

## 35 A, 600 V ultrafast IGBT with low drop diode

### Features

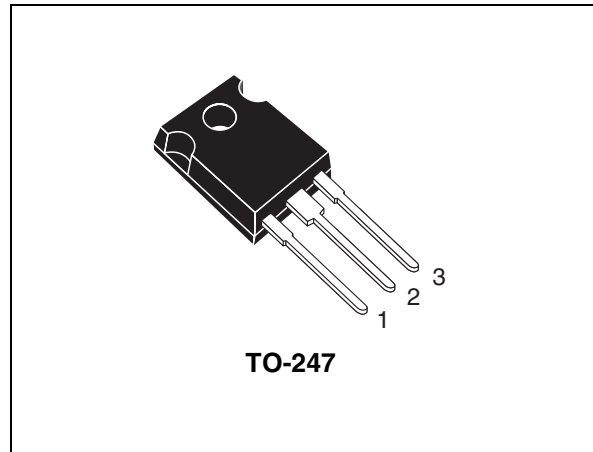
- Improved  $E_{off}$  at elevated temperature
- Low  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Low  $V_F$  soft recovery antiparallel diode

### Applications

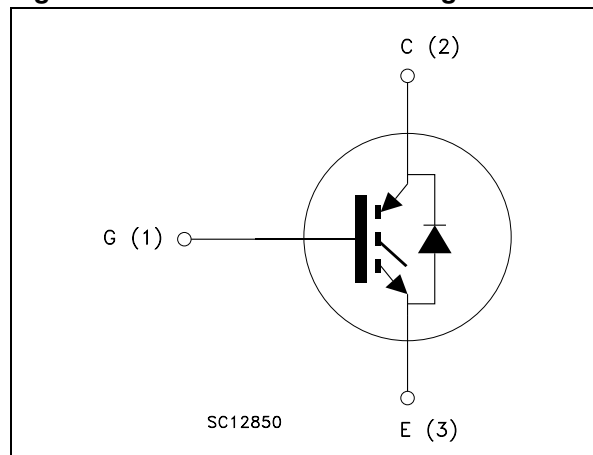
- Welding
- Induction heating
- Resonant converters

### Description

This ultrafast IGBT is developed using a new planar technology to yield a device with tighter switching energy variation ( $E_{off}$ ) versus temperature. The suffix "W" denotes a subset of products designed for high switching frequency operation (over 100 kHz).



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Order code	Marking	Package	Packaging
STGW35HF60WDI	GW35HF60WDI	TO-247	Tube
STGWA35HF60WDI	35HF60WDI	TO-247 long leads	

# Contents

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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	60	70	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100 °C	35	40	A
I <sub>CL</sub> <sup>(2)</sup>	Turn-off latching current	80		A
I <sub>CP</sub> <sup>(3)</sup>	Pulsed collector current	150		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 non 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	200	260	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	0.63	0.48	°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	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 125\text{ °C}$		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 ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$			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
$C_{ies}$ $C_{oes}$ $C_{res}$	Input capacitance Output capacitance Reverse transfer capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	2400 235 50	-	pF pF pF
$Q_g$ $Q_{ge}$ $Q_{gc}$	Total gate charge Gate-emitter charge Gate-collector charge	$V_{CE} = 390\text{ V}, I_C = 20\text{ A},$ $V_{GE} = 15\text{ V},$ (see <a href="#">Figure 17</a> )	-	140 13 52	-	nC nC 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	$V_{CC} = 390\text{ V}, I_C = 20\text{ A}$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V},$ (see <a href="#">Figure 16</a> )	-	30 15 1650	-	ns ns A/ $\mu\text{s}$
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390\text{ V}, I_C = 20\text{ A}$ $R_G = 10\ \Omega, V_{GE} = 15\text{ V},$ $T_J = 125\text{ °C}$ (see <a href="#">Figure 16</a> )	-	30 15 1600	-	ns ns A/ $\mu\text{s}$

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

$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 16</a> )	-	30	-	ns
$t_{d(off)}$	Turn-off delay time		-	175	-	ns
$t_f$	Current fall time		-	40	-	ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 16</a> )	-	50	-	ns
$t_{d(off)}$	Turn-off delay time		-	225	-	ns
$t_f$	Current fall time		-	70	-	ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{off}$	Turn-off switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see <a href="#">Figure 18</a> )	-	185		$\mu\text{J}$
$E_{off}$	Turn-off switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , (see <a href="#">Figure 18</a> )	-	350	530	$\mu\text{J}$

