SGM80581/2/4
220MHz, Rail-to-Rail I/O, CMOS Operational Amplifiers

GENERAL DESCRIPTION

The SGM80581 (single), SGM80582 (dual) and SGM80584 (quad) of high-speed, voltage-feedback CMOS operational amplifiers are designed for video and other applications requiring wide bandwidth. They are unity-gain stable and can drive large output currents. Differential gain is 0.01% and differential phase is 0.1°. Quiescent current is only 4.5mA/Amplifier.

The SGM80581/2/4 are optimized for operation on single or dual supplies as low as 2.5V (±1.25V) and up to 5.5V (±2.75V). Input common mode range extends beyond the supplies. The output swing is within 15mV of the rails, supporting wide dynamic range.

The SGM80581/2/4 are suitable for applications requiring high continuous output current. Multichannel versions feature completely independent circuitry for lowest crosstalk and freedom from interaction.

The single SGM80581 is available in the Green SOT-23-5 and SOIC-8 packages. The dual SGM80582 is available in the Green MSOP-8 and SOIC-8 packages. The quad SGM80584 is available in the Green SOIC-14 package. All are specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **Unity-Gain Bandwidth: 220MHz**
- **Wide Bandwidth: 100MHz GBP**
- **High Slew Rate: 160V/μs**
- **Low Noise: 7nV/$\sqrt{Hz}$ at 1MHz**
- **Rail-to-Rail Input and Output**
- **High Output Current: 150mA (TYP)**
- **Excellent Video Performance:**
  - **Diff Gain: 0.01%, Diff Phase: 0.1°**
  - **0.1dB Gain Flatness: 30MHz**
- **Low Input Bias Current: 2pA**
- **Quiescent Current: 4.5mA/Amplifier (TYP)**
- **Thermal Shutdown**
- **2.5V to 5.5V Single Supplies or ±1.25V to ±2.75V Dual Power Supplies**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  - **SGM80581 Available in Green SOT-23-5 and SOIC-8 Packages**
  - **SGM80582 Available in Green MSOP-8 and SOIC-8 Packages**
  - **SGM80584 Available in Green SOIC-14 Package**

APPLICATIONS

Video Processing
Ultrasound
Optical Networking, Tunable Lasers
Photodiode Transimpedance Amplifiers
Active Filters
High-Speed Integrators
Analog-to-Digital (A/D) Converter Input Buffers
Digital-to-Analog (D/A) Converter Output Amplifiers
Barcode Scanners

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM80581	SOT-23-5	-40℃ to +125℃	SGM80581XN5G/TR	SU1XX	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM80581XS8G/TR	SGM 80581XS8 XXXXX	Tape and Reel, 2500
SGM80582	MSOP-8	-40℃ to +125℃	SGM80582XMS8G/TR	SGM80582 XMS8 XXXXX	Tape and Reel, 4000
	SOIC-8	-40℃ to +125℃	SGM80582XS8G/TR	SGM 80582XS8 XXXXX	Tape and Reel, 2500
SGM80584	SOIC-14	-40℃ to +125℃	SGM80584XS14G/TR	SGM80584XS14 XXXXX	Tape and Reel, 2500

NOTE: XX = Date Code. XXXXX = Date Code and Vendor Code.

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

MARKING INFORMATION

SU1 X X

Date code - Month ("A" = Jan. "B" = Feb. ··· "L" = Dec.)
Date code - Year ("A" = 2010, "B" = 2011 ···)
Chip I.D.

For example: SU1FA (2015, January)

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$ 6V
Input Common Mode Voltage Range
.... $(-V_S) - 0.1V$ to $(+V_S) + 0.1V$
Signal Input Terminals Voltage
.... $(-V_S) - 0.3V$ to $(+V_S) + 0.3V$
Output Short-Circuit .... Continuous
Storage Temperature Range .... -65℃ to +150℃
Junction Temperature .... 150℃
Lead Temperature (Soldering 10sec) .... 260℃
ESD Susceptibility
HBM 6000V
MM 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Specified Voltage Range .... 2.7V to 5.5V
Operating Temperature Range .... -40℃ to +125℃

OVERSTRESS CAUTION

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

ESD SENSITIVITY CAUTION

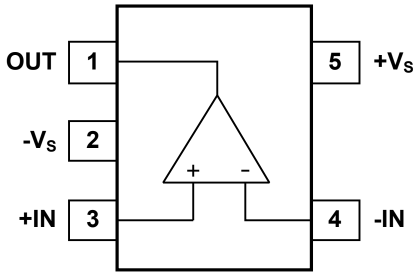
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time.

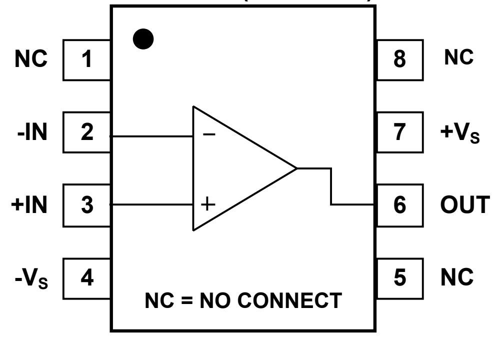
PIN CONFIGURATIONS

SGM80581 (TOP VIEW)



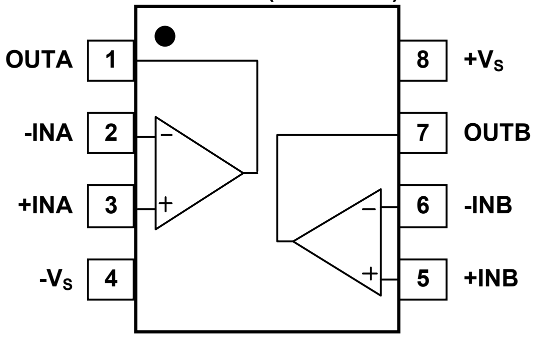
SOT-23-5

SGM80581 (TOP VIEW)



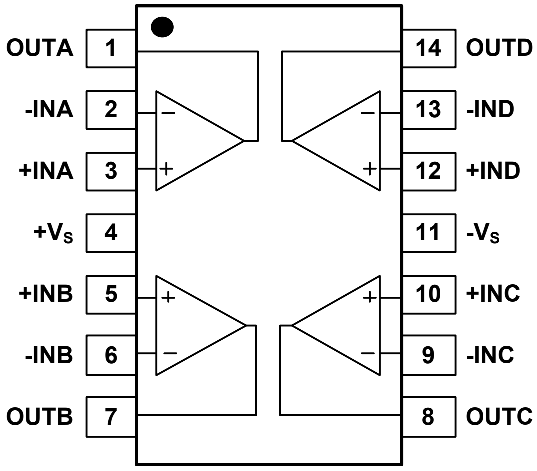
SOIC-8

SGM80582 (TOP VIEW)



SOIC-8/MSOP-8

SGM80584 (TOP VIEW)



