SCY99116

Single-Channel, Rail-to-Rail Output, 3 MHz BW Operational Amplifier

The SCY99116 operational amplifier provides rail−to−rail output operation. This rail−to−rail operation enables the user to make optimal use of the entire supply voltage range while taking advantage of 3 MHz bandwidth. The SCY99116 can operate on supply voltage as low as 2.7 V over the temperature range of −40°C to 105°C. The high bandwidth provides a slew rate of 2.4 V/μs while consuming low quiescent current. Likewise the SCY99116 can run on a supply voltage as high as 16 V making it ideal for a broad range of battery−operated applications. Since this is a CMOS device it has high input impedance and low bias currents making it ideal for interfacing to a wide variety of signal sensors. In addition it comes in a small SOT23−5 / TSOP−5 package allowing for use in high−density PCB's.

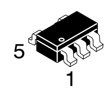
Features

- Rail−To−Rail Output
- Wide Bandwidth: 3 MHz
- High Slew Rate: 2.4 V/μs
- Wide Power−Supply Range: 2.7 V to 16 V
- Low Supply Current: 550 μA
- Low Input Bias Current: 1 pA
- Wide Temperature Range: −40°C to 105°C
- Small Package: 5 Pin SOT−23 (same as TSOP−5)
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

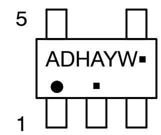
Applications

- Notebook Computers
- Portable Instruments

MARKING DIAGRAM

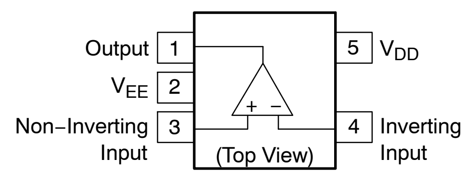


TSOP−5
(SOT23−5)
SN SUFFIX
CASE 483



ADH = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

PIN CONNECTIONS



ORDERING INFORMATION

Device	Package	Shipping†
SCY99116SNT1G	TSOP−5 (Pb−Free)	3000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

MAXIMUM RATINGS

Symbol	Rating	Value	Unit
V_{DD}	Supply Voltage (Note 1)	16.5	V
V_{ID}	Input Differential Voltage (Note 2)	± Supply Voltage	V
V_I	Input Common Mode Voltage Range (Note 1)	−0.2 V to (V_{DD} + 0.2 V)	V
I_I	Maximum Input Current	± 10	mA
I_O	Output Current Range	± 100	mA
	Continuous Total Power Dissipation (Note 1)	200	mW
T_J	Maximum Junction Temperature	150	°C
θ_{JA}	Thermal Resistance	333	°C/W
T_{stg}	Operating Temperature Range (free−air)	−40 to 105	°C
T_{stg}	Storage Temperature	−65 to 150	°C
	Mounting Temperature (Infrared or Convection − 20 sec)	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Continuous short−circuit operation to ground at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C. Output currents in excess of 45 mA over long term may adversely affect reliability. Shorting output to either V+ or V− will adversely affect reliability.
2. ESD data available upon request.

DC ELECTRICAL CHARACTERISTICS (V_{DD} = 2.7 V, 3.3 V, 5 V and ± 5 V (Note 3), T_A = 25°C, R_L ≥ 10 kΩ unless otherwise noted)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input Offset Voltage	V_{IO}	VIC = V_{DD}/2, V_O = V_{DD}/2, R_L = 10 kΩ, R_S = 50 Ω			0.5	5	mV
		T_A = −40°C to +105°C				7	
Offset Voltage Drift	ICV_{OS}	VIC = V_{DD}/2, V_O = V_{DD}/2, R_L = 10 kΩ, R_S = 50 Ω			2		μV/°C
Common Mode Rejection Ratio	CMRR	0 V ≤ VIC ≤ V_{DD} − 1.35 V, R_S = 50 Ω	V_{DD} = 2.7 V	58	87		dB
		T_A = −40°C to +105°C		55			
		0 V ≤ VIC ≤ V_{DD} − 1.35 V, R_S = 50 Ω	V_{DD} = 5 V	65	120		
		T_A = −40°C to +105°C		62			
		0 V ≤ VIC ≤ V_{DD} − 1.35 V, R_S = 50 Ω	V_{DD} = ± 5 V	69	132		
		T_A = −40°C to +105°C		66			
Power Supply Rejection Ratio	PSRR	V_{DD} = 2.7 V to 16 V, VIC = V_{DD}/2, No Load		70	118		dB
		T_A = −40°C to +105°C		65			
Large Signal Voltage Gain	A_{VD}	$V_{O(pp)}$ = V_{DD}/2, R_L = 10 kΩ	V_{DD} = 2.7 V	97	110		dB
		T_A = −40°C to +105°C		76			
		$V_{O(pp)}$ = V_{DD}/2, R_L = 10 kΩ	V_{DD} = 3.3 V	97	115		
		T_A = −40°C to +105°C		76			
		$V_{O(pp)}$ = V_{DD}/2, R_L = 10 kΩ	V_{DD} = 5 V	100	117		
		T_A = −40°C to +105°C		86			
		$V_{O(pp)}$ = V_{DD}/2, R_L = 10 kΩ	V_{DD} = ± 5 V	100	123		
		T_A = −40°C to +105°C		90			
Input Bias Current	I_B	V_{DD} = 5 V, VIC = V_{DD}/2, V_O = V_{DD}/2, R_S = 50 Ω	T_A = 25°C		35	150	pA
			T_A = 105°C			1000	

