STB33N60DM2, STP33N60DM2, STW33N60DM2

N-channel 600 V, 0.110 Ω typ., 24 A MDmesh™ DM2 Power MOSFET in D²PAK, TO-220 and TO-247 packages

Datasheet - production data

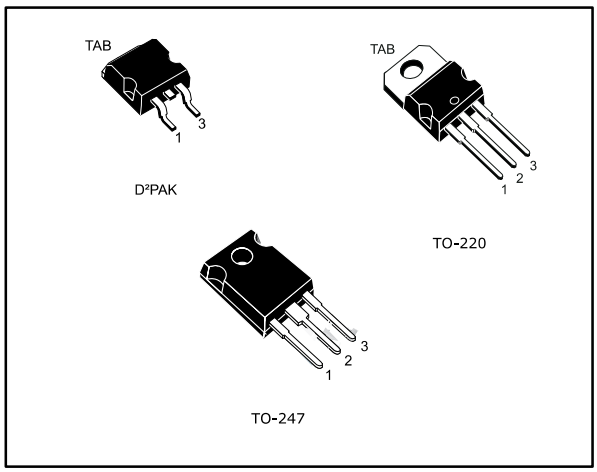
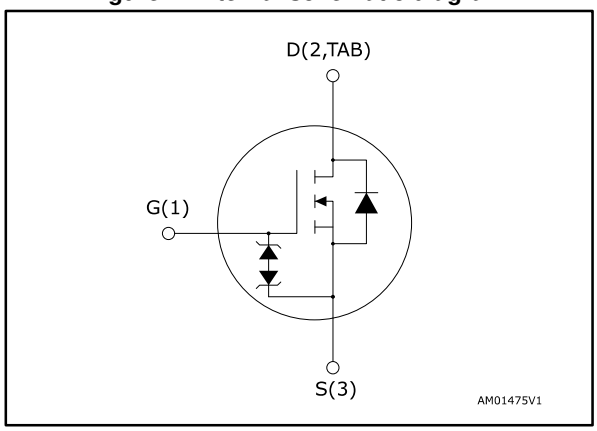


Figure 1: Internal schematic diagram



Features

Order code	V_{DS} @ $T_{Jmax.}$	$R_{DS(on)}$ max.	I_D
STB33N60DM2	650 V	0.130 Ω	24 A
STP33N60DM2	650 V	0.130 Ω	24 A
STW33N60DM2	650 V	0.130 Ω	24 A

- 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

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

Table 1: Device summary

Order code	Marking	Package	Packing
STB33N60DM2	33N60DM2	D²PAK	Tape and reel
STP33N60DM2	33N60DM2	TO-220	Tube
STW33N60DM2	33N60DM2	TO-247	Tube

This is information on a product in full production. www.st.com

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1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	±25	V
I_D	Drain current (continuous) at T_{case} = 25 °C	24	A
	Drain current (continuous) at T_{case} = 100 °C	15.5	
I_{DM}(1)	Drain current (pulsed)	96	A
P_{TOT}	Total dissipation at T_{case} = 25 °C	190	W
dv/dt(2)	Peak diode recovery voltage slope	50	V/ns
dv/dt(3)	MOSFET dv/dt ruggedness	50	
T_{stg}	Storage temperature	-55 to 150	°C
T_j	Operating junction temperature		

Notes:

(1) Pulse width is limited by safe operating area.

(2) $I_{SD} \leq 24$ A, di/dt=900 A/µs; V_{DS} peak < $V_{(BR)DSS}$, V_{DD} = 400 V.

(3) $V_{DS} \leq 480$ V.

Table 3: Thermal data

Symbol	Parameter	Value			Unit
		D²PAK	TO-220	TO-247	
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.66			°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb(1)	30			
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient		62.5	50	

Notes:

(1)When mounted on 1 inch² FR-4, 2 Oz copper board.

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (Pulse width limited by T_{jmax})	5.5	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, $I_D = I_{AR}$, V_{DD} = 50 V)	570	mJ

2 Electrical characteristics

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

Table 5: Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	600			V
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0 V, V_{DS} = 600 V			1	µA
		V_{GS} = 0 V, V_{DS} = 600 V, T_{case} = 125 °C			100	
I_{GSS}	Gate-body leakage current	V_{DS} = 0 V, V_{GS} = ±25 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 12 A		0.110	0.130	Ω

Table 6: Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0 V	-	1870	-	pF
C_{oss}	Output capacitance		-	87	-	
C_{rss}	Reverse transfer capacitance		-	2	-	
$C_{oss\ eq.}$ (1)	Equivalent output capacitance	V_{DD} = 480 V, V_{GS} = 0 V	-	157	-	pF
R_G	Intrinsic gate resistance	f = 1 MHz, I_D= 0 A	-	4.5	-	Ω
Q_g	Total gate charge	V_{DD} = 480 V, I_D = 24 A, V_{GS} = 10 V (see *Figure 19: "Test circuit for gate charge behavior"* and *Figure 23: "Switching time waveform"*)	-	43	-	nC
Q_{gs}	Gate-source charge		-	9.8	-	
Q_{gd}	Gate-drain charge		-	21	-	

Notes:

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

Table 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V, I_D = 12 A R_G = 4.7 Ω, V_{GS} = 10 V (see *Figure 18: "Test circuit for resistive load switching times"* and)	-	17	-	ns
t_r	Rise time		-	8	-	
$t_{d(off)}$	Turn-off delay time		-	62	-	
t_f	Fall time		-	9	-	

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		24	A
I_{SDM}(1)	Source-drain current (pulsed)		-		96	A
V_{SD}(2)	Forward on voltage	V_{GS} = 0 V, I_{SD} = 24 A	-		1.6	V
t_{rr}	Reverse recovery time	I_{SD} = 24 A, di/dt = 100 A/µs, V_{DD} = 60 V (see *Figure 20: "Test circuit for inductive load switching and diode recovery times"*)	-	150		ns
Q_{rr}	Reverse recovery charge		-	0.5		µC
I_{RRM}	Reverse recovery current		-	8.8		A
t_{rr}	Reverse recovery time	I_{SD} = 24 A, di/dt = 100 A/µs, V_{DD} = 60 V, T_j = 150 °C (see *Figure 20: "Test circuit for inductive load switching and diode recovery times"*)	-	316		ns
Q_{rr}	Reverse recovery charge		-	2.85		µC
I_{RRM}	Reverse recovery current		-	18		A

Notes:

(1) Pulse width is limited by safe operating area.

(2) Pulse test: pulse duration = 300 µs, duty cycle 1.5%.

