

## 31 A, 600 V, very fast IGBT with Ultrafast diode

### Features

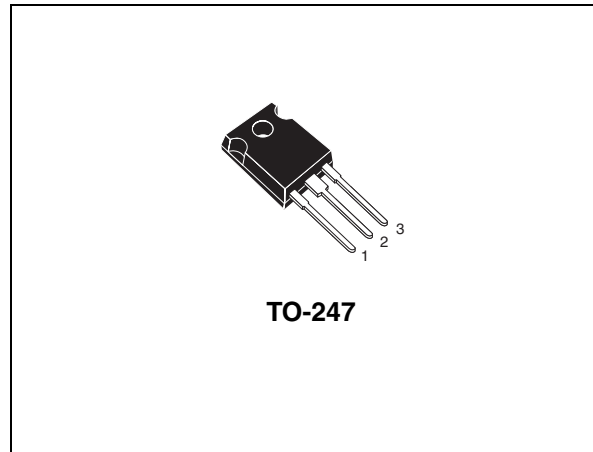
- Low on-voltage drop ( $V_{CE(sat)}$ )
- Very soft Ultrafast recovery anti-parallel diode

### Applications

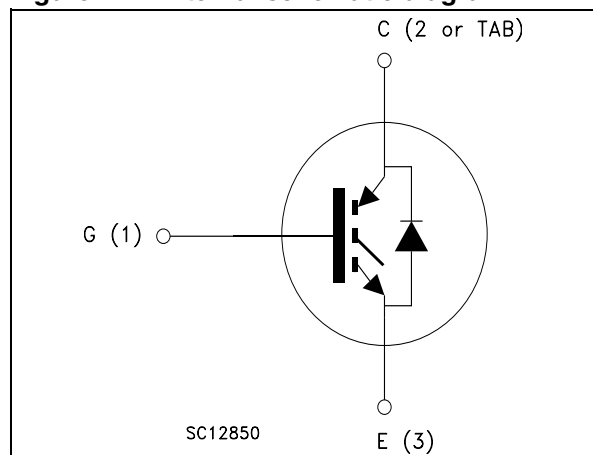
- High frequency motor drives
- SMPS and PFC in both hard switch and resonant topologies

### Description

This device is an ultrafast IGBT. It utilizes the advanced Power MESH™ process resulting in an excellent trade-off between switching performance and low on-state behavior.



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

Part number	Marking	Package	Packaging
STGWA19NC60HD	GWA19NC60HD	TO-247 long leads	Tube

# Contents

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# 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 $T_C = 25\text{ °C}$	52	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	31	A
$I_{CL}^{(2)}$	Turn-off latching current	40	A
$I_{CP}^{(3)}$	Pulsed collector current	60	A
$I_F$	Diode RMS forward current at $T_C = 25\text{ °C}$	20	A
$I_{FSM}$	Surge not repetitive forward current $t_p=10\text{ ms}$ sinusoidal	50	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	208	W
$T_J$	Operating junction temperature	- 55 to 150	$^{\circ}\text{C}$

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.  $V_{clamp} = 80\%V_{CES}$ ,  $T_J = 150\text{ °C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\text{ V}$

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

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.6	$^{\circ}\text{C/W}$
	Thermal resistance junction-case diode	3	$^{\circ}\text{C/W}$
$R_{thJA}$	Thermal resistance junction-ambient	50	$^{\circ}\text{C/W}$

## 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	$V_{GE} = 15\text{ V}, I_C = 12\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 15\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 30\text{ A}, T_J = 100\text{ °C}$ $V_{GE} = 15\text{ V}, I_C = 12\text{ A}, T_J = 125\text{ °C}$		1.8 2 2.5 1.6	2.5	V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	3.75		5.75	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$			150 1	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA
$g_{fs}^{(1)}$	Forward transconductance	$V_{CE} = 15\text{ V}, I_C = 12\text{ A}$		5		S

1. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance			1180		pF
$C_{oes}$	Output capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$	-	130	-	pF
$C_{res}$	Reverse transfer capacitance	$V_{GE} = 0$		36		pF
$Q_g$	Total gate charge	$V_{CE} = 390\text{ V}, I_C = 5\text{ A},$		53		nC
$Q_{ge}$	Gate-emitter charge	$V_{GE} = 15\text{ V},$	-	10	-	nC
$Q_{gc}$	Gate-collector charge	<a href="#">Figure 18</a>		23		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	$V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 19</i>	-	25 7 1600	-	ns ns A/ $\mu$ s
$t_{d(on)}$ $t_r$ $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	$V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ <i>Figure 19</i>	-	24 8 1400	-	ns ns A/ $\mu$ s
$t_{r(Voff)}$ $t_{d(Voff)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 19</i>	-	27 97 73	-	ns ns ns
$t_{r(Voff)}$ $t_{d(Voff)}$ $t_f$	Off voltage rise time Turn-off delay time Current fall time	$V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ <i>Figure 19</i>	-	58 144 128	-	ns ns ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}$ $E_{off}^{(1)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , <i>Figure 19</i>	-	85 189 274	-	$\mu$ J $\mu$ J $\mu$ J
$E_{on}$ $E_{off}^{(1)}$ $E_{ts}$	Turn-on switching losses Turn-off switching losses Total switching losses	$V_{CC} = 390\text{ V}$ , $I_C = 12\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ <i>Figure 19</i>	-	187 407 594	-	$\mu$ J $\mu$ J $\mu$ J

1. Turn-off losses include also the tail of the collector current

**Table 8. Collector-emitter diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_F$	Forward on-voltage	$I_F = 12\text{ A}$ $I_F = 12\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	2.6 2.1	-	V V
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 12\text{ A}$ , $V_R = 40\text{ V}$ , $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 20</i>	-	31 30 2	-	ns nC A
$t_{rr}$ $Q_{rr}$ $I_{rrm}$	Reverse recovery time Reverse recovery charge Reverse recovery current	$I_F = 12\text{ A}$ , $V_R = 40\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$ <i>Figure 20</i>	-	59 102 4	-	ns nC A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

