Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D^2PAK TO-220 TO-247	TO-220FP	
V_{GS}	Gate-source voltage	± 25		V
I_D	Drain current (continuous) at T_C = 25 °C	30	30 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	19	19 (1)	A
I_{DM} (1)	Drain current (pulsed)	120	120 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	190	35	W
dv/dt (2)	Peak diode recovery voltage slope	15		V/ns
dv/dt (3)	MOSFET dv/dt ruggedness	50		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; Tc = 25 °C)		2500	V
T_{stg}	Storage temperature	- 55 to 150		°C
T_j	Max. operating junction temperature	150		°C

1. Limited by maximum junction temperature.
2. $I_{SD} \leq 30$ A, di/dt ≤ 400 A/μs; $V_{Peak} < V_{(BR)DSS}$, $V_{DD = 400\ V}$
3. $V_{DS} \leq 480$ V

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D^2PAK	TO-220FP	TO-220	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	0.66	3.6	0.66		°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max(1)	30				°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max		62.5		50	°C/W

1. 1.When mounted on 1inch² FR-4 board, 2 oz Cu.

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetetive or not repetetive (pulse width limited by T_{jmax})	8	A
E_{AS}	Single pulse avalanche energy (starting t_j = 25°C, I_d= I_{AR}; V_{dd}= 50V)	660	mJ

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified)

Table 5. On /off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS} = 0	650			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0) V_{DS} = 650 V V_{DS} = 650 V, T_C=125 °C				1 100	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 25 V			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 15 A		0.073	0.095	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss} C^{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0	-	3000 74 5.8	-	pF pF pF
$C^{o(tr)(1)}$	Equivalent capacitance time related	V_{DS} = 0 to 520 V, V_{GS} = 0	-	244	-	pF
$C^{o(er)(2)}$	Equivalent capacitance energy related		-	70	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	2.4	-	Ω
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 520 V, I_D = 15 A, V_{GS} = 10 V (see *Figure 20*)	-	71 18 30	-	nC nC nC

1. Time related is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS}

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d\ (v)}$ $t_{r\ (v)}$ $t_{f\ (i)}$ $t_{c(off)}$	Voltage delay time Voltage rise time Current fall time Crossing time	V_{DD} = 400 V, I_D = 20 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 21* and *Figure 24*)	-	66 9 9 13	-	ns ns ns ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (1)	Source-drain current Source-drain current (pulsed)		-		30 120	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 30 A, V_{GS} = 0	-		1.5	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 30 A, di/dt = 100 A/µs V_{DD} = 100 V (see *Figure 24*)	-	382 6.6 35		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD} = 30 A, di/dt = 100 A/µs V_{DD} = 100 V, T_j = 150 °C (see *Figure 24*)	-	522 10.3 40		ns µC A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300 µs, duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D²PAK and TO-220

