NOVOSENSE

NSM2016

Hall-Effect-Based Current Sensor IC with Common-Mode Field Rejection and Overcurrent protection

Datasheet (EN) 1.1

Product Overview

NSM2016 is an integrated path current sensor with a very low on-resistance of 1.2mΩ, reducing heat loss on the chip.

NOVOSENSE innovative isolation technology and signal conditioning design can meet high isolation levels while sensing the current flowing through the internal Busbar.

A differential Hall pair is used internally, so it has a strong immunity to external stray magnetic fields.

NSM2016 has a fixed output mode. Compared with the current sampling method of the Shunt+ isolated op amp, NSM2016 eliminates the need for the primary side power supply and has a simple and convenient layout. At the same time, it has extremely high isolation withstand voltage and lifetime stability.

In high-side current monitoring applications, NSM2016 can reach a working voltage of 600Vpk, and it can withstand 6kV surge voltage without adding any protection devices.

Due to NSM2016 internal accurate temperature compensation algorithm and factory accuracy calibration, this current sensor can maintain good accuracy in the full temperature working range, and the customer does not need to do secondary programming or calibration.

NSM2016 provides overcurrent protect function.

Support 3.3V/5V power supply (different version)

Key Features

- High bandwidth and fast response time
- 380kHz bandwidth
- 1.5μs response time
- High-precision current measurement
- Differential hall sets can immune stray field
- High isolation level that meets UL standards
- Withstand isolation voltage (VISO): 3000Vrms
- Maximum surge isolation withstand voltage (VIOSM): 6kV
- CMTI > 100V/ns
- CTI（I）
- Creepage distance/Clearance distance: 4mm
- NOVOSENSE innovative ‘Spin Current’ technology makes offset temperature drift very small
- Fixed output
- Fault overcurrent protection
- Working temperature: -40°C ~ 125°C
- Primary internal resistance: 1.2mΩ
- SOIC8 package
- UL62368/EN62368 safety certification
- ROHS compliance

Certificate Number: CBS 112807 0002 Rev.00 B 112807 0001 Rev.00

Certificate Number: E520654

Applications

- Solar system
- Industrial power supply
- Motor control
- OBC/DCDC/PTC heater
- Charging pile

Device Information

Part Number	Package	Body Size
NSM2016	SOIC8	4.9mm*3.9mm

Functional Block Diagrams

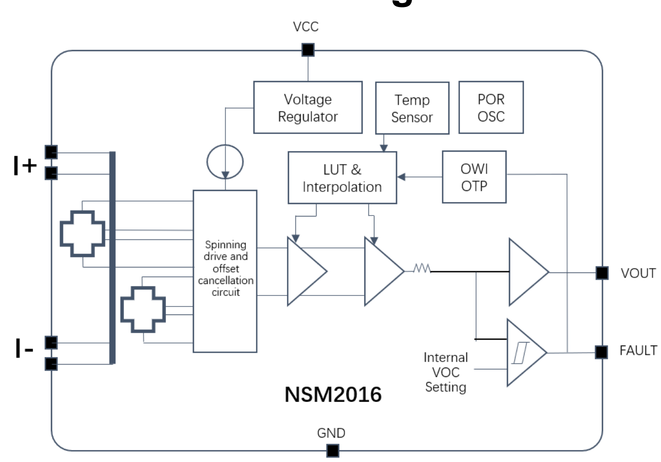

Figure 1. NSM2016 Block Diagram

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1. Pin Configuration and Functions

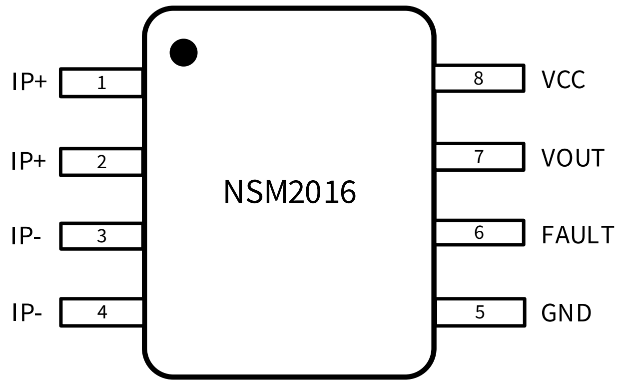


Figure 1.1 NSM2016 Package

Table 1.1 NSM2016 Pin Configuration and Description

NSM2016 Pin NO.	Symbol	Function
1-2	IP+	Current flows into the chip, positive direction
3-4	IP-	Current flows out of the chip, negative direction
5	GND	Ground
6	FAULT	Overcurrent fault, active low, open drain output
7	VOUT	Output voltage
8	VCC	Power supply

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
V_{CC}	V_{CC}	-0.3		6.5	V	
V_{out}		-0.3		VDD+0.3	V	
Other Pins		-0.3		VDD+0.3	V	
Storage Temperature	$T_{Storage}$	-40		150	°C	
Ambient Temperature	$T_{operation}$	-40		125	°C	
Junction Temperature	T_j	-40		150	°C	

3. ESD Ratings

	Ratings	Value	Unit
Electrostatic Discharge	Human body model (HBM), per AEC-Q100-002-RevD ● All pins	±8	kV
	Charged device model (CDM), per AEC-Q100-011-RevB ● All pins	±2	kV

4. Isolation Characteristics

Parameters	Symbol	Rating	Unit	Comments
Surge Voltage	V_{surge}	6	kV	Based on IEC61000-4-5 1.2us/50us waveform
Dielectric Strength Test Voltage	V_{ISO}	3000	Vrms	60s isolation voltage parameters, according to UL62368-1, 3.6kV/ 1s insulation performance will be tested before delivery, and partial discharge is verified to be less than 5pC
Working Voltage for Basic Isolation	V_{WVBI}	424	Vrms	Maximum approved working voltage for basic isolation according to UL60950-1 and UL62368-1
		600	Vdc	
Common-Mode Transient Immunity	CMTI	>100	V/ns	The criterion for judging the failure is that the output peak is greater than 100mV and the duration is longer than 1us
Creepage	Creepage	4	mm	Minimum Creepage
Clearance	Clearance	4	mm	Minimum Clearance
Comparative Tracking Index	CTI	>=600		CTI I

5. Specifications

5.1. Common Characteristics (TA= -40°C to 125°C, VCC = 5Vor3.3V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply Voltage	V_{CC}	3	3.3	3.6	V	3.3V version
		4.5	5	5.5	V	5V version
Supply Current	I_{CC}		12	15	mA	No load, V_{cc}=5V
			7.5	8	mA	No load, V_{cc}=3.3V
Primary Conductor Resistance	R_P		1.2		mΩ	T_A = 25°C
Power-On Time	T_{po}		1		ms	Recommend customer to read output after 1ms power-on time, before 1ms internal OTP is loading, T_A = 25°C
Output Capacitance Load[1][2]	C_L			10	nF	
Output Resistance Load[1][2]	R_L	10			kΩ	
Output Short Current	I_{short_Vout}		±25		mA	V_{out} is short to V_{CC} and short to GND, TA = 25°C

