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

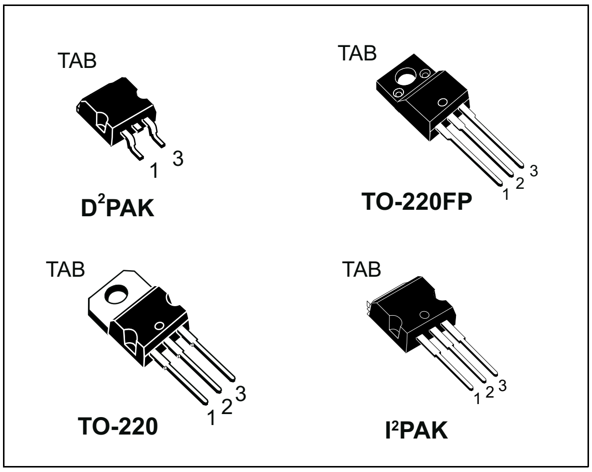
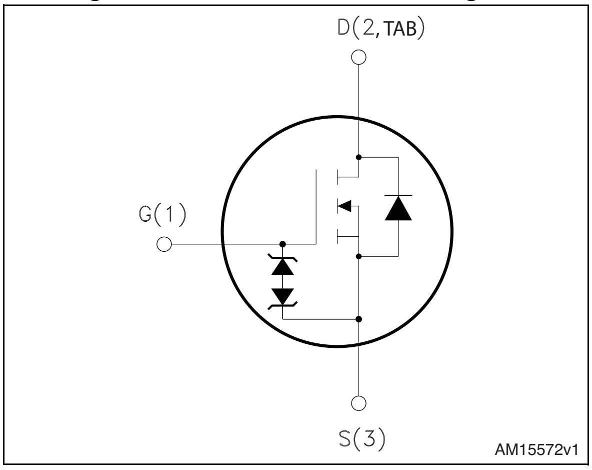


Figure 1. Internal schematic diagram



Features

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

Table 1. Device summary

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

This is information on a product in full production. www.st.com

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. $I_{SD} \le 24$ A, di/dt $\le$ 400 A/µs; $V_{DS\ peak} < V_{(BR)DSS}$, V_{DD}=400 V
4. $V_{DS} \le 520$ V

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		D^2PAK	TO-220FP	TO-220	I^2PAK	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	0.66	3.68	0.66		°C/W
$R_{thj\text{-}pcb}$(1)	Thermal resistance junction-pcb max	30				°C/W
$R_{thj\text{-}amb}$	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, D^2PAK and I^2PAK

