

Features

- Optimized performance for medium operating frequencies up to 5 kHz in hard switching
- Low on-voltage drop ($V_{CE(sat)}$)
- Very soft ultra fast antiparallel diode

Application

- Motor drive

Description

This IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.

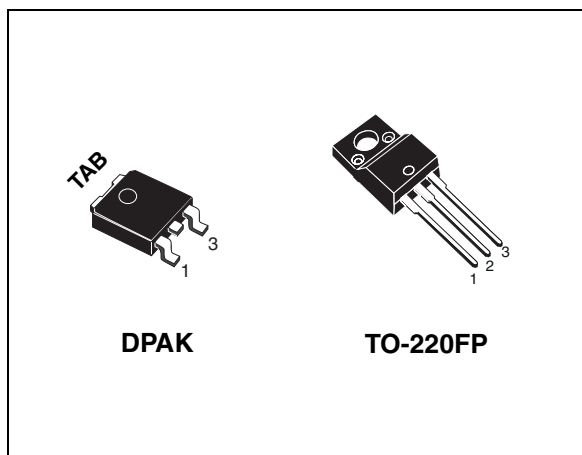


Figure 1. Internal schematic diagram

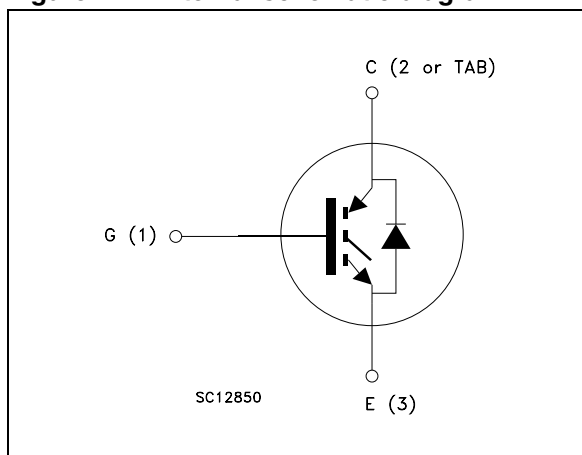


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|----------------|------------|----------|---------------|
| STGD10NC60SDT4 | GD10NC60SD | DPAK | Tape and reel |
| STGF10NC60SD | GF10NC60SD | TO-220FP | Tube |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|--|------------|----------|------|
| | | DPAK | TO-220FP | |
| V _{CES} | Collector-emitter voltage (V _{GE} = 0) | 600 | | V |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 25 °C | 18 | 10 | A |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 100 °C | 10 | 5 | A |
| I _{CL} ⁽²⁾ | Turn-off latching current | 14 | | A |
| I _{CP} ⁽³⁾ | Pulsed collector current | 25 | | A |
| I _F | Diode RMS forward current at T _C =25 °C | 10 | | A |
| I _{FSM} | Surge non repetitive forward current t _p = 10 ms sinusoidal | 20 | | A |
| V _{GE} | Gate-emitter voltage | ±20 | | V |
| P _{TOT} | Total dissipation at T _C = 25 °C | 60 | 25 | W |
| V _{ISO} | Isolation withstand voltage (RMS) from all three leads to external heat sink (t = 1 sec; T _C = 25 °C) | 2500 | | V |
| T _j | Operating junction temperature | -55 to 150 | | °C |

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. V_{clamp} = 80%,(V_{CES}), T_j = 150 °C, R_G = 10 Ω, V_{GE} = 15 V.

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

Table 3. Thermal data

| Symbol | Parameter | Value | | Unit |
|-----------------------|--|-------|----------|------|
| | | DPAK | TO-220FP | |
| R _{thj-case} | Thermal resistance junction-case IGBT | 2.08 | 5 | °C/W |
| | Thermal resistance junction-case diode | 4.5 | | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient | 100 | 62.5 | °C/W |

2 Electrical characteristics

($T_J=25^\circ\text{C}$ unless otherwise specified)

