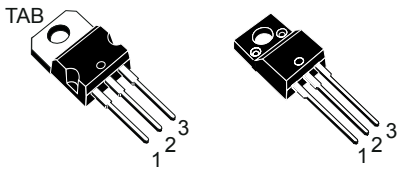
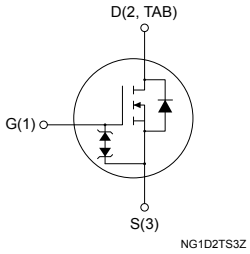
STP9NK65Z, STP9NK65ZFP

Datasheet

N-channel 650 V, 1 Ω typ., 6.4 A SuperMESH Power MOSFET in a TO-220 and TO-220FP packages



TO-220 **TO-220FP**



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D
STP9NK65Z	650 V	1.2 Ω	6.4 A
STP9NK65ZFP			

- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance
- Zener-protected

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 links
STP9NK65Z
STP9NK65ZFP

Product summary	
Order code	**STP9NK65Z**
Marking	P9NK65Z
Package	TO-220
Packing	Tube
Order code	**STP9NK65ZFP**
Marking	P9NK65ZFP
Package	TO-220FP
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
V_{DS}	Drain-source voltage	650		V
V_{GS}	Gate-source voltage	±30		V
I_D	Drain current (continuous) at T_C = 25 °C	6.4	6.4(1)	A
	Drain current (continuous) at T_C = 100 °C	4	4(1)	
I_{DM}(2)	Drain current (pulsed)	25.6	25.6(1)	A
P_{TOT}	Total power dissipation at T_C = 25 °C	125	30	W
ESD	Gate-source human body model (C = 100 pF, R = 1.5 kΩ)	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_{stg}	Storage temperature range	-55 to 150		°C
T_J	Operating junction temperature range			

1. *Limited by maximum junction temperature.*
2. *Pulse width limited by safe operating area.*
3. *I_{SD} ≤ 6.4 A, di/dt ≤ 200 A/µs, V_{DD} = 520 V.*

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		TO-220	TO-220FP	
R_{thJC}	Thermal resistance, junction-to-case	1	4.2	°C/W
R_{thJA}	Thermal resistance, junction-to-ambient	62.5		°C/W

Table 3. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max.)	6.4	A
E_{AS}	Single pulse avalanche energy (starting T_J = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	200	mJ

2 Electrical characteristics

T_C = 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	650	-	-	V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 650 V	-	-	1	µA
		V_{GS} = 0 V, V_{DS} = 650 V, T_C = 125 °C(1)	-	-	50	
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 = 100 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 3.2 A	-	1	1.2	Ω

1. *Specified by design, not tested in production.*

Table 5. Dynamic

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 25 V, f = 1 MHz, V_{GS} = 0 V	-	1145	-	pF
C_{oss}	Output capacitance		-	130	-	pF
C_{rss}	Reverse transfer capacitance		-	28	-	pF
$C_{oss\ eq.}$(1)	Equivalent output capacitance	V_{DS} = 0 to 400 V, V_{GS} = 0 V	-	55	-	pF
Q_g	Total gate charge	V_{DD} = 520 V, I_D = 6.4 A, V_{GS} = 0 to 10 V (see the Figure 16. Test circuit for gate charge behavior)	-	41	-	nC
Q_{gs}	Gate-source charge		-	7.5	-	nC
Q_{gd}	Gate-drain charge		-	22	-	nC

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} = 325 V, I_D = 3.2 A, R_G = 4.7 Ω, V_{GS} = 10 V (see the Figure 15. Test circuit for resistive load switching times and Figure 20. Switching time waveform)	-	20	-	ns
t_r	Rise time		-	12	-	ns
$t_{d(off)}$	Turn-off delay time		-	45	-	ns
t_f	Fall time		-	15	-	ns

