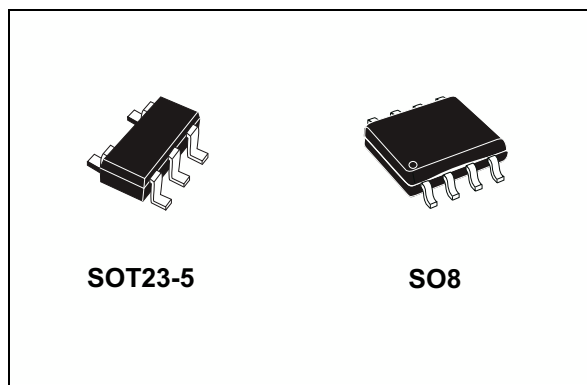


Wide-band rail-to-rail operational amplifiers with standby function

Datasheet - production data



Features

- Operating range from 4.5 to 12 V
- 3 dB-bandwidth: 100 MHz
- Slew rate 100 V/ μ s
- 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 and SO8 packages
- Automotive qualification

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.

For board space and weight saving, the TSH8x series is proposed in SOT23-5 and SO8 plastic micropackages.

Contents

1	Package pin connections	5
2	Absolute maximum ratings and operating conditions	6
3	Electrical characteristics	7
4	Test conditions	18
4.1	Layout precautions	18
4.2	Video capabilities	19
5	Precautions on asymmetrical supply operation	21
6	Package information	22
6.1	SOT23-5 package information	23
6.2	SO8 package information	24
7	Ordering information	25
8	Revision history	26

List of tables

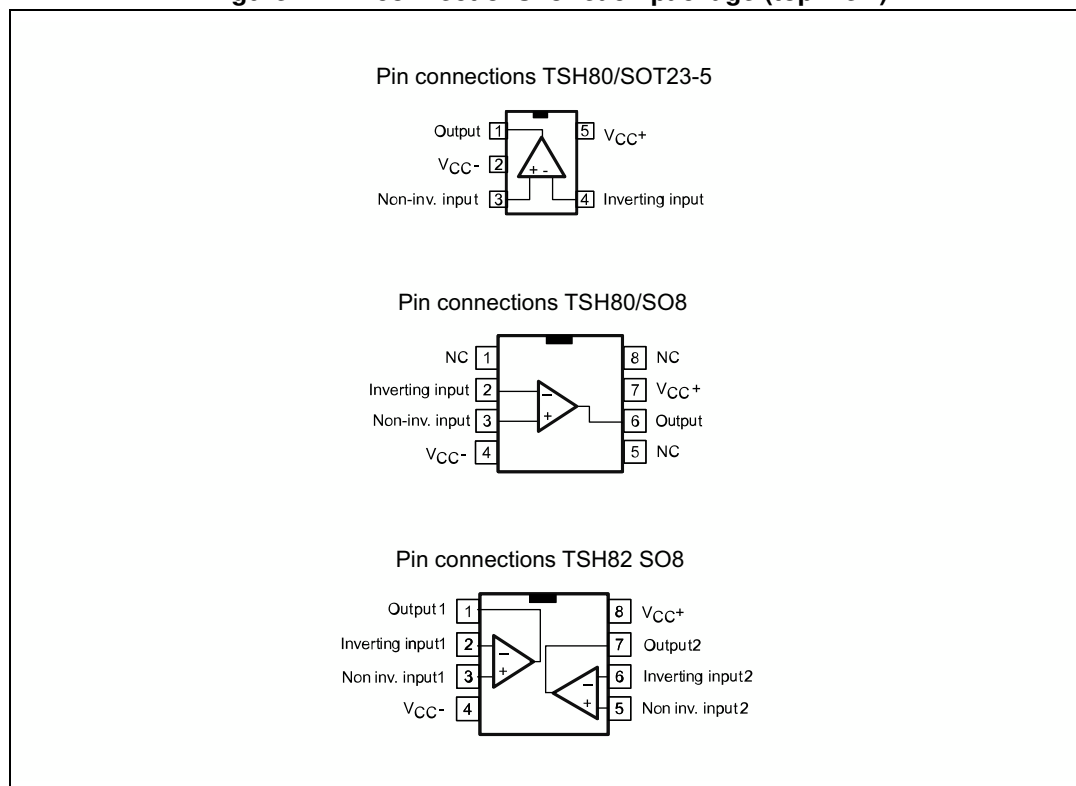
Table 1.	Absolute maximum ratings	6
Table 2.	Operating conditions	6
Table 3.	Electrical characteristics at $V_{CC+} = +5\text{ V}$, $V_{CC-} = \text{GND}$, $V_{ic} = 2.5\text{ V}$, $T_{amb} = 25\text{ °C}$ (unless otherwise specified)	7
Table 4.	Electrical characteristics at $V_{CC+} = +5\text{ V}$, $V_{CC-} = -5\text{ V}$, $V_{ic} = \text{GND}$, $T_{amb} = 25\text{ °C}$ (unless otherwise specified)	10
Table 5.	Standby mode - V_{CC+} , V_{CC-} , $T_{amb} = 25\text{ °C}$ (unless otherwise specified).	11
Table 6.	Video results	20
Table 7.	SOT23-5 package mechanical data	23
Table 8.	SO8 package mechanical data	24
Table 9.	Order codes	25
Table 10.	Document revision history	26

List of figures

Figure 1.	Pin connections for each package (top view)	5
Figure 2.	Closed loop gain and phase vs. frequency (gain = +2, $V_{CC} = \pm 2.5$ V)	13
Figure 3.	Overshoot vs. output capacitance ($V_{CC} = \pm 2.5$ V)	13
Figure 4.	Closed loop gain and phase vs. frequency (gain = -10, $V_{CC} = \pm 2.5$ V)	13
Figure 5.	Closed loop gain and phase vs. frequency (gain = +11, $V_{CC} = \pm 2.5$ V)	13
Figure 6.	Large signal measurement – positive slew rate ($V_{CC} = \pm 2.5$ V)	13
Figure 7.	Large signal measurement – negative slew rate ($V_{CC} = \pm 2.5$ V)	13
Figure 8.	Small signal measurement – rise time ($V_{CC} = \pm 2.5$ V)	14
Figure 9.	Small signal measurement – fall time ($V_{CC} = \pm 2.5$ V)	14
Figure 10.	Channel separation (crosstalk) vs. frequency schematic ($V_{CC} = \pm 2.5$ V)	14
Figure 11.	Channel separation (crosstalk) vs. frequency ($V_{CC} = \pm 2.5$ V)	14
Figure 12.	Equivalent input noise voltage ($V_{CC} = \pm 2.5$ V)	14
Figure 13.	Maximum output swing ($V_{CC} = \pm 2.5$ V)	14
Figure 14.	Standby mode - T_{on} , T_{off} ($V_{CC} = \pm 2.5$ V)	15
Figure 15.	Third order intermodulation ($V_{CC} = \pm 2.5$ V)	15
Figure 16.	Group delay ($V_{CC} = \pm 2.5$ V)	15
Figure 17.	Closed loop gain and phase vs. frequency (gain = +2, $V_{CC} = \pm 5$ V)	16
Figure 18.	Overshoot vs. output capacitance ($V_{CC} = \pm 5$ V)	16
Figure 19.	Closed loop gain and phase vs. frequency (gain = -10, $V_{CC} = \pm 5$ V)	16
Figure 20.	Closed loop gain and phase vs. frequency (gain = +11, $V_{CC} = \pm 5$ V)	16
Figure 21.	Large signal measurement - positive slew rate ($V_{CC} = \pm 5$ V)	16
Figure 22.	Large signal measurement - negative slew rate ($V_{CC} = \pm 5$ V)	16
Figure 23.	Small signal measurement - rise time ($V_{CC} = \pm 5$ V)	17
Figure 24.	Small signal measurement - fall time ($V_{CC} = \pm 5$ V)	17
Figure 25.	Channel separation (crosstalk) vs. frequency schematic ($V_{CC} = \pm 5$ V)	17
Figure 26.	Channel separation (crosstalk) vs. frequency ($V_{CC} = \pm 5$ V)	17
Figure 27.	Equivalent input noise voltage ($V_{CC} = \pm 5$ V)	17
Figure 28.	Maximum output swing ($V_{CC} = \pm 5$ V)	17
Figure 29.	Standby mode - T_{on} , T_{off} ($V_{CC} = \pm 5$ V)	18
Figure 30.	Third order intermodulation ($V_{CC} = \pm 5$ V)	18
Figure 31.	Group delay ($V_{CC} = \pm 5$ V)	18
Figure 32.	CCIR330 video line	19
Figure 33.	Measurement on Rohde and Schwarz VSA	20
Figure 34.	Asymmetrical supply schematic diagram	22
Figure 35.	Use of the TSH8x in a gain = -1 configuration	22
Figure 36.	SOT23-5 package outline	24
Figure 37.	SO8 package outline	25

