

## 45 A, 600 V ultra fast IGBT with low drop diode

### Features

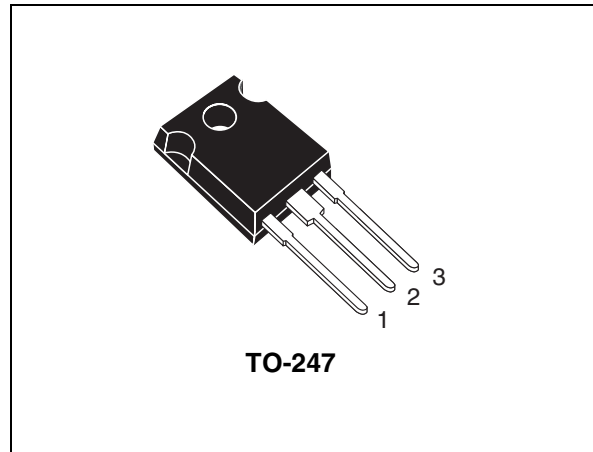
- Improved  $E_{off}$  at elevated temperature
- Low  $V_F$  soft recovery antiparallel diode

### Applications

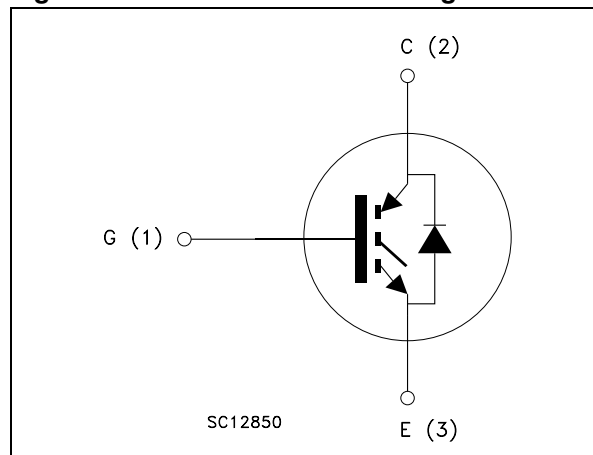
- Welding
- Induction heating
- Resonant converters

### Description

The STGW45HF60WDI is based on a new advanced planar technology concept to yield an IGBT with more stable switching performance ( $E_{off}$ ) versus temperature, as well as lower conduction losses. The device is tailored to high switching frequency operation (over 100 kHz).



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Order code	Marking	Package	Packaging
STGW45HF60WDI	GW45HF60WDI	TO-247	Tube
STGWA45HF60WDI	45HF60WDI	TO-247 long leads	

## Content

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-247	TO-247 long leads	
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0)	600		V
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 25 °C	70	80	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100 °C	45	50	A
I <sub>CP</sub> <sup>(2)</sup>	Pulsed collector current	150		A
I <sub>CL</sub> <sup>(3)</sup>	Turn-off latching current	80		A
V <sub>GE</sub>	Gate-emitter voltage	± 20		V
I <sub>F</sub>	Diode RMS forward current at T <sub>C</sub> = 25 °C	30		A
I <sub>FSM</sub>	Surge not repetitive forward current t <sub>p</sub> = 10 ms sinusoidal	130		A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	250	310	W
T <sub>stg</sub>	Storage temperature	- 55 to 150		°C
T <sub>j</sub>	Operating junction temperature			

1. Calculated according to the iterative formula:

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

2. Pulse width limited by maximum junction temperature and turn-off within RBSOA

3. V<sub>CLAMP</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 15 V, R<sub>G</sub> = 10 Ω, T<sub>J</sub> = 150 °C

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-247	TO-247 long leads	
R <sub>thj-case</sub>	Thermal resistance junction-case IGBT	0.5	0.4	°C/W
	Thermal resistance junction-case diode	1.5		°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient	50		°C/W

## 2 Electrical characteristics

( $T_J = 25\text{ °C}$  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	$V_{GE} = 15\text{ V}, I_C = 30\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 30\text{ A}, T_J = 125\text{ °C}$		1.9 1.65	2.5	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$			500 5	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA

