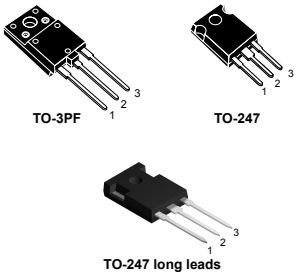
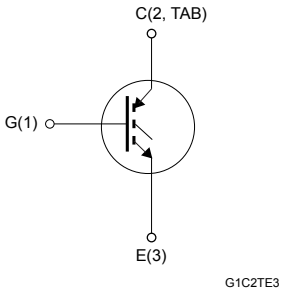
# STGFW40H65FB, STGW40H65FB, STGWA40H65FB

Datasheet

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




### Features

- Maximum junction temperature: $T_J$ = 175 °C
- High speed switching series
- Minimized tail current
- Very low saturation voltage: $V_{CE(sat)}$ = 1.6 V (typ) @ $I_C$ = 40 A
- Safe paralleling
- Tight parameter distribution
- Low thermal resistance

### Applications

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

### Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the new HB series of IGBTs, which represent 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.

| Product status link |
|---|
| STGFW40H65FB |
| STGW40H65FB |
| STGWA40H65FB |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-247, TO-247 long leads | TO-3PF | |
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0 V) | 650 | | V |
| $I_C$ | Continuous collector current at $T_C$ = 25 °C | 80 | | A |
| | Continuous collector current at $T_C$ = 100 °C | 40 | | |
| $I_{CP}$ (1) | Pulsed collector current | 160 | | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | | V |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °C | 283 | 98.6 | W |
| $V_{ISO}$ | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_C$ = 25 °C) | | 3.5 | kV |
| $T_{STG}$ | 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 |
|---|---|---|---|---|
| | | TO-247, TO-247 long leads | TO-3PF | |
| $R_{thJC}$ | Thermal resistance, junction-to-case | 0.53 | 1.52 | °C/W |
| $R_{thJA}$ | Thermal resistance, junction-to-ambient | 50 | | °C/W |

# 2 Electrical characteristics

$T_C$ = 25 °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 V, $I_C$ = 2 mA | 650 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 40 A | | 1.6 | 2 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 125 °C | | 1.7 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 175 °C | | 1.8 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA | 5 | 6 | 7 | V |
| $I_{CES}$ | Collector cut-off current | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V | | | 25 | µA |
| $I_{GES}$ | Gate-emitter leakage current | $V_{CE}$ = 0 V, $V_{GE}$ = ±20 V | | | ±250 | nA |

**Table 4. Dynamic characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{ies}$ | Input capacitance | $V_{CE}$ = 25 V, f = 1 MHz, $V_{GE}$ = 0 V | - | 5412 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 198 | - | |
| $C_{res}$ | Reverse transfer capacitance | | - | 107 | - | |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 40 A, $V_{GE}$ = 0 to 15 V (see Figure 27. Gate charge test circuit) | - | 210 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 39 | - | |
| $Q_{gc}$ | Gate-collector charge | | - | 82 | - | |

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

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 40 A, $V_{GE}$ = 15 V, $R_G$ = 5 Ω (see Figure 26. 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 | - | |
| $E_{on}$ (1) | Turn-on switching energy | | - | 498 | - | µJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 363 | - | |
| $E_{ts}$ | Total switching energy | | - | 861 | - | |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 40 A, $V_{GE}$ = 15 V, $R_G$ = 5 Ω, $T_J$ = 175 °C (see Figure 26. Test circuit for inductive load switching) | - | 38 | - | ns |
| $t_r$ | Current rise time | | - | 14 | - | |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 2186 | - | A/µs |
| $t_{d(off)}$ | 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 | - | |

1. *Including the reverse recovery of the external diode. The diode is the same of the co-packed STGW40H65DFB.*
2. *Including the tail of the collector current.*

