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N-channel 525 V, 2.1  $\Omega$  typ., 4.0 A Power MOSFET  
in DPAK, I<sup>2</sup>PAKFP, TO-220 and IPAK packages

Datasheet - production data

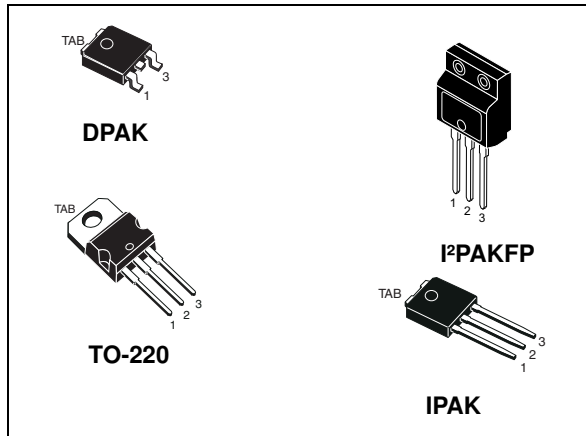
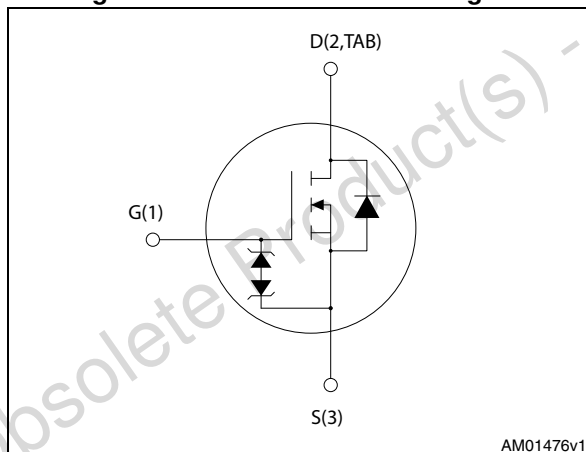


Figure 1. Internal schematic diagram



## Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STDLED524	525 V	< 2.6 $\Omega$	4.0 A	45 W
STFILED524				20 W
STPLED524				45 W
STULED524				

- 100% avalanche tested
- Extremely high dv/dt capability
- Very low intrinsic capacitance
- Improved diode reverse recovery characteristics
- Zener-protected

## Applications

- LED lighting applications

## Description

These Power MOSFETs boast extremely low on-resistance and very good dv/dt capability, rendering them suitable for buck-boost and flyback topologies.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STDLED524	LED524	DPAK	Tape and reel
STFILED524		I <sup>2</sup> PAKFP (TO-281)	Tube
STPLED524		TO-220	
STULED524		IPAK	

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Obsolete Product(s) - Obsolete Product(s)



# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		DPAK, IPAK	I <sup>2</sup> PAKFP	TO-220	
V <sub>DS</sub>	Drain-source voltage	525			V
V <sub>GS</sub>	Gate-source voltage	± 30			V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	4.0	4.0 <sup>(1)</sup>	4.0	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	2.9	2.9 <sup>(1)</sup>	2.9	A
I <sub>DM</sub> <sup>(2)</sup>	Drain current (pulsed)	14	14 <sup>(1)</sup>	14	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	45	20	45	W
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>J</sub> max.)	1.3			A
E <sub>AS</sub>	Single pulse avalanche energy (starting T <sub>J</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	110			mJ
dv/dt <sup>(3)</sup>	Peak diode recovery voltage slope	12			V/ns
V <sub>ISO</sub>	Insulation withstand voltage (AC)		2500		V
T <sub>J</sub> T <sub>stg</sub>	Operating junction temperature Storage temperature	- 55 to 150			°C

- Limited only by maximum temperature allowed.
- Pulse width limited by safe operating area.
- I<sub>SD</sub> ≤ 2.5 A, di/dt ≤ 400 A/μs, V<sub>DS</sub> peak ≤ V<sub>(BR)DSS</sub>, V<sub>DD</sub> = 80% V<sub>(BR)DSS</sub>.

**Table 3. Thermal data**

Symbol	Parameter	Value				Unit
		DPAK	I <sup>2</sup> PAKFP	TO-220	IPAK	
R <sub>thj-case</sub>	Thermal resistance junction-case max.	2.78	6.25	2.78		°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max.		62.5		100	°C/W
R <sub>thj-pcb</sub> <sup>(1)</sup>	Thermal resistance junction-pcb max.	50				°C/W
T <sub>l</sub>	Maximum lead temperature for soldering purpose		300			

- When mounted on 1inch sq FR-4 board, 2 oz Cu.



## 2 Electrical characteristics

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

**Table 4. On/off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{DSS}}$	Drain-source breakdown voltage	$I_{\text{D}} = 1\text{ mA}$ , $V_{\text{GS}} = 0$	525			V
$I_{\text{DSS}}$	Zero gate voltage drain current ( $V_{\text{GS}} = 0$ )	$V_{\text{DS}} = 525\text{ V}$ $V_{\text{DS}} = 525\text{ V}$ , $T_{\text{C}} = 125\text{ °C}$			1 50	$\mu\text{A}$ $\mu\text{A}$
$I_{\text{GSS}}$	Gate-body leakage current ( $V_{\text{DS}} = 0$ )	$V_{\text{GS}} = \pm 20\text{ V}$ ; $V_{\text{DS}} = 0$			10	$\mu\text{A}$
$V_{\text{GS}(\text{th})}$	Gate threshold voltage	$V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 50\text{ }\mu\text{A}$	3	3.6	4.5	V
$R_{\text{DS}(\text{on})}$	Static drain-source on-resistance	$V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 2.2\text{ A}$		2.1	2.6	$\Omega$

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{\text{iss}}$	Input capacitance	$V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0$	-	340	-	$\mu\text{F}$
$C_{\text{oss}}$	Output capacitance			30		$\mu\text{F}$
$C_{\text{rss}}$	Reverse transfer capacitance			6		$\mu\text{F}$
$C_{\text{oss eq.}}^{(1)}$	Equivalent output capacitance	$V_{\text{DS}} = 0$ to $420\text{ V}$ , $V_{\text{GS}} = 0$	-	22	-	$\mu\text{F}$
$R_{\text{g}}$	Gate input resistance	$f = 1\text{ MHz}$ open drain	-	4	-	$\Omega$
$Q_{\text{g}}$	Total gate charge	$V_{\text{DD}} = 400\text{ V}$ , $I_{\text{D}} = 2.5\text{ A}$ , $V_{\text{GS}} = 10\text{ V}$ (see <a href="#">Figure 19</a> )	-	12	-	nC
$Q_{\text{gs}}$	Gate-source charge			2.2		nC
$Q_{\text{gd}}$	Gate-drain charge			7.5		nC

1.  $C_{\text{oss eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{\text{oss}}$  when  $V_{\text{DS}}$  increases from 0 to 80%  $V_{\text{DS}}$ .

