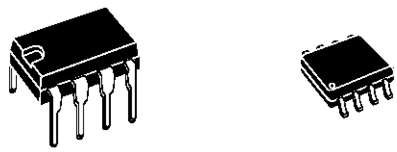
SGS-THOMSON MICROELECTRONICS

TS912

INPUT/OUTPUT **RAIL TO RAIL** DUAL CMOS OPERATIONAL AMPLIFIER

- **RAIL TO RAIL** INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V** (±1.35V to ±8V)
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** TYP
- LOW INPUT OFFSET VOLTAGE : **2mV max.**
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 400µA/Ampli
- SPEED : 1.4MHz - 1.3V/µs
- ESD TOLERANCE : 3KV
- LATCH-UP IMMUNITY
- **SPICE MACROMODEL** INCLUDED IN THIS SPECIFICATION



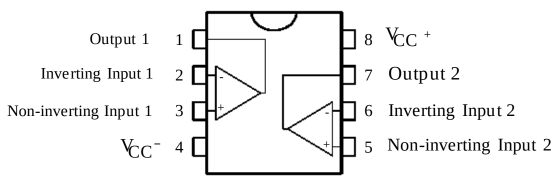
N
DIP8
(Plastic Package)

D
SO8
(Plastic Micropackage)

ORDER CODES

Part Number	Temperature Range	Package	
		N	D
TS912I/AI/BI	-40, +125°C	•	•

PIN CONNECTIONS (top view)



