



TSH60,61,62,63,64

Wide-Band, Low-Power Operational Amplifiers with Standby

- 5V, $\pm 5V$ specifications
- Gain-bandwidth product: 60MHz
- Slew-rate: 80V/ μs
- Output current: up to 45mA
- Input/output rail-to-rail
- Specified for 150 Ω load
- Low distortion, THD: 0.1%
- SO packages

Description

The TSH6x series offers single, dual, triple and quad operational amplifiers featuring high video performances.

The TSH6x op-amps can be used in consumer video applications, such as set-top boxes, DVD players and recorders, or TVs, as either video buffers or video line drivers. Their performances guarantee excellent video quality, enhancing the performance of your video solution.

Running at single supply voltage from 5V to 12V, amplifiers feature large output voltage swing and high output current capability to drive standard 150 Ω loads.

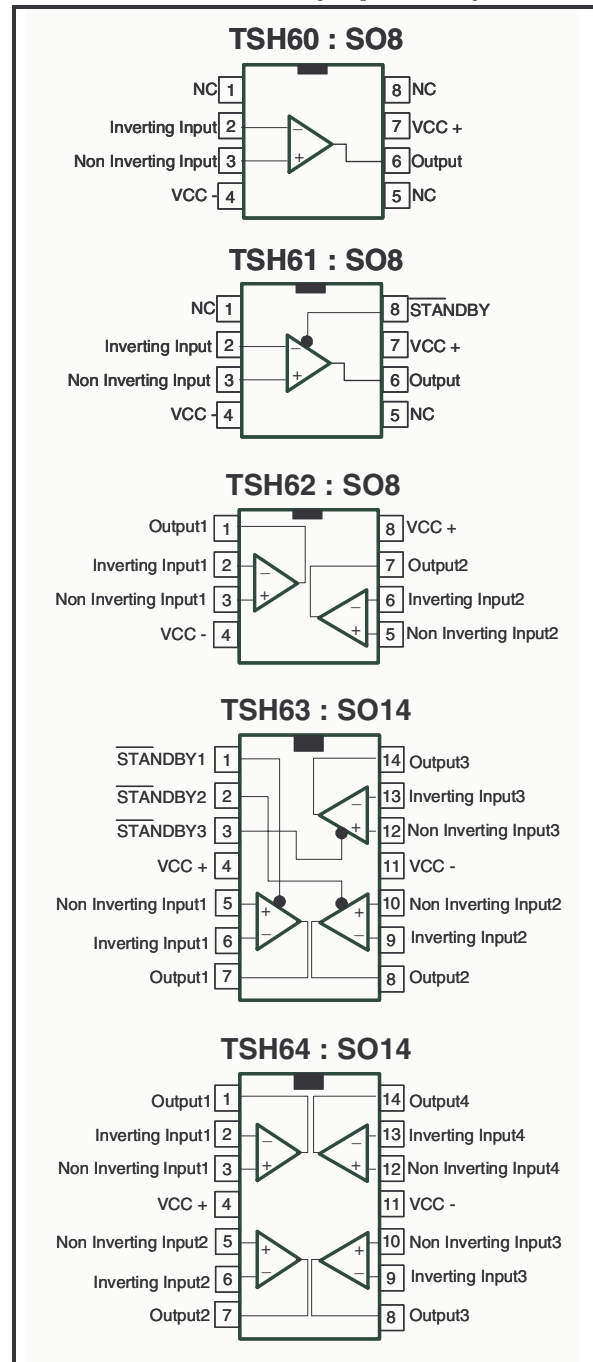
The TSH61 and TSH63 also feature standby inputs, allowing the op amps to be put into a standby mode with low power consumption and high output impedance.

For easy integration into video applications, the TSH6x series is proposed in standard SO8 and SO14 packages.

