TSH70,71,72,73,74,75

WIDE BAND, LOW POWER OPERATIONAL AMPLIFIER WITH STANDBY FUNCTION

- **3V, 5V, ±5V** SPECIFICATIONS
- 3dB-BANDWIDTH : 90MHz
- GAIN-BANDWIDTH PRODUCT : **70MHz**
- SLEW-RATE : **100V/µs**
- OUTPUT CURRENT : up to **55mA**
- INPUT SINGLE SUPPLY VOLTAGE
- OUTPUT RAIL TO RAIL
- SPECIFIED FOR 150Ω LOAD
- LOW DISTORTION, THD : **0.1%**
- SOT23-5, TSSOP and SO PACKAGES

DESCRIPTION

TSH7x serie offers Single, Dual, Triple and Quad operational amplifiers featuring high video performances with large bandwidth, low distortion and excellent supply voltage rejection.

Running at single supply voltage from 3V to 12V, amplifiers feature large output voltage swing and high output current capability to drive standard 150Ω loads. Low operating voltage makes TSH7x amplifiers ideal for use on portable equipments.

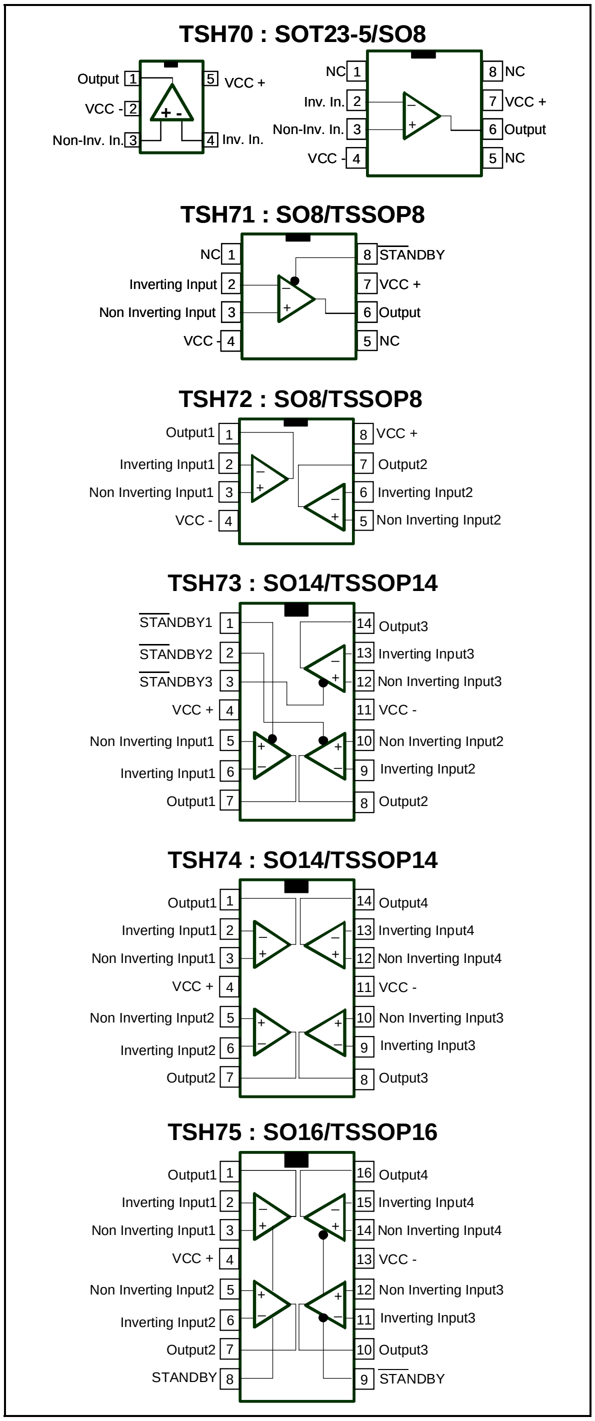
The TSH71, TSH73 and TSH75 also feature some Standby input, each of which allows the op amp to be put into a standby mode with low power consumption and high output impedance.The function allows power saving or signals switching/multiplexing for high speed applications and video applications.

For board space and weight saving, TSH7x series is proposed in SOT23-5, TSSOP and SO packages.

APPLICATION

- Video buffers
- A/D Converters driver
- HiFi applications

PIN CONNECTIONS (top view)



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) SOT23-5 SO8 SO14 SO16 TSSOPO8 TSSOP14 TSSOP16	80 28 22 35 37 32 35	°C/W
R_{thja}	Thermal resistance junction to ambiant area SOT23-5 SO8 SO14 SO16 TSSOPO8 TSSOP14 TSSOP16	250 157 125 110 130 110 110	°C/W
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

OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	3 to 12	V
V_{IC}	Common Mode Input Voltage Range	V_{CC}^{-} to (V_{CC}^{+} -1.1)	V
Standby		(V_{CC}^{-}) to (V_{CC}^{+})	V

ORDER CODES

Type	Temperature	Package	Marking
TSH70CLT	0°C to 70°C	SOT23-5	K301
TSH70CD		SO8	70C
TSH70CDT		SO8 Tape	70C
TSH71CD		SO8	71C
TSH71CDT		SO8 Tape	71C
TSH71CPT		TSSOP8	71C
TSH72CD		SO8	72C
TSH72CDT		SO8 Tape	72C
TSH72CPT		TSSOP8	72C
TSH73CD		SO14	73C
TSH73CDT		SO14 Tape	73C
TSH73CPT		TSSOP14	73C
TSH74CD		SO14	74C
TSH74CDT		SO14 Tape	74C
TSH74CPT		TSSOP14	74C
TSH75CD		SO16	75C
TSH75CDT		SO16 Tape	75C
TSH75CPT		TSSOP16	75C

C = Temperature range

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

P = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)

L = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

ELECTRICAL CHARACTERISTICS

V_{CC}^{+} = 3V, V_{CC}^{-} = GND, V_{ic} = 1.5V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	TestCondition	Min.	Typ.	Max.	Unit
$\lvert V_{io} \rvert$	Input Offset Voltage	T_{amb} = 25°C		1.2	10	mV
		$T_{min.} < T_{amb} < T_{max.}$			12	
ΔV_{io}	Input Offset Voltage Drift vs. Temperature	$T_{min.} < T_{amb} < T_{max.}$		4		µV/°C
I_{io}	Input Offset Current	T_{amb} = 25°C		0.1	3.5	µA
		$T_{min.} < T_{amb} < T_{max.}$			5	
I_{ib}	Input Bias Current	T_{amb} = 25°C		6	15	µA
		$T_{min.} < T_{amb} < T_{max.}$			20	
C_{in}	Input Capacitance			0.2		pF
I_{CC}	Supply Current per Operator	T_{amb} = 25°C		7.2	9.8	mA
		$T_{min.} < T_{amb} < T_{max.}$			11	
CMR	Common Mode Rejection Ratio (δVic/δVio)	+0.1<Vic<+1.9V & Vout=1.5V				dB
		T_{amb} = 25°C	65	90		
		$T_{min.} < T_{amb} < T_{max.}$	64			
SVR	Supply Voltage Rejection Ratio (δVCC/δVio)	T_{amb} = 25°C	66	74		dB
		$T_{min.} < T_{amb} < T_{max.}$	65			
PSR	Power Supply Rejection Ratio (δVCC/δVout)	Positive & Negative Rail		75		dB
A_{vd}	Large Signal Voltage Gain	R_L=150Ω to 1.5V				dB
		V_{out}=1V to 2V				
		T_{amb} = 25°C	70	81		
		$T_{min.} < T_{amb} < T_{max.}$	65			
I_o	Output Short Circuit Current Source	T_{amb}=25°C				mA
		V_{id}=+1, V_{out} to 1.5V				
		V_{id}=-1, V_{out} to 1.5V				
		|Source|	30	43		
		Sink	24	33		
		$T_{min.} < T_{amb} < T_{max.}$				
		V_{id}=+1, V_{out} to 1.5V				
		V_{id}=-1, V_{out} to 1.5V				
		|Source|	22			
		Sink	23			
V_{oh}	High Level Output Voltage	T_{amb}=25°C				V
		R_L = 150Ω to GND	2.45	2.60		
		R_L = 600Ω to GND		2.87		
		R_L = 2kΩ to GND		2.91		
		R_L = 10kΩ to GND		2.93		
		R_L = 150Ω to 1.5V	2.65	2.77		
		R_L = 600Ω to 1.5V		2.90		
		R_L = 2kΩ to 1.5V		2.92		
		R_L = 10kΩ to 1.5V		2.93		
		$T_{min.} < T_{amb} < T_{max.}$				
		R_L = 150Ω to GND	2.4			
		R_L = 150Ω to 1.5V	2.6			

Symbol	Parameter	TestCondition	Min.	Typ.	Max.	Unit
V_{ol}	Low Level Output Voltage	T_{amb}=25°C				mV
		R_L = 150Ω to GND		46	150	
		R_L = 600Ω to GND		52		
		R_L = 2kΩ to GND		53		
		R_L = 10kΩ to GND		54		
		R_L = 150Ω to 1.5V		140	300	
		R_L = 600Ω to 1.5V		90		
		R_L = 2kΩ to 1.5V		68		
		R_L = 10kΩ to 1.5V		57		
		$T_{min.} < T_{amb} < T_{max.}$				
		R_L = 150Ω to GND			200	
		R_L = 150Ω to 1.5V			350	
GBP	Gain Bandwidth Product	F=10MHz				MHz
		A_{VCL}=+11		65		
		A_{VCL}=-10		55		
Bw	Bandwidth @-3dB	A_{VCL}=+1 R_L=150Ω to 1.5V		87		MHz
SR	Slew Rate	A_{VCL}=+2				V/µs
		R_L=150Ω // C_L to 1.5V				
		C_L = 5pF		80		
		C_L = 30pF	45	85		
ϕm	Phase Margin	R_L=150Ω // 30pF to 1.5V		40		°
en	Equivalent Input Noise Voltage	F=100kHz		11		nV/√Hz
THD	Total Harmonic Distortion	A_{VCL}=+2, F=4MHz				dB
		R_L=150Ω // 30pF to 1.5V				
		V_{out}=1Vpp		-61		
		V_{out}=2Vpp		-54		
IM2	Second order intermodulation product	A_{VCL}=+2, V_{out}=2Vpp R_L=150Ω to 1.5V Fin1=180kHz, Fin2=280KHz spurious measurement @100kHz		-76		dBc
IM3	Third order inter modulation product	A_{VCL}=+2, V_{out}=2Vpp R_L=150Ω to 1.5V Fin1=180kHz, Fin2=280KHz spurious measurement @400kHz		-68		dBc
ΔG	Differential gain	A_{VCL}=+2, R_L=150Ω to 1.5V F=4.5MHz, V_{out}=2Vpp		0.5		%
Df	Differential phase	A_{VCL}=+2, R_L=150Ω to 1.5V F=4.5MHz, V_{out}=2Vpp		0.5		°
Gf	Gain Flatness	F=DC to 6MHz, A_{VCL}=+2		0.2		dB
Vo1/Vo2	Channel Separation	F=1MHz to 10MHz		65		dB

