STGD6M65DF2

Trench gate field-stop IGBT, M series 650 V, 6 A low loss

Datasheet - production data

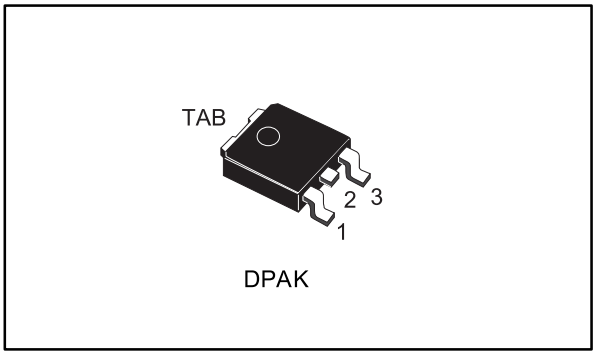
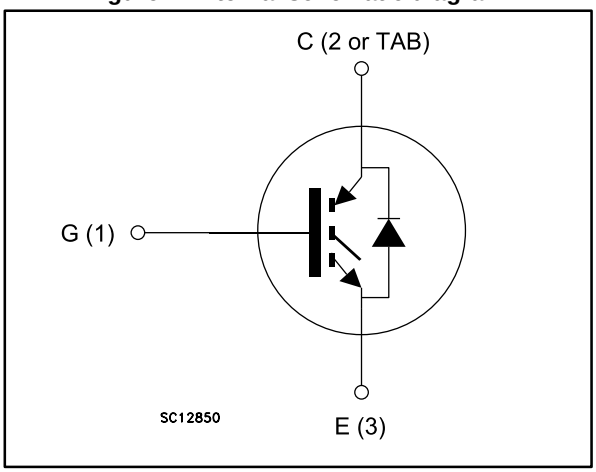


Figure 1: Internal schematic diagram



Features

- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.55 V (typ.) @ I_C = 6 A
- Tight parameter distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

Applications

- Motor control
- UPS
- PFC

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where low-loss and short-circuit functionality are essential. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGD6M65DF2	G6M65DF2	DPAK	Tape and reel

This is information on a product in full production.

www.st.com

Contents

1 Electrical ratings 3
2 Electrical characteristics 4
2.1 Electrical characteristics (curves) 7
3 Test circuits 12
4 Package information 13
4.1 DPAK (TO-252) type A2 package information 14
4.2 DPAK (TO-252) packing information 17
5 Revision history 19

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	650	V
I_C	Continuous collector current at T_C = 25 °C	12	A
	Continuous collector current at T_C = 100 °C	6	A
I_{CP} (1)	Pulsed collector current	24	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	12	A
	Continuous forward current at T_C = 100 °C	6	A
I_{FP} (1)	Pulsed forward current	24	A
P_{TOT}	Total dissipation at T_C = 25 °C	88	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature range	- 55 to 175	°C

Notes:

(1)Pulse width limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	1.7	°C/W
R_{thJC}	Thermal resistance junction-case diode	5	°C/W
R_{thJA}	Thermal resistance junction-ambient	100	°C/W

2 Electrical characteristics

T_C = 25 °C unless otherwise specified

Table 4: Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	V_{GE} = 0 V, I_C = 250 µA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 6 A		1.55	2.0	V
		V_{GE} = 15 V, I_C = 6 A, T_J = 125 °C		1.9		
		V_{GE} = 15 V, I_C = 6 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 6 A		2.2		V
		I_F = 6 A, T_J = 125 °C		2.0		
		I_F = 6 A, T_J = 175 °C		1.9		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 µA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 650 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ± 20 V			±250	µA

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE}= 25 V, f = 1 MHz, V_{GE} = 0 V	-	530	-	pF
C_{oes}	Output capacitance		-	31	-	
C_{res}	Reverse transfer capacitance		-	11	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 6 A, V_{GE} = 15 V (see *Figure 30: " Gate charge test circuit"*)	-	21.2	-	nC
Q_{ge}	Gate-emitter charge		-	5.2	-	
Q_{gc}	Gate-collector charge		-	8.8	-	

Table 6: IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 6 A, V_{GE} = 15 V, R_G = 22 Ω (see *Figure 29: " Test circuit for inductive load switching"*)		15	-	ns
t_r	Current rise time			5.8	-	ns
$(di/dt)_{on}$	Turn-on current slope			828	-	A/µs
$t_{d(off)}$	Turn-off-delay time			90	-	ns
t_f	Current fall time			130	-	ns
E_{on}(1)	Turn-on switching energy			0.036	-	mJ
E_{off}(2)	Turn-off switching energy			0.200	-	mJ
E_{ts}	Total switching energy			0.236	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 6 A, V_{GE} = 15 V, R_G = 22 Ω T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*)		17	-	ns
t_r	Current rise time			7	-	ns
$(di/dt)_{on}$	Turn-on current slope			685	-	A/µs
$t_{d(off)}$	Turn-off-delay time			86	-	ns
t_f	Current fall time			205	-	ns
E_{on}(1)	Turn-on switching energy			0.064	-	mJ
E_{off}(2)	Turn-off switching energy			0.290	-	mJ
E_{ts}	Total switching energy			0.354	-	mJ
t_{sc}	Short-circuit withstand time	V_{CC} ≤ 400 V, V_{GE} = 15 V, T_{Jstart} = 150 °C	6		-	µs
		V_{CC} ≤ 400 V, V_{GE} = 13 V, T_{Jstart} = 150 °C	10		-	µs

Notes:

(1)Turn-on switching energy includes reverse recovery of the diode.

