

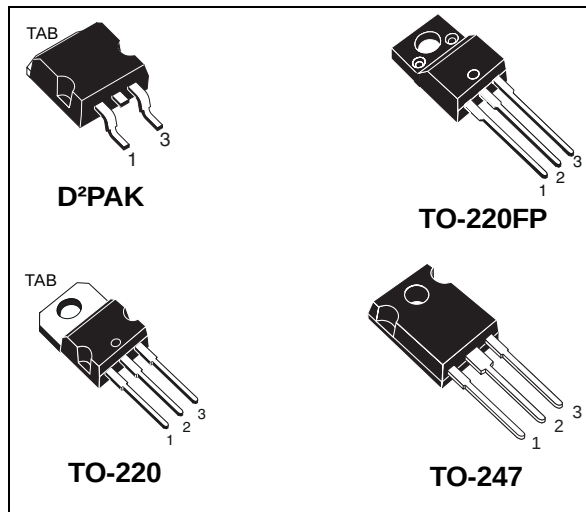
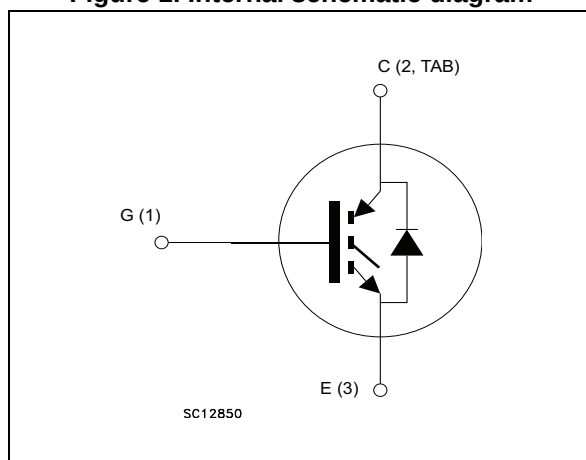


Figure 1. Internal schematic diagram



## Features

- High speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Short circuit rated
- Ultrafast soft recovery antiparallel diode

## Applications

- Inverter
- UPS
- PFC

## Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT series offers the optimum compromise between conduction and switching losses, maximizing the efficiency of very high frequency converters. Furthermore, a positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Table 1. Device summary

| Order codes | Marking   | Package  | Packaging     |
|-------------|-----------|----------|---------------|
| STGB30H60DF | GB30H60DF | D²PAK    | Tape and reel |
| STGF30H60DF | GF30H60DF | TO-220FP | Tube          |
| STGP30H60DF | GP30H60DF | TO-220   |               |
| STGW30H60DF | GW30H60DF | TO-247   |               |

Contents

1      **Electrical ratings** ..... 3

2      **Electrical characteristics** ..... 4

      2.1    Electrical characteristics (curves) ..... 7

3      **Test circuits** ..... 11

4      **Package mechanical data** ..... 12

5      **Packaging mechanical data** ..... 20

6      **Revision history** ..... 23



# 1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol                         | Parameter                                               | TO-220<br>D <sup>2</sup> PAK<br>TO-247 | TO-220FP           | Unit |
|--------------------------------|---------------------------------------------------------|----------------------------------------|--------------------|------|
| V <sub>CES</sub>               | Collector-emitter voltage (V <sub>GE</sub> = 0)         | 600                                    |                    | V    |
| I <sub>C</sub>                 | Continuous collector current at T <sub>C</sub> = 25 °C  | 60                                     | 60 <sup>(1)</sup>  | A    |
| I <sub>C</sub>                 | Continuous collector current at T <sub>C</sub> = 100 °C | 30                                     | 30 <sup>(1)</sup>  | A    |
| I <sub>CP</sub> <sup>(2)</sup> | Pulsed collector current                                | 120                                    | 120 <sup>(1)</sup> | A    |
| V <sub>GE</sub>                | Gate-emitter voltage                                    | ±20                                    |                    | V    |
| I <sub>F</sub>                 | Continuous forward current T <sub>C</sub> = 25 °C       | 60                                     | 60 <sup>(1)</sup>  | A    |
| I <sub>F</sub>                 | Continuous forward current at T <sub>C</sub> = 100 °C   | 30                                     | 30 <sup>(1)</sup>  | A    |
| I <sub>FP</sub> <sup>(2)</sup> | Pulsed forward current                                  | 120                                    | 120 <sup>(1)</sup> | A    |
| P <sub>TOT</sub>               | Total dissipation at T <sub>C</sub> = 25 °C             | 260                                    | 37 <sup>(1)</sup>  | W    |
| T <sub>STG</sub>               | Storage temperature range                               | - 55 to 150                            |                    | °C   |
| T <sub>J</sub>                 | Operating junction temperature                          | - 40 to 175                            |                    |      |

1. Limited by maximum junction temperature

2. Pulse width limited by maximum junction temperature and turn-off within RBSOA.

Table 3. Thermal data

| Symbol     | Parameter                              | Value              |          |        |        | Unit |
|------------|----------------------------------------|--------------------|----------|--------|--------|------|
|            |                                        | D <sup>2</sup> PAK | TO-220FP | TO-220 | TO-247 |      |
| $R_{thJC}$ | Thermal resistance junction-case IGBT  | 0.58               | 4        | 0.58   |        | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 2.5                | 5.6      | 2.5    |        | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient    | 62.5               |          |        | 50     | °C/W |

## 2 Electrical characteristics

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

**Table 4. Static**

| Symbol        | Parameter                                            | Test condition                                                        | Min. | Typ. | Max. | Unit          |
|---------------|------------------------------------------------------|-----------------------------------------------------------------------|------|------|------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage ( $V_{GE} = 0$ ) | $I_C = 2\text{ mA}$                                                   | 600  |      |      | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                 | $V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$                          |      | 2.0  | 2.4  | V             |
|               |                                                      | $V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$<br>$T_J = 175\text{ °C}$ |      | 2.4  |      | V             |
| $V_{GE(th)}$  | Gate threshold voltage                               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$                               | 5.0  | 6.0  | 7.0  | V             |
| $I_{CES}$     | Collector cut-off current ( $V_{GE} = 0$ )           | $V_{CE} = 600\text{ V}$                                               |      |      | 25   | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20\text{ V}$                                            |      |      | 250  | nA            |

**Table 5. Dynamic**

| Symbol    | Parameter                    | Test condition                                                            | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---------------------------------------------------------------------------|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0$             | -    | 3600 | -    | pF   |
| $C_{oes}$ | Output capacitance           |                                                                           |      | 130  |      | pF   |
| $C_{res}$ | Reverse transfer capacitance |                                                                           |      | 65   |      | pF   |
| $Q_g$     | Total gate charge            | $V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ | -    | 105  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |                                                                           | -    | 30   | -    | nC   |
| $Q_{gc}$  | Gate-collector charge        |                                                                           | -    | 35   | -    | nC   |

Table 6. Switching on/off (inductive load)

| Symbol         | Parameter                    | Test condition                                                                                                                      | Min. | Typ. | Max. | Unit       |
|----------------|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                                      | -    | 50   | -    | ns         |
| $t_r$          | Current rise time            |                                                                                                                                     |      | 15   |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |                                                                                                                                     |      | 1600 |      | A/ $\mu$ s |
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$ | -    | 47   | -    | ns         |
| $t_r$          | Current rise time            |                                                                                                                                     |      | 17   |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |                                                                                                                                     |      | 1400 |      | A/ $\mu$ s |
| $t_r(V_{off})$ | Off voltage rise time        | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                                      | -    | 20   | -    | ns         |
| $t_{d(off)}$   | Turn-off delay time          |                                                                                                                                     |      | 160  |      | ns         |
| $t_f$          | Current fall time            |                                                                                                                                     |      | 60   |      | ns         |
| $t_r(V_{off})$ | Off voltage rise time        | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$ | -    | 22   | -    | ns         |
| $t_{d(off)}$   | Turn-off delay time          |                                                                                                                                     |      | 146  |      | ns         |
| $t_f$          | Current fall time            |                                                                                                                                     |      | 88   |      | ns         |
| $t_{sc}$       | Short circuit withstand time | $V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$                                                                                 | 3    | 6    | -    | $\mu$ s    |

