

### Features

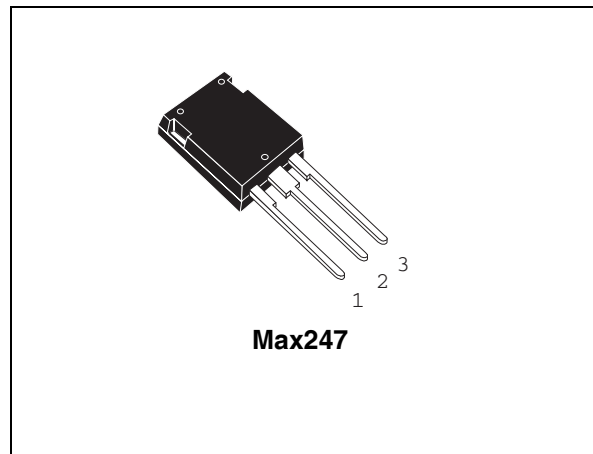
- Very high frequency operation
- Low  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Very soft ultra fast recovery antiparallel diode

### Applications

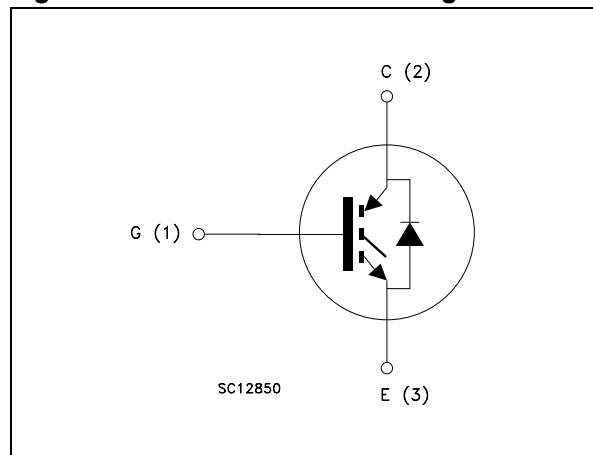
- Very high frequency inverters, UPS
- HF, SMPS and PFC in both hard switch and resonant topologies
- Motor drivers
- Welding

### Description

This IGBT utilizes the advanced Power MESH™ 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
STGY50NC60WD	GY50NC60WD	Max247	Tube

## Contents

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	600	V
$I_C^{(1)}$	Collector current (continuous) at $T_C = 25\text{ °C}$	110	A
$I_C^{(1)}$	Collector current (continuous) at $T_C = 100\text{ °C}$	50	A
$I_{CL}^{(2)}$	Turn-off latching current	180	A
$I_{CP}^{(3)}$	Pulsed collector current	180	A
$I_F$	Diode RMS forward current at $T_C = 25\text{ °C}$	30	A
$I_{FSM}$	Surge not repetitive forward current ( $t_p=10\text{ ms}$ sinusoidal)	120	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	278	W
$T_j$	Operating junction temperature	-55 to 150	$^{\circ}\text{C}$

1. Calculated according to the iterative formula:

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

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

3. Pulse width limited by max. temperature allowed

**Table 2. Thermal resistance**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT max.	0.45	$^{\circ}\text{C/W}$
$R_{thj-case}$	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

( $T_{CASE} = 25\text{ °C}$  unless otherwise specified)

**Table 3. 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	$V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_C = 125\text{ °C}$		2.1 1.9	2.6	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_C = 125\text{ °C}$			500 5	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15\text{ V}, I_C = 40\text{ A}$		25		S

**Table 4. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$		4700		pF
$C_{oes}$	Output capacitance			410		pF
$C_{res}$	Reverse transfer capacitance			90		pF
$Q_g$	Total gate charge	$V_{CE} = 390\text{ V}, I_C = 40\text{ A},$		195		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{ V},$		32		nC
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 16</a>		82		nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390\text{ V}$ , $I_C = 40\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 17, Figure 15</i>		52 17 2400		ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390\text{ V}$ , $I_C = 40\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$ <i>Figure 17, Figure 15</i>		50 19 2020		ns ns A/ $\mu$ s
$t_{r(Voff)}$ $t_{d(Voff)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390\text{ V}$ , $I_C = 40\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 17, Figure 15</i>		31 240 35		ns ns ns
$t_{r(Voff)}$ $t_{d(Voff)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390\text{ V}$ , $I_C = 40\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$ <i>Figure 17, Figure 15</i>		59 280 63		ns ns ns

