

Trench gate field-stop IGBT, HB series 650 V, 40 A high speed

Datasheet - production data

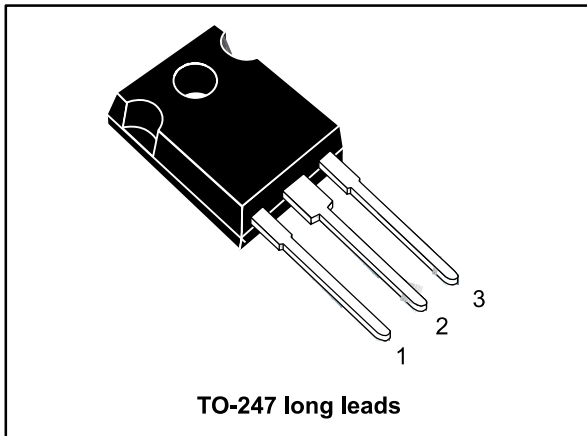
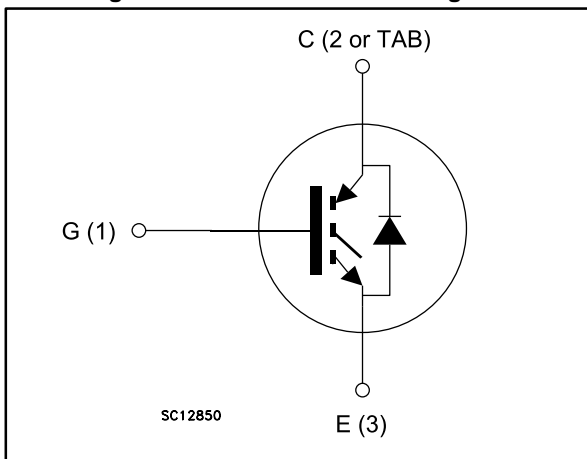


Figure 1: Internal schematic diagram



Features

- Maximum junction temperature: $T_J = 175\text{ }^\circ\text{C}$
- High speed switching series
- Minimized tail current
- Low saturation voltage: $V_{CE(sat)} = 1.6\text{ V (typ.)}$ @ $I_C = 40\text{ A}$
- Tight parameter distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode

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. Furthermore, the 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 | Packing |
|---------------|-----------|-------------------|---------|
| STGWA40H65DFB | G40H65DFB | TO-247 long leads | Tube |

Contents

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1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|-------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$) | 650 | V |
| I_C | Continuous collector current at $T_C = 25\text{ °C}$ | 80 | A |
| | Continuous collector current at $T_C = 100\text{ °C}$ | 40 | |
| $I_{CP}^{(1)}$ | Pulsed collector current | 160 | A |
| V_{GE} | Gate-emitter voltage | ± 20 | V |
| I_F | Continuous forward current at $T_C = 25\text{ °C}$ | 80 | A |
| | Continuous forward current at $T_C = 100\text{ °C}$ | 40 | |
| $I_{FP}^{(1)}$ | Pulsed forward current | 160 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 283 | W |
| T_{STG} | Storage temperature range | - 55 to 150 | °C |
| T_J | Operating junction temperature range | - 55 to 175 | |

Notes:

⁽¹⁾Pulse width limited by maximum junction temperature.

Table 3: Thermal data

| Symbol | Parameter | Value | Unit |
|------------|--|-------|------|
| R_{thJC} | Thermal resistance junction-case IGBT | 0.53 | °C/W |
| R_{thJC} | 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 4: Static characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--------------------------------------|---|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage | $V_{GE} = 0\text{ V}$, $I_C = 2\text{ mA}$ | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$ | | 1.6 | 2 | V |
| | | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$, $T_J = 125\text{ °C}$ | | 1.7 | | |
| | | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$, $T_J = 175\text{ °C}$ | | 1.8 | | |
| V_F | Forward on-voltage | $I_F = 40\text{ A}$ | | 1.7 | 2.45 | V |
| | | $I_F = 40\text{ A}$, $T_J = 125\text{ °C}$ | | 1.4 | | |
| | | $I_F = 40\text{ A}$, $T_J = 175\text{ °C}$ | | 1.3 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$ | 5 | 6 | 7 | V |
| I_{CES} | Collector cut-off current | $V_{GE} = 0\text{ V}$, $V_{CE} = 650\text{ V}$ | | | 25 | μA |
| I_{GES} | Gate-emitter leakage current | $V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$ | | | ± 250 | nA |

Table 5: Dynamic characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$ | - | 5412 | - | pF |
| C_{oes} | Output capacitance | | - | 198 | - | |
| C_{res} | Reverse transfer capacitance | | - | 107 | - | |
| Q_g | Total gate charge | $V_{CC} = 520\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$ (see Figure 29: "Gate charge test circuit") | - | 210 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 39 | - | |
| Q_{gc} | Gate-collector charge | | - | 82 | - | |