1 Package pin connections

Figure 1. Pin connections for each package (top view)



2 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_i	Input voltage ⁽³⁾	± 6	
T_{oper}	Operating free air temperature range	-40 to +85	°C
T_{stg}	Storage temperature	-65 to +150	
T_j	Maximum junction temperature	150	
R_{thjc}	Thermal resistance junction-to-case ⁽⁴⁾ SOT23-5	80	°C/W
	SO8	28	
R_{thja}	Thermal resistance junction-to-ambient area SOT23-5	250	
	SO8	157	
ESD	HBM: human body model ⁽⁵⁾	2	kV
	MM: machine model ⁽⁶⁾	0.2	
	CDM: charged device model ⁽⁷⁾	1.5	

1. All voltage values, except differential voltage are with respect to the network ground terminal.
2. The differential voltage is 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 k Ω 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 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 $(V_{CC}^+ - 1.1)$	

3 Electrical characteristics

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

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

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

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

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

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

1. Tested on the TSH80ILT device only.

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

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

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

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

Table 5. Standby mode - V_{CC}^+ , V_{CC}^- , $T_{\text{amb}} = 25\text{ }^\circ\text{C}$ (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}^+)	
Z_{out}	Output impedance ($R_{\text{out}}//C_{\text{out}}$)	R_{out} C_{out}		10 17		M Ω pF
T_{on}	Time from standby mode to active mode			2		μs
T_{off}	Time from active mode to standby mode	Down to $I_{CC\text{-STBY}} = 10\text{ }\mu\text{A}$		10		

Figure 2. Closed loop gain and phase vs. frequency (gain = +2, $V_{CC} = \pm 2.5$ V)
 $R_L = 150\ \Omega$, $T_{amb} = 25\ ^\circ\text{C}$

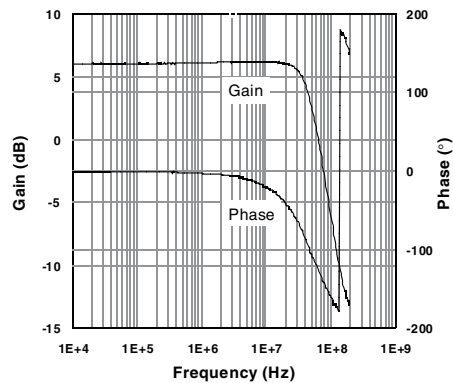


Figure 3. Overshoot vs. output capacitance ($V_{CC} = \pm 2.5$ V)
 Gain = +2, $T_{amb} = 25\ ^\circ\text{C}$

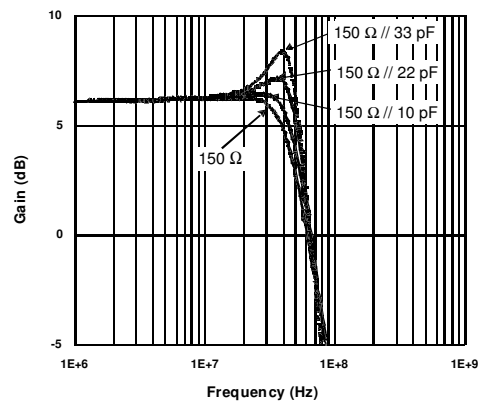


Figure 4. Closed loop gain and phase vs. frequency (gain = -10, $V_{CC} = \pm 2.5$ V)
 $R_L = 150\ \Omega$, $T_{amb} = 25\ ^\circ\text{C}$

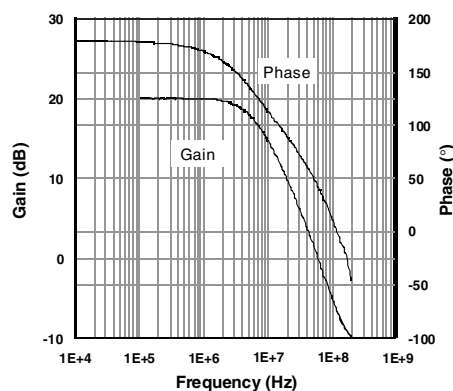


Figure 5. Closed loop gain and phase vs. frequency (gain = +11, $V_{CC} = \pm 2.5$ V)
 $R_L = 150\ \Omega$, $T_{amb} = 25\ ^\circ\text{C}$

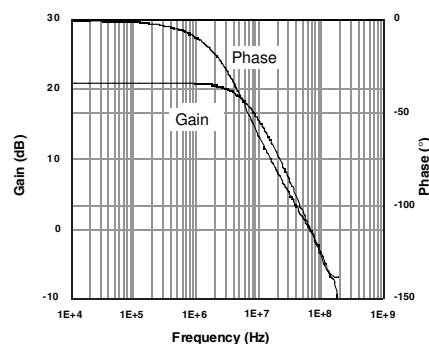


Figure 6. Large signal measurement – positive slew rate ($V_{CC} = \pm 2.5$ V)
 Gain = +2, $Z_L = 150\ \Omega // 5.6\ \text{pF}$, $V_{in} = 400\ \text{mVpk}$

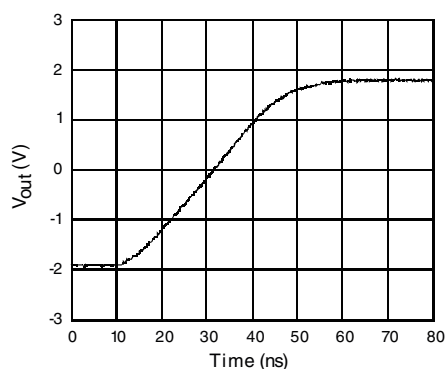


Figure 7. Large signal measurement – negative slew rate ($V_{CC} = \pm 2.5$ V)
 Gain = +2, $Z_L = 150\ \Omega // 5.6\ \text{pF}$, $V_{in} = 400\ \text{mVpk}$

