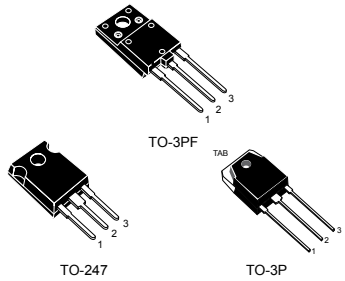
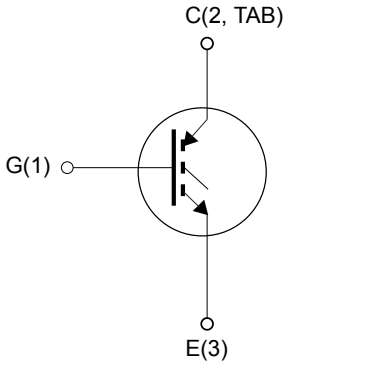
# STGFW20H65FB, STGW20H65FB, STGWT20H65FB

Datasheet

## Trench gate field-stop IGBT, HB series 650 V, 20 A high speed




### Features

- Maximum junction temperature: $T_J$ = 175 °C
- High speed switching series
- Minimized tail current
- $V_{CE(sat)}$ = 1.55 V (typ.) @ $I_C$ = 20 A
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance

### Applications

- Photovoltaic inverters
- Power factor correction
- Welding
- High-frequency converters

### 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 links |
|---|
| STGFW20H65FB |
| STGW20H65FB |
| STGWT20H65FB |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-247, TO-3P | TO-3PF | |
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0 V) | 650 | | V |
| $I_C$ | Continuous collector current at $T_C$ = 25 °C | 40 | | A |
| | Continuous collector current at $T_C$ = 100 °C | 20 | | A |
| $I_{CP}$(1) | Pulsed collector current | 80 | | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | | V |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °C | 168 | 52 | 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 |
|---|---|---|---|---|
| | | TO-247, TO-3P | TO-3PF | |
| $R_{thJC}$ | Thermal resistance junction-case | 0.9 | 2.9 | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50 | | °C/W |

# 2 Electrical characteristics

$T_J$ = 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, $I_C$ = 20 A | | 1.55 | 2 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 125 °C | | 1.65 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 20 A, $T_J$ = 175 °C | | 1.75 | | |
| $V_{GE(th)}$ | 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 | - | 2764 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 80 | - | pF |
| $C_{res}$ | Reverse transfer capacitance | | - | 60 | - | pF |
| $Q_g$ | Total gate charge | $V_{CC}$ = 520 V, $I_C$ = 20 A, $V_{GE}$ = 0 to 15 V (see Figure 26. Gate charge test circuit) | - | 120 | - | nC |
| $Q_{ge}$ | Gate-emitter charge | | - | 20 | - | nC |
| $Q_{gc}$ | Gate-collector charge | | - | 50 | - | nC |

**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, $I_C$ = 20 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V (see Figure 25. Test circuit for inductive load switching) | - | 30 | - | ns |
| $t_r$ | Current rise time | | - | 11 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1400 | - | A/µs |
| $t_{d(off)}$ | Turn-off delay time | | - | 139 | - | ns |
| $t_f$ | Current fall time | | - | 20 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 77 | - | µJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 170 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 247 | - | µJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 20 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V, $T_J$ = 175 °C (see Figure 25. Test circuit for inductive load switching) | - | 29 | - | ns |
| $t_r$ | Current rise time | | - | 12 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1352 | - | A/µs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 147 | - | ns |
| $t_f$ | Current fall time | | - | 38 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 88 | - | µJ |
| $E_{off}$ (2) | Turn-off switching energy | | - | 353 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 441 | - | µJ |

1. *Including the reverse recovery of the external SiC diode STPSC206W.*
2. *Including the tail of the collector current.*

