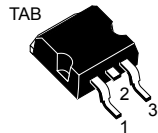
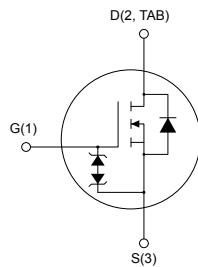


## Automotive-grade N-channel 400 V, 0.063 $\Omega$ typ., 38 A, MDmesh™ DM2 Power MOSFET in a D<sup>2</sup>PAK package



 D<sup>2</sup>PAK


AM01475V1



### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max.	I <sub>D</sub>	P <sub>TOT</sub>
STB45N40DM2AG	400 V	0.072 $\Omega$	38 A	250 W

- AEC-Q101 qualified 
- 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<sub>rr</sub>) and time (t<sub>rr</sub>) combined with low R<sub>DS(on)</sub>, rendering it suitable for the most demanding high-efficiency converters and ideal for bridge topologies and ZVS phase-shift converters.

#### Product status

STB45N40DM2AG

#### Product summary

<b>Order code</b>	STB45N40DM2AG
<b>Marking</b>	45N40DM2
<b>Package</b>	D <sup>2</sup> PAK
<b>Packing</b>	Tape and reel

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate-source voltage	$\pm 25$	V
$I_D$	Drain current (continuous) at $T_{case} = 25\text{ }^\circ\text{C}$	38	A
	Drain current (continuous) at $T_{case} = 100\text{ }^\circ\text{C}$	24	
$I_{DM}^{(1)}$	Drain current (pulsed)	110	A
$P_{TOT}$	Total power dissipation at $T_{case} = 25\text{ }^\circ\text{C}$	250	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	50	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		

1. Pulse width is limited by safe operating area.
2.  $I_{SD} \leq 38\text{ A}$ ,  $di/dt = 800\text{ A}/\mu\text{s}$ ,  $V_{DS\text{ peak}} < V_{(BR)DSS}$ ,  $V_{DD} = 80\% V_{(BR)DSS}$
3.  $V_{DS} \leq 320\text{ V}$

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	0.5	$^\circ\text{C}/\text{W}$
$R_{thj-pcb}^{(1)}$	Thermal resistance junction-pcb	30	

1. 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	7	A
$E_{AS}^{(2)}$	Single pulse avalanche energy	1100	mJ

1. Pulse width is 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	$V_{\text{GS}} = 0\text{ V}$ , $I_{\text{D}} = 1\text{ mA}$	400			V
$I_{\text{DSS}}$	Zero gate voltage drain current	$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 400\text{ V}$			10	$\mu\text{A}$
		$V_{\text{GS}} = 0\text{ V}$ , $V_{\text{DS}} = 400\text{ V}$ , $T_{\text{case}} = 125\text{ }^{\circ}\text{C}^{(1)}$			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	$V_{\text{GS}} = 10\text{ V}$ , $I_{\text{D}} = 19\text{ A}$		0.063	0.072	$\Omega$

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	$V_{\text{DS}} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{\text{GS}} = 0\text{ V}$	-	2600	-	$\mu\text{F}$
$C_{\text{OSS}}$	Output capacitance		-	180	-	
$C_{\text{rSS}}$	Reverse transfer capacitance		-	3.5	-	
$C_{\text{OSS eq.}}^{(1)}$	Equivalent output capacitance	$V_{\text{DS}} = 0\text{ to }320\text{ V}$ , $V_{\text{GS}} = 0\text{ V}$	-	300	-	$\mu\text{F}$
$R_{\text{G}}$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_{\text{D}} = 0\text{ A}$	-	4	-	$\Omega$
$Q_{\text{g}}$	Total gate charge	$V_{\text{DD}} = 320\text{ V}$ , $I_{\text{D}} = 38\text{ A}$ , $V_{\text{GS}} = 0\text{ to }10\text{ V}$ (see Figure 14. Test circuit for gate charge behavior)	-	56	-	nC
$Q_{\text{GS}}$	Gate-source charge		-	13	-	
$Q_{\text{GD}}$	Gate-drain charge		-	28	-	

