



STD10P6F6, STF10P6F6, STP10P6F6, STU10P6F6

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

Datasheet — production data

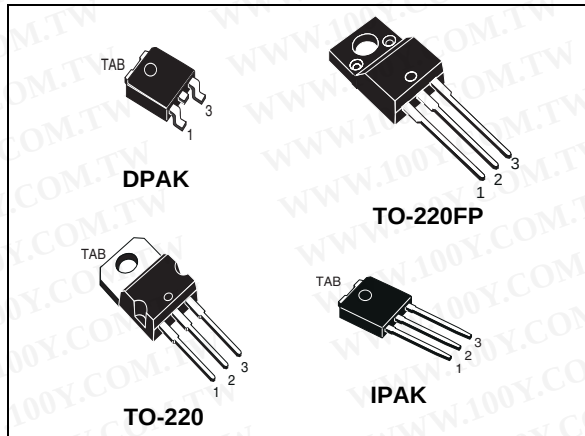
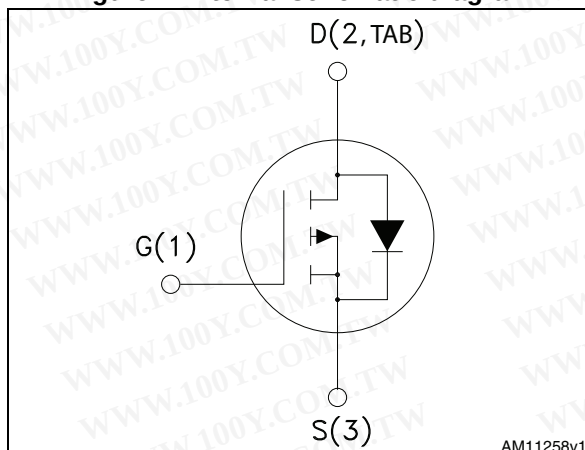


Figure 1. Internal schematic diagram



Features

Order codes	V _{DSS}	R _{DS(on)} max	I _D
STD10P6F6	60 V	0.16 Ω	10 A
STF10P6F6			
STP10P6F6			
STU10P6F6			

- R_{DS(on)} * Q_g industry benchmark
- Extremely low on-resistance R_{DS(on)}
- High avalanche ruggedness
- Low gate drive power losses

Applications

- Switching applications

Description

These devices are P-channel Power MOSFETs developed using the 6th generation of STripFET™ DeepGATE™ technology, with a new gate structure. The resulting Power MOSFETs exhibits the lowest R_{DS(on)} in all packages.

Table 1. Device summary

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

Note: For the P-channel Power MOSFET the actual polarity of the voltages and the current must be reversed.

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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 $T_C = 25\text{ }^{\circ}\text{C}$	10			A
I_D	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	7.2			A
$I_{DM}^{(2)}$	Drain current (pulsed)	40			A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	35	20	30	W
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink ($t=1\text{ s}; T_C=25\text{ }^{\circ}\text{C}$)		2500		V
T_{stg}	Storage temperature	-55 to 175			$^{\circ}\text{C}$
T_j	Max. operating junction temperature	175			$^{\circ}\text{C}$

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	
$R_{thj-case}$	Thermal resistance junction-case max	4.29		7.5	5	$^{\circ}\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max		100	62.5	62.5	$^{\circ}\text{C/W}$
$R_{thj-pcb}$	Thermal resistance junction-pcb max ⁽¹⁾	50				$^{\circ}\text{C/W}$

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

Note: For the P-channel Power MOSFET the actual polarity of the voltages and the current must be reversed.

2 Electrical characteristics

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

Table 4. Static

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

Table 5. Dynamic

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

Note: For the P-channel Power MOSFET the actual polarity of the voltages and the current must be reversed.

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 48\text{ V}$, $I_D = 5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ 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	$I_{SD} = 5\text{ A}$, $V_{GS} = 0$	-		1.1	V
t_{rr}	Reverse recovery time	$I_{SD} = 10\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 48\text{ V}$ 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%

Note: For the P-channel Power MOSFET the actual polarity of the voltages and the current must be reversed.

