STD10P6F6, STF10P6F6, STP10P6F6, STU10P6F6

P-channel -60 V, 0.13 Ω typ., -10 A STripFET™ F6 Power MOSFETs in DPAK, TO-220FP, TO-220 and IPAK packages

Datasheet – production data

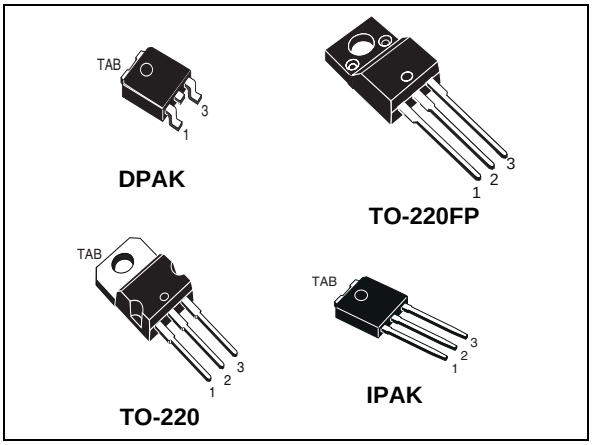
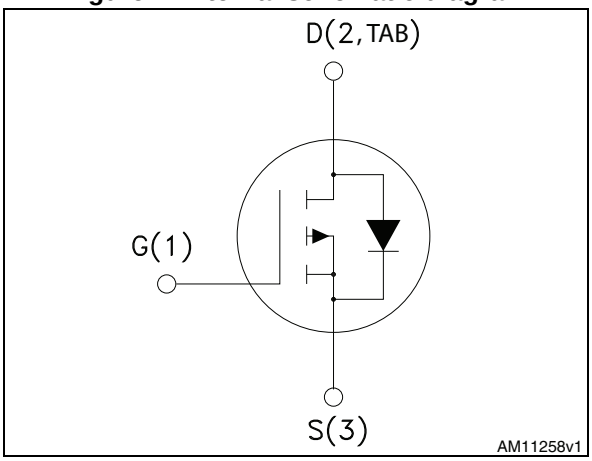


Figure 1. Internal schematic diagram



Features

Order codes	V_{DS}	$R_{DS(on)}$ max	I_D
STD10P6F6	-60 V	0.16 Ω	-10 A
STF10P6F6			
STP10P6F6			
STU10P6F6			

- Very low on-resistance
- Very low gate charge
- High avalanche ruggedness
- Low gate drive power loss

Applications

- Switching applications

Description

These devices are P-channel Power MOSFETs developed using the STripFET™ F6 technology, with a new trench gate structure. The resulting Power MOSFETs exhibit very low $R_{DS(on)}$ in all packages.

Table 1. Device summary

Order codes	Marking	Package	Packing
STD10P6F6	10P6F6	DPAK	Tape and reel
STF10P6F6		TO-220FP	Tube
STP10P6F6		TO-220	
STU10P6F6		IPAK	

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK IPAK	TO-220FP	TO-220	
V_{DS}	Drain-source voltage	-60			V
V_{GS}	Gate-source voltage	± 20			V
I_D (1)	Drain current (continuous) at T_C = 25 °C	-10			A
I_D	Drain current (continuous) at T_C = 100 °C	-7.2			A
I_{DM} (2)	Drain current (pulsed)	-40			A
P_{TOT}	Total dissipation at T_C = 25 °C	35	20	30	W
E_{AS}	Single pulse avalanche energy (starting T_J=25 °C, I_D=-3 A, V_{DD}=40 V)	80			mJ
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T_C=25 °C)		2500		V
V_{DG}	Drain-gate voltage (V_{GS} = 0)	-20			V
T_{stg}	Storage temperature	-55 to 175			°C
T_j	Max. operating junction temperature	175			°C

1. Limited by package
2. Pulse width limited by safe operating area

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		DPAK	IPAK	TO-220FP	TO-220	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	4.29		7.5	5	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max		100	62.5	62.5	°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max(1)	50				°C/W

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

2 Electrical characteristics

(T_{CASE} = 25 °C unless otherwise specified).

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown Voltage	I_D = -250 µA, V_{GS}= 0 V	-60			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = -60 V			-1	µA
		V_{DS} = -60 V, Tc = 125 °C			-10	µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = ±20 V			±100	nA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = -250 µA	-2		-4	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = -10 V, I_D = -5 A		0.13	0.16	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = -48 V, f=1 MHz, V_{GS} = 0 V	-	340	-	pF
C_{oss}	Output capacitance		-	40	-	pF
C_{rss}	Reverse transfer capacitance		-	20	-	pF
Q_g	Total gate charge	V_{DD} = -30 V, I_D = -10 A V_{GS} = -10 V *(see Figure 16)*	-	6.4	-	nC
Q_{gs}	Gate-source charge		-	1.7	-	nC
Q_{gd}	Gate-drain charge		-	1.7	-	nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = -48 V, I_D = -5 A, R_G = 4.7 Ω, V_{GS} = -10 V *(see Figure 15)*	-	64	-	ns
t_r	Rise time		-	5.3	-	ns
$t_{d(off)}$	Turn-off delay time		-	14	-	ns
t_f	Fall time		-	3.7	-	ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		-10	A
I_{SDM}(1)	Source-drain current (pulsed)		-		-40	A
V_{SD}(2)	Forward on voltage	I_{SD} = -5 A, V_{GS} = 0 V	-		-1.1	V
t_{rr}	Reverse recovery time	I_{SD} = -10 A, di/dt = -100 A/µs, V_{DD} = -48 V *(see Figure 17)*	-	20		ns
Q_{rr}	Reverse recovery charge		-	17.8		nC
I_{RRM}	Reverse recovery current		-	-1.8		A

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

2.1 Electrical characteristics (curves)

Note: For the P-channel Power MOSFET, current and voltage polarities are reversed.

