1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK, TO-220	TO-220FP	
V_{GS}	Gate-source voltage	±30		V
I_D	Drain current (continuous) at T_C = 25 °C	12	12(1)	A
	Drain current (continuous) at T_C = 100 °C	7.5	7.5(1)	
I_{DM}(2)	Drain current pulsed	48	48(1)	A
P_{TOT}	Total power dissipation at T_C = 25 °C	160	35	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T_C = 25 °C)		2.5	kV
dv/dt(3)	Peak diode recovery voltage slope	15		V/ns
T_J	Operating junction temperature range	-65 to 150		°C
T_{stg}	Storage temperature range			°C

1. *Limited by maximum junction temperature.*
2. *Pulse width limited by safe operating area.*
3. *I_{SD} ≤ 12 A, di/dt ≤ 400 A/µs, V_{DD} = 80% $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		D²PAK	TO-220	TO-220FP	
$R_{thj\text{-}case}$	Thermal resistance junction-case	2.78		3.57	°C/W
$R_{thj\text{-}a}$	Thermal resistance junction-ambient	62.5			°C/W
$R_{thj\text{-}pcb}$(1)	Thermal resistance junction-pcb	35			°C/W

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	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_{AS}, V_{DD} = 50 V)	400	mJ

2 Electrical characteristics

(T_C = 25 °C unless otherwise specified)

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 250 µA	500			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 500 V			1	µA
		V_{GS} = 0 V, V_{DS} = 500 V, T_C = 125 °C (1)			10	
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±30 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 50 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 6 A		300	350	mΩ

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

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0 V	-	1000	-	pF
C_{oss}	Output capacitance		-	250	-	pF
C_{rss}	Reverse transfer capacitance		-	20	-	pF
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 400 V, V_{GS} = 0 V	-	90	-	pF
$t_{d(on)}$	Turn-on Delay Time	V_{DD} = 250 V, I_D = 6 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	20	-	ns
t_r	Rise Time		-	10	-	ns
Q_g	Total gate charge	V_{DD} = 400 V, I_D = 12 A, V_{GS} = 0 to 10 V (see Figure 14. Test circuit for gate charge behavior)	-	28	-	nC
Q_{gs}	Gate-source charge		-	8	-	nC
Q_{gd}	Gate-drain charge		-	16	-	nC
R_g	Gate input resistance	f = 1 MHz, gate DC Bias = 0, test signal level = 20 mV, open drain	-	1.6	-	Ω

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. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		12	A
I_{SDM} (1)	Source-drain current (pulsed)		-		48	A
V_{SD} (2)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 12 A	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 12 A, di/dt = 100 A/µs, V_{DD} = 100 V (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	270		ns
Q_{rr}	Reverse recovery charge		-	2.23		µC
I_{RRM}	Reverse recovery current		-	16.5		A
t_{rr}	Reverse recovery time	I_{SD} = 12 A, di/dt = 100 A/µs, V_{DD} = 100 V, T_J = 150 °C (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	340		ns
Q_{rr}	Reverse recovery charge		-	3		µC
I_{RRM}	Reverse recovery current		-	18		A

