

Features

- Very low on-voltage drop ($V_{CE(sat)}$)
- Minimum power losses at 5 kHz in hard switching
- Optimized performance for medium operating frequencies.

Application

Medium frequency motor drives

Description

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

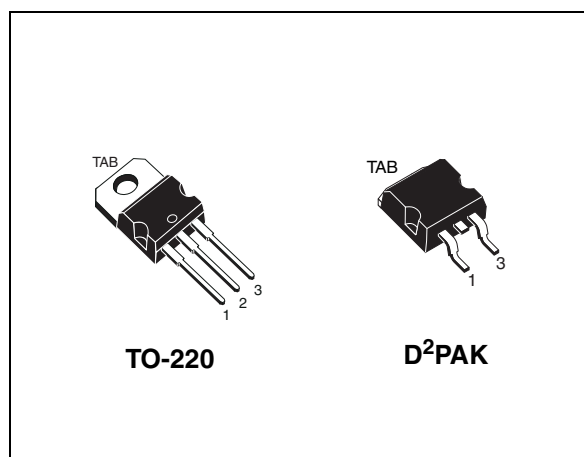


Figure 1. Internal schematic diagram

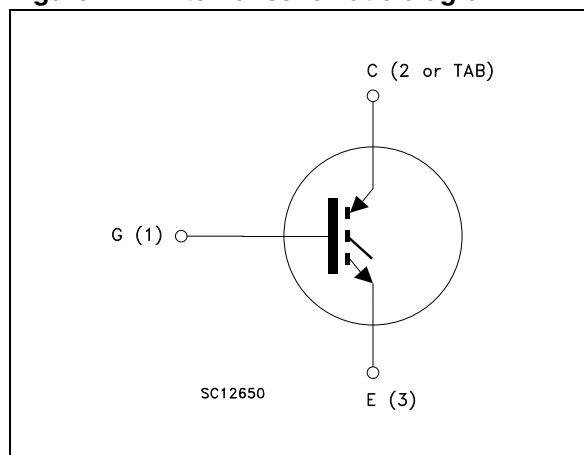


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|---------------|-----------|--------------------|---------------|
| STGB19NC60ST4 | GB19NC60S | D ² PAK | Tape and reel |
| STGP19NC60S | GP19NC60S | TO-220 | Tube |

Contents

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|-------------|------------------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$) | 600 | V |
| $I_C^{(1)}$ | Continuous collector current at $T_C = 25^\circ\text{C}$ | 40 | A |
| $I_C^{(1)}$ | Continuous collector current at $T_C = 100^\circ\text{C}$ | 20 | A |
| $I_{CP}^{(2)}$ | Pulsed collector current | 80 | A |
| $I_{CL}^{(3)}$ | Turn-off latching current | 80 | A |
| V_{GE} | Gate-emitter voltage | ± 20 | V |
| P_{TOT} | Total dissipation at $T_C = 25^\circ\text{C}$ | 130 | W |
| T_j | Operating junction temperature | - 55 to 150 | $^\circ\text{C}$ |

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. Pulse width limited by maximum junction temperature and turn-off within RBSOA
 3. $V_{clamp} = 80\%$ of V_{CES} , $T_j = 150^\circ\text{C}$, $R_G = 10\ \Omega$, $V_{GE} = 15\ \text{V}$

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|-------------|-------------------------------------|-------|---------------------------|
| R_{thj-c} | Thermal resistance junction-case | 0.96 | $^\circ\text{C}/\text{W}$ |
| R_{thj-a} | Thermal resistance junction-ambient | 62.5 | $^\circ\text{C}/\text{W}$ |

