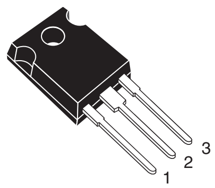
STGW39NC60VD

40 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



TO-247

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 behaviour.

Figure 1. Internal schematic diagram

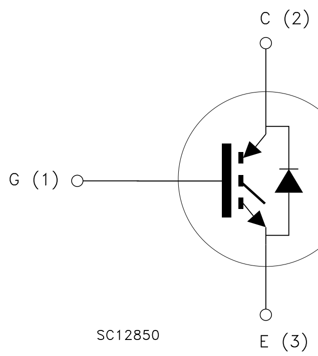


Table 1. Device summary

Order code	Marking	Package	Packaging
STGW39NC60VD	GW39NC60VD	TO-247	Tube

Contents

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	80	A
I_C (1)	Collector current (continuous) at 100 °C	40	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 (tp=10 ms sinusoidal)	120	A
P_{TOT}	Total dissipation at T_C = 25 °C	250	W
T_j	Operating junction temperature	– 55 to 150	°C

1. Calculated according to the iterative formula:

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

2. Vclamp = 80%(V_{CES}) , Tj = 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
$R_{thj\text{-}case}$	Thermal resistance junction-case max (IGBT)	0.5	°C/W
$R_{thj\text{-}case}$	Thermal resistance junction-case max (diode)	1.5	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max	50	°C/W

2 Electrical characteristics

(T_{CASE}=25 °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 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 30 A V_{GE} = 15 V, I_C = 30 A,T_C=125 °C		1.8 1.7	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	V_{CE}= V_{GE}, I_C=1 mA	3.75		5.75	V
I_{CES}	Collector-emitter cut-off current (V_{GE} = 0)	V_{CE} = 600 V V_{CE}= 600 V, T_C = 125 °C			500 5	µA mA
I_{GES}	Gate-emitter cut-off current (V_{CE} = 0)	V_{GE} = ± 20 V			±100	nA
g_{fs} (1)	Forward transconductance	V_{CE} = 15 V, I_C= 30 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 V, f = 1 MHz, V_{GE}= 0		2900 298 59		pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 390 V, I_C = 30 A, V_{GE} = 15 V *(see Figure 19)*		126 16 46		nC nC nC

Table 6. Switching on/off (inductive load)

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

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
E_{on} (1) E_{off}(2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 390V, I_C = 30A R_G= 10Ω, V_{GE}= 15V, *(see Figure 20)*		333 537 870		µJ µJ µJ
E_{on} (1) E_{off} (2) E_{ts}	Turn-on switching losses Turn-off switching losses Total switching losses	V_{CC} = 390V, I_C = 30A R_G= 10Ω, V_{GE}= 15V, T_C= 125°C *(see Figure 20)*		618 1125 1743		µJ µJ µJ

1. Eon is the turn-on losses when a typical diode is used in the test circuit in figure 2 Eon include diode recovery energy. If the IGBT is offered in a package with a co-pak diode, the co-pack 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 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
V_F	Forward on-voltage	I_F = 30 A I_F = 30 A, T_C = 125 °C		2.4 1.8		V V
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 30 A, V_R = 50 V, di/dt =100 A/µs *(see Figure 21)*		45 56 2.55		ns nC A
t_{rr} Q_{rr} I_{rrm}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_F = 30 A, V_R = 50 V, T_C= 125 °C, di/dt =100 A/µs *(see Figure 21)*		100 290 5.8		ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

