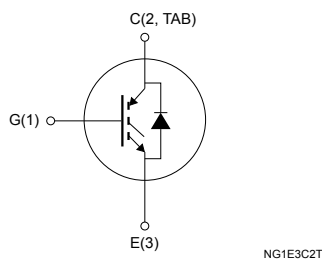
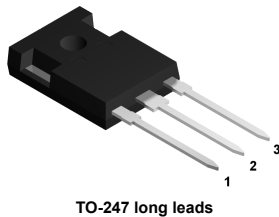


## Trench gate field-stop, 1200 V, 25 A, low-loss, M series IGBT in a TO-247 long leads package



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^{\circ}\text{C}$
- 10  $\mu\text{s}$  of short-circuit withstand time
- Low  $V_{CE(sat)} = 1.85\text{ V (typ.) @ } I_C = 25\text{ A}$
- Tight parameter distribution
- Positive  $V_{CE(sat)}$  temperature coefficient
- Low thermal resistance
- Soft- and fast-recovery antiparallel diode

### Applications

- Industrial drives
- Uninterruptable power supplies (UPS)
- Solar inverters
- Welding

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where the low-loss and the short-circuit functionality is essential.



#### Product status link

STGWA25M120DF3

#### Product summary

|            |                   |
|------------|-------------------|
| Order code | STGWA25M120DF3    |
| Marking    | G25M120DF3        |
| Package    | TO-247 long leads |
| Packing    | Tube              |

## 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol         | Parameter                                             | Value      | Unit |
|----------------|-------------------------------------------------------|------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0\text{ V}$ )   | 1200       | V    |
| $I_C$          | Continuous collector current at $T_C = 25\text{ °C}$  | 50         | A    |
|                | Continuous collector current at $T_C = 100\text{ °C}$ | 25         | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current                              | 100        | A    |
| $V_{GE}$       | Gate-emitter voltage                                  | $\pm 20$   | V    |
|                | Transient gate-emitter voltage                        | $\pm 30$   | V    |
| $I_F$          | Continuous forward current at $T_C = 25\text{ °C}$    | 50         | A    |
|                | Continuous forward current at $T_C = 100\text{ °C}$   | 25         | A    |
| $I_{FP}^{(1)}$ | Pulsed forward current                                | 100        | A    |
| $P_{TOT}$      | Total power dissipation at $T_C = 25\text{ °C}$       | 375        | 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-to-case IGBT  | 0.4   | °C/W |
|                  | Thermal resistance, junction-to-case diode | 0.96  | °C/W |
| $R_{thJA}^{(1)}$ | Thermal resistance, junction-to-ambient    | 50    | °C/W |

1. When mounted on a standard 1 inch<sup>2</sup> area of FR-4 PCB with 2-oz copper.

## 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  | $V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$                                   | 1200 |      |           | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 25\text{ A}$                                  |      | 1.85 | 2.3       | V             |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 25\text{ A}$ ,<br>$T_J = 125\text{ °C}^{(1)}$ |      | 2.1  |           |               |
|               |                                      | $V_{GE} = 15\text{ V}$ , $I_C = 25\text{ A}$ ,<br>$T_J = 175\text{ °C}$       |      | 2.2  |           |               |
| $V_F$         | Forward on-voltage                   | $I_F = 25\text{ A}$                                                           |      | 2.95 | 4.1       | V             |
|               |                                      | $I_F = 25\text{ A}$ , $T_J = 125\text{ °C}$                                   |      | 2.25 |           |               |
|               |                                      | $I_F = 25\text{ A}$ , $T_J = 175\text{ °C}$                                   |      | 1.9  |           |               |
| $V_{GE(th)}$  | Gate threshold voltage               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$                                       | 5    | 6    | 7         | V             |
| $I_{CES}$     | Collector cut-off current            | $V_{GE} = 0\text{ V}$ , $V_{CE} = 1200\text{ V}$                              |      |      | 25        | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current         | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$                            |      |      | $\pm 250$ | nA            |

1. Specified by design, not tested in production.

**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>$V_{GE} = 0\text{ V}$                                                             | -    | 1550 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                                                                                    | -    | 180  | -    |      |
| $C_{res}$ | Reverse transfer capacitance |                                                                                                                                    | -    | 65   | -    |      |
| $Q_g$     | Total gate charge            | $V_{CC} = 960\text{ V}$ , $I_C = 25\text{ A}$ ,<br>$V_{GE} = 0\text{ to }15\text{ V}$<br>(see Figure 29. Gate charge test circuit) | -    | 85   | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                                                                                    | -    | 11.5 | -    |      |
| $Q_{gc}$  | Gate-collector charge        |                                                                                                                                    | -    | 45.5 | -    |      |

