TSH80, TSH81, TSH82, TSH84

Wide band rail-to-rail operational amplifier with standby function

Features

- Operating range from 4.5 to 12 V
- 3 dB-bandwidth: 100 MHz
- Slew-rate 100 V/µs
- Output current up to 55 mA
- Input single supply voltage
- Output rail-to-rail
- Specified for 150 Ω loads
- Low distortion, THD 0.1%
- SOT23-5, TSSOP and SO packages

Applications

- Video buffers
- A/D converter drivers
- Hi-fi applications

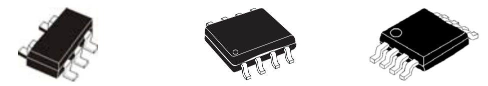
Description

The TSH8x series offers single, dual and quad operational amplifiers featuring high video performance with large bandwidth, low distortion and excellent supply voltage rejection. These amplifiers also feature large output voltage swings and a high output current capability to drive standard 150 Ω loads.

Running at single or dual supply voltages ranging from 4.5 to 12 V, these amplifiers are tested at 5 V (±2.5 V) and 10 V (±5 V) supplies.

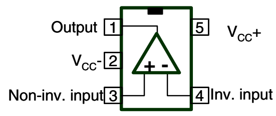
The TSH81 also features a standby mode, which provides the operational amplifier with a low power consumption and high output impedance. This function allows power saving or signal switching/multiplexing for high-speed and video applications.

For board space and weight saving, the TSH8x series is proposed in SOT23-5, TSSOP8, SO-8 and TSSOP14 plastic micropackages.

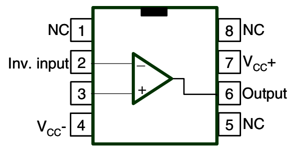


SOT23-5 SO-8 TSSOP8

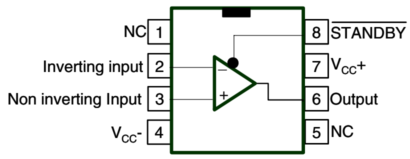
Pin connections TSH80/SOT23-5



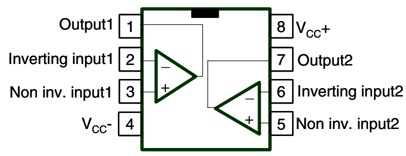
Pin connections TSH80/SO-8



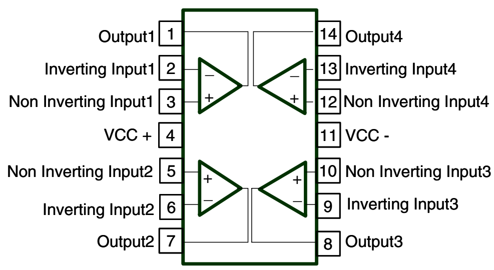
Pin connections TSH81 SO-8/TSSOP8



Pin connections TSH82 SO-8/TSSOP8



Pin connections TSH84 TSSOP14



Contents

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage [(1)]	14	V
V_{id}	Differential input voltage [(2)]	±2	V
V_i	Input voltage [(3)]	±6	V
T_{oper}	Operating free air temperature range	-40 to +85	°C
T_{stg}	Storage temperature	-65 to +150	°C
T_j	Maximum junction temperature	150	°C
R_{thjc}	Thermal resistance junction to case [(4)] SOT23-5 SO8 TSSOP8 TSSOP14	 80 28 37 32	°C/W
R_{thja}	Thermal resistance junction to ambient area SOT23-5 SO8 TSSOP8 TSSOP14	 250 157 130 110	°C/W
ESD	HBM: human body model[(5)] MM: machine model[(6)] CDM: charged device model[(7)]	2 0.2 1	kV

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 terminal.
3. The magnitude of input and output must never exceed V_{CC} +0.3 V.
4. Short-circuits can cause excessive heating.
5. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
6. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
7. Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	4.5 to 12	V
V_{IC}	Common mode input voltage range	V_{CC}^- to $(V_{CC}^+ -1.1)$	V
Standby (pin 8)	Threshold on pin 8 for TSH81	(V_{CC}^-) to (V_{CC}^+)	V

2 Electrical characteristics

Table 3. $V_{CC}^+ = +5$ V, $V_{CC}^- =$ GND, $V_{ic} = 2.5$ V, $T_{amb} = 25°$ C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\|V_{io}\|$	Input offset voltage	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		1.1	10 12	mV
ΔV_{io}	Input offset voltage drift vs. temperature	$T_{min} < T_{amb} < T_{max}$		3		µV/°C
I_{io}	Input offset current	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		0.1	3.5 5	µA
I_{ib}	Input bias current	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		6	15 20	µA
C_{in}	Input capacitance			0.3		pF
I_{CC}	Supply current per operator	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		8.2	10.5 11.5	mA
CMR	Common mode rejection ratio ($\delta V_{ic}/\delta V_{io}$)	$+0.1<V_{ic}<3.9$ V and $V_{out} = 2.5$ V $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	72 70	97		dB
SVR	Supply voltage rejection ratio ($\delta V_{CC}/\delta V_{io}$)	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	68 65	75		dB
PSR	Power supply rejection ratio ($\delta V_{CC}/\delta V_{out}$)	Positive and negative rail		75		dB
A_{vd}	Large signal voltage gain	$R_L = 150\ \Omega$ connected to 1.5 V and $V_{out} = 1$ V to 4 V $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	75 70	84		dB
I_o	|Source|	$V_{id} = +1$, V_{out} connected to 1.5 V $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	35 28	55		mA
	Sink	$V_{id} = -1$, V_{out} connected to 1.5 V $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	33 28	55		

Table 3. $V_{CC}^+ = +5$ V, $V_{CC}^- =$ GND, $V_{ic} = 2.5$ V, $T_{amb} = 25°$ C (unless otherwise specified) (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{oh}	High level output voltage	$T_{amb} = 25°$ C $R_L = 150\ \Omega$ connected to GND $R_L = 600\ \Omega$ connected to GND $R_L = 2\ k\Omega$ connected to GND $R_L = 10\ k\Omega$ connected to GND $R_L = 150\ \Omega$ connected to 2.5 V $R_L = 600\ \Omega$ connected to 2.5 V $R_L = 2\ k\Omega$ connected to 2.5 V $R_L = 10\ k\Omega$ connected to 2.5 V $T_{min} < T_{amb} < T_{max}$ $R_L = 150\ \Omega$ connected to GND $R_L = 150\ \Omega$ connected to 2.5 V	 4.2 4.60[(1)] 4.5 4.1 4.4	 4.36 4.85 4.90 4.93 4.66 4.90 4.92 4.93		V
V_{ol}	Low level output voltage	$T_{amb} = 25°$ C $R_L = 150\ \Omega$ connected to GND $R_L = 600\ \Omega$ connected to GND $R_L = 2\ k\Omega$ connected to GND $R_L = 10\ k\Omega$ connected to GND $R_L = 150\ \Omega$ connected to 2.5 V $R_L = 600\ \Omega$ connected to 2.5 V $R_L = 2\ k\Omega$ connected to 2.5 V $R_L = 10\ k\Omega$ connected to 2.5 V $T_{min} < T_{amb} < T_{max}$ $R_L = 150\ \Omega$ connected to GND $R_L = 150\ \Omega$ connected to 2.5 V		 48 54 55 56 220 105 76 61	 150 400 200 450	mV
GBP	Gain bandwidth product	F = 10 MHz $A_{VCL} = +11$ $A_{VCL} = -10$		 65 55		MHz
Bw	Bandwidth at -3 dB	$A_{VCL} = +1$ $R_L = 150\ \Omega$ connected to 2.5 V		87		MHz
SR	Slew rate	$A_{VCL} = +2$ $R_L = 150\ \Omega // C_L$ to 2.5 V $C_L = 5$ pF $C_L = 30$ pF	 60	 104 105		V/µs
ϕm	Phase margin	$R_L = 150\ \Omega // 30$ pF to 2.5 V		40		° (degree)
en	Equivalent input noise voltage	F = 100 kHz		11		$nV/\sqrt{Hz}$
THD	Total harmonic distortion	$A_{VCL} = +2$, F = 4 MHz $R_L = 150\ \Omega // 30$ pF to 2.5 V $V_{out} = 1V_{pp}$ $V_{out} = 2V_{pp}$		 -61 -54		dB
IM2	Second order intermodulation product	$A_{VCL} = +2$, $V_{out} = 2\ V_{pp}$ $R_L = 150\ \Omega$ connected to 2.5 V $F_{in1} = 180$ kHz, $F_{in2} = 280$ kHz spurious measurement at 100 kHz		-76		dBc

