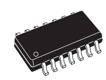
TS902

RAIL TO RAIL CMOS DUAL OPERATIONAL AMPLIFIER (WITH STANDBY POSITION)

- RAIL TO RAIL INPUT AND OUTPUT VOLTAGE RANGES
- **STANDBY** POSITION : REDUCED CONSUMPTION (0.5µA) AND HIGH IMPEDANCE OUTPUTS
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V**
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** typ
- LOW INPUT OFFSET VOLTAGE : **5mV max.**
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 200µA/Ampli (V_{CC} = 3V)
- **SPICE MACROMODEL** INCLUDED IN THIS SPECIFICATION

N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)



D
SO14
(Plastic Micropackage)

DESCRIPTION

The TS902 is a RAIL TO RAIL CMOS dual operational amplifier designed to operate with a 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}^- +350mV V_{CC}^+ -400mV with R_L = 600Ω

This product offers a broad supply voltage operating range from 2.7V to 16V and a supply current of only 200µA/amp. (V_{CC} = 3V).

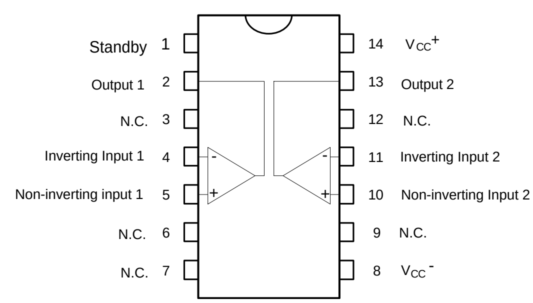
Source and sink output current capability is typically 40mA (at V_{CC} = 3V), fixed by an internal limitation circuit.

The TS902 can be put on STANDBY position (only 0.5µA and high impedance outputs).