(2)Turn-off switching energy also includes the tail of the collector current.

Table 7: Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	I_F = 6 A, V_R = 400 V, V_{GE} = 15 V (see *Figure 29: " Test circuit for inductive load switching"*) di/dt = 1000 A/µs	-	140	-	ns
Q_{rr}	Reverse recovery charge		-	210	-	nC
I_{rrm}	Reverse recovery current		-	6.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	430	-	A/µs
E_{rr}	Reverse recovery energy		-	16	-	µJ
t_{rr}	Reverse recovery time	I_F = 6 A, V_R = 400 V, V_{GE} = 15 V T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*) di/dt = 1000 A/µs	-	200	-	ns
Q_{rr}	Reverse recovery charge		-	473	-	nC
I_{rrm}	Reverse recovery current		-	9.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	428	-	A/µs
E_{rr}	Reverse recovery energy		-	32	-	µJ

2.1 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

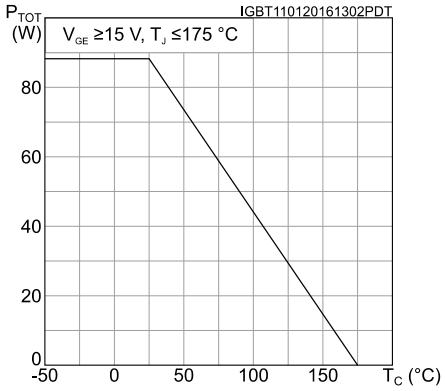


Figure 3: Collector current vs. case temperature

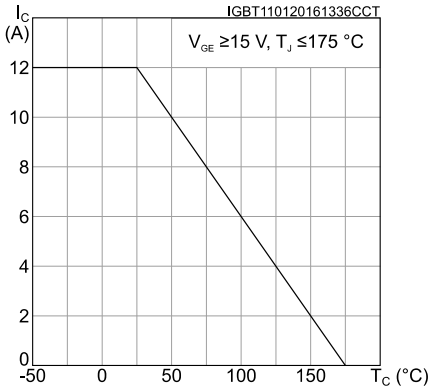


Figure 4: Output characteristics (T_J = 25 °C)

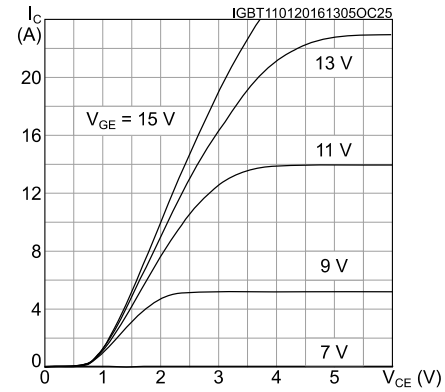


Figure 5: Output characteristics (T_J = 175 °C)

