



STGP19NC60S

N-channel 600V - 20A - TO-220
Medium frequency PowerMESH™ IGBT

Features

| Type | V _{CE(S)} | V _{CE(sat)} (typ)@150°C | I _C @100°C |
|-------------|--------------------|-------------------------------------|--------------------------|
| STGP19NC60S | 600V | < 1.35V | 20A |

- Very low on-voltage drop (V_{CE(sat)})
- High input impedance (voltage driven)
- IGBT co-packaged with ultrafast freewheeling diode.
- Minimum power losses at 5 kHz in hard switching
- Optimized performance for medium operating frequencies.

Application

- Medium frequency motor control

Description

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

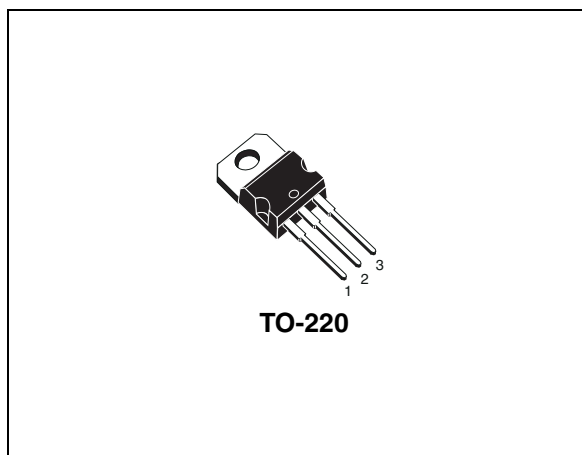


Figure 1. Internal schematic diagram

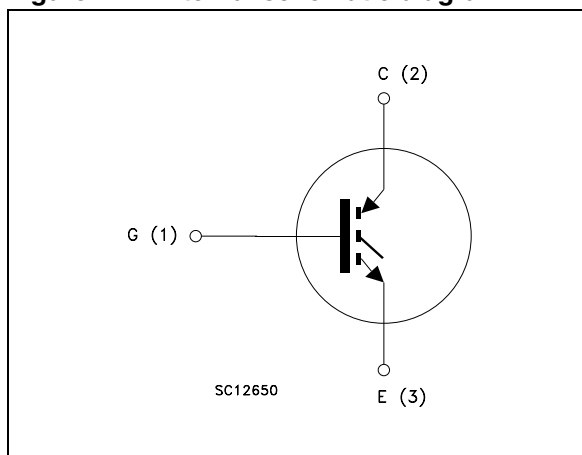


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|-------------|-----------|---------|-----------|
| STGP19NC60S | GP19NC60S | TO-220 | Tube |

Contents

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1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|-------------|------------------|
| V_{CES} | Collector-emitter voltage ($V_{GS} = 0$) | 600 | V |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 25^\circ\text{C}$ | 50 | A |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 100^\circ\text{C}$ | 20 | A |
| $I_{CP}^{(2)}$ | Pulsed collector current | 80 | A |
| V_{GE} | Gate-emitter voltage | ± 20 | V |
| P_{TOT} | Total dissipation at $T_C = 25^\circ\text{C}$ | 125 | W |
| T_j | Operating junction temperature | - 55 to 150 | $^\circ\text{C}$ |

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C, I_C)}$$

2. Pulsed: width limited by max junction temperature allowed

Table 2. Thermal resistance

| Symbol | Parameter | Value | Unit |
|-----------|---|-------|--------------------|
| Rthj-case | Thermal resistance junction-case max IGBT | 1 | $^\circ\text{C/W}$ |
| Rthj-amb | Thermal resistance junction-ambient max | 62.5 | $^\circ\text{C/W}$ |

2 Electrical characteristics

($T_{CASE}=25^{\circ}C$ unless otherwise specified)

Table 3. Static

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|---|---|------|--------------|-----------|---------------|
| $V_{BR(CES)}$ | Collector-emitter breakdown voltage | $I_C = 1mA, V_{GE} = 0$ | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15V, I_C = 12A$ $V_{GE} = 15V, I_C = 12A, T_C = 150^{\circ}C$ | | 1.55 1.35 | 1.9 | V V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}, I_C = 250 \mu A$ | 3.75 | | 5.75 | V |
| I_{CES} | Collector cut-off current ($V_{GE} = 0$) | $V_{CE} = \text{Max rating}, T_C = 25^{\circ}C$ $V_{CE} = \text{Max rating}, T_C = 150^{\circ}C$ | | | 150 1 | μA mA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20V, V_{CE} = 0$ | | | ± 100 | nA |
| g_{fs} | Forward transconductance | $V_{CE} = 15V, I_C = 12A$ | | 10 | | S |

