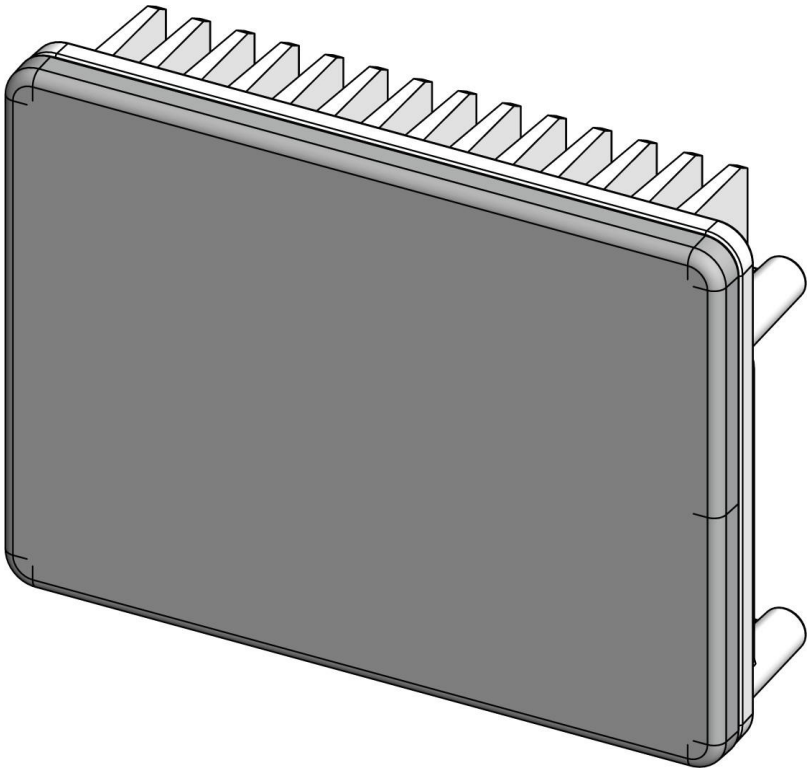
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zPRIME 3.0

Ultra-Resolution Software-Defined Imaging Radar™

User Manual

April 2026

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1 Introduction and Legal

1.1 General Disclaimer

Notice to Users:
The zPRIME 3.0 radar sensor is a high-performance imaging radar intended for integration into commercial, industrial, and autonomous platforms. This product must be installed, configured, and operated by qualified personnel familiar with radar systems, safety practices, and applicable regulations.

zPRIME 3.0 is designed for use in non-life-critical applications unless specifically certified for safety-critical systems. Users must independently validate the radar's suitability for their intended use. Integration, testing, and certification for end-use compliance are the responsibility of the system integrator.

Specifications, software features, and documentation are subject to change without notice. The manufacturer accepts no liability for any loss or damage resulting from reliance on this document.

Hazard Disclaimer:
The zPRIME 3.0 emits millimeter-wave electromagnetic radiation in the 76-81 GHz band. While compliant with applicable emission limits, it should not be operated in proximity to sensitive RF equipment without proper evaluation.

1.2 Regulatory Compliance

zPRIME 3.0 radar sensors are designed to meet regulatory requirements across major global markets. Certification or conformity details may vary by model and configuration.

USA:

FCC ID: **2BFPN-ZPRM3**
This device complies with FCC rules under Part 95 Subpart M for vehicular radar systems operating in the 76-81 GHz frequency band. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC RF Exposure Statement
This device complies with FCC radiation exposure limits set forth for an uncontrolled environment.
This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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EU Declaration of Conformity:



Date	**12.2025**
Manufacturer	**Zadar Labs, Inc.** 530 Division St. Campbell, CA 95008 United States Email: Web: www.zadarlabs.com
Product Name	zPRIME 3.0 Software-Defined Imaging Radar
Models	ZPRM3-T1-77-LR, ZPRM3-T1-77-W, ZPRM3-T1-77-UW, ZPRM3-POE-77-LR, ZPRM3-POE-77-W, ZPRM3-POE-77-UW
Product Description	76-77 and 77-81GHz Software-Defined Imaging Radar Sensor for Automotive / Industrial / Stationary Obstacle Detection and Ranging

This declaration covers all units manufactured in accordance with the above product identification.
This EU Declaration of Conformity is issued under the sole responsibility of the manufacturer identified above.

Directives

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

- 2014/53/EU Radio Equipment Directive (RED)
- 2015/863 Restriction of the use of certain hazardous substances in electronic and electrical equipment + amendments to the Annex II (RoHS III)

Harmonized Standards

ETSI EN 301 091 V2.1.1 (2017-01) - Radar equipment operating in the 76-77 GHz band

ETSI EN 302 264 V2.1.1 (2017-02) - Short range radar equipment operating in the 77-81 GHz band

ETSI EN 301 489-1 V2.2.3 (2019-11) - EMC standard for radio equipment and services

ETSI EN 301 489-51 V2.1.1 (2019-04) - EMC standard for radar equipment operating in the 76-81 GHz band

EN 55032:2015/A11:2020, BS EN 55032:2015+A1:2020 - Electromagnetic compatibility of multimedia equipment - emission requirements

EN/BS EN 55035:2017/A11:2020 - Electromagnetic compatibility of multimedia equipment - immunity requirements

EN IEC 62311:2020 - Human exposure to electromagnetic fields requirements

EN IEC 63000:2018 - Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Radio Frequency Parameters

The radio equipment operates within the following frequency ranges and limits:

- Operating Frequency Range: 76.0-77.0 GHz, 77.0-81.0GHz
- Operating Modes:

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- 76.0-77.0 GHz Long-Range Radar Mode(s)
- 77.0-81.0 GHz Short-Range / High-Resolution Radar Mode(s)

The equipment operates within the power, duty cycle, and emission limits defined by the applicable harmonised standards.

David Wu



Head of Hardware
Campbell, CA
12/23/2025

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Japan:



MIC ID: **211-250913**
MIC Certified under ARIB STD-T111

South Korea:



KC ID: **R-C-ARR-ATA-ZPRM3**
Conformity Assessment Information:

- Holder: Alien Technology Asia Co., Ltd. (㈜ 에일리언테크놀로지아시아)
- Equipment: zPRIME 3.0 Software-Defined Imaging Radar
- Model: ZPRM3
- Date: 2026/01
- Manufacturer: Zadar Labs Inc.
- Equipment Code: LARN7
- COO: USA
- EMC: MSIT Article 7 Section 9 Certified

	KC Wireless Specification
Frequency Band	76-77, 77-81, or 76-81GHz depending on region
Bandwidth	< 1GHz for 76-77 regions, <4GHz for 77-81 regions, <5GHz for 76-81 regions
Transmit Power (TX Power)	< 10dBm + 50% per TX
Modulation Scheme	RFTDMA, Zadar Proprietary
Antenna Configuration	TX: 12 RX: 16 MIMO
Field of View	Horizontal: +/- 60° / Vertical +/- 12 - 45° based on antenna
Range Resolution	3.4cm or greater depending on mode
Velocity Resolution	0.14m/s or greater depending on mode
Maximum Detection Range	1,000m or less depending on mode

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2 Product Overview

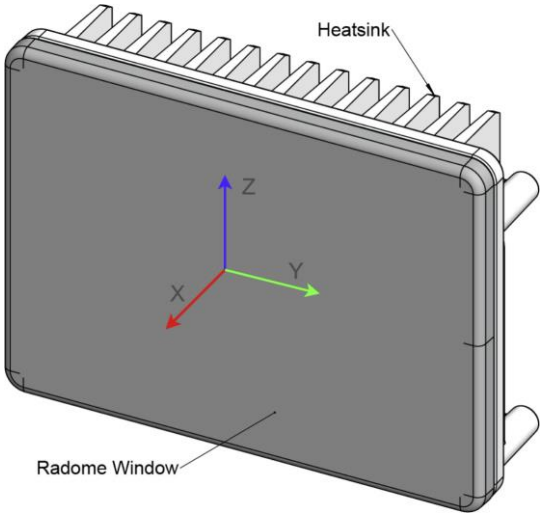


Figure 1. Front View with Coordinate System

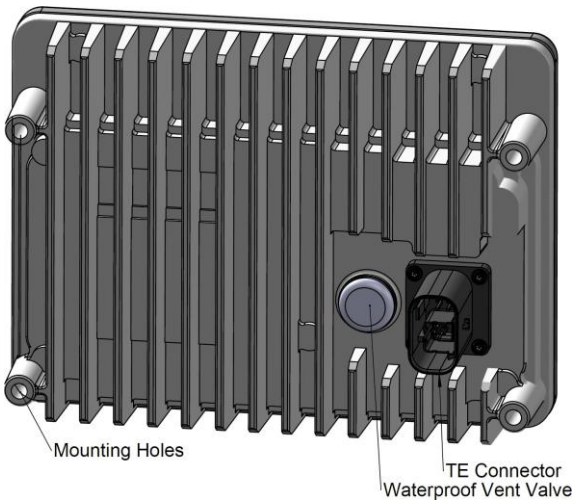


Figure 2. Back View

2.1 zPRIME 3.0 Introduction

zPRIME 3.0 is the industry leading third generation ultra-high-resolution 4D Software-Defined Imaging Radar (SDIR™). zPRIME is designed for demanding perception and safety applications in autonomous systems, industrial automation, and intelligent infrastructure.

zPRIME delivers a rich 4D point cloud with high resolution, range, and reliability for critical sensing applications. Engineered for both indoor and outdoor operation in all weather conditions, zPRIME is built for a long service life.

Key Features

- **True 4D imaging radar:** zPRIME provides true resolution in both Azimuth and Elevation, clearly distinguishing bridges, power lines, and tree canopies.
- **Ultra high static angular resolution:** a custom high resolution beamforming engine separates objects that occupy the same range-doppler cell within 0.35°.
- **Extended detection range:** detect humans up to 350m, vehicles up to 800m, and trucks beyond 1,000m.
- **Ultra-wide field of view:** all models offer 120° horizontal FOV with vertical FOV up to 90°.
- **High frame rate:** 20Hz standard frame rate with special Software-Defined modes up to 50Hz
- **All-weather performance:** operates reliably in rain, dust, fog, and snow under all lighting conditions

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- **Software-Defined Imaging Radar™:** supports software-configurable adaptive transmission modes and processing modes for flexible on-the-fly reconfiguration. SDIR™ features depend on model configuration.
- **Standardized data output:** supports HTTP API for sensor configuration and UDP/Protobuf data output
- **Regular firmware updates:** zPRIME 3.0 performance and features improve on a continuous basis

Typical Applications

- Autonomous vehicles, mobile robots, and industrial vehicles
- Agricultural automation, driverless tractors
- Heavy equipment automation and safety
- Railway and mining automation
- Marine automation and collision avoidance
- Intelligent traffic infrastructure
- Site security and surveillance
- Robotics and SLAM in GPS-denied environments

Hardware Model Variants

Antenna Configuration	Interface	Part Number	Vertical FOV / Approximate Car Detection Range[1]	Horizontal FOV[2]
zPRIME 3.0 Long Range	1000BASE-T1	ZPRM3-T1-77-LR	24° V-FoV / ≈ 800 m	120°
zPRIME 3.0 Wide	1000BASE-T1	ZPRM3-T1-77-W	50° V-FoV / ≈ 400 m	120°
zPRIME 3.0 Ultra-Wide	1000BASE-T1	ZPRM3-T1-77-UW	90° V-FoV / ≈ 250 m	120°

- Special hardware variants of zPRIME exist for customer-specified applications including ultra-long range, explosion proof, and marine variants. For these variants contact Zadar support for customized specifications.

- Note: zPRIME can detect objects beyond the quoted FOV; please refer to section 3.4 for details.

☝All zPRIME models share the same core processing platform and software interface, allowing seamless integration across use cases.

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2.2 Radar Operating Principle

zPRIME uses **Frequency-Modulated Continuous-Wave (FMCW)** radar technology to detect and track objects in its environment in 4D with high precision.

By transmitting this FMCW signal to the environment, the received signal can be used to estimate:

1. Range (distance) to the target
2. Radial velocity (doppler velocity)
3. Azimuth angle
4. Elevation angle
5. Reflectivity (Radar Cross-Section) of the target

Zadar Labs has developed a family of innovative sensors using FMCW radar technology designed to meet the demands of modern autonomy, safety, and security applications that require advanced radar-based perception.

To meet these goals, Zadar has innovated at every level of the radar system spanning both hardware and software. This includes RF frontend, antenna design, signal processing, data processing, and radar perception and this is what allows zPRIME to deliver performance generations beyond available industry standard radar technology.

