



STGW40NC60KD

40 A - 600 V - short circuit rugged IGBT

Features

- Low on-voltage drop ($V_{CE(sat)}$)
- Low C_{res} / C_{ies} ratio (no cross conduction susceptibility)
- Short circuit withstand time 10 μ s
- IGBT co-packaged with ultra fast free-wheeling diode

Applications

- High frequency inverters
- Motor drivers

Description

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

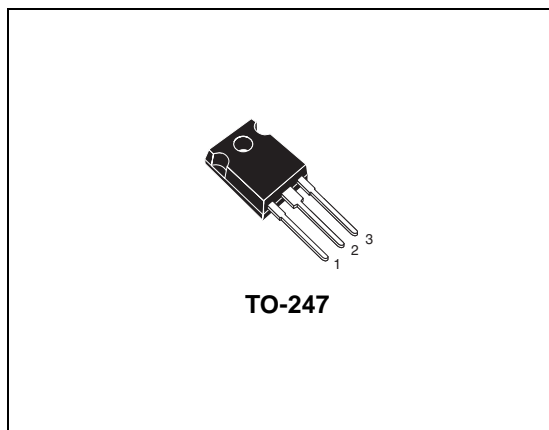


Figure 1. Internal schematic diagram

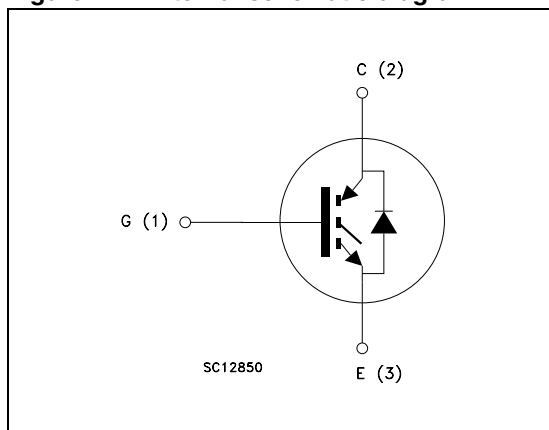


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|--------------|------------|---------|-----------|
| STGW40NC60KD | GW40NC60KD | TO-247 | Tube |

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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 |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 25\text{ °C}$ | 70 | A |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 100\text{ °C}$ | 38 | 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 $T_C = 25\text{ °C}$ | 30 | A |
| I_{FSM} | Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal | 120 | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 250 | W |
| t_{scw} | Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$ $T_j = 125\text{ °C}$, $R_G = 10\text{ }\Omega$ $V_{GE} = 12\text{ V}$ | 10 | μs |
| T_j | Operating junction temperature | - 55 to 150 | $^{\circ}\text{C}$ |

1. Calculated according to the iterative formula:

$$I_c(T_c) = \frac{T_{J(MAX)} - T_c}{R_{thj-c} \times V_{CE(sat)(MAX)} \cdot (T_c, I_c)}$$

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

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. | 0.5 | $^{\circ}\text{C/W}$ |
| | Thermal resistance junction-case diode max. | 1.5 | $^{\circ}\text{C/W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 50 | $^{\circ}\text{C/W}$ |

2 Electrical characteristics

($T_{CASE}=25^{\circ}\text{C}$ 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 | $V_{GE}=15\text{ V}$, $I_C=30\text{ A}$ $V_{GE}=15\text{ V}$, $I_C=30\text{ A}$, $T_C=125^{\circ}\text{C}$ | | 2.1 1.9 | 2.7 | V V |
| I_{CES} | Collector cut-off current ($V_{GE}=0$) | $V_{CE}=600\text{ V}$ $V_{CE}=600\text{ V}$, $T_C=125^{\circ}\text{C}$ | | | 500 5 | μA mA |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}=V_{GE}$, $I_C=250\text{ }\mu\text{A}$ | 4.5 | | 6.5 | V |
| I_{GES} | Gate-emitter cut-off 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} C_{oes} C_{res} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{CE}=25\text{ V}$, $f=1\text{ MHz}$, $V_{GE}=0$ | | 2870 295 69 | | pF pF pF |
| Q_g Q_{ge} Q_{gc} | Total gate charge Gate-emitter charge Gate-collector charge | $V_{CE}=480\text{ V}$, $I_C=30\text{ A}$, $V_{GE}=15\text{ V}$ (see Figure 18) | | 135 27 69.5 | | nC nC nC |