Table 9: Gate-source Zener diode

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

2.1 Electrical characteristics (curves)

Figure 2: Safe operating area for D²PAK

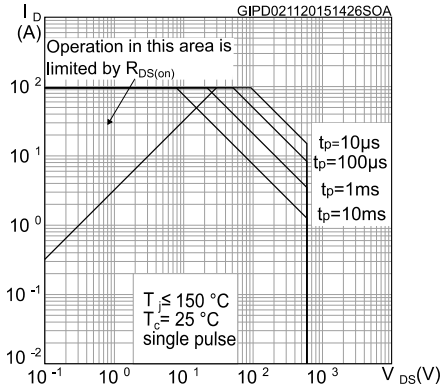


Figure 3: Thermal impedance for D²PAK

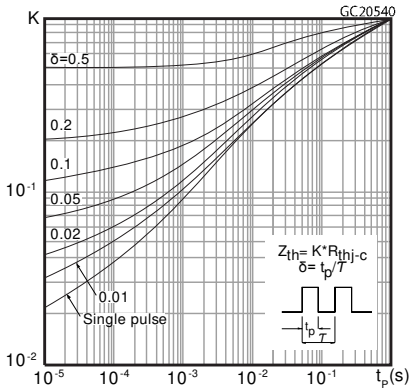


Figure 4: Safe operating area for TO-220

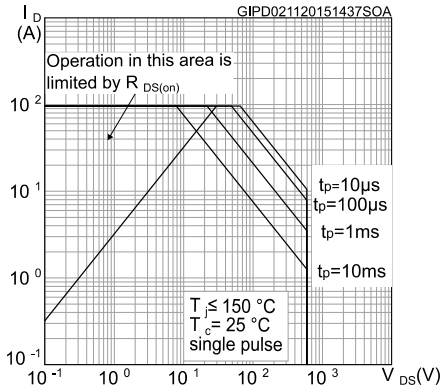


Figure 5: Thermal impedance for TO-220

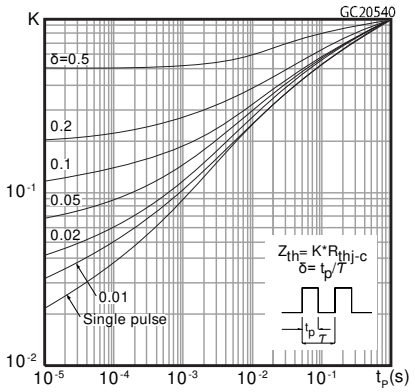


Figure 6: Safe operating area for TO-247

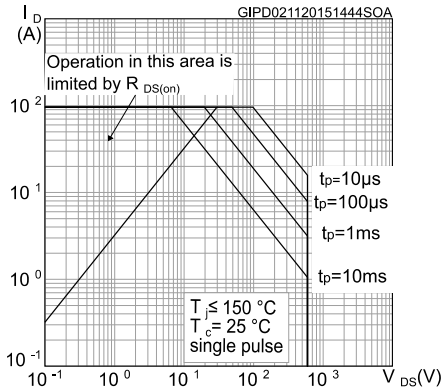


Figure 7: Thermal impedance for TO-247

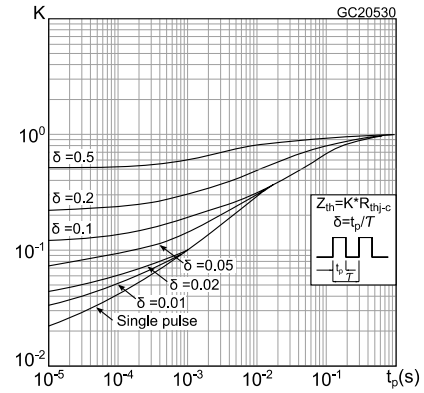


Figure 8: Output characteristics

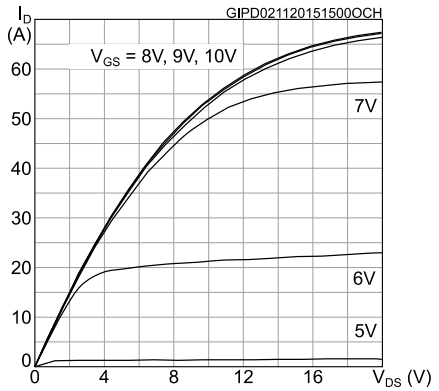


Figure 9: Transfer characteristics

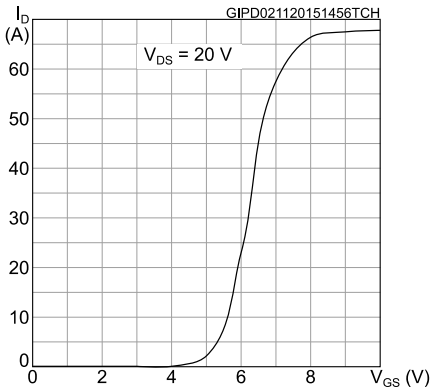


Figure 10: Gate charge vs gate-source voltage

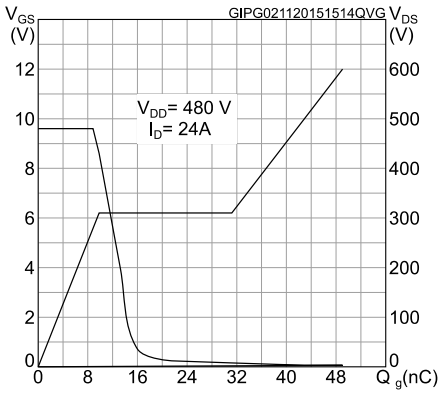


Figure 11: Static drain-source on-resistance

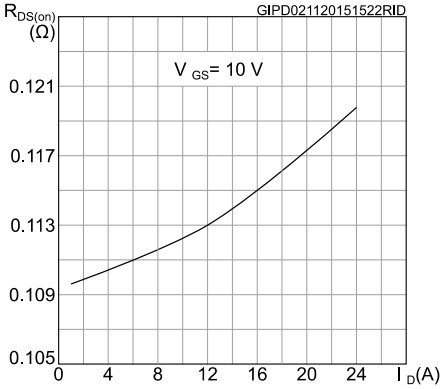


Figure 12: Capacitance variations

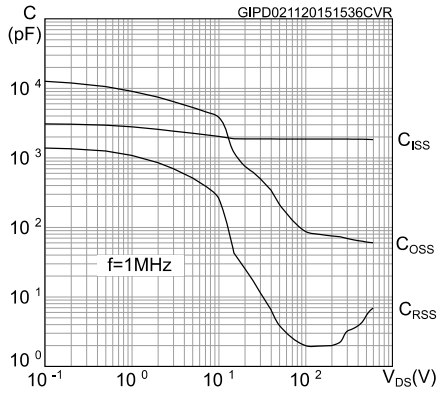


Figure 13: Normalized gate threshold voltage vs temperature