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

2.1 Electrical characteristics (curves)

Figure 1. Safe operating area for D²PAK and TO-220

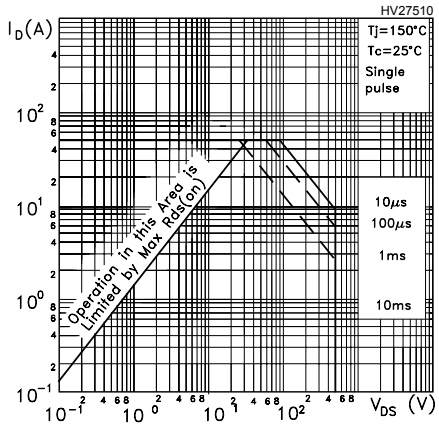


Figure 2. Thermal impedance for D²PAK and TO-220

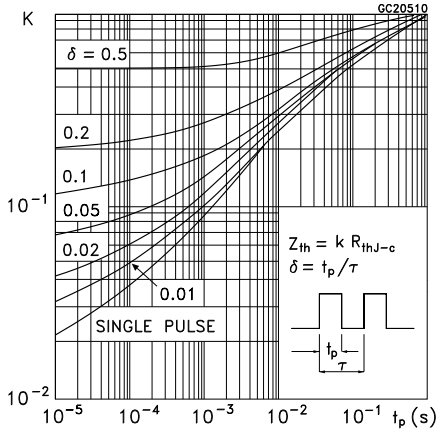


Figure 3. Safe operating area for TO-220FP

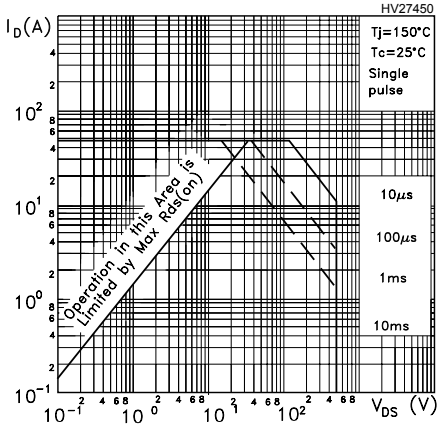


Figure 4. Thermal impedance for TO-220FP

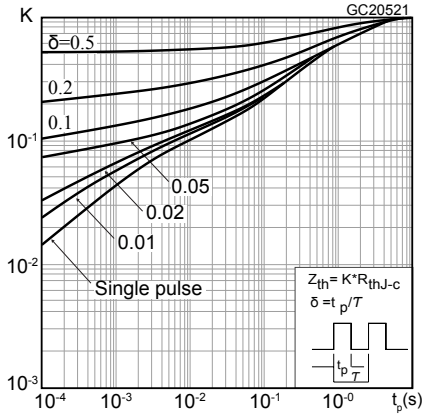


Figure 5. Output characteristics

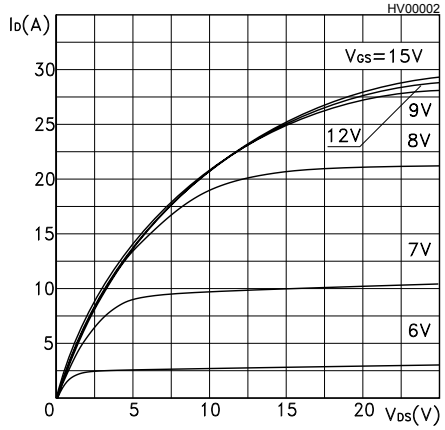


Figure 6. Transfer characteristics