Table 6: IGBT switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|---|------|------|------|------------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 5\text{ }\Omega$ (see Figure 28: "Test circuit for inductive load switching") | | 40 | - | ns |
| t_r | Current rise time | | | 13 | - | |
| $(di/dt)_{on}$ | Turn-on current slope | | | 2413 | - | A/ μs |
| $t_{d(off)}$ | Turn-off-delay time | | | 142 | - | ns |
| t_f | Current fall time | | | 27 | - | |

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit | |
|-----------------|---------------------------|---|------|------|------|---------------|------------------------|
| $E_{on}^{(1)}$ | Turn-on switching energy | $V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 5\ \Omega$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 28: "Test circuit for inductive load switching") | | 498 | - | μJ | |
| $E_{off}^{(2)}$ | Turn-off switching energy | | | 363 | - | | |
| E_{ts} | Total switching energy | | | 861 | - | | |
| $t_{d(on)}$ | Turn-on delay time | | | | 38 | - | ns |
| t_r | Current rise time | | | | 14 | - | |
| $(di/dt)_{on}$ | Turn-on current slope | | | | 2186 | - | $\text{A}/\mu\text{s}$ |
| $t_{d(off)}$ | Turn-off-delay time | | | | 141 | - | ns |
| t_f | Current fall time | | | | 61 | - | |
| $E_{on}^{(1)}$ | Turn-on switching energy | | | | 1417 | - | μJ |
| $E_{off}^{(2)}$ | Turn-off switching energy | | | | 764 | - | |
| E_{ts} | Total switching energy | | | | 2181 | - | |

Notes:

(1)Including the reverse recovery of the diode.

(2)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 | $I_F = 40\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 28: "Test circuit for inductive load switching") | - | 62 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 99 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 3.3 | - | A |
| dl_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 187 | - | $\text{A}/\mu\text{s}$ |
| E_{rr} | Reverse recovery energy | | - | 68 | - | μJ |
| t_{rr} | Reverse recovery time | $I_F = 40\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$ | - | 310 | - | ns |

Electrical characteristics

STGWA40H65DFB

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--|--|------|------|------|------------|
| Q_{rr} | Reverse recovery charge | (see <i>Figure 28: "Test circuit for inductive load switching"</i>) | - | 1550 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 10 | - | A |
| di_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 70 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 674 | - | μ J |