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Rail To Rail Output Voltage[1][2]	V_s	0.1		VCC-0.1	V	T_A = 25°C, C_L=1nF, R_L=10kΩ to V_{CC} or GND
Common Mode Field Rejection[1][2]	CMFR		>40		dB	
Power Supply Rejection Ratio	PSRR		-50		dB	DC to 1 kHz, 100 mVpk-pk ripple around V_{CC} =5V, I_P=0A
Rise Time[1][2]	T_r		1		µs	T_A = 25°C, C_L=1nF, V_{CC}=5V, 50AB "F"Version
Propagation Delay [1][2]	T_{pd}		1		µs	T_A = 25°C, C_L=1nF, V_{CC}=5V, 50AB "F"Version
Response Time[1][2]	$T_{response}$		1.5		µs	T_A = 25°C, C_L=1nF, V_{CC}=5V, 50AB "F"Version
Bandwidth[1][2]	BW		380		kHz	-3dB bandwidth, T_A = 25°C, C_L=1nF, V_{CC}=5V, 50AB, "F"Version
Noise Density[1][2]	ND		120		µArms/√Hz	T_A = 25°C, C_L=1nF, V_{CC}= 5V
			140		µArms/√Hz	T_A = 25°C, C_L=1nF, V_{CC}= 3.3V
Non-Linearity	E_{NL}		±0.2		%	
Fault Pull-Up Resistance	R_{pu}	4.7		100	kΩ	
Overcurrent Threshold	Ift		100		%I_{PR}	
Fault Hysteresis	I_{hys}		10		%I_{PR}	T_A = 25°C, C_L=1nF, NSM2016-50B5F, Ift threshold=100%I_{PR}
Fault Response Time	T_{fr}		1.5		µs	The time from Overcurrent happened to Fault pin active low, 4.7 kΩ pull-up Resistance
Fault Error	E_{fault}		±8		%I_{PR}	T_A = 25°C, C_L=1nF, NSM2016-50B5F, Ift threshold=100%I_{PR}

[1]: Guarantee by design.

[2]: Guaranteed by Bench Validation.

[3]: The increase or decrease of data in 5.X will not send a PCN to the customer if the evaluation does not affect the customer's use.

5.2. NSM2016-20B5F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 5V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	-20		20	A	
Sensitivity	Sens		100		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		2.5		V	I_{pr} = 0A

Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1][2]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.3. NSM2016-20U5F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 5V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	0		20	A	
Sensitivity	Sens		200		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		0.5		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1][2]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.4. NSM2016-25B3F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 3.3V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	-25		25	A	
Sensitivity	Sens		55		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		1.65		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [2][3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[2][3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [2][3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.5. NSM2016-30B3F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 3.3V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	-30		30	A	
Sensitivity	Sens		44		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		1.65		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [2][3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[2][3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [2][3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.6. NSM2016-45B5F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 5V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	-45		45	A	
Sensitivity	Sens		44.4		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		2.5		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [2][3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[2][3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [2][3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.7. NSM2016-50B3F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 3.3V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	-50		50	A	
Sensitivity	Sens		26.4		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		1.65		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [2][3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[2][3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [2][3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.8. NSM2016-50B5F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 5V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	-50		50	A	
Sensitivity	Sens		40		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		2.5		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [2][3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[2][3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [2][3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

5.9. NSM2016-50U5F-DSPR Characteristics (TA= -40°C to 125°C, VCC = 5V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Current sensing range	I_{pr}	0		50	A	
Sensitivity	Sens		80		mV/A	$I_{prmin} < I_{pr} < I_{prmax}$
Zero current output voltage	V_{QVO}		0.5		V	I_{pr} = 0A
Sensitivity error[1][2]	E_{sens}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Offset error[2]	V_{OE}	-10		10	mV	T_A = 25°C~125°C, I_{pr}=0A
			±10		mV	T_A = -40°C~25°C, I_{pr}=0A
Total output error [1]	E_{total}	-2		2	%	T_A = 25°C~125°C
			±2.5		%	T_A = -40°C~25°C
Sensitivity error lifetime drift [2][3]	E_{sens_drift}	-2.3		2.3	%	After reliability test, T_A = 25°C
Offset lifetime drift[2][3]	V_{OE_drift}	-12		12	mV	After reliability test, T_A = 25°C
Total output error lifetime drift [2][3]	E_{total_drift}	-2.8		2.8	%	After reliability test, T_A = 25°C

[1]: In production, total error and sensitivity error are measured and calculated at 20A, A single part will not have both the maximum/minimum sensitivity error and maximum/minimum offset voltage.

[2]: When TA = 25°C~125°C, Min/Max value is the mean value +/-3sigma; When TA = -40°C~25°C, Typical value is the mean value +/-3sigma.according to the statistical law, 99.73% of the data is in this range Inside.

[3]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade1 as a reference. This is the worst case.

*In the chapter 5, the increase or decrease of the material number and the tightening of the parameter range, NOVOSENSE reserves the right not to send PCN to the customer, unless the expansion of the parameter range affects the customer's use and product performance.

6. Function Description

6.1. Overview

NSM2016 current sensor can accurately measure AC/DC current while minimizing the overall measurement cost. Current sensors based on the Hall principle can be widely used in all current monitoring applications such as consumer, industry, and automotive. Compared with current transformers, the extremely small size of NSM2016 SOIC8 can help customers reduce the overall PCB area; compared to Shunt+isolated op amps, NSM2016 only needs low-voltage side power supply, reducing the inconvenience of isolated op amps requiring power supply for both high side and low side. When using NSM2016, you only need to string the primary side pin into the measured current. According to the part of Maxwell equations about electricity and magnetism, a magnetic field will be generated around the energized conductor of the primary side. The Hall and conditioning amplifier circuits in NSM2016 will convert magnetic field into an output voltage, and the output voltage increases or decreases in proportion to the input current.

Benefiting from the typical value of the primary resistance of NSM2016 is only 1.2mohm, as long as the customer conducts a reasonable heat dissipation design, the temperature rise brought by the measurement of large current can be effectively reduced.

At the same time, NSM2016 uses dual Hall sampling internally, the common mode magnetic field brought by the outside world can be effectively reduced. According to the measured typical value, if the 100G common mode magnetic field acts vertically on the chip, it will only bring an error of less than 1G in the output. (Equivalent to input). Because NSM2016 has a good ability to resist common-mode magnetic fields, it can still maintain excellent performance in motor control or some harsh current measurement environments.

6.2. NSM2016 F Version(Fixed Output)

In some applications, the ADC and the current sensor do not share a power rail, so the sensor needs to have absolute sensitivity that does not vary with the power supply voltage. The value of the sensing current can be obtained by (V_{out_IPR}-V_{out_0A})/Sensitivity. For ±50A measurement range, if V_{out_30A} measures 3.7V and V_{out_0A} measures 2.5V, then the input current is (3.7V-2.5V)/40mV/A=30A. In practical applications, the measurement accuracy will not be affected by power supply changes.

