

### Features

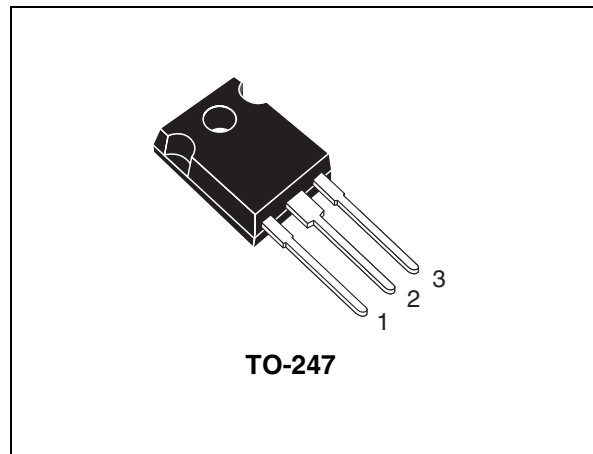
- Improved  $E_{off}$  at elevated temperature
- Low  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Ultra fast soft recovery antiparallel diode

### Applications

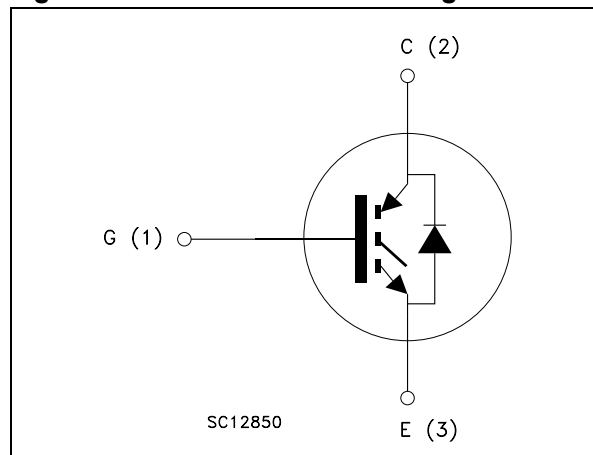
- Welding
- High frequency converters
- Power factor correction

### Description

The “HF” family 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 “W” series is a subset of products tailored to high switching frequency operation (over 100 kHz).



**Figure 1. Internal schematic diagram**



**Table 1. Device summary <sup>(1)</sup>**

Order code	Marking	Package	Packaging
STGW45HF60WD	GW45HF60WDA	TO-247	Tube
	GW45HF60WDB		
	GW45HF60WDC		

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 $T_C = 25\text{ °C}$	70	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	45	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 not repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	120	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	250	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.  $V_{CLAMP} = 80\% (V_{CES})$ ,  $V_{GE} = 15\text{ V}$ ,  $R_G = 10\ \Omega$ ,  $T_J = 150\text{ °C}$

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.5	°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	$V_{GE} = 15\text{ V}, I_C = 30\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 30\text{ A}, T_J = 125\text{ °C}$		1.65	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.  $V_{CE(sat)}$  classification**

Symbol	Parameter	Group	Value		Unit
			Min.	Max.	
$V_{CE(sat)}$	Collector-emitter saturation voltage $V_{GE} = 15\text{ V}, I_C = 30\text{ A}$	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	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	2900	-	pF
$C_{oes}$	Output capacitance			260		pF
$C_{res}$	Reverse transfer capacitance			55		pF
$Q_g$	Total gate charge	$V_{CE} = 400\text{ V}, I_C = 30\text{ A},$ $V_{GE} = 15\text{ V},$ <i>Figure 17</i>	-	160	-	nC
$Q_{ge}$	Gate-emitter charge			17		nC
$Q_{gc}$	Gate-collector charge			65		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	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 6.8\ \Omega$ , $V_{GE} = 15\text{ V}$ , ( <i>Figure 16</i> )	-	30 12 2600	-	ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 6.8\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ ( <i>Figure 16</i> )	-	30 14 2200	-	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	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ , $R_G = 6.8\ \Omega$ , $V_{GE} = 15\text{ V}$ ( <i>Figure 16</i> )	-	30 145 50	-	ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ , $R_G = 6.8\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ ( <i>Figure 16</i> )	-	47 185 65	-	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	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 6.8\ \Omega$ , $V_{GE} = 15\text{ V}$ , ( <i>Figure 18</i> )	-	300 330 630		$\mu$ J $\mu$ J $\mu$ J
$E_{on}^{(1)}$ $E_{off}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 400\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 6.8\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ ( <i>Figure 18</i> )	-	550 550 1100	800	$\mu$ 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 & 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	$I_F = 30\text{ A}$ $I_F = 30\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	2 1.65	2.5	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>see Figure 19</i> )	-	55 110 3	-	ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 30\text{ A}$ , $V_R = 50\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $T_J = 125\text{ }^\circ\text{C}$ , ( <i>see Figure 19</i> )	-	140 400 5.5	-	ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