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	$V_{\text{DD}} = 200\text{ V}$ , $I_{\text{D}} = 19\text{ A}$ , $R_{\text{G}} = 4.7\text{ }\Omega$ , $V_{\text{GS}} = 10\text{ V}$ (see Figure 13. Test circuit for resistive load switching times and Figure 18. Switching time waveform)	-	20	-	ns
$t_{\text{r}}$	Rise time		-	6.7	-	
$t_{\text{d(off)}}$	Turn-off delay time		-	68	-	
$t_{\text{f}}$	Fall time		-	9.8	-	

**Table 7. Source-drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		38	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		110	A
$V_{SD}^{(2)}$	Forward on voltage	$V_{GS} = 0\text{ V}$ , $I_{SD} = 38\text{ A}$	-		1.6	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 38\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	95		ns
$Q_{rr}$	Reverse recovery charge		-	0.4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	8.5		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 38\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $V_{DD} = 60\text{ V}$ , $T_j = 150\text{ }^\circ\text{C}$ (see Figure 15. Test circuit for inductive load switching and diode recovery times)	-	185		ns
$Q_{rr}$	Reverse recovery charge		-	1.62		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	17.5		A

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

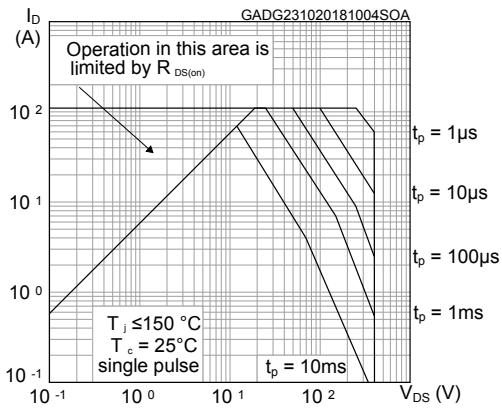
**Table 8. Gate-source Zener diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 250\text{ }\mu\text{A}$ , $I_D = 0\text{ A}$	$\pm 30$	-	-	V

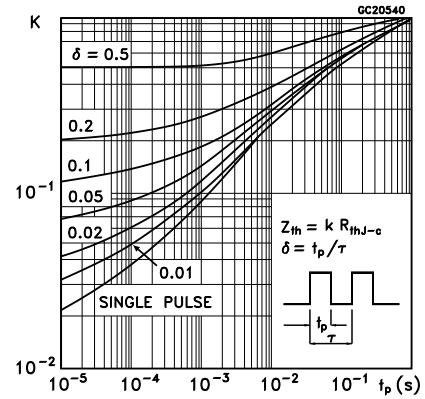
The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

