NST461

High-Accuracy Remote and Local Temperature Sensor with Pin-Programmable Bus Address

Datasheet (EN) 1.0

Product Overview

NST461 is a high precision and low power consumption digital temperature sensor based on the temperature effect of PN junction of CMOS process transistor. Besides the chip itself can achieve high precision temperature measurement, it can also achieve remote temperature measurement with external transistor. NST461 remote temperature measurement functions, mainly through external low-cost transistor or the diode, and at the same time the series resistance offset, programmable non-ideal factors factor(η-factor), programmable offset, programmable temperature limit, programmable digital filter, diode fault detection, and other functions, improve the output precision and noise resistance, heat for the remote monitoring provides a reliable solution. The multi-point temperature measurement function is realized without increasing the cost.

The device is specified to operate in a voltage range of 2.1 V to 3.6 V and a temperature range of -40°C to 125°C. Both local and remote temperature data are represented by a 12-digit code with a resolution of up to 0.0625 ° C. SMBus communication protocol is supported and 9 different programmable addresses are available. It's WQFN(10) package is suitable for PC, servers, communication equipment, battery temperature monitoring, LED lighting and projector thermal control.

Key Features

- Supply and Logic Voltage Range: 2.1 V to 3.6 V
- Remote Diode Temperature Sensor Accuracy:
  - ±1 °C (TA = -20 ~ 85℃)
  - ±1.5℃ (TA = -40 ~ 125℃)
- Local Temperature Sensor Accuracy:
  - ±1 °C (TA = -20 ~ 85℃)
  - ±1.5℃ (TA = -40 ~ 125℃)
- Resolution for Local and Remote Channels: 0.0625 °C
- 37 -µA Operating Current (1 SPS)
- 4 -µA Shutdown Current
- Series Resistance Cancellation
- η-Factor and Offset Correction
- Programmable Digital Filter
- Diode Fault Detection
- SMBus and I2C Serial Interface
- Programmable Address
- 10-Lead WQFN Package

Applications

- Processor Temperature Monitoring
- Telecommunication Equipment
- Servers and Personal Computers
- Precision Instruments
- Test Equipment
- LED Lighting Thermal Control

Device Information

Part Number	*Package*	*Body Size*
NST461-DQNR	WQFN (10)	2mm × 2mm

Typical Application

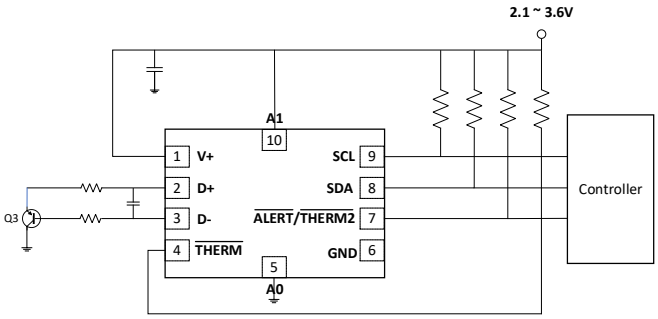

Figure 1. NST461 Block Diagram

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1. Pin Configuration and Functions

10-Pin WQFN
Top View

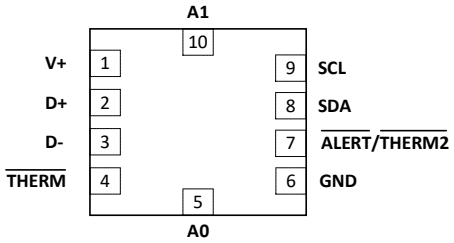


Figure 1.1 NST461 Package

Table 1.1 NST461 Pin Configuration and Description

Pinout		*Type*	*Description*
Name	*NO.*		
A0	5	Digital input	Address select. Connect to GND, V+, or leave floating.
A1	10	Digital input	Address select. Connect to GND, V+, or leave floating.
$\overline{\text{ALERT}}/\overline{\text{THERM2}}$	7	Digital output	Interrupt or SMBus alert output. Can be configured as a second THERM output. Open-drain; requires a pullup resistor to a voltage between 2.1 V and 3.6 V.
D–	3	Analog input	Negative connection to remote temperature sensor.
D+	2	Analog input	Positive connection to remote temperature sensor.
GND	6	Ground	Supply ground connection.
SCL	9	Digital input	Serial clock line for SMBus. Input; requires a pullup resistor to a voltage between 2.1 V and 3.6V if driven by an open-drain output.
SDA	8	Bidirectional digital input-output	Serial data line for SMBus. Open-drain; requires a pullup resistor to a voltage between 2.1V and 3.6 V.
$\overline{\text{THERM}}$	4	Digital output	Thermal shutdown or fan-control pin. Open-drain; requires a pullup resistor to a voltage between 2.1 V and 3.6V.
V+	1	Power supply	Positive supply voltage, 2.1V to 3.6 V.

2. Absolute Maximum Ratings

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply Voltage Pin (VDD)	VDD	-0.3		6	V	
Input voltage	$\overline{\text{THERM}}$, $\overline{\text{ALERT}}$ /$\overline{\text{THERM2}}$, SDA and SCL only	-0.3		6	V	
	D+, A0, A1	-0.3		(V+)+0.3	V	
	D- only	-0.3		0.3	V	
Input current				10	mA	
Storage temperature	T_{stg}	-60		150	°C	
Operation temperature	$TB_{operation}$	-55		150	°C	
Maximum junction temperature				150	°C	
ESD susceptibility	HBM	±5.5			KV	
	CDM	±1.25			KV	

3. ELECTRICAL CHARACTERISTICS

3.1. Electrical characteristics

At TA = –40°C to 125°C and V+ = 2.1 V to 3.6 V, unless otherwise noted.

Parameters	*Symbol*	*Min*	*Typ*	*Max*	*Unit*	*Comments*
Supply						
Supply voltage Range	VDD	2.1		3.6	V	
Pull up resistor Range	R_{pu}		10		KΩ	
Supply sensitivity			0.39		m°C /V	
Quiescent current	I_Q		265	407	µA	Active conversion, local sensor
			400	561		Active conversion, remote sensor
			29	128		Standby mode (between conversions)
			4			Shutdown mode, serial bus inactive
			11	114		Shutdown mode, serial bus active, f_S = 400 kHz
			42	187		Shutdown mode, serial bus active, f_S = 2.17MHz
			60	230		Shutdown mode, serial bus active, f_S = 3.2MHz
Power-on reset threshold	POR		1.2		V	Rising edge
Temperature Measurement						
Temperature Range		-40		125	°C	
Temperature Resolution (local and remote)			0.0625		°C	
Local temperature sensor accuracy	TA_{LOCAL}	-1	±0.5	1	°C	TA = -20 °C to 85 °C, V+ = 2.1 V to 3.6 V
		-1.5	±1	1.5	°C	TA = -40 °C to 125 °C, V+ = 2.1 V to 3.6 V
Remote temperature sensor accuracy	TA_{REMOTE}	-1	±0.5	1	°C	TA = -20 °C to 85 °C, TD = -55 °C to 150 °C, V+ = 2.1 V to 3.6 V
		-1.5	±1	1.5	°C	TA = -40 °C to 125 °C, TD = -55 °C to 150 °C, V+ = 2.1 V to 3.6 V
Conversion time	T_{CONV}	8	14	20	ms	One-shot mode, local channel
	T_{CONV}	7	12	18		One-shot mode, remote channel