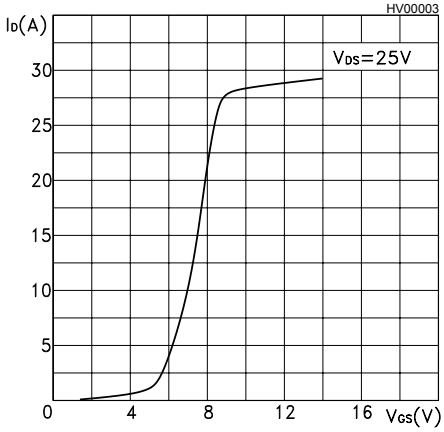


Figure 7. Static drain-source on-resistance

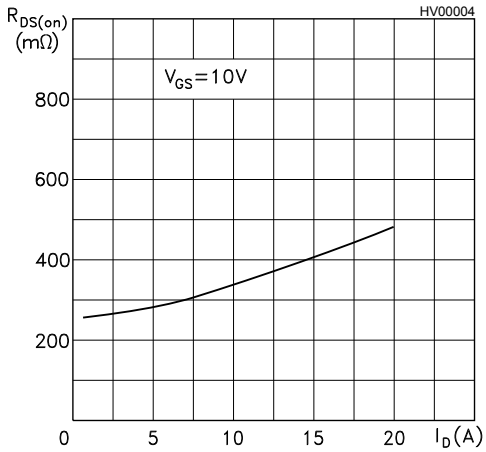


Figure 8. Gate charge vs gate-source voltage

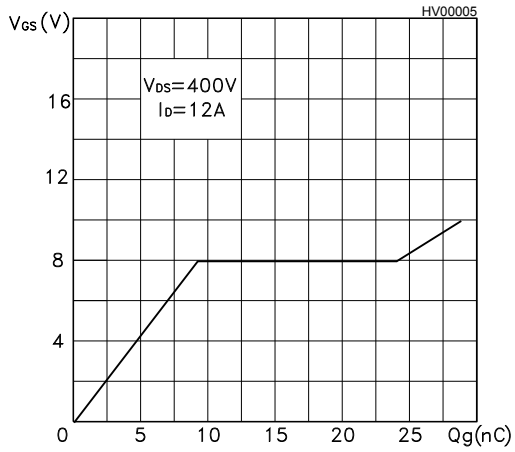


Figure 9. Capacitance variations

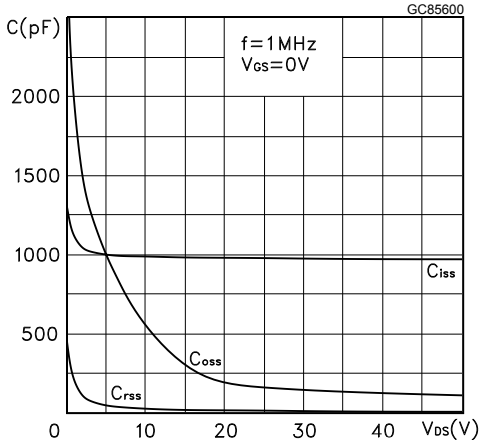


Figure 10. Normalized gate threshold voltage vs temperature

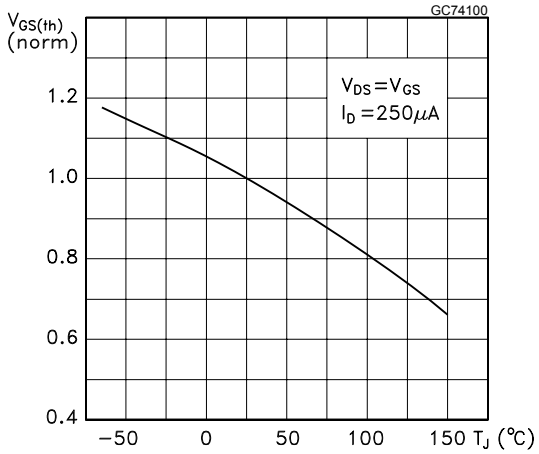


Figure 11. Normalized on resistance vs temperature

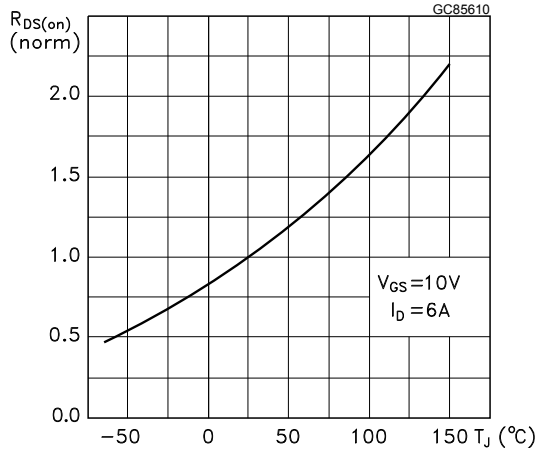
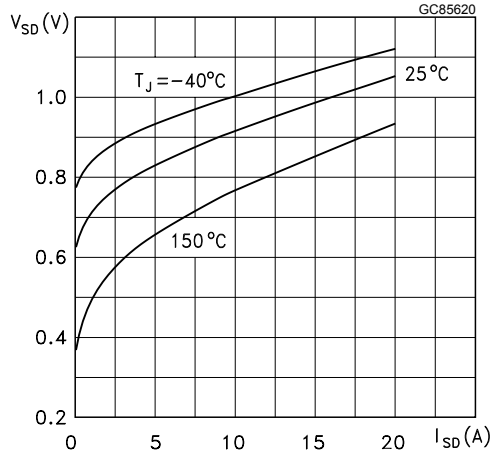


