



STGW39NC60VD

N-channel 40A - 600V - TO-247
Very fast switching PowerMESH™ IGBT

Features

Type	V _{CES}	V _{CE(sat)} (Max)@ 25°C	I _C @100°C
STGW39NC60VD	600V	<2.5V	40A

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

Applications

- High frequency inverters
- UPS
- Motor drivers

Induction heating

Description

Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix “V” identifies a family optimized for high frequency.

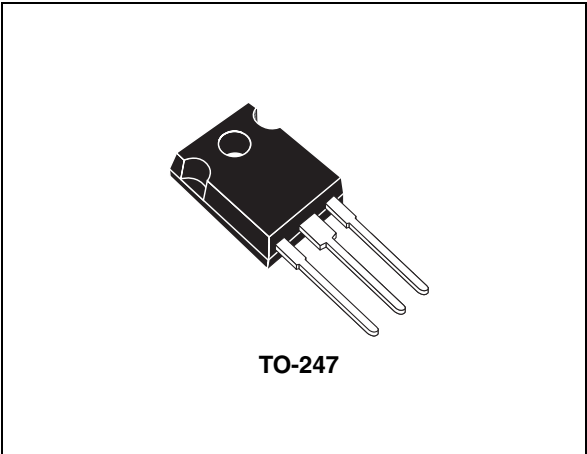


Figure 1. Internal schematic diagram

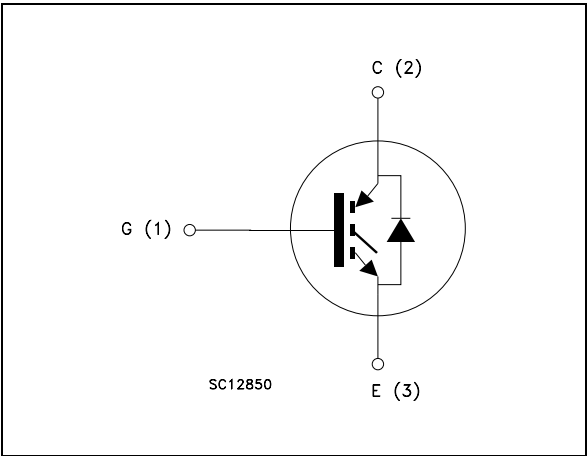


Table 1. Device summary

Order code	Marking	Package	Packaging
STGW39NC60VD	GW39NC60VD	TO-247	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GS} = 0$)	600	V
$I_C^{(1)}$	Collector current (continuous) at 25°C	70	A
$I_C^{(1)}$	Collector current (continuous) at 100°C	40	A
$I_{CL}^{(2)}$	Turn-off SOA minimum current	220	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Diode RMS forward current at $T_C = 25^\circ\text{C}$	30	A
P_{TOT}	Total dissipation at $T_C = 25^\circ\text{C}$	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. $V_{clamp} = 480\text{V}$, $T_j = 150^\circ\text{C}$, $R_G = 10\Omega$, $V_{GE} = 15\text{V}$

Table 3. Thermal resistance

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max (IGBT)	0.5	°C/W
$R_{thj-case}$	Thermal resistance junction-case max (diode)	1.5	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	°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	$I_C = 1\text{mA}$, $V_{GE} = 0$	600			V
$V_{CE(SAT)}$	Collector-emitter saturation voltage	$V_{GE}=15\text{V}$, $I_C=30\text{A}$, $T_j=25^{\circ}\text{C}$ $V_{GE}=15\text{V}$, $I_C=30\text{A}$, $T_j=125^{\circ}\text{C}$		1.8 1.7	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE}= V_{GE}$, $I_C= 250\mu\text{A}$	3.75		5.75	V
I_{CES}	Collector-emitter leakage current ($V_{GE} = 0$)	$V_{CE} = \text{Max rating}$, $T_c=25^{\circ}\text{C}$ $V_{CE}= \text{Max rating}$, $T_c=125^{\circ}\text{C}$			500 5	μA mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{V}$, $V_{CE} = 0$			± 100	nA
g_{fs}	Forward transconductance	$V_{CE} = 15\text{V}$, $I_C = 30\text{A}$		20		S