Table 3. $V_{CC}^{+} = +5$ V, V_{CC}^{-} = GND, $V_{ic} = 2.5$ V, $T_{amb} = 25°$ C (unless otherwise specified) (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
IM3	Third order intermodulation product	$A_{VCL} = +2$, $V_{out} = 2\ V_{pp}$ $R_L = 150\ \Omega$ to 2.5 V $F_{in1} = 180$ kHz, $F_{in2} = 280$ kHz spurious measurement at 400 kHz		-68		dBc
ΔG	Differential gain	$A_{VCL} = +2$, $R_L = 150\ \Omega$ to 2.5 V F = 4.5 MHz, $V_{out} = 2\ V_{pp}$		0.5		%
Df	Differential phase	$A_{VCL} = +2$, $R_L = 150\ \Omega$ to 2.5 V F = 4.5 MHz, $V_{out} = 2\ V_{pp}$		0.5		° (degree)
Gf	Gain flatness	F = DC to 6 MHz, $A_{VCL} = +2$		0.2		dB
Vo1/Vo2	Channel separation	F = 1 MHz to 10 MHz		65		dB

1. Tested on the TSH80ILT only.

Table 4. $V_{CC}^+ = +5$ V, $V_{CC}^- = -5$ V, V_{ic} = GND, $T_{amb} = 25°$ C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\|V_{io}\|$	Input offset voltage	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		0.8	10 12	mV
ΔV_{io}	Input offset voltage drift vs. temperature	$T_{min} < T_{amb} < T_{max}$		2		µV/°C
I_{io}	Input offset current	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		0.1	3.5 5	µA
I_{ib}	Input bias current	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		6	15 20	µA
C_{in}	Input capacitance			0.7		pF
I_{CC}	Supply current per operator	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$		9.8	12.3 13.4	mA
CMR	Common mode rejection ratio ($\delta V_{ic}/\delta V_{io}$)	$-4.9 < V_{ic} < 3.9$ V and V_{out} = GND $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	81 72	106		dB
SVR	Supply voltage rejection ratio ($\delta V_{CC}/\delta V_{io}$)	$T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	71 65	77		dB
PSR	Power supply rejection ratio ($\delta V_{CC}/\delta V_{out}$)	Positive and negative rail		75		dB
A_{vd}	Large signal voltage gain	$R_L = 150\ \Omega$ connected to GND $V_{out} = -4$ to $+4$ $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	75 70	86		dB
I_o	|Source|	$V_{id} = +1$, V_{out} connected to 1.5 V $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	35 28	55		mA
	Sink	$V_{id} = -1$, V_{out} connected to 1.5 V $T_{amb} = 25°$ C $T_{min} < T_{amb} < T_{max}$	30 28	55		
V_{oh}	High level output voltage	$T_{amb} = 25°$ C $R_L = 150\ \Omega$ connected to GND $R_L = 600\ \Omega$ connected to GND $R_L = 2\ k\Omega$ connected to GND $R_L = 10\ k\Omega$ connected to GND $T_{min} < T_{amb} < T_{max}$ $R_L = 150\ \Omega$ connected to GND	4.2 4.1	4.36 4.85 4.9 4.93		V
V_{ol}	Low level output voltage	$T_{amb} = 25°$ C $R_L = 150\ \Omega$ connected to GND $R_L = 600\ \Omega$ connected to GND $R_L = 2\ k\Omega$ connected to GND $R_L = 10\ k\Omega$ connected to GND $T_{min} < T_{amb} < T_{max}$ $R_L = 150\ \Omega$ connected to GND		-4.63 -4.86 -4.9 -4.93	-4.4 -4.3	mV

Table 4. $V_{CC}^+ = +5$ V, $V_{CC}^- = -5$ V, V_{ic} = GND, $T_{amb} = 25°$ C (unless otherwise specified) (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
GBP	Gain bandwidth product	F = 10 MHz $A_{VCL} = +11$ $A_{VCL} = -10$		65 55		MHz
Bw	Bandwidth at -3 dB	$A_{VCL} = +1$ $R_L = 150\ \Omega$ // 30 pF to GND		100		MHz
SR	Slew rate	$A_{VCL} = +2$ $R_L = 150\ \Omega$ // C_L to GND $C_L = 5$ pF $C_L = 30$ pF	 68	117 118		V/µs
ϕm	Phase margin	$R_L = 150\ \Omega$ connected to GND		40		° (degree)
en	Equivalent input noise voltage	F = 100 kHz		11		nV/√Hz
THD	Total harmonic distortion	$A_{VCL} = +2$, F = 4 MHz $R_L = 150\ \Omega$ // 30 pF to GND $V_{out} = 1\ V_{pp}$ $V_{out} = 2\ V_{pp}$		-61 -54		dB
IM2	Second order intermodulation product	$A_{VCL} = +2$, $V_{out} = 2\ V_{pp}$ $R_L = 150\ \Omega$ to GND $F_{in1} = 180$ kHz, $F_{in2} = 280$ kHz spurious measurement at 100 kHz		-76		dBc
IM3	Third order intermodulation product	$A_{VCL} = +2$, $V_{out} = 2\ V_{pp}$ $R_L = 150\ \Omega$ to GND $F_{in1} = 180$ kHz, $F_{in2} = 280$ kHz spurious measurement at 400 kHz		-68		dBc
ΔG	Differential gain	$A_{VCL} = +2$, $R_L = 150\ \Omega$ to GND F = 4.5 MHz, $V_{out} = 2\ V_{pp}$		0.5		%
Df	Differential phase	$A_{VCL} = +2$, $R_L = 150\ \Omega$ to GND F = 4.5 MHz, $V_{out} = 2\ V_{pp}$		0.5		° (degree)
Gf	Gain flatness	F = DC to 6 MHz, $A_{VCL} = +2$		0.2		dB
Vo1/Vo2	Channel separation	F = 1 MHz to 10 MHz		65		dB

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{low}	Standby low level		V_{CC}^-		(V_{CC}^- +0.8)	V
V_{high}	Standby high level		(V_{CC}^- +2)		(V_{CC}^+)	V
$I_{CC-STBY}$	Current consumption per operator when Standby is active	Pin 8 (TSH81) to V_{CC}^-		20	55	µA
Z_{out}	Output impedance (R_{out}//C_{out})	R_{out} C_{out}		10 17		MΩ pF
T_{on}	Time from Standby mode to Active mode			2		µs
T_{off}	Time from Active mode to Standby mode	Down to $I_{CC-STBY}$ = 10 µA		10		µs

Table 6. TSH81 standby control pin status

TSH81 standby control pin 8 ($\overline{\text{STANDBY}}$)	Operator status
V_{low}	Standby
V_{high}	Active