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{\text{d}(\text{on})}$	Turn-on delay time	$V_{\text{DD}} = 260\text{ V}$ , $I_{\text{D}} = 1.25\text{ A}$ , $R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	8	-	ns
$t_{\text{r}}$	Rise time			7		ns
$t_{\text{d}(\text{off})}$	Turn-off-delay time			21		ns
$t_{\text{f}}$	Fall time			14		ns

Table 7. Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		2.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		10	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 2.5 \text{ A}$ , $V_{GS} = 0$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$	-	173		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}$	-	778		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 20</a> )		9		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$	-	196		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 60 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$	-	941		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current	(see <a href="#">Figure 20</a> )		10		A

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

Table 8. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1 \text{ mA}$ , $I_D = 0$	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 the device's integrity. The integrated Zener diodes thus eliminate the need for external components.

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area DPAK, IPAK

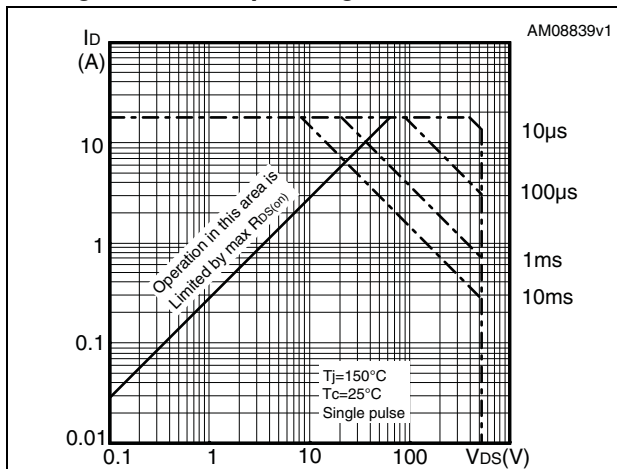


Figure 3. Thermal impedance DPAK, IPAK

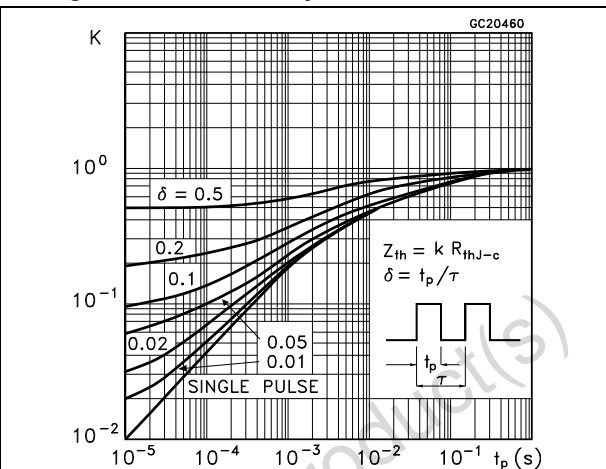


Figure 4. Safe operating area for I<sup>2</sup>PAKFP

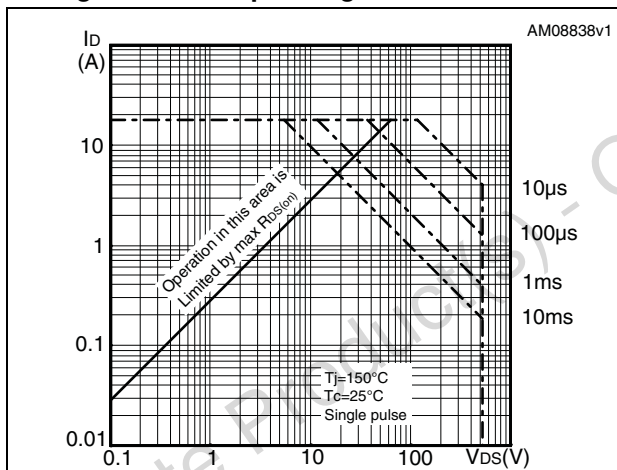


Figure 5. Thermal impedance for I<sup>2</sup>PAKFP

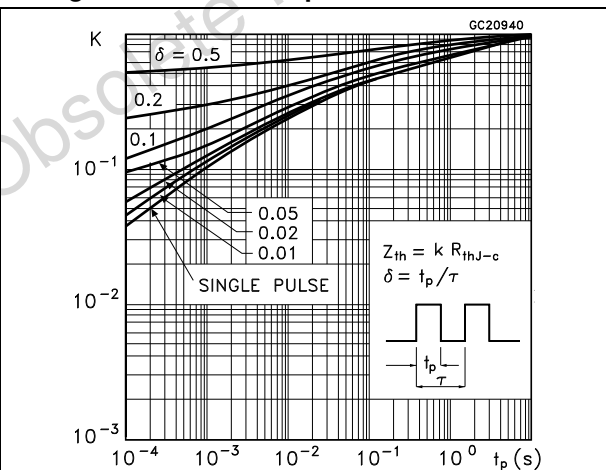


Figure 6. Safe operating area TO-220

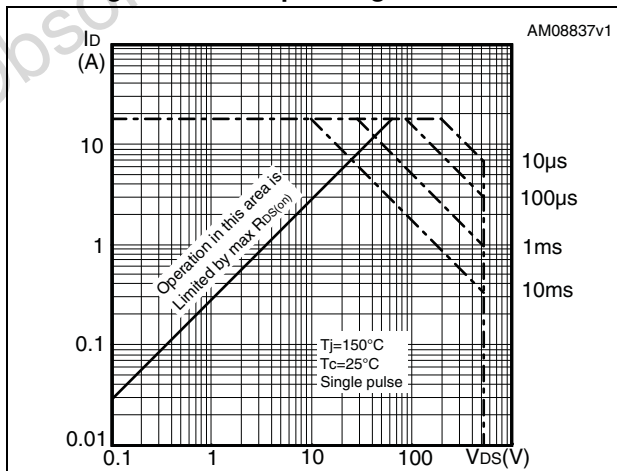


Figure 7. Thermal impedance TO-220

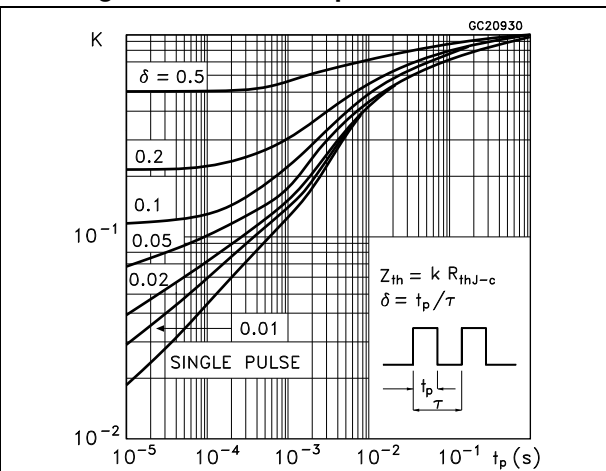


Figure 8. Output characteristics

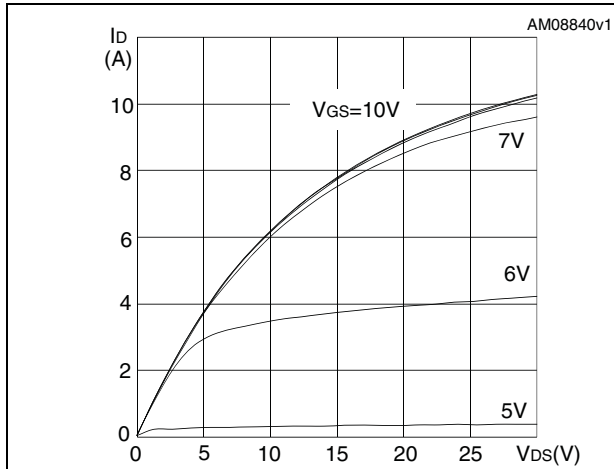


Figure 9. Transfer characteristics

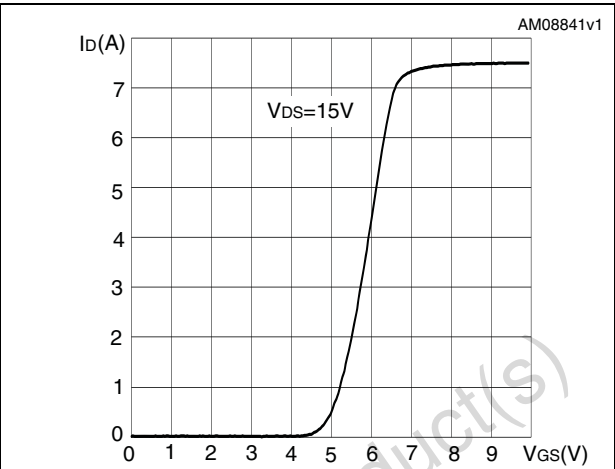


Figure 10. Normalized  $B_{VDSS}$  vs temperature

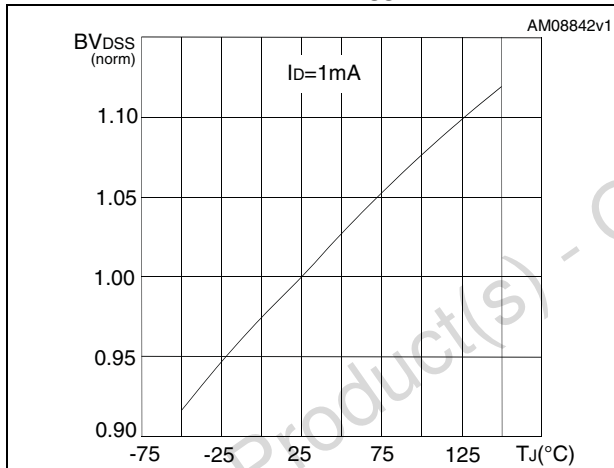


Figure 11. Static drain-source on-resistance

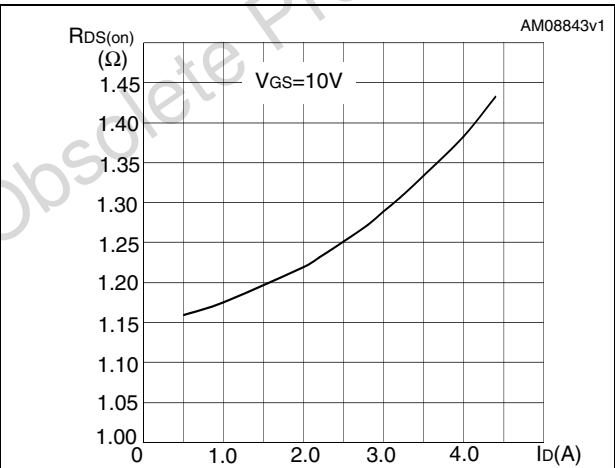


Figure 12. Gate charge vs gate-source voltage

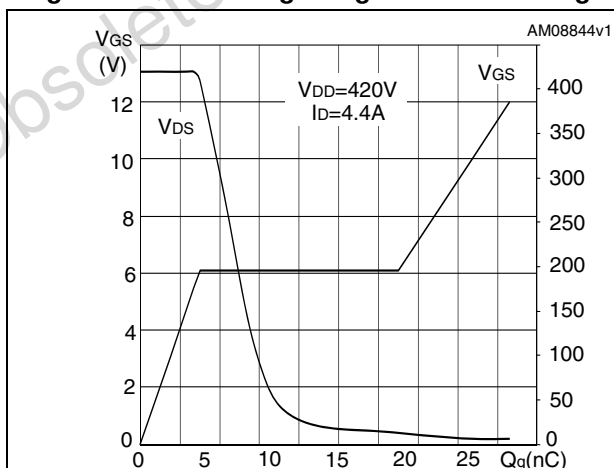


Figure 13. Capacitance variations

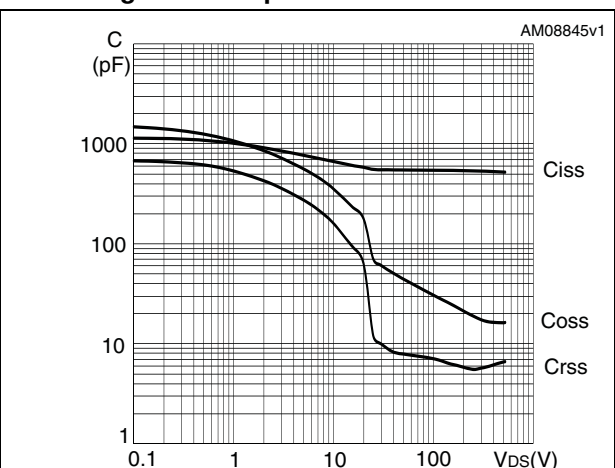




Figure 14. Normalized gate threshold voltage vs temperature

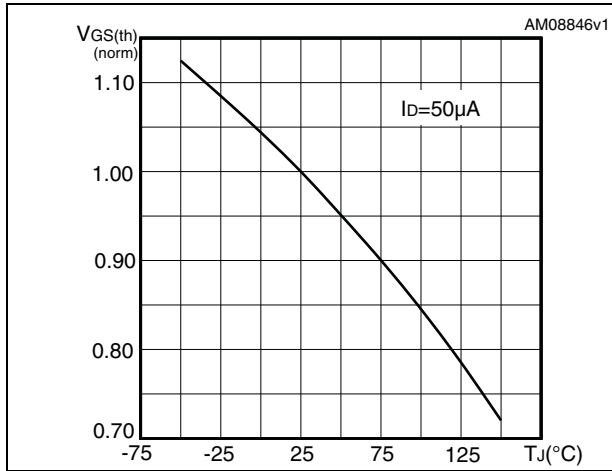


Figure 15. Normalized on-resistance vs temperature

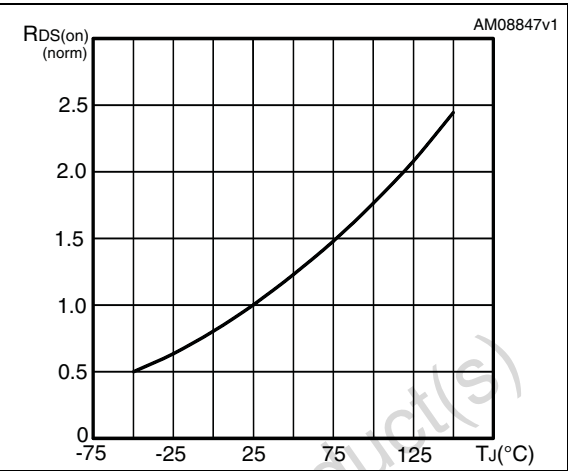


Figure 16. Source-drain diode forward characteristics

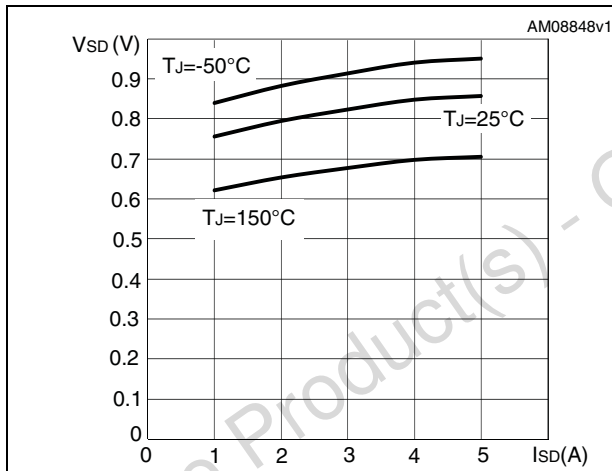
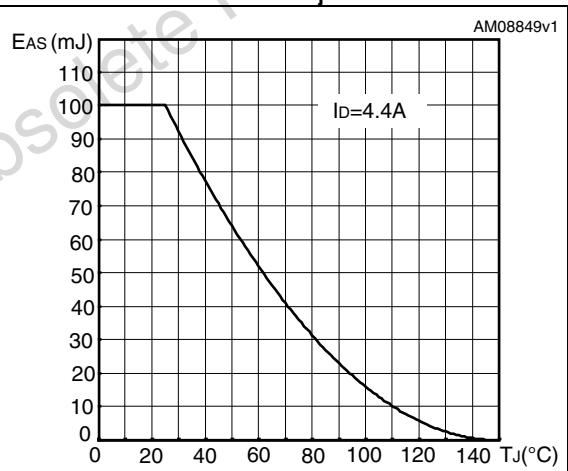
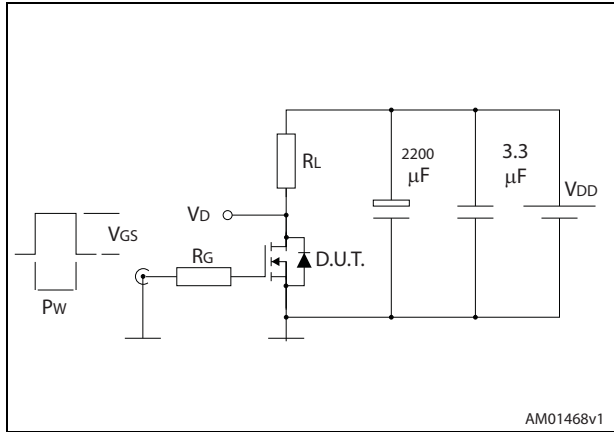


