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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).

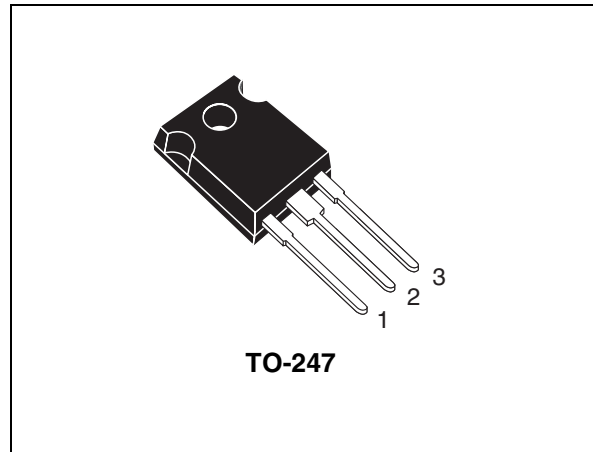


Figure 1. Internal schematic diagram

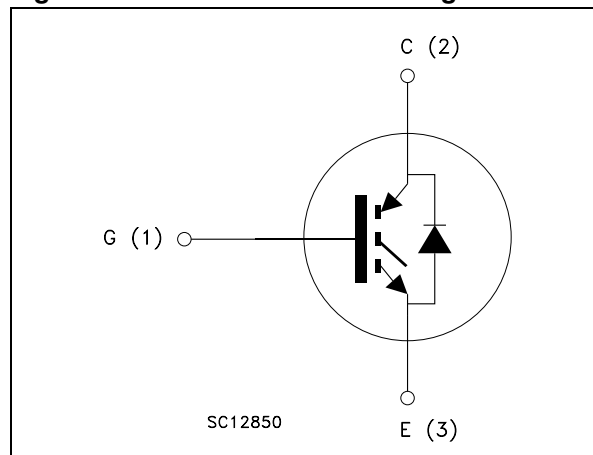


Table 1. Device summary

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

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-247	TO-247 long leads	
V _{CES}	Collector-emitter voltage (V _{GE} = 0)	600		V
I _C ⁽¹⁾	Continuous collector current at T _C = 25 °C	70	80	A
I _C ⁽¹⁾	Continuous collector current at T _C = 100 °C	45	50	A
I _{CP} ⁽²⁾	Pulsed collector current	150		A
I _{CL} ⁽³⁾	Turn-off latching current	80		A
V _{GE}	Gate-emitter voltage	± 20		V
I _F	Diode RMS forward current at T _C = 25 °C	30		A
I _{FSM}	Surge not repetitive forward current t _p = 10 ms sinusoidal	130		A
P _{TOT}	Total dissipation at T _C = 25 °C	250	310	W
T _{stg}	Storage temperature	- 55 to 150		°C
T _j	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_{CLAMP} = 80% (V_{CES}), V_{GE} = 15 V, R_G = 10 Ω, T_J = 150 °C

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		TO-247	TO-247 long leads	
R _{thj-case}	Thermal resistance junction-case IGBT	0.5	0.4	°C/W
	Thermal resistance junction-case diode	1.5		°C/W
R _{thj-amb}	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	μA mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 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	Figure 18		65		nC

Table 6. Switching off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$, $R_{GE} = 4.7\ \Omega$, $V_{GE} = 15\text{ V}$ Figure 17	-	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	$V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$, $R_{GE} = 4.7\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ °C}$ Figure 17	-	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		μJ
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	μJ

