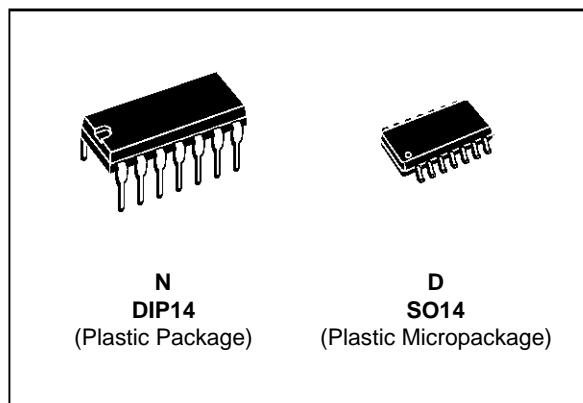


3V RAIL TO RAIL CMOS DUAL OPERATIONAL AMPLIFIER (WITH STANDBY POSITION)

- DEDICATED TO **3.3V** OR **BATTERY SUPPLY** (specified at 3V and 5V)
- RAIL TO RAIL INPUT AND OUTPUT VOLTAGE RANGES
- **STANDBY POSITION** : REDUCED CONSUMPTION (0.5 μ A) AND HIGH IMPEDANCE OUTPUTS
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V**
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** TYP
- SPECIFIED FOR **600 Ω** AND **100 Ω** LOADS
- LOW SUPPLY CURRENT : 200 μ A/Ampli

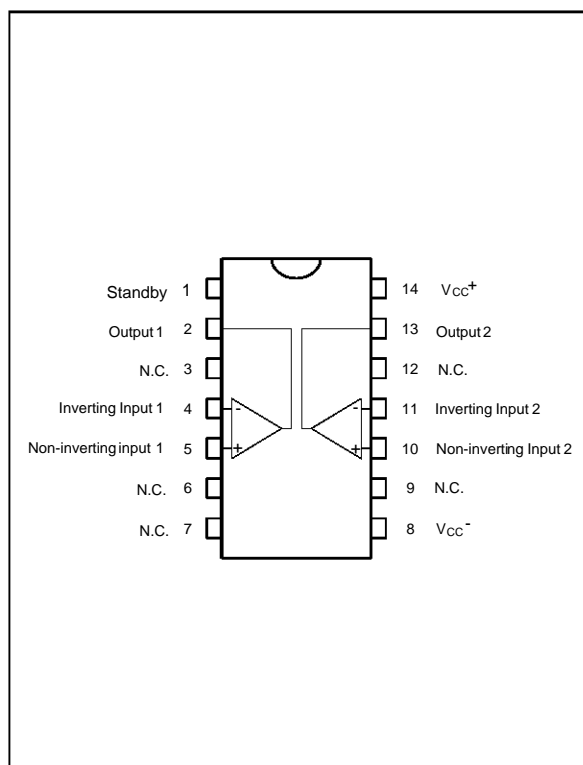
- **SPICE MACROMODEL** INCLUDED IN THIS SPECIFICATION



ORDER CODES

| Part Number | Temperature Range | Package | |
|-------------|------------------------|---------|---|
| | | N | D |
| TS3V902I/AI | -40, +125 $^{\circ}$ 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 $R_L = 10k\Omega$
- $V_{CC}^{-} + 350mV$ $V_{CC}^{+} - 400mV$ with $R_L = 600\Omega$