## 2.1 Electrical characteristics (curves)

**Figure 1. Output characteristics ($T_J$ = 25°C)**

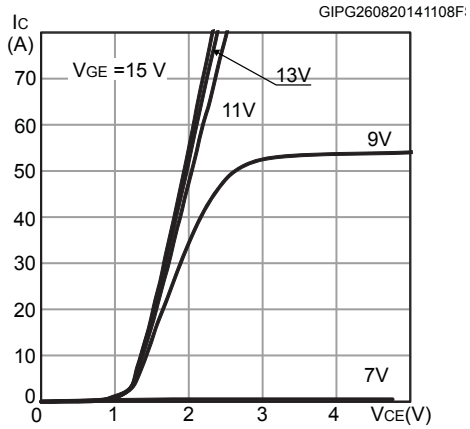



**Figure 2. Output characteristics ($T_J$ = 175°C)**

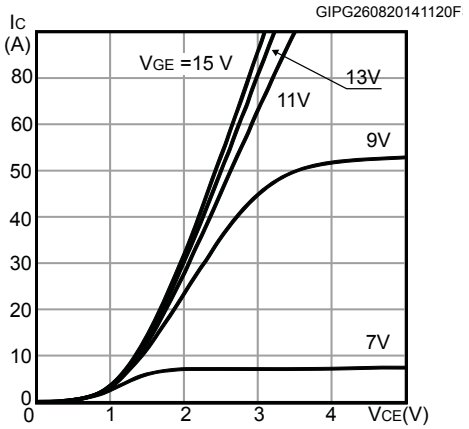



**Figure 3. Transfer characteristics**

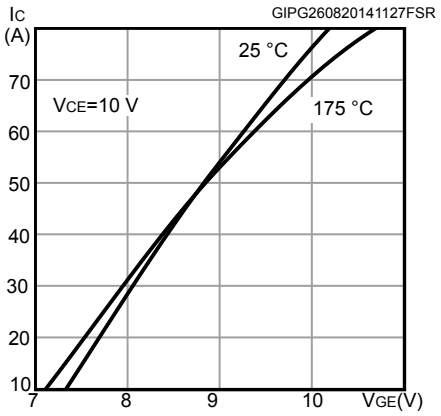



**Figure 4. Collector current vs case temperature for TO-247 and TO-3P**

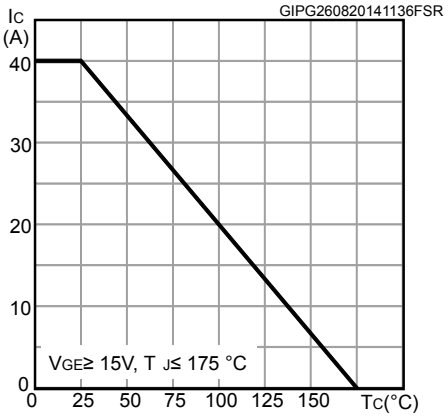



**Figure 5. Collector current vs case temperature for TO-3PF**

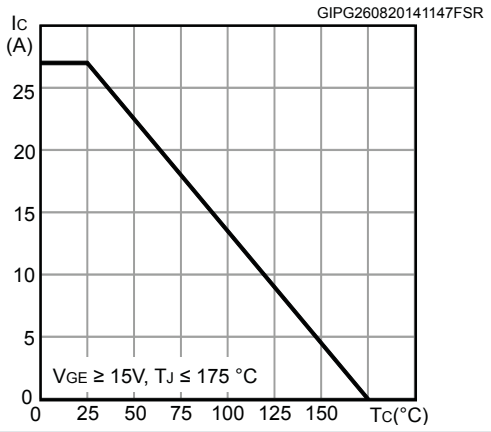



**Figure 6. $V_{CE(sat)}$ vs junction temperature**

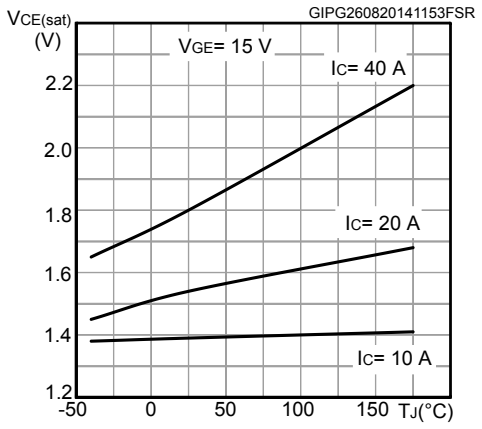


