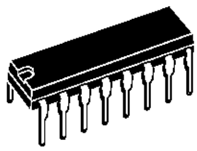
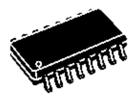
TS3V904

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** 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 **150Ω** LOADS
- LOW SUPPLY CURRENT : 200µA/Ampli



N
DIP16
(Plastic Package)



D
SO16
(Plastic Micropackage)

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 V_{CC}^+ -50mV with R_L = 10kΩ
- V_{CC}^- +350mV V_{CC}^+ -350mV 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.

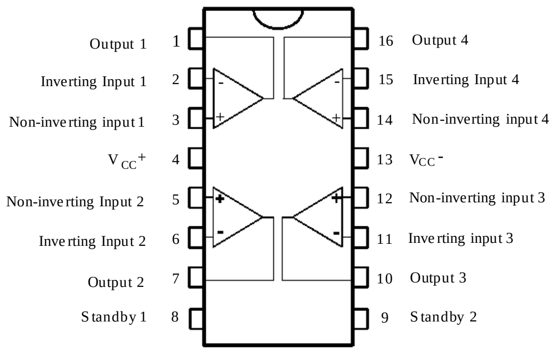
The TS3V904 offers two separate **STANDBY** pins

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

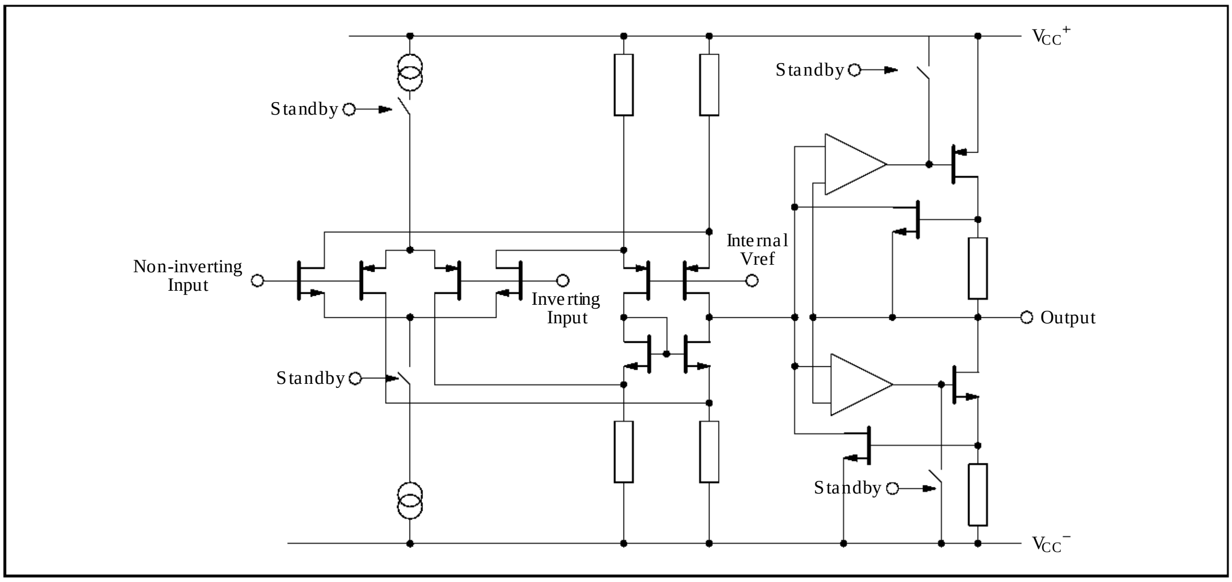
They reduce the consumption of the corresponding operators and put the outputs in a high impedance state.

These two STANDBY pins should never stay not connected.

