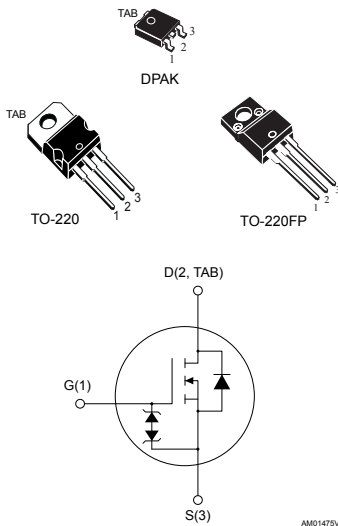




**THE DATASHEET OF
P5NK60ZFP**



N-channel 600 V, 1.2 Ω typ., 5 A SuperMESH™ Power MOSFET in DPAK, TO-220 and TO-220FP packages



Features

Order codes	V_{DS} @ $T_{jmax.}$	$R_{DS(on)}$ max.	Package
STD5NK60ZT4	650 V	1.6 Ω	DPAK
STP5NK60Z			TO-220
STP5NK60ZFP			TO-220FP

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

Applications

- Switching applications

Description

These high-voltage devices are Zener-protected N-channel Power MOSFETs developed using the SuperMESH™ technology by STMicroelectronics, an optimization of the well-established PowerMESH™. In addition to a significant reduction in on-resistance, these devices are designed to ensure a high level of dv/dt capability for the most demanding applications.

Product status link

[STD4NK60ZT4](#)
[STP5NK60Z](#)
[STP5NK60ZFP](#)

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		DPAK, TO-220	TO-220FP	
V _{DS}	Drain-source voltage	600		V
V _{GS}	Gate-source voltage	±30		V
I _D	Drain current (continuous) at T _C = 25 °C	5	5 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	3.16	3.16 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	20	20 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	90	25	W
ESD	Gate-source human body model (R = 1.5 kΩ, C = 100 pF)	3		kV
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	4.5		V/ns
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. $I_{SD} \leq 5 \text{ A}$, $di/dt \leq 200 \text{ A}/\mu\text{s}$, $V_{DSpeak} \leq V_{(BR)DSS}$, $V_{DD} = 80\% V_{(BR)DSS}$.

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		DPAK	TO-220	TO-220FP	
R _{thj-case}	Thermal resistance junction-case	1.39		5	°C/W
R _{thj-amb}	Thermal resistance junction-ambient		62.5		°C/W
R _{thj-pcb} ⁽¹⁾	Thermal resistance junction-pcb	50			°C/W

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _j Max)	5	A
E _{AS}	Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	220	mJ

2 Electrical characteristics

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

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0\text{ V}$	600			V
I_{DSS}	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$			1	μA
		$V_{GS} = 0\text{ V}$, $V_{DS} = 600\text{ V}$, $T_C = 125\text{ °C}$ ⁽¹⁾			50	μA
I_{GSS}	Gate body leakage current	$V_{DS} = 0\text{ V}$, $V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 50\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}$, $I_D = 2.5\text{ A}$		1.2	1.6	Ω

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

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0\text{ V}$	-	690		μF
C_{oss}	Output capacitance			90		
C_{rSS}	Reverse transfer capacitance			20		
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }480\text{ V}$, $V_{GS} = 0\text{ V}$	-	40		μF
Q_g	Total gate charge	$V_{DD} = 400\text{ V}$, $I_D = 5\text{ A}$, $V_{GS} = 0\text{ to }10\text{ V}$ (see Figure 16. Test circuit for gate charge behavior)	-	26	34	nC
Q_{gs}	Gate-source charge			6		
Q_{gd}	Gate-drain charge			14		

1. $C_{oss\text{ eq.}}$ 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 conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 2.5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	16		ns
t_r	Rise time			25		
$t_{d(off)}$	Turn-off delay time	(see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	36		ns
t_f	Fall time			25		
$t_{r(voff)}$	Off-voltage rise time	$V_{DD} = 480\text{ V}$, $I_D = 5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$	-	12		ns
t_f	Fall time			10		
t_c	Cross-over time	(see Figure 17. Test circuit for inductive load switching and diode recovery times and Figure 20. Switching time waveform)		24		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				20	
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 5\text{ A}$, $V_{GS} = 0\text{ V}$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 5\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	485		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 30\text{ V}$ (see Figure 17. Test circuit for inductive load switching and diode recovery times)		2.7		μC
I_{RRM}	Reverse recovery current			11		A

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

Table 8. Gate-Source Zener Diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$, $I_D = 0\text{ A}$	30	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

