NOVOSENSE
纳芯微电子

NSPAS3 Series

Automotive Absolute Pressure Sensor

Datasheet (EN) 1.4

Product Overview

NSPAS3 is a calibrated absolute pressure sensor series product launched by NOVOSENSE for vacuum boost, and Auto TMAP market. 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)

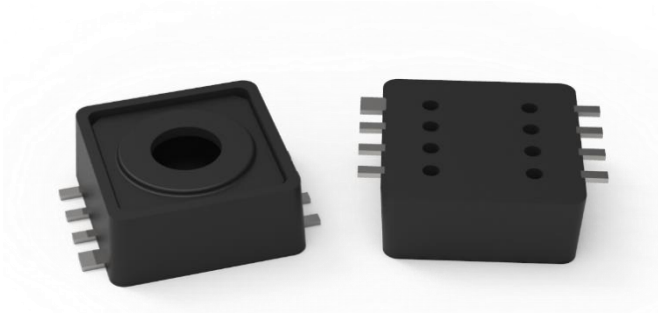
  Better than ±1.5%F.S. (-40°C to 130°C)
- Large temperature range -40°C to 130°C(168H@140°C)
- Over-voltage and Reverse voltage protection

  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

- Automotive applications (manifold air pressure measurement)
- Industrial control
- vacuum boost applications
- Battery pressure sensor
- Motorcycle applications
- Consumer applications
- Weather stations
- Altimeters

Outline



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1. Pin Definition

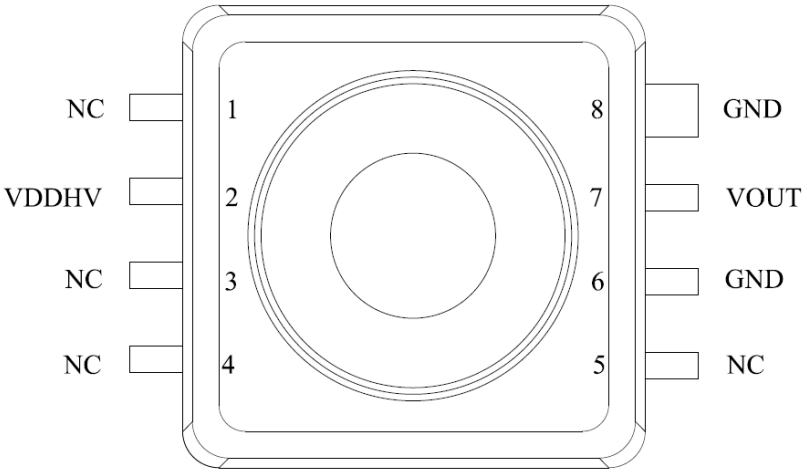


Fig 1.1 Pin Definition (Top view)

Table 1.1 Pin Description

Pin NO.	Pin name	Description
1	NC	No connect
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	±500			V	
Storage temperature	Tstg	-40		130	°C	

3. Operating range

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. Characteristic

4.1. Electrical characteristic

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Output voltage range	VOUT	0.05		4.95	V	
Accuracy pressure	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	I_{avdd}		3.1		mA	
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	T_{UP}		10		ms	
Response time	T_{RESP}		0.8		ms	
Diagnostic response time	T_{diag}			1	ms	
EEPROM data retention	T_{live}	10			years	@150°C

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.

