



# STP20NM60 - STP20NM60FP STB20NM60 STB20NM60-1

N-CHANNEL 600V - 0.25Ω - 20A TO-220/FP/D<sup>2</sup>PAK/I<sup>2</sup>PAK

MDmesh™ Power MOSFET

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>
STP20NM60	600 V	< 0.29 Ω	20 A
STP20NM60FP	600 V	< 0.29 Ω	20 A
STB20NM60	600 V	< 0.29 Ω	20 A
STB20NM60-1	600 V	< 0.29 Ω	20 A

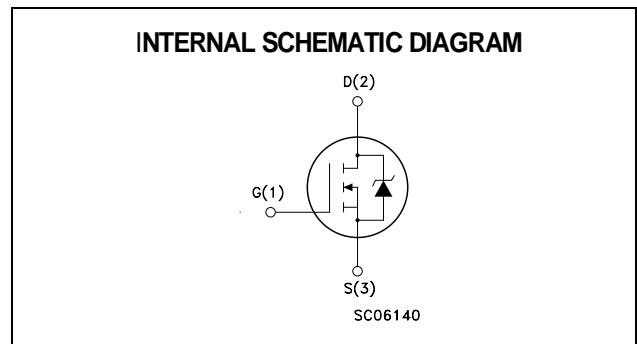
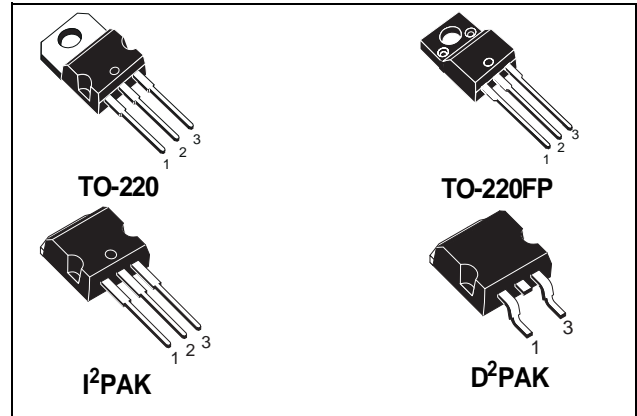
- TYPICAL R<sub>DS(on)</sub> = 0.25Ω
- HIGH dv/dt AND AVALANCHE CAPABILITIES
- 100% AVALANCHE TESTED
- LOW INPUT CAPACITANCE AND GATE CHARGE
- LOW GATE INPUT RESISTANCE

## DESCRIPTION

The MDmesh™ is a new revolutionary MOSFET technology that associates the Multiple Drain process with the Company's PowerMESH™ horizontal layout. The resulting product has an outstanding low on-resistance, impressively high dv/dt and excellent avalanche characteristics. The adoption of the Company's proprietary strip technique yields overall dynamic performance that is significantly better than that of similar competition's products.

## APPLICATIONS

The MDmesh™ family is very suitable for increasing power density of high voltage converters allowing system miniaturization and higher efficiencies.



## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value		Unit
		STP(B)20NM60(-1)	STP20NM60FP	
V <sub>DS</sub>	Drain-source Voltage (V <sub>GS</sub> = 0)	600		V
V <sub>DGR</sub>	Drain-gate Voltage (R <sub>GS</sub> = 20 kΩ)	600		V
V <sub>GS</sub>	Gate- source Voltage	±30		V
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 25°C	20	20(*)	A
I <sub>D</sub>	Drain Current (continuous) at T <sub>C</sub> = 100°C	12.6	12.6(*)	A
I <sub>DM</sub> (●)	Drain Current (pulsed)	80	80(*)	A
P <sub>TOT</sub>	Total Dissipation at T <sub>C</sub> = 25°C	192	45	W
	Derating Factor	1.2	0.36	W/°C
dv/dt(1)	Peak Diode Recovery voltage slope	15		V/ns
V <sub>ISO</sub>	Insulation Withstand Voltage (DC)	--	2500	V
T <sub>stg</sub>	Storage Temperature	-65 to 150		°C
T <sub>j</sub>	Max. Operating Junction Temperature	150		°C

(\*)Pulse width limited by safe operating area

(1)I<sub>SD</sub> ≤ 20A, di/dt ≤ 400A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>j</sub> ≤ T<sub>JMAX</sub>.

(\*)Limited only by maximum temperature allowed

**STP20NM60 / STP20NM60FP / STB20NM60 / STB20NM60-1**

**THERMAL DATA**

			TO-220/D <sup>2</sup> PAK/I <sup>2</sup> PAK	TO-220FP	
Rthj-case	Thermal Resistance Junction-case	Max	0.65	2.8	°C/W
Rthj-amb	Thermal Resistance Junction-ambient	Max	62.5		°C/W
T <sub>l</sub>	Maximum Lead Temperature For Soldering Purpose		300		°C

**AVALANCHE CHARACTERISTICS**

Symbol	Parameter	Max Value	Unit
I <sub>AR</sub>	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T <sub>j</sub> max)	10	A
E <sub>AS</sub>	Single Pulse Avalanche Energy (starting T <sub>j</sub> = 25 °C, I <sub>D</sub> = I <sub>AR</sub> , V <sub>DD</sub> = 50 V)	650	mJ