2.1 Electrical characteristics curves

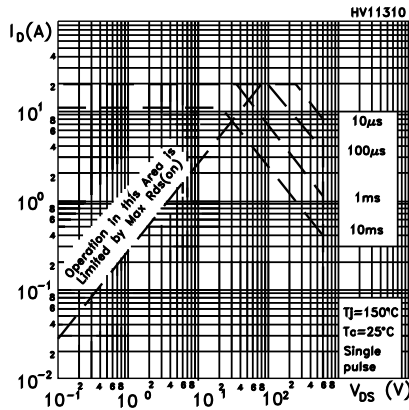
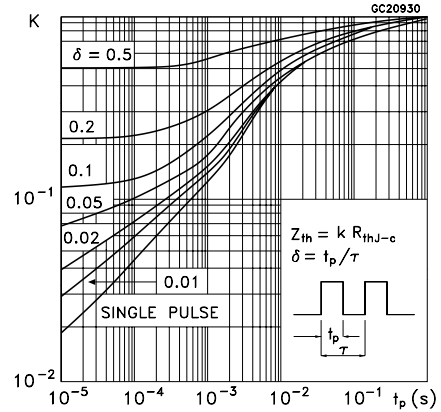
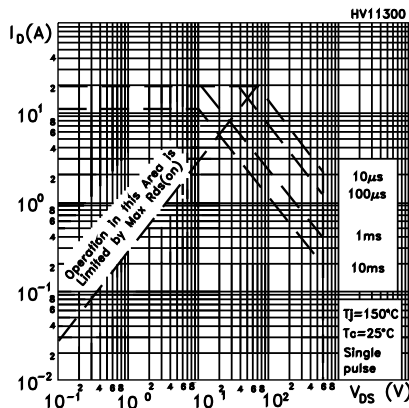
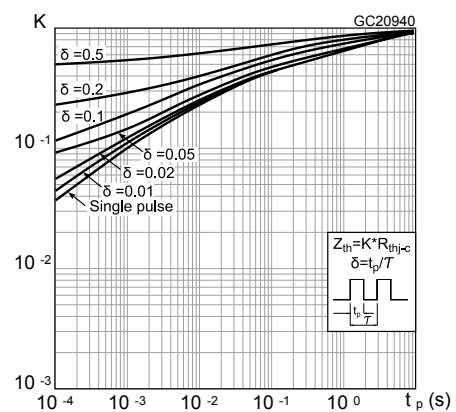
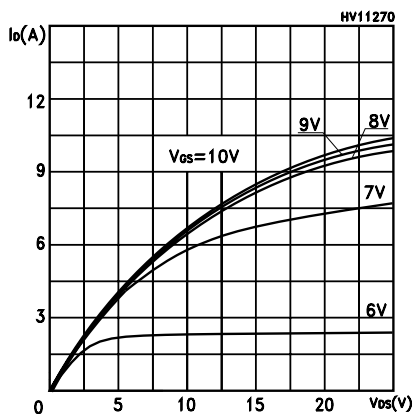
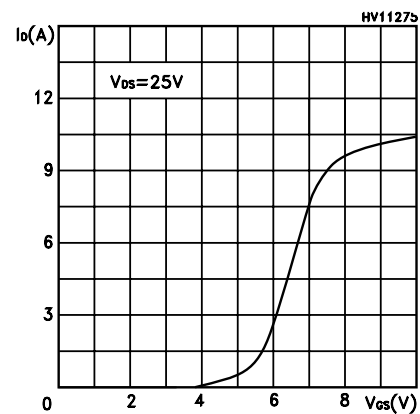
Figure 1. Safe operating area for DPAK and TO-220

Figure 2. Thermal impedance for DPAK 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