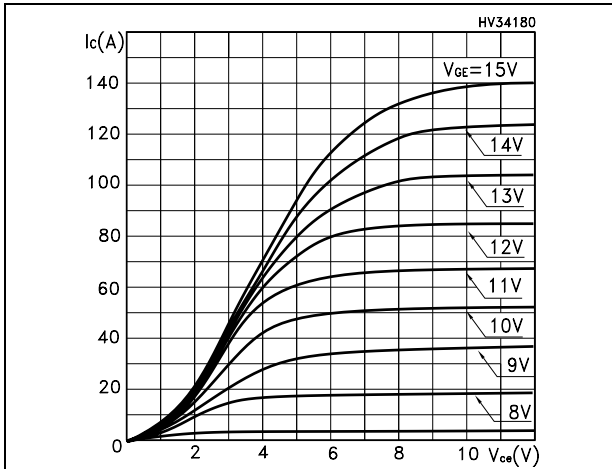


Figure 3. Transfer characteristics

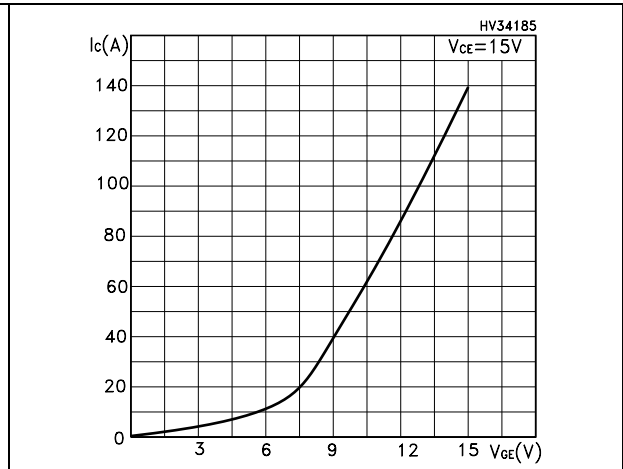


Figure 4. Transconductance

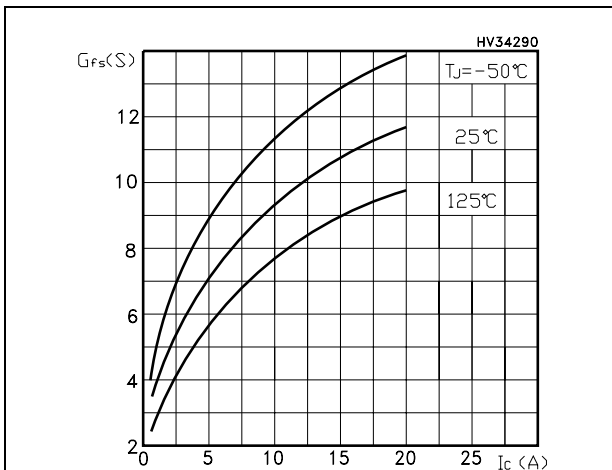


Figure 5. Collector-emitter on voltage vs. temperature

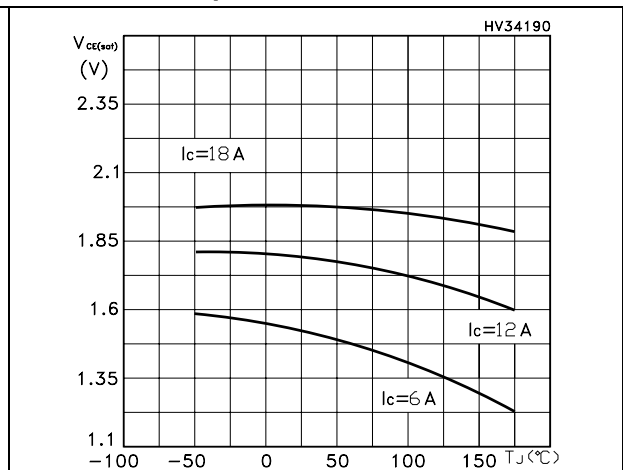


