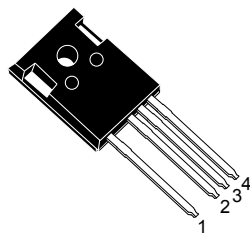
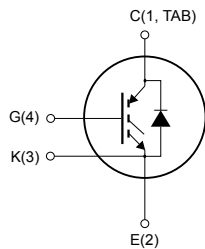


## Trench gate field-stop 650 V, 80 A high speed HB series IGBT



TO247-4



NG4K3E2C1\_TAB



### Features

- $V_{CE(sat)} = 1.6 \text{ V (typ.) @ } I_C = 80 \text{ A}$
- Maximum junction temperature:  $T_J = 175 \text{ }^\circ\text{C}$
- High speed switching series
- Minimized tail current
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode
- Excellent switching performance thanks to the extra driving kelvin pin

### Applications

- Photovoltaic inverters
- High frequency converters

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the new HB series of IGBTs, which represents an optimum compromise between conduction and switching loss to maximize the efficiency of any frequency converter. A faster switching event can be achieved by the Kelvin pin, which separates power path from driving signal. Furthermore, the slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

#### Product status link

[STGW80H65DFB-4](#)

#### Product summary

|            |                |
|------------|----------------|
| Order code | STGW80H65DFB-4 |
| Marking    | G80H65DFB      |
| Package    | TO247-4        |
| Packing    | Tube           |

## 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol                  | Parameter                                                                            | Value              | Unit |
|-------------------------|--------------------------------------------------------------------------------------|--------------------|------|
| $V_{CES}$               | Collector-emitter voltage ( $V_{GE} = 0\text{ V}$ )                                  | 650                | V    |
| $I_C$                   | Continuous collector current at $T_C = 25\text{ °C}$                                 | 120 <sup>(1)</sup> | A    |
|                         | Continuous collector current at $T_C = 100\text{ °C}$                                | 80                 |      |
| $I_{CP}$ <sup>(2)</sup> | Pulsed collector current ( $t_p \leq 1\text{ }\mu\text{s}$ , $T_J < 175\text{ °C}$ ) | 300                | A    |
| $V_{GE}$                | Gate-emitter voltage                                                                 | $\pm 20$           | V    |
|                         | Transient gate-emitter voltage                                                       | $\pm 30$           | V    |
| $I_F$                   | Continuous forward current at $T_C = 25\text{ °C}$                                   | 120 <sup>(1)</sup> | A    |
|                         | Continuous forward current at $T_C = 100\text{ °C}$                                  | 80                 |      |
| $I_{FP}$ <sup>(2)</sup> | Pulsed forward current ( $t_p \leq 1\text{ }\mu\text{s}$ , $T_J < 175\text{ °C}$ )   | 300                | A    |
| $P_{TOT}$               | Total power dissipation at $T_C = 25\text{ °C}$                                      | 470                | W    |
| $T_{STG}$               | Storage temperature range                                                            | - 55 to 150        | °C   |
| $T_J$                   | Operating junction temperature range                                                 | - 55 to 175        |      |

1. Current level is limited by bond wires
2. Defined by design, not subject to production test.

**Table 2. Thermal data**

| Symbol     | Parameter                              | Value | Unit |
|------------|----------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case IGBT  | 0.32  | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 0.66  |      |
| $R_{thJA}$ | 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  | $V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$                          | 650  |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 80\text{ A}$                         |      | 1.6  | 2.0       | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 80\text{ A}$ , $T_J = 125\text{ °C}$ |      | 1.8  |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 80\text{ A}$ , $T_J = 175\text{ °C}$ |      | 1.9  |           |               |
| $V_F$         | Forward on-voltage                   | $I_F = 80\text{ A}$                                                  |      | 2.15 | 2.8       | V             |
|               |                                      | $I_F = 80\text{ A}$ , $T_J = 125\text{ °C}$                          |      | 1.8  |           |               |
|               |                                      | $I_F = 80\text{ A}$ , $T_J = 175\text{ °C}$                          |      | 1.7  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$                              | 5    | 6    | 7         | V             |
| $I_{CES}$     | Collector cut-off current            | $V_{GE} = 0\text{ V}$ , $V_{CE} = 650\text{ V}$                      |      |      | 100       | $\mu\text{A}$ |
| $I_{GES}$     | 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            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$                                                             | -    | 10524 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                 | -    | 385   | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                 | -    | 215   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 520\text{ V}$ , $I_C = 80\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$<br>(see Figure 29. Gate charge test circuit) | -    | 414   | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                                                                                 | -    | 78    | -    |      |
| $Q_{gc}$  | Gate-collector charge        |                                                                                                                                 | -    | 170   | -    |      |

