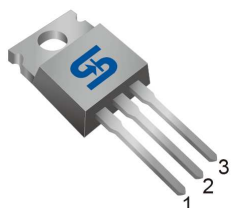
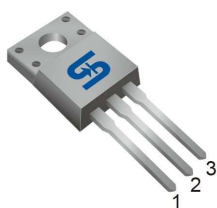




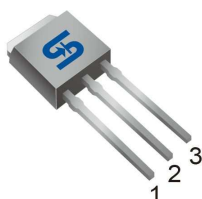
TO-220



ITO-220



TO-251  
(IPAK)



TO-252  
(DPAK)



**Pin Definition:**

1. Gate
2. Drain
3. Source

**PRODUCT SUMMARY**

$V_{DS}$ (V)	$R_{DS(on)}$ ( $\Omega$ )	$I_D$ (A)
600	2.5 @ $V_{GS}=10V$	2

**General Description**

The TSM4NB60 N-Channel Power MOSFET is produced by new advance planar process. This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode.

**Features**

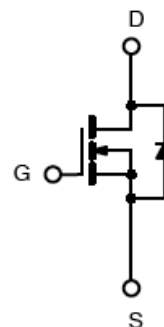
- Low  $R_{DS(ON)}$  2.2 $\Omega$  (Typ.)
- Low gate charge typical @ 14.5nC (Typ.)
- Low  $C_{rss}$  typical @ 7.0pF (Typ.)
- 100% Avalanche Tested

**Ordering Information**

Part No.	Package	Packing
TSM4NB60CH C5G	TO-251	75pcs / Tube
TSM4NB60CP ROG	TO-252	2.5Kpcs / 13" Reel
TSM4NB60CZ C0	TO-220	50pcs / Tube
TSM4NB60CI C0	ITO-220	50pcs / Tube

**Note:** "G" denotes for Halogen Free

**Block Diagram**



N-Channel MOSFET

**Absolute Maximum Rating** ( $T_a = 25^\circ C$  unless otherwise noted)

Parameter	Symbol	Limit			Unit
		IPAK/DPAK	ITO-220	TO-220	
Drain-Source Voltage	$V_{DS}$	600			V
Gate-Source Voltage	$V_{GS}$	$\pm 30$			V
Continuous Drain Current	$I_D$	$T_C = 25^\circ C$			A
		$T_C = 100^\circ C$			A
Pulsed Drain Current *	$I_{DM}$	16			A
Single Pulse Avalanche Energy (Note 2)	$E_{AS}$	100			mJ
Avalanche Current (Repetitive) (Note 1)	$I_{AR}$	4			A
Repetitive Avalanche Energy (Note 1)	$E_{AR}$	5			mJ
Peak Diode Recovery dv/dt (Note 3)	dv/dt	4.5			V/ns
Total Power Dissipation @ $T_C = 25^\circ C$	$P_{TOT}$	50	25	70	W
Operating Junction Temperature	$T_J$	150			$^\circ C$
Storage Temperature Range	$T_{STG}$	-55 to +150			$^\circ C$

**Note:** Limited by maximum junction temperature

### Thermal Performance

Parameter	Symbol	Limit			Unit
		IPAK/DPAK	ITO-220	TO-220	
Thermal Resistance - Junction to Case	$R\theta_{JC}$	2.5	5	1.78	$^{\circ}\text{C/W}$
Thermal Resistance - Junction to Ambient	$R\theta_{JA}$	83	62.5	62.5	$^{\circ}\text{C/W}$

