STB33N65M2, STF33N65M2, STP33N65M2, STI33N65M2

N-channel 650 V, 0.117 Ω typ., 24 A MDmesh™ M2 Power MOSFETs in D²PAK, TO-220FP, TO-220 and I²PAK packages
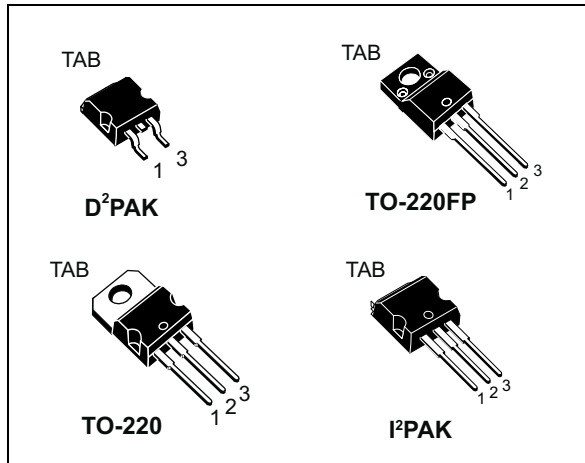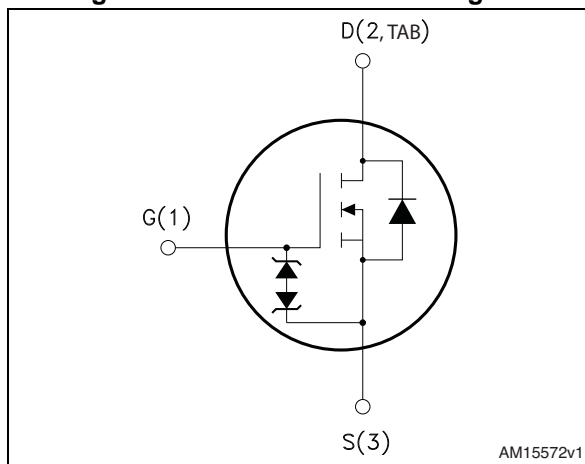
Datasheet - production data

D²PAK

TO-220FP

TO-220

I²PAK

Features

Order codes	V_{DS}	$R_{DS(on)}$ max	I_D
STB33N65M2			
STF33N65M2	650 V	0.14 Ω	24 A
STP33N65M2			
STI33N65M2			

- Extremely low gate charge
- Excellent output capacitance (C_{oss}) profile
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using MDmesh™ M2 technology. Thanks to their strip layout and improved vertical structure, the devices exhibit low on-resistance and optimized switching characteristics, rendering them suitable for the most demanding high efficiency converters.

Figure 1. Internal schematic diagram

Table 1. Device summary

Order codes	Marking	Package	Packaging
STB33N65M2		D²PAK	Tape and reel
STF33N65M2	33N65M2	TO-220FP	
STP33N65M2		TO-220	Tube
STI33N65M2		I²PAK	

This is information on a product in full production.

Contents

1   Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D^2PAK, TO-220, I^2PAK	**TO-220FP**	
V_{GS}	Gate-source voltage	± 25		V
I_D	Drain current (continuous) at T_C = 25 °C	24	24[1]	A
I_D	Drain current (continuous) at T_C = 100 °C	15	15[1]	A
I_{DM} [2]	Drain current (pulsed)	96		A
P_{TOT}	Total dissipation at T_C = 25 °C	190	34	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T_C=25 °C)		2500	V
dv/dt [3]	Peak diode recovery voltage slope	15		V/ns
dv/dt [4]	MOSFET dv/dt ruggedness	50		
T_{stg}	Storage temperature	- 55 to 150		°C
T_j	Max. operating junction temperature	150		

1. Current limited by package.

2. Pulse width limited by safe operating area.

3. $I_{SD} \leq 24$ A, di/dt ≤ 400 A/μs; $V_{DS\ peak} < V_{(BR)DSS}$, V_{DD}=400 V

4. $V_{DS} \leq 520$ V

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D^2PAK	**TO-220FP**	**TO-220**	**I^2PAK**	
$R_{thj-case}$	Thermal resistance junction-case max	0.66	3.68	0.66		°C/W
$R_{thj-pcb}$ [1]	Thermal resistance junction-pcb max	30				°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max		62.5			°C/W

1. When mounted on 1 inch² FR-4, 2 Oz copper board

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by T_{jmax})	2.5	A
E_{AS}	Single pulse avalanche energy (starting T_j=25°C, I_D= I_{AR}; V_{DD}=50 V)	780	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	V_{GS} = 0, I_D = 1 mA	650			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0, V_{DS} = 650 V			1	µA
		V_{GS} = 0, V_{DS} = 650 V, T_C=125 °C			100	µA
I_{GSS}	Gate-body leakage current	V_{DS} = 0, V_{GS} = ± 25 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 12 A		0.117	0.14	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0 V	-	1790	-	pF
C_{oss}	Output capacitance		-	75	-	pF
C_{rss}	Reverse transfer capacitance		-	2	-	pF
$C_{oss\ eq}$[1]	Equivalent output capacitance	V_{GS} = 0 V, V_{DS} = 0 to 520 V	-	380	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz open drain	-	5	-	Ω
Q_g	Total gate charge	V_{DD} = 520 V, I_D = 24 A, V_{GS} = 10 V (see *Figure 17*)	-	41.5	-	nC
Q_{gs}	Gate-source charge		-	6.8	-	nC
Q_{gd}	Gate-drain charge		-	18	-	nC

1. Coss eq. is defined as a constant equivalent capacitance giving the same charging time as Coss when VDS increases from 0 to 80% VDSS