2.1 Electrical characteristics (curves)

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

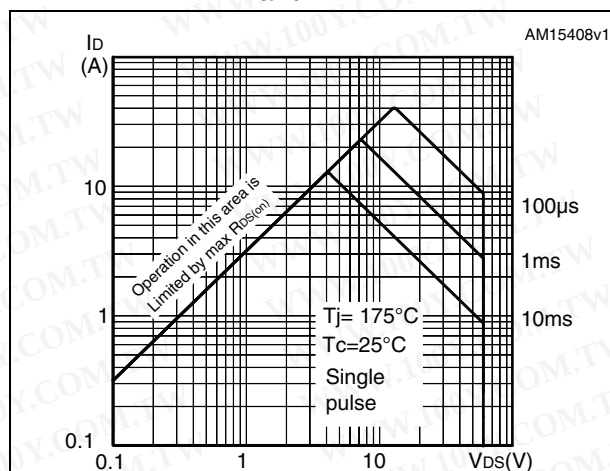


Figure 3. Thermal impedance DPAK, TO-220 and IPAK

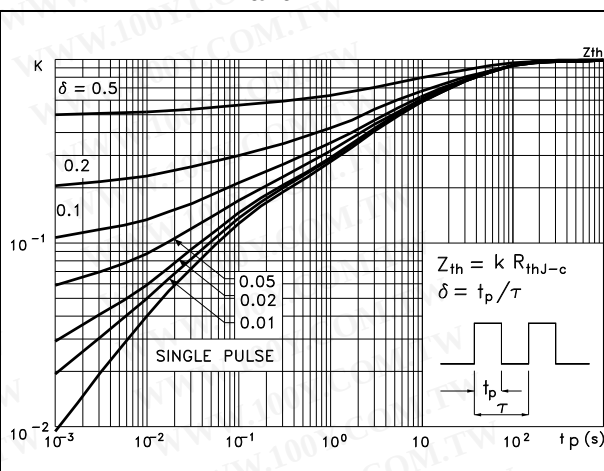


Figure 4. Safe operating area for TO-220FP

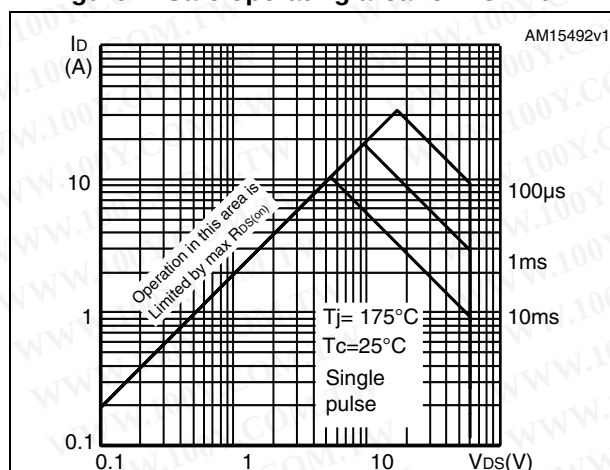


Figure 5. Thermal impedance for TO-220FP

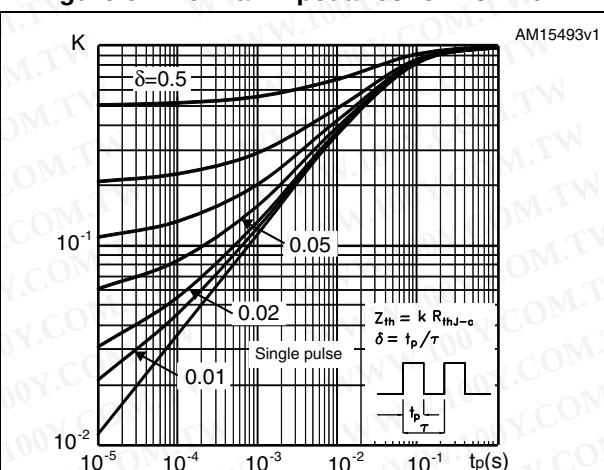


Figure 6. Output characteristics

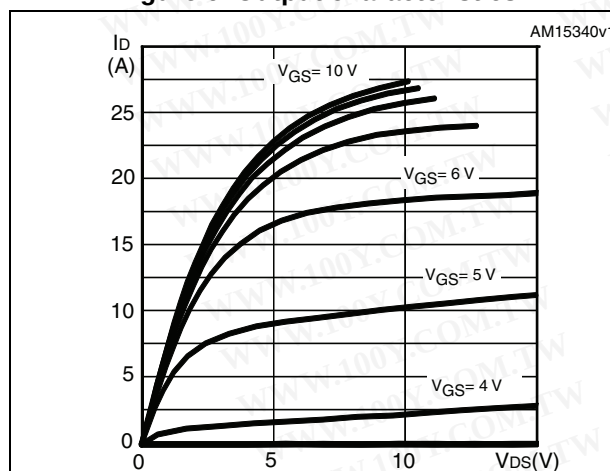


Figure 7. Transfer characteristics

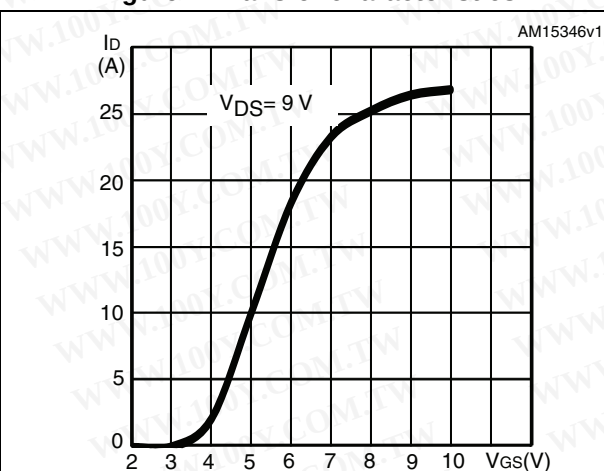


