



# TSH80-TSH81-TSH82

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

## Features

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

## Applications

- Video buffers
- A/D converters driver
- Hi-fi applications

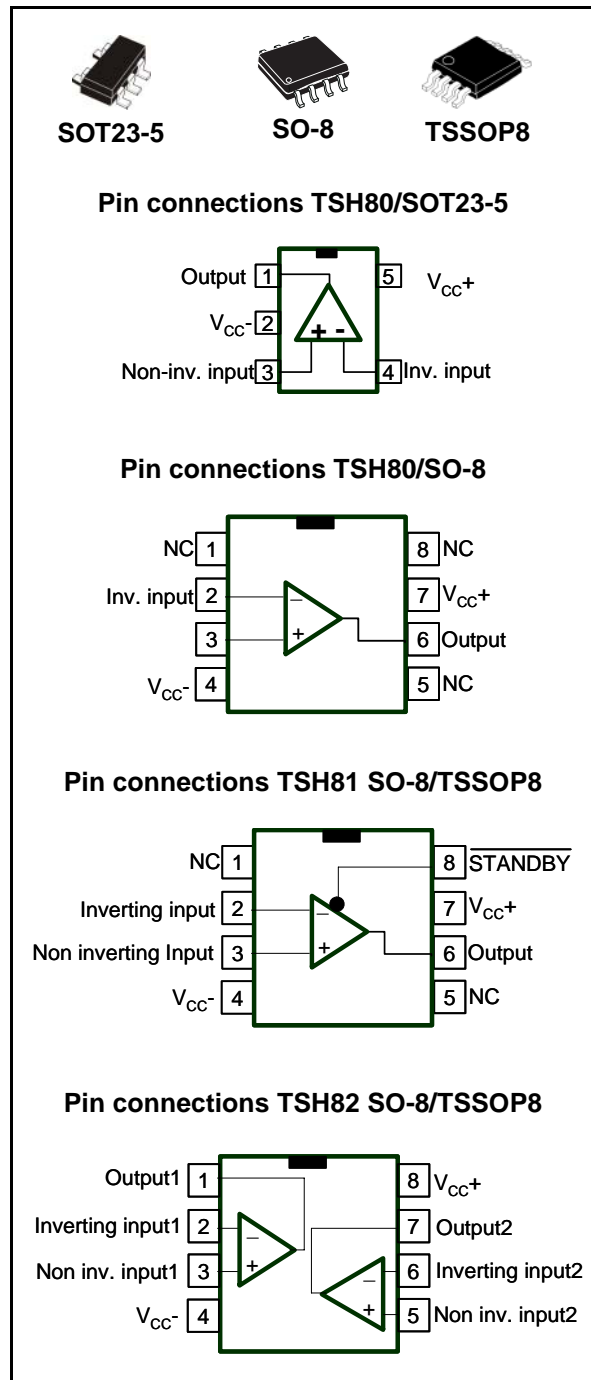
## Description

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

Running at single or dual supply voltage from 4.5V to 12V, these amplifiers are tested at 5V ( $\pm 2.5$ V) and 10V ( $\pm 5$ V) supplies.

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

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



# Contents

- 1      Absolute maximum ratings and operating conditions ..... 3**
- 2      Electrical characteristics ..... 4**
- 3      Test conditions ..... 16**
  - 3.1    Layout precautions ..... 16
  - 3.2    Video capabilities ..... 17
- 4      Precautions on asymmetrical supply operation ..... 19**
- 5      Package information ..... 20**
  - 5.1    SO-8 package mechanical data ..... 21
  - 5.2    TSSOP8 package mechanical data ..... 22
  - 5.3    SOT23-5 package mechanical data ..... 23
- 6      Ordering information ..... 24**
- 7      Revision history ..... 24**

# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage <sup>(1)</sup>	14	V
$V_{id}$	Differential input voltage <sup>(2)</sup>	$\pm 2$	V
$V_i$	Input voltage <sup>(3)</sup>	$\pm 6$	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 <sup>(4)</sup>		
	SOT23-5	80	°C/W
	SO8	28	
TSSOP08	37		
$R_{thja}$	Thermal resistance junction to ambient area		
	SOT23-5	250	°C/W
	SO8	157	
TSSOP08	130		
ESD	Human body model (HBM)	2	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  $V_{CC} + 0.3V$ .
4. Short-circuits can cause excessive heating.

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$ V_{io} $	Input offset voltage	$T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$		1.1	10 12	mV
$\Delta V_{io}$	Input offset voltage drift vs. temperature	$T_{min} < T_{amb} < T_{max}$		3		$\mu V/^{\circ}C$
$I_{io}$	Input offset current	$T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$		0.1	3.5 5	$\mu A$
$I_{ib}$	Input bias current	$T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$		6	15 20	$\mu A$
$C_{in}$	Input capacitance			0.3		pF
$I_{CC}$	Supply current per operator	$T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$		8.2	10.5 11.5	mA
CMR	Common mode rejection ratio ( $\delta V_{ic}/\delta V_{io}$ )	$+0.1 < V_{ic} < 3.9V$ and $V_{out} = 2.5V$ $T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$	72 70	97		dB
SVR	Supply voltage rejection ratio ( $\delta V_{CC}/\delta V_{io}$ )	$T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$	68 65	75		dB
PSR	Power supply rejection ratio ( $\delta V_{CC}/\delta V_{out}$ )	Positive & negative rail		75		dB
$A_{vd}$	Large signal voltage gain	$R_L = 150\Omega$ connected to 1.5V and $V_{out} = 1V$ to 4V $T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$	75 70	84		dB
$I_o$	Source	$V_{id} = +1$ , $V_{out}$ connected to 1.5V $T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$	35 28	55		mA
	Sink	$V_{id} = -1$ , $V_{out}$ connected to 1.5V $T_{amb} = 25^{\circ}C$ $T_{min} < T_{amb} < T_{max}$	33 28	55		
$V_{oh}$	High level output voltage	$T_{amb} = 25^{\circ}C$ $R_L = 150\Omega$ connected to GND $R_L = 600\Omega$ connected to GND $R_L = 2k\Omega$ connected to GND $R_L = 10k\Omega$ connected to GND $R_L = 150\Omega$ connected to 2.5V $R_L = 600\Omega$ connected to 2.5V $R_L = 2k\Omega$ connected to 2.5V $R_L = 10k\Omega$ connected to 2.5V $T_{min} < T_{amb} < T_{max}$ $R_L = 150\Omega$ connected to GND $R_L = 150\Omega$ connected to 2.5V	4.2    4.5   4.1 4.4	4.36 4.85 4.90 4.93 4.66 4.90 4.92 4.93		V

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

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{ol}$	Low level output voltage	$T_{amb} = 25^{\circ}C$ $R_L = 150\Omega$ connected to GND $R_L = 600\Omega$ connected to GND $R_L = 2k\Omega$ connected to GND $R_L = 10k\Omega$ connected to GND $R_L = 150\Omega$ connected to 2.5V $R_L = 600\Omega$ connected to 2.5V $R_L = 2k\Omega$ connected to 2.5V $R_L = 10k\Omega$ connected to 2.5V $T_{min} < T_{amb} < T_{max}$ $R_L = 150\Omega$ connected to GND $R_L = 150\Omega$ connected to 2.5V		48 54 55 56 220 105 76 61	150 400	mV
GBP	Gain bandwidth product	$F = 10MHz$ $A_{VCL} = +11$ $A_{VCL} = -10$		65 55		MHz
Bw	Bandwidth @ -3dB	$A_{VCL} = +1$ $R_L = 150\Omega$ connected to 2.5V		87		MHz
SR	Slew rate	$A_{VCL} = +2$ $R_L = 150\Omega // C_L$ to 2.5V $C_L = 5pF$ $C_L = 30pF$	60	104 105		V/ $\mu s$
$\phi_m$	Phase margin	$R_L = 150\Omega // 30pF$ to 2.5V		40		$^{\circ}$ (degree)
$e_n$	Equivalent input noise voltage	$F = 100kHz$		11		nV/ $\sqrt{Hz}$
THD	Total harmonic distortion	$A_{VCL} = +2$ , $F = 4MHz$ $R_L = 150\Omega // 30pF$ to 2.5V $V_{out} = 1V_{pp}$ $V_{out} = 2V_{pp}$		-61 -54		dB
IM2	Second order intermodulation product	$A_{VCL} = +2$ , $V_{out} = 2V_{pp}$ $R_L = 150\Omega$ connected to 2.5V $F_{in1} = 180kHz$ , $F_{in2} = 280kHz$ spurious measurement @ 100kHz		-76		dBc
IM3	Third order intermodulation product	$A_{VCL} = +2$ , $V_{out} = 2V_{pp}$ $R_L = 150\Omega$ to 2.5V $F_{in1} = 180kHz$ , $F_{in2} = 280kHz$ spurious measurement @ 400kHz		-68		dBc
$\Delta G$	Differential gain	$A_{VCL} = +2$ , $R_L = 150\Omega$ to 2.5V $F = 4.5MHz$ , $V_{out} = 2V_{pp}$		0.5		%
Df	Differential phase	$A_{VCL} = +2$ , $R_L = 150\Omega$ to 2.5V $F = 4.5MHz$ , $V_{out} = 2V_{pp}$		0.5		$^{\circ}$ (degree)
Gf	Gain flatness	$F = DC$ to 6MHz, $A_{VCL} = +2$		0.2		dB
$V_{o1}/V_{o2}$	Channel separation	$F = 1MHz$ to 10MHz		65		dB