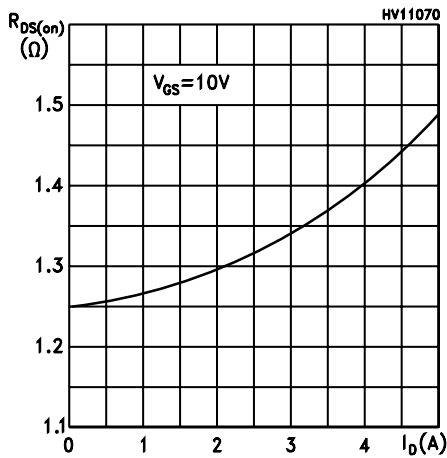
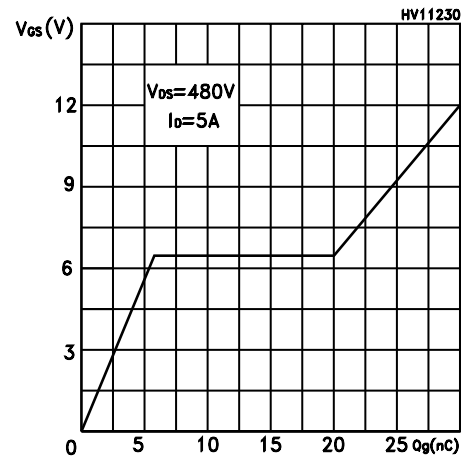
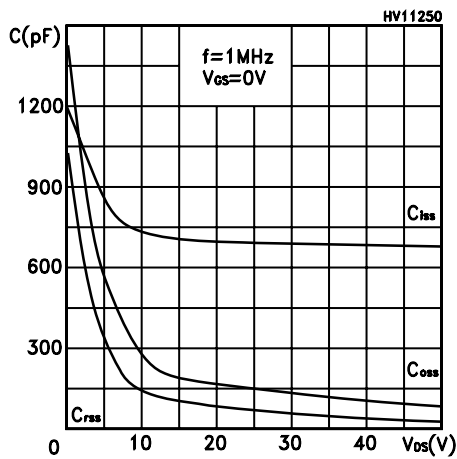
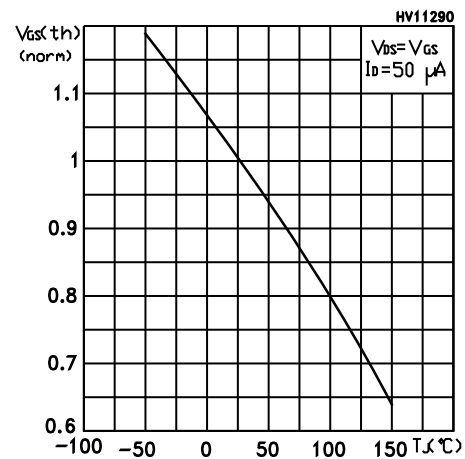
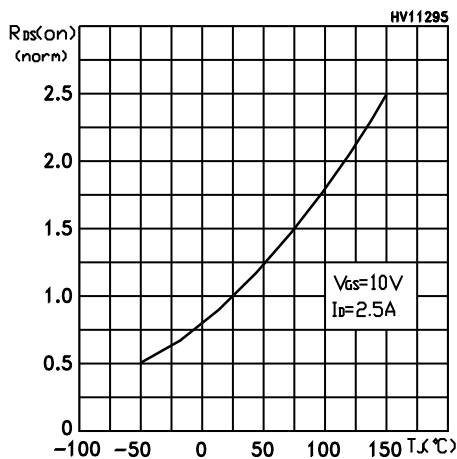
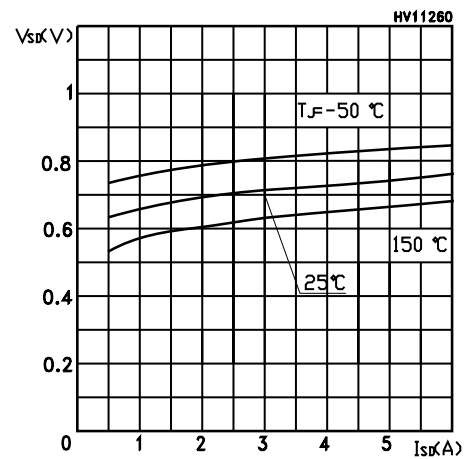
Figure 7. Static drain-source on resistance

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 characteristic


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

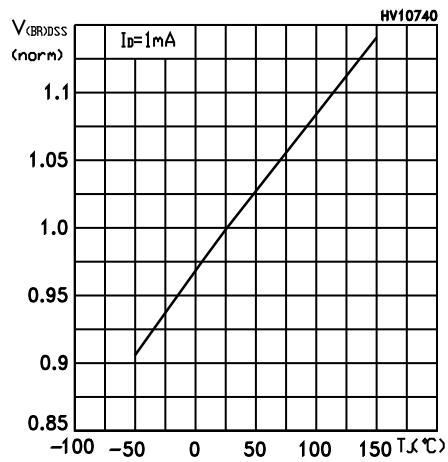
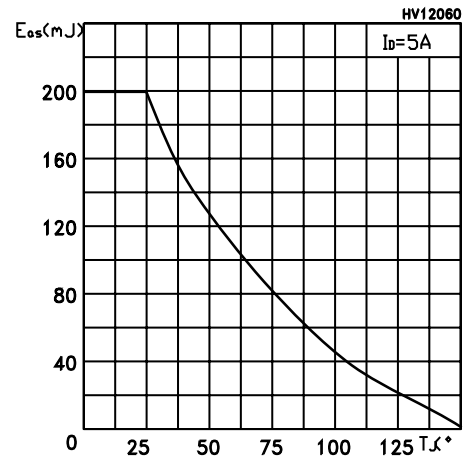
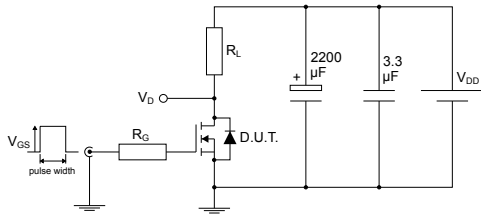


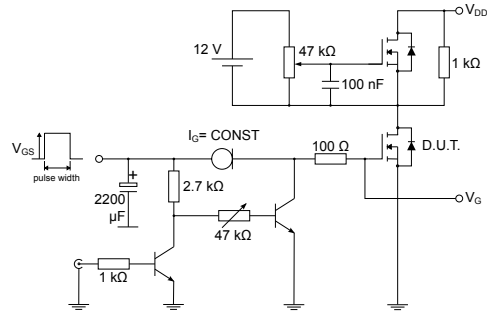
Figure 14. Maximum avalanche energy vs temperature



3 Test circuits

Figure 15. Test circuit for resistive load switching times


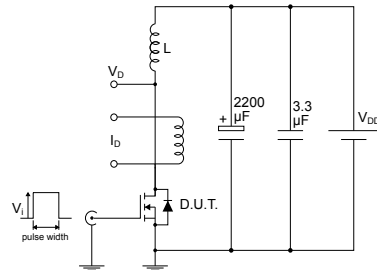
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Figure 16. Test circuit for gate charge behavior


