



STD11NM60ND, STF11NM60ND STP11NM60ND, STU11NM60ND

N-channel 600V - 0.37Ω - 10A - FDmesh™ II Power MOSFET
I²PAK, TO-220, TO-220FP, IPAK, DPAK

Features

Type	V _{DSS} (@T _{jmax})	R _{DS(on)} max	I _D
STD11NM60ND	650 V	< 0.45 Ω	10 A
STF11NM60ND	650 V	< 0.45 Ω	10 A ⁽¹⁾
STI11NM60ND	650 V	< 0.45 Ω	10 A
STP11NM60ND	650 V	< 0.45 Ω	10 A
STU11NM60ND	650 V	< 0.45 Ω	10 A

1. Limited only by maximum temperature allowed

- The worldwide best R_{DS(on)}* area amongst the fast recovery diode devices
- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance
- Extremely high dv/dt and avalanche capabilities

Application

- Switching applications

Description

The FDmesh™ II series belongs to the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout and associates all advantages of reduced on-resistance and fast switching with an intrinsic fast-recovery body diode. It is therefore strongly recommended for bridge topologies, in particular ZVS phase-shift converters.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STD11NM60ND	11NM60ND	DPAK	Tape and reel
STF11NM60ND	11NM60ND	TO-220FP	Tube
STI11NM60ND	11NM60ND	I ² PAK	Tube
STP11NM60ND	11NM60ND	TO-220	Tube
STU11NM60ND	11NM60ND	IPAK	Tube

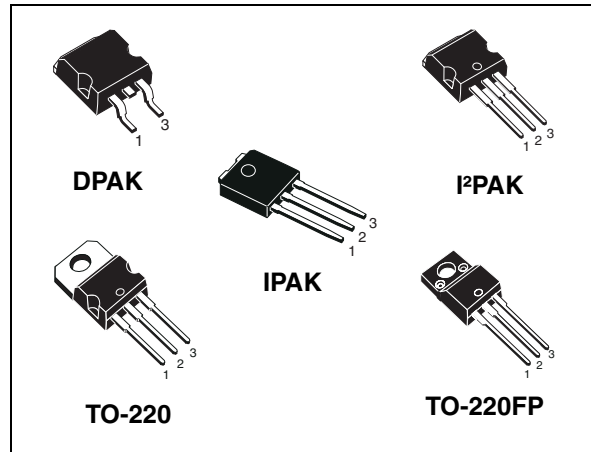
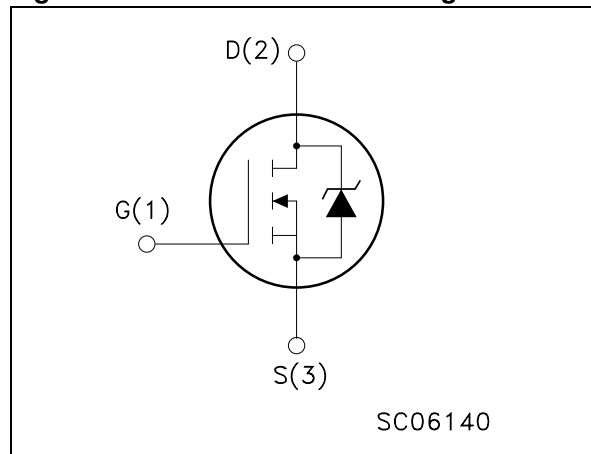


Figure 1. Internal schematic diagram



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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		DPAK/I ² PAK TO-220/IPAK	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	10	10 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100°C	6.3	6.3 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	40	40 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25°C	90	25	W
dv/dt ⁽³⁾	Peak diode recovery voltage slope	40		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1s; T _C =25°C)	--	2500	V
T _{stg}	Storage temperature	-55 to 150		°C
T _j	Max. operating junction temperature	150		°C

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

Table 3. Thermal data

Symbol	Parameter	Value					Unit
		TO-220	I ² PAK	DPAK	IPAK	TO-220FP	
R _{thj-case}	Thermal resistance junction-case max	1.38				5	°C/W
R _{thj-amb}	Thermal resistance junction-amb max	62.5	--	100	62.5	°C/W	
R _{thj-pcb}	Thermal resistance junction-pcb max	--	--	50	--	°C/W	
T _l	Maximum lead temperature for soldering purposes	300				°C	

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I _{AS}	Avalanche current, repetitive or not-repetitive ⁽¹⁾	3.5	A
E _{AS}	Single pulse avalanche energy ⁽²⁾	200	mJ

- Pulse width limited by T_j max
- starting T_j = 25 °C, I_D = I_{AS}, V_{DD} = 50 V

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 = 10 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			1 100	μA μA
I _{GSS}	Gate body leakage current (V _{DS} = 0)	V _{GS} = ±20 V			100	nA
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 = 5 A		0.37	0.45	Ω

1. Value measured at turn off under 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 A		7.5		S
C _{iss} C _{oss} C _{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V _{DS} = 50 V, f = 1 MHz, V _{GS} = 0		850 44 5		pF pF pF
C _{oss eq.} ⁽²⁾	Equivalent output capacitance	V _{GS} = 0, V _{DS} = 0V to 480 V		130		pF
R _g	Gate input resistance	f = 1 MHz Gate DC Bias = 0 Test signal level = 20 mV open drain		3.7		Ω
Q _g Q _{gs} Q _{gd}	Total gate charge Gate-source charge Gate-drain charge	V _{DD} = 480 V, I _D = 10 A V _{GS} = 10 V (see Figure 19)		30 4 16		nC nC nC

