



# TSH150

## WIDE BANDWIDTH AND BIPOLAR INPUTS SINGLE OPERATIONAL AMPLIFIER

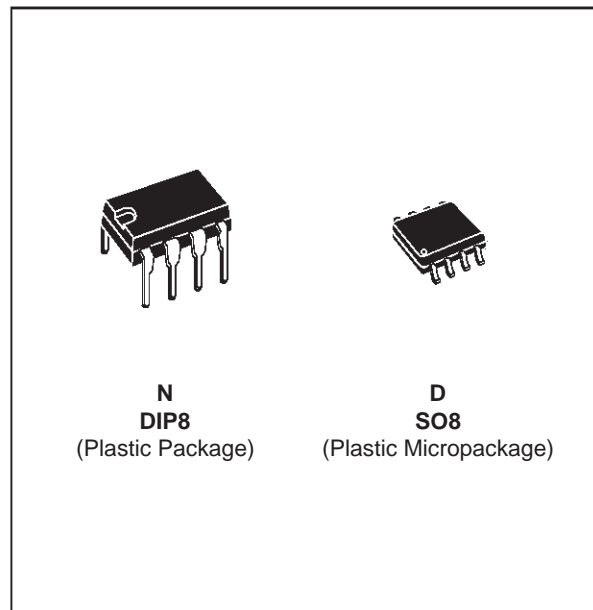
- LOW DISTORTION
- GAIN BANDWIDTH PRODUCT : 150MHz
- UNITY GAIN STABLE
- SLEW RATE : 190V/ $\mu$ s
- VERY FAST SETTTLING TIME : 20ns (0.1%)

### DESCRIPTION:

The TSH150 is a wideband monolithic operational amplifier, internally compensated for unity-gain stability.

Low noise and low distortion, wide bandwidth and high linearity make this amplifier suitable for RF and video applications. Short circuit protection is provided by an internal current-limiting circuit.

The TSH150 has internal electrostatic discharge (ESD) protection circuits and fulfills MILSTD883C-Class2.

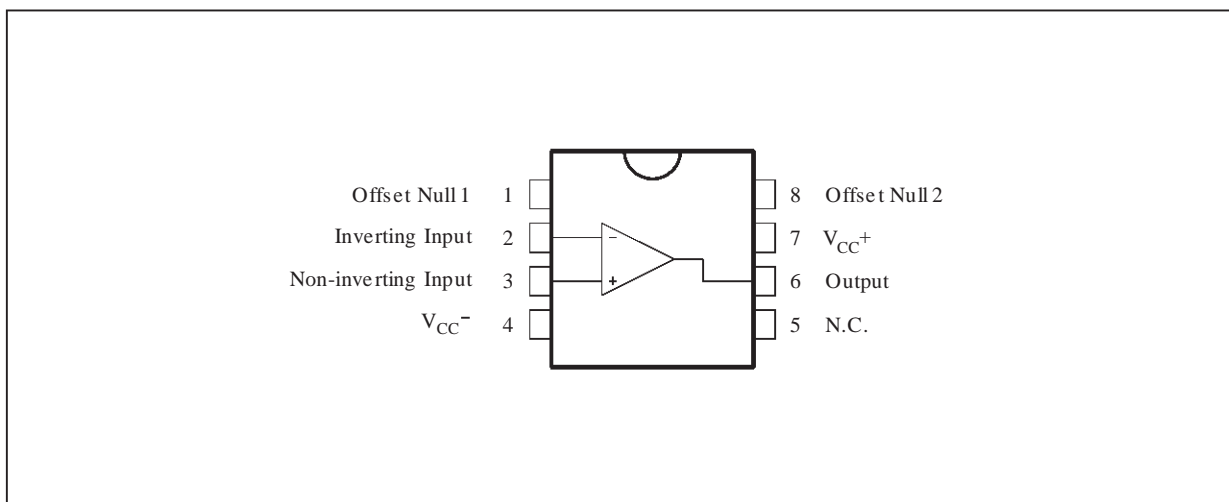


### ORDER CODES

Part Number	Temperature Range	Package	
		N	D
TSH150C	0°C, 70°C	•	•
TSH150I	-40°C, 125°C	•	•

