# TS3V902

## 3V RAIL TO RAIL CMOS DUAL OPERATIONAL AMPLIFIER (WITH STANDBY POSITION)

- DEDICATED TO **3.3V** OR **BATTERY SUPPLY** (specified at 3V and 5V)
- 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
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 200µA/Ampli

- **SPICE MACROMODEL** INCLUDED IN THIS SPECIFICATION

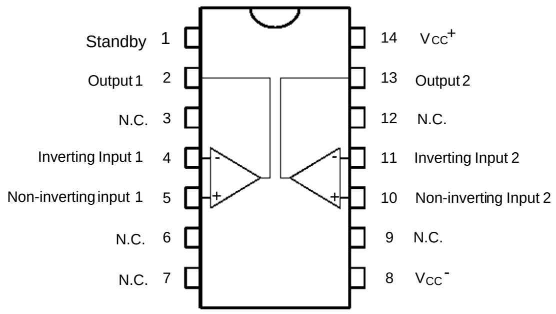
**N**
**DIP14**
(Plastic Package)

**D**
**SO14**
(Plastic Micropackage)

### ORDER CODES

| Part Number | Temperature Range | Package | |
|---|---|---|---|
| | | N | D |
| TS3V902I/AI | -40, +125°C | • | • |

### PIN CONNECTIONS (top view)




### DESCRIPTION

The TS3V902 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 ($V_{CC}$ = 5V) :

- $V_{CC}^-$ +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 TS3V902 can be put on STANDBY position (only 0.5µA and high impedance outputs).

SGS-THOMSON is offering a quad op-amp with the same features : TS3V904.

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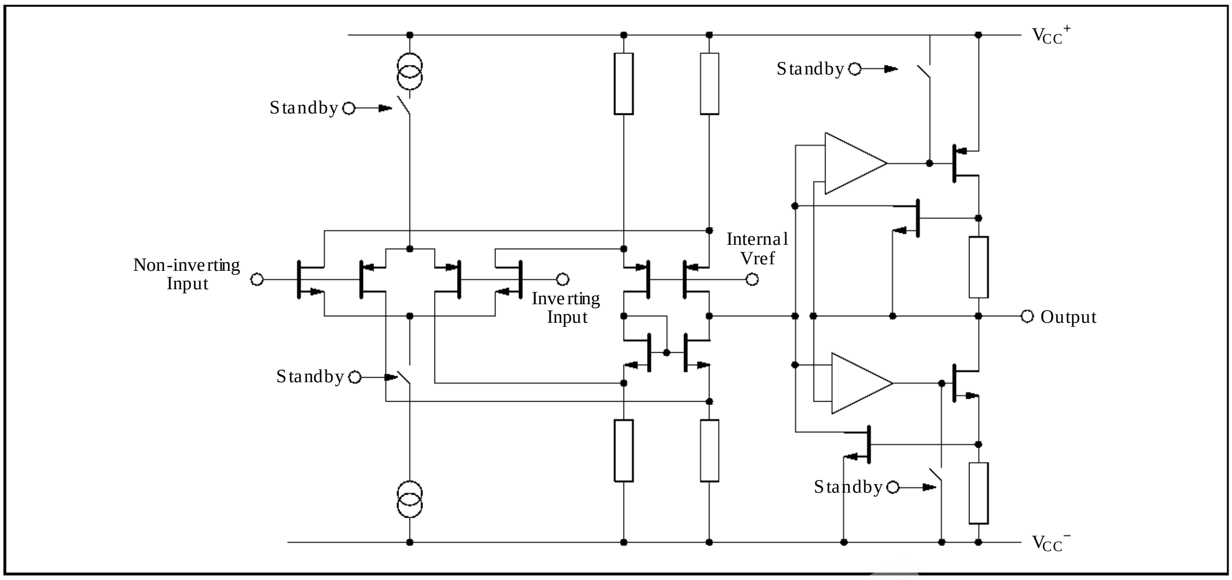
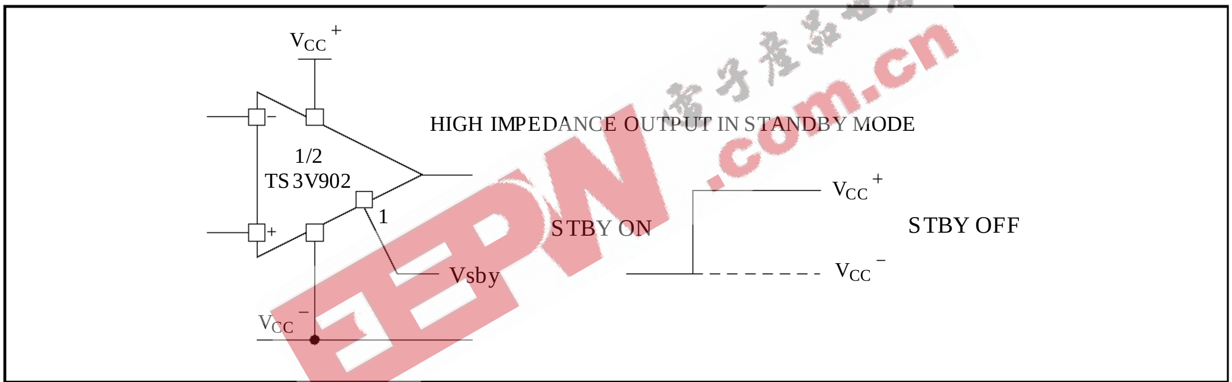
## SCHEMATIC DIAGRAM (1/2 TS3V902)




