Benewake

NOVA 20 User Manual

Solid-State Near-Field Line-Array LiDAR



V1.0

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Benewake (Beijing) Co., Ltd.

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Preface

This manual is intended for R&D engineers integrating NOVA 20 into a complete system. It covers installation, wiring, PC software operation, measurement rate configuration, and UART data parsing. Check the power supply and pin assignments first, complete the initial setup in Chapter 5, and then integrate the host software using Chapter 7.

Scope: This manual defines the external power, communication, and data interfaces of NOVA 20. Use these definitions for host integration and data parsing.

Version	Release date	Description
V1.0	2026-09-26	Initial production release

Contact Details

Official website: en.benewake.com
Contact number: 400-880-9610
Technical support: support@benewake.com
Sales inquiries: bw@benewake.com

Headquarter Address

Benewake (Beijing) Co., Ltd.
Haiguo Jiaye Sci-Tech Park, Haidian District, Beijing, China

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Disclaimer

NOVA 20 is continuously improved, and its specifications and parameters may change. Use the latest official release materials corresponding to the sample during customer integration.

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Safety and Usage Notes

Laser Safety

NOVA 20 uses a 905 nm laser and is classified as Class 1 Eye-safe according to EN 60825. During normal use:

- **Do not disassemble or modify optical components, or look directly into the emission window while powered.**
- **Do not use magnifiers, microscopes, or other optical instruments to observe the operating emitter at close range.**
- **If the optical window is damaged, detached, or its mounting structure is abnormal, disconnect power and contact technical support.**

Electrical and ESD Protection

- **The supply range is DC 5 V ±5%. Reverse polarity, overvoltage, or applying 5 V to signal pins may damage the product.**
- **Startup peak current is less than 850 mA. Provide sufficient power margin and a common ground.**
- **Disconnect power before wiring, unplugging, or assembling; handle bare-board samples as ESD-sensitive devices.**
- **Keep metal chips, liquids, conductive adhesive, and tools away from exposed PCB. The sample module has no specified ingress-protection rating.**

Responsibility boundary: NOVA 20 provides near-field multi-point distance data and does not independently constitute a complete safety function. Robot braking, drop prevention, and collision avoidance require coordinated sensor configuration, host algorithms, control strategy, and actuators.

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1 Product Overview

NOVA 20 is a compact, multipoint linear ranging LiDAR using a fully solid-state dToF architecture. It provides distance data for 20 channels in a physically vertical scan plane. The centers of the two outermost channels are separated by 40°. Applications include near-field obstacle avoidance, drop-off detection, edge sensing, foreign-object detection in doorway areas, and presence detection in robotic and other integrated systems.

Core capability	Description
20-channel line ranging	Channel numbers distinguish multi-point distance data within the field of view.
Strong-light tolerance	Measurement capability: 1 m for a 10% reflectivity target under 100 klux.
Compact and low power	Typical module size ≤25×21×14 mm, weight <3 g, average power <1 W.
Development interfaces	UART; application support for Windows, Linux (Ubuntu), and ROS.

1.1 Included Software and Optional Accessories

- Supplied software: NOVA 20 PC software for Windows 10 and Windows 11.
- Optional accessory: USB-to-LVTTL converter or adapter board for regulated 5 V power and serial communication.
- The optional test harness is not standard equipment and is for testing only. Actual cables, accessories, and software are defined by the packing list.

1.2 Operating Mode

The LiDAR continuously outputs independent 9-byte measurement frames. Each frame contains distance, signal strength, temperature, and channel number. The host organizes 20-point data by channel number and combines time information with application logic to form a near-field distance slice.

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2 Technical Specifications

Category	Parameter	Specification
Measurement	Measurement capability	1 m @ 10% reflectivity, 100 klux
	Blind zone	≤5 cm
	Accuracy	3 cm @ 0.1–0.3 m; 5 cm @ 0.3–0.5 m
	Precision	≤3 cm (1 sigma)
Output	Frame rate	5 / 10 / 25 / 50 Hz, configurable
	Channels	20
Optical	Field of view	40° (outer-channel center directions; −20° to +20°)
	FOV center offset	Maximum ±2°
	Laser wavelength	905 nm
	Laser safety	Class 1 Eye-safe [EN 60825]
Electrical	Supply	DC 5 V ±5%
	Average power	<1 W
	Startup peak current	<850 mA
Environment	Operating temperature	-20 °C to +55 °C
	Storage temperature	-40 °C to +85 °C
Mechanical	Typical module envelope	≤25 × 21 × 14 mm (housing excluded)
	Weight	<3 g
Interface	Hardware interface	1.25 mm, 5-pin
	Communication	UART; default 921600 baud

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3 Mechanical Dimensions and Installation

3.1 Overall Dimensions

The typical module envelope is no larger than 25×21×14 mm (excluding housing). The figure is for structural assessment only; do not take dimensions directly from the image scale. Use the supplied 2D/3D files for formal mechanical design.

