

Product Overview

The NSCSA21xA series are micropower, precision current sense amplifier with a very wide input common mode range. The NSCSA21xA monitors Bidirectional current via the voltage across an external sense resistor. The input common mode voltage range extends from -2V to 28V, with respect to the negative supply voltage (V₋). This allows for the NSCSA21xA to be used for both low and high side current-sensing applications.

Four fixed gains are available: 50 V/V, 75 V/V, 100 V/V or 200 V/V. The four gain selections offer flexibility in the choice of the external current-sense resistor. The very low $\pm 5\mu\text{V}$ (typ) input offset voltage allows small 25mV to 100mV full-scale V_{SHUNT} voltage for very low power loss at full-current measurement.

The NSCSA21xA series operates from a single 2.7V to 28V supply, drawing a typical of 260 μA of supply current. The operating temperature range is specified from -40°C to 125°C, and the NSCSA21xA is offered in a space-saving SC70-6 package.

Key Features

- Survival Common-Mode Input Range: -28V to 28V
- Supply Voltage Range: 2.7V to 28V
- Low Offset Voltage: $\pm 5\mu\text{V}$ (Typical)
- Gain Error: $\pm 0.1\%$ (Typical)
- Operate Current: 260 μA (Typical)
- Gain Options:
 - NSCSA213A: 50 V/V
 - NSCSA215A: 75 V/V
 - NSCSA214A: 100 V/V
 - NSCSA210A: 200 V/V
- SC70 Package
- ROHS&REACH Compliance

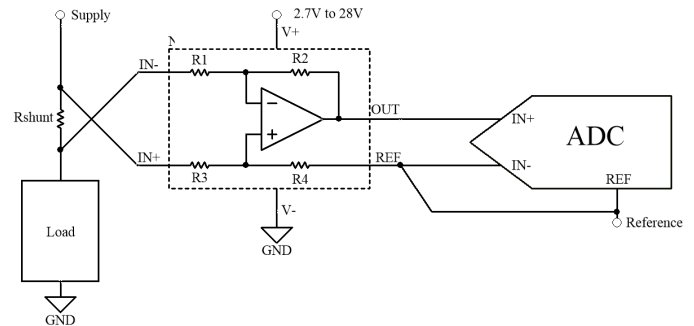
Applications

- Battery Management Systems
- Motor Controls
- Power-System Monitors
- Overcurrent and Fault Detection
- Notebook Computers
- Portable and Battery-Backup Systems

Device Information

Part Number	Gain	Package	Body Size
NSCSA213A-DSCAR	50	SC70-6	2mm×1.25mm
NSCSA215A-DSCAR	75	SC70-6	2mm×1.25mm
NSCSA214A-DSCAR	100	SC70-6	2mm×1.25mm
NSCSA210A-DSCAR	200	SC70-6	2mm×1.25mm

Typical Application

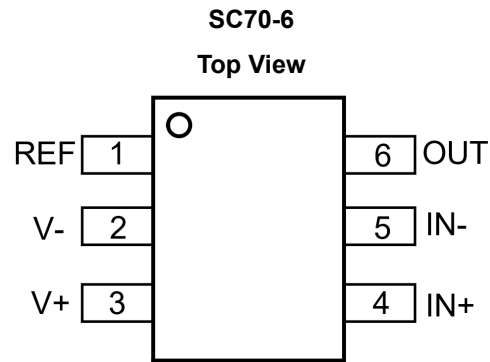


Part Number	Gain	R1 and R3	R2 and R4
NSCSA213A	50	20k Ω	1M Ω
NSCSA215A	75	13.3k Ω	1M Ω
NSCSA214A	100	10k Ω	1M Ω
NSCSA210A	200	5k Ω	1M Ω

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1. Pin Configuration and Functions



<i>Pin No.</i>	<i>Symbol</i>	<i>Type</i>	<i>Function</i>
1	REF	I	Reference voltage, 0 V to V+
2	V-	GND	Ground
3	V+	Power	Supply voltage, 2.7 V to 28 V
4	IN+	I	Non-inverting Input
5	IN-	I	Inverting input
6	OUT	O	Output voltage

2. Specifications

2.1. Absolute Maximum Ratings

Parameters	Symbol	Min	Max	Unit
Supply Voltage ((V ₊) - (V ₋))	V _S	-0.3	30	V
Voltage at IN- and IN+ Pins	V _{IN+} , V _{IN-}	-28	30	V
Voltage at REF Pins	V _{REF}	(V ₋) - 0.3	30	V
Voltage at Output Pins	V _{OUT}	(V ₋) - 0.3	(V ₊) + 0.3	V
Storage Temperature	T _{stg}	-60	150	°C
Maximum Junction Temperature			150	°C

2.2. ESD Ratings

Ratings		Value	Unit
Electrostatic discharge	● Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	±3000	V
	● Charged device model (CDM), per JEDEC specification JESD22-C101	±2000	V

2.3. Recommended Operating Conditions

Parameters	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V _S		5		V
Common-Mode Input Voltage	V _{CM}		12		V
Operation Temperature Range	T _A	-40		125	°C

2.4. Thermal Information

Parameters	Symbol	SC70-6	Unit
Junction-to-ambient thermal resistance	θ _{JA}	179.8	°C/W
Junction-to-case(top) thermal resistance	θ _{JC(top)}	129.4	°C/W
Junction-to-board thermal resistance	θ _{JB}	74.5	°C/W

