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STGD4M65DF2

Trench gate field-stop IGBT, M series 650 V, 4 A low loss

Datasheet - production data

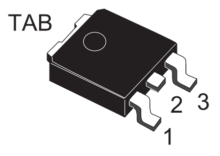
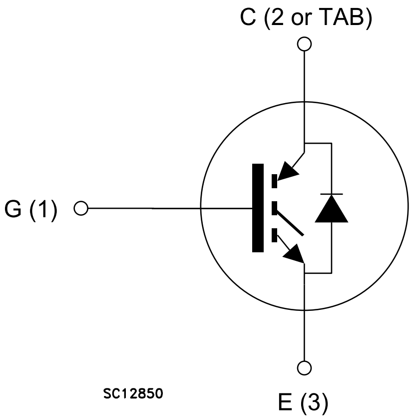


Figure 1: Internal schematic diagram



Features

- 6 µs of short-circuit withstand time
- $V_{CE(sat)}$ = 1.6 V (typ.) @ I_C = 4 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
STGD4M65DF2	G4M65DF2	DPAK	Tape and reel

Contents

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	8	A
	Continuous collector current at T_C = 100 °C	4	A
I_{CP} [(1)]	Pulsed collector current	16	A
V_{GE}	Gate-emitter voltage	±20	V
I_F	Continuous forward current at T_C = 25 °C	8	A
	Continuous forward current at T_C = 100 °C	4	A
I_{FP} [(1)]	Pulsed forward current	16	A
P_{TOT}	Total dissipation at T_C = 25 °C	68	W
T_{STG}	Storage temperature range	- 55 to 150	°C
T_J	Operating junction temperature range	- 55 to 175	°C

Notes:

[(1)] Pulse widht limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	2.2	°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 = 4 A		1.6	2.1	V
		V_{GE} = 15 V, I_C = 4 A, T_J = 125 °C		1.9		
		V_{GE} = 15 V, I_C = 4 A, T_J = 175 °C		2.1		
V_F	Forward on-voltage	I_F = 4 A		1.9		V
		I_F = 4 A, T_J = 125 °C		1.7		
		I_F = 4 A, T_J = 175 °C		1.6		
$V_{GE(th)}$	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	-	369	-	pF
C_{oes}	Output capacitance		-	24.8	-	
C_{res}	Reverse transfer capacitance		-	8	-	
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 4 A, V_{GE} = 15 V (see *Figure 30: " Gate charge test circuit"*)	-	15.2	-	nC
Q_{ge}	Gate-emitter charge		-	3	-	
Q_{gc}	Gate-collector charge		-	7	-	

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 = 4 A, V_{GE} = 15 V, R_G = 47 Ω (see *Figure 29: " Test circuit for inductive load switching"*)		12	-	ns
t_r	Current rise time			6.9	-	ns
$(di/dt)_{on}$	Turn-on current slope			480	-	A/µs
$t_{d(off)}$	Turn-off-delay time			86	-	ns
t_f	Current fall time			120	-	ns
E_{on} (1)	Turn-on switching energy			0.040	-	mJ
E_{off} (2)	Turn-off switching energy			0.136	-	mJ
E_{ts}	Total switching energy			0.176	-	mJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 4 A, V_{GE} = 15 V, R_G = 47 Ω, T_J = 175 °C (see *Figure 29: " Test circuit for inductive load switching"*)		11.6	-	ns
t_r	Current rise time			8	-	ns
$(di/dt)_{on}$	Turn-on current slope			410	-	A/µs
$t_{d(off)}$	Turn-off-delay time			85	-	ns
t_f	Current fall time			211	-	ns
E_{on} (1)	Turn-on switching energy			0.067	-	mJ
E_{off} (2)	Turn-off switching energy			0.210	-	mJ
E_{ts}	Total switching energy			0.277	-	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) Including the reverse recovery of the diode.

(2) Including 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 = 4 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 800 A/µs (see *Figure 29: " Test circuit for inductive load switching"*)	-	133	-	ns
Q_{rr}	Reverse recovery charge		-	140	-	nC
I_{rrm}	Reverse recovery current		-	5	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	520	-	A/µs
E_{rr}	Reverse recovery energy		-	15	-	µJ
t_{rr}	Reverse recovery time	I_F = 4 A, V_R = 400 V, V_{GE} = 15 V, T_J = 175 °C, di/dt = 800 A/µs (see *Figure 29: " Test circuit for inductive load switching"*)	-	236	-	ns
Q_{rr}	Reverse recovery charge		-	370	-	nC
I_{rrm}	Reverse recovery current		-	6.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	378	-	A/µs
E_{rr}	Reverse recovery energy		-	32	-	µJ