Table 6. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max | Unit |
|----------------|-----------------------|---|------|------|-----|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 480 \text{ V}$, $I_C = 30 \text{ A}$ | | 46 | | ns |
| t_r | Current rise time | $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, | | 18.5 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | (see Figure 17) | | 1530 | | A/ μ s |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 480 \text{ V}$, $I_C = 30 \text{ A}$ | | 45 | | ns |
| t_r | Current rise time | $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, | | 19 | | ns |
| $(di/dt)_{on}$ | Turn-on current slope | $T_C = 125^\circ\text{C}$ (see Figure 17) | | 1400 | | A/ μ s |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 480 \text{ V}$, $I_C = 30 \text{ A}$ | | 38 | | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, | | 164 | | ns |
| t_f | Current fall time | (see Figure 17) | | 87 | | ns |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 480 \text{ V}$, $I_C = 30 \text{ A}$, | | 70 | | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$ | | 208 | | ns |
| t_f | Current fall time | $T_C = 125^\circ\text{C}$ (see Figure 17) | | 130 | | ns |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min | Typ. | Max | Unit |
|-----------------|---------------------------|---|-----|------|-----|---------|
| E_{on} | Turn-on switching losses | $V_{CC} = 480 \text{ V}$, $I_C = 30 \text{ A}$ | | 595 | | μ J |
| $E_{off}^{(1)}$ | Turn-off switching losses | $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, | | 716 | | μ J |
| E_{ts} | Total switching losses | (see Figure 17) | | 311 | | μ J |
| E_{on} | Turn-on switching losses | $V_{CC} = 480 \text{ V}$, $I_C = 30 \text{ A}$ | | 808 | | μ J |
| $E_{off}^{(1)}$ | Turn-off switching losses | $R_G = 10 \Omega$, $V_{GE} = 15 \text{ V}$, | | 1200 | | μ J |
| E_{ts} | Total switching losses | $T_C = 125^\circ\text{C}$ (see Figure 17) | | 2008 | | μ J |

1. 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 | $I_F = 30\text{ A}$ | | 2.4 | | V |
| | | $I_F = 30\text{ A}, T_C = 125\text{ °C}$ | | 1.8 | | V |
| t_{rr} | Reverse recovery time | $I_F = 30\text{ A}, V_R = 50\text{ V},$ | | 45 | | ns |
| Q_{rr} | Reverse recovery charge | $di/dt = 100\text{ A/}\mu\text{s}$ | | 56 | | nC |
| I_{rrm} | Reverse recovery current | (see Figure 20) | | 2.55 | | A |
| t_{rr} | Reverse recovery time | $I_F = 30\text{ A}, V_R = 50\text{ V},$ | | 100 | | ns |
| Q_{rr} | Reverse recovery charge | $T_C = 125\text{ °C}, di/dt = 100\text{ A/}\mu\text{s}$ | | 290 | | nC |
| I_{rrm} | Reverse recovery current | (see Figure 20) | | 5.8 | | A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

