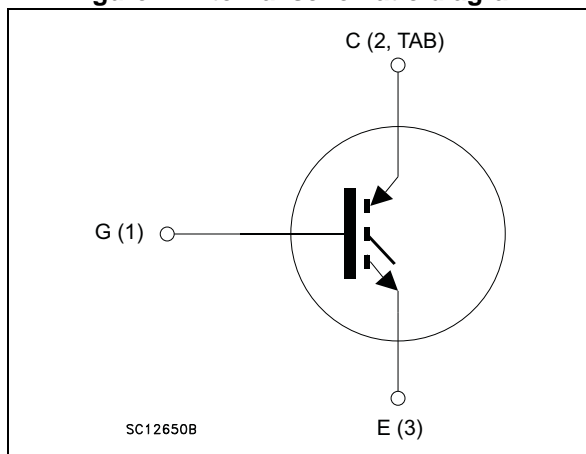


Figure 1. Internal schematic diagram



### Features

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

### Applications

- Photovoltaic inverters
- High frequency converters

### Description

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

Table 1. Device summary

| Order codes  | Marking    | Package | Packaging |
|--------------|------------|---------|-----------|
| STGFW20H65FB | GFW20H65FB | TO-3PF  | Tube      |
| STGW20H65FB  | GW20H65FB  | TO-247  | Tube      |
| STGWT20H65FB | GWT20H65FB | TO-3P   | Tube      |

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter   | Value           |         | Unit |
|----------------|---|-----------------|---------|------|
|                |   | TO-247<br>TO-3P | TO-3PFP |      |
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ )            | 650             |         | V    |
| $I_C$          | Continuous collector current at $T_C = 25\text{ °C}$  | 40              |         | A    |
| $I_C$          | Continuous collector current at $T_C = 100\text{ °C}$ | 20              |         | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current                              | 80              |         | A    |
| $V_{GE}$       | Gate-emitter voltage                                  | $\pm 20$        |         | V    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$             | 168             | 52      | W    |
| $T_{STG}$      | Storage temperature range                             | - 55 to 150     |         | °C   |
| $T_J$          | Operating junction temperature                        | - 55 to 175     |         | °C   |

1. Pulse width limited by maximum junction temperature.

**Table 3. Thermal data**

| Symbol     | Parameter                           | Value  |                 | Unit |
|------------|-------------------------------------|--------|-----------------|------|
|            |                                     | TO-3PF | TO-247<br>TO-3P |      |
| $R_{thJC}$ | Thermal resistance junction-case    | 2.9    | 0.9             | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 50     |                 | °C/W |

## 2 Electrical characteristics

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

**Table 4. Static characteristics**

| Symbol        | Parameter  | Test conditions  | Min. | Typ. | Max. | Unit          |
|---------------|--|--|------|------|------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage ( $V_{GE} = 0$ ) | $I_C = 2\text{ mA}$  | 650  |      |      | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                 | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$                          |      | 1.55 | 2    | V             |
|               |  | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$<br>$T_J = 125\text{ °C}$ |      | 1.65 |      |               |
|               |  | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$<br>$T_J = 175\text{ °C}$ |      | 1.75 |      |               |
| $V_{GE(th)}$  | Gate threshold voltage                               | $V_{CE} = V_{GE}, I_C = 1\text{ mA}$                               | 5    | 6    | 7    | V             |
| $I_{CES}$     | Collector cut-off current ( $V_{GE} = 0$ )           | $V_{CE} = 650\text{ V}$  |      |      | 25   | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20\text{ V}$   |      |      | 250  | nA            |

**Table 5. Dynamic characteristics**

| Symbol    | Parameter                    | Test conditions  | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}, f = 1\text{ MHz},$<br>$V_{GE} = 0$  | -    | 2764 | -    | pF   |
| $C_{oes}$ | Output capacitance           |  | -    | 80   | -    | pF   |
| $C_{res}$ | Reverse transfer capacitance |  | -    | 60   | -    | pF   |
| $Q_g$     | Total gate charge            | $V_{CC} = 520\text{ V}, I_C = 20\text{ A},$<br>$V_{GE} = 15\text{ V},$ see <a href="#">Figure 27</a> | -    | 120  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |  | -    | 20   | -    | nC   |
| $Q_{gc}$  | Gate-collector charge        |  | -    | 50   | -    | nC   |

Table 6. Switching characteristics (inductive load)

| Symbol          | Parameter                 | Test conditions   | Min. | Typ. | Max. | Unit       |
|-----------------|---------------------------|---|------|------|------|------------|
| $t_{d(on)}$     | Turn-on delay time        | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>see <a href="#">Figure 26</a>                                     | -    | 30   | -    | ns         |
| $t_r$           | Current rise time         |   | -    | 11   | -    | ns         |
| $(di/dt)_{on}$  | Turn-on current slope     |   | -    | 1400 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off delay time       |   | -    | 139  | -    | ns         |
| $t_f$           | Current fall time         |   | -    | 20   | -    | ns         |
| $E_{on}^{(1)}$  | Turn-on switching losses  |   | -    | 77   | -    | $\mu$ J    |
| $E_{off}^{(2)}$ | Turn-off switching losses |   | -    | 170  | -    | $\mu$ J    |
| $E_{ts}$        | Total switching losses    |   | -    | 247  | -    | $\mu$ J    |
| $t_{d(on)}$     | Turn-on delay time        | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 26</a> | -    | 29   | -    | ns         |
| $t_r$           | Current rise time         |   | -    | 12   | -    | ns         |
| $(di/dt)_{on}$  | Turn-on current slope     |   | -    | 1352 | -    | A/ $\mu$ s |
| $t_{d(off)}$    | Turn-off delay time       |   | -    | 147  | -    | ns         |
| $t_f$           | Current fall time         |   | -    | 38   | -    | ns         |
| $E_{on}^{(1)}$  | Turn-on switching losses  |   | -    | 88   | -    | $\mu$ J    |
| $E_{off}^{(2)}$ | Turn-off switching losses |   | -    | 353  | -    | $\mu$ J    |
| $E_{ts}$        | Total switching losses    |   | -    | 441  | -    | $\mu$ J    |

1. Energy losses include reverse recovery of the external diode. Turn-on times and energy have been measured applying as freewheeling an external SiC diode STPSC206W
2. Turn-off losses include also the tail of the collector current.

