1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		DPAK, TO-220	TO-220FP	
V_{DS}	Drain-source voltage	900		V
V_{GS}	Gate-source voltage	± 30		V
I_D	Drain current (continuous) at T_C = 25 °C	3	3 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	1.89	1.89 (1)	A
I_{DM} (2)	Drain current (pulsed)	12	12 (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)	4		kV
dv/dt (3)	Peak diode recovery voltage slope	4.5		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T_c = 25 °C)		2.5	kV
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} ≤ 3 A, di/dt ≤ 200 A/µs, $V_{DS(peak)}$ ≤ $V_{(BR)DSS}$, V_{DD} = 80% $V_{(BR)DSS}$.*

Table 2. Thermal data

Symbol	Parameter	Value			Unit
		DPAK	TO-220	TO-220FP	
$R_{thj\text{-}case}$	Thermal resistance junction-case	1.38		5	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		62.5		
$R_{thj\text{-}pcb}$ (1)	Thermal resistance junction-pcb	50			

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

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR} (1)	Avalanche current, repetitive or not-repetitive	3	A
E_{AS} (2)	Single pulse avalanche energy	180	mJ

1. *Pulse width limited by T_{jmax}.*
2. *Starting T_j = 25°C, I_D = I_{AR}, V_{DD} = 50 V.*

2 Electrical characteristics

(T_{CASE} = 25 °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 mA, V_{GS} = 0 V	900			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 900 V			1	µA
		V_{GS} = 0 V, V_{DS} = 900 V, T_C = 125 °C (1)			50	µA
I_{GSS}	Gate body leakage current	V_{DS} = 0 V, V_{GS} = ±20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 50 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 1.5 A		3.6	4.8	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 V, f = 1 MHz, V_{GS} = 0 V	-	590	-	pF
C_{oss}	Output capacitance			63		
C_{rss}	Reverse transfer capacitance			13		
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DS} = 0 to 720 V, V_{GS} = 0 V	-	35	-	pF
Q_g	Total gate charge	V_{DD} = 720 V, I_D = 3 A, V_{GS} = 0 to 10 V (see Figure 16. Test circuit for gate charge behavior)	-	22.7	-	nC
Q_{gs}	Gate-source charge			4.2		
Q_{gd}	Gate-drain charge			12		

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 conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 450 V, I_D = 1.5 A, R_G = 4.7 Ω, V_{GS} = 10 V (see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	18	-	ns
t_r	Rise time			7		
$t_{d(off)}$	Turn-off delay time			45		
t_f	Fall time			18		

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		3	A
I_{SDM} (1)	Source-drain current (pulsed)				12	
V_{SD} (2)	Forward on voltage	I_{SD} = 3 A, V_{GS} = 0 V	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 3 A, di/dt = 100 A/µs	-	510		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 40 V, T_J = 150 °C		2.2		µC
I_{RRM}	Reverse recovery current	(see Figure 17. Test circuit for inductive load switching and diode recovery times)		8.7		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} = ±1 mA, I_D = 0 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, TO-220