2.1 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

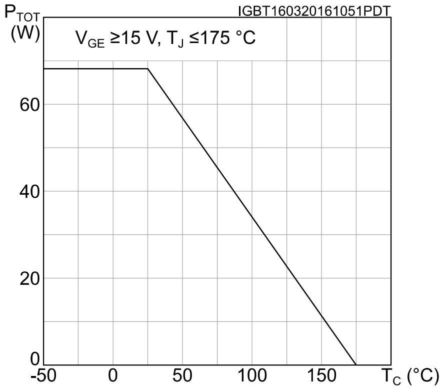


Figure 3: Collector current vs. case temperature

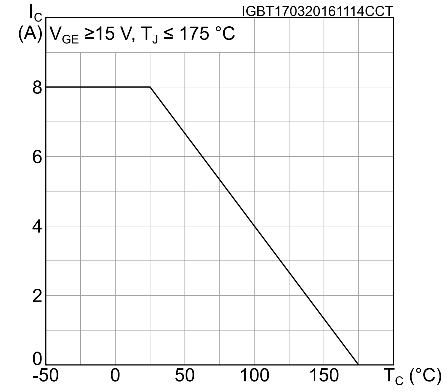


Figure 4: Output characteristics (T_J = 25 °C)

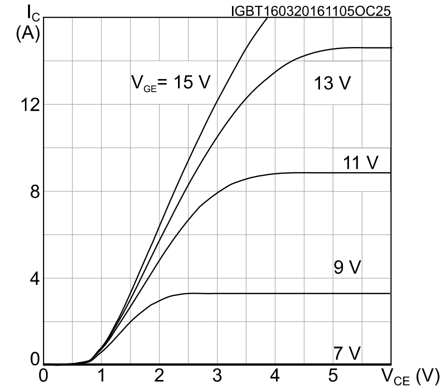


Figure 5: Output characteristics (T_J = 175 °C)

