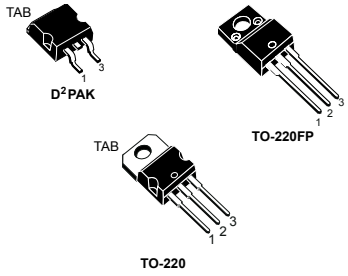
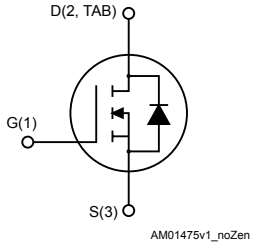
STB22NM60N, STF22NM60N, STP22NM60N

Datasheet

N-channel 600 V, 0.20 Ω typ., 16 A MDmesh™ II Power MOSFETs in D²PAK, TO-220FP and TO-220 packages





Features

Order code	V_{DS} @ $T_{jmax.}$	$R_{DS(on)}$max.	I_D
STB22NM60N	650 V	0.22 Ω	16 A
STF22NM60N			
STP22NM60N			

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

Applications

- Switching applications

Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Product status
STB22NM60N
STF22NM60N
STP22NM60N

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		D^2PAK	TO-220	TO-220FP	
V_{GS}	Gate-source voltage	± 30			V
I_D	Drain current (continuous) at T_C = 25 °C	16		16 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	10		10 (1)	A
I_{DM} (2)	Drain current (pulsed)	64		64 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	125		30	W
dv/dt (3)	Peak diode recovery voltage slope	15			V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T_C = 25 °C)			2500	V
T_j	Operating junction temperature range	-55 to 150			°C
T_{stg}	Storage temperature range				

1. *Limited by maximum junction temperature.*
2. *Pulse width limited by safe operating area.*
3. *I_{SD} ≤ 16 A, di/dt ≤ 400 A/µs, V_{DSpeak} ≤ $V_{(BR)DSS}$, V_{DD} = 80% $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		D^2PAK	TO-220	TO-220FP	
$R_{thj\text{-}case}$	Thermal resistance junction-case	1		4.17	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		62.5		°C/W
$R_{thj\text{-}pcb}$ (1)	Thermal resistance junction-pcb	30			°C/W

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j Max)	6	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	300	mJ

2 Electrical characteristics

(T_{CASE} = 25 °C unless otherwise specified)

Table 4. On/off states

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown voltage	I_D = 1 mA, V_{GS} = 0 V	600			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 600 V			1	µA
		V_{GS} = 0 V, V_{DS} = 600 V, T_C = 125 °C(1)			100	µA
I_{GSS}	Gate body leakage current	V_{DS} = 0 V, V_{GS} = ±25 V			±100	nA
$V_{GS(th)}$	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 = 8 A		0.20	0.22	Ω

1. *Defined by design, not subject to production test.*

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0 V	-	1330	-	pF
C_{oss}	Output capacitance			84		
C_{rss}	Reverse transfer capacitance			4.6		
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 480 V, V_{GS} = 0 V	-	181	-	pF
Rg	Gate input resistance	f = 1 MHz open drain	-	4.7	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 16 A, V_{GS} = 0 to 10 V (see Figure 15. Test circuit for gate charge behavior)	-	44	-	nC
Q_{gs}	Gate-source charge			6		
Q_{gd}	Gate-drain charge			25		

1. *$C_{oss\ eq.}$ 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}.*

Table 6. Switching times

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 8 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 14. Test circuit for resistive load switching times and Figure 19. Switching time waveform)	-	11	-	ns
$t_{r(v)}$	Voltage rise time			18		
$t_{d(off)}$	Turn-off delay time			74		
$t_{f(i)}$	Fall time			38		

Table 7. Source drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		16	A
I_{SDM} (1)	Source-drain current (pulsed)				64	
V_{SD} (2)	Forward on voltage	I_{SD} = 16 A, V_{GS} = 0 V	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 16 A, di/dt = 100 V	-	296		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 60 V (see Figure 16. Test circuit for inductive load switching and diode recovery times)		4		µC
I_{RRM}	Reverse recovery current			26.8		A
t_{rr}	Reverse recovery time	I_{SD} = 16 A, di/dt = 100 A/µs	-	350		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 60 V (see Figure 16. Test circuit for inductive load switching and diode recovery times)		4.7		µC
I_{RRM}	Reverse recovery current			27		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 1. Safe operating area for TO-220, D²PAK

