TS921

RAIL TO RAIL HIGH OUTPUT CURRENT SINGLE OPERATIONAL AMPLIFIER

- RAIL TO RAIL INPUT AND OUTPUT
- LOW NOISE : **9nV/√(Hz)**
- LOW DISTORTION
- HIGH OUTPUT CURRENT : **80mA** (able to drive 32Ω loads)
- HIGH SPEED : **4MHz, 1V/µs**
- OPERATING FROM **2.7V to 12V**
- ESD INTERNAL PROTECTION : 1.5KV
- LATCH-UP IMMUNITY
- MACROMODEL INCLUDED IN THIS SPECIFICATION

DESCRIPTION

The TS921 is a RAIL TO RAIL single BiCMOS operational amplifier optimized and fully specified for 3V and 5V operation.

High output current allows low load impedances to be driven.

The TS921 exhibits a very low noise, low distortion, low offset and high ouput current capability making this device an excellent choice for high quality, low voltage or battery operated audio systems.

The device is stable for capacitive loads up to 500pF.

APPLICATIONS

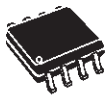
- headphone amplifier
- piezoelectric speaker driver
- sound cards, multimedia systems
- line driver, actuator driver
- servo amplifier
- mobile phone and portable communication sets
- instrumentation with low noise as key factor

ORDER CODE

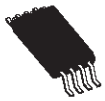
Part Number	Temperature Range	Package		
		N	D	P
TS921I	-40°C, +125°C	•	•	•

N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)
P = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)

N
DIP8
(Plastic Package)

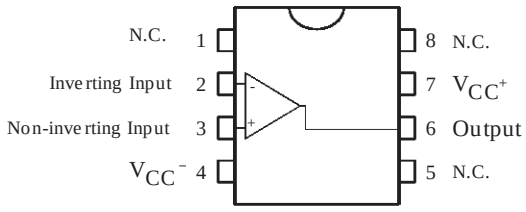


D
SO8
(Plastic Micropackage)



P
TSSOP8
(Thin Shrink Small Outline Package)

PIN CONNECTIONS (top view)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage [1]	14	V
V_{id}	Differential Input Voltage [2]	±1	V
V_i	Input Voltage [3]	-0.3 to 14	V
T_{oper}	Operating Free Air Temperature Range	-40 to +125	°C
I_{stg}	Storage Temperature	-65 to +150	°C
T_j	Maximum Junction Temperature	150	°C
	Output Short Circuit Duration	see note [4]	°C

1. All voltages values, except differential voltage are with respect to network ground terminal.
2. Differential voltagesare the non-inverting input terminal with respect to the inverting input terminal.
3. The magnitude of input and output voltages must never exceed V_{CC}^+ +0.3V.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuit on all amplifiers

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 12	V
V_{icm}	Common Mode Input Voltage Range	V_{CC}^- -0.2 to V_{CC}^+ +0.2	V

ELECTRICAL CHARACTERISTICS

V_{CC}^+ = 3V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage Tmin. ≤ Tamb ≤ Tmax.			3 5	mV
DV_{io}	Input Offset Voltage Drift		2		µV/°C
I_{io}	Input Offset Current V_{out} = 1.5V			30	nA
I_{ib}	Input Bias Current V_{out} = 1.5V		15	100	nA
V_{OH}	High Level Output Voltage RL = 600Ω RL = 32Ω	2.87	2.63		V
V_{OL}	Low Level Output Voltage RL = 600Ω RL = 32Ω		180	100	mV
A_{vd}	Large Signal Voltage Gain (V_{out} = 2Vpk-pk) RL = 600Ω RL = 32Ω		35 16		V/mV
I_{CC}	Supply Current no load, V_{out} = Vcc/2		1	1.5	mA
GBP	Gain Bandwith Product RL = 600Ω		4		MHz
CMR	Common Mode Rejection Ratio	60	80		dB
SVR	Supply Voltage Rejection Ratio Vcc = 2.7 to 3.3 V	60	80		dB
I_o	Output Short Circuit Current	50	80		mA
SR	Slew Rate	0.7	1.3		V/µs
ϕm	Phase Margin at Unit Gain RL = 600Ω, C_L =100pF		68		Degrees
G_m	Gain Margin RL = 600Ω, C_L =100pF		12		dB
e_n	Equivalent Input Noise Voltage f = 1kHz		9		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion V_{out} = 2Vpk-pk, F = 1kHz, A_v = 1, R_L =600Ω		0.005		%

