NSPAS3 Series

Automotive Absolute Pressure Sensor

Datasheet (EN) 2.1

Product Overview

NSPAS3 is a calibrated absolute pressure sensor series product launched by NOVOSENSE for powertrain applications. This series uses an automotive-grade ASIC to calibrate and compensate the MEMS sensor element, the pressure signal from 10kPa to 400kPa can be converted into an analog output signal (0~5V) with a customizable output range. While ensuring the reliability of the product, the two chips are integrated and packaged, reduces the package size greatly. This series provides outstanding performance in terms of initial accuracy and suits applications with harsh automotive temperature and stress conditions needing small drift over lifetime. Reliability test according to AEC-Q100 standard.

Key Features

- High precision pressure sensing

  Better than ±1%F.S. (0°C to 85°C)

  Better than ±1.5%F.S. (-40°C to 130°C)
- Large temperature range -40°C to 130°C(168H@140°C)
- Over-voltage and Reverse voltage protection

  between -24V to 28V
- Directly supplied by high voltage up to 18V (absolute analog output)
- Better than 0.8ms response time
- Ratio-metric/Absolute analog output
- Clamping
- AEC-Q100 qualified

Applications

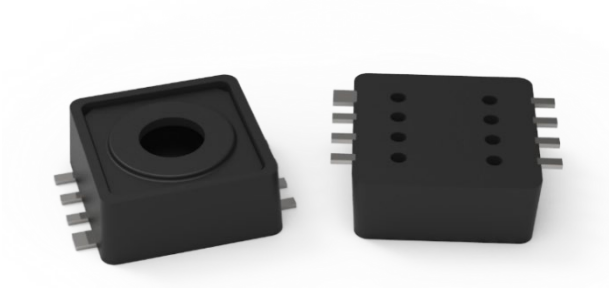
- Motorcycle TMAP applications
- Temperature manifold pressure sensor (TMAP[1])
- ECU barometric absolute pressure (ECU-BAP)
- Canister desorption pressure detection
- Battery pressure sensor
- Seat airbag pressure detection
- Industrial control

1. **Not suitable** for **harsh media applications** like fresh air mixed with high concentrations of corrosive gases such as engine exhaust gas or halogens.

Device Information

Part Number	*Package*	*Body Size*
NSPAS3	7070SOP8	7.0mm × 7.0mm

Outline



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1. Pin Configuration and Functions

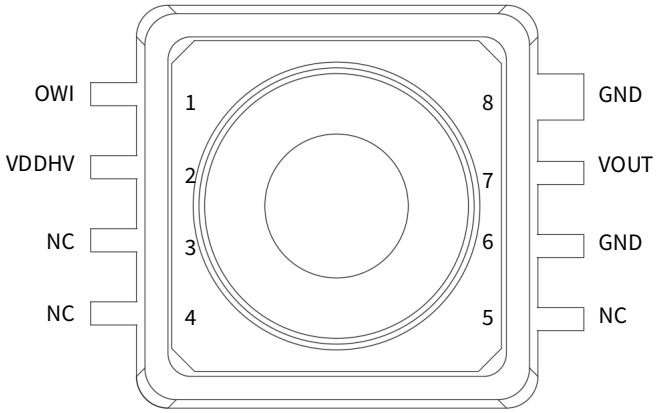


Fig 1.1 Pin Definition (Top view)

Table 1.1 Pin Description

Pin NO.	*Pin name*	*Description*
1	OWI	One-wire interface (leave floating)
2	VDDHV	Power supply with OVP/RVP
3	NC	No connect
4	NC	No connect
5	NC	No connect
6	GND	Ground
7	VOUT	Analog output
8	GND	Ground

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	VDDHV	-24		28	V	70°C, 1 hour
		-30		36	V	70°C, 1 minute
Analog pin voltage	VOUT	-0.3		5.3	V	25°C, VDDHV>5V
Analog output current limit				25	mA	
Proof pressure	P_{proof}	1000			kPa	
Burst pressure	P_{burst}	1500			kPa	
ESD susceptibility	HBM	±2			kV	
	CDM	±750			V	Corner pins
		±500			V	All other pins
Storage temperature	Tstg	-40		130	°C	

3. Recommended Operating Conditions

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	VDDHV	4.5	5	5.5	V	
Operating pressure	P_{amb}	10		400	kPa	
Operating temperature	Topr	-40		130	°C	168H@140°C