## 2.1 Electrical characteristics (curves)

**Figure 1. Power dissipation vs. case temperature for TO-247 and TO-247 long leads**

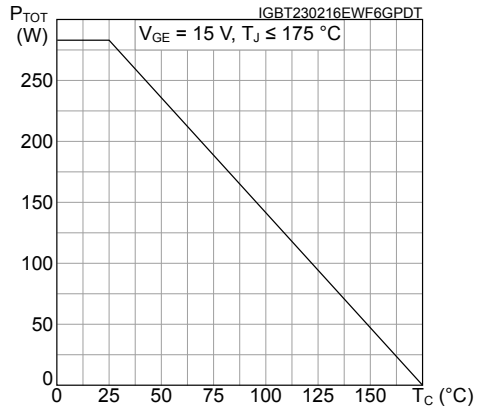



**Figure 2. Collector current vs. case temperature for TO-247 and TO-247 long leads**

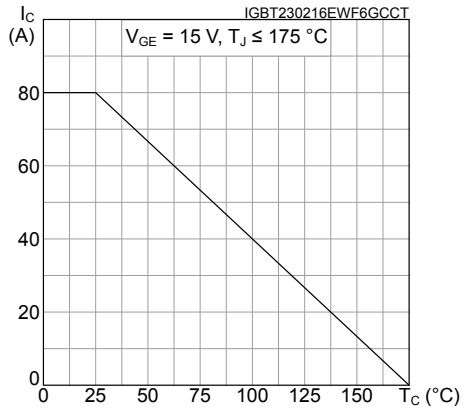



**Figure 3. Power dissipation vs. case temperature for TO-3PF**

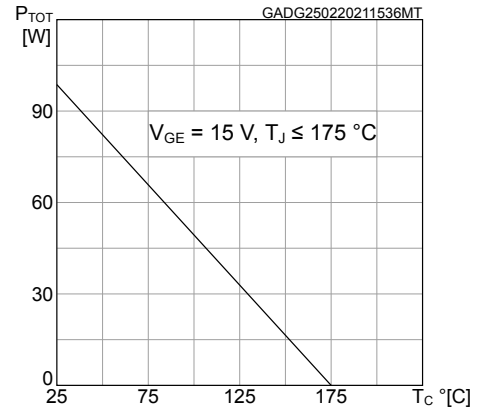



**Figure 4. Collector current vs. case temperature for TO-3PF**

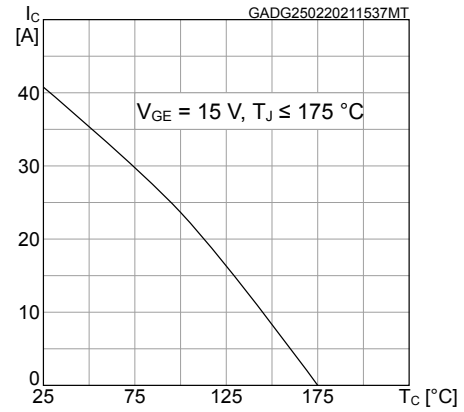



**Figure 5. Output characteristics ($T_J$ = 25 °C)**

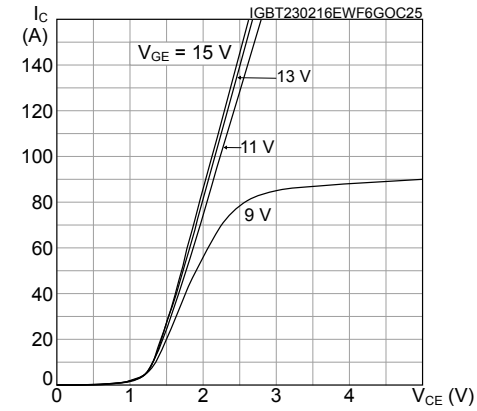



