



STGY50NC60WD

50 A, 600 V, ultra fast IGBT

Features

- Very high frequency operation
- Low C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode

Applications

- Very high frequency inverters, UPS
- HF, SMPS and PFC in both hard switch and resonant topologies
- Motor drivers
- Welding

Description

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

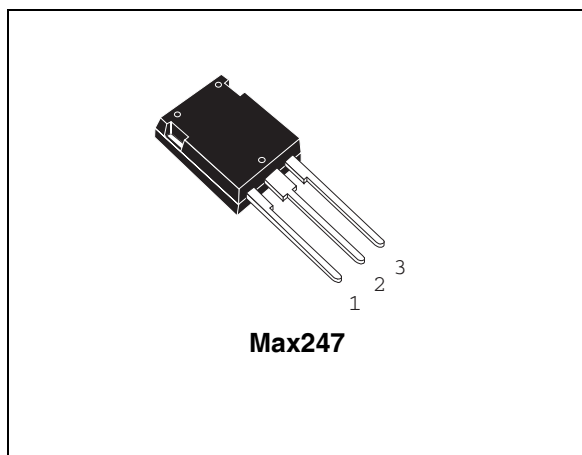


Figure 1. Internal schematic diagram

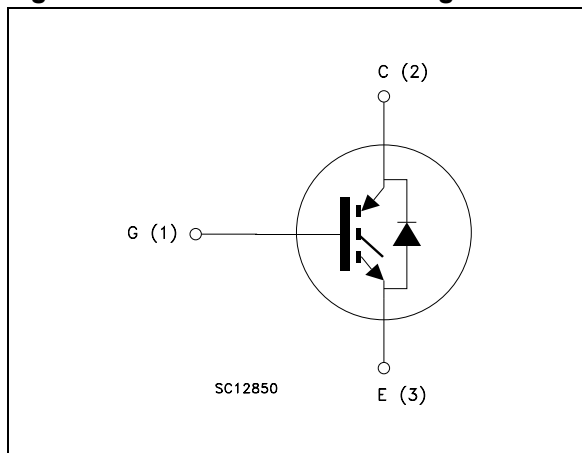


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|--------------|------------|---------|-----------|
| STGY50NC60WD | GY50NC60WD | Max247 | Tube |

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1 Electrical ratings

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|----------------|---|------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$) | 600 | V |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 25\text{ °C}$ | 110 | A |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 100\text{ °C}$ | 50 | A |
| $I_{CL}^{(2)}$ | Turn-off latching current | 180 | A |
| $I_{CP}^{(3)}$ | Pulsed collector current | 180 | A |
| I_F | Diode RMS forward current at $T_C = 25\text{ °C}$ | 30 | A |
| I_{FSM} | Surge not repetitive forward current ($t_p=10\text{ ms}$ sinusoidal) | 120 | A |
| V_{GE} | Gate-emitter voltage | ± 20 | V |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 278 | W |
| 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. $V_{clamp} = 80\%$ of V_{CES} , $T_j = 150\text{ °C}$, $R_G = 10\text{ }\Omega$, $V_{GE} = 15\text{ V}$

3. Pulse width limited by max. temperature allowed

Table 2. Thermal resistance

| Symbol | Parameter | Value | Unit |
|----------------|---|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case IGBT max. | 0.45 | °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 3. 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 | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$ $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$, $T_C = 125\text{ °C}$ | | 2.1 1.9 | 2.6 | 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 ($V_{GE} = 0$) | $V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}$, $T_C = 125\text{ °C}$ | | | 500 5 | μA mA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{ V}$ | | | ± 100 | nA |
| g_{fs} | Forward transconductance | $V_{CE} = 15\text{ V}$, $I_C = 40\text{ A}$ | | 25 | | S |

Table 4. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$ | | 4700 | | pF |
| C_{oes} | Output capacitance | | | 410 | | pF |
| C_{res} | Reverse transfer capacitance | | | 90 | | pF |
| Q_g | Total gate charge | $V_{CE} = 390\text{ V}$, $I_C = 40\text{ A}$, | | 195 | | nC |
| Q_{ge} | Gate-emitter charge | $V_{GE} = 15\text{ V}$, | | 32 | | nC |
| Q_{gc} | Gate-collector charge | Figure 16 | | 82 | | nC |

