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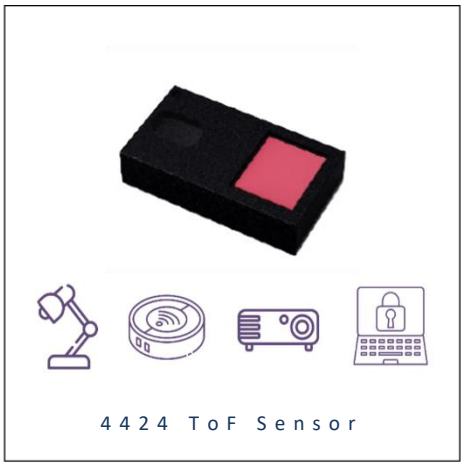
ISO/TS 16949:2009 BS EN ISO 14001:2004 QC 080000 IECQ HSPM

PRODUCT DATASHEET

- ► Time-of-Flight (ToF) Proximity Sensor
- ► 4424 1.00t
- ► 940nm VCSEL

Release Date: 16 December 2024 Version: A1.1

N0S68S42
ToF Proximity Sensor



4424 ToF Sensor

RoHS Compliant

FEATURES:

- **Package:** 4424 Integrated Miniature Module with:
  - ✓ 940nm VCSEL
  - ✓ VCSEL driver
  - ✓ Direct Time of Flight
  - ✓ RoHS 2.0 and REACH Compliant
  - ✓ Ranging sensor with advanced embedded micro controller
  - ✓ Advanced embedded optical cross-talk compensation to simplify cover glass selection
- **Interface:** I^2C (up to 1MHz)
- **Eye Safety:** Class 1
- **Measure Ranging Distance:** 20mm ~ 5m
- **Soldering methods:** Reflow soldering
- **MSL Level:** Level 3 acc. to J-STD 020

APPLICATIONS:

- Robot/AGV/Drone/UAV
- Laser Assisted Autofocus (AF)
- Distance Measurement
- Video Surveillance Equipment
- Gesture Control
- Body Gaming
- AI/ML-on-Edges
- Smart Lighting
- Collision Avoidance

CHARACTERISTICS:

Maximum Ratings (T_a=25°C)

Parameter	Symbol	Ratings	Unit
Power Supply Voltage	V_{DDMAX}	-0.3~3.5	V
Recommended Supply Voltage	V_{DD}	2.6~3.5	V
SCL, SDA, XSHUT, INT	$V_{I/O\ Terminal}$	-0.3~3.5	V
GND, GND2, GND3, GND4, VCSEL_GND	V_g	max. 0.0	V
Operating Temperature	T_{OPR}	-20~+85	°C
Storage Temperature	T_{STG}	-40~+85	°C
Soldering Temperature [1]	T_{sol}	260	°C
Relative Humidity (non-condensing)	RH_{nc}	85	%
ESD withstand Voltage (HBM: JEDEC JS-001-2017)	$V_{ESD-HBM}$	2	kV
ESD withstand Voltage (CDM: JEDEC EIA/JESD22-C101F)	$V_{ESD-CDM}$	500	V

1. The reflow peak soldering temperature is specified according to IPC/JEDEC J-STD-020.

Current Consumption (T_a=25°C)

Parameter	Symbol	Ratings	Unit
Standby Mode Consumption (max.)	I_{SMC}	max. 20	µA
Active Ranging Average Consumption (incl. VCSEL 30Hz@5m)	I_{AAC}	max. 35	mA