**Figure 6. Output characteristics ($T_J$ = 175 °C)**

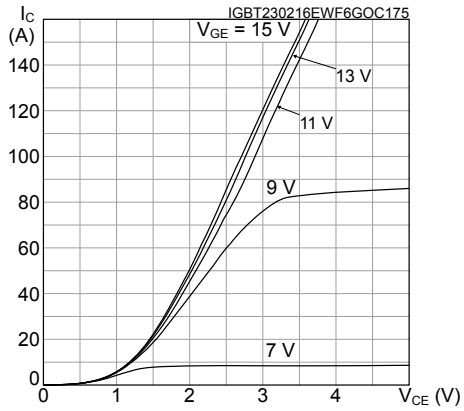


**Figure 7. $V_{CE(sat)}$ vs. junction temperature**

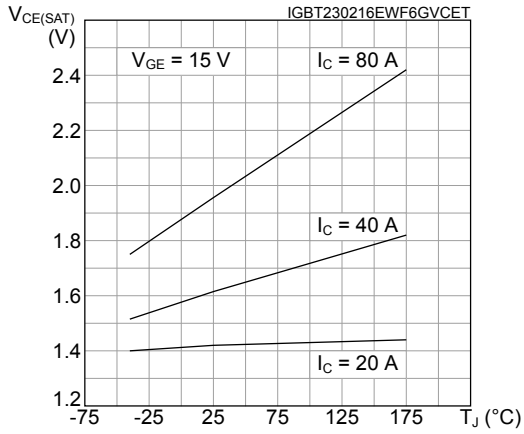



**Figure 8. $V_{CE(sat)}$ vs. collector current**

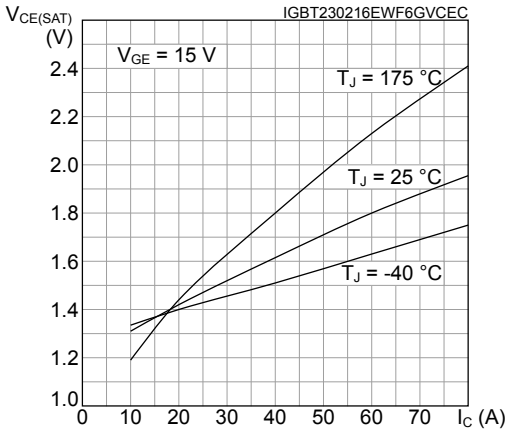



**Figure 9. Collector current vs. switching frequency for TO-247 and TO-247 long leads**

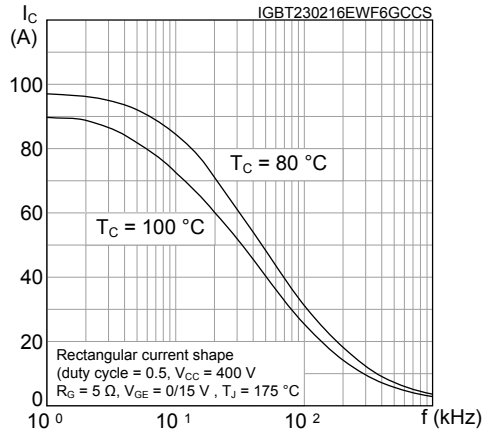



**Figure 10. Collector current vs. switching frequency for TO-3PF**

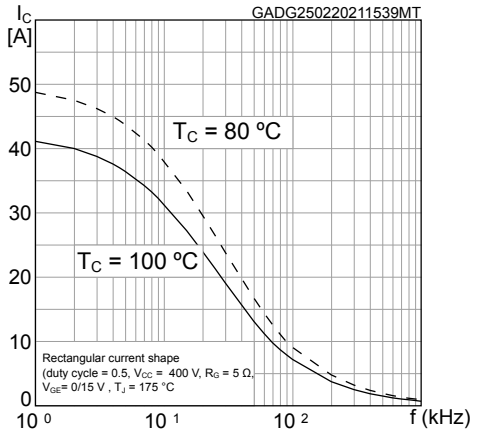



**Figure 11. Forward bias safe operating area for TO-247 and TO-247 long leads**

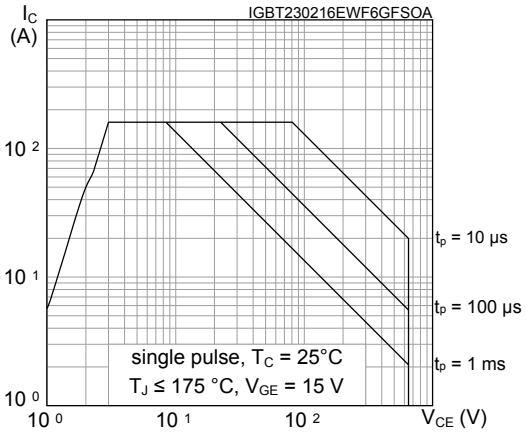