**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			260		pF
$C_{res}$	Reverse transfer capacitance			55		pF
$Q_g$	Total gate charge	$V_{CE} = 400\text{ V}, I_C = 30\text{ A},$	-	160	-	nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{ V}$		17		nC
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 18</a>		65		nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}, I_C = 30\text{ A},$ $R_{GE} = 4.7\ \Omega, V_{GE} = 15\text{ V}$ <a href="#">Figure 17</a>	-	30	-	ns
$t_d(off)$	Turn-off delay time			145		ns
$t_f$	Current fall time			50		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}, I_C = 30\text{ A},$ $R_{GE} = 4.7\ \Omega, V_{GE} = 15\text{ V},$ $T_J = 125\text{ °C}$ <a href="#">Figure 17</a>	-	47	-	ns
$t_d(off)$	Turn-off delay time			185		ns
$t_f$	Current fall time			65		ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{off}$	Turn-off switching losses	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 19</i>	-	330		$\mu\text{J}$
$E_{off}$	Turn-off switching losses	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 4.7\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , <i>Figure 19</i>	-	550	800	$\mu\text{J}$

**Table 8. Collector-emitter diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 30\text{ A}$ $I_F = 30\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	1.4 1.2	1.8	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 20</i>	-	90 305 5.2	-	ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 20</i>	-	235 1100 9	-	ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