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$		2900		pF
C_{oes}	Output capacitance			298		pF
C_{res}	Reverse transfer capacitance			59		pF
Q_g	Total gate charge	$V_{CE} = 390\text{V}$, $I_C = 30\text{A}$, $V_{GE} = 15\text{V}$, (see Figure 19)		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	$V_{CC}=390\text{ V}$, $I_C=30\text{ A}$,		33		ns
t_r	Current rise time	$R_G=10\Omega$, $V_{GE}=15\text{ V}$		13		ns
$(di/dt)_{onf}$	Turn-on current slope	$T_j=25^\circ\text{C}$ (see Figure 18)		2500		A/ μs
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}$, $I_C=30\text{ A}$,		32		ns
t_r	Current rise time	$R_G=10\Omega$, $V_{GE}=15\text{ V}$		14		ns
$(di/dt)_{on}$	Turn-on current slope	$T_j=125^\circ\text{C}$ (see Figure 18)		2280		A/ μs
$t_{r(Voff)}$	Off voltage rise time	$V_{CC}=390\text{ V}$, $I_C=30\text{ A}$,		33		ns
$t_{d(off)}$	Turn-off delay time	$R_G=10\Omega$, $V_{GE}=15\text{ V}$		178		ns
t_f	Current fall time	$T_j=25^\circ\text{C}$ (see Figure 18)		65		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC}=390\text{ V}$, $I_C=30\text{ A}$,		68		ns
$t_{d(off)}$	Turn-off delay time	$R_G=10\Omega$, $V_{GE}=15\text{ V}$		238		ns
t_f	Current fall time	$T_j=125^\circ\text{C}$ (see Figure 18)		128		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC}=390\text{ V}$, $I_C=30\text{ A}$		333		μJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G=10\Omega$, $V_{GE}=15\text{ V}$,		537		μJ
E_{ts}	Total switching losses	$T_j=25^\circ\text{C}$ (see Figure 20)		870		μJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC}=390\text{ V}$, $I_C=30\text{ A}$		618		μJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G=10\Omega$, $V_{GE}=15\text{ V}$,		1125		μJ
E_{ts}	Total switching losses	$T_j=125^\circ\text{C}$ (see Figure 20)		1743		μJ

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-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 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
V_f	Forward on-voltage	$I_f=15\text{ A}$ $I_f=15\text{ A}$, $T_j=125^\circ\text{C}$ $I_f=30\text{ A}$, $T_j=125^\circ\text{C}$		1.3 1.1 1.2	2.9	V V V
t_{rr}	Reverse recovery time	$I_f=30\text{ A}$, $V_R=50\text{ V}$,		45		ns
Q_{rr}	Reverse recovery charge	$T_j=25^\circ\text{C}$, $di/dt=100\text{ A}/\mu\text{s}$		56		nC
I_{rrm}	Reverse recovery current	(see Figure 21)		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	$T_j=125^\circ\text{C}$, $di/dt=100\text{ A}/\mu\text{s}$		290		nC
I_{rrm}	Reverse recovery current	(see Figure 21)		5.8		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