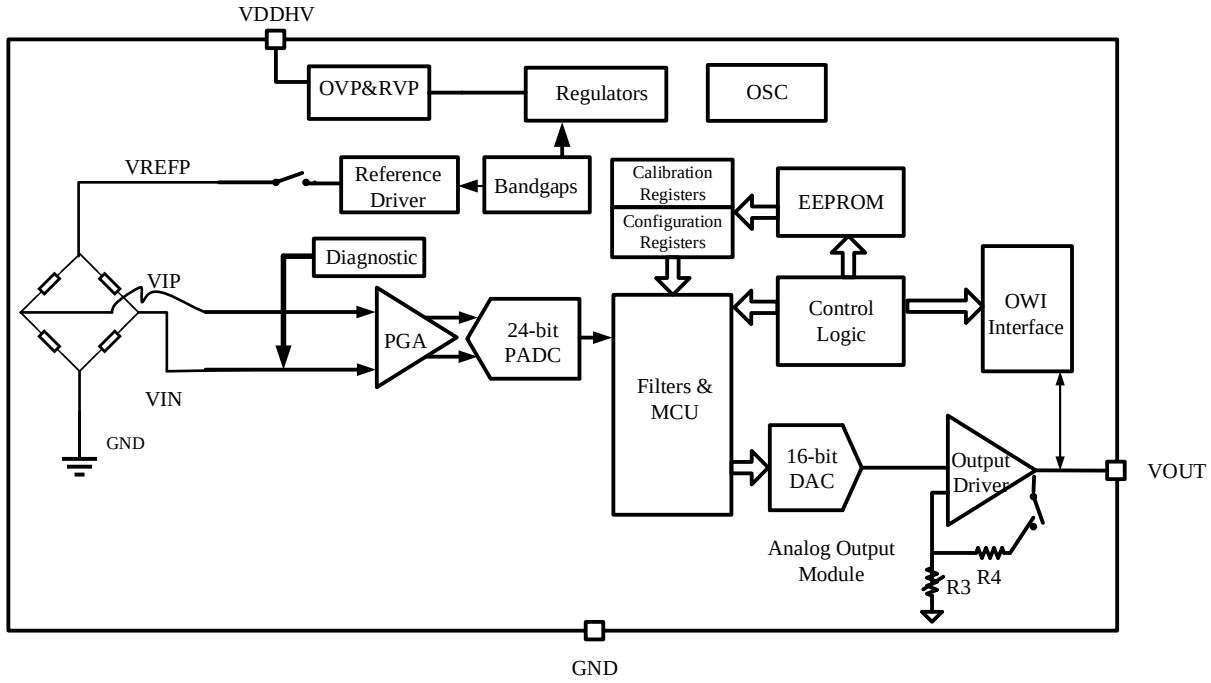


Fig 5.1 Product Function Block Diagram

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:

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

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

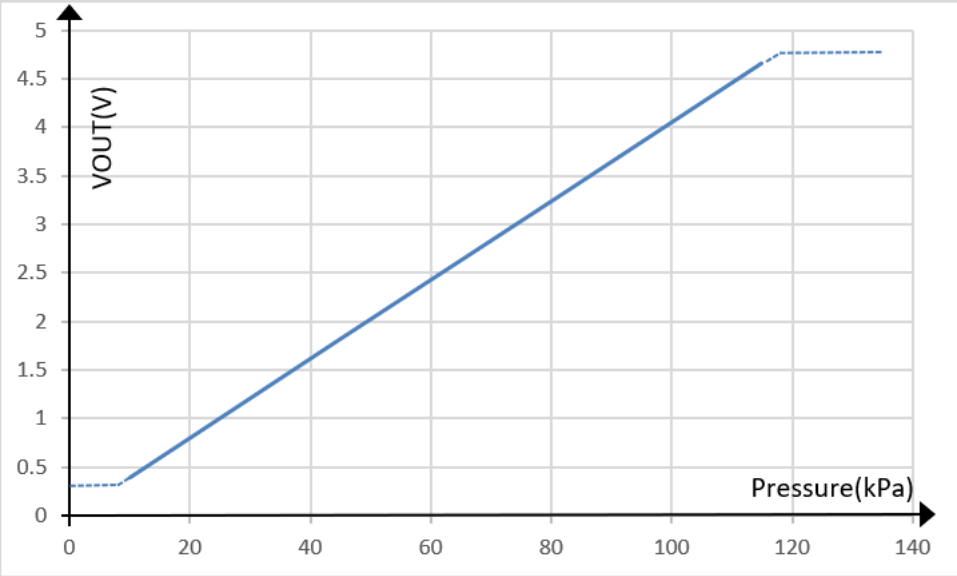


Fig 5.2 NSPAS3N115RRA1 transfer function

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:

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

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%

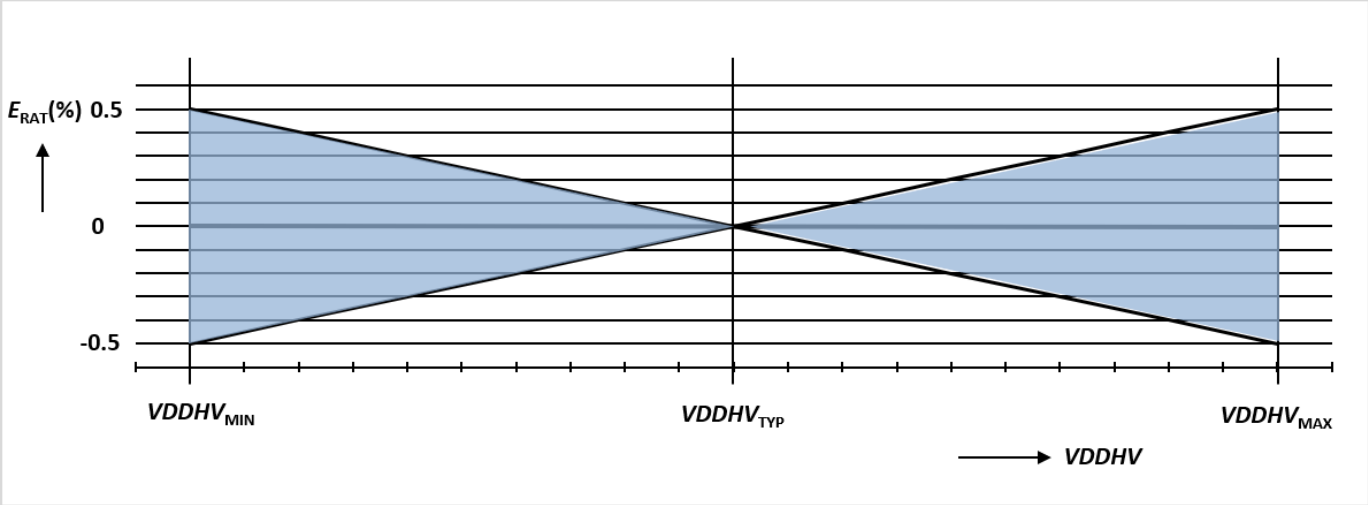


Fig 5.3 Ratiometric error

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 factor
-40	1.50
0	1.00
85	1.00
130	1.50

