



STD10NM60N, STF10NM60N STP10NM60N, STU10NM60N

N-channel 600 V, 0.53 Ω , 10 A, DPAK, TO-220, TO-220FP, IPAK
MDmesh™ II Power MOSFET

Features

Order codes	V_{DSS} @ T_{jmax}	$R_{DS(on)}$ max.	I_D	P_w
STD10NM60N	650 V	< 0.55 Ω	10 A	70 W
STF10NM60N				25 W
STP10NM60N				70 W
STU10NM60N				

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

Application

Switching applications

Description

These devices are N-channel 600 V Power MOSFET realized using the second generation of MDmesh™ technology. It applies the benefits of the multiple drain process to STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product offers improved on-resistance, low gate charge, high dv/dt capability and excellent avalanche characteristics.

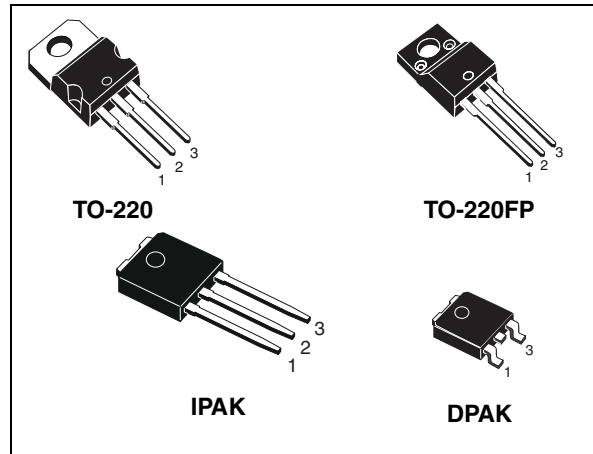


Figure 1. Internal schematic diagram

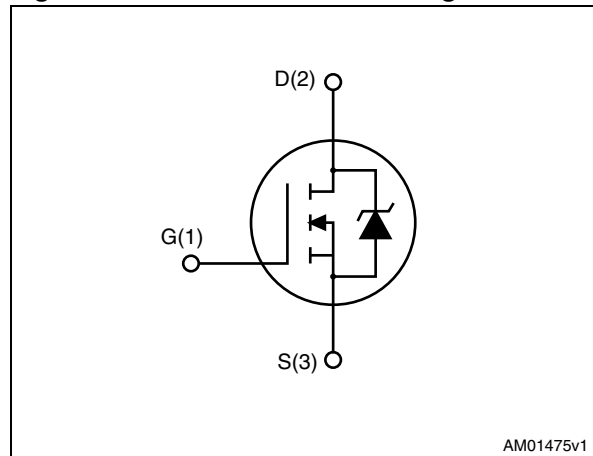


Table 1. Device summary

Order codes	Marking	Package	Packaging
STD10NM60N	10NM60N	DPAK	Tape and reel
STF10NM60N	10NM60N	TO-220FP	Tube
STP10NM60N	10NM60N	TO-220	Tube
STU10NM60N	10NM60N	IPAK	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value				Unit
		TO-220	TO-220FP	IPAK	DPAK	
V _{GS}	Gate- source voltage	± 25				V
I _D	Drain current (continuous) at T _C = 25 °C	10	10 ⁽¹⁾	10		A
I _D	Drain current (continuous) at T _C = 100 °C	5	5 ⁽¹⁾	5		A
I _{DM} ⁽²⁾	Drain current (pulsed)	32	32 ⁽¹⁾	32		A
P _{TOT}	Total dissipation at T _C = 25 °C	70	25	70		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 _J T _{stg}	Operating junction temperature Storage temperature	- 55 to 150				°C

1. Limited only by maximum temperature allowed.
2. Pulse width limited by safe operating area.
3. I_{SD} ≤ 10 A, di/dt ≤ 400 A/μs, V_{DS peak} ≤ V_{(BR)DSS}, V_{DD} = 80% V_{(BR)DSS}.

Table 3. Thermal data

Symbol	Parameter	Value				Unit
		TO-220	TO-220FP	IPAK	DPAK	
R _{thj-case}	Thermal resistance junction-case max	1.79	5	1.79		°C/W
R _{thj-amb}	Thermal resistance junction-ambient max	62.50		100		°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max				50	°C/W
T _J	Maximum lead temperature for soldering purpose	300				°C/W