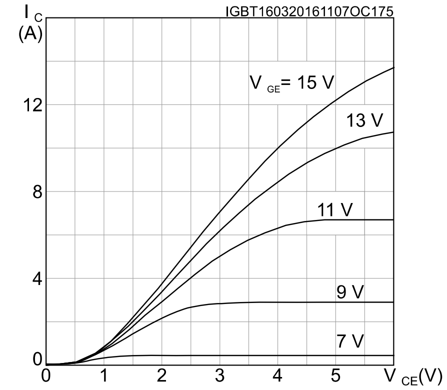


Figure 6: $V_{CE(sat)}$ vs. junction temperature

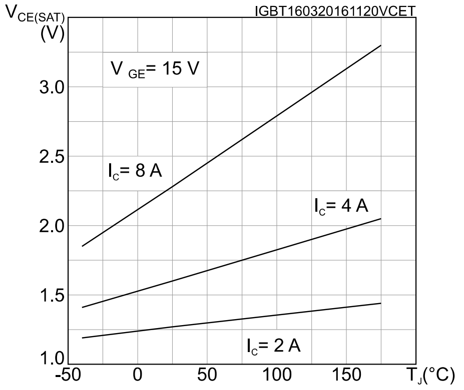


Figure 7: $V_{CE(sat)}$ vs. collector current

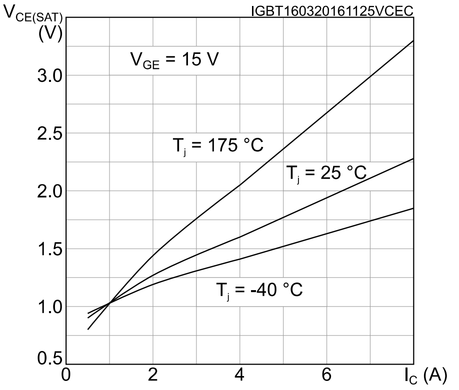


Figure 8: Collector current vs. switching frequency

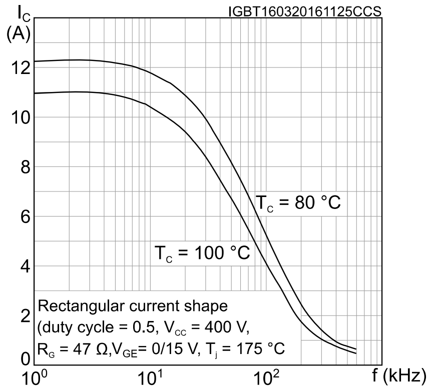


Figure 9: Forward bias safe operating area

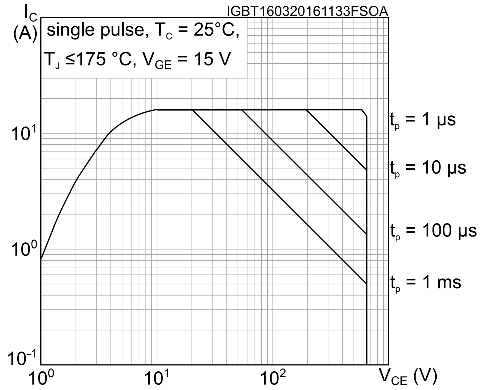


Figure 10: Transfer characteristics

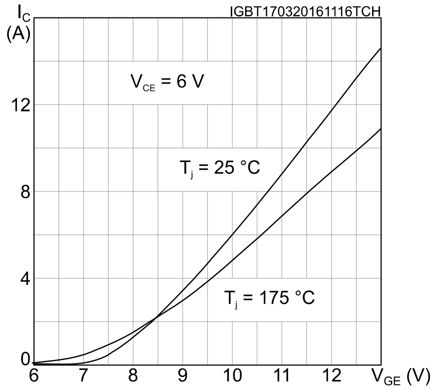


Figure 11: Diode V_F vs. forward current

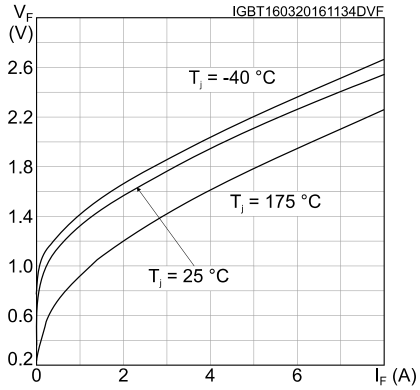


Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature

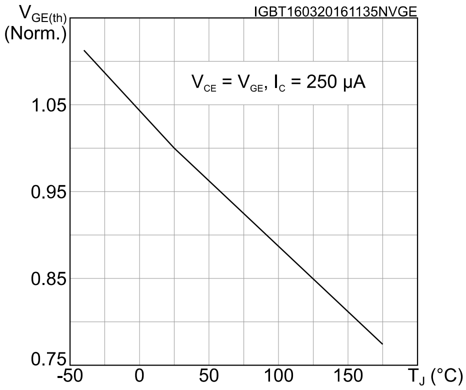


Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature

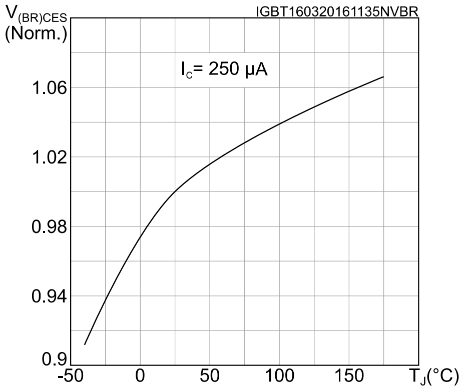


Figure 14: Capacitance variations

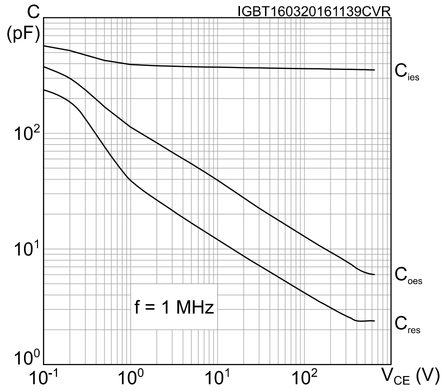


Figure 15: Gate charge vs. gate-emitter voltage

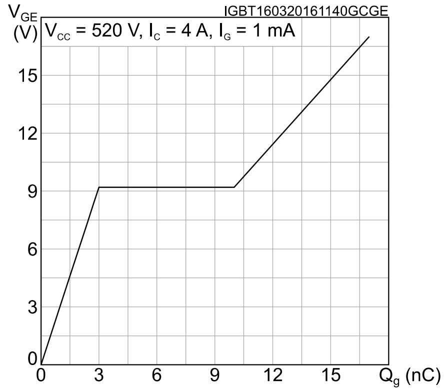


Figure 16: Switching energy vs. collector current

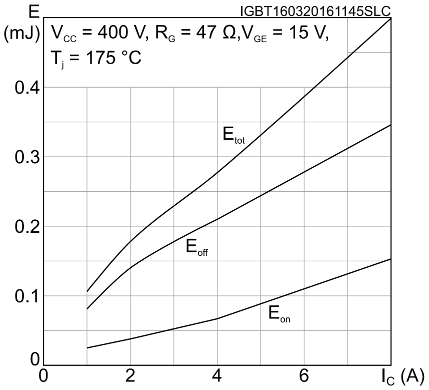


Figure 17: Switching energy vs. gate resistance

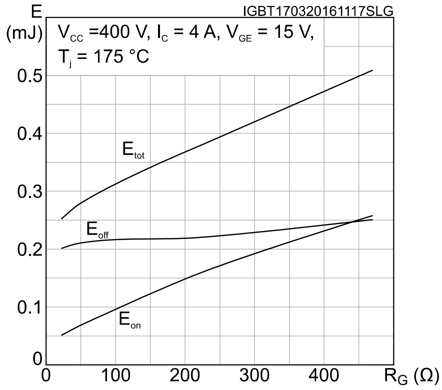


Figure 18: Switching energy vs. temperature

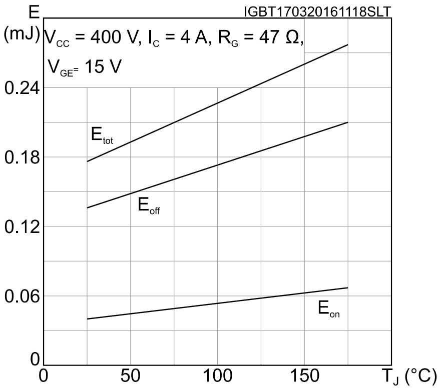


Figure 19: Switching energy vs. collector emitter voltage

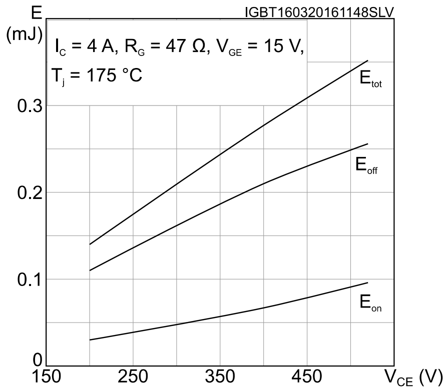


Figure 20: Short-circuit time and current vs. V_{GE}

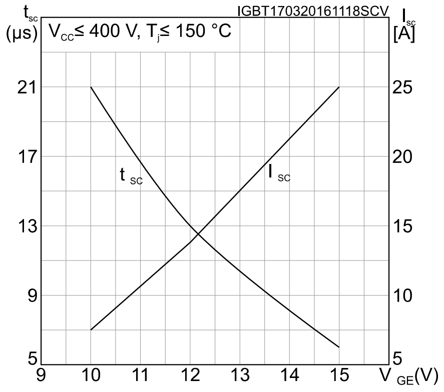


