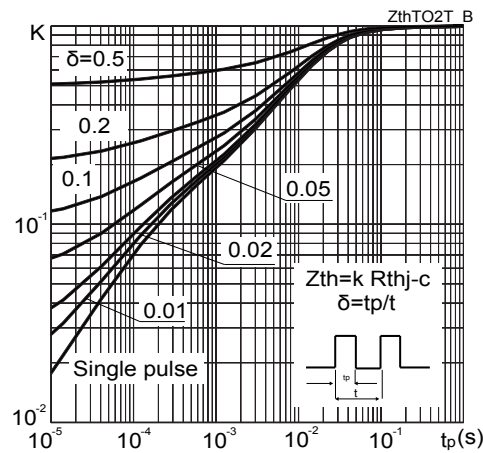


**Figure 24. Reverse recovery energy vs diode current slope**

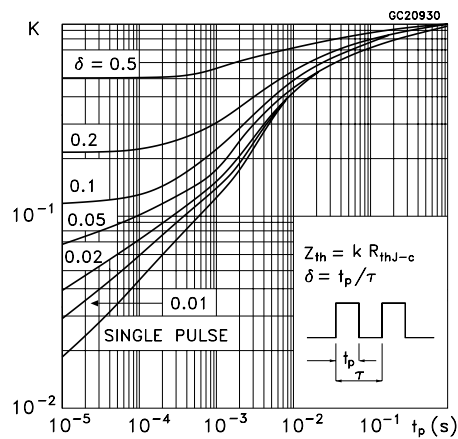




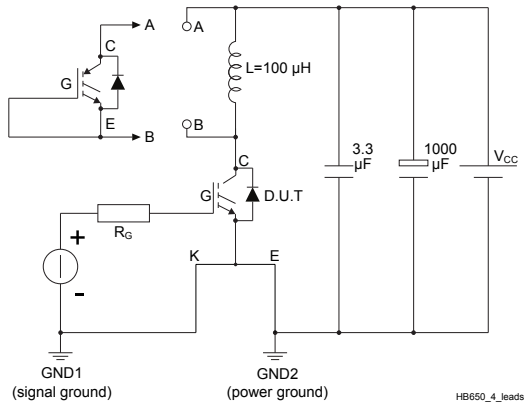
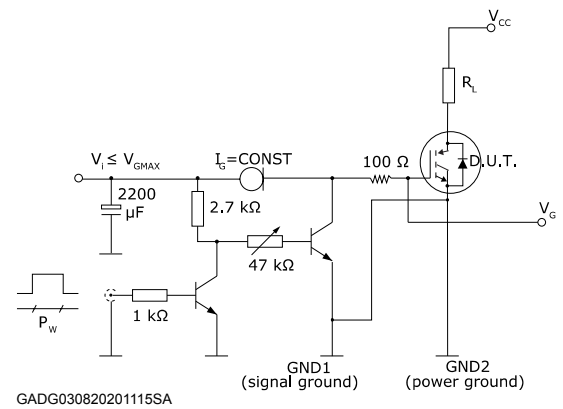
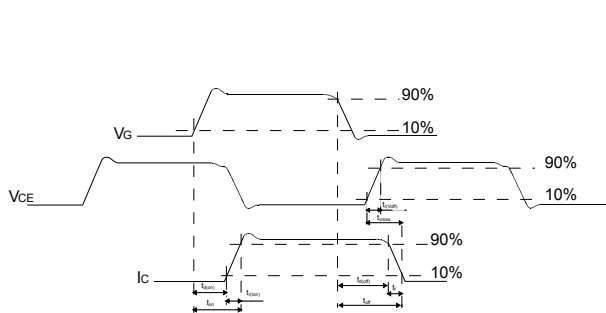
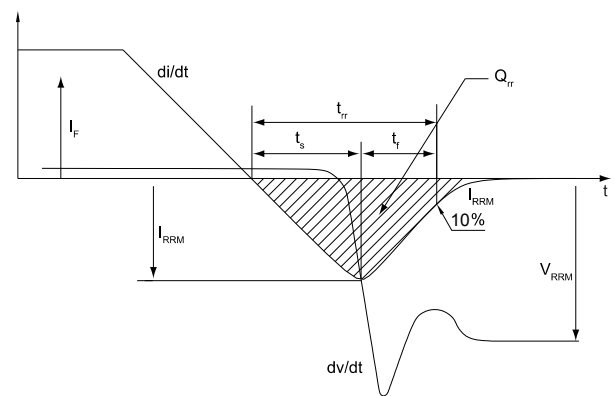
**Figure 25. Thermal impedance for IGBT**