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I _{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _J Max)	4	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
I _{DSS}	Zero gate voltage drain current (V _{GS} = 0)	V _{DS} = max rating V _{DS} = max rating, T _C = 125 °C			1 100	μA μA
I _{GSS}	Gate-body leakage current (V _{DS} = 0)	V _{GS} = ± 25 V; V _{DS} = 0			100	nA
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 = 4 A		0.53	0.55	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C _{iss}	Input capacitance	V _{DS} = 50 V, f = 1 MHz, V _{GS} = 0	-	540	-	pF
C _{oss}	Output capacitance			44		
C _{rss}	Reverse transfer capacitance			1.2		
C _{oss eq} ⁽¹⁾	Equivalent capacitance time related	V _{DS} = 0 to 480 V, V _{GS} = 0	-	110	-	pF
R _g	Gate input resistance	f = 1 MHz open drain	-	6	-	Ω
Q _g	Total gate charge	V _{DD} = 480 V, I _D = 8 A,	-	19	-	nC
Q _{gs}	Gate-source charge	V _{GS} = 10 V		3		
Q _{gd}	Gate-drain charge	(see Figure 17)		10		

1. C_{oss eq} time related 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	$V_{DD} = 300\text{ V}$, $I_D = 4\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 16)		10		ns
t_r	Rise time		-	12	-	ns
$t_{d(off)}$	Turn-off-delay time				32	ns
t_f	Fall time				15	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
I_{SD}	Source-drain current				8	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		32	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 8\text{ A}$, $V_{GS} = 0$	-		1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 8\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$ (see Figure 18)		250		ns
Q_{rr}	Reverse recovery charge		-	2.12		μC
I_{RRM}	Reverse recovery current				17	A
t_{rr}	Reverse recovery time	$I_{SD} = 8\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 60\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$ (see Figure 18)		315		ns
Q_{rr}	Reverse recovery charge		-	2.6		μC
I_{RRM}	Reverse recovery current				16.5	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