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3 Setup and Integration

3.1 Kit Contents

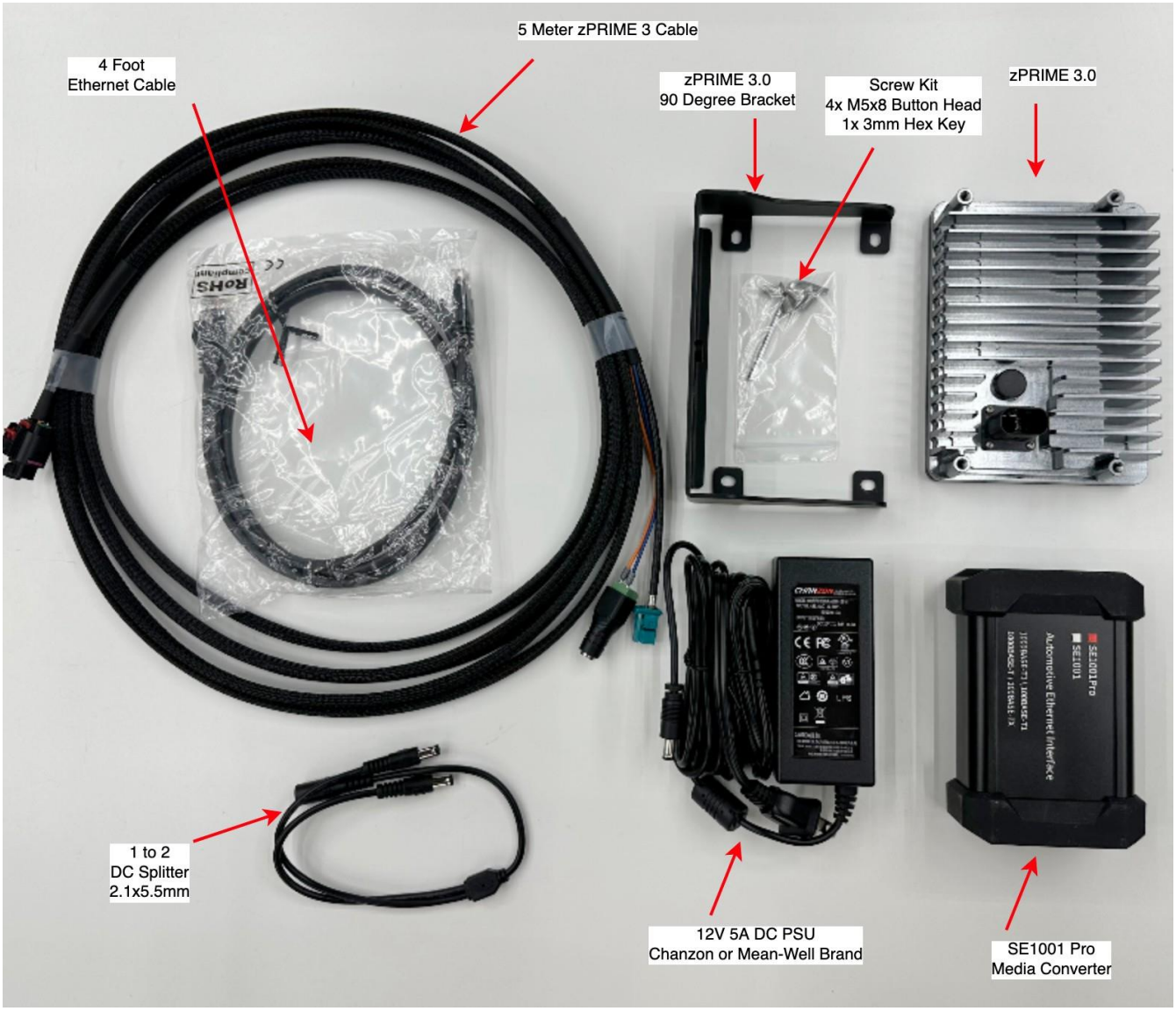


Figure 3. Kit Contents

The zPRIME 3.0 radar evaluation kit includes:

- zPRIME 3.0 Sensor in your specified hardware-configured FOV (LR, W, or UW)
- 5 Meter Power & Data Cable
  - 1000BASE-T1 automotive ethernet with MATENet connector
  - 12V power
- 90° Mounting Bracket
  - Hardware and tools included

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- 1000BASE-T1 to RJ45 ethernet converter
    - Used to convert automotive ethernet to standard ethernet
- 12V DC Power Supply, Worldwide Capable
- 90° Mounting Bracket (Zadar P/N BKT-ZPRM3-90)

Additional accessories are separately available:

- 90° Mounting Bracket (Zadar P/N BKT-ZPRM3-90)
- Flush Mounting Bracket (Zadar P/N BKT-ZPRM3-FLAT)
- Magnet Mounting Kit (Zadar P/N BKT-ZPRM3-MAGNET-KIT)
- Swivel Radar Kit for Surveillance Applications (Zadar P/N BKT-ZPRM3-MULTI-KIT)
    - Comes with universal brackets suitable for pole mount, wall mount, and corner mount use cases

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3.2 Connection Guide

The primary zPRIME interface is 1000BASE-T1 gigabit automotive ethernet. Systems that use standard RJ45 Gigabit Ethernet (1000BASE-T) can use the available RJ45 conversion box to adapt between the two standards.

Automotive ethernet specifications:

Parameter	Value
Default IP Address (can be configured)	192.168.0.10
Default Subnet	255.255.255.0
Automotive Ethernet Configuration	1000BASE-T1 Slave Device
MAC Address	Printed on device

Connecting zPRIME 3.0 to 1000BASE-T1 systems (automotive ethernet)

zPRIME 3.0 supports direct connection for 1000BASE-T1 systems. Data is supplied over TE MATEnet and power is supplied over 12V DC.

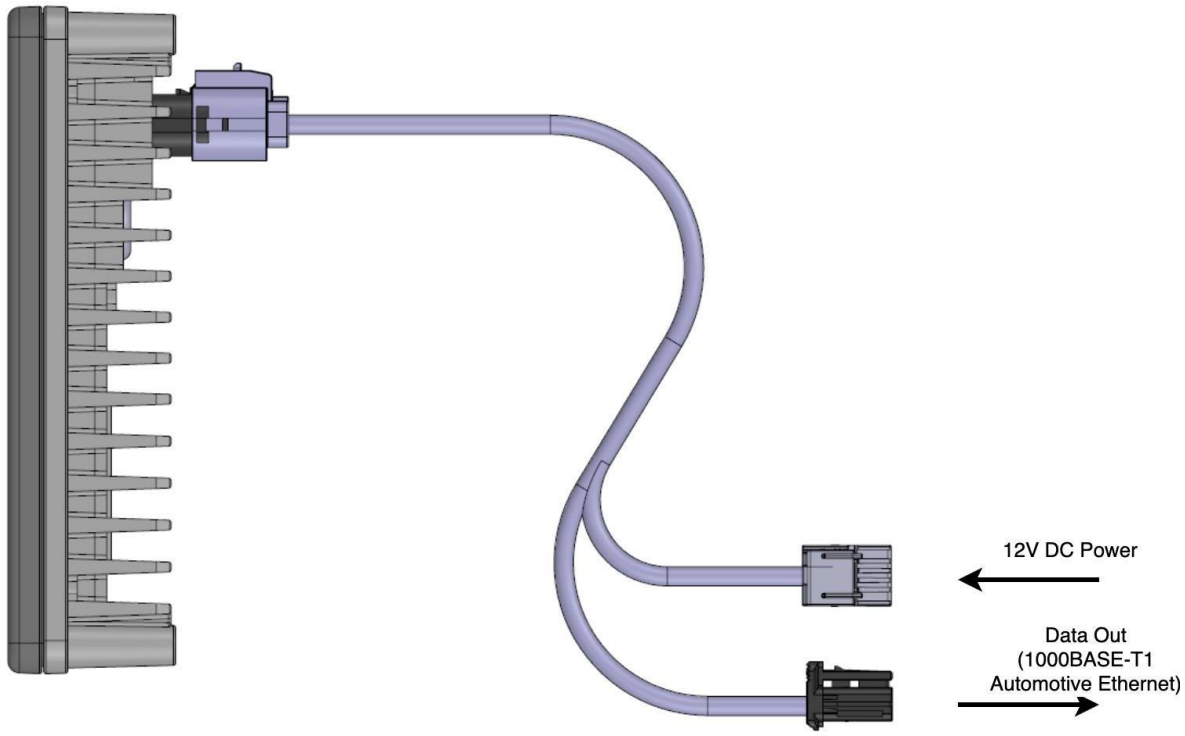


Figure 4. zPRIME with supplied cable assembly

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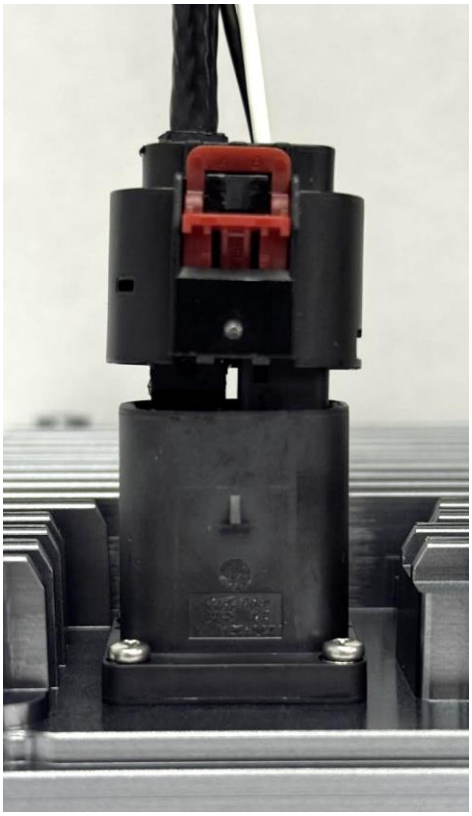


Figure 5. Not connected, red CPA tab disengaged

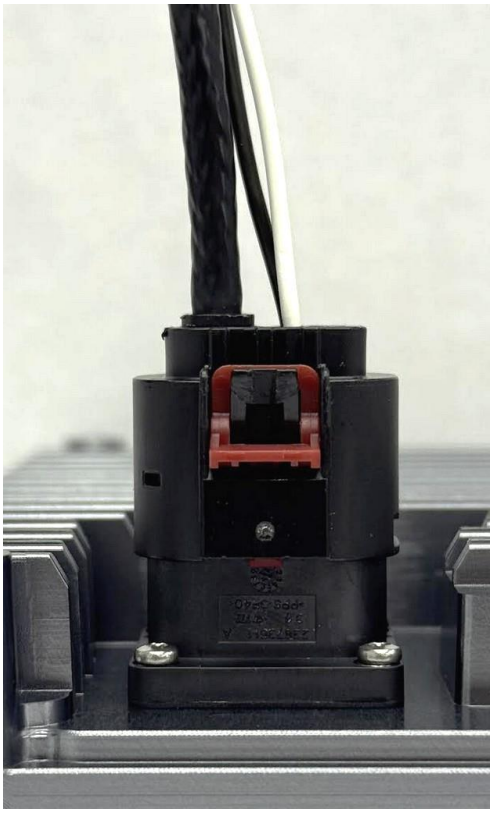


Figure 6. Connected, fully seated and CPA tab engaged

To connect zPRIME:

1. Disconnect power sources
2. Align plug, then push the plug into the socket until the black locking latch audibly clicks
3. Push the red CPA towards the socket until the CPA audibly clicks
4. The cable is now connected, sealed, and protected against accidental disconnection

To disconnect zPRIME:

1. Disconnect power sources
2. Pull the red CPA away from the socket until the CPA audibly clicks and disengages
3. Depress the black locking latch firmly and pull the plug from the socket.

☝Pull via plastic housing only- do not pull plug via wires or damage may result. The weatherproof connector is tightly installed and is difficult to disconnect. When the black locking latch is fully depressed, the connector will disconnect easily. Never force the connector apart!

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Connecting zPRIME 3.0 to RJ45 systems (regular ethernet)

The SE1001 Pro media converter included in the zPRIME 3.0 kit serves to convert 1000BASE-T1 automotive ethernet to 1000BASE-T classic ethernet. To use the kit, connect it as follows:

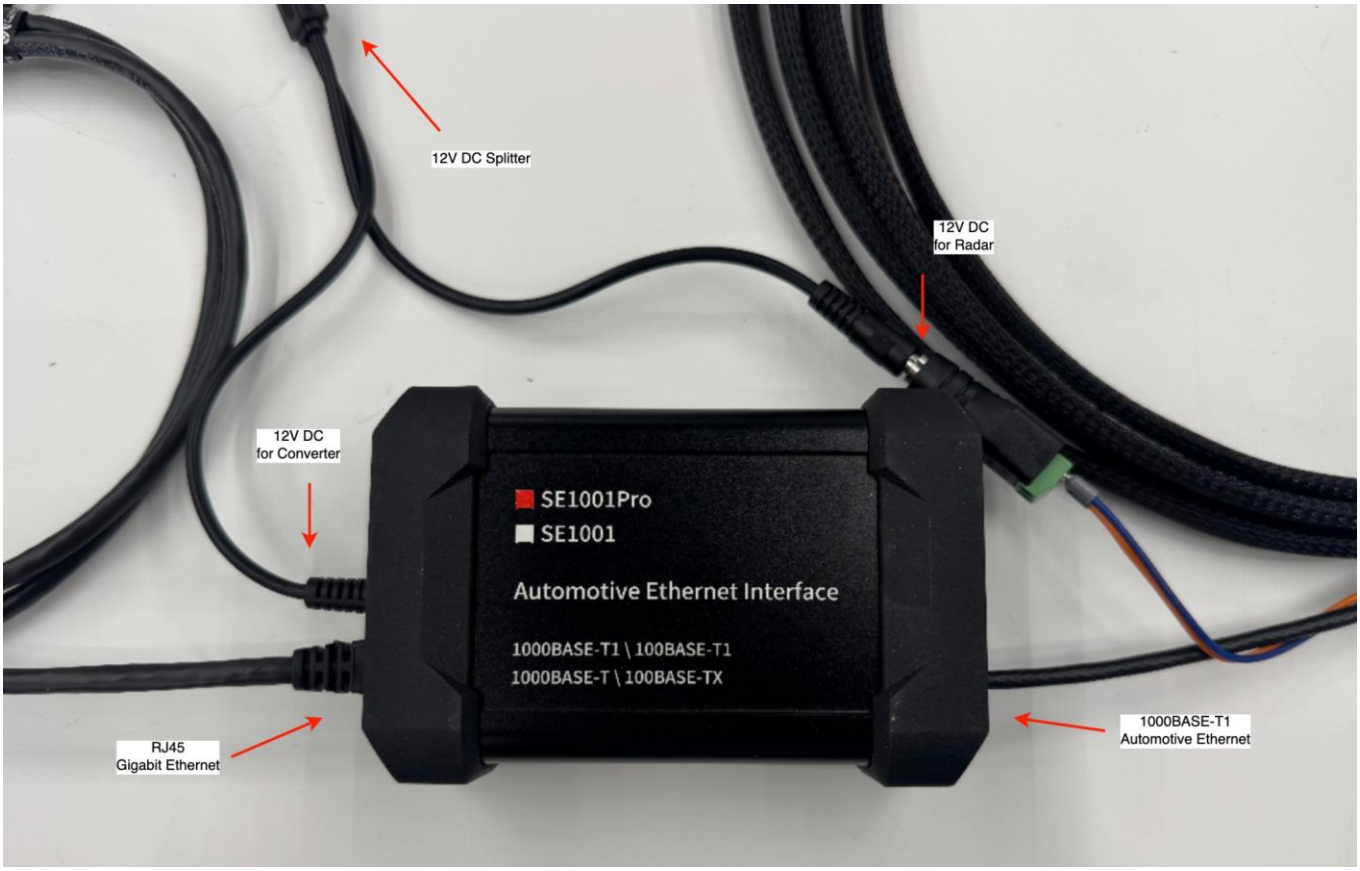


Figure 7. Media converter connections

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Make sure the media converter settings are as follows:

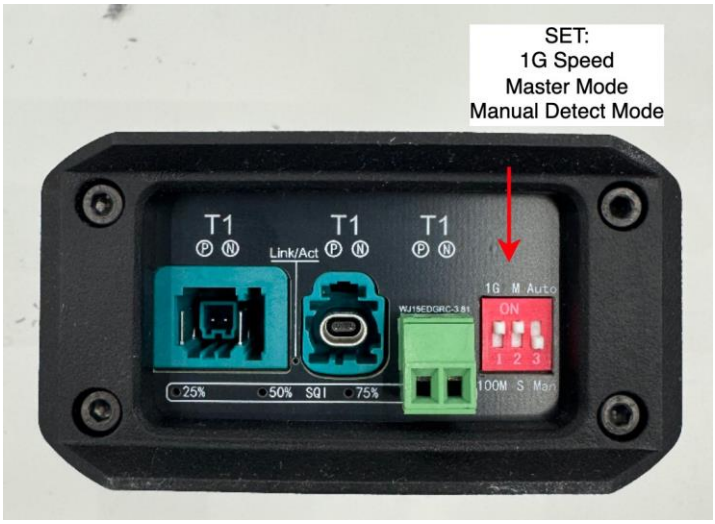


Figure 8. Media converter settings

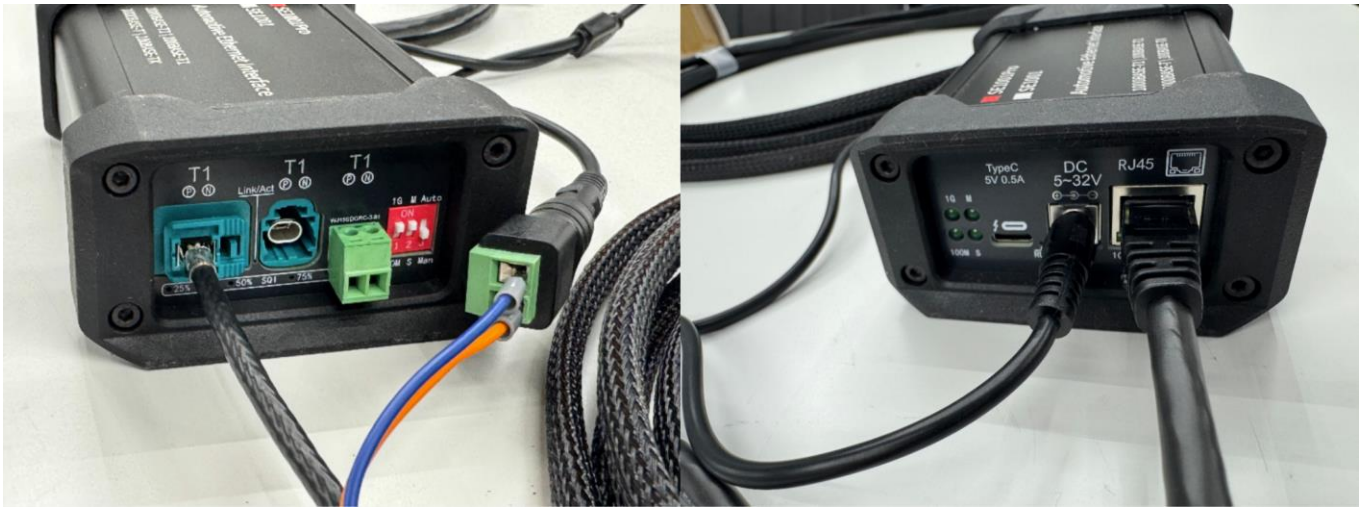


Figure 9. Media converter connections, detailed

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3.3 Electrical and Connector Specification

Radar-Side Socket Specification

zPRIME ships with an 8-pin hybrid data+power connector, part number 1-2387351-1 manufactured by TE Connectivity. This connector requires the cable end to be installed in order to provide IP69K sealing performance.

Radar-Side Socket Pinout

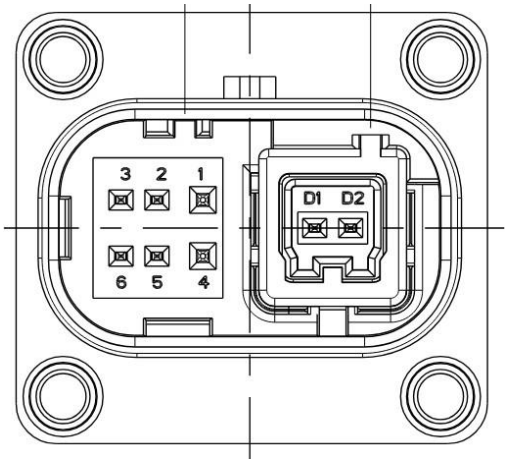


Figure 10. Radar Socket Pinout TE 1-2387351-1

Pinout, 6 pins hybrid power/signal

CNT1 Pin	Signal	Description
Pin 1	VCC	Power supply for radar, nominal 12-24V
Pin 4	GND	Ground for radar
Pin 2	CANH/GPIO (reserved)	Reserved for future CAN bus implementation
Pin 3	CANL (reserved)	Reserved for future CAN bus implementation
Pin 5, 6	Do not connect	Reserved for future use, do not connect

Pinout MATEnet 1000BASE-T1 automotive ethernet

CNT1 Pin	Signal	Description
D2	MDI-P	1000BASE-T1 Positive Signal
D1	MDI-N	1000BASE-T1 Negative Signal

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Cable Specification

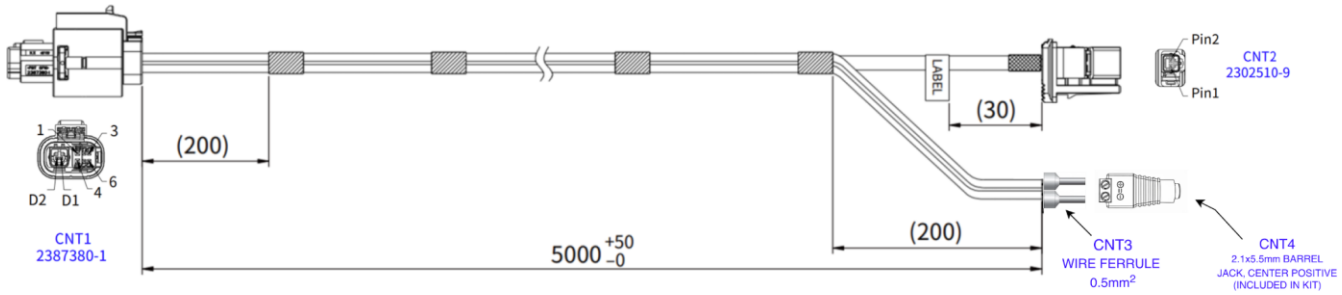


Figure 11. Cable Drawing (Zadar P/N 40-0-0101-2)

Cable Component Specification

Parameter	Value
Cable length	5 meter standard*
CNT1	Cable/Plug Side: 2387380-1
	Mating Socket Side: 1-2387351-1
CNT2	Cable/Plug Side: 2302510-9
	Mating Socket Side: 2304372-1
CNT3	Wire Ferrules, 0.5mm^2
CNT4	DC Barrel Jack Adapter, 2.1x5.5mm, Center Positive

* Alternative lengths are available for special order. Minimums and lead times apply.

Cable Pinout Power/Data

CNT1 Pin	Signal	Wire Color	Cross Section
Pin 1	VCC	Red	0.35 mm^2
Pin 4	GND	Black	0.35mm^2
Pin 2	SIG1 - (not populated by default)	Yellow	0.22mm^2
Pin 3	SIG2 - (not populated by default)	Green	0.22mm^2

Pinout 1000BASE-T1 Automotive Ethernet Twisted Pair

CNT1 Pin	CNT2 Pin	Signal	Wire Color	Cross Section
D2	Pin 1	MDI-P	White	-
D1	Pin 2	MDI-N	Green	-

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Input Voltage Requirements

PARAMETERS		TEST CONDITION	MIN	TYP	MAX	UNIT
VIN	System power supply	Measured at radar input connector. (1)	8	12	27	V
Transient Immunity Compliance		ISO 7637-2, ISO 61000				

(1) In use, cable IR drop at peak radar current consumption must be accounted for. Radar operation is not guaranteed if input voltage at input connector drops below the minimum input voltage.

Power and Current Consumption

PARAMETERS		TEST CONDITION	TYP	MAX	UNIT
P_{avg}	Typical average power consumption during operation, 50% transmission duty cycle*	VIN = 12V	20		W
P_{pk}	Peak power consumption during RF transmission	VIN = 12V	28	30	W
P_{idle}	Idle power consumption, no active transmission	VIN = 12V	7		W
I_{pk}	Maximum input current	VIN = 12V		2.5	A

* Average power consumption varies based on the duty cycle of the configured radar transmission mode. Numbers are based on typical operating modes.

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3.4 Mounting and Installation

Mechanical Drawing and 3D CAD/STEP Files

Parameter	Value
Exterior dimensions (width/height/depth) not including connector	140 x 104 x 35 mm
Exterior dimensions (width/height/depth) including connector	140 x 104 x 46.1 mm
Unit mass	520 g
IP Rating	IP69K
Material, rear housing	ADC12
Material, front cover	Polycarbonate/PBT-GF30

All dimensions are in mm. CAD files are available in our product information folder.

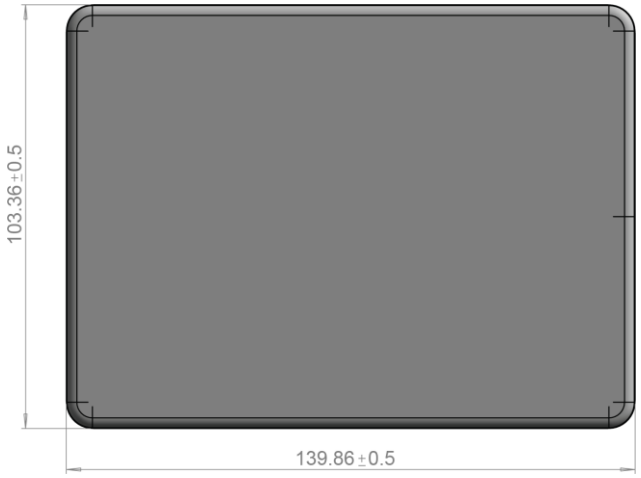


Figure 12. Front Dimensions

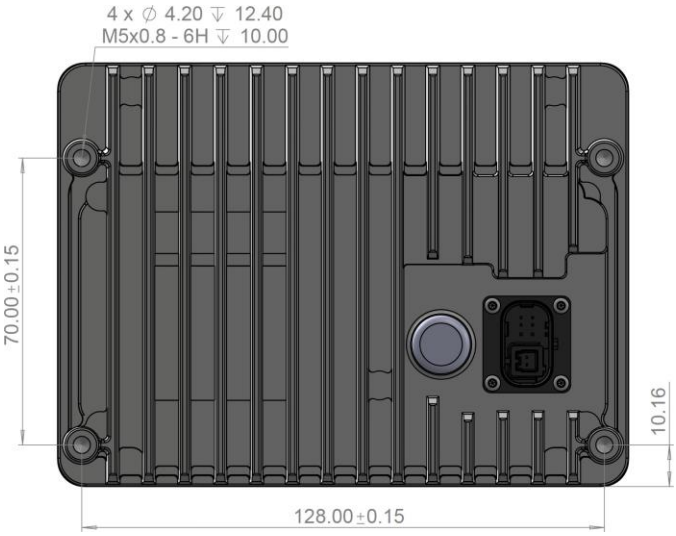


Figure 13. Rear Dimensions

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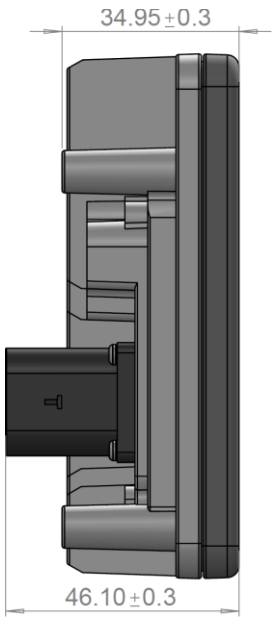


Figure 14. Left Side Dimensions

Impact of Mounting on Radar Performance

Radar mounting location may have an impact on radar performance, where performance could include maximum detectable range, field of view, and noise in the point cloud. Your intended mounting location should be evaluated according to the following criteria to ensure maximum radar performance. All Zadar performance specifications have been evaluated in conditions satisfying the following guidelines.

FOV Considerations and Keepout Zones

The recommended keepout FOV of the radar is included in the following table. We recommend that no metal objects and RF reflectors interfere with the radar keepout FOV. Close-range radar covers, housings, mounting brackets and the like within the keepout FOV should be made out of non-reflective materials such as plastic.