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

| Symbol          | Parameter                    | Test conditions                                                                                                                                                                                     | Min. | Typ. | Max. | Unit       |
|-----------------|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$     | Turn-on delay time           | $V_{CE} = 600\text{ V}$ , $I_C = 25\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 15\ \Omega$<br>(see Figure 28. Test circuit for inductive load switching)                                        |      | 28   | -    | ns         |
| $t_r$           | Current rise time            |                                                                                                                                                                                                     |      | 15   | -    | ns         |
| $(di/dt)_{on}$  | Turn-on current slope        |                                                                                                                                                                                                     |      | 1370 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off delay time          |                                                                                                                                                                                                     |      | 150  | -    | ns         |
| $t_f$           | Current fall time            |                                                                                                                                                                                                     |      | 155  | -    | ns         |
| $E_{on}^{(1)}$  | Turn-on switching energy     |                                                                                                                                                                                                     |      | 0.85 | -    | mJ         |
| $E_{off}^{(2)}$ | Turn-off switching energy    |                                                                                                                                                                                                     |      | 1.3  | -    | mJ         |
| $E_{ts}$        | Total switching energy       |                                                                                                                                                                                                     |      | 2.15 | -    | mJ         |
| $t_{d(on)}$     | Turn-on delay time           | $V_{CE} = 600\text{ V}$ , $I_C = 25\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ , $R_G = 15\ \Omega$ ,<br>$T_J = 175\text{ }^\circ\text{C}$<br>(see Figure 28. Test circuit for inductive load switching) |      | 28   | -    | ns         |
| $t_r$           | Current rise time            |                                                                                                                                                                                                     |      | 17   | -    | ns         |
| $(di/dt)_{on}$  | Turn-on current slope        |                                                                                                                                                                                                     |      | 1270 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off delay time          |                                                                                                                                                                                                     |      | 155  | -    | ns         |
| $t_f$           | Current fall time            |                                                                                                                                                                                                     |      | 240  | -    | ns         |
| $E_{on}^{(1)}$  | Turn-on switching energy     |                                                                                                                                                                                                     |      | 1.6  | -    | mJ         |
| $E_{off}^{(2)}$ | Turn-off switching energy    |                                                                                                                                                                                                     |      | 1.9  | -    | mJ         |
| $E_{ts}$        | Total switching energy       |                                                                                                                                                                                                     |      | 3.5  | -    | mJ         |
| $t_{sc}$        | Short-circuit withstand time | $V_{CC} \leq 600\text{ V}$ , $V_{GE} = 15\text{ V}$ ,<br>$T_{Jstart} \leq 150\text{ }^\circ\text{C}$                                                                                                | 10   |      | -    | $\mu$ s    |

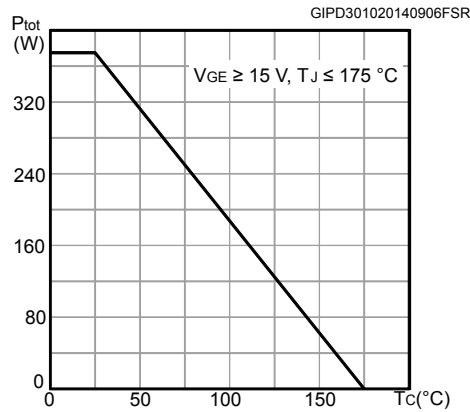
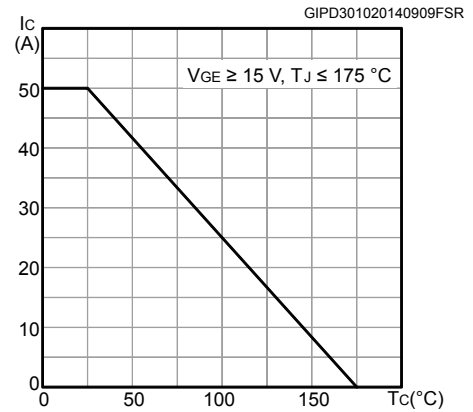
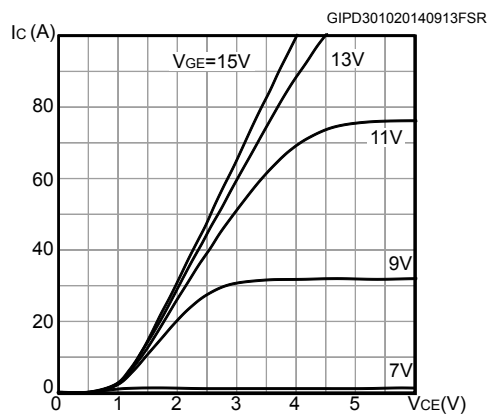
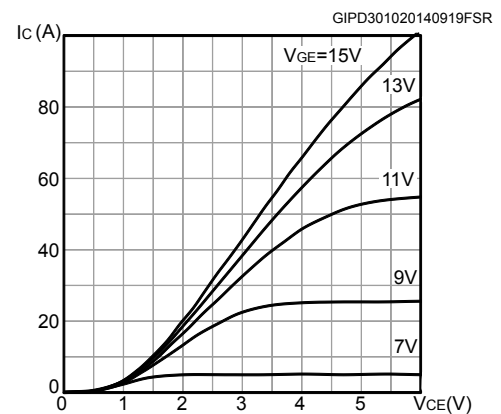
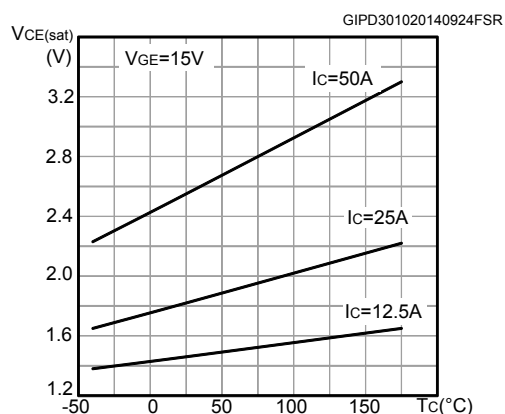
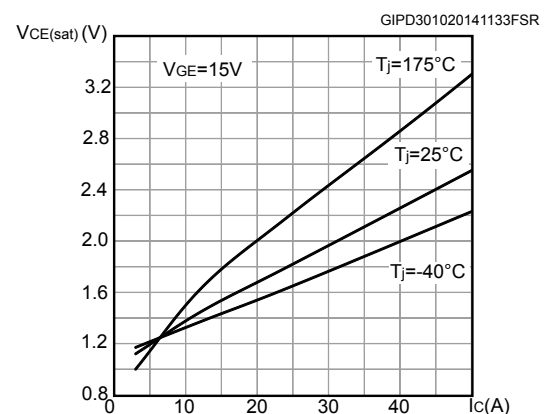
1. Including the reverse recovery of the diode