SOIC-14

ELECTRICAL CHARACTERISTICS

(V_S = 2.7V to 5.5V, T_A = +25℃, V_{CM} = V_S/2, V_{OUT} = V_S/2, R_L = 1kΩ connected to V_S/2, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS					
Input Offset Voltage (V_{OS})	V_S = 5V		1.0	3.0	mV
	-40℃ ≤ T_A ≤ +125℃			6.5	
Input Bias Current (I_B)			2		pA
Input Offset Voltage (I_{OS})			0.1		pA
Input Common Mode Voltage Range (V_{CM})		(-V_S) - 0.1		(-V_S) + 0.1	V
Common Mode Rejection Ratio (CMRR)	V_S = 5.5V, -0.1V < V_{CM} < 5.6V	56	71		dB
	-40℃ ≤ T_A ≤ +125℃	53			
	V_S = 5.5V, -0.1V < V_{CM} < 3.5V	60	71		
	-40℃ ≤ T_A ≤ +125℃	58			
Open-Loop Voltage Gain (A_{OL})	(-V_S) + 0.3V < V_O < (+V_S) - 0.3V, R_L = 1kΩ	89	109		dB
	(-V_S) + 0.4V < V_O < (+V_S) - 0.4V, R_L = 1kΩ	89	109		
	-40℃ ≤ T_A ≤ +125℃	84			
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)	-40℃ ≤ T_A ≤ +125℃		6.5		μV/℃
INPUT IMPEDANCE					
Differential			10^{12} || 4		Ω || pF
Common Mode			10^{12} || 6		Ω || pF
OUTPUT CHARACTERISTICS					
Output Voltage Swing from Rail	V_S = 5V, R_L = 1kΩ		15	62	mV
Short-Circuit Current (I_{SC})	V_S = 5V	110	150		mA
	V_S = 3V		90		
Closed-Loop Output Impedance	f < 100kHz		0.1		Ω
DYNAMIC PERFORMANCE					
-3dB Small Signal Bandwidth (f_{-3dB})	G = +1, V_O = 100mV_{PP}, R_F = 25Ω		220		MHz
	G = +2, V_O = 100mV_{PP}		106		
Gain-Bandwidth Product (GBP)	G = +10, V_O = 100mV_{PP}		100		MHz
Bandwidth for 0.1dB Gain Flatness	G = +2, V_O = 100mV_{PP}		30		MHz
Slew Rate (SR)	V_S = 5V, V_O = 2V_{PP}		160		V/μs
	V_S = 5V, V_O = 4V_{PP}		170		
Rise-and-Fall Time	G = +1, V_O = 200mV_{PP}, 10% to 90%		3.5		ns
	G = +1, V_O = 2V_{PP}, 10% to 90%		12		
Settling Time to 0.1%	V_O = 2V_{PP}		75		ns
	V_O = 4V_{PP}		35		ns
Overload Recovery Time	V_{IN} × Gain = V_S		18		ns
Crosstalk (SGM80582/4)	f = 5MHz		-110		dB

ELECTRICAL CHARACTERISTICS (continued)

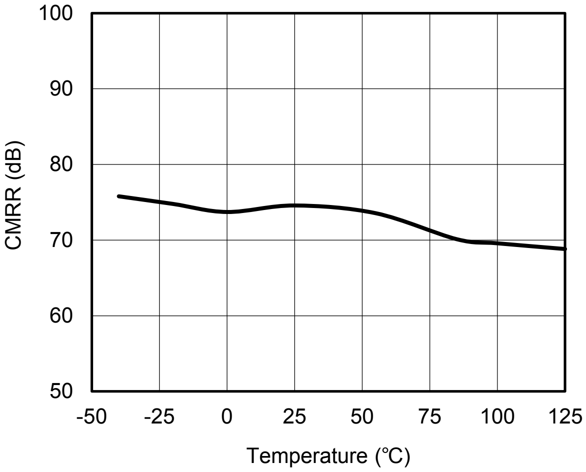
(V_S = 2.7V to 5V, T_A = +25℃, $V_{CM} = V_S/2$, $V_{OUT} = V_S/2$, R_L = 1kΩ connected to $V_S/2$, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
POWER SUPPLY					
Specified Voltage Range (V_S)			2.7 to 5.5		V
Operating Voltage Range		2.5		5.5	V
Power Supply Rejection Ratio (PSRR)	V_S = 2.7V to 5.5V, $V_{CM} = (V_S/2) - 0.55V$		100	540	μV/V
	-40℃ ≤ T_A ≤ +125℃			620	
Quiescent Current/Amplifier (I_Q)	V_S = 5V, I_{OUT} = 0		4.5	7	mA
	-40℃ ≤ T_A ≤ +125℃			9	
NOISE/DISTORTION PERFORMANCE					
Input Voltage Noise Density (e_n)	f = 1MHz		7		$nV/\sqrt{Hz}$
Input Current Noise Density (i_n)	f = 1MHz		10		$fA/\sqrt{Hz}$
Differential Gain Error	PAL, R_L = 150Ω		0.01		%
Differential Phase Error	PAL, R_L = 150Ω		0.1		°
Harmonic Distortion (2nd-Harmonic)	G = +1, f = 1MHz, $V_O = 2V_{PP}$, R_L = 200Ω, V_{CM} = 1.5V		-66		dBc
Harmonic Distortion (3rd-Harmonic)	G = +1, f = 1MHz, $V_O = 2V_{PP}$, R_L = 200Ω, V_{CM} = 1.5V		-76		dBc
THERMAL SHUTDOWN					
Thermal Shutdown			150		℃
Reset from Shutdown			130		℃

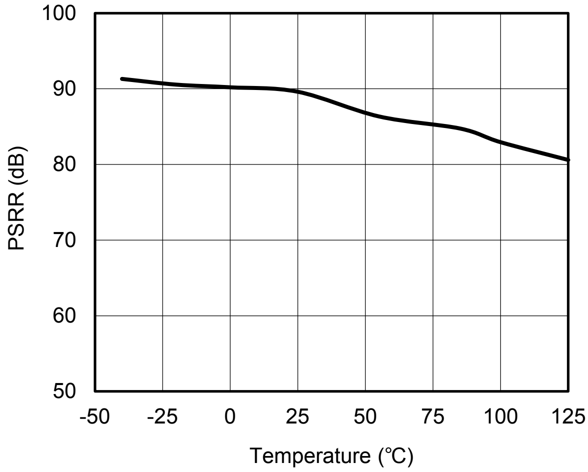
TYPICAL PERFORMANCE CHARACTERISTICS

V_S = 5V, G = +1, R_L = 1kΩ and connected to V_S/2, T_A = +25℃, unless otherwise noted.

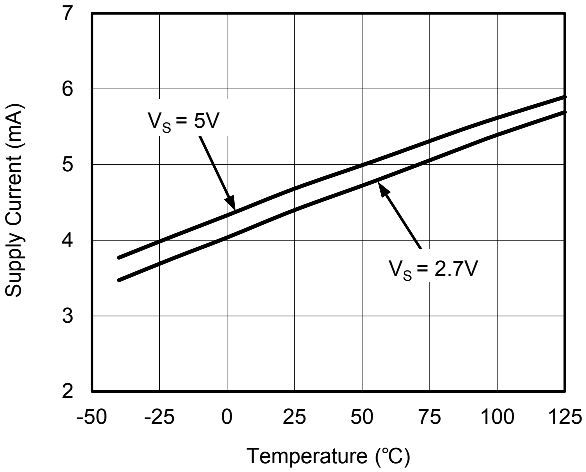
Common Mode Rejection Ratio vs. Temperature



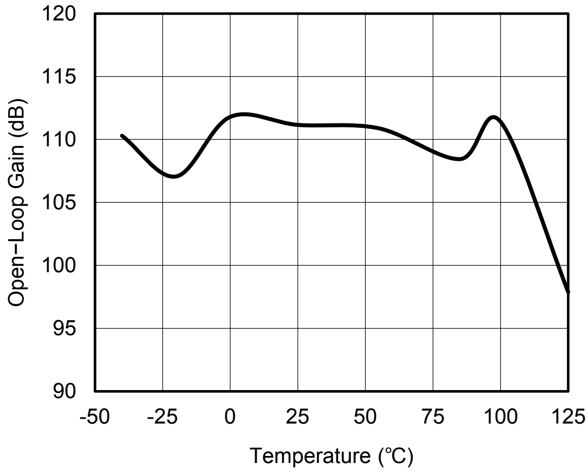
Power Supply Rejection Ratio vs. Temperature



