GT7112

200MHz, High Speed, CMOS, Rail-to-Rail Operational Amplifier Advanced

1. Features

- Single-Supply Operation from +2.5V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 200MHz (Typ.)
- Low Input Bias Current: 10pA (Typ.)
- Low Offset Voltage: 10mV (Max.)
- Quiescent Current:7.8mA (Typ.)
- Operating Temperature: -40°C ~ +125°C
- Available in MSOP8 and SOP8 Packages

2. General Description

The GT7112 is wideband, low-noise, low-distortion operational amplifier, that offer rail-to-rail output and single-supply operation down to 2.5V. They draw 7.8mA of quiescent supply current, as well as low input voltage-noise density (13nV/√Hz) and low input current-noise density (400fA/√Hz). These features make the devices an ideal choice for applications that require low distortion and low noise. The GT7112 has output which swing rail-to-rail and their input common-mode voltage range includes ground and offer wide bandwidth to 200MHz (G=+1) .They are specified over the extended industrial temperature range (-45°C ~ 125°C).The single GT7112 is available in space-saving, MSOP8 and SOP-8 packages.

3. Applications

- Portable Equipment
- Mobile Communications
- Smoke Detector
- Sensor Interface
- Medical Instrumentation
- Handheld Test Equipment
- Imaging/video

4. Pin Configuration

4.1 GT7112 MSOP8 and SOP8 (Top View)

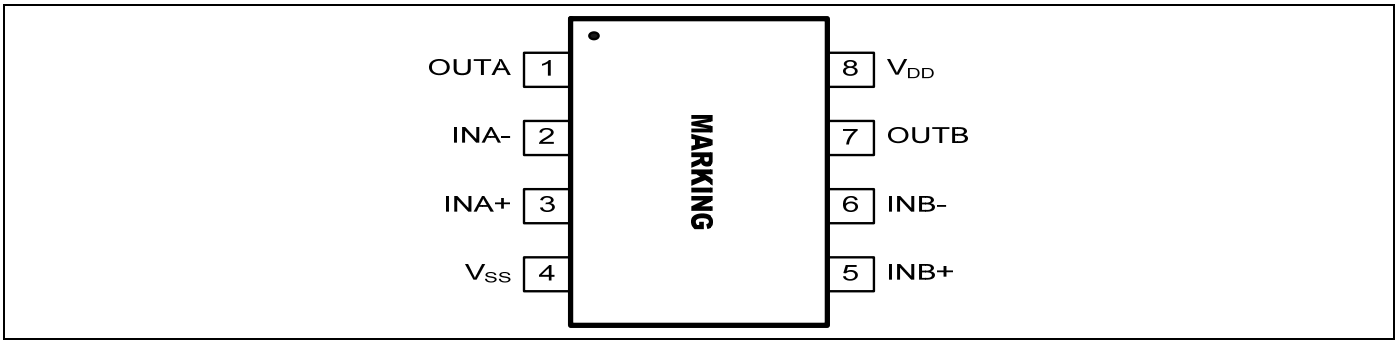


Figure 1. Pin Assignment Diagram (MSOP8 and SOP8 Package)

Note: Please see section "Part Markings" for detailed Marking Information.

5. Application Information

5.1 Size

GT7112 series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the GT7112 series packages save space on printed circuit boards and enable the design of smaller electronic products.

5.2 Power Supply Bypassing and Board Layout

GT7112 series operates from a single 2.5V to 5.5V supply or dual ±1.25V to ±2.75V supplies. For best performance, a 0.1μF ceramic capacitor should be placed close to the V_{DD} pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate 0.1μF ceramic capacitors.

5.3 Low Supply Current

The low supply current (typical 7.8mA) of GT7112 series will help to maximize battery life. They are ideal for battery powered systems

5.4 Operating Voltage

GT7112 series operate under wide input supply voltage (2.2V to 5.5V). In addition, all temperature specifications apply from -40°C to +125°C. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

5.5 Rail-to-Rail Input

The input common-mode range of GT7112 series extends 100mV beyond the supply rails (V_{SS}-0.1V to V_{DD}+0.1V). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

5.6 Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of GT7112 series can typically swing to less than 10mV from supply rail in light resistive loads (>100kΩ), and 60mV of supply rail in moderate resistive loads (10kΩ).

5.7 Capacitive Load Tolerance

The GT7112 series can directly drive 200pF capacitive load in unity-gain without oscillation. Increasing the gain enhances the amplifier's ability to drive greater capacitive loads. In unity-gain configurations, the capacitive load drive can be improved by inserting an isolation resistor R_{ISO} in series with the capacitive load, as shown in *Figure 2*.

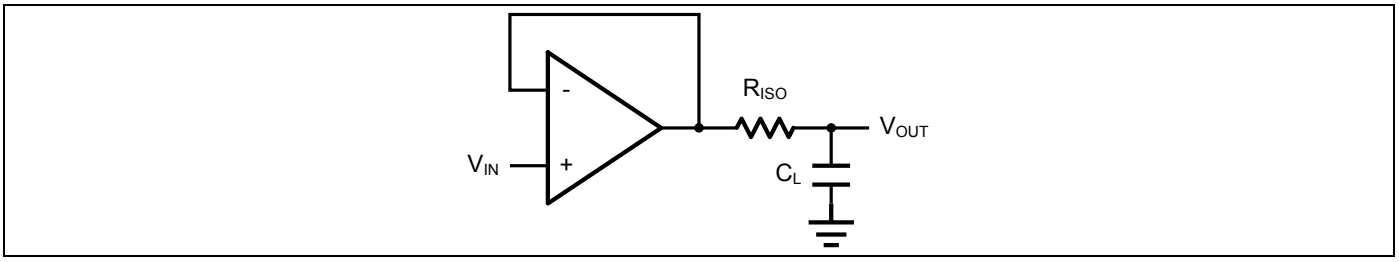


Figure 2. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load R_L in parallel with the capacitive load, a voltage divider (proportional to R_{ISO}/R_L) is formed, this will result in a gain error.

The circuit in *Figure 3* is an improvement to the one in *Figure 2*. R_F provides the DC accuracy by feed-forward the V_{IN} to R_L. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving the phase margin in the overall feedback loop. Capacitive drive can be increased

by increasing the value of C_F. This in turn will slow down the pulse response.

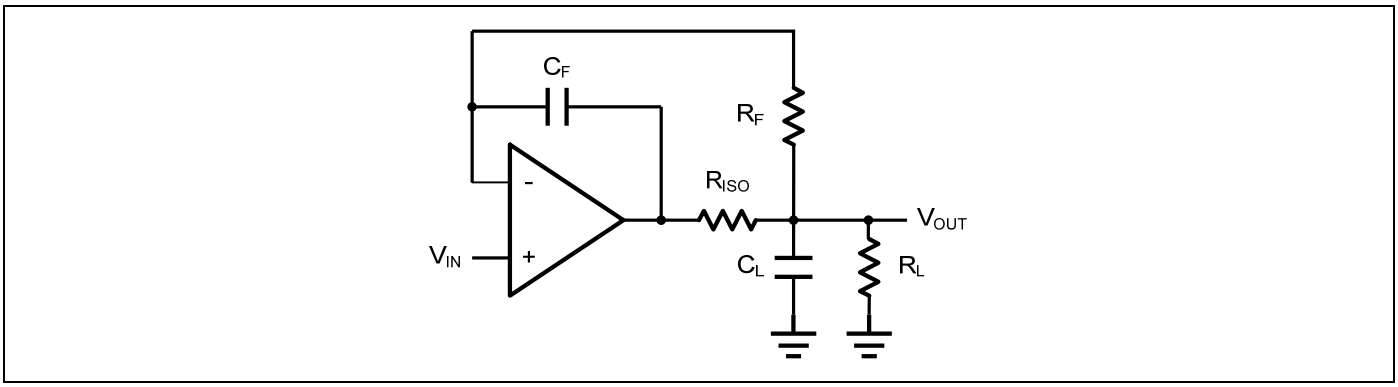


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

5.8 Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. *Figure 4.* shown the differential amplifier using GT7112.

