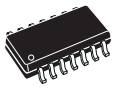
TSH93

HIGH SPEED LOW POWER TRIPLE OPERATIONAL AMPLIFIER

- LOW SUPPLY CURRENT : 4.5mA
- HIGH SPEED : 150MHz - 110V/µs
- UNITY GAIN STABILITY
- LOW OFFSET VOLTAGE : 4mV
- LOW NOISE 4.2 nV/√Hz
- LOW COST
- SPECIFIED FOR 600Ω AND 150Ω LOADS
- HIGH VIDEO PERFORMANCES :
  Differential Gain : 0.03%
  Differential Phase : 0.07°
  Gain Flatness : 6MHz, 0.1dB max. @ 10dB gain
- HIGH AUDIO PERFORM
- ESD TOLERANCE : 2kV



D
SO14
(Plastic Micropackage)

DESCRIPTION

The TSH93 is a triple low power high frequency op-amp, designated for high quality video signal processing. The device offers an excellent speed consumption ratio with 4.5mA per amplifier for 150MHz bandwidth.

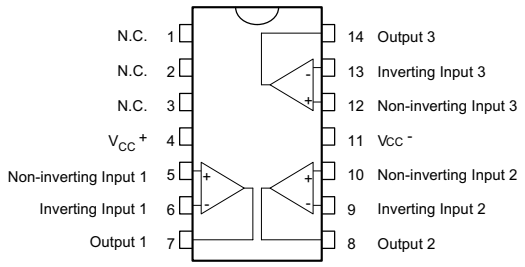
High slew rate and low noise make it also suitable for high quality audio applications.

ORDER CODE

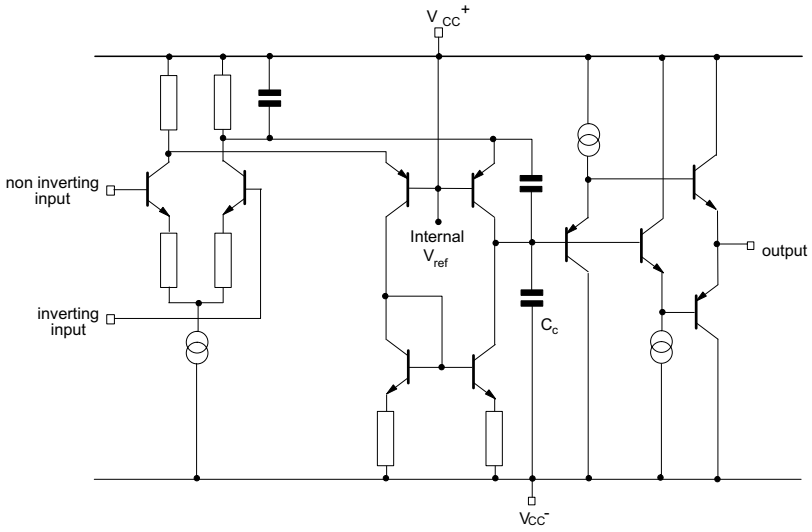
Part Number	Temperature Range	Package
		D
TSH93I	-40°C, +125°C	•

D = Small Outline Package (SO) - also available in Tape & Reel (DT)

PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM (1/3)



MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage [1]	14	V
V_{id}	Differential Input Voltage [2]	±5	V
V_i	Input Voltage [3]	-0.3 to 12	V
T_{oper}	Operating Free-Air Temperature range	-40 to +125	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C

1. All voltages 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	7 to 12	V
V_{ic}	Common Mode Input Voltage Range	V_{CC}^- +2 to V_{CC}^+ -1	V