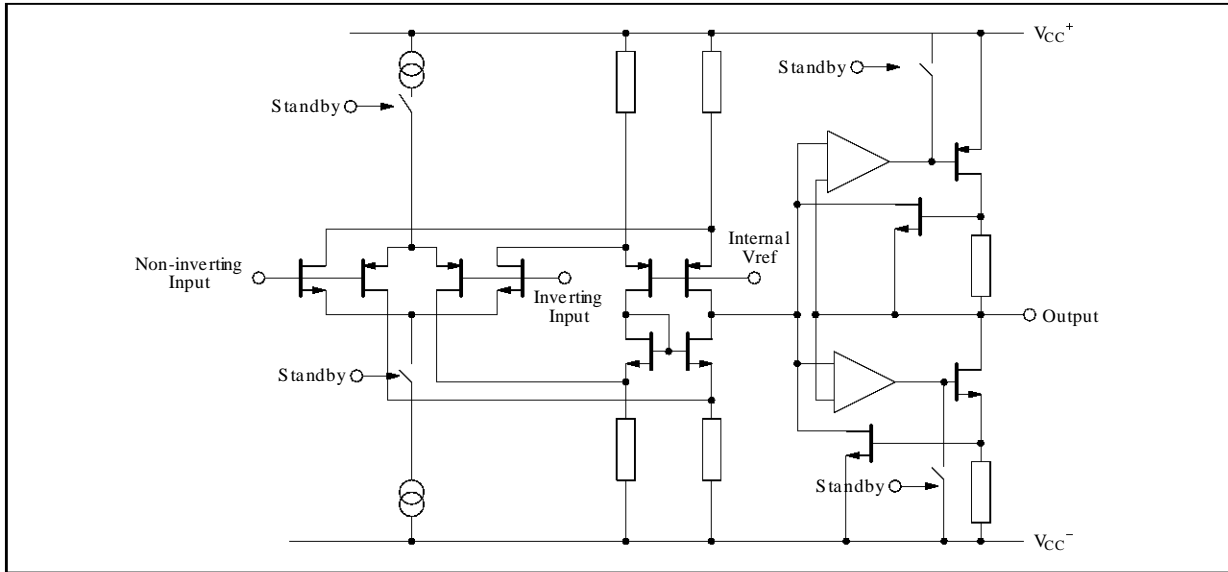
This product offers a broad supply voltage operating range from 2.7V to 16V and a supply current of only 200 μ A/amp. ($V_{CC} = 3V$).

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

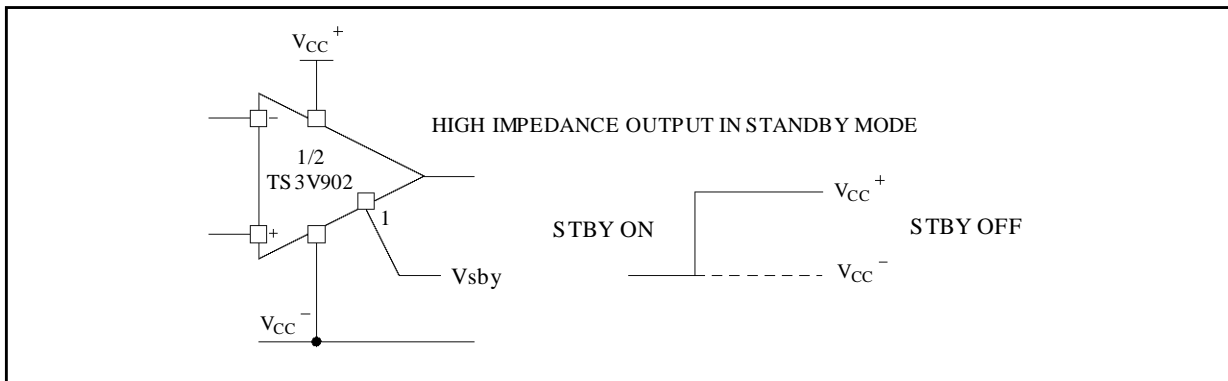
The TS3V902 can be put on STANDBY position (only 0.5 μ A and high impedance outputs).

