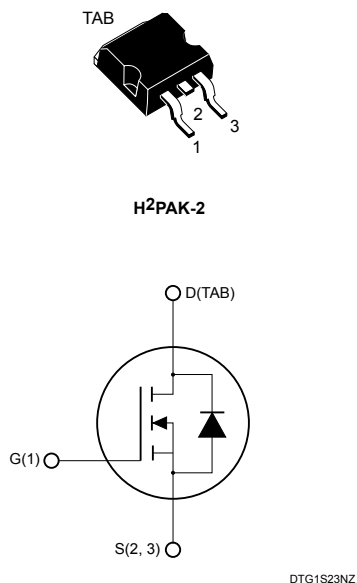



## Automotive-grade N-channel 1200 V, 7.25 $\Omega$ typ., 1.5 A, MDmesh™ K5 Power MOSFET in an H<sup>2</sup>PAK-2 package



### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STH2N120K5-2AG	1200 V	10 $\Omega$	1.5 A	60 W

- AEC-Q101 qualified 
- Industry's lowest R<sub>DS(on)</sub> x area
- Industry's best FoM (figure of merit)
- Ultra-low gate charge
- 100% avalanche tested

### Applications

- Switching applications

### Description

This very high voltage N-channel Power MOSFET is designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Product status
STH2N120K5-2AG

Product summary <sup>(1)</sup>	
Order code	STH2N120K5-2AG
Marking	2N120K5
Package	H <sup>2</sup> PAK-2
Packing	Tape and reel

1. HTRB test was performed at 80% of V<sub>(BR)DSS</sub> according to AEC-Q101 rev. C. All other tests were performed according to AEC-Q101 rev. D.

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_{case} = 25\text{ }^{\circ}\text{C}$	1.5	A
	Drain current (continuous) at $T_{case} = 100\text{ }^{\circ}\text{C}$	1	
$I_{DM}^{(1)}$	Drain current (pulsed)	2.5	A
$P_{TOT}$	Total dissipation at $T_{case} = 25\text{ }^{\circ}\text{C}$	60	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	
$T_{stg}$	Storage temperature range	-55 to 150	$^{\circ}\text{C}$
$T_j$	Operating junction temperature range		

- Pulse width is limited by safe operating area.
- $I_{SD} \leq 1.5\text{ A}$ ,  $di/dt = 100\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$
- $V_{DS} \leq 960\text{ V}$

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	2.08	$^{\circ}\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	30	

- When mounted on an 1-inch<sup>2</sup> FR-4, 2 Oz copper board.

**Table 3. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}^{(1)}$	Avalanche current, repetitive or not repetitive	0.5	A
$E_{AS}^{(2)}$	Single pulse avalanche energy	80	mJ

- Pulse width is limited by  $T_{jmax}$ .
- Starting  $T_j = 25\text{ }^{\circ}\text{C}$ ,  $I_D = I_{AR}$ ,  $V_{DD} = 50\text{ V}$

## 2 Electrical characteristics

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

**Table 4. Static**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(\text{BR})\text{DSS}}$	Drain-source breakdown voltage	$V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 1\text{ mA}$	1200			V
$I_{\text{DSS}}$	Zero gate voltage drain current	$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 1200\text{ V}$			0.5	$\mu\text{A}$
		$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 1200\text{ V}$ , $T_{\text{case}} = 125\text{ }^{\circ}\text{C}^{(1)}$			100	
$I_{\text{GSS}}$	Gate-body leakage current	$V_{\text{DS}} = 0\text{ V}$ , $V_{\text{GS}} = \pm 20\text{ V}$			$\pm 100$	nA
$V_{\text{GS(th)}}$	Gate threshold voltage	$V_{\text{DS}} = V_{\text{GS}}$ , $I_{\text{D}} = 100\text{ }\mu\text{A}$	2	3	4	V
$R_{\text{DS(on)}}$	Static drain-source on-resistance	$V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 0.5\text{ A}$		7.25	10	$\Omega$