## STANDBY POSITION

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## 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<br>TS3V902I/AI | -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

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

| Symbol | Parameter | TS3V902I/AI | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $V_{io}$ | Input Offset Voltage ($V_{ic}$ = $V_o$ = $V_{CC}/2$) TS3V902<br>TS3V902A<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ TS3V902<br>TS3V902A | | | 10<br>5<br>12<br>7 | mV |
| $DV_{io}$ | Input Offset Voltage Drift | | 5 | | µV/°C |
| $I_{io}$ | Input Offset Current - (note 1)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 100<br>200 | pA |
| $I_{ib}$ | Input Bias Current - (note 1)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 150<br>300 | pA |
| $I_{CC}$ | Supply Current (per amplifier, $A_{VCL}$ = 1, no load)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 200 | 300<br>400 | µA |
| CMR | Common Mode Rejection Ratio<br>$V_{ic}$ = 0 to 3V, $V_o$ = 1.5V | | 60 | | dB |
| SVR | Supply Voltage Rejection Ratio ($V_{CC}^{+}$ = 2.7 to 3.3V, $V_O$ = $V_{CC}$ /2) | | 80 | | dB |
| $A_{vd}$ | Large Signal Voltage Gain ($R_L$ = 10kΩ, $V_O$ = 1.2V to 1.8V)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 3<br>2 | 10 | | V/mV |
| $V_{OH}$ | High Level Output Voltage ($V_{id}$ = 1V) $R_L$ = 10kΩ<br>$R_L$ = 600Ω<br>$R_L$ = 100Ω<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L$ = 10kΩ<br>$R_L$ = 600Ω | 2.9<br>2.2<br><br>2.8<br>2.1 | 2.97<br>2.7<br>2 | | V |
| $V_{OL}$ | Low Level Output Voltage ($V_{id}$ = -1V $R_L$ = 10kΩ<br>$R_L$ = 600Ω<br>$R_L$ = 100Ω<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L$ = 10kΩ<br>$R_L$ = 600Ω | | 30<br>250<br>900 | 100<br>600<br><br>150<br>900 | mV |
| $I_o$ | Output Short Circuit Current ($V_{id}$ = ±1V) Source ($V_o$ = $V_{CC}^{-}$)<br>Sink ($V_o$ = $V_{CC}^{+}$) | | 40<br>40 | | mA |
| GBP | Gain Bandwidth Product<br>($A_{VCL}$ = 100, $R_L$ = 10kΩ, $C_L$ = 100pF, f = 100kHz) | | 0.7 | | MHz |
| SR | Slew Rate ($A_{VCL}$ = 1, $R_L$ = 10kΩ, $C_L$ = 100pF, $V_i$ = 1.3V to 1.7V) | | 0.5 | | V/µs |
| ∅m | Phase Margin | | 30 | | Degrees |
| $e_n$ | Equivalent Input Noise Voltage ($R_s$ = 100Ω, f = 1kHz) | | 30 | | $\frac{nV}{\sqrt{Hz}}$ |
| $V_{O1}/V_{O2}$ | Channel Separation (f = 1kHz) | | 120 | | dB |