Figure 12. Source-drain diode forward characteristics



3 Test circuits

Figure 13. Test circuit for resistive load switching times

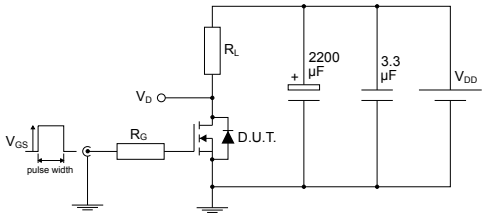


Figure 14. Test circuit for gate charge behavior

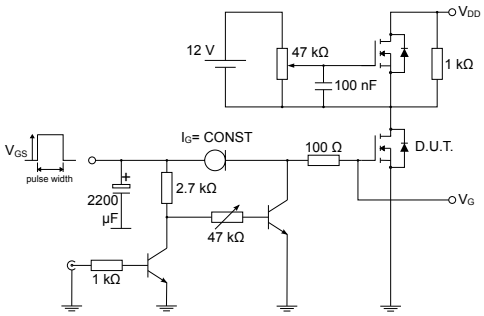


Figure 15. Test circuit for inductive load switching and diode recovery times

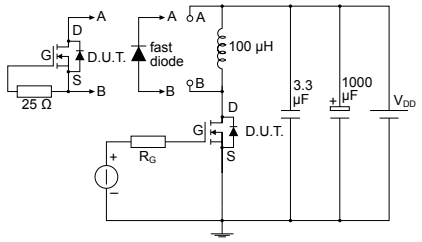


Figure 16. Unclamped inductive load test circuit

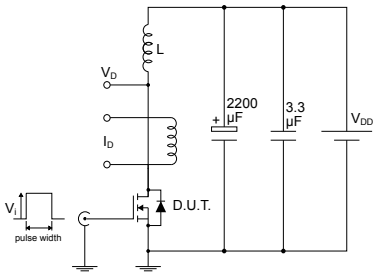


Figure 17. Unclamped inductive waveform

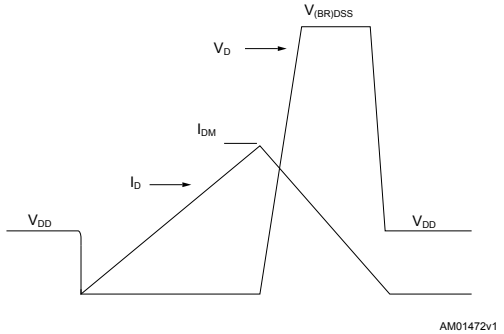
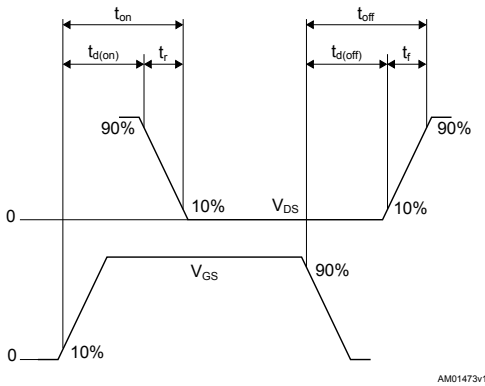


Figure 18. Switching time waveform



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 19. **D²PAK (TO-263) type A package outline**