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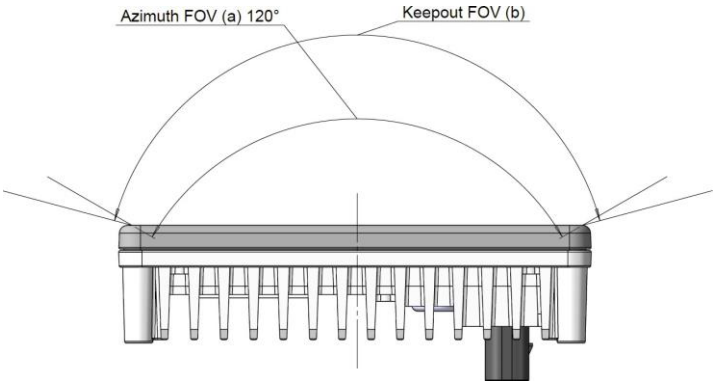


Figure 15. Azimuth Keep-Out

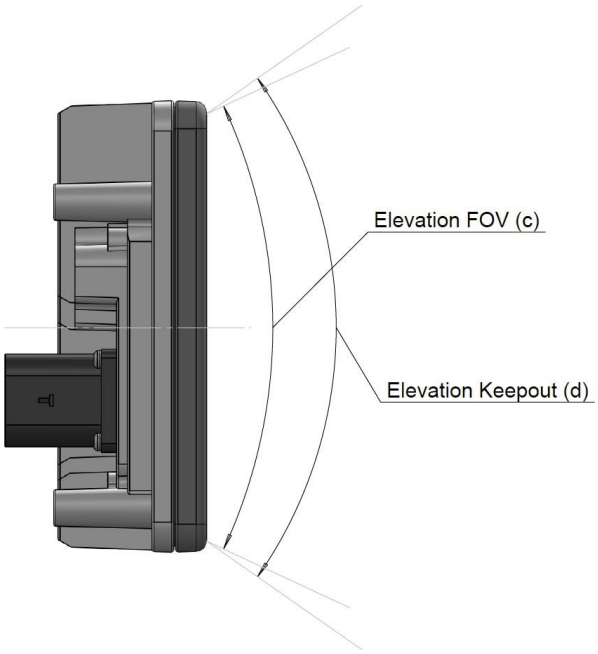


Figure 16. Elevation Keep-Out

		Azimuth		**Elevation**	
Model	**Part No.**	**FOV** *(a)*	**Keep Out** *(b)*	**FOV** *(c)*	**Keep Out** *(d)*
Long-Range	ZPRM3-T1-77-LR	±60°	±75°	±12°	±25°
Wide	ZPRM3-T1-77-W	±60°	±75°	±25°	±35°
Ultra-Wide	ZPRM3-T1-77-UW	±60°	±75°	±45°	±55°

Horizontal FOV Limits:

The horizontal field-of-view limits listed for each variant are soft limits. The specified HFOV corresponds to the antenna -6dB response, an industry standard metric. However, all zPRIME radars can detect objects at horizontal angles up to a hard limit of ±89° (178° total).

Important: Detection performance beyond the specified FOV depends on target radar cross-section (RCS). Any points detected beyond the specified FOV limits should be treated as “bonus”, unqualified performance and is provided without any guarantees unless the unit has been specially qualified by Zadar. Customers can implement an angle filter to remove points beyond the quoted FOV if desired.

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Elevation FOV Limits:

The elevation field-of-view limits listed for -LR and -W variants are hard limits. These models will not detect objects beyond the quoted FOV.

The elevation field-of-view limits listed for -UW variants are soft limits, with a hard limit at ±89°. In practice, it is unlikely that any points will be detected more than 10 degrees beyond the quoted VFOV.

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Fascia Covers, Bumpers, and User-Attached Radomes

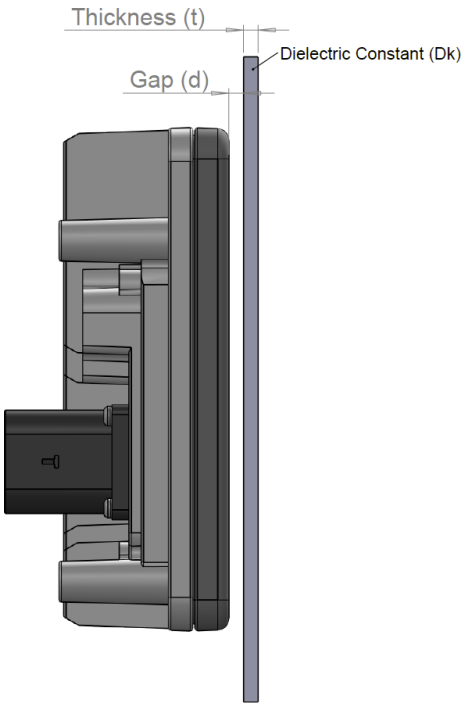


Figure 17. Appropriate Radome Design

Placing an enclosure, cover, or bumper in front of the radar will act as an additional radome. This will affect sensor performance in terms of maximum range and point cloud noise. As the radar's transmitted signal must travel through the additional material, the sensor's performance across FOV will depend on the material, paint type, thickness, and distance from the radar. The material should be plastic, but certain materials and paints perform better than others in terms of dielectric loss.

Good material selection and design will minimize the impact of adding an additional radome. Hence, we recommend proceeding carefully if the user chooses to install the radar behind a surface. If installing a bumper or cover is required in your application, we recommend benchmarking performance with and without the additional cover. Zadar support can help with good radome design.

Thermal Guidelines

zPRIME is rated for operation up to 85°C ambient in still air. The unit has internal temperature monitoring and will shut off if an over-temperature event occurs. Thermal performance may be degraded if the heatsink is obstructed or covered.

☝Based on environmental conditions and operational mode, zPRIME can run hot to the touch. The radar will monitor its own temperature to keep it within limits.

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Ingress Protection

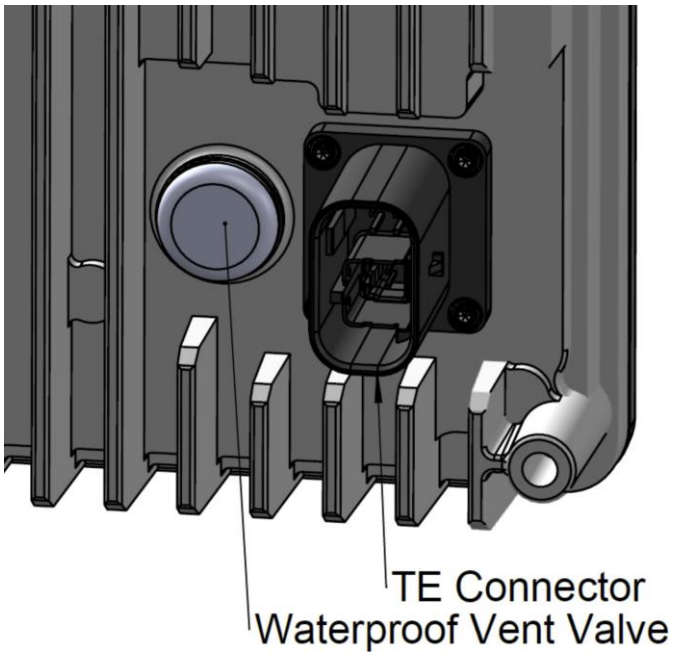


Figure 18. Vent Location

zPRIME sensors are fully sealed and are IP69K rated when the cable is installed. The cable must be installed to guarantee protection against water and dust ingress.

zPRIME sensors include a moisture vent on the back to improve reliability under cyclic temperature, humidity, and pressure variations. Avoid direct jets of water on this vent or the ingress protection may be compromised.

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4 Radar Operation

4.1 Operational Overview

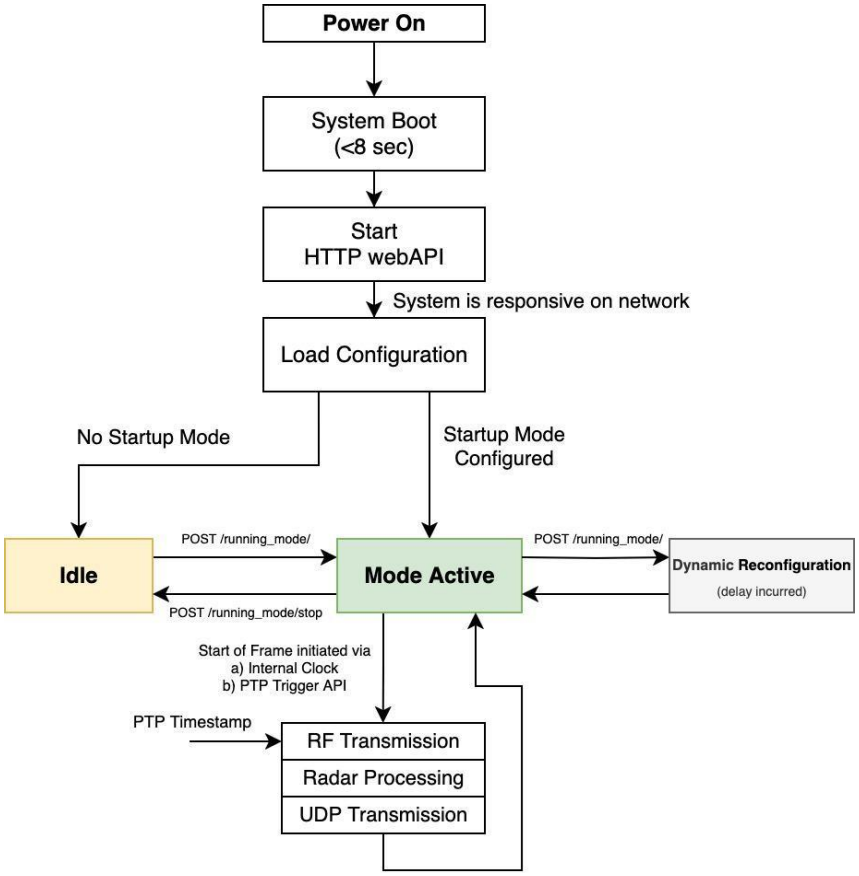


Figure 19. Radar State Machine

After applying 12V power, the radar takes approximately 8 seconds to boot. During this time the radar will not be reachable on the network. After boot is complete, and the T1 ethernet link comes up, the radar will be discoverable by ping and by Avahi mDNS auto-discovery. The radar's HTTP webAPI and configuration webpage will also become available.

By default, if no startup mode is set, the radar will enter idle mode. If a startup mode is set, then the radar will automatically begin framing according to the saved settings. Data will be sent to the UDP destination IP and port as saved in its configuration.

At any time, the radar can be started, stopped, or the mode can be changed via the HTTP webAPI. Changing modes while the radar is running will result in a delay while radar internal settings are reconfigured.

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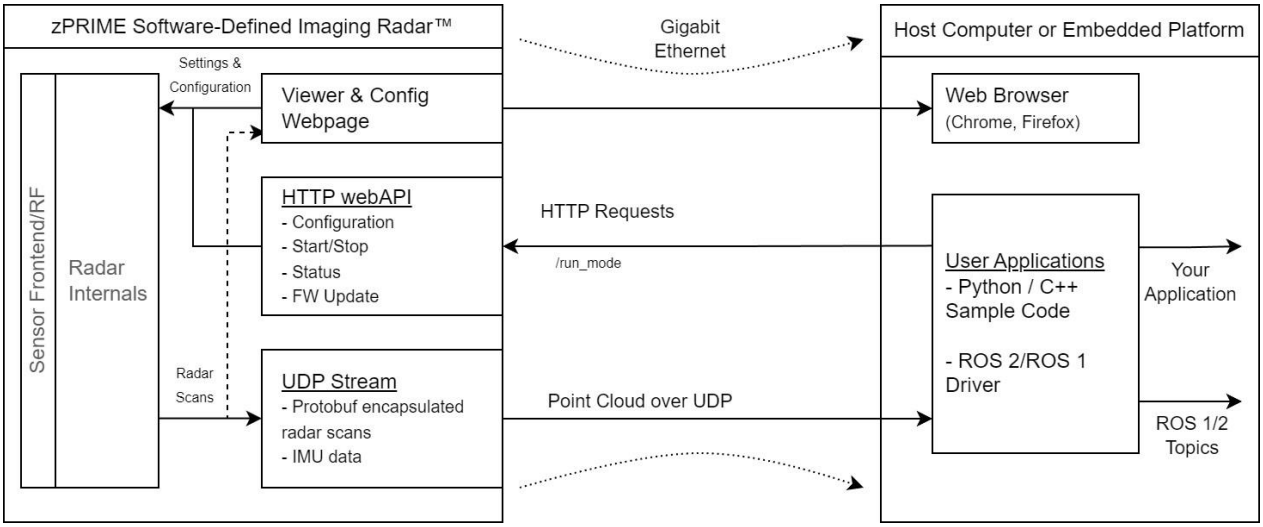


Figure 20. Software Integration Concept

Control of radar operation including starting and stopping transmission, selecting the operational mode, updating firmware, and changing basic settings such as sensor IP address can be achieved in two ways: via the configuration webpage or via the HTTP webAPI.

The configuration webpage provides an easy way to get started with the sensor. The HTTP webAPI allows users to write software to control the radar for production and real-world deployments.

Radar data outputs are provided via UDP stream. After a frame is complete, the radar scan data (point cloud, odometry, plus optional clusters, tracks, and classification) is formatted and then packed into the Protobuf data format. This Protobuf packed data is then sent over the network via UDP to a configurable destination where the receiver will then re-assemble and unpack the Protobuf data to extract the radar scan.

Protobuf provides a convenient, standardized, and forwards/backwards-compatible method of transmitting data. It allows Zadar Labs to add new data outputs to zPRIME in future firmware upgrades without breaking compatibility with existing user deployments.

Examples to start/stop/configure the radar via HTTP webAPI and receive point cloud data via UDP are provided in Python and C++.