## 2.1 Electrical characteristics (curve)

Figure 2. Output characteristics ( $T_J = 25^\circ\text{C}$ )

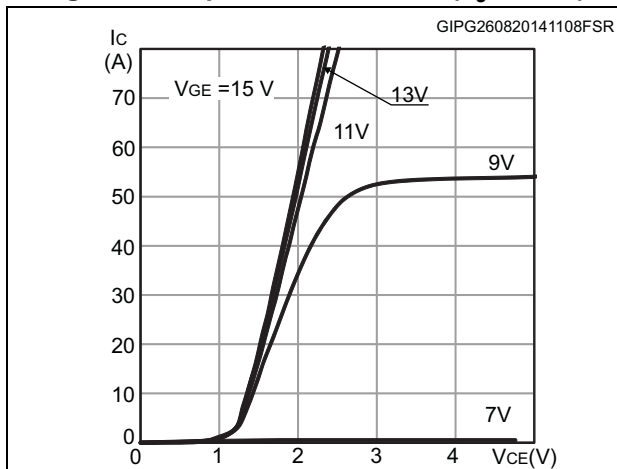


Figure 3. Output characteristics ( $T_J = 175^\circ\text{C}$ )

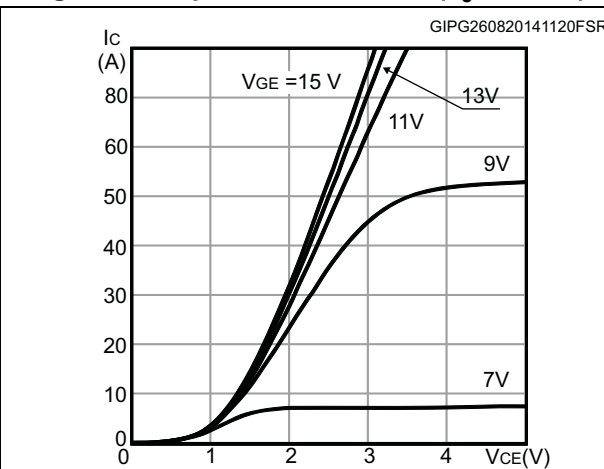


Figure 4. Transfer characteristics

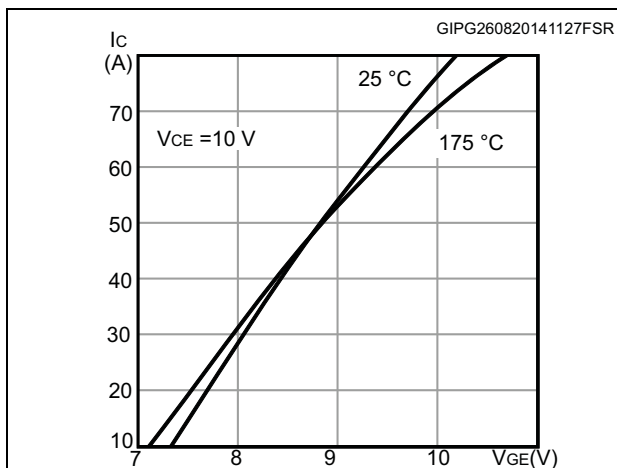


Figure 5. Collector current vs. case temperature for TO-247 and TO-3P

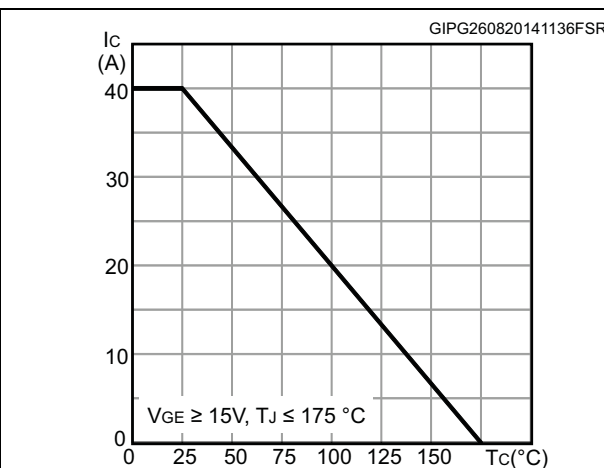


Figure 6. Collector current vs. case temperature for TO-3PF

