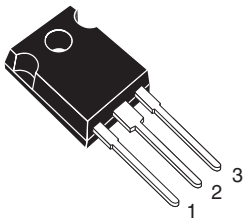
STGW60H65DF

60 A, 650 V field stop trench gate IGBT with very fast diode

Datasheet – production data

Features

- High speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- 6 µs short-circuit withstand time
- Very fast soft recovery antiparallel diode
- Lead free package

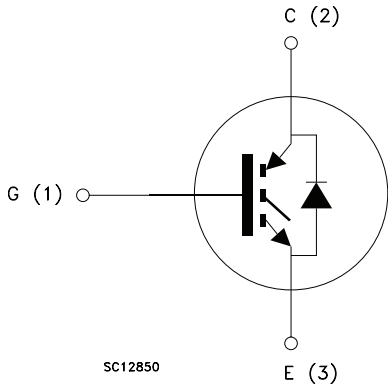


TO-247

Applications

- Photovoltaic inverters
- Uninterruptible power supply
- Welding
- Power factor correction
- High switching frequency converters

Figure 1. Internal schematic diagram



Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT is the result of a compromise between conduction and switching losses, maximizing the efficiency of high switching frequency converters. Furthermore, a slightly positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Table 1. Device summary

Order code	Marking	Package	Packaging
STGW60H65DF	GW60H65DF	TO-247	Tube

This is information on a product in full production. www.st.com

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	650	V
I_C	Continuous collector current at T_C = 25 °C	120	A
I_C	Continuous collector current at T_C = 100 °C	60	A
I_{CP} (1)	Pulsed collector current	240	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	120	A
I_F	Continuous forward current at T_C = 100 °C	60	A
I_{FP} (1)	Pulsed forward current	240	A
P_{TOT}	Total dissipation at T_C = 25 °C	360	W
t_{SC}	Short-circuit withstand time at V_{CC} = 400 V, V_{GE} = 15 V	6	µs
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature		

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

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.35	°C/W
R_{thJC}	Thermal resistance junction-case diode	1.38	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	°C/W

2 Electrical characteristics

T_J = 25 °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 = 2 mA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 60 A		1.9		V
		V_{GE} = 15 V, I_C = 60 A T_J = 150 °C		2.1		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA		6.0		V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 650 V			25	µA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ± 20 V			250	nA

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0	-	7150 345 125	-	pF pF pF
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 60 A, V_{GE} = 15 V	-	206	-	nC
Q_{ge}	Gate-emitter charge		-	60	-	nC
Q_{gc}	Gate-collector charge		-	70	-	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_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V	-	67 46 1043	-	ns ns A/µs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V T_J = 150 °C	-	64 49 990	-	ns ns A/µs
$t_r(V_{off})$ $t_{d(off)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V	-	41 165 34	-	ns ns ns
$t_r(V_{off})$ $t_{d(off)}$ t_f	Off voltage rise time Turn-off delay time Current fall time	V_{CE} = 400 V, I_C = 60 A, R_G = 10 Ω, V_{GE} = 15 V T_J = 150 °C	-	49 169 78	-	ns ns ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Eon (1)	Turn-on switching losses	V_{CE} = 400 V, I_C = 60 A,	-	1.5	-	mJ
E_{off} (2)	Turn-off switching losses	R_G = 10 Ω, V_{GE} = 15 V		1.1		mJ
E_{ts}	Total switching losses			2.6		mJ
Eon (1)	Turn-on switching losses	V_{CE} = 400 V, I_C = 60 A,	-	2.7	-	mJ
E_{off} (2)	Turn-off switching losses	R_G = 10 Ω, V_{GE} = 15 V		1.5		mJ
E_{ts}	Total switching losses	T_J = 150 °C		4.2		mJ

