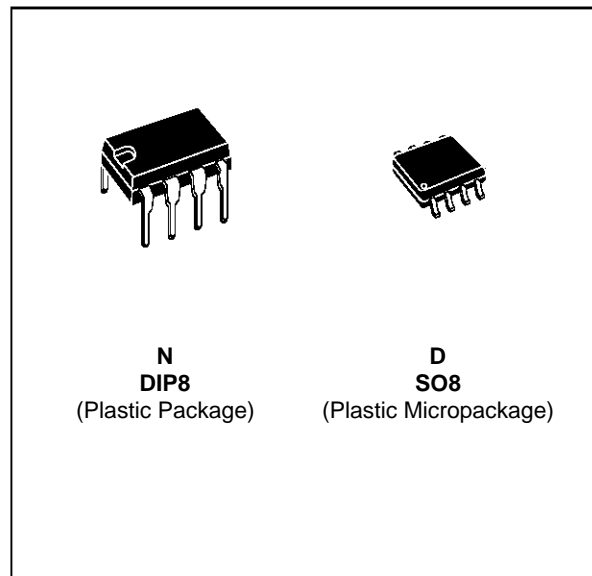


## 3V RAIL TO RAIL CMOS DUAL OPERATIONAL AMPLIFIER

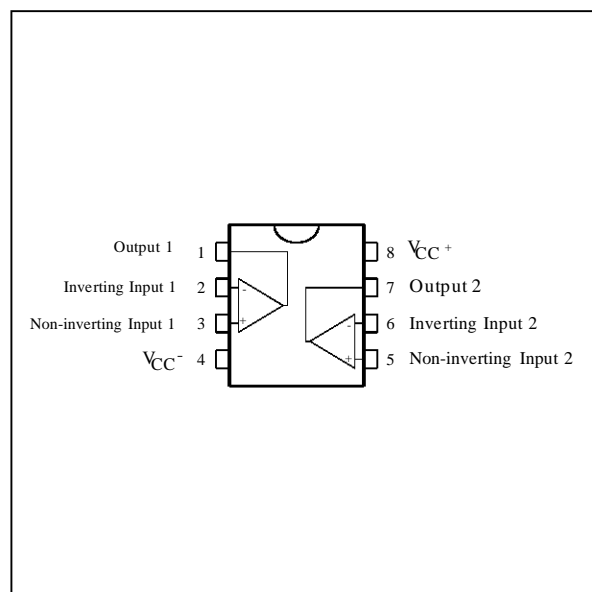
- DEDICATED TO **3.3V OR BATTERY SUPPLY** (specified at 3V and 5V)
- RAIL TO RAIL INPUT AND OUTPUT VOLTAGE RANGES
- SINGLE SUPPLY OPERATION FROM **2.7V TO 16V**
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA** typ
- LOW INPUT OFFSET VOLTAGE : **2mV max.**
- SPECIFIED FOR **600Ω** AND **100Ω** LOADS
- LOW SUPPLY CURRENT : 200μA/Ampli (VCC = 3V)
  
- ESD TOLERANCE : 3KV
- LATCH-UP IMMUNITY
  
- **MACROMODEL** INCLUDED IN THIS SPECIFICATION



### ORDER CODES

Part Number	Temperature Range	Package	
		N	D
TS3V912I/AI/BI	-40, +125°C	•	•

### PIN CONNECTIONS (top view)



### DESCRIPTION

The TS3V912 is a RAIL TO RAIL CMOS dual 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 :

