



# STGW50HF60SD

60 A, 600 V, very low drop IGBT with soft and fast recovery diode

## Features

- Very low on-state voltage drop
- Low switching off
- High current capability
- Very soft ultra fast recovery antiparallel diode

## Application

- PV inverter
- UPS

## Description

STGW50HF60SD is a very low drop IGBT based on new advanced planar technology, showing extremely low on-state voltage and limited turn-off losses. The overall performance makes this IGBT ideal in low frequency switches of mixed frequency topologies for  $PF \leq 1$ .

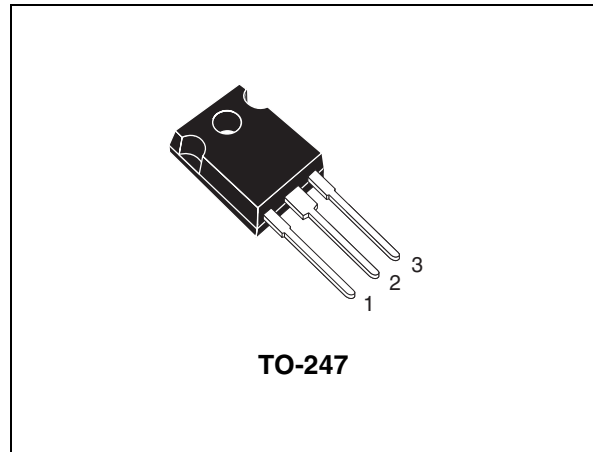


Figure 1. Internal schematic diagram

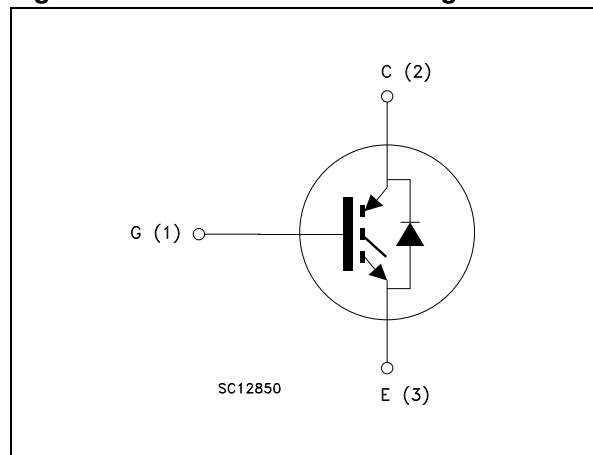


Table 1. Device summary

Order code	Marking	Package	Packaging
STGW50HF60SD	GW50HF60SD	TO-247	Tube

# 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 $T_C = 25\text{ °C}$	110	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	60	A
$I_{CL}^{(2)}$	Turn-off latching current	60	A
$I_{CP}^{(3)}$	Pulsed collector current	130	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	284	W
$I_F$	Diode RMS forward current at $T_C = 25\text{ °C}$	30	A
$I_{FSM}$	Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	120	A
$T_j$	Operating junction temperature	- 55 to 150	°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 maximum junction temperature and turn-off within RBSOA

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.44	°C/W
$R_{thj-case}$	Thermal resistance junction-case diode	1.25	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient	50	°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	$V_{GE} = 15 \text{ V}, I_C = 30 \text{ A}$		1.15	1.45	V
		$V_{GE} = 15 \text{ V}, I_C = 30 \text{ A}, T_J = 125^\circ\text{C}$		1.05		V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250 \mu\text{A}$	3.5		5.7	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600 \text{ V}$			50	$\mu\text{A}$
		$V_{CE} = 600 \text{ V}, T_J = 125^\circ\text{C}$			500	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20 \text{ V}$			$\pm 100$	nA
$g_{fs}$	Forward transconductance	$V_{CE} = 15 \text{ V}, I_C = 30 \text{ A}$		25		S

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$ $C_{oes}$ $C_{res}$	Input capacitance	$V_{CE} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GE} = 0$	-	4300	-	pF
	Output capacitance			400		
	Reverse transfer capacitance			100		
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total gate charge	$V_{CE} = 480 \text{ V}, I_C = 30 \text{ A}, V_{GE} = 15 \text{ V}$	-	200	-	nC
	Gate-emitter charge			27		nC
	Gate-collector charge			90		nC