Figure 17. Maximum avalanche energy vs starting T<sub>J</sub>



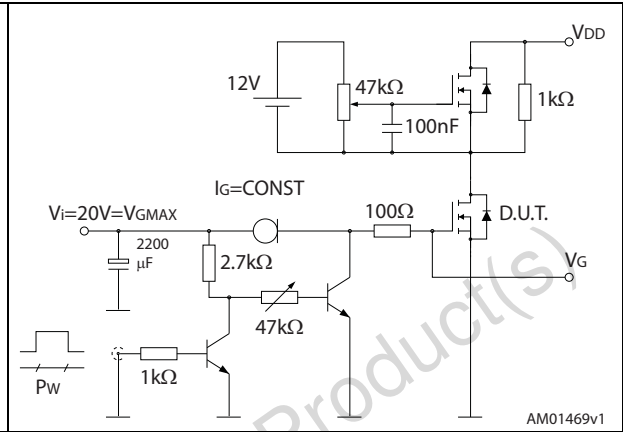
### 3 Test circuits

Figure 18. Switching times test circuit for resistive load



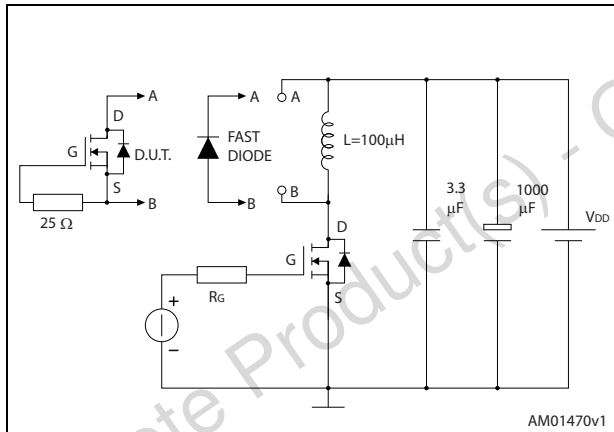
AM01468v1

Figure 19. Gate charge test circuit



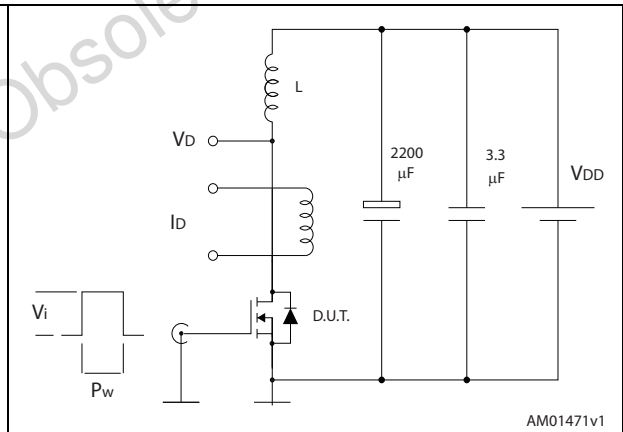
AM01469v1

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



