



# STGW39NC60VD

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

PRELIMINARY DATA

## General features

Type	V <sub>CES</sub>	V <sub>CE(sat)</sub> (Max) @ 25°C	I <sub>C</sub> @100°C
STGW39NC60VD	600V	<2.5V	40A

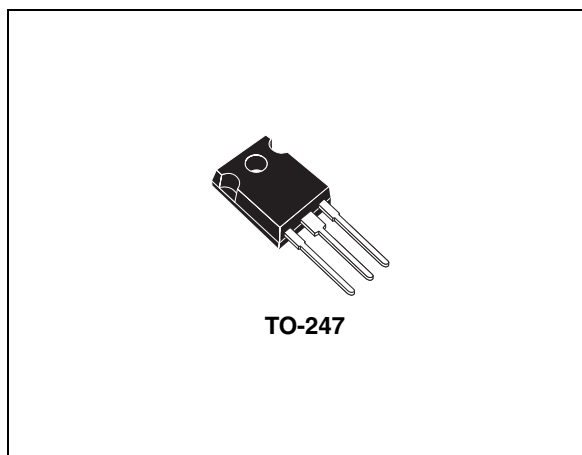
- Low C<sub>RES</sub> / C<sub>IES</sub> ratio (no cross conduction susceptibility)
- High frequency operation
- Very soft ultra fast recovery anti parallel diode

## Description

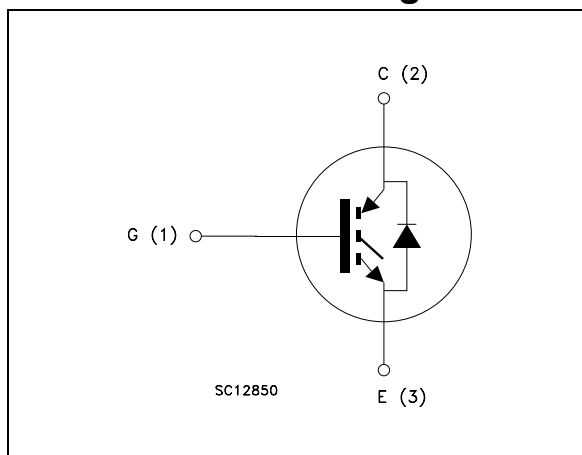
Using the latest high voltage technology based on a patented strip layout, STMicroelectronics has designed an advanced family of IGBTs, the PowerMESH™ IGBTs, with outstanding performances. The suffix "V" identifies a family optimized for high frequency application.

## Applications

- High frequency inverters, ups
- Motor drivers
- Induction heating



## Internal schematic diagram



## Order codes

Part number	Marking	Package	Packaging
STGW39NC60VD	GW39NC60VD	TO-247	Tube

# Contents

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# 1 Electrical ratings

**Table 1. 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
$I_{CL}^{(2)}$	Collector current (pulsed)	220	A
$V_{GE}$	Gate-emitter voltage	± 20	V
$I_F$	Diode RMS forward current at $T_C = 25^\circ\text{C}$	15	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	250	W
$T_j$	Operating junction temperature	- 55 to 150	°C
$T_{stg}$	Storage temperature		
$T_L$	Maximum lead temperature for soldering purpose (1.6 mm from case, for 10 sec.)	300	°C

1. Calculated according to the iterative formula:

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

2.  $V_{clamp} = 480\text{V}$ ,  $T_j = 150^\circ\text{C}$ ,  $R_G = 10\Omega$ ,  $V_{GE} = 15\text{V}$

**Table 2. Thermal resistance**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case Max	0.5	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient Max	50	°C/W

## 2 Electrical characteristics

( $T_{CASE}=25^{\circ}C$  unless otherwise specified)