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 | $V_{GE} = 15\text{V}, I_C = 12\text{A}$ $V_{GE} = 15\text{V}, I_C = 12\text{A}, T_j = 125^\circ\text{C}$ | | 1.55 1.35 | 1.9 | V V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}, I_C = 250\ \mu\text{A}$ | 4.2 | | 6.2 | 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 ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{V}, V_{CE} = 0$ | | | ± 100 | nA |
| g_{fs} | Forward transconductance | $V_{CE} = 15\text{V}, I_C = 12\text{A}$ | | 10 | | S |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{V}, f = 1\text{MHz},$ $V_{GE} = 0$ | - | 1190 | - | pF |
| C_{oes} | Output capacitance | | | 135 | | pF |
| C_{res} | Reverse transfer capacitance | | | 28.5 | | pF |
| Q_g | Total gate charge | $V_{CE} = 480\text{V}, I_C = 12\text{A},$ | - | 54.5 | - | nC |
| Q_{ge} | Gate-emitter charge | $V_{GE} = 15\text{V},$ | | 8.7 | | nC |
| Q_{gc} | Gate-collector charge | Figure 18 | | 25.8 | | 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 | $V_{CC} = 480V, I_C = 12A$ $R_G = 10\Omega, V_{GE} = 15V,$ <i>Figure 19</i> | - | 17.5 6.2 1870 | - | ns ns A/ μ s |
| $t_{d(on)}$ t_r (di/dt) _{on} | Turn-on delay time Current rise time Turn-on current slope | $V_{CC} = 480V, I_C = 12A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>Figure 19</i> | - | 17 6.5 1700 | - | ns ns A/ μ s |
| $t_{r(Voff)}$ $t_{d(Voff)}$ t_f | Off voltage rise time Turn-off delay time Current fall time | $V_{CC} = 480V, I_C = 12A$ $R_G = 10\Omega, V_{GE} = 15V,$ <i>Figure 19</i> | - | 90 175 215 | - | ns ns ns |
| $t_{r(Voff)}$ $t_{d(Voff)}$ t_f | Off voltage rise time Turn-off delay time Current fall time | $V_{CC} = 480V, I_C = 12A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>Figure 19</i> | - | 155 245 290 | - | ns ns ns |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|--|------|---------------------|------|-------------------------------|
| E_{on} $E_{off}^{(1)}$ E_{ts} | Turn-on switching losses Turn-off switching losses Total switching losses | $V_{CC} = 480V, I_C = 12A$ $R_G = 10\Omega, V_{GE} = 15V,$ <i>Figure 17</i> | - | 135 815 995 | - | μ J μ J μ J |
| E_{on} $E_{off}^{(1)}$ E_{ts} | Turn-on switching losses Turn-off switching losses Total switching losses | $V_{CC} = 480V, I_C = 12A$ $R_G = 10\Omega, V_{GE} = 15V,$ $T_j = 125^\circ C$ <i>Figure 17</i> | - | 200 1175 1375 | - | μ J μ J μ J |