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

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

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

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

**Table 5. Standby mode -  $V_{CC}^+$ ,  $V_{CC}^-$ ,  $T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)**

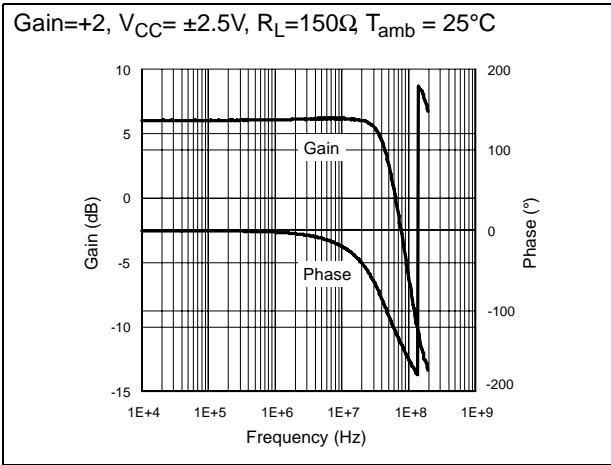
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{low}$	Standby low level		$V_{CC}^-$		$(V_{CC}^- + 0.8)$	V
$V_{high}$	Standby high level		$(V_{CC}^- + 2)$		$(V_{CC}^+)$	V
$I_{CC-STBY}$	Current consumption per operator when Standby is active	pin 8 (TSH81) to $V_{CC}^-$		20	55	$\mu\text{A}$
$Z_{out}$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

**Table 6. TSH81 standby control pin status**

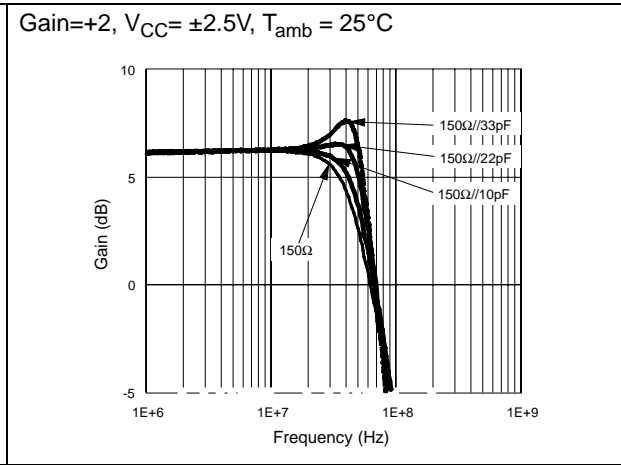
TSH81 standby control pin 8 (STANDBY)	Operator status
$V_{low}$	Standby
$V_{high}$	Active



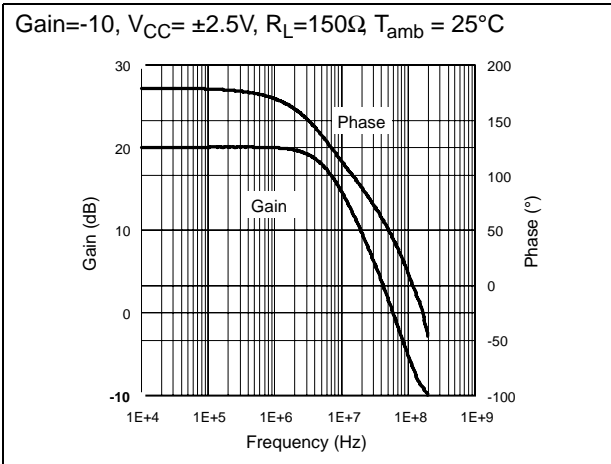
**Figure 1. Closed loop gain and phase vs. frequency**



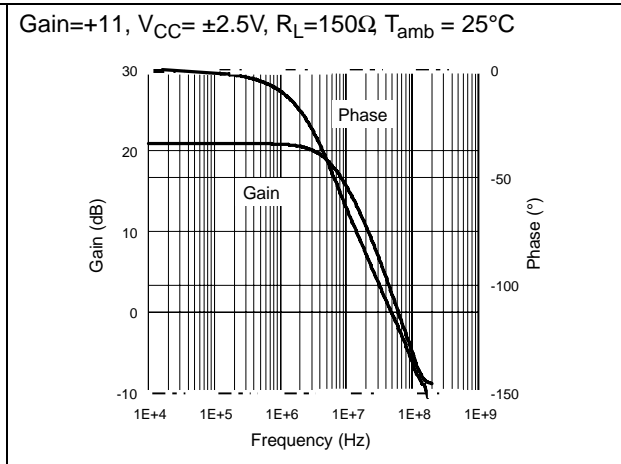
**Figure 2. Overshoot vs. output capacitance**



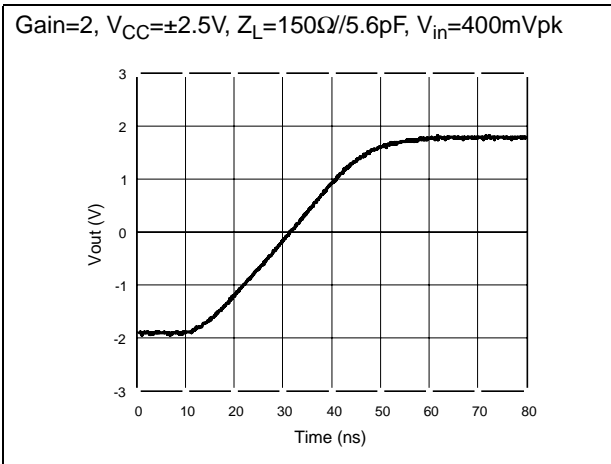
**Figure 3. Closed loop gain and phase vs. frequency**



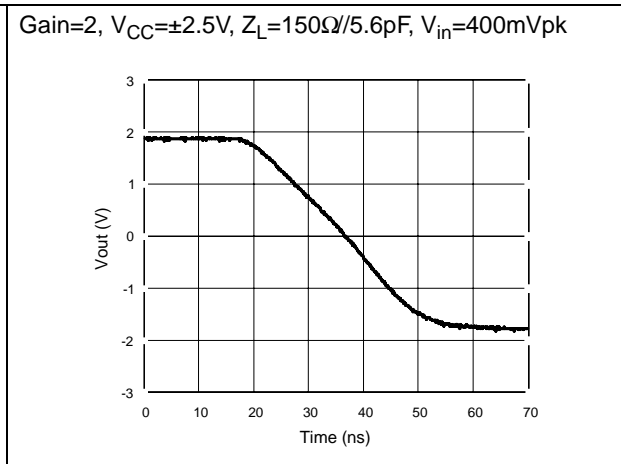
**Figure 4. Closed loop gain and phase vs. frequency**