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4.2 Network Topology

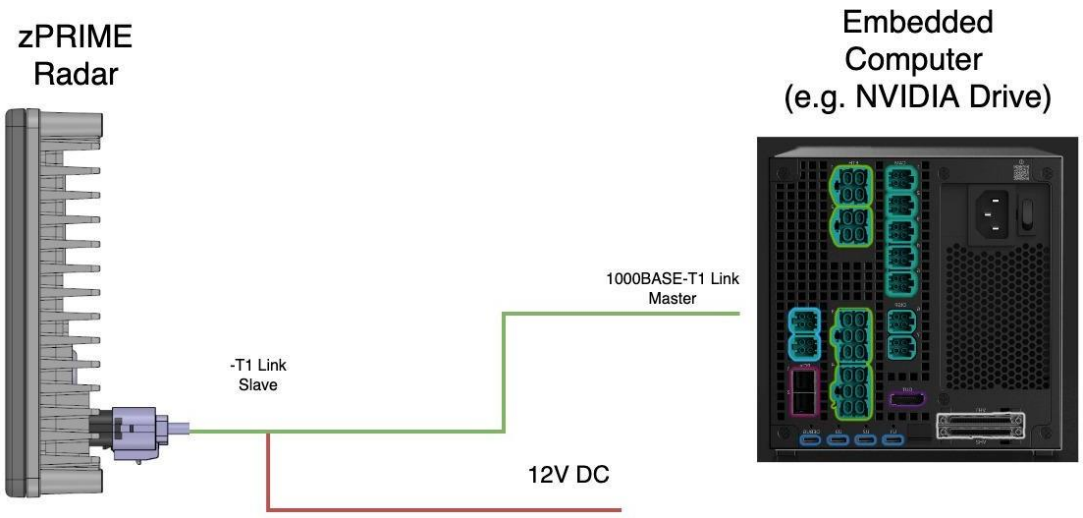


Figure 21. Direct connection of zPRIME to a 1000BASE-T1 host device

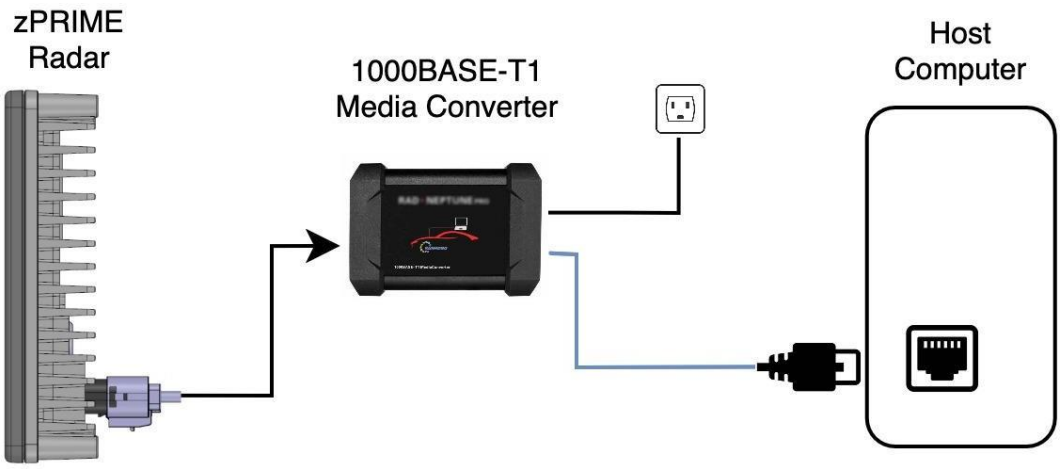


Figure 22. Connection of zPRIME to an RJ45 (1000BASE-T, traditional ethernet) host device

For the default network configuration, see section **3.2 Connection Guide**.

To connect to a radar, the host computer must be on the same subnet as the sensor. The host cannot have the same IP address as the sensor. One suggested configuration for host IP would be:

Suggested Computer Network Configuration

IPv4 Address	Subnet Mask	DHCP
192.168.0.20	255.255.255.0	Off / Static IP

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Ubuntu Network Configuration

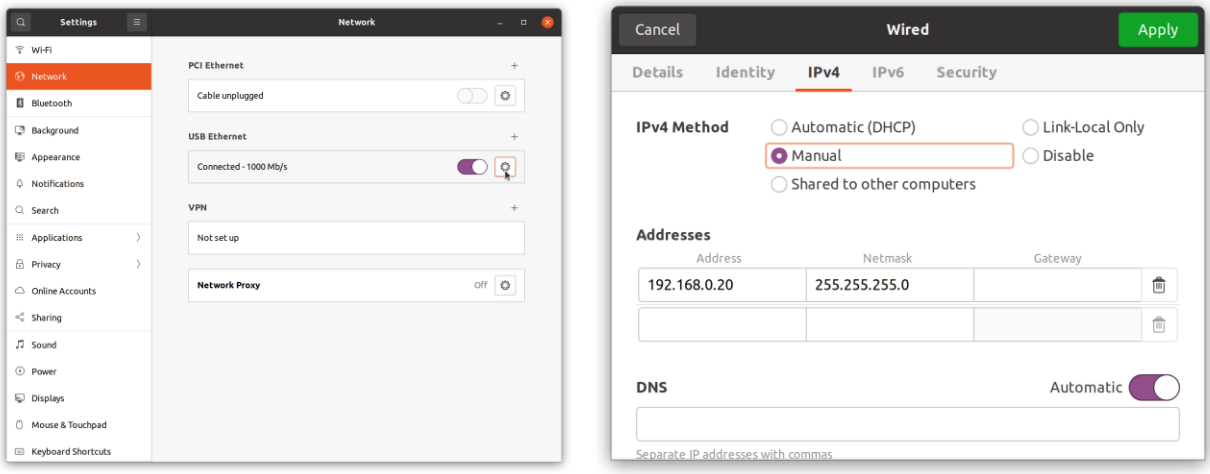


Figure 23. Ubuntu Network Settings

1. Navigate to the Settings pane
2. Select the 'Network' tab and configure your Ethernet adapter settings
3. Set 'IPv4' network settings to 'Manual' with an IP address of 192.168.0.20 and a subnet mask of 255.255.255.0
4. Select 'Apply'
5. Check your network settings have been applied by using the `ifconfig` utility and ensure the settings displayed there match the settings you selected

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Windows 11 Network Configuration

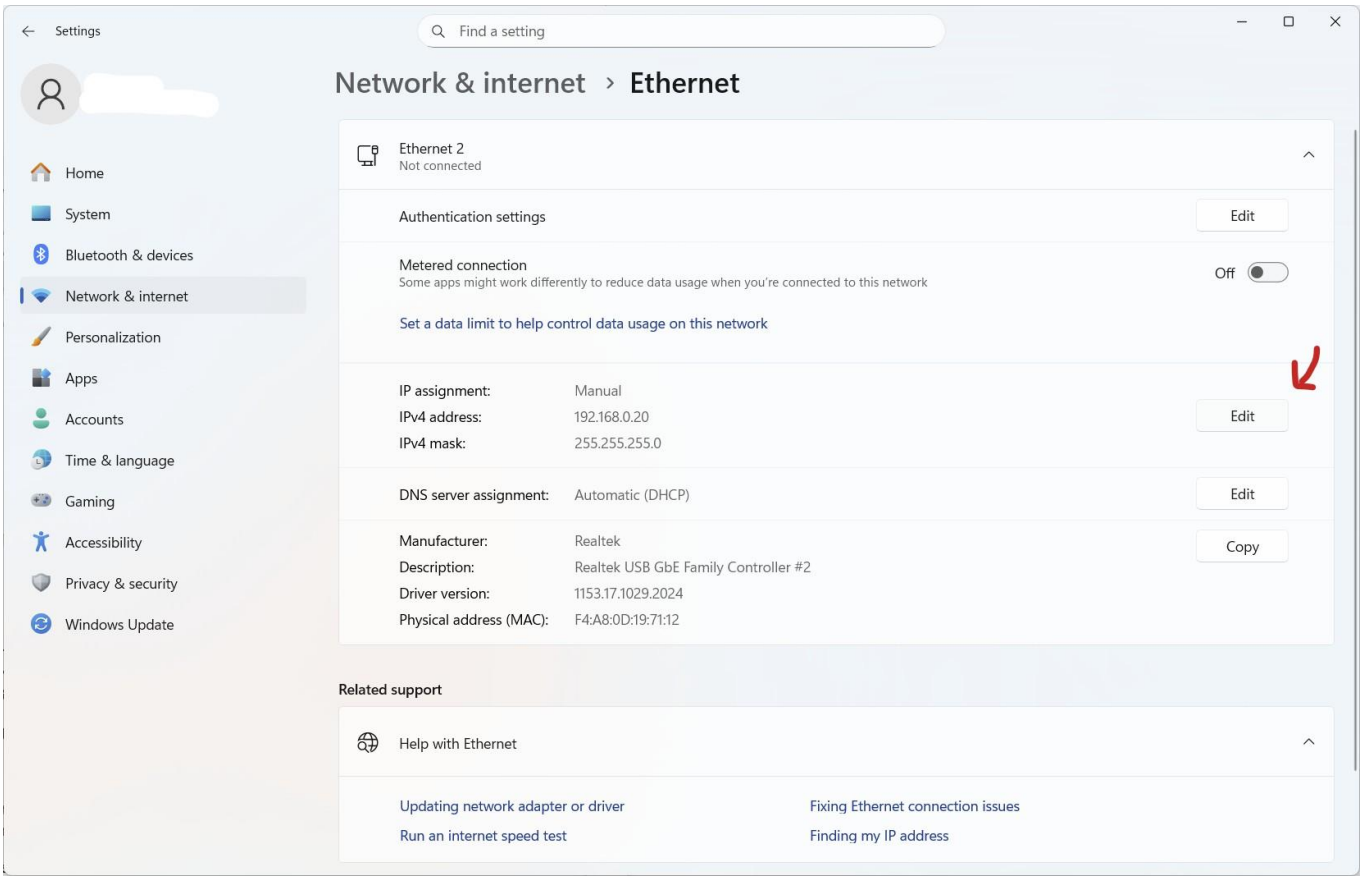


Figure 24. Windows Network Settings

Step 1: Access Network Settings

1. Click on the **Start** menu and select **Settings** (or press Win + I).
2. In the **Settings** window, navigate to **Network & Internet** from the left sidebar.
3. Under **Network & Internet**, click on **Ethernet**.

Step 2: Modify IP Configuration

4. Scroll down and locate the **IP assignment** section.
5. Click the **Edit** button next to **IP assignment**.
6. In the **Edit IP settings** window, select **Manual** from the drop-down menu.
7. Toggle **IPv4** to the "On" position.

Step 3: Enter IP Address Details

8. In the **IP address** field, enter: 192.168.0.20.

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9. In the **Subnet mask** field, enter: 255.255.255.0

Step 4: Save and Apply Settings

10. Click **Save** to apply the static IP configuration.
11. Close the **Settings** window.

Step 5: Verify Configuration

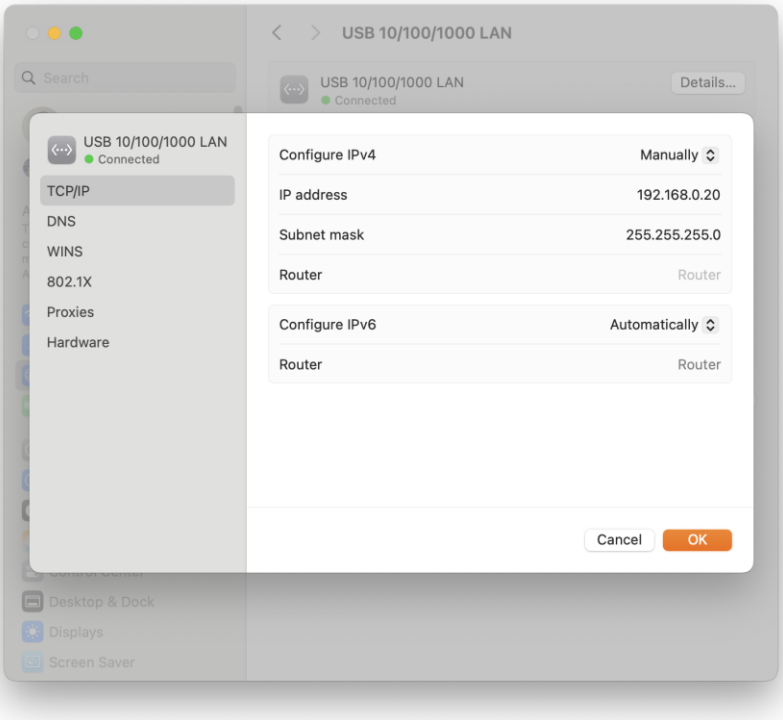
12. Open **Command Prompt** (Win + R, type cmd, then press Enter).
13. Type the following command and press Enter:

```
None
ipconfig /all
```

14. Confirm that the Ethernet adapter now shows the manually assigned IP address (192.168.0.20) with the correct subnet mask and gateway.

Your Windows 11 device is now configured with a static IP address on the **192.168.0.0/24** network.

MacOS Network Configuration



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Figure 25. MacOS Network Settings

1. Plug in your ethernet adapter and the network cable.
2. Click the Apple Logo in the upper left corner > System Settings… → left-side panel Network.
3. In the main pane you'll see your interfaces. Select USB 10/100/1000 LAN (or whatever name your adapter shows).
4. Click the Details… button on the right.
5. In the pop-up sidebar, choose TCP/IP.
6. Next to Configure IPv4, open the dropdown and pick Manually.
7. Fill in the Fields:

Field	Value
IP Address	`192.168.0.20`
Subnet Mask	`255.255.255.0`
Router (Gateway)	*(leave blank or add if needed, e.g. `192.168.0.1`)*

8. Press OK → Apply.
9. Verify the new address appears under the interface name and the status dot is green.

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4.3 Verifying Network Connection

Each sensor presents a unique local URL at `zPRIME-[radar serial number].local`.

> For example, a radar with serial number 4225CDW001 would be reachable at `zPRIME-4225CDW001.local`

A valid connection to the radar can be checked one of four ways:

1. Pinging the sensor directly at its IP address (by default, 192.168.0.10)
    a. `ping 192.168.0.10`
2. Pinging the sensor at its .local sensor URL
    a. `ping zPRIME-4225CDW001.local`
3. Visiting the configuration webpage in your web browser by its .local URL
4. Using the avahi-discover utility to discover the sensor using mDNS. This method can be used to recover the IP address of a sensor if it has been misconfigured or lost.

The IP address and DHCP configuration can be changed via the configuration webpage or via HTTP webAPI. Details on how to do this can be found later in this guide.