1. Defined by design, not subject to production test.

**Table 5. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{\text{iss}}$	Input capacitance	$V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0\text{ V}$	-	124	-	pF
$C_{\text{oss}}$	Output capacitance		-	13	-	
$C_{\text{rss}}$	Reverse transfer capacitance		-	0.5	-	
$C_{\text{o(tr)}}^{(1)}$	Time-related equivalent capacitance	$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 0\text{ to }960\text{ V}$	-	15	-	pF
$C_{\text{o(er)}}^{(2)}$	Energy-related equivalent capacitance		-	5	-	
$R_{\text{G}}$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_{\text{D}} = 0\text{ A}$	-	16	-	$\Omega$
$Q_{\text{g}}$	Total gate charge	$V_{\text{DD}} = 960\text{ V}$ , $I_{\text{D}} = 1.5\text{ A}$ , $V_{\text{GS}} = 0\text{ to }10\text{ V}$ (see Figure 13. Test circuit for gate charge behavior)	-	5.3	-	nC
$Q_{\text{gs}}$	Gate-source charge		-	0.8	-	
$Q_{\text{gd}}$	Gate-drain charge		-	3.5	-	

1.  $C_{\text{o(tr)}}$  is a constant capacitance value giving the same charging time as  $C_{\text{oss}}$  while  $V_{\text{DS}}$  is rising from 0 to 80%  $V_{\text{DSS}}$ .

2.  $C_{\text{o(er)}}$  is a constant capacitance value giving the same stored energy as  $C_{\text{oss}}$  while  $V_{\text{DS}}$  is rising from 0 to 80%  $V_{\text{DSS}}$ .

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{\text{d(on)}}$	Turn-on delay time	$V_{\text{DD}} = 600\text{ V}$ , $I_{\text{D}} = 0.75\text{ A}$ , $R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 10\text{ V}$ (see Figure 12. Test circuit for resistive load switching times and Figure 17. Switching time waveform)	-	10.3	-	ns
$t_{\text{r}}$	Rise time		-	7.8	-	
$t_{\text{d(off)}}$	Turn-off delay time		-	34	-	
$t_{\text{f}}$	Fall time		-	39	-	

**Table 7. Source-drain diode**

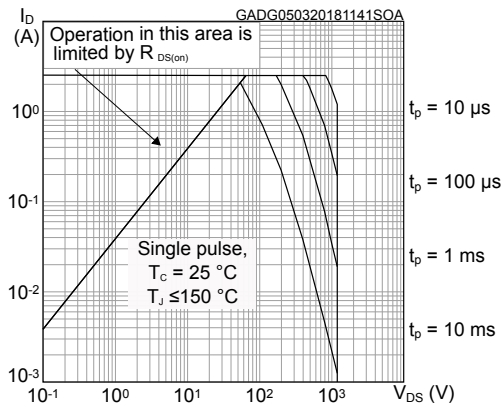
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		1.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		2.5	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 1.5\text{ A}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 1.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see Figure 14. Test circuit for inductive load switching and diode recovery times)	-	350		ns
$Q_{rr}$	Reverse recovery charge		-	1.35		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	7.7		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 1.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 14. Test circuit for inductive load switching and diode recovery times)	-	600		ns
$Q_{rr}$	Reverse recovery charge		-	2.09		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	7.7		A

1. Pulse width is limited by safe operating area.

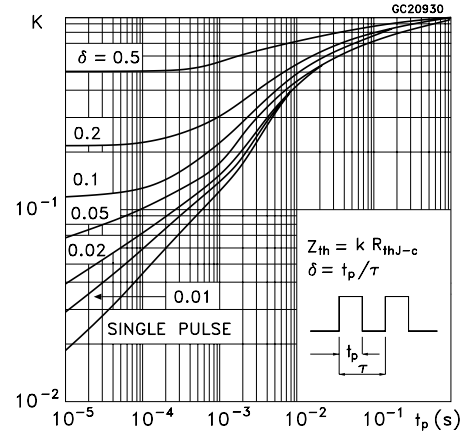
2. Pulse test: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%.