Table 5. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|--|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 390\text{ V}$, $I_C = 40\text{ A}$ | | 52 | | ns |
| t_r | Current rise time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, | | 17 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | <i>Figure 17, Figure 15</i> | | 2400 | | A/ μ s |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 390\text{ V}$, $I_C = 40\text{ A}$ | | 50 | | ns |
| t_r | Current rise time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, | | 19 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | $T_C = 125\text{ }^\circ\text{C}$ <i>Figure 17, Figure 15</i> | | 2020 | | A/ μ s |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC} = 390\text{ V}$, $I_C = 40\text{ A}$ | | 31 | | ns |
| $t_{d(Voff)}$ | Turn-off delay time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, | | 240 | | ns |
| t_f | Current fall time | <i>Figure 17, Figure 15</i> | | 35 | | ns |
| $t_{r(Voff)}$ | Off voltage rise time | $V_{CC} = 390\text{ V}$, $I_C = 40\text{ A}$ | | 59 | | ns |
| $t_{d(Voff)}$ | Turn-off delay time | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, | | 280 | | ns |
| t_f | Current fall time | $T_C = 125\text{ }^\circ\text{C}$ <i>Figure 17, Figure 15</i> | | 63 | | ns |

Table 6. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|---|------|------|------|---------|
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CC} = 390\text{ V}$, $I_C = 40\text{ A}$ | | 365 | 470 | μ J |
| $E_{off}^{(2)}$ | Turn-off switching losses | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, | | 560 | 790 | μ J |
| E_{ts} | Total switching losses | <i>Figure 15</i> | | 925 | 1260 | μ J |
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CC} = 390\text{ V}$, $I_C = 40\text{ A}$ | | 635 | | μ J |
| $E_{off}^{(2)}$ | Turn-off switching losses | $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, | | 910 | | μ J |
| E_{ts} | Total switching losses | $T_C = 125\text{ }^\circ\text{C}$ <i>Figure 15</i> | | 1545 | | μ J |

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in *Figure 18*. 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 7. Collector-emitter diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|--|--|------|-------------------|------|---------------|
| V_F | Forward on-voltage | $I_F = 40\text{ A}$ $I_F = 40\text{ A}, T_C = 125\text{ °C}$ | | 3.2 2.2 | | V V |
| t_{rr} Q_{rr} I_{rrm} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_F = 40\text{ A}, V_R = 50\text{ V},$ $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 18</i> | | 55 100 3.6 | | ns nC A |
| t_{rr} Q_{rr} I_{rrm} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_F = 40\text{ A}, V_R = 50\text{ V},$ $T_C = 125\text{ °C},$ $di/dt = 100\text{ A}/\mu\text{s}$ (<i>Figure 18</i>) | | 164 525 6.4 | | ns nC A |