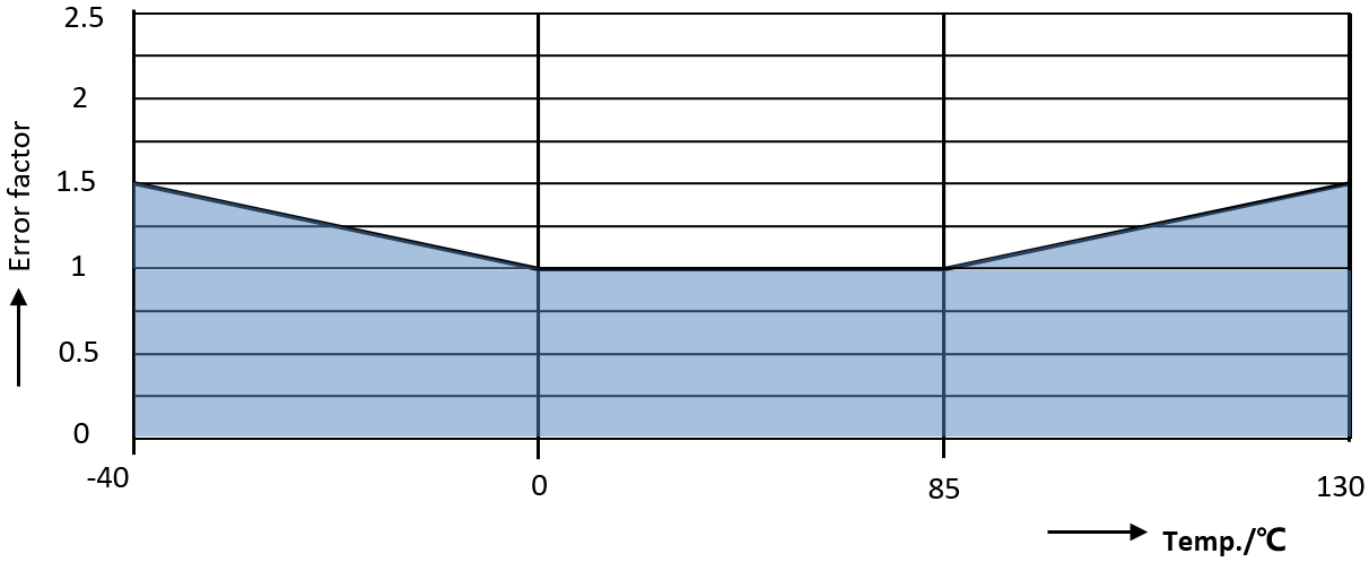


Fig 5.4 Accuracy for Pressure Acquisition

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).