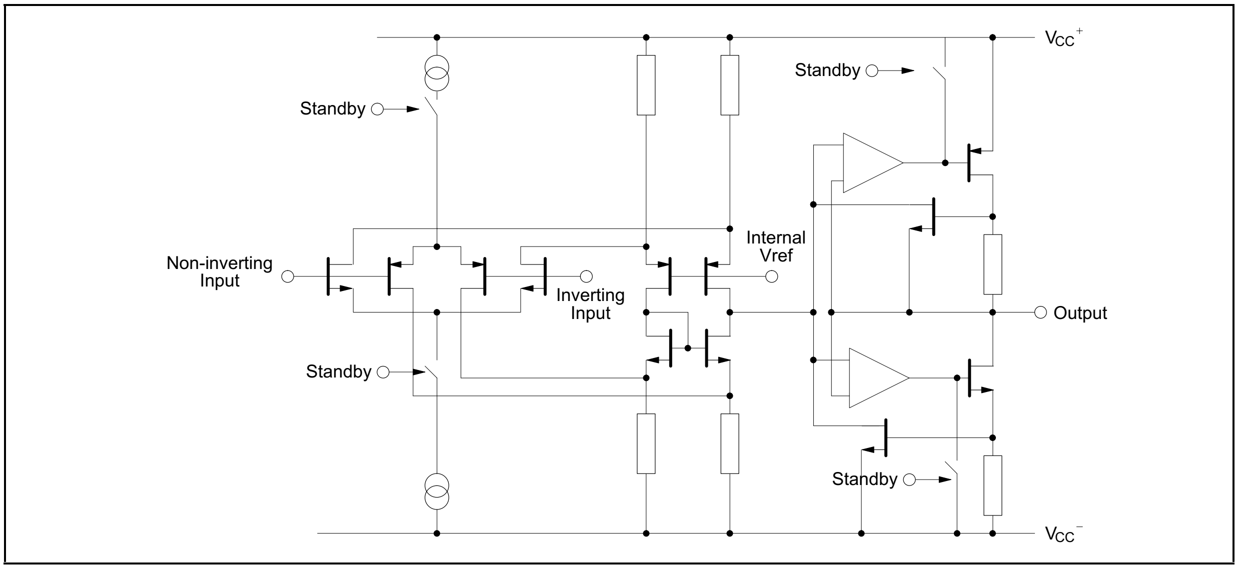
ORDER CODE

Part Number	Temperature Range	Package
		D
TS902I	-40, +125°C	•

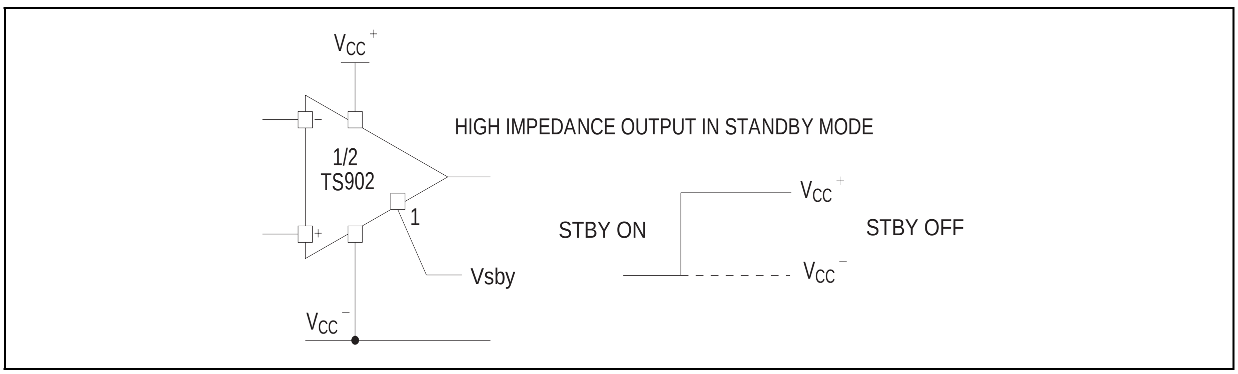
PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM (1/2 TS902)



STANDBY POSITION



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage 1)	18	V
V_{id}	Differential Input Voltage 2)	±18	V
V_i	Input Voltage 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 TS902I	-40 to + 125	°C
T_{stg}	Storate Temperature	-65 to +150	°C

1. All voltages values, except differential voltage are with respect to network ground terminal.
2. Differential voltagesare 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 $V_{CC/2}$, Standby OFF, $T_{amb} = 25°C$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage ($V_{ic} = V_o = V_{CC/2}$) TS902 $T_{min.} \le T_{amb} \le T_{max.}$ TS902			10 12	mV
ΔV_{io}	Input Offset Voltage Drift		5		µV/°C
I_{io}	Input Offset Current [1] $T_{min.} \le T_{amb} \le T_{max.}$		1	100 200	pA
I_{ib}	Input Bias Current [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 $10V$, $V_o = 5V$		 90 75		dB
SVR	Supply Voltage Rejection Ratio ($V_{CC}^+ = 5$ to $10V$, $V_o = V_{CC/2}$)		90		dB
A_{vd}	Large Signal Voltage Gain ($R_L = 10k\Omega$, $V_o = 2.5V$ to $7.5V$) $T_{min.} \le T_{amb} \le T_{max.}$	15 10	60		V/mV
V_{OH}	High Level Output Voltage ($V_{id} = 1V$) $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \le T_{amb} \le T_{max.}$ $R_L = 10k\Omega$ $R_L = 600\Omega$	9.85 9 9.8 9	9.95 9.35 7.8		V
V_{OL}	Low Level Output Voltage ($V_{id} = -1V$) $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \le T_{amb} \le T_{max.}$ $R_L = 10k\Omega$ $R_L = 600\Omega$		50 650 2300	150 800 150 900	mV
I_o	Output Short Circuit Current ($V_{id} = \pm 1V$) Source ($V_o = V_{CC}$) Sink ($V_o = V_{CC}^+$)		60 60		mA
GBP	Gain Bandwith Product ($A_{VCL} = 100$, $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$)		1.4		MHz
SR	Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 2.5V$ to $7.5V$)		1		V/µs
ϕm	Phase Margin		40		Degrees
en	Equivalent Input Noise Voltage ($R_s = 100\Omega$, $f = 1kHz$)		30		$nV/\sqrt{Hz}$
THD	Total Harmonic Distortion ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_o = 4.75V$ to $5.25V$, $f = 1kHz$)		0.02		%
C_{in}	Input Capacitance		1.5		pF
V_{O1}/V_{O2}	Channel Separation (f = 1kHz)		120		dB

1. Maximum values including unavoidable inaccuracies of the industrial test

STANDBY MODE

$V_{CC}^+ = 10V$, $V_{cc}^- = 0V$, $T_{amb} = 25°C$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{inSBY/ON}$	Pin 1 Threshold Voltage for STANDBY ON		8.2		V
$V_{inSBY/OFF}$	Pin 1 Threshold Voltage for STANDBY OFF		8.5		V
$I_{CC\ SBY}$	Total Consumption in Standby Position (STANDBY ON)		1		µA