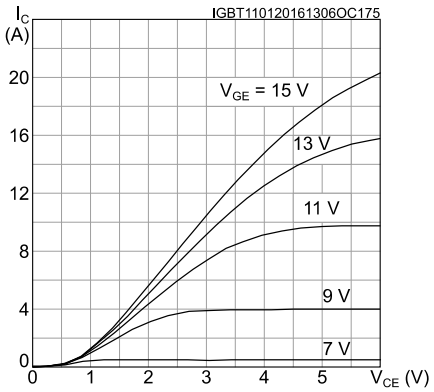


Figure 6: $V_{CE(sat)}$ vs. junction temperature

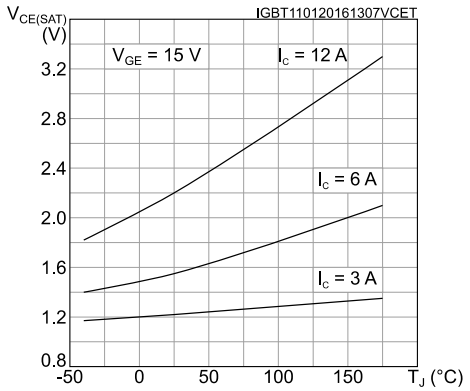


Figure 7: $V_{CE(sat)}$ vs. collector current

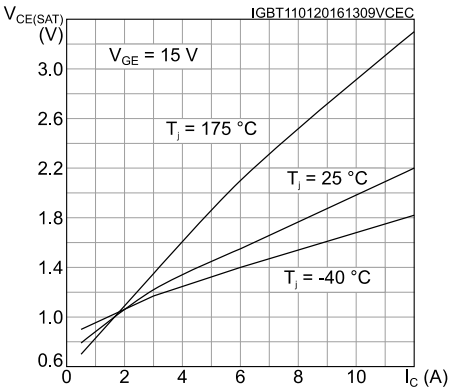


Figure 8: Collector current vs. switching frequency

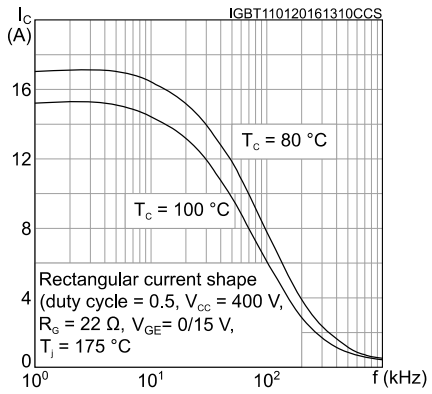


Figure 9: Forward bias safe operating area

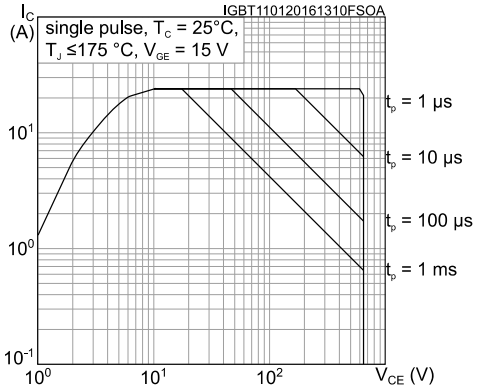


Figure 10: Transfer characteristics

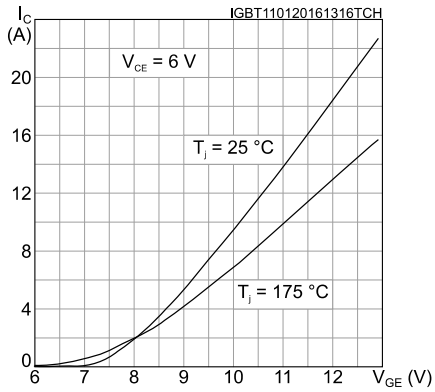


Figure 11: Diode V_F vs. forward current

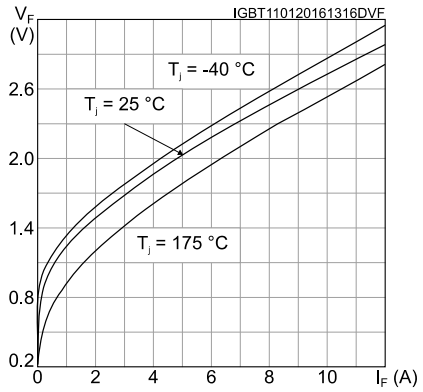


Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature

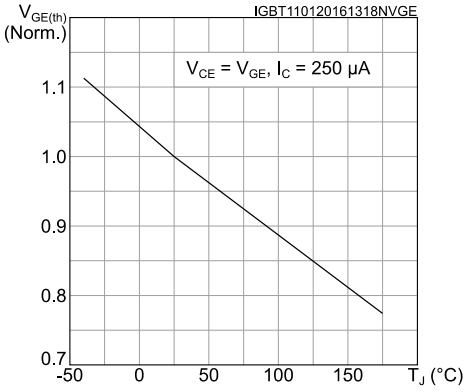


Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature