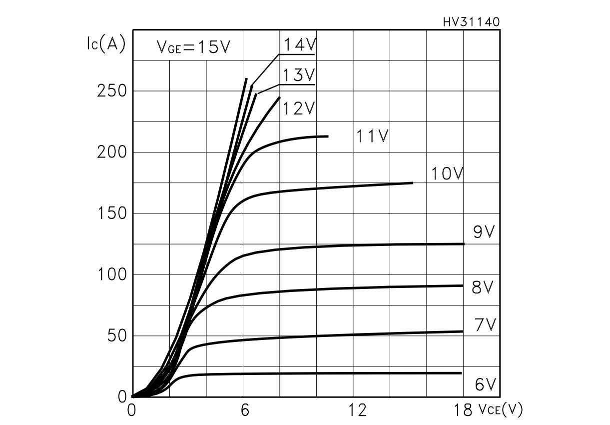


Figure 3. Transfer characteristics

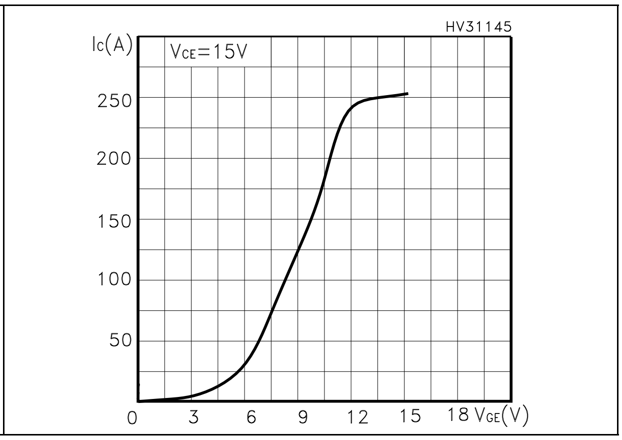


Figure 4. Transconductance

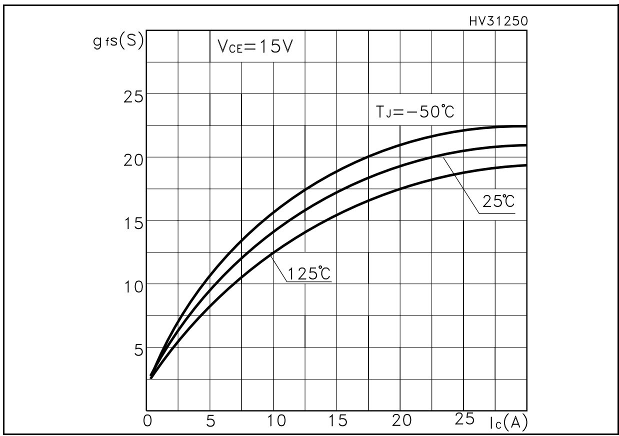


Figure 5. Collector-emitter on voltage vs temperature

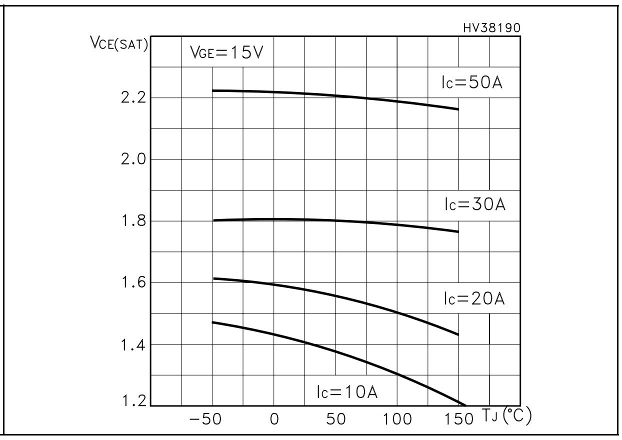


Figure 6. Collector-emitter on voltage vs collector current

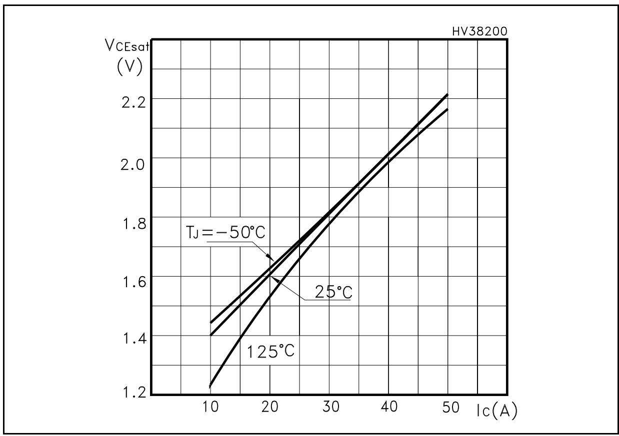


Figure 7. Normalized gate threshold vs temperature