Figure 1. Closed loop gain and phase vs. frequency

Gain = +2, V_{CC} = ±2.5 V, R_L = 150 Ω, T_{amb} = 25° C

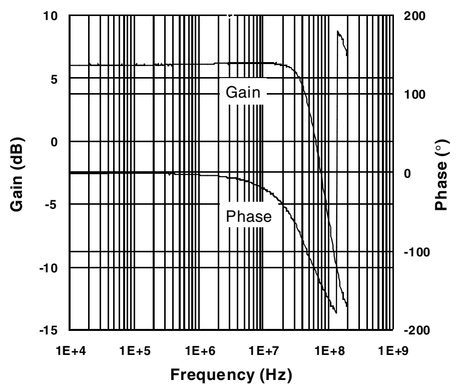


Figure 2. Overshoot vs. output capacitance

Gain = +2, V_{CC} = ±2.5 V, T_{amb} = 25° C

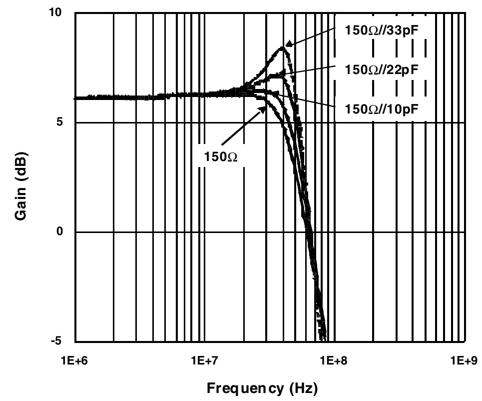


Figure 3. Closed loop gain and phase vs. frequency

Gain = -10, V_{CC} = ±2.5 V, R_L = 150 Ω, T_{amb} = 25° C

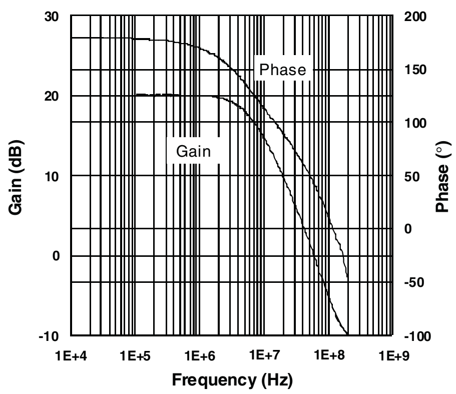


Figure 4. Closed loop gain and phase vs. frequency

Gain = +11, V_{CC} = ±2.5 V, R_L = 150 Ω, T_{amb} = 25° C

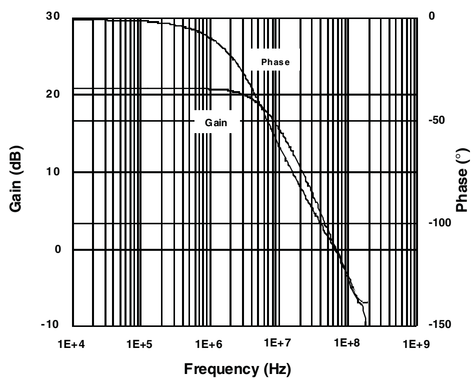


Figure 5. Large signal measurement - positive slew rate

Gain = +2, V_{CC} = ±2.5 V, Z_L = 150 Ω//5.6 pF, V_{in} = 400

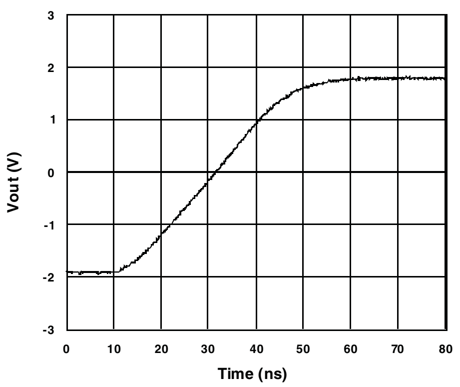


Figure 6. Large signal measurement - negative slew rate

Gain = +2, V_{CC} = ±2.5 V, Z_L = 150 Ω//5.6 pF, V_{in} = 400 mVpk

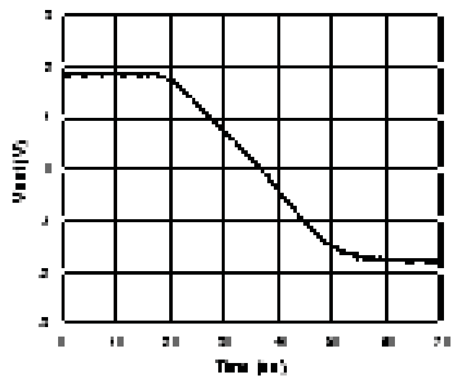


Figure 7. Small signal measurement - rise time

Gain = +2, V_{CC} = ±2.5 V, R_L = 150 Ω, V_{in} = 400 mVpk

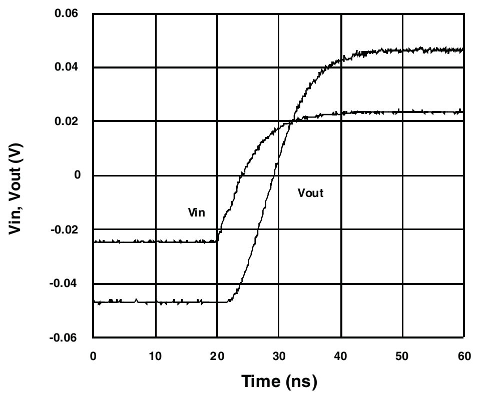


Figure 8. Small signal measurement - fall time

Gain = +2, V_{CC} = ±2.5 V, R_L = 150 Ω, V_{in} = 400 mVpk

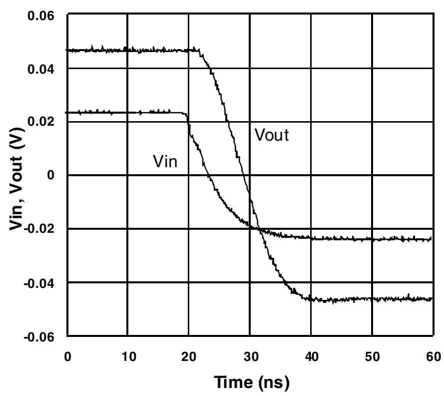


Figure 9. Channel separation (crosstalk) vs. frequency

Measurement configuration: crosstalk = 20 log(V0/V1)