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

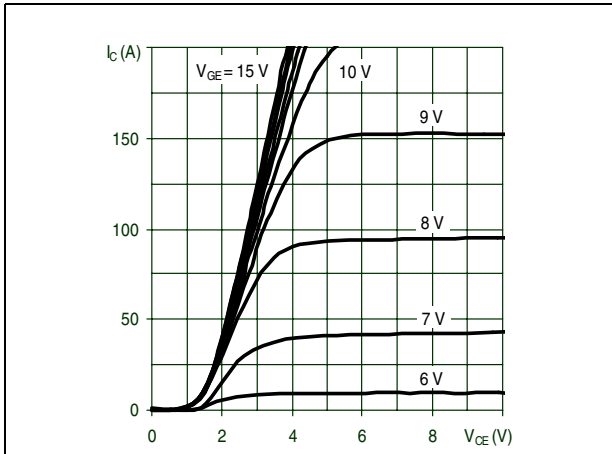


Figure 3. Transfer characteristics

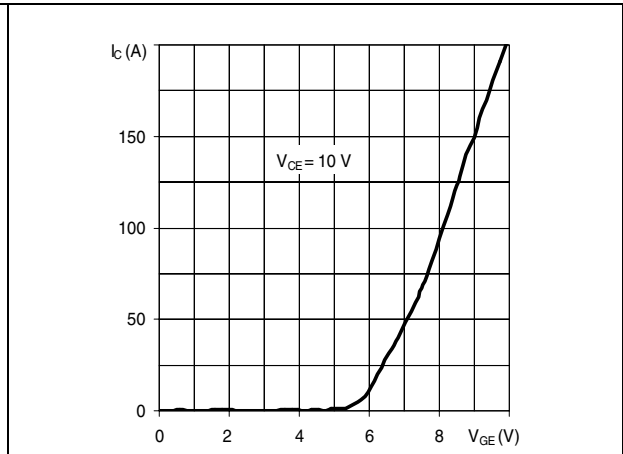


Figure 4. Normalized $V_{CE(sat)}$ vs. I_c

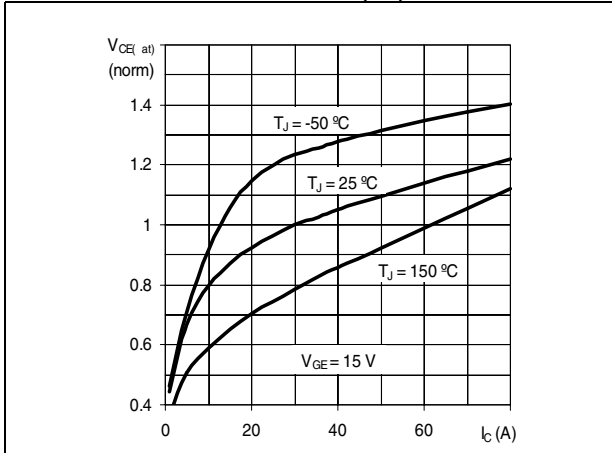


Figure 5. Normalized $V_{CE(sat)}$ vs. temperature

