



# STGW40N120KD STGWA40N120KD

40 A, 1200 V short circuit rugged IGBT with Ultrafast diode

## Features

- Low on-losses
- High current capability
- Low gate charge
- Short circuit withstand time 10  $\mu$ s
- IGBT co-packaged with Ultrafast free-wheeling diode

## Applications

- Motor control

## Description

This high voltage and short-circuit rugged IGBT utilizes the advanced PowerMESH™ process resulting in an excellent trade-off between switching performance and low ON-state behavior.

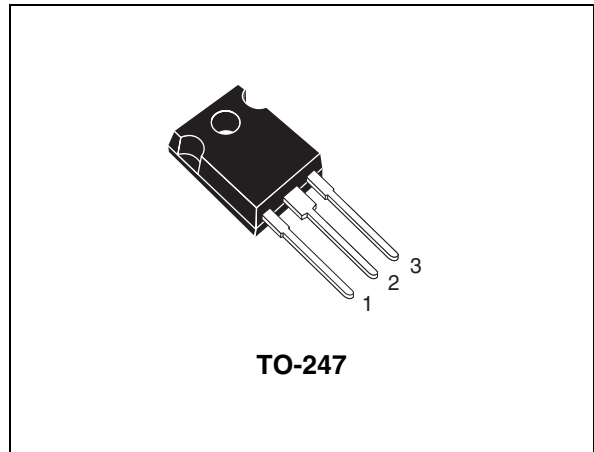


Figure 1. Internal schematic diagram

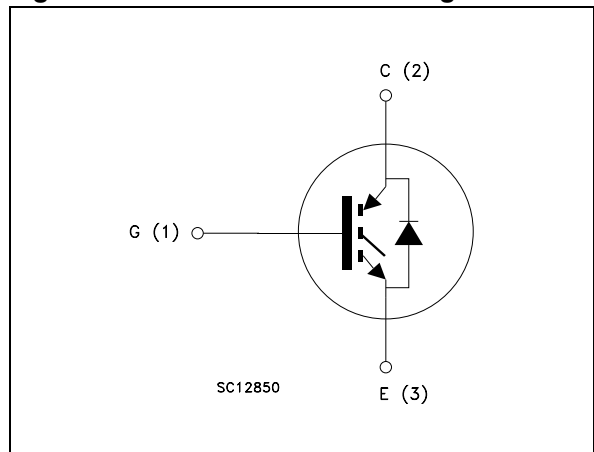


Table 1. Device summary

Order codes	Markings	Package	Packaging
STGW40N120KD	GW40N120KD	TO-247	Tube
STGWA40N120KD	GWA40N120KD	TO-247 long leads	Tube

# Contents

<b>1</b>	<b>Electrical ratings</b> .....	<b>3</b>
<b>2</b>	<b>Electrical characteristics</b> .....	<b>4</b>
	2.1 Electrical characteristics (curves) .....	6
<b>3</b>	<b>Test circuits</b> .....	<b>9</b>
<b>4</b>	<b>Package mechanical data</b> .....	<b>10</b>
<b>5</b>	<b>Revision history</b> .....	<b>14</b>

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	1200	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	80	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	40	A
$I_{CL}^{(2)}$	Turn-off latching current	85	A
$I_{CP}^{(3)}$	Pulsed collector current	120	A
$V_{GE}$	Gate-emitter voltage	$\pm 25$	V
$t_{SCW}$	Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$ $T_j = 125\text{ °C}$ , $R_G = 10\ \Omega$ , $V_{GE} = 12\text{ V}$	10	$\mu\text{s}$
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	240	W
$I_F$	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	100	A
$T_j$	Operating junction temperature	- 55 to 125	$^{\circ}\text{C}$

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.  $V_{clamp} = 80\%$  of  $V_{CES}$ ,  $T_j = 125\text{ °C}$ ,  $R_G = 10\ \Omega$ ,  $V_{GE} = 15\text{ V}$