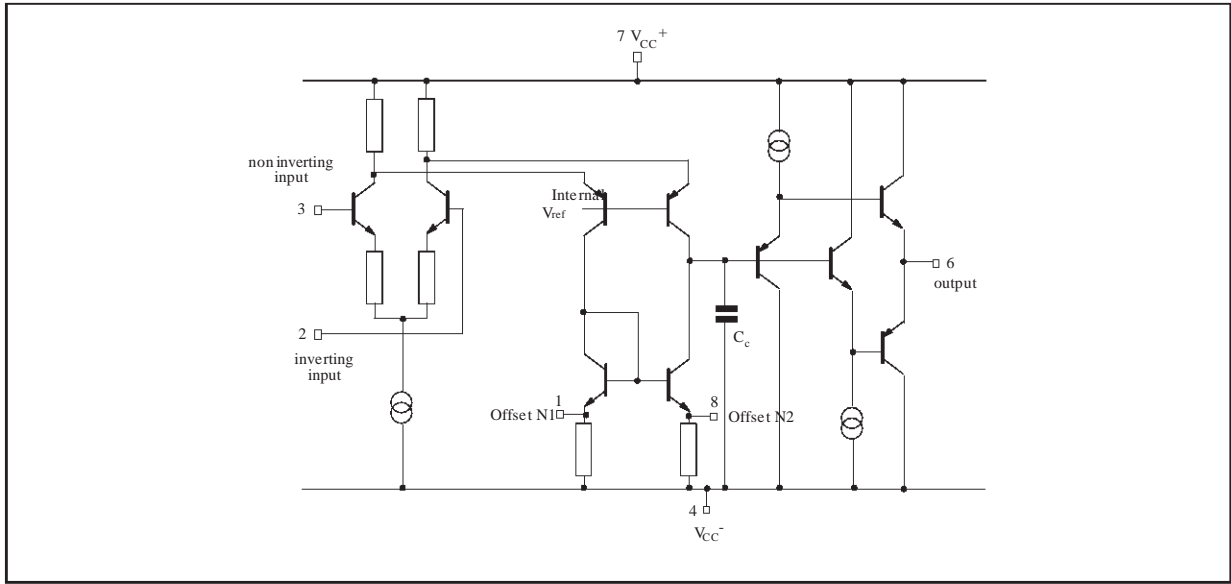
150-01.TBL

### PIN CONNECTIONS (top view)



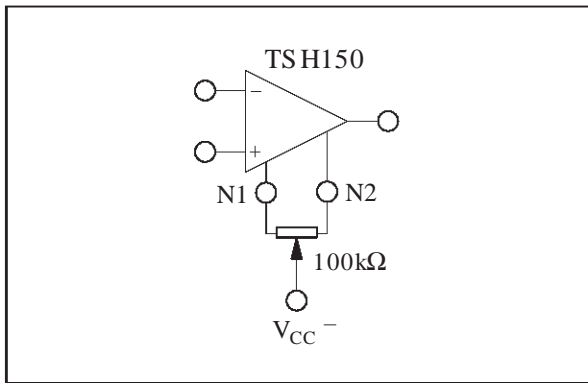
150-01.EPS

**SCHEMATIC DIAGRAM**



150-02.EPS

**INPUT OFFSET VOLTAGE NULL CIRCUIT**



150-03.EPS

**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	$\pm 7$	V
$V_{id}$	Differential Input Voltage	$\pm 5$	V
$V_i$	Input Voltage Range	$\pm 5$	V
$I_{in}$	Current On Inputs Current On Offset Null Pins	$\pm 50$ $\pm 20$	mA
$T_{oper}$	Operating Free-Air Temperature Range	TSH150C -40 to +125	$^{\circ}C$
$T_{stg}$	Storage Temperature Range	-65 to 150	$^{\circ}C$

150-02.TBL

**OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	$\pm 3$ to $\pm 6$	V
$V_{ic}$	Common Mode Input Voltage Range	$V_{CC-} + 2$ to $V_{CC+} - 1$	V