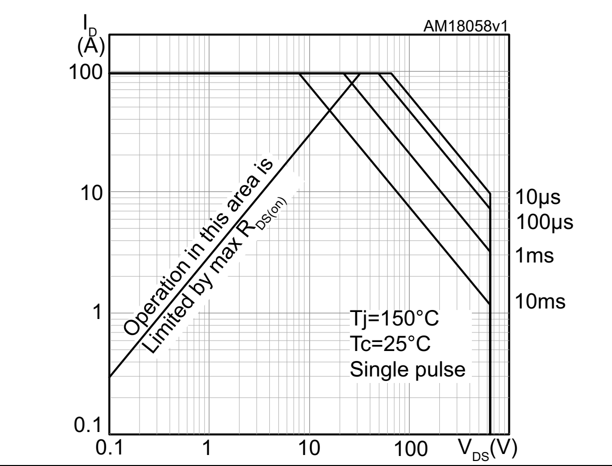


Figure 3. Thermal impedance for TO-220, D^2PAK and I^2PAK

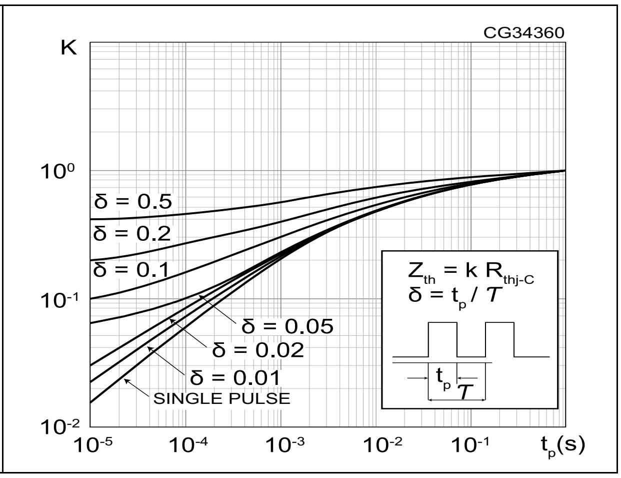


Figure 4. Safe operating area for TO-220FP

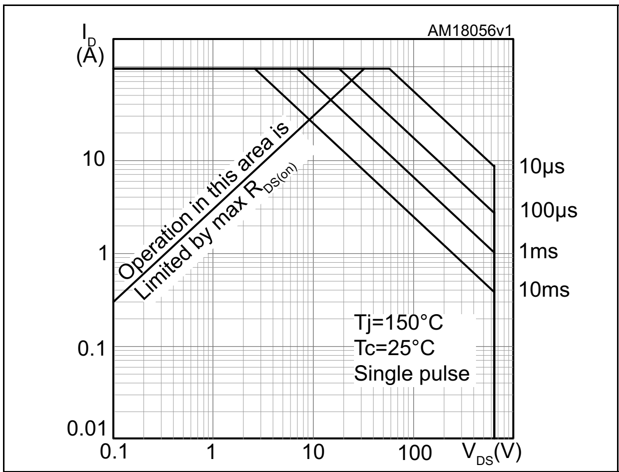


Figure 5. Thermal impedance for TO-220FP

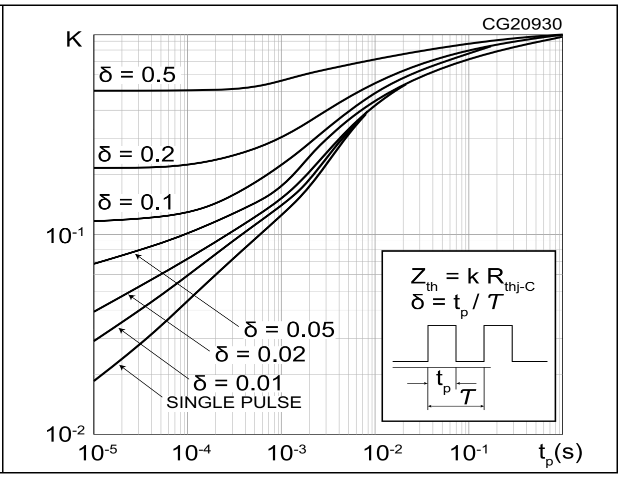


Figure 6. Output characteristics

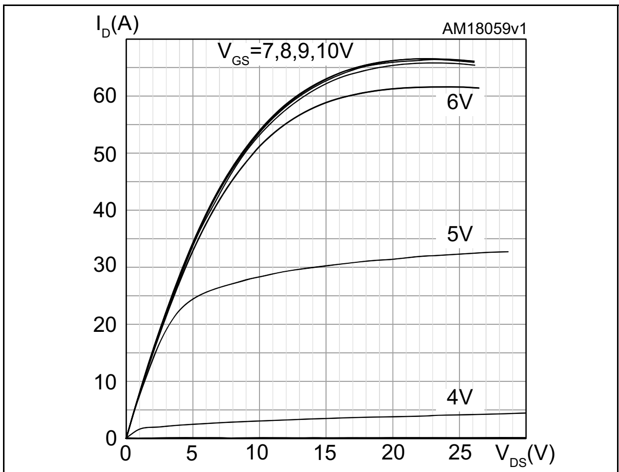


Figure 7. Transfer characteristics

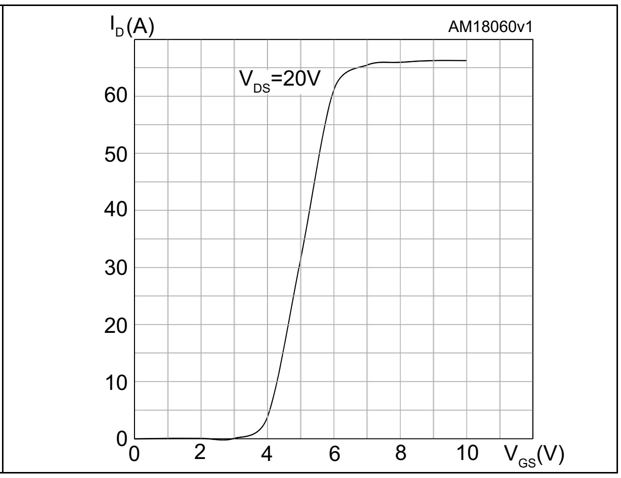