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min.} \le T_{amb} \le T_{max.}$			4 6	mV
I_{io}	Input Offset Current $T_{min.} \le T_{amb} \le T_{max.}$		1	2 5	µA
I_{ib}	Input Bias Current $T_{min.} \le T_{amb} \le T_{max.}$		5	15 20	µA
I_{CC}	Supply Current (per amplifier, no load) $T_{min.} \le T_{amb} \le T_{max.}$		4.5	6 8	mA
CMR	Common-mode Rejection Ratio V_{ic} = -3V to +4V, V_o = 0V $T_{min.} \le T_{amb} \le T_{max.}$	80 70	100		dB
SVR	Supply Voltage Rejection Ratio V_{CC} = ±5V to ±3V $T_{min.} \le T_{amb} \le T_{max}$	60 50	75		dB
Avd	Large Signal Voltage Gain R_L = 100Ω, Vo = ±2.5V $T_{min.} \le T_{amb} \le T_{max.}$	57 54	70		dB
V_{OH}	High Level Output Voltage V_{id} = 1V R_L = 600Ω R_L = 150Ω $T_{min.} \le T_{amb} \le T_{max.}$ R_L = 150Ω	 3 2.5 2.4	 3.5 3		V
V_{OL}	Low Level Output Voltage V_{id} = 11V R_L = 600Ω R_L = 150Ω $T_{min.} \le T_{amb} \le T_{max.}$ R_L = 150Ω		 -3.5 -2.8	 -3 -2.5 -2.4	V
I_o	Output Short Circuit Current Vid = ±1V Source Sink $T_{min.} \le T_{amb} \le T_{max.}$ Source Sink	 20 20 15 15	 36 40		mA
GBP	Gain Bandwidth Product A_{VCL} = 100, R_L = 600Ω, C_L = 15pF, f = 7.5MHz	90	150		MHz
f_T	Transition Frequency		90		MHz
SR	Slew Rate V_{in} = -2 to +2V, A_{VCL} = +1, R_L = 600Ω, C_L = 15pF	62	110		V/µs
e_n	Equivalent Input Voltage Noise R_s = 50Ω, f = 1kHz		4.2		nV/√Hz
ϕm	Phase Margin A_{VM} = +1		35		Degrees
V_{O1}/V_{O2}	Channel Seperation f = 1MHz to 10MHz		65		dB
Gf	Gain Flatness f = DC to 6MHz, A_{VCL} = 10dB			0.1	dB
THD	Total Harmonic Distortion f = 1kHz, V_o = ±2.5V, R_L = 600Ω		0.01		%
ΔG	Differential Gain f = 3.58MHz, A_{VCL} = +2, R_L = 150Ω		0.03		%
Δφ	Differential Phase f = 3.58MHz, A_{VCL} = +2, R_L = 150Ω		0.07		Degree

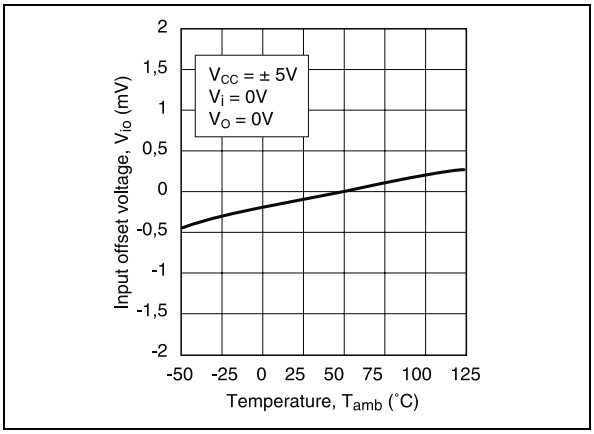
PRINTED CIRCUIT LAYOUT

As for any high frequency device, a few rules must be observed when designing the PCB to get the best performances from this high speed op amp.
From the most to the least important points :

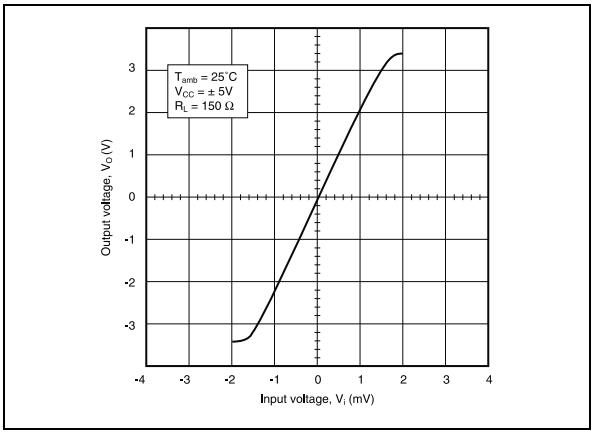
- ❑ Each power supply lead has to be bypassed to ground with a 10nF ceramic capacitor very close to the device and a 10µF capacitor.
- ❑ To provide low inductance and low resistance common return, use a ground plane or common point return for power and signal.
- ❑ All leads must be wide and as short as possible especially for op amp inputs. This is in order to decrease parasitic capacitance and inductance.
- ❑ Use small resistor values to decrease time constant with parasitic capacitance.
- ❑ Choose component sizes as small as possible (SMD).

On output, decrease capacitor load so as to avoid circuit stability being degraded which may cause oscillation. You can also add a serial resistor in order to minimise its influence.

