

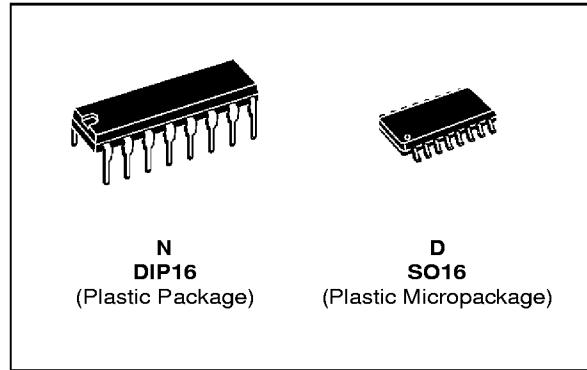


**SGS-THOMSON**  
MICROELECTRONICS

**TS3V904**

## 3V INPUT/OUTPUT RAIL TO RAIL QUAD 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
- 2 SEPARATE STANDBY : REDUCED CONSUMPTION ( $0.5\mu A$ ) AND HIGH IMPEDANCE OUTPUTS
- SINGLE (OR DUAL) SUPPLY OPERATION FROM 2.7V TO 16V
- EXTREMELY LOW INPUT BIAS CURRENT : 1 $pA$  TYP
- LOW INPUT OFFSET VOLTAGE : 5mV max.
- SPECIFIED FOR 600 $\Omega$  AND 150 $\Omega$  LOADS
- LOW SUPPLY CURRENT : 200 $\mu A$ /Ampli



### ORDER CODES

Part Number	Temperature Range		Package	
	N	D		
TS3V904I/AI	-40, +125°C		•	•

### DESCRIPTION

The TS3V904 is a RAIL TO RAIL quad CMOS operational amplifier designed to operate with a single 3V supply voltage.

The input voltage range  $V_{icm}$  includes the two supply rails  $V_{CC^+}$  and  $V_{CC^-}$ .

The output reaches :

- $V_{CC^-} + 50mV \quad V_{CC^+} - 50mV$  with  $R_L = 10k\Omega$
- $V_{CC^-} + 350mV \quad V_{CC^+} - 350mV$  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 $\mu A$ /amp. ( $V_{CC} = 3V$ )

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

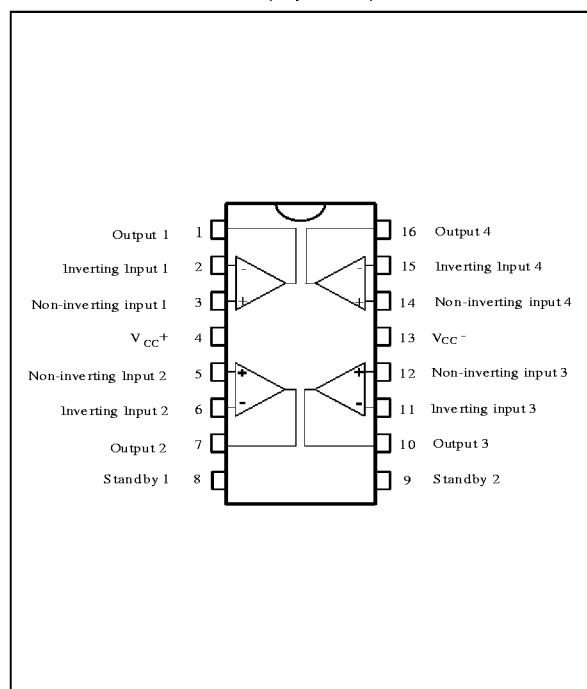
The TS3V904 offers two separate STANDBY pins

- STANDBY 1 acting on the n°2 and n°3 operators
- STANDBY 2 acting on the n°1 and n°4 operators

They reduce the consumption of the corresponding operators and put the outputs in a high impedance state.