**Table 5. IGBT switching characteristics (inductive load)**

| Symbol          | Parameter                 | Test conditions                                                                                                                                                                                  | Min. | Typ. | Max. | Unit       |
|-----------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$     | Turn-on delay time        | $V_{CE} = 400\text{ V}$ , $I_C = 80\text{ A}$ , $V_{GE} = 15\text{ V}$ ,<br>$R_G = 10\ \Omega$<br>(see Figure 28. Test circuit for inductive load switching)                                     |      | 75   | -    | ns         |
| $t_r$           | Current rise time         |                                                                                                                                                                                                  |      | 35   | -    |            |
| $(di/dt)_{on}$  | Turn-on current slope     |                                                                                                                                                                                                  |      | 1750 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off-delay time       |                                                                                                                                                                                                  |      | 336  | -    | ns         |
| $t_f$           | Current fall time         |                                                                                                                                                                                                  |      | 23   | -    |            |
| $E_{on}^{(1)}$  | Turn-on switching energy  |                                                                                                                                                                                                  |      | 1    | -    | mJ         |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                                  |      | 1.7  | -    |            |
| $E_{is}$        | Total switching energy    |                                                                                                                                                                                                  |      | 2.7  | -    |            |
| $t_{d(on)}$     | Turn-on delay time        | $V_{CE} = 400\text{ V}$ , $I_C = 80\text{ A}$ , $V_{GE} = 15\text{ V}$ ,<br>$R_G = 10\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$<br>(see Figure 28. Test circuit for inductive load switching) |      | 66   | -    | ns         |
| $t_r$           | Current rise time         |                                                                                                                                                                                                  |      | 38   | -    |            |
| $(di/dt)_{on}$  | Turn-on current slope     |                                                                                                                                                                                                  |      | 1670 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off-delay time       |                                                                                                                                                                                                  |      | 403  | -    | ns         |
| $t_f$           | Current fall time         |                                                                                                                                                                                                  |      | 45   | -    |            |
| $E_{on}^{(1)}$  | Turn-on switching energy  |                                                                                                                                                                                                  |      | 1.5  | -    | mJ         |
| $E_{off}^{(2)}$ | Turn-off switching energy |                                                                                                                                                                                                  |      | 2.47 | -    |            |
| $E_{is}$        | Total switching energy    |                                                                                                                                                                                                  |      | 3.97 | -    |            |

