

### Features

- Improved  $E_{off}$  at elevated temperature
- Minimal tail current
- Low conduction losses
- $V_{CE(sat)}$  classified for easy parallel connection
- Ultra fast soft recovery antiparallel diode

### Applications

- Welding
- High frequency converters
- Power factor correction

### Description

The STGW35HF60WD 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).

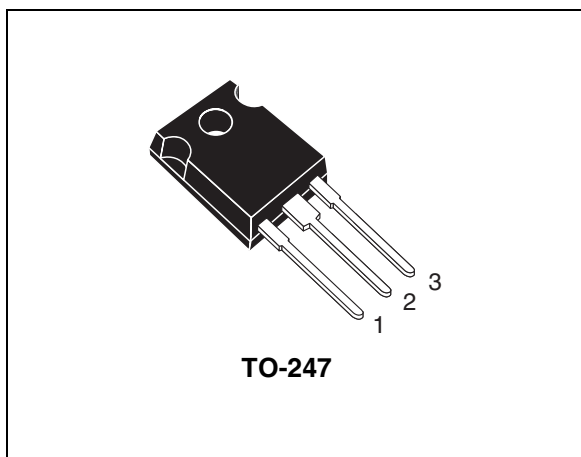


Figure 1. Internal schematic diagram

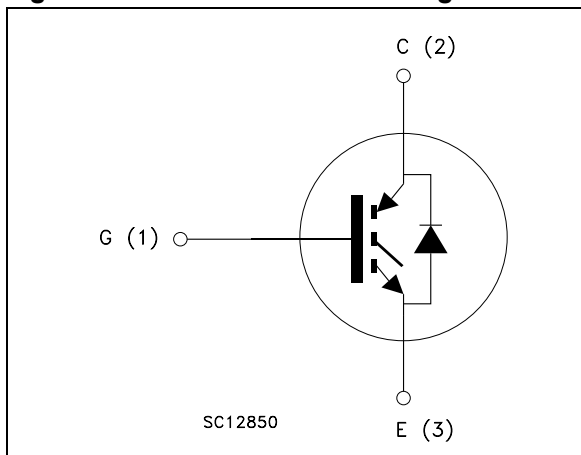


Table 1. Device summary

Order code	Marking <sup>(1)</sup>	Package	Packaging
STGW35HF60WD	GW35HF60WDA	TO-247	Tube
	GW35HF60WDB		
	GW35HF60WDC		

1. Collector-emitter saturation voltage is classified in group A, B and C, see [Table 5: VCE\(sat\) classification](#). STMicroelectronics reserves the right to ship from any group according to production availability.

# 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 $T_C = 25\text{ °C}$	60	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	35	A
$I_{CP}^{(2)}$	Pulsed collector current	150	A
$I_{CL}^{(3)}$	Turn-off latching current	80	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	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
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	200	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.  $V_{CLAMP} = 80\% (V_{CES})$ ,  $V_{GE} = 15\text{ V}$ ,  $R_G = 10\text{ }\Omega$ ,  $T_J = 150\text{ °C}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.63	°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	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$			2.5	V
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 125\text{ °C}$		1.65		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 1\text{ mA}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$			250	$\mu\text{A}$
		$V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$			1	mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA

**Table 5.  $V_{CE(sat)}$  classification**

Symbol	Parameter	Group	Value		Unit
			Min.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$	A	1.68	1.92	V
		B	1.88	2.17	
		C	2.13	2.50	

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	2400	-	$\mu\text{F}$
$C_{oes}$	Output capacitance			235		$\mu\text{F}$
$C_{res}$	Reverse transfer capacitance			50		$\mu\text{F}$
$Q_g$	Total gate charge	$V_{CE} = 400\text{ V}, I_C = 20\text{ A},$	-	140	-	nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{ V},$		13		nC
$Q_{gc}$	Gate-collector charge	(see <a href="#">Figure 17</a> )		52		nC

**Table 7. 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	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see <a href="#">Figure 16</a> )	-	30 15 1650	-	ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 16</a> )	-	30 15 1600	-	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	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 16</a> )	-	30 175 40	-	ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 16</a> )	-	50 225 70	-	ns ns ns

**Table 8. Switching energy (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$ $E_{off}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see <a href="#">Figure 18</a> )	-	290 185 475		$\mu$ J $\mu$ J $\mu$ J
$E_{on}^{(1)}$ $E_{off}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 18</a> )	-	420 350 770	530	$\mu$ 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-pak diode, the co-pak diode is used as external diode. IGBTs and diode are at the same temperature (25 °C and 125 °C).  $E_{on}$  include diode recovery energy.