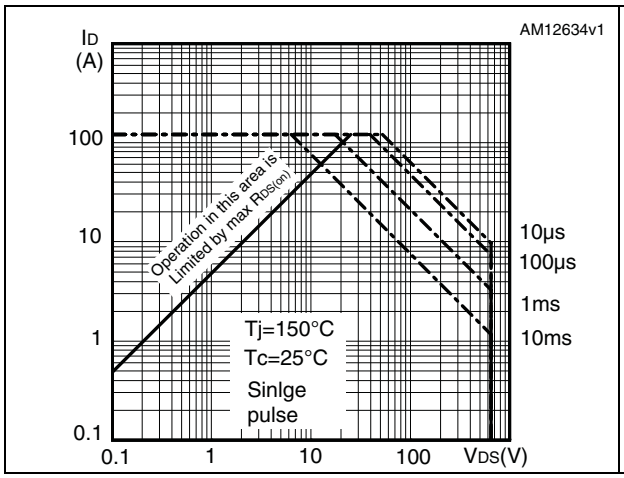


Figure 3. Thermal impedance for D²PAK and TO-220

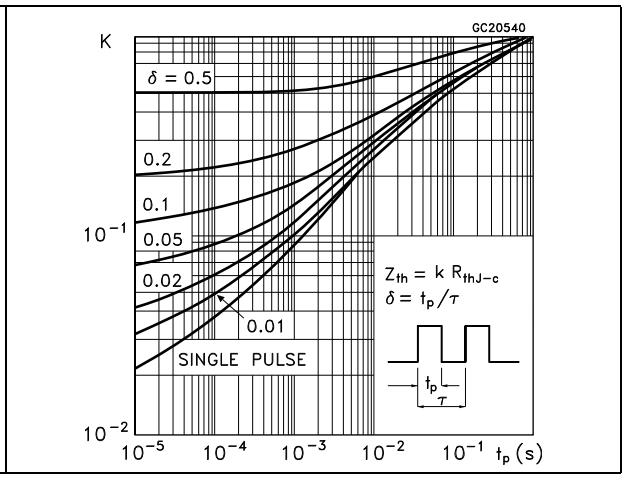


Figure 4. Safe operating area for TO-220FP

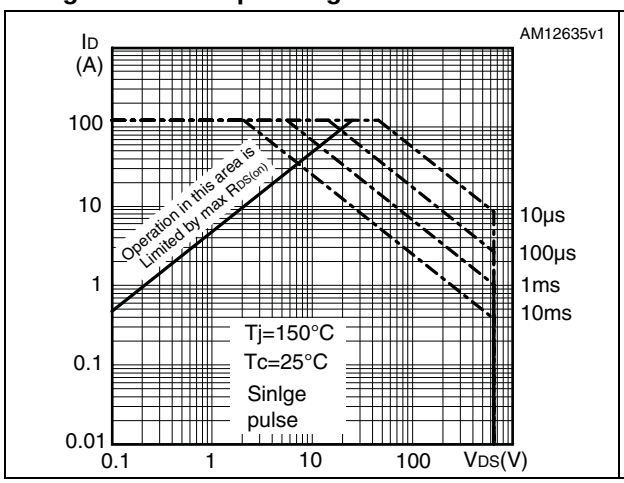


Figure 5. Thermal impedance for TO-220FP

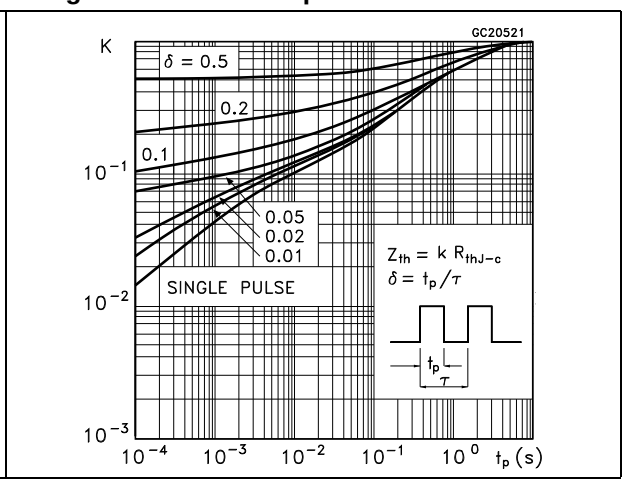


Figure 6. Safe operating area for TO-247

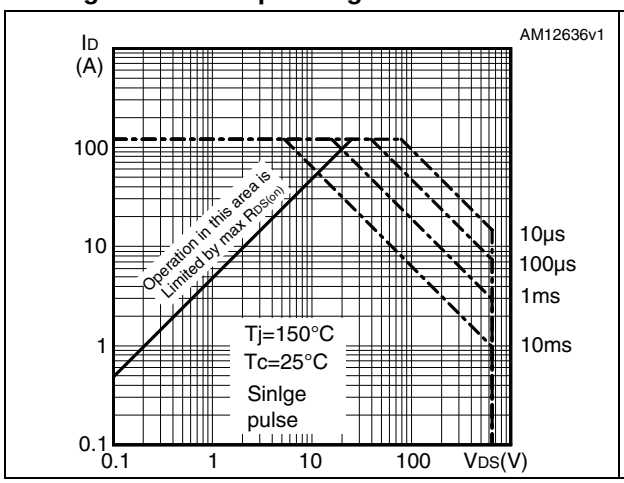


Figure 7. Thermal impedance for TO-247

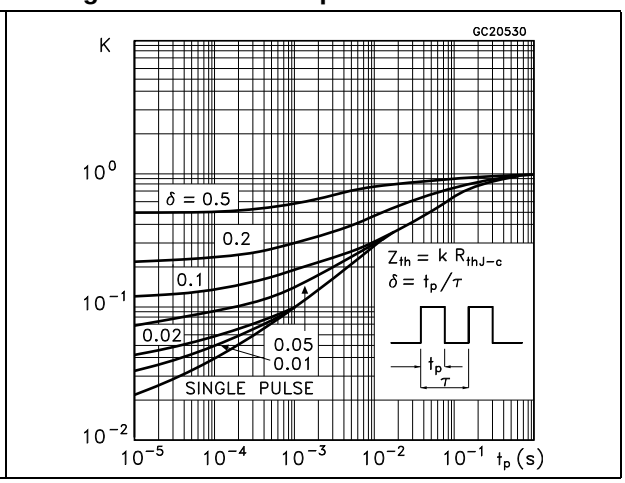