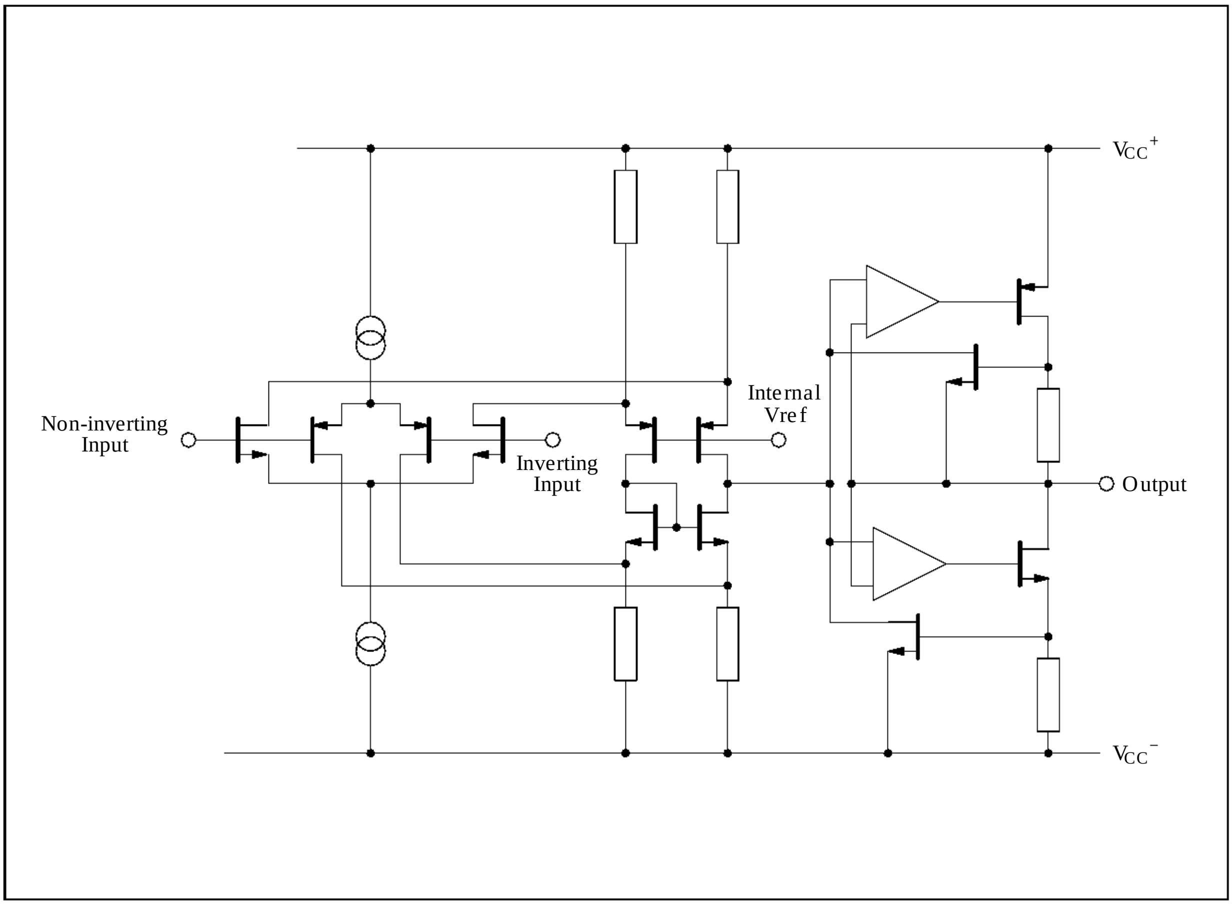
DESCRIPTION

The TS912 is a RAIL TO RAIL dual CMOS operational amplifier designed to operate with single or dual supply voltage.
The input voltage range V_{icm} includes the two supply rails V_{CC}^+ and V_{CC}^-.
The output reaches :

- V_{CC}^- +50mV V_{CC}^+ -50mV with R_L = 10kΩ
- V_{CC}^- +650mV V_{CC}^+ -650mV with R_L = 600Ω

This product offers a broad supply voltage operating range from 2.7V to 16V, a supply current of only 400µA/amp (V_{CC} = 10V) and a high output current capability fixed by an internal limitation circuit : I_{source} = 65mA - I_{sink} = 75mA

SCHEMATIC DIAGRAM (1/2 TS912)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage - (note 1)	18	V
V_{id}	Differential Input Voltage - (note 2)	±18	V
V_i	Input Voltage - (note 3)	-0.3 to 18	V
I_{in}	Current on Inputs	±50	mA
I_o	Current on Outputs	±130	mA
T_{oper}	Operating Free Air Temperature Range TS912I/AI/BI	-40 to +125	°C
T_{stg}	Storage Temperature	-65 to +150	°C

Notes :
1. All voltage values, except differential voltage are with respect to network ground terminal.
2. Differential voltages are 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.

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	2.7 to 16	V
V_{icm}	Common Mode Input Voltage Range	V_{CC}^- -0.2 to V_{CC}^++0.2	V

ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = 10V, V_{CC}^{-} = 0V, R_L,C_L connected to $V_{CC}/2$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	TS912I/AI/BI			Unit
		Min.	Typ.	Max.	
V_{io}	Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$) TS912 TS912A TS912B $T_{min.} \le T_{amb} \le T_{max.}$ TS912 TS912A TS912B			10 5 2 12 7 3	mV
DV_{io}	Input Offset Voltage Drift		5		μV/°C
I_{io}	Input Offset Current - (note 1) $T_{min.} \le T_{amb} \le T_{max.}$		1	100 200	pA
I_{ib}	Input Bias Current - (note 1) $T_{min.} \le T_{amb} \le T_{max.}$		1	150 300	pA
I_{CC}	Supply Current (per amplifier, A_{VCL} = 1, no load) $T_{min.} \le T_{amb} \le T_{max.}$		400	600 700	μA
CMR	Common Mode Rejection Ratio V_{ic} = 3 to 7V, V_o = 5V V_{ic} = 0 to 10V, V_o = 5V	60 50	90 75		dB
SVR	Supply Voltage Rejection Ratio (V_{CC}^{+} = 5 to 10V, $V_O = V_{CC}/2$)	60	90		dB
A_{vd}	Large Signal Voltage Gain (R_L = 10kΩ, V_O = 2.5V to 7.5V) $T_{min.} \le T_{amb} \le T_{max.}$	20 15	60		V/mV
V_{OH}	High Level Output Voltage (V_{id} = 1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min.} \le T_{amb} \le T_{max.}$ R_L = 10kΩ R_L = 600Ω	9.95 9.85 9 9.8 8.8	 9.95 9.35 7.8		V
V_{OL}	Low Level Output Voltage (V_{id} = -1V) R_L = 100kΩ R_L = 10kΩ R_L = 600Ω R_L = 100Ω $T_{min.} \le T_{amb} \le T_{max.}$ R_L = 10kΩ R_L = 600Ω		 50 650 2300	50 150 800 150 900	mV
I_o	Output Short Circuit Current (V_{id} = ±1V) Source ($V_o = V_{CC}^{-}$) Sink ($V_o = V_{CC}^{+}$)	45 50	65 75		mA
GBP	Gain Bandwidth Product (A_{VCL} = 100, R_L = 10kΩ, C_L = 100pF, f = 100kHz)		1.4		MHz
SR^{+}	Slew Rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 2.5V to 7.5V)		1.3		V/μs
SR^{-}	Slew Rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i = 2.5V to 7.5V)		0.8		V/μs
∅m	Phase Margin		40		Degrees
e_n	Equivalent Input Noise Voltage (R_s = 100Ω, f = 1kHz)		30		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_O = 4.75V to 5.25V, f = 1kHz)		0.024		%
C_{in}	Input Capacitance		1.5		pF
V_{O1}/V_{O2}	Channel Separation (f = 1kHz)		120		dB

