

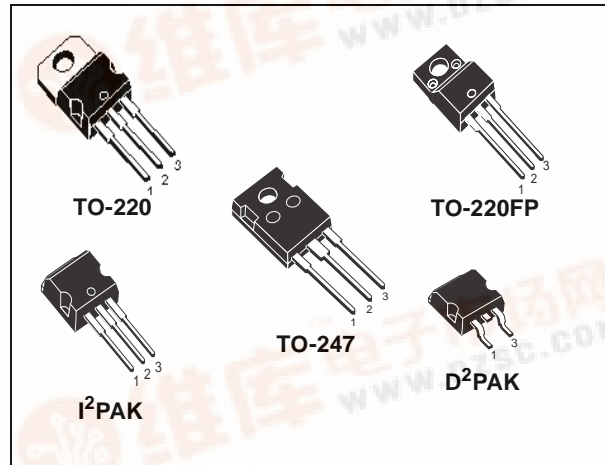


STP13NK60Z/FP, STB13NK60Z STB13NK60Z-1, STW13NK60Z

N-CHANNEL 600V-0.48Ω-13A TO-220/FP/D²PAK/I²PAK/TO-247
Zener-Protected SuperMESH™ Power MOSFET

TYPE	V _{DSS}	R _{DS(on)}	I _D	P _w
STP13NK60Z	600 V	< 0.55 Ω	13 A	150 W
STP13NK60ZFP	600 V	< 0.55 Ω	13 A	35 W
STB13NK60Z	600 V	< 0.55 Ω	13 A	150 W
STB13NK60Z-1	600 V	< 0.55 Ω	13 A	150 W
STW13NK60Z	600 V	< 0.55 Ω	13 A	150 W

- TYPICAL R_{DS(on)} = 0.48 Ω
- EXTREMELY HIGH dv/dt CAPABILITY
- 100% AVALANCHE TESTED
- GATE CHARGE MINIMIZED
- VERY LOW INTRINSIC CAPACITANCES
- VERY GOOD MANUFACTURING REPEATABILITY



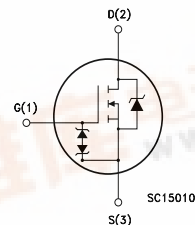
DESCRIPTION

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.

APPLICATIONS

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

INTERNAL SCHEMATIC DIAGRAM



ORDERING INFORMATION

SALES TYPE	MARKING	PACKAGE	PACKAGING
STP13NK60Z	P13NK60Z	TO-220	TUBE
STP13NK60ZFP	P13NK60ZFP	TO-220FP	TUBE
STB13NK60ZT4	B13NK60Z	D ² PAK	TAPE & REEL
STB13NK60Z	B13NK60Z	D ² PAK	TUBE (ONLY UNDER REQUEST)
STB13NK60Z-1	B13NK60Z	I ² PAK	TUBE
STW13NK60Z	W13NK60Z	TO-247	TUBE



STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value		Unit
		STP13NK60Z STB13NK60Z/-1 STW13NK60Z	STP13NK60ZFP	
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 (continuous) at T _C = 25°C	13	13 (*)	A
I _D	Drain Current (continuous) at T _C = 100°C	8.2	8.2 (*)	A
I _{DM} (•)	Drain Current (pulsed)	52	52 (*)	A
P _{TOT}	Total Dissipation at T _C = 25°C	150	35	W
	Derating Factor	1.20	0.27	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	4.5		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} ≤ 13 A, di/dt ≤ 200A/μs, V_{DD} ≤ V_{(BR)DSS}, T_j ≤ T_{JMAX}.
 (*) Limited only by maximum temperature allowed

THERMAL DATA

		TO-220 I ² PAK TO-247	D ² PAK	TO-220FP	
R _{thj-case}	Thermal Resistance Junction-case Max	0.83		3.6	°C/W
R _{thj-pcb}	Thermal Resistance Junction-pcb Max (#)		60		°C/W
R _{thj-amb}	Thermal Resistance Junction-ambient Max	62.5			°C/W
T _I	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)	10	A
E _{AS}	Single Pulse Avalanche Energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	400	mJ

GATE-SOURCE ZENER DIODE

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

(#) When mounted on minimum Footprint

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.

STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

ELECTRICAL CHARACTERISTICS ($T_{CASE} = 25^{\circ}C$ 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 ($V_{GS} = 0$)	$V_{DS} = \text{Max Rating}$ $V_{DS} = \text{Max Rating}, T_C = 125^{\circ}C$			1 50	μA μA
I_{GSS}	Gate-body Leakage Current ($V_{DS} = 0$)	$V_{GS} = \pm 20 \text{ V}$			± 10	μA
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 100 \mu A$	3	3.75	4.5	V
$R_{DS(on)}$	Static Drain-source On Resistance	$V_{GS} = 10 \text{ V}, I_D = 5 \text{ A}$		0.48	0.55	Ω

DYNAMIC

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$g_{fs} (1)$	Forward Transconductance	$V_{DS} = 8 \text{ V}, I_D = 5 \text{ A}$		11		S
C_{iss} C_{oss} C_{rss}	Input Capacitance Output Capacitance Reverse Transfer Capacitance	$V_{DS} = 25 \text{ V}, f = 1 \text{ MHz}, V_{GS} = 0$		2030 210 48		pF pF pF
$C_{oss \text{ eq.}} (3)$	Equivalent Output Capacitance	$V_{GS} = 0V, V_{DS} = 0V \text{ to } 480 \text{ V}$		125		pF

SWITCHING ON

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on Delay Time Rise Time	$V_{DD} = 300 \text{ V}, I_D = 5 \text{ A}$ $R_G = 4.7\Omega, V_{GS} = 10 \text{ V}$ (Resistive Load see, Figure 3)		22 14		ns ns
Q_g Q_{gs} Q_{gd}	Total Gate Charge Gate-Source Charge Gate-Drain Charge	$V_{DD} = 480 \text{ V}, I_D = 10 \text{ A},$ $V_{GS} = 10 \text{ V}$		66 11 33	92	nC nC nC