Remote sensor source current	High			5.8		µA	Series resistance 1 kΩ (max)
	Medium			51			
	Low			103			
Temperature sensor error versus supply (local or remote)			-0.25	±0.1	0.25	°C	V+ = 2.1 V to 3.6 V
Remote transistor ideality factor		η		1.008			NST461 optimized ideality factor
Serial Interface							
High-level input voltage		V_{IH}	1.4			V	
Low-level input voltage		V_{IL}			0.45	V	
Hysteresis				200		mV	
SDA output-low sink current			6			mA	
Low-level output voltage		V_{OL}		0.15	0.4	V	I_O = -6 mA
Serial bus input leakage current			-1		1	µA	0 V ≤ VIN ≤ 5.5 V
Serial bus input capacitance				3		pF	SCL
				4.6		pF	SDA
Serial bus clock frequency			0.001		3.2	MHz	
Serial bus timeout			20	25	30	ms	
Digital DC Characteristics							
VIN(1) Logical “1” Input Voltage		V_{IH}	VDD*0.7		VDD+0.3	V	
VIN(0) Logical “0” Input Voltage		V_{IL}	-0.3		VDD*0.3	V	
IIN(1) Logical “1” Input Current					1	µA	
IIN(0) Logical “0” Input Current					-1	µA	
Input capacitance		C_{IN}		2.5		pF	
IOH High Current Level Output Open drain leakage		IOH			1	µA	V_{OH}=VDD
Low Level Output Voltage		VOL		0.15	0.4	V	IOL= 6 mA
Output-low sink current			6			mA	
Thermal response							
Stirred oil thermal response time to 63% of final value (package only)				0.4		s	WQFN (10)

(1) Drift data is based on a 1000-hour stress test at +125 °C with VDD = 3.6V.

3.2. I²C Timing Diagram

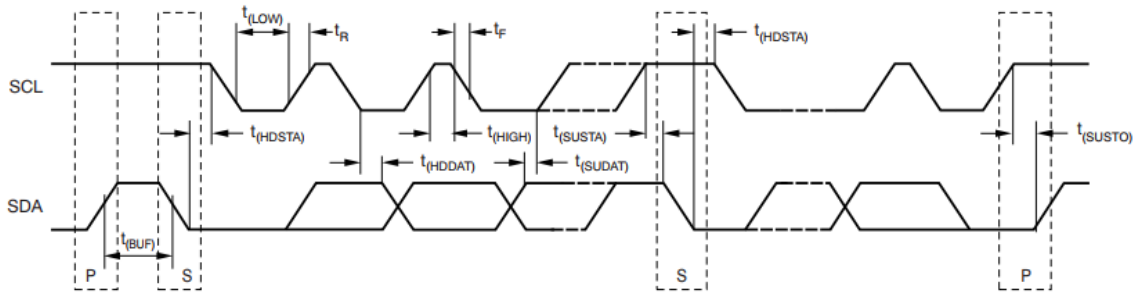


Figure 3.1. I2C Timing Diagram

3.3. I²C TIMING CHARACTERISTICS

Parameters	*Symbol*	*FAST MODE*		*HIGH-SPEED MODE*		*Unit*	*Comments*
		Min	*Max*	*Min*	*Max*		
SCL operating frequency	f_{SCL}	0.001	0.4	0.001	3.2	MHz	
Bus-free time between STOP and START conditions	$t_{(BUF)}$	1300		160		ns	
Hold time after repeated START condition; after this period, the first clock is generated	$t_{(HDSTA)}$	600		160		ns	
Repeated START condition setup time	$t_{(SUSTA)}$	600		160		ns	
STOP condition setup time	$t_{(SUSTO)}$	600		160		ns	
Data hold time	$T_{(HDDAT)}$	0	900	0	150	ns	
Data setup time	$T_{(SUDAT)}$	100		40		ns	
SCL clock low period	$T_{(LOW)}$	1300		320		ns	
SCL clock high period	$T_{(HIGH)}$	600		60		ns	
Data fall time	t_{FD}		300		130	ns	
Clock rise time	t_{RC}		300		40	ns	
			1000			ns	SCL ≤ 100 kHz
Clock fall time	t_{FC}		300		40	ns	

3.4. TYPICAL CHARACTERISTICS

At TA = 25 °C and V+ = 3.3 V, unless otherwise noted.

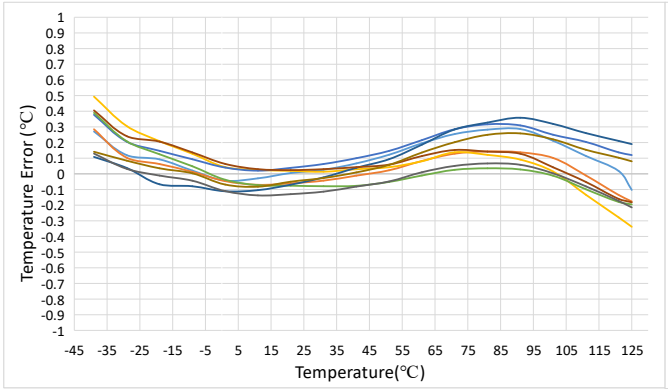


Figure 3.2 Local Temperature Error vs Temperature

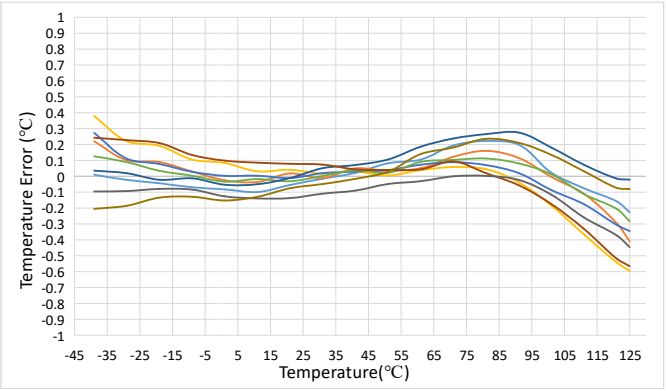


Figure 3.3 Remote Temperature Error vs Temperature

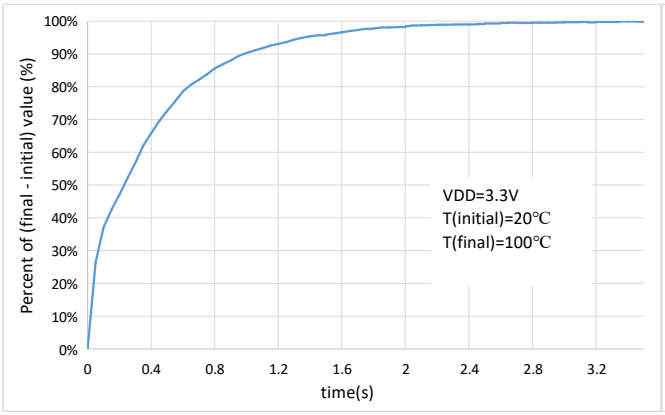


Figure 3.4 Thermal response in stilling Oil

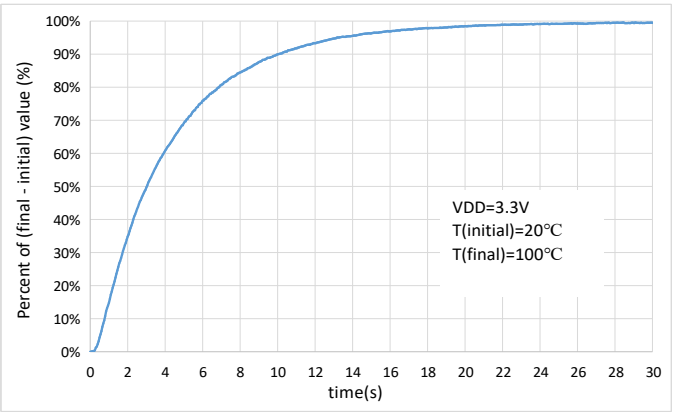


Figure 3.5 Thermal response in stilling Air

4. FUNCTION DESCRIPTION

4.1. Function description

The functional block diagram of NST461 is shown in Figure 4.1. Supports one local and one remote high-precision temperature sensor, nine bus addresses, and compatible with SMBUS and I2C interfaces. The operating temperature ranges from -40 ℃ to 125 ℃.