Figure 8. Output characteristics

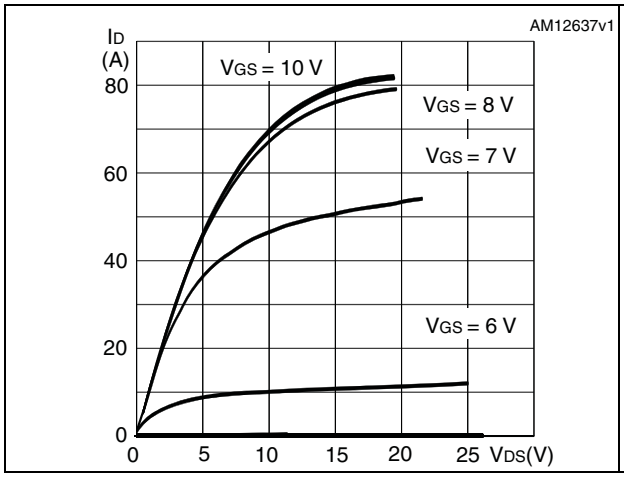


Figure 9. Transfer characteristics

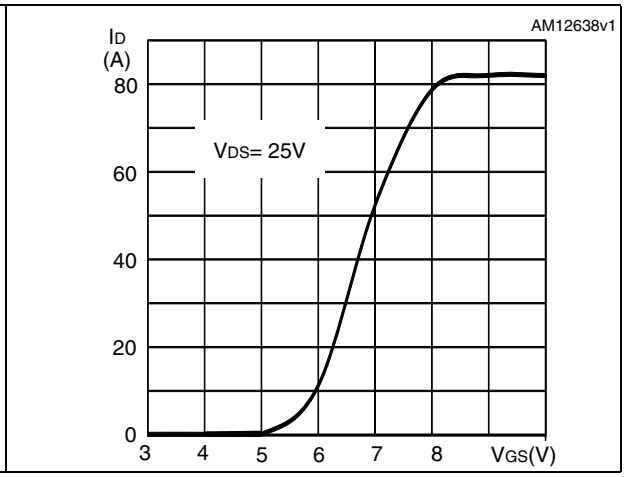


Figure 10. Gate charge vs gate-source voltage

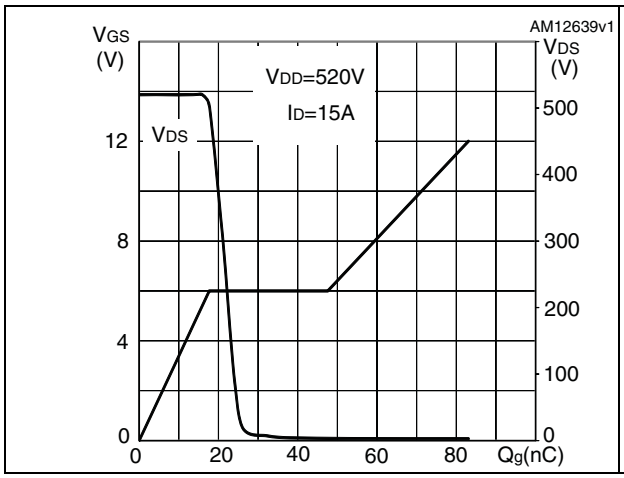


Figure 11. Static drain-source on-resistance

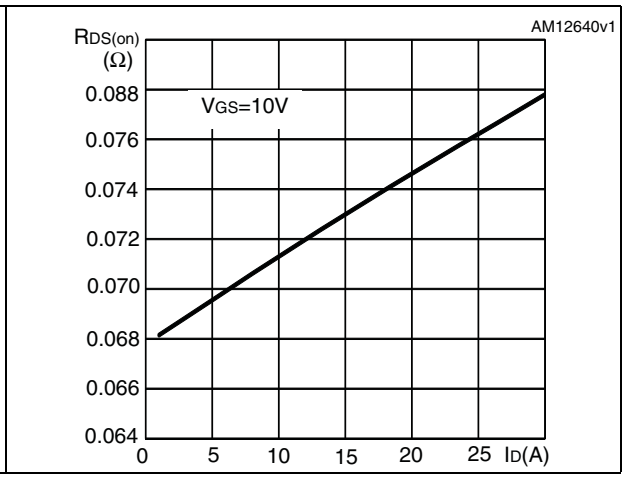


Figure 12. Capacitance variations

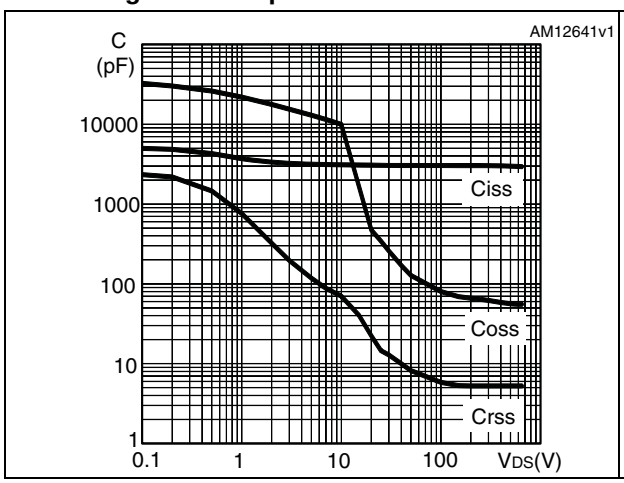


Figure 13. Output capacitance stored energy

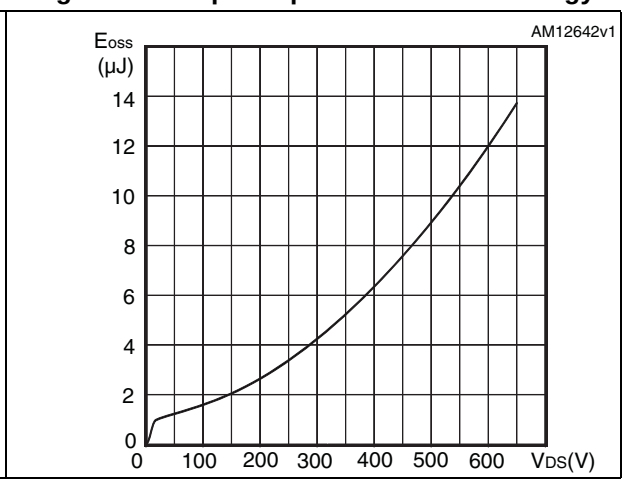


