NOVOSENSE

NST235-Q1STR
High Precision Ultra-low Current Analog Temperature Sensor
Datasheet (EN) 1.0

Product Overview

The NST235-Q1STR is an automotive-grade precision CMOS IC linear analogue temperature sensor. The NST235-Q1STR offers typical accuracy from 0°C to +70°C, a positive slope output of 10mV/°C over the full -40°C to +150°C temperature range, and is supplied over a range of 2.3 V to 5.5 V. The NST235-Q1STR is a low-power temperature sensor with an operating current of just 17μA, resulting in negligible self-heating of the device. The NST235-Q1STR is available in a SOT-23(3) package and is suitable for a variety of automotive applications, including electric power steering, gearshift systems, battery management systems, and automotive audio mainframes.

Key Features

- High Accuracy Over –40 °C to 150 °C Temperature Range
  - 0 °C ~ 70°C: ± 0.5 °C (Typical)
  - 0 °C ~ 70°C: ± 1.5 °C (Maximum)
  - -40 °C ~ 150°C: ± 2.5 °C (Maximum)
- Operating Voltage Range: 2.3V to 5.5V
- Average Sensor Gain o: 10mV/°C
- Output Impedance: 1Ω (Typical)
- Operating Current: 17μA (Typical)
- Push-Pull Output Current Drain: 500μA (Maximum)
- AEC-Q100 Grade 1 Qualified
- Predictable Curvature Error
- Output Short Protection
- Suitable for Remote Applications
- Package: SOT-23(3)
- ROHS Compliance for SOT-23(3)

Applications

- Electric power steering
- Power supply modules
- Gearshift systems
- Battery management systems
- Automotive audio mainframes

Device Information

Part Number	*Package*	*Body Size*
NST235-Q1STR	SOT-23(3)	2.90mm × 1.30mm

Functional Block Diagram

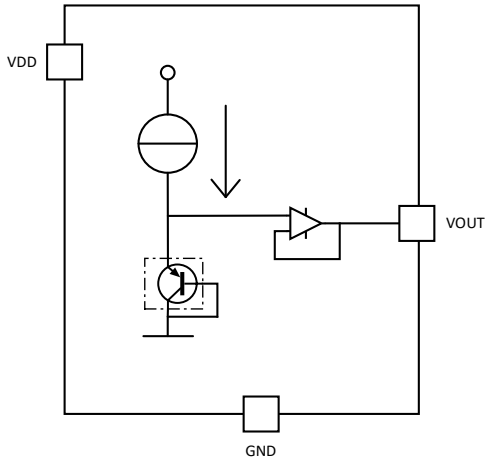

Figure 1. NST235-Q1STR Block Diagram

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1. Pin Configuration and Functions

(Top View)

Package:3-Pin SOT-23

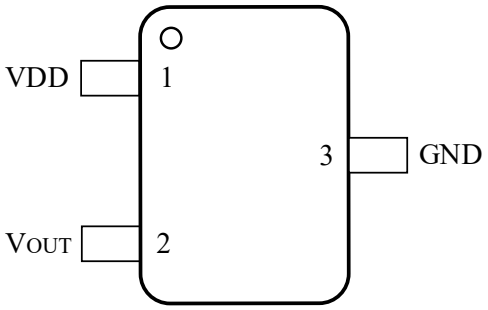


Figure 1.1 NST235-Q1STR Pin Configuration

Table 1.1 NST235-Q1STR Pin Configuration and Function Description

NST235-Q1STR PIN NO.	*Symbol*	*Function*
1	VDD	Power supply input pin
2	VOUT	Analog voltage output
3	GND	Ground pin

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply Voltage Pin (VDD)	VDD	-0.3		6.5	V	
Output Voltage	Vout	-0.3		VDD+0.3	V	
Storage Temperature		-60		155	°C	
Operation Temperature	$TB_{operation}$	-40		150	°C	
Maximum Junction Temperature				155	°C	

3. ESD Ratings

	Ratings	Value	Unit
Electrostatic discharge	Human body model (HBM), per AEC-Q100-002	±4.5	kV
	Charged device model (CDM), per AEC-Q100-011	±750	V

4. Specifications

4.1. Electrical Characteristics

All typical values at TA = +25°C and VDD = +3.3V, unless otherwise noted.

