STGD10HF60KD

Automotive-grade 10 A, 600 V, short-circuit rugged IGBT with Ultrafast diode

Datasheet - production data

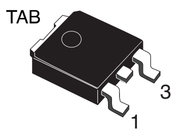
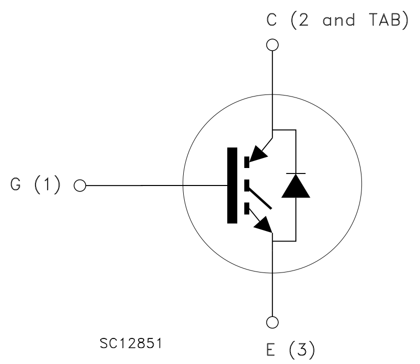


Figure 1. Internal schematic diagram



Features

- Designed for automotive applications and AEC-Q101 qualified
- Low on-voltage drop ($V_{CE(sat)}$)
- Low C_{res} / C_{ies} ratio (no cross conduction susceptibility)
- Switching losses include diode recovery energy
- Short-circuit rated
- Very soft Ultrafast recovery anti-parallel diode

Applications

- High frequency inverters
- SMPS and PFC in both hard switch and resonant topologies
- Motor drives
- Injection systems

Description

This device utilizes the advanced PowerMESH™ process for the IGBT and the Turbo 2 Ultrafast high voltage technology for the diode. The combination results in a very good trade-off between conduction losses and switching behavior rendering the product ideal for diverse high voltage applications operating at high frequencies.

Table 1. Device summary

Order code	Marking	Package	Packaging
STGD10HF60KD	GD10HF60KD	DPAK	Tape and reel

Contents

1 Electrical ratings

T_{CASE} = 25 °C unless otherwise specified.

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0)	600	V
I_C (1)	Collector current (continuous) at T_C = 25 °C	18	A
I_C (1)	Collector current (continuous) at T_C = 100 °C	10	A
I_{CL} (2)	Turn-off latching current	30	A
I_{CP} (3)	Pulsed collector current	30	A
V_{GE}	Gate-emitter voltage	± 20	V
V_{GEM}	Gate-emitter voltage pulsed (t_p ≤ 1 ms)	± 30	V
I_F	Diode RMS forward current	7	A
I_{FSM}	Surge non repetitive forward current t_p = 10 ms sinusoidal	20	A
P_{TOT}	Total dissipation	62.5	W
t_{scw}	Short circuit withstand time (V_{CE} = 50 V, V_{GE} = 15 V, T_C = 150 °C)	10	µs
T_j	IGBT operating junction temperature	– 55 to 150	°C
	Diode operating junction temperature	– 55 to 175	°C
T_{stg}	Storage temperature	– 65 to 150	°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. Vclamp = 80% of V_{CES}, T_j =150 °C, R_G=10 Ω, V_{GE}=15 V
3. Pulse width limited by max. junction temperature allowed

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case IGBT	2	°C/W
$R_{thj\text{-}case}$	Thermal resistance junction-case diode	5.8	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	100	°C/W

2 Electrical characteristics

T_{CASE}=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 = 1 mA, T_C = -40 °C (1) I_C = 1 mA I_C = 1 mA, T_C = 150 °C	600	610 650 700		V V V
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ±20 V V_{GE} = ±20 V, T_C = 150 °C			±100 ± 1	nA μA
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 600 V V_{CE} = 600 V, T_C = 150 °C			150 1	μA mA
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 μA	4.5		6.5	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 5 A	1.75		2.75	V

1. Value guaranteed by design

Table 5. Dynamic (1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE}= 0	-	430	-	pF
C_{oes}	Output capacitance		-	45	-	pF
C_{res}	Reverse transfer capacitance		-	10	-	pF
Q_g	Total gate charge	V_{CE} = 400 V, I_C = 5 A, V_{GE} = 15 V	-	23	-	nC
Q_{ge}	Gate-emitter charge		-	4	-	nC
Q_{gc}	Gate-collector charge		-	11	-	nC

1. Values guaranteed by design

Table 6. Switching on/off (inductive load) (1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CC} = 400 V, I_C = 5 A R_G = 10 Ω, V_{GE} = 15 V	-	9.5	-	ns
t_r	Current rise time		-	4.4	-	ns
$(di/dt)_{on}$	Turn-on current slope			930		A/μs
$t_{d(on)}$	Turn-on delay time	V_{CC} = 400 V, I_C = 5 A R_G = 10 Ω, V_{GE}= 15 V T_C = 150 °C	-	11	-	ns
t_r	Current rise time		-	4.8	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	904	-	A/μs
$tr_{(Voff)}$	Off voltage rise time	V_{CC} = 400 V, I_C = 5 A, R_{GE} = 10 Ω, V_{GE} = 15 V	-	34	-	ns
$td_{(off)}$	Turn-off delay time		-	87	-	ns
t_f	Current fall time		-	100	-	ns
$tr_{(Voff)}$	Off voltage rise time	V_{CC} = 400 V, I_C = 5 A, R_{GE} = 10 Ω, V_{GE} = 15 V T_C= 150 °C	-	83	-	ns
$td_{(off)}$	Turn-off delay time		-	93	-	ns
t_f	Current fall time		-	224	-	ns

1. Value guaranteed by design

Table 7. Switching energy (inductive load) (1)

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
Eon (2)	Turn-on switching losses	V_{CC} = 400 V, I_C = 5 A R_G = 10 Ω, V_{GE} = 15 V	-	45	-	μJ
E_{off} (3)	Turn-off switching losses		-	105	-	μJ
E_{ts}	Total switching losses		-	150	-	μJ
Eon (2)	Turn-on switching losses	V_{CC} = 400 V, I_C = 5 A R_G = 10 Ω, V_{GE}= 15 V T_C = 150 °C	-	84	-	μJ
E_{off} (3)	Turn-off switching losses		-	286	-	μJ
E_{ts}	Total switching losses		-	370	-	μJ

1. Value guaranteed by design
2. IGBT and diode are at the same temperature
3. 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 = 3 A	-	1.75	2.5	V
		I_F = 3 A, T_C= 150 °C	-	1.45		V
t_{rr} (1)	Reverse recovery time	I_F = 3 A, V_R = 400 V, di/dt = 100 A/µs	-	50		ns
Q_{rr} (1)	Reverse recovery charge		-	45		nC
I_{rm} (1)	Reverse recovery current		-	1.7		A
t_{rr} (1)	Reverse recovery time	I_F = 3 A, V_R = 400 V, T_C= 150 °C, di/dt = 100 A/µs	-	100		ns
Q_{rr} (1)	Reverse recovery charge		-	150		nC
I_{rm} (1)	Reverse recovery current		-	3.1		A