Table 7. Source drain diode

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-	-	6.4	A
I_{SDM}(1)	Source-drain current (pulsed)		-	-	25.6	A
V_{SD}(2)	Forward on voltage	I_{SD} = 6.4 A, V_{GS} = 0 V	-	-	1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 6.4 A, di/dt = 100 A/µs,	-	400	-	ns
Q_{rr}	Reverse recovery charge	V_{DD} = 50 V, T_J = 150 °C	-	2.6	-	µC
I_{RRM}	Reverse recovery current	(see the Figure 17. Test circuit for inductive load switching and diode recovery times)	-	13	-	A

1. *Pulse width is 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

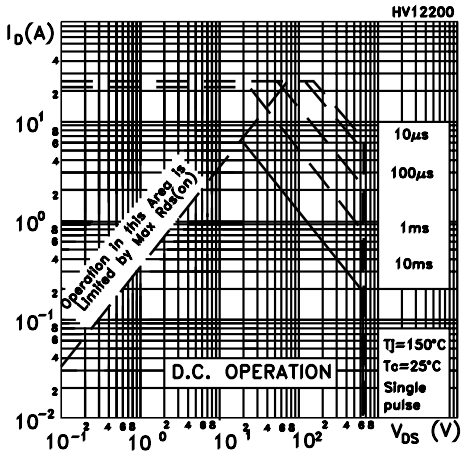