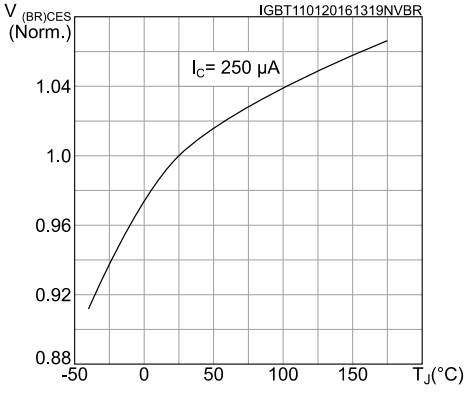


Figure 14: Capacitance variations

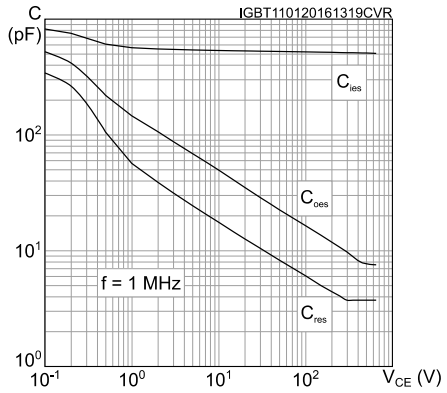


Figure 15: Gate charge vs. gate-emitter voltage

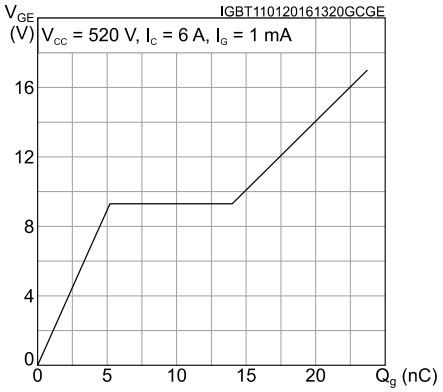


Figure 16: Switching energy vs. collector current

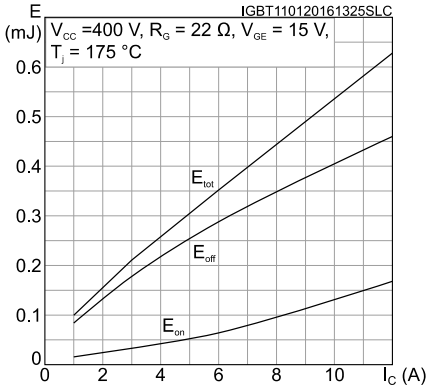


Figure 17: Switching energy vs. gate resistance

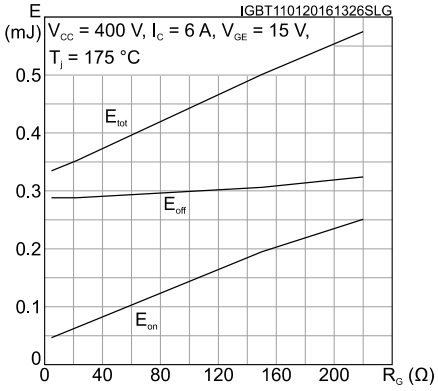


Figure 18: Switching energy vs. temperature

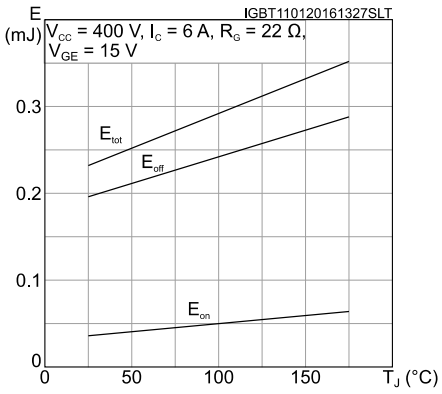


Figure 19: Switching energy vs. collector emitter voltage

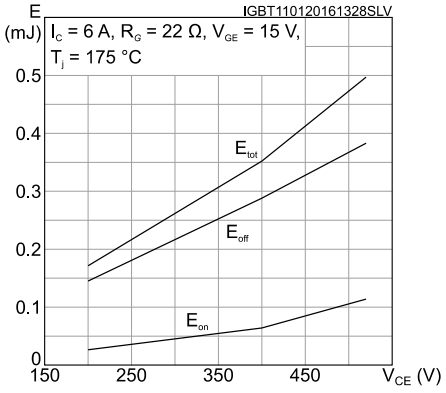


Figure 20: Short-circuit time and current vs. V_{GE}

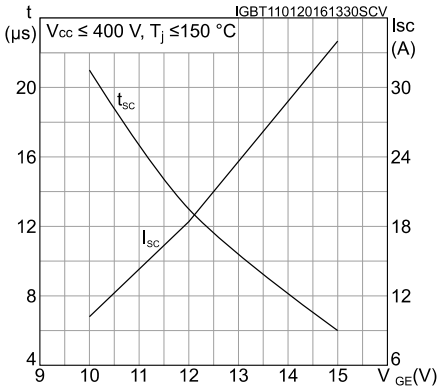