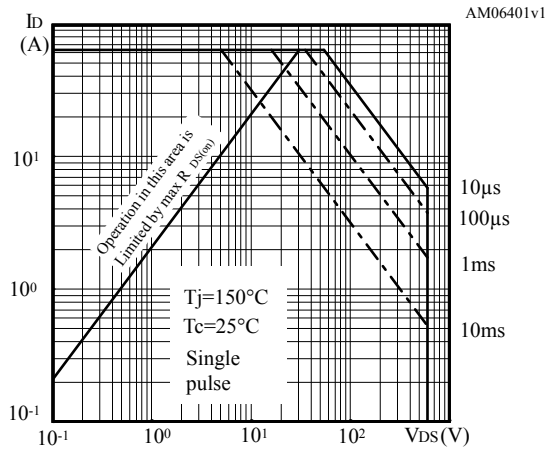


Figure 2. Thermal impedance for TO-220, D²PAK

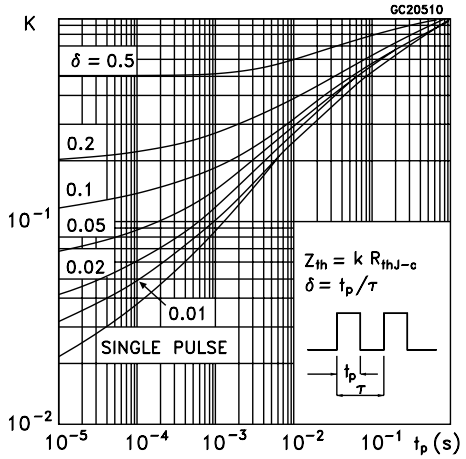


Figure 3. Safe operating area for TO-220FP

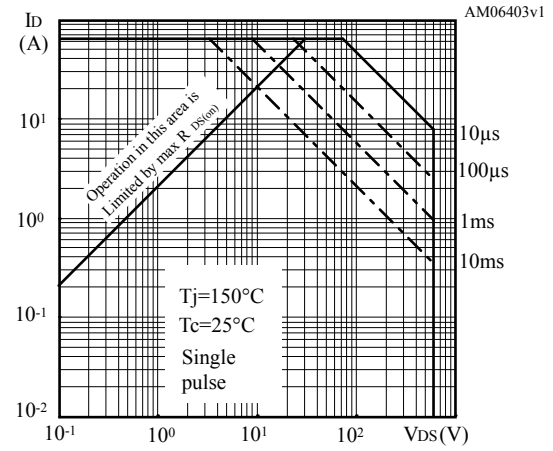


Figure 4. Thermal impedance for TO-220FP

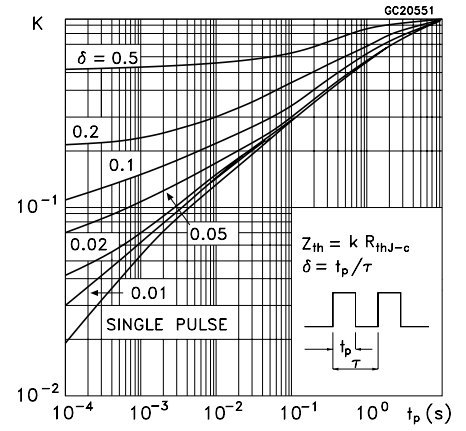


Figure 5. Output characterisics

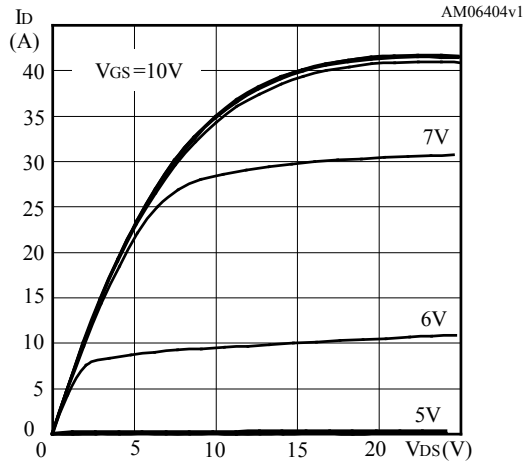


Figure 6. Transfer characteristics

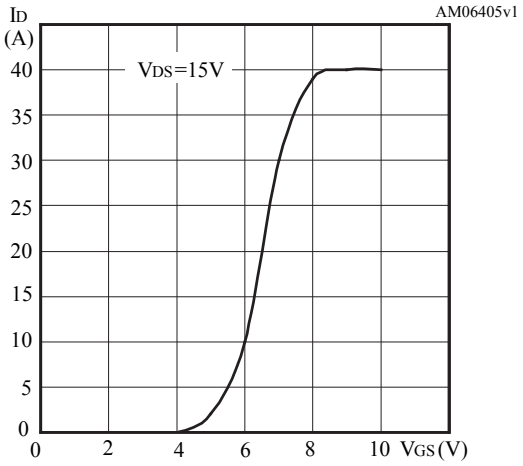


Figure 7. Gate charge vs gate-source voltage

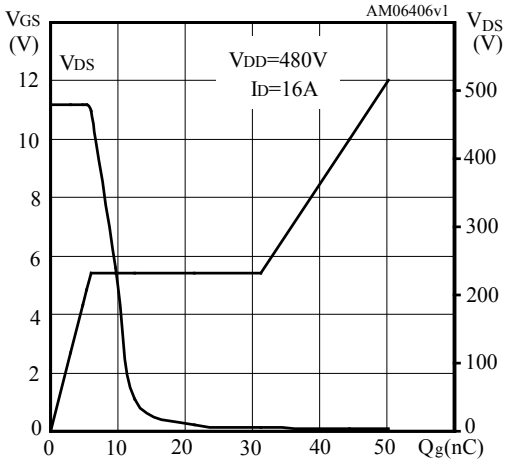


Figure 8. Static drain-source on resistance

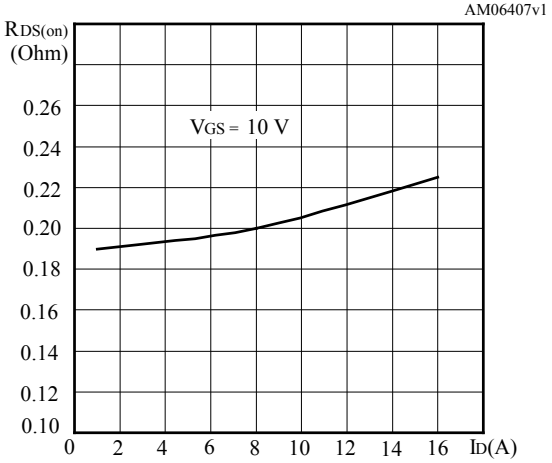


Figure 9. Capacitance variations

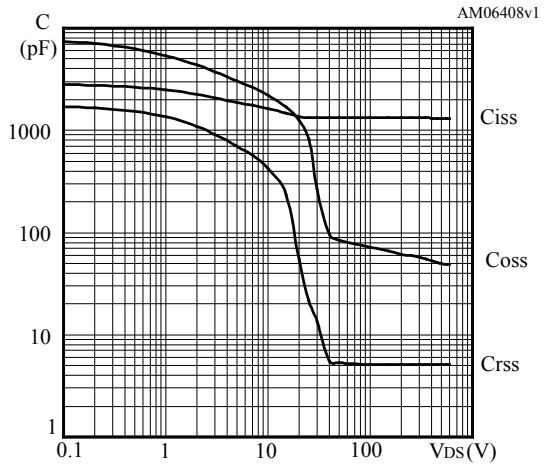


Figure 10. Output capacitance stored energy

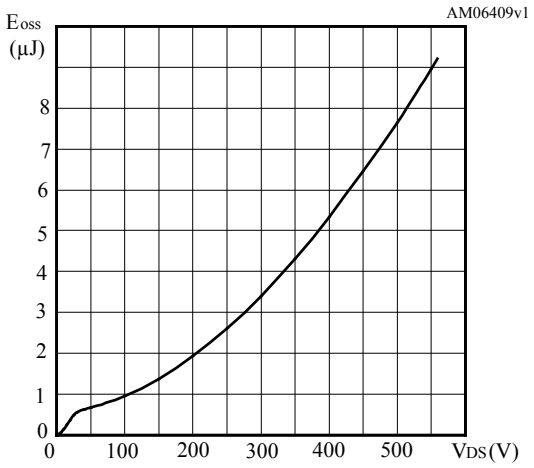