ELECTRICAL CHARACTERISTICS

V_{CC}^+ = 5V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min.} \le T_{amb} \le T_{max.}$			3 5	mV
DV_{io}	Input Offset Voltage Drift		2		µV/°C
I_{io}	Input Offset Current V_{out} = 1.5V			30	nA
I_{ib}	Input Bias Current V_{out} = 1.5V		15	100	nA
V_{OH}	High Level Output Voltage R_L = 600Ω R_L = 32Ω	4.85	4.4		V
V_{OL}	Low Level Output Voltage R_L = 600Ω R_L = 32Ω		300	120	mV
A_{vd}	Large Signal Voltage Gain (V_{out} = $2V_{pk}$-V_{pk}) R_L = 600Ω R_L = 32Ω		35 16		V/mV
I_{cc}	Supply Current no load, V_{out} = $V_{cc/2}$		1	1.5	mA
GBP	Gain Bandwith Product R_L = 600Ω		4		MHz
CMR	Common Mode Rejection Ratio	60	80		dB
SVR	Supply Voltage Rejection Ratio V_{cc} = 4.5 to 5.5V	60	80		dB
I_o	Output Short Circuit Current	50	80		mA
SR	Slew Rate	0.7	1.3		V/µs
ϕm	Phase Margin at Unit Gain R_L = 600Ω, C_L =100pF		68		Degrees
G_m	Gain Margin R_L = 600Ω, C_L =100pF		12		dB
e_n	Equivalent Input Noise Voltage f = 1kHz		9		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion V_{out} = 2Vpk-pk, F = 1kHz, A_v = 1, R_L =600Ω		0.005		%

MACROMODELS

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** Standard Linear Ics Macromodels, 1996.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY