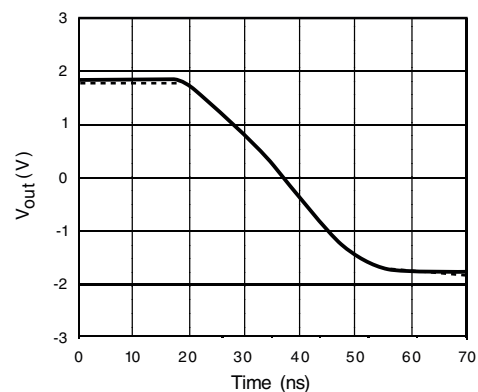


Figure 8. Small signal measurement – rise time
($V_{CC} = \pm 2.5\text{ V}$)

Gain = +2, $R_L = 150\ \Omega$,

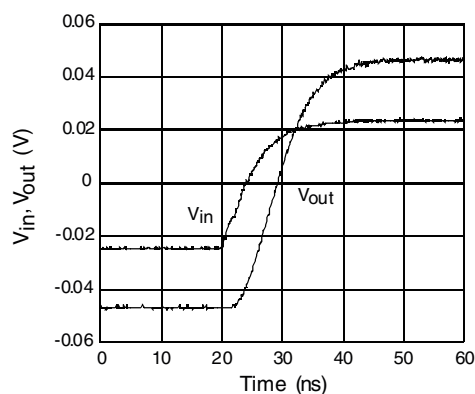


Figure 9. Small signal measurement – fall time
($V_{CC} = \pm 2.5\text{ V}$)

Gain = +2, $R_L = 150\ \Omega$, $V_{in} = 400\text{ mV}_{pk}$

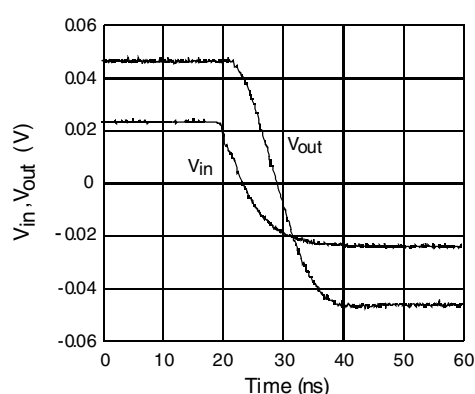
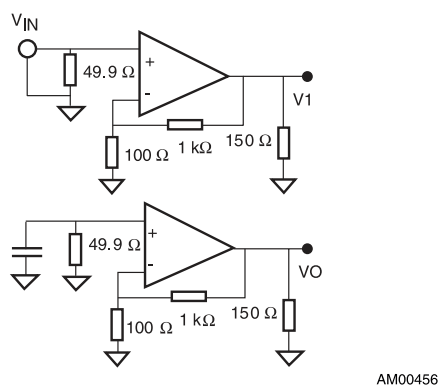


Figure 10. Channel separation (crosstalk) vs. frequency schematic ($V_{CC} = \pm 2.5\text{ V}$)

Measurement configuration:



AM00456

Figure 11. Channel separation (crosstalk) vs. frequency ($V_{CC} = \pm 2.5\text{ V}$)

Gain = +11, $Z_L = 150\ \Omega // 27\text{ pF}$

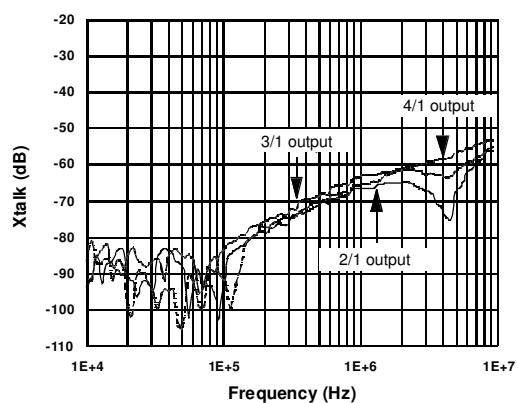


Figure 12. Equivalent input noise voltage
($V_{CC} = \pm 2.5\text{ V}$)

Gain = +100, no load

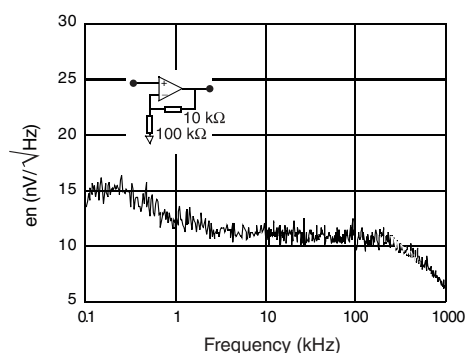
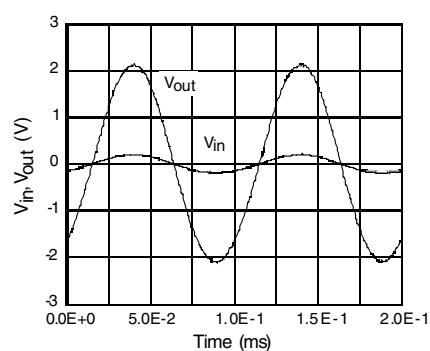
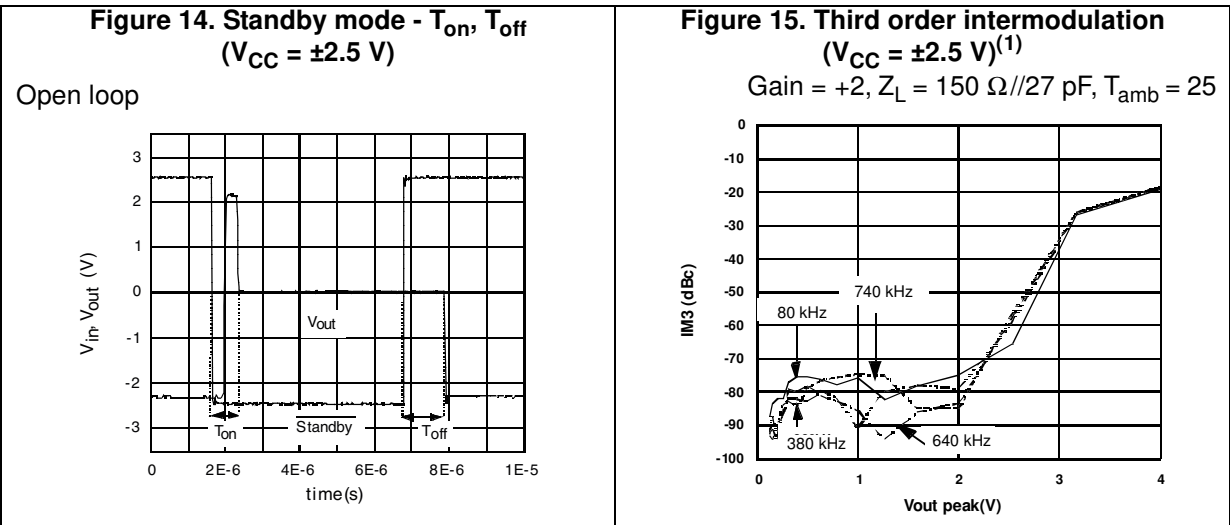


Figure 13. Maximum output swing
($V_{CC} = \pm 2.5\text{ V}$)