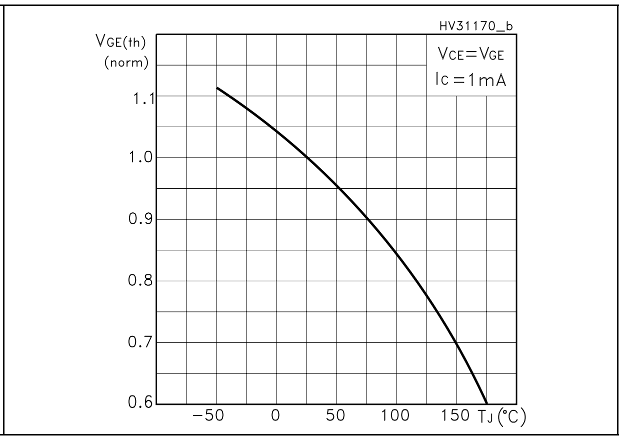


Figure 8. Normalized breakdown voltage vs temperature

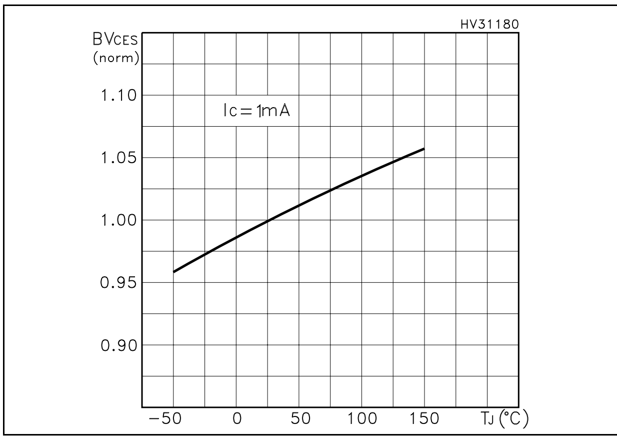


Figure 9. Gate charge vs gate-emitter voltage

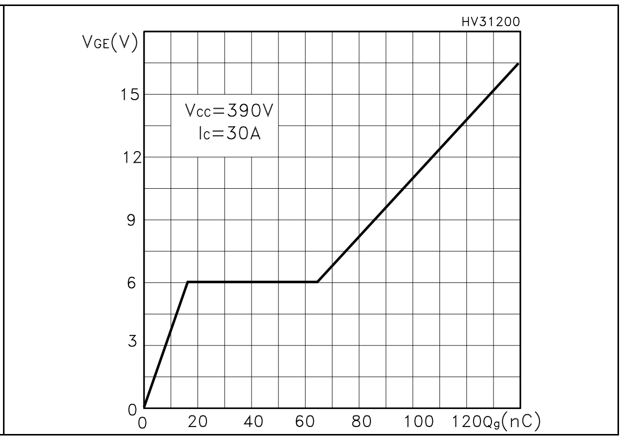


Figure 10. Capacitance variations

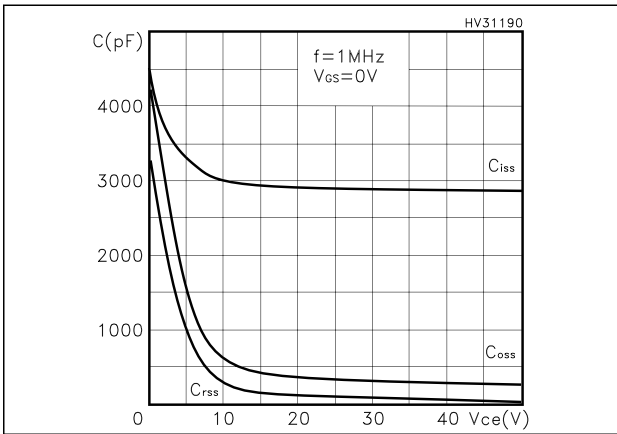


Figure 11. Switching losses vs temperature

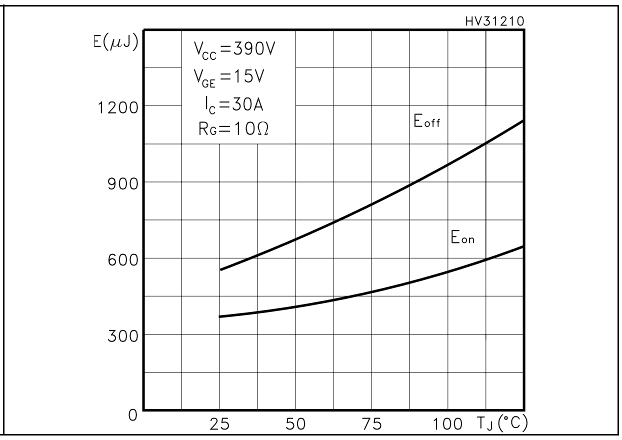


