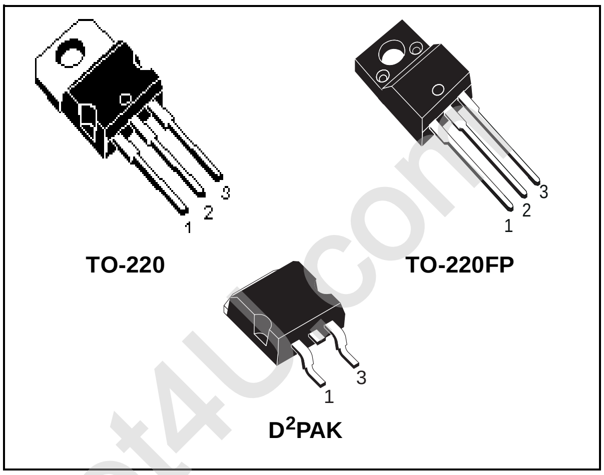
STP9NK60ZD - STF9NK60ZD
STB9NK60ZD

N-CHANNEL 600V - 0.85Ω - 7A TO-220/TO-220FP/D^{2}PAK
Fast Diode SuperMESH™ MOSFET

ADVANCED DATA

TYPE	V_{DSS}	$R_{DS(on)}$	I_D	Pw
STP9NK60ZD	600 V	< 0.95 Ω	7 A	125 W
STF9NK60ZD	600 V	< 0.95 Ω	7 A	30 W
STB9NK60ZD	600 V	< 0.95 Ω	7 A	125 W

- TYPICAL R_{DS}(on) = 0.85 Ω
- VERY HIGH dv/dt CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- LOW INTRINSIC CAPACITANCES
- FAST INTERNAL RECOVERY DIODE



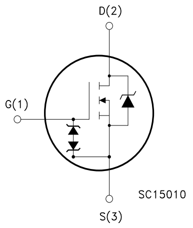
DESCRIPTION

The Fast SuperMESH™ series associates all advantages of reduced on-resistance, zener gate protection and very high dv/dt capability with a Fast body-drain recovery diode. Such series complements the “FDmesh™” Advanced Technology.

APPLICATIONS

- HID BALLAST
- ZVS PHASE-SHIFT FULL BRIDGE CONVERTERS

INTERNAL SCHEMATIC DIAGRAM



ORDERING INFORMATION

SALES TYPE	MARKING	PACKAGE	PACKAGING
STP9NK60ZD	P9NK60ZD	TO-220	TUBE
STF9NK60ZD	F9NK60ZD	TO-220FP	TUBE
STB9NK60ZDT4	B9NK60ZD	D^{2}PAK	TAPE & REEL

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value		Unit
		TO-220 / D^2PAK	**TO-220FP**	
V_{DS}	Drain-source Voltage (V_{GS} = 0)	600		V
V_{DGR}	Drain-gate Voltage (R_{GS} = 20 kΩ)	600		V
V_{GS}	Gate- source Voltage	± 30		V
I_D	Drain Current (continuos) at T_C = 25°C	7	7 (*)	A
I_D	Drain Current (continuos) at T_C = 100°C	4.3	4.3 (*)	A
I_{DM} (•)	Drain Current (pulsed)	28	28 (*)	A
P_{TOT}	Total Dissipation at T_C = 25°C	125	30	W
	Derating Factor	1	0.24	W/°C
$V_{ESD(G-S)}$	Gate source ESD (HBM-C=100pF, R=1.5KΩ)	4000		V
dv/dt (1)	Peak Diode Recovery voltage slope	15		V/ns
V_{ISO}	Insulation Withstand Voltage (DC)	-	2500	V
T_j T_{stg}	Operating Junction Temperature Storage Temperature	-55 to 150		°C

(•) Pulse width limited by safe operating area
(1) $I_{SD} \leq 7A$, di/dt ≤500A/µs, $V_{DD} \leq V_{(BR)DSS}$, T_j = 25°C
(*) Limited only by maximum temperature allowed

THERMAL DATA

		TO-220 D^2PAK	TO-220FP	Unit
Rthj-pcb	Thermal Resistance Junction-pcb Max (When mounted on minimum Footprint)	30		°C/W
Rthj-case	Thermal Resistance Junction-case Max	1	4.16	°C/W
Rthj-amb	Thermal Resistance Junction-ambient Max	62.5		°C/W
T_l	Maximum Lead Temperature For Soldering Purpose	300		°C

AVALANCHE CHARACTERISTICS

Symbol	Parameter	Max Value	Unit
I_{AR}	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by T_j max)	7	A
E_{AS}	Single Pulse Avalanche Energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	235	mJ

GATE-SOURCE ZENER DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BV_{GSO}	Gate-Source Breakdown Voltage	Igs=± 1mA (Open Drain)	30			V