6.3. Overcurrent Fault Performance

NSM2016 has overcurrent protect function. When the primary current exceeds the overcurrent threshold, the internal error comparator reverses, driving Open Drain Output to work, and the Fault pin is pulled down.

Overcurrent Fault is triggered when the primary current (positive or negative current) exceeds the overcurrent threshold set. Fault is cleared when the absolute value of the primary current is less than the current threshold set minus current hysteresis. Tfr is Fault Response time：the time from the primary current meets the overcurrent condition to Fault pin is pulled down. The timing of overcurrent protection is as follows:

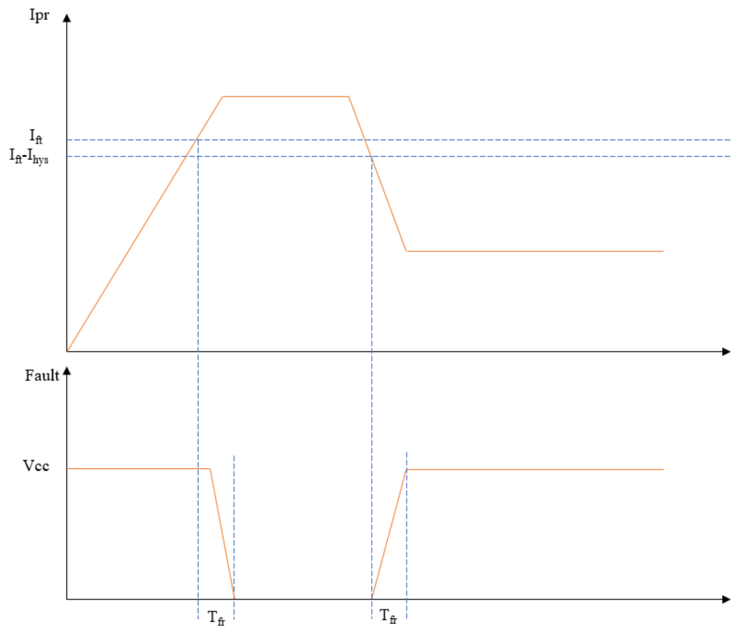


Figure 6.1 NSM2016 Overcurrent Performance

The NSM2016 has feature for Fault latched. With this feature, when the device meets the overcurrent condition, the Fault pin will remain latched low even if the overcurrent condition is disappeared. The way to reset device is Power on and Off again. Overcurrent Latch Performance is as follows:

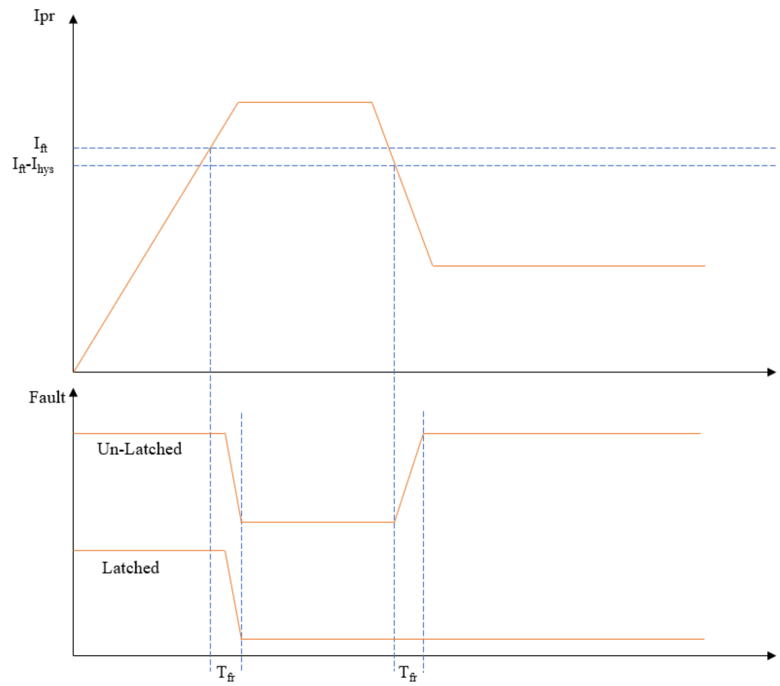
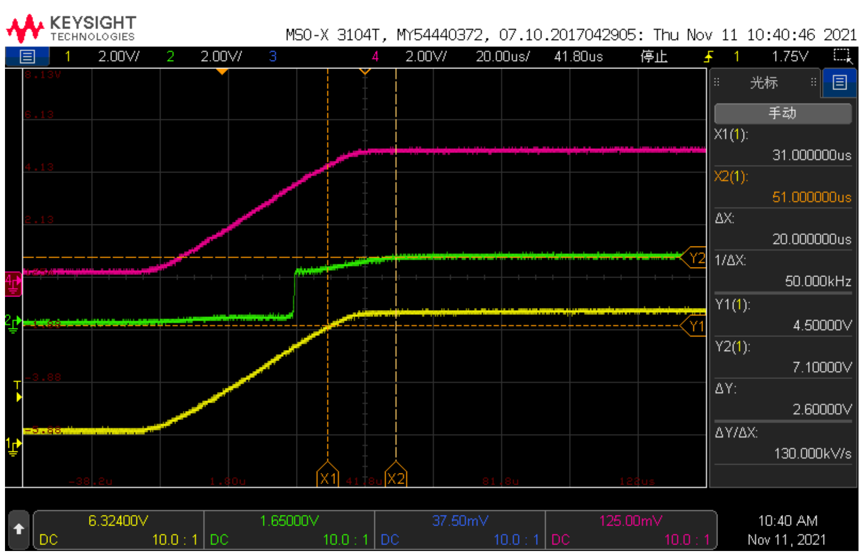