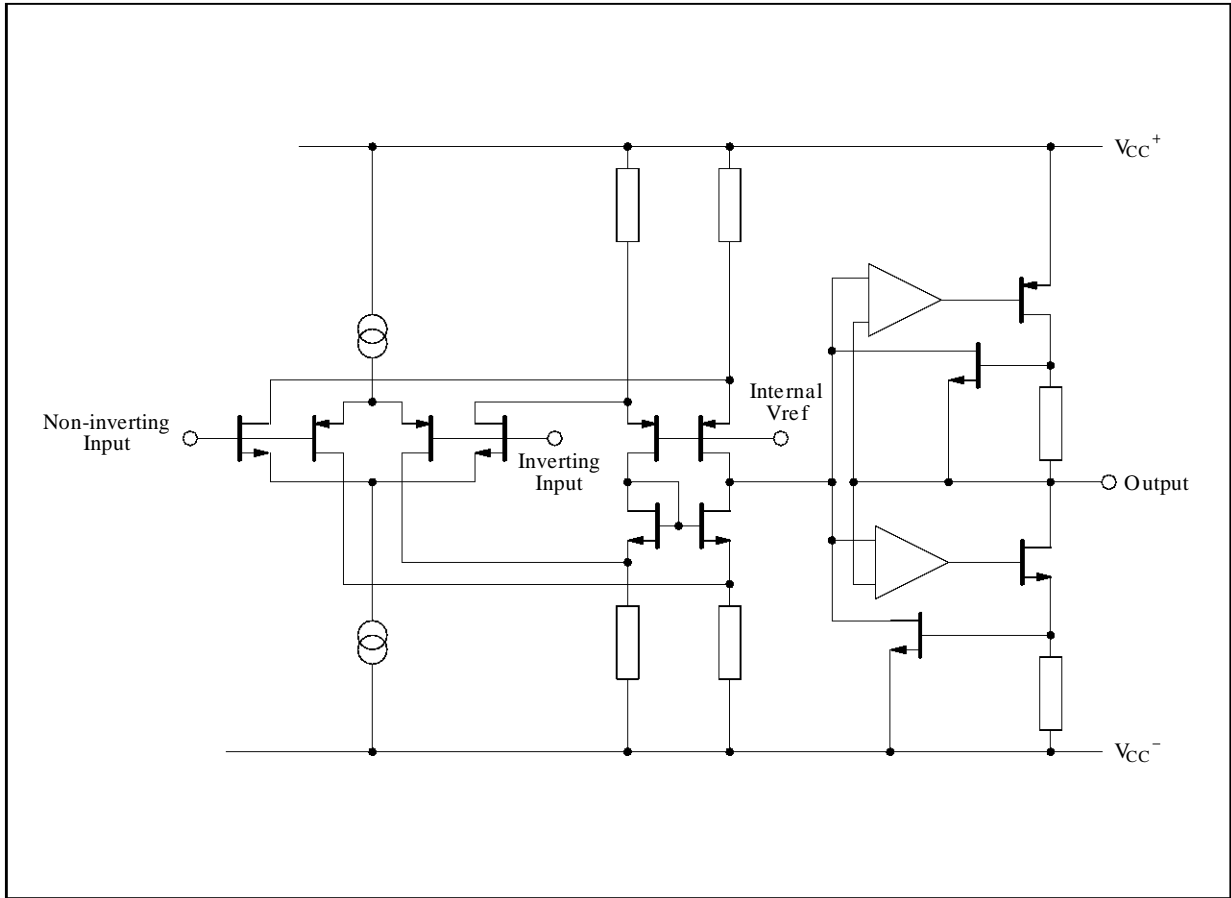
- $V_{CC}^- + 40mV$      $V_{CC}^+ - 50mV$     with  $R_L = 10k\Omega$
- $V_{CC}^- + 350mV$      $V_{CC}^+ - 350mV$     with  $R_L = 600\Omega$

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 quad op-amp with the same features : TS3V914.