Figure 8. Gate charge vs gate-source voltage

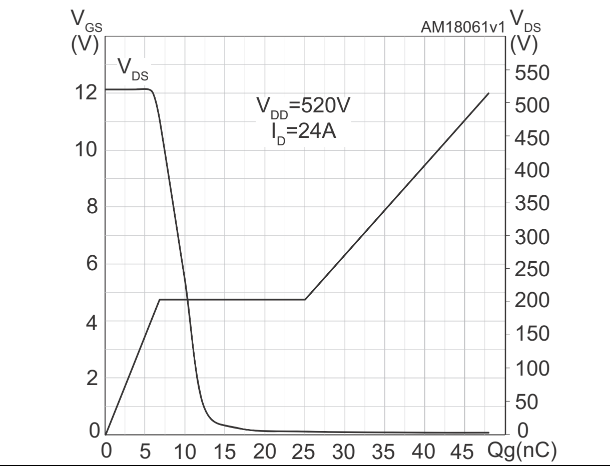


Figure 9. Static drain-source on-resistance

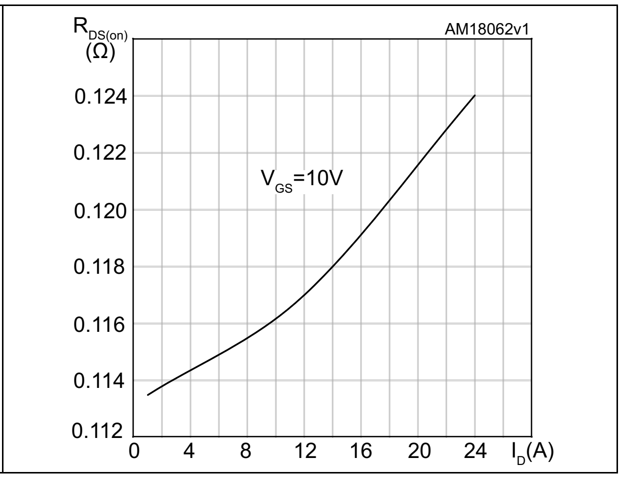


Figure 10. Capacitance variations

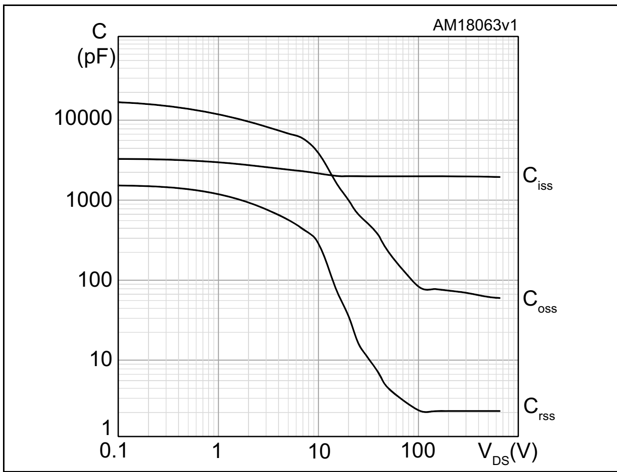


Figure 11. Output capacitance stored energy

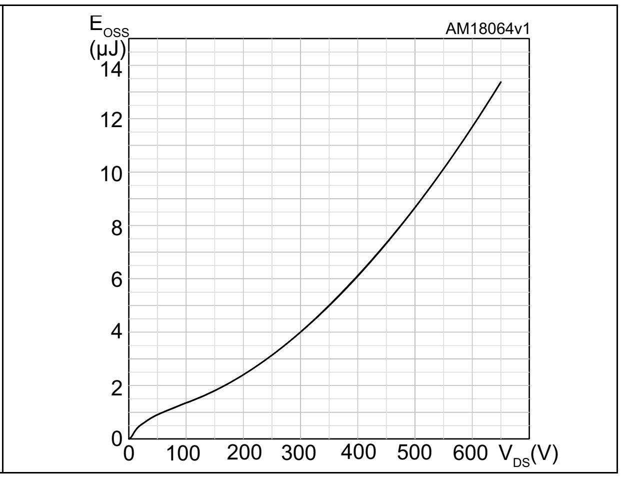


Figure 12. Normalized gate threshold voltage vs temperature

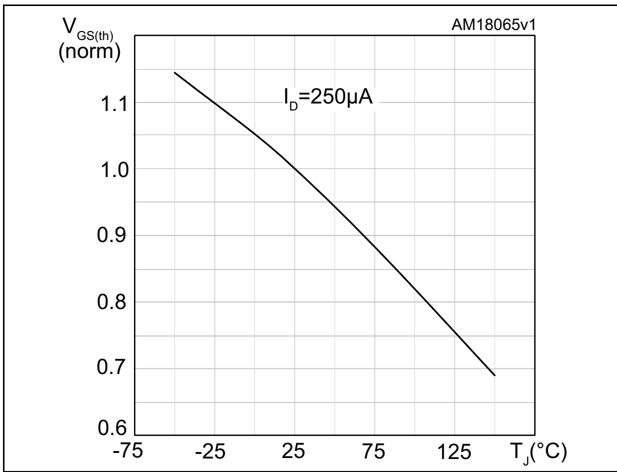
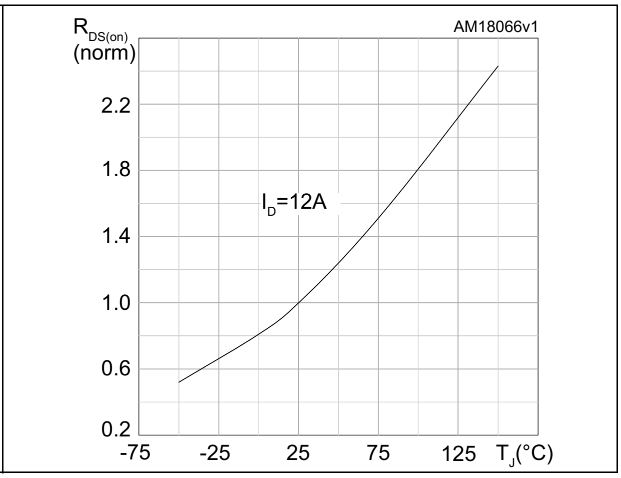