Table 4. Static

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|--|------|--------------|-----------|---------------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage ($V_{GE}=0$) | $I_C=1\text{ mA}$ | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}=15\text{ V}$, $I_C=5\text{ A}$ $V_{GE}=15\text{ V}$, $I_C=5\text{ A}$, $T_J=125^\circ\text{C}$ | | 1.45 1.45 | 1.65 | V V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}=V_{GE}$, $I_C=250\text{ }\mu\text{A}$ | 3.75 | | 5.75 | V |
| I_{CES} | Collector cut-off current ($V_{GE}=0$) | $V_{CE}=600\text{ V}$ $V_{CE}=600\text{ V}$, $T_J=125^\circ\text{C}$ | | | 150 1 | μA mA |
| I_{GES} | Gate-emitter leakage ($V_{CE}=0$) | $V_{GE}=\pm 20\text{ V}$ | | | ± 100 | nA |
| g_{fs} | Forward transconductance | $V_{CE}=15\text{ V}$, $I_C=5\text{ A}$ | | 3.5 | | S |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE}=25\text{ V}$, $f=1\text{ MHz}$, $V_{GE}=0$ | - | 365 | - | pF |
| C_{oes} | Output capacitance | | | 44 | | |
| C_{res} | Reverse transfer capacitance | | | 8 | | |
| Q_g | Total gate charge | $V_{CE}=480\text{ V}$, $I_C=5\text{ A}$, | - | 18 | - | nC |
| Q_{ge} | Gate-emitter charge | $V_{GE}=15\text{ V}$ | | 8 | | |
| Q_{gc} | Gate-collector charge | Figure 18 | | 3.5 | | |

Table 6. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|--|------|-------------------|------|------------------------|
| $t_{d(on)}$ t_r $(di/dt)_{on}$ | Turn-on delay time Current rise time Turn-on current slope | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, <i>Figure 19</i> | - | 19 4 1330 | - | ns ns A/ μ s |
| $t_{d(on)}$ t_r $(di/dt)_{on}$ | Turn-on delay time Current rise time Turn-on current slope | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125^\circ\text{C}$ <i>Figure 19</i> | - | 18 4.5 1000 | - | ns ns A/ μ s |
| $t_r(V_{off})$ $t_{d(off)}$ t_f | Off voltage rise time Turn-off delay time Current fall time | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, <i>Figure 19</i> | - | 100 160 205 | - | ns ns ns |
| $t_r(V_{off})$ $t_{d(off)}$ t_f | Off voltage rise time Turn-off delay time Current fall time | $V_{CC} = 390\text{ V}$, $I_C = 5\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125^\circ\text{C}$ <i>Figure 19</i> | - | 165 250 310 | - | ns ns ns |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|--|------|------------------|------|-------------------------------|
| $E_{on}^{(1)}$ $E_{off}^{(2)}$ E_{ts} | Turn-on switching losses Turn-off switching losses Total switching losses | $V_{CC} = 480\text{ V}$, $I_C = 5\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, <i>Figure 17</i> | - | 60 340 400 | - | μ J μ J μ J |
| $E_{on}^{(1)}$ $E_{off}^{(2)}$ E_{ts} | Turn-on switching losses Turn-off switching losses Total switching losses | $V_{CC} = 480\text{ V}$, $I_C = 5\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125^\circ\text{C}$ <i>Figure 17</i> | - | 90 540 630 | - | μ J μ J μ J |

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in *Figure 17*. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature.
2. Turn-off losses included also include also the tail of the collector current.

Table 8. Collector-emitter diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|--|--|------|-----------------|------|---------------|
| V_F | Forward on-voltage | $I_F = 5\text{ A}$ $I_F = 5\text{ A}$, $T_J = 125^\circ\text{C}$ | - | 2 1.65 | 2.45 | V V |
| t_{rr} Q_{rr} I_{rrm} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_F = 5\text{ A}$, $V_R = 40\text{ V}$, $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 20</i> | - | 22 14 1.3 | | ns nC A |
| t_{rr} Q_{rr} I_{rrm} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_F = 5\text{ A}$, $V_R = 40\text{ V}$, $T_J = 125^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 20</i> | - | 34 35 2.1 | | ns nC A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