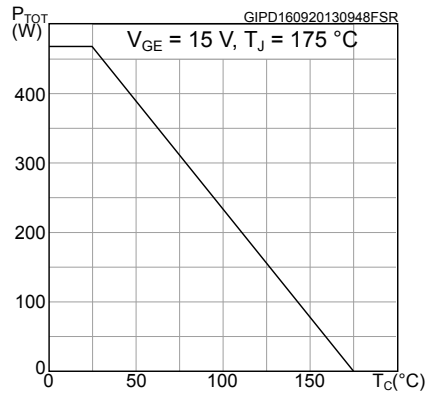
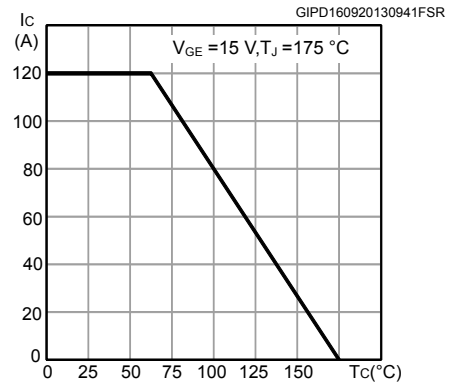
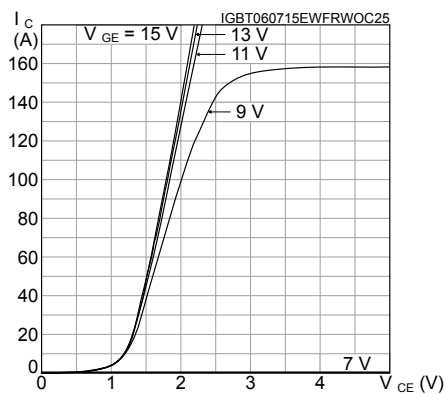
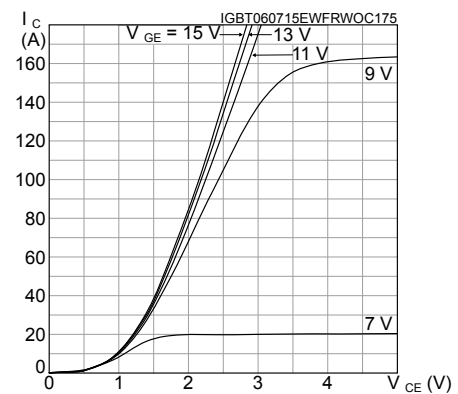
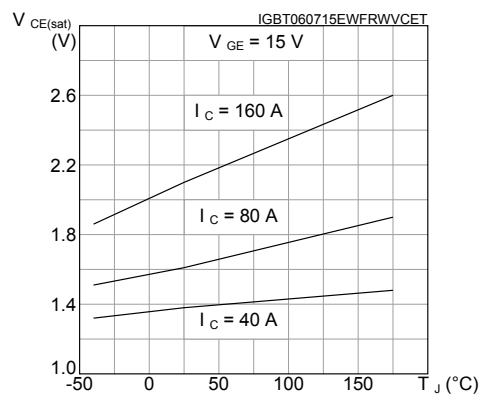
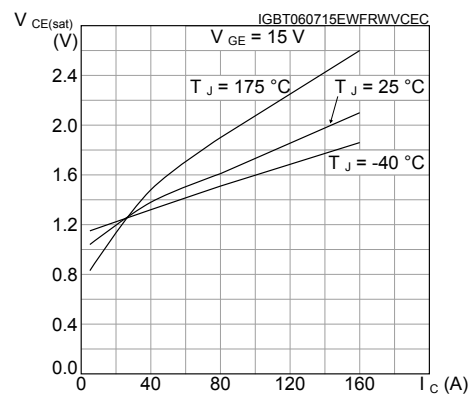
1. Including the reverse recovery of the diode.

2. Including the tail of the collector current.

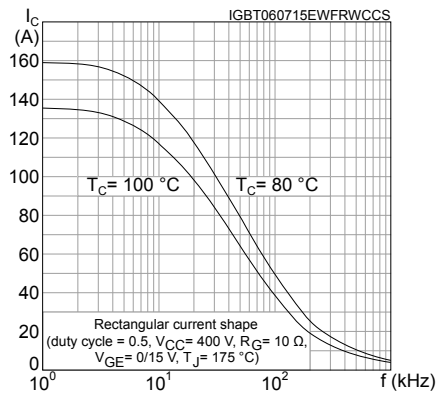
**Table 6. Diode switching characteristics (inductive load)**

| Symbol       | Parameter                                                  | Test conditions                                                                                                                                                                                              | Min. | Typ. | Max. | Unit       |
|--------------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 80\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$<br>$di/dt = 1000\text{ A}/\mu\text{s}$<br>(see Figure 28. Test circuit for inductive load switching)                                     | -    | 112  | -    | ns         |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                              | -    | 955  | -    | nC         |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                              | -    | 27.2 | -    | A          |
| $dl_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                              | -    | 1515 | -    | A/ $\mu$ s |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                              | -    | 170  | -    | $\mu$ J    |
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 80\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 175\text{ }^\circ\text{C}$ $di/dt = 1000\text{ A}/\mu\text{s}$<br>(see Figure 28. Test circuit for inductive load switching) | -    | 164  | -    | ns         |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                              | -    | 3838 | -    | nC         |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                              | -    | 52   | -    | A          |
| $dl_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                              | -    | 785  | -    | A/ $\mu$ s |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                              | -    | 635  | -    | $\mu$ J    |

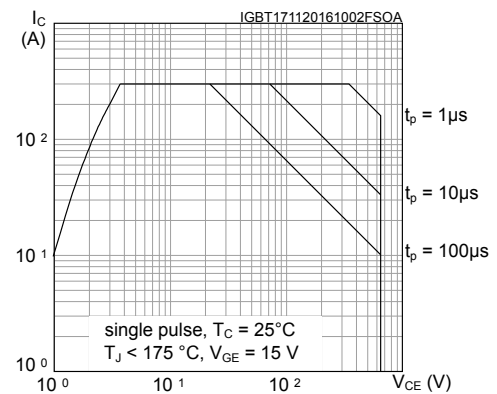
## 2.1 Electrical characteristics (curves)