Figure 8. Gate charge vs gate-source voltage

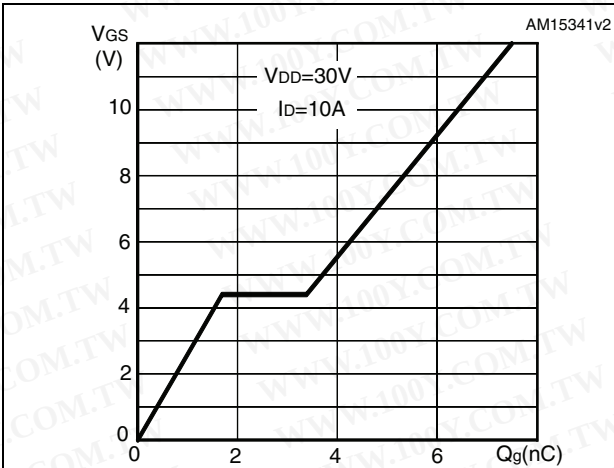


Figure 9. Static drain-source on-resistance

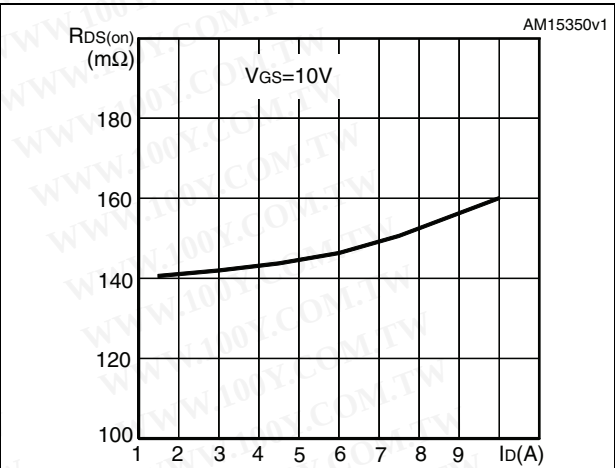


Figure 10. Capacitance variations

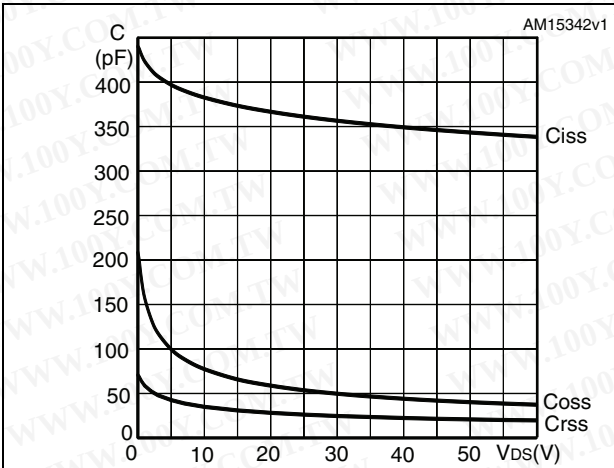


Figure 11. Normalized B_{VDS} vs temperature

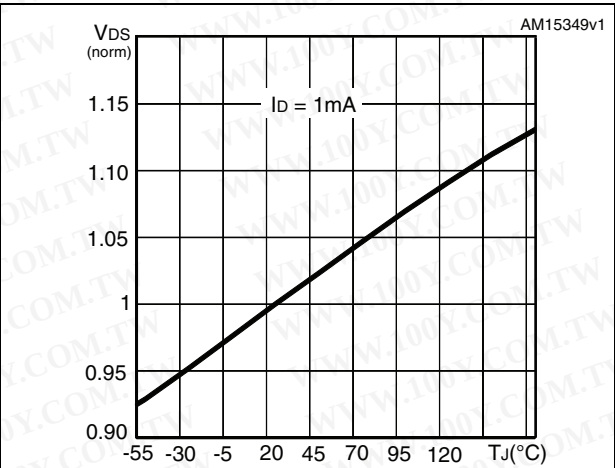


Figure 12. Normalized gate threshold voltage vs temperature

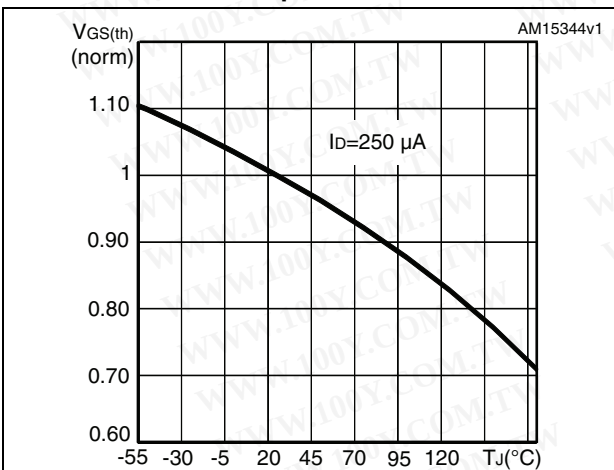


Figure 13. Normalized on-resistance vs temperature

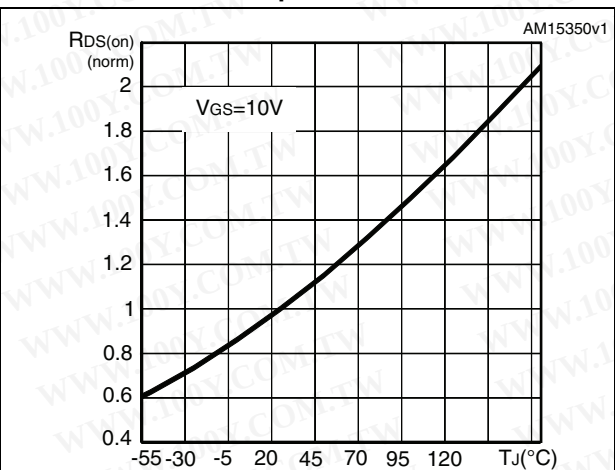
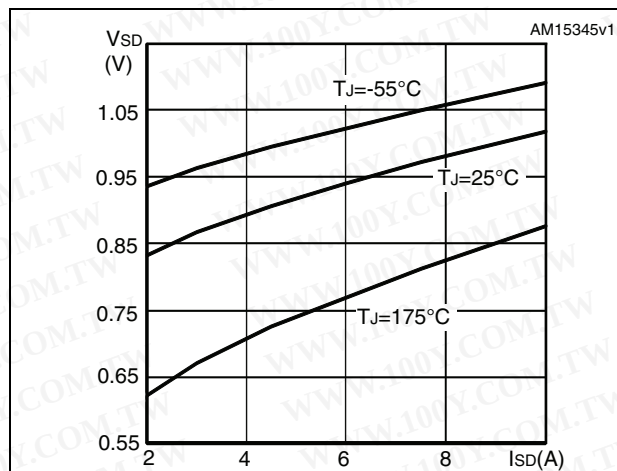


