

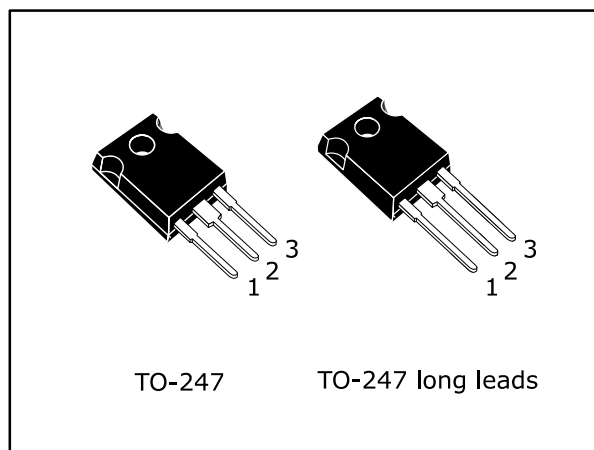
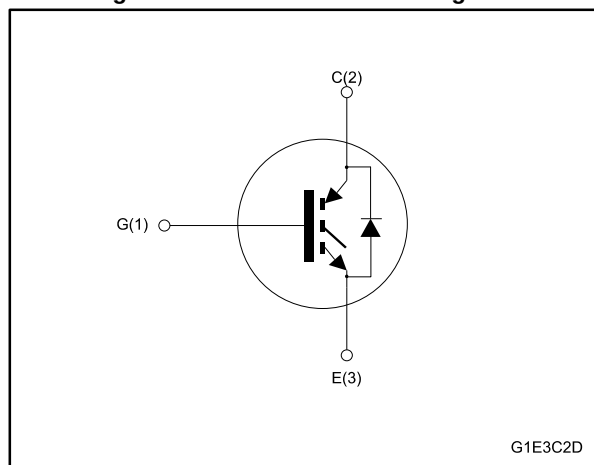


Figure 1: Internal schematic diagram



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^{\circ}\text{C}$
- High speed switching series
- Minimized tail current
- $V_{CE(sat)} = 2.1\text{ V (typ.) @ } I_C = 40\text{ A}$
- $5\text{ }\mu\text{s}$  minimum short circuit withstand time at  $T_J = 150\text{ }^{\circ}\text{C}$
- Safe paralleling
- Very fast recovery antiparallel diode
- Low thermal resistance

### Applications

- Uninterruptible power supply
- Welding machines
- Photovoltaic inverters
- Power factor correction
- High frequency converters

### Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the H series of IGBTs, which represents an optimum compromise between conduction and switching losses to maximize the efficiency of high switching frequency converters. Furthermore, a slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

| Order code     | Marking    | Package           | Packaging |
|----------------|------------|-------------------|-----------|
| STGW40H120DF2  | G40H120DF2 | TO-247            | Tube      |
| STGWA40H120DF2 | G40H120DF2 | TO-247 long leads | Tube      |

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol         | Parameter                                                                           | Value      | Unit |
|----------------|-------------------------------------------------------------------------------------|------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ )                                          | 1200       | V    |
| $I_C$          | Continuous collector current at $T_C = 25\text{ °C}$                                | 80         | A    |
| $I_C$          | Continuous collector current at $T_C = 100\text{ °C}$                               | 40         | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current                                                            | 160        | A    |
| $V_{GE}$       | Gate-emitter voltage                                                                | $\pm 20$   | V    |
| $V_{GE}$       | Transient gate-emitter voltage ( $t_p \leq 10\text{ }\mu\text{s}$ , $D \leq 0.01$ ) | $\pm 30$   | V    |
| $I_F$          | Continuous forward current at $T_C = 25\text{ °C}$                                  | 80         | A    |
| $I_F$          | Continuous forward current at $T_C = 100\text{ °C}$                                 | 40         | A    |
| $I_{FP}^{(1)}$ | Pulsed forward current                                                              | 160        | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$                                           | 468        | W    |
| $T_{STG}$      | Storage temperature range                                                           | -55 to 150 | °C   |
| $T_J$          | Operating junction temperature range                                                | -55 to 175 | °C   |

**Notes:**

<sup>(1)</sup>Pulse width limited by maximum junction temperature.

Table 3: Thermal data

| Symbol     | Parameter                              | Value | Unit |
|------------|----------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case IGBT  | 0.32  | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 1.3   | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient    | 50    | °C/W |