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

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.42	$^{\circ}\text{C/W}$
$R_{thj-case}$	Thermal resistance junction-case diode	1.6	$^{\circ}\text{C/W}$
$R_{thj-amb}$	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 ( $V_{GE} = 0$ )	$I_C = 1\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$ $V_{GE} = 15\text{ V}$ , $I_C = 30\text{ A}$ , $T_J = 125\text{ °C}$		2.8 2.7	3.85	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$	4.5		6.5	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 1200\text{ V}$ $V_{CE} = 1200\text{ V}$ , $T_J = 125\text{ °C}$			500 10	$\mu\text{A}$ mA
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			$\pm 100$	nA

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$		2577		pF
$C_{oes}$	Output capacitance		-	196	-	pF
$C_{res}$	Reverse transfer capacitance			39.5		pF
$Q_g$	Total gate charge	$V_{CE} = 960\text{ V}$ , $I_C = 30\text{ A}$ , $V_{GE} = 15\text{ V}$		126		nC
$Q_{ge}$	Gate-emitter charge		-	22.2	-	nC
$Q_{gc}$	Gate-collector charge			67		nC

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see <a href="#">Figure 16</a> )		48		ns
$t_r$	Current rise time		-	40	-	ns
$(di/dt)_{on}$	Turn-on current slope			540		A/ $\mu\text{s}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ °C}$ (see <a href="#">Figure 16</a> )		45		ns
$t_r$	Current rise time		-	38	-	ns
$(di/dt)_{on}$	Turn-on current slope			665		A/ $\mu\text{s}$
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 960\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , (see <a href="#">Figure 16</a> )		84		ns
$t_{d(off)}$	Turn-off delay time		-	338	-	ns
$t_f$	Current fall time			210		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 960\text{ V}$ , $I_C = 30\text{ A}$ $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 125\text{ °C}$ (see <a href="#">Figure 16</a> )		144		ns
$t_{d(off)}$	Turn-off delay time		-	420	-	ns
$t_f$	Current fall time			360		ns

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960\text{ V}$ , $I_C = 30\text{ A}$		3.7		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,	-	5.7	-	mJ
$E_{ts}$	Total switching losses	(see <a href="#">Figure 16</a> )		9.4		mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960\text{ V}$ , $I_C = 30\text{ A}$		4.7		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,	-	9.3	-	mJ
$E_{ts}$	Total switching losses	$T_J = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 16</a> )		14		mJ

- $E_{on}$  is the turn-on losses when a typical diode is used in the test circuit in [Figure 16](#). If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature (25°C and 125°C)
- 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	$I_F = 20\text{ A}$ $I_F = 20\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	1.9 1.7	-	V V
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 45\text{ V}$ ,		84		ns
$Q_{rr}$	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	235	-	nC
$I_{rrm}$	Reverse recovery current	(see <a href="#">Figure 19</a> )		5.6		A
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 45\text{ V}$ ,		152		ns
$Q_{rr}$	Reverse recovery charge	$T_J = 125\text{ }^\circ\text{C}$ ,	-	722	-	nC
$I_{rrm}$	Reverse recovery current	$di/dt = 100\text{ A}/\mu\text{s}$ (see <a href="#">Figure 19</a> )		9		A