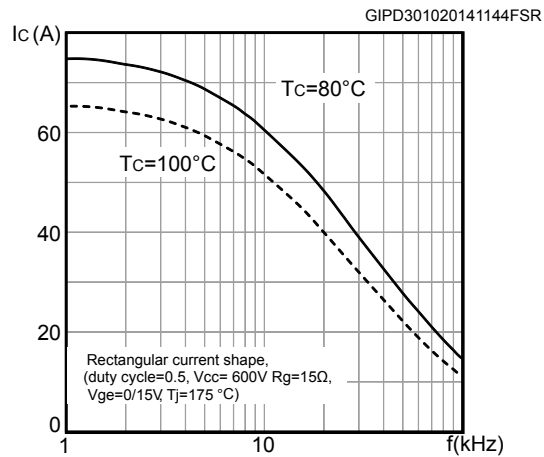
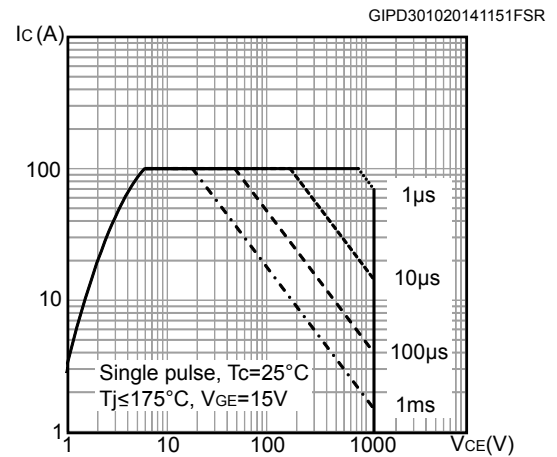
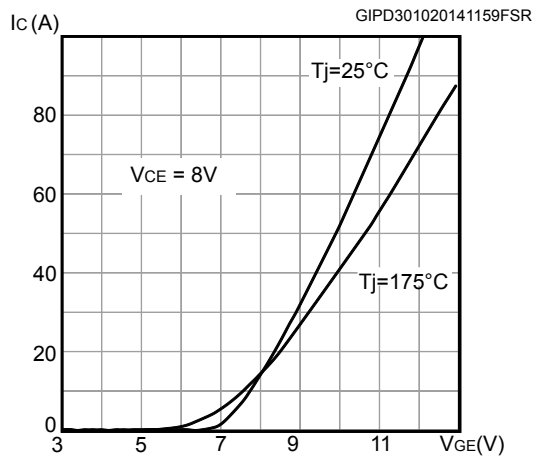
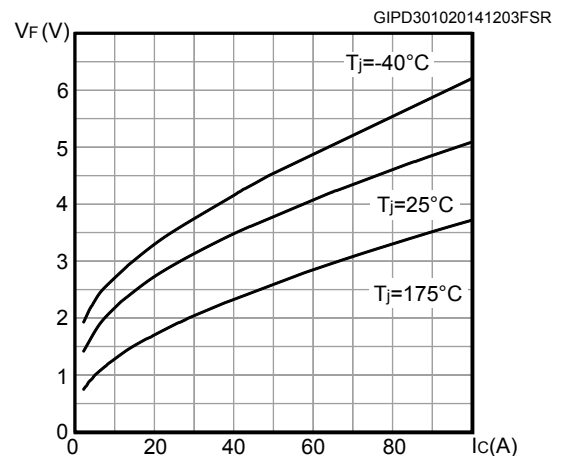
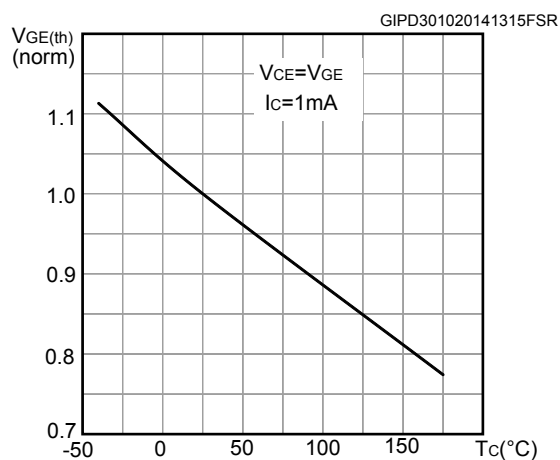
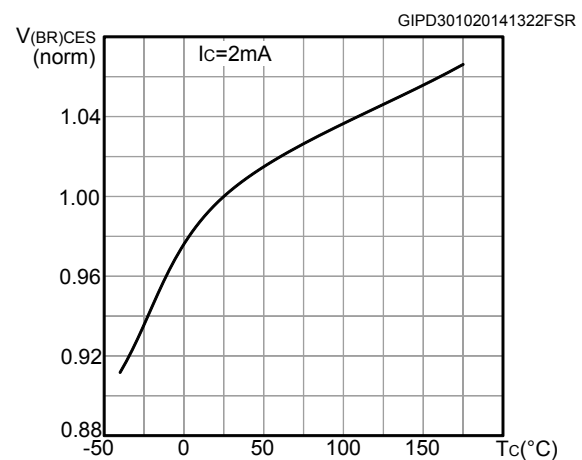
2. Including the tail of the collector current