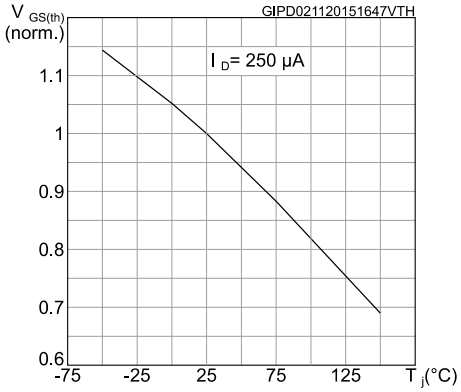


Figure 14: Normalized on-resistance vs temperature

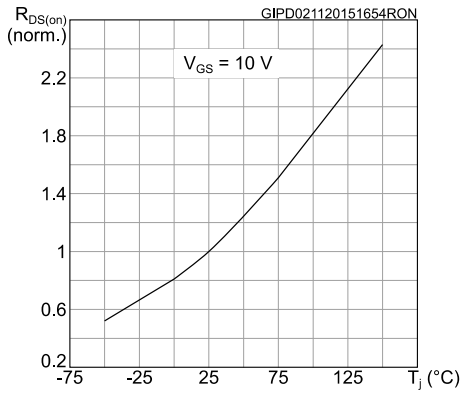


Figure 15: Normalized V(BR)DSS vs temperature

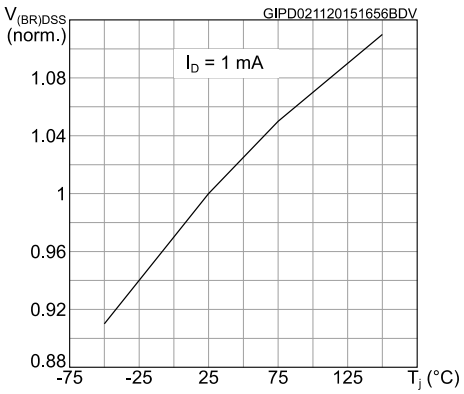


Figure 16: Output capacitance stored energy

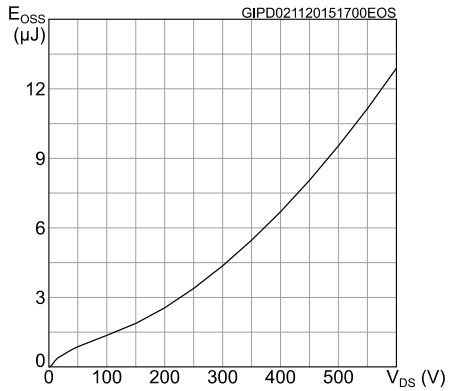
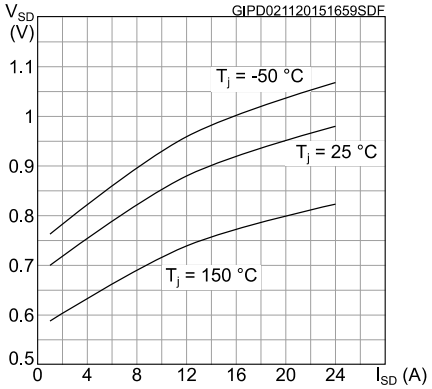


Figure 17: Source- drain diode forward characteristics



3 Test circuits

Figure 18: Test circuit for resistive load switching times

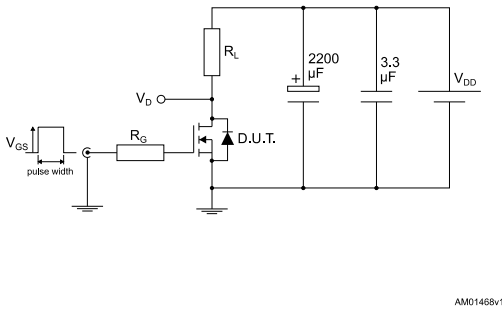


Figure 19: Test circuit for gate charge behavior

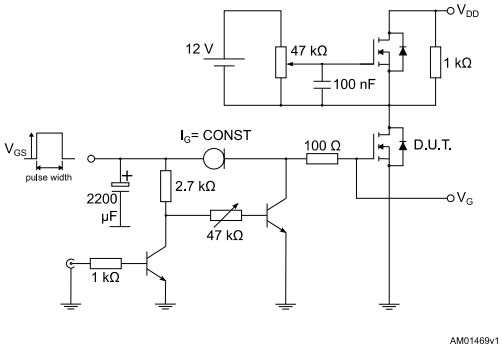


Figure 20: Test circuit for inductive load switching and diode recovery times

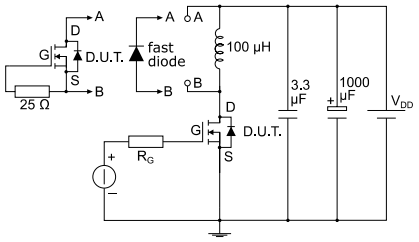


Figure 21: Unclamped inductive load test circuit

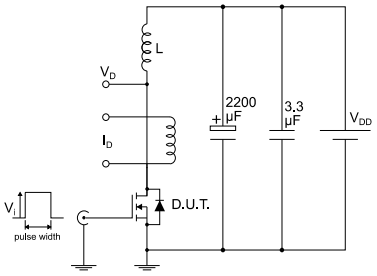


Figure 22: Unclamped inductive waveform

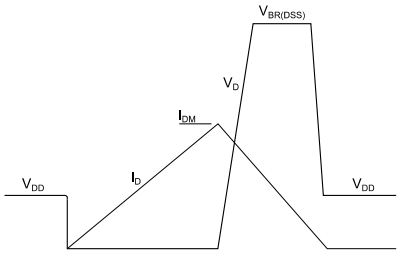
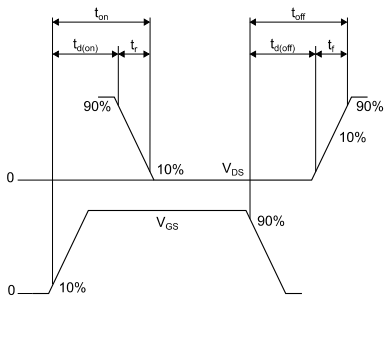


Figure 23: Switching time waveform



4 Package information

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***. ECOPACK® is an ST trademark.

