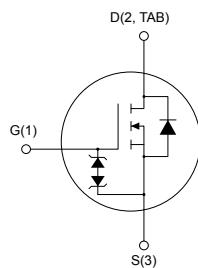


## N-channel 600 V, 1.38 $\Omega$ typ., 3.5 A MDmesh™ DM2 Power MOSFET in a DPAK package


**DPAK**


AM01475V1

### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$	$P_{TOT}$
STD5N60DM2	600 V	1.55 $\Omega$	3.5 A	45 W

- Fast-recovery body diode
- Extremely low gate charge and input capacitance
- Low on-resistance
- 100% avalanche tested
- Extremely high dv/dt ruggedness
- Zener-protected

### Applications

- Switching applications

### Description

This high-voltage N-channel Power MOSFET is part of the MDmesh™ DM2 fast recovery diode series. It offers very low recovery charge ( $Q_{rr}$ ) and time ( $t_{rr}$ ) combined with low  $R_{DS(on)}$ , rendering it suitable for the most demanding high-efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

#### Product status link

[STD5N60DM2](#)

#### Product summary

<b>Order code</b>	STD5N60DM2
<b>Marking</b>	5N60DM2
<b>Package</b>	DPAK
<b>Packing</b>	Tape and reel

# 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 $T_{case} = 25\text{ }^\circ\text{C}$	3.5	A
	Drain current (continuous) at $T_{case} = 100\text{ }^\circ\text{C}$	2	
$I_{DM}^{(1)}$	Drain current (pulsed)	14	A
$P_{TOT}$	Total dissipation at $T_{case} = 25\text{ }^\circ\text{C}$	45	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	40	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	40	
$T_{stg}$	Storage temperature range	-55 to 150	$^\circ\text{C}$
$T_j$	Operating junction temperature range		

1. Pulse width is limited by safe operating area.
2.  $I_{SD} \leq 3.5\text{ A}$ ,  $di/dt=400\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 480\text{ V}$ .
3.  $V_{DS} \leq 480\text{ V}$ .

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	2.78	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	50	

1. When mounted on a 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	1	A
$E_{AS}^{(2)}$	Single pulse avalanche energy	132	mJ

1. Pulse width limited by  $T_{jmax}$ .
2. 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	$V_{\text{GS}} = 0\text{ V}, I_{\text{D}} = 1\text{ mA}$	600			V
$I_{\text{DSS}}$	Zero gate voltage drain current	$V_{\text{GS}} = 0\text{ V}, V_{\text{DS}} = 600\text{ V}$			1	$\mu\text{A}$
		$V_{\text{GS}} = 0\text{ V}, V_{\text{DS}} = 600\text{ V}, T_{\text{case}} = 125\text{ }^{\circ}\text{C}^{(1)}$			100	
$I_{\text{GSS}}$	Gate-body leakage current	$V_{\text{DS}} = 0\text{ V}, V_{\text{GS}} = \pm 25\text{ V}$			$\pm 5$	$\mu\text{A}$
$V_{\text{GS(th)}}$	Gate threshold voltage	$V_{\text{DS}} = V_{\text{GS}}, I_{\text{D}} = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{\text{DS(on)}}$	Static drain-source on-resistance	$V_{\text{GS}} = 10\text{ V}, I_{\text{D}} = 1.75\text{ A}$		1.38	1.55	$\Omega$

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	$V_{\text{DS}} = 100\text{ V}, f = 1\text{ MHz}, V_{\text{GS}} = 0\text{ V}$	-	214	-	$\mu\text{F}$
$C_{\text{oss}}$	Output capacitance		-	12	-	
$C_{\text{riss}}$	Reverse transfer capacitance		-	3.5	-	
$C_{\text{oss eq.}}^{(1)}$	Equivalent output capacitance	$V_{\text{DS}} = 0\text{ to }480\text{ V}, V_{\text{GS}} = 0\text{ V}$	-	21	-	$\mu\text{F}$
$R_{\text{G}}$	Intrinsic gate resistance	$f = 1\text{ MHz}, I_{\text{D}} = 0\text{ A}$	-	6.5	-	$\Omega$
$Q_{\text{g}}$	Total gate charge	$V_{\text{DD}} = 480\text{ V}, I_{\text{D}} = 3.5\text{ A}, V_{\text{GS}} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	5.3	-	nC
$Q_{\text{gs}}$	Gate-source charge		-	1.4	-	
$Q_{\text{gd}}$	Gate-drain charge		-	2.7	-	

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%  $V_{\text{DSS}}$ .