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	TestCondition	Min.	Typ.	Max.	Unit
$\lvert V_{io} \rvert$	Input Offset Voltage	T_{amb} = 25°C		1.1	10	mV
		$T_{min.} < T_{amb} < T_{max.}$			12	
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		0.1	3.5	µA
		$T_{min.} < T_{amb} < T_{max.}$			5	
I_{ib}	Input Bias Current	T_{amb} = 25°C		6	15	µA
		$T_{min.} < T_{amb} < T_{max.}$			20	
C_{in}	Input Capacitance			0.3		pF
I_{CC}	Supply Current per Operator	T_{amb} = 25°C		8.2	10.5	mA
		$T_{min.} < T_{amb} < T_{max.}$			11.5	
CMR	Common Mode Rejection Ratio (δVic/δVio)	+0.1<Vic<3.9V & Vout=2.5V				dB
		T_{amb} = 25°C	72	97		
		$T_{min.} < T_{amb} < T_{max.}$	71			
SVR	Supply Voltage Rejection Ratio (δVCC/δVio)	T_{amb} = 25°C	68	75		dB
		$T_{min.} < T_{amb} < T_{max.}$	67			
PSR	Power Supply Rejection Ratio (δVCC/δVout)	Positive & Negative Rail		75		dB
A_{vd}	Large Signal Voltage Gain	R_L=150Ω to 1.5V				dB
		V_{out}=1V to 4V				
		T_{amb} = 25°C	75	84		
		$T_{min.} < T_{amb} < T_{max.}$	70			
I_o	Output Short Circuit Current Source	T_{amb}=25°C				mA
		V_{id}=+1, V_{out} to 1.5V				
		V_{id}=-1, V_{out} to 1.5V				
		|Source|	35	55		
		Sink	33	55		
		$T_{min.} < T_{amb} < T_{max.}$				
		V_{id}=+1, V_{out} to 1.5V				
		V_{id}=-1, V_{out} to 1.5V				
		|Source|	34			
		Sink	32			
V_{oh}	High Level Output Voltage	T_{amb}=25°C				V
		R_L = 150Ω to GND	4.2	4.36		
		R_L = 600Ω to GND		4.85		
		R_L = 2kΩ to GND		4.90		
		R_L = 10kΩ to GND		4.93		
		R_L = 150Ω to 2.5V	4.5	4.66		
		R_L = 600Ω to 2.5V		4.90		
		R_L = 2kΩ to 2.5V		4.92		
		R_L = 10kΩ to 2.5V		4.93		
		$T_{min.} < T_{amb} < T_{max.}$				
		R_L = 150Ω to GND	4.1			
		R_L = 150Ω to 2.5V	4.4			

Symbol	Parameter	TestCondition	Min.	Typ.	Max.	Unit
V_{ol}	Low Level Output Voltage	T_{amb}=25°C R_L = 150Ω to GND R_L = 600Ω to GND R_L = 2kΩ to GND R_L = 10kΩ to GND R_L = 150Ω to 2.5V R_L = 600Ω to 2.5V R_L = 2kΩ to 2.5V R_L = 10kΩ to 2.5V $T_{min.} < T_{amb} < T_{max.}$ R_L = 150Ω to GND R_L = 150Ω to 2.5V		 48 54 55 56 220 105 76 61	 150 400 200 450	mV
GBP	Gain Bandwidth Product	F=10MHz A_{VCL}=+11 A_{VCL}=-10		 65 55		MHz
Bw	Bandwidth @-3dB	A_{VCL}=+1 R_L=150Ω to 2.5V		87		MHz
SR	Slew Rate	A_{VCL}=+2 R_L=150Ω // C_L to 2.5V C_L = 5pF C_L = 30pF	 60	 104 105		V/µs
ϕm	Phase Margin	R_L=150Ω // 30pF to 2.5V		40		°
en	Equivalent Input Noise Voltage	F=100kHz		11		nV/√Hz
THD	Total Harmonic Distortion	A_{VCL}=+2, F=4MHz R_L=150Ω // 30pF to 2.5V V_{out}=1Vpp V_{out}=2Vpp		 -61 -54		dB
IM2	Second order intermodulation product	A_{VCL}=+2, V_{out}=2Vpp R_L=150Ω to 2.5V Fin1=180kHz, Fin2=280kHz spurious measurement @100kHz		-76		dBc
IM3	Third order inter modulation product	A_{VCL}=+2, V_{out}=2Vpp R_L=150Ω to 2.5V Fin1=180kHz, Fin2=280KHz spurious measurement @400kHz		-68		dBc
∆G	Differential gain	A_{VCL}=+2, R_L=150Ω to 2.5V F=4.5MHz, V_{out}=2Vpp		0.5		%
Df	Differential phase	A_{VCL}=+2, R_L=150Ω to 2.5V F=4.5MHz, V_{out}=2Vpp		0.5		°
Gf	Gain Flatness	F=DC to 6MHz, A_{VCL}=+2		0.2		dB
Vo1/Vo2	Channel Separation	F=1MHz to 10MHz		65		dB

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$\lvert V_{io} \rvert$	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 (δVic/δVio)	-4.9<Vic<3.9V & Vout=GND T_{amb} = 25°C $T_{min.} < T_{amb} < T_{max.}$	81 80	106		dB
SVR	Supply Voltage Rejection Ratio (δVCC/δVio)	T_{amb} = 25°C $T_{min.} < T_{amb} < T_{max.}$	71 70	77		dB
PSR	Power Supply Rejection Ratio (δVCC/δVout)	Positive & Negative Rail		75		dB
A_{vd}	Large Signal Voltage Gain	R_L=150Ω to GND V_{out}=-4 to +4 T_{amb} = 25°C $T_{min.} < T_{amb} < T_{max.}$	75 70	86		dB
I_o	Output Short Circuit Current Source	T_{amb}=25°C V_{id}=+1, V_{out} to 1.5V V_{id}=-1, V_{out} to 1.5V $\lvert$Source$\rvert$ Sink $T_{min.} < T_{amb} < T_{max.}$ V_{id}=+1, V_{out} to 1.5V V_{id}=-1, V_{out} to 1.5V $\lvert$Source$\rvert$ Sink	35 30 34 29	55 55		mA
V_{oh}	High Level Output Voltage	T_{amb}=25°C R_L = 150Ω to GND R_L = 600Ω to GND R_L = 2kΩ to GND R_L = 10kΩ to GND $T_{min.} < T_{amb} < T_{max.}$ R_L = 150Ω 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 = 150Ω to GND R_L = 600Ω to GND R_L = 2kΩ to GND R_L = 10kΩ to GND $T_{min.} < T_{amb} < T_{max.}$ R_L = 150Ω to GND		-4.63 -4.86 -4.9 -4.93	-4.4 -4.3	mV
GBP	Gain Bandwidth Product	F=10MHz A_{VCL}=+11 A_{VCL}=-10		65 55		MHz
Bw	Bandwidth @-3dB	A_{VCL}=+1 R_L=150Ω // 30pF to GND		100		MHz

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
SR	Slew Rate	A_{VCL}=+2 R_L=150Ω // C_L to GND C_L = 5pF C_L = 30pF	 68	 117 118		V/µs
φm	Phase Margin	R_L=150Ω to gnd		40		°
en	Equivalent Input Noise Voltage	F=100kHz		11		nV/√Hz
THD	Total Harmonic Distortion	A_{VCL}=+2, F=4MHz R_L=150Ω // 30pF to gnd V_{out}=1Vpp V_{out}=2Vpp		 -61 -54		dB
IM2	Second order intermodulation product	A_{VCL}=+2, V_{out}=2Vpp R_L=150Ω to gnd Fin1=180kHz, Fin2=280KHz spurious measurement @100kHz		-76		dBc
IM3	Third order intermodulation product	A_{VCL}=+2, V_{out}=2Vpp R_L=150Ω to gnd Fin1=180kHz, Fin2=280KHz spurious measurement @400kHz		-68		dBc
ΔG	Differential gain	A_{VCL}=+2, R_L=150Ω to gnd F=4.5MHz, V_{out}=2Vpp		0.5		%
Df	Differential phase	A_{VCL}=+2, R_L=150Ω to gnd F=4.5MHz, V_{out}=2Vpp		0.5		°
Gf	Gain Flatness	F=DC to 6MHz, A_{VCL}=+2		0.2		dB
Vo1/Vo2	Channel Separation	F=1MHz to 10MHz		65		dB

STANDBY MODE

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

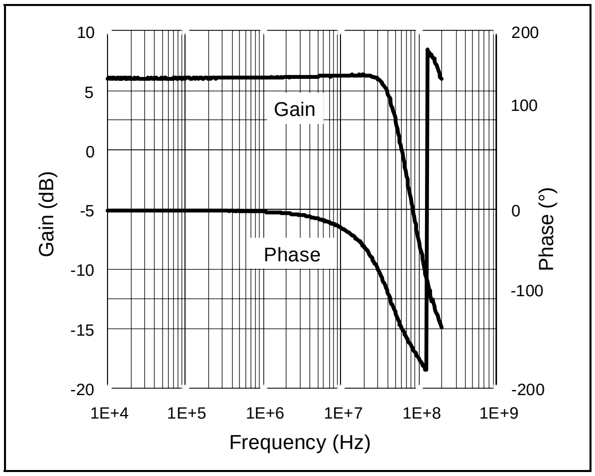
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Vl_{ow}	Standby Low Level		V_{CC}^-		$(V_{CC}^-$ +0.8)	V
V_{high}	Standby High Level		$(V_{CC}^-$ +2)		(V_{CC}^+)	V
$I_{CC\ SBY}$	Current Consumption per Operator when STANDBY is Active	pin 8 (TSH71) to V_{CC}^- pin 1,2 or 3 (TSH73) to V_{CC}^- pin 8 (TSH75) to V_{CC}^+ pin 9 (TSH75) to V_{CC}^-		20	55	µA
Z_{out}	Output Impedance (Rout//Cout)	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 $I_{CC\ SBY}$ = 10µA		10		µs

TSH71 STANDBY CONTROL pin 8 ($\overline{\text{SBY}}$)	**OPERATOR STATUS**
V_{low}	Standby
V_{high}	Active

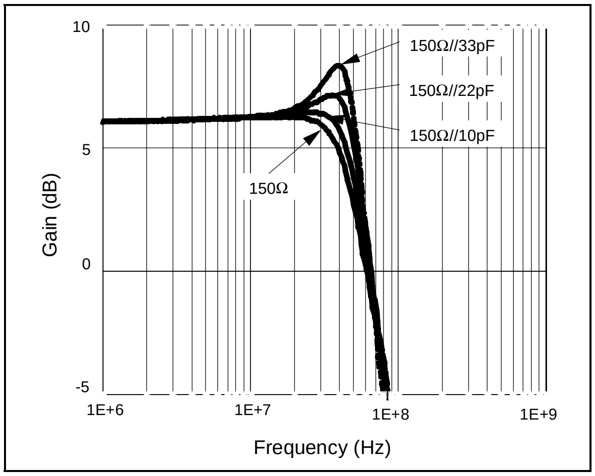
TSH73 STANDBY CONTROL			**OPERATOR STATUS**		
pin 1 ($\overline{\text{SBY}}$ OP1)	**pin 2** ($\overline{\text{SBY}}$ OP2)	**pin 3** ($\overline{\text{SBY}}$ OP3)	OP1	OP1	OP3
V_{low}	x	x	Standby	x	x
V_{high}	x	x	Active	x	x
x	V_{low}	x	x	Standby	x
x	V_{high}		x	Active	x
x	x	V_{low}	x	x	Standby
x	x	V_{high}	x	x	Active