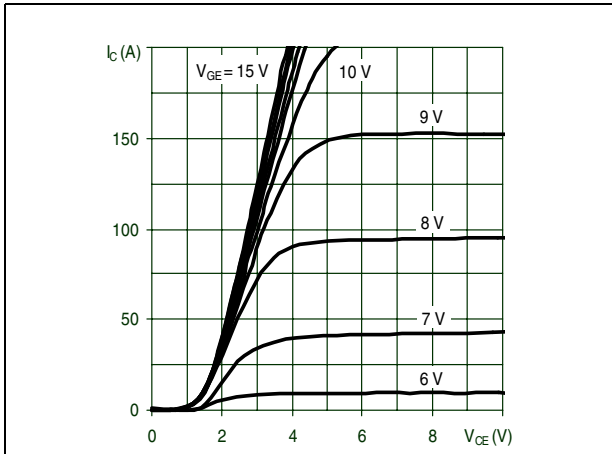


Figure 3. Transfer characteristics

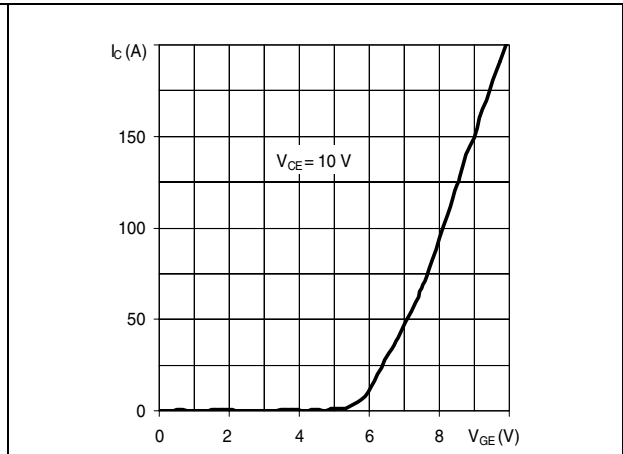


Figure 4. Normalized  $V_{CE(sat)}$  vs.  $I_c$

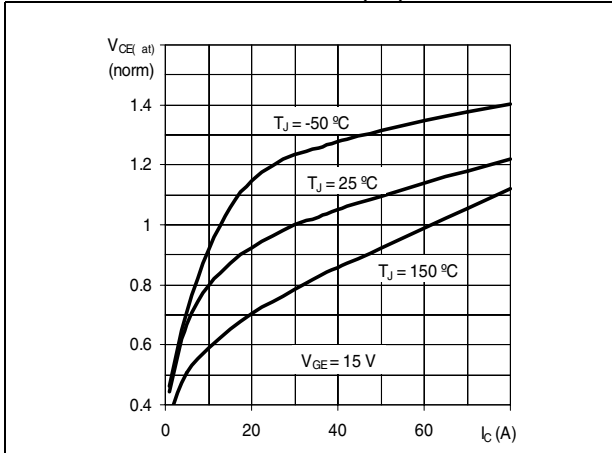


Figure 5. Normalized  $V_{CE(sat)}$  vs. temperature

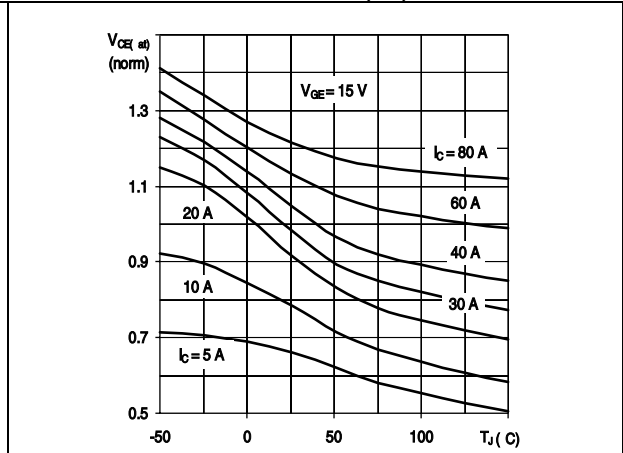


Figure 6. Normalized breakdown voltage vs. temperature

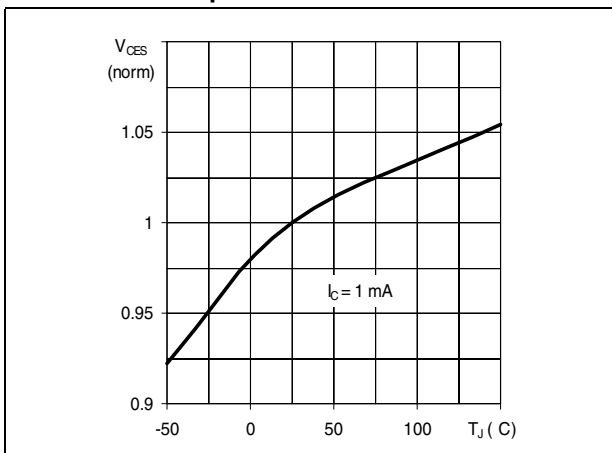