Figure 21: Switching times vs. collector current

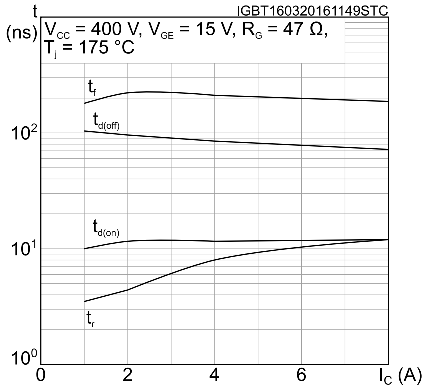


Figure 22: Switching times vs. gate resistance

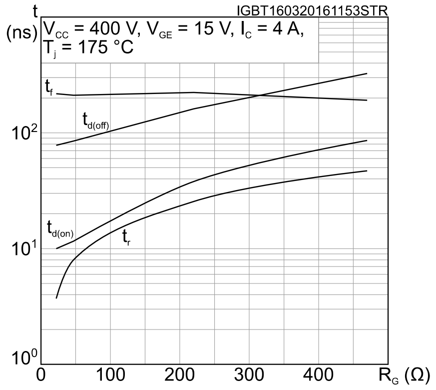


Figure 23: Reverse recovery current vs. diode current slope

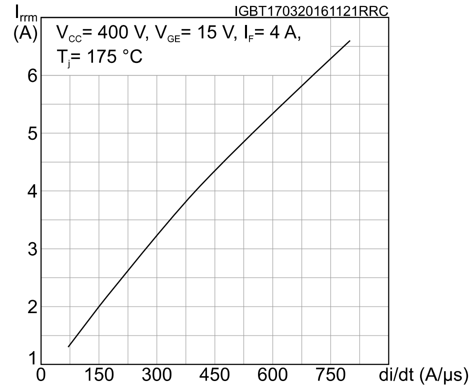


Figure 24: Reverse recovery time vs. diode current slope

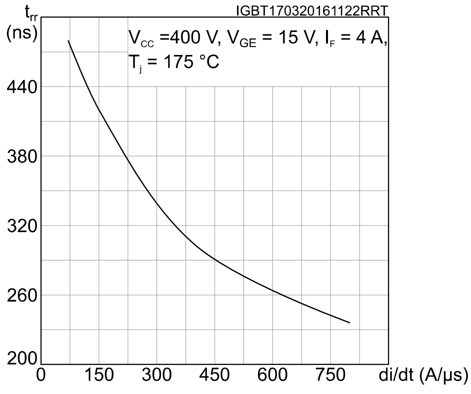


Figure 25: Reverse recovery charge vs. diode current slope

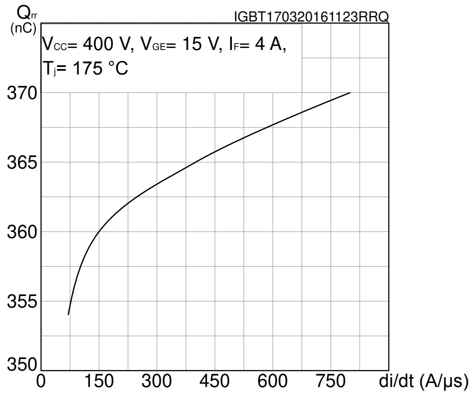


Figure 26: Reverse recovery energy vs. diode current slope

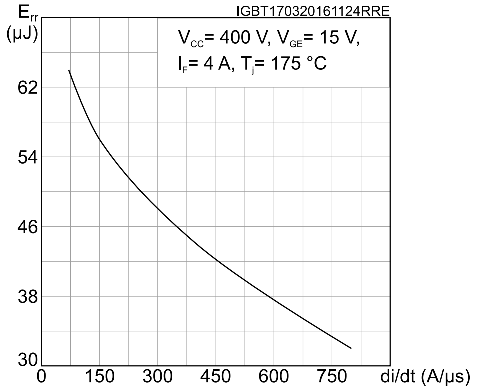


Figure 27: Thermal impedance for IGBT

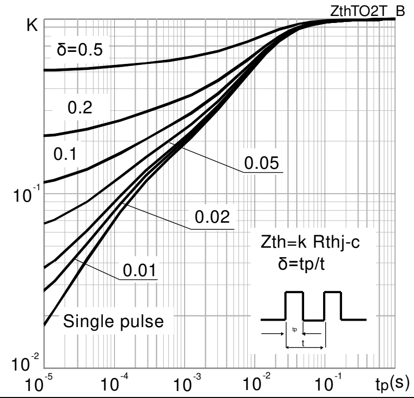
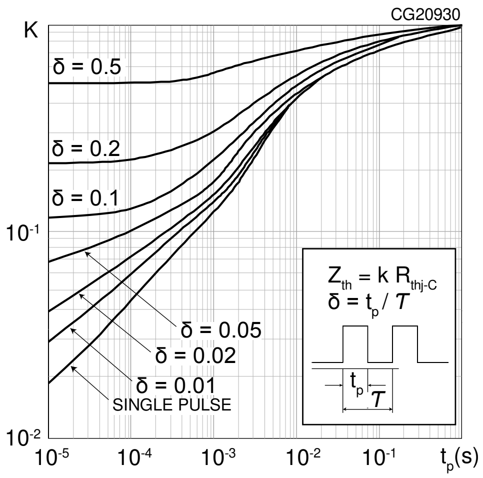