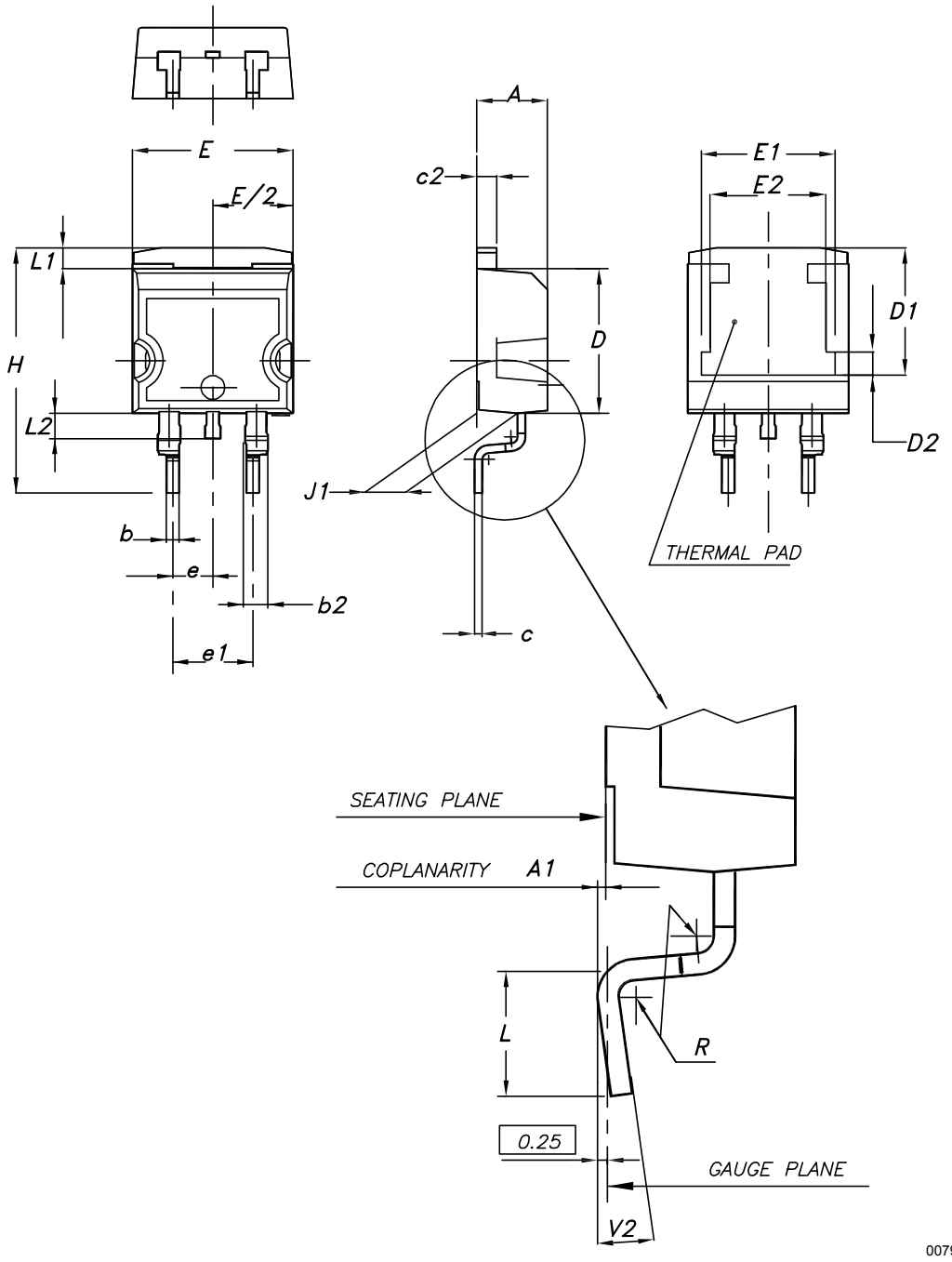
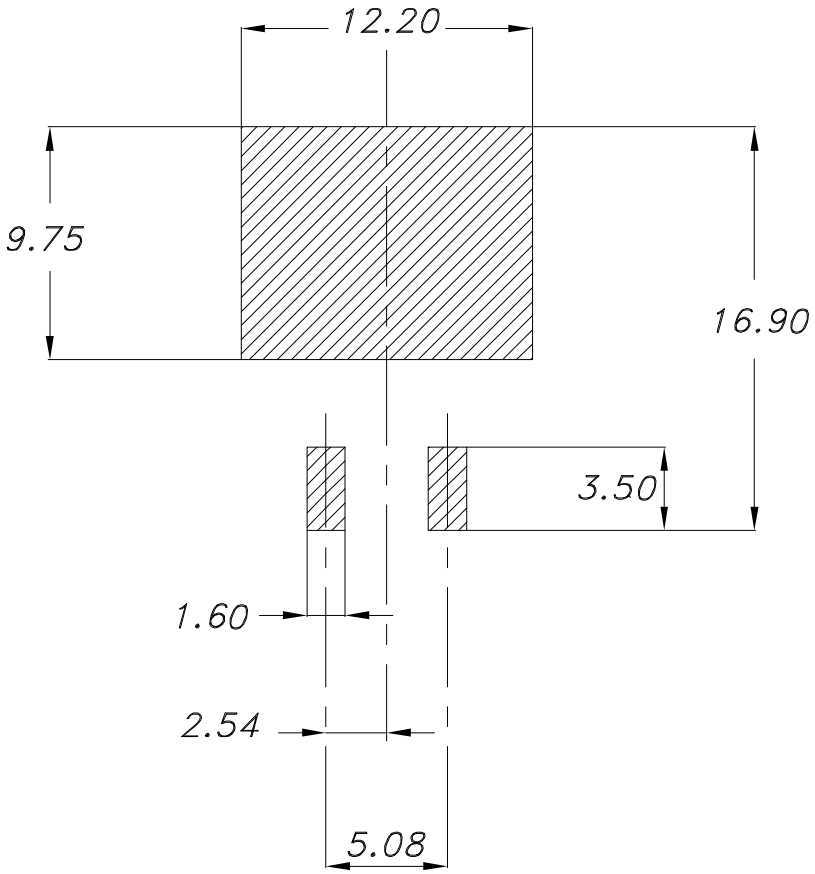


Table 7. D²PAK (TO-263) type A package mechanical data

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°

Figure 20. D²PAK (TO-263) recommended footprint (dimensions are in mm)