Figure 6. Gate charge vs. gate-source voltage

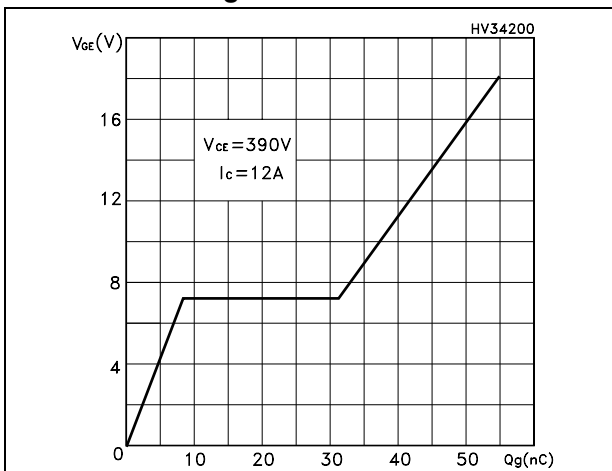


Figure 7. Capacitance variations

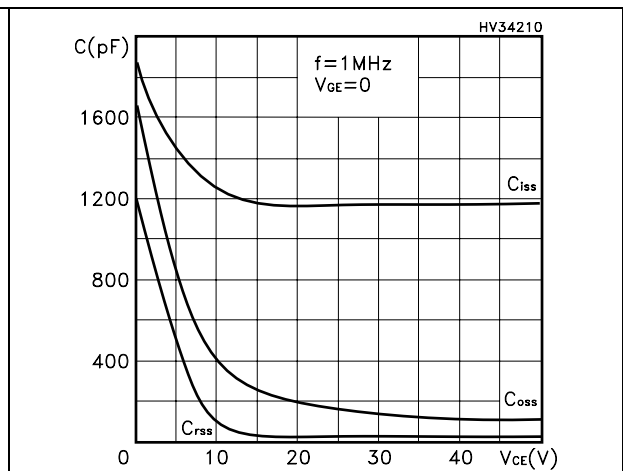


Figure 8. Normalized gate threshold voltage vs. temperature

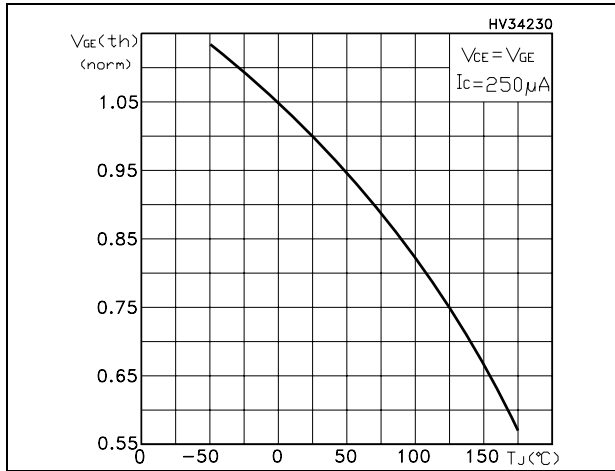


Figure 9. Collector-emitter on voltage vs. collector current