**Table 6. Switching times**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{\text{d(on)}}$	Turn-on delay time	$V_{\text{DD}} = 300\text{ V}, I_{\text{D}} = 1.75\text{ A}, R_{\text{G}} = 4.7\text{ }\Omega, V_{\text{GS}} = 10\text{ V}$ (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	7.2	-	ns
$t_{\text{r}}$	Rise time		-	4.1	-	
$t_{\text{d(off)}}$	Turn-off delay time		-	17	-	
$t_{\text{f}}$	Fall time		-	19.8	-	

**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		3.5	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		14	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 3.5\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 3.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see <a href="#">Figure 15. Test circuit for inductive load switching and diode recovery times</a> )	-	58	70	ns
$Q_{rr}$	Reverse recovery charge		-	109		nC
$I_{RRM}$	Reverse recovery current		-	4		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 3.5\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ °C}$ (see <a href="#">Figure 15. Test circuit for inductive load switching and diode recovery times</a> )	-	109		ns
$Q_{rr}$	Reverse recovery charge		-	309		nC
$I_{RRM}$	Reverse recovery current		-	5		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

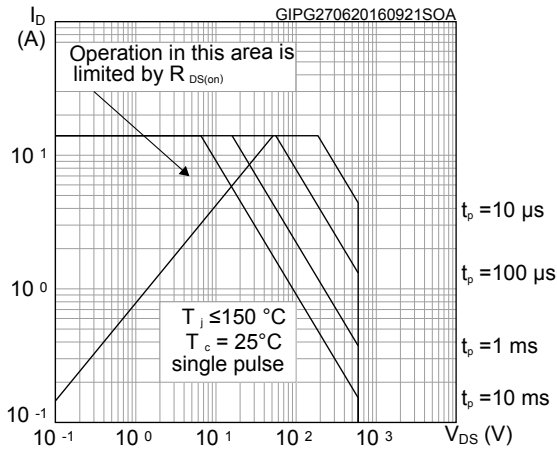


Figure 2. Thermal impedance

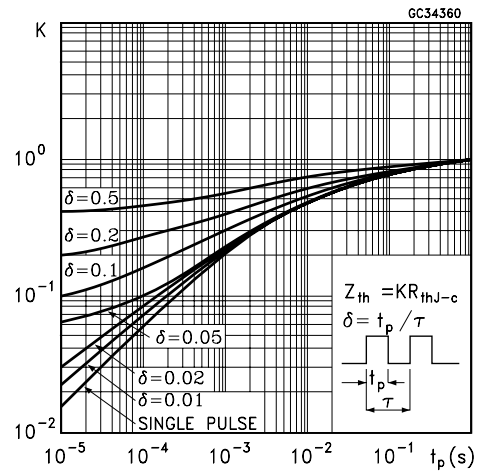


Figure 3. Output characteristics

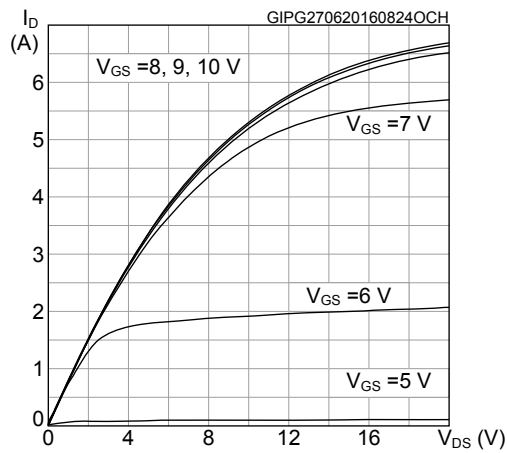


Figure 4. Transfer characteristics

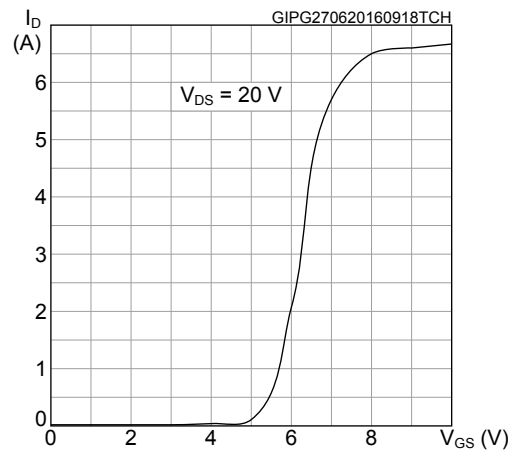


Figure 5. Gate charge vs gate-source voltage

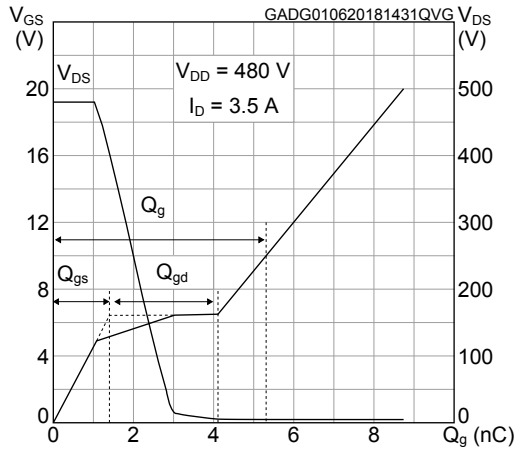


Figure 6. Static drain-source on-resistance