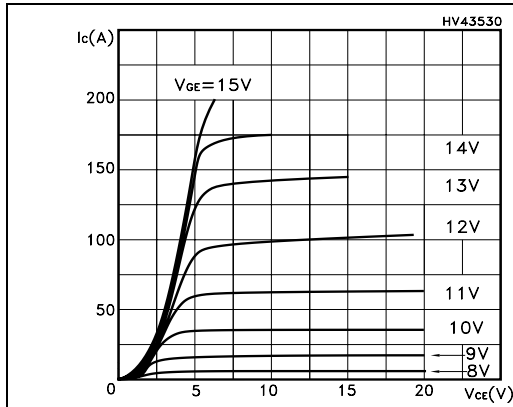


Figure 3. Transfer characteristics

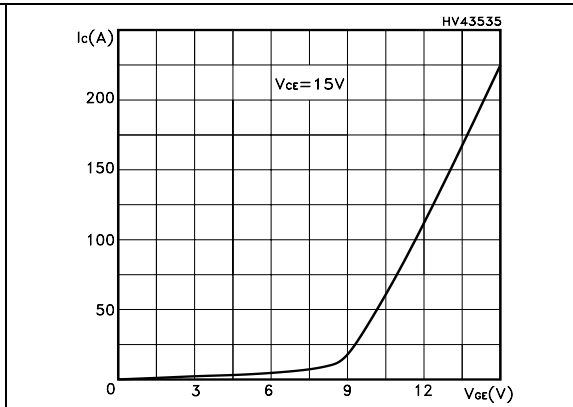


Figure 4. Transconductance

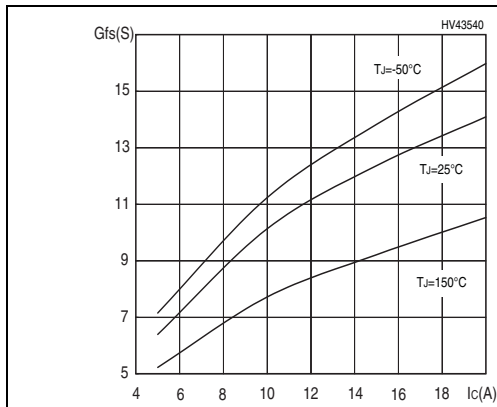


Figure 5. Collector-emitter on voltage vs temperature

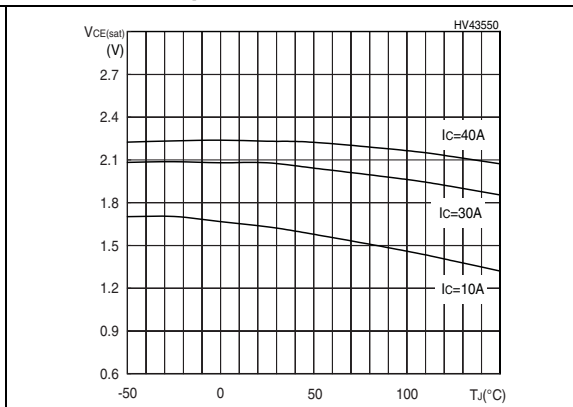


Figure 6. Gate charge vs gate-source voltage

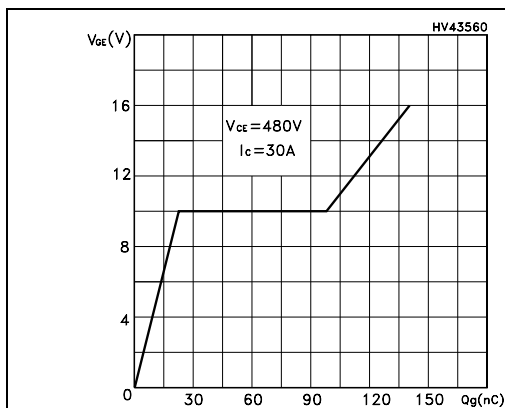


Figure 7. Capacitance variations

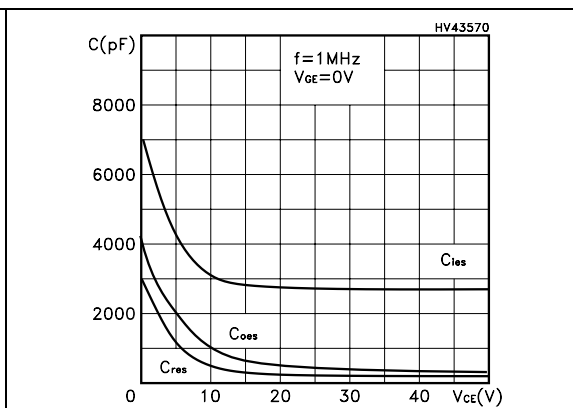


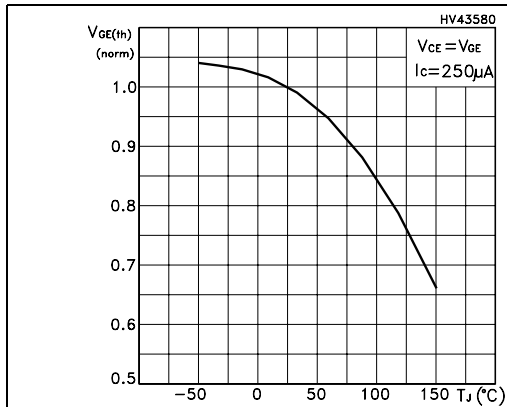