1. Eon is the turn-on losses when a typical diode is used in the test circuit in *Figure 23*. 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).
2. 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 = 60 A	-		2.6	V
		I_F = 60 A, T_J = 150 °C		1.6		V
t_{rr}	Reverse recovery time	I_F = 60 A, V_R = 400 V,	-	62	-	ns
Q_{rr}	Reverse recovery charge	di/dt = 1700 A/µs		930		nC
I_{rrm}	Reverse recovery current			30		A
t_{rr}	Reverse recovery time	I_F = 60 A, V_R = 400 V,	-	100	-	ns
Q_{rr}	Reverse recovery charge	di/dt = 1630 A/µs		2800		nC
I_{rrm}	Reverse recovery current	T_J = 150 °C		58		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics (T_J = -40 °C)

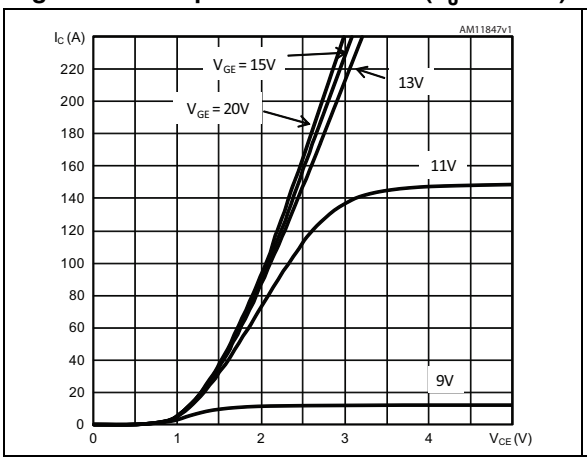


Figure 3. Output characteristics (T_J = 25 °C)

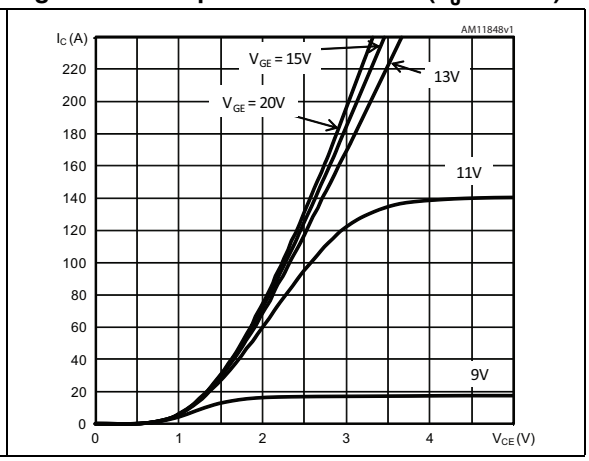


Figure 4. Output characteristics (T_J = 150 °C)