**Table 3. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{BR(CES)}$	Collector-emitter breakdown voltage	$I_C = 1mA, V_{GE} = 0$	600			V
$V_{CE(SAT)}$	Collector-emitter saturation voltage	$V_{GE}=15V, I_C=30A, T_j=25^{\circ}C$ $V_{GE}=15V, I_C=30A, T_j=125^{\circ}C$		1.8 1.6	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE}= V_{GE}, I_C= 250\mu A$	3.75		5.75	V
$I_{CES}$	Collector-emitter leakage current ( $V_{GE} = 0$ )	$V_{CE} = \text{Max rating}, T_c=25^{\circ}C$ $V_{CE}= \text{Max rating}, T_c=125^{\circ}C$			500 10	$\mu A$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20V, V_{CE} = 0$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15V, I_C = 30A$		20		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25V, f = 1 \text{ MHz}, V_{GE} = 0$		2900		pF
$C_{oes}$	Output capacitance			298		pF
$C_{res}$	Reverse transfer capacitance			59		pF
$Q_g$	Total gate charge	$V_{CE} = 390V, I_C = 30A,$		126		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15V,$		16		nC
$Q_{gc}$	Gate-collector charge	(see Figure 16)		46		nC

**Table 5. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}$ , $I_C=30\text{ A}$ , $R_G=10\Omega$ , $V_{GE}=15\text{ V}$ $T_j=25^\circ\text{C}$ (see Figure 15)		33		ns
$t_r$	Current rise time			13		ns
$(di/dt)_{onf}$	Turn-on current slope			2500		A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}$ , $I_C=30\text{ A}$ , $R_G=10\Omega$ , $V_{GE}=15\text{ V}$ $T_j=125^\circ\text{C}$ (see Figure 15)		32		ns
$t_r$	Current rise time			14		ns
$(di/dt)_{on}$	Turn-on current slope			2280		A/ $\mu\text{s}$
$t_{r(Voff)}$	Off voltage rise time	$V_{CC}=390\text{ V}$ , $I_C=30\text{ A}$ , $R_G=10\Omega$ , $V_{GE}=15\text{ V}$ $T_j=25^\circ\text{C}$ (see Figure 15)		33		ns
$t_{d(off)}$	Turn-off delay time			178		ns
$t_f$	Current fall time			65		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC}=390\text{ V}$ , $I_C=30\text{ A}$ , $R_G=10\Omega$ , $V_{GE}=15\text{ V}$ $T_j=125^\circ\text{C}$ (see Figure 15)		68		ns
$t_{d(off)}$	Turn-off delay time			238		ns
$t_f$	Current fall time			128		ns

**Table 6. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\Omega$ , $V_{GE} = 15\text{ V}$ , $T_j = 25^\circ\text{C}$ (see Figure 17)		333		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses			537		$\mu\text{J}$
$E_{ts}$	Total switching losses			870		$\mu\text{J}$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\Omega$ , $V_{GE} = 15\text{ V}$ , $T_j = 125^\circ\text{C}$ (see Figure 17)		618		$\mu\text{J}$
$E_{off}^{(2)}$	Turn-off switching losses			1125		$\mu\text{J}$
$E_{ts}$	Total switching losses			1743		$\mu\text{J}$

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 & 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	$I_f = 15\text{ A}$		1.6	2.8	V
		$I_f = 15\text{ A}$ , $T_j = 125^\circ\text{C}$		1.4		V
$t_{rr}$	Reverse recovery time	$I_f = 15\text{ A}$ , $V_R = 40\text{ V}$ , $T_j = 25^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 18)		45		ns
$Q_{rr}$	Reverse recovery charge			56		nC
$I_{rrm}$	Reverse recovery current			2.55		A
$t_{rr}$	Reverse recovery time	$I_f = 15\text{ A}$ , $V_R = 40\text{ V}$ , $T_j = 125^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 18)		100		ns
$Q_{rr}$	Reverse recovery charge			290		nC
$I_{rrm}$	Reverse recovery current			5.8		A