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

SCHEMATIC DIAGRAM (1/2 TS3V902)



STANDBY POSITION



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 | -40 to +125 | $^{\circ}C$ |
| T_{stg} | Storage Temperature | -65 to +150 | $^{\circ}C$ |

- 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, $T_{amb} = 25^\circ C$
(unless otherwise specified)

| Symbol | Parameter | TS3V902I/AI | | | Unit |
|-----------------|---|---|--------------------------|--------------------------------|------------------------|
| | | Min. | Typ. | Max. | |
| V_{io} | Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | | 10 5 12 7 | mV |
| DV_{io} | Input Offset Voltage Drift | | 5 | | $\mu V/^\circ C$ |
| I_{io} | Input Offset Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 100 200 | pA |
| I_{ib} | Input Bias Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 150 300 | pA |
| I_{CC} | Supply Current (per amplifier, $A_{VCL} = 1$, no load) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 200 | 300 400 | μA |
| CMR | Common Mode Rejection Ratio $V_{ic} = 0$ 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 ($R_L = 10k\Omega$, $V_o = 1.2V$ to $1.8V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | 3 2 | 10 | | V/mV |
| V_{OH} | High Level Output Voltage ($V_{id} = 1V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ | 2.9 2.2 2.8 2.1 | 2.97 2.7 2 | V |
| V_{OL} | Low Level Output Voltage ($V_{id} = -1V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ | | 30 250 900 150 900 | mV |
| I_o | Output Short Circuit Current ($V_{id} = \pm 1V$) | Source ($V_o = V_{CC}^-$) Sink ($V_o = V_{CC}^+$) | 40 40 | | mA |
| GBP | Gain Bandwidth Product ($A_{VCL} = 100$, $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$) | | 0.7 | | MHz |
| SR | Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 1.3V$ to $1.7V$) | | 0.5 | | V/ μs |
| ϕ_m | Phase Margin | | 30 | | Degrees |
| e_n | Equivalent Input Noise Voltage ($R_s = 100\Omega$, $f = 1kHz$) | | 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

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

| Symbol | Parameter | TS3V902I/AI | | | Unit |
|-----------|--|---|---------------------------|---------------------------------|------------------|
| | | Min. | Typ. | Max. | |
| V_{io} | Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | | 10 5 12 7 | mV |
| DV_{io} | Input Offset Voltage Drift | | 5 | | $\mu V/^\circ C$ |
| I_{io} | Input Offset Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 100 200 | pA |
| I_{ib} | Input Bias Current - (note 1) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 150 300 | pA |
| I_{CC} | Supply Current (per amplifier, $A_{VCL} = 1$, no load) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 230 | 350 450 | μA |
| CMR | Common Mode Rejection Ratio $V_{ic} = 1.5$ 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 $3.5V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | 7 5 | 30 | | V/mV |
| V_{OH} | High Level Output Voltage ($V_{id} = 1V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ | 4.85 4.2 4.8 4.1 | 4.95 4.6 3.7 | V |
| V_{OL} | Low Level Output Voltage ($V_{id} = -1V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ | | 50 350 1400 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 Bandwidth Product ($A_{VCL} = 100, R_L = 10k\Omega, C_L = 100pF, f = 100kHz$) | | 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 |
| ϕ_m | Phase Margin | | 30 | | Degrees |

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

STANDBY MODE

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

| Symbol | Parameter | TS3V902I/AI | | | Unit |
|-----------------|--|-------------|------|------|---------|
| | | Min. | Typ. | Max. | |
| $V_{inSBY/ON}$ | 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 |

TYPICAL CHARACTERISTICS

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

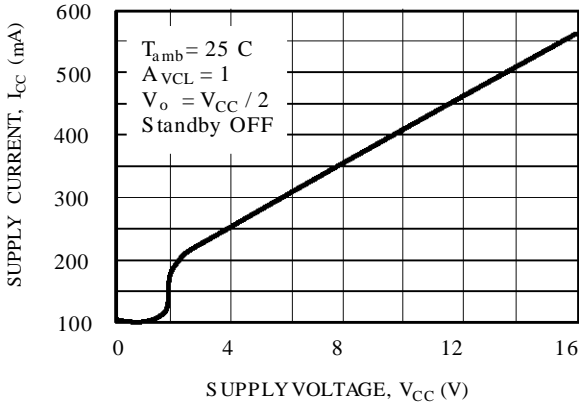


Figure 1b : Supply Current (each amplifier) versus Supply Voltage (in STANDBY mode)

