



STGB10NC60KD, STGD10NC60KD STGF10NC60KD, STGP10NC60KD

10 A, 600 V short-circuit rugged IGBT

Features

- Lower on voltage drop ($V_{CE(sat)}$)
- Lower C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode
- Short-circuit withstand time 10 μ s

Description

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

Applications

- High frequency motor controls
- SMPS and PFC in both hard switch and resonant topologies
- Motor drives

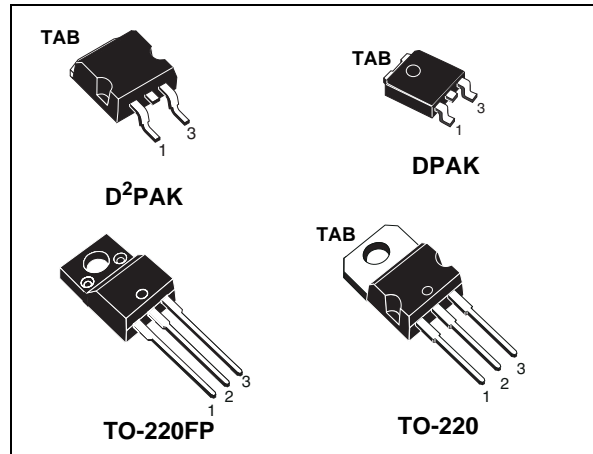


Figure 1. Internal schematic diagram

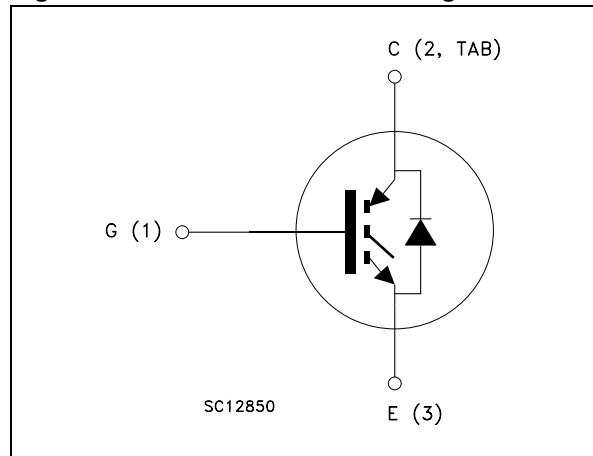


Table 1. Device summary

| Order codes | Marking | Packages | Packaging |
|----------------|------------|--------------------|---------------|
| STGB10NC60KDT4 | GB10NC60KD | D ² PAK | Tape and reel |
| STGD10NC60KDT4 | GD10NC60KD | DPAK | |
| STGF10NC60KD | GF10NC60KD | TO-220FP | Tube |
| STGP10NC60KD | GP10NC60KD | TO-220 | |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|--------------------------------|---|------------------------------|------|----------|------|
| | | D ² PAK TO-220 | DPAK | TO-220FP | |
| V _{CES} | Collector-emitter voltage (V _{GE} = 0) | 600 | | | V |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 25°C | 20 | | 9 | A |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 100°C | 10 | | 6 | A |
| I _{CL} ⁽²⁾ | Turn-off latching current | 30 | | | A |
| I _{CP} ⁽³⁾ | Pulsed collector current | 30 | | | A |
| V _{GE} | Gate-emitter voltage | ±20 | | | V |
| 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 |
| P _{TOT} | Total dissipation at T _C = 25°C | 65 | 62 | 25 | W |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; T _C =25°C) | -- | | 2500 | V |
| t _{scw} | Short-circuit withstand time V _{CE} = 0.5 V _{CES} , T _J = 125 °C, R _G = 10 Ω, V _{GE} = 12 V | 10 | | | μs |
| T _{stg} | Storage temperature | - 55 to 150 | | | °C |
| T _J | Operating junction temperature | | | | |

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}, V_{GE} = 15 V, R_G = 10 Ω, T_J = 150 °C

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

Table 3. Thermal data

| Symbol | Parameter | Value | | | Unit |
|----------------|--|------------------------------|------|----------|------|
| | | TO-220 D ² PAK | DPAK | TO-220FP | |
| $R_{thj-case}$ | Thermal resistance junction-case IGBT | 1.9 | 2 | 5 | °C/W |
| $R_{thj-case}$ | Thermal resistance junction-case diode | 4 | 4.5 | 7 | |
| $R_{thj-amb}$ | Thermal resistance junction-ambient | 62.5 | 100 | 62.5 | |

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 | $V_{GE} = 15\text{V}$, $I_C = 5\text{A}$ $V_{GE} = 15\text{V}$, $I_C = 5\text{A}$, $T_j = 125^\circ\text{C}$ | | 2.2 1.8 | 2.5 | V V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}$, $I_C = 250\mu\text{A}$ | 4.5 | | 6.5 | 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 current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{V}$ | | | ± 100 | nA |
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{CE} = 15\text{V}$, $I_C = 5\text{A}$ | | 15 | | S |