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

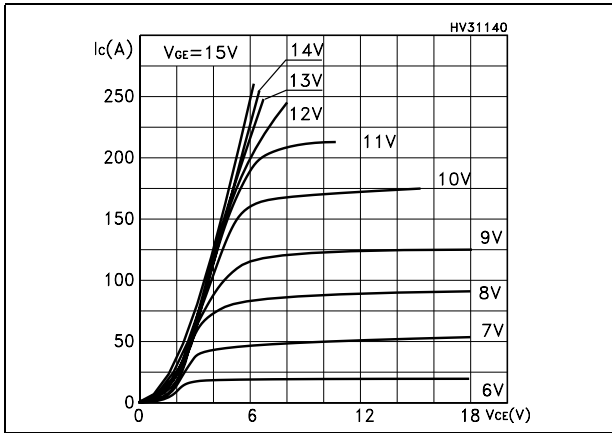


Figure 2. Transfer characteristics

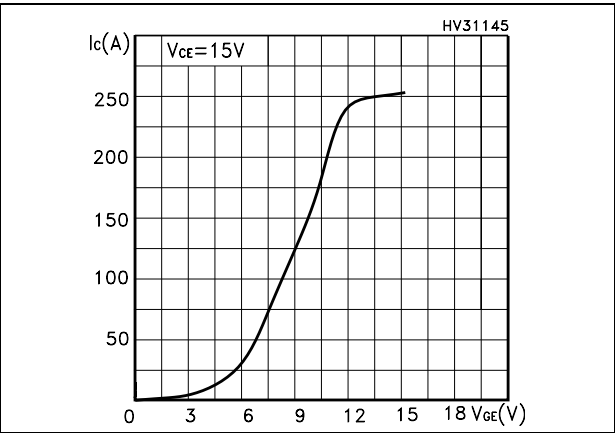


Figure 3. Transconductance

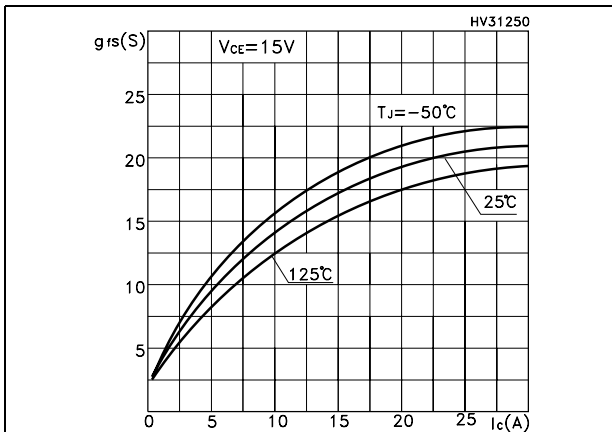


Figure 4. Collector-emitter on voltage vs temperature

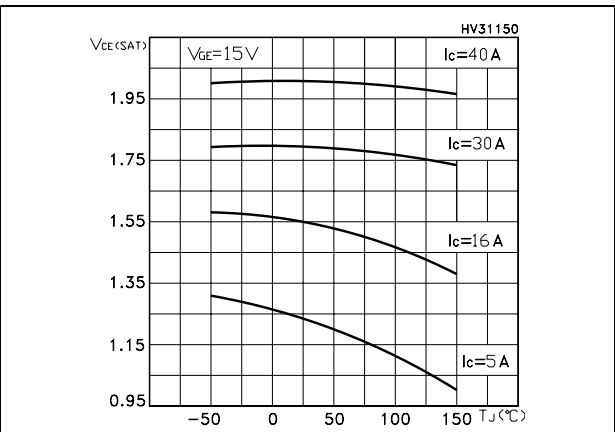


