

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

### Features

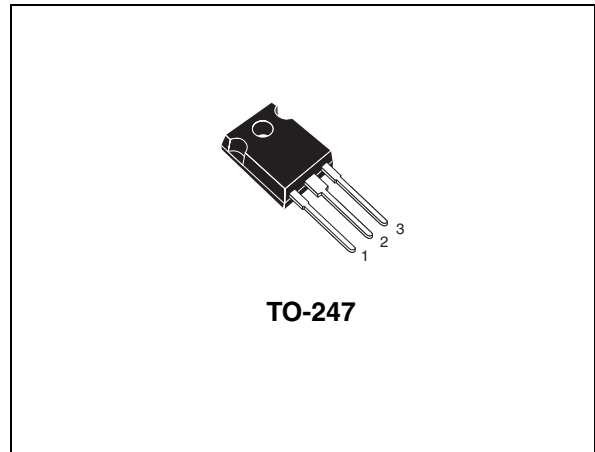
- Low on-voltage drop ( $V_{CE(sat)}$ )
- Very soft Ultrafast recovery anti-parallel diode

### Applications

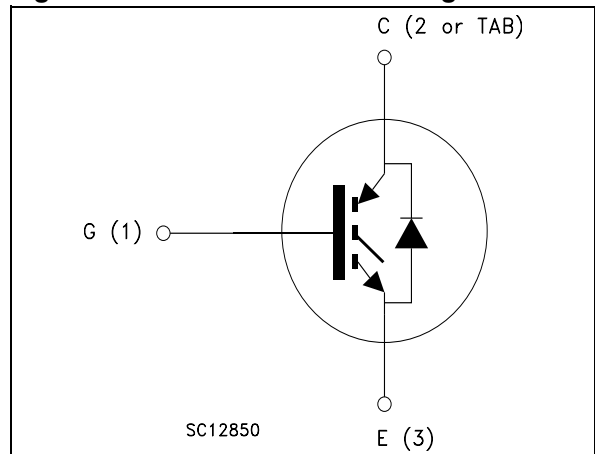
- High frequency motor drives
- SMPS and PFC in both hard switch and resonant topologies