## 2 Electrical characteristics

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

**Table 4: Static characteristics**

| Symbol        | Parameter                            | Test conditions                                                         | Min. | Typ. | Max.      | Unit          |
|---------------|--------------------------------------|-------------------------------------------------------------------------|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage  | $V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$                             | 1200 |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$                            |      | 2.1  | 2.6       | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ ,<br>$T_J = 125\text{ °C}$ |      | 2.4  |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ ,<br>$T_J = 175\text{ °C}$ |      | 2.5  |           |               |
| $V_F$         | Forward on-voltage                   | $I_F = 40\text{ A}$                                                     |      | 3.9  | 4.9       | V             |
|               |                                      | $I_F = 40\text{ A}$ , $T_J = 125\text{ °C}$                             |      | 3.05 |           |               |
|               |                                      | $I_F = 40\text{ A}$ , $T_J = 175\text{ °C}$                             |      | 2.8  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 2\text{ mA}$                                 | 5    | 6    | 7         | V             |
| $I_{CES}$     | Collector cut-off current            | $V_{GE} = 0\text{ V}$ , $V_{CE} = 1200\text{ V}$                        |      |      | 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 5: Dynamic characteristics**

| Symbol    | Parameter                    | Test conditions                                                                                                                        | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0\text{ V}$                                                                 | -    | 3200 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                        | -    | 220  | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                        | -    | 80   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 960\text{ V}$ , $I_C = 40\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ (see <a href="#">Figure 30: "Gate charge test circuit"</a> ) | -    | 158  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                                                                                        | -    | 17   | -    |      |
| $Q_{gc}$  | Gate-collector charge        |                                                                                                                                        | -    | 85   | -    |      |

Table 6: IGBT switching characteristics (inductive load)

| Symbol         | Parameter                    | Test conditions                                                                                                                                                                               | Min. | Typ. | Max. | Unit       |
|----------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 600\text{ V}$ , $I_C = 40\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$<br>(see <a href="#">Figure 31: "Switching waveform"</a> )                                      |      | 18   | -    | ns         |
| $t_r$          | Current rise time            |                                                                                                                                                                                               |      | 37   | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |                                                                                                                                                                                               |      | 1755 | -    | A/ $\mu$ s |
| $t_{d(off)}$   | Turn-off-delay time          |                                                                                                                                                                                               |      | 152  | -    | ns         |
| $t_f$          | Current fall time            |                                                                                                                                                                                               |      | 83   | -    | ns         |
| $E_{on(1)}$    | Turn-on switching energy     |                                                                                                                                                                                               |      | 1    | -    | mJ         |
| $E_{off(2)}$   | Turn-off switching energy    |                                                                                                                                                                                               |      | 1.32 | -    | mJ         |
| $E_{ts}$       | Total switching energy       |                                                                                                                                                                                               |      | 2.32 | -    | mJ         |
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 600\text{ V}$ , $I_C = 40\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$<br>$T_J = 175\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 31: "Switching waveform"</a> ) |      | 36   | -    | ns         |
| $t_r$          | Current rise time            |                                                                                                                                                                                               |      | 20   | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |                                                                                                                                                                                               |      | 1580 | -    | A/ $\mu$ s |
| $t_{d(off)}$   | Turn-off-delay time          |                                                                                                                                                                                               |      | 161  | -    | ns         |
| $t_f$          | Current fall time            |                                                                                                                                                                                               |      | 190  | -    | ns         |
| $E_{on(1)}$    | Turn-on switching energy     |                                                                                                                                                                                               |      | 1.81 | -    | mJ         |
| $E_{off(2)}$   | Turn-off switching energy    |                                                                                                                                                                                               |      | 2.46 | -    | mJ         |
| $E_{ts}$       | Total switching energy       |                                                                                                                                                                                               |      | 4.27 | -    | mJ         |
| $t_{sc}$       | Short-circuit withstand time | $V_{CC} = 600\text{ V}$ , $V_{GE} = 15\text{ V}$ ,<br>$T_{Jstart} = 150\text{ }^\circ\text{C}$                                                                                                | 5    |      | -    | $\mu$ s    |

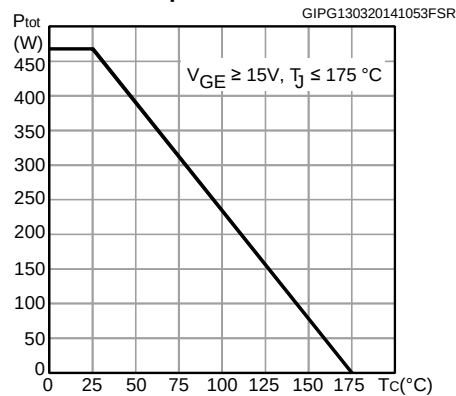
**Notes:**<sup>(1)</sup>Including the reverse recovery of the diode.<sup>(2)</sup>Including the tail of the collector current.

Table 7: Diode switching characteristics (inductive load)

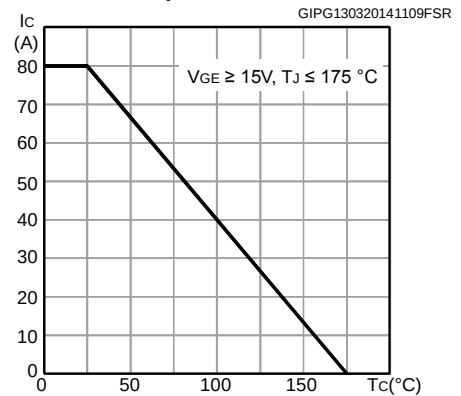
| Symbol       | Parameter                                                  | Test conditions                                                                                                                                                                                       | Min. | Typ. | Max. | Unit          |
|--------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 40\text{ A}$ , $V_R = 600\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$<br>(see <a href="#">Figure 31: "Switching waveform"</a> ) $di/dt = 500\text{ A}/\mu\text{s}$                                   | -    | 488  |      | ns            |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                       | -    | 2.59 |      | $\mu\text{C}$ |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                       | -    | 11.6 |      | A             |
| $dl_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                       | -    | 406  |      | A/ $\mu$ s    |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                       | -    | 0.38 |      | mJ            |
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 40\text{ A}$ , $V_R = 600\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 31: "Switching waveform"</a> ) $di/dt = 500\text{ A}/\mu\text{s}$ | -    | 484  |      | ns            |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                       | -    | 4.5  |      | $\mu\text{C}$ |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                       | -    | 18.6 |      | A             |
| $dl_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                       | -    | 170  |      | A/ $\mu$ s    |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                       | -    | 0.94 |      | mJ            |

