NOVOSENSE

NST60-Q1STR
High Precision Ultra-low Current Analog Temperature Sensor

Datasheet (EN) 1.0

Product Overview

The NST60-Q1STR is a high precision CMOS analog output temperature sensor. The device offers a maximum accuracy of ±1.5°C at 25°C and a maximum of ±2.5°C over the full temperature range. The device is specified at the full temperature range of -40°C to 150°C and the power supply operating range is 2.4V to 5.5V.

The NST60 device provides a positive slope output of 6.25mV/°C over -40°C to 150°C. it is highly linear and does not require complex calculations or lookup tables to derive temperature.

The NST60-Q1STR is a low-power temperature sensor with an operating current of just 17uA, resulting in negligible self-heating of the device. The NST60-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

- Operating Voltage Range: 2.4V to 5.5V
- Operating Temperature Range: –40°C to 150°C
- AEC-Q100 qualified
- Accuracy at 25 °C: ±1.5°C (Maximum)
- Accuracy at -40°C and 150°C: ±2.5°C (Maximum)
- Average Sensor Gain: 6.25 mV/°C
- Output Impedance: 1 Ω (Typical)
- Operating Current: 17μA (Typical)
- Push-Pull Output Current Drain: 500μA (Maximum)
- 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*
NST60-Q1STR	SOT-23(3)	2.90mm × 1.30mm

Functional Block Diagrams

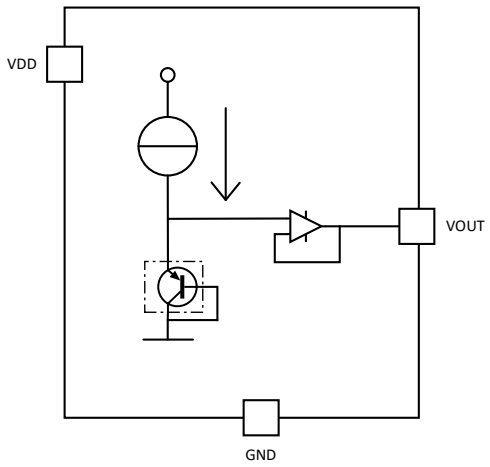

Figure 1. NST60-Q1STR Block Diagram

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1. Pin Configuration and Functions

(Top View)

Package:3-Pin SOT-23

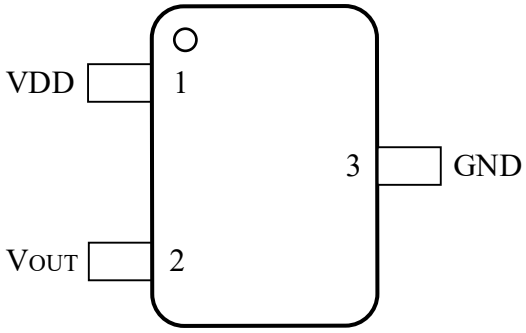

Figure 1.1 NST60-Q1STR Pin Configuration

Table 1.1 NST60-Q1STR Pin Function Description

Pinout		Type	Description
No.	Name		
1	VDD	Power	Power supply input pin
2	V_{OUT}	Analog output	Analog voltage output
3	GND	GND	Ground pin, connect to power supply negative terminal. This pin must be grounded for optimum thermal conductivity.

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	2.4		5.5	V	
Supply Sensitivity			0.6		°C /V	
Operation Current	I_{conv}		17		μA	
Temperature Range						
Temperature Range		-40		150	°C	
Accuracy(Using equation 5-1)		-1.5		1.5	°C	25°C
		-2.5		2.5	°C	-40°C to 150°C
Output Voltage at 0°C			0.424		V	
Vout Drive Capability				500	μA	
Sensor Gain			6.25		mV/°C	
Output Impedance			1		Ω	
Temperature Coefficient of Quiescent Current			-0.019		μA /°C	
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 = 3.3V, unless otherwise noted.