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 325 V, I_D = 12 A, R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 16* and *Figure 21*)	-	13.5	-	ns
t_r	Rise time		-	11.5	-	ns
$t_{d(off)}$	Turn-off delay time		-	72.5	-	ns
t_f	Fall time		-	9	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		24	A
I_{SDM} [1]	Source-drain current (pulsed)		-		96	A
V_{SD} [2]	Forward on voltage	V_{GS} = 0 V, I_{SD} = 24 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 24 A, di/dt = 100 A/µs V_{DD} = 60 V (see *Figure 18*)	-	426		ns
Q_{rr}	Reverse recovery charge		-	7		µC
I_{RRM}	Reverse recovery current		-	33.5		A
t_{rr}	Reverse recovery time	I_{SD} = 24 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 18*)	-	544		ns
Q_{rr}	Reverse recovery charge		-	10		µC
I_{RRM}	Reverse recovery current		-	36.5		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 TO-220, D²PAK and I²PAK
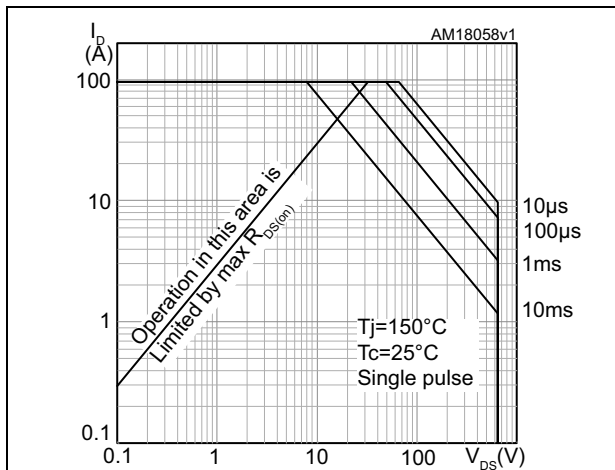
Figure 3. Thermal impedance for TO-220, D²PAK and I²PAK
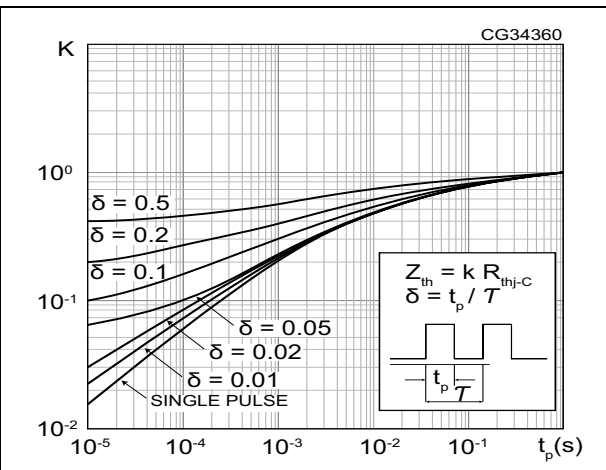
Figure 4. Safe operating area for TO-220FP
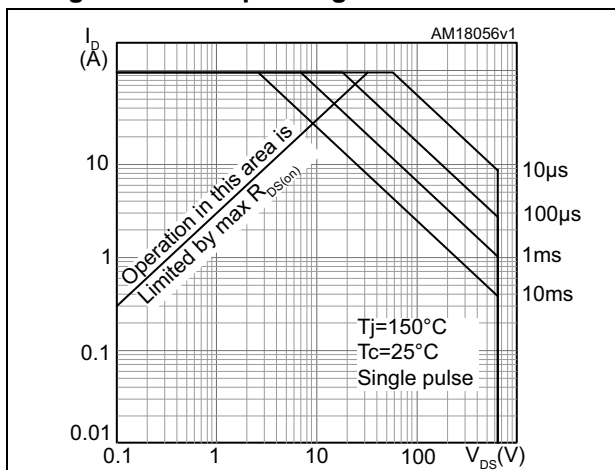
Figure 5. Thermal impedance for TO-220FP
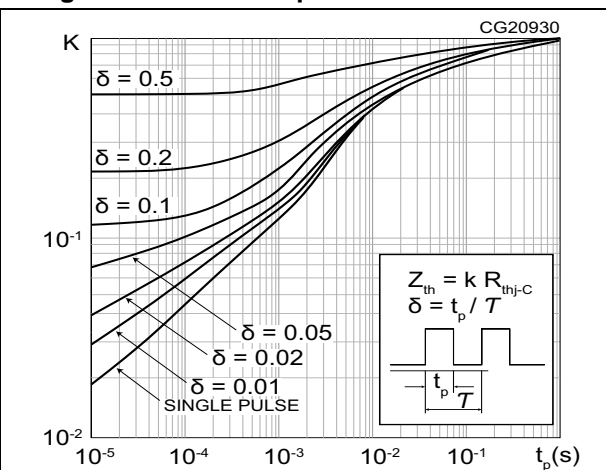
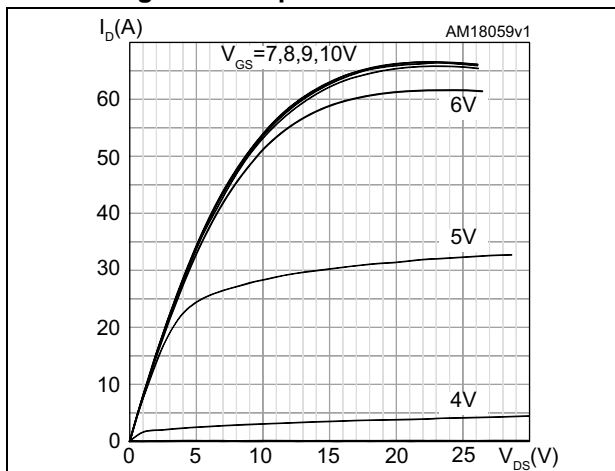**Figure 6. Output characteristics**
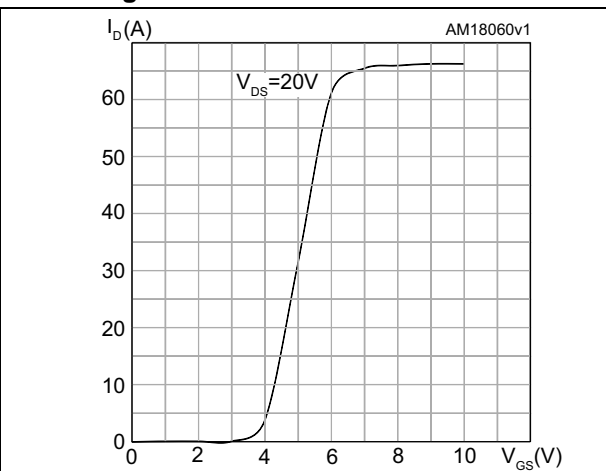