Note 1 : Maximum values including unavoidable inaccuracies of the industrial test.

TYPICAL CHARACTERISTICS

Figure 1 : Supply Current (each amplifier) versus Supply Voltage

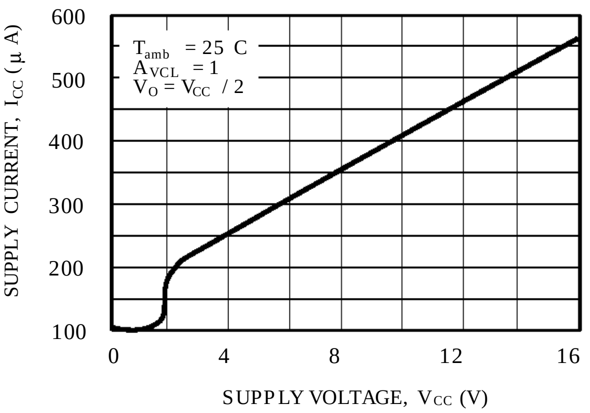


Figure 2 : Input Bias Current versus Temperature

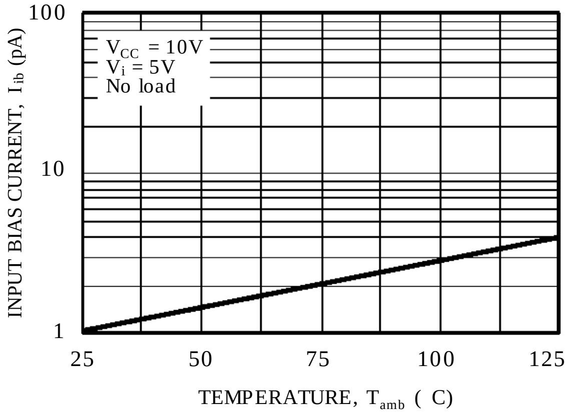


Figure 3a : High Level Output Voltage versus High Level Output Current

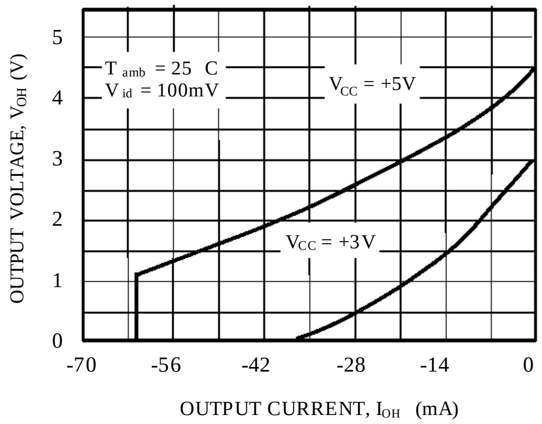


Figure 3b : High Level Output Voltage versus High Level Output Current

