Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		D²PAK, 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	7	7[1]	A
I_D	Drain current (continuous) at T_C=100°C	4.4	4.4[1]	A
I_{DM}[2]	Drain current (pulsed)	28	28[1]	A
P_{TOT}	Total dissipation at T_C = 25°C	125	30	W
	Derating Factor	1	0.24	W/°C
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)	--	2500	V
T_J T_{stg}	Operating junction temperature Storage temperature	-55 to 150		°C

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 7A$, di/dt $\leq 200A/\mu s$, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		D²PAK	TO-220	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	1		4.2	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max		62.5		°C/W
$R_{thj-pcb}$	Thermal resistance junction-pcb max [1]	30			°C/W

1. When mounted on minimum footprint

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive(1)	7	A
E_{AS}	Single pulse avalanche energy (2)	235	mJ

1. Pulse width limited by $T_{j\ Max}$
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 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage V_{GS}= 0	I_D = 1 mA	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = 600 V, V_{DS} = 600 V, T_C = 125 °C			1 50	µA µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	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= 3.5 A		0.85	0.95	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{DS} =15 V, I_D = 3.5 A	-	5.3		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} =25 V, f=1 MHz, V_{GS}=0	-	1110 135 30		pF pF pF
$C_{oss\ eq}$ (2)	Equivalent output capacitance	V_{GS}=0, V_{DS} =0 V to 480 V	-	72		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD}=480 V, I_D = 7 A V_{GS} =10 V (see *Figure 18*)	-	38 7 21	53	nC nC nC

1. Pulsed: pulse duration=300µs, duty cycle 1.5%
2. $C_{oss\ eq.}$ 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 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on delay time Rise time	V_{DD}=300 V, I_D=3.5 A, R_G=4.7 Ω, V_{GS}=10 V (see *Figure 19*)	-	19 17	-	ns ns
$t_{d(off)}$ t_f	Turn-off delay time Fall time	V_{DD}=300 V, I_D=3.5 A, R_G=4.7 Ω, V_{GS}=10 V (see *Figure 19*)	-	43 15	-	ns ns

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	30	-	-	V

The built-in back-to-back Zener diodes have been specifically designed to enhance not only the device’s ESD capability, but also to make them capable of safely absorbing any voltage transients that may occasionally be applied from gate to source. In this respect, the Zener voltage is appropriate to achieve efficient and cost-effective protection of device integrity. The integrated Zener diodes thus eliminate the need for external components.

Table 9. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		7	A
I_{SDM}(1)	Source-drain current (pulsed)		-		28	A
V_{SD}(2)	Forward on voltage	I_{SD}=7 A, V_{GS}=0	-		1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD}=7 A, di/dt = 100 A/µs, V_{DD}=30 V, Tj=150 °C	-	480 3.5 14.5		ns µC A