**SCHEMATIC DIAGRAM (1/2 TS3V912)**



**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	$^{\circ}C$
	TS3V912I/AI/BI		
$T_{stg}$	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	TS3V912/AI/BI			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 2 12 7 3	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 $3.3V$ , $V_o = V_{CC}/2$ )	50	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 ( $V_{id} = 1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $R_L = 10k\Omega$ $R_L = 600\Omega$	2.95 2.9 2.3  2.8 2.1	2.96 2.6 2	V
$V_{OL}$	Low Level Output Voltage ( $V_{id} = -1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $R_L = 10k\Omega$ $R_L = 600\Omega$		50 70 400  100 600	mV
$I_o$	Output Short Circuit Current ( $V_{id} = \pm 1V$ )	Source ( $V_o = V_{CC}^-$ ) Sink ( $V_o = V_{CC}^+$ )	20 20	40 40	mA
GBP	Gain Bandwidth Product ( $A_{VCL} = 100$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $f = 100kHz$ )		0.8		MHz
$SR^+$	Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1.3V$ to $1.7V$ )		0.4		V/ $\mu s$
$SR^-$	Slew Rate ( $A_{VCL} = 1$ , $R_L = 10k\Omega$ , $C_L = 100pF$ , $V_i = 1.3V$ to $1.7V$ )		0.3		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	TS3V912/AI/BI			Unit	
		Min.	Typ.	Max.		
$V_{io}$	Input Offset Voltage ( $V_{ic} = V_o = V_{CC}/2$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	TS3V912 TS3V912A TS3V912B TS3V912 TS3V912A TS3V912B			10 5 2 12 7 3	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 $3.5V, V_o = 2.5V$		60	85		dB
SVR	Supply Voltage Rejection Ratio ( $V_{CC}^+ = 3$ to $5V, V_o = V_{CC}/2$ )		55	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	40		V/mV
$V_{OH}$	High Level Output Voltage ( $V_{id} = 1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $R_L = 10k\Omega$ $R_L = 600\Omega$	4.95 4.9 4.25  4.8 4.1	4.95 4.55 3.7		V
$V_{OL}$	Low Level Output Voltage ( $V_{id} = -1V$ ) $T_{min.} \leq T_{amb} \leq T_{max.}$	$R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$  $R_L = 10k\Omega$ $R_L = 600\Omega$		40 350 1400	50 100 500  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	65 65		mA
GBP	Gain Bandwidth Product ( $A_{VCL} = 100, R_L = 10k\Omega, C_L = 100pF, f = 100kHz$ )			1		MHz
$SR^+$	Slew Rate ( $A_{VCL} = 1, R_L = 10k\Omega, C_L = 100pF, V_i = 1V$ to $4V$ )			0.8		V/ $\mu s$
$SR^-$	Slew Rate ( $A_{VCL} = 1, R_L = 10k\Omega, C_L = 100pF, V_i = 1V$ to $4V$ )			0.6		V/ $\mu s$
$e_n$	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
$\phi_m$	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