**Table 6. 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	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 15)	-	50 20 1280	-	ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 15)	-	47 22 1100	-	ns ns A/ $\mu$ s
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 15)	-	370 220 465	-	ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 15)	-	700 250 800	-	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	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see Figure 15)	-	0.25 4.2 4.45	-	mJ mJ mJ
$E_{on}^{(1)}$ $E_{off}^{(2)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see Figure 15)	-	0.45 7.8 8.25	-	mJ mJ mJ

1.  $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in Figure 15. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and 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	$I_F = 30\text{ A}$ $I_F = 30\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	2.8 1.8	-	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 18)	-	67 140 4	-	ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 18)	-	103 390 7	-	ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

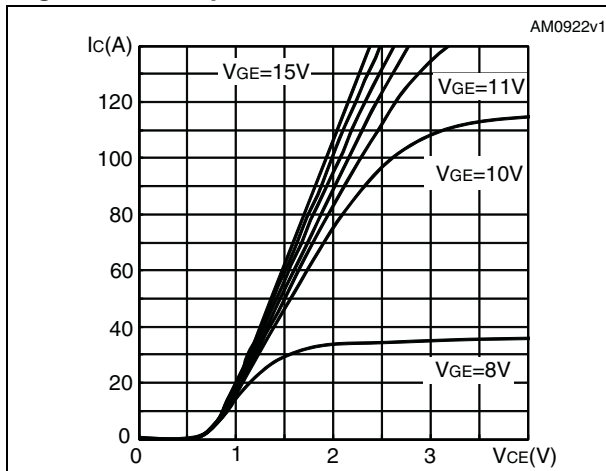


Figure 3. Transfer characteristics

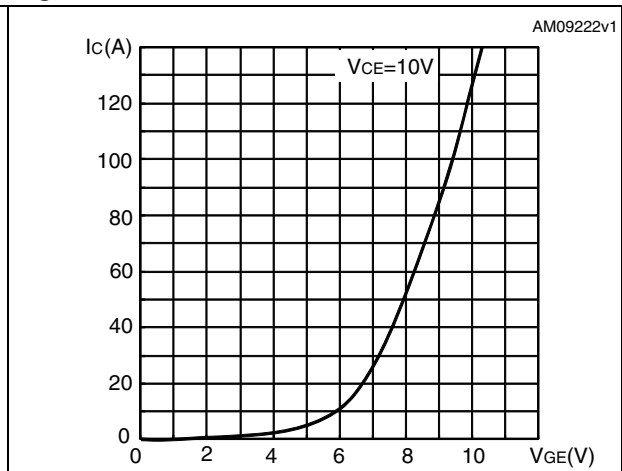


Figure 4. Collector-emitter on voltage vs temperature

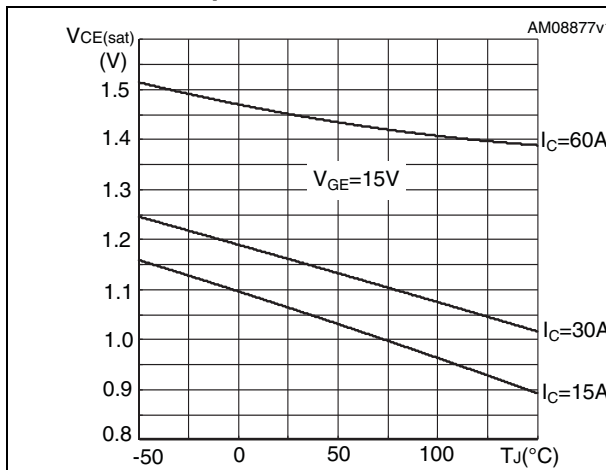


Figure 5. Collector-emitter on voltage vs collector current