Figure 5. Collector-emitter on voltage vs collector current

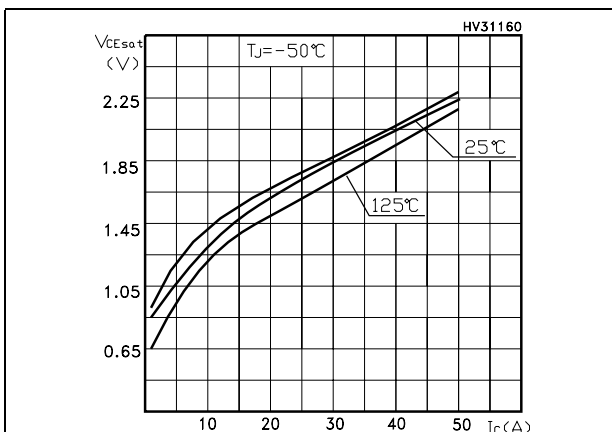


Figure 6. Normalized gate threshold vs temperature

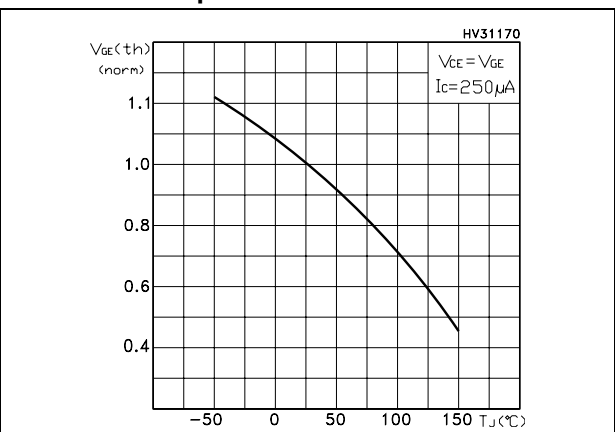


Figure 7. Normalized breakdown voltage vs temperature

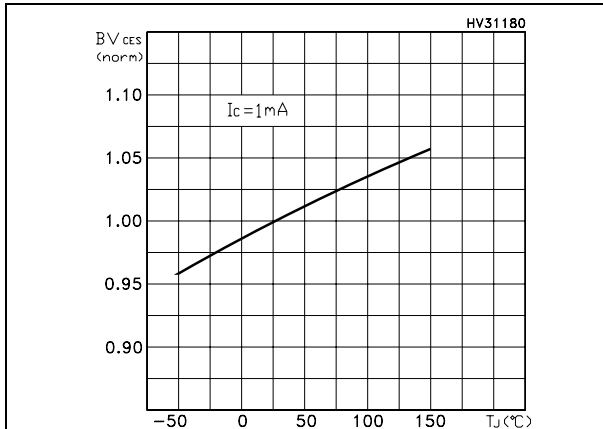


Figure 8. Gate charge vs gate-emitter voltage

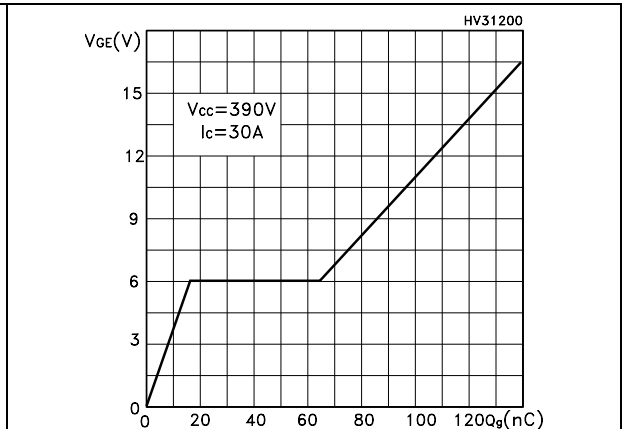