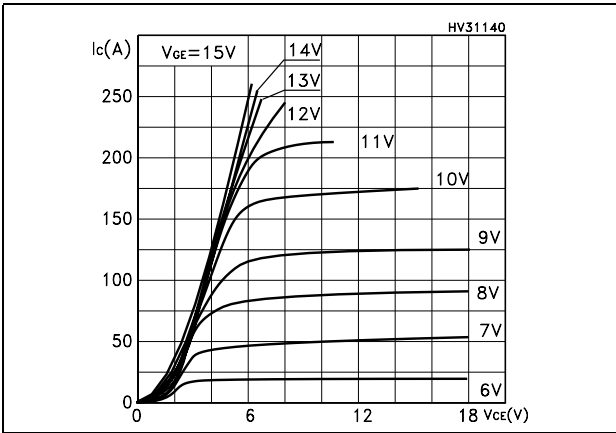


Figure 3. Transfer characteristics

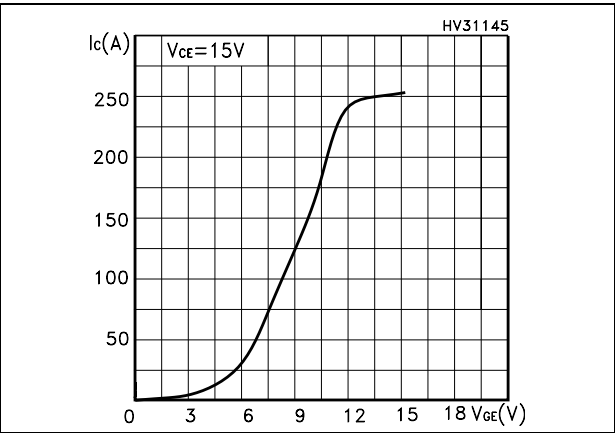


Figure 4. Transconductance

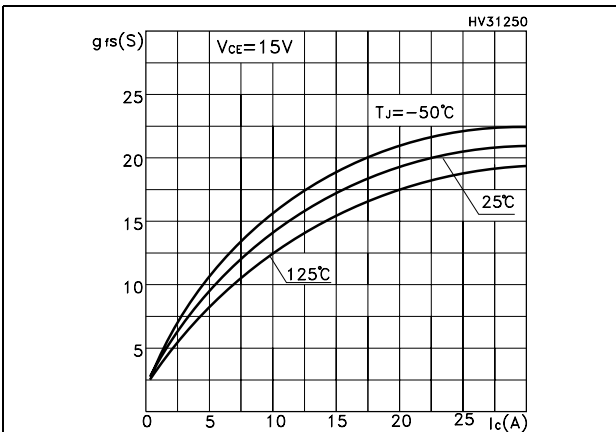


Figure 5. Collector-emitter on voltage vs temperature

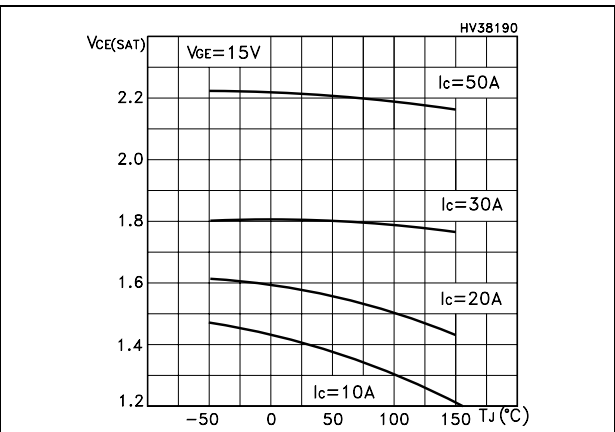


Figure 6. Collector-emitter on voltage vs collector current

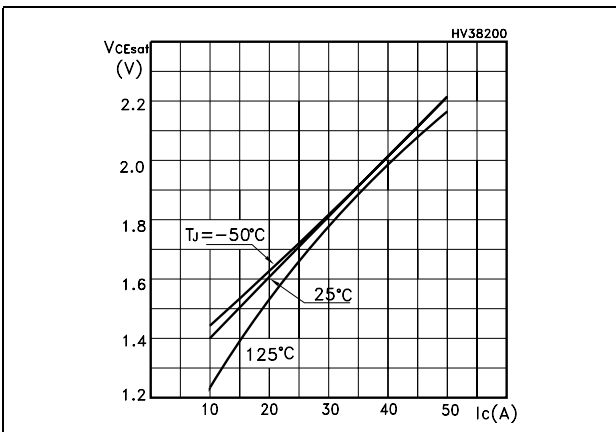


Figure 7. Normalized gate threshold vs temperature