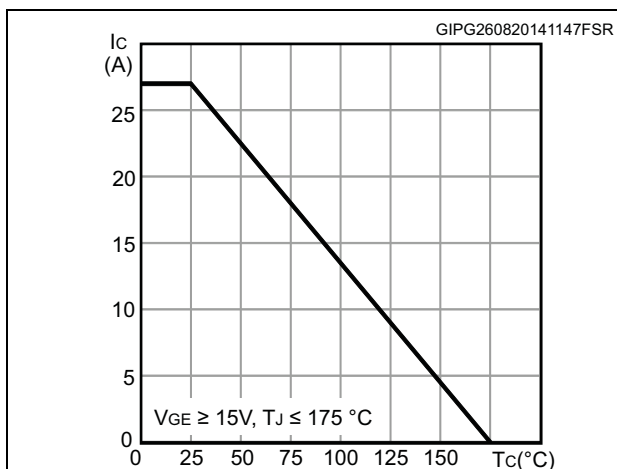


Figure 7.  $V_{CE(sat)}$  vs. junction temperature

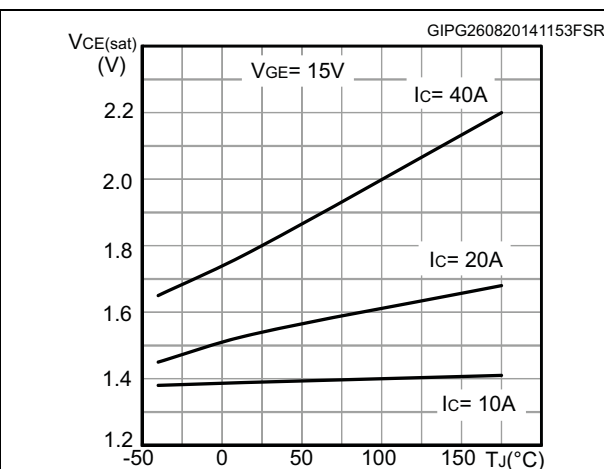


Figure 8. Power dissipation vs. case temperature for TO-247 and TO-3P

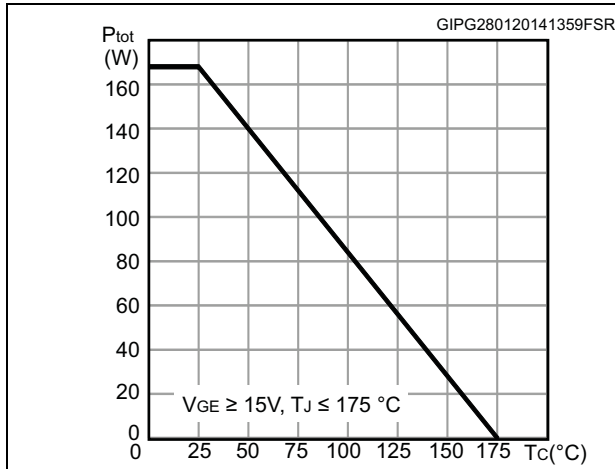


Figure 9. Power dissipation vs. case temperature for TO-3PF

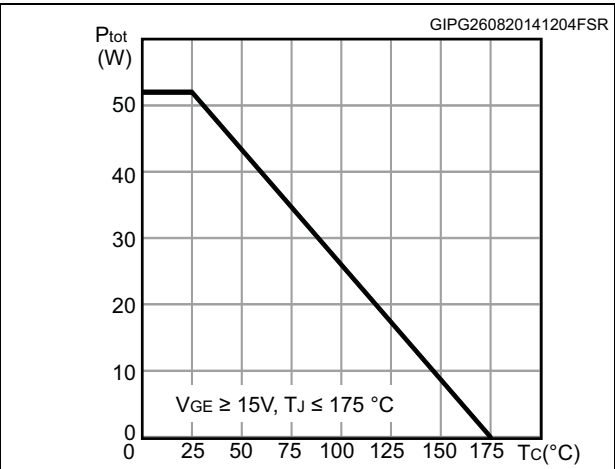


Figure 10. Forward bias safe operating area for TO-247 and TO-3P

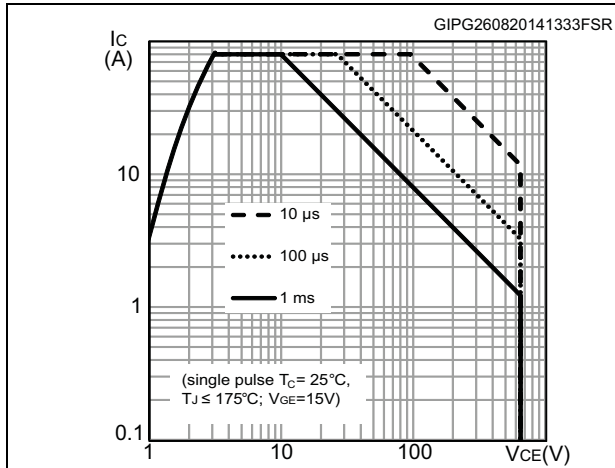


Figure 11. Forward bias safe operating area for TO-3PF

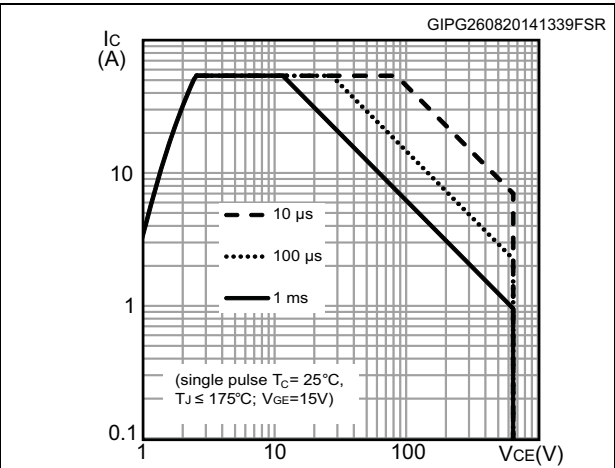