## 2.2 Electrical characteristics (curves)

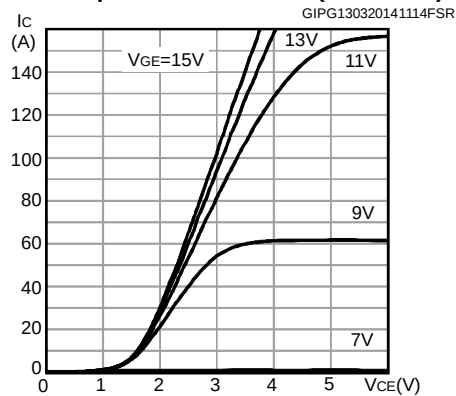
**Figure 2: Power dissipation vs. case temperature**



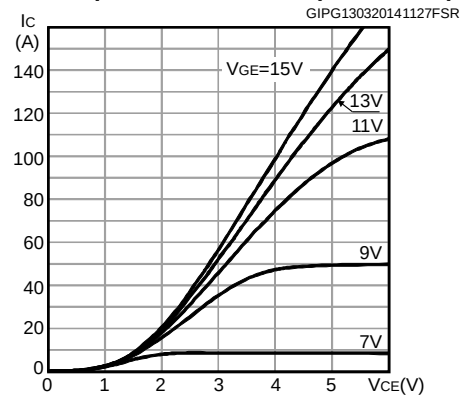
**Figure 3: Collector current vs. case temperature**



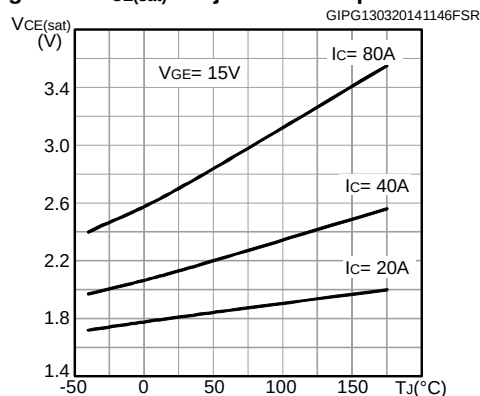
**Figure 4: Output characteristics ( $T_J = 25^\circ C$ )**



