

# STFW3N150, STH3N150-2, STP3N150, STW3N150

N-channel 1500 V, 2.5 A, 6  $\Omega$  typ., PowerMESH™ Power MOSFETs  
in TO-3PF, H<sup>2</sup>PAK-2, TO-220 and TO247 packages

Datasheet - production data

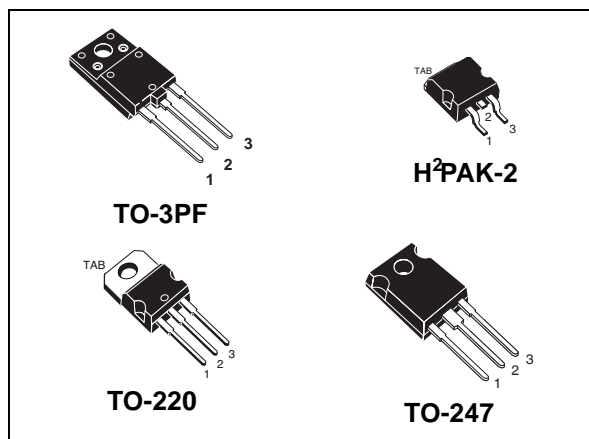
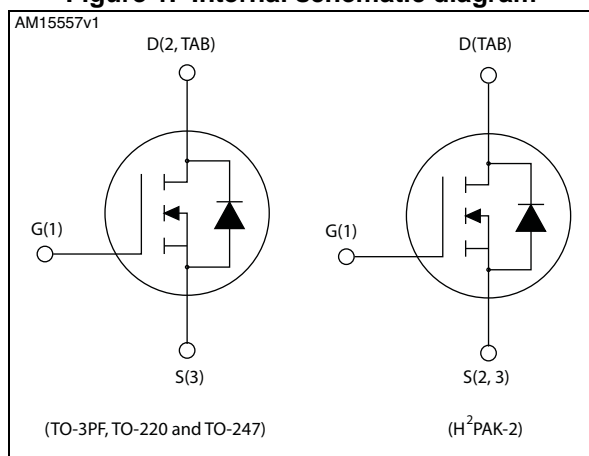


Figure 1. Internal schematic diagram



## Features

Order codes	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STFW3N150	1500 V	9 $\Omega$	2.5 A	63 W
STH3N150-2				140 W
STP3N150				
STW3N150				

- 100% avalanche tested
- Intrinsic capacitances and Q<sub>g</sub> minimized
- High speed switching
- Fully isolated TO-3PF plastic package, creepage distance path is 5.4 mm (typ.)

## Applications

- Switching applications

## Description

These Power MOSFETs are designed using the company's consolidated strip layout-based MESH OVERLAY™ process. The result is a product that matches or improves on the performance of comparable standard parts from other manufacturers.

Table 1. Device summary

Order codes	Marking	Packages	Packaging
STFW3N150	3N150	TO-3PF	Tube
STH3N150-2		H <sup>2</sup> PAK-2	Tape and reel
STP3N150		TO-220	Tube
STW3N150		TO-247	

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# 1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-3PF	H <sup>2</sup> PAK-2, TO-220, TO-247	
V <sub>DS</sub>	Drain-source voltage	1500		V
V <sub>GS</sub>	Gate-source voltage	± 30		V
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 25 °C	2.5 <sup>(1)</sup>	2.5	A
I <sub>D</sub>	Drain current (continuous) at T <sub>C</sub> = 100 °C	1.6 <sup>(1)</sup>	1.6	A
I <sub>DM</sub> <sup>(1)</sup>	Drain current (pulsed)	10 <sup>(1)</sup>	10	A
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	63	140	W
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T <sub>C</sub> =25 °C)	3500		V
	Derating factor	0.5	1.12	W/°C
T <sub>stg</sub>	Storage temperature	-50 to 150		°C
T <sub>j</sub>	Max. operating junction temperature	150		°C

1. Pulse width limited by safe operating area

Table 3. Thermal data

Symbol	Parameter	TO-3PF	H <sup>2</sup> PAK-2	TO-220	TO-247	Unit
R <sub>thj-case</sub>	Thermal resistance junction-case max	2	0.89			°C/W
R <sub>thj-amb</sub>	Thermal resistance junction-ambient max	50		62.5	50	°C/W
R <sub>thj-pcb</sub>	Thermal resistance junction-pcb max		35 <sup>(1)</sup>			°C/W

1. When mounted on 1 inch<sup>2</sup> FR-4 board, 2 oz Cu

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I <sub>AR</sub>	Avalanche current, repetitive or not-repetitive (pulse width limited by T <sub>j</sub> max)	2.5	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)	450	mJ

## 2 Electrical characteristics

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

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{DSS}}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{\text{GS}} = 0$	1500			V
$I_{\text{DSS}}$	Zero gate voltage drain current ( $V_{\text{GS}} = 0$ )	$V_{\text{DS}} = 1500\text{ V}$			10	$\mu\text{A}$
		$V_{\text{DS}} = 1500\text{ V}$ , $T_C = 125\text{ }^{\circ}\text{C}$			500	$\mu\text{A}$
$I_{\text{GSS}}$	Gate-body leakage current ( $V_{\text{DS}} = 0$ )	$V_{\text{GS}} = \pm 30\text{ V}$			$\pm 100$	nA
$V_{\text{GS(th)}}$	Gate threshold voltage	$V_{\text{DS}} = V_{\text{GS}}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{\text{DS(on)}}$	Static drain-source on-resistance	$V_{\text{GS}} = 10\text{ V}$ , $I_D = 1.3\text{ A}$		6	9	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{\text{fs}}^{(1)}$	Forward transconductance	$V_{\text{DS}} = 30\text{ V}$ , $I_D = 1.3\text{ A}$	-	2.6	-	S
$C_{\text{iss}}$	Input capacitance	$V_{\text{DS}} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0$	-	939	-	pF
			-		-	pF
			-		-	pF
$C_{\text{oss}}$	Output capacitance		-	102	-	pF
$C_{\text{rss}}$	Reverse transfer capacitance		-	13.2	-	pF
$C_{\text{oss eq.}}^{(2)}$	Equivalent output capacitance	$V_{\text{DS}} = 0$ to $1200\text{ V}$ , $V_{\text{GS}} = 0$	-	100	-	pF
$R_g$	Gate input resistance	$f = 1\text{ MHz}$ , gate DC Bias = 0, test signal level = $20\text{ mV}$ , $I_D = 0$	-	4	-	$\Omega$
$Q_g$	Total gate charge	$V_{\text{DD}} = 1200\text{ V}$ , $I_D = 2.5\text{ A}$ ,	-	29.3	-	nC
$Q_{\text{gs}}$	Gate-source charge	$V_{\text{GS}} = 10\text{ V}$	-	4.6	-	nC
$Q_{\text{gd}}$	Gate-drain charge	(Figure 19)	-	17	-	nC