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for D²PAK and TO-220

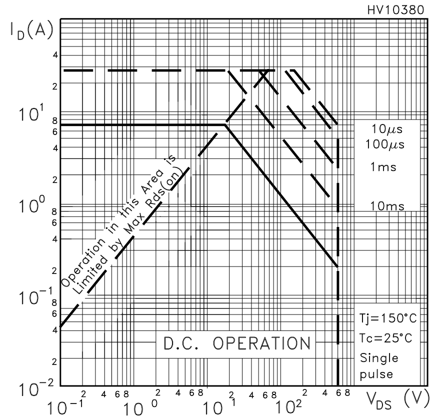


Figure 3. Thermal impedance for D²PAK and TO-220

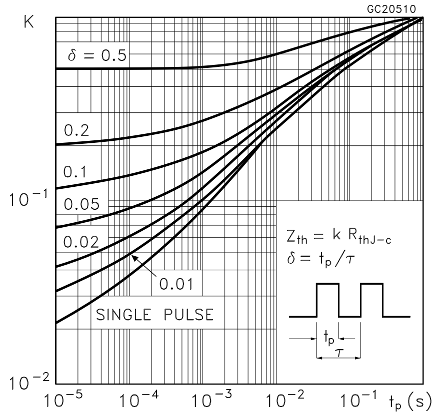


Figure 4. Safe operating area for TO-220FP

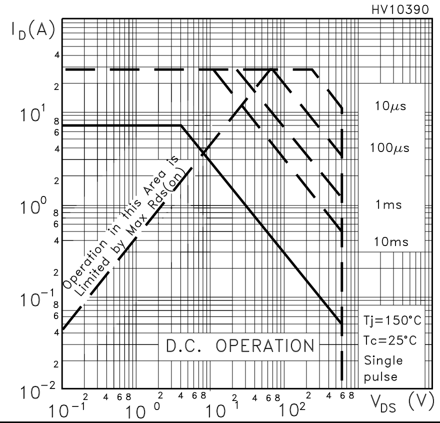


Figure 5. Thermal impedance for TO-220FP

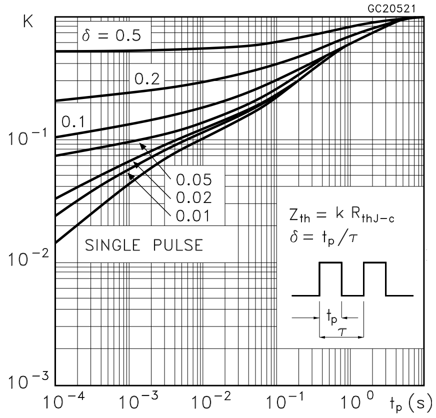


Figure 6. Output characterisics

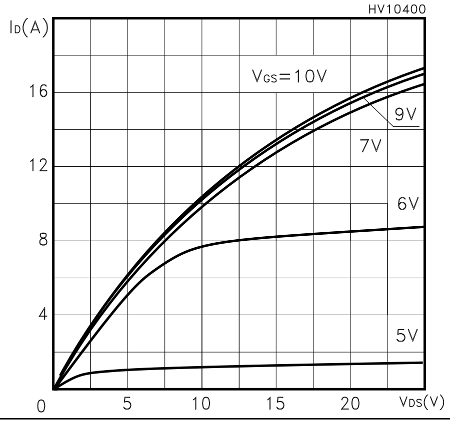


Figure 7. Transfer characteristics

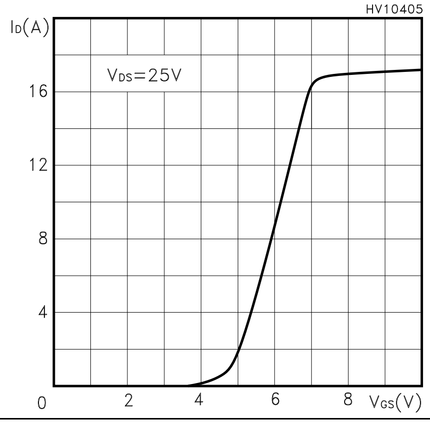


Figure 8. Transconductance

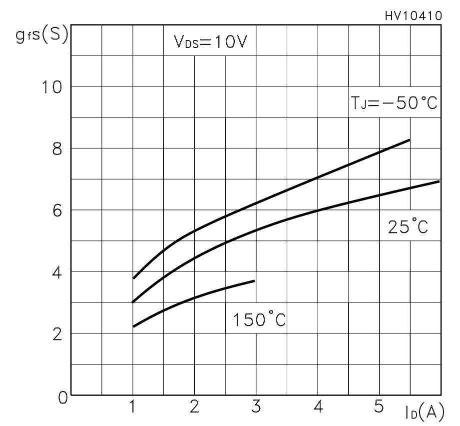


Figure 9. Static drain-source on-resistance

