

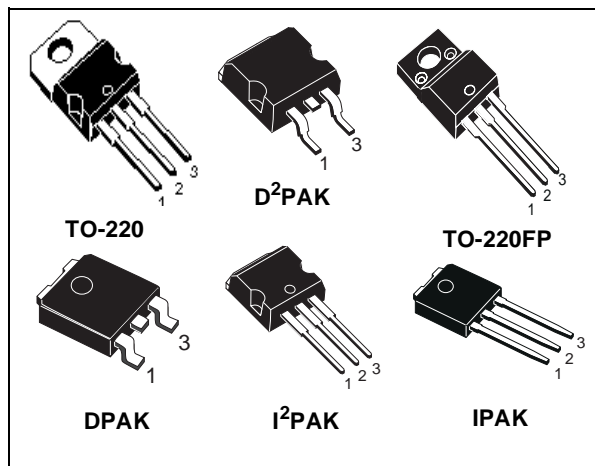


# STP4NK60Z-STP4NK60ZFP-STB4NK60Z-1 STB4NK60Z-STD4NK60Z-STD4NK60Z-1

N-CHANNEL 600V-1.76 $\Omega$ -4A TO-220/FP/DPAK/IPAK/D<sup>2</sup>PAK/I<sup>2</sup>PAK  
Zener-Protected SuperMESH™ Power MOSFET

TYPE	V <sub>DSS</sub>	R <sub>DS(on)</sub>	I <sub>D</sub>	P <sub>w</sub>
STP4NK60Z	600 V	< 2 $\Omega$	4 A	70 W
STP4NK60ZFP	600 V	< 2 $\Omega$	4 A	25 W
STB4NK60Z	600 V	< 2 $\Omega$	4 A	70 W
STB4NK60Z-1	600 V	< 2 $\Omega$	4 A	70 W
STD4NK60Z	600 V	< 2 $\Omega$	4 A	70 W
STD4NK60Z-1	600 V	< 2 $\Omega$	4 A	70 W

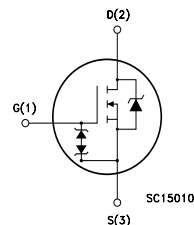
- TYPICAL R<sub>DS(on)</sub> = 1.76  $\Omega$
- EXTREMELY HIGH dv/dt CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY



## DESCRIPTION

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications. Such series complements ST full range of high voltage MOSFETs including revolutionary MDmesh™ products.

## INTERNAL SCHEMATIC DIAGRAM



## APPLICATIONS

- HIGH CURRENT, HIGH SPEED SWITCHING
- IDEAL FOR OFF-LINE POWER SUPPLIES, ADAPTORS AND PFC
- LIGHTING

## ORDERING INFORMATION

SALES TYPE	MARKING	PACKAGE	PACKAGING
STP4NK60Z	P4NK60Z	TO-220	TUBE
STP4NK60ZFP	P4NK60ZFP	TO-220FP	TUBE
STB4NK60ZT4	B4NK60Z	D <sup>2</sup> PAK	TAPE & REEL
STB4NK60Z-1	B4NK60Z	I <sup>2</sup> PAK	TUBE
STD4NK60ZT4	D4NK60Z	DPAK	TAPE & REEL
STD4NK60Z-1	D4NK60Z	IPAK	TUBE

**STP4NK60Z,STP4NK60ZFP,STB4NK60Z,STB4NK60Z-1,STD4NK60Z,STD4NK60Z-1****ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value			Unit
		STP4NK60Z STB4NK60Z STB4NK60Z-1	STP4NK60ZFP	STD4NK60Z STD4NK60Z-1	
$V_{DS}$	Drain-source Voltage ( $V_{GS} = 0$ )	600			V
$V_{DGR}$	Drain-gate Voltage ( $R_{GS} = 20\text{ k}\Omega$ )	600			V
$V_{GS}$	Gate- source Voltage	$\pm 30$			V
$I_D$	Drain Current (continuous) at $T_C = 25^\circ\text{C}$	4	4 (*)	4	A
$I_D$	Drain Current (continuous) at $T_C = 100^\circ\text{C}$	2.5	2.5 (*)	2.5	A
$I_{DM}(\bullet)$	Drain Current (pulsed)	16	16 (*)	16	A
$P_{TOT}$	Total Dissipation at $T_C = 25^\circ\text{C}$	70	25	70	W
	Derating Factor	0.56	0.2	0.56	W/ $^\circ\text{C}$
$V_{ESD(G-S)}$	Gate source ESD(HBM-C=100pF, R=1.5K $\Omega$ )	3000			V
$dv/dt(1)$	Peak Diode Recovery voltage slope	4.5			V/ns
$V_{ISO}$	Insulation Withstand Voltage (DC)	-	2500	-	V
$T_j$ $T_{stg}$	Operating Junction Temperature Storage Temperature	-55 to 150 -55 to 150			$^\circ\text{C}$ $^\circ\text{C}$

(●) Pulse width limited by safe operating area

(1)  $I_{SD} \leq 4\text{A}$ ,  $di/dt \leq 200\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_j \leq T_{JMAX}$ .

(\*) Limited only by maximum temperature allowed

**THERMAL DATA**

		TO-220 D <sup>2</sup> PAK I <sup>2</sup> PAK	TO-220FP	DPAK IPAK	
$R_{thj-case}$	Thermal Resistance Junction-case Max	1.78	5	1.78	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal Resistance Junction-ambient Max	62.5		100	$^\circ\text{C}/\text{W}$
$T_l$	Maximum Lead Temperature For Soldering Purpose	300			$^\circ\text{C}$

**AVALANCHE CHARACTERISTICS**

Symbol	Parameter	Max Value	Unit
$I_{AR}$	Avalanche Current, Repetitive or Not-Repetitive (pulse width limited by $T_j$ max)	4	A
$E_{AS}$	Single Pulse Avalanche Energy (starting $T_j = 25^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	120	mJ

**GATE-SOURCE ZENER DIODE**

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$BV_{GSO}$	Gate-Source Breakdown Voltage	$I_{GS} = \pm 1\text{mA}$ (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 source. 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.