3. V_{DD} = ±5 V is shorthand for V_{DD} = +5 V and V_{EE} = −5 V.

DC ELECTRICAL CHARACTERISTICS (V_{DD} = 2.7 V, 3.3 V, 5 V and ±5 V (Note 3), T_A = 25°C, R_L ≥ 10 kΩ unless otherwise noted)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input Offset Current	I_{IO}	V_{DD} = 5 V, VIC = V_{DD}/2, V_O = V_{DD}/2, R_S = 50 Ω	T_A = 25°C		11	150	pA
			T_A = 105°C			1000	
Differential Input Resistance	$r_{i(d)}$				1000		GΩ
Common−mode Input Capacitance	C_{IC}	f = 21 kHz			8		pF
Output Swing (High−level)	V_{OH}	VIC = V_{DD}/2, I_{OH} = −1 mA	V_{DD} = 2.7 V	2.55	2.6		V
		T_A = −40°C to +105°C		2.48			
		VIC = V_{DD}/2, I_{OH} = −1 mA	V_{DD} = 3.3 V	3.15	3.21		
		T_A = −40°C to +105°C		3.00			
		VIC = V_{DD}/2, I_{OH} = −1 mA	V_{DD} = 5 V	4.9	4.93		
		T_A = −40°C to +105°C		4.85			
		VIC = V_{DD}/2, I_{OH} = −1 mA	V_{DD} = ±5 V	4.92	4.96		
		T_A = −40°C to +105°C		4.9			
		VIC = V_{DD}/2, I_{OH} = −5 mA	V_{DD} = 2.7 V	1.9	2.27		V
		T_A = −40°C to +105°C		1.5			
		VIC = V_{DD}/2, I_{OH} = −5 mA	V_{DD} = 3.3 V	2.5	2.89		
		T_A = −40°C to +105°C		2.1			
		VIC = V_{DD}/2, I_{OH} = −5 mA	V_{DD} = 5 V	4.6	4.68		
		T_A = −40°C to +105°C		4.5			
		VIC = V_{DD}/2, I_{OH} = −5 mA	V_{DD} = ±5 V	4.7	4.78		
		T_A = −40°C to +105°C		4.65			
Output Swing (Low−level)	V_{OL}	VIC = V_{DD}/2, I_{OL} = −1 mA	V_{DD} = 2.7 V		0.03	0.15	V
		T_A = −40°C to +105°C				0.22	
		VIC = V_{DD}/2, I_{OL} = −1 mA	V_{DD} = 3.3 V		0.03	0.15	
		T_A = −40°C to +105°C				0.22	
		VIC = V_{DD}/2, I_{OL} = −1 mA	V_{DD} = 5 V		0.03	0.1	
		T_A = −40°C to +105°C				0.15	
		VIC = V_{DD}/2, I_{OL} = −1 mA	V_{DD} = ±5 V		0.05	0.08	
		T_A = −40°C to +105°C				0.1	
		VIC = V_{DD}/2, I_{OL} = −5 mA	V_{DD} = 2.7 V		0.14	0.7	V
		T_A = −40°C to +105°C				1.1	
		VIC = V_{DD}/2, I_{OL} = −5 mA	V_{DD} = 3.3 V		0.13	0.7	
		T_A = −40°C to +105°C				1.1	
		VIC = V_{DD}/2, I_{OL} = −5 mA	V_{DD} = 5 V		0.13	0.4	
		T_A = −40°C to +105°C				0.5	
		VIC = V_{DD}/2, I_{OL} = −5 mA	V_{DD} = ±5 V		0.16	0.30	
		T_A = −40°C to +105°C				0.35	

3. V_{DD} = ±5 V is shorthand for V_{DD} = +5 V and V_{EE} = −5 V.

DC ELECTRICAL CHARACTERISTICS (V_{DD} = 2.7 V, 3.3 V, 5 V and ±5 V (Note 3), T_A = 25°C, R_L ≥ 10 kΩ unless otherwise noted)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Current	I_O	V_O = 0.5 V from rail, V_{DD} = 2.7 V	Positive rail		4		mA
			Negative rail		5		
		V_O = 0.5 V from rail, V_{DD} = 5 V	Positive rail		7		
			Negative rail		8		
		V_O = 0.5 V from rail, V_{DD} = 10 V	Positive rail		13		
			Negative rail		12		
Power Supply Quiescent Current	I_{DD}	$V_O = V_{DD}/2$	V_{DD} = 2.7 V		470	560	μA
			V_{DD} = 3.3 V		475	620	
			V_{DD} = 5 V		480	660	
			V_{DD} = 10 V		490	800	
		T_A = −40°C to +105°C				1000	

3. V_{DD} = ±5 V is shorthand for V_{DD} = +5 V and V_{EE} = −5 V.

AC ELECTRICAL CHARACTERISTICS (V_{DD} = 2.7 V, 5 V, and ±5 V (Note 4), T_A = 25°C, and R_L ≥ 10 kΩ unless otherwise noted)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Unity Gain Bandwidth	UGBW	R_L = 2 kΩ, C_L = 10 pF	V_{DD} = 2.7 V		3.0		MHz
			V_{DD} = 5 V to 10 V		3.2		
Slew Rate at Unity Gain	SR	$V_{O(pp)} = V_{DD}/2$, R_L = 10 kΩ, C_L = 50 pF	V_{DD} = 2.7 V	1.35	2.0		V/μS
		T_A = −40°C to +105°C		1			
		$V_{O(pp)} = V_{DD}/2$, R_L = 10 kΩ, C_L = 50 pF	V_{DD} = 5 V	1.45	2.3		
		T_A = −40°C to +105°C		1.2			
		$V_{O(pp)} = V_{DD}/2$, R_L = 10 kΩ, C_L = 50 pF	V_{DD} = ±5 V	1.8	2.6		
		T_A = −40°C to +105°C		1.3			
Phase Margin	θ_m	R_L = 2 kΩ, C_L = 10 pF			74		°
Gain Margin		R_L = 2 kΩ, C_L = 10 pF			17		dB
Settling Time to 0.1%	t_S	V−step(pp) = 1 V, AV = −1, R_L = 2 kΩ, C_L = 10 pF	V_{DD} = 2.7 V		2.9		μS
		V−step(pp) = 1 V, AV = −1, R_L = 2 kΩ, C_L = 47 pF	V_{DD} = 5 V, ±5 V		2		
Total Harmonic Distortion plus Noise	THD+N	V_{DD} = 2.7 V, $V_{O(pp)} = V_{DD}/2$, R_L = 2 kΩ, f = 10 kHz	AV = 1		0.03		%
			AV = 10		0.05		
			AV = 100		0.18		
		V_{DD} = 5 V, ± 5 V, $V_{O(pp)} = V_{DD}/2$, R_L = 2 kΩ, f = 10 kHz	AV = 1		0.02		
			AV = 10		0.09		
			AV = 100		0.5		
Input−Referred Voltage Noise	e_n	f = 1 kHz			90		nV/√Hz
		f = 10 kHz			35		
Input−Referred Current Noise	i_n	f = 1 kHz			0.6		fA/√Hz

