

## **Electrical ratings**

Table 1. Absolute maximum ratings

Symbol Parameter		Va	Value		
Symbol	Parameter	DPAK, TO-220	TO-220FP	- Unit	
V <sub>DS</sub>	Drain-source voltage	90	00	V	
V <sub>GS</sub>	Gate-source voltage	±	30	V	
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	3	3 (1)	А	
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	1.89	1.89 (1)	А	
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	12	12 (1)	А	
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	90	25	W	
ESD	Gate-source human body model (R = 1,5 k $\Omega$ , C = 100 pF)	4		kV	
dv/dt (3)	Peak diode recovery voltage slope	4	.5	V/ns	
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_c$ = 25 °C)		2.5	kV	
Tj	T <sub>j</sub> Operating junction temperature range		FF to 450		
T <sub>stg</sub>	Storage temperature range	-55 to 150		°C	

- 1. Limited by maximum junction temperature.
- 2. Pulse width limited by safe operating area.
- 3.  $I_{SD} \le 3$  A,  $di/dt \le 200$  A/ $\mu$ s,  $V_{DS(peak)} \le V_{(BR)DSS}$ ,  $V_{DD} = 80\%$   $V_{(BR)DSS}$ .

Table 2. Thermal data

Symbol	Symbol Parameter -		Value			
Symbol Farameter		DPAK	TO-220	TO-220FP	Unit	
R <sub>thj-case</sub>	Thermal resistance junction-case	1.38		5		
R <sub>thj-amb</sub>	Thermal resistance junction-ambient		62.		°C/W	
R <sub>thj-pcb</sub> (1)	Thermal resistance junction-pcb	50				

<sup>1.</sup> When mounted on 1inch² FR-4, 2 Oz copper board.

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I <sub>AR</sub> (1)	Avalanche current, repetitive or not-repetitive	3	Α
E <sub>AS</sub> (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.

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#### 2 Electrical characteristics

(T<sub>CASE</sub> = 25 °C unless otherwise specified)

Table 4. On/off states

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V <sub>(BR)DSS</sub> Drain-source breakdown voltage		I <sub>D</sub> = 1 mA, V <sub>GS</sub> = 0 V	900			V
lass	Zero gate voltage drain	V <sub>GS</sub> = 0 V, V <sub>DS</sub> = 900 V			1	μA
I <sub>DSS</sub>	current	$V_{GS}$ = 0 V, $V_{DS}$ = 900 V, $T_{C}$ = 125 °C <sup>(1)</sup>			50	μA
I <sub>GSS</sub>	Gate body leakage current	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ±20 V			±10	μΑ
V <sub>GS(th)</sub>	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 50 \mu A$	3	3.75	4.5	V
R <sub>DS(on)</sub>	Static drain-source on resistance	V <sub>GS</sub> = 10 V, I <sub>D</sub> = 1.5 A		3.6	4.8	Ω

<sup>1.</sup> Defined by design, not subject to production test.

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
C <sub>iss</sub>	Input capacitance			590		
C <sub>oss</sub>	Output capacitance	V <sub>DS</sub> = 25 V, f = 1 MHz, V <sub>GS</sub> = 0 V	_	63	_	pF
C <sub>rss</sub>	Reverse transfer capacitance			13		
Coss eq. (1)	Equivalent output capacitance	V <sub>DS</sub> = 0 to 720 V, V <sub>GS</sub> = 0 V	-	35	-	pF
Qg	Total gate charge	V <sub>DD</sub> = 720 V, I <sub>D</sub> = 3 A, V <sub>GS</sub> = 0 to 10 V		22.7 4.2	-	
Q <sub>gs</sub>	Gate-source charge	(see Figure 16. Test circuit for gate charge	-			nC
Q <sub>gd</sub>	Q <sub>gd</sub> Gate-drain charge behavior)			12		

<sup>1.</sup>  $C_{\text{oss eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$ .

Table 6. Switching times

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
t <sub>d(on)</sub>	Turn-on delay time	V <sub>DD</sub> = 450 V, I <sub>D</sub> = 1.5 A,	18	18		
t <sub>r</sub>	Rise time	$R_{\rm G} = 4.7 \ \Omega, \ V_{\rm GS} = 10 \ V$		7		
t <sub>d(off)</sub>	Turn-off delay time	(see Figure 15. Test circuit for resistive load switching times and Figure 20. Switching	-	45	-	ns
t <sub>f</sub>	Fall time	time waveform)		18		