TYPICAL CHARACTERISTICS

Figure 1a : Supply Current (each amplifier) vs Supply Voltage

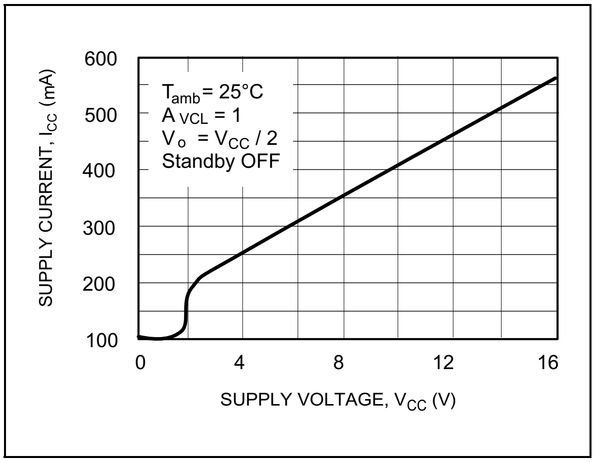


Figure 1b : Supply Current (each amplifier) vs Supply Voltage (in STANDBY mode)

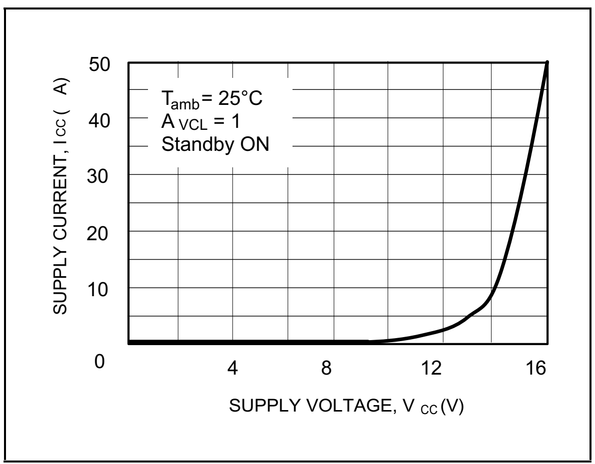


Figure 2 : Input Bias Current vs Temperature

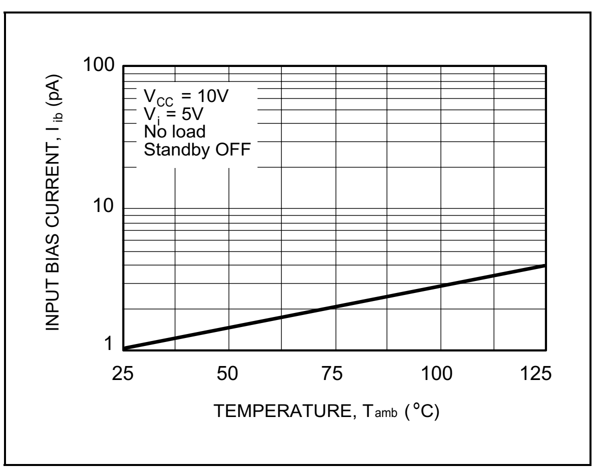


Figure 3a : High Level Output Voltage vs High Level Output Current

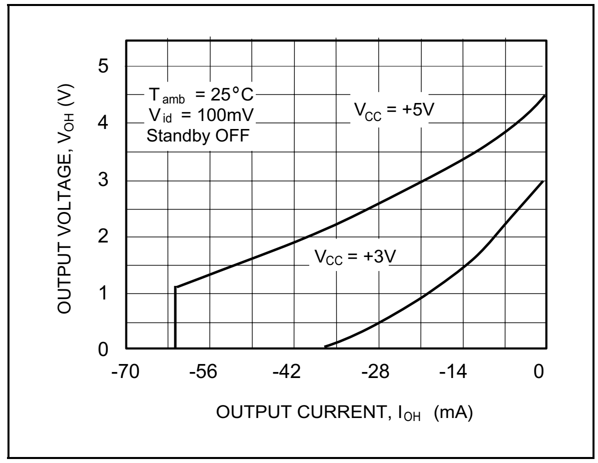