2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

Figure 2. Transfer characteristics

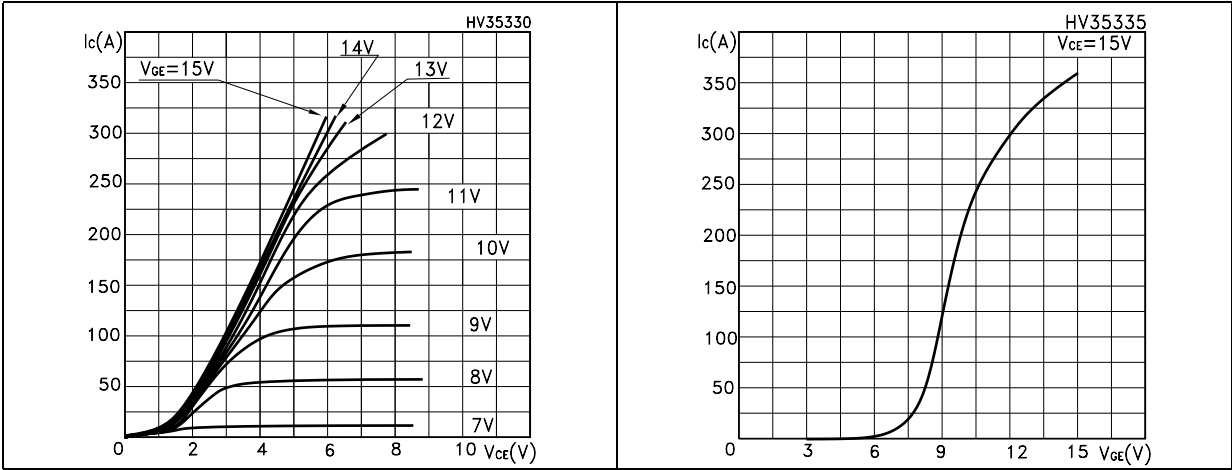


Figure 3. Transconductance

Figure 4. Collector-emitter on voltage vs temperature

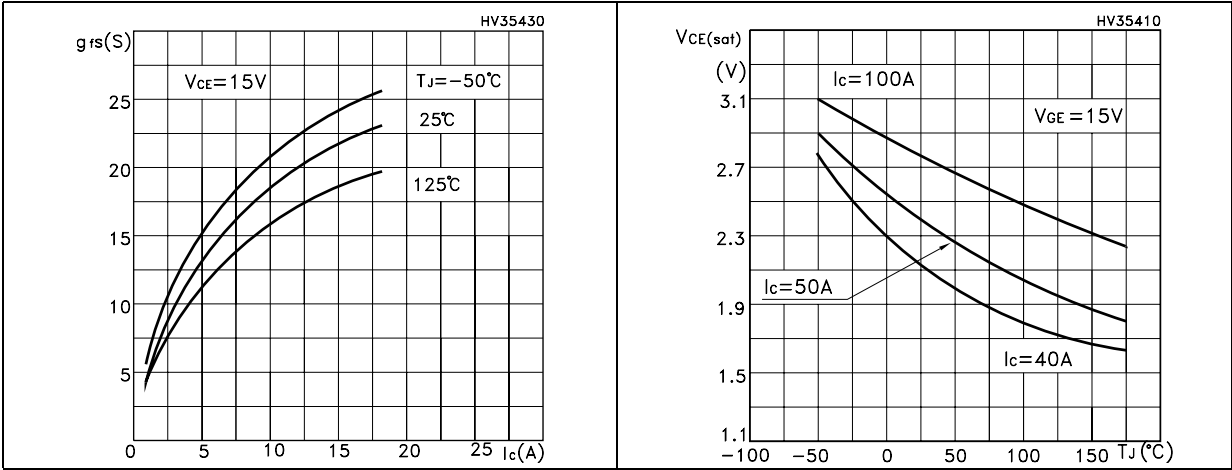


Figure 5. Gate charge vs gate-source voltage

Figure 6. Capacitance variations