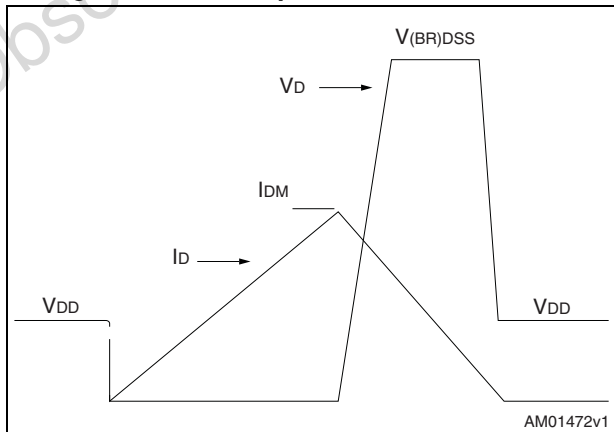
AM01470v1

Figure 21. Unclamped inductive load test circuit



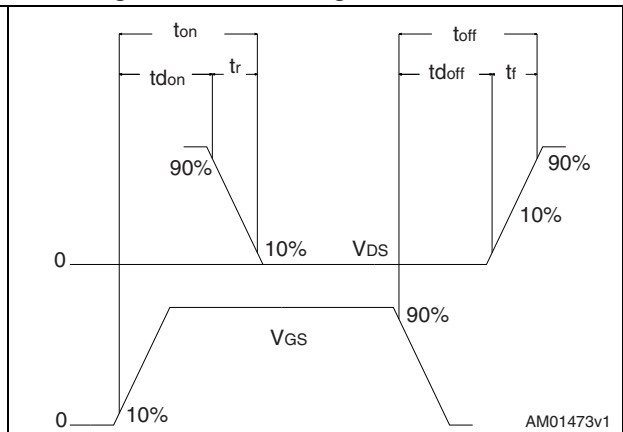
AM01471v1

Figure 22. Unclamped inductive waveform



AM01472v1

Figure 23. Switching time waveform



AM01473v1

## 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) drawings

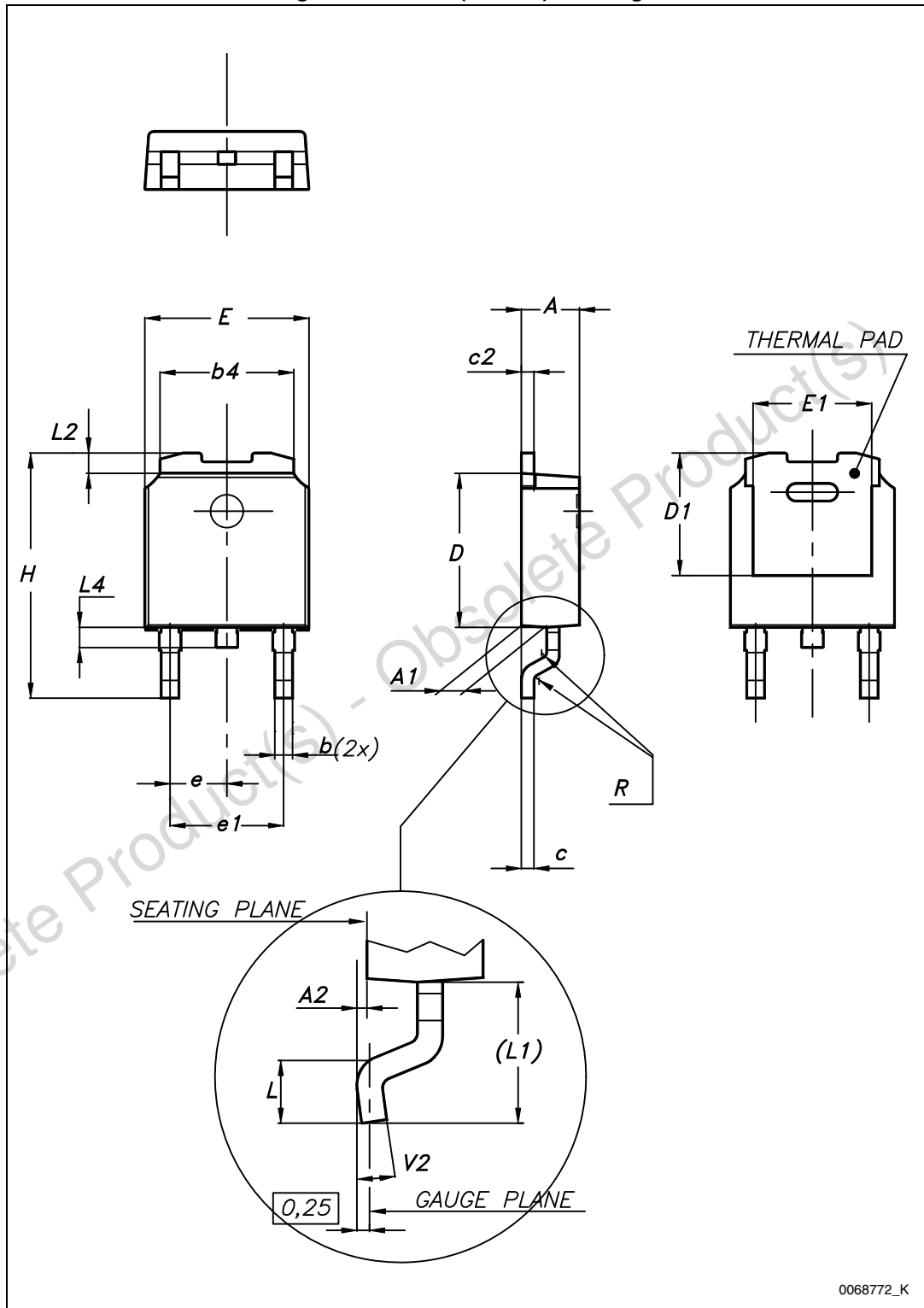
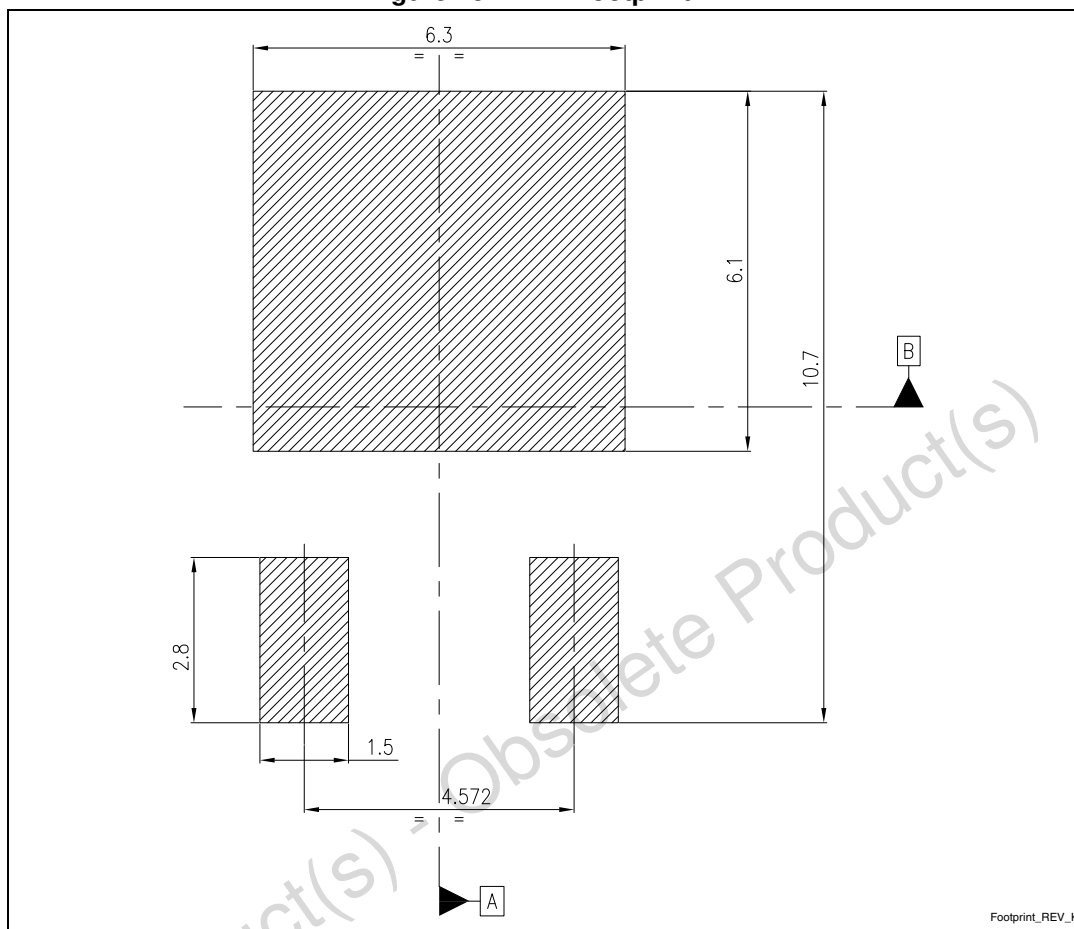