Table 4. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25V, f = 1MHz,$ $V_{GE} = 0$ | | 1190 | | pF |
| C_{oes} | Output capacitance | | | 135 | | pF |
| C_{res} | Reverse transfer capacitance | | | 28.5 | | pF |
| Q_g | Total gate charge | $V_{CE} = 480V, I_C = 12A,$ | | 54.5 | | nC |
| Q_{ge} | Gate-emitter charge | $V_{GE} = 15V,$ | | 8.7 | | nC |
| Q_{gc} | Gate-collector charge | Figure 17 | | 25.8 | | nC |

Table 5. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|---|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 480V, I_C = 12A$ | | 17.5 | | ns |
| t_r | Current rise time | $R_G = 10\Omega, V_{GE} = 15V,$ | | 6.2 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | <i>Figure 18</i> | | 1870 | | A/ μ s |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 480V, I_C = 12A$ | | 17 | | ns |
| t_r | Current rise time | $R_G = 10\Omega, V_{GE} = 15V,$ | | 6.5 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | $T_j = 125^\circ C$ <i>Figure 18</i> | | 1700 | | A/ μ s |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC} = 480V, I_C = 12A$ | | 90 | | ns |
| $t_{d(Voff)}$ | Turn-off delay time | $R_G = 10\Omega, V_{GE} = 15V,$ | | 175 | | ns |
| t_f | Current fall time | <i>Figure 18</i> | | 215 | | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC} = 480V, I_C = 12A$ | | 155 | | ns |
| $t_{d(Voff)}$ | Turn-off delay time | $R_G = 10\Omega, V_{GE} = 15V,$ | | 245 | | ns |
| t_f | Current fall time | $T_j = 125^\circ C$ <i>Figure 18</i> | | 290 | | ns |

Table 6. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|---|------|------|------|---------|
| E_{on} | Turn-on switching losses | $V_{CC} = 480V, I_C = 12A$ | | 135 | | μ J |
| $E_{off}^{(1)}$ | Turn-off switching losses | $R_G = 10\Omega, V_{GE} = 15V,$ | | 815 | | μ J |
| E_{ts} | Total switching losses | <i>Figure 16</i> | | 995 | | μ J |
| E_{on} | Turn-on switching losses | $V_{CC} = 480V, I_C = 12A$ | | 200 | | μ J |
| $E_{off}^{(1)}$ | Turn-off switching losses | $R_G = 10\Omega, V_{GE} = 15V,$ | | 1175 | | μ J |
| E_{ts} | Total switching losses | $T_j = 125^\circ C$ <i>Figure 16</i> | | 1375 | | μ J |