Figure 7. Normalized gate threshold voltage vs. temperature

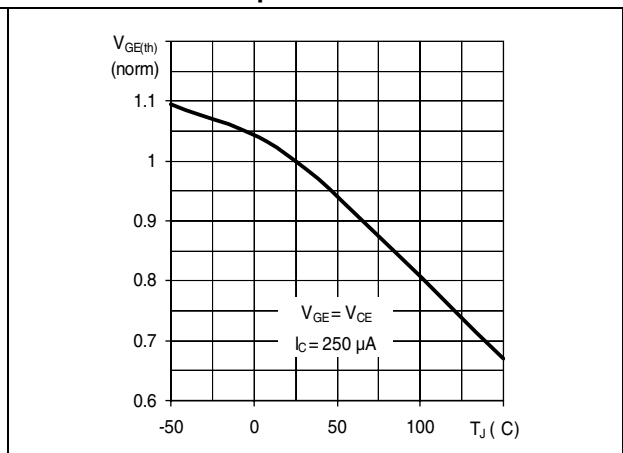


Figure 8. Gate charge vs. gate-emitter voltage

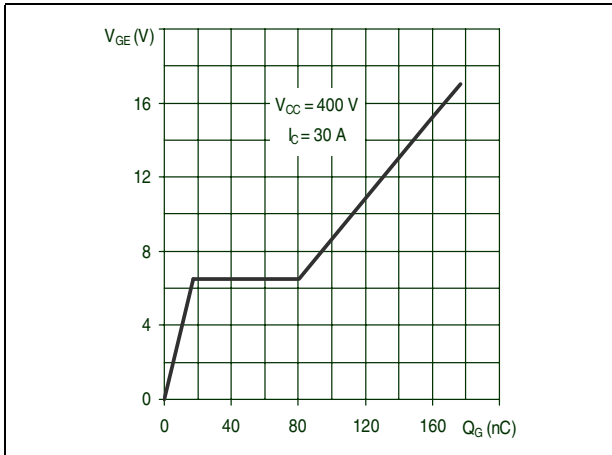


Figure 9. Capacitances variations

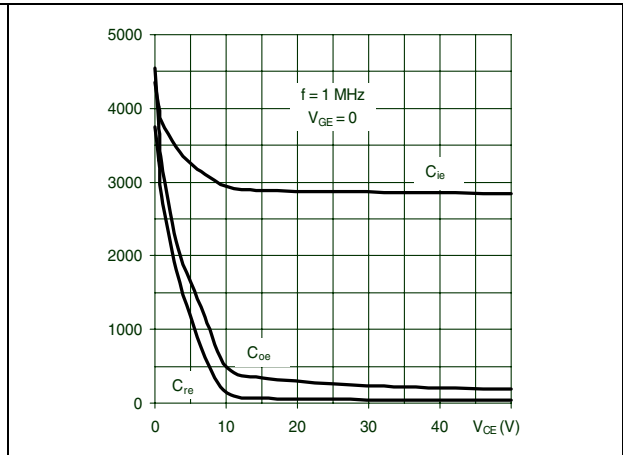


Figure 10. Switching losses vs. temperature

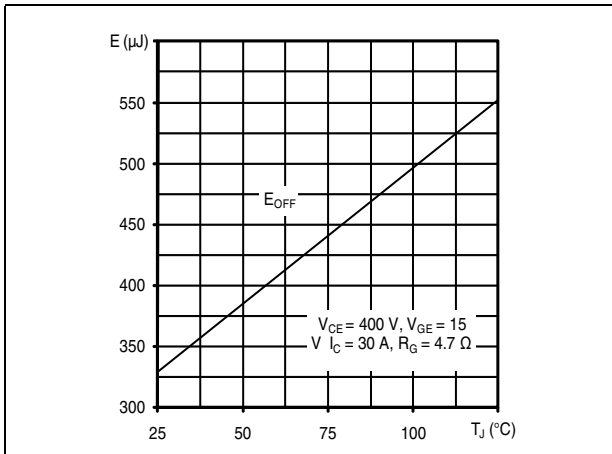


Figure 11. Switching losses vs. gate resistance