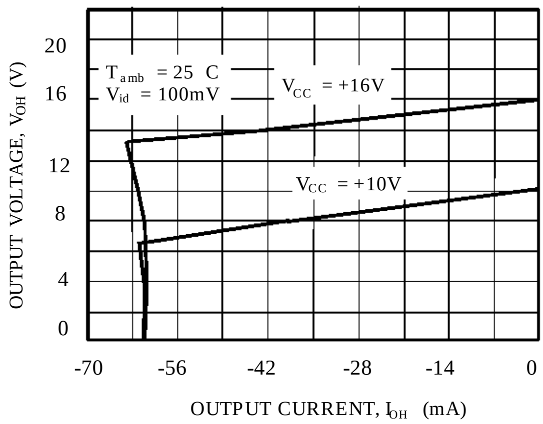


Figure 4a : Low Level Output Voltage versus Low Level Output Current

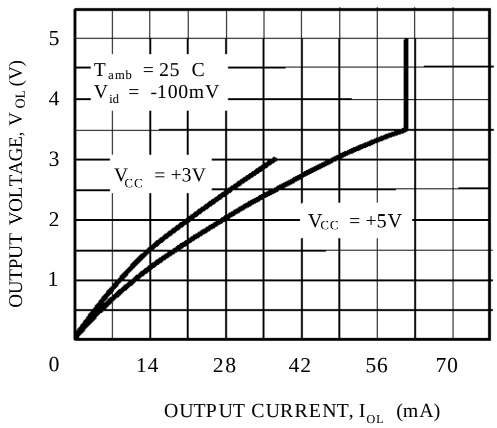


Figure 4b : Low Level Output Voltage versus Low Level Output Current

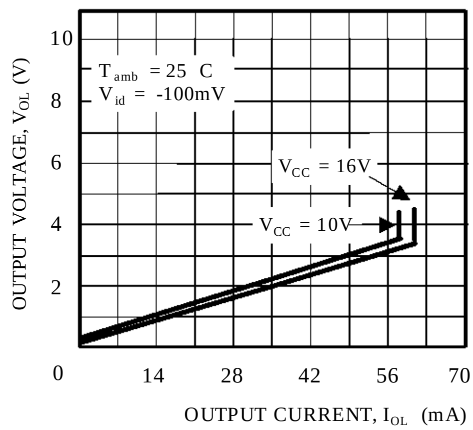


Figure 5a : Open Loop Frequency Response and Phase Shift

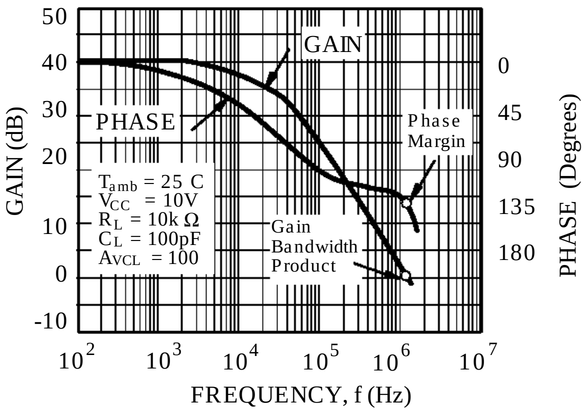


Figure 5b : Open Loop Frequency Response and Phase Shift

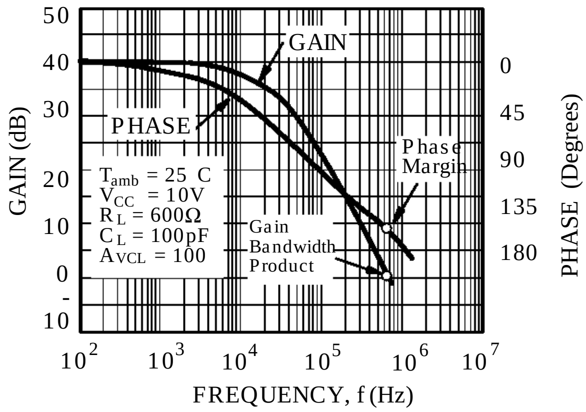