1. Pulsed: pulse duration = 300μs, 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_{DSS}

Table 7. Switching times

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 300\text{ V}$, $I_D = 5\text{ A}$, $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 18)		16		ns
t_r	Rise time			7		ns
$t_{d(off)}$	Turn-off delay time			50		ns
t_f	Fall time			9		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
I_{SD}	Source-drain current				10	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				40	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 10\text{ A}$, $V_{GS} = 0$			1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 10\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 100\text{ V}$ (see Figure 20)		130		ns
Q_{rr}	Reverse recovery charge			0.69		μC
I_{RRM}	Reverse recovery current			11		A
t_{rr}	Reverse recovery time	$V_{DD} = 100\text{ V}$ $di/dt = 100\text{ A}/\mu\text{s}$, $I_{SD} = 10\text{ A}$ $T_j = 150\text{ }^\circ\text{C}$ (see Figure 20)		200		ns
Q_{rr}	Reverse recovery charge			1.2		μC
I_{RRM}	Reverse recovery current			12		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 / I²PAK

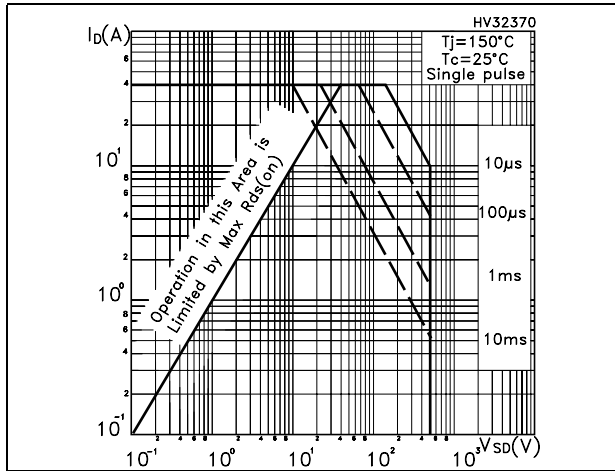


Figure 3. Thermal impedance for TO-220 / I²PAK

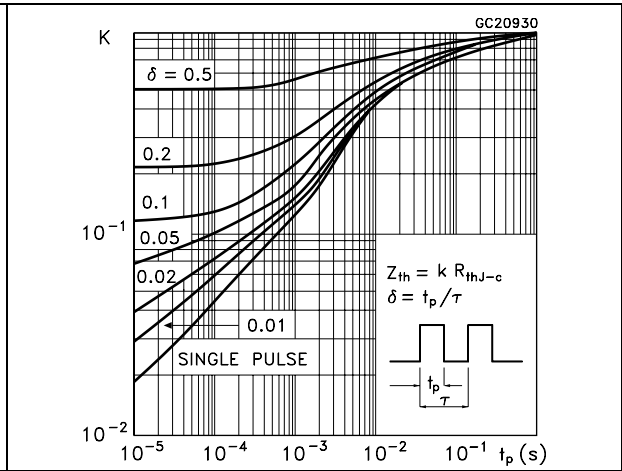


Figure 4. Safe operating area for TO-220FP

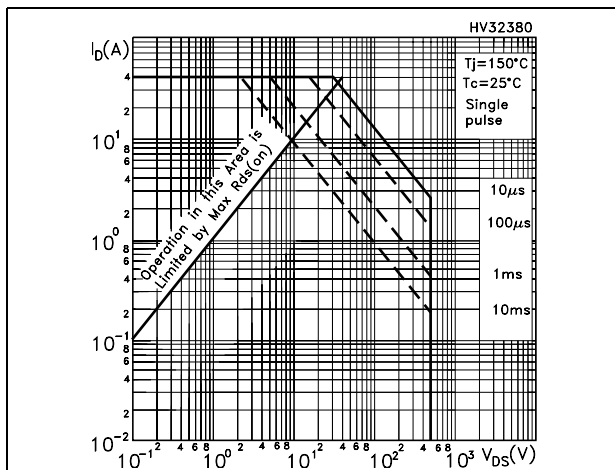


Figure 5. Thermal impedance for TO-220FP

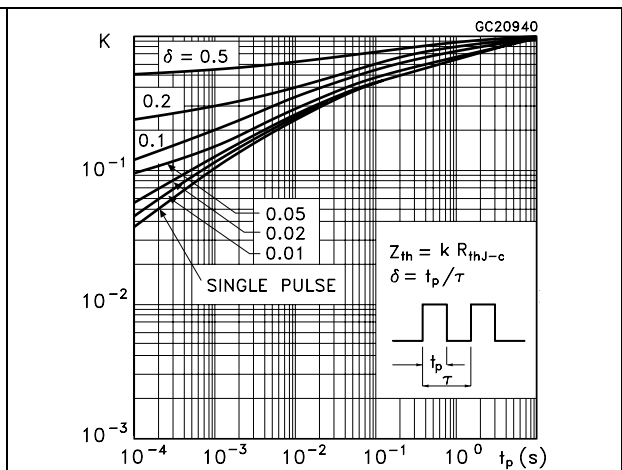


Figure 6. Safe operating area for DPAK / IPAK

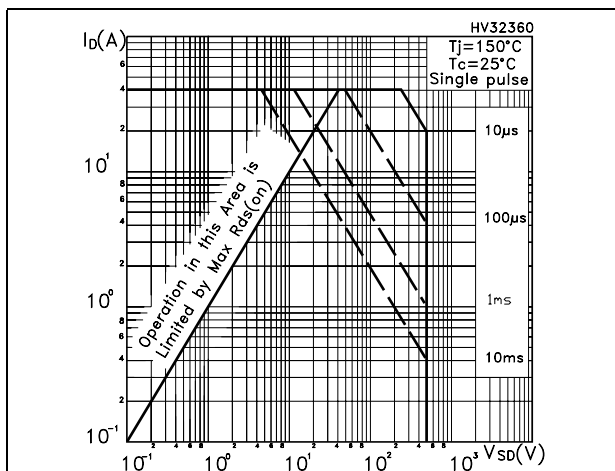


Figure 7. Thermal impedance for DPAK / IPAK

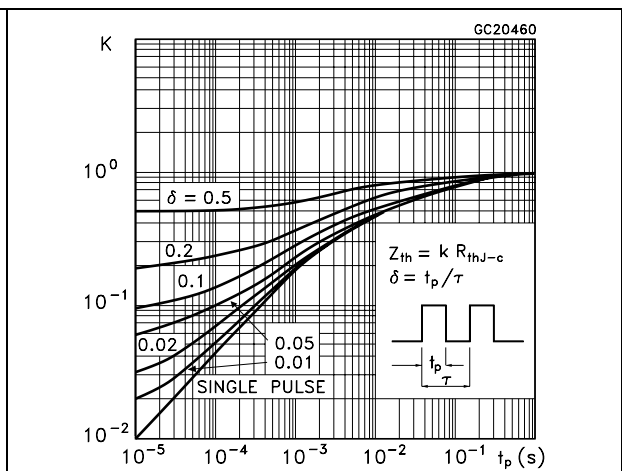