Figure 12. Switching losses vs gate resistance

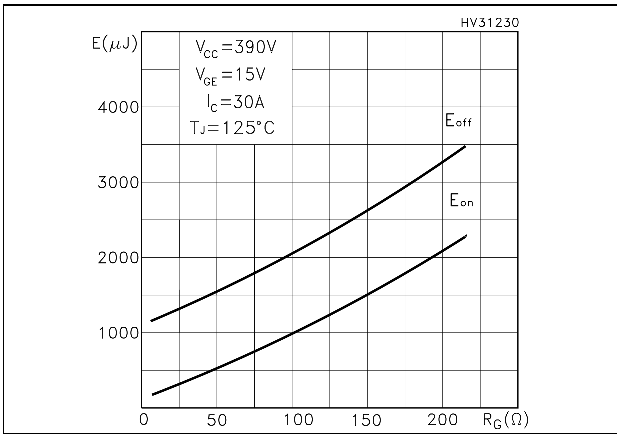


Figure 13. Switching losses vs collector current

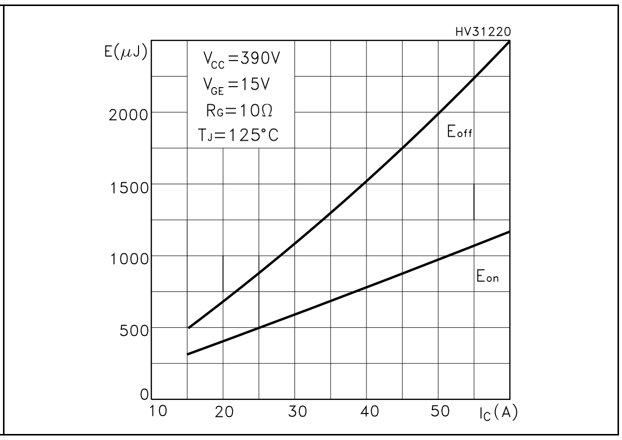


Figure 14. Thermal impedance

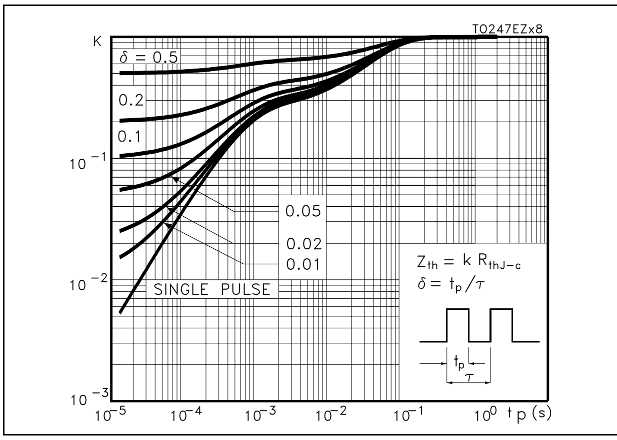


Figure 15. Turn-off SOA

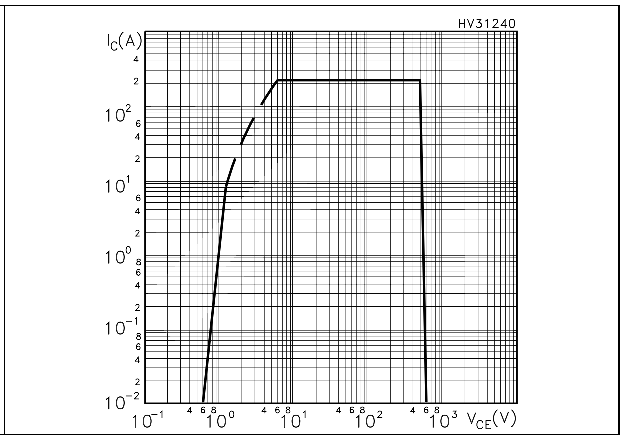


Figure 16. Emitter-collector diode characteristics

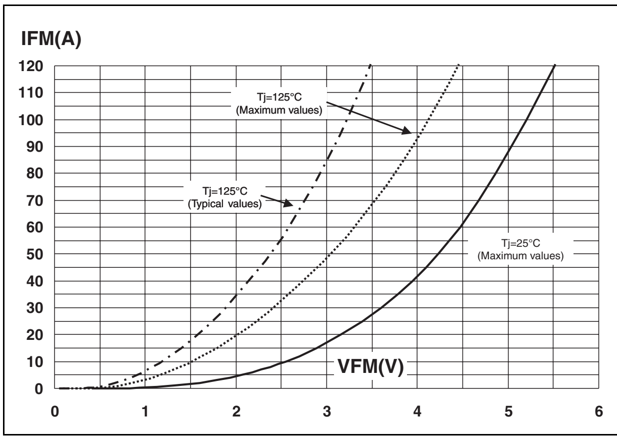
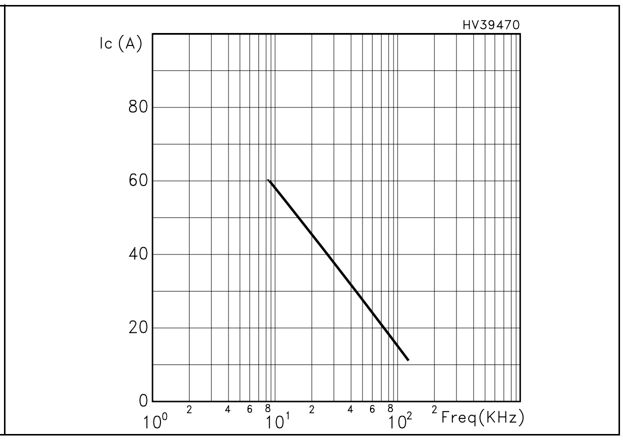


Figure 17. I_C vs. frequency



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 $\Delta T = T_J - T_C = 125\ °C - 75\ °C = 50\ °C$

- 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

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

- Typical values @ 125 °C for switching losses are used (test conditions: V_{CE} = 390 V, V_{GE} = 15 V, R_G = 10 Ω). 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).