1. Pulsed: pulse duration =  $300\text{ }\mu\text{s}$ , duty cycle 1.5%

2.  $C_{\text{oss eq.}}$  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%  $V_{\text{DSS}}$

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 750\text{ V}$ , $I_D = 1.25\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GS} = 10\text{ V}$ (Figure 18)	-	24	-	ns
$t_r$	Rise time		-	47	-	ns
$t_{d(off)}$	Turn-off-delay time		-	45	-	ns
$t_f$	Fall time		-	61	-	ns

Table 8. 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	$I_{SD} = 2.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (Figure 20)	-	410		ns
$Q_{rr}$	Reverse recovery charge		-	2.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	11.7		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 2.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (Figure 20)	-	540		ns
$Q_{rr}$	Reverse recovery charge		-	3.3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	12.3		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-3PF

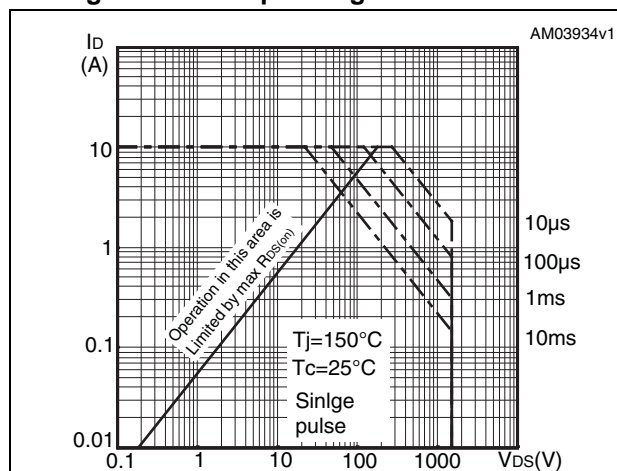


Figure 3. Thermal impedance for TO-3PF

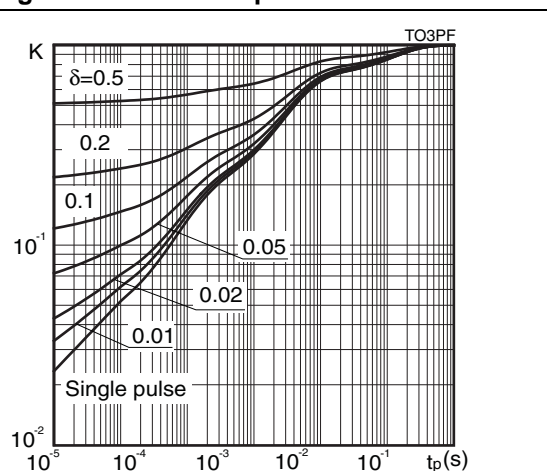
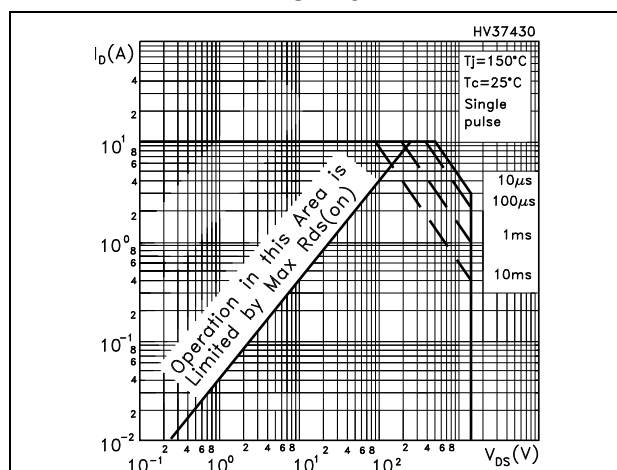
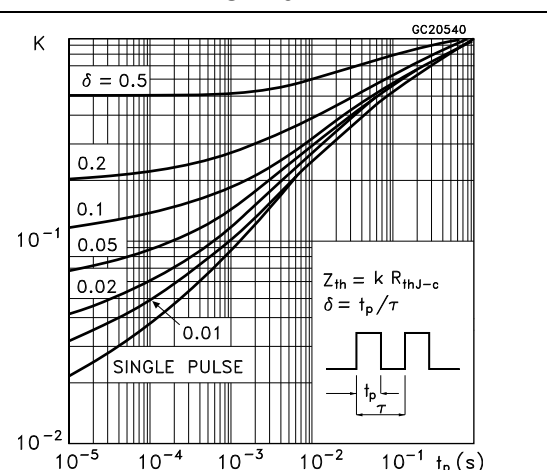
Figure 4. Safe operating area for H<sup>2</sup>PAK-2 and TO-220Figure 5. Thermal impedance for H<sup>2</sup>PAK-2 and TO-220