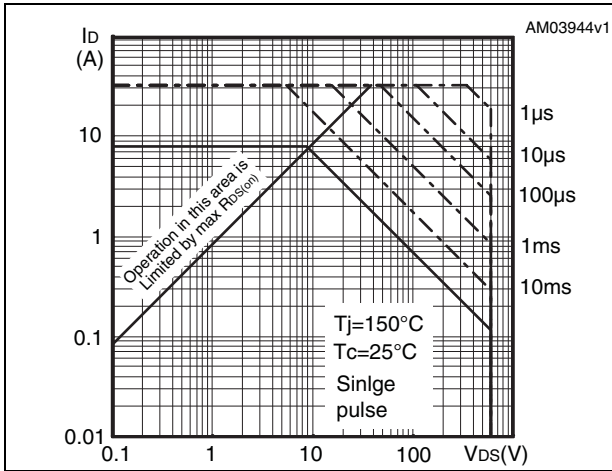


Figure 3. Thermal impedance for TO-220

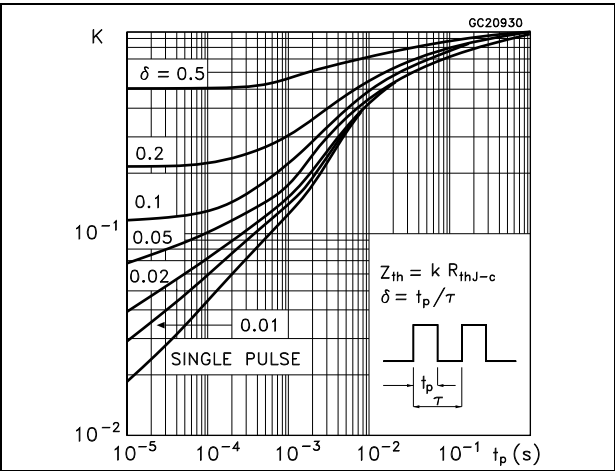


Figure 4. Safe operating area for TO-220FP

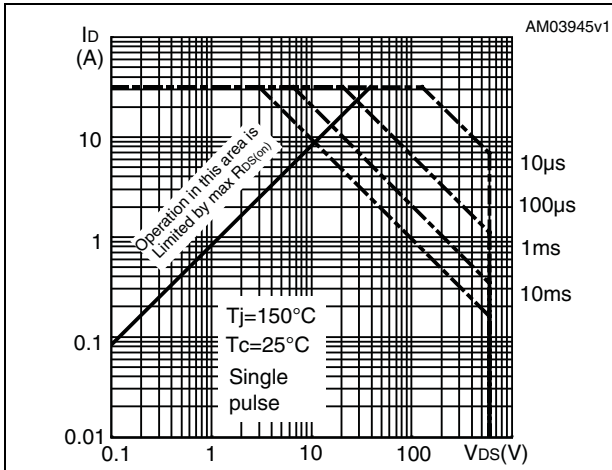


Figure 5. Thermal impedance for TO-220FP

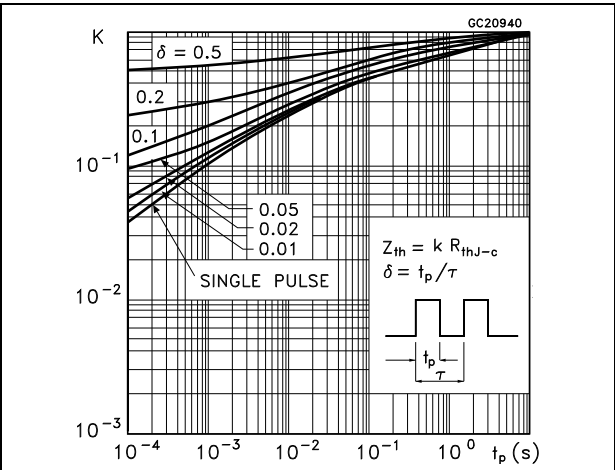


Figure 6. Safe operating area for DPAK, IPAK