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply						
Supply Voltage Range	VDD	2.3	3.3	5.5	V	
Supply Sensitivity			0.6		°C /V	
Operation Current	Iconv		17		μA	
Temperature Range						
Temperature Range		-40		150	°C	
Accuracy (Using equation 5-2)			±0.5	±1.5	°C	from 0°C to 70°C
			±0.5	±2.5	°C	from -40°C to 150°C
Output Voltage at 0°C			0.5		V	
Vout Drive Capability				500	μA	
Sensor Gain			10		mV/°C	
Output Impedance			1		Ω	
Load Regulation			0.5		mV	Source ≤50μA
Thermal Response						
Stirred Oil Thermal Response Time to 63% of Final Value (Package Only)			0.59		s	
Drift						
Drift[1]			±0.03		°C	

Notes: 1. Drift data is based on a 1000-hour stress test at +150°C with VDD = 5.5V.

4.2. Typical Characteristics

at VDD = 3.3 V, unless otherwise noted.

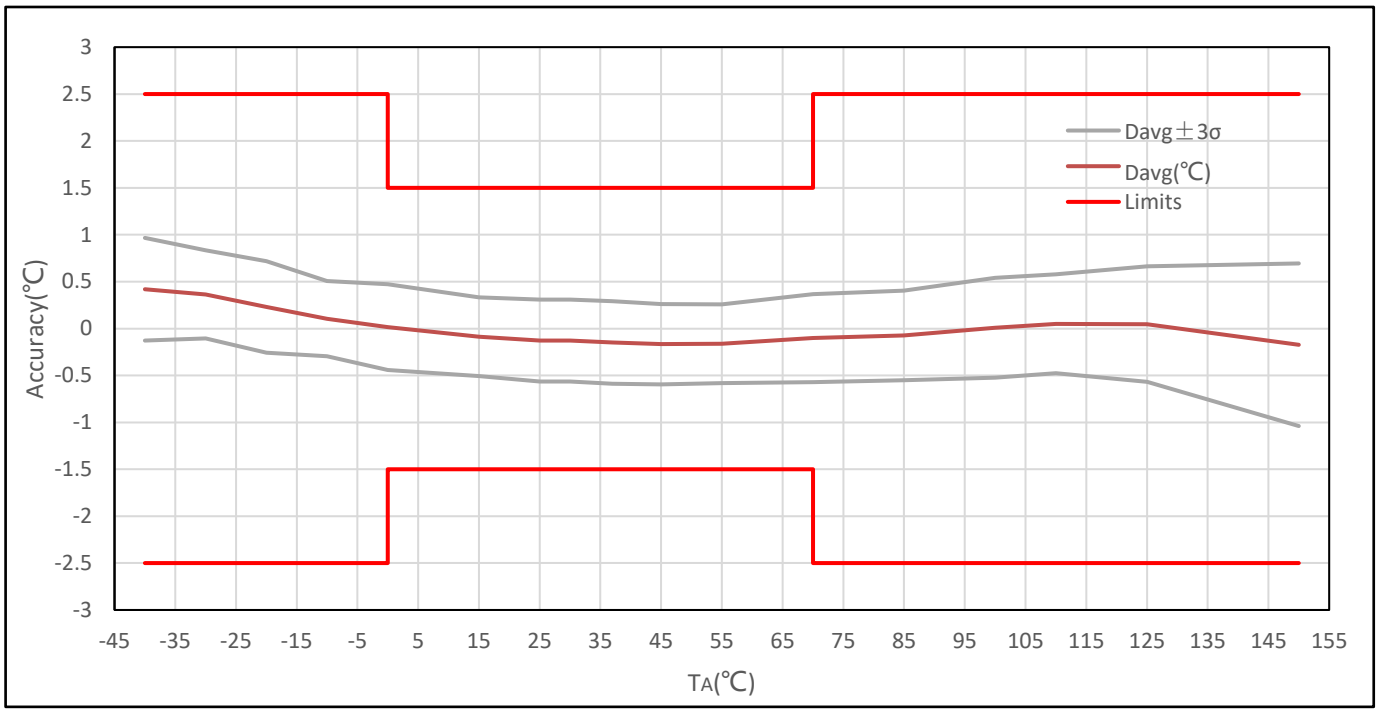


Figure 4.1 Temperature Error vs Temperature

5. Function Description

5.1. Overview

The NST235-Q1STR is a high performance CMOS analog output temperature sensor. The device has an accuracy of ±1.5°C from 0°C to 70°C. NST235-Q1STR can operate in the temperature range of -40°C~150°C, with a maximum accuracy error of ±2.5°C.

NST235-Q1STR operates in the voltage range of 2.3V~5.5V, has a positive slope output of 10mv/°C, has high linearity, and does not require complex calculations or table lookup to derive the temperature.

The NST235-Q1STR is a low-power temperature sensor with a typical operating current of 17μA, so the spontaneous heat of the device is negligible. The NST235-Q1STR is packaged in SOT-23(3) and is suitable for a variety of automotive applications such as electric power steering, shift systems, battery management systems and car audio hosts.