Figure 9. Capacitance variations

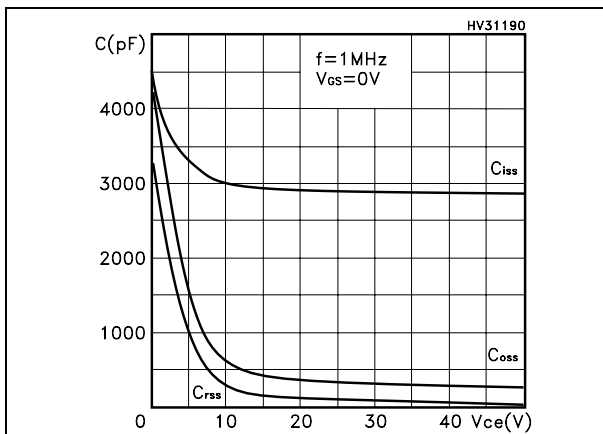


Figure 10. Switching losses vs temperature

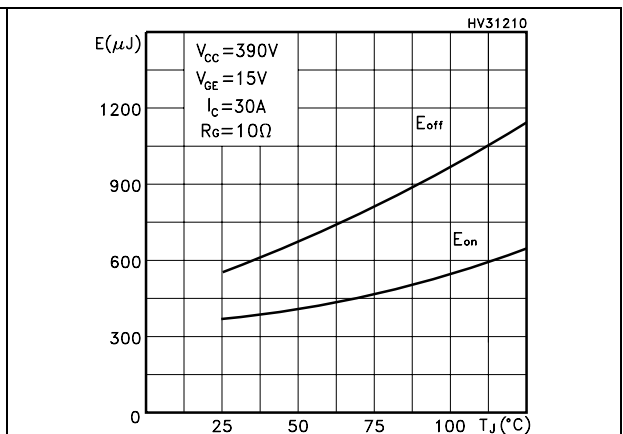


Figure 11. Switching losses vs gate resistance Figure 12. Switching losses vs collector current

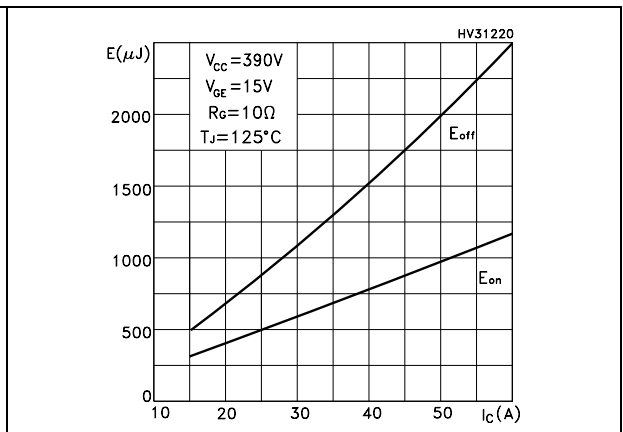
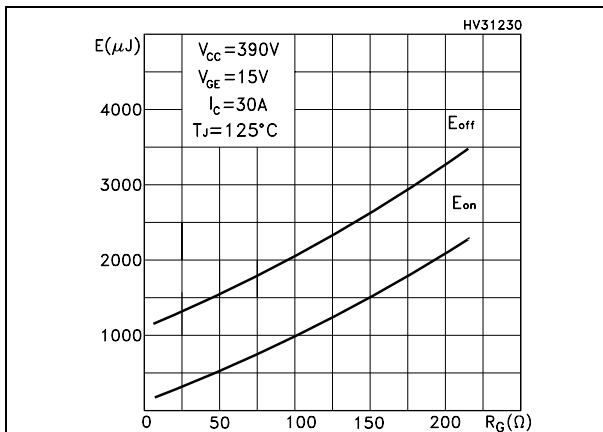