**Table 8. Collector-emitter diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	1.3 1.1	1.7	V V
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 50\text{ V}$ ,	-	85	-	ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	240	-	nC
$I_{rrm}$	Reverse recovery current	(see <a href="#">Figure 19</a> )	-	5.2	-	A
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 50\text{ V}$ ,	-	230	-	ns
$Q_{rr}$	Reverse recovery charge	$T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$	-	930	-	nC
$I_{rrm}$	Reverse recovery current	(see <a href="#">Figure 19</a> )	-	8.7	-	A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

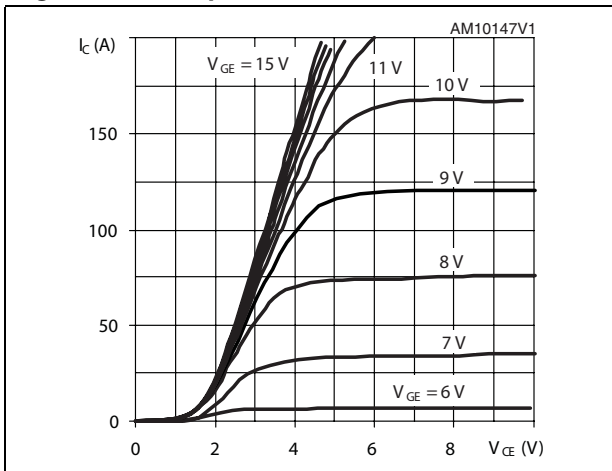


Figure 3. Transfer characteristics

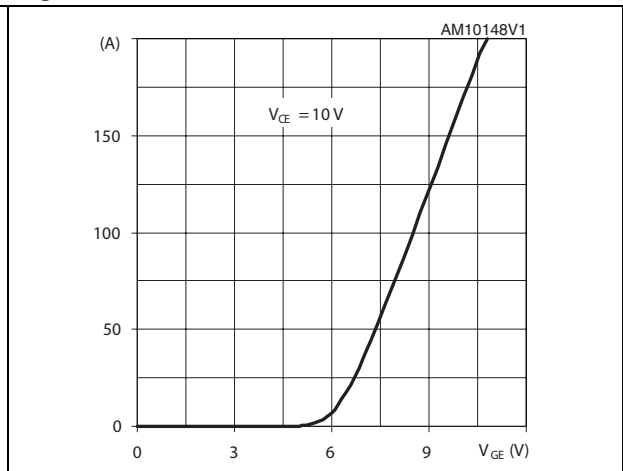


Figure 4. Normalized  $V_{CE(sat)}$  vs.  $I_C$

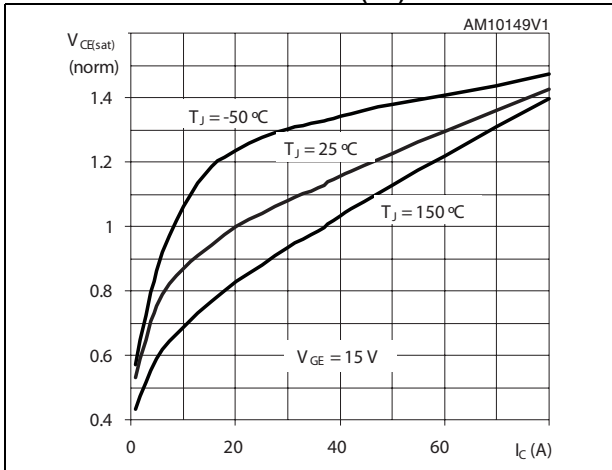


Figure 5. Normalized  $V_{CE(sat)}$  vs. temperature

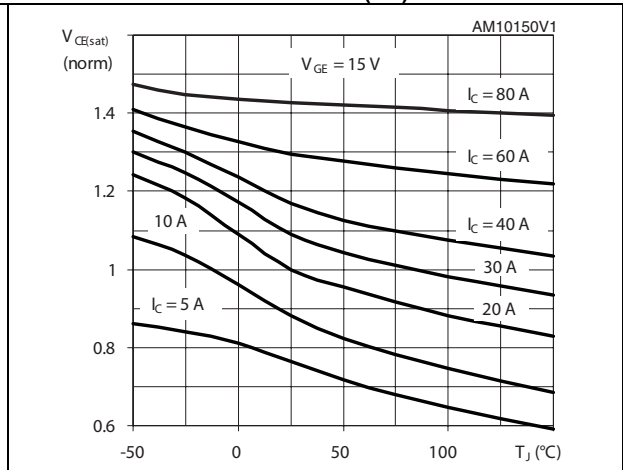


Figure 6. Normalized breakdown voltage vs. temperature

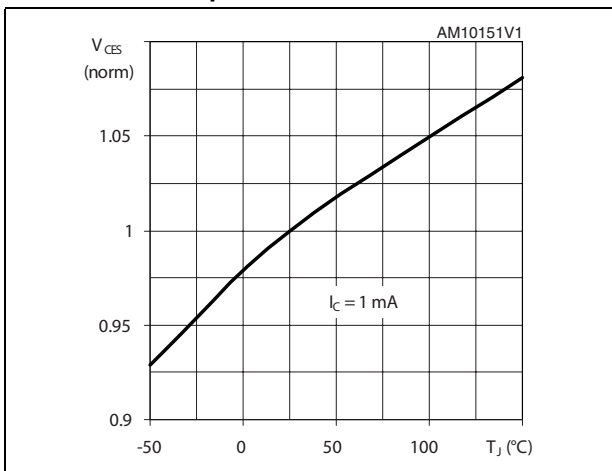


Figure 7. Normalized gate threshold voltage vs. temperature

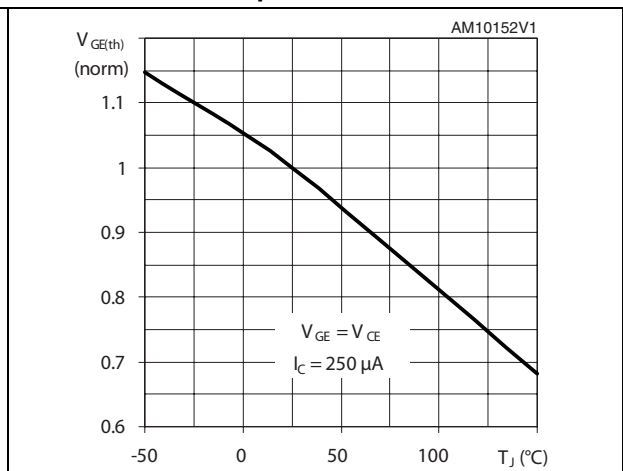


Figure 8. Gate charge vs. gate-emitter voltage