**Figure 12. Forward bias safe operating area for TO-3PF**

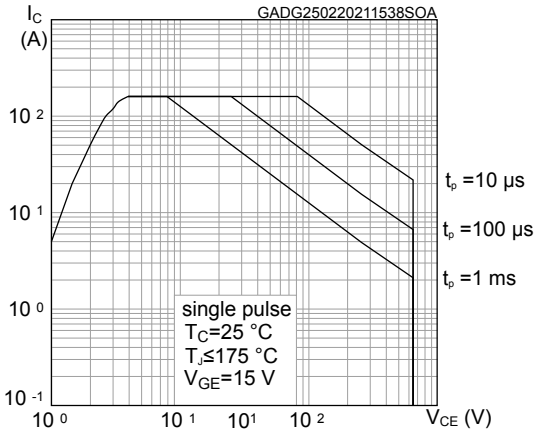


**Figure 13. Transfer characteristics**

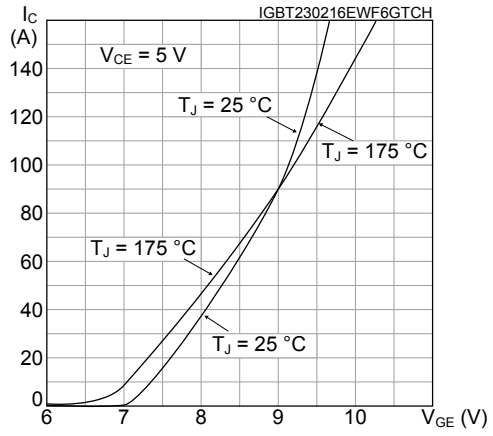



**Figure 14. Normalized $V_{GE(th)}$ vs. junction temperature**

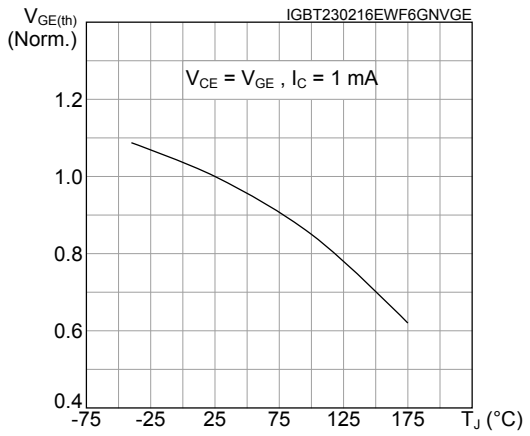



**Figure 15. Normalized $V_{(BR)CES}$ vs. junction temperature**

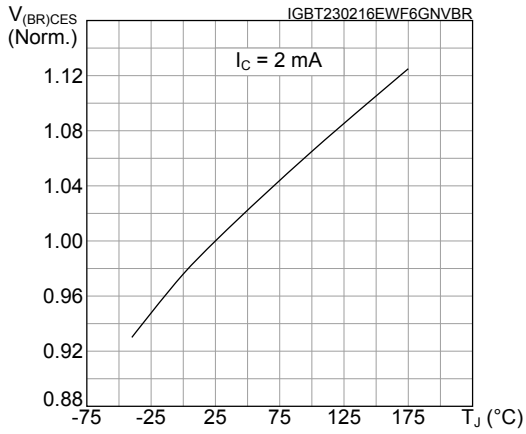



**Figure 16. Capacitance variation**

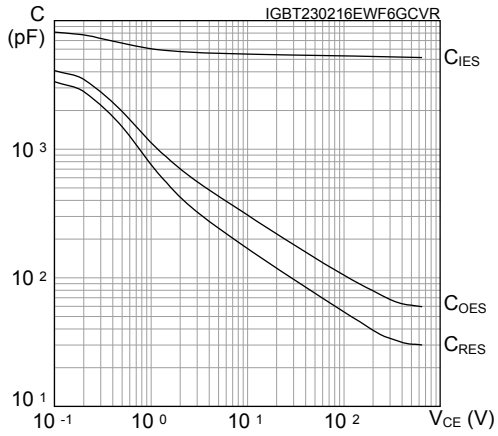



**Figure 17. Gate charge vs. gate-emitter voltage**

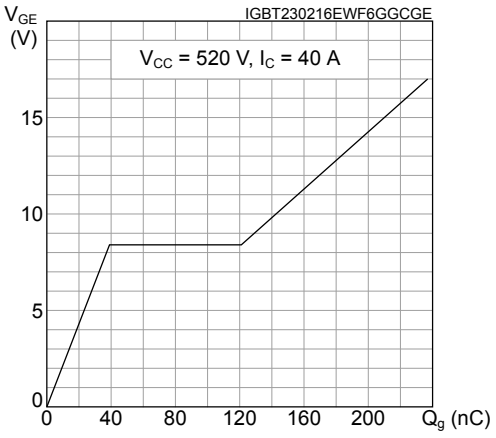



**Figure 18. Switching energy vs. collector current**

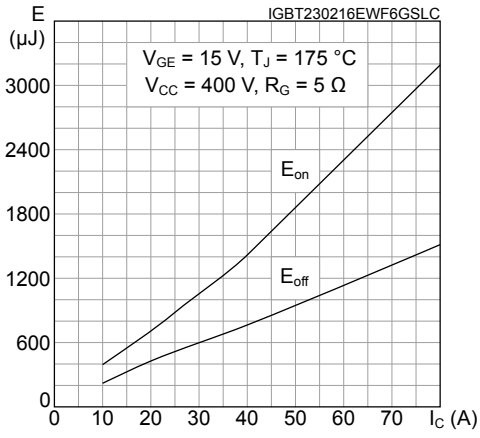