### Electrical Specifications (Ta = 25°C unless otherwise noted)

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{GS} = 0V, I_D = 250\mu A$	$BV_{DSS}$	600	--	--	V
Drain-Source On-State Resistance	$V_{GS} = 10V, I_D = 2A$	$R_{DS(ON)}$	--	2.2	2.5	$\Omega$
Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\mu A$	$V_{GS(TH)}$	2.5	3.5	4.5	V
Zero Gate Voltage Drain Current	$V_{DS} = 600V, V_{GS} = 0V$	$I_{DSS}$	--	--	1	$\mu A$
Gate Body Leakage	$V_{GS} = \pm 30V, V_{DS} = 0V$	$I_{GSS}$	--	--	$\pm 100$	nA
Forward Transfer Conductance	$V_{DS} = 40V, I_D = 2A$	$g_{fs}$	--	2.6	--	S
<b>Dynamic</b>						
Total Gate Charge	$V_{DS} = 480V, I_D = 4A,$ $V_{GS} = 10V$ (Note 4,5)	$Q_g$	--	14.5	--	nC
Gate-Source Charge		$Q_{gs}$	--	3.4	--	
Gate-Drain Charge		$Q_{gd}$	--	7	--	
Input Capacitance	$V_{DS} = 25V, V_{GS} = 0V,$ $f = 1.0\text{MHz}$	$C_{iss}$	--	500	--	pF
Output Capacitance		$C_{oss}$	--	53.2	--	
Reverse Transfer Capacitance		$C_{rss}$	--	7	--	
<b>Switching</b>						
Turn-On Delay Time	$V_{GS} = 10V, I_D = 4A,$ $V_{DD} = 300V, R_G = 25\Omega$ (Note 4,5)	$t_{d(on)}$	--	11	--	nS
Turn-On Rise Time		$t_r$	--	20	--	
Turn-Off Delay Time		$t_{d(off)}$	--	30	--	
Turn-Off Fall Time		$t_f$	--	19	--	
<b>Source-Drain Diode Ratings and Characteristic</b>						
Source Current	Integral reverse diode in the MOSFET	$I_S$	--	--	4	A
Source Current (Pulse)		$I_{SM}$	--	--	16	A
Diode Forward Voltage	$I_S = 4A, V_{GS} = 0V$	$V_{SD}$	--	--	1.13	V
Reverse Recovery Time	$V_{GS} = 0V, I_S = 4A,$ $di/dt = 100A/\mu s$	$t_{fr}$	--	522	--	nS
Reverse Recovery Charge		$Q_{fr}$	--	1.6	--	$\mu C$

**Note 1:** Repetitive Rating: Pulse Width Limited by Maximum Junction Temperature

**Note 2:**  $V_{DD} = 50V, I_{AS} = 4A, L = 8mH, R_G = 25\Omega$ , Starting  $T_J = 25^{\circ}\text{C}$

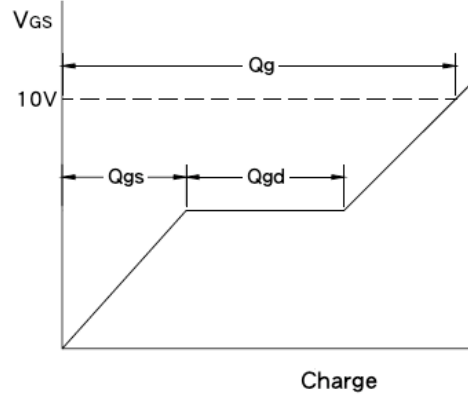
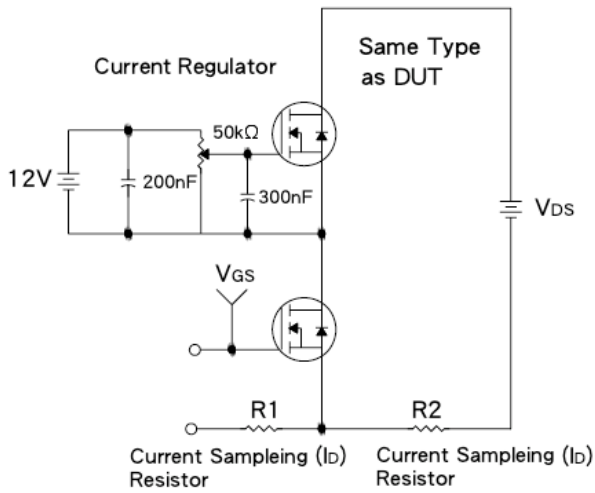
**Note 3:**  $I_{SD} \leq 4A, di/dt \leq 200A/\mu s, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^{\circ}\text{C}$