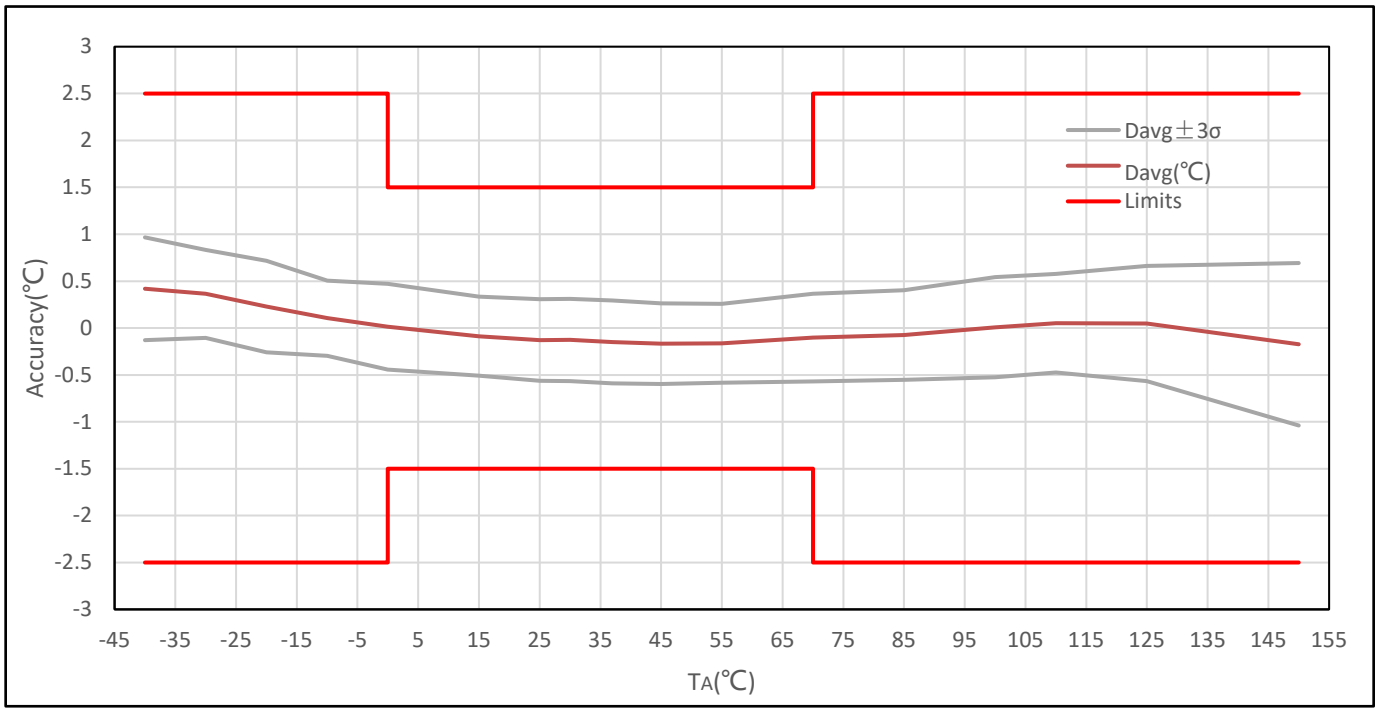

Figure 4.1 Temperature Error vs Temperature

5. Function Description

5.1. Overview

The NST60-Q1STR is a high precision CMOS analog output temperature sensor. The device offers a maximum accuracy of ±1.5°C at 25°C and a maximum of ±2.5°C over the full temperature range. The device is specified at the full temperature range of -40°C to 150°C and the power supply operating range is 2.4V to 5.5V.

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5.2. Functional Block Diagram

The NST60-Q1STR Functional Block Diagram as shown in Figure 5.1.

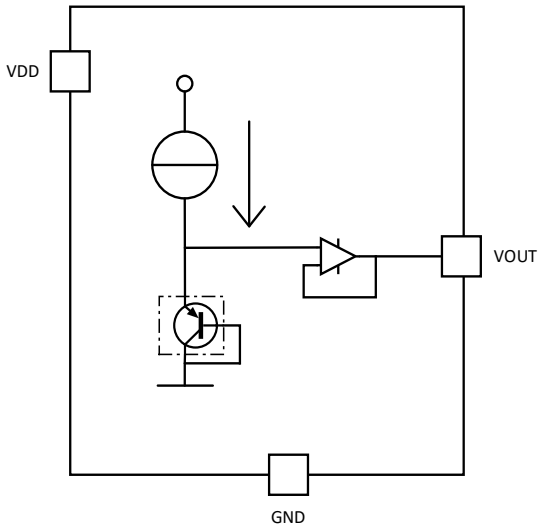


Figure 5.1 NST60-Q1STR Functional Block Diagram

5.3. Feature Description

5.3.1.NST60-Q1STR Transfer Function

The accuracy of NST60-Q1STR can be expressed by a simple linear transfer function. In the full temperature range, the high-precision linear transfer function is:

$$Vo = 6.25mV/℃ \times T + 424mV \quad (5\text{-}1)$$

Table 5.1 Temperature to Voltage Output Characteristic Table

TEMP (℃)	VOUT (mV)
-40	174
-25	268
0	424
25	580
100	1049

TEMP (℃)	VOUT (mV)
125	1205
150	1362

5.3.2.Application Curve

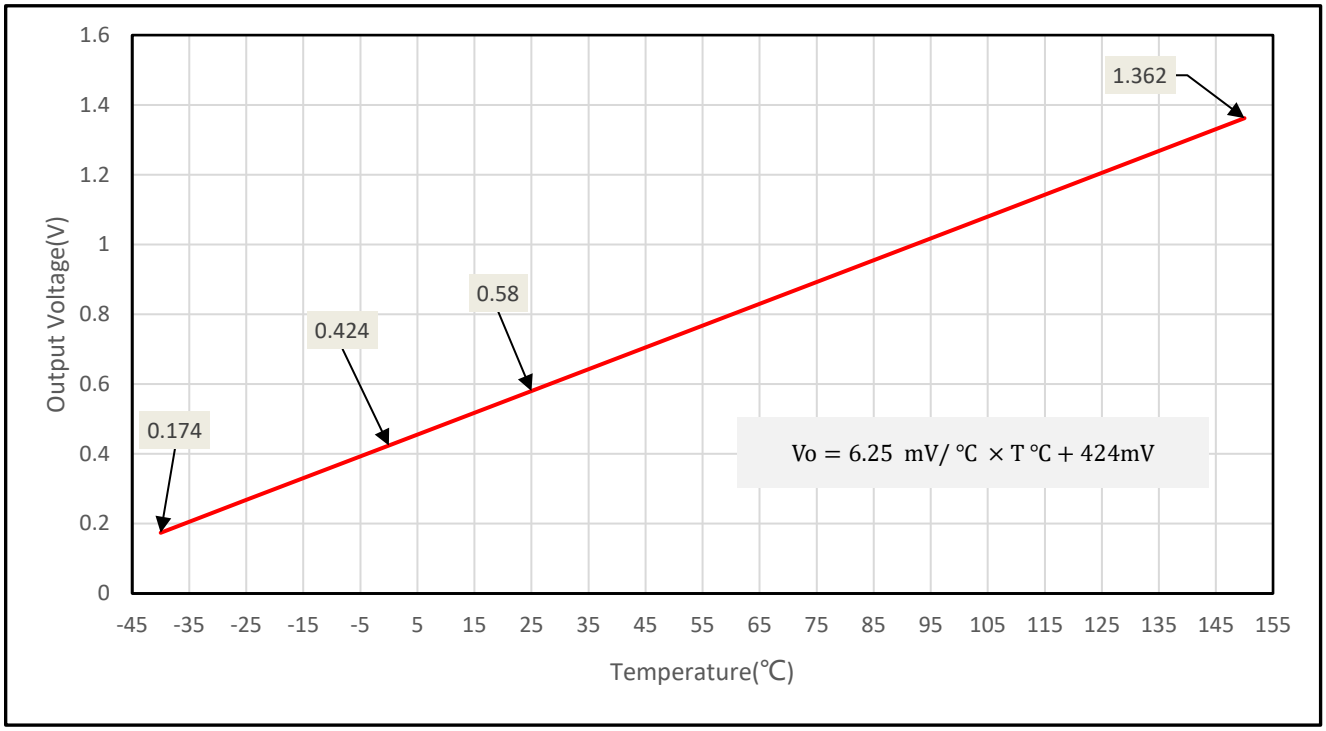


Figure 5.2 Output Voltage vs Temperature

6. Application Information

6.1. Capacitive Loads

As shown in the structure diagram, the output stage of NST60-Q1STR is an amplifier. Generally, the output of the amplifier directly connected to the capacitive load is unstable. However, NST60-Q1STR uses a special design, which makes it have 1000pF capacitive load capacity as shown in the Figure 6.2. If a larger capacitor is connected to filter the noise, an isolation resistance should be added between the output of NST60-Q1STR and the capacitor as shown in the Table 6.1.