3. Electrical Characteristics

At $T_A = +25^\circ\text{C}$, $V_{\text{SHUNT}} = V_{\text{IN}+} - V_{\text{IN}-}$, and, $V_S = (V_+) - (V_-) = 5\text{V}$, $V_{\text{IN}+} = 12\text{V}$, $V_{\text{SHUNT}} = 0\text{mV}$, and $V_{\text{REF}} = V_S / 2$, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Unit	
INPUT							
Common-Mode Input Range	V_{CM}		-2		28	V	
Common-Mode Rejection Ratio	CMRR	$V_{\text{CM}} = -1.5\text{V to } 28\text{V}$ $T_A = -40^\circ\text{C to } 125^\circ\text{C}^1$	Gain=50	100	120	dB	
			Gain=75				
Offset Voltage, RTI ²	V_{OS}	NSCSA213A (Gain=50)			± 15	± 90	
			NSCSA215A (Gain=75)			± 15	± 70
			NSCSA214A (Gain=100)			± 15	± 70
			NSCSA210A (Gain=200)			± 5	± 40
Offset Voltage Drift, RTI ²	dV_{OS}/dT	$T_A = -40^\circ\text{C to } 125^\circ\text{C}^3$		± 0.1	± 0.5	$\mu\text{V}/^\circ\text{C}$	
Input Bias Current	I_B			10	15	μA	
Input offset current	I_{OS}			± 0.01		μA	
OUTPUT							
Gain Error	GE	$V_{\text{SHUNT}} = -5\text{mV to } 5\text{mV}$ $T_A = -40^\circ\text{C to } 125^\circ\text{C}^1$		± 0.1	± 0.5	%	
Gain Drift		$T_A = -40^\circ\text{C to } 125^\circ\text{C}^3$		± 3	± 10	ppm/ $^\circ\text{C}$	
Nonlinearity Error				± 0.01		%	
Maximum capacitive load		No sustained oscillation		1		nF	
VOLTAGE OUTPUT							
Swing to V+		$R_L = 10\text{ k}\Omega$ to (V.) $T_A = -40^\circ\text{C to } 125^\circ\text{C}^1$		$(V_+) - 0.05$	$(V_+) - 0.2$	V	
Swing to V-		$R_L = 10\text{ k}\Omega$ to (V.) $T_A = -40^\circ\text{C to } 125^\circ\text{C}^1$		$(V_-) + 5$	$(V_-) + 50$	mV	
FREQUENCY RESPONSE							
Input Voltage-Noise Density			NSCSA213A (Gain=50)		42	nV/ $\sqrt{\text{Hz}}$	
			NSCSA215A (Gain=75)		38		
			NSCSA214A (Gain=100)		36		
			NSCSA210A (Gain=200)		32		
Slew Rate	SR	$C_L = 10\text{ pF}$		2		V/ μs	
Bandwidth	BW	$C_L = 10\text{ pF}$	Gain=50		200	kHz	
			Gain=75		125		
			Gain=100		100		
			Gain=200		50		

¹ All devices are 100% production tested at $T_A = 25^\circ\text{C}$. All temperature limits are guaranteed by characterization results.

² RTI means referred to input

³ Not production tested, guaranteed by characterization results

Electrical Characteristics (continued)

At $T_A = +25^\circ\text{C}$, $V_{\text{SHUNT}} = V_{\text{IN+}} - V_{\text{IN-}}$, and, $V_S = (V+) - (V-) = 5\text{V}$, $V_{\text{IN+}} = 12\text{V}$, $V_{\text{SHUNT}} = 0\text{mV}$, and $V_{\text{REF}} = V_S / 2$, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Unit
SUPPLY						
Supply Voltage Range	V_S	$T_A = -40^\circ\text{C}$ to 125°C ¹	2.7		28	V
Quiescent Current	I_Q	$T_A = +25^\circ\text{C}$		260		μA
		$T_A = -40^\circ\text{C}$ to 125°C ¹			320	
Power Supply Ratio	PSRR	NSCSA213A (Gain=50) NSCSA215A (Gain=75) NSCSA214A (Gain=100)	100	125		dB
		NSCSA210A (Gain=200)	110	135		

¹ All devices are 100% production tested at $T_A = 25^\circ\text{C}$. All temperature limits are guaranteed by characterization results.

4. Typical Performance Characteristics

at $T_A = +25^\circ\text{C}$, $V_{\text{SHUNT}} = V_{\text{IN}+} - V_{\text{IN}-}$, and, $V_S = (V+) - (V-) = 5\text{V}$, $V_{\text{IN}+} = 12\text{V}$, $V_{\text{SHUNT}} = 0\text{mV}$, and $V_{\text{REF}} = V_S / 2$, unless otherwise noted.