Figure 6.2 NSM2016 Overcurrent Latch Performance

6.4. NSM2016 Power-On Time Wave

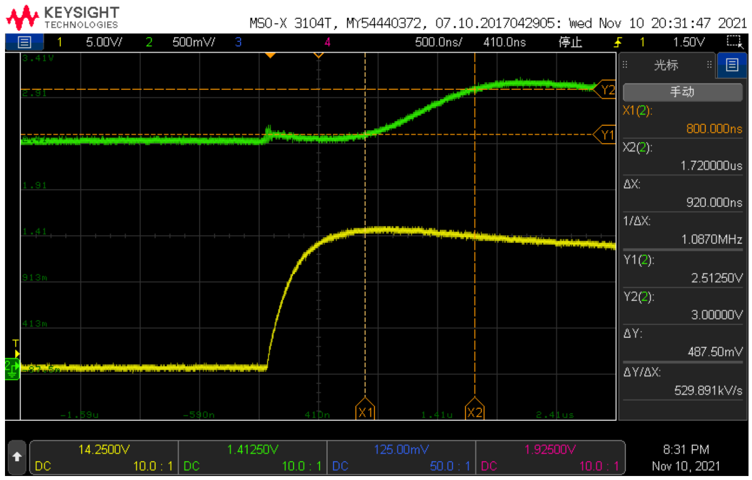
Yellow: VCC 、 Green: VOUT 、Red: Fault



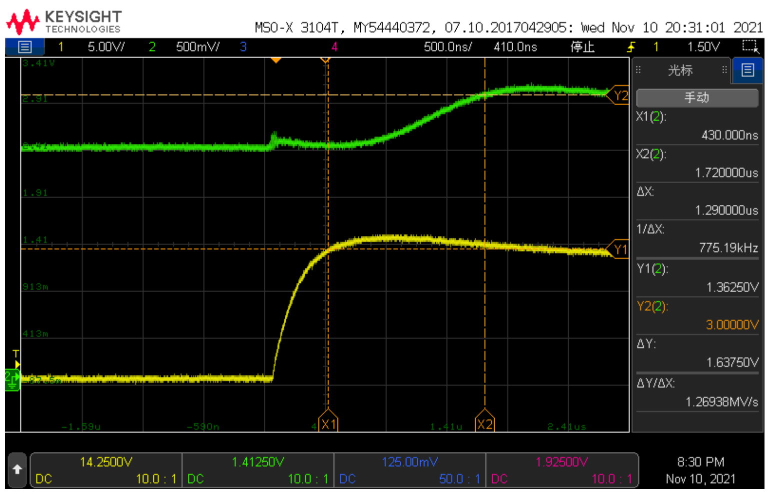
Note：The above waveform DUT is NSM2016-50B5F-DSPR

6.5. NSM2016 Rise Time and Response Time Wave

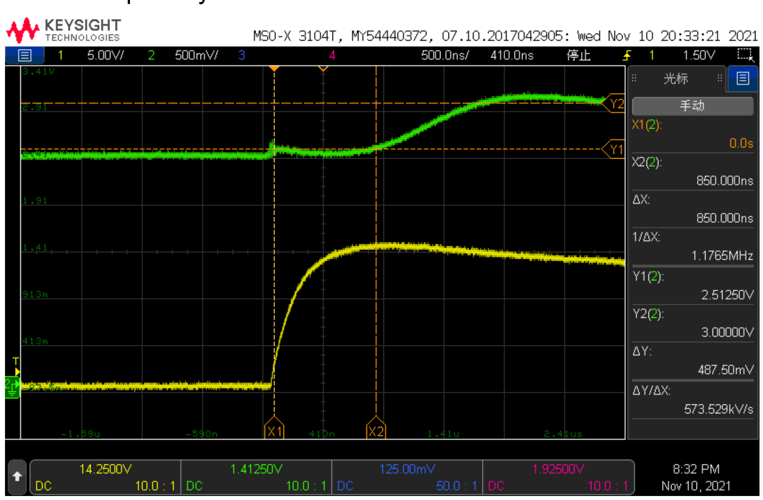
(1) Rise time Yellow：primary current、 Green：VOUT