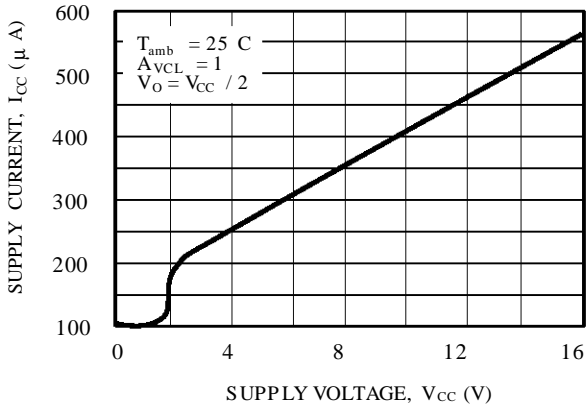


Figure 2 : Input Bias Current versus Temperature

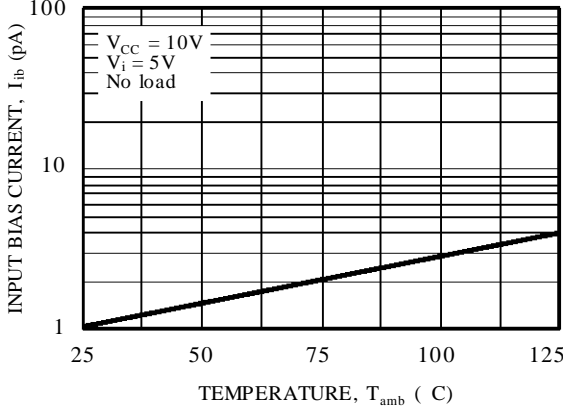


Figure 3a : High Level Output Voltage versus High Level Output Current

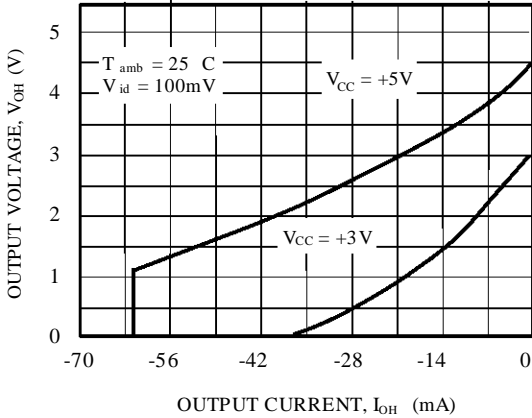


Figure 3b : High Level Output Voltage versus High Level Output Current

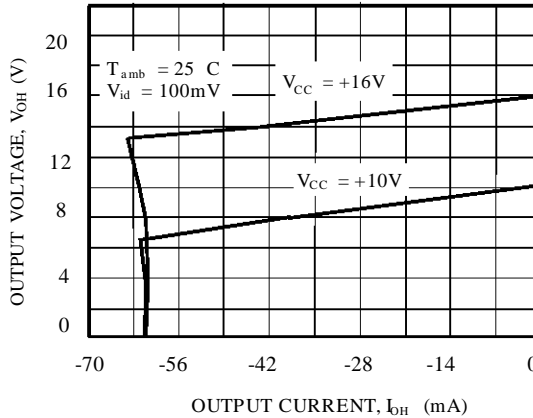


Figure 4a : Low Level Output Voltage versus Low Level Output Current

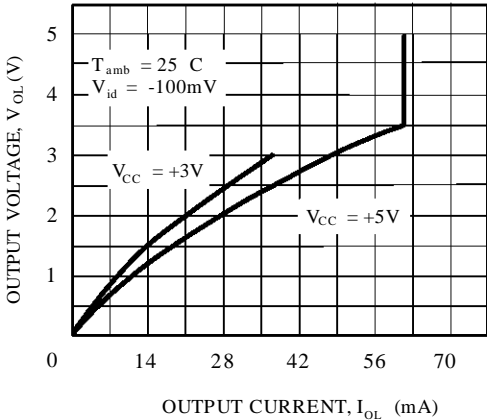
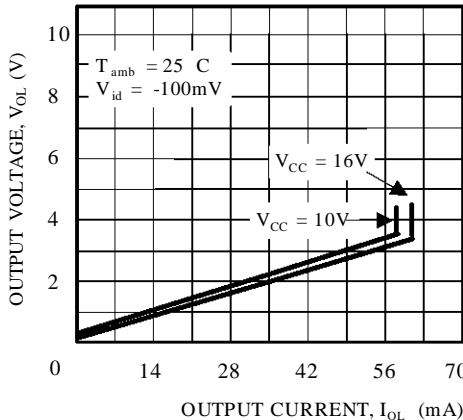
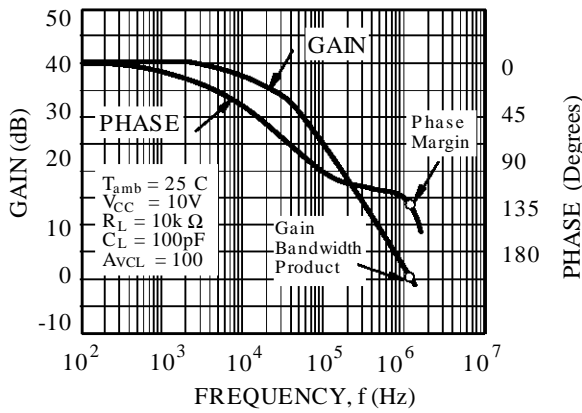