1. Pulse test: pulse duration < 300 μs , duty cycle < 2 %

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{V}$, $f = 1\text{MHz}$, $V_{GE} = 0$ | | 380 | | pF |
| C_{oes} | Output capacitance | | - | 46 | - | pF |
| C_{res} | Reverse transfer capacitance | | | | 8.5 | pF |
| Q_g | Total gate charge | $V_{CE} = 390\text{V}$, $I_C = 5\text{A}$, | | 19 | | nC |
| Q_{ge} | Gate-emitter charge | $V_{GE} = 15\text{V}$, | - | 5 | - | nC |
| Q_{gc} | Gate-collector charge | (see Figure 19) | | 9 | | nC |

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 | $V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V$ <i>(see Figure 20)</i> | - | 17 6 655 | - | ns ns A/ μ s |
| $t_{d(on)}$ t_r $(di/dt)_{on}$ | Turn-on delay time Current rise time Turn-on current slope | $V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>(see Figure 20)</i> | - | 16.5 6.5 575 | - | 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 | $V_{CC} = 390V, I_C = 5A,$ $R_{GE} = 10\Omega, V_{GE} = 15V$ <i>(see Figure 20)</i> | - | 33 72 82 | - | ns ns ns |
| $t_r(V_{off})$ $t_{d(off)}$ t_f | Off voltage rise time Turn-off delay time Current fall time | $V_{CC} = 390V, I_C = 5A,$ $R_{GE} = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>(see Figure 20)</i> | - | 60 106 136 | - | 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 | $V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V$ <i>(see Figure 20)</i> | - | 55 85 140 | - | 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 | $V_{CC} = 390V, I_C = 5A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>(see Figure 20)</i> | - | 87 162 249 | - | 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 2. If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs & Diode are at the same temperature (25°C and 125°C)
2. Turn-off losses 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 | $I_F=5$ A | - | 2 | - | V |
| | | $I_F=5$ A, $T_J=125$ °C | - | 1.6 | - | V |
| t_{rr} | Reverse recovery time | $I_F=5$ A, $V_R=40$ V, $di/dt=100$ A/ μ s | - | 22 | - | ns |
| Q_{rr} | Reverse recovery charge | (see Figure 5) | - | 14 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 1.3 | - | A |
| t_{rr} | Reverse recovery time | $I_F=5$ A, $V_R=40$ V, $T_J=125$ °C, $di/dt=100$ A/ μ s | - | 35 | - | ns |
| Q_{rr} | Reverse recovery charge | (see Figure 5) | - | 40 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 2.2 | - | A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