Figure 7. Transfer characteristics

Figure 8. Gate charge vs gate-source voltage
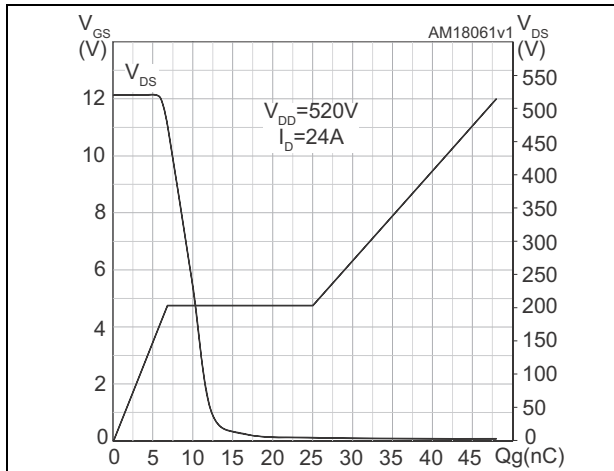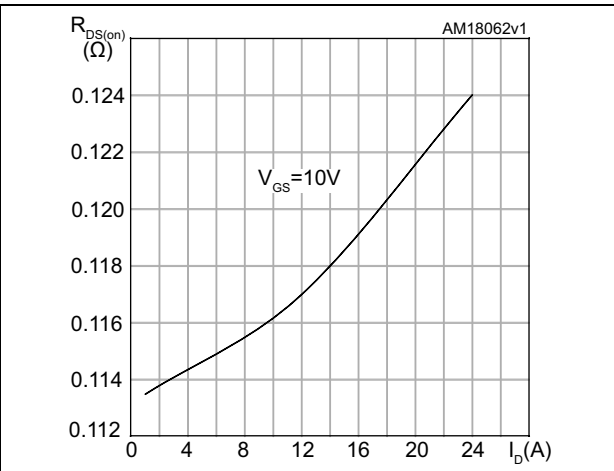

Figure 9. Static drain-source on-resistance

Figure 10. Capacitance variations
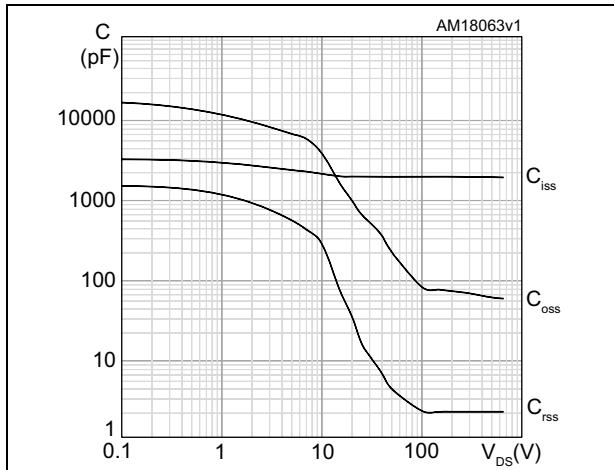
Figure 11. Output capacitance stored energy
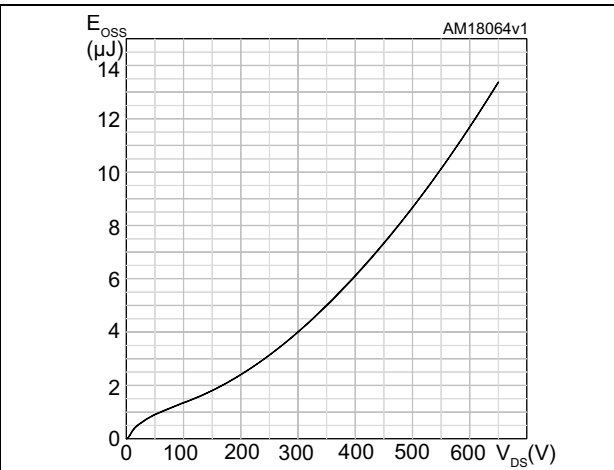
Figure 12. Normalized gate threshold voltage vs temperature
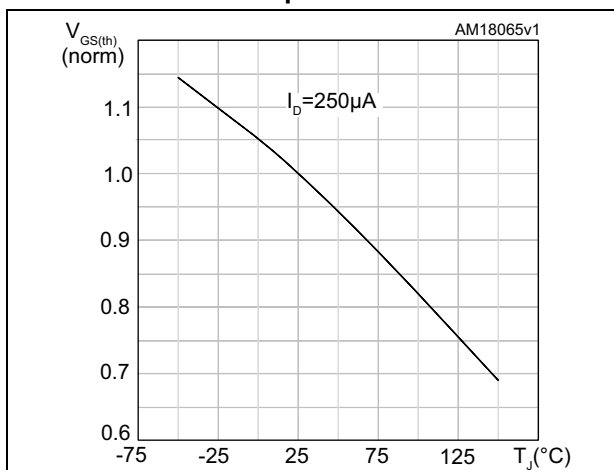
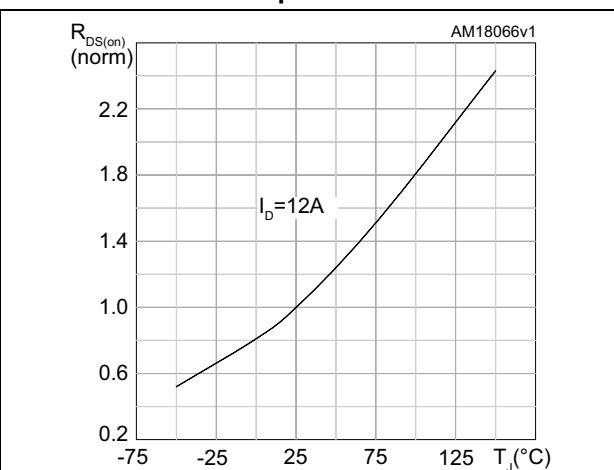**Figure 13. Normalized on-resistance vs temperature**
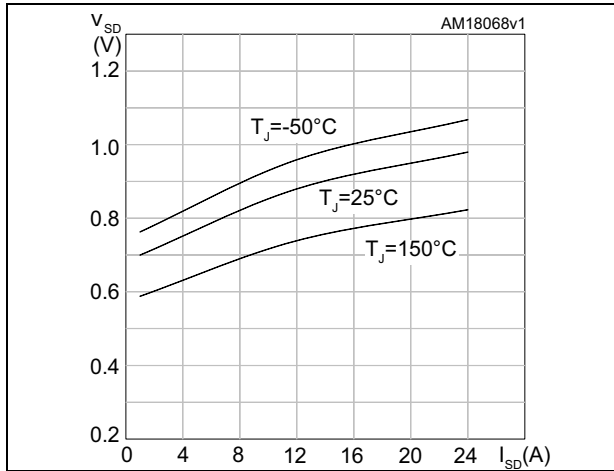
Figure 14. Source-drain diode forward characteristics