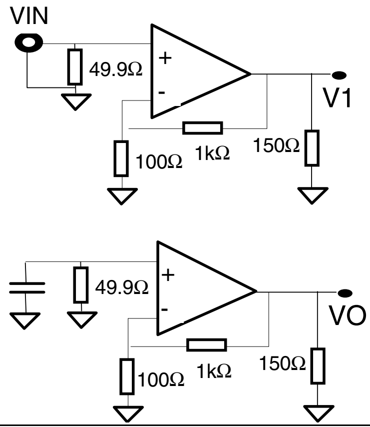


Figure 10. Channel separation (crosstalk) vs. frequency

Gain = +11, V_{CC} = ±2.5 V, Z_L = 150 Ω//27 pF

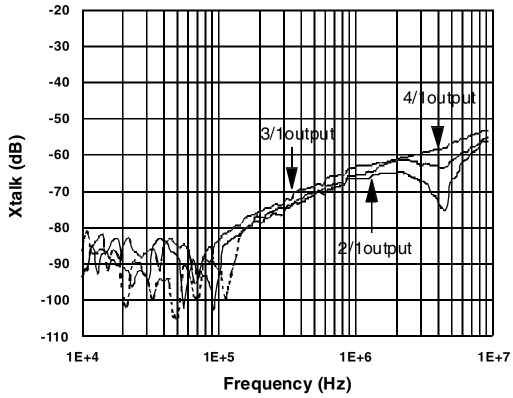


Figure 11. Equivalent input noise voltage

Gain = +100, V_{CC} = ±2.5 V, no load

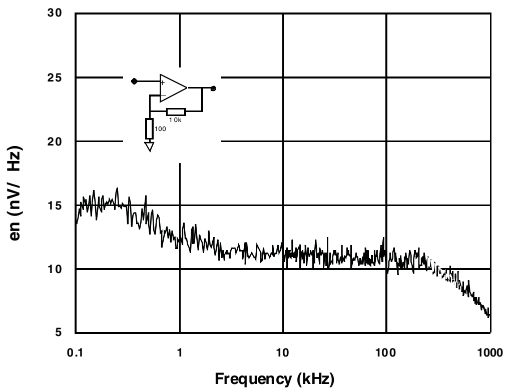


Figure 12. Maximum output swing

Gain = +11, V_{CC} = ±2.5 V, R_L = 150 Ω

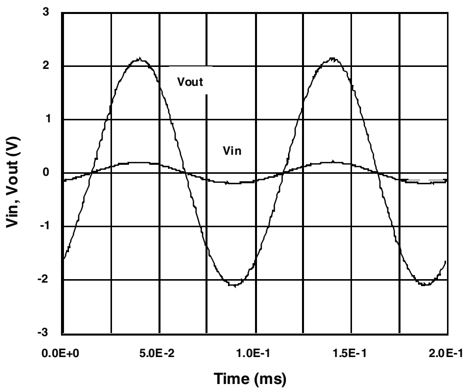


Figure 13. Standby mode - T_{on}, T_{off}

V_{CC} = ±2.5 V, open loop

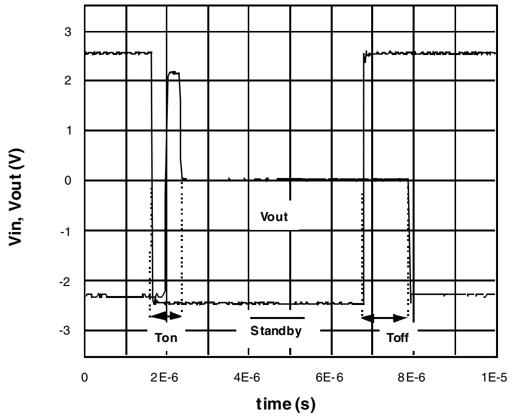
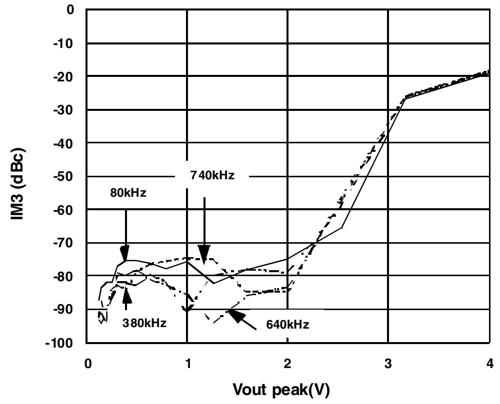


Figure 14. Third order intermodulation(1)

Gain = +2, V_{CC} = ±2.5 V, Z_L = 150 Ω//27 pF, T_{amb} = 25° C



1. The IFR2026 synthesizer generates a two-tone signal (F1 = 180 kHz, F2 = 280 kHz), each tone having the same amplitude. The HP3585 spectrum analyzer measures the intermodulation products as a function of the output voltage. The generator and the spectrum analyzer are phase locked for better accuracy.