Figure 2. Normalized transient thermal impedance for TO-220

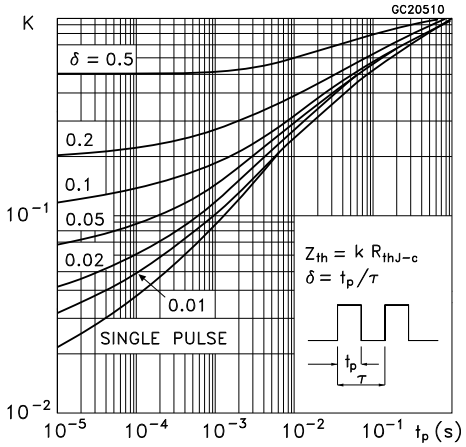


Figure 3. Safe operating area for TO-220FP

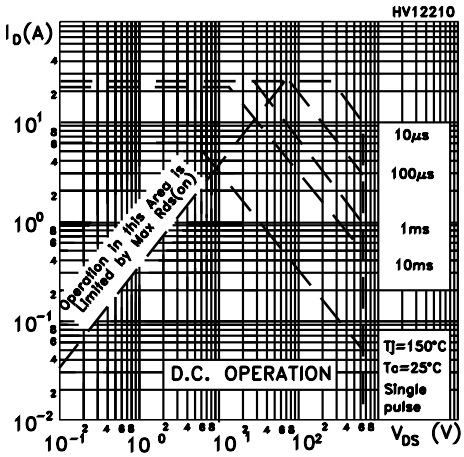


Figure 4. Normalized transient thermal impedance for TO-220FP

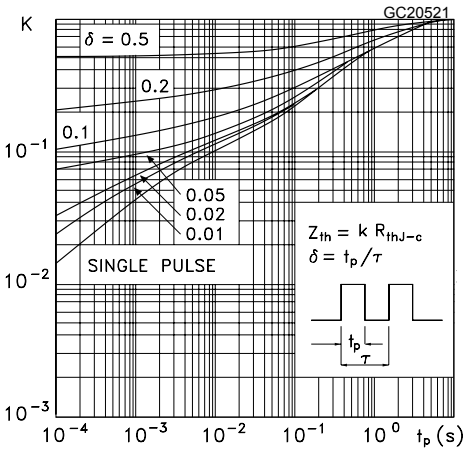


Figure 5. Typical output characterisics

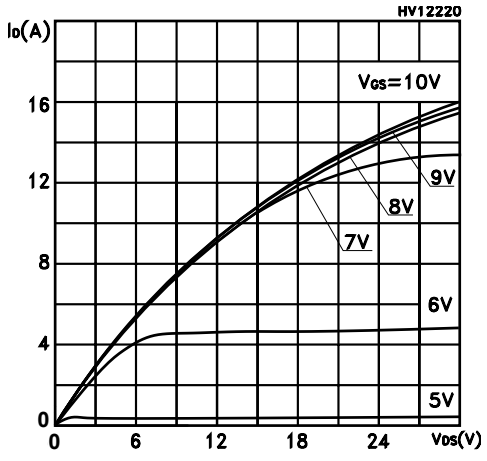


Figure 6. Typical transfer characteristics

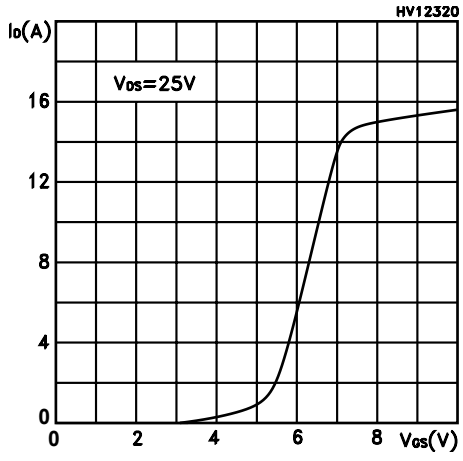


Figure 7. Typical static drain-source on-resistance

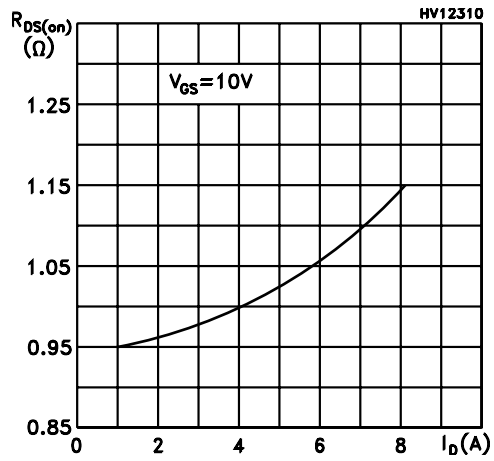


Figure 8. Typical gate charge characteristics