Figure 11. Normalized gate threshold voltage vs temperature

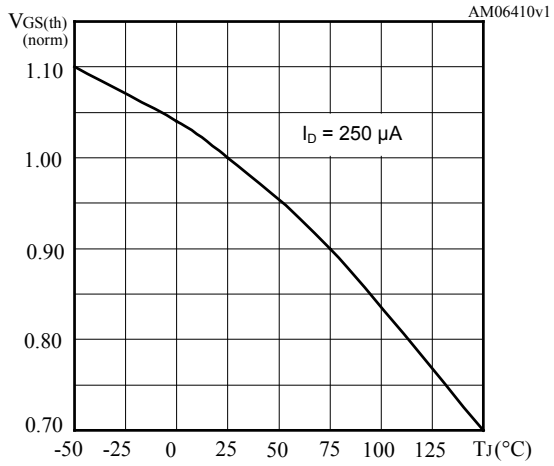


Figure 12. Normalized on resistance vs temperature

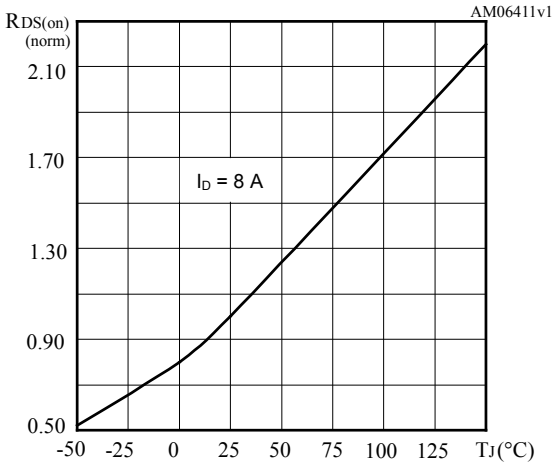
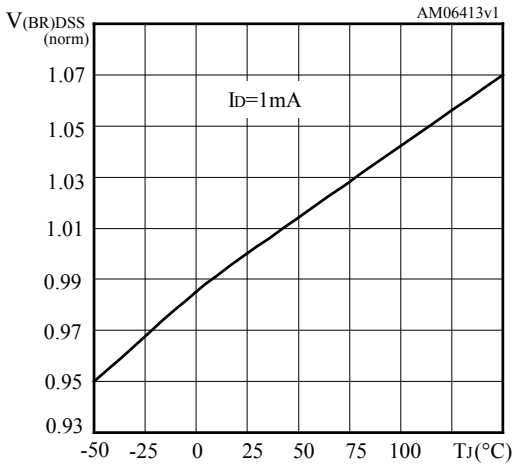


Figure 13. Normalized $V_{(BR)DSS}$ vs temperature



3 Test circuits

Figure 14. Test circuit for resistive load switching times

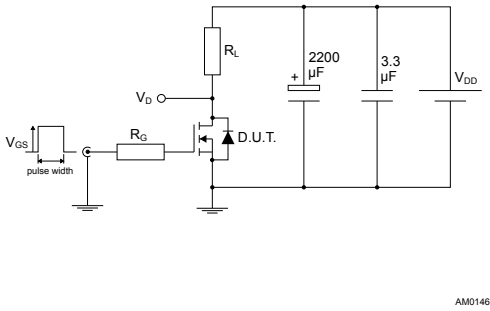


Figure 15. Test circuit for gate charge behavior

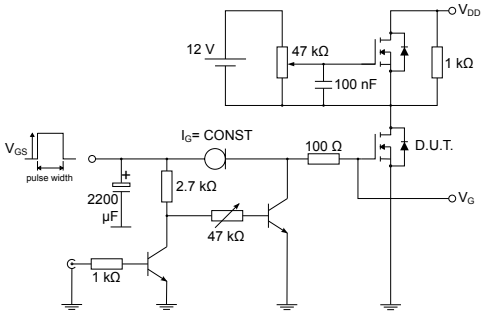


Figure 16. Test circuit for inductive load switching and diode recovery times

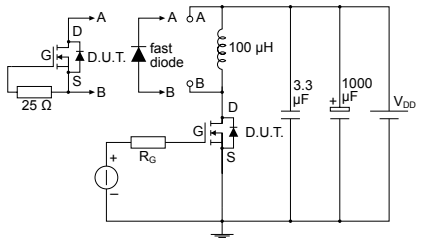


Figure 17. Unclamped inductive load test circuit

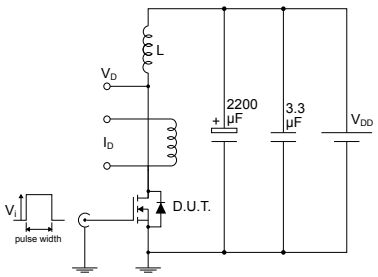


Figure 18. Unclamped inductive waveform

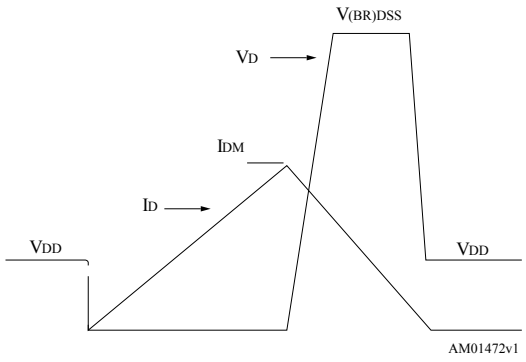
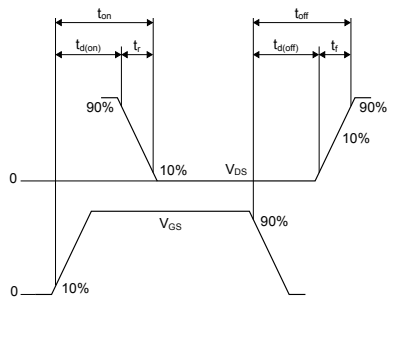