**Table 6. 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	$V_{CC} = 390\text{ V}$ , $I_C = 40\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 15</i>		365 560 925	470 790 1260	$\mu$ J $\mu$ J $\mu$ J
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 40\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_C = 125\text{ }^\circ\text{C}$ <i>Figure 15</i>		635 910 1545		$\mu$ J $\mu$ J $\mu$ J

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in *Figure 18*. 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	$I_F = 40 \text{ A}$		3.2		V
		$I_F = 40 \text{ A}, T_C = 125 \text{ }^\circ\text{C}$		2.2		V
$t_{rr}$	Reverse recovery time	$I_F = 40 \text{ A}, V_R = 50 \text{ V},$ $di/dt = 100 \text{ A}/\mu\text{s}$		55		ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100 \text{ A}/\mu\text{s}$		100		nC
$I_{rrm}$	Reverse recovery current	<i>Figure 18</i>		3.6		A
$t_{rr}$	Reverse recovery time	$I_F = 40 \text{ A}, V_R = 50 \text{ V},$ $T_C = 125 \text{ }^\circ\text{C},$ $di/dt = 100 \text{ A}/\mu\text{s}$ ( <i>Figure 18</i> )		164		ns
$Q_{rr}$	Reverse recovery charge	$T_C = 125 \text{ }^\circ\text{C},$ $di/dt = 100 \text{ A}/\mu\text{s}$ ( <i>Figure 18</i> )		525		nC
$I_{rrm}$	Reverse recovery current	$di/dt = 100 \text{ A}/\mu\text{s}$ ( <i>Figure 18</i> )		6.4		A