2.1 Electrical characteristics (curves)

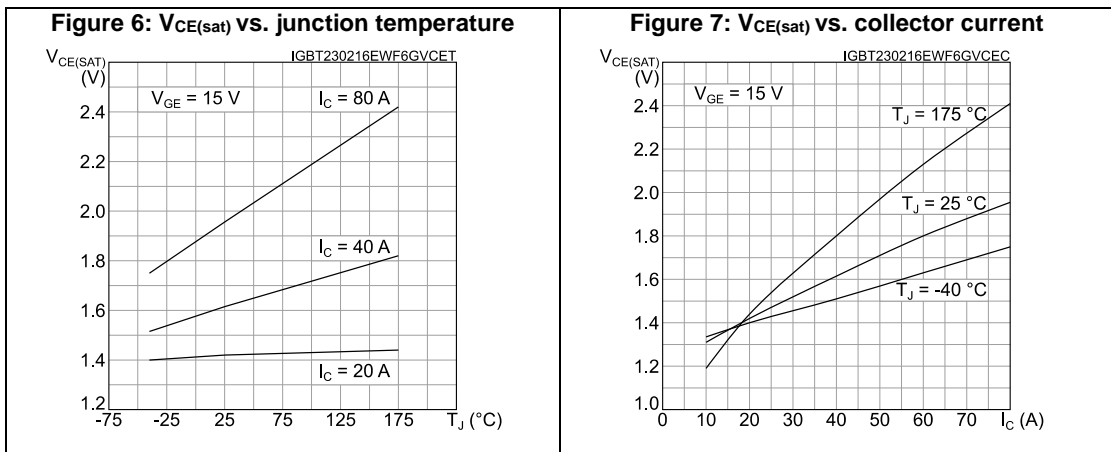
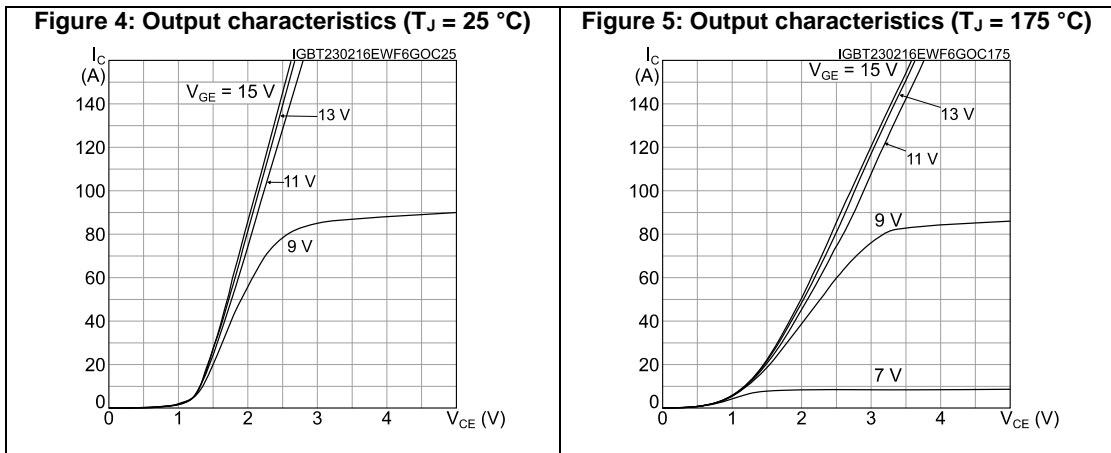
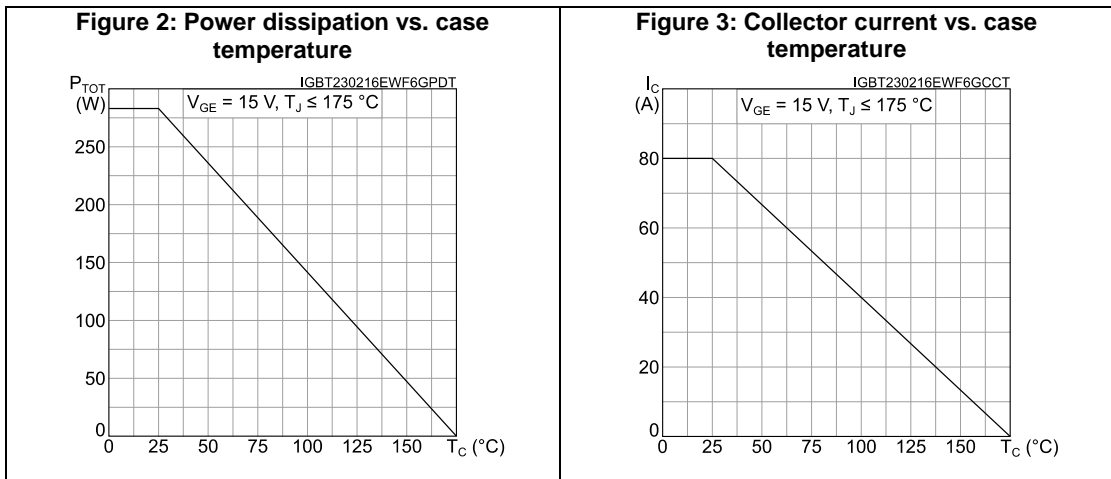


