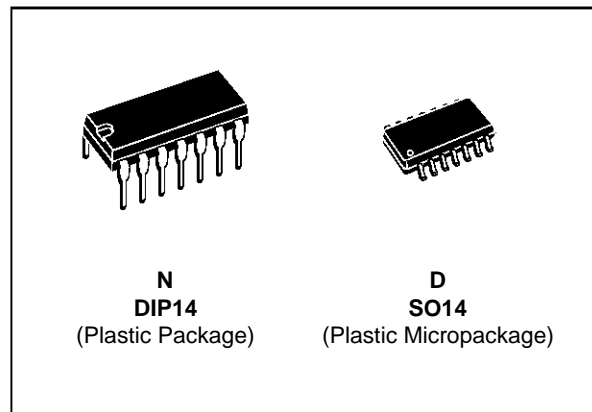


## 3V RAIL TO RAIL CMOS QUAD OPERATIONAL AMPLIFIER

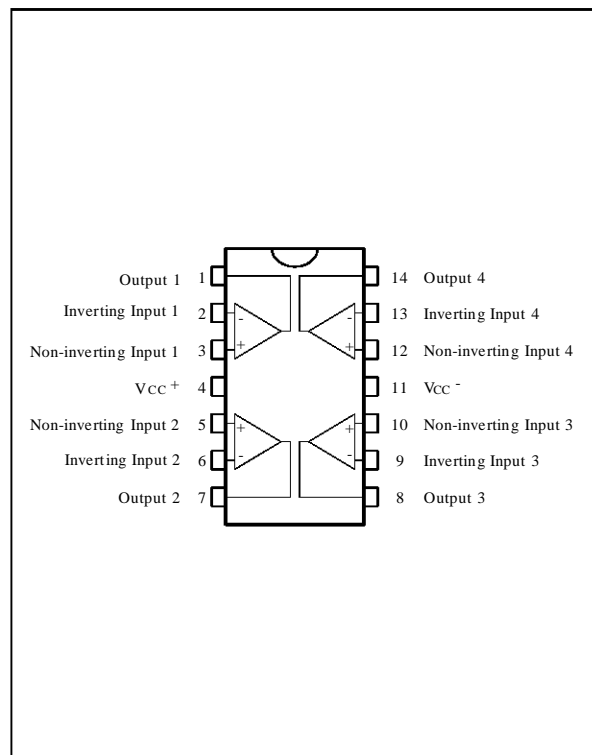
- DEDICATED TO 3.3V APPLICATIONS AND BATTERY-SUPPLIED (fully specified at  $V_{CC} = 3V$  and  $5V$ )
- **RAIL TO RAIL** INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE (OR DUAL) SUPPLY OPERATION FROM **2.7V TO 16V**
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** TYP
- LOW INPUT OFFSET VOLTAGE : 5mV max.
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 200μA/Ampli
  
- **SPICE MACROMODEL** INCLUDED IN THIS SPECIFICATION



### ORDER CODES

Part Number	Temperature Range	Package	
		N	D
TS3V914/AI	-40, +125°C	•	•

### PIN CONNECTIONS (top view)



### DESCRIPTION

The TS3V914 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 :