1. Limits guaranteed by design

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics (T_C = -50°C)

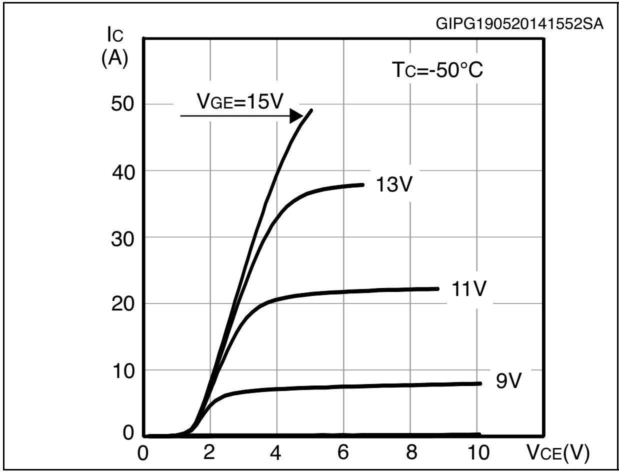


Figure 3. Output characteristics (T_C = 25°C)

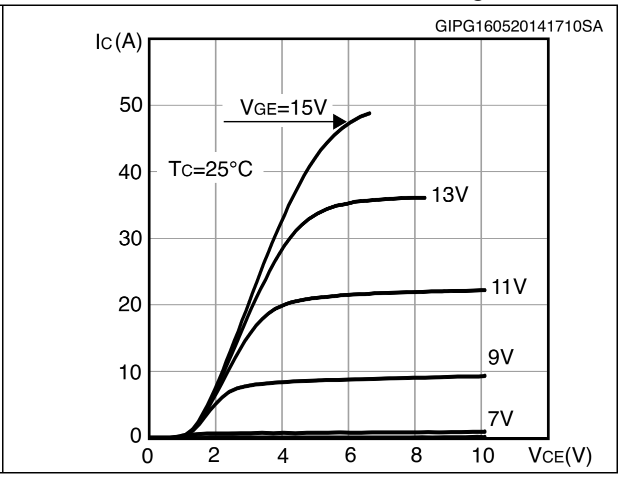


Figure 4. Output characteristics (T_C = 150°C)