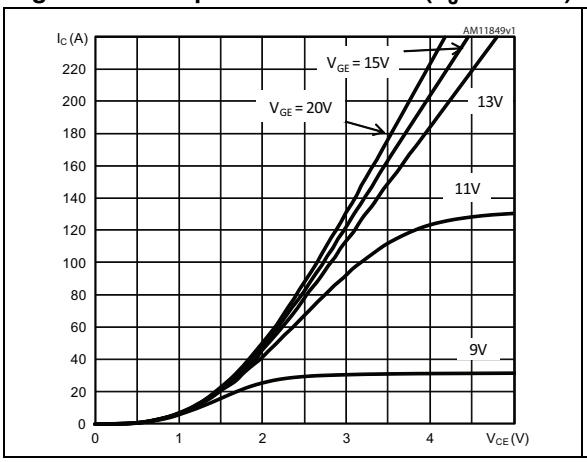


Figure 5. Transfer characteristics

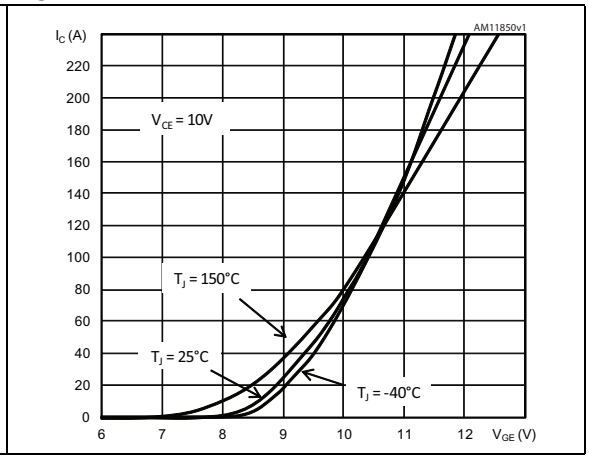


Figure 6. $V_{CE(SAT)}$ vs. junction temperature

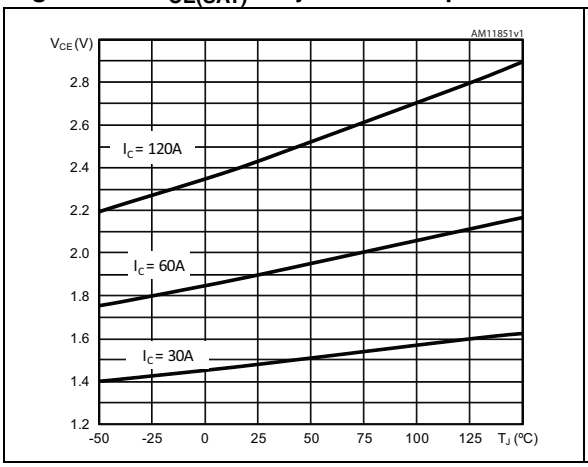


Figure 7. $V_{CE(SAT)}$ vs. collector current

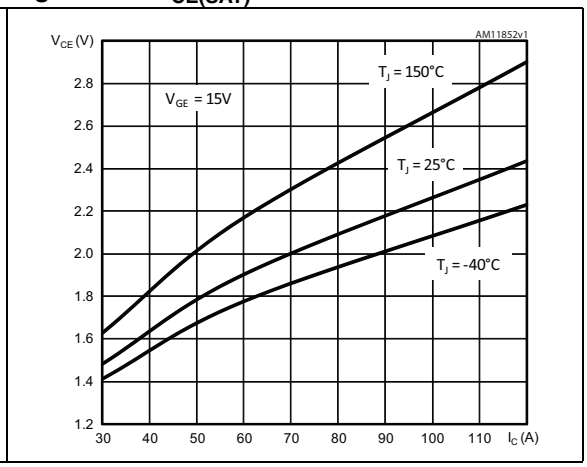


Figure 8. Normalized $V_{GE(th)}$ vs. junction temperature

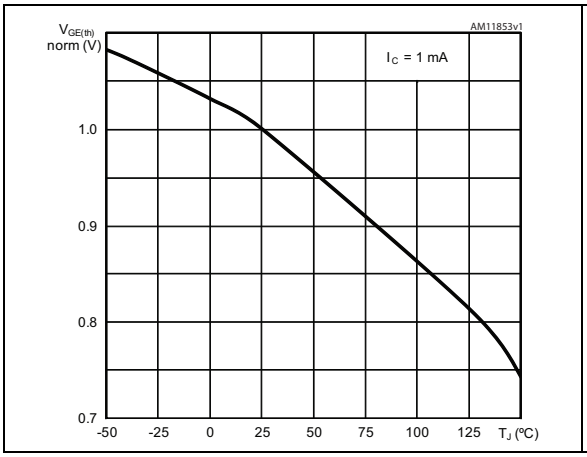


Figure 9. Gate charge vs. gate-emitter voltage

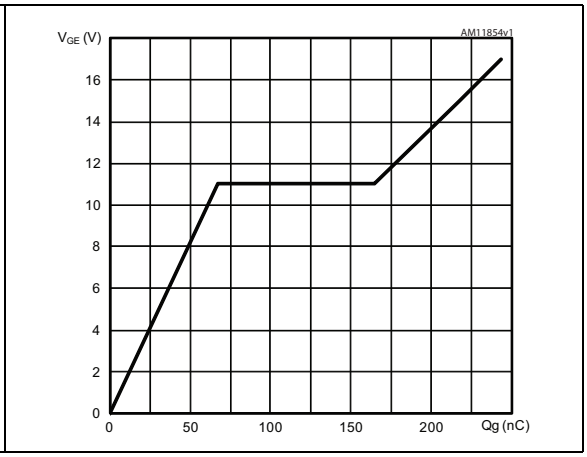


Figure 10. Capacitance variations (f = 1 MHz, V_{GE} = 0)