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Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
I <sub>SD</sub>	Source-drain current				3	
I <sub>SDM</sub> <sup>(1)</sup>	Source-drain current (pulsed)		-		12	A
V <sub>SD</sub> (2)	Forward on voltage	I <sub>SD</sub> = 3 A, V <sub>GS</sub> = 0 V	-		1.6	V
t <sub>rr</sub>	Reverse recovery time	I <sub>SD</sub> = 3 A, di/dt = 100 A/μs		510		ns
Q <sub>rr</sub>	Reverse recovery charge	V <sub>DD</sub> = 40 V, T <sub>J</sub> = 150 °C	_	2.2		μC
I <sub>RRM</sub>	Reverse recovery current	(see Figure 17. Test circuit for inductive load switching and diode recovery times)		8.7		А

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

Table 8. Gate-source Zener diode

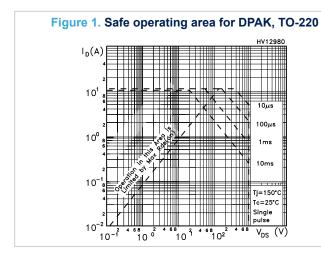
Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
V <sub>(BR)GSO</sub>	Gate-source breakdown voltage	$I_{GS} = \pm 1 \text{ mA}, I_{D} = 0 \text{ A}$	30	-	-	V

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.

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#### **Electrical characteristics curves** 2.1



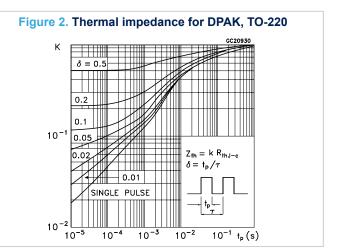
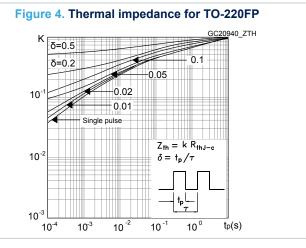
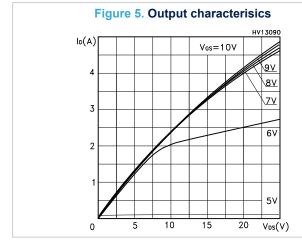
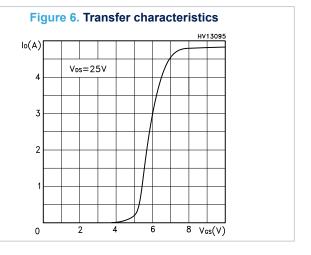


Figure 3. Safe operating area for TO-220FP 10<sup>1</sup>







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Figure 7. Static drain-source on resistance

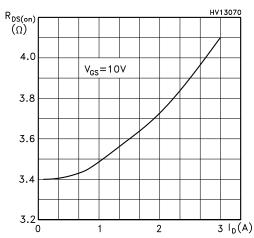


Figure 8. Gate charge vs gate-source voltage

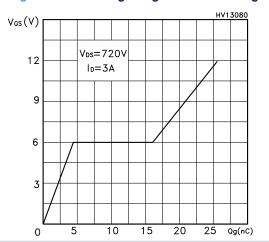


Figure 9. Capacitance variations

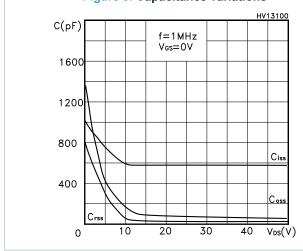


Figure 10. Normalized gate threshold voltage vs temperature

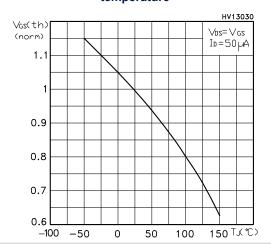


Figure 11. Normalized on resistance vs temperature

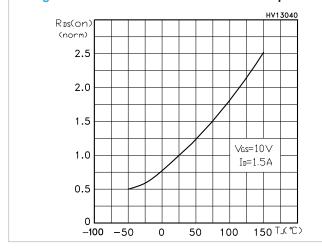
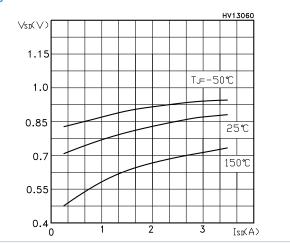


Figure 12. Source-drain diode forward characteristics



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Figure 13. Maximum avalanche energy vs temperature

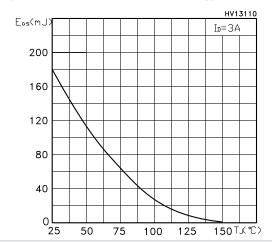
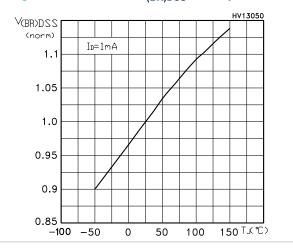