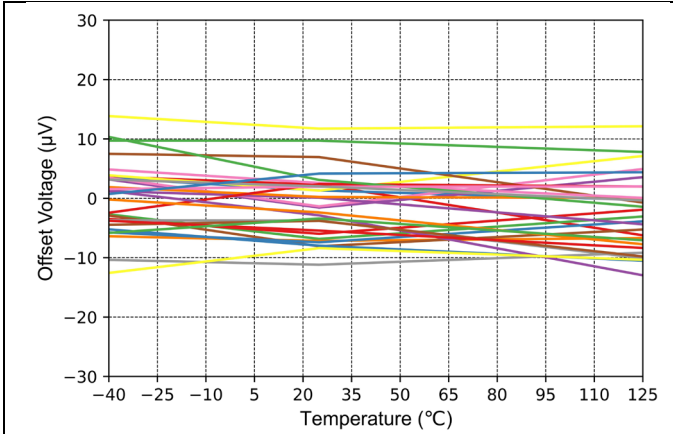


Figure 4-1 Input Offset Voltage vs Temperature

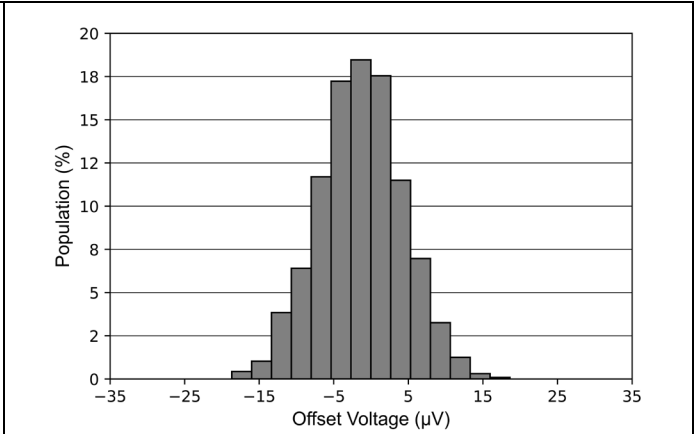


Figure 4-2 Input Offset Voltage Distribution

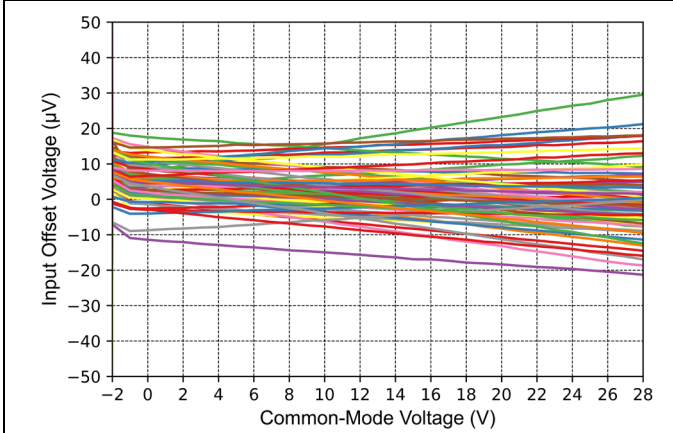


Figure 4-3 Input Offset Voltage vs Common-mode Voltage

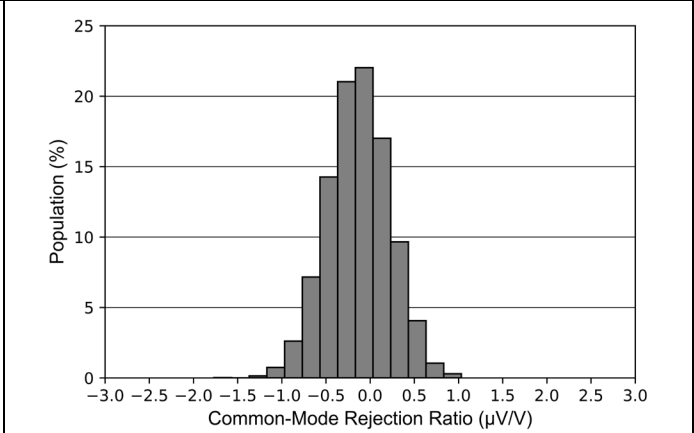


Figure 4-4 Common-Mode Rejection Ratio Distribution

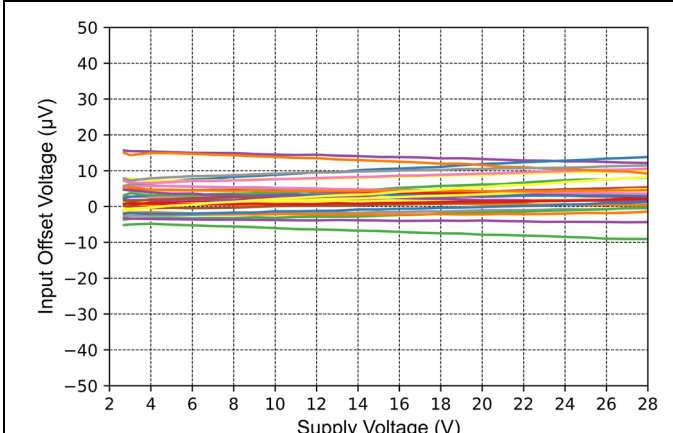


Figure 4-5 Input Offset Voltage vs Supply Voltage

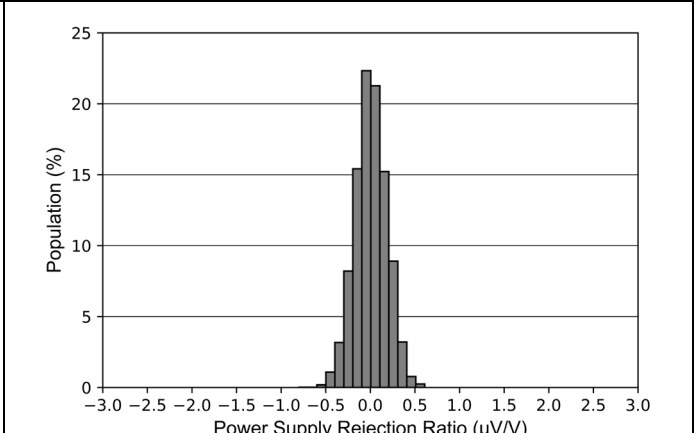


Figure 4-6 Power Supply Rejection Ratio Distribution

Typical Performance Characteristics (continued)

at $T_A = +25^\circ\text{C}$, $V_{\text{SHUNT}} = V_{\text{IN}+} - V_{\text{IN}-}$, and, $V_S = (V+) - (V-) = 5\text{V}$, $V_{\text{IN}+} = 12\text{V}$, $V_{\text{SHUNT}} = 0\text{mV}$, and $V_{\text{REF}} = V_S / 2$, unless otherwise noted.