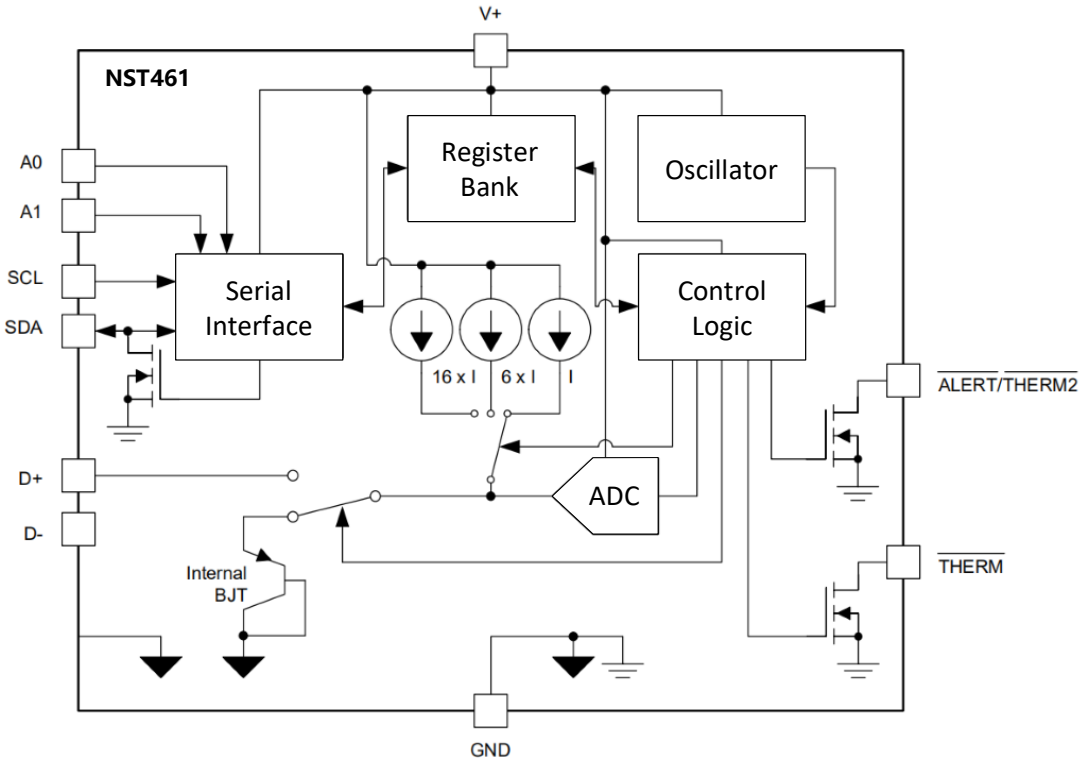


Figure 4.1 NST461 Functional Block Diagram

4.2. Feature Description

4.2.1. Digital Temperature Sensor

Temperature is measured in both shut down mode and continuous mode, and the converted data is stored in the corresponding data register. The resolution of all temperature data is 0.0625 ° C, and the default temperature range is -64 ° C to +127.875 ° C. You can also configure the register to extend the temperature range from -64 ° C to +191 ° C. The temperature data formats in default and extended modes are shown in Table 4.1.

Table 4.1. Temperature Data Format

TEMPERATURE (℃)	*DEFAULT RANGE (-64 ℃TO 127 ℃)*	*EXTENDED RANGE(-64 ℃TO 191 ℃)*
Diode Fault	0110 0000 0000 0000	0000 0000 0000 0000
-64	1100 0000 0000 0000	0000 0000 0000 0000
-25	1110 0111 0000 0000	0010 0111 0000 0000
0	0000 0000 0000 0000	0100 0000 0000 0000
0.0625	0000 0000 0001 0000	0100 0000 0001 0000
25	0001 1001 0000 0000	0101 1001 1000 0000
50	0011 0010 0000 0000	0111 0010 0000 0000
125	0111 1101 0000 0000	1011 1101 0000 0000
127	0111 1111 0000 0000	1011 1111 0000 0000
150	0111 1111 0000 0000	1101 0110 0000 0000

190	0111 1111 0000 0000	1111 1110 0000 0000
191	0111 1111 0000 0000	1111 1111 0000 0000
>= 191.875	0111 1111 0000 0000	1111 1111 0001 0000

Note:

(1) In the extended range, all temperatures < -64 ℃ will be reported as -64 ℃.

(2) For the default range, all temperatures > +127.875 ℃ will be reported as +127.875 ℃.

(3) For the extended range, all temperatures > +191.875 ℃ will be reported as +191.875 ℃.

4.2.2. Series Resistance Cancellation

The series resistance cancellation function automatically eliminates temperature errors caused by the wiring resistance from the NST461 to the remote transistor. The NST461 device eliminates 1 kΩ series resistance, so no additional temperature offset correction is required.

4.2.3. Differential Input Capacitance

The NST461 device ensures that the temperature error remains small when the differential input capacitance reaches 1000pF.

4.2.4. η-Factor Correction

NST461 allows remote channel measurements to be converted to temperature values using different η coefficient values. The remote channel uses continuous current excitation to extract differential Vbe voltage measurements to determine the temperature of the remote transistor. To provide maximum flexibility to the user, the NST461 provides 7-bit registers for each remote channel to program the desired coefficient of the diode used to eliminate all temperature errors.

4.2.5. Filtering

Remote junction temperature sensors usually work in complex environments. To reduce the impact of noise and temperature spikes on the reported temperature, the NST461 device has built-in filters at the remote channel differential input. It is recommended to place a bypass capacitor between 100 pF and 1nf at the input of the remote temperature sensor to reduce unnecessary coupling signals and make the data more stable. There are three levels of filtering in the remote channel, and the specific effects are shown in Figures 4.2 and 4.3.