Figure 14. Source-drain diode forward characteristics

3 Test circuits

Figure 15. Switching times test circuit for resistive load

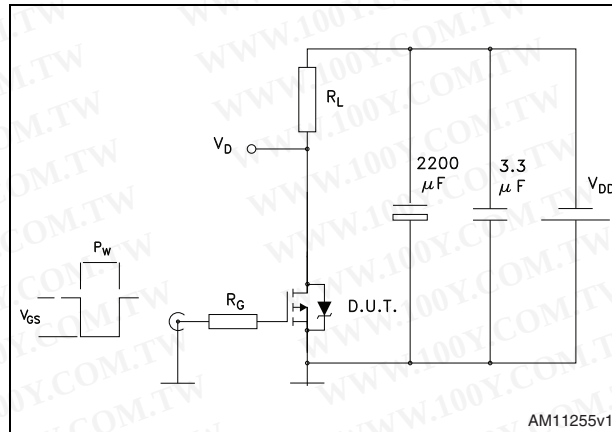


Figure 16. Gate charge test circuit

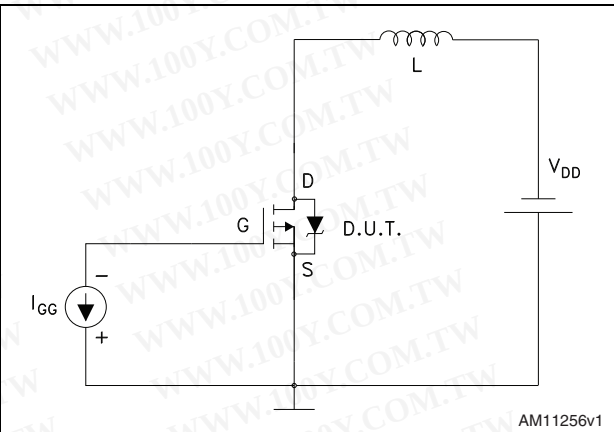
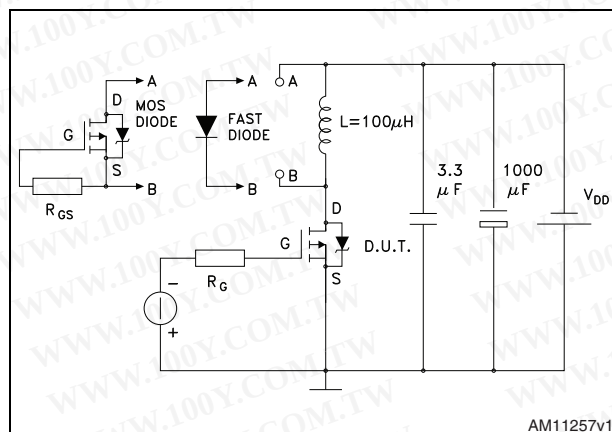


Figure 17. Test circuit for diode recovery behaviour



4 Package 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 8. DPAK (TO-252) 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		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 18. DPAK (TO-252) drawing