1. Turn-off losses include also the tail of the collector current

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

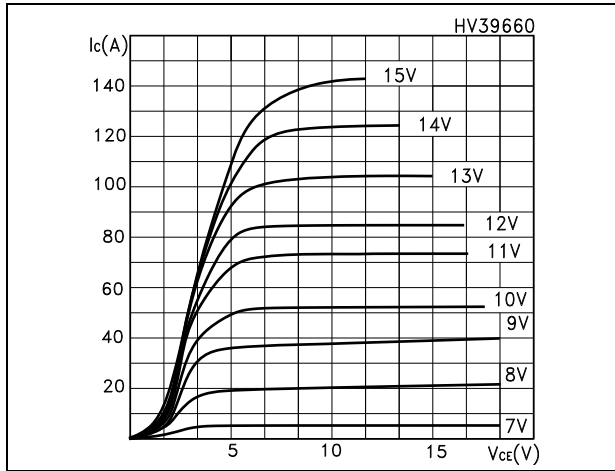


Figure 3. Transfer characteristics

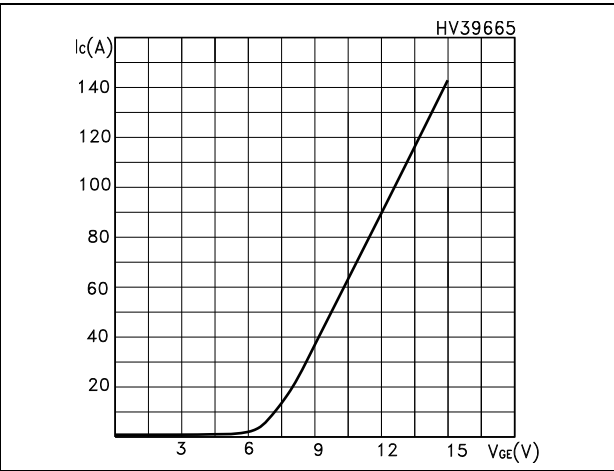


Figure 4. Transconductance

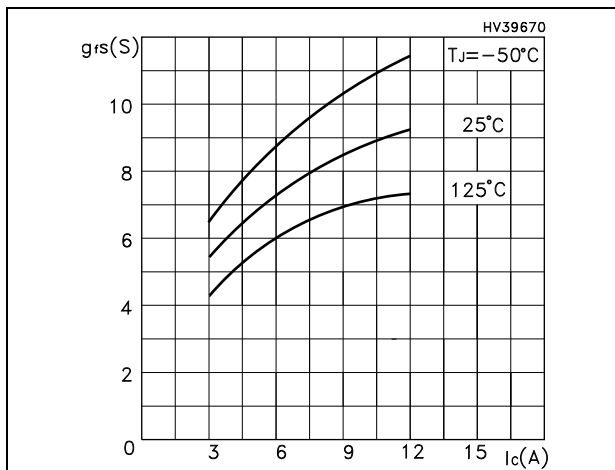


Figure 5. Collector-emitter on voltage vs temperature

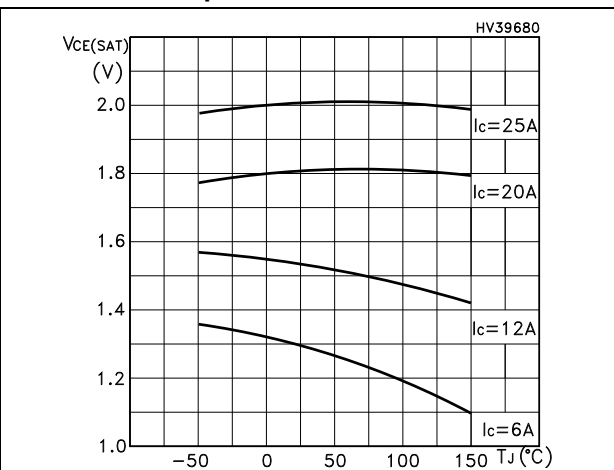


Figure 6. Gate charge vs gate-source voltage