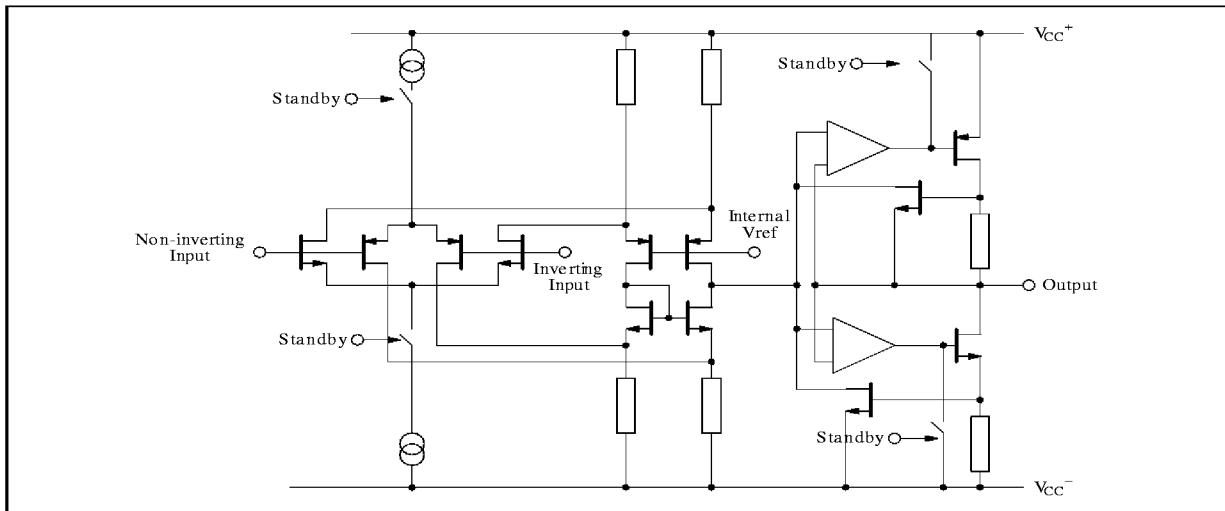
These two STANDBY pins should never stay not connected.

### PIN CONNECTIONS (top view)

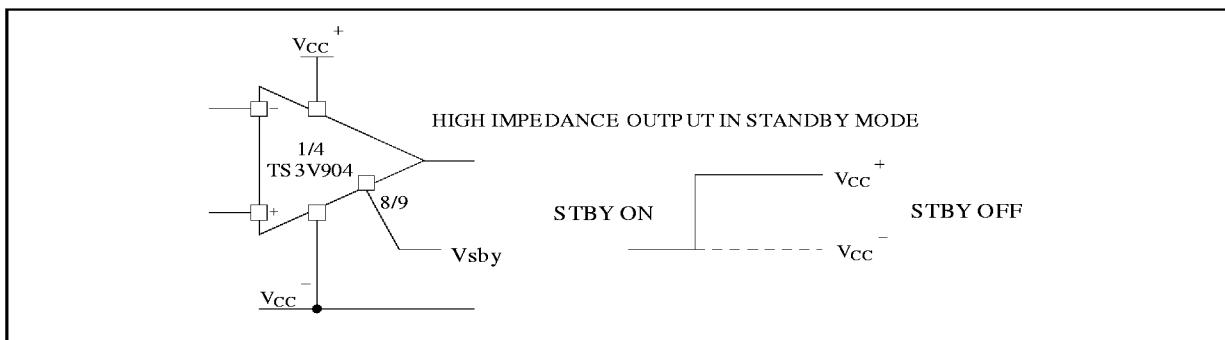


## TS3V904

### SCHEMATIC DIAGRAM (1/4 TS3V904)



### STANDBY POSITION



### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage - (note 1)	18	V
$V_{id}$	Differential Input Voltage - (note 2)	$\pm 18$	V
$V_i$	Input Voltage - (note 3)	-0.3 to 18	V
$I_{in}$	Current on Inputs	$\pm 50$	mA
$I_o$	Current on Outputs	$\pm 130$	mA
$T_{oper}$	Operating Free Air Temperature Range	TS3V904I/AI	$-40$ to $+125$