SWITCHING OFF

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$ t_f	Turn-off Delay Time Fall Time	$V_{DD} = 300 \text{ V}, I_D = 5 \text{ A}$ $R_G = 4.7\Omega, V_{GS} = 10 \text{ V}$ (Resistive Load see, Figure 3)		61 12		ns ns
$t_r(V_{off})$ t_f t_c	Off-voltage Rise Time Fall Time Cross-over Time	$V_{DD} = 480V, I_D = 10 \text{ A},$ $R_G = 4.7\Omega, V_{GS} = 10V$ (Inductive Load see, Figure 5)		10 9 20		ns ns ns

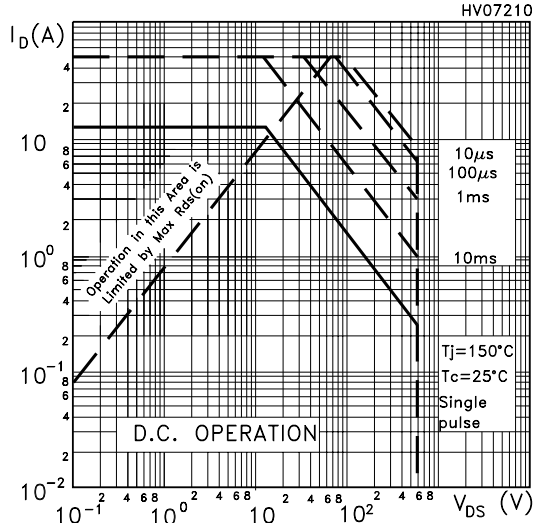
SOURCE DRAIN DIODE

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{SD} $I_{SDM} (2)$	Source-drain Current Source-drain Current (pulsed)				10 40	A A
$V_{SD} (1)$	Forward On Voltage	$I_{SD} = 10 \text{ A}, V_{GS} = 0$			1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse Recovery Time Reverse Recovery Charge Reverse Recovery Current	$I_{SD} = 10 \text{ A}, di/dt = 100 \text{ A}/\mu s$ $V_{DD} = 35 \text{ V}, T_j = 150^{\circ}C$ (see test circuit, Figure 5)		570 4.5 16		ns μC A

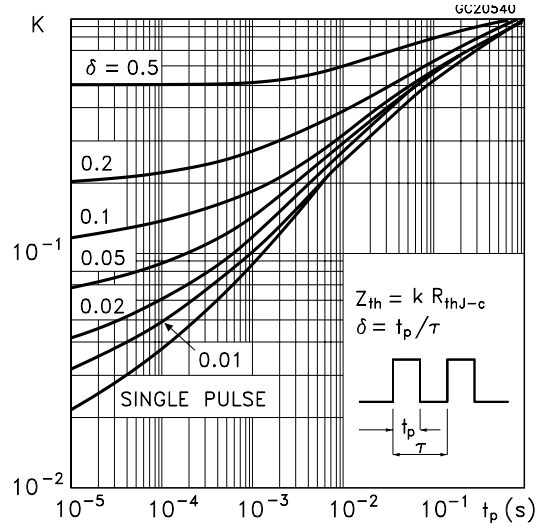
- Note: 1. Pulsed: Pulse duration = 300 μs , duty cycle 1.5 %.
2. Pulse width limited by safe operating area.
3. $C_{oss \text{ eq.}}$ is defined as a constant equivalent capacitance giving the same charging time as C_{oss} when V_{DS} increases from 0 to 80% V_{DSS} .

STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

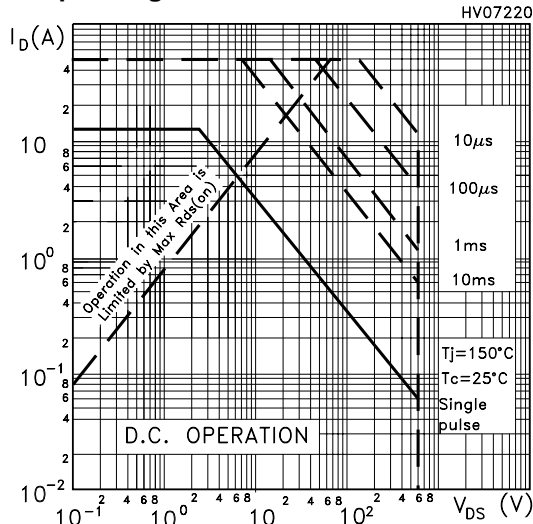
Safe Operating Area For TO-220/D²PAK/I²PAK



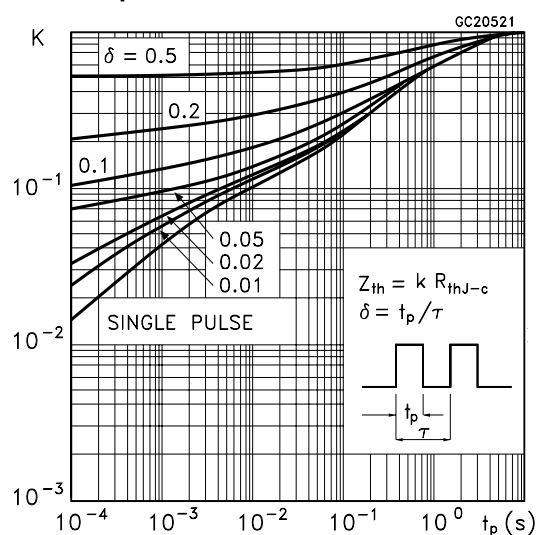
Thermal Impedance For TO-220/D²PAK/I²PAK