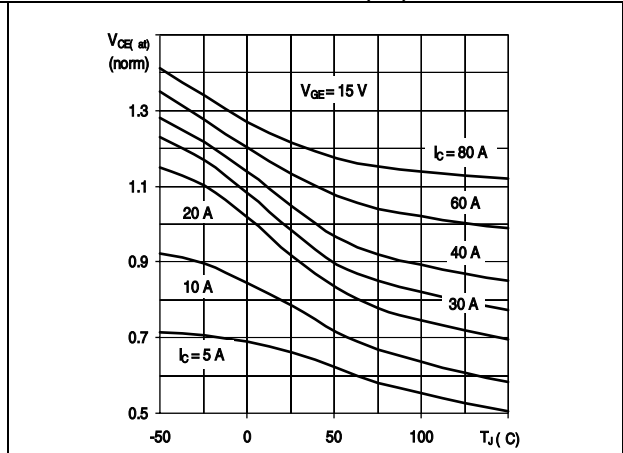


Figure 6. Normalized breakdown voltage vs. temperature

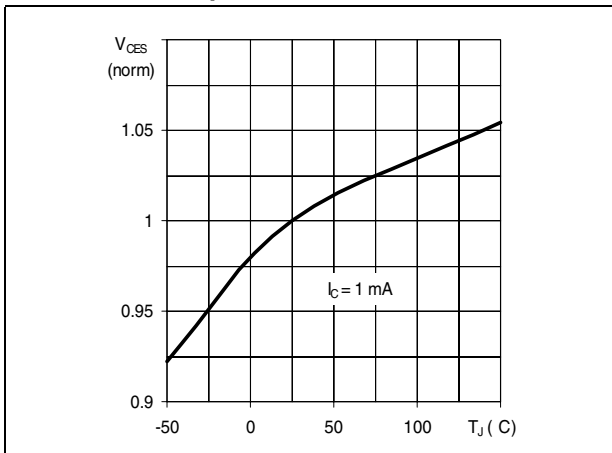


Figure 7. Normalized gate threshold voltage vs. temperature

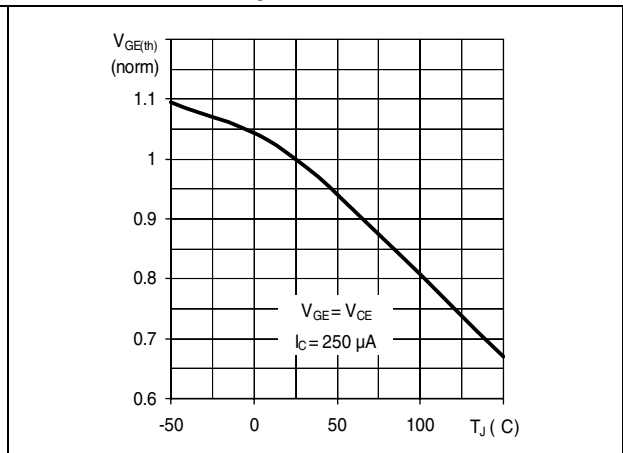


Figure 8. Gate charge vs. gate-emitter voltage

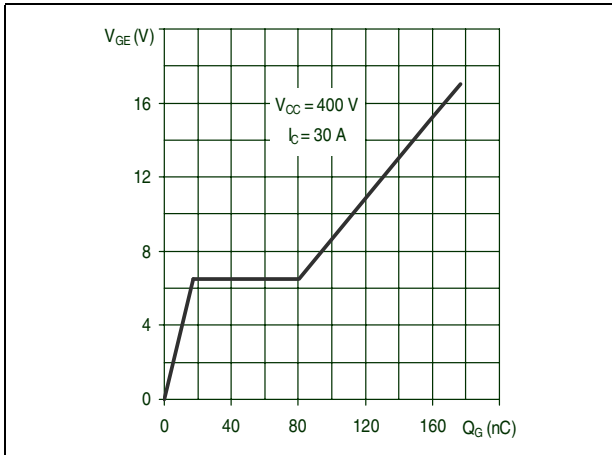