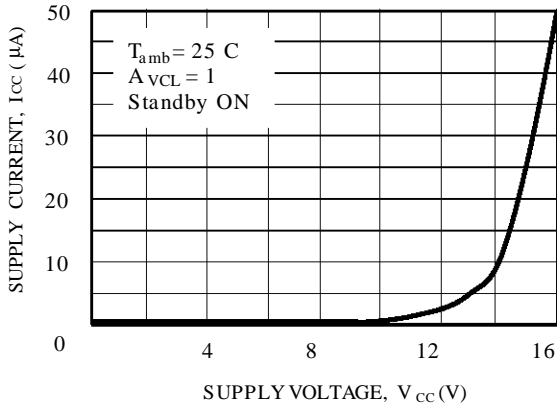


Figure 2 : Input Bias Current versus Temperature

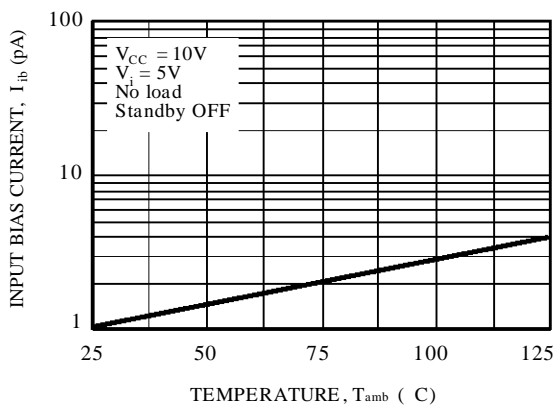


Figure 3a : High Level Output Voltage versus High Level Output Current

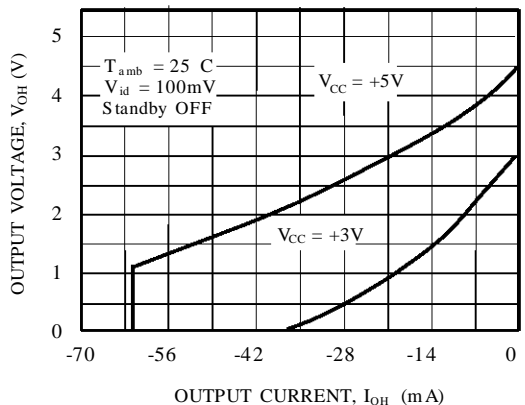


Figure 3b : High Level Output Voltage versus High Level Output Current

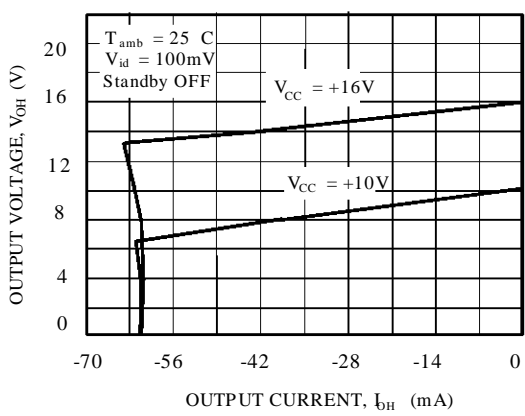


Figure 4a : Low Level Output Voltage versus Low Level Output Current