Figure 14. Normalized gate threshold voltage vs temperature

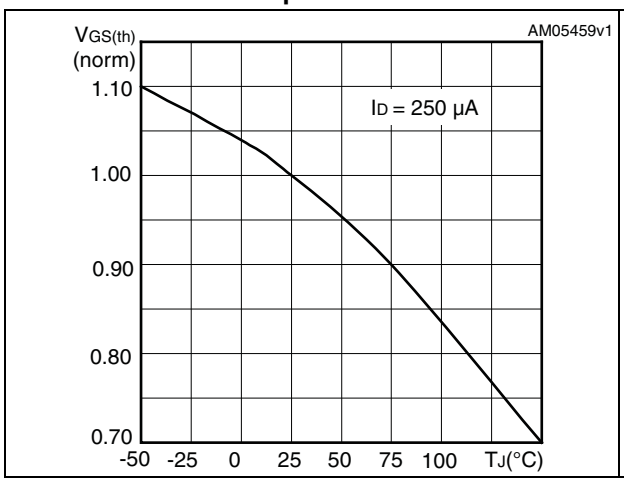


Figure 15. Normalized on-resistance vs temperature

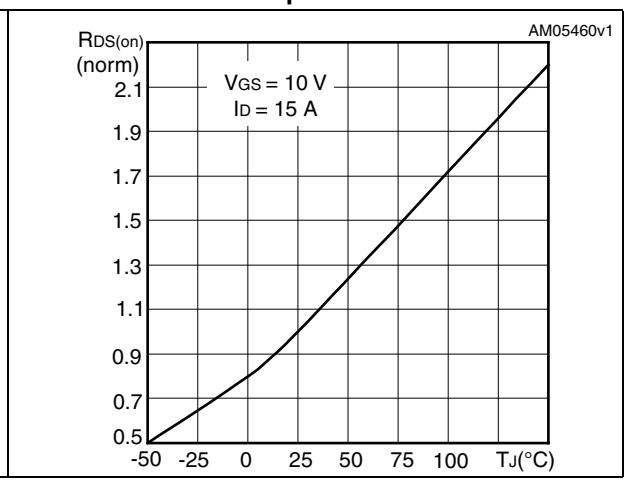


Figure 16. Source-drain diode forward characteristics

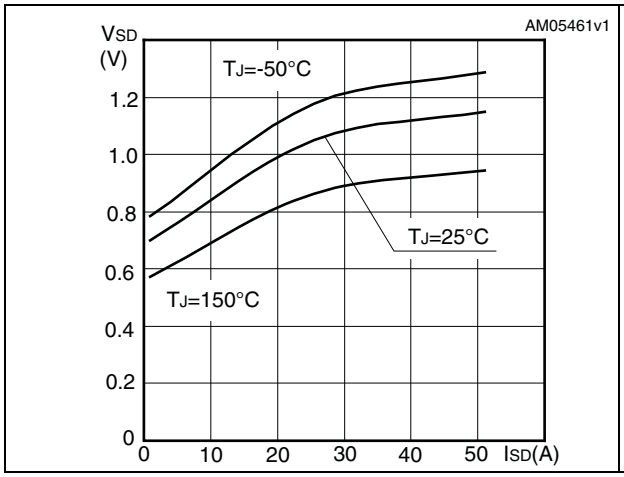


Figure 17. Normalized V_{DS} vs temperature

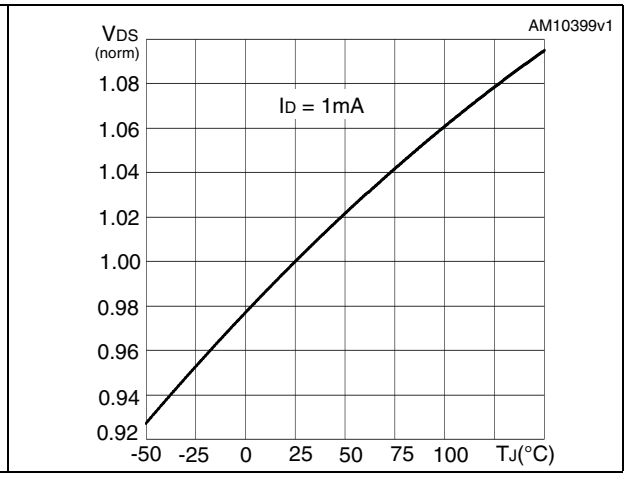
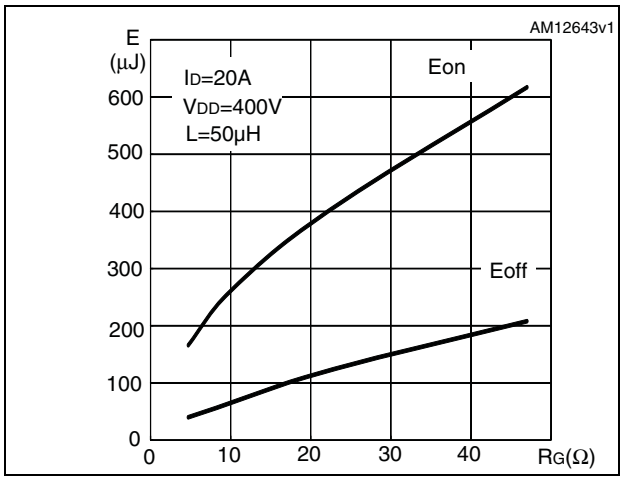


Figure 18. Switching losses vs gate resistance (1)