When the equipment is in an extremely noisy environment, it may be necessary to add an RC low-pass filter network to the output of NST60-Q1STR, such as a 1μF capacitor and a 200Ω series resistor. This low-pass filter will improve the thermal response time of NST60-Q1STR and has the function of filtering high-frequency noise as shown in the Figure 6.3.

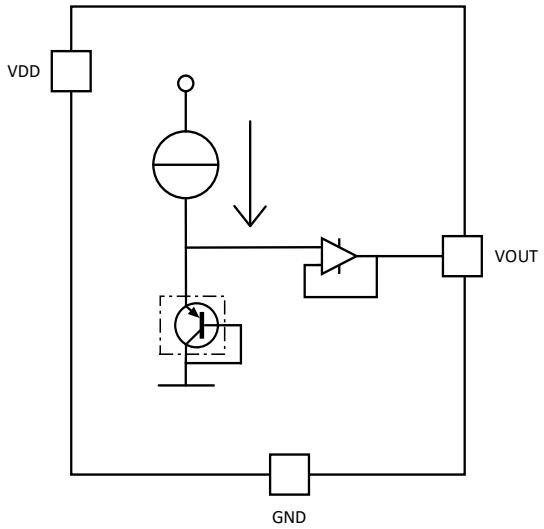


Figure 6.1 NST60-Q1STR Structure Diagram

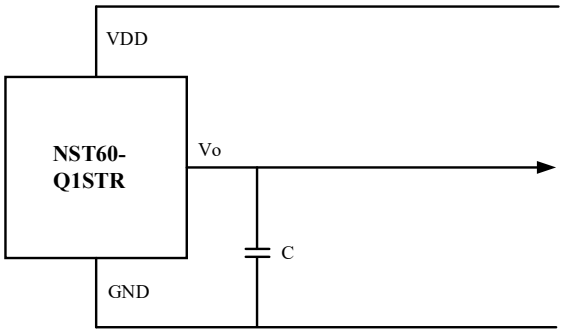


Figure 6.2 NST60-Q1STR No Decoupling Required for Capacitive Loads Less Than 1000 pF

Table 6.1 Capacitive Loading Isolation

C(μF)	Minimum R(Ω)
1	200
0.1	470
0.01	680
0.001	1000

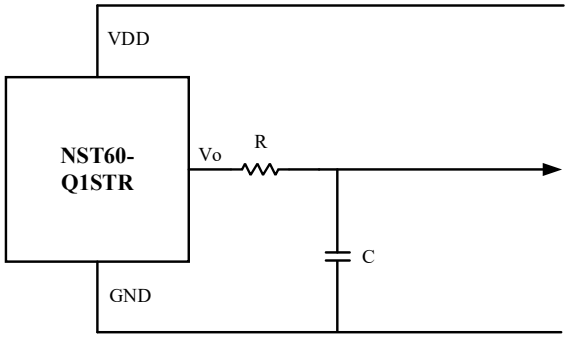


Figure 6.3 NST60-Q1STR With RC Filter

6.2. Typical Application

As shown in Figure 6.4, the NST60-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.

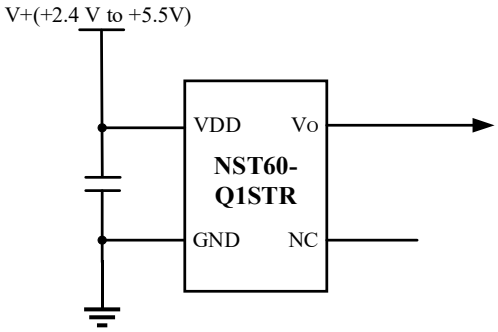


Figure 6.4 Typical Connections of the NST60-Q1STR

6.3. System Examples

6.3.1. Conserving Power Dissipation with Shutdown

Although NST60-Q1STR has extremely low power consumption, for power-sensitive applications it can simply be shut down by driving its supply pin with the output of a logic gate as shown in Figure 6.5.