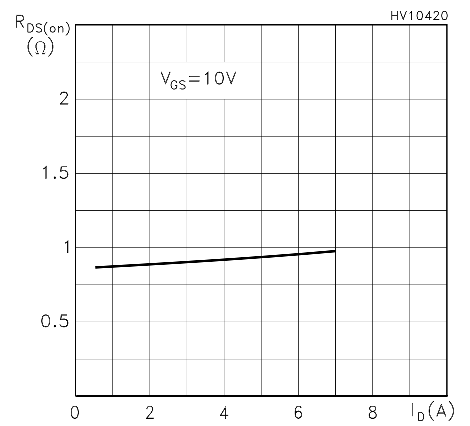


Figure 10. Gate charge vs gate-source voltage

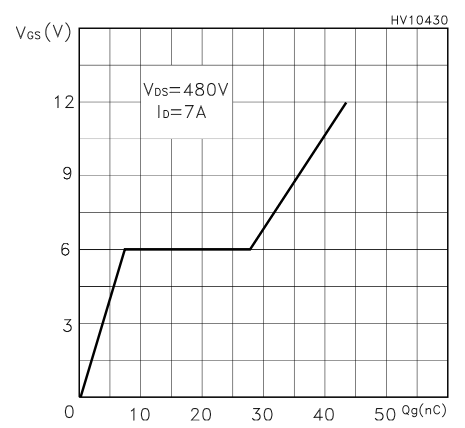


Figure 11. Capacitance variations

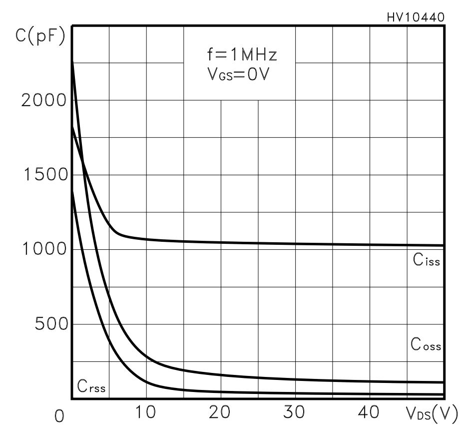


Figure 12. Normalized gate threshold voltage vs temperature

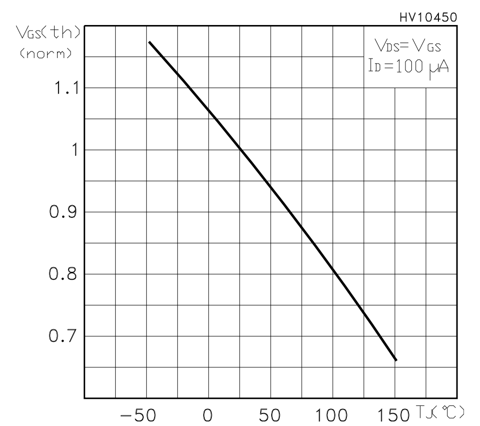


Figure 13. Normalized on-resistance vs temperature

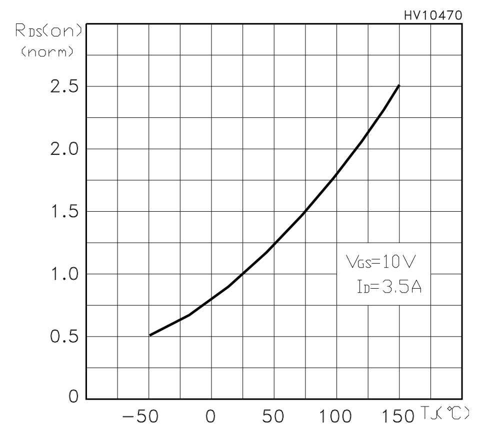


Figure 14. Source-drain diode forward characteristics

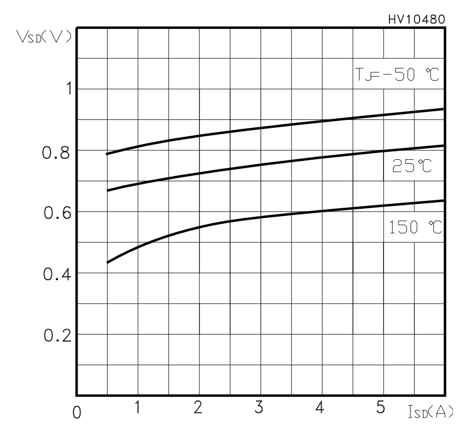


Figure 15. Normalized B_{VDSS} vs temperature

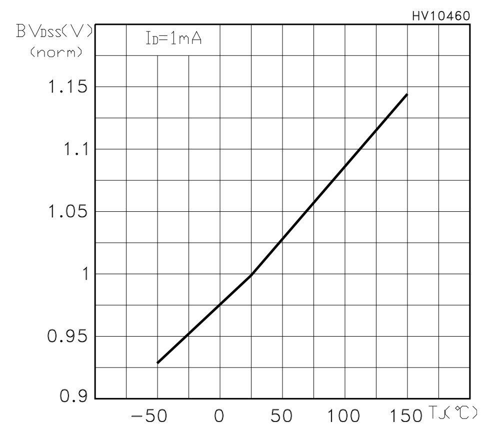
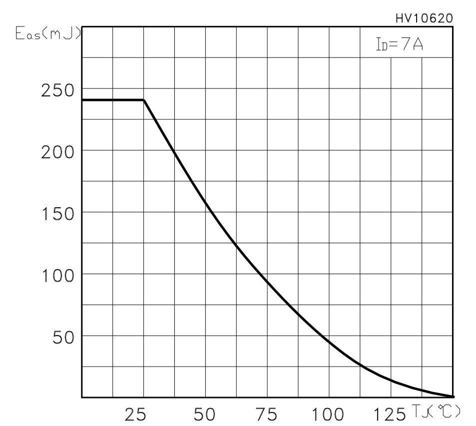


