

### Features

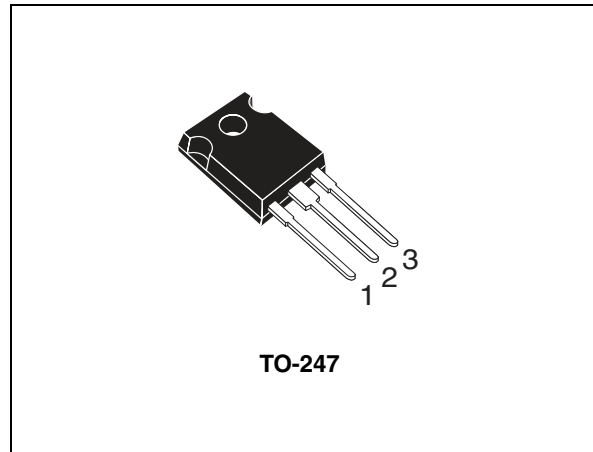
- High current capability
- High frequency operation up to 50 KHz
- Very soft ultra fast recovery antiparallel diode

### Description

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

### Applications

- High frequency inverters, UPS
- Motor drive
- SMPS and PFC in both hard switch and resonant topologies



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Order code	Marking	Package	Packaging
STGW20NC60VD	GW20NC60VD	TO-247	Tube

# Contents

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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
$I_C^{(1)}$	Continuous collector current at $T_C = 25^\circ\text{C}$	60	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100^\circ\text{C}$	30	A
$I_{CP}^{(2)}$	Pulsed collector current	150	A
$I_{CL}^{(3)}$	Turn-off latching current	100	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Diode RMS forward current at $T_C = 25^\circ\text{C}$	30	A
$I_{FSM}$	Surge not repetitive forward current $t_p = 10$ ms sinusoidal	120	A
$P_{TOT}$	Total dissipation at $T_C = 25^\circ\text{C}$	200	W
$T_j$	Operating junction temperature	- 55 to 150	$^\circ\text{C}$
$T_{stg}$	Storage temperature		

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(\max)} - T_C}{R_{thj-c} \times V_{CE(sat)(\max)}(T_{j(\max)}, I_C(T_C))}$$

- Pulse width limited by maximum junction temperature and turn-off within RBSOA.
- $V_{clamp} = 80\% V_{CES}$ ,  $T_J = 150^\circ\text{C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\ \text{V}$ .

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.63	$^\circ\text{C/W}$
	Thermal resistance junction-case diode	1.5	$^\circ\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	50	$^\circ\text{C/W}$

## 2 Electrical characteristics

( $T_j = 25^\circ\text{C}$  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	$V_{GE}=15 \text{ V}, I_C=20 \text{ A}$ $V_{GE}=15 \text{ V}, I_C=20 \text{ A}, T_j=125^\circ\text{C}$		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-cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600 \text{ V}$ $V_{CE}=600 \text{ V}, T_j= 125^\circ\text{C}$			250 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15 \text{ V}, I_C= 20 \text{ A}$		15		S

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{V}, f = 1 \text{ MHz}, V_{GE}= 0$	-	2200		pF
$C_{oes}$	Output capacitance			225		pF
$C_{res}$	Reverse transfer capacitance			50		pF
$Q_g$	Total gate charge	$V_{CE} = 390\text{V}, I_C = 20\text{A},$ $V_{GE} = 15\text{V},$ <i>(see Figure 18)</i>	-	100	140	nC
$Q_{ge}$	Gate-emitter charge			16		nC
$Q_{gc}$	Gate-collector charge			45		nC

**Table 6. Switching on/off (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ ,		31		ns
$t_r$	Current rise time	$R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$	-	11	-	ns
$(di/dt)_{onf}$	Turn-on current slope	(see Figure 17)		1600		A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ ,		31		ns
$t_r$	Current rise time	$R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$	-	11.5	-	ns
$(di/dt)_{on}$	Turn-on current slope	$T_j=125^\circ\text{C}$ (see Figure 17)		1500		A/ $\mu\text{s}$
$t_{r(Voff)}$	Off voltage rise time	$V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ ,		28		ns
$t_{d(off)}$	Turn-off delay time	$R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$	-	100	-	ns
$t_f$	Current fall time	(see Figure 17)		75		ns
$t_{r(Voff)}$	Off voltage rise time	$V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ ,		66		ns
$t_{d(off)}$	Turn-off delay time	$R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$	-	150	-	ns
$t_f$	Current fall time	$T_j=125^\circ\text{C}$ (see Figure 17)		130		ns