Figure 3b : High Level Output Voltage vs High Level Output Current

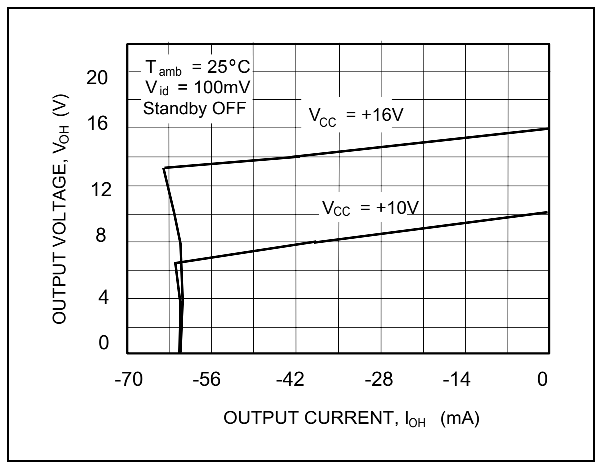


Figure 4a : Low Level Output Voltage vs Low Level Output Current

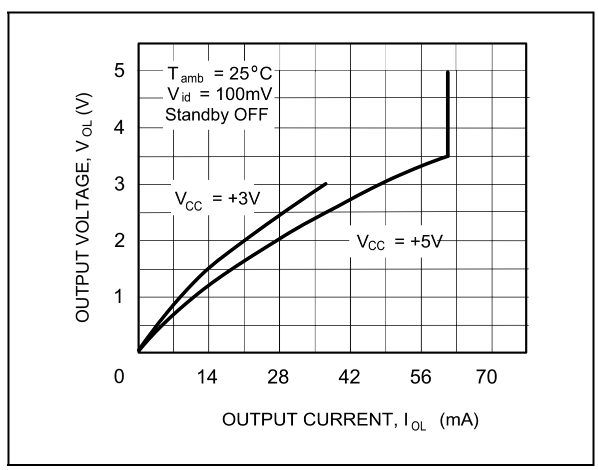


Figure 4b : Low Level Output Voltage vs Low Level Output Current

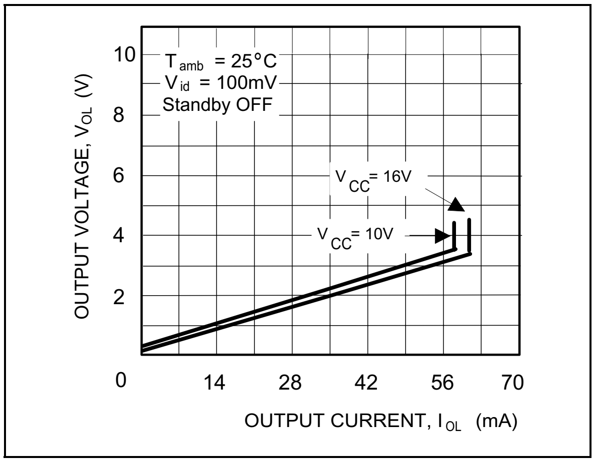


Figure 5a : Gain and Phase vs Frequency

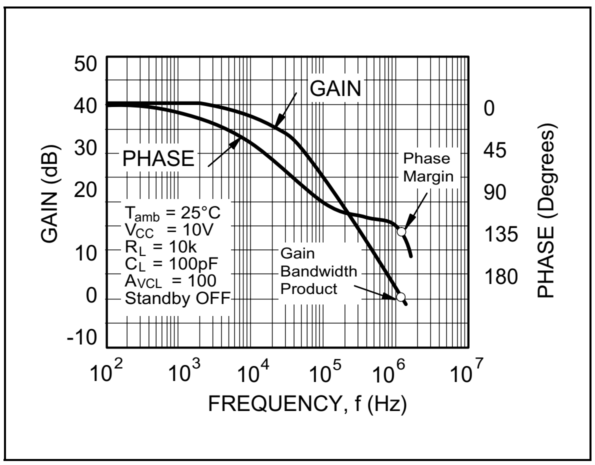


Figure 5b : Gain and Phase vs Frequency