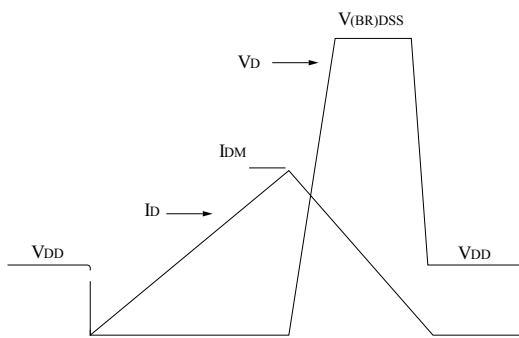
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Figure 17. Test circuit for inductive load switching and diode recovery times

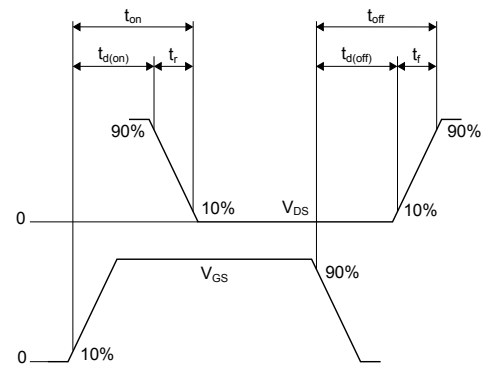

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Figure 18. Unclamped inductive load test circuit


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Figure 19. Unclamped inductive waveform


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Figure 20. Switching time waveform


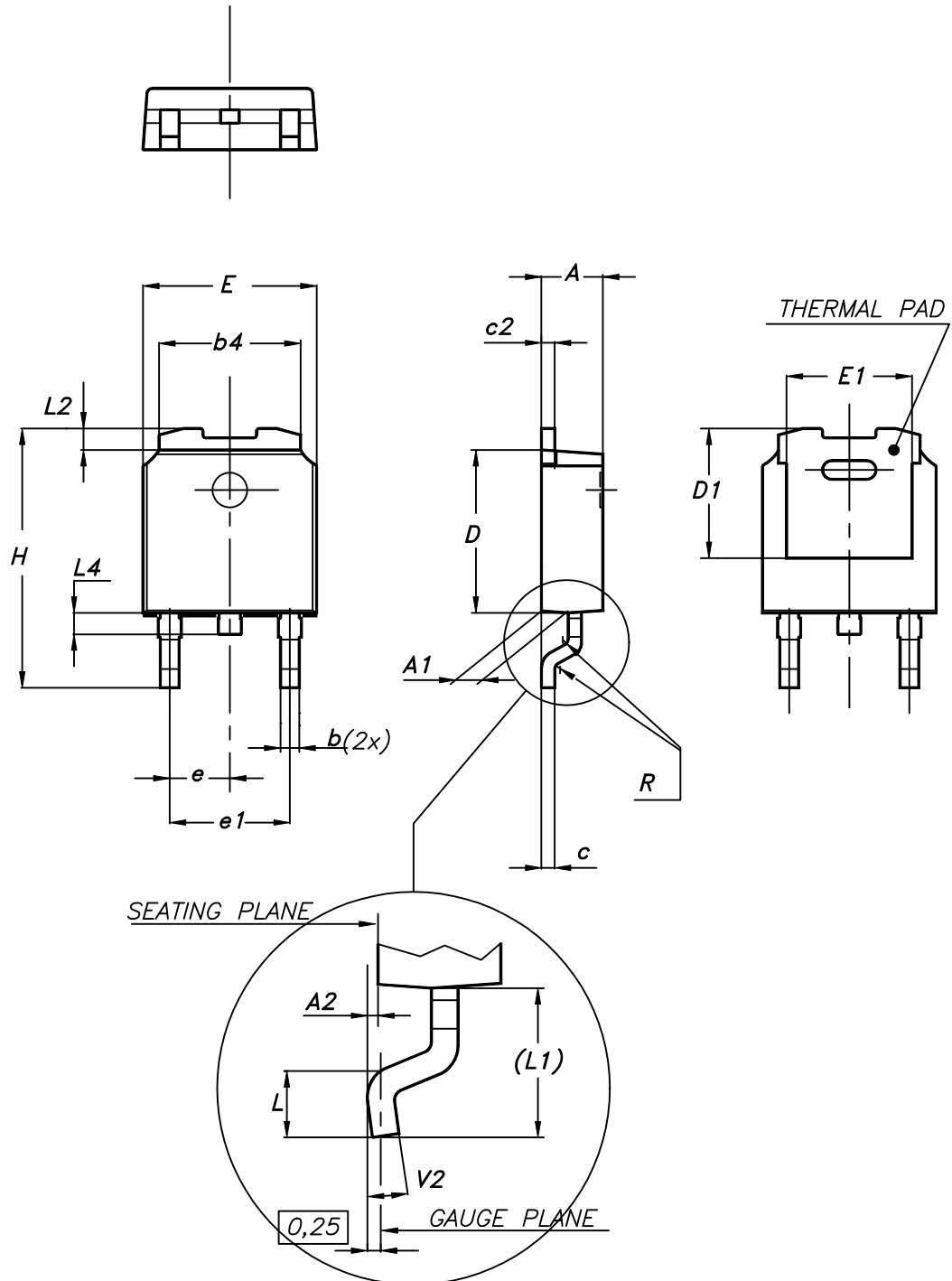
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4 Package information