Figure 6a : Gain Bandwidth Product versus Supply Voltage

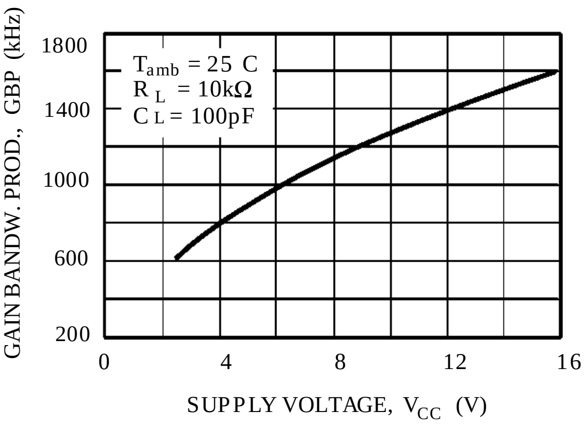


Figure 6b : Gain bandwidth Product versus Supply Voltage

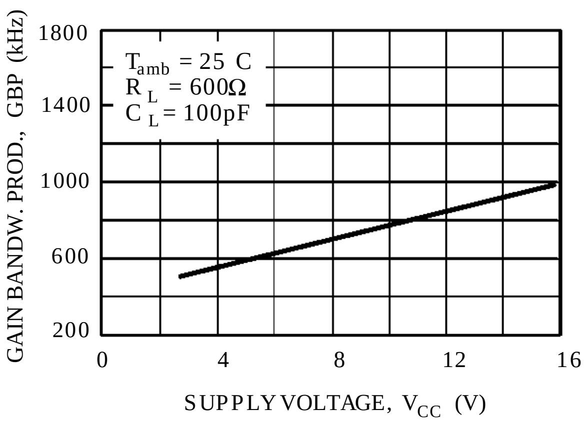


Figure 7a : Phase Margin versus Supply Voltage

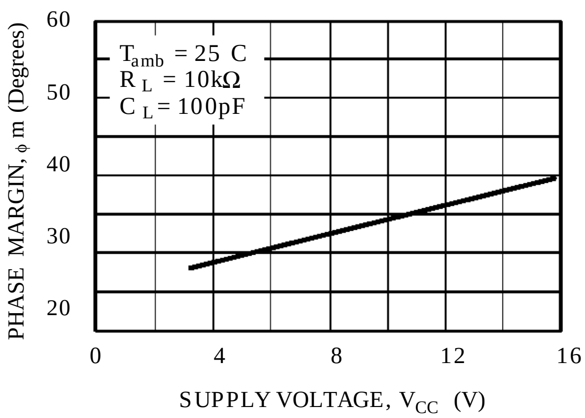


Figure 7b : Phase Margin versus Supply Voltage

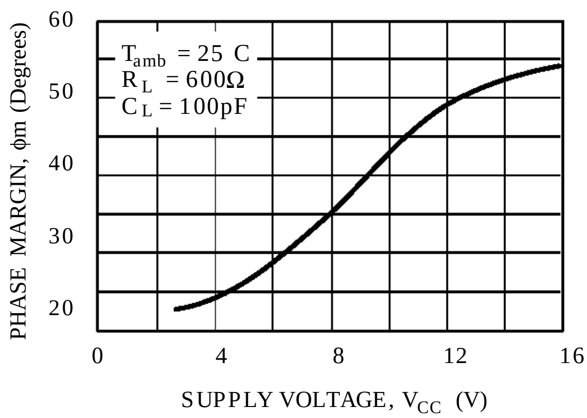
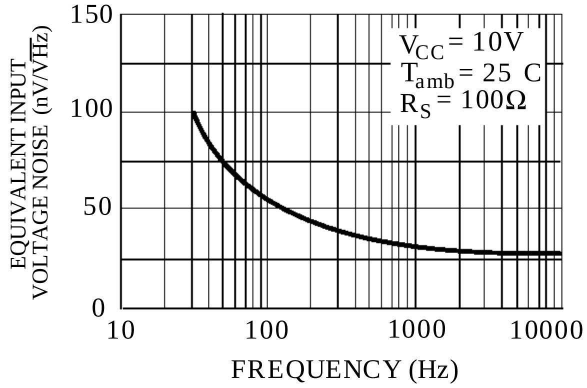
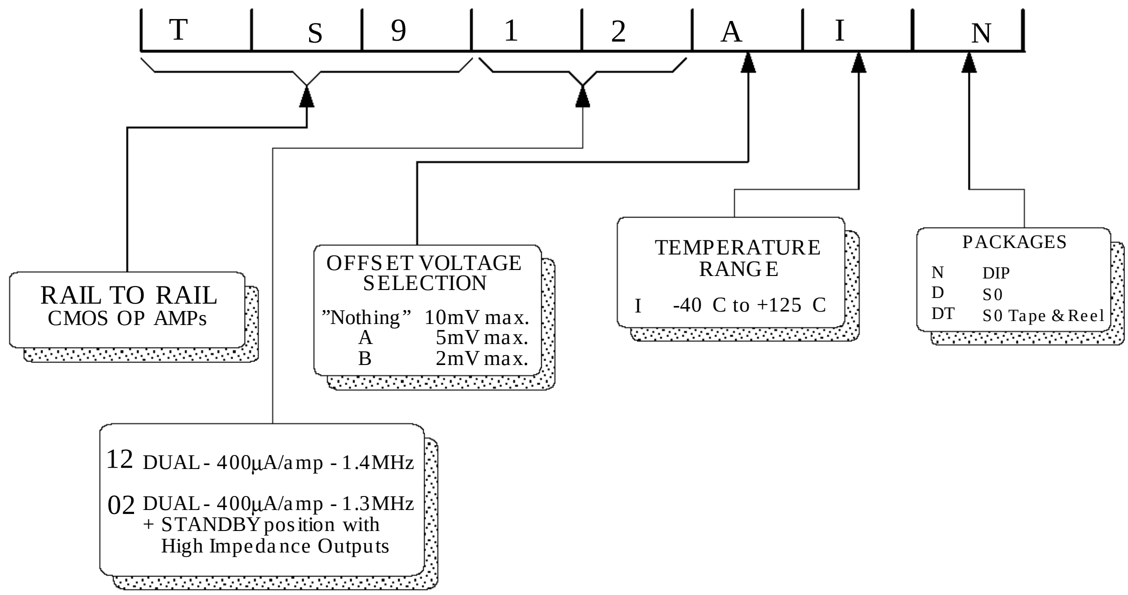