**Figure 7. Power dissipation vs case temperature for TO-247 and TO-3P**

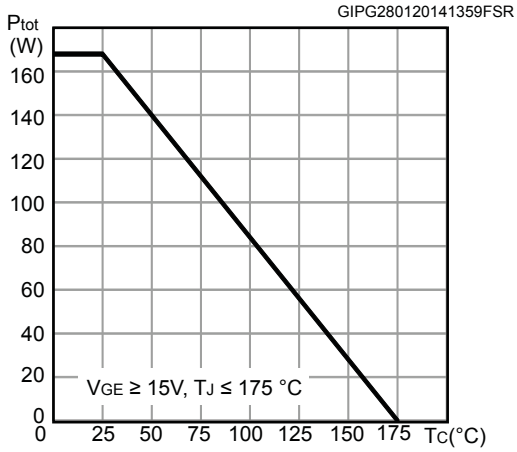



**Figure 8. Power dissipation vs case temperature for TO-3PF**

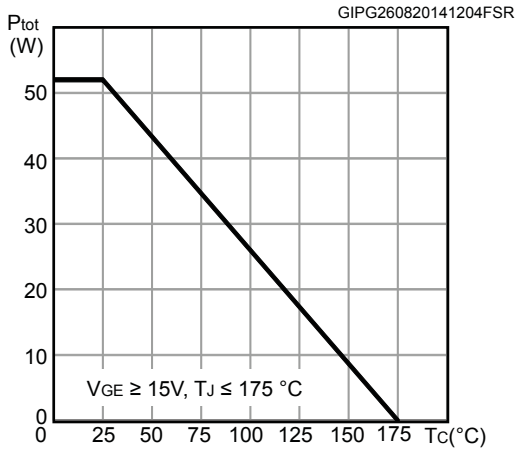



**Figure 9. Forward bias safe operating area for TO-247 and TO-3P**

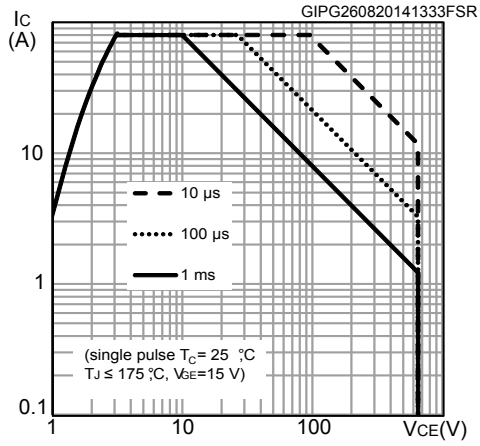



**Figure 10. Forward bias safe operating area for TO-3PF**

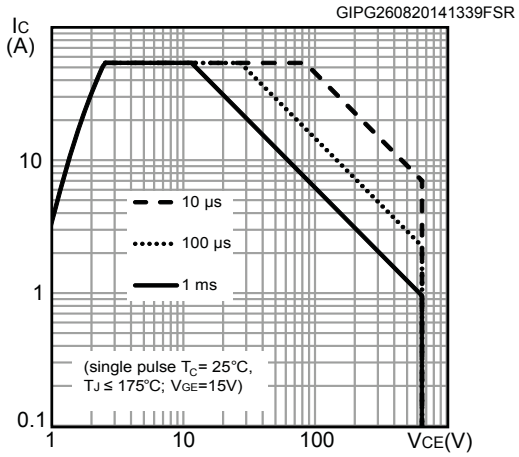



**Figure 11. Collector current vs. switching frequency for TO-247 and TO-3P**

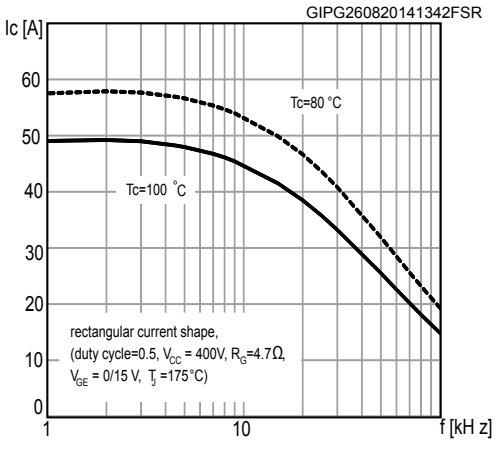