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 DPAK (TO-252) type A2 package information

Figure 21. DPAK (TO-252) type A2 package outline



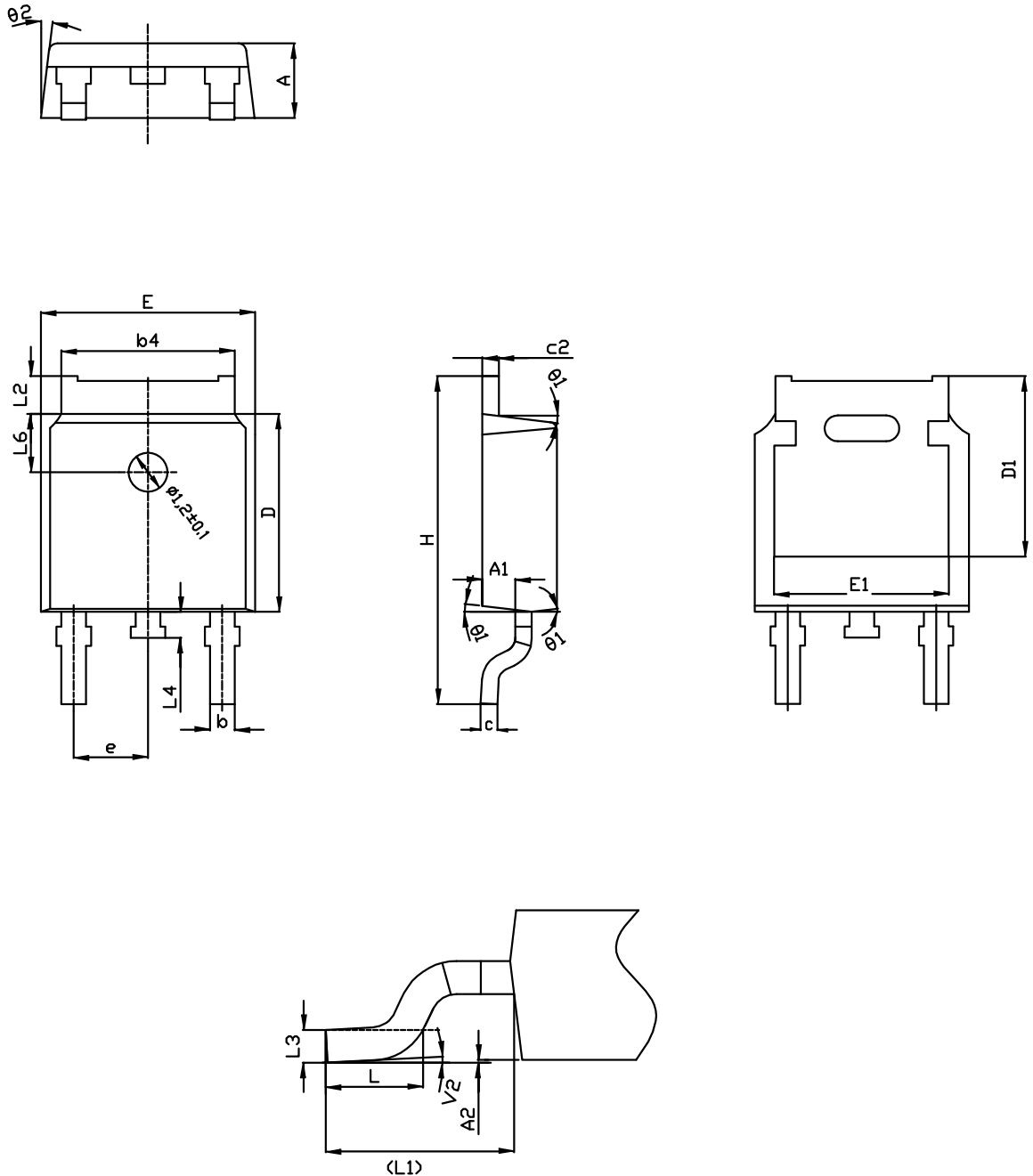
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Table 9. DPAK (TO-252) type A2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
E	6.40		6.60
E1	5.10	5.20	5.30
e	2.159	2.286	2.413
e1	4.445	4.572	4.699
H	9.35		10.10
L	1.00		1.50
L1	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