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

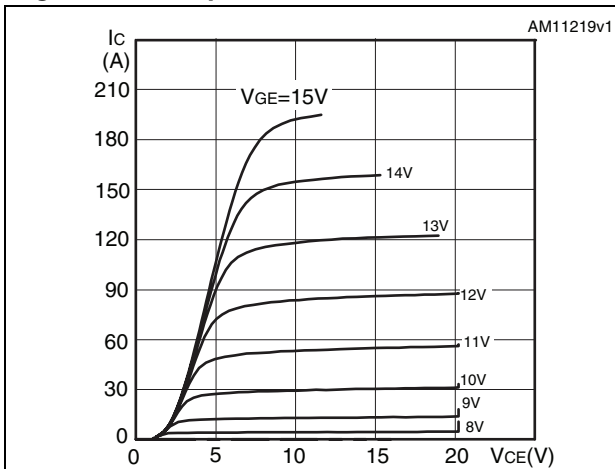


Figure 3. Transfer characteristics

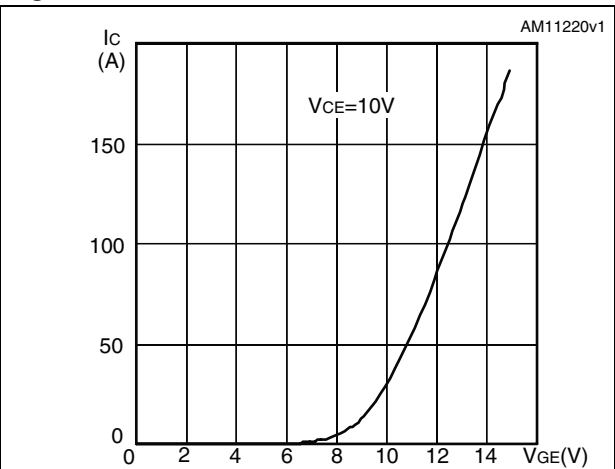


Figure 4. Collector-emitter on voltage vs. collector current

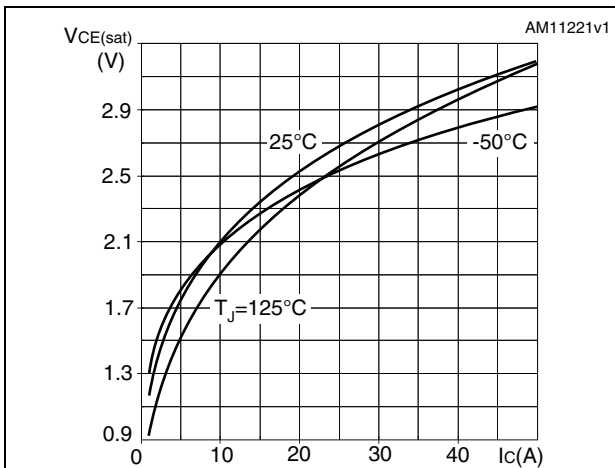


Figure 5. Collector-emitter on voltage vs. temperature

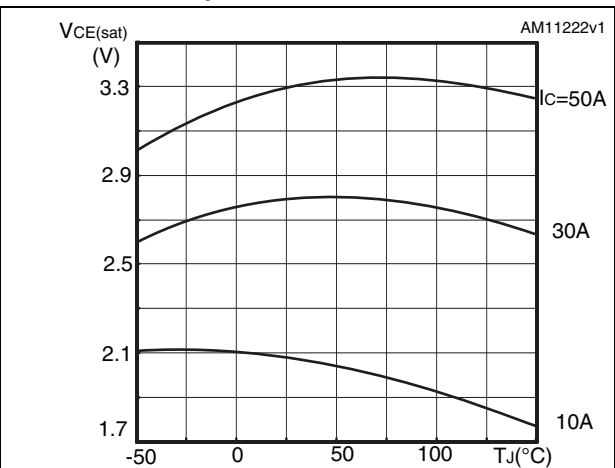