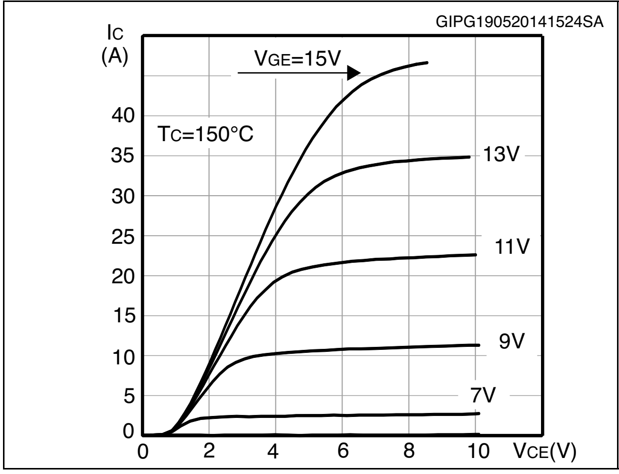


Figure 5. Transfer characteristics

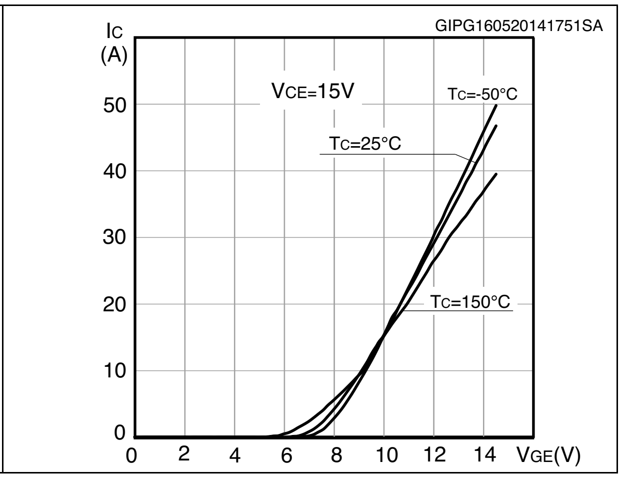


Figure 6. Collector-emitter on voltage vs. collector current

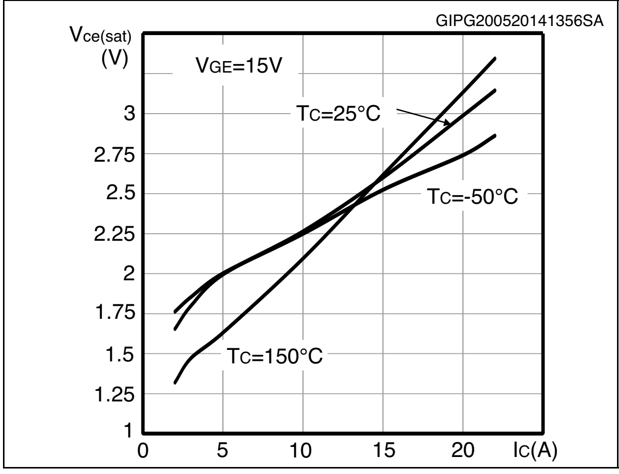


Figure 7. Collector-emitter on voltage vs. temperature

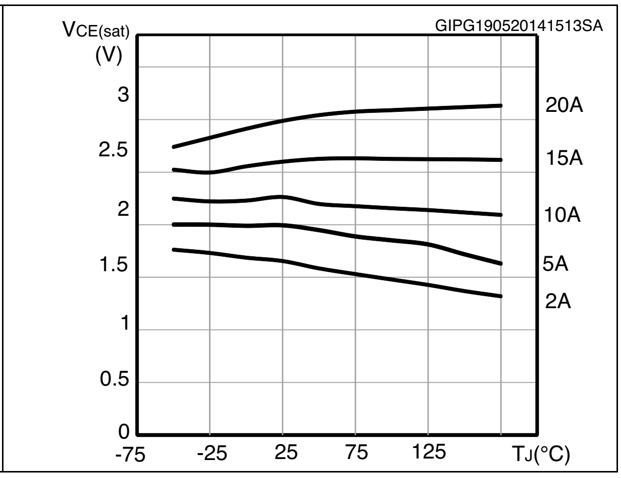


Figure 8. Normalized $V_{(BR)CES}$ vs. temperature

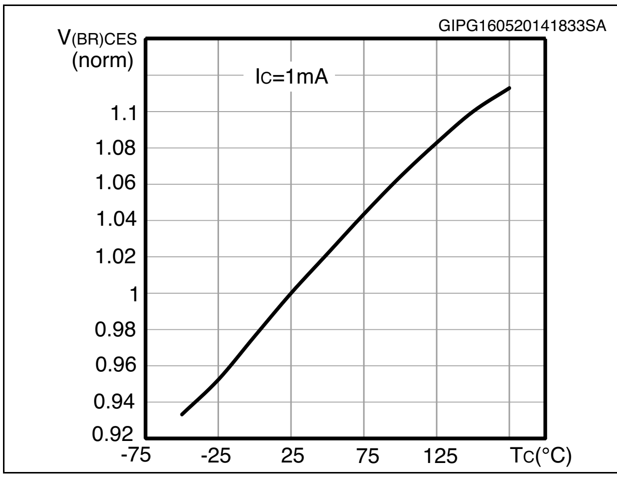


Figure 9. Normalized gate threshold vs. temperature

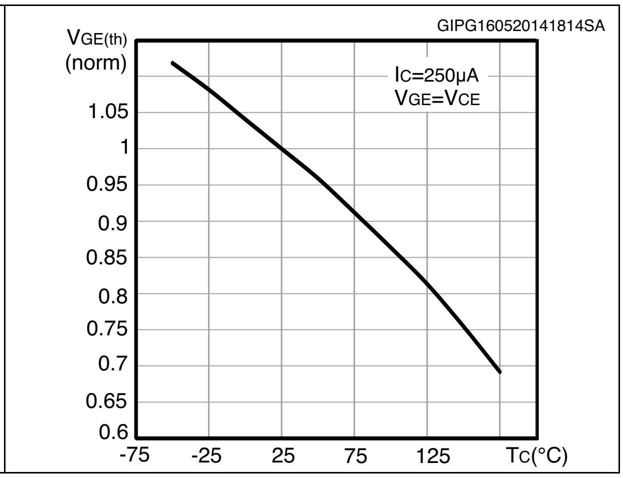


Figure 10. Gate charge vs. gate-emitter voltage

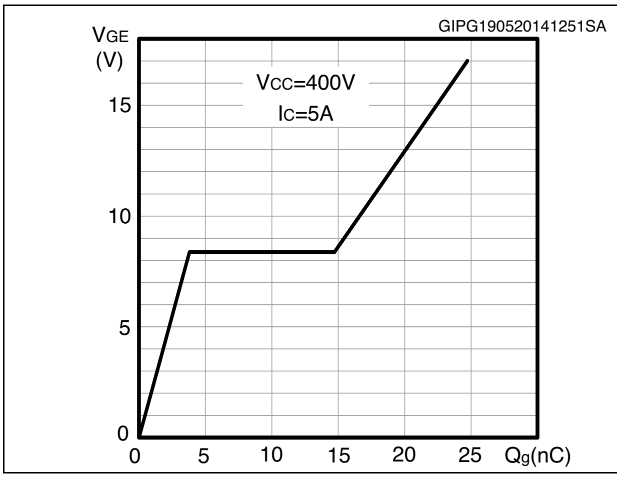


Figure 11. Capacitance variations

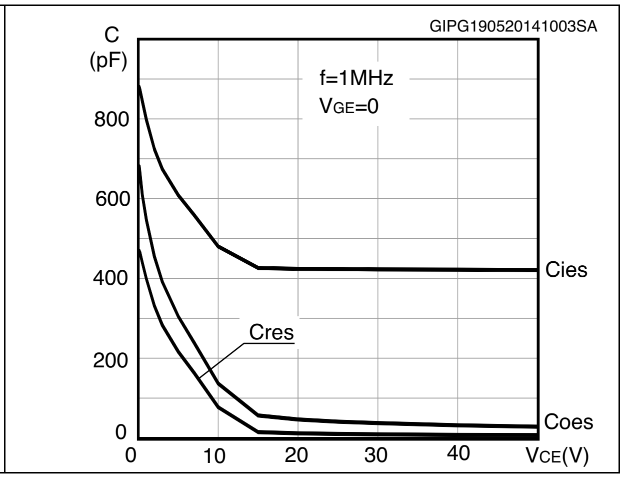


Figure 12. Switching losses vs. temperature

