CONSONANCE

High Side Current Sense Amplifier

CN106

General Description

The CN106 is high-side current sense amplifier. Design flexibility is provided by the excellent device characteristics: 300µV maximum input offset voltage and 20nA maximum input bias current.

The CN106 monitors current via the voltage across an external current sense resistor, then internal circuitry multiplies the sensed voltage by a fixed gain of 20, and converts the multiplied voltage to a ground-referenced output voltage.

The low input offset voltage allows for monitoring very small sense voltages. As a result, a small valued current sense resistor can be used, which minimizes the power loss.

The wide 3V to 32V input voltage range, high accuracy and wide operating temperature range make the CN106 ideal for industrial control and power management applications. The very low power supply current of the CN106 also makes it suitable for low power and battery-powered applications.

The device is available in 5 pin SOT-23 package.

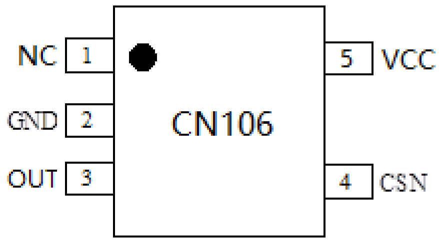
Features

- Operating Voltage Range: 3V to 32V
- Internally Fixed Gain: 20
- Input Offset Voltage:
  - CN106A: 300uV max.
  - CN106B: 1.5mV max.
  - CN106C: 5mV max.
- Low Input Bias Current: 20nA Maximum
- PSRR: 100dB
- Low Supply Current: 60uA@VCC=12V
- Operating Temperature Range
  -40°C to +85°C
- Available in SOT-23-5
- Lead-free, Rohs-compliant and Halogen-free

Applications

- Photovoltaic/Solar System
- Current Shunt Measurement
- Batteries Monitoring
- Motor Control
- Over Current and Fault Detection
- Lamp Monitoring

Pin Assignment



Typical Application Circuit

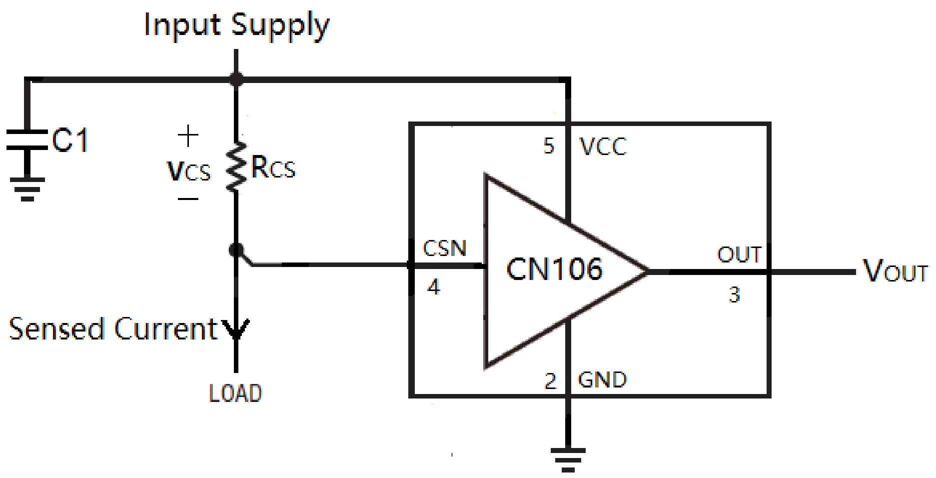


Figure 1 Typical Application Circuit

Ordering Information:

Part No.	Top Marking	Input Offset Voltage	Shipping
CN106A	106A	300uV max.	Tape and Reel, 3000/Reel
CN106B	106B	1.5mV max.	Tape and Reel, 3000/Reel
CN106C	106C	5mV max.	Tape and Reel, 3000/Reel