4. V_{DD} = ±5 V is shorthand for V_{DD} = +5 V and V_{EE} = −5 V.

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

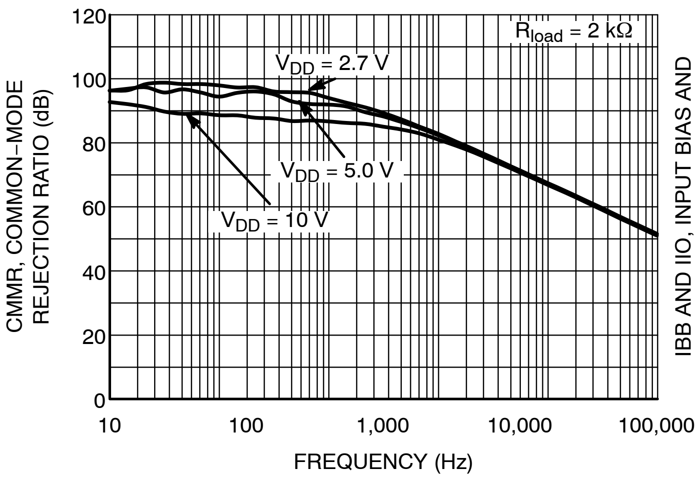


Figure 1. CMRR vs. Frequency

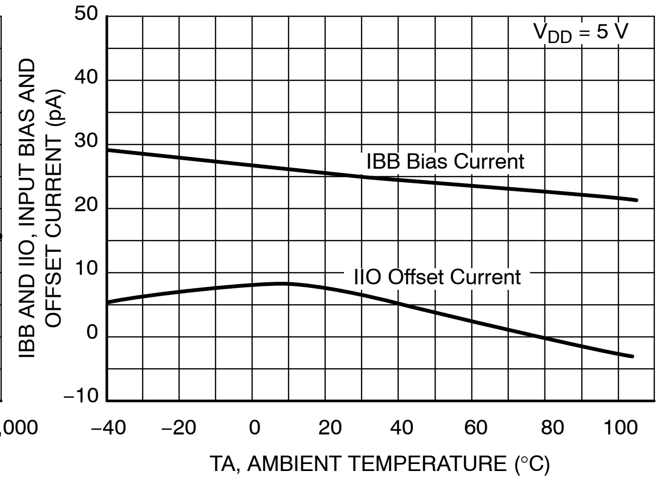


Figure 2. Input Bias Offset Current

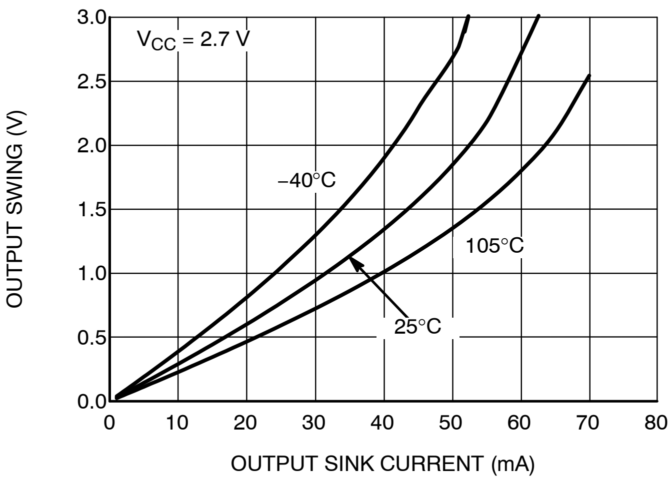


Figure 3. VOL OUTPUT SWING

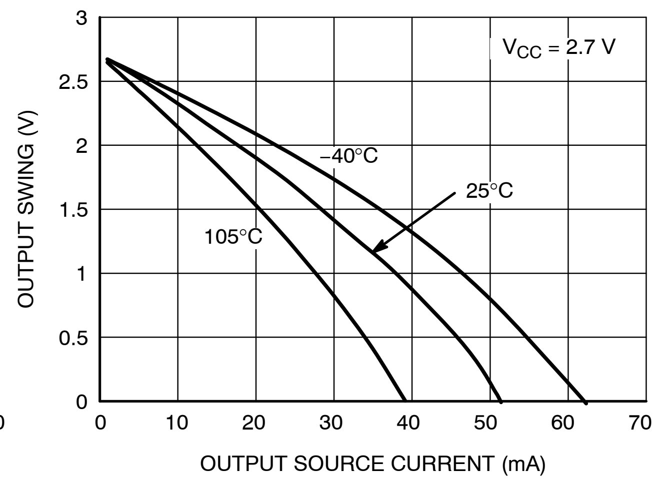


Figure 4. VOH OUTPUT SWING

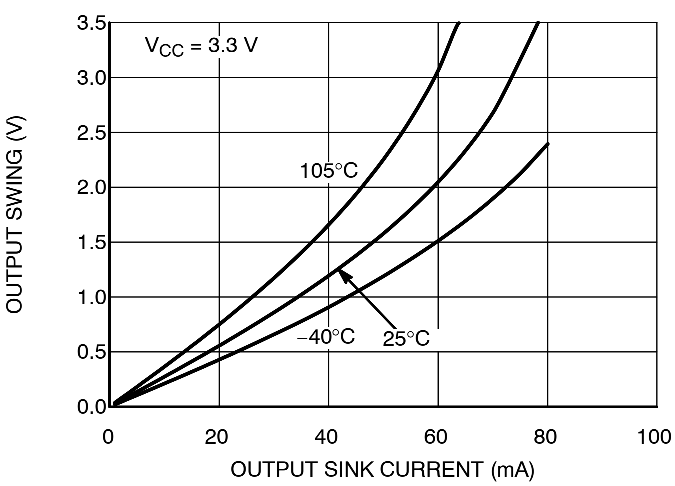


Figure 5. VOL OUTPUT SWING

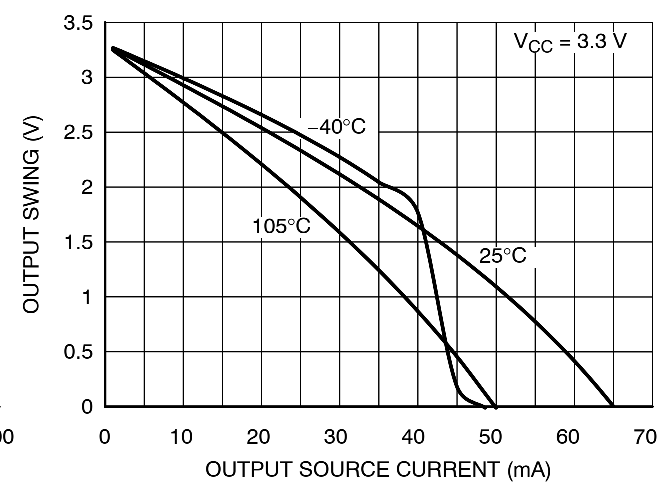