**Table 9. Collector-emitter diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	1.8 1.4	2.25	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 20\text{ A}$ , $V_R = 50\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see <a href="#">Figure 19</a> )	-	50 90 3	-	ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 20\text{ A}$ , $V_R = 50\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ (see <a href="#">Figure 19</a> )	-	135 375 5.5	-	ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

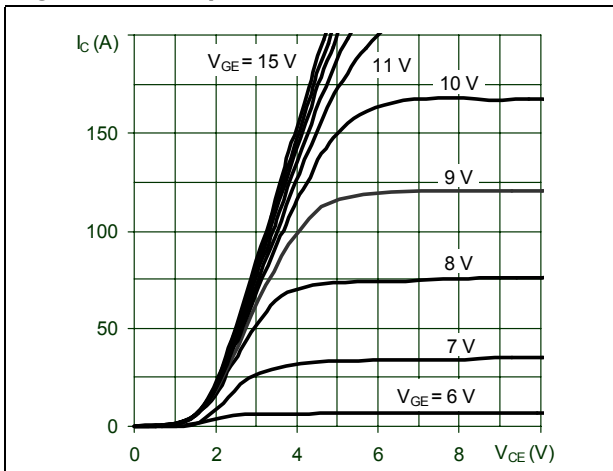


Figure 3. Transfer characteristics

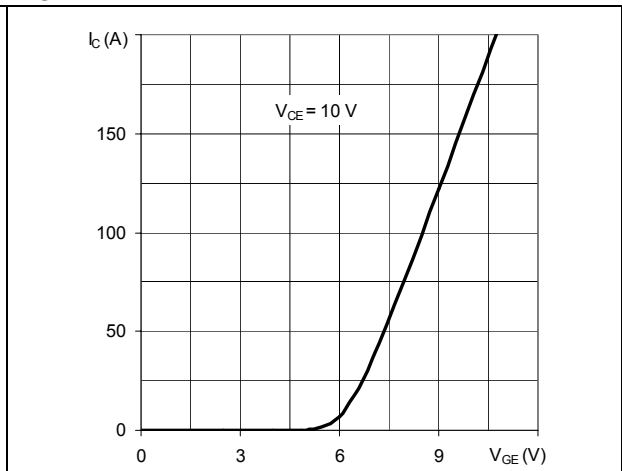


Figure 4. Normalized  $V_{CE(sat)}$  vs.  $I_C$

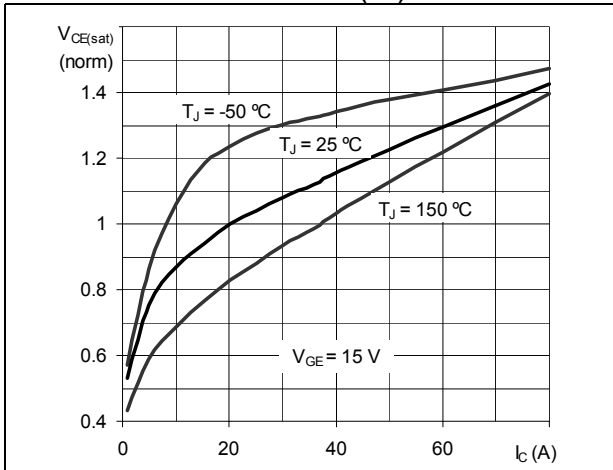


Figure 5. Normalized  $V_{CE(sat)}$  vs. temperature

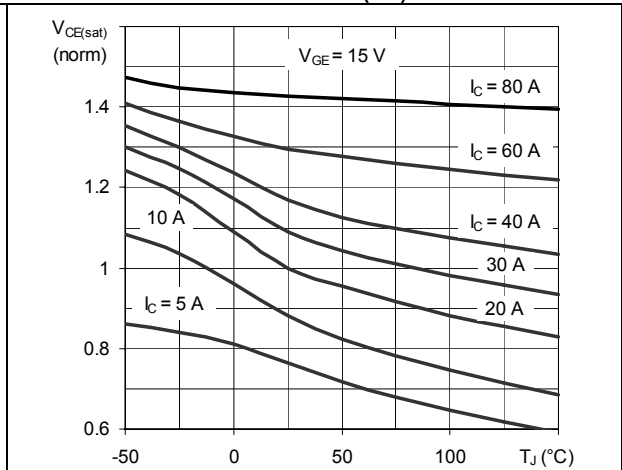


Figure 6. Normalized breakdown voltage vs. temperature

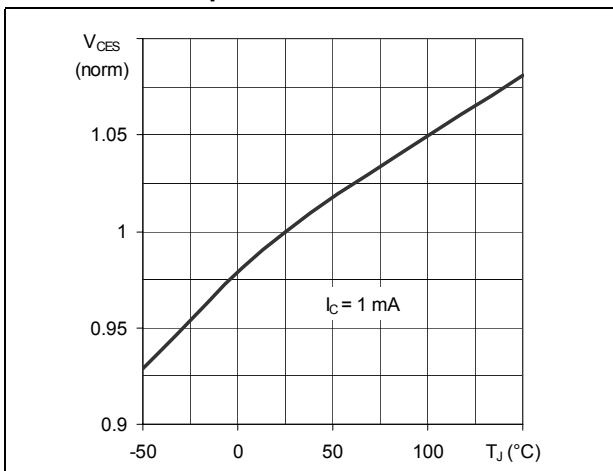
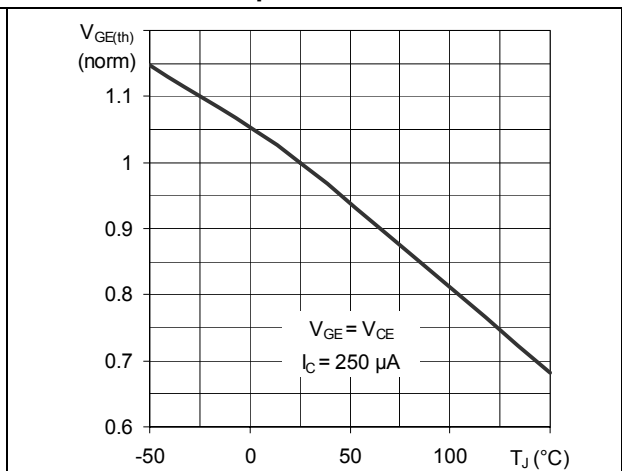
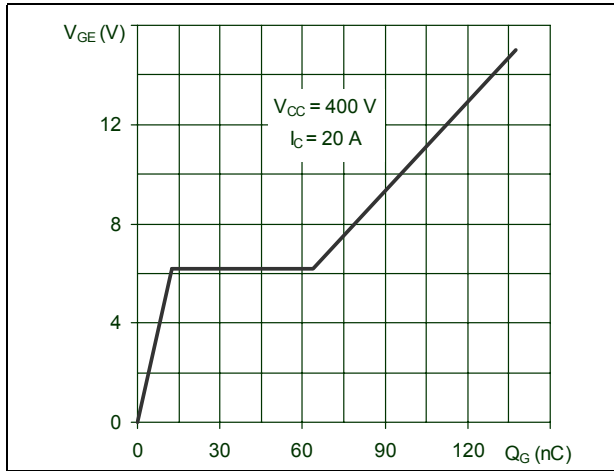


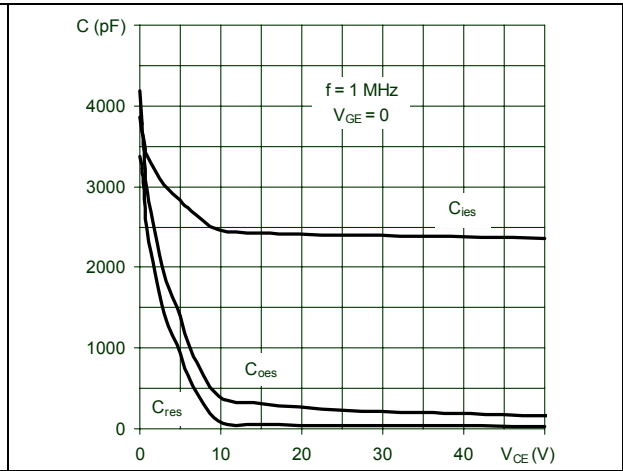
Figure 7. Normalized gate threshold voltage vs. temperature