Figure 19. Switching time waveform



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 D²PAK (TO-263) type A package information

Figure 20. D²PAK (TO-263) type A package outline

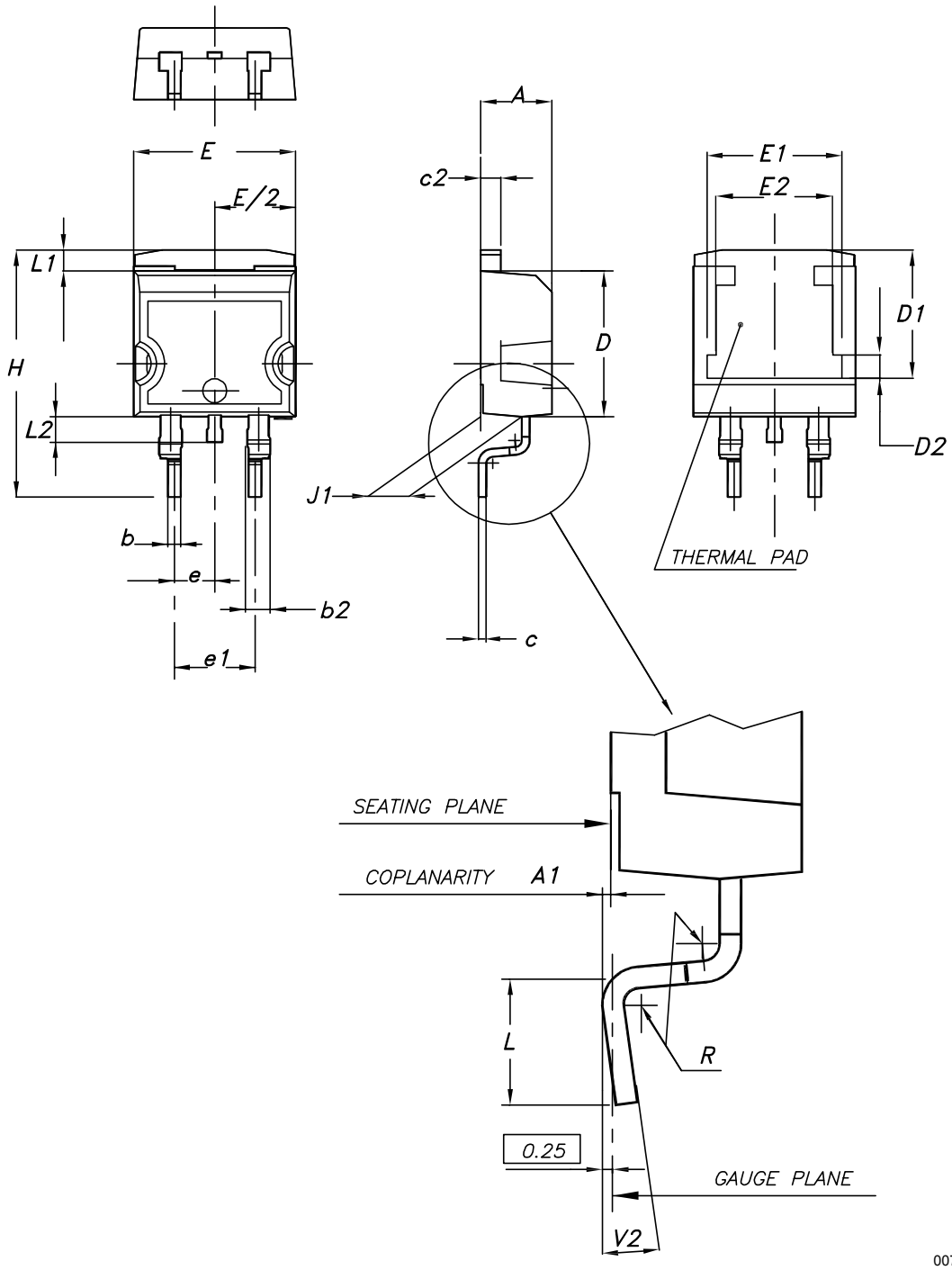


Table 8. D²PAK (TO-263) type A package mechanical data

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	10.00		10.40
E1	8.30	8.50	8.70
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