4.2 DPAK (TO-252) type C2 package information

Figure 22. DPAK (TO-252) type C2 package outline

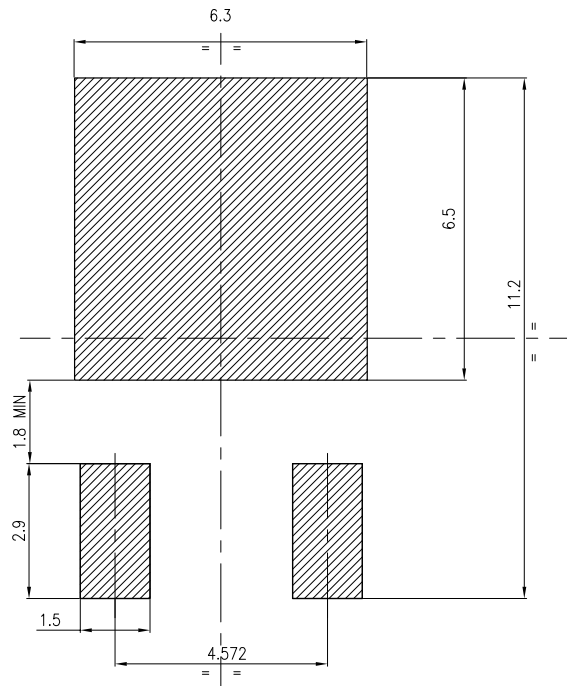


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Table 10. DPAK (TO-252) type C2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20	2.30	2.38
A1	0.90	1.01	1.10
A2	0.00		0.10
b	0.72		0.85
b4	5.13	5.33	5.46
c	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.10		5.60
E	6.50	6.60	6.70
E1	5.20		5.50
e	2.186	2.286	2.386
H	9.80	10.10	10.40
L	1.40	1.50	1.70
L1	2.90 REF		
L2	0.90		1.25
L3	0.51 BSC		
L4	0.60	0.80	1.00
L6	1.80 BSC		
θ1	5°	7°	9°
θ2	5°	7°	9°
V2	0°		8°

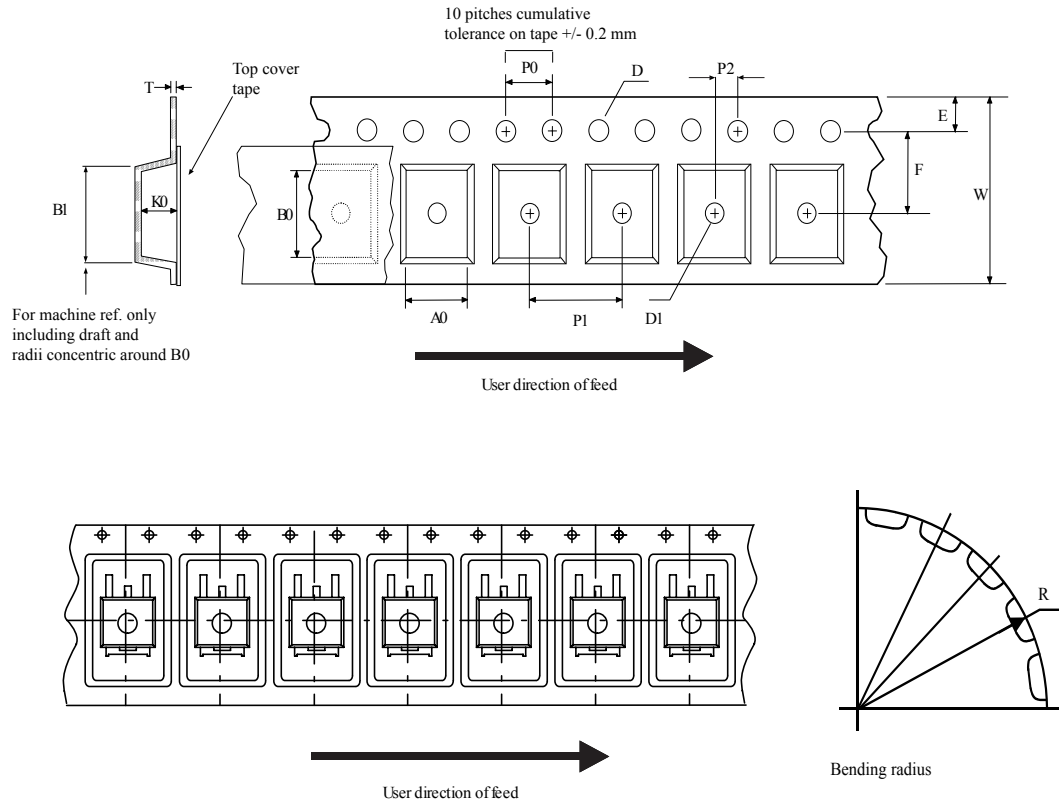
Figure 23. DPAK (TO-252) recommended footprint (dimensions are in mm)