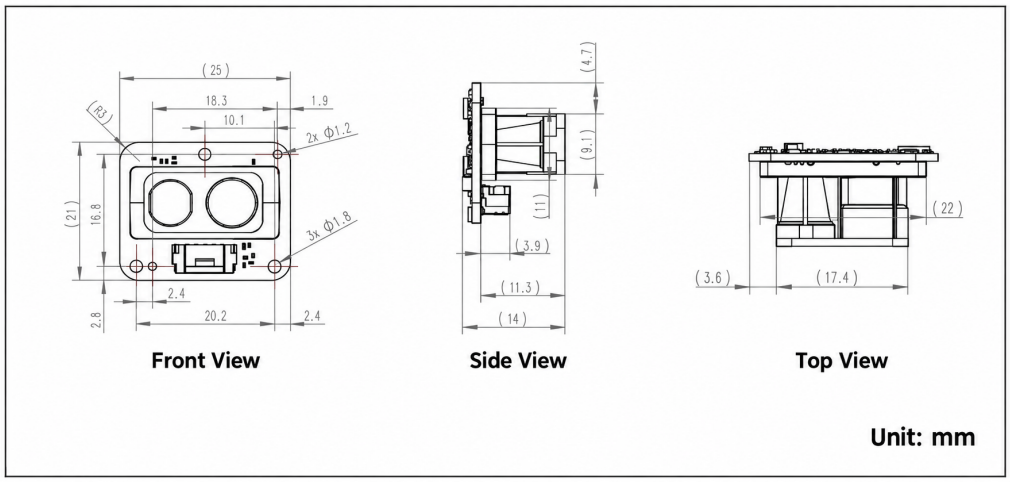


Figure 1 NOVA 20 front, side, and top views (unit: mm)

3.2 Installation Principles

- **Keep the emission and receiving optical windows unobstructed; housing openings and trim must not intrude into the effective field of view.**
- **Keep the mounting surface flat and avoid PCB bending; fastening force must not be transferred to the lens or optical bracket.**
- **Reserve space for the connector, cable bending, and service access.**
- **Avoid locations exposed to continuous high temperature, strong vibration, condensation, or direct moisture.**
- **After system design is complete, re-validate the effective field of view for target materials, strong light, edges, and low obstacles.**

3.3 Local Coordinate System and Scan Direction

Figure 2 adds the local axes to the FOV side view in the product specification. The optical window faces forward along +X, and the scan plane is vertical. +Y points physically upward; +Z points to the LiDAR's right, out of the page in this view. The 0° forward direction is the angular bisector, not a measurement channel. ch0 and ch19 are raw UART channel indices. O is a schematic origin, not a mechanical datum.

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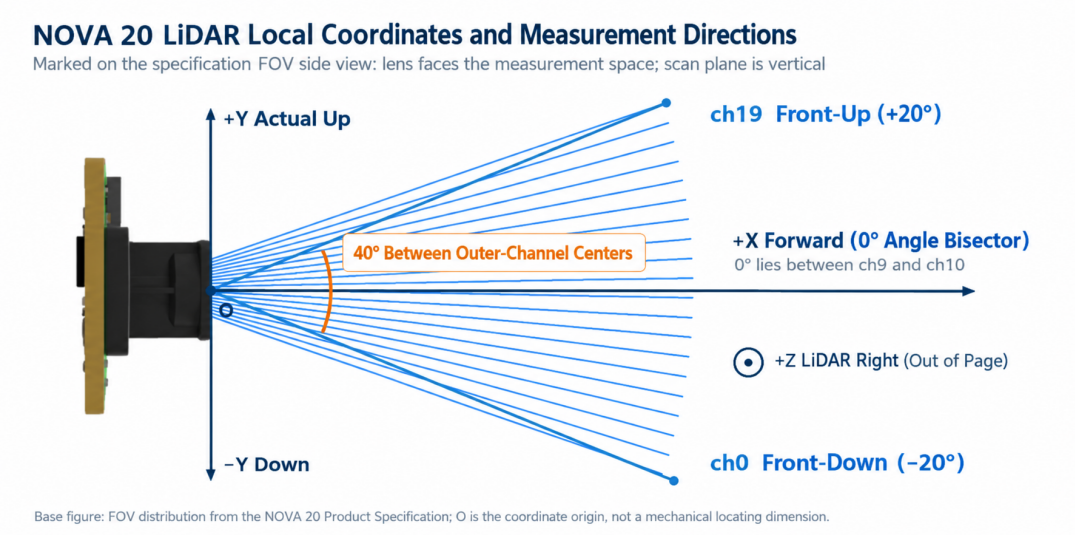


Figure 2 Local coordinates on the NOVA 20 specification FOV side view

The raw Zone_index ranges from 0 to 19. ch0 is the lower forward endpoint (−20°), and ch19 is the upper forward endpoint (+20°). Their center directions are separated by 40°; the forward direction lies between ch9 and ch10. The intermediate channels use a nominal equal-angle default model: angle = −20° + ch × 40° / 19. This model is not a per-channel calibration result.

For a valid distance r in millimeters, the local scan-plane coordinates are x = r × cos(angle), y = r × sin(angle), and z = 0. UART measurement frames contain distance and the raw channel index, not spatial coordinates. The point number displayed by the PC software is Zone_index + 1.