**Table 7. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ ,		220	300	$\mu\text{J}$
$E_{off}$	Turn-off switching losses	$R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$ ,	-	330	450	$\mu\text{J}$
$E_{ts}$	Total switching losses	(see Figure 19)		550	750	$\mu\text{J}$
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC}=390\text{ V}$ , $I_C=20\text{ A}$ ,		450		$\mu\text{J}$
$E_{off}$	Turn-off switching losses	$R_G=3.3\ \Omega$ , $V_{GE}=15\text{ V}$ ,	-	770		$\mu\text{J}$
$E_{ts}$	Total switching losses	$T_j=125^\circ\text{C}$ (see Figure 19)		1220		$\mu\text{J}$

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in Figure 19.  $E_{on}$  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 ( $25^\circ\text{C}$  and  $125^\circ\text{C}$ ).

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}, T_j = 125^\circ\text{C}$	-	2 1.6	-	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 20\text{ A}, V_R = 40\text{ V},$ $T_j = 25^\circ\text{C}, di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 20)	-	44 66 3	-	ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 20\text{ A}, V_R = 40\text{ V},$ $T_j = 125^\circ\text{C},$ $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 20)	-	88 237 5.4	-	ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

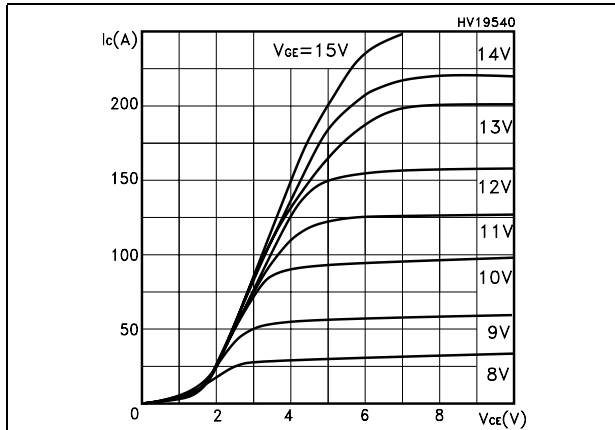


Figure 3. Transfer characteristics

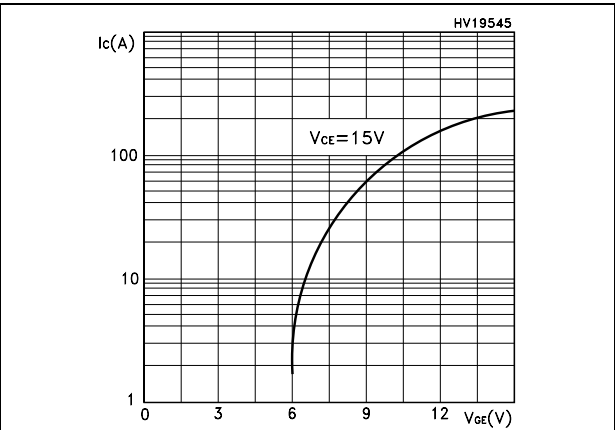


Figure 4. Transconductance

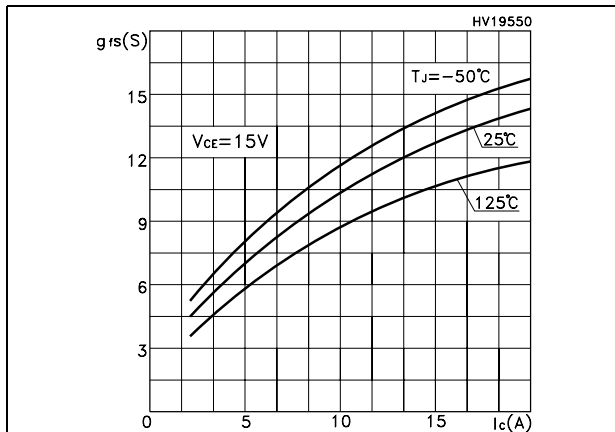


Figure 5. Collector-emitter on voltage vs temperature