Figure 6. Safe operating area for TO-247

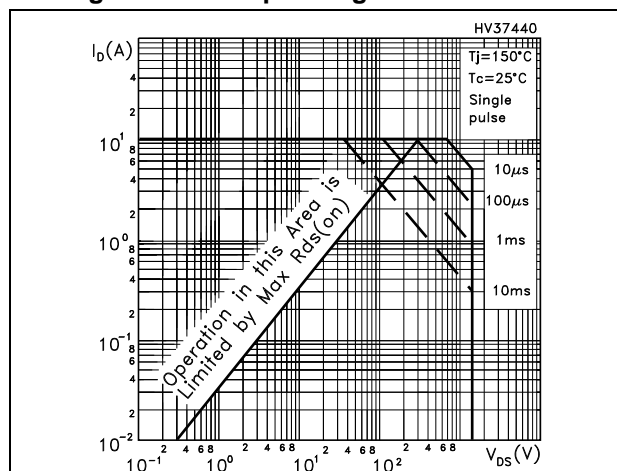


Figure 7. Thermal impedance for TO-247

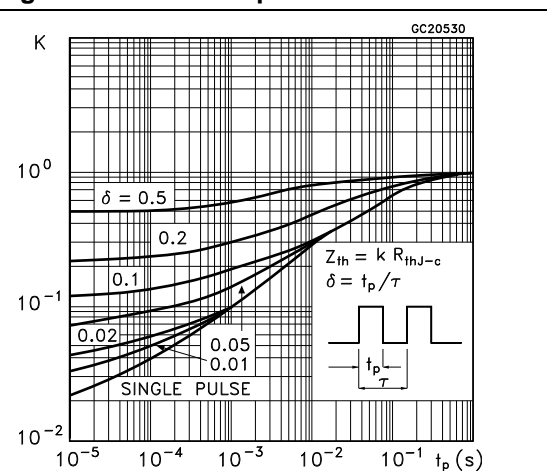


Figure 8. Output characteristics

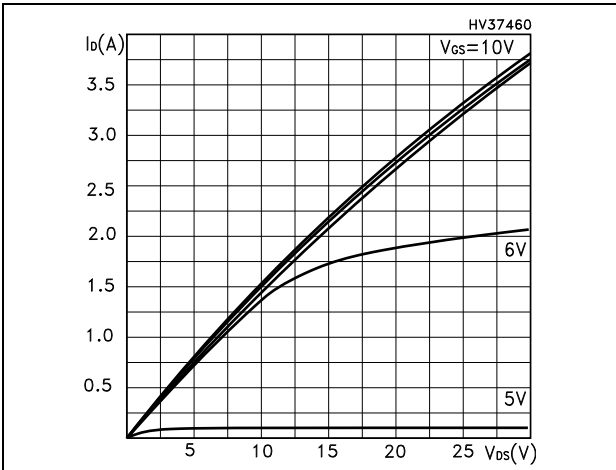


Figure 9. Transfer characteristics

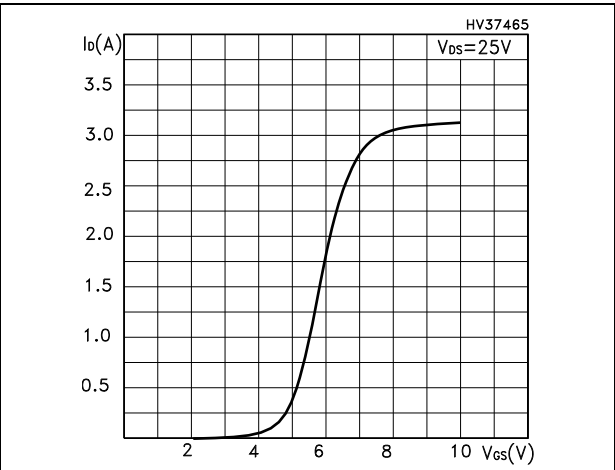


Figure 10. Normalized  $BV_{DSS}$  vs. temperature

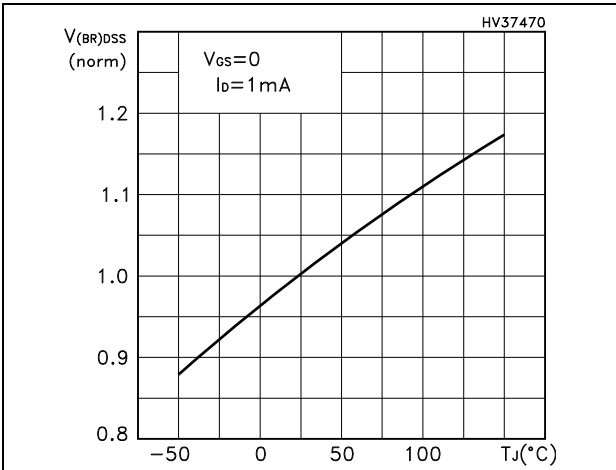


Figure 11. Static drain-source on-resistance

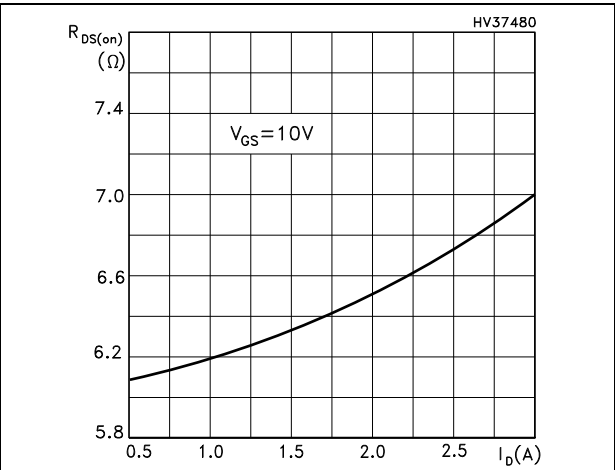