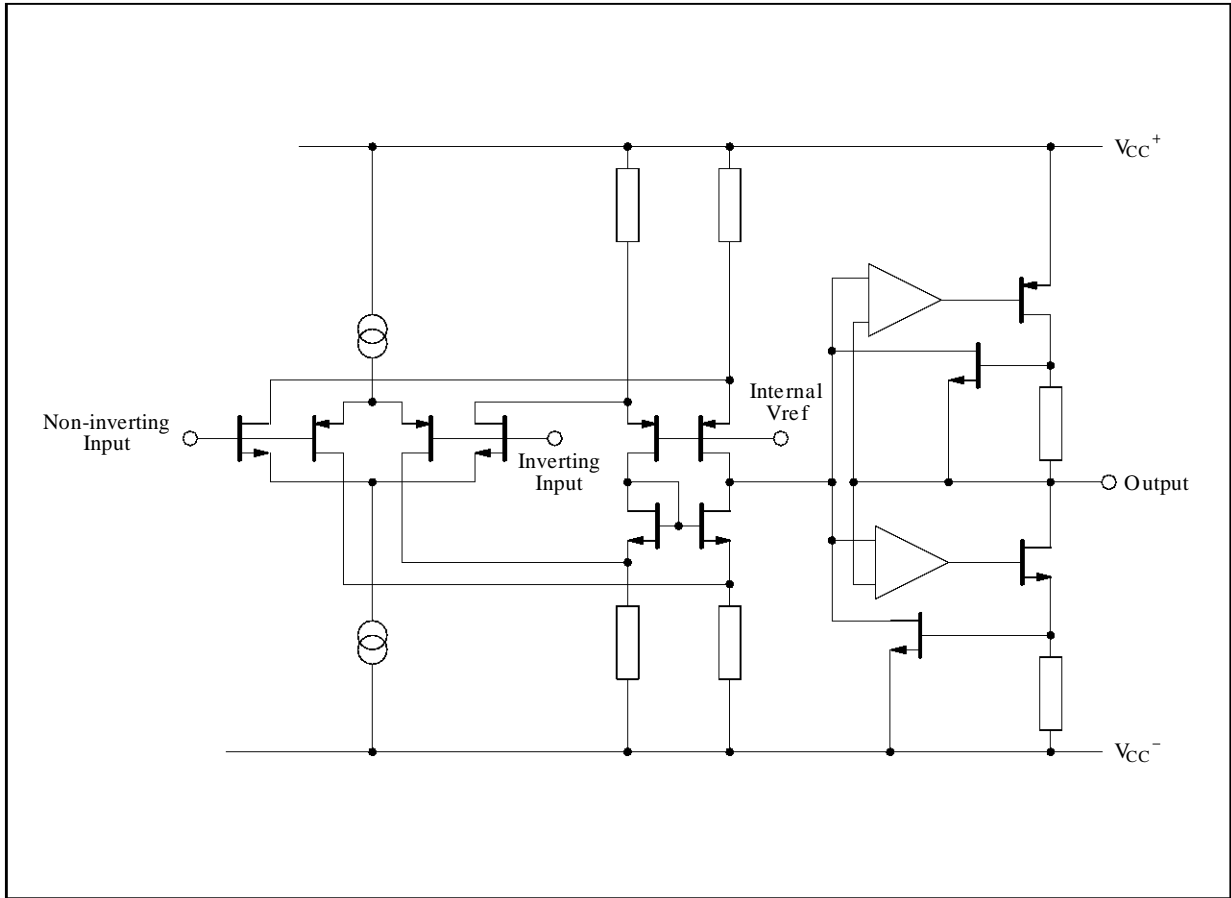
- $V_{CC}^- + 50mV$   $V_{CC}^+ - 50mV$  with  $R_L = 10k\Omega$
- $V_{CC}^- + 350mV$   $V_{CC}^+ - 350mV$  with  $R_L = 600\Omega$

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

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

SGS-THOMSON is offering a dual op-amp with the same features : TS3V912.

**SCHEMATIC DIAGRAM (1/4 TS3V914)**



**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	-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  $V_{CC}/2$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

Symbol	Parameter	TS3V914I/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	$\mu A$
CMR	Common Mode Rejection Ratio $V_{ic} = 0$ to $3V$ , $V_o = 1.5V$		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 ( $V_{id} = 1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ 2.9 $R_L = 600\Omega$ 2.3 $R_L = 100\Omega$	2.96 2.6 2		V
$V_{OL}$	Low Level Output Voltage ( $V_{id} = -1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$		50 300 900	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 ( $A_{VCL} = 100$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $f = 100kHz$ )		0.8		MHz
$SR^+$	Positive Slew Rate $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $V_i = 1.3V$ to $1.7V$ , $C_L = 100pF$		0.5		V/ $\mu s$
$SR^-$	Negative Slew Rate		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.