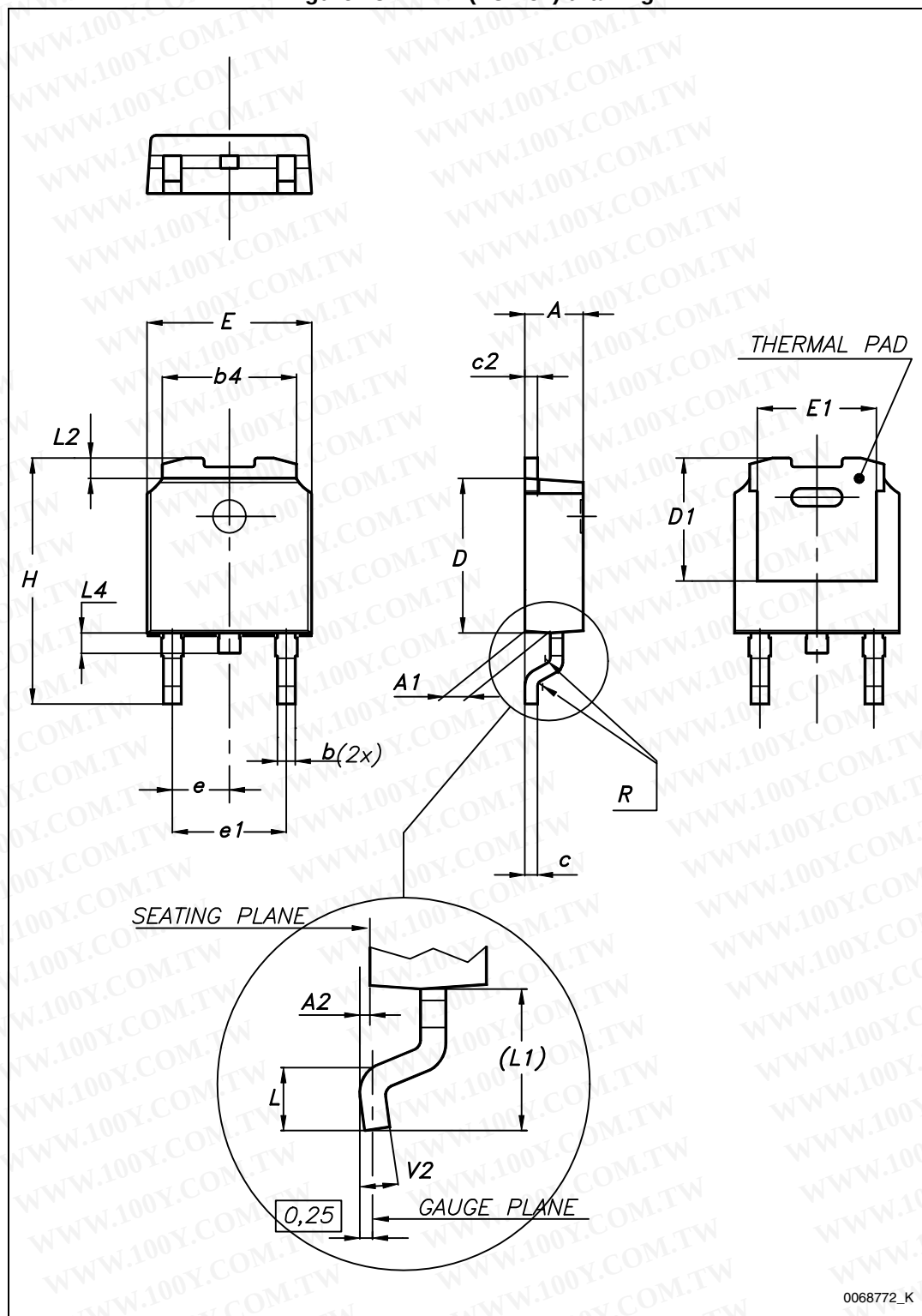
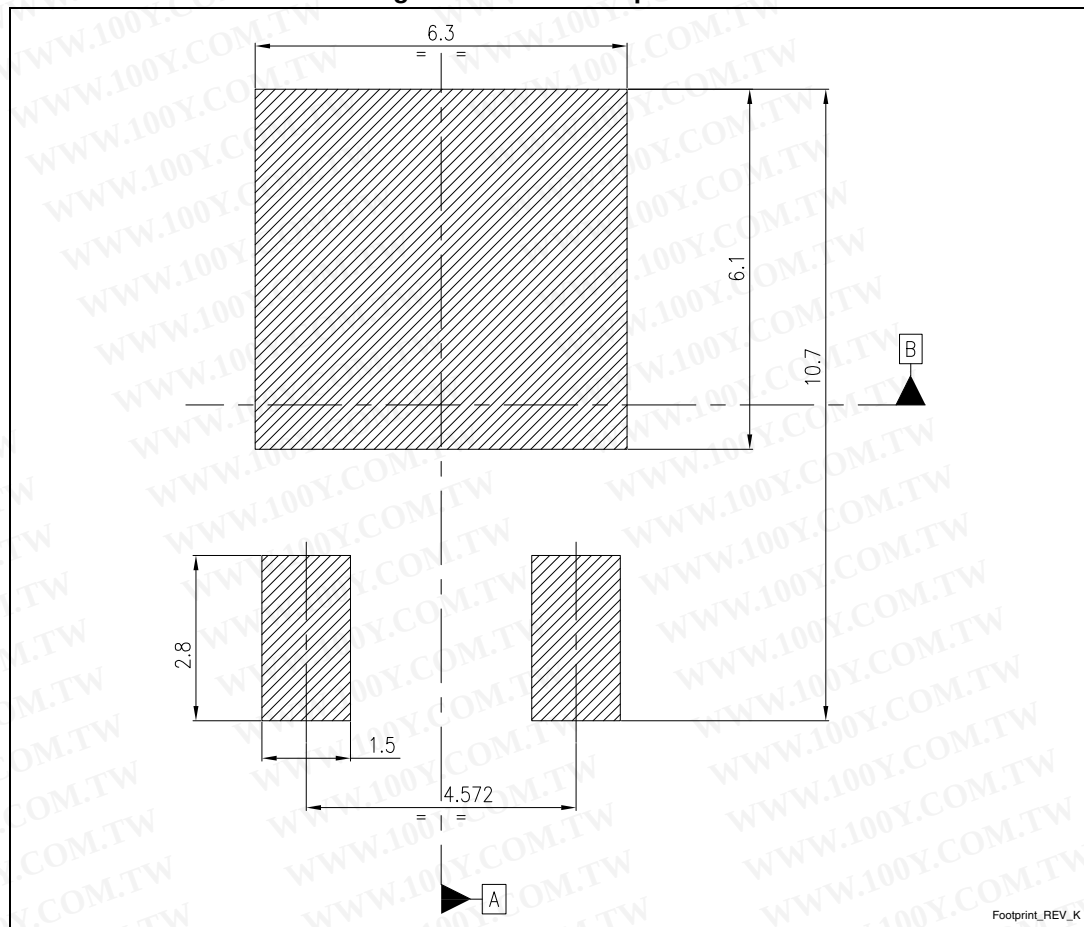


Figure 19. DPAK footprint (a)



a. All dimensions are in millimeters

Table 9. 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 20. TO-220FP drawing