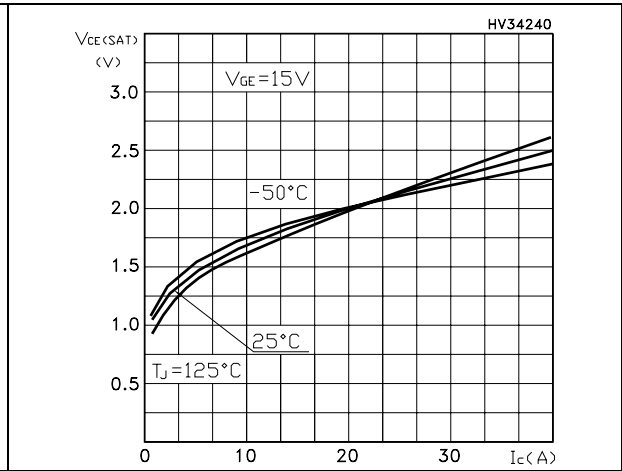


Figure 10. Normalized breakdown voltage vs. temperature

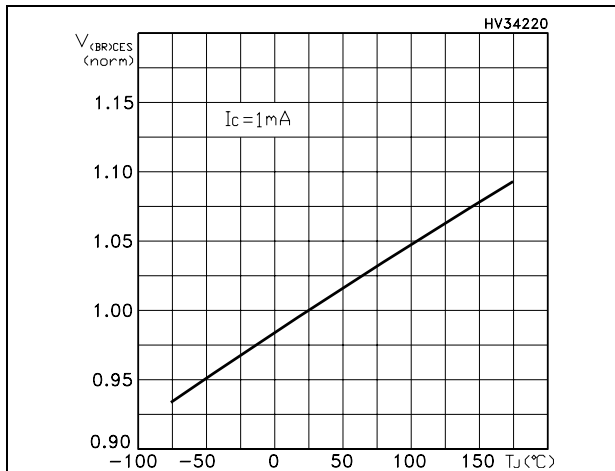


Figure 11. Switching losses vs. temperature

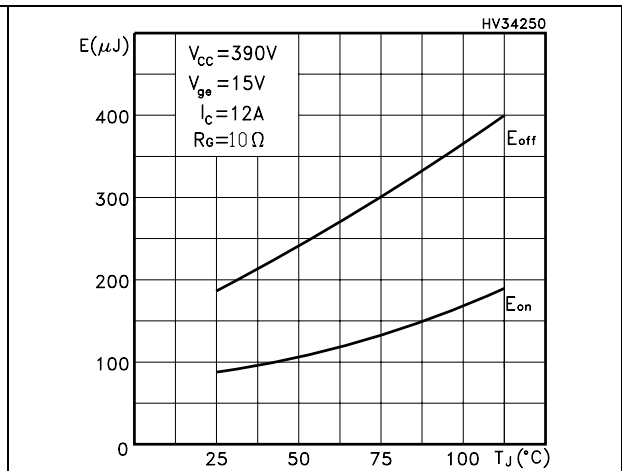


Figure 12. Switching losses vs. gate resistance