# STP4NK60Z,STP4NK60ZFP,STB4NK60Z,STB4NK60Z-1,STD4NK60Z,STD4NK60Z-1

## ELECTRICAL CHARACTERISTICS (TCASE =25°C UNLESS OTHERWISE SPECIFIED) ON/OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source Breakdown Voltage	$I_D = 1 \text{ mA}$ , $V_{GS} = 0$	600			V
$I_{DSS}$	Zero Gate Voltage Drain Current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating}$ , $T_C = 125^\circ\text{C}$			1 50	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body Leakage Current ( $V_{DS} = 0$ )	$V_{GS} = \pm 20\text{V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}$ , $I_D = 50\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static Drain-source On Resistance	$V_{GS} = 10\text{V}$ , $I_D = 2 \text{ A}$		1.76	2	$\Omega$

## DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs} (1)$	Forward Transconductance	$V_{DS} = 15 \text{ V}$ , $I_D = 2 \text{ A}$		3		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{DS} = 25\text{V}$ , $f = 1 \text{ MHz}$ , $V_{GS} = 0$		510 67 13		pF pF pF
$C_{oss \text{ eq. (3)}}$	Equivalent Output Capacitance	$V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V to } 480\text{V}$		38.5		pF

## SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ $t_r$	Turn-on Delay Time Rise Time	$V_{DD} = 300 \text{ V}$ , $I_D = 2 \text{ A}$ $R_G = 4.7\Omega$ , $V_{GS} = 10 \text{ V}$ (Resistive Load see, Figure 3)		12 9.5		ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total Gate Charge Gate-Source Charge Gate-Drain Charge	$V_{DD} = 480\text{V}$ , $I_D = 4 \text{ A}$ , $V_{GS} = 10\text{V}$		18.8 3.8 9.8	26	nC nC nC

## SWITCHING OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$ $t_f$	Turn-off Delay Time Fall Time	$V_{DD} = 300 \text{ V}$ , $I_D = 2 \text{ A}$ $R_G = 4.7\Omega$ , $V_{GS} = 10 \text{ V}$ (Resistive Load see, Figure 3)		29 16.5		ns ns
$t_r(V_{off})$ $t_f$ $t_c$	Off-voltage Rise Time Fall Time Cross-over Time	$V_{DD} = 480\text{V}$ , $I_D = 4\text{A}$ , $R_G = 4.7\Omega$ , $V_{GS} = 10\text{V}$ (Inductive Load see, Figure 5)		12 12 19.5		ns ns ns

## SOURCE DRAIN DIODE

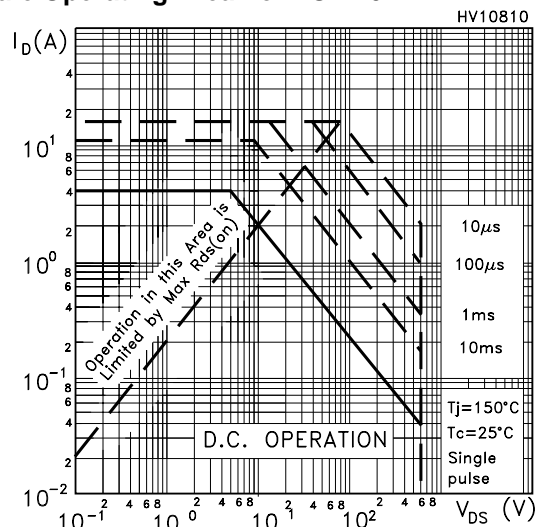
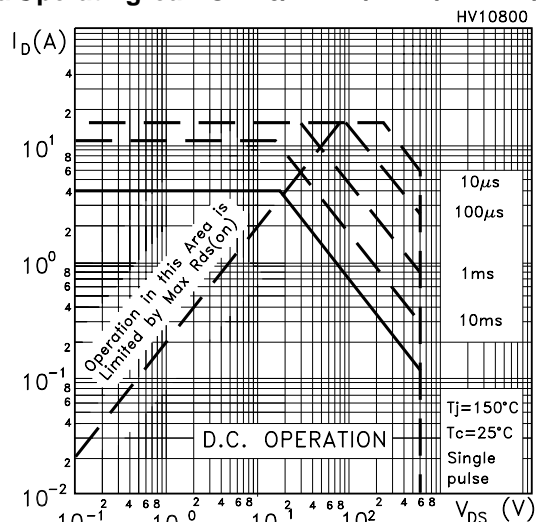
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$I_{SD}$ $I_{SDM} (2)$	Source-drain Current Source-drain Current (pulsed)				4 16	A A
$V_{SD} (1)$	Forward On Voltage	$I_{SD} = 4 \text{ A}$ , $V_{GS} = 0$			1.6	V
$t_{rr}$ $Q_{rr}$ $I_{RRM}$	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 4 \text{ A}$ , $di/dt = 100\text{A}/\mu\text{s}$ $V_{DD} = 24\text{V}$ , $T_J = 150^\circ\text{C}$ (see test circuit, Figure 5)		400 1700 8.5		ns nC A

Note: 1. Pulsed: Pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5 %.

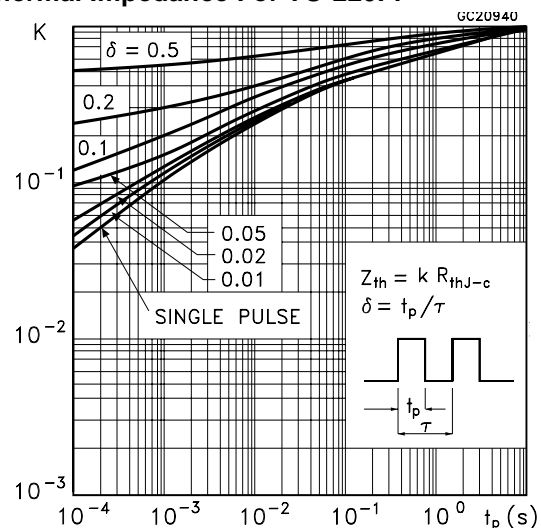
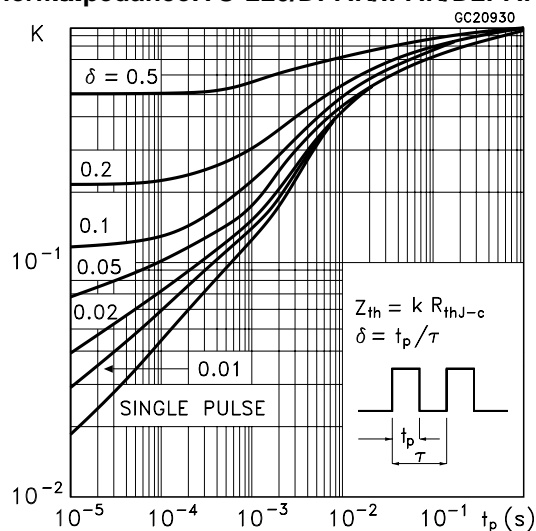
2. Pulse width limited by safe operating area.

3.  $C_{oss \text{ eq.}}$  is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$ .