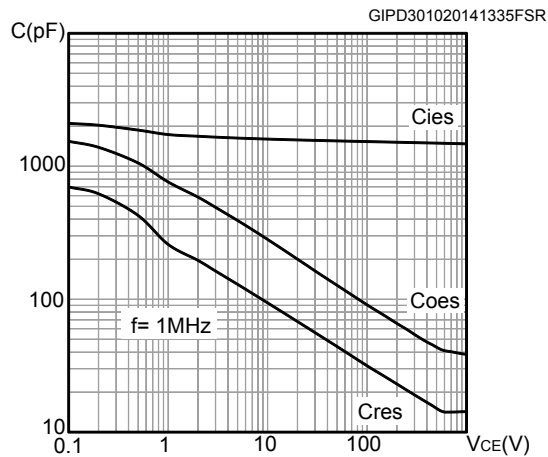
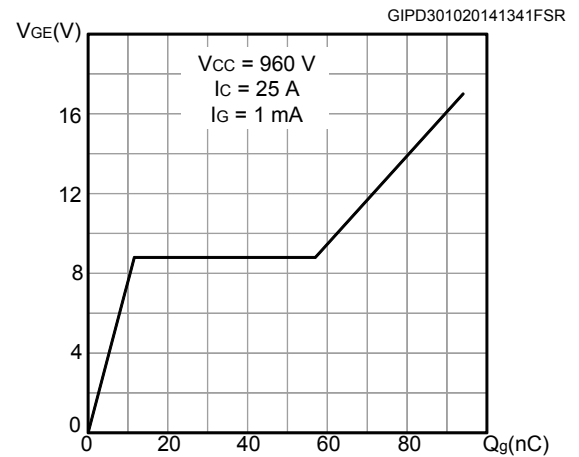
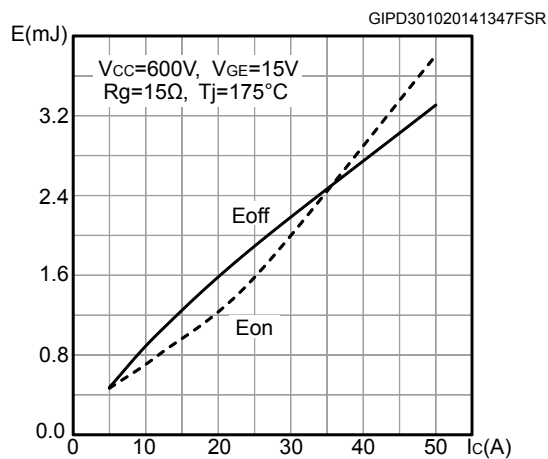
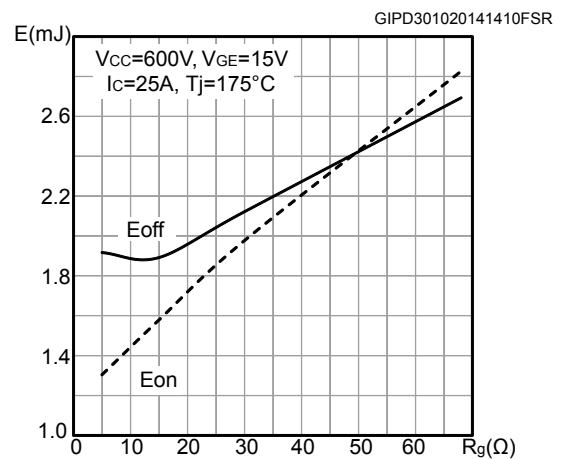
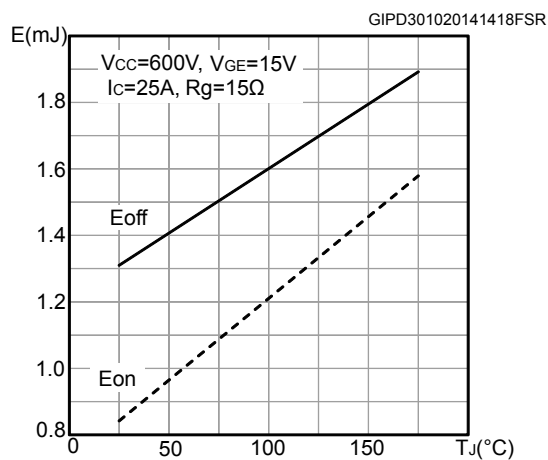
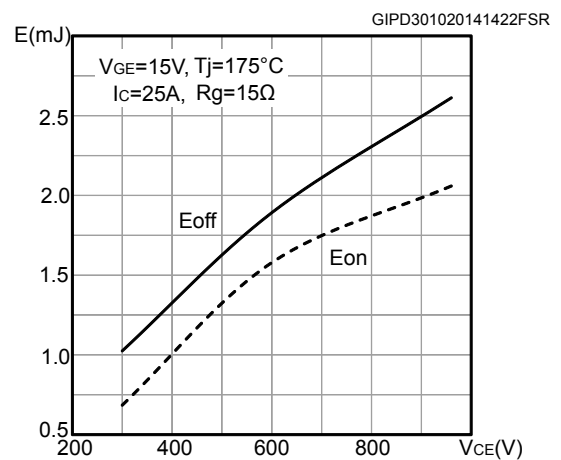
**Table 6. Diode switching characteristics (inductive load)**