**Figure 5: Output characteristics ( $T_J = 175^\circ C$ )**



**Figure 6:  $V_{CE(sat)}$  vs. junction temperature**



**Figure 7:  $V_{CE(sat)}$  vs. collector current**

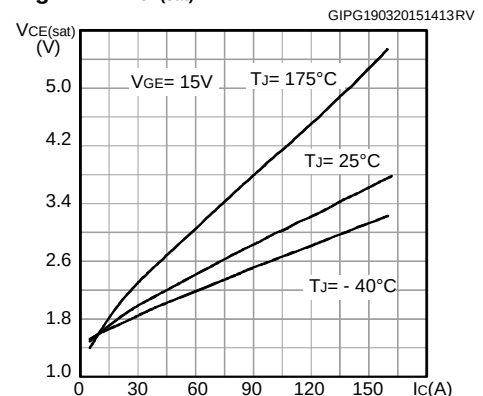


Figure 8: Collector current vs. switching frequency

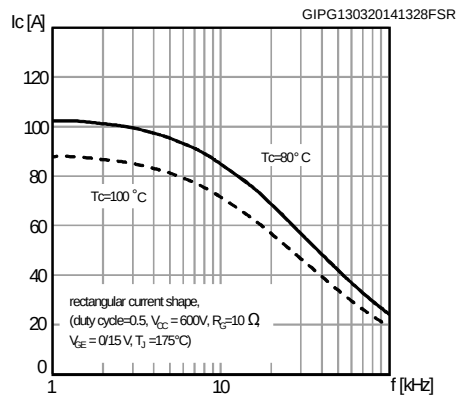


Figure 9: Forward bias safe operating area

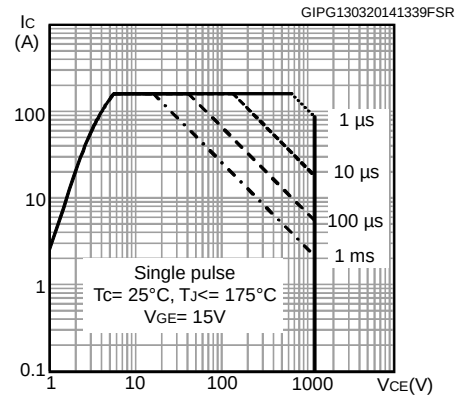


Figure 10: Transfer characteristics

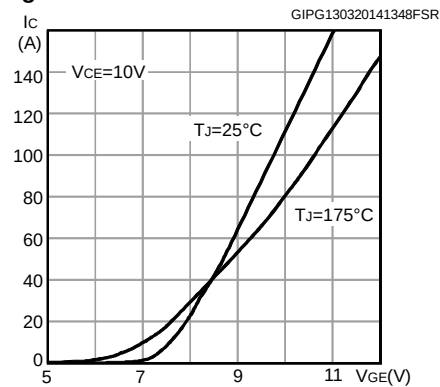
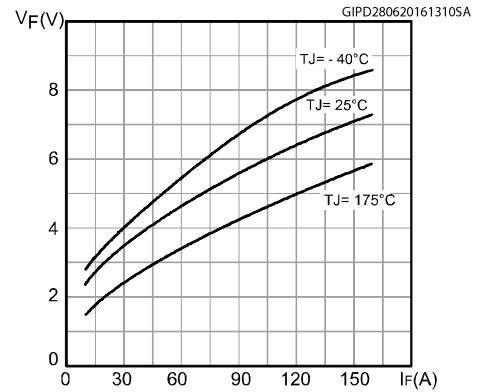
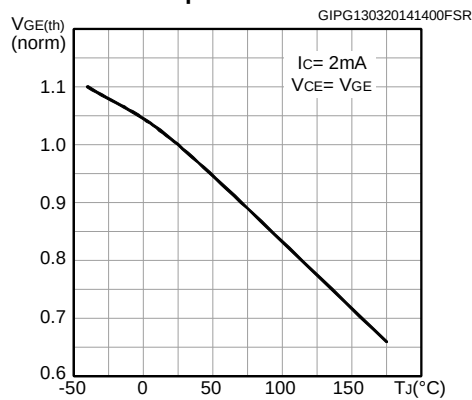
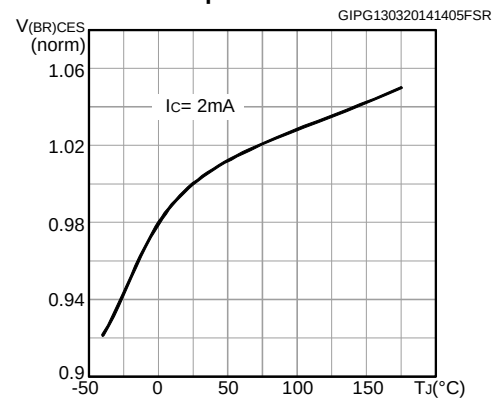
Figure 11: Diode  $V_F$  vs. forward currentFigure 12: Normalized  $V_{GE(th)}$  vs. junction temperatureFigure 13: Normalized  $V_{(BR)CES}$  vs. junction temperature