6. Typical Application

6.1. Application circuit

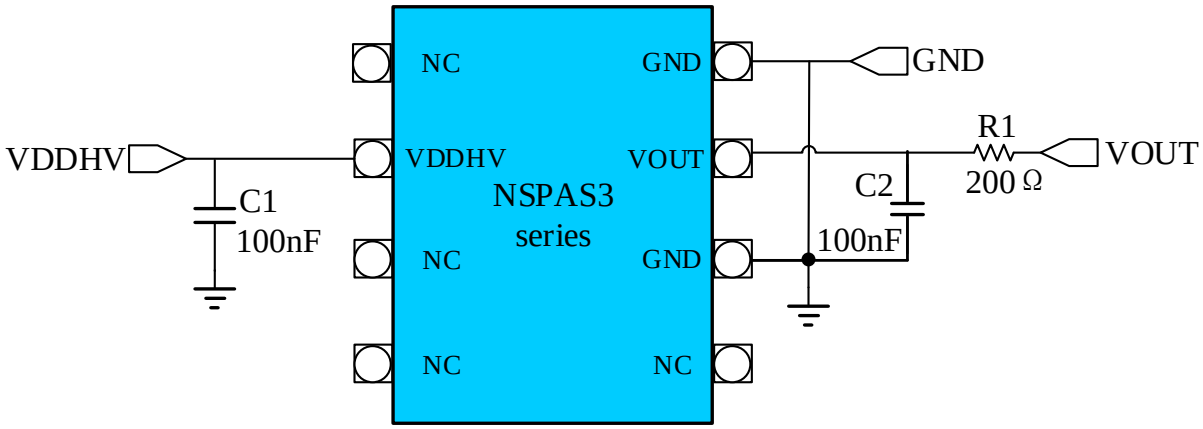


Fig 6.1 Application Circuit

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

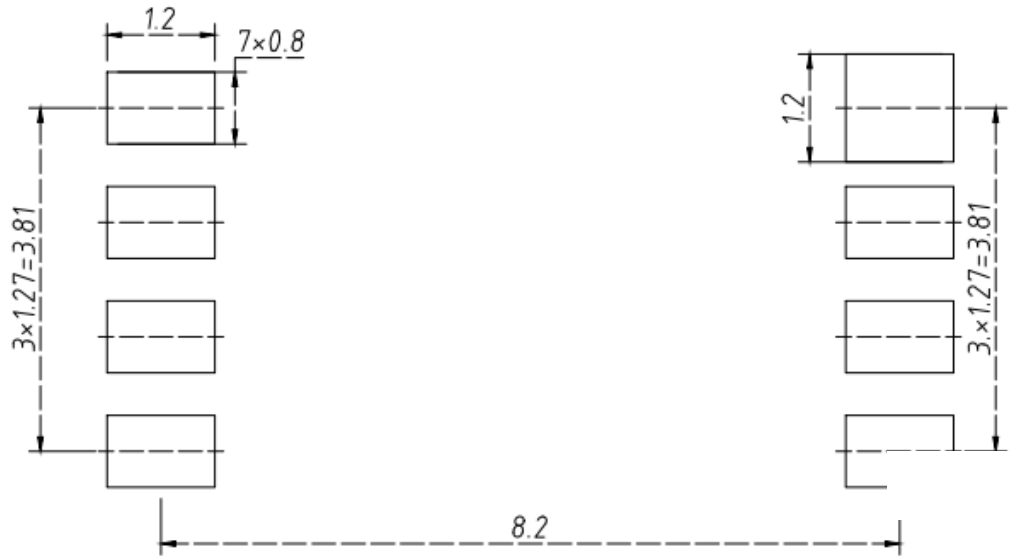


Fig 6.2 Footprint mm

7. Package information

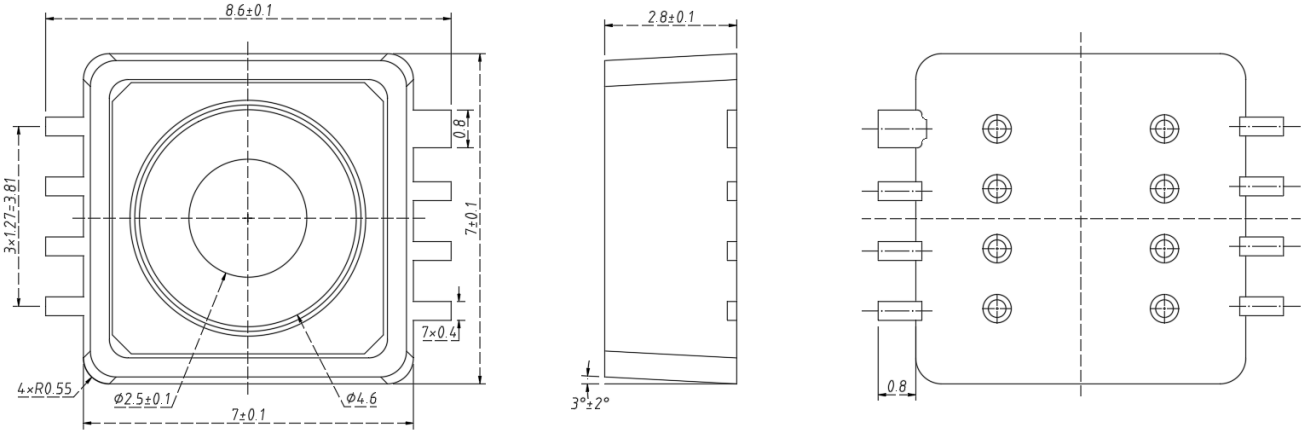


Fig 7.1 Package Outline mm

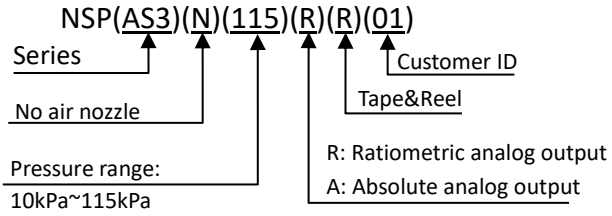
8. Order Information

Product Type	Output type	Pressure range(kPaA)		Output range(VDDHV=5V)		Clamp level		Voltage	Gain and offset	
		P_L	P_H	O_L	O_H	V_{CL}	V_{CH}		A	B
NSPAS3N115RR01	Ratiometric	10.00kPa	115.00kPa	0.400V	4.650V	0.4V	4.65V	5V	0.008095	-0.000952
NSPAS3N115RR02	Ratiometric	15.00kPa	115.00kPa	0.200V	4.700V	0.2V	4.7V	5V	0.009000	-0.095000
NSPAS3N115RR03	Ratiometric	20.00kPa	115.00kPa	0.400V	4.650V	0.4V	4.65V	5V	0.008947	-0.098947
NSPAS3N115RR04	Ratiometric	15.00kPa	115.00kPa	0.500V	4.500V	0.4V	4.6V	5V	0.008000	-0.020000
NSPAS3N115RR05	Ratiometric	40.00kPa	115.00kPa	0.200V	4.700V	0.2V	4.7V	5V	0.012000	-0.440000
NSPAS3N115RR06	Ratiometric	40.00kPa	115.00kPa	0.500V	4.500V	0.3V	4.7V	5V	0.010667	-0.326667
NSPAS3N102RR07	Ratiometric	15.00kPa	102.00kPa	0.250V	4.850V	NA	NA	5V	0.010575	-0.108621
NSPAS3N250RR08	Ratiometric	15.00kPa	250.00kPa	0.315V	4.310V	0.3V	4.7V	5V	0.003400	0.012000
NSPAS3N100AR10	Absolute	10.00kPa	100.00kPa	1.217V	4.660V	NA	NA	5V	0.007651	0.166889
NSPAS3N107RR11	Ratiometric	13.30kPa	106.70kPa	0.500V	4.600V	0.3V	4.8V	5V	0.008779	-0.016767