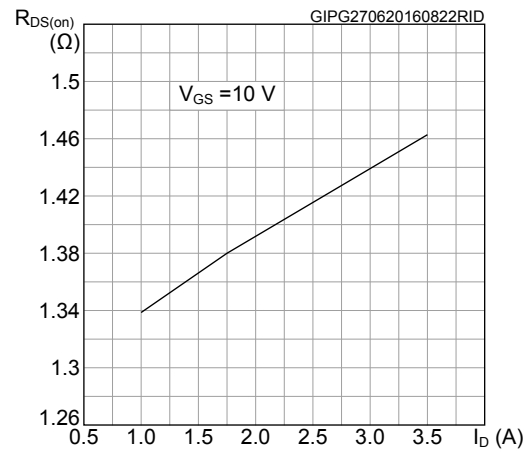


Figure 7. Capacitance variations

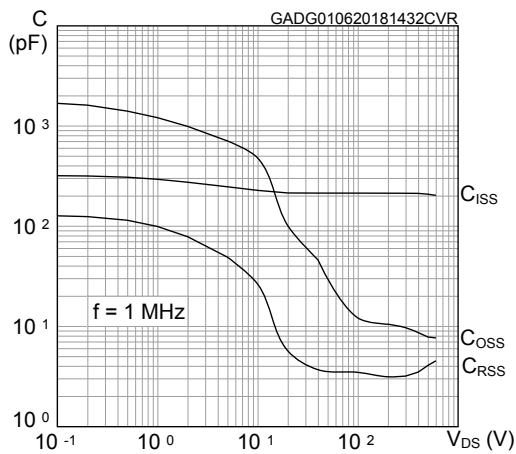


Figure 8. Output capacitance stored energy

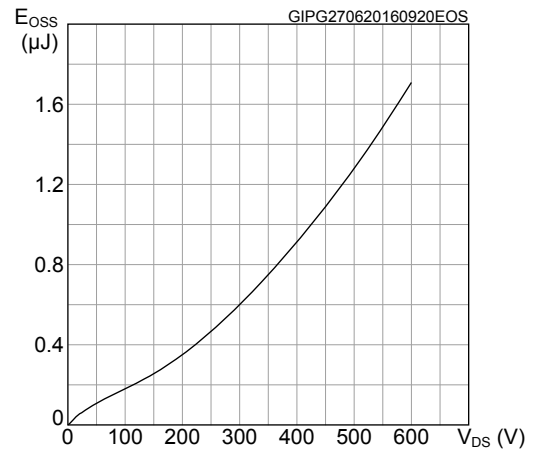


Figure 9. Normalized gate threshold voltage vs temperature

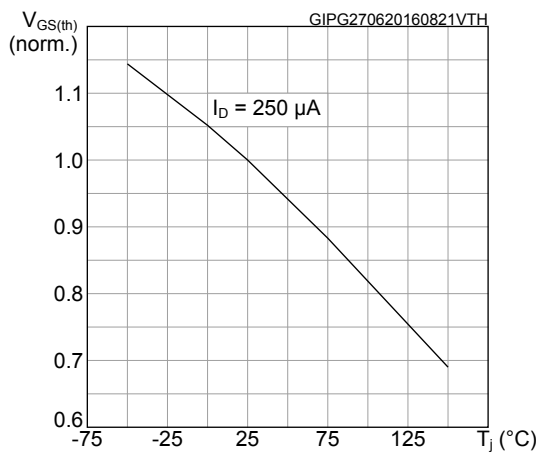


Figure 10. Normalized on-resistance vs temperature

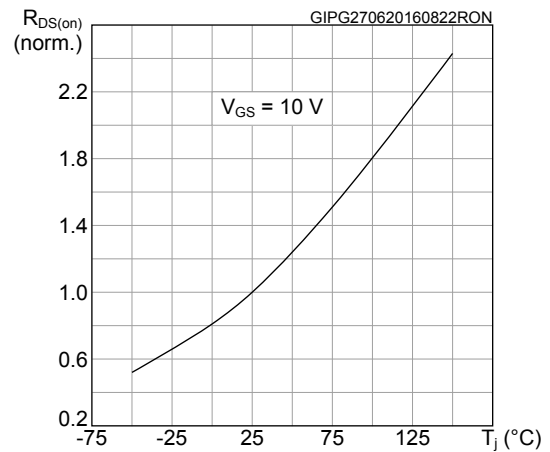


Figure 11. Source-drain diode forward characteristics

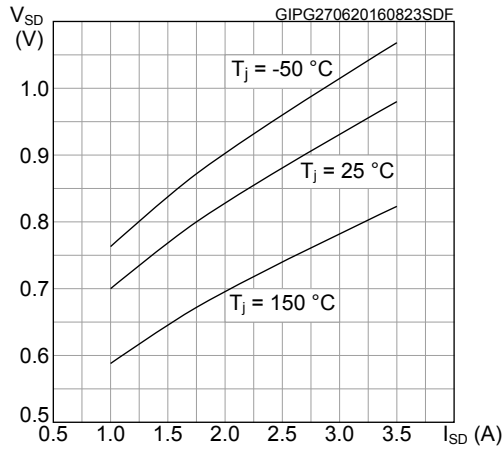
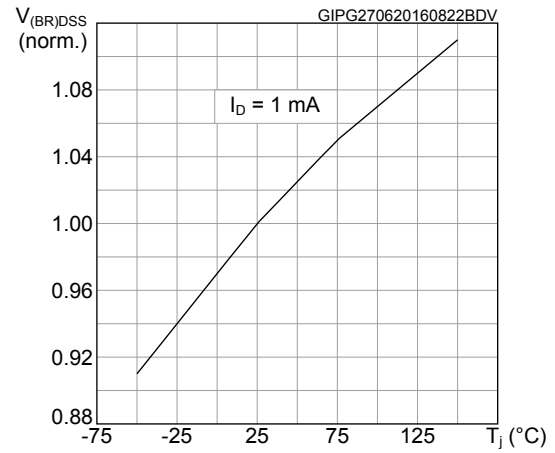


Figure 12. Normalized  $V_{(BR)DSS}$  vs temperature



### 3 Test circuits

**Figure 13. Test circuit for resistive load switching times**

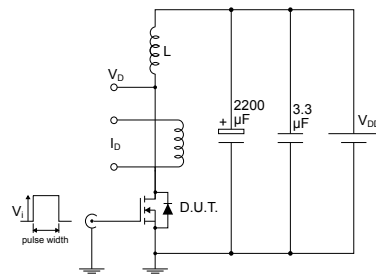

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**Figure 14. Test circuit for gate charge behavior**