Figure 15. Group delay

Gain = +2, V_{CC} = ±2.5 V, Z_L = 150 Ω//27 pF, T_{amb} = 25° C

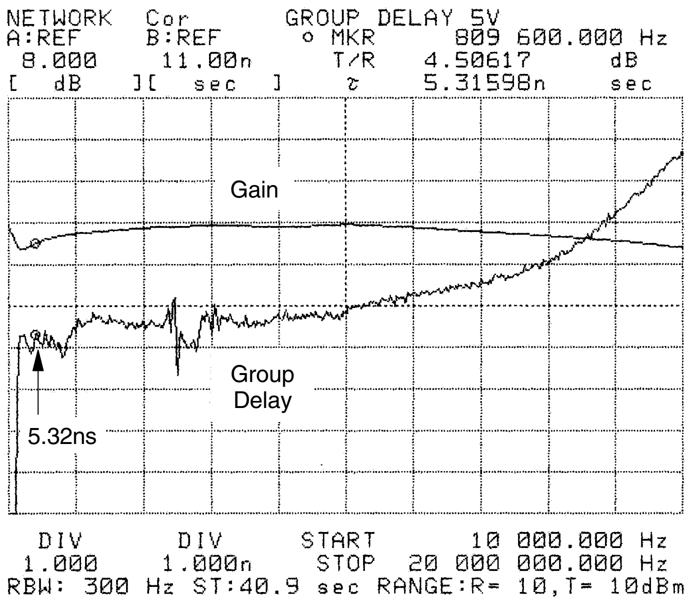


Figure 16. Closed loop gain and phase vs. frequency

Gain = +2, V_{CC} = ±5 V, R_L = 150 Ω, T_{amb} = 25° C

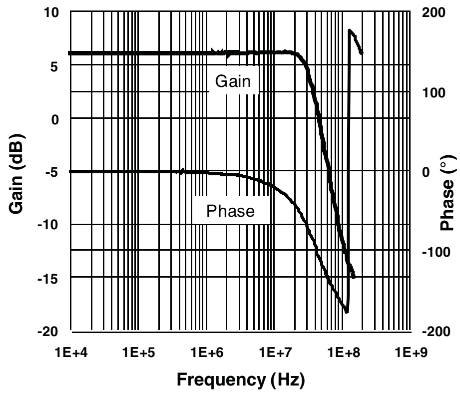


Figure 17. Overshoot vs. output capacitance

Gain = +2, V_{CC} = ±5 V, T_{amb} = 25° C

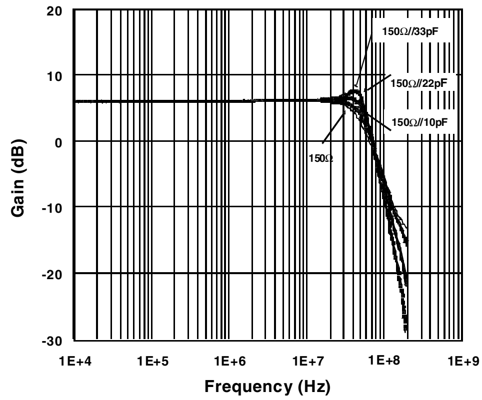


Figure 18. Closed loop gain and phase vs. frequency

Gain = -10, V_{CC} = ±5 V, R_L = 150 Ω, T_{amb} = 25° C

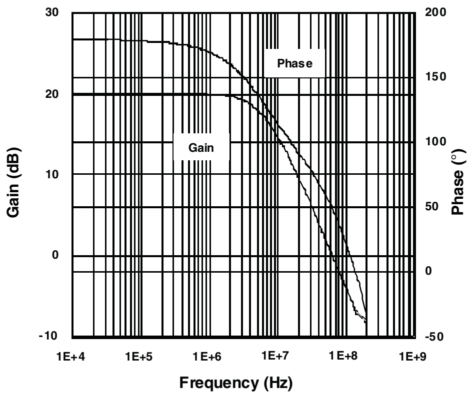


Figure 19. Closed loop gain and phase vs. frequency

Gain = +11, V_{CC} = ±5 V, R_L = 150 Ω, T_{amb} = 25° C

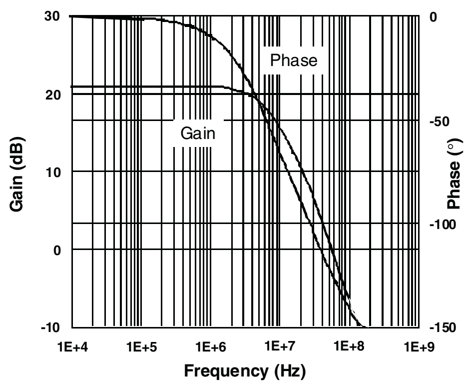


Figure 20. Large signal measurement - positive slew rate

Gain = +2, V_{CC} = ±5 V, Z_L = 150 Ω//5.6 pF, V_{in} = 400 mVpk

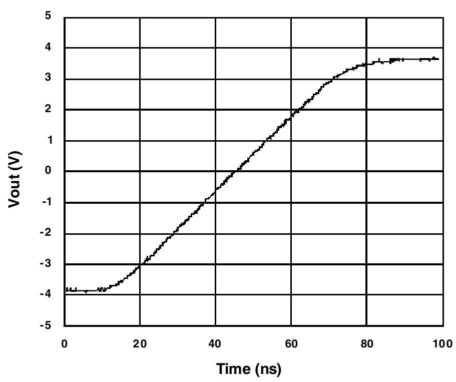


Figure 21. Large signal measurement - negative slew rate

Gain = +2, V_{CC} = ±5 V, Z_L = 150 Ω//5.6 pF, V_{in} = 400 mVpk

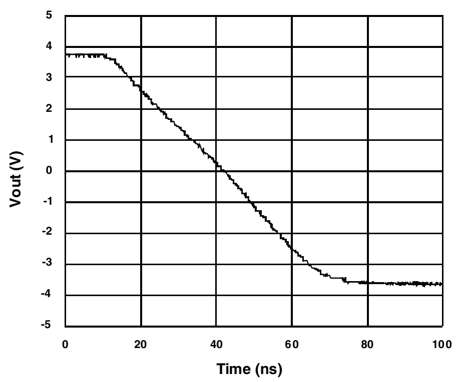


Figure 22. Small signal measurement - rise time

Gain = +2, V_{CC} = ±5 V, R_L = 150 Ω, V_{in} = 400 mVpk

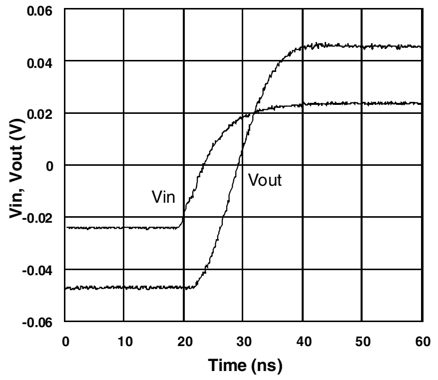


Figure 23. Small signal measurement - fall time

Gain = +2, V_{CC} = ±5 V, R_L = 150 Ω, V_{in} = 400 mVpk

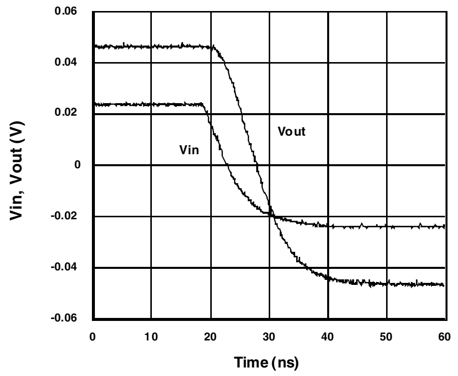


Figure 24. Channel separation (crosstalk) vs. frequency

Measurement configuration: crosstalk = 20 log(V0/V1)

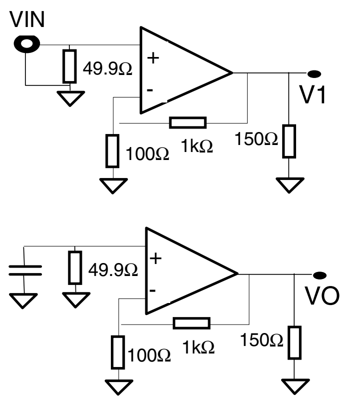


Figure 25. Channel separation (crosstalk) vs. frequency

Gain = +11, V_{CC} = ±5 V, Z_L = 150 Ω / 27 pF

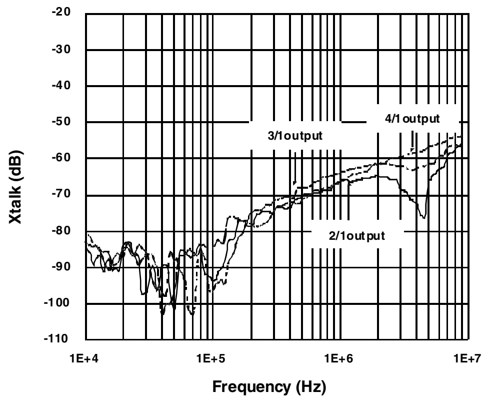


Figure 26. Equivalent input noise voltage

Gain = +100, V_{CC} = ±5 V, no load

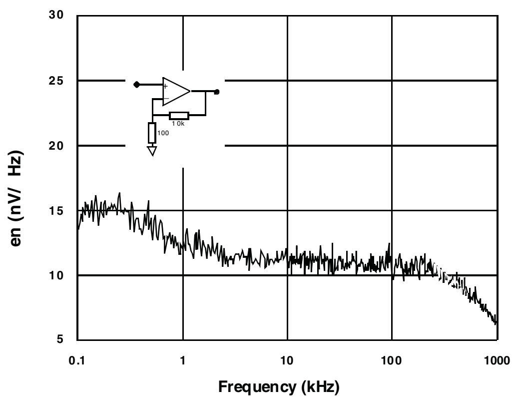


Figure 27. Maximum output swing

Gain = +11, V_{CC} = ±5 V, R_L = 150 Ω

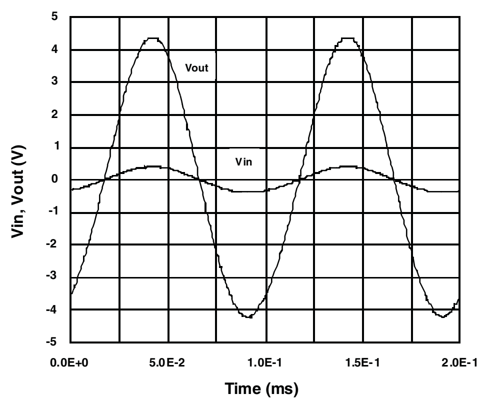


Figure 28. Standby mode - T_{on}, T_{off}

V_{CC} = ±5 V, open loop

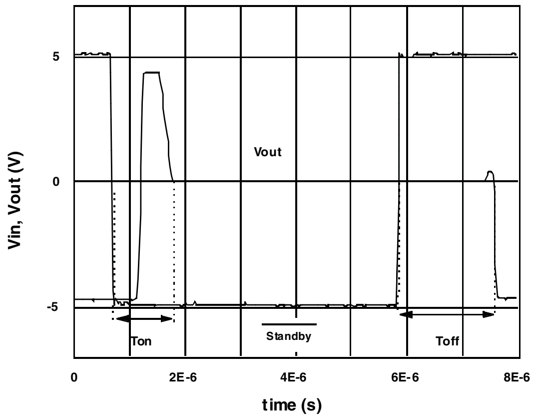
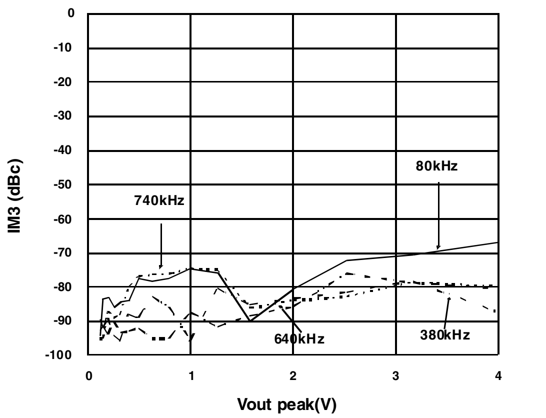