**ELECTRICAL CHARACTERISTICS (T<sub>CASE</sub> = 25 °C UNLESS OTHERWISE SPECIFIED)**  
OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source Breakdown Voltage	I <sub>D</sub> = 250 μA, V <sub>GS</sub> = 0	600			V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current (V <sub>GS</sub> = 0)	V <sub>DS</sub> = Max Rating V <sub>DS</sub> = Max Rating, T <sub>C</sub> = 125 °C			1 10	μA μA
I <sub>GSS</sub>	Gate-body Leakage Current (V <sub>DS</sub> = 0)	V <sub>GS</sub> = ±30V			±100	nA

**ON (1)**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA	3	4	5	V
R <sub>DS(on)</sub>	Static Drain-source On Resistance	V <sub>GS</sub> = 10V, I <sub>D</sub> = 10A		0.25	0.29	Ω

**DYNAMIC**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g <sub>fs</sub> (1)	Forward Transconductance	V <sub>DS</sub> > I <sub>D(on)</sub> × R <sub>DS(on)max</sub> , I <sub>D</sub> = 10A		11		S
C <sub>iss</sub>	Input Capacitance	V <sub>DS</sub> = 25V, f = 1 MHz, V <sub>GS</sub> = 0		1500		pF
C <sub>oss</sub>	Output Capacitance			350		pF
C <sub>rss</sub>	Reverse Transfer Capacitance			35		pF
C <sub>oss eq.</sub> (2)	Equivalent Output Capacitance	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 400V		130		pF
R <sub>g</sub>	Gate Input Resistance	f=1 MHz Gate DC Bias=0 Test Signal Level=20mV Open Drain		1.6		Ω

1. Pulsed: Pulse duration = 300 μs, duty cycle 1.5 %.

2. C<sub>oss eq.</sub> is defined as a constant equivalent capacitance giving the same charging time as C<sub>oss</sub> when V<sub>DS</sub> increases from 0 to 80% V<sub>DSS</sub>.

**ELECTRICAL CHARACTERISTICS (CONTINUED)**  
SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on Delay Time	$V_{DD} = 200V, I_D = 10 A$ $R_G = 4.7\Omega, V_{GS} = 10V$		25		ns
$t_r$	Rise Time	(see test circuit, Figure 3)		20		ns
$Q_g$	Total Gate Charge	$V_{DD} = 400V, I_D = 20A,$ $V_{GS} = 10V$		39	54	nC
$Q_{gs}$	Gate-Source Charge			10		nC
$Q_{gd}$	Gate-Drain Charge			20		nC

SWITCHING OFF

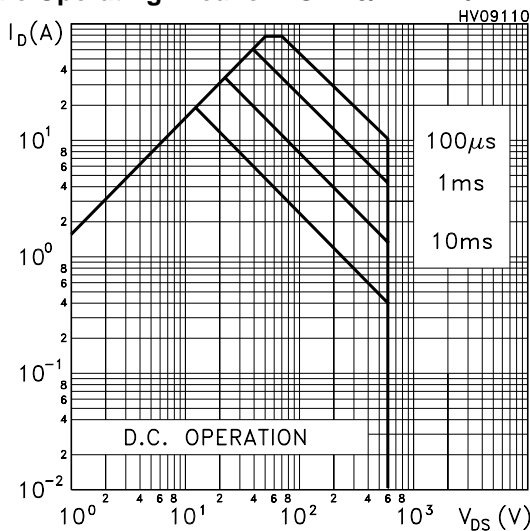
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{r(Voff)}$	Off-voltage Rise Time	$V_{DD} = 480V, I_D = 20 A,$ $R_G = 4.7\Omega, V_{GS} = 10V$		6		ns
$t_f$	Fall Time	(see test circuit, Figure 5)		11		ns
$t_c$	Cross-over Time			21		ns

SOURCE DRAIN DIODE

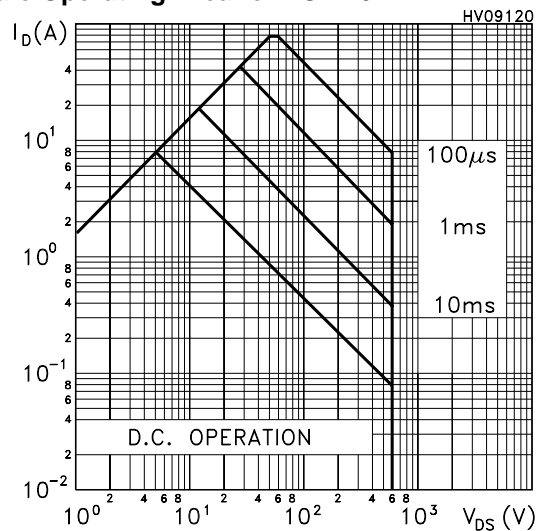
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain Current				20	A
$I_{SDM(2)}$	Source-drain Current (pulsed)				80	A
$V_{SD(1)}$	Forward On Voltage	$I_{SD} = 20 A, V_{GS} = 0$			1.5	V
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 20 A, di/dt = 100A/\mu s,$ $V_{DD} = 100 V, T_j = 25^\circ C$		390		ns
$Q_{rr}$	Reverse Recovery Charge	(see test circuit, Figure 5)		5		$\mu C$
$I_{rrm}$	Reverse Recovery Current			25		A
$t_{rr}$	Reverse Recovery Time	$I_{SD} = 20 A, di/dt = 100A/\mu s,$ $V_{DD} = 100 V, T_j = 150^\circ C$		510		ns
$Q_{rr}$	Reverse Recovery Charge	(see test circuit, Figure 5)		6.5		$\mu C$
$I_{rrm}$	Reverse Recovery Current			26		A

Note: 1. Pulsed: Pulse duration = 300  $\mu s$ , duty cycle 1.5 %.  
2. Pulse width limited by safe operating area.