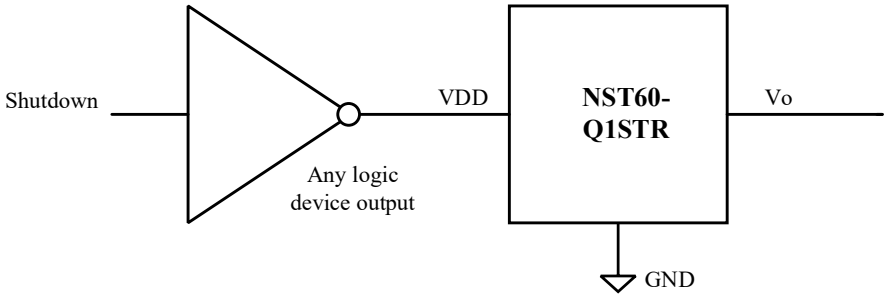


Figure 6.5 Conserving Power Dissipation with Shutdown

6.3.2. Analog-to-Digital Converter Input Stage

The input structure of most CMOS ADCs is sample and hold structure. When ADC charges the sampling capacitor, it needs to draw instantaneous current from the signal source (such as NST60-Q1STR temperature sensor and many operational amplifiers). By adding RC filter to the output stage of NST60-Q1STR, this requirement can be met. At this time, the instantaneous current is provided by the output capacitor. This ADC is shown as an example only, in Figure 6.6.

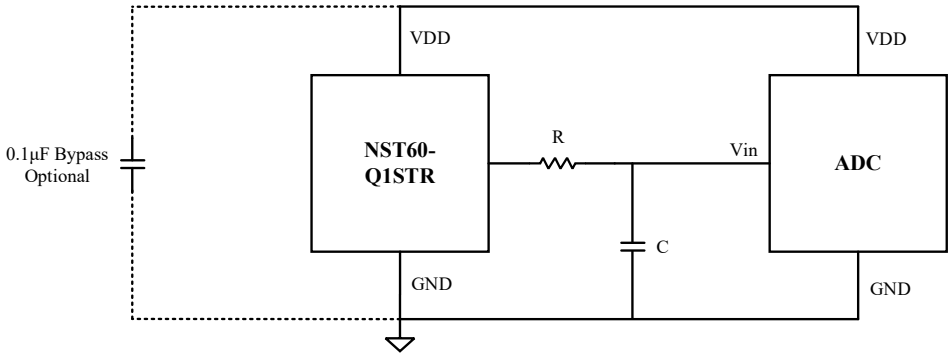
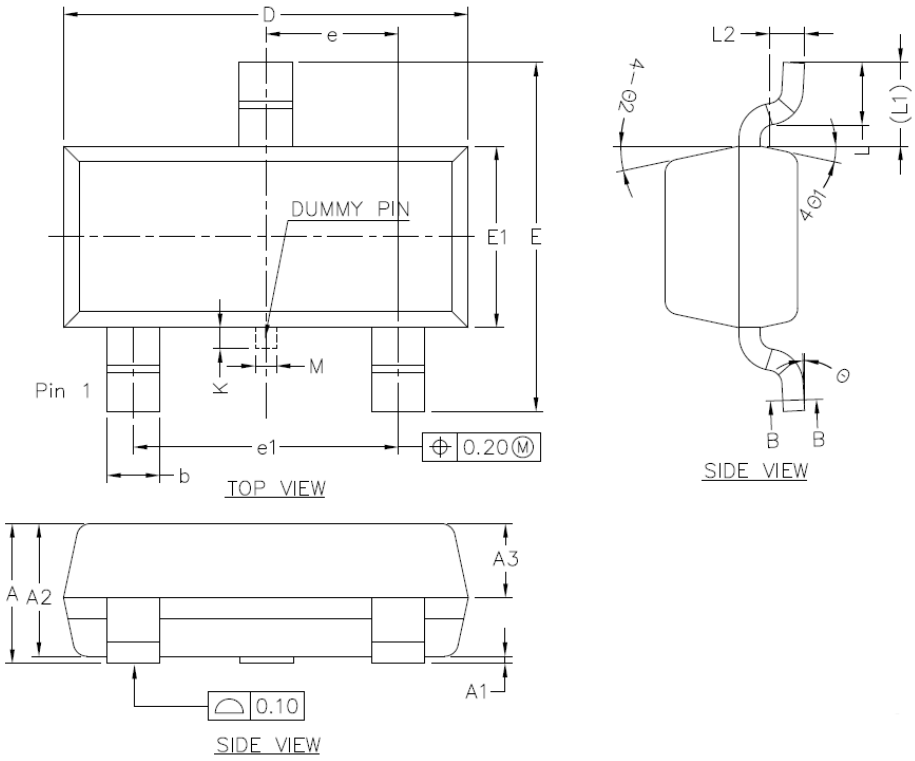


Figure 6.6 Suggested Connection to a Sampling Analog to Digital Converter Input Stage