Applications

- Standard definition video buffers
- Set-top boxes
- DVD players and recorders
- Analog and digital TVs

Pin connections (top view)



1 Order Codes

Type	Temperature Range	Packages	Packing	Marking
TSH60CD/CDT	0°C to 70°C	SO8	Tube or Tape & Reel	TSH60C
TSH61CD/CDT				TSH61C
TSH62CD/CDT				TSH62C
TSH63CD/CDT		TSH63C		
TSH64CD/CDT		TSH64C		
		SO14		

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
V_i	Input Voltage ⁽³⁾	± 6	V
T_{oper}	Operating Free Air Temperature Range	0 to +70	°C
T_{stg}	Storage Temperature	-65 to +150	°C
T_j	Maximum Junction Temperature	150	°C
R_{thjc}	Thermal Resistance Junction to Case ⁽⁴⁾		°C/W
	SO8 SO14	28 22	
R_{thja}	Thermal Resistance Junction to Ambient Area		°C/W
	SO8 SO14	157 125	
ESD	HumanBodyModel	2	kV

1. All voltages values, except differential voltage are with respect to network ground terminal
2. Differential voltages are 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

3 Standby Mode

Table 3. V_{CC}^+ (positive supply voltage), V_{CC}^- (negative supply voltage, or ground), $T_{amb} = 25^{\circ}\text{C}$ (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 (TSH61) to V_{CC}^- pin 1,2 or 3 (TSH63) to V_{CC}^-		20	55	μA
Z_{out}	Output Impedance (R_{out}/C_{out})	R_{out} C_{out}		10 17		$\text{M}\Omega$ pF
T_{on}	Time from Standby Mode to Active Mode			2		μs
T_{off}	Time from Active Mode to Standby Mode	Down to $I_{CC\ STBY} = 10\mu\text{A}$		10		μs

TSH61 Standby Control pin 8 ($\overline{\text{STBY}}$)		Operator Status	
V_{low}		Standby	
V_{high}		Active	

TSH63 Standby Control			Operator Status		
$\overline{\text{pin 1}}$ ($\overline{\text{STBY OP1}}$)	$\overline{\text{pin 2}}$ ($\overline{\text{STBY OP2}}$)	$\overline{\text{pin 3}}$ ($\overline{\text{STBY OP3}}$)	OP1	OP1	OP3
V_{low}	x	x	Standby	x	x
V_{high}	x	x	Active	x	x
x	V_{low}	x	x	Standby	x
x	V_{high}		x	Active	x
x	x	V_{low}	x	x	Standby
x	x	V_{high}	x	x	Active