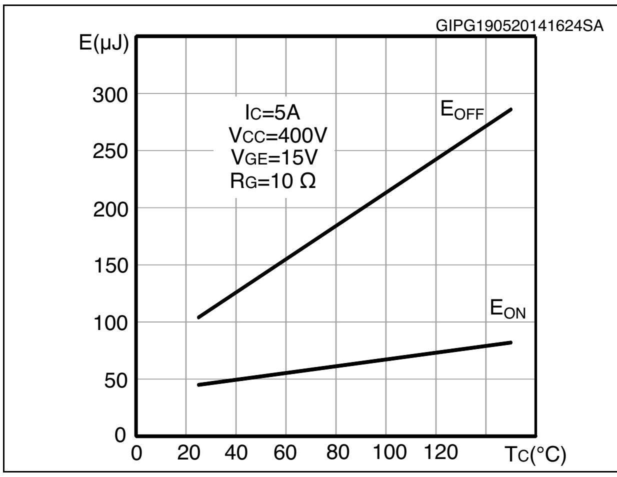


Figure 13. Switching losses vs. gate resistance

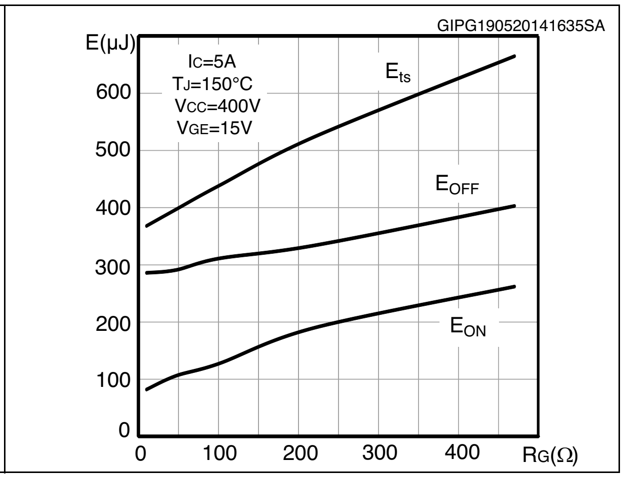


Figure 14. Switching losses vs. collector current

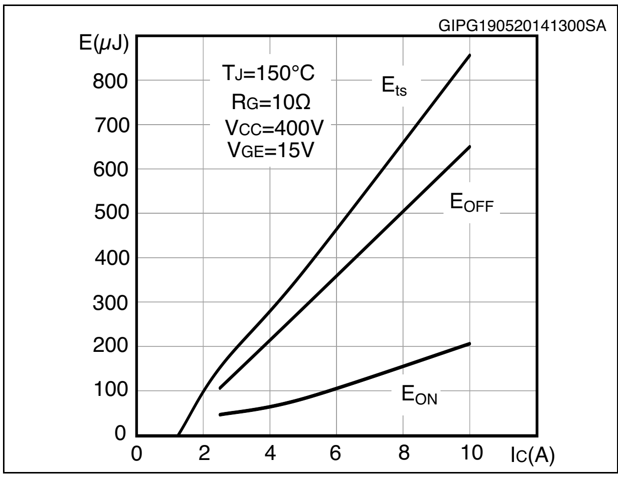


Figure 15. Short-circuit widthstand time and current vs. gate-emitter voltage

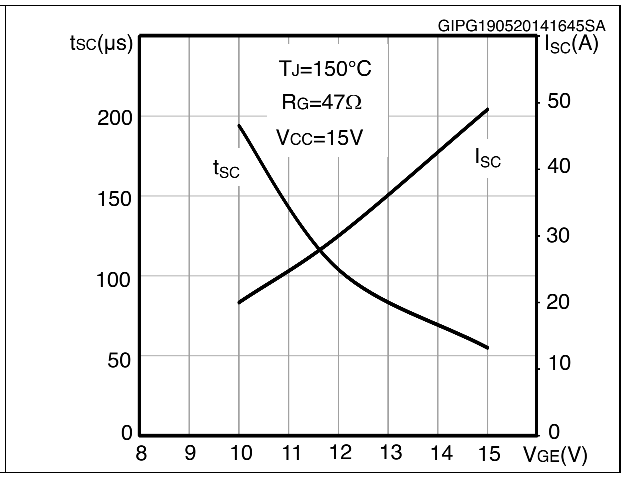


Figure 16. RBSOA

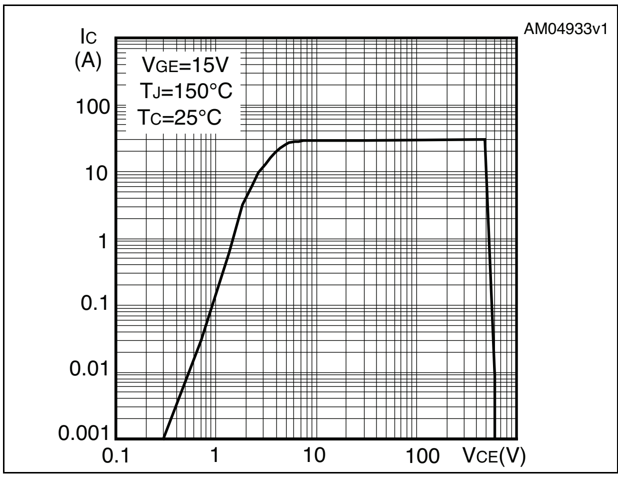


Figure 17. Switching times vs. gate resistance at T_J=25 °C

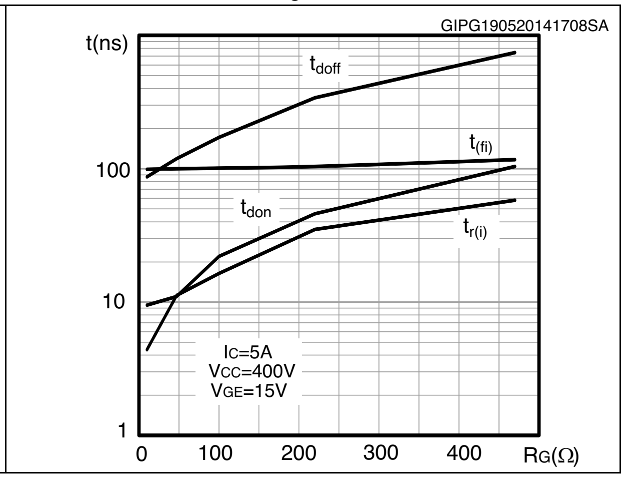


Figure 18. Switching times vs. gate resistance at T_J=150 °C

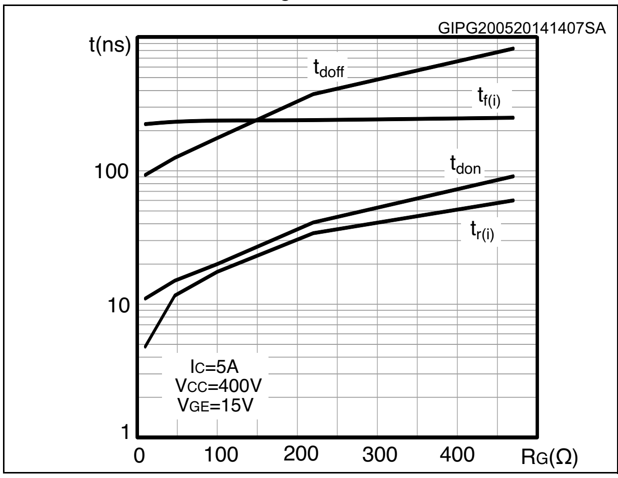


Figure 19. Switching times vs. collector current