Figure 8: Collector current vs. switching frequency

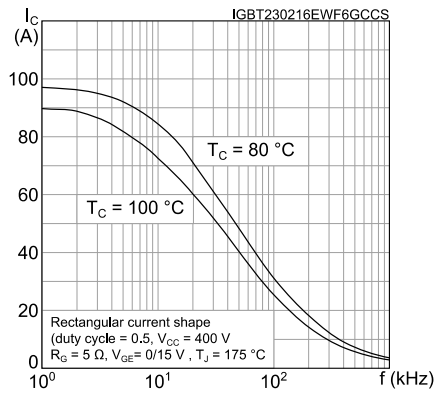


Figure 9: Forward bias safe operating area

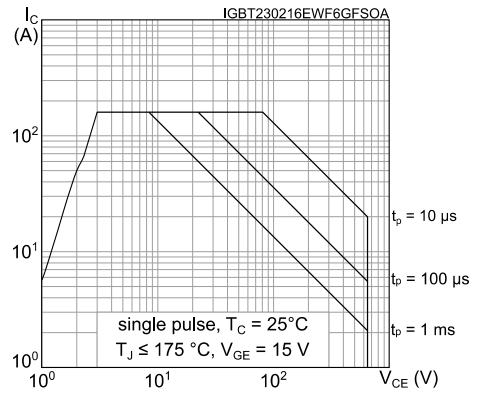


Figure 10: Transfer characteristics

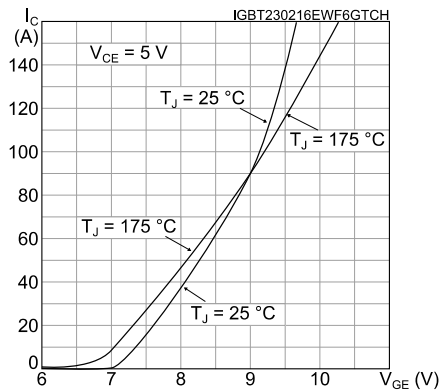


Figure 11: Diode V_F vs. forward current

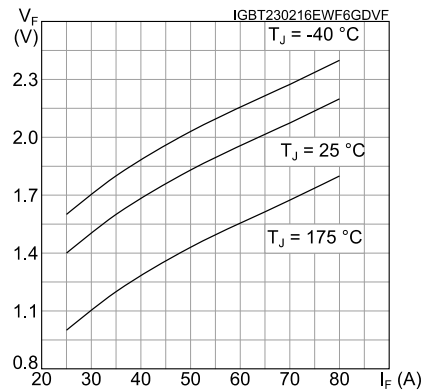


Figure 12: Normalized V_GE(th) vs. junction temperature

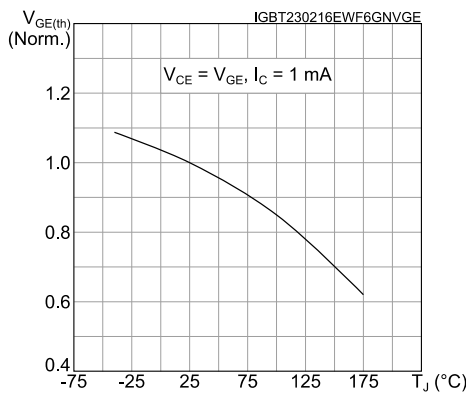
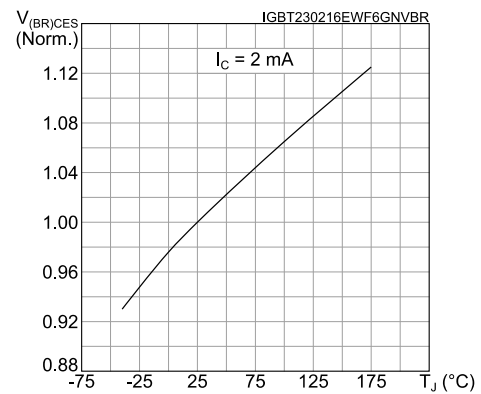


Figure 13: Normalized V_(BR)CES vs. junction temperature



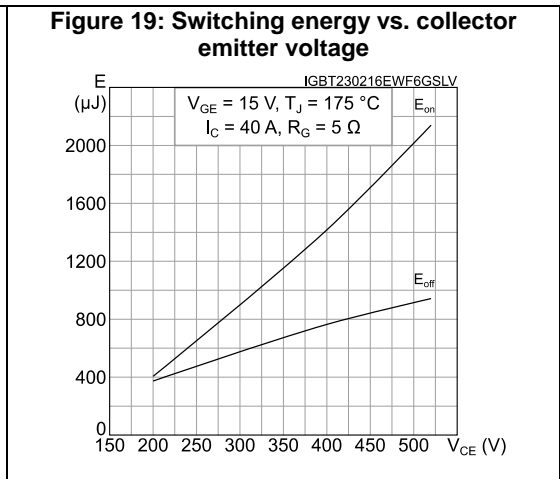
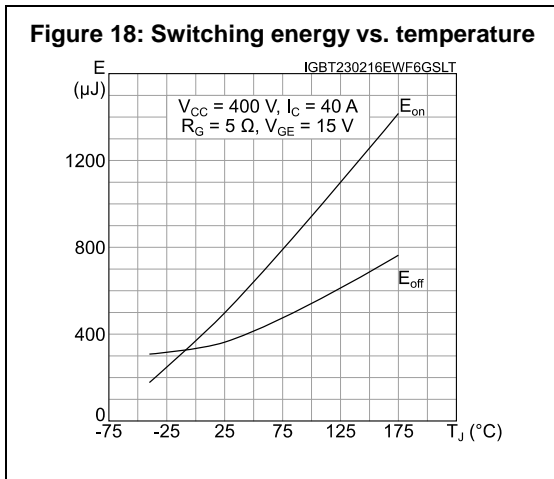
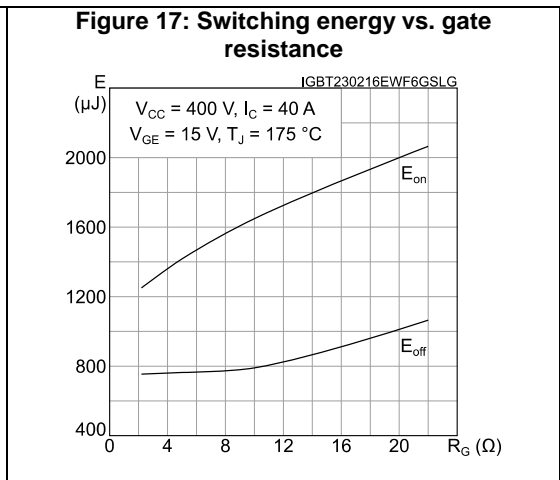
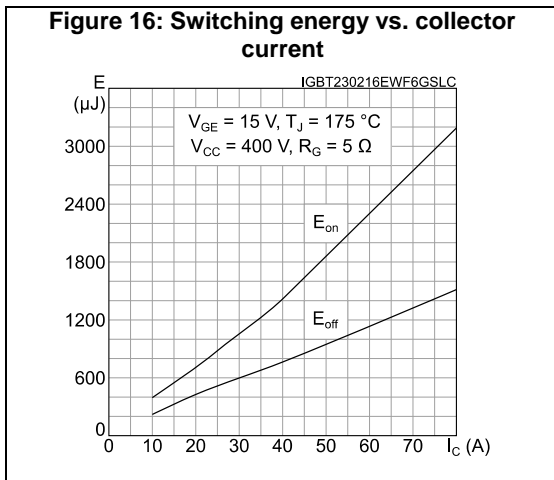
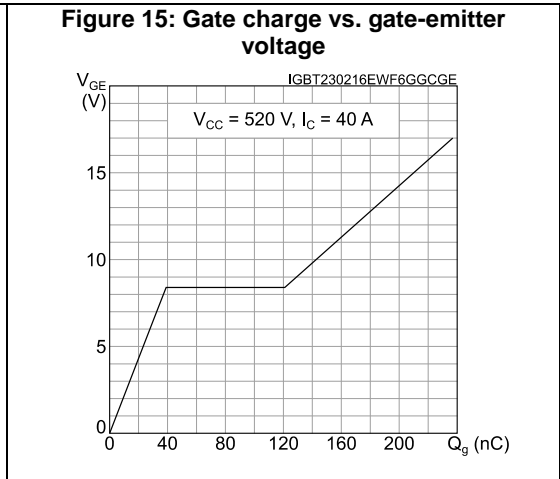
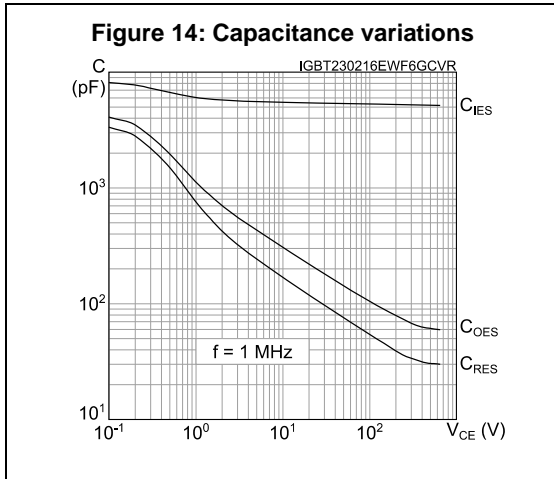