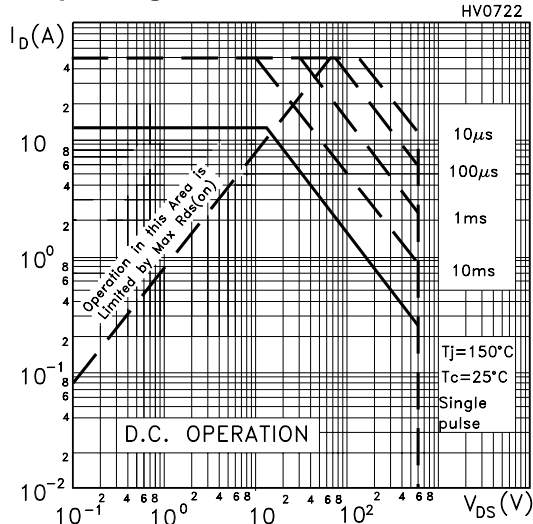
Safe Operating Area For TO-220FP



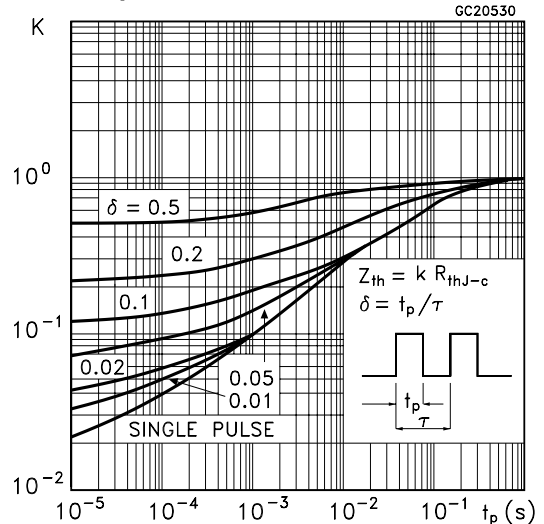
Thermal Impedance For TO-220FP



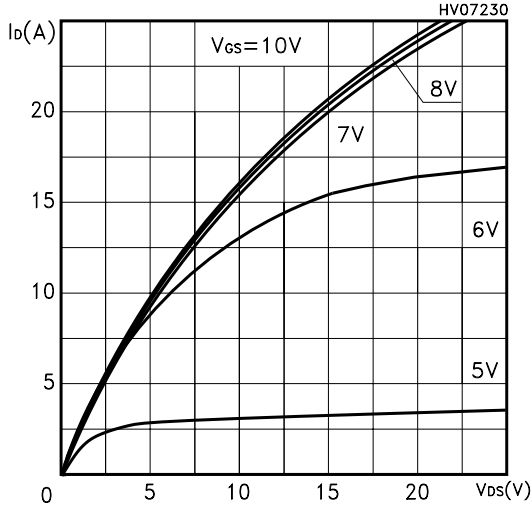
Safe Operating Area For TO-247



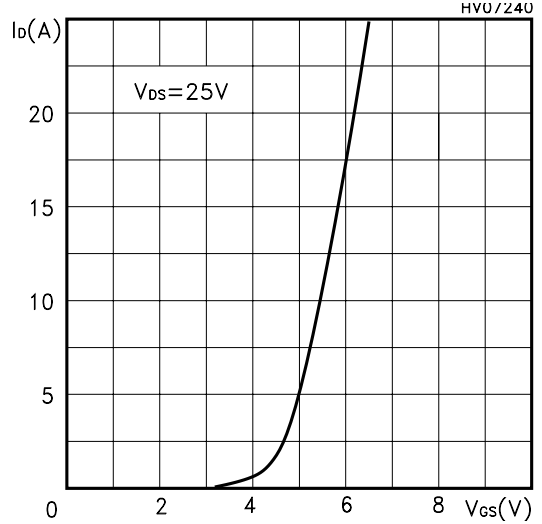
Thermal Impedance For TO-247



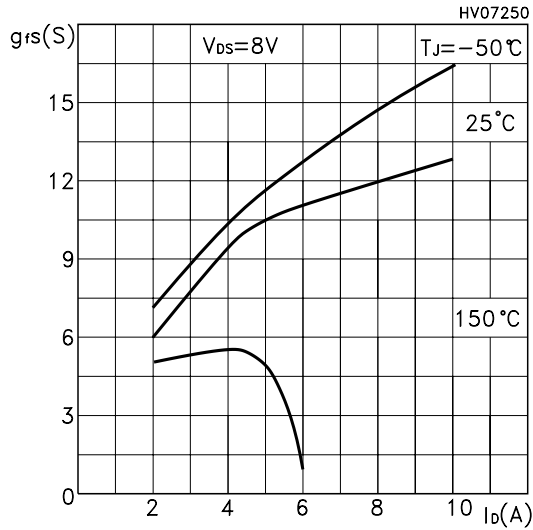
Output Characteristics



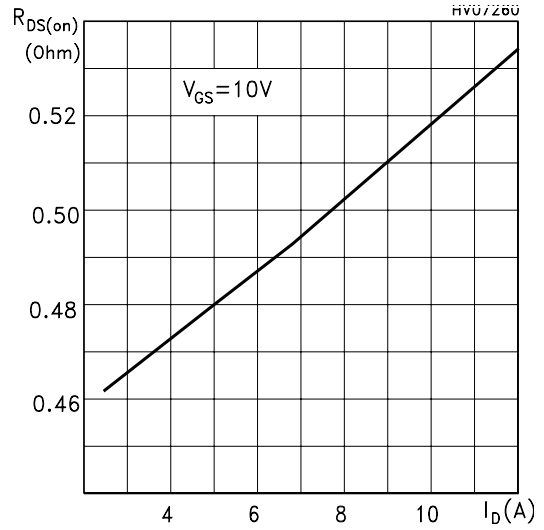
Transfer Characteristics