Figure 13. Normalized on-resistance vs temperature



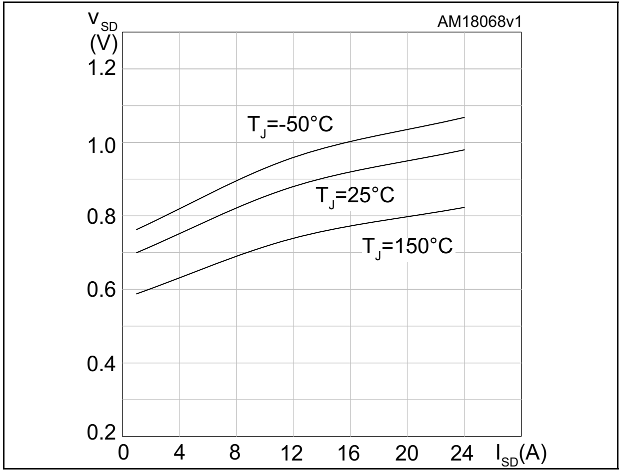


Figure 14. Source-drain diode forward characteristics

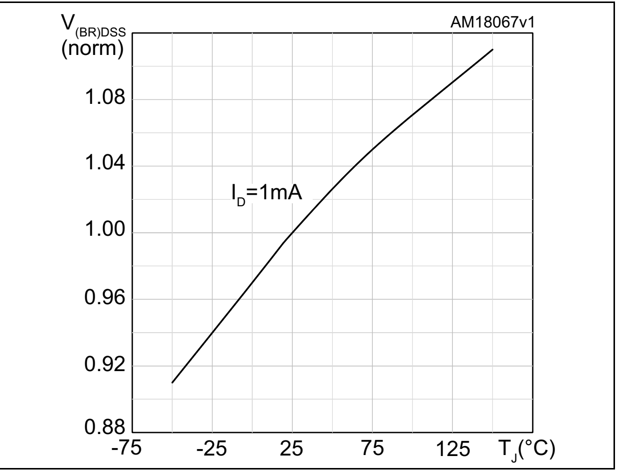


Figure 15. Normalized $V_{(BR)DSS}$ vs temperature

3 Test circuits

Figure 16. Switching times test circuit for resistive load

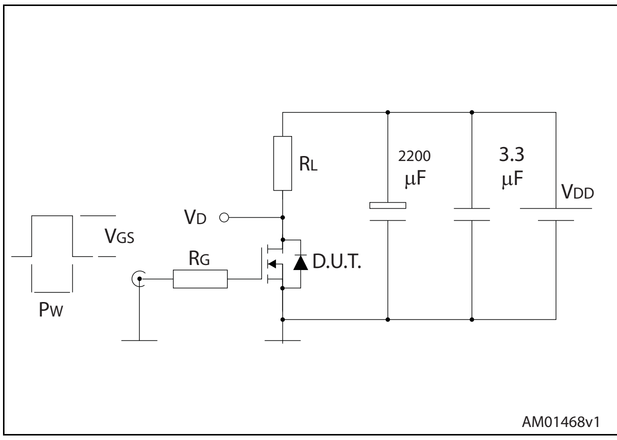


Figure 17. Gate charge test circuit

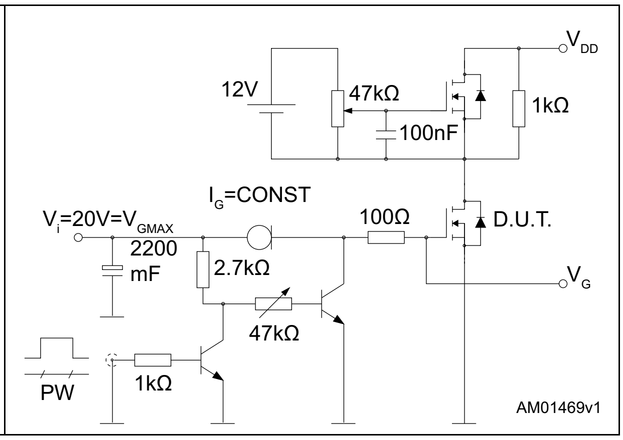


Figure 18. Test circuit for inductive load switching and diode recovery times

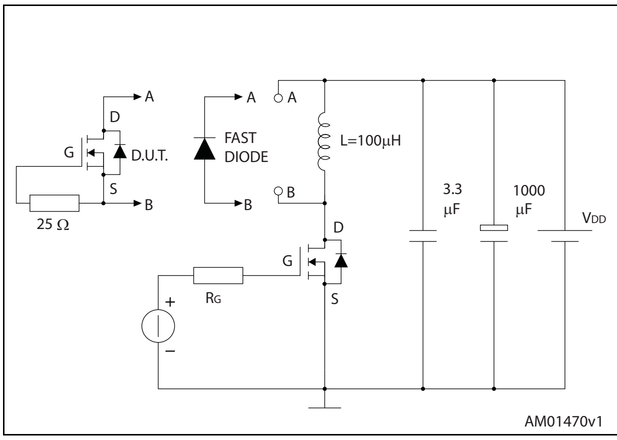


Figure 19. Unclamped inductive load test circuit

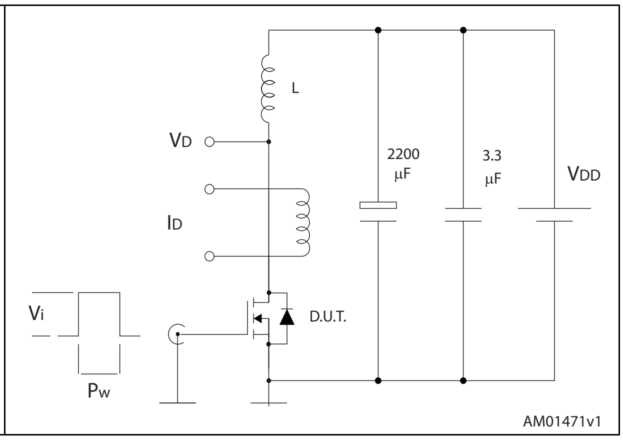


Figure 20. Unclamped inductive waveform

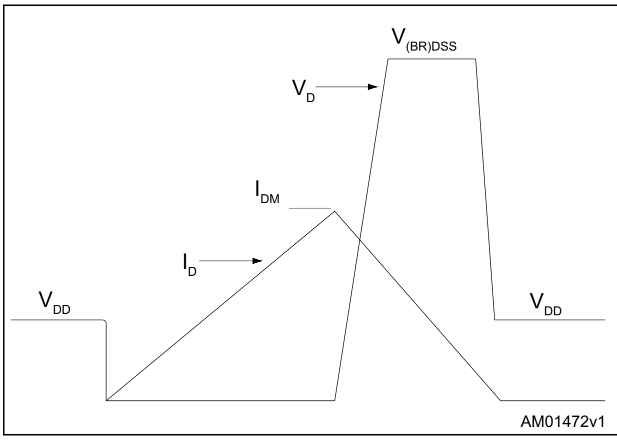
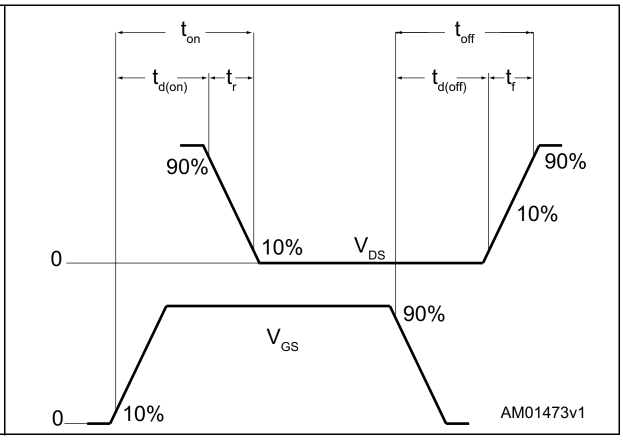