Figure 6. VOH OUTPUT SWING

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

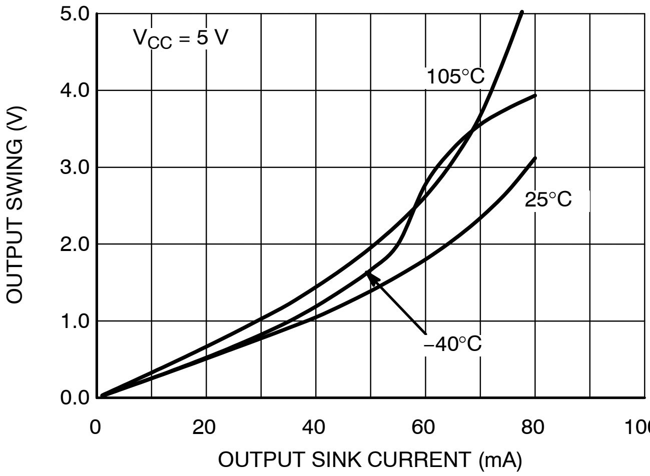


Figure 7. VOL OUTPUT SWING

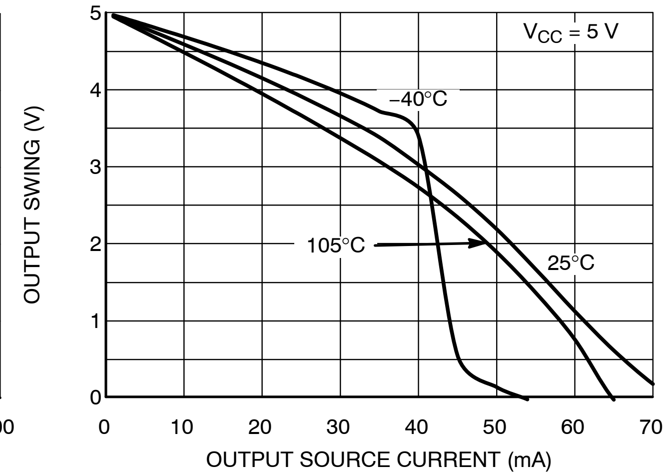


Figure 8. VOH OUTPUT SWING

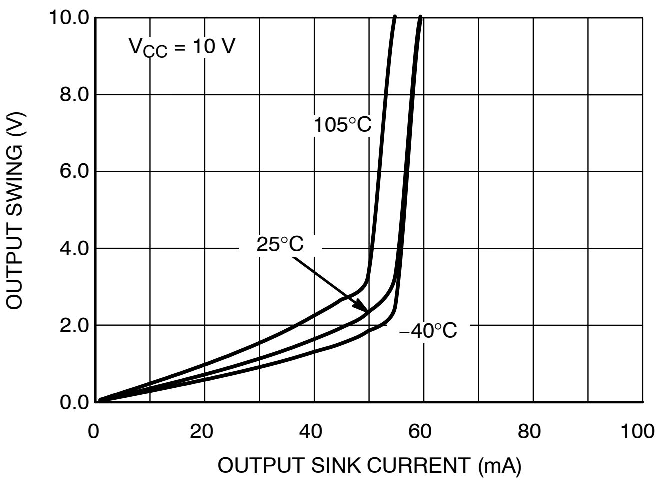


Figure 9. VOL OUTPUT SWING

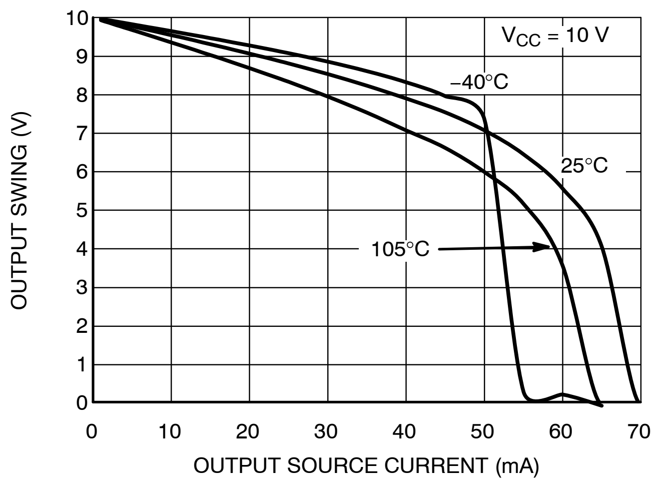


Figure 10. VOH OUTPUT SWING

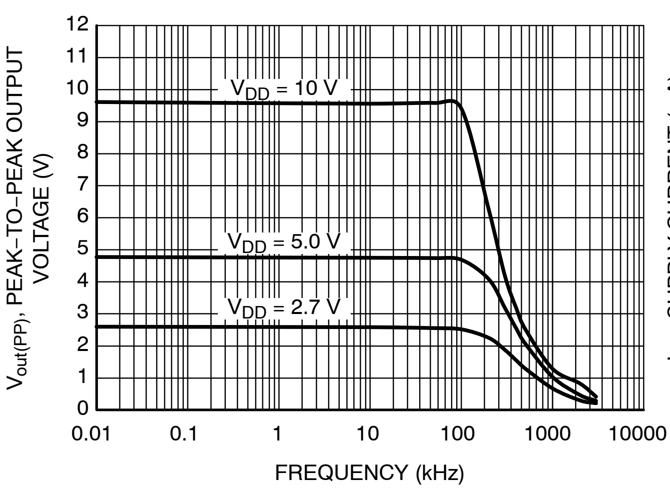


Figure 11. Peak−to−Peak Output Voltage vs. Frequency

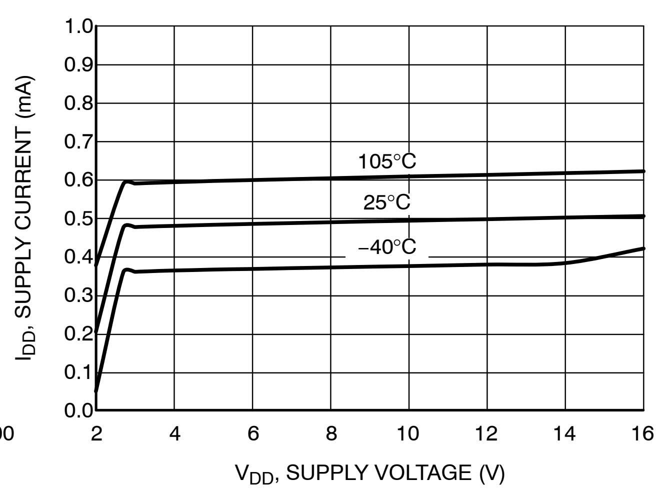