Gain = +11, $R_L = 150\ \Omega$





1. The IFR2026 synthesizer generates a two-tone signal ($F_1 = 180\text{ kHz}$, $F_2 = 280\text{ kHz}$), 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 16. Group delay ($V_{CC} = \pm 2.5\text{ V}$)

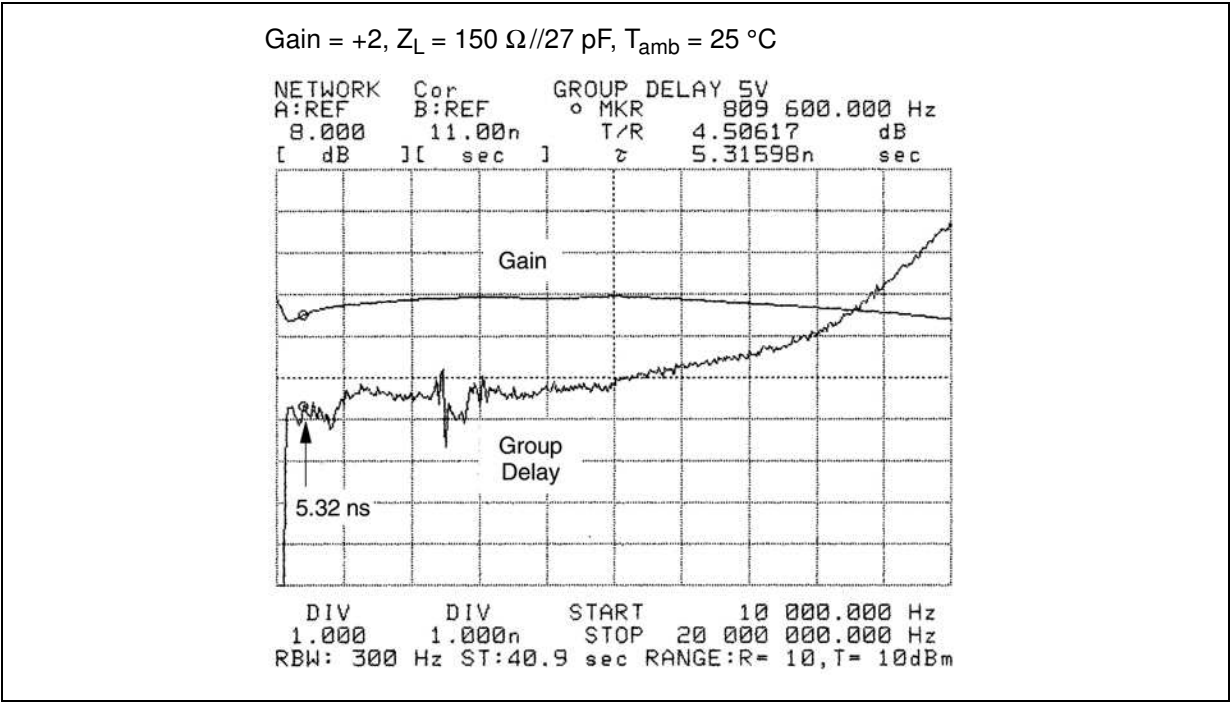


Figure 17. Closed loop gain and phase vs. frequency (gain = +2, $V_{CC} = \pm 5$ V)

$R_L = 150\ \Omega$, $T_{amb} = 25\ ^\circ\text{C}$

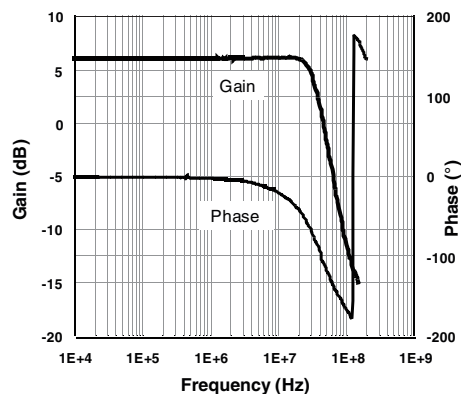


Figure 18. Overshoot vs. output capacitance ($V_{CC} = \pm 5$ V)

Gain = +2, $T_{amb} = 25\ ^\circ\text{C}$

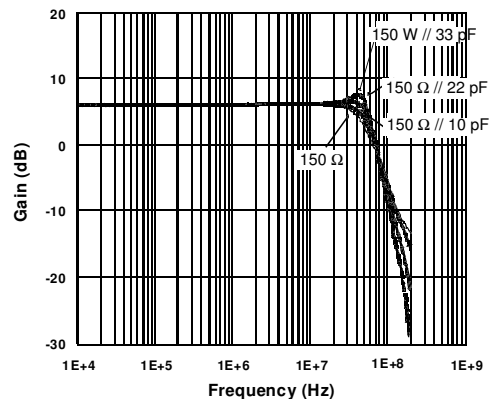


Figure 19. Closed loop gain and phase vs. frequency (gain = -10, $V_{CC} = \pm 5$ V)

$R_L = 15$

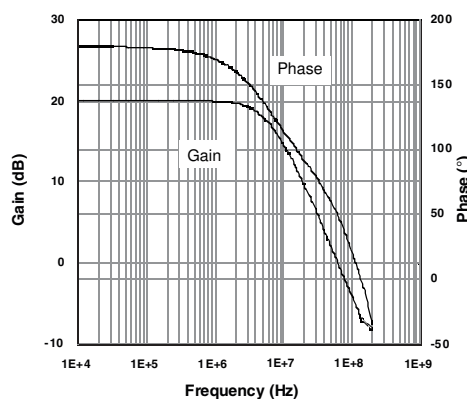


Figure 20. Closed loop gain and phase vs. frequency (gain = +11, $V_{CC} = \pm 5$ V)

$R_L = 150\ \Omega$, $T_{amb} = 25\ ^\circ\text{C}$

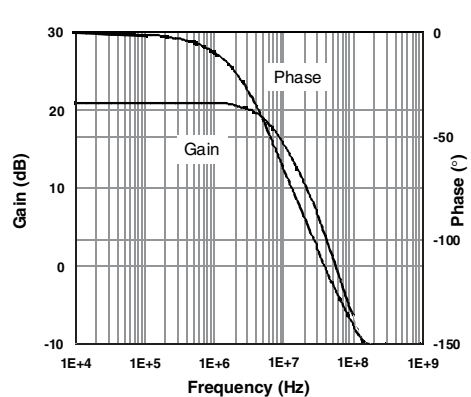


Figure 21. Large signal measurement - positive slew rate ($V_{CC} = \pm 5$ V)

Gain = +2, $Z_L = 150\ \Omega // 5.6\ \text{pF}$, $V_{in} = 400\ \text{mVpk}$

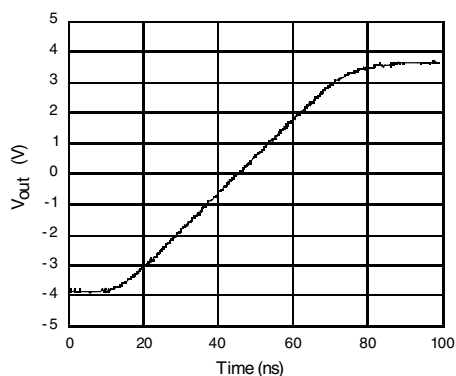


Figure 22. Large signal measurement - negative slew rate ($V_{CC} = \pm 5$ V)