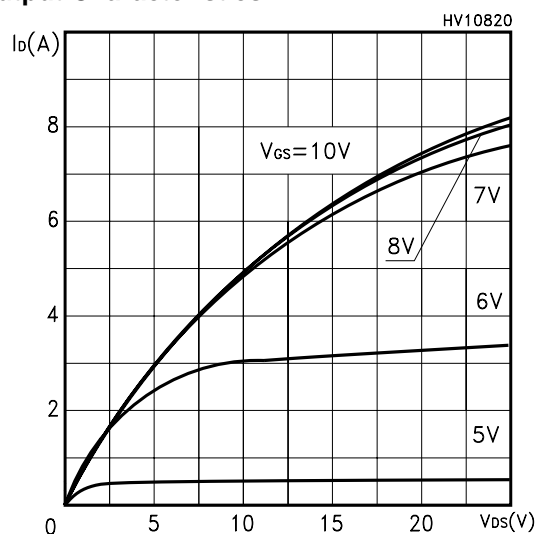
# Safe Operating Area: TO-220/DPAK/IPAK/D2PAK/I2PAK Safe Operating Area For TO-220FP



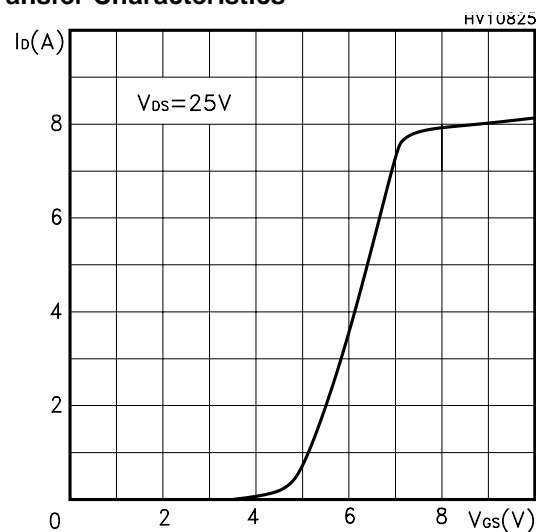
## Thermal Impedance: TO-220/DPAK/IPAK/D2PAK/I2PAK Thermal Impedance For TO-220FP