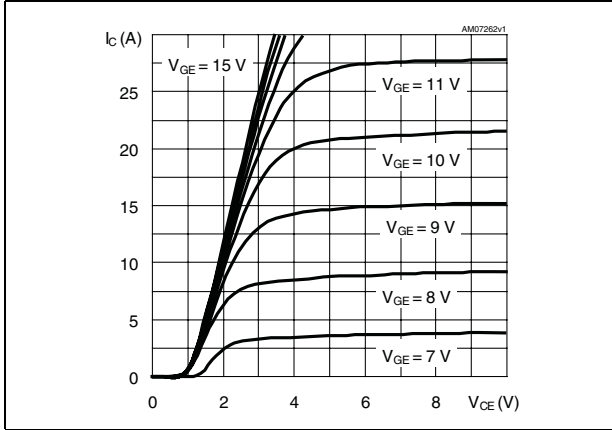


Figure 3. Transfer characteristics

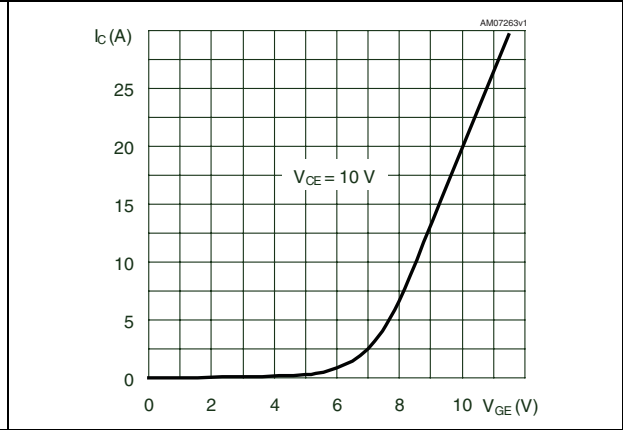


Figure 4. Collector-emitter on voltage vs collector current

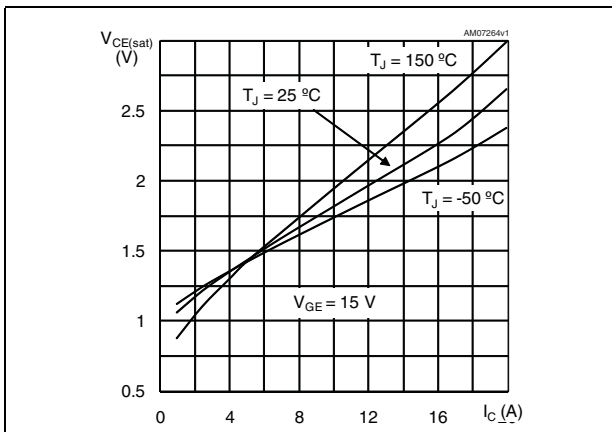


Figure 5. Collector-emitter on voltage vs temperature

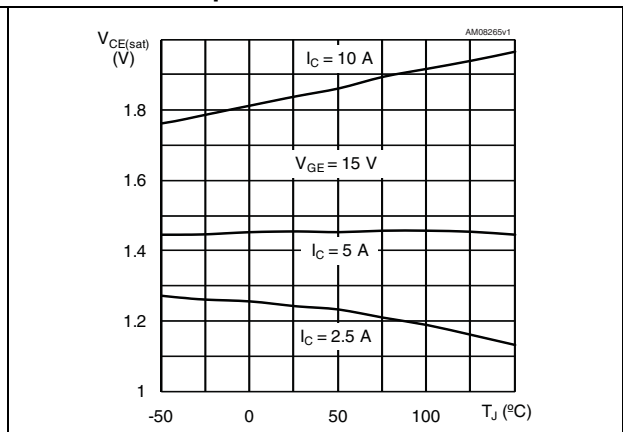


Figure 6. Normalized breakdown voltage vs temperature

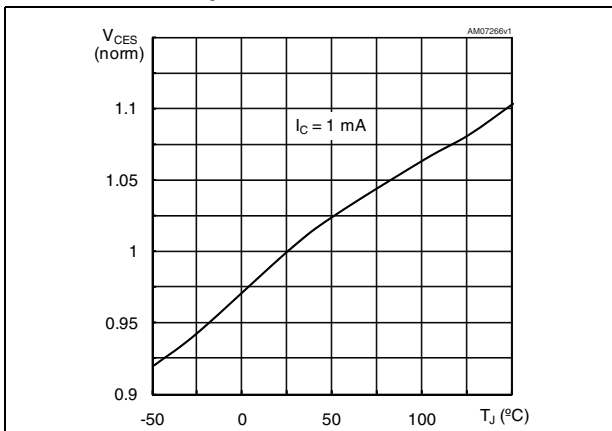