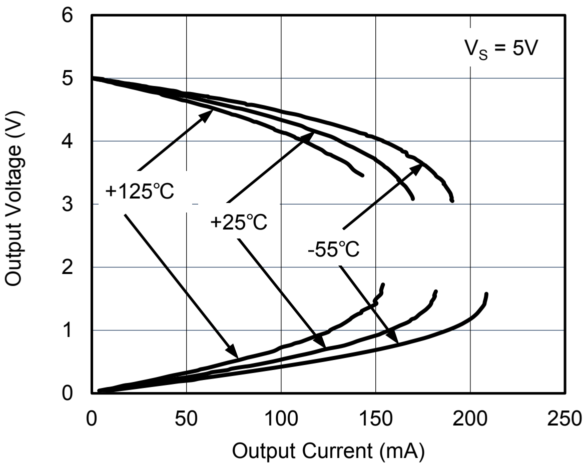
Supply Current vs. Temperature



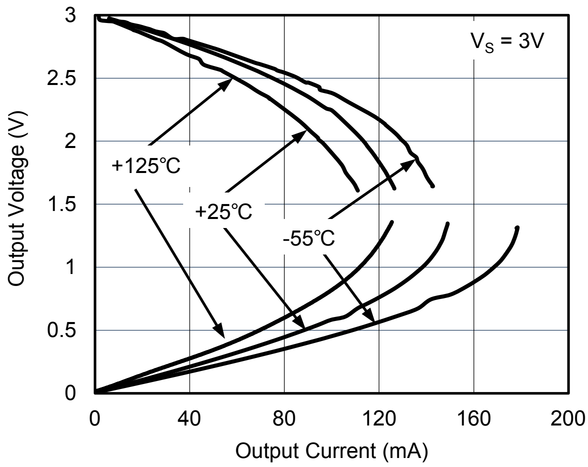
Open-Loop Gain vs. Temperature



Output Voltage Swing vs. Output Current



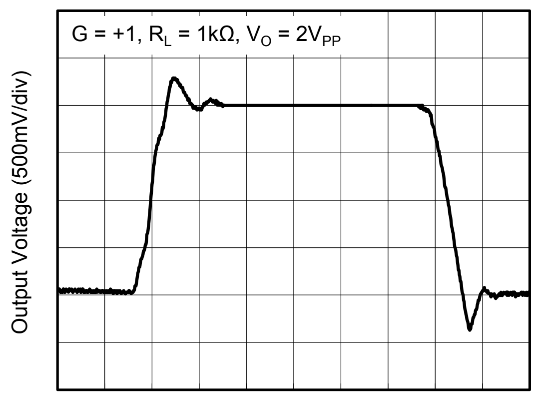
Output Voltage Swing vs. Output Current



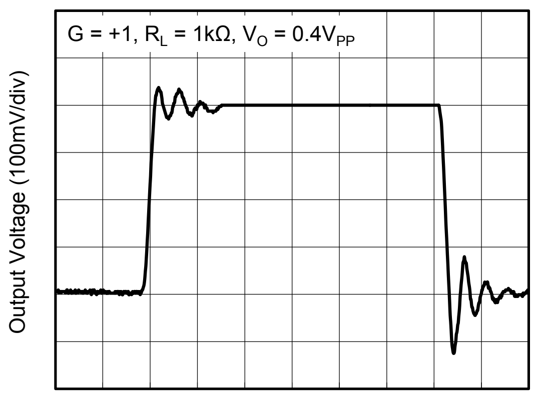
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_S = 5V, G = +1, R_L = 1kΩ and connected to V_S/2, T_A = +25℃, unless otherwise noted.

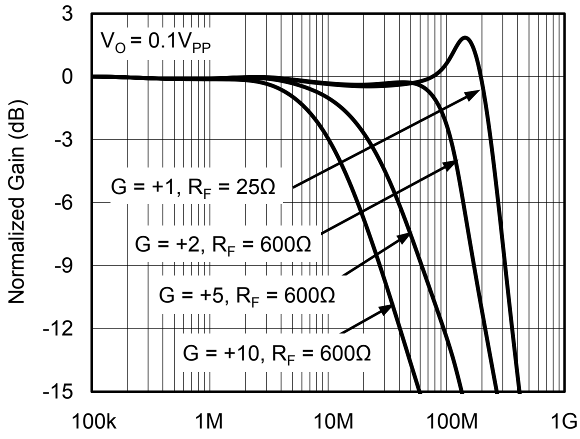
Non-inverting Large Signal Step Response



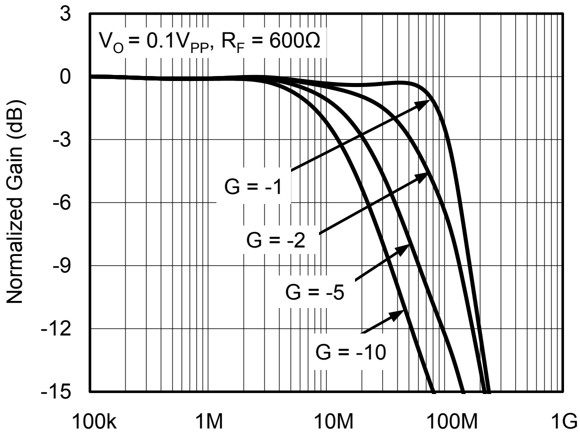
Non-inverting Small Signal Step Response



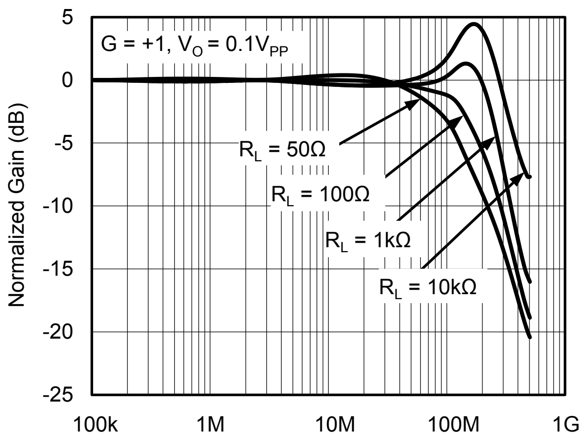
Non-inverting Small Signal Frequency Response



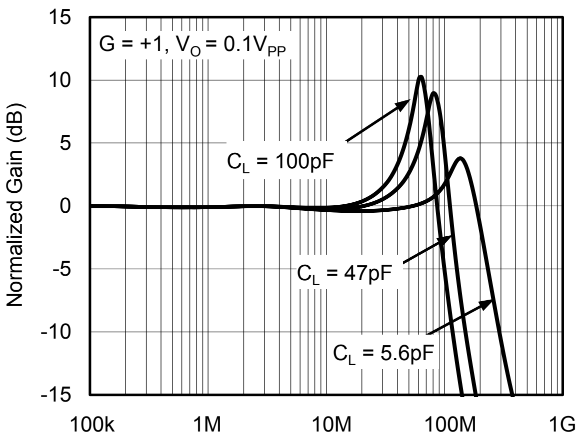
Inverting Small Signal Frequency Response



Frequency Response for Various R_L



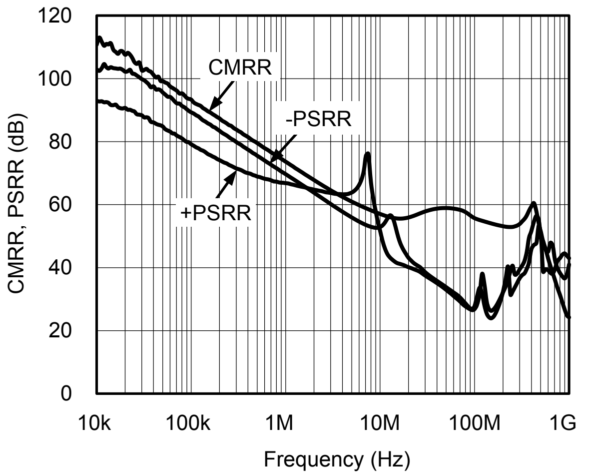
Frequency Response for Various C_L



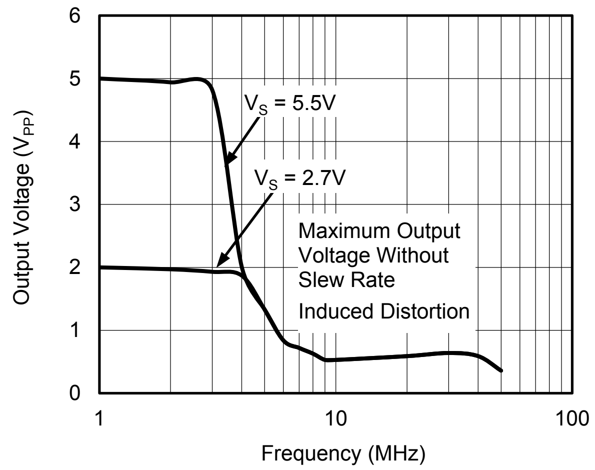
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_S = 5V, G = +1, R_L = 1kΩ and connected to V_S/2, T_A = +25℃, unless otherwise noted.

