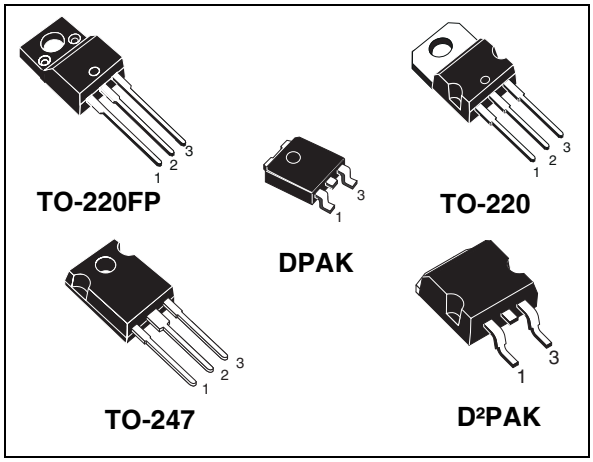
STB13NM60N,STD13NM60N,STF13NM60N STP13NM60N,STW13NM60N

N-channel 600 V, 0.28 Ω, 11 A MDmesh™ II Power MOSFET in D²PAK, DPAK, TO-220FP, TO-220, TO-247

Features

Type	V_{DSS} (@Tjmax)	$R_{DS(on)}$ max	I_D
STB13NM60N	650 V	< 0.36 Ω	11 A
STD13NM60N	650 V	< 0.36 Ω	11 A
STF13NM60N	650 V	< 0.36 Ω	11 A
STP13NM60N	650 V	< 0.36 Ω	11 A
STW13NM60N	650 V	< 0.36 Ω	11 A

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance



Application

- Switching applications

Description

This series of devices implements second generation MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

Figure 1. Internal schematic diagram

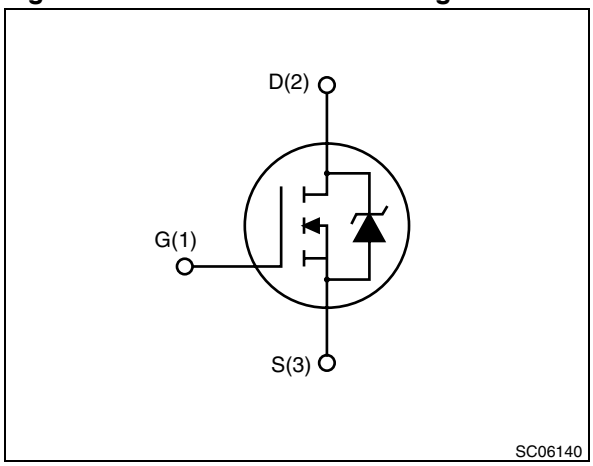


Table 1. Device summary

Order codes	Marking	Packages	Packaging
STB13NM60N	13NM60N	D²PAK	Tape and reel
STD13NM60N	13NM60N	DPAK	Tape and reel
STF13NM60N	13NM60N	TO-220FP	Tube
STP13NM60N	13NM60N	TO-220	Tube
STW13NM60N	13NM60N	TO-247	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		DPAK,TO-220, TO-247, D²PAK	TO-220FP	
V_{DS}	Drain-source voltage (V_{GS} = 0)	600		V
V_{GS}	Gate-source voltage	± 25		V
I_D	Drain current (continuous) at T_C = 25 °C	11	11 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	6.93	6.93 (1)	A
I_{DM} (2)	Drain current (pulsed)	44	44 (1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	90	25	W
dv/dt (3)	Peak diode recovery voltage slope	15		V/ns
V_{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s;T_C=25 °C)		2500	V
T_{stg}	Storage temperature	–55 to 150		°C
T_j	Max. operating junction temperature	150		°C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 11$ A, di/dt $\leq$ 400 A/µs, $V_{DD} \leq 80\%\ V_{(BR)DSS}$

Table 3. Thermal data

Symbol	Parameter	Value					Unit
		DPAK	D²PAK	TO-220	TO-247	TO-220FP	
$R_{thj\text{-}case}$	Thermal resistance junction-case max	1.39				5	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient max			62.5	50	62.5	°C/W
$R_{thj\text{-}pcb}$	Thermal resistance junction-pcb max	50	30				°C/W
T_l	Maximum lead temperature for soldering purpose			300			°C

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max)	3.5	A
E_{AS}	Single pulse avalanche energy (starting T_J=25 °C, I_D=I_{AS}, V_{DD}=50 V)	200	mJ

2 Electrical characteristics

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

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS} = 0	600			V
dv/dt (1)	Drain source voltage slope	V_{DD}=480 V, I_D = 9 A, V_{GS}=10 V		45		V/ns
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = Max rating V_{DS} = Max rating, @125 °C			1 10	µA µA
I_{GSS}	Gate-body leakage current (V_{DS} = 0)	V_{GS} = ± 20 V			0.1	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 250 µA	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS} = 10 V, I_D = 5.5 A		0.28	0.36	Ω

1. Characteristic value at turn off on inductive load

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{DS}=15 V, I_D = 5.5 A	-	7	-	S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} = 50 V, f = 1 MHz, V_{GS} = 0	-	790 60 3.6	-	pF pF pF
$C_{oss\ eq.}$ (2)	Equivalent output capacitance	V_{GS} = 0, V_{DS} = 0 to 480 V	-	135	-	pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD} = 480 V, I_D = 11 A, V_{GS} = 10 V, *(see Figure 21)*	-	30 15 4	-	nC nC nC
R_G	Gate input resistance	f=1 MHz Gate DC Bias=0 Test signal level = 20 mV open drain	-	4.7	-	Ω

1. Pulsed: Pulse duration = 300 µs, duty cycle 1.5%
2. $C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DS}

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 = 5.5 A	-	3	-	ns
t_r	Rise time	R_G = 4.7 Ω V_{GS} = 10 V		8		ns
$t_{d(off)}$	Turn-off delay time	*(see Figure 20)*		30		ns
t_f	Fall time			10		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ.	Max	Unit
I_{SD}	Source-drain current		-		11	A
I_{SDM} (1)	Source-drain current (pulsed)				44	A
V_{SD} (2)	Forward on voltage	I_{SD} = 11 A, V_{GS} = 0	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 9 A, di/dt = 100 A/µs	-	230		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 100 V		2		µC
I_{RRM}	Reverse recovery current	*(see Figure 22)*		18		A
t_{rr}	Reverse recovery time	I_{SD} = 9 A, di/dt = 100 A/µs	-	290		ns
Q_{rr}	Reverse recovery charge	V_{DD} = 100 V, T_j = 150 °C		190		µC
I_{RRM}	Reverse recovery current	*(see Figure 22)*		17		A