Figure 14: Capacitance variations

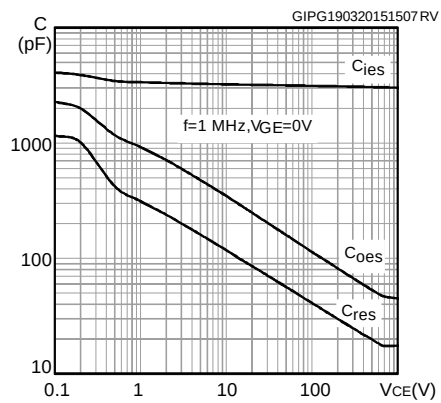


Figure 15: Gate charge vs. gate-emitter voltage

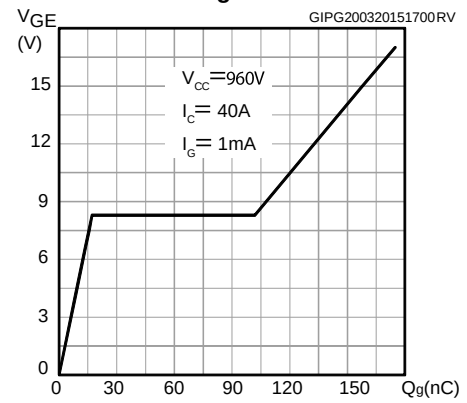


Figure 16: Switching energy vs. collector current

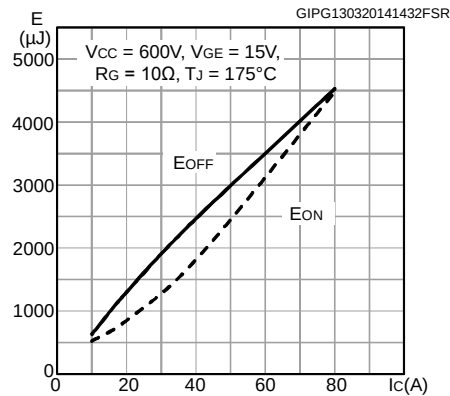


Figure 17: Switching energy vs. gate resistance

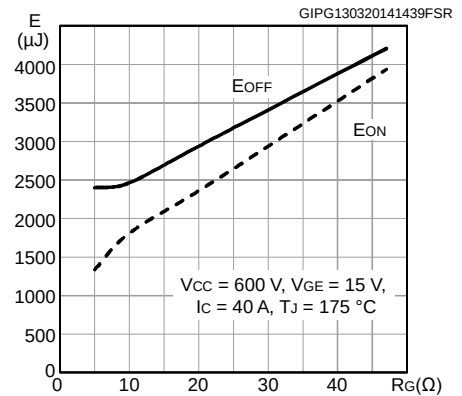


Figure 18: Switching energy vs. temperature

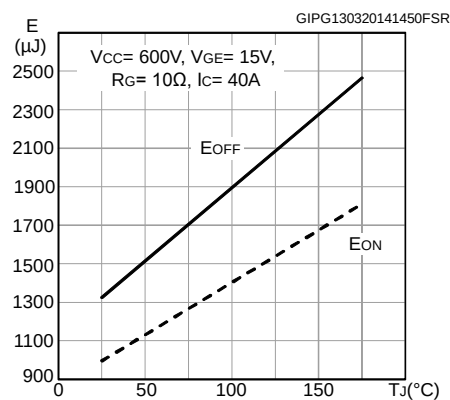


Figure 19: Switching energy vs. collector emitter voltage

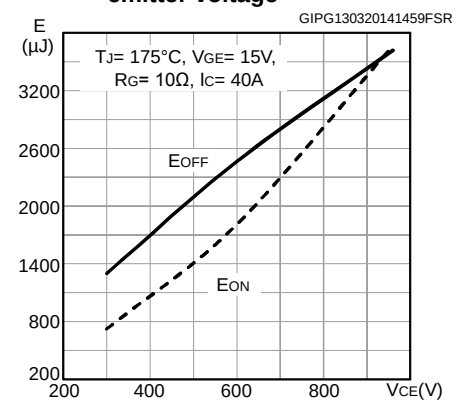




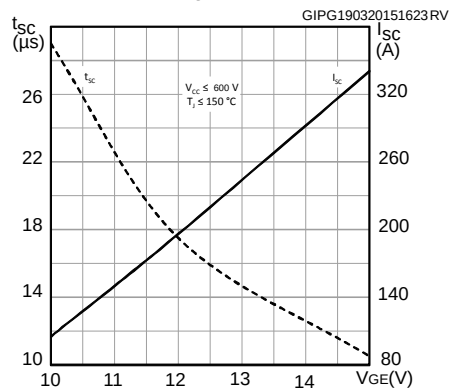
Figure 20: Short-circuit time and current vs.  $V_{GE}$ 

