

## N-channel 250 V, 0.195 $\Omega$ , 14 A STripFET™ II Power MOSFET in DPAK, TO-220FP and TO-220 packages

Datasheet – production data

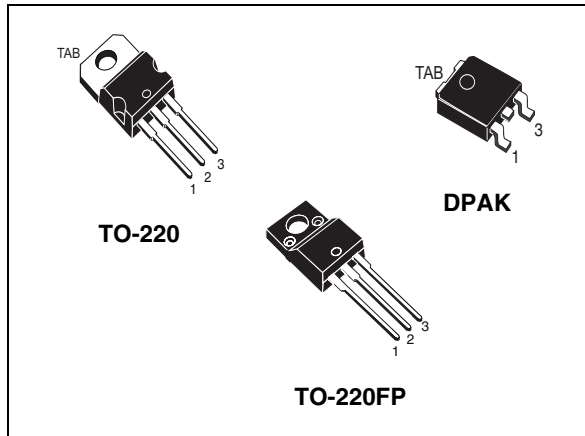
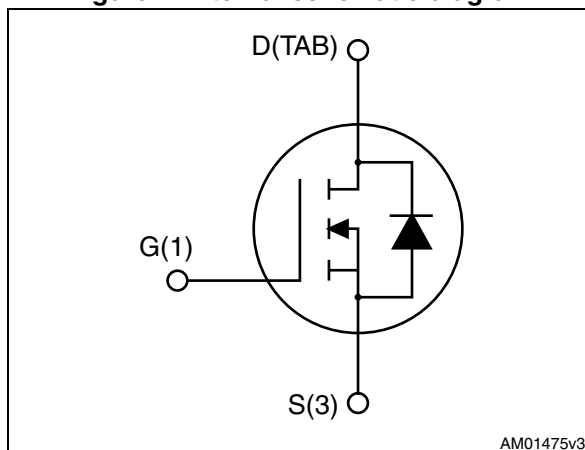


Figure 1. Internal schematic diagram



### Features

Order codes	$V_{DS}$	$R_{DS(on) \max}$	$I_D$	$P_{TOT}$
STD16NF25	250 V	0.235 $\Omega$	14 A	100 W
STF16NF25			14 A <sup>(1)</sup>	25 W
STP16NF25			14 A	100 W

1. Limited by maximum junction temperature

- Exceptional dv/dt capability
- 100% avalanche tested
- Application oriented characterization

### Applications

- Switching applications

### Description

These Power MOSFETs have been developed using STMicroelectronics' unique STripFET process, which is specifically designed to minimize input capacitance and gate charge. This renders the devices suitable for use as primary switch in advanced high-efficiency isolated DC-DC converters for telecom and computer applications, and applications with low gate charge driving requirements.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STD16NF25	16NF25	DPAK	Tape and reel
STF16NF25		TO-220FP	Tube
STP16NF25		TO-220	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		DPAK TO-220	TO-220FP	
$V_{DS}$	Drain-source voltage	250		V
$V_{GS}$	Gate- source voltage	± 20		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	14	14 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	8.8	8.8 <sup>(1)</sup>	A
$I_{DM}^{(2)}$	Drain current (pulsed)	56	56 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	85	25	W
	Derating factor	0.68	0.2	W/°C
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	15		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; $T_C = 25\text{ °C}$ )		2500	V
$T_{stg}$	Storage temperature	-55 to 150		°C
$T_j$	Max. operating junction temperature			

1. Limited by maximum junction temperature
2. Pulse width limited by safe operating area.
3.  $I_{SD} \leq 13A$ ,  $di/dt \leq 300A/\mu s$ ,  $V_{DD} \leq 80\% V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		TO-220	DPAK	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	1.47		5	°C/W
$R_{thj-pcb}$	Thermal resistance junction to pcb max		50		°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5		62.5	°C/W

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_{jmax}$ )	13	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ °C}$ , $I_{AR} = 13\text{ A}$ , $V_{DD} = 50\text{ V}$ )	100	mJ

## 2 Electrical characteristics

( $T_C = 25\text{ °C}$  unless otherwise specified)

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0, I_D = 1\text{ mA}$	250			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0, V_{DS} = 250\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0, V_{DS} = 250\text{ V}, T_C = 125\text{ °C}$			10	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0, V_{GS} = \pm 20\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}, I_D = 6.5\text{ A}$		0.195	0.235	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 25\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$	-	680	-	pF
$C_{oss}$	Output capacitance		-	125	-	pF
$C_{rss}$	Reverse transfer capacitance		-	20	-	pF
$C_{oss\text{ eq.}}^{(1)}$	Equivalent output capacitance	$V_{DS} = 0\text{ to }200\text{ V}, V_{GS} = 0$	-	48	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}, I_D = 0$	-	2.1	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 200\text{ V}, I_D = 13\text{ A}, V_{GS} = 10\text{ V}$ (see <a href="#">Figure 19</a> )	-	18	-	nC
$Q_{gs}$	Gate-source charge		-	3	-	nC
$Q_{gd}$	Gate-drain charge		-	8	-	nC

1.  $C_{oss\text{ eq.}}$  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
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 125\text{ V}$ , $I_D = 6.5\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	9	-	ns
$t_r$	Rise time		-	17	-	ns
$t_{d(off)}$	Turn-off delay time		-	35	-	ns
$t_f$	Fall time		-	17	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-	-	14	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-	-	56	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 13\text{ A}$ , $V_{GS} = 0$	-	-	1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 13\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see <a href="#">Figure 20</a> )	-	133		ns
$Q_{rr}$	Reverse recovery charge		-	651		nC
$I_{RRM}$	Reverse recovery current		-	10		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 13\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$ (see <a href="#">Figure 20</a> )	-	157		ns
$Q_{rr}$	Reverse recovery charge		-	895		nC
$I_{RRM}$	Reverse recovery current		-	11		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