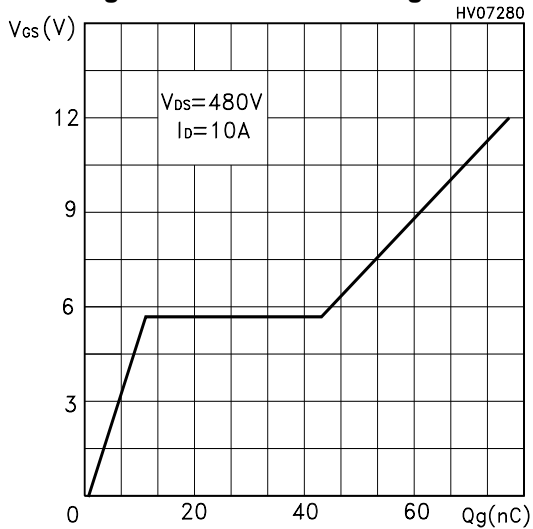
Transconductance



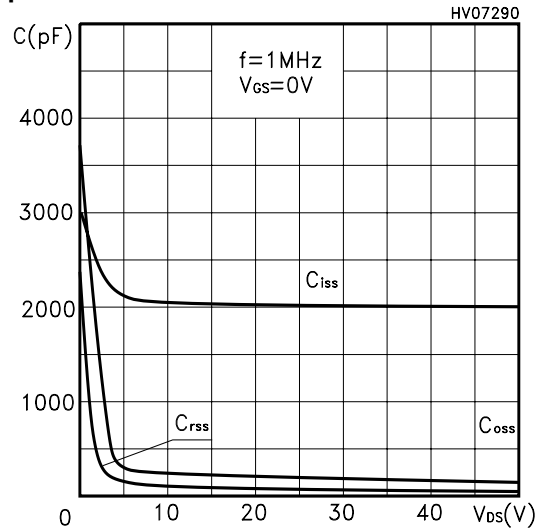
Static Drain-source On Resistance



Gate Charge vs Gate-source Voltage

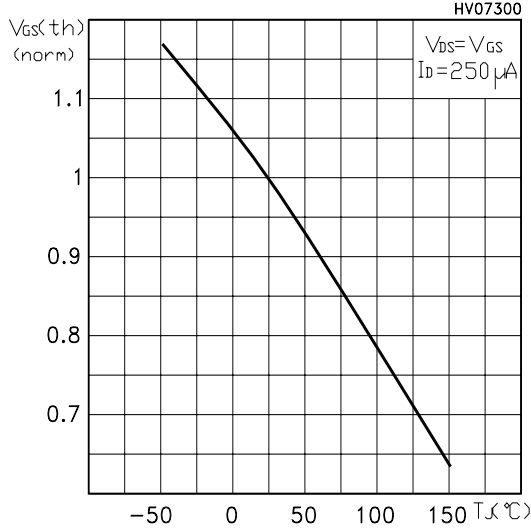


Capacitance Variations

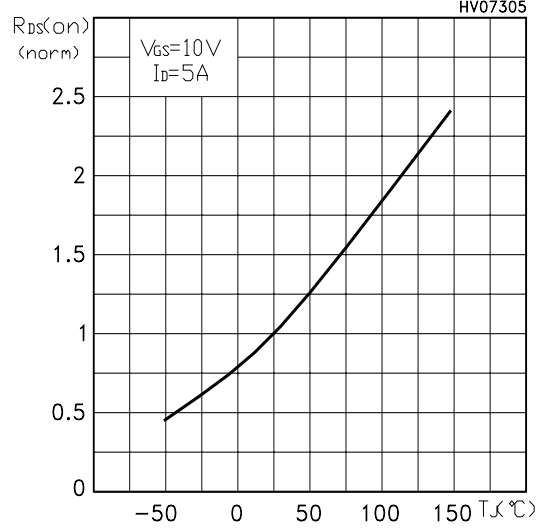


STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

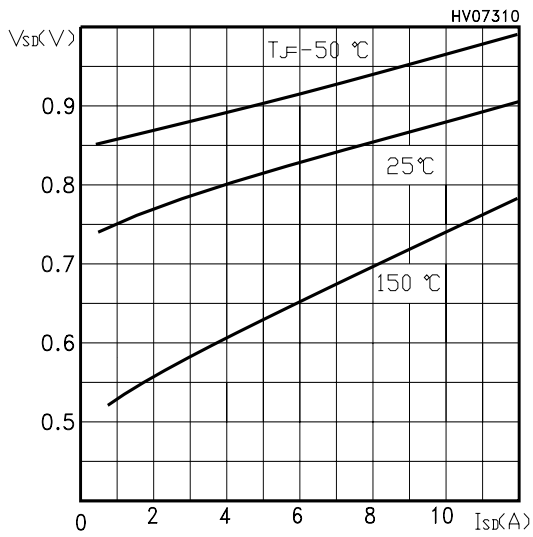
Normalized Gate Threshold Voltage vs Temp.