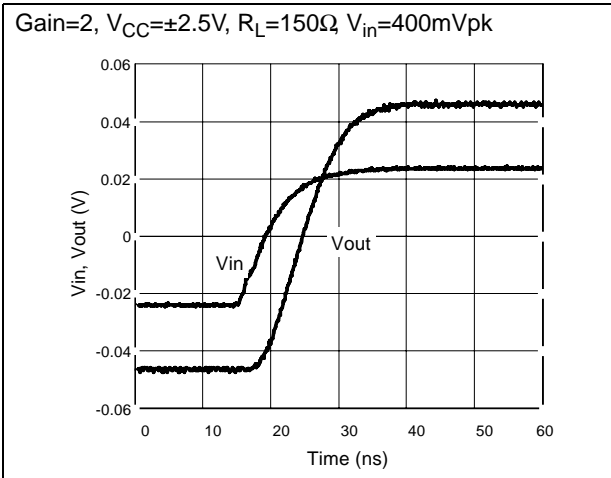
**Figure 5. Large signal measurement - positive slew rate**



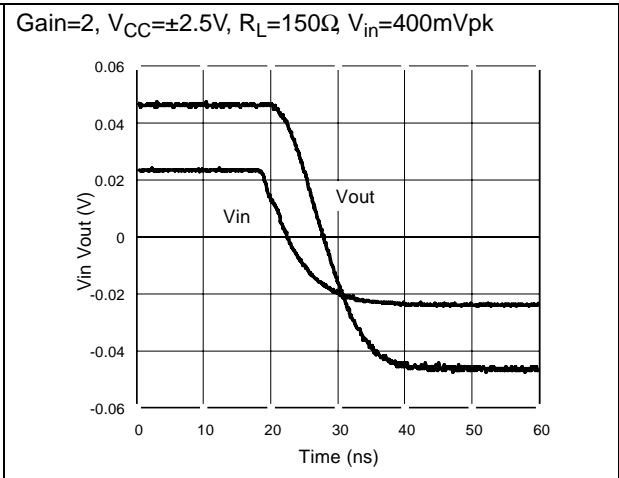
**Figure 6. Large signal measurement - negative slew rate**



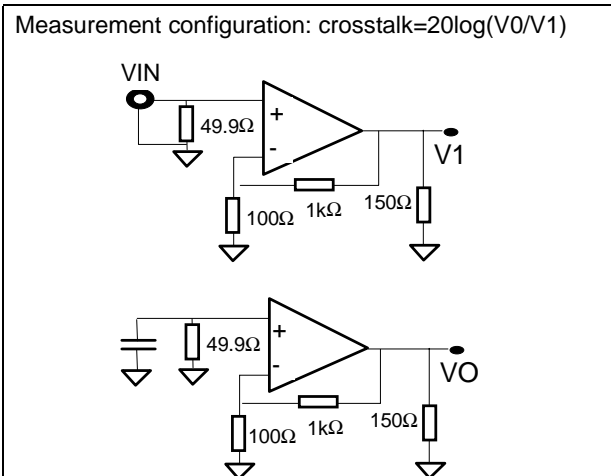
**Figure 7. Small signal measurement - rise time**



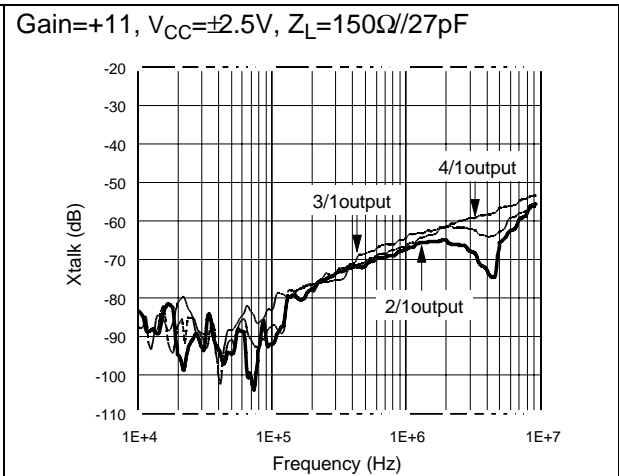
**Figure 8. Small signal measurement - fall time**



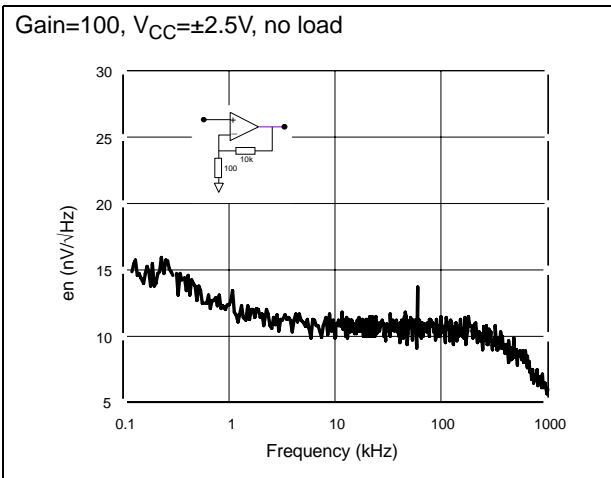
**Figure 9. Channel separation (crosstalk) vs. frequency**