(2) Response time Yellow：primary current、 Green：VOUT

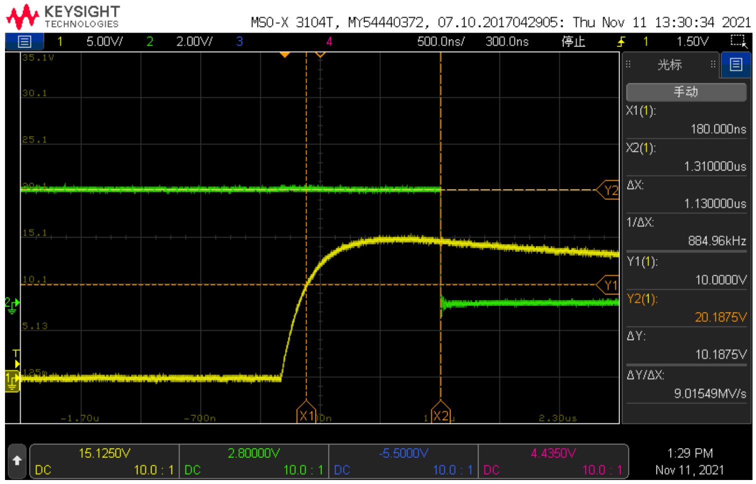


(3) Propagation Delay time Yellow：primary current、 Green：VOUT



Note：The above waveform DUT is NSM2016-50B5F-DSPR

(4) Fault Response time Yellow：primary current、 Green：VOUT



Note：The above waveform DUT is NSM2016-10B5F-DSPR

6.6. NSM2016 Bandwidth Test

100Hz-400kHz input signal，-3dB Bandwidth : 380kHz。

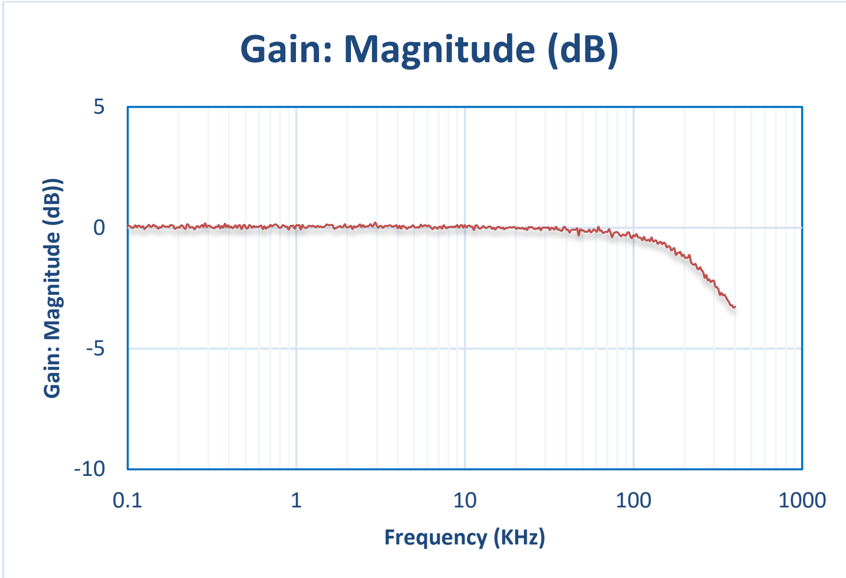


Figure 6.3 NSM2016 Amplitude frequency response curve

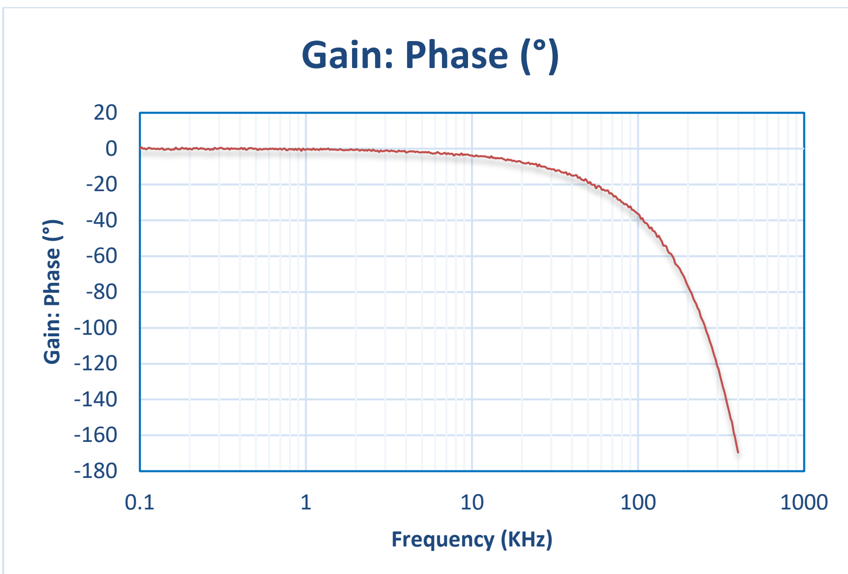


Figure 6.4 NSM2016 Phase frequency response curve

Note：The above waveform DUT is NSM2016-50B5F-DSPR

6.7. Definition of NSM2016 Terms

Power-On Time (T_{po})

When the power supply climbs from 0 to the chip's working range, NSM2016 needs some time to establish the internal working logic. Tpo time is defined as: the time from the power supply climbing to V_{ccmin} to the output reaching the steady state within ±10%, As shown below:

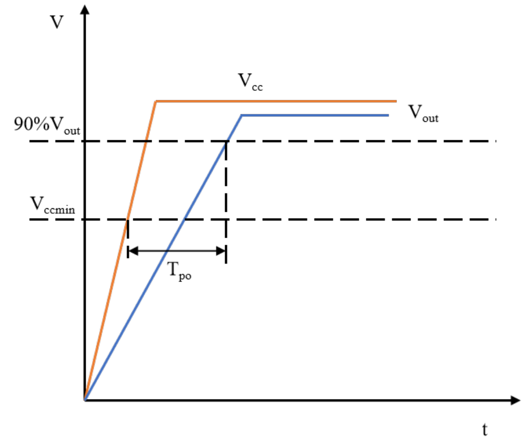


Figure 6.5 NSM2016 Power-on Time

Rise Time (T_r)

The time from 10% to 90% of the output signal is defined as the output rise time. For step input signals, there is such an approximate relationship between the rise time and bandwidth of the output signal: f(-3dB) = 0.35/T_r.

Propagation Delay (T_{pd})

The time from 20% of the primary current to 20% of the output signal is defined as the output propagation delay time.

Response Time (Tresponse)

The time from 90% of the primary current to 90% of the output signal is defined as the output response time.

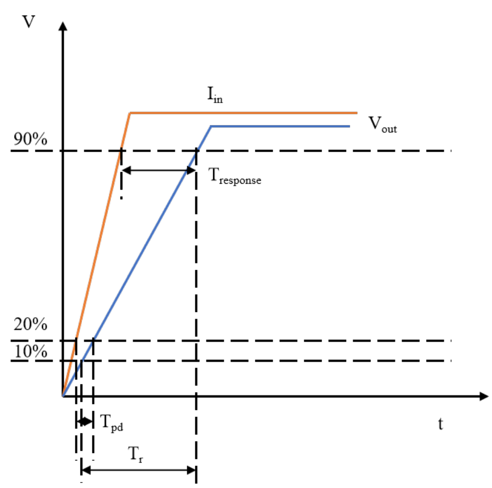


Figure 6.6 NSM2016 Response Time

Sensitivity and Sensitivity Error

Sensitivity is defined as the ratio of the output voltage proportional to the primary input current. Sensitivity is the slope of the curve in the figure below.

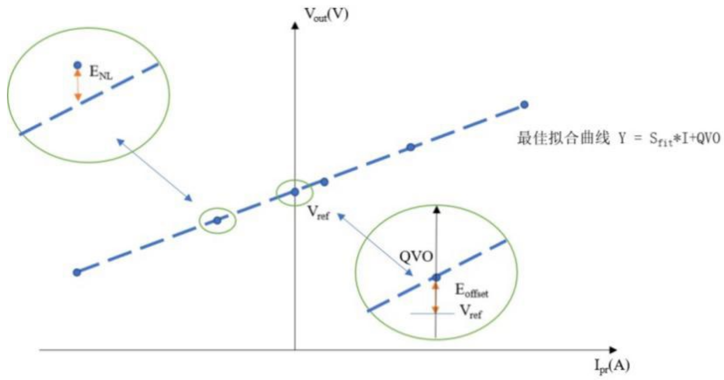


Figure 6.7 NSM2016 Sensitivity and Error

The sensitivity error is defined as the deviation between the slope of the best-fit curve and the slope of the ideal curve. The slope of the best-fit curve comes from the measured value:

$$E_{sens} = \frac{(S_{fit} - S_{ideal})}{S_{ideal}} * 100\%$$

Offset Error

The zero current output error is defined as the difference between the output voltage and the ideal 0A output voltage($V_{out\_0A\_ideal}$), when the primary current is 0A, $V_{out\_0A\_ideal}$ is VCC/2 or 0.1*VCC:

$$E_{offset} = QVO - V_{out\_0A\_ideal}$$

Non-linear Error

The linearity error is defined as the error from the maximum deviation point of the best-fit curve to the full scale. The mathematical expression is as follows:

$$E_{NL} = \frac{V_{NL}}{FS} * 100\%$$

among them:

$V_{NL} = V_{outmax} - (S_{fit} * I_{max} + QVO)$, V_{NL} is the output error of the maximum deviation point;

FS is Full scale of output voltage;

V_{outmax} is the output voltage furthest from the fitted curve;

I_{max} is the primary current furthest from the fitted curve;

Total Error

The total error is defined as the error between the actual given current and the current measured by the chip, in other words, the difference between the actual output voltage and the ideal output voltage. It should be known that in different current ranges, the factors that dominate the total error are different. If it is under low current measurement, the zero point error is the main source of error; if under high current measurement, the total error caused by the zero point error is very small, and the dominant error is the sensitivity error.