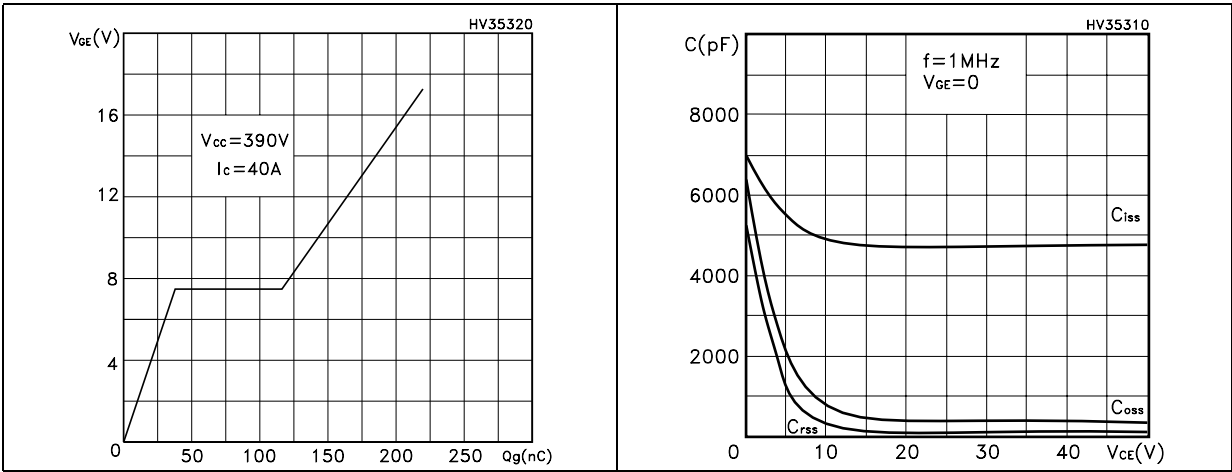


Figure 7. Normalized gate threshold voltage vs temperature

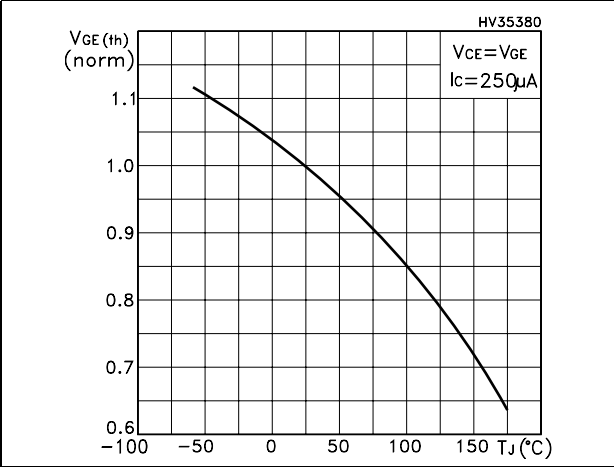


Figure 8. Collector-emitter on voltage vs collector current

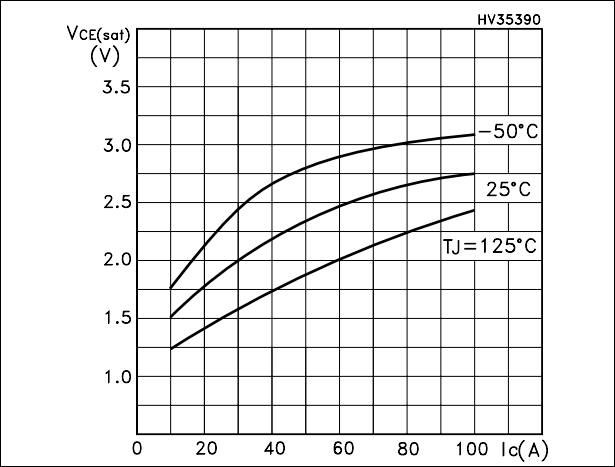


Figure 9. Normalized breakdown voltage vs temperature

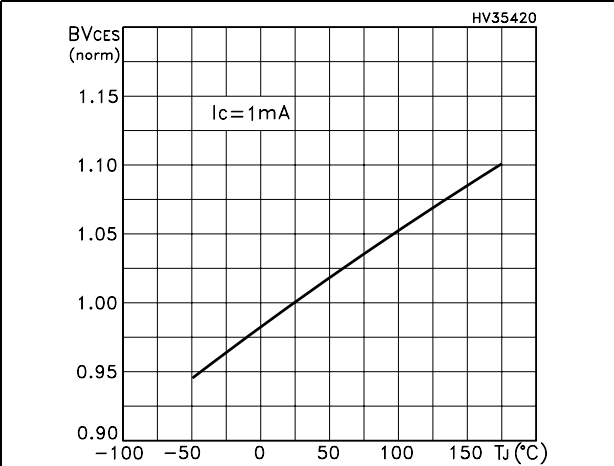


Figure 10. Switching losses vs temperature