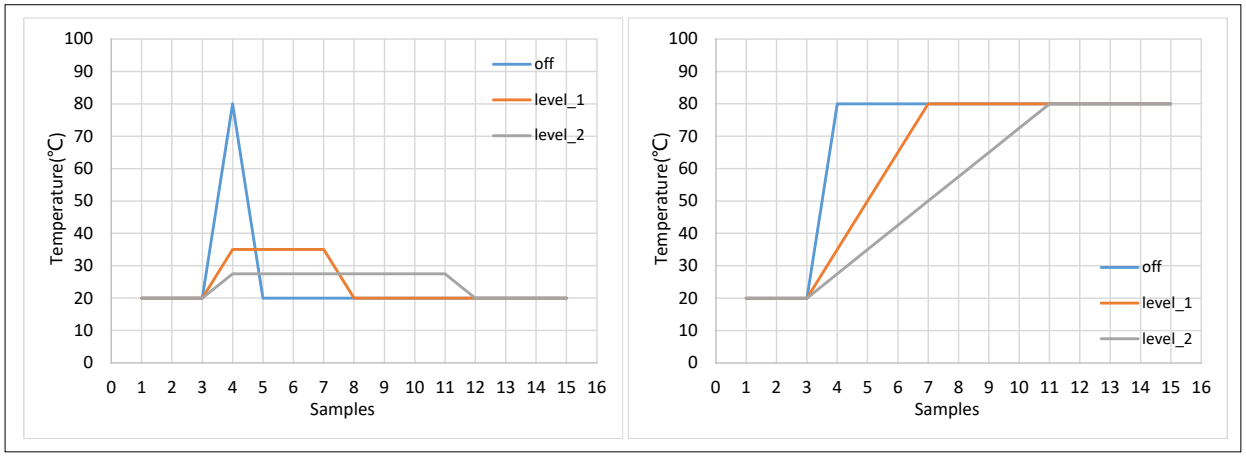


Figure 4.2 Filter Response to Impulse Inputs

Figure 4.3 Filter Response to Step Inputs

4.2.6. Sensor Fault

The NST461 is capable of detecting DP and DN pin disconnections and short circuits. The device will check for diode faults on the remote temperature channel each time the temperature is measured. When a diode fault is detected, the ALERT pin is set to active (unless shielded) and returns a temperature measurement of -64°C with the corresponding status bit set. A circuit break between DP and DN, a short circuit between VDD and DP, and a short circuit between DP and GND are all considered diode failures.

4.2.7. Alert and Therm Functions

The ALERT and THERM pin responses of the NST461 are shown in Figures 4.4 and 4.5. ALERT and THERM are independent of each other and THERM cannot be blocked. When the temperature exceeds the number of times the user set THERM pin is allowed to fire until the temperature drops to the lower limit of the user set THERM temperature trigger minus hysteresis, the THERM pin responds and the response cannot be cleared by reading the status register of the response. The ALERT pin has two modes, interrupt and compare. In interrupt mode, when the temperature value exceeds its maximum limit value, the ALERT pin responds and establishes the corresponding status bit. When the temperature drops to the lower limit of the corresponding temperature value, the response will not be released until the user reads the corresponding status bit and releases the response. In comparison mode, when the temperature exceeds the set maximum limit, the ALERT responds, reading the status bit and not releasing the response status until the temperature drops to the lower limit of the set temperature minus hysteresis.

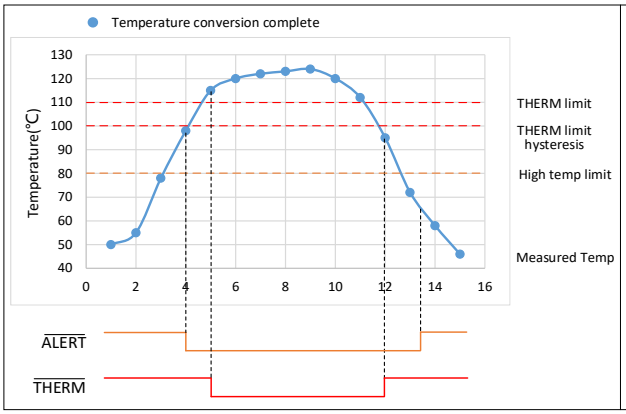


Figure 4.4 $\overline{\text{ALERT}}$ and $\overline{\text{THERM}}$ interrupt operation

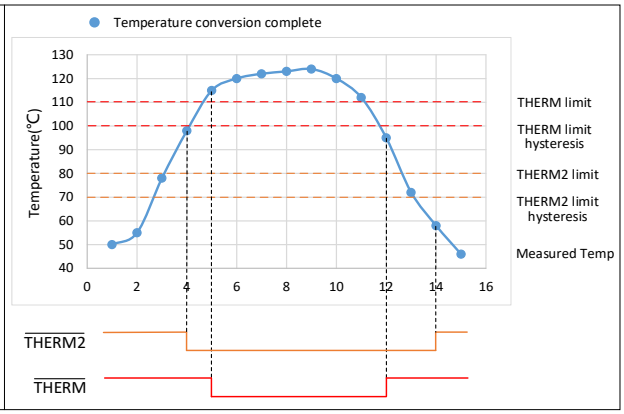


Figure 4.5 $\overline{\text{THERM}}$ and $\overline{\text{THERM2}}$ interrupt operation

4.3. Device Functional Modes

4.3.1. Shutdown Mode (SD)

The NST461 shutdown mode ensures minimum power consumption by turning off all device circuits except the communication interface. When the register (0x0F) is configured, the device will perform data conversion and re-enter the low-power mode.

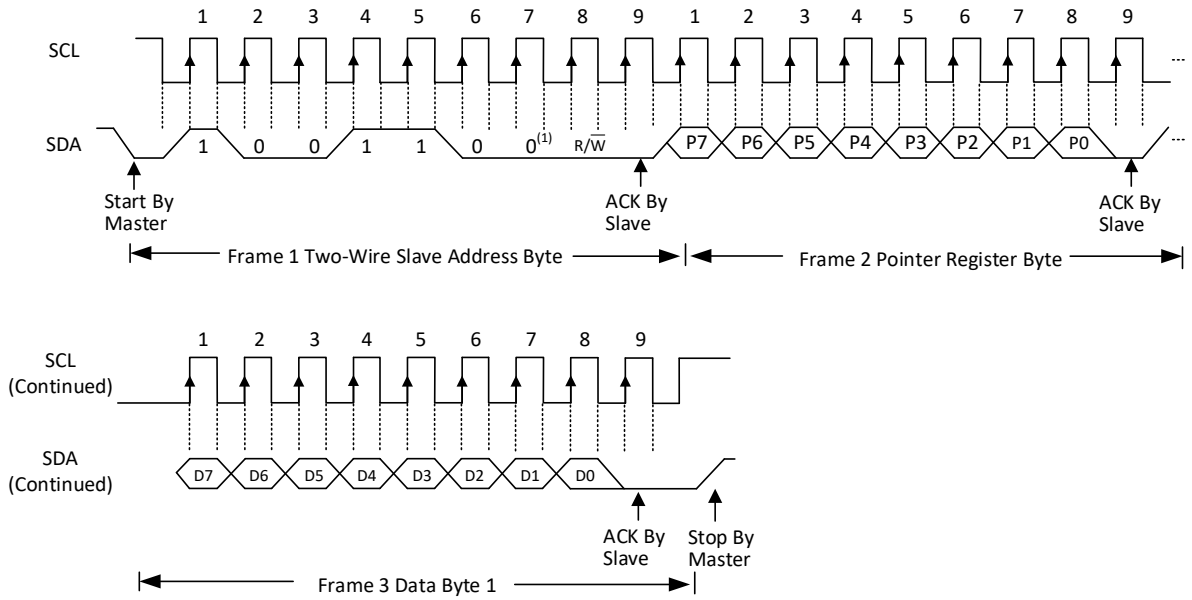
4.3.2. Continuous mode

When the NST461 is put into continuous operation mode, the device will always perform data conversion to keep the value in the temperature data register up-to-date.