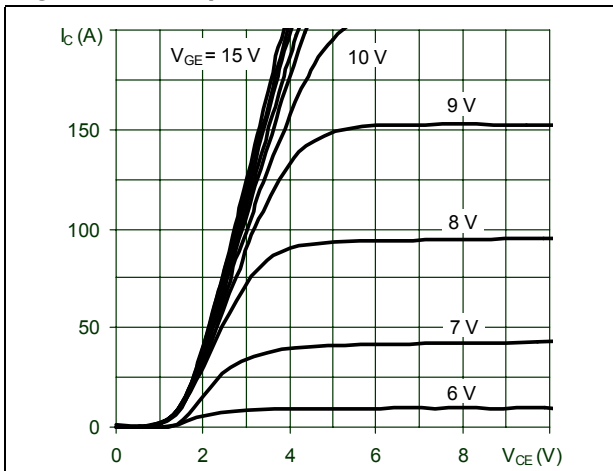


Figure 3. Transfer characteristics

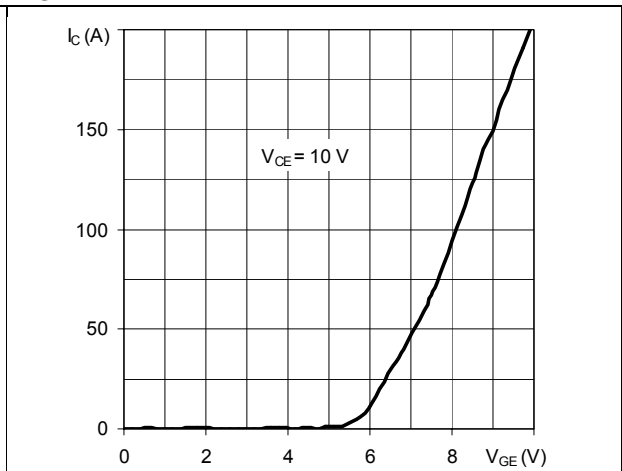


Figure 4. Normalized  $V_{CE(sat)}$  vs.  $I_C$

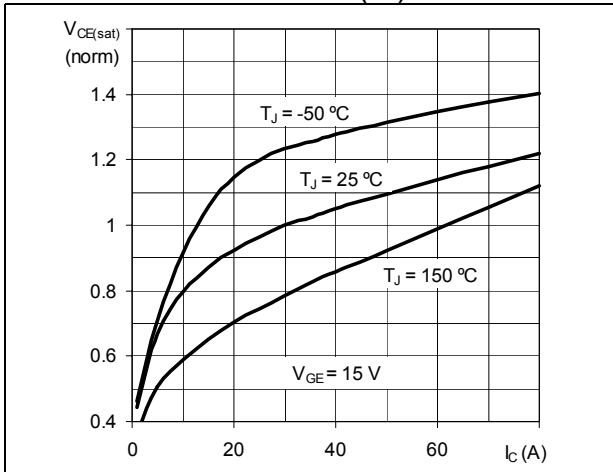


Figure 5. Normalized  $V_{CE(sat)}$  vs. temperature

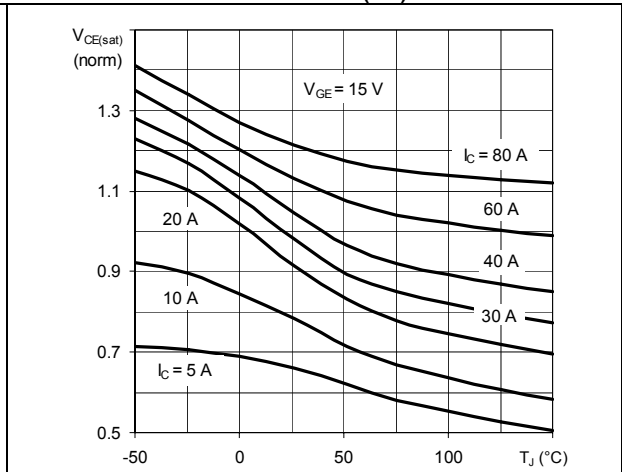