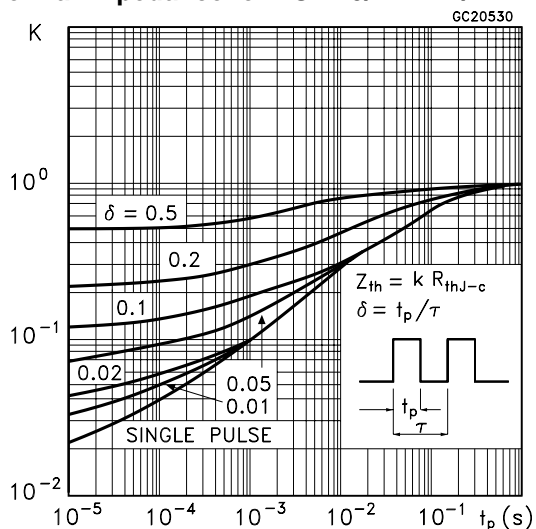
Safe Operating Area for TO-220/D2PAK/I2PAK



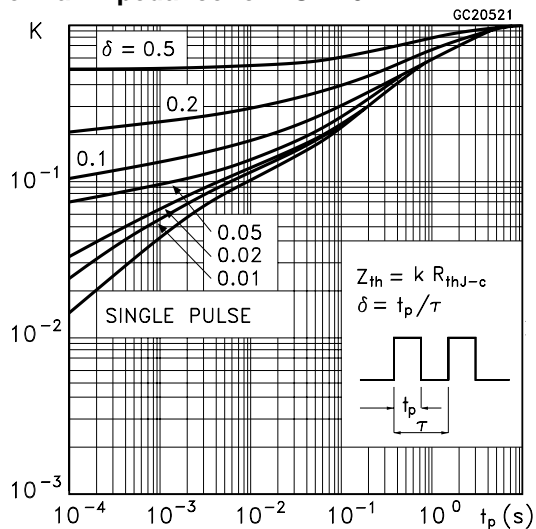
Safe Operating Area for TO-220FP



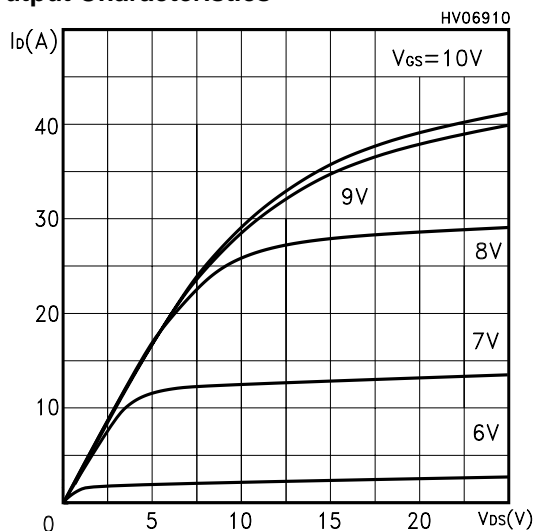
Thermal Impedance for TO-220/D2PAK/I2PAK