150-03.TBL

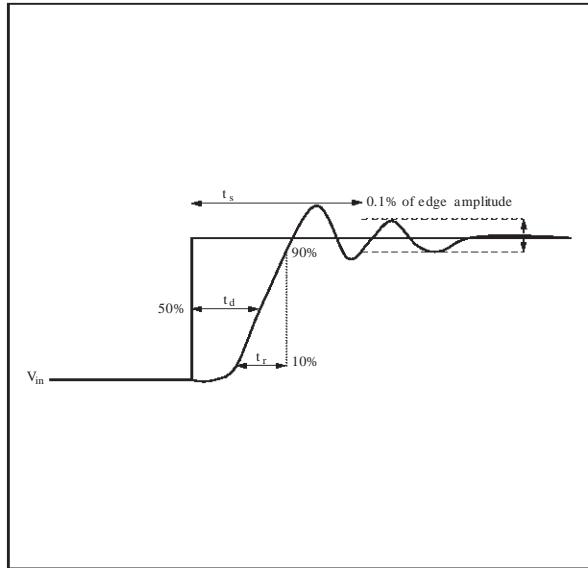
**ELECTRICAL CHARACTERISTICS** $V_{CC} = \pm 5V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter	TSH150C, I			Unit
		Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage $T_{min} \leq T_{amb} \leq T_{max}$ .		0.3	5 7	mV
$DV_{io}$	Input Offset Voltage Drift $T_{min} \leq T_{amb} \leq T_{max}$ .		10		$\mu V/^{\circ}C$
$I_{ib}$	Input Bias Current		5	30	$\mu A$
$I_{io}$	Input Offset Current		0.1	2	$\mu A$
$I_{CC}$	Supply Current, no load $T_{min} \leq T_{amb} \leq T_{max}$ .		$V_{CC} = \pm 5V$ 23 $V_{CC} = \pm 3V$ 21 $V_{CC} = \pm 6V$ 25 $V_{CC} = \pm 5V$ 32	30 28 40 32	mA
$A_{vd}$	Large Signal Voltage Gain $V_o = \pm 2.5V$	$R_L = \infty$ 800 $R_L = 100\Omega$ 300 $R_L = 50\Omega$ 200	1300 850 650		V/V
$V_{icm}$	Input Common Mode Voltage Range	-3 to +4	-3.5 to +4.5		V
CMR	Common Mode Rejection Ratio $V_{ic} = V_{icm \text{ min.}}$	60	100		dB
SVR	Supply Voltage Rejection Ratio $V_{CC} = \pm 5V$ to $\pm 3V$	50	70		dB
$V_o$	Output Voltage $T_{min} \leq T_{amb} \leq T_{max}$ .	$R_L = 100\Omega$ $\pm 3$ $R_L = 50\Omega$ $\pm 2.8$ $R_L = 100\Omega$ $\pm 2.9$ $R_L = 50\Omega$ $\pm 2.7$	+3.5 -3.7 +3.3 -3.5		V
$I_o$	Output Short Circuit Current $V_{id} = \pm 1V$ , $V_o = 0V$	$\pm 50$	$\pm 100$		mA
GBP	Gain Bandwidth Product $A_{VCL} = 100$ , $R_L = 100\Omega$ , $C_L = 15pF$ , $f = 7.5MHz$		150		MHz
SR	Slew Rate $V_{in} = \pm 2V$ , $A_{VCL} = 1$ , $R_L = 100\Omega$ , $C_L = 15pF$	100	190		V/ $\mu s$
$e_n$	Equivalent Input Voltage Noise $R_S = 50\Omega$	$f_o = 1kHz$ 7 $f_o = 10kHz$ 6.5 $f_o = 100kHz$ 6.2 $f_o = 1MHz$ 5.5			$\frac{nV}{\sqrt{Hz}}$
$K_{ov}$	Overshoot $V_{in} = \pm 2V$ , $A_{VCL} = 1$ , $R_L = 100\Omega$ , $C_L = 15pF$		5		%
$t_s$	Settling Time 0.1% - (note 1) $V_{in} = \pm 1V$ , $A_{VCL} = -1$		20		ns
$t_r$ , $t_f$	Rise and Fall Time - (note 1) $V_{in} = \pm 100mV$ , $A_{VCL} = 2$		3.5		ns
$t_d$	Delay Time - (note 1) $V_{in} = \pm 100mV$ , $A_{VCL} = 2$		2.5		ns
$\phi_m$	Phase Margin $A_{VM} = 1$ , $R_L = 100\Omega$ , $C_L = 15pF$		50		Degrees
THD	Total Harmonic Distortion $A_{VCL} = 10$ , $f = 1KHz$ , $V_o = \pm 2.5V$ , no load		0.02		%
FPB	Full Power Bandwidth - (note 2) $V_o = 5V_{pp}$ , $R_L = 100\Omega$ $V_o = 2V_{pp}$ , $R_L = 100\Omega$		12 30		MHz