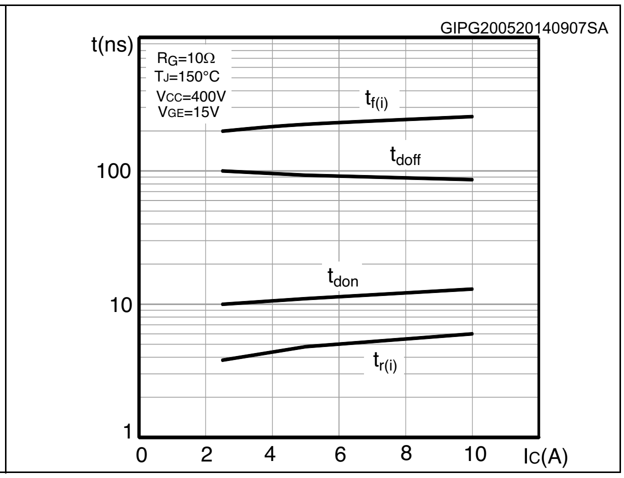


Figure 20. Diode forward voltage drop vs. forward current

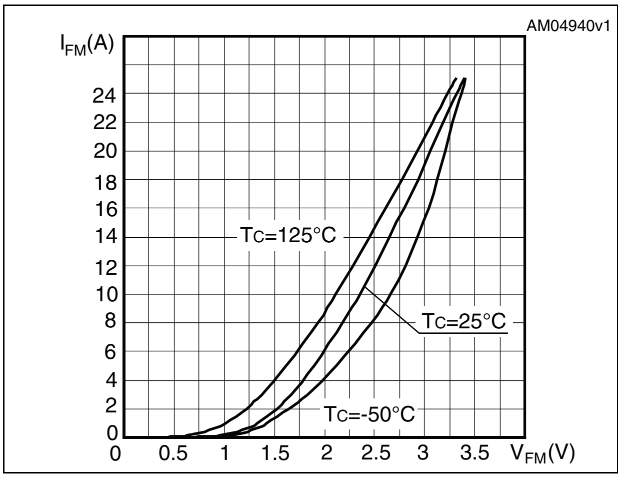


Figure 21. Peak reverse recovery current vs. di/dt

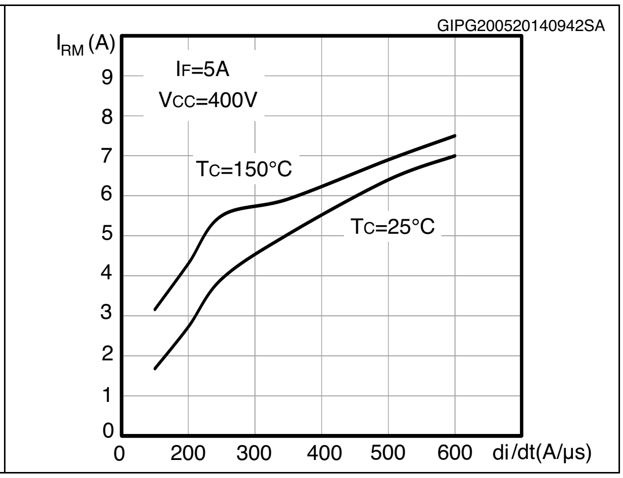


Figure 22. Reverse recovery time vs. di/dt

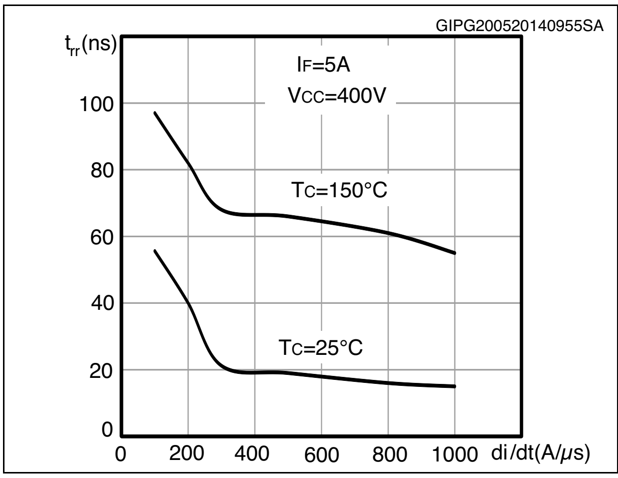


Figure 23. Reverse recovery softness factor vs. di/dt

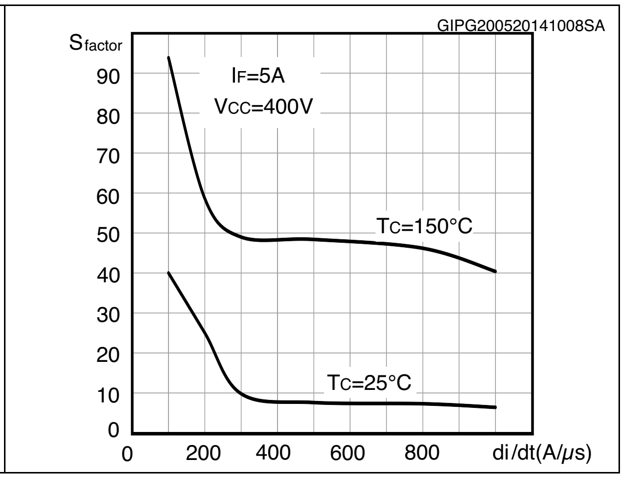


Figure 24. Reverse recovery charges vs. di/dt

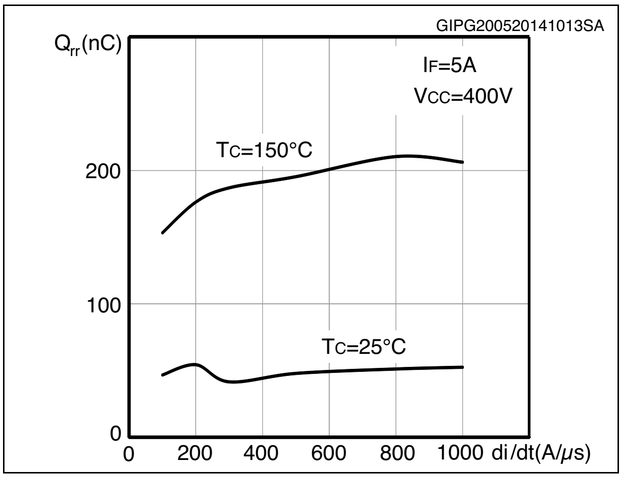


Figure 25. IGBT thermal impedance

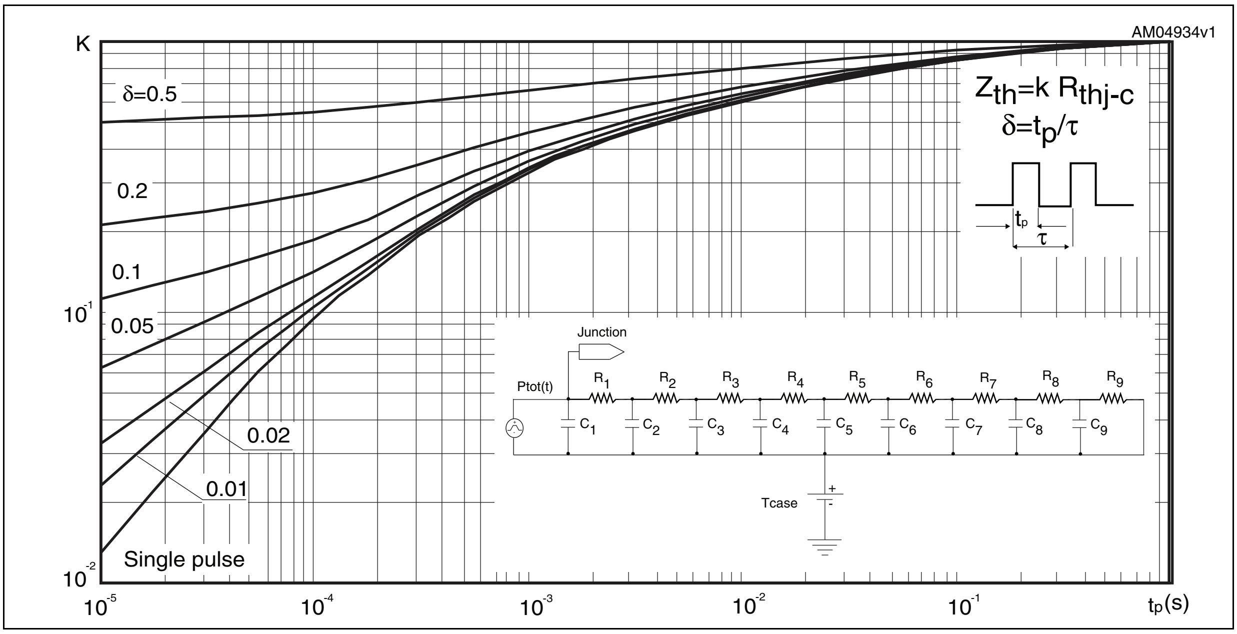


Table 9. IGBT RC-Cauer thermal network

Symbol	Value	Unit	Symbol	Value	Unit
R_1	0.344	°C/W	C_1	0.4E-3	W*s/°C
R_2	0.0686	°C/W	C_2	0.162E-4	W*s/°C