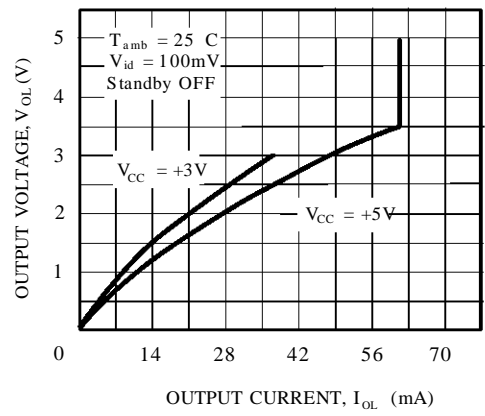


Figure 4b : Low Level Output Voltage versus Low Level Output Current

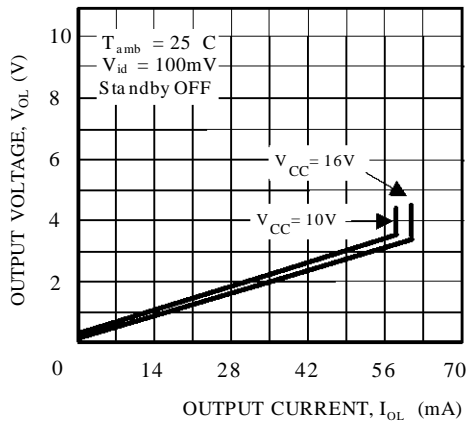


Figure 5a : Open Loop Frequency Response and Phase Shift

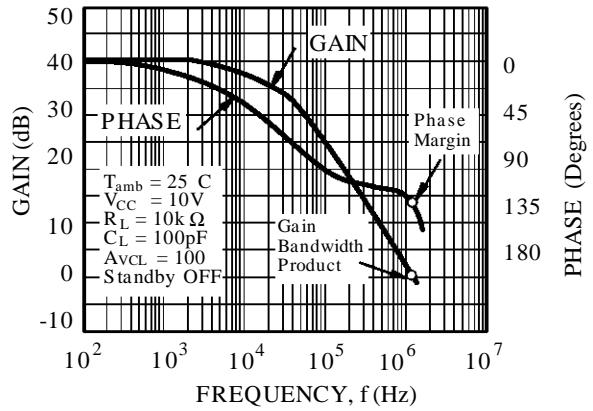


Figure 5b : Open Loop Frequency Response and Phase Shift

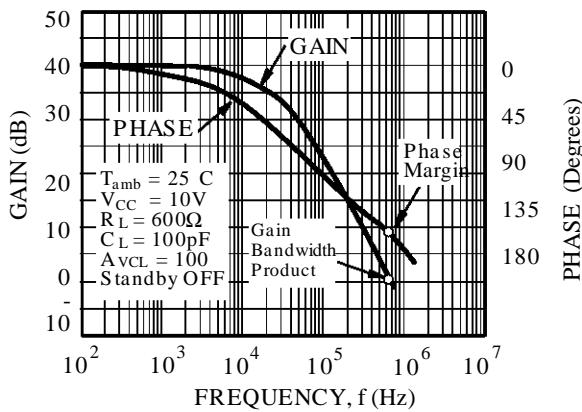