Pin Description

Pin No.	Symbol	Description
1	NC	**NC.** No Connection.
2	GND	**Ground.** Negative Terminal of Power Supply (Ground)
3	OUT	**Output Voltage.** The output voltage is referenced to ground (GND), and is 20 times of the voltage between VCC and CSN pin.
4	CSN	**Negative Terminal of Current Sense Voltage.** The voltage between VCC and CSN pin is sensed and amplified by CN106. Generally a current sense resistor (R_{CS} in Figure 1) is connected between VCC pin and CSN pin, CSN pin is tied to the negative terminal of external current sense resistor.
5	VCC	**Positive Terminal of Input Supply.** This pin is the power supply of internal circuit. VCC pin is also the positive terminal of current sense voltage. Generally a current sense resistor (R_{CS} in Figure 1) is connected between VCC pin and CSN pin, VCC should be tied to the positive terminal of current sense resistor.

ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (With respect to GND)
VCC..............…...….......-0.3V to +36V
The other Pins……..…....-0.3V to VCC
Input/Output Current
All Pins………………................20mA

Thermal Resistance…………………....220°C/W
Operating Temperature.……..……..-40 to +85°C
Storage Temperature.......……........-65 to +150°C
Lead Temperature (soldering, 10s) ....+260°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

(VCC=12V, T_A= －40℃ to 85℃, Typical values are at T_A=25℃, unless otherwise noted.)

Parameters	Symbol	Test Conditions	Min	Typ	Max	Unit
Operating Voltage Range	VCC		3		32	V
Operating Current	I_{VCC}	VCC＝12V, VCC−CSN＝−6mV	40	60	80	uA
Input Offset Voltage	V_{OS}	CN106A			300	uV
		CN106B			1.5	mV
		CN106C			5	mV
Input Bias Current	I_B				20	nA
Gain	A_V			20		V/V
Power Supply Rejection Ratio	PSRR	VCC＝3V to 32V, V_{CS}=20mV		100		dB
		VCC＝3V to 32V, V_{CS}＝50mV		87		dB
Maximum Sense Voltage	V_{CSmax}				1	V
Minimum Output Voltage	V_{OUTmin}	CN106A			60	mV
		CN106B			100	mV
		CN106C			150	mV
Maximum Output Voltage	V_{OUTmax}				VCC−2	V
Signal Bandwidth	BW	-3dB		200		KHz
Input Step Response	t_r	VCC−CSN＝100mV step		3.5		uS
Output Resistance	R_{OUT}	OUT Pin to GND		20		KΩ

Detailed Description

The CN106 high side current sense amplifier provides accurate monitoring of current through a user-selected sense resistor. The sensed voltage is amplified by a gain of 20 and level shifted from the positive power supply to a ground-referred output. The output signal is analog and may be used as is, or processed with an output filter depending on application enviroment.

Applications Information

Selection of Current Sense Resistor

The external current sense resistor (R_{CS} in Figure 1) has a significant effect on the function of a current sensing system and must be chosen with care.

First, the power dissipation in the resistor should be considered. The system load current will cause both heat and voltage loss in R_{CS}. So proper consideration should be provided to make sure that the heat and voltage loss will not affect the system's normal operation, even under peak load conditions.

Secondly, the minimum current sense resistor value will be set by the resolution, the minimum signal that can be accurately represented by this sense amplifier is limited by the input offset voltage. So the minimum sense voltage should be no less than CN106's input offset voltage. The larger the minimum sense voltage is, the lower the error is. As an example, the CN106A has a maximum input offset voltage of 300μV, if the minimum current is 20mA, then the minimum current sense resistor is 15mΩ, which will set V_{CS} to 300μV.

Lastly, R_{CS} must be small enough that V_{CS} does not exceed the maximum sense voltage specified by the CN106, even under peak load conditions.

Current Sense Resistor Connection

Kelvin connection of the CSN pin and VCC pin to the current sense resistor should be used, since solder connections and PC board interconnections that carry high current can cause significant error in measurement due to their relatively large resistances. One 10mm × 10mm square trace of one-ounce copper is approximately 0.5mΩ. A 1mV error can be caused by a 2A current flowing through this small interconnect. This will cause a 1% error in a 100mV signal. A 10A load current in the same interconnect will cause a 5% error for the same 100mV signal.