1. Pulse width limited by safe operating area
2. Pulsed: pulse duration = 300 µs, duty cycle 1.5%

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220 and D²PAK

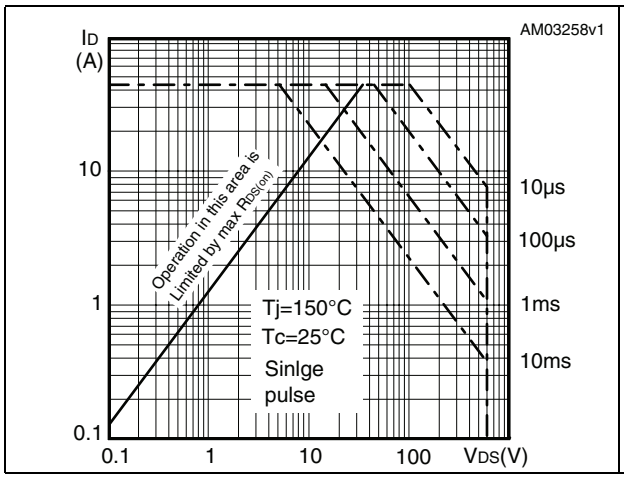


Figure 3. Thermal impedance for TO-220 and D²PAK

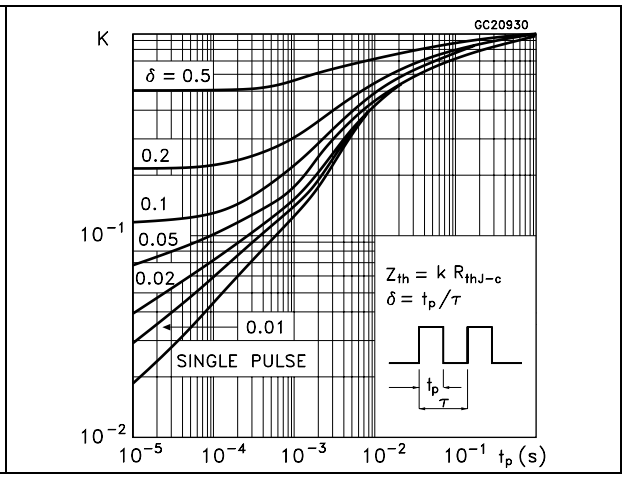


Figure 4. Safe operating area for TO-247

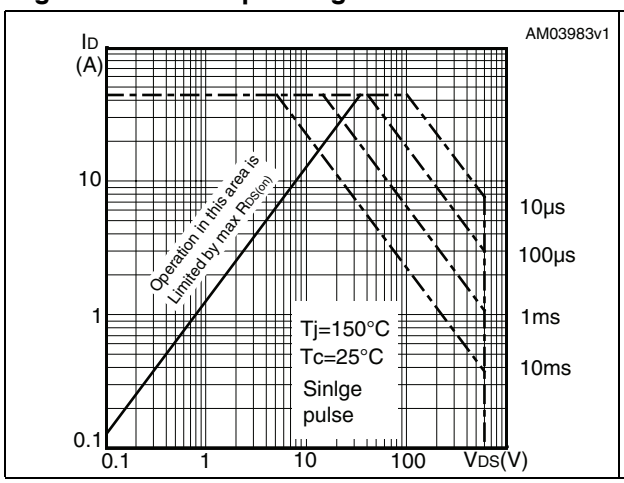


Figure 5. Thermal impedance for TO-247

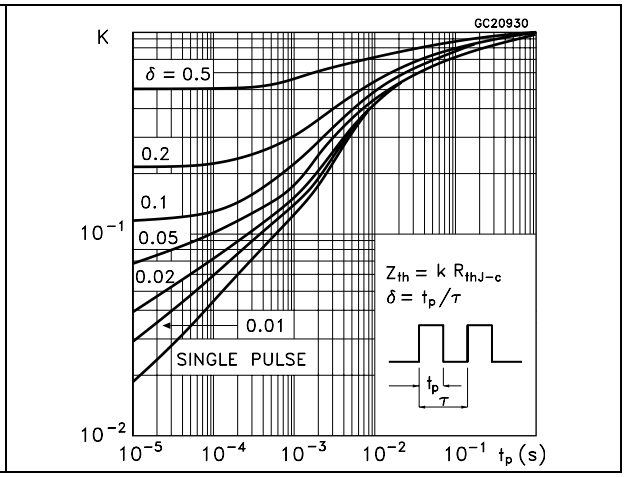


Figure 6. Safe operating area for TO-220FP

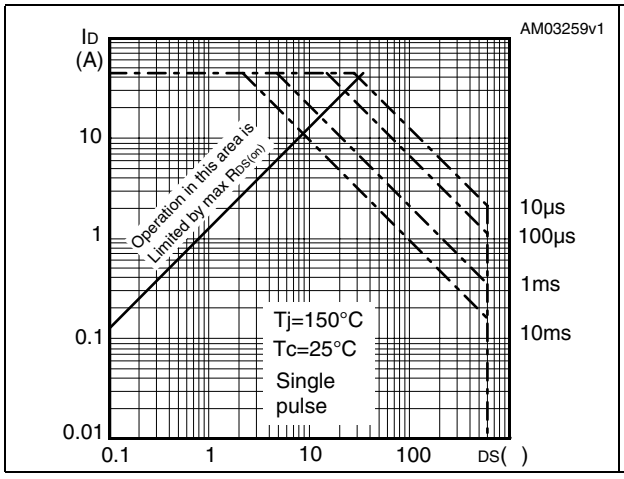