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

## STANDBY MODE

$V_{CC}^{+}$ = 3V, $V_{CC}^{-}$ = 0V, $T_{amb}$ = 25°C (unless otherwise specified)

| Symbol | Parameter | TS3V902I/AI | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $V_{inSBY/ON}$ | Pin 1 Threshold Voltage for STANDBY ON | | 1.2 | | V |
| $V_{inSBY/OFF}$ | Pin 1 Threshold Voltage for STANDBY OFF | | 1.2 | | V |
| $I_{CC\ SBY}$ | Total Consumption in Standby Position (STANDBY ON) | | 0.5 | | µA |

## ELECTRICAL CHARACTERISTICS

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

| Symbol | Parameter | TS3V902I/AI Min. | TS3V902I/AI Typ. | TS3V902I/AI Max. | Unit |
|---|---|---|---|---|---|
| $V_{io}$ | Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$) TS3V902<br>TS3V902A<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ TS3V902<br>TS3V902A | | | 10<br>5<br>12<br>7 | mV |
| $DV_{io}$ | Input Offset Voltage Drift | | 5 | | µV/°C |
| $I_{io}$ | Input Offset Current - (note 1)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 100<br>200 | pA |
| $I_{ib}$ | Input Bias Current - (note 1)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 150<br>300 | pA |
| $I_{CC}$ | Supply Current (per amplifier, $A_{VCL} = 1$, no load)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | | 230 | 350<br>450 | µA |
| CMR | Common Mode Rejection Ratio<br>$V_{ic} = 1.5$ to $3.5V$, $V_o = 2.5V$ | | 85 | | dB |
| SVR | Supply Voltage Rejection Ratio ($V_{CC}^{+} = 2.7$ to $3.3V$, $V_O = V_{CC}/2$) | | 80 | | dB |
| $A_{vd}$ | Large Signal Voltage Gain ($R_L = 10k\Omega$, $V_O = 1.5V$ to $3.5V$)<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ | 7<br>5 | 30 | | V/mV |
| $V_{OH}$ | High Level Output Voltage ($V_{id} = 1V$) $R_L = 10k\Omega$<br>$R_L = 600\Omega$<br>$R_L = 100\Omega$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L = 10k\Omega$<br>$R_L = 600\Omega$ | 4.85<br>4.2<br><br>4.8<br>4.1 | 4.95<br>4.6<br>3.7 | | V |
| $V_{OL}$ | Low Level Output Voltage ($V_{id} = -1V$) $R_L = 10k\Omega$<br>$R_L = 600\Omega$<br>$R_L = 100\Omega$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L = 10k\Omega$<br>$R_L = 600\Omega$ | | 50<br>350<br>1400 | 100<br>680<br><br>150<br>900 | mV |
| $I_o$ | Output Short Circuit Current ($V_{id} = \pm1V$) Source ($V_o = V_{CC}^{-}$)<br>Sink ($V_o = V_{CC}^{+}$) | | 60<br>60 | | mA |
| GBP | Gain Bandwidth Product<br>($A_{VCL} = 100$, $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$) | | 0.8 | | MHz |
| SR | Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 1V$ to $4V$) | | 0.8 | | V/µs |
| ∅m | Phase Margin | | 30 | | Degrees |

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

## STANDBY MODE

$V_{CC}^{+} = 5V$, $V_{CC}^{-} = 0V$, $T_{amb} = 25^oC$ (unless otherwise specified)

| Symbol | Parameter | TS3V902I/AI Min. | TS3V902I/AI Typ. | TS3V902I/AI Max. | Unit |
|---|---|---|---|---|---|
| $V_{inSBY/ON}$ | Pin 1 Threshold Voltage for STANDBY ON | | 5.2 | | V |
| $V_{inSBY/OFF}$ | Pin 1 Threshold Voltage for STANDBY OFF | | 5.2 | | V |
| $I_{CC\ SBY}$ | Total Consumption in Standby Position (STANDBY ON) | | 0.5 | | µA |