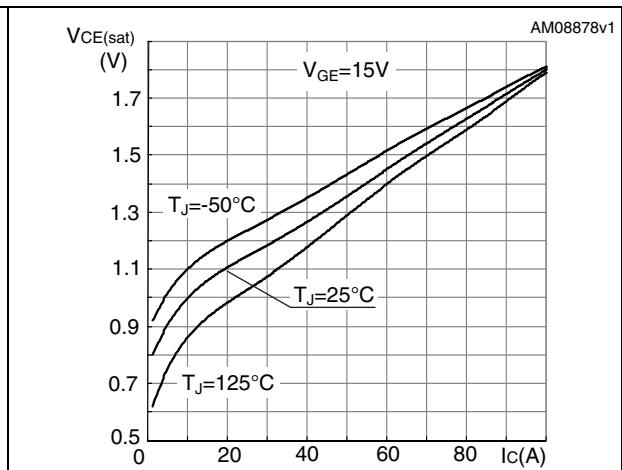


Figure 6. Breakdown voltage vs temperature

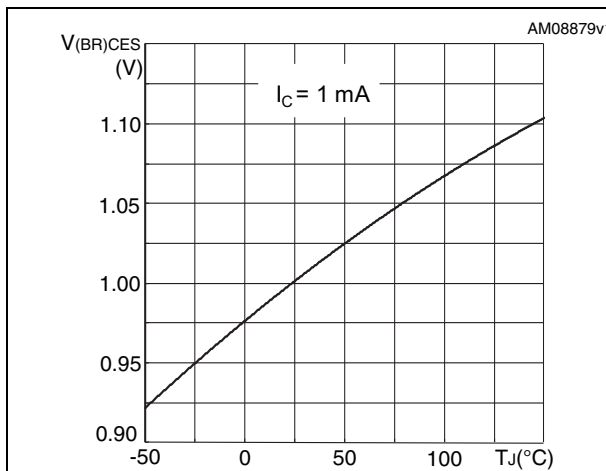


Figure 7. Gate threshold voltage vs temperature

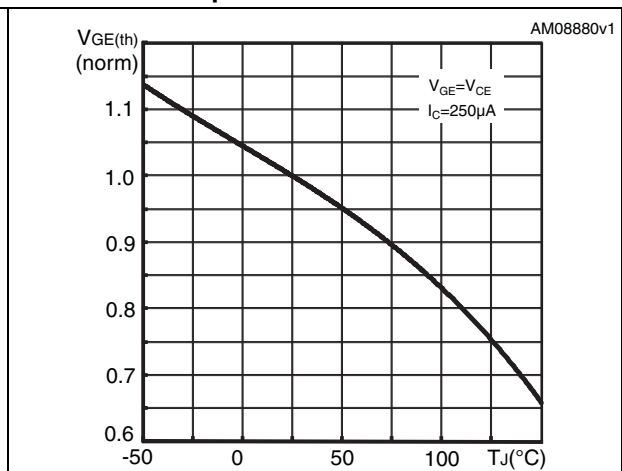


Figure 8. Gate charge vs gate-emitter voltage Figure 9. Capacitance variations

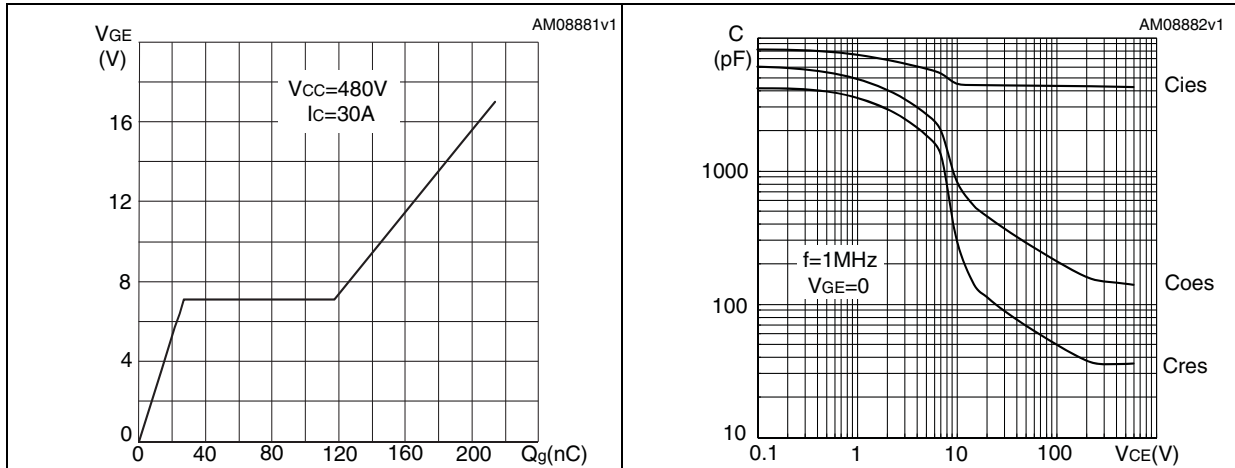


Figure 10. Switching losses vs collector current

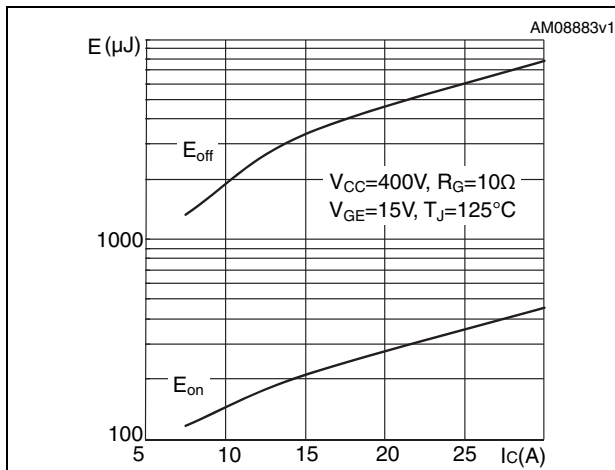


Figure 11. Switching losses vs gate resistance

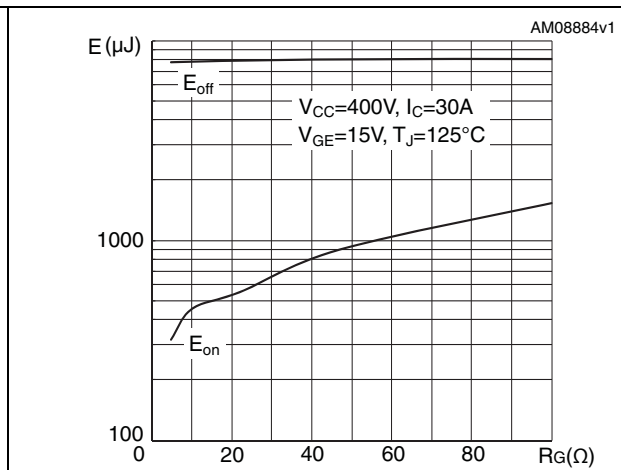


Figure 12. Switching losses vs temperature

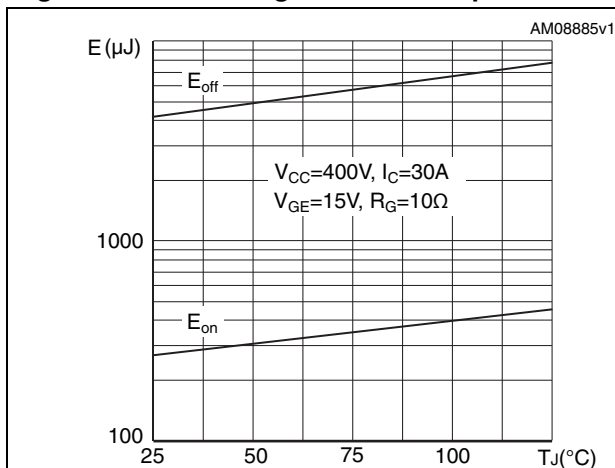
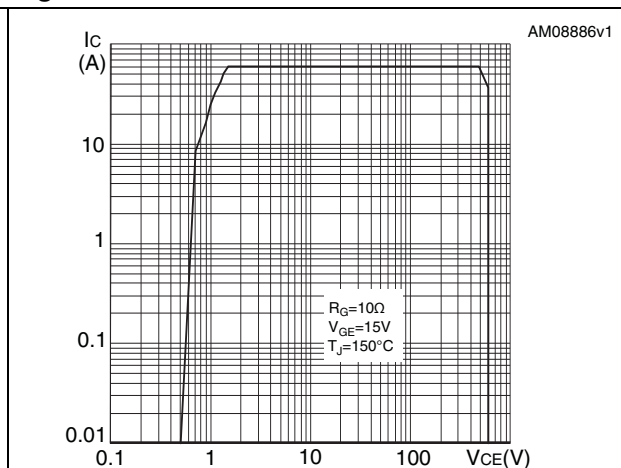
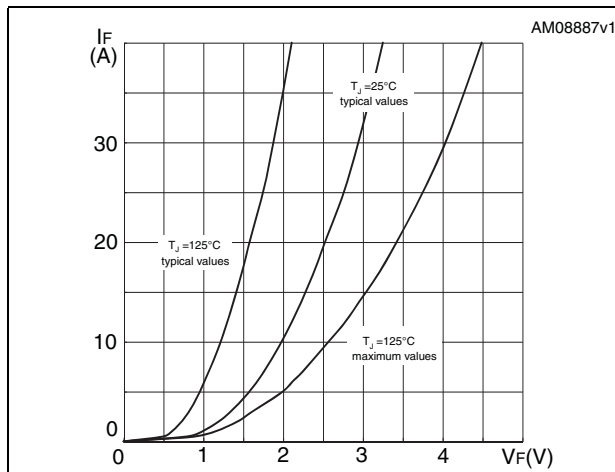