Footprint_26

4.2 TO-220 type A package information

Figure 21. **TO-220 type A package outline**

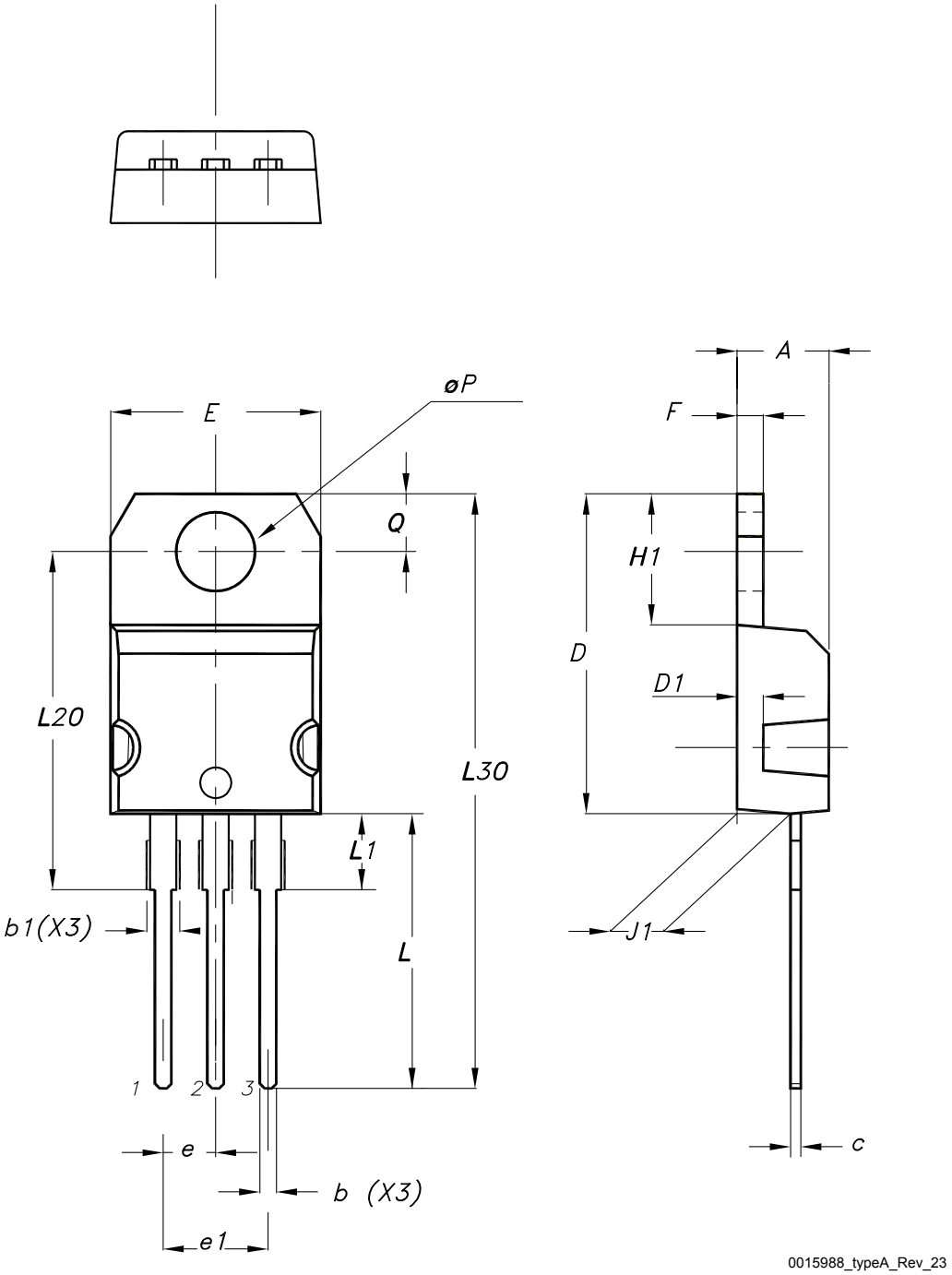


Table 8. **TO-220 type A package mechanical data**

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
Slug flatness		0.03	0.10

4.3 TO-220FP package information

Figure 22. **TO-220FP package outline**

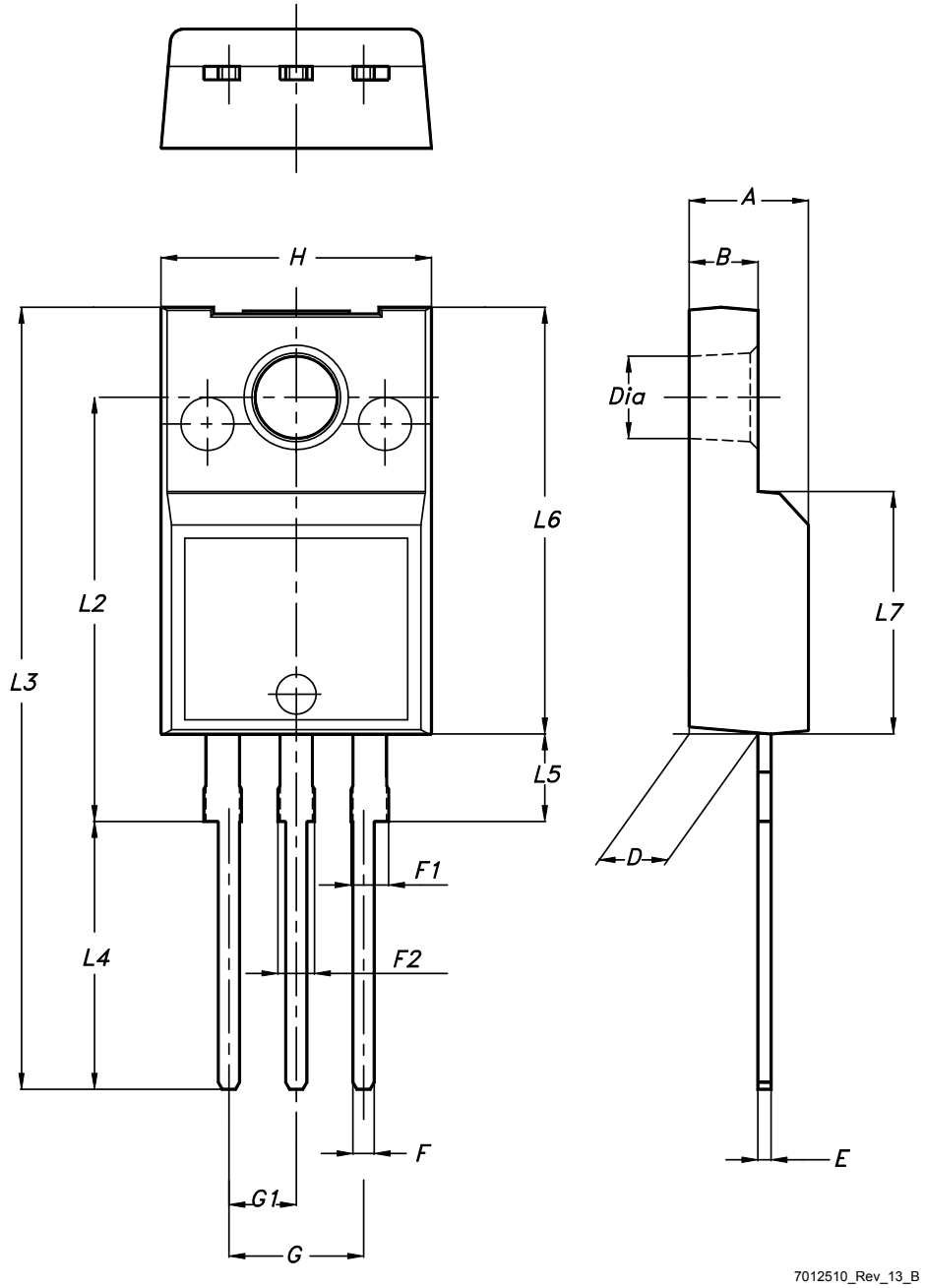


Table 9. **TO-220FP package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

4.4 D²PAK packing information

Figure 23. D²PAK tape outline