TSH75 STANDBY CONTROL		**OPERATOR STATUS**			
pin 8 (SBY OP2)	**pin 9** ($\overline{\text{SBY}}$ OP3)	OP1	OP2	OP3	OP4
V_{high}	V_{low}	Active	Standby	Standby	Active
V_{high}	V_{high}	Active	Standby	Active	Active
V_{low}	V_{low}	Active	Active	Standby	Active
V_{low}	V_{high}	Active	Active	Active	Active

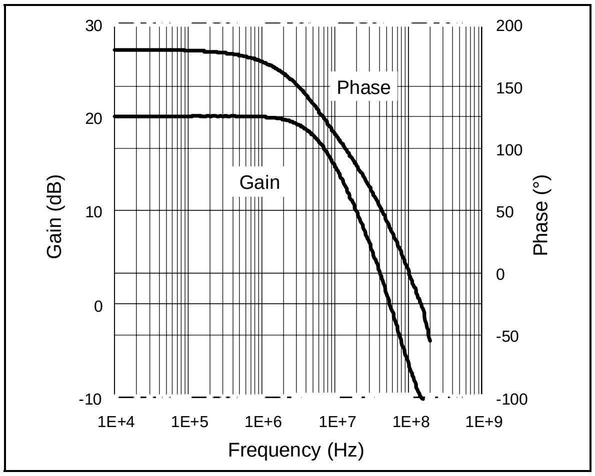
Closed Loop Gain and Phase vs. Frequency
Gain=+2, Vcc= ±1.5V, RL=150Ω, T_{amb} = 25°C



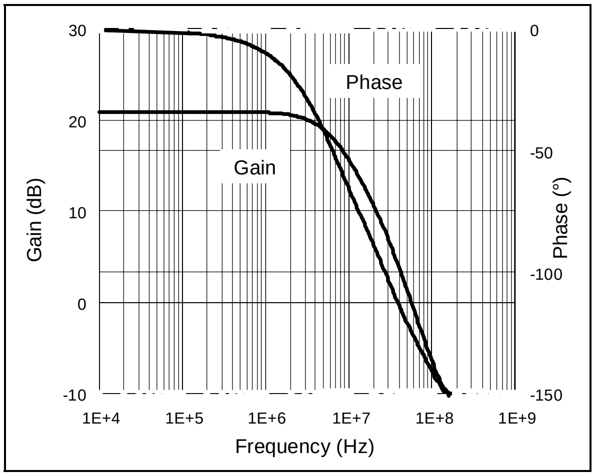
Overshoot function of output capacitance
Gain=+2, Vcc= ±1.5V, T_{amb} = 25°C



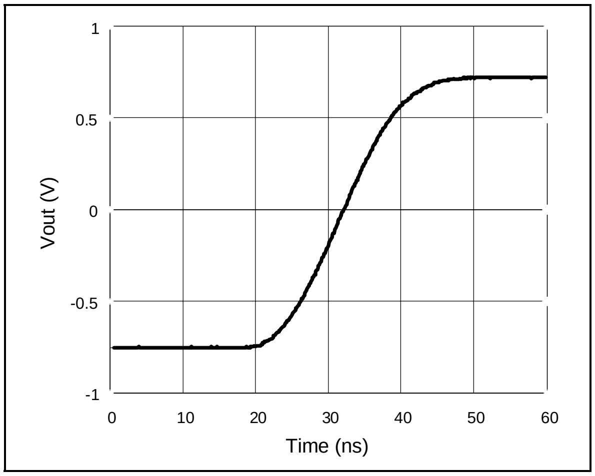
Closed Loop Gain and Phase vs. Frequency
Gain=-10, Vcc= ±1.5V, RL=150Ω, T_{amb} = 25°C



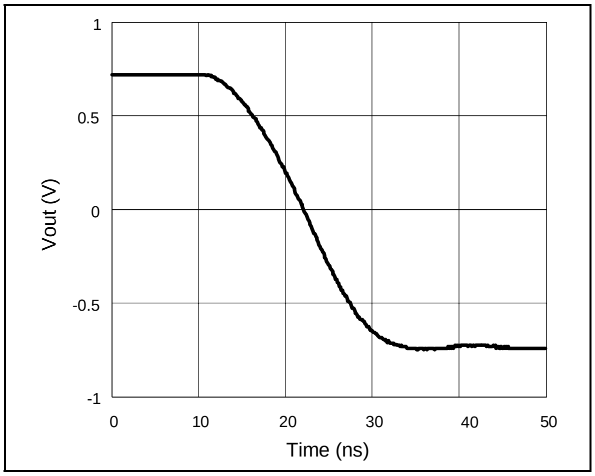
Closed Loop Gain and Phase vs. Frequency
Gain=+11, Vcc= ±1.5V, RL=150Ω, T_{amb} = 25°C



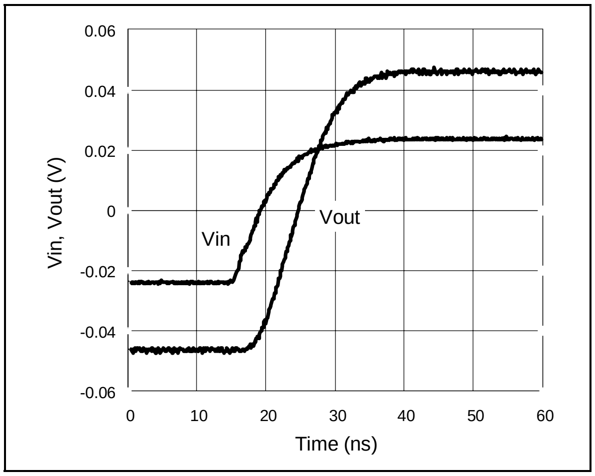
Large Signal Measurement - Positive Slew Rate
Gain=2,Vcc=±1.5V,ZL=150Ω//5.6pF,Vin=400mVpk



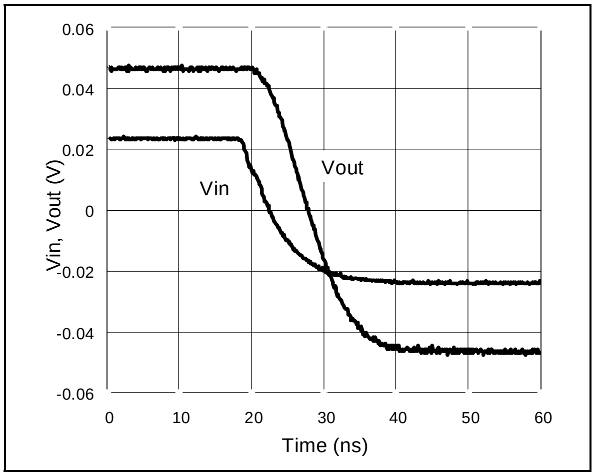
Large Signal Measurement - Negative Slew Rate
Gain=2,Vcc=±1.5V,ZL=150Ω//5.6pF,Vin=400mVpk



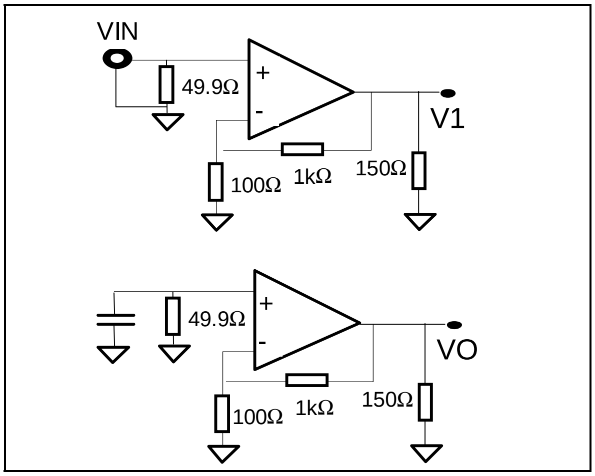
Small Signal Measurement - Rise Time
Gain=2,Vcc=±1.5V, ZL=150Ω,Vin=400mVpk



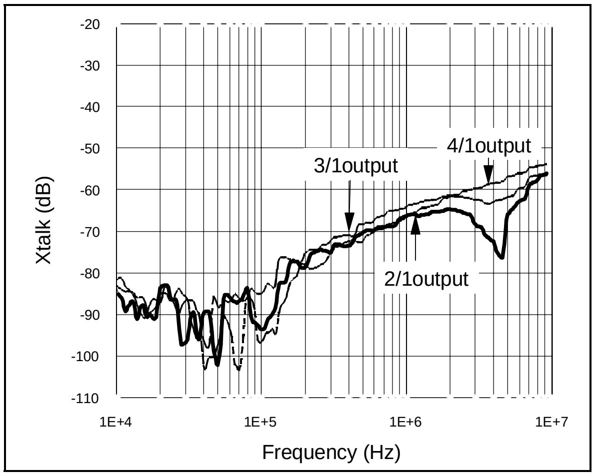
Small Signal Measurement - Fall Time
Gain=2,Vcc=±1.5V, ZL=150Ω,Vin=400mVpk



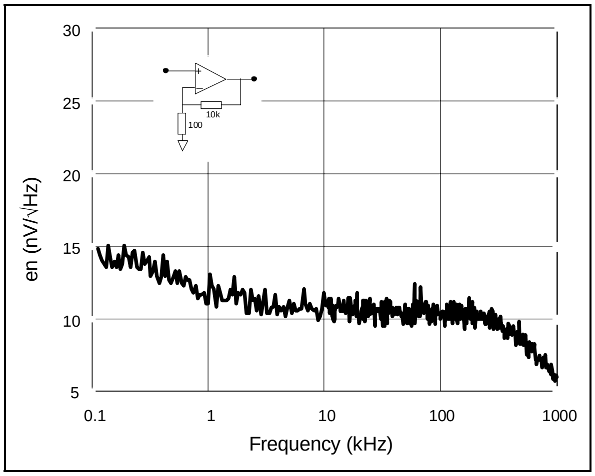
Channel separation (Xtalk) vs frequency
Measurement configuration : **Xtalk=20log(V0/V1)**



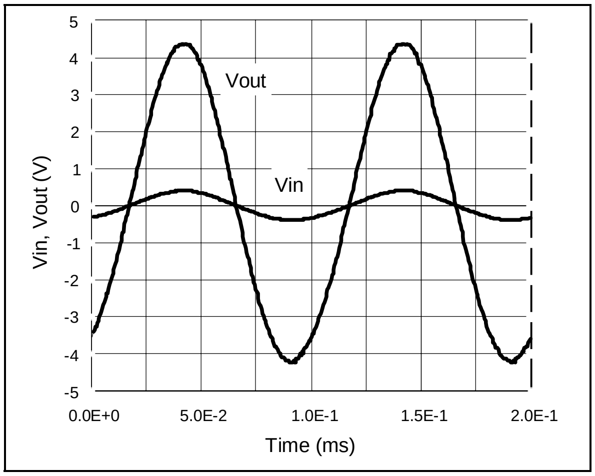
Channel separation (Xtalk) vs frequency
Gain=+11, Vcc=±1.5V, ZL=150Ω//27pF