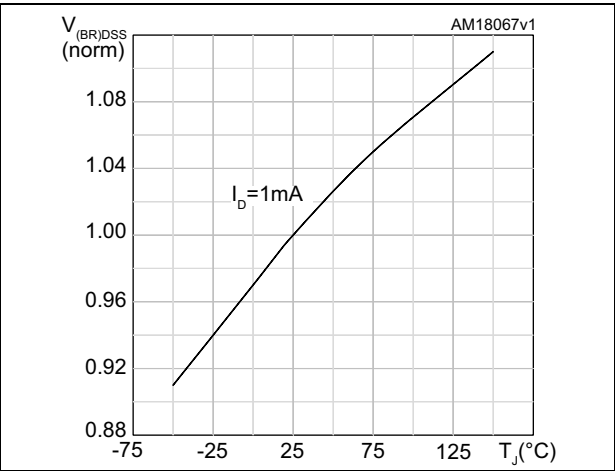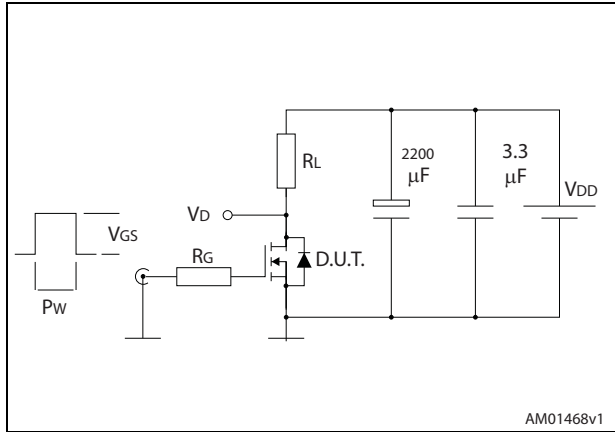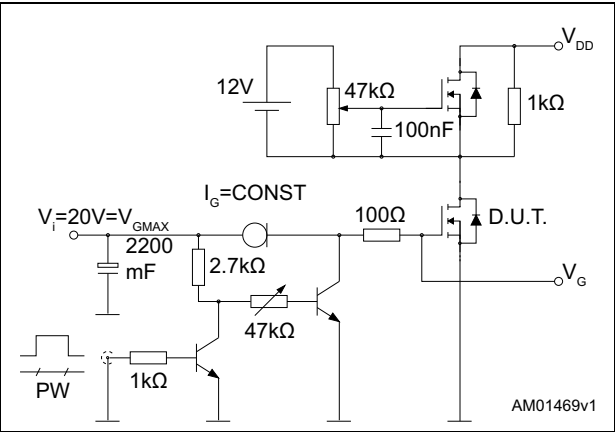**Figure 15. Normalized $V_{(BR)DSS}$ vs temperature**
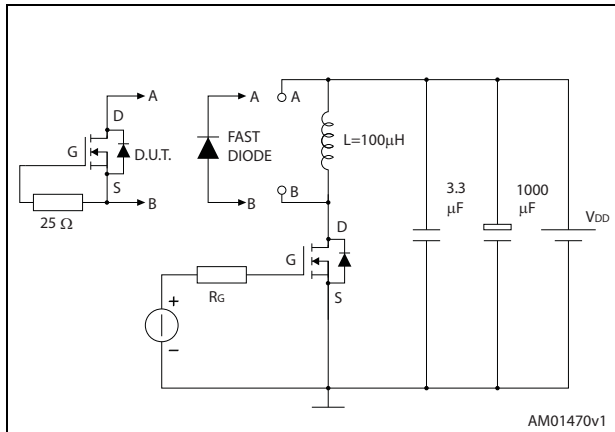
3 Test circuits

Figure 16. Switching times test circuit for resistive load
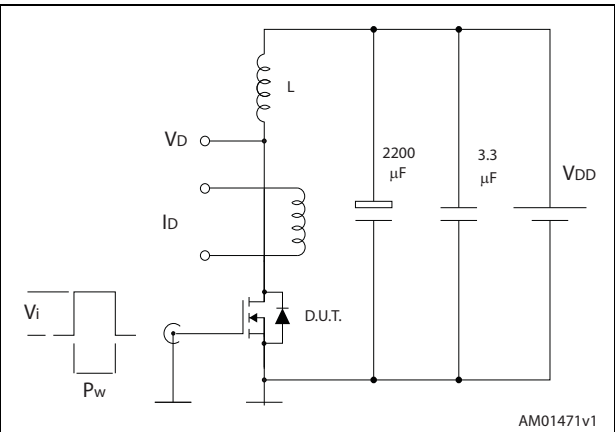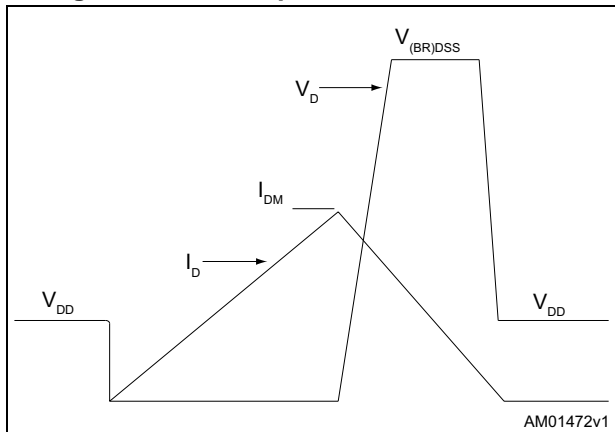

Figure 17. Gate charge test circuit

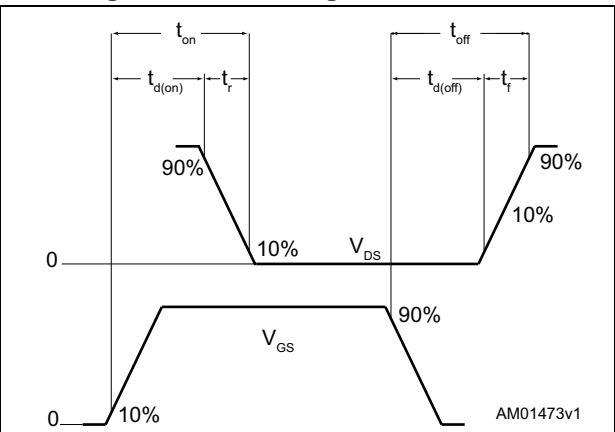**Figure 18. Test circuit for inductive load switching and diode recovery times**