4.4. Programming

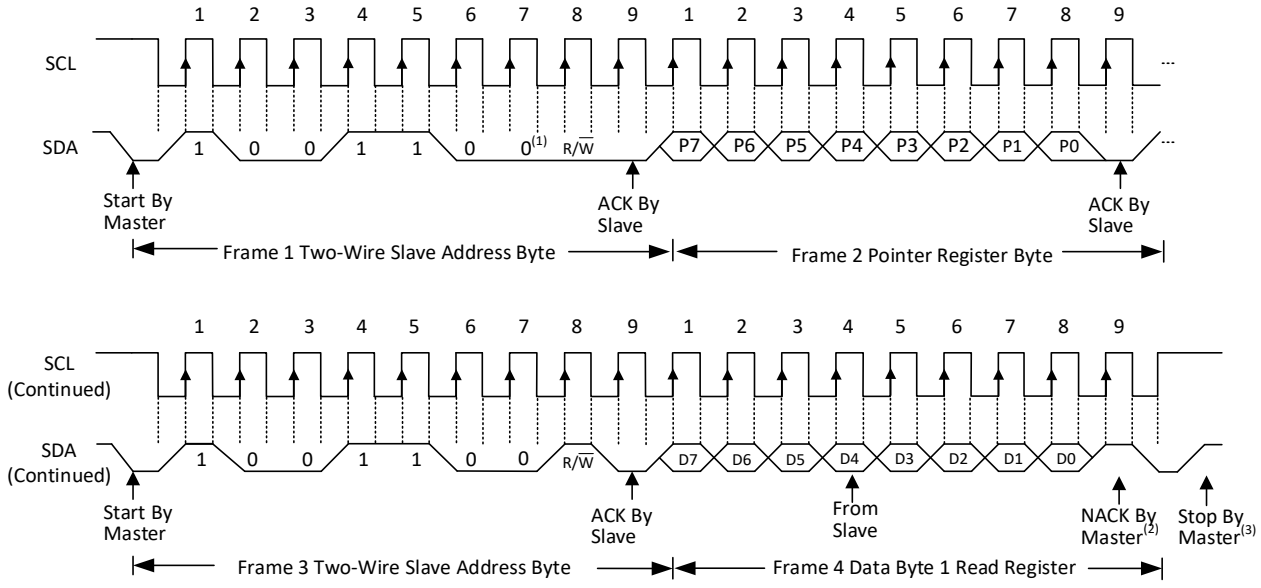
4.4.1. Serial Interface

The write timing and read timing communication timing diagrams of NST461 are shown in Figure 4.6 and Figure 4.7. The NST461 supports fast (1khz to 400khz) and high-speed (1khz to 3.2MHz) transmission protocols and is compatible with up to nine devices with different addresses on the bus.



NOTE: (1) Slave address 1001100 is shown.

Figure 4.6. Two-Wire Timing Diagram for the NST461 Write Word Format



(1) Slave address 1001100 is shown.

(2) The master must leave SDA high to terminate a single-byte read operation.

(3) Master should leave SDA high to terminate a two-byte read operation.

Figure 4.7. Two-Wire Timing Diagram for Single-Byte Read Format

Serial Bus Address

By controlling the different states of address pins A0 and A1, the communication address of the device is programmed. There are altogether 9 address types.

Table 4.2. SMBus Address Decode

A1 CONNECTION	A0 CONNECTION	SLAVE ADDRESS	
		BINARY	HEX
GND	GND	1001 000	48
GND	Float	1001 001	49
GND	V+	1001 010	4A
Float	GND	1001 011	4B
Float	Float	1001 100	4C
Float	V+	1001 101	4D
V+	GND	1001 110	4E
V+	Float	1001 111	4F
V+	V+	1010 000	50

Read and Write Operations

When reading temperature data register data, NST461 supports continuous data reading mode, that is, two bytes are read repeatedly in the same data register, without sending pointer register bytes continuously, you can read the full data high and low bytes.

Timeout Function

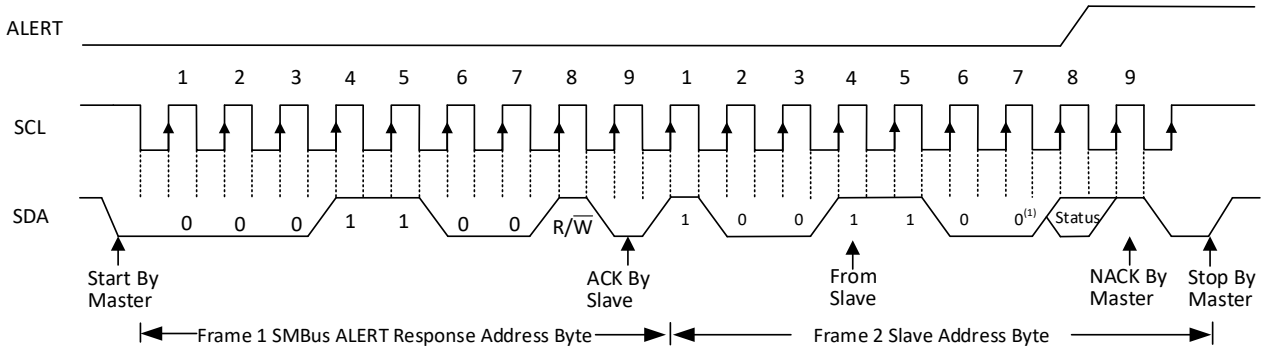
If the SCL is pulled down for more than 25ms, the bus timeout function will be triggered, at which point the device will release the bus and wait for the boot condition. This feature prevents bus communication exceptions due to NST461.

High-Speed Mode

The NST461 supports high-speed mode. After the bus starts, the master control device switches the bus to the high-speed running state by sending the high-speed mode command code (0000 1xxx). At this time, the fastest signal transmission speed supported is 3.2MHz. Until the bus receives a stop signal and the device switches to fast mode.

4.4.2. SMBus Alert Function

Figure 4.9 shows that when multiple products are mounted on the bus, if the device alert responds, it can broadcast 0001_100X on the bus, at which time the alert responding devices will return the slave address of the responding device in turn.



(1) Slave address 1001100 is shown.

Figure 4.9. SMBus Alert Function

The NST461 will respond to the ARA in the following way:

Send Slave Address and verify that full slave address was sent (i.e. the SMBus communication from the device was not prematurely stopped due to a bus contention event).

Set the MASK bit to clear the $\overline{\text{ALERT}}$ pin.

Application Note: The ARA does not clear the Status Register and if the MASK bit is cleared prior to the Status Register being cleared, the $\overline{\text{ALERT}}$ pin will be reasserted.

4.4.3. General-Call Reset

The NST461 device supports a reset using the two-line universal call address 00h (0000 0000b). The NST461 device recognizes the common call address and responds with the second byte. If the second byte is 06h (0000 010b), NST461 performs a software reset. This software reset restores the power-on reset state to all NST461 registers and aborts any transitions in progress. The NST461 device does not respond to any other values in the second byte.