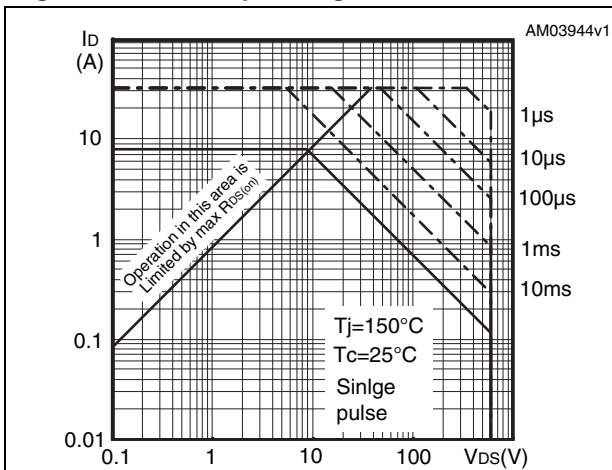


Figure 7. Thermal impedance for DPAK, IPAK

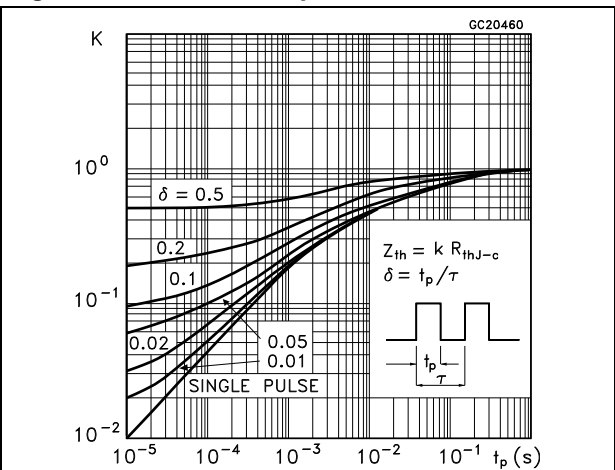


Figure 8. Output characteristics

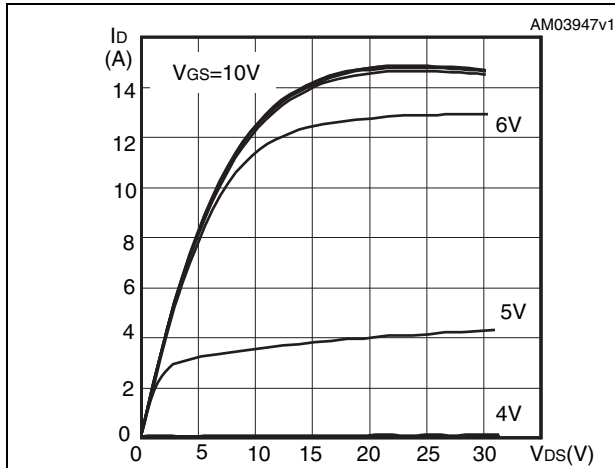


Figure 9. Transfer characteristics

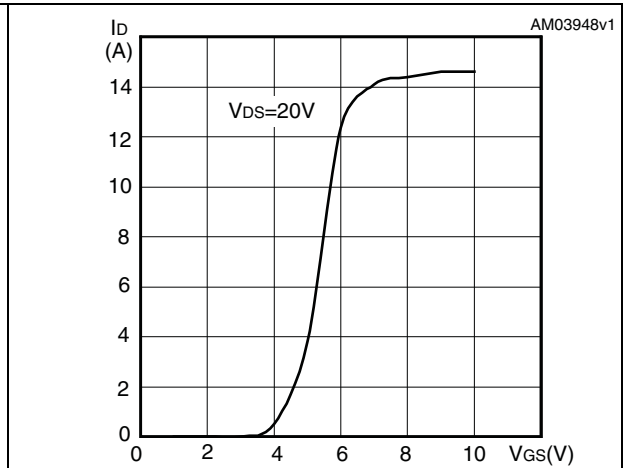


Figure 10. Normalized BV_{DSS} vs temperature