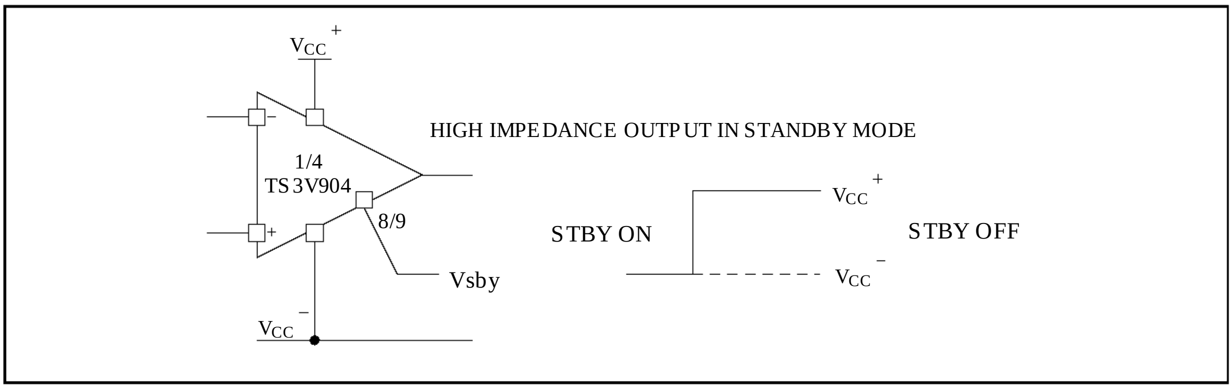
PIN CONNECTIONS (top view)



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)		±18	V
V_i	Input Voltage - (note 3)		-0.3 to 18	V
I_{in}	Cunnent on Inputs		±50	mA
I_o	Current on Outputs		±130	mA
T_{oper}	Operating Free Air Temperature Range	TS3V904I/AI	-40 to +125	^oC

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°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		µV/°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		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 = 10kΩ, 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 = 10kΩ R_L = 600Ω R_L = 100Ω R_L = 10kΩ R_L = 600Ω	2.9 2.3 2.8 2.1	2.96 2.6 2		V
V_{OL}	Low Level Output Voltage (V_{id} = -1V) $T_{min.} \leq T_{amb} \leq T_{max.}$	R_L = 10kΩ R_L = 600Ω R_L = 100Ω R_L = 10kΩ R_L = 600Ω		50 300 900	100 400 150 600	mV
I_o	Output Short Circuit Current (V_{id} = ±1V)	Source (V_o = V_{CC}^-) Sink (V_o = V_{CC}^+)		40 40		mA
GBP	Gain Bandwidth Product (A_{VCL} = 100, R_L = 10kΩ, C_L = 100pF, f = 100kHz)			0.8		MHz
SR^+	Positive Slew Rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i =1.3V to 1.7V)			0.5		V/µs
SR^-	Negative Slew Rate (A_{VCL} = 1, R_L = 10kΩ, C_L = 100pF, V_i =1.3V to 1.7V)			0.4		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	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		µA

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}^+, $T_{amb} = 25^oC$ (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$) TS3V904 TS3V904A $T_{min.} \le T_{amb} \le T_{max.}$ TS3V904 TS3V904A			10 5 12 7	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) $T_{min.} \le T_{amb} \le T_{max.}$		230	350 450	μA
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 $3.5V$) $T_{min.} \le T_{amb} \le T_{max.}$	10 7	30		V/mV
V_{OH}	High Level Output Voltage ($V_{id} = 1V$) $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \le T_{amb} \le T_{max.}$ $R_L = 10k\Omega$ $R_L = 600\Omega$	4.9 4.25 4.8 4.1	4.95 4.65 3.7		V
V_{OL}	Low Level Output Voltage ($V_{id} = -1V$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \le T_{amb} \le T_{max.}$ $R_L = 10k\Omega$ $R_L = 600\Omega$		50 350 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^+	Positive Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 1V$ to $4V$)		0.8		V/μs
SR^-	Negative Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 1V$ to $4V$)		0.5		V/μs
∅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

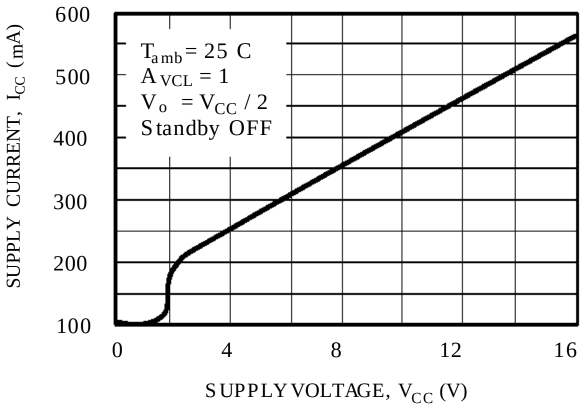


Figure 1b : Supply Current (each amplifier) versus Supply Voltage (in STANDBY)