**ELECTRICAL CHARACTERISTICS**

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

Symbol	Parameter	TS3V914I/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	$\mu A$
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 ( $V_{id} = 1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ 4.90 $R_L = 600\Omega$ 4.25 $R_L = 100\Omega$	4.95 4.65 3.7		V
$V_{OL}$	Low Level Output Voltage ( $V_{id} = -1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$	50 350 1400	100 500	mV
$I_o$	Output Short Circuit Current ( $V_{id} = \pm 1V$ )	Source ( $V_o = V_{CC}^-$ ) 45 Sink ( $V_o = V_{CC}^+$ ) 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 $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $V_i = 1V$ to $4V$ , $C_L = 100pF$		0.8		V/ $\mu s$
$SR^-$	Negative Slew Rate		0.5		V/ $\mu s$
$\phi_m$	Phase Margin		30		Degrees

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

TYPICAL CHARACTERISTICS

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

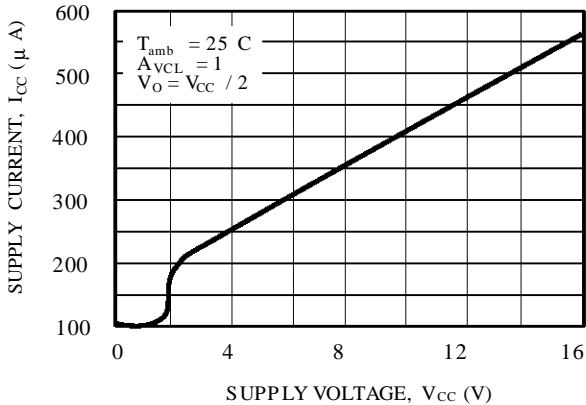


Figure 2 : Input Bias Current versus Temperature

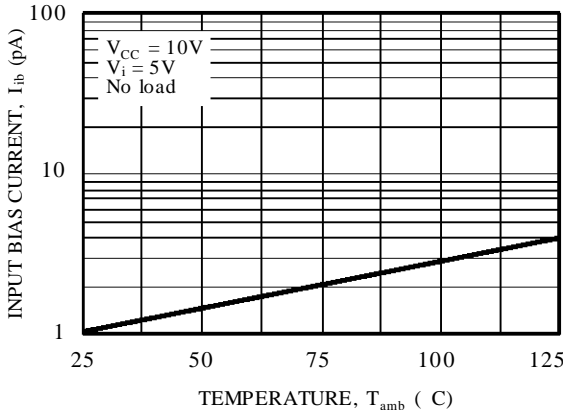


Figure 3a : High Level Output Voltage versus High Level Output Current

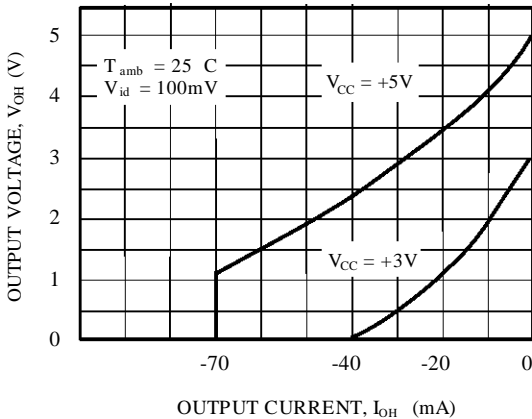


Figure 3b : High Level Output Voltage versus High Level Output Current

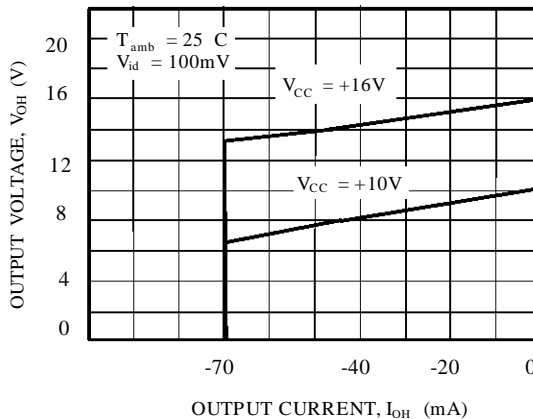


Figure 4a : Low Level Output Voltage versus Low Level Output Current

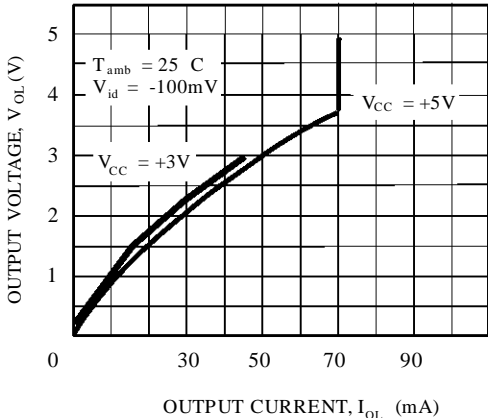
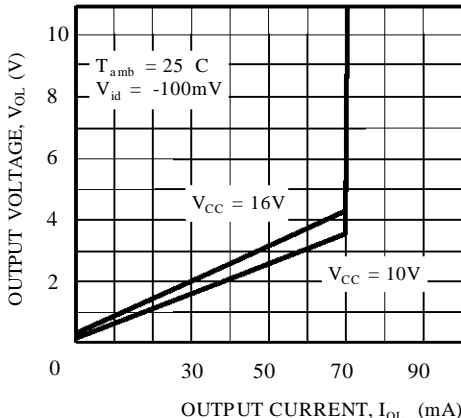
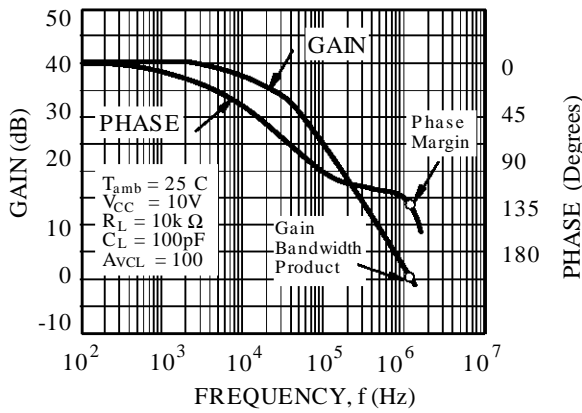


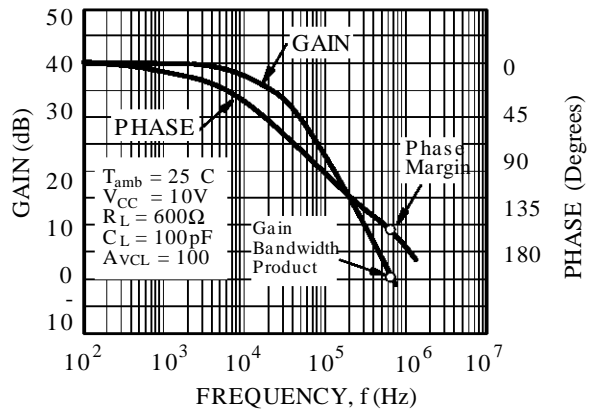
Figure 4b : Low Level Output Voltage versus Low Level Output Current



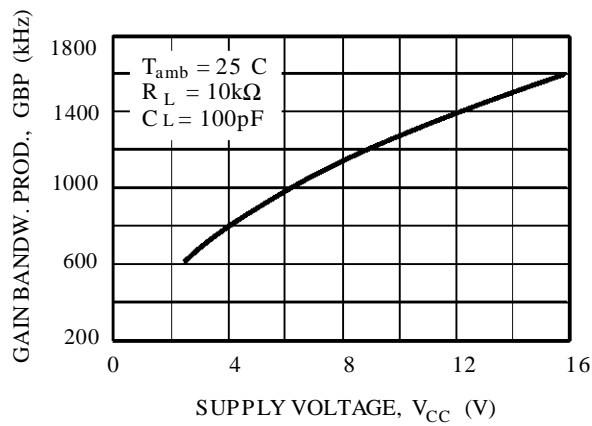
**Figure 5a :** Open Loop Frequency Response and Phase Shift



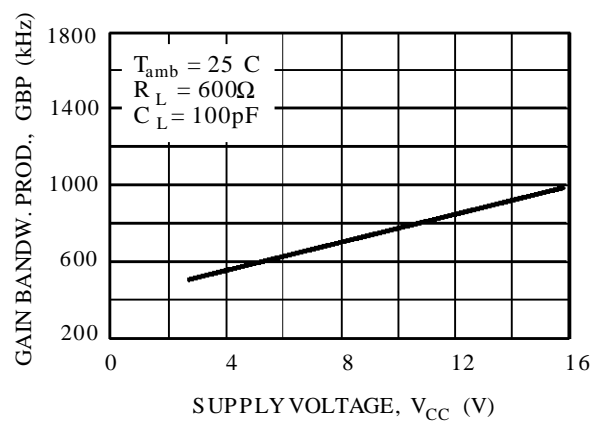
**Figure 5b :** Open Loop Frequency Response and Phase Shift