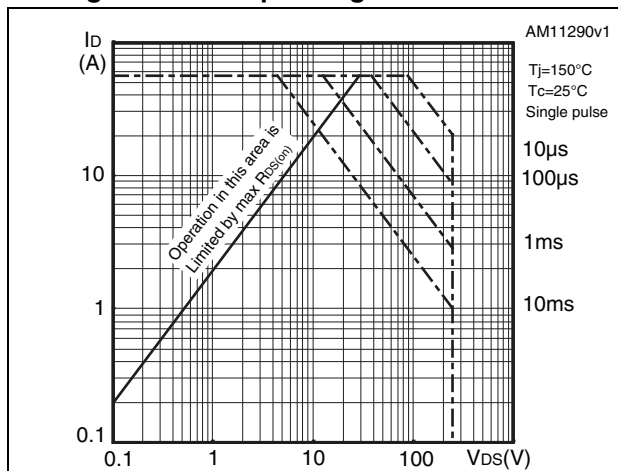


Figure 3. Thermal impedance for TO-220

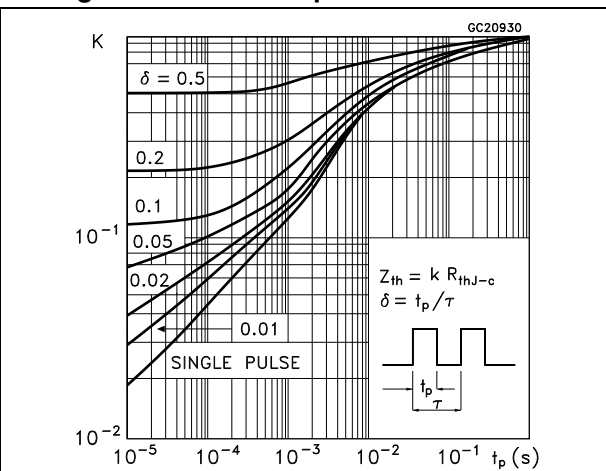


Figure 4. Safe operating area for TO-220FP

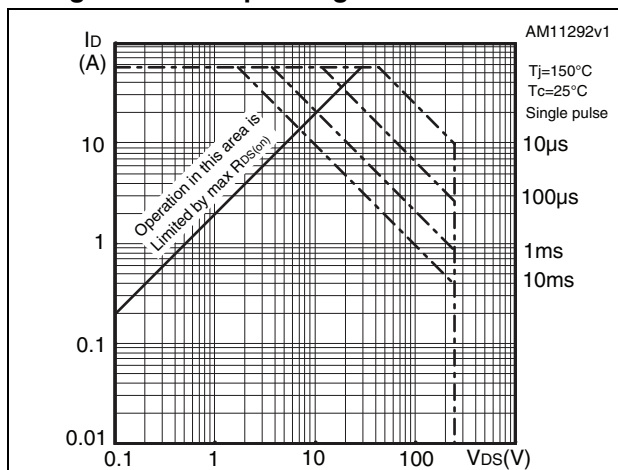


Figure 5. Thermal impedance for TO-220FP

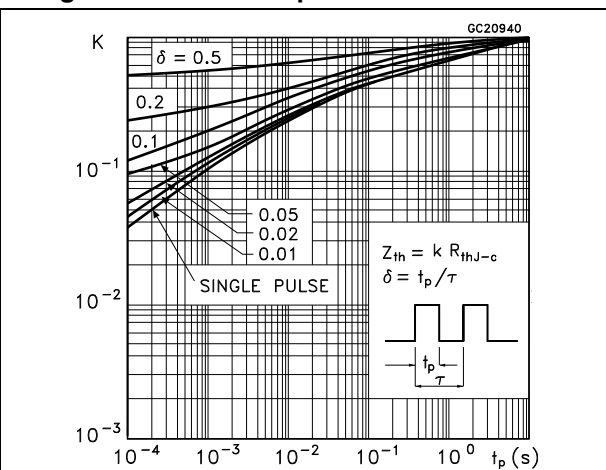


Figure 6. Safe operating area for DPAK

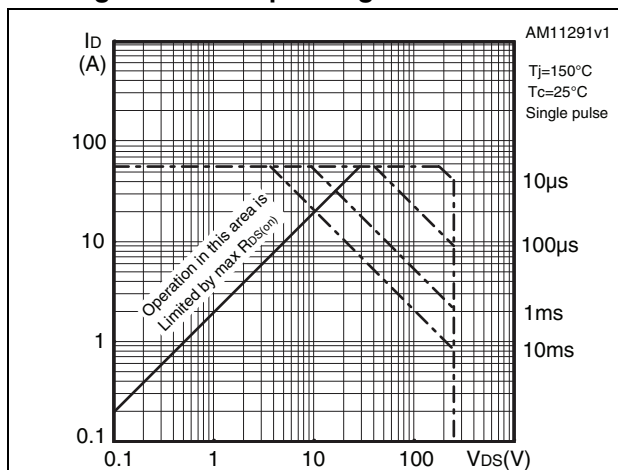


Figure 7. Thermal impedance for DPAK