PROTECTION FEATURES OF GATE-TO-SOURCE ZENER DIODES

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to souce. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

ELECTRICAL CHARACTERISTICS (T_{CASE} =25°C UNLESS OTHERWISE SPECIFIED)

ON/OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	I_D = 1mA, 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 50	µA µA
I_{GSS}	Gate-body Leakage Current (V_{DS} = 0)	V_{GS} = ± 20V			±10	µA
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 100µA	2.5	3.5	4.5	V
$R_{DS(on)}$	Static Drain-source On Resistance	V_{GS} = 10V, I_D = 3.5 A		0.85	0.95	Ω

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward Transconductance	V_{DS} = 15 V, I_D = 3.5 A		5.3		S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	V_{DS} = 25V, f = 1 MHz, V_{GS} = 0		1110 135 30		pF pF pF
$C_{oss\ eq.}$ (3)	Equivalent Output Capacitance	V_{GS} = 0V, V_{DS} = 0V to 480V		72		pF

SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on Delay Time Rise Time	V_{DD} = 300 V, I_D = 3.5 A R_G = 4.7Ω V_{GS} = 10 V (Resistive Load see, Figure 3)		22 17		ns ns
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	V_{DD} = 480V, I_D = 7 A, V_{GS} = 10V		41 8.7 21	53	nC nC nC

SWITCHING OFF

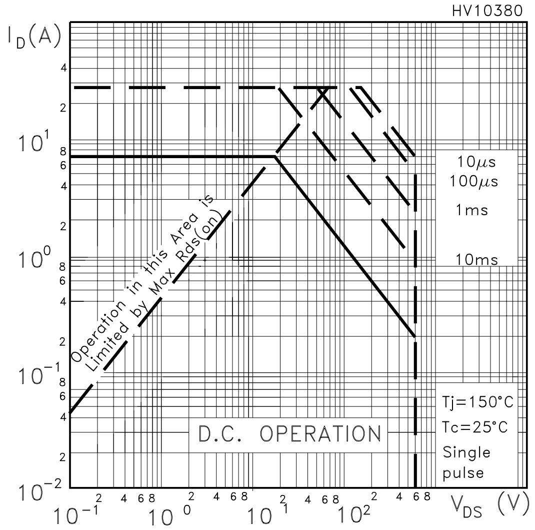
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$ t_f	Turn-off Delay Time Fall Time	V_{DD} = 300 V, I_D = 3.5 A R_G = 4.7Ω V_{GS} = 10 V (Resistive Load see, Figure 3)		42 15		ns ns
$t_{r(Voff)}$ t_f t_c	Off-voltage Rise Time Fall Time Cross-over Time	V_{DD} = 480V, I_D = 7 A, R_G = 4.7Ω, V_{GS} = 10V (Inductive Load see, Figure 5)		11 8 20		ns ns ns

SOURCE DRAIN DIODE

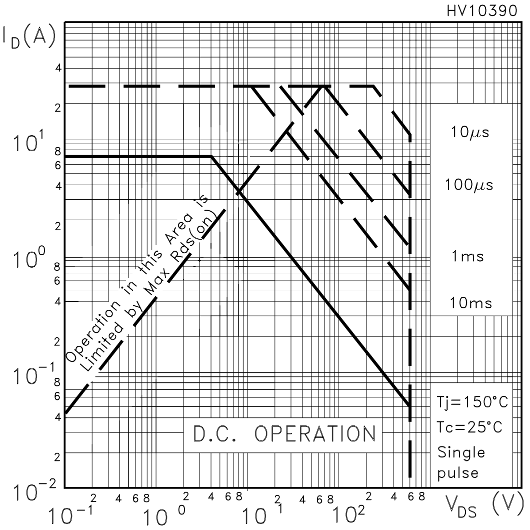
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM} (2)	Source-drain Current Source-drain Current (pulsed)				7 28	A A
V_{SD} (1)	Forward On Voltage	I_{SD} = 7 A, V_{GS} = 0			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 7 A, di/dt = 100A/µs V_{DD} = 30V, T_j = 25°C (see test circuit, Figure 5)		150 663 8.5		ns µC A
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	I_{SD} = 7 A, di/dt = 100A/µs V_{DD} = 30V, T_j = 150°C (see test circuit, Figure 5)		194 935 9.6		ns µC A

Note:
1. Pulsed: Pulse duration = 300 µs, duty cycle 1.5 %.
2. Pulse width limited by safe operating area.
3. $C_{oss\ eq.}$ 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}.