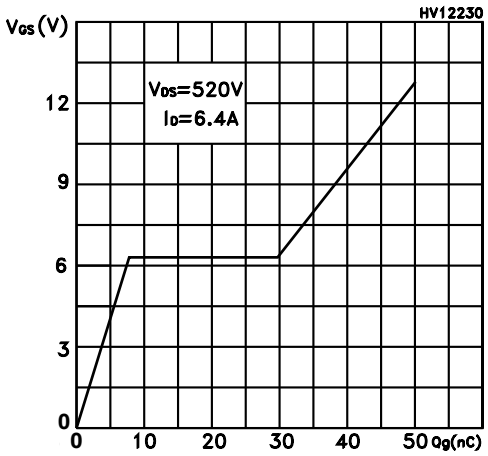


Figure 9. Typical capacitance variations

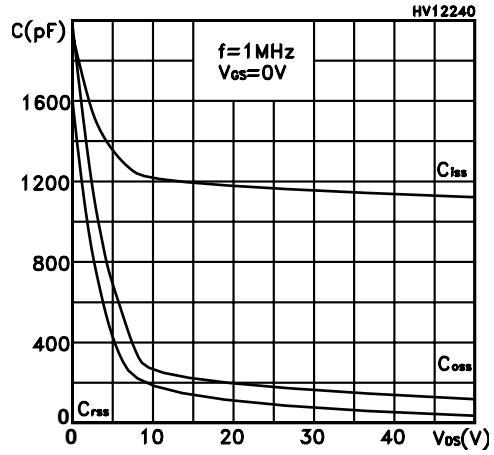


Figure 10. Normalized gate threshold vs temperature

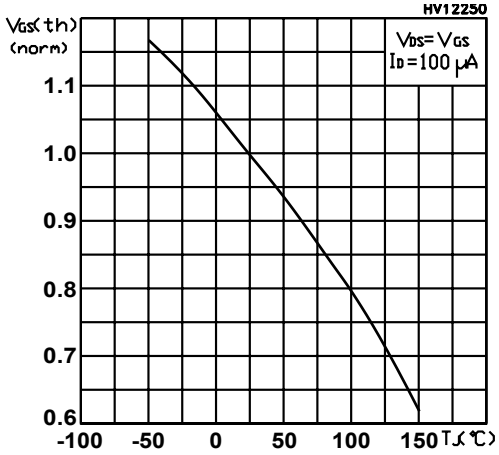


Figure 11. Normalized on-resistance vs temperature

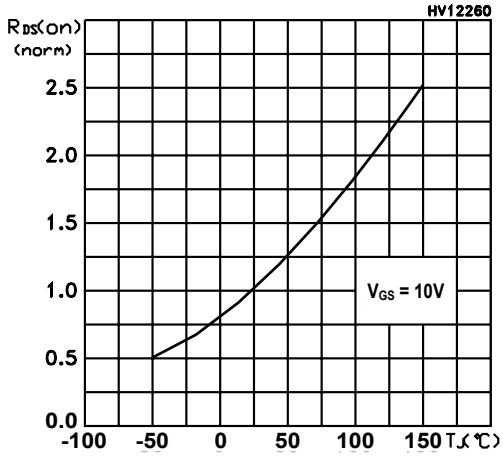


Figure 12. Typical reverse diode forward characteristics

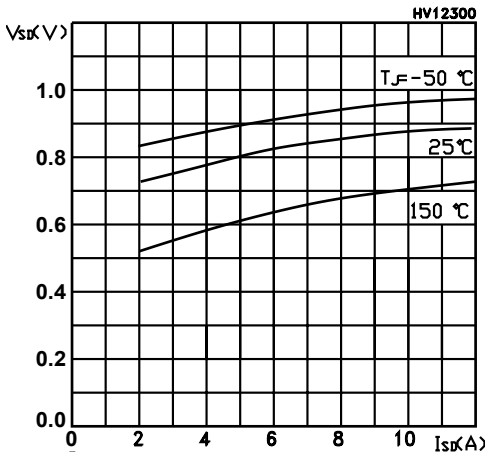


Figure 13. Normalized breakdown voltage vs temperature

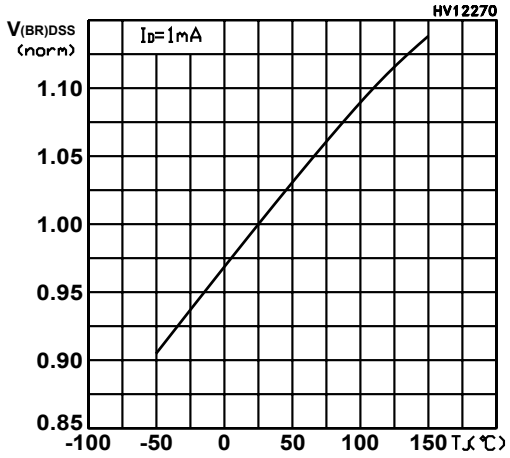
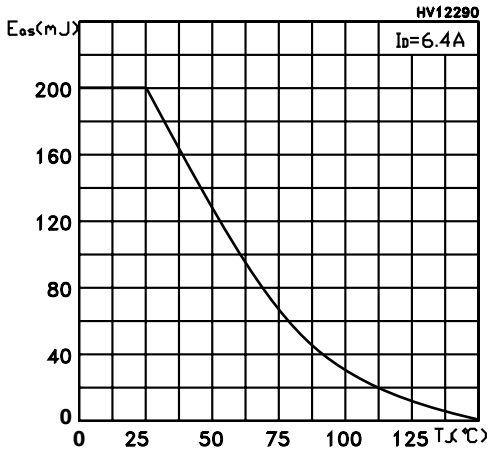
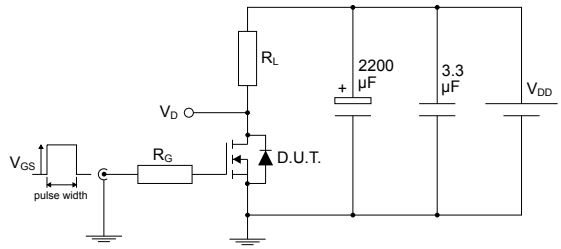