## 2.1 Electrical characteristics (curves)

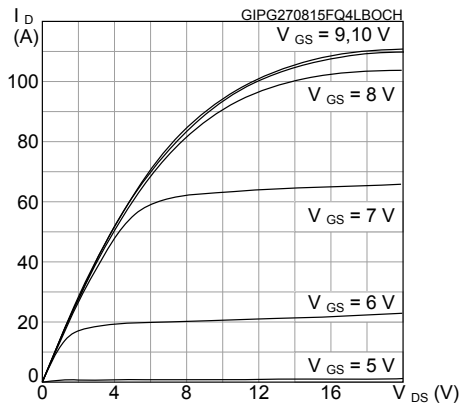
**Figure 1. Safe operating area**



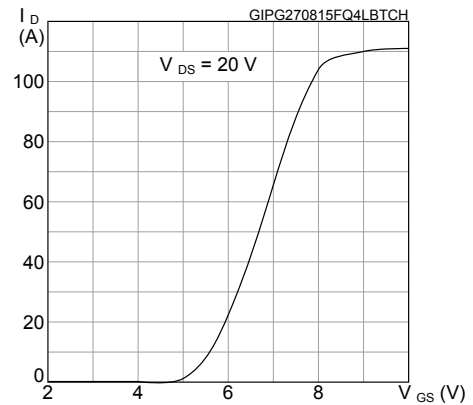
**Figure 2. Thermal impedance**



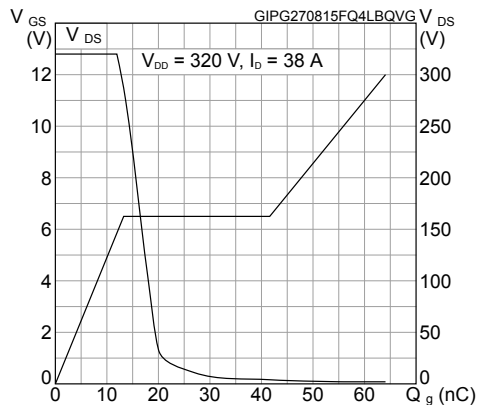
**Figure 3. Output characteristics**



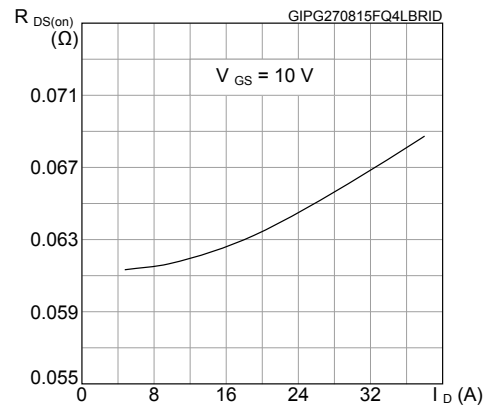
**Figure 4. Transfer characteristics**



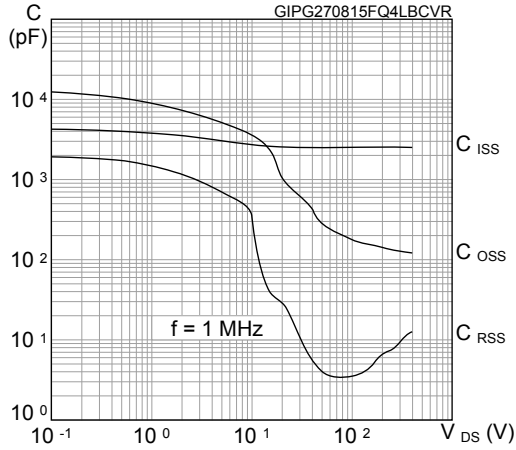
**Figure 5. Gate charge vs gate-source voltage**



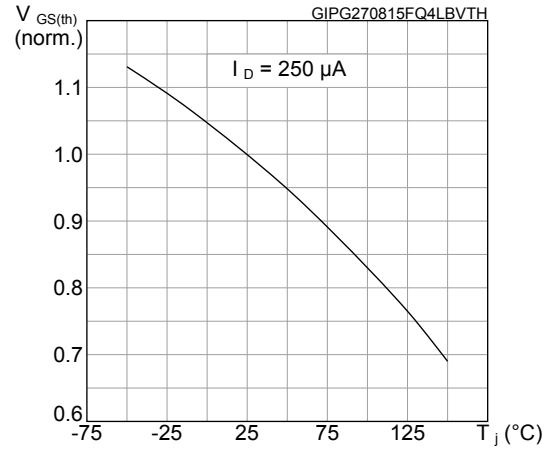
**Figure 6. Static drain-source on-resistance**