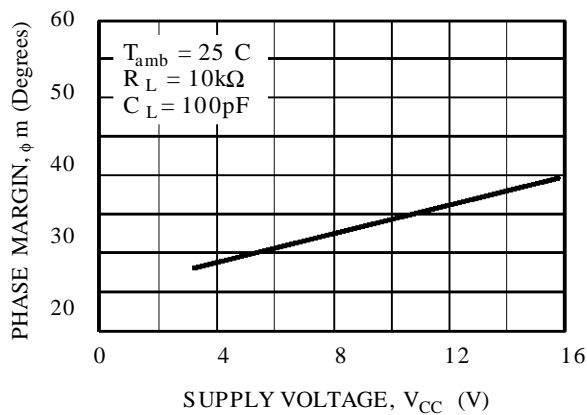
**Figure 6a :** Gain Bandwidth Product versus Supply Voltage



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



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



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

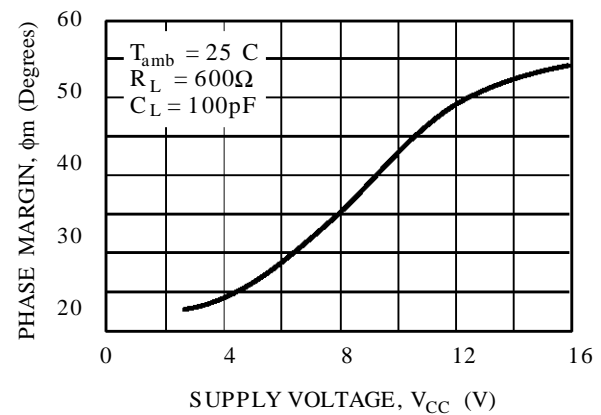
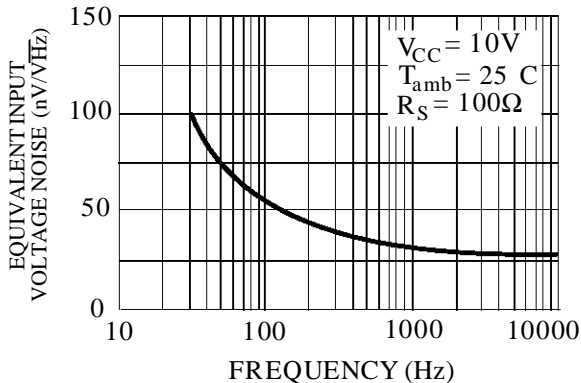
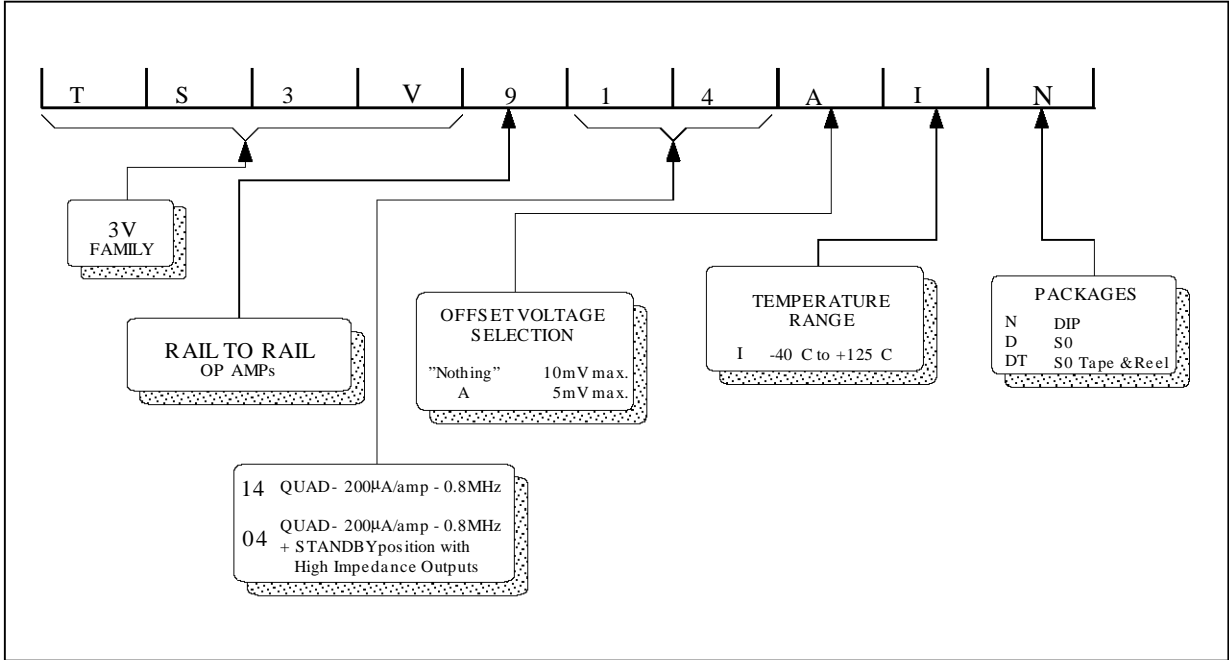