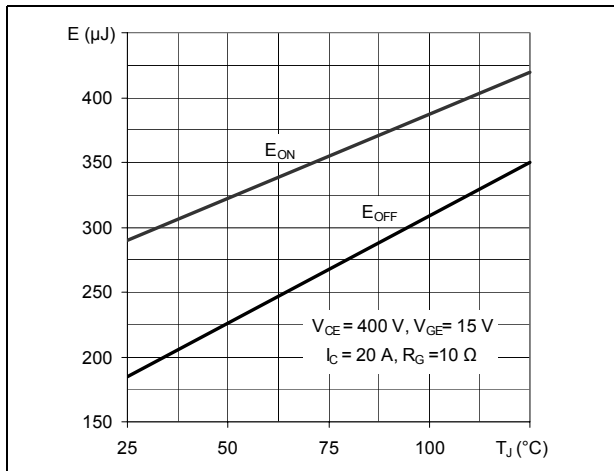
**Figure 8. Gate charge vs. gate-emitter voltage**



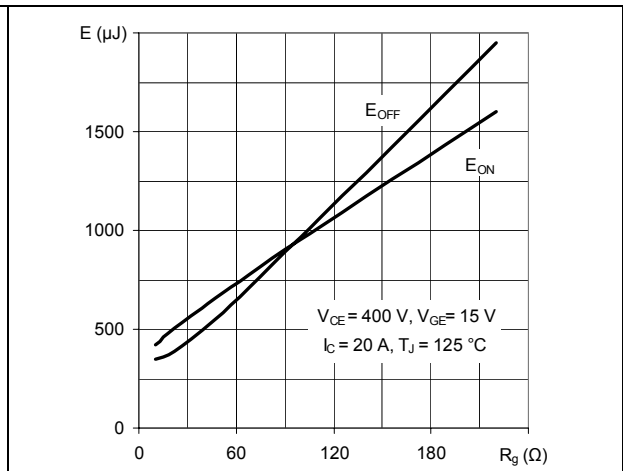
**Figure 9. Capacitance variations**



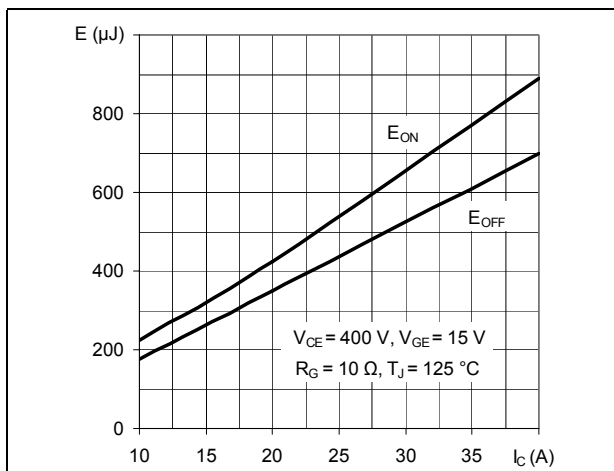
**Figure 10. Switching losses vs temperature**