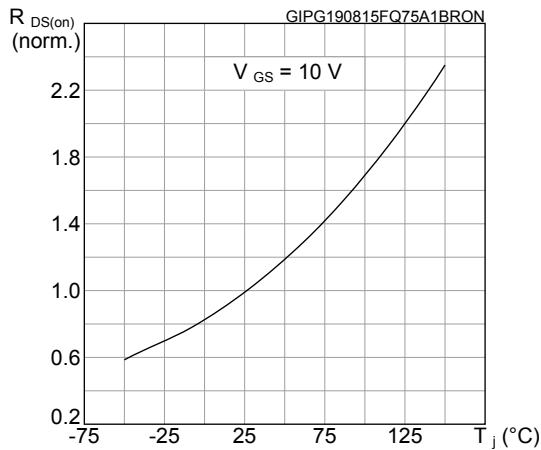
**Figure 7. Capacitance variations**



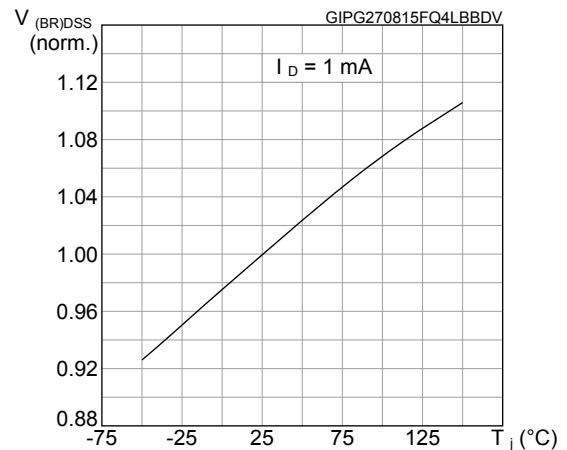
**Figure 8. Normalized gate threshold voltage vs temperature**



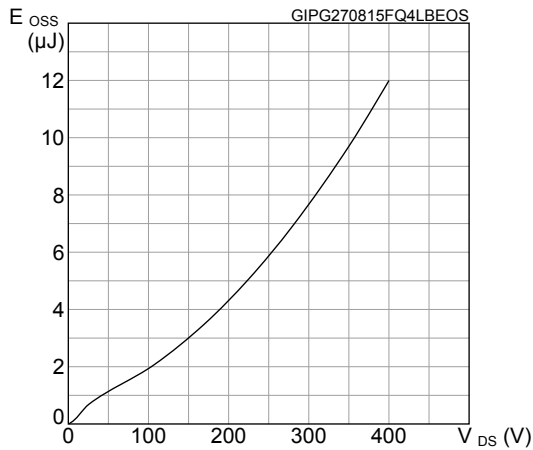
**Figure 9. Normalized on-resistance vs temperature**



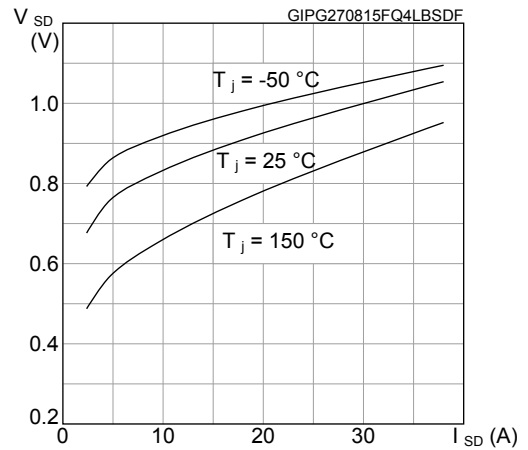
**Figure 10. Normalized  $V_{(BR)DSS}$  vs temperature**



**Figure 11. Output capacitance stored energy**



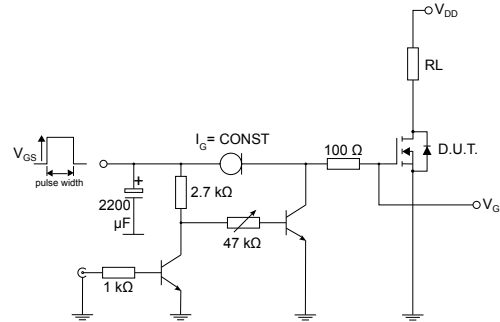
**Figure 12. Source-drain diode forward characteristics**