NSPAS3N115RRA1	Ratiometric	10.00kPa	115.00kPa	0.400V	4.650V	0.3V	4.7V	5V	0.008095	-0.000952
NSPAS3N250RRB1	Ratiometric	10.00kPa	250.00kPa	0.400V	4.650V	0.3V	4.7V	5V	0.003542	0.044583
NSPAS3N300RRC1	Ratiometric	10.00kPa	300.00kPa	0.400V	4.650V	0.3V	4.7V	5V	0.002931	0.050690
NSPAS3N150RRC2	Ratiometric	10.00kPa	150.00kPa	0.500V	4.500V	0.4V	4.6V	5V	0.005714	0.042857
NSPAS3N115RRD1	Ratiometric	10.00kPa	115.00kPa	0.400V	4.650V	0.3V	4.8V	5V	0.008095	-0.000952
NSPAS3N107RRD2	Ratiometric	13.30kPa	106.70kPa	0.500V	4.800V	0.3V	4.8V	5V	0.009208	-0.022463
NSPAS3N250RRD3	Ratiometric	20.00kPa	250.00kPa	0.400V	4.650V	0.3V	4.8V	5V	0.003696	0.006087
NSPAS3N107RRD4	Ratiometric	13.30kPa	106.70kPa	0.500V	4.600V	0.33V	4.73V	5V	0.008779	-0.016767
NSPAS3N350RRD5	Ratiometric	10.00kPa	350.00kPa	0.368V	4.960V	NA	NA	5V	0.002701	0.046588
NSPAS3N350RRD6	Ratiometric	44.80kPa	350.00kPa	0.500V	4.500V	0.3V	4.7V	5V	0.002621	-0.017431
NSPAS3N120RRD7	Ratiometric	10.00kPa	120.00kPa	0.300V	4.800V	0.2V	4.85V	5V	0.008182	-0.021818
NSPAS3N102RRD8	Ratiometric	20.00kPa	102.00kPa	0.512V	4.854V	0.25V	4.95V	5V	0.010590	-0.109405
NSPAS3N165RRE1	Ratiometric	60.00kPa	165.00kPa	0.200V	4.800V	NA	NA	5V	0.008762	-0.485714
NSPAS3N165RRE2	Ratiometric	60.00kPa	165.00kPa	0.132V	3.168V	NA	NA	3.3V	0.008762	-0.485714
NSPAS3N400RRF1	Ratiometric	50.00kPa	400.00kPa	0.500V	4.500V	0.3V	4.7V	5V	0.002286	-0.014286