## 2.1 Electrical characteristics (curves)

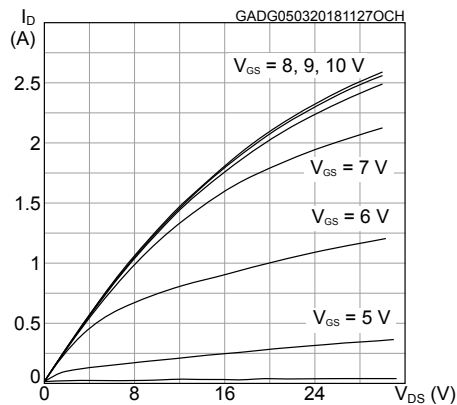
**Figure 1. Safe operating area**



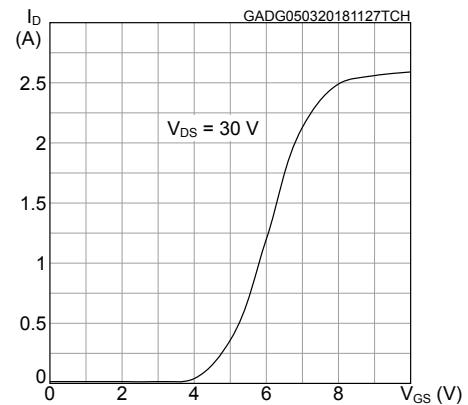
**Figure 2. Thermal impedance**



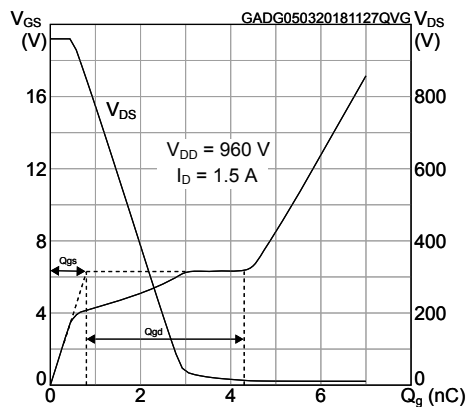
**Figure 3. Output characteristics**



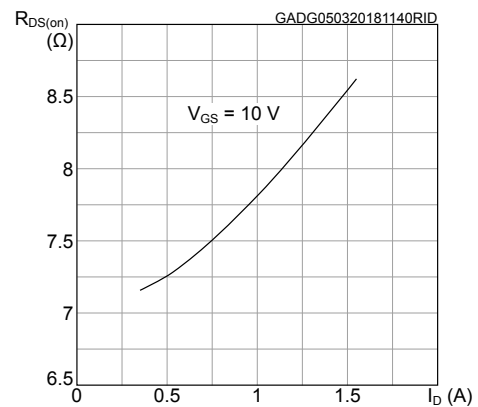
**Figure 4. Transfer characteristics**



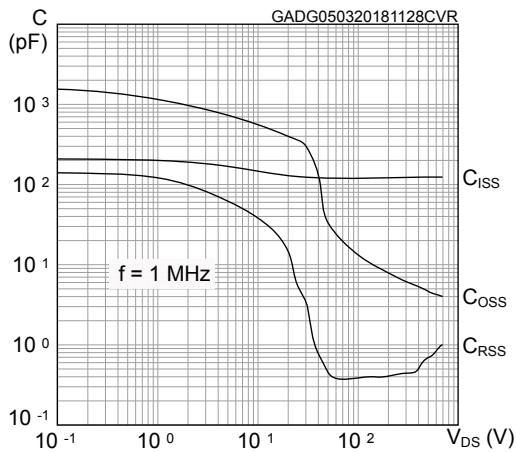
**Figure 5. Gate charge vs gate-source voltage**



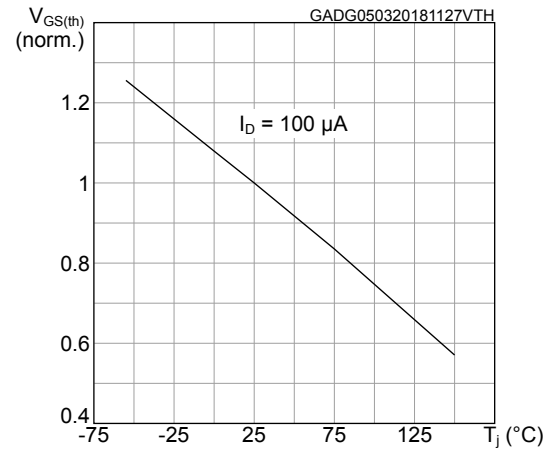
**Figure 6. Static drain-source on-resistance**