Figure 8 : Input Voltage Noise versus Frequency



ORDERING INFORMATION



MACROMODEL

- **RAIL TO RAIL** INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V** (±1.35V to ±8V)
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA typ.**
- LOW INPUT OFFSET VOLTAGE : **2mV max.**
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 400µA/Ampli
- SPEED : 1.4MHz - 1.3V/µs

Applies to : TS912I,AI

```
** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY

.SUBCKT TS912 1 3 2 4 5 (analog)
**********************************************************
.MODEL MDTH D IS=1E-8 KF=6.563355E-14 CJO=10F
* INPUT STAGE
CIP 2 5 1.500000E-12
CIN 1 5 1.500000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 6.500000E+00
RIN 15 16 6.500000E+00
RIS 11 15 7.655100E+00
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0.000000E+00
VOFN 13 14 DC 0
IPOL 13 5 4.000000E-05
CPS 11 15 3.82E-08
DINN 17 13 MDTH 400E-12
VIN 17 5 -0.5000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 -0.5000000E+00
FCP 4 5 VOFP 7.750000E+00
FCN 5 4 VOFN 7.750000E+00
* AMPLIFYING STAGE
FIP 5 19 VOFP 5.500000E+02
FIN 5 19 VOFN 5.500000E+02
RG1 19 5 5.087344E+05
RG2 19 4 5.087344E+05
CC 19 29 2.200000E-08
HZTP 30 29 VOFP 12.33E+02
HZTN  5 30 VOFN 12.33E+02
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 3135
VIPM 28 4 150
HONM 21 27 VOUT 3135
VINM 5 27 150
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 65
COUT 3 5 1.000000E-12
DOP 19 68 MDTH 400E-12
VOP 4 25 1.924
HSCP 68 25 VSCP1 1E8
DON 69 19 MDTH 400E-12
VON 24 5 2.4419107
HSCN 24 69 VSCN1 1.5E8
VSCTHP 60 61 0.1375
DSCP1 61 63 MDTH 400E-12
VSCP1 63 64 0
ISCP 64 0 1.000000E-8
DSCP2 0 64 MDTH 400E-12
DSCN2 0 74 MDTH 400E-12
ISCN 74 0 1.000000E-8
VSCN1 73 74 0
DSCN1 71 73 MDTH 400E-12
VSCTHN 71 70 -0.75
ESCP 60 0 2 1 500
ESCN 70 0 2 1 -2000
.ENDS
```