### 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

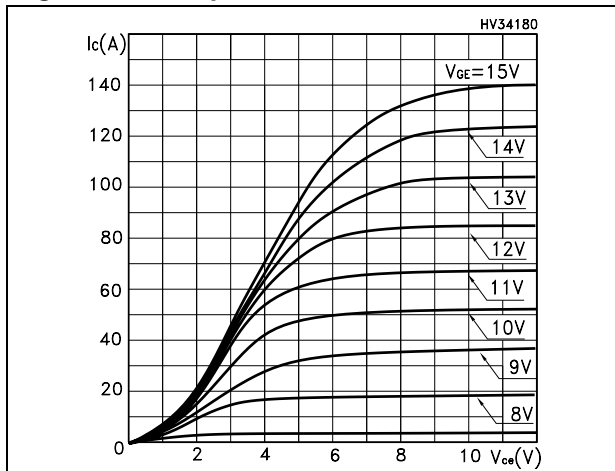


Figure 3. Transfer characteristics

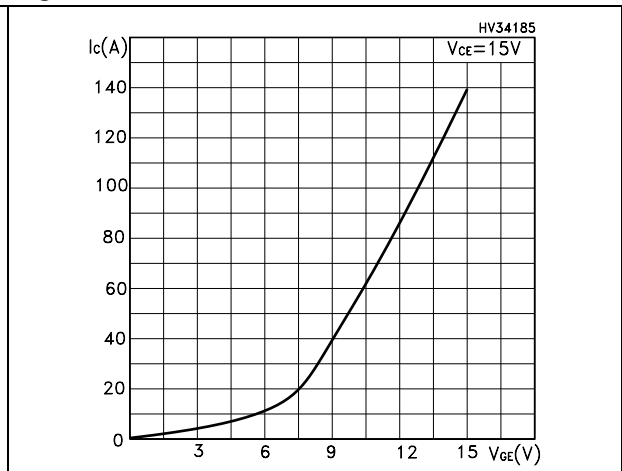


Figure 4. Transconductance

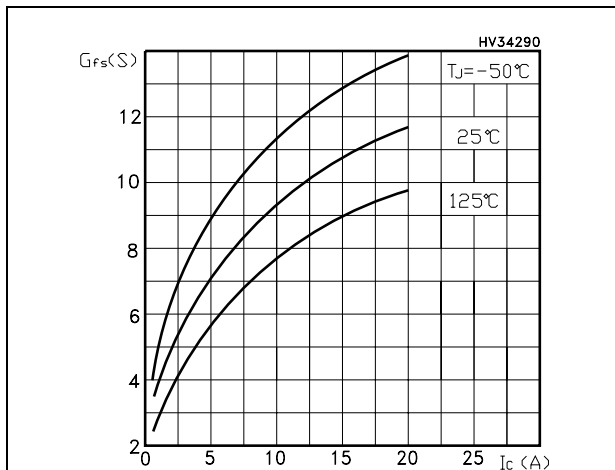