5.2. Functional Block Diagram

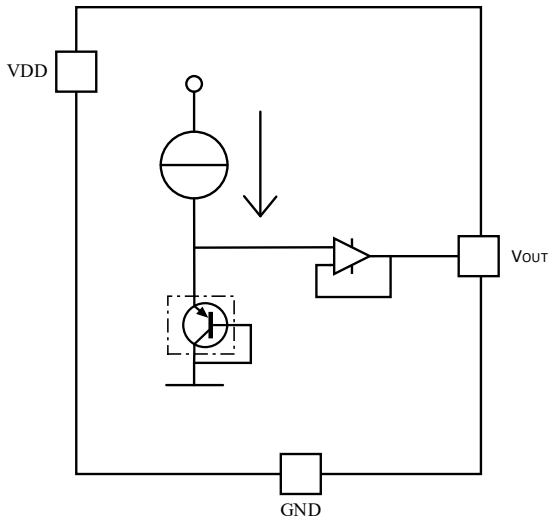


Figure 5.1 NST235-Q1STR Functional Block Diagram

5.3. Feature Description

5.3.1.NST235-Q1STR Transfer Function

The NST235-Q1STR device is linear. However, the output voltage will shift a little when the temperature is greater than 100°C. In order to achieve the highest accuracy performance of the device, we use piecewise linear function to describe the conversion relationship between temperature and output voltage. In the whole working temperature range, the conversion relationship of NST235-Q1STR is shown in Table 5.1. The parameters of the piecewise linear function used in the three temperature ranges are shown in Table 5.2, and the output voltage is calculated by Equation 5-1:

$$V_O = T_C \times (T_A - T_I) + V_{OF} \quad (5\text{-}1)$$

Where,

- V_O is the output voltage at a given temperature.
- T_A is the ambient temperature in °C.
- T_I is the temperature inflection point for a piecewise segment in °C.
- T_C is the temperature coefficient or gain of NST235-Q1STR.
- V_{OF} is the voltage offset of NST235-Q1STR.

Therefore, in a certain output voltage range (VR), given the output voltage value, the corresponding T_A can be calculated using Equation 5-2. For accuracy insensitive applications, the parameters in the first row of Table 5.1 can be used directly.

$$T_A = \frac{(V_O - V_{OF})}{T_C} + T_I \quad (5\text{-}2)$$

Table 5.1 NST235-Q1STR Piecewise Linear Function Summary

T_A (°C)	V_R (mV)	T_I (°C)	T_C (mV/°C)	V_{OF} (mV)
–40 to 100	< 1500	0	10	500
100 to 125	1500 to 1752.5	100	10.1	1500
125 to 150	> 1752.5	125	10.6	1752.5