Example: at a distance of 1000 mm, the local coordinates are approximately (940, −342, 0) mm for ch0 and (940, +342, 0) mm for ch19. The sign of Y indicates whether the target is below or above the LiDAR.

When publishing a ROS point cloud, use a LiDAR-local frame with x forward, y upward, and z = 0, and express coordinates in meters. Do not label this frame directly as the robot's base_link. Transform it to the robot body frame using the actual mounting extrinsics and TF.

Integration check: After installation, place targets above and below the scan-plane center. Verify ch0 at the lower end, ch19 at the upper end, and the direction shown by the host.

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4 Hardware Interface and Wiring

4.1 Connector and 5-Pin Interface

The LiDAR end of the test harness uses a Molex 5055650501 plug (Micro-Lock Plus, 1.25 mm pitch, 5 positions). Figure 3 shows the harness-side mating face, with the latch at the top. The triangle on the left marks Pin 1; Pins 2 through 5 follow from left to right.

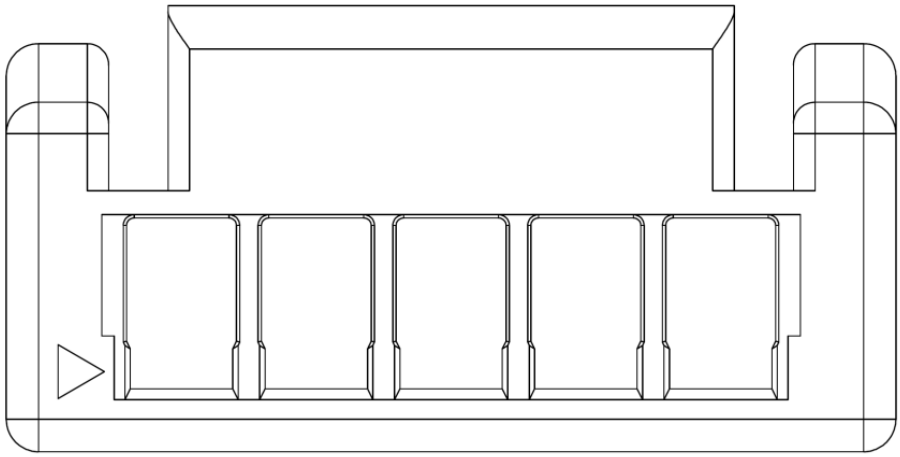


Figure 3 Test harness 5-pin plug mating face (triangle marks Pin 1)

Pin	Signal	Mating-face position	Direction or function
1	VCC	1st from left	Power input, DC 5 V ±5%
2	GND	2nd from left	Power and signal ground
3	TX	3rd from left	LiDAR output; connect to host RX
4	RX	4th from left	LiDAR input; connect to host TX
5	TOF_EN	5th from left	Enable control; separate blue wire on test harness, outside the 4-pin connector

Caution: Signal names are relative to the LiDAR: TX is its output and RX is its input. Cross-connect TX and RX when connecting a third-party serial host, and provide a common ground.

4.2 Optional Test Harness and Adapter Connection

Figure 4 shows an optional harness for development and serial testing only; it is not standard equipment. The connectors are Molex 5055650501 (5-pin, LiDAR) and MH1.25-4Y (4-pin, adapter). Wires are 100 ±3 mm long, gauge 26#. The blue TOF_EN wire has a separate tinned end outside the 4-pin connector. Insulate it when unused to prevent short circuits. A custom system harness may be designed using the interface definition.

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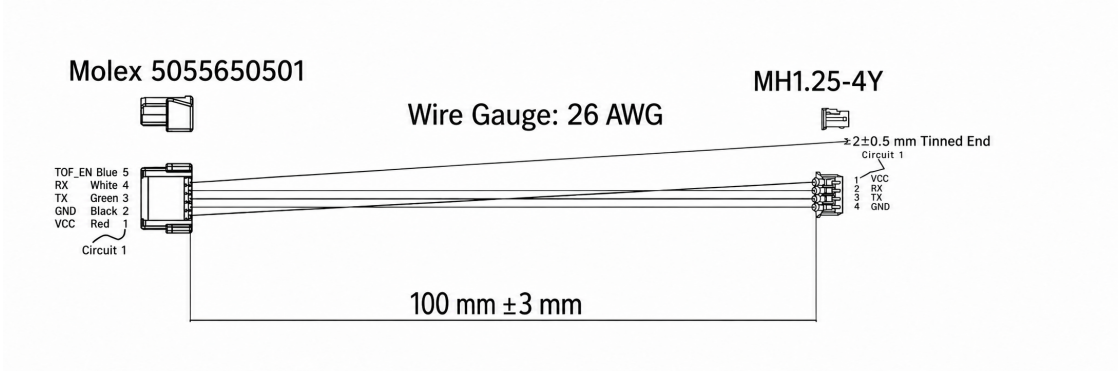


Figure 4 Optional NOVA 20 test harness (not standard equipment; testing only)

LiDAR 5-pin end	Test harness 4-pin end	Host connection
Pin 1 VCC (red)	Pin 1 VCC	Regulated DC 5 V supply
Pin 2 GND (black)	Pin 4 GND	Host ground; common ground required
Pin 3 TX (green)	Pin 3 TX	Host UART RX
Pin 4 RX (white)	Pin 2 RX	Host UART TX
Pin 5 TOF_EN (blue)	Outside 4-pin connector	Separate wire end; insulate when unused

Caution: Figure 3 shows the harness-side mating face; the board-side view may be mirrored. Verify Pin 1, mating orientation, and actual wire order before making a harness. Do not wire by color alone.