R_3	0.0958	°C/W	C_3	0.684E-3	W*s/°C
R_4	0.177	°C/W	C_4	0.923E-4	W*s/°C
R_5	0.250	°C/W	C_5	0.3E-2	W*s/°C
R_6	0.245	°C/W	C_6	0.9E-2	W*s/°C
R_7	0.152	°C/W	C_7	0.678E-3	W*s/°C
R_8	0.135	°C/W	C_8	0.807E-3	W*s/°C
R_9	0.530	°C/W	C_9	0.248	W*s/°C

Figure 26. Diode thermal impedance

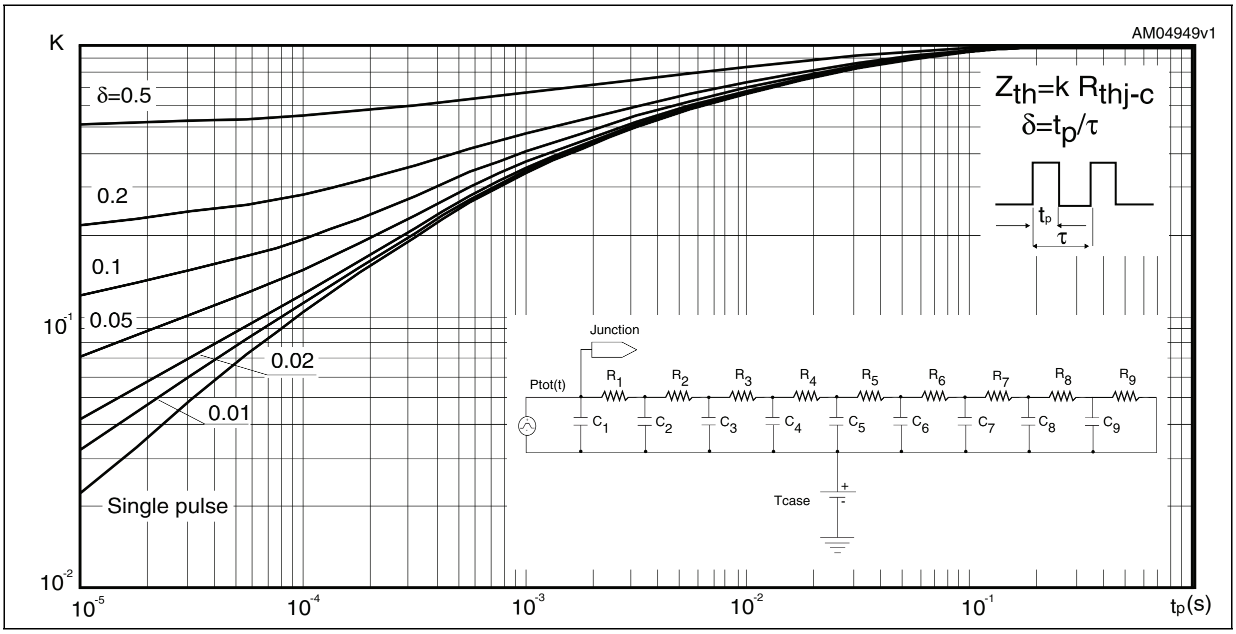


Table 10. Diode RC-Cauer thermal network

Symbol	Value	Unit	Symbol	Value	Unit
R_1	0.478	°C/W	C_1	0.8E-4	W*s/°C
R_2	0.542	°C/W	C_2	1E-4	W*s/°C
R_3	0.600	°C/W	C_3	2E-4	W*s/°C
R_4	0.277	°C/W	C_4	0.5E-5	W*s/°C
R_5	0.844	°C/W	C_5	0.145E-2	W*s/°C
R_6	0.313	°C/W	C_6	0.499E-4	W*s/°C
R_7	0.108	°C/W	C_7	0.727E-3	W*s/°C
R_8	0.891	°C/W	C_8	0.393E-4	W*s/°C
R_9	1.73	°C/W	C_9	0.0176	W*s/°C