Figure 19. Unclamped inductive load test circuit

Figure 20. Unclamped inductive waveform

Figure 21. Switching time waveform

4   Package mechanical data

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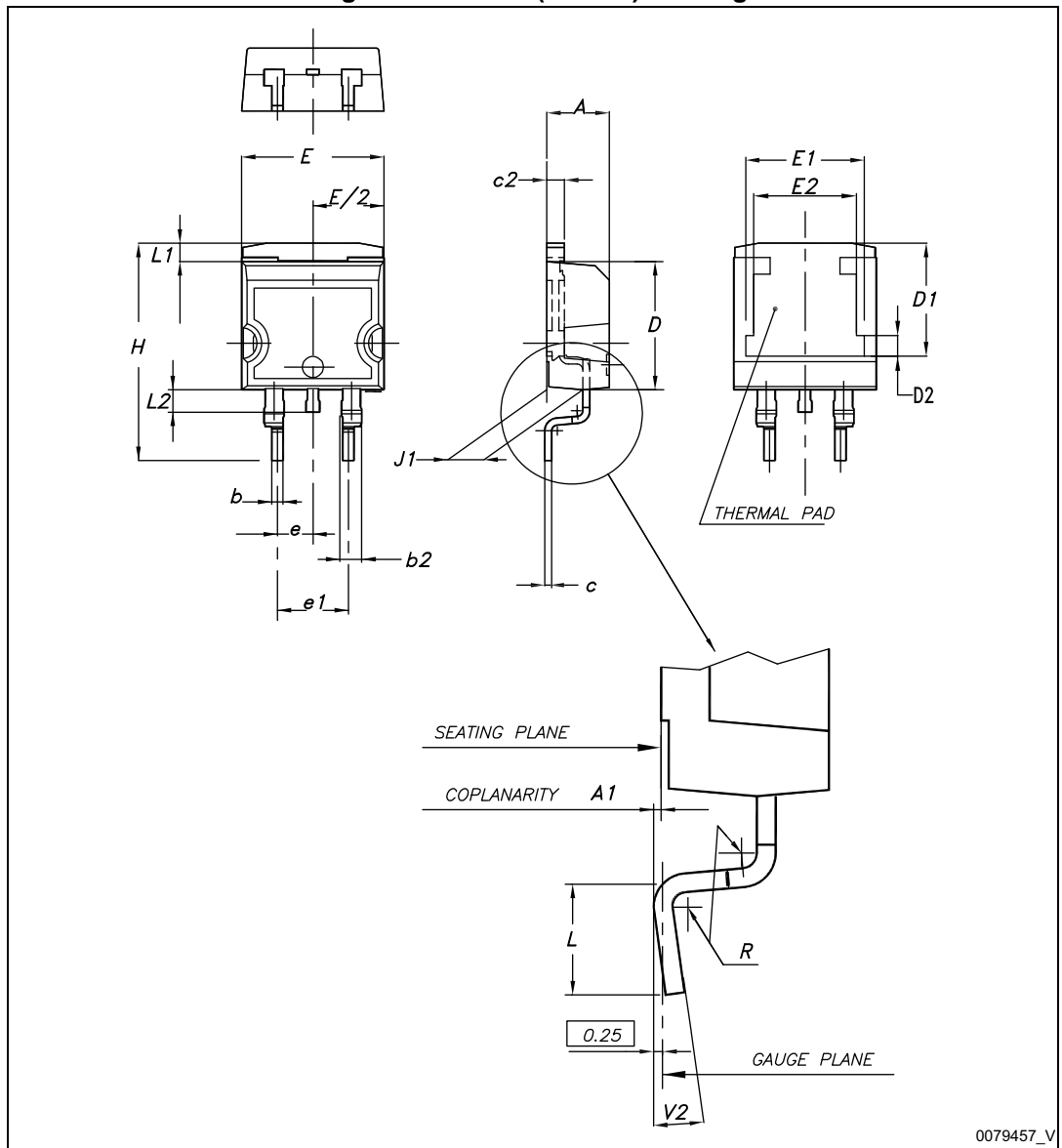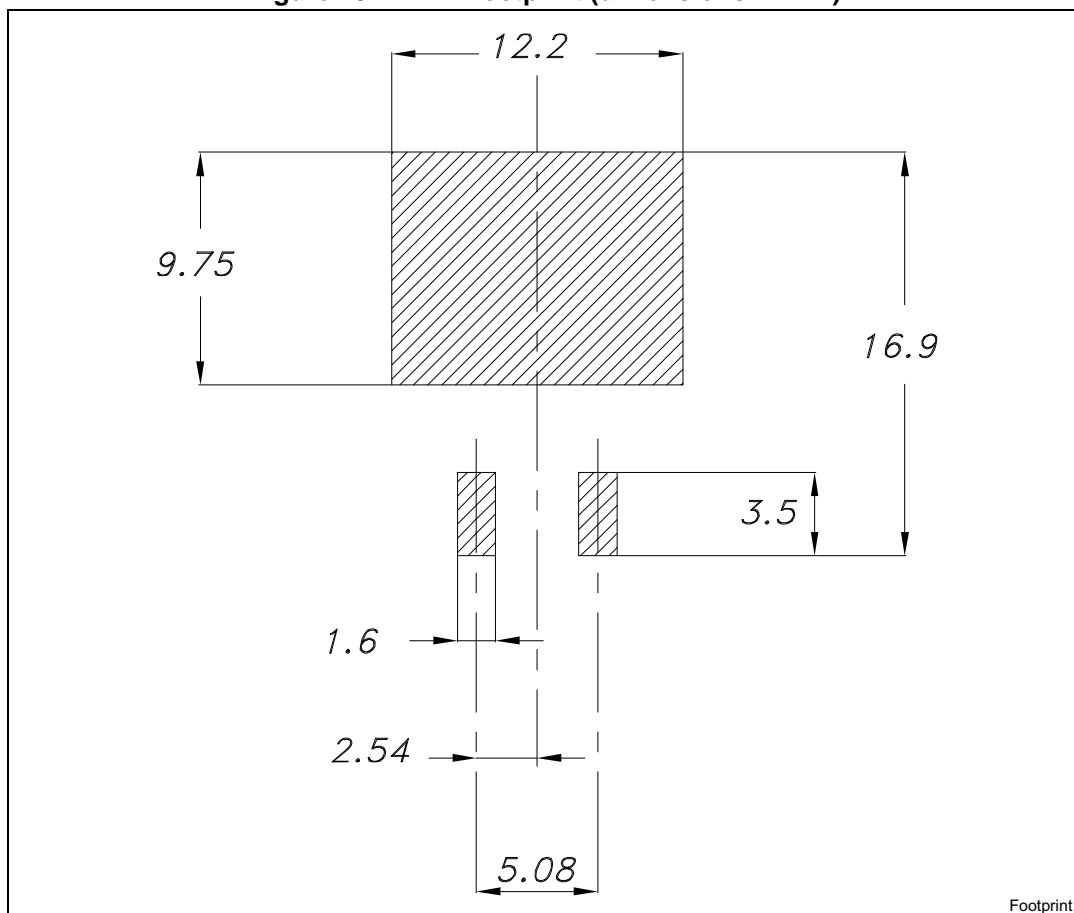## 4.1   D²PAK, STB33N65M2