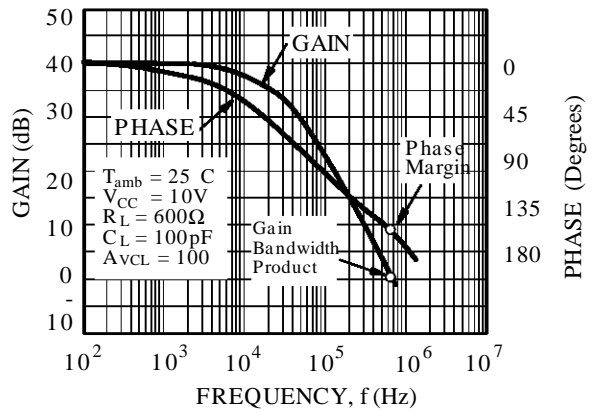
Figure 4b : Low Level Output Voltage versus Low Level Output Current



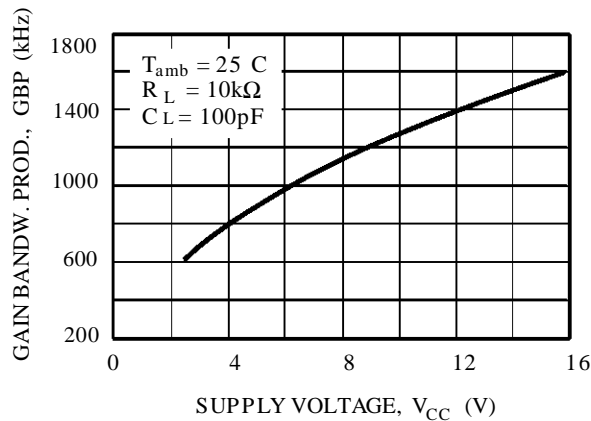
**Figure 5a :** Open Loop Frequency Response and Phase Shift



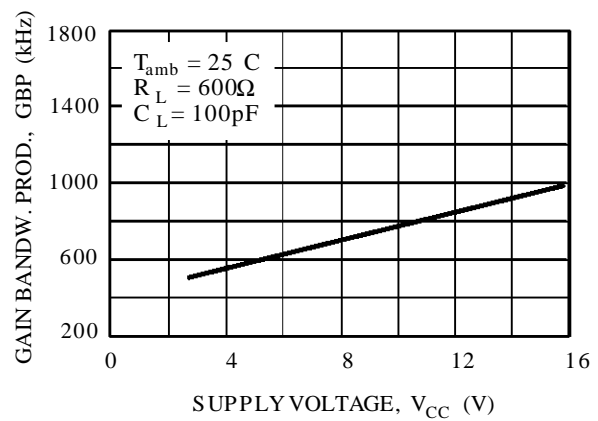
**Figure 5b :** Open Loop Frequency Response and Phase Shift



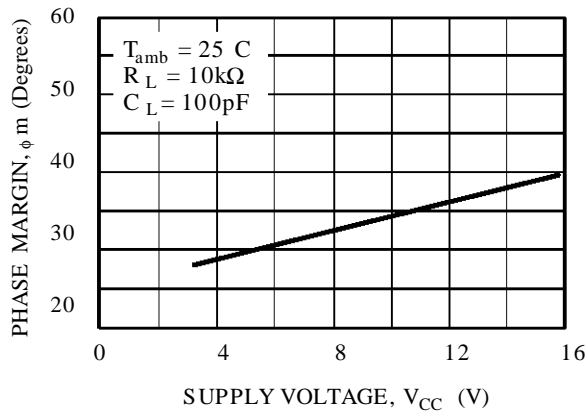
**Figure 6a :** Gain Bandwidth Product versus Supply Voltage