Figure 12. Gate charge vs. gate-source voltage

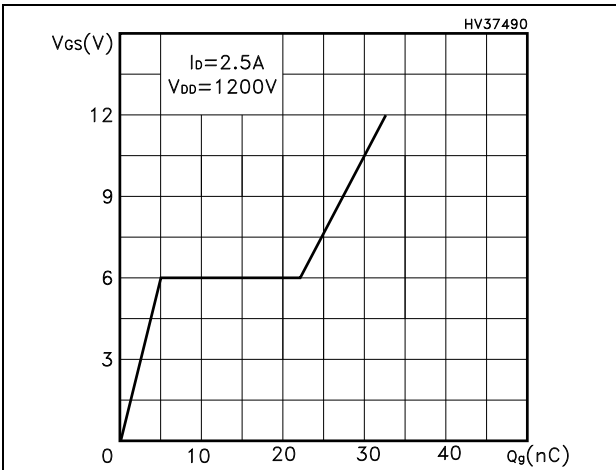


Figure 13. Capacitance variations

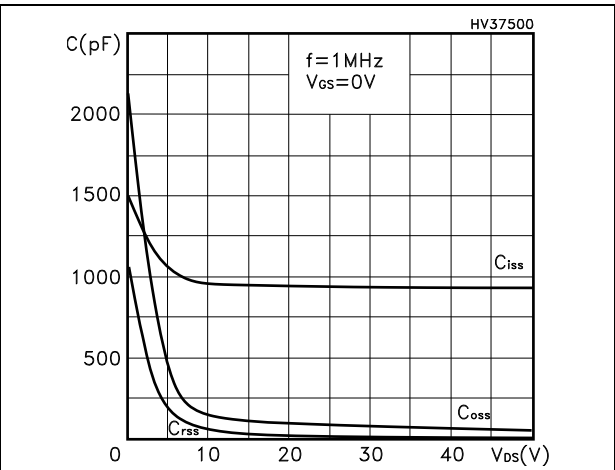


Figure 14. Normalized gate threshold voltage vs. temperature

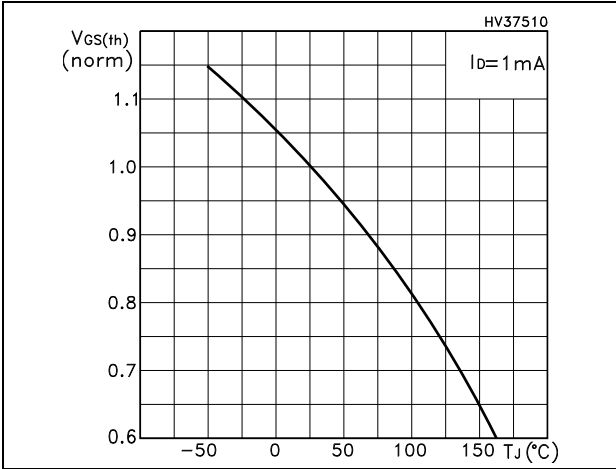


Figure 15. Normalized on resistance vs. temperature

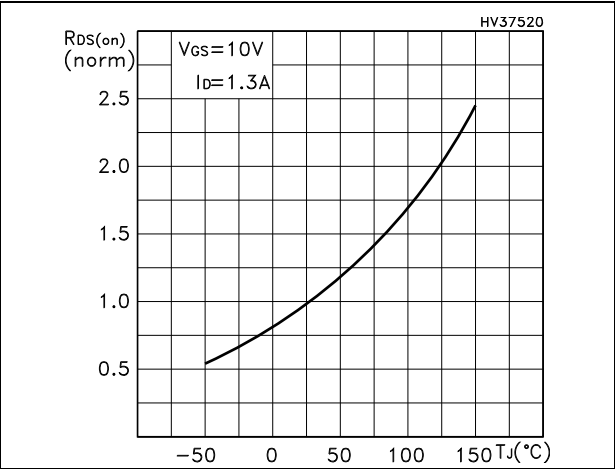


Figure 16. Source-drain diode forward characteristics

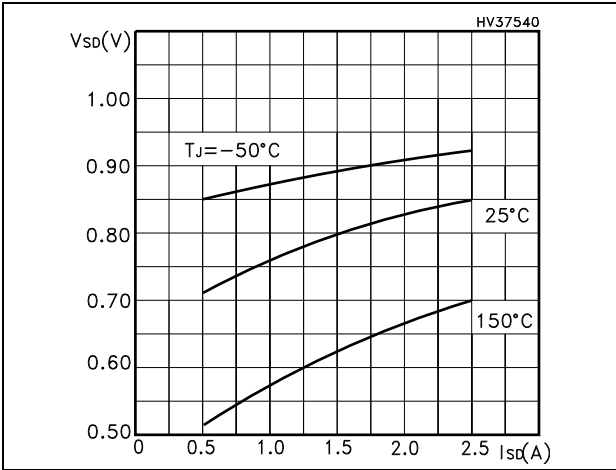
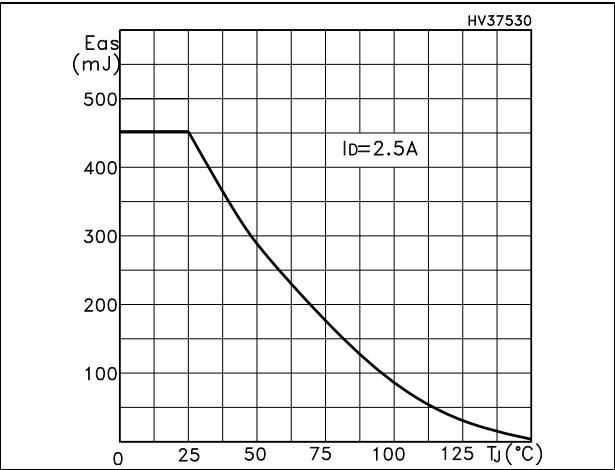