4.2 D²PAK (TO-263) type B package information

Figure 21. D²PAK (TO-263) type B package outline

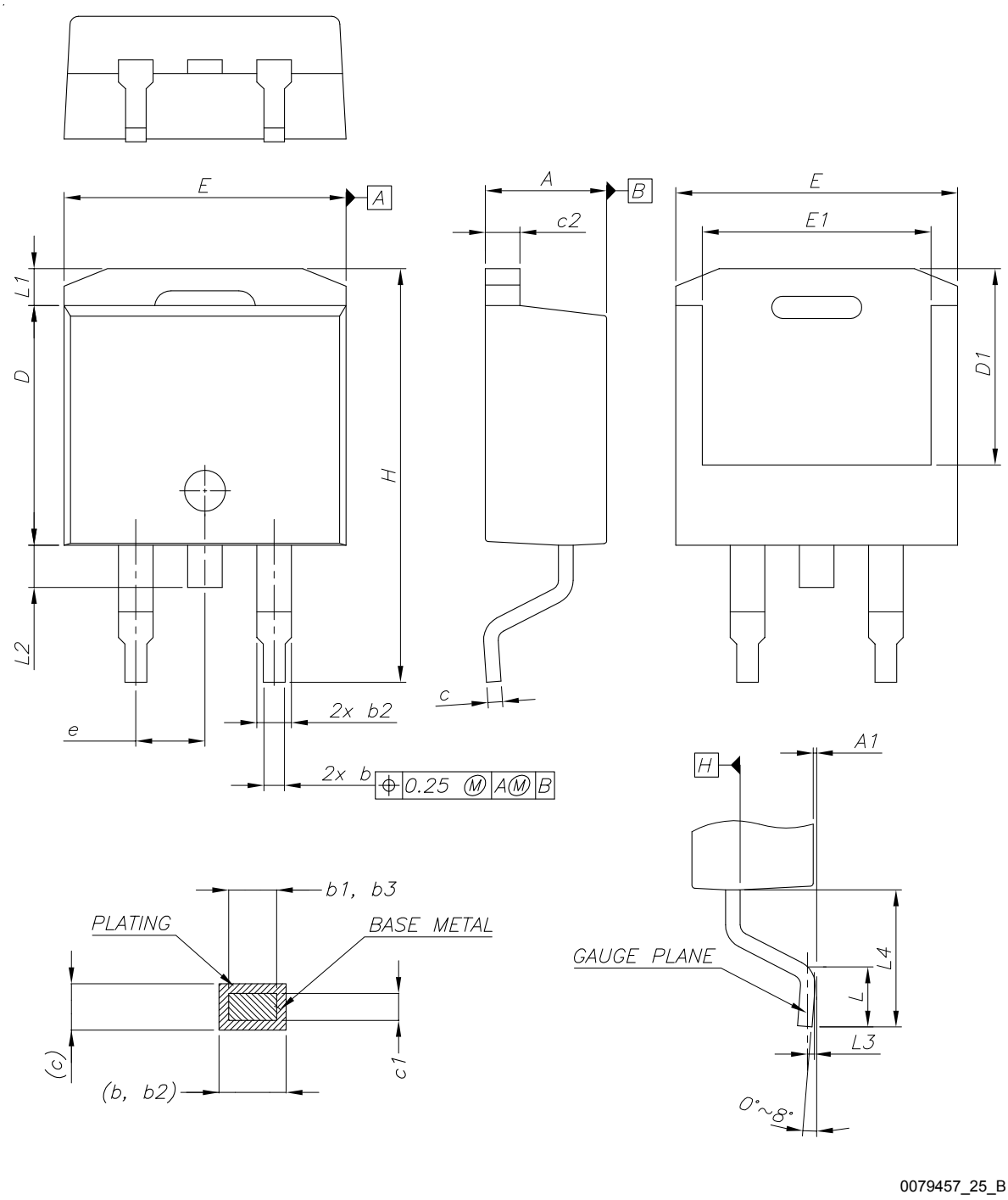


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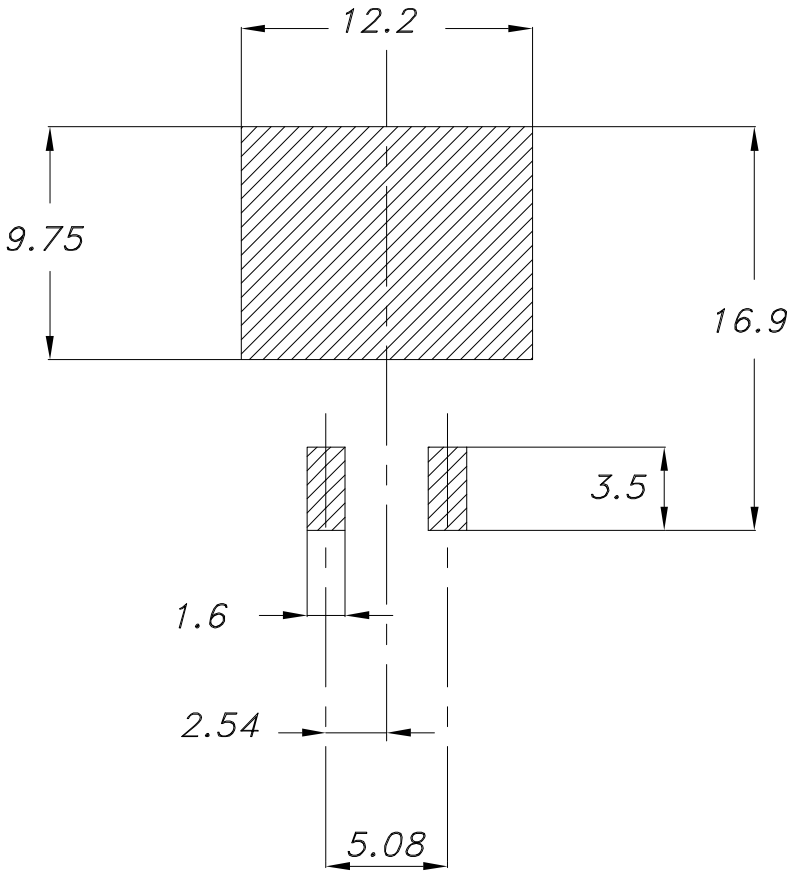
Table 9. **D²PAK (TO-263) type B mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.36		4.56
A1	0		0.25
b	0.70		0.90
b1	0.51		0.89
b2	1.17		1.37
b3	1.36		1.46
c	0.38		0.694
c1	0.38		0.534
c2	1.19		1.34
D	8.60		9.00
D1	6.90		7.50
E	10.15		10.55
E1	8.10		8.70
e		2.54 BSC	
H	15.00		15.60
L	1.90		2.50
L1			1.65
L2			1.78
L3		0.25	
L4	4.78		5.28