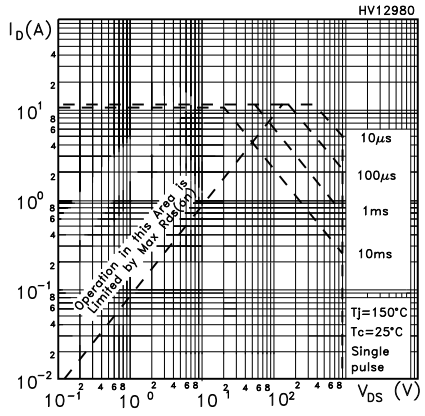


Figure 2. Thermal impedance for DPAK, TO-220

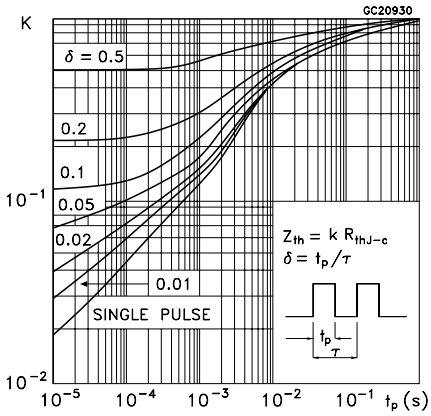


Figure 3. Safe operating area for TO-220FP

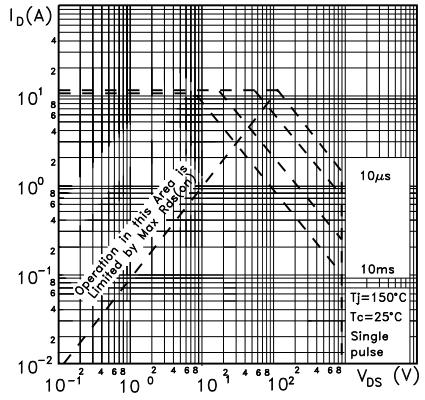


Figure 4. Thermal impedance for TO-220FP

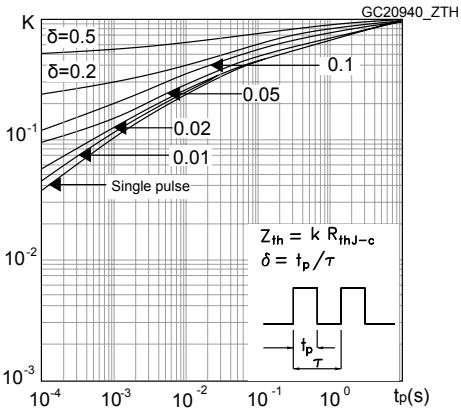


Figure 5. Output characterisics

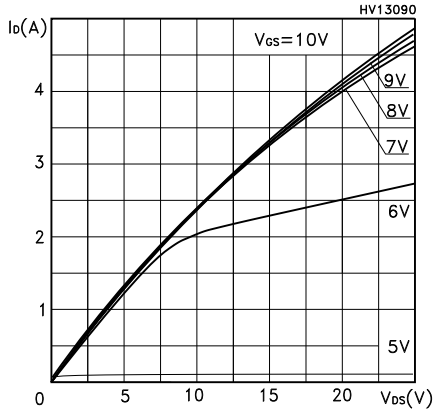


Figure 6. Transfer characteristics

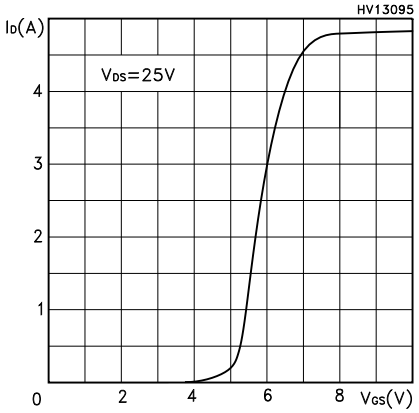


Figure 7. Static drain-source on resistance

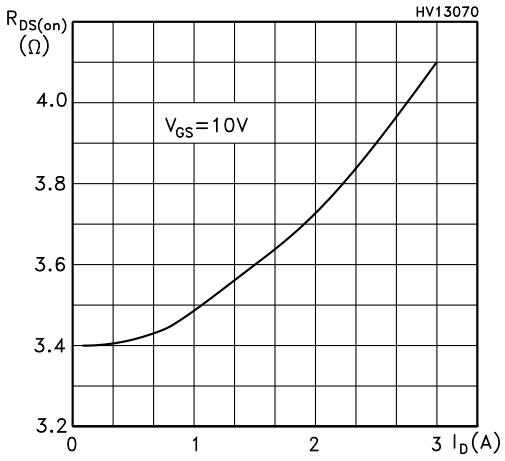


Figure 8. Gate charge vs gate-source voltage