Figure 5. Collector-emitter on voltage vs. temperature

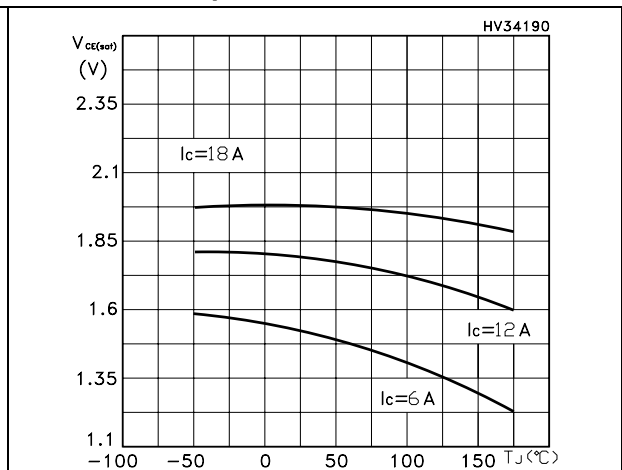


Figure 6. Gate charge vs. gate-source voltage

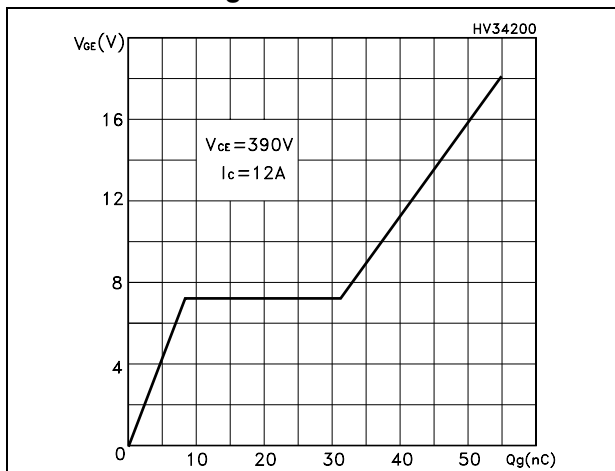
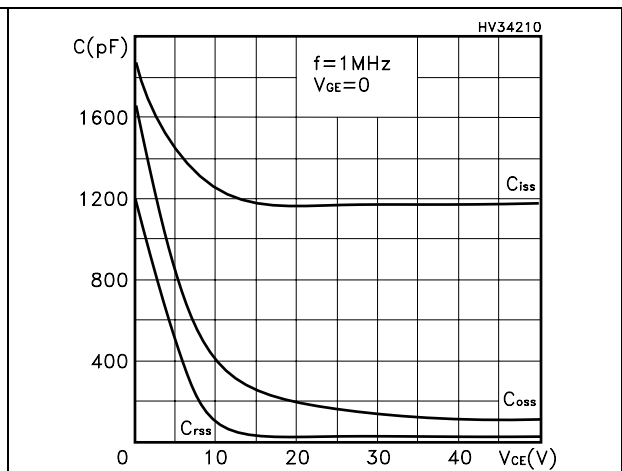
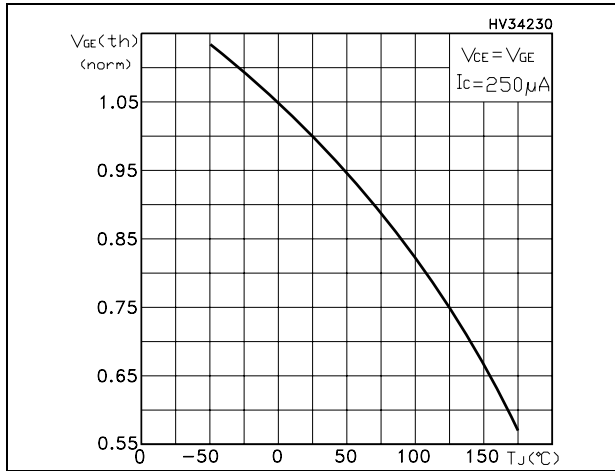