**Figure 19. Switching energy vs. gate resistance**

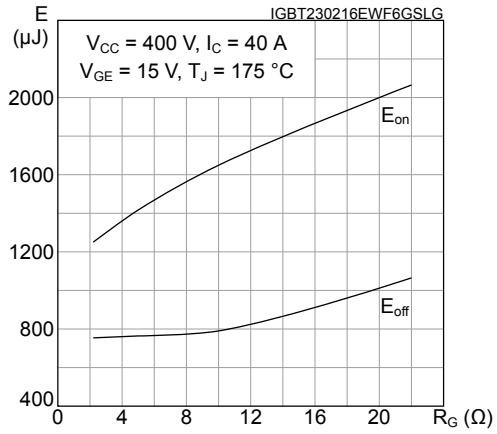



**Figure 20. Switching energy vs. temperature**

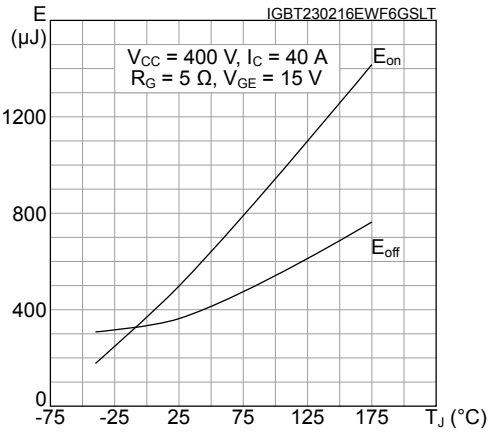



**Figure 21. Switching energy vs. collector emitter voltage**

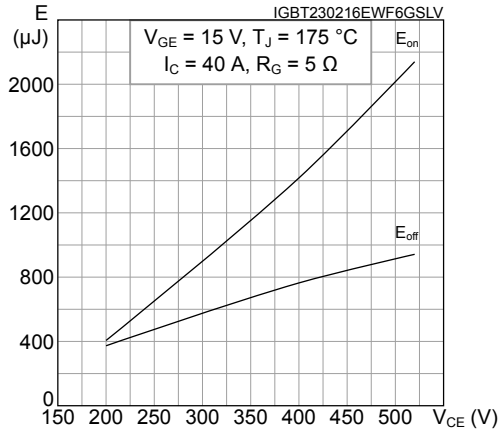



**Figure 22. Switching times vs. collector current**

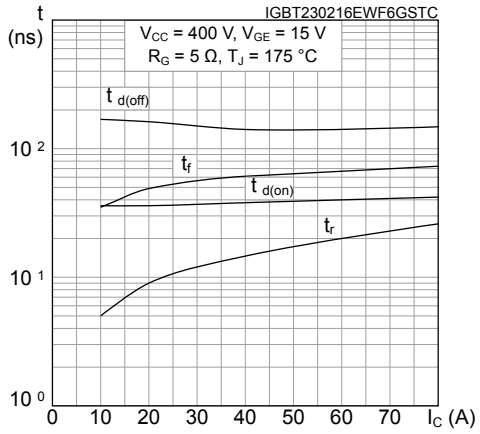



**Figure 23. Switching times vs. gate resistance**

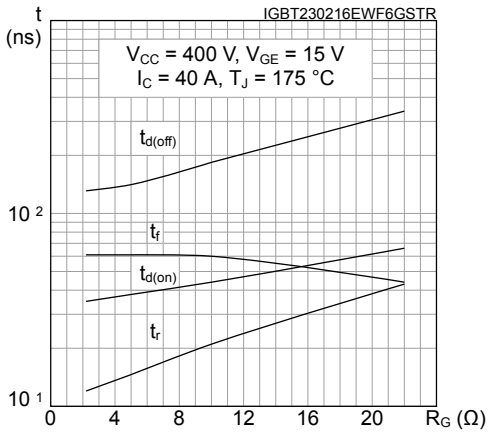


**Figure 24. Thermal impedance for TO-247 and TO-247 long leads**

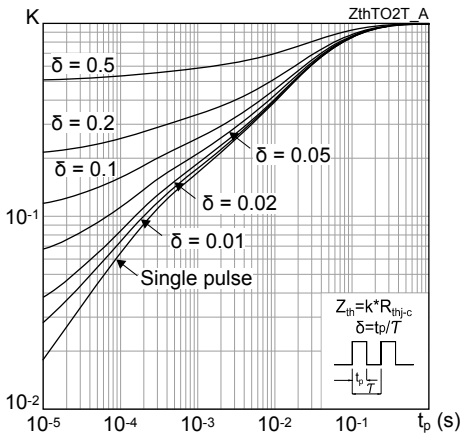
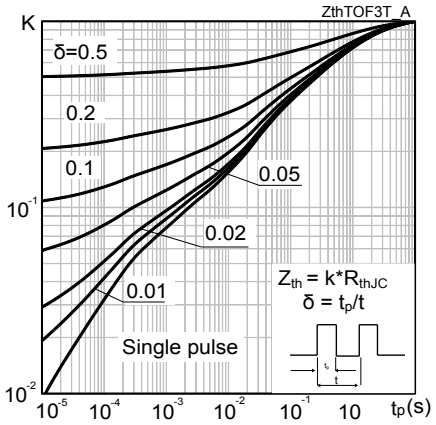