Figure 7. Normalized gate threshold vs temperature

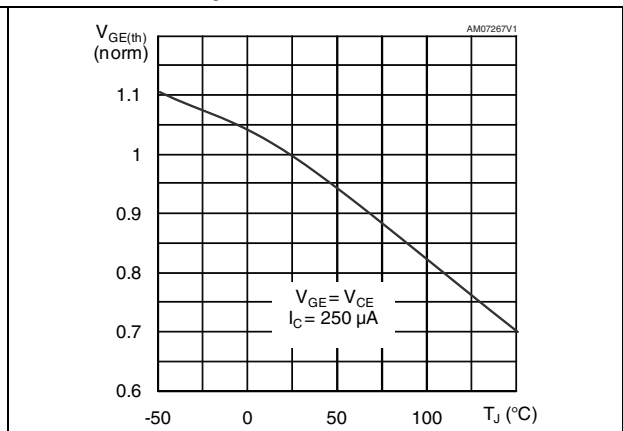


Figure 8. Capacitance variations

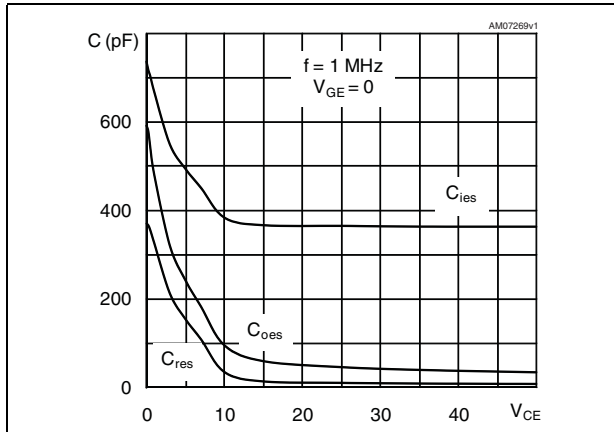


Figure 9. Gate charge vs gate-emitter voltage

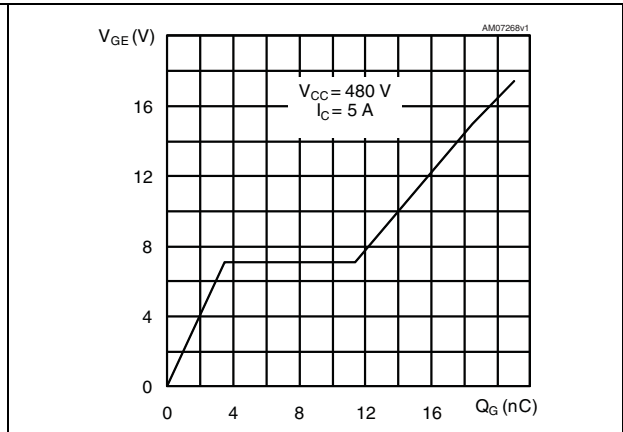


Figure 10. Switching losses vs temperature

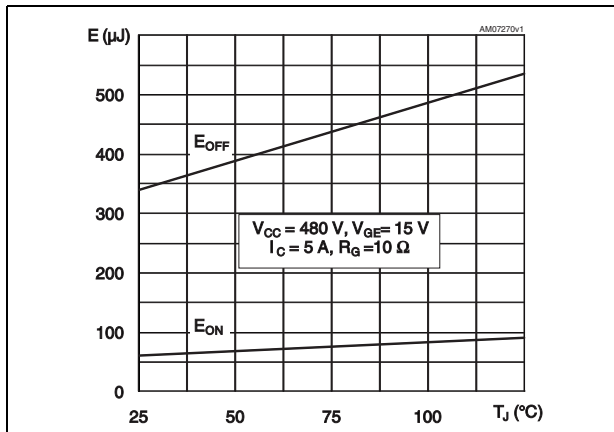


Figure 11. Switching losses vs gate resistance