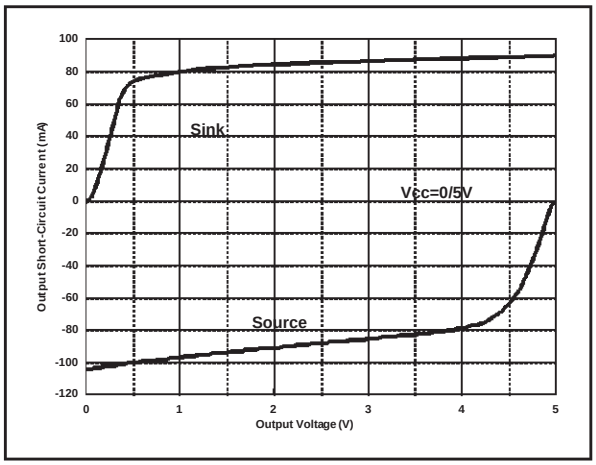
.SUBCKT TS921 1 3 2 4 5 (analog)
**********************************************************
.MODEL MDTH D IS=1E-8 KF=2.664234E-16 CJO=10F
* INPUT STAGE
CIP 2 5 1.000000E-12
CIN 1 5 1.000000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 8.125000E+00
RIN 15 16 8.125000E+00
RIS 11 15 2.238465E+02
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 153.5u
VOFN 13 14 DC 0
IPOL 13 5 3.200000E-05
CPS 11 15 1e-9
DINN 17 13 MDTH 400E-12
VIN 17 5 -0.100000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 0.400000E+00
FCP 4 5 VOFP 1.865000E+02
FCN 5 4 VOFN 1.865000E+02
FIBP 2 5 VOFP 6.250000E-03