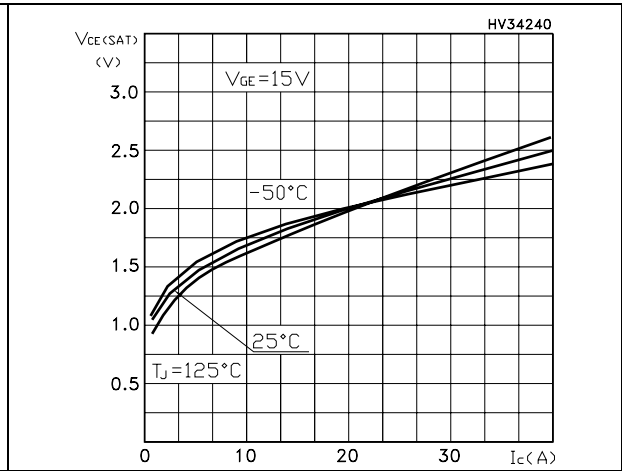
Figure 7. Capacitance variations



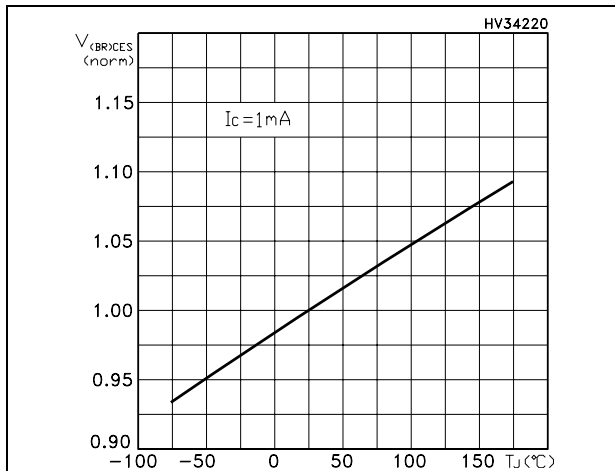
**Figure 8. Normalized gate threshold voltage vs. temperature**



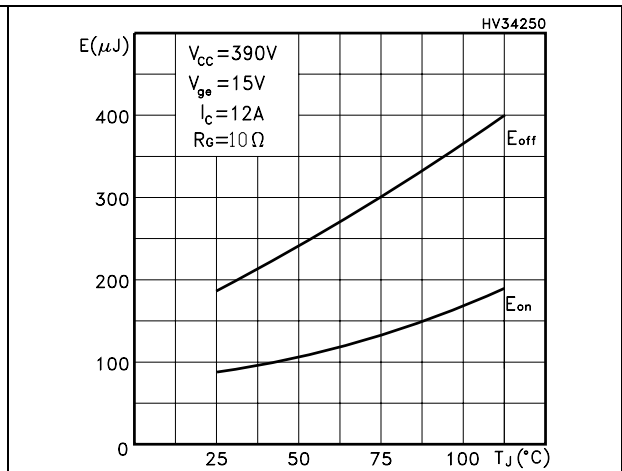
**Figure 9. Collector-emitter on voltage vs. collector current**