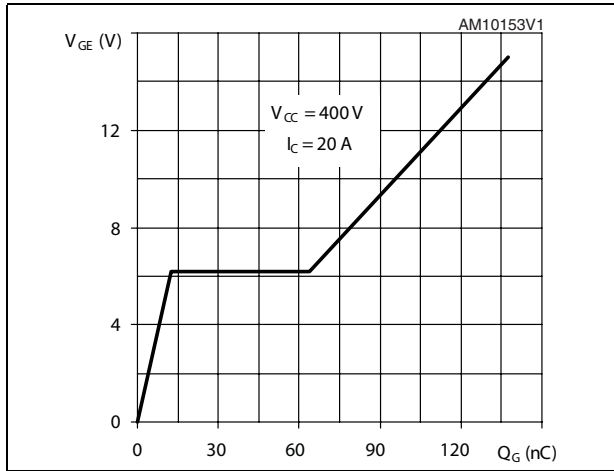


Figure 9. Capacitance variations

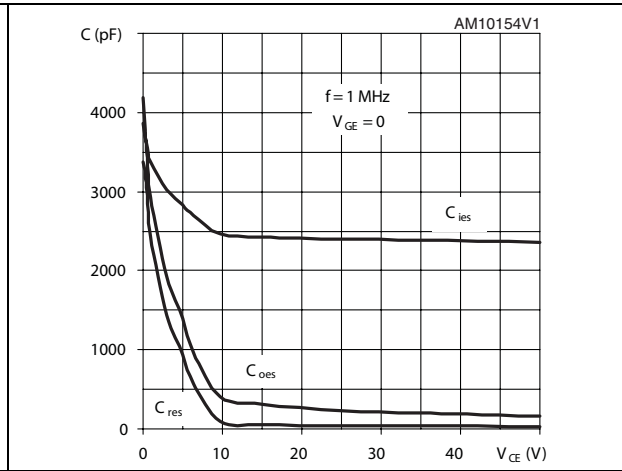


Figure 10. Switching losses vs temperature

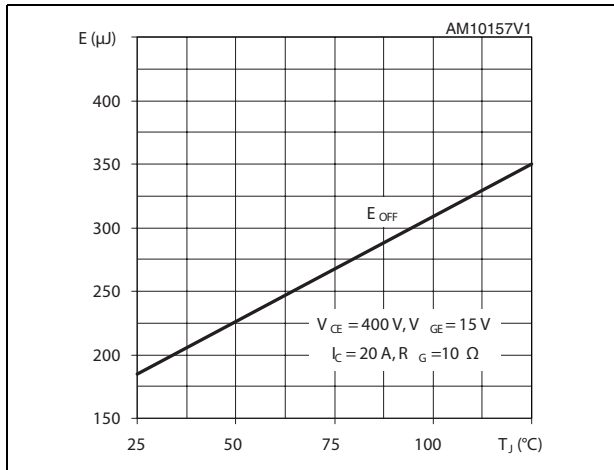


Figure 11. Switching losses vs gate resistance

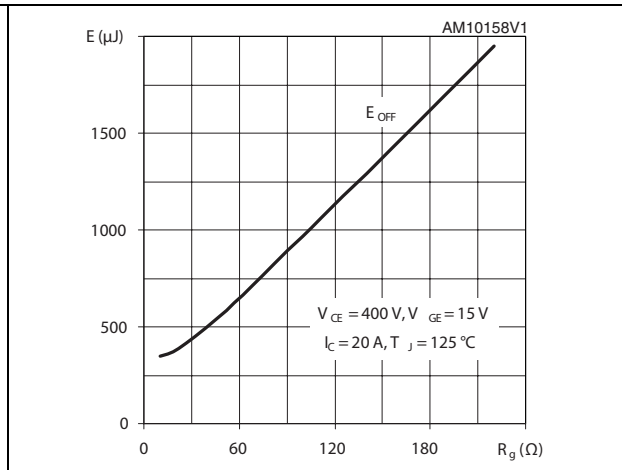


Figure 12. Switching losses vs collector current

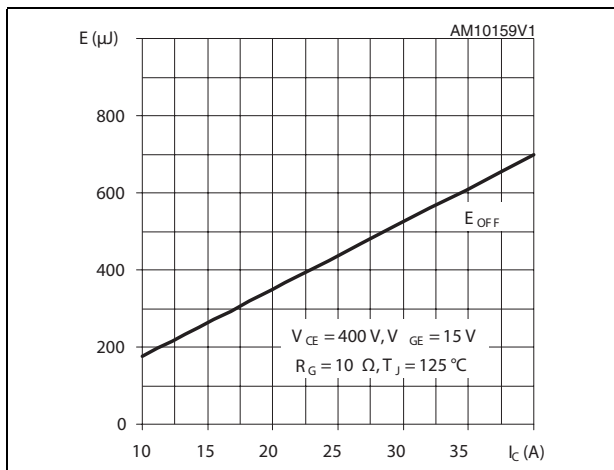


Figure 13. Diode forward on voltage

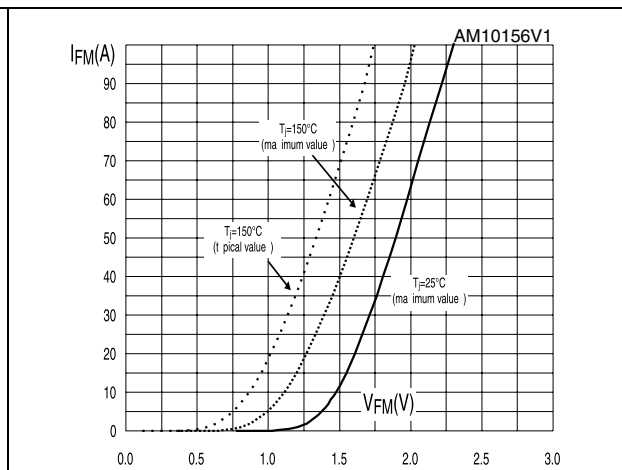


Figure 14. Turn-off SOA

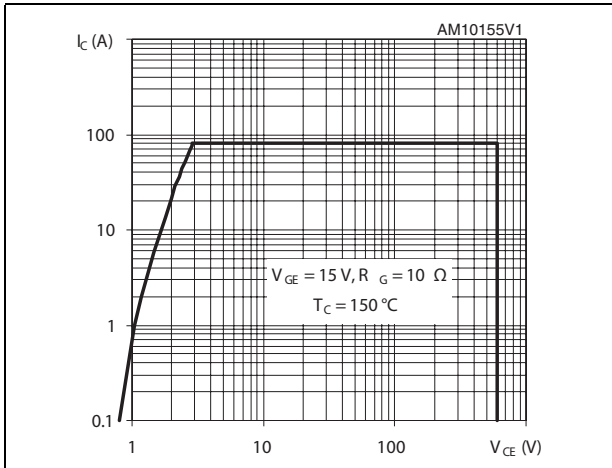
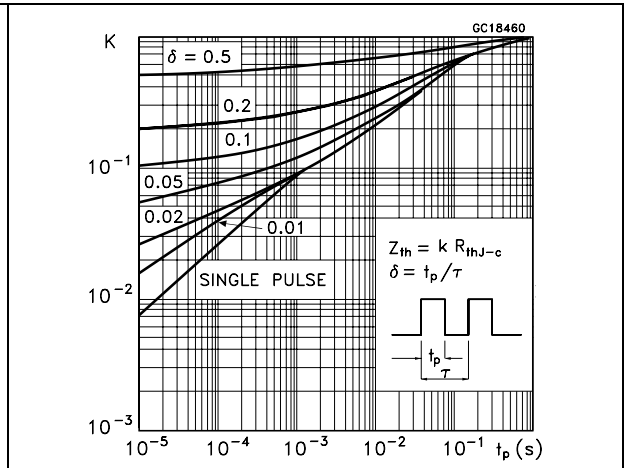