Table 5.2 NST235-Q1STR Transfer Table

Temperature (°C)	VOUT (mV) *Ideal Linear Values*	VOUT (mV) *Piecewise Linear Values*
–40	100	100
–35	150	150
–30	200	200
–25	250	250
–20	300	300
–15	350	350
–10	400	400
–5	450	450
0	500	500
5	550	550
10	600	600
15	650	650
20	700	700
25	750	750
30	800	800
35	850	850
40	900	900
45	950	950
50	1000	1000
55	1050	1050
60	1100	1100
65	1150	1150
70	1200	1200
75	1250	1250
80	1300	1300
85	1350	1350
90	1400	1400
95	1450	1450
100	1500	1500

Table 5.2 NST235-Q1STR Transfer Table(Continued)

Temperature (°C)	VOUT (mV) *Ideal Linear Values*	VOUT (mV) *Piecewise Linear Values*
105	1550	1550.5
110	1600	1601
115	1650	1651.5
120	1700	1702
125	1750	1752.5
130	1800	1805.5
135	1850	1858.5
140	1900	1911.5
145	1950	1964.5
150	2000	2017.5

5.3.2.Application Curve

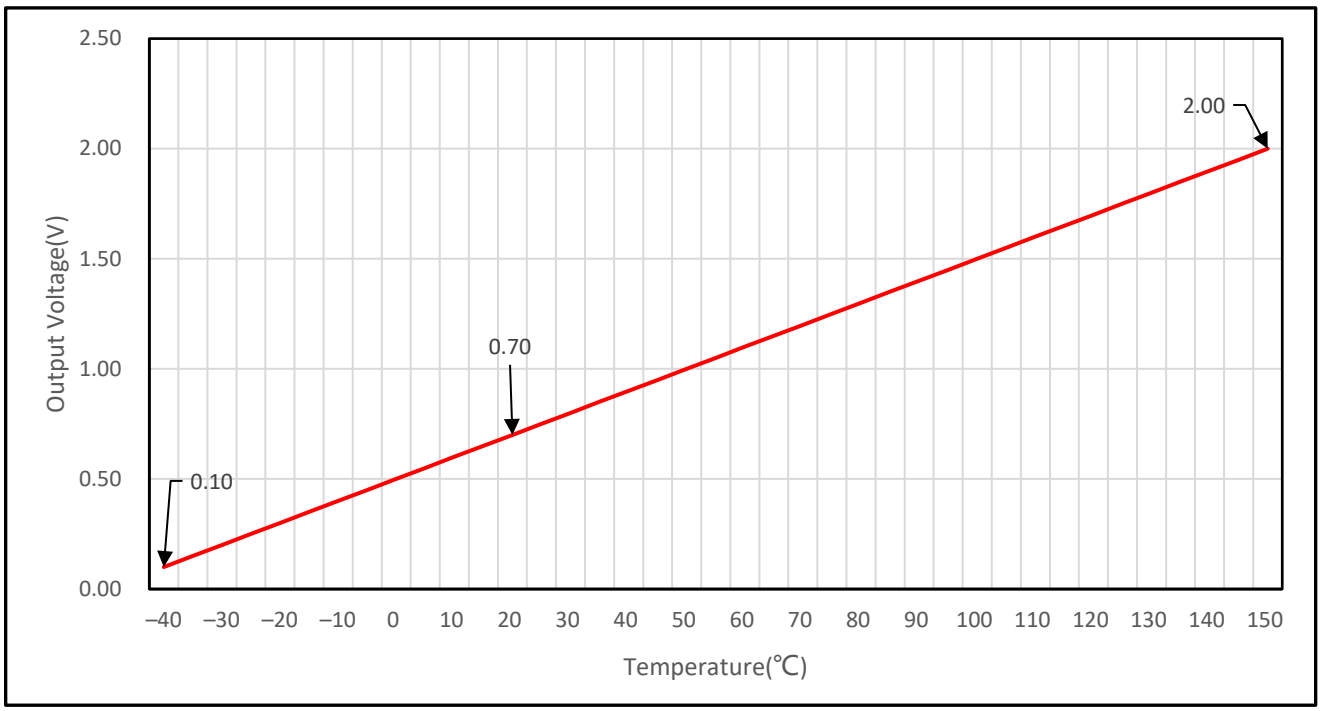


Figure 5.2 Output Voltage vs Temperature

6. Application Information

6.1. Typical Application

As shown in Figure 6.1, the NST235-Q1STR has an extremely low supply current and a wide supply range, therefore, it can be easily driven by a battery. In order to reduce the noise in the output voltage, it is recommended to add a 0.1μF capacitor between the power and the ground.