Interrupt Pin (GPIO) Digital Input and Output

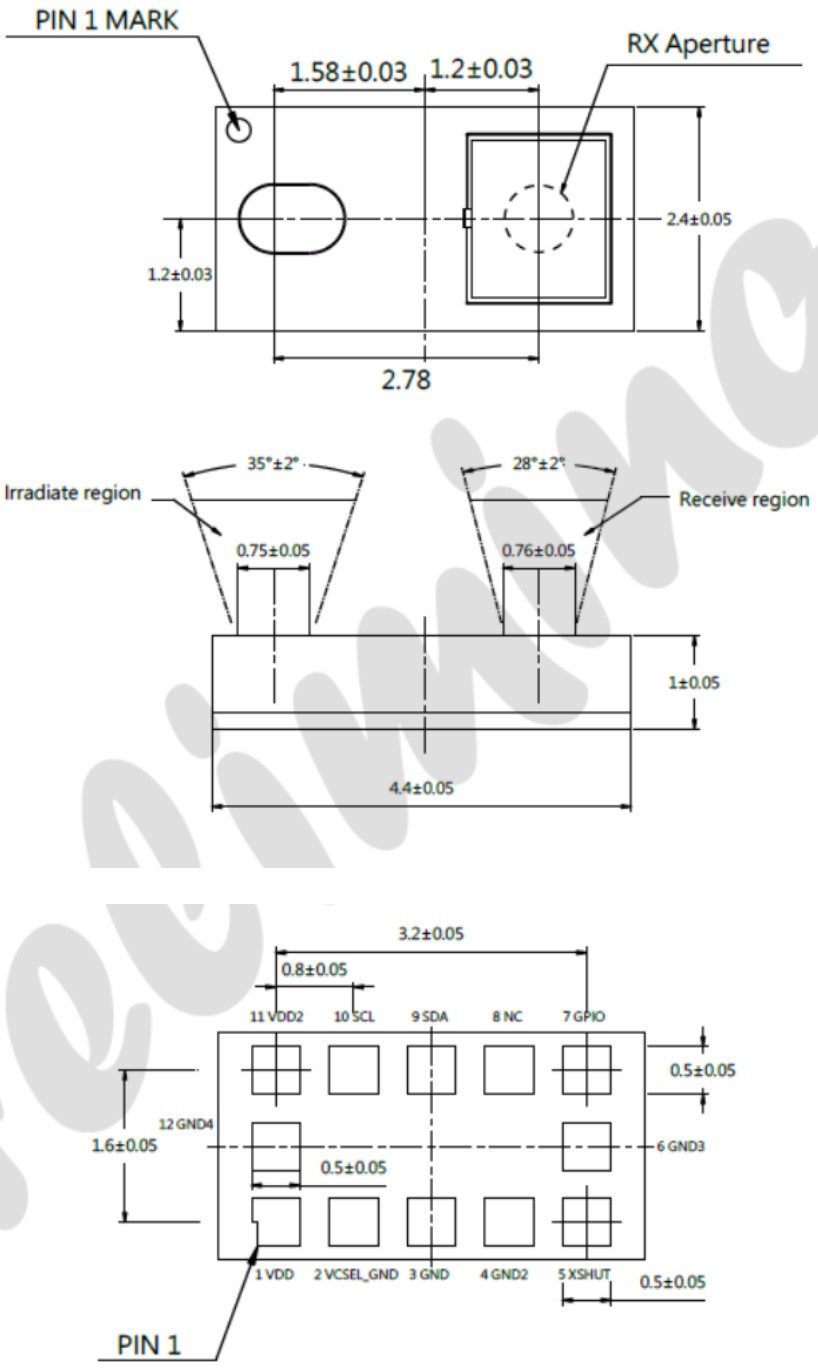
Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Low Level Input Voltage	V_{IL}	---	---	0.3 V_{DD}	V
High Level Input Voltage	V_{IH}	0.52 V_{DD}	---	V_{DD}	V
Low Level Output Voltage (I_{OUT}=4mA)	V_{OL}	---	---	0.14	V
High Level Output Voltage (I_{OUT}=4mA)	V_{OH}	V_{DD}-0.5	---	---	V

I2C Interface (SDA/SCL) Digital Input and Output

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Low Level Input Voltage	V_{IL}	0	---	0.3 V_{DD}	V
High Level Input Voltage	V_{IH}	0.52 V_{DD}	---	V_{DD}	V
Low Level Output Voltage (I_{OUT}=4mA)	V_{OL}	---	---	0.14	V

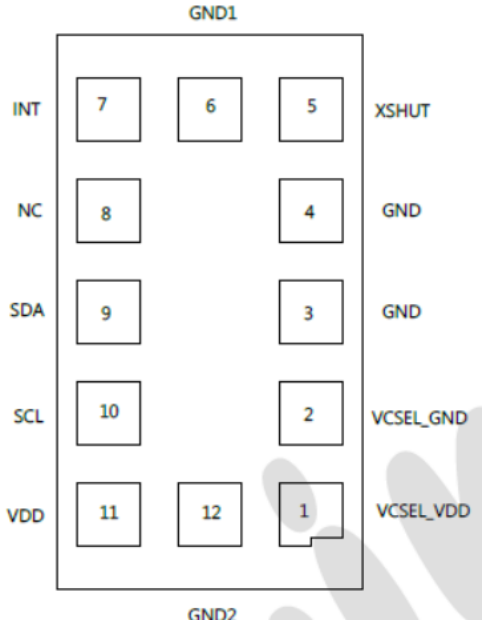
OUTLINE DIMENSION:

Package Dimension:



1. All dimensions are in millimetre (mm).
2. Tolerance ±0.1mm, unless otherwise noted.
3. Keep free of mechanical items which interfere with module operation in irradiate and receive area.

PIN CONFIGURATION:



Pin number	Signal name	Signal type	Signal description
1	VCSEL_VDD	Supply	To be connected to main supply,2.8~3.5V
2	VCSEL_GND	Ground	VCSEL ground, to be connected to main ground
3	GND	Ground	To be connected to main ground
4	GND	Ground	To be connected to main ground
5	XSHUT	Digital input	X shutdown pin ,active low
6	GND1	Ground	To be connected to main ground
7	INT	Digital output	Open drain output
8	NC	NC	Do not connect, must be left floating
9	SDA	Digital input/output	I^2C serial data
10	SCL	Digital input	I^2C serial clock input
11	VDD	Supply	Supply, to be connected to main supply
12	GND2	Ground	To be connected to main ground

1. XSHUT digital input controls whether the device enters reset and low power consumption mode. After the device is powered on, the input level of XSHUT needs to be pulled up, and the sensor enters the working mode.
   - Low level input voltage: the device resets and enters the low-power standby mode.
   - High level input voltage: the device wakes up from standby mode.

2. INT can be used as data interrupt. The high and low levels of GPIO are used to indicate whether the measurement data is ready.

1. Function Description:

1.1 System Function Description:

The N0S68S42 system function description is shown in figure 1. The host application program is controlling the N0S68S42 sensor device via API in the ToF SDK. The SDK is applied for the functions of device initialization, ranging and measurement Functional APIs such as distance mode configuration and calibration that are available for users to take full advantage of the device capabilities.