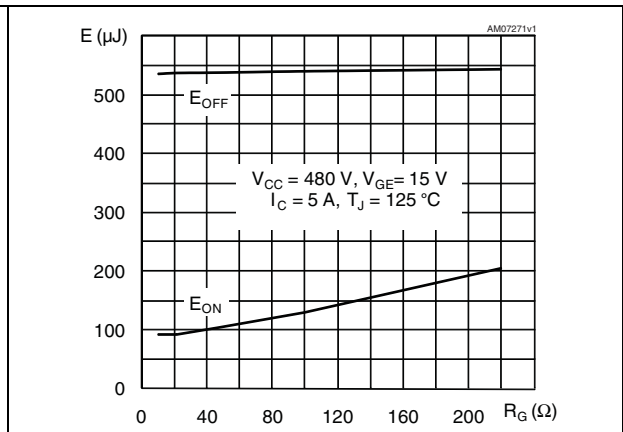


Figure 12. Switching losses vs collector current

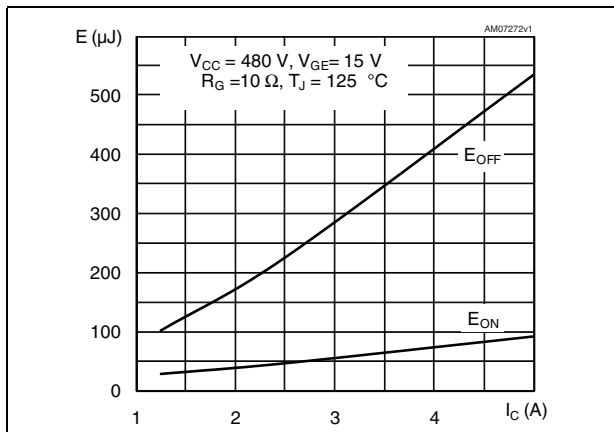


Figure 13. Diode forward on voltage

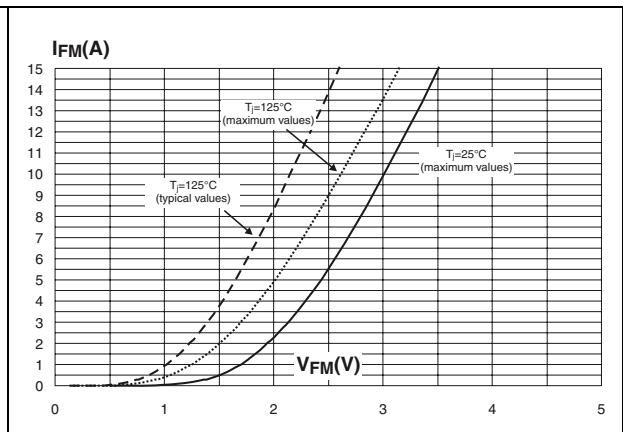


Figure 14. Thermal impedance for DPAK

Figure 15. Thermal impedance for TO-220FP

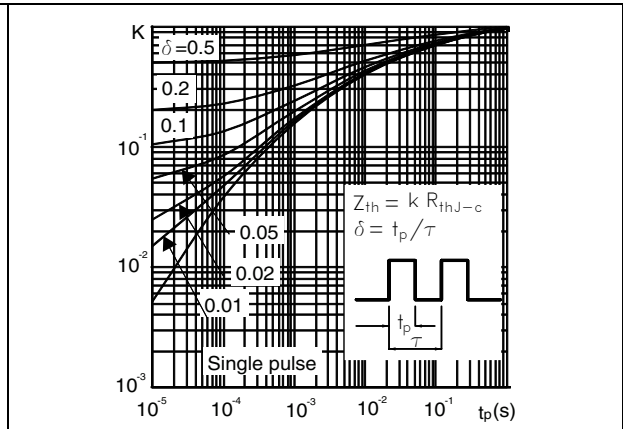
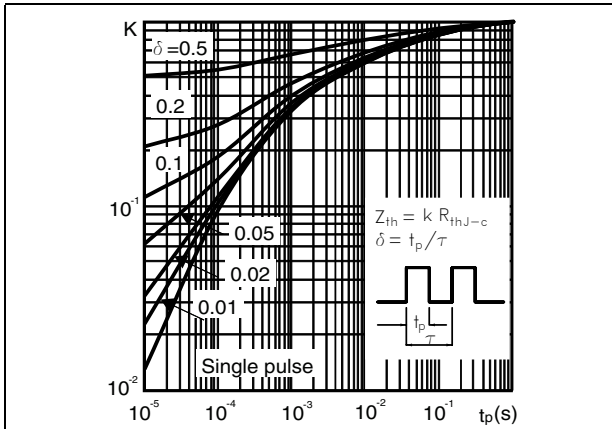
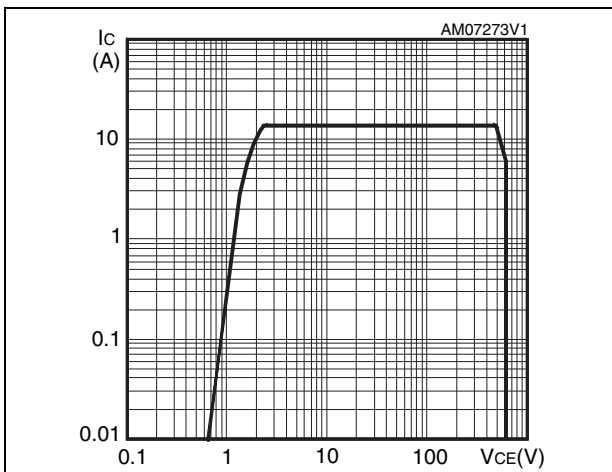