**Note 4:** Pulse test: pulse width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$

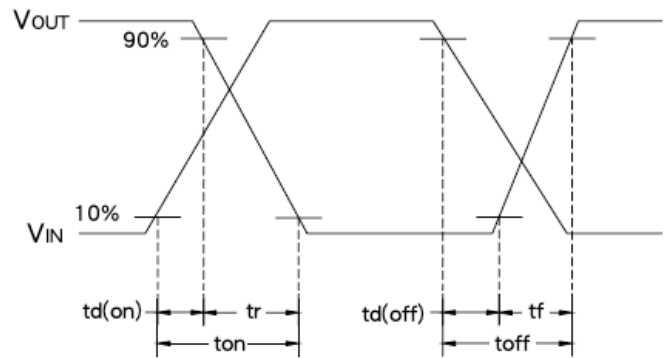
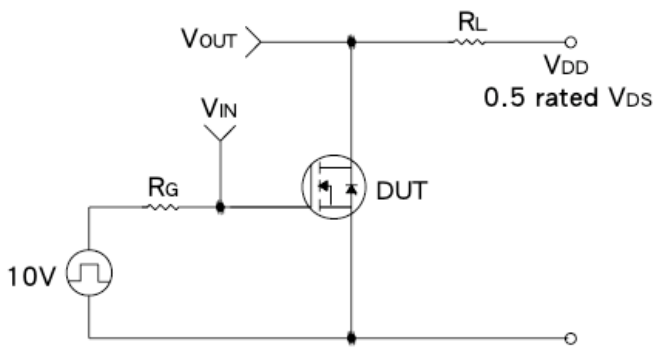
**Note 5:** Essentially Independent of Operating Temperature



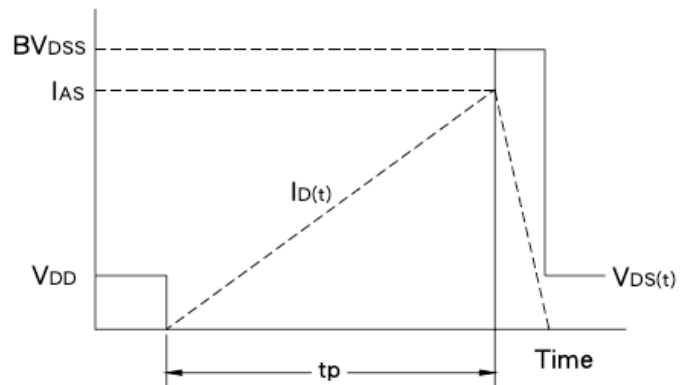
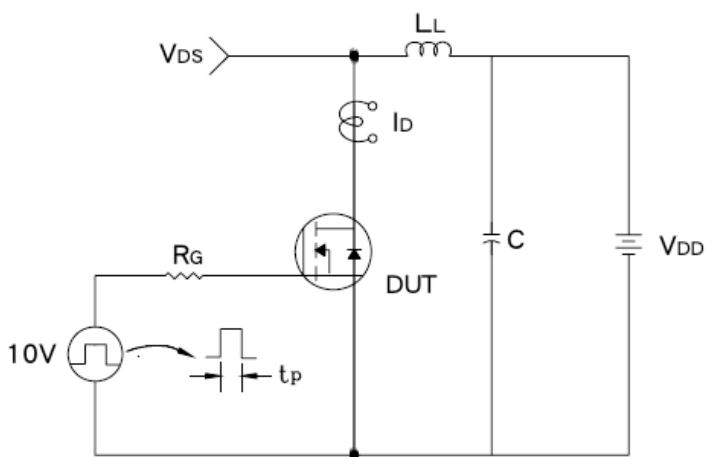
### Gate Charge Test Circuit & Waveform