Figure 8. Output characteristics

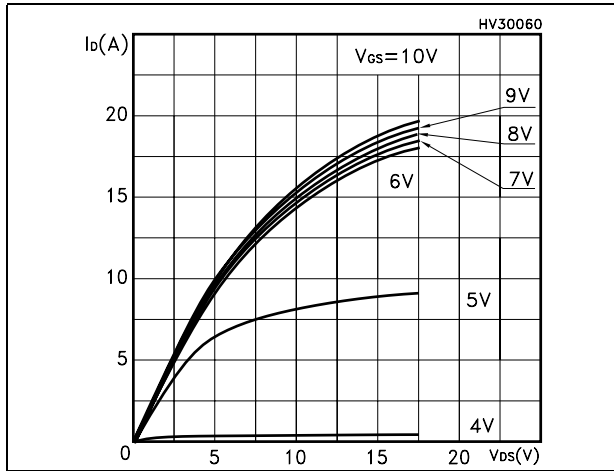


Figure 9. Transfer characteristics

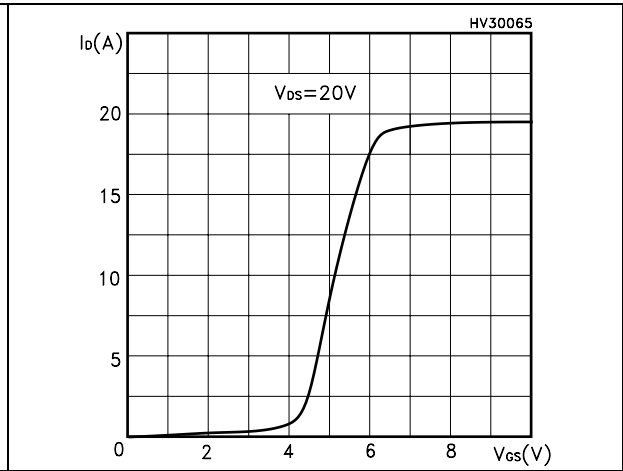


Figure 10. Transconductance

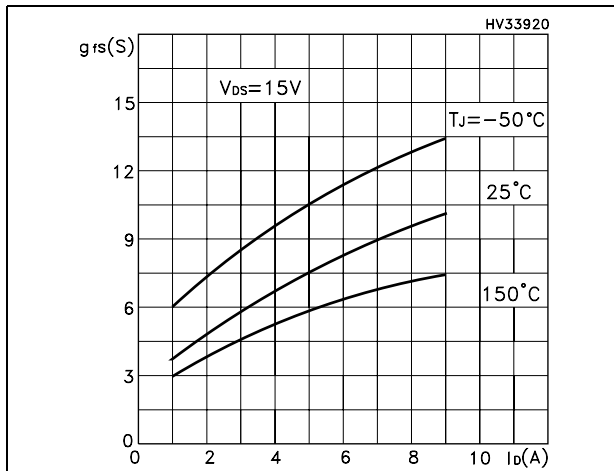


Figure 11. Static drain-source on resistance

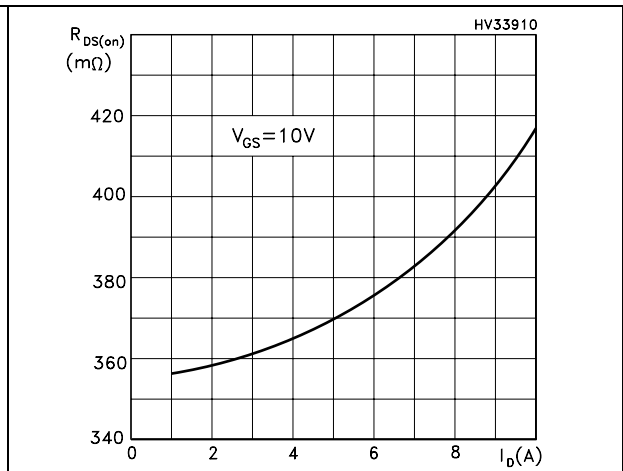


Figure 12. Gate charge vs gate-source voltage

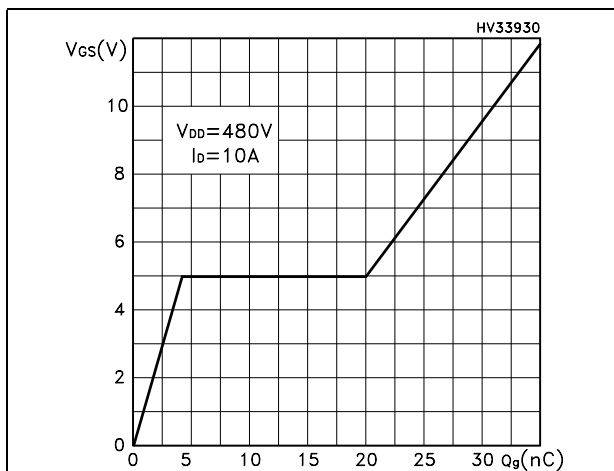


Figure 13. Capacitance variations

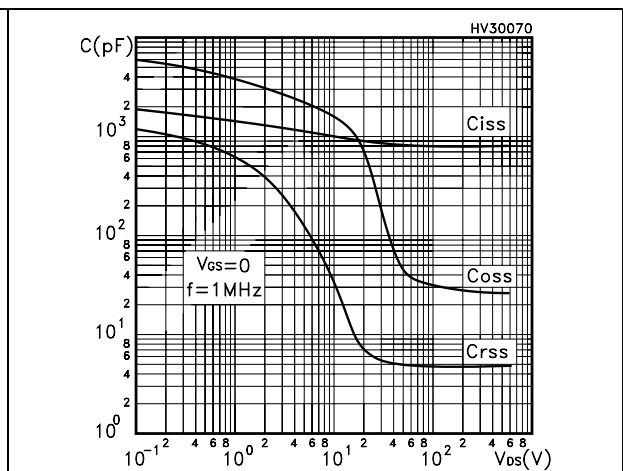


Figure 14. Normalized gate threshold voltage vs temperature

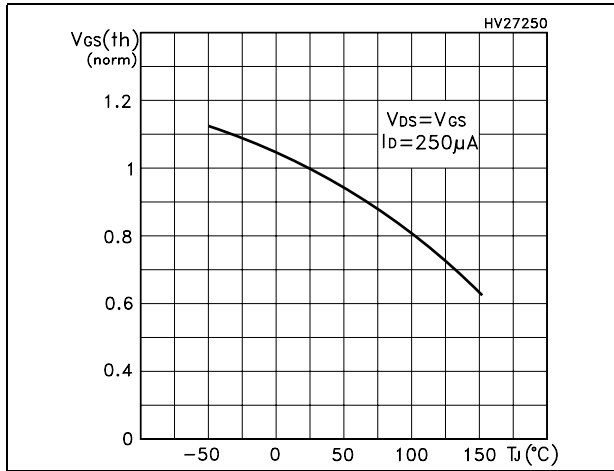


Figure 15. Normalized on resistance vs temperature

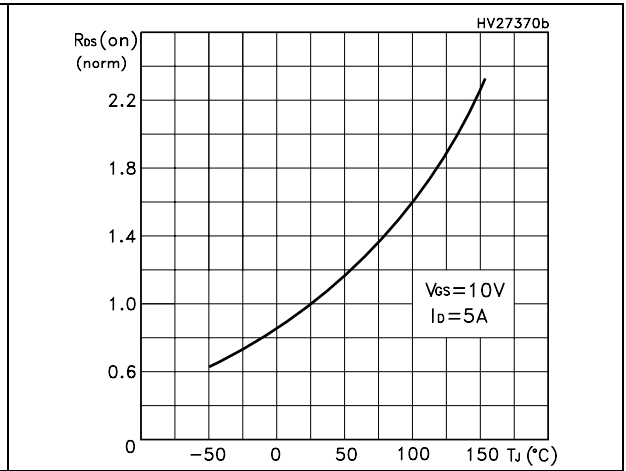


Figure 16. Source-drain diode forward characteristics

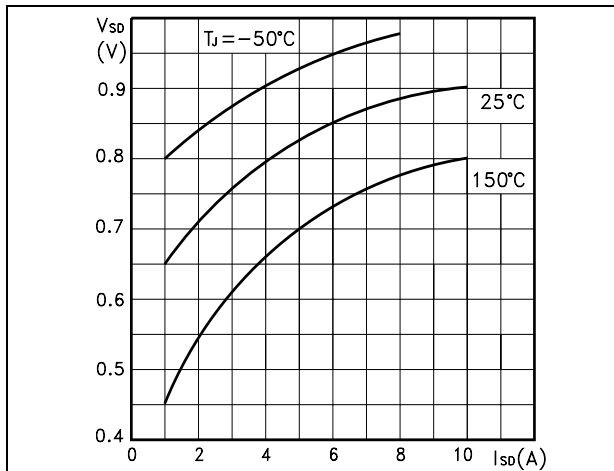
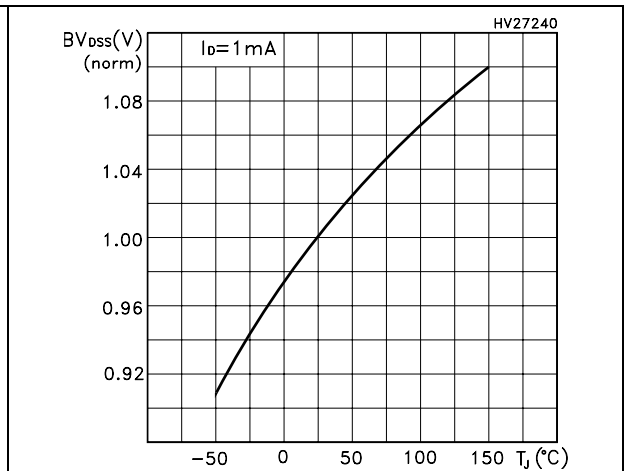