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

2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

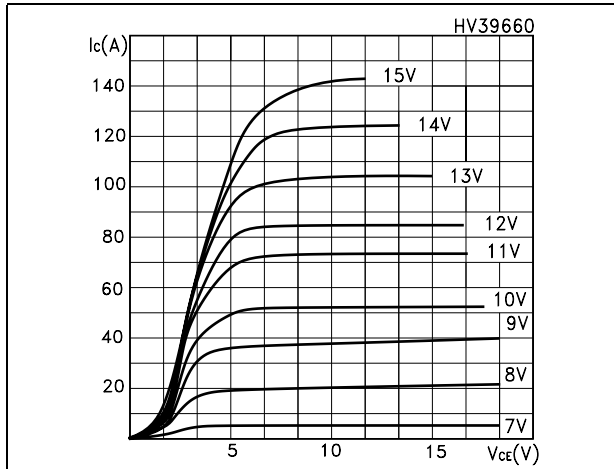


Figure 2. Transfer characteristics

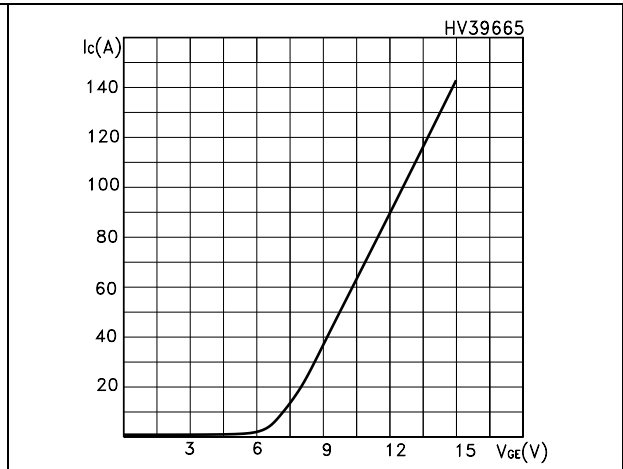


Figure 3. Transconductance

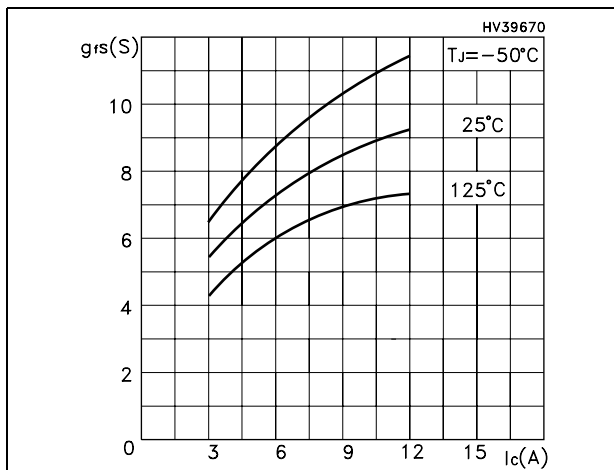


Figure 4. Collector-emitter on voltage vs temperature

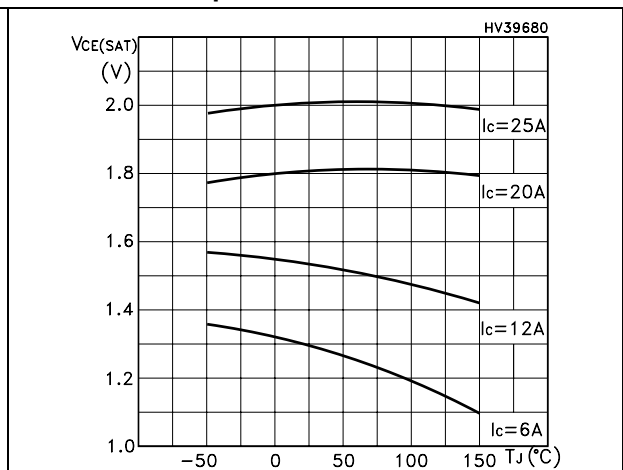


Figure 5. Gate charge vs gate-source voltage