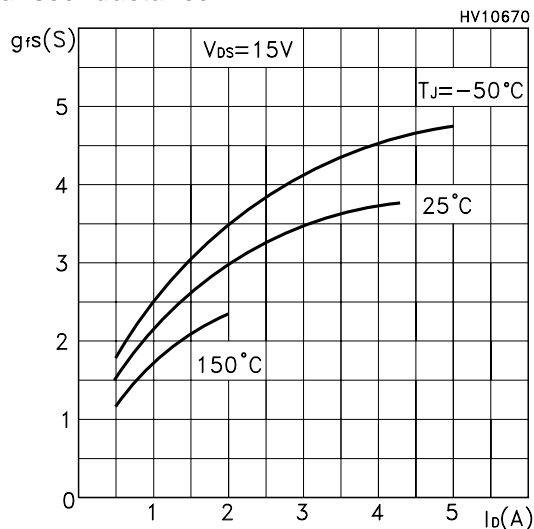
## Output Characteristics



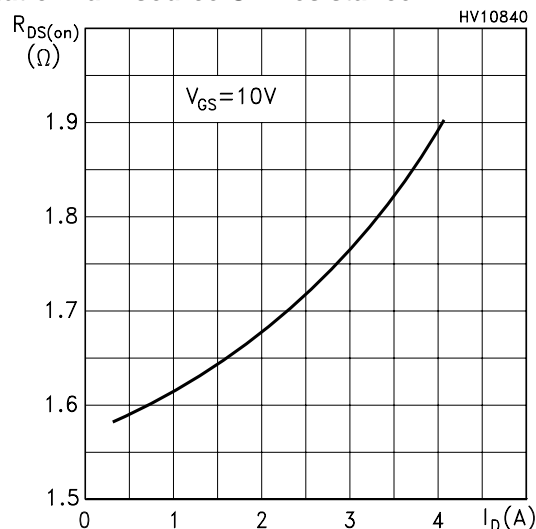
## Transfer Characteristics



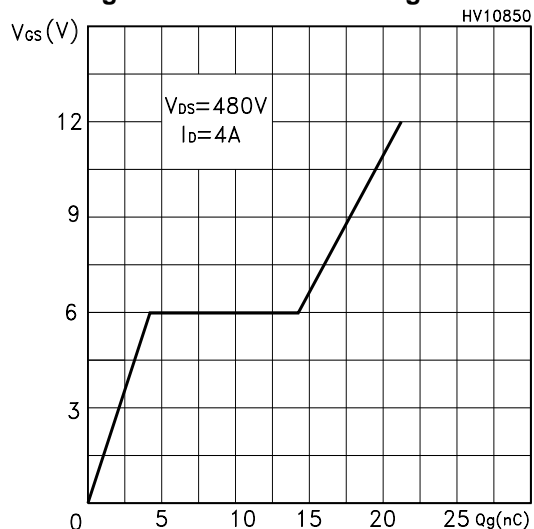
Transconductance



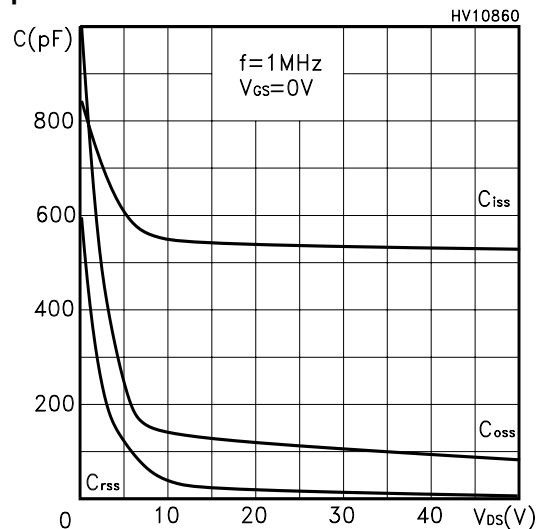
Static Drain-source On Resistance



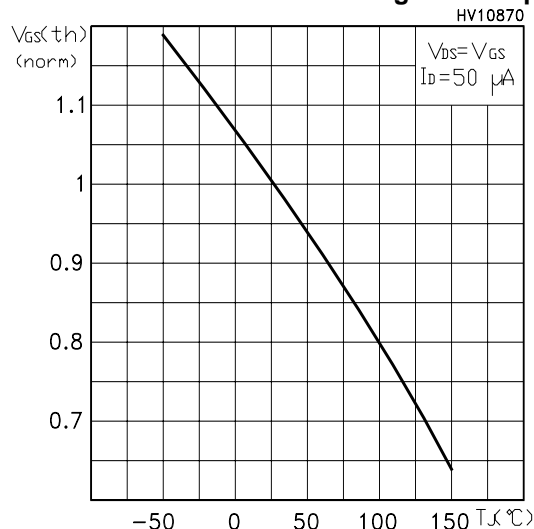
Gate Charge vs Gate-source Voltage



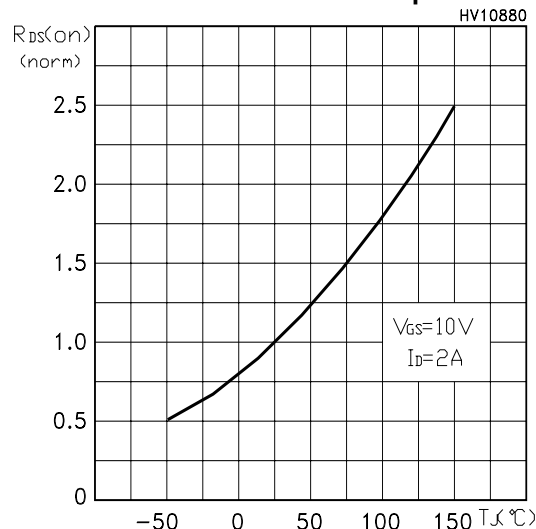
Capacitance Variations



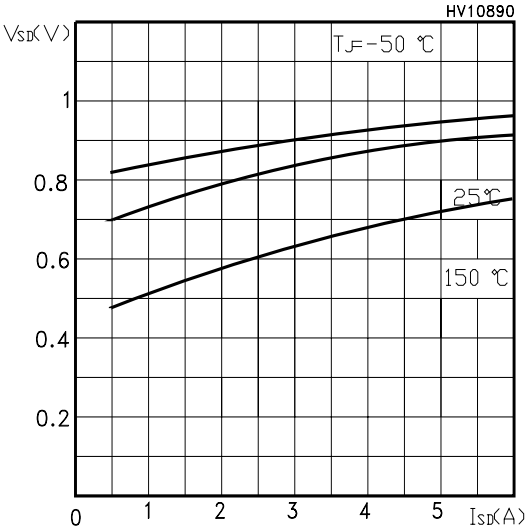
Normalized Gate Threshold Voltage vs Temp.



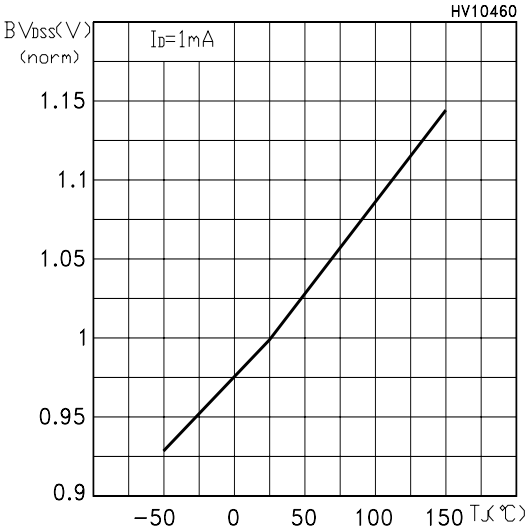
Normalized On Resistance vs Temperature



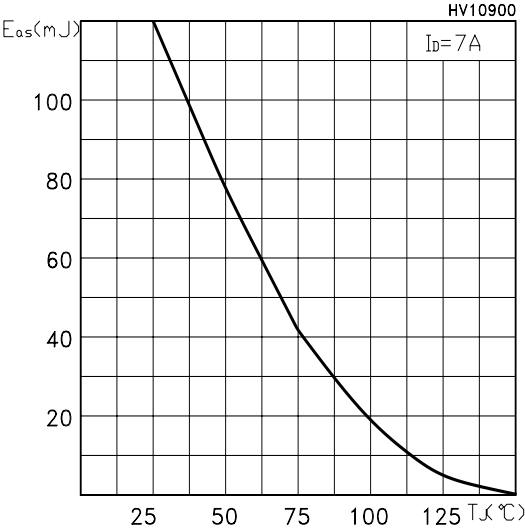
Source-drain Diode Forward Characteristics



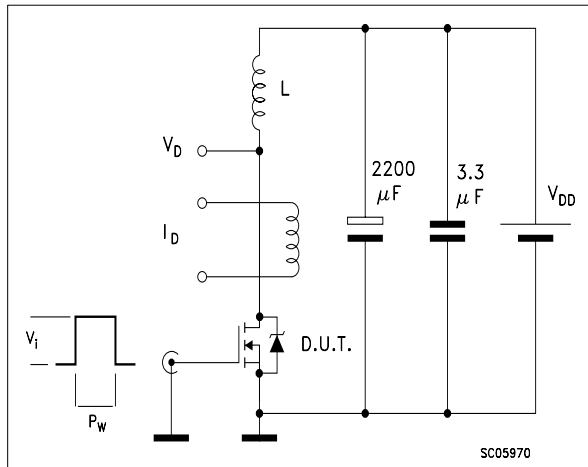
Normalized BVDSS vs Temperature



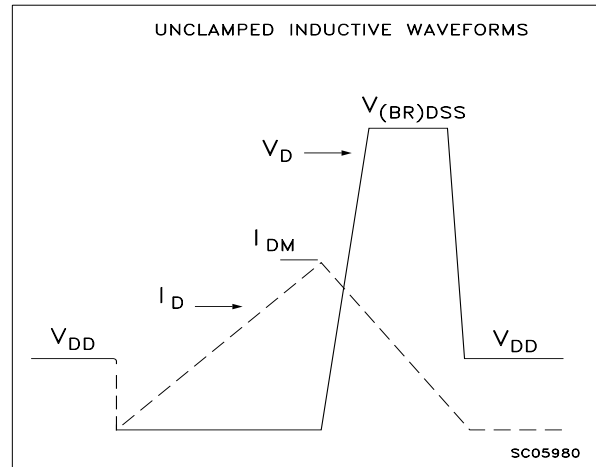
Maximum Avalanche Energy vs Temperature



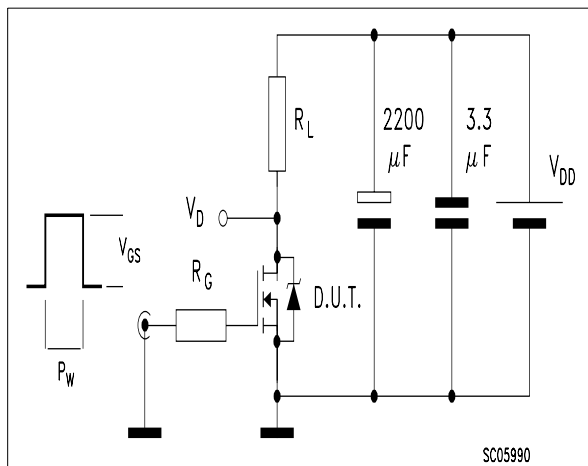
**Fig. 1: Unclamped Inductive Load Test Circuit**