FIBN 5 1 VOFN 6.250000E-03
* GM1 STAGE ***************
FGM1P 119 5 VOFP 1.1
FGM1N 119 5 VOFN 1.1
RAP 119 4 2.6E+06
RAN 119 5 2.6E+06
* GM2 STAGE ***************
G2P 19 5 119 5 1.92E-02
G2N 19 5 119 4 1.92E-02
R2P 19 4 1E+07
R2N 19 5 1E+07
**************************
VINT1 500 0 5
GCONVP 500 501 119 4 19.38 !envoie ds VP,
I(VP)=(V119-V4)/2/Ut VP 501 0 0
GCONVN 500 502 119 5 19.38 !envoie ds VN,
I(VN)=(V119-V5)/2/Ut VN 502 0 0
********* orientation isink isource *******
VINT2 503 0 5
FCOPY 503 504 VOUT 1
DCOPYP 504 505 MDTH 400E-9
VCOPYP 505 0 0
DCOPYN 506 504 MDTH 400E-9
VCOPYN 0 506 0
**************************
F2PP 19 5 poly(2) VCOPYP VP 0 0 0 0 0.5 !multiplie
I(vout)*I(VP)=Iout*(V119-V4)/2/Ut
F2PN 19 5 poly(2) VCOPYP VN 0 0 0 0 0.5 !multiplie
I(vout)*I(VN)=Iout*(V119-V5)/2/Ut
F2NP 19 5 poly(2) VCOPYN VP 0 0 0 0 1.75 !multiplie
I(vout)*I(VP)=Iout*(V119-V4)/2/Ut
F2NN 19 5 poly(2) VCOPYN VN 0 0 0 0 1.75 !multiplie
I(vout)*I(VN)=Iout*(V119-V5)/2/Ut
* COMPENSATION ************
CC 19 119 25p
* OUTPUT***********
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 6.250000E+02
VIPM 28 4 5.000000E+01
HONM 21 27 VOUT 6.250000E+02
VINM 5 27 5.000000E+01
VOUT 3 23 0
ROUT 23 19 6
COUT 3 5 1.300000E-10
DOP 19 25 MDTH 400E-12
VOP 4 25 1.052
DON 24 19 MDTH 400E-12
VON 24 5 1.052
.ENDS
```