Figure 22. D²PAK (TO-263) drawing

Table 9. D²PAK (TO-263) mechanical data

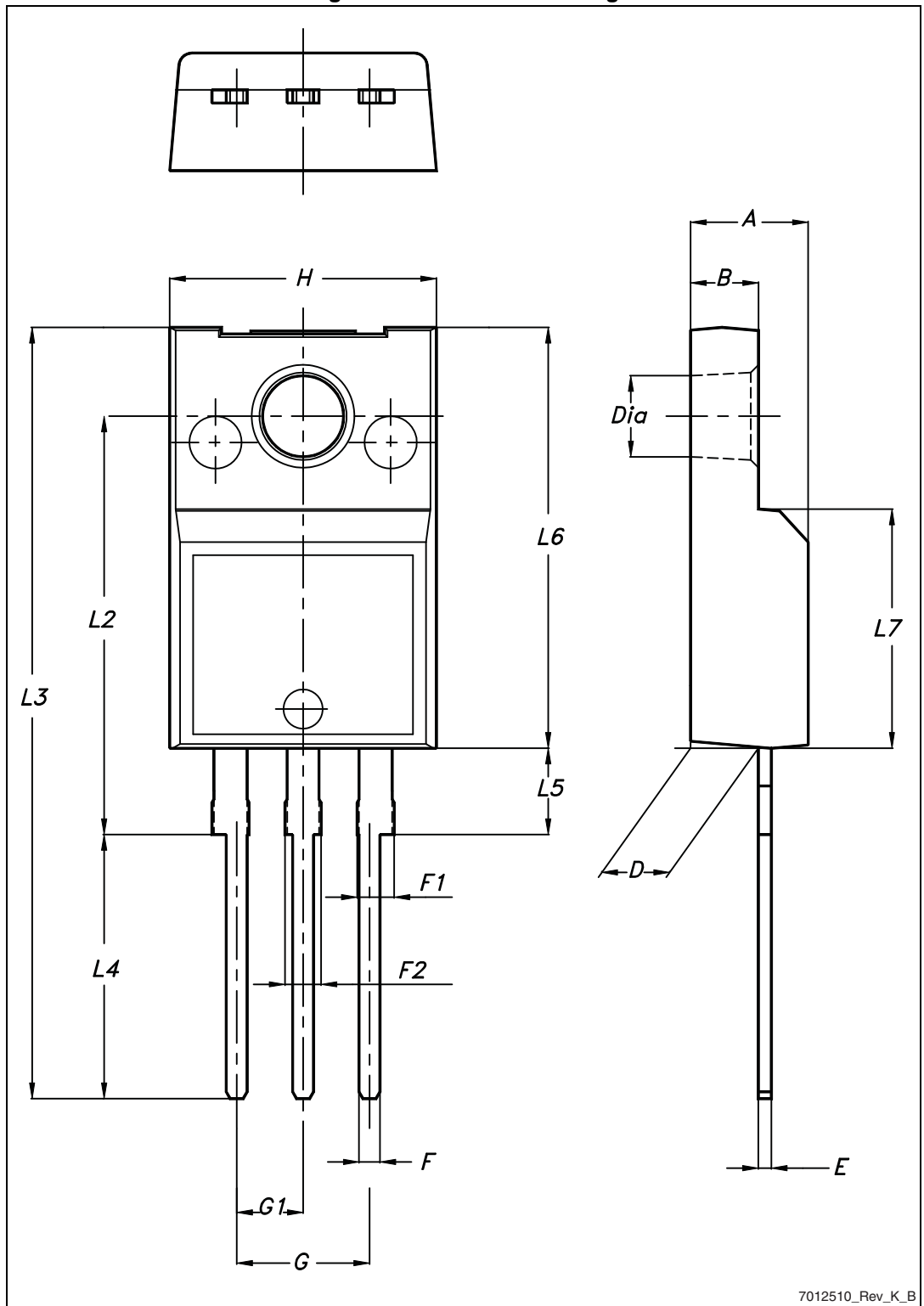| Dim.	mm		
	Min.	**Typ.**	**Max.**
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 23. D²PAK footprint (dimensions in mm)