Figure 22. D²PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint

4.3 D²PAK packing information

Figure 23. D²PAK tape outline

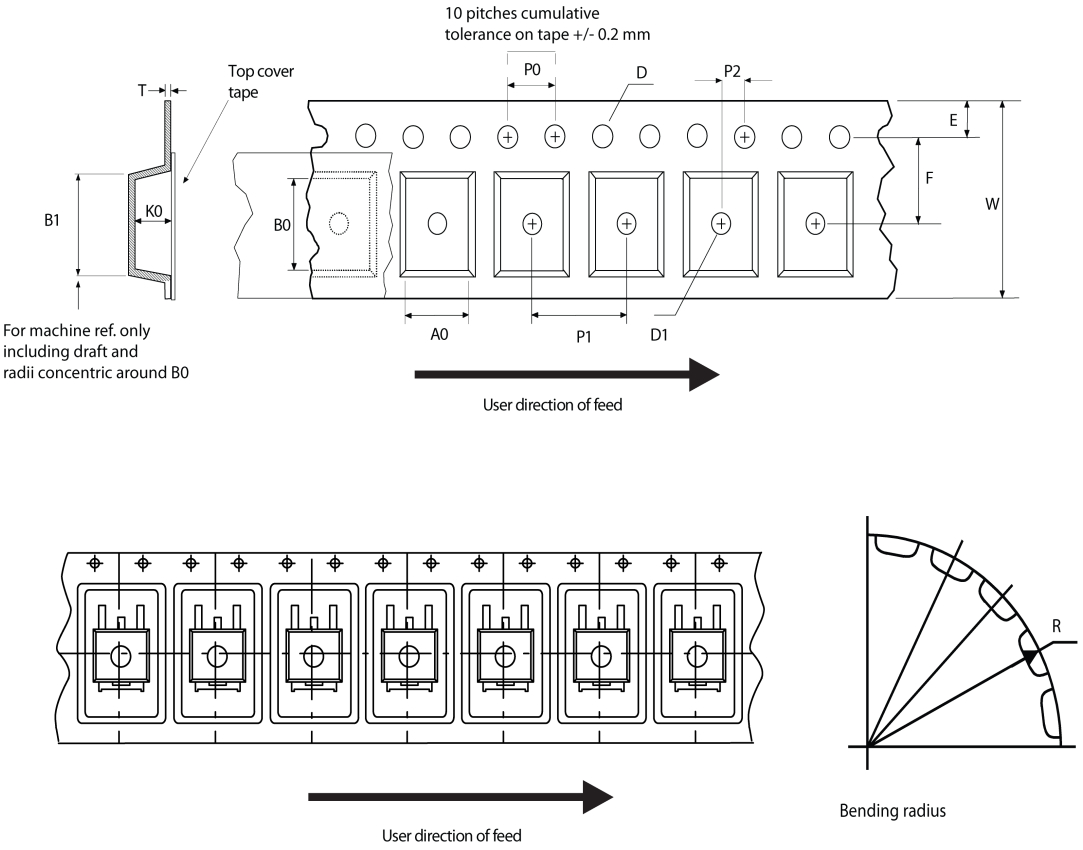


Figure 24. **D²PAK reel outline**

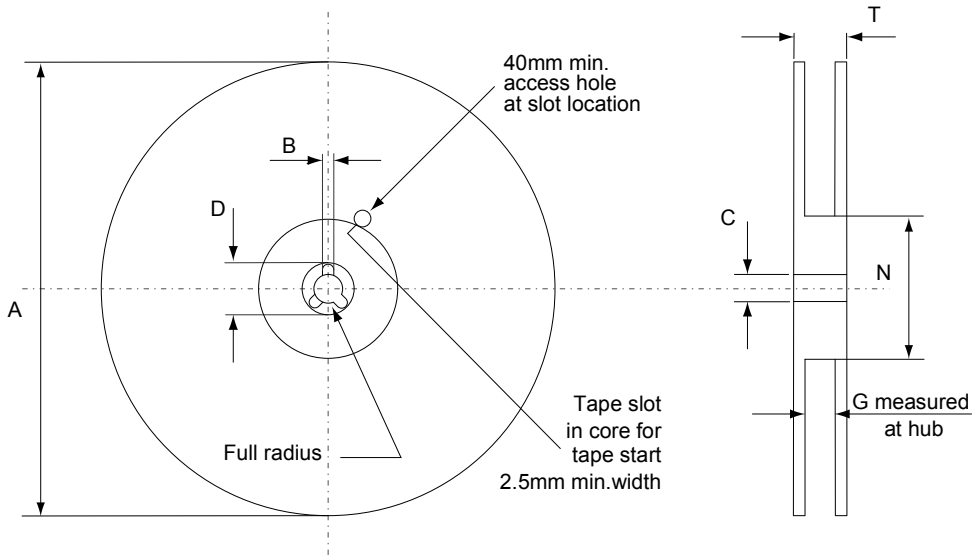


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Table 10. **D²PAK tape and reel mechanical data**

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 quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