Figure 20: Switching times vs. collector current

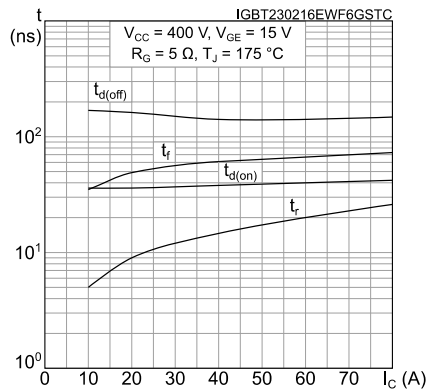


Figure 21: Switching times vs. gate resistance

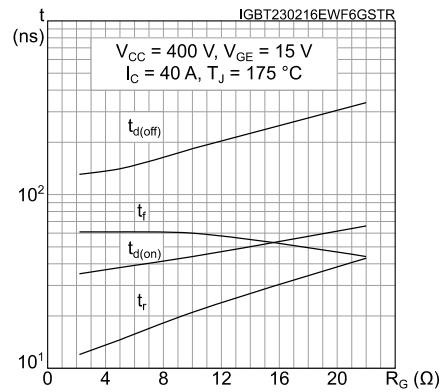


Figure 22: Reverse recovery current vs. diode current slope

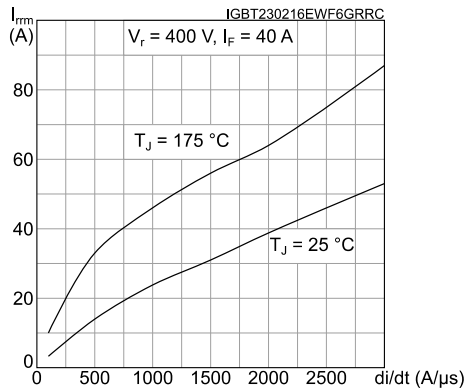


Figure 23: Reverse recovery time vs. diode current slope