**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**


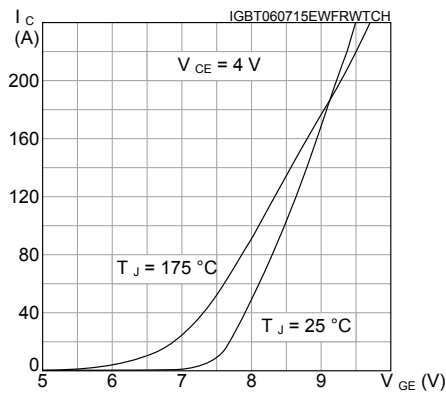
**Figure 7. Collector current vs. switching frequency**



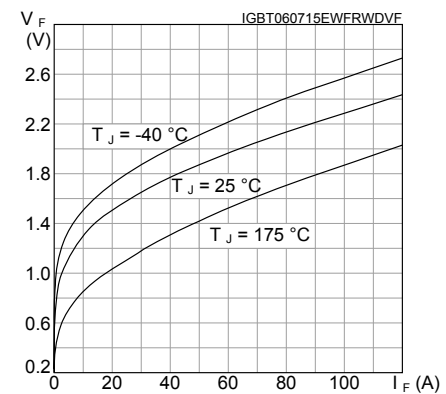
**Figure 8. Forward bias safe operating area**



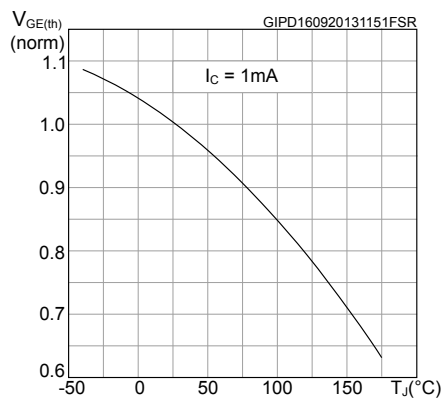
**Figure 9. Transfer characteristics**



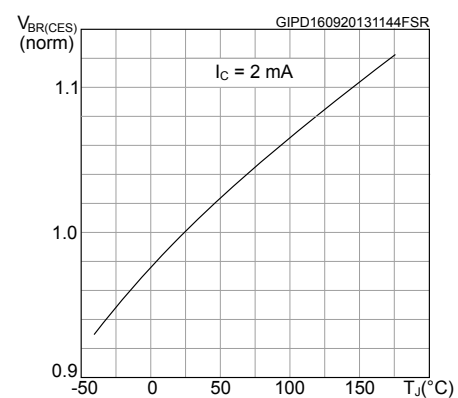
**Figure 10. Diode V\_F vs. forward current**



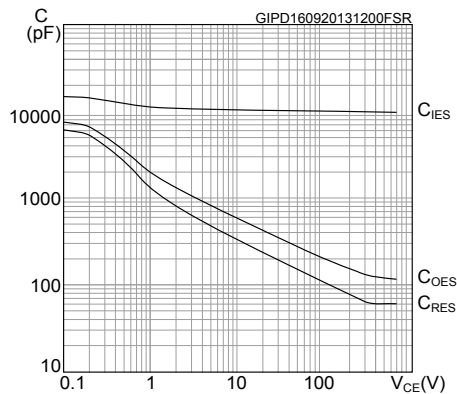
**Figure 11. Normalized V\_{GE(th)} vs. junction temperature**



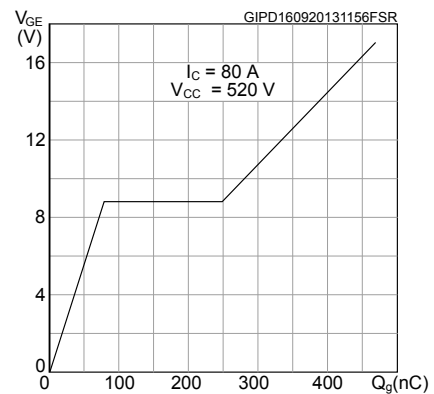
**Figure 12. Normalized V\_{BR(CES)} vs. junction temperature**