Figure 13. Turn-off SOA



**Figure 14. Emitter-collector diode characteristics**

### 3 Test circuits

Figure 15. Test circuit for inductive load switching

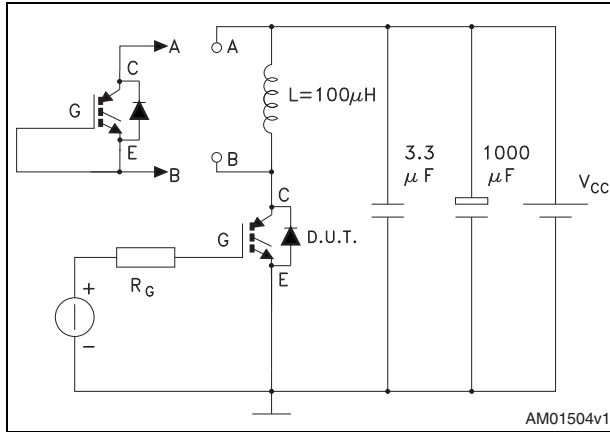


Figure 16. Gate charge test circuit

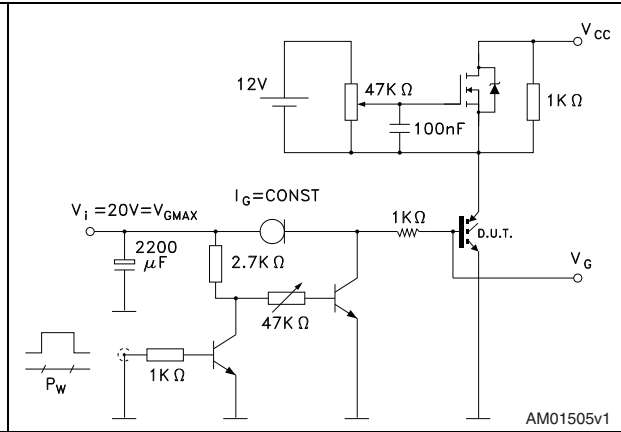


Figure 17. Switching waveform

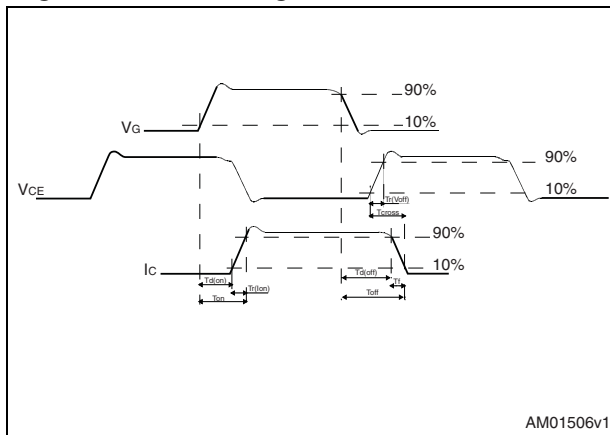
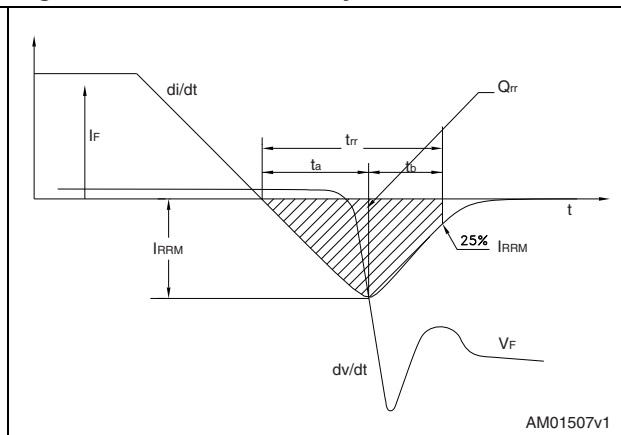