Gain = +2, $Z_L = 150\ \Omega // 5.6\ \text{pF}$, $V_{in} = 400\ \text{mVpk}$

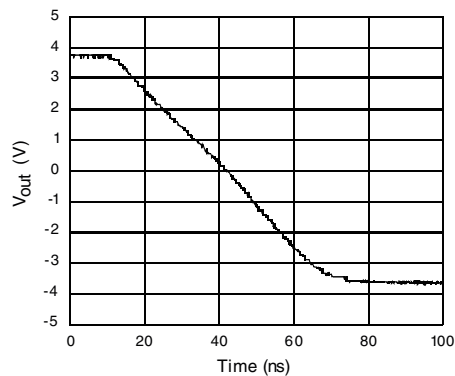


Figure 23. Small signal measurement - rise time
($V_{CC} = \pm 5\text{ V}$)

Gain = +2, $R_L = 150\ \Omega$, $V_{in} = 400\text{ mVpk}$

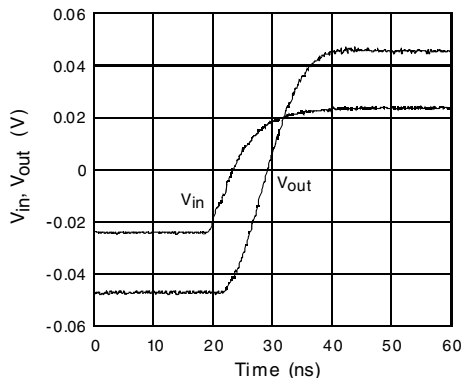


Figure 24. Small signal measurement - fall time
($V_{CC} = \pm 5\text{ V}$)

Gain = +2, $R_L = 150\ \Omega$, $V_{in} = 400\text{ mVpk}$

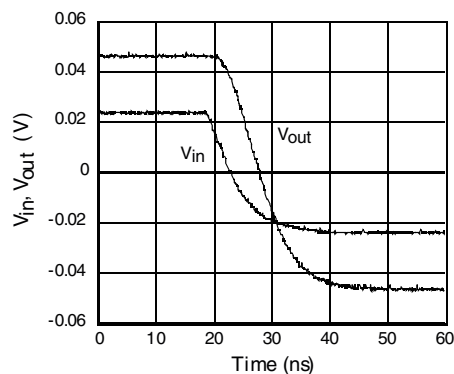
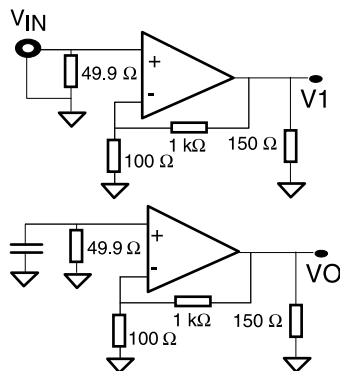


Figure 25. Channel separation (crosstalk) vs. frequency schematic ($V_{CC} = \pm 5\text{ V}$)

Measurement configuration:



AM00458

Figure 26. Channel separation (crosstalk) vs. frequency ($V_{CC} = \pm 5\text{ V}$)

Gain = +11, $Z_L = 150\ \Omega // 27\text{ pF}$

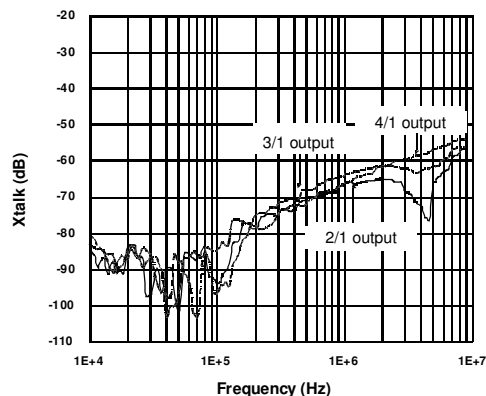


Figure 27. Equivalent input noise voltage
($V_{CC} = \pm 5\text{ V}$)

Gain = +100, no load

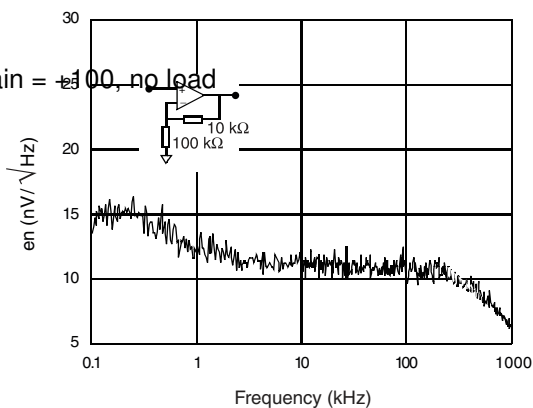
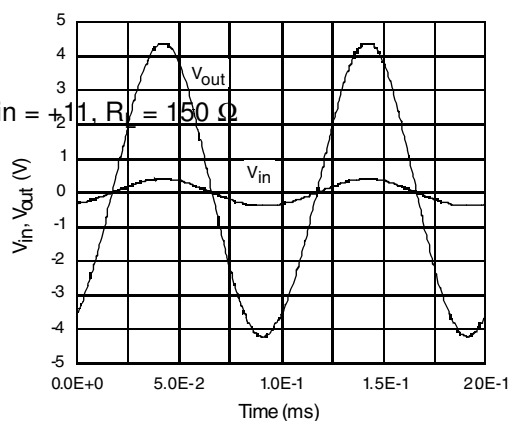
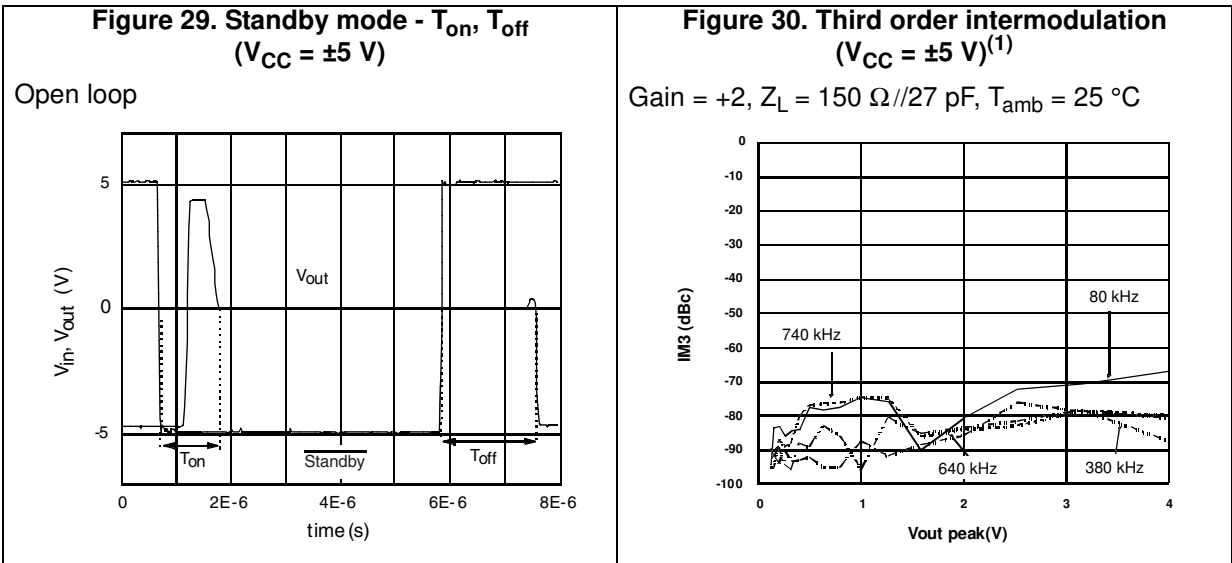