Figure 17. Maximum avalanche energy vs  $T_J$





### 3 Test circuits

Figure 18. Switching times test circuit for resistive load

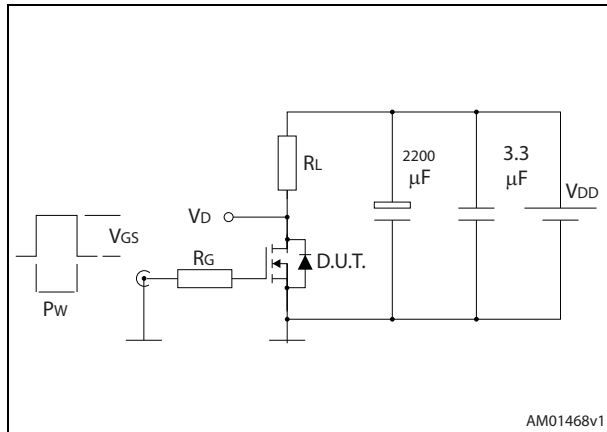


Figure 19. Gate charge test circuit

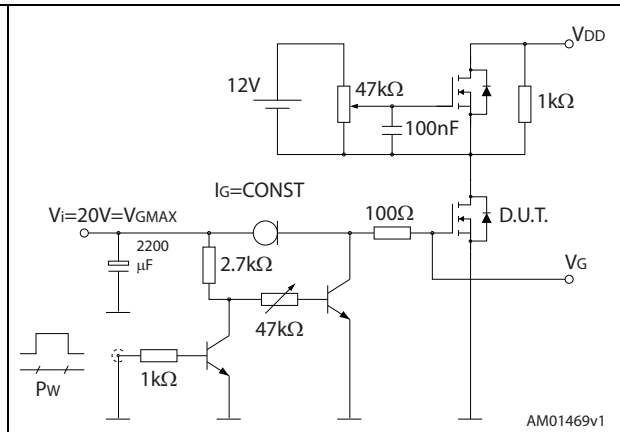


Figure 20. Test circuit for inductive load switching and diode recovery times

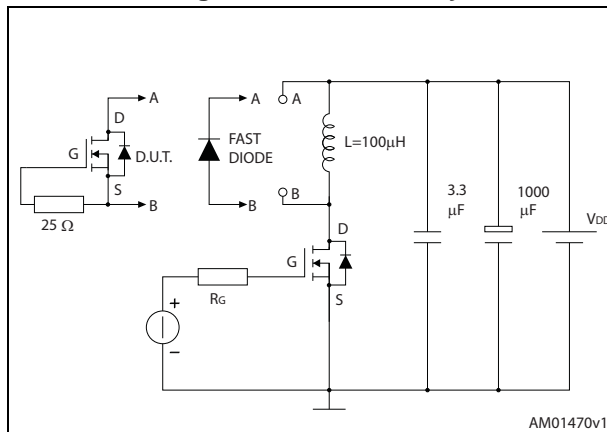


Figure 21. Unclamped inductive load test circuit

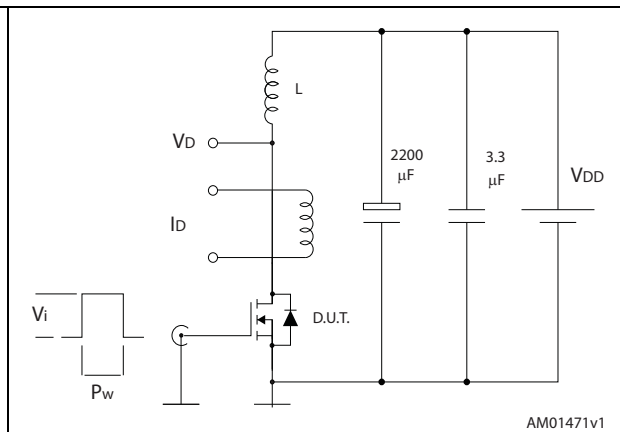


Figure 22. Unclamped inductive waveform

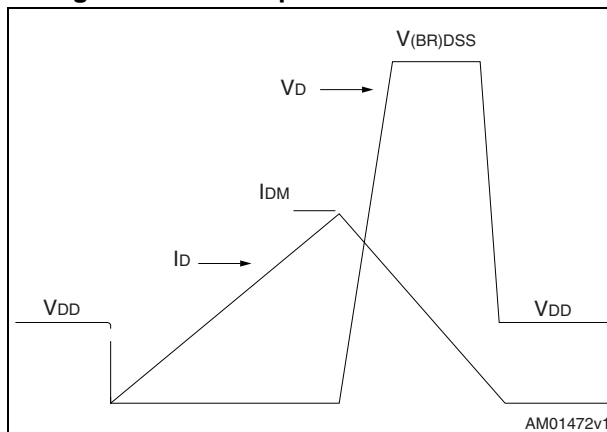
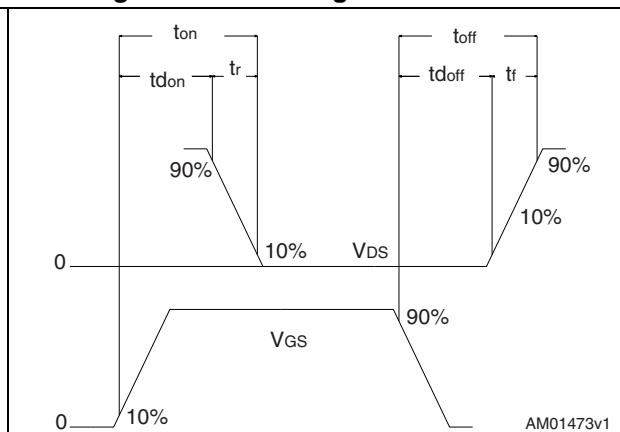