Figure 7. Thermal impedance for TO-220FP

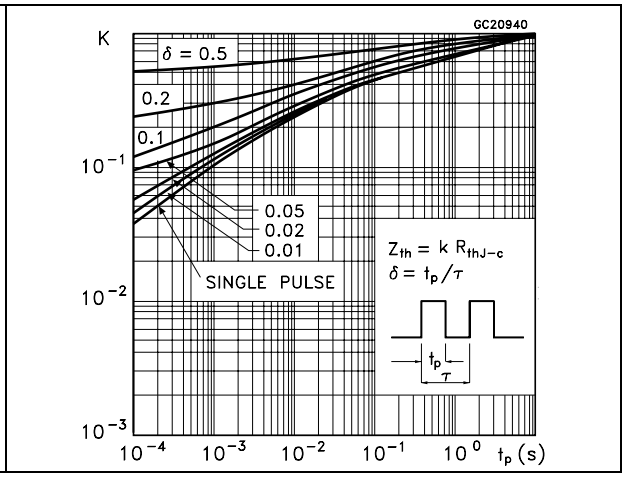


Figure 8. Safe operating area for DPAK

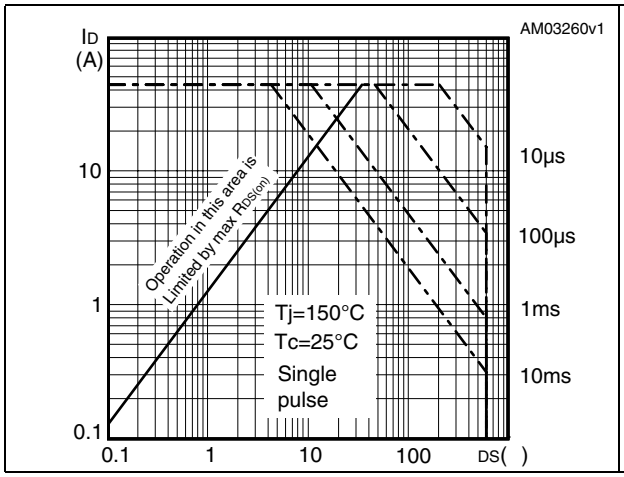


Figure 9. Thermal impedance for DPAK

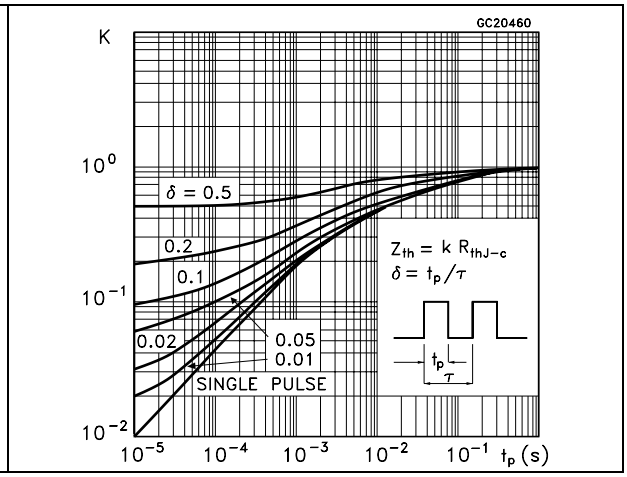


Figure 10. Output characteristics

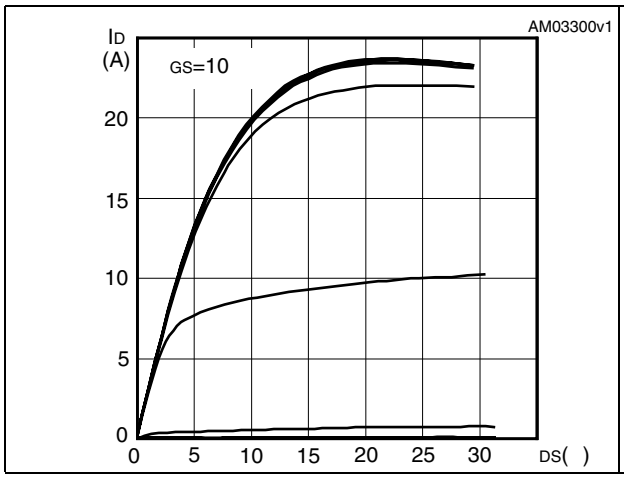


Figure 11. Transfer characteristics

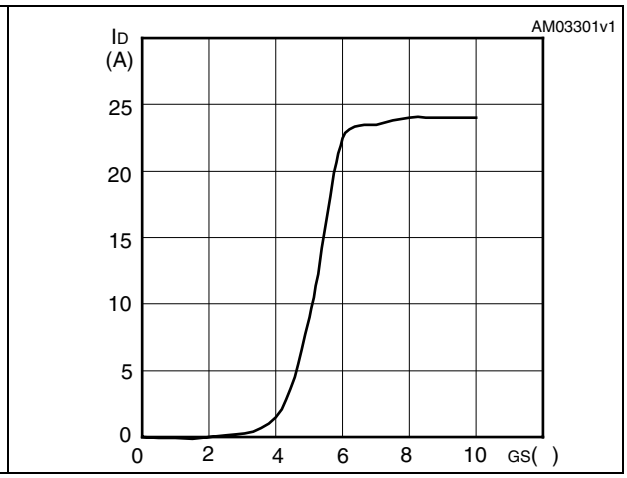


Figure 12. Transconductance

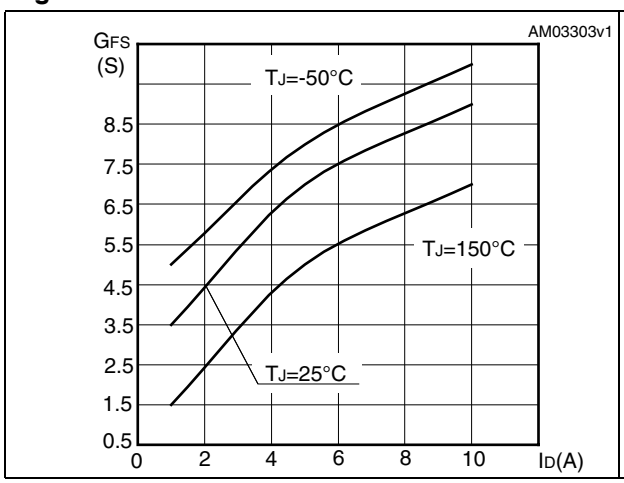


Figure 13. Static drain-source on resistance