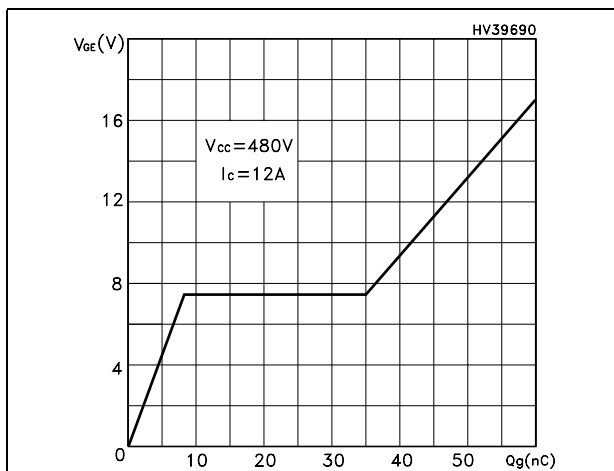


Figure 6. Capacitance variations

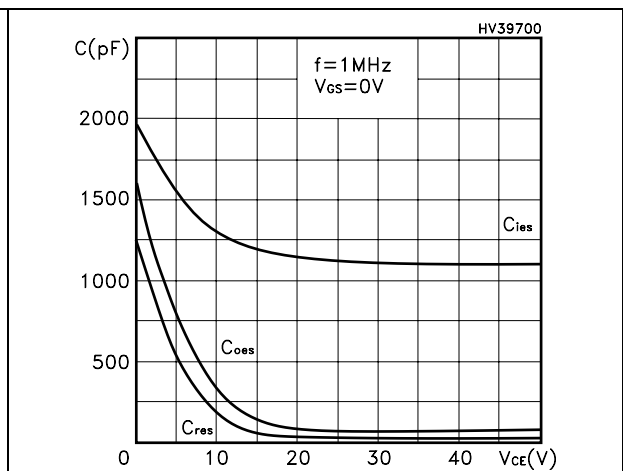


Figure 7. Normalized gate threshold voltage vs temperature

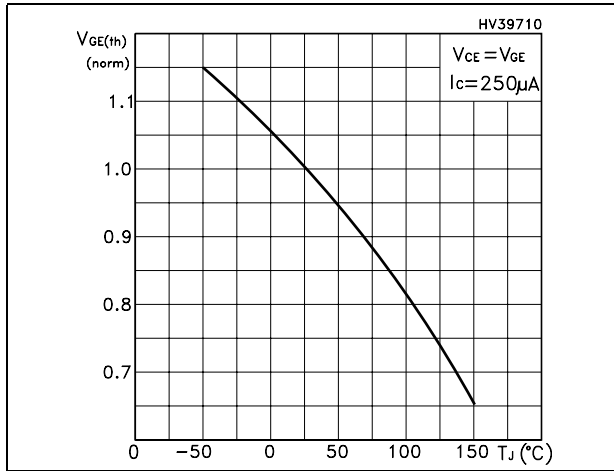


Figure 8. Collector-emitter on voltage vs collector current

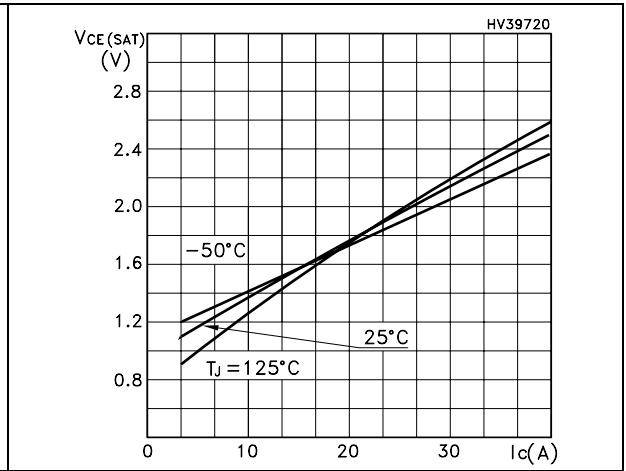


Figure 9. Normalized breakdown voltage vs temperature

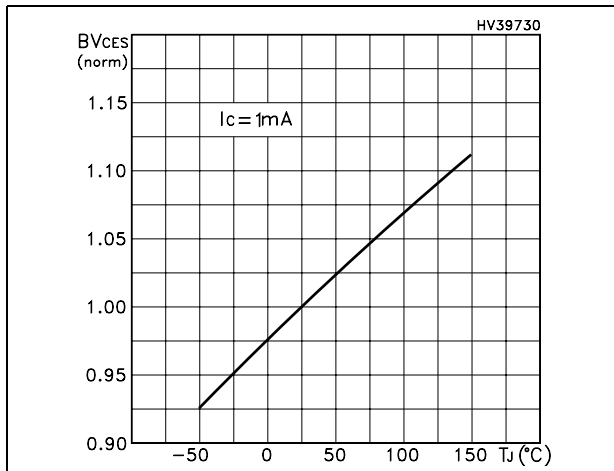