Figure 9. Capacitances variations

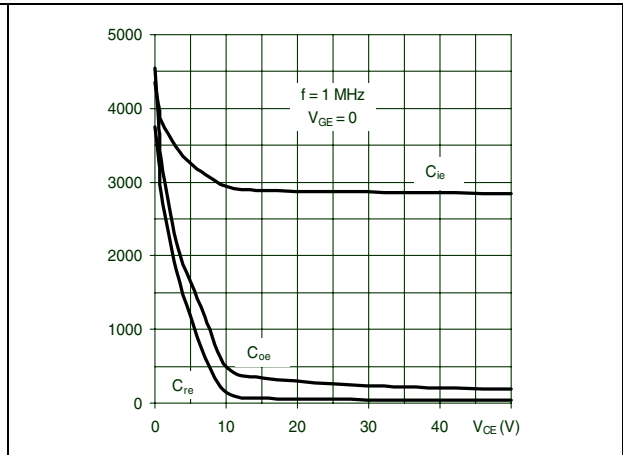


Figure 10. Switching losses vs. temperature

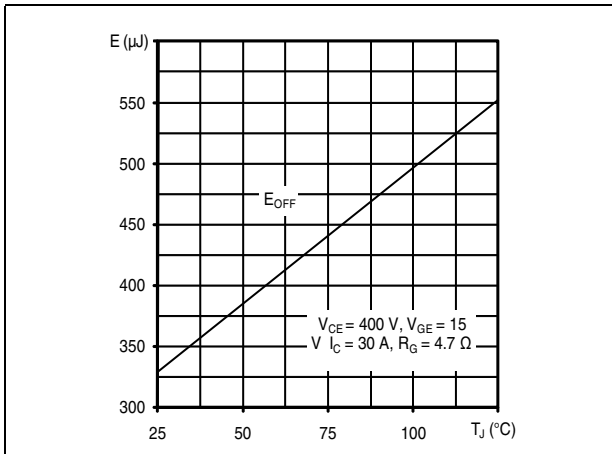


Figure 11. Switching losses vs. gate resistance

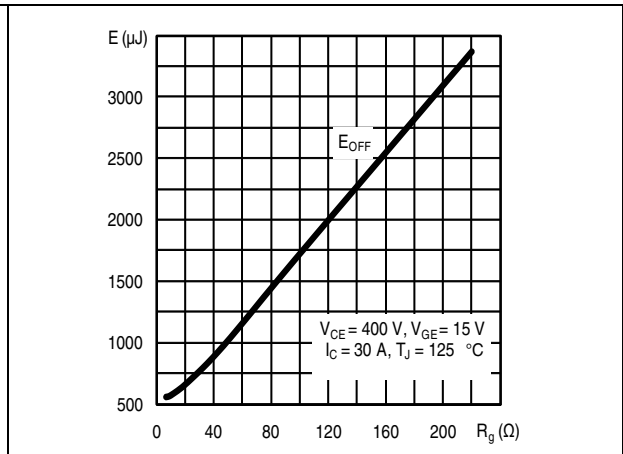


Figure 12. Switching losses vs. collector current