Figure 6a : Gain Bandwidth Product versus Supply Voltage

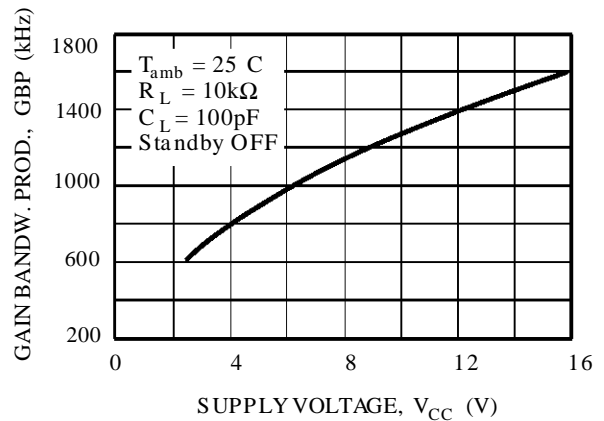


Figure 6b : Gain bandwidth Product versus Supply Voltage

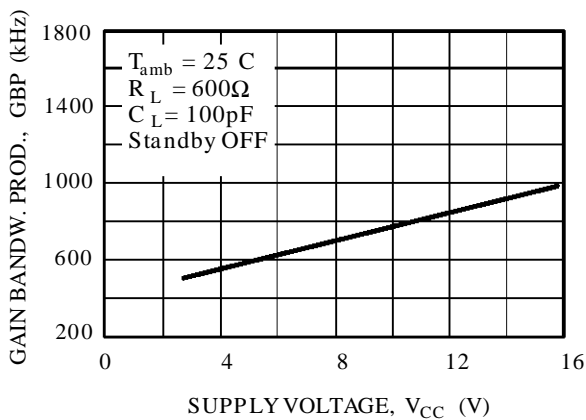


Figure 7a : Phase Margin versus Supply Voltage

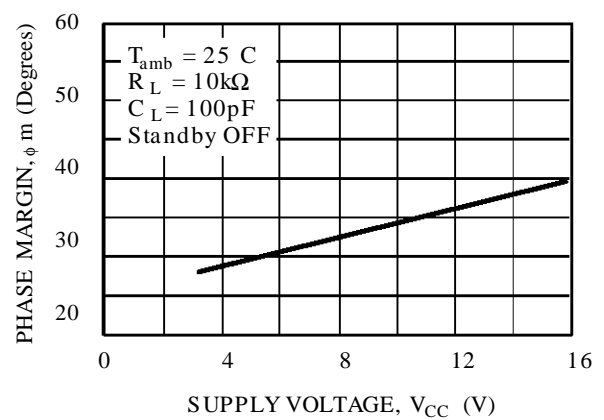


Figure 7b : Phase Margin versus Supply Voltage

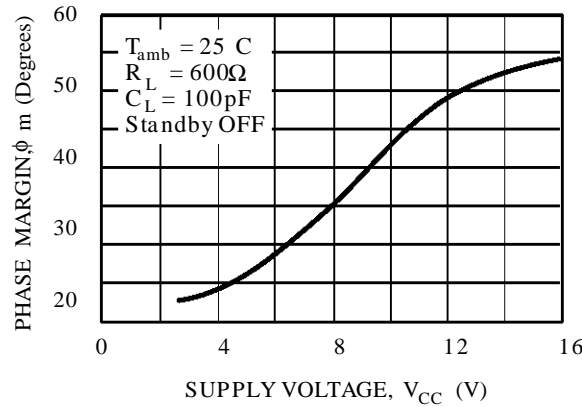
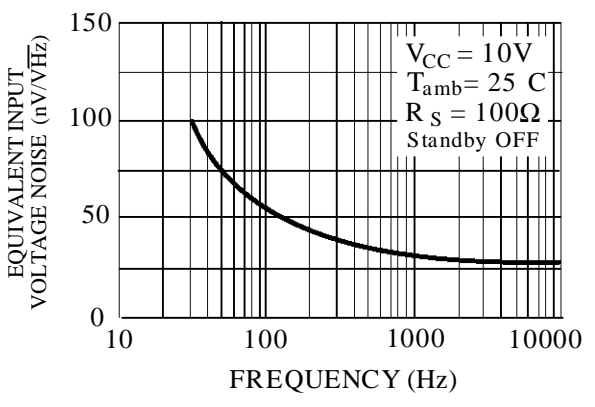