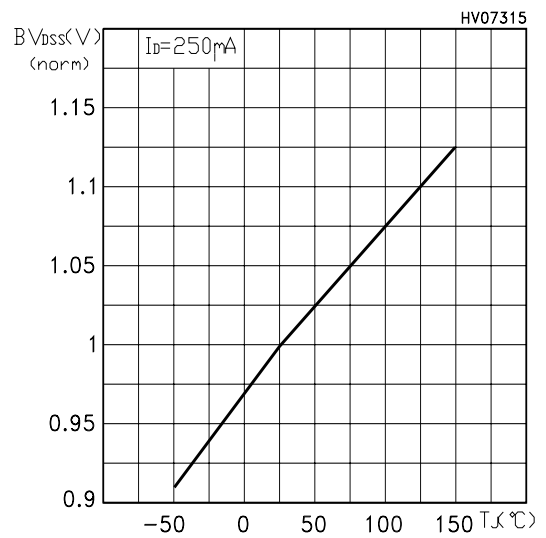
Normalized On Resistance vs Temperature



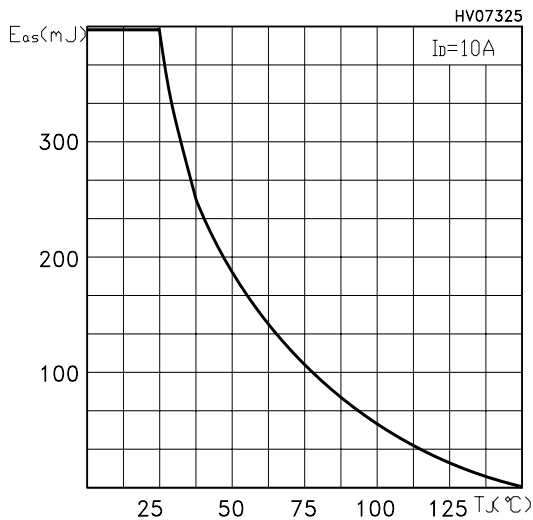
Source-drain Diode Forward Characteristics



Normalized BVDSS vs Temperature



Maximum Avalanche Energy vs Temperature



STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

Fig. 1: Unclamped Inductive Load Test Circuit

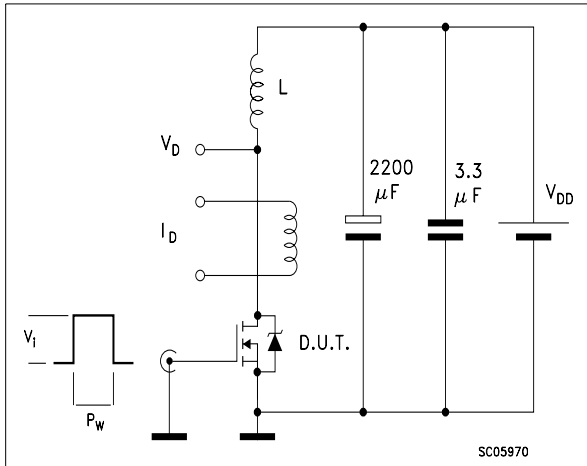


Fig. 2: Unclamped Inductive Waveform

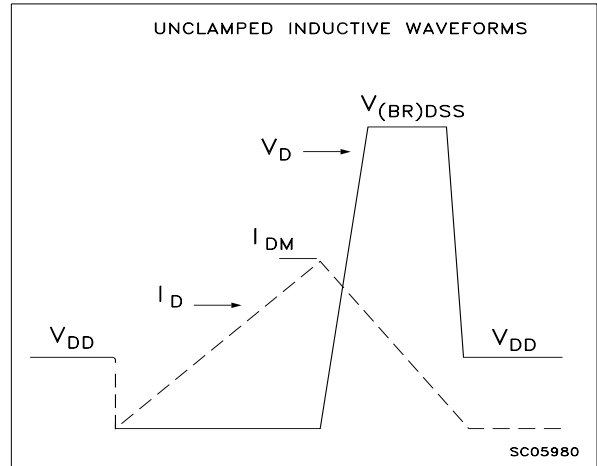


Fig. 3: Switching Times Test Circuit For Resistive Load

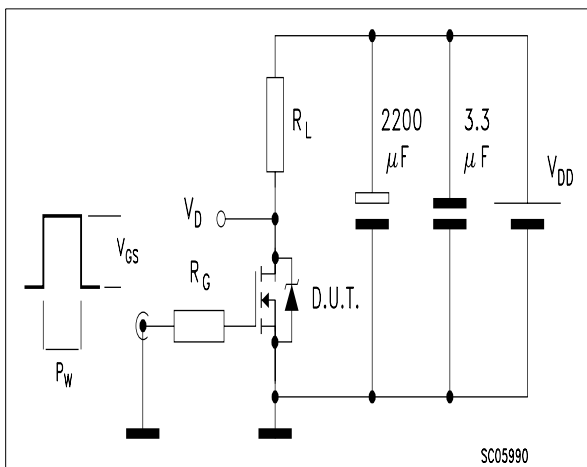


Fig. 4: Gate Charge test Circuit

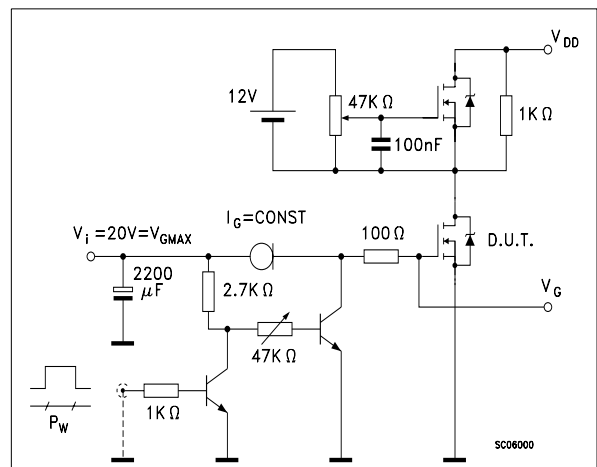
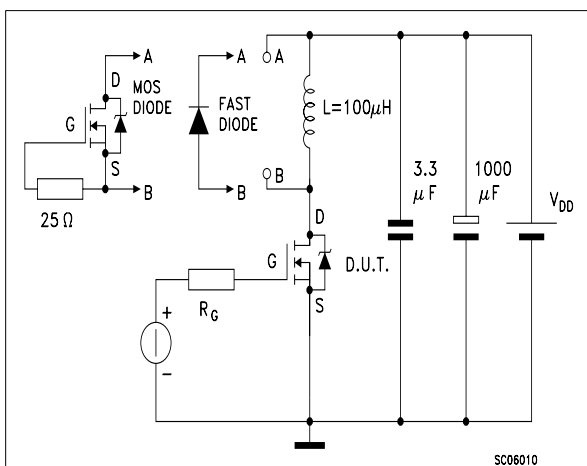