4 Electrical Characteristics

Table 4. $V_{CC}^+ = 5V$, $V_{CC}^- = GND$, $V_{ic} = 2.5V$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
$ V_{io} $	Input Offset Voltage	$T_{amb} = 25^\circ C$ $T_{min.} < T_{amb} < T_{max.}$		1.5	10 12	mV
I_{ib}	Input Bias Current			6		μA
C_{in}	Input Capacitance			0.3		pF
I_{CC}	Supply Current per Operator			8.2		mA
CMRR	Common Mode Rejection Ratio ($\delta V_{ic}/\delta V_{io}$)	$+0.1 < V_{ic} < 3.9V$ & $V_{out} = 2.5V$		85		dB
PSRR	Power Supply Rejection Ratio ($\delta V_{CC}/\delta V_{out}$)	Positive & Negative Rail		70		dB
A_{vd}	Large Signal Voltage Gain	$R_L = 150\Omega$ to 1.5V $V_{out} = 1V$ to 4V		78		dB
I_o	Output Short Circuit Current Source	$V_{id} = +1$, V_{out} to 1.5V $V_{id} = -1$, V_{out} to 1.5V ISourceI Sink		45 45		mA
V_{oh}	High Level Output Voltage	$R_L = 150\Omega$ to GND $R_L = 150\Omega$ to 2.5V		4.36 4.66		V
V_{ol}	Low Level Output Voltage	$R_L = 150\Omega$ to GND $R_L = 150\Omega$ to 2.5V		48 220	100 400	mV
Bw	Bandwidth @ -3dB	$A_{VCL} = +1$ $R_L = 150\Omega$ to 2.5V		60		MHz
SR	Slew Rate	$A_{VCL} = +2$ $R_L = 150\Omega$ to 2.5V		86		V/ μs
ϕ_m	Phase Margin	$R_L = 150\Omega$ to 2.5V		40		$^\circ$
THD	Total Harmonic Distortion	$A_{VCL} = +2$, $F = 4MHz$ $R_L = 150\Omega$ to 2.5V $V_{out} = 1V_{pp}$ $V_{out} = 2V_{pp}$		-57 -51		dB
ΔG	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		$^\circ$
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. $V_{CC}^+ = 5V$, $V_{CC}^- = -5V$, $V_{IC} = GND$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$ V_{io} $	Input Offset Voltage	$T_{min.} < T_{amb} < T_{max.}$		1.2	10 12	mV
I_{ib}	Input Bias Current			6		μA
C_{in}	Input Capacitance			0.7		pF
I_{CC}	Supply Current per Operator			9.8		mA
CMRR	Common Mode Rejection Ratio ($\delta V_{ic}/\delta V_{io}$)	$-4.9 < V_{ic} < 3.9V$ & $V_{out} = GND$		94		dB
PSRR	Power Supply Rejection Ratio ($\delta V_{CC}/\delta V_{out}$)	Positive & Negative Rail		70		dB
A_{vd}	Large Signal Voltage Gain	$R_L = 150\Omega$ to GND $V_{out} = -4$ to $+4$		80		dB
I_o	Output Short Circuit Current Source	$V_{id} = +1$, V_{out} to 1.5V $V_{id} = -1$, V_{out} to 1.5V Source Sink		45 45		mA
V_{oh}	High Level Output Voltage	$R_L = 150\Omega$ to GND		4.36		V
V_{ol}	Low Level Output Voltage	$R_L = 150\Omega$ to GND		-4.63	-4.4	mV
Bw	Bandwidth @-3dB	$A_{VCL} = +1$ $R_L = 150\Omega$ to GND		74		MHz
SR	Slew Rate	$A_{VCL} = +2$ $R_L = 150\Omega$ to GND		98		V/ μs
ϕ_m	Phase Margin	$R_L = 150\Omega$ to GND		40		$^\circ$
THD	Total Harmonic Distortion	$A_{VCL} = +2$, $F = 4MHz$ $R_L = 150\Omega$ to GND $V_{out} = 1V_{pp}$ $V_{out} = 2V_{pp}$		-57 -51		dB
ΔG	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		$^\circ$
Gf	Gain Flatness	$F = DC$ to 6MHz, $A_{VCL} = +2$		0.2		dB
Vo1/Vo2	Channel Separation	$F = 1MHz$ to 10MHz		65		dB

Figure 1. Closed loop gain and phase vs. frequency (Gain = +2, $V_{CC} = \pm 2.5V$, $R_L = 150\Omega$, $T_{amb} = 25^\circ C$)

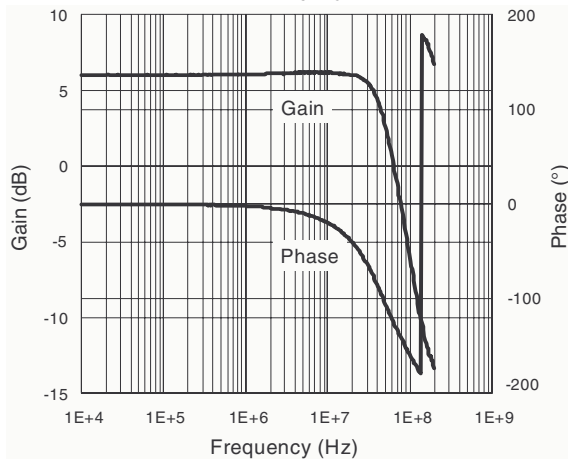


Figure 2. Standby mode - T_{on} , T_{off} ($V_{CC} = \pm 2.5V$, open loop)