Figure 6. Normalized breakdown voltage vs. temperature

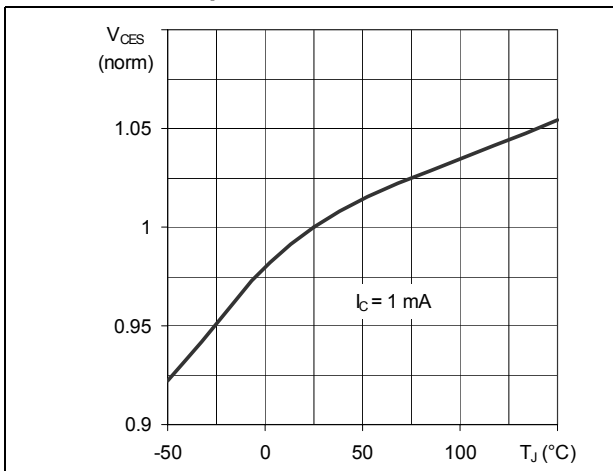
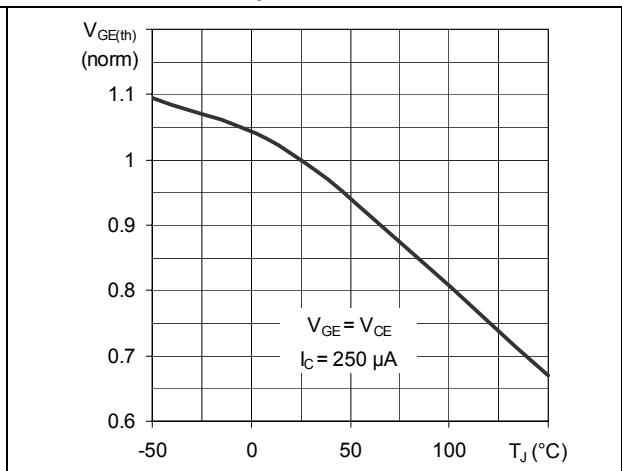
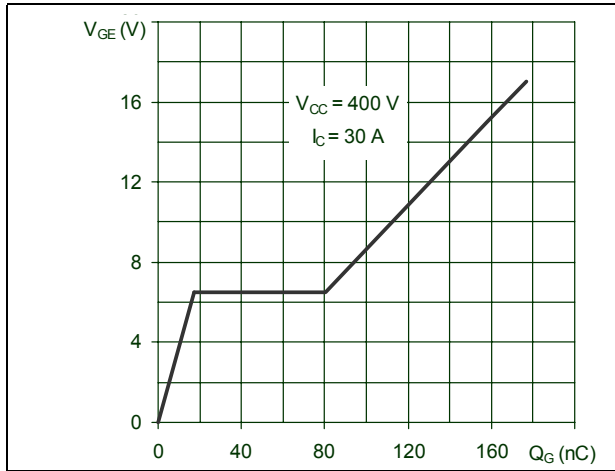


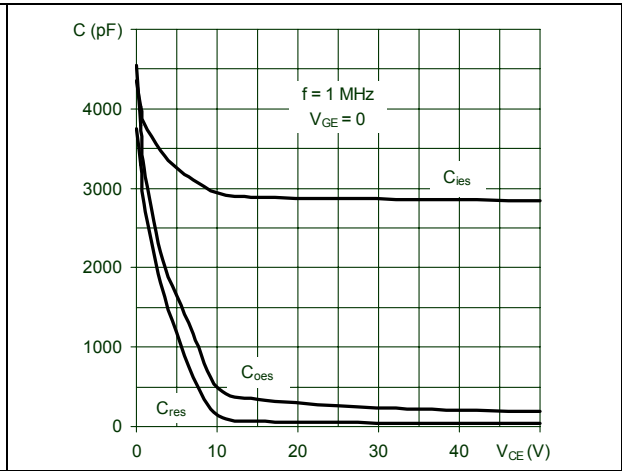
Figure 7. Normalized gate threshold voltage vs. temperature