4.3 Power Design

- **Use a stable 5 V supply with at least 1 A transient capability to cover startup peak current and cable-drop margin.**
- **Confirm 4.75–5.25 V at the LiDAR side; supply ripple and ground bounce may cause serial errors or measurement fluctuations.**
- **When making an adapter board, do not directly parallel USB 5 V with an external 5 V supply.**

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5 Quick Start

5.1 Recommended Connection

Connection link	Function
NOVA 20	Outputs distance data for 20 channels
Test harness (optional, nonstandard)	Molex 5055650501 to MH1.25-4Y; testing only
USB-to-LVTTL adapter (optional)	Stable 5 V supply and serial conversion
Windows 10/11 PC	Runs the supplied PC software and records data

5.2 Power-On and Communication

1. Disconnect power and verify the VCC, GND, TX, and RX connections.
2. Connect NOVA 20 using the optional test harness (Figure 4), then the USB-to-LVTTL converter or adapter board.
3. Connect the converter to a Windows 10/11 PC and confirm that the serial port is recognized.
4. Start the supplied PC software and select the appropriate serial port.
5. Set the host baud rate to match the LiDAR's current setting (factory default: 921600 baud), with 8 data bits, 1 stop bit, no parity, and no hardware flow control.
6. Open the port. Check that channel distances, signal strength, temperature, and channel indices are displayed.
7. Move a target above and below the scan-plane center. Check that the corresponding channel distances and display direction agree.

5.3 First Power-On Acceptance

Check item	Pass criterion
Supply	4.75–5.25 V at the LiDAR; no abnormal heating after power-up
Serial link	Stable data at the current LiDAR baud rate, 8-N-1 (default: 921600 baud)
Frame synchronization	Consistent 0x59 0x59 header and valid checksums for 9-byte frames
Channels	Different target positions change data for different Zone_index values
Dynamic response	Distances track target motion continuously, without prolonged stale data

No data: Close the serial port first, then check power, common ground, crossed TX/RX, port occupancy by another program, and baud rate 921600.

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6 PC Software

6.1 Operating Environment

The supplied software package includes NOVA 20 PC software for Windows 10 and Windows 11. The product specification also lists support for Linux (Ubuntu) and ROS. Refer to the delivered software packages for the corresponding drivers and examples.

6.2 Basic Operation

1. **Extract the software package and start the PC software according to the instructions included in the package.**
2. **Select the port associated with the USB-to-LVTTL converter from the serial port list.**
3. **Confirm that the host baud rate matches the LiDAR's current setting (factory default: 921600-8-N-1) and disable hardware flow control.**
4. **Open the port and confirm that distances and signal strength are refreshed continuously for the channels.**
5. **Use the software's recording function when test records are needed. If recording is not available in the installed version, the host application can save the raw serial byte stream directly.**

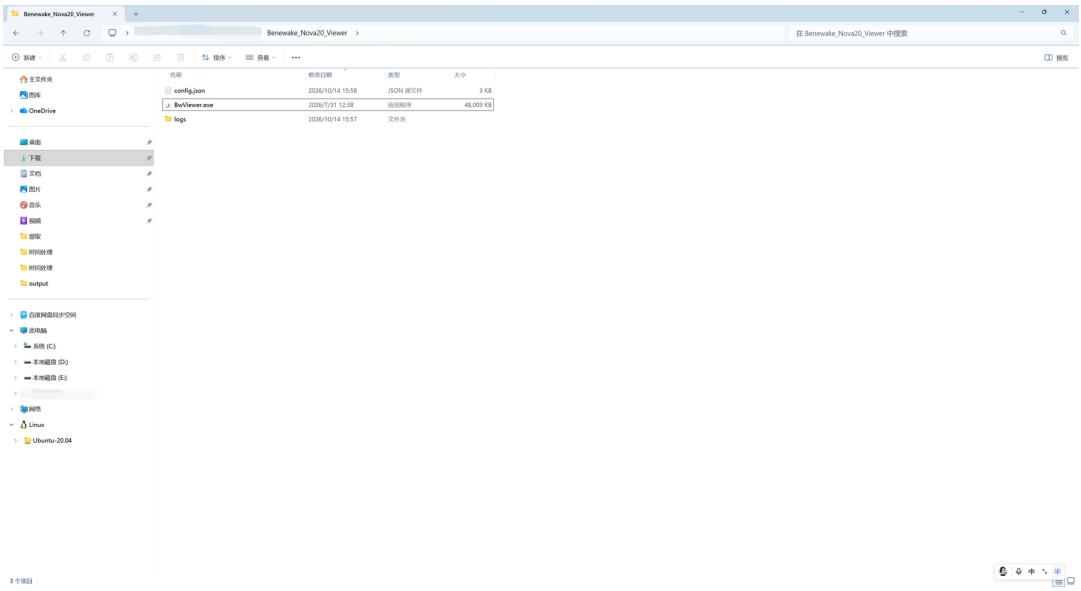


Figure 5 Extract and start the NOVA 20 PC software

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Figure 6 Select the serial port and connect