Figure 13. Thermal impedance

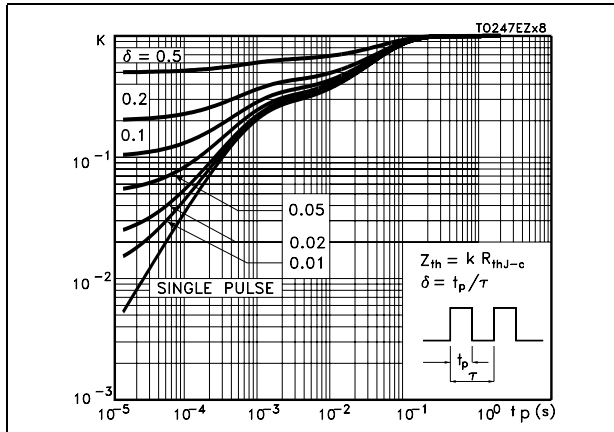
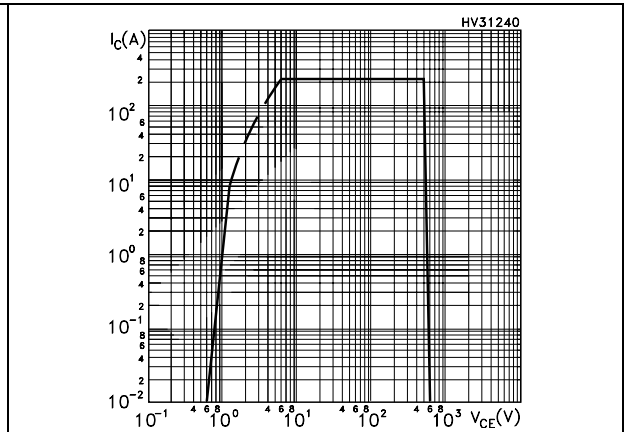