**Figure 10. Channel separation (crosstalk) vs. frequency**



**Figure 11. Equivalent input noise voltage**



**Figure 12. Maximum output swing**

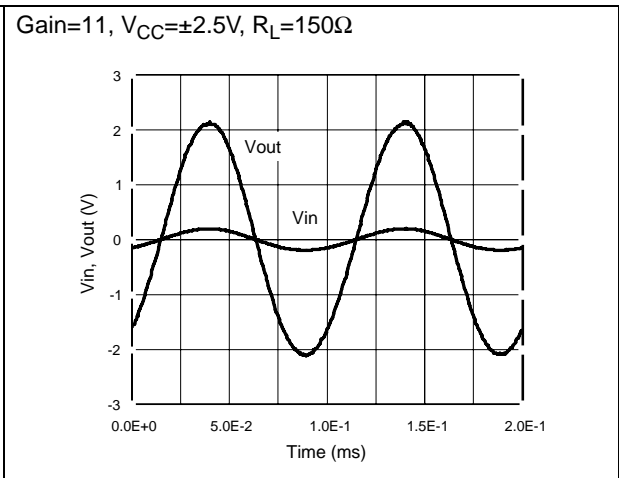


Figure 13. Standby mode -  $T_{on}$ ,  $T_{off}$

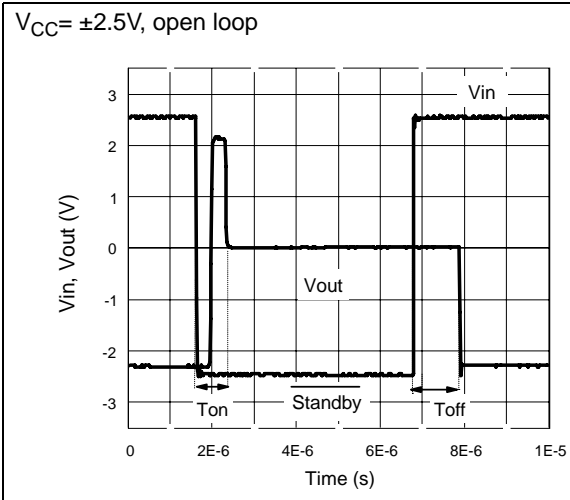
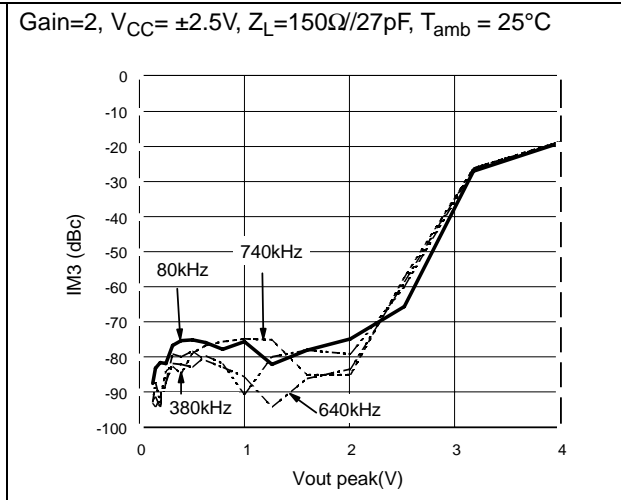
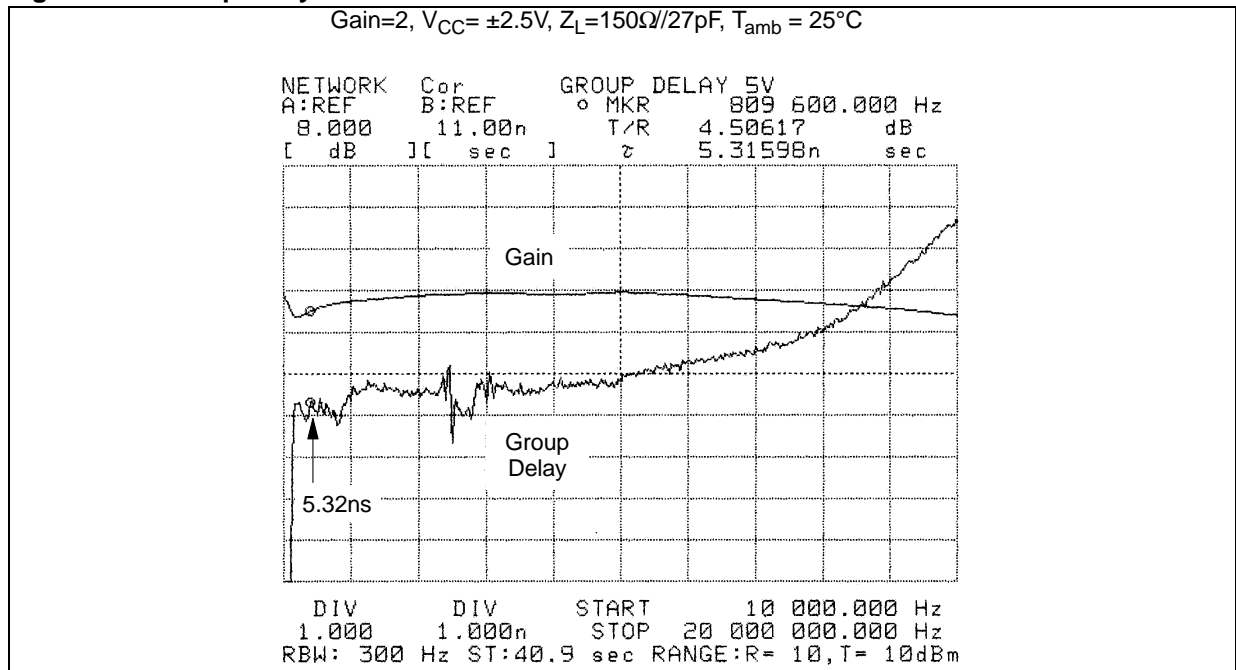


Figure 14. Third order intermodulation<sup>(1)</sup>

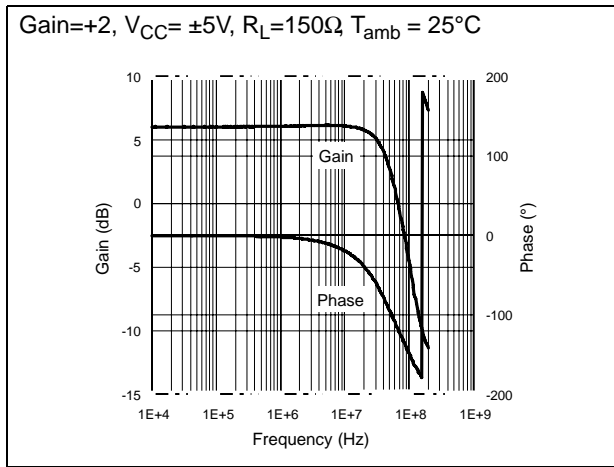


1. The IFR2026 synthesizer generates a two-tone signal ( $F_1=180kHz$ ,  $F_2=280kHz$ ), each tone having the same amplitude. The HP3585 spectrum analyzer measures the intermodulation products as a function of the output voltage. The generator and the spectrum analyzer are phase locked for better accuracy.

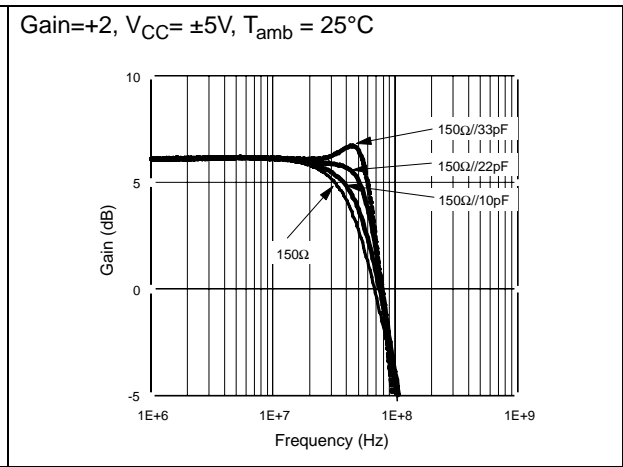
Figure 15. Group delay



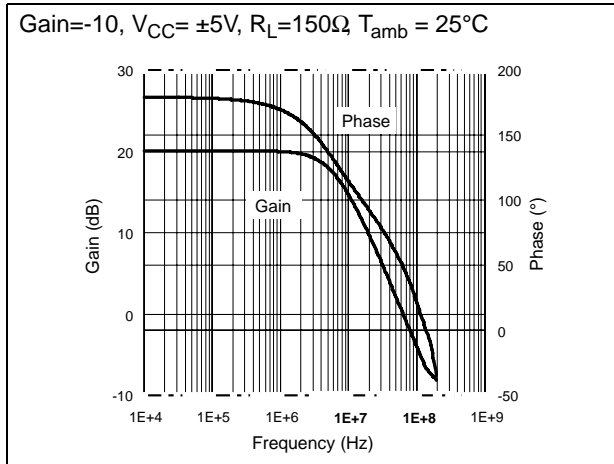
**Figure 16. Closed loop gain and phase vs. frequency**



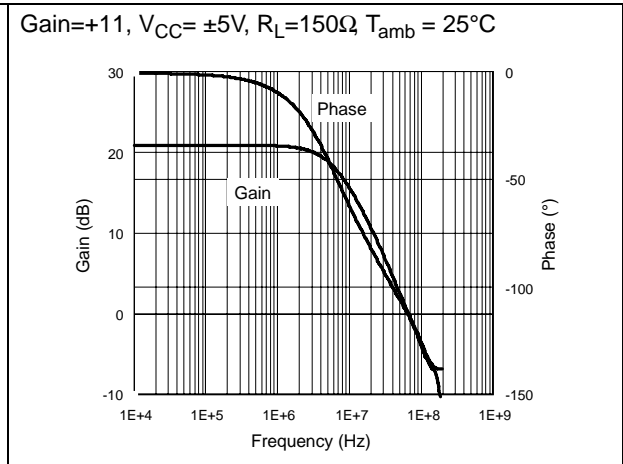
**Figure 17. Overshoot vs. output capacitance**



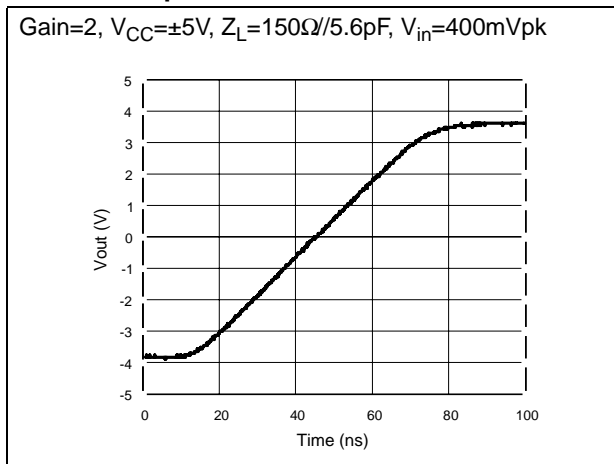
**Figure 18. Closed loop gain and phase vs. frequency**