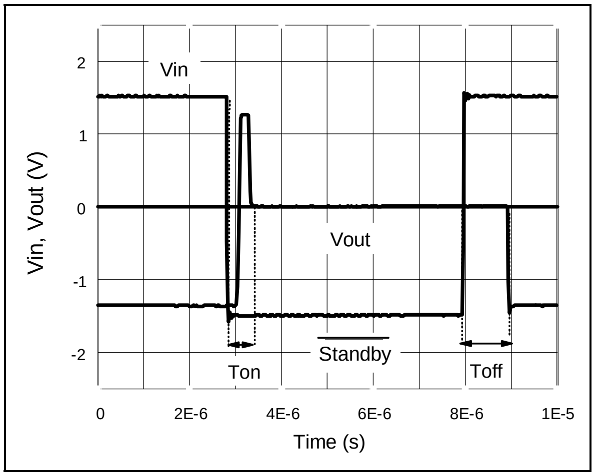
Equivalent Noise Voltage
Gain=100, Vcc=±1.5V, No load



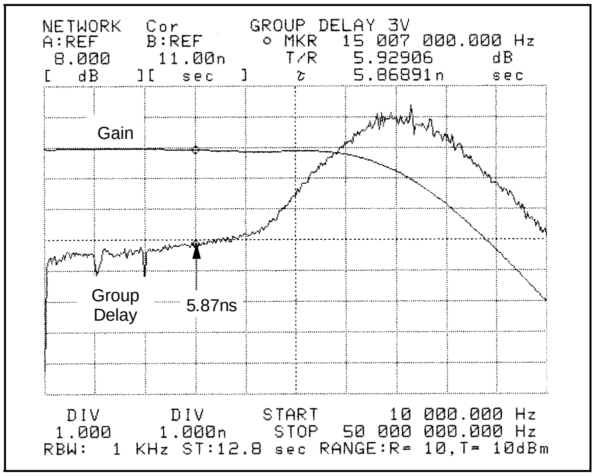
Maximum Output Swing
Gain=11, Vcc=±5V, RL=150Ω



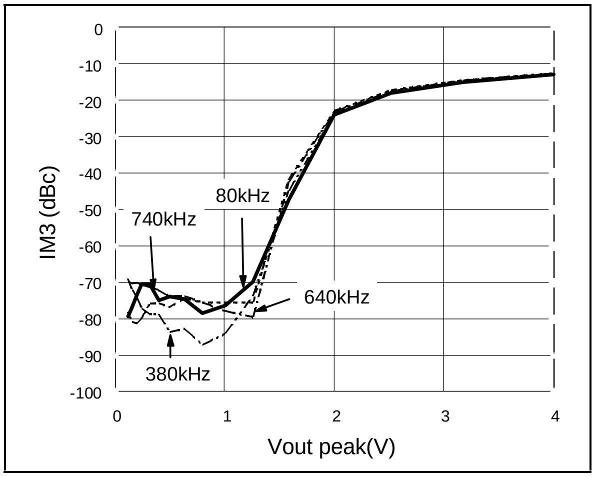
Standby Mode - Ton, Toff
Vcc= ±1.5V, Open Loop



Group Delay
Gain=2, Vcc=±1.5V, ZL=150Ω//27pF, T_{amb} = 25°C



Third Order Intermodulation
Gain=2, Vcc=±1.5V, ZL=150Ω//27pF, T_{amb} = 25°C

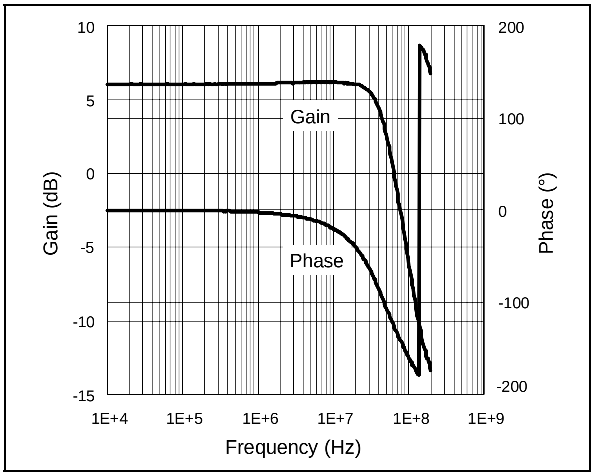


Intermodulation products

The IFR2026 synthesizer generates a two tones signal (F1=180kHz, F2=280kHz); each tone having the same amplitude level.
The HP3585 spectrum analyzer measures the intermodulation products function of the output voltage. The generator and the spectrum analyzer are phase locked for precision considerations.

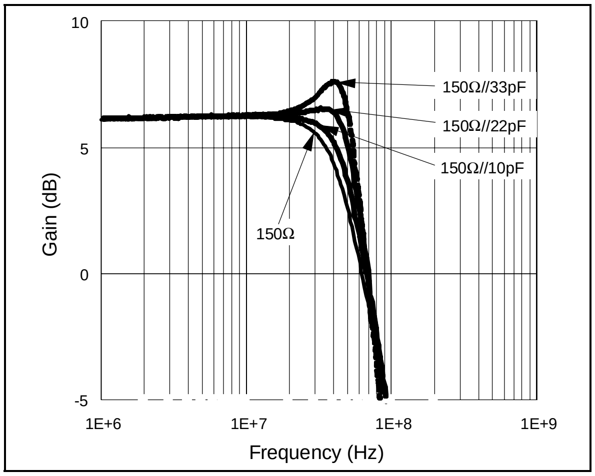
Closed Loop Gain and Phase vs. Frequency

Gain=+2, Vcc= ±2.5V, RL=150Ω, T_{amb} = 25°C



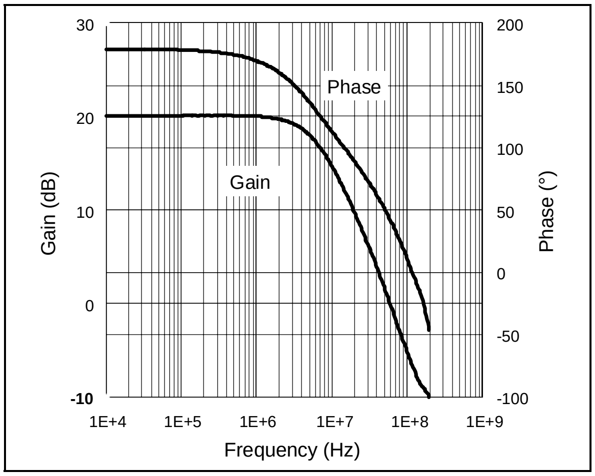
Overshoot function of output capacitance

Gain=+2, Vcc= ±2.5V, T_{amb} = 25°C



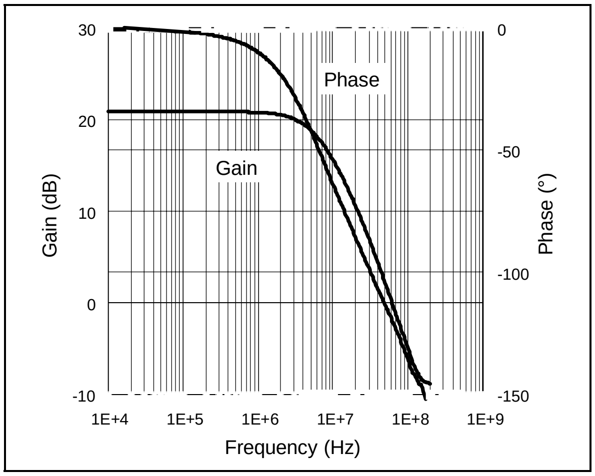
Closed Loop Gain and Phase vs. Frequency

Gain=-10, Vcc= ±2.5V, RL=150Ω, T_{amb} = 25°C



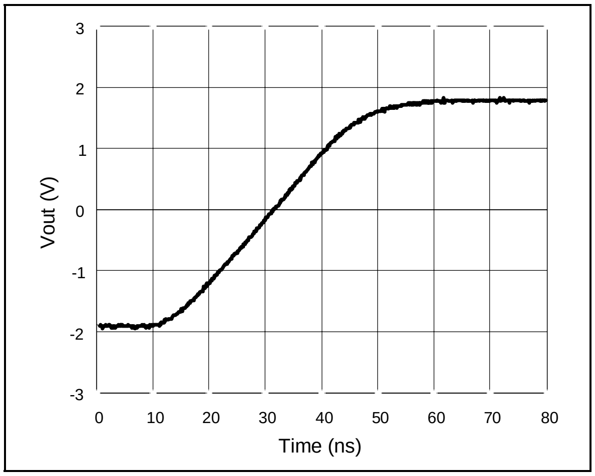
Closed Loop Gain and Phase vs. Frequency

Gain=+11, Vcc= ±2.5V, RL=150Ω, T_{amb} = 25°C



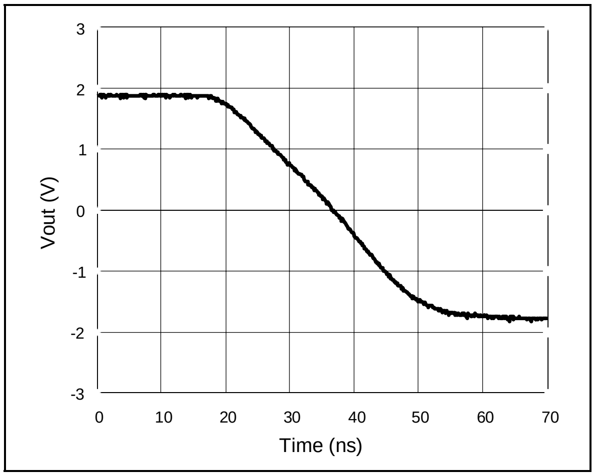
Large Signal Measurement - Positive Slew Rate

Gain=2,Vcc=±2.5V,ZL=150Ω//5.6pF,Vin=400mVpk

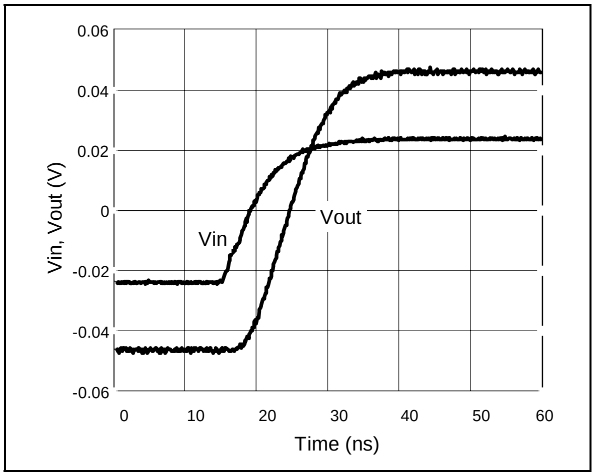


Large Signal Measurement - Negative Slew Rate

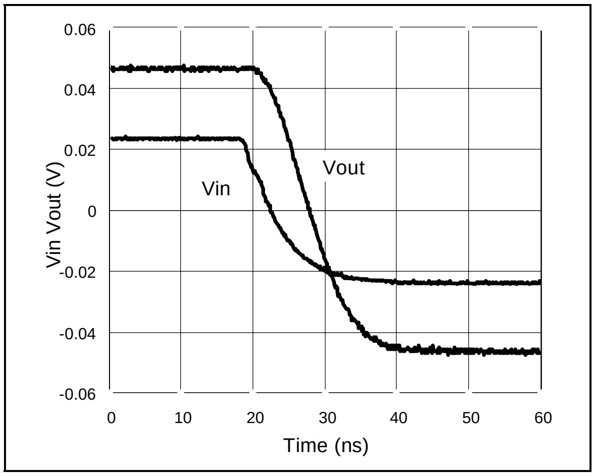
Gain=2,Vcc=±2.5V,ZL=150Ω//5.6pF,Vin=400mVpk