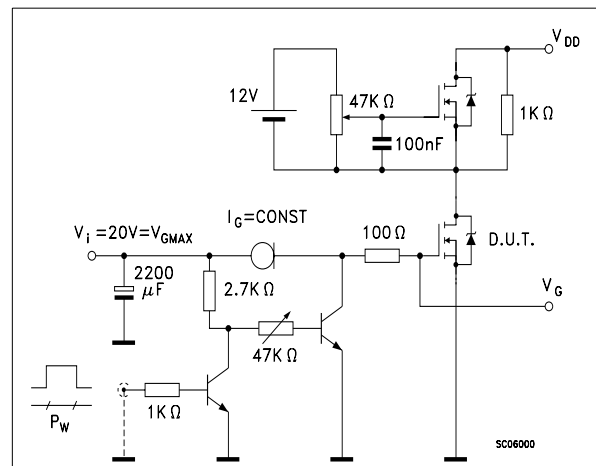
**Fig. 2: Unclamped Inductive Waveform**



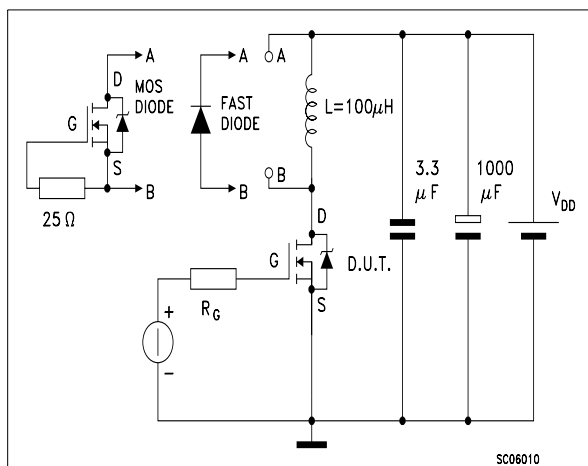
**Fig. 3: Switching Times Test Circuit For Resistive Load**



**Fig. 4: Gate Charge test Circuit**

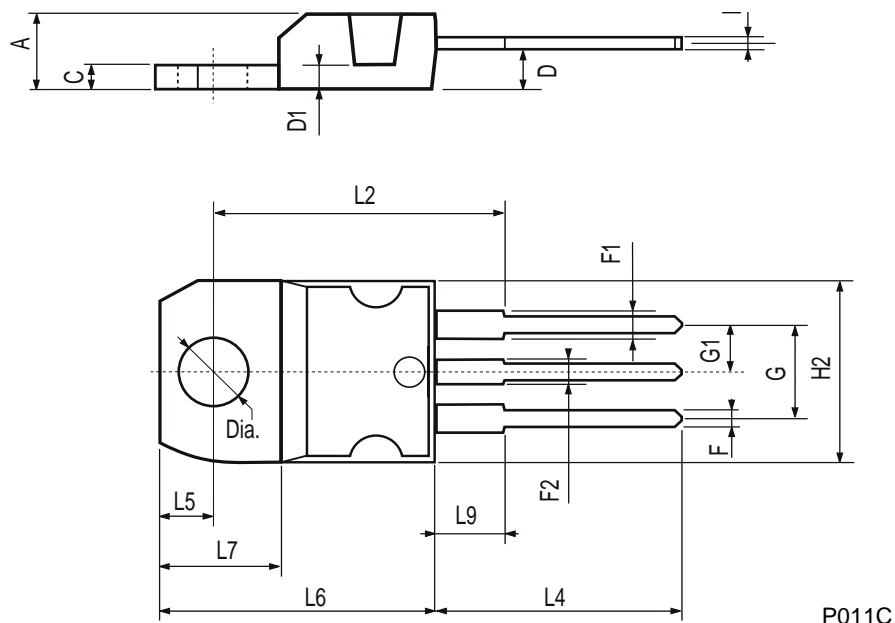


**Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times**



TO-220 MECHANICAL DATA

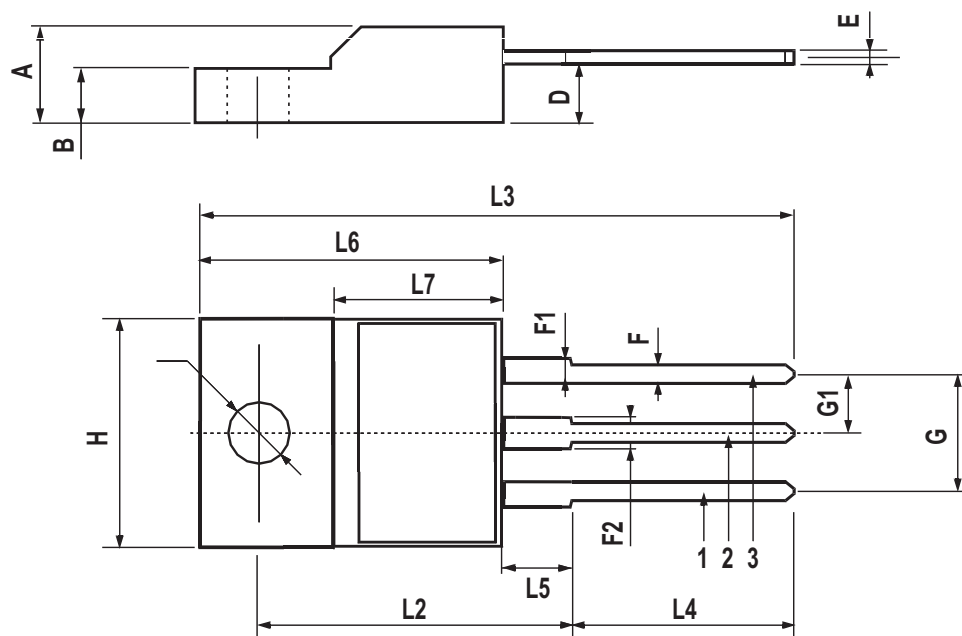
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106
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