Figure 14. Maximum avalanche energy vs temperature



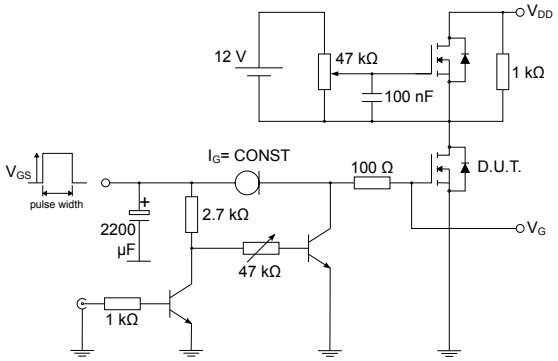
3 Test circuits

Figure 15. Test circuit for resistive load switching times



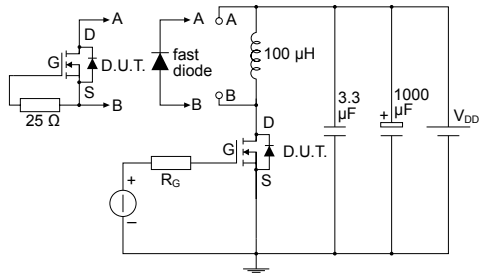
AM01468v1

Figure 16. Test circuit for gate charge behavior



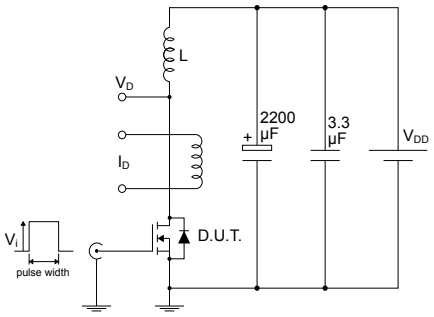
AM01469v1

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



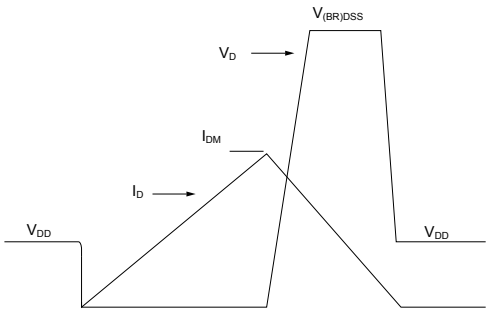
AM01470v1

Figure 18. Unclamped inductive load test circuit



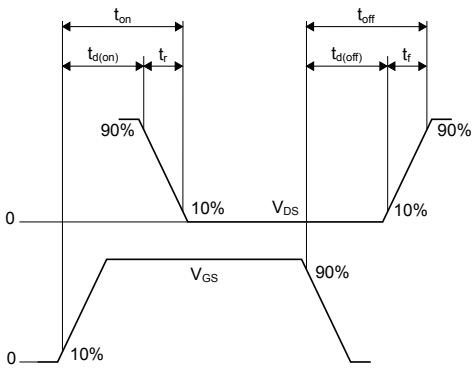
AM01471v1

Figure 19. Unclamped inductive waveform



AM01472v1

Figure 20. Switching time waveform



AM01473v1

4 Package information

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 TO-220 type A package information