Figure 21. Switching time waveform



4 Package mechanical data

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 D^2PAK, STB33N65M2

Figure 22. D²PAK (TO-263) drawing

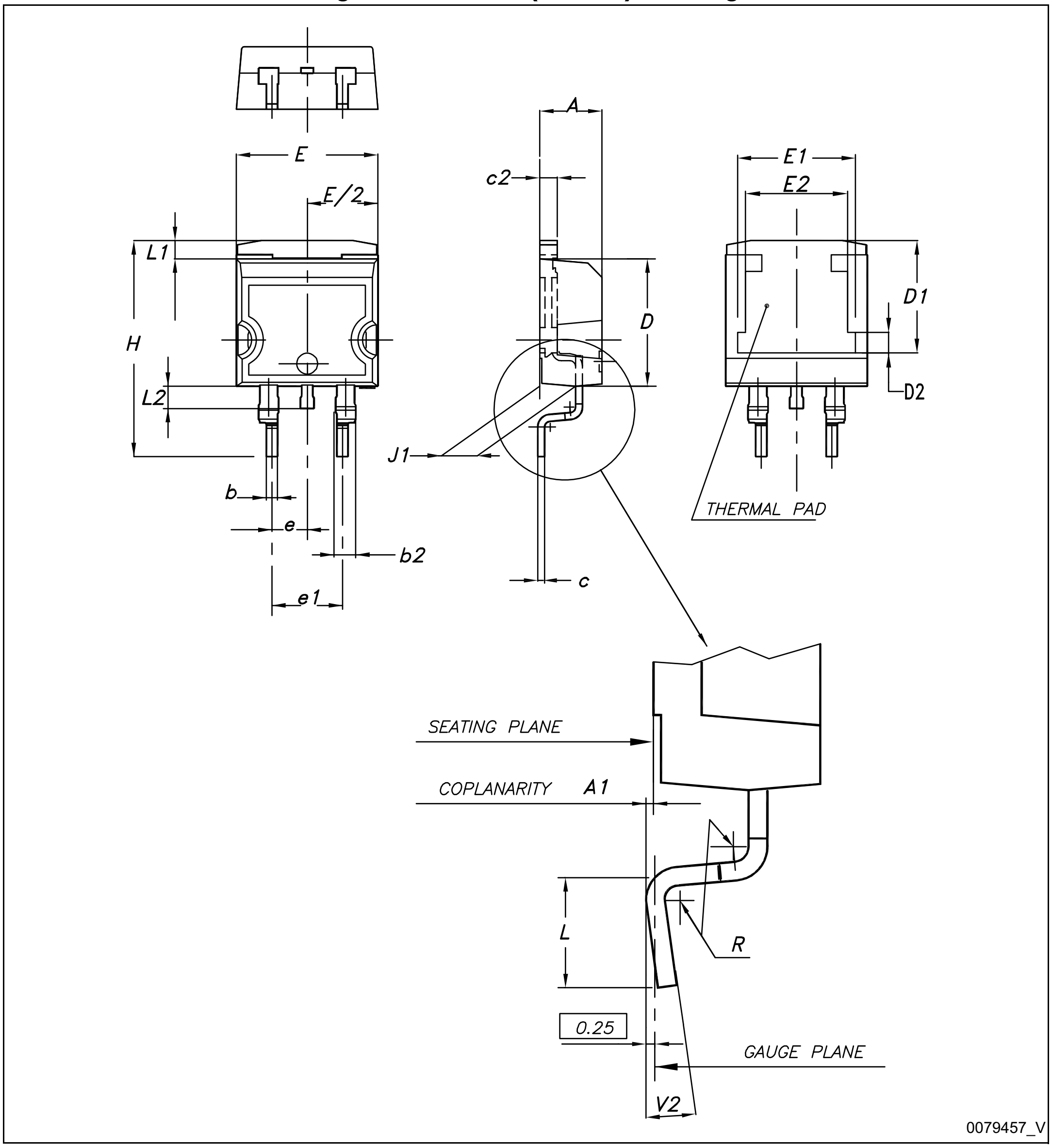
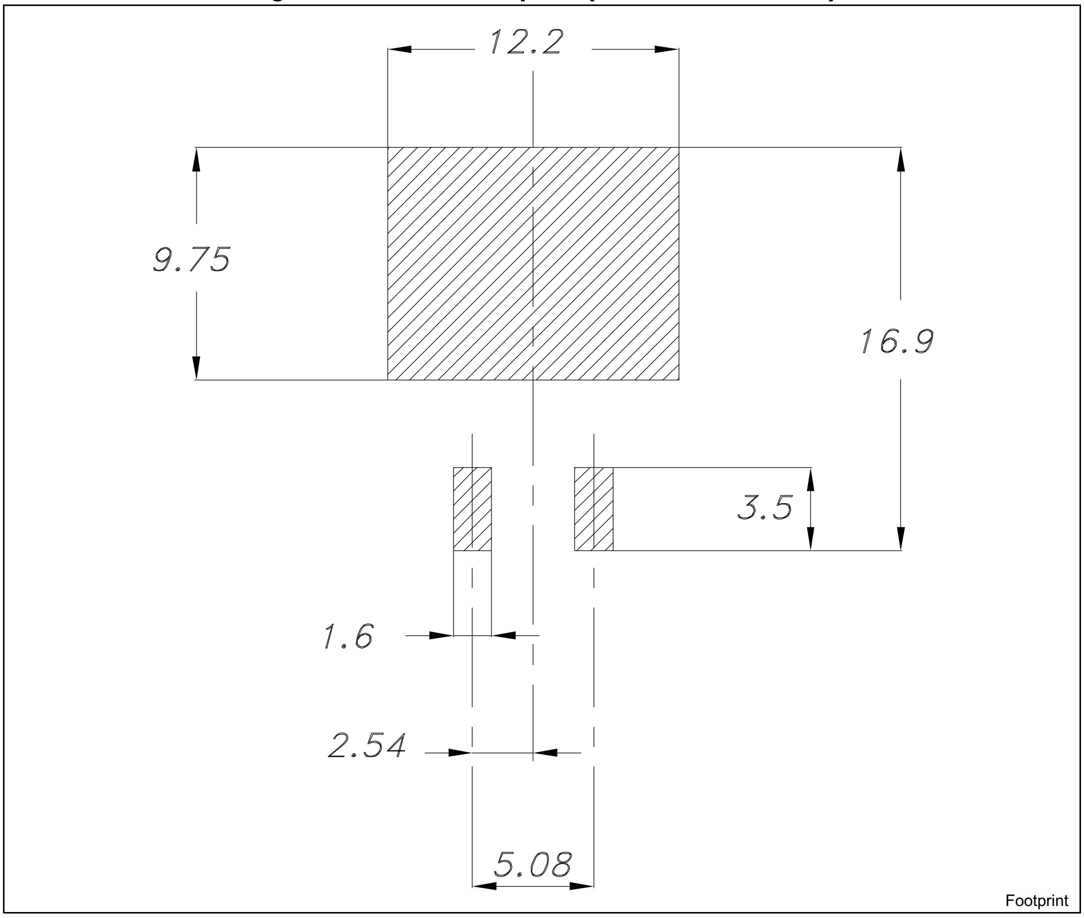