Footprint

4.2　TO-220FP, STF33N65M2

Figure 24. TO-220FP drawing

7012510_Rev_K_B

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
Ø	3		3.2

4.3 TO-220, STP33N65M2

Figure 25. TO-220 type A drawing

0015988_typeA_Rev_T
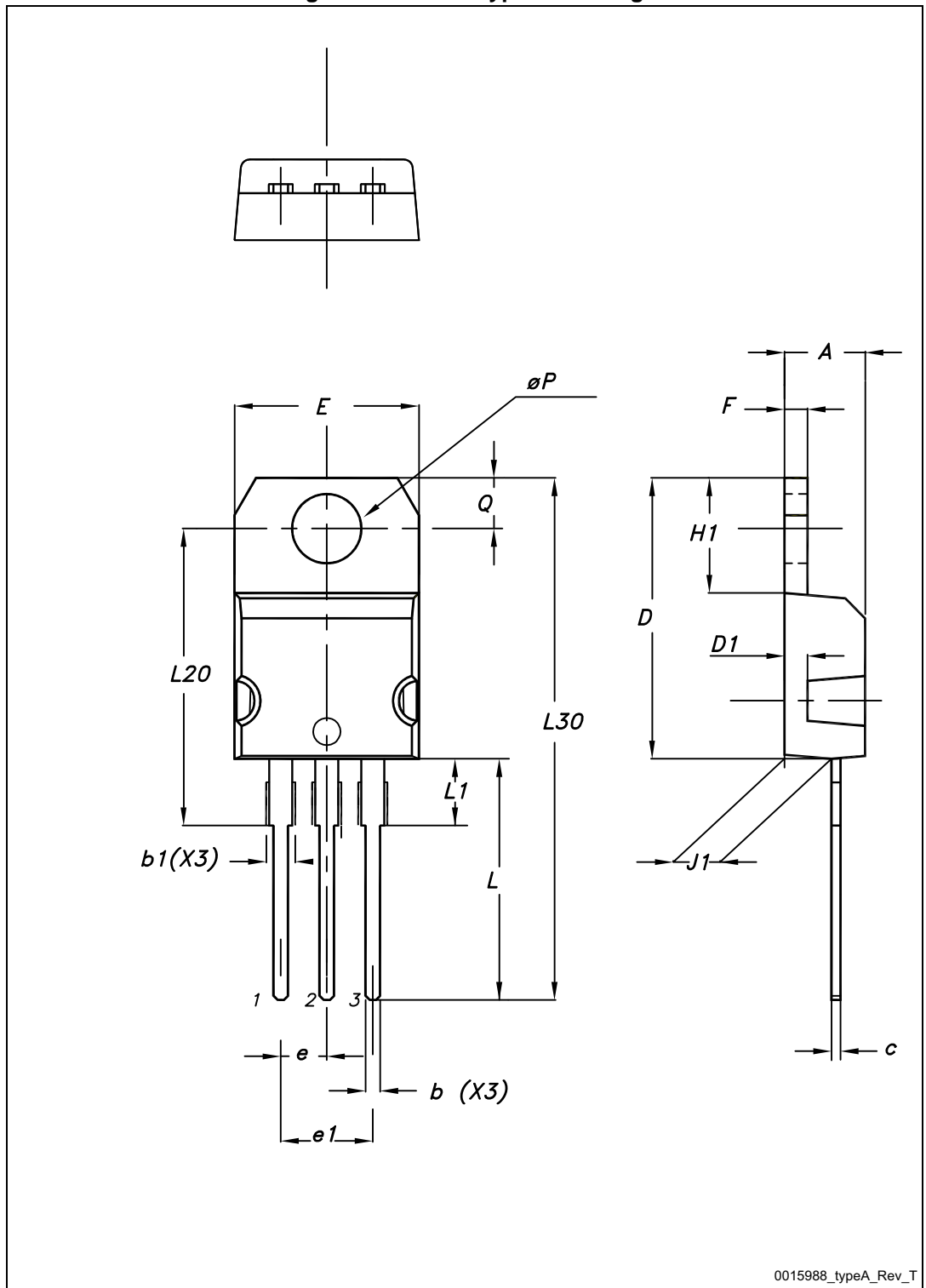
Table 11. TO-220 type A mechanical data

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

4.4   I²PAK, STI33N65M2

Figure 26. I²PAK (TO-262) drawing
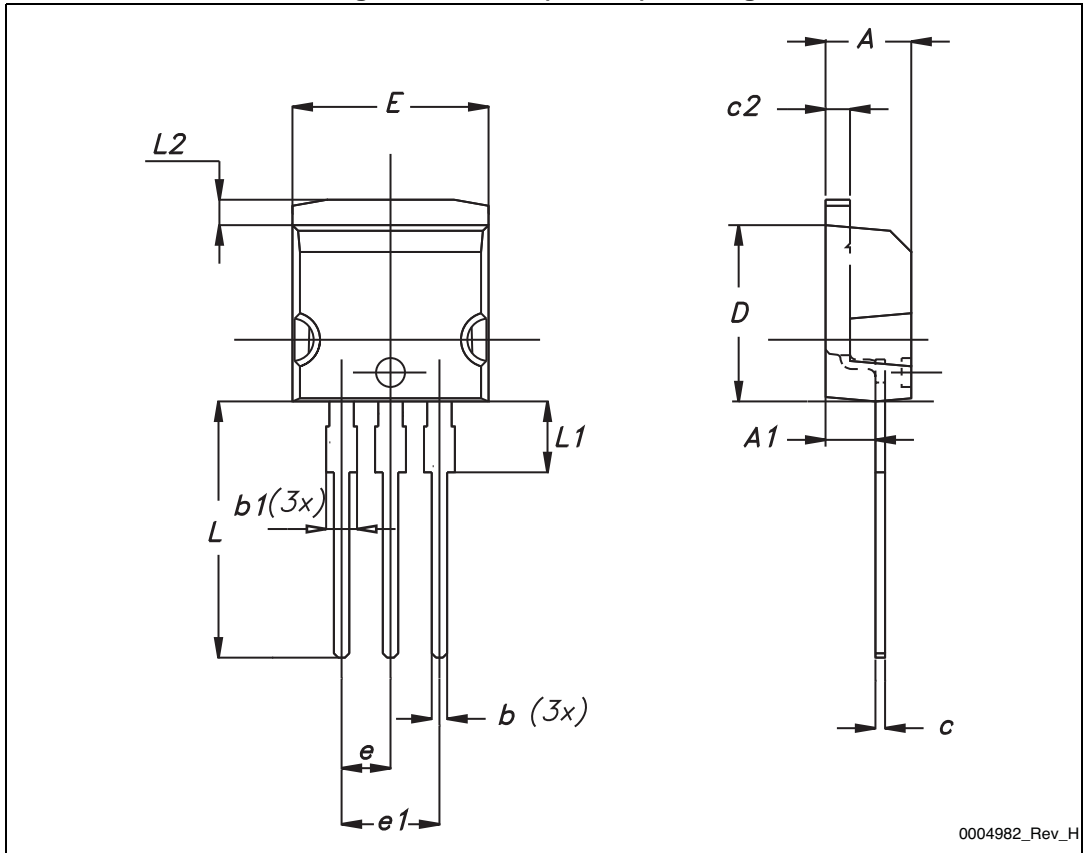
Table 12. I²PAK (TO-262) mechanical data