4. Specifications

4.1. Electrical Characteristics

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Output voltage range	VOUT	0.05		4.95	V	
Accuracy pressure [1]	Acc_P	-1%		1%	%F.S.	@0°C ~85°C
		-1.5%		1.5%	%F.S.	@-40°C ~130°C
Power on reset	$VDDHV_{POR}$		2.5		V	
Operating current [2]	I_{avdd}	2.5	3.1	3.7	mA	@25℃
Output RMS noise	V_{rms}		0.5		mV	
Output load resistance	R_{load}	1			kOhm	
Output load capacitance	C_{load}			150	nF	
Output short current limit	I_{short_lmt}	10		25	mA	Output short to VDDHV or GND
Clamp low level	V_{clampl}	0%		50%	%VDDHV	
Clamp high level	V_{clamph}	50%		100%	%VDDHV	
Clamp level error	ΔV_{clamp}		40		mV	@VDDHV=5V
Power up time [2]	T_{UP}	8	10	12	ms	@25℃
Response time	T_{RESP}		0.8		ms	
Diagnostic response time	T_{diag}			1	ms	
EEPROM data retention	T_{live}	10			years	@150°C

1. Pressure accuracy is qualified with part number NSPAS3N115RRG1. For pressure accuracy of different part number, please refer to complete part number list at chapter 8.
2. These characteristics are tested at room temperature.

5. Function Description

5.1. Overview

NSPAS3 uses a MEMS piezoresistive absolute pressure sensor element as a pressure sensitive component that provide an original signal output that is proportional to ambient pressure. The built-in conditioning IC drives the sensitive component and amplifies, temperature compensates, and linearizes the original signal to output a voltage signal that is linear with the applied pressure.

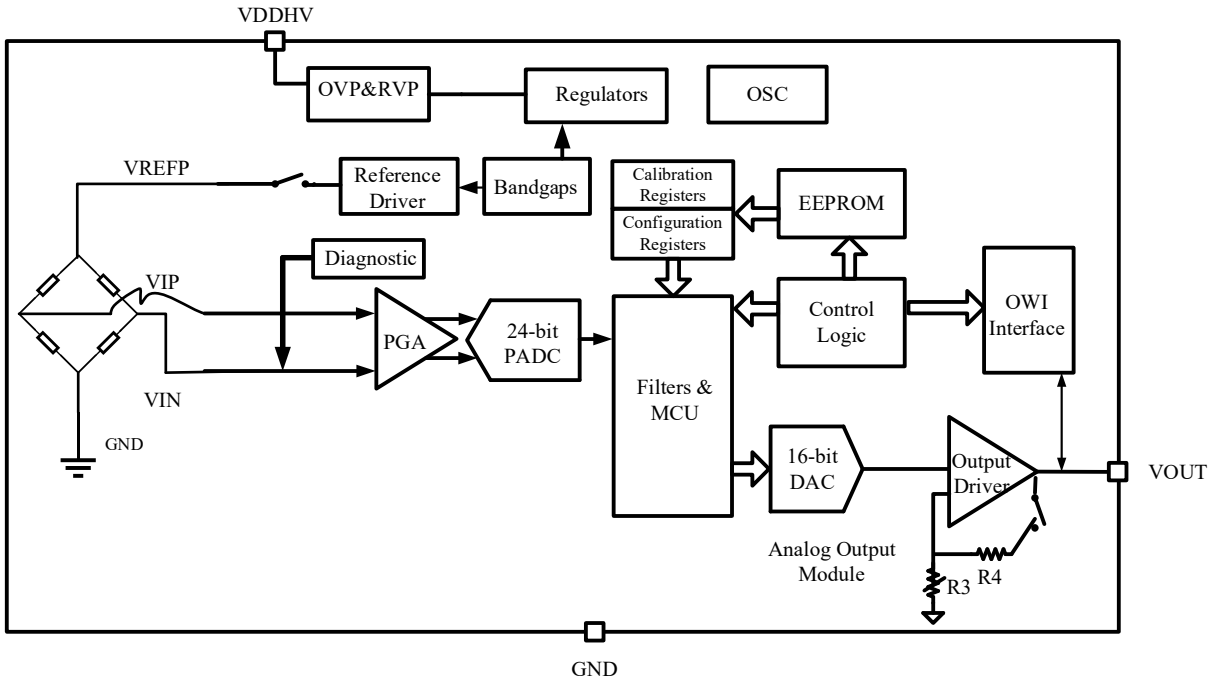


Fig 5.1 Product Function Block Diagram

5.2. Transfer Function

NSPAS3 series device is fully calibrated on delivery. The sensor has a linear transfer function between the applied pressure and the output signal:

Ratiometric: $VOUT = (A \times P + B) \times VDDHV$

Absolute: $VOUT = (A \times P + B) \times 5$

Note: 1) P is the pressure value, absolute pressure, range: 10kPe~400kPa; the transfer function is only established in the pressure range.