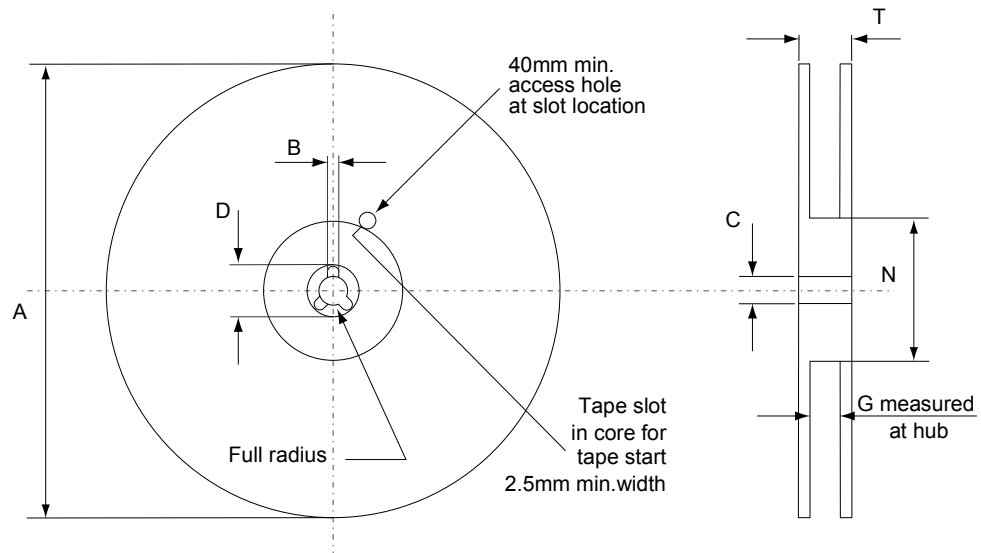
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4.3 DPAK (TO-252) packing information

Figure 24. DPAK (TO-252) tape outline



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Figure 25. DPAK (TO-252) reel outline


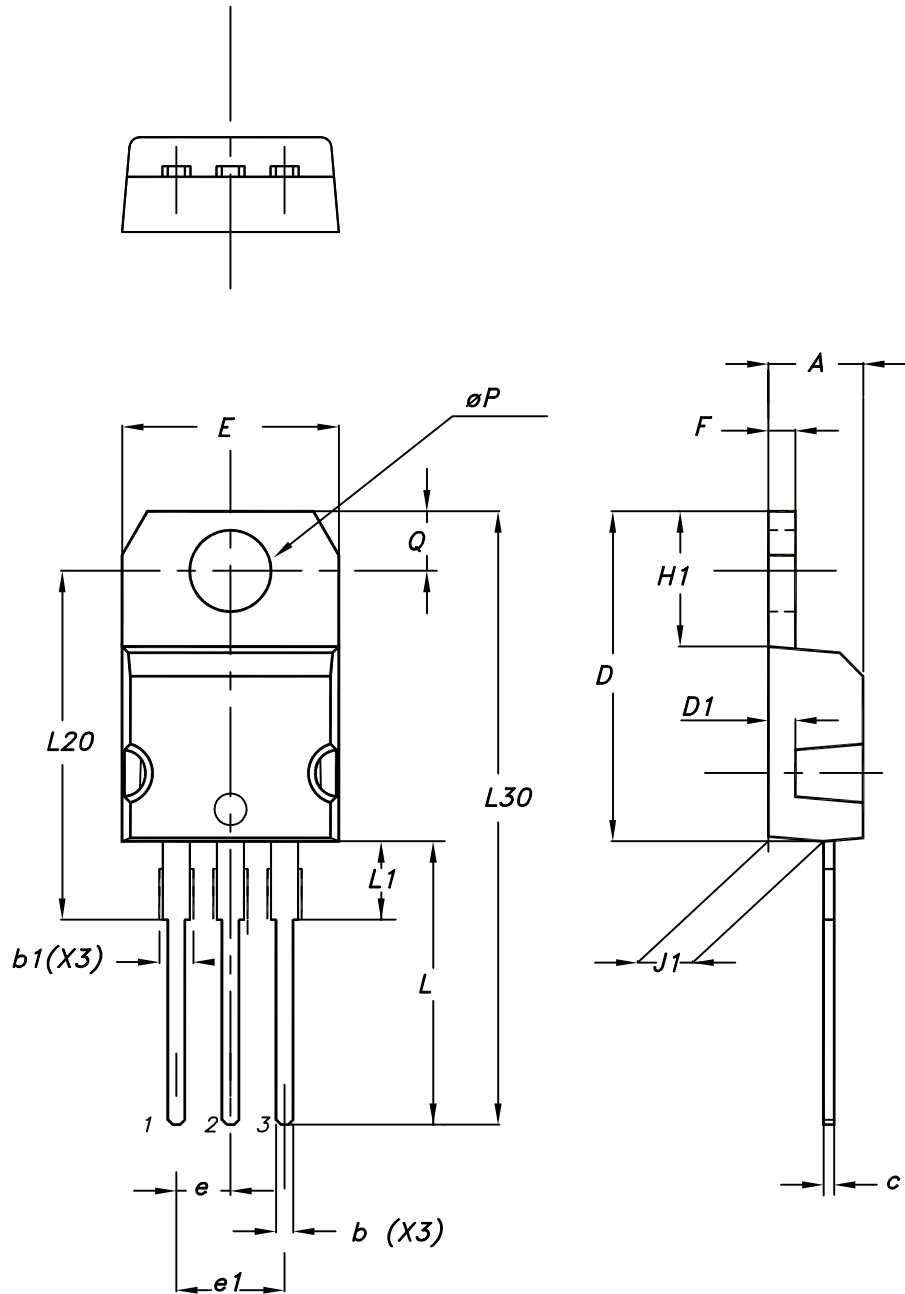
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Table 11. DPAK (TO-252) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