Figure 2. Safe operating area for DPAK, TO-220 and IPAK

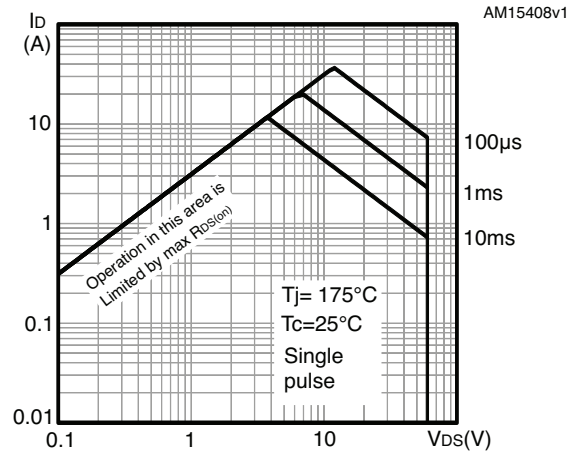


Figure 3. Thermal impedance DPAK, TO-220 and IPAK

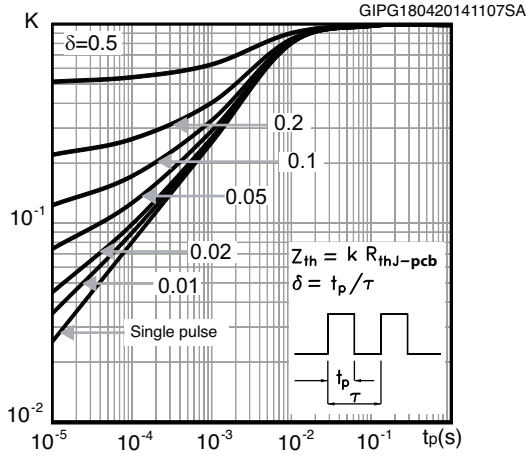


Figure 4. Safe operating area for TO-220FP

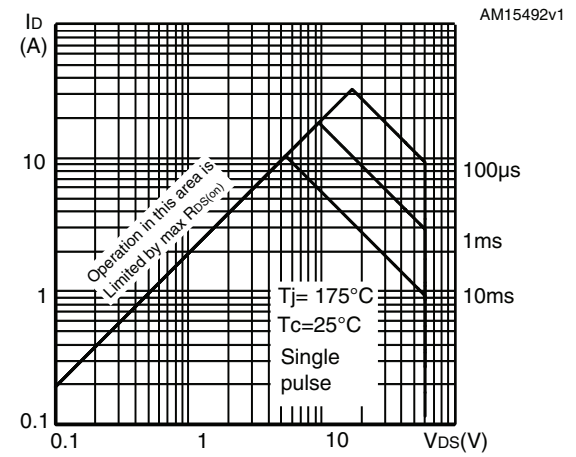


Figure 5. Thermal impedance for TO-220FP

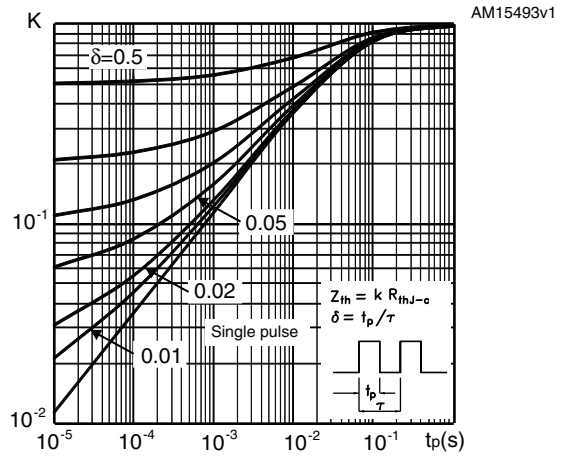


Figure 6. Output characteristics

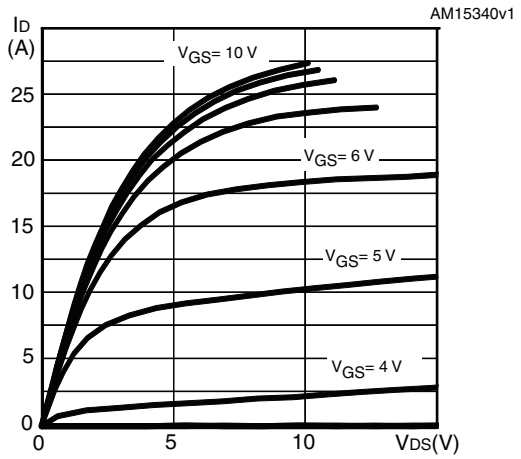


Figure 7. Transfer characteristics

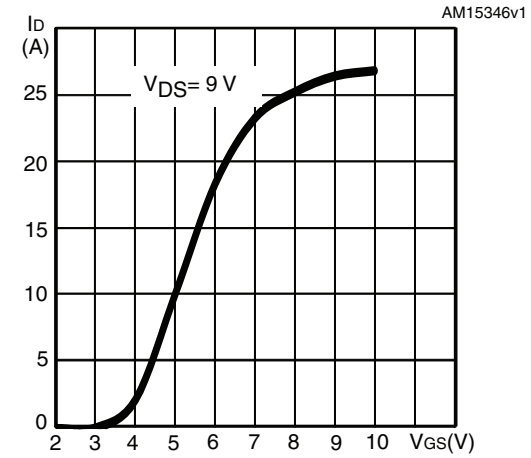


Figure 8. Gate charge vs gate-source voltage