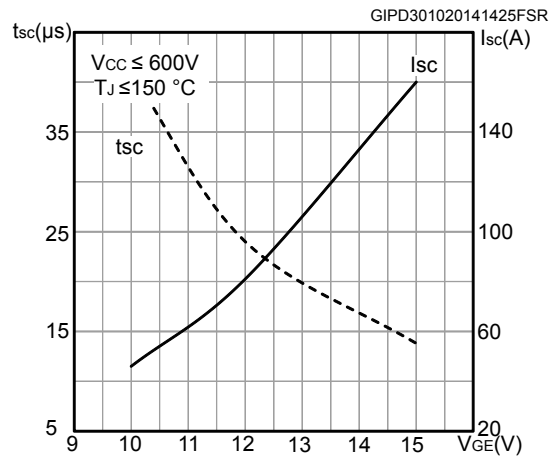
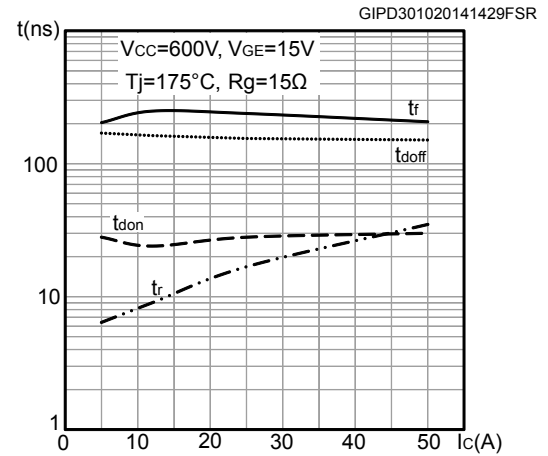
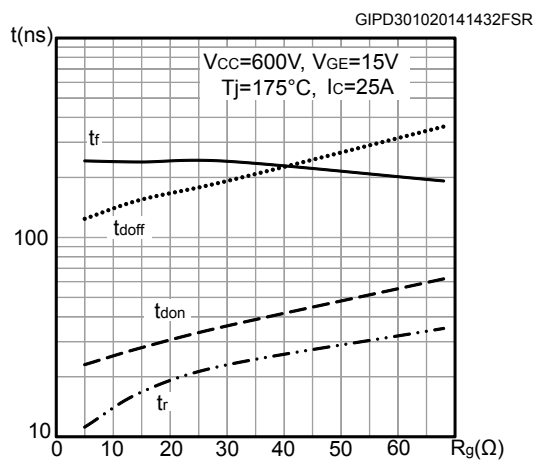
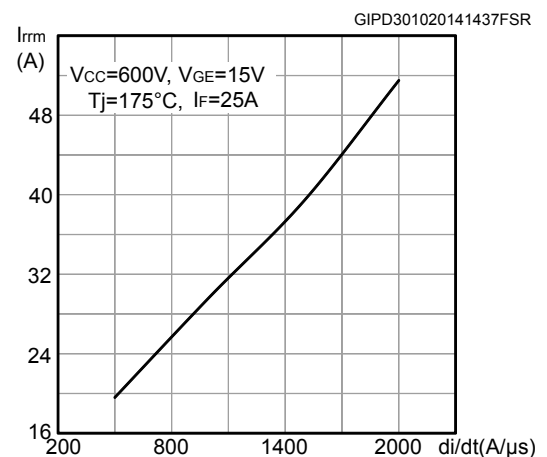
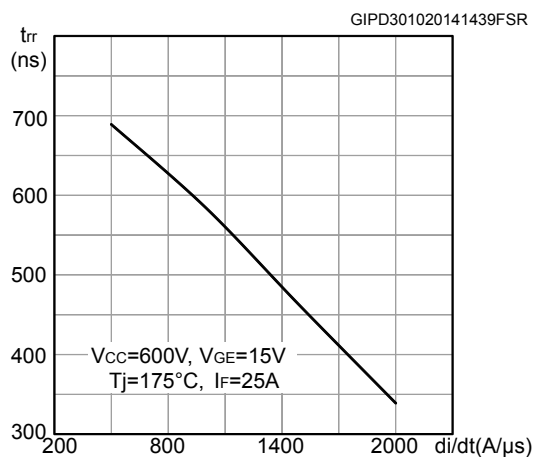
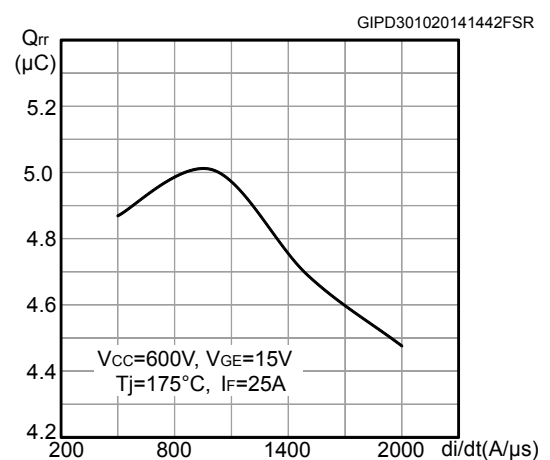
| Symbol       | Parameter                                                  | Test conditions                                                                                                                                                                                                   | Min. | Typ. | Max. | Unit          |
|--------------|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 25\text{ A}$ , $V_R = 600\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$<br>(see Figure 28. Test circuit for inductive load switching)                                        | -    | 265  | -    | ns            |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                                   | -    | 1.2  | -    | $\mu\text{C}$ |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                                   | -    | 19   | -    | A             |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                                   | -    | 1090 | -    | A/ $\mu$ s    |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                                   | -    | 0.22 | -    | mJ            |
| $t_{rr}$     | Reverse recovery time                                      | $I_F = 25\text{ A}$ , $V_R = 600\text{ V}$ ,<br>$V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ ,<br>$di/dt = 1000\text{ A}/\mu\text{s}$<br>(see Figure 28. Test circuit for inductive load switching) | -    | 585  | -    | ns            |
| $Q_{rr}$     | Reverse recovery charge                                    |                                                                                                                                                                                                                   | -    | 5    | -    | $\mu\text{C}$ |
| $I_{rrm}$    | Reverse recovery current                                   |                                                                                                                                                                                                                   | -    | 30   | -    | A             |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ |                                                                                                                                                                                                                   | -    | 270  | -    | A/ $\mu$ s    |
| $E_{rr}$     | Reverse recovery energy                                    |                                                                                                                                                                                                                   | -    | 0.75 | -    | mJ            |