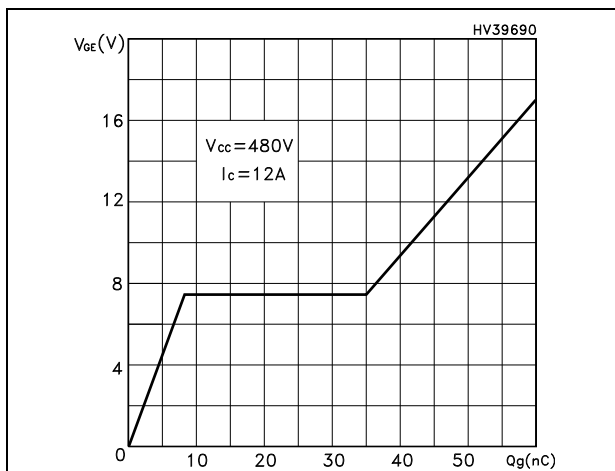


Figure 7. Capacitance variations

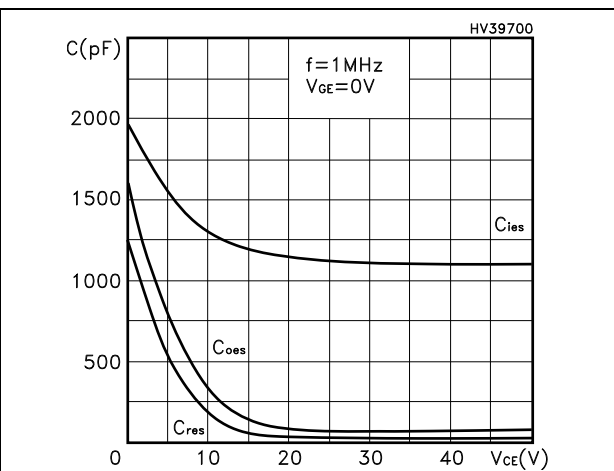


Figure 8. Normalized gate threshold voltage vs temperature

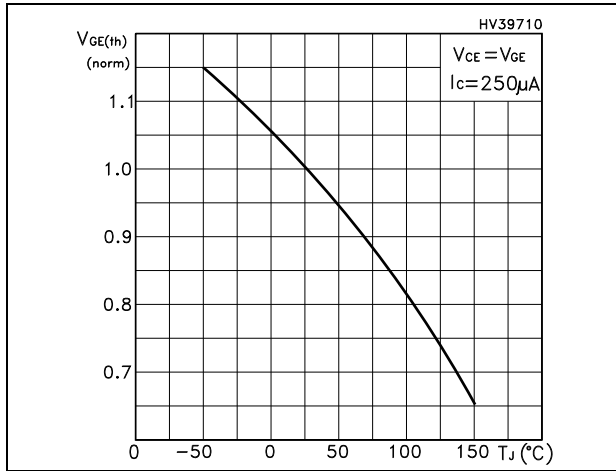


Figure 9. Collector-emitter on voltage vs collector current

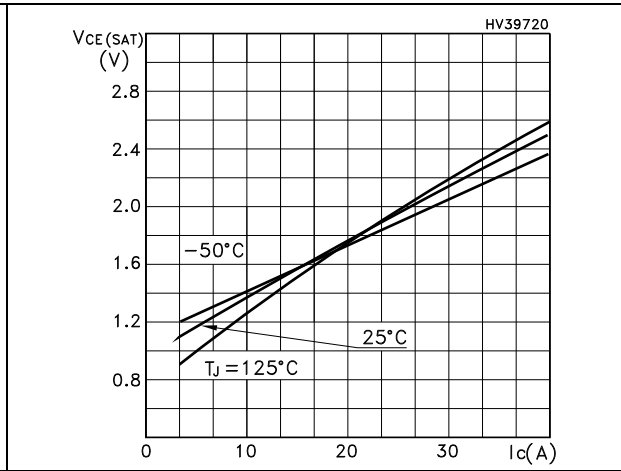


Figure 10. Normalized breakdown voltage vs temperature

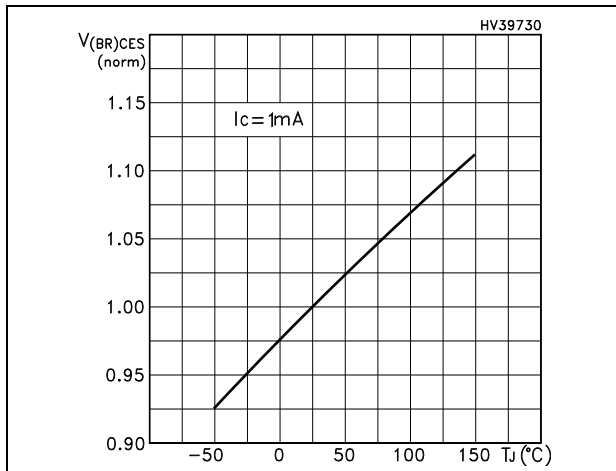