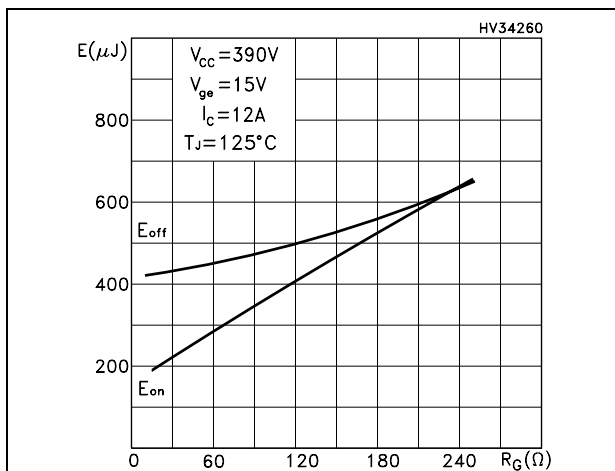


Figure 13. Switching losses vs. collector current

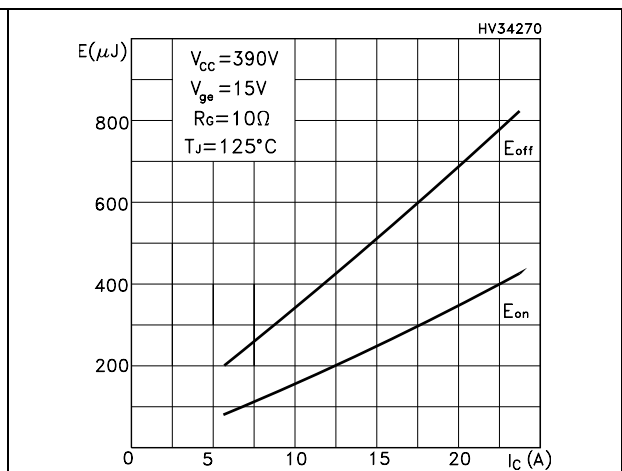


Figure 14. Turn-off SOA

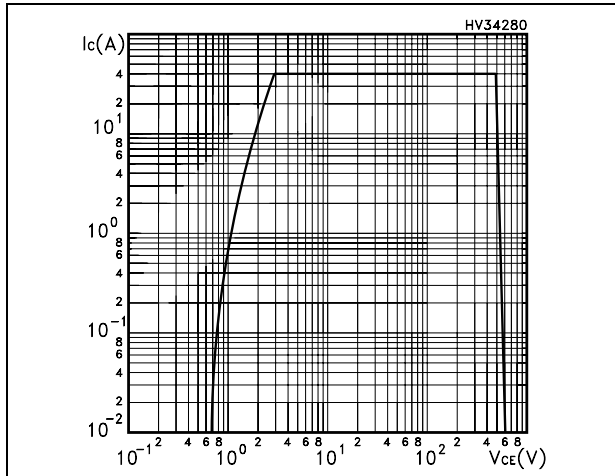


Figure 15. Thermal impedance

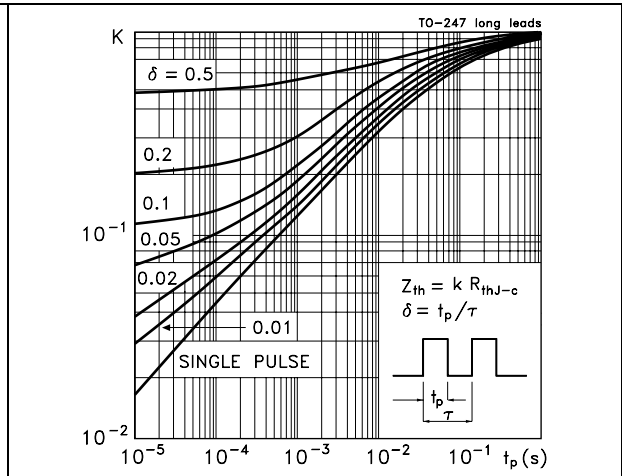
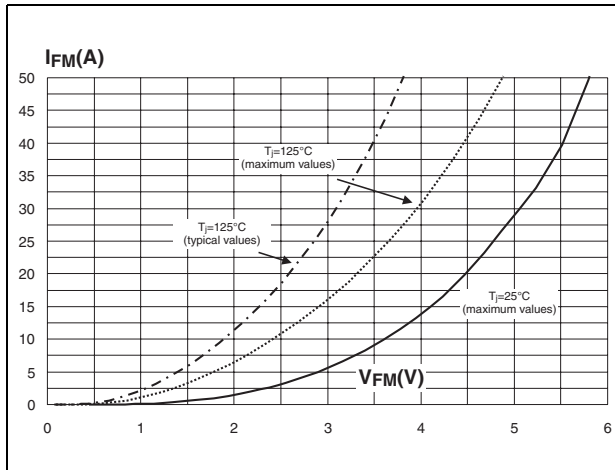