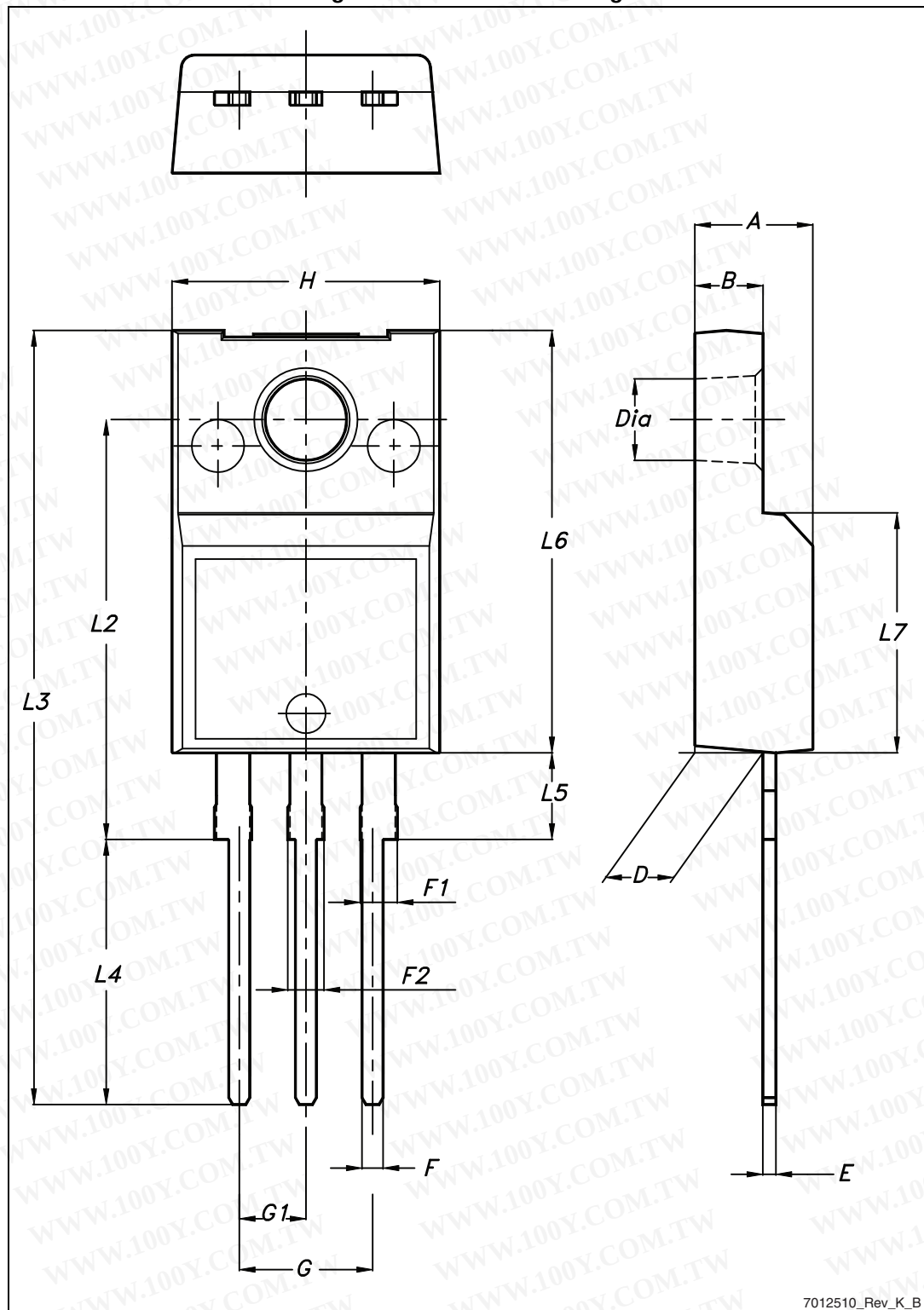


Table 10. TO-220 type A mechanical data

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	
ØP	3.75		3.85
Q	2.65		2.95