Figure 8 : Input Voltage Noise versus Frequency



STANDBY APPLICATION

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

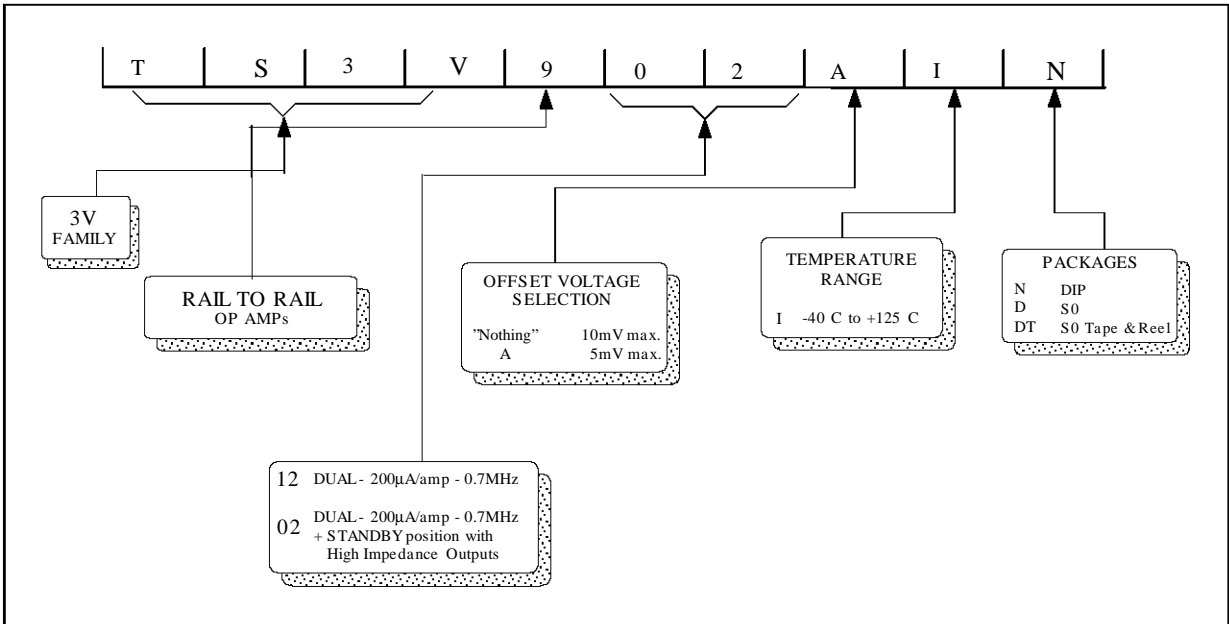
In this configuration (standby ON) :