1. Eon including reverse recovery of a SiC diode.

3 Test circuits

Figure 19. Switching times test circuit for resistive load

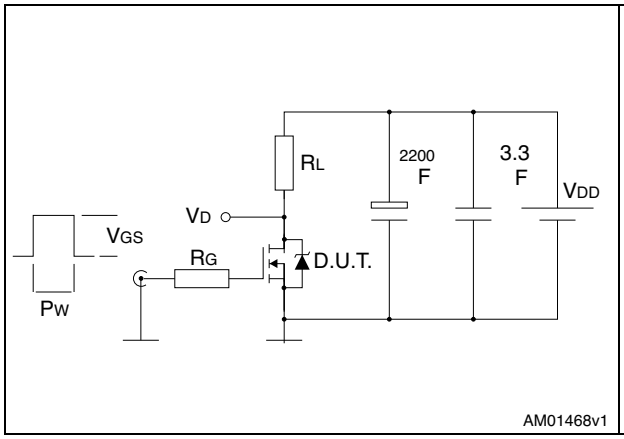


Figure 20. Gate charge test circuit

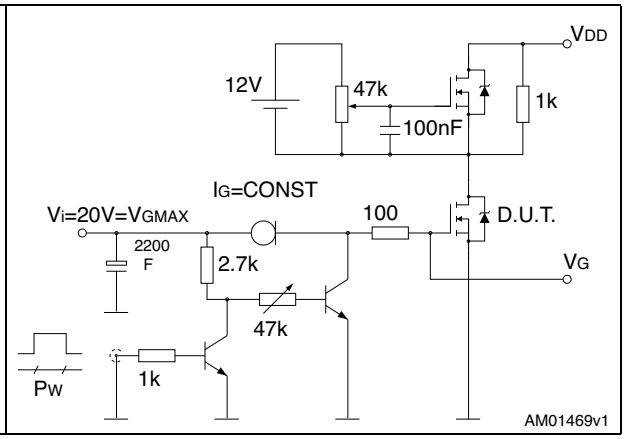


Figure 21. Test circuit for inductive load switching and diode recovery times

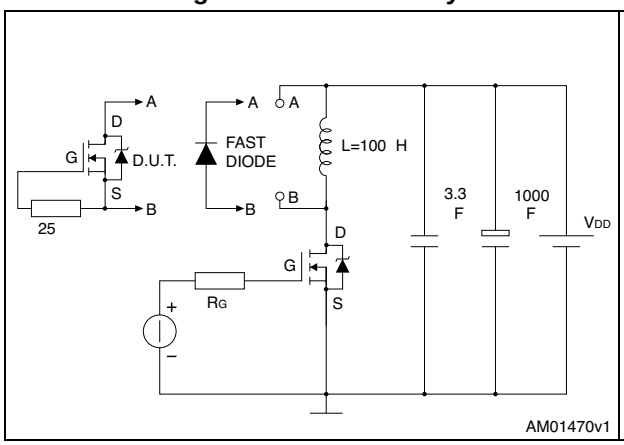


Figure 22. Unclamped inductive load test circuit

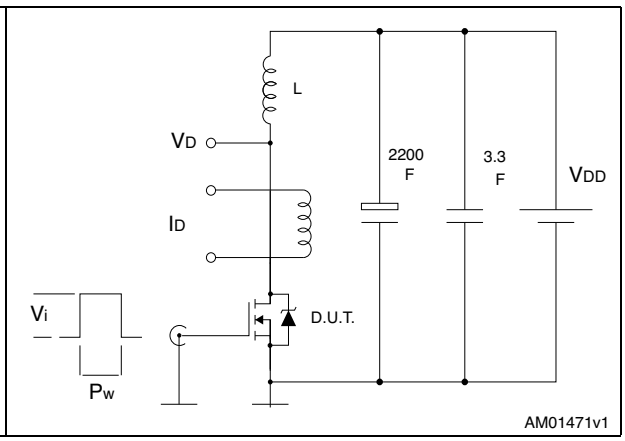


Figure 23. Unclamped inductive waveform

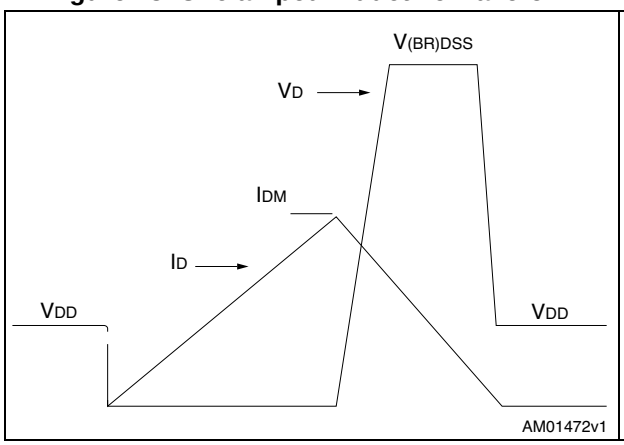
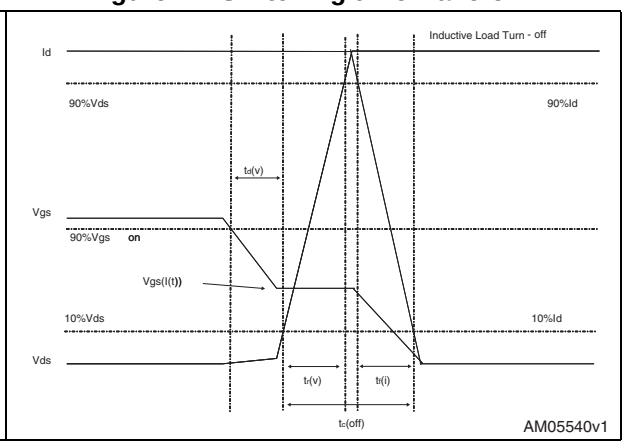


Figure 24. Switching time waveform



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. D²PAK (TO-263) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 25. D²PAK (TO-263) drawing

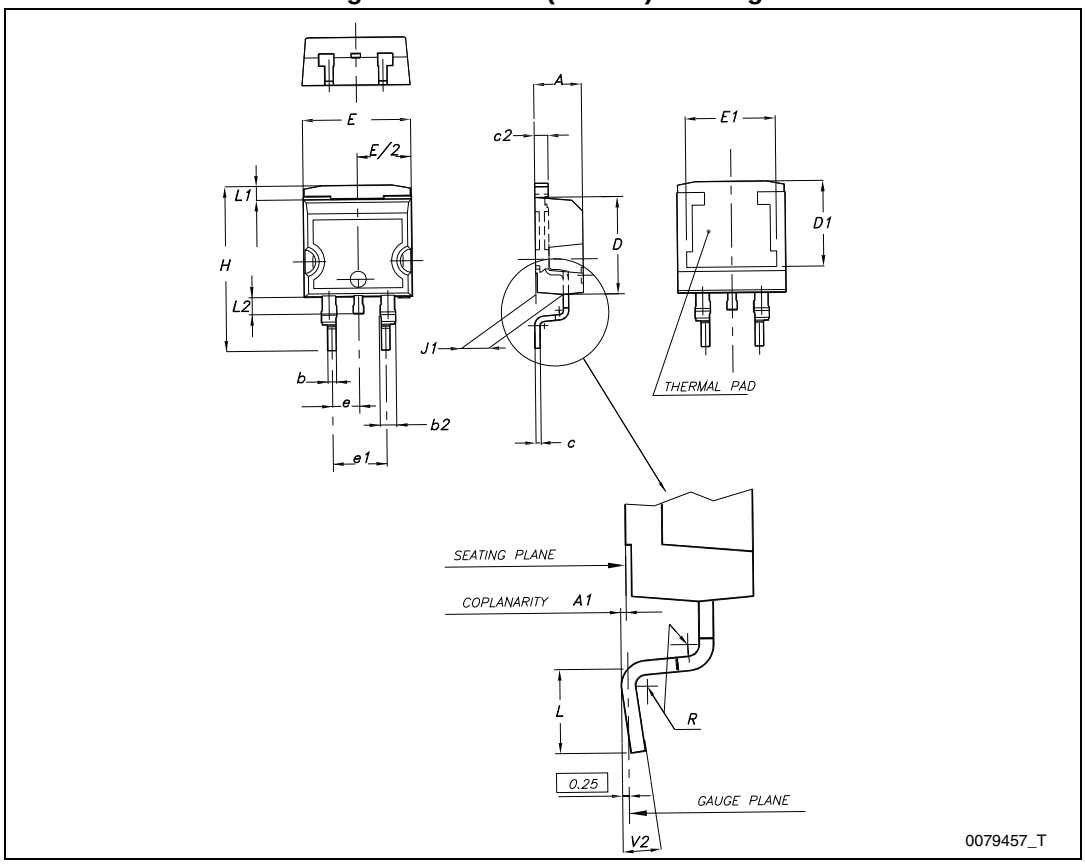
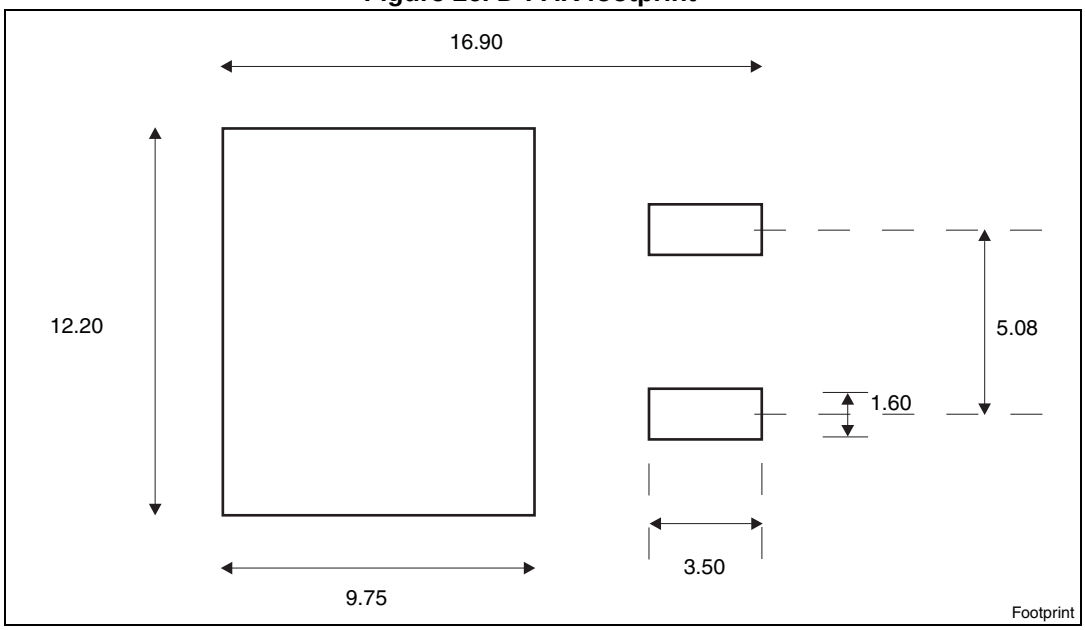