**Figure 25. Thermal impedance for TO-3PF**



# 3 Test circuits

**Figure 26. Test circuit for inductive load switching**

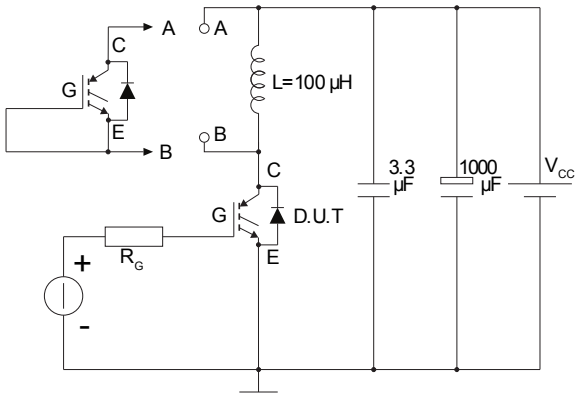



**Figure 27. Gate charge test circuit**

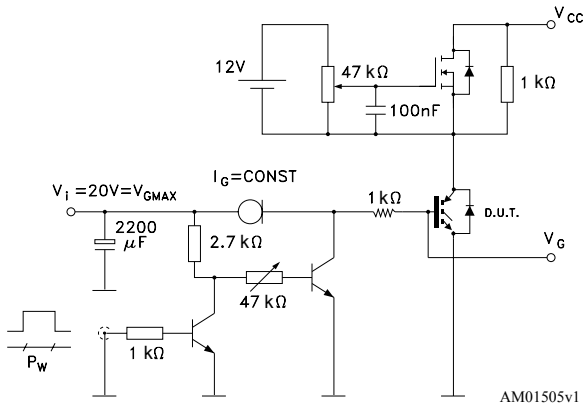
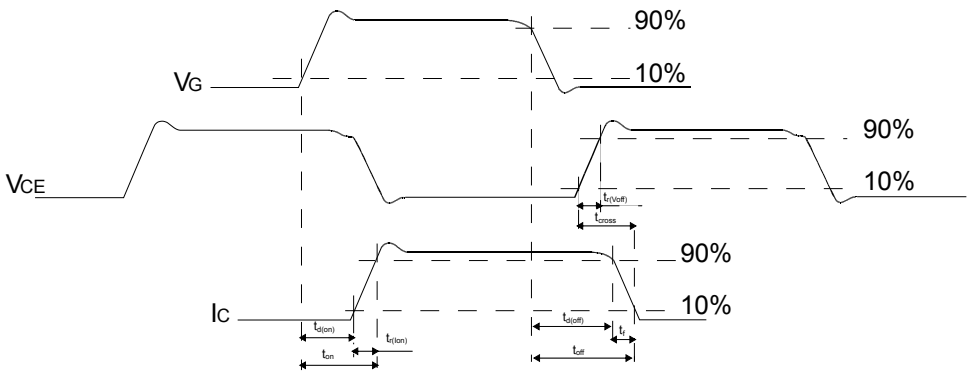