Figure 21: Switching times vs. collector current

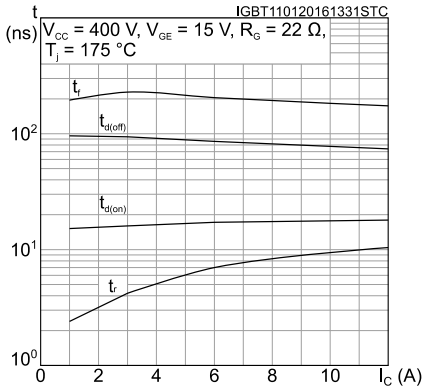


Figure 22: Switching times vs. gate resistance

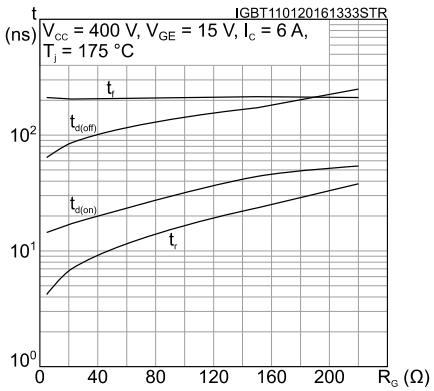


Figure 23: Reverse recovery current vs. diode current slope

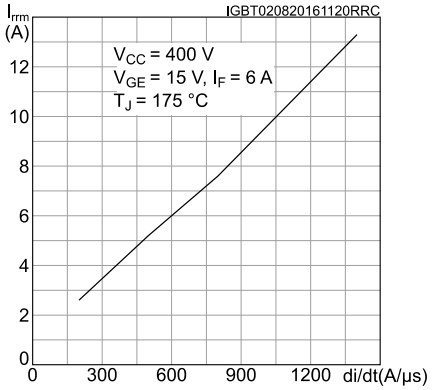


Figure 24: Reverse recovery time vs. diode current slope

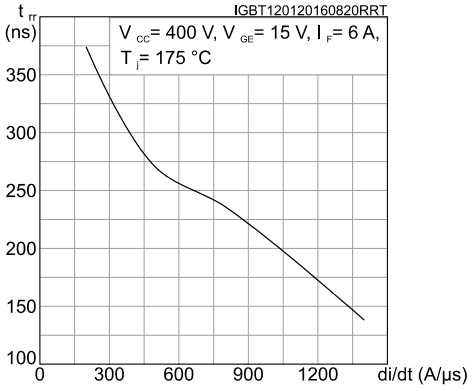


Figure 25: Reverse recovery charge vs. diode current slope

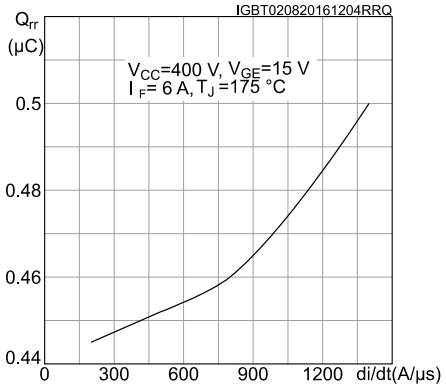


Figure 26: Reverse recovery energy vs. diode current slope

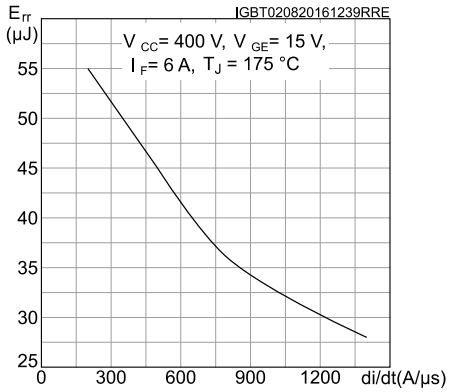


Figure 27: Thermal impedance for IGBT

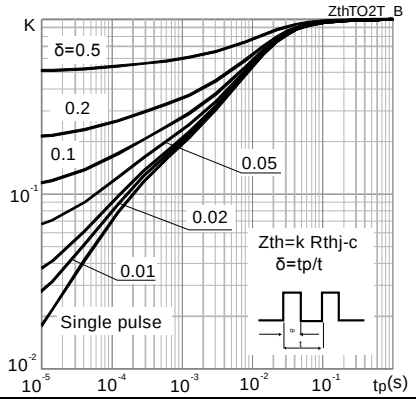
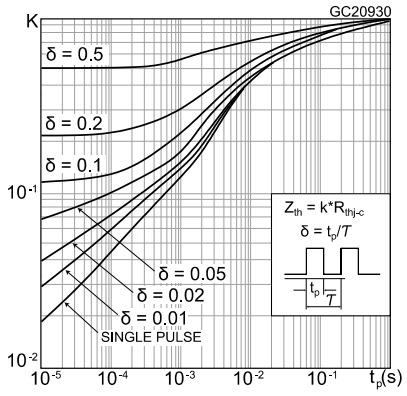