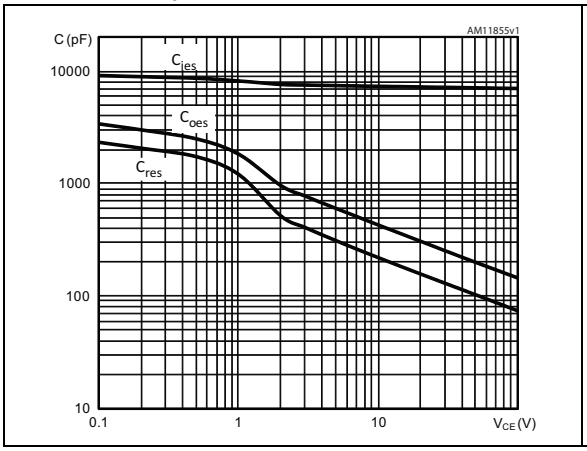


Figure 11. Switching losses vs. collector current

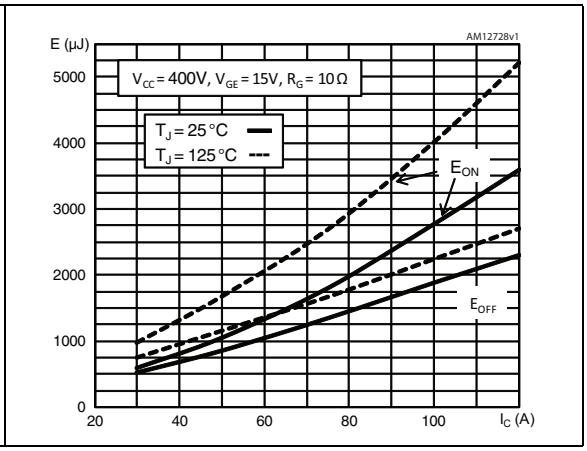


Figure 12. Switching losses vs. gate resistance

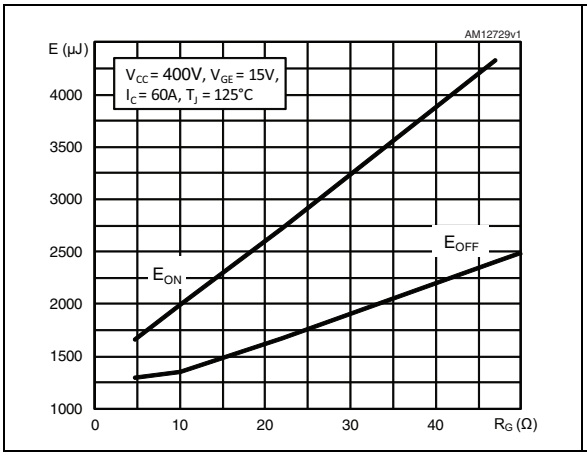


Figure 13. Switching losses vs. temperature

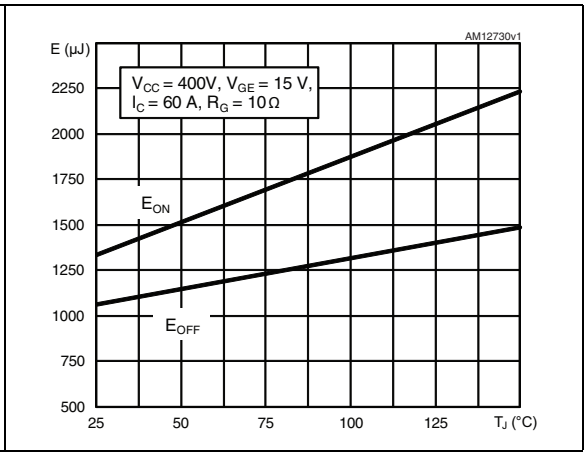


Figure 14. Turn-OFF SOA

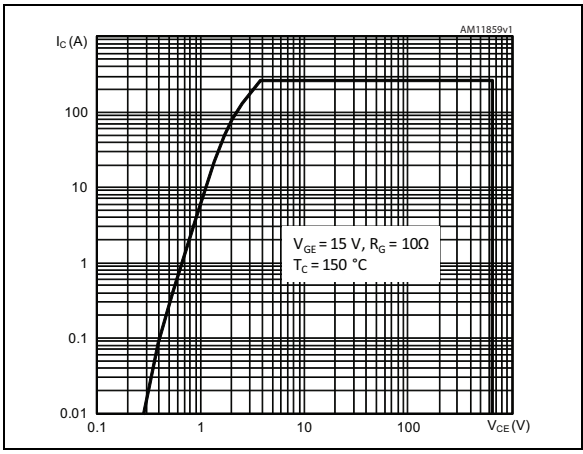