DIM.	mm.		
	min.	typ	max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

5   Packaging mechanical data

Figure 27. Tape for D²PAK (TO-263)
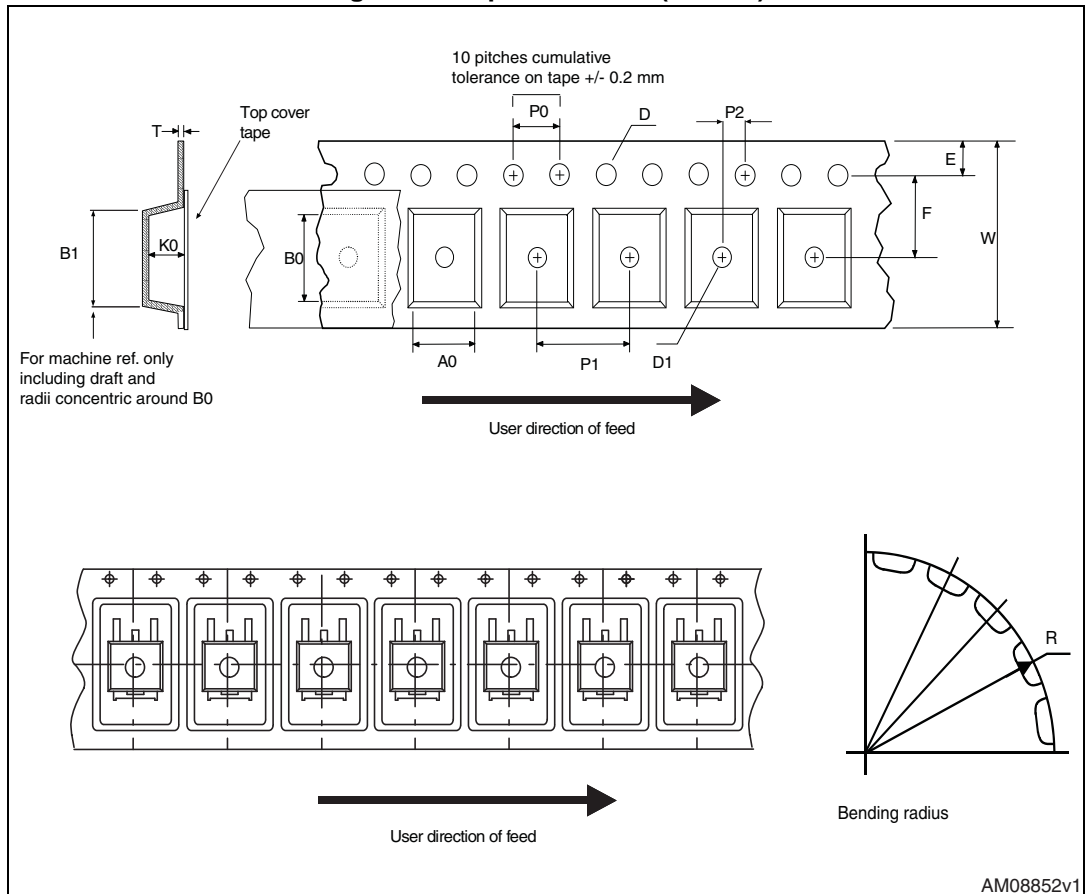
Figure 28. Reel for D²PAK (TO-263)
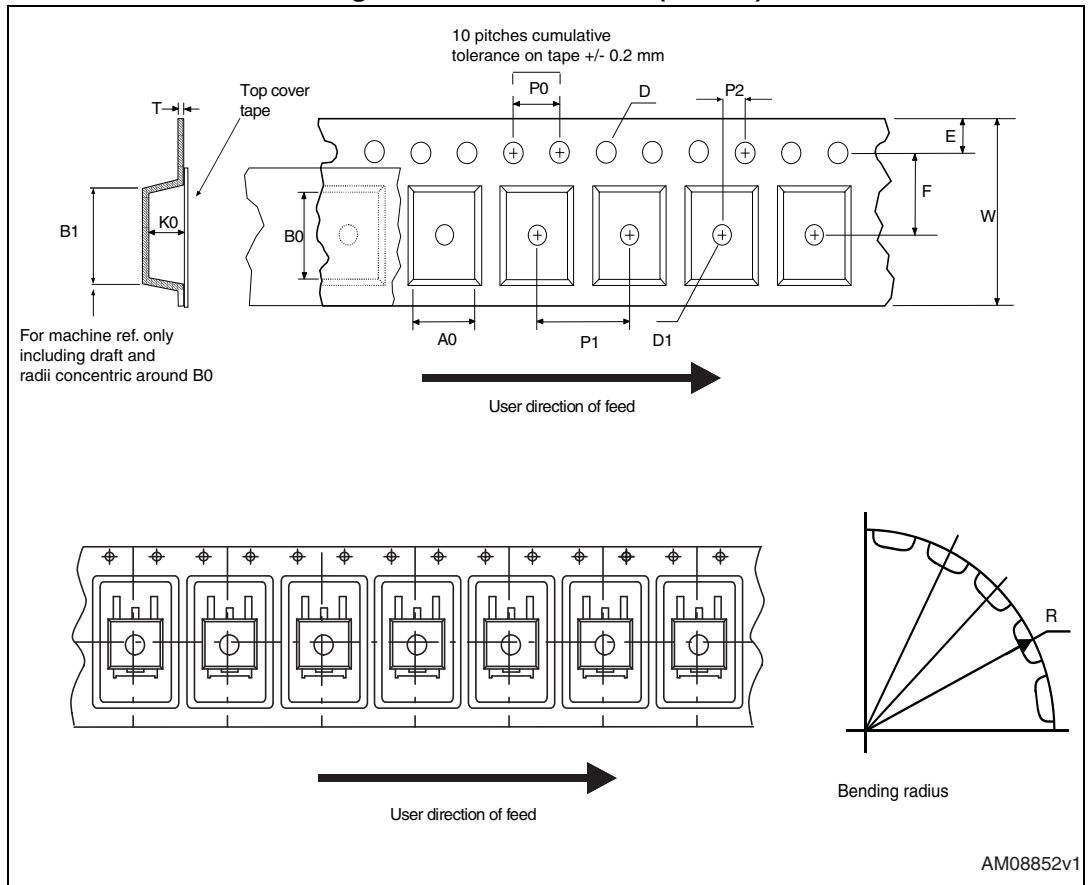
Table 13. D²PAK (TO-263) tape and reel mechanical data

	Tape			Reel		
		mm				mm	
Dim.	Min.	Max.	Dim.	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			

6 Revision history

Table 14. Document revision history

Date	Revision	Changes
10-Dec-2014	1	First release.

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