## 2.1 Electrical characteristics (curves)

Figure 1. Output characteristics

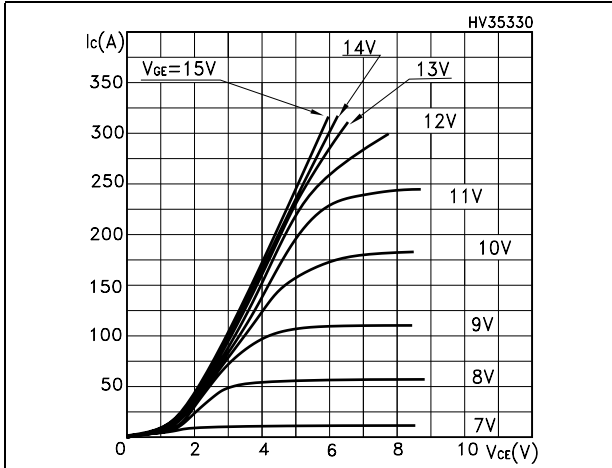


Figure 2. Transfer characteristics

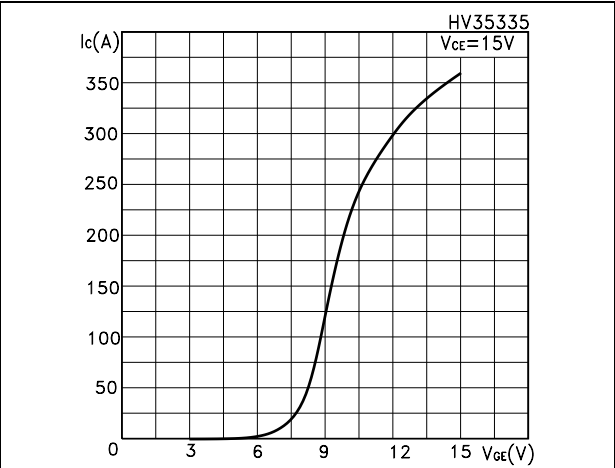


Figure 3. Transconductance

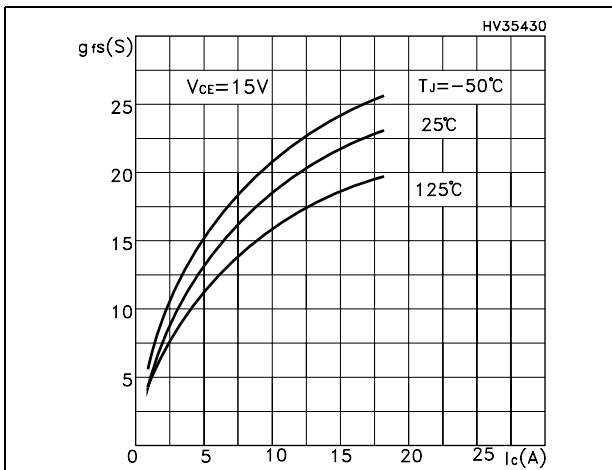


Figure 4. Collector-emitter on voltage vs temperature

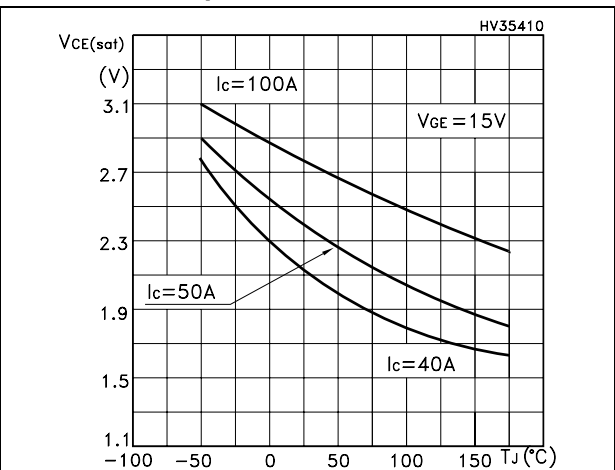


Figure 5. Gate charge vs gate-source voltage

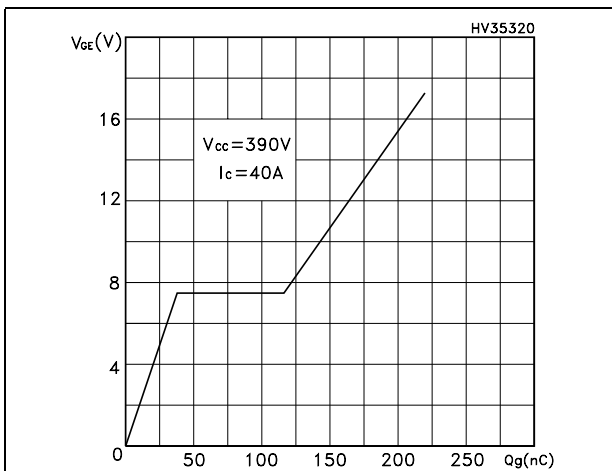


Figure 6. Capacitance variations

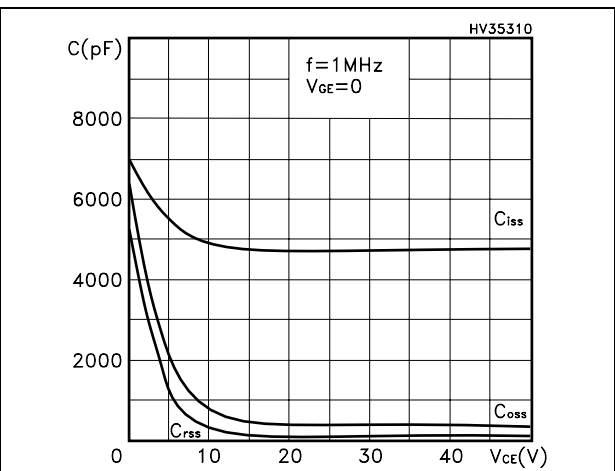