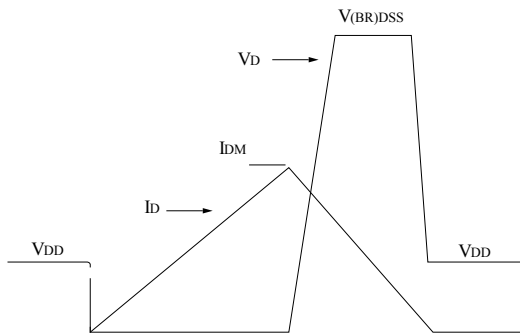

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**Figure 15. Test circuit for inductive load switching and diode recovery times**

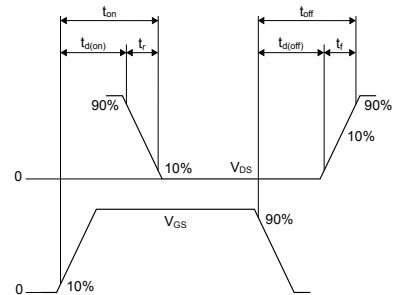

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**Figure 16. Unclamped inductive load test circuit**


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**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


AM01473v1



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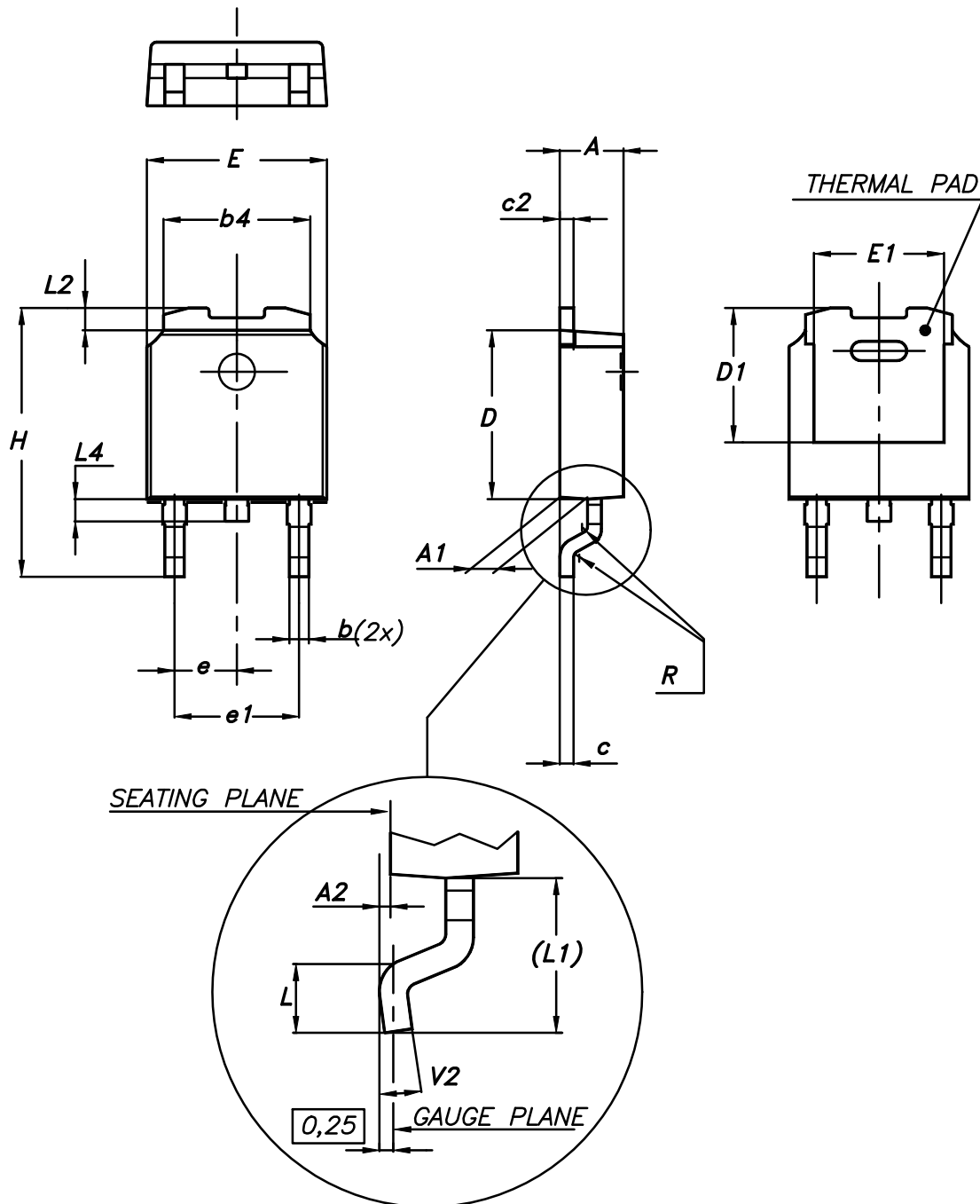
## 4 Package information