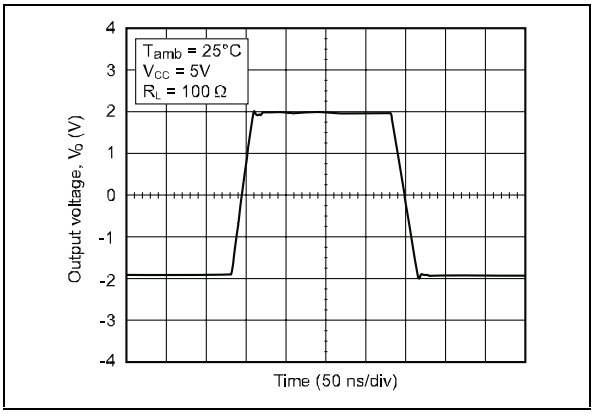
INPUT OFFSET VOLTAGE DRIFT VERSUS TEMPERATURE



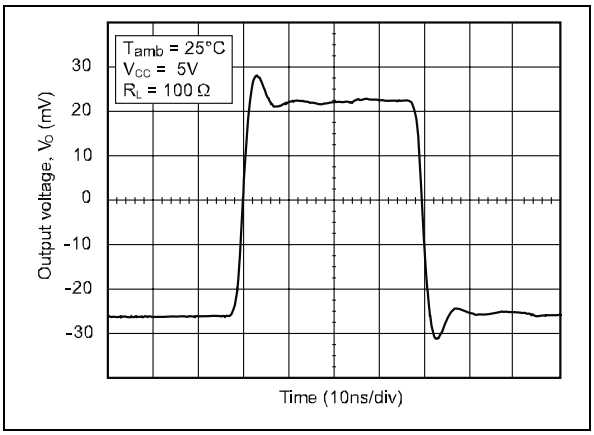
STATIC OPEN LOOP VOLTAGE GAIN



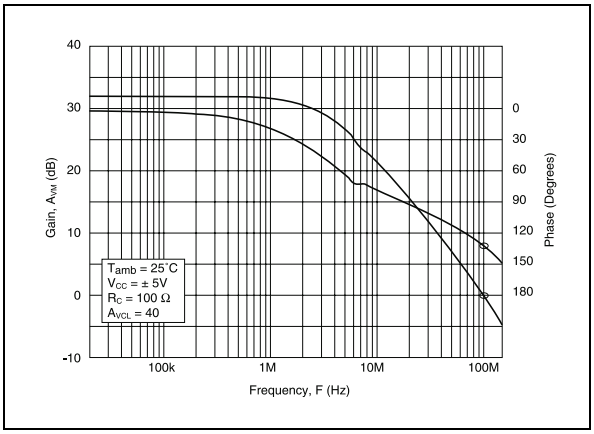
LARGE SIGNAL FOLLOWER RESPONSE



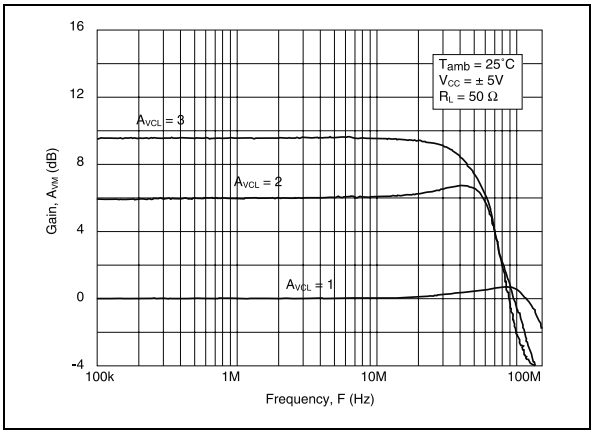
SMALL SIGNAL FOLLOWER RESPONSE



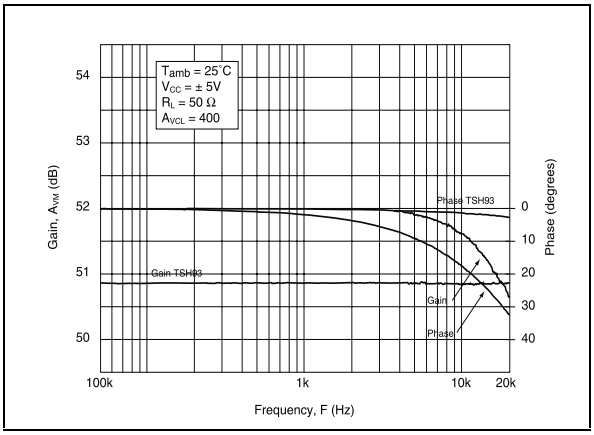
OPEN LOOP FREQUENCY RESPONSE AND PHASE SHIFT



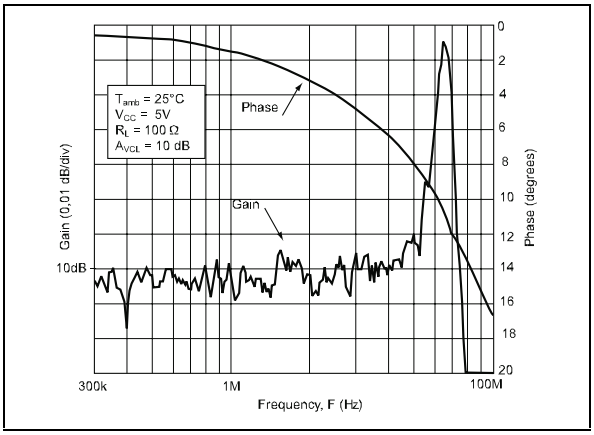