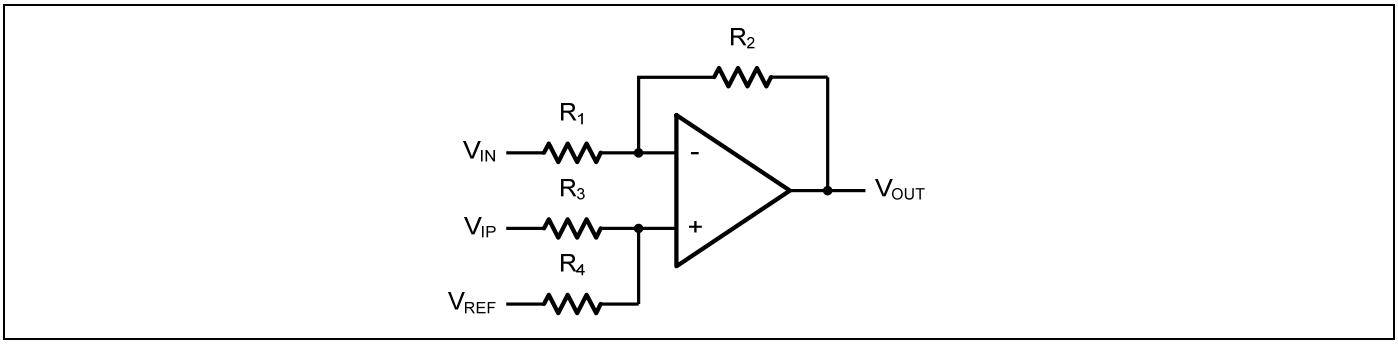


Figure 4. Differential Amplifier

$$V_{OUT}=(\frac{R_1+R_2}{R_3+R_4})\frac{R_4}{R_1}V_{IN}-\frac{R_2}{R_1}V_{IP}+(\frac{R_1+R_2}{R_3+R_4})\frac{R_3}{R_1}V_{REF}$$

If the resistor ratios are equal (i.e. R_1=R_3 and R_2=R_4), then

$$V_{OUT}=\frac{R_2}{R_1}(V_{IP}-V_{IN})+V_{REF}$$

5.9 Instrumentation Amplifier

The input impedance of the previous differential amplifier is set by the resistors R_1, R_2, R_3, and R_4. To maintain the high input impedance, one can use a voltage follower in front of each input as shown in the following two instrumentation amplifiers.

5.10 Three-Op-Amp Instrumentation Amplifier

The triple GT7112 can be used to build a three-op-amp instrumentation amplifier as shown in Figure 5.

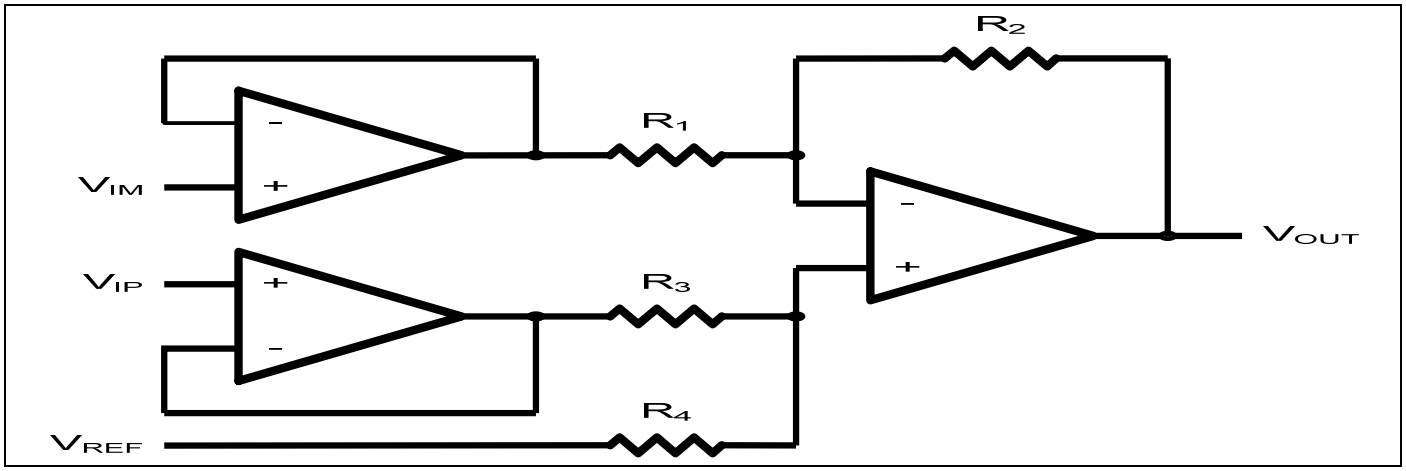


Figure 5. Instrument Amplifier

The amplifier in Figure 5 is a high input impedance differential amplifier with gain of R_2/R_1. The two differential voltage followers assure the high input impedance of the amplifier.

5.11 Two-Op-Amp Instrumentation Amplifier

GT7112 can also be used to make a high input impedance two-op-amp instrumentation amplifier as shown in Figure 6.

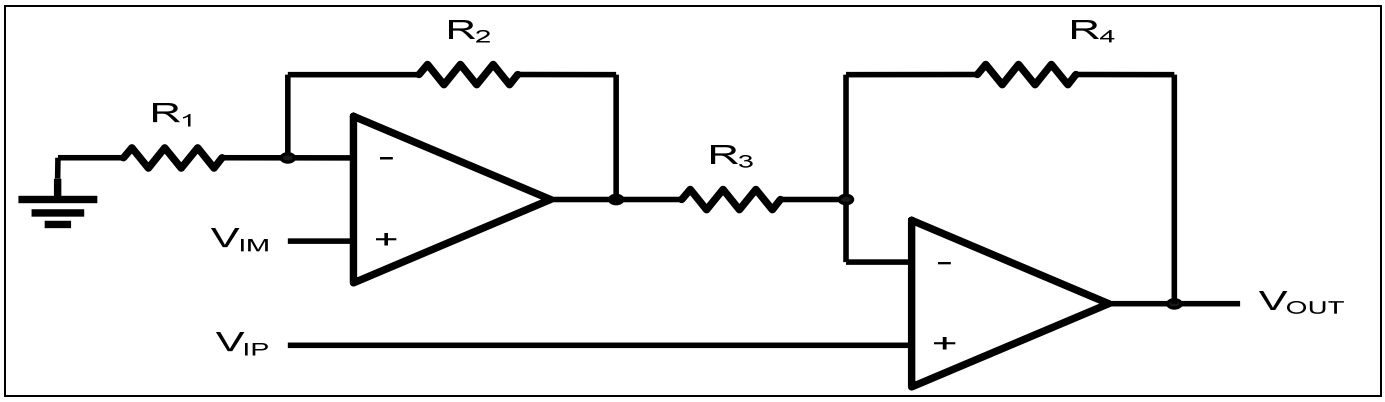


Figure 6. Instrument Amplifier

$$V_o = (1+\frac{R_4}{R_3})(V_2 - V_1)$$

Where $R_1=R_3$ and $R_2=R_4$. If all resistors are equal, then $V_o=2(V_2-V_1)$

5.12 Single-Supply Inverting Amplifier

The inverting amplifier is shown in Figure 6. The capacitor C_1 is used to block the DC signal going into the AC signal source V_{IN}. The value of R_1 and C_1 set the cut-off frequency to $f_C=1/(2\pi R_1C_1)$. The DC gain is defined by $V_{OUT}=-(R_2/R_1)V_{IN}$