**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  $V_{CC}/2$ , pin 8 and pin 9 connected to  $V_{CC^+}$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage ( $V_{ic} = V_o = V_{CC}/2$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	TS3V904 TS3V904A TS3V904 TS3V904A		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	$\mu A$
CMR	Common Mode Rejection Ratio $V_{ic} = 0$ to $3V$ , $V_o = 1.5V$	40	70		dB
SVR	Supply Voltage Rejection Ratio ( $V_{CC^+} = 2.7$ to $3.3V$ , $V_o = V_{CC}/2$ )	40	70		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 ( $V_{id} = 1V$ ) $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L = 10k\Omega$ $R_L = 600\Omega$	2.9 2.3	2.96 2.6 2		V
$V_{OL}$	Low Level Output Voltage ( $V_{id} = -1V$ ) $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $T_{min.} \leq T_{amb} \leq T_{max.}$ $R_L = 10k\Omega$ $R_L = 600\Omega$		50 300 900	100 400 150 600	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 ( $A_{VCL} = 100$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $f = 100kHz$ )		0.8		MHz
SR <sup>+</sup>	Positive Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1.3V$ to $1.7V$ )		0.5		$V/\mu s$
SR <sup>-</sup>	Negative Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1.3V$ to $1.7V$ )		0.4		$V/\mu s$
$\phi_m$	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	TS3V904I/AI			Unit
		Min.	Typ.	Max.	
$V_{in\ SBY/ON}$	Pin 8/9 Threshold Voltage for STANDBY ON		1.2		V
$V_{in\ SBY/OFF}$	Pin 8/9 Threshold Voltage for STANDBY OFF		1.5		V
$I_{cc\ SBY}$	Total Consumption Standby 1 ON - Standby 2 OFF Standby 1 OFF - Standby 2 ON Standby 1 and 2 ON		400 400 0.5		$\mu A$