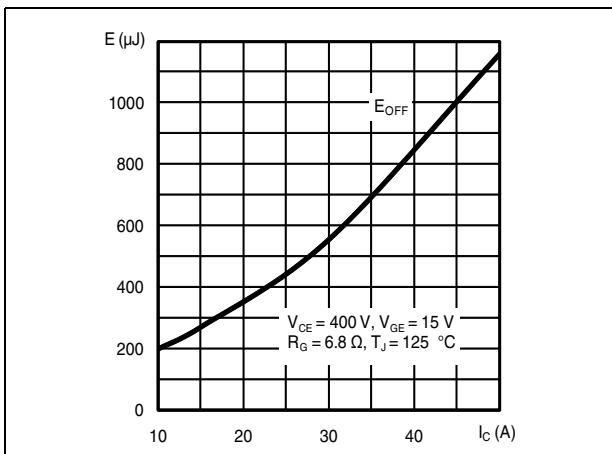


Figure 13. Turn-off SOA

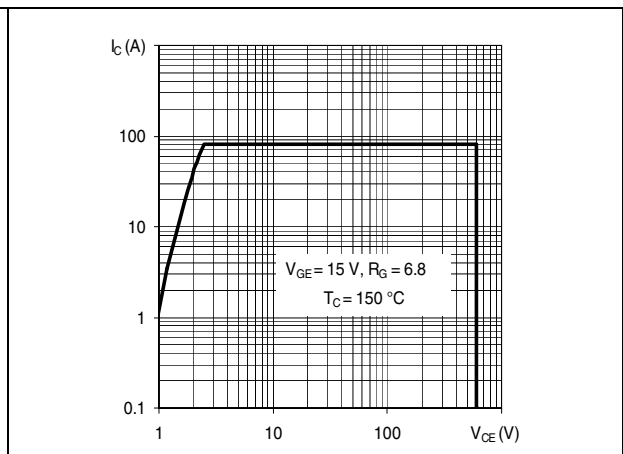


Figure 14. Diode forward on voltage

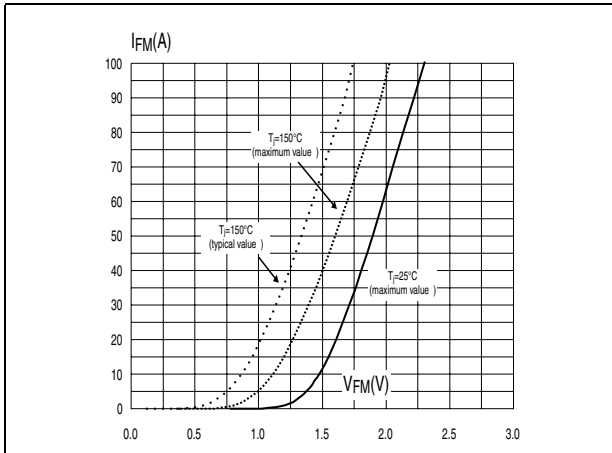


Figure 15. Thermal impedance for TO-247

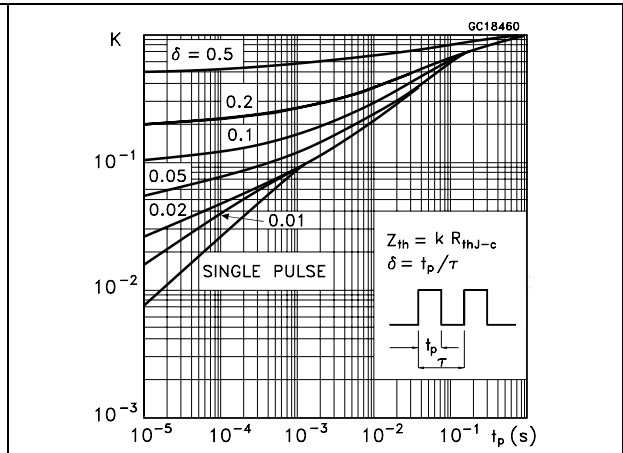
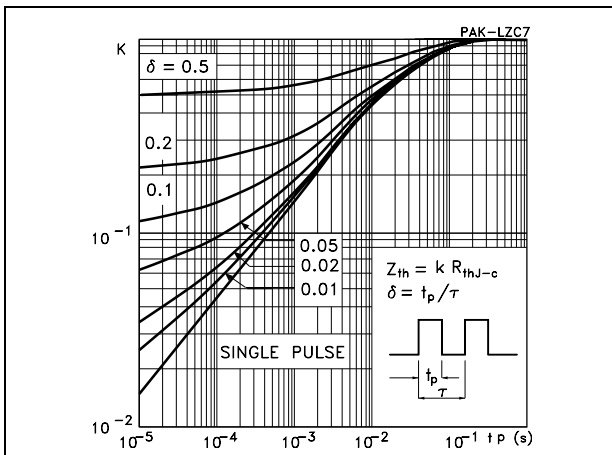