5. Register Information

The NST461 device contains several registers to hold configuration information, temperature measurements, and status information. Table 5.1 describes these registers

Table 5.1. Register Map

Write_Addr	*Read_Addr*	*R/W*	*Description*	*Default*
00	00	WR	Local Temperature Register (high byte)	00
01	01	WR	Remote Temperature Register (high byte)	00
02	02	WR	Status Registers	00
09	03	WR	Configuration Register	00
0A	04	WR	Conversion Rate Register	08
0B	05	WR	Local Temperature High Limit Register	7F
0C	06	WR	Local Temperature Low Limit Register	80
0D	07	WR	Remote Temperature High Limit Register（high byte）	7F
0E	08	WR	Remote Temperature Low Limit Register（high byte）	80
10	10	WR	Remote Temperature Register (low byte)	00
11	11	WR	Romote Temperature Offset Register（high byte）	00
12	12	WR	Romote Temperature Offset Register（low byte）	00
13	13	WR	Remote Temperature High Limit Register（low byte）	F0
14	14	WR	Remote Temperature low Limit Register（low byte）	00
15	15	WR	Local Temperature Register (low byte)	00
16	16	WR	Channel Enable Register	03
19	19	WR	Remote Temperature THERM Limit Register	7F
20	20	WR	Local Temperature THERM Limit Register	7F
21	21	WR	THERM Hys Register	0A
22	22	WR	Consective ALERT Register	01
23	23	WR	η Factor	00
24	24	WR	Digital Filter Control Register	00
FE	FE	WR	ID	55

5.1. Pointer Register

5.1.1. Local and Remote Temperature Registers

Table 5.2. Temperature Data Registers

Write Addr	*Read Addr*	*R/W*	*Bit7*	*Bit6*	*Bit5*	*Bit4*	*Bit3*	*Bit2*	*Bit1*	*Bit0*	*Default*	*Description*
00	00	R	128	64	32	16	8	4	2	1	00	Local Temperature Register (high byte)
01	01	R	128	64	32	16	8	4	2	1	00	Remote Temperature Register (high byte)
10	10	R	0.5	0.25	0.125	0.0625	0	0	0	0	00	Remote Temperature Register (low byte)
15	15	R	0.5	0.25	0.125	0.0625	0	0	0	0	00	Local Temperature Register (low byte)

As shown in the above table, both local and remote temperature data are composed of 12 bits of valid data, and the minimum separation rate is 0.0625℃

5.1.2. Status Register

Table 5.3. Status Register Format

Write Addr	Read Addr	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default	Description
02	02	R	BUSY	LHIGH	LLOW	RHIGH	RLOW	OPEN	RTHRM	LTHRM	00	Status Registers

This register mainly contains the ADC status register and the sensor alarm status of each channel.

- Bit 7 - BUSY - This bit indicates that the ADC is currently converting. This bit does not cause either the $\overline{\text{ALERT}}$ or $\overline{\text{THERM}}$ pins to be asserted.
- Bit 6 - LHIGH – This bit asserts the pin when the local temperature channel exceeds its programming high threshold limit.
- Bit 5 - LLOW – This bit asserts the pin when the local temperature channel falls below its programming low threshold limit.
- Bit 4 - RHIGH - This bit asserts the pin when the remote temperature channel is above its programming high threshold limit.
- Bit 3 - RLOW - This bit asserts the pin when the remote temperature channel falls below its programming low threshold limit.
- Bit 2 - FAULT - This bit is asserted when a diode fault is detected on any of the remote channels. See the remote temperature Fault Register for specific channel information. When set, this bit will assert the $\overline{\text{ALERT}}$ pin.
- Bit 1 - $\overline{\text{RTHERM}}$ - This bit is set when the remote temperature channel exceeds its programmed temperature limit.
- Bit 0 - $\overline{\text{LTHERM}}$ - Set this bit when the local temperature channel exceeds its programmed temperature limit.

5.1.3. Configuration Register

Table 5.4. Configuration Register Bit Descriptions

Write Addr	Read Addr	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default	Description
09	03	WR	MASK_ALL	SD	ALERT/THERM2	0	0	RANGE	0	0	00	Configuration Register

This register mainly contains the configuration that controls the alarm switch of the sensor, the operating mode, the alarm pin expansion, and the measurable temperature range

- Bit 7 - MASK_ALL - Masks the $\overline{\text{ALERT}}$ pin from asserting.
  - '0' (default) - The $\overline{\text{ALERT}}$ pin is not masked. If any of the appropriate status bits are set the $\overline{\text{ALERT}}$ pin will be asserted.
  - '1' - The $\overline{\text{ALERT}}$ pin is masked. It will not be asserted for any interrupt condition unless it is configured in comparator mode. The Status Registers will be updated normally.
- Bit 6 – RUN/SD - enables or disables the temperature-measurement circuitry.
  - '0' (default) - The device is in Active mode and converting on all channels.
  - '1' - The device is in shutdown mode and a single conversion can be started by writing to the one-shot start register; see the One-Shot Start Register section for more information.
- Bit 5 - $\overline{\text{ALERT}}$/$\overline{\text{THERM2}}$- Controls the operation of the $\overline{\text{ALERT}}$ pin.
  - '0' (default) - The $\overline{\text{ALERT}}$ pin acts as described in Section 4.2.7.
  - '1' - The $\overline{\text{ALERT}}$ pin acts in $\overline{\text{THERM2}}$ mode as described in Section 4.2.7. In this mode the MASK_ALL bit is ignored.
- Bit 2 - RANGE - Configures the measurement range and data format of the temperature channels.
  - '0' (default) - The temperature measurement range is -64 ℃ to +127.875 ℃ and the data format is binary.
  - '1' -The temperature measurement range is -64 ℃ to +191.875 ℃ and the data format is offset binary (see Table 4.1).

5.1.4. Conversion Rate Register

Table 5.5. Conversion Rate

Write Addr	Read Addr	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default	Description
0A	04	WR	0	0	0	0	CR3	CR2	CR1	CR0	08	Conversion Rate Register

Table 5.6. Conversion Rate

VALUE	CONVERSIONS PER SECOND	TIME (Seconds)
00h	0.0625	16
01h	0.125	8
02h	0.25	4
03h	0.5	2
04h	1	1
05h	2	0.5
06h	4	0.25
07h	8	0.125
08h	16(default)	0.0625(default)
0B-0Fh	1	1

Tables 5.5 and 5.6 show the data conversion rates represented by the different codes configured

5.1.5. Limit Registers

Table 5.7. Temperature Limit Registers

Write Addr	Read Addr	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default	Description
0B	05	WR	128	64	32	16	8	4	2	1	7F	Local Temperature High Limit Register
0C	06	WR	128	64	32	16	8	4	2	1	80	Local Temperature Low Limit Register
0D	07	WR	128	64	32	16	8	4	2	1	7F	Remote Temperature High Limit Register（high byte）
0E	08	WR	128	64	32	16	8	4	2	1	80	Remote Temperature Low Limit Register（high byte）
13	13	WR	0.5	0.25	0.125	0.0625	0	0	0	0	F0	Remote Temperature High Limit Register（low byte）

14	14	WR	0.5	0.25	0.125	0.0625	0	0	0	0	00	Remote Temperature low Limit Register（low byte）
19	19	WR	128	64	32	16	8	4	2	1	7F	Remote Temperature THERM Limit Register
20	20	WR	128	64	32	16	8	4	2	1	7F	Local Temperature THERM Limit Register

Table 5.7 contains the threshold setting registers of all states. When the temperature reaches the threshold condition set by the corresponding register, alarms (including Alert and THERM) in the corresponding mode will be triggered. In addition, if the device works in the low-power mode, a data conversion (Start one shot) is required to refresh the alarm state. According to the latest conversion data to determine whether to trigger or close the alarm state, if the alert is masked, the normal alarm can not be carried out, THERM in any working state can not be masked.