ELECTRICAL CHARACTERISTICS

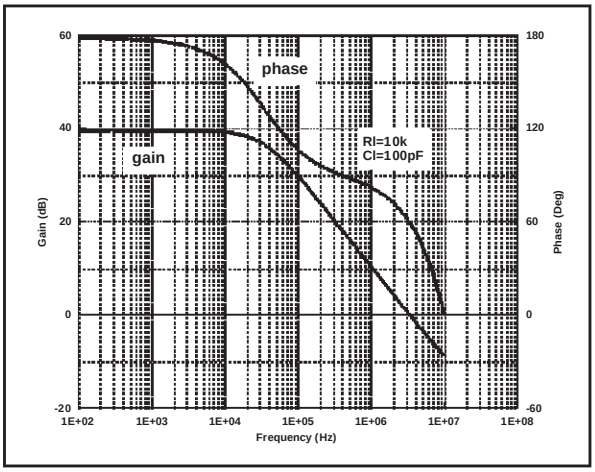
V_{CC}^+ = 3V, V_{CC}- = 0V, R_L, C_L connected to $V_{CC/2}$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{vd}	R_L = 10kΩ	200	V/mV
I_{CC}	No load, per operator	1.2	mA
V_{icm}		-0.2 to 3.2	V
V_{OH}	R_L = 10kΩ	2.95	V
V_{OL}	R_L = 10kΩ	25	mV
I_{sink}	V_O = 3V	80	mA
I_{source}	V_O = 0V	80	mA
GBP	R_L = 600kΩ	4	MHz
SR	R_L = 10kΩ, C_L = 100pF	1.3	V/µs
ϕm	R_L = 600kΩ	68	Degrees

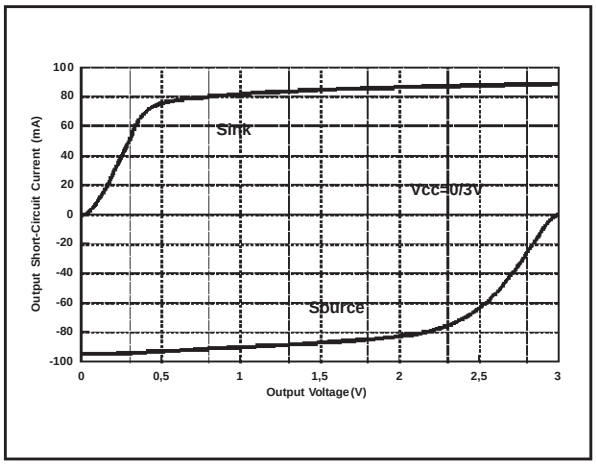
OUTPUT SHORT CIRCUIT CURRENT vs OUTPUT VOLTAGE



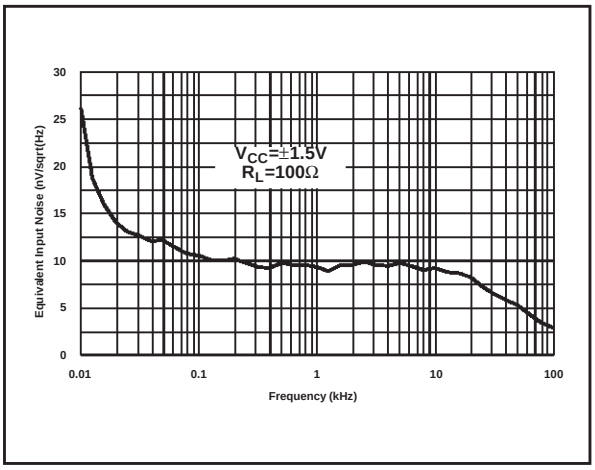
VOLTAGE GAIN AND PHASE vs FREQUENCY



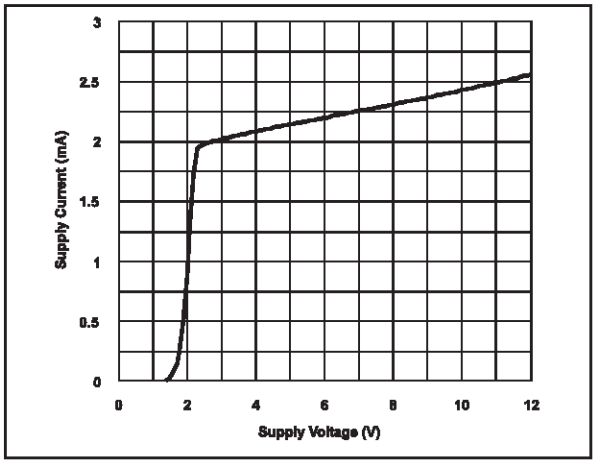