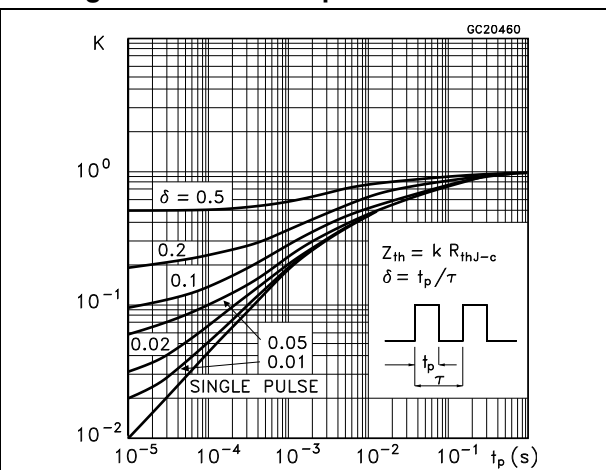


Figure 8. Output characteristics

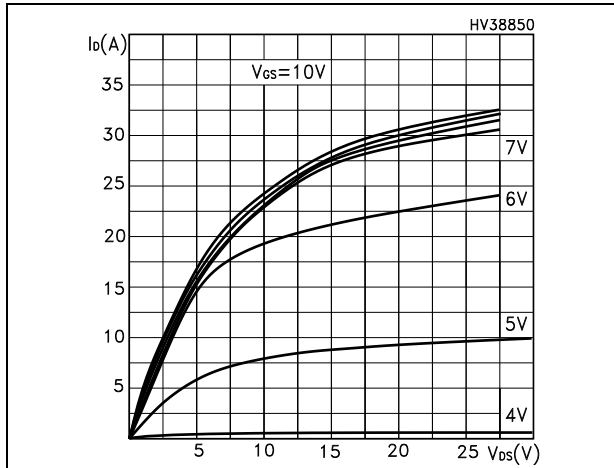


Figure 9. Transfer characteristics

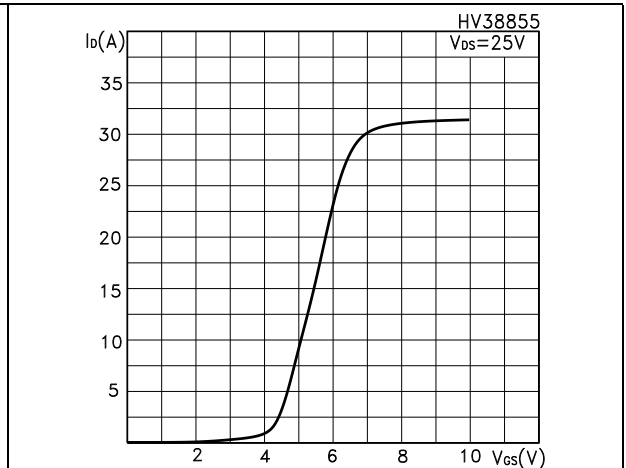


Figure 10. Normalized  $BV_{DSS}$  vs temperature

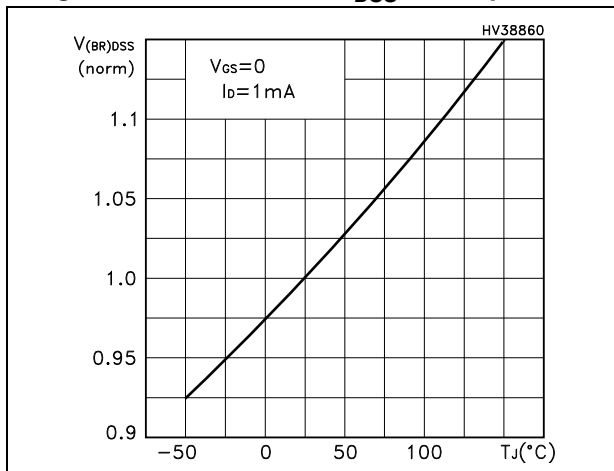


Figure 11. Static-drain source on-resistance

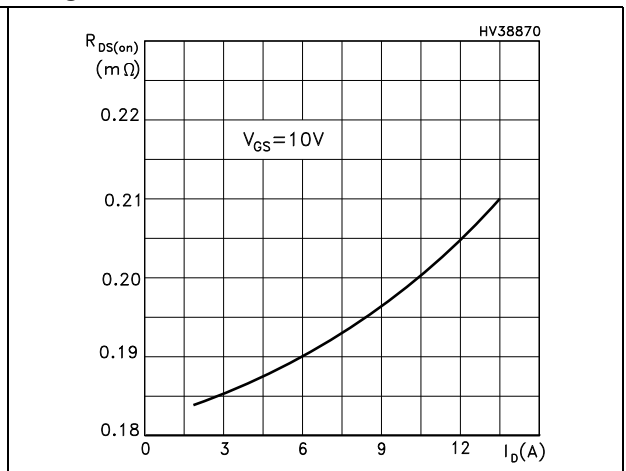


Figure 12. Gate charge vs gate-source voltage

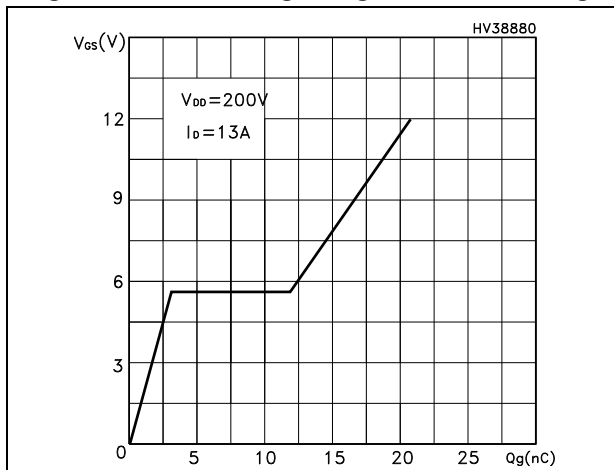