Table 7. Switching energy (inductive load)

| Symbol          | Parameter                 | Test condition                                                                                                                       | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CE} = 400\text{ V}$ , $I_C = 30\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                                       | -    | 0.35 | -    | mJ   |
| $E_{off}^{(2)}$ | Turn-off switching losses |                                                                                                                                      |      | 0.40 |      | mJ   |
| $E_{ts}$        | Total switching losses    |                                                                                                                                      |      | 0.75 |      | mJ   |
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CE} = 400\text{ V}$ , $I_C = 230\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$ |      | 0.61 |      | mJ   |
| $E_{off}^{(2)}$ | Turn-off switching losses |                                                                                                                                      |      | 0.84 |      | mJ   |
| $E_{ts}$        | Total switching losses    |                                                                                                                                      |      | 1.45 |      | mJ   |

1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

| Symbol    | Parameter                | Test condition                                                                                                   | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_F$     | Forward on-voltage       | $I_F = 30\text{ A}$                                                                                              | -    | 2.0  | 2.3  | V    |
|           |                          | $I_F = 30\text{ A}$ , $T_J = 175\text{ °C}$                                                                      |      | 1.5  |      | V    |
| $t_{rr}$  | Reverse recovery time    | $V_r = 400\text{ V}$ , $I_F = 30\text{ A}$ ;<br>$di_F/dt = 400\text{ A / } \mu\text{s}$                          | -    | 110  | -    | ns   |
| $Q_{rr}$  | Reverse recovery charge  |                                                                                                                  |      | 136  |      | nC   |
| $I_{rrm}$ | Reverse recovery current |                                                                                                                  |      | 2.5  |      | A    |
| $t_{rr}$  | Reverse recovery time    | $V_r = 400\text{ V}$ , $I_F = 30\text{ A}$ ;<br>$di_F/dt = 400\text{ A / } \mu\text{s}$<br>$T_J = 175\text{ °C}$ | -    | 190  | -    | ns   |
| $Q_{rr}$  | Reverse recovery charge  |                                                                                                                  |      | 506  |      | nC   |
| $I_{rrm}$ | Reverse recovery current |                                                                                                                  |      | 5.3  |      | A    |

## 2.1 Electrical characteristics (curves)

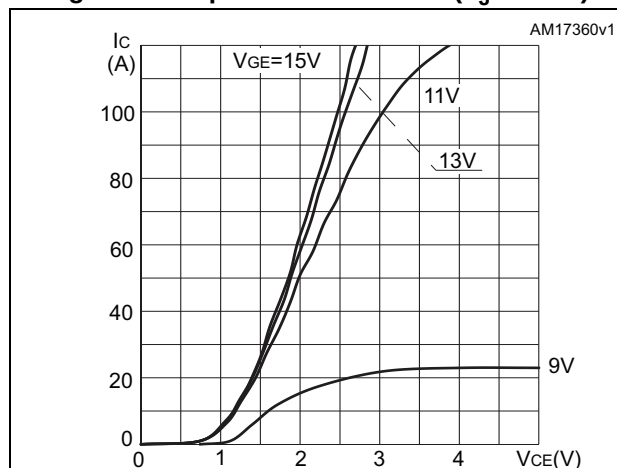
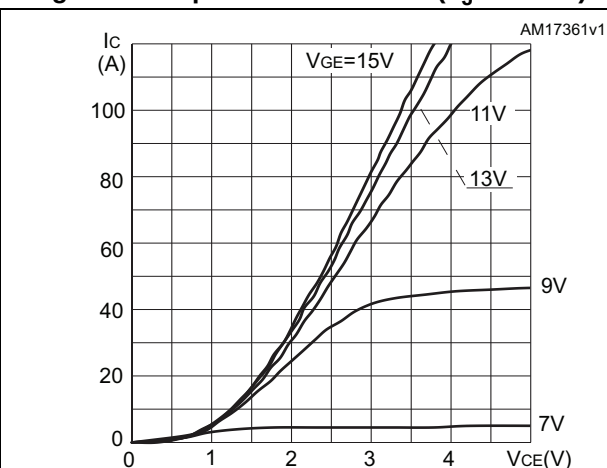
Figure 2. Output characteristics ( $T_J = 25^\circ\text{C}$ )Figure 3. Output characteristics ( $T_J = 175^\circ\text{C}$ )

Figure 4. Transfer characteristics

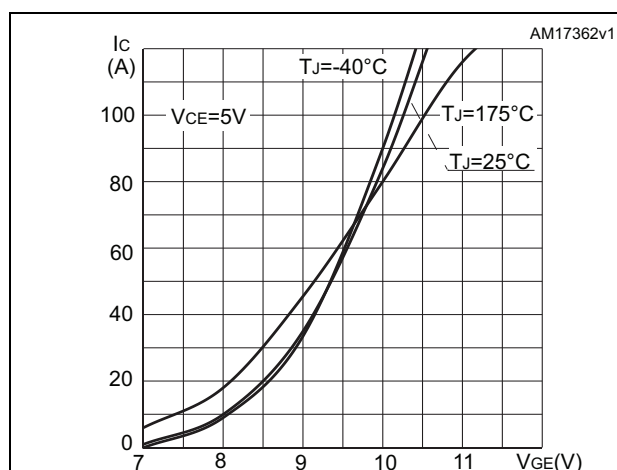
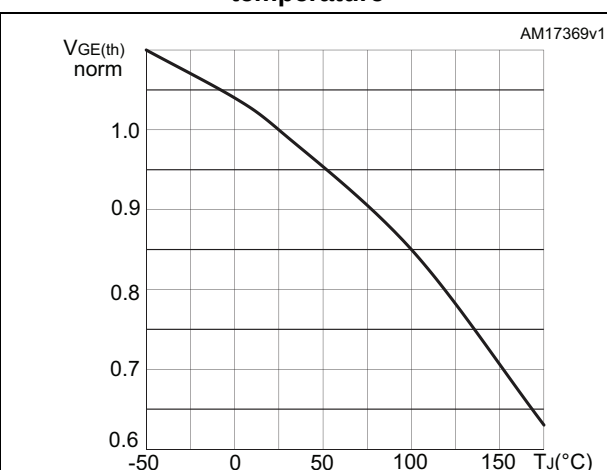
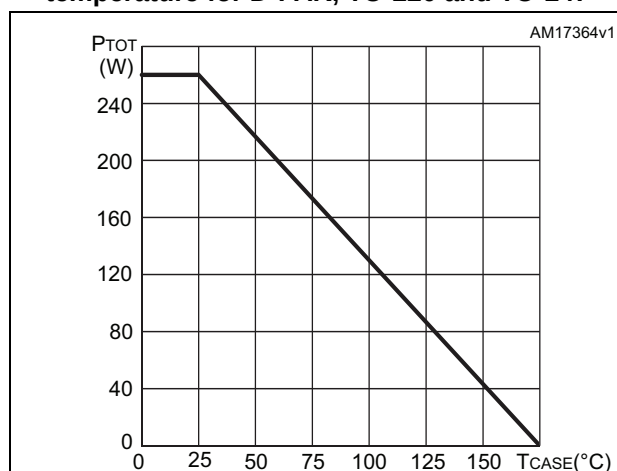
Figure 5. Normalized  $V_{GE(th)}$  vs. junction temperatureFigure 6. Power dissipation vs. case temperature for D<sup>2</sup>PAK, TO-220 and TO-247