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## TYPICAL CHARACTERISTICS

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

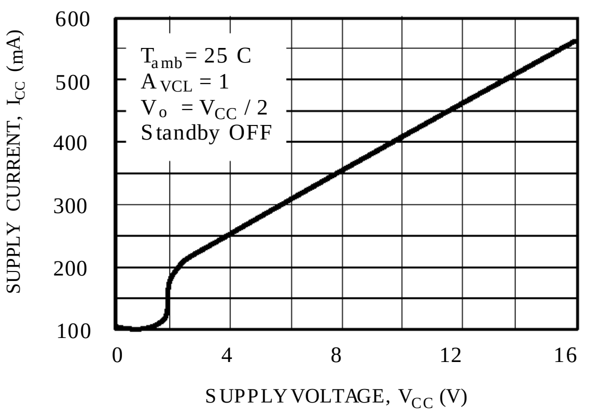


**Figure 1b :** Supply Current (each amplifier) versus Supply Voltage (in STANDBY mode)

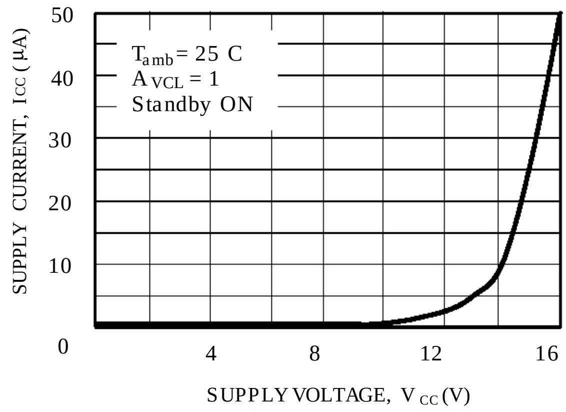


**Figure 2 :** Input Bias Current versus Temperature

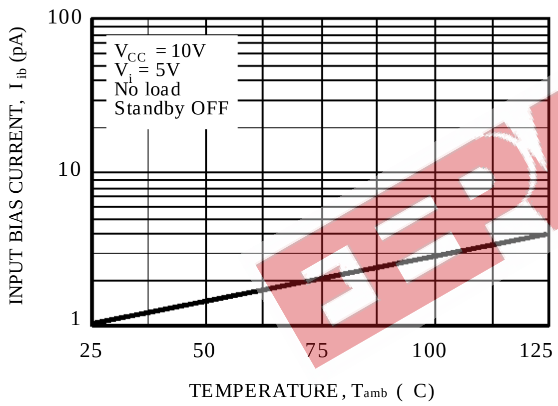


**Figure 3a :** High Level Output Voltage versus High Level Output Current

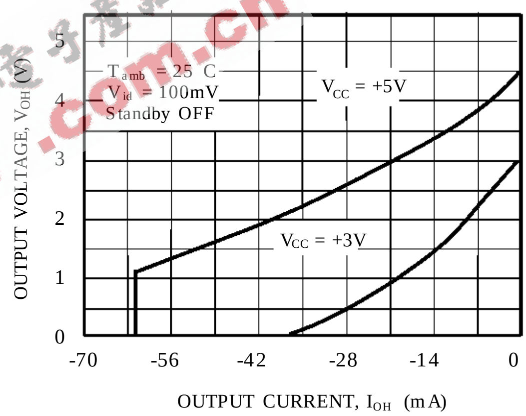


**Figure 3b :** High Level Output Voltage versus High Level Output Current

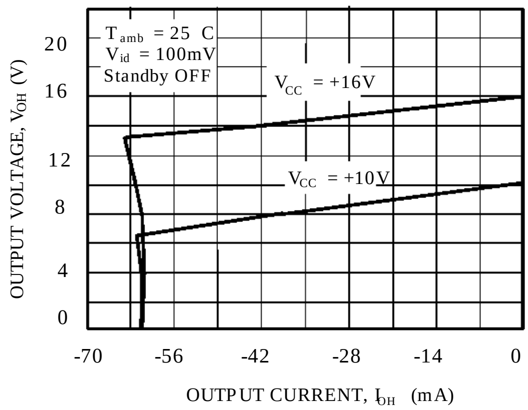