Figure 16. Forward voltage drop vs. forward current





### 3 Test circuits

Figure 17. Test circuit for inductive load switching

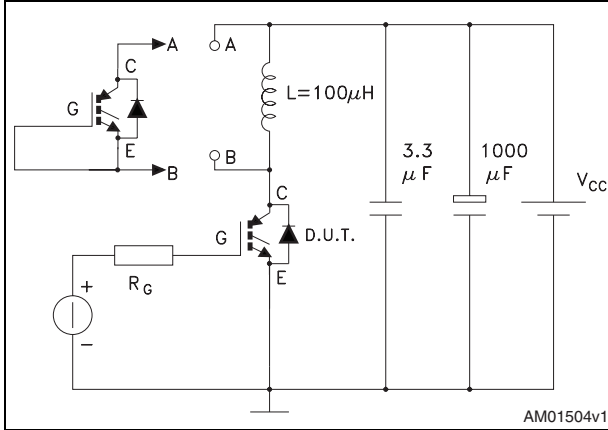


Figure 18. Gate charge test circuit

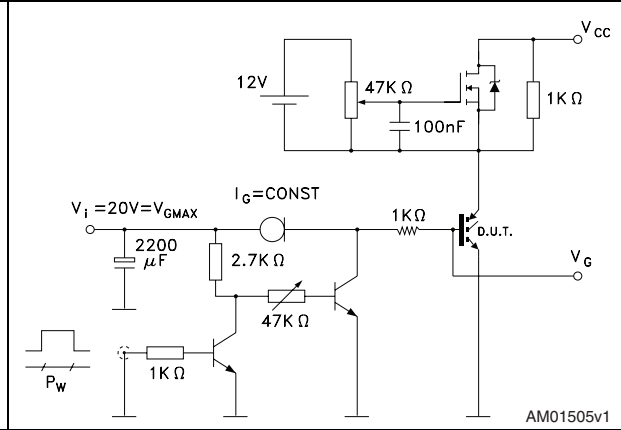


Figure 19. Switching waveform

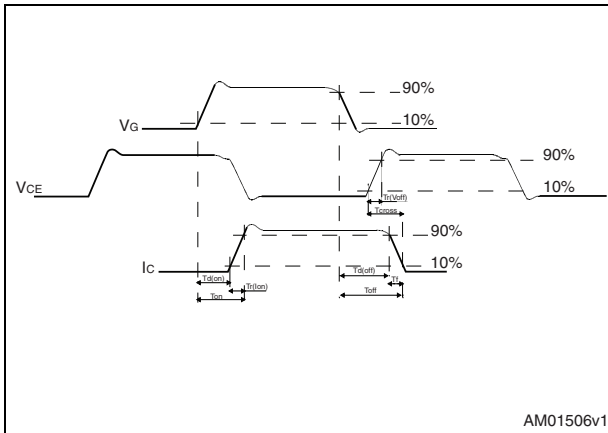
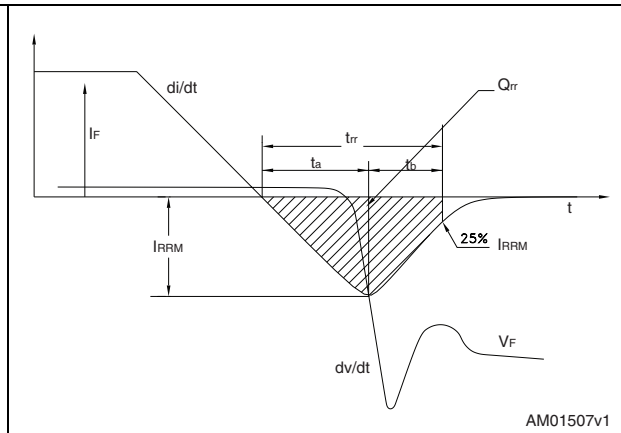


Figure 20. Diode recovery time waveform



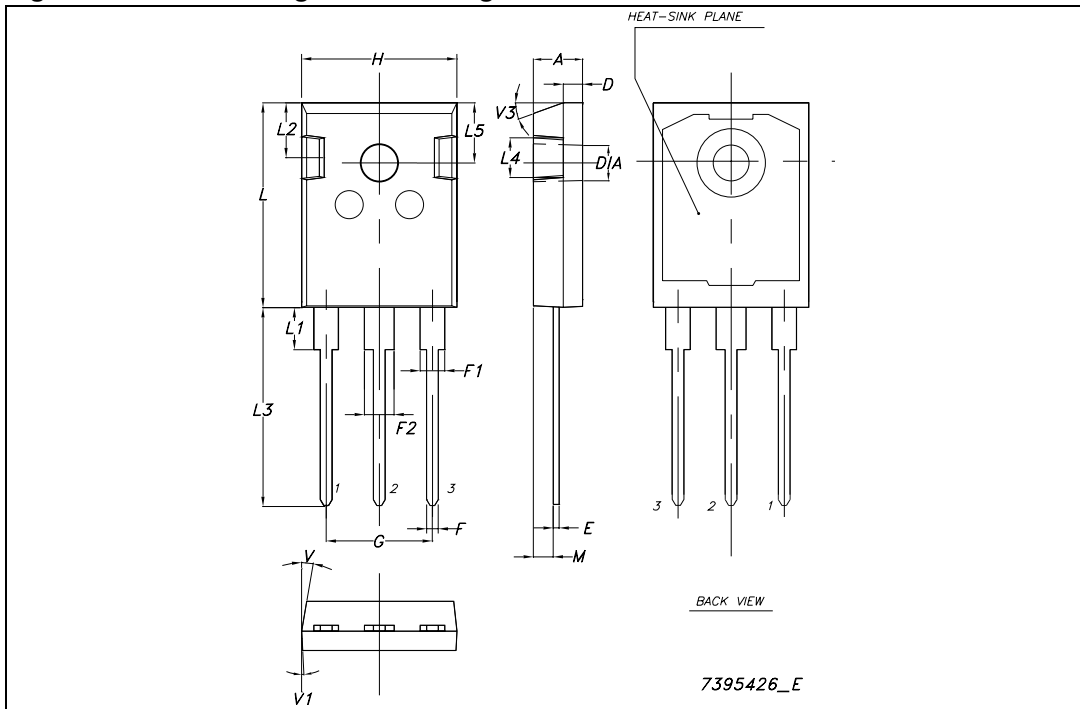
## 4 Package mechanical data

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

Table 9. 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 10. Document revision history**

Date	Revision	Changes
14-Sep-2011	1	Initial release.

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