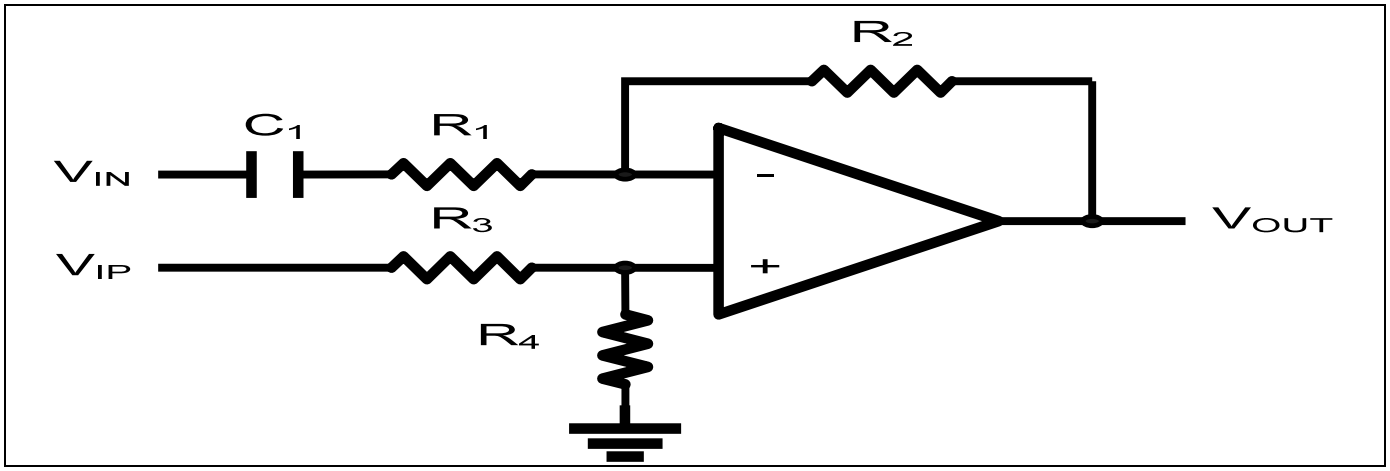


Figure 7. Instrument Amplifier

5.13 Low Pass Active Filter

The low pass active filter is shown in *Figure 8*. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_C=1/(2\pi R_3C_1)$.

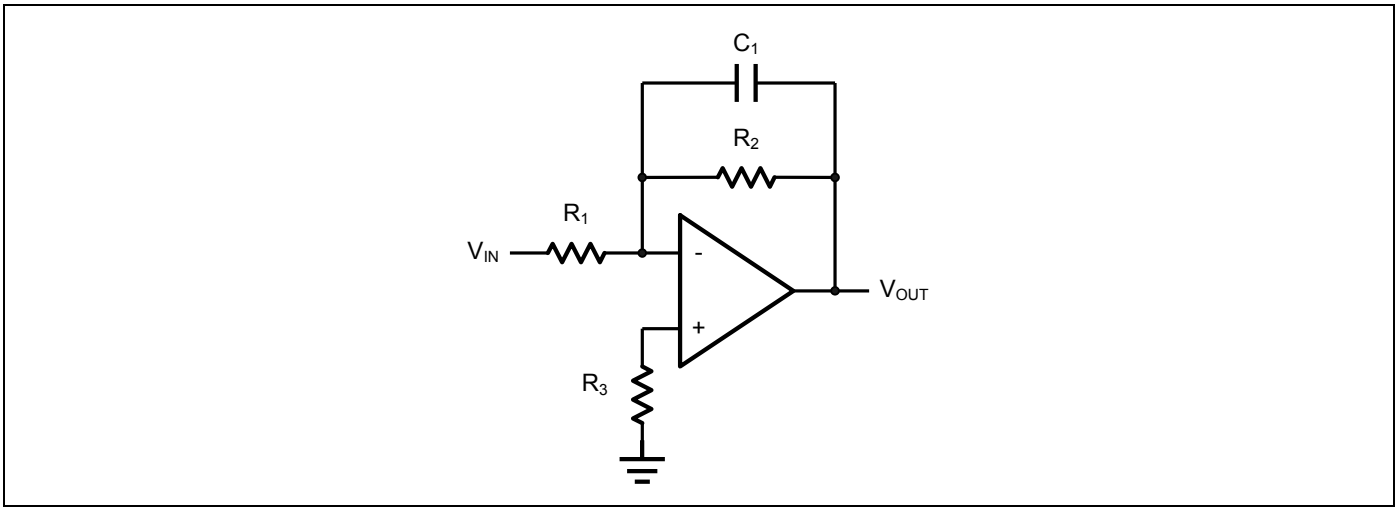


Figure 8. Low Pass Active Filter

5.14 Sallen-Key 2nd Order Active Low-Pass Filter

GT7112 can be used to form a 2nd order Sallen-Key active low-pass filter as shown in *Figure 9*. The transfer function from V_{IN} to V_{OUT} is given by

$$\frac{V_{OUT}}{V_{IN}}(S)=\frac{\frac{1}{C_1C_2R_1R_2}A_{LP}}{S^2+S(\frac{1}{C_1R_1}+\frac{1}{C_1R_2}+\frac{1}{C_2R_2}-\frac{A_{LP}}{C_2R_2})+\frac{1}{C_1C_2R_1R_2}}$$

Where the DC gain is defined by $A_{LP}=1+R_3/R_4$, and the corner frequency is given by

$$\omega C = \sqrt{\frac{1}{C_1 C_2 R_1 R_2}}$$

The pole quality factor is given by

$$\frac{\omega C}{Q} = \frac{1}{C_1 R_1} + \frac{1}{C_1 R_2} + \frac{1}{C_2 R_2} - \frac{A_{LP}}{C_2 R_2}$$

Let R1=R2=R and C1=C2=C, the corner frequency and the pole quality factor can be simplified as below

$$\omega_C = \frac{1}{CR}$$

And $Q=2-R_3/R_4$

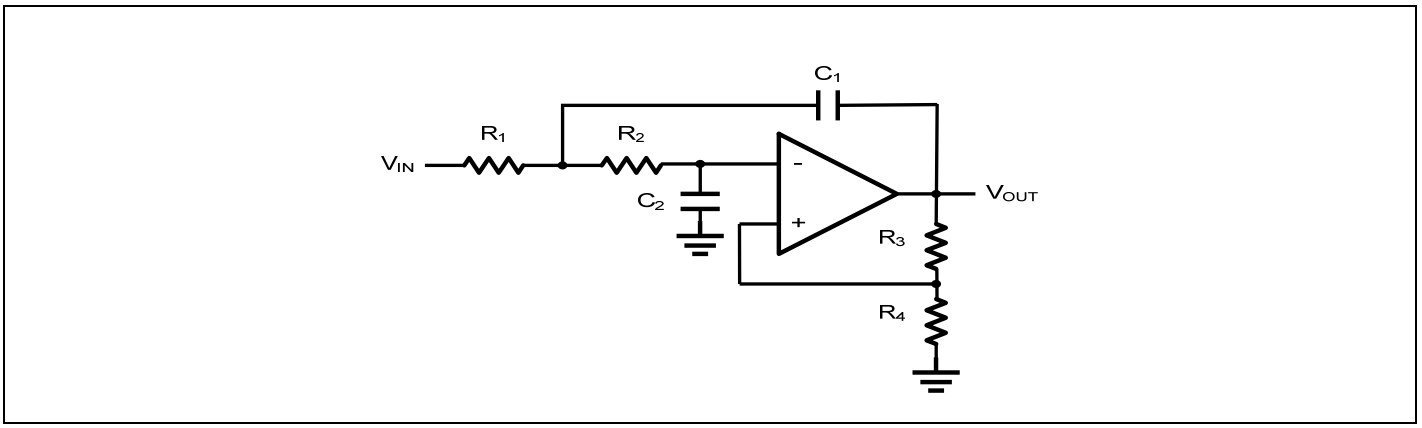


Figure 9. Sanllen-Key 2nd Order Active Low-Pass Filter

5.15 Sallen-Key 2nd Order high-Pass Active Filter

The 2nd order Sallen-key high-pass filter can be built by simply interchanging those frequency selective components R_1, R_2, C_1, and C_2 as shown in *Figure 10*.