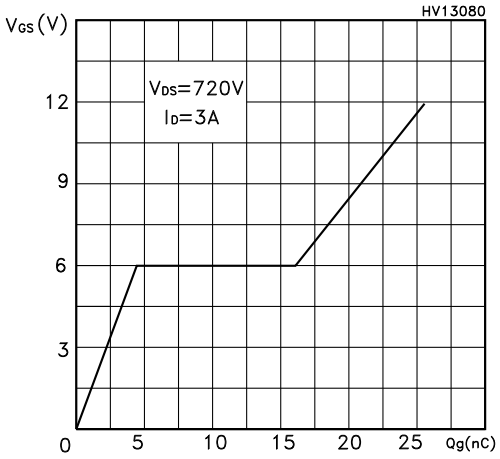


Figure 9. Capacitance variations

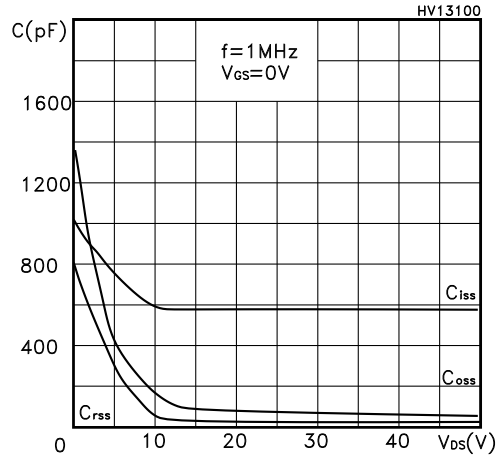


Figure 10. Normalized gate threshold voltage vs temperature

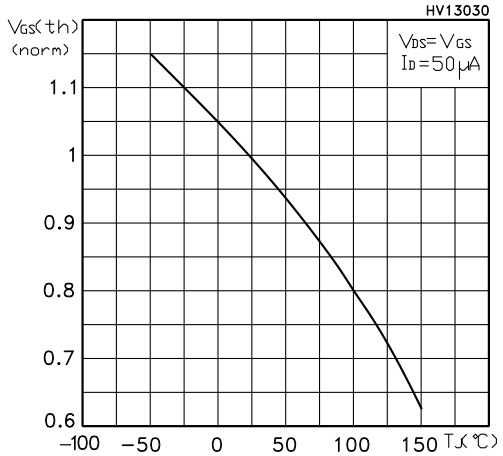


Figure 11. Normalized on resistance vs temperature

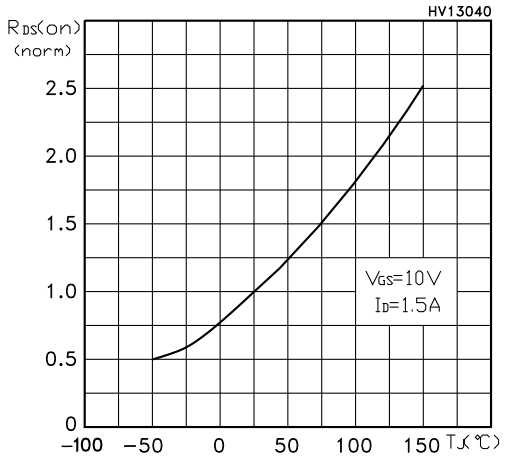


Figure 12. Source-drain diode forward characteristics

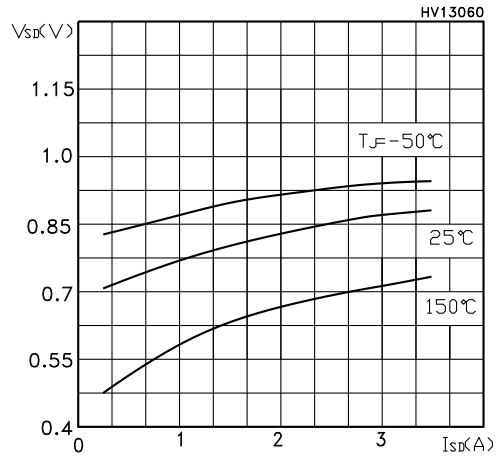


Figure 13. Maximum avalanche energy vs temperature

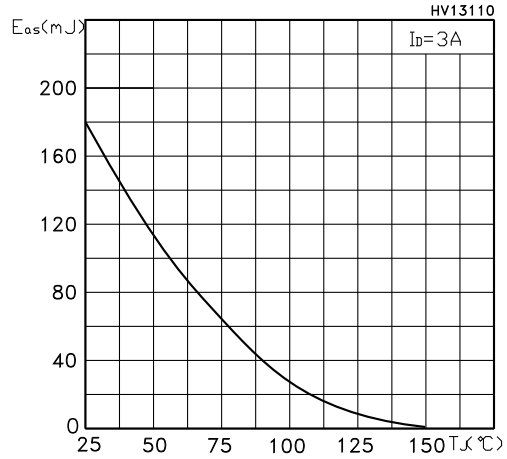
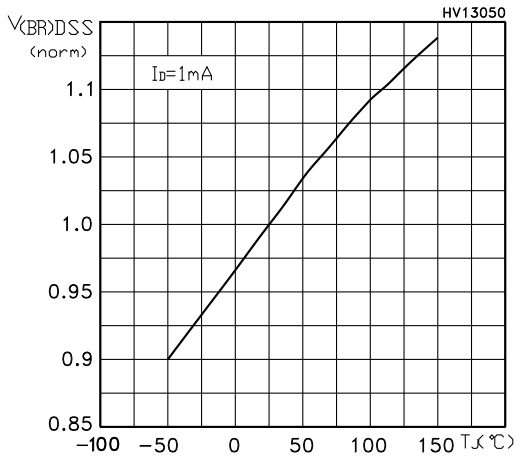