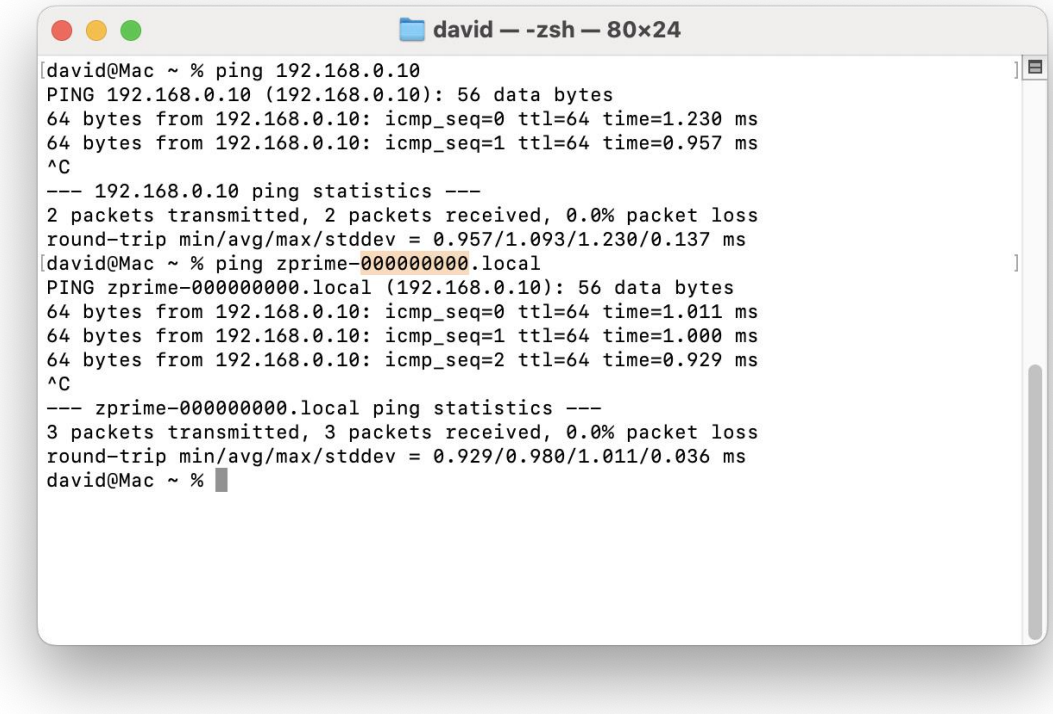


Figure 26. Pinging the Radar

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4.4 Point Cloud Viewer and Management Webpage

Each zPRIME sensor hosts a local webpage that can be used to change radar settings and view the live radar point cloud, all through your internet browser.

This webpage can be reached one of two ways:

1. Browsing the radar's .local URL: `zPRIME-[radar serial number].local`
2. Browsing the radar's IP address, by default: `192.168.0.10`

If you have issues connecting or visiting the webpage:

- Make sure the radar is powered correctly and can be reached via pinging the network. Check the previous section to ensure the network is active and connected.
- The radar's .local URL should work even if the radar's IP address has been changed, as long as the radar's IP remains on the host computer's subnet.

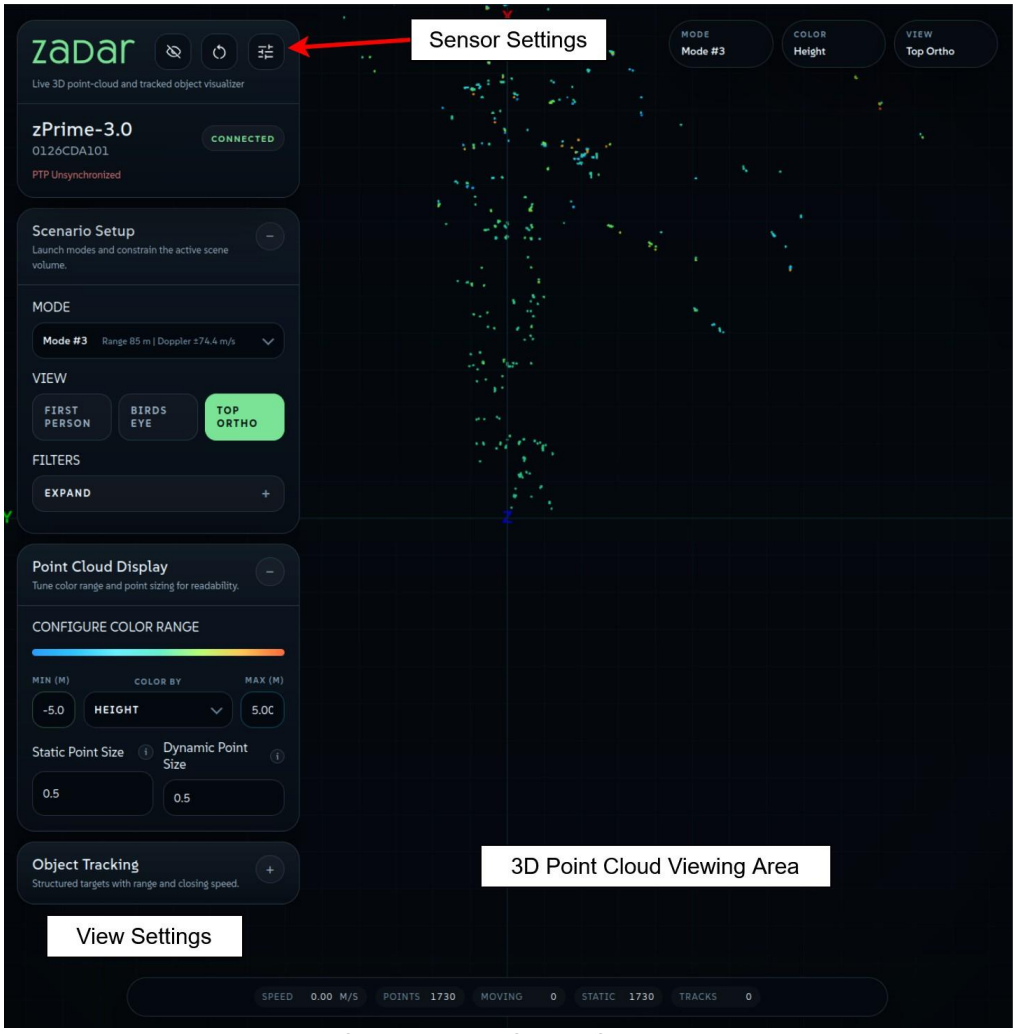


Figure 27. Radar Webpage

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Basic Operations

Action	Result
Left click - Drag	Rotate the 3D view
Right click - Drag	Translate/shift the 3D view
Left click an object	Brings up object information display
Scroll	Zoom in/out to the display center
S key	Snap to nearest flat view (upwards, sideways, or forward)
O key	Toggle between orthographic and perspective projections
X, Y, Z keys	Toggles YZ, XZ, and XY coordinate planes
Spacebar	Freezes data view to the current frame and stops updates to the display

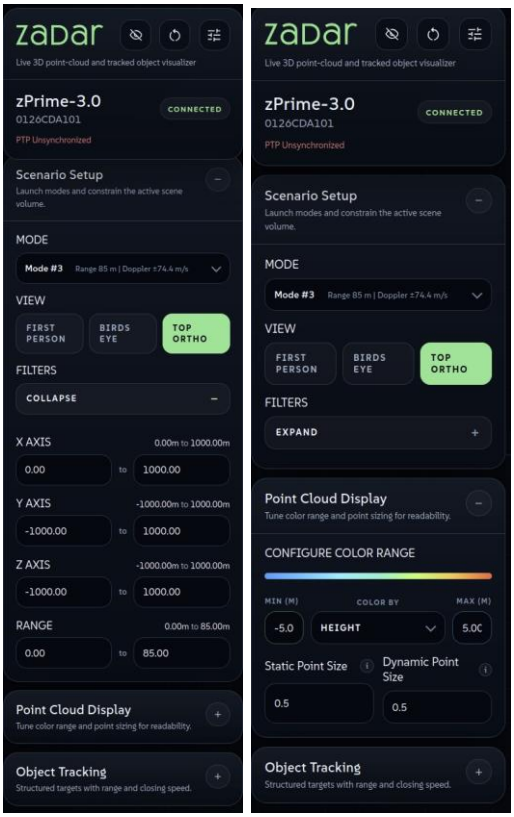


Figure 28. Radar Viewer Options

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Radar Settings Configuration via Webpage

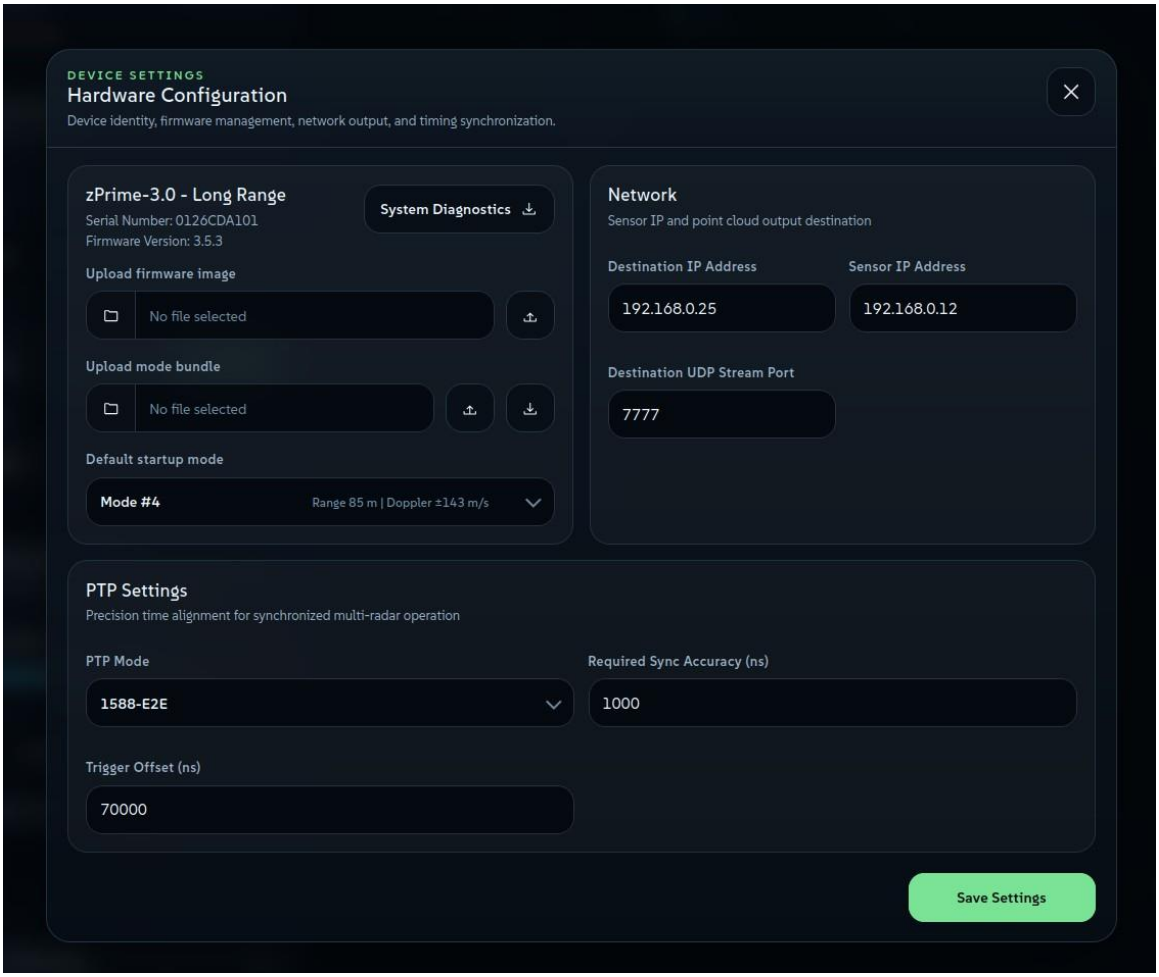


Figure 29. Radar Settings Pane

Firmware & Modes	
Upload Firmware Image	Use this to update firmware releases provided by Zadar. The system will automatically reboot.
Upload Mode Bundle	Use this to upload new mode configurations provided by Zadar Use this to download and save the existing mode configuration
Default Startup Mode	Set the operational mode to automatically launch on radar startup
Network	
Destination IP Address	Set the destination where UDP radar point cloud data is sent to. Typically, this is the host computer's IP address.

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Destination UDP Stream Port	Set the destination port which receives the radar data.
Sensor IP Address	Change the IP address of the sensor. This requires a manual reboot to apply.
PTP Settings	
PTP Mode	PTP Profile to follow. Supported profiles are 1588v2-E2E and automotive-slave
Required Sync Accuracy	Refer to PTP section in this manual for details.
Trigger Offset	Refer to PTP section in this manual for details.

4.5 HTTP REST API Guide

This is an **optional** section, most radar settings can be configured manually via the web page.

The radar can be configured via our configuration REST API. This allows users to:

- Query radar status
- Start the radar
- Change operating modes
- Change data output destination
- Update firmware and operating modes
- And more

Specific details, exact specifications and example cURL commands for the REST API can be found in the API Documentation: zPRIME-Standalone-Configuration-Endpoints.pdf

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Rest API Endpoint Diagram

/api/v1

- device
  - modes [GET]
  - reboot [PUT]
  - clock [GET]
  - ptp_sync [GET]
  - running_mode [GET, POST]
    - stop [POST]
  - network
    - ipv4
      - address [GET]
  - system
    - sensor_info [GET]
    - diagnostics [GET]
- system
  - network
    - ipv4
      - address [GET, PUT, DELETE]
  - output_destination
    - ipaddress [GET, PUT, DELETE]
    - pcl
      - port [GET, PUT, DELETE]
    - imu
      - port [GET, PUT, DELETE]
  - ptp
    - mode [GET, PUT]
    - sync_accuracy [GET, PUT]
    - trigger_offset [GET, PUT]
  - flash
    - image [POST]
    - modes [POST]
  - startup_mode [GET, PUT, DELETE]
  - system_config [DELETE]

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API Endpoint Quick Guide

Refer to the API Documentation for specific cURL commands. Some common ones are here:

Setting	Endpoint Name (In API Documentation)
Radar IP Address	Device IP Address - PUT (Static IP)

None

```
curl -X PUT http://zPrime-${radarSN}.local:8080/api/v1/system/network/ipv4/address -H "Content-Type: application/json" -d '{"ip_address": "192.168.1.100"}'
```

Destination IP Address	Output Destination IP Address - PUT

None

```
curl -X PUT http://zPrime-${radarSN}.local:8080/api/v1/system/output_destination/ipaddress -H "Content-Type: application/json" -d '{"ip_address": "192.168.0.101"}'
```

Destination Point Cloud / DQE Port	Point Cloud (PCL) Port - PUT

None

```
curl -X PUT http://zPrime-${radarSN}.local:8080/api/v1/system/output_destination/pcl/port -H "Content-Type: application/json" -d '{"pcl_port": 12345}'
```

Radar Mode on Boot	Startup Mode - PUT

None

```
curl -X PUT http://zPrime-${radarSN}.local:8080/api/v1/system/startup_mode -H "Content-Type: application/json" -d '{"mode": 1}'
```

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5 Data Format and Interpretation

The radar will send point cloud data over UDP to the destination IP address and PCL port that you configured. You will need to create a UDP listener on these ports and IP addresses to receive the data. 4D Point Cloud data and optional SW outputs such as clusters, tracks, classified objects, and onboard radar odometry are also sent to the PCL port.