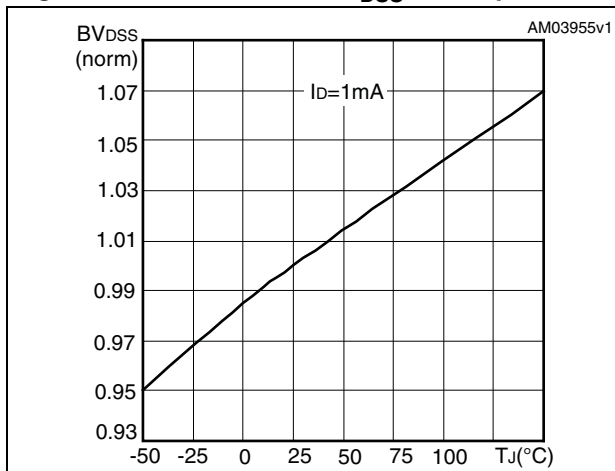


Figure 11. Static drain-source on resistance

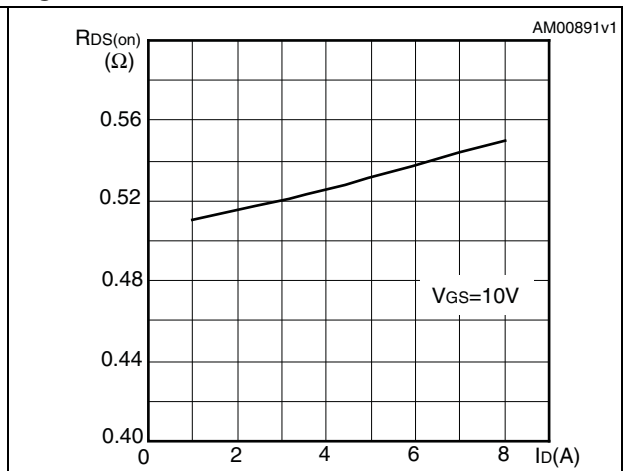


Figure 12. Gate charge vs gate-source voltage

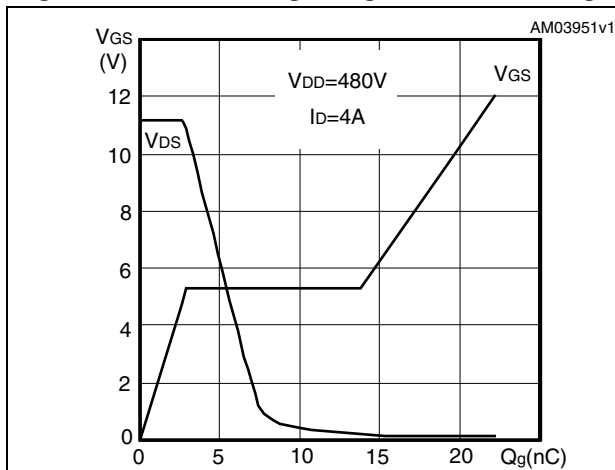


Figure 13. Capacitance variations

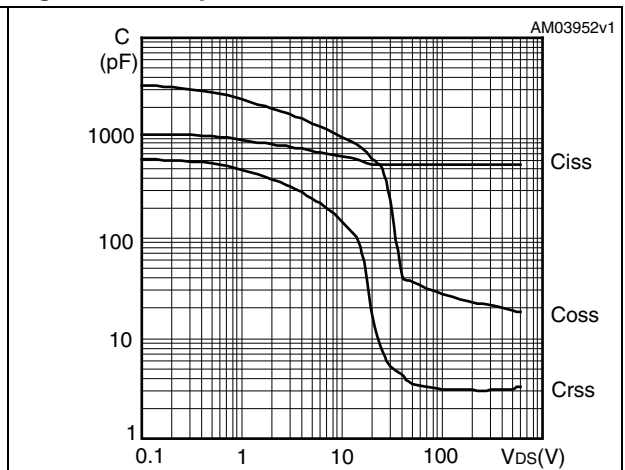
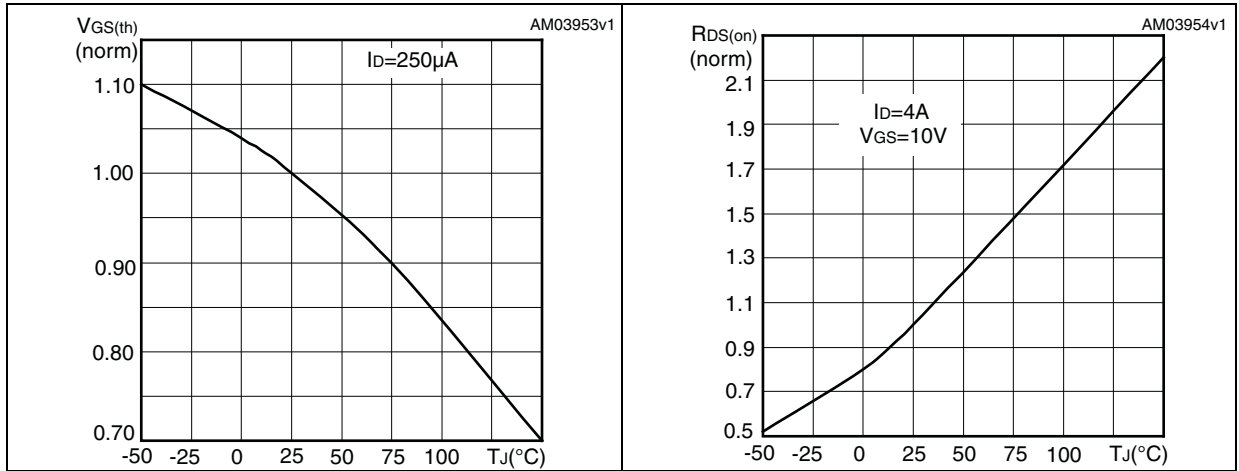