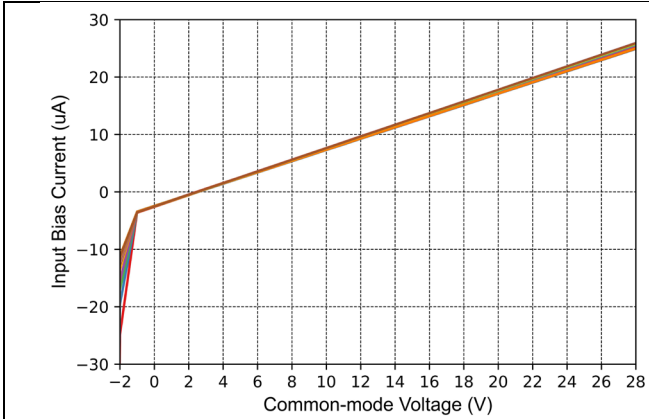


Figure 4-7 Input bias current vs Common-mode Voltage

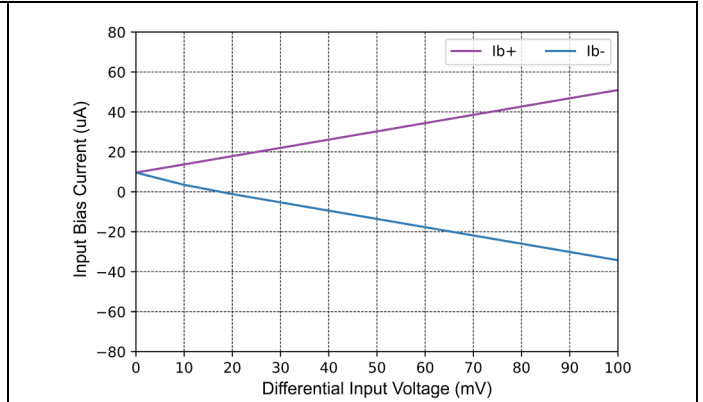


Figure 4-8 Input Bias Current vs Differential Input Voltage

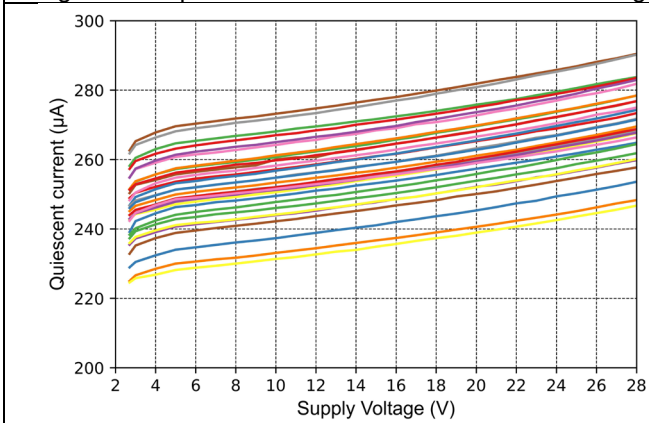


Figure 4-9 Quiescent Current vs Supply Voltage

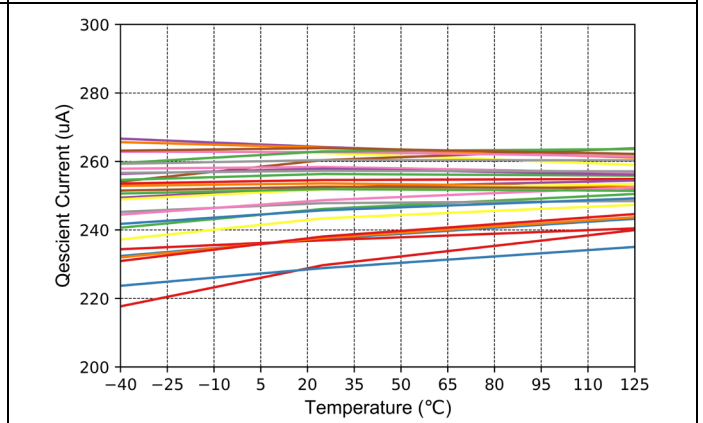


Figure 4-10 Quiescent Current vs Temperature

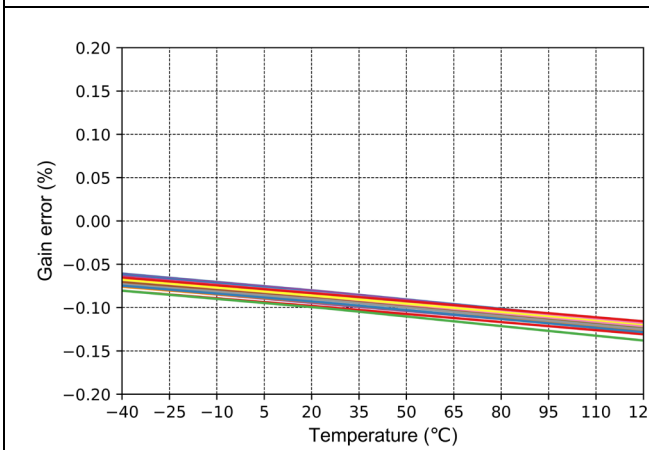


Figure 4-11 Gain Error vs Temperature

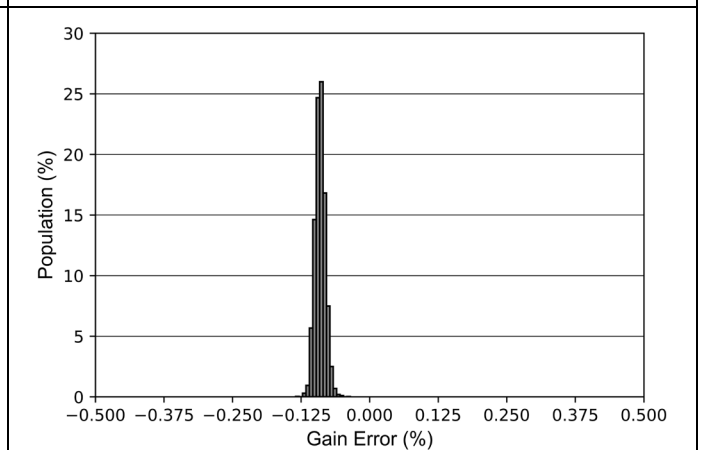


Figure 4-12 Gain Error Distribution

Typical Performance Characteristics (continued)

at $T_A = +25^\circ\text{C}$, $V_{\text{SHUNT}} = V_{\text{IN}+} - V_{\text{IN}-}$, and, $V_S = (V+) - (V-) = 5\text{V}$, $V_{\text{IN}+} = 12\text{V}$, $V_{\text{SHUNT}} = 0\text{mV}$, and $V_{\text{REF}} = V_S / 2$, unless otherwise noted.