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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](http://www.st.com). ECOPACK® is an ST trademark.

**4.1 DPAK (TO-252) type A package information**

Figure 19. DPAK (TO-252) type A package outline



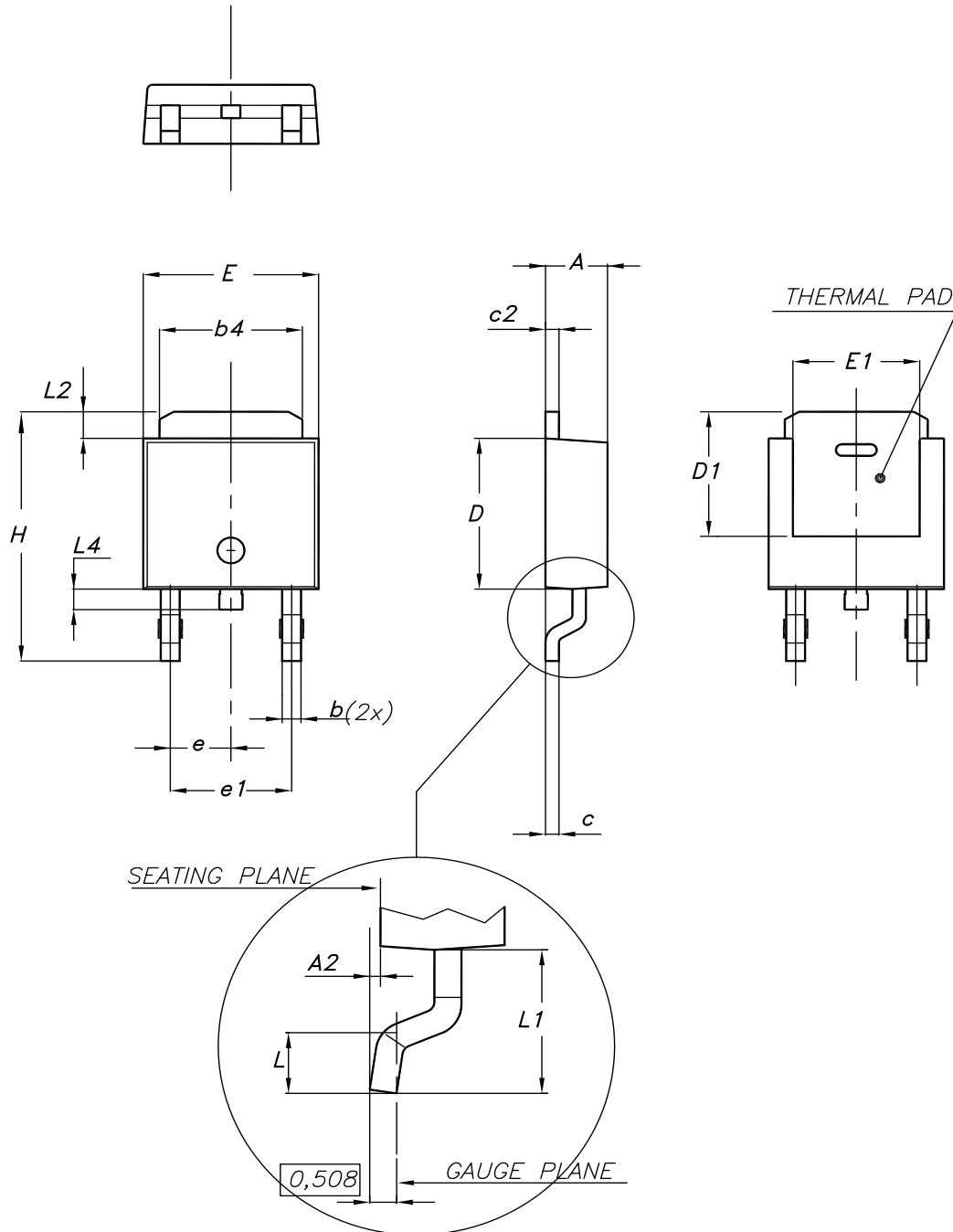
0068772\_A\_25

**Table 8. DPAK (TO-252) type A 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	4.95	5.10	5.25
E	6.40		6.60
E1	4.60	4.70	4.80
e	2.159	2.286	2.413
e1	4.445	4.572	4.699
H	9.35		10.10
L	1.00		1.50
(L1)	2.60	2.80	3.00