Figure 15. Thermal impedance





### 3 Test circuits

Figure 16. Test circuit for inductive load switching

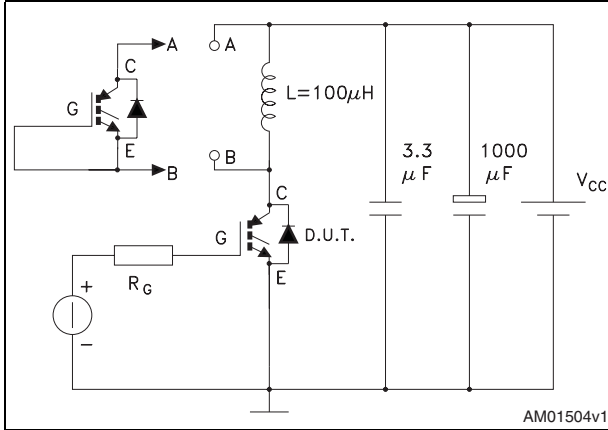


Figure 17. Gate charge test circuit

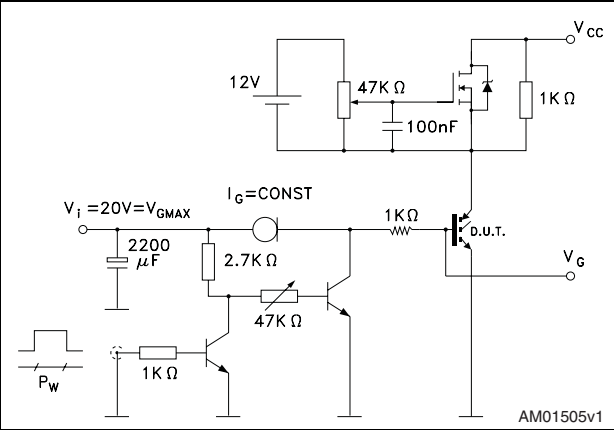


Figure 18. Switching waveform

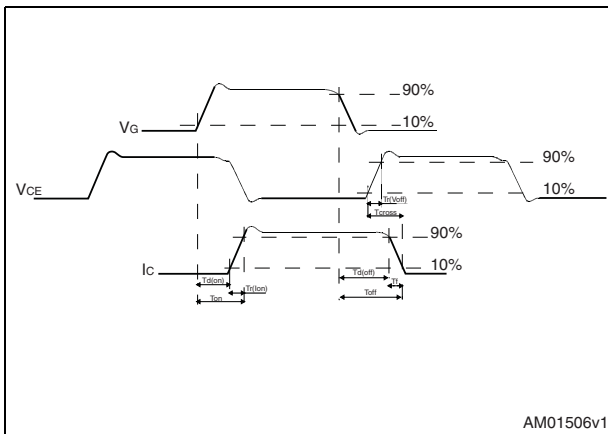
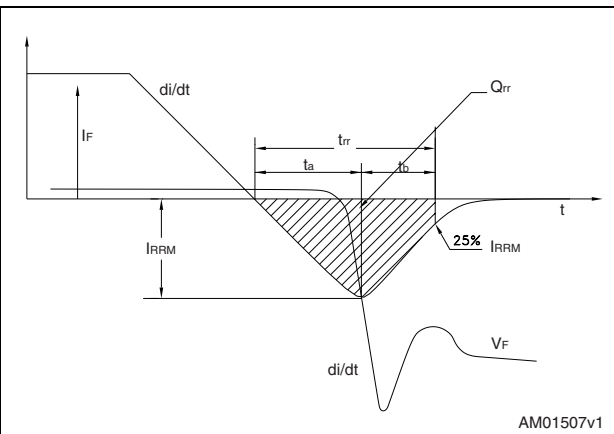