**Figure 12. Collector current vs. switching frequency for TO-3PF**

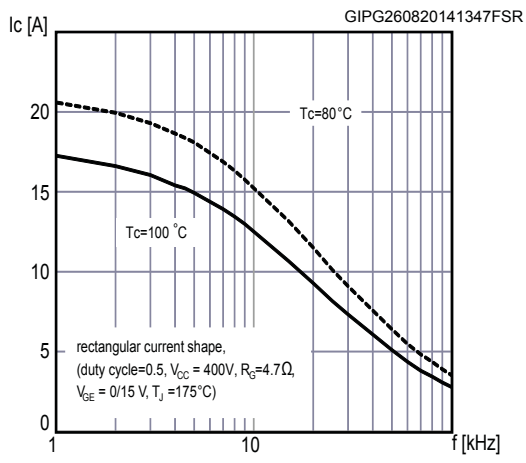


**Figure 13. Normalized $V_{GE(th)}$ vs junction temperature**

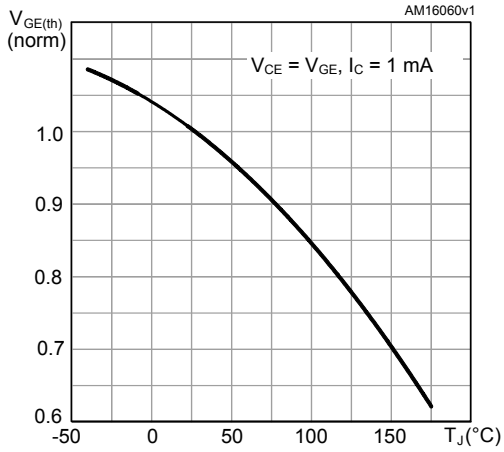



**Figure 14. Normalized $V_{(BR)CES}$ vs junction temperature**

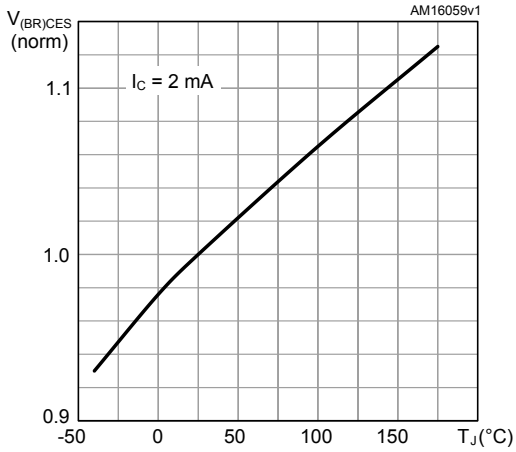



**Figure 15. Switching energy vs temperature**

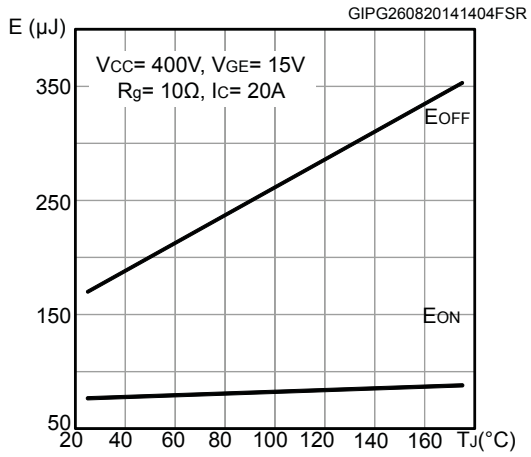



**Figure 16. Switching energy vs gate resistance**

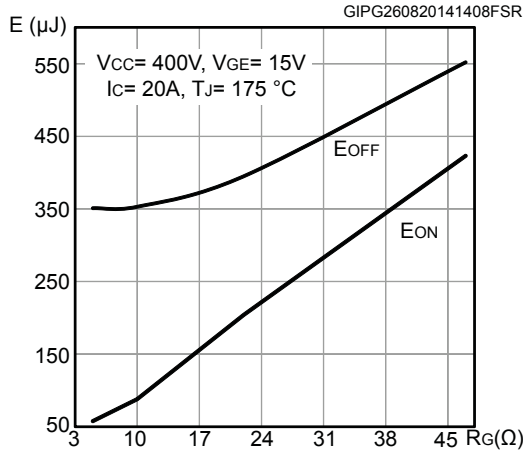



**Figure 17. Switching energy vs collector current**

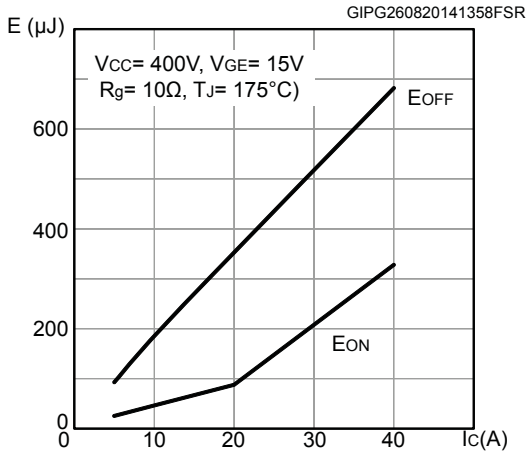