Figure 18. Diode recovery time waveform





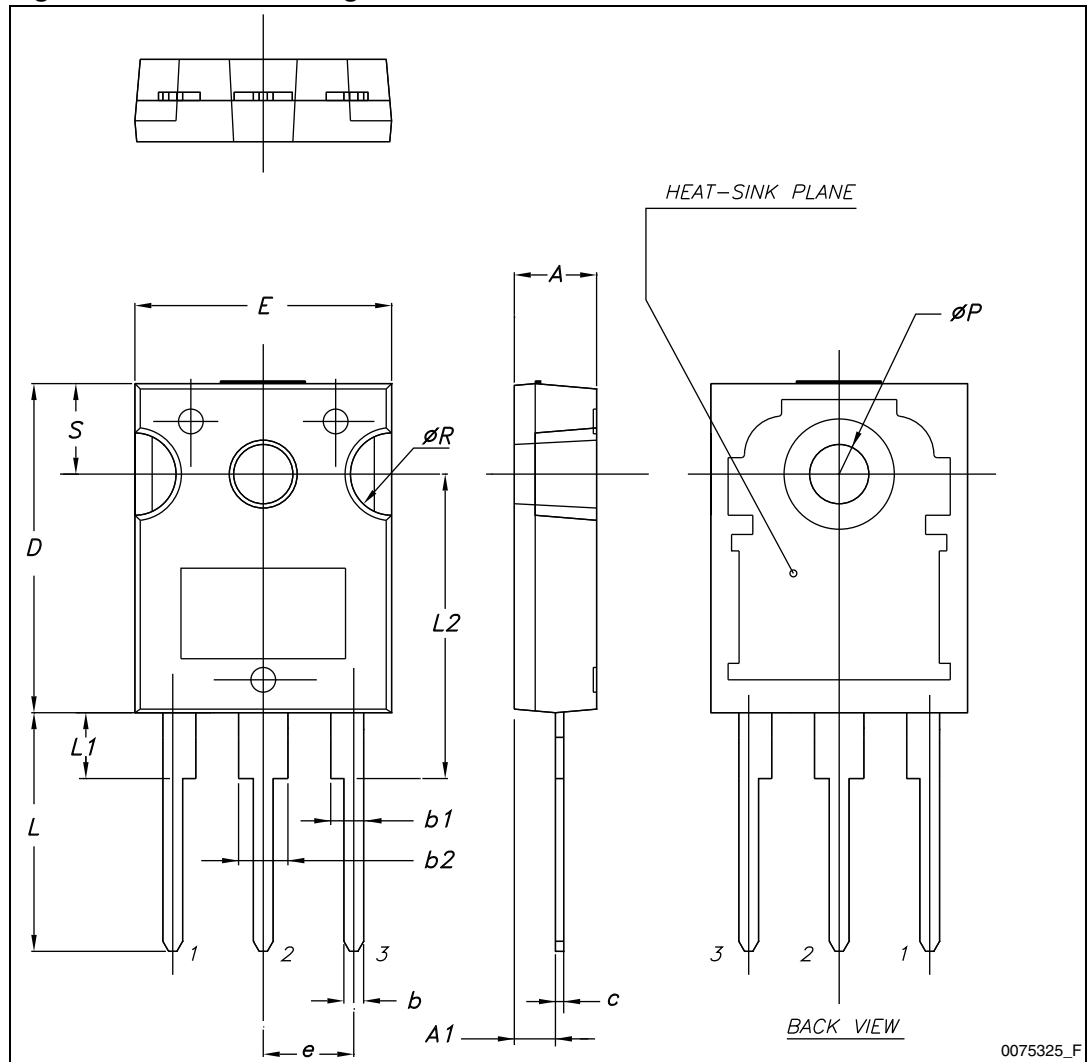
## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<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.

Table 9. 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	

Figure 19. TO-247 drawing



## 5 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
15-Jan-2010	1	Initial release.
21-Dec-2010	2	Document status promoted to datasheet.

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