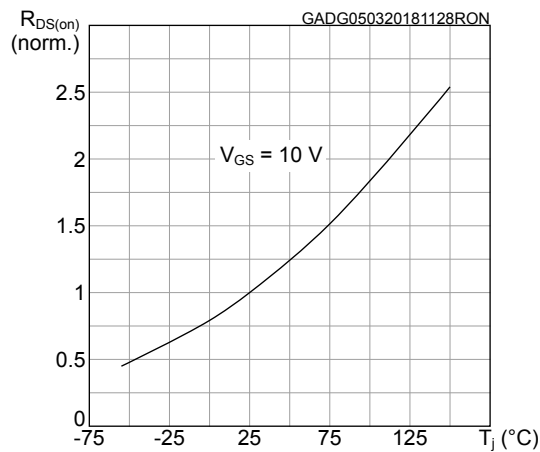
**Figure 7. Capacitance variations**



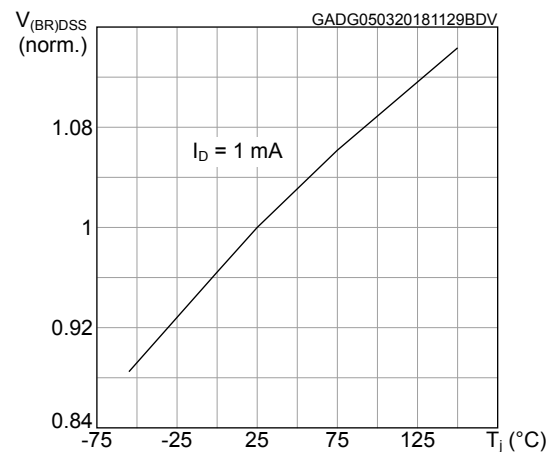
**Figure 8. Normalized gate threshold voltage vs temperature**



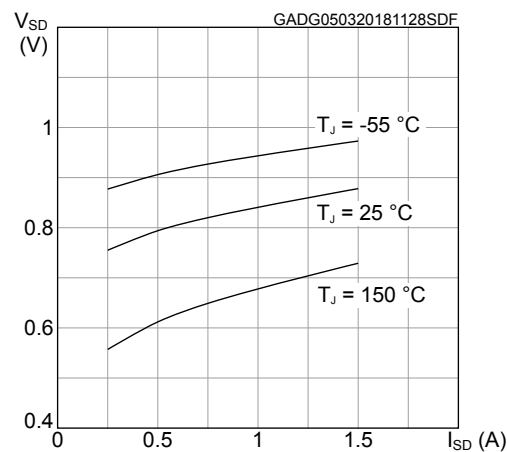
**Figure 9. Normalized on-resistance vs temperature**



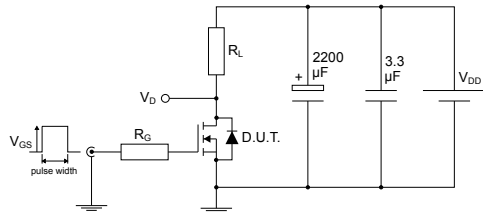
**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**



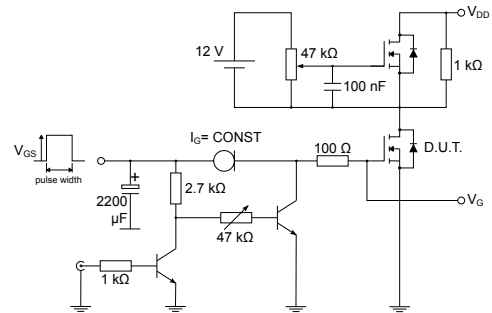
**Figure 11. Source- drain diode forward characteristics**