Figure 7. Power dissipation vs. case temperature for TO-220FP

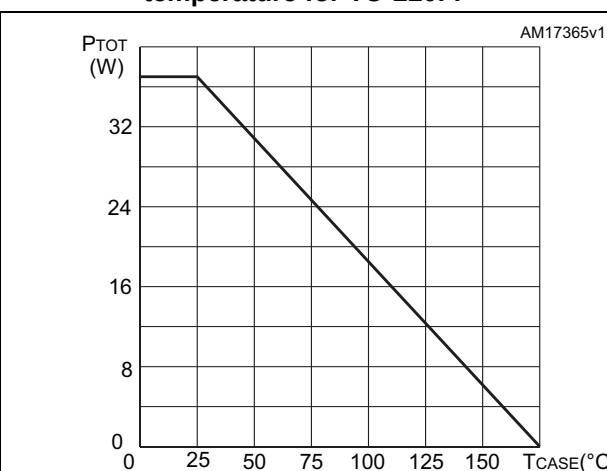


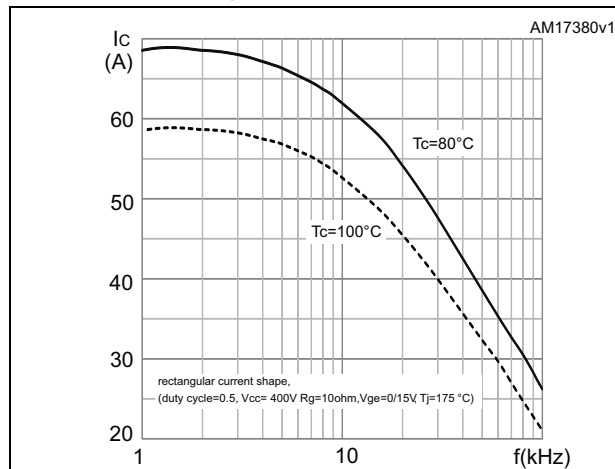
Figure 8. Collector current vs. frequency for D<sup>2</sup>PAK, TO-220 and TO-247

Figure 9. Collector current vs. frequency for TO-220FP

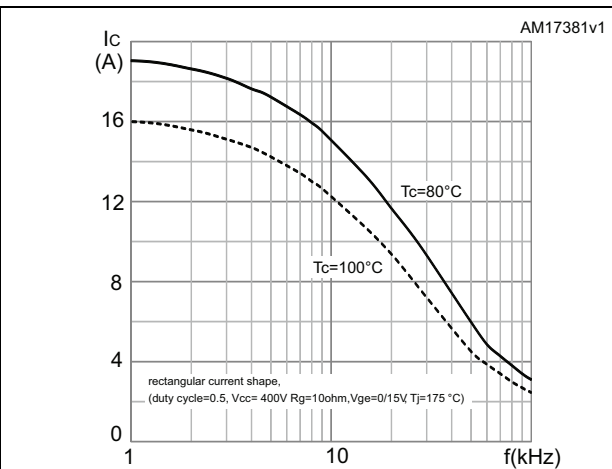
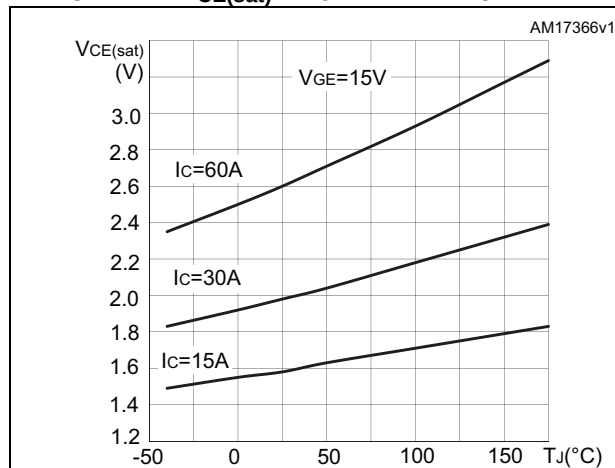
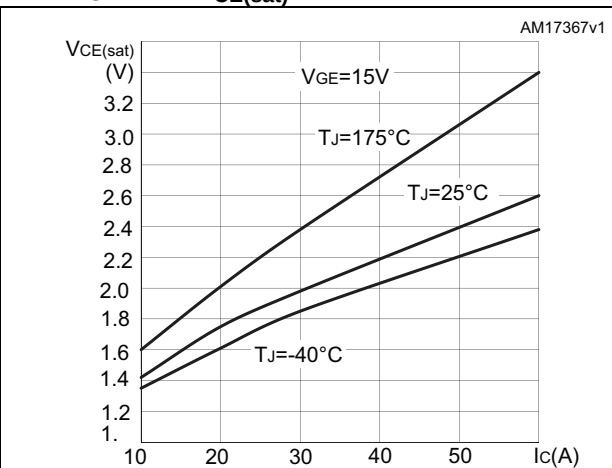
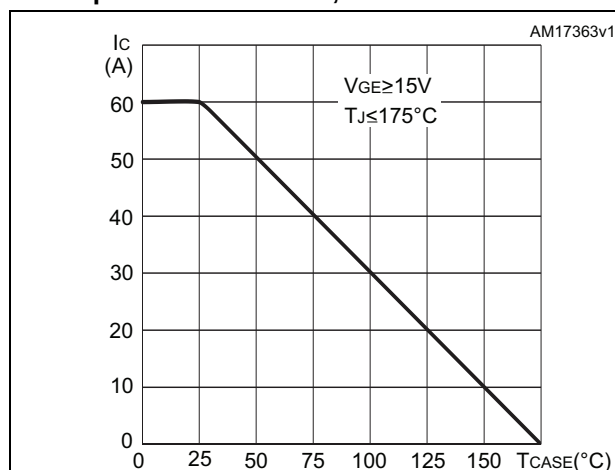
Figure 10.  $V_{CE(sat)}$  vs. junction temperatureFigure 11.  $V_{CE(sat)}$  vs. collector currentFigure 12. Collector current vs. case temperature for D<sup>2</sup>PAK, TO-220 and TO-247

Figure 13. Collector current vs. case temperature for TO-220FP

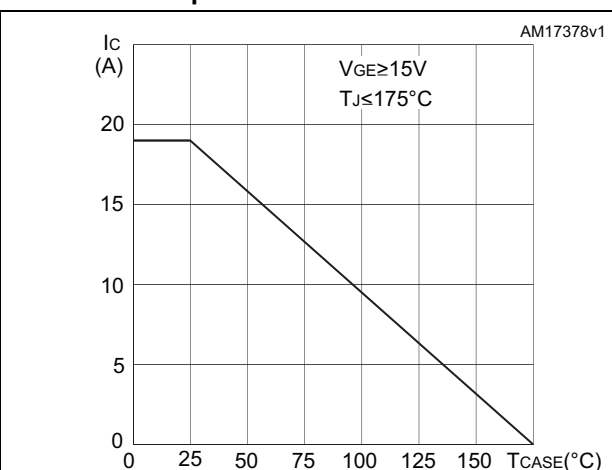


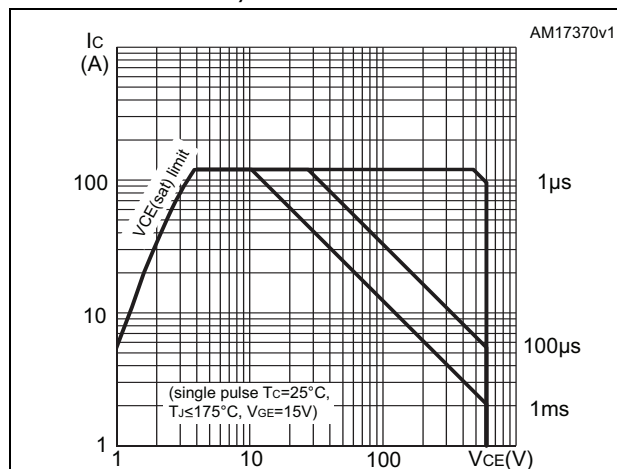
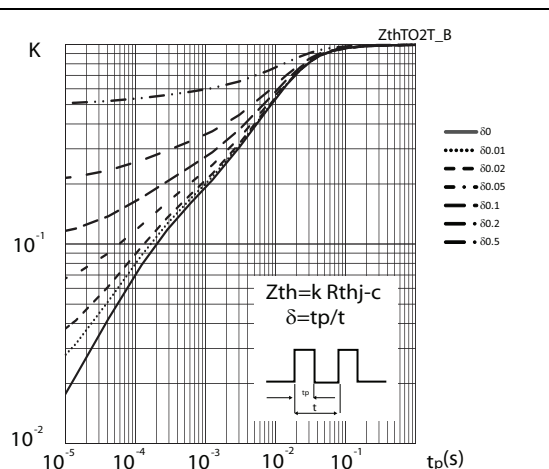
Figure 14. Forward bias safe operating area for TO-220, D<sup>2</sup>PAK and TO-247Figure 15. Thermal impedance for TO-220, D<sup>2</sup>PAK and TO-247