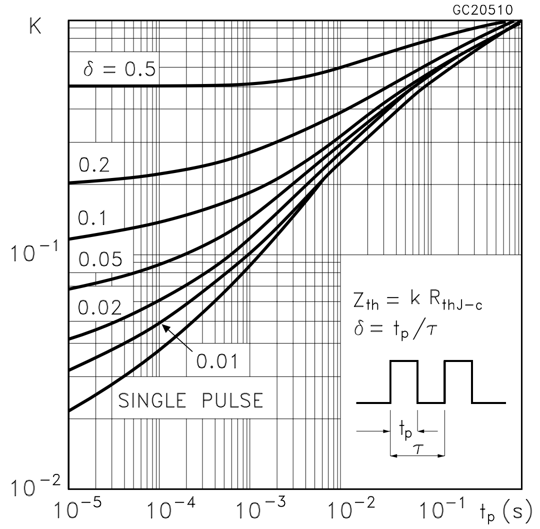
Safe Operating Area For TO-220/D²PAK



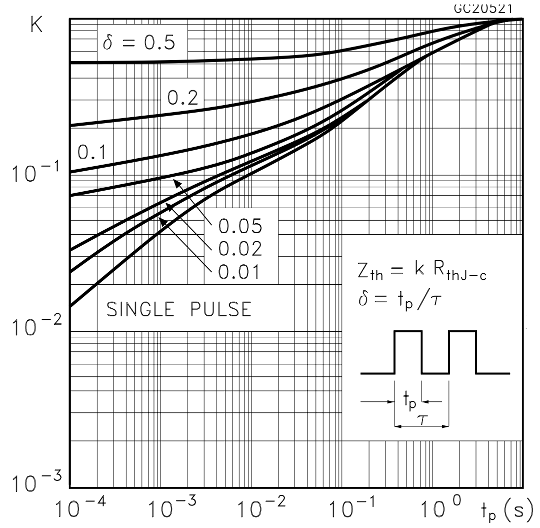
Safe Operating Area For TO-220FP



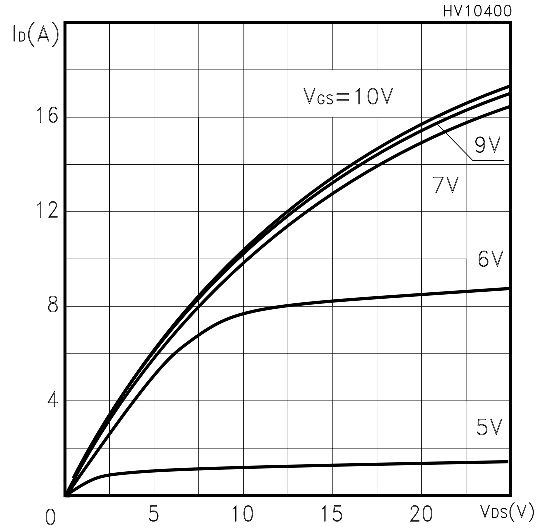
Thermal Impedance For TO-220/D²PAK



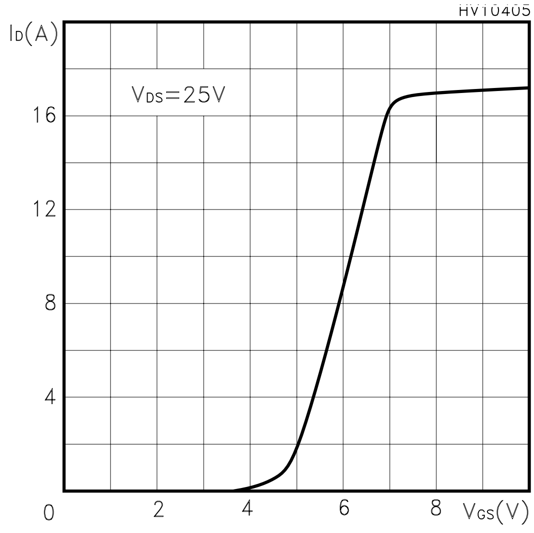
Thermal Impedance For TO-220FP



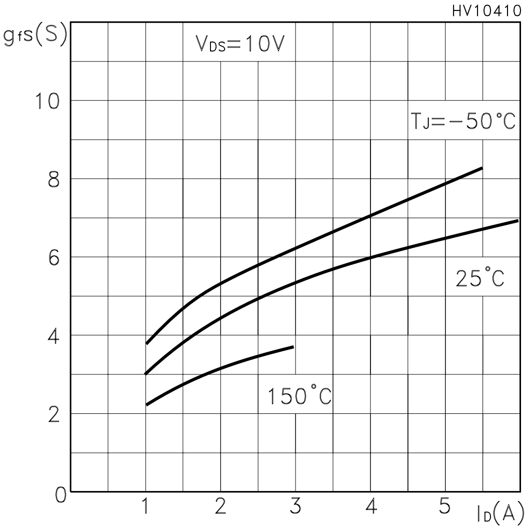
Output Characteristics



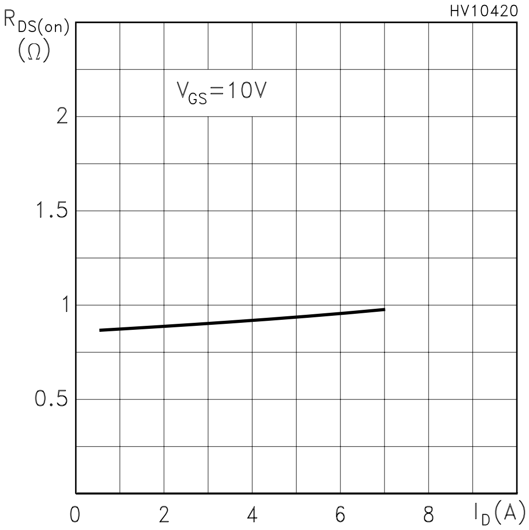