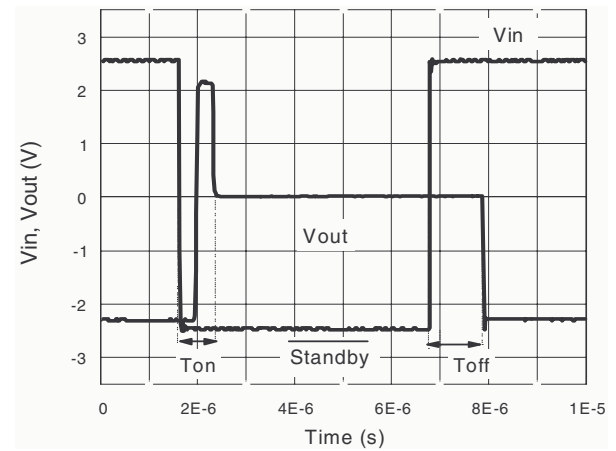


Figure 3. Large signal measurement - positive slew rate (Gain = 2, $V_{CC} = \pm 2.5V$, $R_L = 150\Omega/5.6pF$, $V_{in} = 1Vpk$)

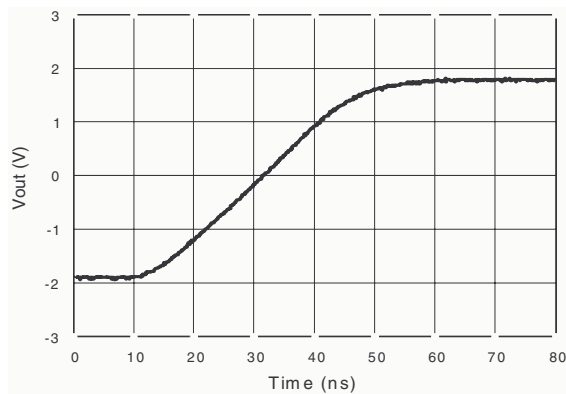


Figure 4. Large signal measurement - negative slew rate (Gain = 2, $V_{CC} = \pm 2.5V$, $R_L = 150\Omega/5.6pF$, $V_{in} = 1Vpk$)

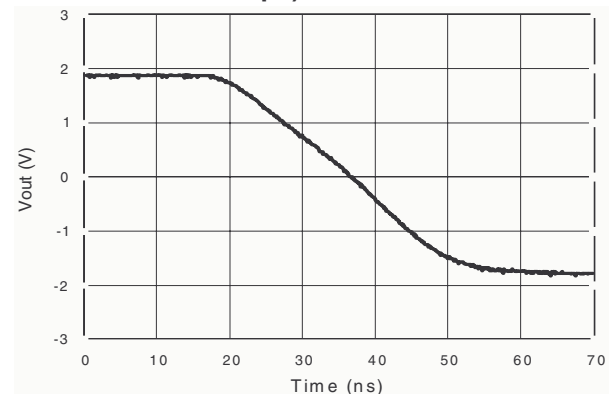


Figure 5. Small signal measurement - rise time (Gain = 2, $V_{CC} = \pm 2.5V$, $Z_L = 150\Omega$, $V_{in} = 25mVpk$)

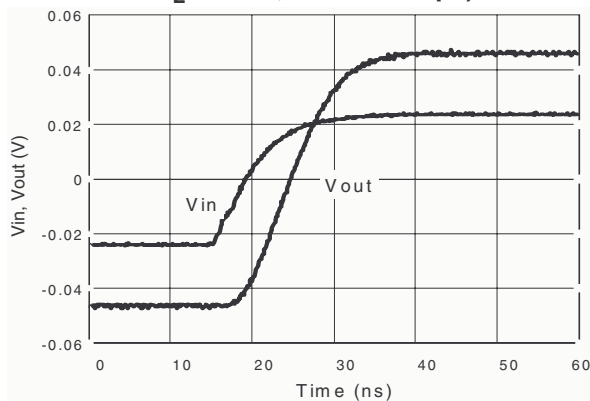


Figure 6. Small signal measurement - fall time (Gain = 2, $V_{CC} = \pm 2.5V$, $Z_L = 150\Omega$, $V_{in} = 25mVpk$)

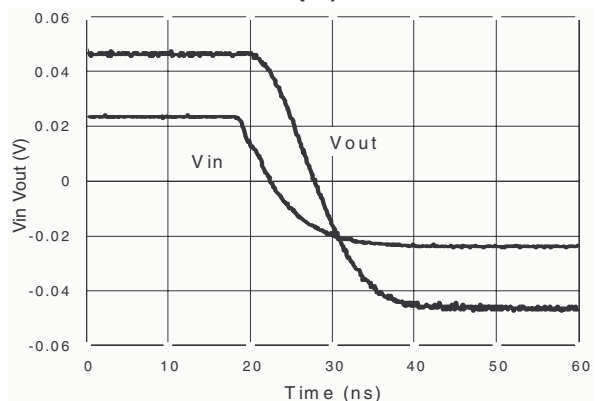


Figure 7. Equivalent noise voltage
(Gain = 100, $V_{CC} = \pm 2.5V$, no load)