**Figure 18. Switching energy vs collector emitter voltage**

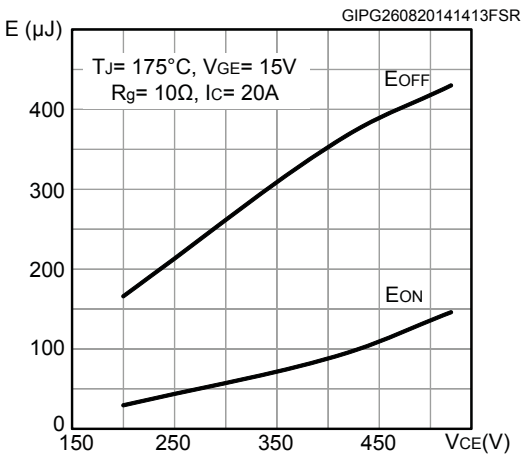


**Figure 19. Switching times vs collector current**

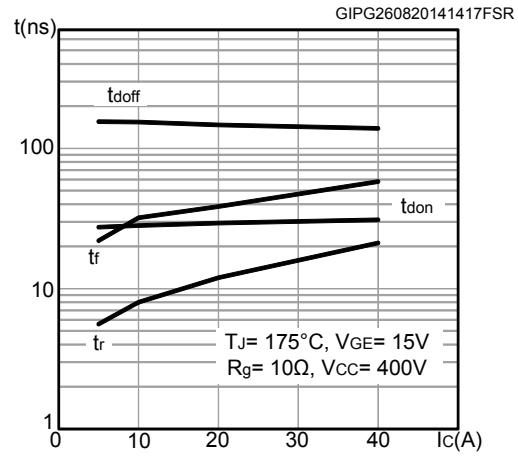



**Figure 20. Switching times vs gate resistance**

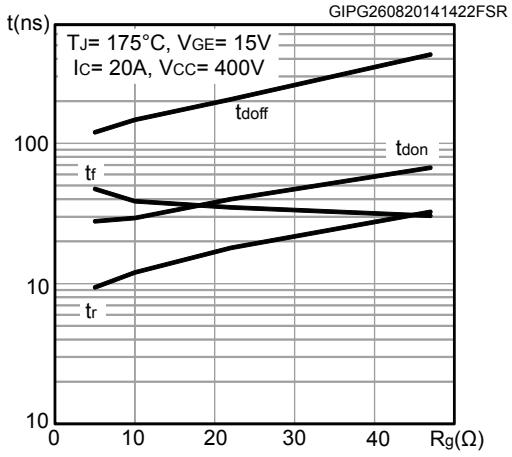



**Figure 21. Capacitance variations**

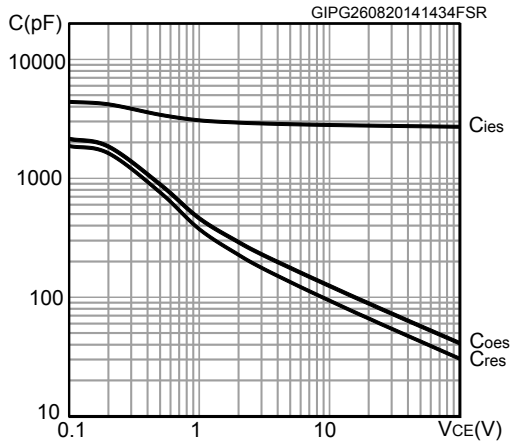



**Figure 22. Gate charge vs gate-emitter voltage**

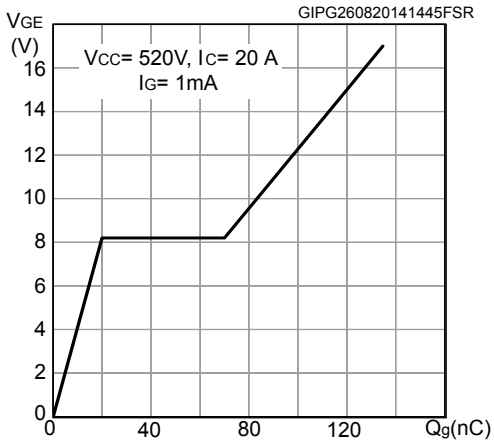



**Figure 23. Thermal impedance for TO-247 and TO-3P**

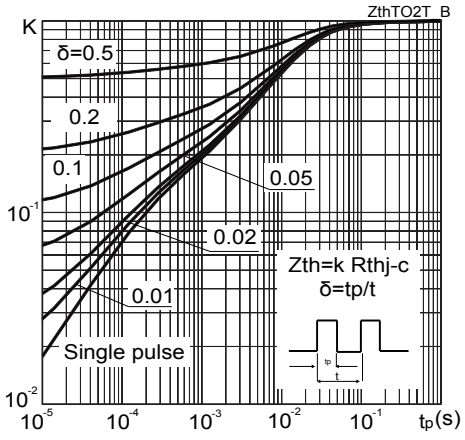
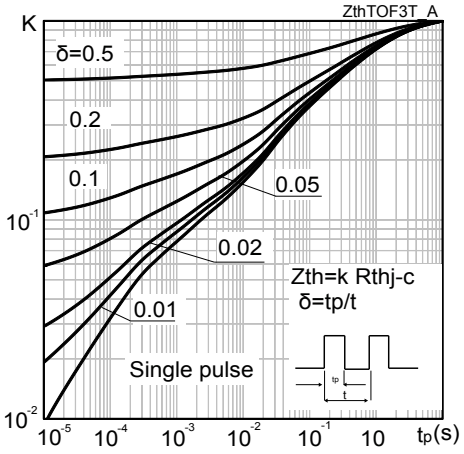