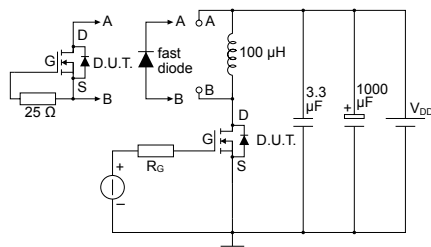
### 3 Test circuits

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

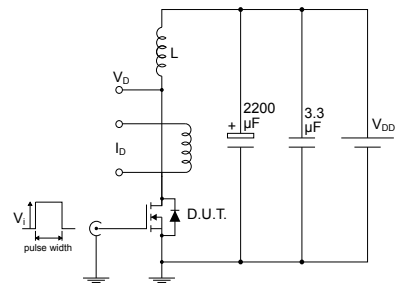

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**Figure 14. Test circuit for gate charge behavior**


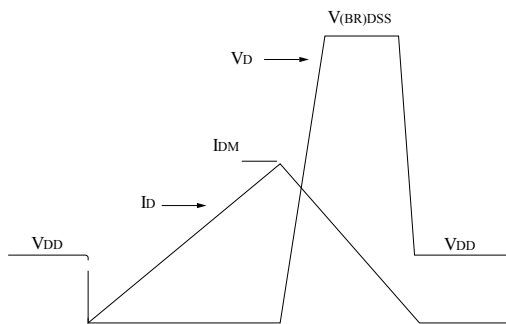
AM01469v10

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


AM01470v1

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


AM01471v1

**Figure 17. Unclamped inductive waveform**


AM01472v1

**Figure 18. Switching time waveform**


AM01473v1

## 4 Package information

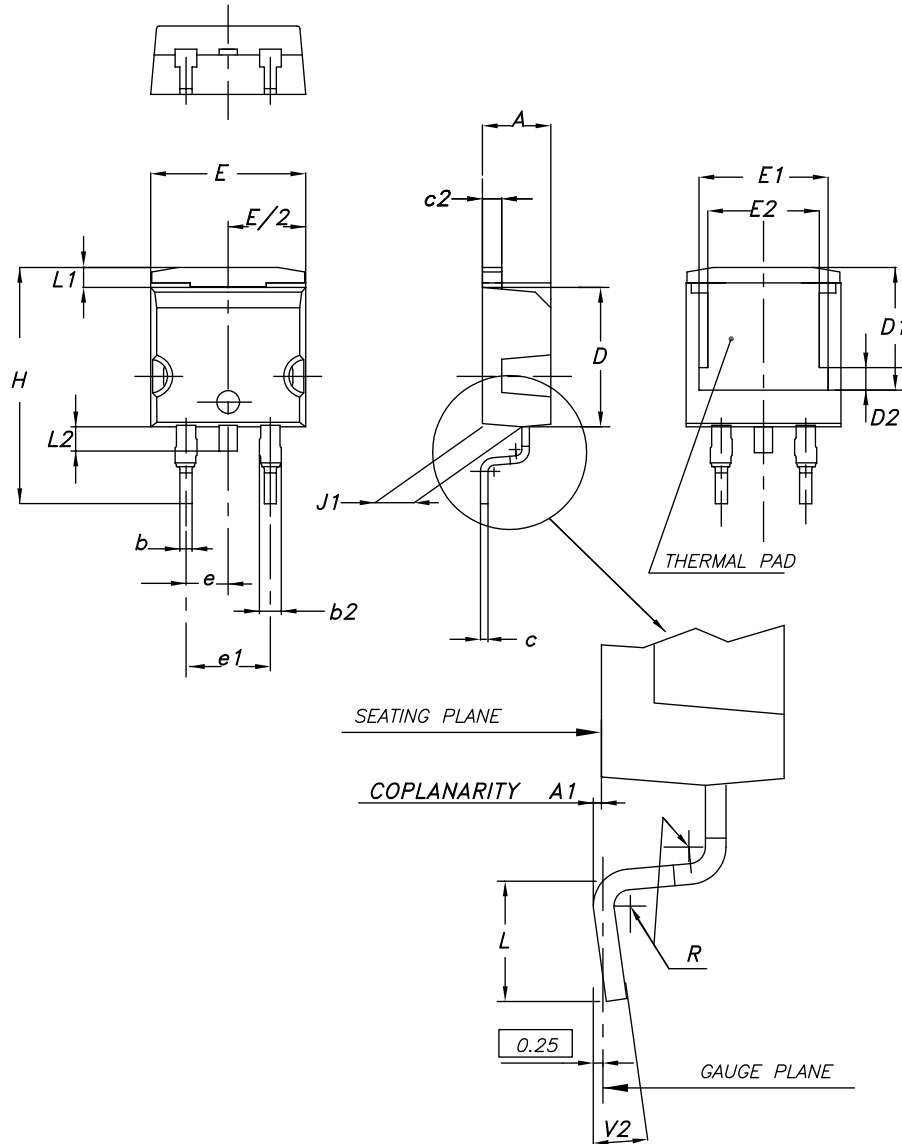
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### 4.1 D<sup>2</sup>PAK (TO-263) type A2 package information