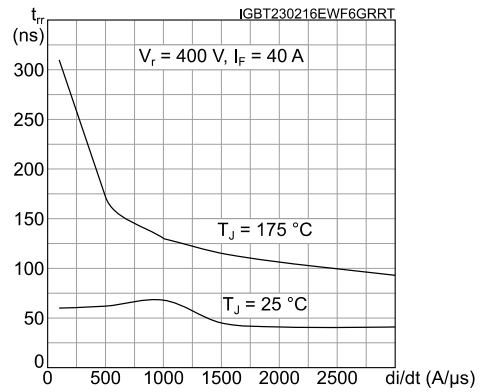


Figure 24: Reverse recovery charge vs. diode current slope

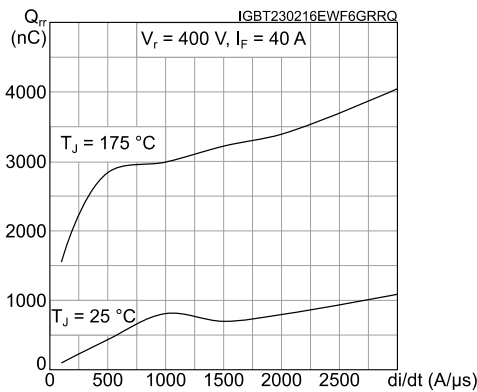


Figure 25: Reverse recovery energy vs. diode current slope

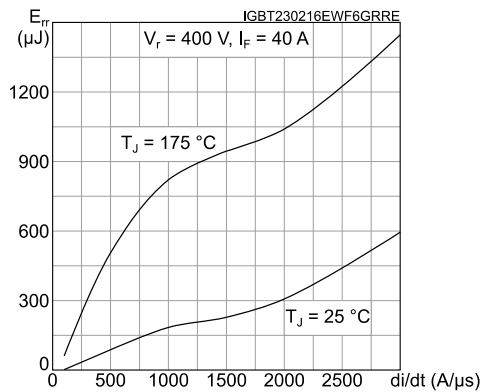
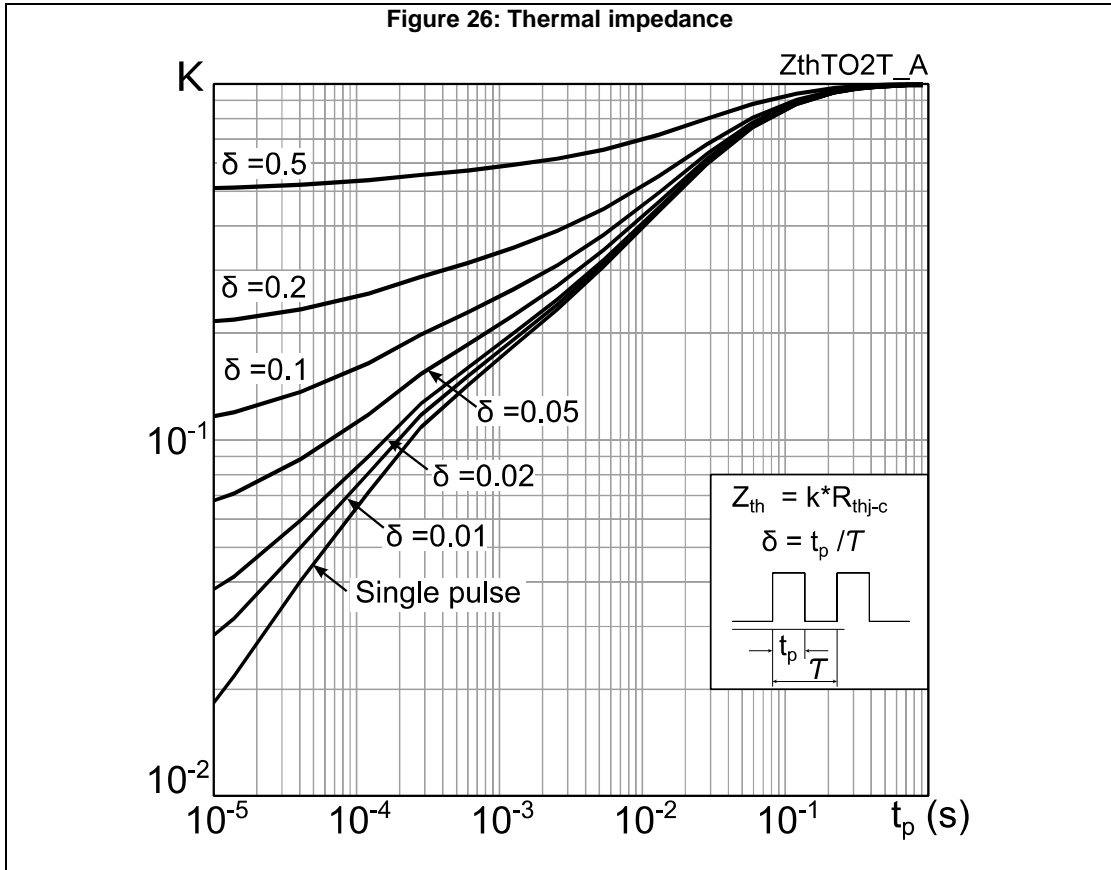
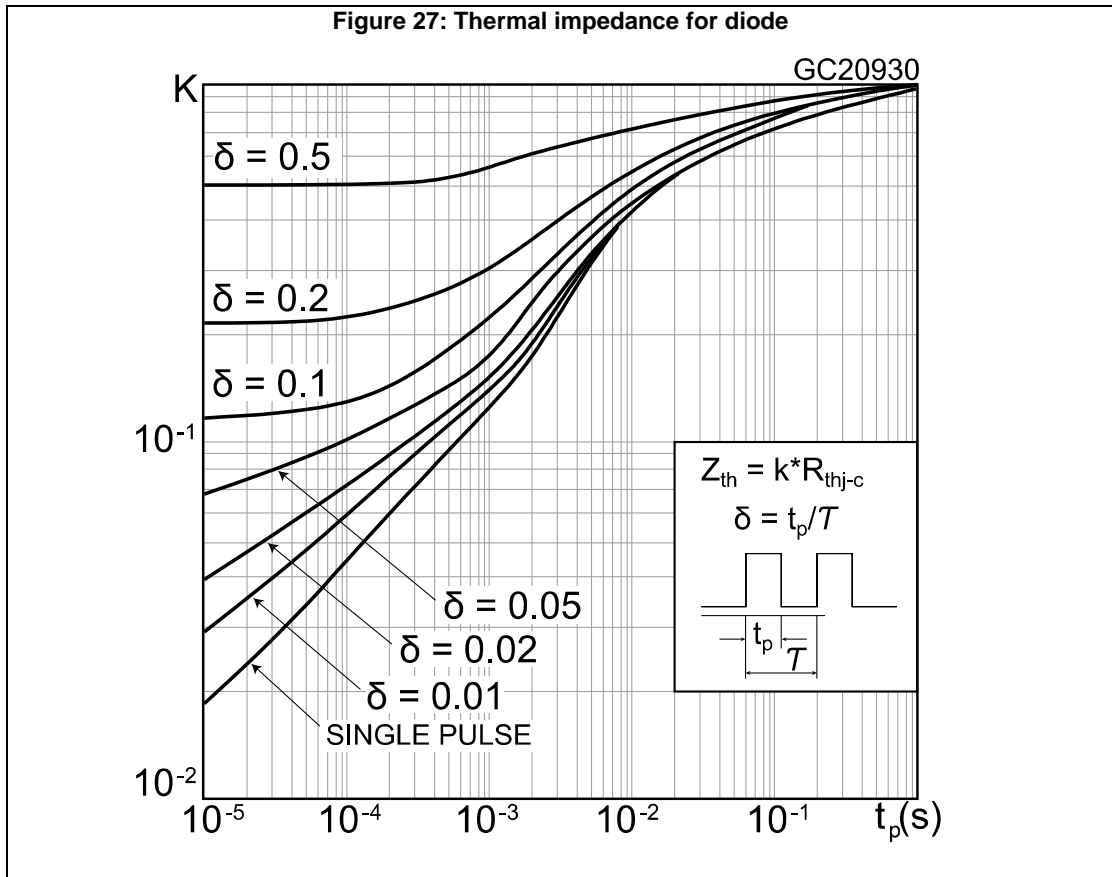