Figure 17. Normalized BV_{DSS} vs temperature



3 Test circuits

Figure 18. Switching times test circuit for resistive load

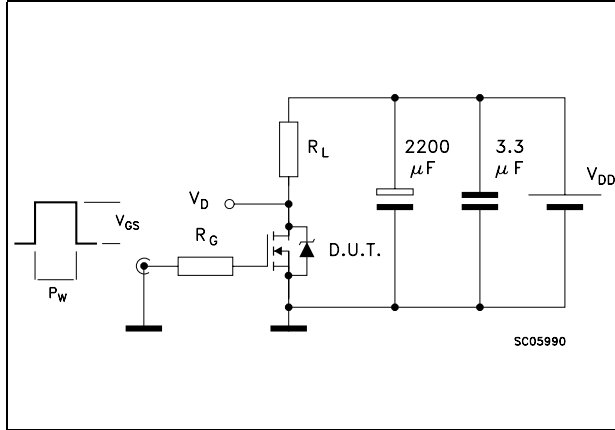


Figure 19. Gate charge test circuit

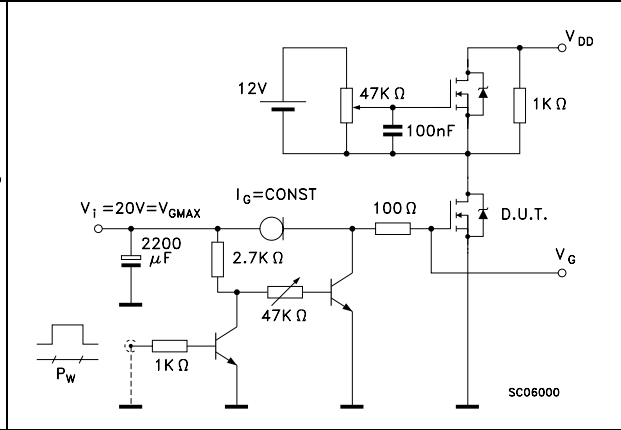


Figure 20. Test circuit for inductive load switching and diode recovery times

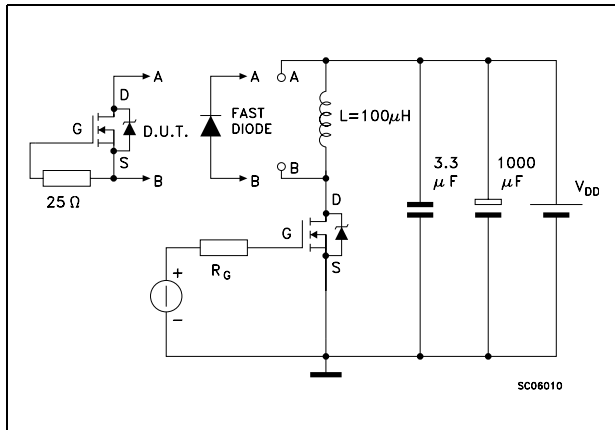


Figure 21. Unclamped Inductive load test circuit

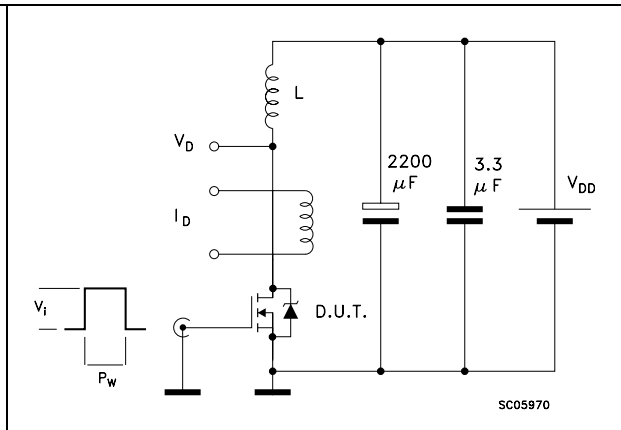


Figure 22. Unclamped inductive waveform

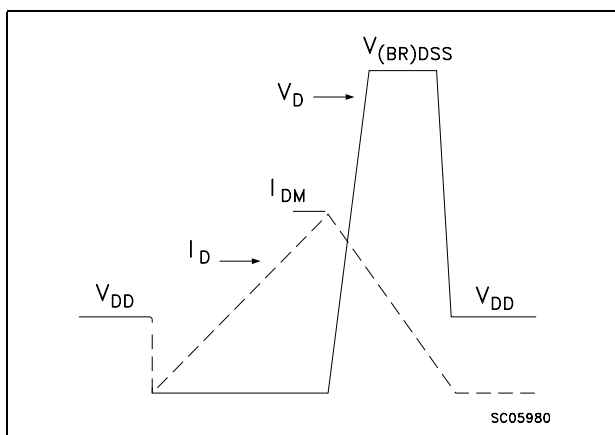
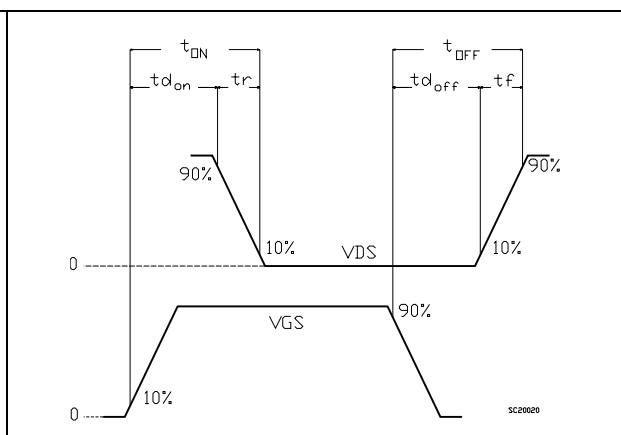