Figure 16. Thermal impedance for TO-247 narrow leads



3 Test circuits

Figure 17. Test circuit for inductive load switching

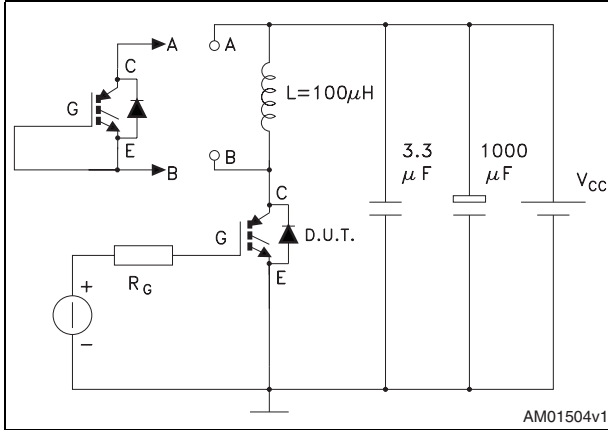


Figure 18. Gate charge test circuit

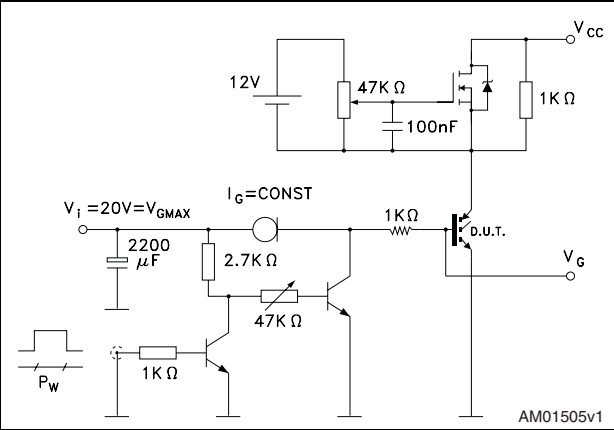


Figure 19. Switching waveform

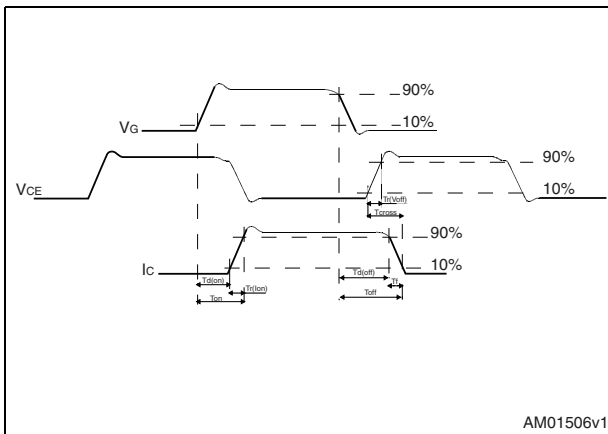
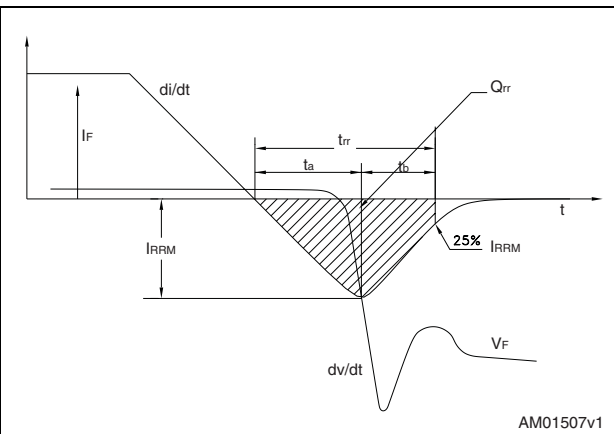


Figure 20. Diode recovery time waveform



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. 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

