



STGW45NC60VD

45 A - 600 V - very fast IGBT

Features

- Low C_{RES} / C_{IES} ratio (no cross conduction susceptibility)
- IGBT co-packaged with ultra fast free-wheeling diode

Applications

- High frequency inverters
- UPS
- Motor drivers
- Induction heating

Description

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

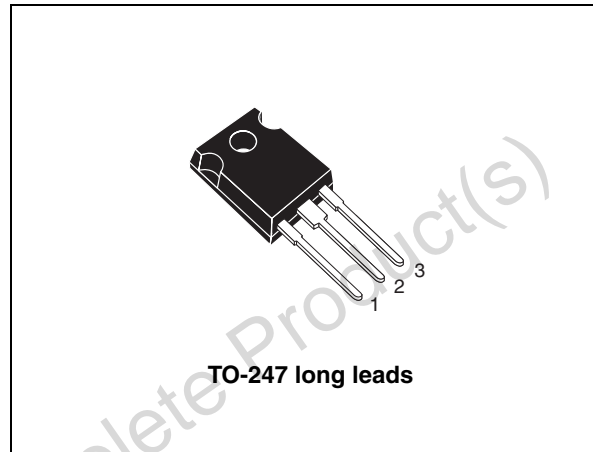


Figure 1. Internal schematic diagram

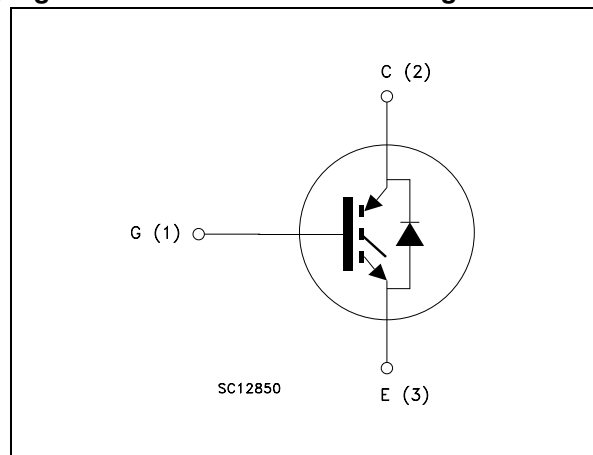


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|--------------|------------|-------------------|-----------|
| STGW45NC60VD | GW45NC60VD | TO-247 long leads | Tube |

Contents

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Obsolete Product(s) - Obsolete Product(s)

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|--|-------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$) | 600 | V |
| $I_C^{(1)}$ | Collector current (continuous) at 25 °C | 90 | A |
| $I_C^{(1)}$ | Collector current (continuous) at 100 °C | 50 | A |
| $I_{CL}^{(2)}$ | Turn-off latching current | 220 | A |
| $I_{CP}^{(3)}$ | Pulsed collector current | 220 | A |
| V_{GE} | Gate-emitter voltage | ± 20 | V |
| I_F | Diode RMS forward current at $T_C = 25$ °C | 30 | A |
| I_{FSM} | Surge non repetitive forward current ($t_p=10$ ms sinusoidal) | 120 | A |
| P_{TOT} | Total dissipation at $T_C = 25$ °C | 270 | W |
| T_j | Operating junction temperature | - 55 to 150 | °C |

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{JMAX} - T_C}{R_{THJ-C} \times V_{CESAT(MAX)}(T_C)} \cdot I_C^{(1)}$$

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

3. Pulse width limited by max. junction temperature allowed

Table 3. Thermal resistance

| Symbol | Parameter | Value | Unit |
|----------------|--|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case (IGBT) max | 0.46 | °C/W |
| $R_{thj-case}$ | Thermal resistance junction-case (diode) max | 1.5 | °C/W |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 50 | °C/W |