Figure 8 : Input Voltage Noise versus Frequency



ORDERING INFORMATION



MACROMODEL

- RAIL TO RAIL INPUT AND OUTPUT VOLTAGE RANGES
- STANDBY POSITION : REDUCED CONSUMPTION (1µA) 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 : 1.5mV max.
- SPECIFIED FOR 600Ω AND 100Ω LOADS
- LOW SUPPLY CURRENT : 400µA/Ampli
- SPEED : 1.3MHz - 1.3V/µs

Applies to : TS3V914I,AI,BI

\*\* Standard Linear Ics Macromodels, 1993.

\*\* CONNECTIONS :

- \* 1 INVERTING INPUT
- \* 2 NON-INVERTING INPUT
- \* 3 OUTPUT
- \* 4 POSITIVE POWER SUPPLY
- \* 5 NEGATIVE POWER SUPPLY

.SUBCKT TS3V914\_3 1 3 2 4 5 (analog)

\*\*\*\*\*

.MODEL MDTH D IS=1E-8 KF=6.564344E-14 CJO=10F

\* INPUT STAGE

CIP 2 5 1.000000E-12  
CIN 1 5 1.000000E-12  
EIP 10 5 2 5 1  
EIN 16 5 1 5 1  
RIP 10 11 6.500000E+00  
RIN 15 16 6.500000E+00  
RIS 11 15 1.271505E+01  
DIP 11 12 MDTH 400E-12  
DIN 15 14 MDTH 400E-12  
VOFP 12 13 DC 0.000000E+00  
VOFN 13 14 DC 0  
IPOL 13 5 4.000000E-05  
CPS 11 15 2.125860E-08  
DINN 17 13 MDTH 400E-12  
VIN 17 5 0.000000E+00  
DINR 15 18 MDTH 400E-12  
VIP 4 18 0.000000E+00  
FCP 4 5 VOFP 5.000000E+00  
FCN 5 4 VOFN 5.000000E+00  
\* AMPLIFYING STAGE  
FIP 5 19 VOFP 2.750000E+02  
FIN 5 19 VOFN 2.750000E+02  
RG1 19 5 1.916825E+05  
RG2 19 4 1.916825E+05  
CC 19 29 2.200000E-08  
HZTP 30 29 VOFP 1.3E+03

HZTN 5 30 VOFN 1.3E+03  
DOPM 19 22 MDTH 400E-12  
DONM 21 19 MDTH 400E-12  
HOPM 22 28 VOUT 3800  
VIPM 28 4 150  
HONM 21 27 VOUT 3800  
VINM 5 27 150  
EOUT 26 23 19 5 1  
VOUT 23 5 0  
ROUT 26 3 75  
COUT 3 5 1.000000E-12  
DOP 19 68 MDTH 400E-12  
VOP 4 25 1.724  
HSCP 68 25 VSCP1 0.8E8  
DON 69 19 MDTH 400E-12  
VON 24 5 1.7419107  
HSCN 24 69 VSCN1 0.8E+08  
VSCTHP 60 61 0.0875  
\*\* VSCTHP = le seuil au dessus de vio  
\* 500  
\*\* c.a.d 275U-000U dus a l'offset  
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 -0.55  
\*\* VSCTHN = le seuil au dessous de vio  
\* 2000  
\*\* c.a.d -375U-000U dus a l'offset  
ESCP 60 0 2 1 500  
ESCN 70 0 2 1 -2000  
.ENDS