Table 9. D²PAK (TO-263) mechanical data

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)



4.2 TO-220FP, STF33N65M2

Figure 24. TO-220FP drawing

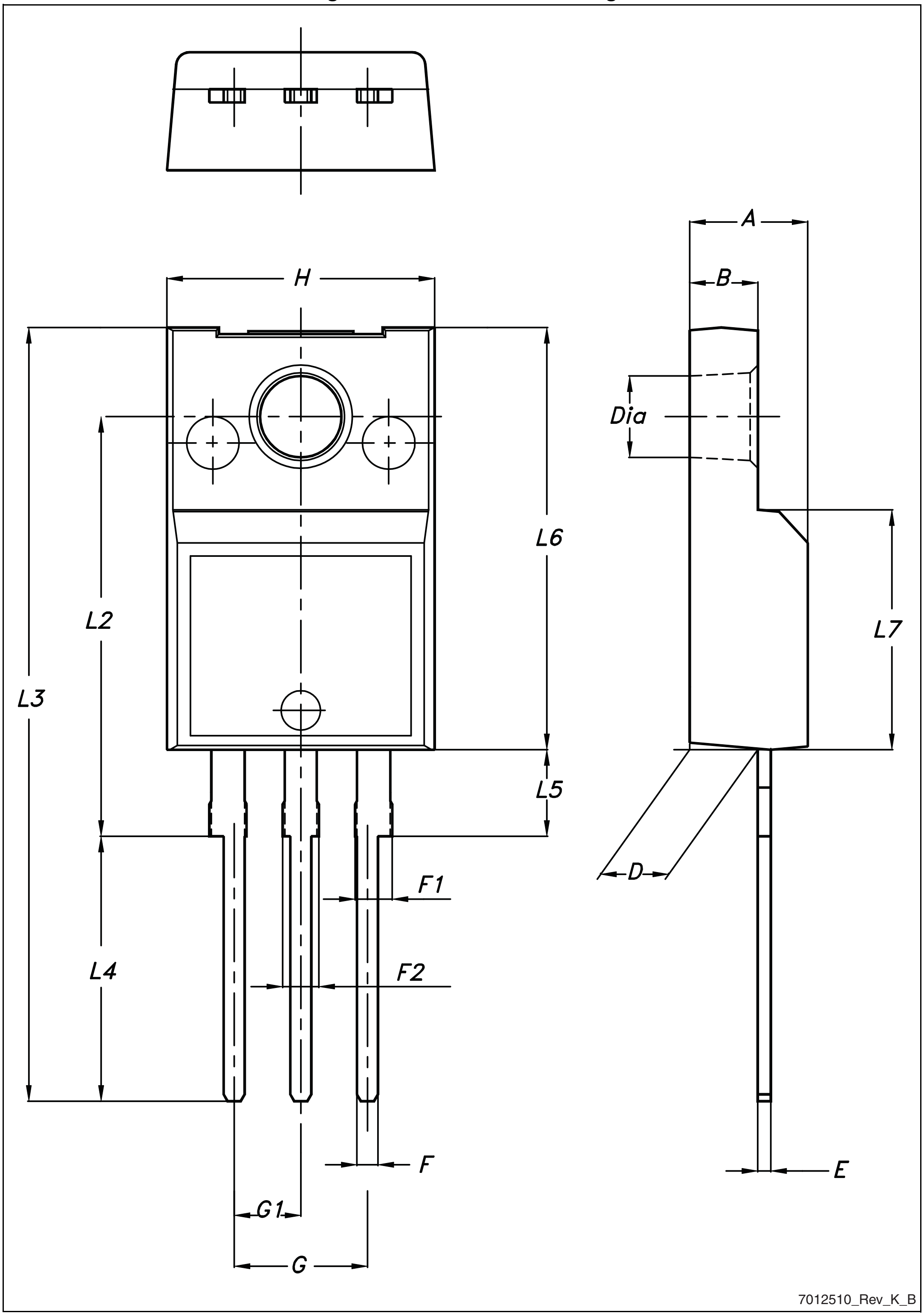


Table 10. TO-220FP mechanical data

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