Figure 16. Forward bias safe operating area for TO-220FP

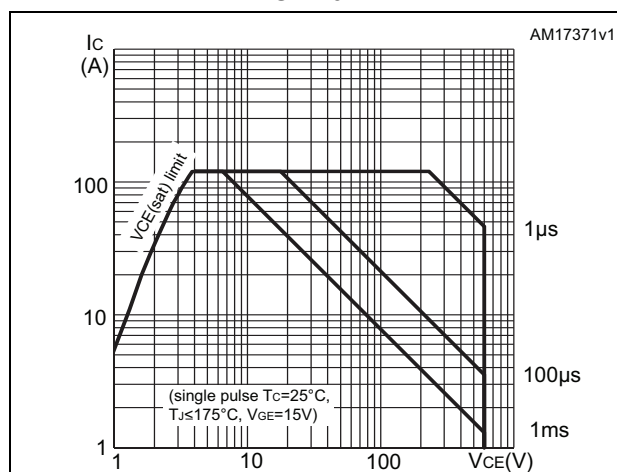


Figure 17. Thermal impedance for TO-220FP

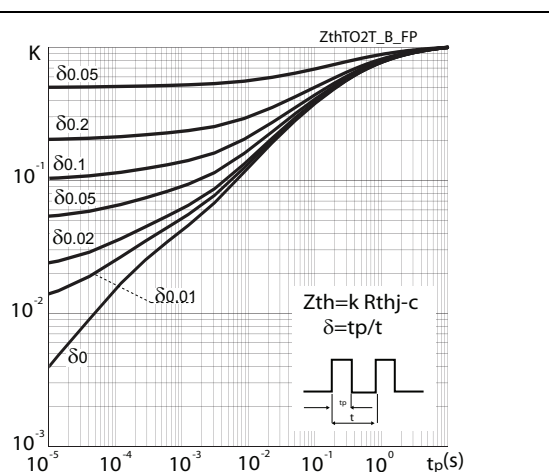


Figure 18. Gate charge vs. gate-emitter voltage

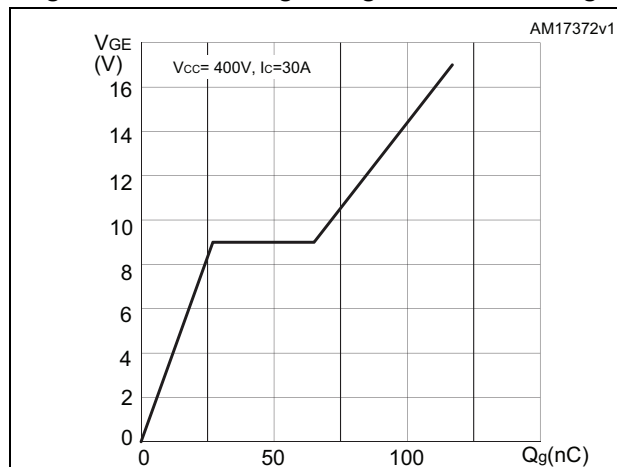


Figure 19. Capacitance variations vs. VCE

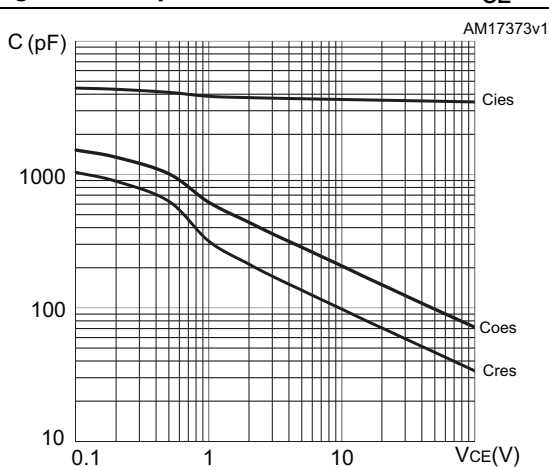


Figure 20. Diode VF vs. forward current

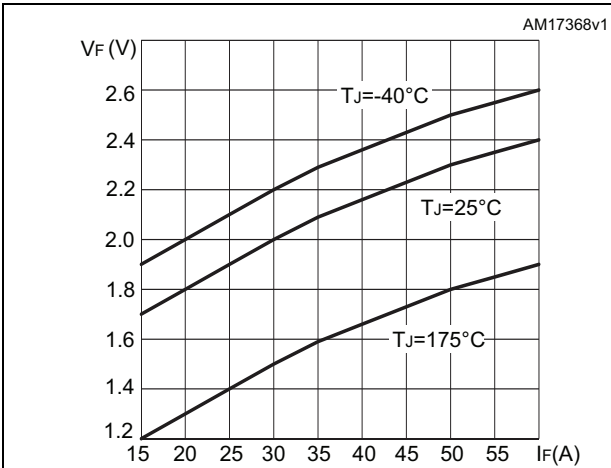


Figure 21. Switching losses vs. gate resistance

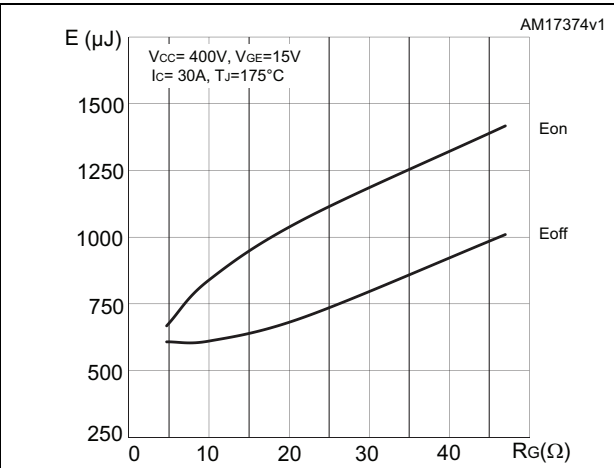


Figure 22. Switching losses vs. collector current

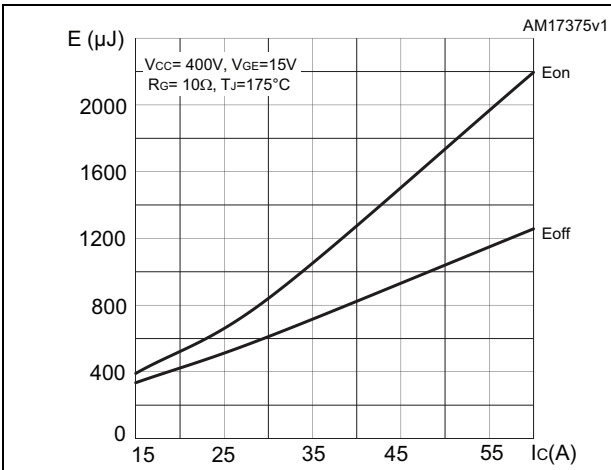


Figure 23. Switching losses vs temperature

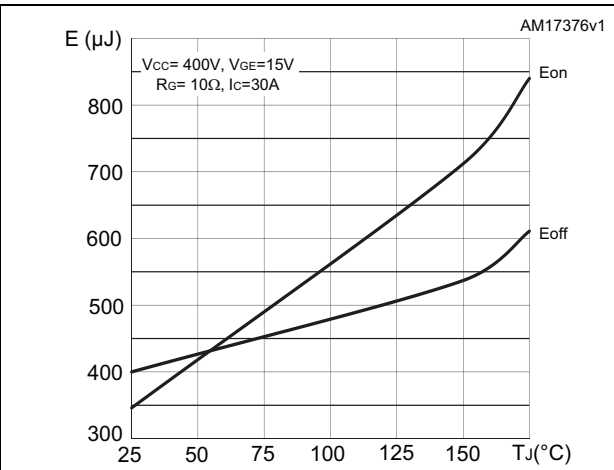
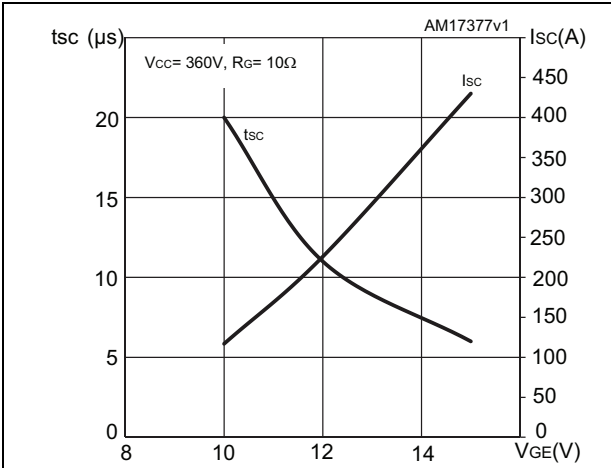


Figure 24. Short circuit time & current vs. VGE



### 3 Test circuits

Figure 25. Test circuit for inductive load switching

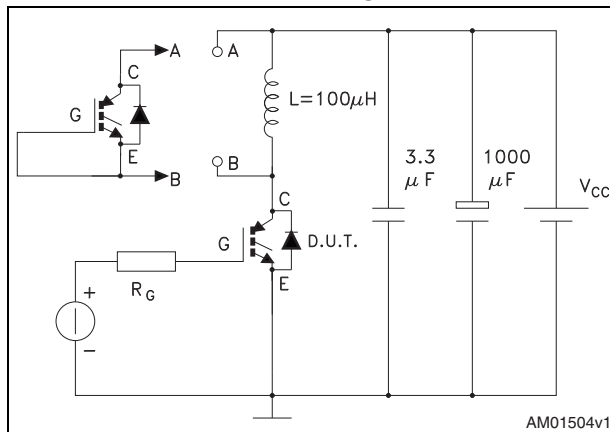


Figure 26. Gate charge test circuit