Figure 12. Supply Current vs. Supply Voltage

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

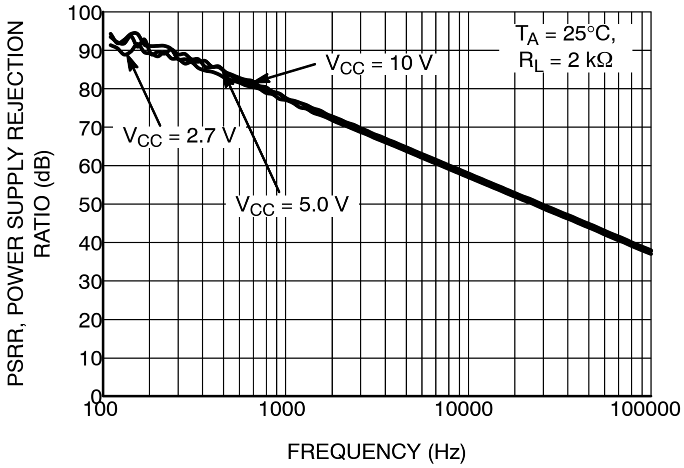


Figure 13. Power Supply Rejection Ratio

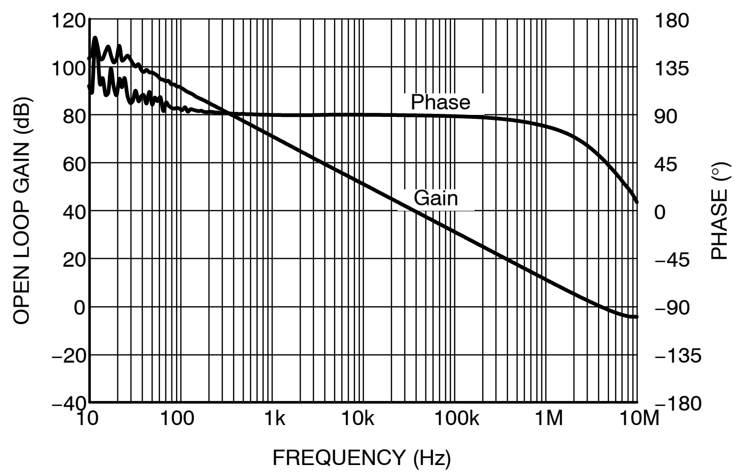


Figure 14. Open Loop Gain / Phase vs. Frequency

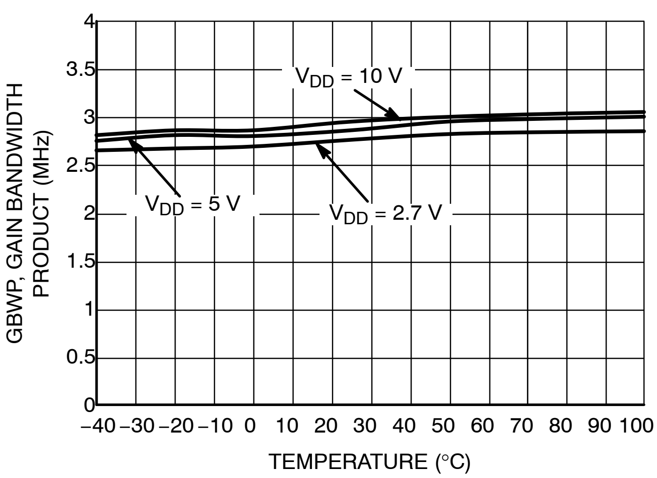


Figure 15. Gain Bandwidth Product vs. Temperature

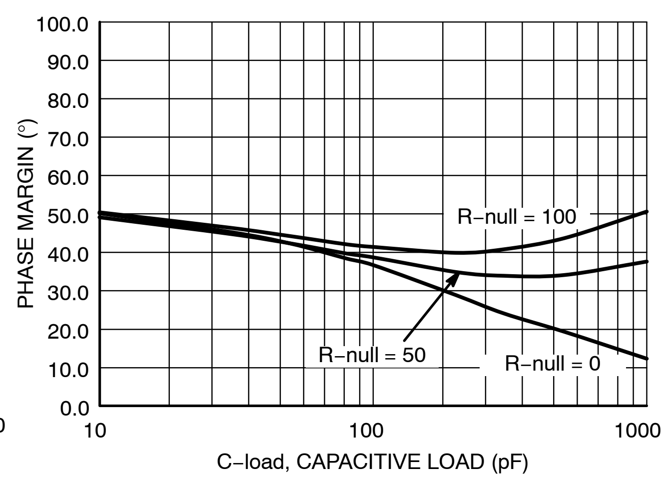


Figure 16. Phase Margin vs. Capacitive Load

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

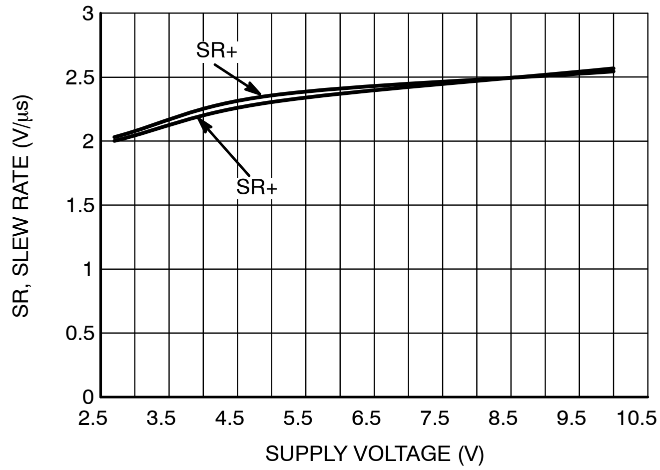