Figure 26. D²PAK footprint[a]



a. All dimension are in millimeters

Table 10. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 27. TO-220FP drawing

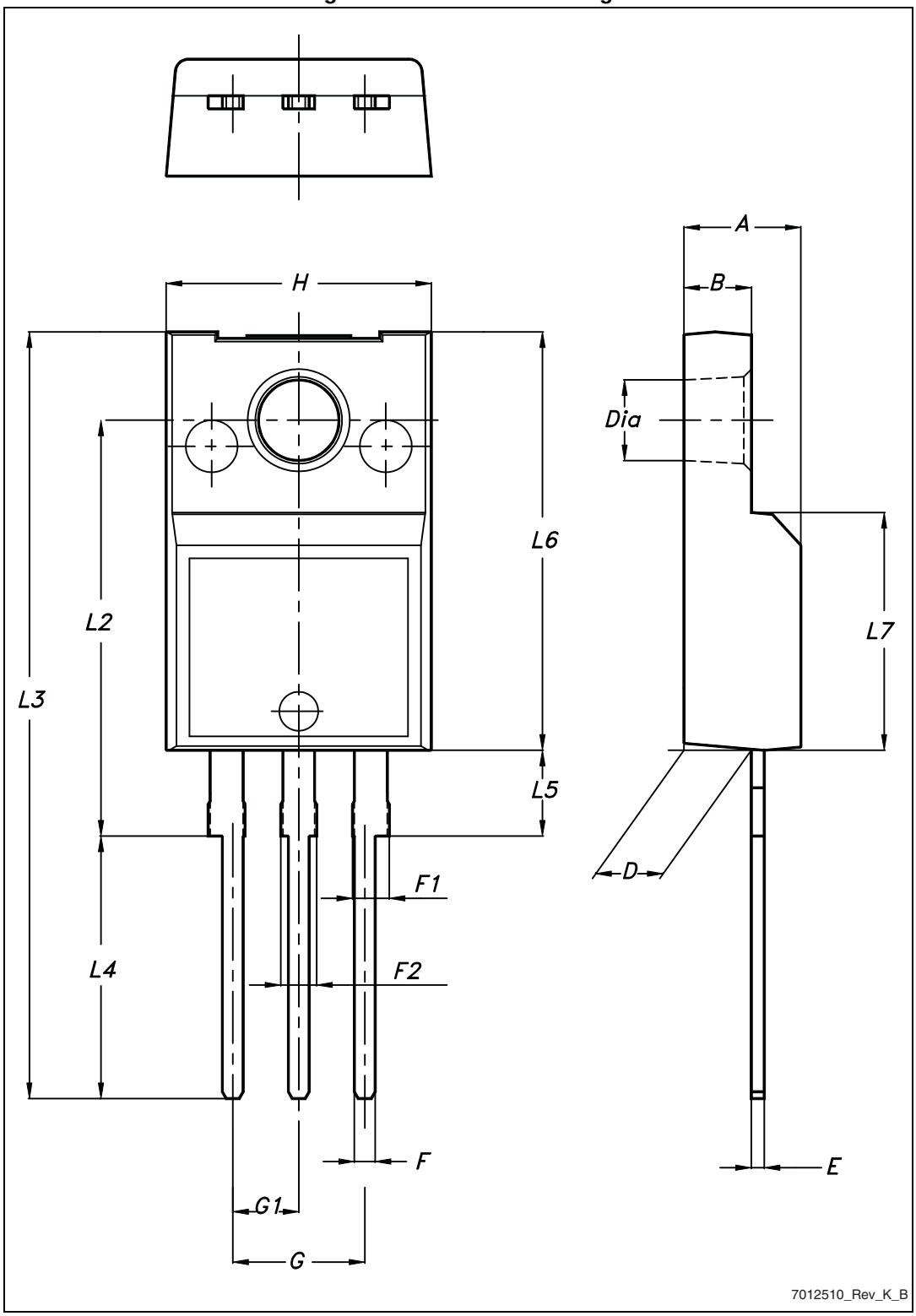