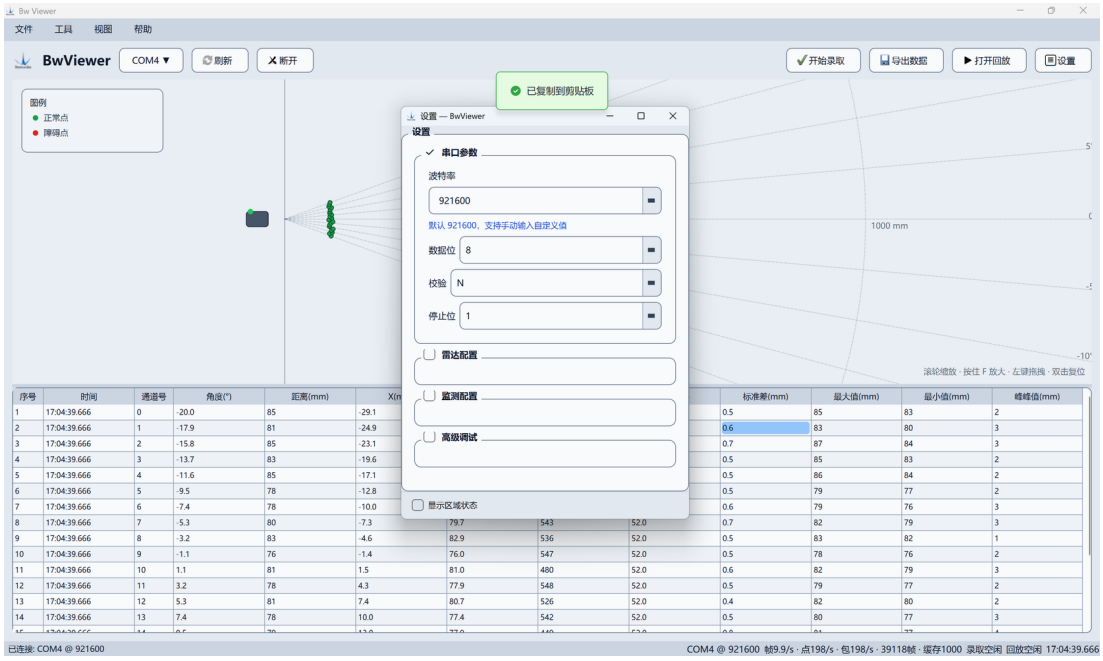


Figure 7 Configure the serial port parameters

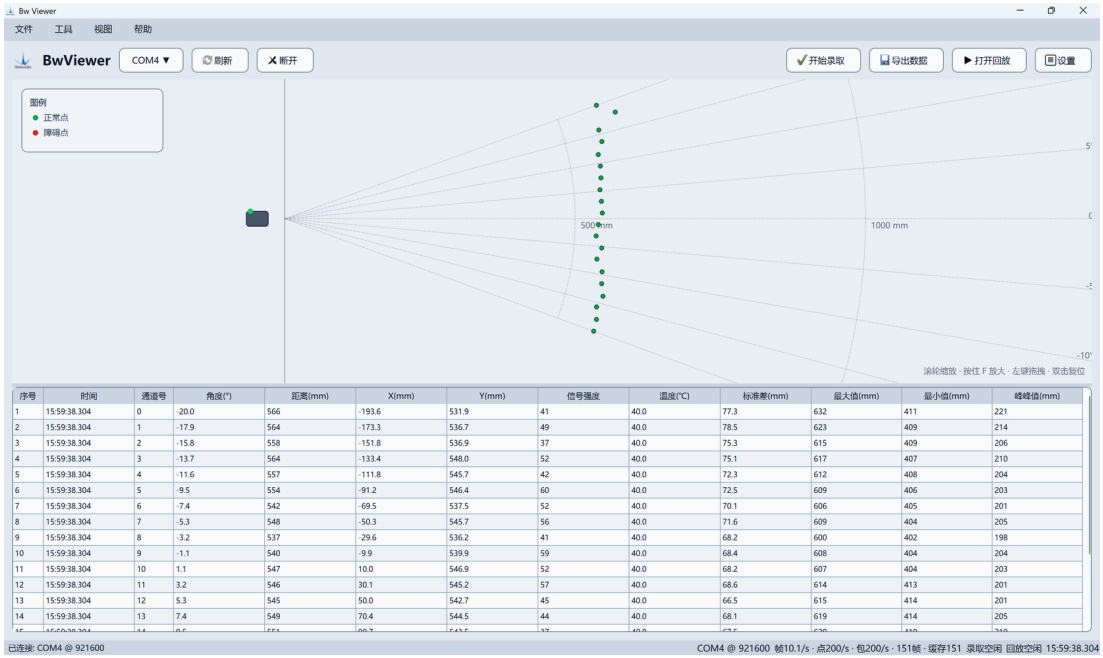


Figure 8 View multichannel measurement data

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Figure 9 Recording and data-export controls