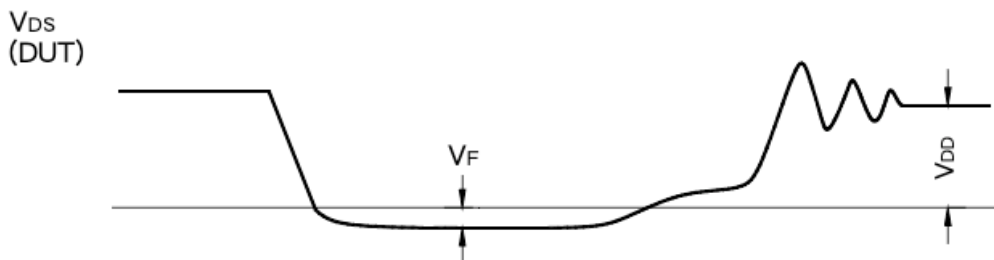
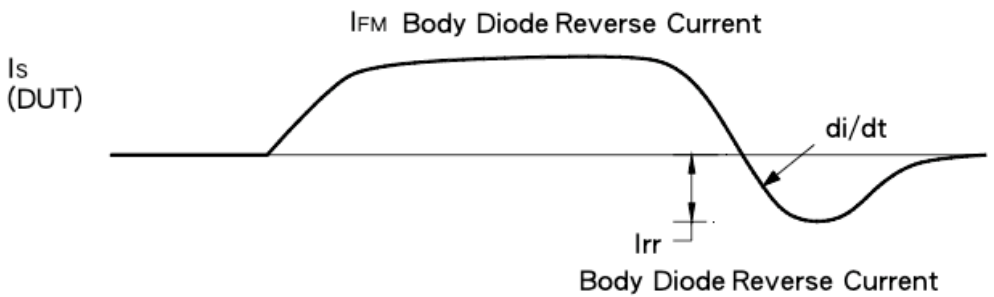
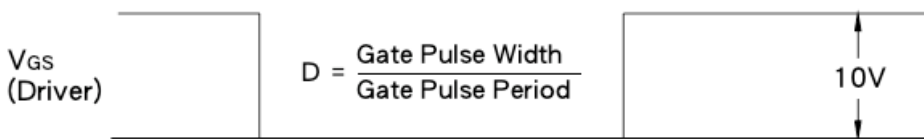
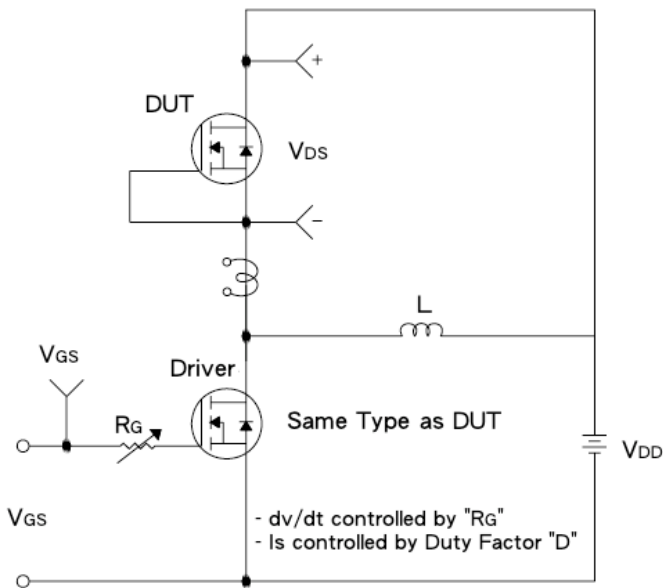
### Resistive Switching Test Circuit & Waveform