Figure 21: Switching times vs. collector current

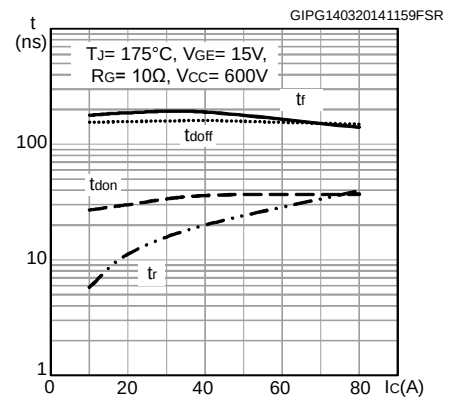


Figure 22: Switching times vs. gate resistance

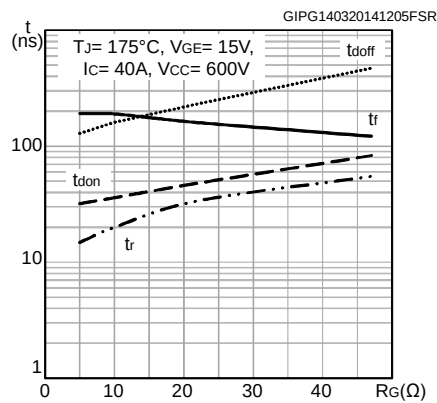


Figure 23: Reverse recovery current vs. diode current slope

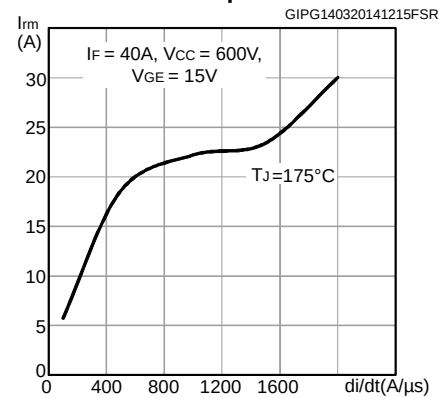


Figure 24: Reverse recovery time vs. diode current slope

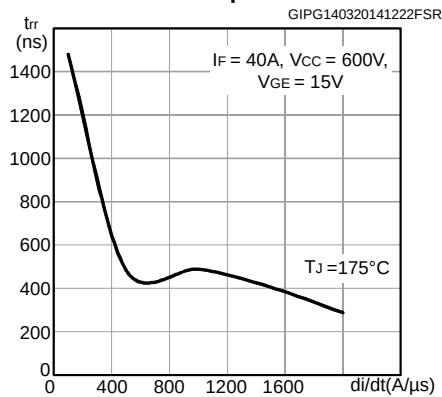


Figure 25: Reverse recovery charge vs. diode current slope

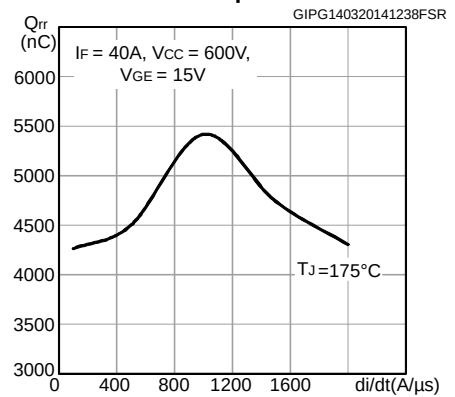


Figure 26: Reverse recovery energy vs. diode current slope

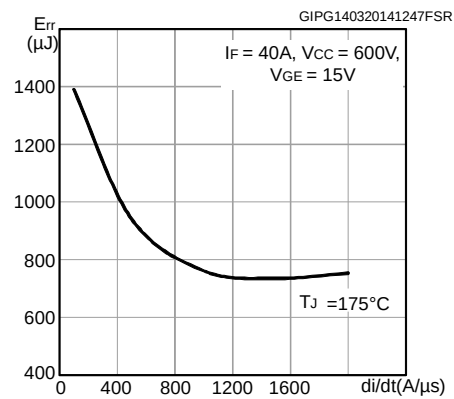


Figure 27: Thermal impedance for IGBT

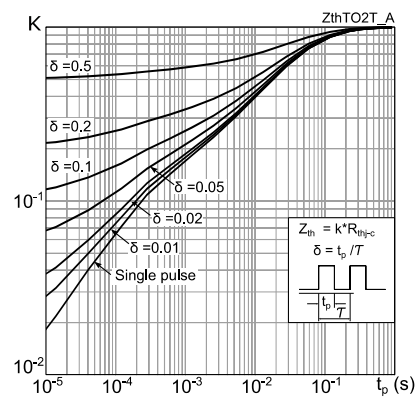
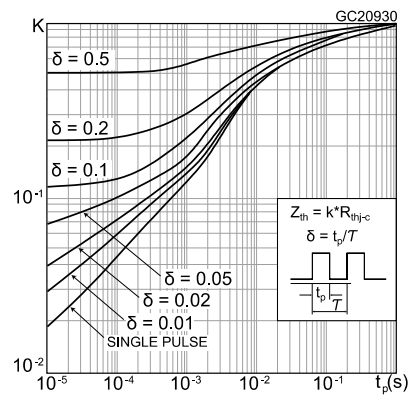
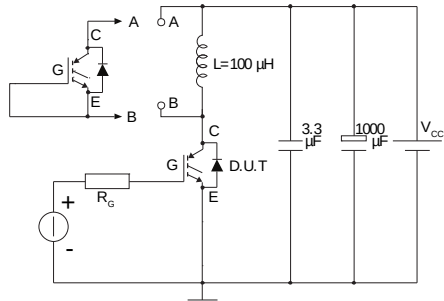