Transfer Characteristics



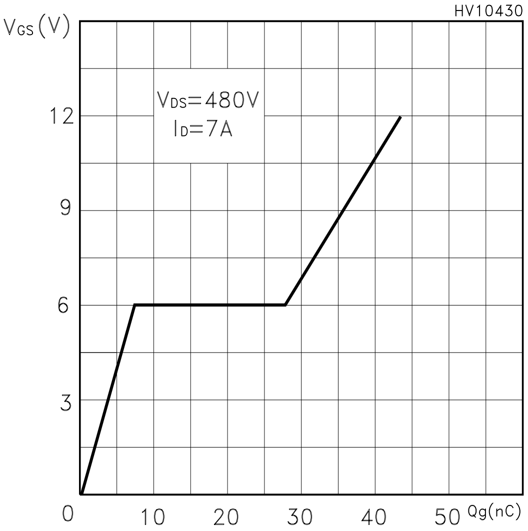
Transconductance



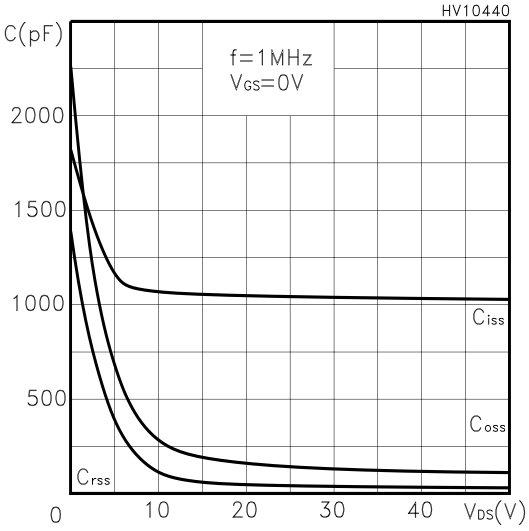
Static Drain-source On Resistance



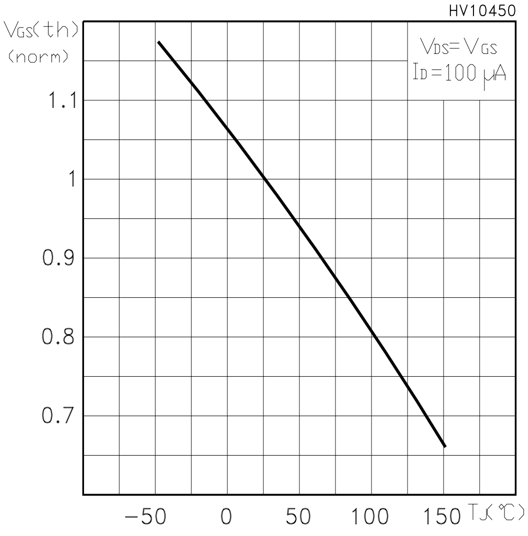
Gate Charge vs Gate-source Voltage



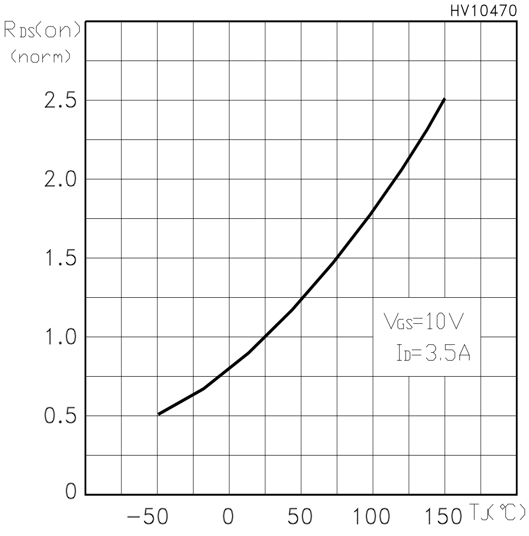
Capacitance Variations



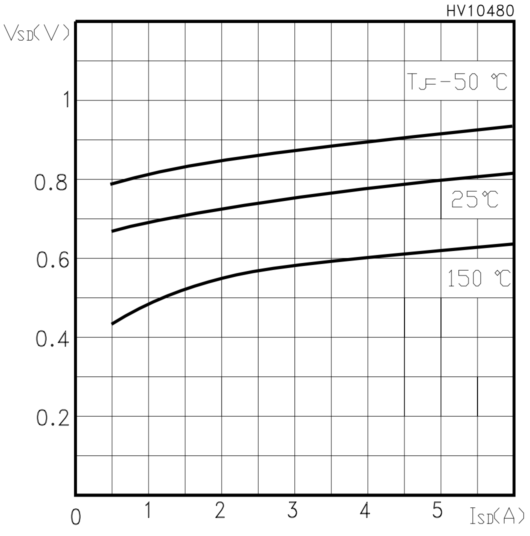
Normalized Gate Threshold Voltage vs Temp.