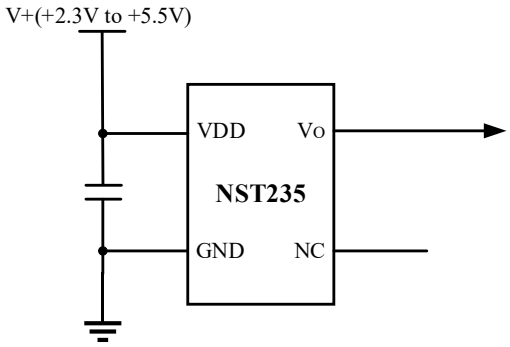
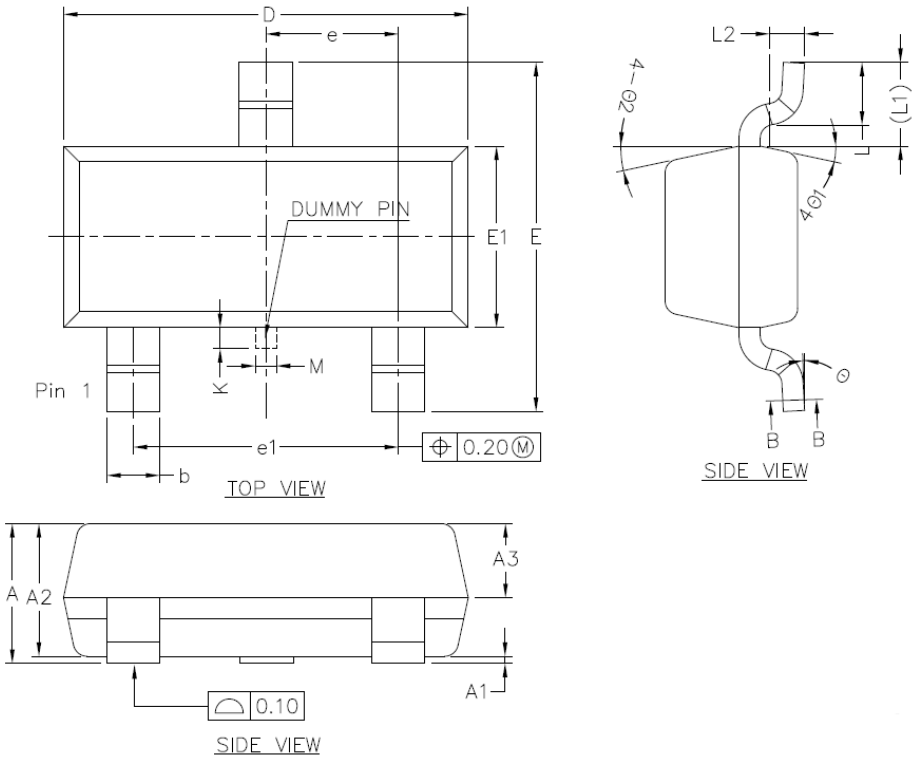