A current sense resistor with integrated Kelvin sense terminals will give the best results, especially for the applications of large current sensing.

Error Sources

The CN106 uses an amplifier and current sense resistor to amplify the sense voltage and level shift the result. The output is then heavily dependent on the characteristics of amplifier, such as gain and input offset voltage. The input offset voltage of the amplifier adds directly to the value of the sense voltage, V_{CS}. This is the dominant error of the system and it limits the low end of the dynamic range. The paragraph "Selection of Current Sense Resistor" provides details.

Minimum Output Voltage (V_{OUTmin})

When current sense voltage V_{CS} = 0V, the output voltage may be slightly positive, this is the result of input offset voltages and of a small amount of quiescent current flowing through the output device. The minimum output voltage in the section of "Electrical Characteristics" includes both these effects.

Maximum Output Voltage (V_{OUTmax})

The maximum output voltage is limited by the required voltage drop across the output device that is internally connected between VCC and OUT pin. The required voltage drop across the output device is 2V max., so the maximum output voltage is VCC−2V.

Output Filtering

The output signal may be used as is, or processed with an output filter. In collaboration with OUT pin's output resistor Ro, a capacitor (C2 as shown in Figure 2) from OUT pin to GND forms a low-pass filter, which will reduce the unwanted noise from the output, and may be used as a charge reservoir to keep the output steady while driving a switching circuit such as a MUX or ADC. This output capacitor in parallel with the internal resistor Ro will create a pole in the output response at:

$$f_{-3DB} = \frac{1}{2\pi * Ro * C_{OUT}}$$

Where, Ro is the output resistance of OUT pin, which is 20KΩ typical.

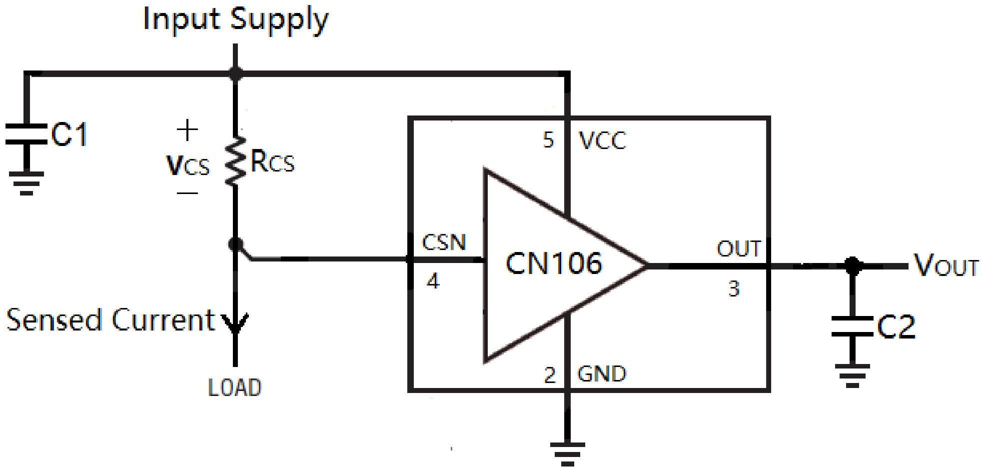


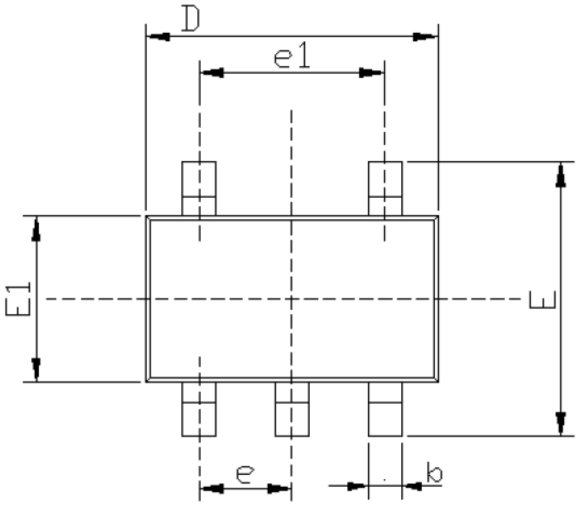
Figure 2 Capacitor C2 Forms a Low-pass Filter with OUT pin's Resistance