**Figure 24. Thermal impedance for in TO-3PF**



# 3 Test circuits

**Figure 25. Test circuit for inductive load switching**

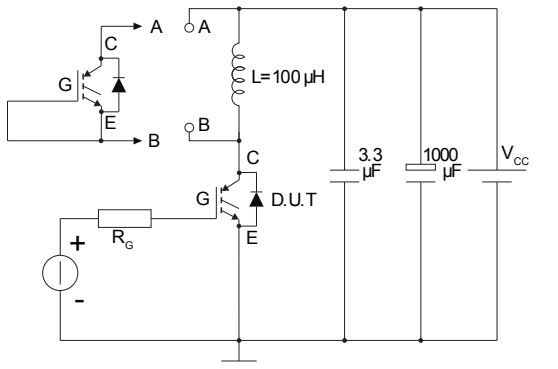



**Figure 26. Gate charge test circuit**

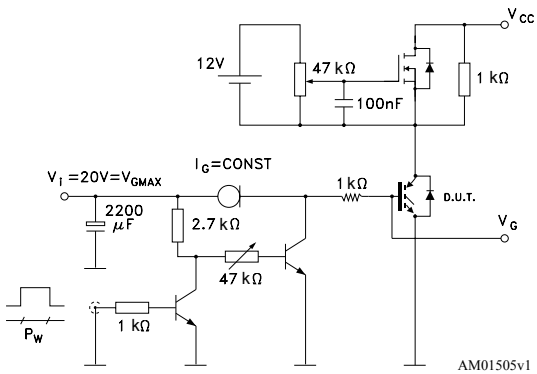



**Figure 27. Switching waveform**

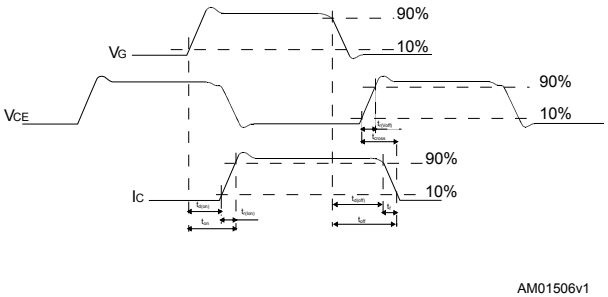
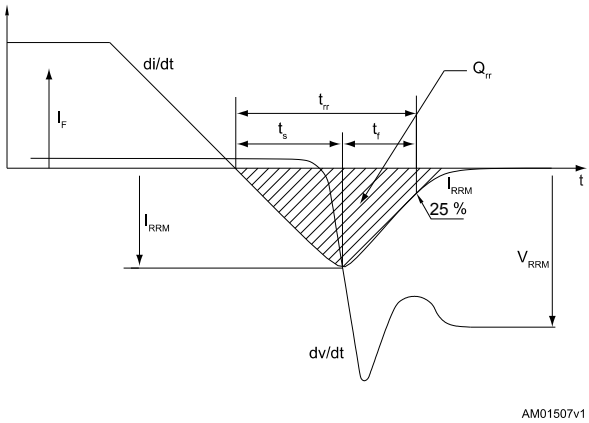