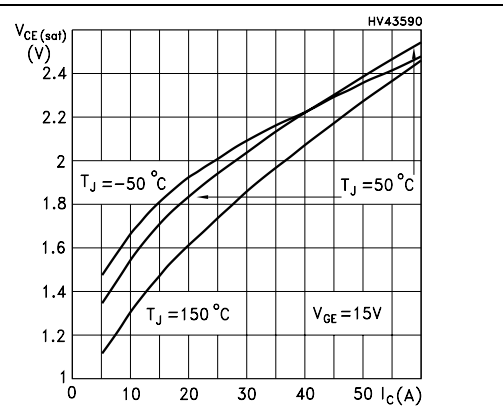
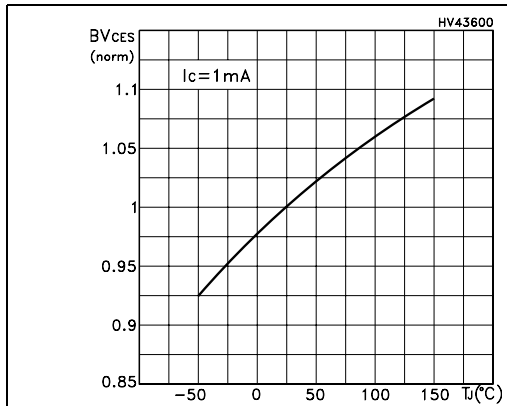
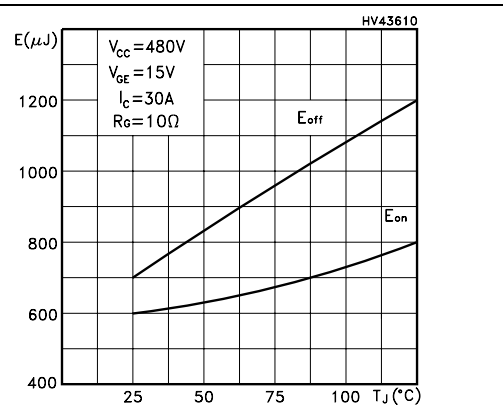
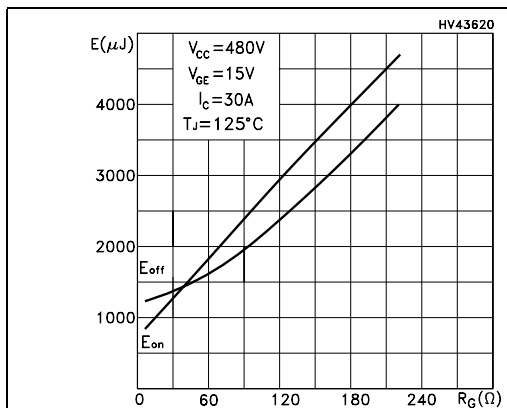
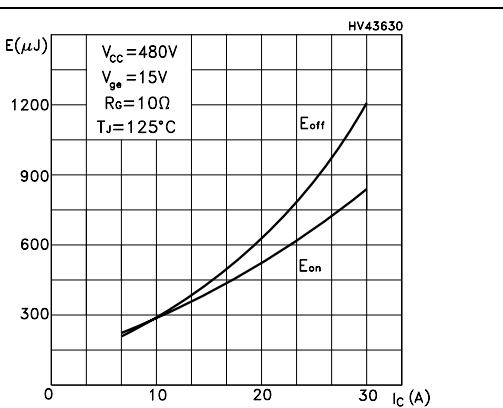
Figure 8. Normalized gate threshold voltage vs temperature**Figure 9. Collector-emitter on voltage vs collector current****Figure 10. Normalized breakdown voltage vs temperature****Figure 11. Switching losses vs temperature****Figure 12. Switching losses vs gate resistance****Figure 13. Switching losses vs collector current**