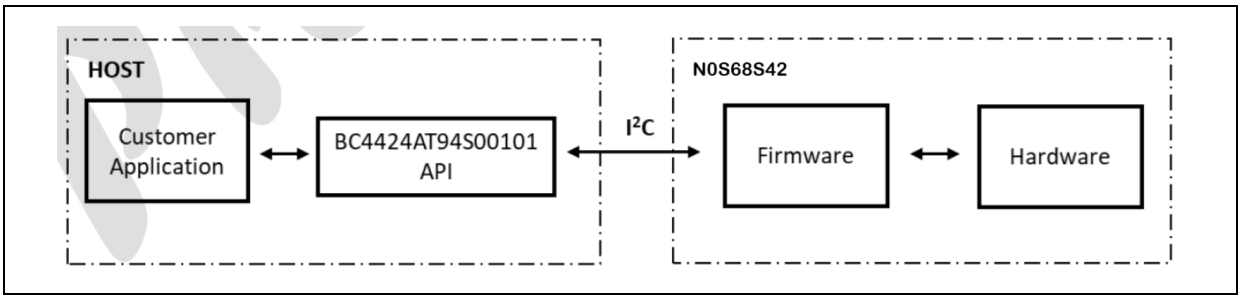


Figure 1. System Function Description

1.2 Firmware State Machine Description:

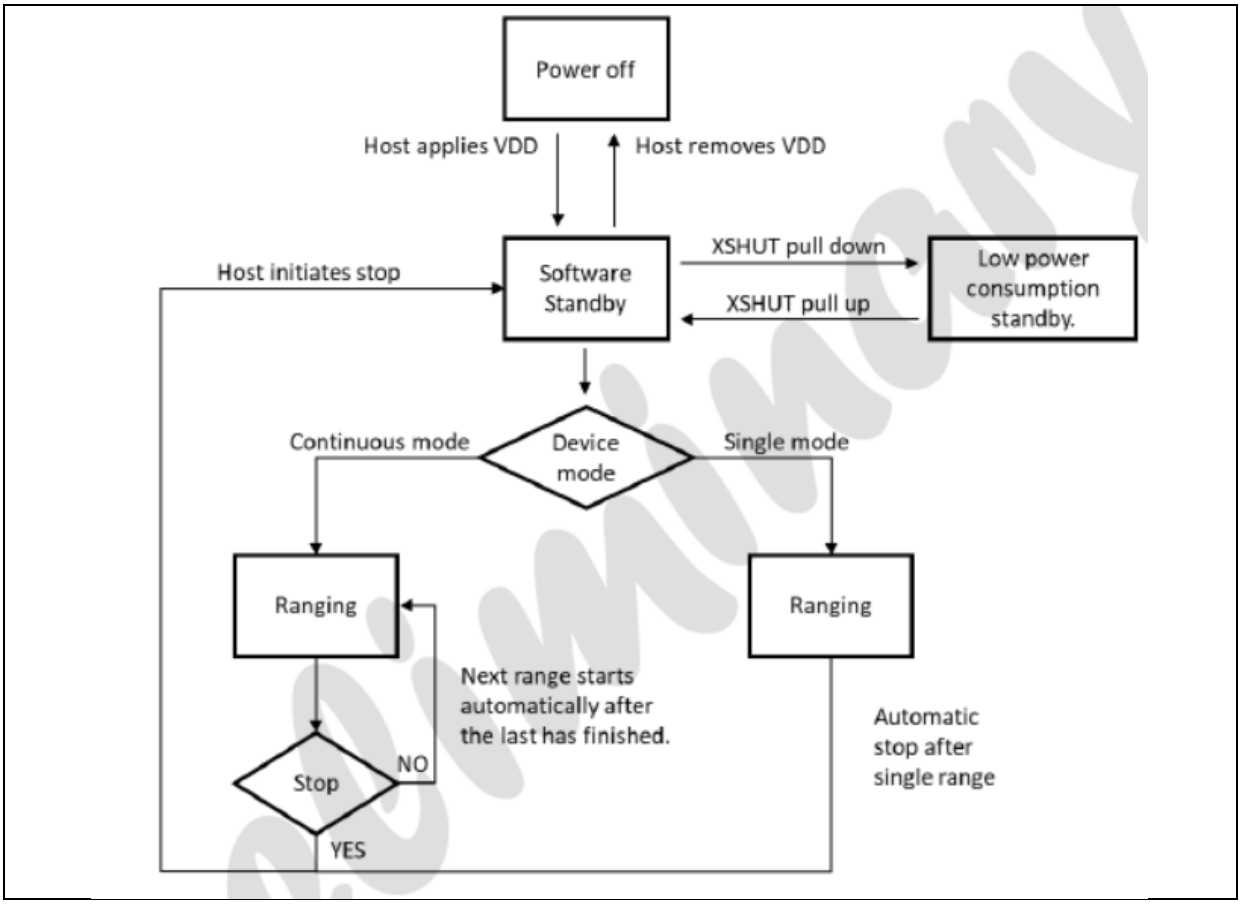


Figure 2. Firmware State Machine

1.3 Working Mode:

1.3.1 Device mode

- Single measure mode:
  - After the call is completed once, the N0S68S42 system will automatically return to the software standby state.
- Continuous measure mode:
  - After one measurement is completed, N0S68S42 will automatically carry out the next measurement. Until the host initiates N0S68S42 stop, it returns to software ready status after finished last measure.

1.3.2 Measurement mode:

- Measurement mode is a configurable option in working mode, and the default is normal mode. Customers can configure this mode according to their own needs.

1.3.3 Multi-Target Measurement mode:

- The product can detect multi object within FOV at the same time, the demo kit can output four zone results simultaneously.