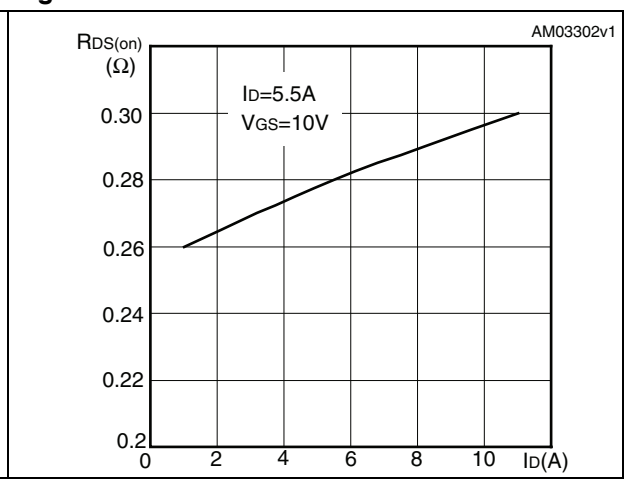


Figure 14. Gate charge vs gate-source voltage

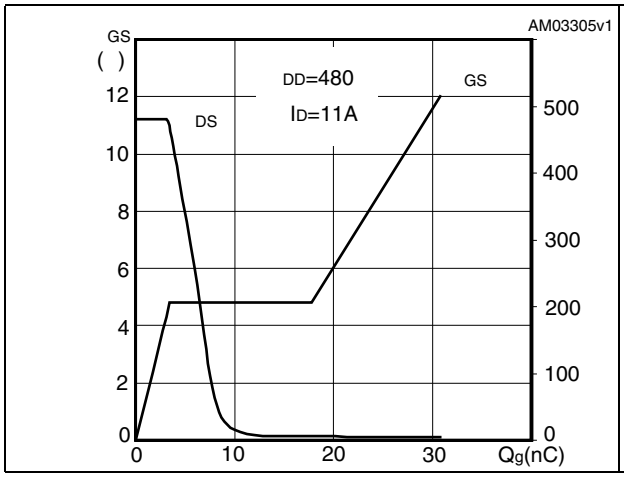


Figure 15. Capacitance variations

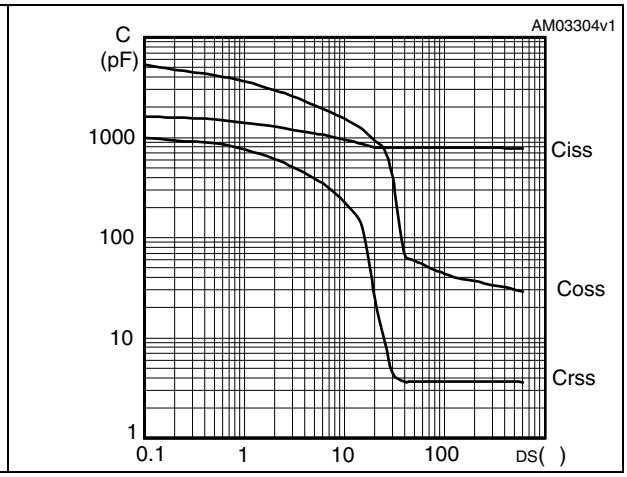


Figure 16. Normalized gate threshold voltage vs temperature

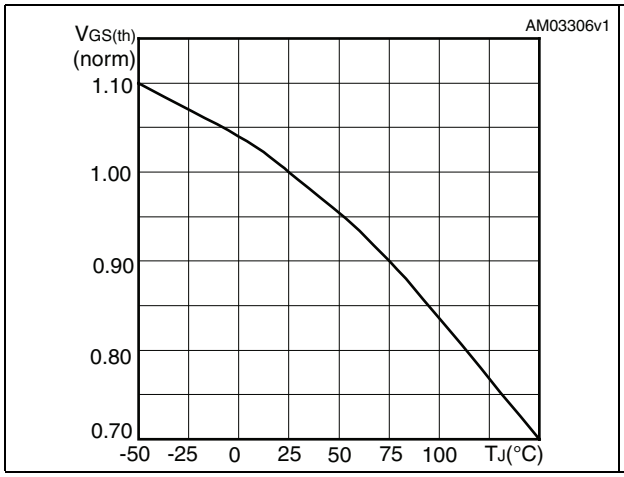


Figure 17. Normalized on resistance vs temperature

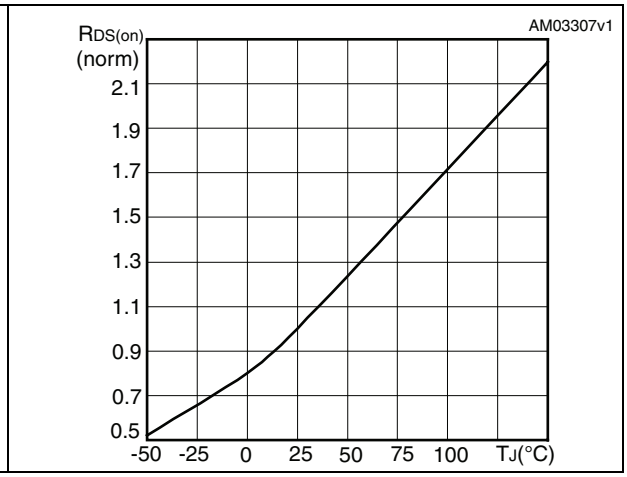


Figure 18. Source-drain diode forward characteristics

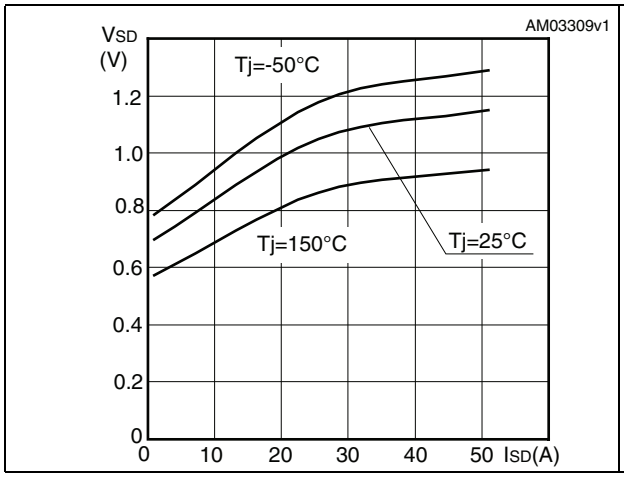
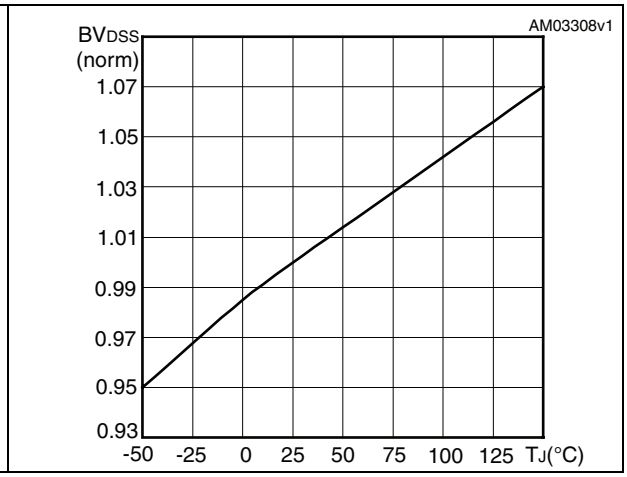