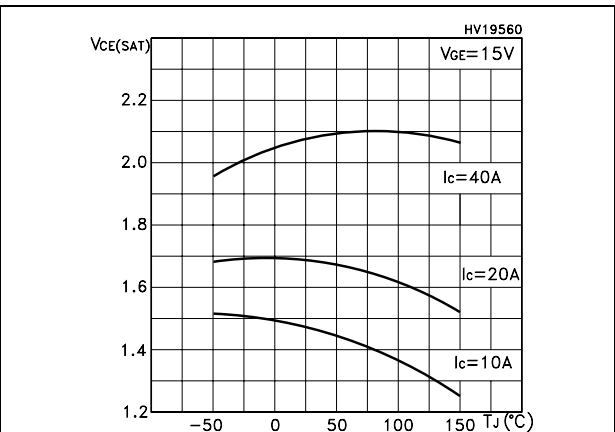


Figure 6. Collector-emitter on voltage vs collector current

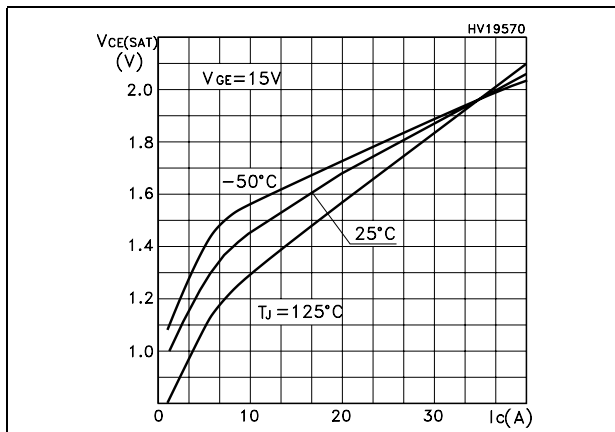


Figure 7. Normalized gate threshold vs temperature

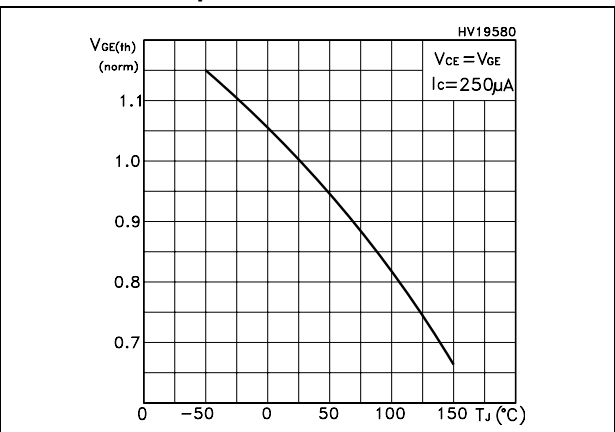


Figure 8. Normalized breakdown voltage vs temperature

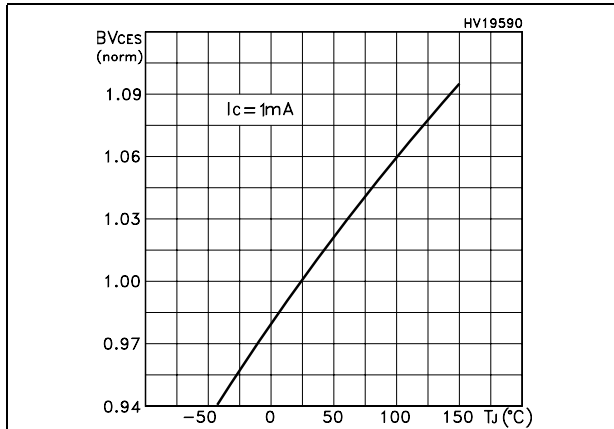


Figure 9. Gate charge vs gate-emitter voltage

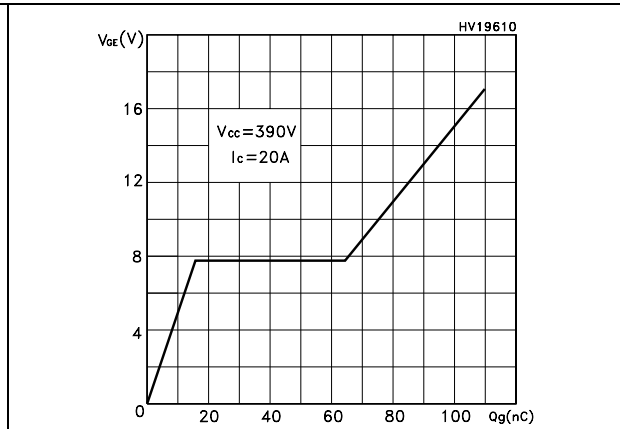


Figure 10. Capacitance variations

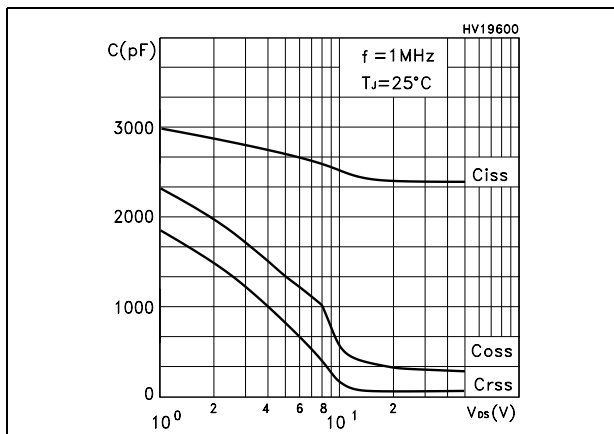


Figure 11. Switching losses vs temperature

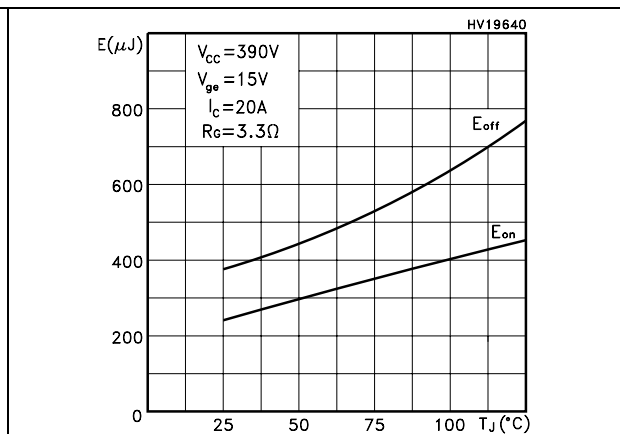


Figure 12. Switching losses vs gate resistance Figure 13. Switching losses vs collector current

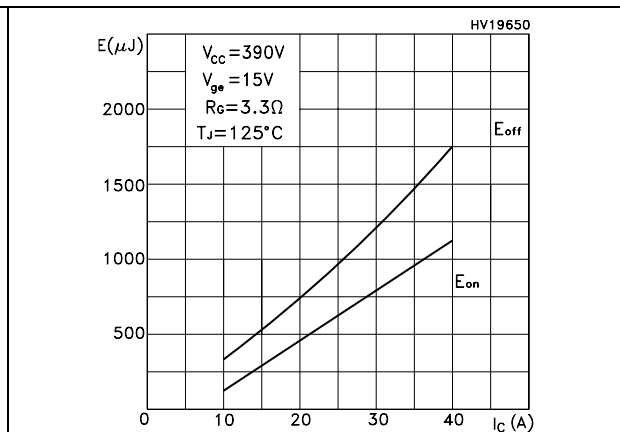
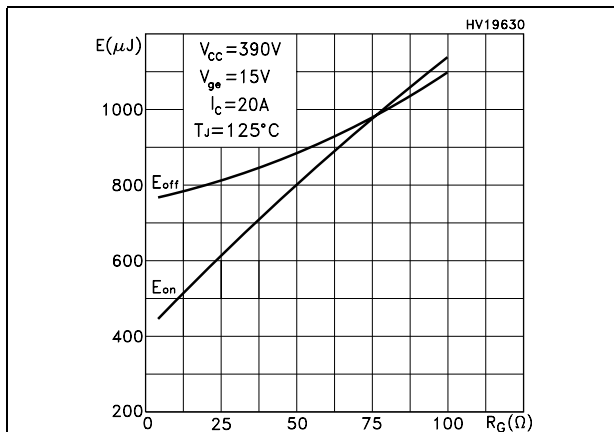