Figure 28. Maximum output swing
($V_{CC} = \pm 5\text{ V}$)

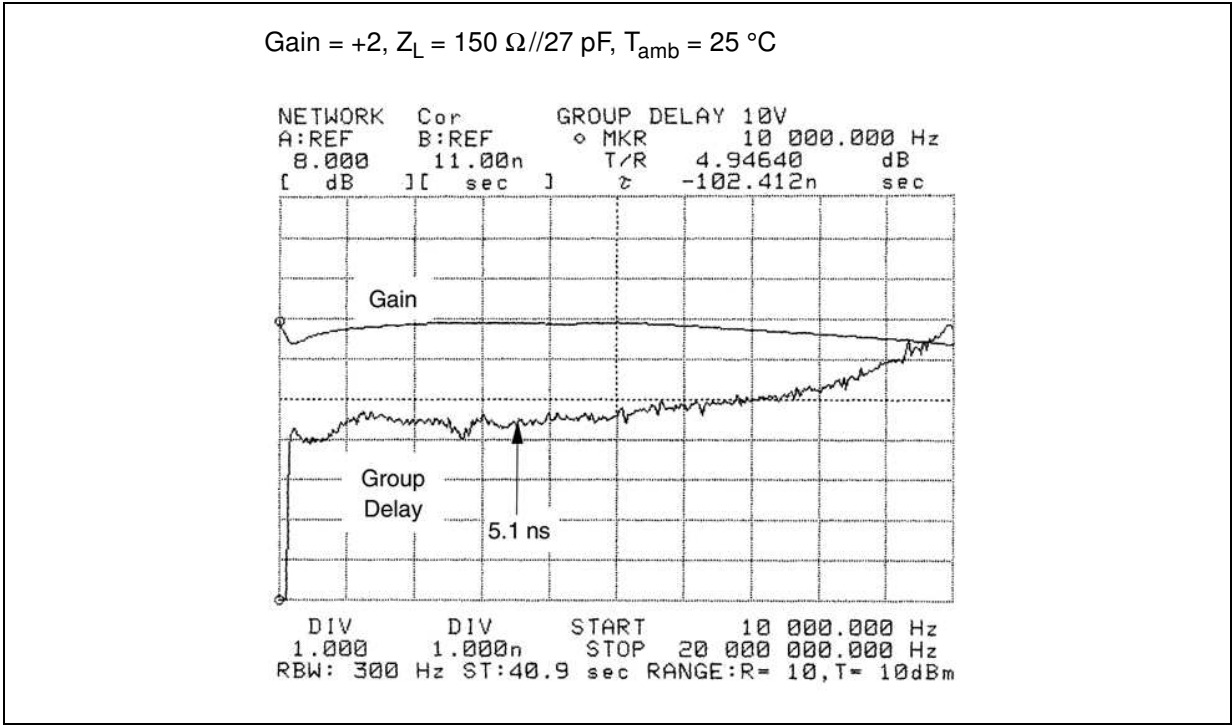
Gain = +11, $R_L = 150\ \Omega$





1. The IFR2026 synthesizer generates a two-tone signal ($F_1 = 180\text{ kHz}$, $F_2 = 280\text{ kHz}$), 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 31. Group delay ($V_{CC} = \pm 5\text{ V}$)



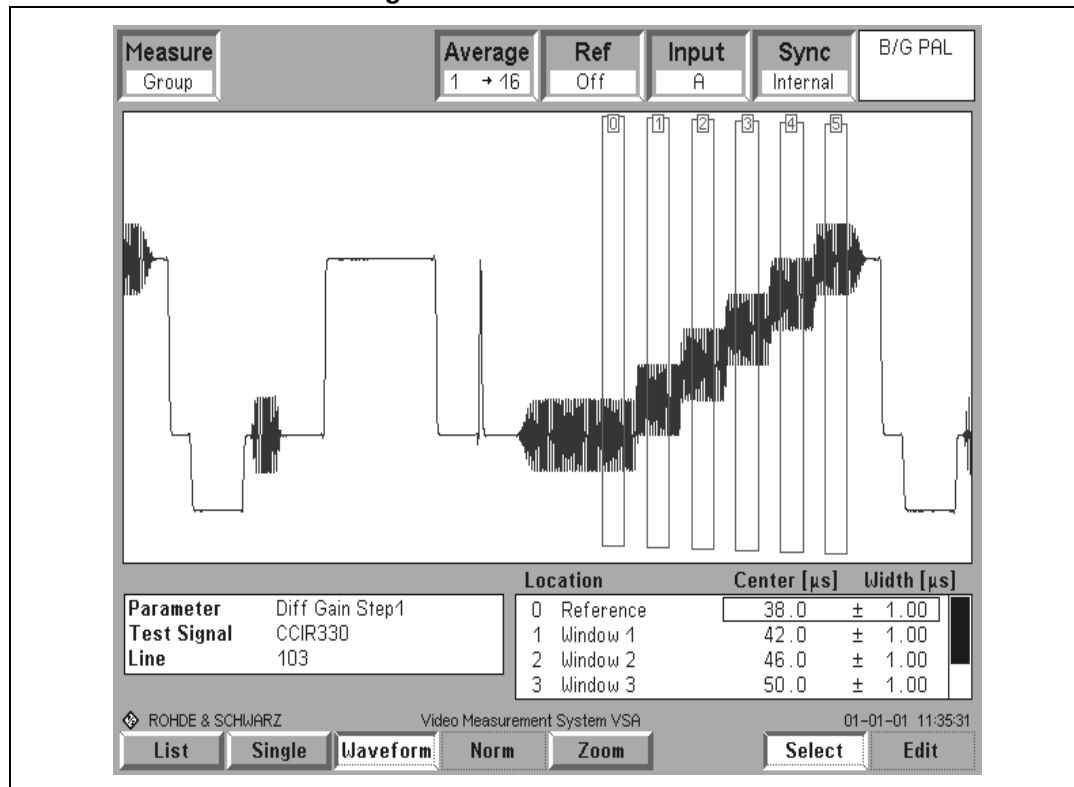
4 Test conditions

4.1 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 μ F 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 is improved. All leads must be wide and must be 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 k Ω).
- Choose the smallest component size possible (SMD).
- On the output, the load capacitance must be negligible to maintain good stability. Place a serial resistance as close as possible to the output pin to minimize the effect of the load capacitance.

Figure 32. CCIR330 video line



4.2 Video capabilities

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

The video line contains of 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 Rohde & Schwarz CCVS. The output measurement is made by the Rohde and Schwarz VSA.