**Figure 26. Thermal impedance for diode**



### 3 Test circuits

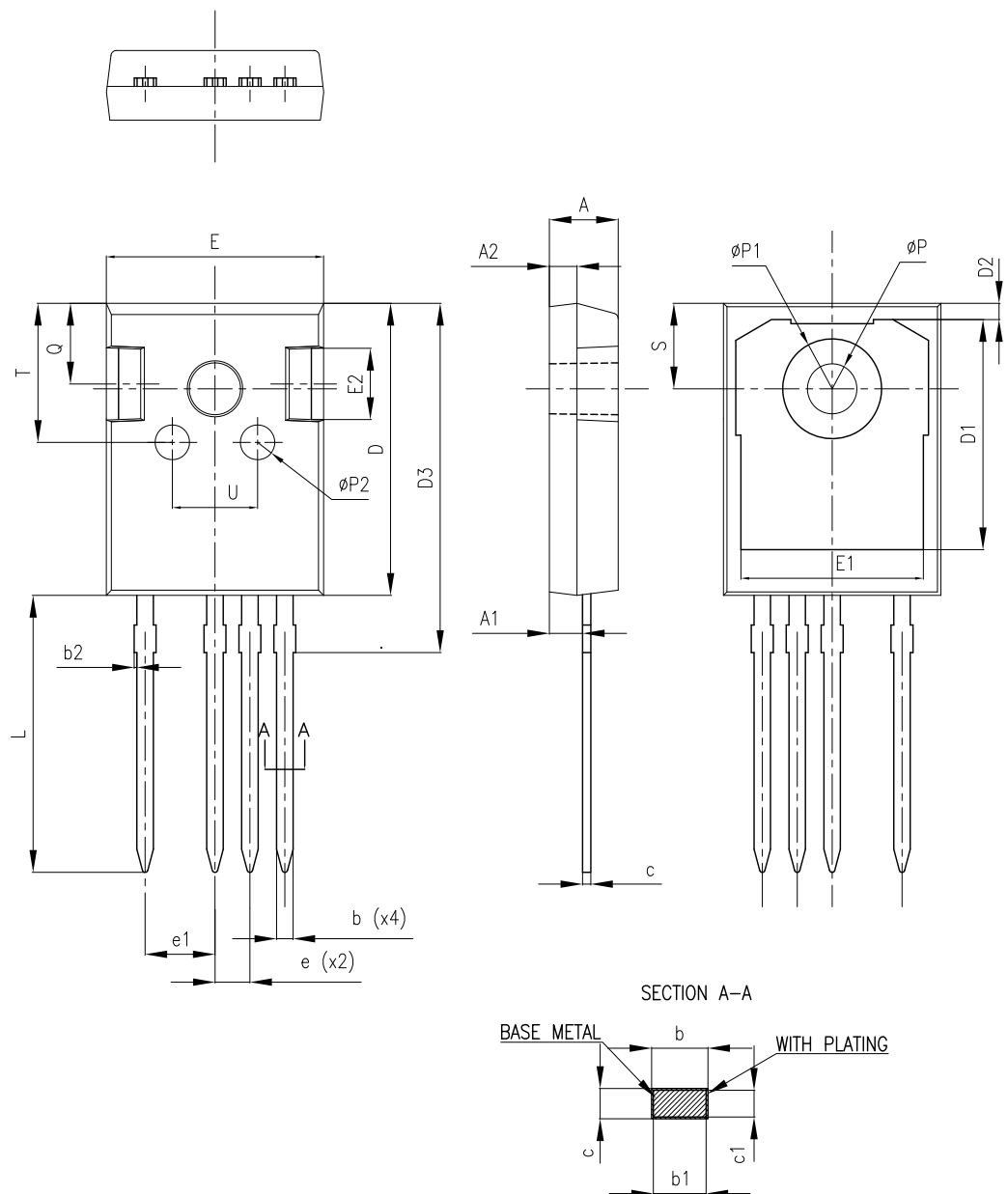
**Figure 27. Test circuit for inductive load switching**

**Figure 28. Gate charge test circuit**

**Figure 29. Switching waveform**

**Figure 30. Diode reverse recovery waveform**


## 4 Package information

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

### 4.1 TO247-4 package information

**Figure 31. TO247-4 package outline**



8405626\_2

**Table 7. TO247-4 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  |       | 1.29  |
| b1   | 1.15  | 1.20  | 1.25  |
| b2   | 0     |       | 0.20  |
| c    | 0.59  |       | 0.66  |
| c1   | 0.58  | 0.60  | 0.62  |
| D    | 20.90 | 21.00 | 21.10 |
| D1   | 16.25 | 16.55 | 16.85 |
| D2   | 1.05  | 1.20  | 1.35  |
| D3   | 24.97 | 25.12 | 25.27 |
| E    | 15.70 | 15.80 | 15.90 |
| E1   | 13.10 | 13.30 | 13.50 |
| E2   | 4.90  | 5.00  | 5.10  |
| E3   | 2.40  | 2.50  | 2.60  |
| e    | 2.44  | 2.54  | 2.64  |
| e1   | 4.98  | 5.08  | 5.18  |
| L    | 19.80 | 19.92 | 20.10 |
| P    | 3.50  | 3.60  | 3.70  |
| P1   |       |       | 7.40  |
| P2   | 2.40  | 2.50  | 2.60  |
| Q    | 5.60  |       | 6.00  |
| S    |       | 6.15  |       |
| T    | 9.80  |       | 10.20 |
| U    | 6.00  |       | 6.40  |

## Revision history

**Table 8. Document revision history**

| Date        | Version | Changes        |
|-------------|---------|----------------|
| 03-Aug-2020 | 1       | First release. |

## Contents

|            |                                                  |           |
|------------|--------------------------------------------------|-----------|
| <b>1</b>   | <b>Electrical ratings .....</b>                  | <b>2</b>  |
| <b>2</b>   | <b>Electrical characteristics.....</b>           | <b>3</b>  |
| <b>2.1</b> | <b>Electrical characteristics (curves) .....</b> | <b>5</b>  |
| <b>3</b>   | <b>Test circuits .....</b>                       | <b>10</b> |
| <b>4</b>   | <b>Package information.....</b>                  | <b>11</b> |
| <b>4.1</b> | <b>TO247-4 package information .....</b>         | <b>11</b> |
|            | <b>Revision history .....</b>                    | <b>13</b> |

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