Figure 13. Capacitance variations

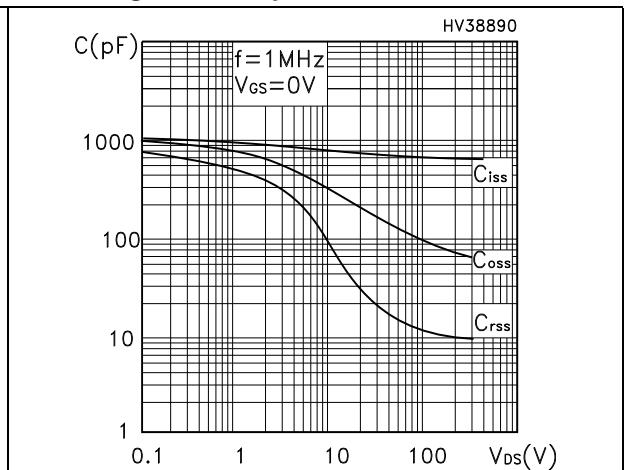


Figure 14. Normalized gate threshold voltage vs temperature

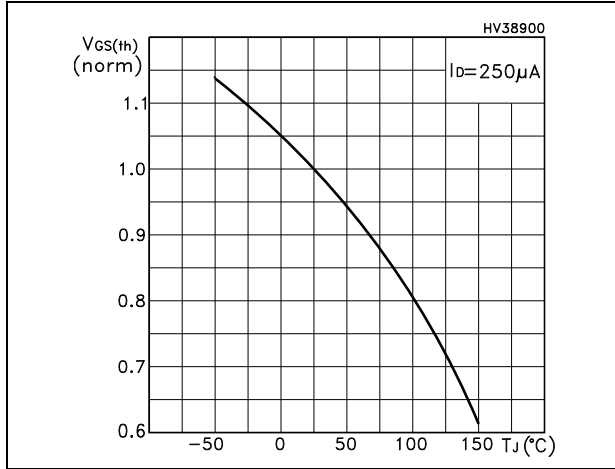


Figure 15. Normalized on-resistance vs temperature

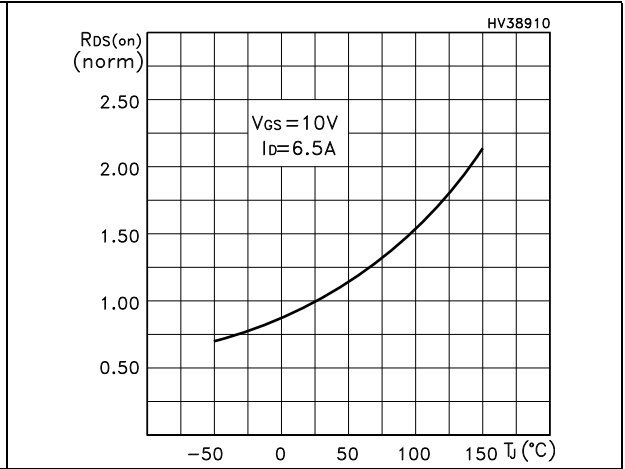


Figure 16. Source-drain diode forward characteristics

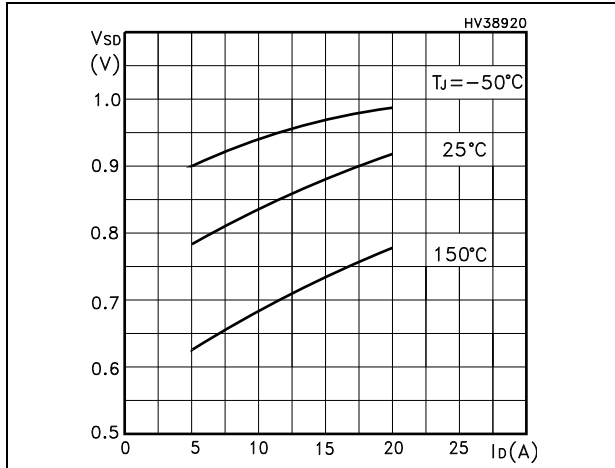
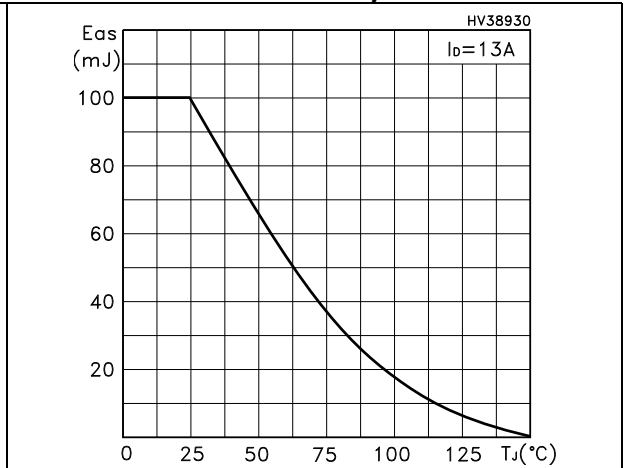