2 Electrical characteristics

($T_{CASE}=25\text{ °C}$ 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 | $V_{GE} = 15\text{ V}, I_C = 30\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 30\text{ A}, T_C = 125\text{ °C}$ | | 1.8 1.7 | 2.4 | V V |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}, I_C = 1\text{ mA}$ | 3.75 | | 5.75 | V |
| I_{CES} | Collector cut-off current ($V_{GE} = 0$) | $V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_C = 125\text{ °C}$ | | | 500 5 | μA mA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{ V}$ | | | ± 100 | nA |
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{CE} = 15\text{ V}, I_C = 30\text{ A}$ | | 20 | | S |

1. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0$ | | 290 | | pF |
| C_{oes} | Output capacitance | | | 0 | | pF |
| C_{res} | Reverse transfer capacitance | | | 298 | | pF |
| Q_g | Total gate charge | $V_{CE} = 390\text{ V}, I_C = 30\text{ A},$ $V_{GE} = 15\text{ V}$ <i>(see Figure 19)</i> | | 126 | | nC |
| Q_{ge} | Gate-emitter charge | | | 16 | | nC |
| Q_{gc} | Gate-collector charge | | | 46 | | nC |

Table 6. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-----------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 390\text{ V}$, $I_C = 30\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 18) | | 33 | | ns |
| t_r | Current rise time | | | 13 | | ns |
| $(di/dt)_{onf}$ | Turn-on current slope | | | | 2500 | |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 390\text{ V}$, $I_C = 30\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_C = 125\text{ }^\circ\text{C}$ (see Figure 18) | | 32 | | ns |
| t_r | Current rise time | | | 14 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | | | 2280 | |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC} = 390\text{ V}$, $I_C = 30\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 18) | | 33 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 178 | | ns |
| t_f | Current fall time | | | | 65 | |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC} = 390\text{ V}$, $I_C = 30\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_C = 125\text{ }^\circ\text{C}$ (see Figure 18) | | 68 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 238 | | ns |
| t_f | Current fall time | | | | 128 | |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|--|------|------|------|---------|
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CC} = 390\text{ V}$, $I_C = 30\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 20) | | 333 | | μ J |
| $E_{off}^{(2)}$ | Turn-off switching losses | | | 537 | | μ J |
| E_{ts} | Total switching losses | | | | 870 | |
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CC} = 390\text{ V}$, $I_C = 30\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_C = 125\text{ }^\circ\text{C}$ (see Figure 20) | | 618 | | μ J |
| $E_{off}^{(2)}$ | Turn-off switching losses | | | 1125 | | μ J |
| E_{ts} | Total switching losses | | | | 1743 | |

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in figure 2 E_{on} include diode recovery energy. 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 (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 | $I_F = 30\text{ A}$ $I_F = 30\text{ A}, T_C = 125\text{ °C}$ | | 2.4 | | V |
| | | | | 1.8 | | V |
| t_{rr} | Reverse recovery time | $I_F = 30\text{ A}, V_R = 50\text{ V},$ $di/dt = 100\text{ A}/\mu\text{s}$ <i>(see Figure 21)</i> | | 45 | | ns |
| Q_{rr} | Reverse recovery charge | | | 56 | | nC |
| I_{rrm} | Reverse recovery current | | | 2.55 | | A |
| t_{rr} | Reverse recovery time | $I_F = 30\text{ A}, V_R = 50\text{ V},$ $T_C = 125\text{ °C},$ $di/dt = 100\text{ A}/\mu\text{s}$ <i>(see Figure 21)</i> | | 100 | | ns |
| Q_{rr} | Reverse recovery charge | | | 290 | | nC |
| I_{rrm} | Reverse recovery current | | | 5.8 | | A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