6.3 Interpreting Data

- Distance is expressed in millimeters (mm), as specified for the product.
- Signal strength is a relative measure of the received echo and helps assess data quality. It is not a direct reflectivity measurement.
- The temperature field is a device status reference; it is not the ambient or housing temperature.
- Use the channel index to organize the 20-point data. During initial integration, verify the physical direction with targets above and below the LiDAR.

6.4 Setting the Measurement Rate

NOVA 20 supports four measurement rates: 5, 10, 25, and 50 Hz. The PC software's display refresh rate affects only the display and does not change the device measurement rate. Without the PC software, use the UART configuration and save commands in Section 7.6.

1. Connect the LiDAR, open the serial port, and open the LiDAR configuration window in the PC software.
2. Select 5, 10, 25, or 50 Hz and apply it for the current power-on session.
3. Wait for a successful configuration indication and confirm that the displayed measurement rate matches the selected rate. Do not assume the change has taken effect without confirmation.
4. To retain the setting after power loss, save it to the device and wait for the save confirmation.
5. Restart the device and check the measurement rate to verify that it was saved.

Applying and saving the measurement rate are separate operations. A rate applied only for the current power-on session should not be assumed to persist after power loss.

6.5 Setting the LiDAR Baud Rate

This procedure changes the LiDAR's UART baud rate. The factory default is 921600 baud. The baud rate command performs its own save operation, and the new baud rate takes effect after a soft reset or power cycle. See Section 7.7 for the commands.

1. Connect at the LiDAR's current baud rate and confirm stable data reception. Factory-default devices use 921600-8-N-1.
2. At the current baud rate, send the raw hexadecimal bytes for the target baud rate from the table in Section 7.7.

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3. Receive the configuration ACK at the current baud rate. Check the returned baud rate, status 0x00, and checksum. Status 0x00 means that the baud rate value was accepted; it does not confirm that the setting was successfully saved to Flash.
4. Still at the current baud rate, send the soft reset command 5A 04 02 60 and receive the reset ACK 5A 05 02 00 61. Alternatively, power-cycle the device after Step 3.
5. After the LiDAR has restarted, change the host port to the target baud rate, reconnect, and check the ranging data. A further power cycle is recommended to verify that the new baud rate is retained.

Do not send 5A 04 11 6F when changing the baud rate; it is not required. If reconnection fails, confirm that the LiDAR has restarted, check both the previous and target baud rates, and inspect the supply, common ground, and port availability.

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7 UART Protocol

7.1 Serial Port Configuration

Item	Setting
Signal level	LVTTL UART
Baud rate	Factory default: 921600 baud; configuration in Section 7.7
Data bits	8
Stop bits	1
Parity	None
Hardware flow control	None

7.2 Measurement Frame Structure

Each measurement frame is fixed at 9 bytes, least significant byte first.

Byte	Field	Description
0	Header 0	0x59
1	Header 1	0x59
2	Dist_L	Distance low byte
3	Dist_H	Distance high byte
4	Peak_L	Signal intensity low byte
5	Peak_H	Signal intensity high byte
6	Temp	Temperature in °C, for device-state reference
7	Zone_index	Channel number / point number
8	Check_sum	Low 8 bits of the sum of the first 8 bytes

7.3 Field Calculations

```
Distance_mm = Dist_L | (Dist_H << 8)
Peak        = Peak_L | (Peak_H << 8)
Temperature = Temp
Checksum    = sum(frame[0:8]) & 0xFF
```

7.4 Data Parsing Example

```
59 59 C9 00 23 00 20 01 BF
```

Field	Raw value	Parsed result

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Field	Raw value	Parsed result
Header	59 59	Valid
Distance	C9 00	0x00C9 = 201 mm
Intensity	23 00	0x0023 = 35
Temperature	20	32 °C
Channel	01	Point 1
Checksum	BF	sum(first 8 bytes) & 0xFF = 0xBF

7.5 Continuous Byte-Stream Parsing

The serial byte stream may start at any position, and bytes may be lost due to interference. The host shall search for the two-byte header, wait for a complete 9-byte frame, and verify the checksum. If verification fails, discard only one byte and re-synchronize.

```
def parse_nova20(buffer: bytearray):
    while len(buffer) >= 2:
        pos = buffer.find(b"\x59\x59")
        if pos < 0:
            buffer[:] = buffer[-1:] if buffer[-1] == 0x59 else b""
            return
        del buffer[:pos]
        if len(buffer) < 9:
            return
        frame = bytes(buffer[:9])
        if (sum(frame[:8]) & 0xFF) != frame[8]:
            del buffer[0]
            continue
        yield {"distance_mm": frame[2] | (frame[3] << 8),
               "peak": frame[4] | (frame[5] << 8),
               "temp_c": frame[6], "zone": frame[7]}
        del buffer[:9]
```

Code 1 Python reference parsing logic (not an SDK API)

7.6 Measurement Rate Commands

A customer host can send the commands below using the UART parameters in Section 7.1 without the PC software. Send each sequence as raw hexadecimal bytes, not as a text string containing spaces. The supported measurement rates are 5, 10, 25, and 50 Hz.