Figure 12. Collector current vs. switching frequency for TO-247 and TO-3P

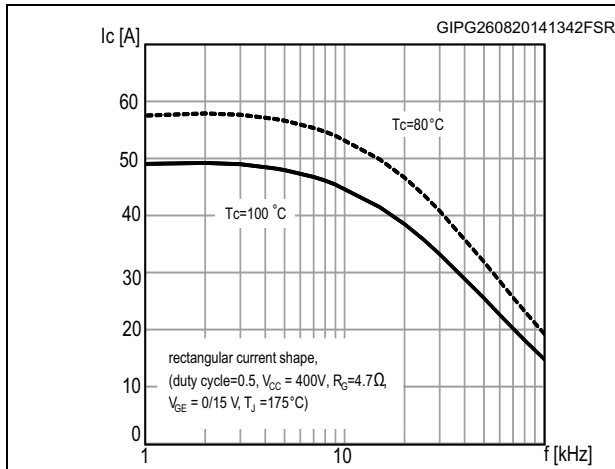


Figure 13. Collector current vs. switching frequency for TO-3PF

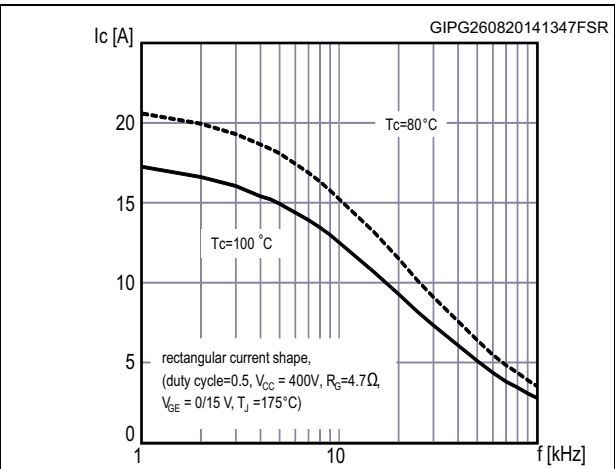


Figure 14. Normalized  $V_{GE(th)}$  vs. junction temperature

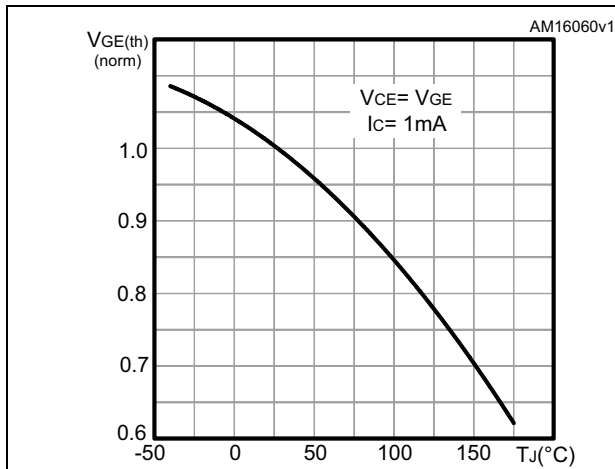


Figure 15. Normalized  $V_{(BR)CES}$  vs. junction temperature

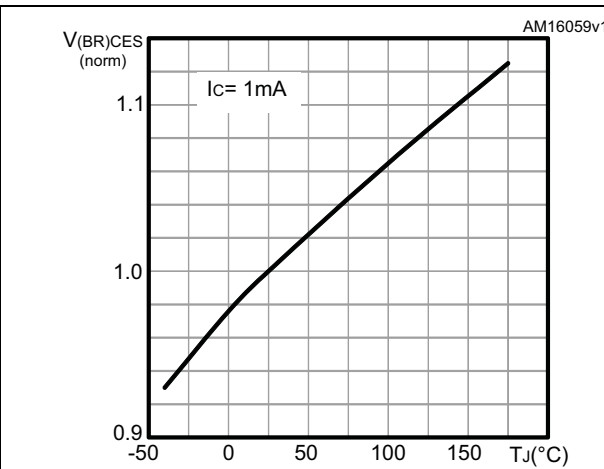


Figure 16. Switching losses vs temperature

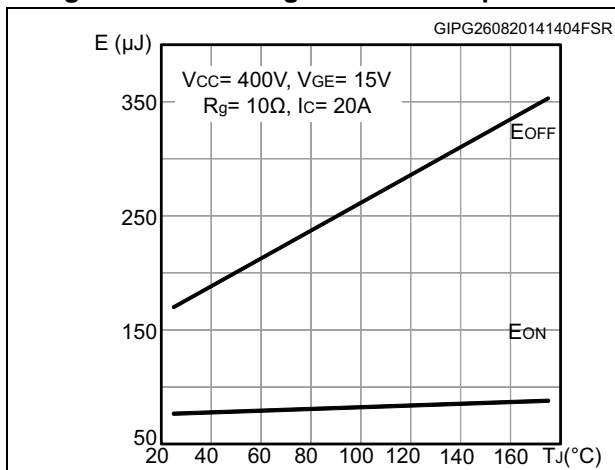