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

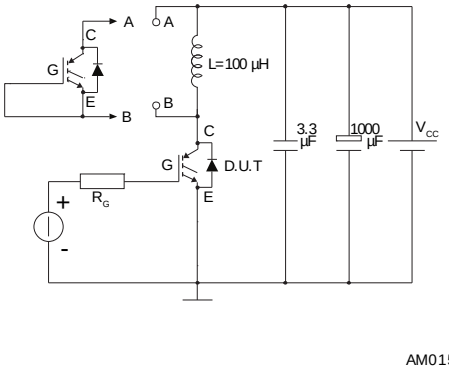


Figure 30: Gate charge test circuit

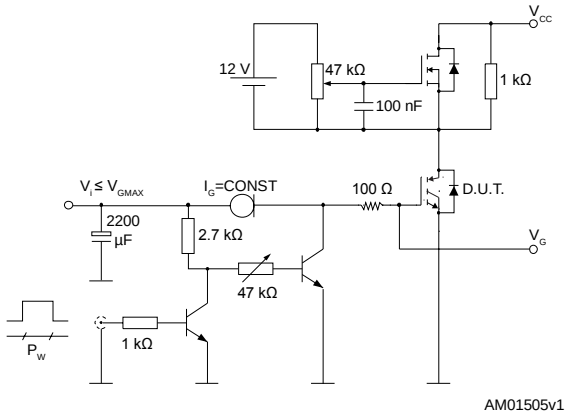


Figure 31: Switching waveform

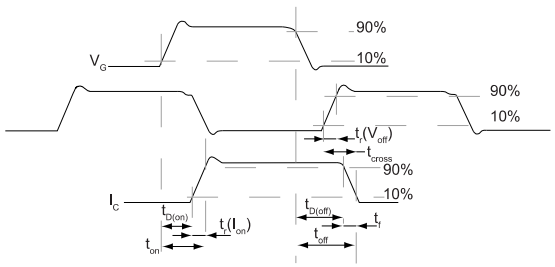
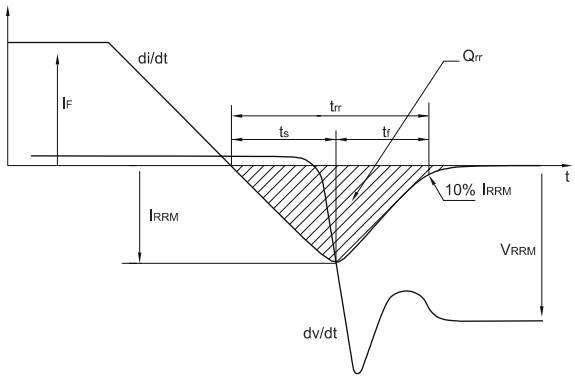