Figure 14. Turn-off SOA





### 3 Test circuit

Figure 15. Test circuit for inductive load switching

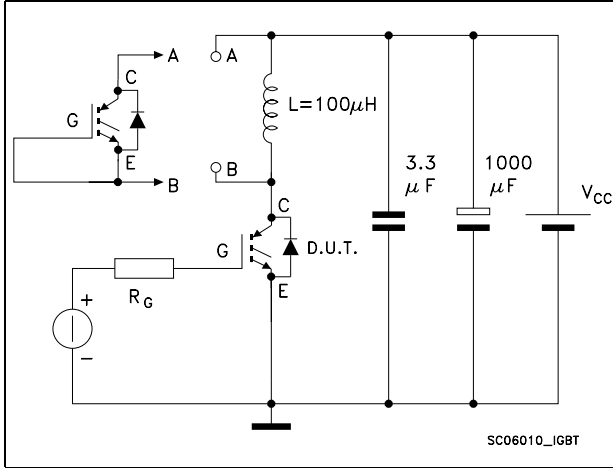


Figure 16. Gate charge test circuit

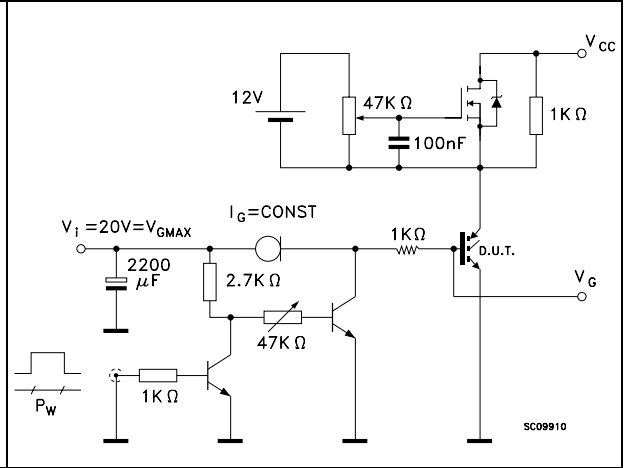


Figure 17. Switching waveforms

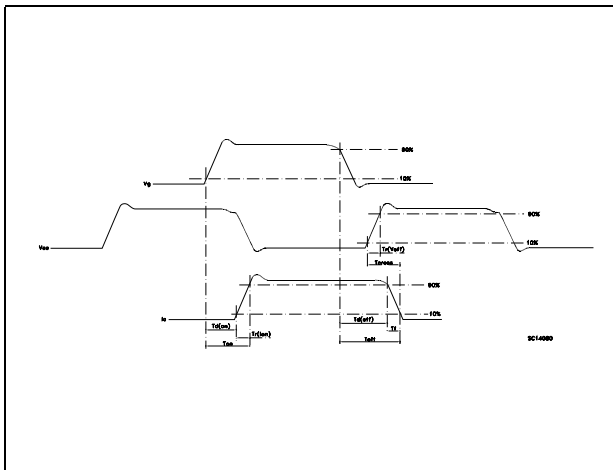
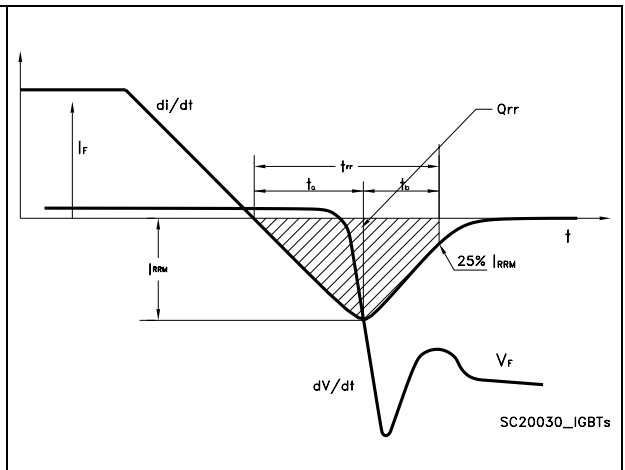


Figure 18. Diode recovery times waveform

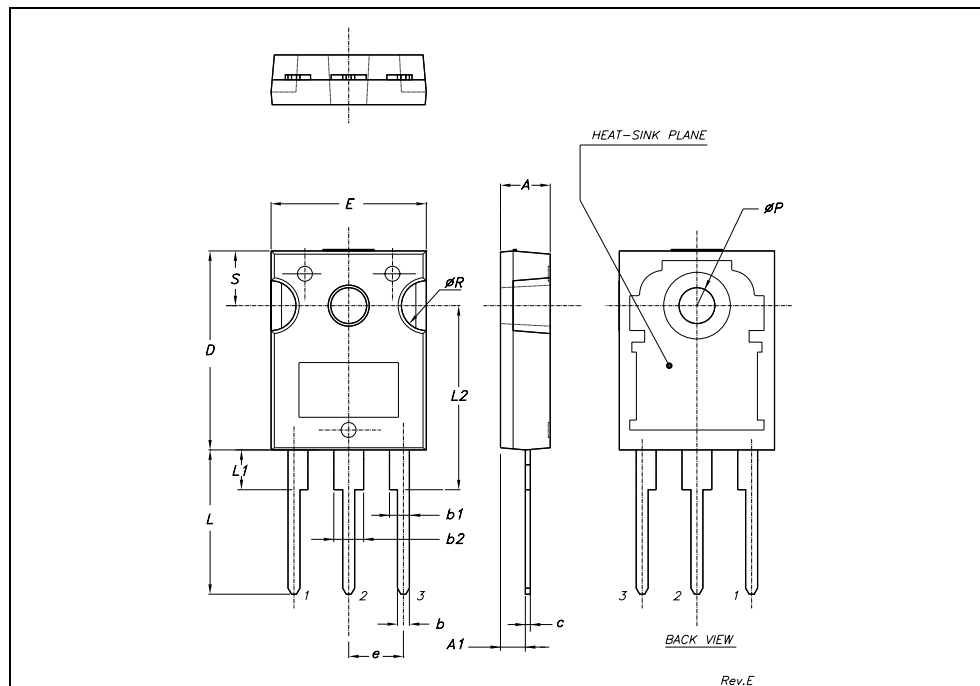


## 4 Package mechanical data

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](http://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 8. 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>
28-Jul-2006	4	Modified value on <i>Dynamic</i>

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