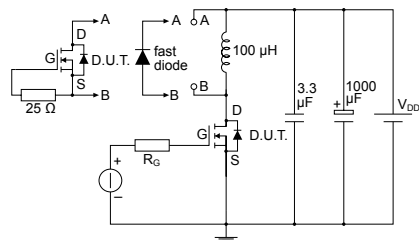
### 3 Test circuits

**Figure 12. Test circuit for resistive load switching times**


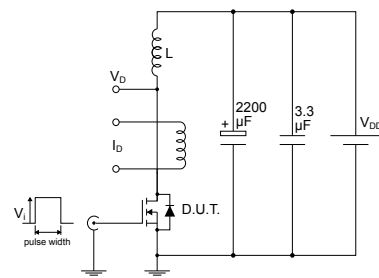
AM01468v1

**Figure 13. Test circuit for gate charge behavior**


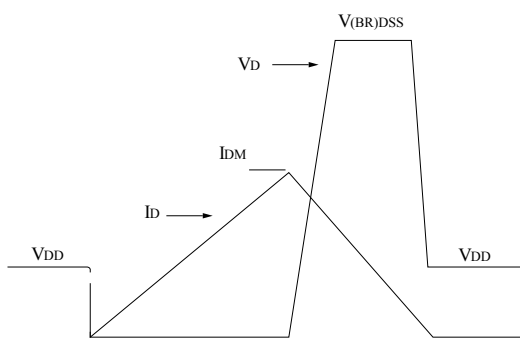
AM01469v1

**Figure 14. Test circuit for inductive load switching and diode recovery times**


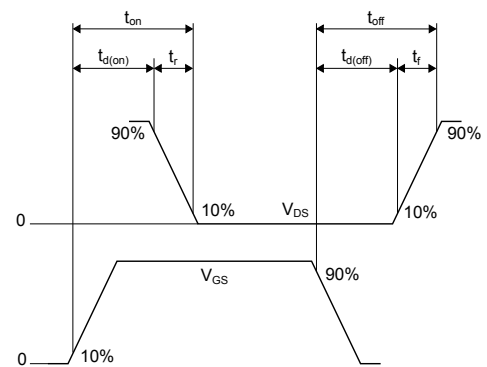
AM01470v1

**Figure 15. Unclamped inductive load test circuit**


AM01471v1

**Figure 16. Unclamped inductive waveform**


AM01472v1

**Figure 17. Switching time waveform**


AM01473v1

## **4 Package information**

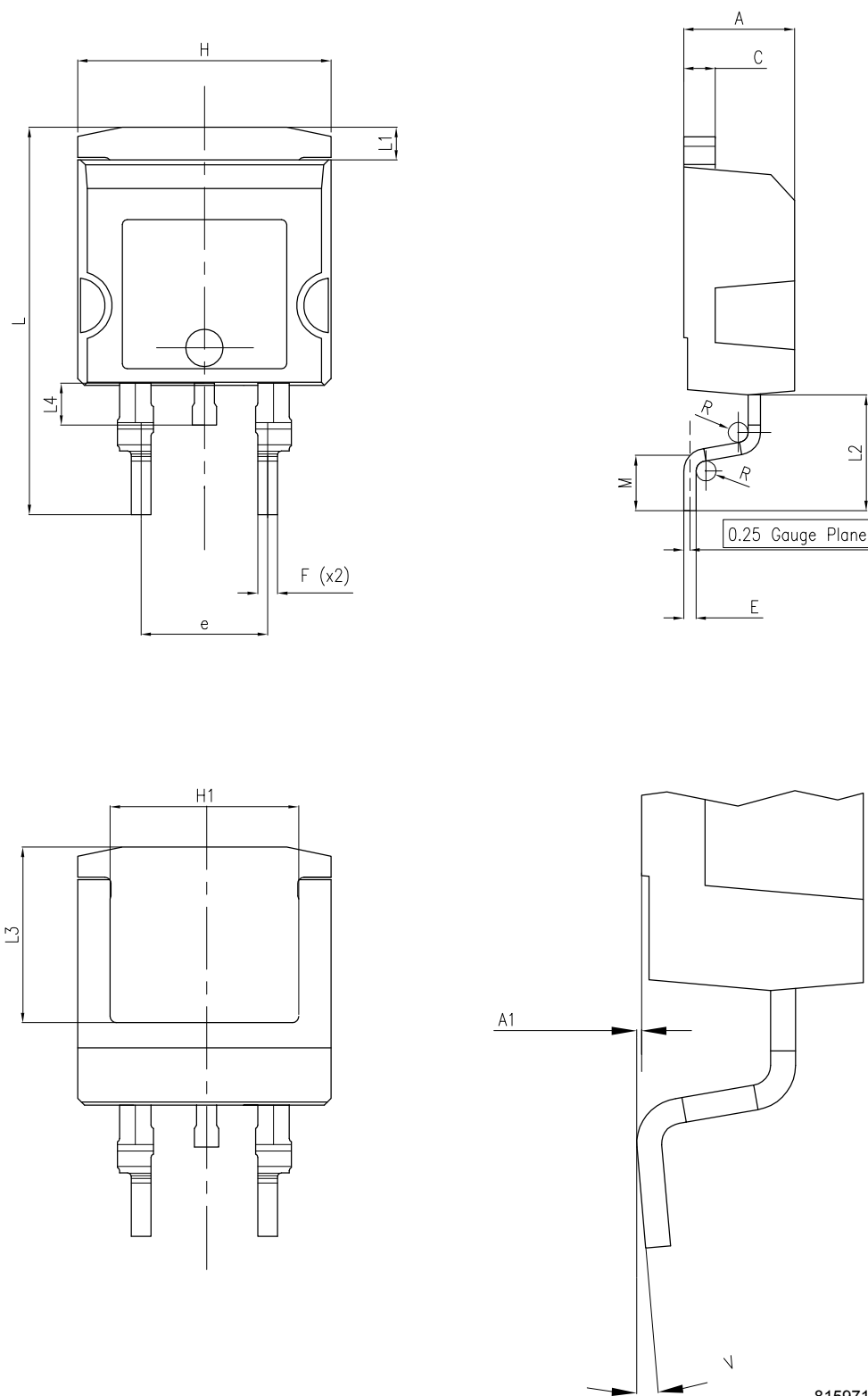
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## 4.1 H<sup>2</sup>PAK-2 package information