2) VDDHV must in the operating voltage range;

Table 5.1 NSPAS3N115RRA1 transfer function coefficient

Product Type	Pressure Range		Output Range		Gain and Offset	
	P_L	P_H	O_L	O_H	A	B
NSPAS3N115RRA1	10kPa	115kPa	0.4V	4.65V	0.008095	-0.00095

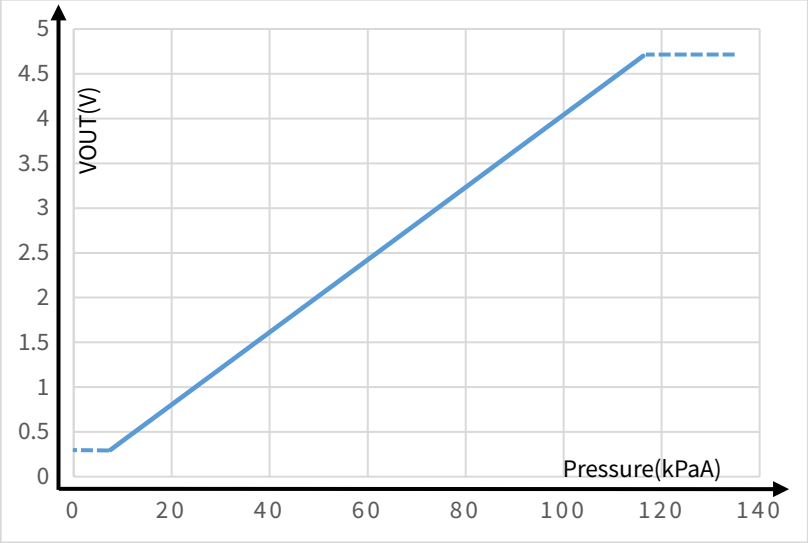


Fig 5.2 NSPAS3N115RRA1 Transfer Function

5.3. Accuracy

Factors affecting the accuracy of NSPAS3 series products include power supply voltage (ratiometric error), pressure, temperature and aging effects. Standard output refers to the theoretical voltage output calculated by the transfer function of the pressure in the range. The error equals the deviation between the measured output voltage value and the specified output voltage value. The accuracy in the following analysis is in a typical application circuit.

5.3.1 Ratiometric Error

Ideally the sensor is ratiometric - the output (VOUT) scales by the same ratio that VDDHV increases or decreases. The ratiometric error is defined as the difference between the ratio that VDDHV changed and the ratio that VOUT changed, expressed as a percentage. The calculation formula is as follows:

$$E_{RAT}(\%) = ((VOUT(@VDDHV) - VOUT(@5V) \times VDDHV/5V) / 5V) \times 100\%$$

The output voltage VOUT is ratiometric to VDDHV. VDDHV must be in the operating range.

Table 5.2 Ratiometric Output Error

Supply Voltage (V)	*Max. Ratiometric Error E_{RAT}(%) @ $VDDHV_{TYP}$*
$VDDHV_{MIN}$	±0.5%
$VDDHV_{TYP}$	0
$VDDHV_{MAX}$	±0.5%