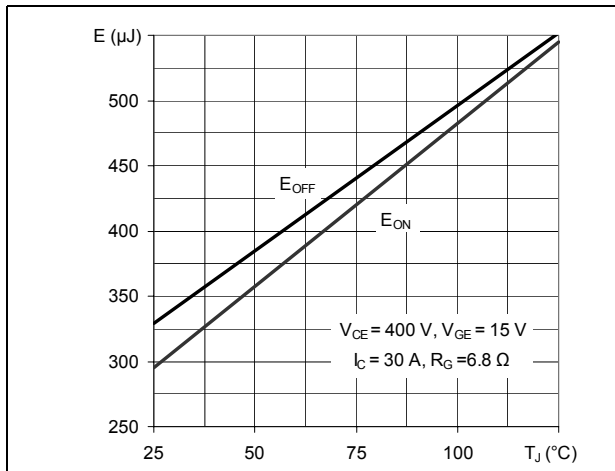
**Figure 8. Gate charge vs. gate-emitter voltage**



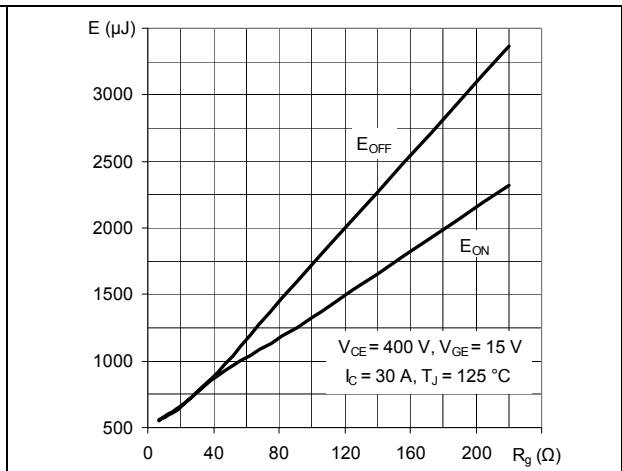
**Figure 9. Capacitance variations**



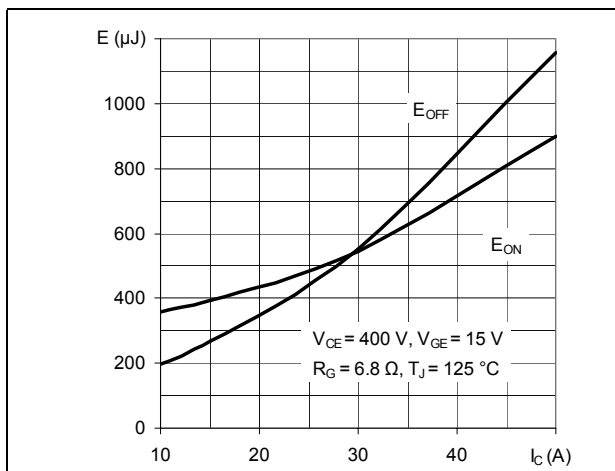
**Figure 10. Switching losses vs temperature**