Figure 25. DPAK footprint (a)



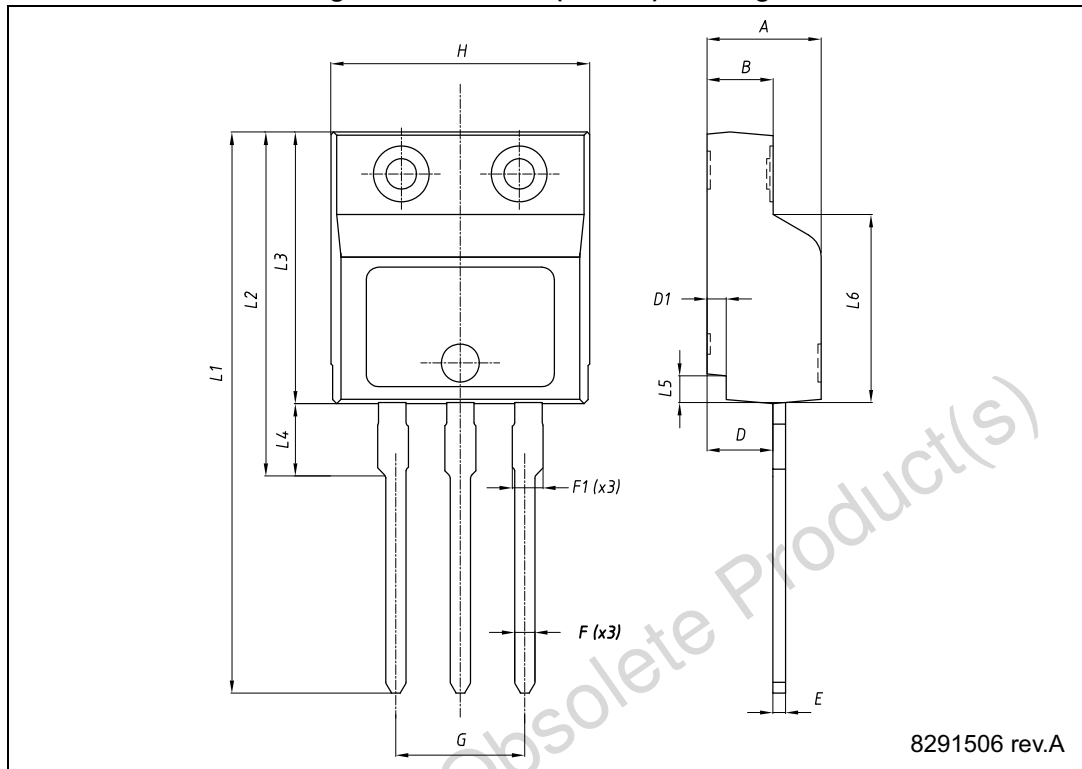
a. All dimensions are in millimeters.