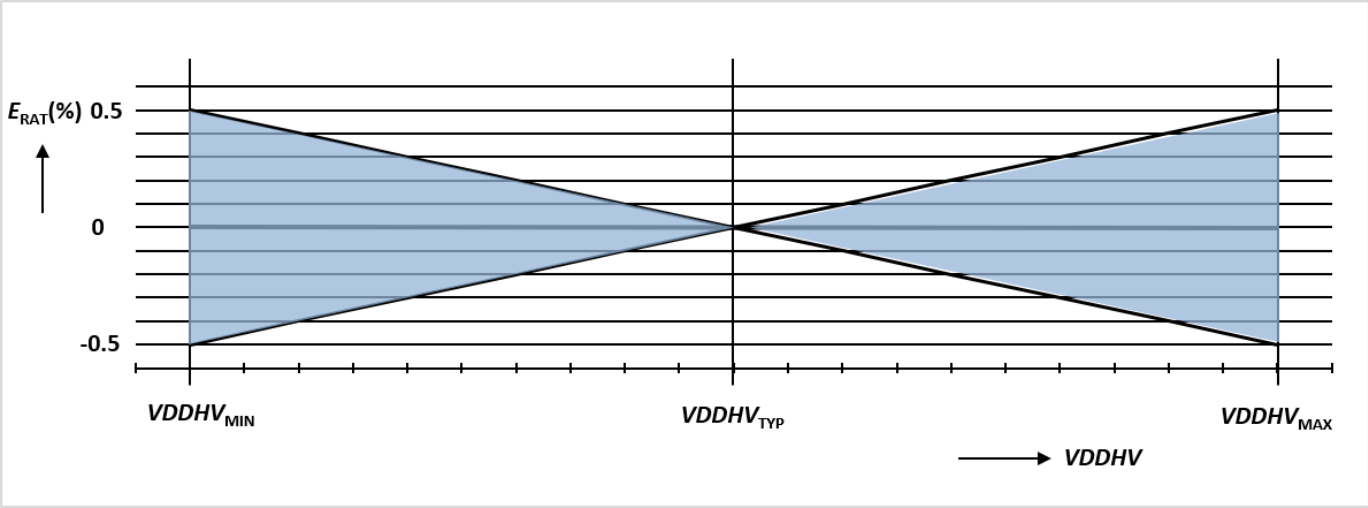


Fig 5.3 Ratiometric Error

5.3.2 Overall Accuracy

The accuracy error includes errors introduced by all influencing factors within the operating range of pressure and temperature, including:

Pressure:

Output deviation from target transfer function over the specified pressure range

Temperature:

Output deviation over the temperature range

Aging:

Parameter drift over life time

Ps: Ratiometric signal error is not included in the overall accuracy. For error measurements, the supply voltage must have the nominal value (VDDHV = 5V).

Table 5.3 Accuracy

Temperature (°C)	*Error(%F.S.)*
-40	1.50
0	1.00
85	1.00
130	1.50

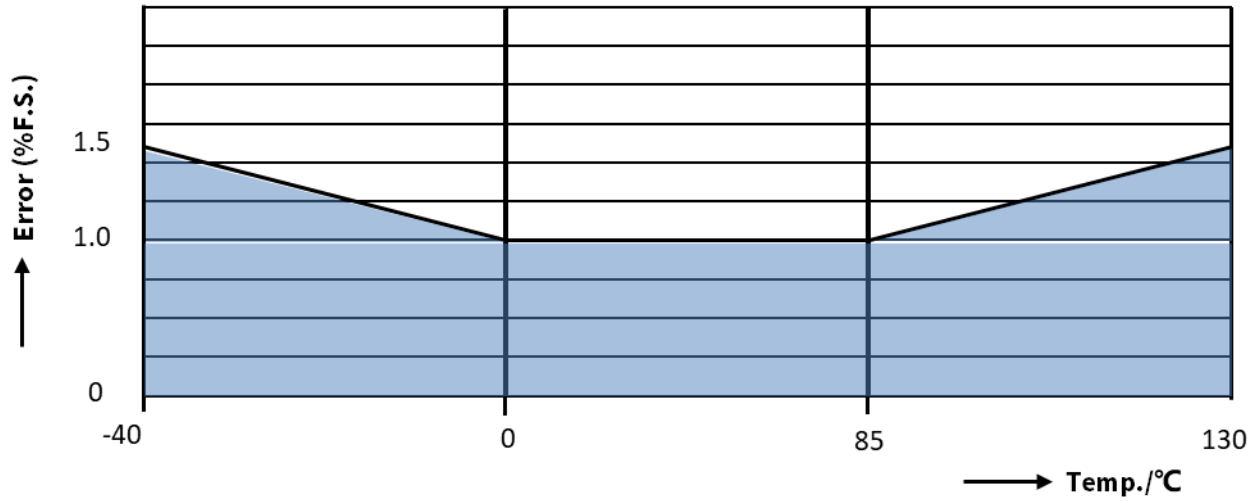


Fig 5.4 Accuracy for Pressure Acquisition

5.4. Alarm

NSPAS3 series have output alarm functions; when MEMS differential signal short to VDDHV/GND, the Vout will be pulled up to high voltage (4.9V@VDDHV=5V). The alarm function is OFF on default in order to optimize the response speed.