3 Test circuits

Figure 27. Test circuit for inductive load switching

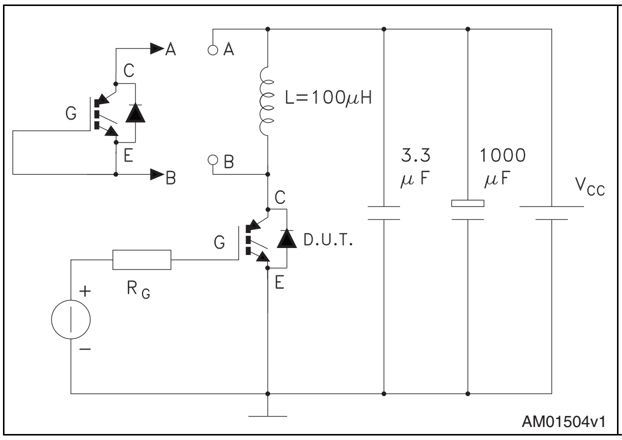


Figure 28. Gate charge test circuit

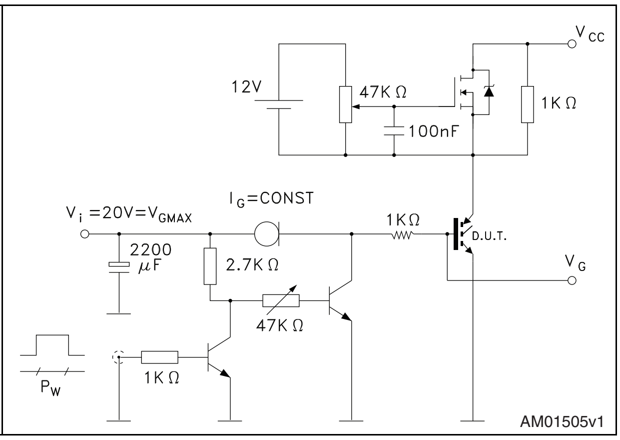


Figure 29. Switching waveforms

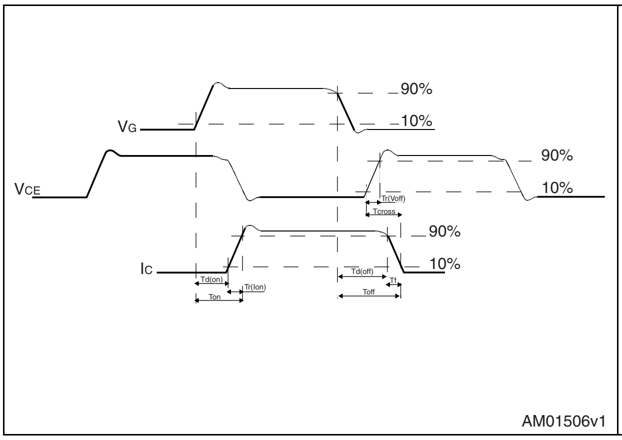
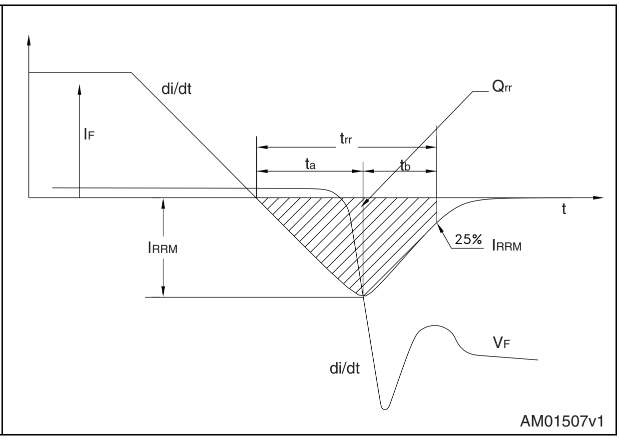


Figure 30. Diode recovery times waveform



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.

Figure 31. DPAK (TO-252) type A drawing

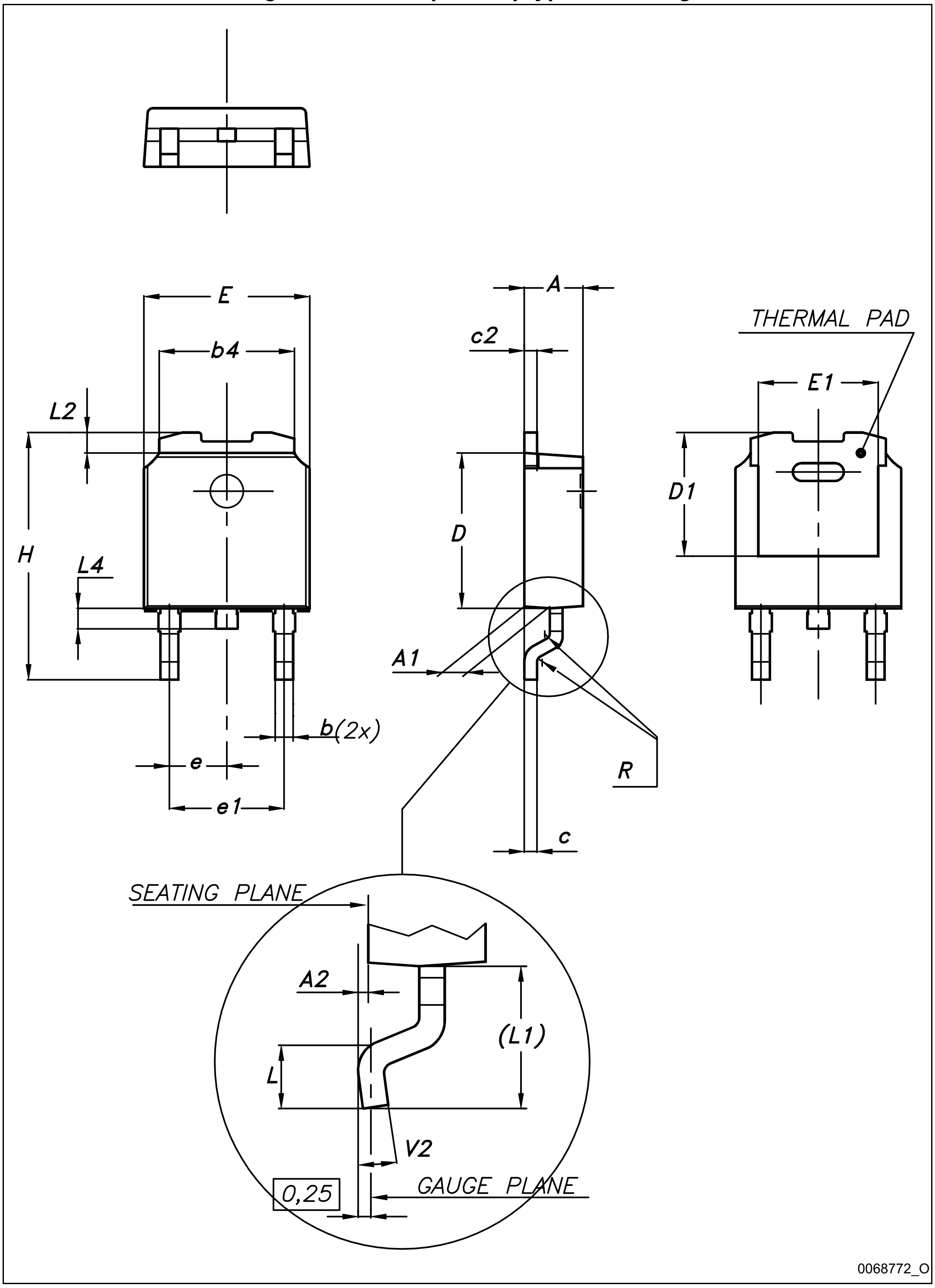
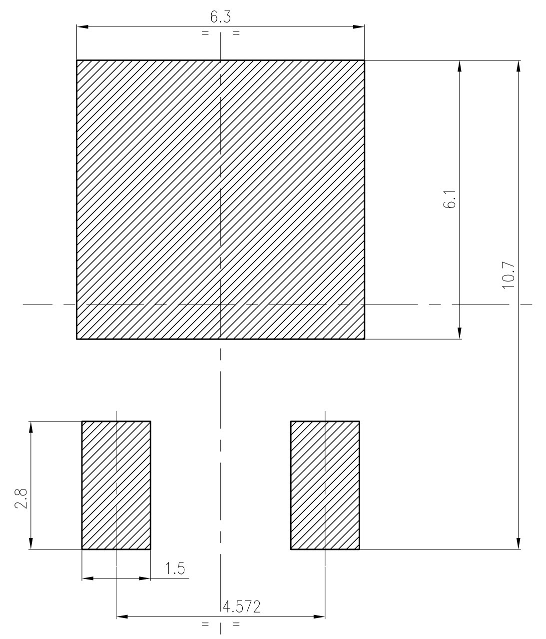