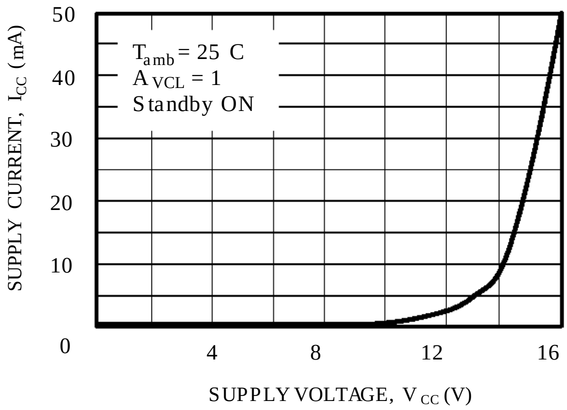


Figure 2 : Input Bias Current versus Temperature

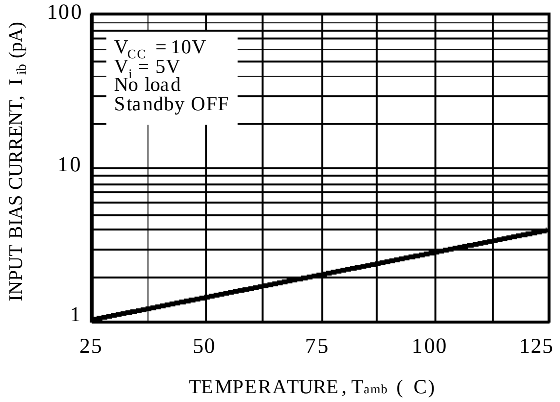


Figure 3a : High Level Output Voltage versus High Level Output Current

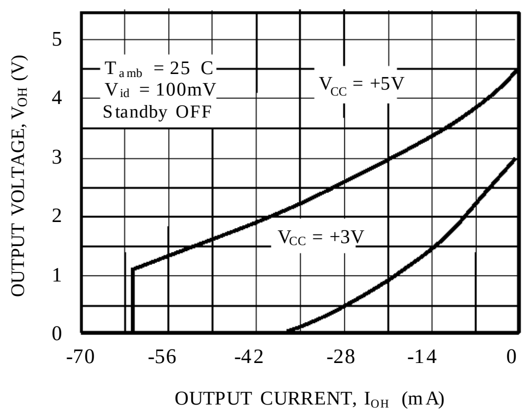


Figure 3b : High Level Output Voltage versus High Level Output Current

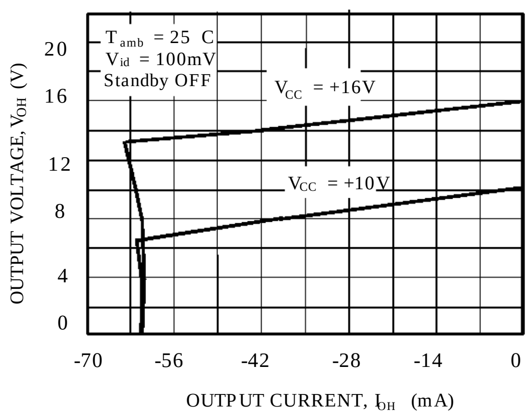


Figure 4a : Low Level Output Voltage versus Low Level Output Current

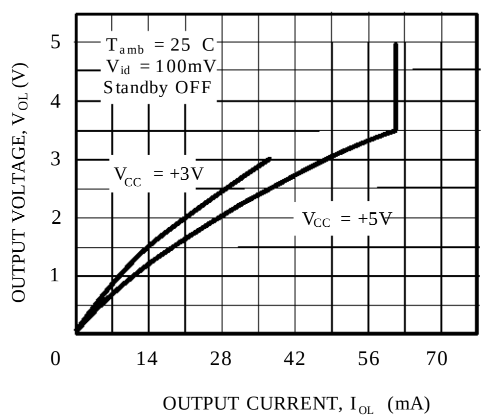


Figure 4b : Low Level Output Voltage versus Low Level Output Current