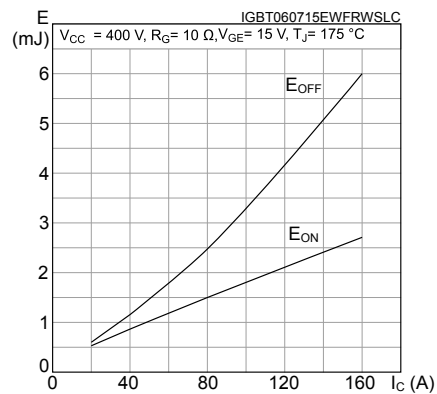
**Figure 13. Capacitance variations**



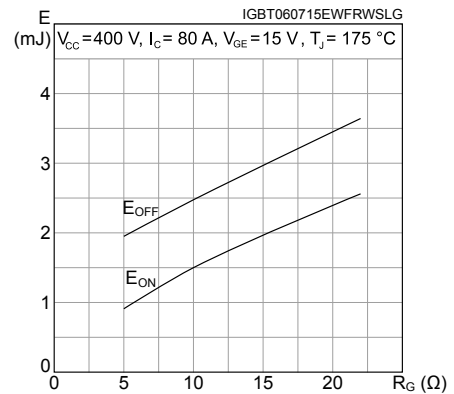
**Figure 14. Gate charge vs. gate-emitter voltage**



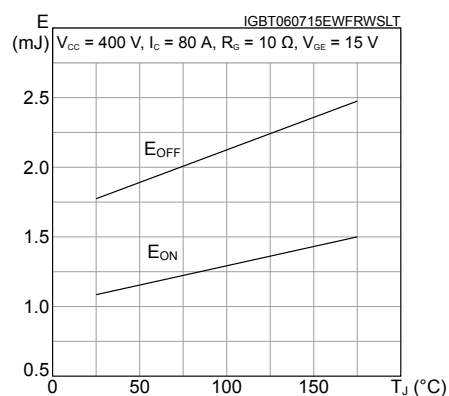
**Figure 15. Switching energy vs. collector current**



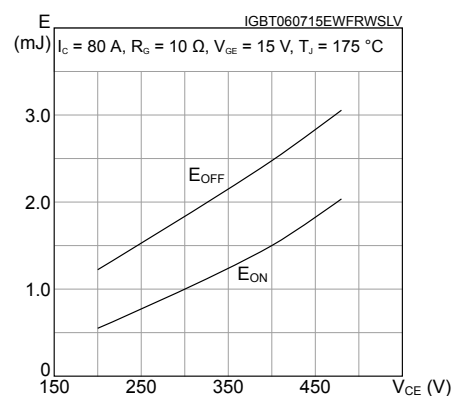
**Figure 16. Switching energy vs. gate resistance**



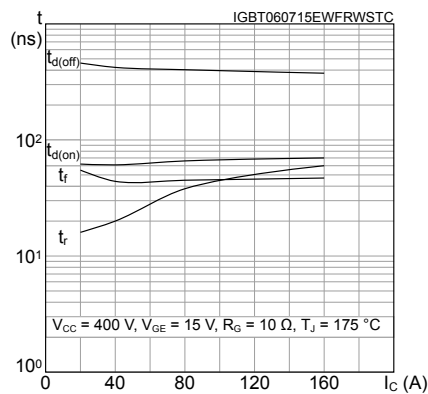
**Figure 17. Switching energy vs. temperature**



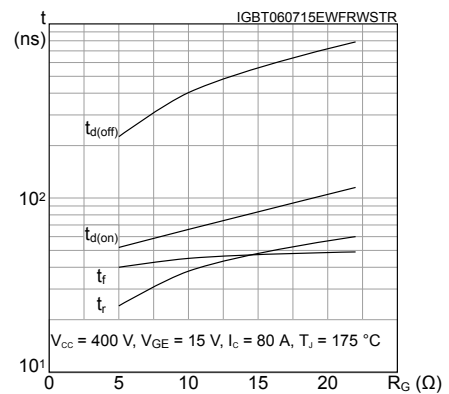
**Figure 18. Switching energy vs. collector emitter voltage**