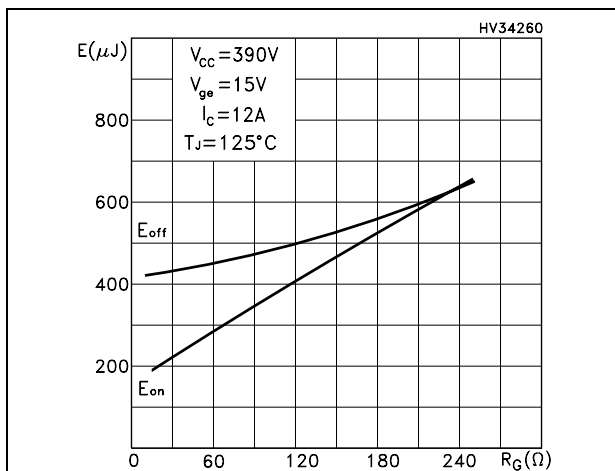
**Figure 10. Normalized breakdown voltage vs. temperature**



**Figure 11. Switching losses vs. temperature**



**Figure 12. Switching losses vs. gate resistance**



**Figure 13. Switching losses vs. collector current**

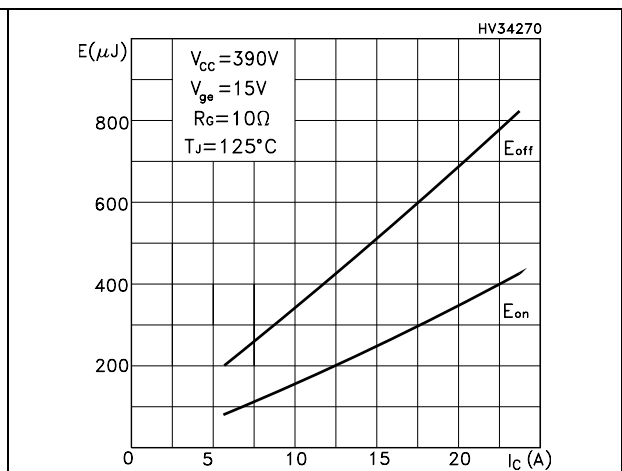


Figure 14. Turn-off SOA

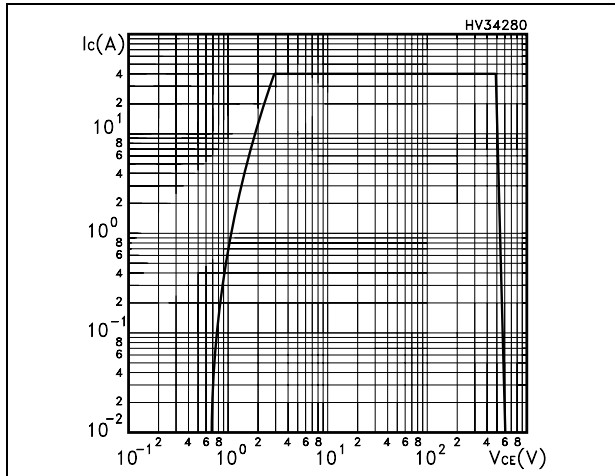


Figure 15. Thermal impedance

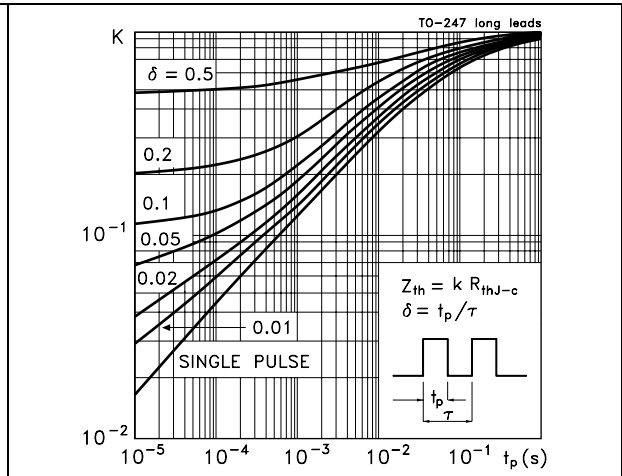
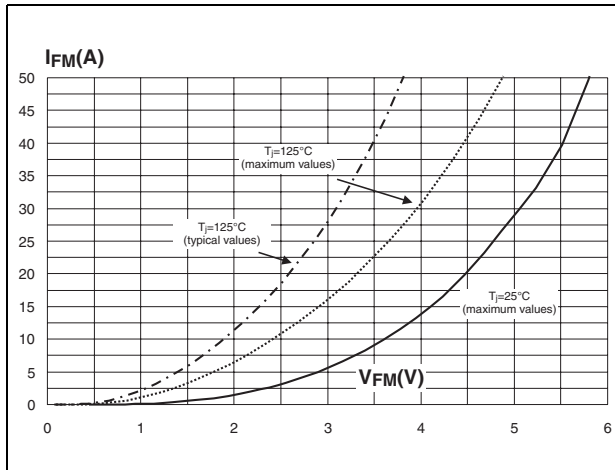


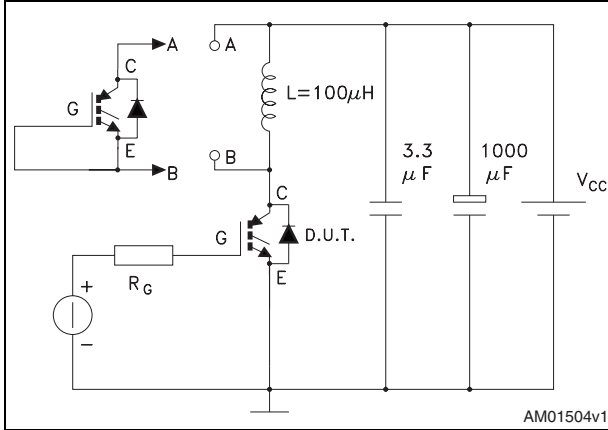
Figure 16. Forward voltage drop vs. forward current