Figure 17. Switching losses vs gate resistance

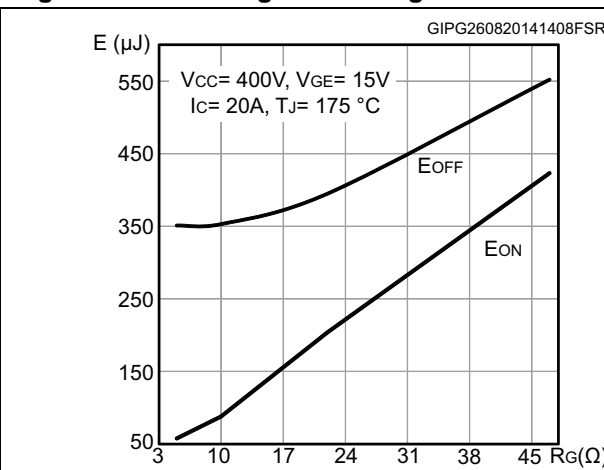


Figure 18. Switching losses vs collector current

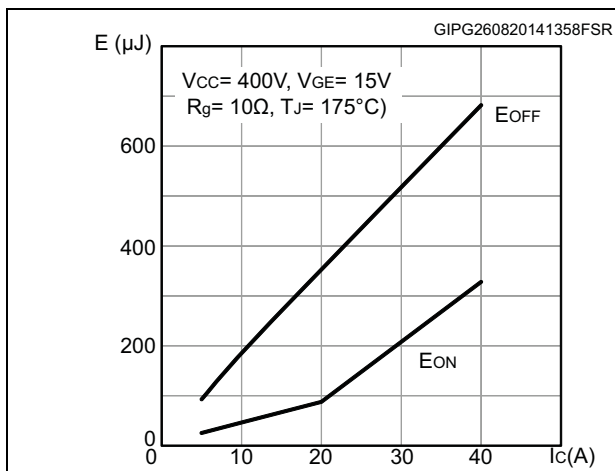


Figure 19. Switching losses vs collector emitter voltage

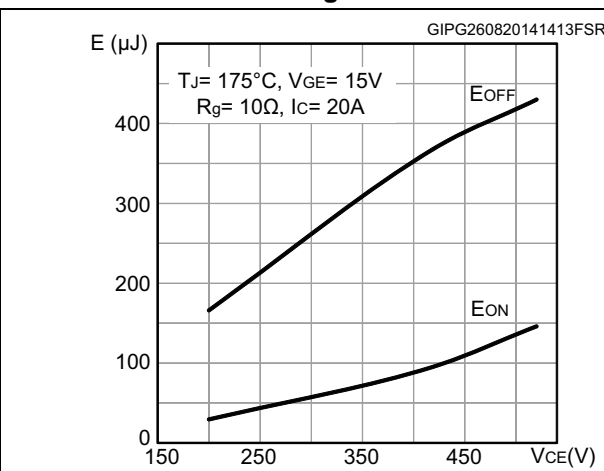




Figure 20. Switching times vs collector current

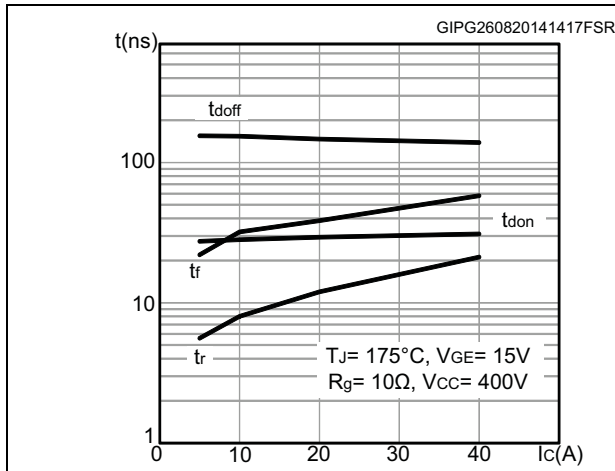


Figure 21. Switching times vs gate resistance

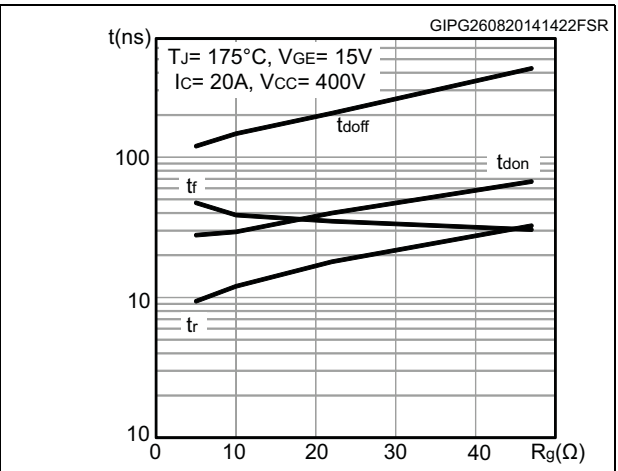


Figure 22. Capacitance variations