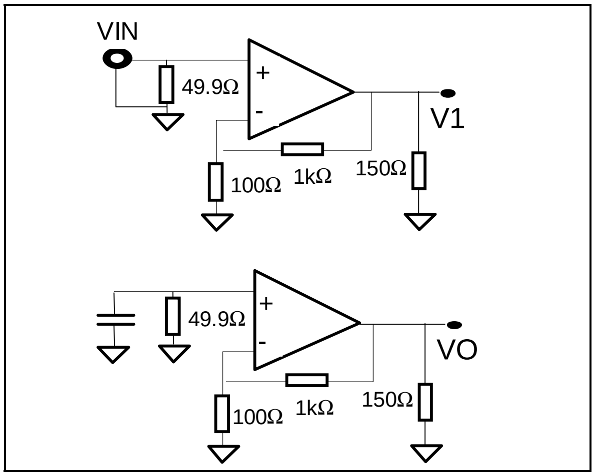
Small Signal Measurement - Rise Time
Gain=2,Vcc=±2.5V,Zl=150Ω,Vin=400mVpk



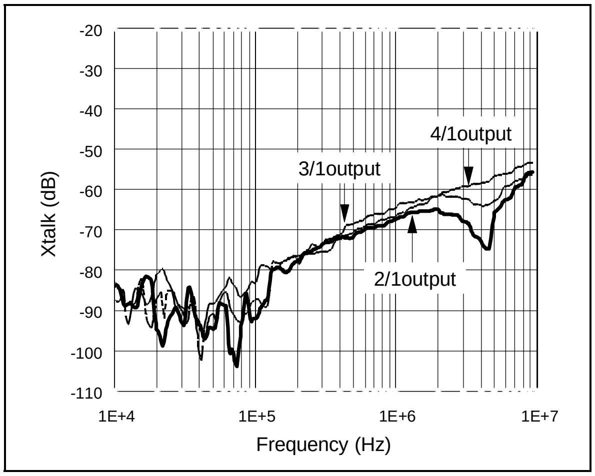
Small Signal Measurement - Fall Time
Gain=2,Vcc=±2.5V,Zl=150Ω,Vin=400mVpk



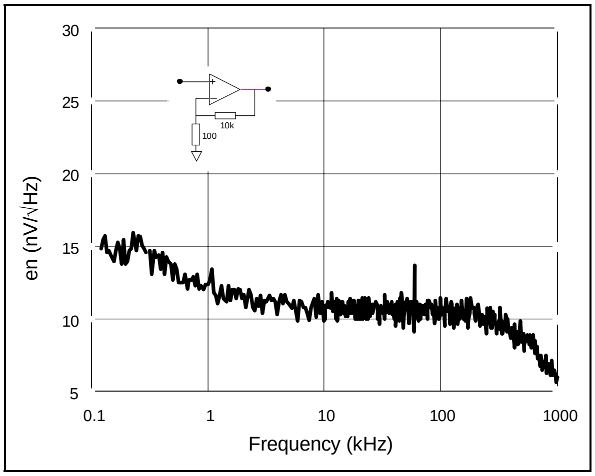
Channel separation (Xtalk) vs frequency
Measurement configuration : **Xtalk=20log(V0/V1)**



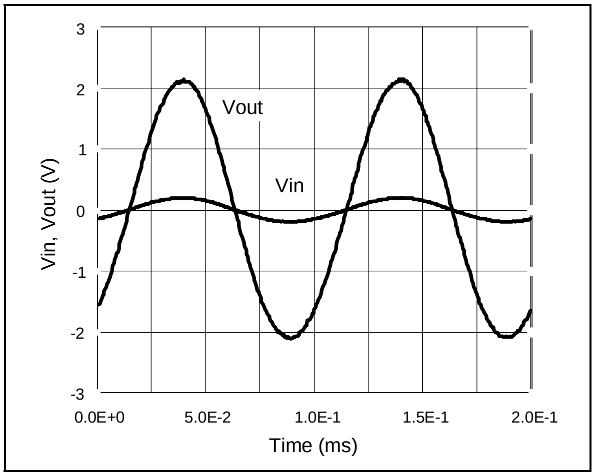
Channel separation (Xtalk) vs frequency
Gain=+11, Vcc=±2.5V, ZL=150Ω//27pF



Equivalent Noise Voltage
Gain=100, Vcc=±2.5V, No load

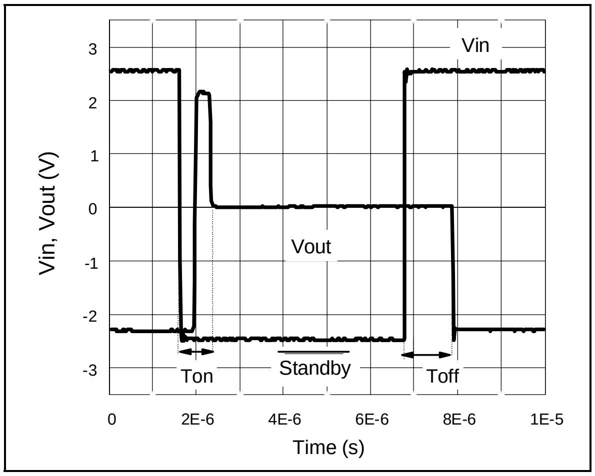


Maximum Output Swing
Gain=11, Vcc=±2.5V, RL=150Ω



Standby Mode - Ton, Toff

Vcc= ±2.5V, Open Loop



Intermodulation products

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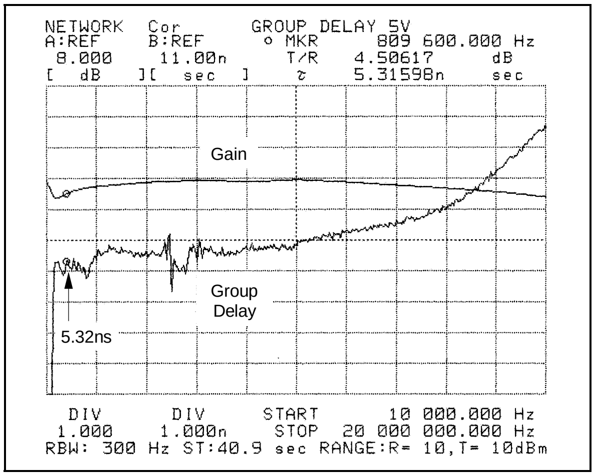
The HP3585 spectrum analyzer measures the intermodulation products function of the output voltage. The generator and the spectrum analyzer are phase locked for precision considerations.

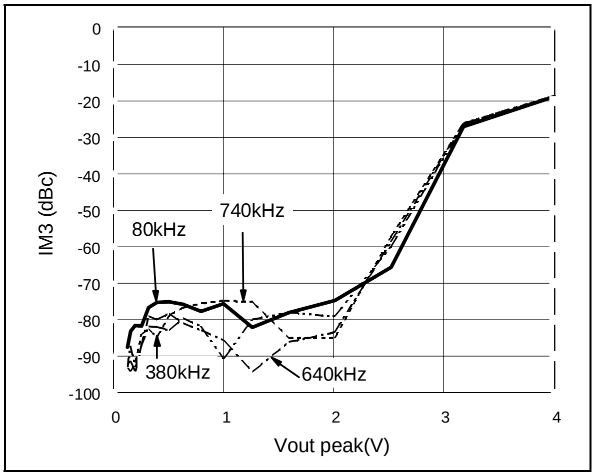
Group Delay

Gain=2, Vcc= ±2.5V, ZL=150Ω//27pF, $T_{amb} = 25^{\circ}C$

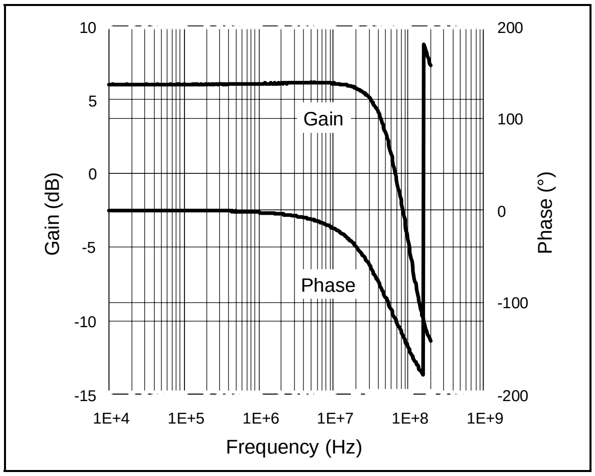


Third Order Intermodulation

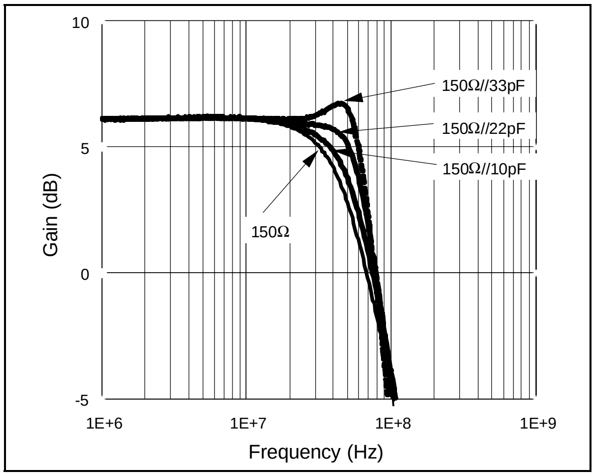
Gain=2, Vcc= ±2.5V, ZL=150Ω//27pF, $T_{amb} = 25^{\circ}C$



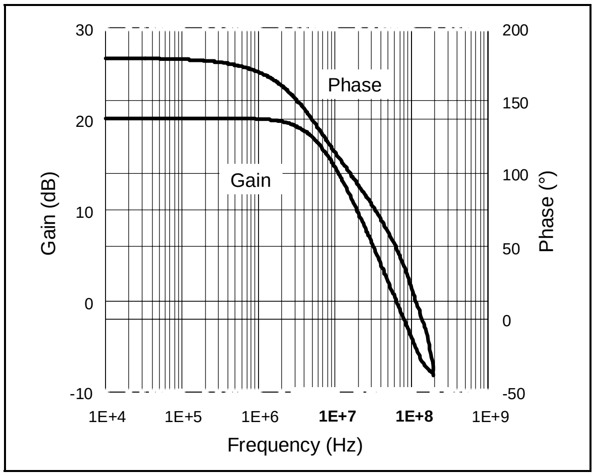
Closed Loop Gain and Phase vs. Frequency
Gain=+2, Vcc= ±5V, RL=150Ω, T_{amb} = 25°C