4.1 D²PAK package information

Figure 24: D²PAK (TO-263) type A package outline

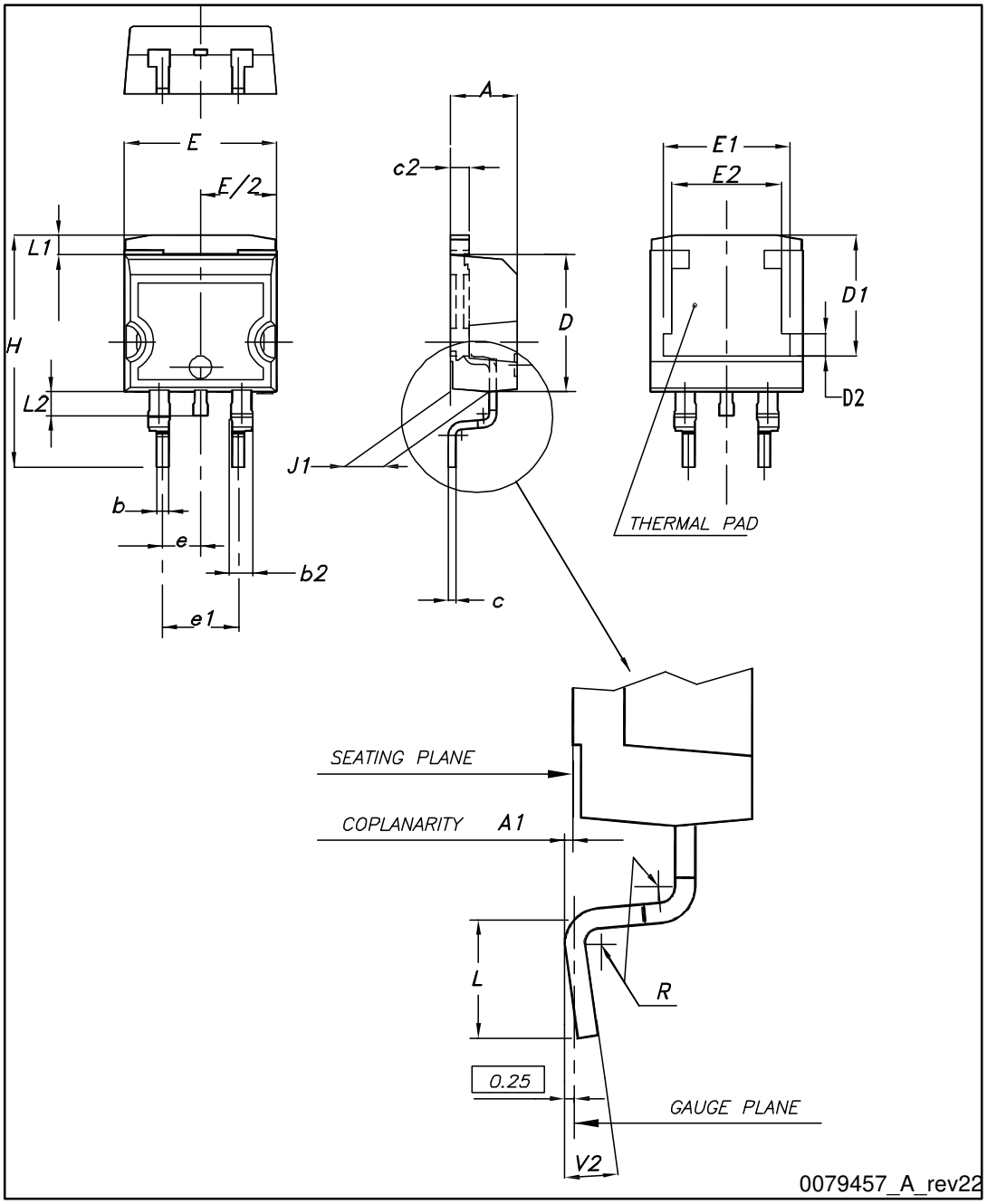
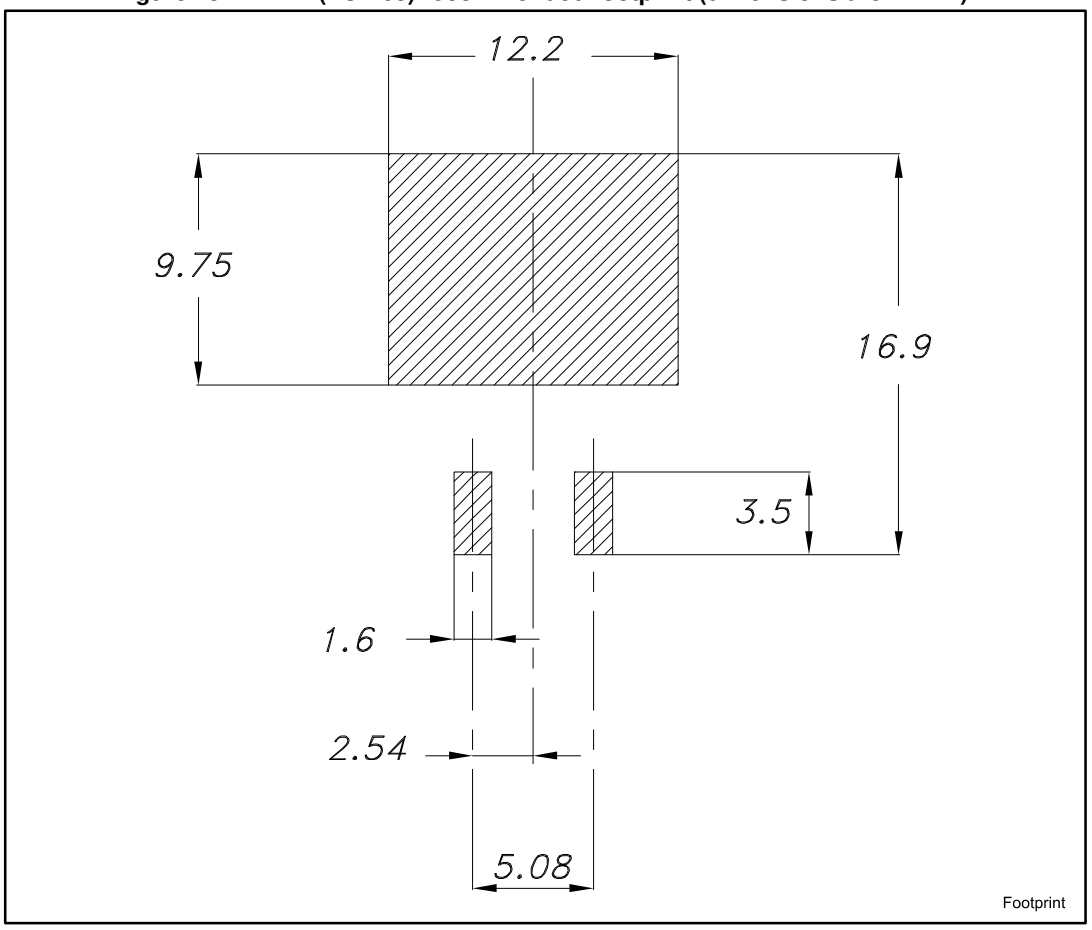