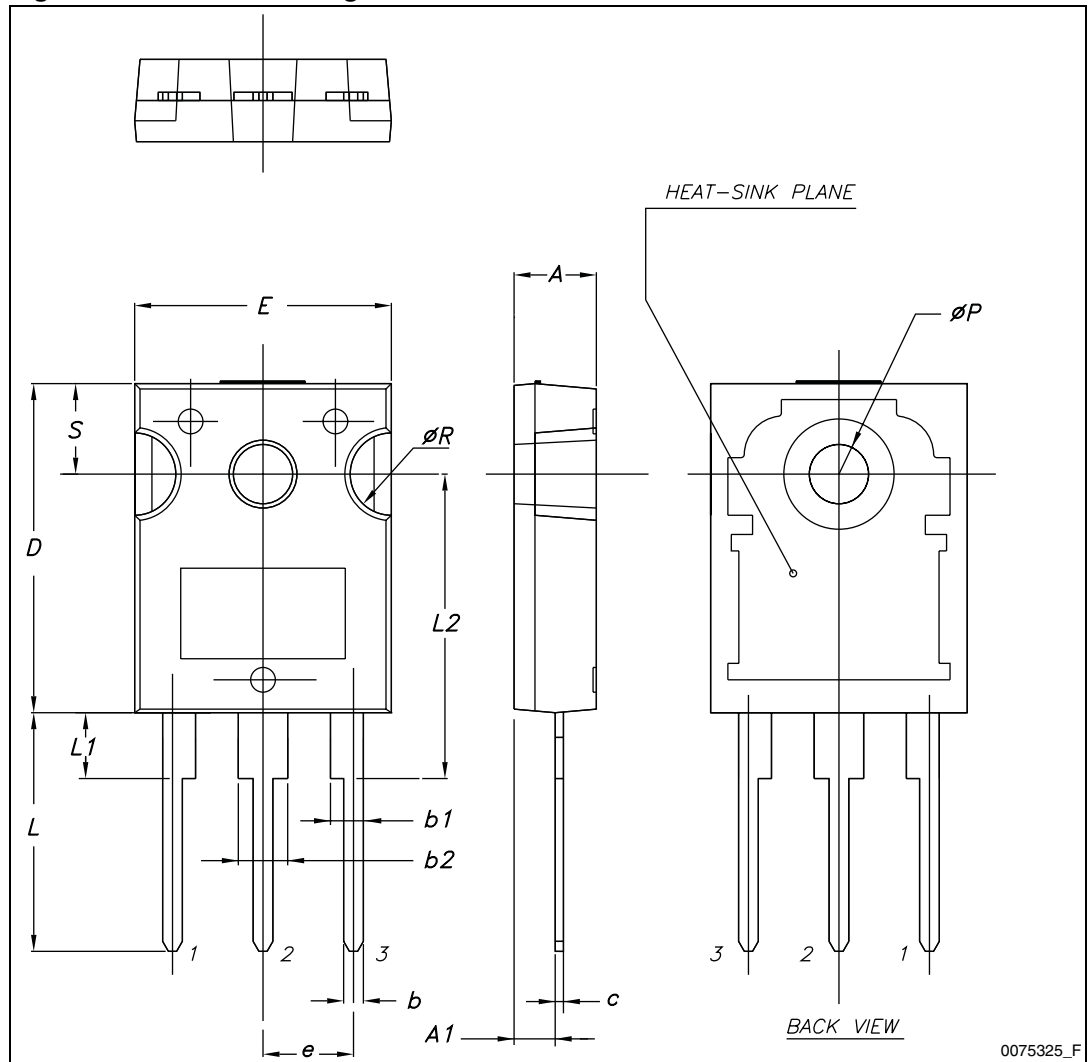
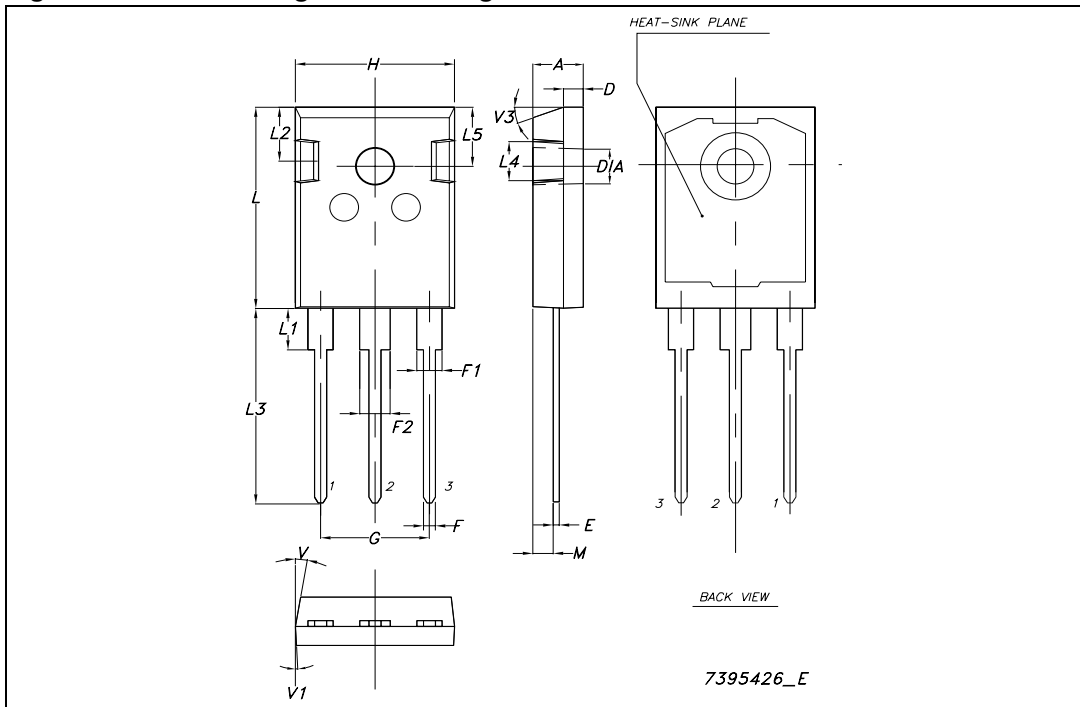


Table 10. TO-247 long leads mechanical data

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 Table 5 , Table 6 , Table 7 and Table 8 . Inserted Section 2.1: Electrical characteristics (curves) . Updated TO-247 long leads package mechanical data.

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