Figure 29. Third order intermodulation[1]

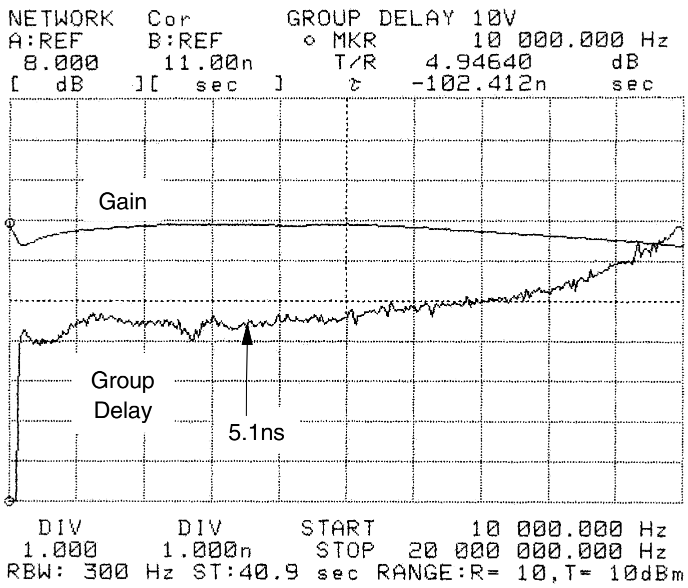
Gain = +2, V_{CC} = ±5 V, Z_L = 150 Ω /27 pF, T_{amb} = 25° C



1. The IFR2026 synthesizer generates a two-tone signal (F1 = 180 kHz, F2 = 280 kHz), each tone having the same amplitude. The HP3585 spectrum analyzer measures the intermodulation products as a function of the output voltage. The generator and the spectrum analyzer are phase locked for better accuracy.

Figure 30. Group delay

Gain = +2, V_{CC} = ±5 V, Z_L = 150 Ω/27 pF, T_{amb} = 25° C



3 Test conditions

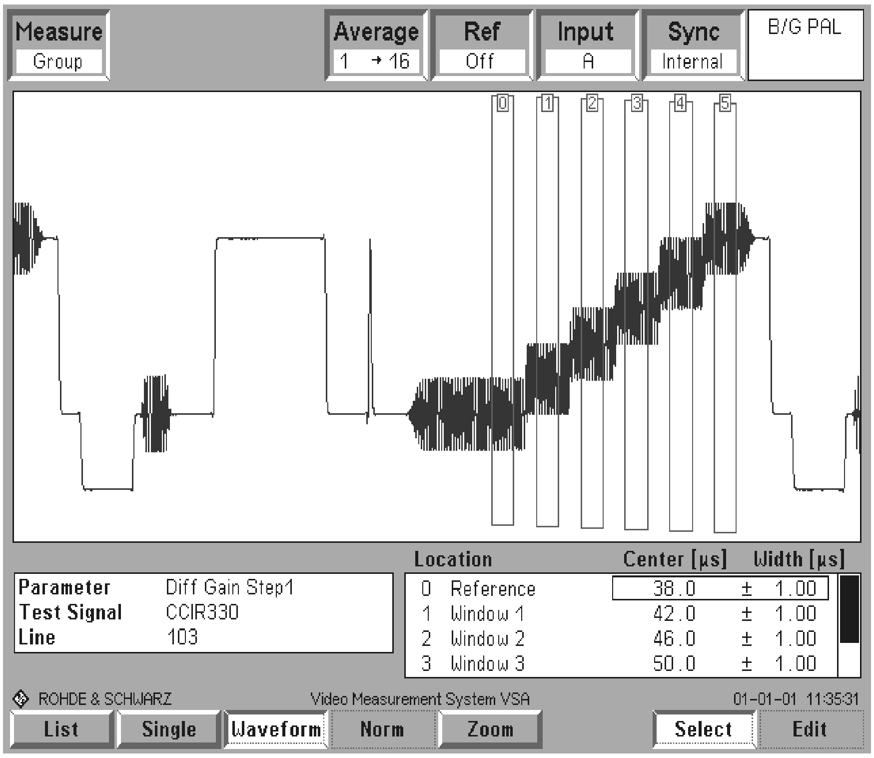
3.1 Layout precautions

To make the best use of the TSH8X circuits at high frequencies, some precautions have to be taken with regard to the power supplies.

- In high-speed circuit applications, the implementation of a proper ground plane on both sides of the PCB is mandatory to ensure low inductance and low resistance common return.
- Power supply bypass capacitors (4.7 µF and ceramic 100 pF) should be placed as close as possible to the IC pins in order to improve high frequency bypassing and reduce harmonic distortion. The power supply capacitors must be incorporated for both the negative and positive pins.
- All inputs and outputs must be properly terminated with output resistors; thus, the amplifier load is resistive only and the stability of the amplifier will be improved.

  All leads must be wide and as short as possible especially for op-amp inputs and outputs in order to decrease parasitic capacitance and inductance.
- Time constants result from parasitic capacitance. To reduce time constants in lower-gain applications, use a low feedback resistance (under 1 kΩ).
- Choose the smallest possible component sizes (SMD).
- On the output, the load capacitance must be negligible to maintain good stability. You can put a serial resistance as close as possible to the output pin to minimize the effect of the load capacitance.

Figure 31. CCIR330 video line



3.2 Video capabilities

To characterize the differential phase and differential gain a CCIR330 video line is used.

The video line contains five (flat) levels of luminance onto which the chrominance signal is superimposed. The luminance gives various amplitudes which define the saturation of the signal. The chrominance gives various phases which define the color of the signal.

Differential phase (or differential gain) distortion is present if a signal chrominance phase (gain) is affected by the luminance level. The differential phase and gain represent the ability to uniformly process the high frequency information at all luminance levels.

When a differential gain is present, color saturation is not correctly reproduced.

The input generator is the Rhode & Schwarz CCVS. The output measurement is done by the Rhode and Schwarz VSA.