Figure 19. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 20. Switching times test circuit for resistive load

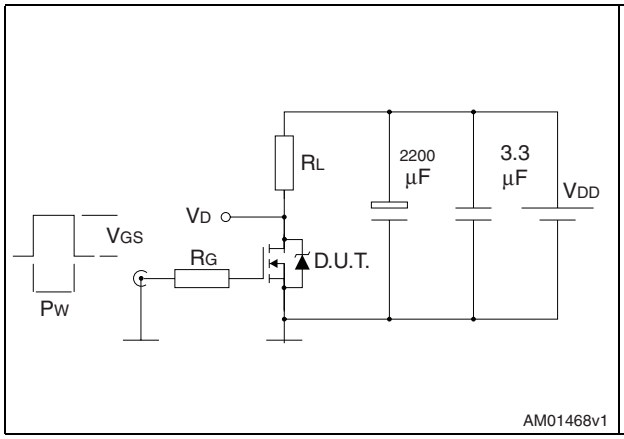


Figure 21. Gate charge test circuit

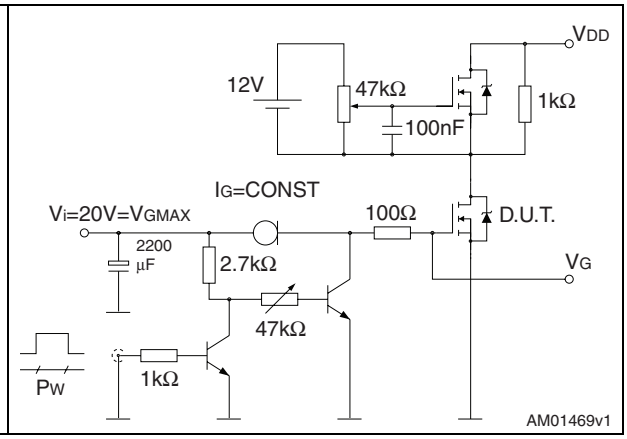


Figure 22. Test circuit for inductive load switching and diode recovery times

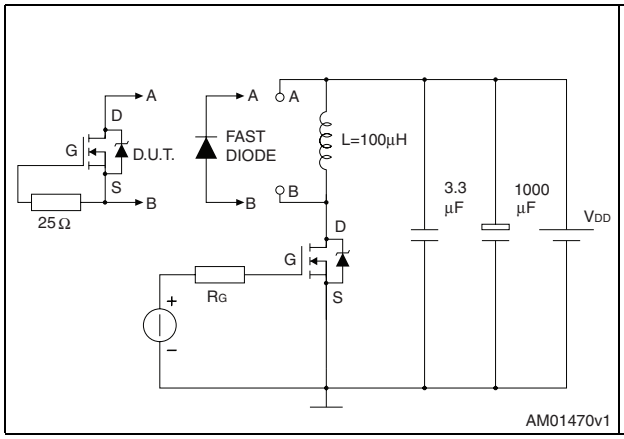


Figure 23. Unclamped inductive load test circuit

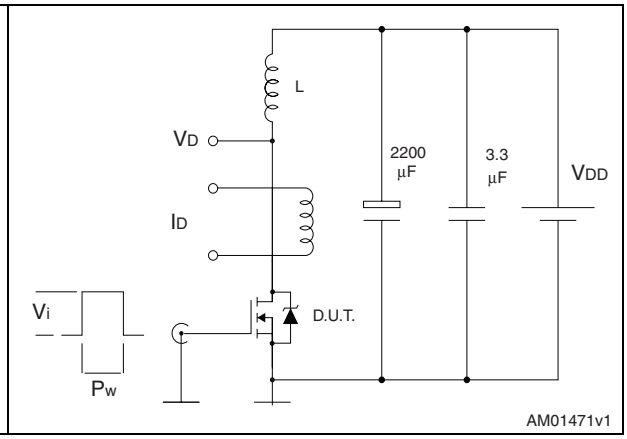


Figure 24. Unclamped inductive waveform

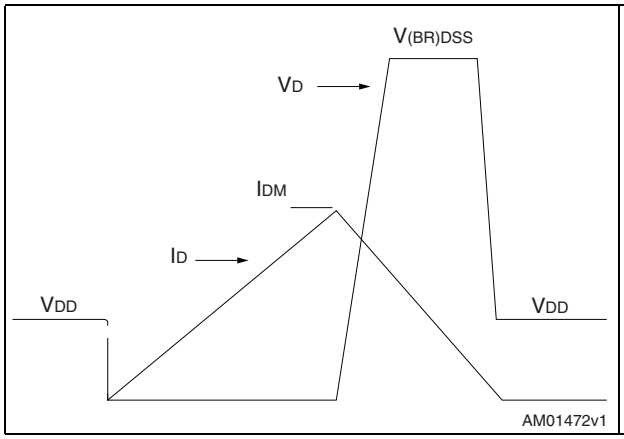
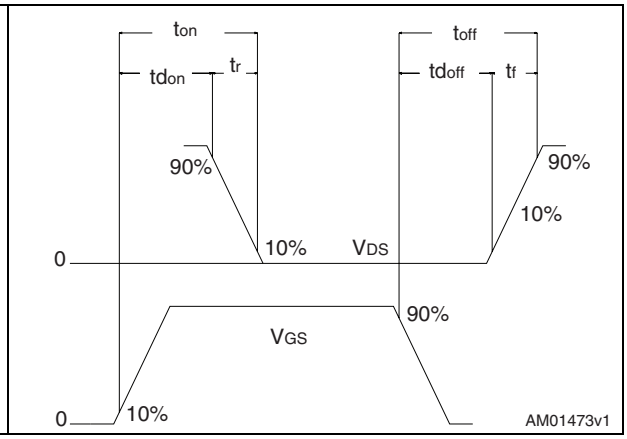