Figure 14. Thermal Impedance

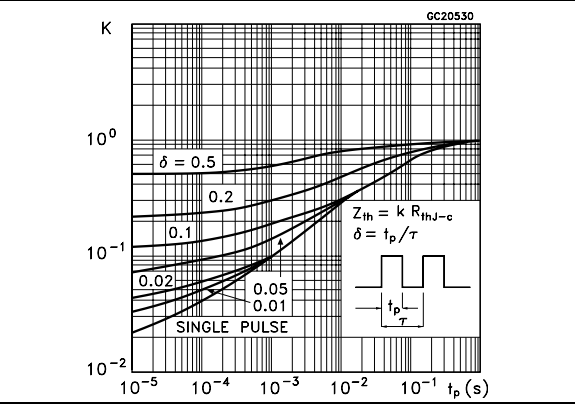


Figure 15. Turn-off SOA

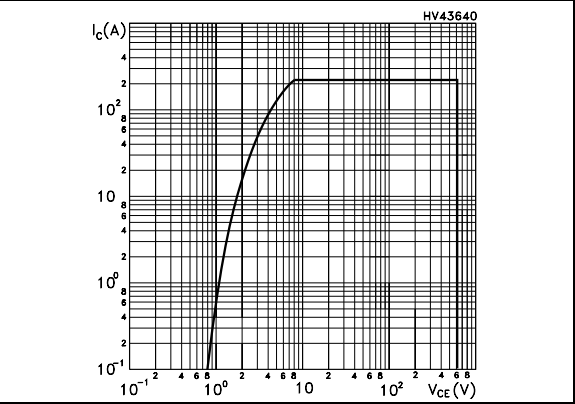
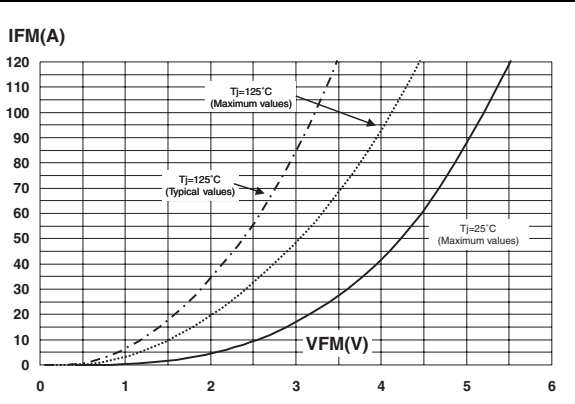