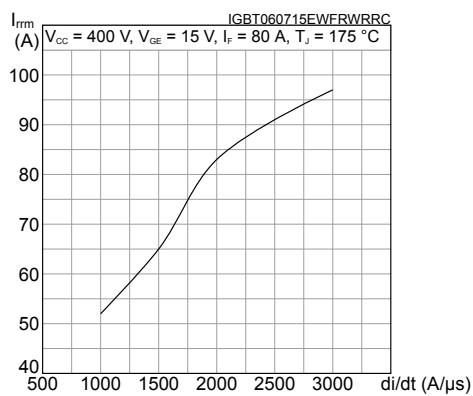
**Figure 19. Switching times vs. collector current**



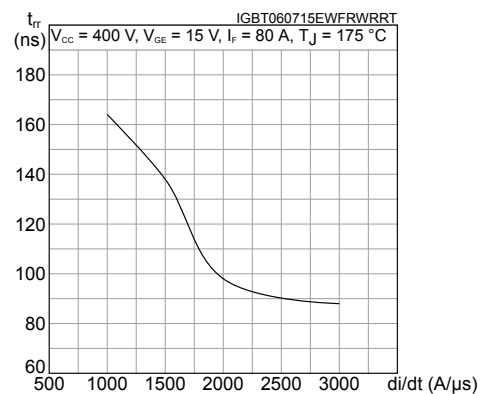
**Figure 20. Switching times vs. gate resistance**



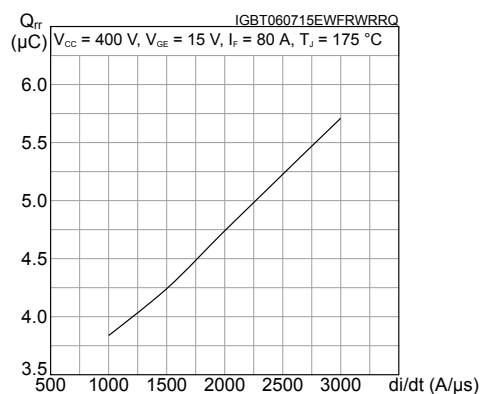
**Figure 21. Reverse recovery current vs. diode current slope**



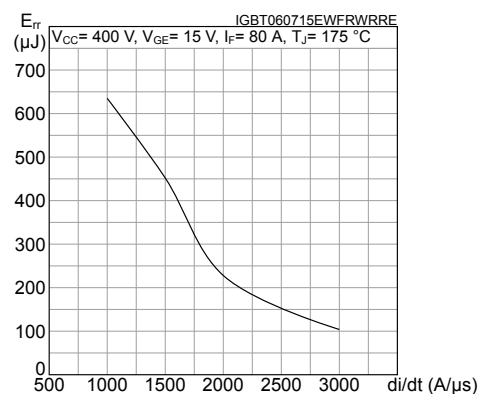
**Figure 22. Reverse recovery time vs. diode current slope**