Note 1 : See test waveform figure

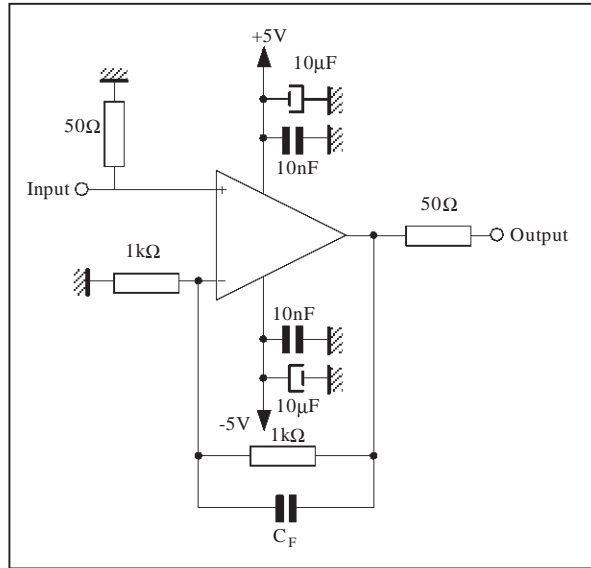
Note 2 : Full power bandwidth =  $\frac{SR}{\pi V_{opp}}$

TEST WAVEFORM



150-04.EPS

EVALUATION CIRCUIT



150-05.EPS

PRINTED CIRCUIT LAYOUT

As for any high frequency device, a few rules must be observed when designing the PCB to get the best performances from this high speed op amp.

From the most to the least important points :

- Each power supply lead has to be bypassed to ground with a 10nF ceramic capacitor very close to the device and a 10μF tantalum capacitor.
- To provide low inductance and low resistance common return, use a ground plane or common point return for power and signal.
- All leads must be wide and as short as possible especially for op amp inputs. This is in order to decrease parasitic capacitance and inductance.
- Use small resistor values to decrease time constant with parasitic capacitance. Be aware on TSH150 device of the  $I_{i_o}$  error and input noise currents with high feedback resistor values.
- Choose component sizes as small as possible (SMD).
- On output, decrease capacitor load so as to avoid circuit stability being degraded which may cause oscillation. You can also add a serial resistor in order to minimise its influence.
- One can add in parallel with feedback resistor a few pF ceramic capacitor  $C_F$  adjusted to optimize the settling time.

**MACROMODEL**

- LOW DISTORTION
- GAIN BANDWIDTH PRODUCT : 150MHz
- UNITY GAIN STABLE
- SLEW RATE : 190V/μs
- VERY FAST SETTLING TIME : 20ns (0.1%)

**Applies to : TSH150C,I**

\*\* Standard Linear Ics Macromodels, 1993.

\*\* CONNECTIONS :

- \* 1 INVERTING INPUT
- \* 2 NON-INVERTING INPUT
- \* 3 OUTPUT
- \* 4 POSITIVE POWER SUPPLY
- \* 5 NEGATIVE POWER SUPPLY

.SUBCKT TSH150 1 3 2 4 5 (analog)