Figure 32. Measurement on Rhode and Schwarz VSA

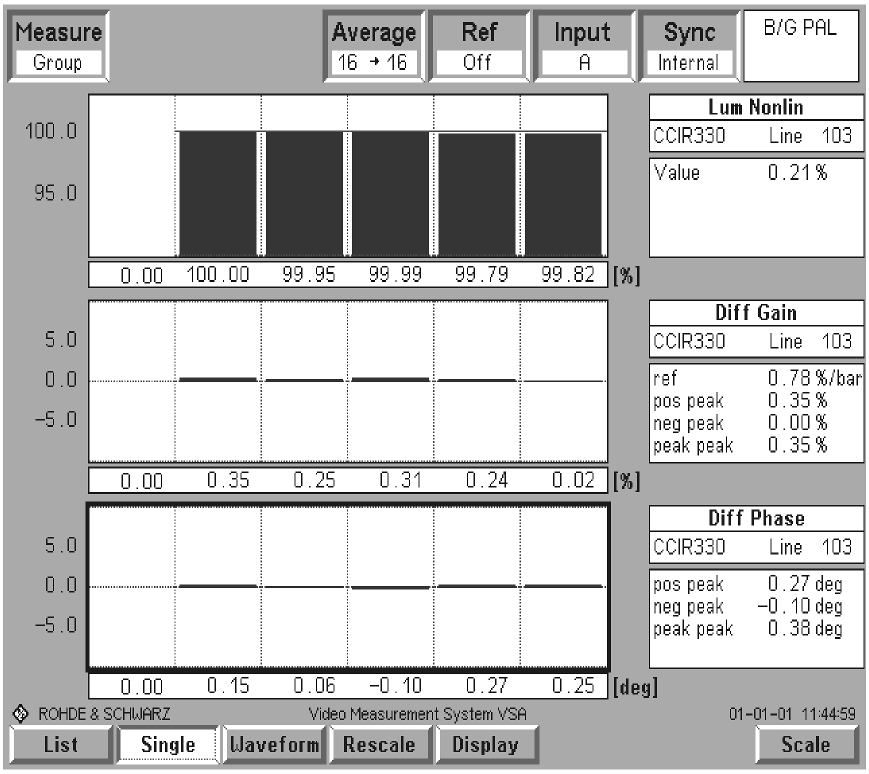


Table 7. Video results

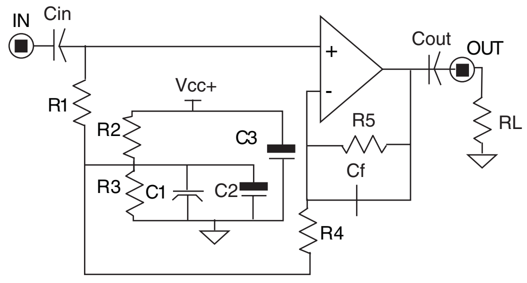
Parameter	Value (V_{CC} = ±2.5 V)	Value (V_{CC} = ±5 V)	Unit
Lum NL	0.1	0.3	%
Lum NL Step 1	100	100	%
Lum NL Step 2	100	99.9	%
Lum NL Step 3	99.9	99.8	%
Lum NL Step 4	99.9	99.9	%
Lum NL Step 5	99.9	99.7	%
Diff Gain pos	0	0	%
Diff Gain neg	-0.7	-0.6	%
Diff Gain pp	0.7	0.6	%
Diff Gain Step1	-0.5	-0.3	%
Diff Gain Step2	-0.7	-0.6	%
Diff Gain Step3	-0.3	-0.5	%
Diff Gain Step4	-0.1	-0.3	%
Diff Gain Step5	-0.4	-0.5	%
Diff Phase pos	0	0.1	Degree
Diff Phase neg	-0.2	-0.4	Degree
Diff Phase pp	0.2	0.5	Degree
Diff Phase Step1	-0.2	-0.4	Degree
Diff Phase Step2	-0.1	-0.4	Degree
Diff Phase Step3	-0.1	-0.3	Degree
Diff Phase Step4	0	0.1	Degree
Diff Phase Step5	-0.2	-0.1	Degree

4 Precautions on asymmetrical supply operation

The TSH8x can be used with either a dual or a single supply. If a single supply is used, the inputs are biased to the mid-supply voltage ($+V_{CC}/2$). This bias network must be carefully designed so as to reject any noise present on the supply rail.

As the bias current is 15 µA, you should use a high resistance R1 (approximately 10 kΩ) to avoid introducing an offset mismatch at the amplifier's inputs.

Figure 33. Asymmetrical supply schematic diagram



C1, C2, C3 are bypass capacitors intended to filter perturbations from V_{CC}. The following capacitor values are appropriate.

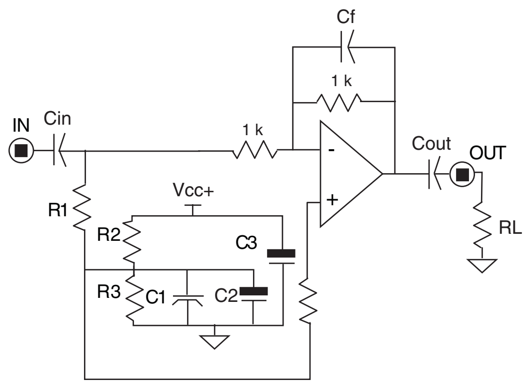
C1 = 100 nF and C2 = C3 = 100 µF

R2 and R3 are such that the current through them must be superior to 100 times the bias current. Therefore, you could use the following resistance values.

R2 = R3 = 4.7 kΩ

C_{in} and C_{out} are chosen to filter the DC signal by the low pass filters (R1, C_{in}) and (R_{out}, C_{out}). With R1 = 10 kΩ, $R_{out} = R_L = 150\ \Omega$, and C_{in} = 2 µF, C_{out} = 220 µF the cutoff frequency obtained is lower than 10 Hz.