Figure 25. Switching time waveform



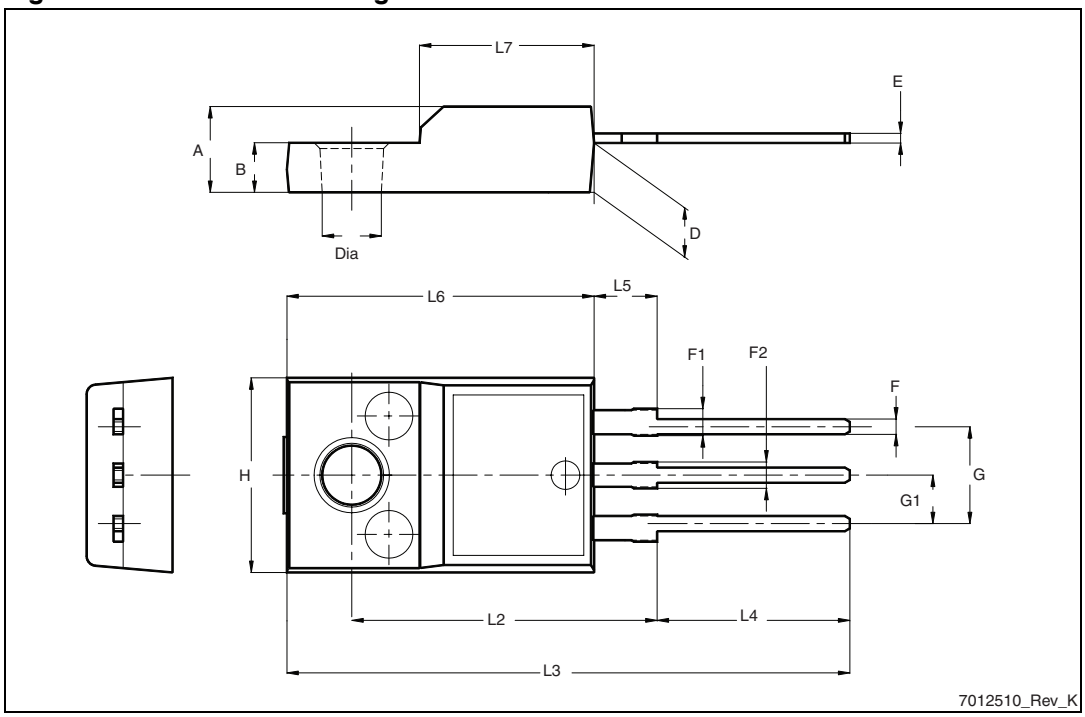
4 Package mechanical data

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.

Table 9. TO-220FP mechanical data

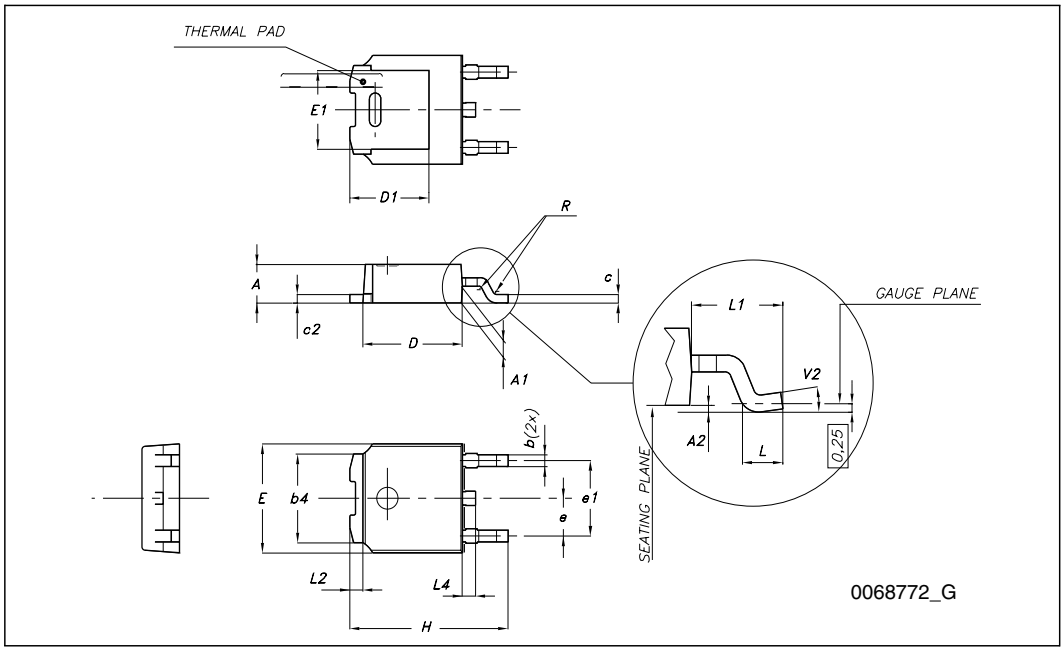
Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

Figure 26. TO-220FP drawing



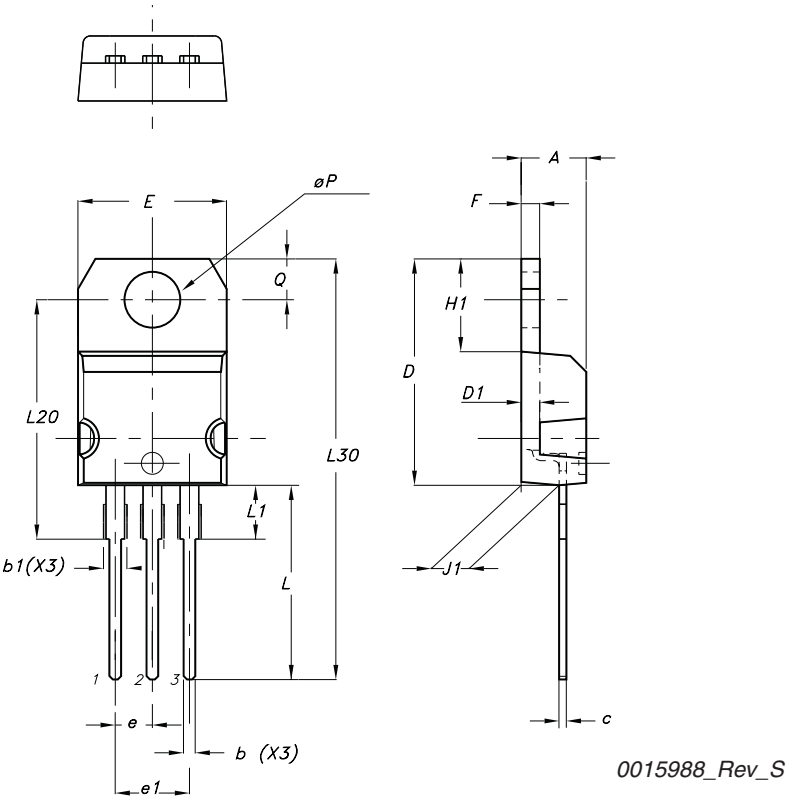
TO-252 (DPAK) mechanical data

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		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0 °		8 °