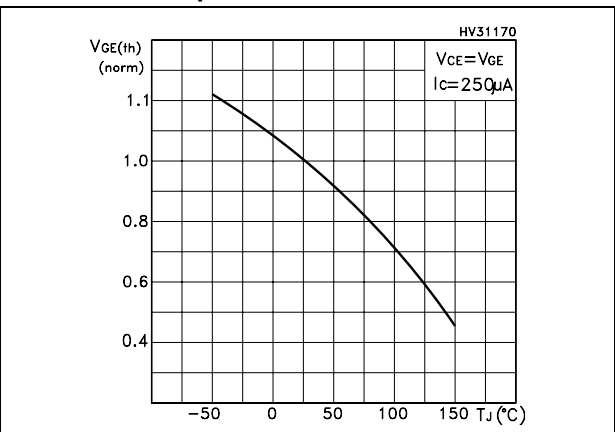


Figure 8. Normalized breakdown voltage vs temperature

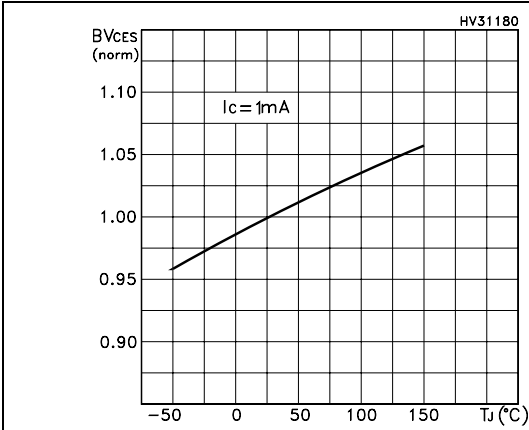


Figure 9. Gate charge vs gate-emitter voltage

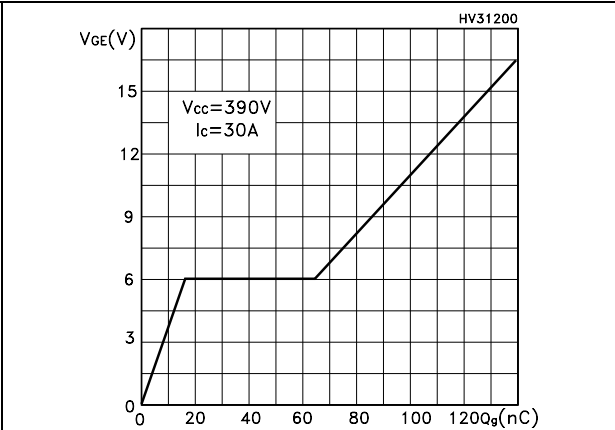


Figure 10. Capacitance variations

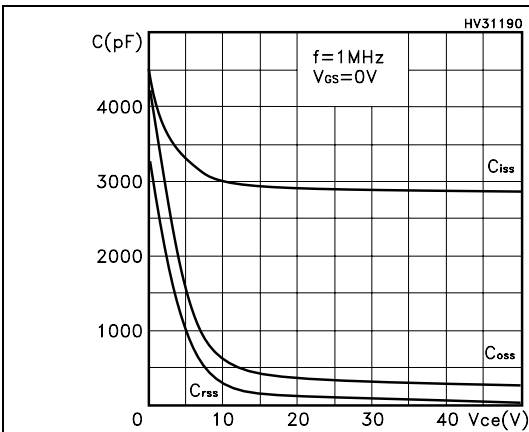


Figure 11. Switching losses vs temperature

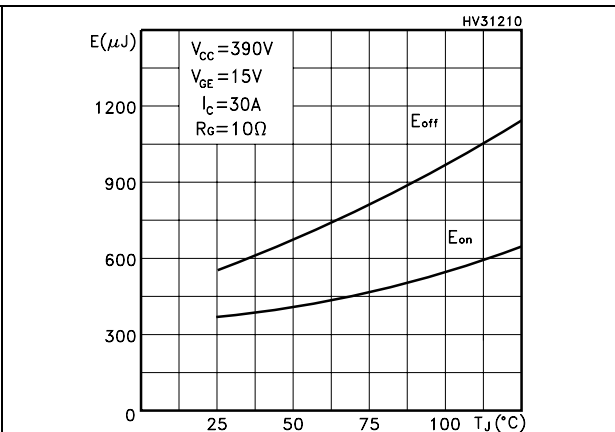


Figure 12. Switching losses vs gate resistance