Figure 16. Maximum avalanche energy vs temperature



3 Test circuits

Figure 17. Switching times test circuit for resistive load

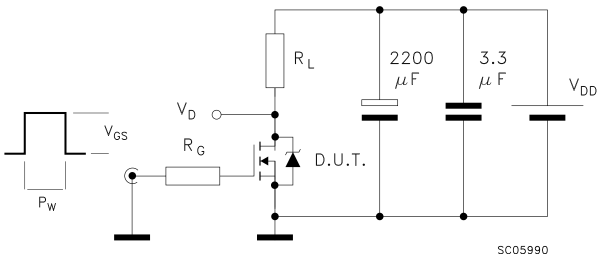


Figure 18. Gate charge test circuit

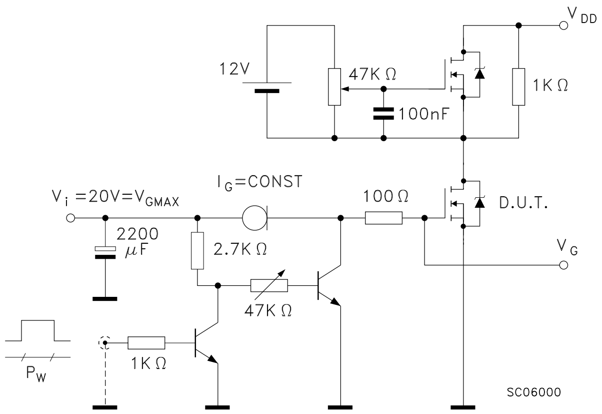


Figure 19. Test circuit for inductive load switching and diode recovery times

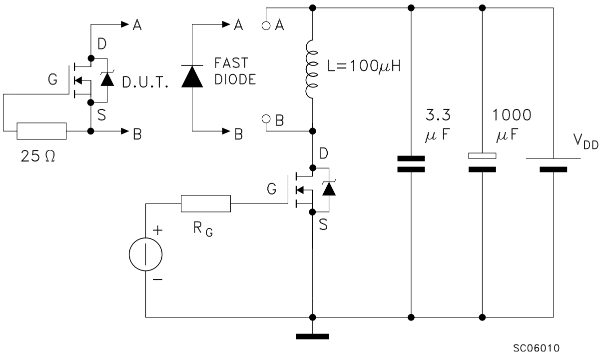


Figure 20. Unclamped Inductive load test circuit

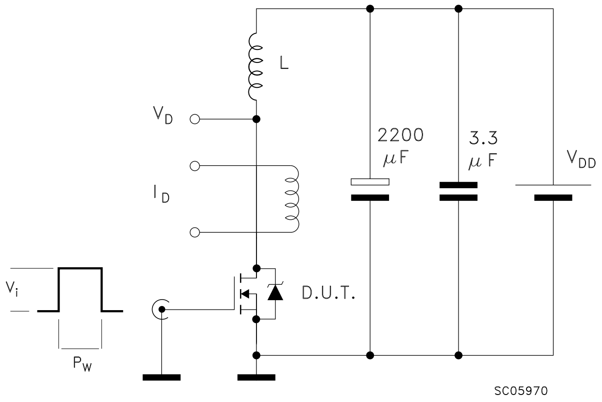