**Applies to : TS3V914I,AI,BI**

```

** Standard Linear lcs Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
* 6 STANDBY
.SUBCKT TS3V914_5 1 3 2 4 5 (analog)
*****
.MODEL MDTH D IS=1E-8 KF=6.564344E-14 CJO=10F
* INPUT STAGE
CIP 2 5 1.000000E-12
CIN 1 5 1.000000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 6.500000E+00
RIN 15 16 6.500000E+00
RIS 11 15 7.322092E+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
IPOL 13 5 4.000000E-05
CPS 11 15 2.498970E-08
DINN 17 13 MDTH 400E-12
VIN 17 5 0.000000E+00
DINR 15 18 MDTH 400E-12
VIP 4 18 0.000000E+00
FCP 4 5 VOFP 5.750000E+00
FCN 5 4 VOFN 5.750000E+00
ISTB0 5 4 500N
* AMPLIFYING STAGE
FIP 5 19 VOFP 4.400000E+02
FIN 5 19 VOFN 4.400000E+02
RG1 19 5 4.904961E+05
RG2 19 4 4.904961E+05
CC 19 29 2.200000E-08
HZTP 30 29 VOFP 1.8E+03
HZTN 5 30 VOFN 1.8E+03
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 3800
VIPM 28 4 230
HONM 21 27 VOUT 3800
VINM 5 27 230
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 82
COUT 3 5 1.000000E-12
DOP 19 68 MDTH 400E-12
VOP 4 25 1.724
HSCP 68 25
VSCP1 0.8E+08
DON 69 19 MDTH 400E-12
VON 24 5 1.7419107
HSCN 24 69
VSCN1 0.8E+08