Figure 11. Switching losses vs temperature

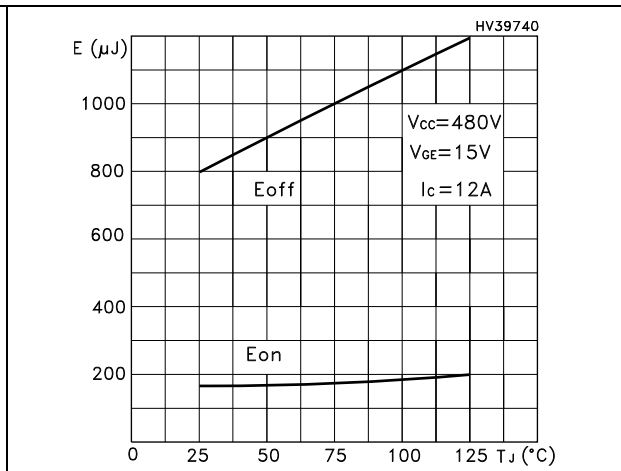


Figure 12. Switching losses vs gate resistance

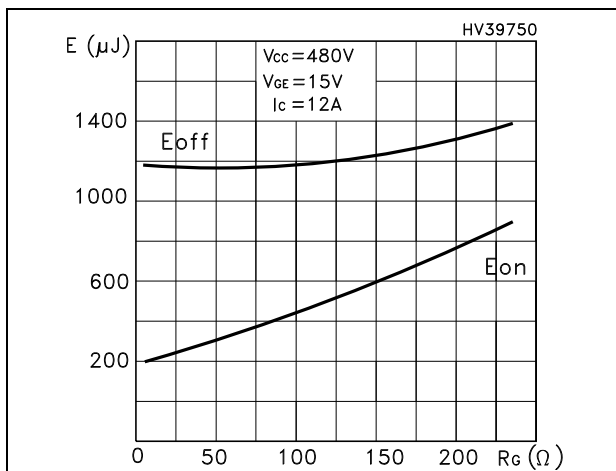


Figure 13. Switching losses vs collector current

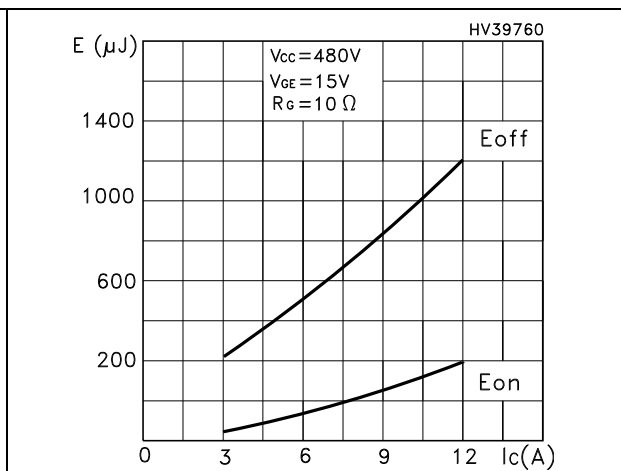


Figure 14. Turn-off SOA

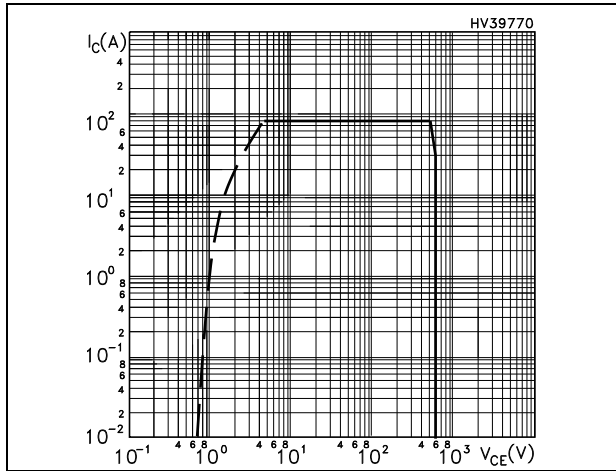


Figure 15. Thermal impedance

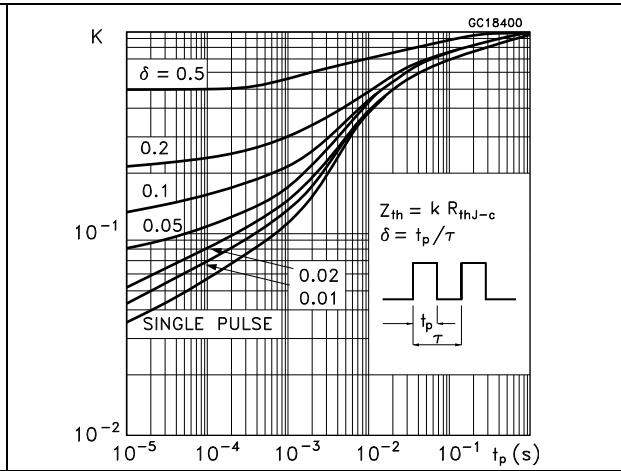
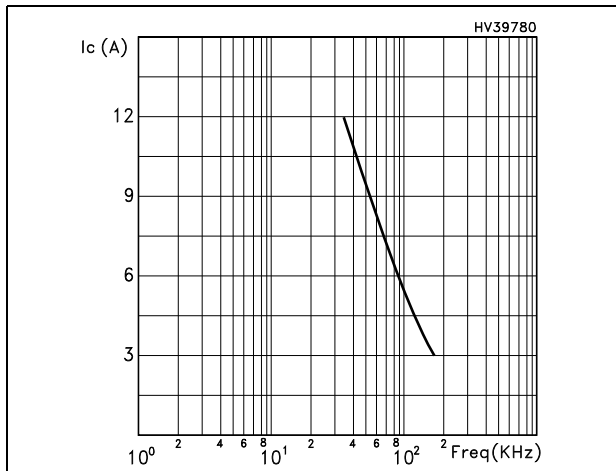