3 Test circuit

Figure 18. Test circuit for inductive load switching

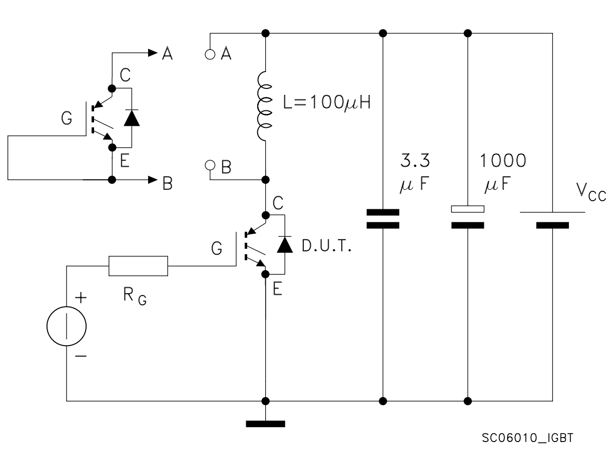


Figure 19. Gate charge test circuit

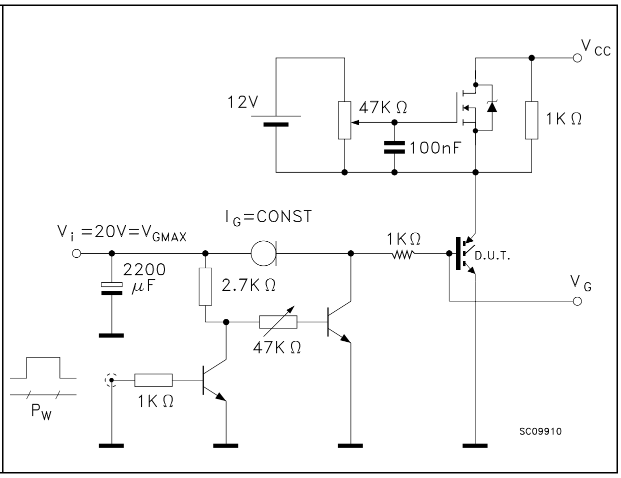


Figure 20. Switching waveforms

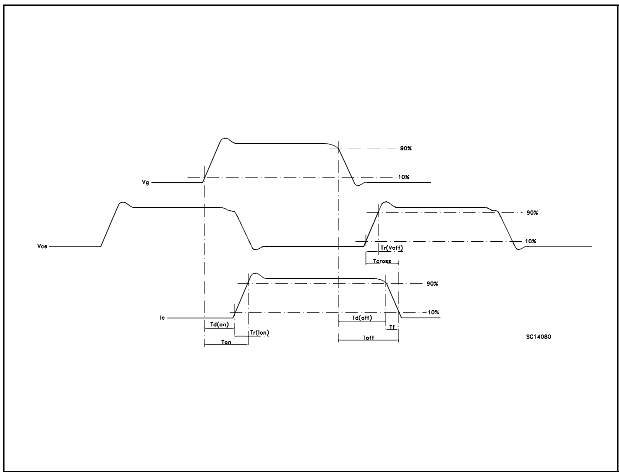
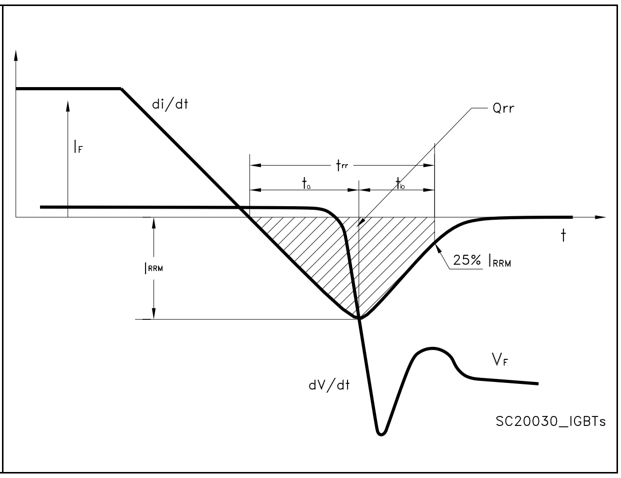


Figure 21. Diode recovery times waveform

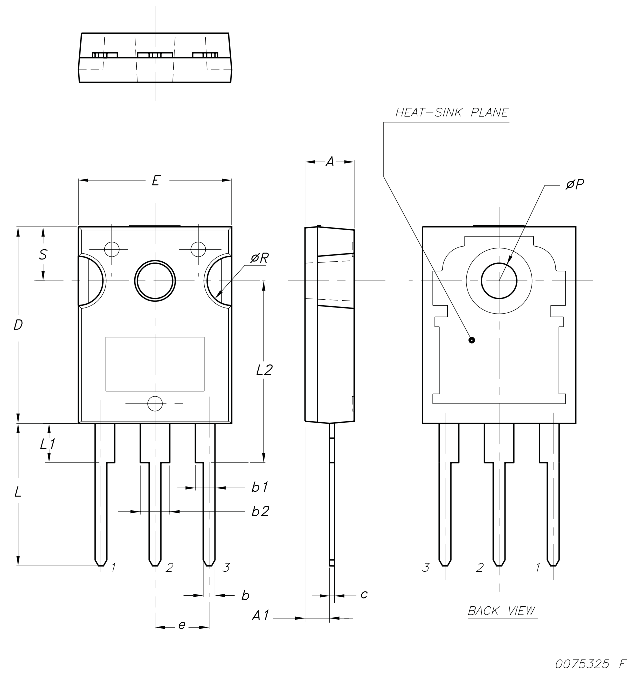


4 Package mechanical data

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*

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
17-Nov-2005	1	First release
05-May-2006	2	Inserted curves
10-Jul-2006	3	Modified value on *Absolute maximum ratings*
01-Dec-2006	4	Modified value on *Dynamic*
16-May-2007	5	New curves updated: *Figure 5* and *Figure 6*
22-Aug-2007	6	Added new *Figure 17* and new section *2.2: Frequency applications*
31-Jan-2008	7	Modified: *Table 8: Collector-emitter diode*