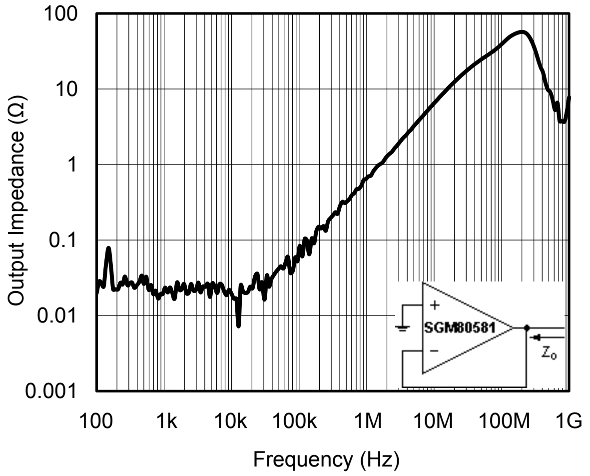
CMRR, PSRR vs. Frequency



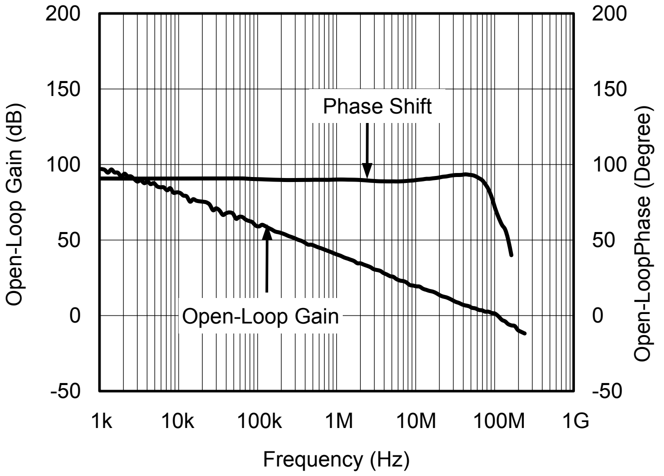
Maximum Output Voltage vs. Frequency



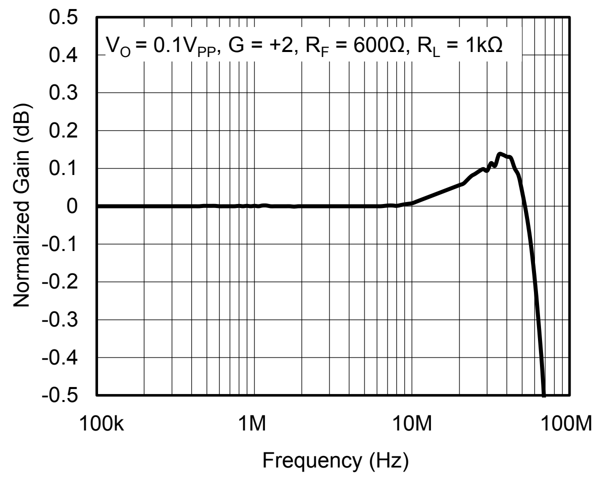
Closed-Loop Output Impedance vs. Frequency



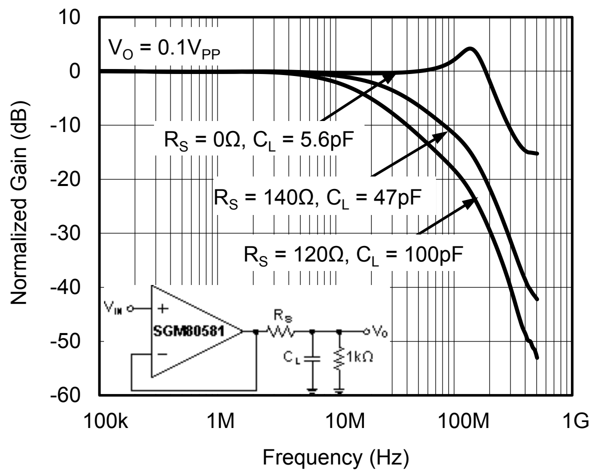
Gain and Phase Margin vs. Frequency



0.1dB Gain Flatness

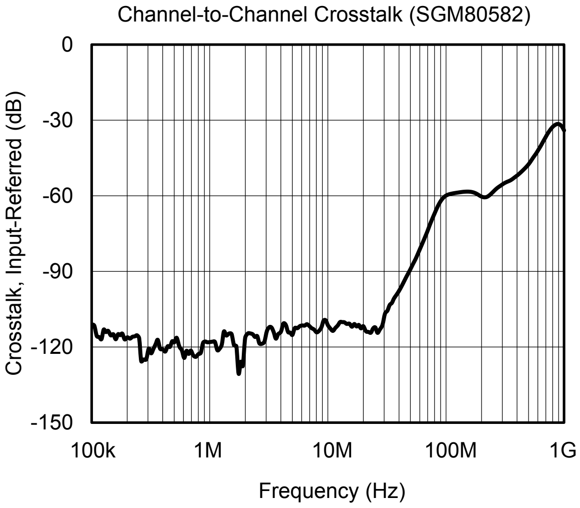


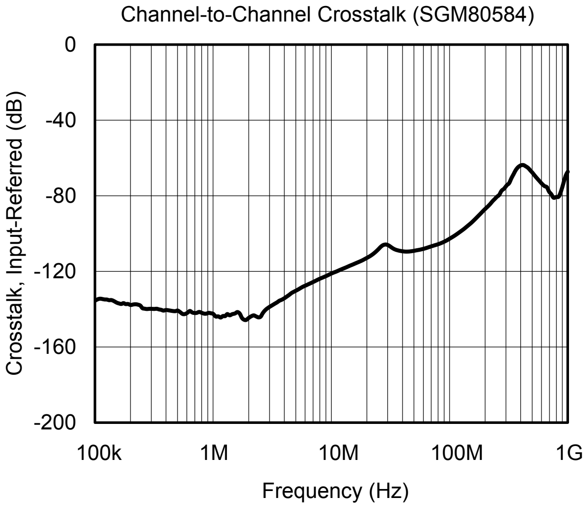
Frequency Response vs. Capacitive Load

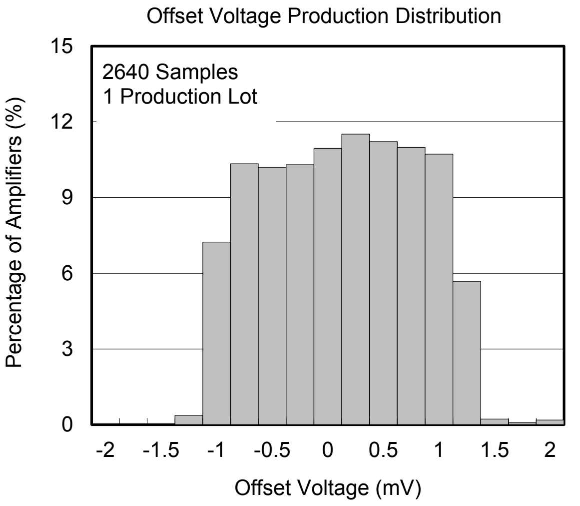


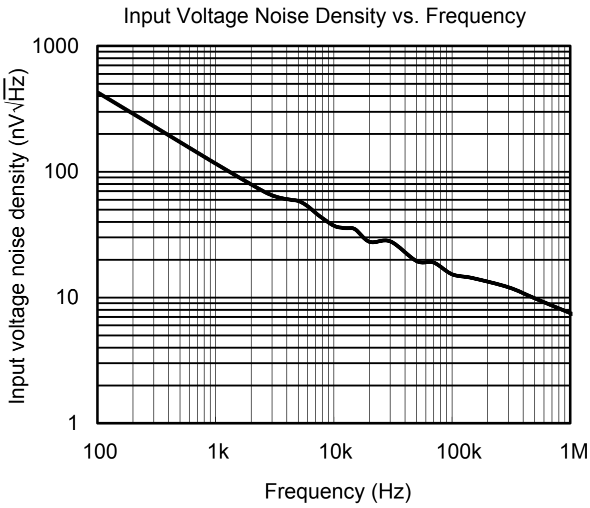
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

V_S = 5V, G = +1, R_L = 1kΩ and connected to V_S/2, T_A = +25℃, unless otherwise noted.