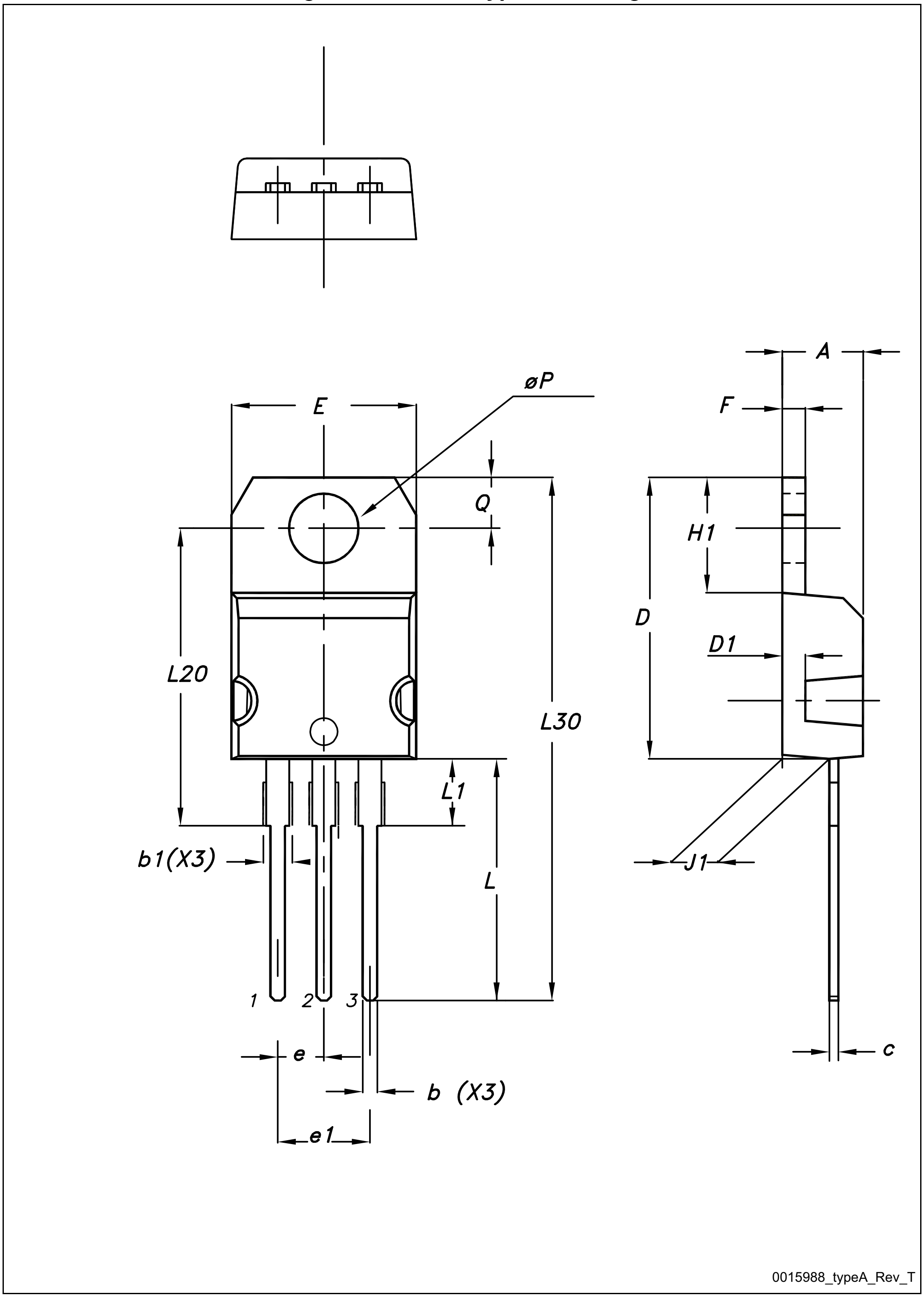


Table 11. TO-220 type A mechanical data

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

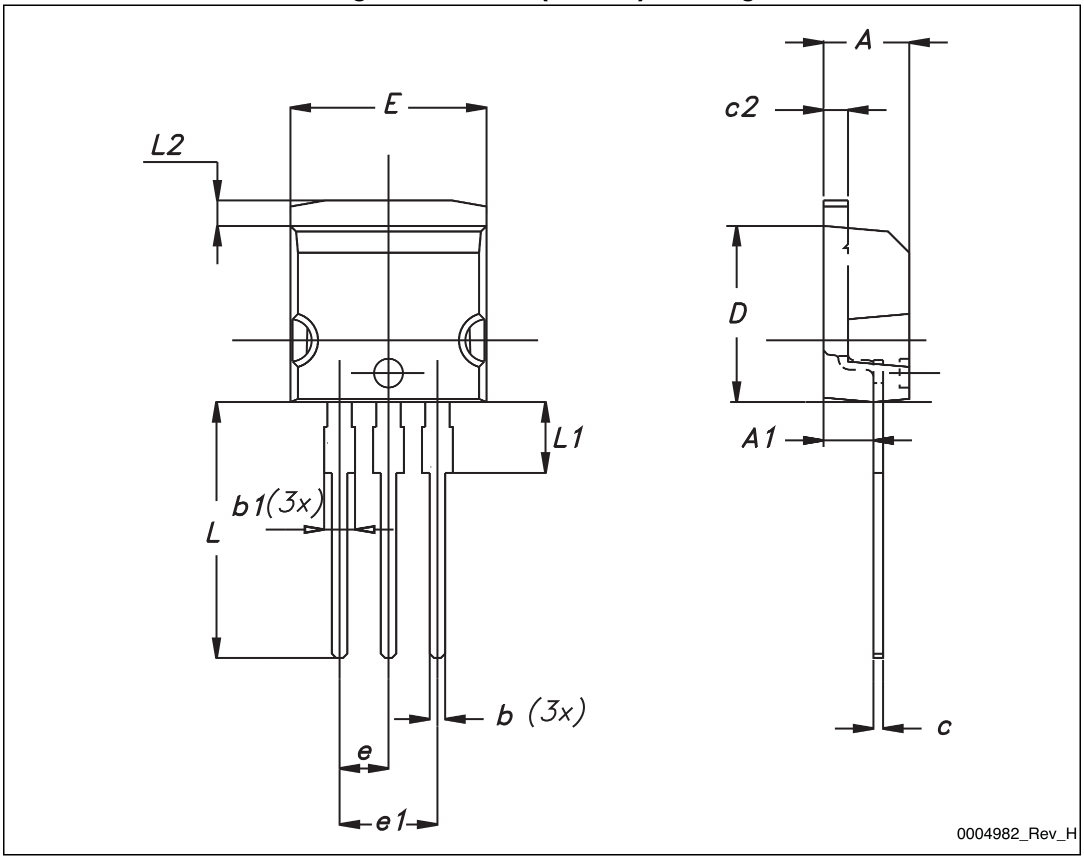


Table 12. I²PAK (TO-262) mechanical data

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)