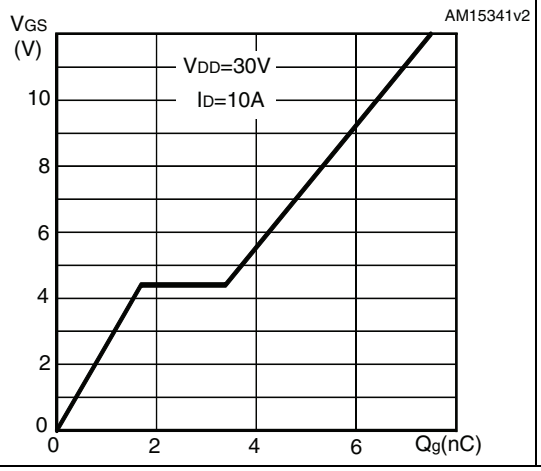


Figure 9. Static drain-source on-resistance

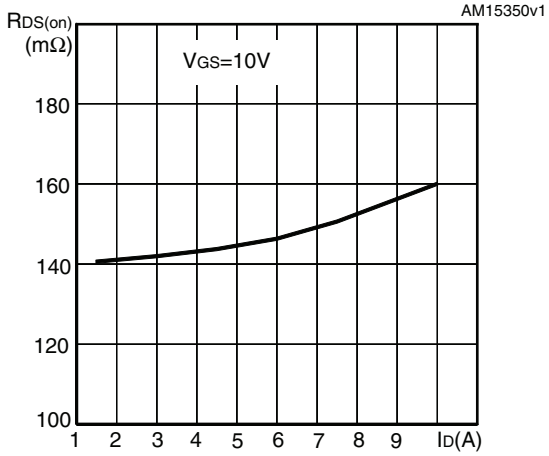


Figure 10. Capacitance variations

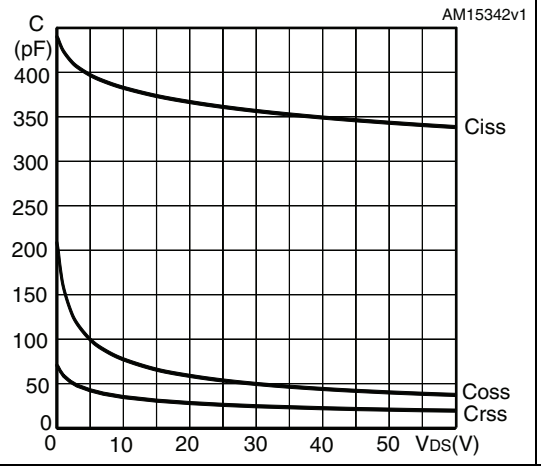


Figure 11. Normalized $V_{(BR)DSS}$ vs temperature

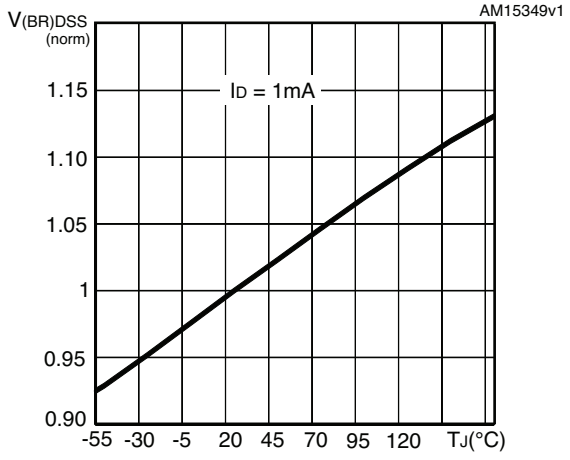


Figure 12. Normalized gate threshold voltage vs temperature

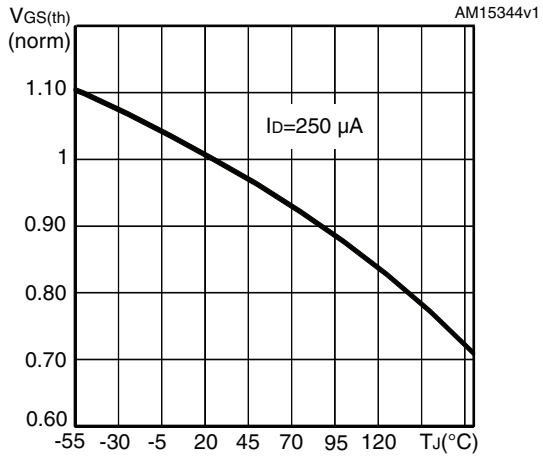


Figure 13. Normalized on-resistance vs temperature

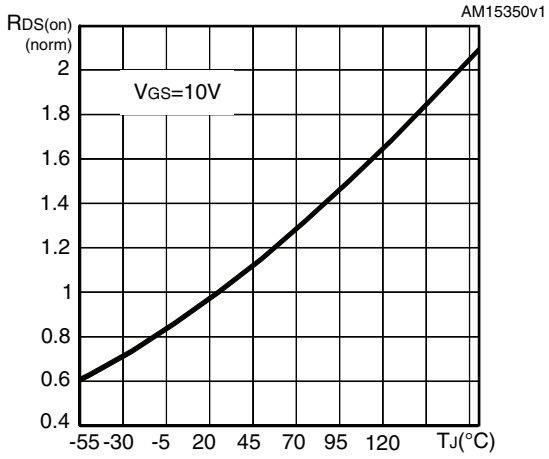
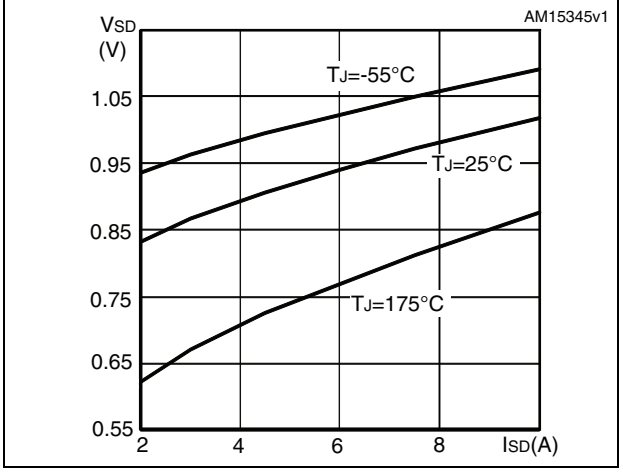