APPLICATION INFORMATION

The SGM80581/2/4 are CMOS, rail-to-rail I/O, high-speed, voltage-feedback operational amplifiers designed for video, high-speed and other applications. They are available as single, dual or quad operational amplifiers.

The amplifier features a 100MHz gain-bandwidth product, and 160V/μs slew rate. It is unity-gain stable and can be operated as a +1V/V voltage follower.

Operating Voltage

The SGM80581/2/4 are specified over a power supply range of 2.7V to 5.5V (±1.35V to ±2.75V). However, the supply voltage may range from 2.5V to 5.5V (±1.25V to ±2.75V). Supply voltages higher than 6V (absolute maximum) can permanently damage the amplifier.

Rail-to-Rail Output

A class AB output stage with common-source transistors is used to achieve rail-to-rail output. For high-impedance loads (> 1kΩ), the output voltage swing is typically within 15mV from the supply rails.

Rail-to-Rail Input

The specified input common mode voltage range of the SGM80581/2/4 extends 100mV beyond the supply rails. This is achieved with a complementary input stage, an N-channel input differential pair in parallel with a P-channel differential pair, as shown in Figure 1. The N-channel pair is active for input voltages close to the positive rail, typically ($+V_S$) - 1.2V to 100mV above the positive supply, while the P-channel pair is on for input voltages from 100mV below the negative supply to approximately ($+V_S$) - 1.2V. There is a small transition region, typically ($+V_S$) - 1.5V to ($+V_S$) - 0.9V, in which both pairs are on. This 600mV transition region can vary ±500mV with process variation. Thus, the transition region (both input stages on) can range from ($+V_S$) - 2.0V to ($+V_S$) - 1.5V on the low end, up to ($+V_S$) - 0.9V to ($+V_S$) - 0.4V on the high end.

A folded-cascode adds the signal from the two input pairs and presents a differential signal to the class AB output stage.

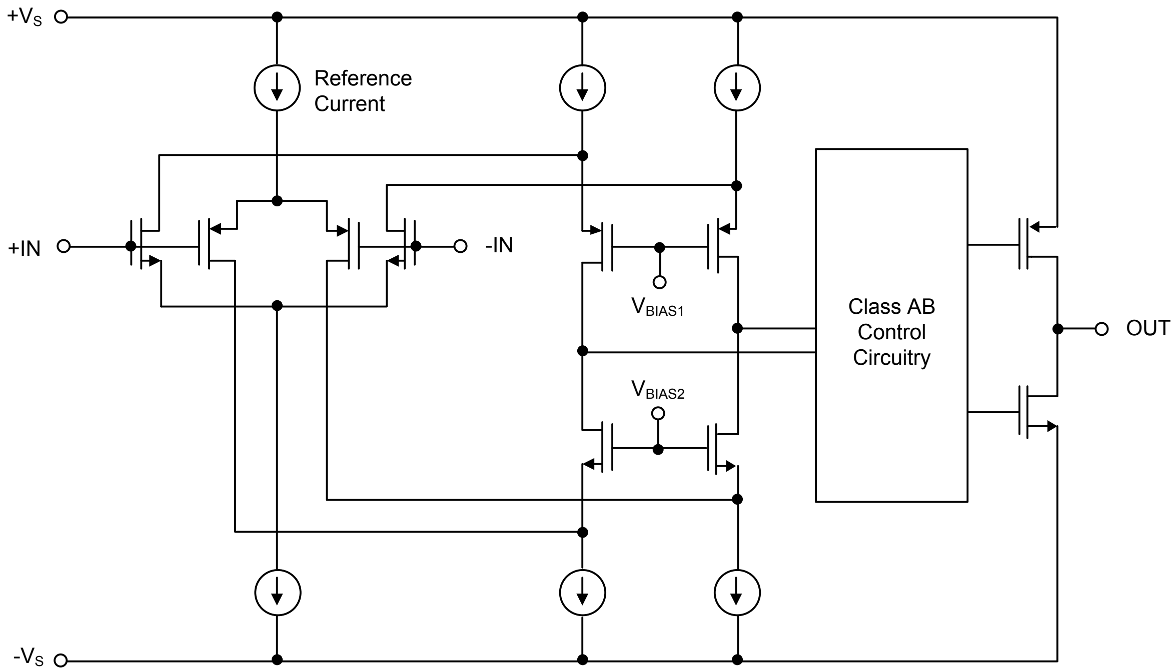


Figure 1. Simplified Schematic

APPLICATION INFORMATION (continued)

Output Drive

The SGM80581's output stage can supply a continuous output current of ±100mA, as shown in Figure 2. For maximum reliability, it is not recommended to run a continuous DC current in excess of ±110mA. For supplying continuous output currents greater than ±110mA, the SGM80581 may be operated in parallel, as shown in Figure 3.

The on-chip thermal shutdown circuit is provided to protect the SGM80581/2/4 from dangerously high junction temperatures. At 150℃, the protection circuit will shut down the amplifier. Normal operation will resume when the junction temperature cools to below 130℃.

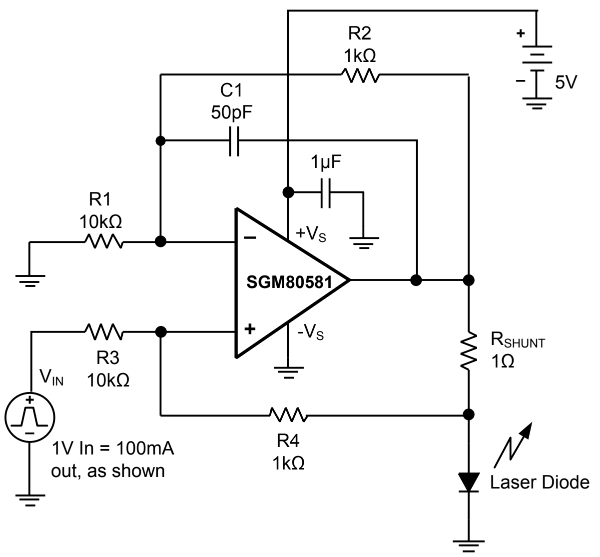


Figure 2. Laser Diode Driver

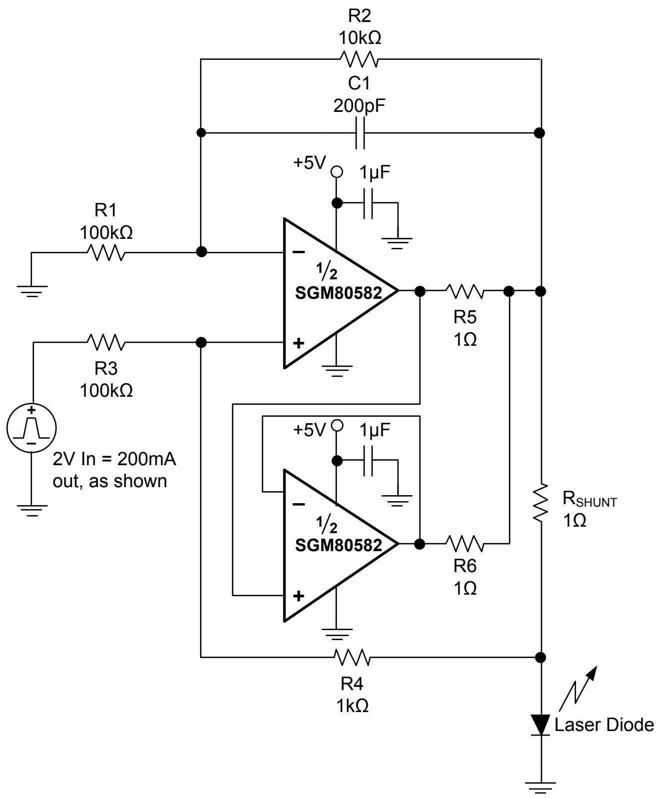


Figure 3. Parallel Operation

Video

The SGM80581 output stage is capable of driving standard back-terminated 75Ω video cables, as shown in Figure 4. By back-terminating a transmission line, it does not exhibit a capacitive load to its driver. A properly back-terminated 75Ω video cable does not appear as capacitance; it presents only a 150Ω resistive load to the SGM80581 output. The SGM80581/2/4 can be used as an amplifier for RGB graphic signals, which have a voltage of zero at the video black level, by offsetting and AC-coupling the signal. See Figure 5.