Figure 17. Maximum avalanche energy vs starting Tj





### 3 Test circuit

Figure 18. Switching times test circuit for resistive load

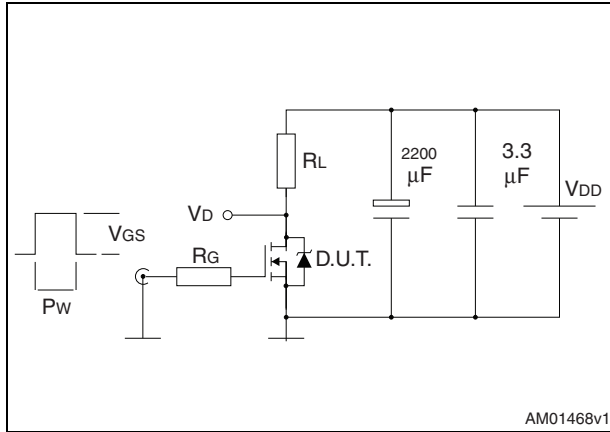


Figure 19. Gate charge test circuit

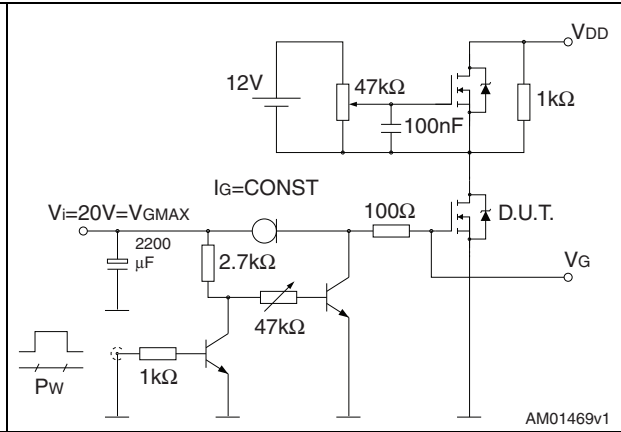


Figure 20. Test circuit for inductive load switching and diode recovery times

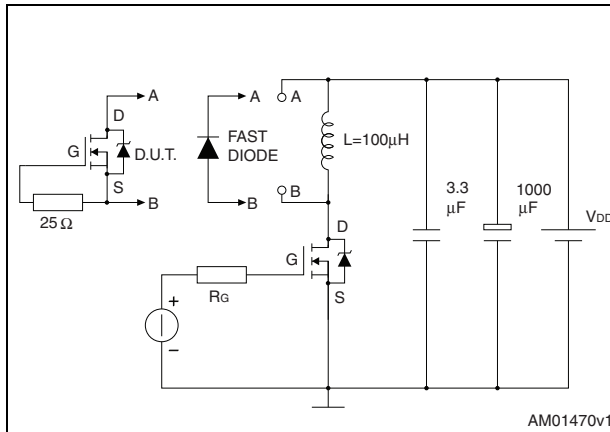


Figure 21. Unclamped inductive load test circuit

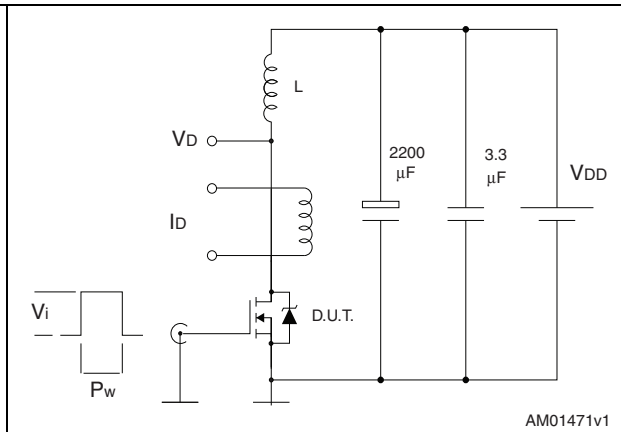


Figure 22. Unclamped inductive waveform

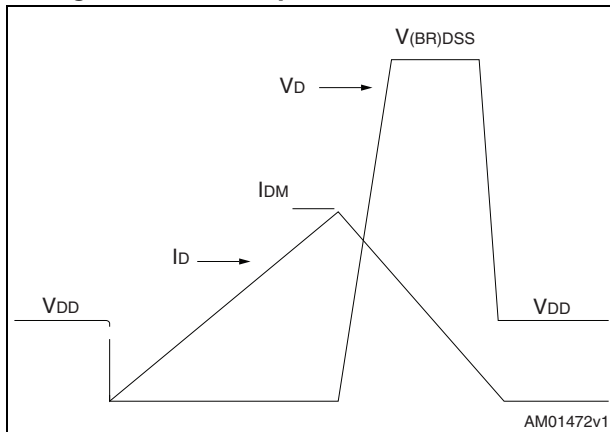
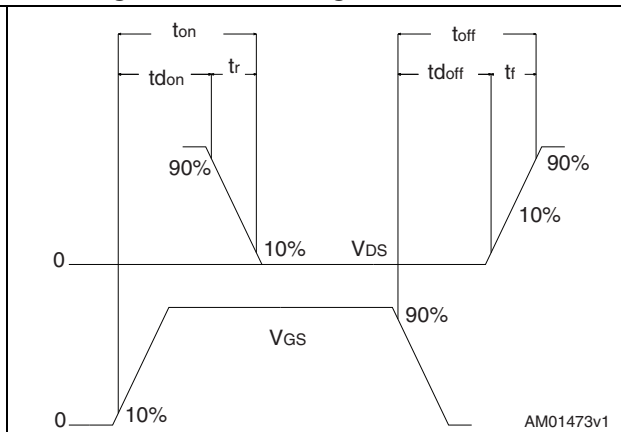


Figure 23. Switching time waveform



## 4 Package mechanical data

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

Table 9. 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 24. DPAK (TO-252) drawing