Figure 23. Switching time waveform



## 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.

Figure 24. TO-3PF drawing

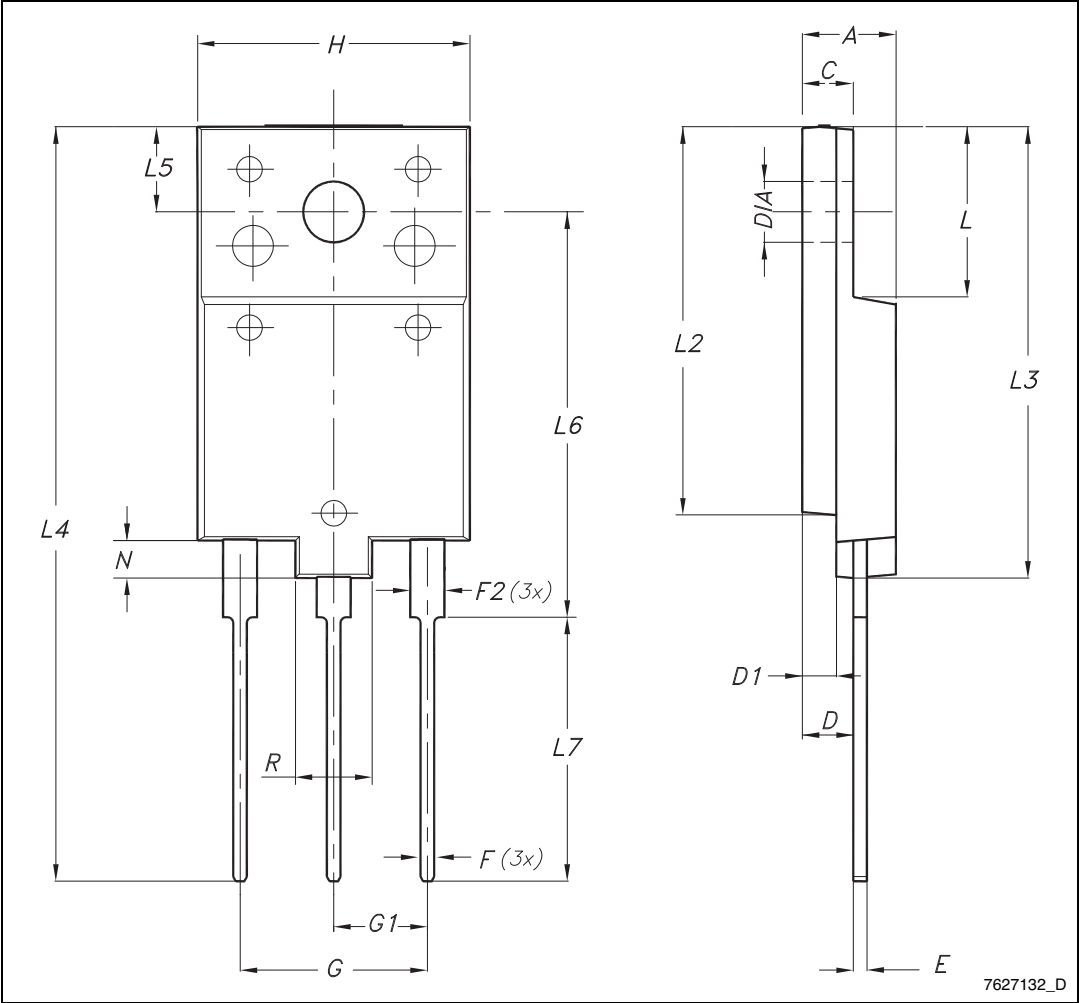


Table 9. TO-3PF mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80

Figure 25. H<sup>2</sup>PAK-2 drawing

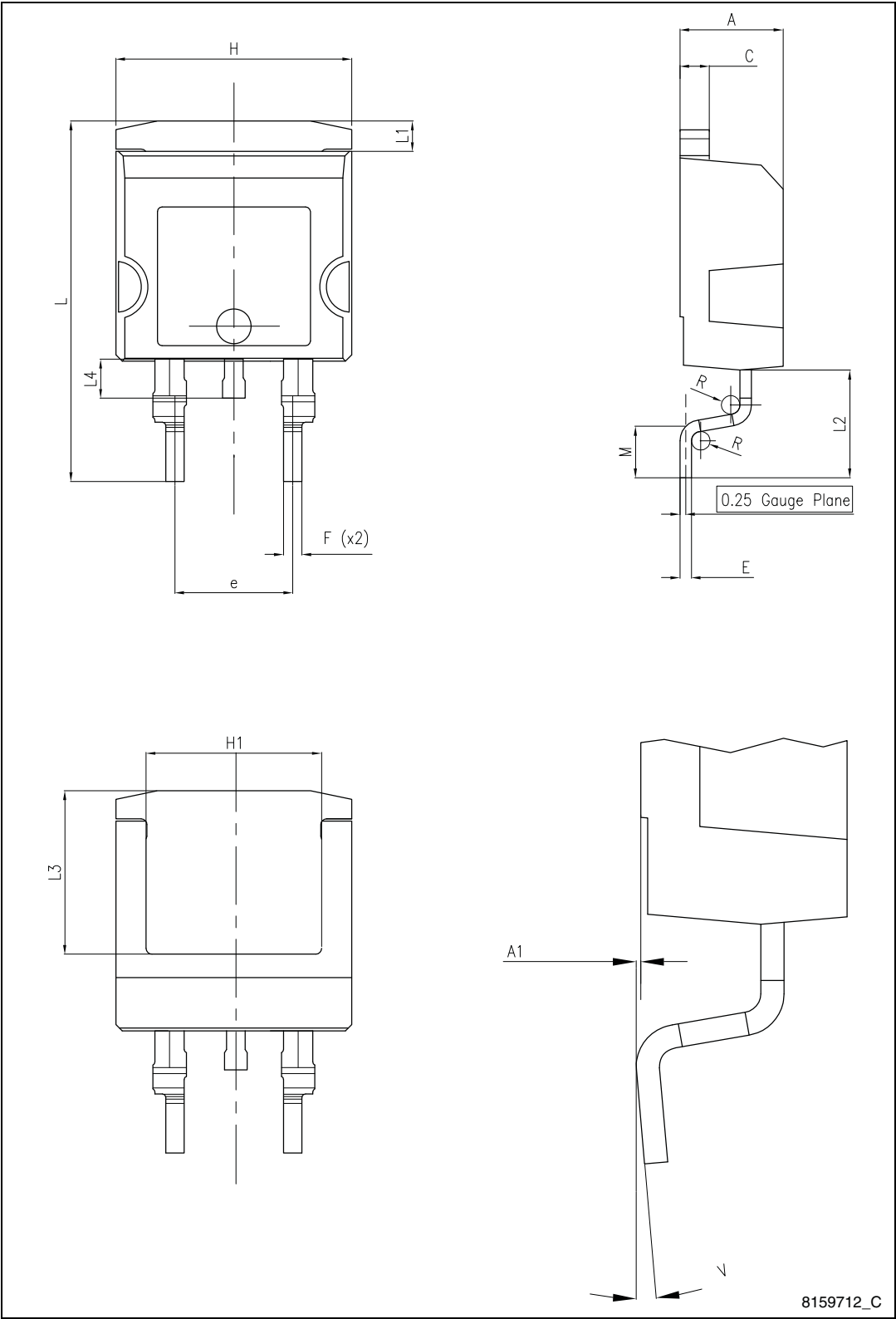


Table 10. H<sup>2</sup>PAK-2 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.30	-	4.80
A1	0.03		0.20
C	1.17		1.37
e	4.98		5.18
E	0.50		0.90
F	0.78		0.85
H	10.00		10.40
H1	7.40		7.80
L	15.30		15.80
L1	1.27		1.40
L2	4.93		5.23
L3	6.85		7.25
L4	1.5		1.7
M	2.6		2.9
R	0.20		0.60
V	0°		8°

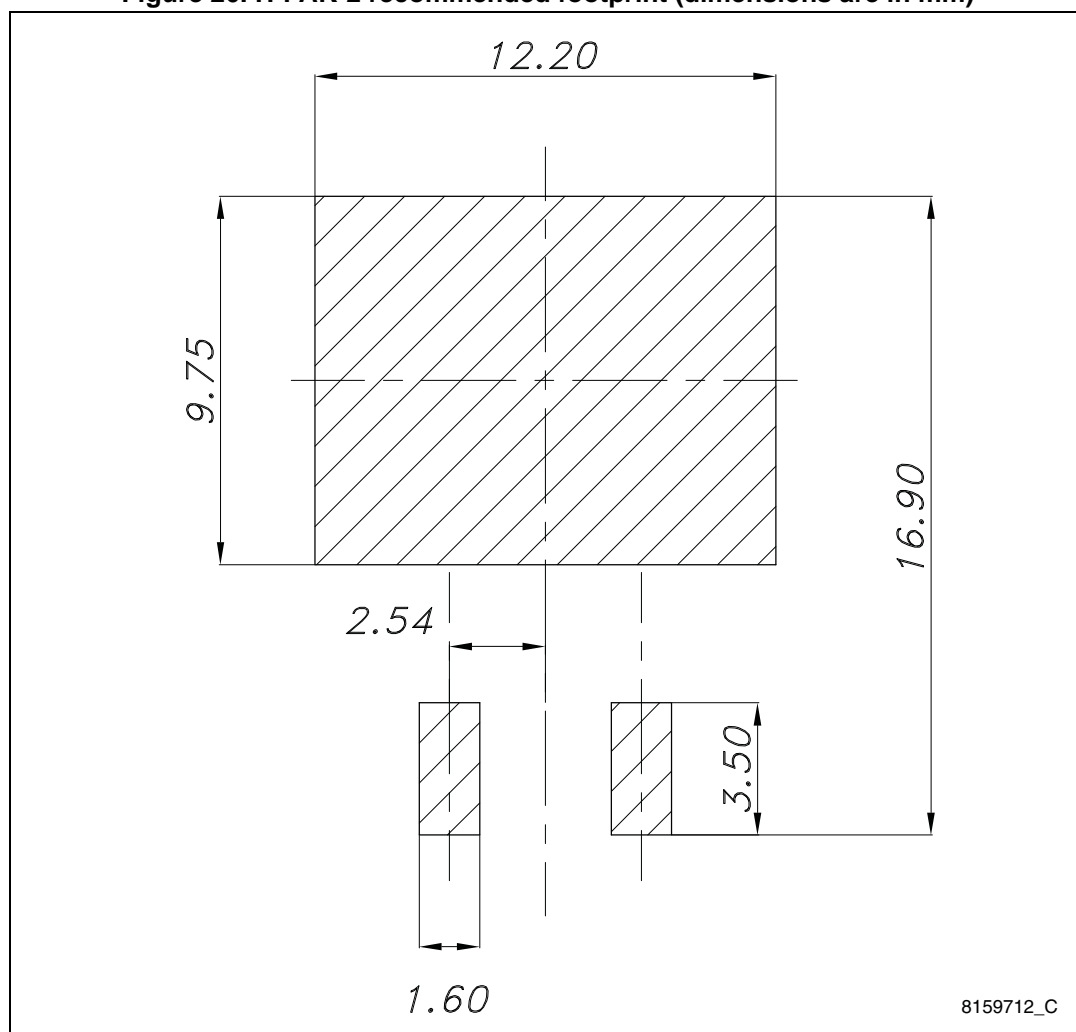
Figure 26. H<sup>2</sup>PAK-2 recommended footprint (dimensions are in mm)