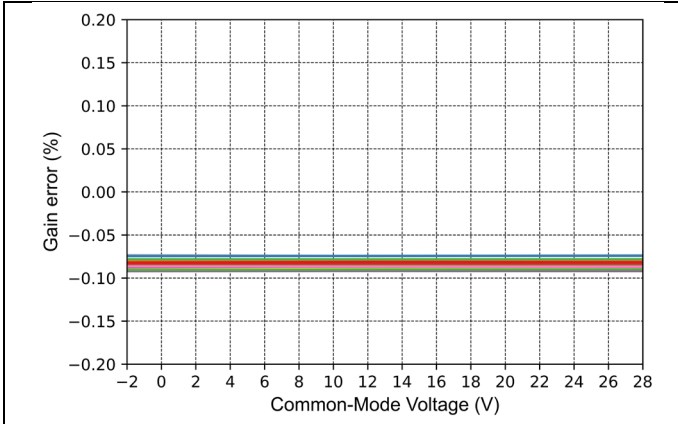


Figure 4-13 Gain Error vs Common-mode Voltage

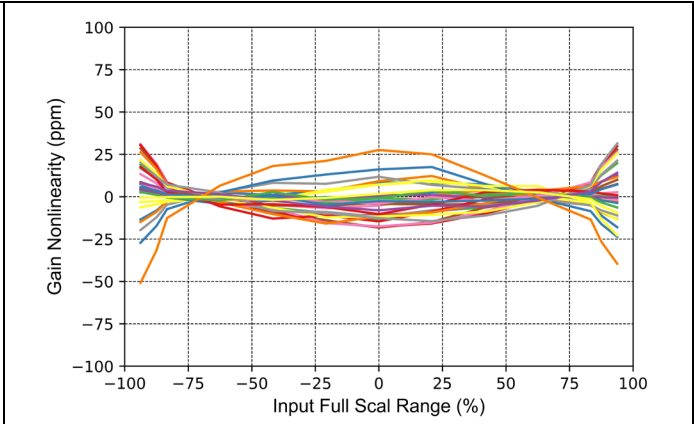


Figure 4-14 Gain Nonlinearity error vs Input Range

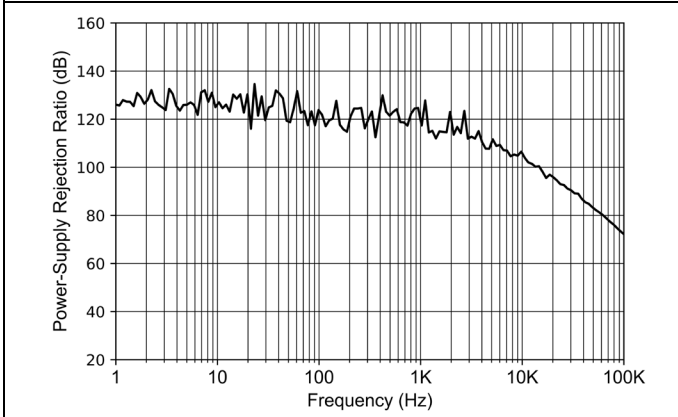


Figure 4-15 Power-Supply Rejection Ratio vs Frequency

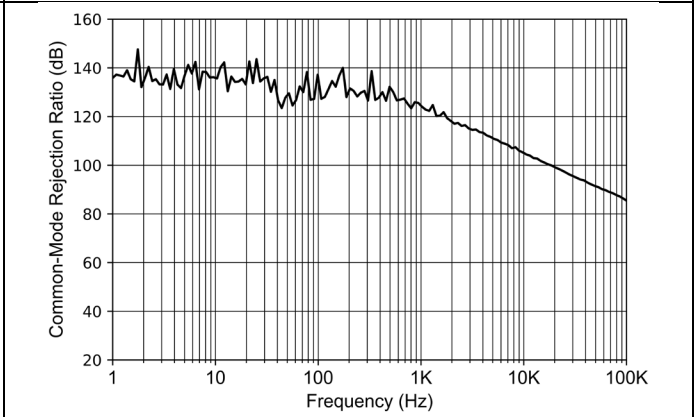


Figure 4-16 Common-Mode Rejection Ratio vs Frequency

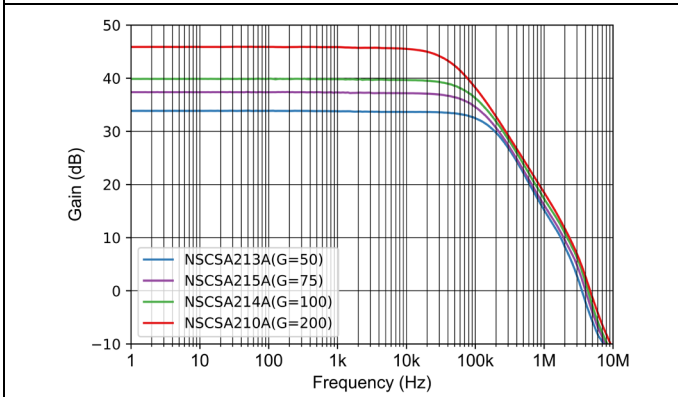


Figure 4-17 Gain vs Frequency

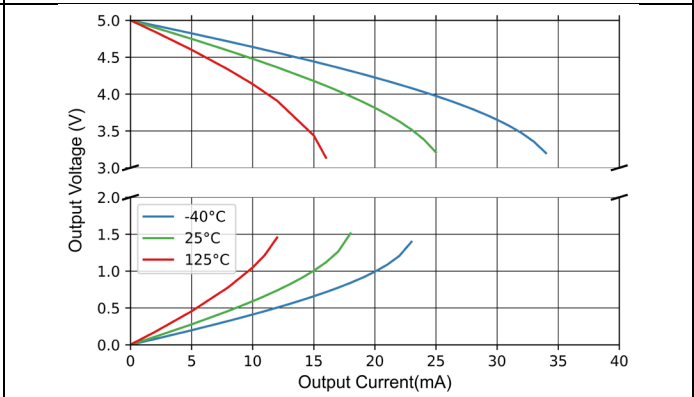


Figure 4-18 Output Voltage vs Output Current

Typical Performance Characteristics (continued)

at $T_A = +25^\circ\text{C}$, $V_{\text{SHUNT}} = V_{\text{IN}+} - V_{\text{IN}-}$, and, $V_S = (V+) - (V-) = 5\text{V}$, $V_{\text{IN}+} = 12\text{V}$, $V_{\text{SHUNT}} = 0\text{mV}$, and $V_{\text{REF}} = V_S / 2$, unless otherwise noted.