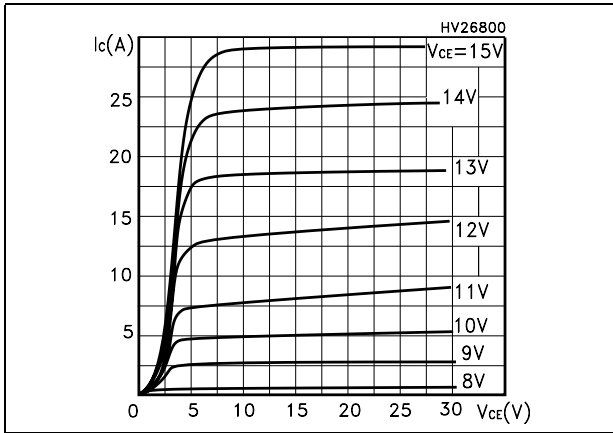


Figure 3. Transfer characteristics

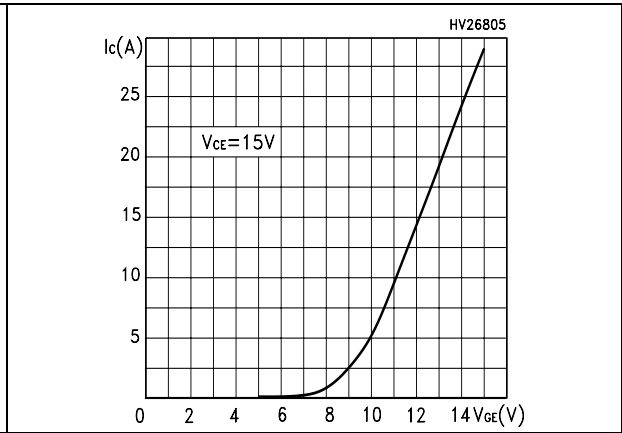


Figure 4. Transconductance

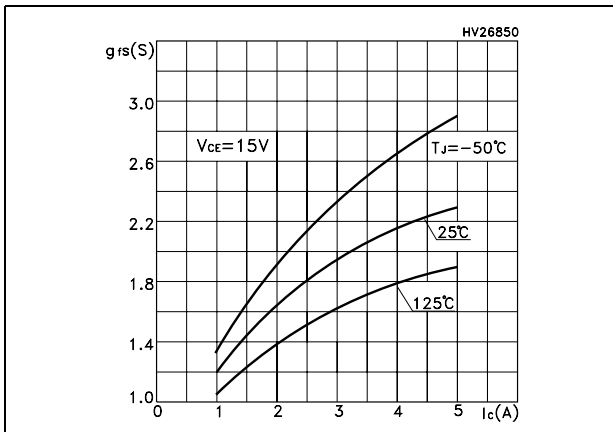


Figure 5. Collector-emitter on voltage vs temperature

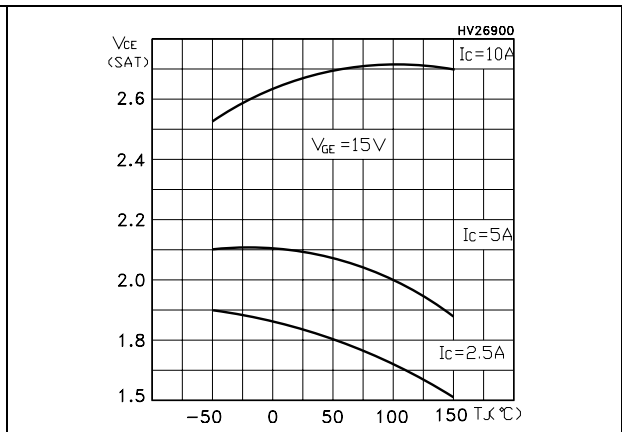


Figure 6. Gate charge vs gate-source voltage Figure 7. Capacitance variations

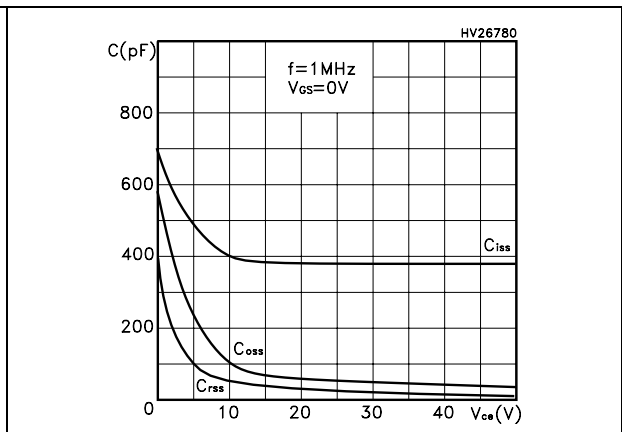
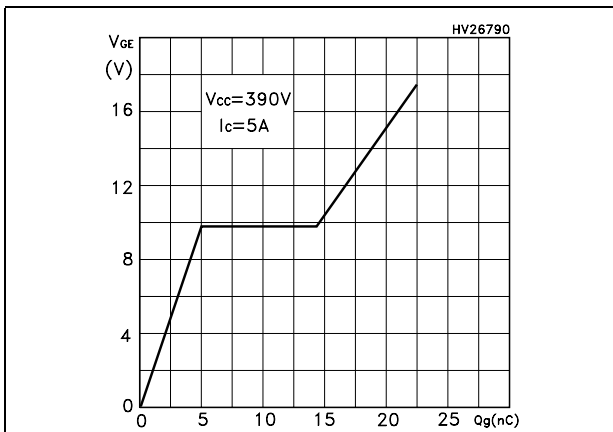