NSPAS3N300RRF2	Ratiometric	20.00kPa	300.00kPa	0.400V	4.650V	0.3V	4.7V	5V	0.003036	0.019286
NSPAS3N115RRG1	Ratiometric	20.00kPa	115.00kPa	0.400V	4.650V	0.3V	4.7V	5V	0.008947	-0.098947
NSPAS3N102RRH1	Ratiometric	15.00kPa	102.00kPa	0.250V	4.950V	NA	4.95V	5V	0.010805	-0.112069
NSPAS3N120RRK1	Ratiometric	12.00kPa	120.00kPa	0.493V	4.740V	NA	4.97V	5V	0.007865	0.004222
NSPAS3N115RRK2	Ratiometric	15.00kPa	115.00kPa	0.180V	4.650V	0.1V	4.85V	5V	0.008940	-0.098100
NSPAS3N120RRK3	Ratiometric	10.00kPa	120.00kPa	0.400V	4.710V	0.35V	4.8V	5V	0.007836	0.001636
NSPAS3N350RRK4	Ratiometric	10.00kPa	350.00kPa	0.500V	4.500V	0.3V	4.7V	5V	0.002353	0.076471
NSPAS3N120ARK5	Absolute	12.00kPa	120.00kPa	0.493V	4.740V	NA	4.97V	5V	0.007865	0.004222
NSPAS3N100RRK6	Ratiometric	20.00kPa	100.00kPa	1.292V	4.460V	NA	NA	5V	0.007920	0.100000
NSPAS3N160RRK7	Ratiometric	20.00kPa	160.00kPa	0.710V	4.510V	NA	4.77V	5V	0.005429	0.033429
NSPAS3N120RRK8	Ratiometric	20.00kPa	120.00kPa	0.800V	4.700V	NA	4.9V	5V	0.007800	0.004000
NSPAS3N241RRM1	Ratiometric	22.90kPa	241.30kPa	0.502V	4.510V	NA	4.78	5V	0.003670	0.016349
NSPAS3N261RRM2	Ratiometric	10.32kPa	261.30kPa	0.500V	4.500V	NA	4.82	5V	0.003188	0.067105
NSPAS3N391RRM3	Ratiometric	31.05kPa	391.30kPa	0.500V	4.500V	NA	4.6	5V	0.002221	0.031048
NSPAS3N400RRM4	Ratiometric	50.00kPa	400.00kPa	0.500V	3.611V	NA	NA	5V	0.001778	0.011114
NSPAS3N350RRM5	Ratiometric	10.00kPa	350.00kPa	0.400V	4.650V	0.3V	4.7V	5V	0.002500	0.055000