Figure 16. Ic vs. frequency



2.2 Frequency applications

For a fast IGBT suitable for high frequency applications, the typical collector current vs. maximum operating frequency curve is reported. That frequency is defined as follows:

$$f_{MAX} = (P_D - P_C) / (E_{ON} + E_{OFF})$$

- The maximum power dissipation is limited by maximum junction to case thermal resistance:

Equation 1

$$P_D = \Delta T / R_{THJ-C}$$

considering $\Delta T = T_J - T_C = 125\text{ °C} - 75\text{ °C} = 50\text{ °C}$

- The conduction losses are:

Equation 2

$$P_C = I_C * V_{CE(SAT)} * \delta$$

with 50% of duty cycle, V_{CESAT} typical value @ 125°C.

- Power dissipation during ON & OFF commutations is due to the switching frequency:

Equation 3

$$P_{SW} = (E_{ON} + E_{OFF}) * \text{freq.}$$

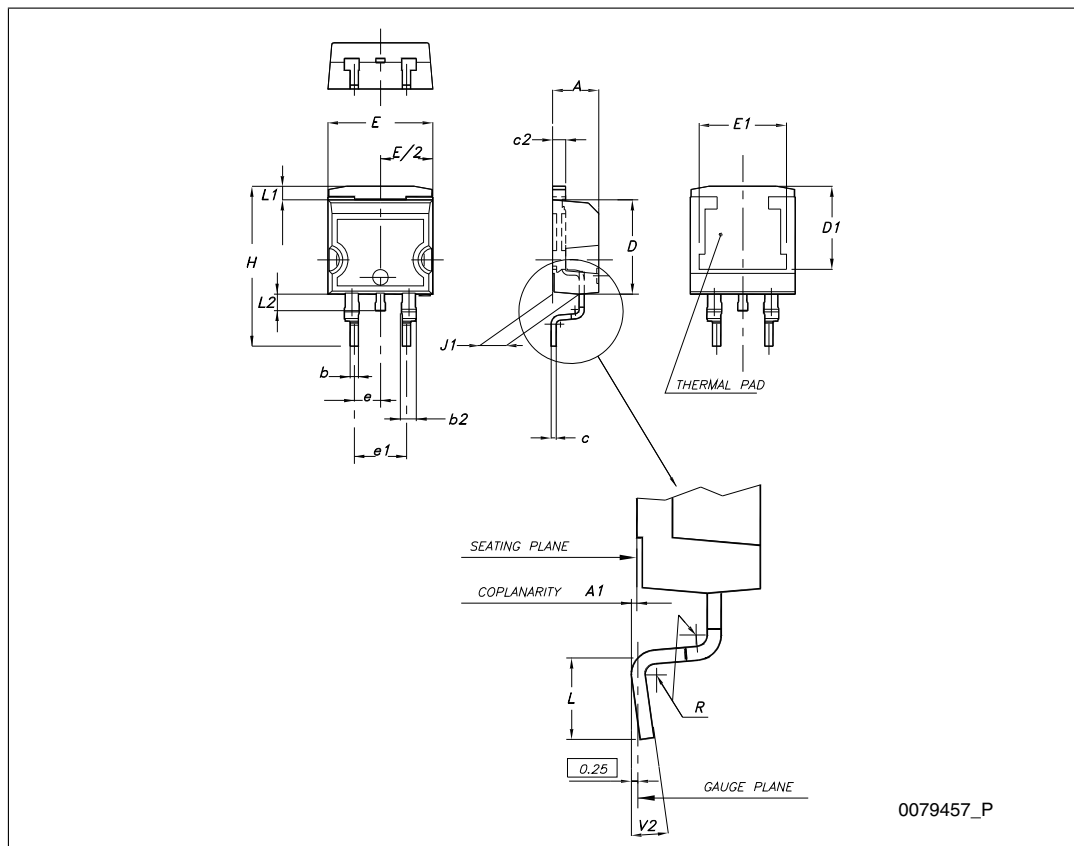
Typical values @ 125°C for switching losses are used (test conditions: $V_{CE} = 480\text{V}$, $V_{GE} = 15\text{V}$, $R_G = 10\text{ Ohm}$). Furthermore, diode recovery energy is included in the E_{ON} (see [Note 1](#)), while the tail of the collector current is included in the E_{OFF} measurements.