Figure 8. Normalized gate threshold voltage vs temperature

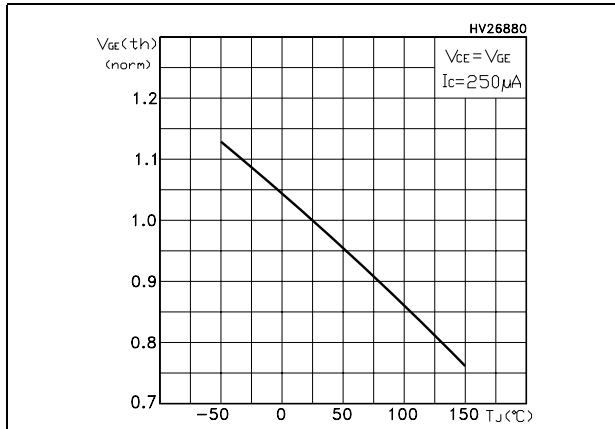


Figure 9. Collector-emitter on voltage vs collector current

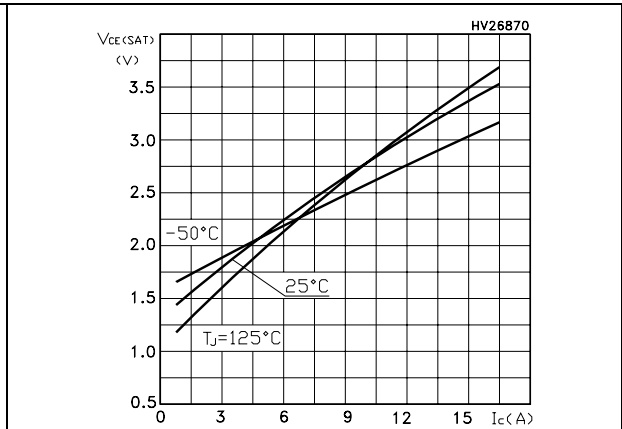


Figure 10. Normalized breakdown voltage vs temperature

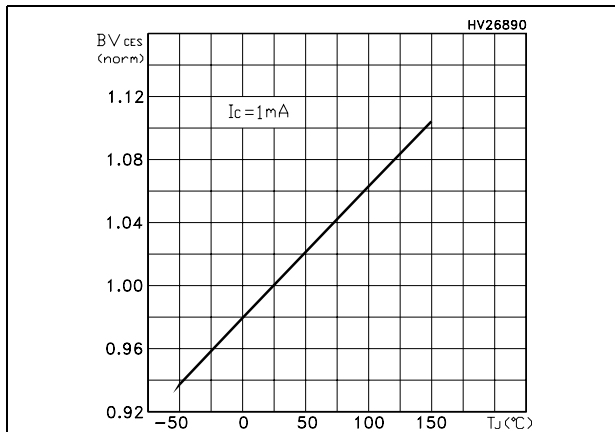


Figure 11. Switching losses vs temperature

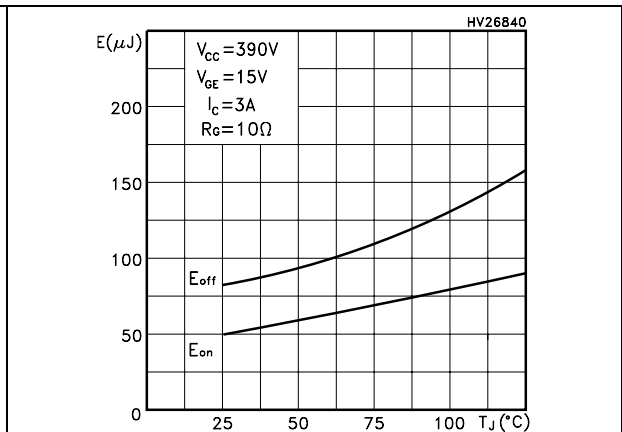


Figure 12. Switching losses vs gate resistance