- 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

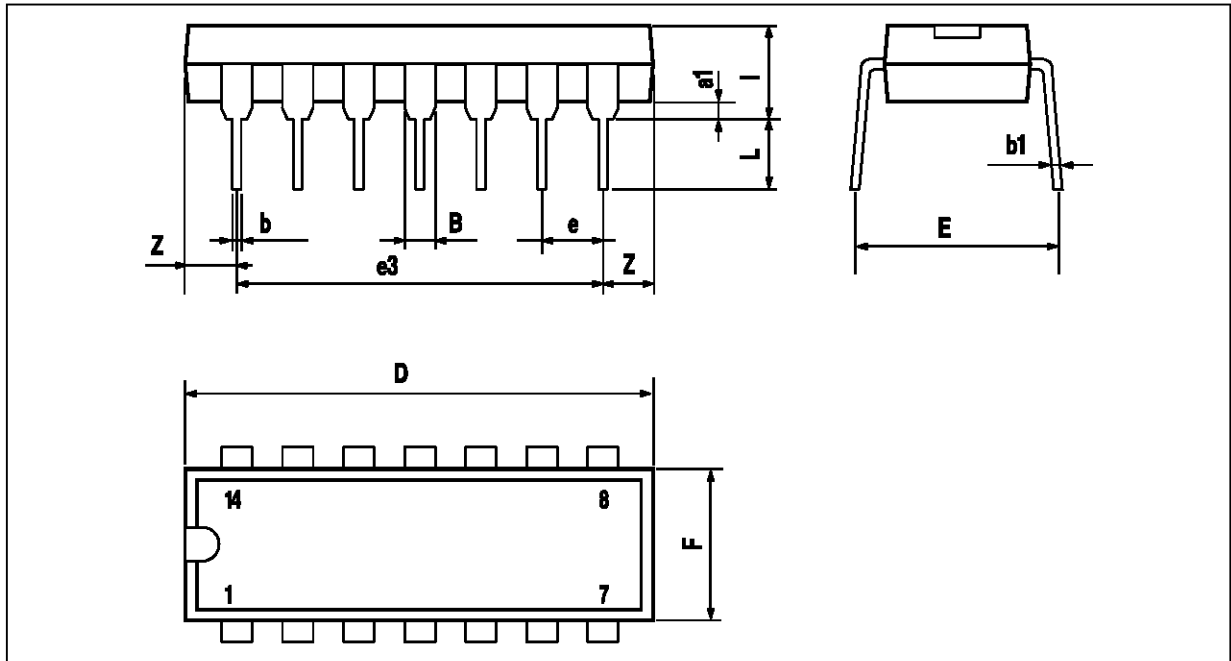
ELECTRICAL CHARACTERISTICS

$V_{CC}^+ = 5V$, $V_{CC}^- = 0V$, R_L, C_L connected to $V_{CC}/2$, standby off, $T_{amb} = 25^\circ C$
(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 |
| $\varnothing m$ | $R_L = 10k\Omega$, $C_L = 100pF$ | 30 | Degrees |
| $I_{CC\ STBY}$ | $V_{STBY} = 0V$ | 500 | nA |

TS3V902

PACKAGE MECHANICAL DATA
14 PINS - PLASTIC DIP

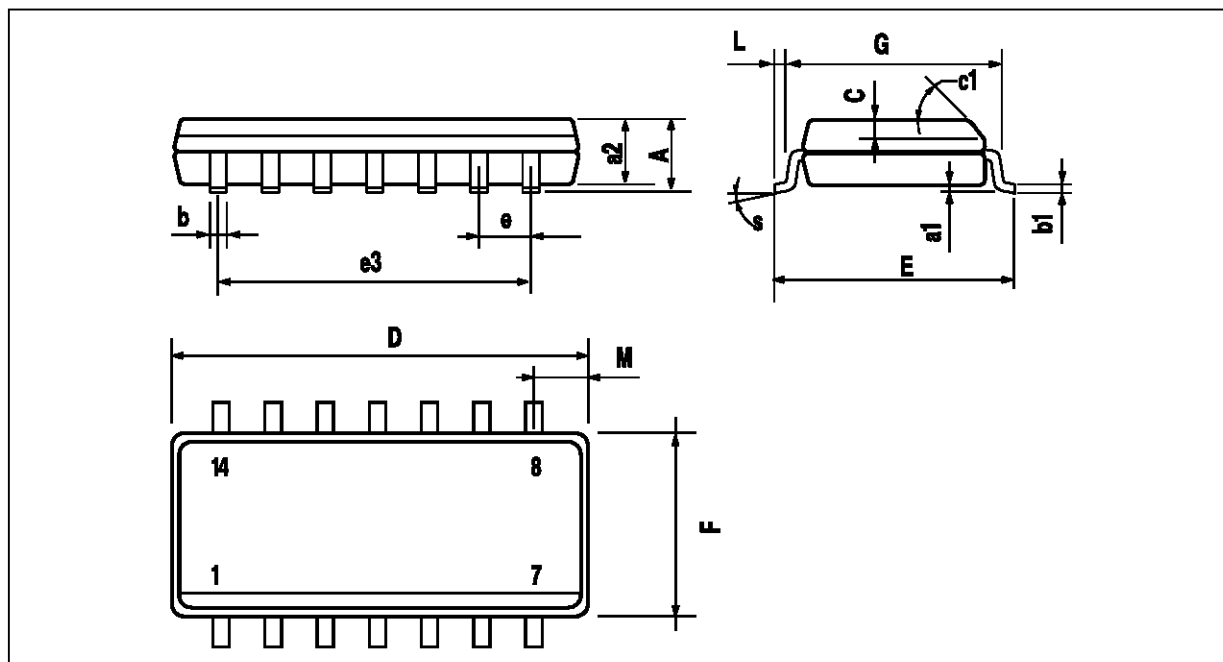


PM-DIP14EPS

| 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

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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