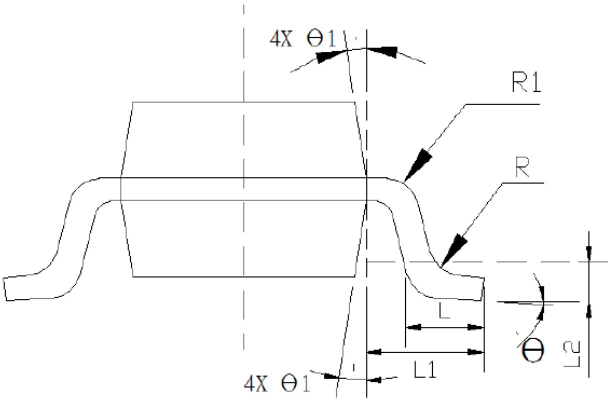
Power Supply Rejection Ratio (PSRR)

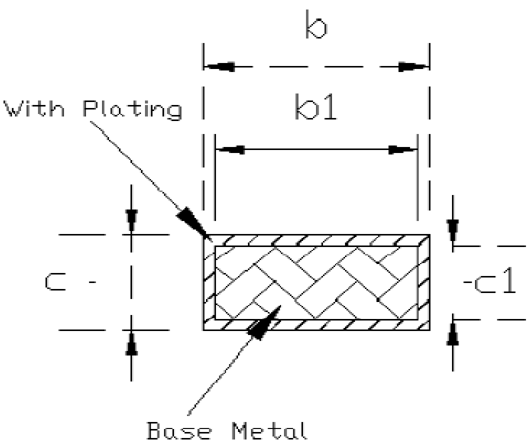
The power supply rejection ratio (PSRR) measures the ability of the current-sensing amplifier to reject any variation of the supply voltage VCC. The PSRR is referred back to the input so that its effect can be compared with the applied differential sense voltage. The PSRR is defined by the formula:

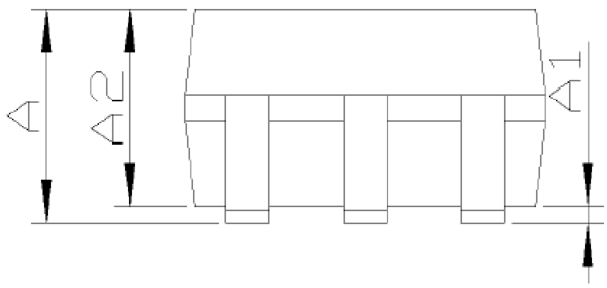
$$PSRR = -20 * \log\left(\frac{\Delta V_{OUT}}{\Delta VCC * AV}\right)$$

Package Information (SOT-23-5)









Common Dimensions (Units of Measure=Millimeter)			
SYMBOL	MINIMUM	NOMINAL	MAXIMUM
A	-	-	1.35
A1	0	-	0.15
A2	1.00	1.10	1.20
b	0.35	-	0.45
b1	0.32	-	0.38
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.35	0.45	0.60
L1	0.6 REF		
L2	0.25 REF		
R	0.10	-	-
R1	0.10	-	0.25
Θ	0°	4°	8°
Θ 1	5°	10°	15°

NOTES:

1. All DIMENSIONS REFER TO JEDEC STANDARD MO-178
2. DIMENSION D DOES NOT INCLUDE MOLD FLASH
3. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH
4. FLASH OR PROTRUSION SHALL NOT EXCEED 0.25mm PER SIDE.

Important Notice

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