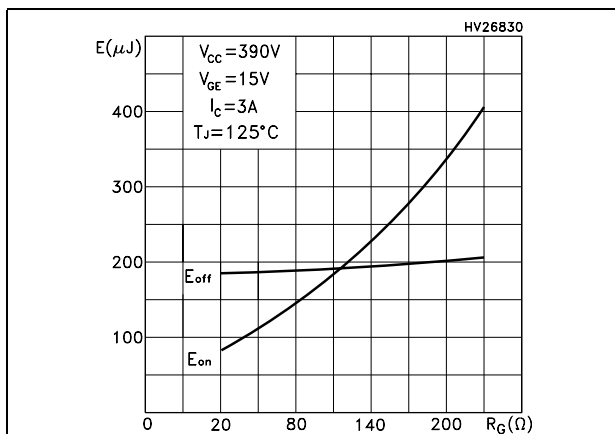


Figure 13. Switching losses vs collector current

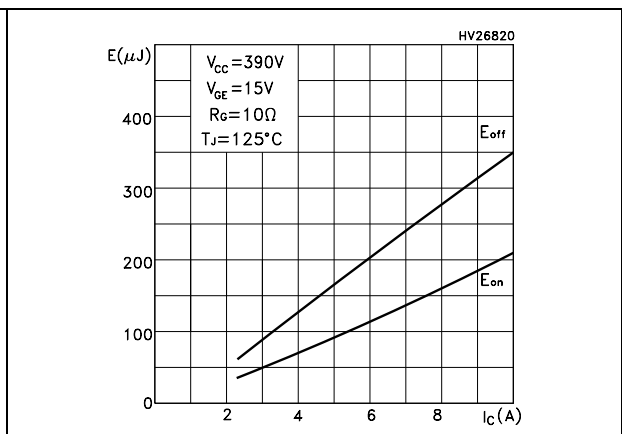


Figure 14. Thermal impedance for D²PAK, DPAK and TO-220

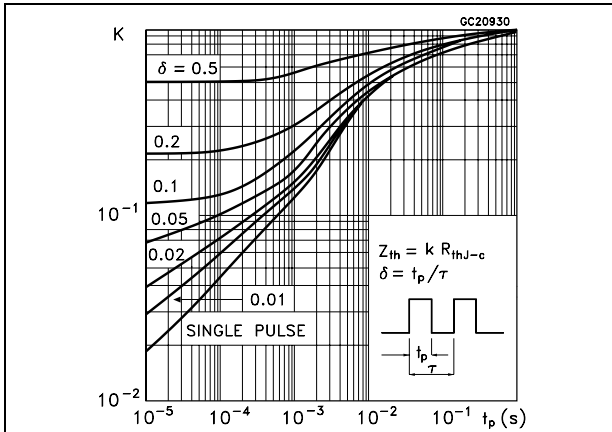


Figure 15. Turn-off SOA

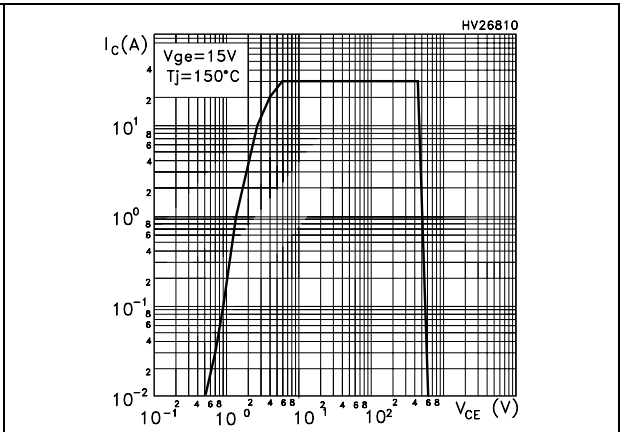


Figure 16. Emitter-collector diode characteristics

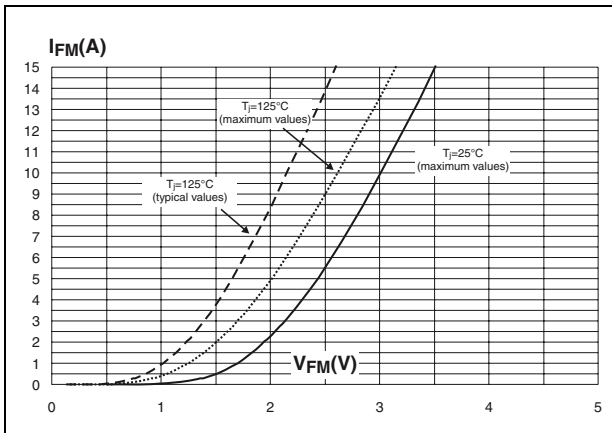
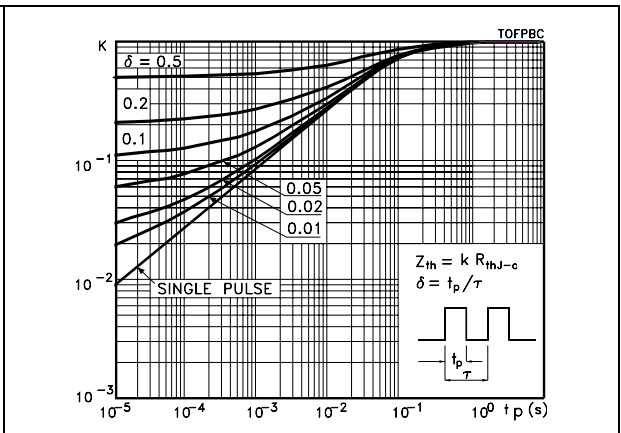