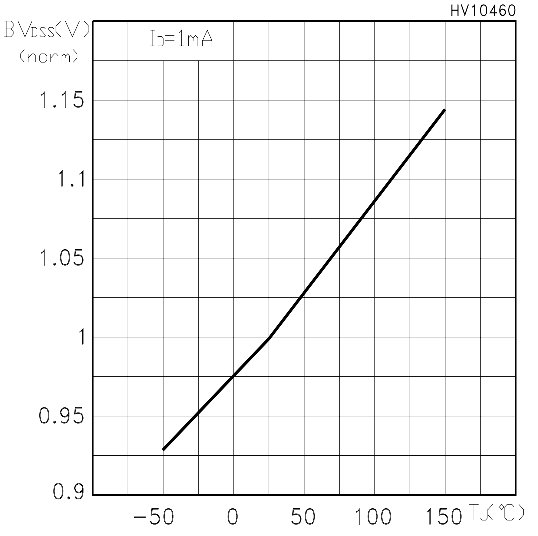
Normalized On Resistance vs Temperature



Source-drain Diode Forward Characteristics



Normalized BVDSS vs Temperature



Maximum Avalanche Energy vs Temperature

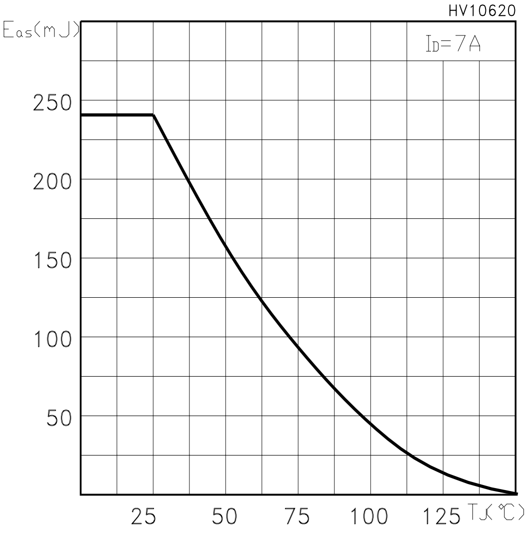


Fig. 1: Unclamped Inductive Load Test Circuit

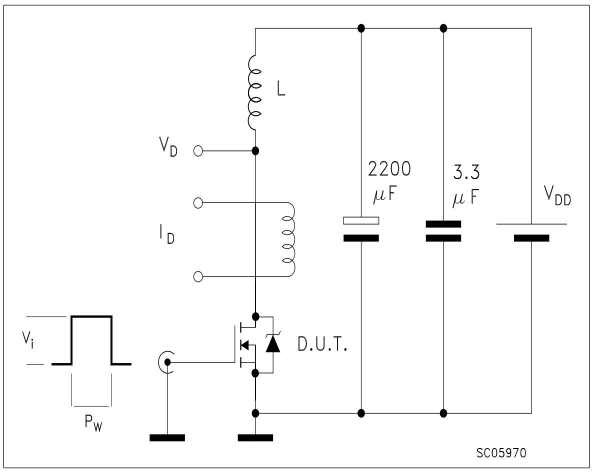