$$E_{total}(I_{pr}) = \frac{V_{out_{ideal}}(I_{pr}) - V_{out}(I_{pr})}{FS}$$

7. Application Note

7.1. Typical Application Circuit

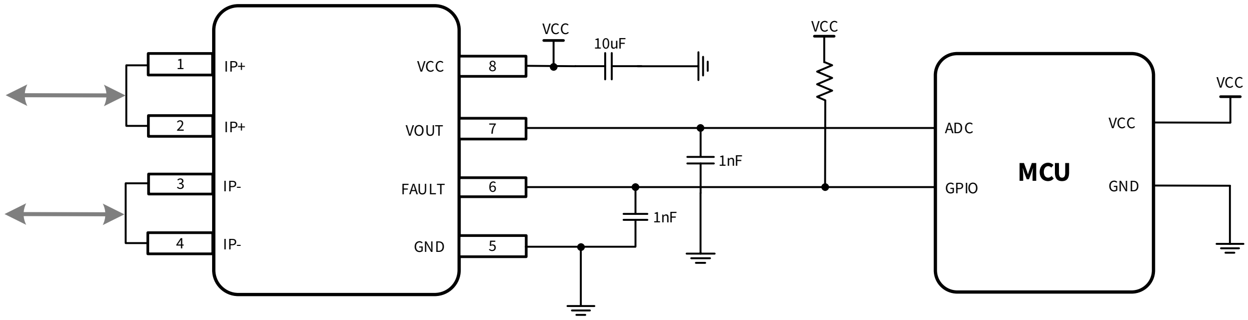


Figure 7.1 Typical application diagram of fixed output mode

7.2. PCB Layout

For NSM2016 in high-current monitoring applications, a reasonable layout will make the system heat dissipation faster and better. The copper area on the NSM2016 Demo board is 21mm*18mm (very small copper area is used to illustrate the worse situation, rather than a large copper area), the top layer and the bottom layer are 2oz copper thick. Under this layout, after 30 minutes, after the 35A current stabilizes, the surface temperature of the chip is as shown in the lower right picture. The highest point temperature is around 70°C. Foreign competitors can reach 90°C under the same layout. . The reason why NSM2016 is better than competitors for heat dissipation is due to the use of packaging materials with better heat dissipation coefficients and a copper frame with better heat dissipation coefficients. If customers want to achieve better heat dissipation, they can use multi-layer boards and thicken the copper thickness to achieve it, and can use active heat dissipation solutions in the system, such as adding heat sinks and fans. If you need to use the NSM2016 Demo board to evaluate the performance of this current sensor, please contact NOVOSENSE sales team for support.

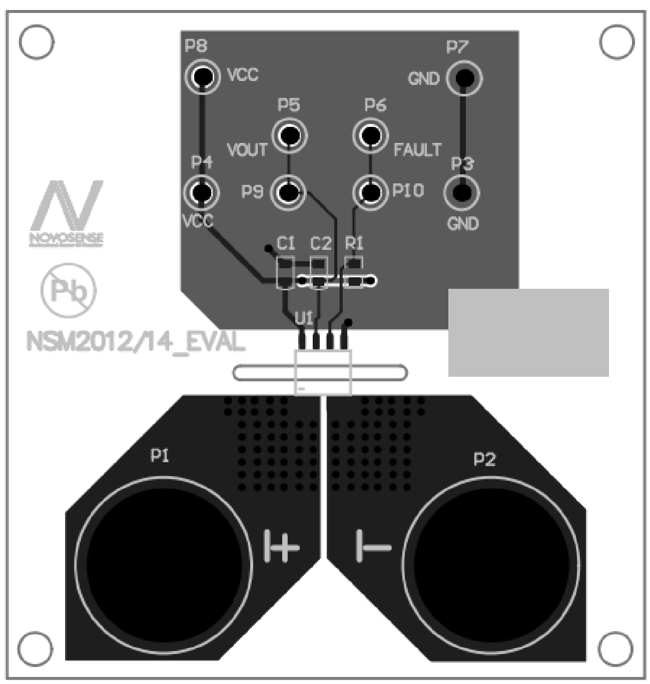


Figure 7.2 NSM2016 PCB Layout

7.3. Thermal Evaluation

The thermal evaluation experiment is tested at room temperature, which mainly illustrates the temperature rise of the NSM2016 current sensor under different currents. With these data and the above-mentioned layout guide, customers can design heat dissipation according to actual application requirements. The ambient temperature in this experiment is room temperature. The surface is mounted on the above Demo board for temperature rise test. There is no external active heat dissipation device (such as a fan, etc.). The relationship between junction temperature and time is measured. 20 minutes of temperature data are collected. Under normal circumstances, the temperature rise It is basically fixed in about 10 minutes, and the specific test data are as follows:

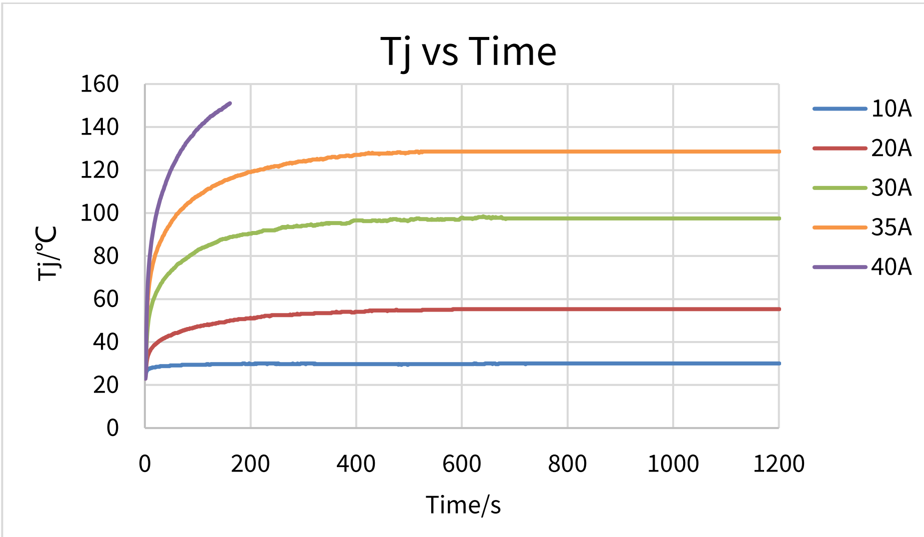


Figure 7.3 NSM2016 Junction temperature vs. Different continues current

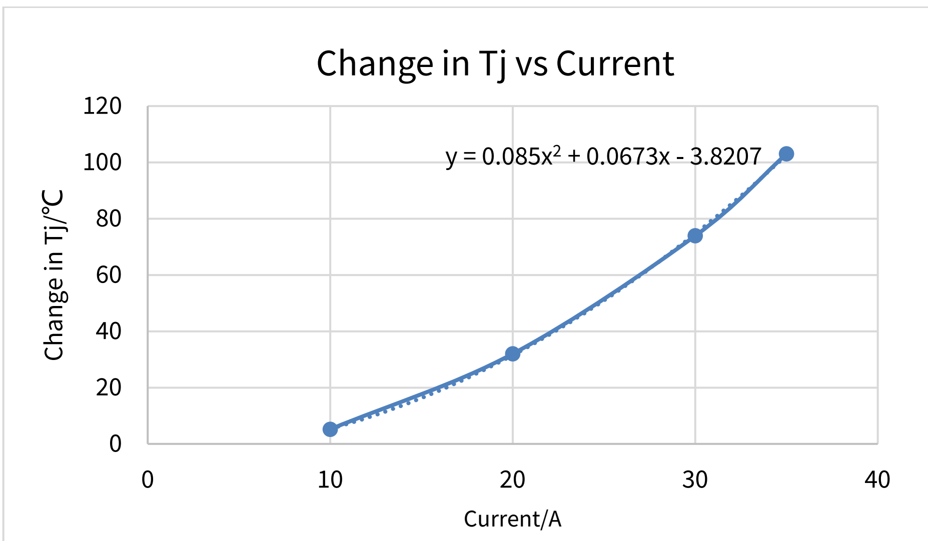
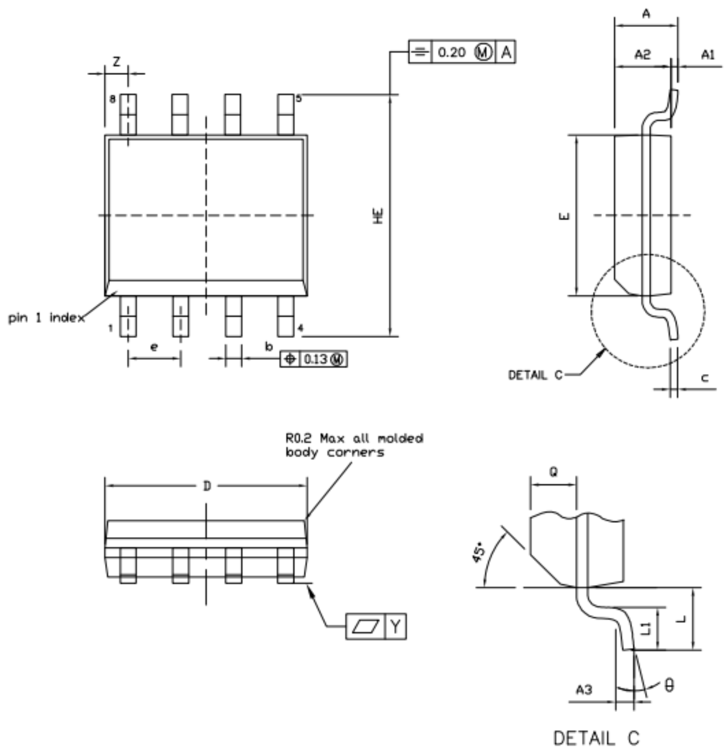


Figure 7.4 NSM2016 Estimation function of junction temperature at different currents (PCB is in worst case)

It is important to note that the above temperature rise experiment data is only based on the Demo board, in order to reflect the relationship between NSM2016 current and temperature in a worst case. Customers can reduce the temperature rise of Tj by increasing or thickening the copper area of the PCB, using multi-layer boards, or adding active heat dissipation devices such as fans (Tj<150°C). If customers compare NSM2016 with other competing products, please refer to the same PCB design instead of using specially designed PCB provided by competing products. NOVOSENSE can provide a 16-pin general-purpose Demo board for comparison of temperature rises of competing products.

8. Package Information



※ CONTROLLING DIMENSION : MM

SYMBOL	MILLIMETER		
	MIN.	NOM.	MAX.
A	---	---	1.75
A1	0.10	---	0.25
A2	1.25	1.35	1.45
b	0.33	0.38	0.49
c	0.19	0.20	0.25
D	4.80	4.90	5.00
E	3.80	3.90	4.00
Q	0.60	0.65	0.70
HE	5.80	6.00	6.20
e	1.27 BSC		
L	1.05 BSC		
L1	0.40	0.64	1.00
Y	---	0.10	---
Z	0.3	0.5	0.7
A3	0.25 BSC		
θ	0°	5°	8°

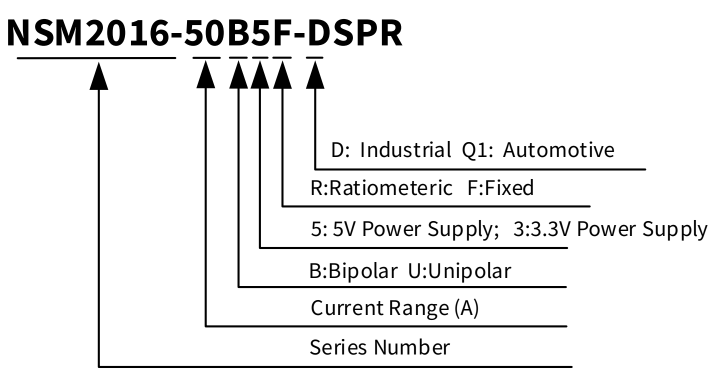
Figure 8.1 SOIC8 Package Shape and Dimension in millimeters

9. Order Information

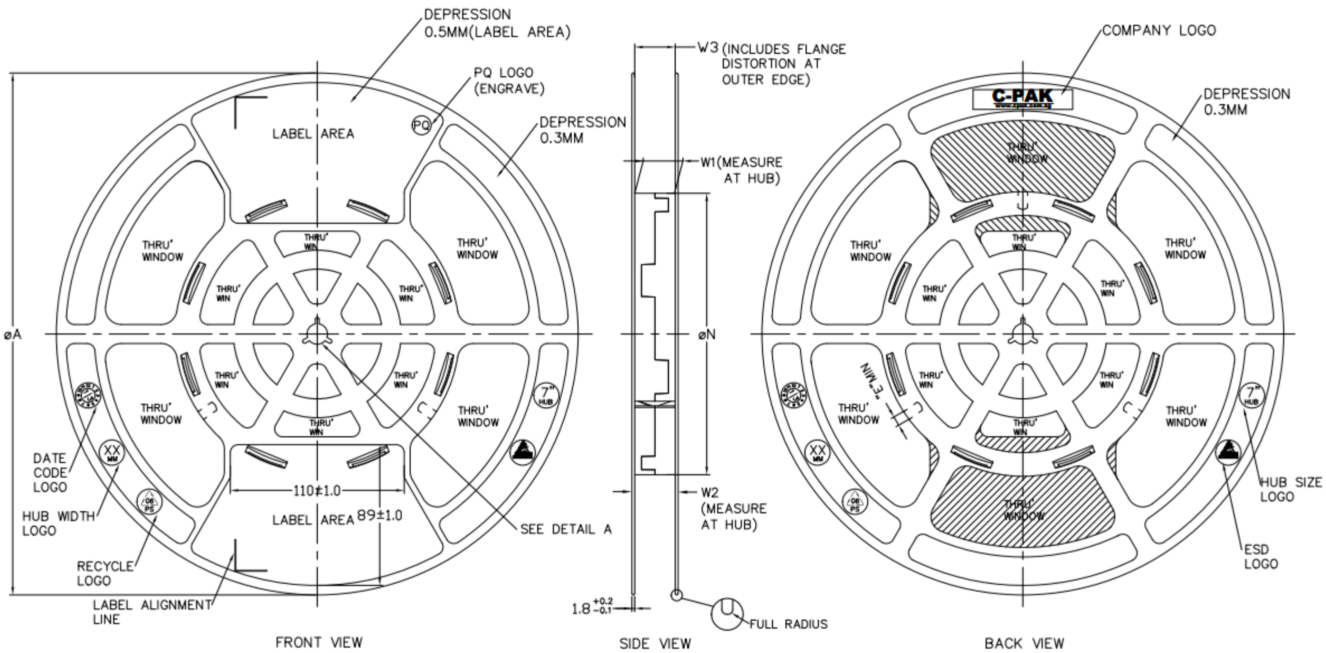
Order information:

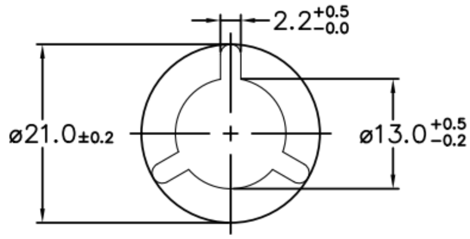
Part number	Primary current(A)	Power supply(V)	Sensitivity(mV/A)	MSL	MPQ	Package
NSM2016-20B5F-DSPR	±20	5	100	2	2.5k	SOIC8
NSM2016-20U5F-DSPR	20	5	200	2	2.5k	SOIC8
NSM2016-25B3F-DSPR	±25	3.3	55	2	2.5k	SOIC8
NSM2016-30B3F-DSPR	±30	3.3	44	2	2.5k	SOIC8
NSM2016-45B5F-DSPR	±45	5	44.4	2	2.5k	SOIC8
NSM2016-50B3F-DSPR	±50	3.3	26.4	2	2.5k	SOIC8
NSM2016-50B5F-DSPR	±50	5	40	2	2.5k	SOIC8
NSM2016-50U5F-DSPR	50	5	80	2	2.5k	SOIC8

Naming Rules:



10. Tape and Reel Information



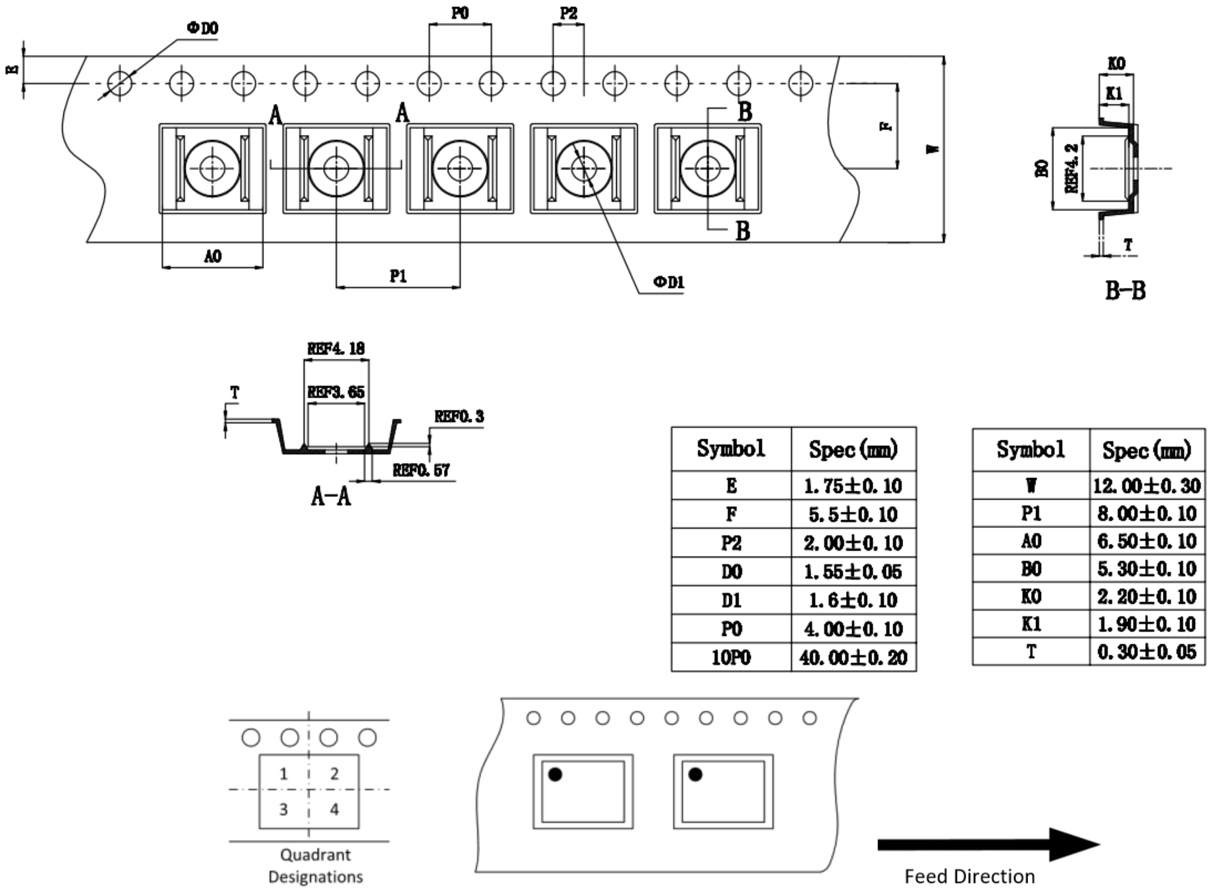


ARBOR HOLE
DETAIL A
SCALE : 3:1

PRODUCT SPECIFICATION						
TAPE WIDTH	ØA ±2.0	ØN ±2.0	W1	W2 (MAX)	W3	E (MIN)
08MM	330	178	8.4 $^{+1.5}_{-0.0}$	14.4	SHALL ACCOMMODATE TAPE WIDTH WITHOUT INTERFERENCE	5.5
12MM	330	178	12.4 $^{+2.0}_{-0.0}$	18.4		5.5
16MM	330	178	16.4 $^{+2.0}_{-0.0}$	22.4		5.5
24MM	330	178	24.4 $^{+2.0}_{-0.0}$	30.4		5.5
32MM	330	178	32.4 $^{+2.0}_{-0.0}$	38.4		5.5

SURFACE RESISTIVITY			
LEGEND	SR RANGE	TYPE	COLOUR
A	BELOW 10^{12}	ANTISTATIC	ALL TYPES
B	10^{6} TO 10^{11}	STATIC DISSIPATIVE	BLACK ONLY
C	10^{5} & BELOW 10^{5}	CONDUCTIVE (GENERIC)	BLACK ONLY
E	10^{9} TO 10^{11}	ANTISTATIC (COATED)	ALL TYPES

Note: MPQ(SOIC8):2.5K



Symbol	Spec (mm)
E	1.75±0.10
F	5.5±0.10
P2	2.00±0.10
D0	1.55±0.05
D1	1.6±0.10
P0	4.00±0.10
10P0	40.00±0.20

Symbol	Spec (mm)
W	12.00±0.30
P1	8.00±0.10
A0	6.50±0.10
B0	5.30±0.10
K0	2.20±0.10
K1	1.90±0.10
T	0.30±0.05

Figure 10.1 Tape and Reel Information of SOIC8

11. Revision History

Revision	Description	Date
1.0	Release 1.0 version	2023/12/08
1.1	(a) Changed ESD description according to new template (b) Update part-number in chapter 5.2~5.9 and order information in chapter 9 (c) Add MPQ in order information	2024/9/30

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