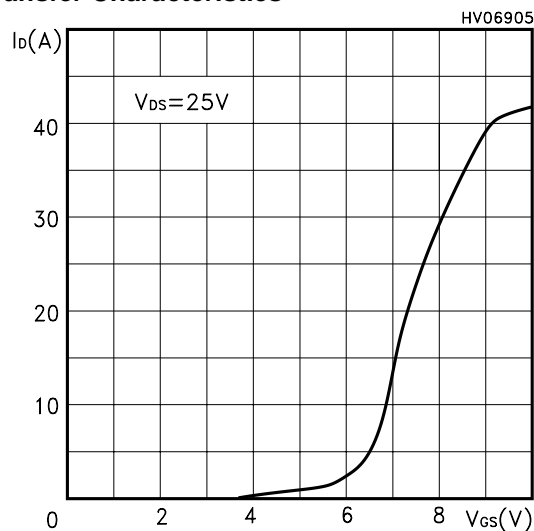
Thermal Impedance for TO-220FP



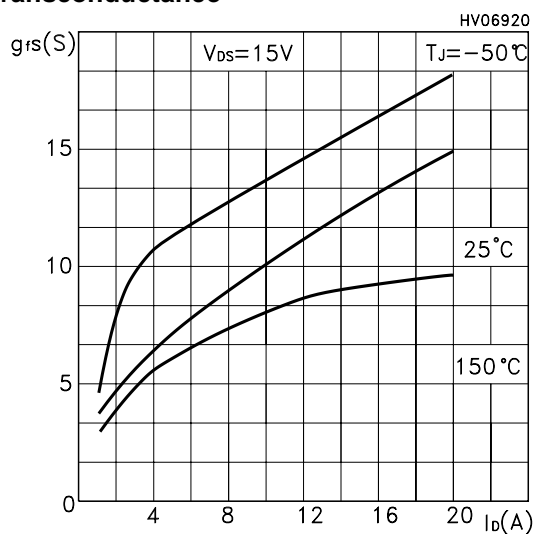
Output Characteristics



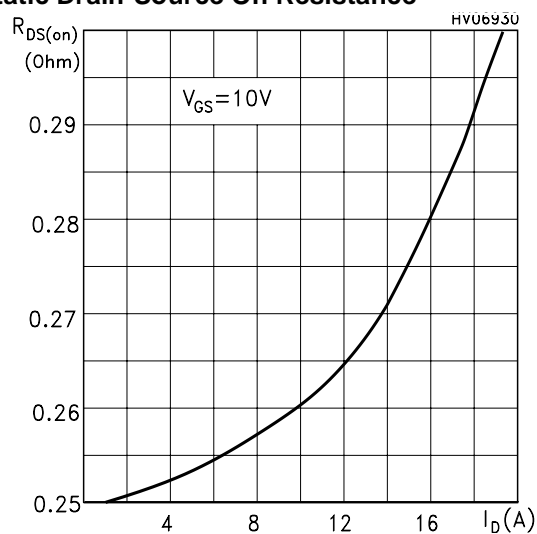
Transfer Characteristics



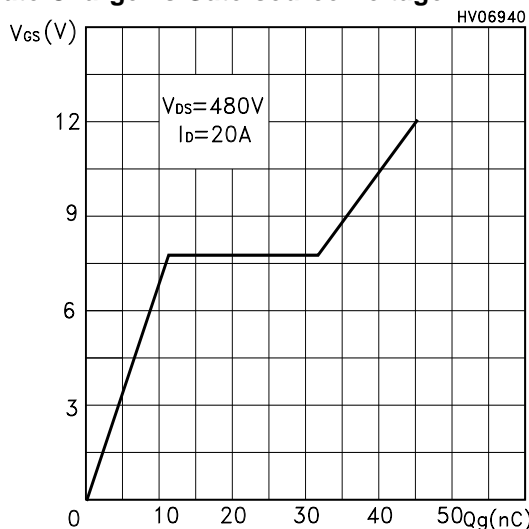
Transconductance



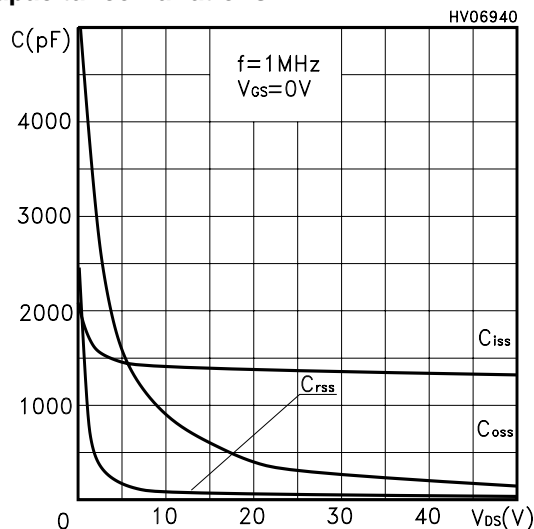
Static Drain-Source On Resistance



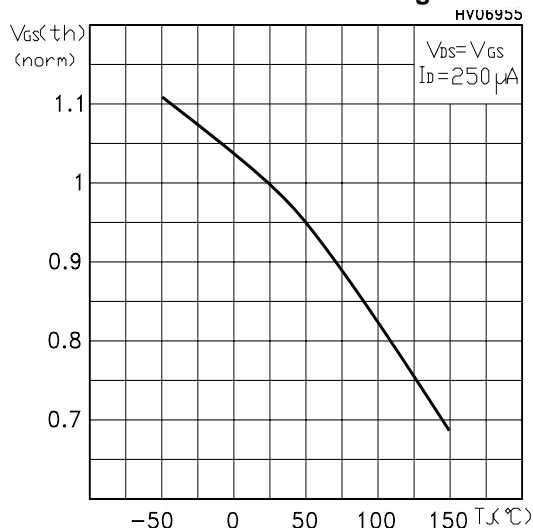
Gate Charge vs Gate-source Voltage



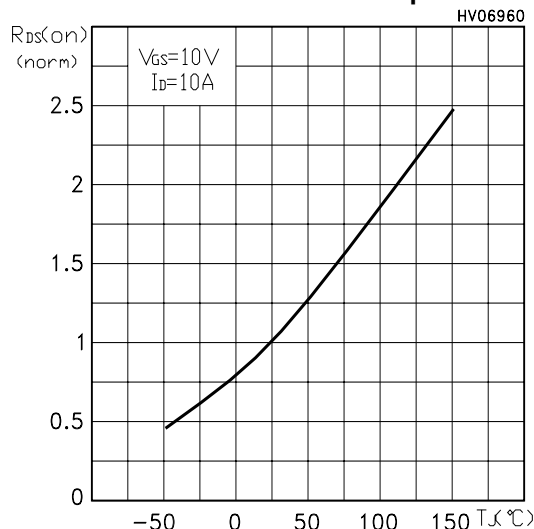
Capacitance Variations



Normalized Gate Threshold Voltage vs Temp.