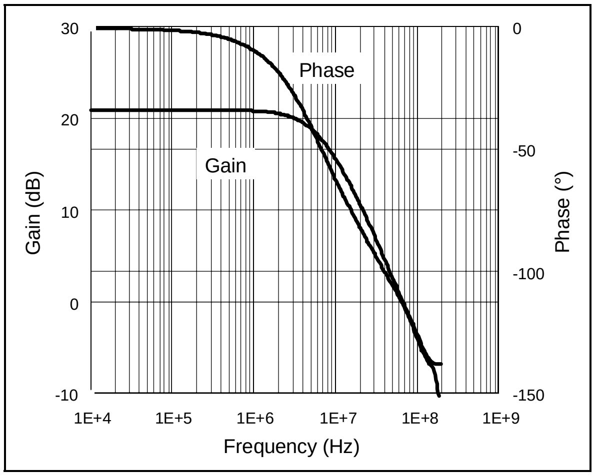
Overshoot function of output capacitance
Gain=+2, Vcc= ±5V, T_{amb} = 25°C



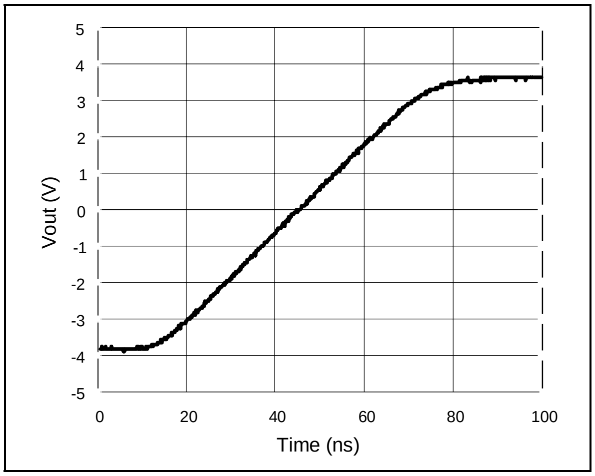
Closed Loop Gain and Phase vs. Frequency
Gain=-10, Vcc= ±5V, RL=150Ω, T_{amb} = 25°C



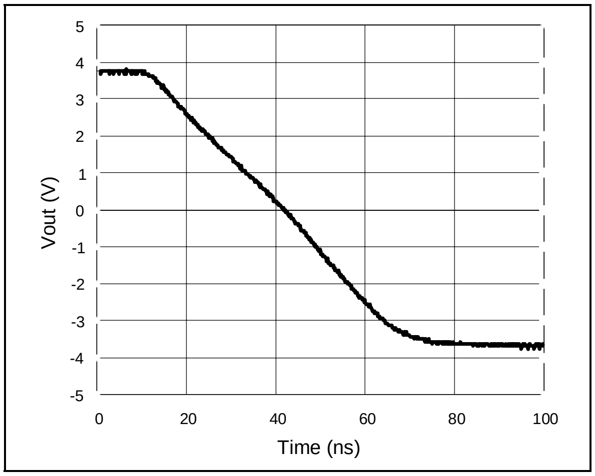
Closed Loop Gain and Phase vs. Frequency
Gain=+11, Vcc= ±5V, RL=150Ω, T_{amb} = 25°C



Large Signal Measurement - Positive Slew Rate
Gain=2,Vcc=±5V,ZL=150Ω//5.6pF,Vin=400mVpk

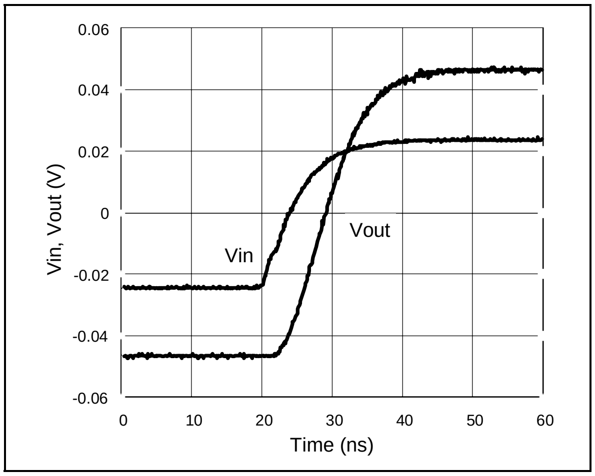


Large Signal Measurement - Negative Slew Rate
Gain=2,Vcc=±5V,ZL=150Ω//5.6pF,Vin=400mVpk



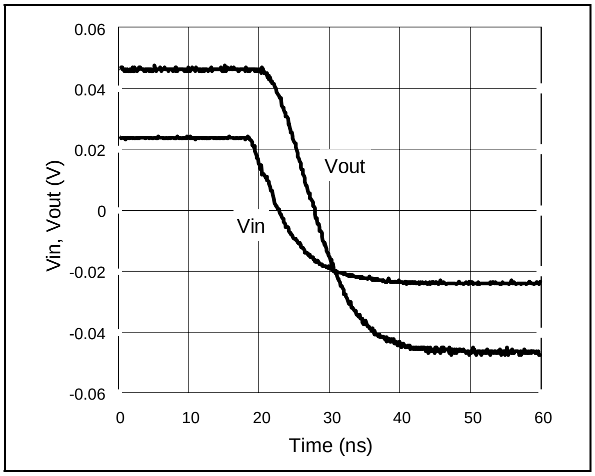
Small Signal Measurement - Rise Time

Gain=2,Vcc=±5V,ZL=150Ω,Vin=400mVpk



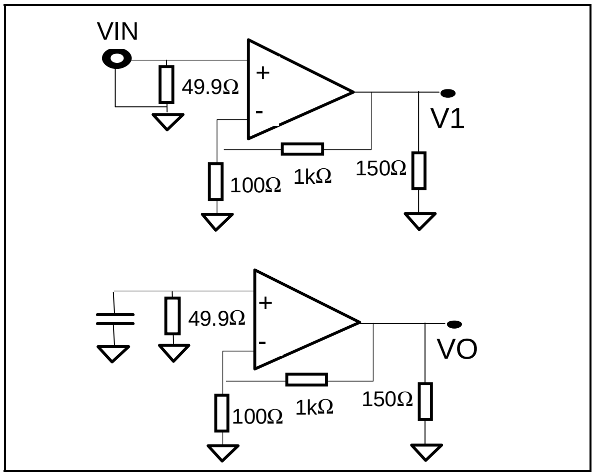
Small Signal Measurement - Fall Time

Gain=2,Vcc=±5V,ZL=150Ω,Vin=400mVpk



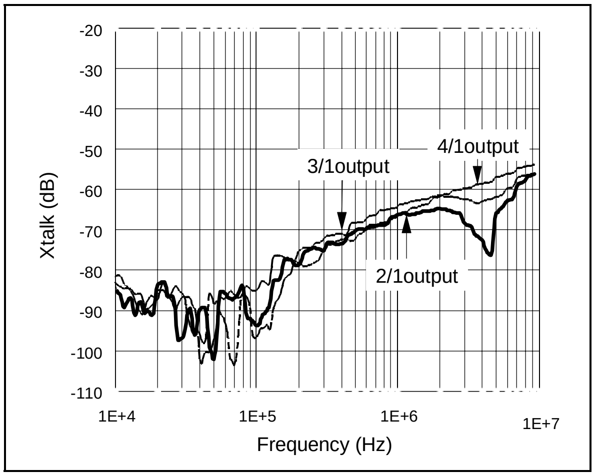
Channel separation (Xtalk) vs frequency

Measurement configuration : **Xtalk=20log(V0/V1)**



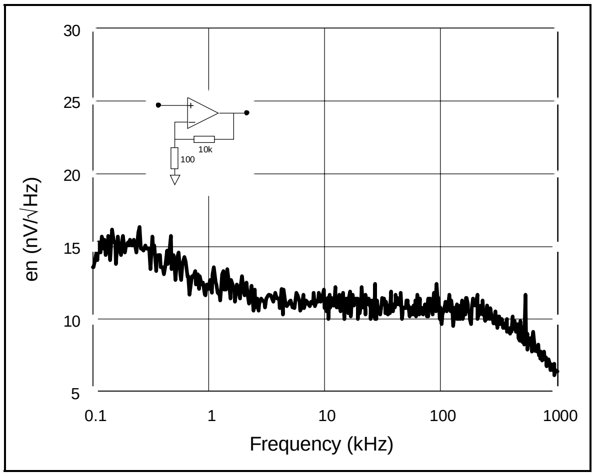
Channel separation (Xtalk) vs frequency

Gain=+11, Vcc=±5V, ZL=150Ω//27pF



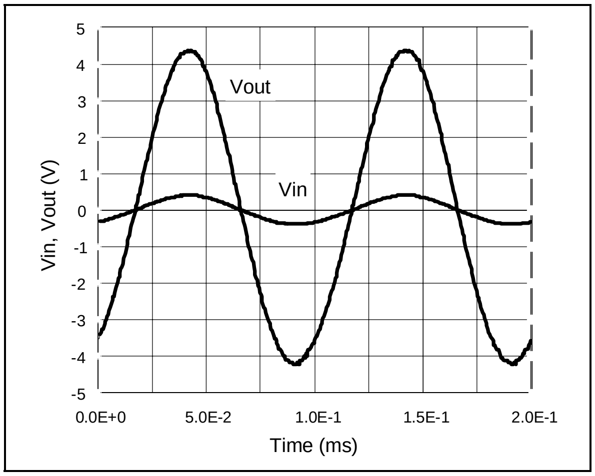
Equivalent Noise Voltage

Gain=100, Vcc=±5V, No load



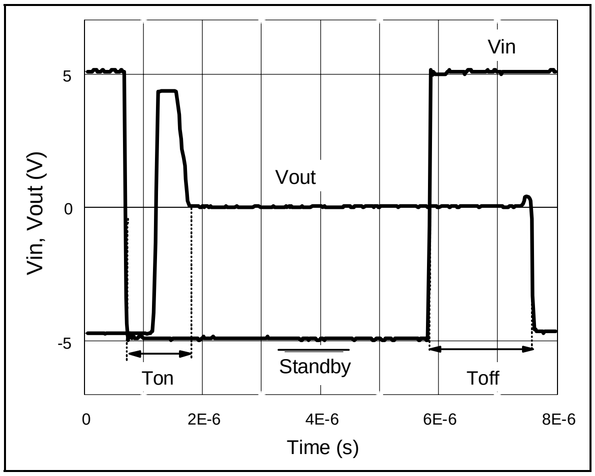
Maximum Output Swing

Gain=11, Vcc=±5V, RL=150Ω



Standby Mode - Ton, Toff

Vcc=±5V, Open Loop



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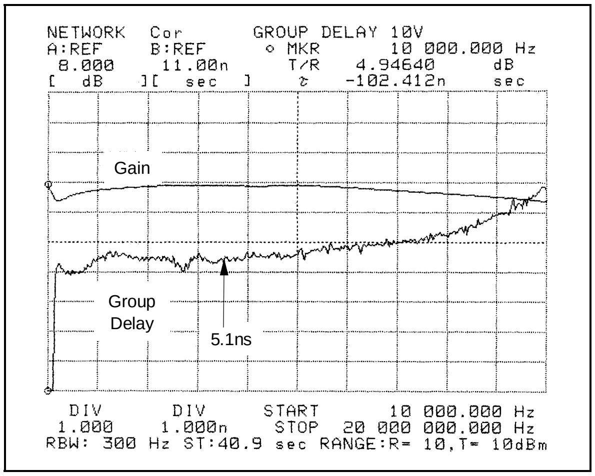
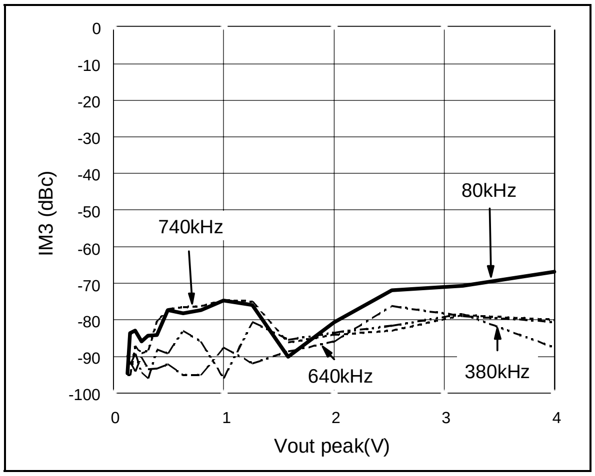
Group Delay