6. Typical Application

6.1. Application Circuit

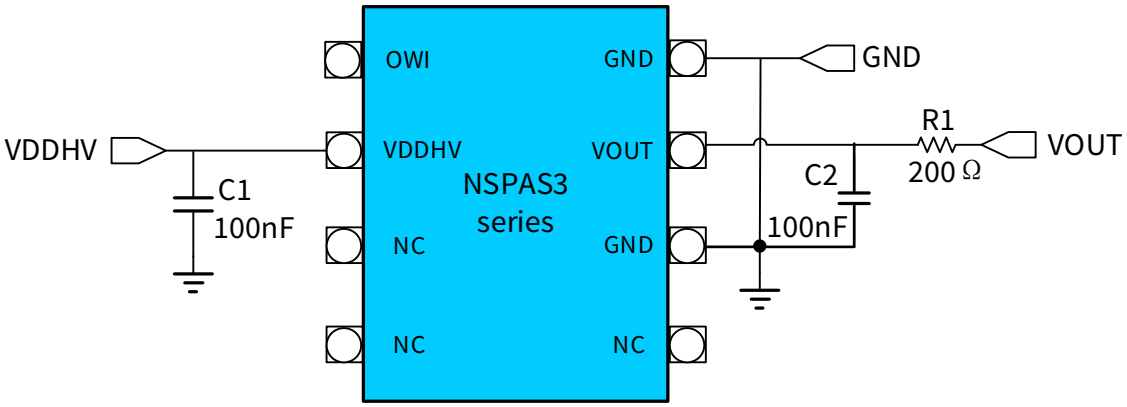


Fig 6.1 Application Circuit

Note：

1）For applications with higher ESD requirements, can add TVS between VOUT and GND and between VDDHV and GND.

2）Please contact NOVOSENSE for detailed peripheral recommended circuit.

6.2. Recommended Footprint

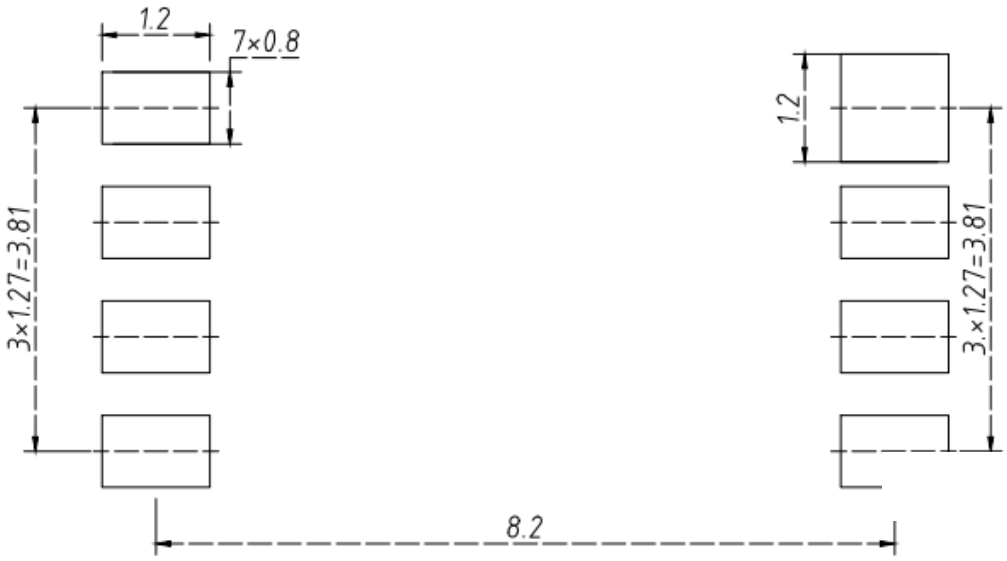


Fig 6.2 Footprint mm

6.3. Soldering Parameters

Table 6.1 Soldering Parameters

Reflow Condition		*Lead-free Assembly*
Pre Heat	Temperature Min (Ts(min))	150°C
	Temperature Max (Ts(max)	200°C
	Time (min to max) (ts)	60 – 180 secs
Average ramp up rate (Liquidus Temp (T_L) to peak		3°C/second max
T_S(max)to T_L - Ramp-up Rate		3°C/second max
Reflow	Temperature (T_L) (Liquidus)	217°C
	Time (min to max) (t_L)	60 – 150 seconds
Peak Temperature (T_P)		260°C
Time within 5°C of actual peak Temperature (tp)		20 – 40 seconds
Ramp-down Rate		6°C/second max
Time 25°C to peak Temperature (T_P)		8 minutes Max.
Do not exceed		260°C