Figure 21. TO-220 type A package outline

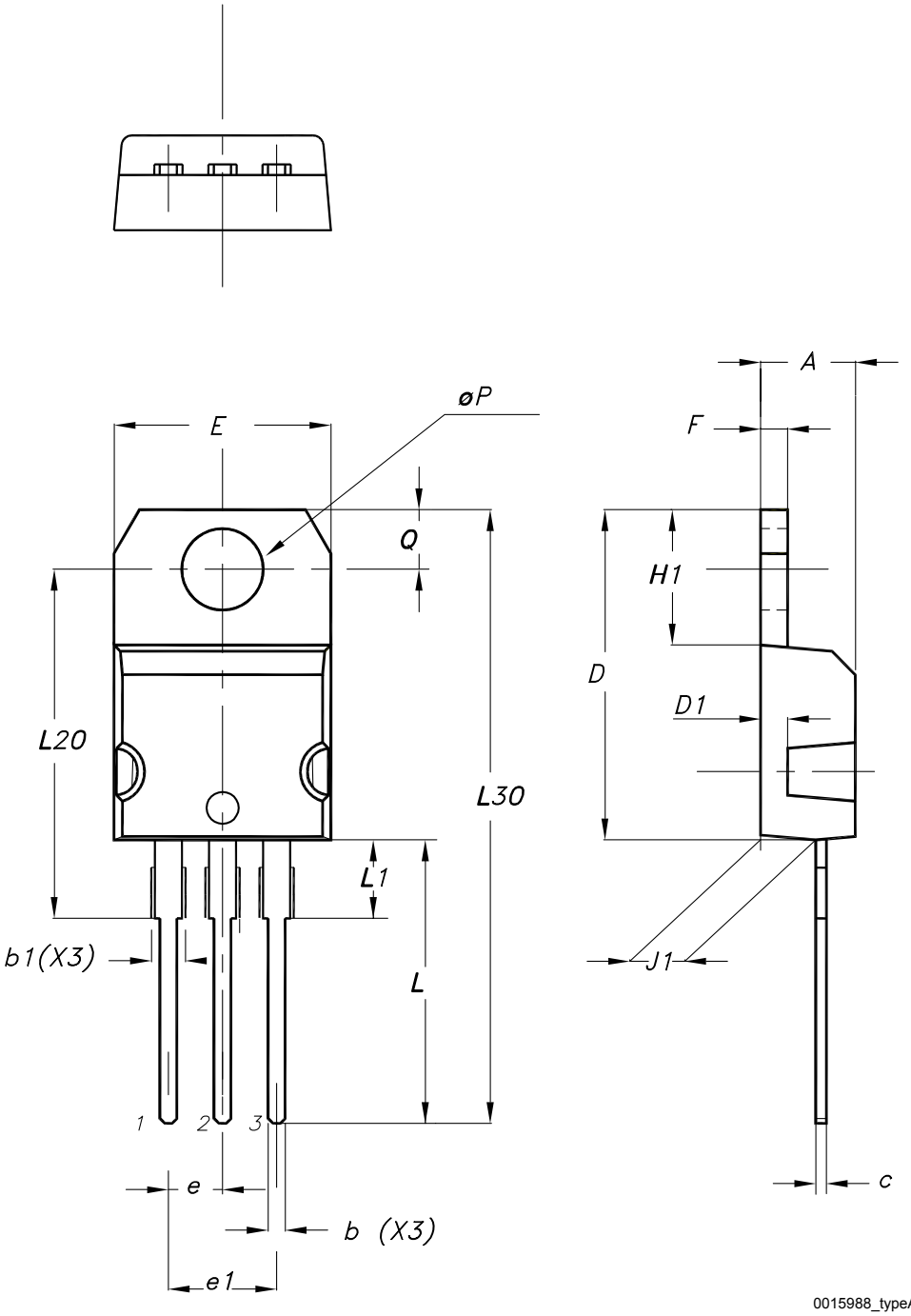


Table 8. **TO-220 type A package mechanical data**

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

4.2 TO-220FP type B package information

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

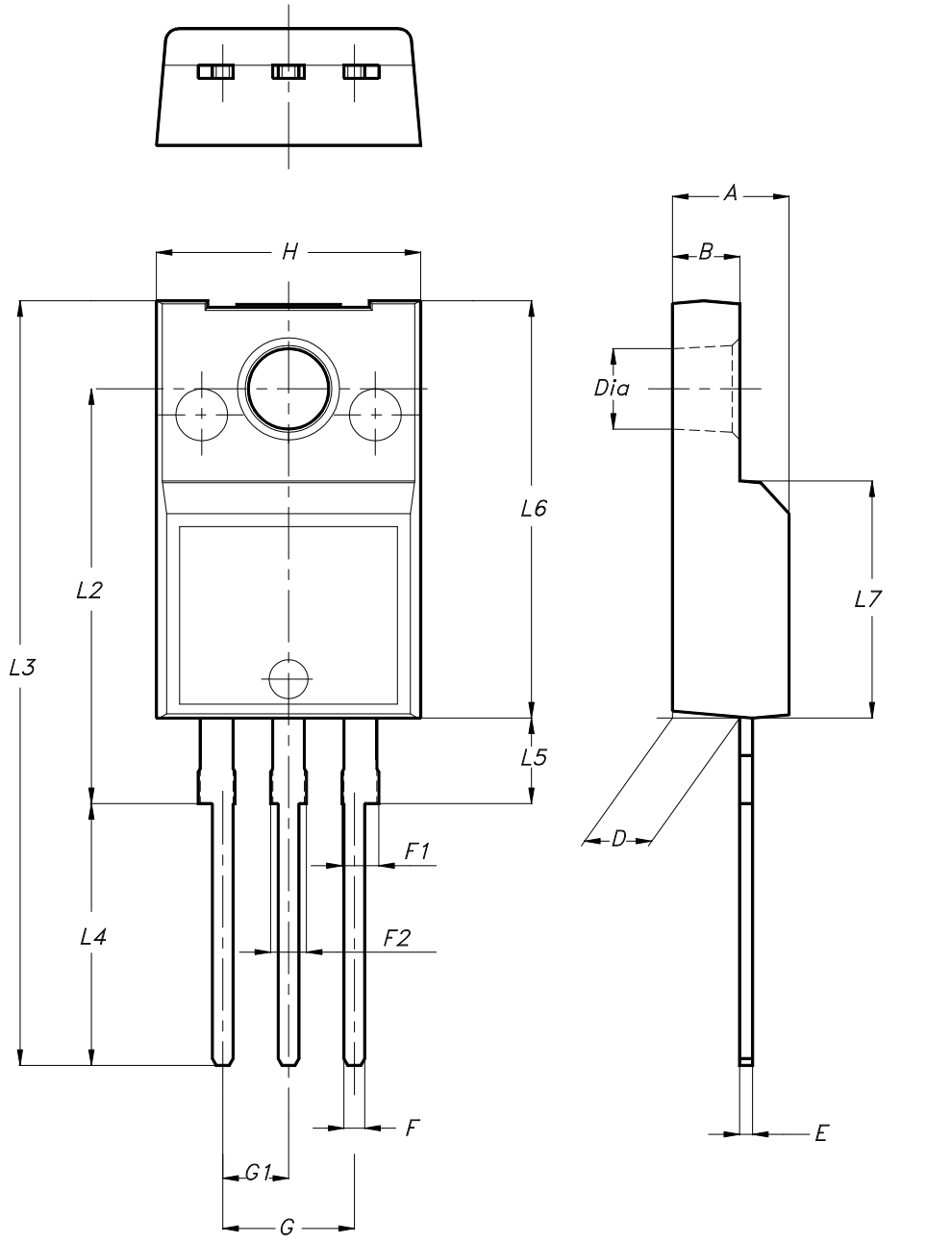


Table 9. **TO-220FP type B package mechanical data**

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

Revision history

Table 10. **Document revision history**

Date	Version	Changes
11-Sep-2006	2	Complete version.
19-Dec-2007	3	The document has been reformatted.
26-Jan-2012	4	Modified: *Features* in cover page. Updated: *Section 4: Package mechanical data*. Minor text changes.
10-Feb-2026	5	Updated Section 4: Package information. Minor text changes.

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