Fig. 2: Unclamped Inductive Waveform

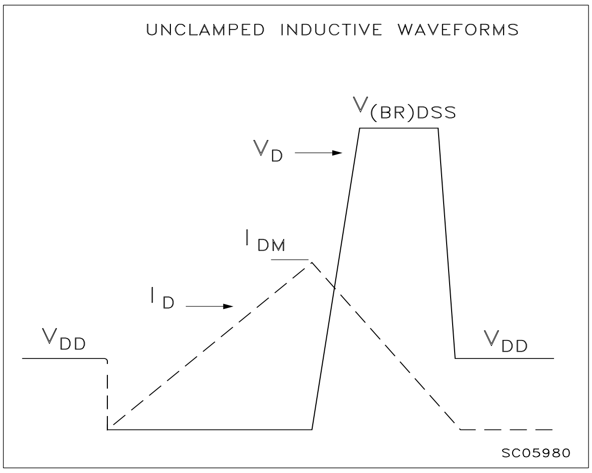


Fig. 3: Switching Times Test Circuit For Resistive Load

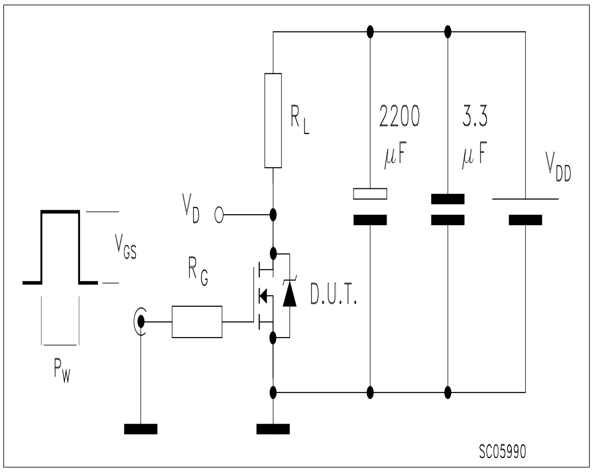


Fig. 4: Gate Charge test Circuit

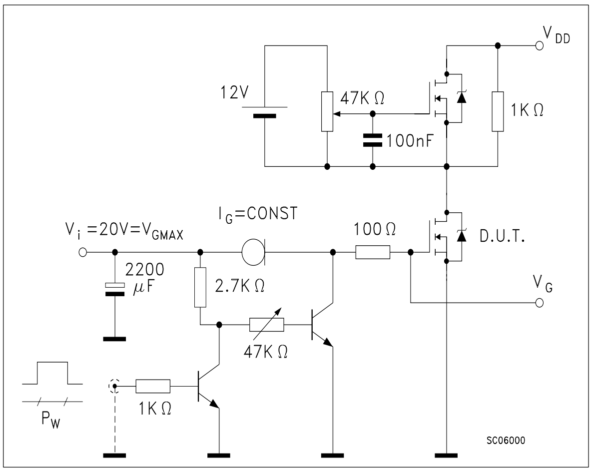
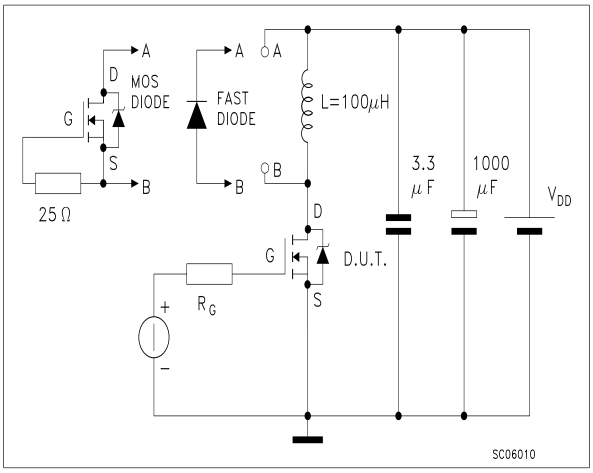
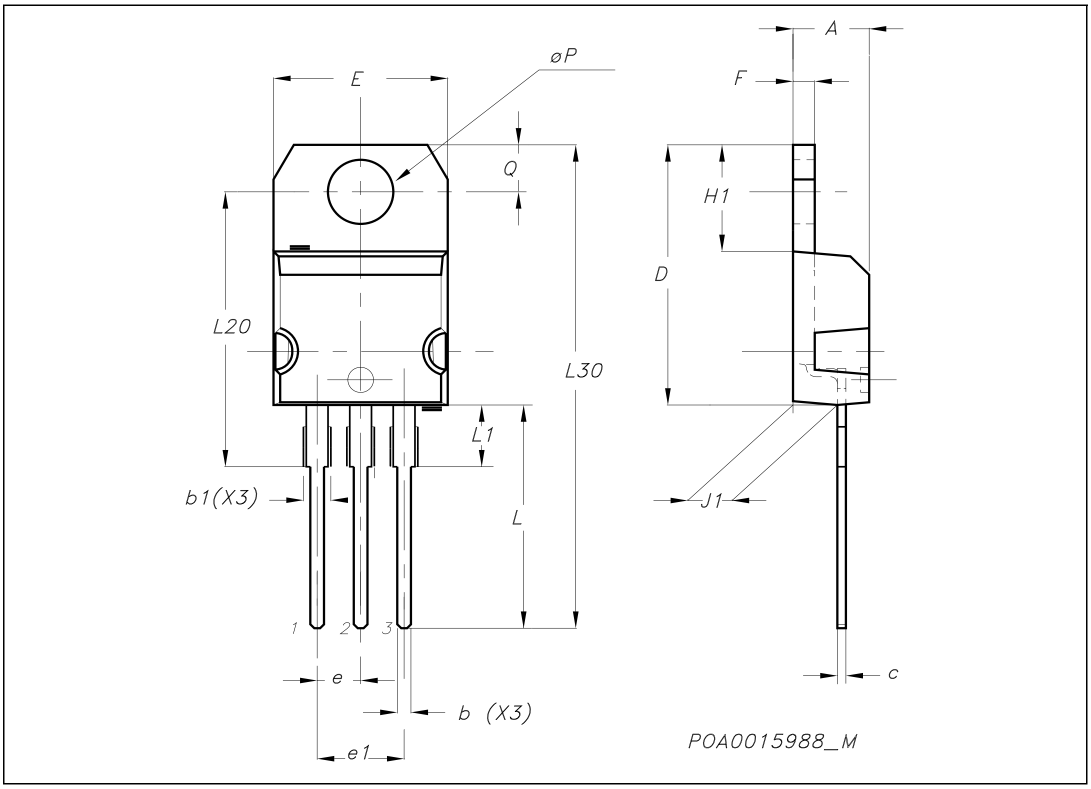


Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



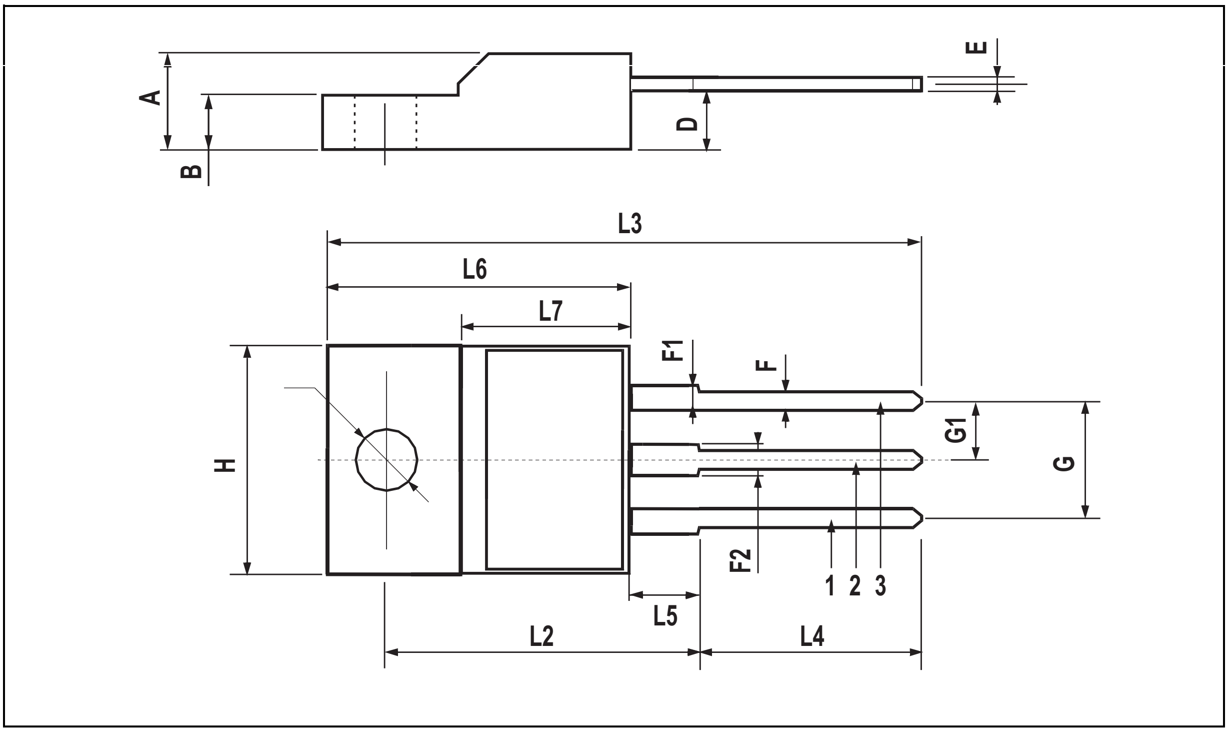
TO-220 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
b	0.61		0.88	0.024		0.034
b1	1.15		1.70	0.045		0.066
c	0.49		0.70	0.019		0.027
D	15.25		15.75	0.60		0.620
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		0.052
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	
øP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