**Figure 4a :** Low Level Output Voltage versus Low Level Output Current

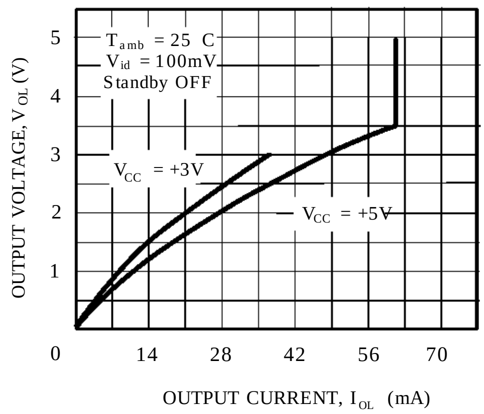

**Figure 4b :** Low Level Output Voltage versus Low Level Output Current

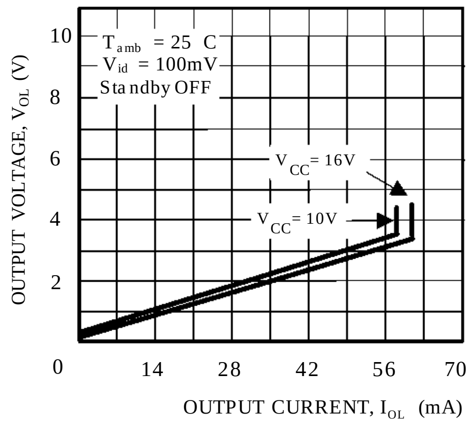


**Figure 5a :** Open Loop Frequency Response and Phase Shift

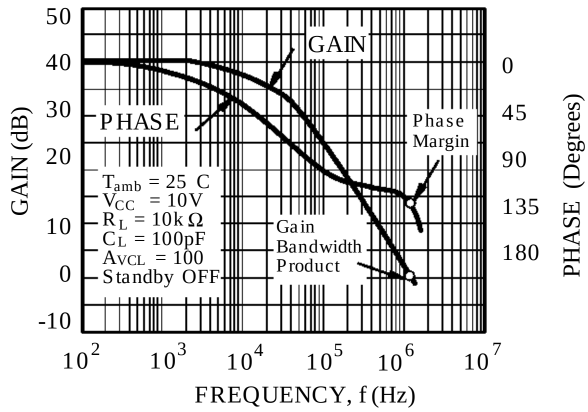


**Figure 5b :** Open Loop Frequency Response and Phase Shift

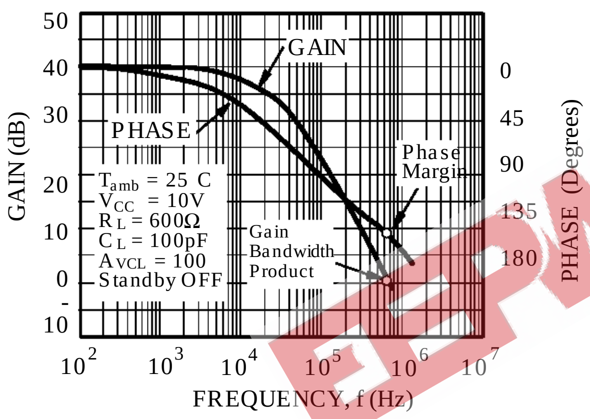


**Figure 6a :** Gain Bandwidth Product versus Supply Voltage

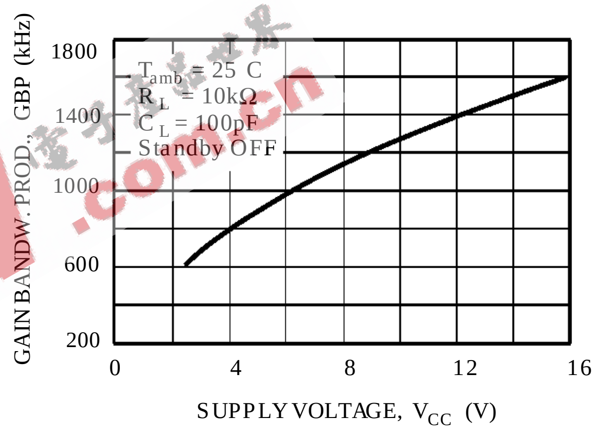