Figure 10. Switching losses vs temperature

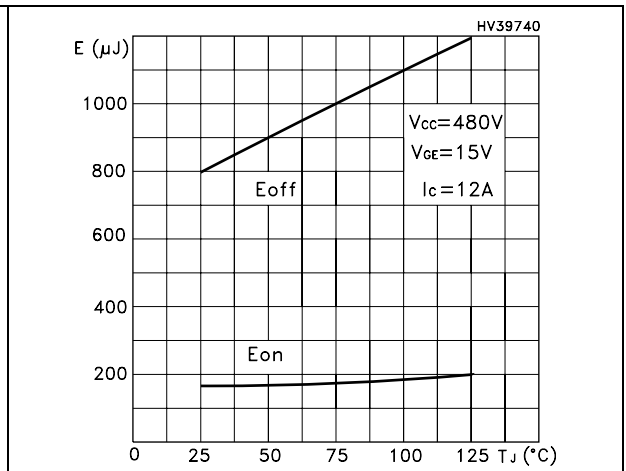


Figure 11. Switching losses vs gate resistance

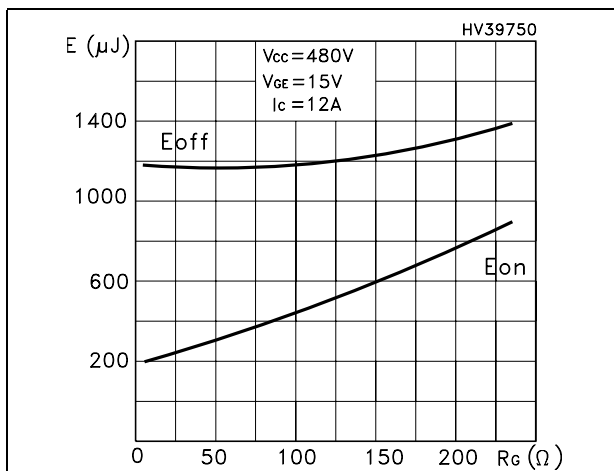


Figure 12. Switching losses vs collector current

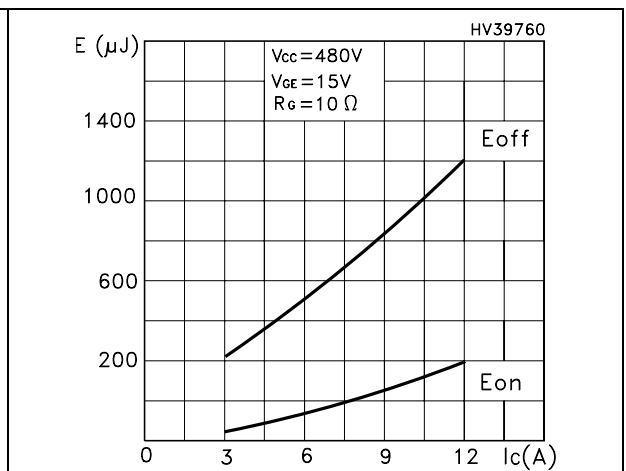


Figure 13. Turn-off SOA

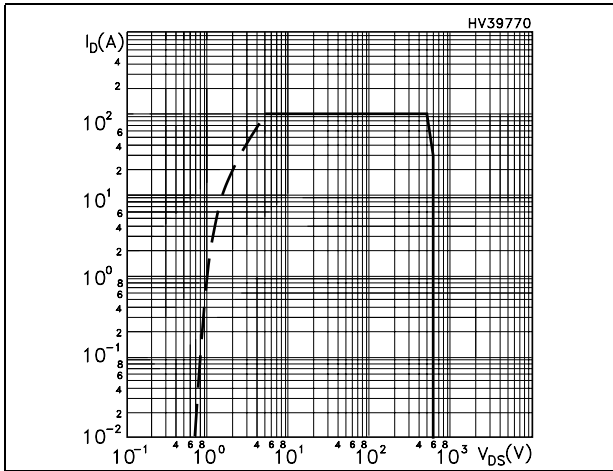


Figure 14. Thermal impedance

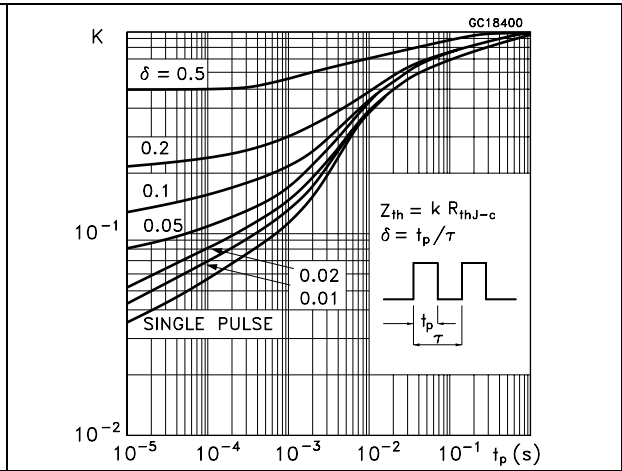
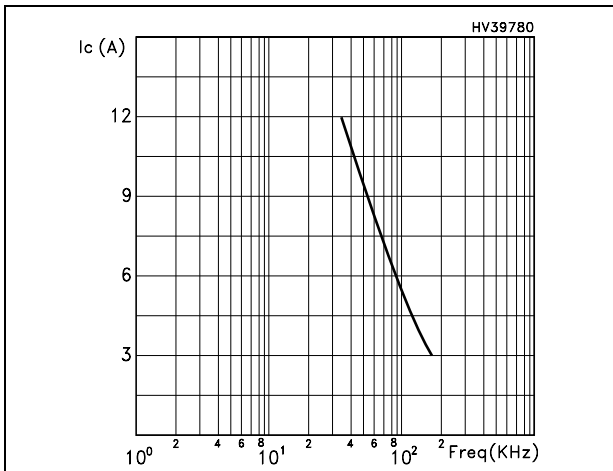