Figure 19. D<sup>2</sup>PAK (TO-263) type A2 package outline

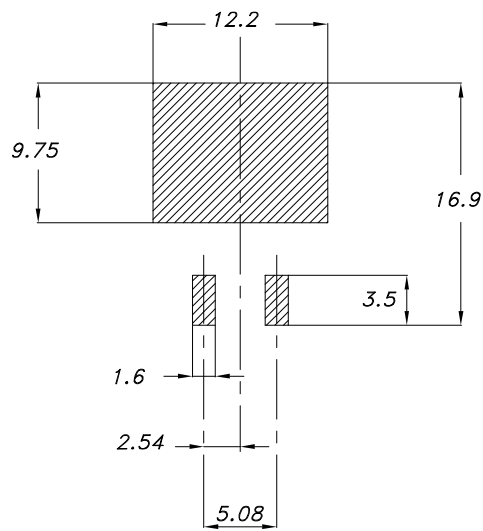


0079457\_A2\_25

**Table 9. D<sup>2</sup>PAK (TO-263) type A2 package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.70	8.90	9.10
E2	7.30	7.50	7.70
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

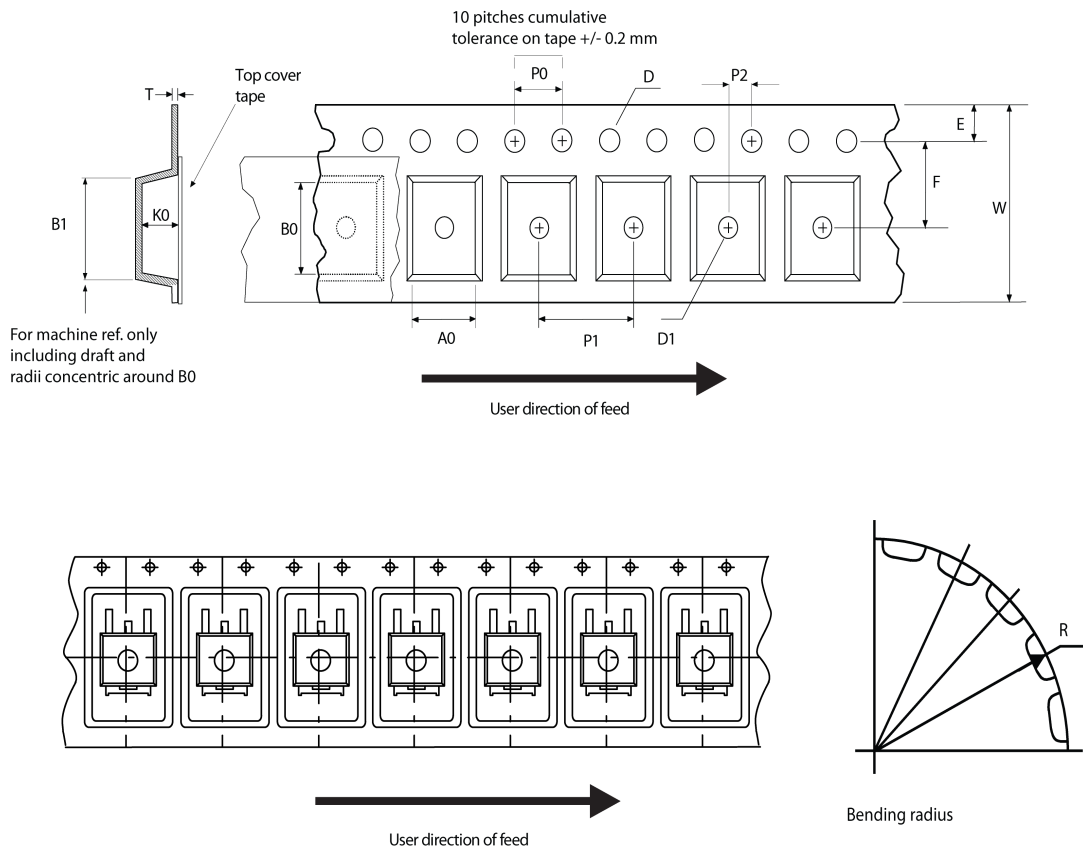
**Figure 20. D<sup>2</sup>PAK (TO-263) recommended footprint (dimensions are in mm)**