5.1.6. Remote Temperature Offset Register

Table5.8. Remote Temperature Offset Register

Write Addr	*Read Addr*	*R/W*	*Bit7*	*Bit6*	*Bit5*	*Bit4*	*Bit3*	*Bit2*	*Bit1*	*Bit0*	*Default*	*Description*
11	R/W	0	128	64	32	16	8	4	2	1	00	
12	R/W	0	0.5	0.25	0.125	0.0625	0	0	0	0	00	

The NST461 can be configured with the above two registers to achieve precise compensation for the remote channel, which can be combined with the N-factor for accurate system calibration over the full temperature range.

5.1.7. One-Shot Start Register

Table5.9. One-Shot Start Register

Write Addr	*Read Addr*	*R/W*	*Bit7*	*Bit6*	*Bit5*	*Bit4*	*Bit3*	*Bit2*	*Bit1*	*Bit0*	*Default*	*Description*
0F	0F	W	NA	NA	NA	NA	NA	NA	NA	NA	NA	start one shot

When the device is in low power state, a data conversion can be performed immediately after any value is written to the register. When the device is in continuous working mode, the register writing operation will not take effect.

5.1.8. Consecutive ALERT Register

Table 5.10. Consecutive ALERT Register

Write Addr	*Read Addr*	*R/W*	*Bit7*	*Bit6*	*Bit5*	*Bit4*	*Bit3*	*Bit2*	*Bit1*	*Bit0*	*Default*	*Description*
22	22	WR	TIMEOUT				CONAL2	CONAL1	CONAL0	1	70	Consective ALERT Register

Consective Alert Register mainly includes the timeout function control switch, THERM or Alert pin trigger number configuration register. When the alarm trigger times reach the preset value, the corresponding pin will respond, the corresponding status register and the status register of the corresponding channel will be set to 1, and the alarm trigger count will be cleared to zero for the next measurement.

- Bits 3-1 – CALRT [2:0] - Determine the number of consecutive measurements that must have an out of limit condition or diode

fault before the $\overline{\text{ALERT}}$ pin is asserted. All temperature channels use this value to set the respective counters. The bits are decoded as shown in Table 5.11. The default setting is 1 consecutive out of limit conversion.

Table 5.11. Consecutive Alert Settings

Bit3	*bit2*	*bit1*	*bit0*	*NUMBER OF CONSECUTIVE OUT OF LIMIT MEASUREMENTS*
0	0	0	1	1 (default)
0	0	1	1	2
0	1	1	1	3
1	1	1	1	4

5.1.9. THERM Hys Register

Table 5.12. THERM Hys Register

Write Addr	***Read Addr***	***R/W***	***Bit7***	***Bit6***	***Bit5***	***Bit4***	***Bit3***	***Bit2***	***Bit1***	***Bit0***	***Default***	***Description***
21	21	WR	128	64	32	16	8	4	2	1	0A	THERM Hys Register

After the THERM hysteresis register is configured, when the measured temperature falls below the set limit minus the hysteresis, the flag will be reset and the pin status will return to the default state.

5.1.10. η-Factor Correction Register

Table 5.13. η-Factor Registers

Write Addr	***Read Addr***	***R/W***	***Bit7***	***Bit6***	***Bit5***	***Bit4***	***Bit3***	***Bit2***	***Bit1***	***Bit0***	***Default***	***Description***
23	23	WR	RT n Factor[7:0]								00	RT n Factor

This register is used to adjust the different ideal factors used by the application for different sensors. Table 5.14 shows the actual ideal factors for different codes.

Table 5.14. η-Factor Look-Up Table

BINARY	*η-adjust HEX*	*DECIMAL*	*η*
0111 1111	7F	127	0.950205
0000 1010	0A	10	1.003195
0000 1000	8	8	1.004153
0000 0110	6	6	1.005112
0000 0100	4	4	1.006073
0000 0010	2	2	1.007035
0000 0001	1	1	1.007517
0000 0000	0	0	1.008
1111 1111	FF	–1	1.008483
1111 1110	FE	–2	1.008966
1111 1100	FC	–4	1.009935
1111 1010	FA	–6	1.010905
1111 1000	F8	–8	1.011877

1111 0110	F6	–10	1.012851
1000 0000	80	–128	1.073829

5.1.11. Filter Control Register

Table 5.15. Filter Configuration Register

Write Addr	Read Addr	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default	Description
24	24	WR	0	0	0	0	0	0	DF1	DF0	00	Digital Filter Control Register

Only remote channel 1 of the device has filter function, with three different levels, the specific configuration code is shown in the following table.

- Bits 1-0 – FILTER [1:0] - Control the level of digital filtering that is applied to the Remote Temperature.

Table 5.16. FILTER Decode

FILTER [1:0]		DESCRIPTION
1	0	
0	0	Disabled (default)
0	1	Level 1
1	0	Level 1
1	1	Level 2

5.1.12. ID Register

Table 5.17. ID Register

Write Addr	Read Addr	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default	Description
FE	FE	R	0	1	0	1	1	1	0	1	55	ID

The Manufacturer ID register contains an 8-bit word that identifies novosense as the manufacturer of the NST461.

6. Typical Application

6.1. Application information

The NST461 device requires only one transistor connected between the DP and DN pins to perform remote temperature measurements. If you do not use the remote channel and only measure the local temperature, hang the DP pin in the air. The SCL, SDA, ALERT, and THERM pins require pull-up resistors to ensure proper communication. A 0.1µF power decoupling capacitor is recommended for local bypass.

6.2. Typical application

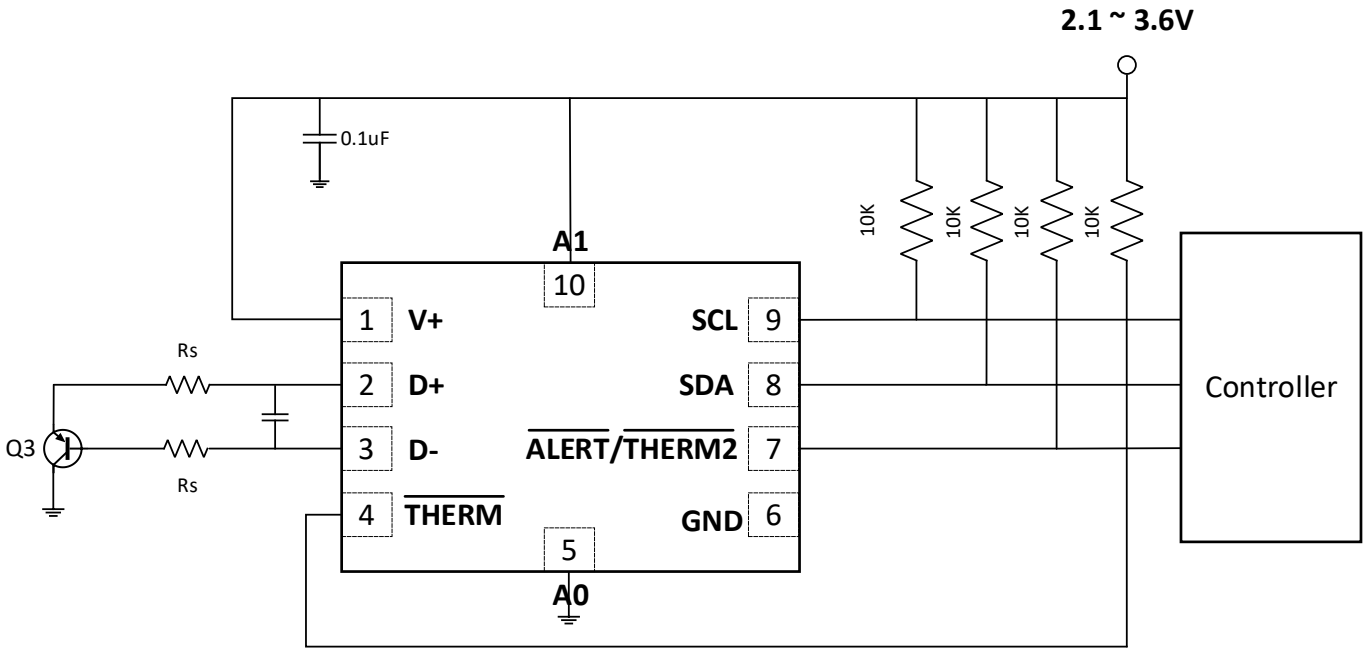
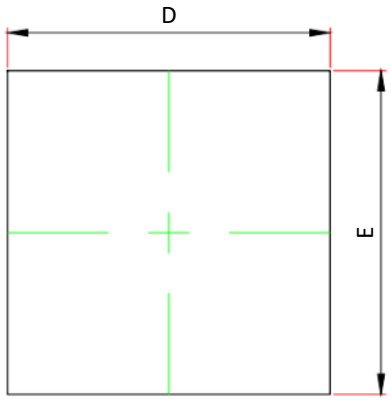