Figure 6. Gate charge vs. gate-source voltage

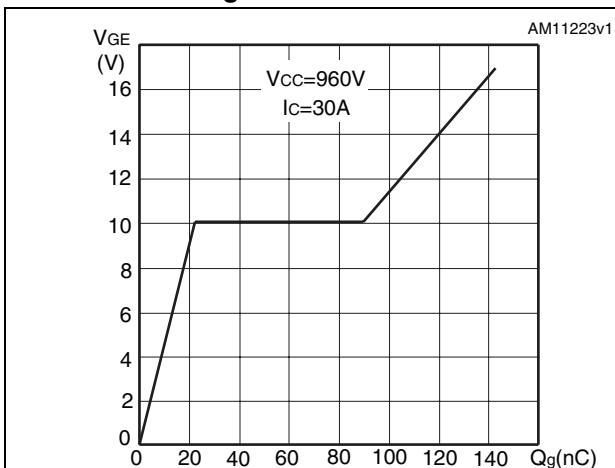


Figure 7. Capacitance variations

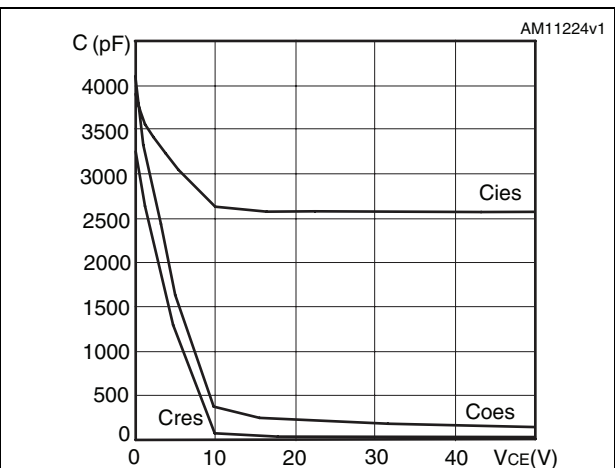


Figure 8. Normalized gate threshold voltage vs. temperature

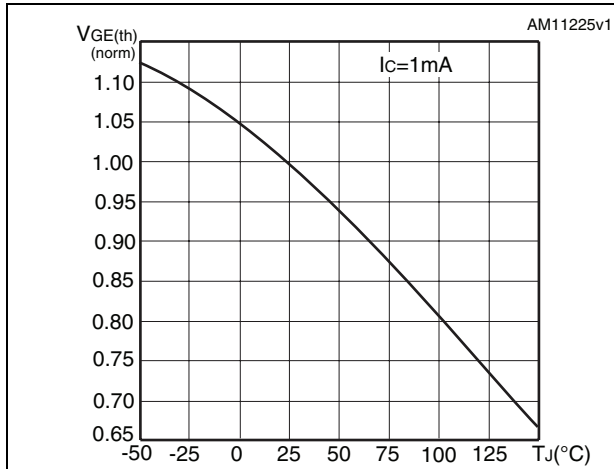


Figure 9. Normalized breakdown voltage vs. temperature

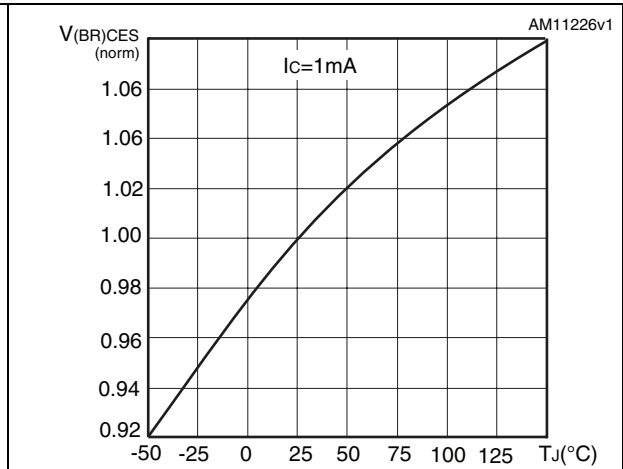


Figure 10. Switching losses vs. collector current