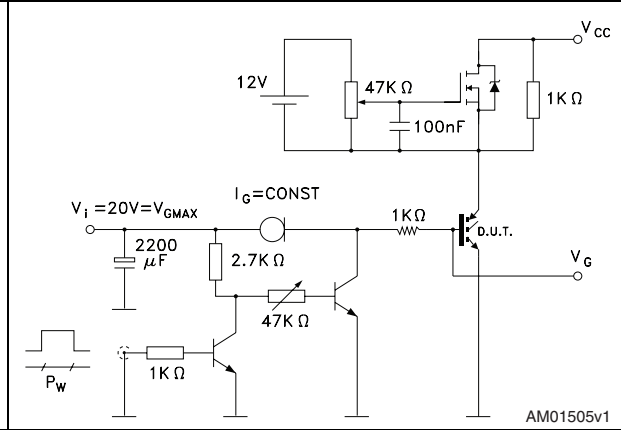
### 3 Test circuits

Figure 17. Test circuit for inductive load switching



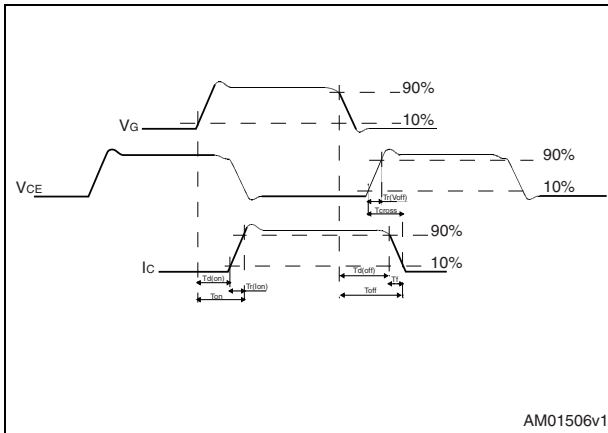
AM01504v1

Figure 18. Gate charge test circuit



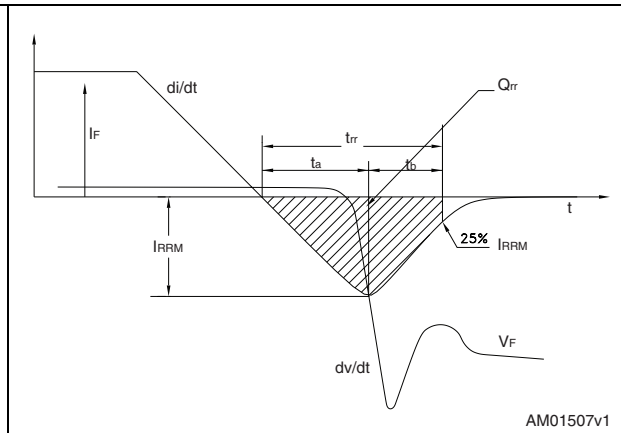
AM01505v1

Figure 19. Switching waveform



AM01506v1

Figure 20. Diode recovery time waveform



AM01507v1

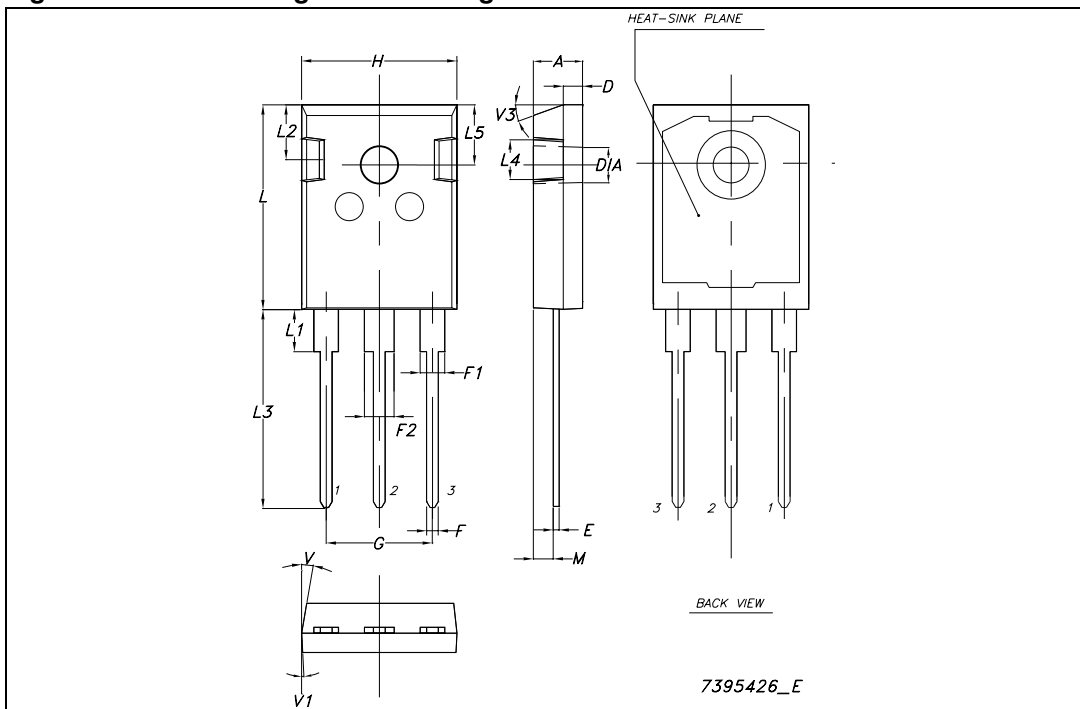
## 4 Package mechanical data

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 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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