Table 10. I<sup>2</sup>PAKFP (TO-281) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
D1	0.65		0.85
E	0.45		0.70
F	0.75		1.00
F1			1.20
G	4.95	-	5.20
H	10.00		10.40
L1	21.00		23.00
L2	13.20		14.10
L3	10.55		10.85
L4	2.70		3.20
L5	0.85		1.25
L6	7.30		7.50

Figure 26. I<sup>2</sup>PAKFP (TO-281) drawings



Obsolete Product(s) - Obsolete Product(s)

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 drawings

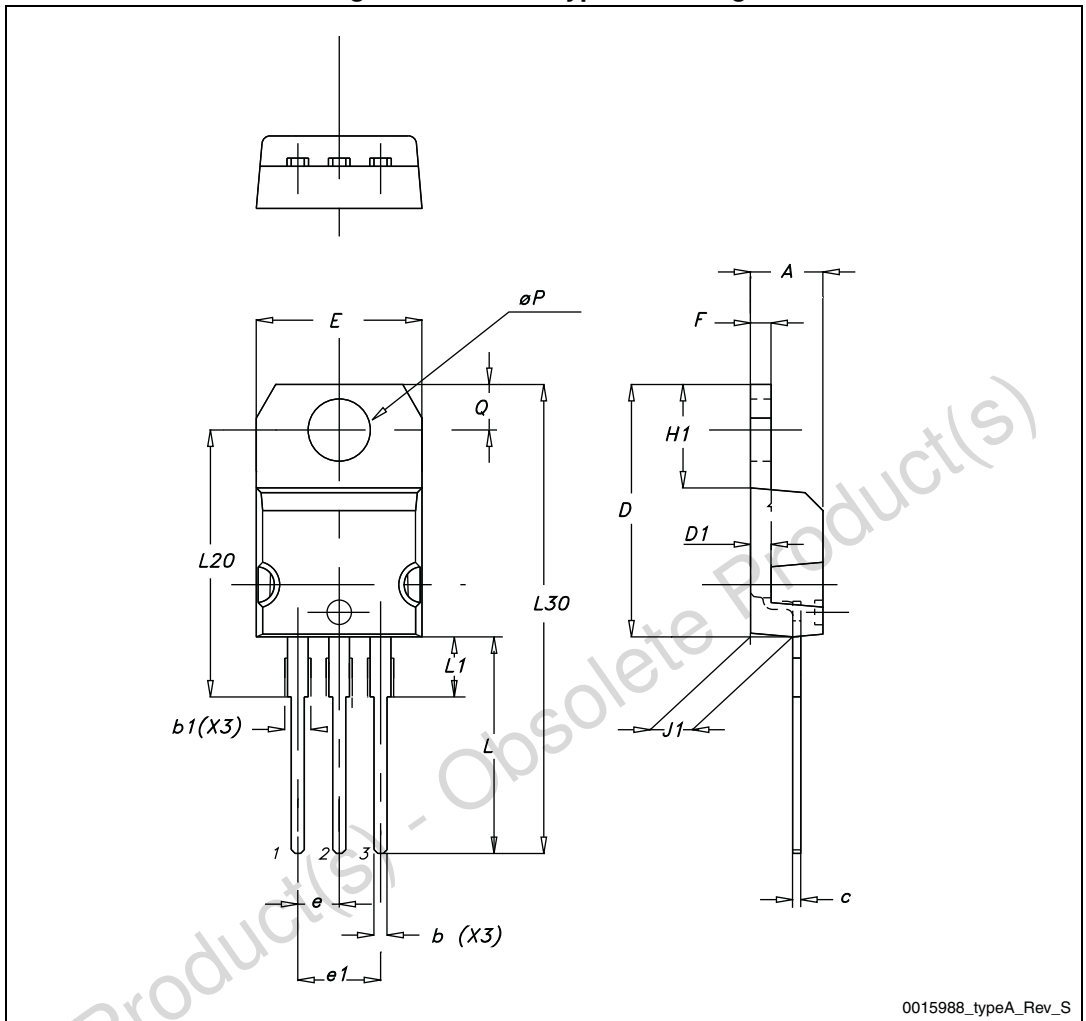
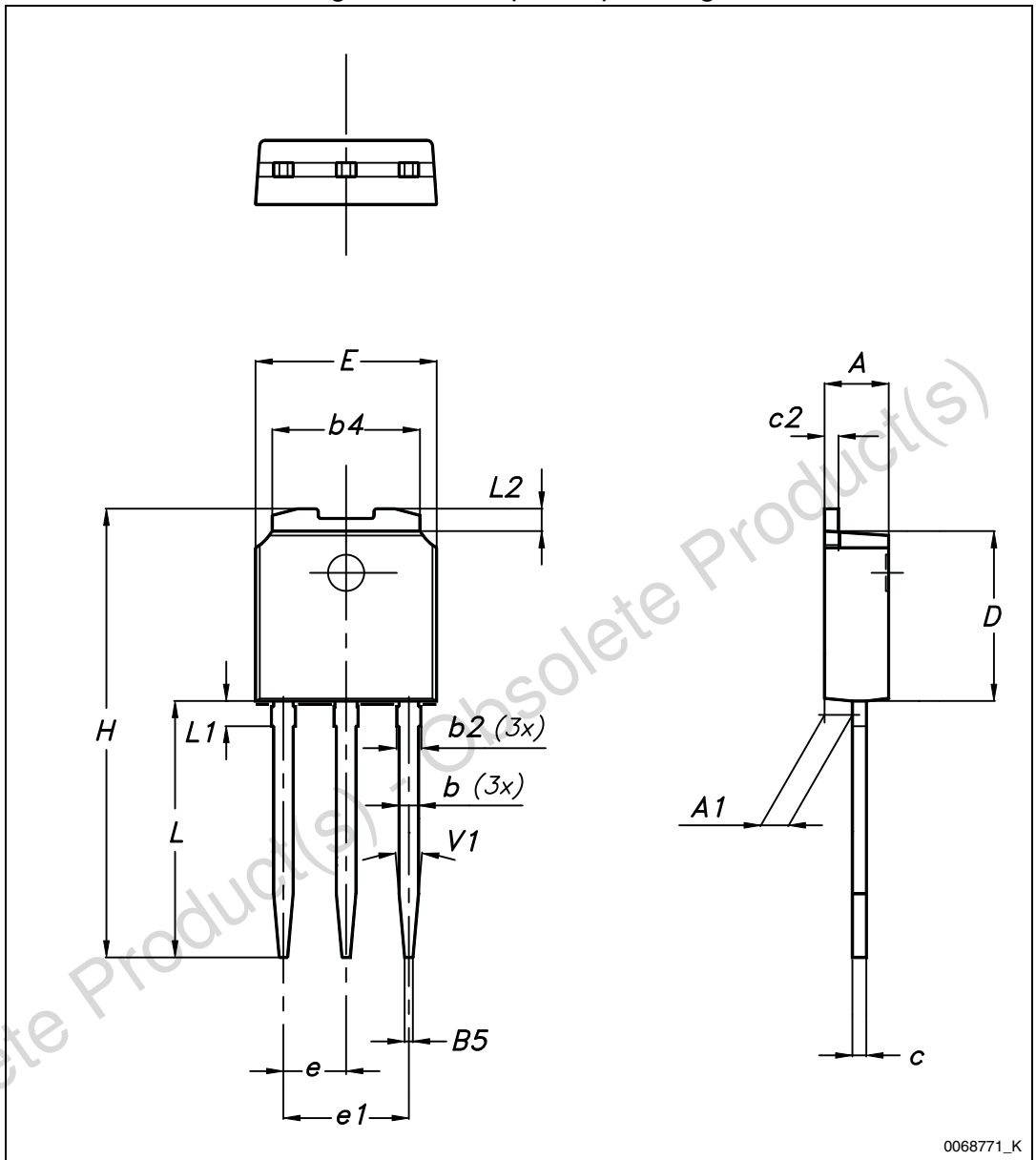