Operation	Command	Successful ACK
Set 5 Hz	5A 06 03 78 00 DB	5A 06 03 78 00 DB
Set 10 Hz	5A 06 03 F0 00 53	5A 06 03 F0 00 53
Set 25 Hz	5A 06 03 58 02 BD	5A 06 03 58 02 BD
Set 50 Hz	5A 06 03 B0 04 17	5A 06 03 B0 04 17
Save current rate	5A 04 11 6F	5A 05 11 00 70

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A valid measurement rate command takes effect immediately for the current power-on session. To retain the rate after power loss, first receive the complete configuration ACK, then send the save command in the last row. After receiving the save ACK, restart the device to verify the setting. Command ACKs and measurement data share the UART; distinguish them by their headers. A timeout or invalid checksum leaves the operation unconfirmed.

Nonstandard-rate ACK example: if the host sends 5A 06 03 F4 01 58 and the device returns 5A 06 03 58 02 BD, interpret the returned frame as an effective rate of 25 Hz. Do not infer the actual rate solely from the transmitted command. This example illustrates ACK handling and does not add another supported measurement rate.

7.7 Baud Rate Commands

Send these commands at the LiDAR's current baud rate as raw hexadecimal bytes. 0x5A is the header, 0x08 is the frame length, and 0x06 is the command ID. The next 4 bytes contain the target baud rate as a little-endian integer. The last byte is the low 8 bits of the sum of the first 7 bytes.

Target baud rate (baud)	Command frame
9600	5A 08 06 80 25 00 00 0D
14400	5A 08 06 40 38 00 00 E0
19200	5A 08 06 00 4B 00 00 B3
38400	5A 08 06 00 96 00 00 FE
43000	5A 08 06 F8 A7 00 00 07
57600	5A 08 06 00 E1 00 00 49
76800	5A 08 06 00 2C 01 00 95
115200	5A 08 06 00 C2 01 00 2B
128000	5A 08 06 00 F4 01 00 5D
230400	5A 08 06 00 84 03 00 EF
256000	5A 08 06 00 E8 03 00 53
460800	5A 08 06 00 08 07 00 77
921600	5A 08 06 00 10 0E 00 86

Receive the ACK at the current baud rate: 5A 09 06 [target baud rate, 4 bytes, little-endian] [status] [checksum]. Status 0x00 means the value was accepted. The checksum is the low 8 bits of the sum of the preceding 8 bytes. The ACK does not confirm successful Flash storage.

Operation	Host baud rate	Command or ACK
Send configuration	921600	5A 08 06 00 84 03 00 EF
Receive configuration ACK	921600	5A 09 06 00 84 03 00 00 F0
Send soft reset	921600	5A 04 02 60

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Operation	Host baud rate	Command or ACK
Receive reset ACK	921600	5A 05 02 00 61
Reconnect after restart	230400	Check ranging data

A power cycle after the configuration ACK can replace the soft reset. The baud rate command performs its own save operation; the new rate takes effect after restart. Do not send 5A 04 11 6F. An additional power cycle is recommended to verify continued data reception at 230400 baud.

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8 System Integration

8.1 Organizing Data

- Update channel data using Zone_index as the key and save the reception timestamp.
- Before using a complete 20-point set in algorithms, set a maximum allowed latency to avoid mixing stale channel data.
- Only data passing both header and checksum validation may enter the application layer.
- Do not determine obstacles from an intensity threshold alone; combine distance continuity, target material, and field measurements.

8.2 Fault Protection

Fault	Host-side recommendation
Checksum failure	Discard candidate frame and search again for 0x59 0x59
Serial timeout	Mark data unavailable; check power, cable, and port occupancy
Channel not updated for a long time	Mark channel stale; do not present previous value as real-time
Distance jump	Check plausibility using adjacent frames/channels and intensity
Temperature near operating limit	Log temperature and verify system cooling and ambient conditions

8.3 Power-On and Power-Off

Allow the LiDAR to establish a stable data stream after power-on. Before enabling the control loop, complete serial synchronization and the first valid-data check. After power loss or serial interruption, switch the sensing state to unavailable first, then reconnect.

8.4 TOF_EN Usage

TOF_EN is the product-side enable-control signal and is not brought out on the optional USB-LVTTL 4-pin adapter. If the system needs this pin, confirm its valid level and default power-on state against the current sample hardware documentation. Do not apply 5 V directly or use it as a power pin.