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

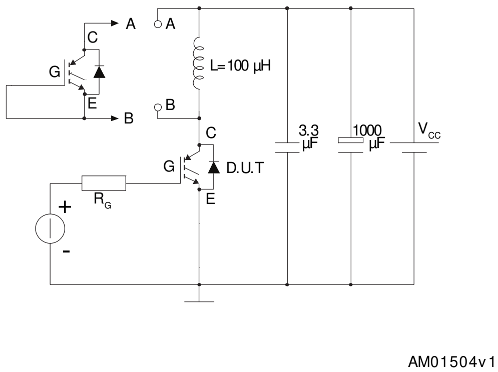


Figure 30: Gate charge test circuit

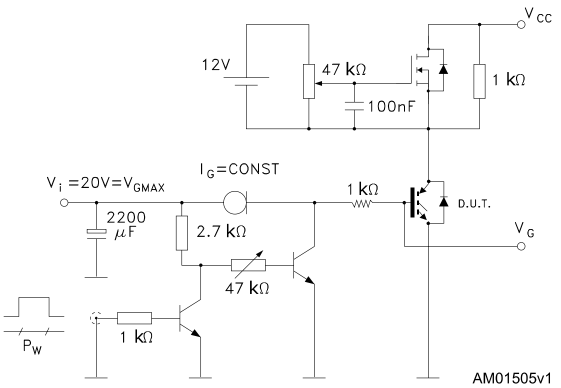


Figure 31: Switching waveform

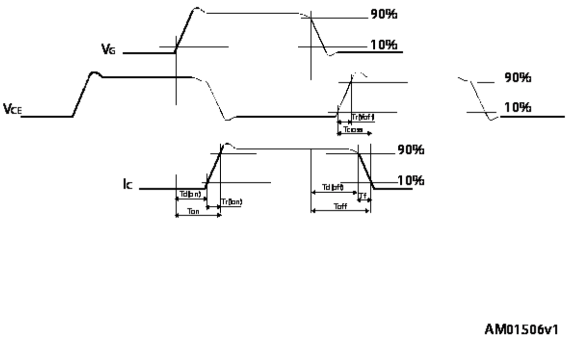