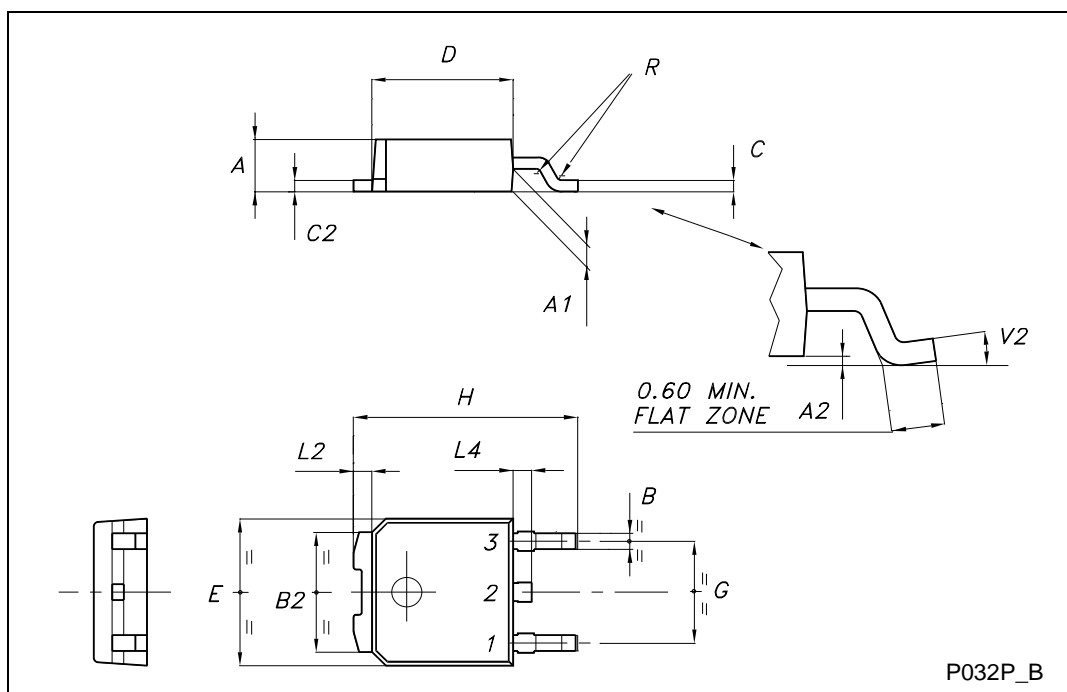
## TO-220FP MECHANICAL DATA

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		1.5	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



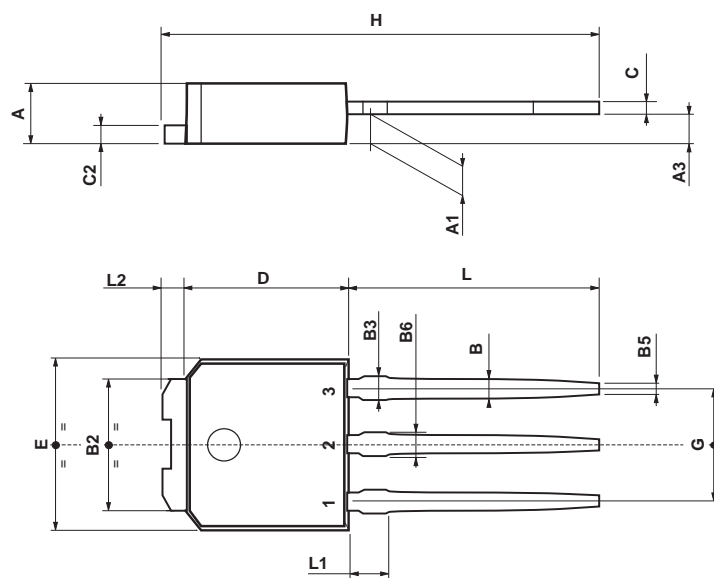
TO-252 (DPAK) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.20		2.40	0.087		0.094
A1	0.90		1.10	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.90	0.025		0.035
B2	5.20		5.40	0.204		0.213
C	0.45		0.60	0.018		0.024
C2	0.48		0.60	0.019		0.024
D	6.00		6.20	0.236		0.244
E	6.40		6.60	0.252		0.260
G	4.40		4.60	0.173		0.181
H	9.35		10.10	0.368		0.398
L2		0.8			0.031	
L4	0.60		1.00	0.024		0.039
V2	0°		8°	0°		0°



TO-251 (IPAK) MECHANICAL DATA

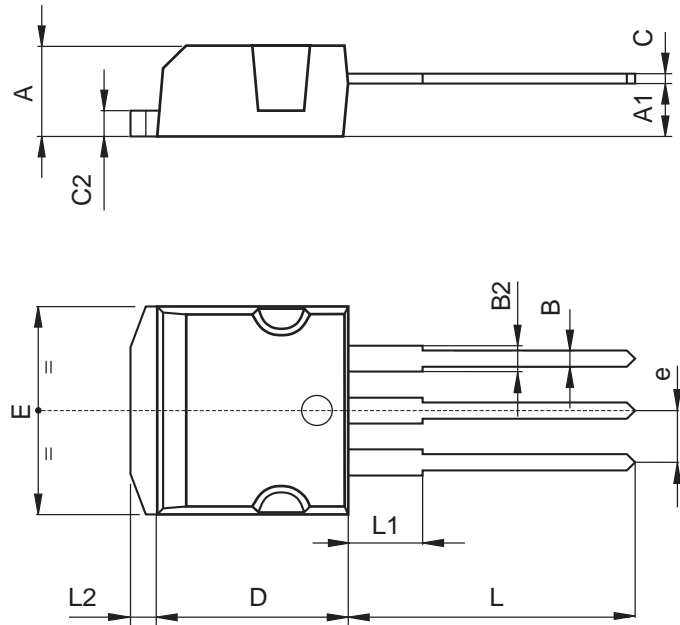
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A3	0.7		1.3	0.027		0.051
B	0.64		0.9	0.025		0.031
B2	5.2		5.4	0.204		0.212
B3			0.85			0.033
B5		0.3			0.012	
B6			0.95			0.037
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
E	6.4		6.6	0.252		0.260
G	4.4		4.6	0.173		0.181
H	15.9		16.3	0.626		0.641
L	9		9.4	0.354		0.370
L1	0.8		1.2	0.031		0.047
L2		0.8	1		0.031	0.039