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9 Troubleshooting

Symptom	Possible cause	Action
No serial port on PC	Driver missing, USB port or converter fault	Change USB port; check Device Manager and converter driver
Port opens but no data	Power fault, TX/RX reversed, wrong baud rate	Measure 5 V at LiDAR; share ground; cross TX/RX; use the current baud rate
Port occupied	Multiple programs opened port	Close other serial programs and reconnect
Many checksum failures	Ripple, ground, level mismatch, or lost bytes	Improve power/ground; confirm LVTTL; re-sync on header
Distance unchanged	Target outside FOV, wrong channel mapping, or stale data	Move a close target; observe Zone_index; check timestamps
No valid close-range result	Target in blind zone or window obstructed	Move target beyond 5 cm and clean window
Distance fluctuates in strong light	Reflectivity, incidence angle, or illuminance beyond validation	Re-test with actual material and mounting angle; use robust application logic
Abnormal heating/restarts	Insufficient power, short circuit, mounting stress, or high temperature	Disconnect power; check wiring and supply; power on only after correction

When submitting an issue: Provide sample serial information, host-software/firmware versions, wiring photo, supply voltage, raw serial data, and reproduction steps.

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10 Maintenance Storage and Transport

10.1 Optical Window

Keep the window clean and dry. When cleaning is required, disconnect power first and gently use dust-free air or lint-free material suitable for optical surfaces. Avoid scratches and solvent residue.

10.2 Storage

Storage temperature: -40 °C to +85 °C. Place bare-board samples in ESD packaging and avoid high humidity, condensation, corrosive gases, and mechanical compression. After long-term storage, inspect the connector, PCB, and optical window before use.

10.3 Transportation

Secure the module and lens area during transportation to prevent impact loads from acting directly on the optical structure or connector. Provide both ESD and cushioning protection inside the package.

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Appendix A Complete 2D Drawing

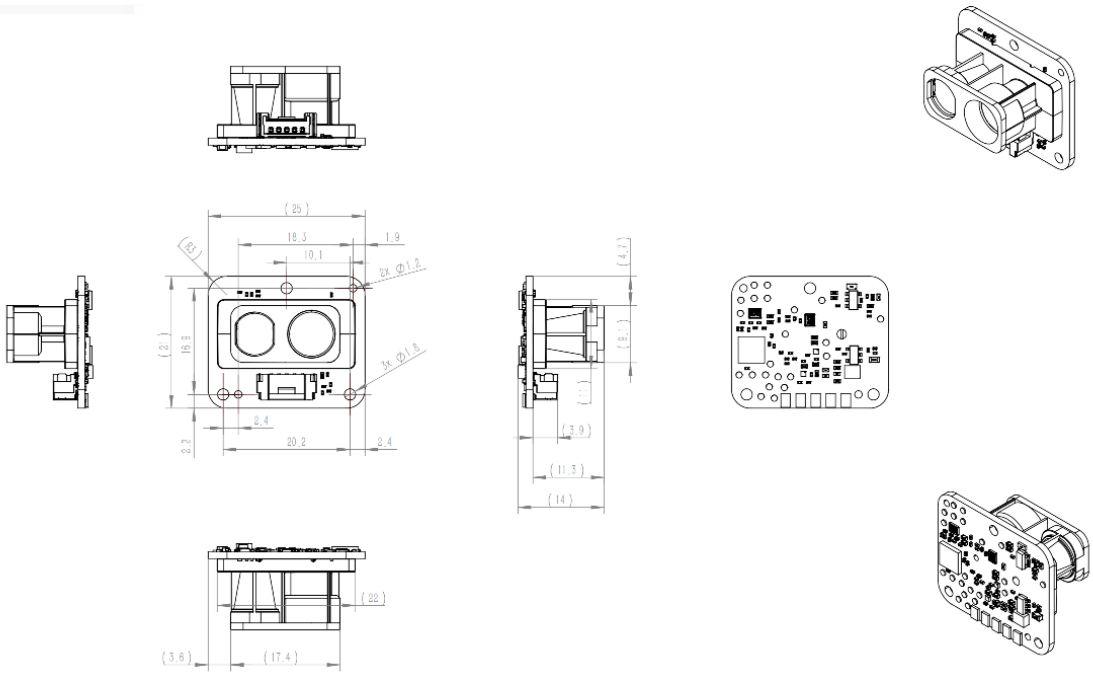


Figure A-1 NOVA 20 complete 2D engineering drawing (use the original engineering file for structural design)

Appendix B Development Resources and Versions

Resource	V1.0 usage notes
Product specification	NOVA 20 Product Specification V2.2
PC software	Supplied; supports Windows 10/11; device rate configuration is in Section 6.4
Linux / ROS	Support declared in product specification; actual driver package is subject to delivery
SDK API	This manual does not define unpublished APIs; parse UART data directly as in Chapter 7
Firmware version	Read from the product label, PC software, or accompanying release notes
Production differences	Use the frozen specification, firmware, software package, and corresponding release notes

Appendix C Terms

Term	Description
dToF	Direct Time of Flight
FOV	Field of View
Peak	Relative quantity of echo signal strength

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Term	Description
Zone_index	Measurement channel / point number
LVTTL	Low-voltage TTL level serial interface

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