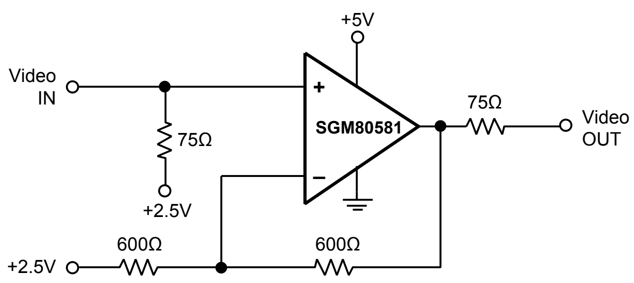


Figure 4. Single-Supply Video Line Driver

APPLICATION INFORMATION (continued)

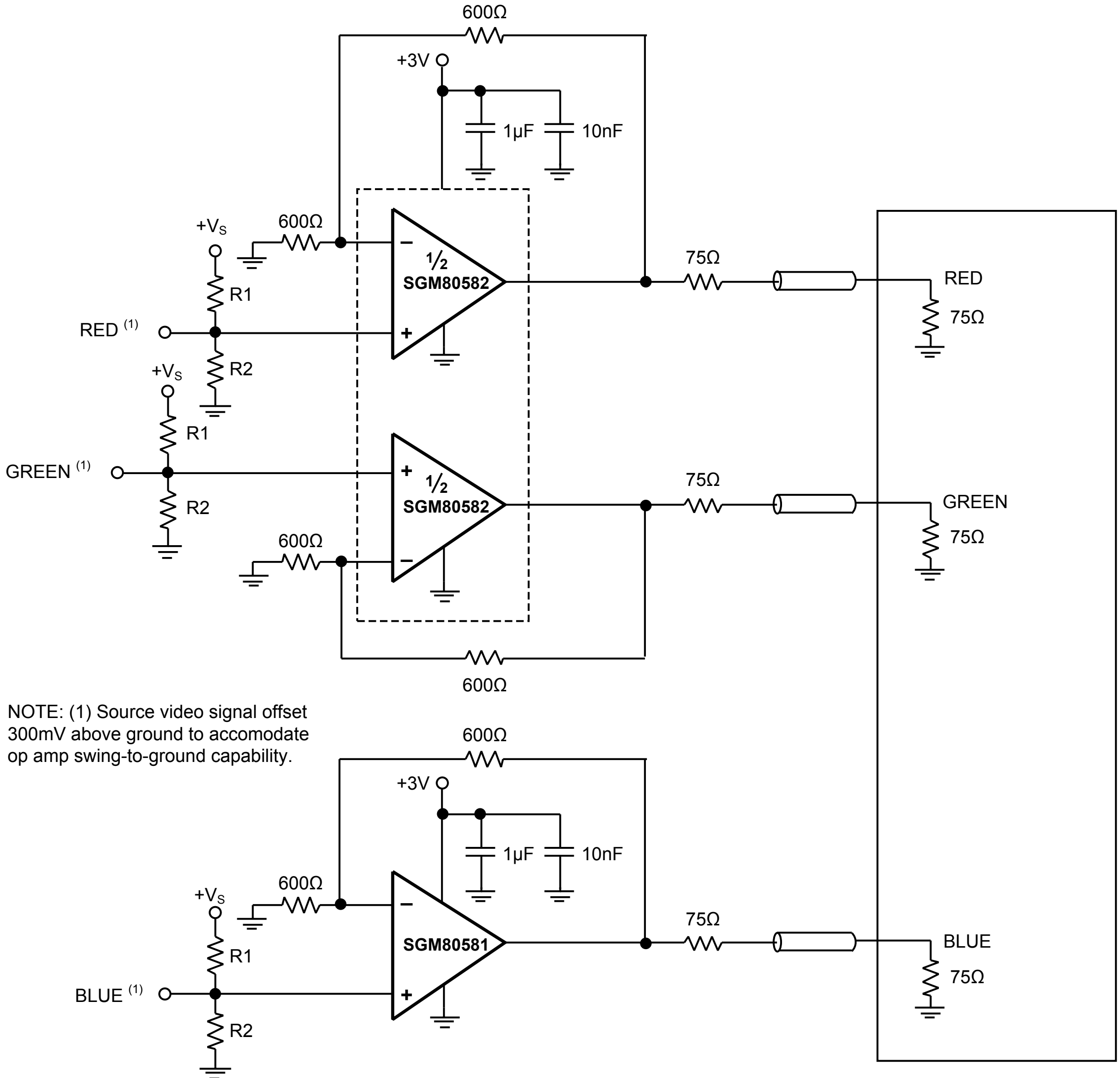


Figure 5. RGB Cable Driver

APPLICATION INFORMATION (continued)

Driving Analog-to-Digital Converters

The SGM80581/2/4 operational amplifiers offer 75ns of settling time to 0.1%, making them a good choice for driving high- and medium-speed sampling A/D converters and reference circuits. The SGM80581/2/4 provide effective means of buffering the A/D converter's input capacitance and resulting charge injection while providing signal gain.

Figure 6 illustrates the SGM80581 driving an A/D converter. With the SGM80581 in an inverting configuration, a capacitor across the feedback resistor can be used to filter high-frequency noise in the signal.

Capacitive Load and Stability

The SGM80581/2/4 operational amplifiers can drive a wide range of capacitive loads. However, all operational amplifiers under certain conditions may become unstable. Operational amplifier configuration, gain, and load value are just a few of the factors to consider when determining stability. An operational amplifier in unity-gain configuration is most susceptible to the effects of capacitive loading. The capacitive load reacts with the operational amplifier's output resistance, along with any additional load resistance, to create a pole in the small-signal response that degrades the phase margin.

One method of improving capacitive load drive in the unity-gain configuration is to insert a resistor in series with the output, as shown in Figure 7. This significantly reduces ringing with large capacitive loads. However, if there is a resistive load in parallel with the capacitive load, R_S creates a voltage divider. This introduces a DC error at the output and slightly reduces output swing. This error may be insignificant.

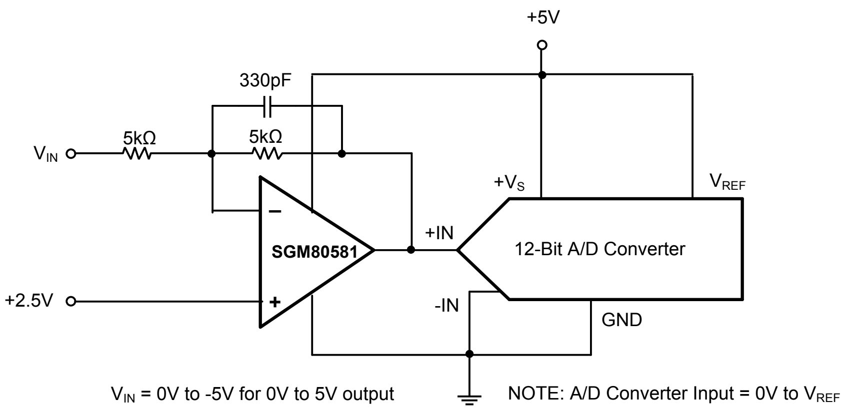


Figure 6. The SGM80581 in Inverting Configuration Driving an ADC

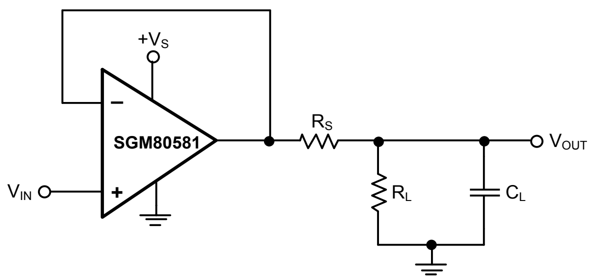


Figure 7. Series Resistor in Unity-Gain Configuration Improves Capacitive Load Drive

APPLICATION INFORMATION (continued)

Wideband Transimpedance Amplifier

Wide bandwidth, low input bias current, low input voltage and current noise make the SGM80581/2/4 ideal wideband photodiode transimpedance amplifiers for low-voltage single-supply applications. Low-voltage noise is important because photodiode capacitance causes the effective noise gain of the circuit to increase at high frequency.