Figure 14. Normalized $V_{(BR)DSS}$ vs temperature



3 Test circuits

Figure 15. Test circuit for resistive load switching times

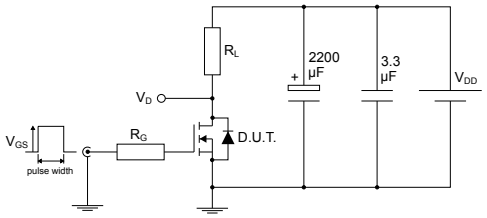


Figure 16. Test circuit for gate charge behavior

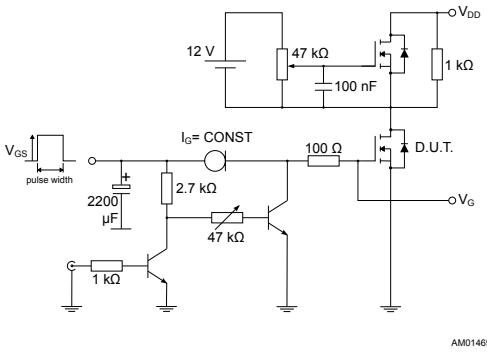


Figure 17. Test circuit for inductive load switching and diode recovery times

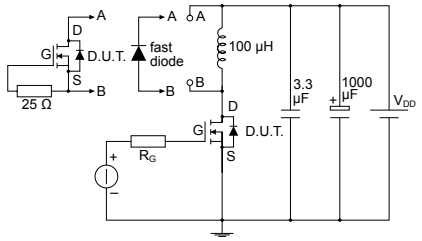


Figure 18. Unclamped inductive load test circuit

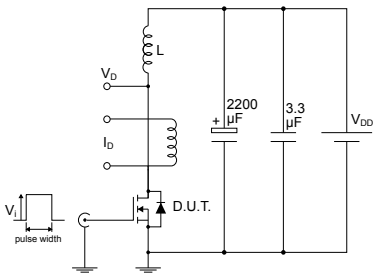


Figure 19. Unclamped inductive waveform

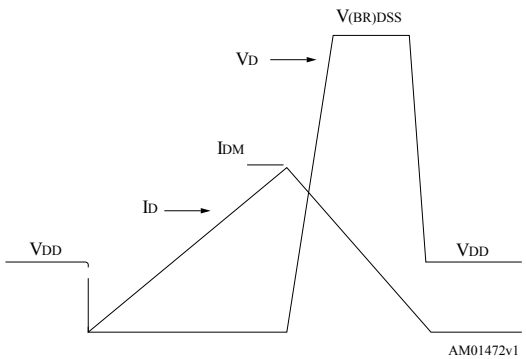
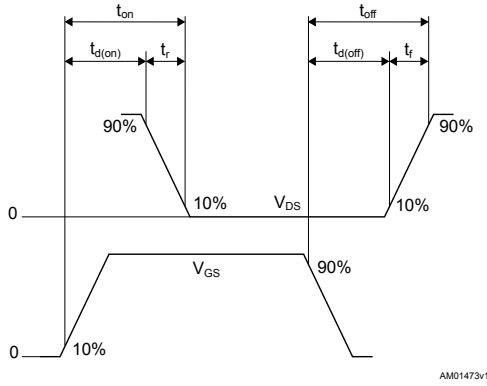


Figure 20. Switching time waveform



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 DPAK (TO-252) type A2 package information