Figure 19. Diode recovery time waveform



## 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 20. TO-247 drawing

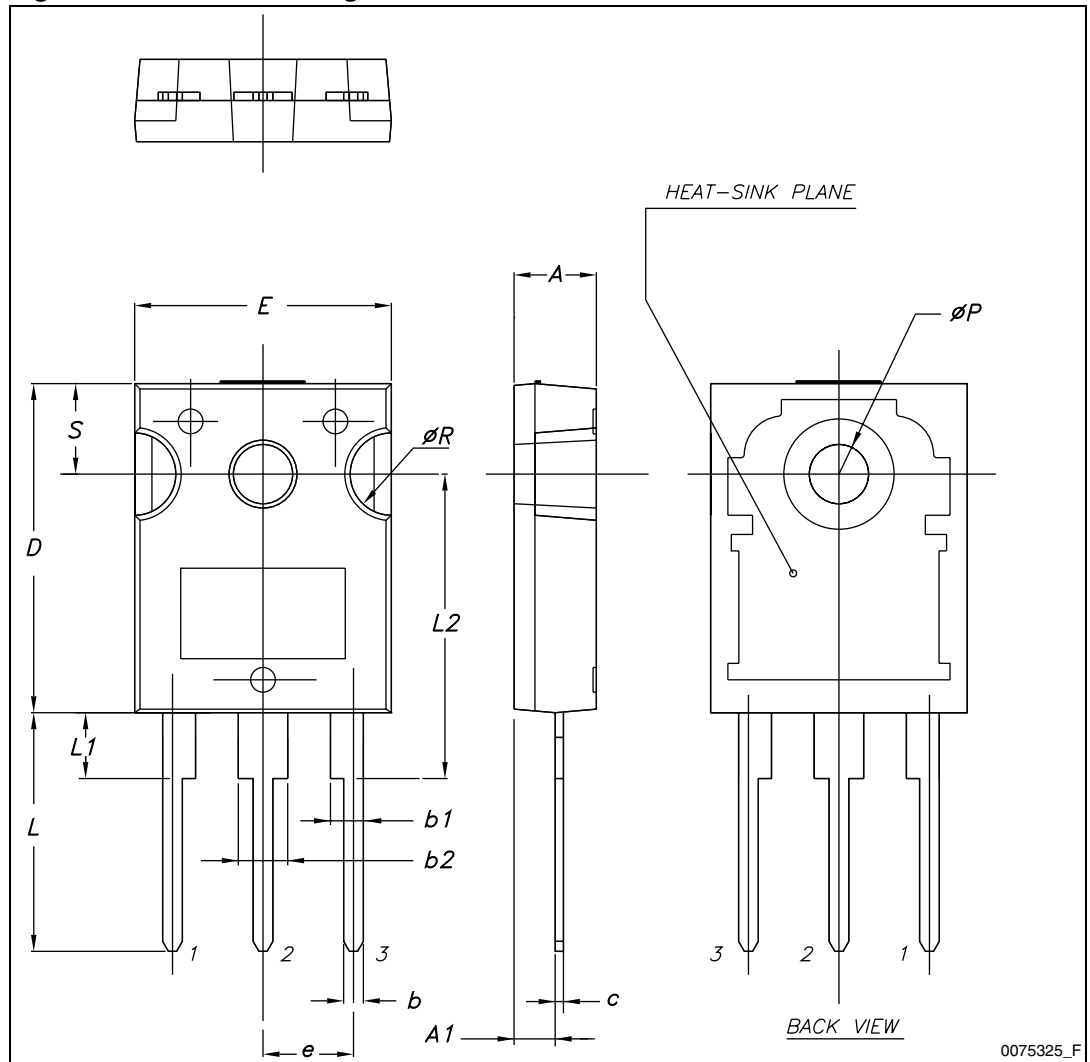
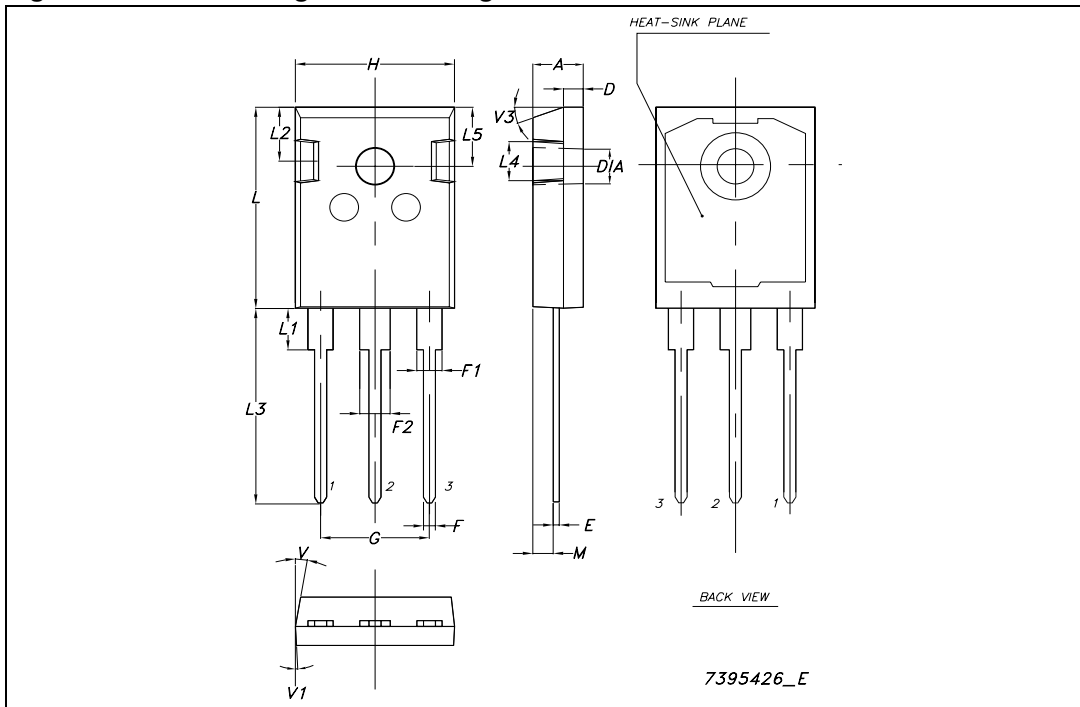


Table 10. TO-247 long leads mechanical data

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 21. TO-247 long leads drawing



## 5 Revision history

Table 11. Document revision history

Date	Revision	Changes
03-Aug-2009	1	Initial release.
02-Sep-2009	2	Minor text changes throughout the document Removed watermark.
25-Aug-2011	3	Inserted new <a href="#">Section 2.1: Electrical characteristics (curves)</a> . Updated <a href="#">Section 4: Package mechanical data</a> . Minor text changes.

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