L2	0.65	0.80	0.95
L4	0.60		1.00
R		0.20	
V2	0°		8°

## 4.2 DPAK (TO-252) type E package information

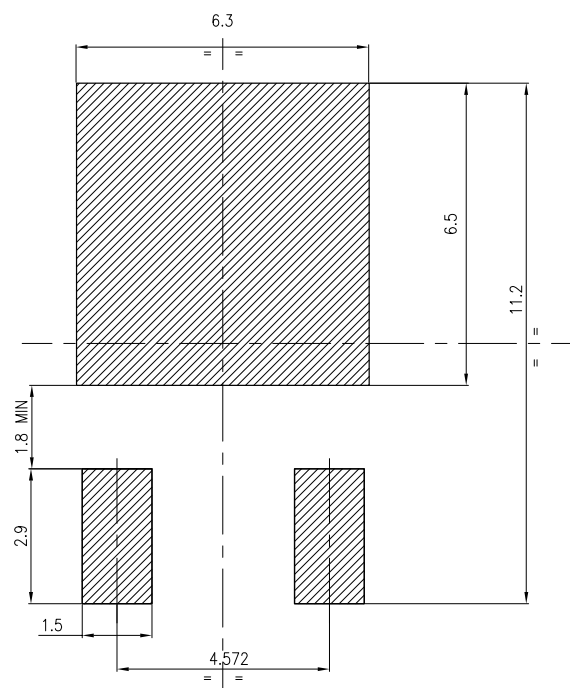
Figure 20. DPAK (TO-252) type E package outline



0068772\_type-E\_rev.25

**Table 9. DPAK (TO-252) type E mechanical data**

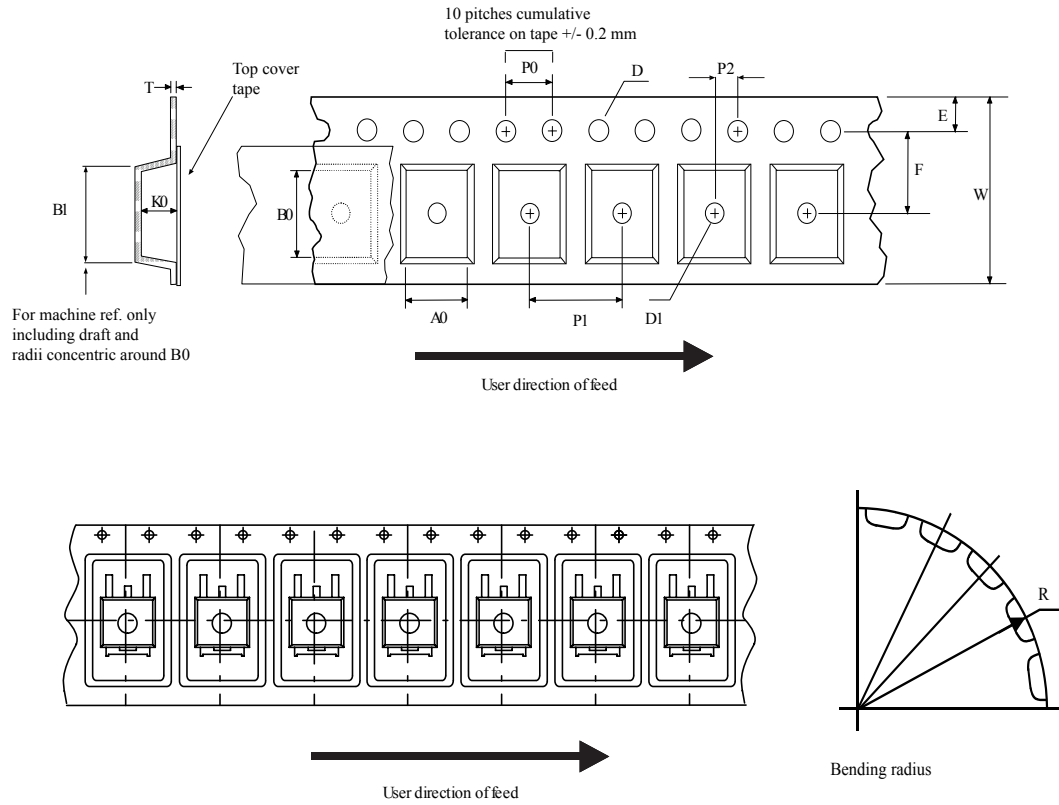
Dim.	mm		
	Min.	Typ.	Max.
A	2.18		2.39
A2			0.13
b	0.65		0.884
b4	4.95		5.46
c	0.46		0.61
c2	0.46		0.60
D	5.97		6.22
D1	5.21		
E	6.35		6.73
E1	4.32		
e		2.286	
e1		4.572	
H	9.94		10.34
L	1.50		1.78
L1		2.74	
L2	0.89		1.27
L4			1.02