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

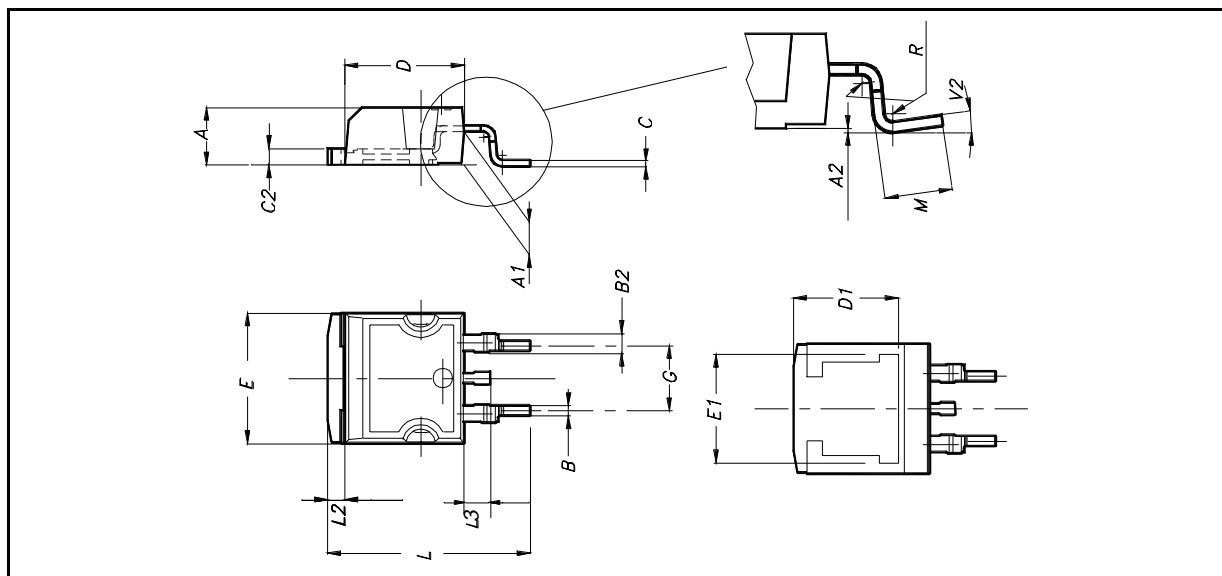
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
e	2.4		2.7	0.094		0.106
E	10		10.4	0.393		0.409
L	13.1		13.6	0.515		0.531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



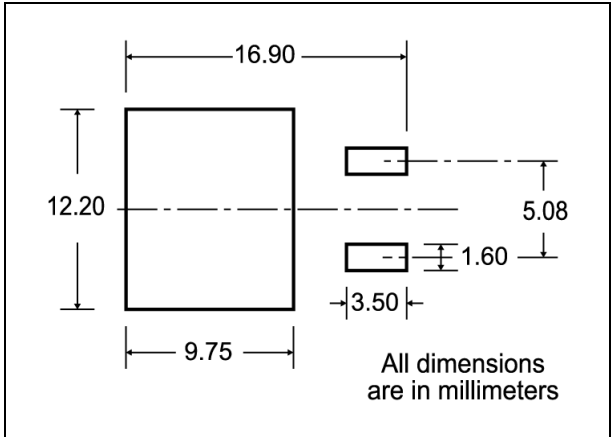
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D<sup>2</sup>PAK MECHANICAL DATA

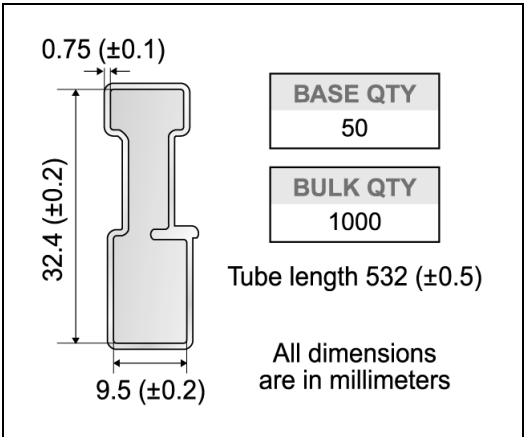
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334	
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°			