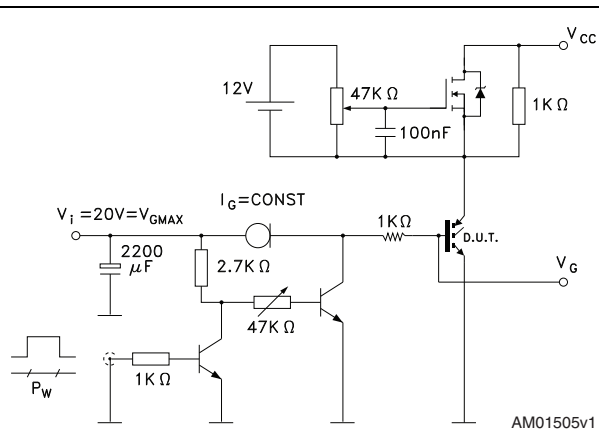


Figure 27. Switching waveform

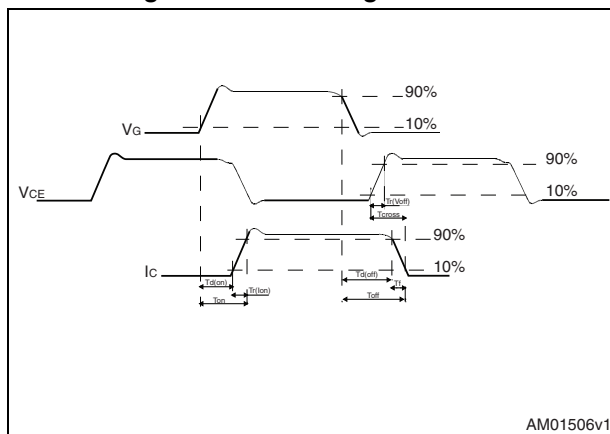
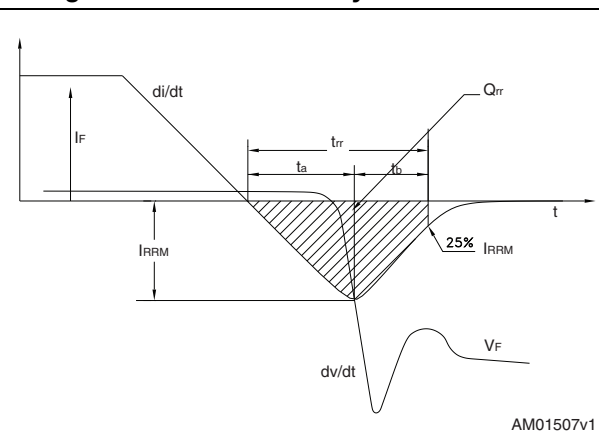


Figure 28. Diode recovery time waveform



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

**Table 9. D<sup>2</sup>PAK (TO-263) mechanical data**

| Dim. | mm   |      |       |
|------|------|------|-------|
|      | Min. | Typ. | Max.  |
| A    | 4.40 |      | 4.60  |
| A1   | 0.03 |      | 0.23  |
| b    | 0.70 |      | 0.93  |
| b2   | 1.14 |      | 1.70  |
| c    | 0.45 |      | 0.60  |
| c2   | 1.23 |      | 1.36  |
| D    | 8.95 |      | 9.35  |
| D1   | 7.50 |      |       |
| E    | 10   |      | 10.40 |
| E1   | 8.50 |      |       |
| e    |      | 2.54 |       |
| e1   | 4.88 |      | 5.28  |
| H    | 15   |      | 15.85 |
| J1   | 2.49 |      | 2.69  |
| L    | 2.29 |      | 2.79  |
| L1   | 1.27 |      | 1.40  |
| L2   | 1.30 |      | 1.75  |
| R    |      | 0.4  |       |
| V2   | 0°   |      | 8°    |