Figure 16. Forward voltage drop versus forward current



3 Test circuit

Figure 17. Test circuit for inductive load switching

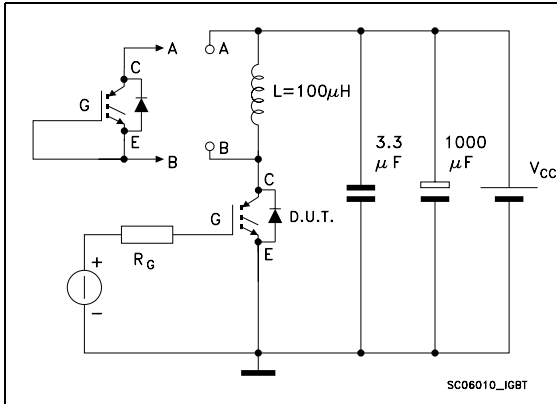


Figure 19. Switching waveforms

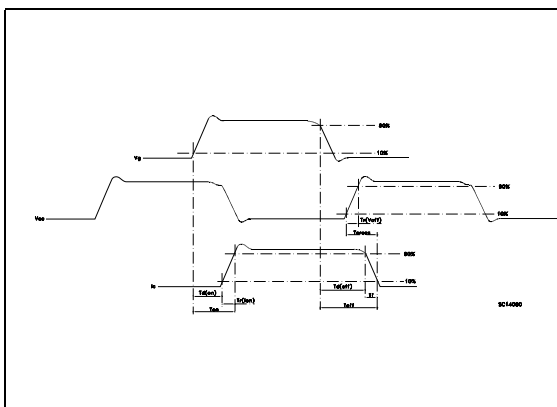


Figure 18. Gate charge test circuit

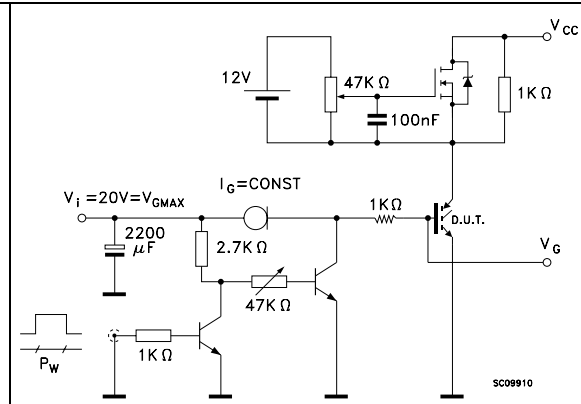
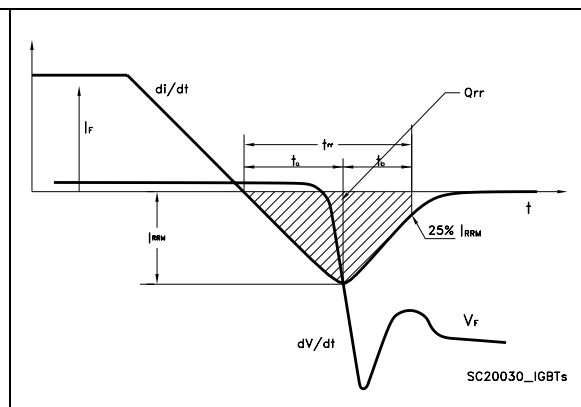


Figure 20. Diode recovery times waveform

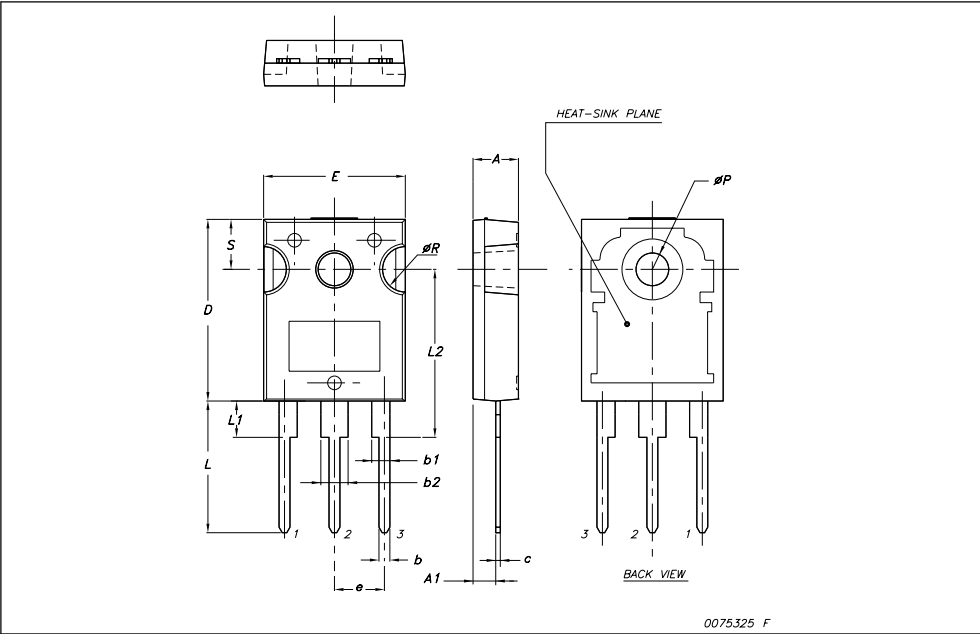


4 Package mechanical data

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

TO-247 Mechanical data

| Dim. | mm. | | |
|------|-------|-------|-------|
| | Min. | Typ | Max. |
| A | 4.85 | | 5.15 |
| A1 | 2.20 | | 2.60 |
| b | 1.0 | | 1.40 |
| b1 | 2.0 | | 2.40 |
| b2 | 3.0 | | 3.40 |
| c | 0.40 | | 0.80 |
| D | 19.85 | | 20.15 |
| E | 15.45 | | 15.75 |
| e | | 5.45 | |
| L | 14.20 | | 14.80 |
| L1 | 3.70 | | 4.30 |
| L2 | | 18.50 | |
| øP | 3.55 | | 3.65 |
| øR | 4.50 | | 5.50 |
| S | | 5.50 | |



5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|-----------------|
| 11-Jun-2008 | 1 | Initial release |

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