Table 10: D²PAK (TO-263) type A package mechanical data

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		10.40
E1	8.50	8.70	8.90
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 25: D²PAK (TO-263) recommended footprint (dimensions are in mm)



4.2 D²PAK packing information

Figure 26: Tape outline

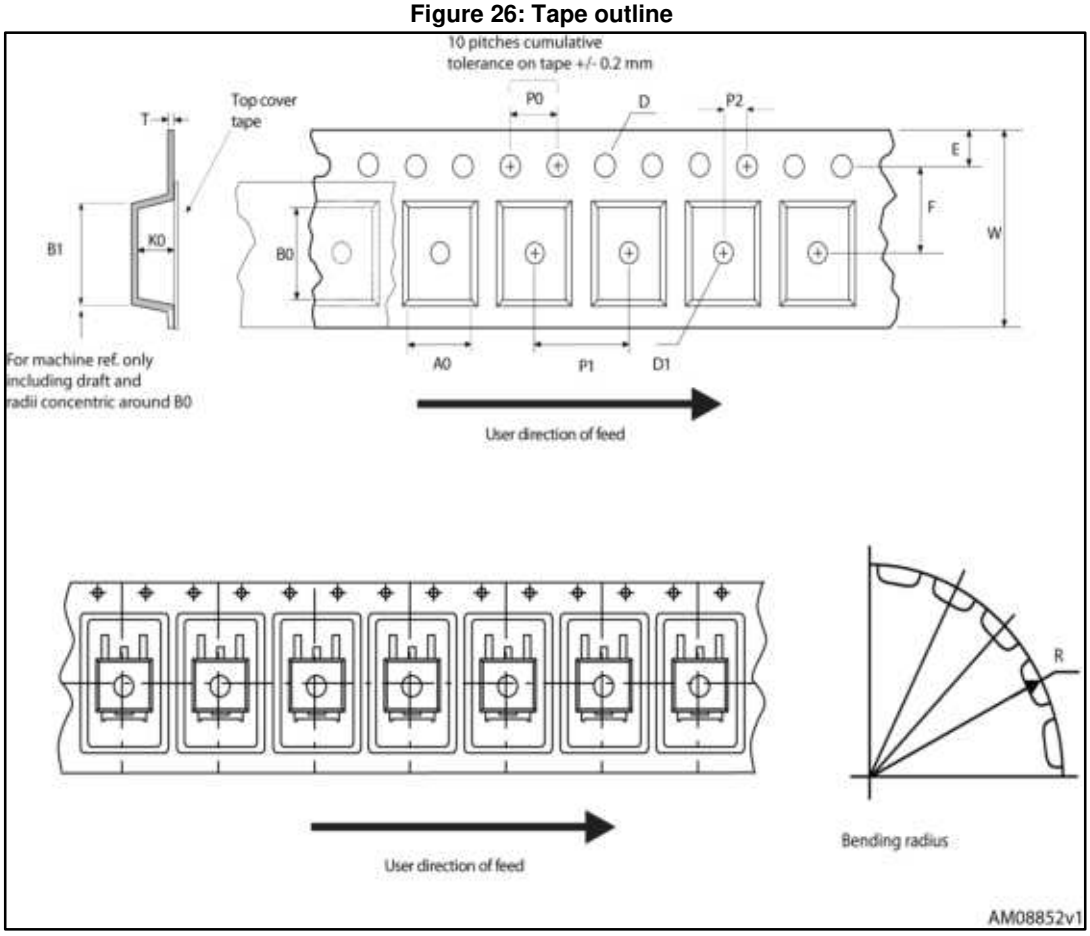


Figure 27: Reel outline

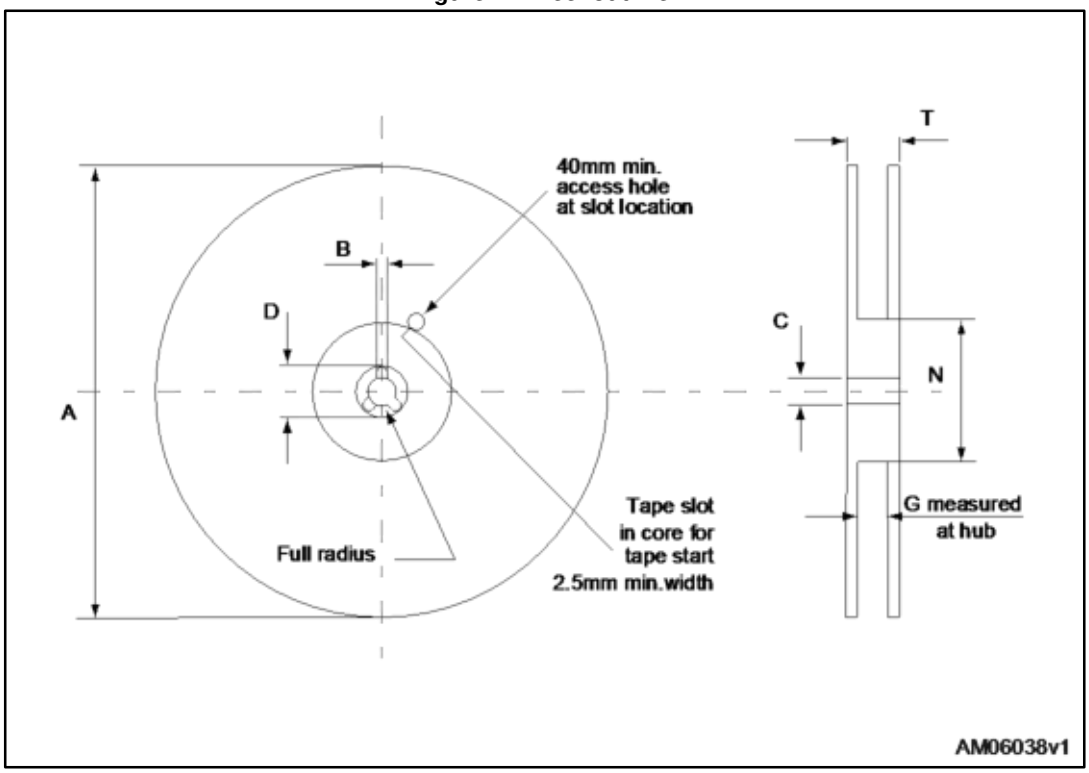


Table 11: D²PAK tape and reel mechanical data