The key elements to a transimpedance design, as shown in Figure 8, are the expected diode capacitance, the desired transimpedance gain (R_F), and the Gain-Bandwidth Product (GBP) of the SGM80581 (100MHz). With these 3 variables set, the feedback capacitor value (C_F) may be set to control the frequency response.

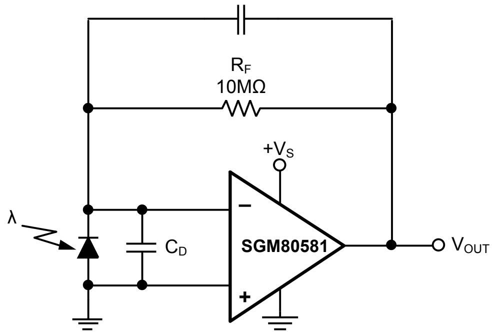


Figure 8. Transimpedance Amplifier

To achieve a maximally flat 2nd-order Butterworth frequency response, the feedback pole should be set to:

$$\frac{1}{2\pi R_F C_F} = \sqrt{\frac{GBP}{4\pi R_F C_D}} \quad (1)$$

Typical surface-mount resistors have a parasitic capacitance of around 0.2pF that must be deducted from the calculated feedback capacitance value. Bandwidth is calculated by:

$$f_{-3dB} = \sqrt{\frac{GBP}{2\pi R_F C_D}}\,Hz \quad (2)$$

PCB Layout

Good high-frequency printed circuit board (PCB) layout techniques should be employed for the SGM80581/2/4. Generous use of ground planes, short and direct signal traces, and a suitable bypass capacitor located at the $+V_S$ pin will assure clean, stable operation. Large areas of copper also provide a means of dissipating heat that is generated in normal operation.

Sockets are definitely not recommended for use with any high-speed amplifier.

A 10nF ceramic bypass capacitor is the minimum recommended value; adding a 1μF or larger tantalum capacitor in parallel can be beneficial when driving a low-resistance load. Providing adequate bypass capacitance is essential to achieving very low harmonic and intermodulation distortion.

Power Dissipation

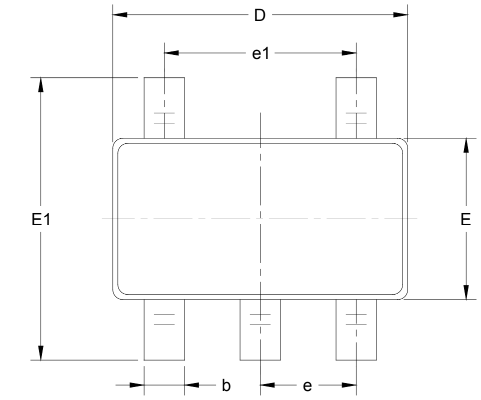
Power dissipation depends on power-supply voltage, signal and load conditions. With DC signals, power dissipation is equal to the product of output current times the voltage across the conducting output transistor, V_S - V_O. Power dissipation can be minimized by using the lowest possible power-supply voltage necessary to assure the required output voltage swing.

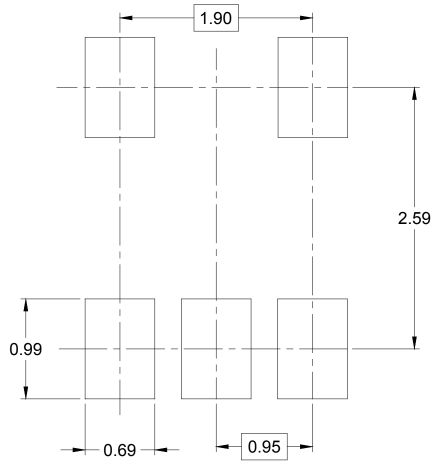
For resistive loads, the maximum power dissipation occurs at a DC output voltage of one-half the power-supply voltage. Dissipation with AC signals is lower.

Any tendency to activate the thermal protection circuit indicates excessive power dissipation or an inadequate heatsink. For reliable operation, junction temperature should be limited to 150℃ (maximum). To estimate the margin of safety in a complete design, increase the ambient temperature until the thermal protection is triggered at 150℃. The thermal protection should trigger at more than 35℃ above the maximum expected ambient condition of your application.

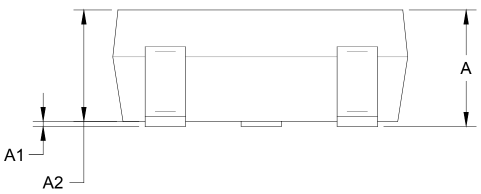
PACKAGE OUTLINE DIMENSIONS

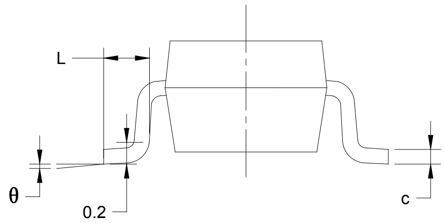
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

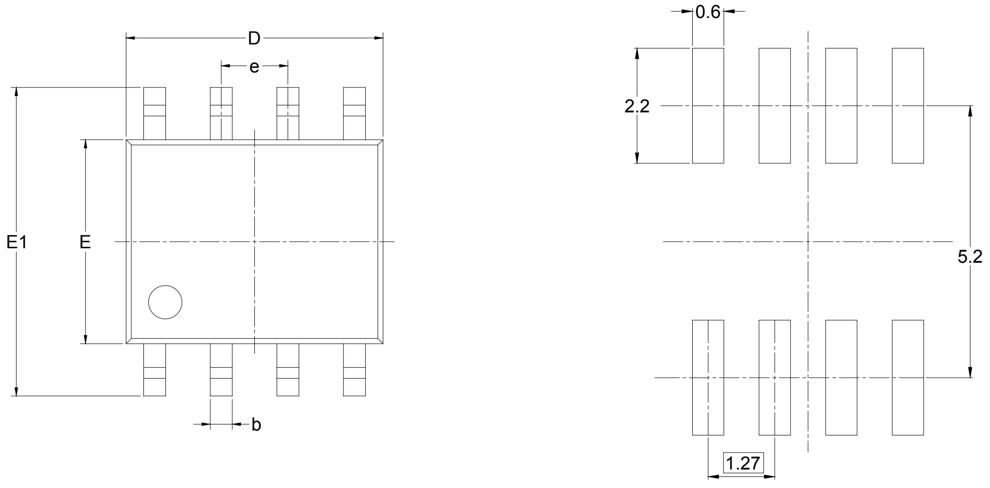




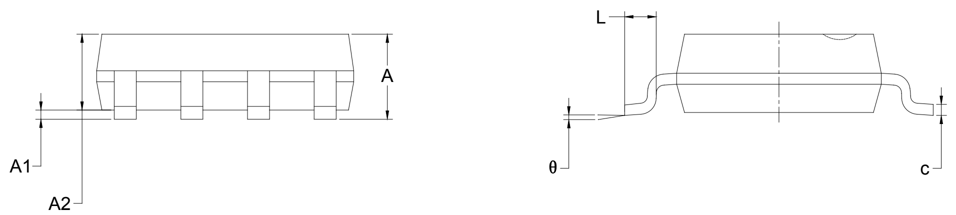
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