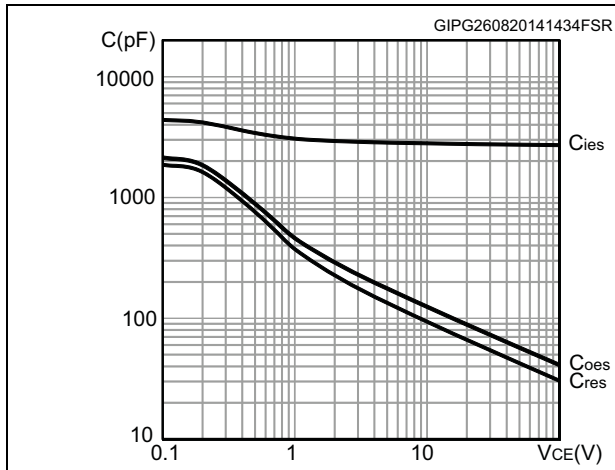


Figure 23. Gate charge vs. gate-emitter voltage

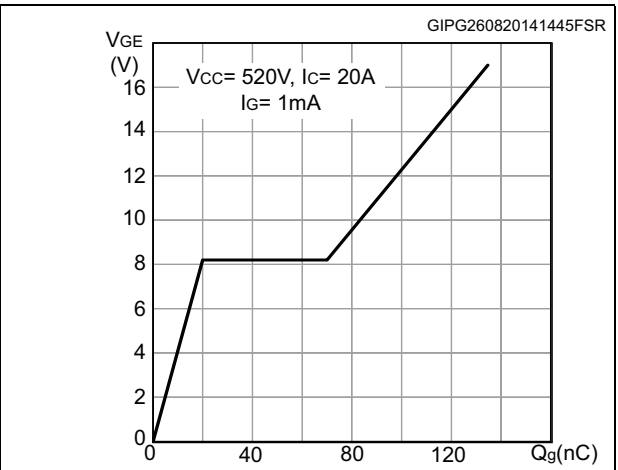


Figure 24. Thermal impedance for TO-247 and TO-3P

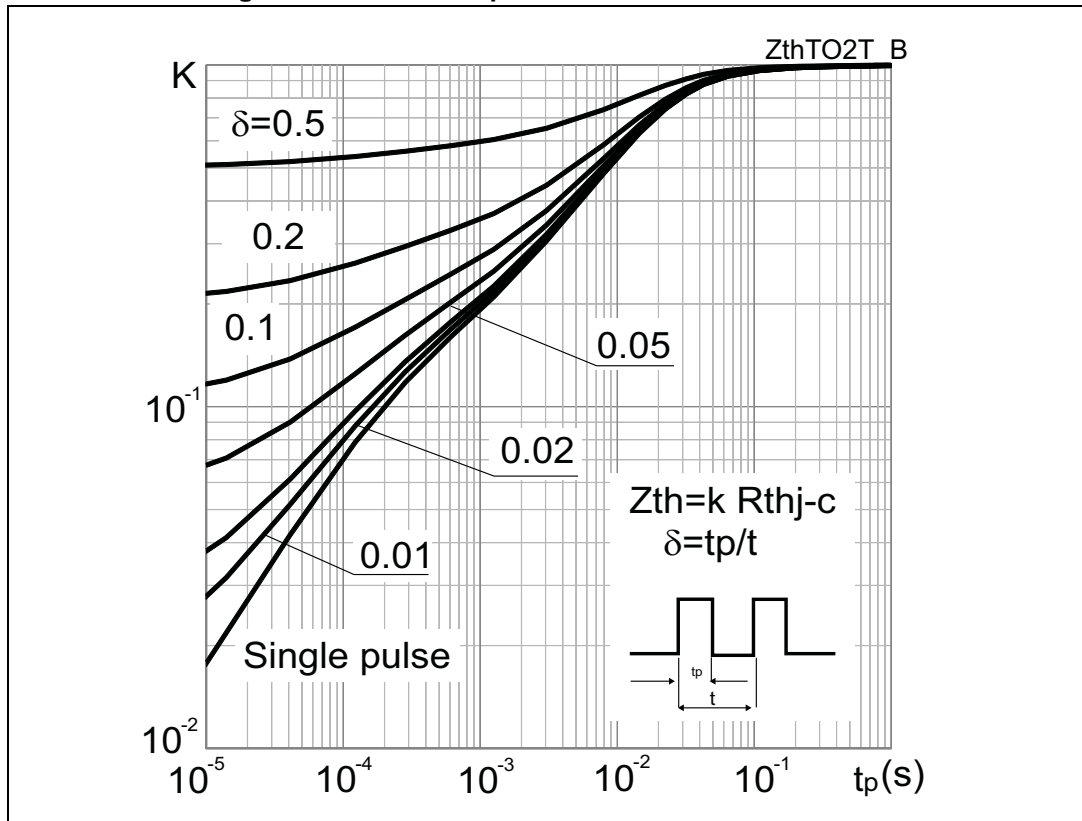
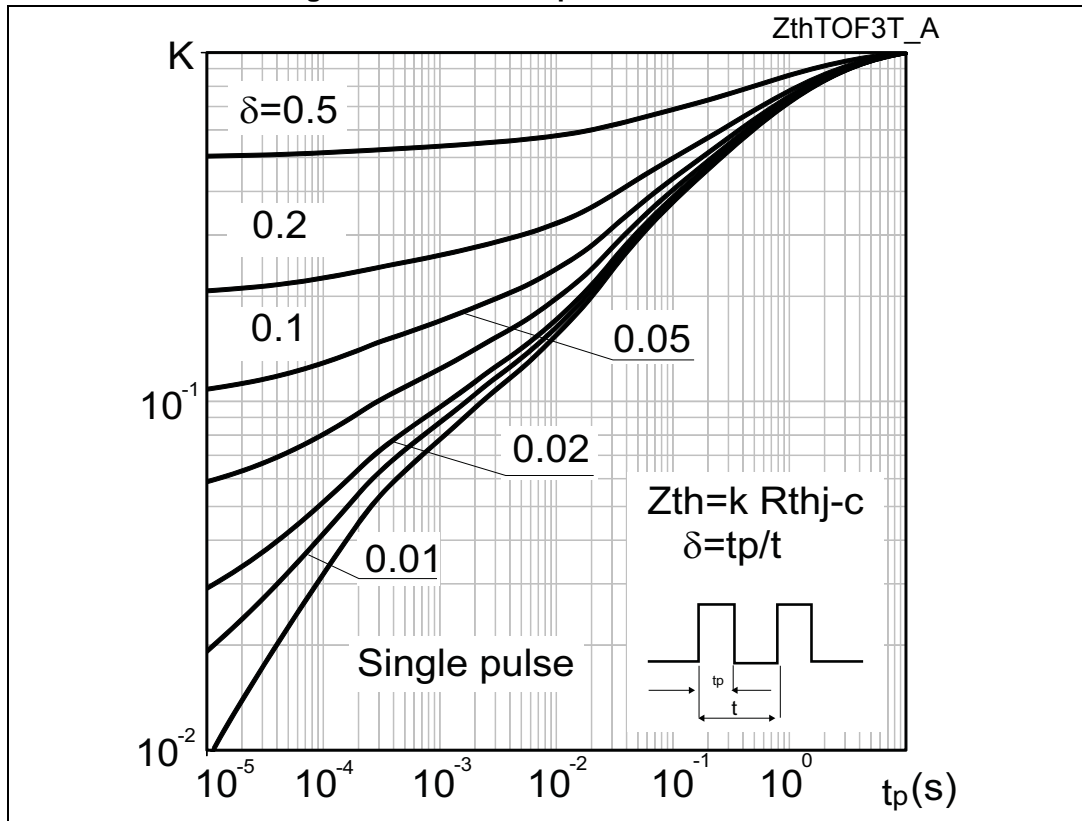


Figure 25. Thermal impedance for TO-3PF



### 3 Test circuits

Figure 26. Test circuit for inductive load switching

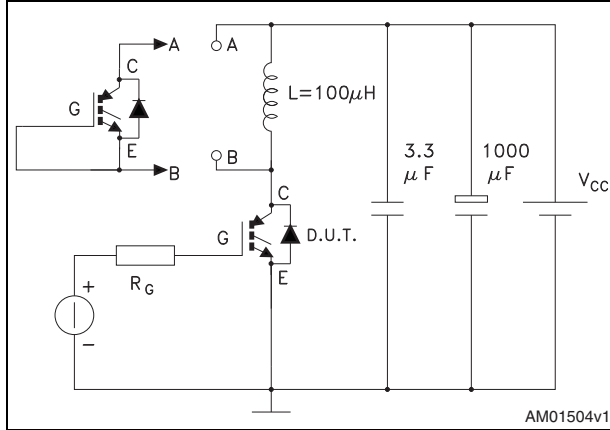


Figure 27. Gate charge test circuit

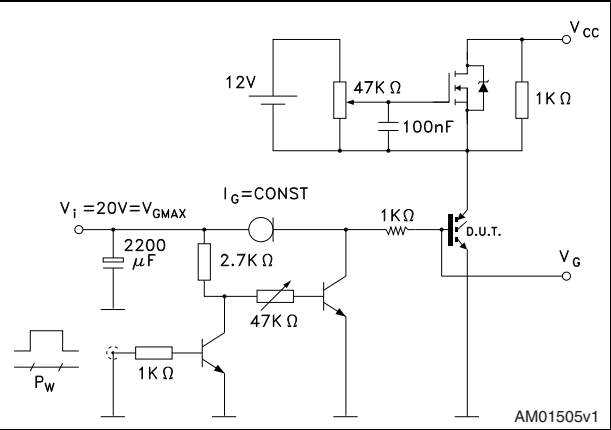
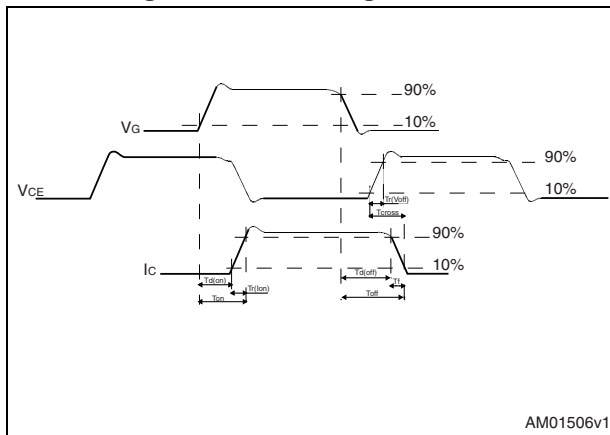