Figure 17. Slew Rate vs. Supply Voltage

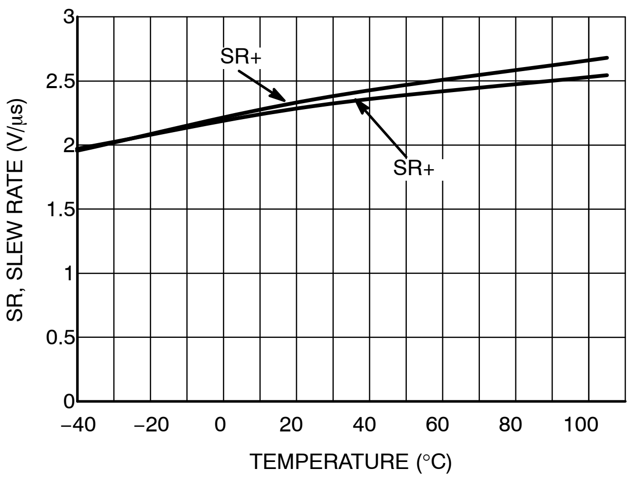


Figure 18. Slew Rate vs. Temperature

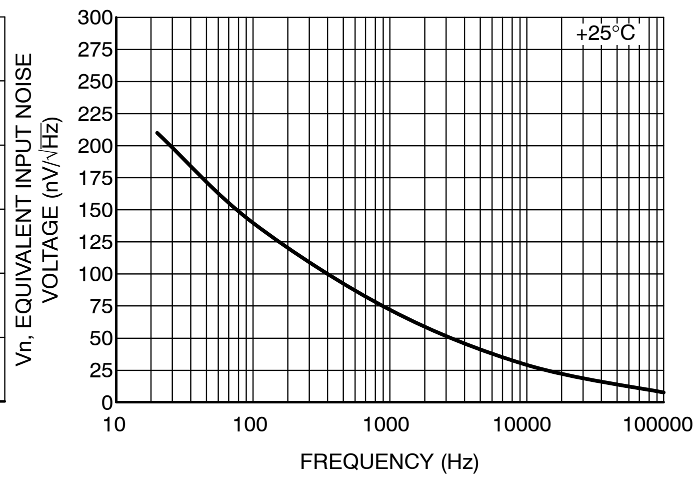


Figure 19. Equivalent Input Noise Voltage vs. Frequency

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

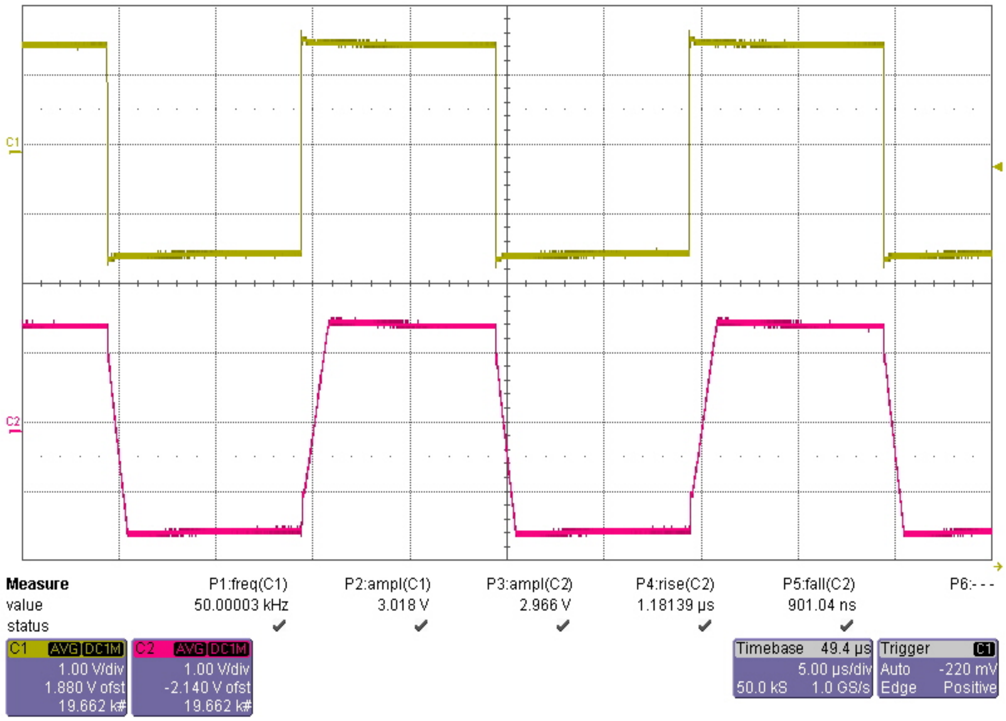


Figure 20. Voltage−Follower Large−Signal Pulse Response (V_{DD} = 3 V)

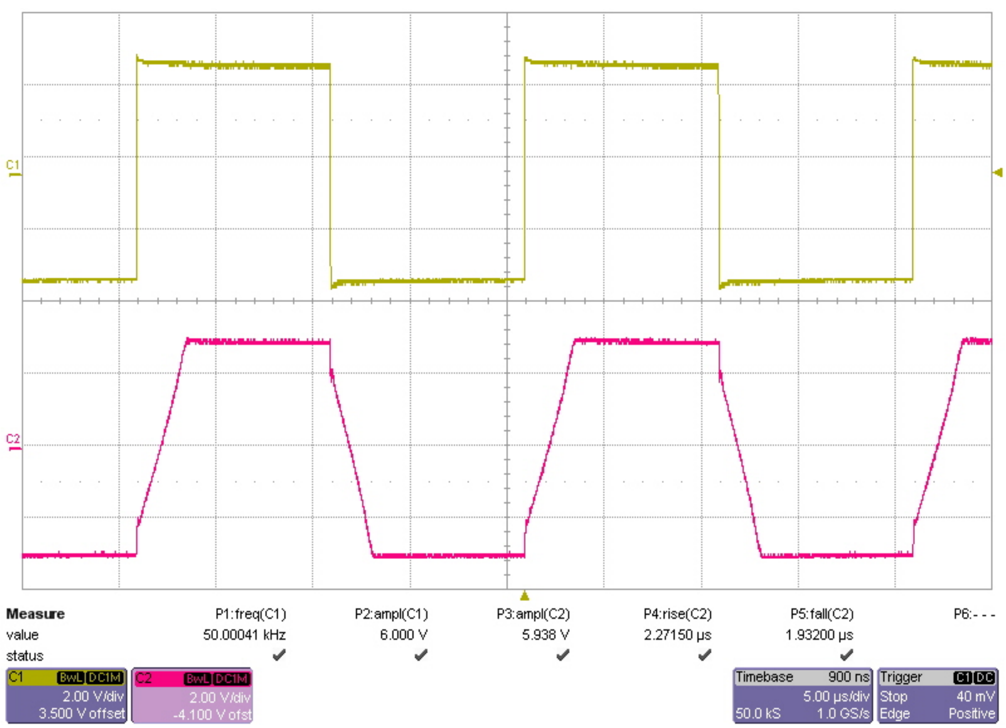


Figure 21. Voltage−Follower Large−Signal Pulse Response (V_{DD} = 6 V)