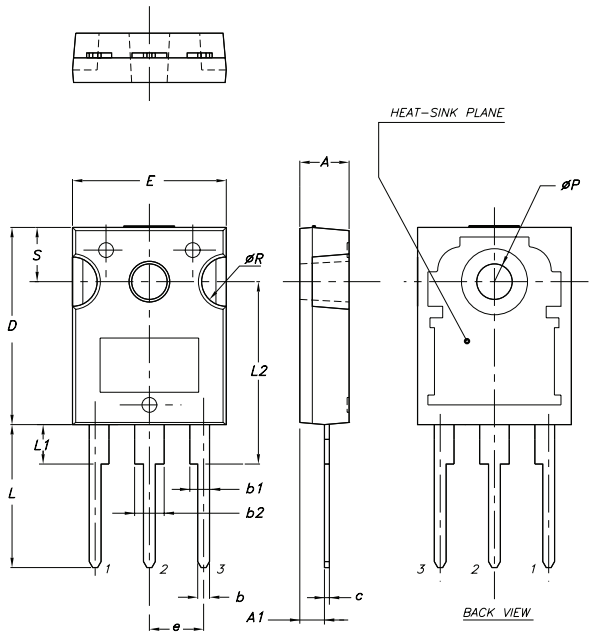
TO-220 type A mechanical data

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	
∅P	3.75		3.85
Q	2.65		2.95



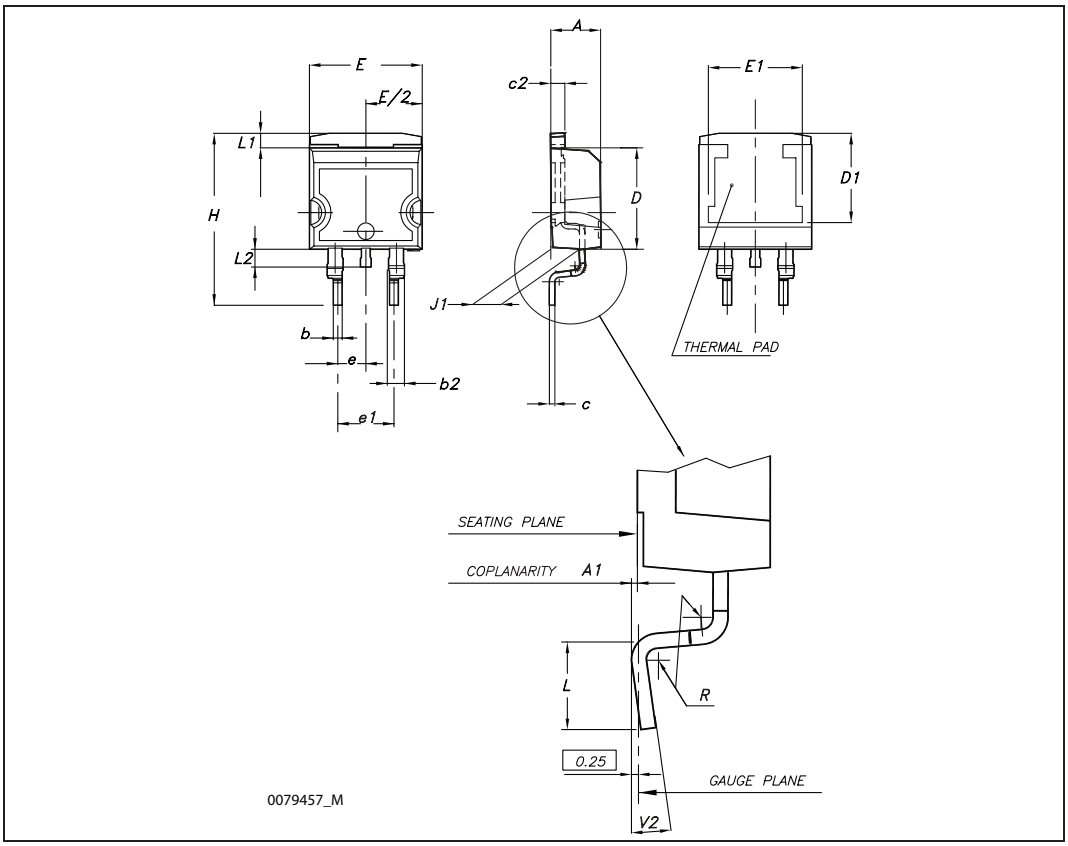
TO-247 Mechanical data

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		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
øP	3.55		3.65
øR	4.50		5.50
S		5.50	



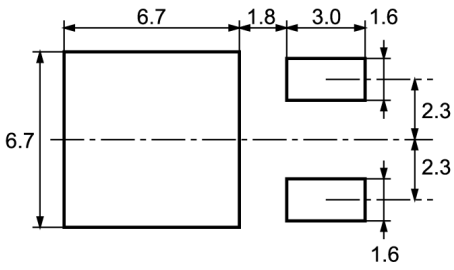
D²PAK (TO-263) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