SOIC-8



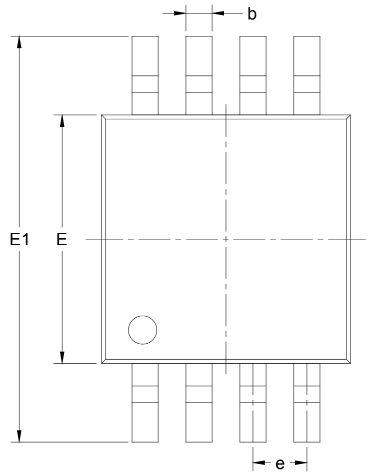
RECOMMENDED LAND PATTERN (Unit: mm)

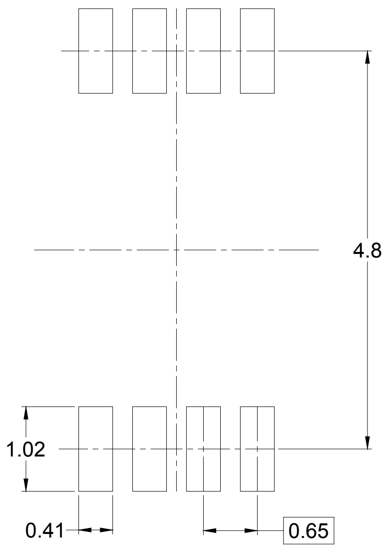


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

MSOP-8





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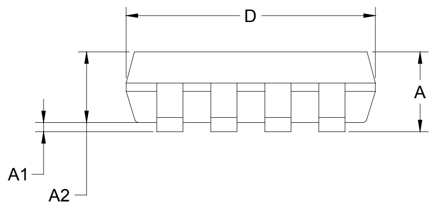
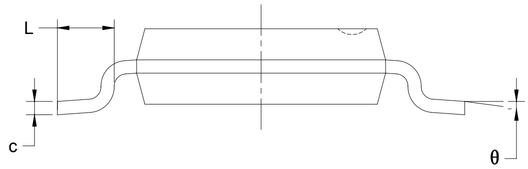
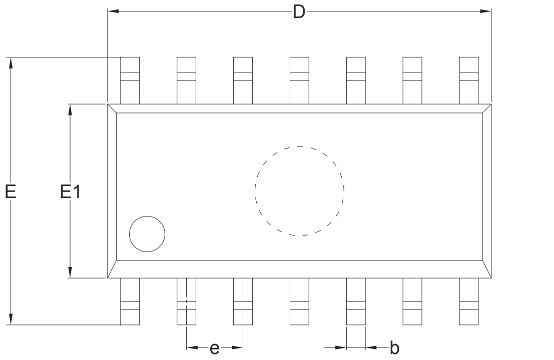


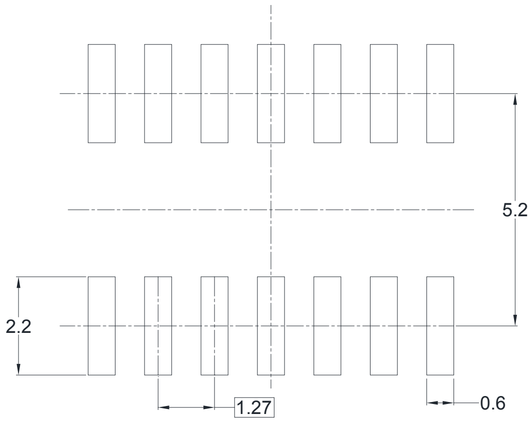


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

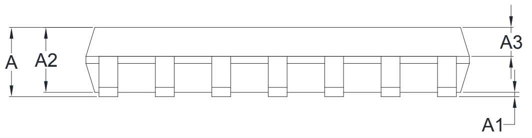
PACKAGE OUTLINE DIMENSIONS

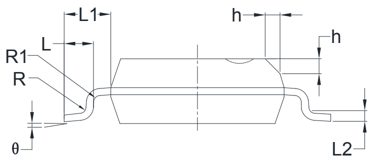
SOIC-14





RECOMMENDED LAND PATTERN (Unit: mm)

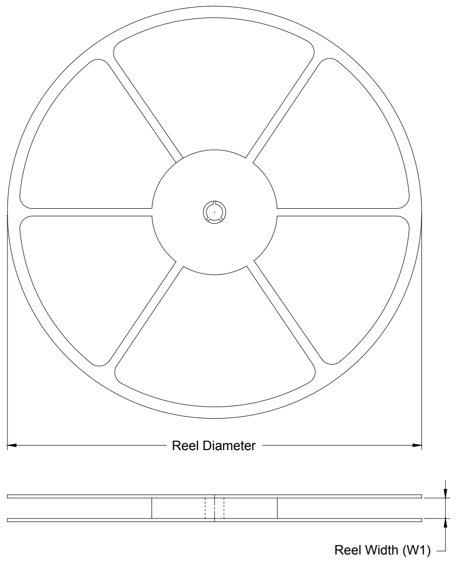




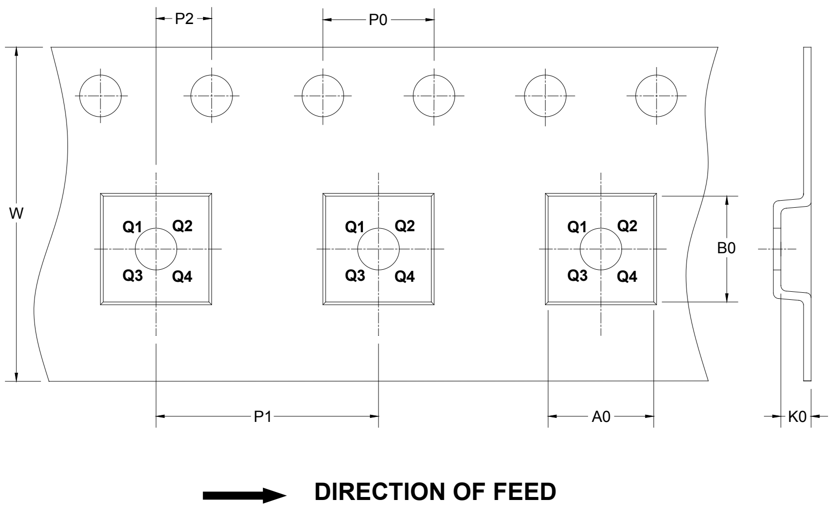
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	0.018	0.032
L1	1.04 REF		0.040 REF	
L2	0.25 BSC		0.01 BSC	
R	0.07		0.003	
R1	0.07		0.003	
h	0.30	0.50	0.012	0.020
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



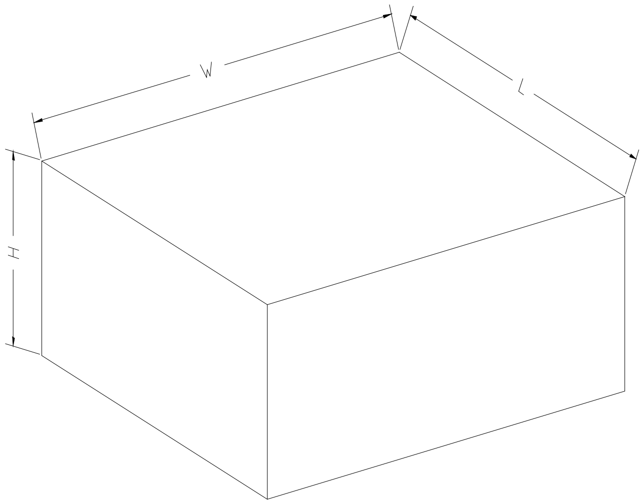
NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-5	7″	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOIC-8	13″	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13″	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
SOIC-14	13″	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1

DD0001

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
7″ (Option)	368	227	224	8
7″	442	410	224	18
13″	386	280	370	5

DD0002