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			

4.3 TO-220 type A package information

Figure 28: TO-220 type A package outline

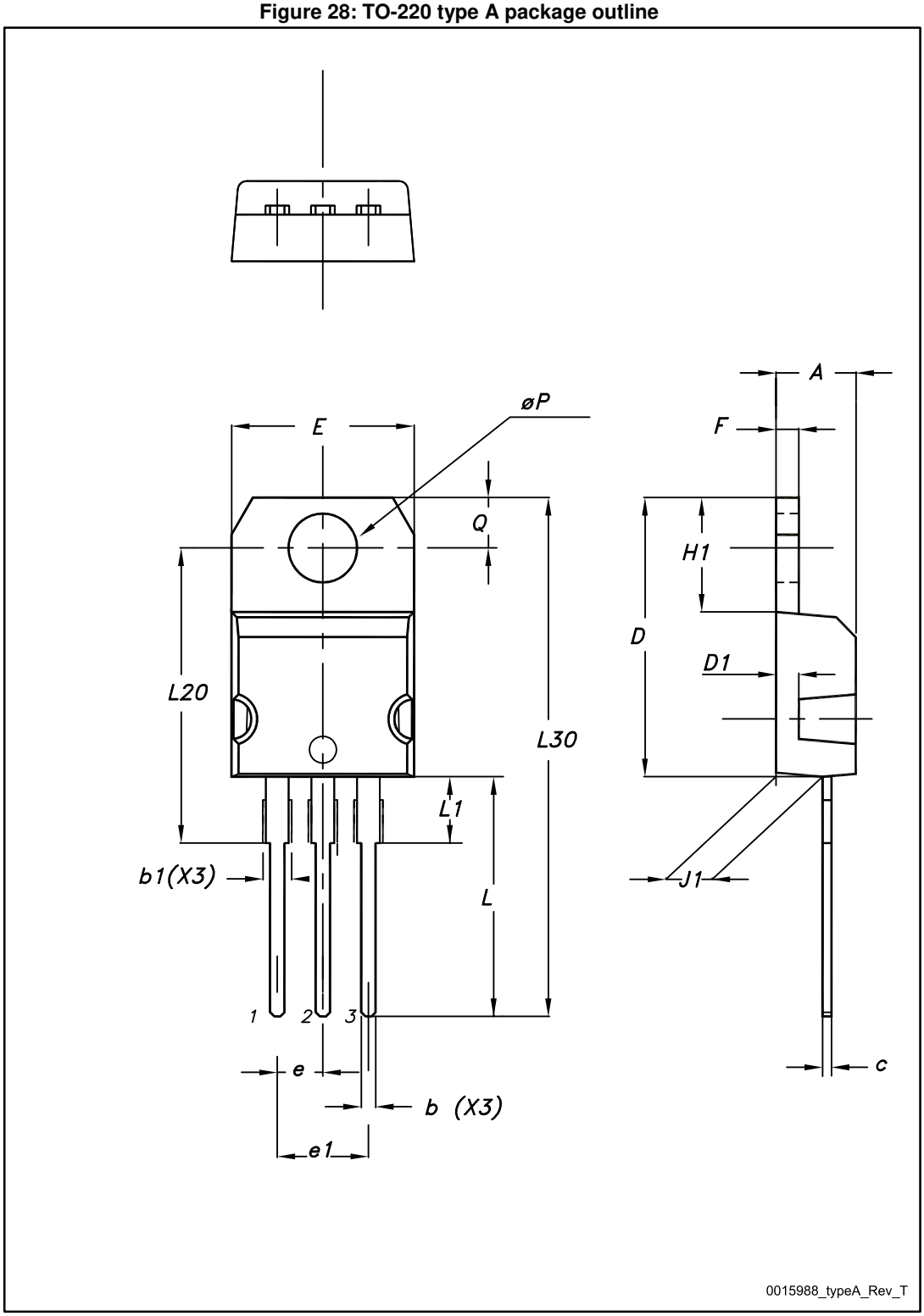


Table 12: TO-220 type A mechanical data

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

4.4 TO-247 package information

Figure 29: TO-247 package outline

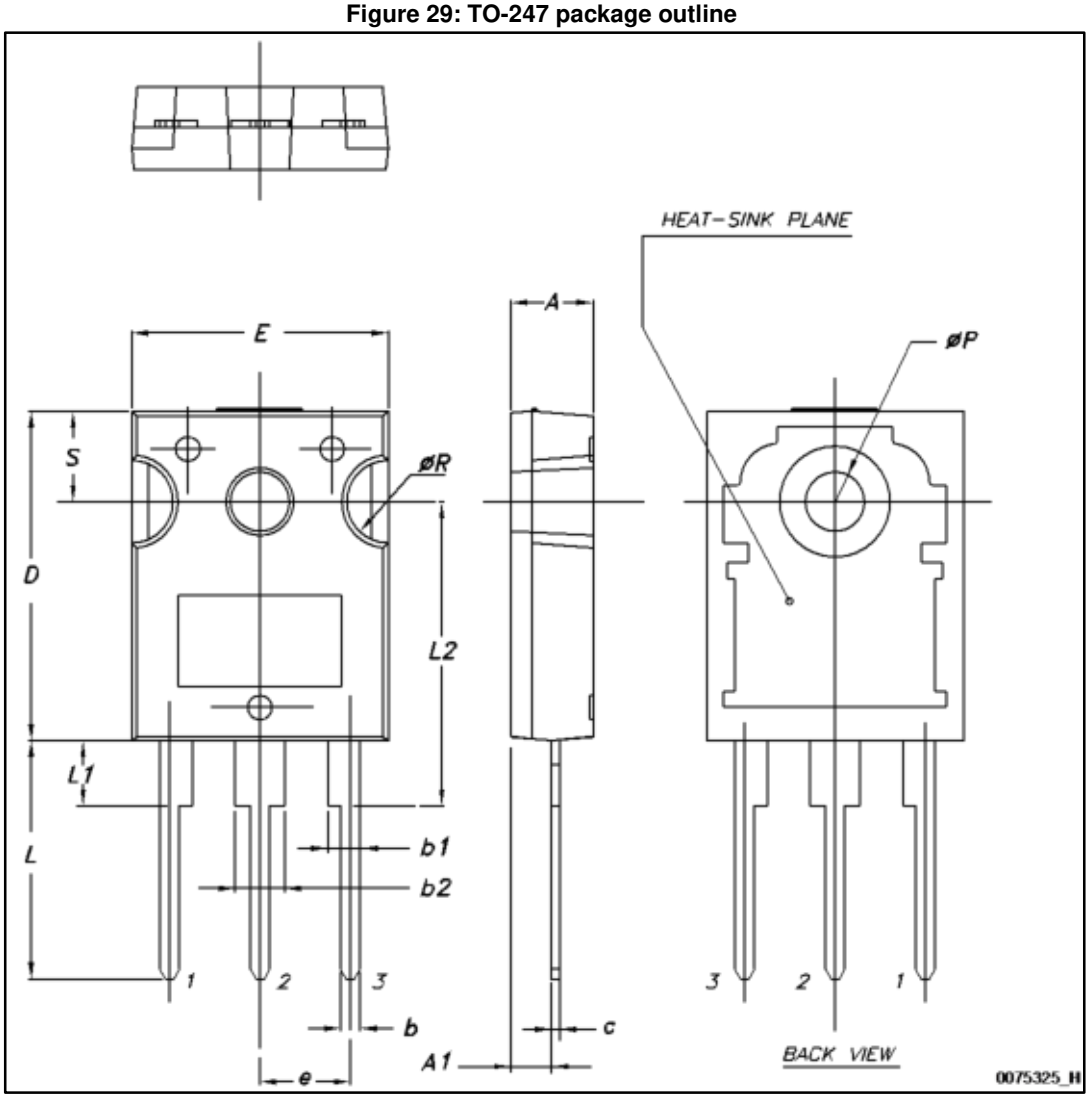


Table 13: TO-247 package mechanical data

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 Revision history

Table 14: Document revision history

Date	Revision	Changes
16-Oct-2014	1	First release.
02-Nov-2015	2	Document status promoted from preliminary to production data. Updated title and features in cover page. Updated *Table 2: "Absolute maximum ratings"*, *Table 4: "Avalanche characteristics"*, *Table 5: "Static"*, *Table 6: "Dynamic"*, *Table 7: "Switching times"* and *Table 8: "Source-drain diode"*. Added *Section 2.1 Electrical characteristics (curves).*

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