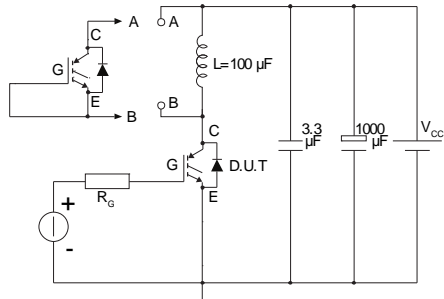
Figure 26: Thermal impedance





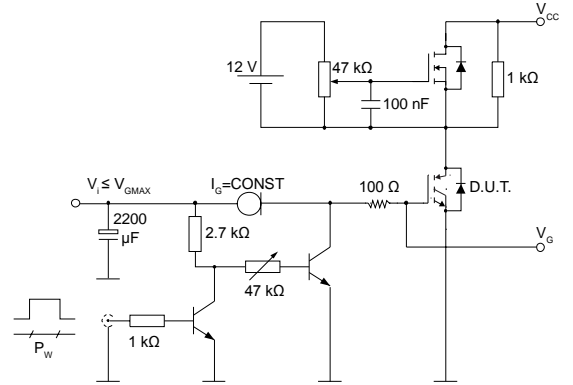
3 Test circuits

Figure 28: Test circuit for inductive load switching



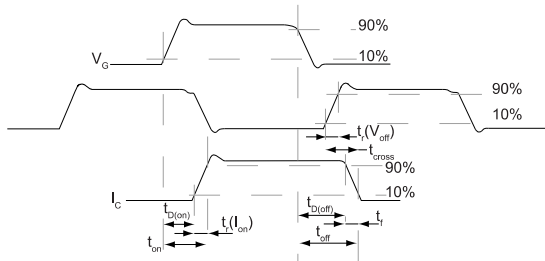
AM01504v1

Figure 29: Gate charge test circuit



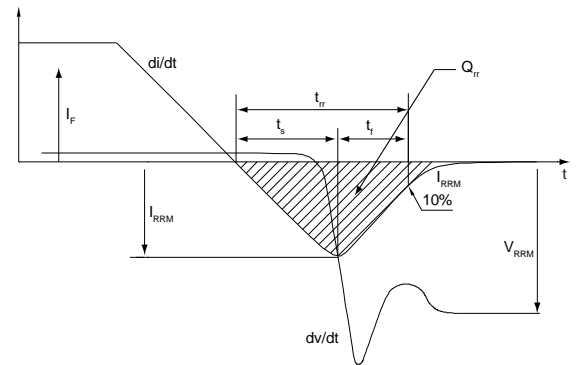
AM01505v1

Figure 30: Switching waveform



AM01506v1

Figure 31: Diode reverse recovery waveform



AM01507v1

4 Package mechanical data

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. ECOPACK® is an ST trademark.