Figure 15. Short circuit time & current vs. V_{GE}

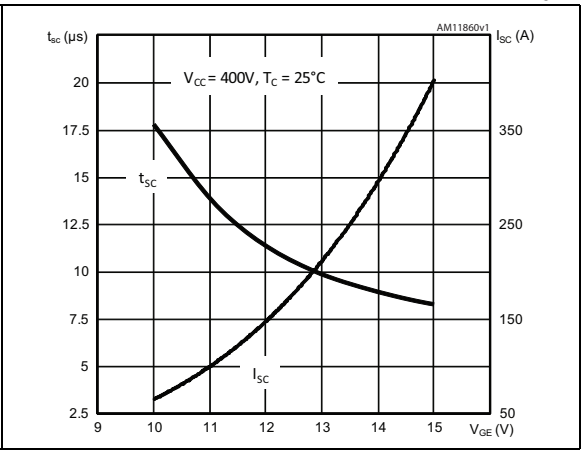


Figure 16. Diode forward current vs. forward voltage

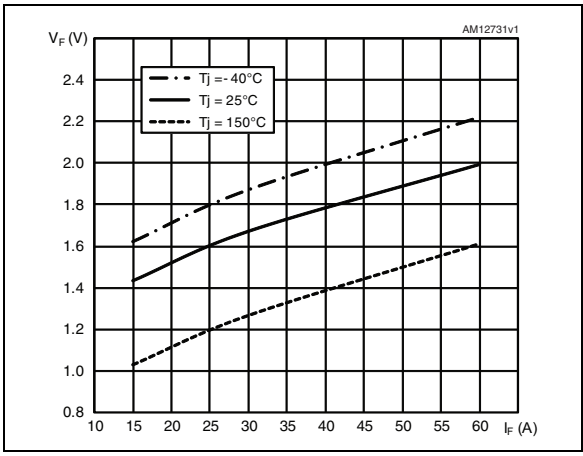


Figure 17. Diode forward current vs. junction temperature

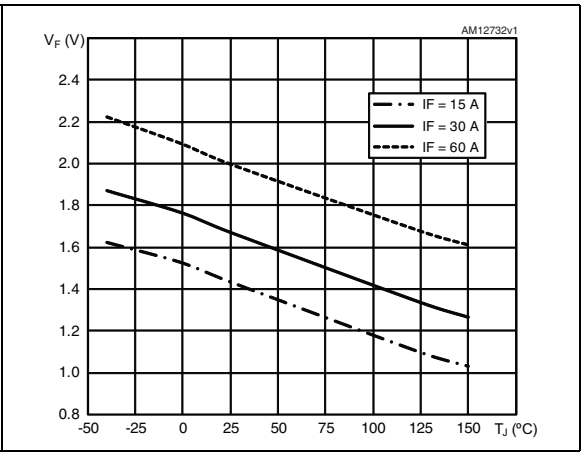


Figure 18. Reverse recovery current as a function of diode current slope

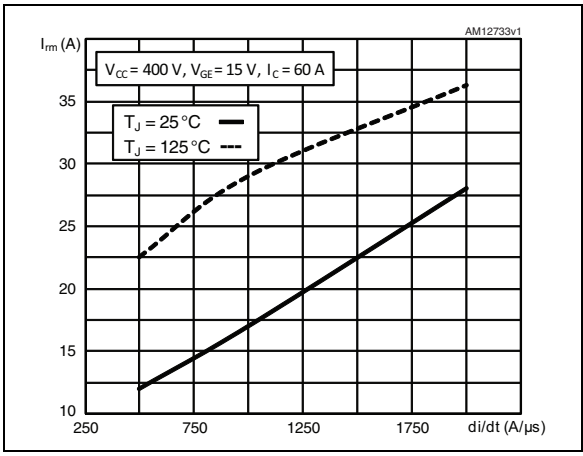