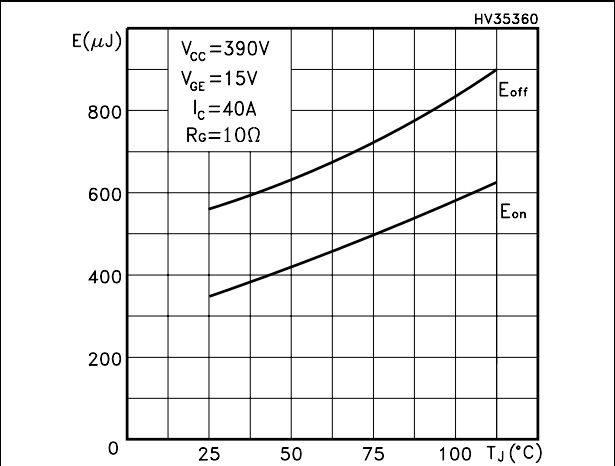


Figure 11. Switching losses vs gate resistance

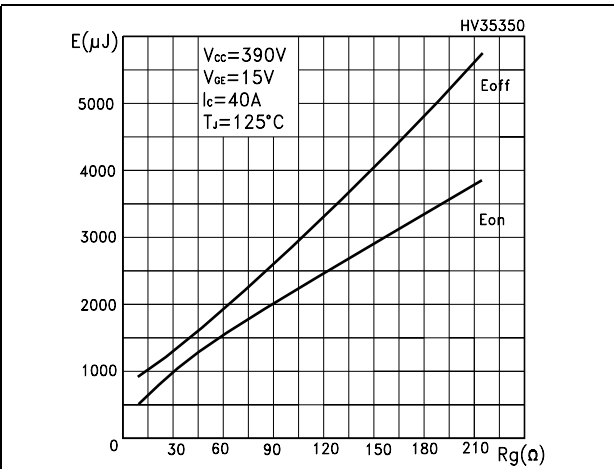


Figure 12. Switching losses vs collector current

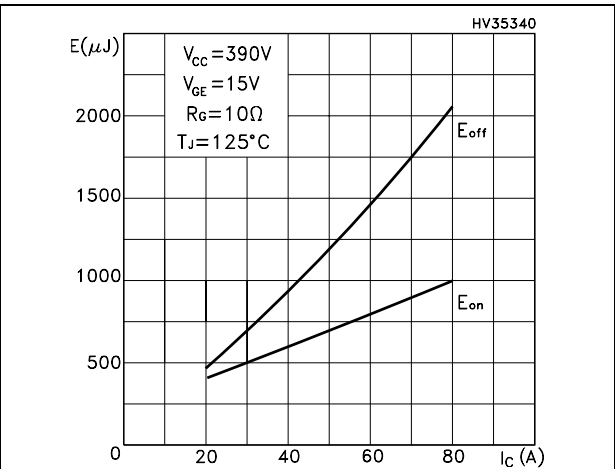


Figure 13. Turn-off SOA

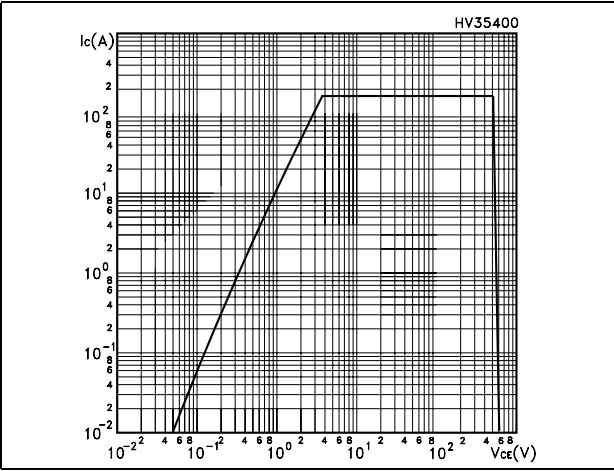
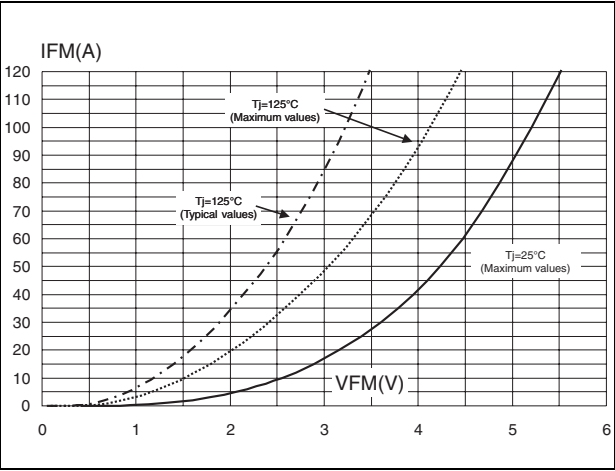