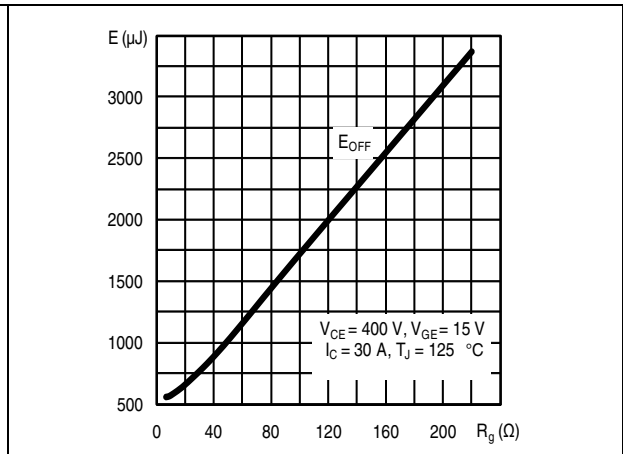


Figure 12. Switching losses vs. collector current

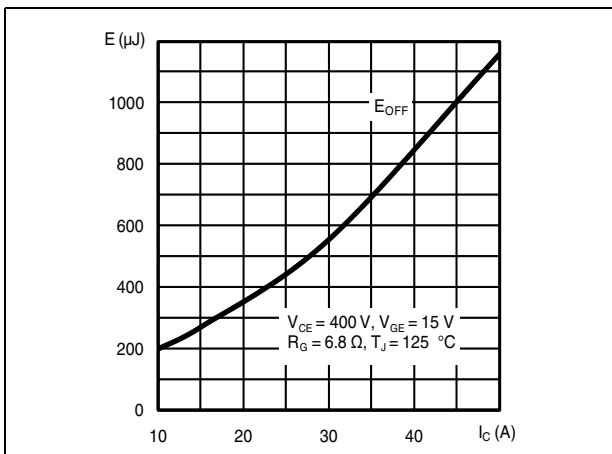


Figure 13. Turn-off SOA

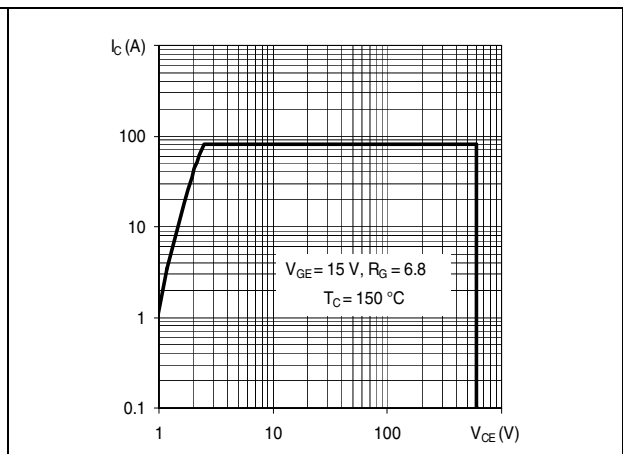


Figure 14. Diode forward on voltage

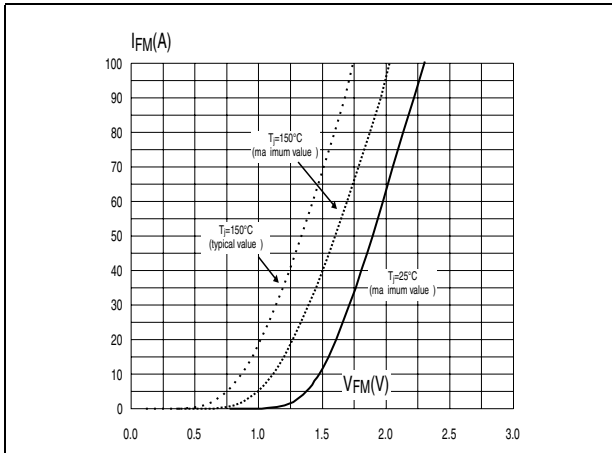


Figure 15. Thermal impedance for TO-247

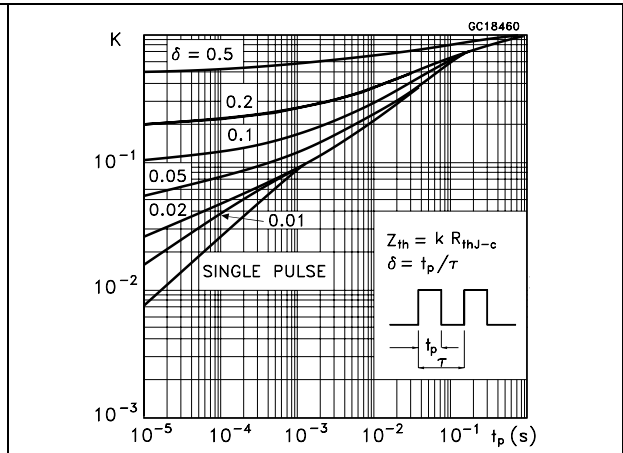
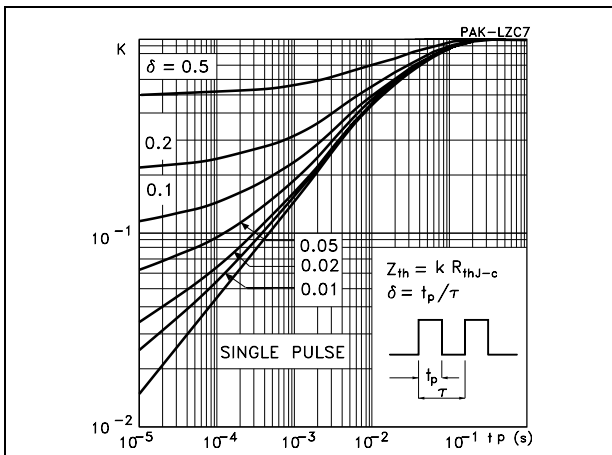