1.4 Typical Ranging Flow:

A typical complete measurement process consists of the following three stages:

- Waiting for the device to start
- Initialize sensor device
- Ranging

1.4.1 Wait for the device to start

The device check by itself and initial to standby mode in this step. Please check these items If the error happens.

- Peripheral circuit error.
- The sensor is damaged due to SMT issue or excessive temperature.
- There is a problem with the I^2C reading and writing program. Please check the waveform for analysis.

1.4.2 Ranging

A Ranging operation is including working mode and starting ranging configuration. The working mode is applied on what the users configure in different conditions. Since the ranging mode enabled, the user needs to filter the invalid ranges of depth data as 65500 or 65300.

Note: If the target is not too far away and the measure data of the sensor is keeping the outliner value as 65300, please check whether the welding or peripheral circuit layout meets the standard.

1.5 Power Sequence:

Since the power is supplying to VDD/VCSEL_VDD, it is necessary to ensure that the XSHUT pin is in a high state to enable I^2C for the communicate normally. While the device enters the pre-boot configuration stage, and the initialization will be start automatically after the firmware is streaming in. After the initialization is completed, the system is ready for the range measurement. I^2C is only involved from the pre-boot configuration phase to the initialization phase. During the firmware startup phase, the device polls through I^2C, and if the startup is successful, the polling ends.

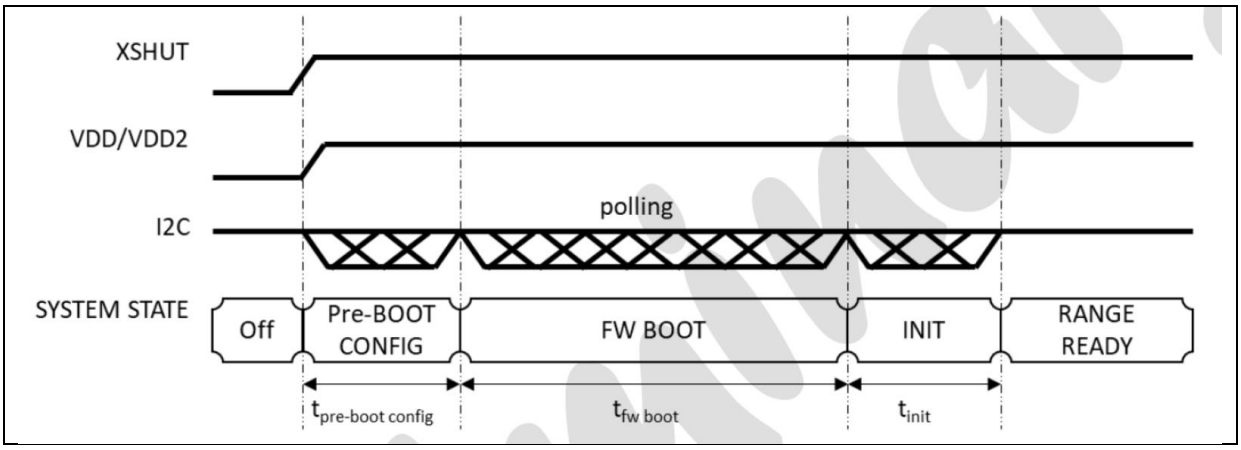


Figure 3. Power-On Sequence

Note:

- $t_{pre\text{-}boot\ config}$: The time from sensor power-up to pre-boot configuration, maximum up to 1.2ms.
- $t_{fw\ boot}$: The time for the sensor firmware to start, maximum up to 9ms.
- t_{init}: The time of sensor initialization, maximum is 0.8ms.

1.6 Standby Mode:

N0S68S42 has standby mode, which can greatly reduce the power consumption of sensor.

1.6.1 Entering standby mode:

- Hardware mode: Pull-down the XSHUT pin before entry to standby mode.

1.6.2 Wake up device:

- If the hardware is used to enter the standby mode, that raise the XSHUT level high to wake up device.

2. Control Interface:

2.1 I²C Timing:

I²C bus is composed of serial data line (SDA) and serial clock line (SCL), which is used to send and receive data. All controlled devices are connected in parallel on the bus. The I²C bus speed is 1MHz and the N0S68S42 address is 0x5c.

During data transmission, the host sends a start signal, and then sends 7-bit device address and 1-bit read-write control bit R/W in order from high to low; When the read-write control bit is 0, it indicates that the master writes to the slave, and 1 indicates that the master reads to the slave, and then receives the slave response, as shown in Figure 4.

Figure 4. Address: 0x5c

As shown in Figure 5 Data Transmission Protocol, the slave is connected to the bus with open drain structure, and both SCL and SDA need to be connected to pull-up resistance, so when the bus is idle, both lines are at high level. When any device outputs low level, it will pull the bus low.

- Start bit: when SCL is at high level, pull SDA down to generate start signal. After the slave detects the start signal, it shall be accurate ready to receive data. The data transmission state is from the start signal to the stop signal, which is completed by the bidirectional data line SDA.
- Stop bit: when SCL is high level, pull SDA high to generate end signal. After the slave detects the end signal, stop receiving data.