CLOSE LOOP FREQUENCY RESPONSE



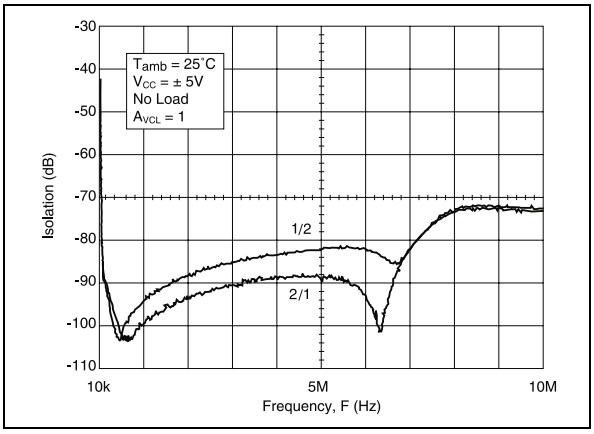
AUDIO BANDWIDTH FREQUENCY RESPONSE AND PHASE SHIFT (TSH93 vs Standard 15MHz Audio Op-Amp)



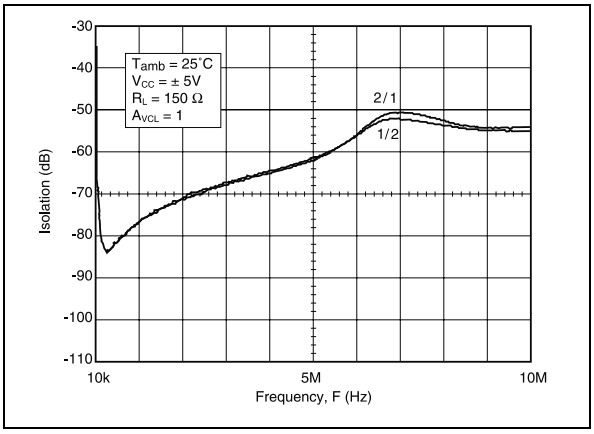
GAIN FLATNESS AND PHASE SHIFT VERSUS FREQUENCY



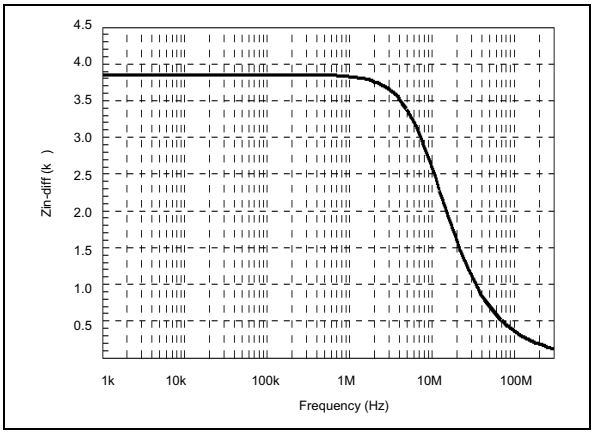
CROSS TALK ISOLATION VERSUS FREQUENCY (SO14 PACKAGE)



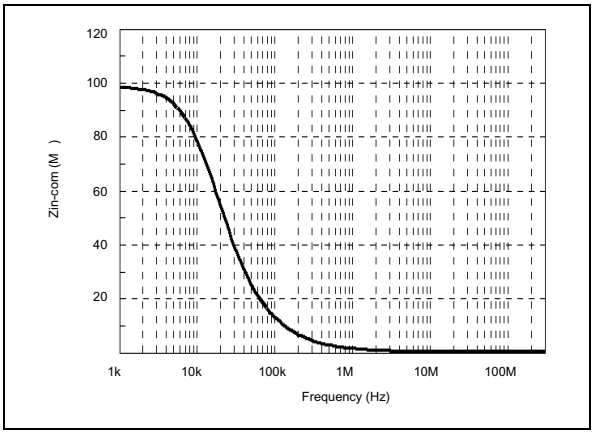
CROSS TALK ISOLATION VERSUS FREQUENCY (SO14 PACKAGE)