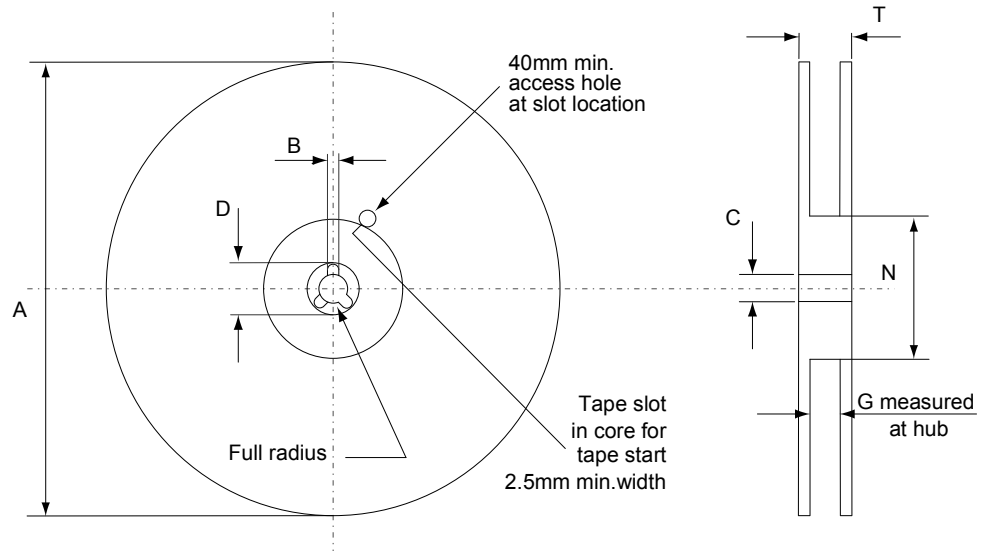
Footprint

## 4.2 D<sup>2</sup>PAK packing information

**Figure 21. D<sup>2</sup>PAK tape outline**



AM08852v1

**Figure 22. D<sup>2</sup>PAK reel outline**


AM06038v1

**Table 10. D<sup>2</sup>PAK 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	Base quantity Bulk quantity			
P1	11.9	12.1				1000
P2	1.9	2.1				1000
R	50					
T	0.25	0.35				
W	23.7	24.3				

## Revision history

**Table 11. Document revision history**

Date	Revision	Changes
27-Aug-2015	1	Initial version
04-Aug-2016	2	Updated <i>Figure 2: "Safe operating area"</i> . Minor text changes.
14-Feb-2018	3	Removed maturity status indication from cover page. Updated <i>Section 4.1 D<sup>2</sup>PAK (TO-263) type A2 package information</i> . Minor text changes
23-Oct-2018	4	Updated <a href="#">Table 1. Absolute maximum ratings</a> and <a href="#">Table 7. Source-drain diode</a> . Updated <a href="#">Figure 1. Safe operating area</a> and <a href="#">Figure 14. Test circuit for gate charge behavior</a> . Minor text changes.

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