Figure 32: Diode reverse recovery waveform



4 Package information

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.

4.1 DPAK (TO-252) type A2 package information

Figure 33: DPAK (TO-252) type A2 package outline

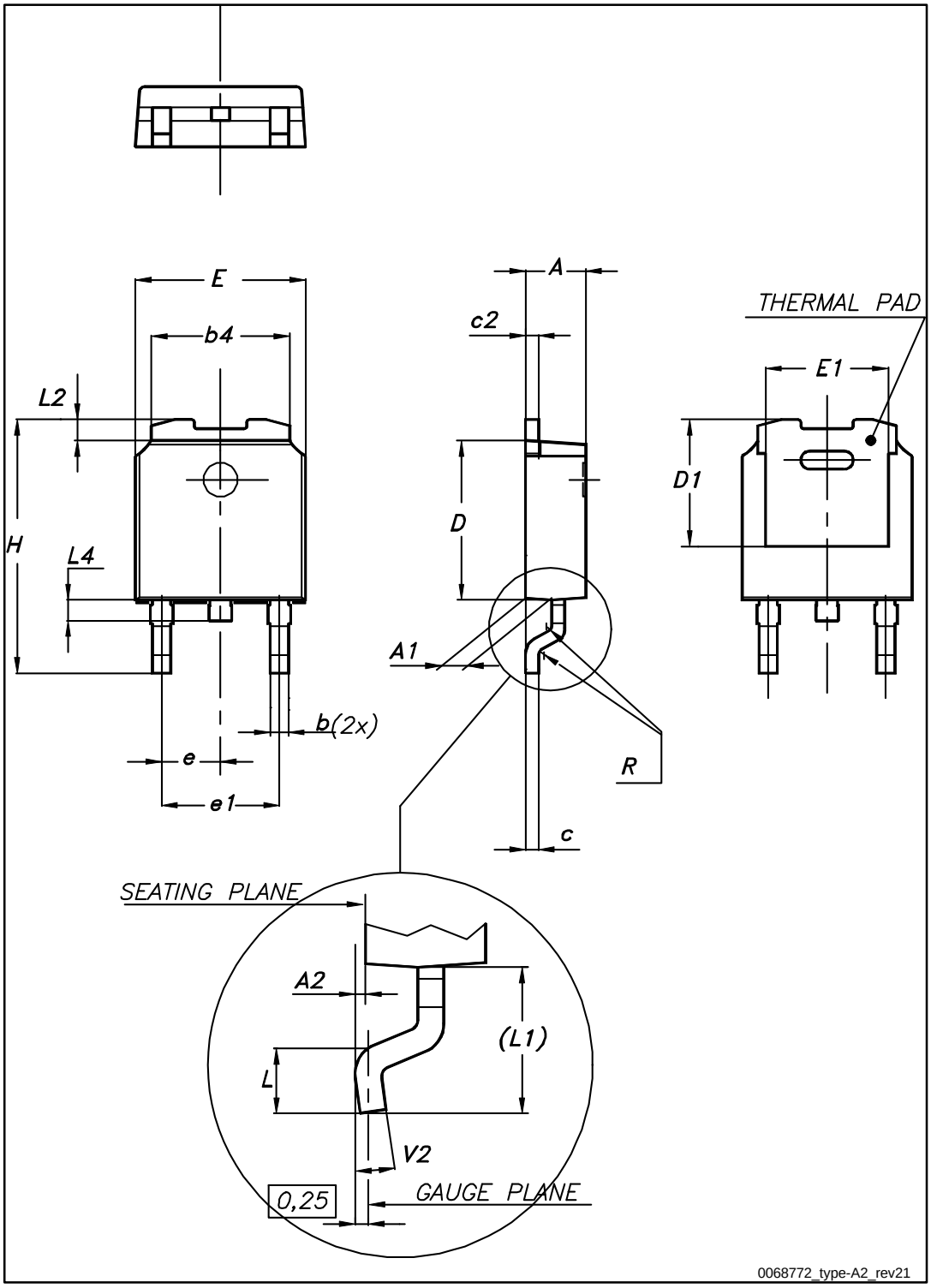
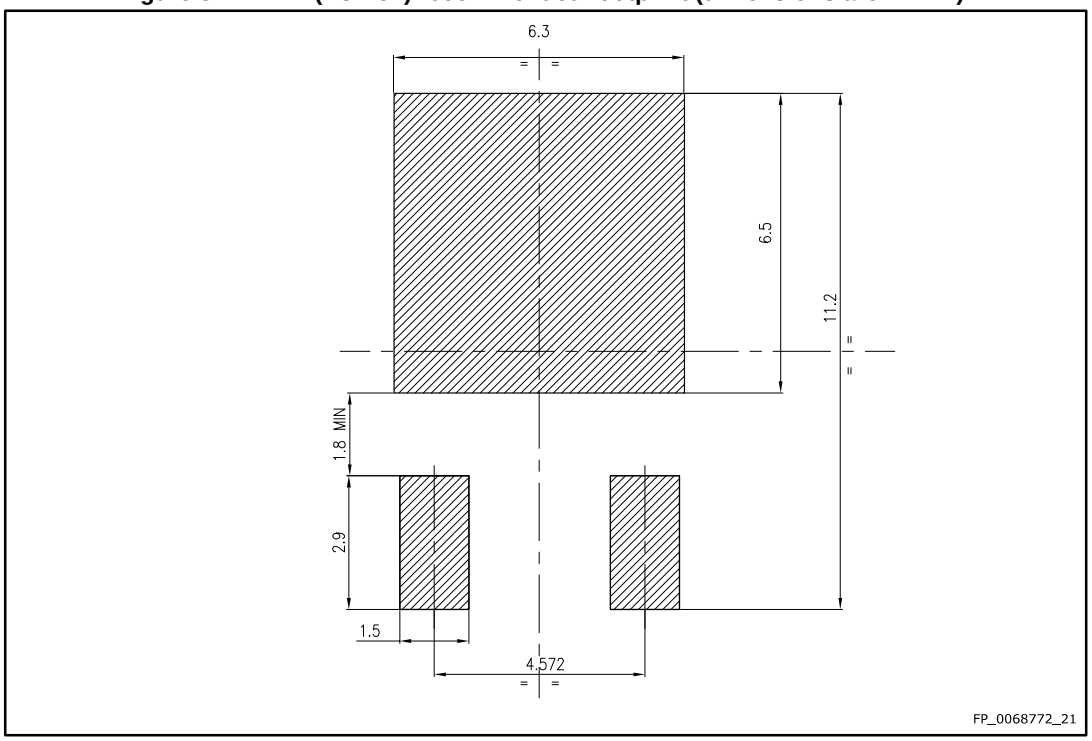