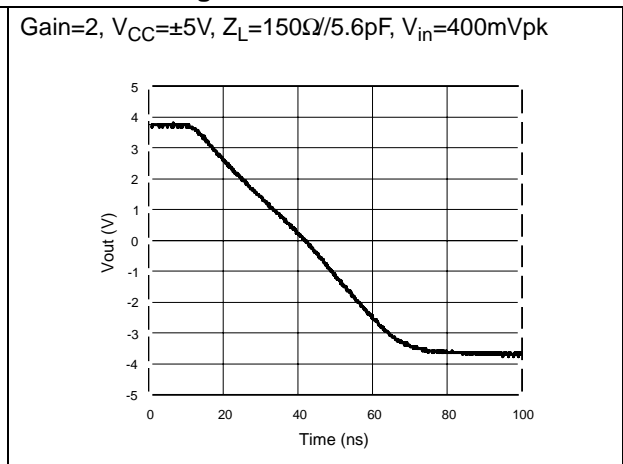
**Figure 19. Closed loop gain and phase vs. frequency**



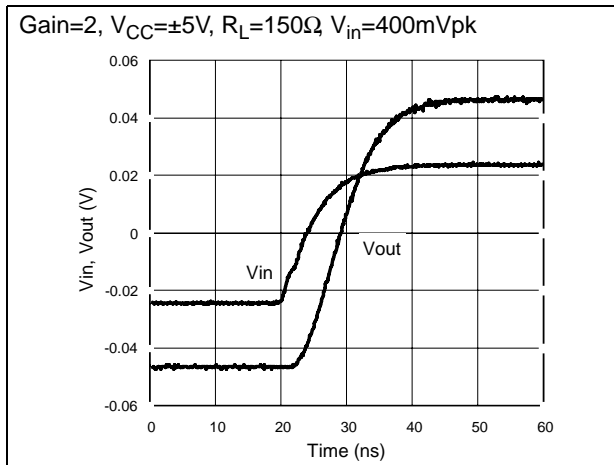
**Figure 20. Large signal measurement - positive slew rate**



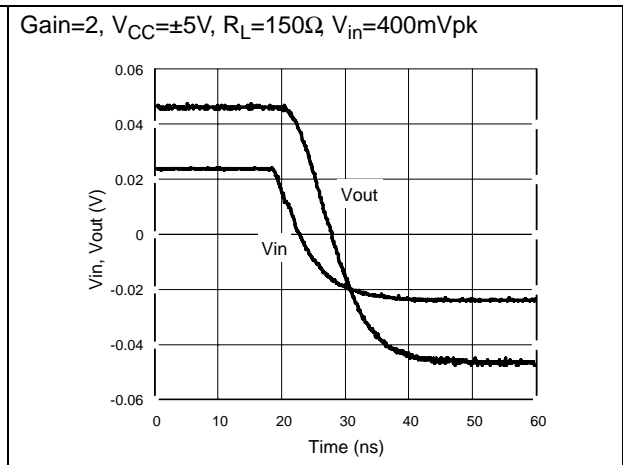
**Figure 21. Large signal measurement - negative slew rate**



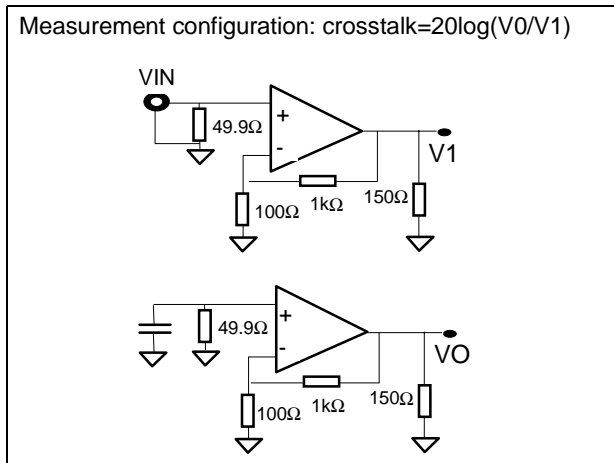
**Figure 22. Small signal measurement - rise time**



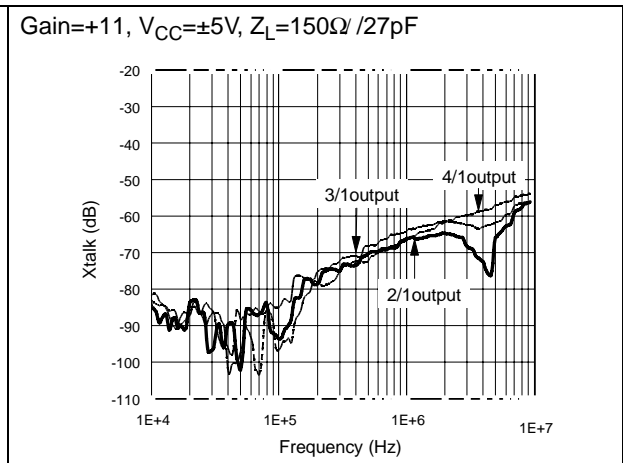
**Figure 23. Small signal measurement - fall time**



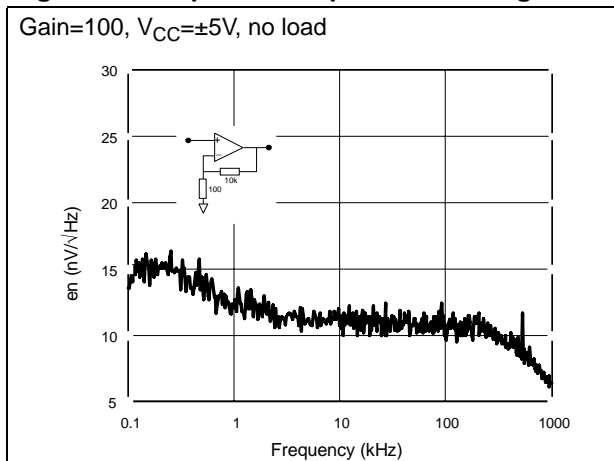
**Figure 24. Channel separation (crosstalk) vs. frequency**



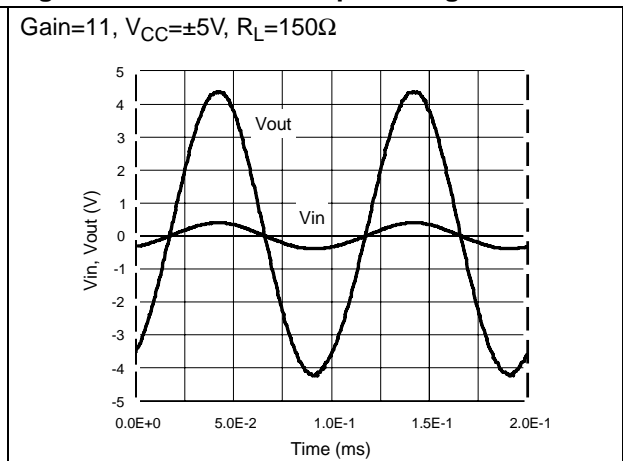
**Figure 25. Channel separation (crosstalk) vs. frequency**



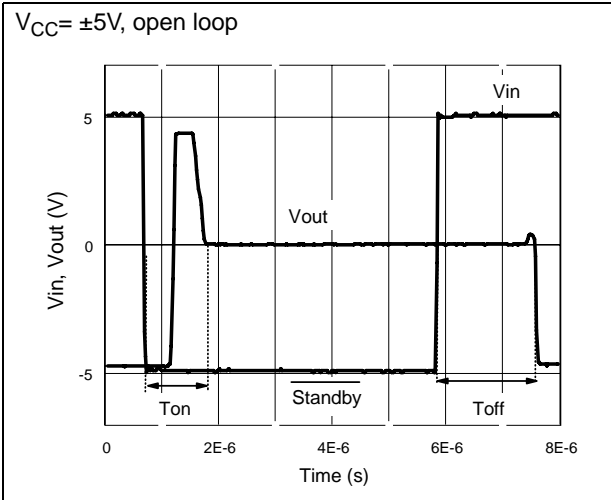
**Figure 26. Equivalent input noise voltage**