Figure 14. Source-drain diode forward characteristics



3 Test circuits

Figure 15. Switching times test circuit for resistive load

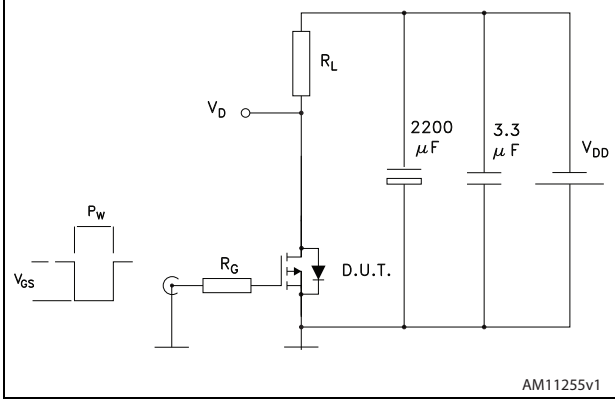


Figure 16. Gate charge test circuit

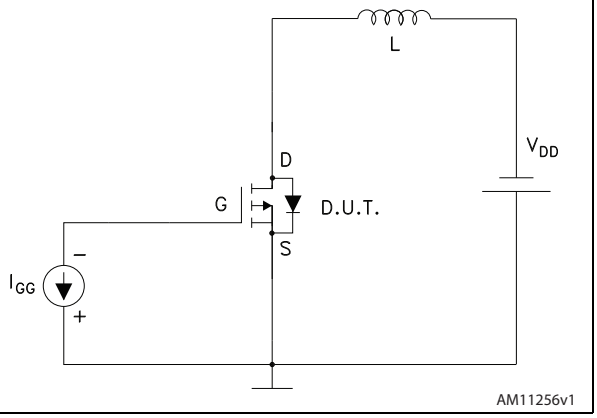
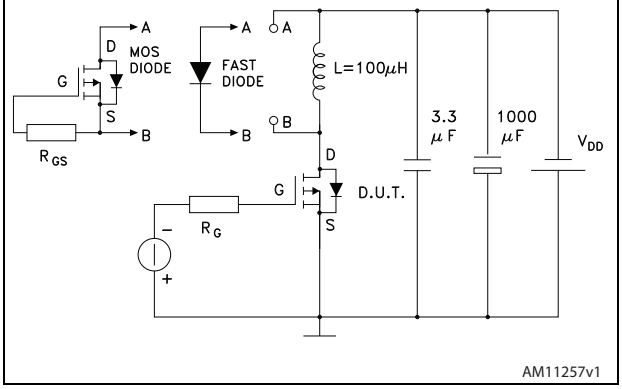


Figure 17. Test circuit for diode recovery behaviour



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 package information

Figure 18. DPAK (TO-252) type C package outline

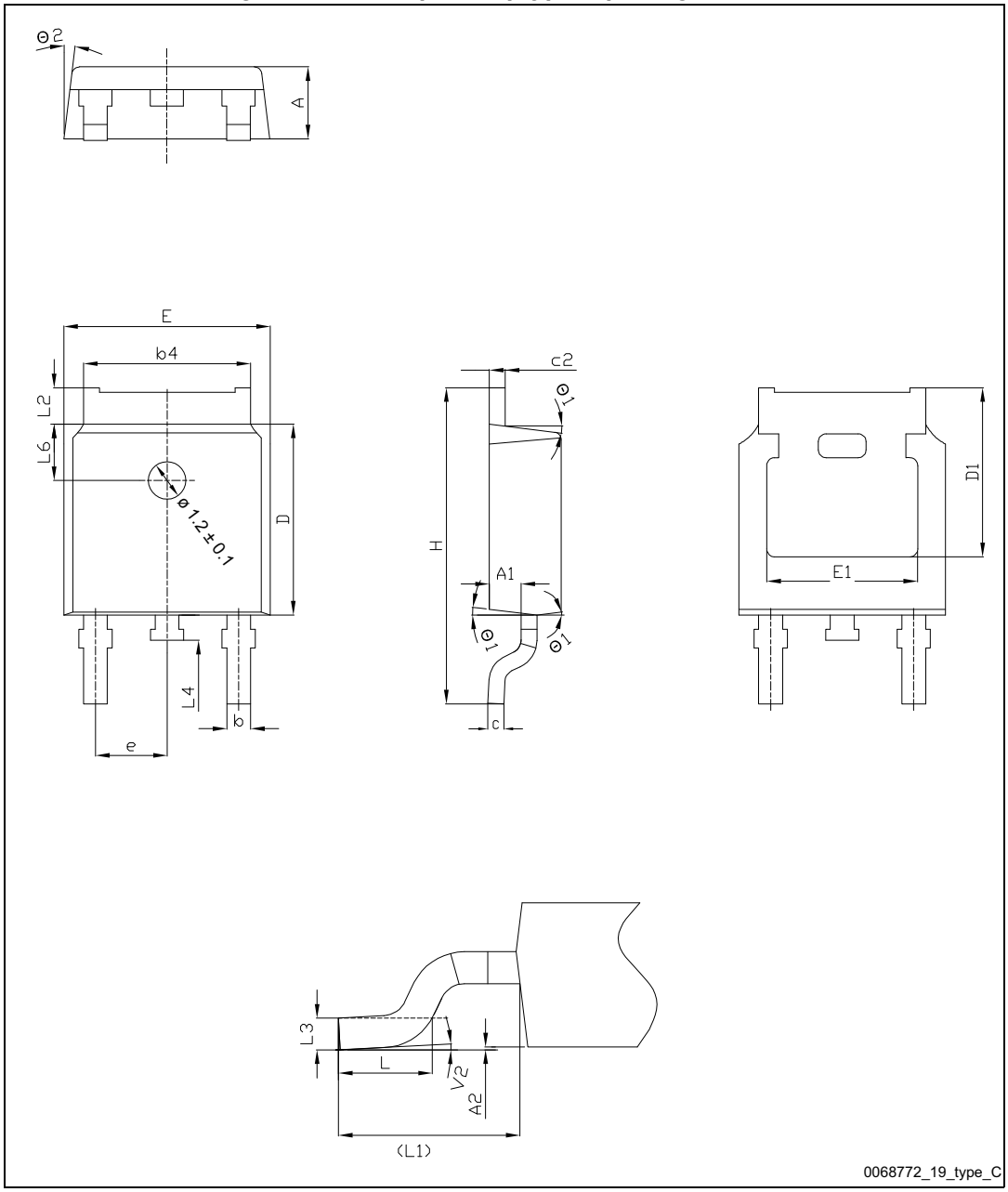
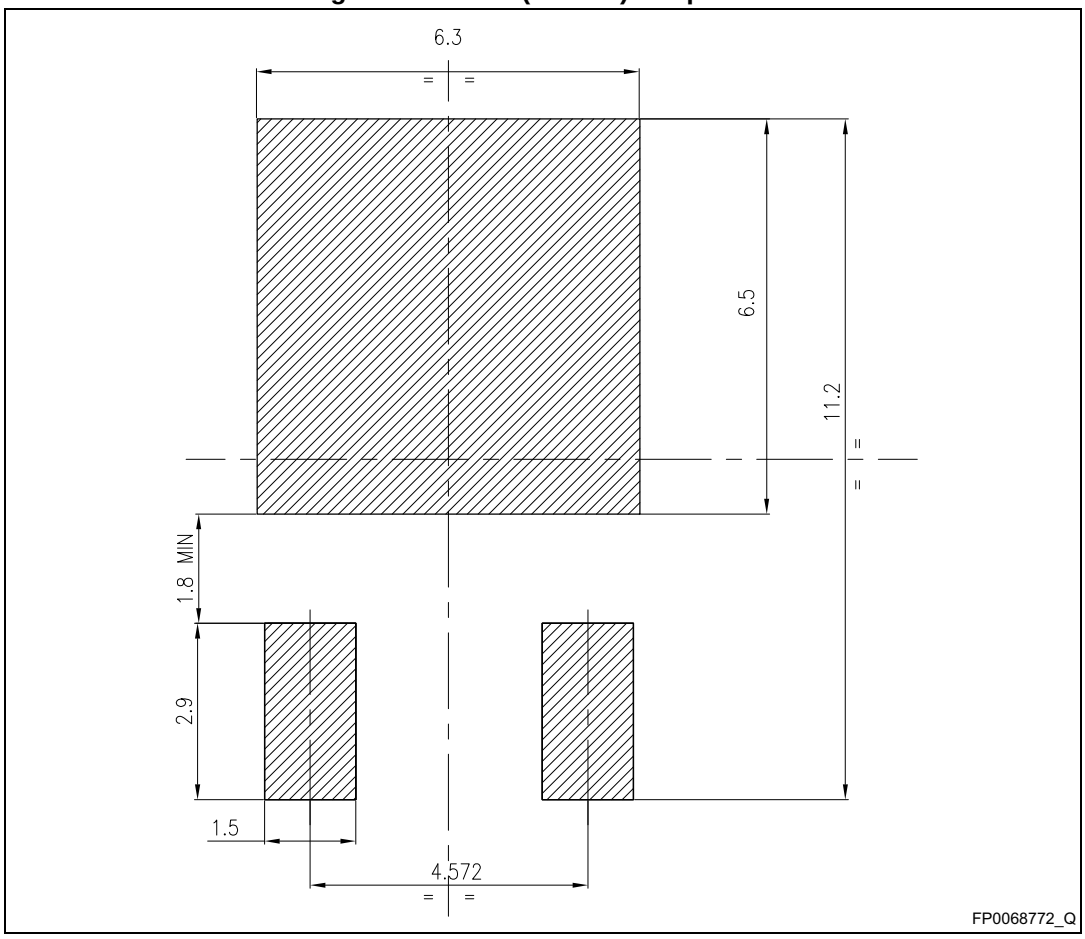