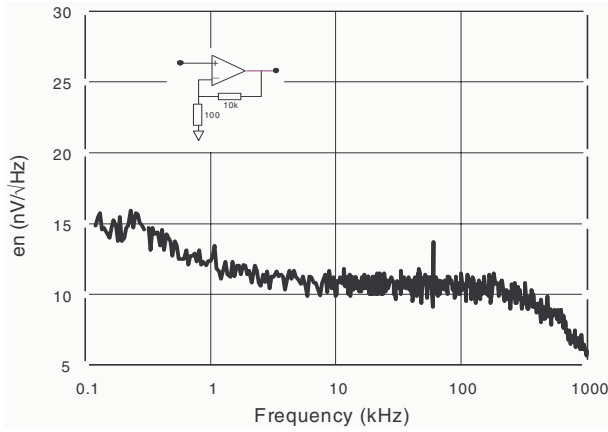
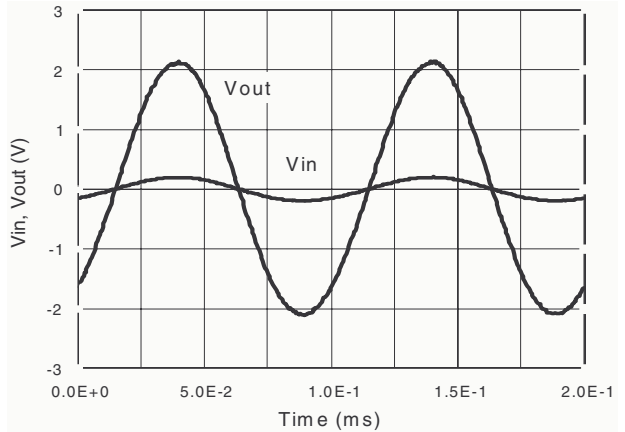


Figure 8. Maximum output swing
(Gain = 11, $V_{CC} = \pm 2.5V$, $R_L = 150\Omega$)



5 Video Applications

TSH6x operational amplifiers can be used to buffer standard definition video signals on 75-ohm video lines. An example of a video channel is shown below. A typical third-order filter and its response are also shown.