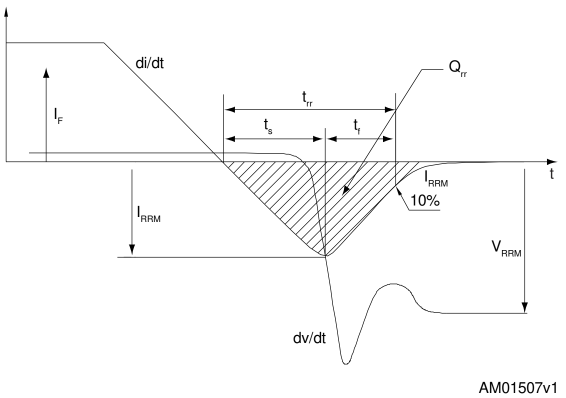


Figure 32: Diode reverse recovery waveform



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

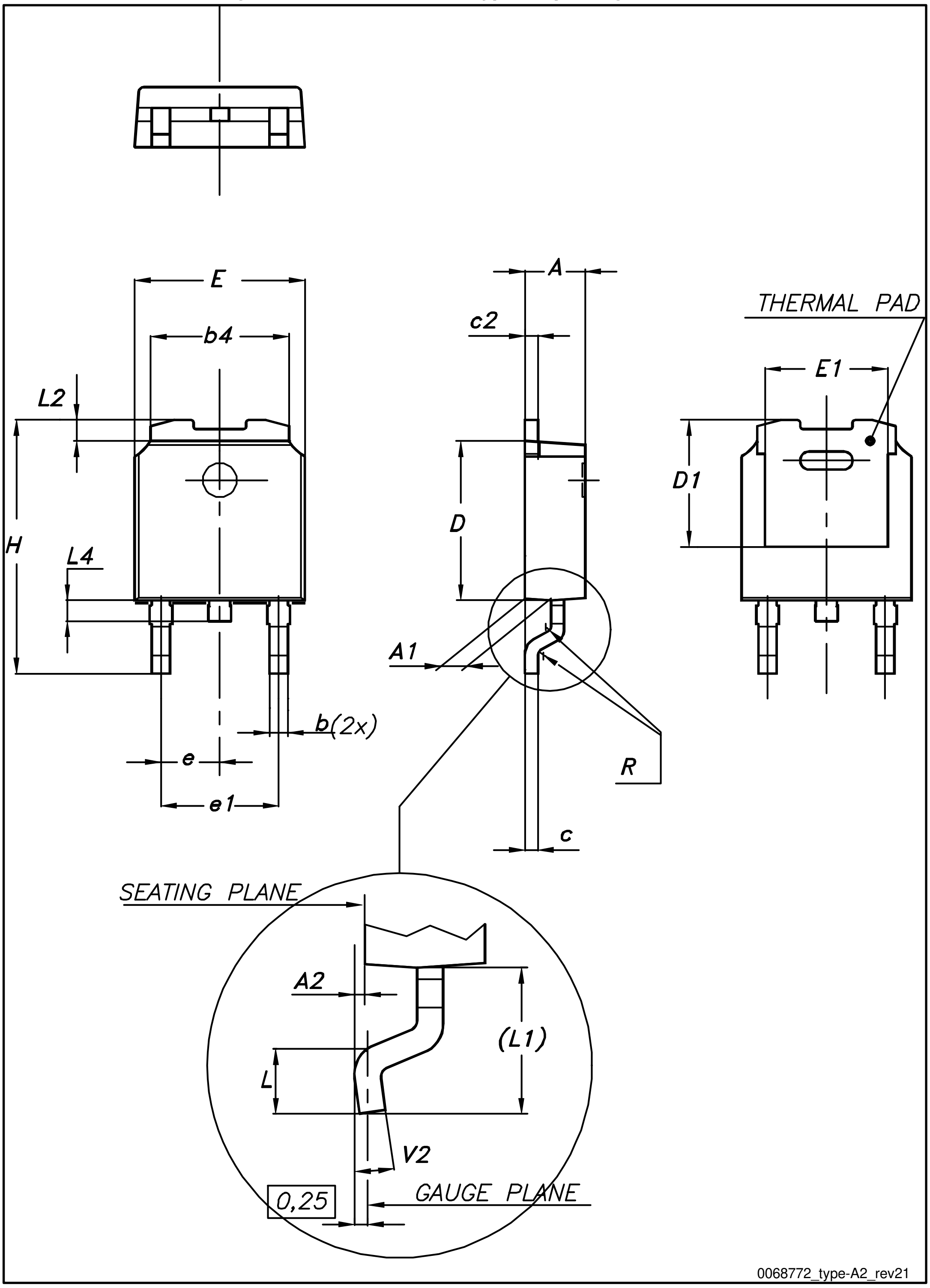
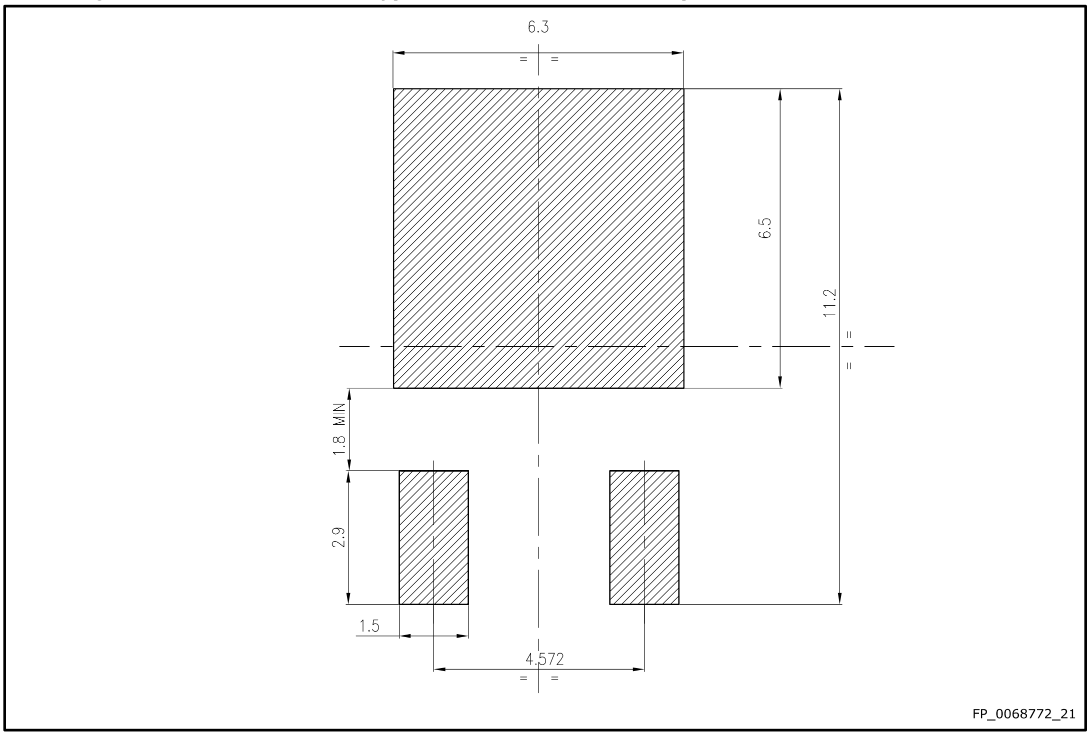