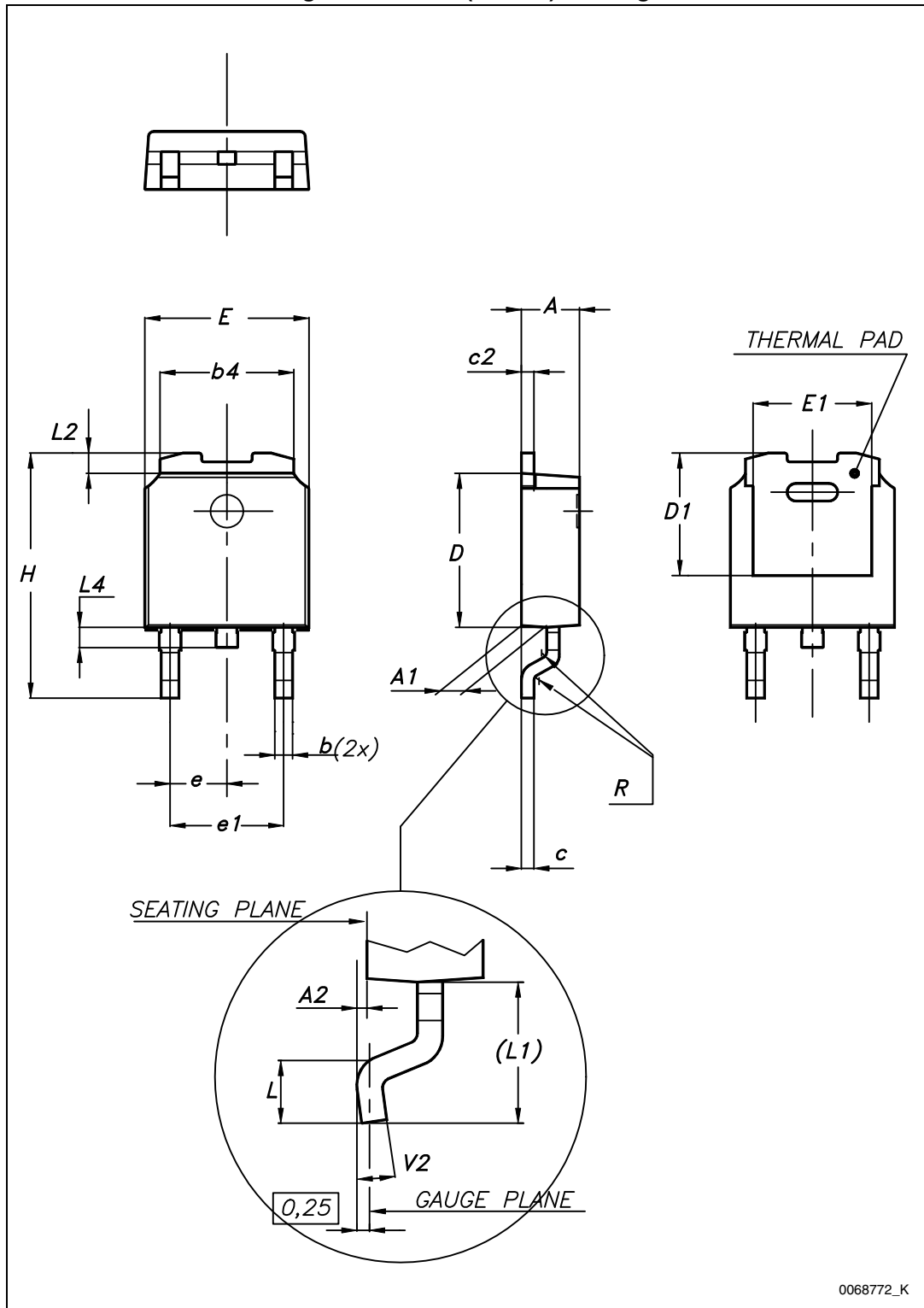
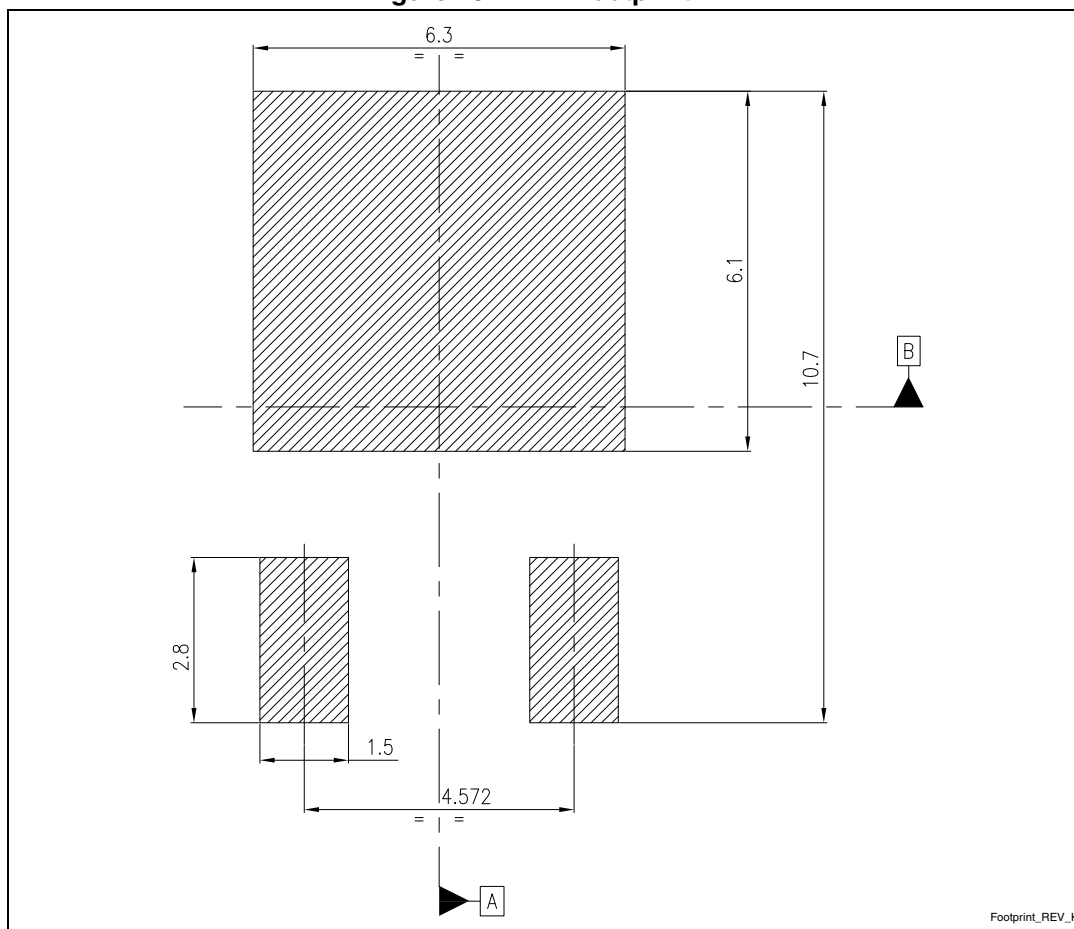


Figure 25. DPAK footprint (a)