Figure 21. Unclamped inductive waveform

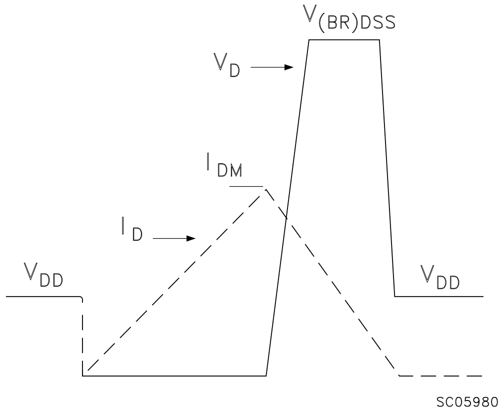
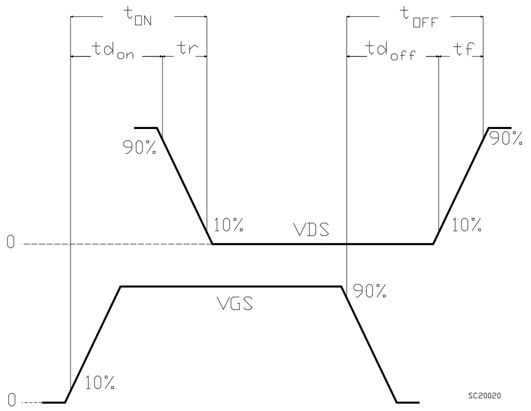


Figure 22. Switching time waveform



4 Package mechanical data

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.

Table 10. D²PAK (TO-263) 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		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 23. D²PAK (TO-263) drawing

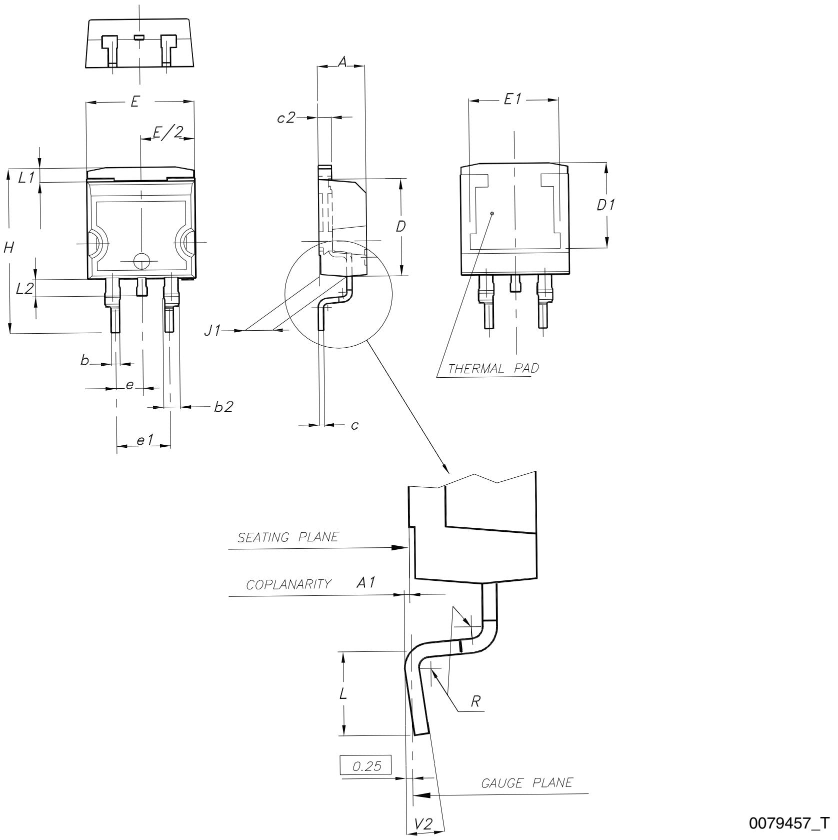
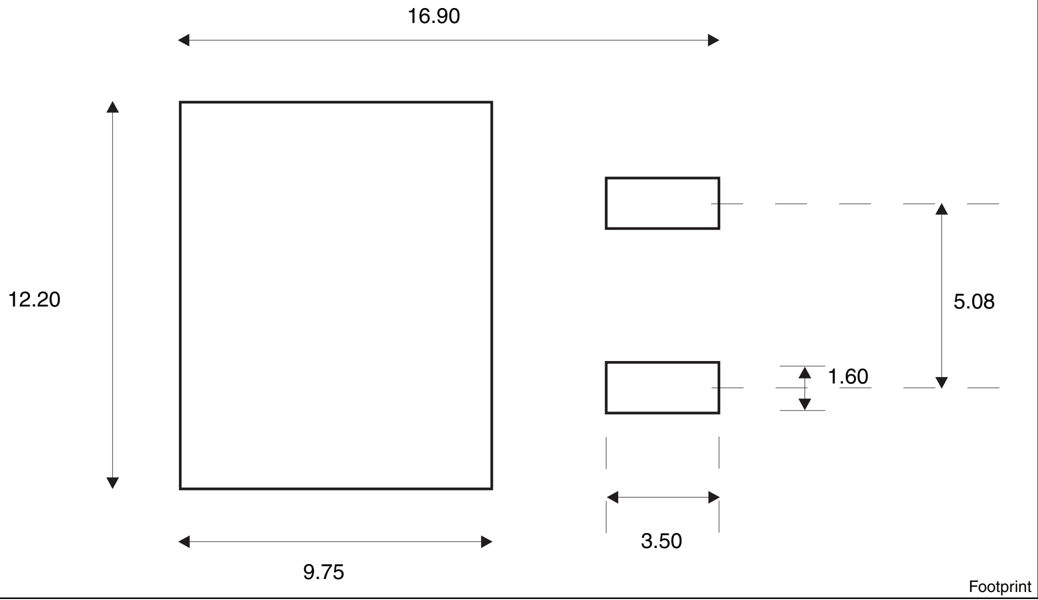