DIFFERENTIAL INPUT IMPEDANCE VERSUS FREQUENCY



COMMON INPUT IMPEDANCE VERSUS FREQUENCY



MACROMODEL

Applies to: TSH93I

```
** Standard Linear Ics Macromodels, 1997.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVEPOWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
.SUBCKT TSH93 1 3 2 4 5(analog)
*******************************************************
.MODEL MDTH D IS=1E-8 KF=1.809064E-15 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 2.600000E-01
RIN 15 16 2.600000E-01
RIS 11 15 3.645298E-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 1.000000E-03
CPS 11 15 2.986990E-10
DINN 17 13 MDTH 400E-12
VIN 17 5 2.000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 1.000000E+00
FCP 4 5 VOFP 3.500000E+00
FCN 5 4 VOFN 3.500000E+00
FIBP 2 5 VOFP 1.000000E-02
FIBN 5 1 VOFN 1.000000E-02
* AMPLIFYING STAGE
FIP 5 19 VOFP 2.530000E+02
FIN 5 19 VOFN 2.530000E+02
RG1 19 5 3.160721E+03
RG2 19 4 3.160721E+03
CC 19 5 2.00000E-09
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 1.504000E+03
VIPM 28 4 5.000000E+01
HONM 21 27 VOUT 1.400000E+03
VINM 5 27 5.000000E+01
**********************
RZP1 5 80 1E+06
RZP2 4 80 1E+06
GZP 5 82 19 80 2.5E-05
RZP2H 83 4 10000
RZP1H 83 82 80000
RZP2B 84 5 10000
RZP1B 82 84 80000
LZPH 4 83 3.535e-02
LZPB 84 5 3.535e-02
EOUT 26 23 82 5 1
VOUT 23 5 0
ROUT 26 3 35
COUT 3 5 30.000000E-12
DOP 19 25 MDTH 400E-12
VOP 4 25 2.361965E+00
DON 24 19 MDTH 400E-12
VON 24 5 2.361965E+00
.ENDS
```

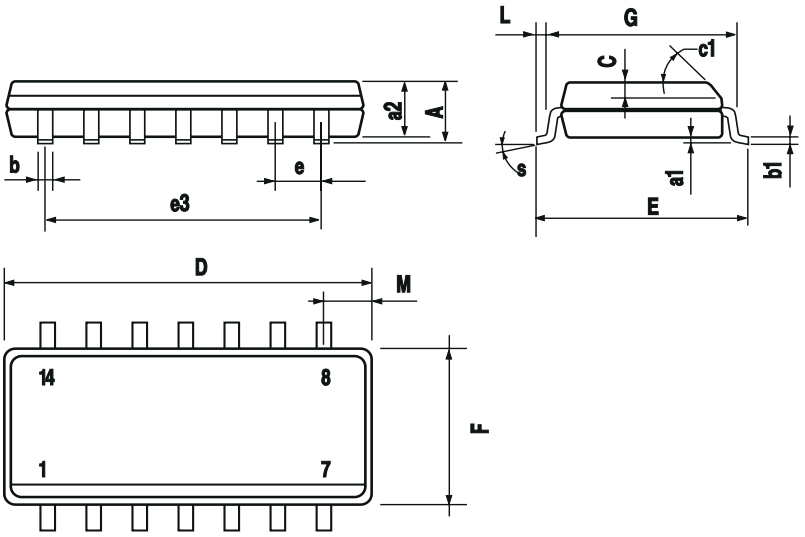
ELECTRICAL CHARACTERISTICS

V_{CC} = ±5V, T_{amb} = 25°C (unless otherwise specificed)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{vd}	R_L = 600Ω	3.2	V/mV
I_{CC}	No load / Ampli	5.2	mA
V_{icm}		-3 to 4	V
V_{OH}	R_L = 600Ω	+3.6	V
V_{OL}	R_L = 600Ω	-3.6	V
I_{sink}	V_o = 0V	40	mA
I_{source}	V_o = 0V	40	mA
GBP	R_L = 600Ω, C_L = 15pF	147	MHz
SR	R_L = 600Ω, C_L = 15pF	110	V/µs
ϕm	R_L = 600Ω, C_L = 15pF	42	Degrees

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	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 (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F (1)	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.)					

Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

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