Figure 14. Thermal impedance

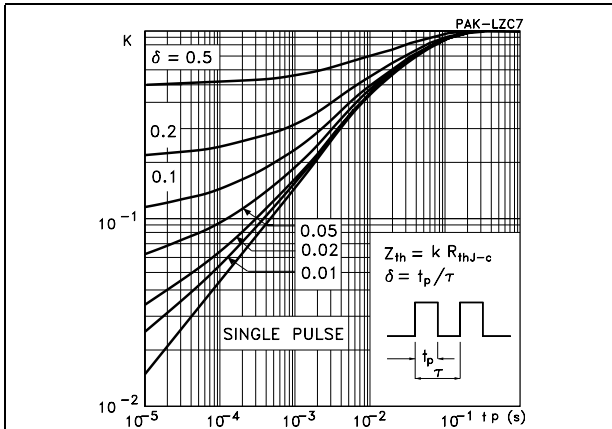


Figure 15. Turn-off SOA

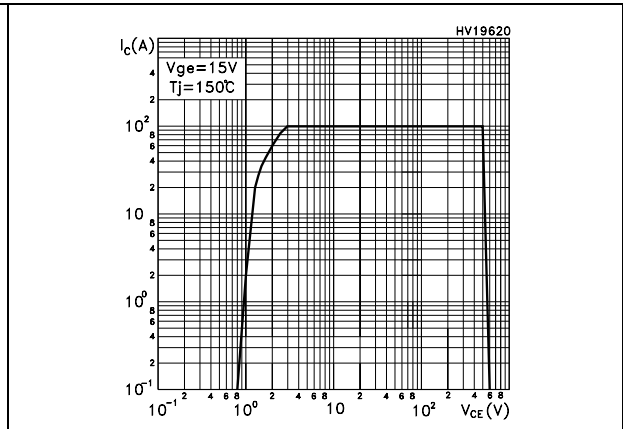
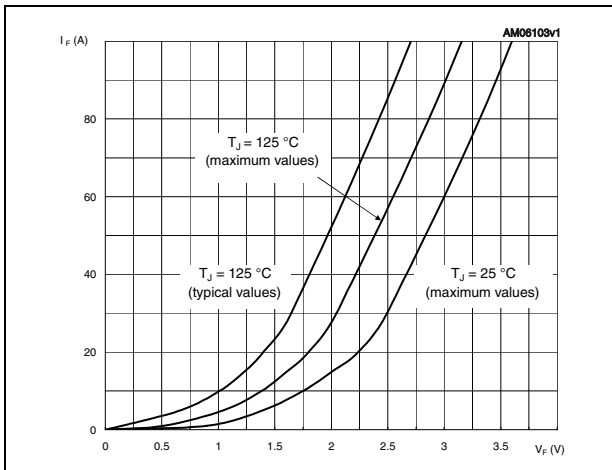