Table 8. DPAK (TO-252) type C package mechanical data

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	5.25		
E	6.50	6.60	6.70
e	2.186	2.286	2.386
E1	4.70		
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 19. DPAK (TO-252) footprint [(a)]



a. All dimensions are in millimeters

4.2 DPAK packing information

Figure 20. Tape for DPAK (TO-252)

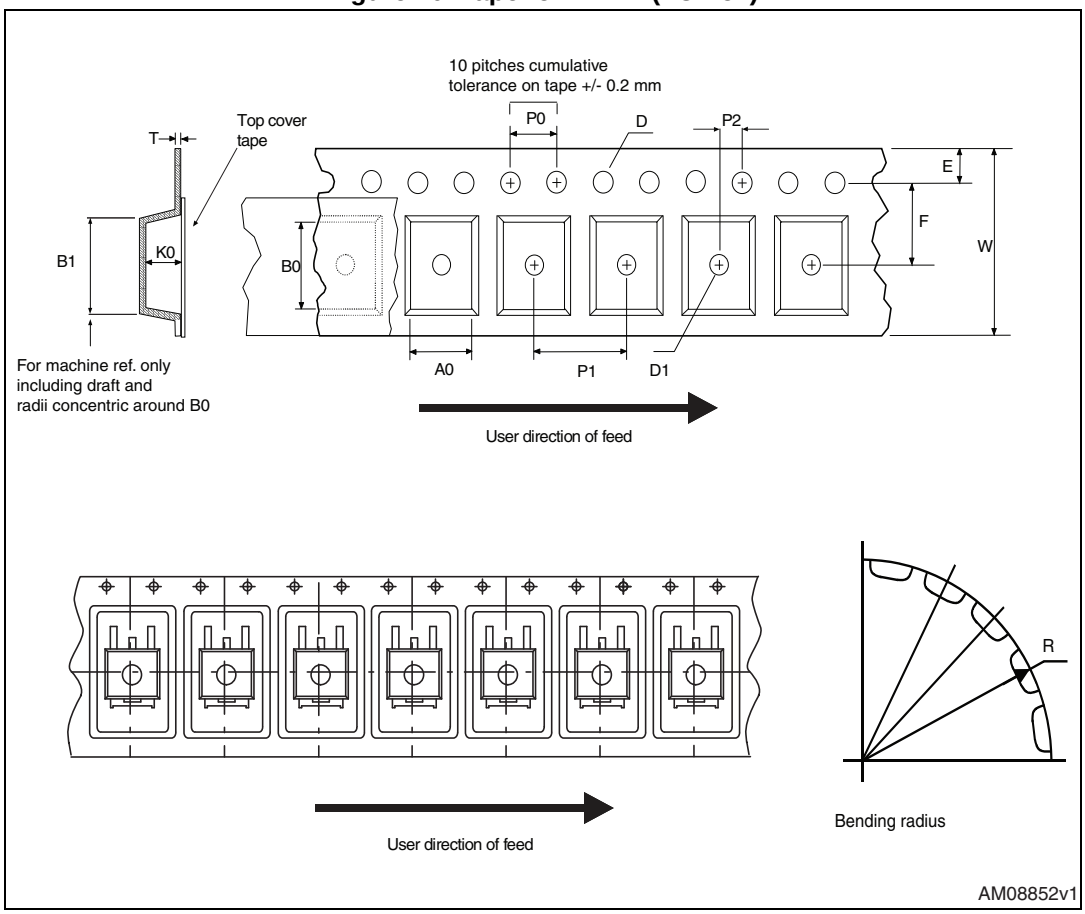


Figure 21. Reel for DPAK (TO-252)