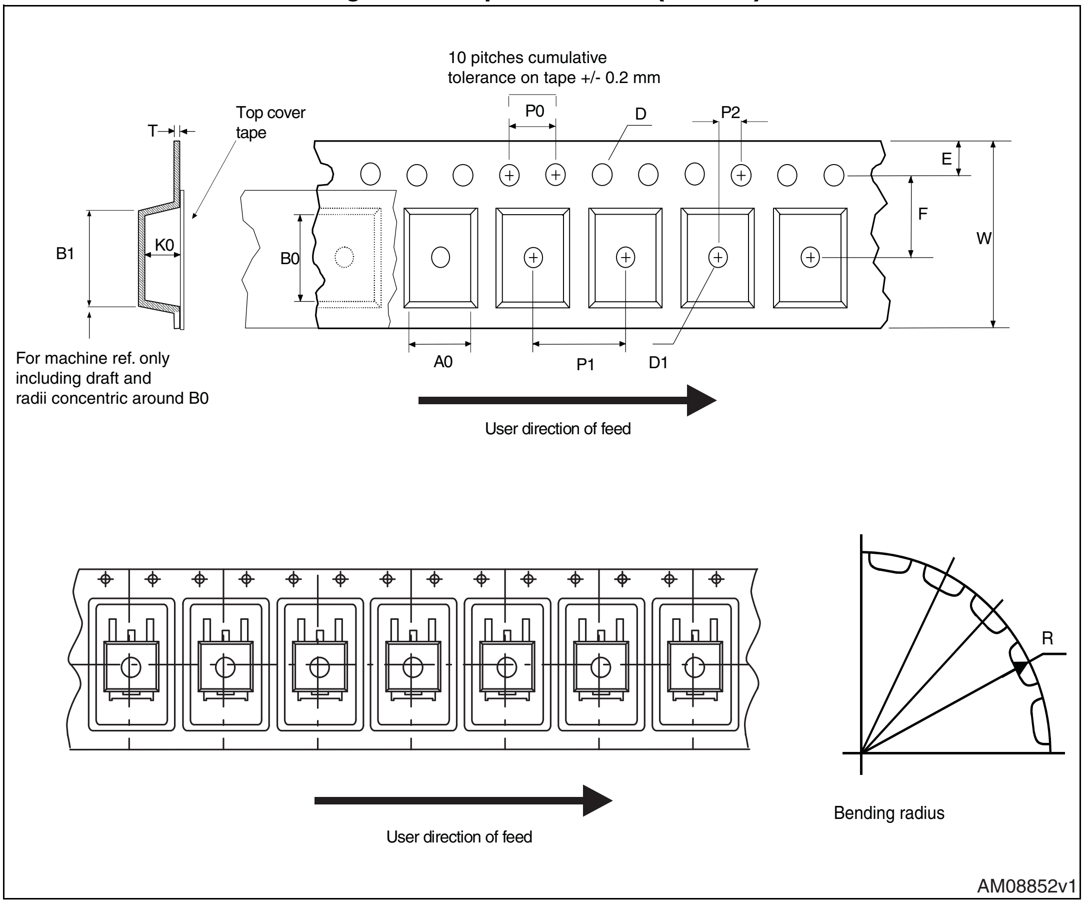


Figure 28. Reel for D²PAK (TO-263)

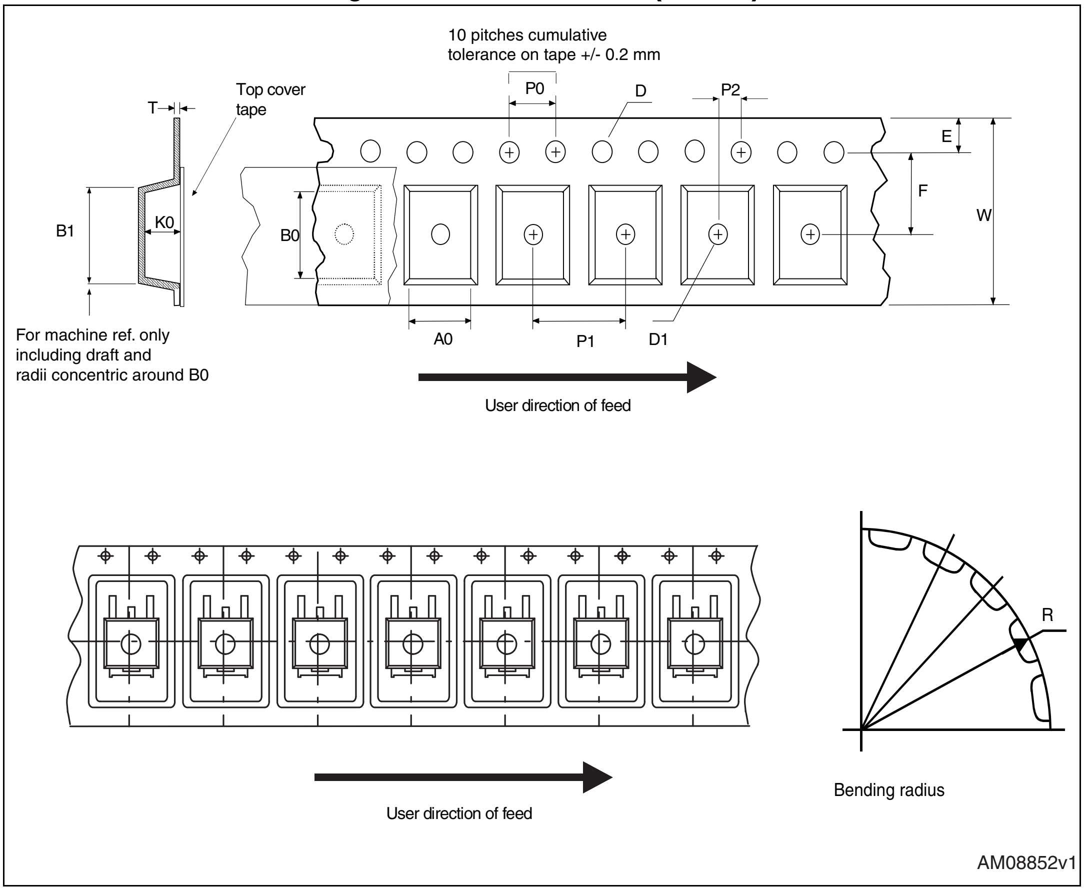


Table 13. D²PAK (TO-263) tape and reel mechanical data

Tape			Reel		
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			

6 Revision history

Table 14. Document revision history

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

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