Gain=2, Vcc=±5V, ZL=150Ω//27pF, T_{amb} = 25°C



Third Order Intermodulation

Gain=2, Vcc=±5V, ZL=150Ω//27pF, T_{amb} = 25°C



TESTING CONDITIONS:

Layout precautions:

To use the TSH7X circuits in the best manner at high frequencies, some precautions have to be taken for power supplies:

- First of all, the implementation of a proper ground plane in both sides of the PCB is mandatory for high speed circuit applications to provide low inductance and low resistance common return.

- Power supply bypass capacitors (4.7uF 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.

- Proper termination of all inputs and outputs must be in accordance with output termination resistors; then the amplifier load will be only resistive and the stability of the amplifier will be improved.

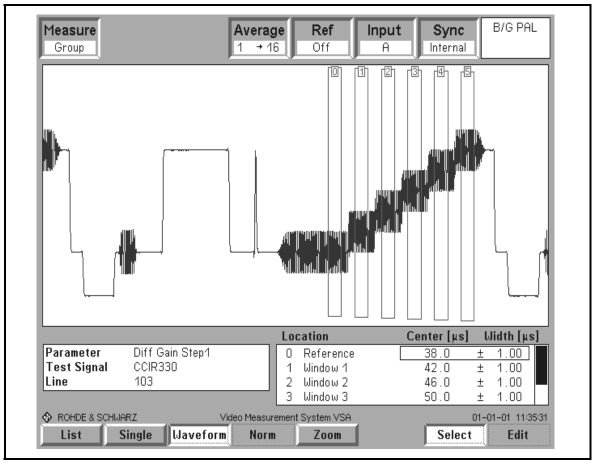
All leads must be wide and as short as possible especially for op amp inputs and outputs in order to decrease parasitic capacitance and inductance.

- For lower gain application, attention should be paid not to use large feedback resistance (>1kΩ) to reduce time constant with parasitic capacitances.

- Choose component sizes as small as possible (SMD).

- Finally, on output, the load capacitance must be negligible to maintain good stability. You can put a serial resistance the closest to the output pin to minimize its influence.

CCIR330 video line



Measure: Group
Average: 1 → 16
Ref: Off
Input: A
Sync: Internal
B/G PAL

Parameter: Diff Gain Step1
Test Signal: CCIR330
Line: 103

	Location	Center [µs]	Width [µs]
0	Reference	38.0	± 1.00
1	Window 1	42.0	± 1.00
2	Window 2	46.0	± 1.00
3	Window 3	50.0	± 1.00

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Maximum input level:

The input level must not exceed the following values:

- ☐ negative peak: must be greater than -Vcc+400mV.
- ☐ positive peak value: must be lower than +Vcc-400mV.

The electrical characteristics show the influence of the load on this parameter.

Video capabilities:

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

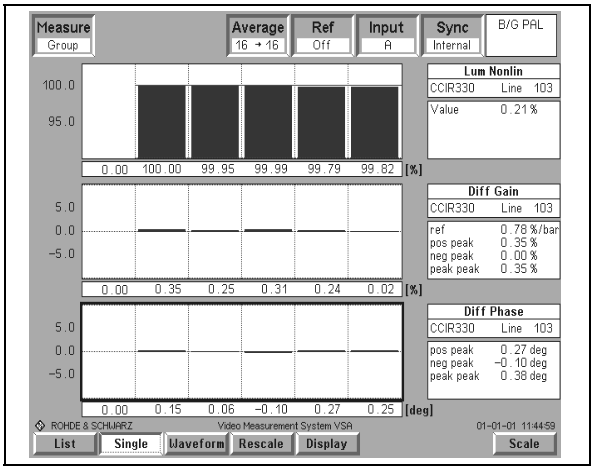
The video line contains 5 (flat) levels of luma on which is superimposed chroma signal. (the first level contains no luma). The luma gives various amplitudes which define the saturation of the signal. The chrominance gives various phases which define the colour of the signal.

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

When differential gain is present, colour saturation is not correctly reproduced.

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

Measurement on Rohde and Schwarz VSA.



Measure: Group
Average: 16 → 16
Ref: Off
Input: A
Sync: Internal
B/G PAL

Lum Nonlin [%]	0.00	100.00	99.95	99.99	99.79	99.82
Diff Gain [%]	0.00	0.35	0.25	0.31	0.24	0.02
Diff Phase [deg]	0.00	0.15	0.06	-0.10	0.27	0.25

Lum Nonlin
CCIR330 Line 103
Value 0.21 %

Diff Gain
CCIR330 Line 103
ref 0.78 %/bar
pos peak 0.35 %
neg peak 0.00 %
peak peak 0.35 %

Diff Phase
CCIR330 Line 103
pos peak 0.27 deg
neg peak -0.10 deg
peak peak 0.38 deg

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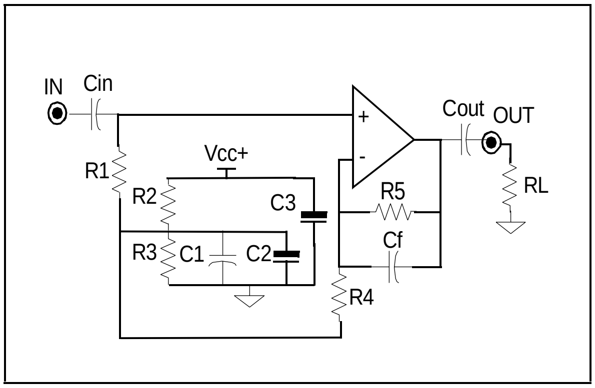
Video Results:

Parameter	Value Vcc=+-2.5V	Value Vcc=+-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	deg
Diff Phase neg	-0.2	-0.4	deg
Diff Phase pp	0.2	0.5	deg
Diff Phase Step1	-0.2	-0.4	deg
Diff Phase Step2	-0.1	-0.4	deg
Diff Phase Step3	-0.1	-0.3	deg
Diff Phase Step4	0	0.1	deg
Diff Phase Step5	-0.2	-0.1	deg

Precautions on asymmetrical supply operation:

The TSH7X 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 (+Vcc/2). This bias network must be carefully designed, in order to reject any noise present on the supply rail.

As the bias current is 15uA, you must carefully choose the resistance R1 not to introduce an offset mismatch at the amplifier inputs.

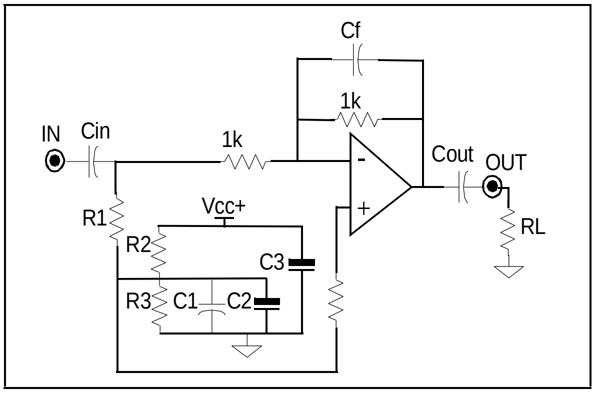


R1=10KΩ will be convenient. C1, C2, C3 are bypass capacitors from perturbation on Vcc as well as for the input and output signals. We choose C1=100nF and C2=C3=100uF.

R2, R3 are such that the current through them must be superior to 100 times the bias current. So, we take R2=R3=4.7KΩ.

Cin, as Cout are chosen to filter the DC signal by the lowpass filters (R1,Cin) and (Rout, Cout). By taking R1=10KΩ, RL=150Ω, and Cin=2uF, Cout=220uF we provide a cutoff frequency below 10Hz.

Use of the TSH7X in gain=-1 configuration:

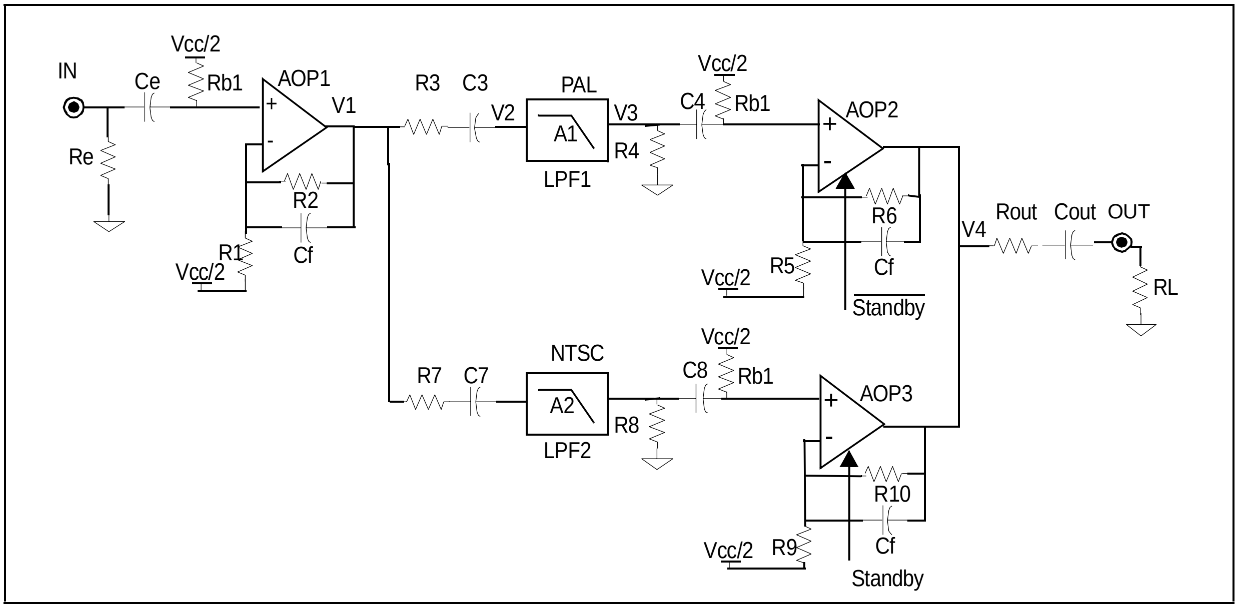


Some precautions have to be added, specially for low power supply application.