Figure 33. Measurement on Rohde and Schwarz VSA

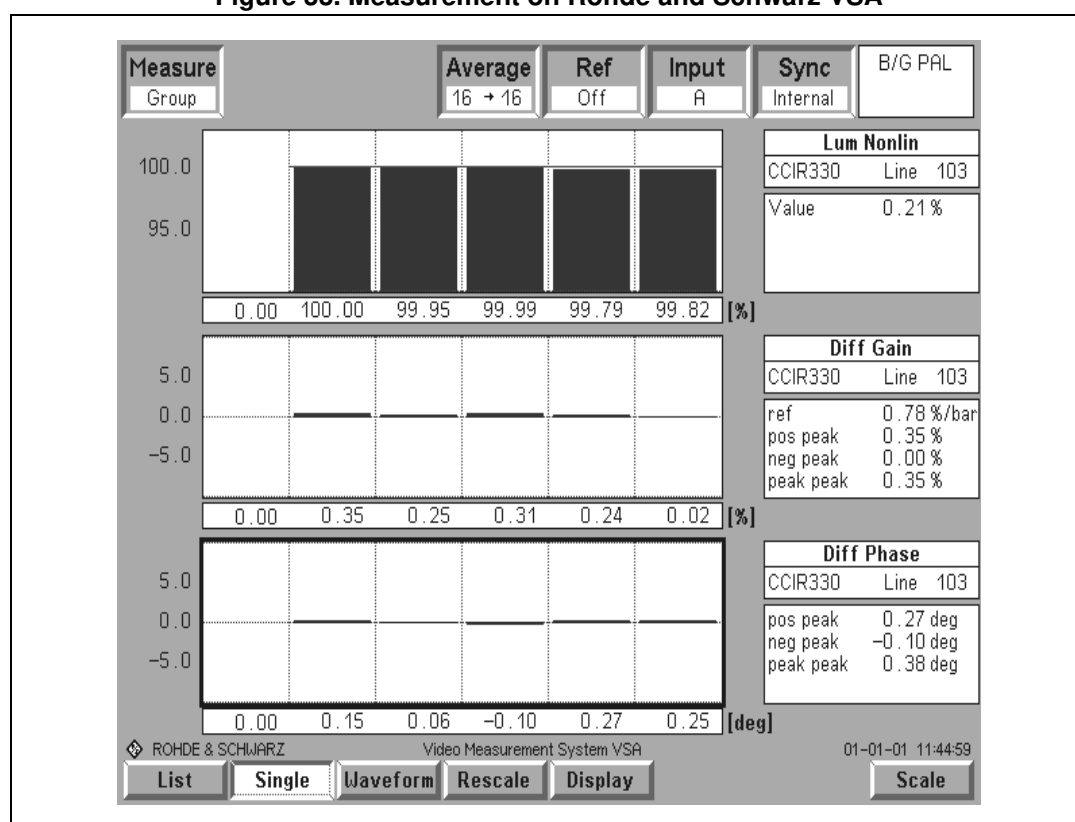


Table 6. Video results

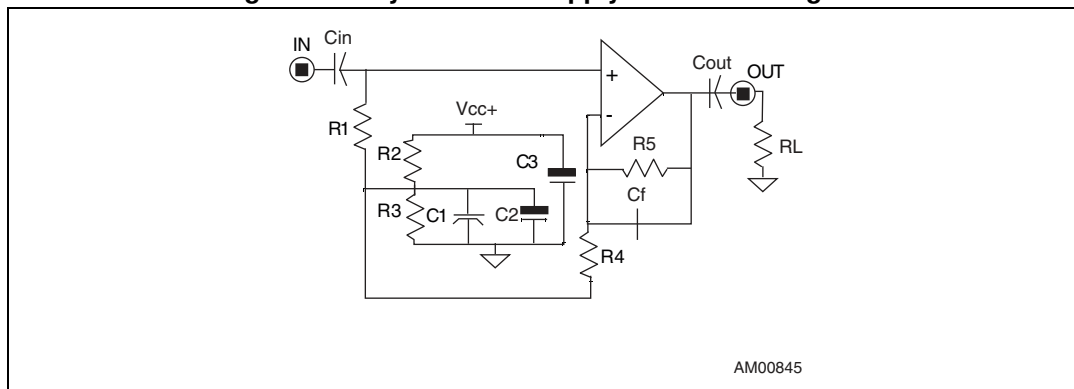
Parameter	Value ($V_{CC} = \pm 2.5 \text{ V}$)	Value ($V_{CC} = \pm 5 \text{ V}$)	Unit
Lum NL	0.1	0.3	%
Lum NL Step1	100	100	
Lum NL Step2	100	99.9	
Lum NL Step3	99.9	99.8	
Lum NL Step4	99.9	99.9	
Lum NL Step5	99.9	99.7	
Diff Gain pos	0	0	
Diff Gain neg	-0.7	-0.6	
Diff Gain pp	0.7	0.6	
Diff Gain Step1	-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	
Diff Phase pp	0.2	0.5	
Diff Phase Step1	-0.2	-0.4	
Diff Phase Step2	-0.1	-0.4	
Diff Phase Step3	-0.1	-0.3	
Diff Phase Step4	0	0.1	
Diff Phase Step5	-0.2	-0.1	

5 Precautions on asymmetrical supply operation

The TSH8x device 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 $15\ \mu\text{A}$, use a high resistance $R1$ (approximately $10\ \text{k}\Omega$) to avoid introducing an offset mismatch at the amplifier's inputs.

Figure 34. Asymmetrical supply schematic diagram



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

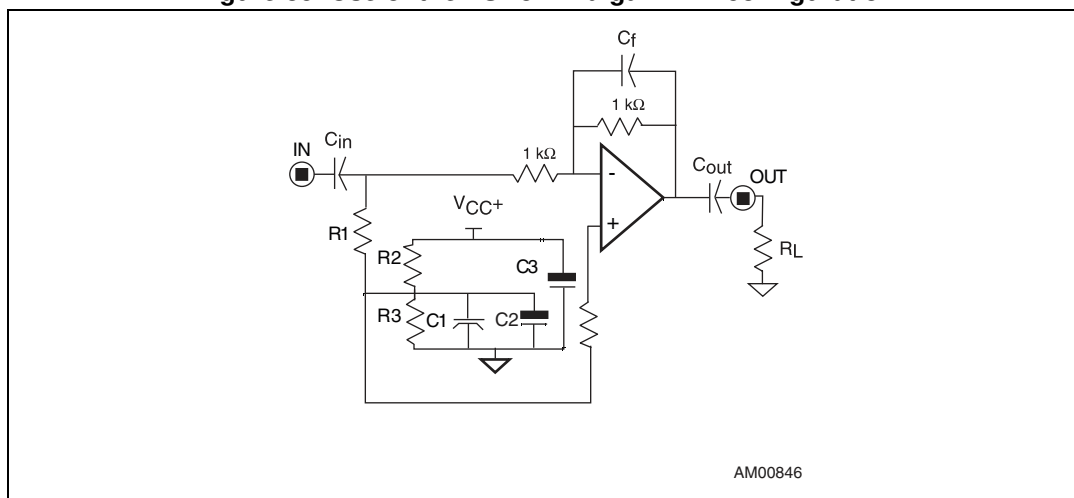
$$C1 = 100\ \text{nF} \text{ and } C2 = C3 = 100\ \mu\text{F}$$

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

$$R2 = R3 = 4.7\ \text{k}\Omega$$

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 $R1 = 10\ \text{k}\Omega$, $R_{out} = R_L = 150\ \Omega$, and $C_{in} = 2\ \mu\text{F}$, $C_{out} = 220\ \mu\text{F}$ the cutoff frequency obtained is lower than $10\ \text{Hz}$.

Figure 35. Use of the TSH8x in a gain = -1 configuration



6 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.