**Figure 11. Switching losses vs. gate resistance**



**Figure 12. Switching losses vs. collector current**



**Figure 13. Turn-off SOA**

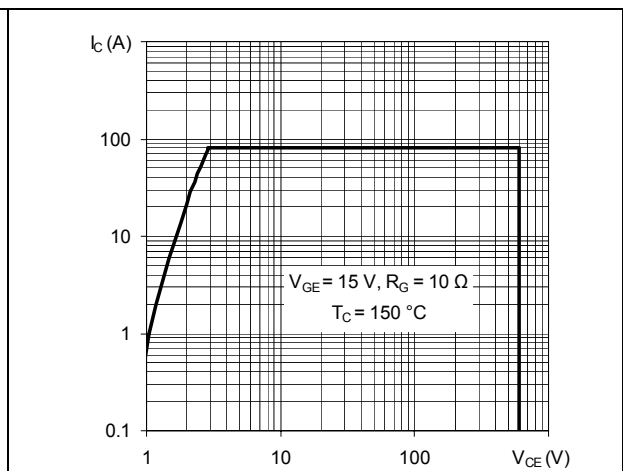


Figure 14. Diode forward on voltage

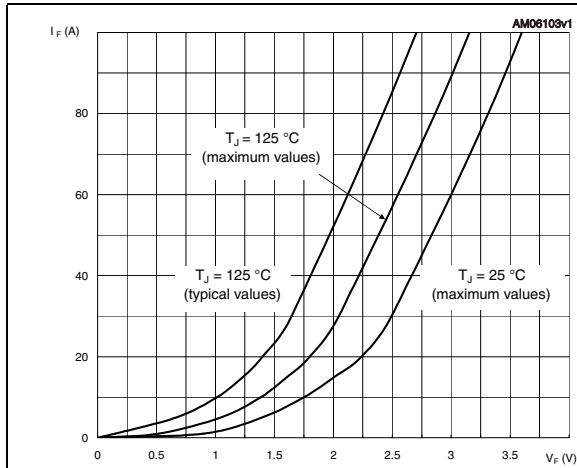
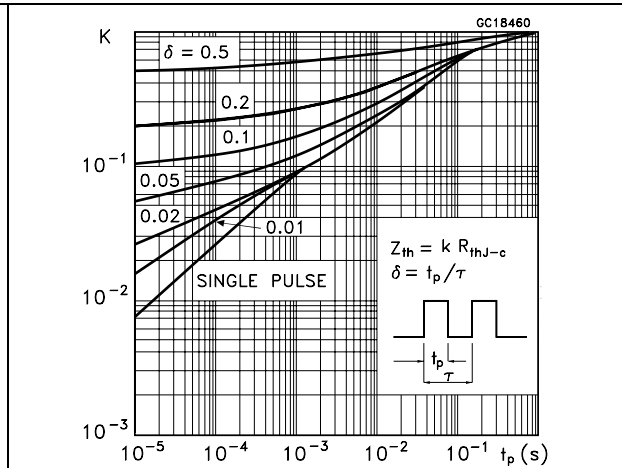