**Figure 21. DPAK (TO-252) type E recommended footprint (dimensions are in mm)**


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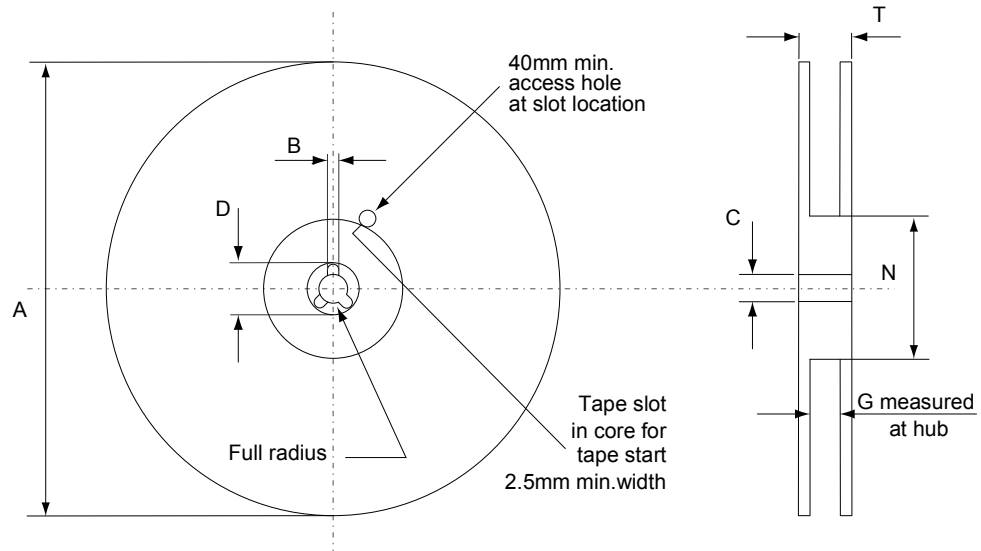
### 4.3 DPAK (TO-252) packing information

**Figure 22. DPAK (TO-252) tape outline**



AM08852v1

Figure 23. DPAK (TO-252) reel outline



AM06038v1

Table 10. 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			

## Revision history

**Table 11. Document revision history**

Date	Revision	Changes
05-Jul-2016	1	First release.
17-May-2017	2	Updated <i>Section 1: "Electrical ratings"</i> . Added <i>Section 4.2: "DPAK (TO-252) type C package information"</i> . Minor text changes.
01-Jun-2018	3	Updated <a href="#">Table 3. Avalanche characteristics</a> , <a href="#">Table 5. Dynamic</a> , <a href="#">Figure 5. Gate charge vs gate-source voltage</a> and <a href="#">Figure 7. Capacitance variations</a> . Updated <a href="#">Section 4 Package information</a> .



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