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



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



**Figure 13. Turn-off SOA**

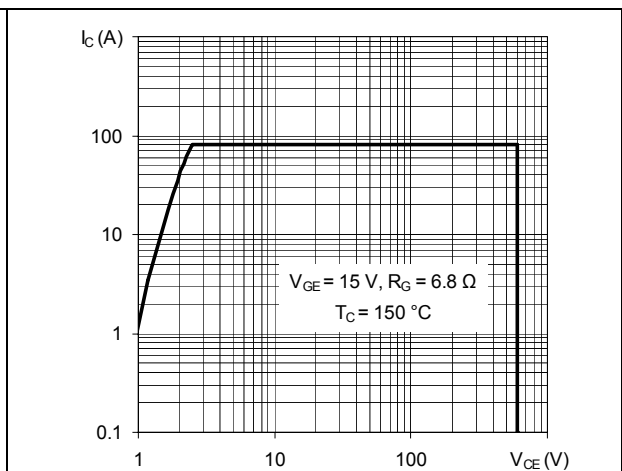


Figure 14. Diode forward on voltage

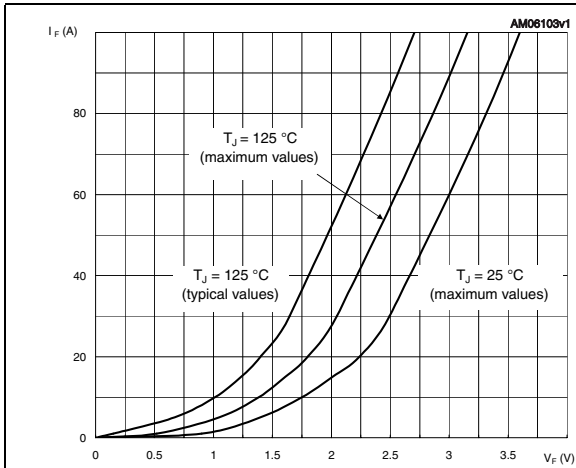
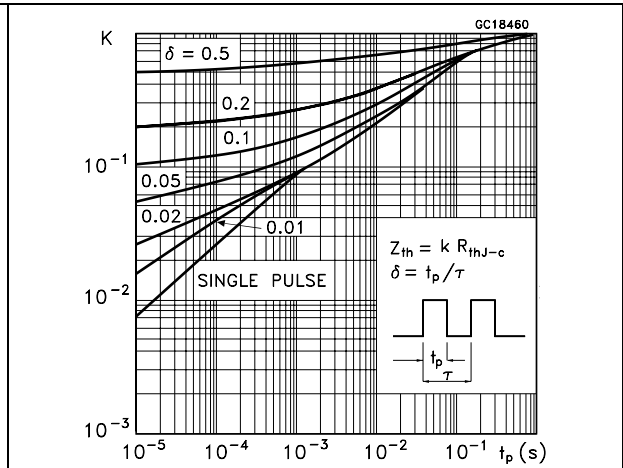