Figure 7. Normalized gate threshold voltage vs temperature

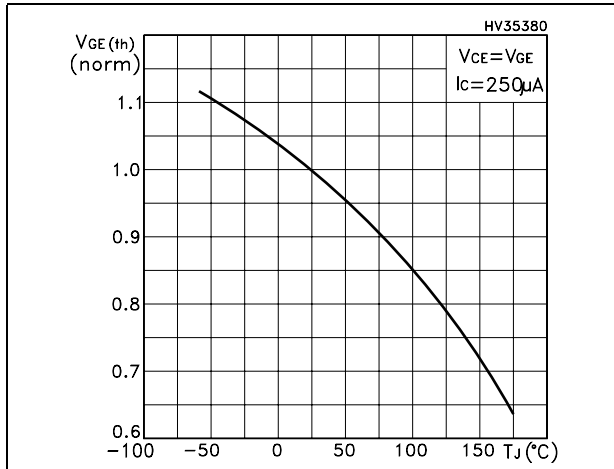


Figure 8. Collector-emitter on voltage vs collector current

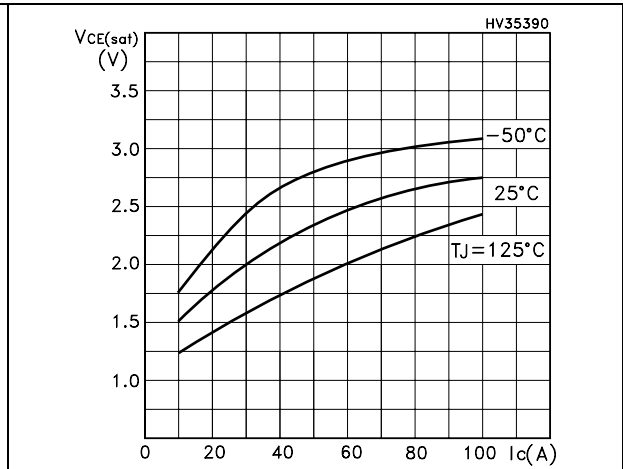


Figure 9. Normalized breakdown voltage vs temperature

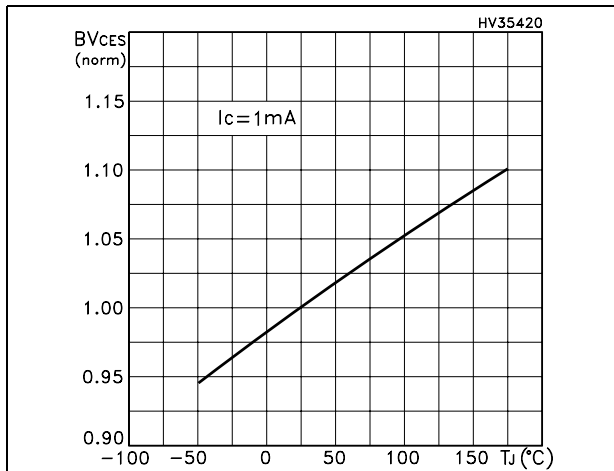


Figure 10. Switching losses vs temperature

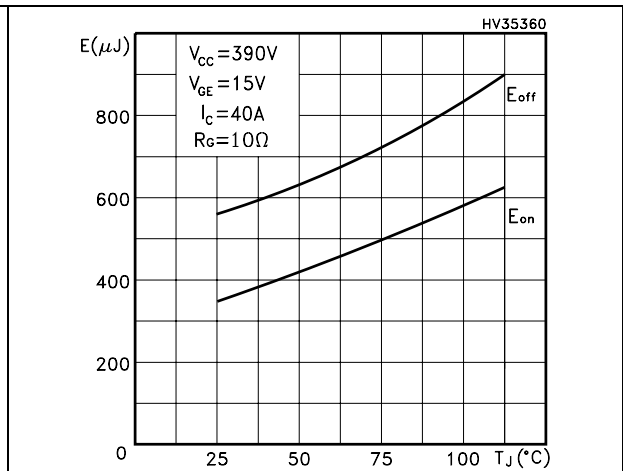


Figure 11. Switching losses vs gate resistance

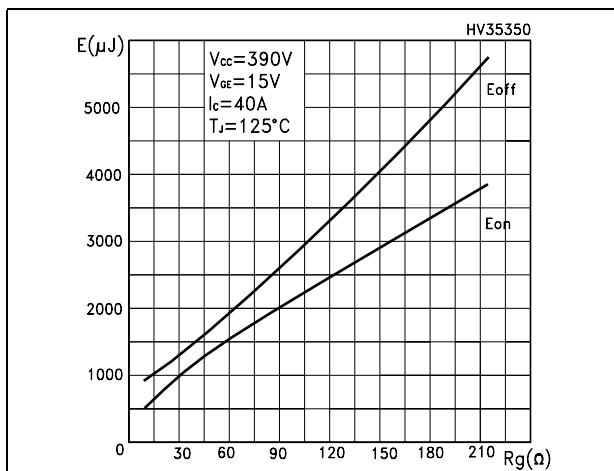