## 2.1 Electrical characteristics (curves)

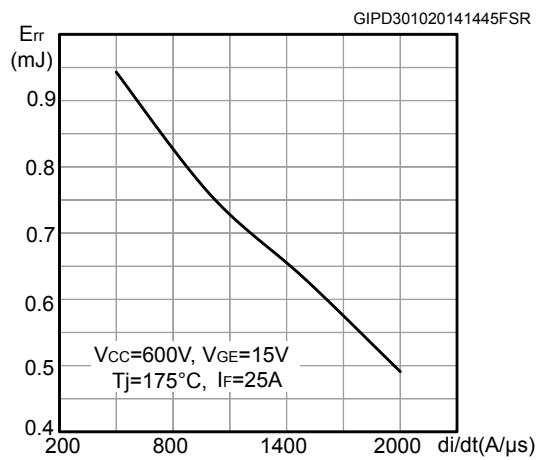
**Figure 1. Power dissipation vs case temperature**

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

**Figure 3. Output characteristics ( $T_J = 25 \text{ }^\circ\text{C}$ )**

**Figure 4. Output characteristics ( $T_J = 175 \text{ }^\circ\text{C}$ )**

**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. 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**


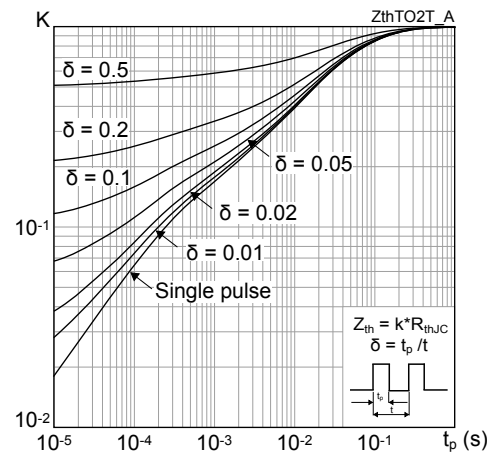
**Figure 13. Capacitance variations**

**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 junction temperature**

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


**Figure 19. Short-circuit time and current vs  $V_{GE}$** 

**Figure 20. Switching times vs collector current**

**Figure 21. Switching times vs gate resistance**

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

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

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


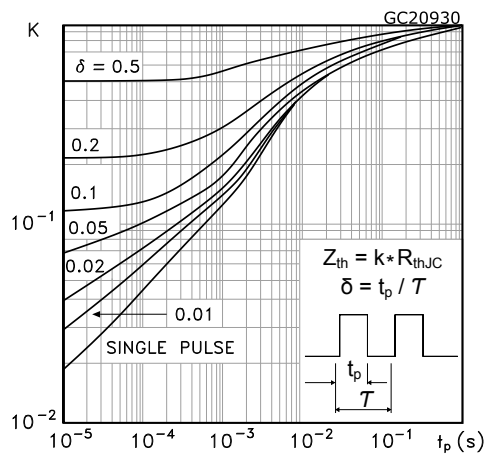
**Figure 25. Reverse recovery energy vs diode current slope**



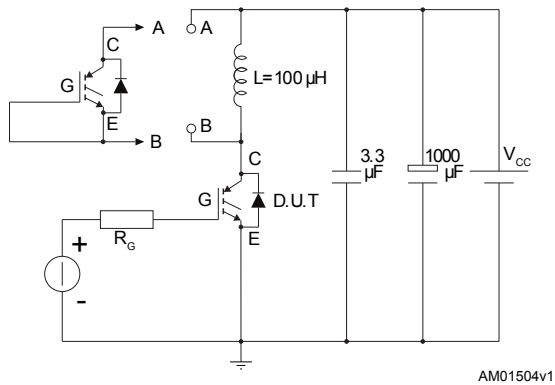
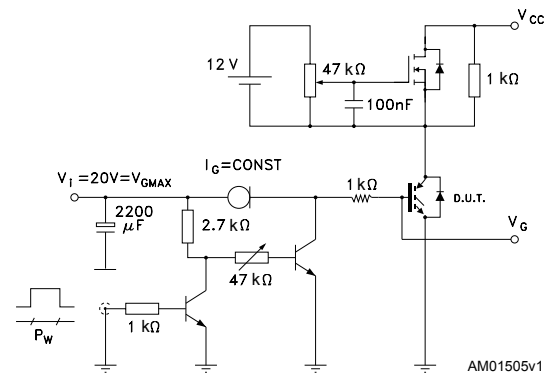
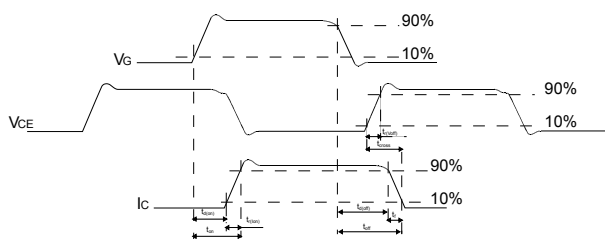
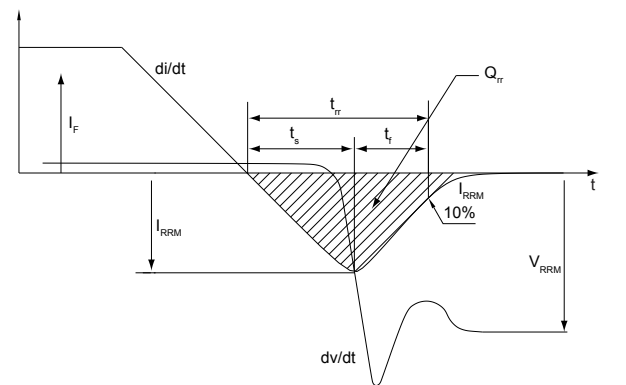
**Figure 26. Thermal impedance for IGBT**