Figure 34. Use of the TSH8x in a gain = -1 configuration



5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

5.1 SO-8 package information

Figure 35. SO-8 package mechanical drawing

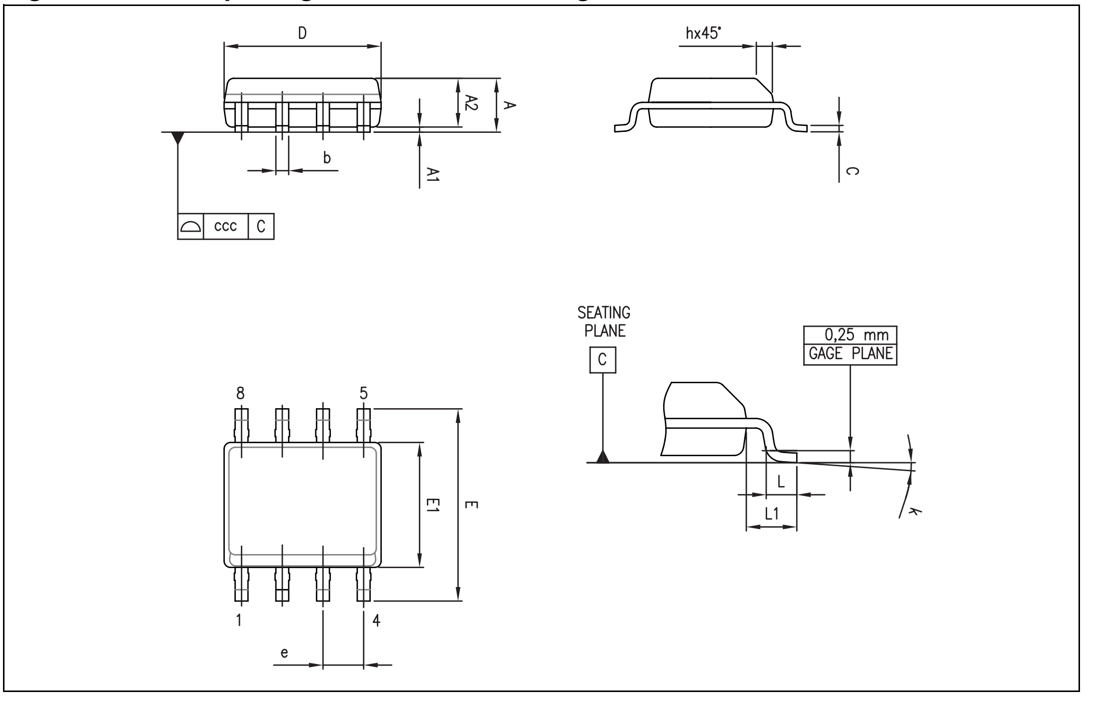


Table 8. SO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

5.2 TSSOP8 package information

Figure 36. TSSOP8 package mechanical drawing

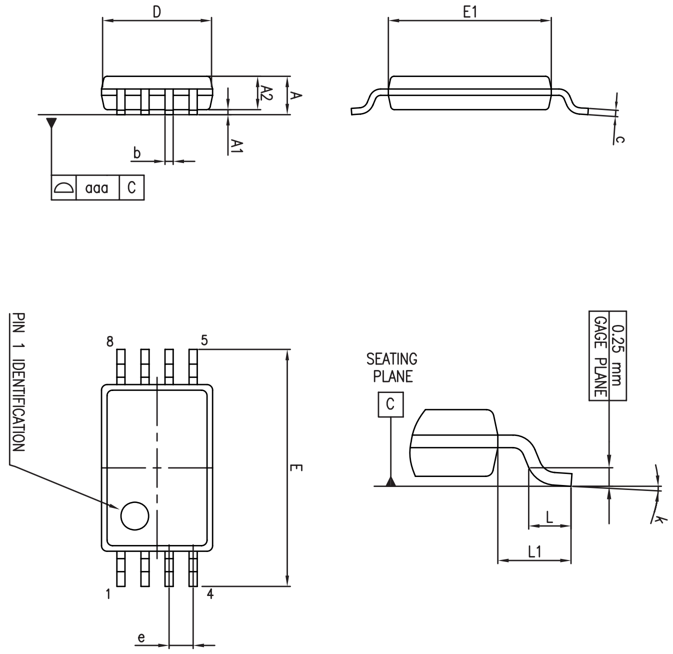


Table 9. TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa			0.10			0.004

5.3 TSSOP14 package information

Figure 37. TSSOP14 package mechanical drawing

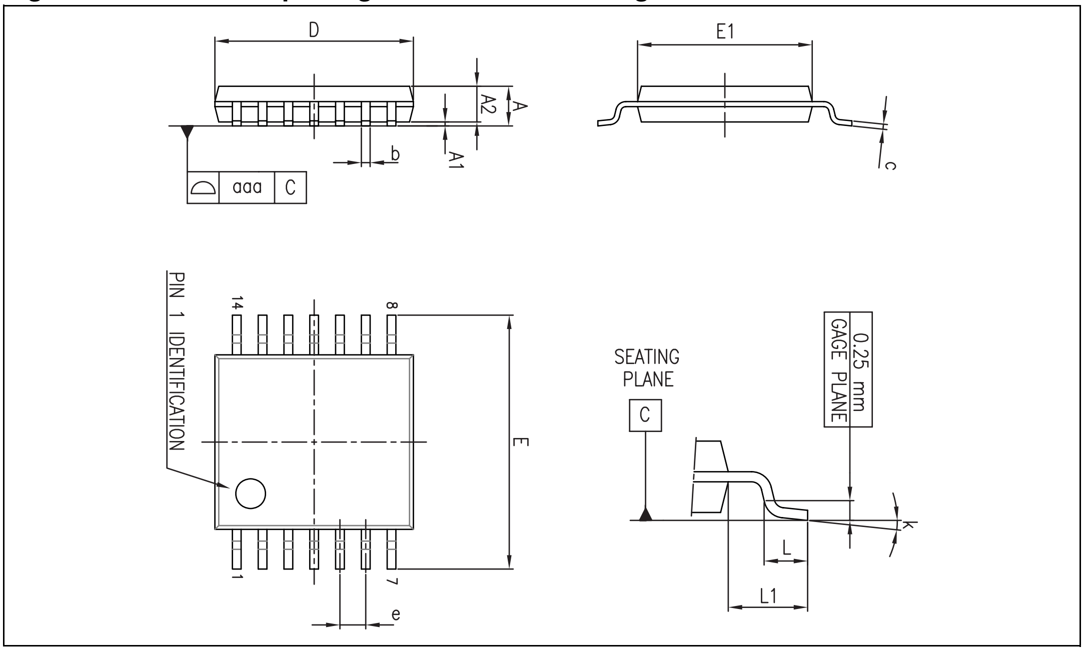


Table 10. TSSOP14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.176
e		0.65			0.0256	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	0°		8°	0°		8°
aaa			0.10			0.004

5.4 SOT23-5 package information

Figure 38. SOT23-5 package mechanical drawing

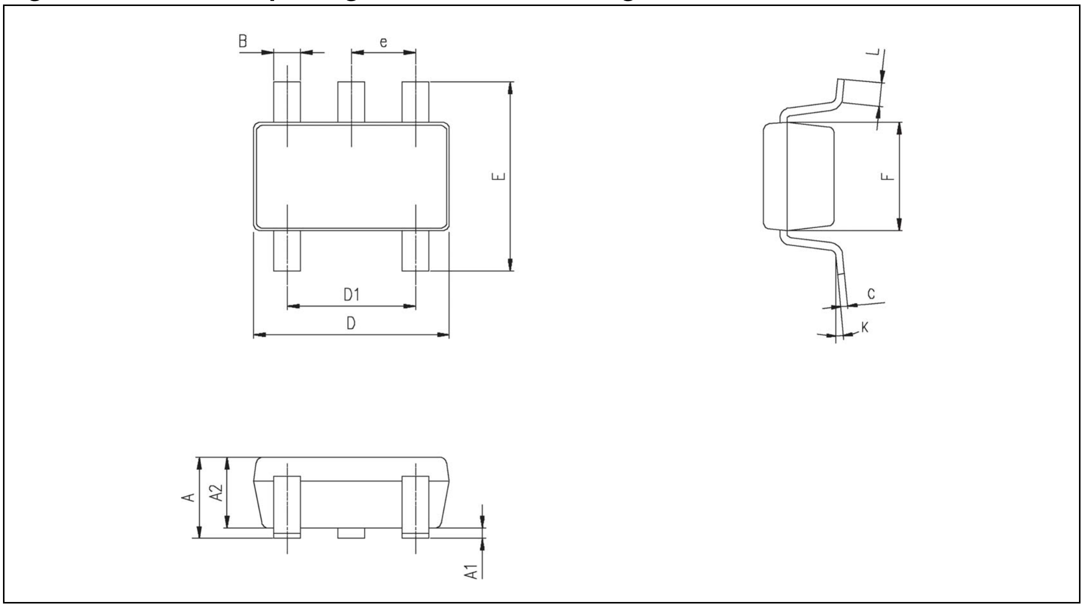


Table 11. SOT23-5 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1			0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.013	0.015	0.019
C	0.09	0.15	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.35	0.60	0.004	0.013	0.023
K	0 degrees		10 degrees			

6 Ordering information

Table 12. Order codes

Type	Temperature range	Package	Packaging	Marking
TSH80ILT	-40°C to +85°C	SOT23-5	Tape & reel	K303
TSH80IYLT(1)		SOT23-5 (Automotive grade level)		K310
TSH80ID/DT		SO-8	Tube or tape & reel	TSH80I
TSH80IYD/IYDT(1)		SO-8 (Automotive grade level)		SH80IY
TSH81ID/DT		SO-8		TSH81I
TSH81IPT		TSSOP8	Tape & reel	SH81I
TSH82ID/DT		SO-8	Tube or tape & reel	TSH82I
TSH82IPT		TSSOP8	Tape & reel	SH82I
TSH84IPT		TSSOP14	Tape & reel	SH84I

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

7 Revision history

Date	Revision	Changes
1-Feb-2003	1	First release.
2-Aug-2005	2	PPAP references inserted in the datasheet, see *Table 12: Order codes on page 25*.
12-Apr-2007	3	Corrected temperature range for TSH80IYD/IYDT and TSH82IYD/IYDT order codes in *Table 12: Order codes on page 25*.
24-Oct-2007	4	TSH81IYPT PPAP references inserted in the datasheet, see *Table 12: Order codes on page 25*.
19-May-2009	5	Added data relating to the quad TSH84 device. Removed TSH81IYPT, TSH81IYD-IYDT, TSH82IYPT and TSH82IYD-IYDT order codes in *Table 12: Order codes*.

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