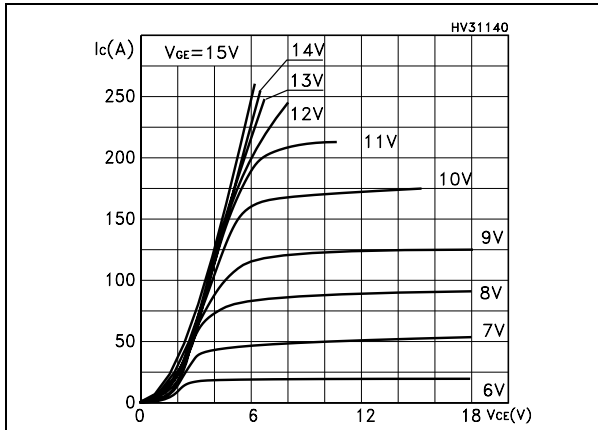


Figure 3. Transfer characteristics

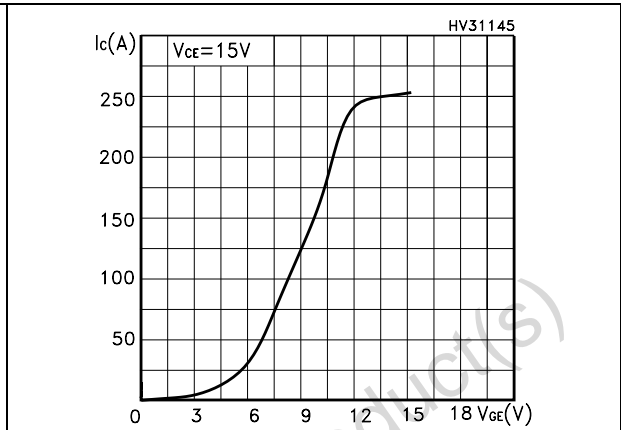


Figure 4. Transconductance

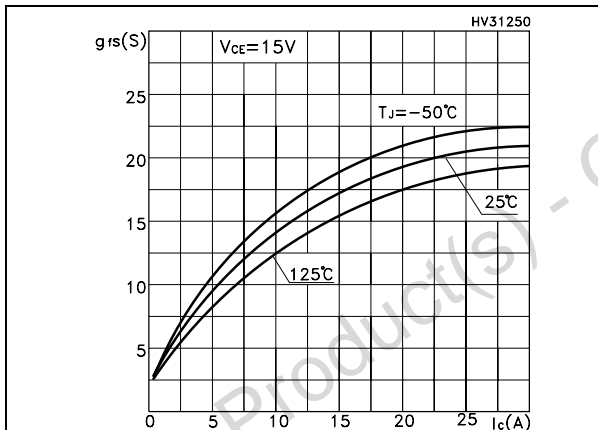


Figure 5. Collector-emitter on voltage vs temperature

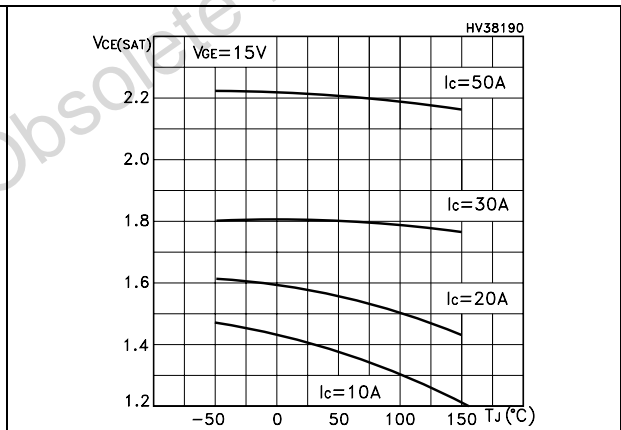


Figure 6. Collector-emitter on voltage vs collector current

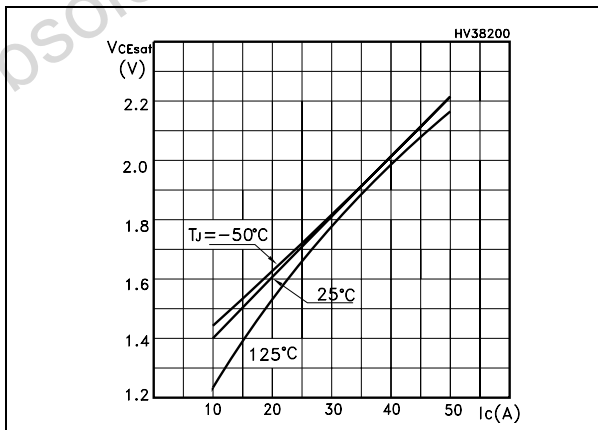


Figure 7. Normalized gate threshold vs temperature