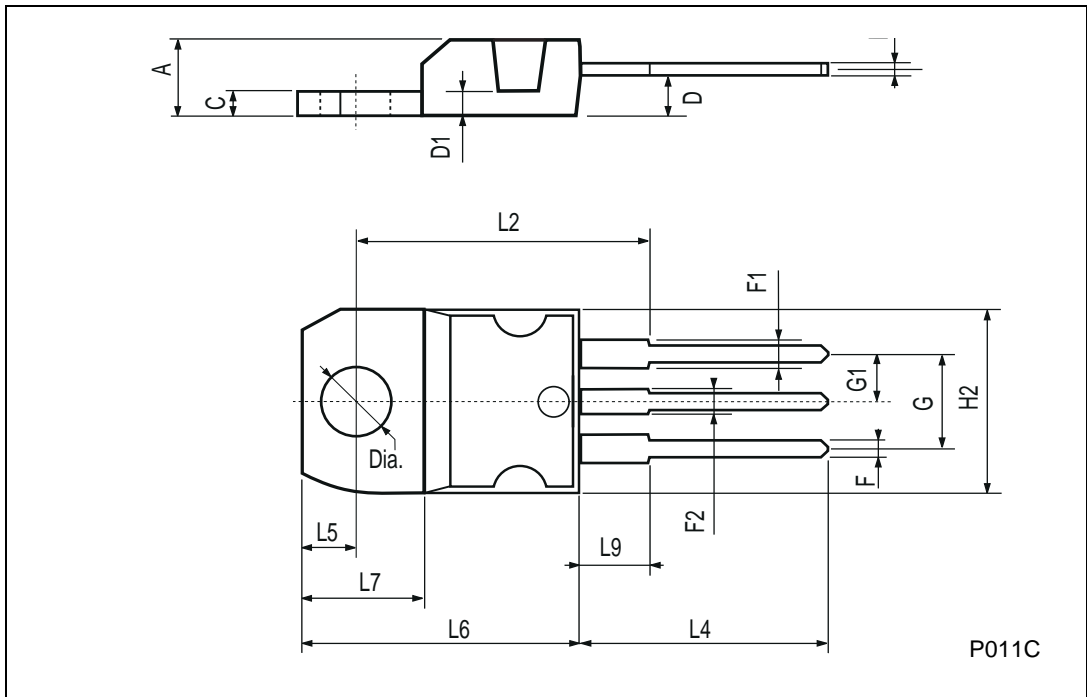
Fig. 5: Test Circuit For Inductive Load Switching And Diode Recovery Times



STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

TO-220 MECHANICAL DATA

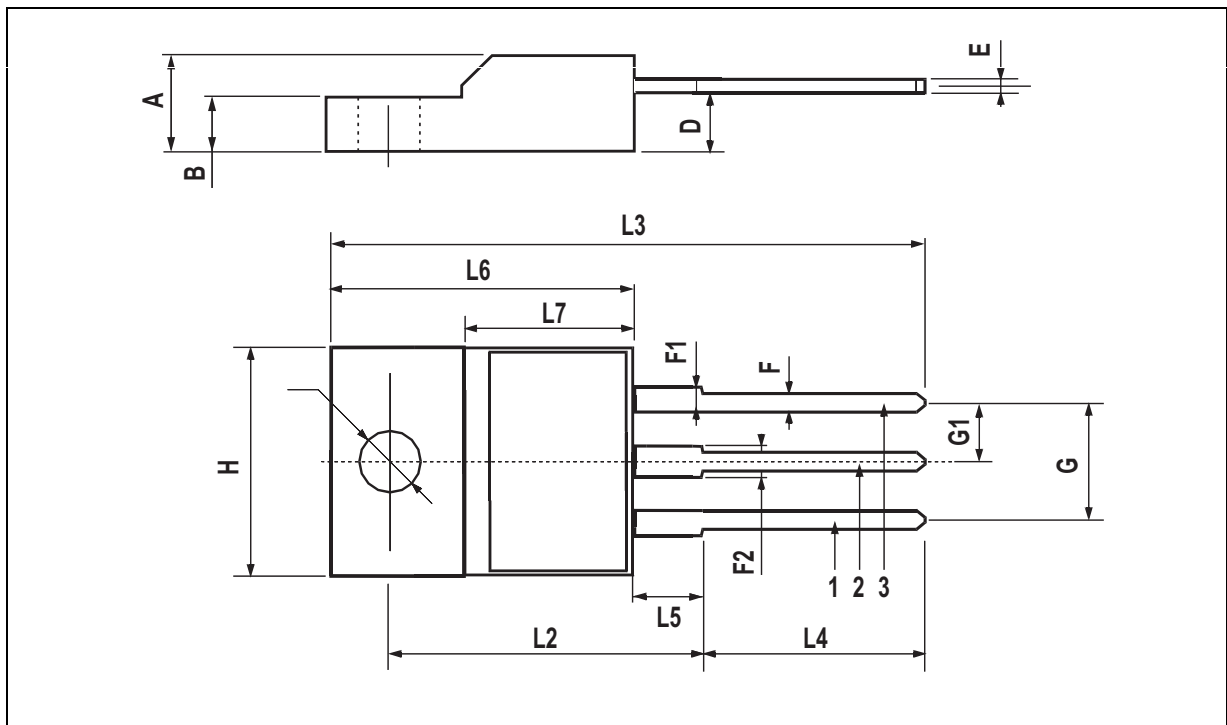
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.40		4.60	0.173		0.181
C	1.23		1.32	0.048		0.051
D	2.40		2.72	0.094		0.107
D1		1.27			0.050	
E	0.49		0.70	0.019		0.027
F	0.61		0.88	0.024		0.034
F1	1.14		1.70	0.044		0.067
F2	1.14		1.70	0.044		0.067
G	4.95		5.15	0.194		0.203
G1	2.4		2.7	0.094		0.106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



STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

TO-220FP MECHANICAL DATA

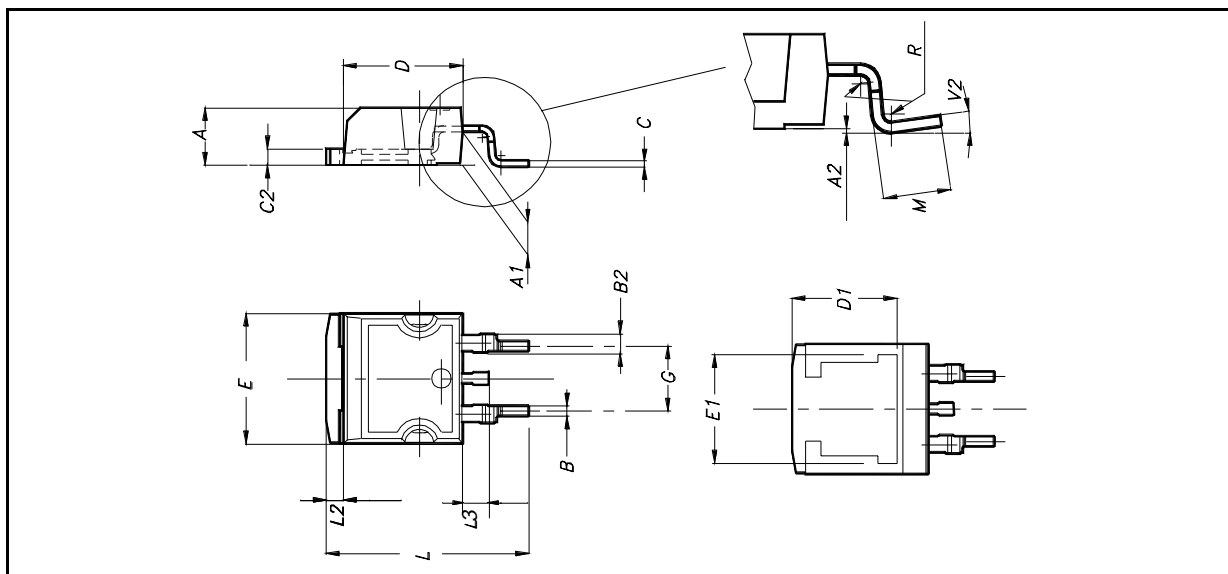
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.5	0.045		0.067
F2	1.15		1.5	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			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



STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

D²PAK MECHANICAL DATA

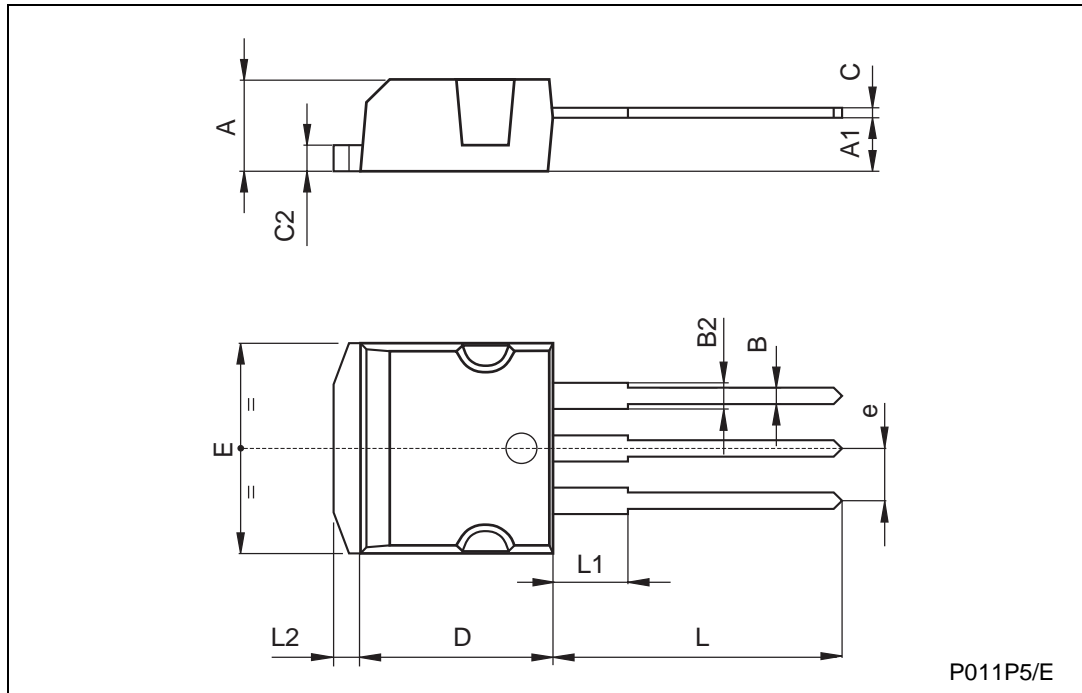
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
A2	0.03		0.23	0.001		0.009
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1		8			0.315	
E	10		10.4	0.393		
E1		8.5			0.334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



STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

TO-262 (I²PAK) MECHANICAL DATA

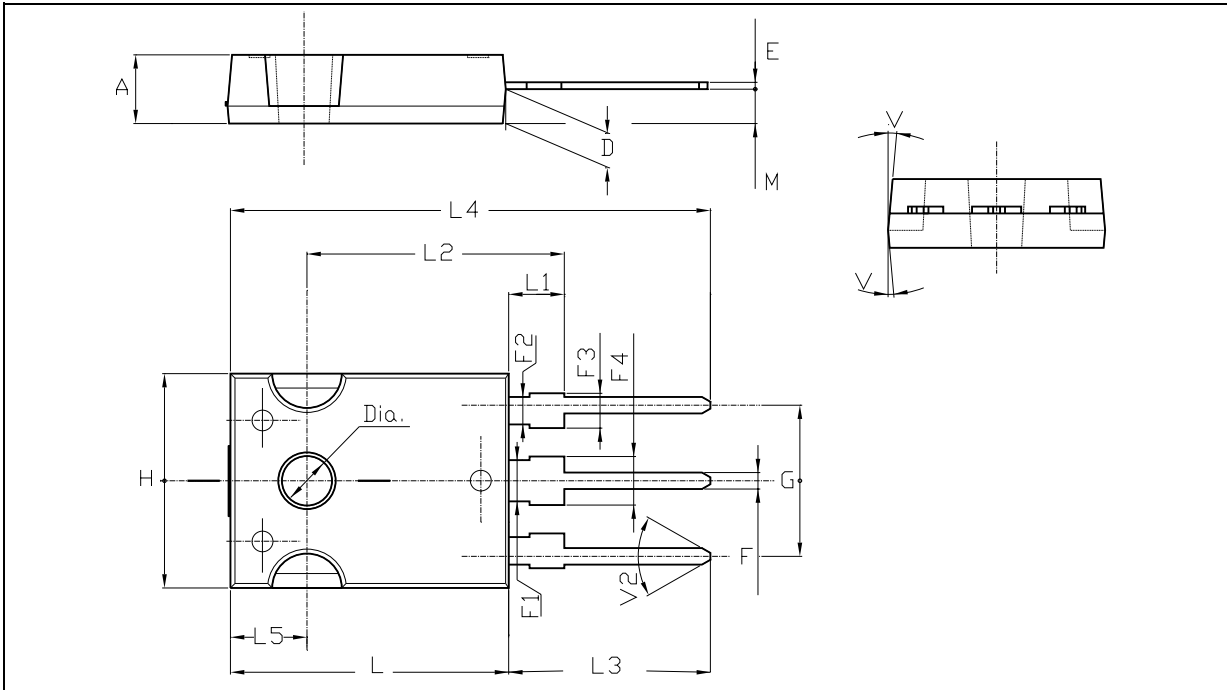
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	4.4		4.6	0.173		0.181
A1	2.49		2.69	0.098		0.106
B	0.7		0.93	0.027		0.036
B2	1.14		1.7	0.044		0.067
C	0.45		0.6	0.017		0.023
C2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
e	2.4		2.7	0.094		0.106
E	10		10.4	0.393		0.409
L	13.1		13.6	0.515		0.531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



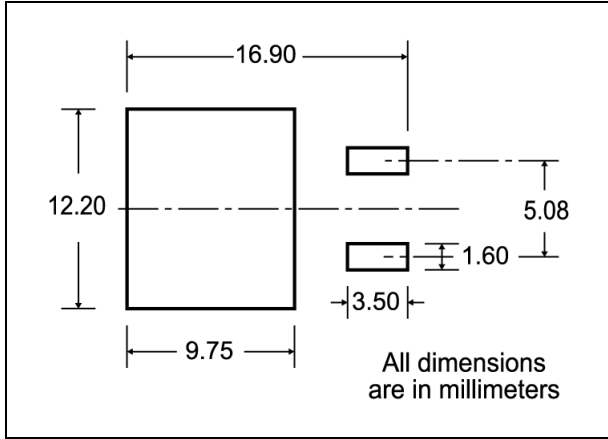
STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

TO-247 MECHANICAL DATA

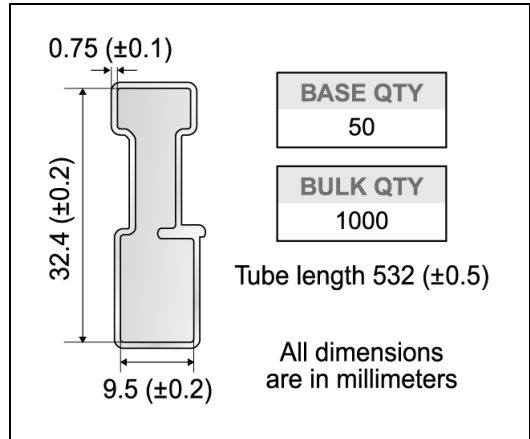
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.85		5.15	0.19		0.20
D	2.20		2.60	0.08		0.10
E	0.40		0.80	0.015		0.03
F	1		1.40	0.04		0.05
F1		3			0.11	
F2		2			0.07	
F3	2		2.40	0.07		0.09
F4	3		3.40	0.11		0.13
G		10.90			0.43	
H	15.45		15.75	0.60		0.62
L	19.85		20.15	0.78		0.79
L1	3.70		4.30	0.14		0.17
L2		18.50			0.72	
L3	14.20		14.80	0.56		0.58
L4		34.60			1.36	
L5		5.50			0.21	
M	2		3	0.07		0.11
V		5°			5°	
V2		60°			60°	
Dia	3.55		3.65	0.14		0.143



D²PAK FOOTPRINT



TUBE SHIPMENT (no suffix)*



TAPE AND REEL SHIPMENT (suffix "T4")*

Diagram showing the tape mechanical data. It includes a circular view of the tape with dimensions A, B, C, D, and a full radius. A note indicates a 40 mm min. access hole at the slot location. Another note indicates a tape slot in the core for tape start with a 2.5 mm min. width. A side view shows dimensions T, C, N, and G measured at the hub.

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. It includes a side view of the reel with dimensions K₀, T, D, P₂, P₀, E, F, W, B₀, D₁, A₀, P₁, and a center line of cavity. A note indicates a 10 pitches cumulative tolerance on tape of ±0.2 mm. A bottom view shows the reel with dimensions TRL and FEED DIRECTION. A bending radius diagram shows R min.

STP13NK60Z, STP13NK60ZFP, STB13NK60Z, STB13NK60Z-1, STW13NK60Z

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