Figure 15. Ic vs. frequency



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.

3 Test circuit

Figure 16. Test circuit for inductive load switching

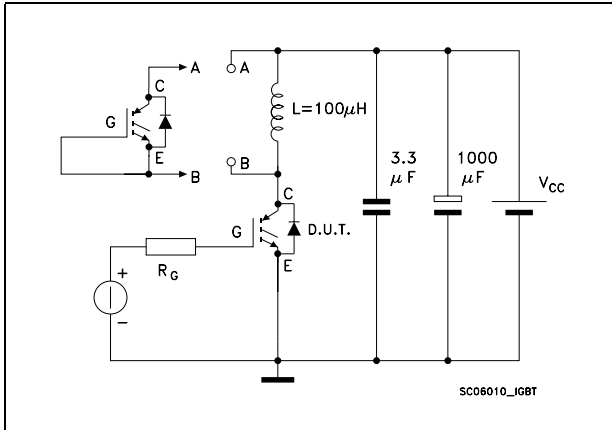


Figure 18. Switching waveform

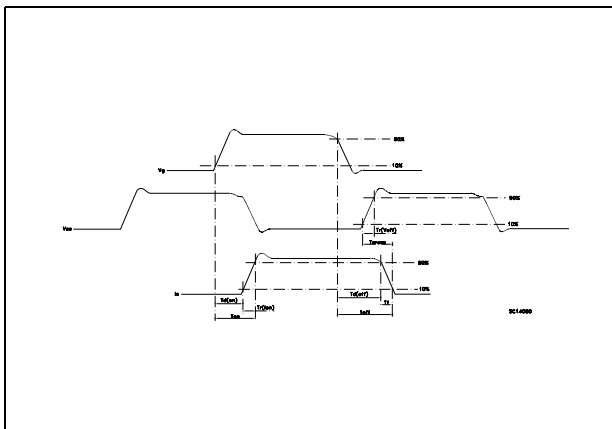


Figure 17. Gate charge test circuit

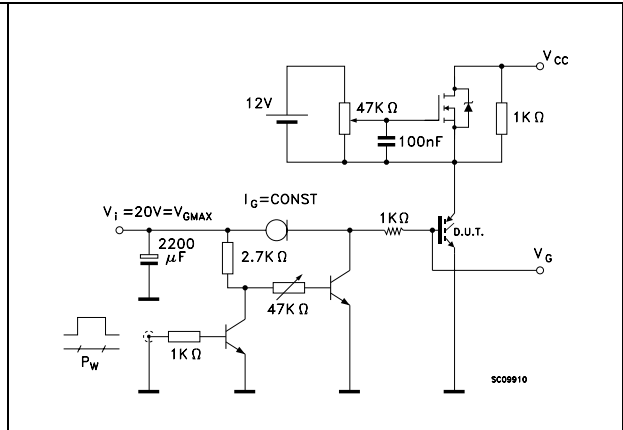
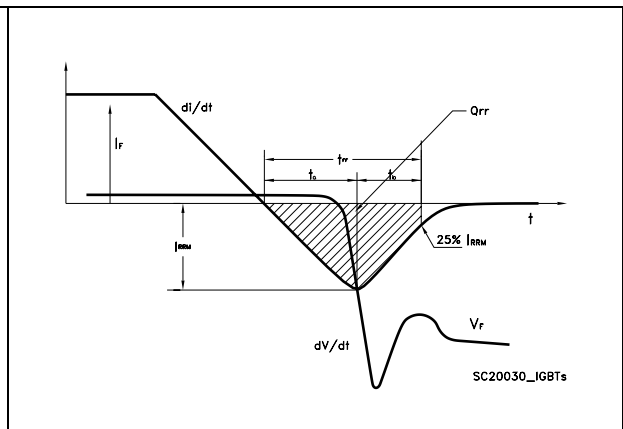