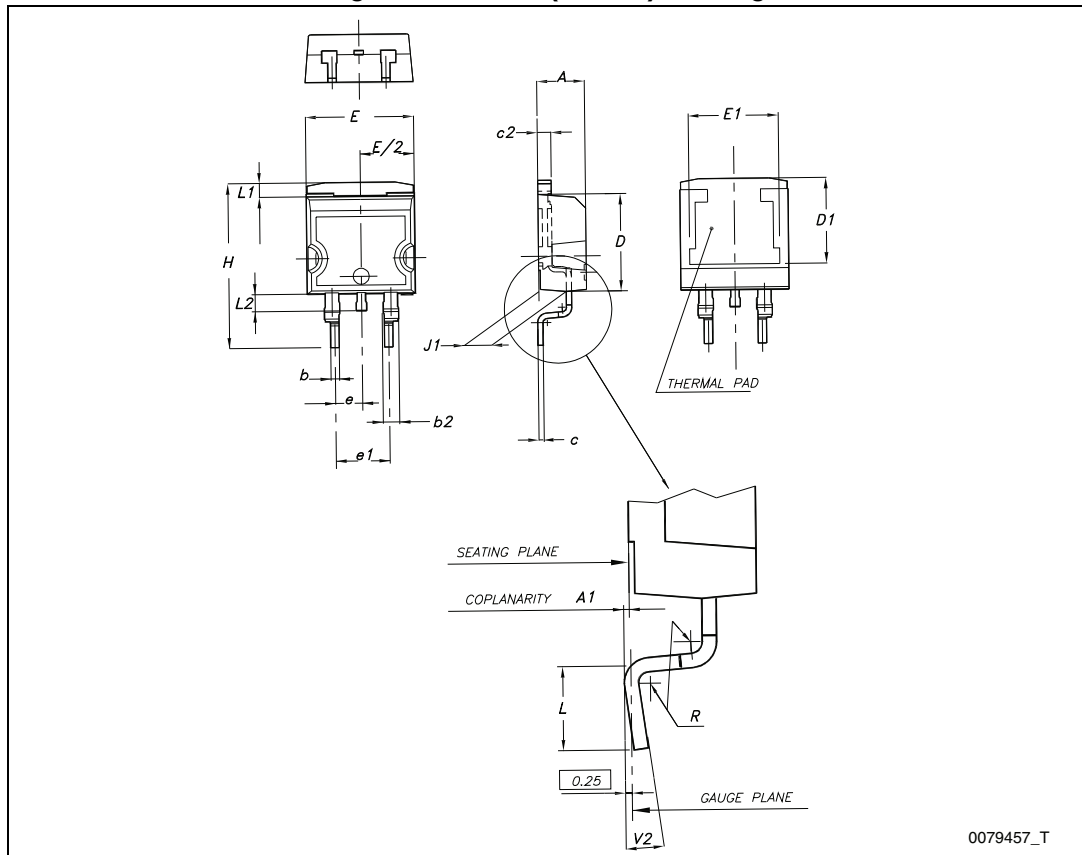
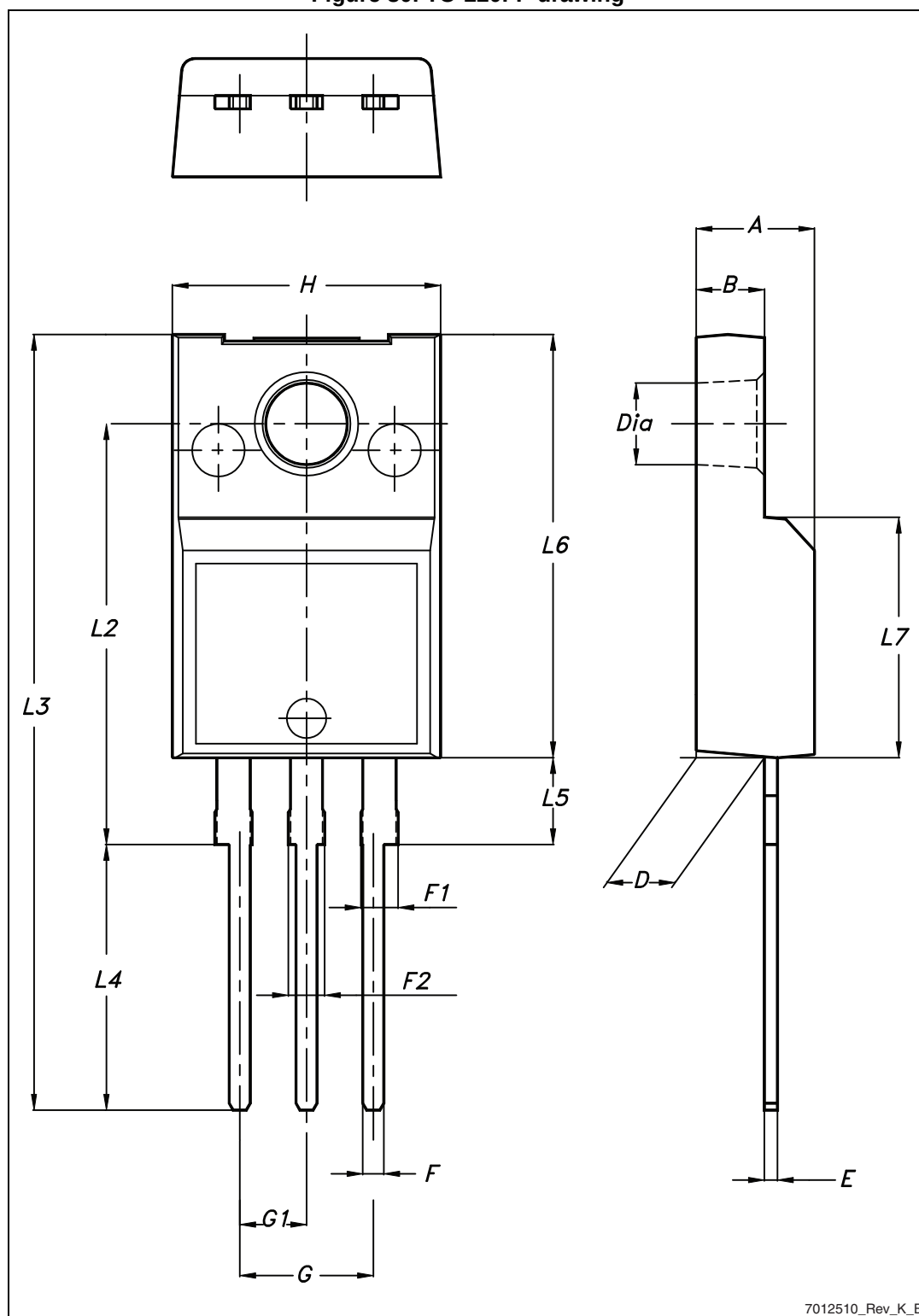
Figure 29. D<sup>2</sup>PAK (TO-263) drawing

Table 10. TO-220FP mechanical data

| Dim. | mm   |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    | 4.4  |      | 4.6  |
| B    | 2.5  |      | 2.7  |
| D    | 2.5  |      | 2.75 |
| E    | 0.45 |      | 0.7  |
| F    | 0.75 |      | 1    |
| F1   | 1.15 |      | 1.70 |
| F2   | 1.15 |      | 1.70 |
| G    | 4.95 |      | 5.2  |
| G1   | 2.4  |      | 2.7  |
| H    | 10   |      | 10.4 |
| L2   |      | 16   |      |
| L3   | 28.6 |      | 30.6 |
| L4   | 9.8  |      | 10.6 |
| L5   | 2.9  |      | 3.6  |
| L6   | 15.9 |      | 16.4 |
| L7   | 9    |      | 9.3  |
| Dia  | 3    |      | 3.2  |

Figure 30. TO-220FP drawing



7012510\_Rev\_K\_B

Table 11. TO-220 type A mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.40  |       | 4.60  |
| b    | 0.61  |       | 0.88  |
| b1   | 1.14  |       | 1.70  |
| c    | 0.48  |       | 0.70  |
| D    | 15.25 |       | 15.75 |
| D1   |       | 1.27  |       |
| E    | 10    |       | 10.40 |
| e    | 2.40  |       | 2.70  |
| e1   | 4.95  |       | 5.15  |
| F    | 1.23  |       | 1.32  |
| H1   | 6.20  |       | 6.60  |
| J1   | 2.40  |       | 2.72  |
| L    | 13    |       | 14    |
| L1   | 3.50  |       | 3.93  |
| L20  |       | 16.40 |       |
| L30  |       | 28.90 |       |
| ØP   | 3.75  |       | 3.85  |
| Q    | 2.65  |       | 2.95  |