## TS3V904

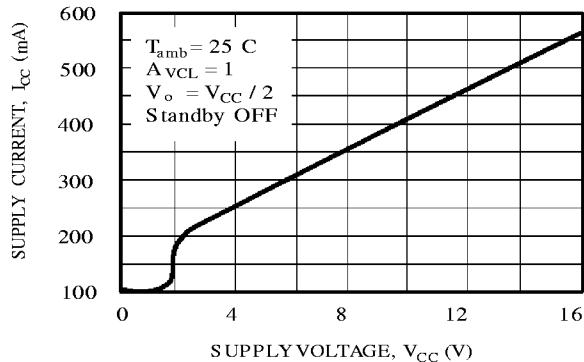
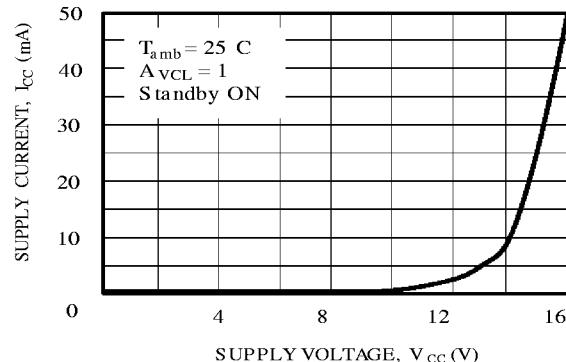
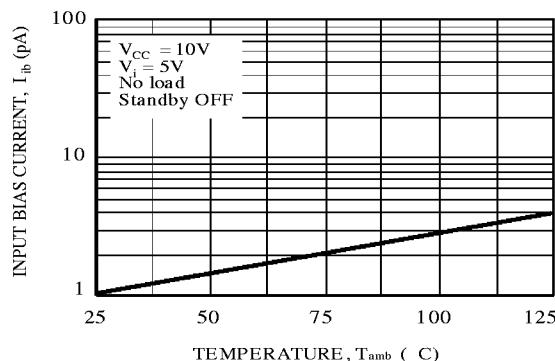
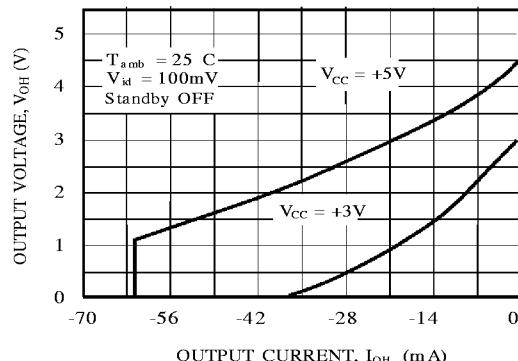
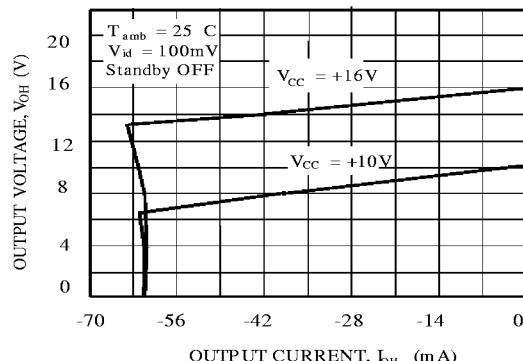
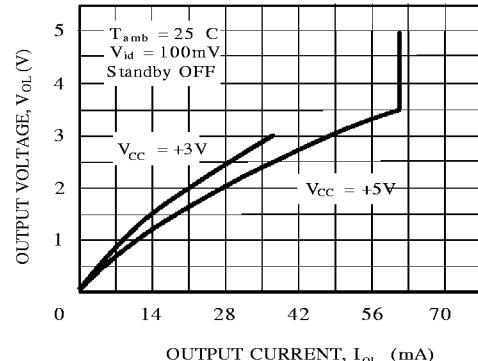
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### ELECTRICAL CHARACTERISTICS

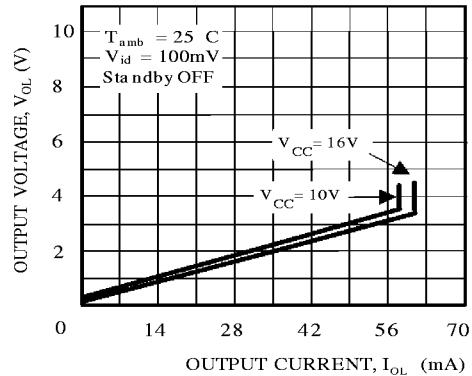
$V_{CC^+} = 5V$ ,  $V_{CC^-} = 0V$ ,  $R_L, C_L$  connected to  $V_{CC}/2$ , pin 8 and pin 9 connected to  $V_{CC^+}$ ,  $T_{amb} = 25^\circ C$   
(unless otherwise specified)

Symbol	Parameter		Min.	Typ.	Max.	Unit
$V_{IO}$	Input Offset Voltage ( $V_{IC} = V_O = V_{CC}/2$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	TS3V904 TS3V904A TS3V904 TS3V904A			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	$\mu A$
CMR	Common Mode Rejection Ratio $V_{IC} = 1.5$ to $3.5V$ , $V_O = 2.5V$		50	75		dB
SVR	Supply Voltage Rejection Ratio ( $V_{CC^+} = 3$ to $5V$ , $V_O = V_{CC}/2$ )		50	80		dB
$A_{VD}$	Large Signal Voltage Gain ( $R_L = 10k\Omega$ , $V_O = 1.5V$ to $3.5V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$		10 7	30		V/mV
$V_{OH}$	High Level Output Voltage ( $V_{id} = 1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $R_L = 10k\Omega$ $R_L = 600\Omega$	4.9 4.25	4.95 4.65 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	100 500  150 750	mV
$I_o$	Output Short Circuit Current ( $V_{id} = \pm 1V$ )	Source ( $V_O = V_{CC^-}$ ) Sink ( $V_O = V_{CC^+}$ )	45 45	60 60		mA
GBP	Gain Bandwidth Product ( $A_{VCL} = 100$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $f = 100kHz$ )			0.9		MHz
SR <sup>+</sup>	Positive Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1V$ to $4V$ )			0.8		$V/\mu s$
SR <sup>-</sup>	Negative Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1V$ to $4V$ )			0.5		$V/\mu s$
$\phi_m$	Phase Margin			30		Degrees