Table 11. TO-220 type A mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

Figure 28. TO-220 type A drawing

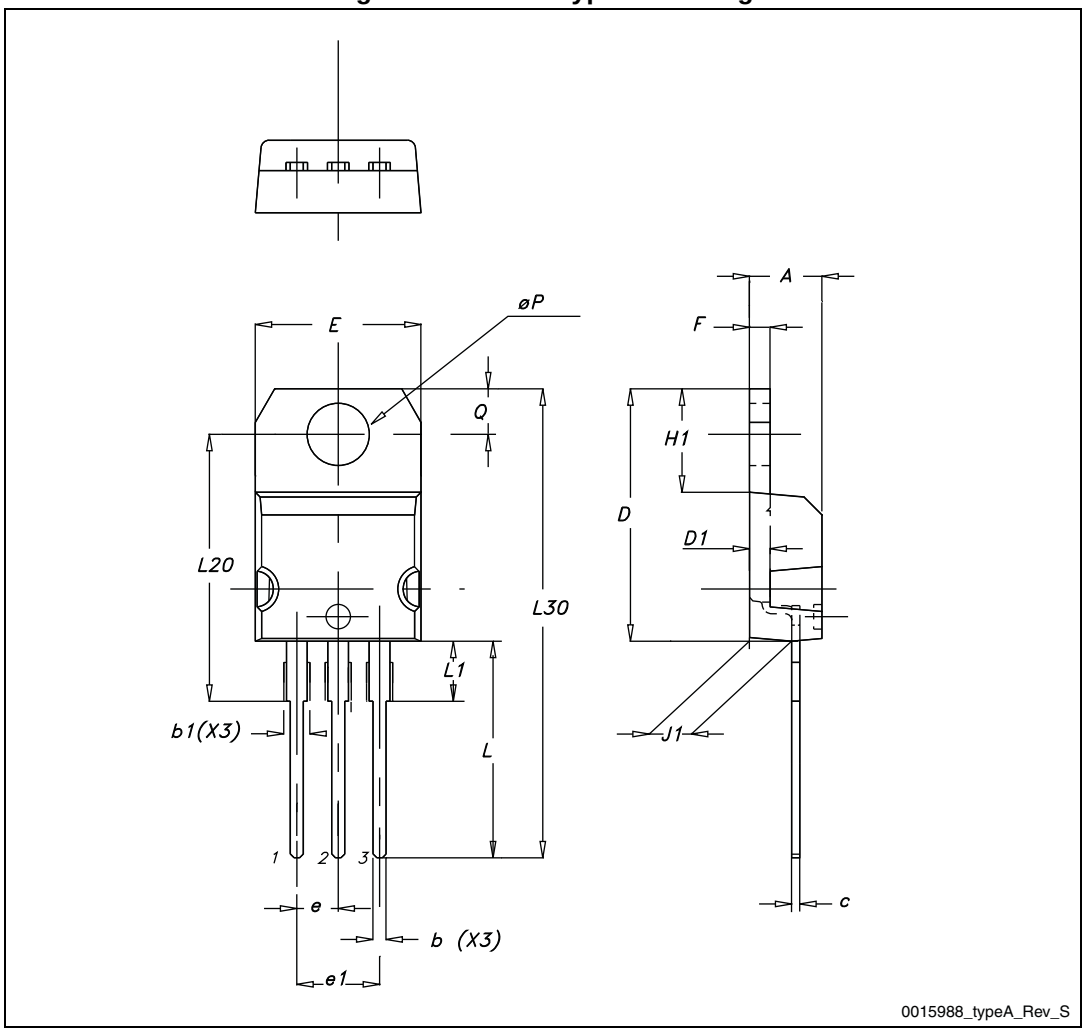
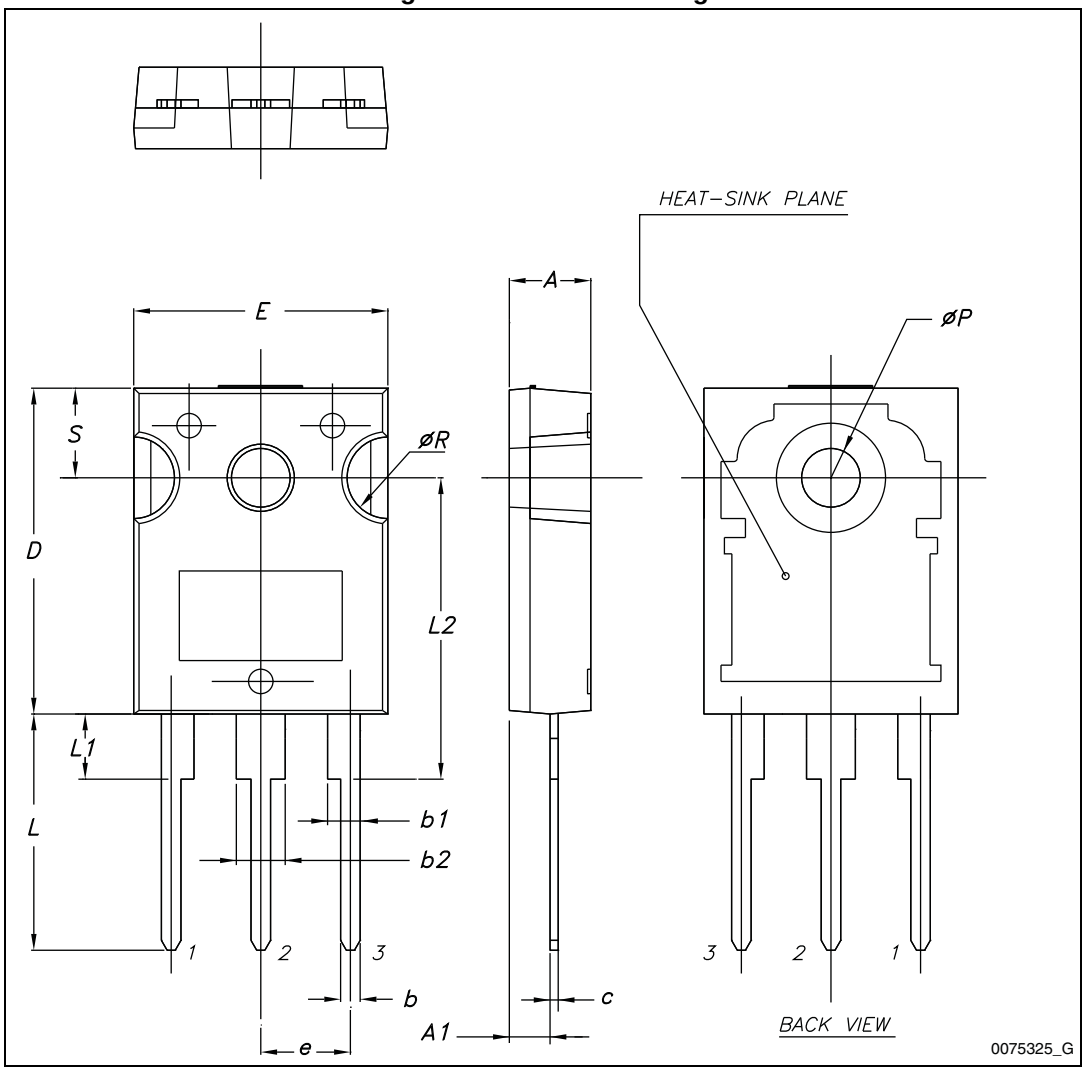