Figure 28. Switching waveform



## 4 Package 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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 TO-3PF, STGFW20H65FB

Figure 29. TO-3PF drawing

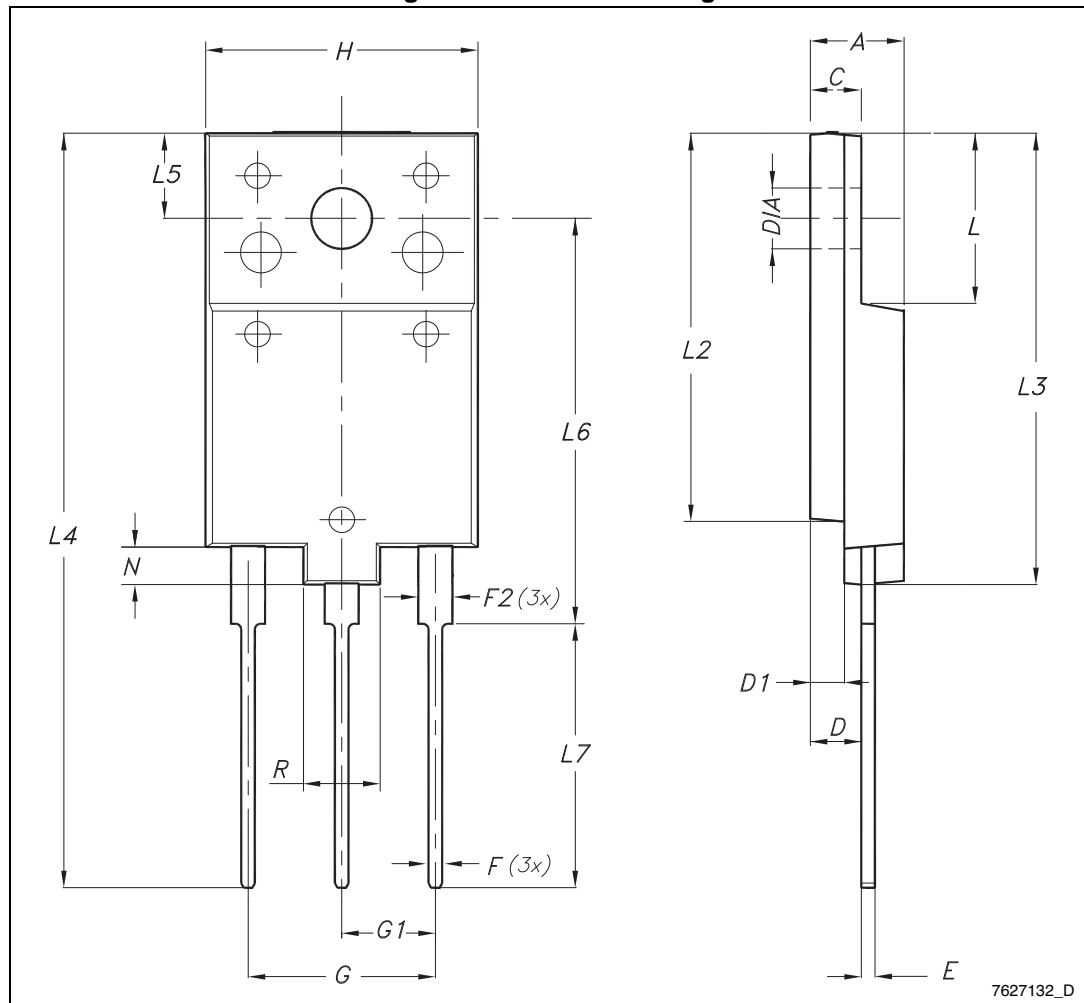
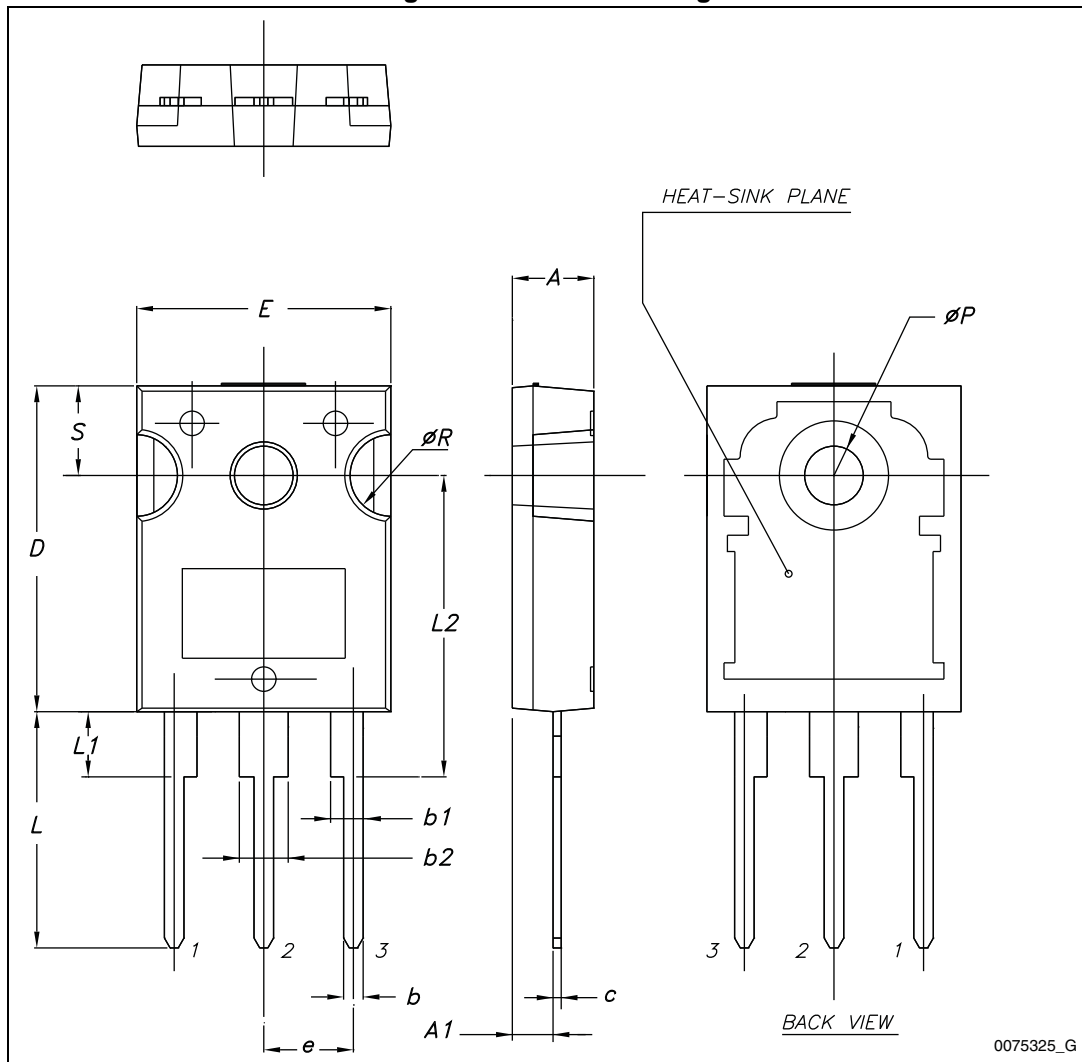