Note：

1） The environmental cleanliness should be monitored & large particles should be avoided during assembly process.

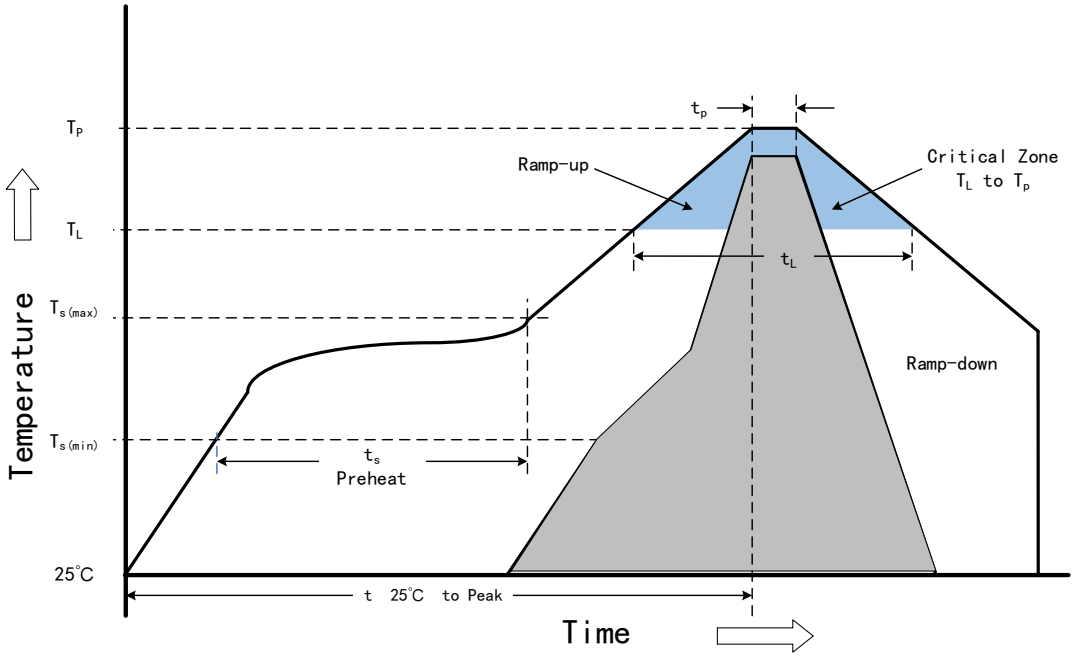
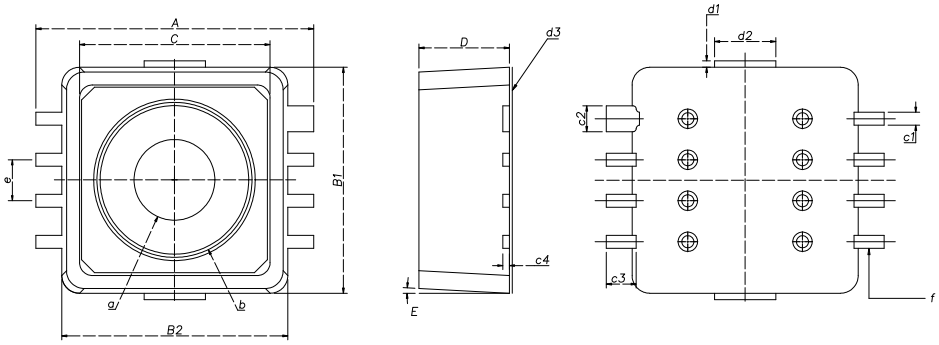