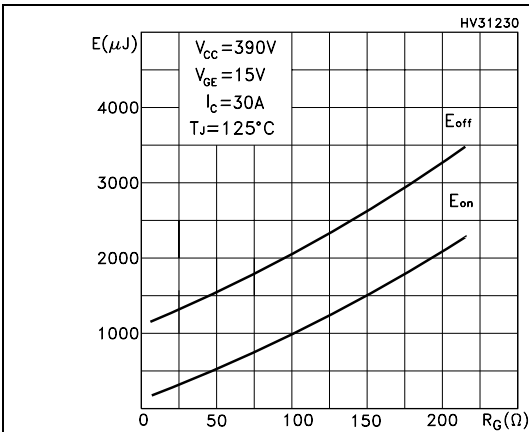


Figure 13. Switching losses vs collector current

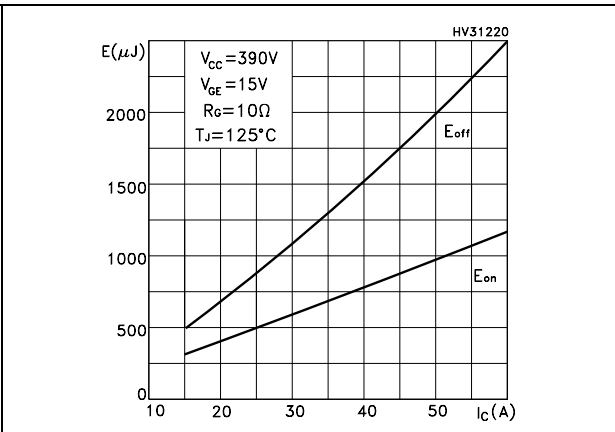


Figure 14. Thermal impedance

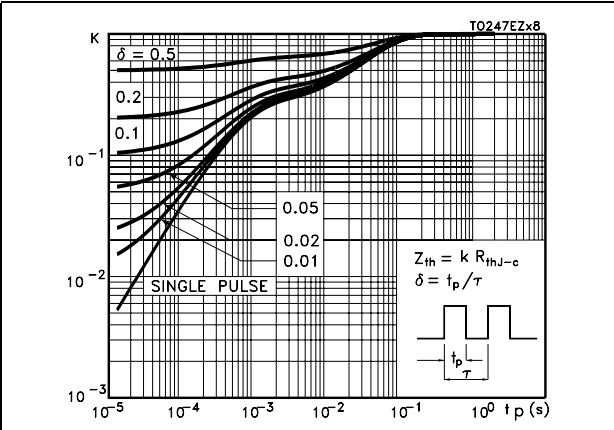


Figure 15. Turn-off SOA

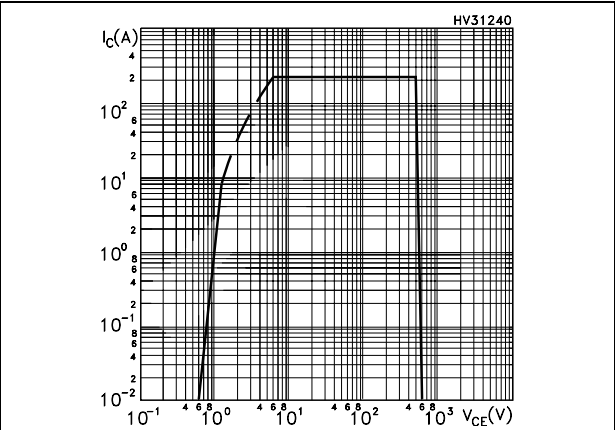


Figure 16. Emitter-collector diode characteristics

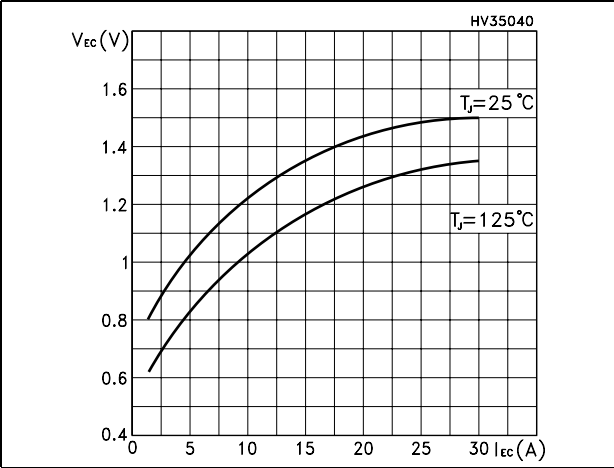
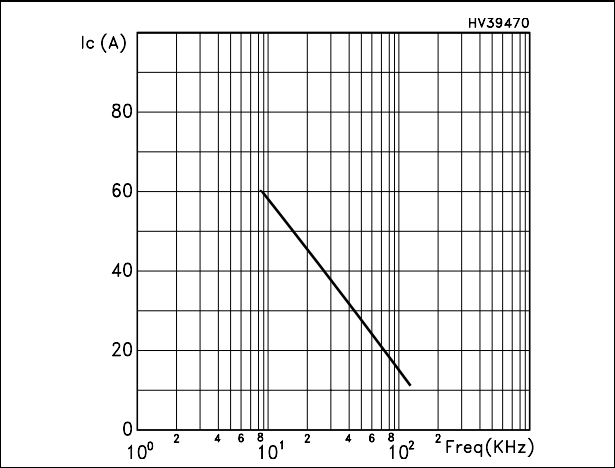