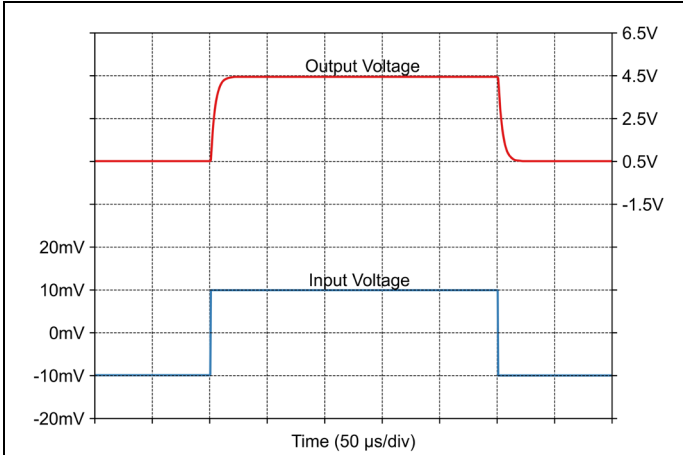


Figure 4-19 Step Response

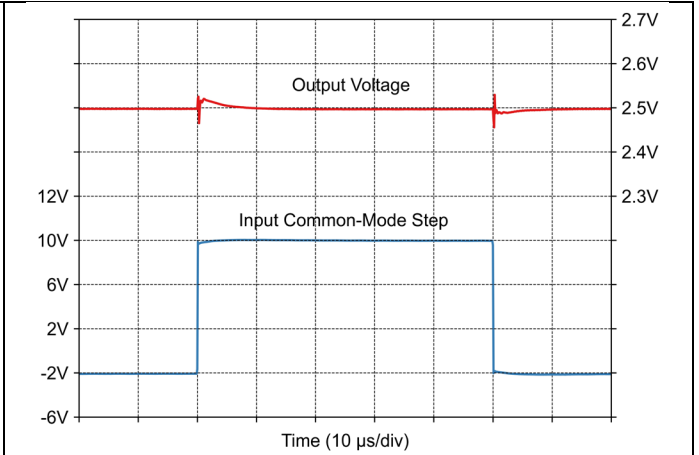


Figure 4-20 Enhanced PWM Rejection

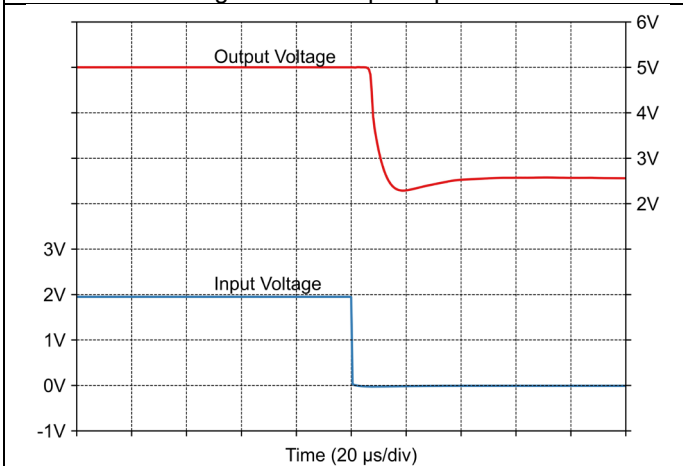


Figure 4-21 Noninverting Differential Input Overload Recovery

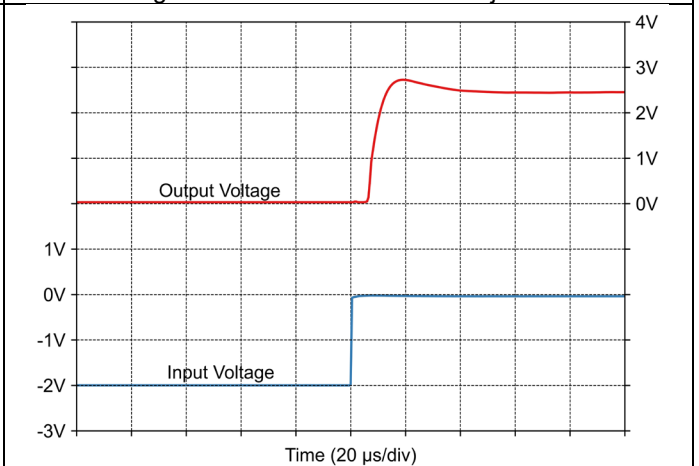


Figure 4-22 Inverting Differential Input Overload Recovery

5. Function Description

5.1. Overview

The NSCSA21xA series current sensor amplifiers offer a wide common-mode range from -2V to 28V, this current amplifier protects a main amplifier, 4 precisely matched resistors, oscillator, power on reset circuit, bandgap reference and LDO, and input common mode bias circuit.

The NSCSA21xA series are micropower, precision current sense amplifier with a very wide input common mode range. The NSCSA21xA monitors Bidirectional current via the voltage across an external sense resistor. The input common mode range extends from -2V to 28V, with respect to the negative supply voltage (V^-). This allows for the NSCSA21xA to be used for both low and high side current-sensing applications.