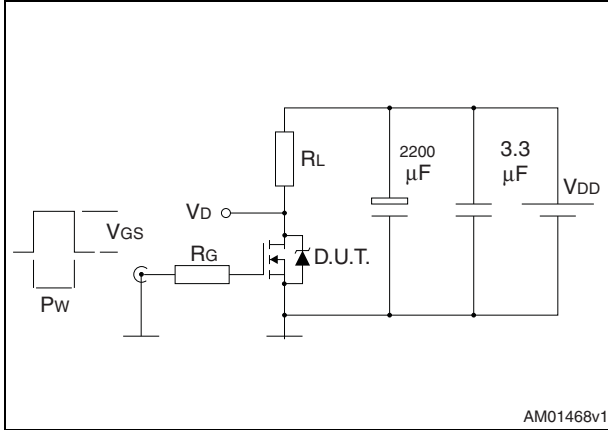
Figure 14. Normalized gate threshold voltage vs temperature

Figure 15. Normalized on resistance vs temperature



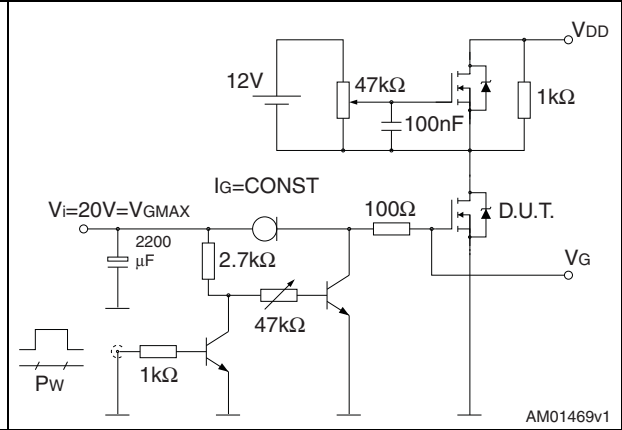
3 Test circuits

Figure 16. Switching times test circuit for resistive load



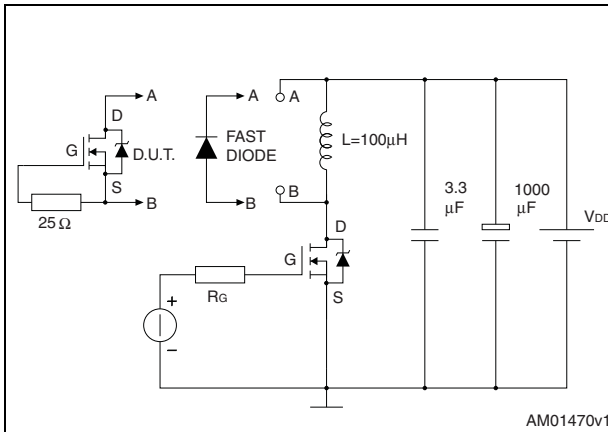
AM01468v1

Figure 17. Gate charge test circuit



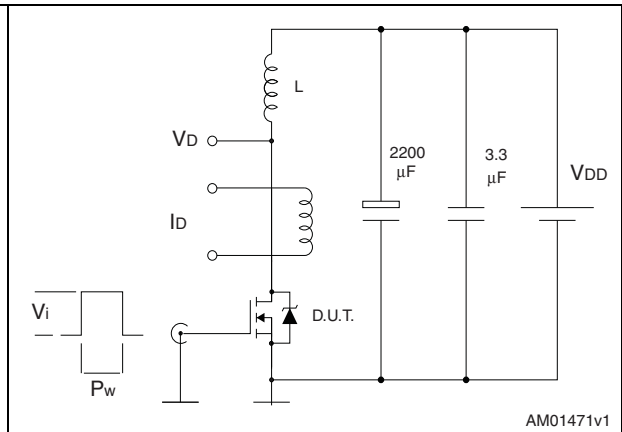
AM01469v1

Figure 18. Test circuit for inductive load switching and diode recovery times



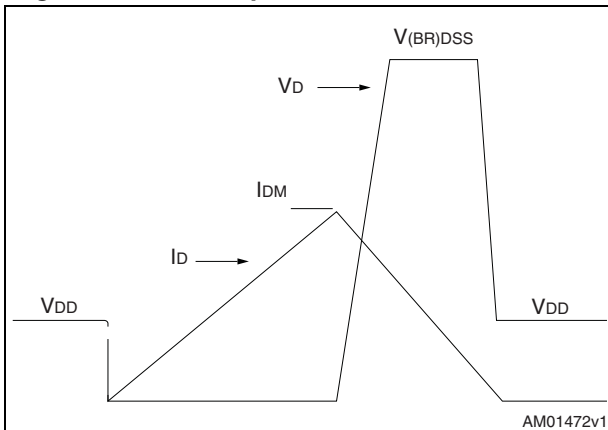
AM01470v1

Figure 19. Unclamped inductive load test circuit



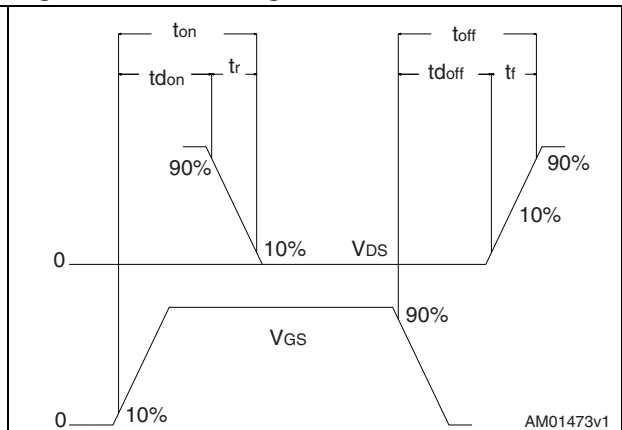
AM01471v1

Figure 20. Unclamped inductive waveform



AM01472v1

Figure 21. Switching time waveform