Figure 17. I_c vs. frequency



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

- 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: $V_{CE} = 390\text{V}$, $V_{GE} = 15\text{V}$, $R_G = 10\text{ Ohm}$). 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

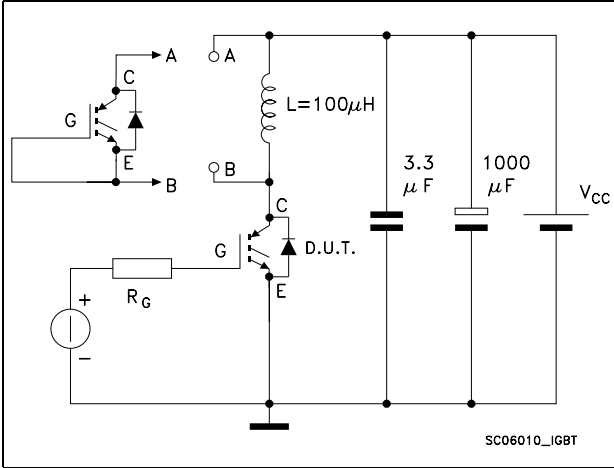


Figure 19. Gate charge test circuit

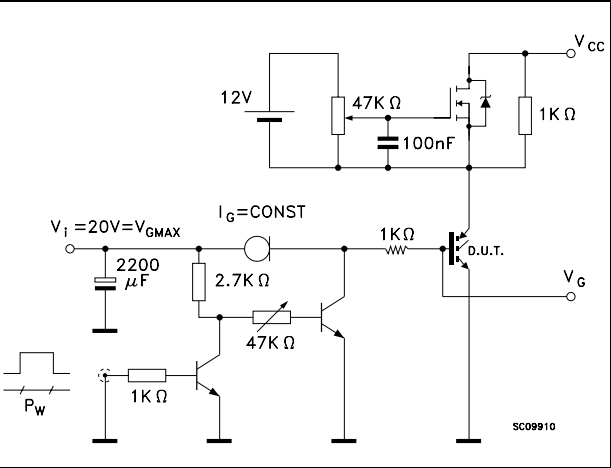


Figure 20. Switching waveforms

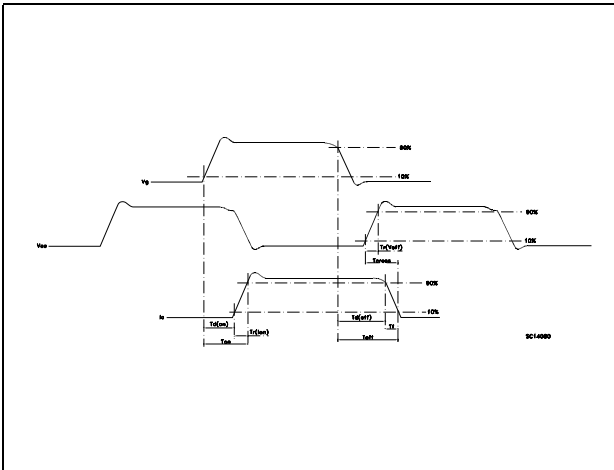
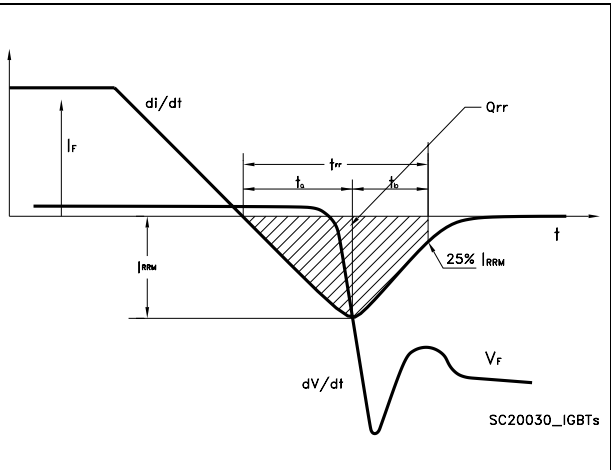