Figure 16. Thermal impedance for TO-247 narrow leads





### 3 Test circuits

Figure 17. Test circuit for inductive load switching

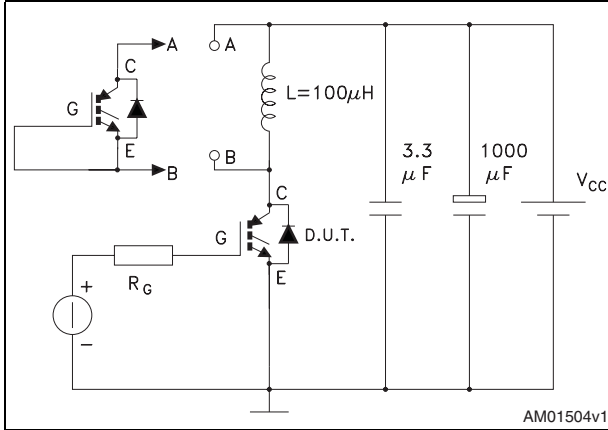


Figure 18. Gate charge test circuit

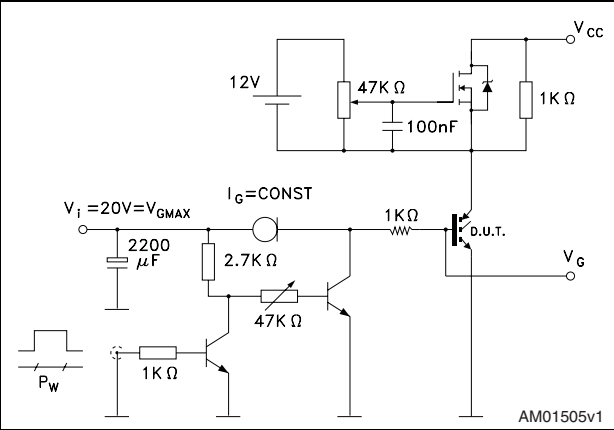


Figure 19. Switching waveform

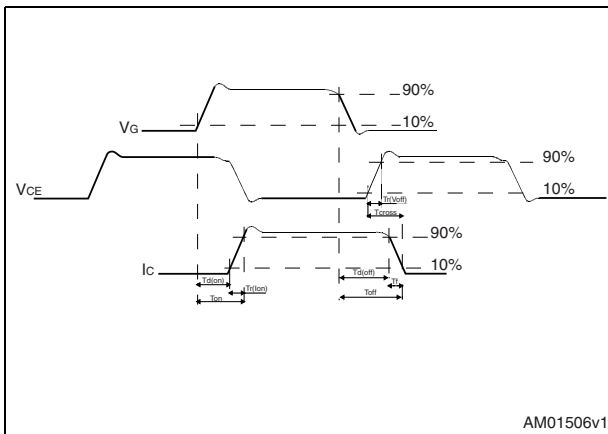
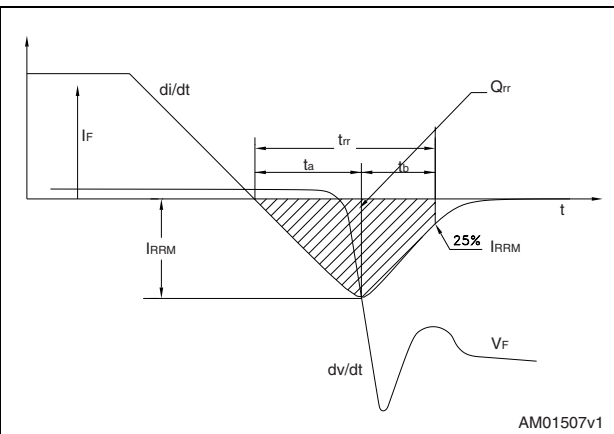