**Figure 28. Switching waveform**



# 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

## 4.1 TO-3PF package information

**Figure 29. TO-3PF package outline**

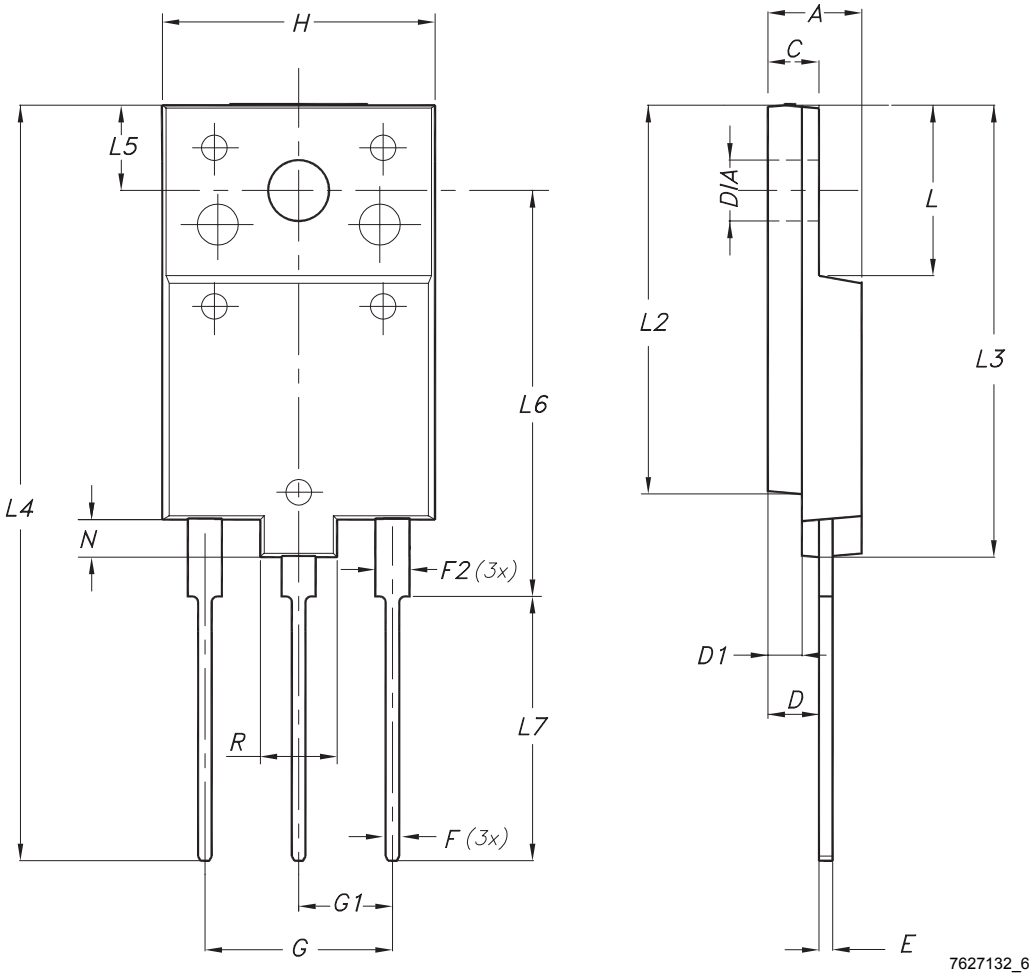
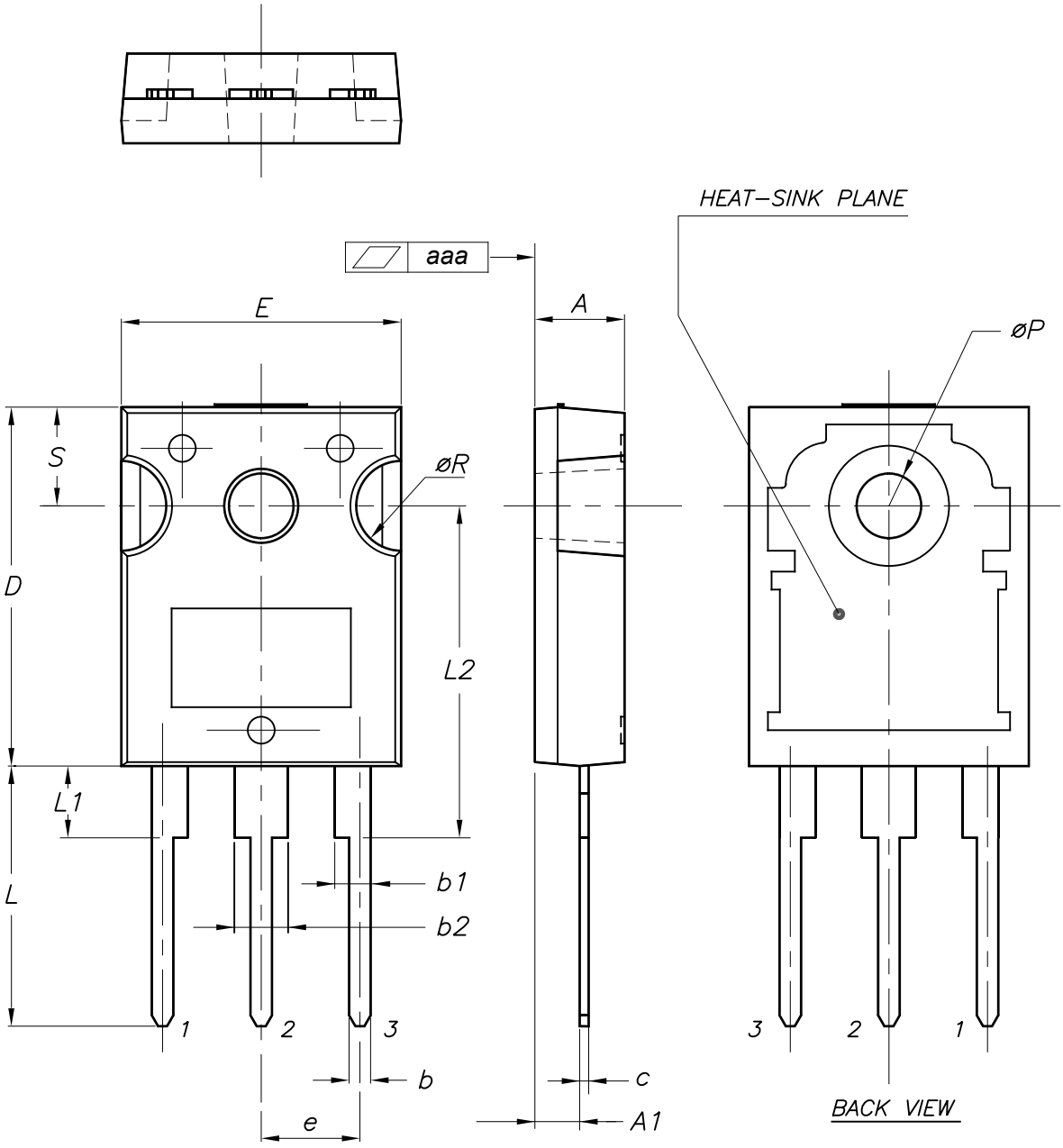