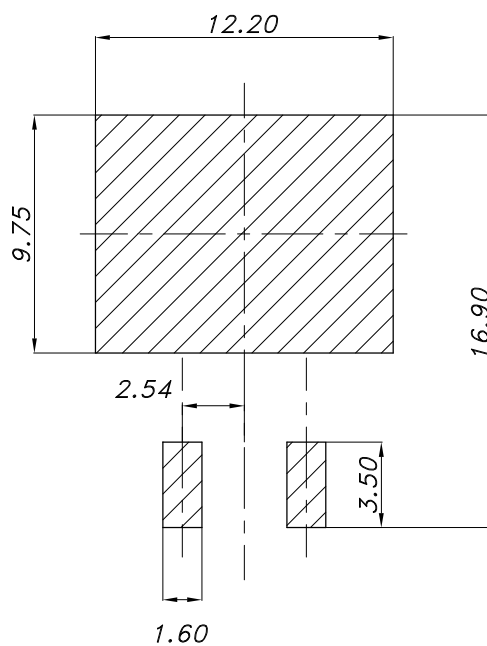
Figure 18. H<sup>2</sup>PAK-2 package outline



8159712\_6

**Table 8. H<sup>2</sup>PAK-2 package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.30	-	4.70
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°

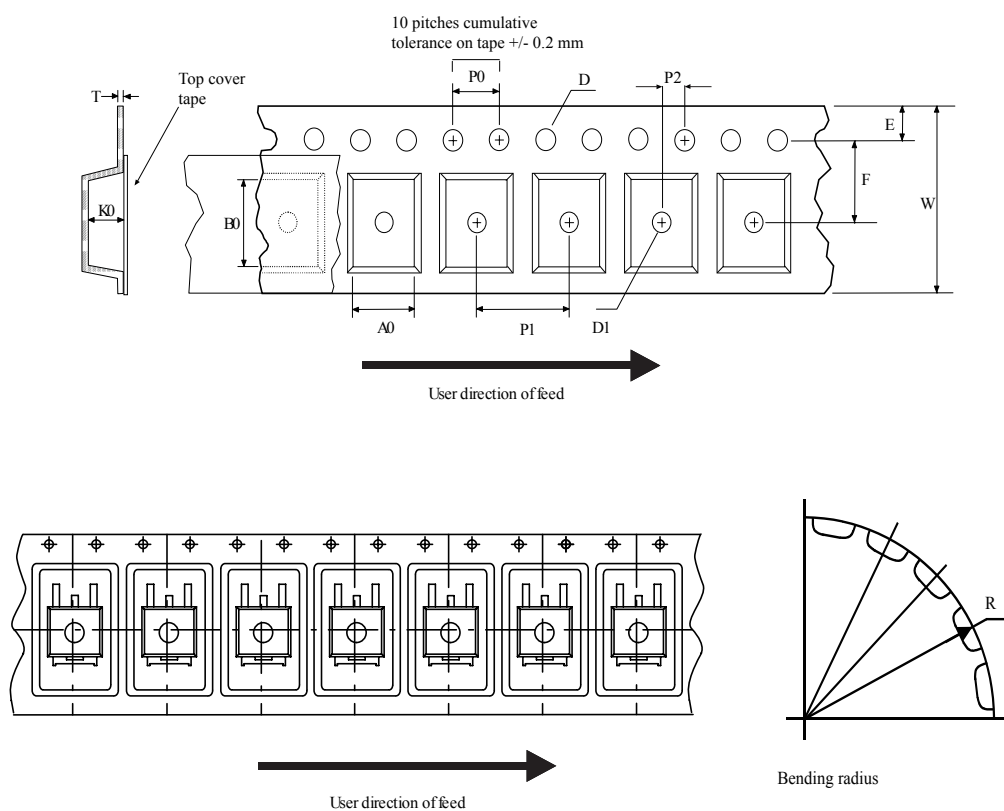
**Figure 19. H<sup>2</sup>PAK-2 recommended footprint**