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

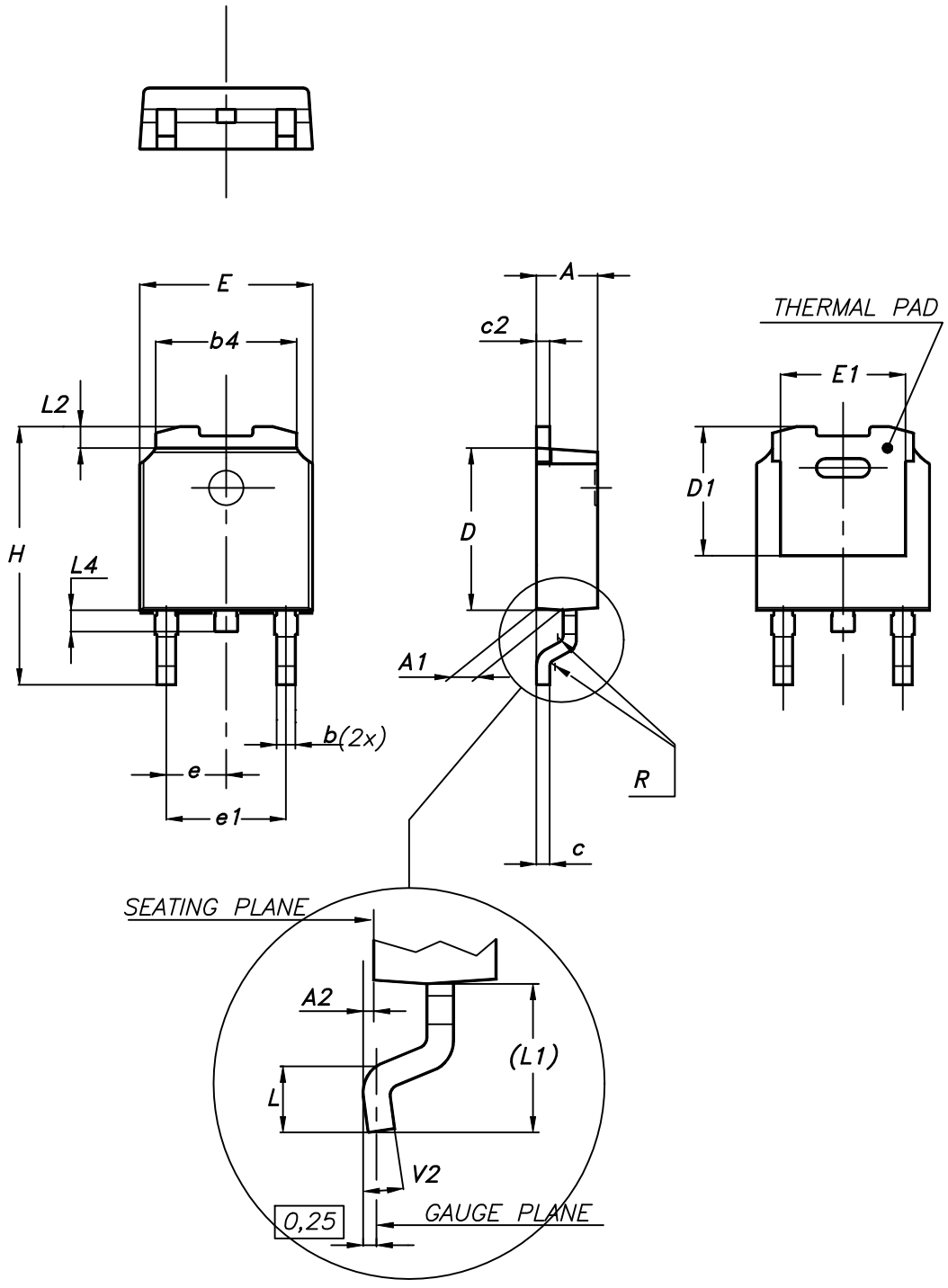
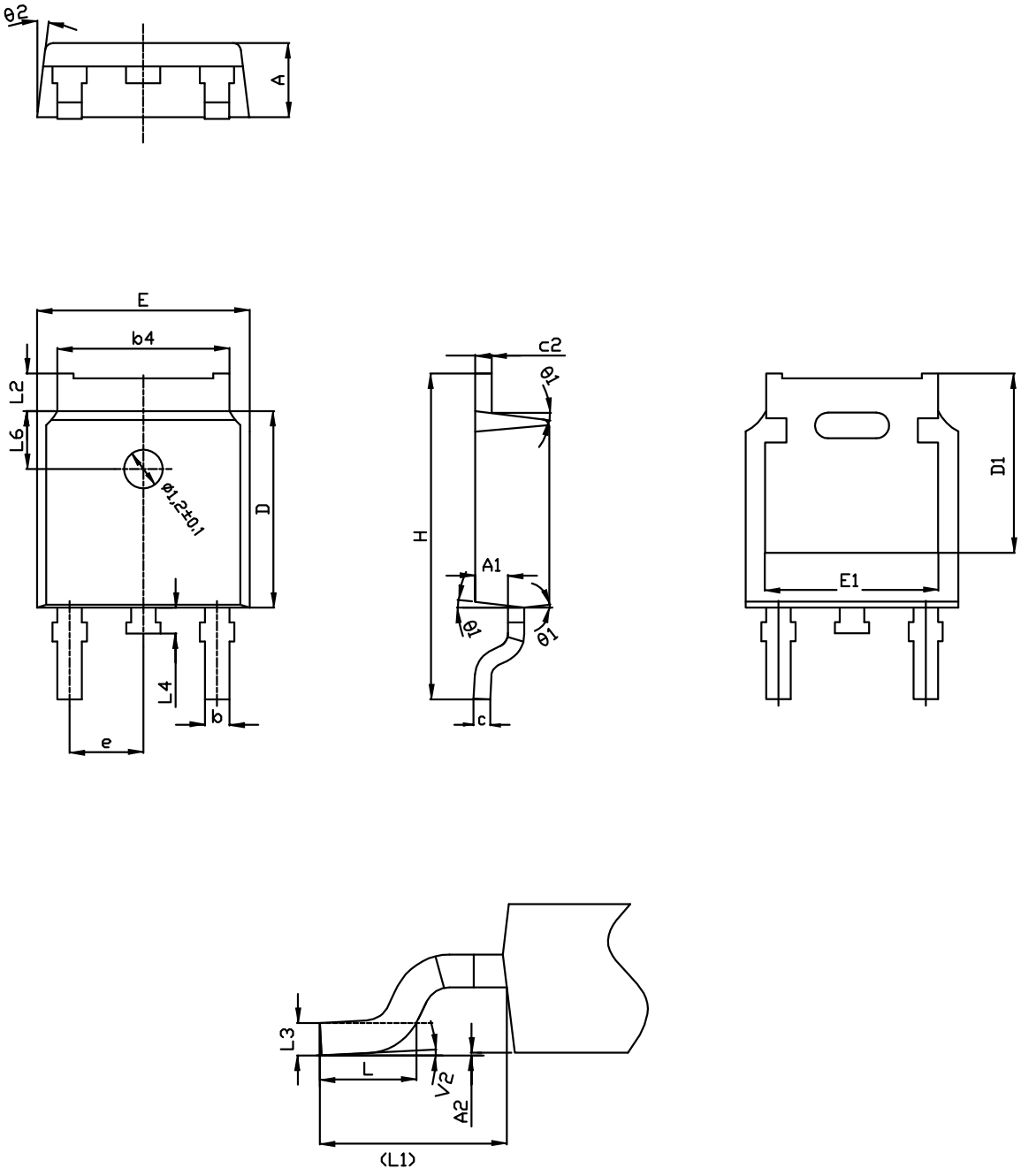