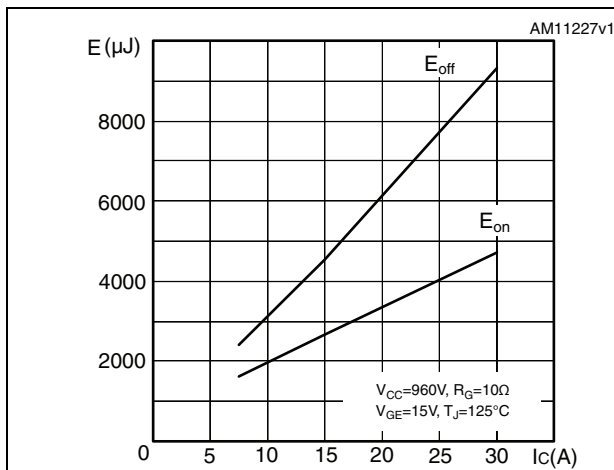


Figure 11. Switching losses vs. gate resistance

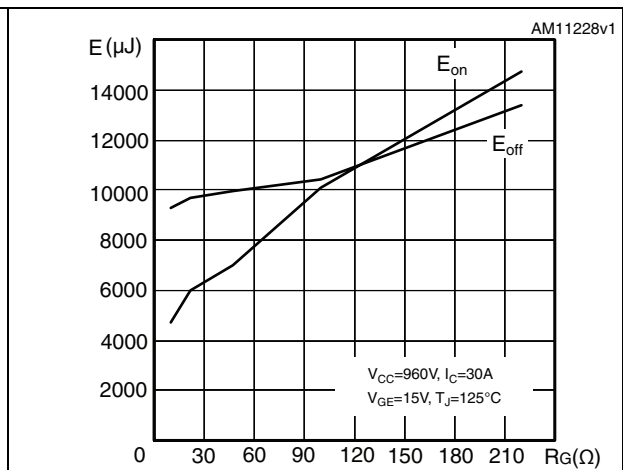


Figure 12. Switching losses vs. temperature

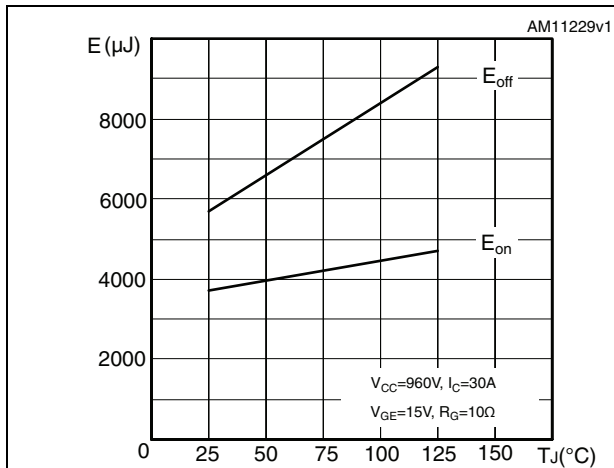


Figure 13. Thermal impedance

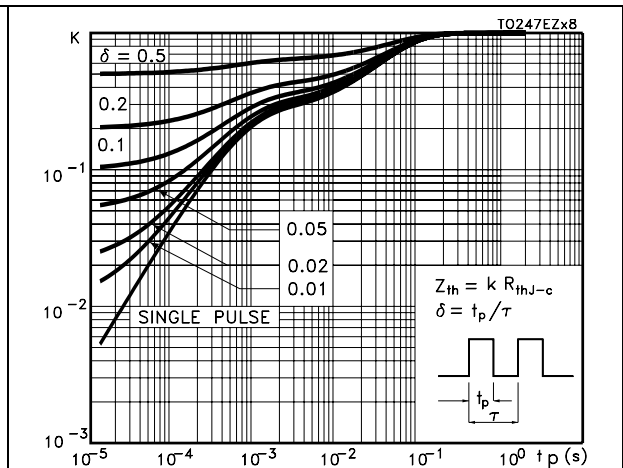


Figure 14. Turn-off SOA

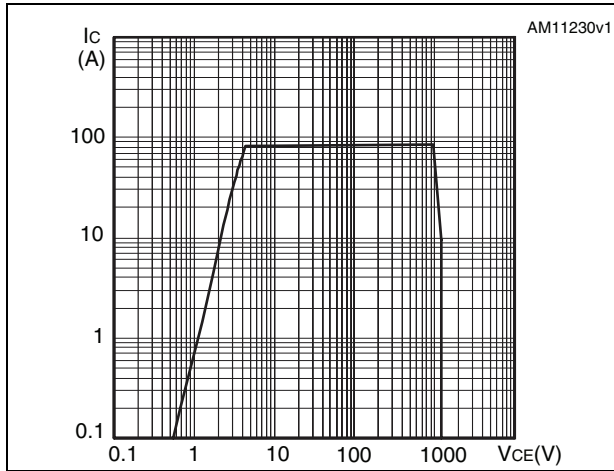
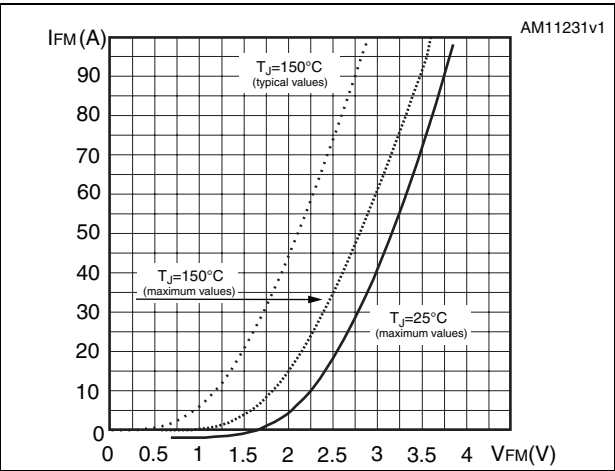