Figure 23. Switching time waveform

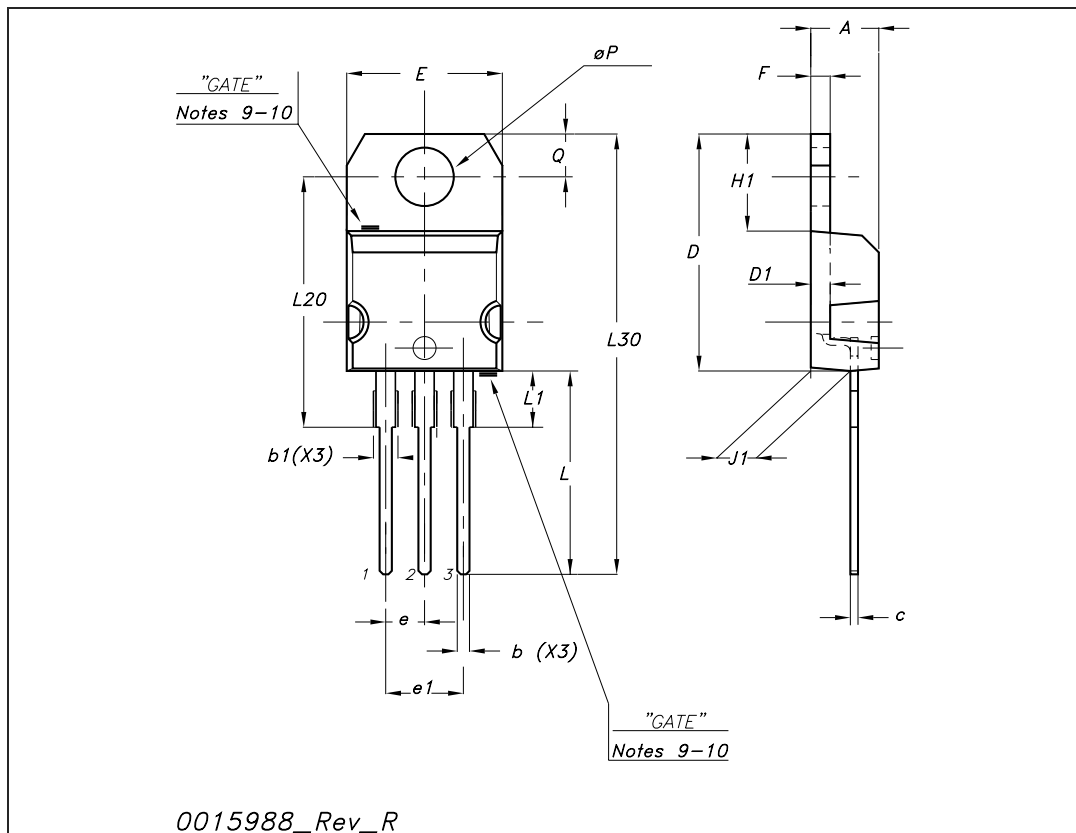


4 **Package mechanical data**

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

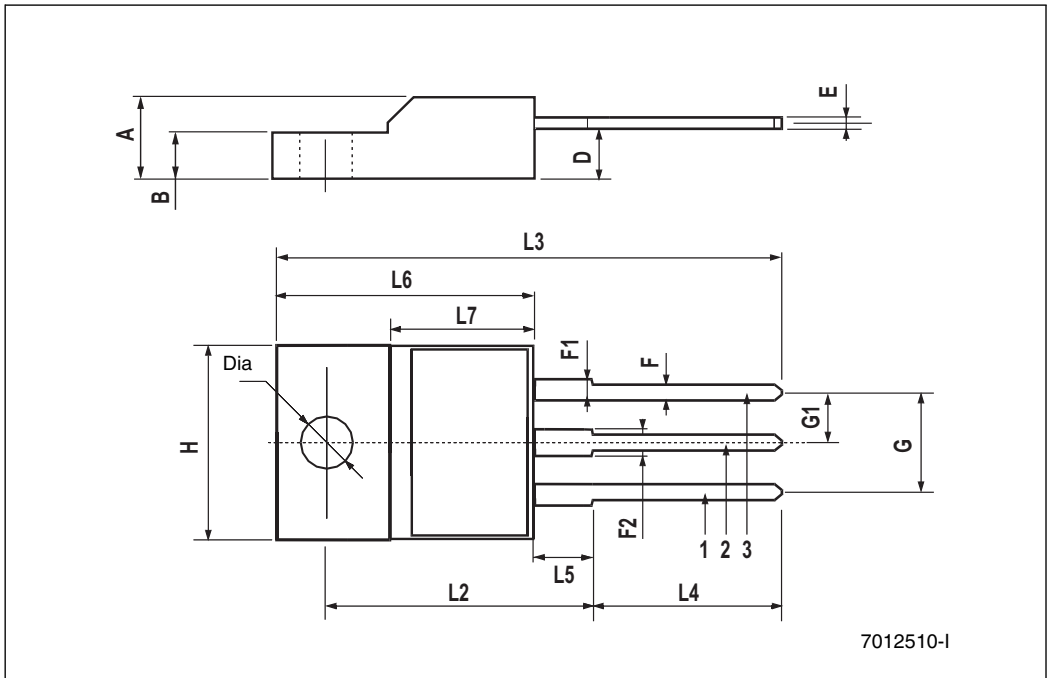
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.48		0.70	0.019		0.027
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



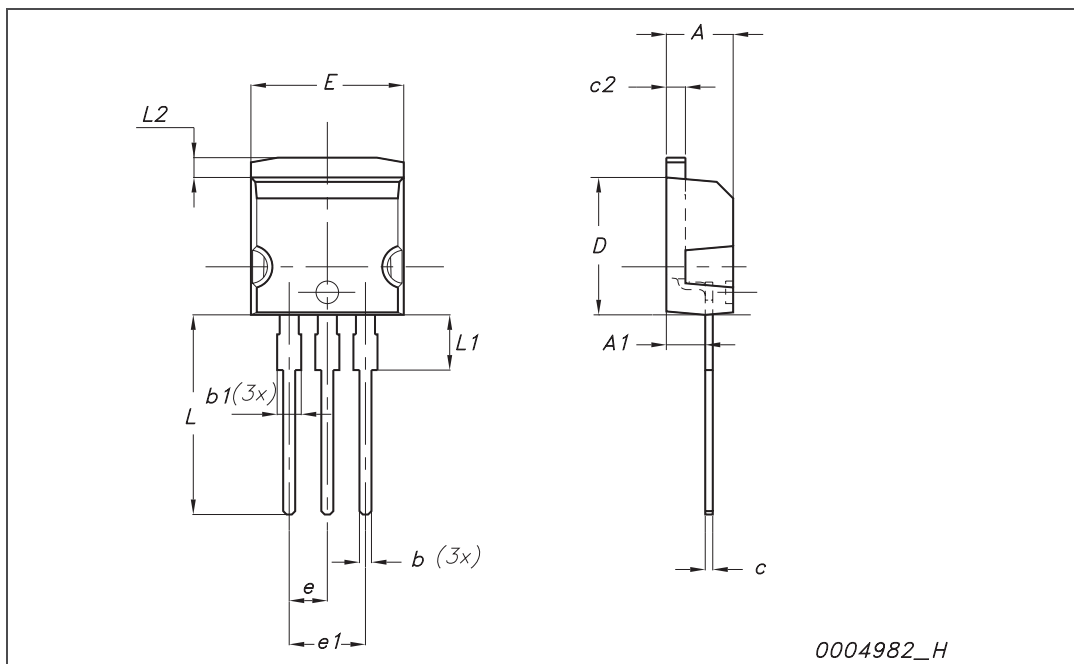
TO-220FP mechanical data

Dim.	mm.			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.40		4.60	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.70	0.017		0.027
F	0.75		1.00	0.030		0.039
F1	1.15		1.50	0.045		0.067
F2	1.15		1.50	0.045		0.067
G	4.95		5.20	0.195		0.204
G1	2.40		2.70	0.094		0.106
H	10		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.80		10.60	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.90		16.40	0.626		0.645
L7	9		9.30	0.354		0.366
Dia	3		3.2	0.118		0.126