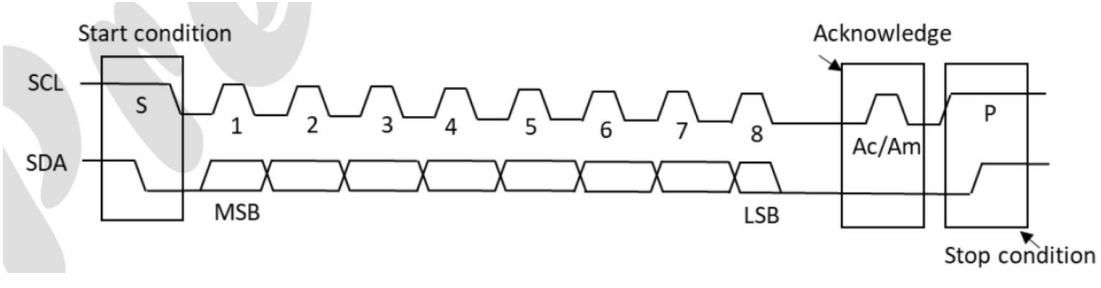


Figure 5. Data Transfer Protocol

During data transmission, when the clock line SCL is at low level, SDA allows to change the transmitted data bits. When the SCL is at high level, SDA is required to remain stable, which is equivalent to transmitting 1 bit of data in one clock cycle.

At the end of the 8th clock cycle, the master releases the SDA to make the slave respond. In the 9th clock cycle, the slave pulls the SDA down to respond; In the 9th clock cycle, if SCL is high level and SDA is not detected as low level, it is regarded as non-response, indicating that the data transmission fails. At the end of the 9th clock cycle or the end of the current transmission, the slave releases SDA to enable the host to continue transmitting data. If the host sends a stop signal, the transmission ends.

After the start bit starts, the first byte (7-Bit device address and 1-bit read-write control bit) is sent and received from the slave Start sending the word address after the response of. Inside N0S68S42 is a series of sequentially addressed storage units. When we analyse the memory in the device, When the storage unit reads and writes, first specify the address of the storage unit, that is, the word address, and then write the content to the address for data transmission, the format is shown in below figure 6.

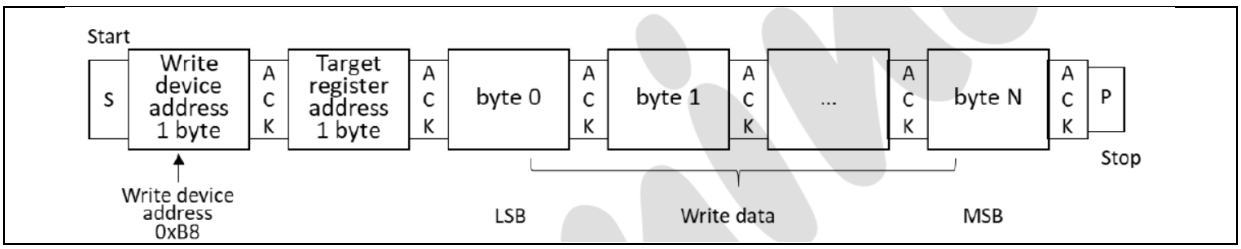


Figure 6. Data Format (Write)

For the read timing, after sending the device address (write command) and word address, send the start signal and device address (read command) again. First do the virtual write operation to make the storage unit address pointer of the slave point to the storage unit address we want to read, and then read the data normally. The format is shown in below figure 7.

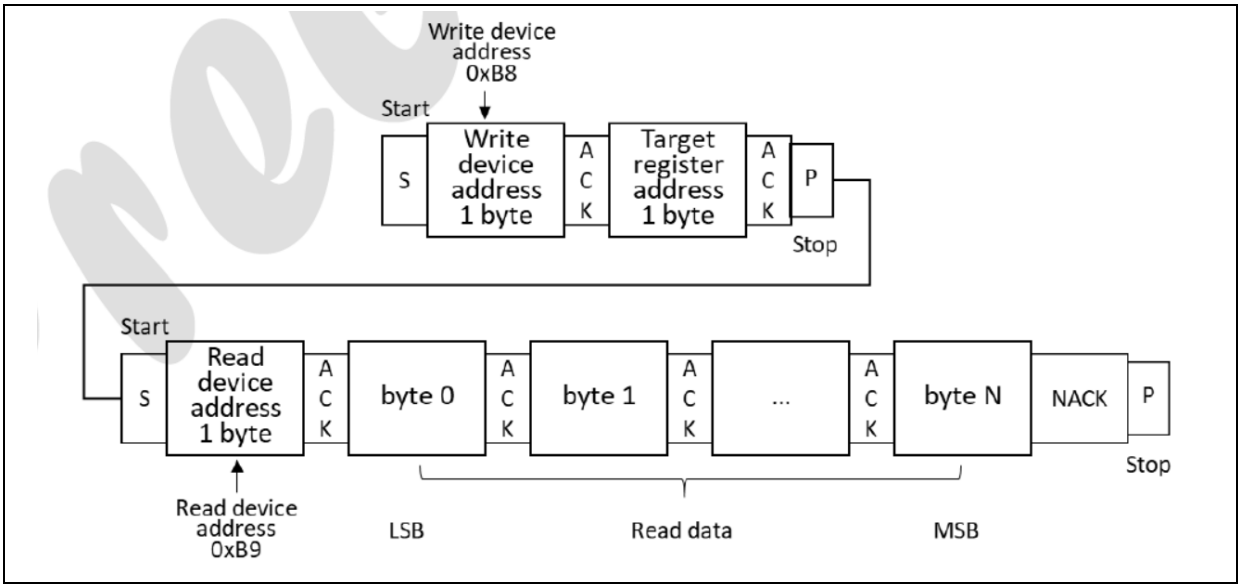


Figure 7. Data Format (Read)

2.2 I²C Interface – Timing Characteristics:

Timings are given for all PVT conditions.