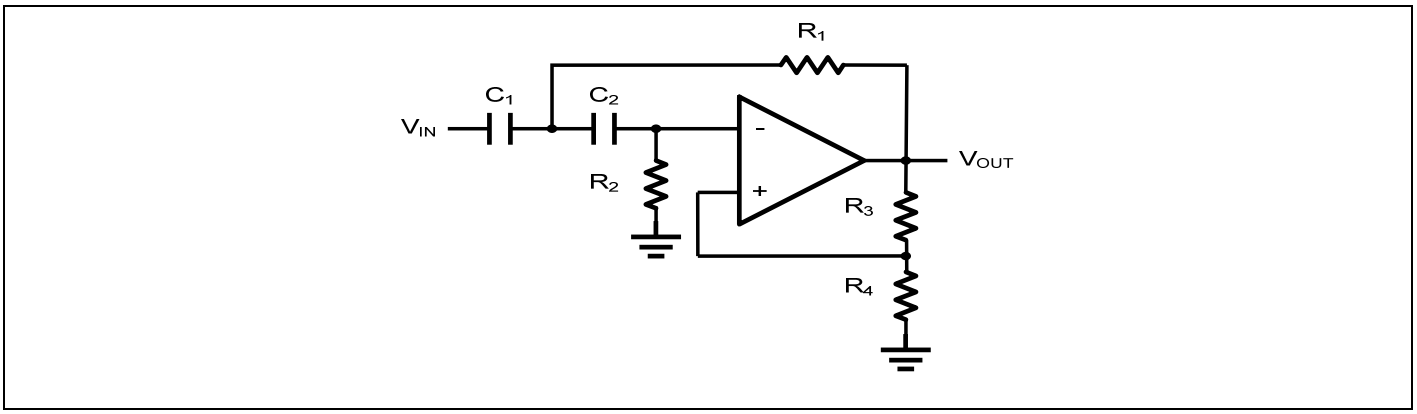


Figure 10. Sanllen-Key 2nd Order Active High-Pass Filter

$$\frac{V_{OUT}}{V_{IN}}(S) = \frac{S^2 A_{HP}}{S^2 + S\left(\frac{1}{C_1 R_1} + \frac{1}{C_2 R_2} + \frac{1 - A_{HP}}{C_1 R_1}\right) + \frac{1}{C_1 C_2 R_1 R_2}}$$

Where $A_{HP}=1+R_3/R_4$

6. Electrical Characteristics

6.1 Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+7V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	V_{DD}+0.5V
PDB Input Voltage	Vss-0.5V	+7V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+150°C	
Storage Temperature Range	-65°C	+150°C
Lead Temperature (soldering, 10sec)	+300°C	
Package Thermal Resistance (T_A=+25°C)		
MSOP8, θ_{JA}	190°C	
SOP8, θ_{JA}	130°C	

Note: Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

6.2 Electrical Characteristics

(V_{DD} = +5V, Vss = 0V, V_{CM} = 0V, V_{OUT} = V_{DD}/2, R_L=100K tied to V_{DD}/2, SHDNB = V_{DD}, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A =+25°C.) (Notes 1,2)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Supply-Voltage Range	V_{DD}	Guaranteed by the PSRR test	2.5	-	5.5	V
Quiescent Supply Current (per Amplifier)		V_{DD} = 5V	3.1	3.9	4.7	mA
Input Offset Voltage	V_{OS}	T_A=25°C	-	±3	±5	mV
		T_A=-40°C~+85°C	-	-	±8	
		T_A=-40°C~+125°C	-	-	±10	
Input Offset Voltage Tempco	$\Delta V_{OS}/\Delta T$		-	±2	-	µV/°C
Input Bias Current	I_B	(Note 3)	-	±10	±100	pA
Input Offset Current	I_{OS}	(Note 3)	-	±10	±100	pA
Input Common-Mode Voltage Range	V_{CM}	Guaranteed by the T_A = 25°C CMRR test, T_A = -40°C ~ +125°C	-0.1	-	V_{DD}+0.1	V
Common-Mode Rejection Ratio	CMRR	Vss-0.1V≤V_{CM}≤V_{DD}+0.1V T_A = 25°C	-	75	-	dB
		Vss≤V_{CM}≤5V_{DD} T_A = 25°C	72	90	-	
		Vss-0.1V≤V_{CM}≤V_{DD}+0.1V T_A = -40°C ~ +125°C	-	68	-	
Power-Supply Rejection Ratio	PSRR	V_{DD} = +2.5V to +5.5V	75	90	-	dB
Open-Loop Voltage Gain	A_V	R_L = 10kΩ to V_{DD}/2 V_{OUT} = 100mV to V_{DD}-125mV	90	100	-	dB
		R_L = 1kΩ to V_{DD}/2 V_{OUT} = 200mV to V_{DD}-250mV	80	95	-	
		R_L = 500Ω to V_{DD}/2 V_{OUT} = 350mV to V_{DD}-500mV	70	80	-	
Output Voltage Swing	V_{OUT}	|V_{IN+}-V_{IN-}| ≥ 10mV V_{DD}-V_{OH}	-	10	35	mV
		R_L = 10kΩ to V_{DD}/2 V_{OL}-V_{SS}	-	10	30	
		|V_{IN+}-V_{IN-}| ≥ 10mV V_{DD}-V_{OH}	-	80	50	
		R_L = 1kΩ to V_{DD}/2 V_{OL}-V_{SS}	-	30	50	
		|V_{IN+}-V_{IN-}| ≥ 10mV V_{DD}-V_{OH}	-	100	140	
		R_L = 500Ω to V_{DD}/2 V_{OL}-V_{SS}	-	100	140	
Output Short-Circuit Current	I_{SC}	Sinking or Sourcing	-	±120	-	mA
-3 dB Gain Bandwidth Product	GBW	A_V = +1V/V	-	200	-	MHz
Slew Rate	SR	A_V = +1V/V	-	100	-	V/µs

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Capacitance	Cin			1.5		pF
Differential Phase error (NTSC)	DP	G=2,R_L=150Ω	-	0.03	-	Deg
Differential Gain error (NTSC)	DG	G=2,R_L=150Ω	-	0.09	-	dB
Settling Time	t_S	To 0.01%, V_{OUT} = 2V step A_V = +1V/V	-	52	-	Ns
Capacitive-Load Stability	Cload	No sustained oscillations Av=+1V/V		200		pF
Over Load Recovery Time		V_{IN} × Gain=V_S	-	2	-	μs
Input Voltage Noise Density	e_n	f = 1KHz f=30KHz	-	15 13	-	nV/√Hz
Input Current Noise Density	in	F=1KHz	-	400		fA/√Hz
Total Harmonic Distortion plus Noise	THD+N	f_C=5MHZ,V_{OUT}=2Vp-p,G=+2	-	-60	-	dB

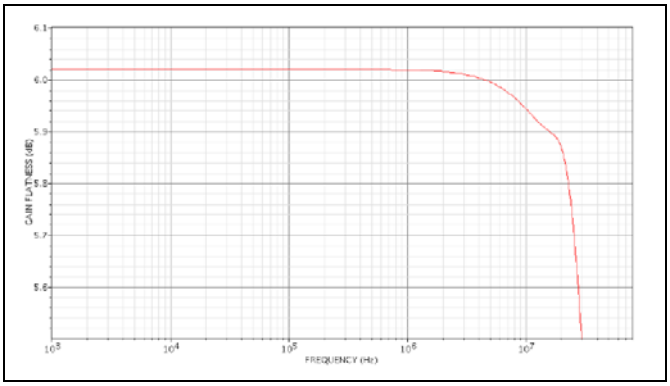
Note 1: All devices are 100% production tested at T_A = +25°C; all specifications over the automotive temperature range is guaranteed by design, not production tested.