Figure 9. Implementation of a video driver on a video DAC output

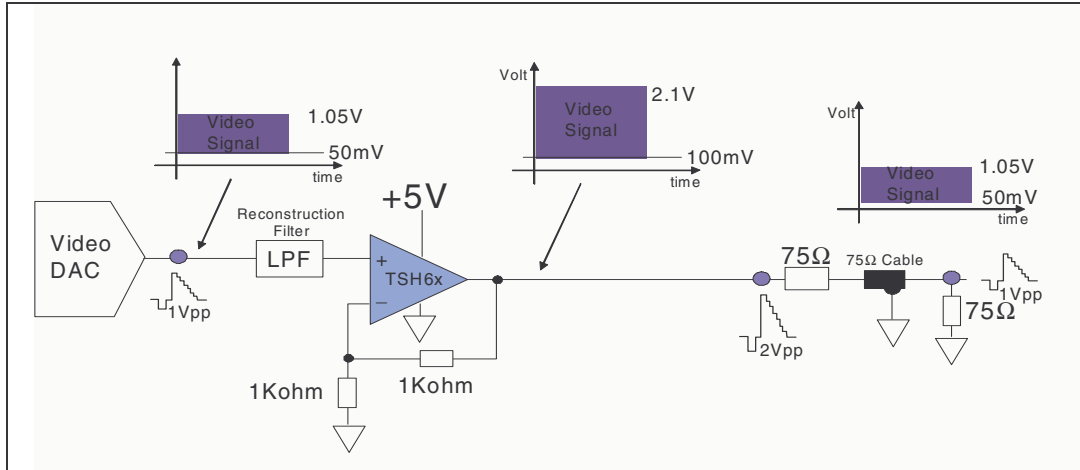
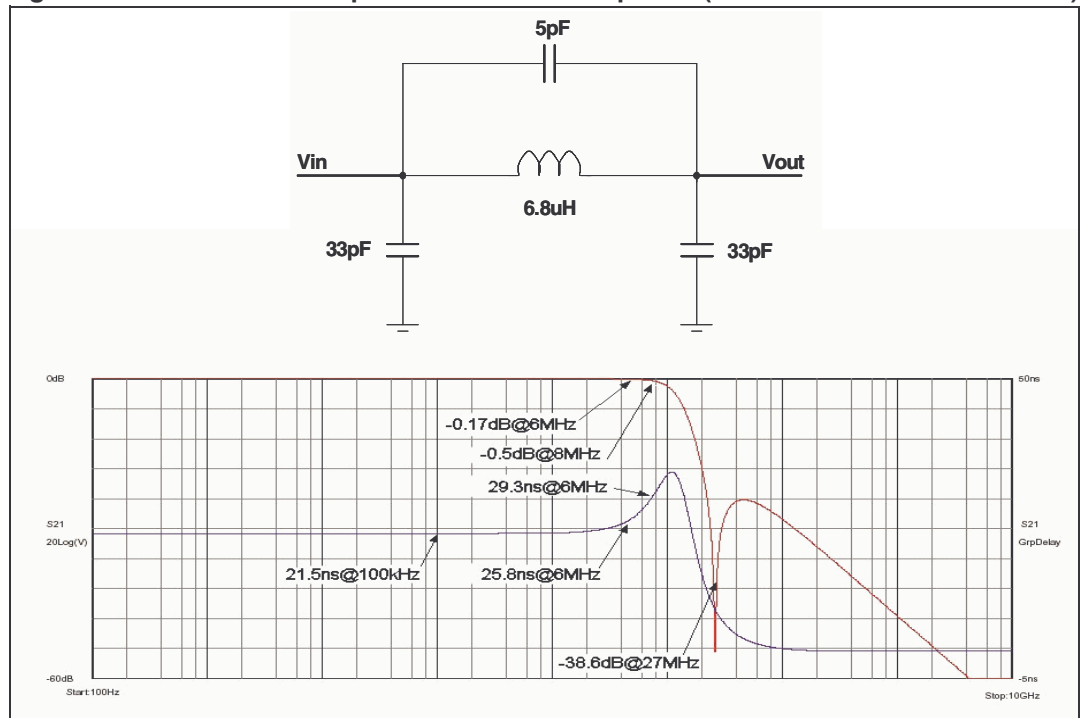