Figure 14. Normalized V<sub>(BR)DSS</sub> vs temperature



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#### 3 Test circuits

Figure 15. Test circuit for resistive load switching times

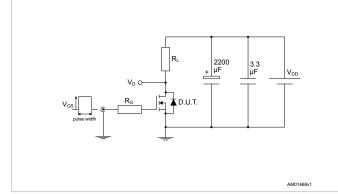


Figure 16. Test circuit for gate charge behavior

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

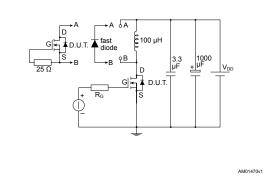


Figure 18. Unclamped inductive load test circuit

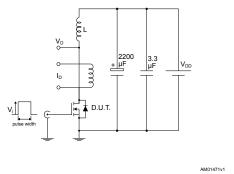


Figure 19. Unclamped inductive waveform

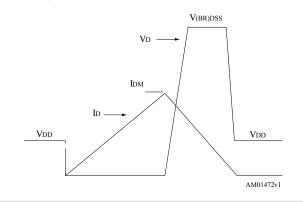
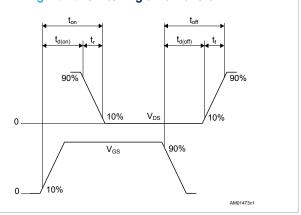


Figure 20. Switching time waveform



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## 4 Package information

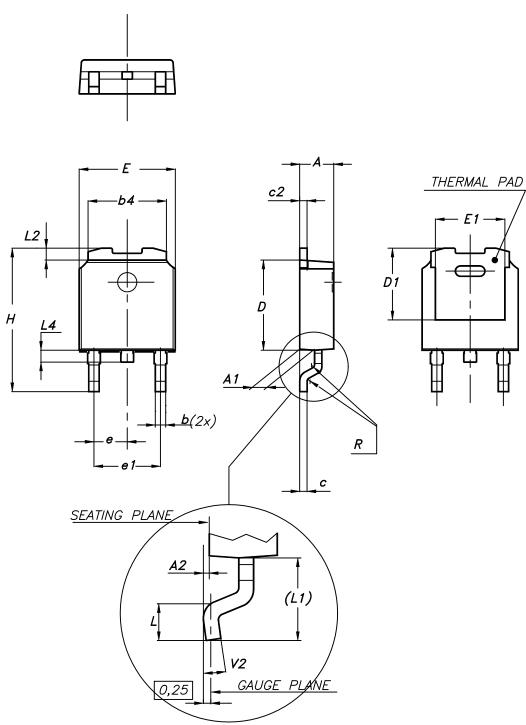
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

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#### 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

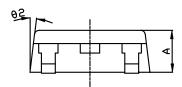
Dim.		mm	
DIM.	Min.	Тур.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
С	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1	4.95	5.10	5.25
Е	6.40		6.60
E1	5.10	5.20	5.30
е	2.159	2.286	2.413
e1	4.445	4.572	4.699
Н	9.35		10.10
L	1.00		1.50
L1	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00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

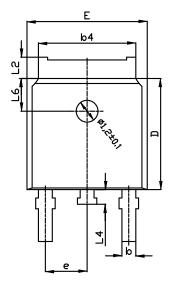
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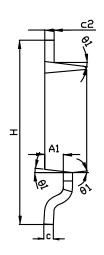


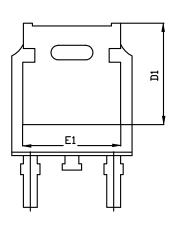
#### 4.2 DPAK (TO-252) type C2 package information

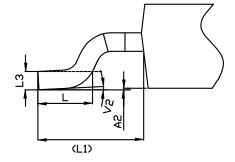
Figure 22. DPAK (TO-252) type C2 package outline











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

Dim.		mm	
DIM.	Min.	Тур.	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
С	0.47		0.60
c2	0.47		0.60
D	6.00	6.10	6.20
D1	5.10		5.60
Е	6.50	6.60	6.70
E1	5.20		5.50
е	2.186	2.286	2.386
Н	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°

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

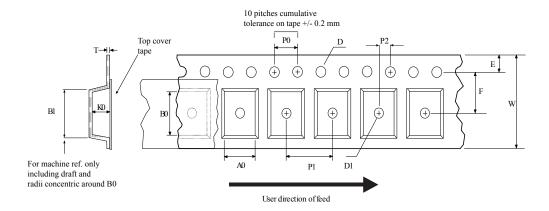
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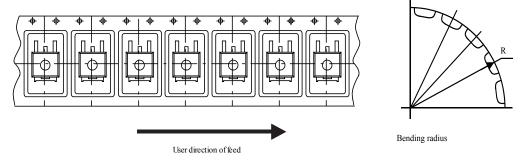
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#### 4.3 DPAK (TO-252) packing information