8159712\_6

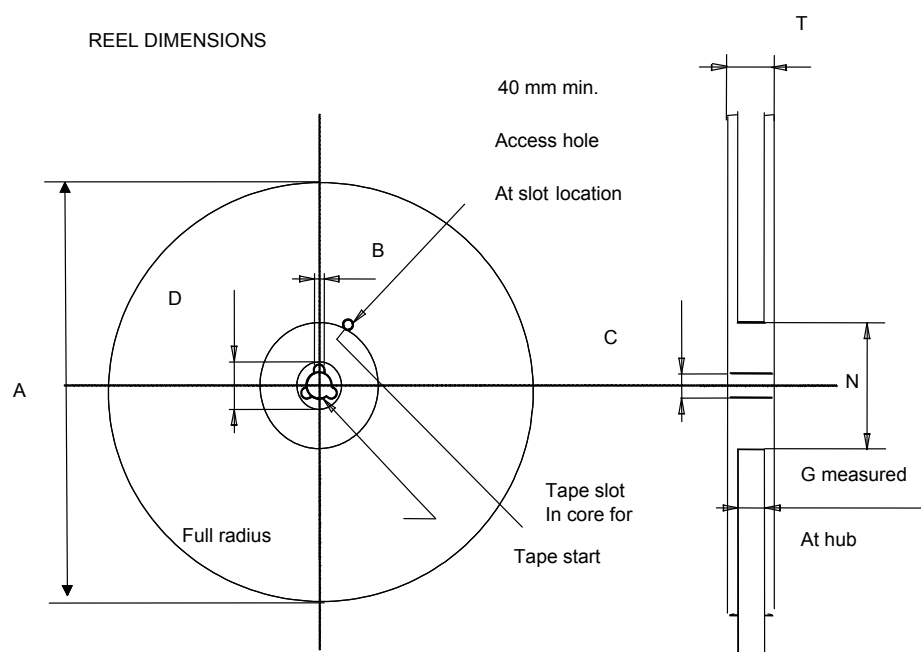
*Note:*      *Dimensions are in mm.*

## 4.2 Packing information

Figure 20. Tape outline



AM08852v2

**Figure 21. Reel outline**

**Table 9. 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 quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

## Revision history

**Table 10. Document revision history**

Date	Version	Changes
23-Mar-2018	1	Initial release. The document status is preliminary data.
30-Jul-2018	2	The document status was promoted from preliminary to production data. Updated title and features on cover page.
31-Jul-2018	3	Updated the current table. The date for revision 2 was erroneously reported as "19-Jun-2018" instead of "30-Jul-2018".
05-Sep-2018	4	Updated $I_{DSS}$ parameter in <a href="#">Table 4. Static</a> .

## Contents

<b>1</b>	<b>Electrical ratings .....</b>	<b>2</b>
<b>2</b>	<b>Electrical characteristics.....</b>	<b>3</b>
<b>2.1</b>	Electrical characteristics (curves) .....	5
<b>3</b>	<b>Test circuits .....</b>	<b>7</b>
<b>4</b>	<b>Package information.....</b>	<b>8</b>
<b>4.1</b>	H <sup>2</sup> PAK-2 package information .....	8
<b>4.2</b>	Packing information .....	10
	<b>Revision history .....</b>	<b>13</b>

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