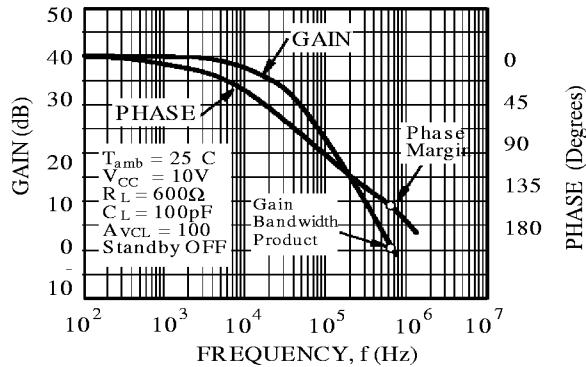
Note 1 : Maximum values including unavoidable inaccuracies of the industrial test.

**TYPICAL CHARACTERISTICS**(standby OFF = standby 1 and 2 OFF)  
(standby ON = standby 1 and 2 ON)**Figure 1a** : Supply Current (each amplifier) versus Supply Voltage**Figure 1b** : Supply Current (each amplifier) versus Supply Voltage (in STANDBY)**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

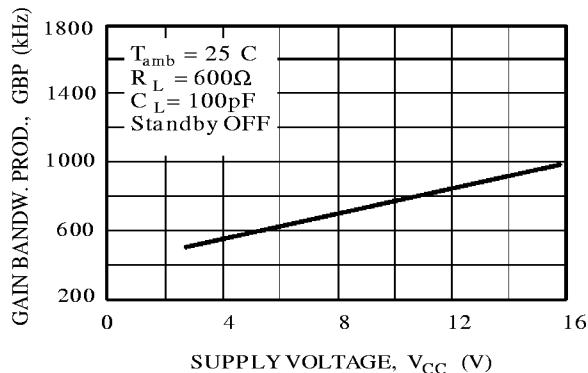
**Figure 4b : Low Level Output Voltage versus Low Level Output Current**



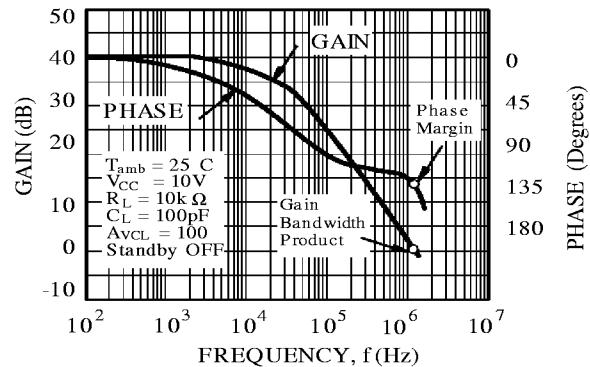
**Figure 5b : Open Loop Frequency Response and Phase Shift**