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

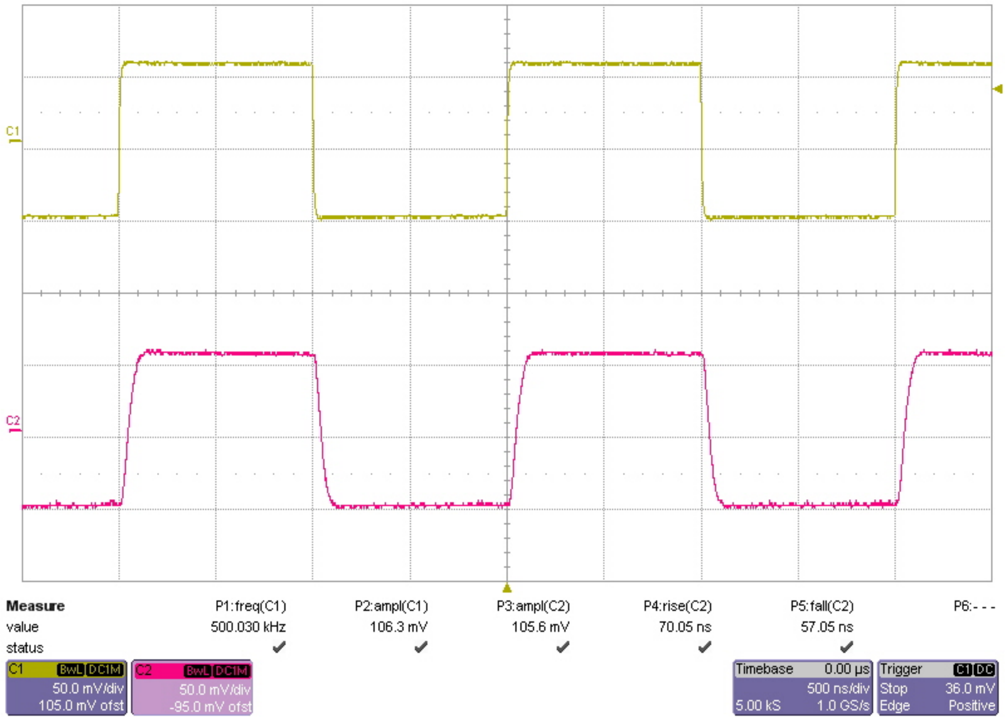


Figure 22. Voltage−Follower Small−Signal Pulse Response

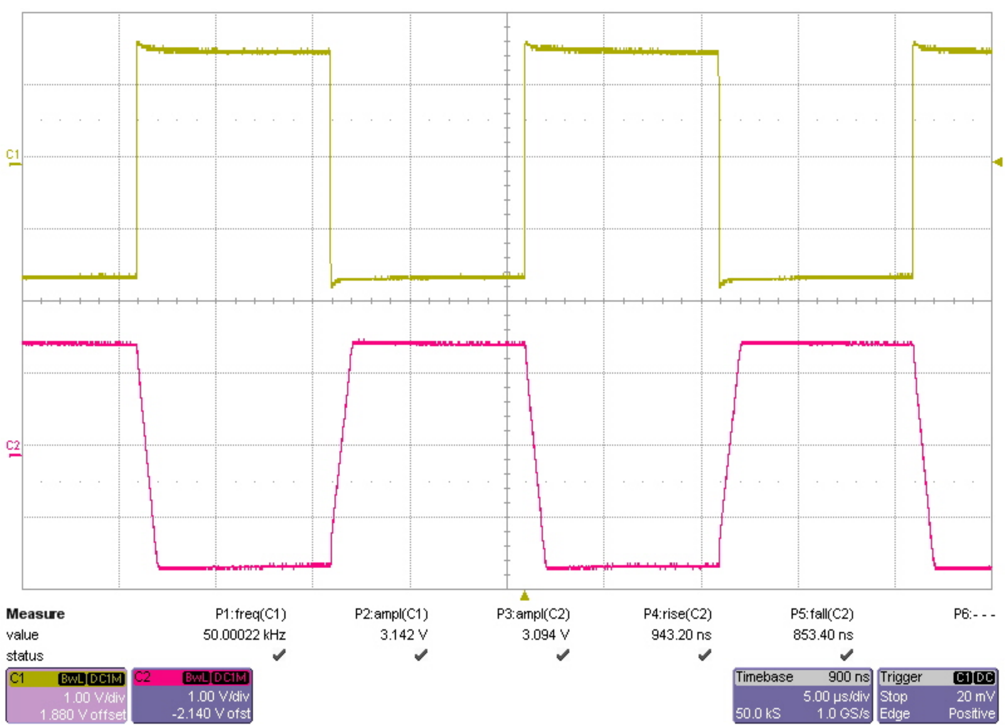


Figure 23. Inverting Large−Signal Pulse Response (V_{DD} = 3 V)

TYPICAL CHARACTERISTICS

(V_{DD} = 5 V single−supply, T_A = 25°C, R_L = 2 kΩ, and C_L = 10 pF unless otherwise noted)

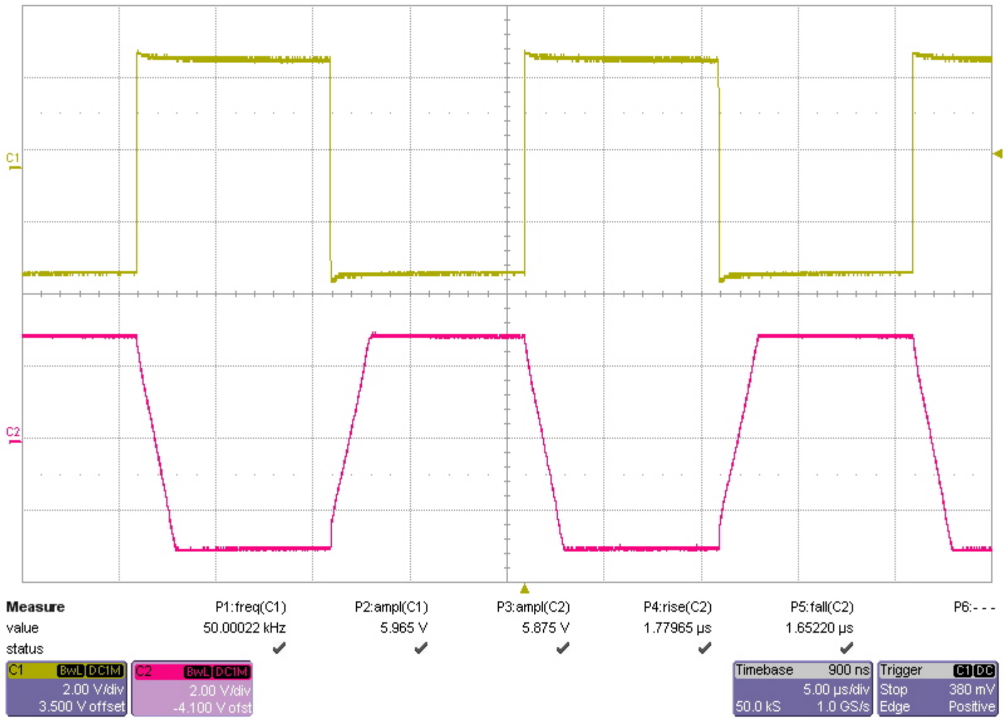


Figure 24. Inverting Large−Signal Pulse Response (V_{DD} = 6 V)

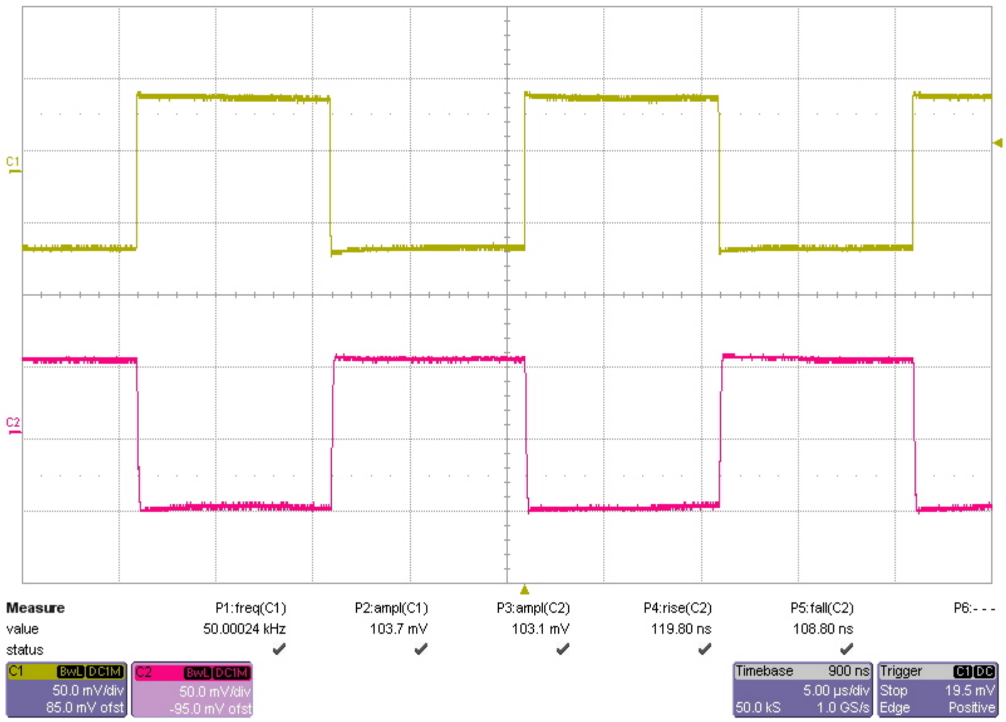
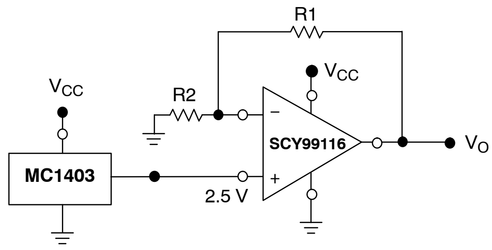