Figure 15. Thermal impedance



### 3 Test circuits

Figure 16. Test circuit for inductive load switching

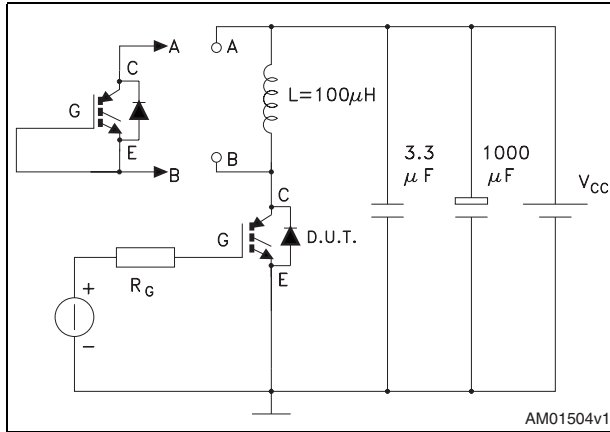


Figure 17. Gate charge test circuit

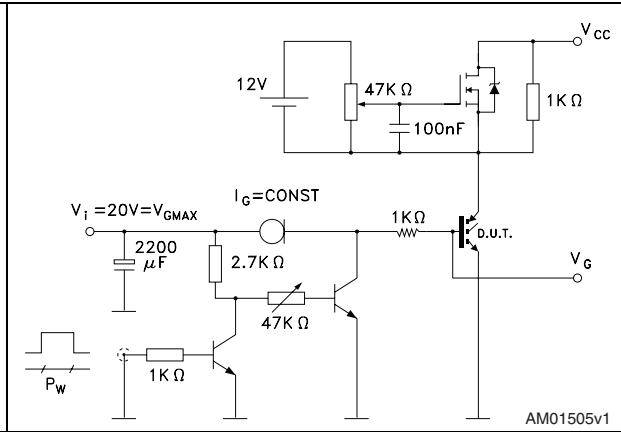


Figure 18. Switching waveform

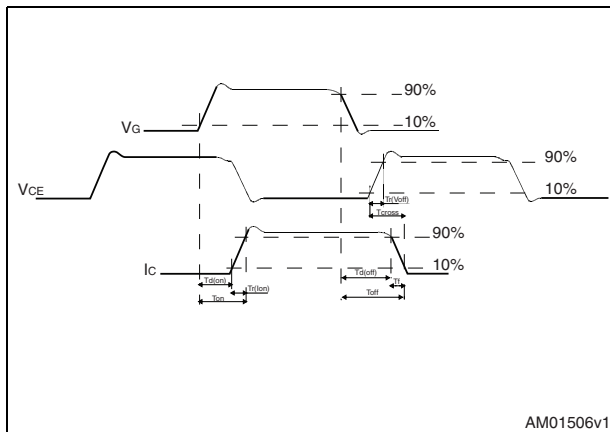
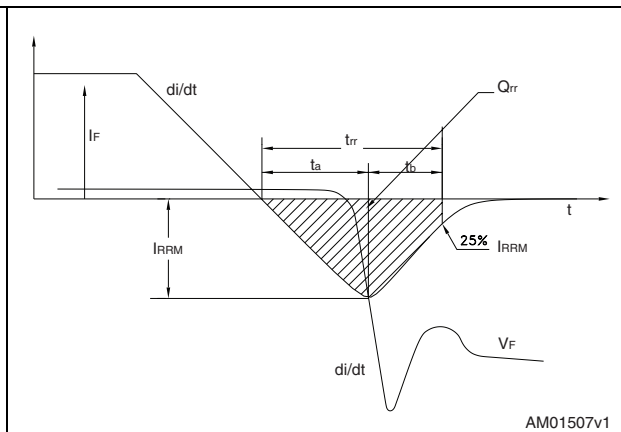


Figure 19. Diode recovery time waveform



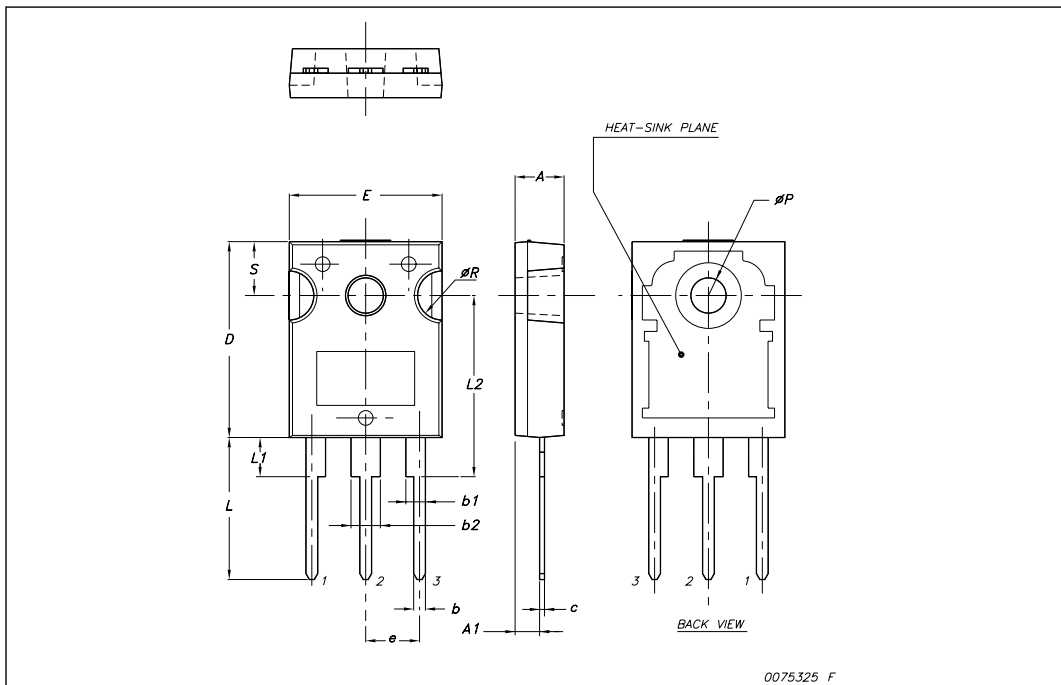


## 4 Package mechanical data

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

**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
16-Apr-2009	1	Initial release.
04-Aug-2009	2	– Modified $I_C$ value on Test conditions <a href="#">Table 4</a> – Modified $R_G$ value on Test conditions <a href="#">Table 7</a> and <a href="#">Table 8</a>
28-Apr-2010	3	– Document status promoted from preliminary data to datasheet – Inserted $V_{CE(sat)}$ grouping A, B and C (see <a href="#">Table 5</a> ) – Inserted dynamic parameters on <a href="#">Table 5</a> , <a href="#">Table 6</a> and <a href="#">Table 7</a> – Inserted <a href="#">Section 2.1: Electrical characteristics (curves)</a>

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