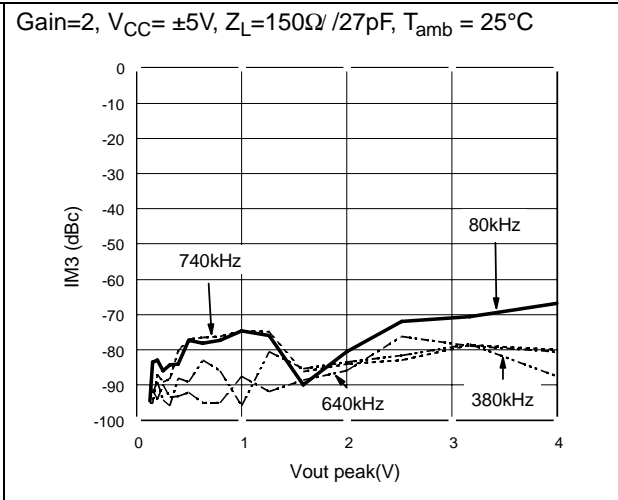
**Figure 27. Maximum output swing**



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

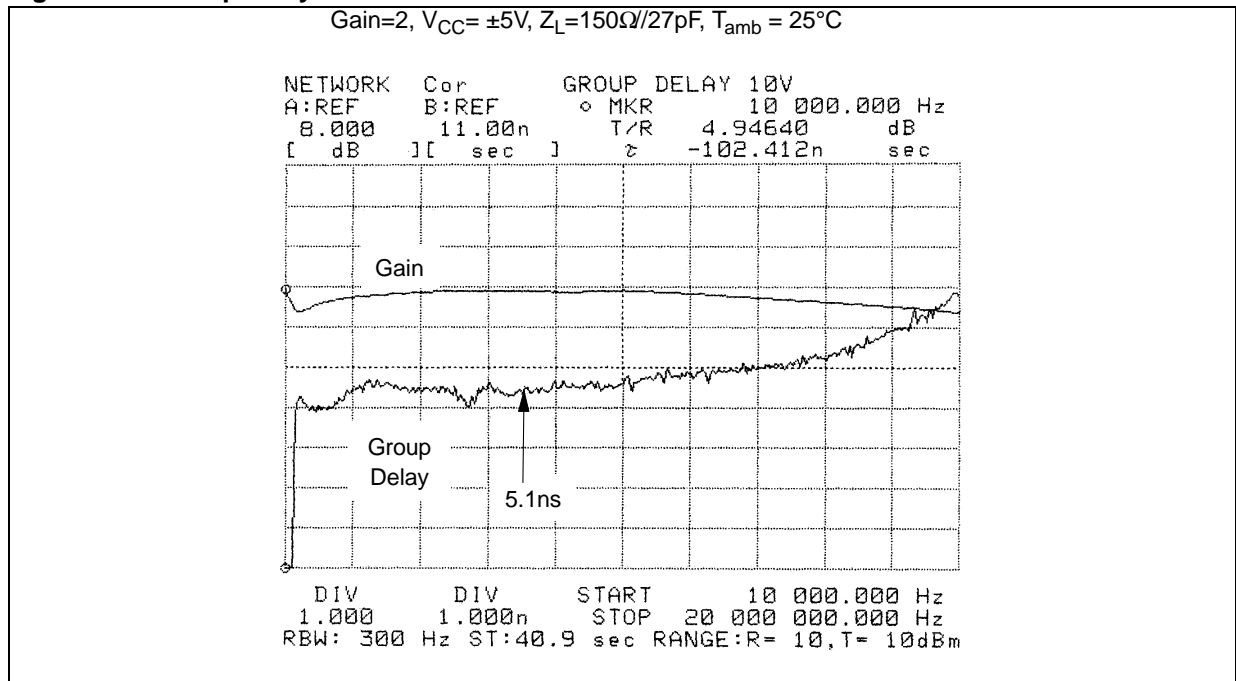


**Figure 29. Third order intermodulation<sup>(1)</sup>**



1. The IFR2026 synthesizer generates a two-tone signal ( $F_1=180kHz$ ,  $F_2=280kHz$ ), 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**



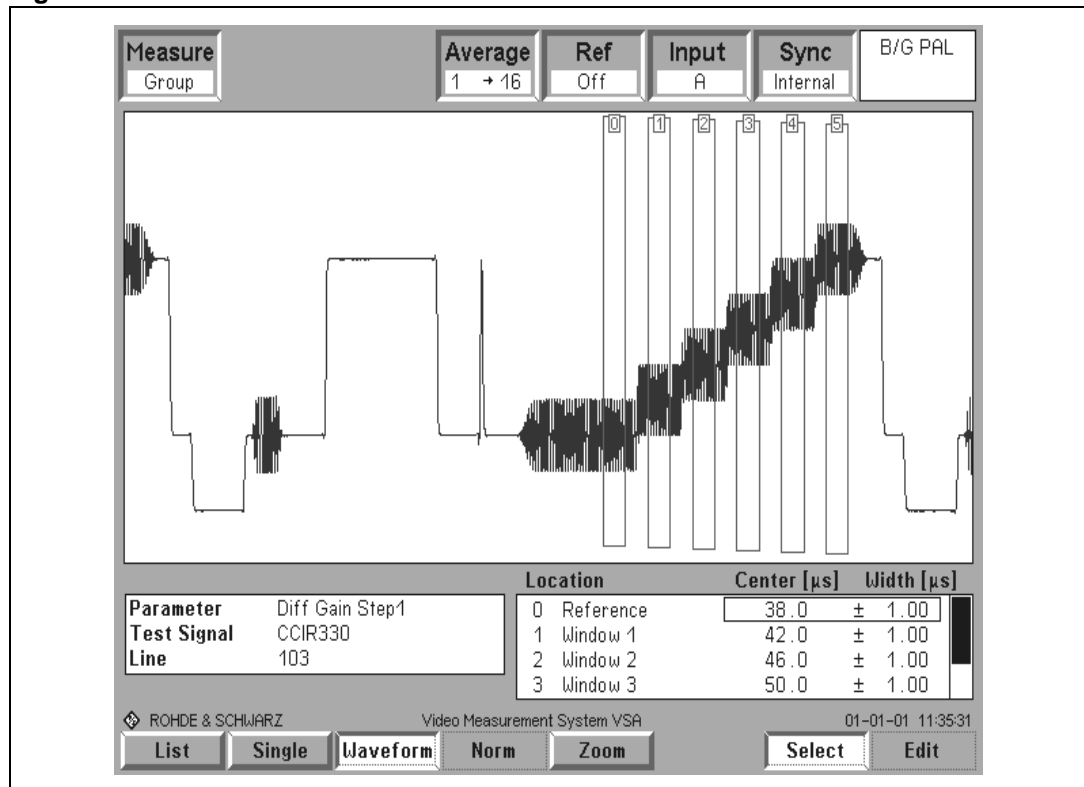
### 3 Test conditions

#### 3.1 Layout precautions

To use the TSH8X circuits in the best manner at high frequencies, some precautions have to be taken for 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 (4.7µF and ceramic 100pF) 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 the 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.
- In lower gain applications, use a low feedback resistance (under 1kΩ) to reduce the time constant with parasitic capacitance.
- Choose component sizes as small as possible (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 5 (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 luminance level. Differential phase and gain represent the ability to uniformly process the high frequency information at all luminance levels.