Figure 19. Reverse recovery time as a function of diode current slope

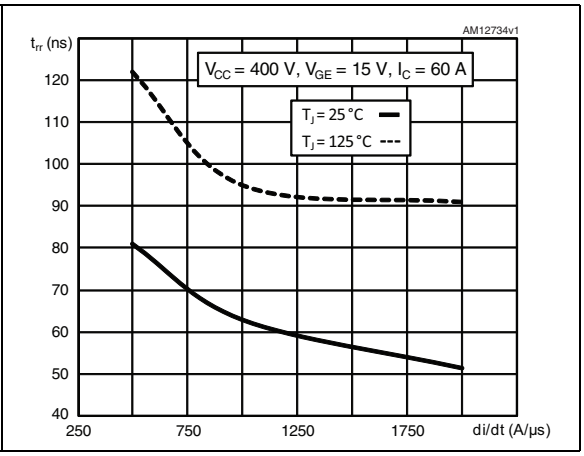


Figure 20. Reverse recovery charge as a function of diode current slope

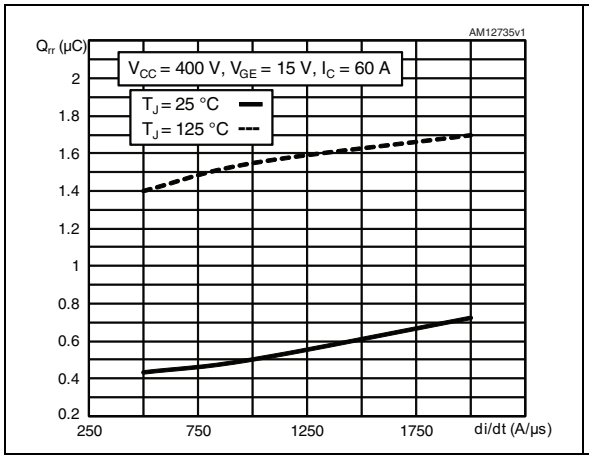


Figure 21. Maximum normalized Z_{th} junction to case (IGBT)

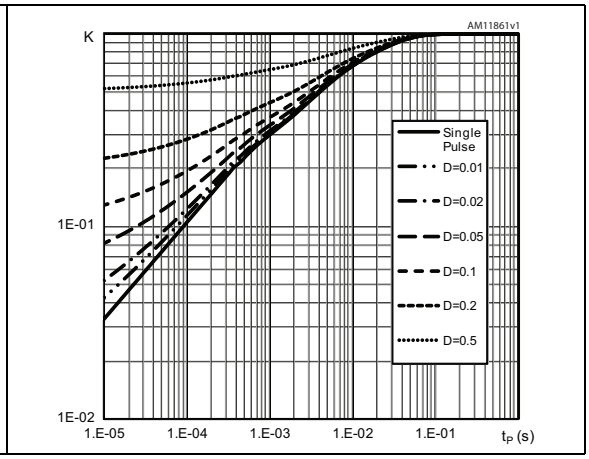
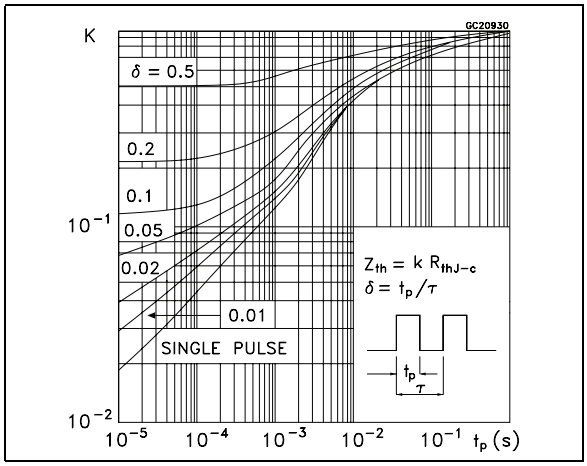