Table 8: DPAK (TO-252) type A2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	5.10	5.20	5.30
e	2.16	2.28	2.40
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
L1	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 34: DPAK (TO-252) recommended footprint (dimensions are in mm)



4.2 DPAK (TO-252) packing information

Figure 35: DPAK (TO-252) tape outline

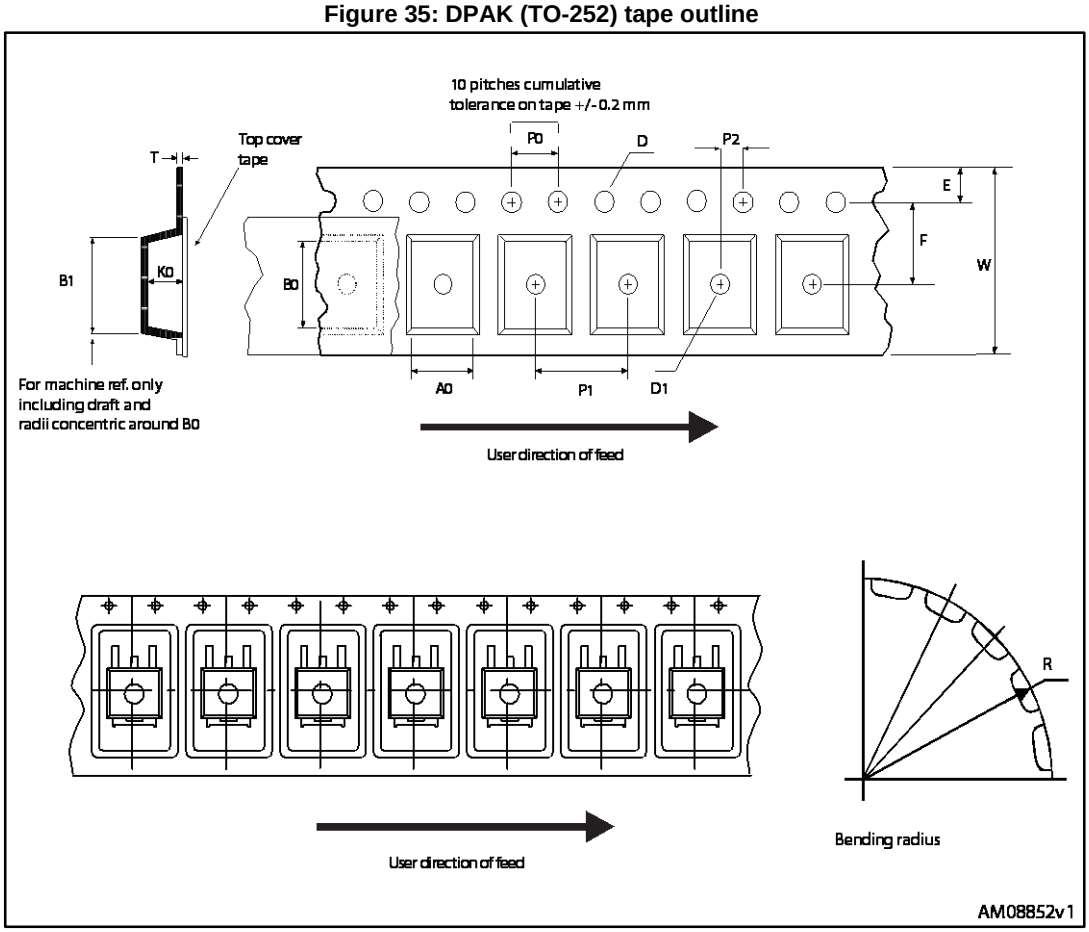


Figure 36: DPAK (TO-252) reel outline

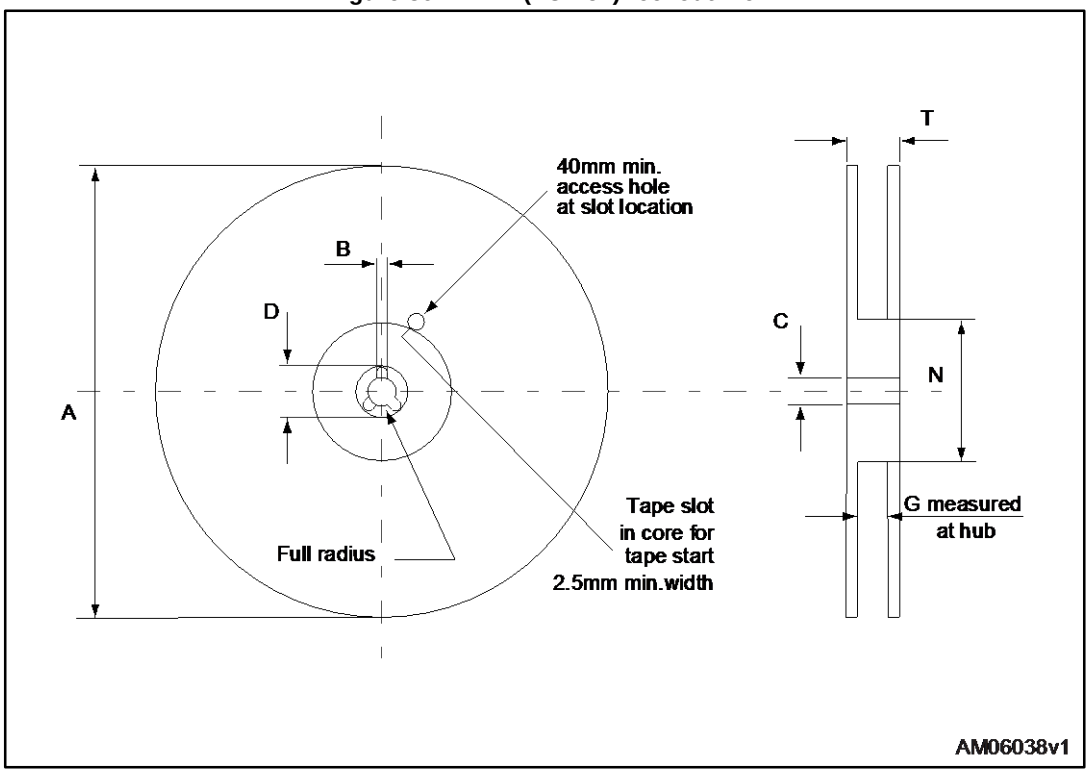


Table 9: DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

5 Revision history

Table 10: Document revision history

Date	Revision	Changes
30-Nov-2015	1	First release.
13-Jan-2016	2	Modified: *Table 4: "Static characteristics"*, *Table 5: "Dynamic characteristics"*, *Table 6: "IGBT switching characteristics (inductive load)"* and *Table 7: "Diode switching characteristics (inductive load)"* Added: *Section 2.1: "Electrical characteristics (curves)"* Minor text changes
04-Aug-2016	3	Updated: *Table 2: "Absolute maximum ratings"*, *Table 4: "Static characteristics"*, *Table 6: "IGBT switching characteristics (inductive load)"*,*Table 7: "Diode switching characteristics (inductive load)"*. Updated *Figure 9: "Forward bias safe operating area"*, *Figure 12: "Normalized VGE(th) vs. junction temperature"*, *Figure 20: "Short-circuit time and current vs. VGE"*,*Figure 23: "Reverse recovery current vs. diode current slope"*. Changed:*Figure 25: "Reverse recovery charge vs. diode current slope"*, and *Figure 26: "Reverse recovery energy vs. diode current slope"*. Document status promoted from preliminary to production data.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2016 STMicroelectronics – All rights reserved