Figure 28: Thermal impedance for diode



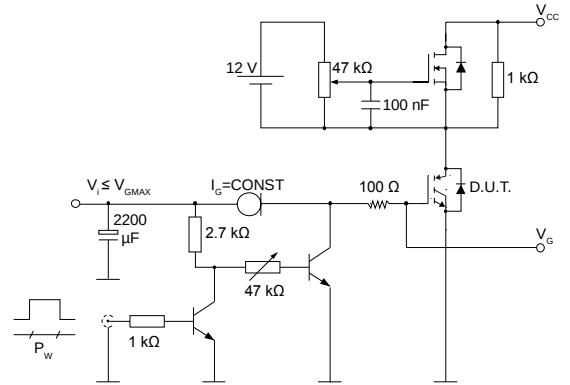
### 3 Test circuits

**Figure 29: Test circuit for inductive load switching**



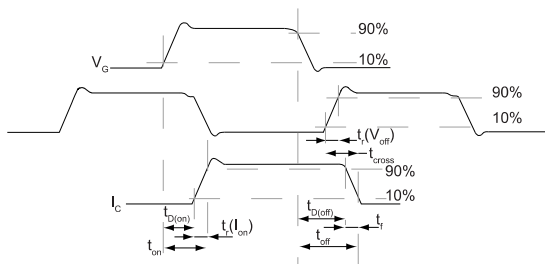
AM01504v1

**Figure 30: Gate charge test circuit**



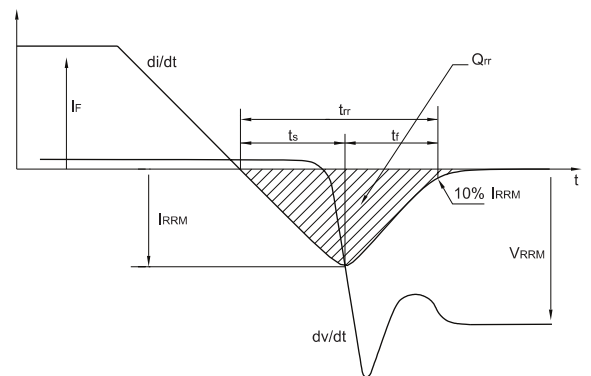
AM01505v1

**Figure 31: Switching waveform**



AM01506v1

**Figure 32: Diode reverse recovery waveform**



AM01507v1

## 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 TO-247 package information

Figure 33: TO-247 package outline

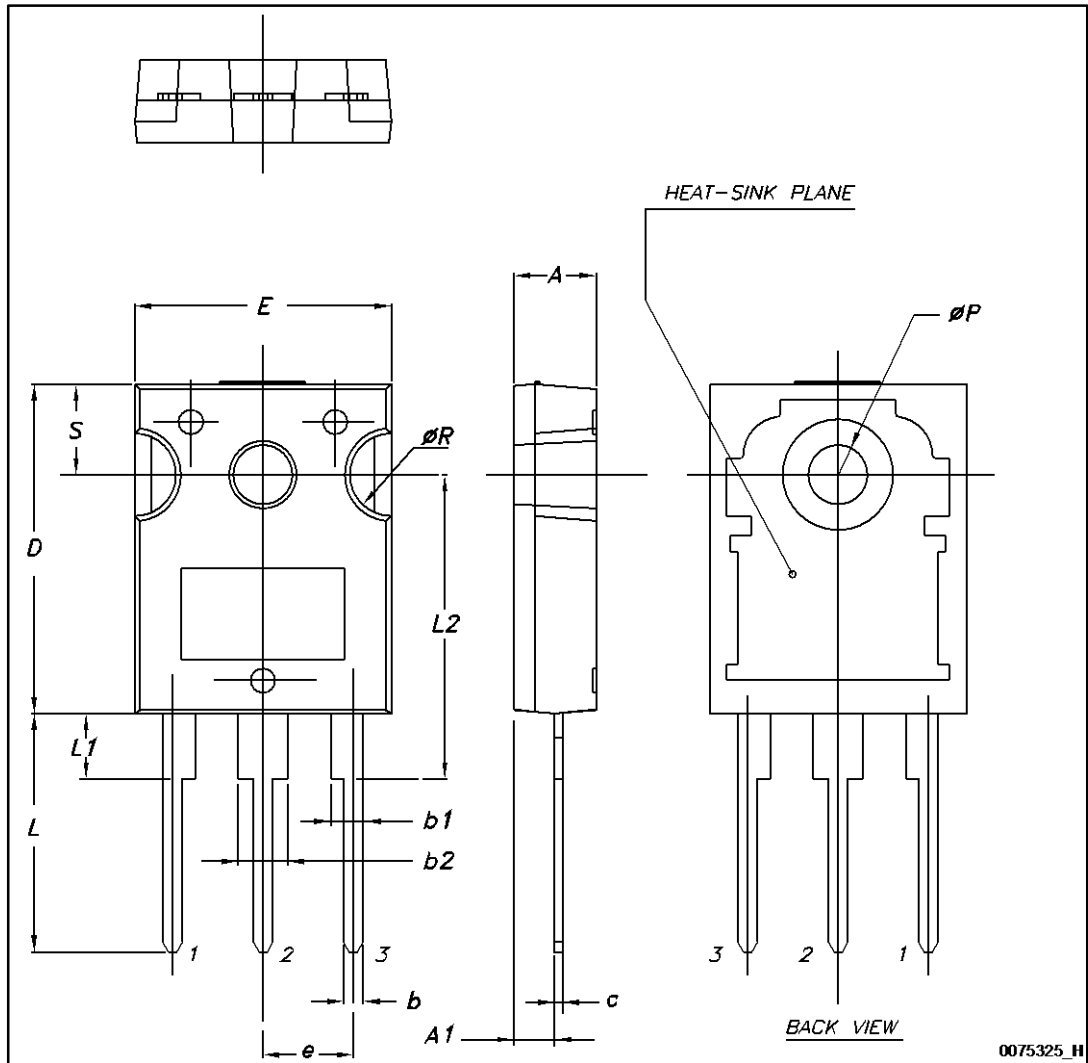


Table 8: TO-247 package mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.85  |       | 5.15  |
| A1   | 2.20  |       | 2.60  |
| b    | 1.0   |       | 1.40  |
| b1   | 2.0   |       | 2.40  |
| b2   | 3.0   |       | 3.40  |
| c    | 0.40  |       | 0.80  |
| D    | 19.85 |       | 20.15 |
| E    | 15.45 |       | 15.75 |
| e    | 5.30  | 5.45  | 5.60  |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    | 5.30  | 5.50  | 5.70  |