Figure 21. TO-220 type A drawing

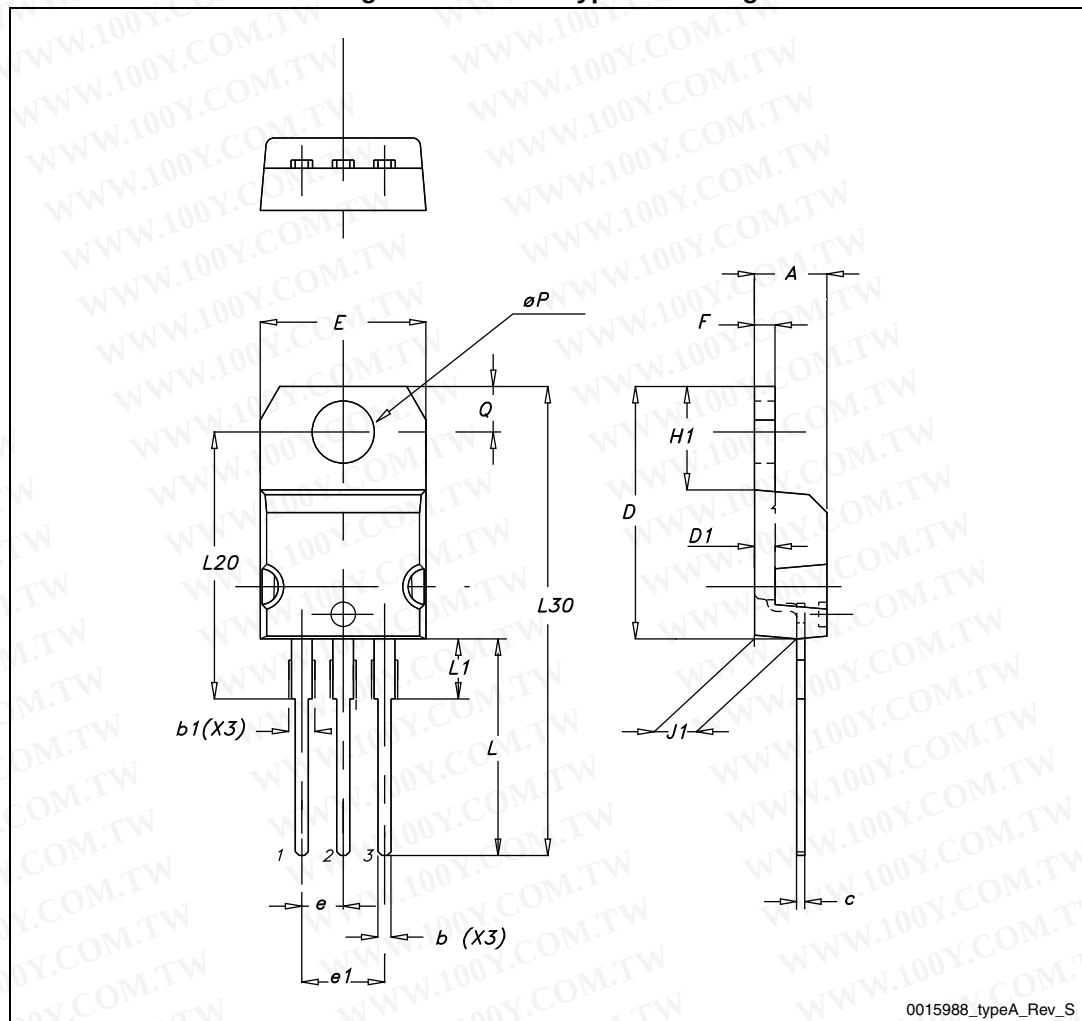
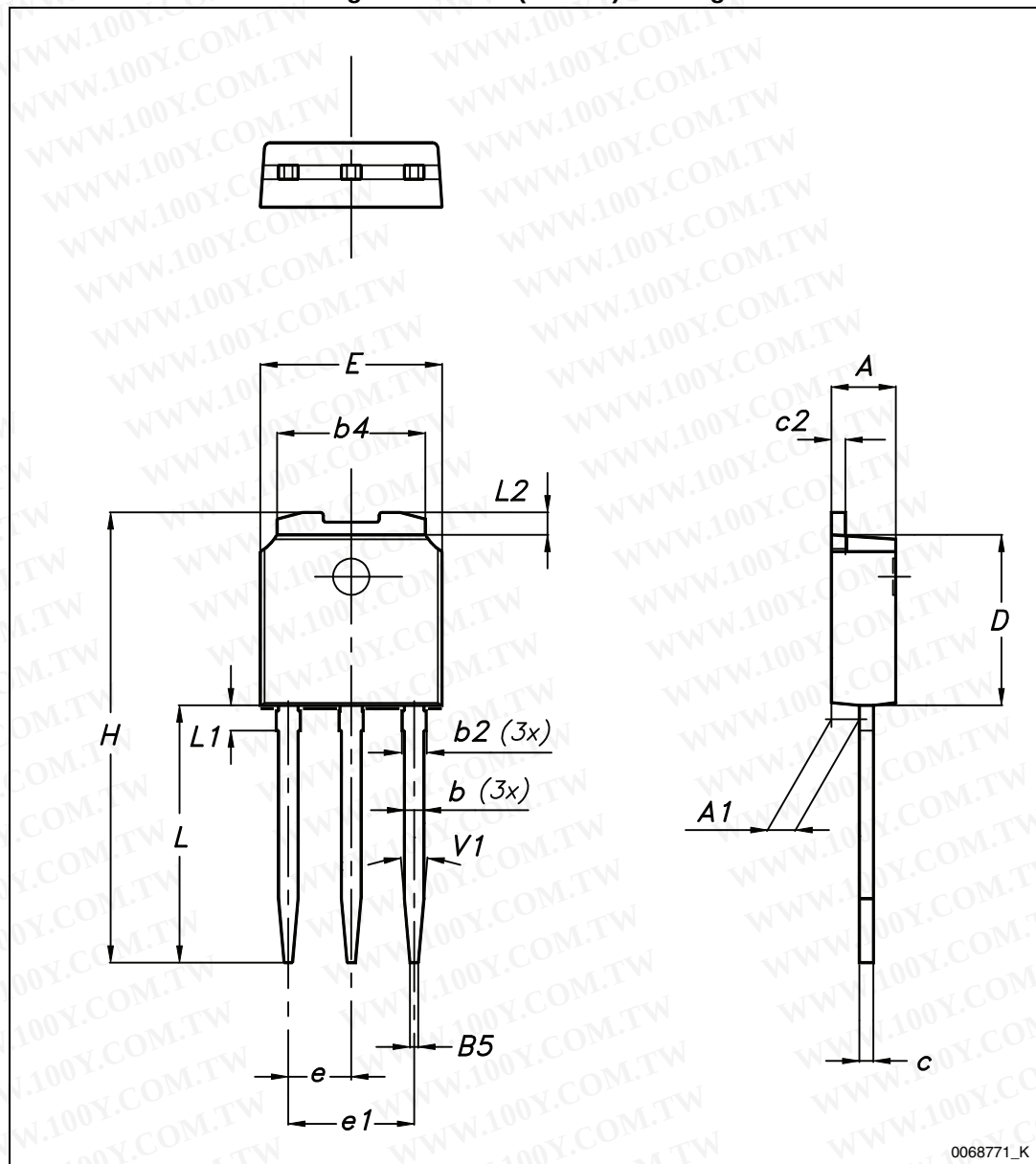


Table 11. IPAK (TO-251) mechanical data

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 22. IPAK (TO-251) drawing



5 Packaging mechanical data

Table 12. 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			

Figure 23. Tape for DPAK (TO-252)