Symbol	Parameter	Minimum	Typical	Maximum	Unit
F_{I2C}	Operating frequency	0.00		1000	kHz
t_{LOW}	Clock pulse width low	0.50			µs
t_{HIGH}	Clock pulse width high	0.26			µs
t_{SP}	Pulse width of spikes which are suppressed by the input filter			50	ns
t_{BUF}	Bus free time between transmissions	0.5			µs
$t_{HD.STA}$	Start hold time	0.26			µs
$t_{SU.STA}$	Start setup time	0.26			µs
$t_{HD.DAT}$	Data in hold time	0.00		0.9	µs
$t_{SU.DAT}$	Data in setup time	50			ns
t_R	SCL/SDA rise time			120	ns
t_F	SCL/SDA fall time			120	ns
$t_{SU.STO}$	Stop setup time	0.26			µs
$C_{i/o}$	Input/output capacitance (SDA)			10	pF
C_{in}	Input capacitance (SCL)			4	pF
C_L	Load capacitance		140	550	pF

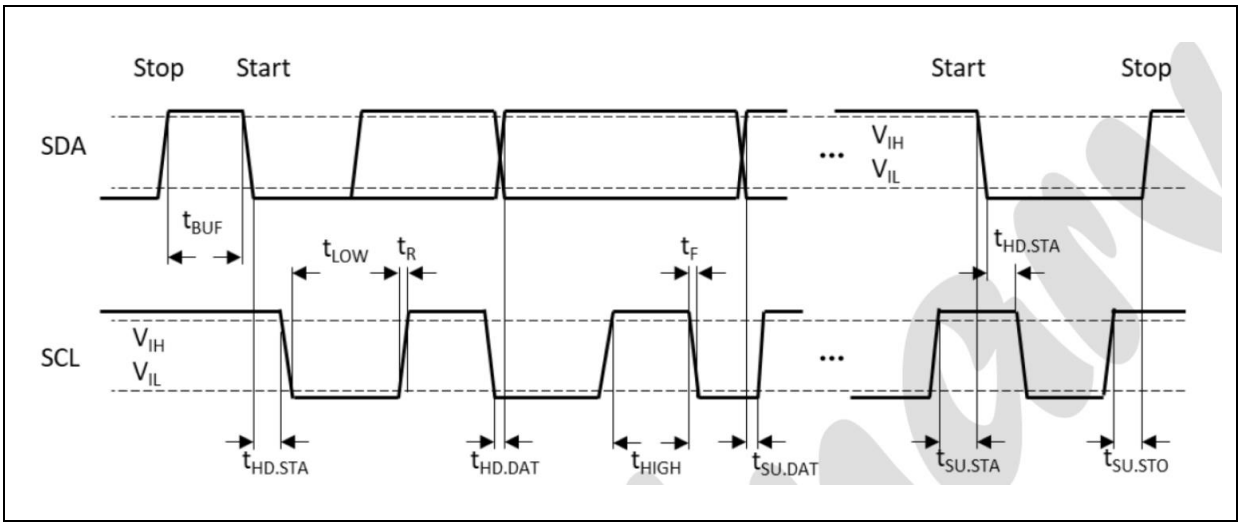


Figure 8. I2C Timing Characteristics

3. Performance:

Measurement conditions of maximum ranging distance and ranging accuracy scene:

- Target reflectance used: grey (18%), white (90%).
- The sensor is corrected at a distance of 50cm.
- Indoor: without strong light, in white light 300lux environment.
- Operating voltage: 3.3V @T_a=25°C.
- All distances are for the full field of view covered (FOV=25°).
- Max single measurement time is 33ms.

3.1 Maximum Ranging Distance

Target reflectivity	Condition	Indoor
White card (90%)	typical	5000 mm
Gray card (18%)	typical	2800 mm

3.2 Ranging Accuracy

Parameter	Indoor	
	20-250 mm	250-5000 mm
White card (90%)	±10 mm	±2%
Gray card (18%)	±10 mm	±4%

4. Application Schematic:

The capacitance on the external power supply VDD should be closed to the sensor pin1 and pin11 as possible.

Xshut pin needs to be connected to the host terminal. If the status of the host terminal pin is uncertain, it needs to be connected with a pull-up resistance value of 10kΩ.