### E<sub>AS</sub> Test Circuit & Waveform



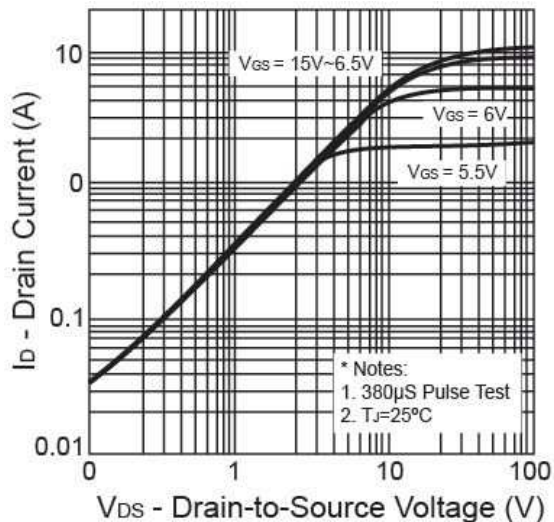
**Diode Reverse Recovery Time Test Circuit & Waveform**



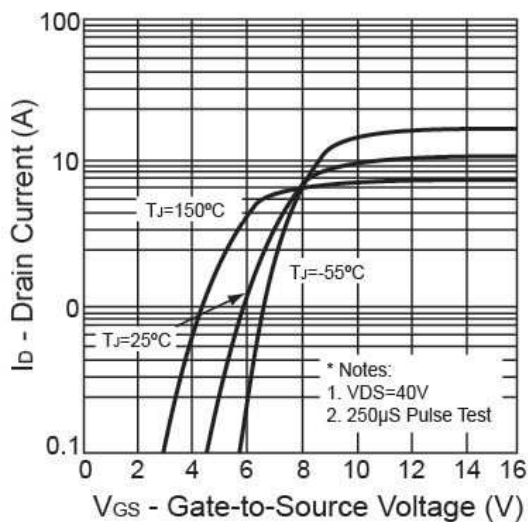


**Electrical Characteristics Curve** (Ta = 25°C, unless otherwise noted)

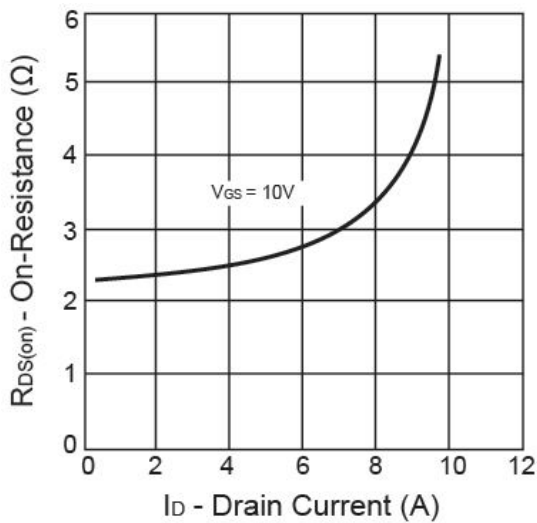
**Output Characteristics**



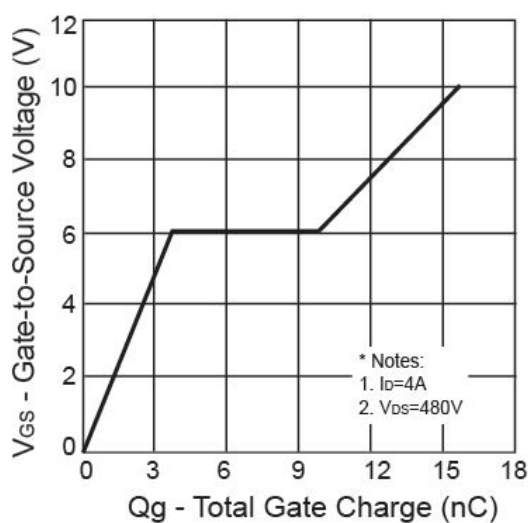
**Transfer Characteristics**



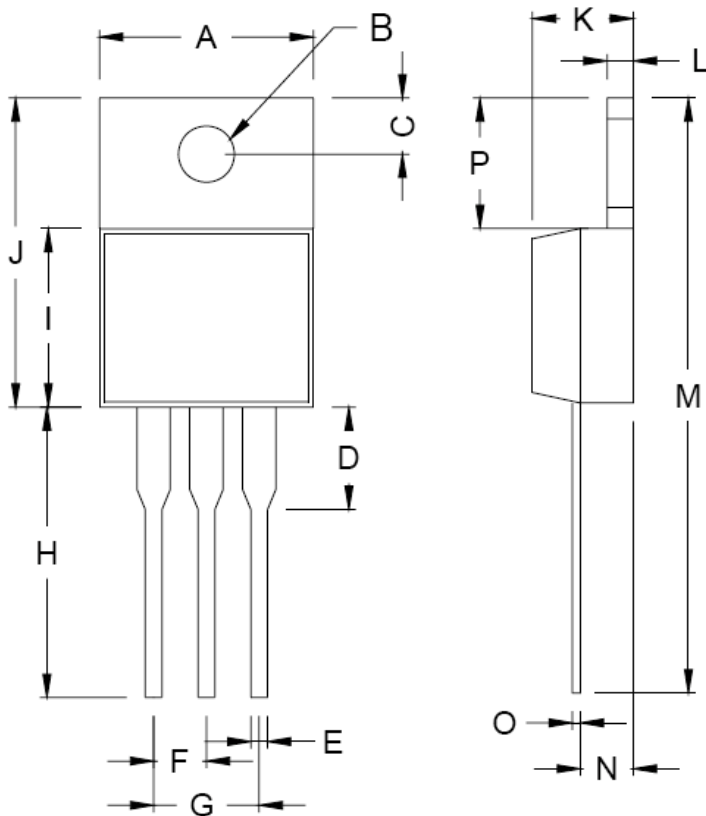
**On-Resistance vs. Drain Current**



**Gate Charge**

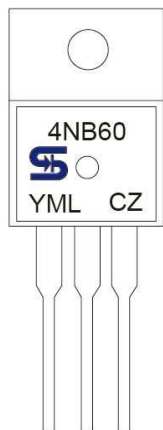