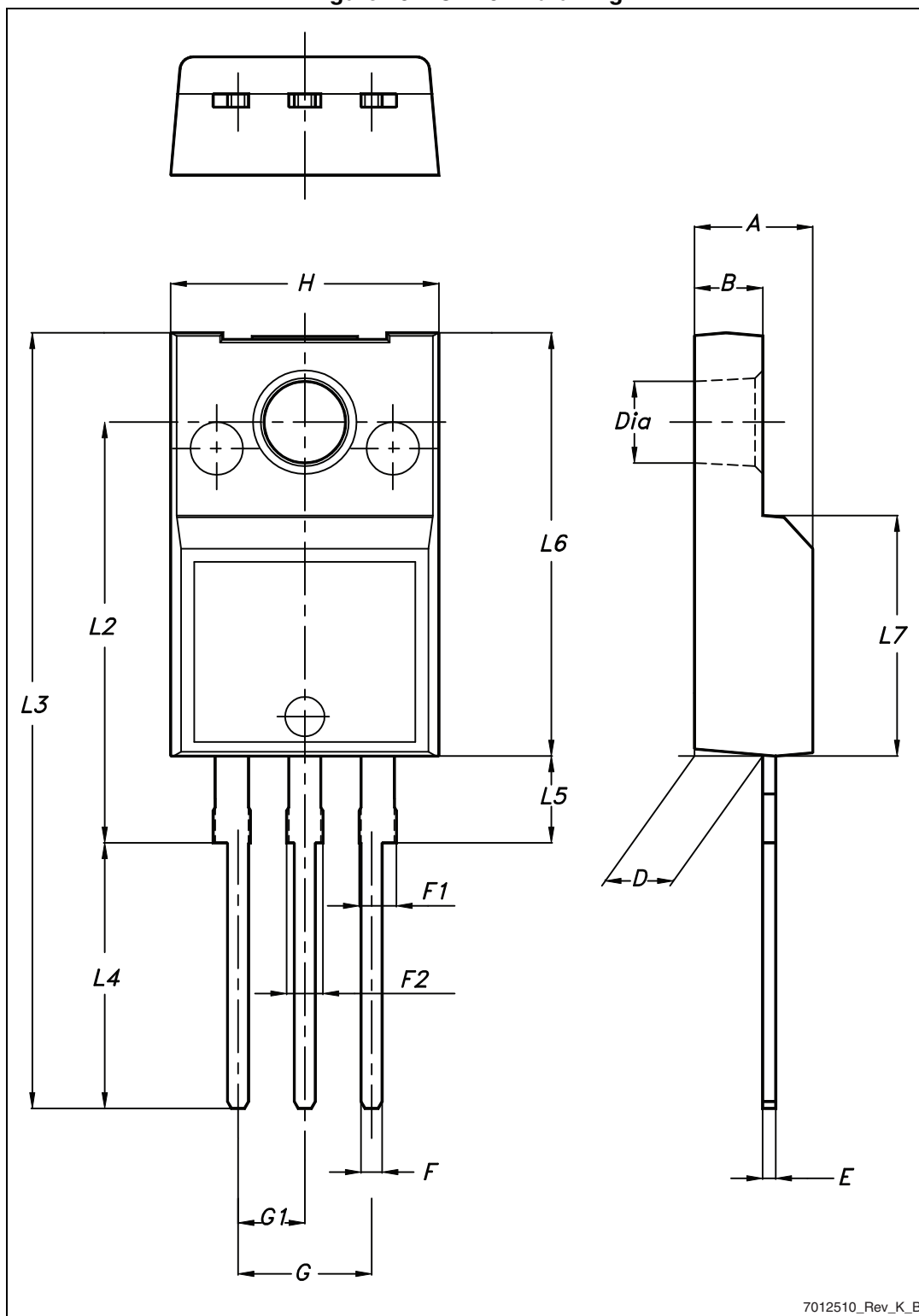


a. All dimensions are in millimeters

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

Figure 26. TO-220FP drawing



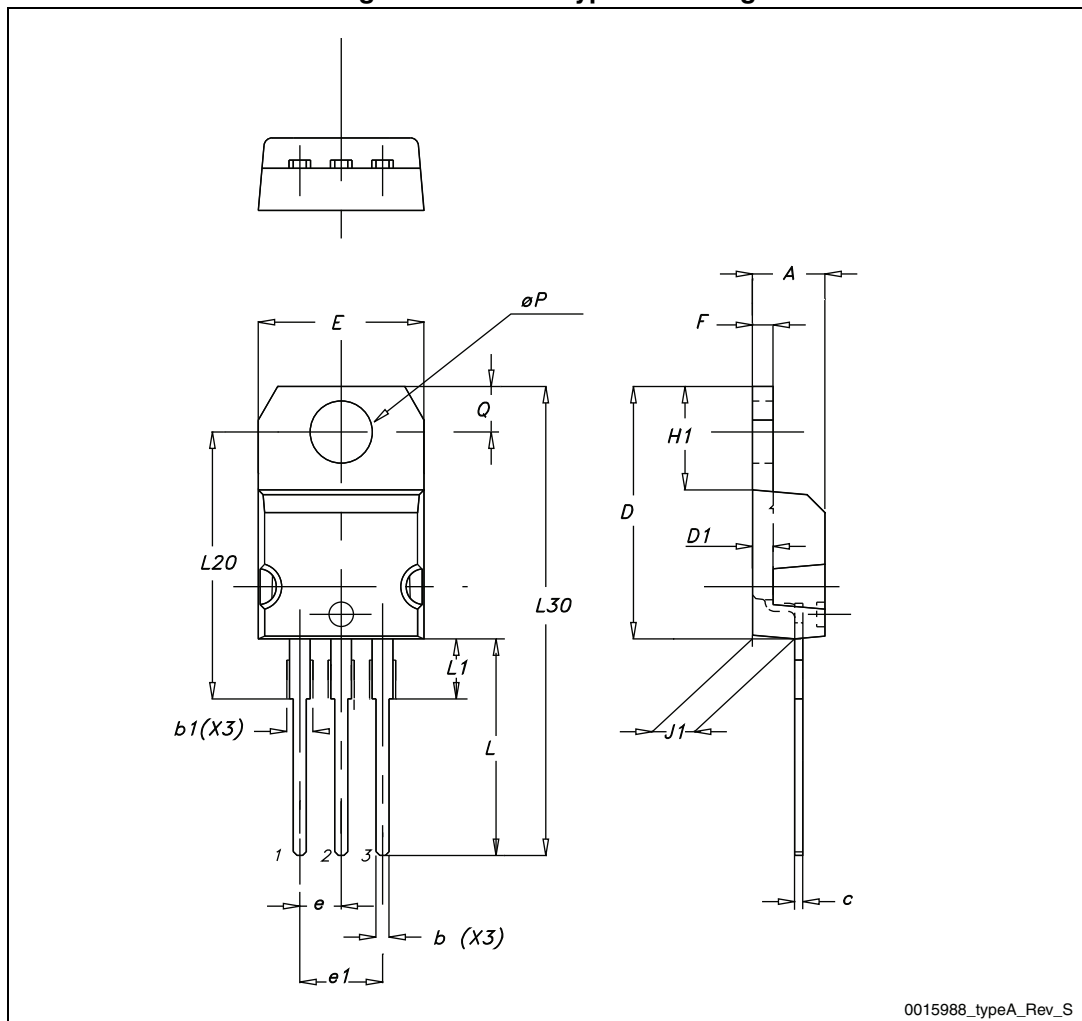
7012510\_Rev\_K\_B

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	
ØP	3.75		3.85
Q	2.65		2.95



Figure 27. TO-220 type A 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 28. Tape for DPAK (TO-252)