Note 2: Parameter is guaranteed by design.

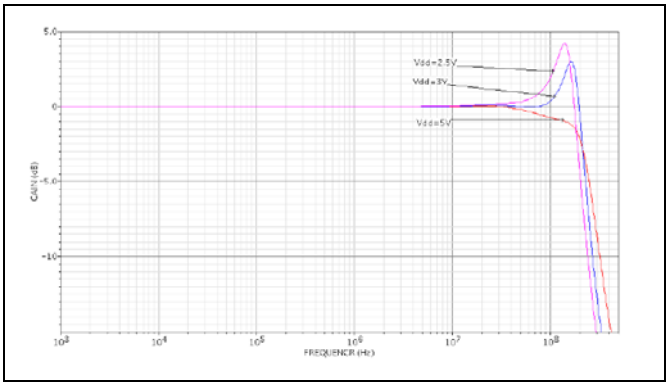
Note 3: Peak-to-peak input noise voltage is defined as six times rms value of input noise voltage.

6.3 Typical characteristics

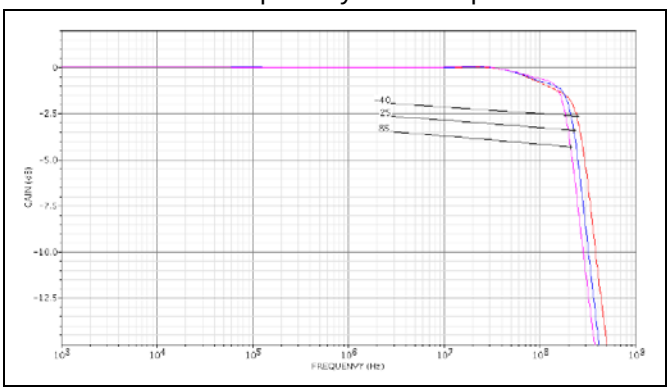
0.1dB Gain Flatness vs. Frequency; G=+2



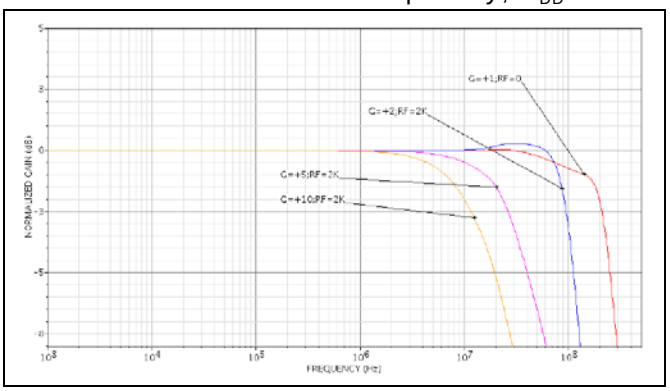
Gain vs. Frequency vs Supply



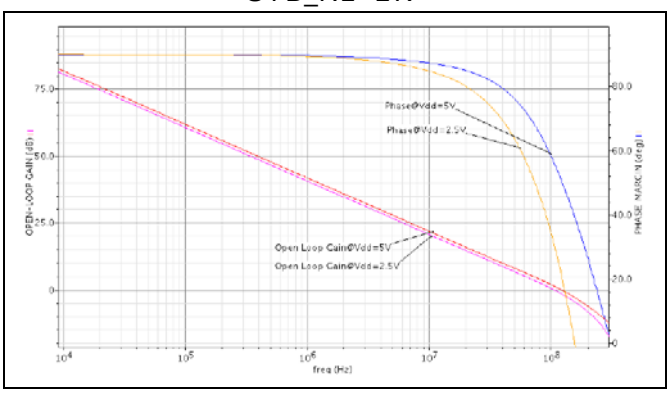
Gain vs. Frequency vs Temperature



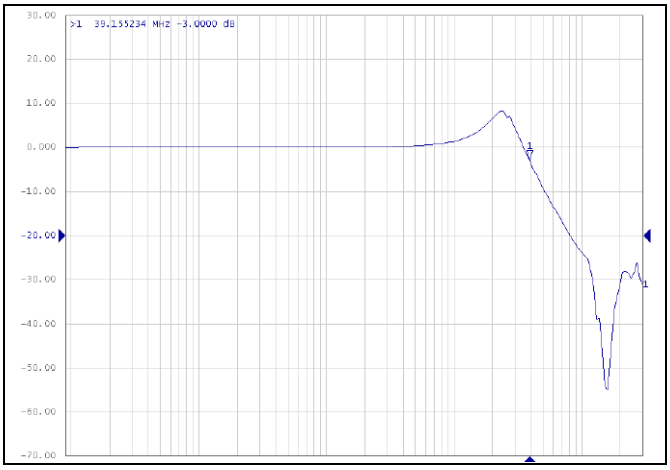
Normalized Gain vs. Frequency; V_{DD}=5V