### TO-220 Mechanical Drawing



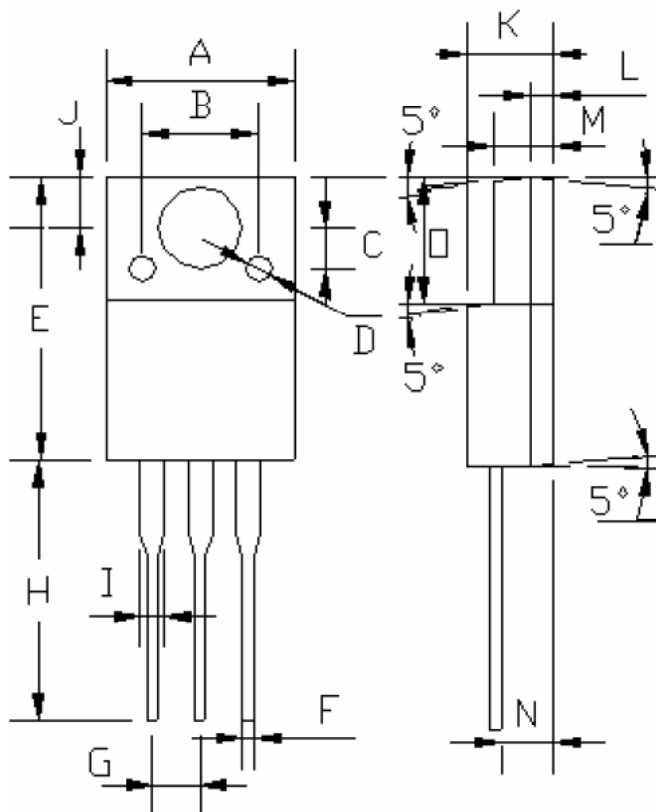
DIM	TO-220 DIMENSION			
	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.000	10.500	0.394	0.413
B	3.740	3.910	0.147	0.154
C	2.440	2.940	0.096	0.116
D	-	6.350	-	0.250
E	0.381	1.106	0.015	0.040
F	2.345	2.715	0.092	0.058
G	4.690	5.430	0.092	0.107
H	12.700	14.732	0.500	0.581
J	14.224	16.510	0.560	0.650
K	3.556	4.826	0.140	0.190
L	0.508	1.397	0.020	0.055
M	27.700	29.620	1.060	1.230
N	2.032	2.921	0.080	0.115
O	0.255	0.610	0.010	0.024
P	5.842	6.858	0.230	0.270