Figure 27. TO-220 type A drawing

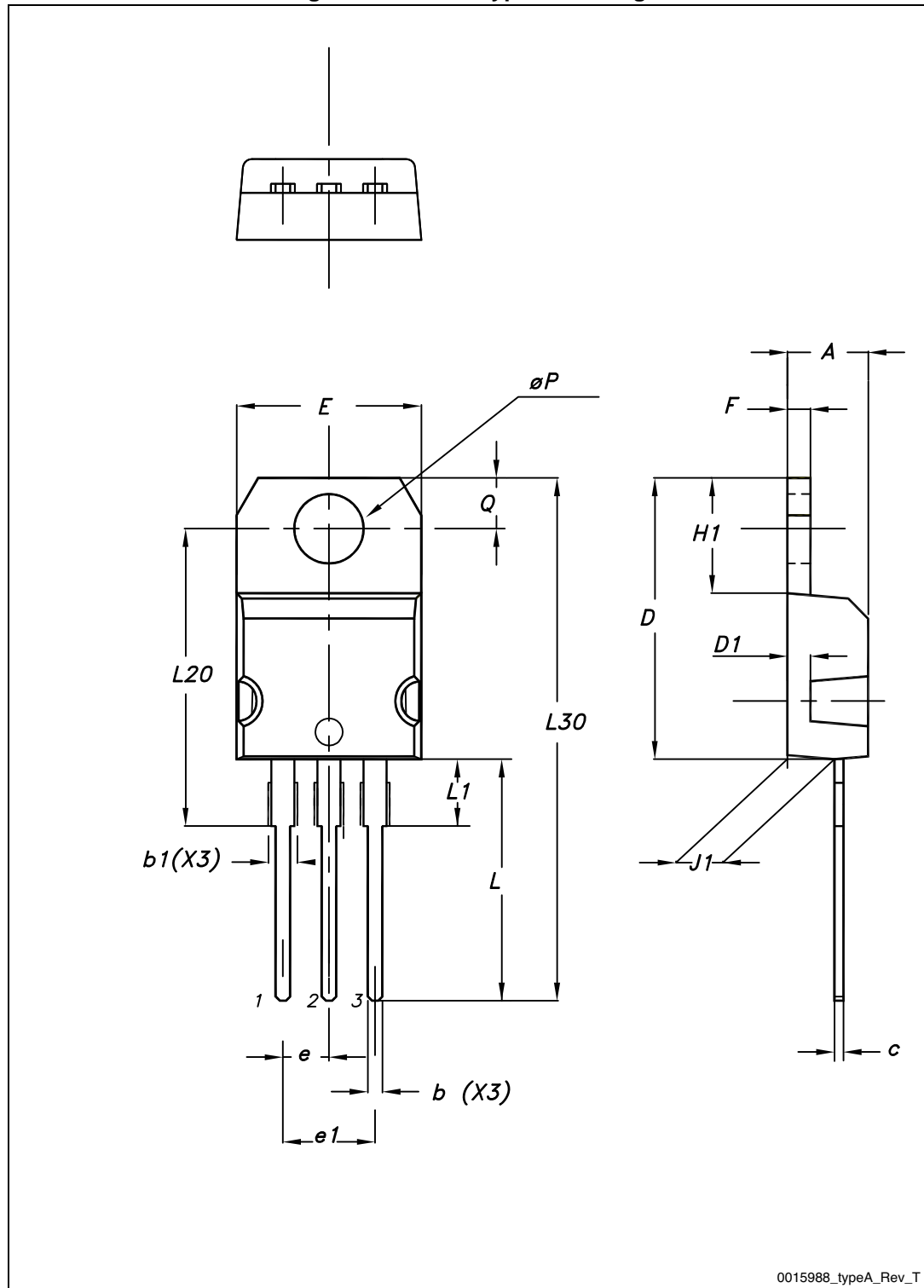




Table 11. TO-220 type A mechanical data

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 28. TO-247 drawing

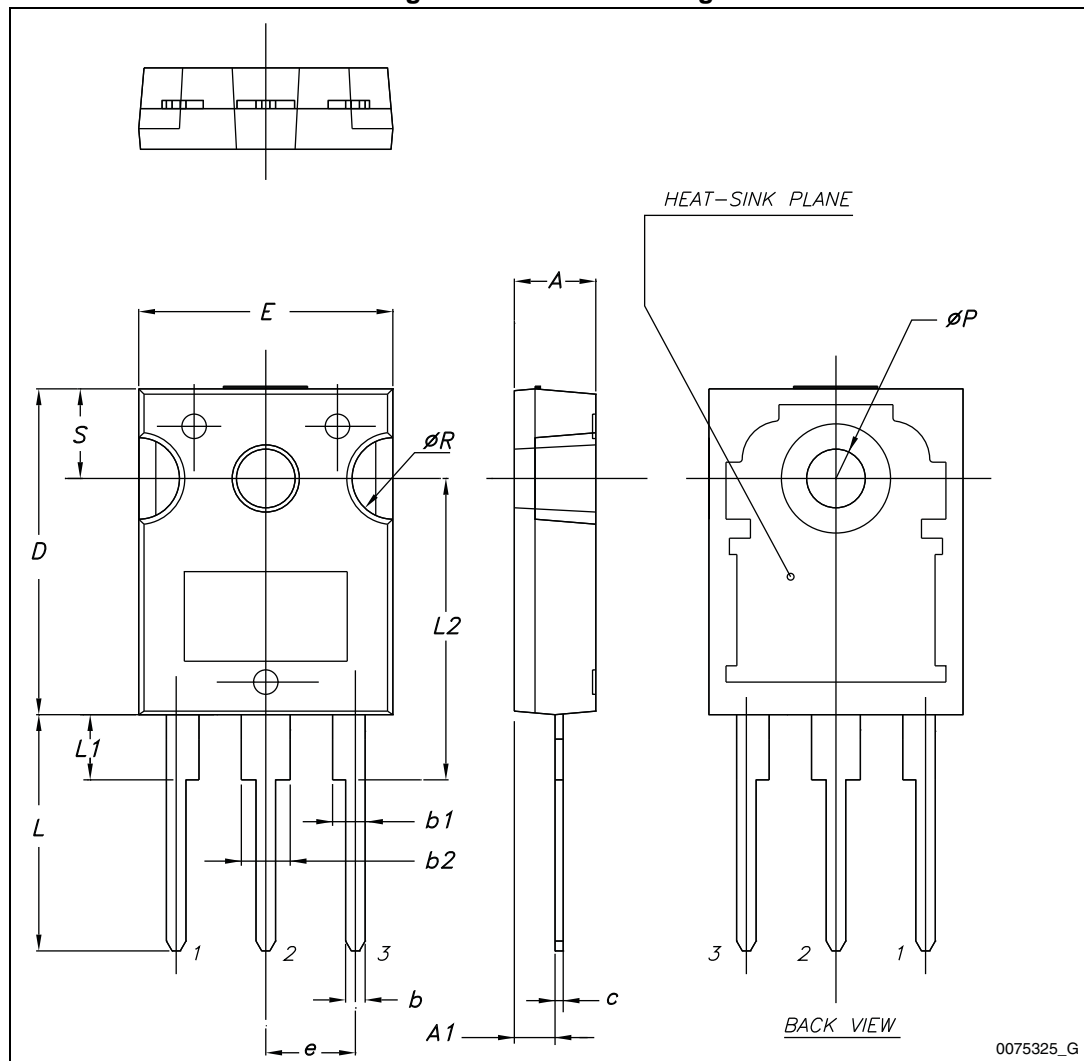


Table 12. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

## 5 Packaging mechanical data

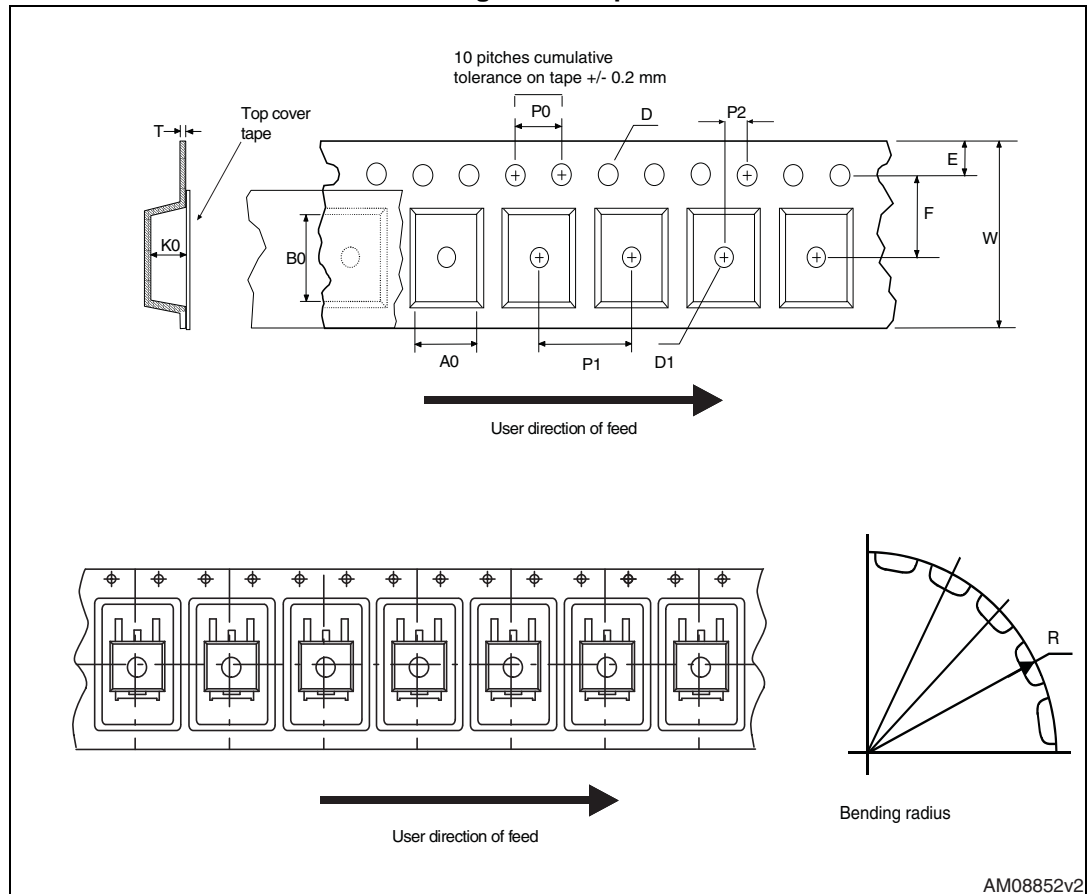
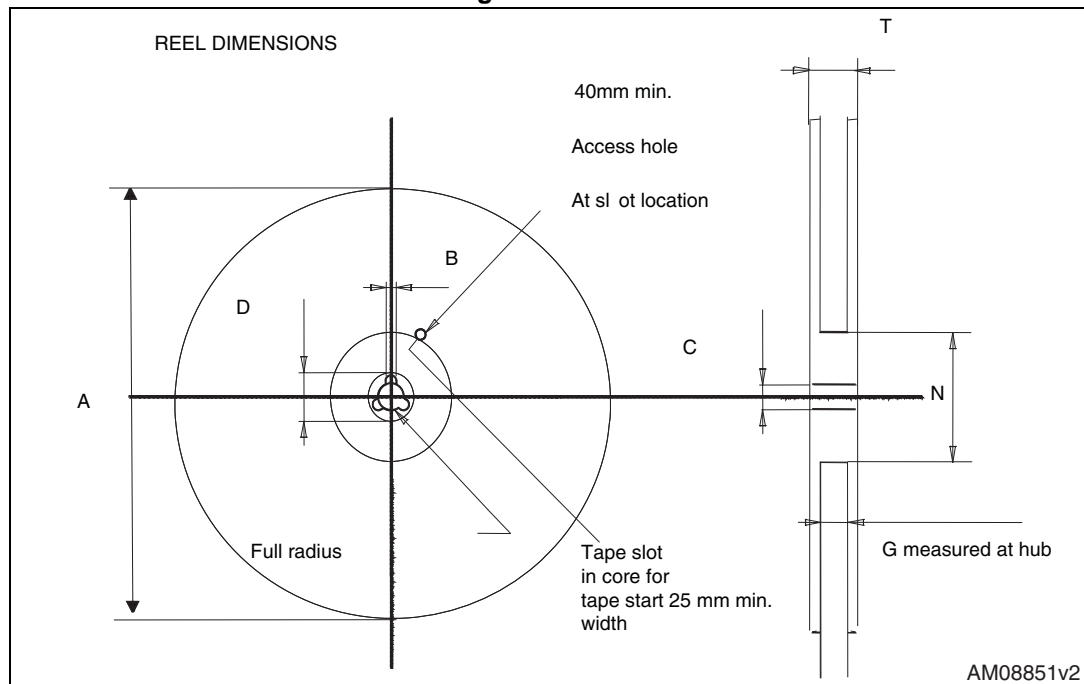
**Figure 29. Tape**

Figure 30. Reel

Table 13. H<sup>2</sup>PAK-2 tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

## 6 Revision history

**Table 14. Document revision history**

Date	Revision	Changes
12-Jan-2007	1	First release
17-Apr-2007	2	Added new value on <a href="#">Table 6</a> .
14-May-2007	3	The document has been reformatted
29-Aug-2007	4	$R_{DS(on)}$ value changed, updated <a href="#">Figure 15</a>
09-Apr-2008	5	Added new package: TO-3PF
13-Feb-2009	6	Added $P_{TOT}$ value for TO-3PF ( <a href="#">Table 2: Absolute maximum ratings</a> )
01-Dec-2009	7	<ul style="list-style-type: none"> <li>– Document status promoted from preliminary data to datasheet</li> <li>– Removed TO-220FH package and mechanical data</li> </ul>
10-Dec-2009	8	Corrected $V_{ISO}$ value in <a href="#">Table 2: Absolute maximum ratings</a>
29-Jun-2010	9	Corrected unit in <a href="#">Table 3</a> .
08-Feb-2013	10	<ul style="list-style-type: none"> <li>– Minor text changes</li> <li>– Modified: <a href="#">Table 3</a></li> <li>– Changed: <a href="#">Figure 1</a></li> <li>– Added: H<sup>2</sup>PAK-2 package</li> </ul>
18-Feb-2014	11	<ul style="list-style-type: none"> <li>– Modified: <a href="#">Figure 1</a></li> <li>– Updated: <a href="#">Figure 18</a>, <a href="#">19</a>, <a href="#">20</a> and <a href="#">21</a></li> <li>– Updated: <a href="#">Figure 27</a> and <a href="#">Table 11</a></li> <li>– Updated: <a href="#">Section 4: Package mechanical data</a></li> <li>– Minor text changes</li> </ul>

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