AM01473v1

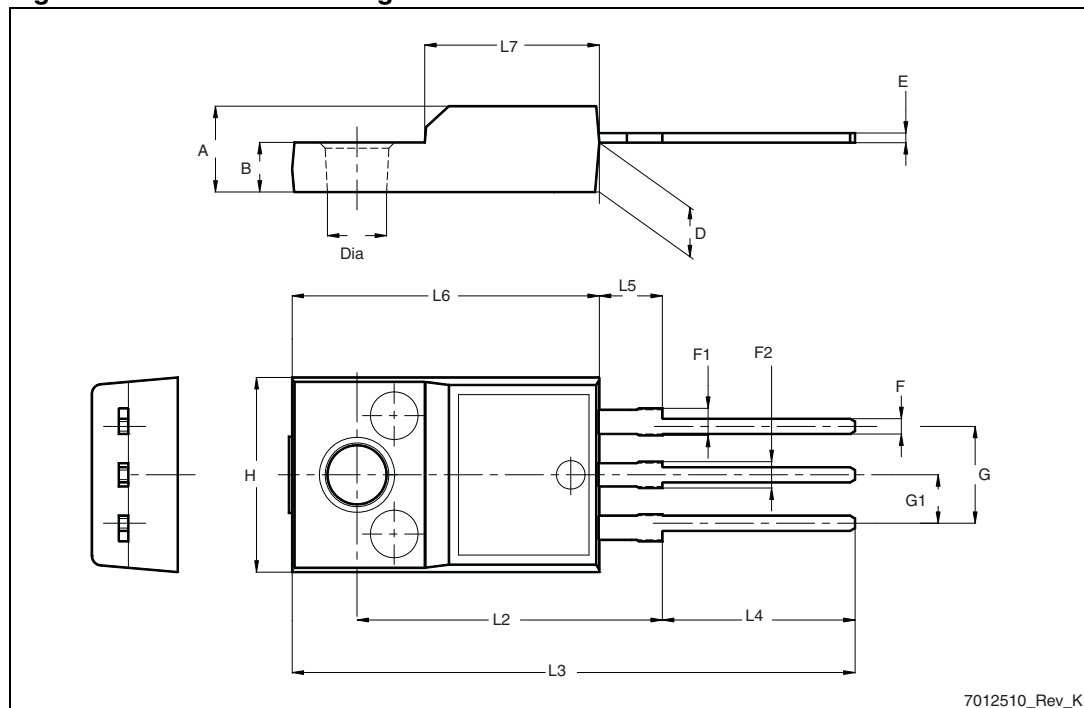
4 Package mechanical data

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

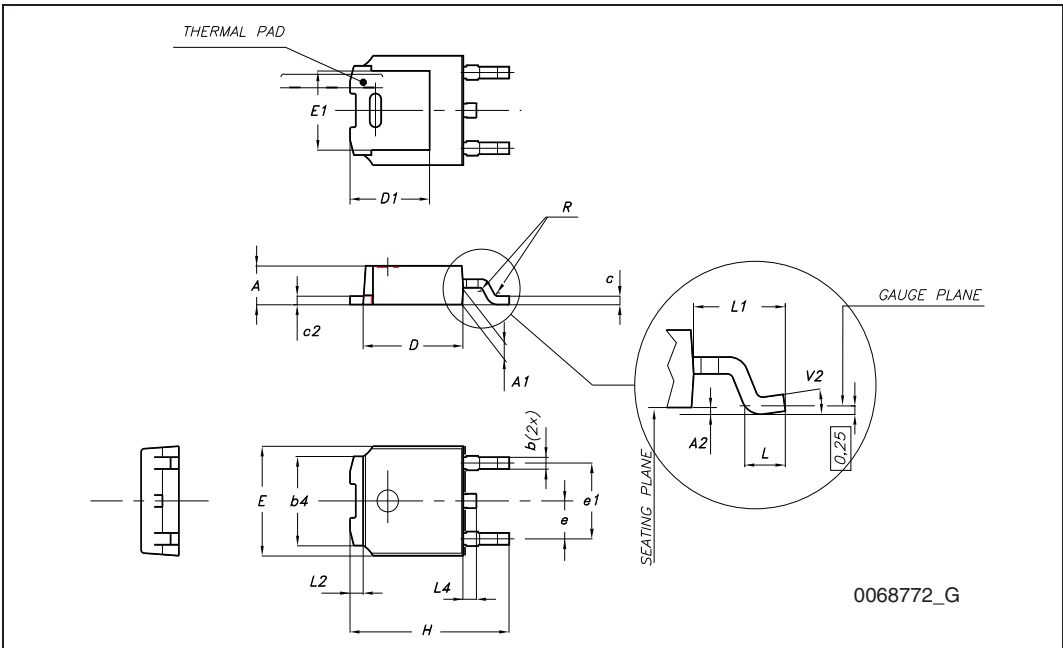
Figure 22. TO-220FP drawing



7012510_Rev_K

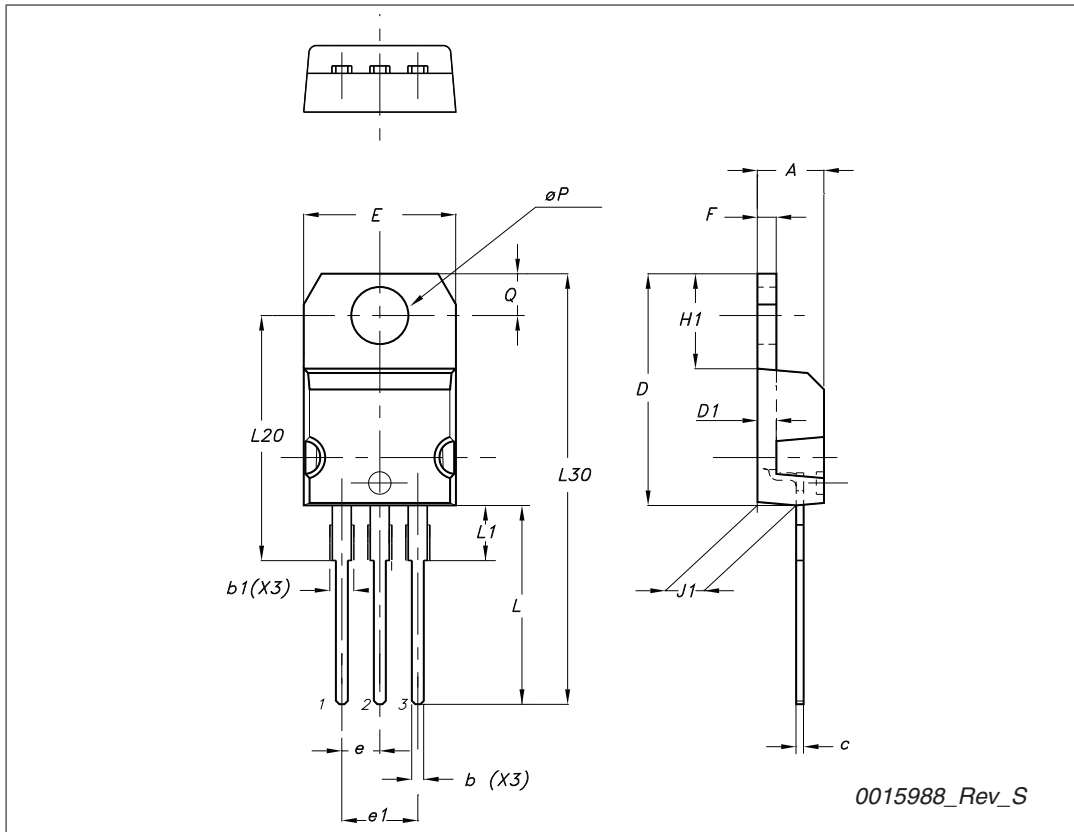
TO-252 (DPAK) mechanical data

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°



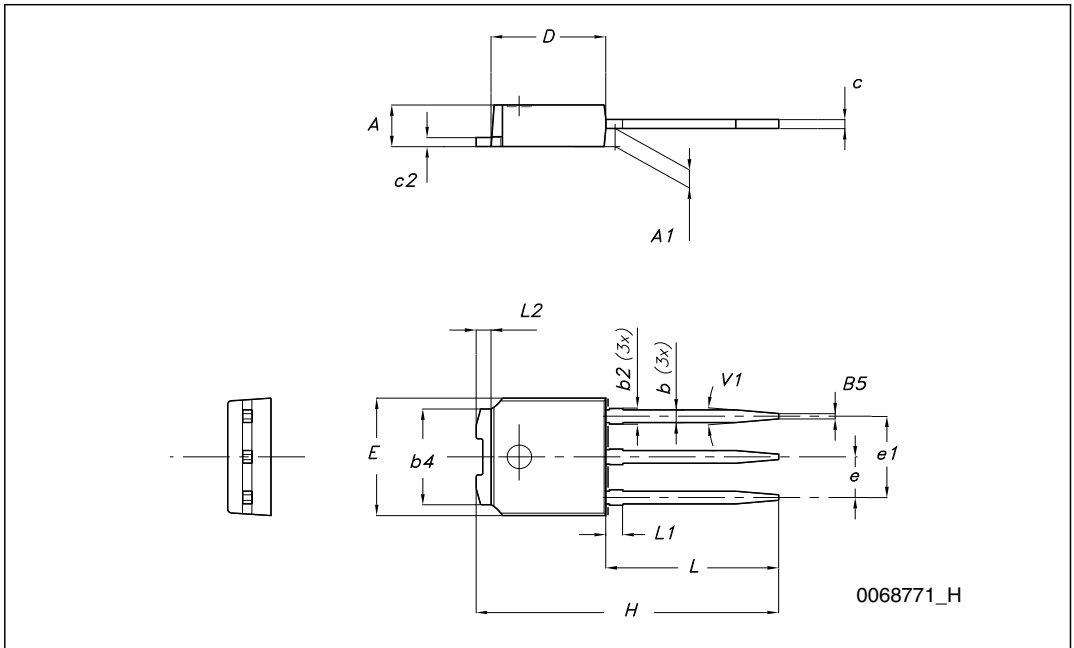
TO-220 type A mechanical data

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



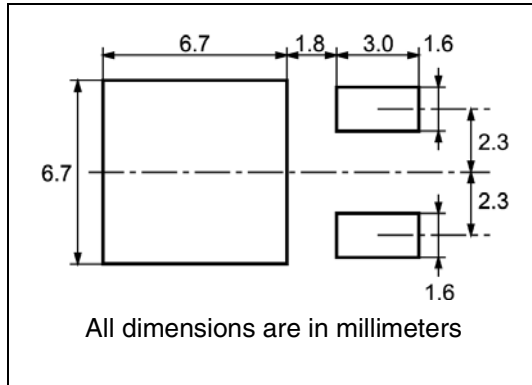
TO-251 (IPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
(L1)	0.80		1.20
L2		0.80	
V1		10°	



5 Packaging mechanical data

DPAK FOOTPRINT



TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

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

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

BASE QTY

2500

BULK QTY

2500

10 pitches cumulative tolerance on tape +/- 0.2 mm

TOP COVER TAPE

Center line of cavity

User Direction of Feed

FEED DIRECTION

Bending radius

R min.

For machine ref. only including draft and radii concentric around B0

6 Revision history

Table 10. Document revision history

Date	Revision	Changes
10-Jun-2009	1	First release
12-Jan-2010	2	<i>Figure 4: Safe operating area for TO-220FP</i> has been corrected
31-Mar-2010	3	<i>Features</i> have been corrected
17-Sep-2010	4	Content reworked to improve readability
24-Nov-2010	5	Corrected I_D value

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