Normalized On Resistance vs Temperature



Source-drain Diode Forward Characteristics

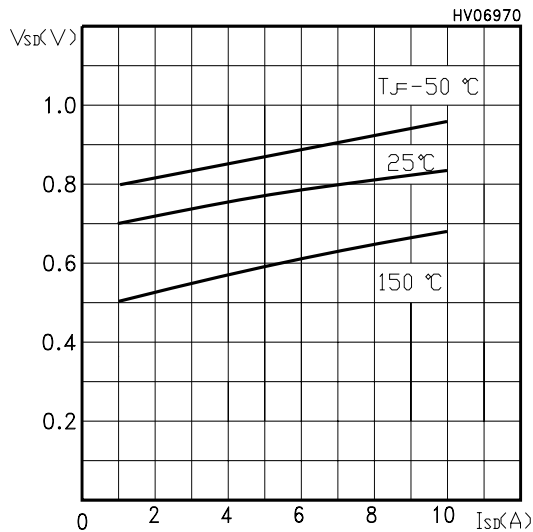


Fig. 1: Unclamped Inductive Load Test Circuit

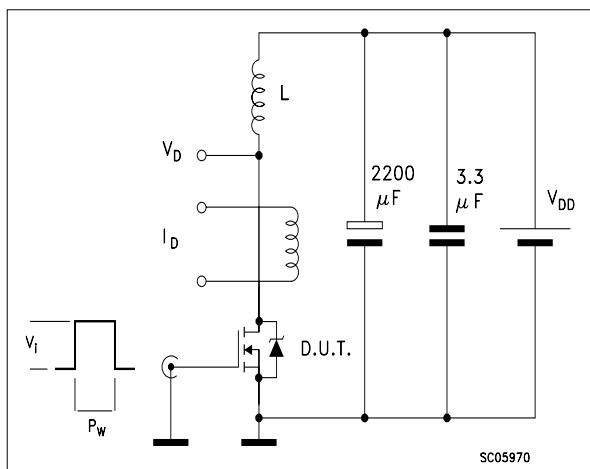


Fig. 2: Unclamped Inductive Waveform

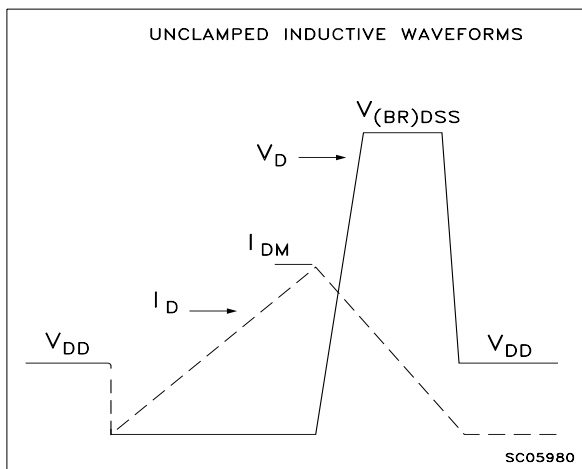


Fig. 3: Switching Times Test Circuit For Resistive Load

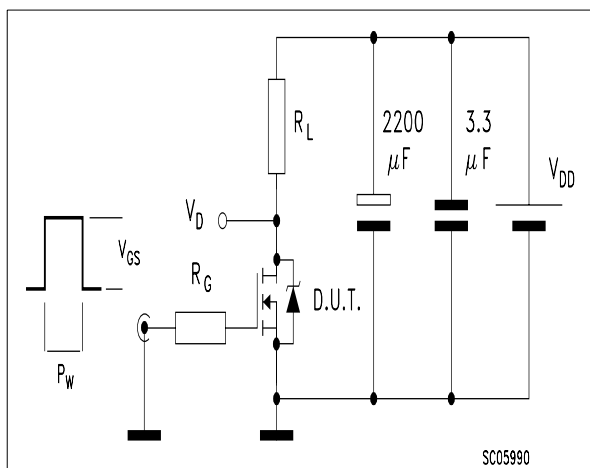


Fig. 4: Gate Charge test Circuit

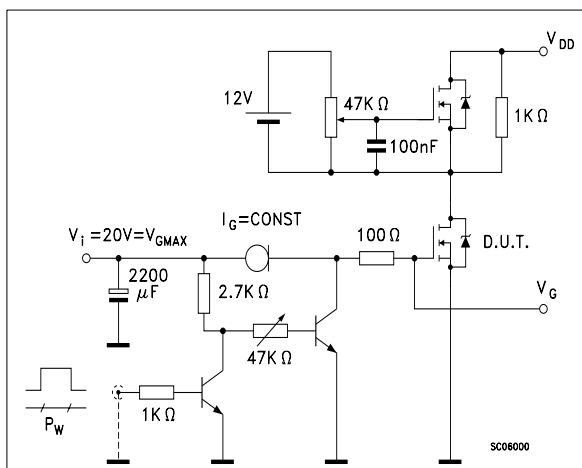