**Figure 27. Thermal impedance for diode**



### 3 Test circuits

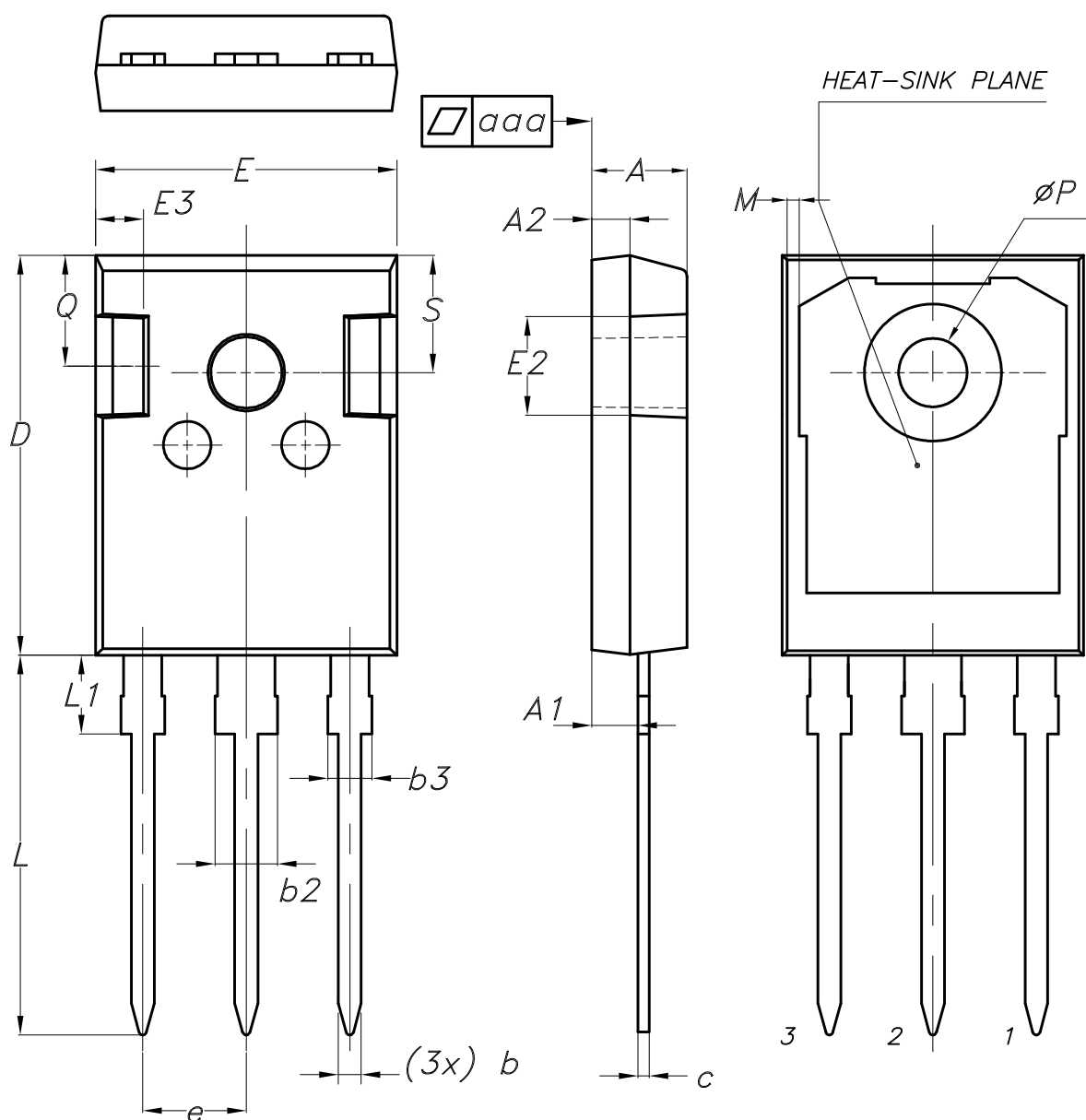
**Figure 28. Test circuit for inductive load switching**

**Figure 29. Gate charge test circuit**

**Figure 30. Switching waveform**

**Figure 31. 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 32. TO-247 long leads package outline



BACK VIEW

8463846\_6

**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                                                                                             |
|-------------|---------|-----------------------------------------------------------------------------------------------------|
| 20-Jun-2018 | 1       | Initial release. This part number was previously included in datasheet DS10300.                     |
| 10-Oct-2024 | 2       | Updated <i>Section 4.1: TO-247 long leads package information</i> .<br>Minor text changes.          |
| 01-Aug-2025 | 3       | Updated <a href="#">Section 4.1: TO-247 long leads package information</a> .<br>Minor text changes. |



## Contents

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| <b>2</b> | <b>Electrical characteristics.....</b>      | <b>3</b>  |
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| 4.1      | TO-247 long leads package information. .... | 11        |
|          | <b>Revision history .....</b>               | <b>13</b> |

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