Four fixed gains are available: 50 V/V, 75 V/V, 100 V/V or 200 V/V. The four gain selections offer flexibility in the choice of the external current-sense resistor. The very low $\pm 5\mu\text{V}$ (typ) input offset voltage allows small 25mV to 100mV full-scale V_{SHUNT} voltage for very low power loss at full-current measurement.

The NSCSA21xA series operates from a single 2.7V to 28V supply, drawing a typical of 260 μA of supply current. The operating temperature range is specified from -40°C to 125°C, and the NSCSA21xA is offered in a space-saving SC70-6 package.

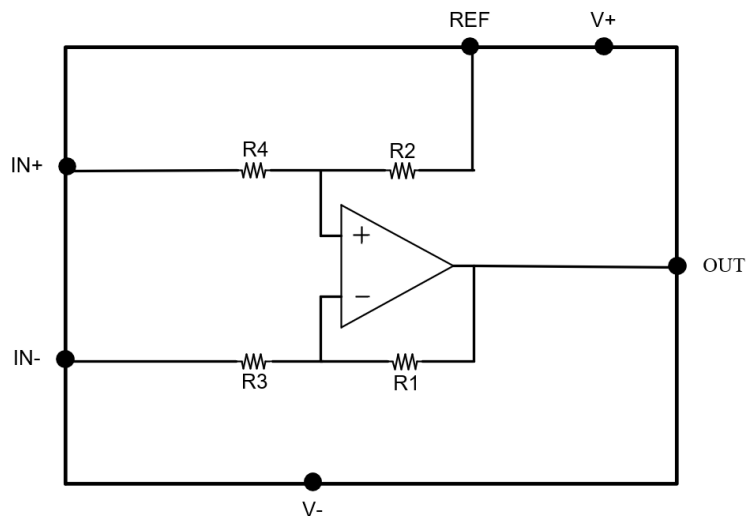


Figure 5-1 NSCSA21xA Functional Block Diagram

6. Application Note

6.1. Typical Application Circuit

The NSCSA21xA series are bidirectional current-sense amplifier. Figure 6-1 show typical application circuit.