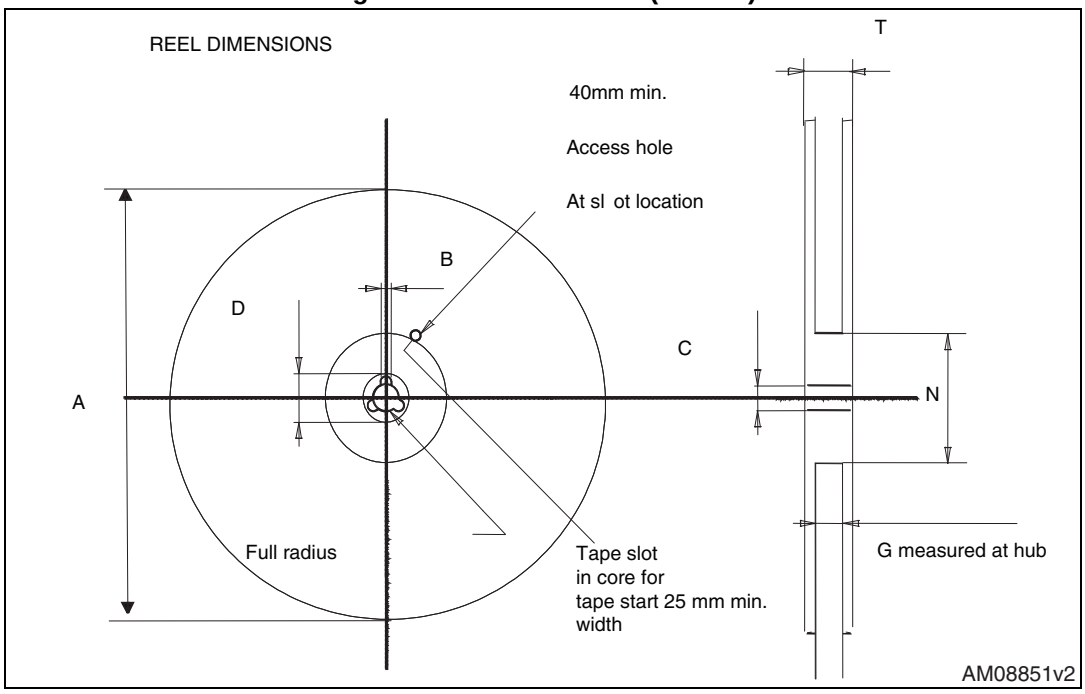


Table 9. DPAK (TO-252) tape and reel mechanical data

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			

4.3 TO-220FP package information

Figure 22. TO-220FP package outline

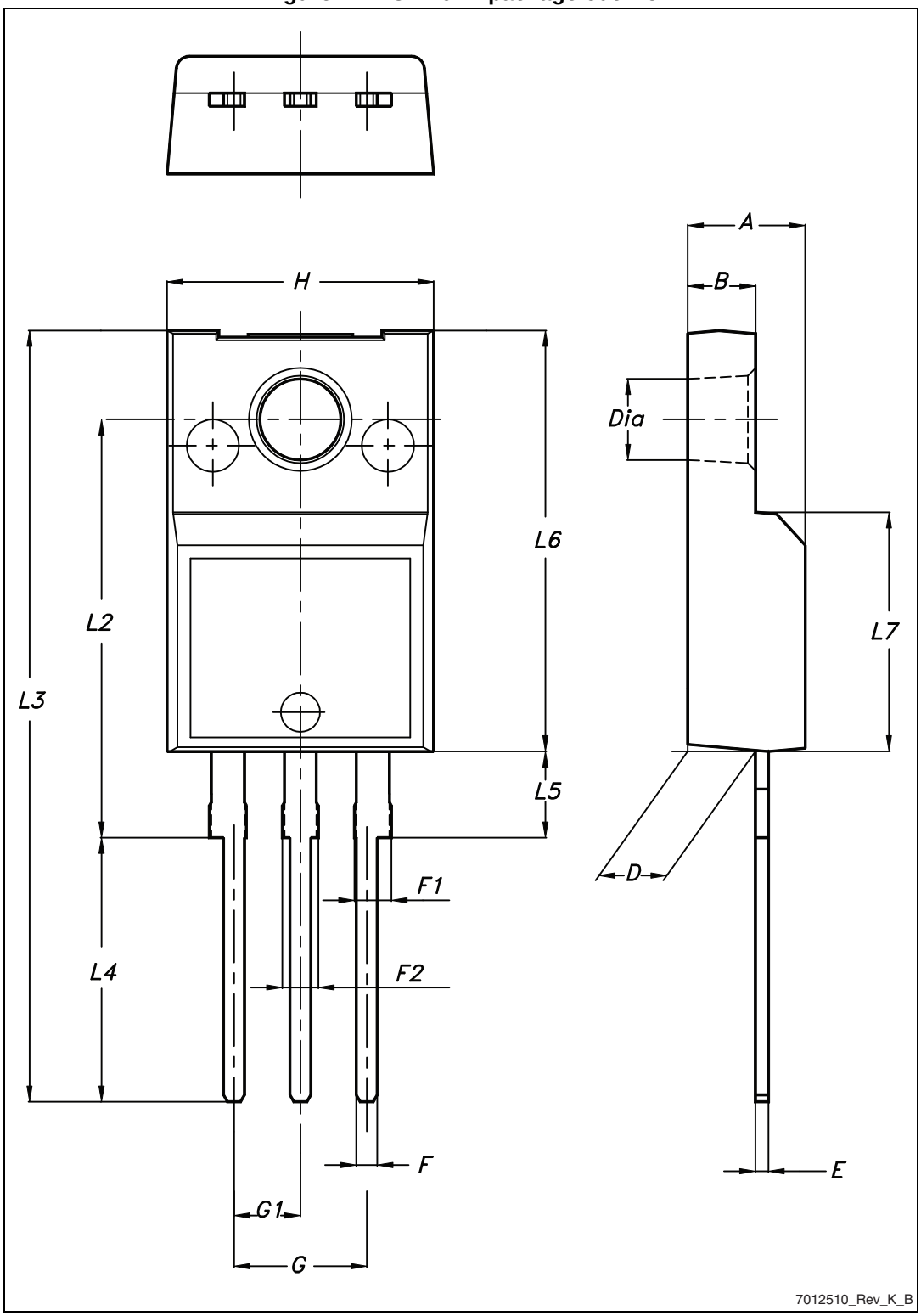


Table 10. TO-220FP mechanical data

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

4.4 TO-220 package information

Figure 23. TO-220 type A package outline

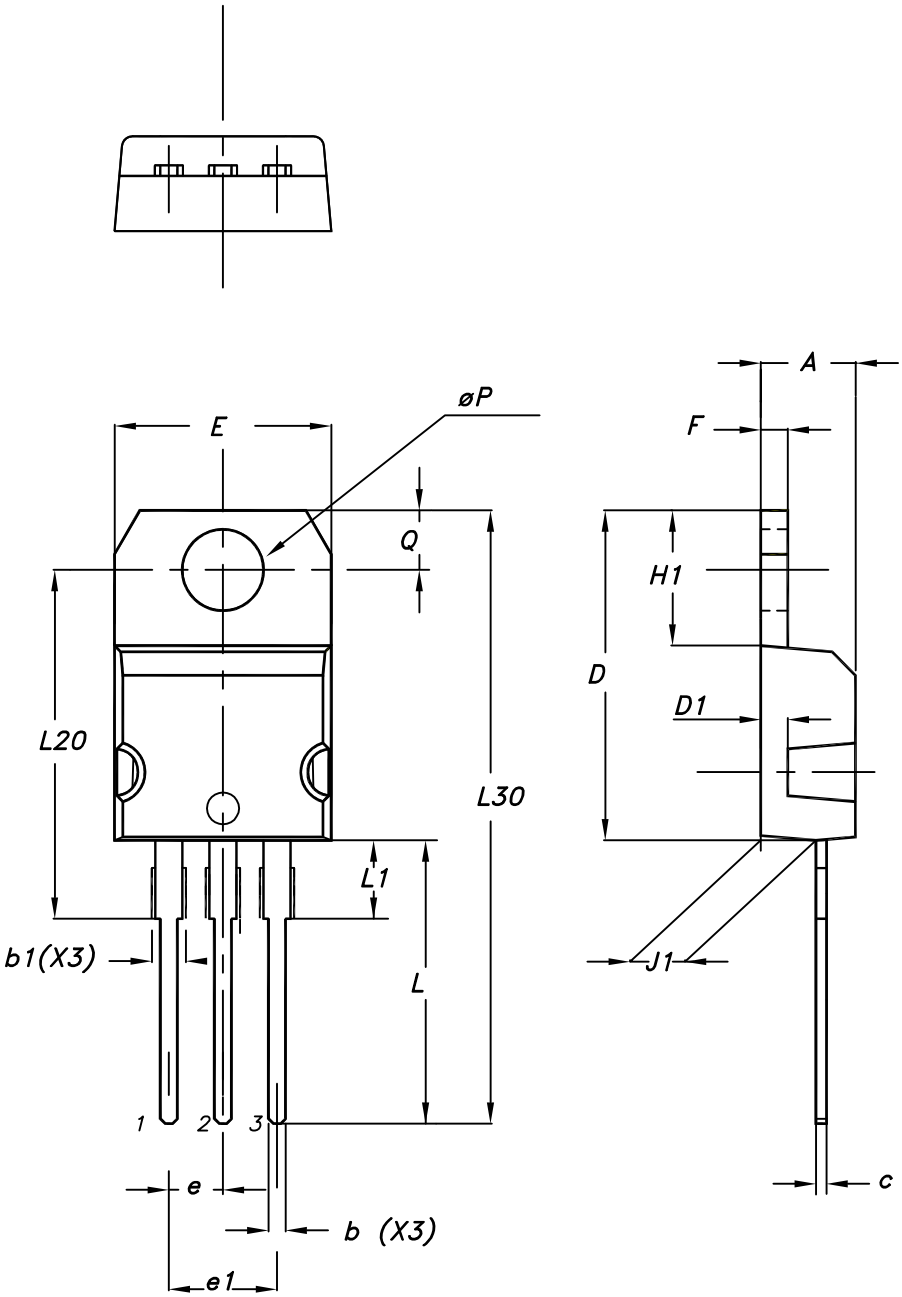


Table 11. TO-220 type A mechanical data

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

4.5 IPAK package information

Figure 24. IPAK (TO-251) type A package outline

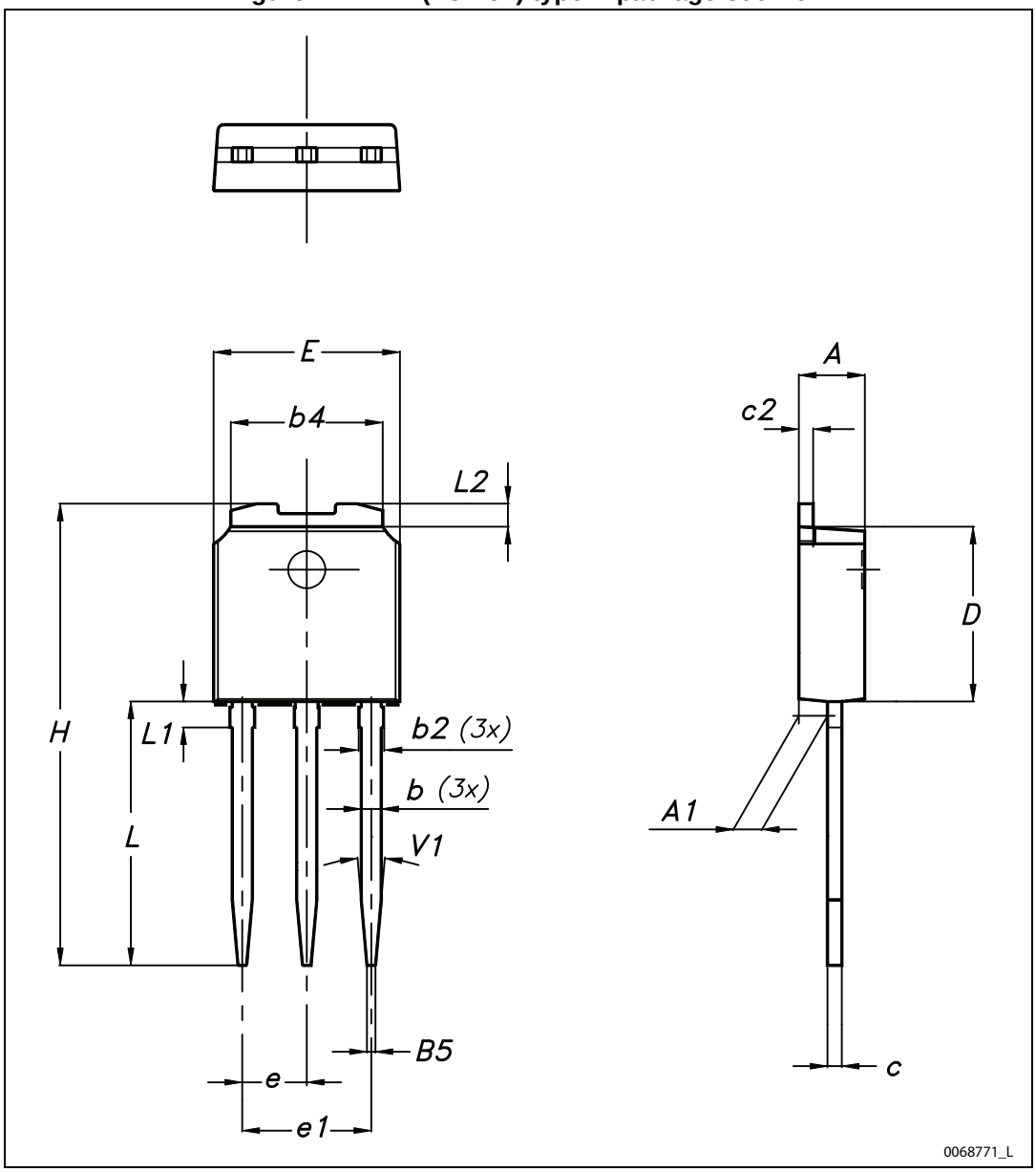


Table 12. IPAK (TO-251) type A mechanical data