4.4 D²PAK type B packing information

Figure 25. **D²PAK type B tape outline**

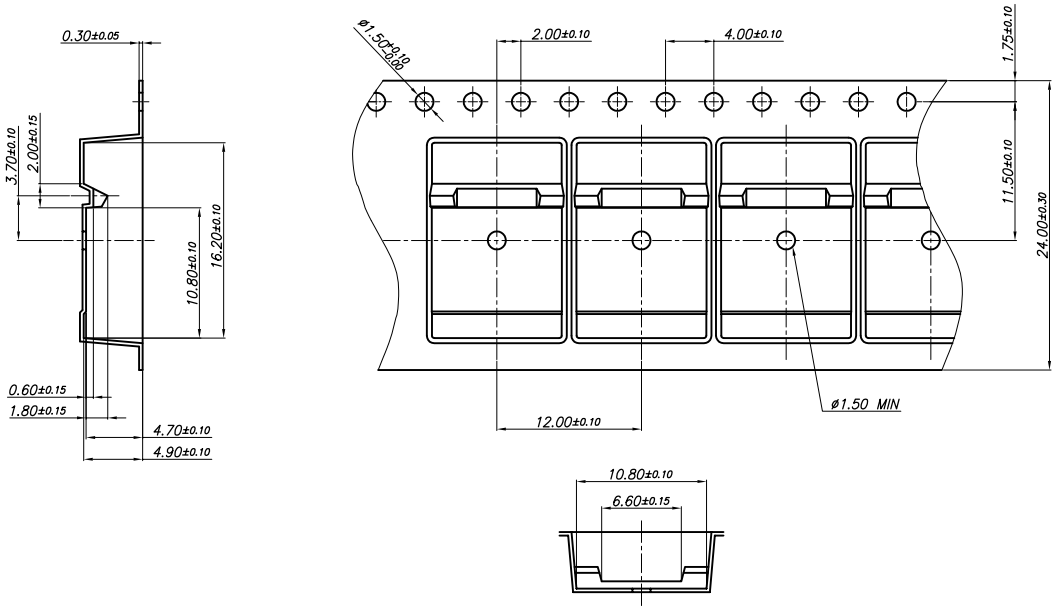

Figure 26. **D²PAK type B reel outline**

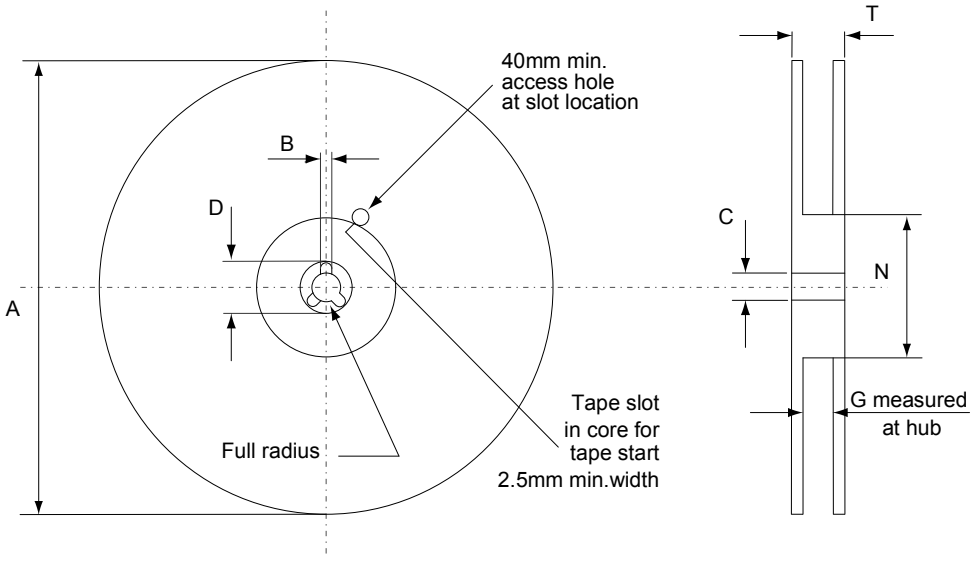

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Table 11. D²PAK type B reel mechanical data