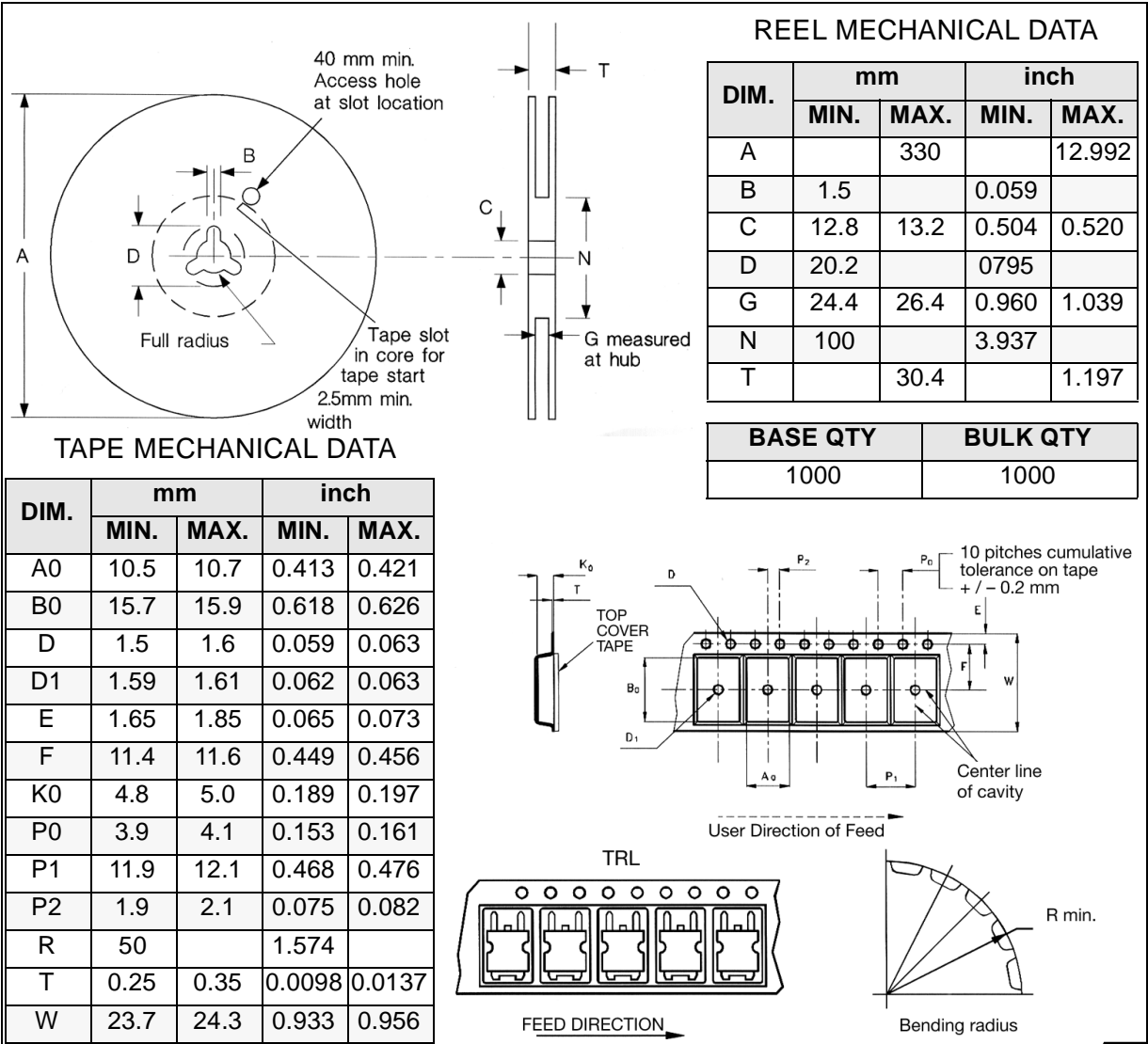
# D<sup>2</sup>PAK FOOTPRINT



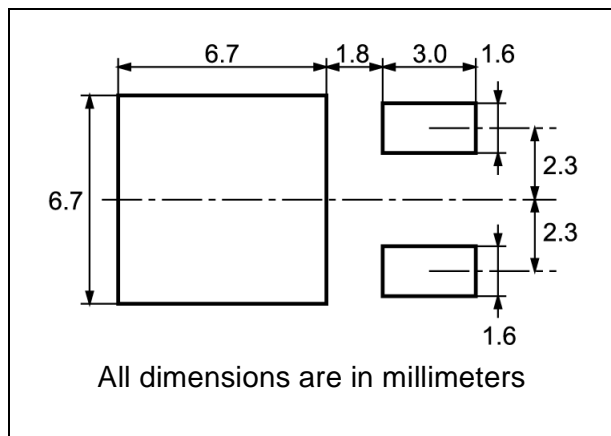
# TUBE SHIPMENT (no suffix)\*



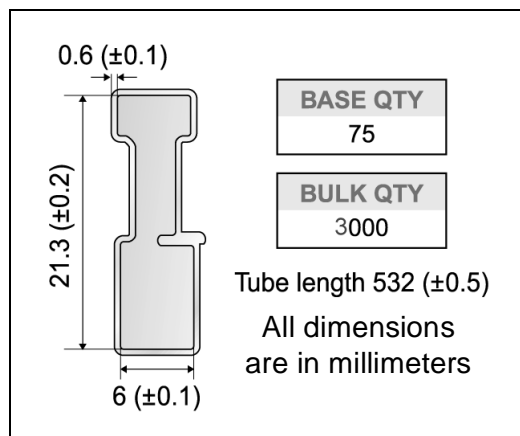
# TAPE AND REEL SHIPMENT (suffix "T4")\*



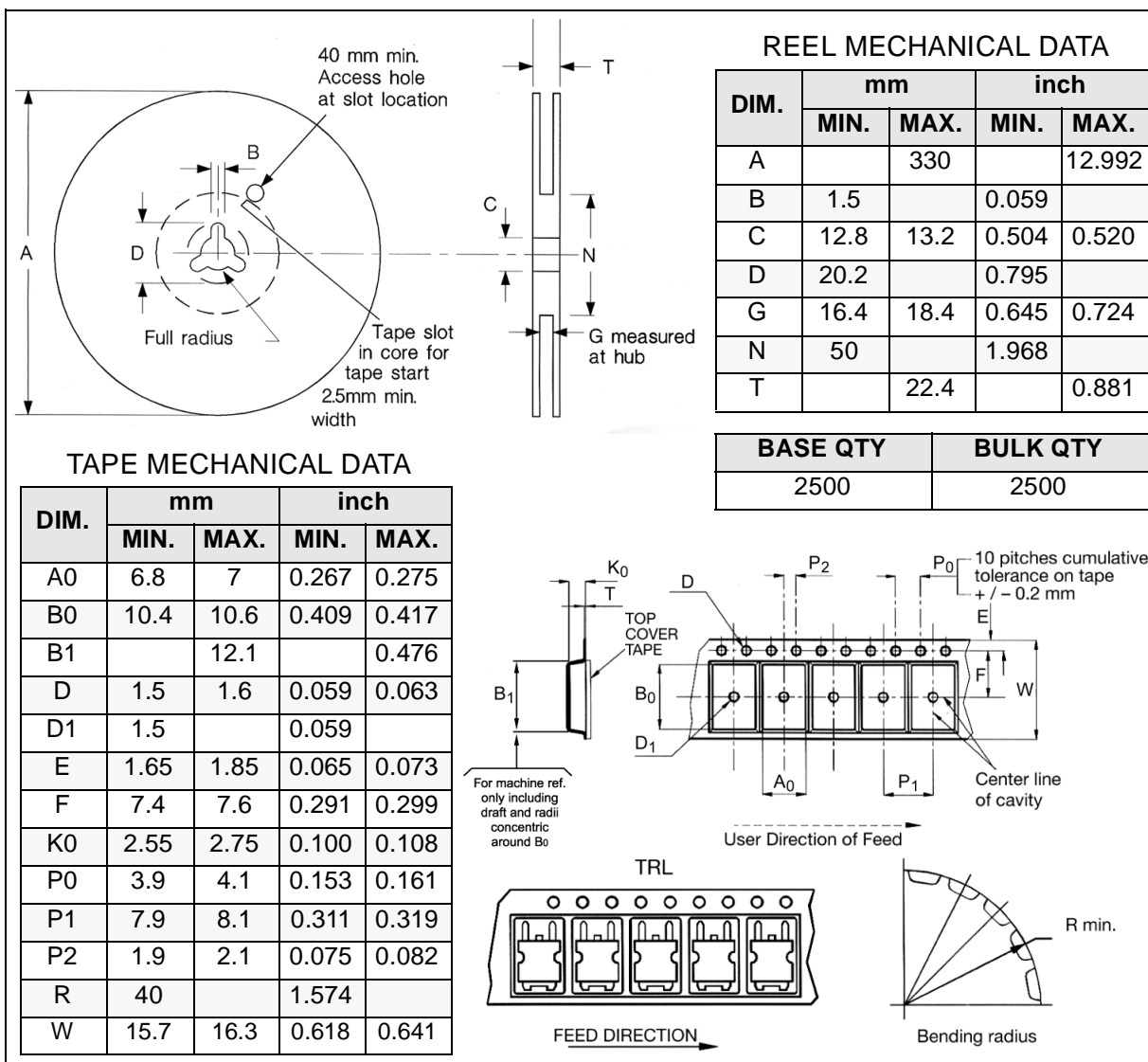
## DPAK FOOTPRINT



## TUBE SHIPMENT (no suffix)\*



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



\* on sales type



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