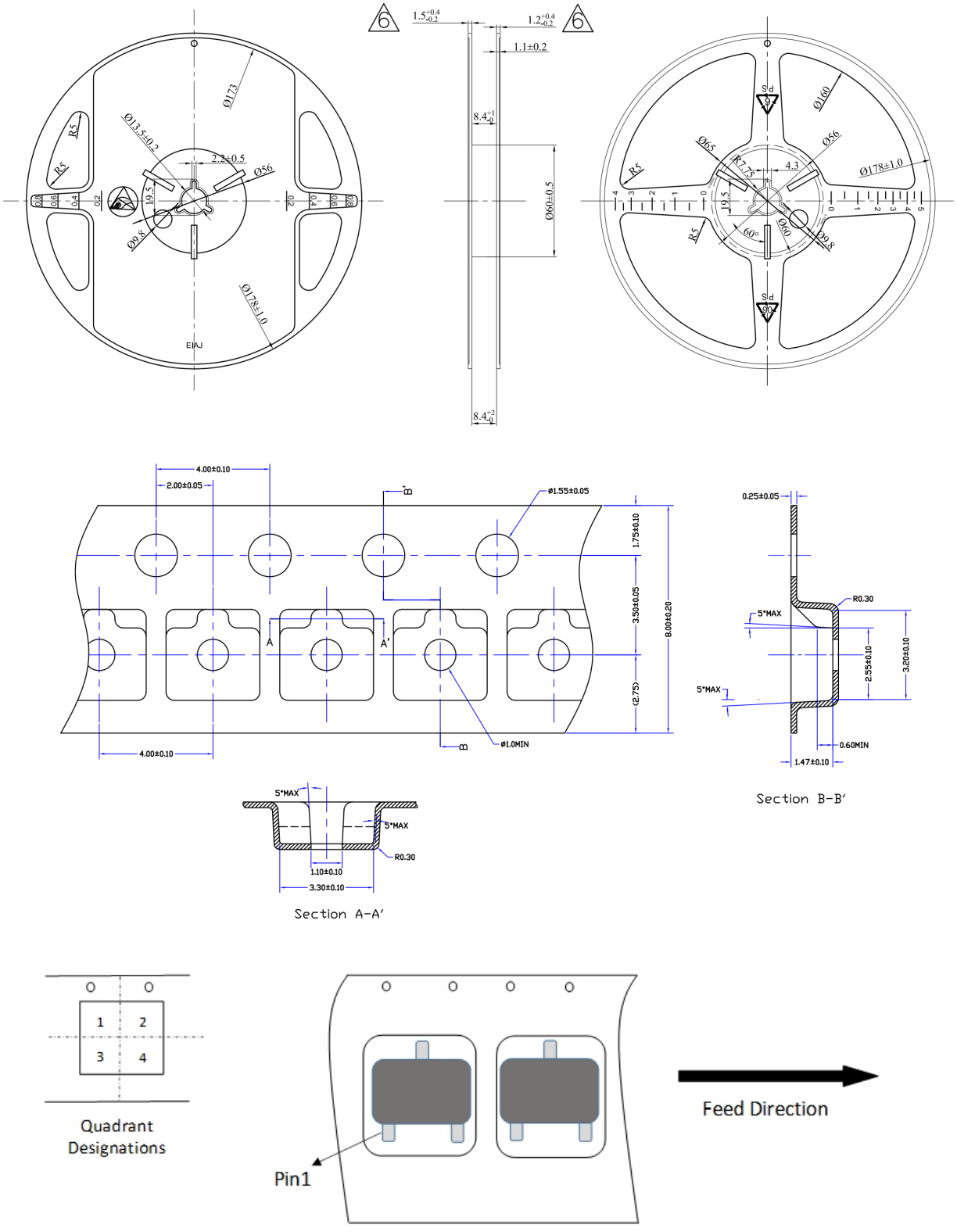
7. Package Information

7.1. SOT-23(3) Package



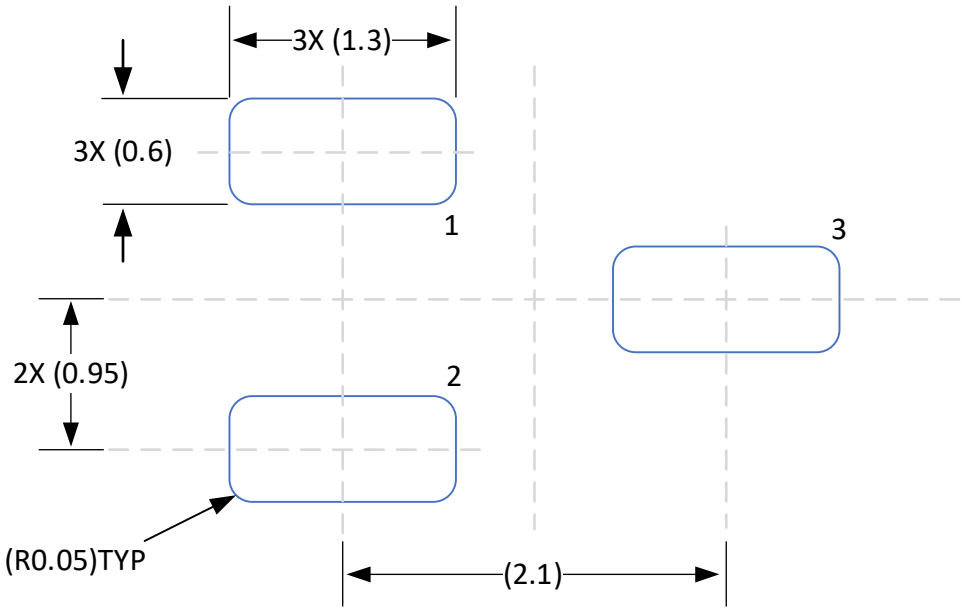
SYMBOL	MIN	NOM	MAX
A	0.89	—	1.12
A1	0.01	—	0.10
A2	0.88	0.95	1.02
A3	0.43	0.53	0.63
b	0.36	—	0.50
b1	0.35	0.38	0.45
c	0.14	—	0.20
c1	0.14	0.15	0.16
D	2.80	2.90	3.00
E	2.35	2.50	2.64
E1	1.20	1.30	1.40
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
L	0.40	0.45	0.60
L1	0.60REF		
L2	0.25BSC		
M	0.10	0.15	0.25
K	0	—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

7.2. SOT-23(3) Tape and Reel