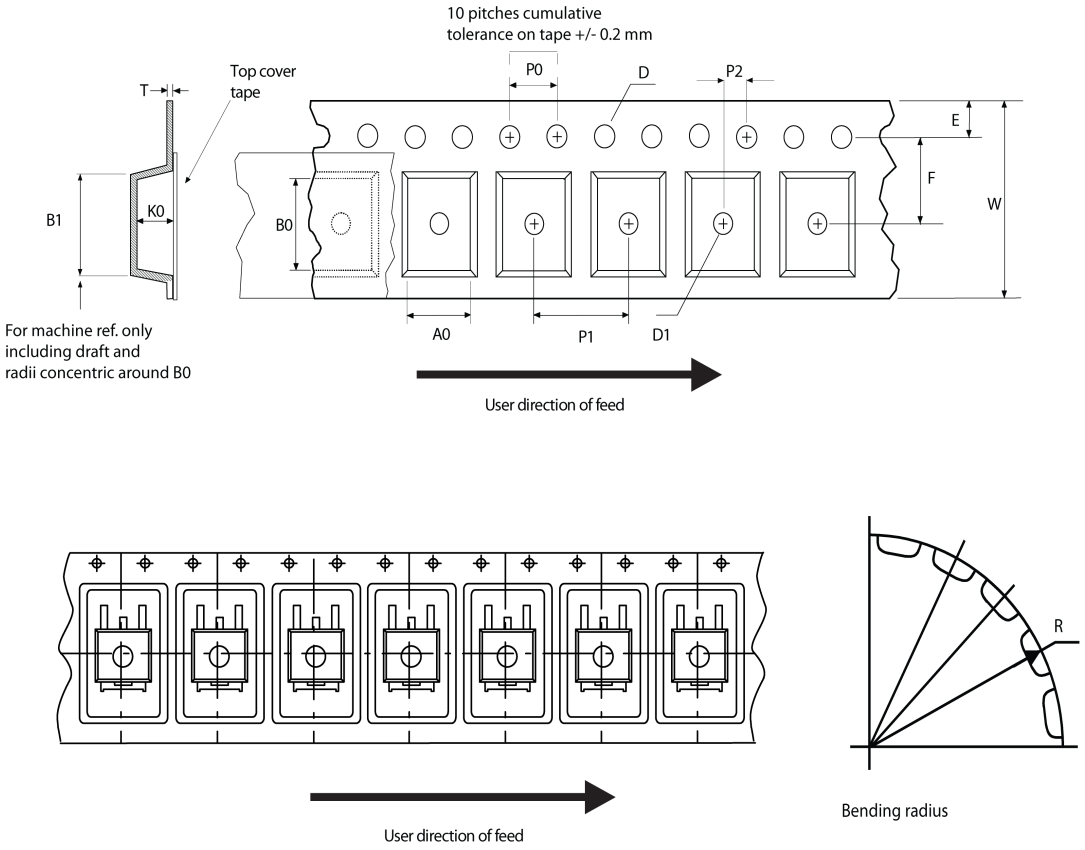


Figure 24. **D²PAK reel outline**

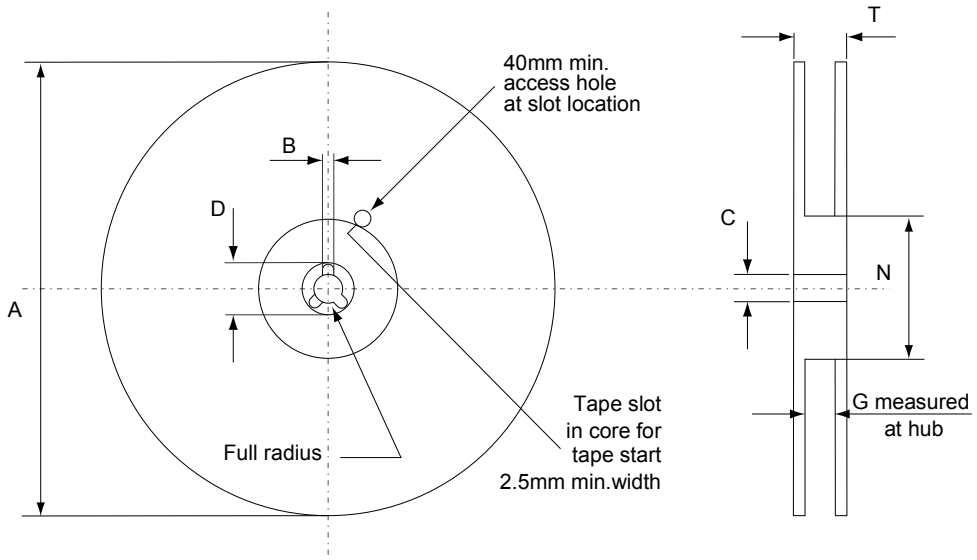


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Table 10. **D²PAK tape and reel mechanical data**

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			

5 Ordering information

Table 11. **Order codes**

Order codes	Marking	Package	Packing
STB12NM50T4	B12NM50	D²PAK	Tape and reel
STP12NM50	P12NM50	TO-220	Tube
STP12NM50FP	P12NM50FP	TO-220FP	Tube

Revision history

Table 12. **Document revision history**

Date	Revision	Changes
14-Mar-2004	8	Preliminary version
15-Feb-2006	9	New voltage value on first page at tjmax.
05-Apr-2006	10	Inserted ecopack indication
27-Jul-2006	11	New template, no content change
22-Oct-2020	12	The part number STB12NM50-1 have been moved to a separate datasheet and the document has been updated accordingly. Updated cover page. Updated Section 1 Electrical ratings and Section 2 Electrical characteristics. Added Section Section 5 Ordering information. Minor text changes.

Contents