Figure 24. D²PAK footprint[a]



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a. All dimension are in millimeters

Table 11. TO-220 type A mechanical data

Dim.	mm		
	Min.	**Typ.**	**Max.**
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		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		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95

Figure 25. TO-220 type A drawing

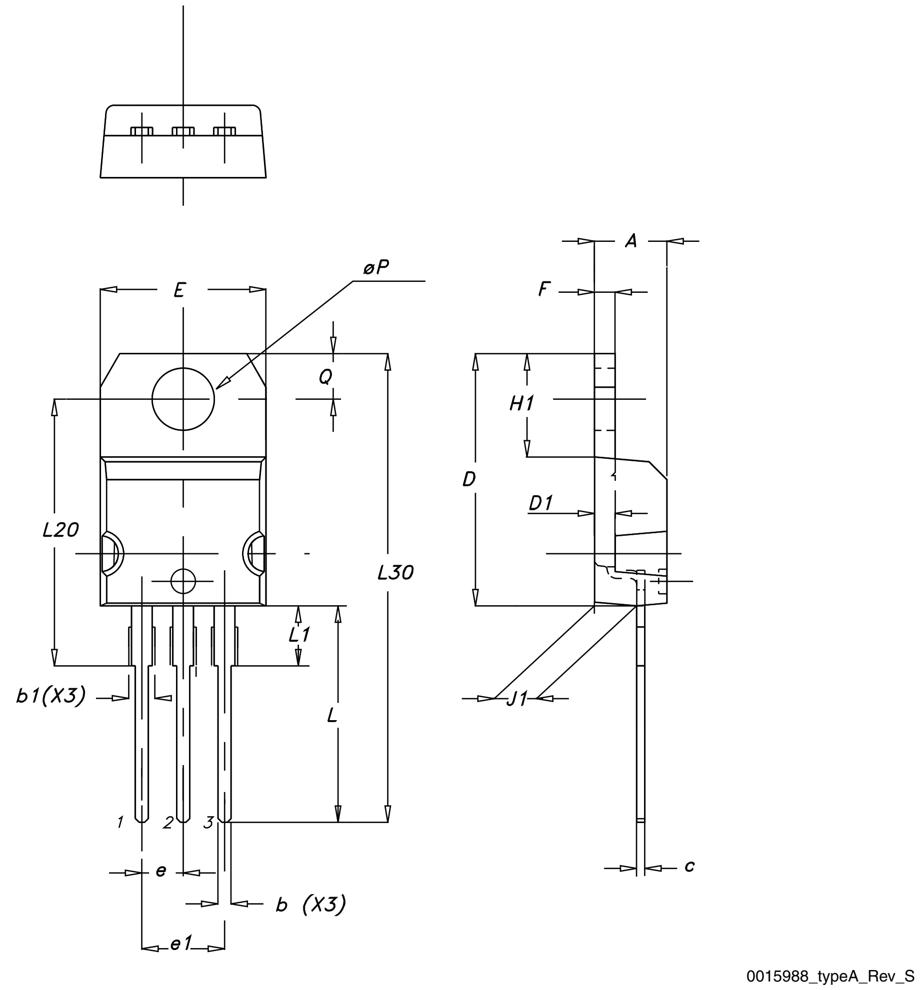