Figure 16. Emitter-collector diode characteristics



### 3 Test circuits

Figure 17. Test circuit for inductive load switching

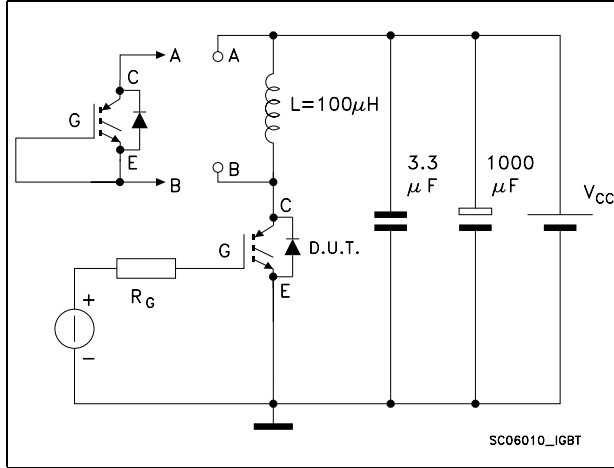


Figure 18. Gate charge test circuit

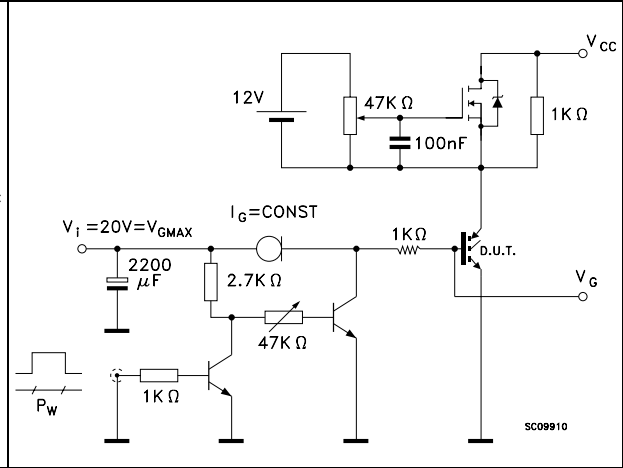


Figure 19. Switching waveforms

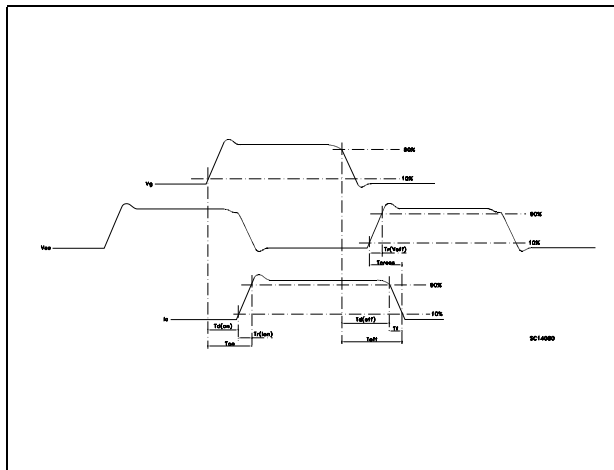
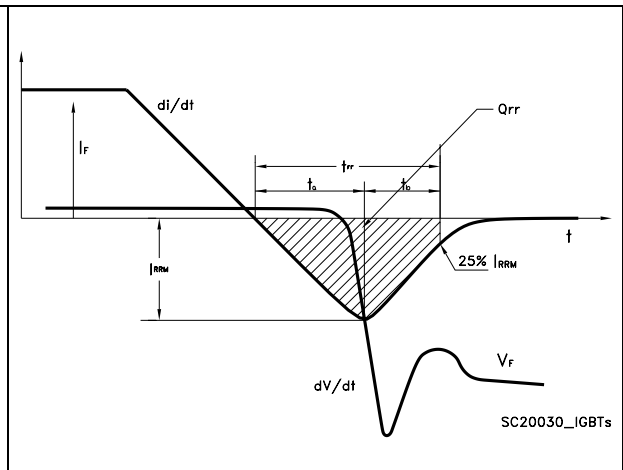


Figure 20. Diode recovery times waveform

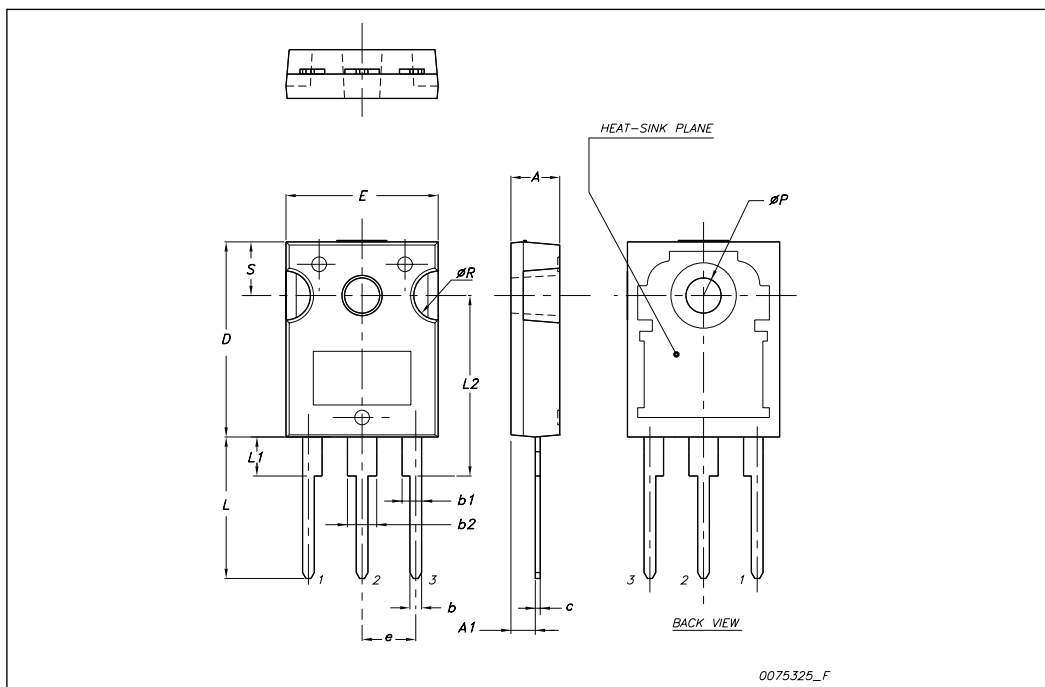


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

**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. Revision history

Date	Revision	Changes
12-Jul-2004	4	Stylesheet updated. Added switching losses maximum values in <a href="#">Table 7: Switching energy (inductive load)</a> . Inserted <a href="#">Figure 20: Diode recovery times waveform</a> .
09-Mar-2010	5	Inserted $I_{FSM}$ parameter on <a href="#">Table 2: Absolute maximum ratings</a> . Updated <a href="#">Figure 16: Emitter-collector diode characteristics</a> and package mechanical data. Minor text changes to improve readability.

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