Figure 20. Diode recovery time waveform



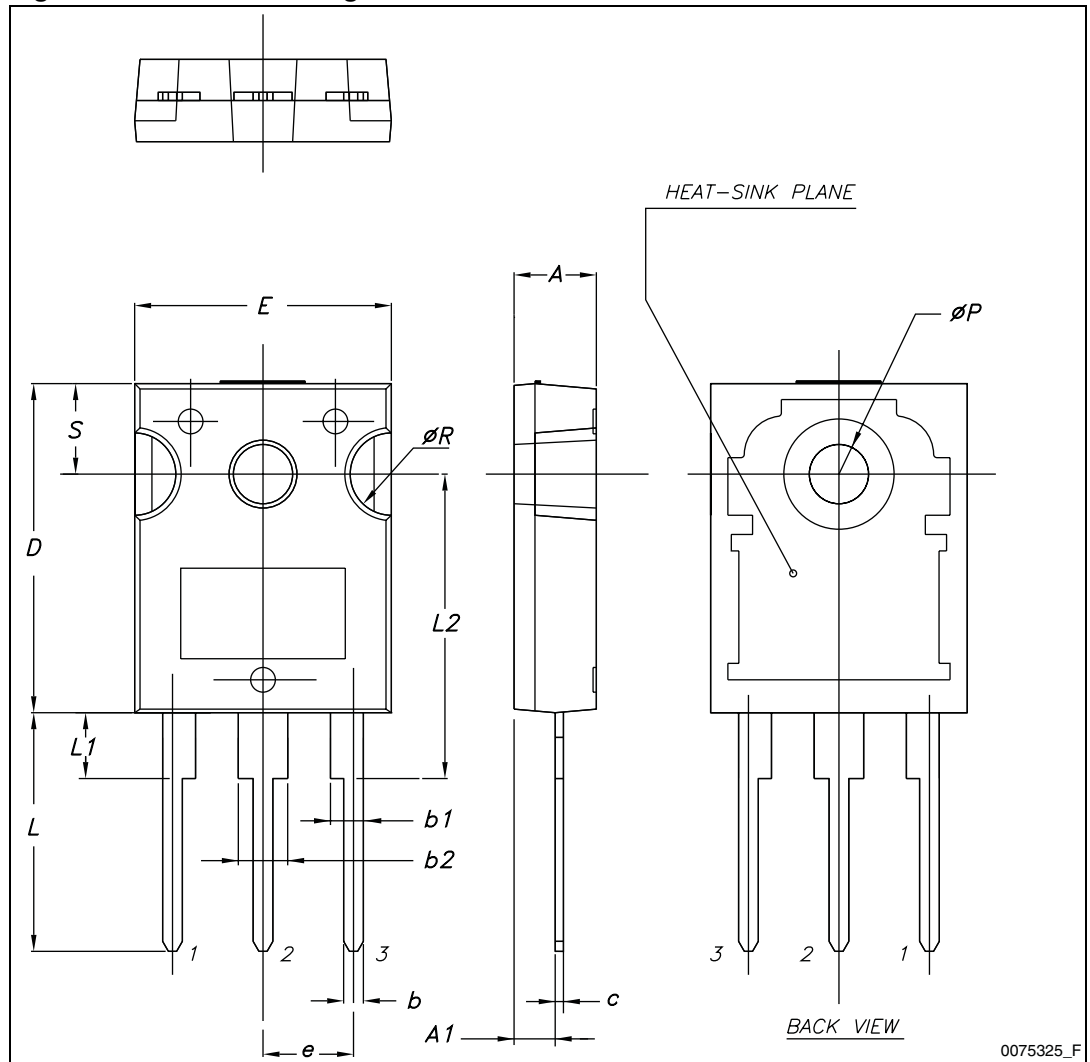
## 4 Package mechanical data

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 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 21. TO-247 drawing