Figure 31. TO-220 type A drawing

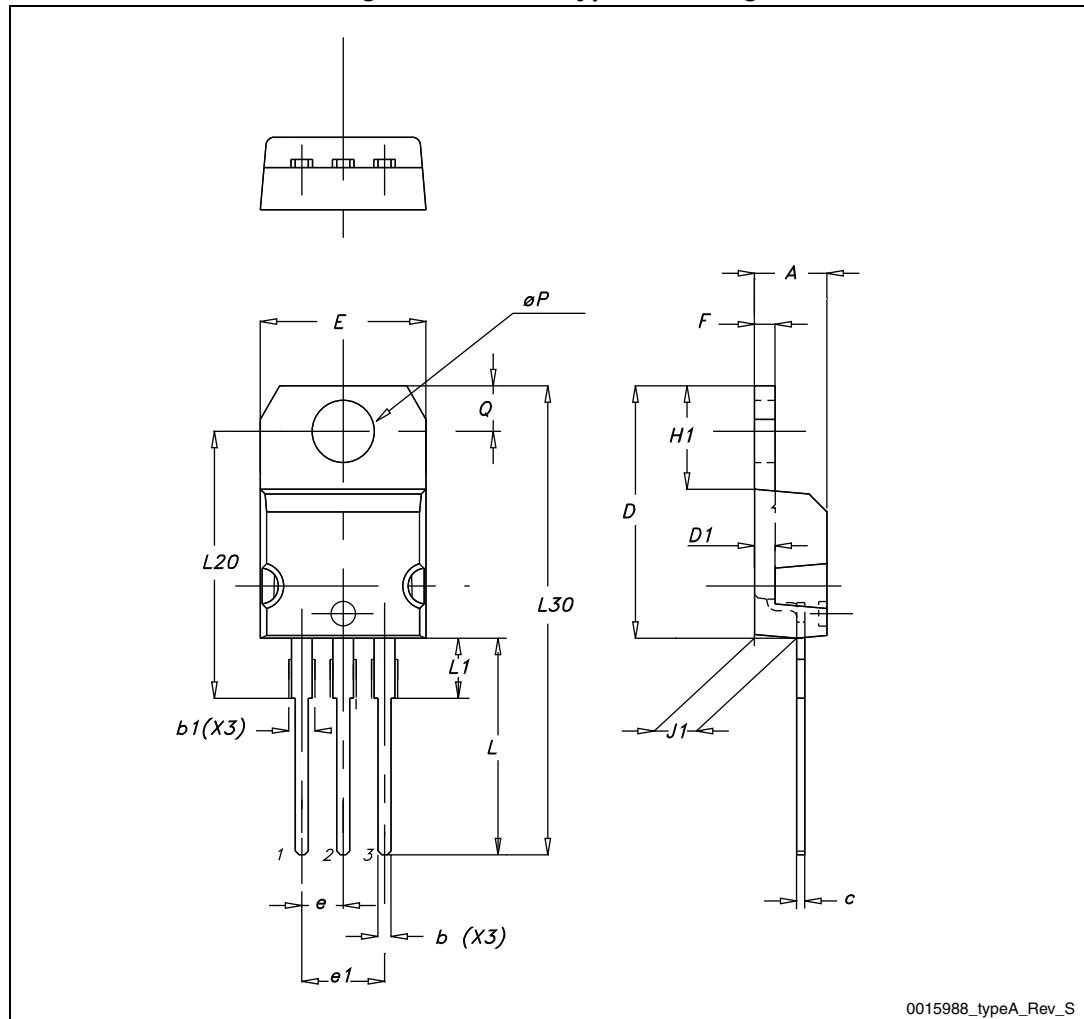
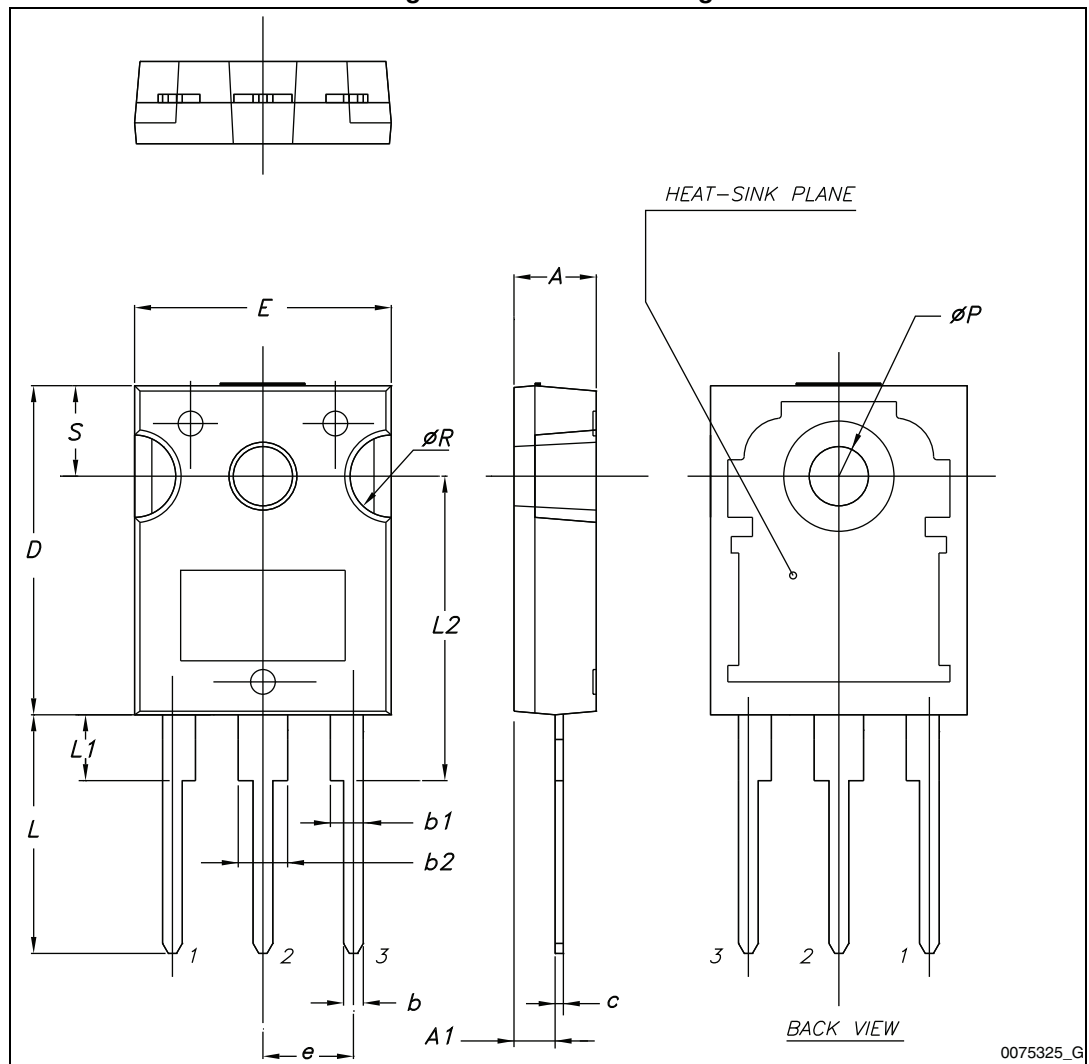