\*\*\*\*\*

.MODEL MDTH D IS=1E-8 KF=1.568191E-15 CJO=10F

\* INPUT STAGE

CIP 2 5 1.000000E-12

CIN 1 5 1.000000E-12

EIP 10 5 2 5 1

EIN 16 5 1 5 1

RIP 10 11 1.040000E+02

RIN 15 16 1.040000E+02

RIS 11 15 3.264539E+02

DIP 11 12 MDTH 400E-12

DIN 15 14 MDTH 400E-12

VOFP 12 13 DC -9.162265E-05

VOFN 13 14 DC 0

IPOL 13 5 1.000000E-03

CPS 11 15 5.757255E-12

DINN 17 13 MDTH 400E-12

VIN 17 5 1.5000000e+00

DINR 15 18 MDTH 400E-12

VIP 4 18 0.500000E+00

FCP 4 5 VOFP 2.200000E+01

FCN 5 4 VOFN 2.200000E+01

FIBP 2 5 VOFP 1.000000E-02

FIBN 5 1 VOFN 1.000000E-02

\* AMPLIFYING STAGE

FIP 5 19 VOFP 4.370000E+02

FIN 5 19 VOFN 4.370000E+02

RG1 19 5 1.124121E+03

RG2 19 4 1.124121E+03

CC 19 29 2.000000E-09

HZTP 30 29 VOFP 5.574976E+01

HZTN 5 30 VOFN 5.574976E+01

DOPM 19 22 MDTH 400E-12

DONM 21 19 MDTH 400E-12

HOPM 22 28 VOUT 5.000000E+02

VIPM 28 4 5.000000E+01

HONM 21 27 VOUT 5.000000E+02

VINM 5 27 5.000000E+01

EOUT 26 23 19 5 1

VOUT 23 5 0

ROUT 26 3 2.180423E+01

COUT 3 5 1.000000E-12