OUTPUT SHORT CIRCUIT CURRENT vs OUTPUT VOLTAGE



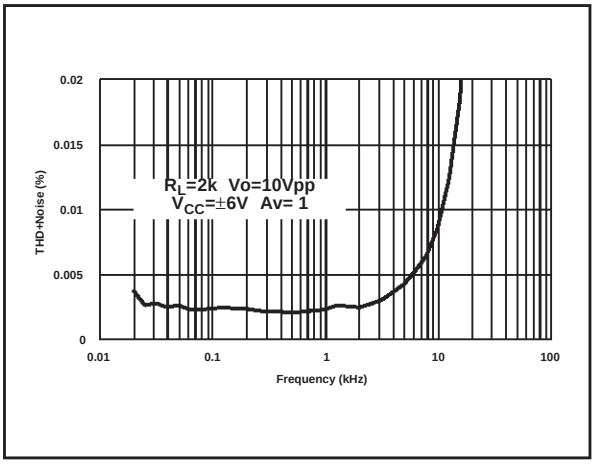
EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY



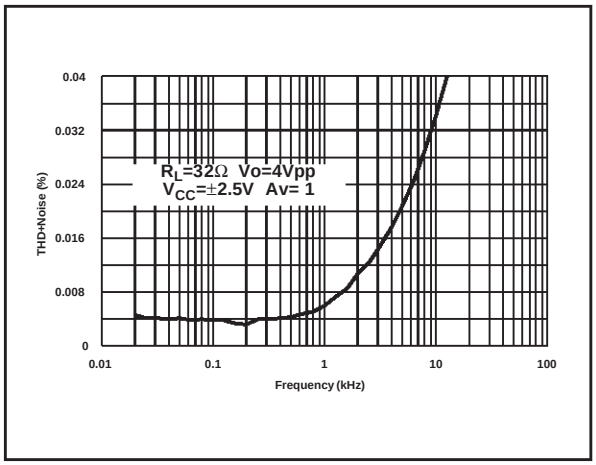
OUTPUT SUPPLY CURRENT vs SUPPLY VOLTAGE



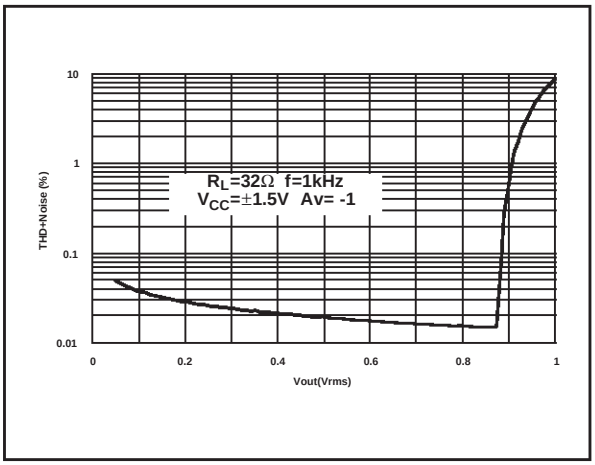
THD + NOISE vs FREQUENCY



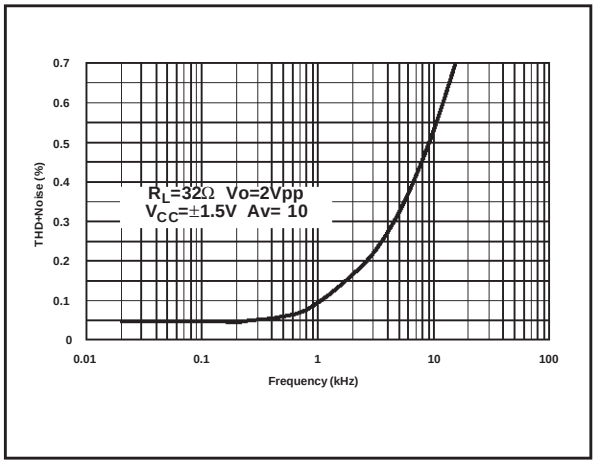
THD + NOISE vs FREQUENCY



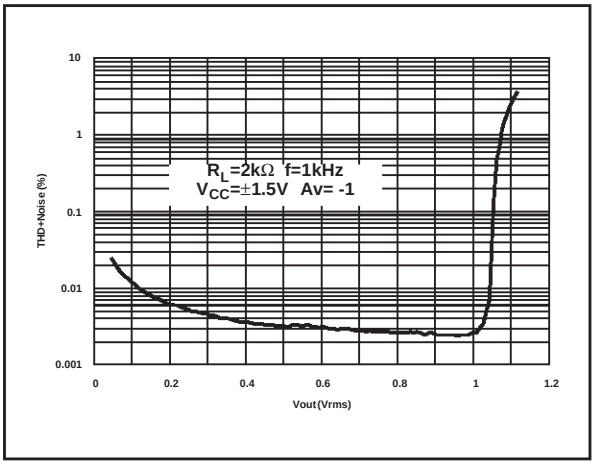
THD + NOISE vs OUTPUT VOLTAGE



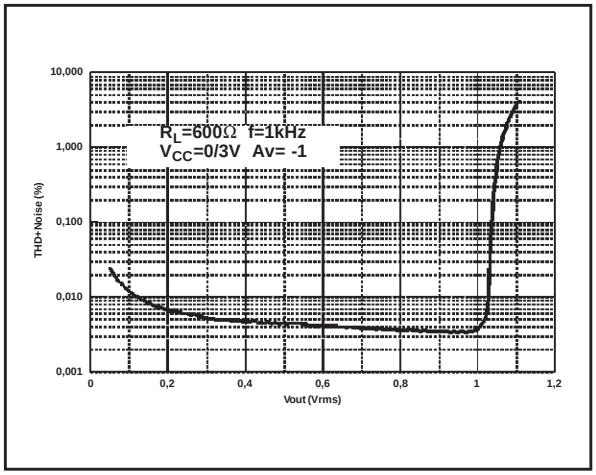
THD + NOISE vs FREQUENCY



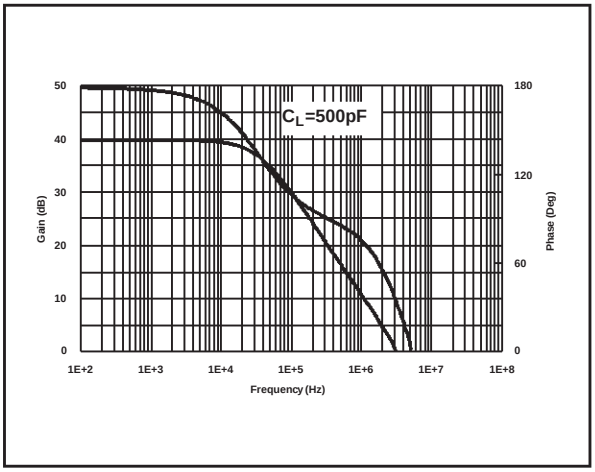
THD + NOISE vs OUTPUT VOLTAGE



THD + NOISE vs OUTPUT VOLTAGE