6.1 SOT23-5 package information

Figure 36. SOT23-5 package outline

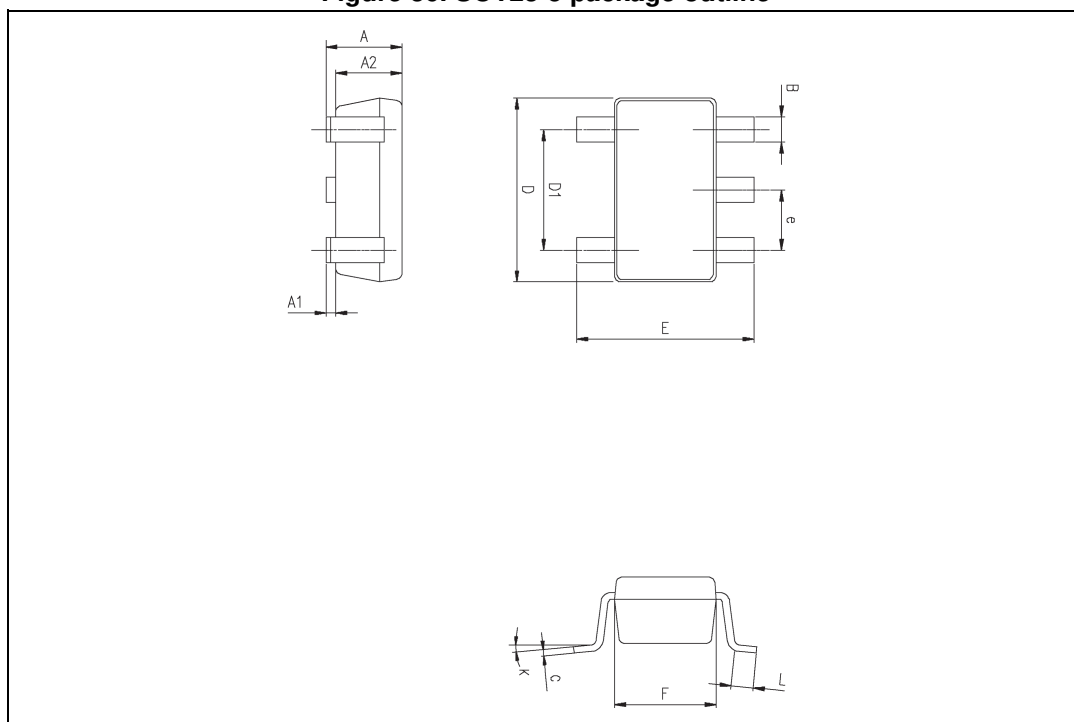


Table 7. SOT23-5 package mechanical data

Symbol	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°		10°			

6.2 SO8 package information

Figure 37. SO8 package outline

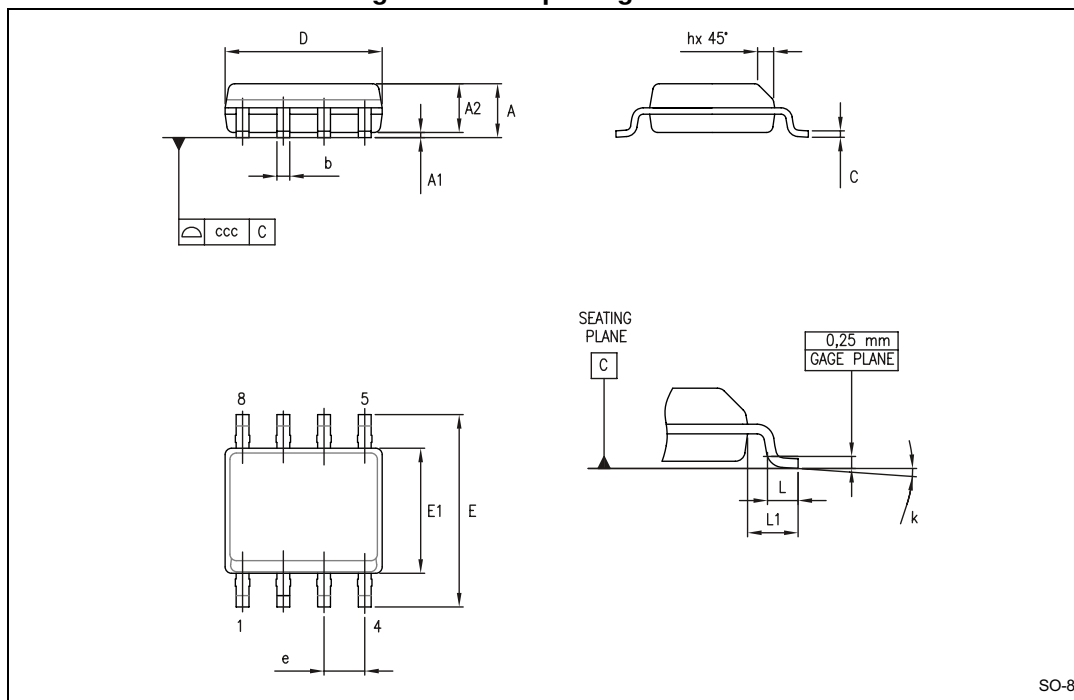


Table 8. SO8 package mechanical data

Symbol	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

7 Ordering information

Table 9. Order codes

Type	Temperature range	Package	Packaging	Marking
TSH80IYLT ⁽¹⁾	-40 to +85 °C	SOT23-5 (automotive grade level)	Tape and reel	K310
TSH82IDT		SO8	Tape and reel	TSH82I
TSH82IYDT ⁽¹⁾		SO8 (automotive grade level)	Tape and reel	TSH82IY

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

8 Revision history

Table 10. Document 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 28.
12-Apr-2007	3	Corrected temperature range for TSH80IYD/IYDT and TSH82IYD/IYDT order codes in Table 12: Order codes on page 28.
24-Oct-2007	4	TSH81IYPT PPAP references inserted in the datasheet, see Table 12: Order codes on page 28.
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.
24-Jul-2012	6	Added TSSOP14 package to figure on page 1, updated titles of Figure 2 to Figure 31, updated Section 6: Package information, removed TSH80ID-IDT, TSH80IYD, TSH81ID-IDT and TSH82ID order codes from Table 12: Order codes. Modified note 1 below Table 12: Order codes, minor corrections throughout document.
13-Sep-2012	7	Updated TSH80IYLT order code (status qualified) in Table 12. Removed TSH80IYD, TSH80IYDT, TSH80ID/DT, TSH81ID/DT, and TSH82ID order code from Table 12. Replaced TSH82DT by TSH82IDT order code in Table 12. Minor corrections throughout document
30-Apr-2013	8	Updated Features: added automotive qualification Figure 1: Pin connections for each package (top view): updated pin connections of SO8/TSSOP8 packages for TSH81 device. Replaced Figure 36: SOT23-5 package outline Table 12: Order codes: added automotive order code TSH82IYDT
03-Jul-2014	9	Updated CDM to 1.5 kV in Table 1: Absolute maximum ratings Table 12: Order codes: added automotive order code TSH80IYDT and removed shipping option in tubes from TSH82IDT
18-Nov-2024	10	Removed obsolete part numbers. Updated Table 9 .

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. For additional information about ST trademarks, please refer to www.st.com/trademarks. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2024 STMicroelectronics – All rights reserved