Figure 22. Maximum normalized Z_{th} junction to case (Diode)



3 Test circuits

Figure 23. Test circuit for inductive load switching

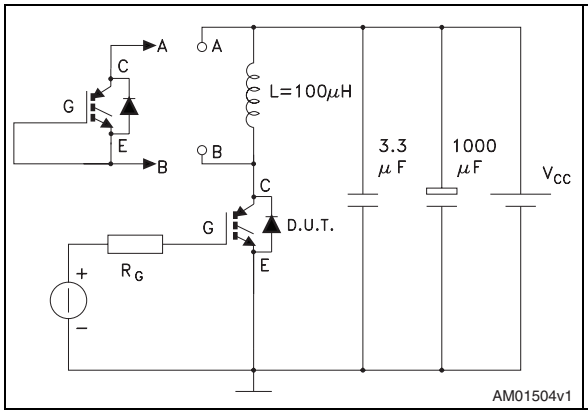


Figure 24. Gate charge test circuit

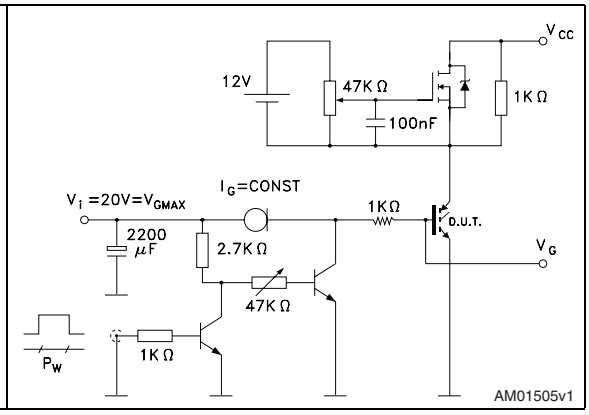


Figure 25. Switching waveform

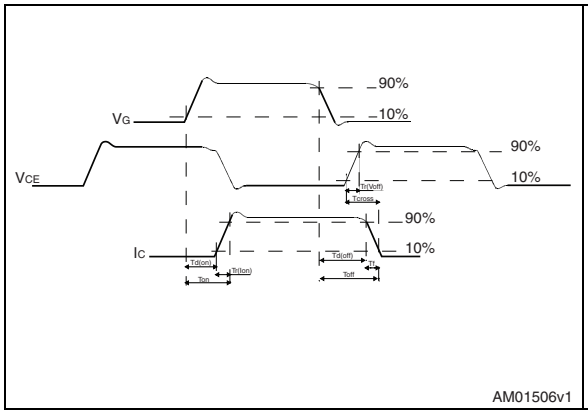
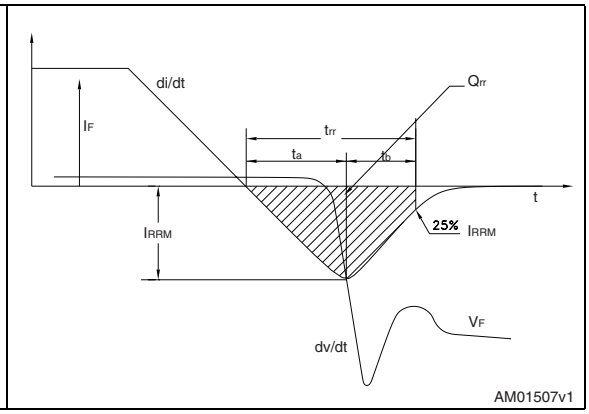