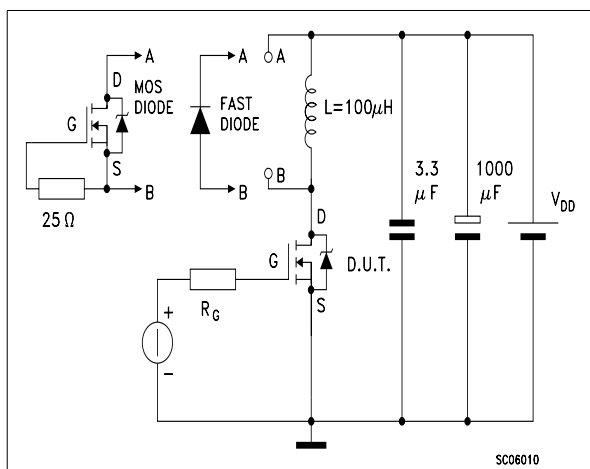
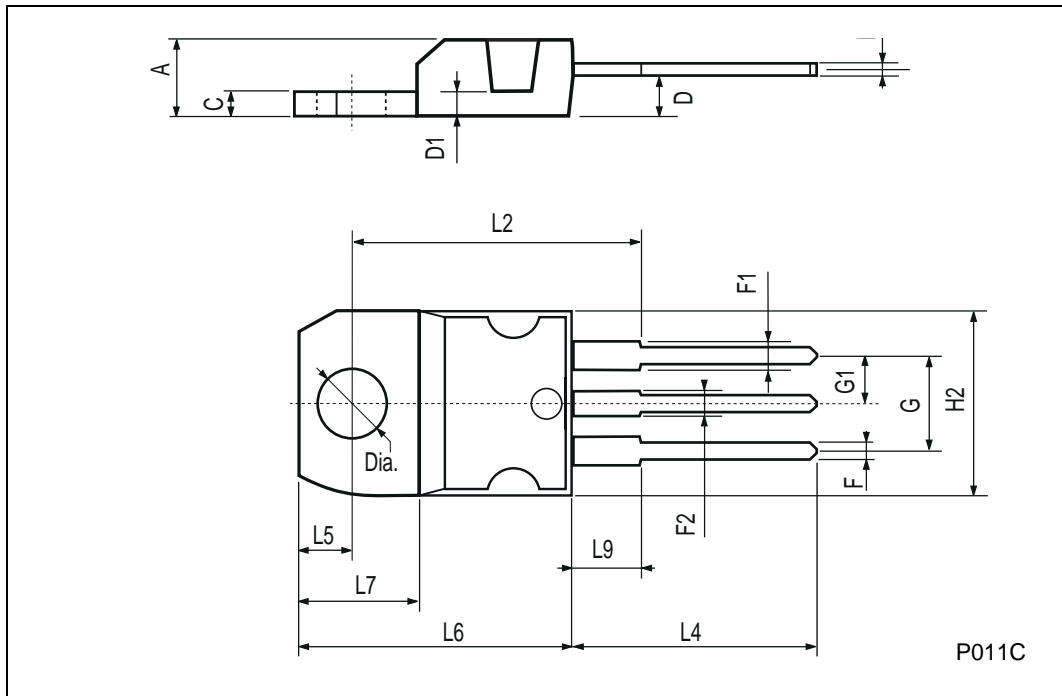


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



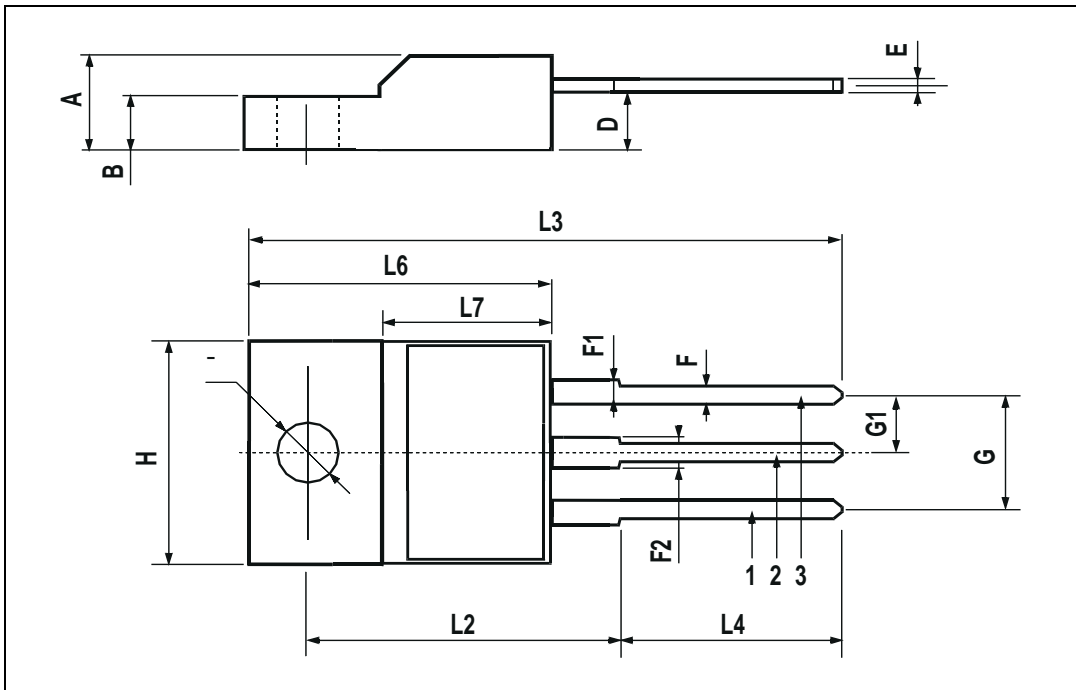
TO-220 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
H2	10.0		10.40	0.393		0.409
L2		16.4			0.645	
L4	13.0		14.0	0.511		0.551
L5	2.65		2.95	0.104		0.116
L6	15.25		15.75	0.600		0.620
L7	6.2		6.6	0.244		0.260
L9	3.5		3.93	0.137		0.154
DIA.	3.75		3.85	0.147		0.151