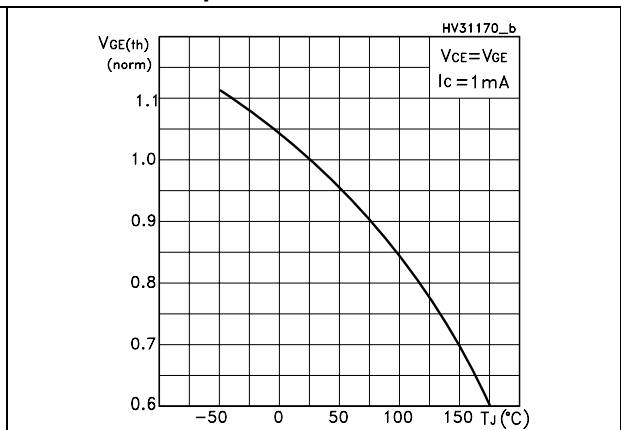


Figure 8. Normalized breakdown voltage vs temperature

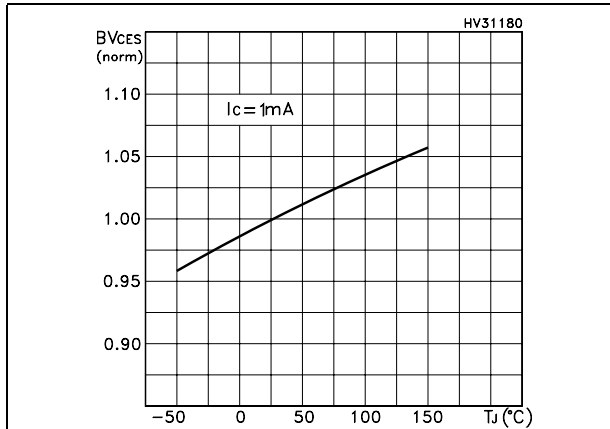


Figure 9. Gate charge vs gate-emitter voltage

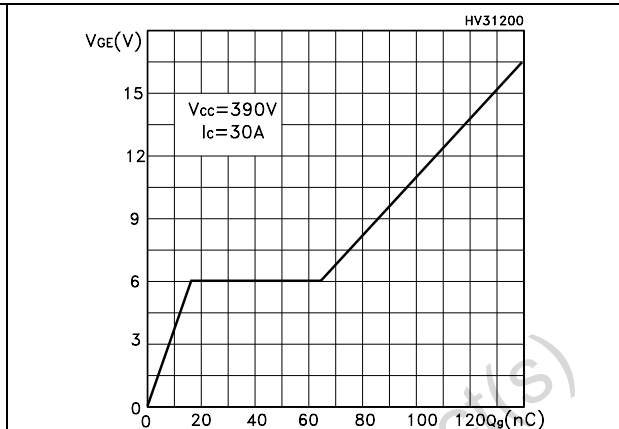


Figure 10. Capacitance variations

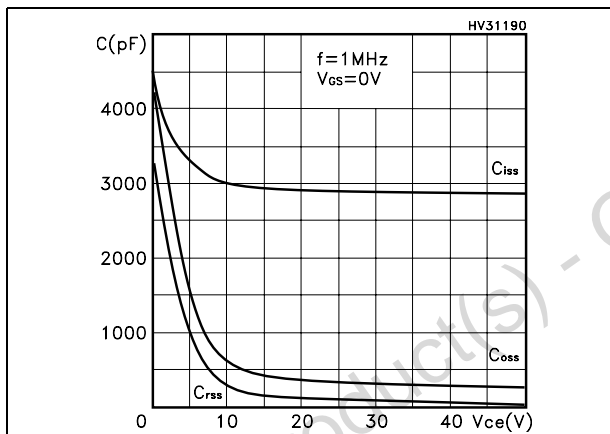


Figure 11. Switching losses vs temperature

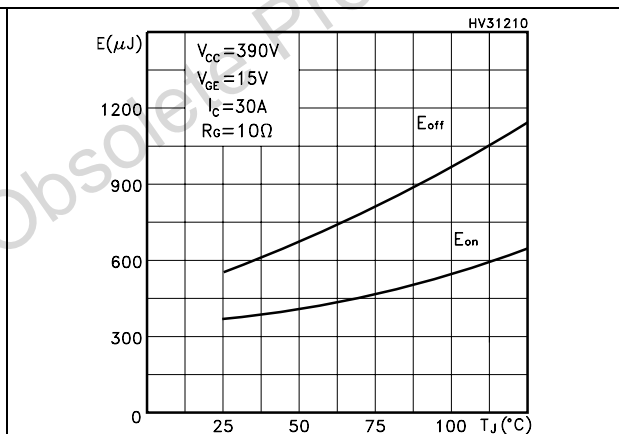


Figure 12. Switching losses vs gate resistance

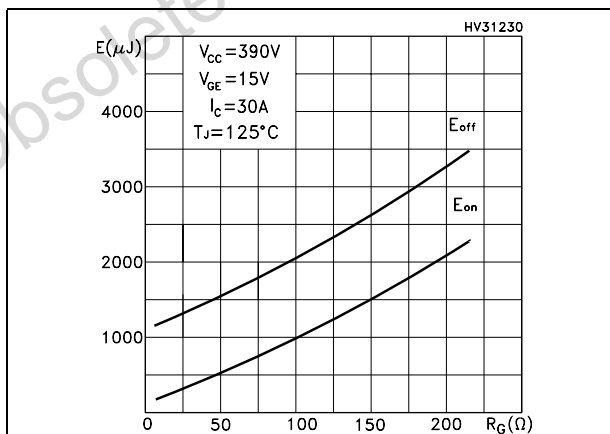