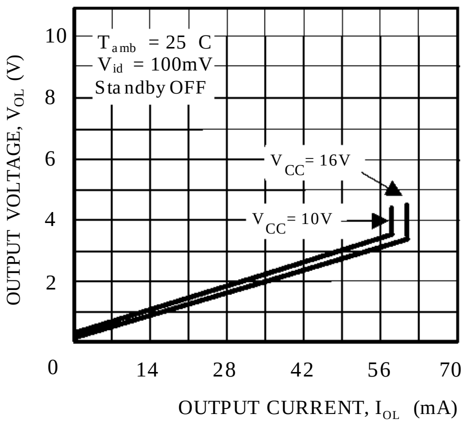


Figure 5a : Open Loop Frequency Response and Phase Shift

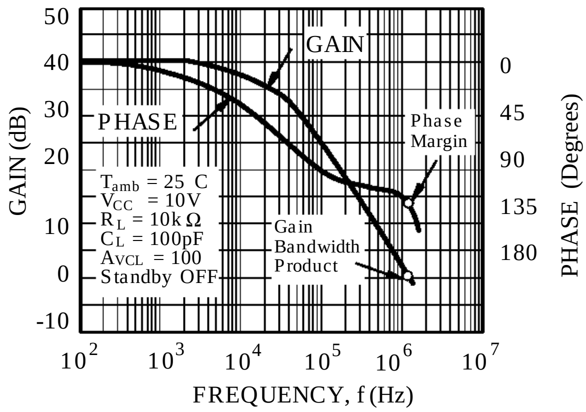


Figure 5b : Open Loop Frequency Response and Phase Shift

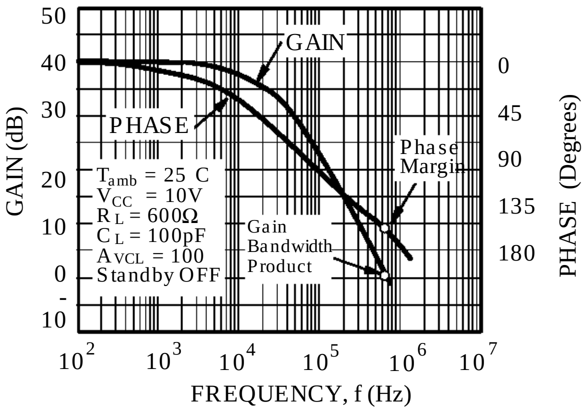


Figure 6a : Gain Bandwidth Product versus Supply Voltage

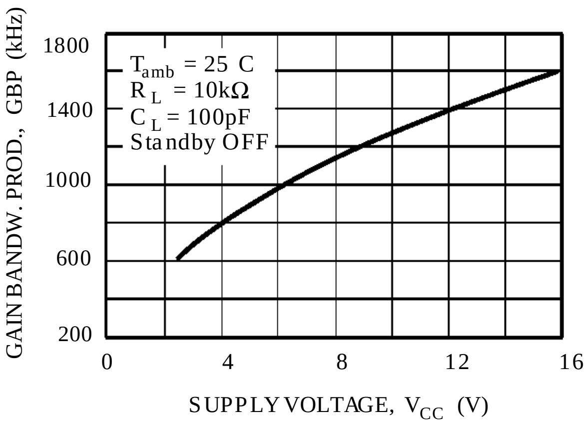


Figure 6b : Gain bandwidth Product versus Supply Voltage

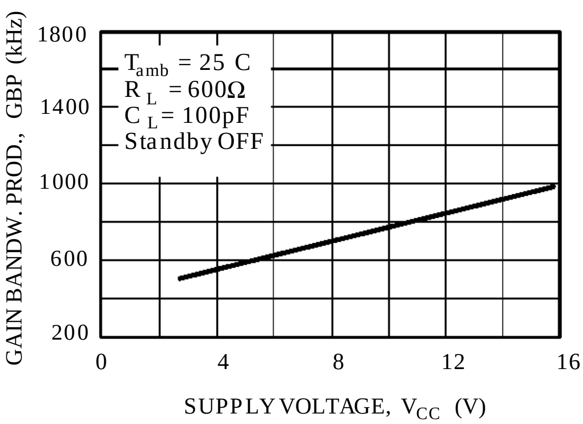


Figure 7a : Phase Margin versus Supply Voltage

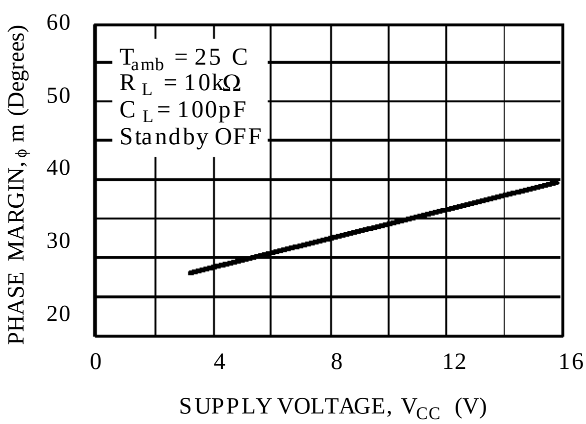