Table 11. DPAK (TO-252) type A mechanical data

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		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 32. DPAK (TO-252) type A footprint [a]



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a. All dimensions are in millimeters

5 Packaging mechanical data

Figure 33. Tape for DPAK (TO-252)

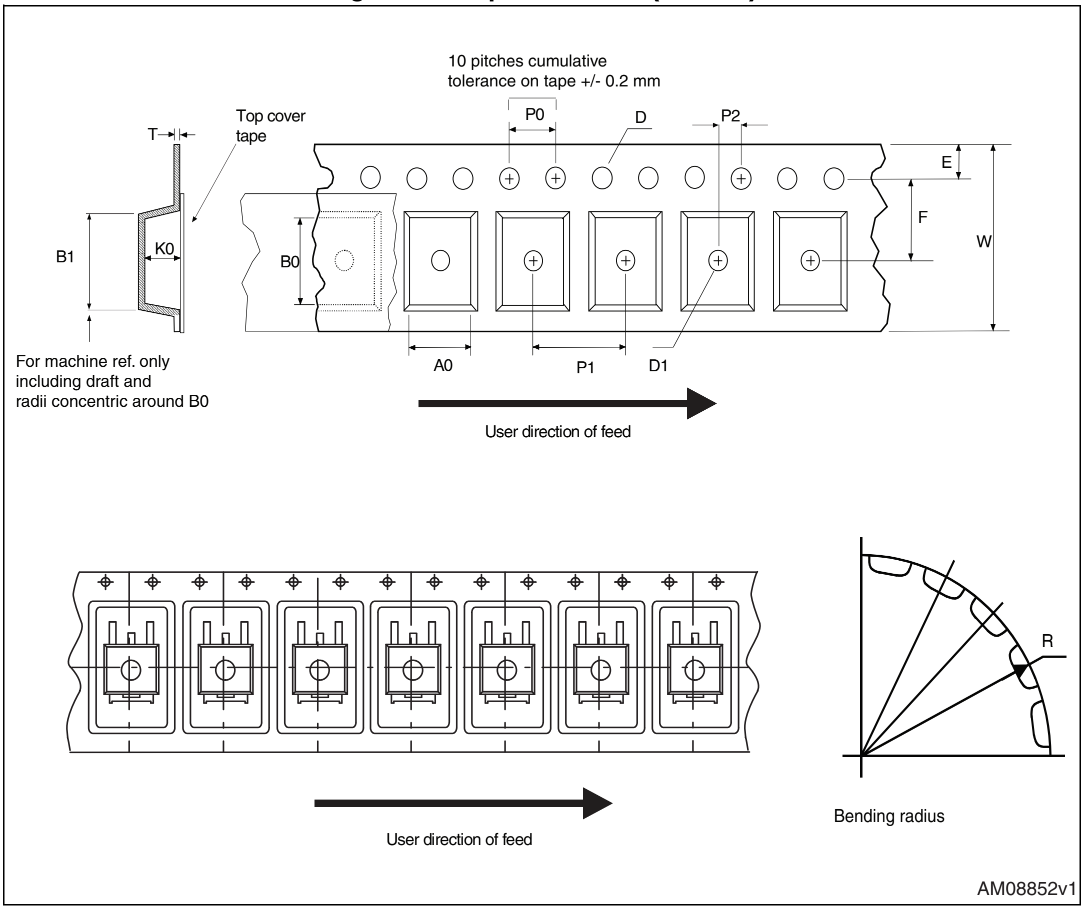

Figure 34. Reel for DPAK (TO-252)

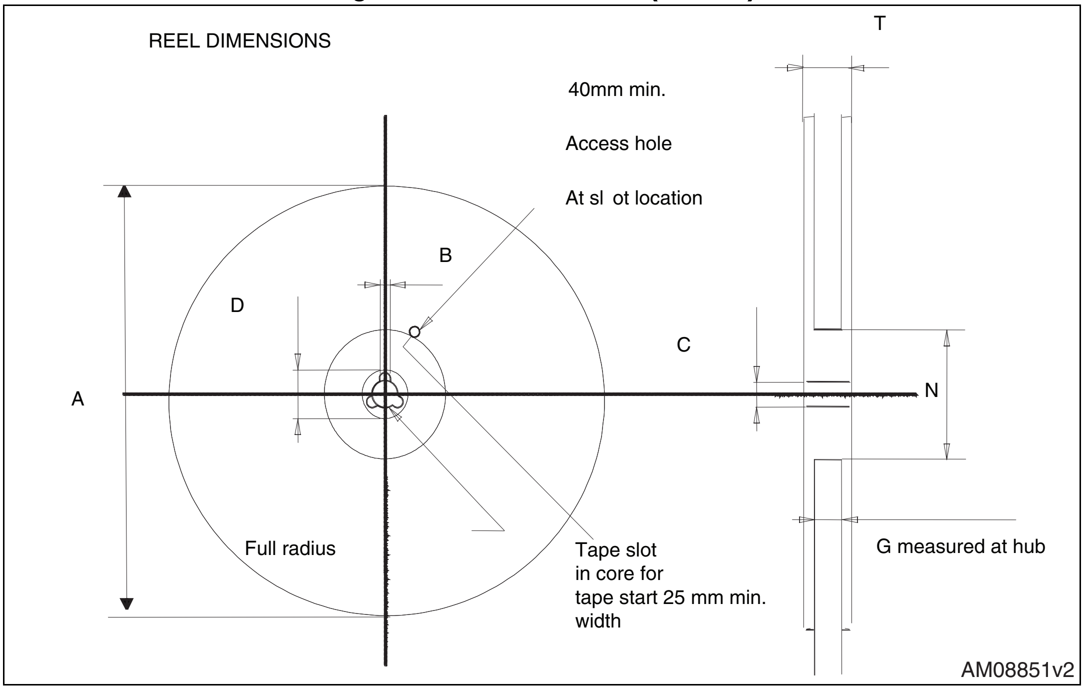

Table 12. DPAK (TO-252) tape and reel mechanical data

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			

6 Revision history

Table 13. Document revision history

Date	Revision	Changes
28-Feb-2012	1	First release
27-May-2014	2	– Added: *Section 2.1: Electrical characteristics (curves)* – Updated: *Section 4: Package mechanical data* – Minor text changes