Figure 13. Switching losses vs collector current

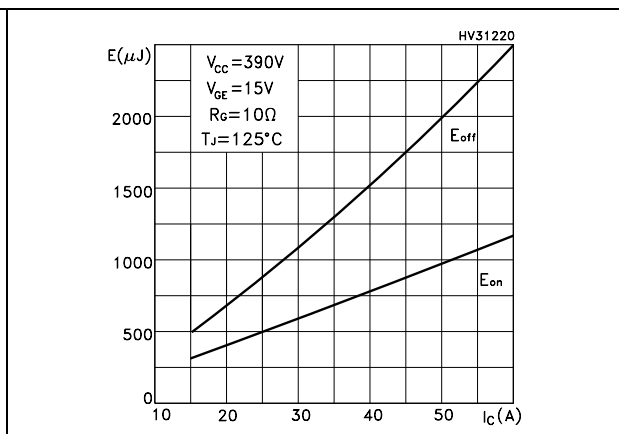


Figure 14. Thermal impedance

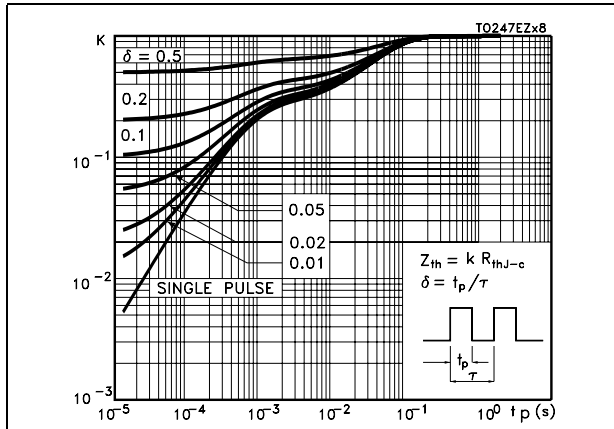


Figure 15. Turn-off SOA

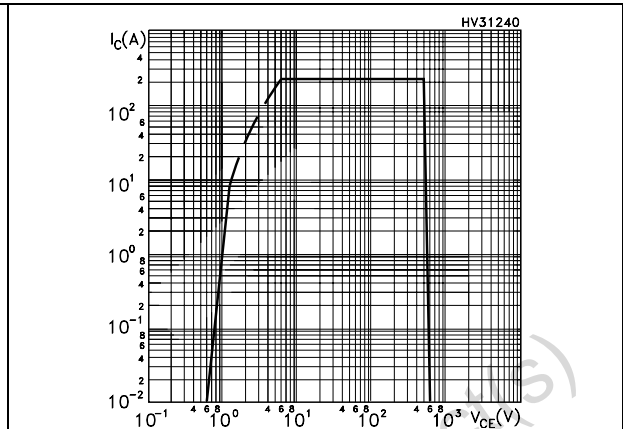


Figure 16. Emitter-collector diode characteristics

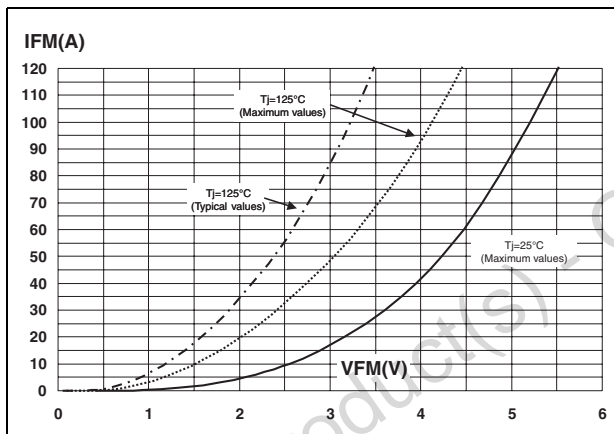
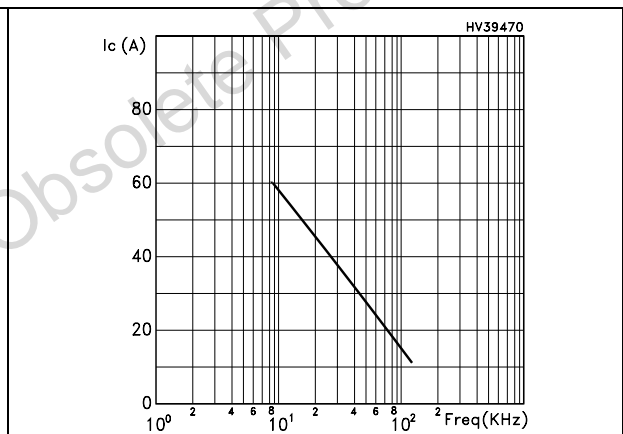


Figure 17. Ic vs. frequency



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 $\Delta T = T_J - T_C = 125\text{ }^\circ\text{C} - 75\text{ }^\circ\text{C} = 50\text{ }^\circ\text{C}$

- 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 and 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: $V_{CE} = 390 \text{ V}$, $V_{GE} = 15 \text{ V}$, $R_G = 10 \Omega$). Furthermore, diode recovery energy is included in the E_{ON} (see note 2), while the tail of the collector current is included in the E_{OFF} measurements (see note 3).