When 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**

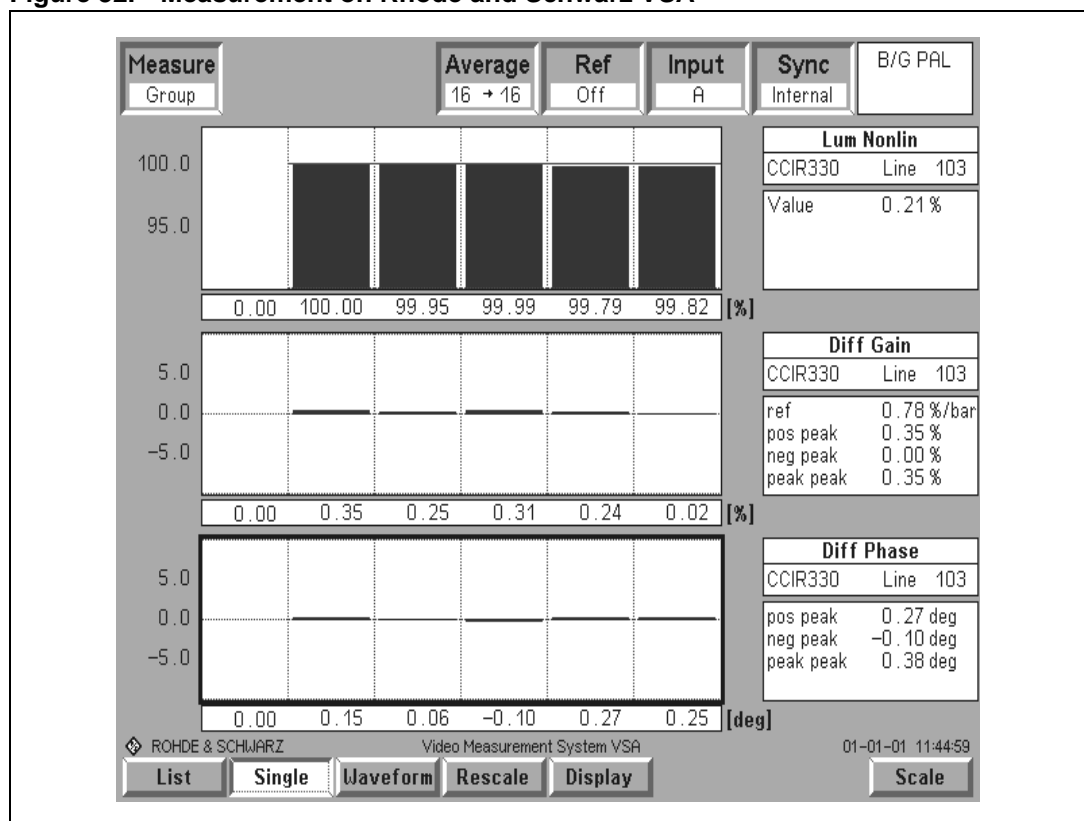




Table 7. Video results

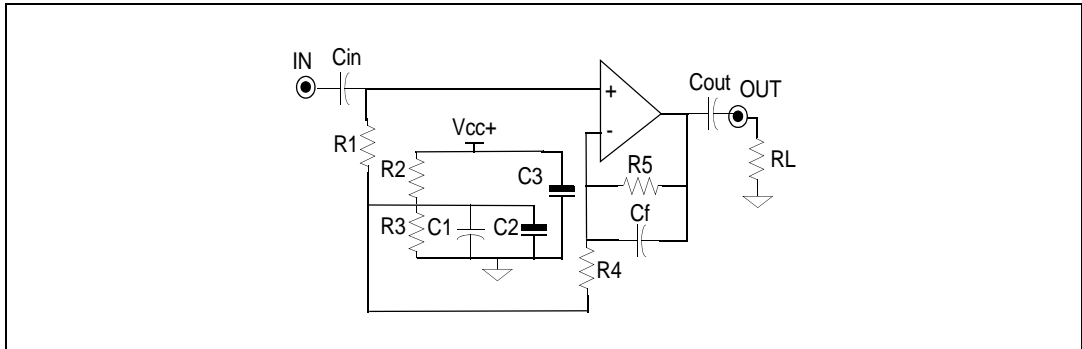
Parameter	Value ( $V_{CC}=\pm 2.5V$ )	Value ( $V_{CC}=\pm 5V$ )	Unit
Lum NL	0.1	0.3	%
Lum NL Step 1	100	100	%
Lum NL Step 2	100	99.9	%
Lum NL Step 3	99.9	99.8	%
Lum NL Step 4	99.9	99.9	%
Lum NL Step 5	99.9	99.7	%
Diff Gain pos	0	0	%
Diff Gain neg	-0.7	-0.6	%
Diff Gain pp	0.7	0.6	%
Diff Gain Step1	-0.5	-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 either with 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, in order to reject any noise present on the supply rail.

As the bias current is  $15\mu A$ , you should use a high resistance R1 (approximately  $10k\Omega$ ) to avoid introducing an offset mismatch at the amplifier inputs.

**Figure 33. Asymmetrical supply schematic diagram**



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

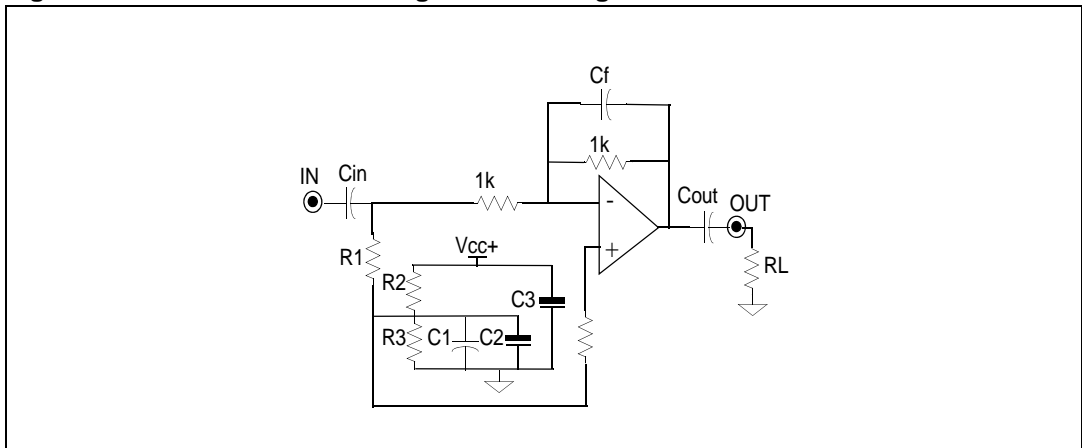
$$C1=100nF \text{ and } C2=C3=100\mu F$$

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:

$$R2=R3=4.7k\Omega$$

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

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

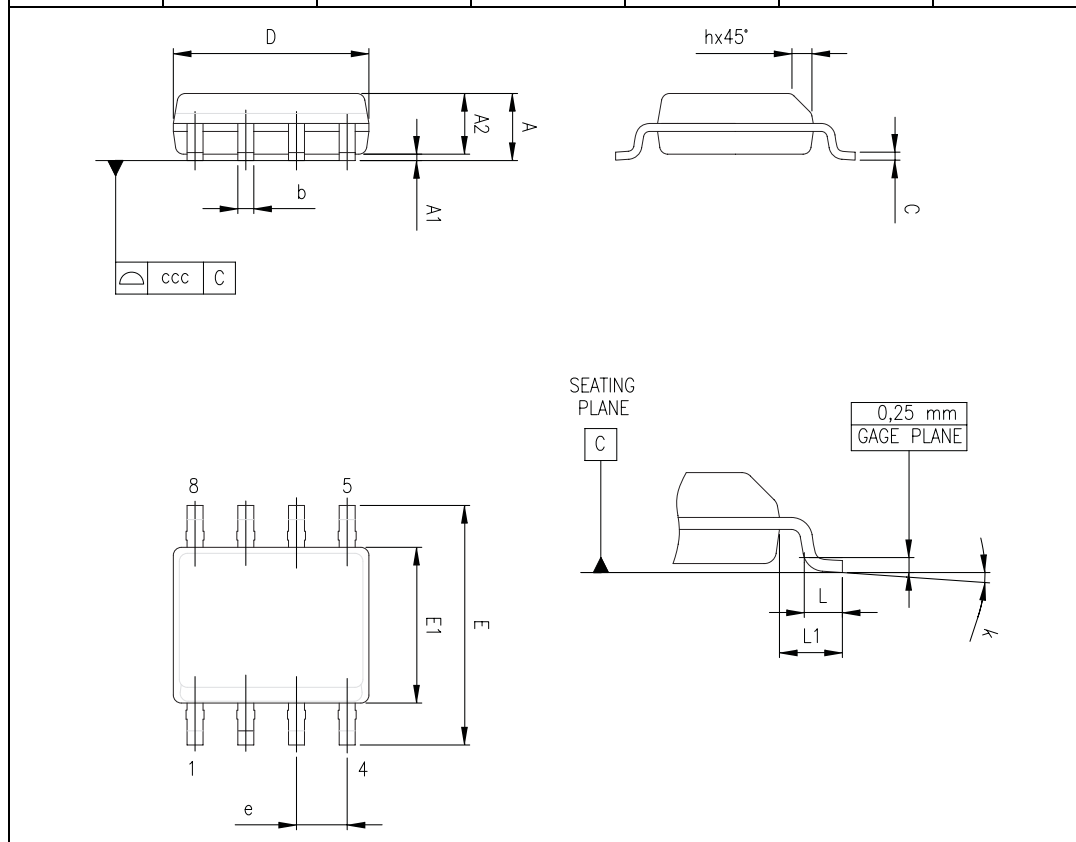


## 5 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

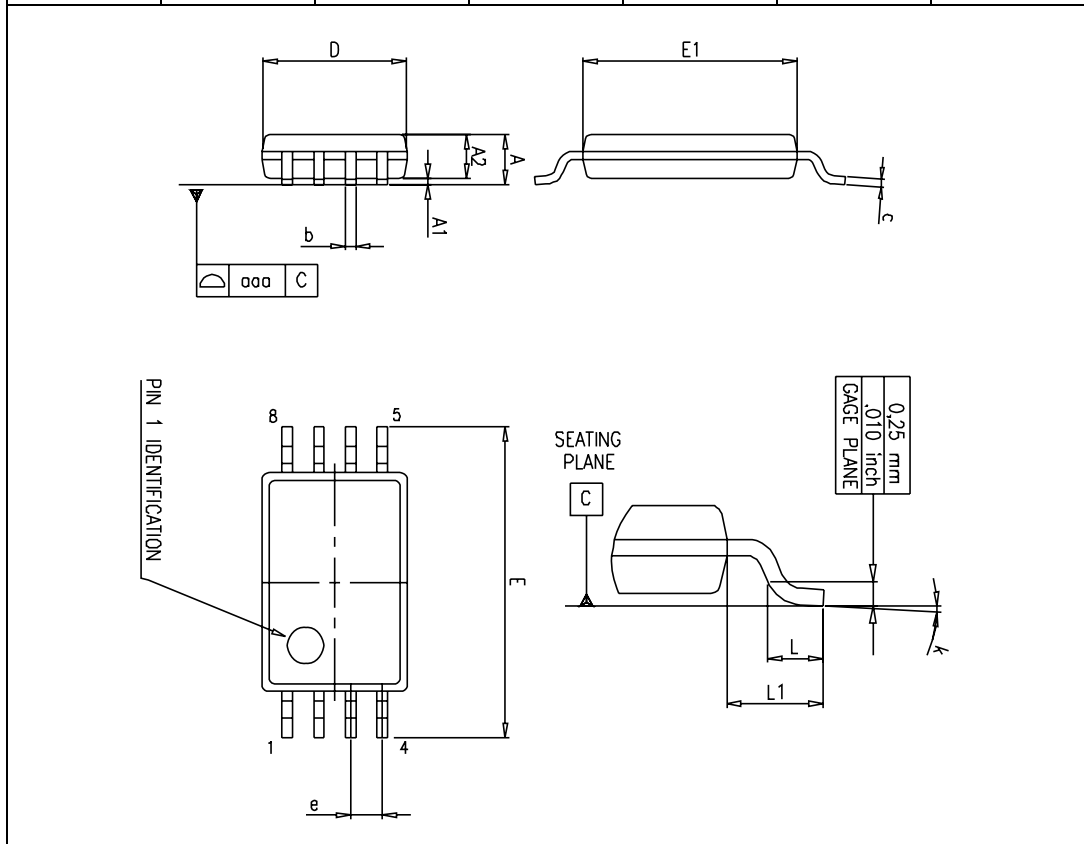
### 5.1 SO-8 package mechanical data

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
H	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
k	1°		8°	1°		8°
ccc			0.10			0.004



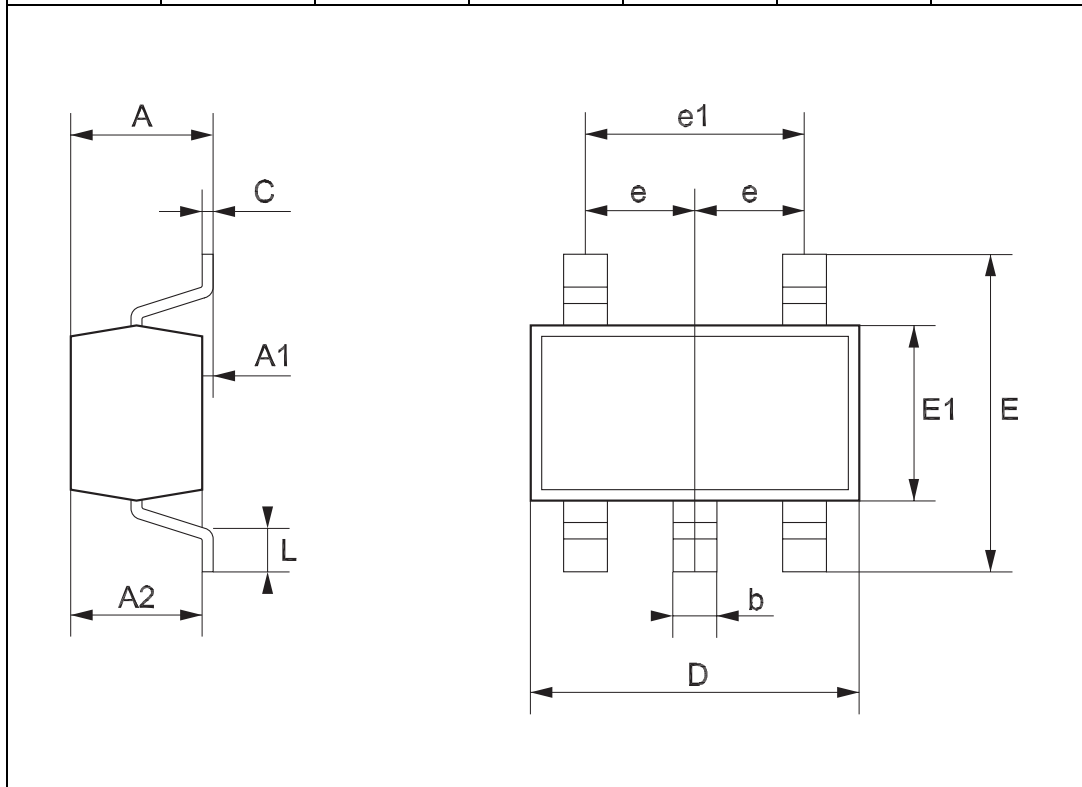
### 5.2 TSSOP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			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		0.1			0.004	



### 5.3 SOT23-5 package mechanical data

Ref.	Dimensions					
	Millimeters			Mils		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	35.4		57.1
A1	0.00		0.15	0.00		5.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	2.60		3.00	102.3		118.1
E1	1.50		1.75	59.0		68.8
e		0.95			37.4	
e1		1.9			74.8	
L	0.35		0.55	13.7		21.6



## 6 Ordering information

**Table 8. Order codes**

Type	Temperature range	Package	Packaging	Marking
TSH80ILT	-40°C to +85°C	SOT23-5	Tape & reel	K303
TSH80IYLT <sup>(1)</sup>		SOT23-5 (Automotive grade level)		K310
TSH80ID/DT		SO-8	Tube or tape & reel	TSH80I
TSH80IYD/IYDT <sup>(1)</sup>		SO-8 (Automotive grade level)		SH80IY
TSH81ID/DT		SO-8		TSH81I
TSH81IPT		TSSOP8	Tape & reel	SH81I
TSH81IYPT <sup>(1)</sup>		TSSOP8 (Automotive grade level)		H81IY
TSH82ID/DT		SO-8	Tube or tape & reel	TSH82I
TSH82IPT		TSSOP8	Tape & reel	SH82I
TSH82IYD/IYDT <sup>(1)</sup>		SO-8 (Automotive grade level)	Tube or tape & reel	SH82IY

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 <a href="#">Table 8: Order codes on page 23</a> .
12-Apr-2007	3	Corrected temperature range for TSH80IYD/IYDT and TSH82IYD/IYDT order codes in <a href="#">Table 8: Order codes on page 23</a> .
24-Oct-2007	4	TSH81IYPT PPAP references inserted in the datasheet, see <a href="#">Table 8: Order codes on page 23</a> .

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