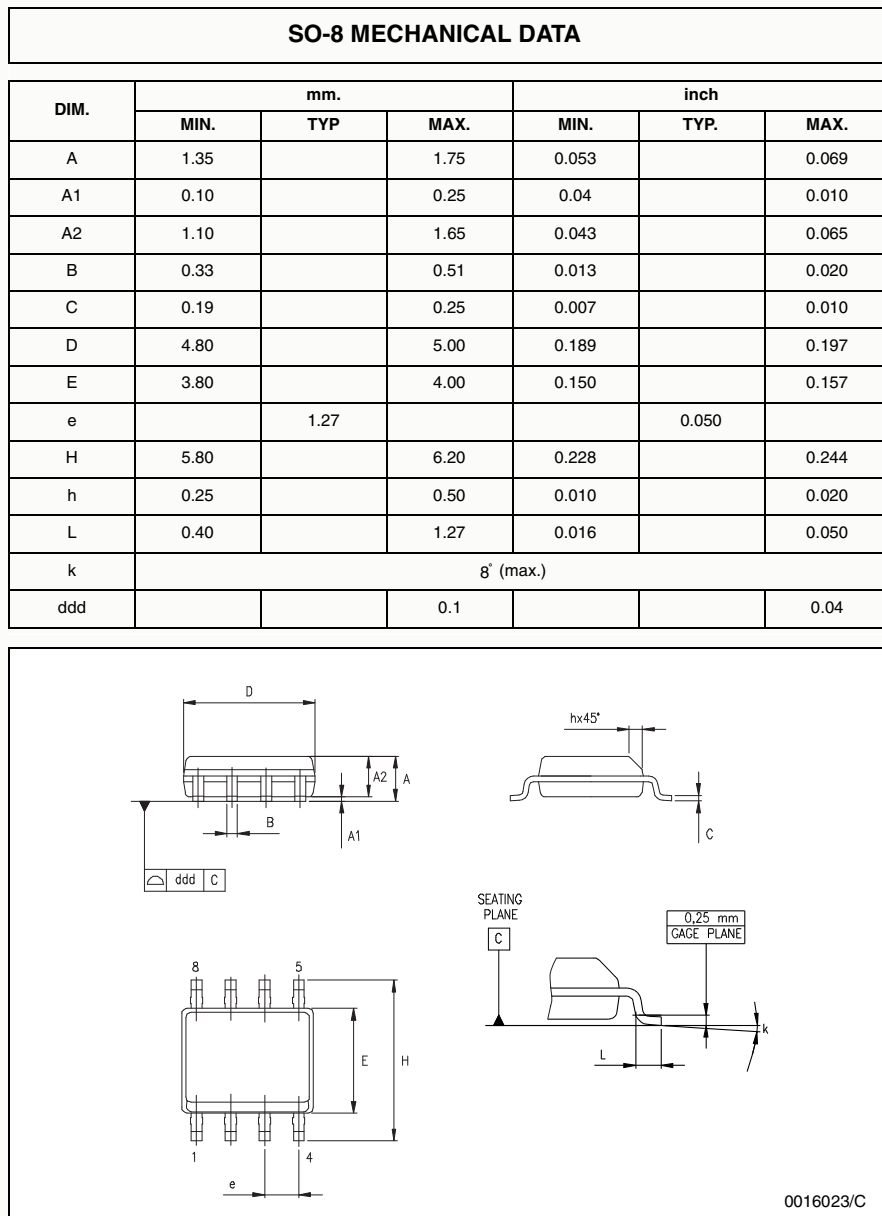
Figure 10. Third order low-pass filter and its response (for standard definition video)



6 Package Mechanical Data

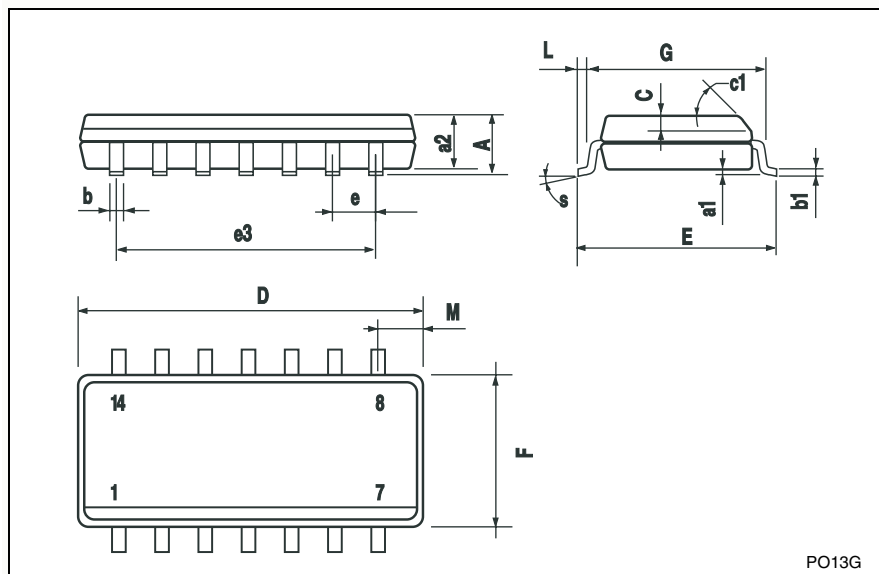
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6.1 SO-8 package



6.2 SO-14 package

SO-14 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



7 Revision History

Table 6. Document revision history

Date	Revision	Changes
March 2006	1	First Release.

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