VSCTHP 60 61 0.0875
** VSCTHP = le seuil au dessus de vio
* 500
** c.a.d 275U-000U dus a l'offset
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 -0.55
** VSCTHN = le seuil au dessous de vio
* 2000
** c.a.d -375U-000U dus a l'offset
ESCP 60 0 2 1 500
ESCN 70 0 2 1 -2000
.ENDS

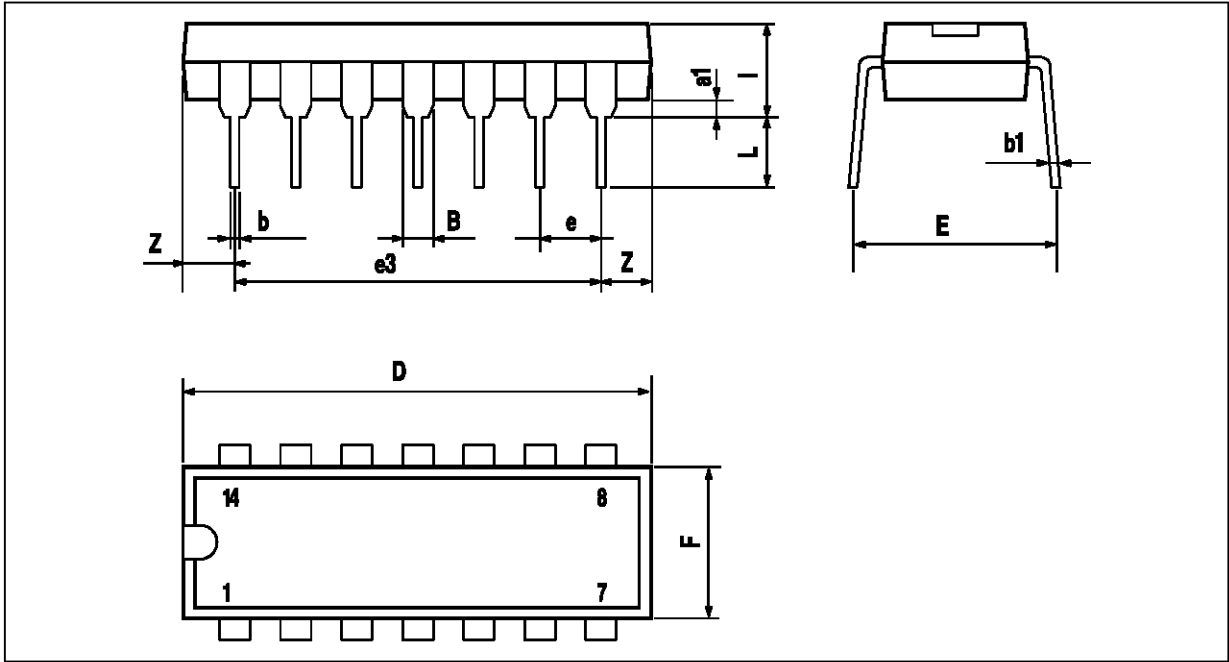
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**ELECTRICAL CHARACTERISTICS**

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

Symbol	Conditions	Value	Unit
$V_{io}$		0	mV
$A_{vd}$	$R_L = 10k\Omega$	10	V/mV
$I_{CC}$	No load, per operator	100	$\mu A$
$V_{icm}$		-0.2 to 3.2	V
$V_{OH}$	$R_L = 600\Omega$	2.6	V
$V_{OL}$	$R_L = 600\Omega$	300	mV
$I_{sink}$	$V_O = 3V$	40	mA
$I_{source}$	$V_O = 0V$	40	mA
GBP	$R_L = 10k\Omega$ , $C_L = 100pF$ , $F = 100kHz$	0.8	MHz
SR	$R_L = 10k\Omega$ , $C_L = 100pF$	0.5	V/ $\mu s$
$\varnothing m$		30	Degrees

**PACKAGE MECHANICAL DATA**  
 14 PINS - PLASTIC DIP



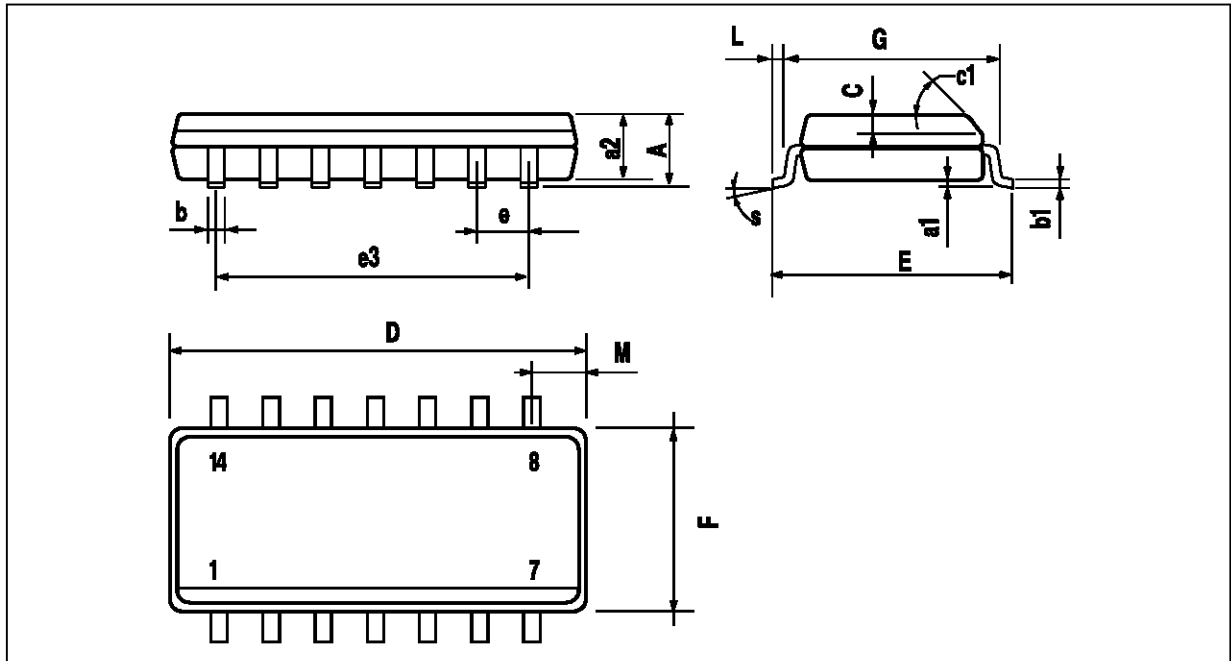
PM-DIP14.EPS

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

**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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