Figure 16. Turn-off SOA



3 Test circuits

Figure 17. Test circuit for inductive load switching

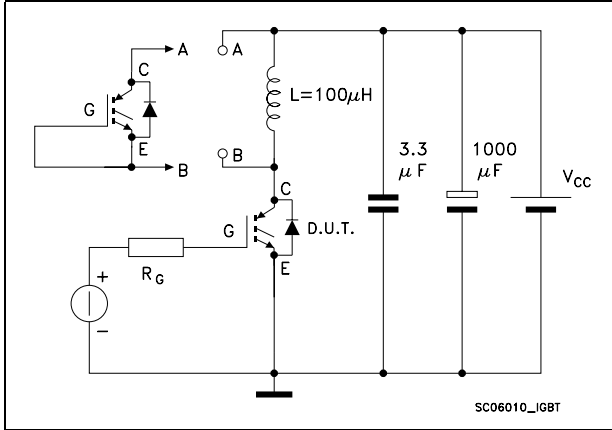


Figure 18. Gate charge test circuit

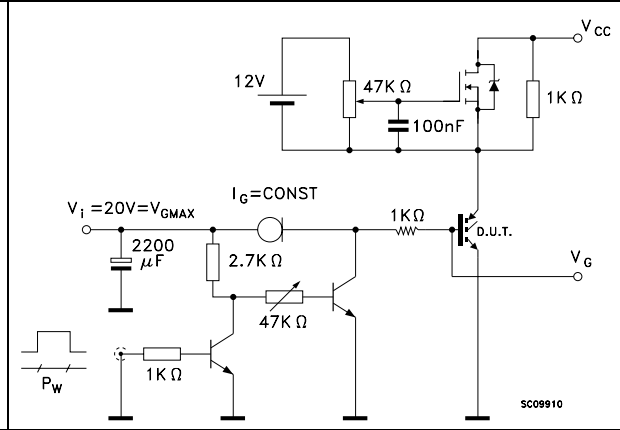


Figure 19. Switching waveforms

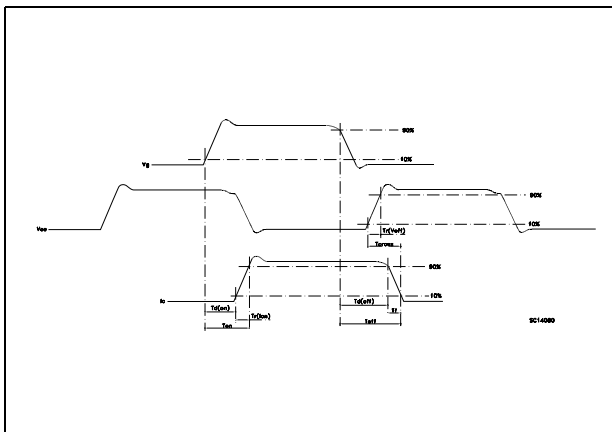
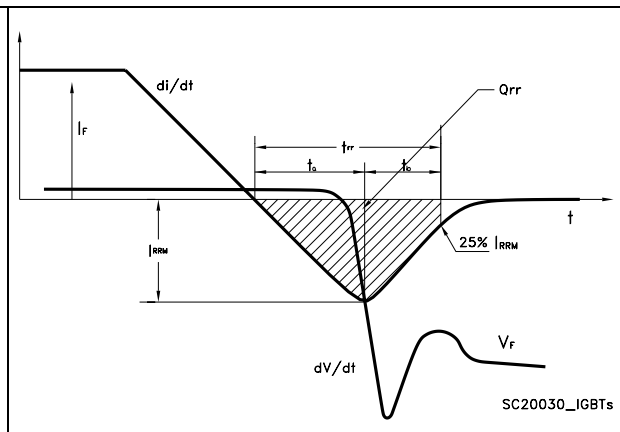