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

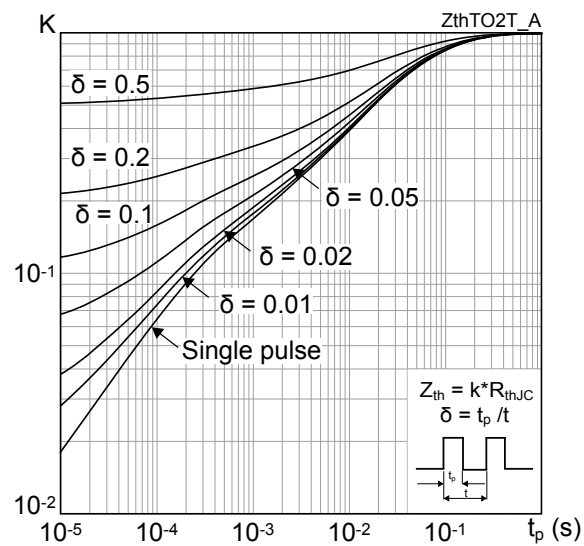


**Figure 24. Reverse recovery energy vs. diode current slope**

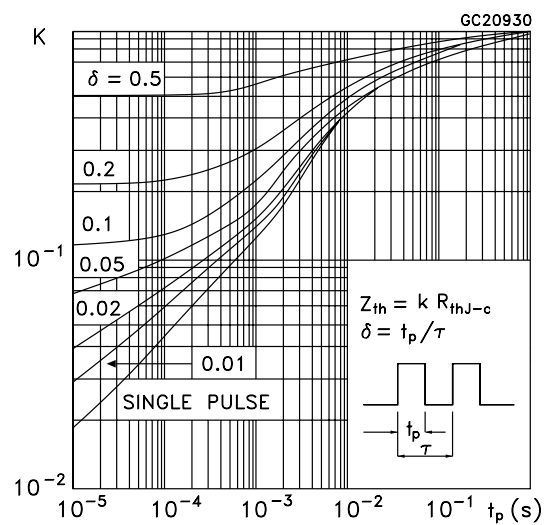




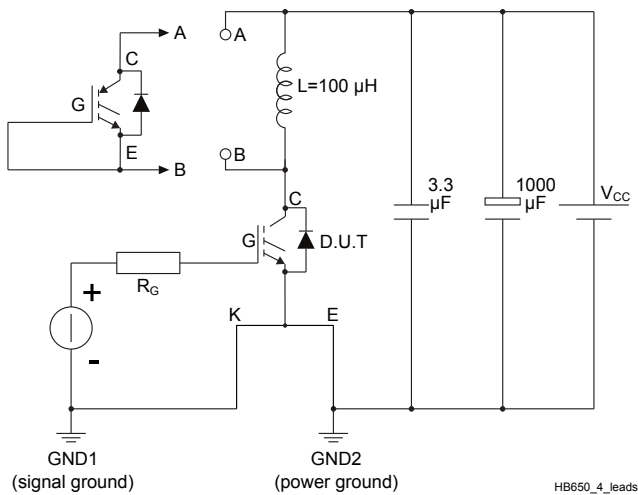
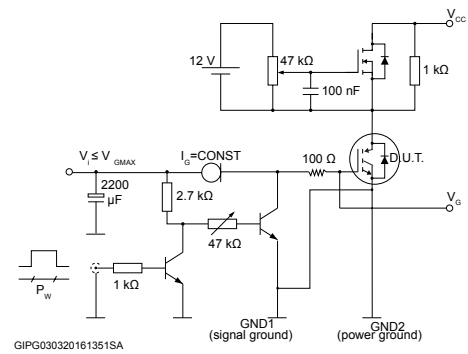
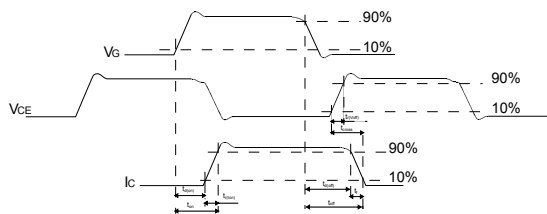
**Figure 25. Thermal impedance for IGBT**



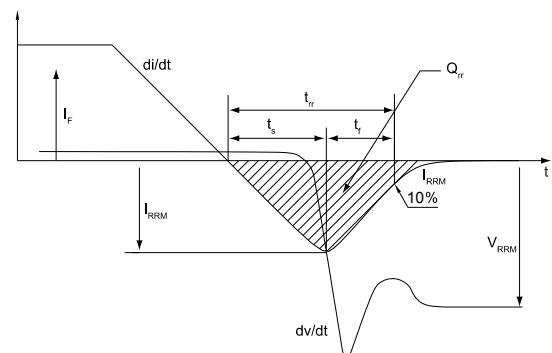
**Figure 26. Thermal impedance for diode**