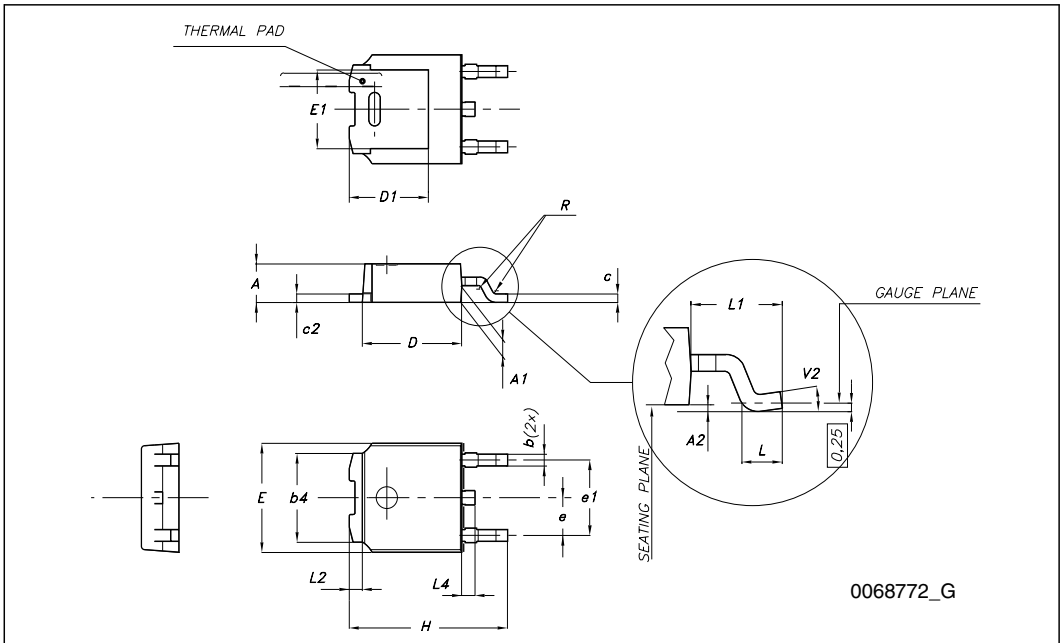
I²PAK (TO-262) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



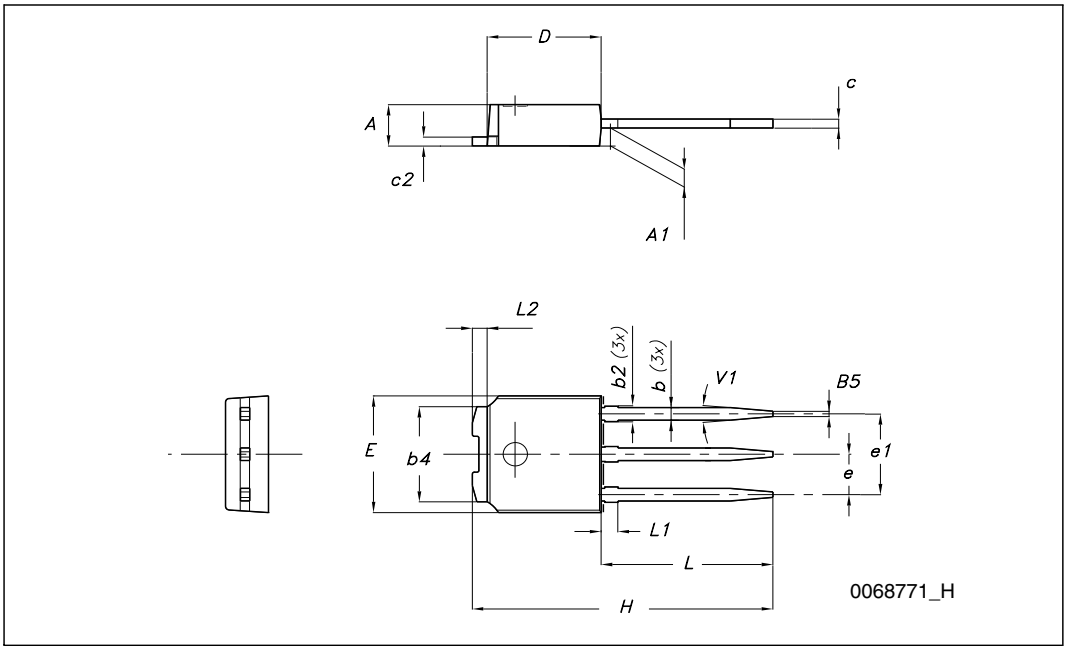
TO-252 (DPAK) mechanical data

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°



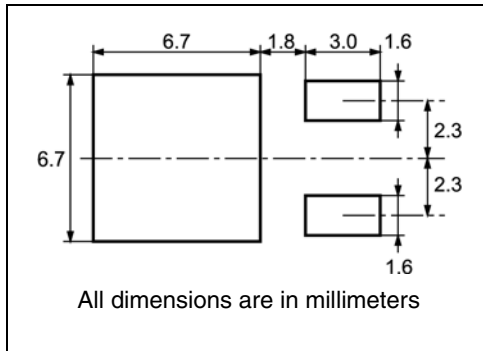
TO-251 (IPAK) mechanical data

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

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

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

10 pitches cumulative tolerance on tape +/- 0.2 mm

TOP COVER TAPE

Center line of cavity

User Direction of Feed

TRL

FEED DIRECTION

Bending radius

R min.

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

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
23-Apr-2008	1	First release

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