Table 12. TO-247 mechanical data

| 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  |

Figure 32. TO-247 drawing

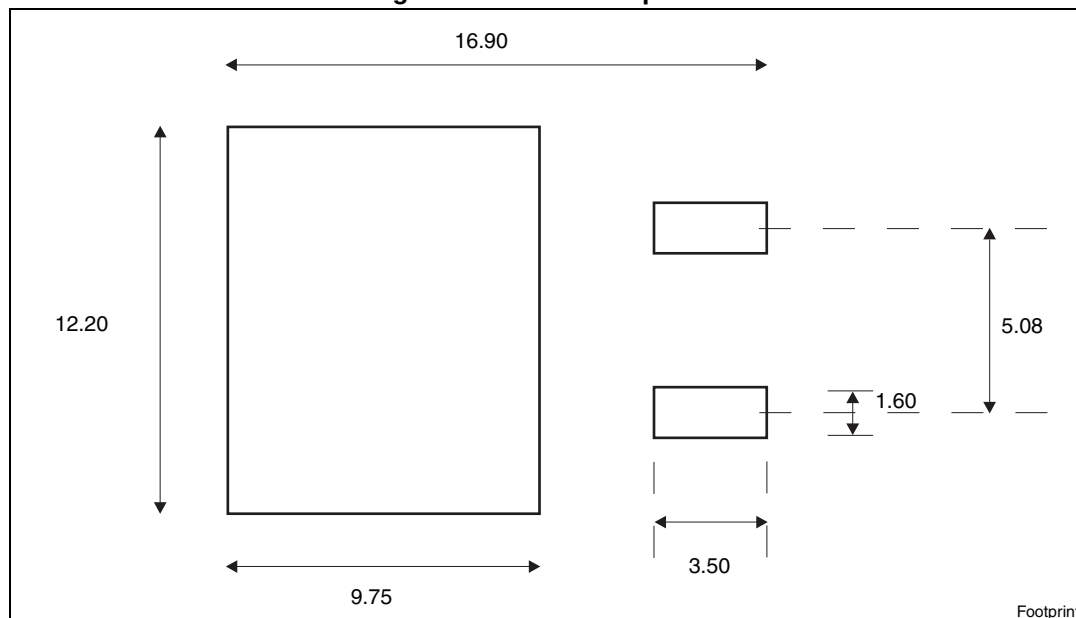


## 5 Packaging mechanical data

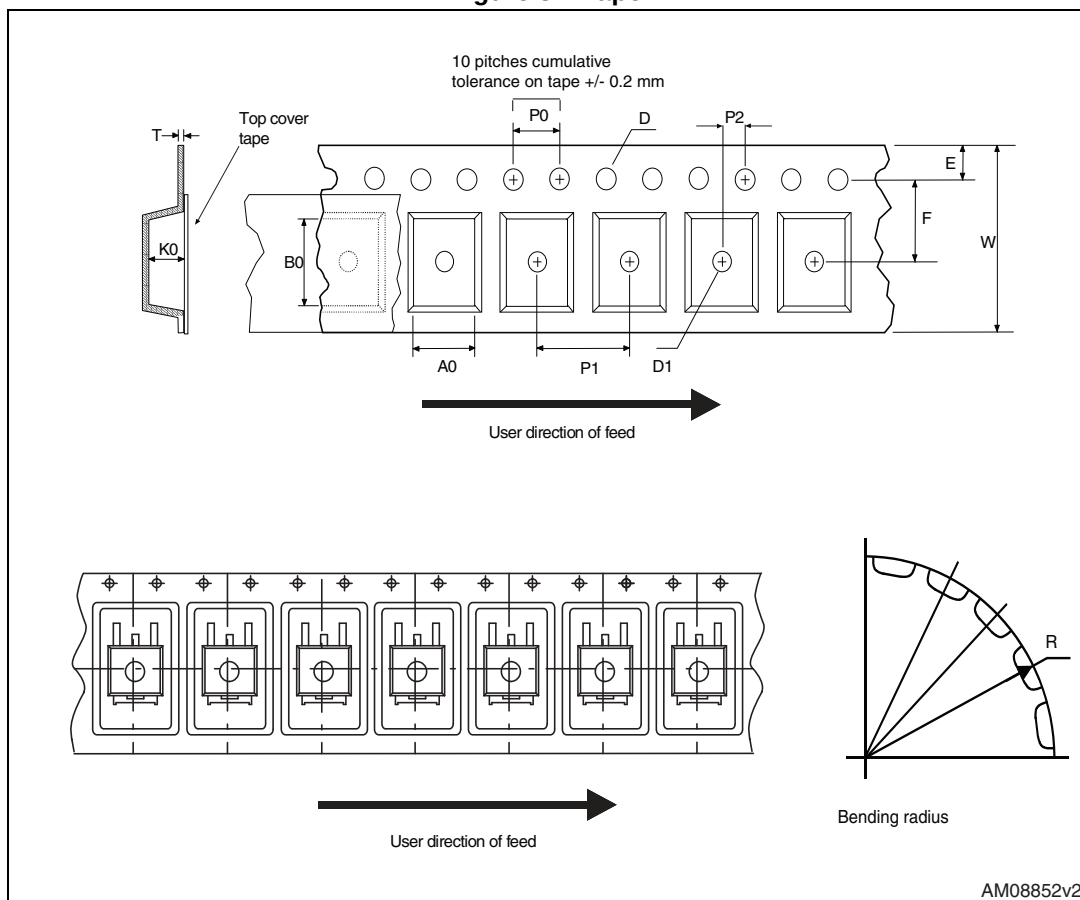
**Table 13. D<sup>2</sup>PAK (TO-263) tape and reel mechanical data**

| Tape |      |      | Reel     |      |      |
|------|------|------|----------|------|------|
| Dim. | mm   |      | Dim.     | mm   |      |
|      | Min. | Max. |          | Min. | Max. |
| A0   | 10.5 | 10.7 | A        |      | 330  |
| B0   | 15.7 | 15.9 | B        | 1.5  |      |
| D    | 1.5  | 1.6  | C        | 12.8 | 13.2 |
| D1   | 1.59 | 1.61 | D        | 20.2 |      |
| E    | 1.65 | 1.85 | G        | 24.4 | 26.4 |
| F    | 11.4 | 11.6 | N        | 100  |      |
| K0   | 4.8  | 5.0  | T        |      | 30.4 |
| P0   | 3.9  | 4.1  |          |      |      |
| P1   | 11.9 | 12.1 | Base qty |      | 1000 |
| P2   | 1.9  | 2.1  | Bulk qty |      | 1000 |
| R    | 50   |      |          |      |      |
| T    | 0.25 | 0.35 |          |      |      |
| W    | 23.7 | 24.3 |          |      |      |

**Figure 33. D<sup>2</sup>PAK footprint<sup>(a)</sup>**

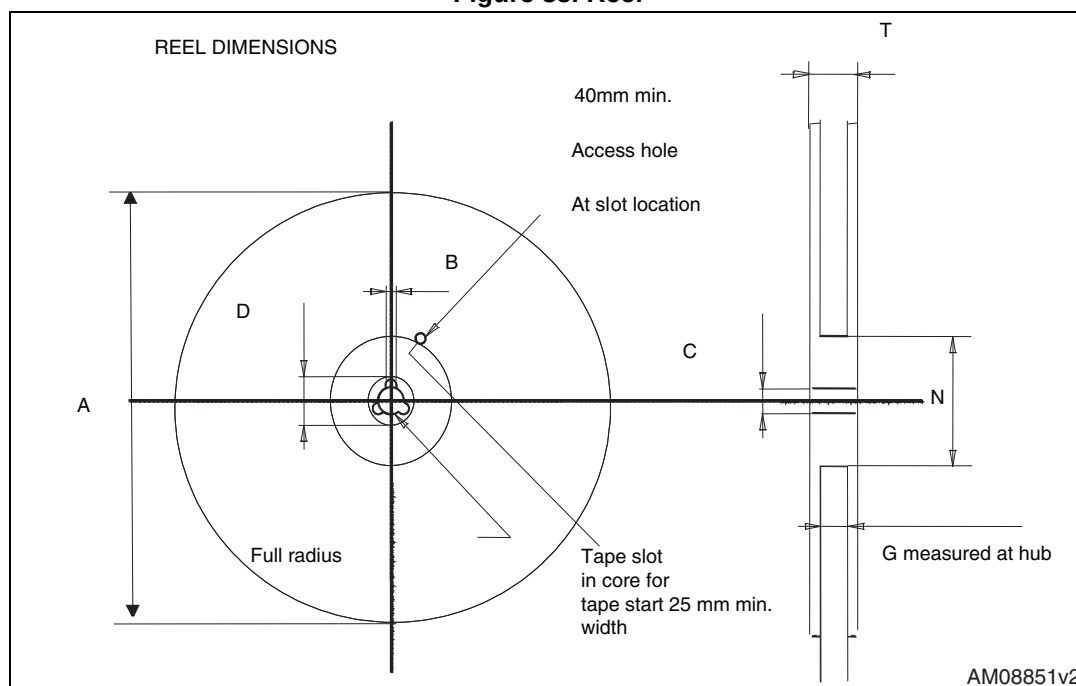


### Figure 34. Tape



a. All dimensions are in millimeters

**Figure 35. Reel**



## 6 Revision history

**Table 14. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                        |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14-Oct-2011 | 1        | Initial release.                                                                                                                                                                               |
| 03-Oct-2012 | 2        | Document status promoted from target specification to preliminary data.                                                                                                                        |
| 20-Mar-2013 | 3        | Document status promoted from preliminary data to production data.<br>Added new root part number STGF30H60DF in TO-220FP package.<br>Added new root part number STGW30H60DF in TO-247 package. |

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