### 3 Test circuits

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

**Figure 28. Gate charge test circuit**

**Figure 29. Switching waveform**


AM01506v1

**Figure 30. Diode reverse recovery waveform**


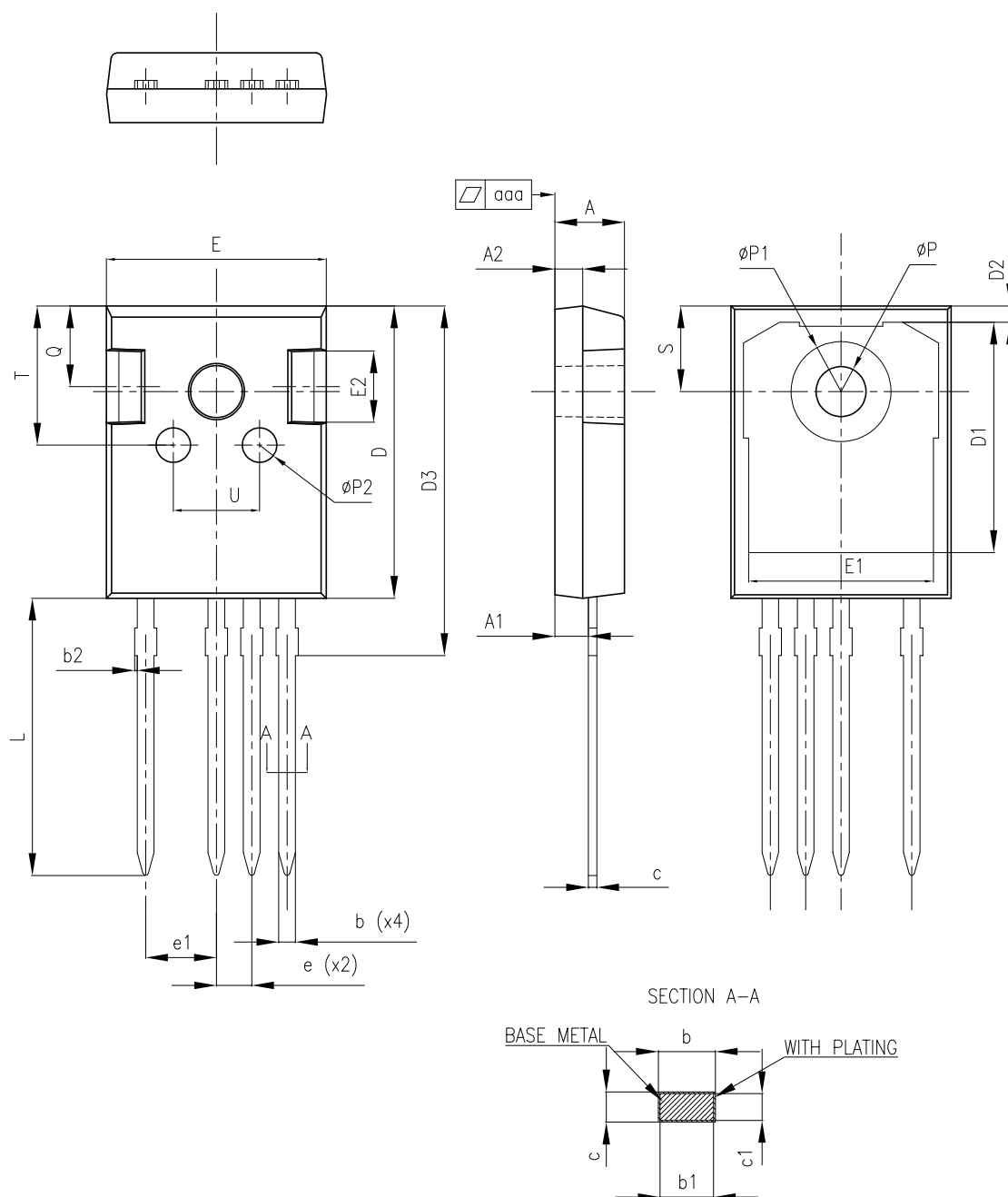
GADG140820170937SA

## 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



**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  |
| aaa  |       | 0.04  | 0.10  |

## Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                               |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 05-Aug-2015 | 1        | First release.                                                                                                                                                                                                        |
| 17-Nov-2016 | 2        | Updated features in cover page.<br>Updated <i>Table 2: "Absolute maximum ratings"</i> and <i>Figure 9: "Forward bias safe operating area"</i> .<br>Minor text changes.                                                |
| 03-Mar-2017 | 3        | Updated the title in cover page, <i>Table 2: "Absolute maximum ratings"</i> , <i>Table 4: "Static characteristics"</i> and <i>Table 6: "IGBT switching characteristics (inductive load)"</i> .<br>Minor text changes. |
| 03-Jul-2019 | 4        | Updated <i>Table 1. Absolute maximum ratings</i> .<br>Minor text changes.                                                                                                                                             |
| 03-Dec-2021 | 5        | Updated <a href="#">Table 4. Dynamic characteristics</a> .<br>Updated <a href="#">Section 4.1 TO247-4 package information</a> .                                                                                       |

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| <b>2</b> | <b>Electrical characteristics.....</b>    | <b>3</b>  |
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| <b>3</b> | <b>Test circuits .....</b>                | <b>10</b> |
| <b>4</b> | <b>Package information.....</b>           | <b>11</b> |
| 4.1      | TO247-4 package information .....         | 11        |
|          | <b>Revision history .....</b>             | <b>13</b> |

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