Figure 7b : Phase Margin versus Supply Voltage

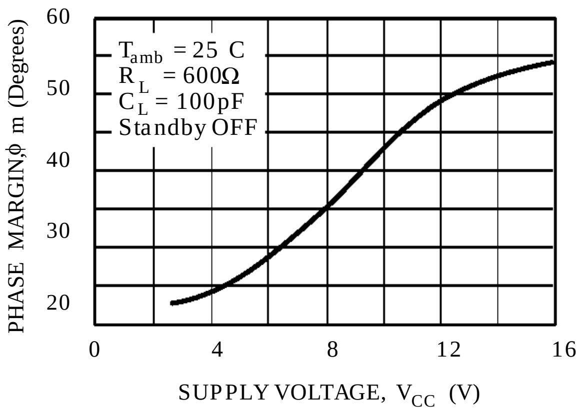
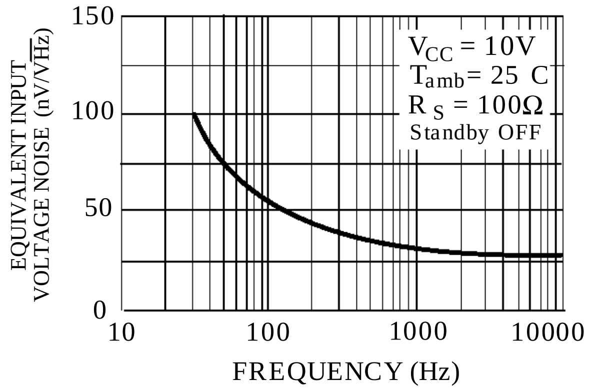


Figure 8 : Input Voltage Noise versus Frequency



STANDBY APPLICATION

The 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.

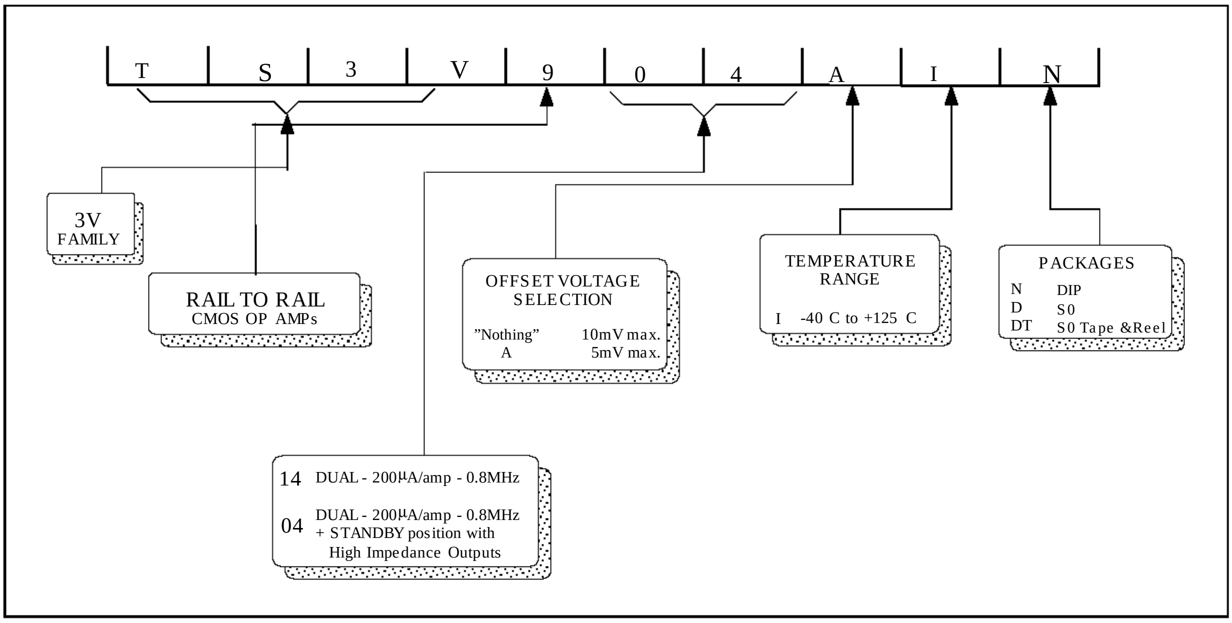
When one of these standby is activated (STANDBY ON) :

- 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_{CC} = 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 sinked.

The standby pins 8 and 9 should never stay unconnected.