### Marking Diagram



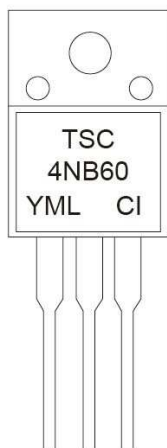
- Y** = Year Code
- M** = Month Code  
(**A**=Jan, **B**=Feb, **C**=Mar, **D**=Apr, **E**=May, **F**=Jun, **G**=Jul, **H**=Aug, **I**=Sep, **J**=Oct, **K**=Nov, **L**=Dec)
- L** = Lot Code

### ITO-220 Mechanical Drawing



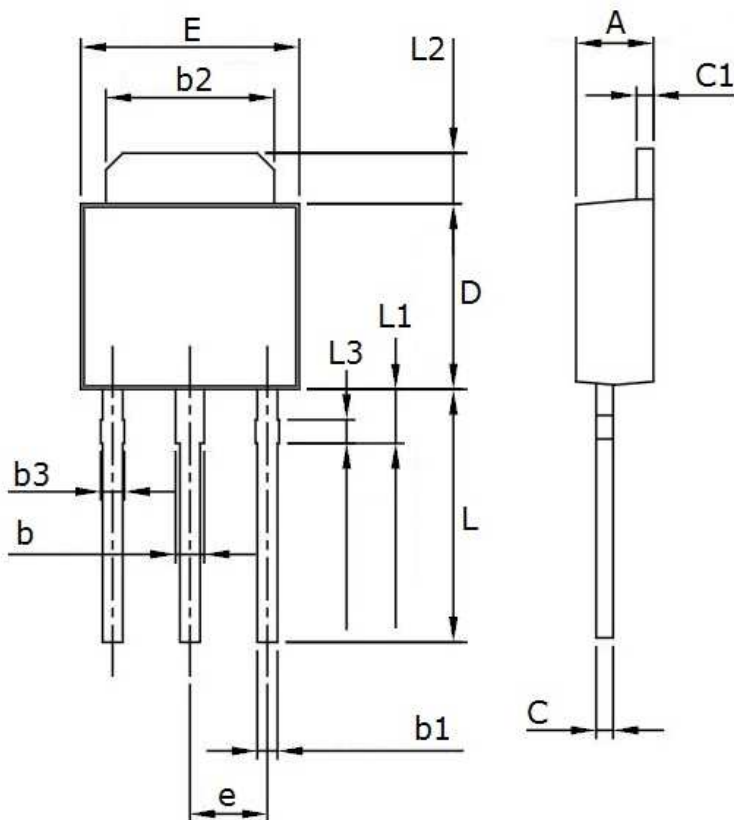
ITO-220 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.04	10.07	0.395	0.396
B	6.20 (typ.)		0.244 (typ.)	
C	2.20 (typ.)		0.087 (typ.)	
D	§ 1.40 (typ.)		§ 0.055 (typ.)	
E	15.0	15.20	0.591	0.598
F	0.52	0.54	0.020	0.021
G	2.35	2.73	0.093	0.107
H	13.50	13.55	0.531	0.533
I	1.11	1.49	0.044	0.058
J	2.60	2.80	0.102	0.110
K	4.49	4.50	0.176	0.177
L	1.15 (typ.)		0.045 (typ.)	
M	3.03	3.05	0.119	0.120
N	2.60	2.80	0.102	0.110
O	6.55	6.65	0.258	0.262

### Marking Diagram



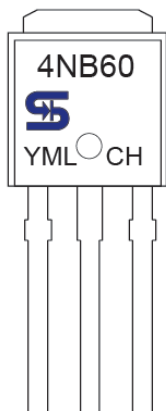
- Y = Year Code
- M = Month Code
- (A=Jan, B=Feb, C=Mar, D=Apr, E=May, F=Jun, G=Jul, H=Aug, I=Sep, J=Oct, K=Nov, L=Dec)
- L = Lot Code