Figure 17. Thermal impedance for TO-220FP



3 Test circuits

Figure 18. Test circuit for inductive load switching

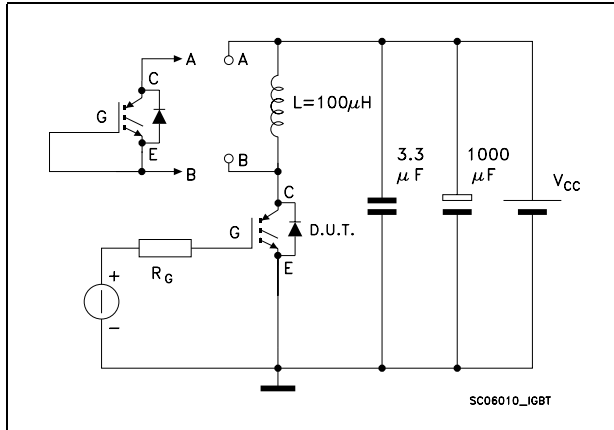


Figure 19. Gate charge test circuit

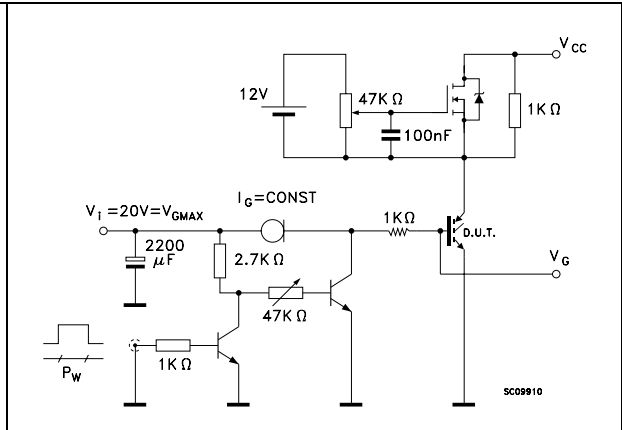


Figure 20. Switching waveform

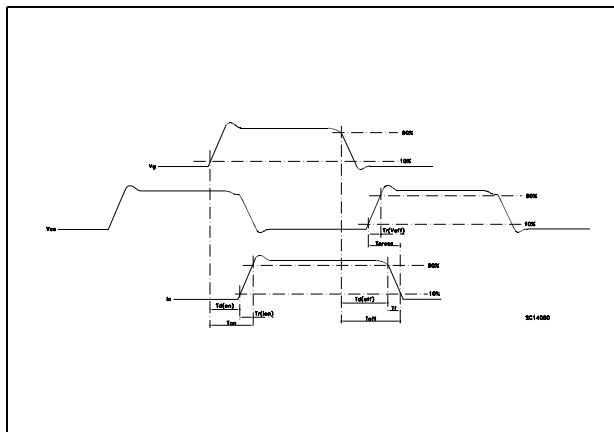
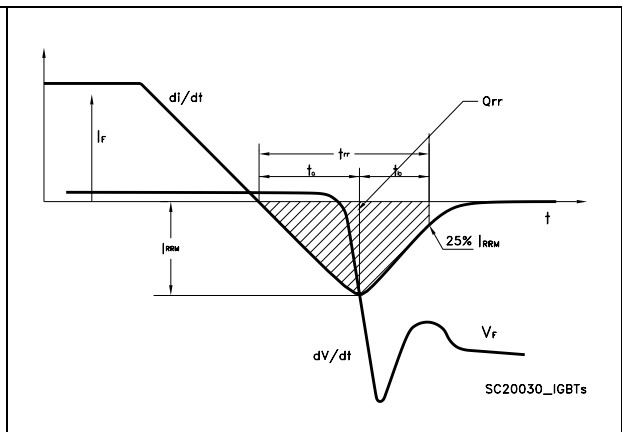


Figure 21. Diode recovery time waveform



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.

Table 9. D²PAK package mechanical data

| Dim. | mm | | | inch | | |
|------|------|------|-------|-------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| A1 | 0.03 | | 0.23 | 0.001 | | 0.009 |
| b | 0.70 | | 0.93 | 0.027 | | 0.037 |
| b2 | 1.14 | | 1.70 | 0.045 | | 0.067 |
| c | 0.45 | | 0.60 | 0.017 | | 0.024 |
| c2 | 1.23 | | 1.36 | 0.048 | | 0.053 |
| D | 8.95 | | 9.35 | 0.352 | | 0.368 |
| D1 | 7.50 | | | 0.295 | | |
| E | 10 | | 10.40 | 0.394 | | 0.409 |
| E1 | 8.50 | | | 0.334 | | |
| e | | 2.54 | | | 0.1 | |
| e1 | 4.88 | | 5.28 | 0.192 | | 0.208 |
| H | 15 | | 15.85 | 0.590 | | 0.624 |
| J1 | 2.49 | | 2.69 | 0.099 | | 0.106 |
| L | 2.29 | | 2.79 | 0.090 | | 0.110 |
| L1 | 1.27 | | 1.40 | 0.05 | | 0.055 |
| L2 | 1.30 | | 1.75 | 0.051 | | 0.069 |
| R | | 0.4 | | | 0.016 | |
| V2 | 0° | | 8° | 0° | | 8° |