Figure 20. Diode recovery time waveform



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. ECOPACK is an ST trademark.

TO-252 (DPAK) mechanical data

| DIM. | mm. | | |
|------|------|------|-------|
| | min. | typ | max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| A2 | 0.03 | | 0.23 |
| b | 0.64 | | 0.90 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| D1 | | 5.10 | |
| E | 6.40 | | 6.60 |
| E1 | | 4.70 | |
| e | | 2.28 | |
| e1 | 4.40 | | 4.60 |
| H | 9.35 | | 10.10 |
| L | 1 | | |
| L1 | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

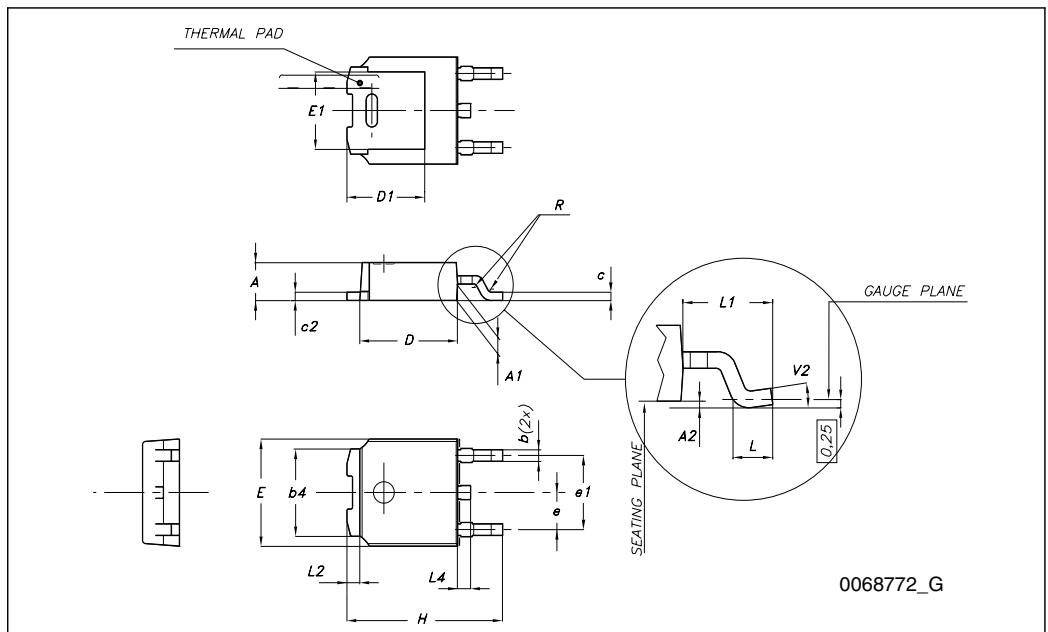
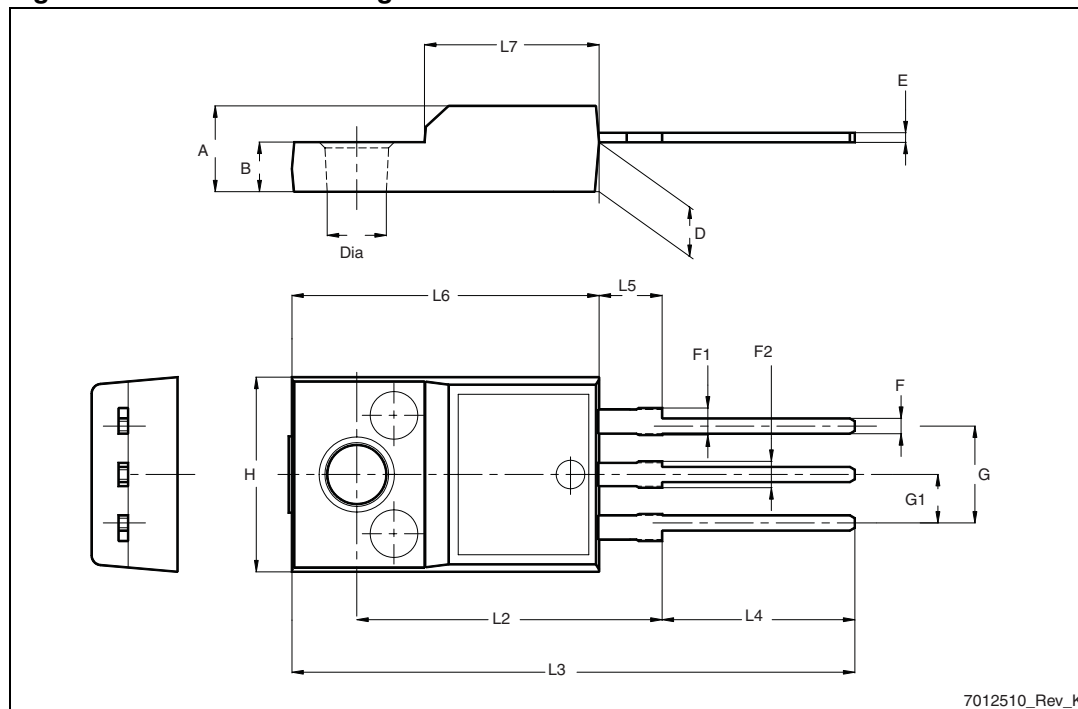