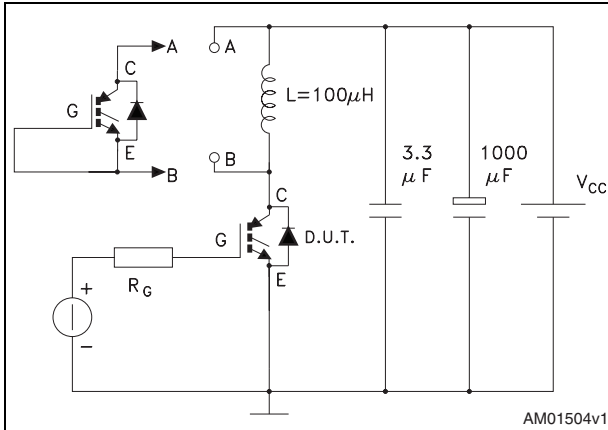
Figure 15. Forward voltage drop vs. forward current





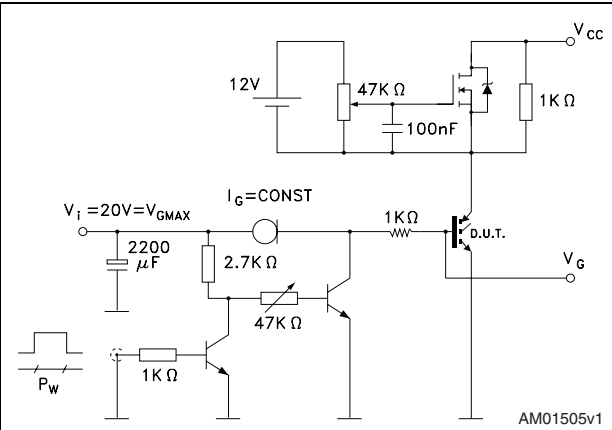
### 3 Test circuits

Figure 16. Test circuit for inductive load switching



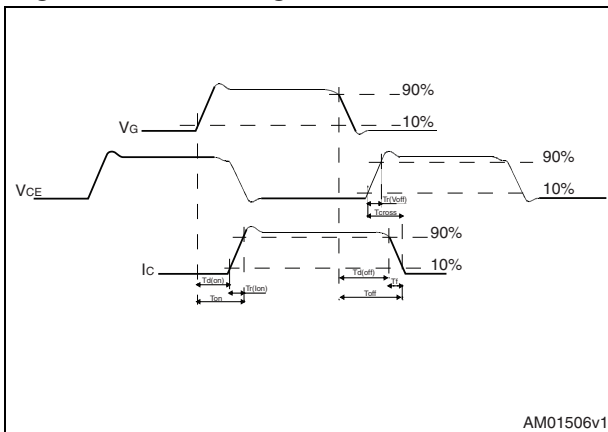
AM01504v1

Figure 17. Gate charge test circuit



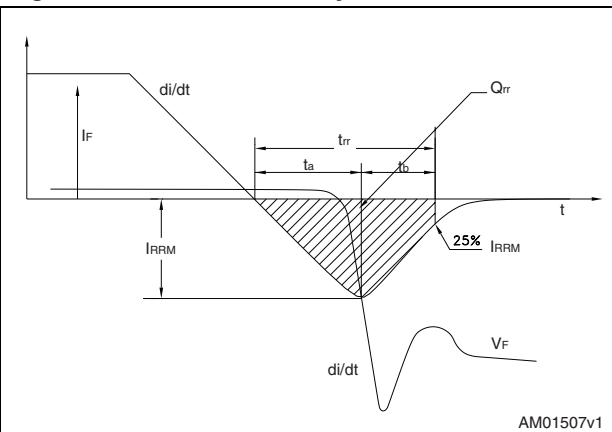