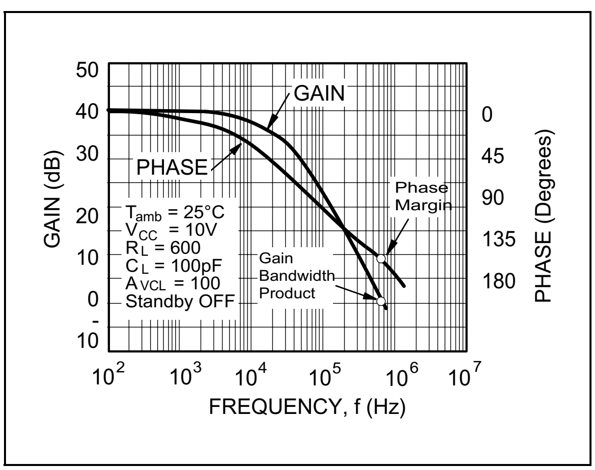


Figure 6a : Gain Bandwidth Product vs Supply Voltage

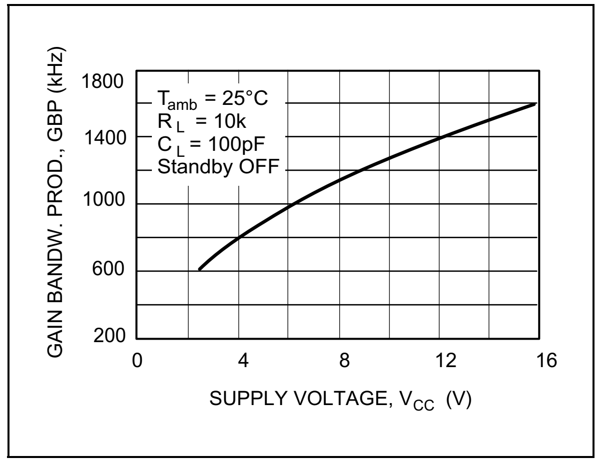


Figure 6b : Gain Bandwidth Product vs Supply Voltage

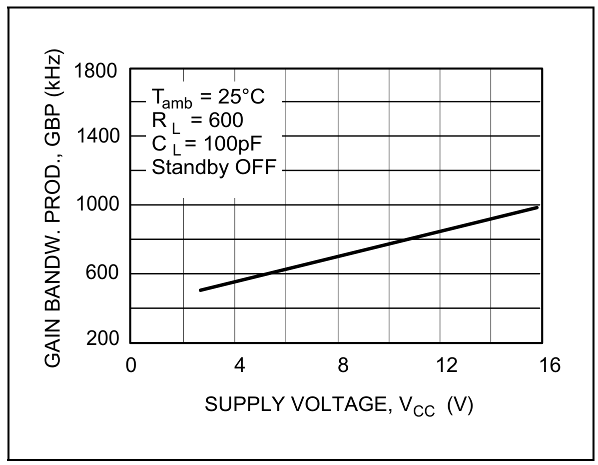


Figure 7a : Phase Margin vs Supply Voltage

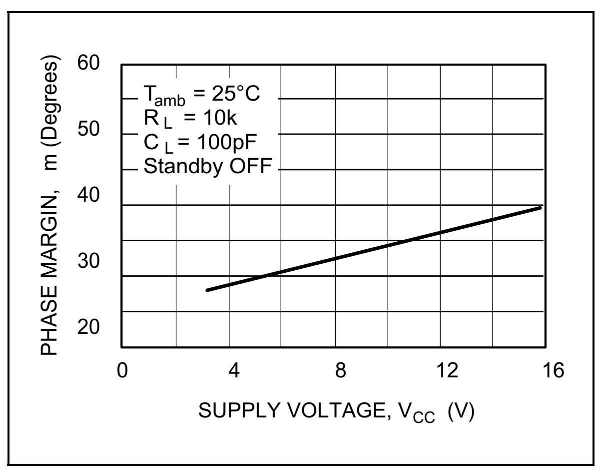


Figure 7b : Phase Margin vs Supply Voltage

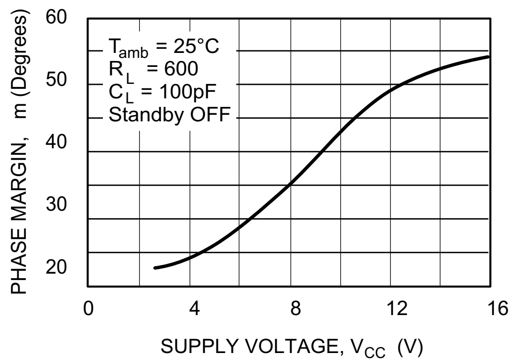
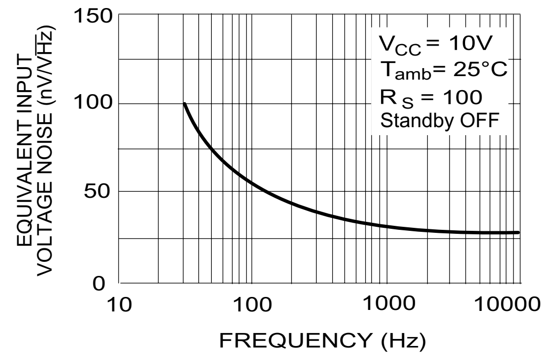