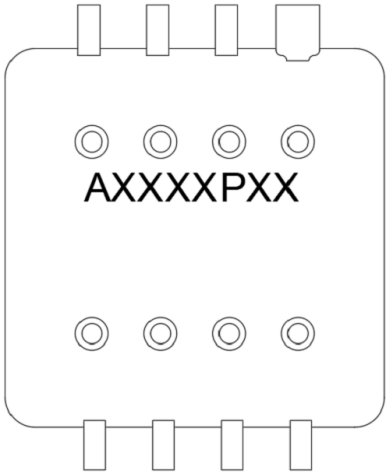
Enter the following link to download the latest selection table:

https://www.novosns.com/Public/Uploads/ueditor/upload/file/20210818/1629266429660879.png

Naming Convention:

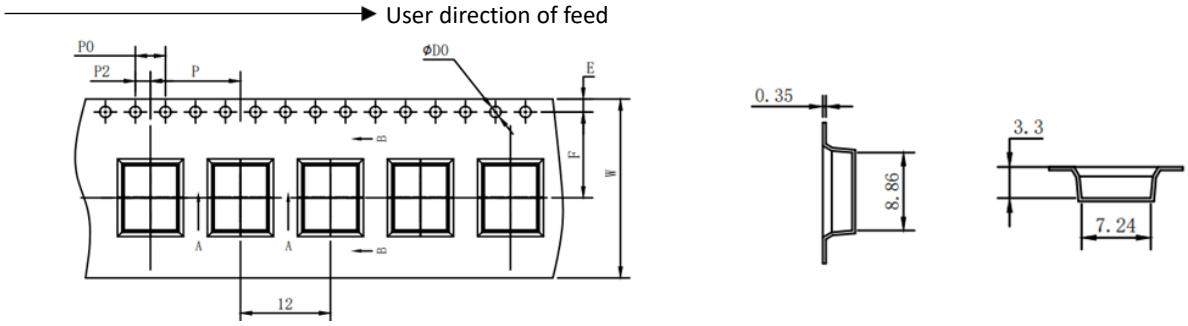


9. Identification Code



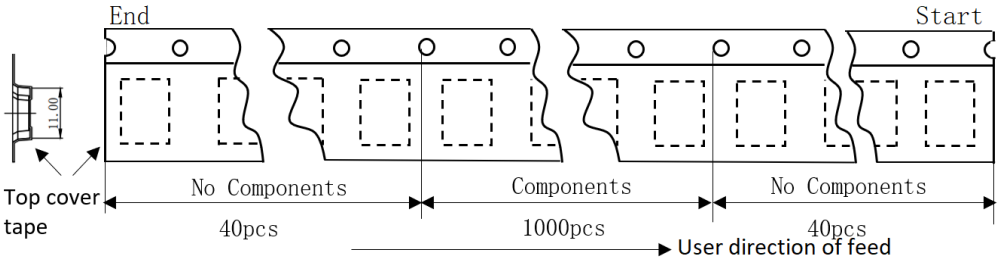
AxxxPxx: Package lot number.

10. Tape/Reel information

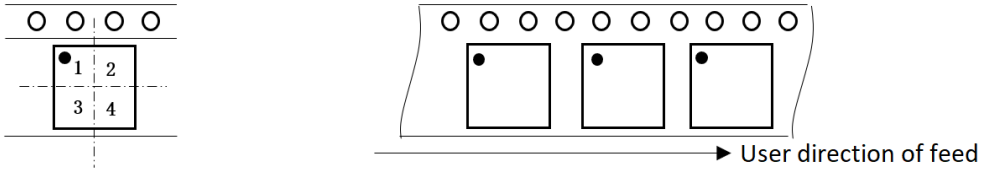


Series	E(mm)	F(mm)	P2(mm)	D0(mm)	P0(mm)	10P0(mm)	W(mm)	P(mm)	A0(mm)	B0(mm)	K0(mm)	T(mm)
NSPAS3	1.75±0.10	11.5±0.10	2.0±0.10	1.5+0.1	4.0±0.1	40.0±0.20	24.0±0.30	12.0±0.1	7.24±0.1	8.86+0.10	3.30±0.10	0.35±0.05

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.



Pin1 is located at the second quadrant, as shown in the following figure.



11. Revision

Revision	Description	Date
0.1	Initial Version.	2020/12/18
0.2	Update logo, font	2021/02/24
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
1.3	Add part No.	2021/11/24
1.4	Update clamp voltage level expression to percentage of VDDHV	2022/03/15