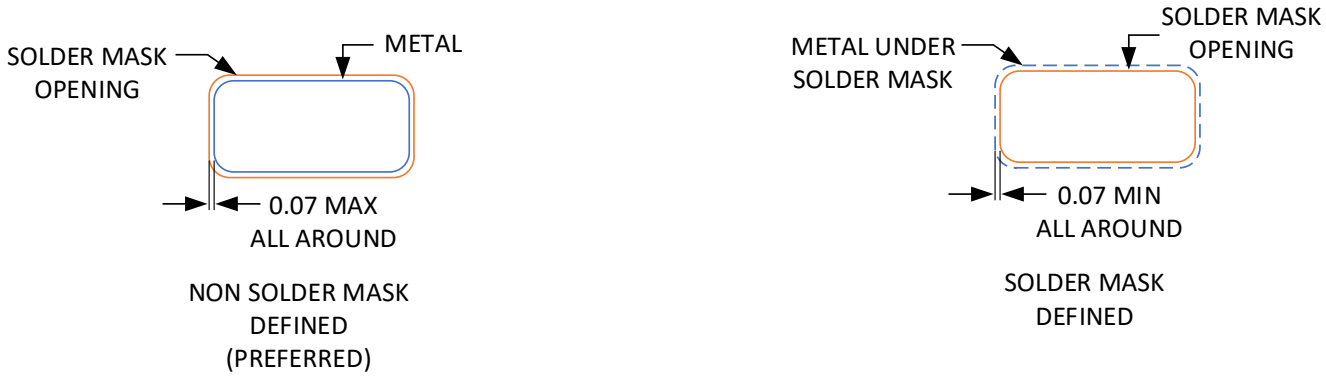


Tape and Reel Information of SOT-23(3)

7.3. Land Pattern



LAND PATTERN EXAMPLE



SOLDER MASK DETAILS

8. Order Information

NST60-Q1STR-Q1STR	Unit	MSL	Marking	Description
NST60-Q1STR	3000ea/Reel	1	60XXYY	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
NST60-Q1STR	60XXYY	Line 1	60	Fixed product code
			XX	Last 2 of the current year
			YY	Weekly

10. Revision History

Revision	Description	Date
1.0	Initial Version	2024/11/10

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