Table 12. TO-247 mechanical data

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 29. TO-247 drawing



5 Packaging mechanical data

Table 13. D²PAK (TO-263) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 30. Tape

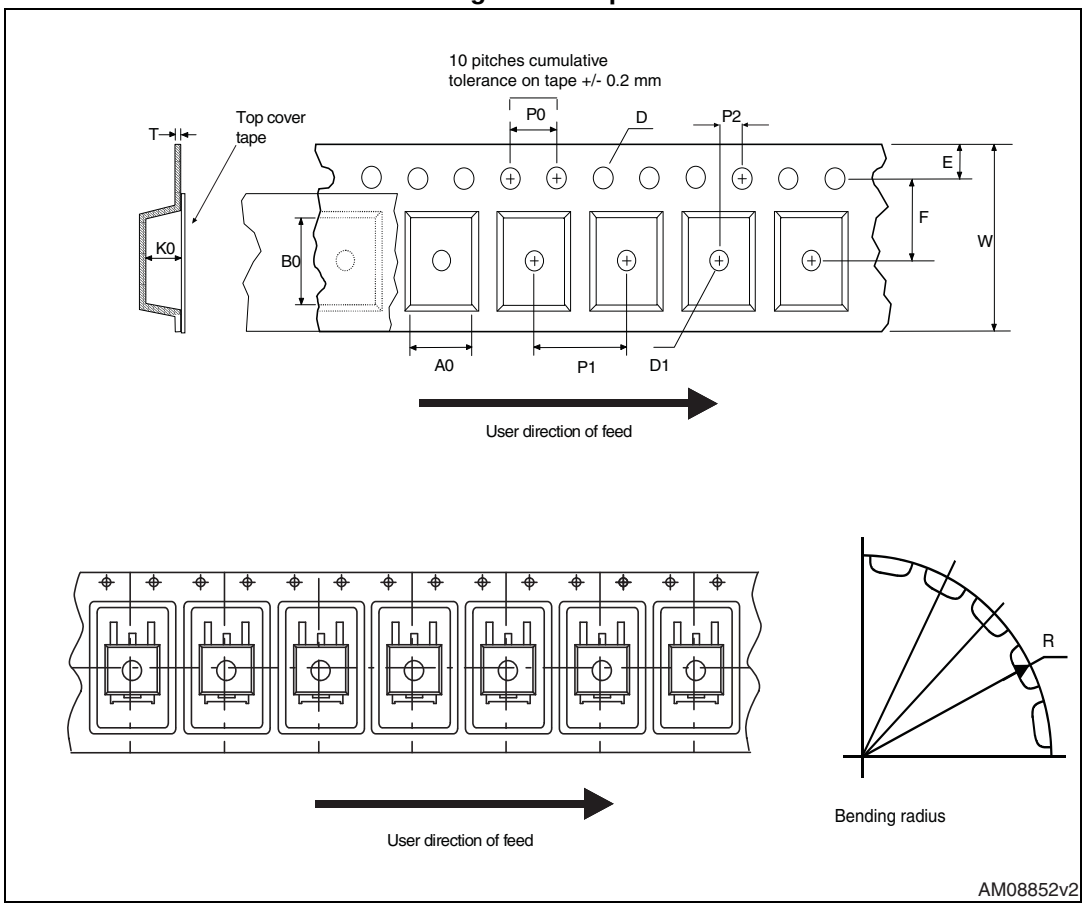
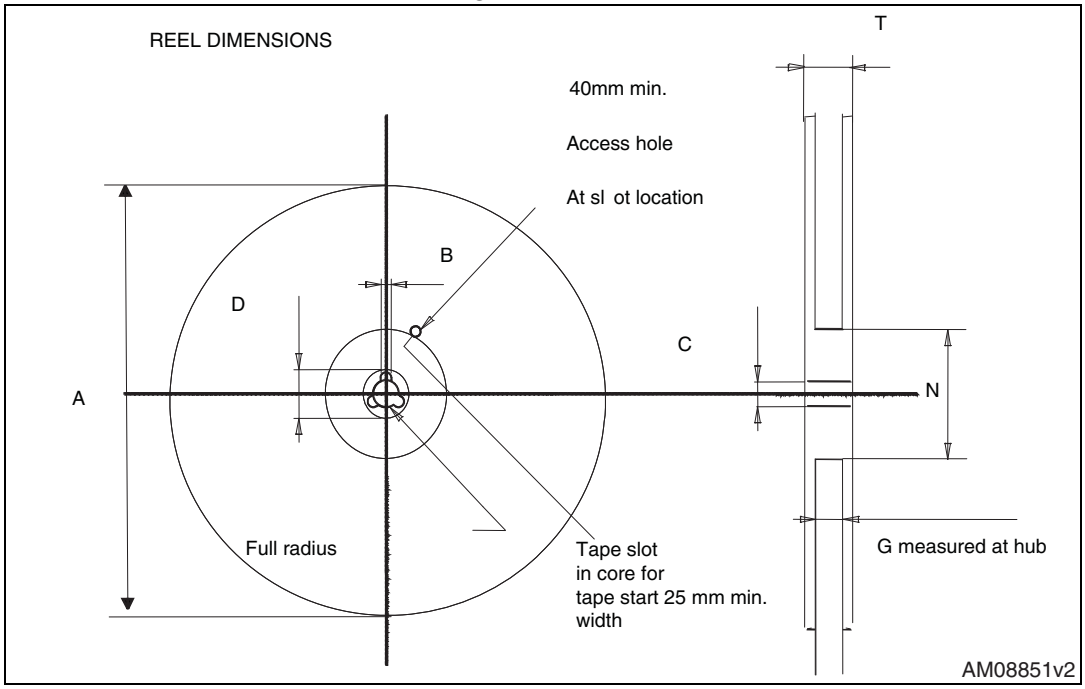


Figure 31. Reel



6 Revision history

Table 14. Document revision history

Date	Revision	Changes
22-Feb-2012	1	First release.
21-Jun-2012	2	Document status changed from preliminary data to production data. Added *Section 2.1: Electrical characteristics (curves)*.
05-Mar-2013	3	Added dv/dt value on *Table 2: Absolute maximum ratings*.

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