## 4.2 TO-247 long leads package information

Figure 34: TO-247 long lead package outline

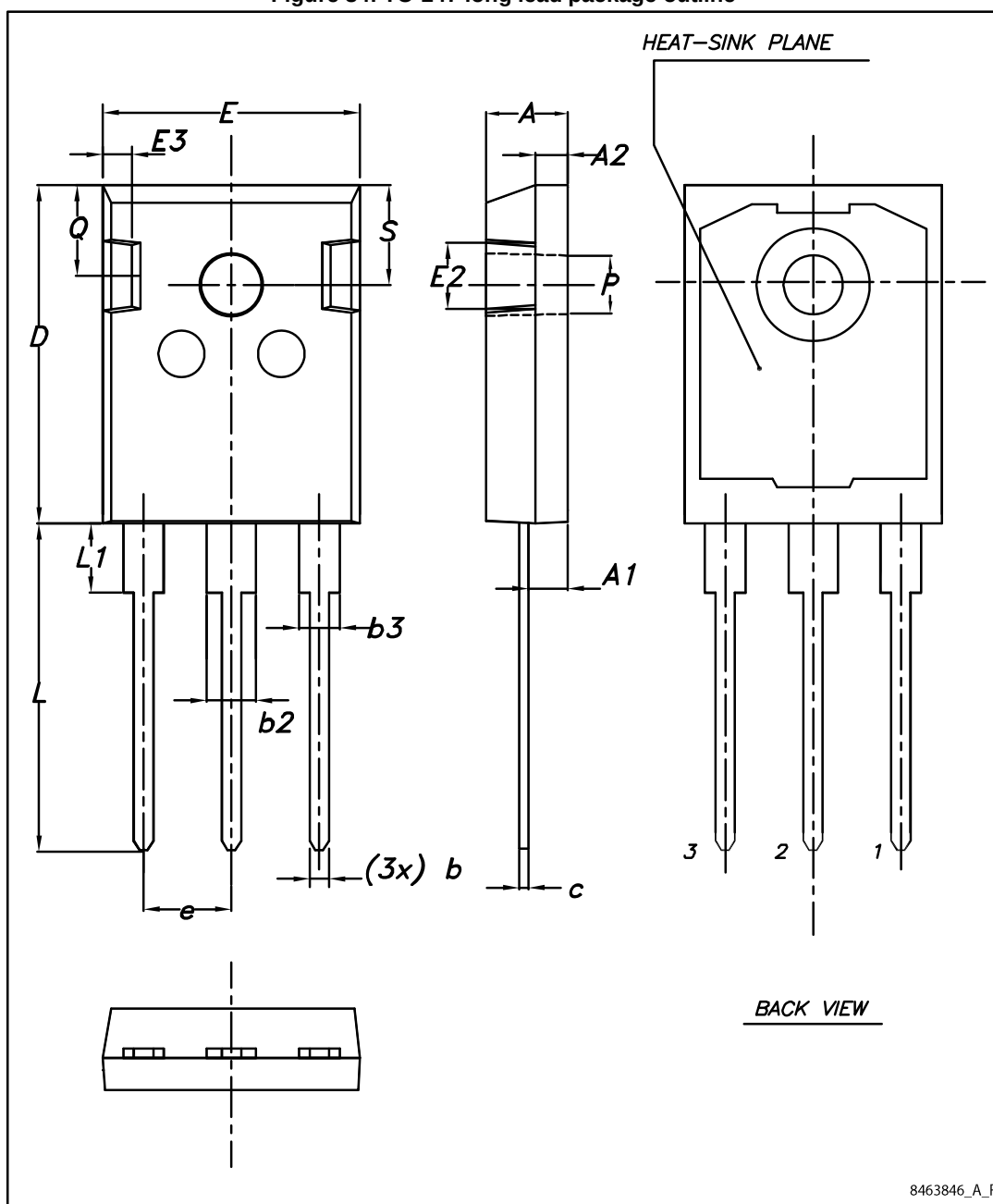


Table 9: TO-247 long lead package mechanical data

| 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  |
| P    | 3.50  | 3.60  | 3.70  |
| Q    | 5.60  |       | 6.00  |
| S    | 6.05  | 6.15  | 6.25  |

## 5 Revision history

**Table 10: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                             |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 03-Oct-2012 | 1        | First release.                                                                                                                                                                                                                                      |
| 29-Jan-2014 | 2        | Updated features in cover page.<br>Updated Table 4: Static characteristics, Table 5: Dynamic characteristics and Table 7: Diode switching characteristics (inductive load).<br>Minor text changes.                                                  |
| 24-Mar-2014 | 3        | Updated title and description in cover page.<br>Updated Table 4: Static characteristics, Table 5: Dynamic characteristics and Table 7: Diode switching characteristics (inductive load).<br>Added Section 2.1: Electrical characteristics (curves). |
| 31-Mar-2015 | 4        | Added device in TO-247 long leads.<br>Updated 4: Package information.<br>Updated Figure 7, Figure 11, Figure 14, Figure 15, Figure 20, Figure 21 and added Figure 26.<br>Minor text changes.                                                        |
| 28-Jun-2016 | 5        | Modified: <i>Table 2: "Absolute maximum ratings", Section 2: "Electrical characteristics", Table 6: "IGBT switching characteristics (inductive load)"</i><br>Minor text changes.                                                                    |



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