Figure 15. Thermal impedance



### 3 Test circuits

Figure 16. Test circuit for inductive load switching

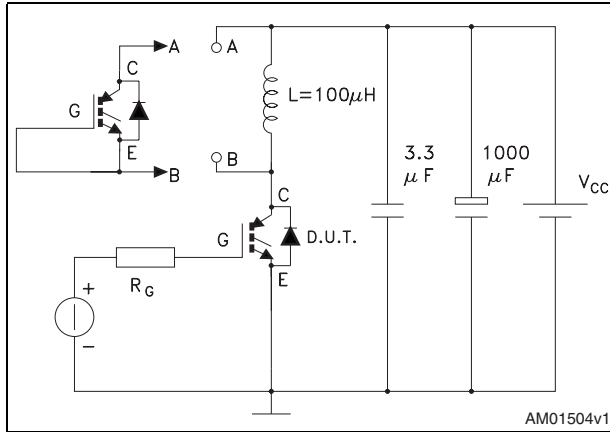


Figure 17. Gate charge test circuit

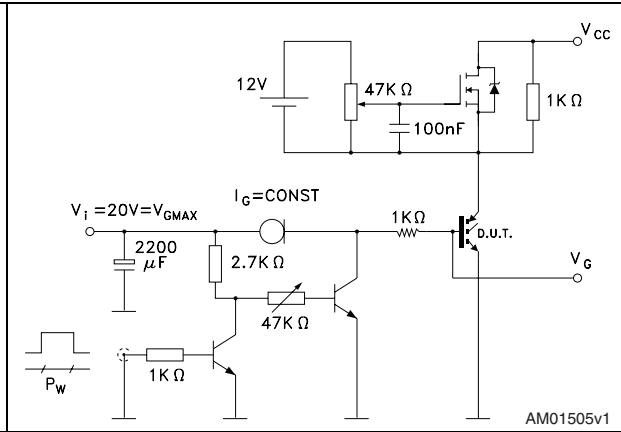


Figure 18. Switching waveform

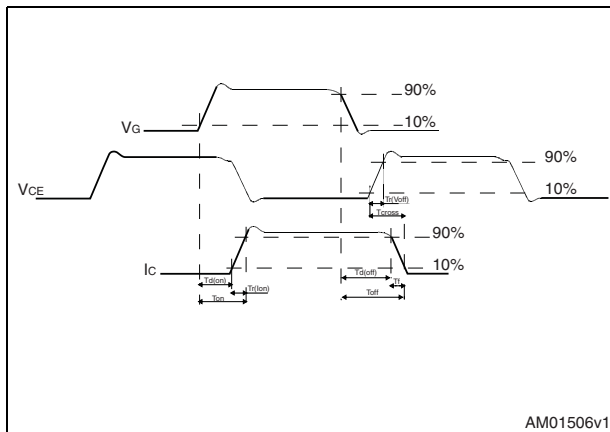
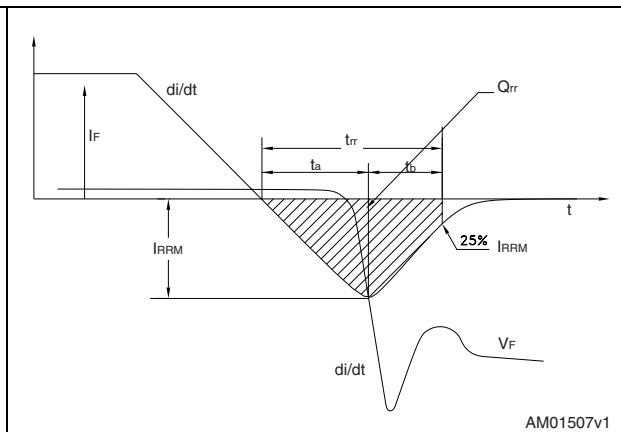


Figure 19. Diode recovery time waveform



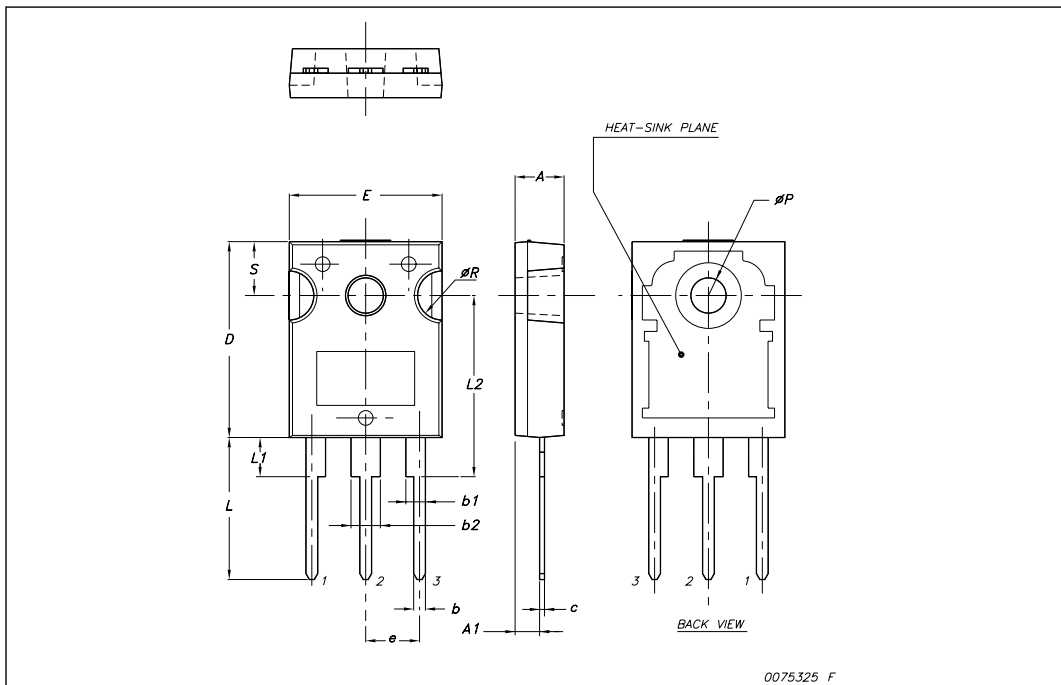


## 4 Package mechanical data

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.

**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	



## 5 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
14-Apr-2009	1	Initial release.
03-Aug-2009	2	Inserted dynamic parameters on <a href="#">Table 6</a> an <a href="#">Table 7</a> Document status promoted from preliminary data to datasheet
02-Sep-2009	3	Minor text changes throughout the document Removed watermark
30-Sep-2009	4	Inserted $V_{CE(sat)}$ grouping A, B and C (see <a href="#">Table 5: <math>V_{CE(sat)}</math> classification</a> )
10-May-2010	5	Inserted <a href="#">Section 2.1: Electrical characteristics (curves)</a>

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