Figure 19. Diode recovery time waveform

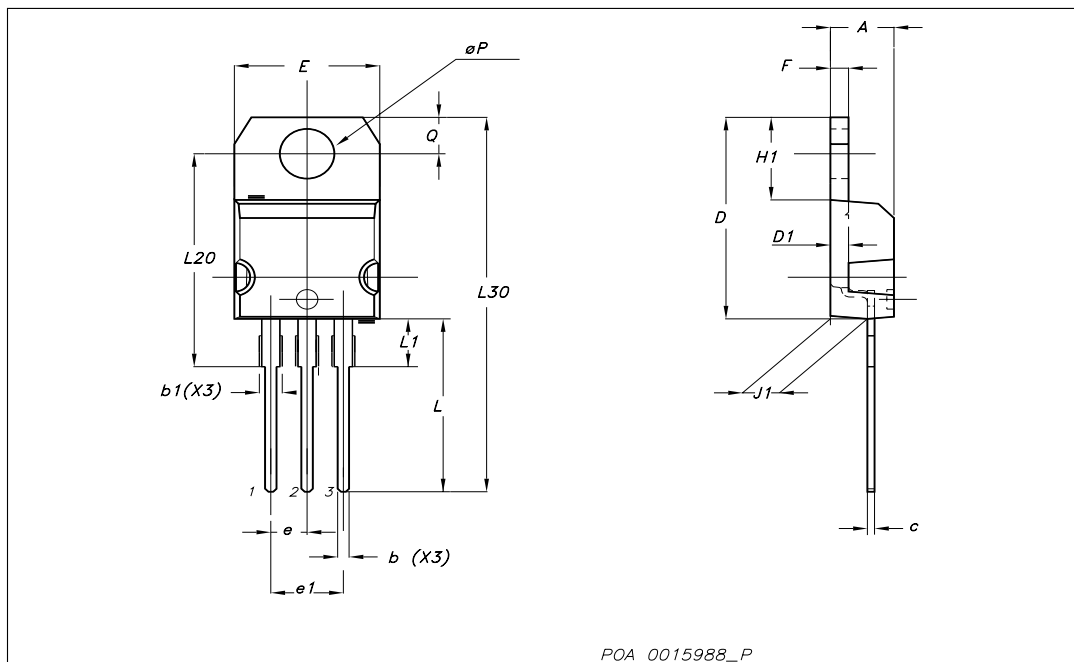


4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

TO-220 mechanical data

| Dim | mm | | | inch | | |
|-----|-------|-------|-------|-------|-------|-------|
| | Min | Typ | Max | Min | Typ | Max |
| A | 4.40 | | 4.60 | 0.173 | | 0.181 |
| b | 0.61 | | 0.88 | 0.024 | | 0.034 |
| b1 | 1.14 | | 1.70 | 0.044 | | 0.066 |
| c | 0.49 | | 0.70 | 0.019 | | 0.027 |
| D | 15.25 | | 15.75 | 0.6 | | 0.62 |
| D1 | | 1.27 | | | 0.050 | |
| E | 10 | | 10.40 | 0.393 | | 0.409 |
| e | 2.40 | | 2.70 | 0.094 | | 0.106 |
| e1 | 4.95 | | 5.15 | 0.194 | | 0.202 |
| F | 1.23 | | 1.32 | 0.048 | | 0.051 |
| H1 | 6.20 | | 6.60 | 0.244 | | 0.256 |
| J1 | 2.40 | | 2.72 | 0.094 | | 0.107 |
| L | 13 | | 14 | 0.511 | | 0.551 |
| L1 | 3.50 | | 3.93 | 0.137 | | 0.154 |
| L20 | | 16.40 | | | 0.645 | |
| L30 | | 28.90 | | | 1.137 | |
| ∅P | 3.75 | | 3.85 | 0.147 | | 0.151 |
| Q | 2.65 | | 2.95 | 0.104 | | 0.116 |



5 Revision history

Table 7. 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> |

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