Obsolete Product(s) - Obsolete Product(s)

3 Test circuit

Figure 18. Test circuit for inductive load switching

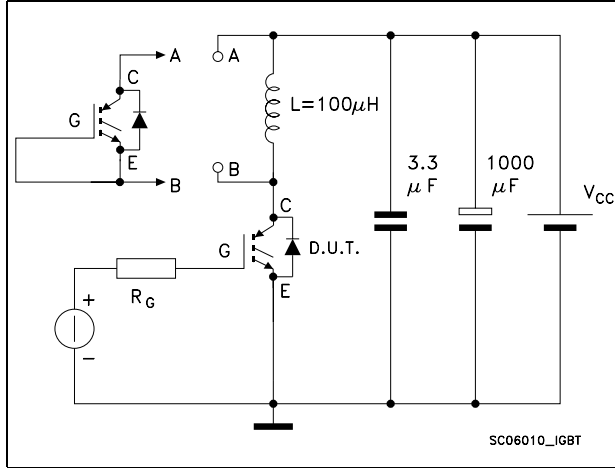


Figure 19. Gate charge test circuit

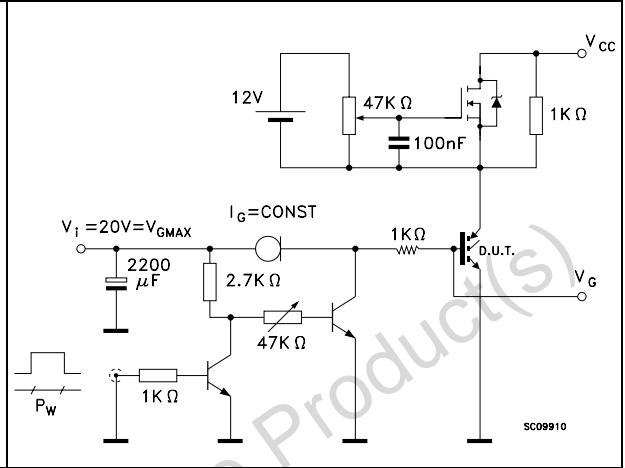


Figure 20. Switching waveforms

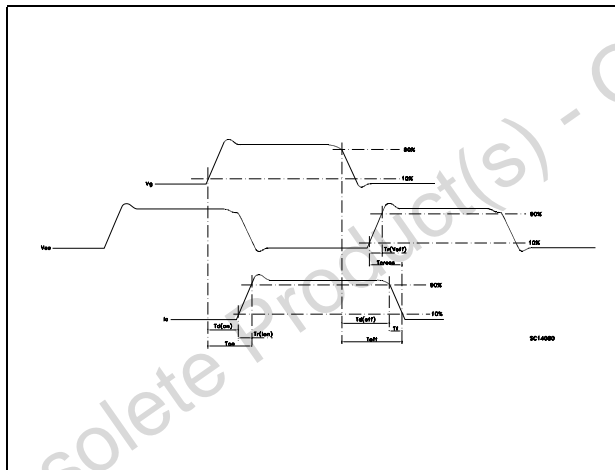
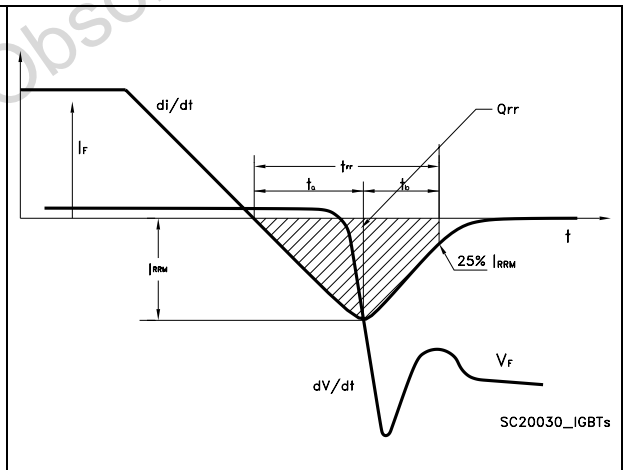