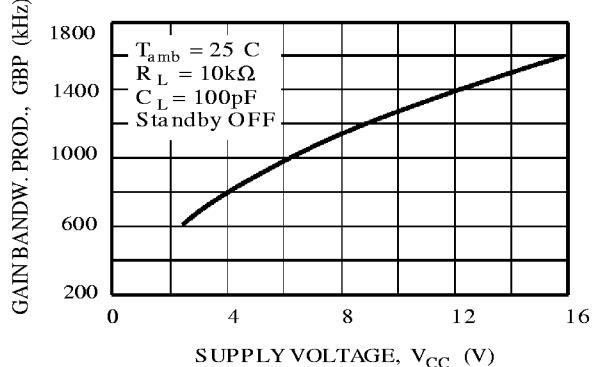
**Figure 6b : Gain bandwidth Product versus Supply Voltage**



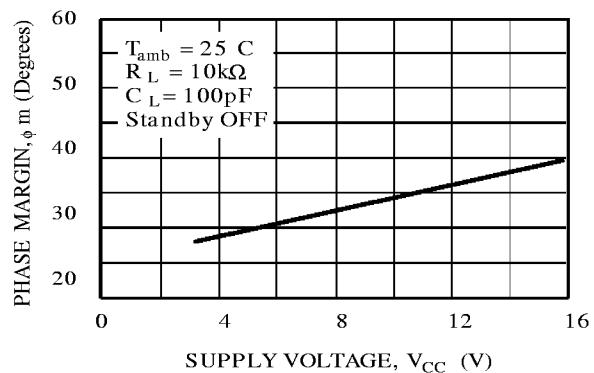
**Figure 5a : Open Loop Frequency Response and Phase Shift**

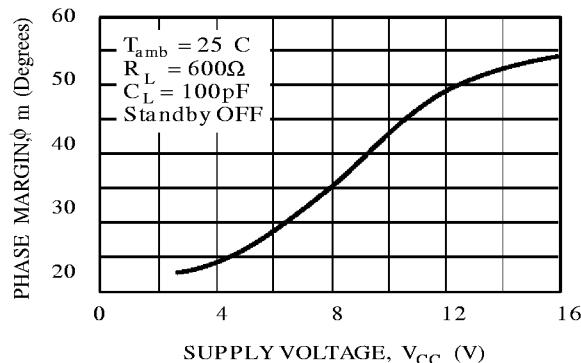
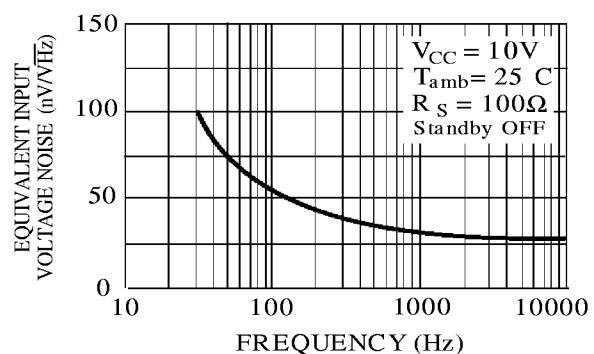


**Figure 6a : Gain Bandwidth Product versus Supply Voltage**



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



**Figure 7b : Phase Margin versus Supply Voltage****Figure 8 : Input Voltage Noise versus Frequency**

## STANDBY APPLICATION

The TS3V904 offers two separate STANDBY pins :

- **STANDBY 1** (pin 8) acting on the n°2 and n°3 operators.
- **STANDBY 2** (pin 9) acting on the n°1 and n°4 operators.