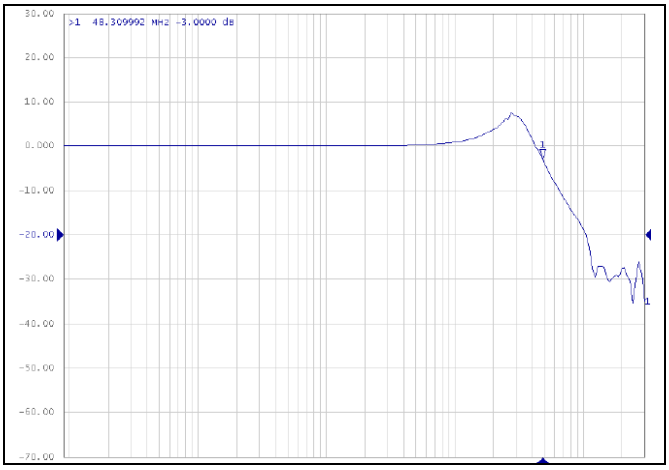
STB_RL=2K



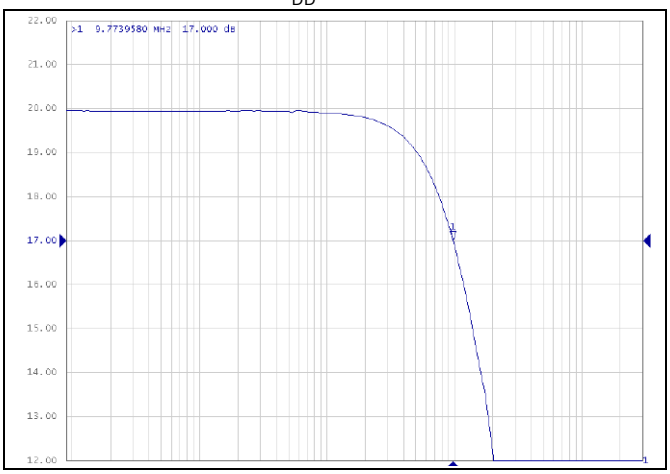
G=+1; RF=2K; V_{PP}=0.2V; V_{DD}=2.5V



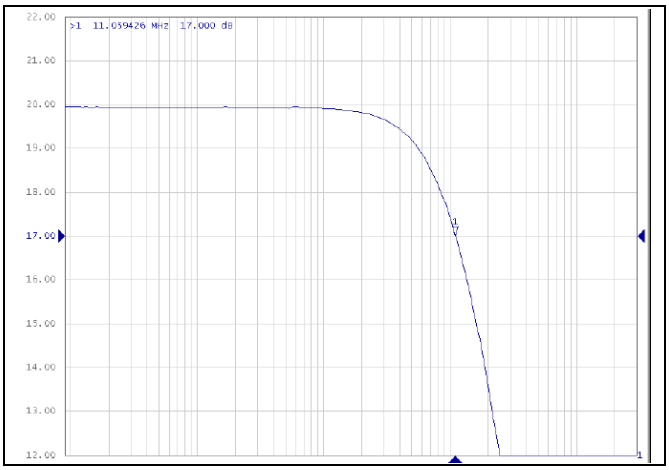
G=+1; RF=2K; V_{PP}=0.2V; V_{DD}=5V



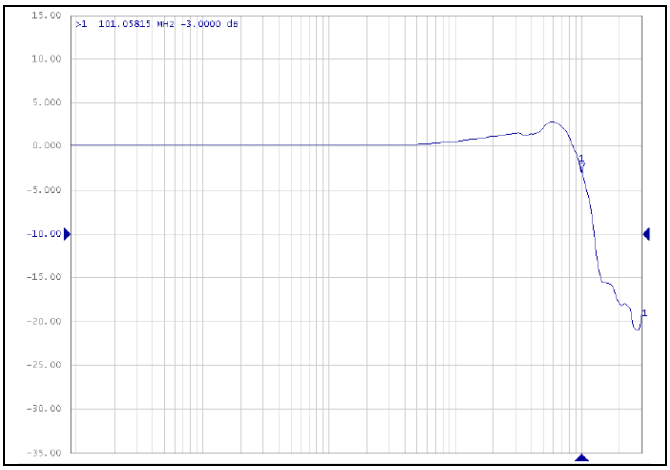
G=+2;RF=100Ω; RI=150 Ω V_{PP}=0.2V; V_{DD}=2.5V



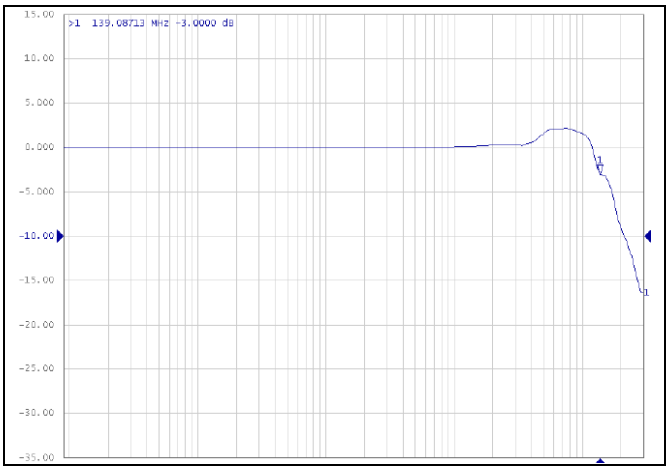
G=-10; RF=2K; V_{PP}=0.2V; V_{DD}=5V



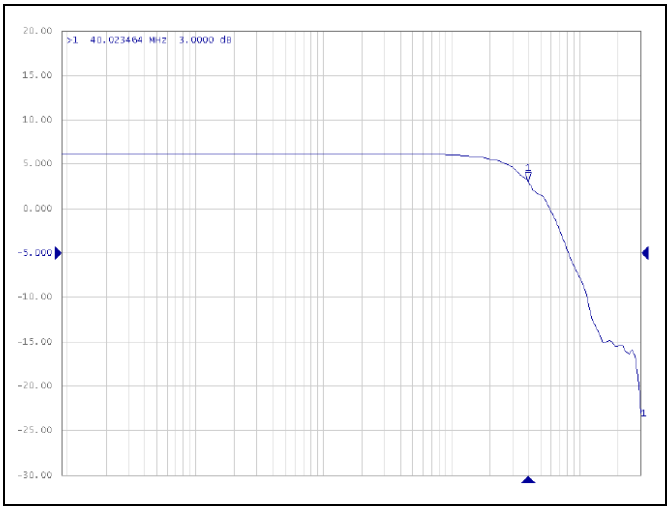
G=+1; RF=2K; V_{PP}=0.2V; V_{DD}=2.5V



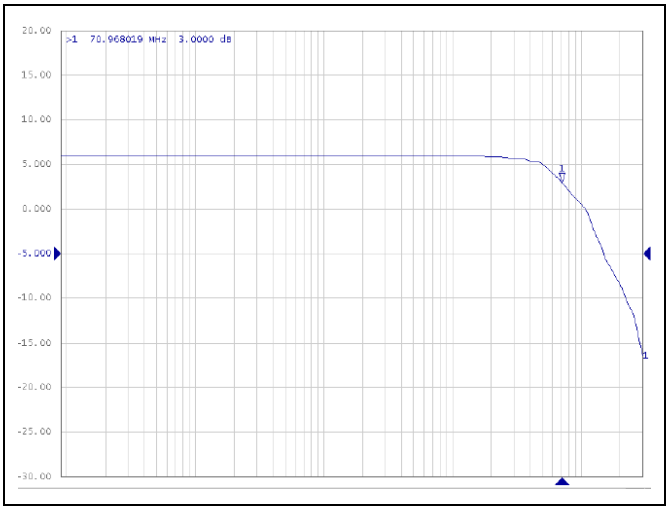
G=+1; RF=2K; V_{PP}=0.2V; V_{DD}=5V



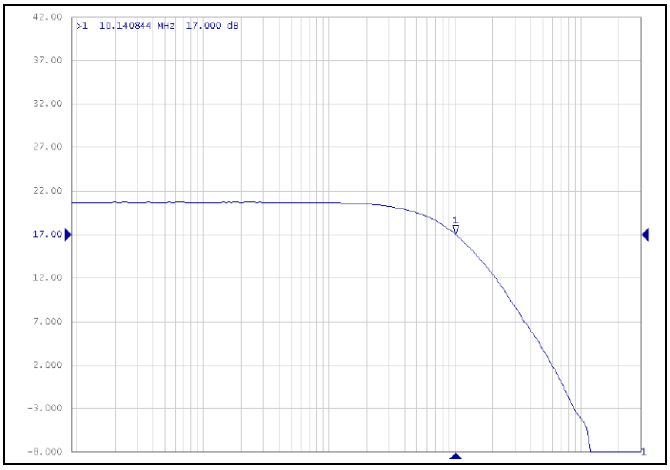
G=+2; RF=100 Ω; RI=150 Ω V_{PP}=0.2V; V_{DD}=2.5V



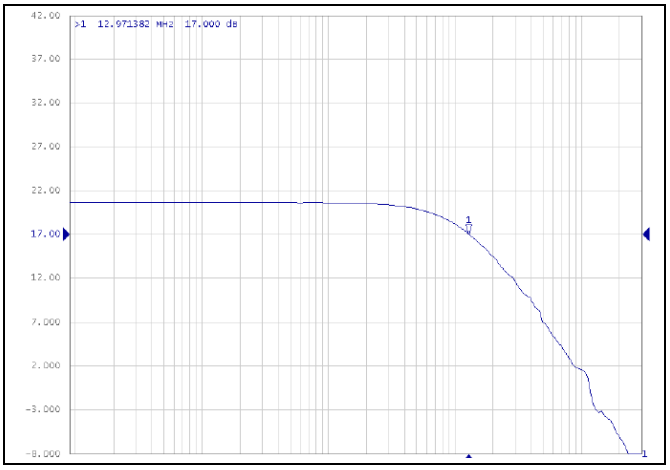
G=+2; RF=100 Ω; RI=150 Ω V_{PP}=0.2V; V_{DD}=5V