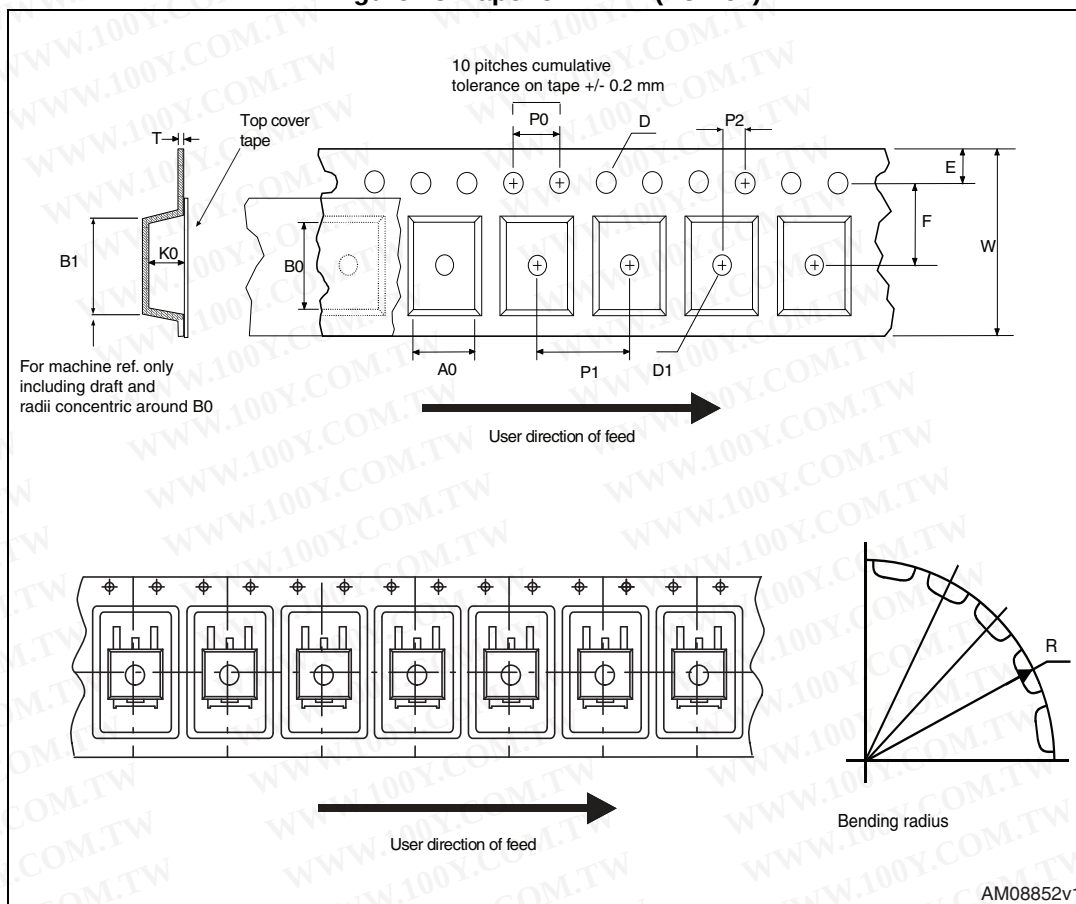
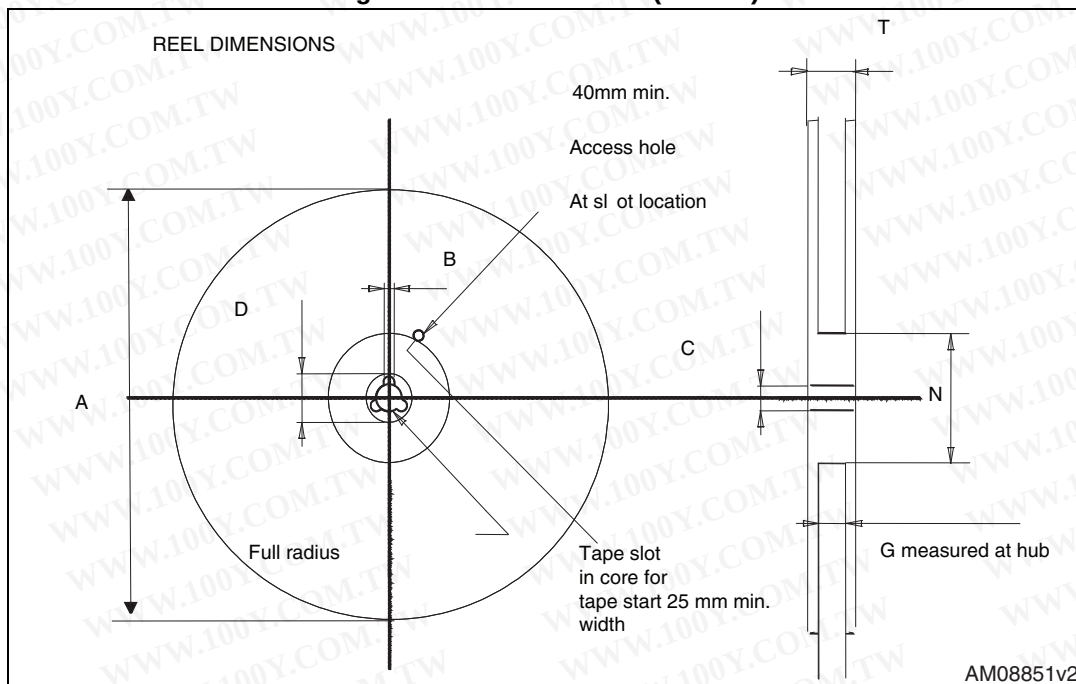


Figure 24. Reel for DPAK (TO-252)



6 Revision history

Table 13. Document revision history

Date	Revision	Changes
10-May-2012	1	First release.
20-Jun-2012	2	Updated title on the coverpage. 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, $R_{thj-case}$ values, Table 5, 6 and 7 typical values – Updated mechanical data only for DPAK in Section 4: Package mechanical data

STD10P6F6, STF10P6F6, STP10P6F6, STU10P6F6

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