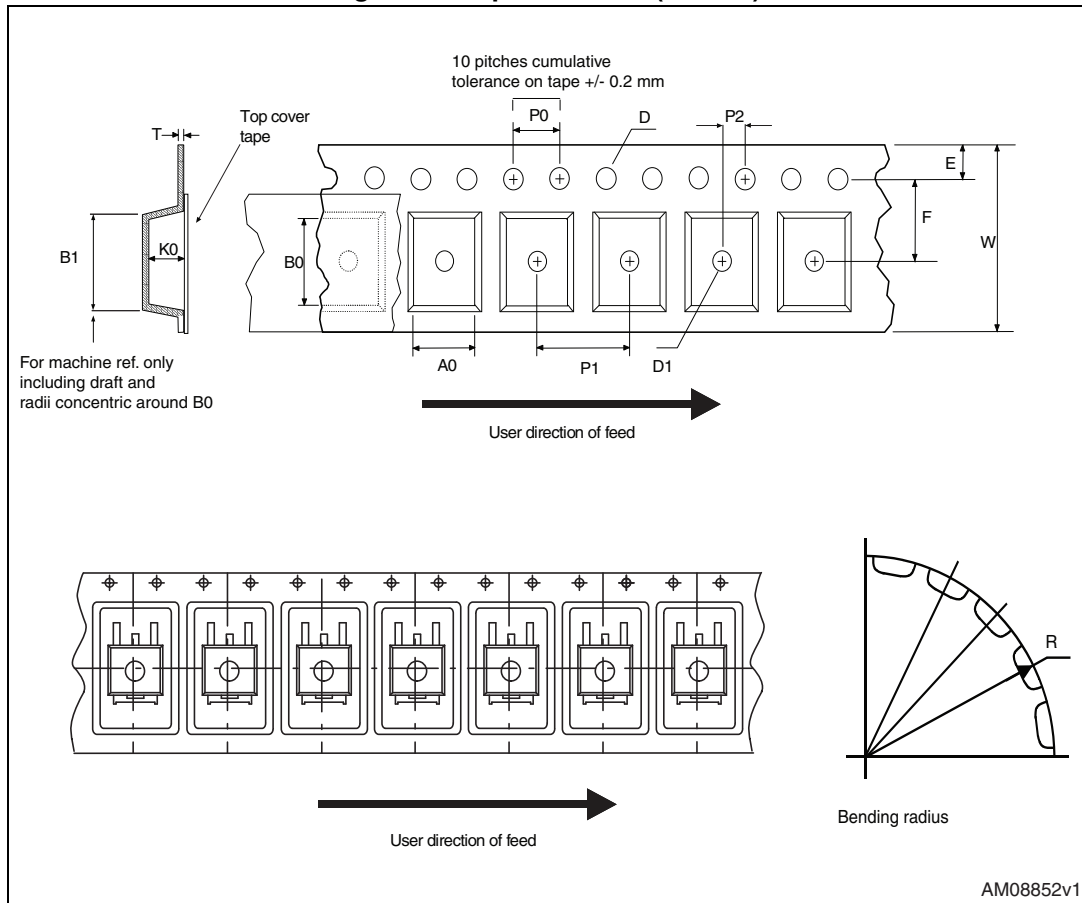
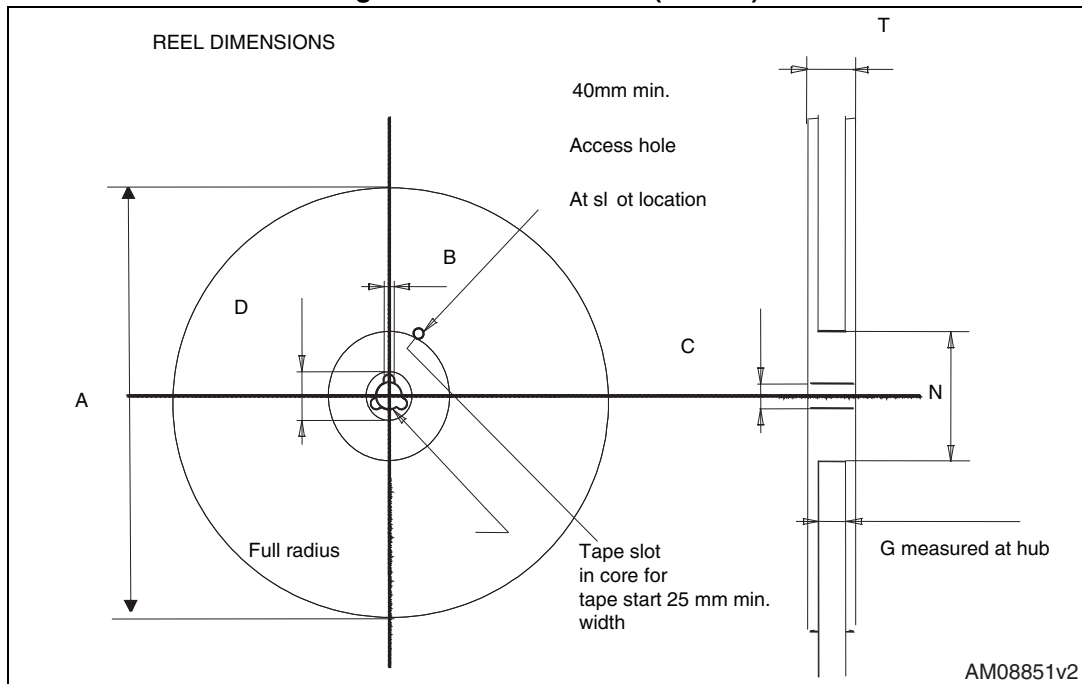


Figure 29. Reel for DPAK (TO-252)



## 6 Revision history

**Table 13. Document revision history**

Date	Revision	Changes
12-Oct-2007	1	Initial release.
13-Nov-2007	2	Modified: <i>Figure 13: Capacitance variations</i> .
29-Mar-2012	3	<p><i>Figure 2: Safe operating area for TO-220</i>, <i>Figure 4: Safe operating area for TO-220FP</i> and <i>Figure 6: Safe operating area for DPAK</i> have been updated.</p> <p><i>Section 4: Package mechanical data</i> and <i>Section 5: Packaging mechanical data</i> have been updated.</p> <p>Minor text changes</p>
06-Mar-2013	4	<ul style="list-style-type: none"> <li>– Modified: <math>P_{TOT}</math>, derating factor values, <i>note 1</i> on <i>Table 2</i>, <math>R_{thj-case}</math>, <math>R_{thj-amb}</math> only for TO-220 and DPAK</li> <li>– Updated: <i>Section 4: Package mechanical data</i></li> <li>– Minor text changes</li> </ul>

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