4.4 TO-220 type A package information

Figure 26. TO-220 type A package outline



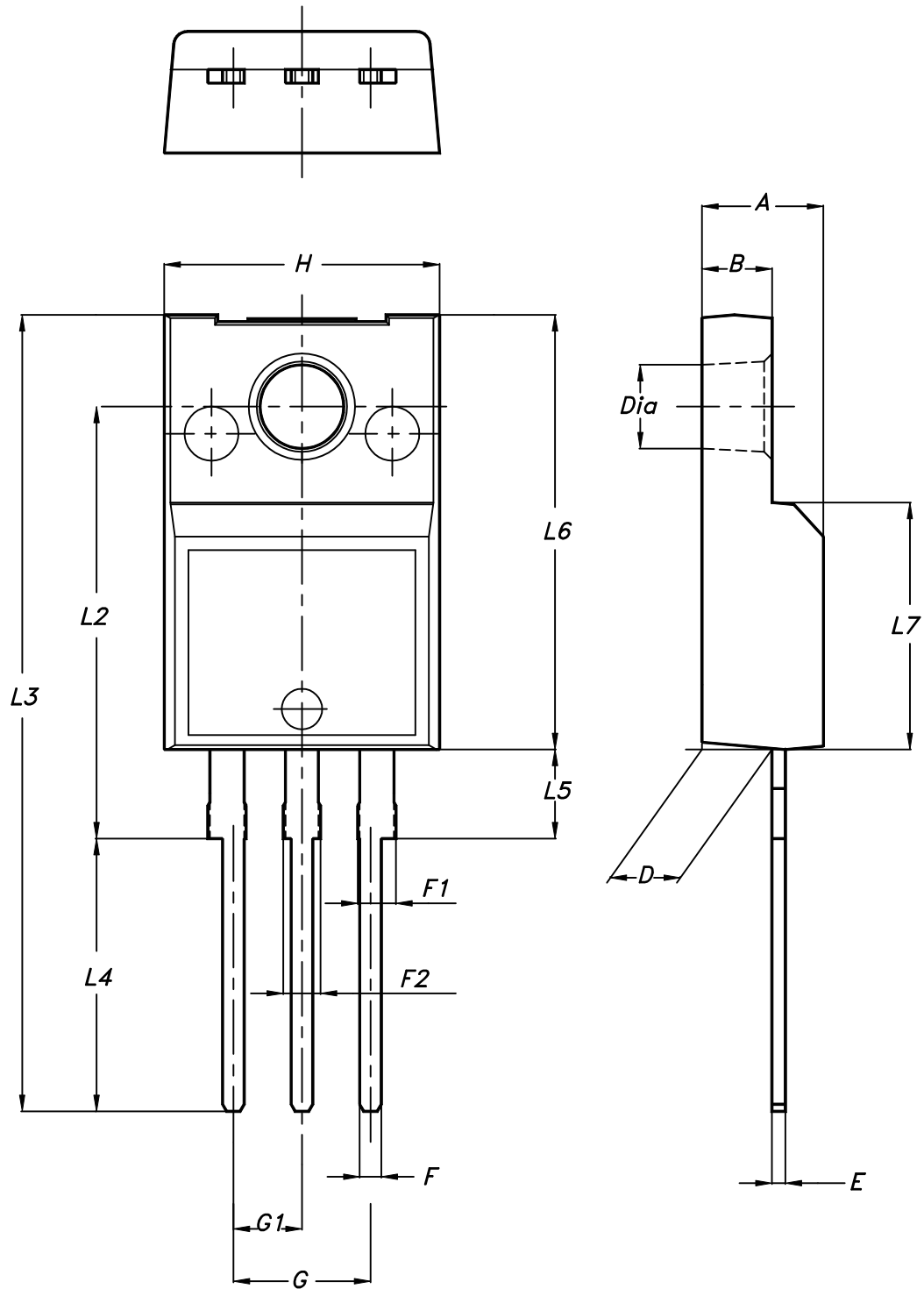
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Table 12. TO-220 type A package mechanical data

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

4.5 TO-220FP package information

Figure 27. TO-220FP package outline



7012510_Rev_12_B

Table 13. 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

5 Ordering information

Table 14. Order codes

Order code	Marking	Package	Packing
STD5NK60ZT4	D5NK60Z	DPAK	Tape and reel
STP5NK60Z	P5NK60Z	TO-220	Tube
STP5NK60ZFP	P5NK60ZFP	TO-220FP	Tube

Revision history

Table 15. Document revision history

Date	Version	Changes
05-Apr-2005	1	First issue
29-Apr-2005	2	Modified value in Table 7.
06-Sep-2005	3	Inserted Ecopack indication
14-Oct-2005	4	Modified value on Table 1
28-Oct-2005	5	Tape & Reel info added
14-Nov-2005	6	Modified value on Table 6
15-Dec-2005	7	Various corrections
22-Aug-2018	8	Removed maturity status indication from cover page. The document status is production data. Updated Section 4 Package information . Minor text changes.

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