**Figure 6b :** Gain bandwidth Product versus Supply Voltage

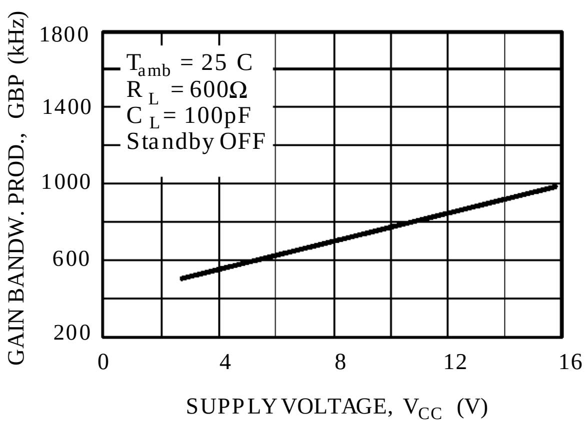


**Figure 7a :** Phase Margin versus Supply Voltage

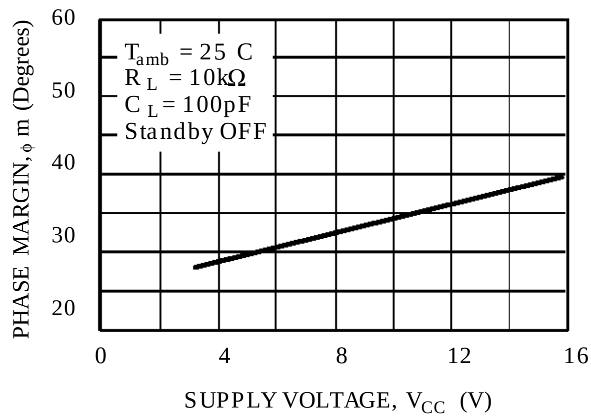



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**Figure 7b :** Phase Margin versus Supply Voltage

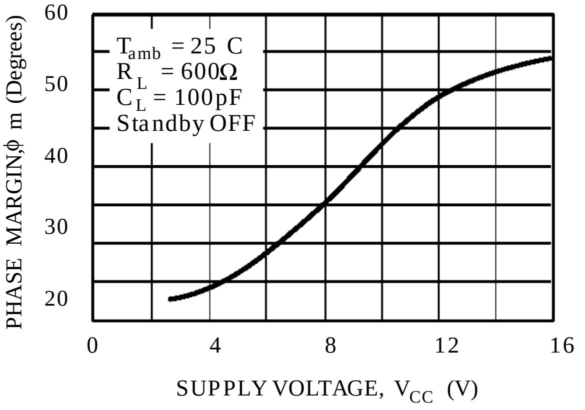
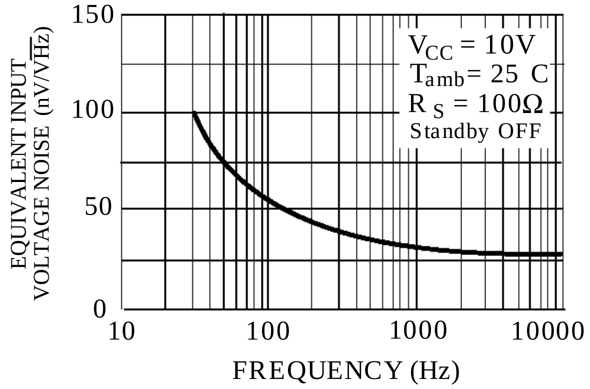



**Figure 8 :** Input Voltage Noise versus Frequency




## STANDBY APPLICATION

The two operators of the TS3V902 are **both** put on **STANDBY.**

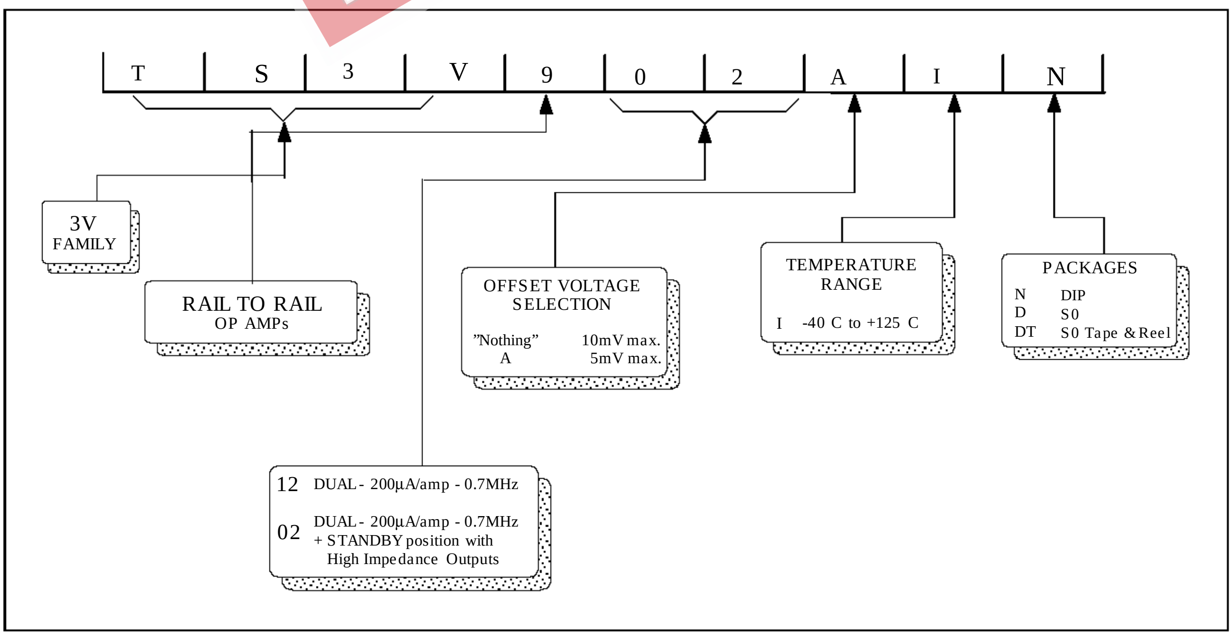
In this configuration (standby ON) :