Figure 12. Switching losses vs collector current

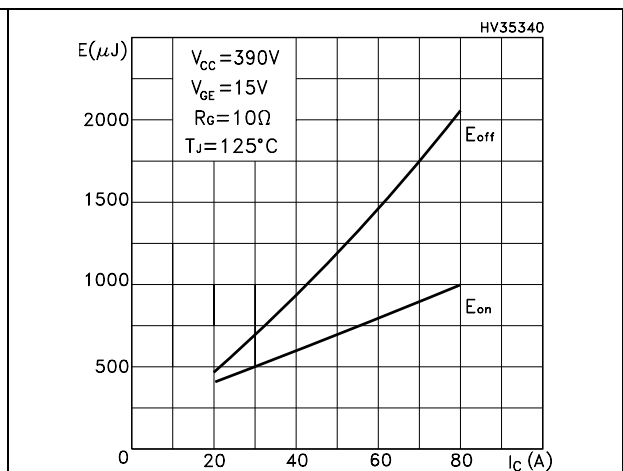




Figure 13. Turn-off SOA

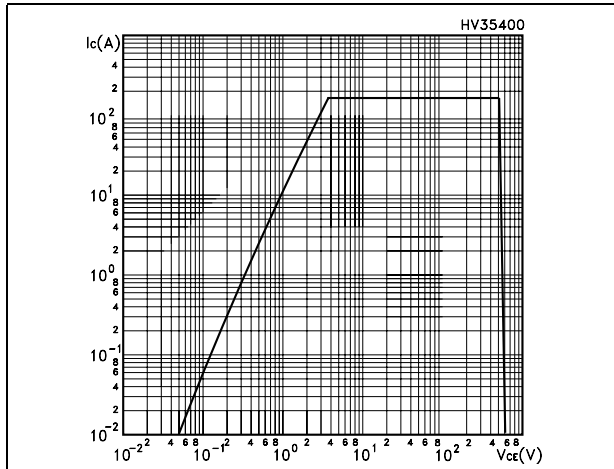
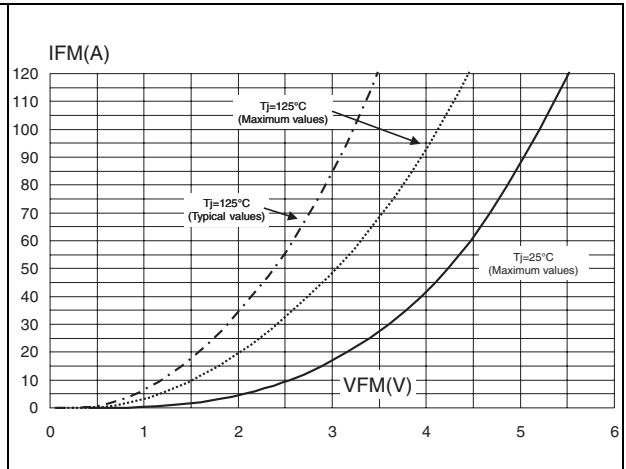


Figure 14. Forward voltage drop vs. forward current



### 3 Test circuit

Figure 15. Test circuit for inductive load switching



Figure 16. Gate charge test circuit

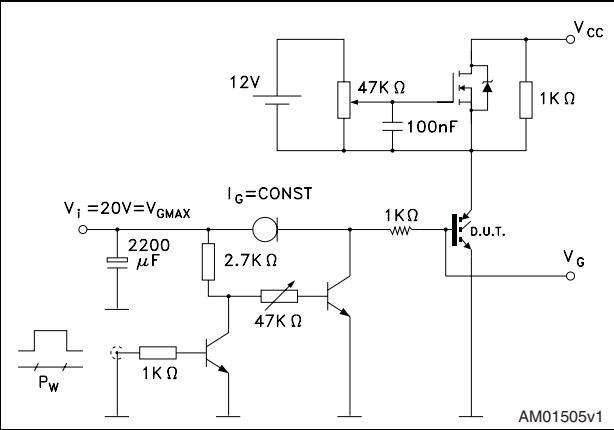


Figure 17. Switching waveform

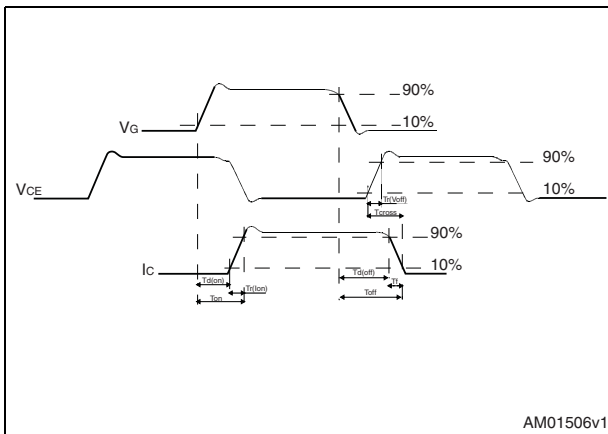
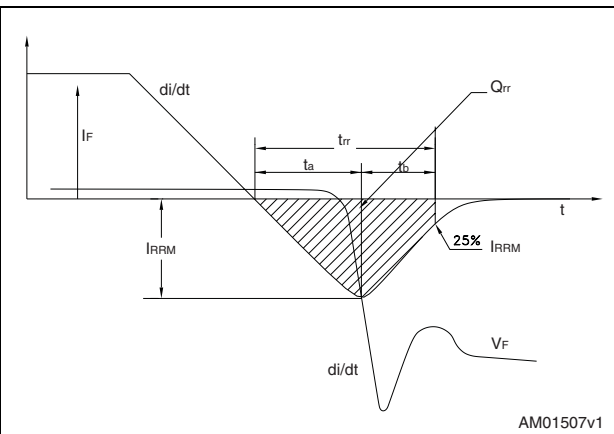