Figure 24. DPAK (TO-252) tape outline





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A 40mm min. access hole at slot location

Tape slot in core for tape start 2.5mm min.width

Figure 25. DPAK (TO-252) reel outline

AM06038v1

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

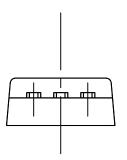
Tape				Reel	
Dim.	mm		Dim.	1	nm
Dilli.	Min.	Max.	Dilli.	Min.	Max.
A0	6.8	7	Α		330
В0	10.4	10.6	В	1.5	
B1		12.1	С	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
Е	1.65	1.85	N	50	
F	7.4	7.6	Т		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base	qty.	2500
P1	7.9	8.1	Bulk	qty.	2500
P2	1.9	2.1			
R	40				
Т	0.25	0.35			
W	15.7	16.3			

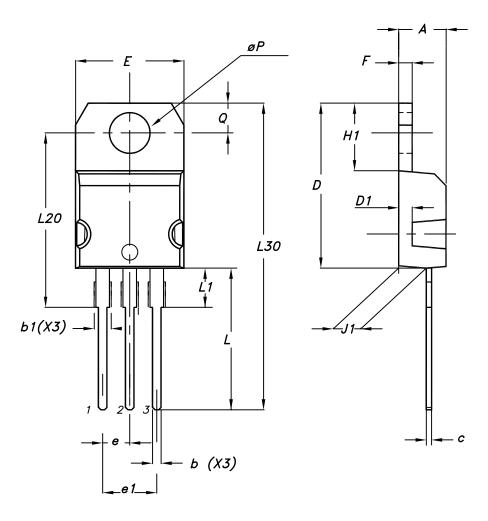
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## 4.4 TO-220 type A package information

Figure 26. TO-220 type A package outline





 $0015988\_typeA\_Rev\_21$ 



Table 12. TO-220 type A package mechanical data

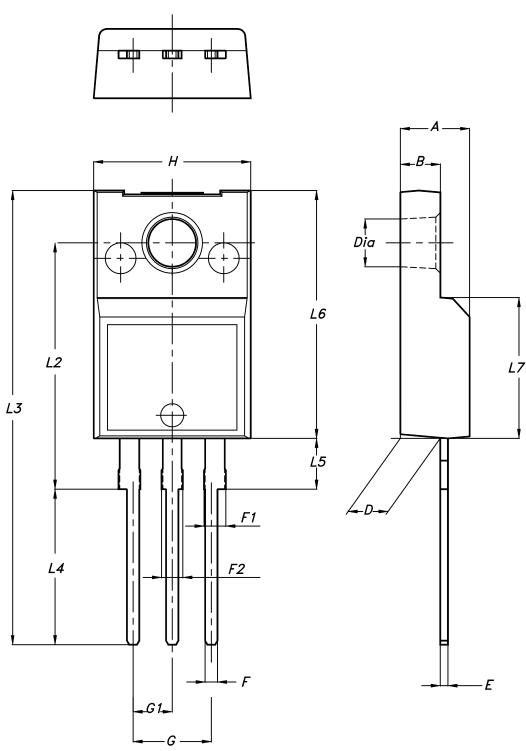
Dim.		mm	
Dilli.	Min.	Тур.	Max.
А	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
С	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		10.40
е	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øΡ	3.75		3.85
Q	2.65		2.95

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## 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			
Dilli.	Min.	Тур.	Max.	
А	4.4		4.6	
В	2.5		2.7	
D	2.5	2.5 2.1 0.45 0.		
Е	0.45			
F	0.75		1	
F1	1.15		1.70	
F2	1.15		1.70	
G	4.95		5.2	
G1	2.4		2.7	
Н	10		10.4	
L2		16		
L3	28.6		30.6	
L4	9.8		10.6	
L5	2.9	2.9 3.6		
L6	15.9		16.4	
L7	9		9.3	
Dia	3		3.2	

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# 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	Tube

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## **Revision history**

Table 15. Document revision history

Date	Version	Changes
24-Oct-2006	1	First release.
29-Jan-2013	2	<ul> <li>The part number STD3NK90Z-1 has been moved to a separate datasheet</li> <li>Minor text changes</li> <li>Updated: Section 4: Package mechanical data</li> </ul>
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.

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