Figure 22. D²PAK package drawing

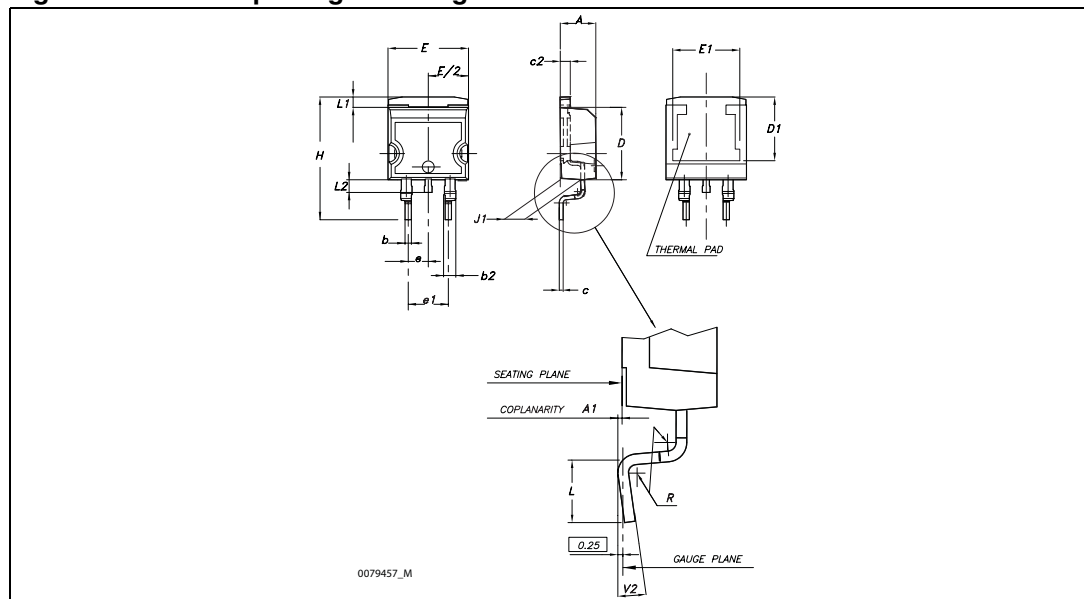


Table 10. DPAK package mechanical data

| 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° |

Figure 23. DPAK package drawing

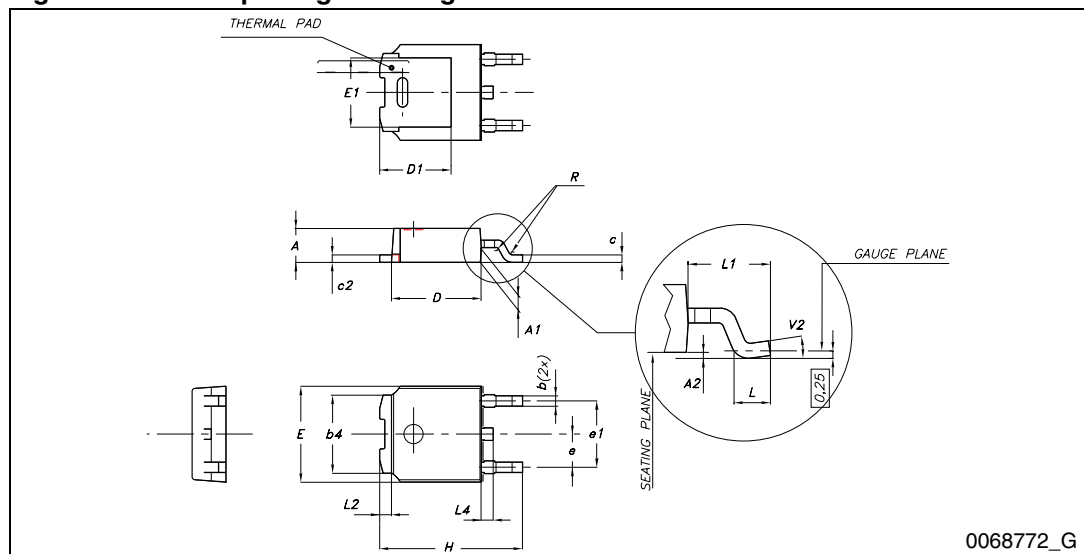


Table 11. TO-220FP package mechanical data

| 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 24. TO-220FP package drawing

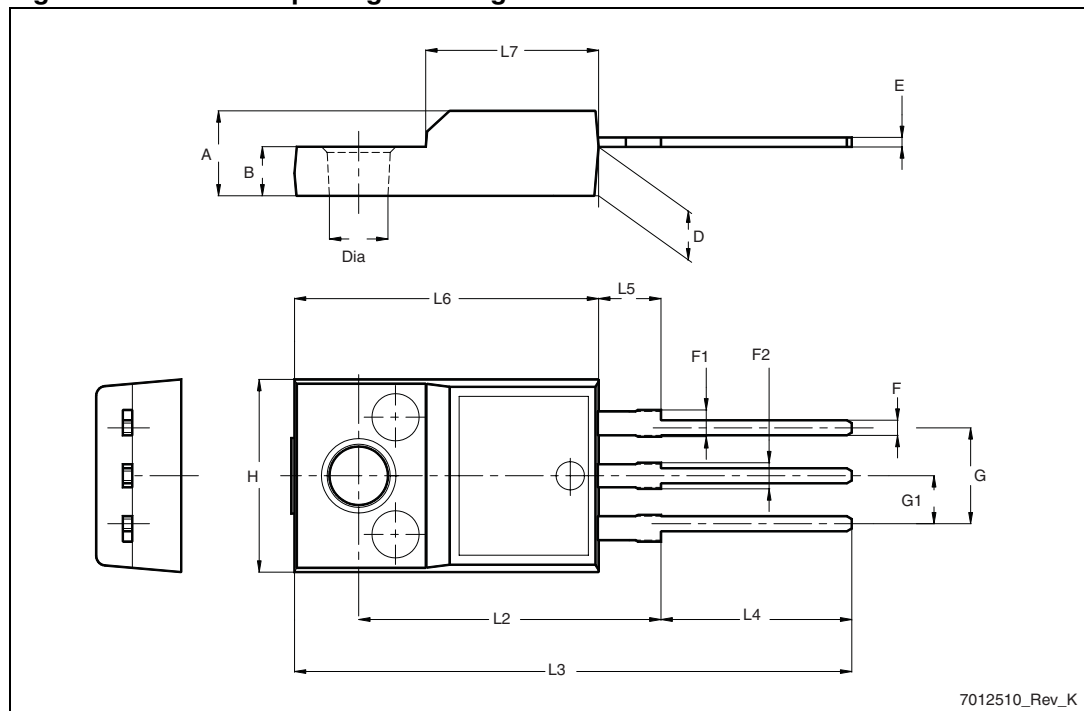
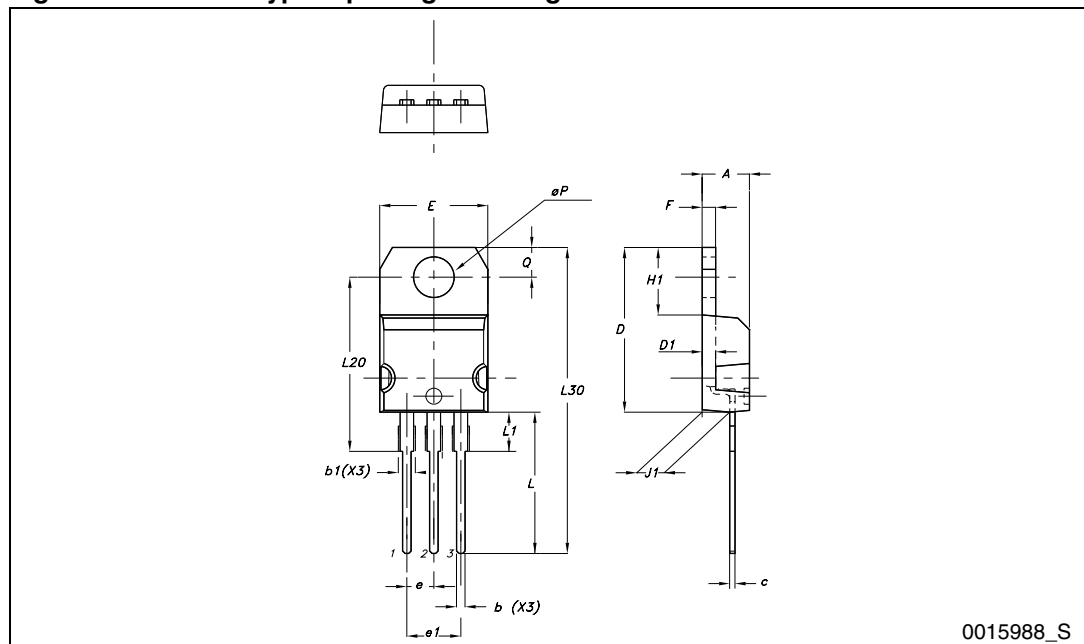