**TO-251 Mechanical Drawing**



TO-251 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.10	2.50	0.083	0.098
b	0.65	1.05	0.026	0.041
b1	0.58	0.62	0.023	0.024
b2	4.80	5.20	0.189	0.205
b3	0.68	0.72	0.027	0.028
C	0.35	0.65	0.014	0.026
C1	0.40	0.60	0.016	0.024
D	5.30	5.70	0.209	0.224
E	6.30	6.70	0.248	0.264
e	2.30 BSC		0.09 BSC	
L	7.00	8.00	0.276	0.315
L1	1.40	1.80	0.055	0.071
L2	1.30	1.70	0.051	0.067
L3	0.50	0.90	0.020	0.035

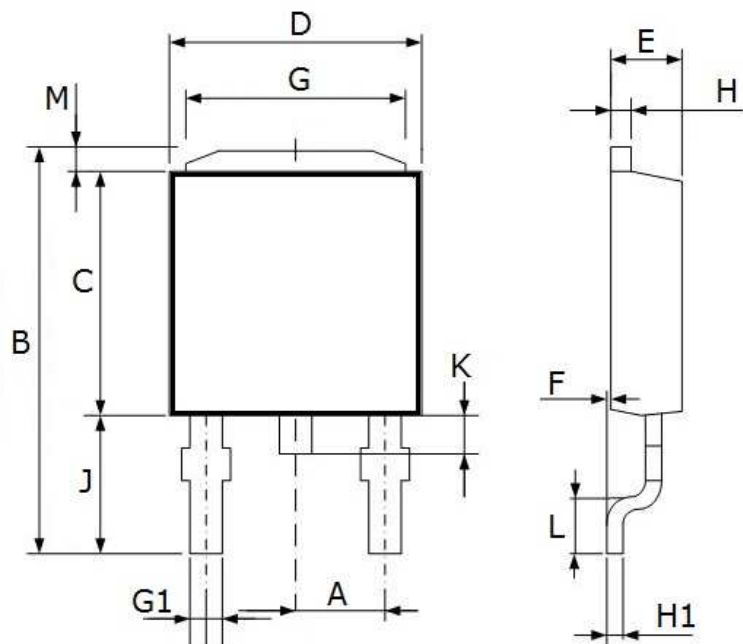
**Marking Diagram**



- Y** = Year Code
- M** = Month Code for Halogen Free Product  
(O=Jan, P=Feb, Q=Mar, R=Apr, S=May, T=Jun, U=Jul, V=Aug, W=Sep, X=Oct, Y=Nov, Z=Dec)
- L** = Lot Code

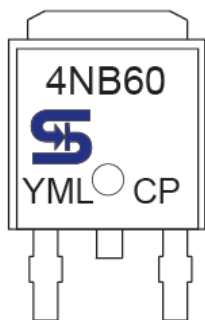


**TO-252 Mechanical Drawing**



TO-252 DIMENSION				
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.30 BSC		0.090 BSC	
B	10.20	10.80	0.402	0.425
C	5.30	5.70	0.209	0.224
D	6.30	6.70	0.248	0.264
E	2.10	2.50	0.083	0.098
F	0.00	0.20	0.000	0.008
G	4.80	5.20	0.189	0.205
G1	0.40	0.80	0.016	0.031
H	0.40	0.60	0.016	0.024
H1	0.35	0.65	0.014	0.026
J	3.35	3.65	0.132	0.144
K	0.50	1.10	0.020	0.043
L	0.90	1.50	0.035	0.059
M	1.30	1.70	0.051	0.067

**Marking Diagram**



- Y** = Year Code
- M** = Month Code for Halogen Free Product  
(O=Jan, P=Feb, Q=Mar, R=Apl, S=May, T=Jun, U=Jul, V=Aug, W=Sep, X=Oct, Y=Nov, Z=Dec)
- L** = Lot Code

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