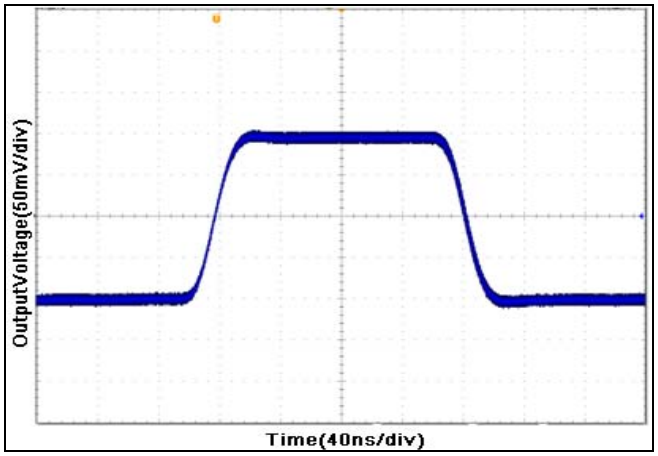
G=+10; RF=2K; V_{PP}=0.2V; V_{DD}=2.5V



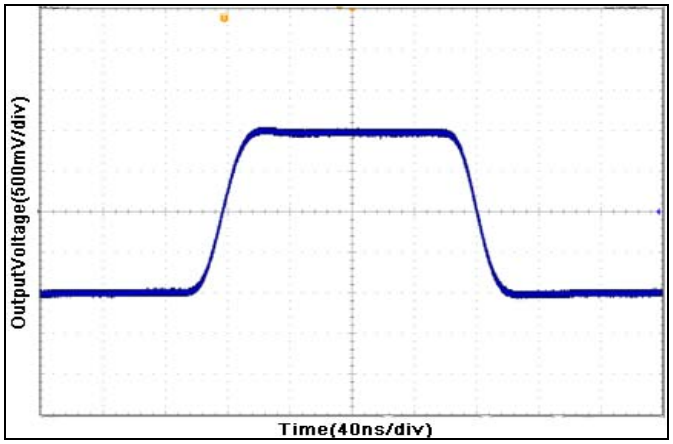
G=+10;RF=2K;V_{PP}=0.2V;V_{DD}=5V



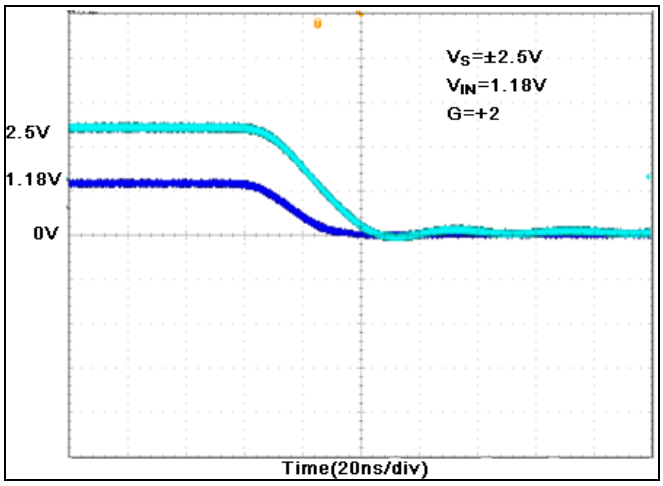
Non-Inverting Small Signal Step Response



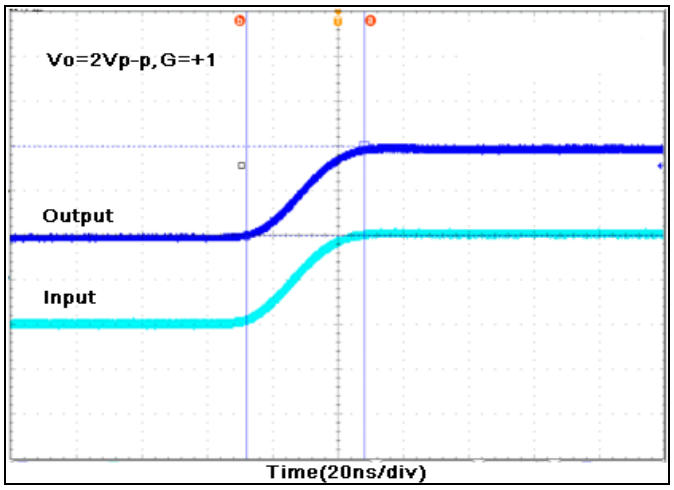
Non-Inverting Large Signal Step Response



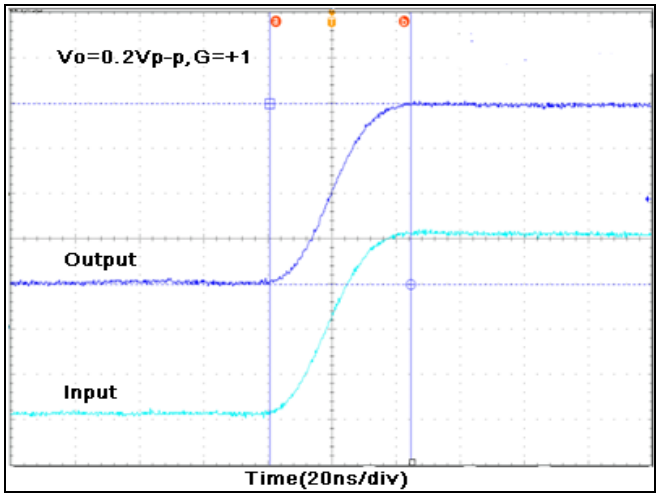
Overload Recovery Time



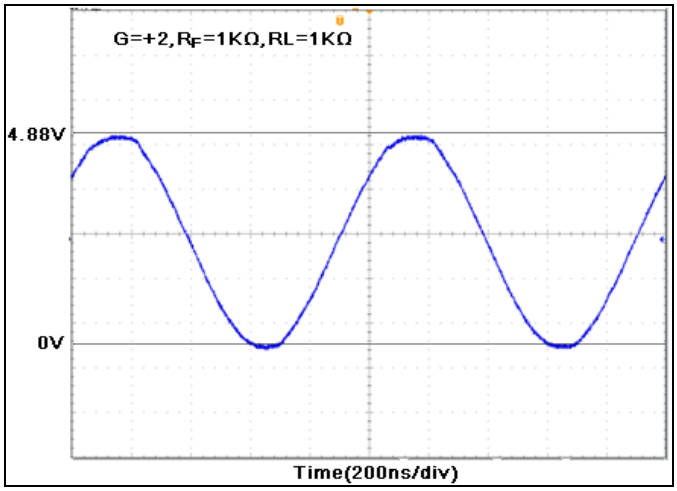
Output Settling Time(large signal)



Output Settling Time(small signal)



Rail-To-Rail



7. Ordering Information

GT XXXX - XX X X

- Temperature Range
  - I Industrial: -40°C~+125°C
- Pb Status
  - G GREEN
- Package Type:
  - S MSOP8
  - G SOP8
- Part Number
- Giantec Prefix
  - GT Giantec

Order Number	Package Description	Package Option
GT7112-SGI-TR	MSOP8	Tape and Reel 3000
GT7112-GGI-TR	SOP8	Tape and Reel 4000

8. Part Markings

8.1 GT7112-SGI (Top View)

G	T	7	1	1	1	S	G	I
				Lot Number				
●		Y	Y	W	W	S	V	

GT7112SGI

Lot Number	States the last 9 characters of the wafer lot information
●	Pin 1 Indicator
YY	Seal Year
	00 = 2000
	01 = 2001
	99 = 2099
WW	Seal Week
	01 = Week 1
	02 = Week 2
	.
	.
	.
	51 = Week 51
	52 = Week 52
S	Subcon Code
	J = ASESH
	L = ASEKS
V	Die Version