Fig 6.3 Soldering Profile

7. Package Information



TOP VIEW SIDE VIEW BOTTOM VIEW

CONTROLLING DIMENSION: MM

	MILLMETRE		
SYMBOL	MIN	NOM	MAX
A	8.5	8.6	8.7
B1	6.9	7.0	7.1
B2	6.9	7.0	7.1
C	5.8	5.9	6.0
D	2.7	2.8	2.9
E	1°	3°	5°
a	ø2.4	ø2.5	ø2.6
b	ø4.7	ø4.8	ø4.9
c1	0.35	0.4	0.5
c2	0.75	0.8	0.9
c3	0.9	1.0	1.1
c4	0.15	0.2	0.3
d1	BURR MAX 0.2		
d2	BURR MAX 1.9		
d3	PLASTIC PROTRUSION OF 0.03MAX		
e	1.27 bac		
f	PAD TO PAD FLATNESS 0.1 MAX		

Fig 7.1 Package Outline mm

8. Order Information

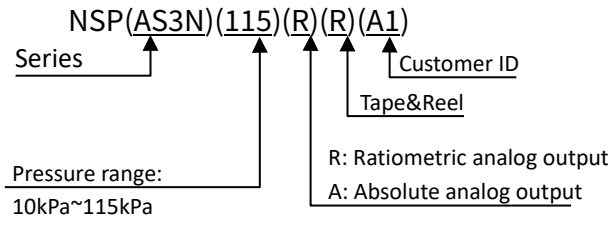
Product Type	Output Type	Pressure Range		Output Range		Clamp Level		Gain and Offset		Supply Voltage	Accuracy	
		P_L	P_H	O_L	O_H	V_{CL}	V_{CH}	A	B		0~85 ℃	-40~130 ℃
NSPAS3N115RR03	Ratiometric	20.00kPa	115.00kPa	0.400V	4.650V	0.40V	4.65V	0.008947	-0.098947	5.0V	±1.0%	±1.5%
NSPAS3N115RRA1	Ratiometric	10.00kPa	115.00kPa	0.400V	4.650V	0.30V	4.70V	0.008095	-0.000952	5.0V	±1.0%	±1.5%
NSPAS3N250RRB1	Ratiometric	10.00kPa	250.00kPa	0.400V	4.650V	0.30V	4.70V	0.003542	0.044583	5.0V	±1.0%	±1.5%
NSPAS3N115RRD1	Ratiometric	10.00kPa	115.00kPa	0.400V	4.650V	0.30V	4.80V	0.008095	-0.000952	5.0V	±1.0%	±1.5%
NSPAS3N250RRD3	Ratiometric	20.00kPa	250.00kPa	0.400V	4.650V	0.30V	4.80V	0.003696	0.006087	5.0V	±1.0%	±1.5%
NSPAS3N107RRD4	Ratiometric	13.30kPa	106.70kPa	0.500V	4.600V	0.33V	4.73V	0.008779	-0.016767	5.0V	±1.0%	±1.5%
NSPAS3N350RRD6	Ratiometric	44.80kPa	350.00kPa	0.500V	4.500V	0.30V	4.70V	0.002621	-0.017431	5.0V	±1.0%	±1.5%
NSPAS3N165RRE1	Ratiometric	60.00kPa	165.00kPa	0.200V	4.800V	NA	NA	0.008762	-0.485714	5.0V	±1.5%	±2.0%
NSPAS3N115RRG1	Ratiometric	20.00kPa	115.00kPa	0.400V	4.650V	0.30V	4.70V	0.008947	-0.098947	5.0V	±1.0%	±1.5%
NSPAS3N115RRK2	Ratiometric	15.00kPa	115.00kPa	0.180V	4.650V	0.10V	4.85V	0.008940	-0.098100	5.0V	±1.0%	±1.5%

Please scan the following QR code or visit the download link for complete part number list.

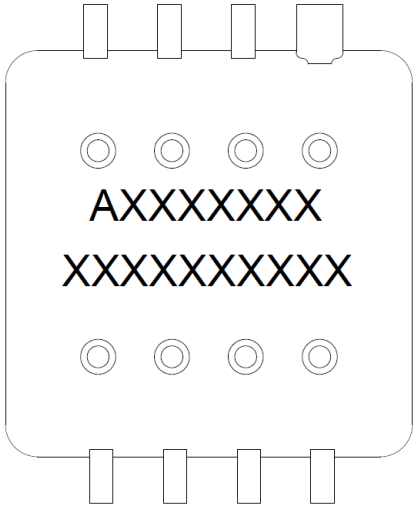
https://www.novosns.com//Public/Uploads/uploadfile4/nspas3-series.pdf