Table 12. IPAK (TO-251) mechanical data

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 28. IPAK (TO-251) drawings



## 5 Packaging mechanical data

Table 13. 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 29. Tape for DPAK (TO-252)

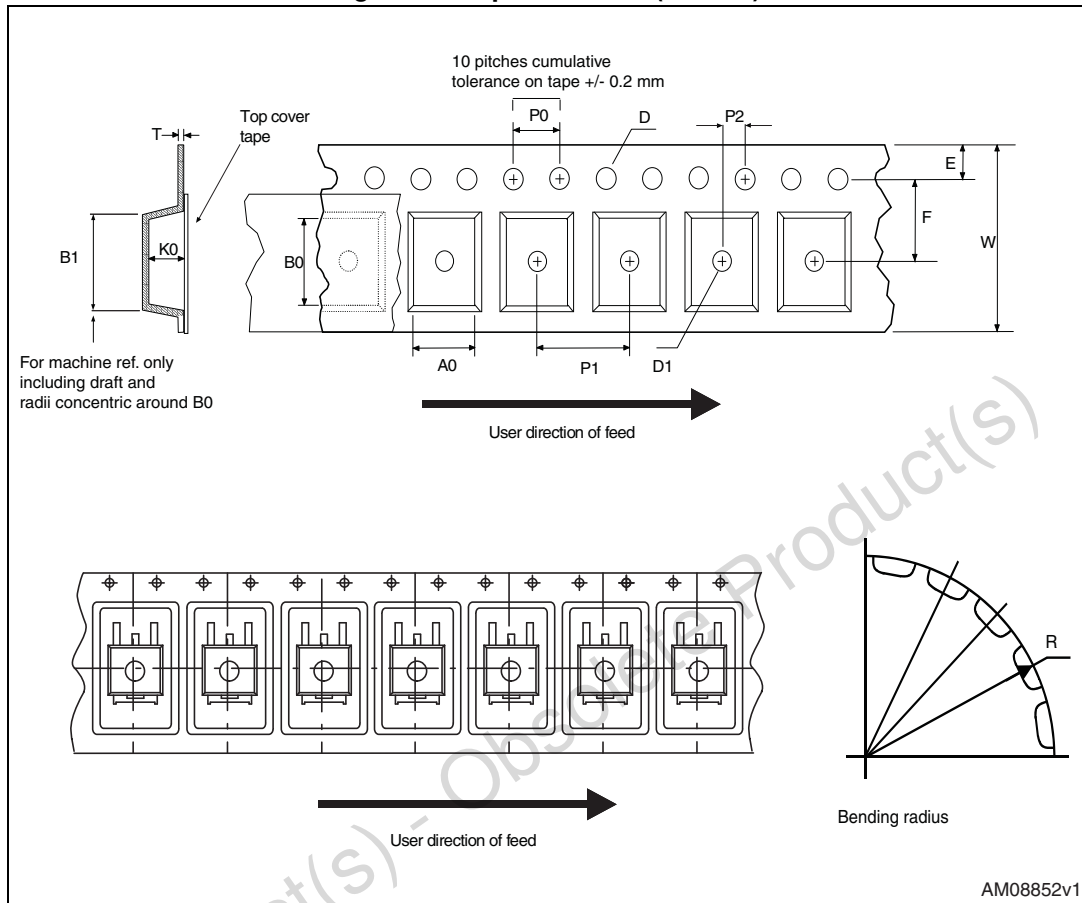
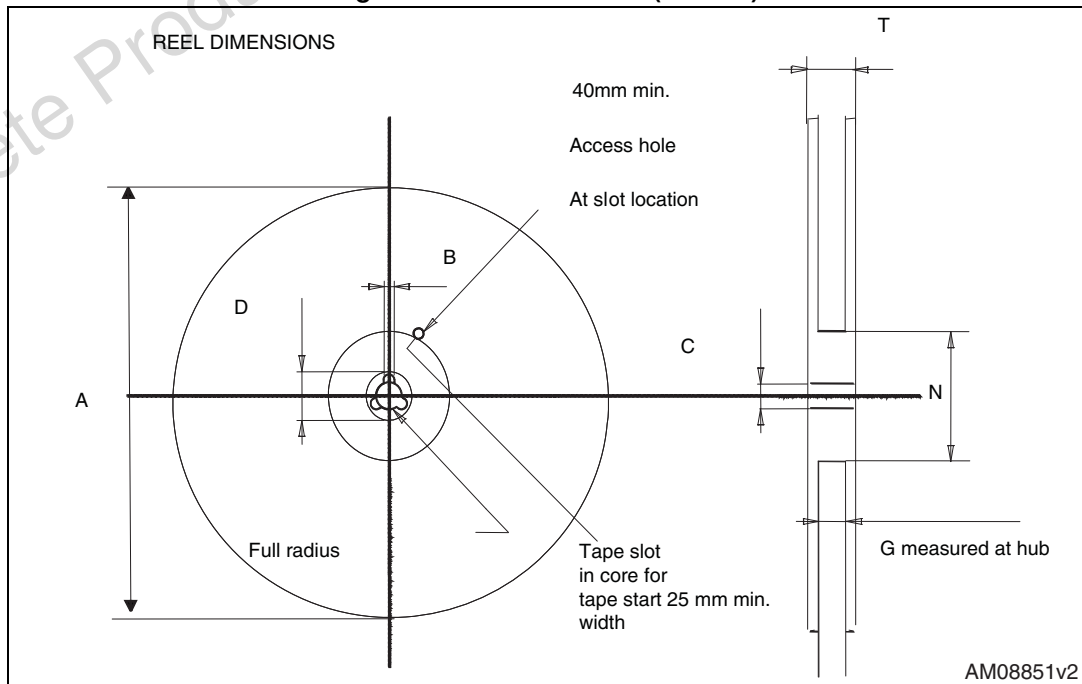


Figure 30. Reel for DPAK (TO-252)



## 6 Revision history

Table 14. Document revision history

Date	Revision	Changes
27-Aug-2013	1	First release.

Obsolete Product(s) - Obsolete Product(s)

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