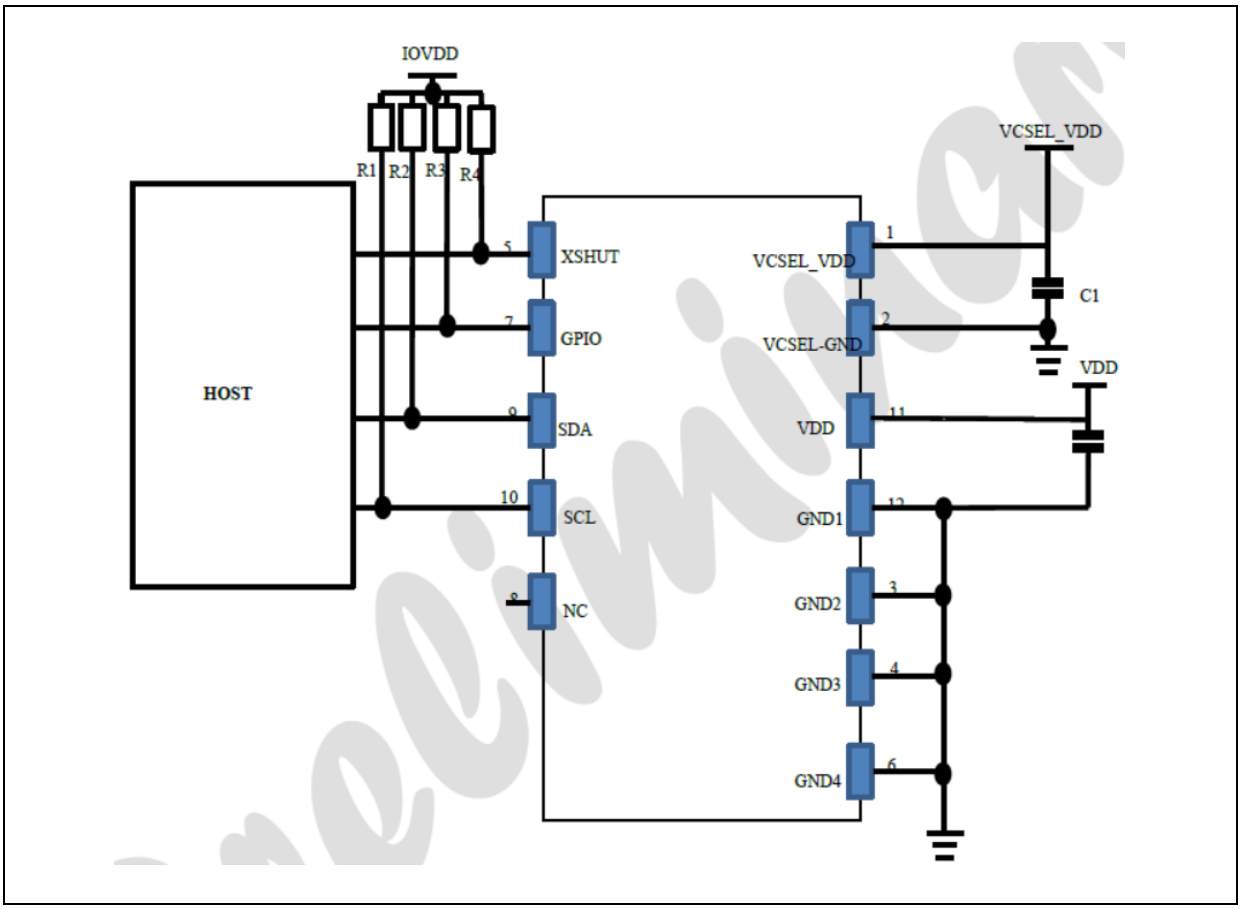


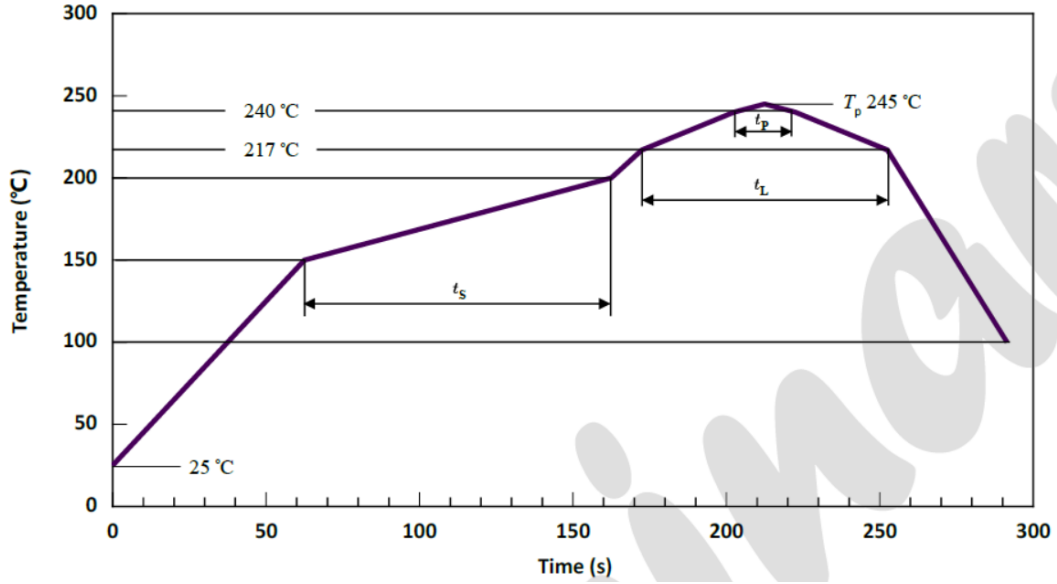
Figure 9. Application Schematic

Lib ref.	Quantity	Position	Parameter	Tolerance
Capacitor	1	C1	4.7μF	±20%
Capacitor	1	C2	100nF	±20%
Resistor	2	R1、R2	1.5k-2.0k	5%
Resistor	2	R3、R4	10k	5%

Note: If the parasitic capacitance of the user's equipment is relatively large, the pull-up resistors of I^2C can be appropriately reduced and the rise time of I^2C waveform can be reduced.