Table 7. TO-3PF mechanical data

| 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   | 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    |
| N    | 1.80  |      | 2.20  |
| R    | 3.80  |      | 4.20  |
| Dia  | 3.40  |      | 3.80  |

### 4.2 TO-247, STGW20H65FB

Figure 30. TO-247 drawing



0075325\_G

Table 8. TO-247 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, STGWT20H65FB

Figure 31. TO-3P drawing

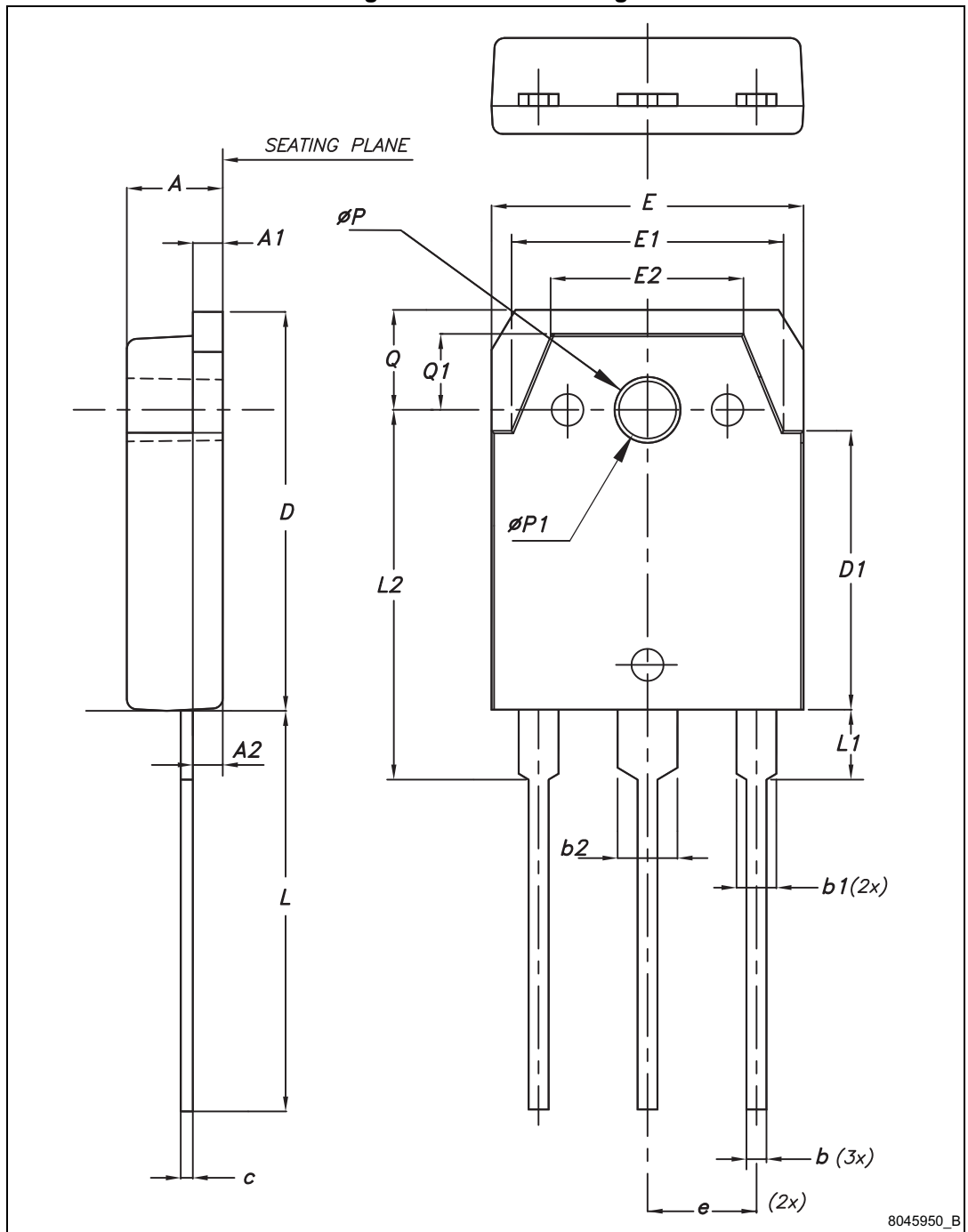


Table 9. TO-3P mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.60  | 4.80  | 5     |
| 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    | 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     | 5.20  |
| Q1   | 3.60  | 3.80  | 4     |

## 5 Revision history

Table 10. Document revision history

| Date        | Revision | Changes          |
|-------------|----------|------------------|
| 28-Aug-2014 | 1        | Initial release. |

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