NSPAS3 Series

Naming Convention:



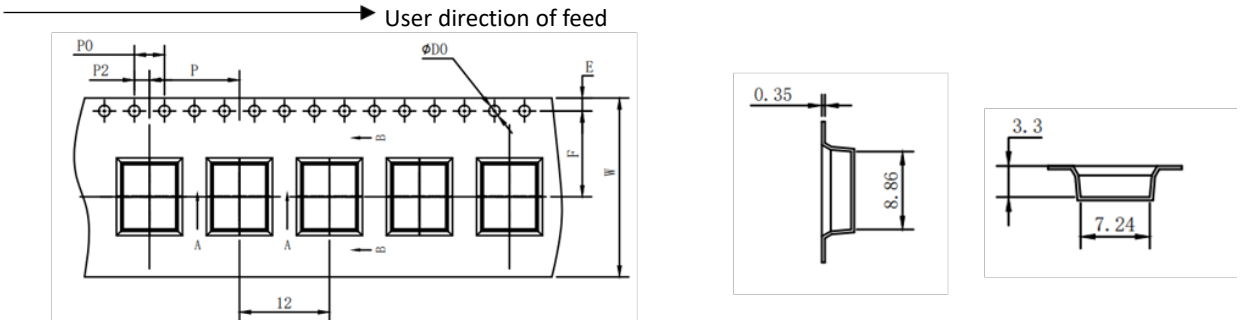
9. Identification Code



AXXXXXXX: Package lot number.

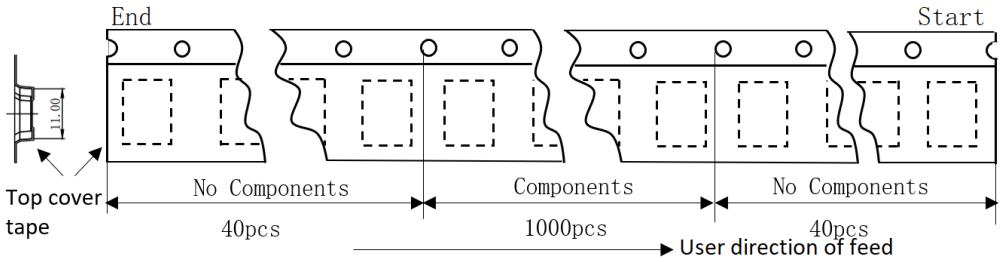
XXXXXXXXXX: Product serial number.

10. Tape/Reel Information

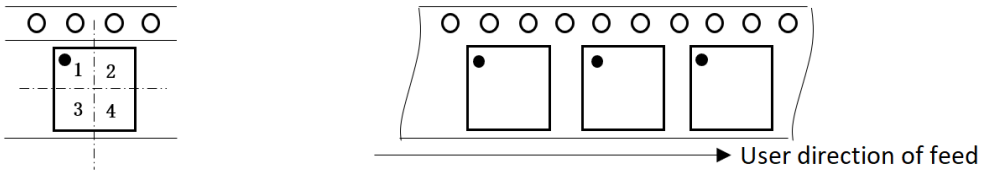


Series	E(mm)	F(mm)	P2(mm)	D0(mm)	P0(mm)	10P0(mm)	W(mm)	P(mm)	A0(mm)	B0(mm)	K0(mm)	T(mm)
NSPAS3	1.75±0.10	11.5±0.10	2.0±0.10	1.5+0.1	4.0±0.1	40.0±0.20	24.0±0.30	12.0±0.1	7.24±0.1	8.86+0.10	3.30±0.10	0.35±0.05

There is no component at the head and the tail of each tape/reel, where the space is 40pcs, as shown in the following figure.



Pin8 is located at the second quadrant, as shown in the following figure.



Minimum ordering quantity(MOQ):1000EA.

Standard pack quantity(SPQ): 1000EA.

11. Revision History

Revision	*Description*	*Date*
1.0	Release version	2021/4/1
1.1	Add part No.	2021/5/28
1.2	200Ω resistance is added to the typical application circuit; the selection table is updated to the official website;	2021/8/18
2.0	Formal release	2023/10/31
2.1	Add comments for TMAP application; remove VBS application; simplify naming convention.	2024/4/24

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