Figure 18. Diode recovery time waveform



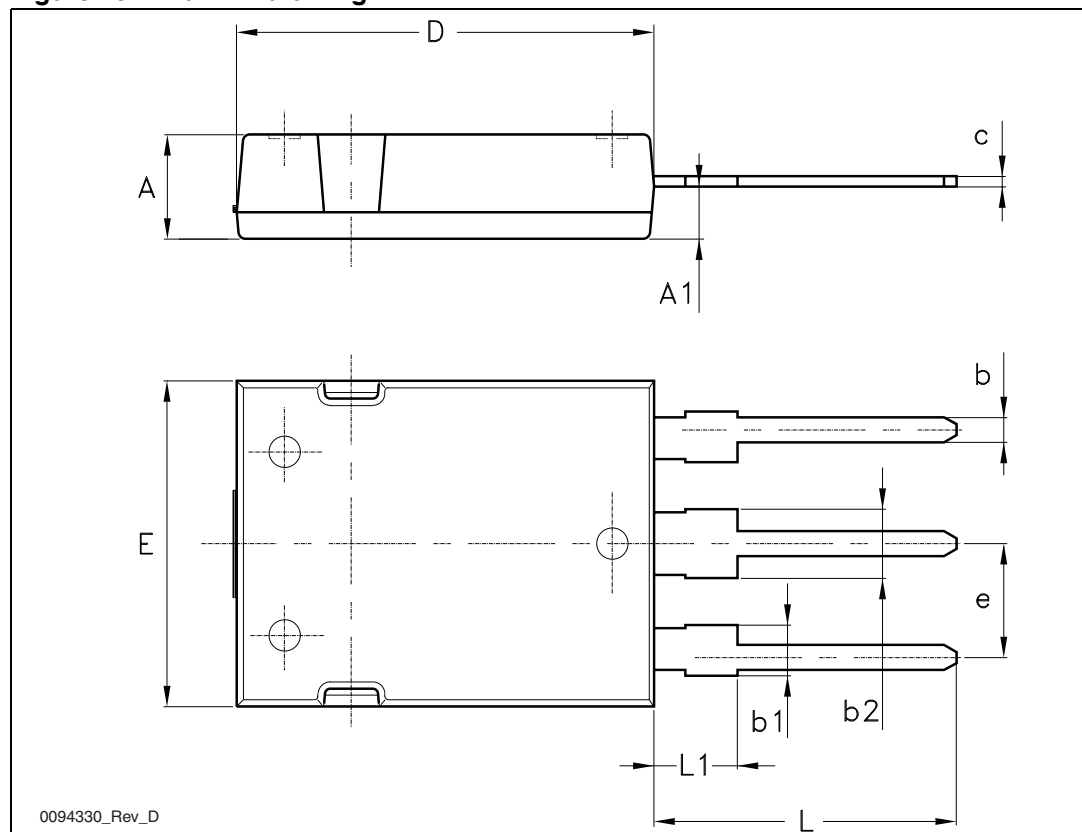
## 4 Package mechanical data

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

Table 8. Max247 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.70		5.30
A1	2.20		2.60
b	1.00		1.40
b1	2.00		2.40
b2	3.00		3.40
c	0.40		0.80
D	19.70		20.30
e	5.35		5.55
E	15.30		15.90
L	14.20		15.20
L1	3.70		4.30

Figure 19. Max247 drawing



## 5 Revision history

**Table 9. Document revision history**

Date	Revision	Changes
09-Oct-2006	1	Initial release.
07-May-2007	2	Complete version
02-Jul-2007	3	Modified value on <a href="#">Table 2: Thermal resistance</a>
04-Nov-2008	4	<a href="#">Table 8: Max247 mechanical data</a> and <a href="#">Figure 19: Max247 drawing</a> have been updated.
09-Jan-2009	5	<a href="#">Figure 13: Turn-off SOA</a> has been updated.

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