5.1 Receiving and Deserializing Radar (Point Cloud) Data

All radar data is sent over UDP to the destination IP address and port(s). At the destination address, a listener should be set up to receive the data. A parser must be written to reconstruct the incoming packets into a complete radar scan frame. Zadar provides sample code in Python and C++ to parse incoming radar data.

The radar scan can include:

- Point cloud (provided on all radars)
- Clusters
- Tracks
- Classification
- Radar-based odometry
- Custom outputs on a customer-by-customer basis

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UDP Transfer Scheme

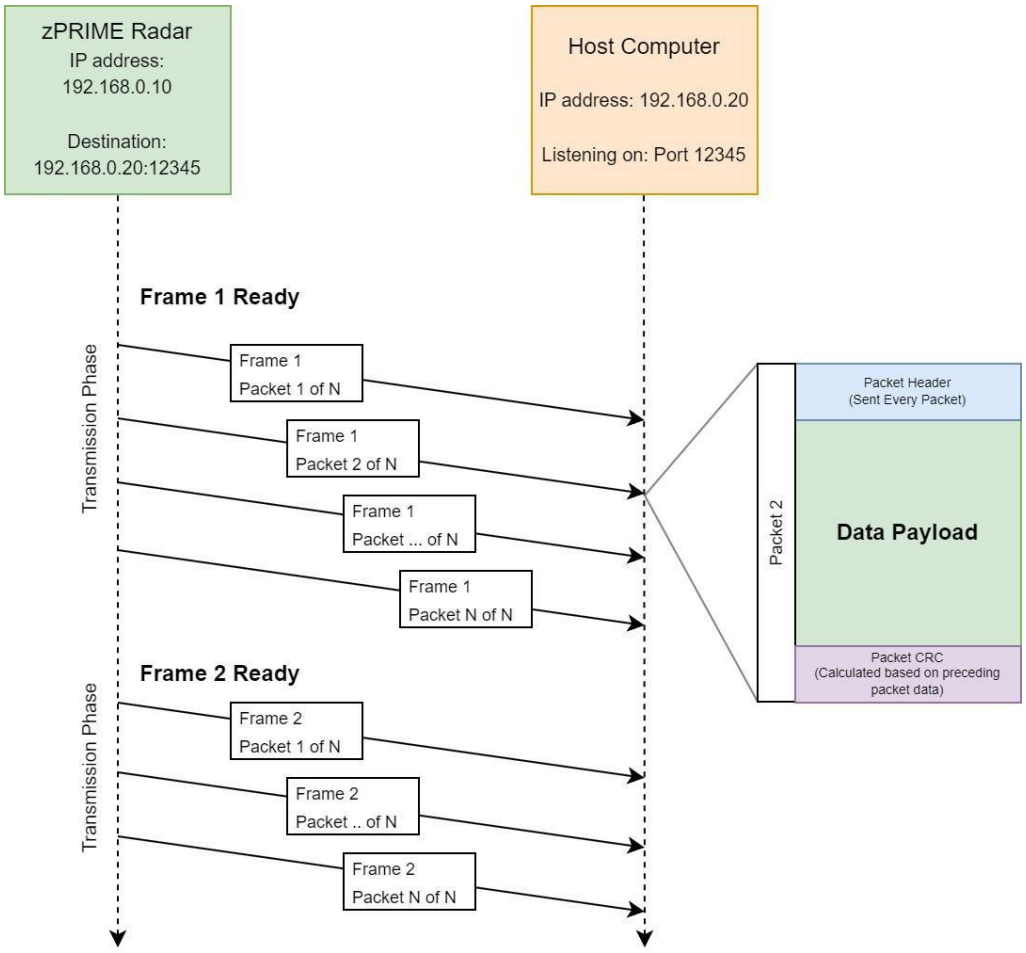


Figure 30. UDP Packet Transfer

Each frame is fragmented into packets, and each packet has a maximum size of 1500 bytes.
Each packet consists of:

1. Packet header
2. Data payload (protobuf binary data fragment)
3. Packet footer/CRC

The header identifies how to assemble the frame from these packets. When the full data payload is assembled, it can be decoded into the radar data stream using protobuf. Since UDP is used for transmission there is a possibility of data loss or reordering over the network. If data loss occurs the whole frame must be dropped, and data loss can be detected by ensuring:

1. All packets for a given frame have been received and are in order based on packet header data
2. The data in each packet received matches the CRC appended to each packet

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Packet Struct

Note: The values in the header are little-endian

Note: All timestamps come from the radar's internal clock. If a PTP grandmaster is active on the network, the radar's internal clock will be continuously synchronized to the PTP time.

C/C++

```
struct __attribute__((__packed__)) UDPPointCloudHeader {
    uint16_t radar_id;                    // ID number for radar
    uint16_t  data_format;      // 0 for pre-scaled values, 1 for unscaled values
    uint32_t points_in_frame;             // Number of points in the current frame
    struct timespec timestamp;            // Timestamp of current frame
    uint16_t frame_id;                    // Current frame number
    uint16_t packets_in_frame;            // Number of packets required for this frame
    uint16_t packet_index;                // Index of current packet, out of packets_in_frame
    uint16_t data_size;                   // Number of bytes in the data section of the packet
};

struct __attribute__((__packed__)) UDPPointCloudPacket {
    UDPPointCloudHeader header;
    char buffer[1400];
    uint64_t crc;
};
```

In the header, the *frame_id* tells you which frame this packet belongs to. *packets_in_frame* tells you how many packets this frame will have, and *packet_index* (0-indexed) tells you the order in which the packet belongs. *data_size* tells you how many bytes of data are in the data segment.

To reconstruct a full data payload, concatenate data segments in order from index 0 to packets_in_frame - 1. The final 8 bytes of the packet are the crc, we use crc-64-xz as the algorithm to determine the crc of the packet. Please compare the packet crc with the computed crc of the entire packet excluding the crc section.

Once the last packet is received and the full data payload is assembled, pass the data payload to protobuf to deserialize the wire-format. Once deserialized, please refer to our .proto file and your protobuf library to handle and extract the data. Additional details about the meaning of our data outputs can be found in our software documentation.

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Sample Radar Data UDP Parser Code

Sample code can be found in the ZadarSoftwareDriver under api_templates, additionally linked below is the same sample code.

Standalone Python Examples

The above examples, covers parsing and deserializing the information from UDP to be usable by an application. The radar example shows the X, Y, Z, and doppler of 5 points from the scan along with the number of points in the point cloud.

The following examples will assume the existence of the deserialized ZadarFrame object in python named **radarframe**

Extracting 4D Point Cloud

The deserialized ZadarFrame object contains a radar_scan object that will contain the point cloud. Please refer to our .proto file to see which fields exist, and our software documentation contains information on the meaning of each field.

```python
radarframe.radar_scan
len(radarframe.radar_scan.points) #Number of points in the point cloud
radarframe.radar_scan.points[59].snr #SNR of the 60th point
```

Extracting Radar Odometry

Not all sensors have onboard radar odometry enabled.

The deserialized ZadarFrame object contains an odometry object that will contain the odometry data. Please refer to our .proto file to see which fields exist, and our software documentation contains information on the meaning of each field.

```python
radarframe.odometry
radarframe.odometry.vx #X-Axis component of velocity of the radar
```

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Extracting Clusters

Not all sensors have onboard radar clusters enabled.

The deserialized ZadarFrame object contains a clusters object that will contain cluster information. Please refer to our .proto file to see which fields exist, and our software documentation contains information on the meaning of each field.

```python
len(radarframe.clusters) #Number of clusters in radarframe
radarframe.clusters[5].doppler #Doppler of 6th cluster
```

Extracting Tracks

Not all sensors have onboard radar tracks enabled.

The deserialized ZadarFrame object contains a tracks object that will contain the tracking information. Please refer to our .proto file to see which fields exist, and our software documentation contains information on the meaning of each field.

```python
len(radarframe.tracks) #Number of tracks in radar frame
radarframe.tracks[2].track_id #Track id of the 3rd track
```

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5.2 Coordinate Systems

zPRIME follows ISO 8855 coordinate system standards:

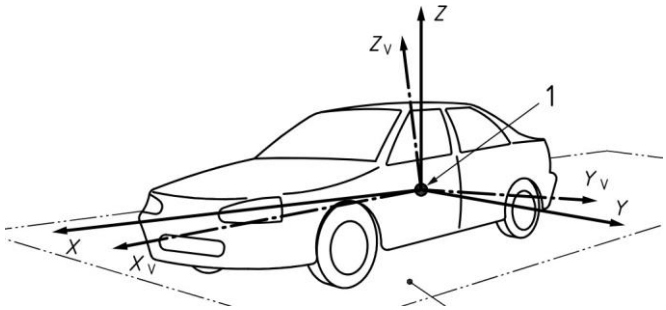


Figure 31. Coordinate System Conventions

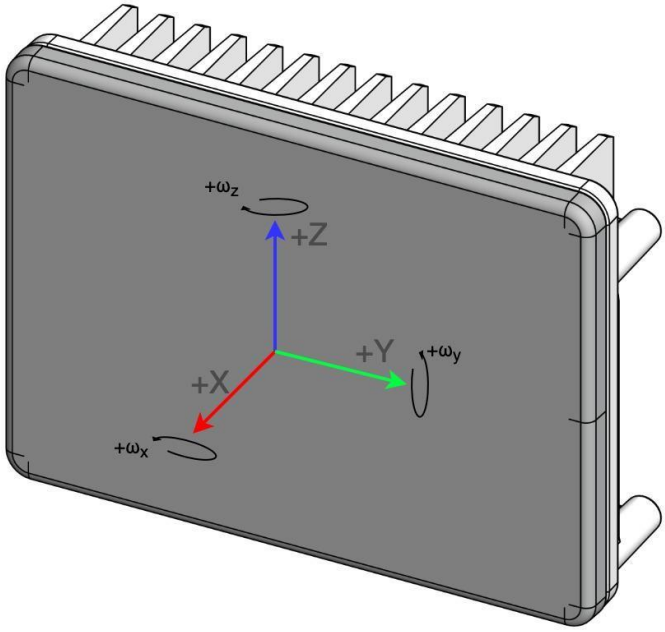


Figure 32. Radar Coordinate Systems
Omega (rotational rate) is clockwise positive

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5.3 PTP Time Synchronization

zPRIME supports synchronized operation using either IEEE1588v2 PTP and 802.1AS gPTP profiles. When a grandmaster is present on the network, zPRIME will automatically synchronize its internal clock and timestamps according to the grandmaster.

PTP Network Connection Topologies

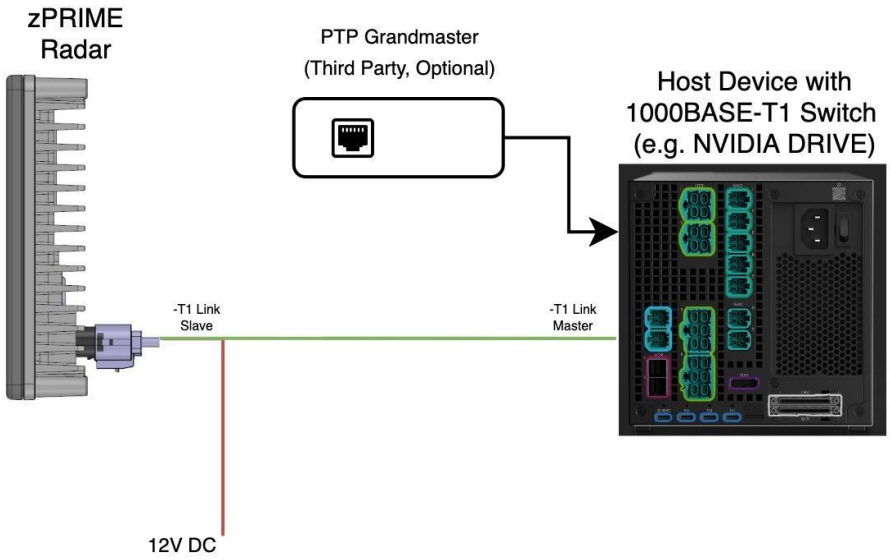


Figure 34. PTP Network Topology with 1000BASE-T1 Network

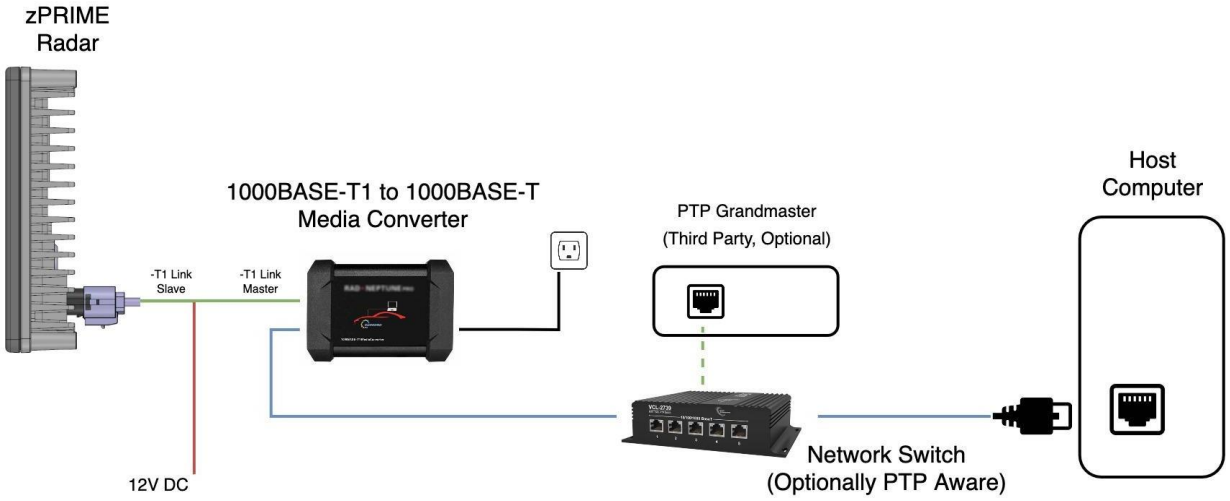


Figure 35. PTP Network Topology with RJ45/1000BASE-T Network

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PTP Timestamping & Triggering

zPRIME supports PTP timestamping of frame start times and synchronized triggering of frames. The API for PTP configuration includes the following endpoints:

- *ptp_sync* - get the current PTP synchronization status
  - *synchronized* - true if *sync_quality_ns* is better than the *sync_accuracy,* and the sensor considers the time synchronized
  - *sync_quality_ns* - The quality of the current synchronization, measured as the max difference between local and master clock over the past 5 seconds
- *ptp/mode* - select the current PTP mode from a list of predefined options
  - *1588-E2E* - Standard IEEE1588v2 PTP, with end-to-end delay measurement
  - *automotive-slave* - 802.1as / gPTP mode, acting as a slave with BMCA disabled
- *ptp/sync_accuracy* - the highest clock inaccuracy (in ns) to still be considered synchronized
- *ptp/trigger_offset* - allows the trigger to be offset from the second-boundary by a specified offset (in ns), for staggering sensor frame times and interference mitigation

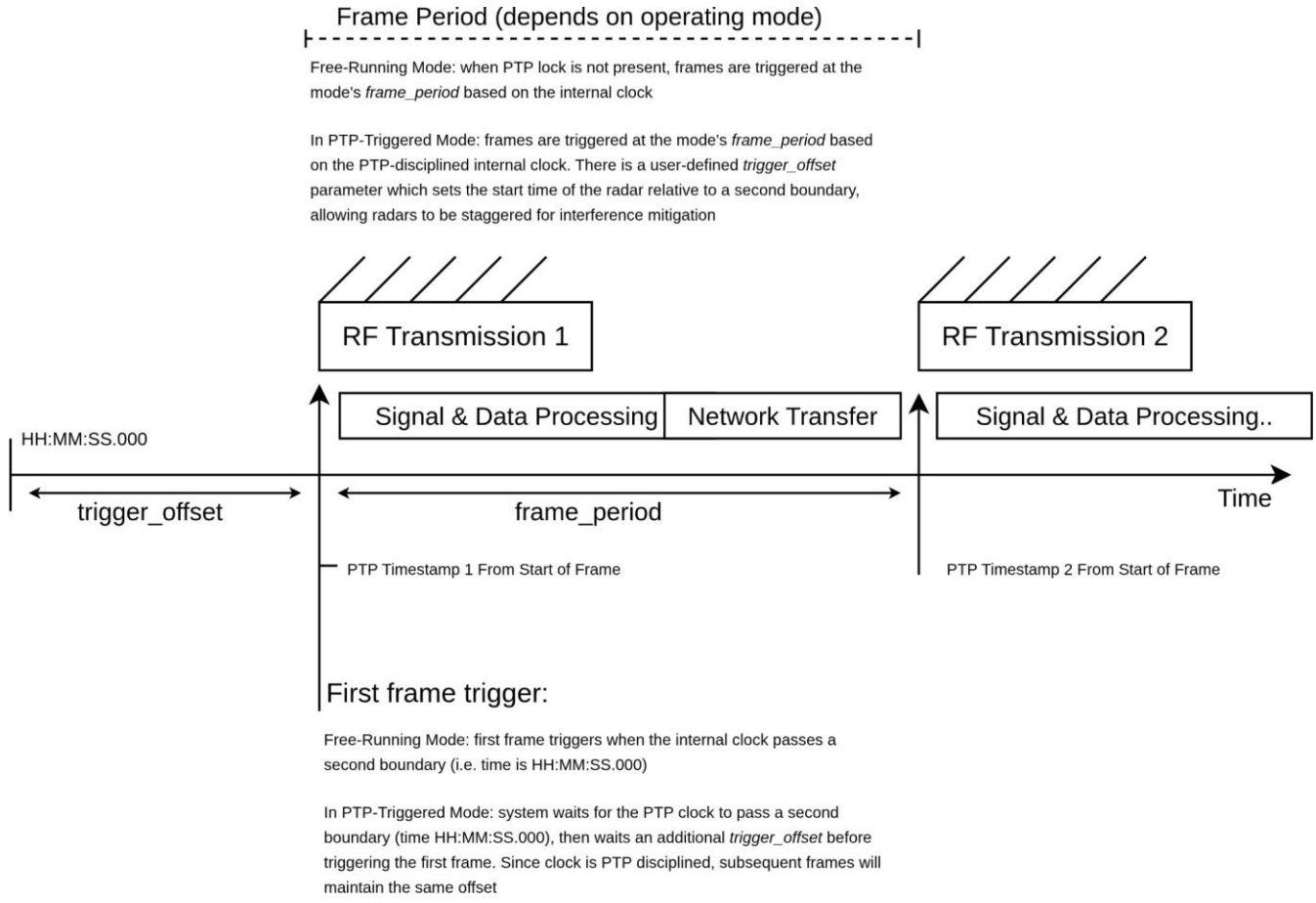


Figure 36. PTP Timing Scheme

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PTP Establishment Or Loss of Sync

The system is designed to allow timestamping and triggering based on PTP, without depending on it.

Establishment of Sync

When PTP synchronization is established, the system will begin to discipline the internal clock to match the master clock. This may result in the current time jumping forward or backward, as necessary, to match the master clock. Once the clock is synchronized, there will be only minor adjustments to the clock to keep it in sync.

If sensor is not yet running:
The clock synchronization will occur seamlessly and when the sensor is started, it will be synchronized to the PTP clock.

If sensor is already running:
If the sensor is already running when PTP sync is established, it will be momentarily impossible to both meet a consistent frame rate and also synchronize the trigger to the master clock. To minimize disruption, the sensor will skip a single frame if a time adjustment would cause two frames to have a period less than frame_period. Framing will then continue as usual.
There are two cases for time adjustment, both will result in a single longer-than-normal frame period, and a discontinuity in the reported timestamps. (Figure 37)

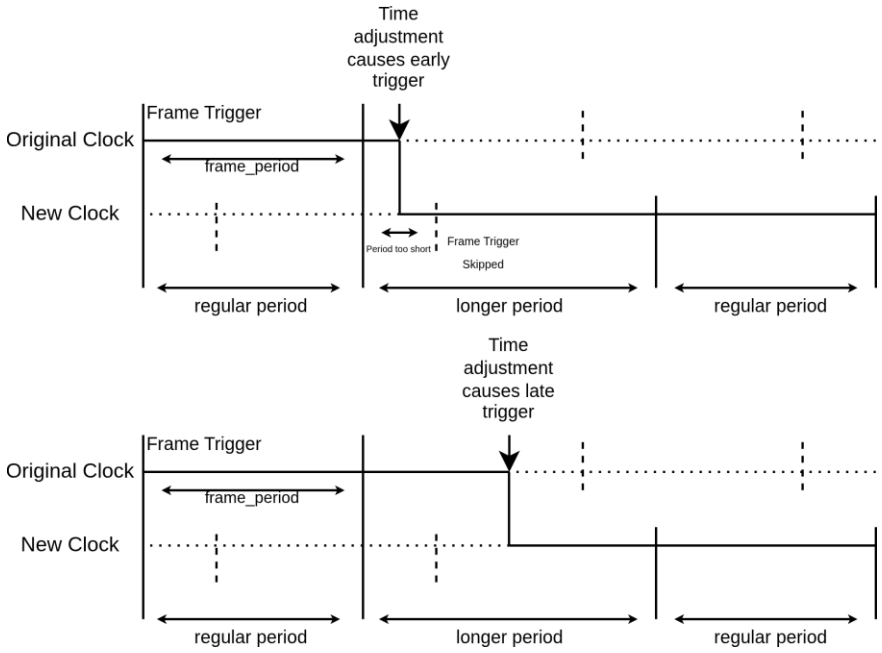


Figure 37. PTP Trigger Time Adjustment behavior

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Loss of Sync

In the event of a loss of PTP sync, the sensor's internal clock will continue to run based on the last settings it had established during PTP sync. This will gradually drift, on the order of nanoseconds-microseconds per second, until PTP sync is re-established. The trigger will remain synchronized to the timestamp, so any loss of synchronization will not be visible in the timestamp until PTP synchronization is re-established.

Current PTP synchronization status can be probed by the user using the *ptp_sync* API endpoint.

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6 Troubleshooting and Maintenance

6.1 Basic Diagnostics, Common Issues, and Fixes

I can't visit the webpage of the radar.

- Check your network configuration settings and see if you can ping the radar via the network. Make sure to wait 7-8 seconds after power on for the radar to boot before trying to ping or visit the webpage.
- Try visiting the bare IP address (default 192.168.0.10) and the local address of the radar (zPRIME-[serialnumber].local) in your browser.
- Make sure your computer's network is properly configured with the correct IPv4 static address. Use the network configuration section to double check this is done properly.

I've lost the IP address of zPRIME.

- If you still have network contact to zPRIME, ping the sensor or visit the webpage via the local address of the radar (zPRIME-[serialnumber].local). The ping destination or the webpage settings pane will tell you the IP address of the sensor.
- If you do not have contact to zPRIME and you do not know if your local IP address is set correctly, you can use Avahi/mDNS discovery to find the IP address of the sensor. In Linux, this can be done via the avahi-browse utility.

I'm not sure if zPRIME is booting. How can I check?

- After applying power, zPRIME should immediately link up a 1000BASE-T1 link master. Even if you don't have a host connected, the link up should occur. Check the link status on your 1000BASE-T1 PHY or media converter- if it doesn't come up, check the 1000BASE-T1 cable and make sure the power supply is stable.

6.2 Firmware Updates

Firmware updates can be applied to zPRIME in two ways:

1. Via web browser: visit the web configurator for zPRIME. In the settings pane, there will be an option to upload a new firmware image. Select your downloaded firmware image here and wait for the upgrade process to complete. It may take a few minutes and the radar will automatically reconnect after the process is complete. DO NOT DISCONNECT POWER OR DATA TO THE RADAR DURING THIS PROCESS OR DAMAGE MAY OCCUR.
2. Via HTTP/REST API: there is an endpoint to upload new firmware images for automatic firmware upgrade.

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7 Appendix

7.1 Standard Operational Modes

zPRIME 3.0 - Worldwide

FW Release 4.0 and below

Mode ID for each zPRIME Variant											
	LR	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	W	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	NA	
	U	**1**	**2**	**3**	**4**	**5**	**6**	NA			
Max Range		30m	30m	85m	85m	250m	250m	400m	400m	800m	800m
Minimum Range		0.05m	0.05m	0.1m	0.2m	0.3m	0.75m	0.5m	1.0m	1.0m	2.0m
Range Resolution		3.3cm	3.3cm	8.9cm	17.8cm	26.2cm	52.3cm	41.9cm	82.2cm	83.4cm	167.4cm
Doppler Ambiguity*		40.4m/s	74.4m/s	74.4m/s	143.4m/s	74.4m/s	143.4m/s	74.4m/s	143.4m/s	74.4m/s	143.4m/s
Doppler Resolution		0.079m/s	0.145m/s	0.145m/s	0.14m/s	0.145m/s	0.14m/s	0.145m/s	0.14m/s	0.145m/s	0.14m/s
Field of View (H x V)		120° x 24° (LR) / 120° x 48° (W) / 120° x 90° (U)									
Angular Res. (H x V)		0.35° x 0.35° (LR) / 0.35° x 0.90° (W) / 0.35° x 1.6° (U)									
Frame Time		50ms									
* The platform speed needs to be less than 1/2 of the provided range for Doppler Ambiguity, otherwise the reported platform velocity might be folded.											

zPRIME 3.0 - Japan Models

FW Release 4.0 and below

Mode ID for each zPRIME Variant										
	LR	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	W	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**NA**	
	U	**1**	**2**	**3**	**4**	**5**	**NA**			
Max Range		30m	30m	85m	85m	250m	250m	400m	400m	800m
Minimum Range		0.05m	0.05m	0.1m	0.2m	0.3m	0.75m	0.5m	1.0m	1.0m
Range Resolution		3.3cm	3.3cm	8.9cm	17.8cm	26.2cm	52.3cm	41.9cm	82.2cm	83.4cm
Doppler Ambiguity*		40.4m/s	74.4m/s	74.4m/s	143.4m/s	74.4m/s	143.4m/s	74.4m/s	143.4m/s	74.4m/s
Doppler Resolution		0.079m/s	0.145m/s	0.145m/s	0.14m/s	0.145m/s	0.14m/s	0.145m/s	0.14m/s	0.145m/s
Field of View (H x V)		120° x 24° (LR) / 120° x 48° (W) / 120° x 90° (U)								
Angular Res. (H x V)		0.35° x 0.35° (LR) / 0.35° x 0.90° (W) / 0.35° x 1.6° (U)								
Frame Time		50ms								
* The platform speed needs to be less than 1/2 of the provided range for Doppler Ambiguity, otherwise the reported platform velocity might be folded.										

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8 Revision History

Date	Revision	Notes
04/20/2026	1.1	Update web viewer documentation for FW 4.0 Add standard zPRIME 3.0 operational modes to appendix Add new notes on radar FOV
2/03/2026	1.03	Revised PTP synchronization behavior
1/20/2026	1.02	Revised cable harness drawing
12/23/2025	1.01	Added EU Declaration of Conformity Updated kit photo Updated media converter instructions
9/29/2025	1.0	Initial revision of unified user manual

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