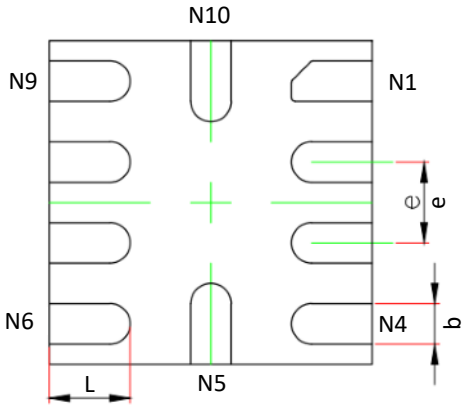
Figure 4.1. NST461 Basic Connections Using a Discrete Remote Transistor

7. Package Information

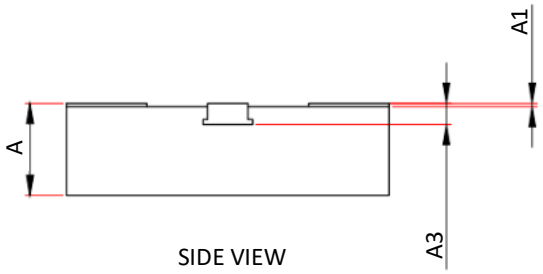
7.1. WQFN(10) package



TOP VIEW



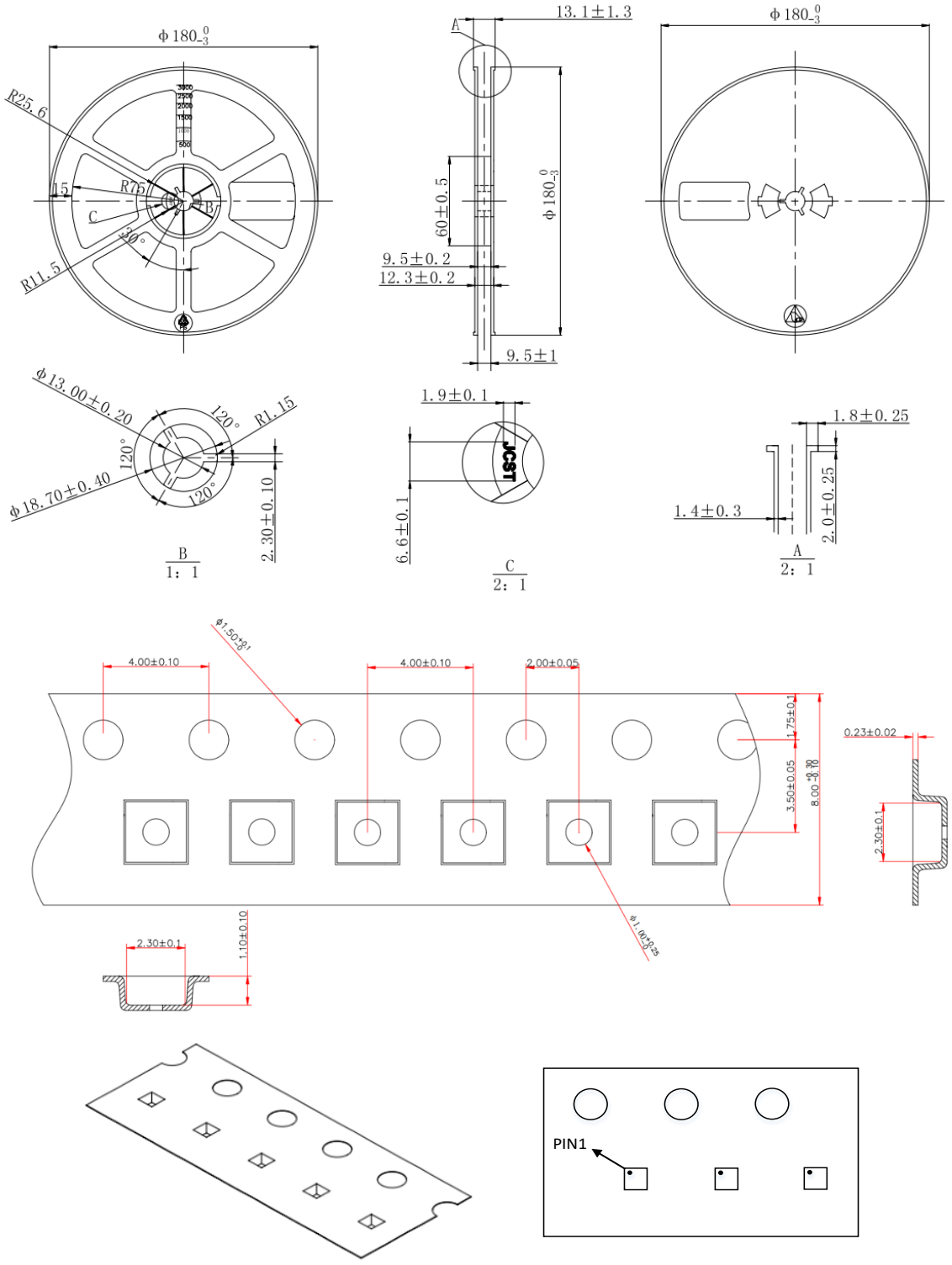
BOTTOM VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	-0.004	0.046	0.000	0.002
A3	0.110REF		0.004REF	
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
b	0.200	0.300	0.008	0.012
e	0.500BSC		0.020BSC	
L	0.450	0.550	0.018	0.022

7.2. Tape and Reel Information



8. Ordering Information

Type	Unit	Marking	Description
NST461-DQNR	4000ea/Reel	6XXX	WQFN-10 package, Reel

9. Revision History

Revision	*Description*	*Date*
1	Release Version	2022/10/10

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