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



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



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

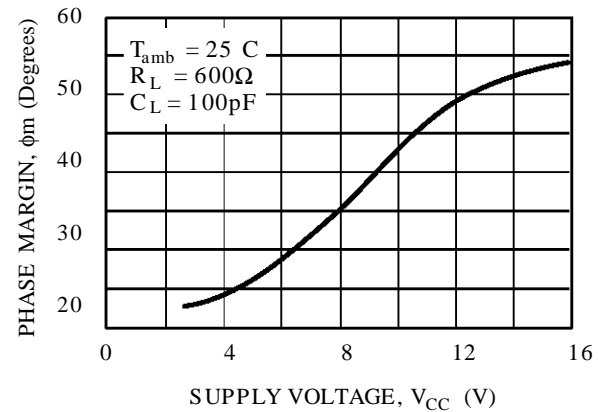
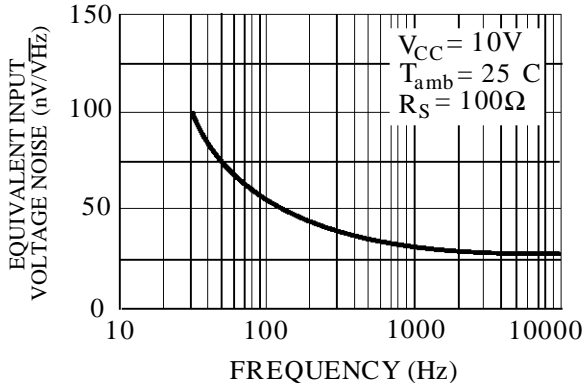
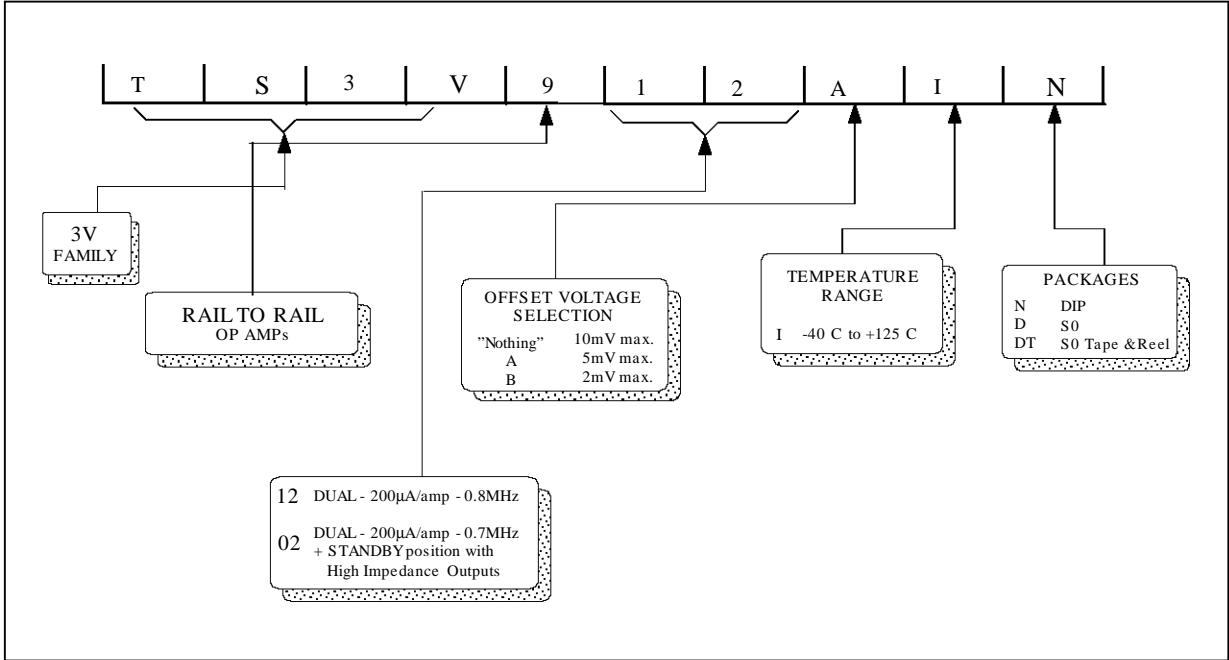


Figure 8 : Input Voltage Noise versus Frequency



ORDERING INFORMATION



# TS3V912

## Applies to : TS3V912 (V<sub>CC</sub> = 3V)

\*\* Standard Linear Ics Macromodels, 1993.