Table 12. TO-220 type A mechanical data

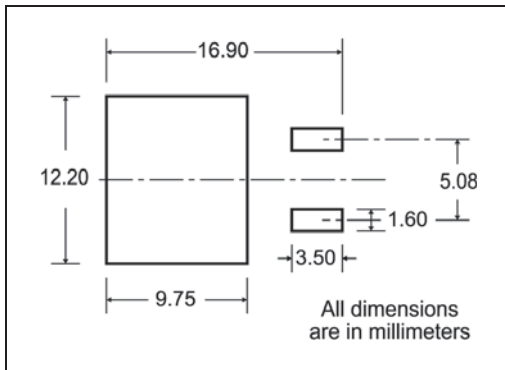
| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.70 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 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 25. TO-220 type A package drawing



5 Packaging mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

TAPE MECHANICAL DATA

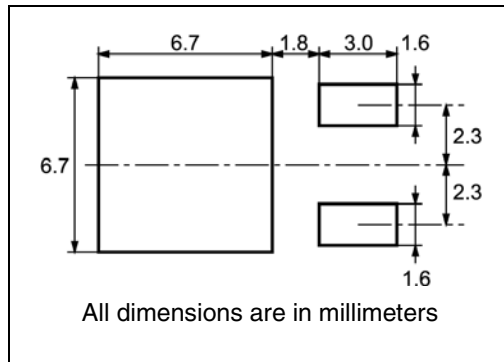
| DIM. | mm | | inch | |
|------|------|------|--------|--------|
| | MIN. | MAX. | MIN. | MAX. |
| A0 | 10.5 | 10.7 | 0.413 | 0.421 |
| B0 | 15.7 | 15.9 | 0.618 | 0.626 |
| D | 1.5 | 1.6 | 0.059 | 0.063 |
| D1 | 1.59 | 1.61 | 0.062 | 0.063 |
| E | 1.65 | 1.85 | 0.065 | 0.073 |
| F | 11.4 | 11.6 | 0.449 | 0.456 |
| K0 | 4.8 | 5.0 | 0.189 | 0.197 |
| P0 | 3.9 | 4.1 | 0.153 | 0.161 |
| P1 | 11.9 | 12.1 | 0.468 | 0.476 |
| P2 | 1.9 | 2.1 | 0.075 | 0.082 |
| R | 50 | | 1.574 | |
| T | 0.25 | 0.35 | 0.0098 | 0.0137 |
| W | 23.7 | 24.3 | 0.933 | 0.956 |

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 | 24.4 | 26.4 | 0.960 | 1.039 |
| N | 100 | | 3.937 | |
| T | | 30.4 | | 1.197 |

| BASE QTY | BULK QTY |
|----------|----------|
| 1000 | 1000 |

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 2500 **BULK QTY** 2500

6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 14-Jun-2005 | 1 | New release. |
| 19-Jul-2005 | 2 | Complete version. |
| 27-Jan-2006 | 3 | Inserted ecopack indication. |
| 01-Mar-2006 | 4 | The document has been reformatted. |
| 08-Feb-2007 | 5 | Modified value on Table 6.: Switching on/off (inductive load) . |
| 24-Nov-2009 | 6 | Inserted DPAK package option. |

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