DOP 19 25 MDTH 400E-12

VOP 4 25 1.511965E+00

DON 24 19 MDTH 400E-12

VON 24 5 1.511965E+00

.ENDS

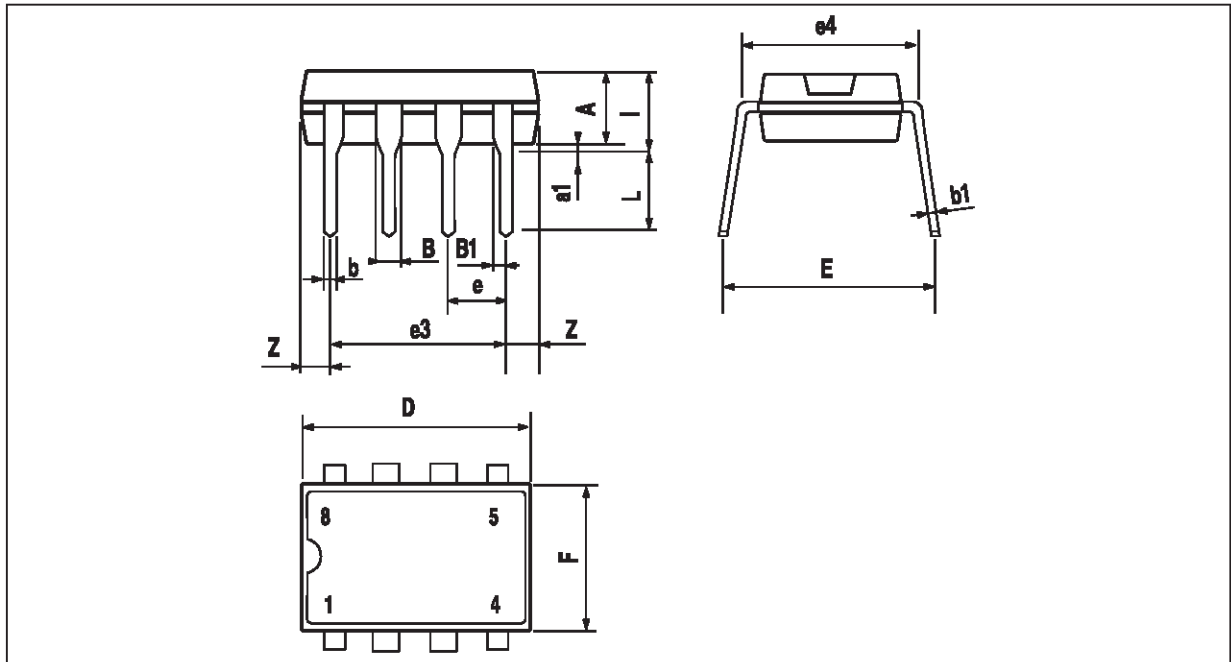
**ELECTRICAL CHARACTERISTICS**

$V_{CC} = \pm 5V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Conditions	Value	Unit
$V_{io}$		0	mV
$A_{vd}$	$R_L = 100\Omega$	1	V/mV
$I_{CC}$	No load	21	mA
$V_{icm}$		-3.5 to 4.5	V
$V_{OH}$	$R_L = 100\Omega$	+3.6	V
$V_{OL}$	$R_L = 100\Omega$	-3.6	V
$I_{sink}$	$V_O = 0V$	108	mA
$I_{source}$	$V_O = 0V$	108	mA
GBP	$R_L = 100\Omega$ , $C_L = 15pF$	147	MHz
SR	$R_L = 100\Omega$ , $C_L = 15pF$	180	V/μs
$\varnothing_m$	$R_L = 100\Omega$ , $C_L = 15pF$	42	Degrees
$t_s$	$A_V = -1$ at 0.1%	22.6	ns

# TSH150

## PACKAGE MECHANICAL DATA 8 PINS - PLASTIC DIP

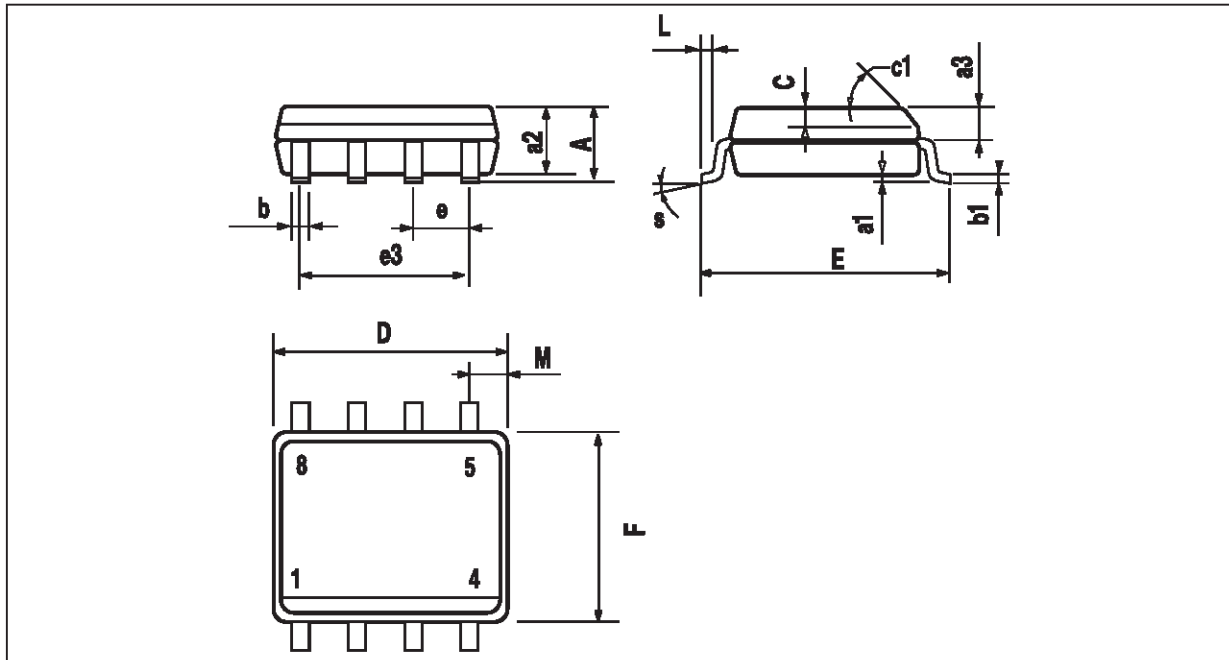


PM-DIP8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL

**PACKAGE MECHANICAL DATA**  
8 PINS - PLASTIC MICROPACKAGE (SO)



PM-SO8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

SO8.TBL

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