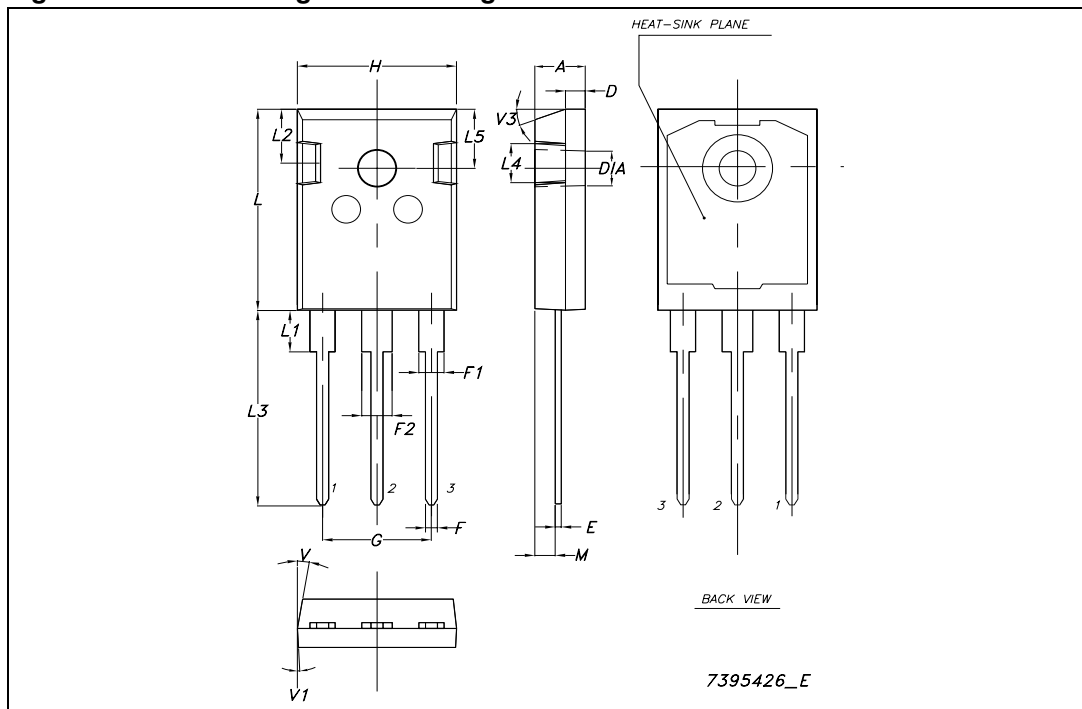


0075325\_F

Table 10. TO-247 long leads mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90		5.15
D	1.85		2.10
E	0.55		0.67
F	1.07		1.32
F1	1.90		2.38
F2	2.87		3.38
G	10.90 BSC		
H	15.77		16.02
L	20.82		21.07
L1	4.16		4.47
L2	5.49		5.74
L3	20.05		20.30
L4	3.68		3.93
L5	6.04		6.29
M	2.27		2.52
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66

Figure 22. TO-247 long leads drawing



## 5 Revision history

**Table 11. Document revision history**

Date	Revision	Changes
04-Aug-2009	1	Initial release.
21-Dec-2010	2	Document status promoted from preliminary data to datasheet. Inserted dynamic parameters on <a href="#">Table 5</a> , <a href="#">Table 6</a> , <a href="#">Table 7</a> and <a href="#">Table 8</a> . Inserted <a href="#">Section 2.1: Electrical characteristics (curves)</a> . Updated TO-247 long leads package mechanical data.

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