DIM	mm.		
	min.	typ.	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
B5		0.30	
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
L1	0.80		1.20
L2		0.80	1.00
V1		10°	

Figure 25. IPAK (TO-251) type C package outline

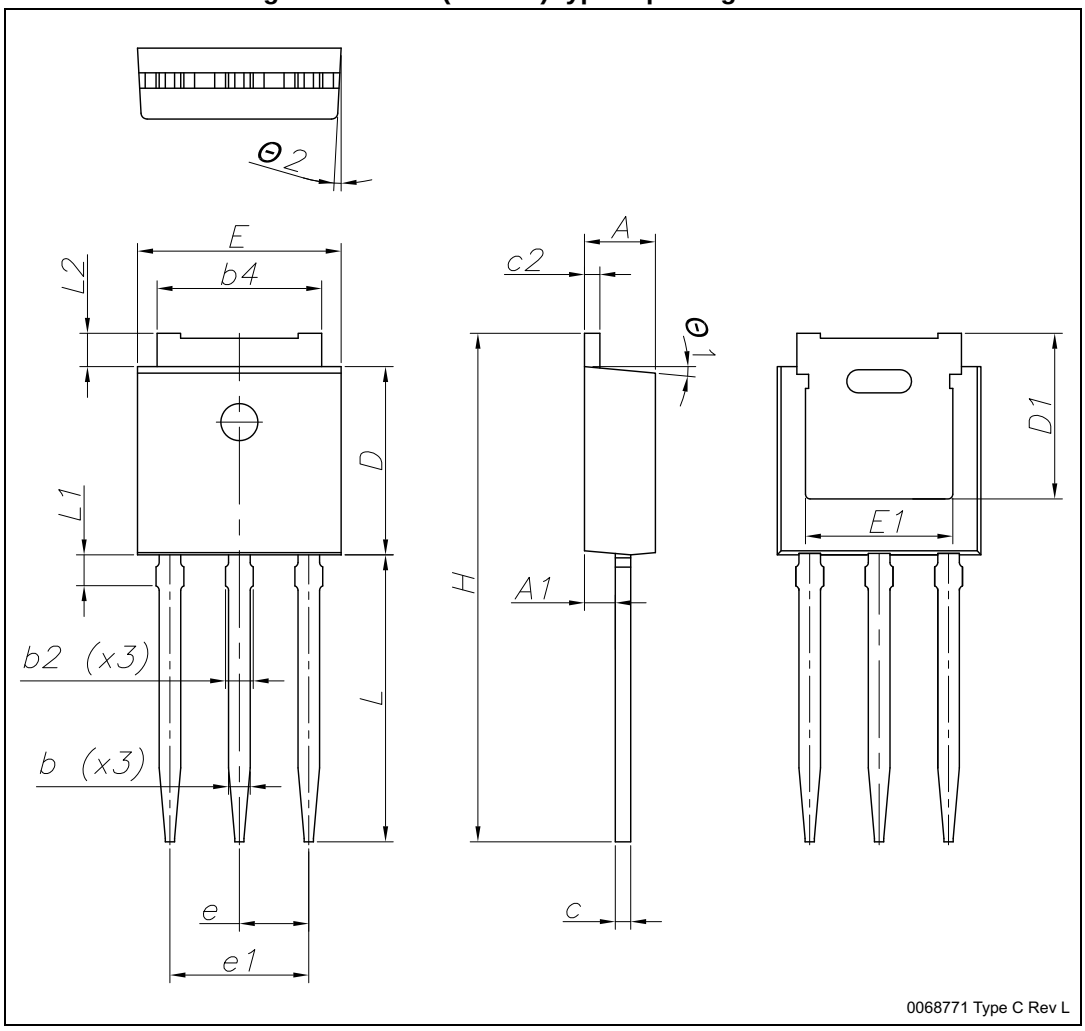


Table 13. IPAK (TO-251) type C mechanical data

Dim.	mm		
	min.	typ.	max.
A	2.20	2.30	2.35
A1	0.90	1.00	1.10
b	0.66		0.79
b2			0.90
b4	5.23	5.33	5.43
c	0.46		0.59
c2	0.46		0.59
D	6.00	6.10	6.20
D1	5.20	5.37	5.55
E	6.50	6.60	6.70
E1	4.60	4.78	4.95
e	2.20	2.25	2.30
e1	4.40	4.50	4.60
H	16.18	16.48	16.78
L	9.00	9.30	9.60
L1	0.80	1.00	1.20
L2	0.90	1.08	1.25
θ1	3°	5°	7°
θ2	1°	3°	5°

5 Revision history

Table 14. Document revision history

Date	Revision	Changes
10-May-2012	1	First release.
20-Jun-2012	2	Updated title on the cover page. Updated all parameter values in *Table 5*, *Table 6* and *Figure 1*.
17-May-2013	3	– Added: TO-220FP and IPAK packages – Updated: $R_{DS(on)}$ value in cover page, $R_{thj\text{-}case}$ values, *Table 5*, *6* and *7* typical values – Updated mechanical data only for DPAK in *Section 4: Package information*
24-Apr-2014	4	– Updated: *Figure 2* and *3* – Updated: *Section 4.1: DPAK package information* and *Section 4.4: TO-220 package information* – Minor text changes
27-Jul-2015	5	– All voltage and current polarities inverted – Added: note in *Section 2.1: Electrical characteristics (curves)* – Updated: *Section 4.1* and *Section 4.5* – Text and formatting changes throughout document