4.1 TO-247 long lead package information

Figure 32: TO-247 long lead package outline

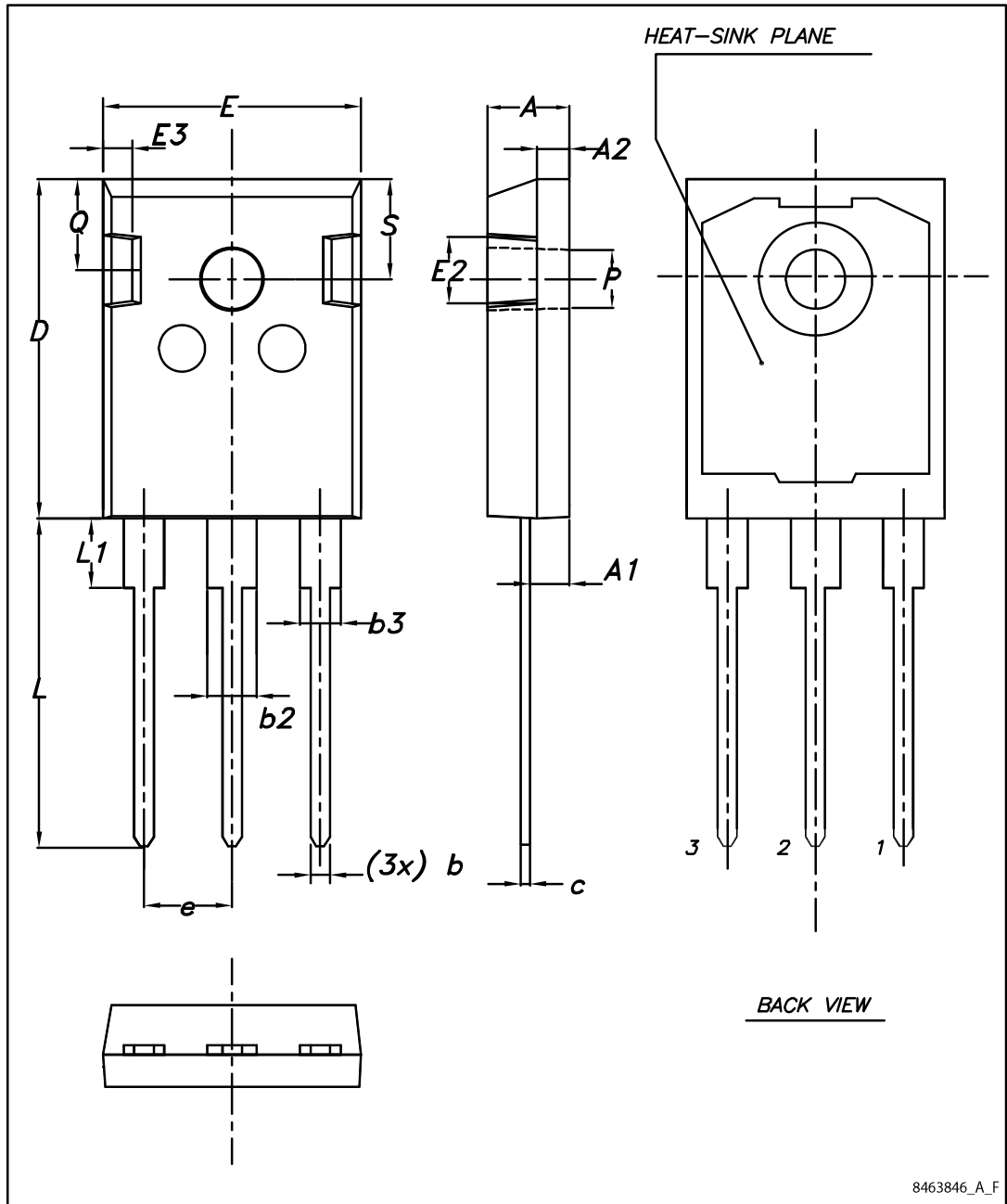


Table 8: TO-247 long lead package mechanical data

| 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 9: Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 06-Jun-2016 | 1 | Initial version. Part number previously included in datasheet DocID024363. |

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Тел: +7 (812) 336 43 04 (многоканальный)
Email: org@lifeelectronics.ru