Table 6. **TO-3PF mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 5.30 | | 5.70 |
| C | 2.80 | | 3.20 |
| D | 3.10 | | 3.50 |
| D1 | 1.80 | | 2.20 |
| E | 0.80 | | 1.10 |
| F | 0.65 | | 0.95 |
| F2 | 1.80 | | 2.20 |
| G | 10.30 | | 11.50 |
| G1 | | 5.45 | |
| H | 15.30 | | 15.70 |
| L | 9.80 | 10.00 | 10.20 |
| L2 | 22.80 | | 23.20 |
| L3 | 26.30 | | 26.70 |
| L4 | 43.20 | | 44.40 |
| L5 | 4.30 | | 4.70 |
| L6 | 24.30 | | 24.70 |
| L7 | 14.60 | | 15.00 |
| N | 1.80 | | 2.20 |
| R | 3.80 | | 4.20 |
| Dia | 3.40 | | 3.80 |

## 4.2 TO-247 package information

Figure 30. **TO-247 package outline**




0075325_10

Table 7. **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 |
| aaa | | 0.04 | 0.10 |

## 4.3 TO-247 long leads package information

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

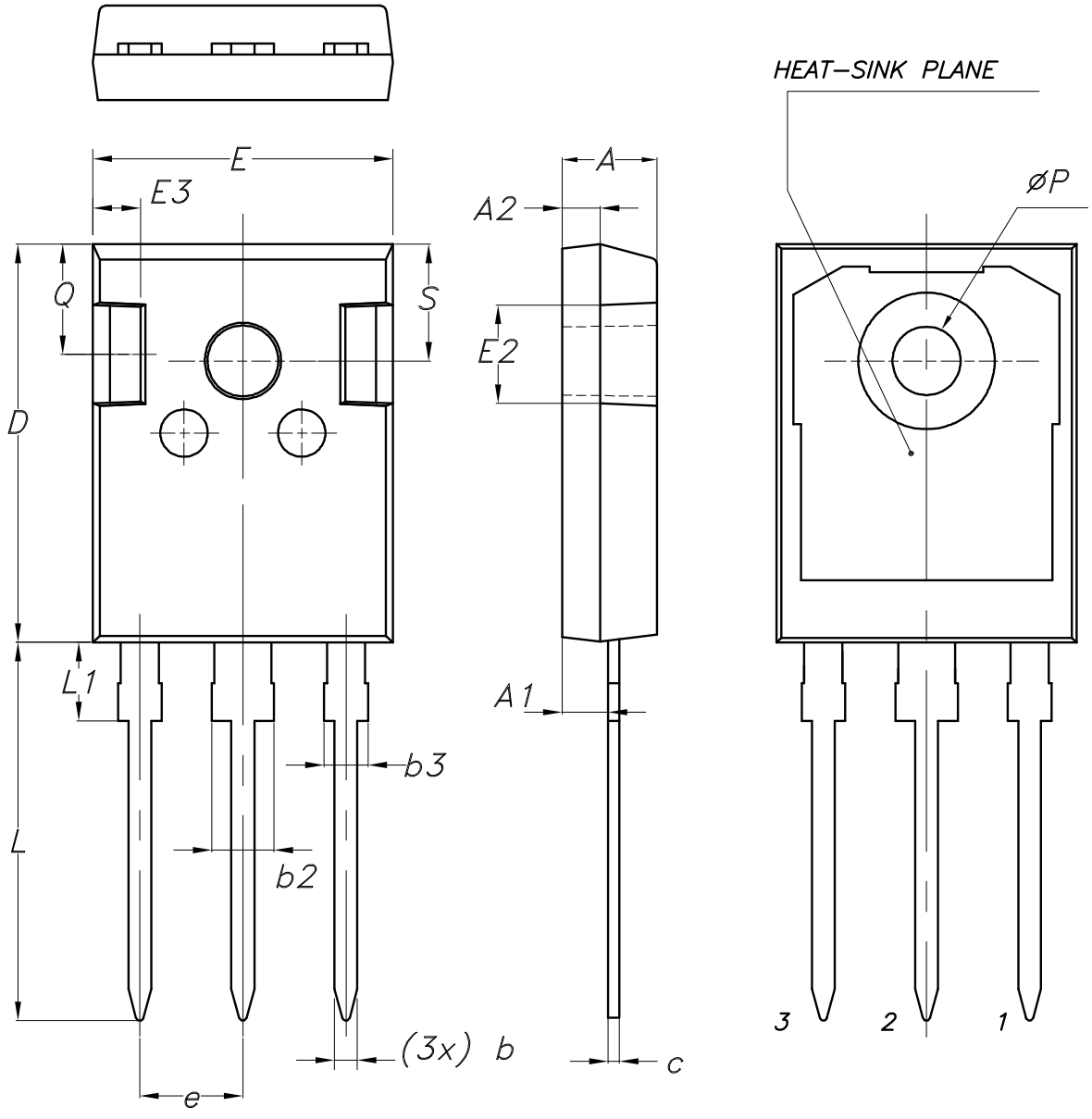


Table 8. **TO-247 long leads package mechanical data**

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

# 5 Ordering information

Table 9. **Order codes**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STGFW40H65FB | GFW40H65FB | TO-3PF | Tube |
| STGW40H65FB | GW40H65FB | TO-247 | |
| STGWA40H65FB | GWA40H65FB | TO-247 long leads | |

## Revision history

Table 10. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 30-Aug-2013 | 1 | Initial release |
| 11-Sep-2013 | 2 | Document status changed from preliminary to production data. Inserted *Section 2.1: Electrical characteristics (curves)*. |
| 28-Feb-2014 | 3 | Updated title and description in cover page. |
| 05-Mar-2014 | 4 | Updated units in *Table 6: Switching characteristics (inductive load)*. |
| 11-Apr-2014 | 5 | Added part number and references for the device in a TO-3PF package. |
| 03-Nov-2016 | 6 | Added device in TO-247 long leads and updated the document accordingly.<br>Updated *Section 2.1: Electrical characteristics (curves)* and *Section 4.3: TO-247 long leads, package information*.<br>Minor text changes. |
| 21-Mar-2017 | 7 | Updated *Table 1: "Device summary"*.<br>Added *Figure 26: "Thermal impedance for TO-3PF"*.<br>Minor text changes |
| 09-Mar-2021 | 8 | The part number STGWT40H65FB has been removed and the document has been updated accordingly.<br>Updated title in cover page.<br>Updated Section 1 Electrical ratings and Section 2.1 Electrical characteristics (curves).<br>Minor text changes |

# Contents