AM01505v1

Figure 18. Switching waveform



AM01506v1

Figure 19. Diode recovery time waveform



AM01507v1

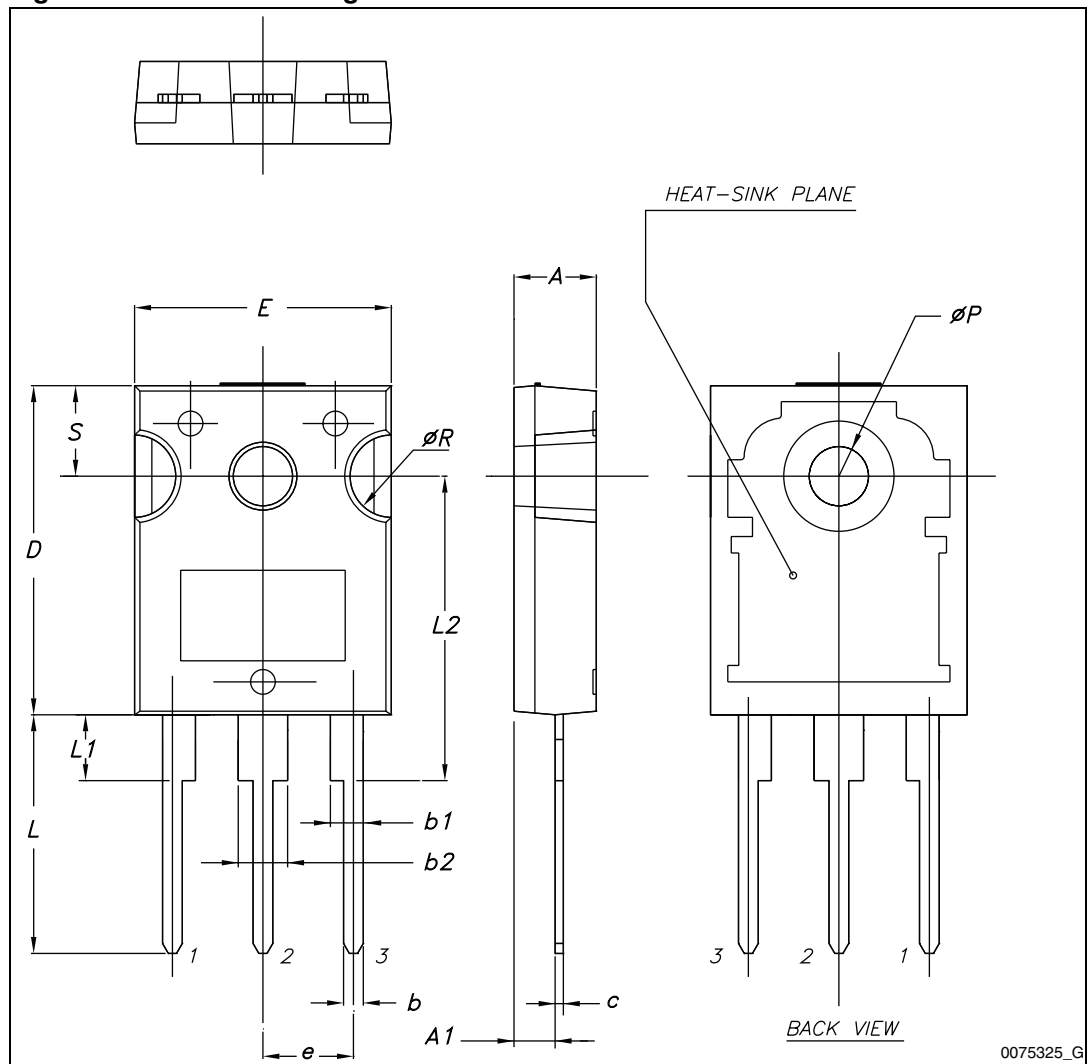
## 4 Package mechanical data

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 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	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