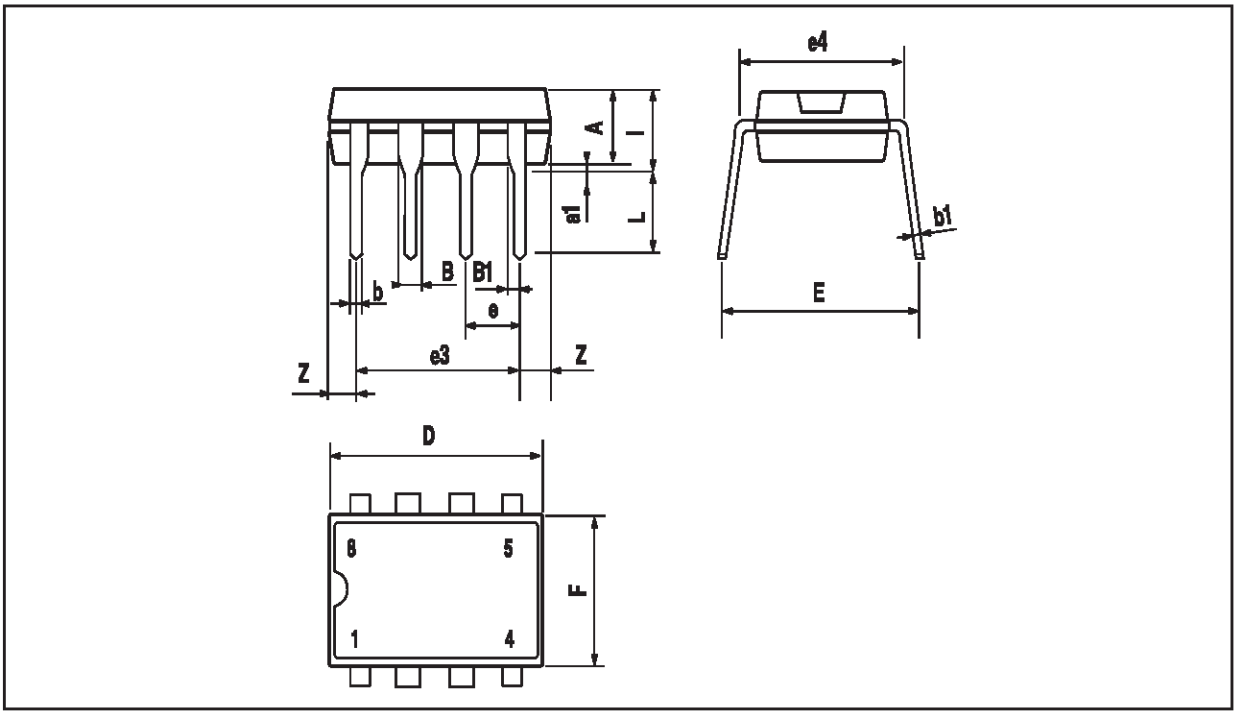


OPEN LOOP GAIN AND PHASE vs FREQUENCY



PACKAGE MECHANICAL DATA

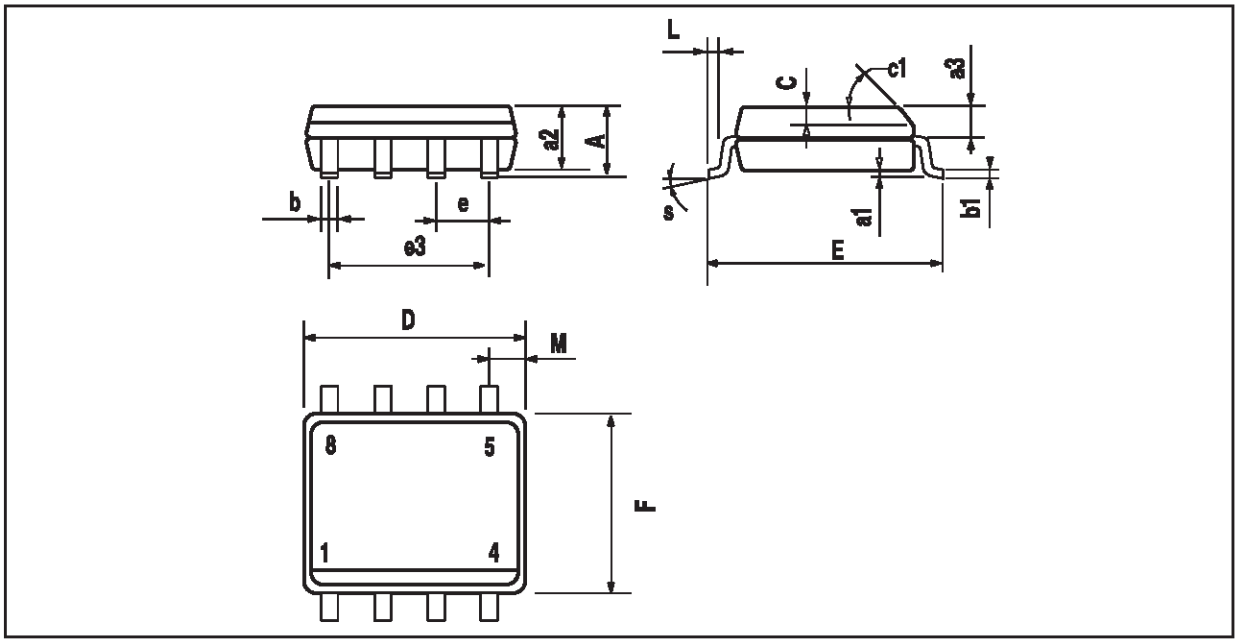
8 PINS - PLASTIC DIP



Dim.	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			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

PACKAGE MECHANICAL DATA

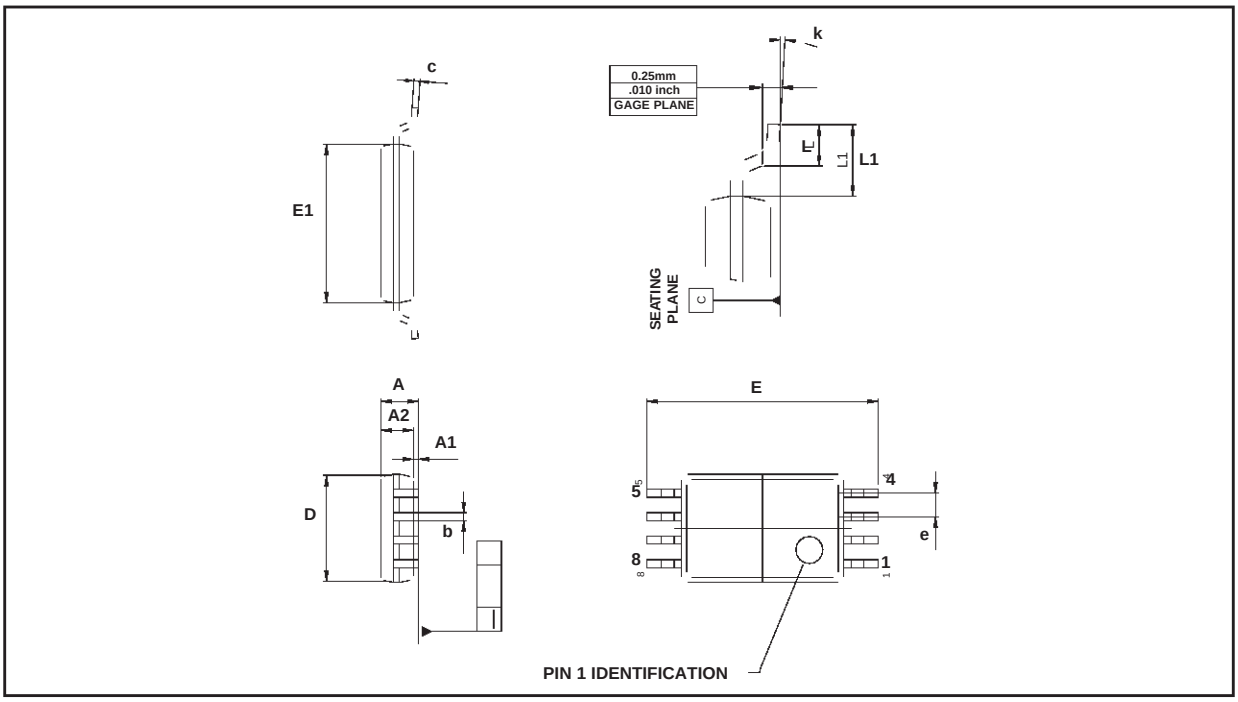
8 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	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.)					

PACKAGE MECHANICAL DATA

8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030
L	0.45	0.600	0.75	0.018	0.024	0.030
L1		1.000			0.039	

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