Table 8: DPAK (TO-252) type A2 mechanical data

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) type A2 recommended footprint (dimensions are in mm)



4.2 Packing information

Figure 35: DPAK (TO-252) tape outline

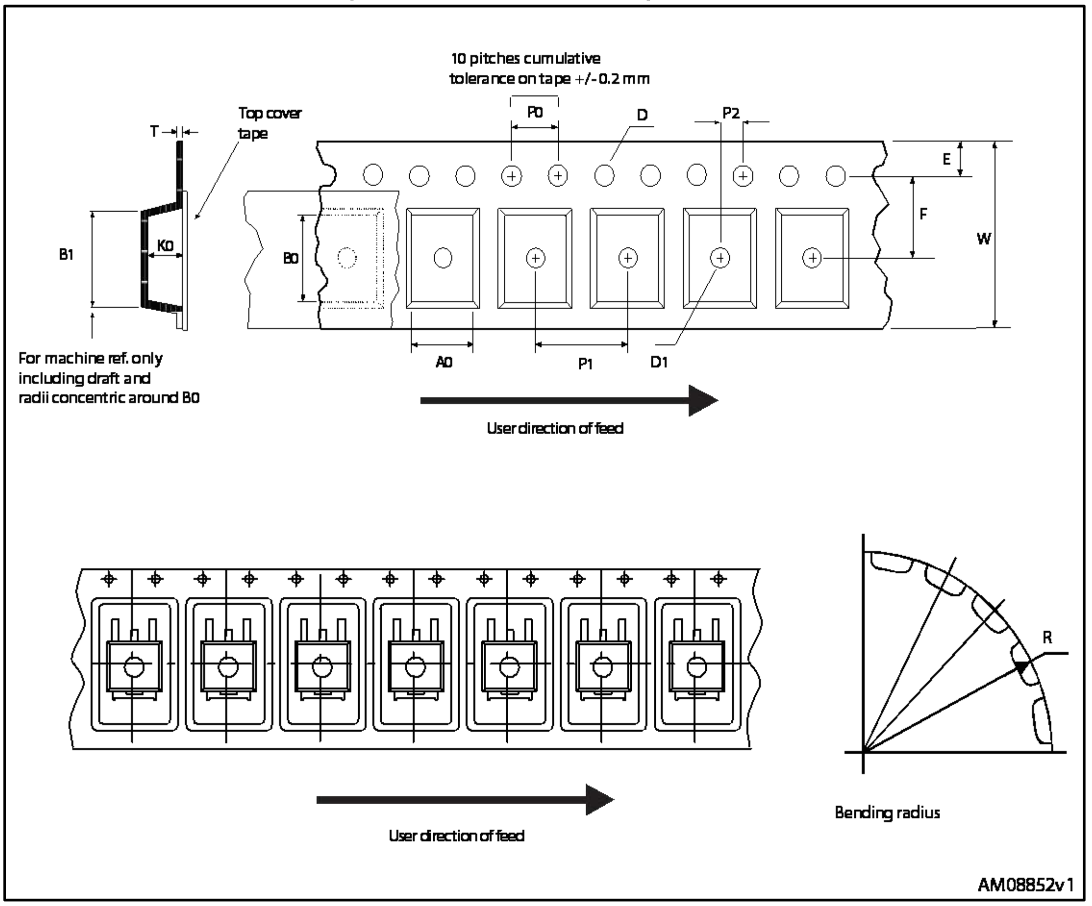


Figure 36: DPAK (TO-252) reel outline

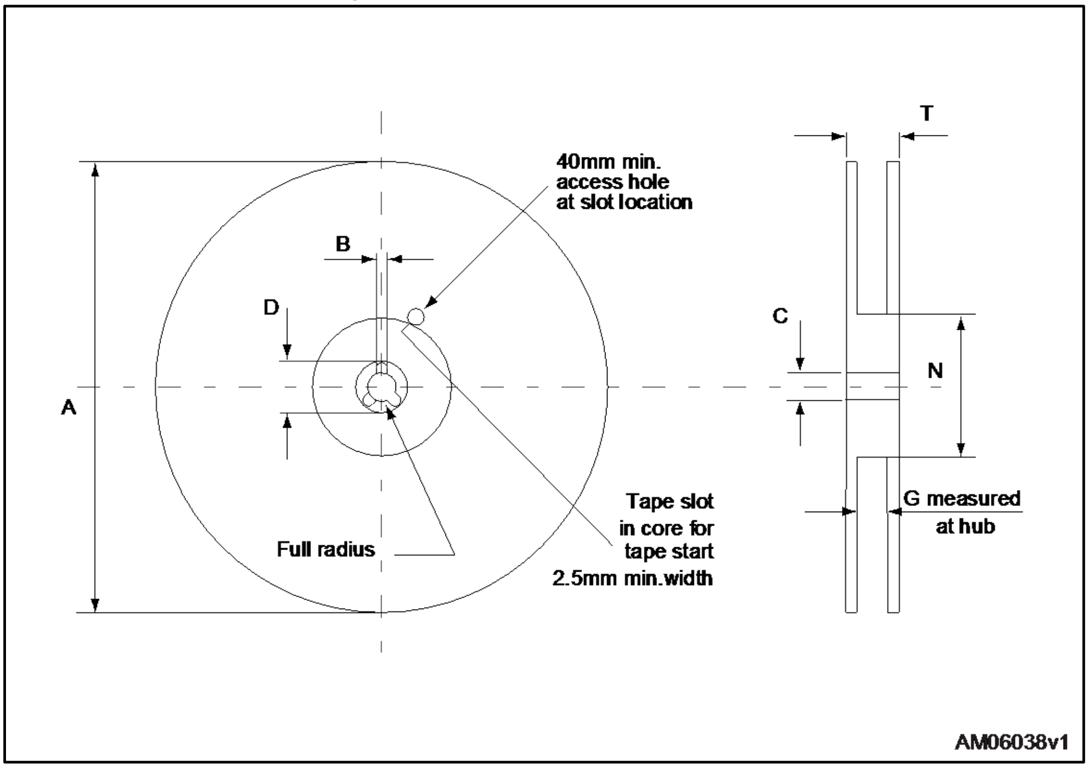


Table 9: DPAK (TO-252) tape and reel mechanical data

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
25-Nov-2015	1	First release.
18-Apr-2016	2	Modified: features in cover page Modified: Table 2: *"Absolute maximum ratings"*, 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
28-Apr-2016	3	Modified: Table 1: *"Device summary"* in cover page Minor text changes
21-Nov-2016	4	Updated *Table 2: "Absolute maximum ratings"* Updated *Figure 25: "Reverse recovery charge vs. diode current slope"* Updated *Figure 32: " Diode reverse recovery waveform"*