Dim.	mm	
	Min.	Max.
A		330
B	1.5	
C	12.8	13.2
D	20.2	
G	24.4	26.4
N	100	
T		30.4

4.5 TO-220FP package information

Figure 27. **TO-220FP package outline**

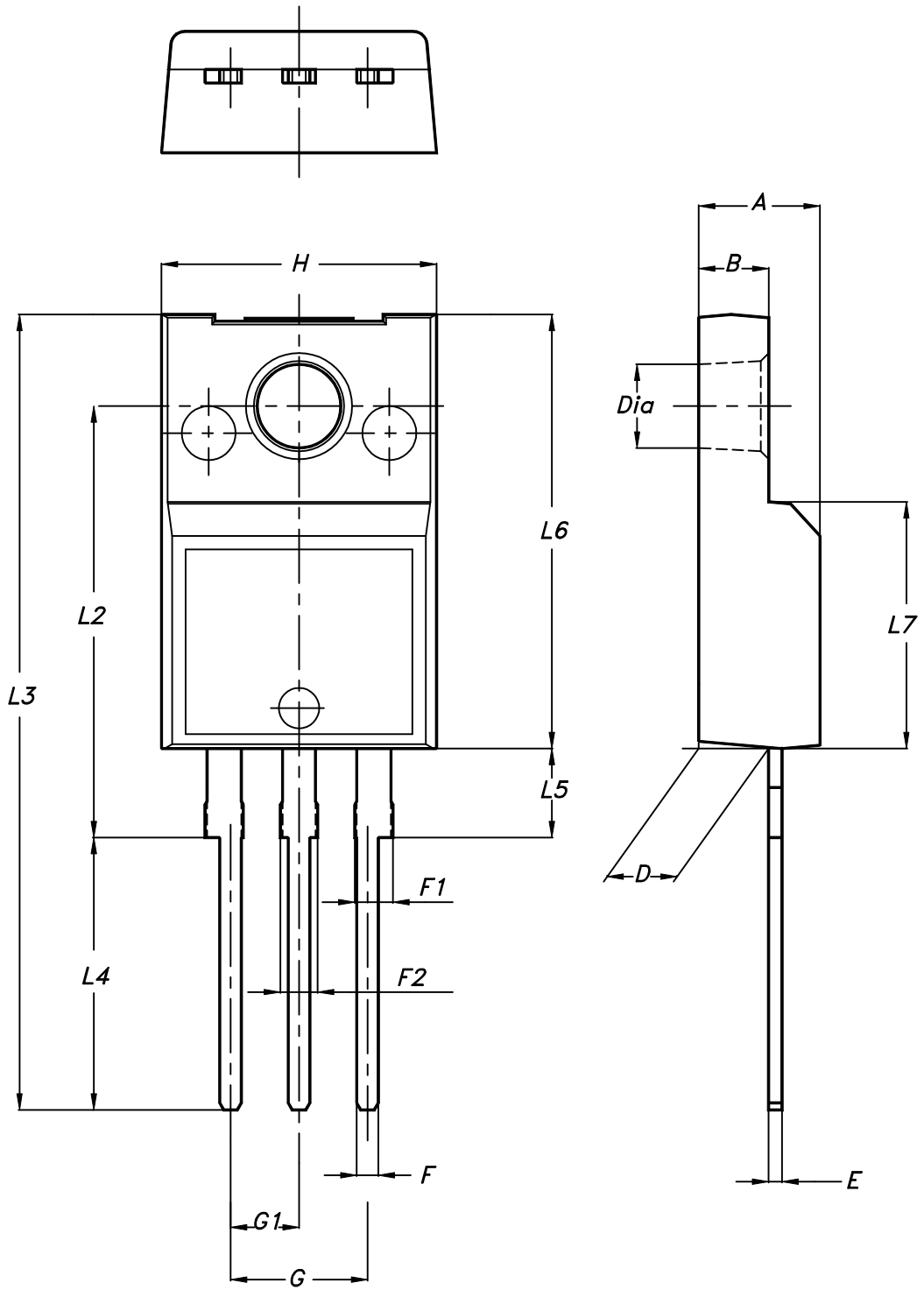

Table 12. **TO-220FP package mechanical data**

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

4.6 TO-220 type A package information

Figure 28. **TO-220 type A package outline**

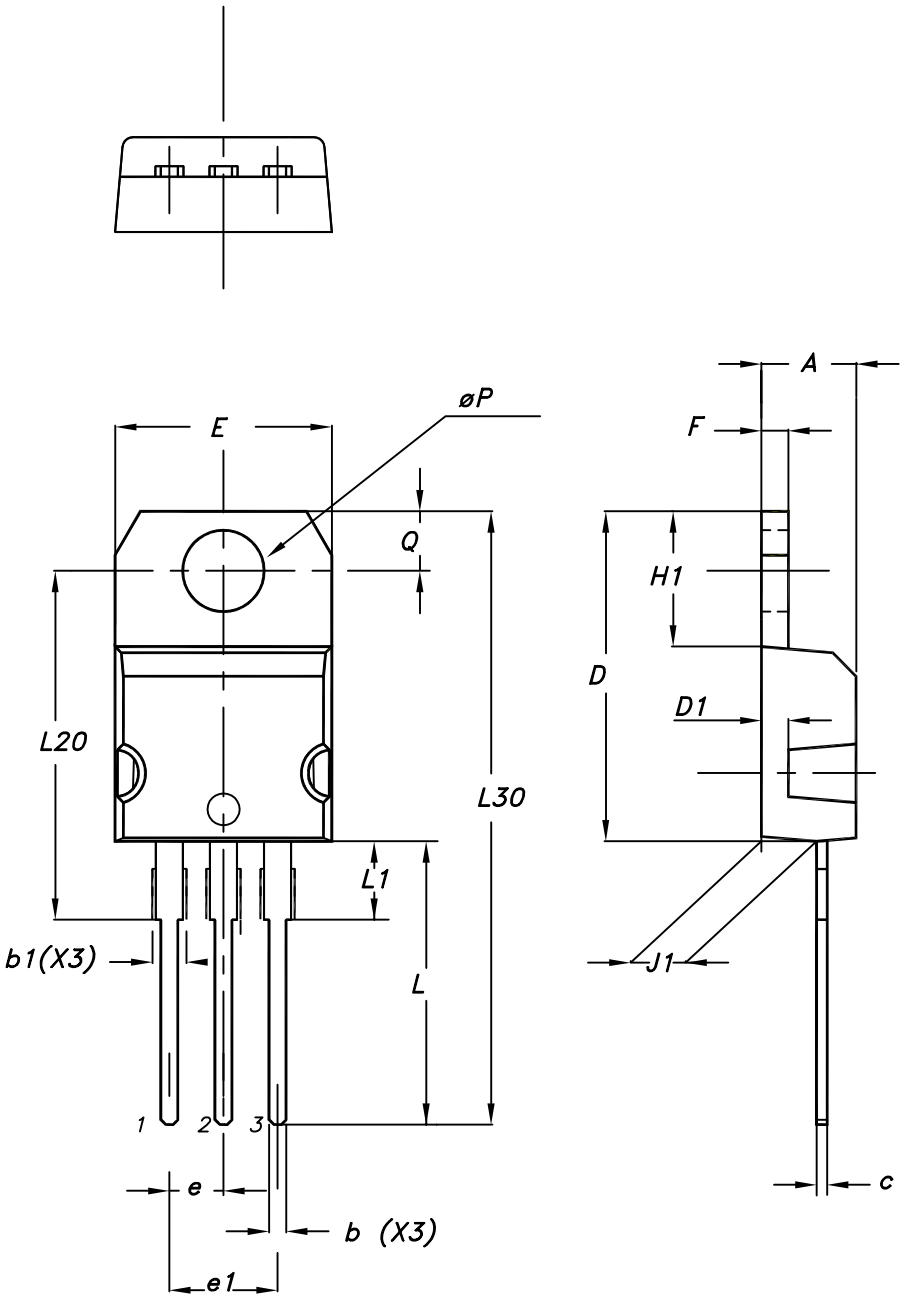

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Table 13. **TO-220 type A package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95

5 Ordering information

Table 14. **Order codes**

Order code	Marking	Package	Packing
STB22NM60N	22NM60N	D^2PAK	Tape and reel
STF22NM60N		TO-220FP	Tube
STP22NM60N		TO-220	

Revision history

Table 15. **Document revision history**

Date	Version	Changes
02-Jul-2009	1	First release.
18-Feb-2010	2	Document status promoted from preliminary data to datasheet.
27-Aug-2010	3	New package, mechanical data has been inserted: I²PAK.
05-Nov-2011	4	Some value changed in *Table 5: On /off states*.
02-May-2018	5	The part numbers STI22NM60N and STW22NM60N have been moved to a separate datasheet. Removed maturity status indication from cover page. The document status is production data Updated title and features in cover page. Updated Section 1 Electrical ratings, Section 2 Electrical characteristics, Section 2.1 Electrical characteristics curves and Section 4 Package information. Minor text changes.