Table 9. TO-220FP mechanical data

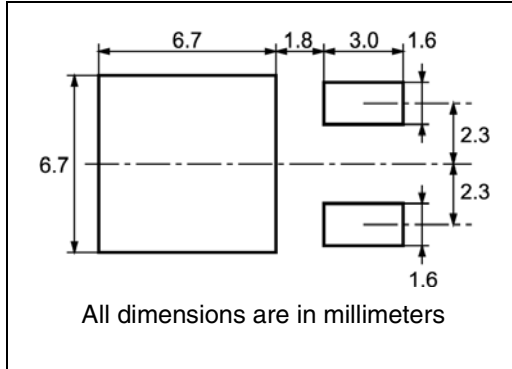
| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | 4.4 | | 4.6 |
| B | 2.5 | | 2.7 |
| D | 2.5 | | 2.75 |
| E | 0.45 | | 0.7 |
| F | 0.75 | | 1 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.2 |
| G1 | 2.4 | | 2.7 |
| H | 10 | | 10.4 |
| L2 | | 16 | |
| L3 | 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 21. TO-220FP drawing



5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT

| REEL MECHANICAL DATA | | | | |
|----------------------|------|------|-------|--------|
| DIM. | mm | | inch | |
| | MIN. | MAX. | MIN. | MAX. |
| A | | 330 | | 12.992 |
| B | 1.5 | | 0.059 | |
| C | 12.8 | 13.2 | 0.504 | 0.520 |
| D | 20.2 | | 0.795 | |
| G | 16.4 | 18.4 | 0.645 | 0.724 |
| N | 50 | | 1.968 | |
| T | | 22.4 | | 0.881 |

TAPE MECHANICAL DATA

| DIM. | mm | | inch | |
|------|------|------|-------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 6.8 | 7 | 0.267 | 0.275 |
| B0 | 10.4 | 10.6 | 0.409 | 0.417 |
| B1 | | 12.1 | | 0.476 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.5 | | 0.059 | |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 7.4 | 7.6 | 0.291 | 0.299 |
| K0 | 2.55 | 2.75 | 0.100 | 0.108 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 7.9 | 8.1 | 0.311 | 0.319 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 40 | | 1.574 | |
| W | 15.7 | 16.3 | 0.618 | 0.641 |

| BASE QTY | BULK QTY |
|----------|----------|
| 2500 | 2500 |

6 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 06-Jul-2009 | 1 | Initial release |
| 14-Jun-2010 | 2 | Inserted Section 2.1: Electrical characteristics (curves) . |

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