Table 9. DPAK (TO-252) type A2 mechanical data

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**

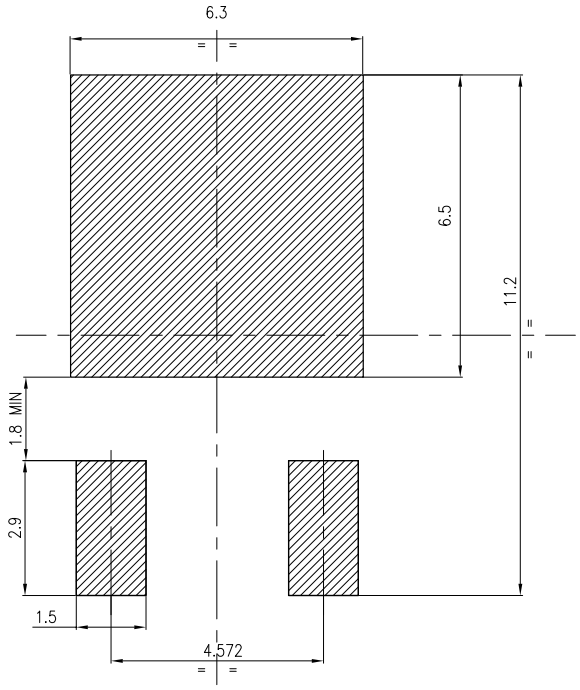


0068772_C2_25

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)**



4.3 DPAK (TO-252) packing information

Figure 24. **DPAK (TO-252) tape outline**

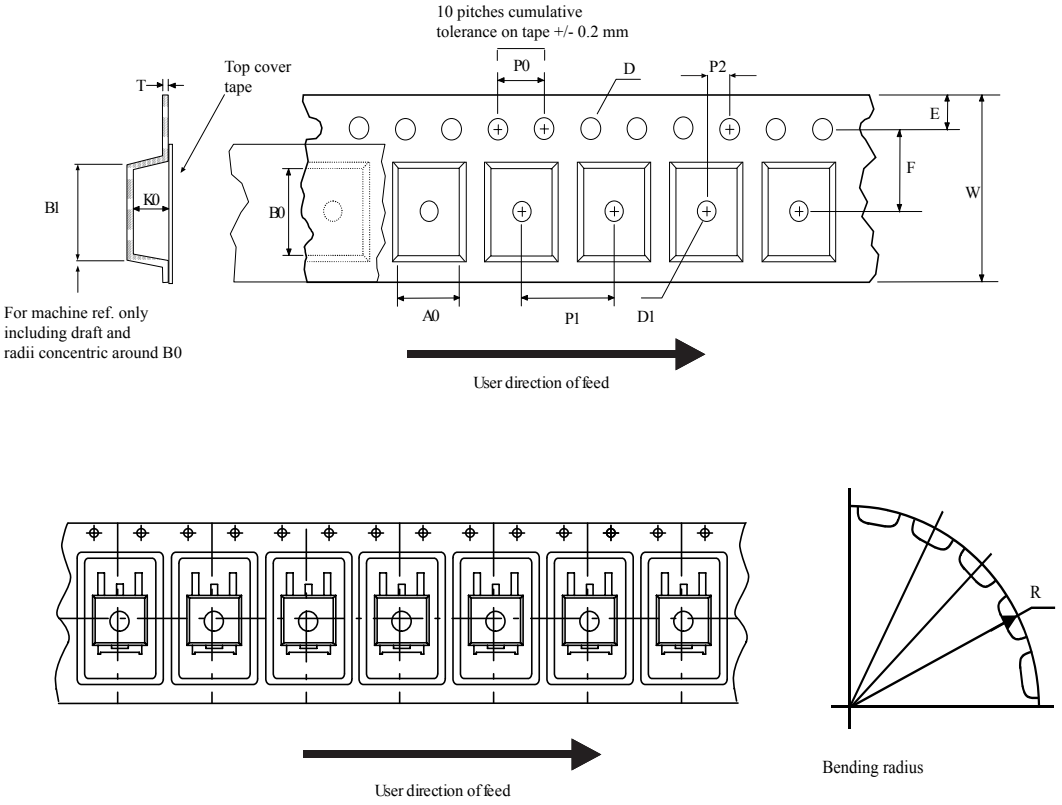
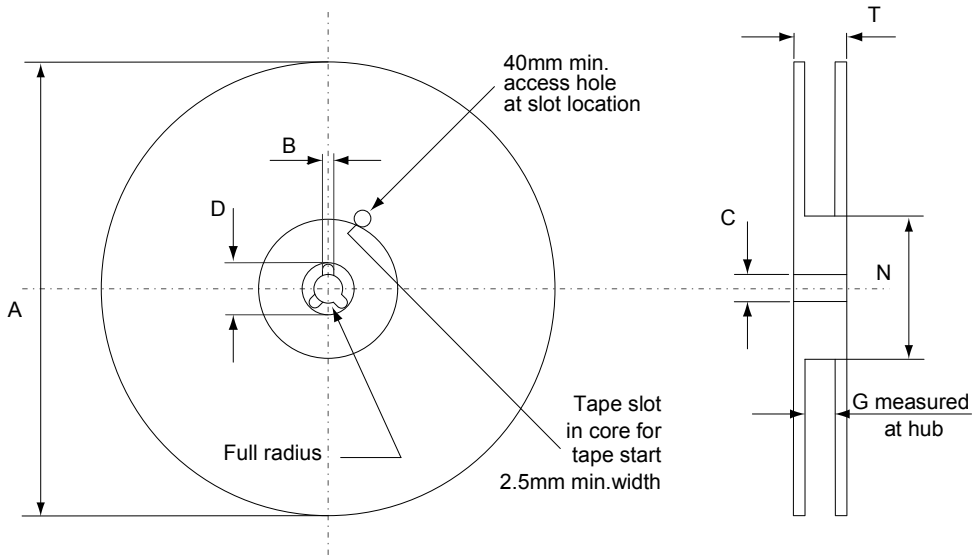