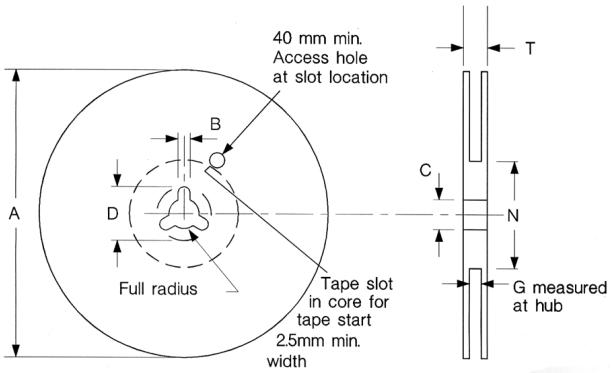
5 Packaging mechanical data

DPAK FOOTPRINT



All dimensions are in millimeters

TAPE AND REEL SHIPMENT



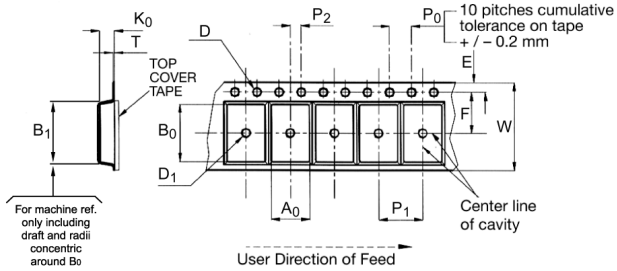
REEL MECHANICAL DATA

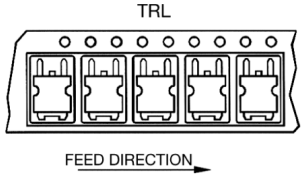
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	16.4	18.4	0.645	0.724
N	50		1.968	
T		22.4		0.881

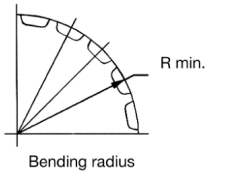
BASE QTY	BULK QTY
2500	2500

TAPE MECHANICAL DATA

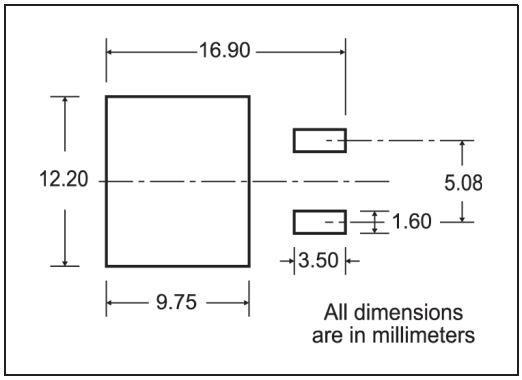
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	6.8	7	0.267	0.275
B0	10.4	10.6	0.409	0.417
B1		12.1		0.476
D	1.5	1.6	0.059	0.063
D1	1.5		0.059	
E	1.65	1.85	0.065	0.073
F	7.4	7.6	0.291	0.299
K0	2.55	2.75	0.100	0.108
P0	3.9	4.1	0.153	0.161
P1	7.9	8.1	0.311	0.319
P2	1.9	2.1	0.075	0.082
R	40		1.574	
W	15.7	16.3	0.618	0.641



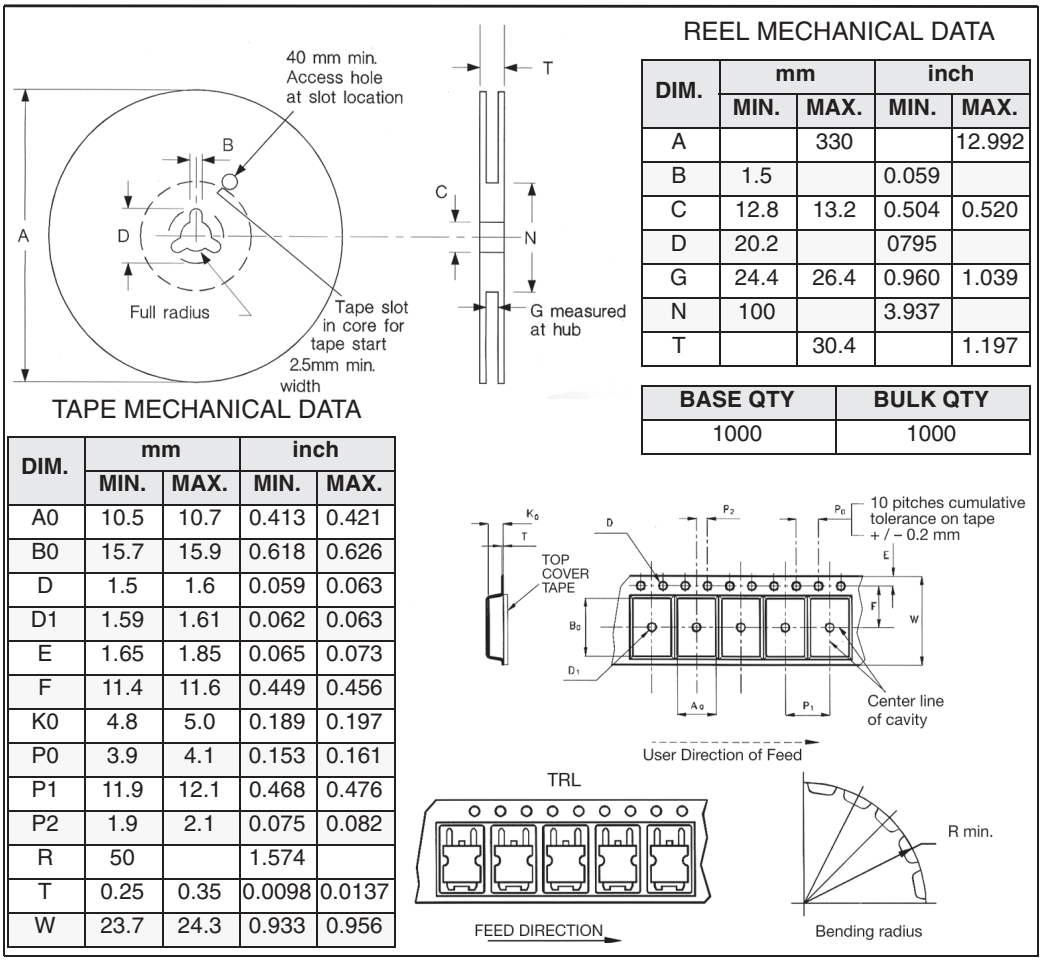




D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



REEL MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

6 Revision history

Table 10. Document revision history

Date	Revision	Changes
29-Feb-2009	1	First release
13-Jan-2010	2	– Added new package, mechanical data: TO-247 – Added new package, mechanical data: D²PAK

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