A feedback capacitance Cf should be added for better stability. The table summarizes the impact of the capacitance Cf on the phase margin of the circuit.

Parameter	Cf (pF)	Vcc=!1.5V	Vcc=!2.5V	Vcc=!5V	Unit
Phase Margin	0	28	43	56	deg
f-3dB		40	39.3	38.3	MHz
Phase Margin	5.6	30	43	56	deg
f-3dB		40	39.3	38.3	MHz
Phase Margin	22	37	52	67	deg
f-3dB		37	34	32	MHz
Phase Margin	33	48	65	78	deg
f-3dB		33.7	30.7	27.6	MHz

Example of a video application :



This example shows a possible application of the TSH7X circuit. Here, you can multiplex the channels for the different standard PAL, NTSC as you filter for the different bands; the video signal can be filtered with two different cutoff frequencies, corresponding to a PAL encoded signal (LPF1) or a NTSC signal (LPF2).

You can multiplex input signals, as the outputs are in high impedance state in standby mode.This enables you, to use a PAL filter as the Standby mode is active and to use the NTSC filter otherwise.

The video application requires 1Vpeak at input and output.

Calculation of components:

A decoupling capacitor is provided to cutoff the frequencies below 10Hz according I bias.Hence Ce=10uF, with Rb1=10KΩ. At the output, Cout=220uF.

The AOP1 is in 6dB configuration for the adaptation bridge. R1=R2=1KΩ.V1=2Vpk. V2=1Vpk

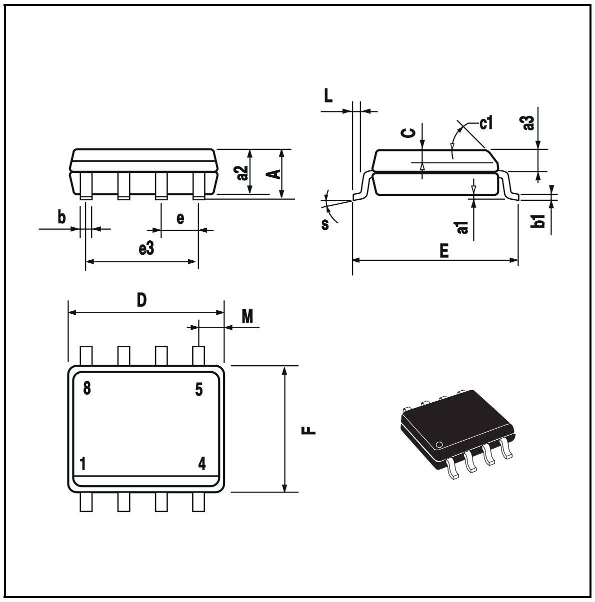
For the PAL communication, we need a lowpass filtering. The load resistance R4 is function of the output resistance of the filter.V3=V2/A1 where A1 is the attenuation factor of the filter LPF1.

To compensate the filter insertion loss, we add an additional factor to the gain of the 2nd amplifier AOP2.

For example, for an attenuation of 3dB, we choose R5=300Ω and R6=1KΩ. We have V4=2Vpk and Vout=1Vpk.

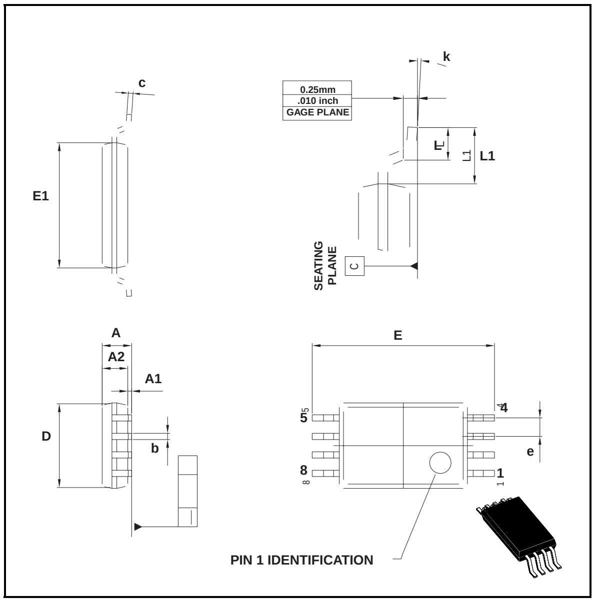
The calculation of the parameters R7, C7, R8, C8, R9, R10 will be exactly the same .

PACKAGE MECHANICAL DATA
8 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

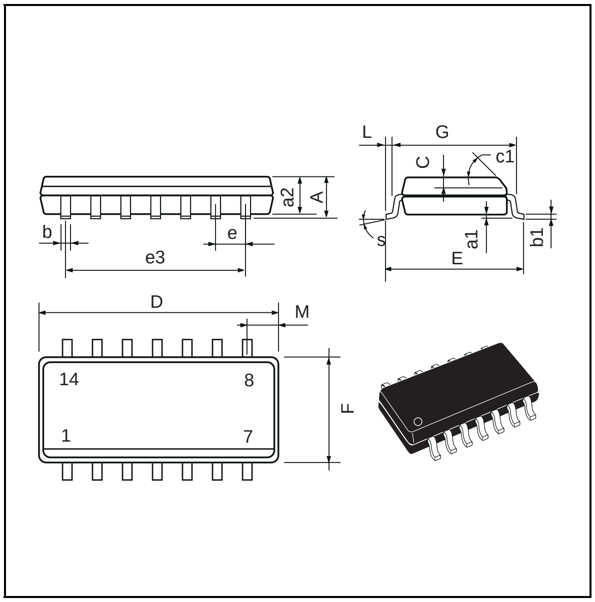
PACKAGE MECHANICAL DATA
8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)

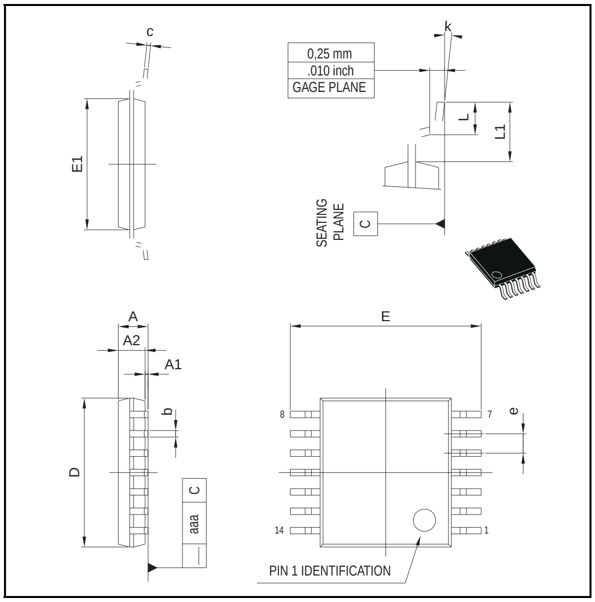


Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F (1)	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

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

PACKAGE MECHANICAL DATA

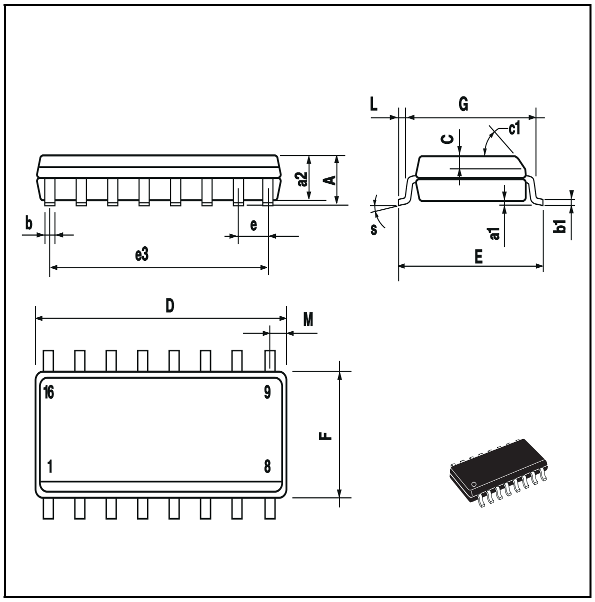
14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	4.90	5.00	5.10	0.192	0.196	0.20
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030

PACKAGE MECHANICAL DATA

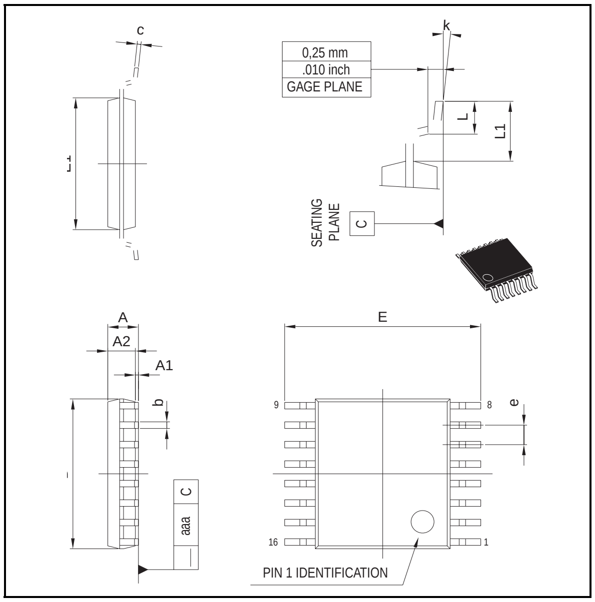
16 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.209
L	0.5		1.27	0.020		0.050
M			0.62			0.024
S	8° (max.)					

PACKAGE MECHANICAL DATA

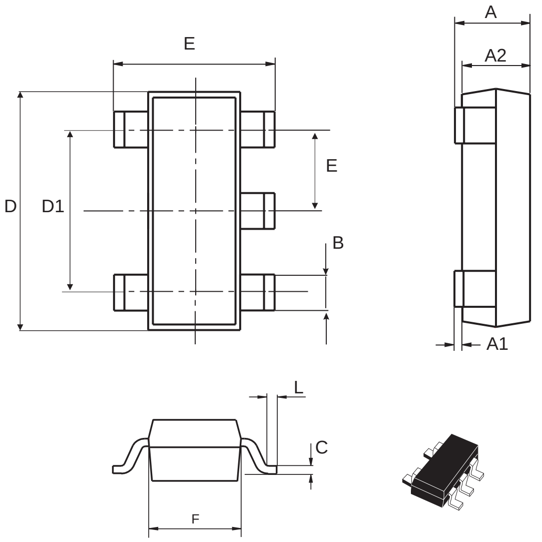
16 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	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	0.0118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.5	0.60	0.004	0.014	0.024

PACKAGE MECHANICAL DATA

5 PINS - TINY PACKAGE (SOT23)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	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	0.0118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.5	0.60	0.004	0.014	0.024
K	0d		10d	0d		10d

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