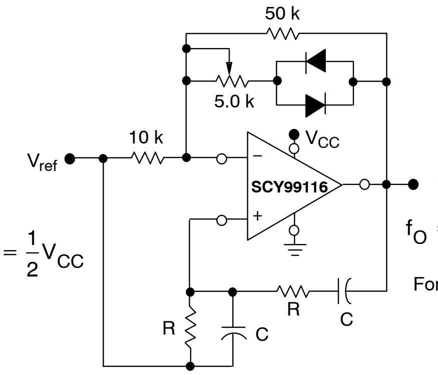
Figure 25. Inverting Small−Signal Pulse Response

APPLICATIONS



$$V_O = 2.5\ V(1 + \frac{R1}{R2})$$

Figure 26. Voltage Reference

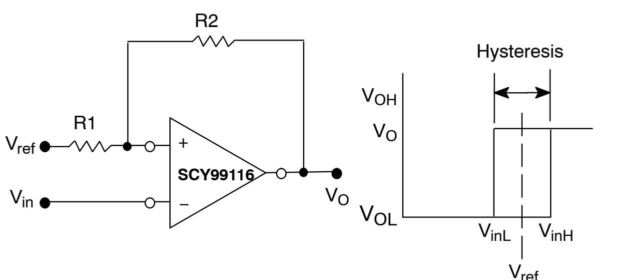


$$V_{ref} = \frac{1}{2} V_{CC}$$

$$f_O = \frac{1}{2\pi RC}$$

For: f_o = 1.0 kHz
R = 16 kΩ
C = 0.01 μF

Figure 27. Wien Bridge Oscillator

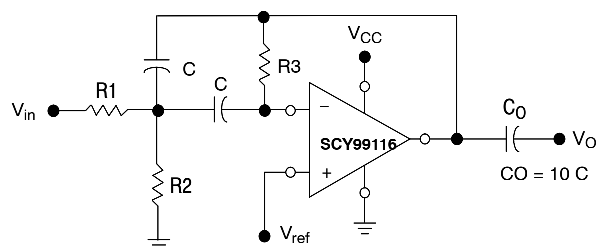


$$V_{in}L = \frac{R1}{R1 + R2} (V_{OL} - V_{ref}) + V_{ref}$$

$$V_{in}H = \frac{R1}{R1 + R2} (V_{OH} - V_{ref}) + V_{ref}$$

$$H = \frac{R1}{R1 + R2} (V_{OH} - V_{OL})$$

Figure 28. Comparator with Hysteresis



Given: f_o = center frequency
$A(f_o)$ = gain at center frequency

Choose value f_o, C

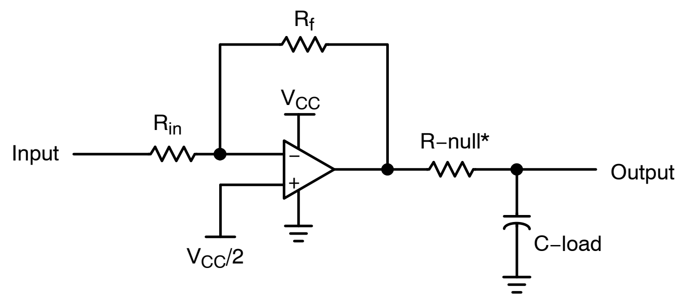
Then : $$R3 = \frac{Q}{\pi f_O C}$$

$$R1 = \frac{R3}{2\ A(f_O)}$$

$$R2 = \frac{R1\ R3}{4Q^2\ R1 - R3}$$

For less than 10% error from operational amplifier, $((Q_O\ f_O)/BW) < 0.1$ where f_o and BW are expressed in Hz. If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

Figure 29. Multiple Feedback Bandpass Filter

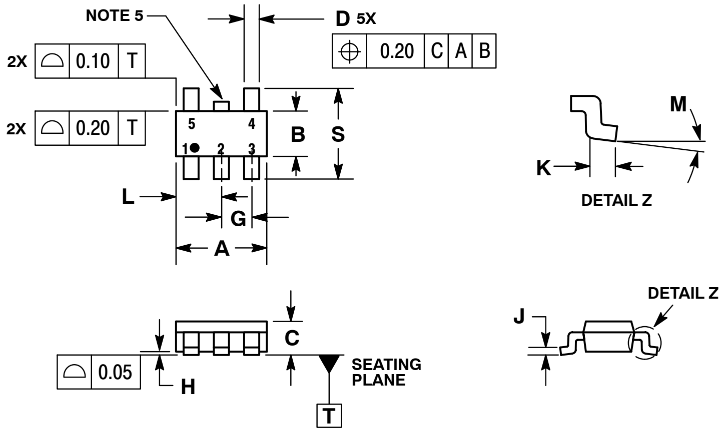


*R-null can be added in series with the output to improve stability when driving capacitive loads. R-null can be optimized by observing the step-response on a scope. A practical starting value can be read from the Phase-Margin vs Capacitive Load plot shown in the Typical Characteristics.

Figure 30. Driving a C−load

PACKAGE DIMENSIONS

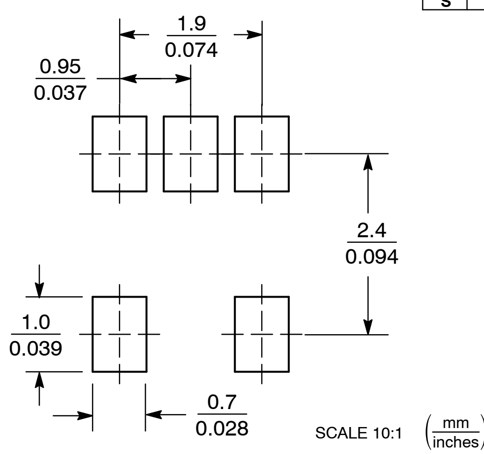
TSOP−5
(SOT23−5)
CASE 483−02
ISSUE H



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.
5. OPTIONAL CONSTRUCTION: AN ADDITIONAL TRIMMED LEAD IS ALLOWED IN THIS LOCATION. TRIMMED LEAD NOT TO EXTEND MORE THAN 0.2 FROM BODY.

	MILLIMETERS	
DIM	MIN	MAX
A	3.00 BSC	
B	1.50 BSC	
C	0.90	1.10
D	0.25	0.50
G	0.95 BSC	
H	0.01	0.10
J	0.10	0.26
K	0.20	0.60
L	1.25	1.55
M	0 °	10 °
S	2.50	3.00

SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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