\*\* CONNECTIONS :

\* 1 INVERTING INPUT

\* 2 NON-INVERTING INPUT

\* 3 OUTPUT

\* 4 POSITIVE POWER SUPPLY

\* 5 NEGATIVE POWER SUPPLY

.SUBCKT TS3V912\_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

**ELECTRICAL CHARACTERISTICS** V<sub>CC</sub><sup>+</sup> = 3V, V<sub>CC</sub><sup>-</sup> = 0V, R<sub>L</sub>, C<sub>L</sub> connected to V<sub>CC</sub>/2, T<sub>amb</sub> = 25°C  
(unless otherwise specified)

Symbol	Conditions	Value	Unit
V <sub>io</sub>		0	mV
A <sub>vd</sub>	R <sub>L</sub> = 10kΩ	10	V/mV
I <sub>CC</sub>	No load, per operator	200	μA
V <sub>icm</sub>		-0.2 to 3.2	V
V <sub>OH</sub>	R <sub>L</sub> = 10kΩ	2.96	V
V <sub>OL</sub>	R <sub>L</sub> = 10kΩ	30	mV
I <sub>sink</sub>	V <sub>O</sub> = 3V	40	mA
I <sub>source</sub>	V <sub>O</sub> = 0V	40	mA
GBP	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 100pF	0.8	MHz
SR	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 100pF	0.3	V/μs