Figure 21. Diode recovery times waveform

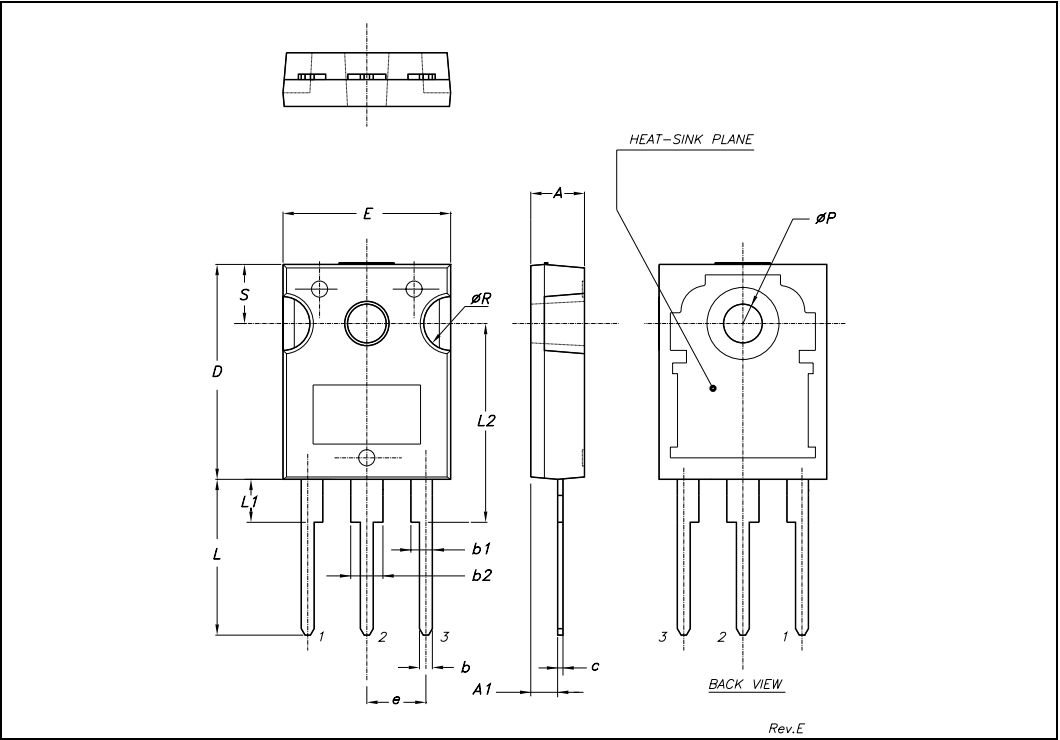


4 **Package mechanical data**

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.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
A1	2.20		2.60	0.086		0.102
b	1.0		1.40	0.039		0.055
b1	2.0		2.40	0.079		0.094
b2	3.0		3.40	0.118		0.134
c	0.40		0.80	0.015		0.03
D	19.85		20.15	0.781		0.793
E	15.45		15.75	0.608		0.620
e		5.45			0.214	
L	14.20		14.80	0.560		0.582
L1	3.70		4.30	0.14		0.17
L2		18.50			0.728	
øP	3.55		3.65	0.140		0.143
øR	4.50		5.50	0.177		0.216
S		5.50			0.216	



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 <i>Absolute maximum ratings</i>
01-Dec-2006	4	Modified value on <i>Dynamic</i>
16-May-2007	5	New curves updated: <i>Figure 5</i> and <i>Figure 6</i>
22-Aug-2007	6	Added new <i>Figure 17</i> and new section <i>2.2: Frequency applications</i>

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