Figure 26. Diode recovery time waveform



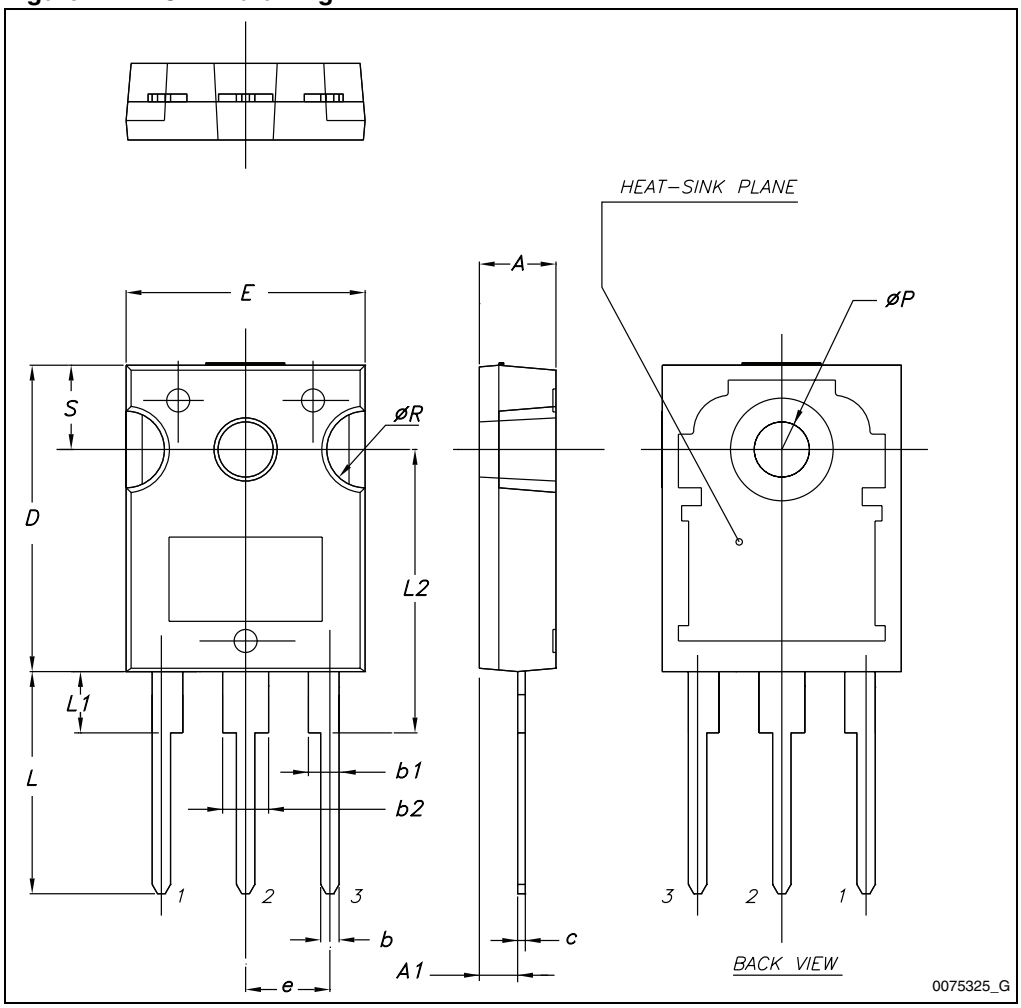
4 Package mechanical data

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. 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	
∅P	3.55		3.65
∅R	4.50		5.50
S	5.30	5.50	5.70

Figure 27. TO-247 drawing



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
28-Mar-2012	1	Initial release.
06-Jun-2012	2	Document status promoted from preliminary data production data. Added: *Section 2.1: Electrical characteristics (curves) on page 5*.
26-Jul-2012	3	Updated: *Figure 8 on page 6*.
09-Jan-2013	4	Modified: V_F typ. and max. values *Table 8 on page 4*.

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.

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