**TO-220FP MECHANICAL DATA**

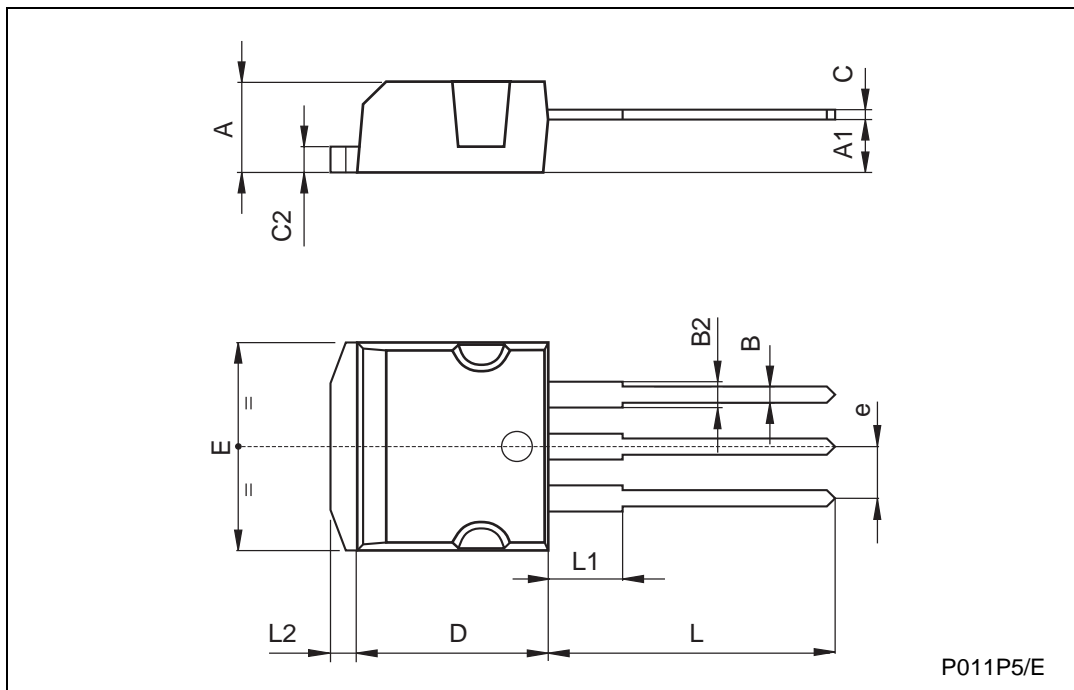
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	0.385		0.417
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
∅	3		3.2	0.118		0.126





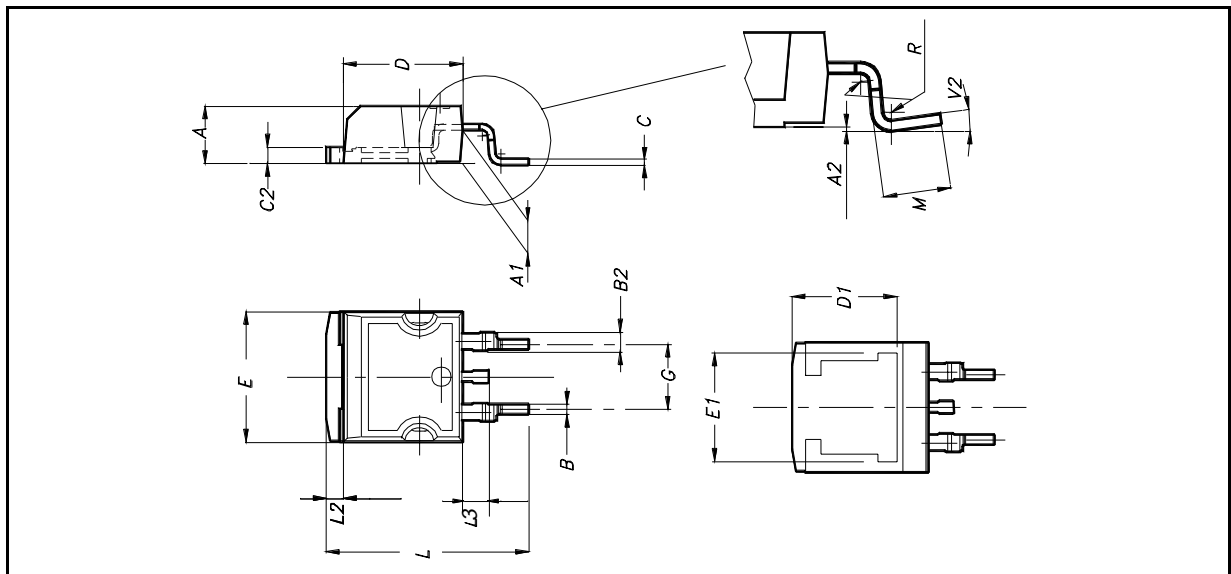
TO-262 (I<sup>2</sup>PAK) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
e	2.4		2.7	0.094		0.106
E	10		10.4	0.393		0.409
L	13.1		13.6	0.515		0.531
L1	3.48		3.78	0.137		0.149
L2	1.27		1.4	0.050		0.055