Figure 14. Forward voltage drop vs. forward current



3 Test circuit

Figure 15. Test circuit for inductive load switching

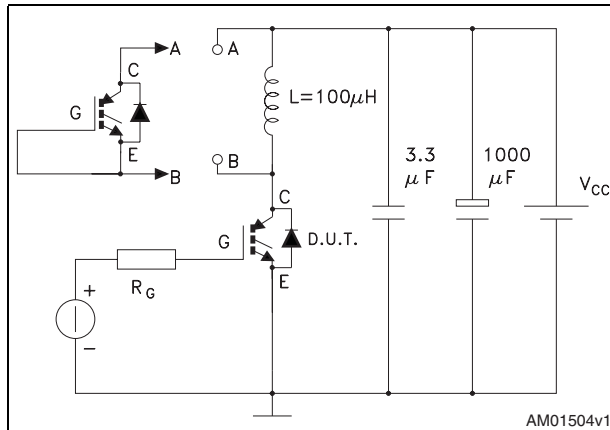


Figure 16. Gate charge test circuit

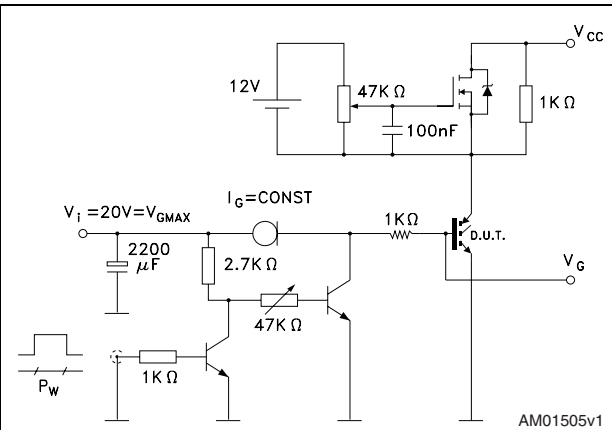


Figure 17. Switching waveform

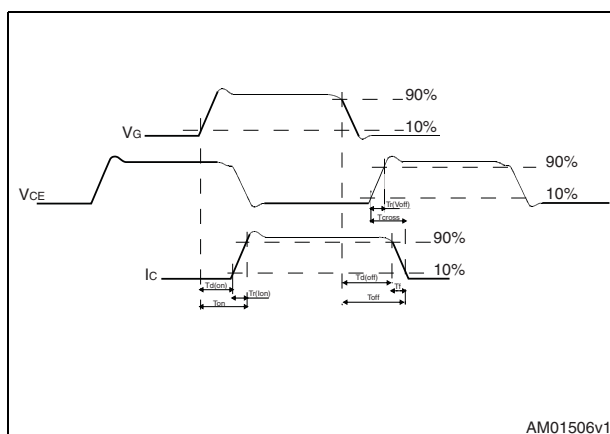
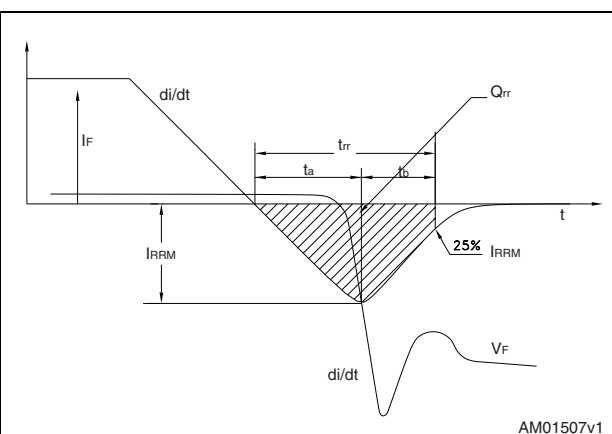