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.

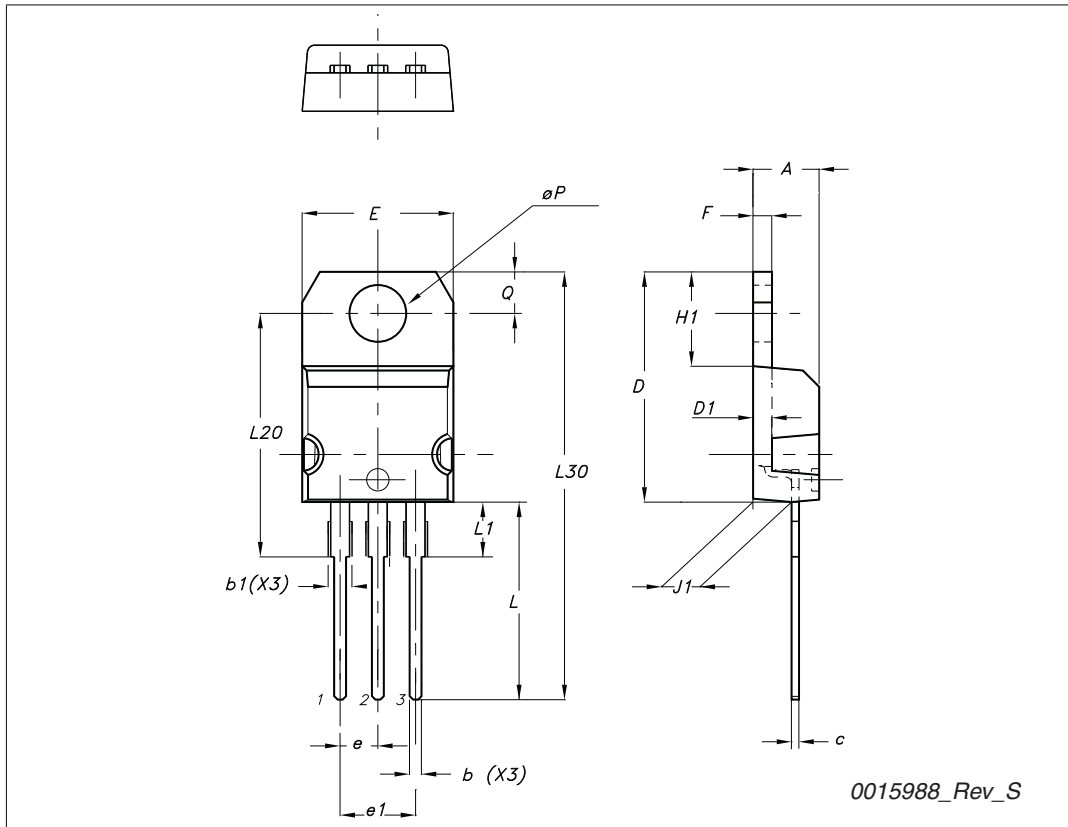
D²PAK (TO-263) mechanical data

| 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° |



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 | |
| ∅P | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |



5 Revision history

Table 8. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 02-Jul-2007 | 1 | First release |
| 13-Aug-2007 | 2 | From target to preliminary version |
| 18-Sep-2007 | 3 | Added new section: <i>Electrical characteristics (curves)</i> |
| 18-Aug-2009 | 4 | Inserted D ² PAK package |
| 08-Nov-2010 | 5 | Modified gate threshold voltage range on <i>Table 4: Static</i> |

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