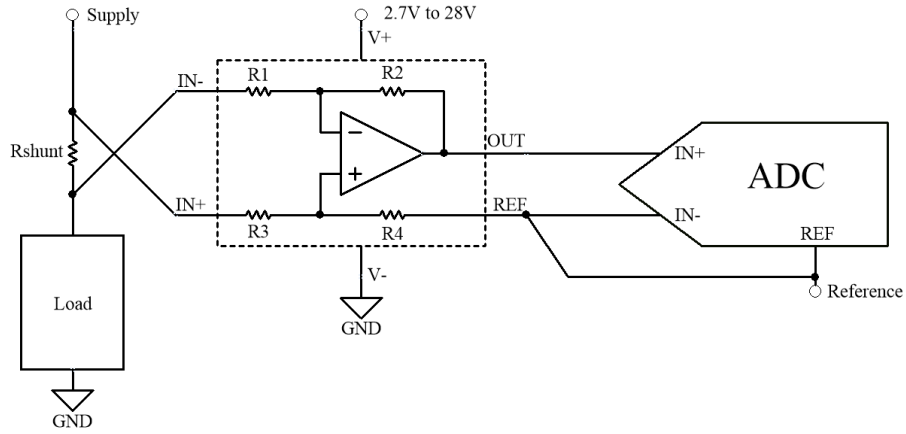


Figure 6-1 Typical Application Circuit

7. Package Information

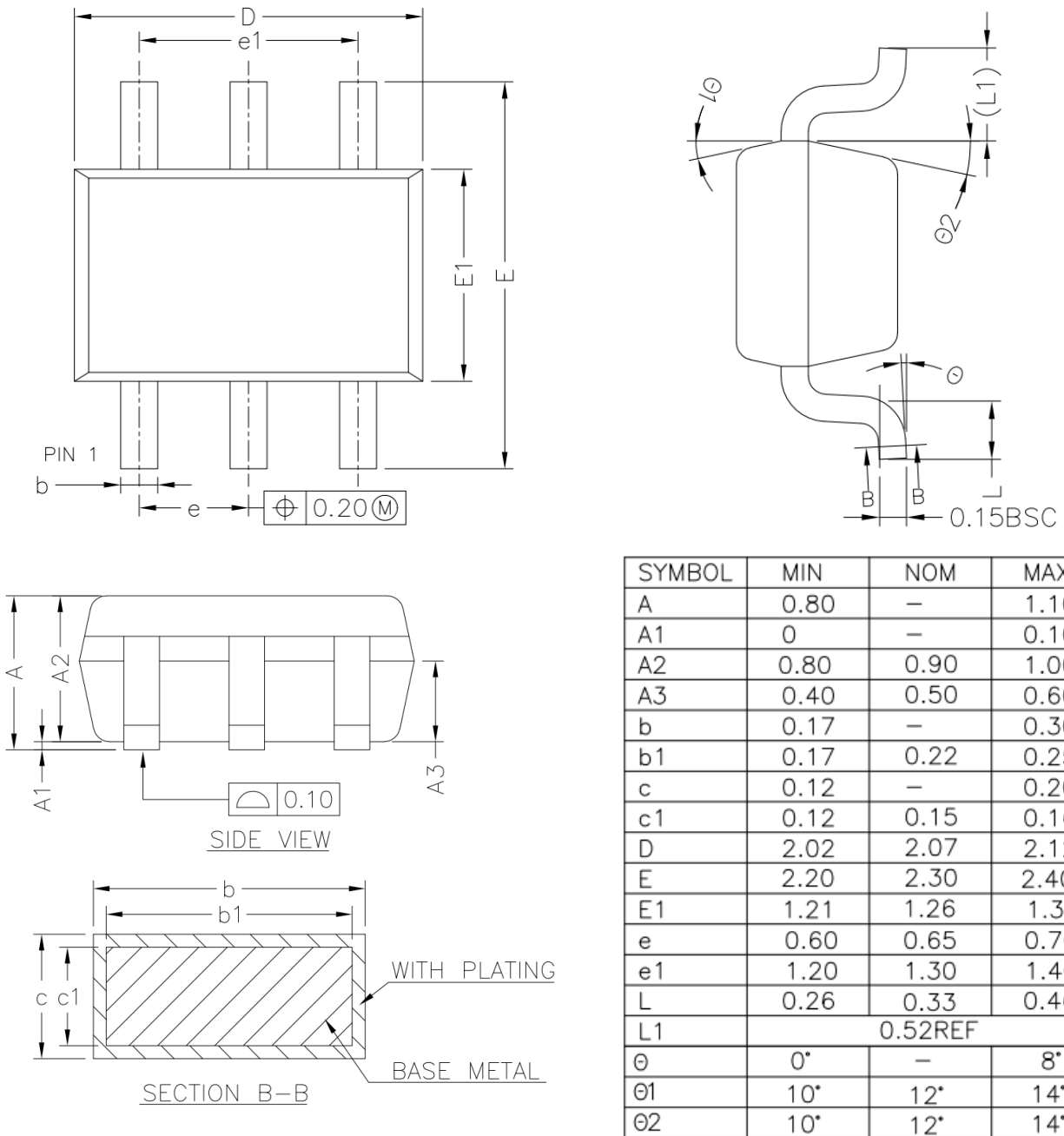


Figure 7-1 SC70-6 Package Shape and Dimension in millimeters

8. Order Information

<i>Part Number</i>	<i>Gain</i>	<i>Temperature</i>	<i>MSL</i>	<i>Package Type</i>	<i>SPQ</i>
NSCSA213A-DSCAR	50	-40 to 125°C	MSL1	SC70-6	3000
NSCSA215A-DSCAR	75	-40 to 125°C	MSL1	SC70-6	3000
NSCSA214A-DSCAR	100	-40 to 125°C	MSL1	SC70-6	3000
NSCSA210A-DSCAR	200	-40 to 125°C	MSL1	SC70-6	3000

9. Tape and Reel Information

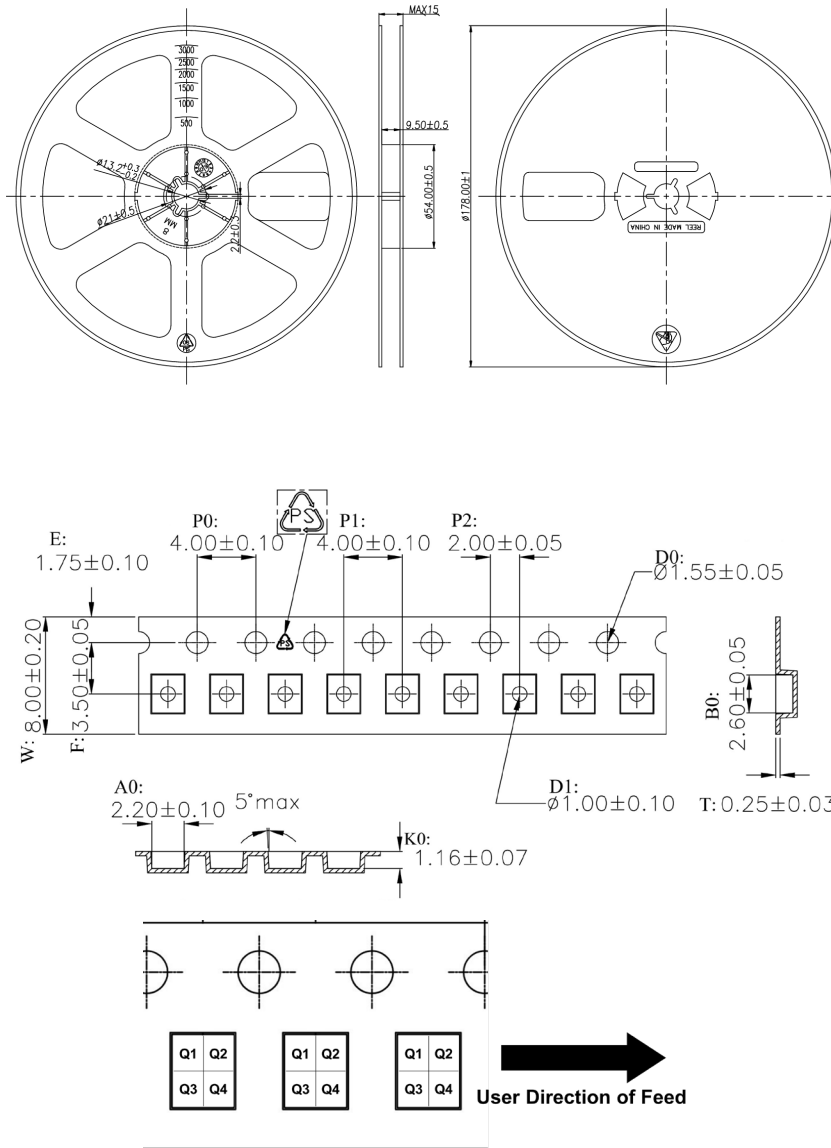


Figure 9-1 Tape and Reel Information of SC70-6

Device	Reel Diameter	Reel Width	W	A0	B0	P0	P1	P2	K0	D0	D1	PIN1 Quadrant
NSCSA213A -DSCAR	178	9.5	8.0	2.2	2.6	4.0	4.0	2.0	1.16	1.55	1.0	Q3
NSCSA215A -DSCAR	178	9.5	8.0	2.2	2.6	4.0	4.0	2.0	1.16	1.55	1.0	Q3
NSCSA214A -DSCAR	178	9.5	8.0	2.2	2.6	4.0	4.0	2.0	1.16	1.55	1.0	Q3
NSCSA210A -DSCAR	178	9.5	8.0	2.2	2.6	4.0	4.0	2.0	1.16	1.55	1.0	Q3

10. Revision History

<i>Revision</i>	<i>Description</i>	<i>Date</i>
1.0	Initial Version	2025/8

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