**Applies to : TS3V912 (V<sub>CC</sub> = 5V)**

```

** 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 TS3V912_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

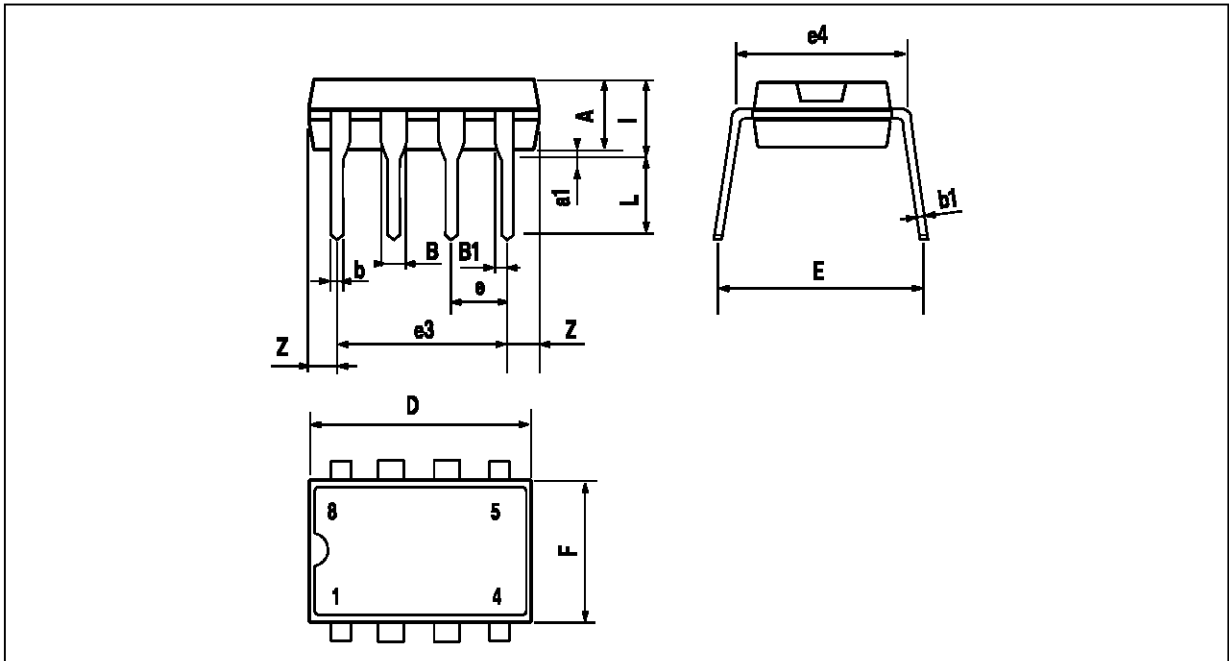
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**ELECTRICAL CHARACTERISTICS** V<sub>CC</sub><sup>+</sup> = 5V, V<sub>CC</sub><sup>-</sup> = 0V, R<sub>L</sub>, C<sub>L</sub> connected to V<sub>CC</sub>/2, T<sub>amb</sub> = 25°C (unless otherwise specified)

Symbol	Conditions	Value	Unit
V <sub>io</sub>		0	mV
A <sub>vd</sub>	R <sub>L</sub> = 10kΩ	50	V/mV
I <sub>CC</sub>	No load, per operator	230	μA
V <sub>icm</sub>		-0.2 to 5.2	V
V <sub>OH</sub>	R <sub>L</sub> = 10kΩ	4.95	V
V <sub>OL</sub>	R <sub>L</sub> = 10kΩ	40	mV
I <sub>sink</sub>	V <sub>O</sub> = 5V	65	mA
I <sub>source</sub>	V <sub>O</sub> = 0V	65	mA
GBP	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 100pF	1	MHz
SR	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 100pF	0.8	V/μs

**TS3V912**

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

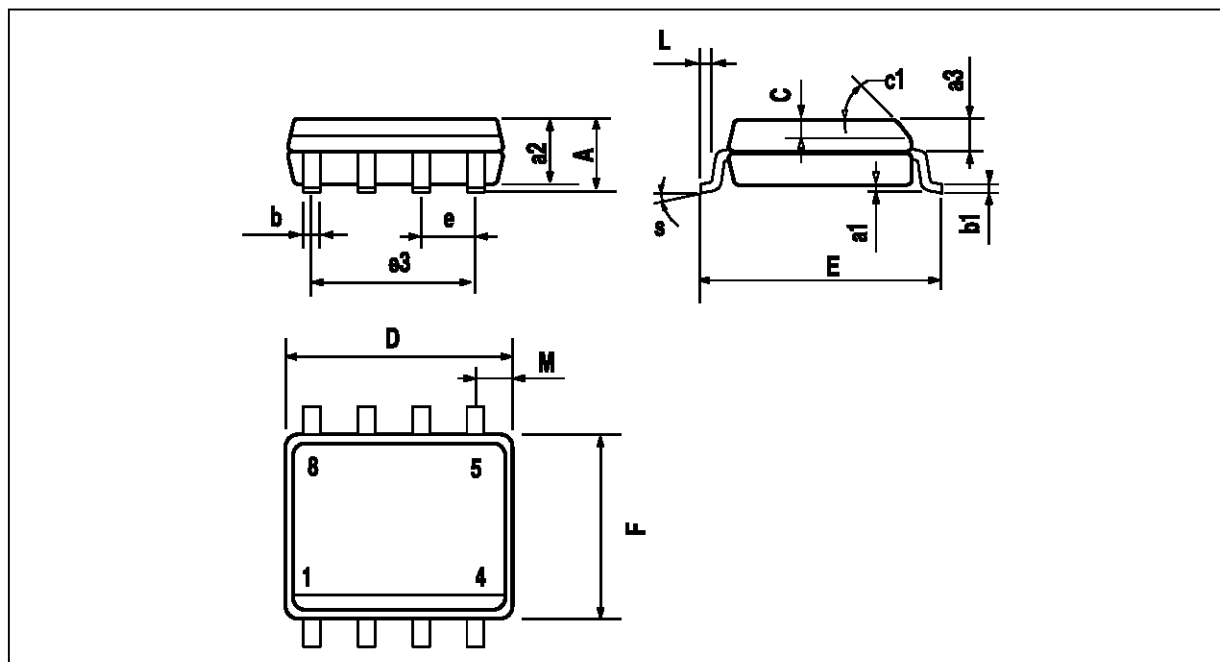


PM-DIP8.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

DIP8.TBL

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



PM-S08:EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

S08:TEL

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