RECOMMENDED SOLDERING PROFILE:

Lead-free Solder IR Reflow:



Profile Feature	Symbol	Pb-Free (SnAgCu) Assembly			Unit
		Minimum	Recommendation	Maximum	
Ramp-up rate to preheat 25 °C to 150 °C			2	3	K/s
Time t_S T_{Smin} to T_{Smax}	t_S	60	100	120	s
Ramp-up rate to peak T_{Smax} to T_P			2	3	K/s
Liquidus temperature	T_L		217		°C
Time above liquidus temperature	t_L		80	100	s
Peak temperature	T_P		245	260	°C
Time within 5 °C of the specified peak temperature TP - 5 K	T_P	10	20	30	s
Ramp-down Rate T_P to 100 °C			3	4	K/s
Time 25 °C to T_P				480	s

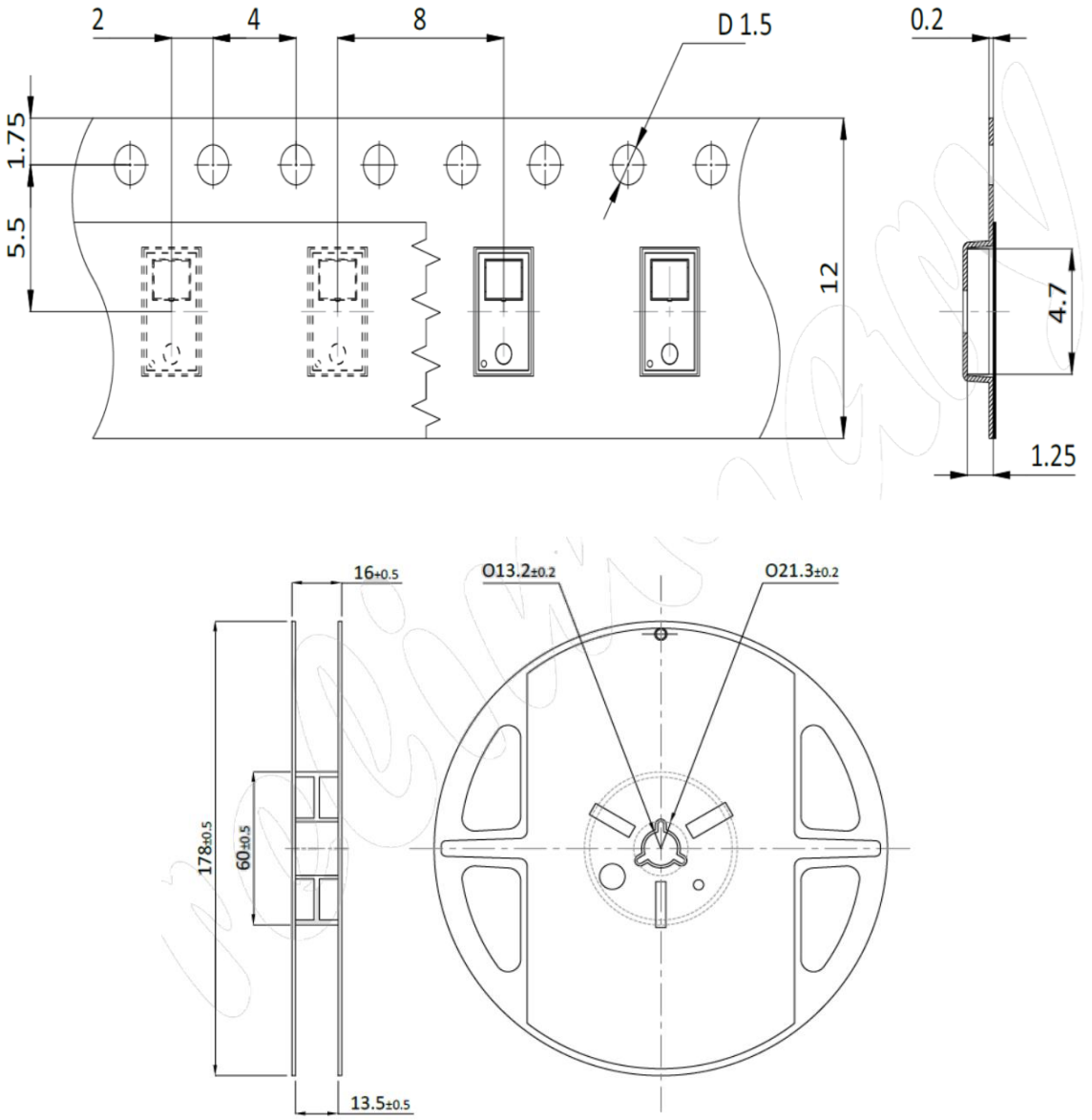
Note:

1. We recommend the reflow temperature 240°C (±5°C). The maximum soldering temperature should be limited to 260°C.
2. Maxima reflow soldering: 3 times.
3. Before, during, and after soldering, should not apply stress on the components and PCB board.

PACKING SPECIFICATION:

Reel Dimension:

Max.1000pcs/reel



1. Dimensions are in millimeters.
2. 1000 pieces per reel.
3. Dimensions acc. to EIA 481-E.

PRECAUTIONS OF USE:

Storage:

It is recommended to store the products in the following conditions:

- Humidity: 60% R.H. Max.
- Temperature: 5°C~30°C (41°F ~86°F).

Shelf life in sealed bag: 12 months at 5°C~30°C and <60% R.H.

Once the package is opened, the products should be used within 1 week. Otherwise, they should be kept in a damp-proof box with descanting agent stored at R.H.<10% and apply baking before use.

ESD (Electrostatic Discharge):

Static Electricity or power surge will damage the LED. Use of a conductive wrist band or anti-electrosatic glove is recommended when handing the LED all time. All devices, equipment, machinery, work tables, and storage racks must be properly grounded.

REVISION RECORD:

Version	Date	Summary of Revision
A1.0	14/03/2024	Datasheet set-up.
A1.1	16/12/2024	Update specification.