Figure 6.1 Typical Connections of the NST235-Q1STR

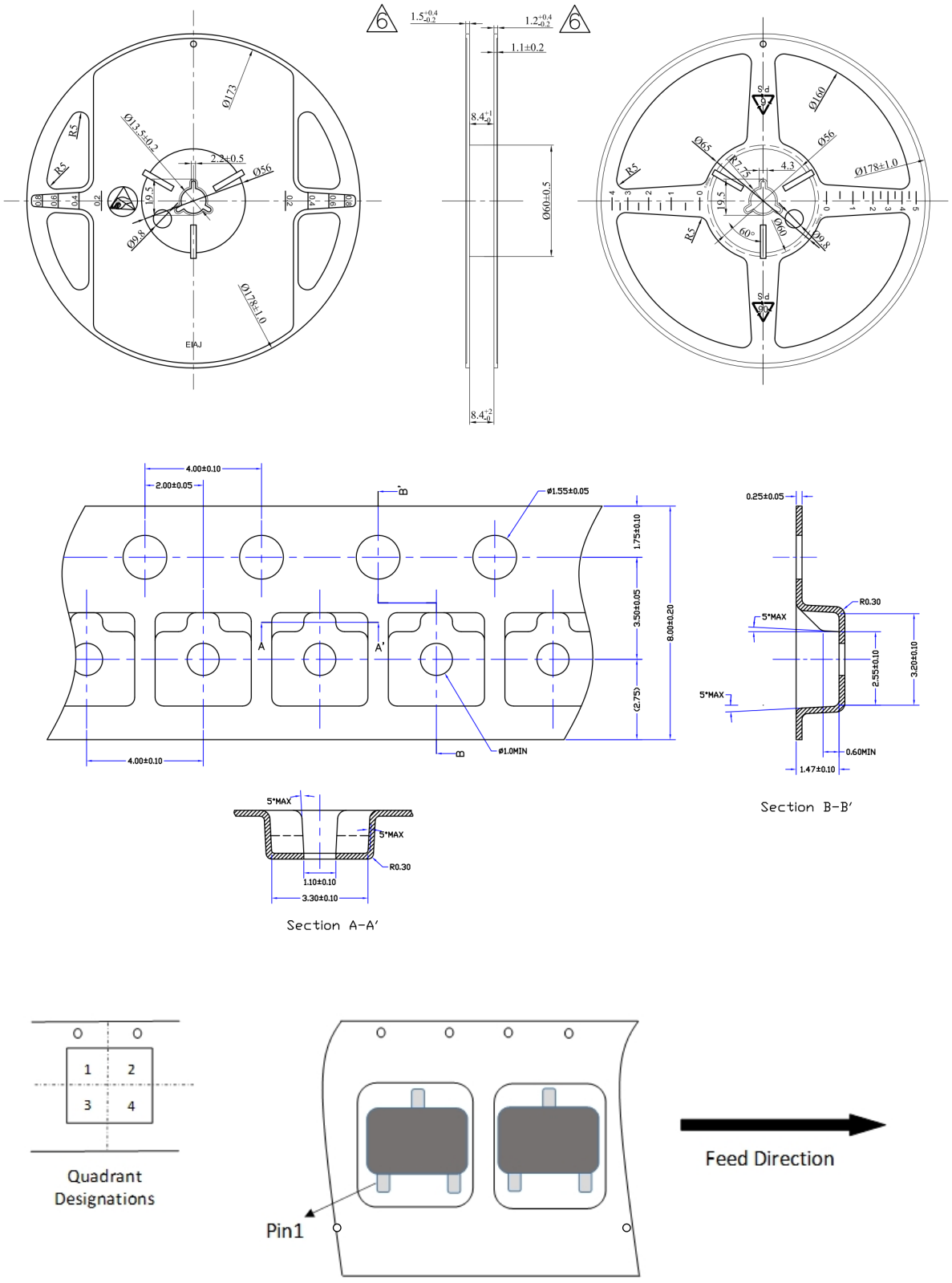
7. Package Information

7.1. SOT-23(3) Package



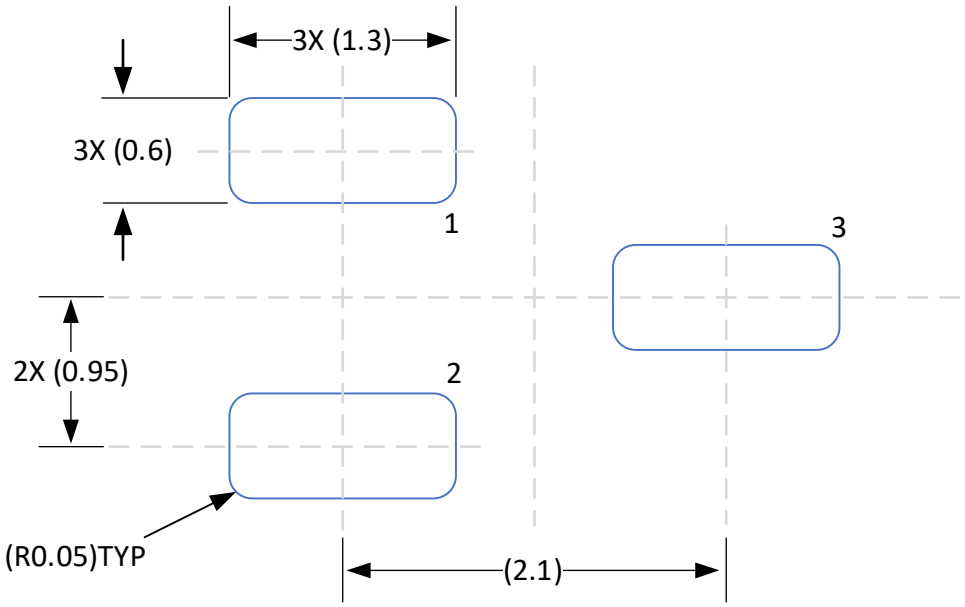
SYMBOL	MIN	NOM	MAX
A	0.89	—	1.12
A1	0.01	—	0.10
A2	0.88	0.95	1.02
A3	0.43	0.53	0.63
b	0.36	—	0.50
b1	0.35	0.38	0.45
c	0.14	—	0.20
c1	0.14	0.15	0.16
D	2.80	2.90	3.00
E	2.35	2.50	2.64
E1	1.20	1.30	1.40
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.40	0.45	0.60
L1	0.60REF		
L2	0.25BSC		
M	0.10	0.15	0.25
K	0	—	0.25
θ	0°	—	8°
θ1	10°	12°	14°
θ2	10°	12°	14°

7.2. Tape and Reel Information

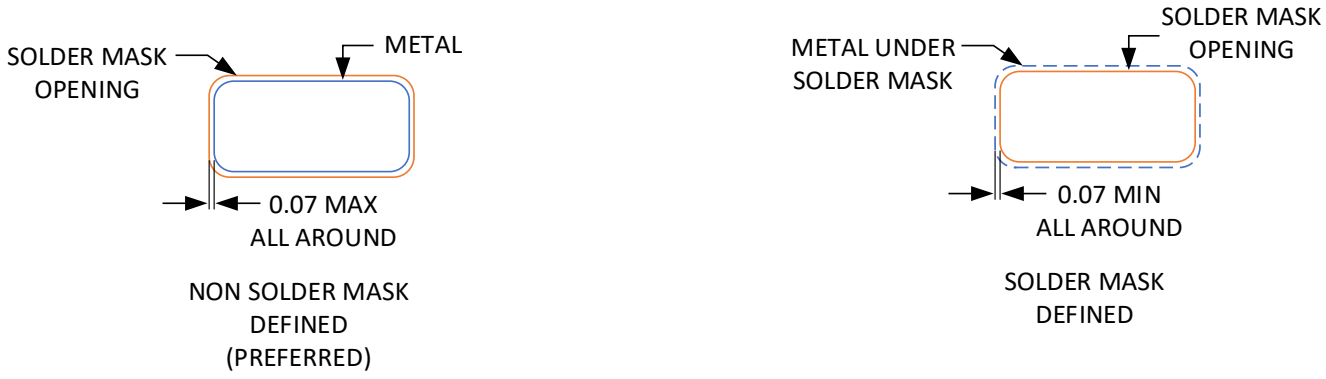


Tape and Reel Information of SOT-23(3)

7.3. Land Pattern



LAND PATTERN EXAMPLE



SOLDER MASK DETAILS

8. Order Information

NST235-Q1STR	Unit	MSL	Marking	Description
NST235-Q1STR	3000ea/Reel	1	235XYY	SOT-23(3) package, Reel
NOTE: All packages are RoHS-compliant with peak reflow temperatures of 260 °C according to the JEDEC industry standard classifications and peak solder temperatures (Reflow profile: J-STD-020E).				

9. Marking

	Type	Line	Name	Remark
NST235-Q1STR	235XYY	Line 1	235	Fixed product code
			X	Last of the year
			YY	Weekly

10. Revision History

Revision	Description	Date
1.0	Initial Version	2024/11/10

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