**Figure 28. Diode reverse recovery waveform**



# 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**

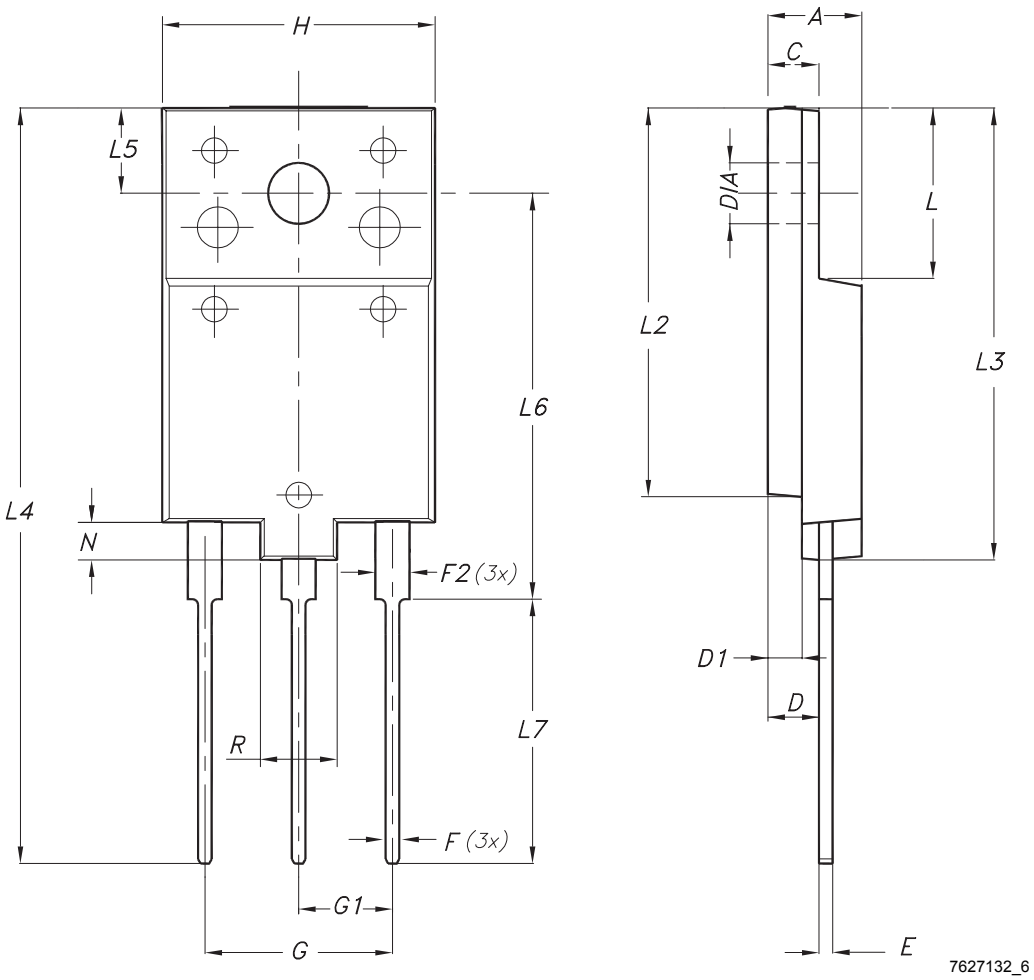


Table 6. **TO-3PF mechanical data**

| 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**

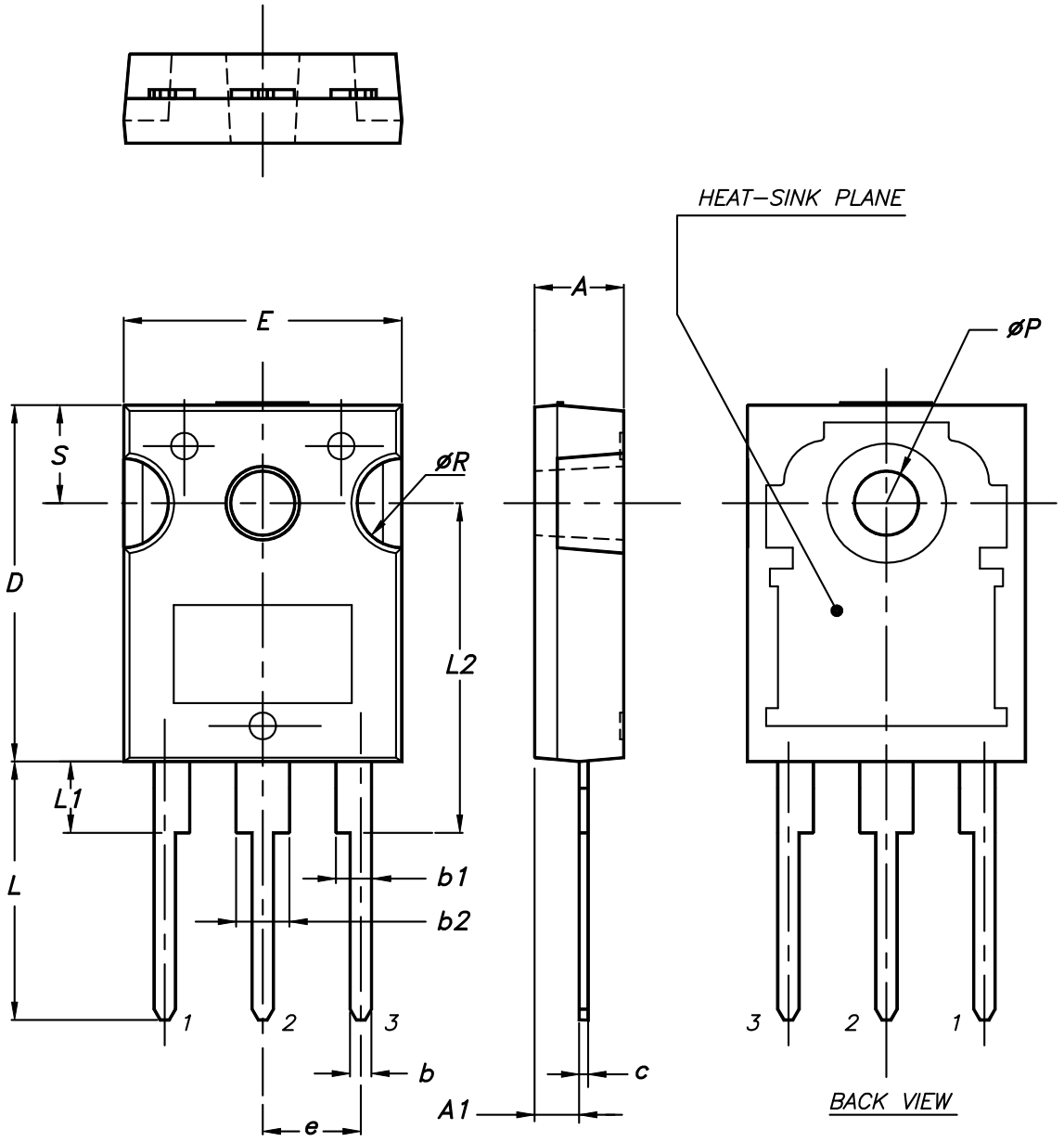


Table 7. **TO-247 package mechanical data**

| 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 |

## 4.3 TO-3P package information

Figure 31. **TO-3P package outline**

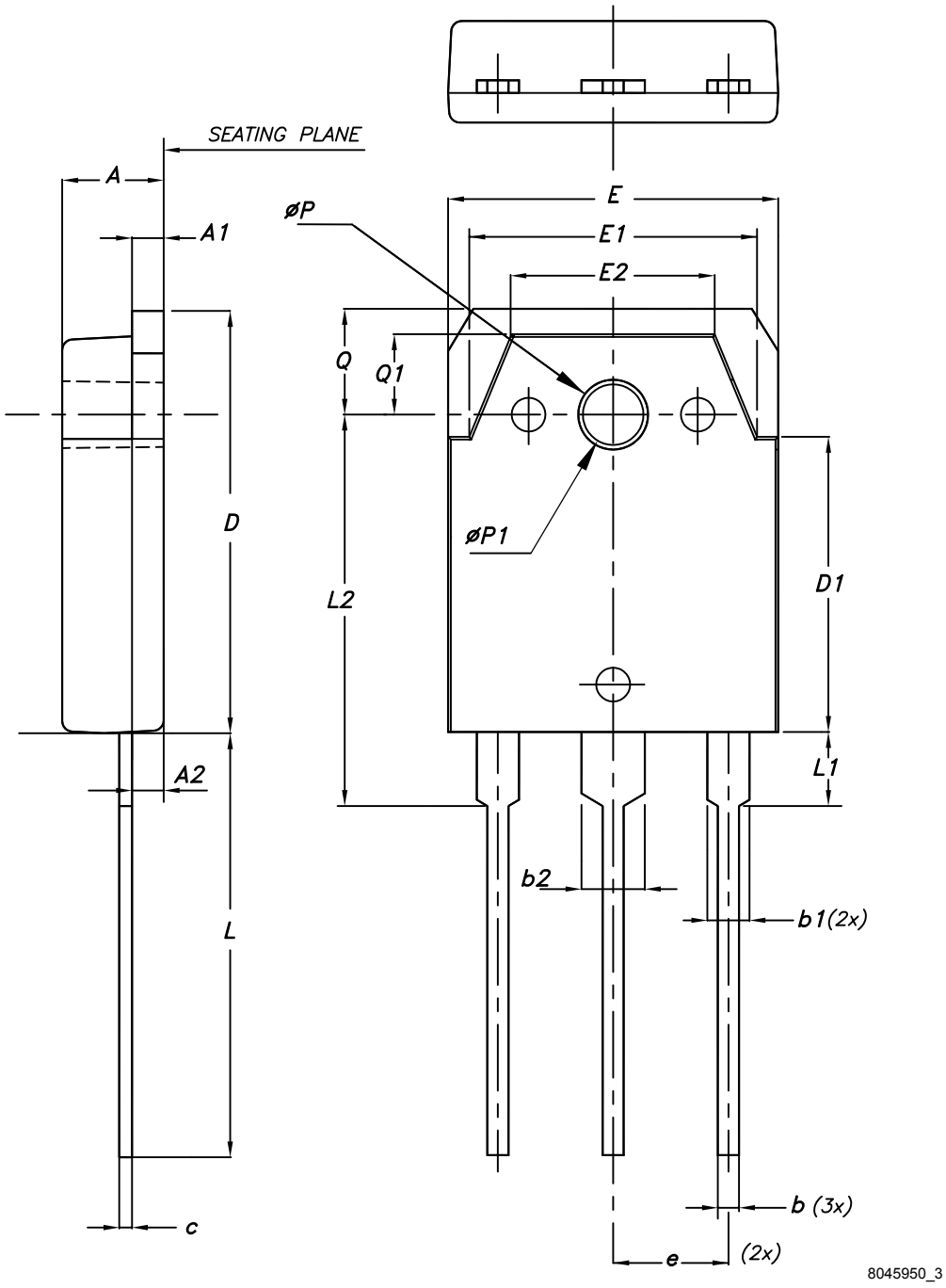


Table 8. **TO-3P package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.60 | 4.80 | 5.00 |
| A1 | 1.45 | 1.50 | 1.65 |
| A2 | 1.20 | 1.40 | 1.60 |
| b | 0.80 | 1.00 | 1.20 |
| b1 | 1.80 | 2.00 | 2.20 |
| b2 | 2.80 | 3.00 | 3.20 |
| c | 0.55 | 0.60 | 0.75 |
| D | 19.70 | 19.90 | 20.10 |
| D1 | 13.70 | 13.90 | 14.10 |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 13.40 | 13.60 | 13.80 |
| E2 | 9.40 | 9.60 | 9.90 |
| e | 5.15 | 5.45 | 5.75 |
| L | 19.80 | 20.00 | 20.20 |
| L1 | 3.30 | 3.50 | 3.70 |
| L2 | 18.20 | 18.40 | 18.60 |
| ØP | 3.30 | 3.40 | 3.50 |
| ØP1 | 3.10 | 3.20 | 3.30 |
| Q | 4.80 | 5.00 | 5.20 |
| Q1 | 3.60 | 3.80 | 4.00 |

# 5 Ordering information

Table 9. **Order codes**

| Order code | Marking | Package | Packing |
|---|---|---|---|
| STGFW20H65FB | G20H65FB | TO-3PF | Tube |
| STGW20H65FB | GW20H65FB | TO-247 | |
| STGWT20H65FB | GWT20H65FB | TO-3P | |

## Revision history

Table 10. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 28-Aug-2014 | 1 | Initial release. |
| 15-Apr-2020 | 2 | Updated applications in cover page.<br>Updated Table 9. Order codes.<br>Minor text changes. |

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