Figure 18. Diode recovery time waveform



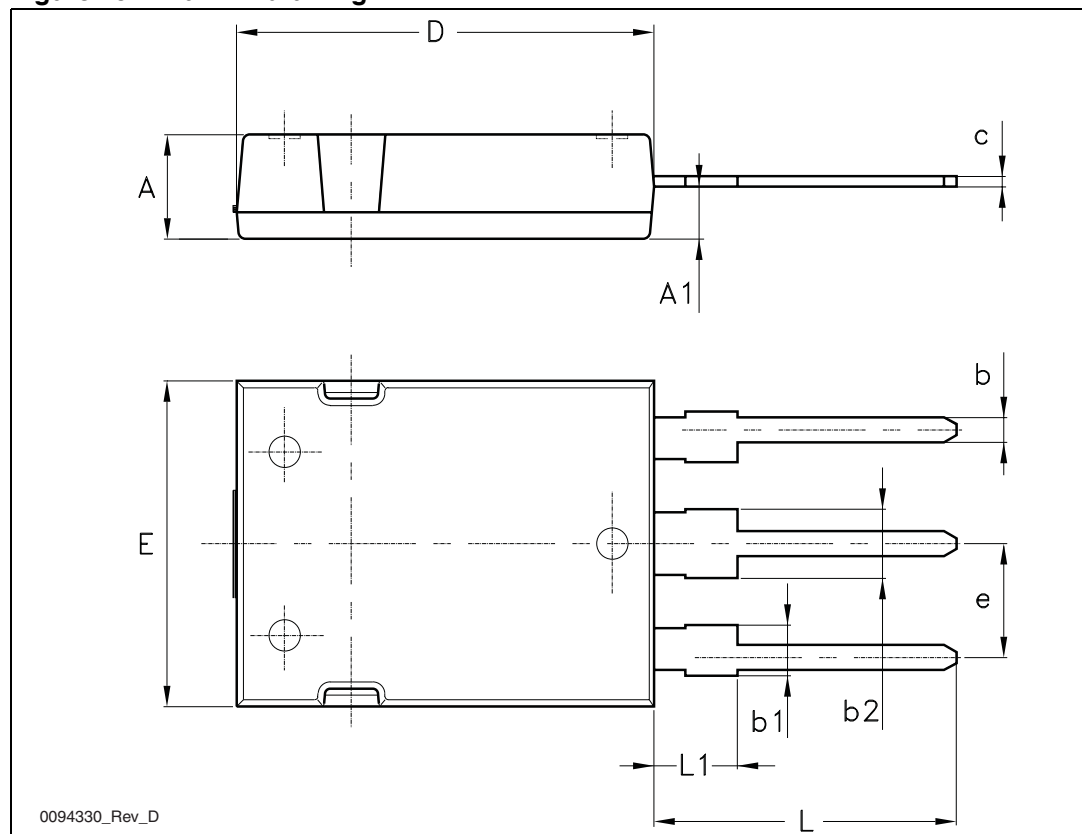
4 **Package mechanical data**

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 8. Max247 mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.70 | | 5.30 |
| A1 | 2.20 | | 2.60 |
| b | 1.00 | | 1.40 |
| b1 | 2.00 | | 2.40 |
| b2 | 3.00 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.70 | | 20.30 |
| e | 5.35 | | 5.55 |
| E | 15.30 | | 15.90 |
| L | 14.20 | | 15.20 |
| L1 | 3.70 | | 4.30 |

Figure 19. Max247 drawing



5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 09-Oct-2006 | 1 | Initial release. |
| 07-May-2007 | 2 | Complete version |
| 02-Jul-2007 | 3 | Modified value on Table 2: Thermal resistance |
| 04-Nov-2008 | 4 | Table 8: Max247 mechanical data and Figure 19: Max247 drawing have been updated. |
| 09-Jan-2009 | 5 | Figure 13: Turn-off SOA has been updated. |

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