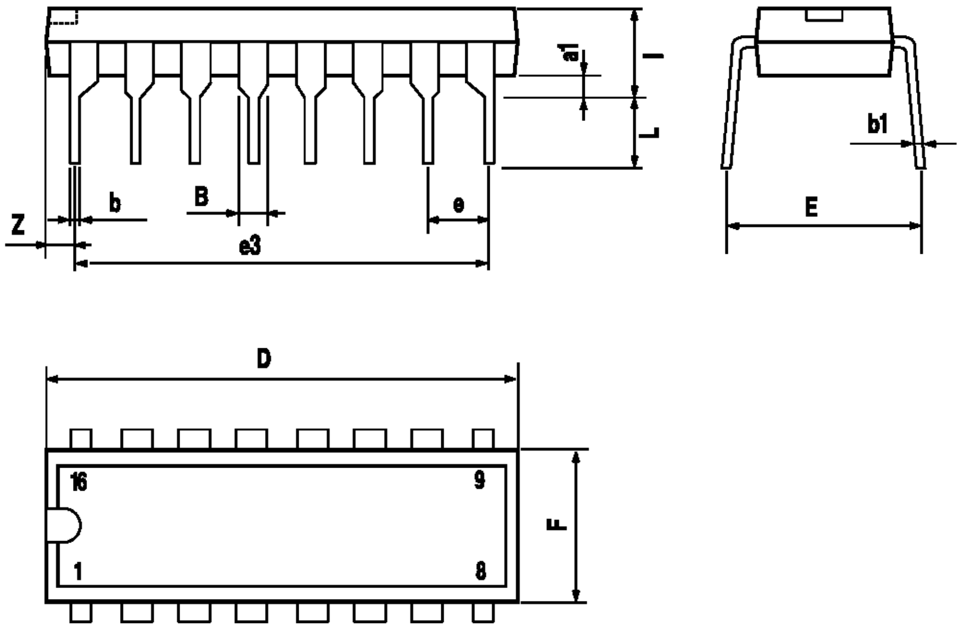
- The **"standby OFF"** state, is reached when the pins 8 or 9 voltage is **higher than $V_{in\ SBY/OFF}$**.
- The **"standby ON"** state, is assured by the pins 8 or 9 voltage **lower than $V_{in\ SBY/OFF}$**. (see electrical characteristics)

ORDERING INFORMATION



PACKAGE MECHANICAL DATA

16 PINS - PLASTIC DIP



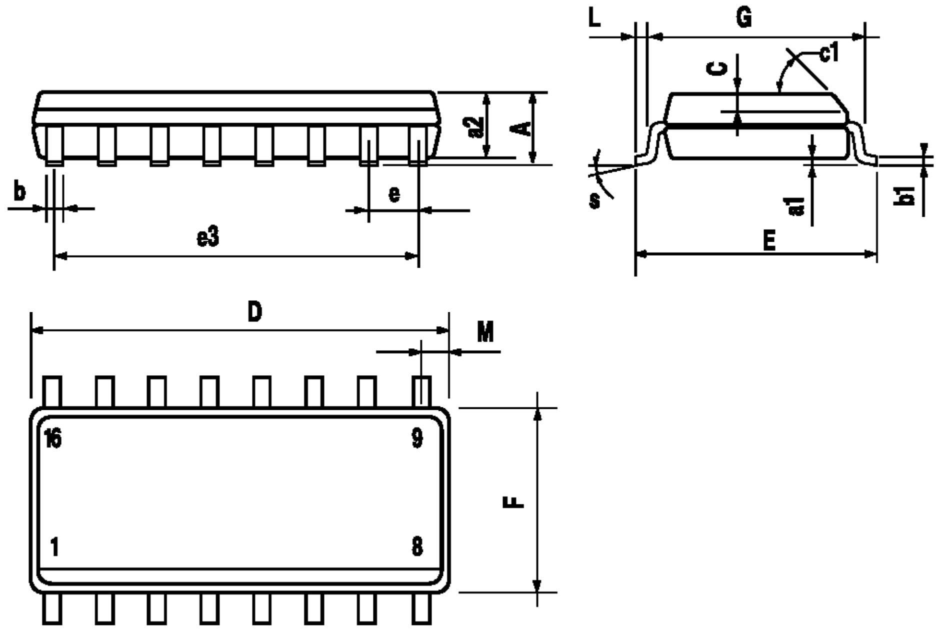
PM-DIP16.EPS

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)



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^{o} (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^{o} (max.)					

SO16.TBL

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