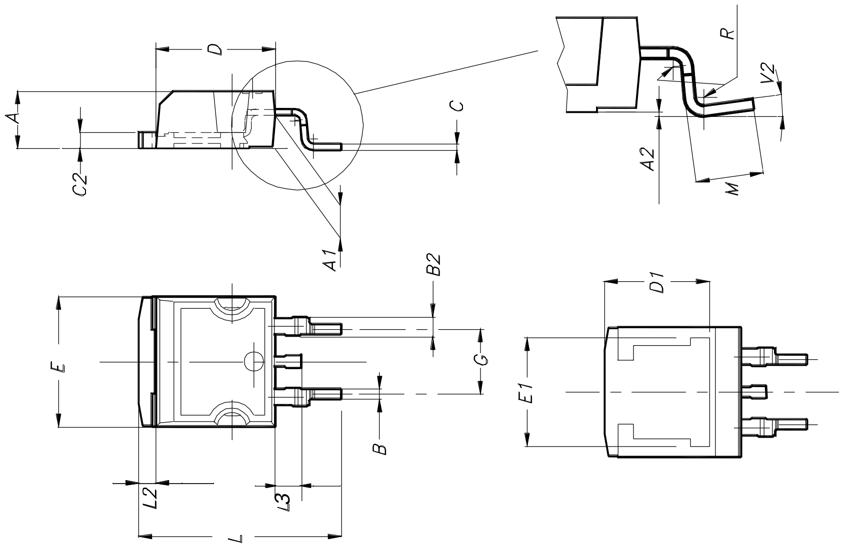
TO-220FP MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		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		1.5	0.045		0.067
F2	1.15		1.5	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	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126

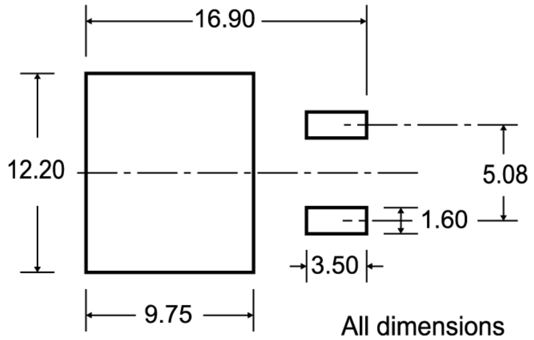


D^{2}PAK MECHANICAL DATA

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	0º		8º			

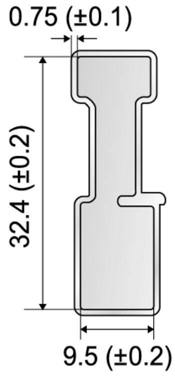


D^{2}PAK FOOTPRINT



All dimensions
are in millimeters

TUBE SHIPMENT (no suffix)*



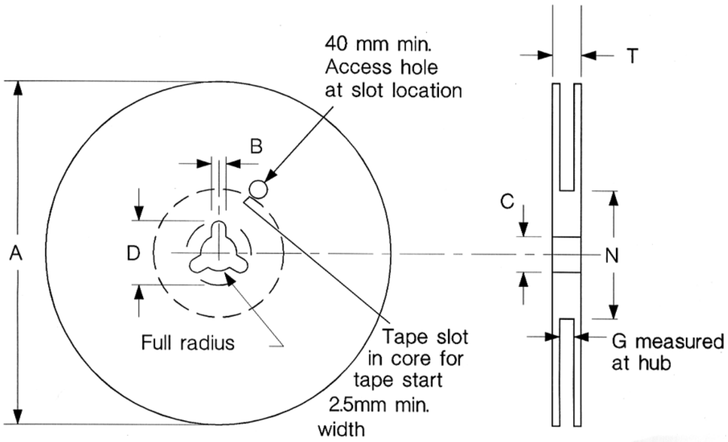
BASE QTY
50

BULK QTY
1000

Tube length 532 (±0.5)

All dimensions
are in millimeters

TAPE AND REEL SHIPMENT (suffix ”T4”)*



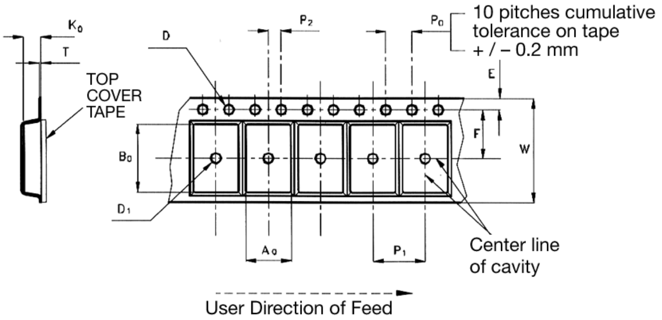
REEL MECHANICAL DATA

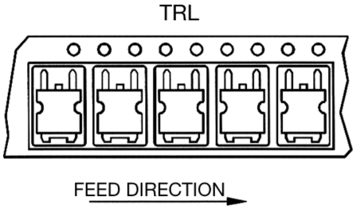
DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

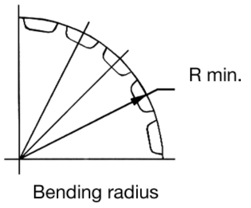
BASE QTY	BULK QTY
1000	1000

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







sales type

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