- The **total consumption** of the circuit is considerably **reduced** down to **0.5μA** ($V_{CC}$ = 3V). This standby consumption versus $V_{CC}$ 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)

## ORDERING INFORMATION



## MACROMODEL

- **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** (±1.35V to ±8V)
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** TYP
- LOW INPUT OFFSET VOLTAGE : **5mV max.**
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 200µA/Ampli
- SPEED : 0.7MHz - 0.5V/µs

### Applies to : TS3V902I,AI

```
** 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 TS3V902 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 |
| $A_{vd}$ | $R_L$ = 10kΩ | 30 | V/mV |
| $I_{CC}$ | No load, per operator | 230 | µA |
| $V_{icm}$ | | -0.2 to 5.2 | V |
| $V_{OH}$ | $R_L$ = 10kΩ | 4.95 | V |
| $V_{OL}$ | $R_L$ = 10kΩ | 50 | mV |
| $I_{sink}$ | $V_O$ = 10V | 60 | mA |
| $I_{source}$ | $V_O$ = 0V | 60 | mA |
| GBP | $R_L$ = 10kΩ, $C_L$ = 100pF | 0.8 | MHz |
| SR | $R_L$ = 10kΩ, $C_L$ = 100pF | 0.8 | V/µs |
| ∅m | $R_L$ = 10kΩ, $C_L$ = 100pF | 30 | Degrees |
| $I_{CC\ STBY}$ | $V_{STBY}$ = 0V | 500 | nA |

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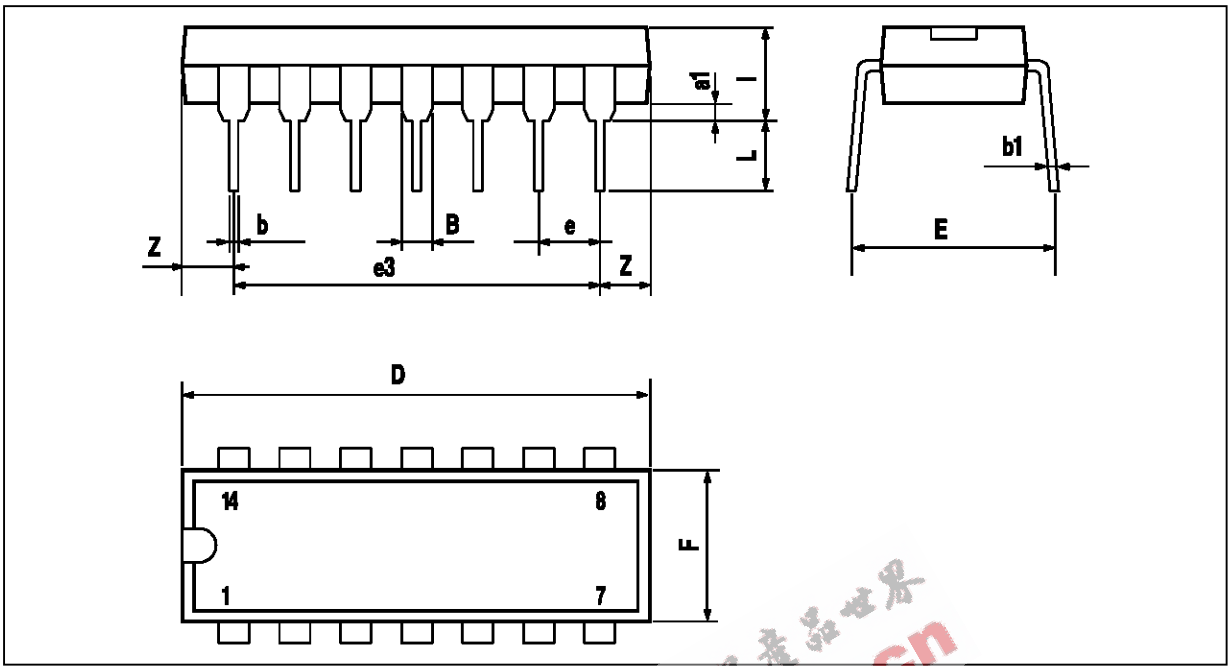
## PACKAGE MECHANICAL DATA

14 PINS - PLASTIC DIP




PM-DIP14.EPS

| Dimensions | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| a1 | 0.51 | | | 0.020 | | |
| B | 1.39 | | 1.65 | 0.055 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 15.24 | | | 0.600 | |
| F | | | 7.1 | | | 0.280 |
| i | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | 1.27 | | 2.54 | 0.050 | | 0.100 |

DIP14.TBL

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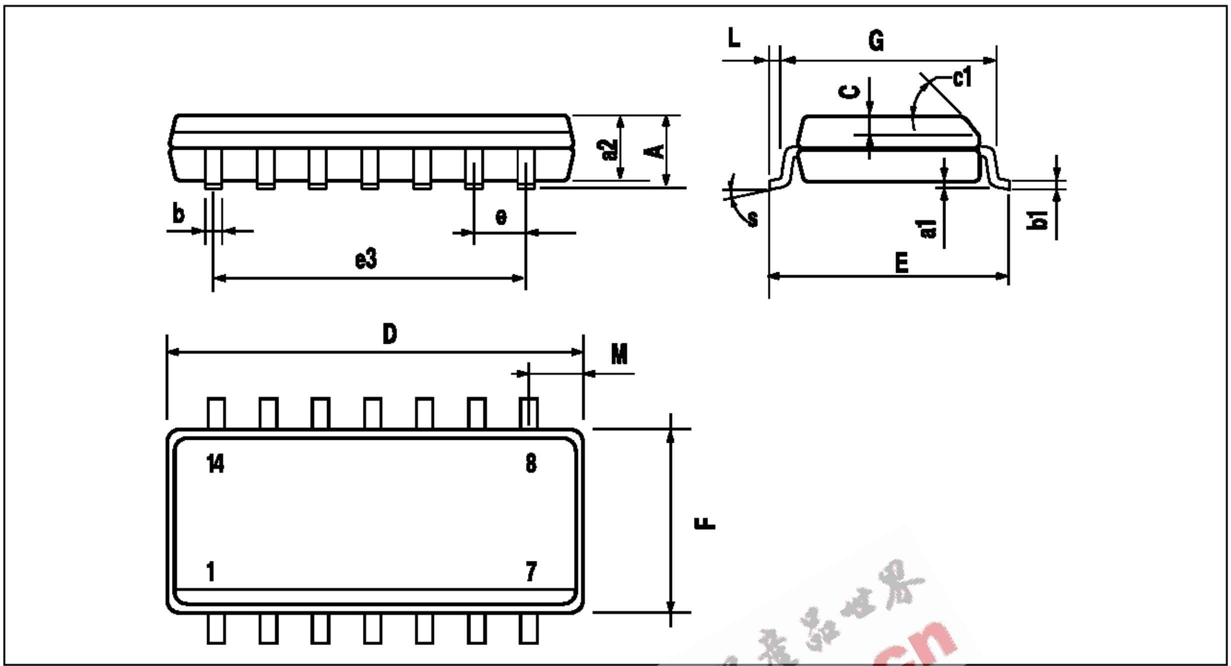
## PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)




PM-SO14.EPS

| Dimensions | 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 | 8.55 | | 8.75 | 0.336 | | 0.334 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 7.62 | | | 0.300 | |
| F | 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.) | | | | | |

SO14.TBL

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