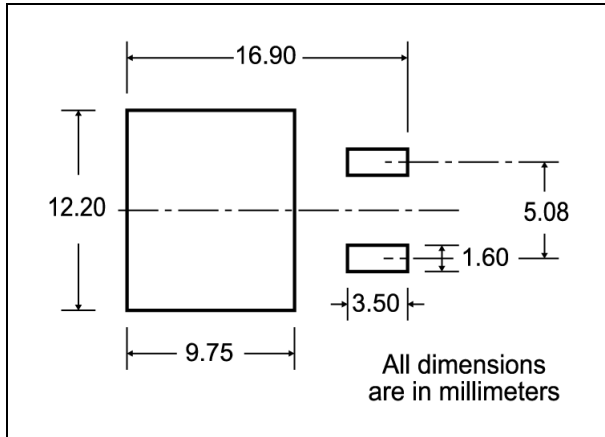


**D<sup>2</sup>PAK MECHANICAL DATA**

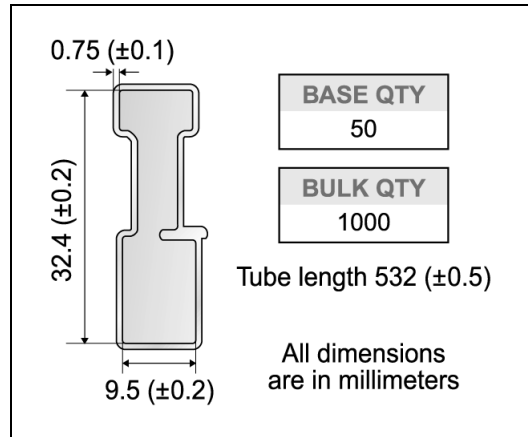
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
G	4.88		5.28	0.192		0.208
L	15		15.85	0.590		0.625
L2	1.27		1.4	0.050		0.055
L3	1.4		1.75	0.055		0.068
M	2.4		3.2	0.094		0.126
R		0.4			0.015	
V2	0°		8°			



**D<sup>2</sup>PAK FOOTPRINT**



**TUBE SHIPMENT (no suffix)\***



**TAPE AND REEL SHIPMENT (suffix "T4")\***

Diagram showing the tape mechanical data. The tape width is A. The distance from the center of the tape to the edge of the mounting pads is B. The distance from the center of the tape to the edge of the mounting pads is C. The distance from the center of the tape to the edge of the mounting pads is D. The distance from the center of the tape to the edge of the mounting pads is G. The distance from the center of the tape to the edge of the mounting pads is N. The distance from the center of the tape to the edge of the mounting pads is T. The distance from the center of the tape to the edge of the mounting pads is 40 mm min. Access hole at slot location. The distance from the center of the tape to the edge of the mounting pads is 2.5mm min. width. The distance from the center of the tape to the edge of the mounting pads is Full radius. The distance from the center of the tape to the edge of the mounting pads is Tape slot in core for tape start.

**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

**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	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

Diagram showing the reel mechanical data. The distance from the center of the reel to the edge of the mounting pads is K<sub>0</sub>. The distance from the center of the reel to the edge of the mounting pads is T. The distance from the center of the reel to the edge of the mounting pads is D. The distance from the center of the reel to the edge of the mounting pads is P<sub>2</sub>. The distance from the center of the reel to the edge of the mounting pads is P<sub>0</sub>. The distance from the center of the reel to the edge of the mounting pads is E. The distance from the center of the reel to the edge of the mounting pads is F. The distance from the center of the reel to the edge of the mounting pads is W. The distance from the center of the reel to the edge of the mounting pads is B<sub>0</sub>. The distance from the center of the reel to the edge of the mounting pads is D<sub>1</sub>. The distance from the center of the reel to the edge of the mounting pads is A<sub>0</sub>. The distance from the center of the reel to the edge of the mounting pads is P<sub>1</sub>. The distance from the center of the reel to the edge of the mounting pads is Center line of cavity. The distance from the center of the reel to the edge of the mounting pads is 10 pitches cumulative tolerance on tape +/- 0.2 mm. The distance from the center of the reel to the edge of the mounting pads is User Direction of Feed. The distance from the center of the reel to the edge of the mounting pads is R min. The distance from the center of the reel to the edge of the mounting pads is Bending radius. The distance from the center of the reel to the edge of the mounting pads is FEED DIRECTION.

\* on sales type



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