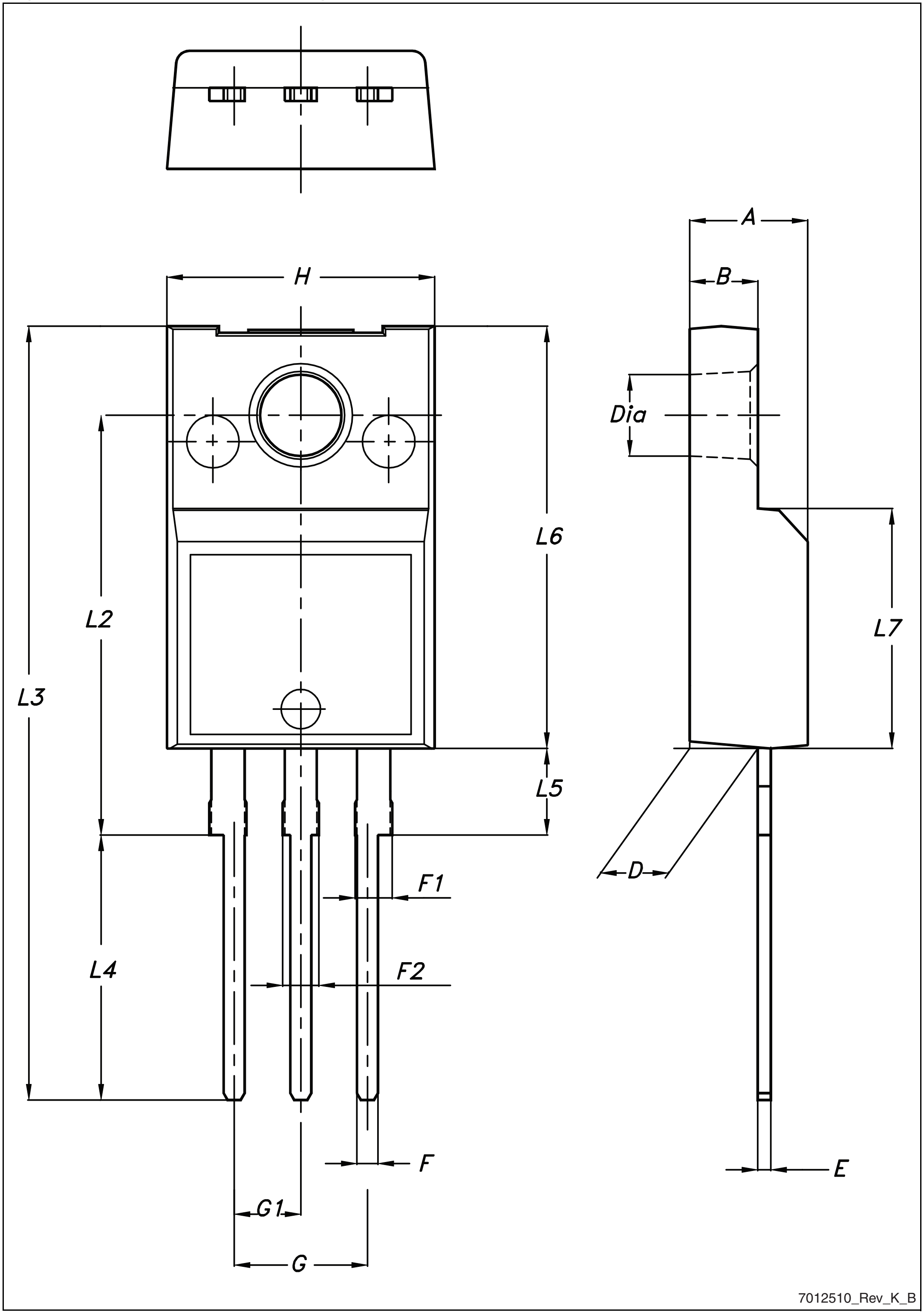


Table 12. TO-220FP mechanical data

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

Figure 26. TO-220FP drawing



5 Revision history

Table 13. Document revision history

Date	Revision	Changes
31-Jan-2013	3	– Minor text changes – The part number STB9NK60Z-1 has been moved to a separate datasheet – Updated: *Section 4: Package mechanical data*.

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