Figure 20. TO-247 drawing dimensions

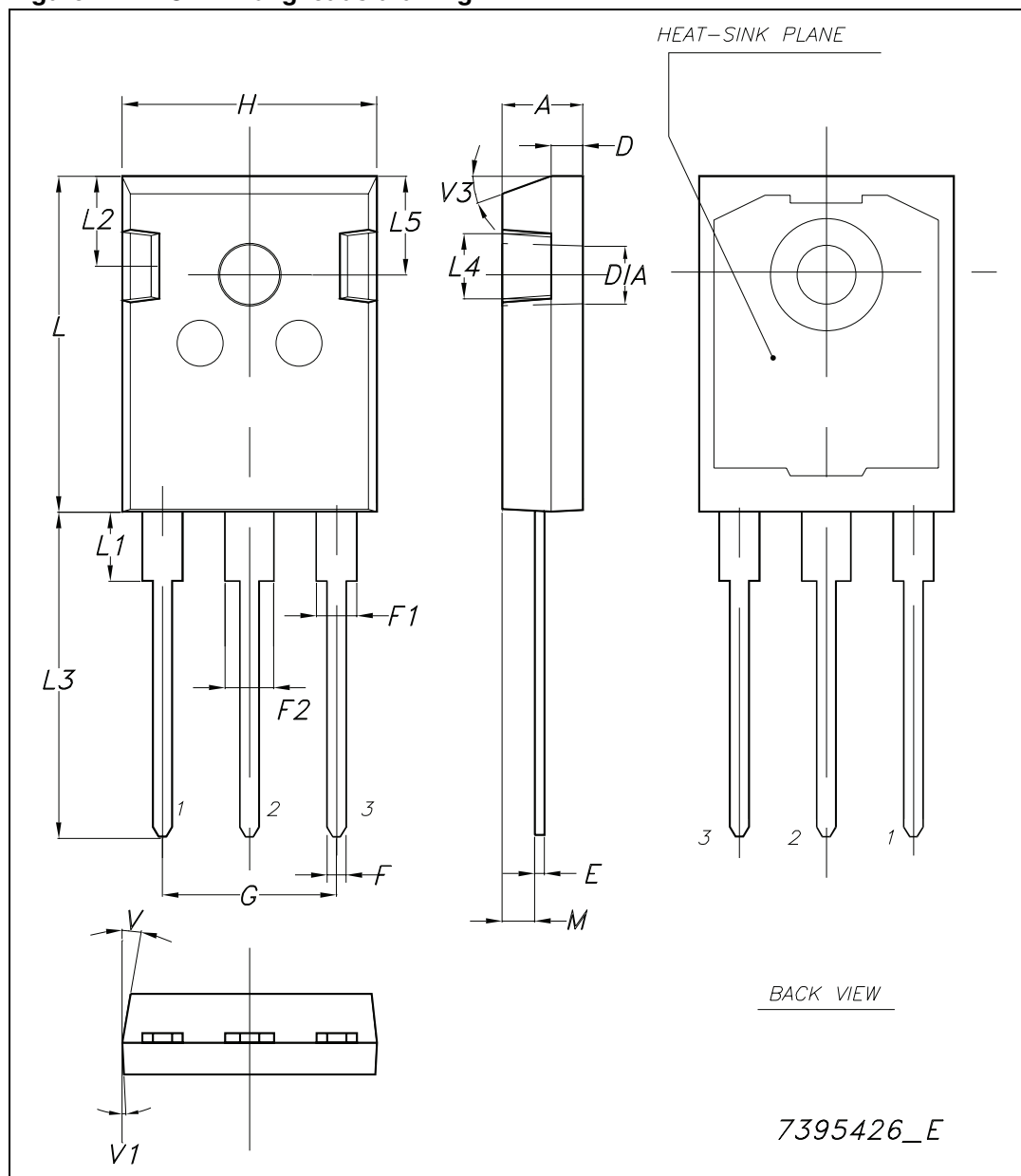


0075325\_G

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
22-Jan-2009	1	Initial release
29-Jun-2009	2	Document status promoted from preliminary data to datasheet.
09-Jul-2009	3	Inserted dynamic values <a href="#">Table 5 on page 4</a> , <a href="#">Table 6 on page 4</a> and <a href="#">Table 7 on page 5</a> .
11-Jan-2012	4	Added order code STGWA40N120KD <a href="#">Table 1 on page 1</a> , <a href="#">Section 2.1 on page 6</a> , mechanical data TO-247 long leads <a href="#">Table 10 on page 12</a> and <a href="#">Figure 21 on page 13</a> .
27-Feb-2012	5	Modified: <a href="#">Description on page 1</a> .

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY TWO AUTHORIZED ST REPRESENTATIVES, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2012 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)