8.2 GT7112-GGI (Top View)

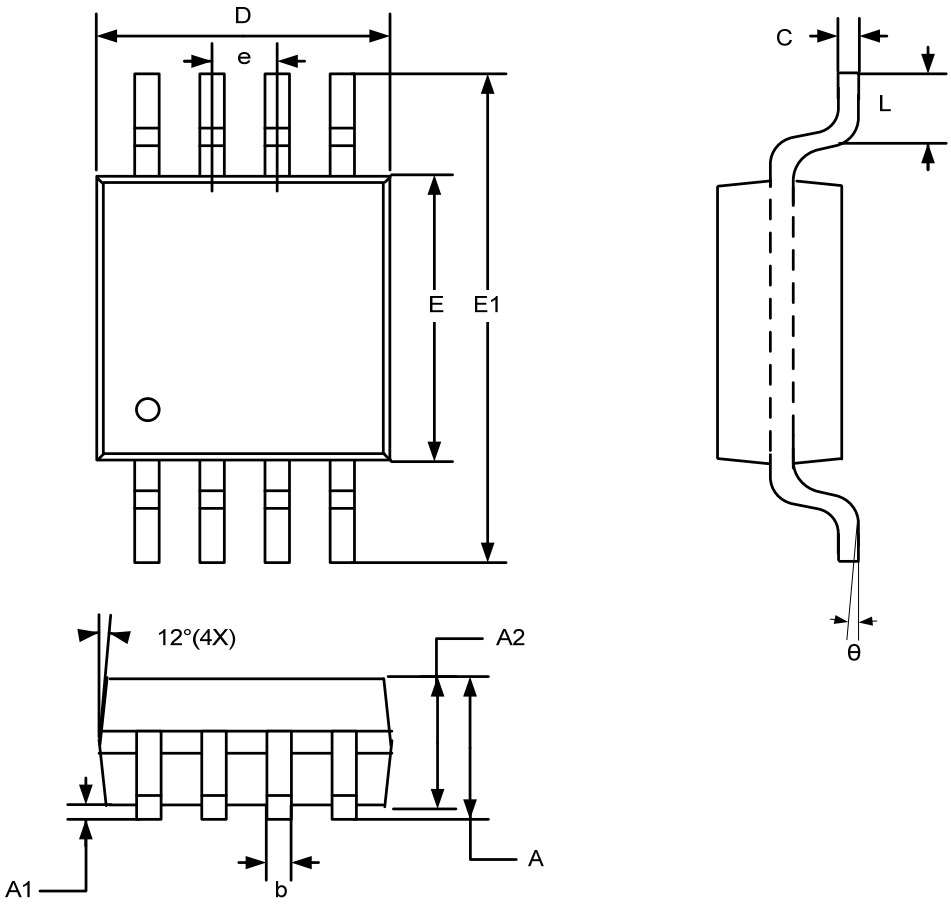
G	T	7	1	1	1	G	G	I
				Lot Number				
●		Y	Y	W	W	S	V	

GT7112GGI

Lot Number	States the last 9 characters of the wafer lot information
●	Pin 1 Indicator
YY	Seal Year
	00 = 2000
	01 = 2001
	99 = 2099
WW	Seal Week
	01 = Week 1
	02 = Week 2
	.
	.
	.
	51 = Week 51
	52 = Week 52
S	Subcon Code
	J = ASESH
	L = ASEKS
V	Die Version

9. Package Information

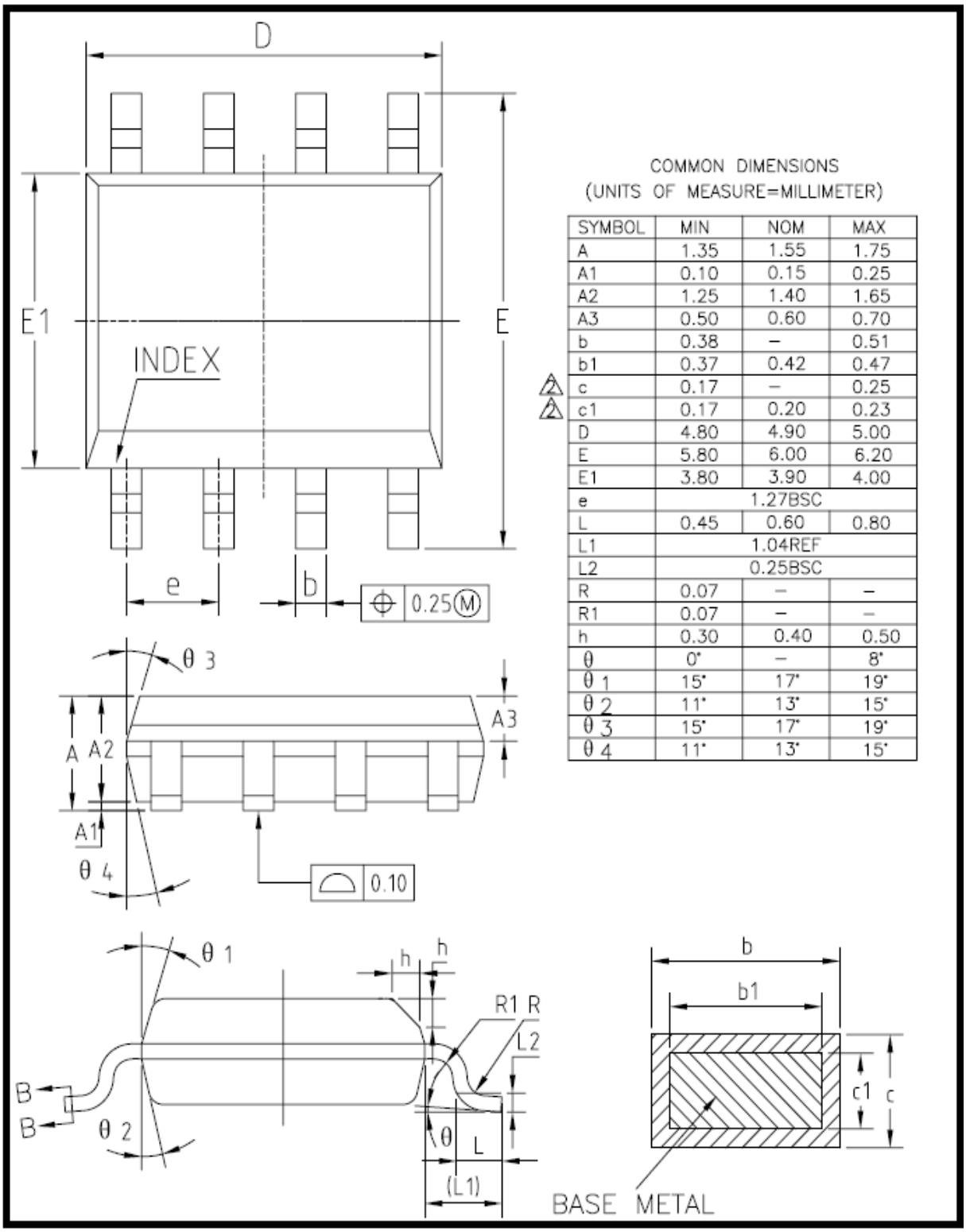
9.1 MSOP8



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	--	--	1.10	--	--	0.043
A1	0.05	--	0.15	0.002	--	0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.25	--	0.40	0.010	--	0.016
C	0.13	--	0.23	0.005	--	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
E1	4.90 BSC			0.193 BSC		
e	0.65 BSC			0.026 BSC		
L	--	--	0.55	--	--	0.022
Θ	0	--	7°	0	--	7°

Note:
1. Controlling Dimension:MM
2. Dimension D and E1 do not include Mold protrusion
3. Refer to Jedec standard MO187
4. Drawing is not to scale

9.2 SOP8



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.15	0.25
A2	1.25	1.40	1.65
A3	0.50	0.60	0.70
b	0.38	–	0.51
b1	0.37	0.42	0.47
2 c	0.17	–	0.25
2 c1	0.17	0.20	0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27BSC	
L	0.45	0.60	0.80
L1		1.04REF	
L2		0.25BSC	
R	0.07	–	–
R1	0.07	–	–
h	0.30	0.40	0.50
θ	0°	–	8°
θ 1	15°	17°	19°
θ 2	11°	13°	15°
θ 3	15°	17°	19°
θ 4	11°	13°	15°

10. Revision History

Revision	Date	Descriptions
A0	Sept.,2013	Initial Version