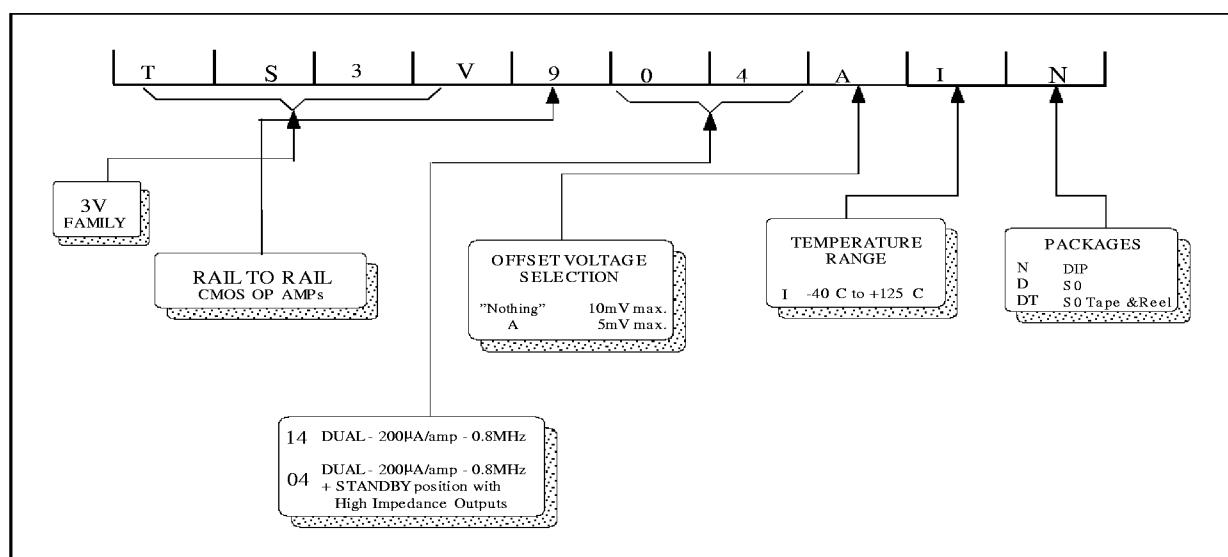
When one of these standby is activated (STANDBY ON) :

- The supply current of the corresponding operators is considerably reduced. The total consumption of the circuit is then divided by 2 (one STANDBY ON) or decreased down to 0.5µA (V<sub>CC</sub> = 3V, two STANDBY ON). (ref. figure 1b).
- All the outputs of the corresponding operators are in high impedance state. No output current can then be sourced or sunked.

The standby pins 8 and 9 should never stay unconnected.

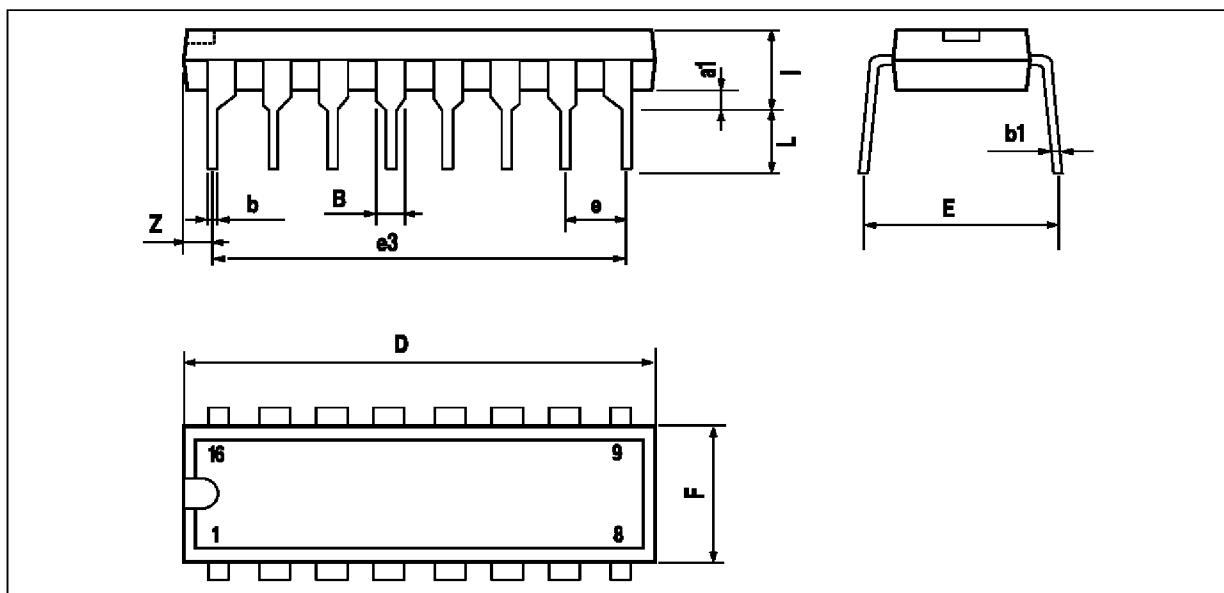
- The "**standby OFF**" state, is reached when the pins 8 or 9 voltage is **higher than V<sub>in SBY/OFF</sub>**.
- The "**standby ON**" state, is assured by the pins 8 or 9 voltage **lower than V<sub>in SBY/OFF</sub>**. (see electrical characteristics)