Figure 21. Diode recovery times waveform



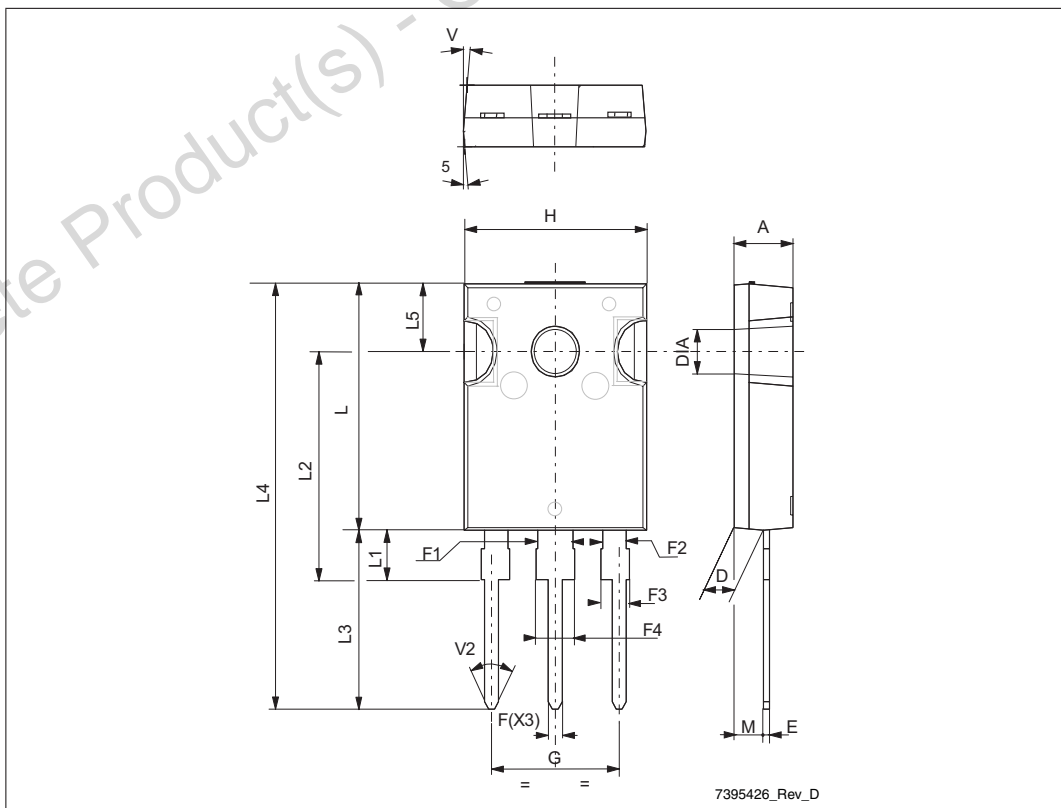
4 Package mechanical data

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

Obsolete Product(s) - Obsolete Product(s)

TO-247 long leads mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.85 | | 5.16 |
| D | 2.2 | | 2.6 |
| E | 0.4 | | 0.8 |
| F | 1 | | 1.4 |
| F1 | | 3 | |
| F2 | | 2 | |
| F3 | 1.9 | | 2.4 |
| F4 | 3 | | 3.4 |
| G | | 10.9 | |
| H | 15.45 | | 16.03 |
| L | 19.85 | | 21.09 |
| L1 | 3.7 | | 4.3 |
| L2 | 18.3 | | 19.13 |
| L3 | 14.2 | | 20.3 |
| L4 | 34.05 | | 41.38 |
| L5 | 5.35 | | 6.3 |
| M | 2 | | 3 |
| V | | 5° | |
| V2 | | 60° | |
| DIA | 3.55 | | 3.65 |



5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|---------------|
| 19-Mar-2008 | 1 | First release |

Obsolete Product(s) - Obsolete Product(s)

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