Figure 8 : Input Voltage Noise vs Frequency



STANDBY APPLICATION

The two operators of the TS902 are **both** put on **STANDBY**.
In this configuration (standby ON) :

- ❑ The **total consumption** of the circuit is considerably reduced down to 0.5µA (V_{CC} = 3V). This standby consumption vs V_{CC} curve is given figure 1b.
- ❑ The **both outputs** are in **high impedance** state. No output current can then be sourced or sinked by the device.

The standby pin 1 should never stay unconnected.

- ❑ The **“standby OFF”** state, is reached when the pin 1 voltage is **higher than $V_{in\ SBY/OFF}$**.
- ❑ The **“standby ON”** state is assured by a pin 1 voltage **lower than $V_{in\ SBY/ON}$**. (see electrical characteristics)

MACROMODELS
Applies to : TS902I

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

.SUBCKT TS902 1 3 2 4 5 6 (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 0 2 0 1
EIN 16 0 1 0 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
FPOL 13 0 VSTB 1
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 8.6E+00
FCN 5 4 VOFN 8.6E+00
ISTB0 5 4 900NA
* AMPLIFYING STAGE
FIP 0 19 VOFP 5.500000E+02
FIN 0 19 VOFN 5.500000E+02
RG1 19 120 5.087344E+05
GCOM1 120 5 POLY(1) 110 109 LEVEL=1 6.25E+11
RG2 121 19 5.087344E+05
GCOM2 121 4 POLY(1) 110 109 LEVEL=1  6.25E+11
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 26 103 65
COUT 103 5 1.000000E-12
GCOM 103 3 POLY(1) 110 109 LEVEL=1  6.25E+11
* OUTPUT SWING
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
* STAND BY
RMI1 4 111 1E+12
RMI2 5 111 1E+12
RSTBIN 6 0 1E+12
ESTBIN 106 0 6 0 1
ESTBREF 106 107 111 0 1
DSTB1 107 108 MDTH 400E-12
VSTB 108 109 0
ISTB 109 0 40U
RSTB 109 110 1
DSTB2 0 110 MDTH 400E-12
.ENDS
```

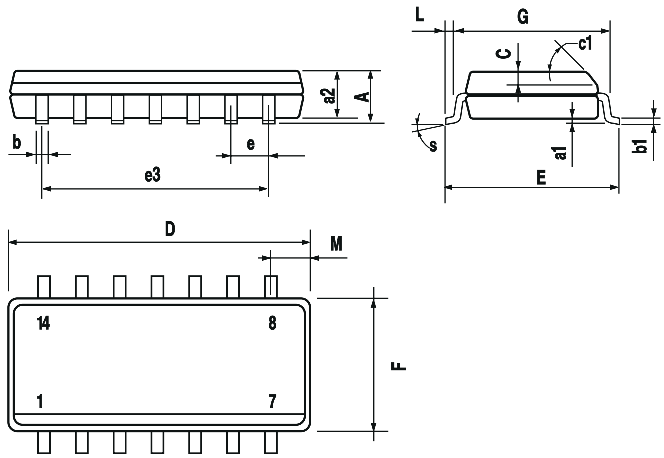
ELECTRICAL CHARACTERISTICS

$V_{CC}^{+} = 5V$, $V_{CC}- = 0V$, R_L, C_L connected to $V_{CC/2}$, Standby OFF, $T_{amb} = 25°C$ (unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{vd}	$R_L = 10k\Omega$	30	V/mV
I_{CC}	No load, per operator	230	µA
V_{icm}		-0.2 to 5.2	V
V_{OH}	$R_L = 10k\Omega$	4.95	V
V_{OL}	$R_L = 10k\Omega$	50	mV
I_{sink}	$V_O = 10V$	60	mA
I_{source}	$V_O = 0V$	60	mA
GBP	$R_L = 10k\Omega$, $C_L = 100pF$	0.8	MHz
SR	$R_L = 10k\Omega$, $C_L = 100pF$	0.8	V/µs
ϕm	$R_L = 10k\Omega$, $C_L = 100pF$	30	Degrees
$I_{CC\ STBY}$	$V_{STBY} = 0V$	500	nA

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F (1)	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

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