## ORDERING INFORMATION



## TS3V904

### PACKAGE MECHANICAL DATA 16 PINS - PLASTIC DIP

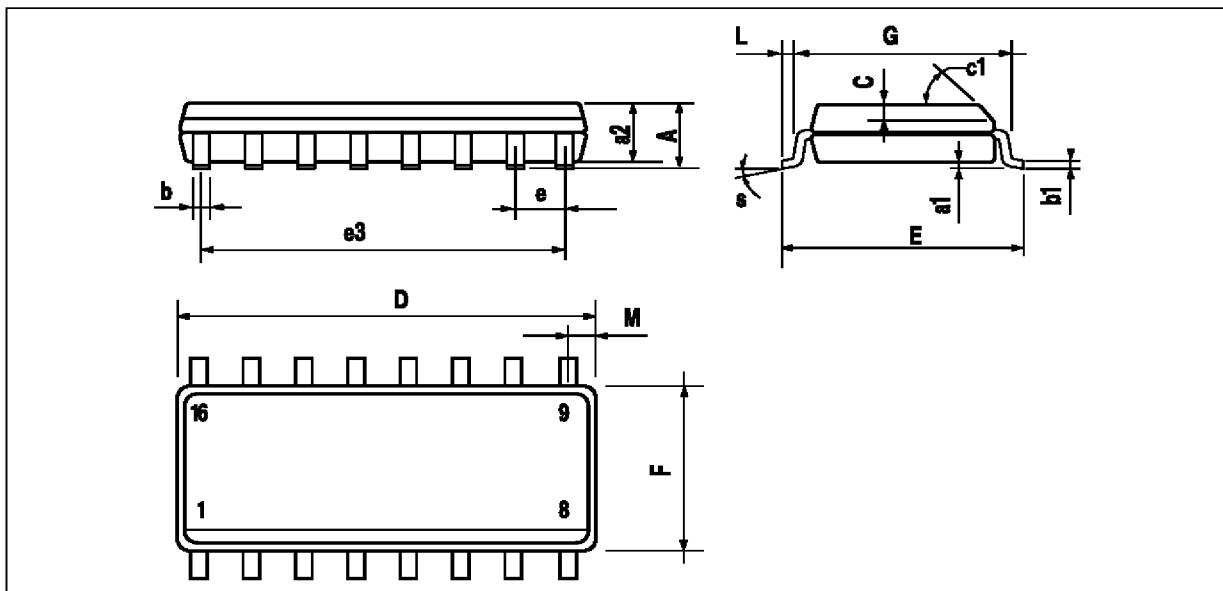


PM-DIP16.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	0.77		1.65	0.030		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		17.78			0.700	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050

DIP16.TBL

**PACKAGE MECHANICAL DATA**  
16 PINS - PLASTIC MICROPACKAGE (SO)



PM-SO16.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	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.209
L	0.5		1.27	0.020		0.050
M			0.62			0.024
S		8° (max.)				

SO16.TBL

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