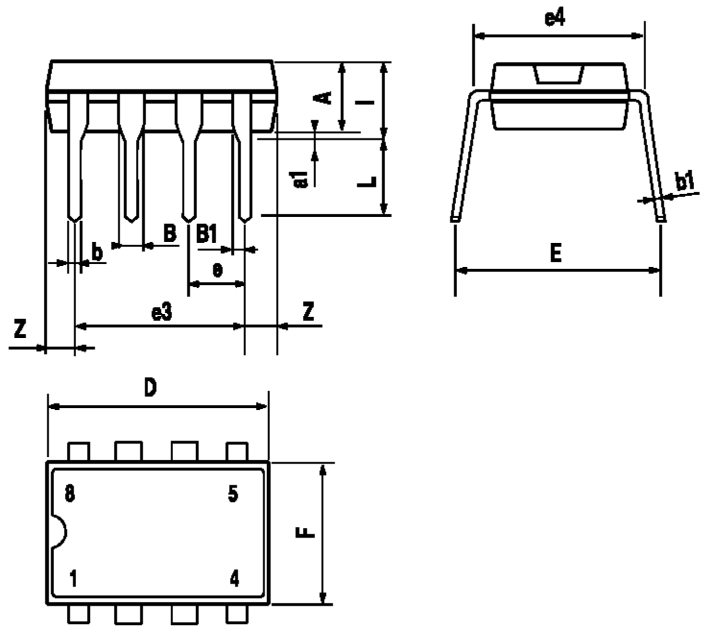
ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = 10V, 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	20	V/mV
I_{CC}	No load, per operator	350	μA
V_{icm}		-0.2 to 10.2	V
V_{OH}	R_L = 10kΩ	9.95	V
V_{OL}	R_L = 10kΩ	50	mV
I_{sink}	V_O = 10V	50	mA
I_{source}	V_O = 0V	50	mA
GBP	R_L = 10kΩ, C_L = 100pF	1	MHz
SR	R_L = 10kΩ, C_L = 100pF	1	V/μs
∅m	R_L = 10kΩ, C_L = 100pF	40	Degrees

PACKAGE MECHANICAL DATA

8 PINS - PLASTIC DIP



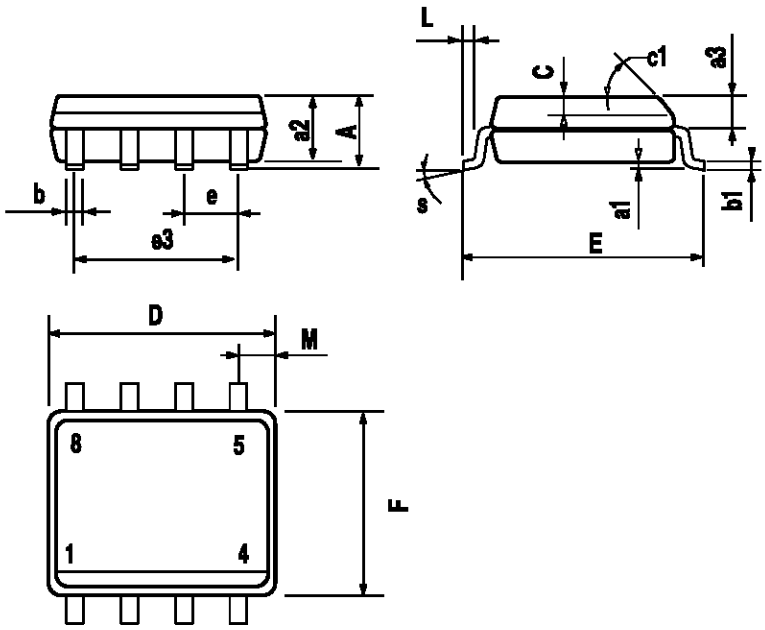
PM-DIP8.EPS

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			0260
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.)					

S08.TBL

Information furnished is believed to be accurate and reliable. However, SGS-THOMSON Microelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of SGS-THOMSON Microelectronics. Specification mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. SGS-THOMSON Microelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of SGS-THOMSON Microelectronics.

© 1996 SGS-THOMSON Microelectronics – Printed in Italy – All Rights Reserved

SGS-THOMSON Microelectronics GROUP OF COMPANIES

Australia - Brazil - Canada - China - France - Germany - Hong Kong - Italy - Japan - Korea - Malaysia - Malta - Morocco The Netherlands - Singapore - Spain - Sweden - Switzerland - Taiwan - Thailand - United Kingdom - U.S.A.

ORDER CODE :