Figure 25. **DPAK (TO-252) reel outline**



AM06038v1

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**

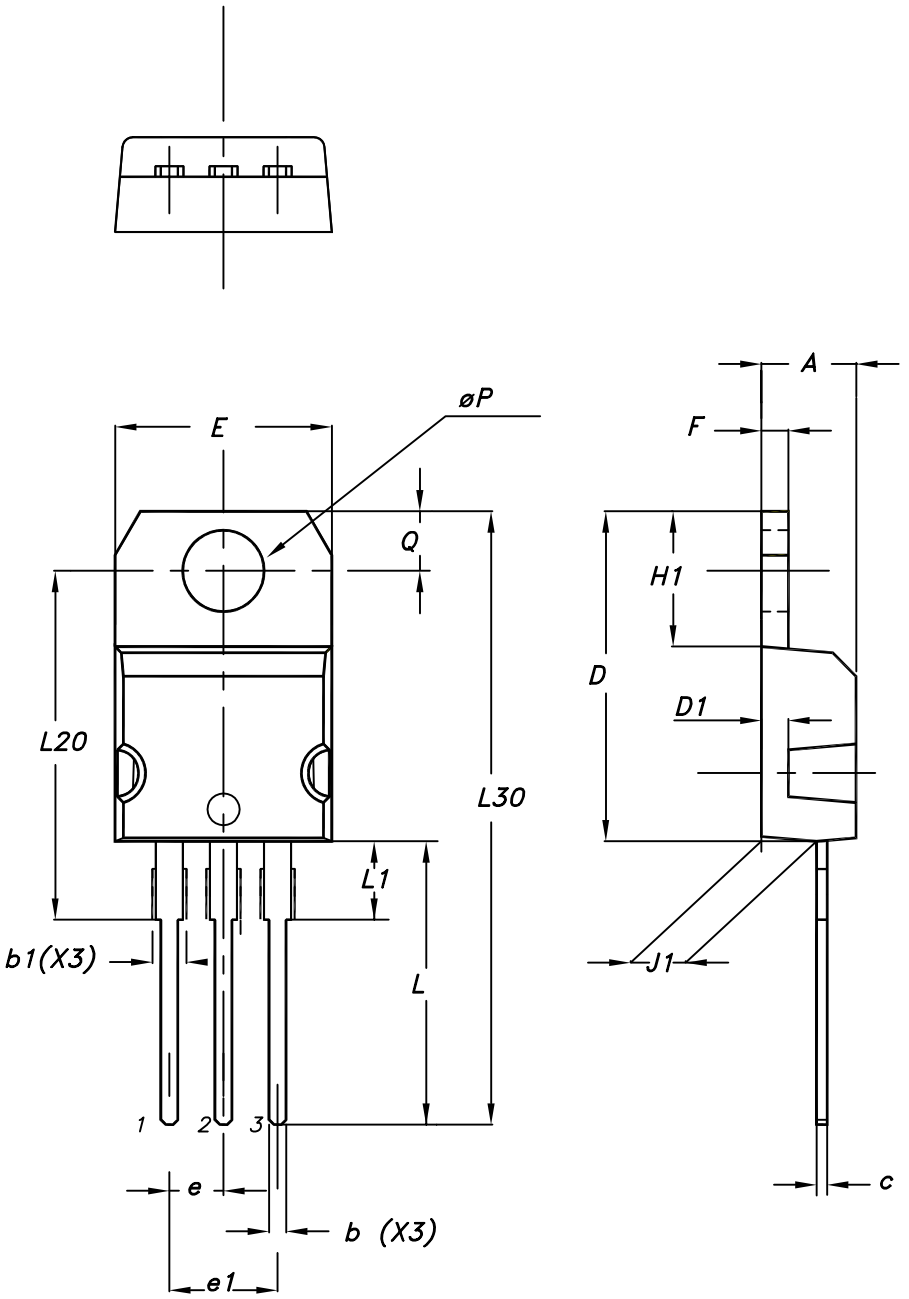


Table 12. **TO-220 type A package mechanical data**

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**

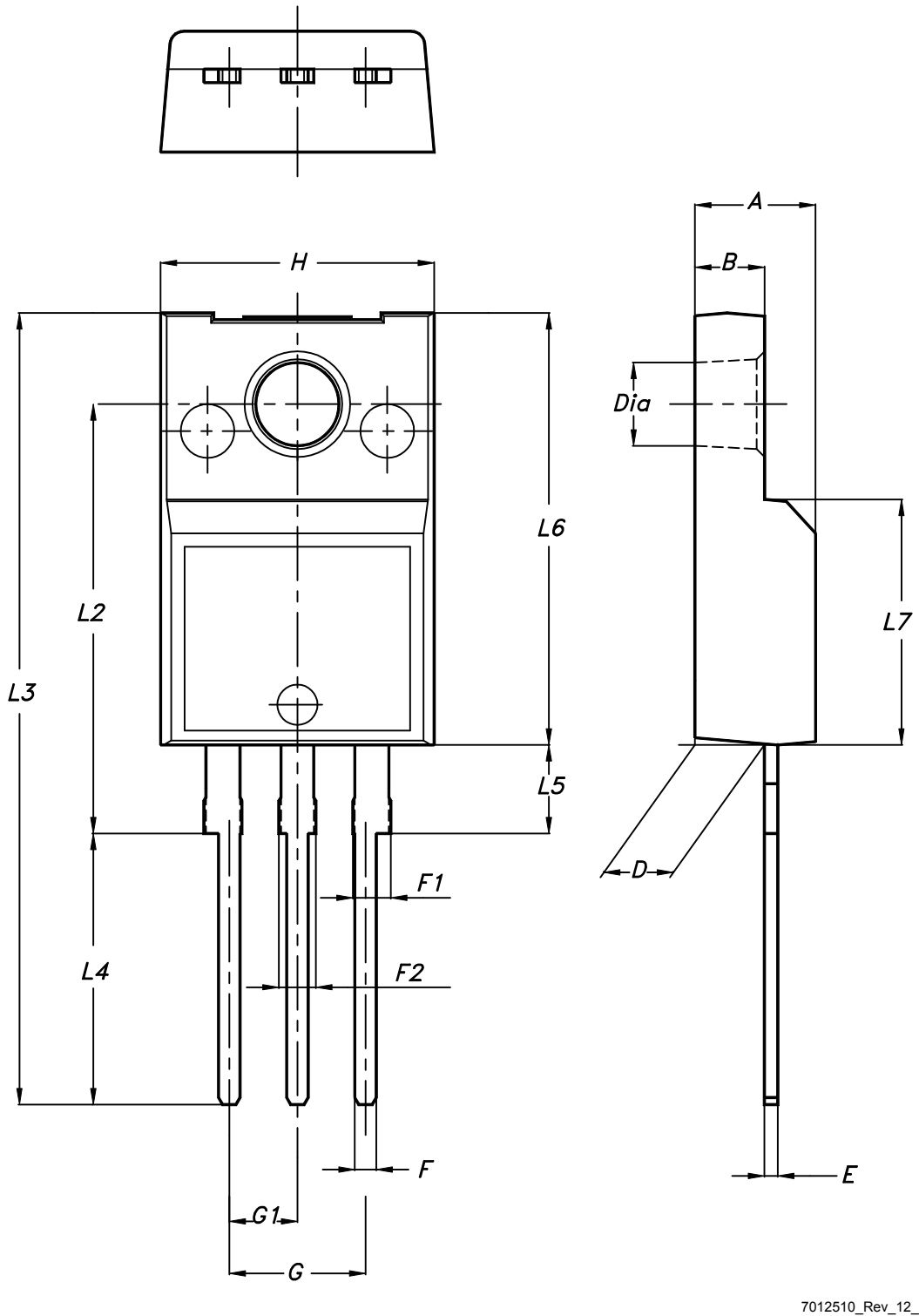


Table 13. **TO-220FP package mechanical data**

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
STD3NK90ZT4	D3NK90Z	DPAK	Tape and reel
STP3NK90Z	P3NK90Z	TO-220	Tube
STP3NK90ZFP	P3NK90ZFP	TO-220FP	

Revision history

Table 15. **Document revision history**

Date	Version	Changes
24-Oct-2006	1	First release.
29-Jan-2013	2	– The part number STD3NK90Z-1 has been moved to a separate datasheet – Minor text changes – Updated: Section 4: Package mechanical data
20-Aug-2018	3	Removed maturity status indication from cover page. The document status is production data. Updated title in cover page, Section 1 Electrical ratings, Section 2 Electrical characteristics and Section 4 Package information. Minor text changes.

Contents