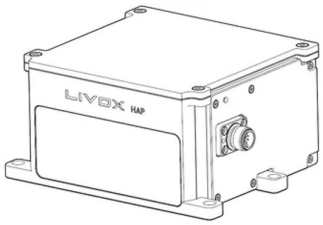
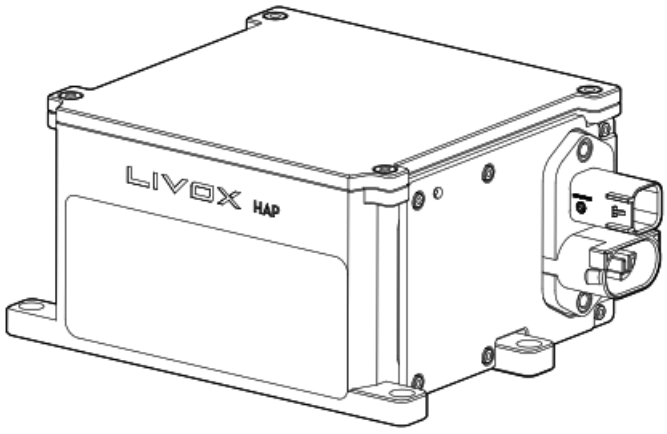


LIVOX T1 HAP High Performance LiDAR Sensor User Guide

LIVOX HAP

T1
Sensor User Guide



Contents

DISCLAIMER

This product is NOT a toy and is not suitable for children under 16. Adults should keep the product out of the reach of children and exercise caution when operating this product in the presence of children. This product incorporates various advanced technologies. However, inappropriate use of the product could result in personal injury or property damage. Read the materials associated with the product before using it for the first time. These documents are included in the product package or are available on the UVOXTM Technology Company Limited ("Livox") website **(www.livoxtech.com**). The information in this document affects your safety and your legal rights and responsibilities. Read this entire document carefully to ensure proper configuration before use. Failure to read and follow the instructions and warnings in this document may result in serious injury to yourself or others, damage to or loss of your Livox product, or damage to other objects in the vicinity. By using this product, you hereby signify that you have read this disclaimer carefully and that you understand and agree to abide by the terms and conditions herein. EXCEPT EXPRESSLY PROVIDED IN UVOX AFTER-SALES SERVICE POLICIES AVAILABLE AT **www.livoxtech.com**, THE PRODUCT AND ALL MATERIALS, AND CONTENT AVAILABLE THROUGH THE PRODUCT ARE PROVIDED "AS IS" AND ON AN "AS AVAILABLE" BASIS, WITHOUT WARRANTY OR CONDITION OF ANY KIND, EITHER EXPRESS OR IMPLIED. LUVOX DISCLAIMS ALL WARRANTIES OF ANY KIND, EXCEPT AS EXPRESSLY PROVIDED IN LIVOX AFTERSALES SERVICE POLICIES, WHETHER EXPRESS OR IMPLIED, RELATING TO THE PRODUCT, PRODUCT ACCESSORIES, AND ALL MATERIALS, INCLUDING (A) ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE, QUIET ENJOYMENT, OR NON-INFRINGEMENT; AND (B) ANY WARRANTY ARISING OUT OF COURSE OF DEALING, USAGE, OR TRADE. LUVOX DOES NOT WARRANT, EXCEPT AS EXPRESSLY PROVIDED IN LIVOX WARRANTY, THAT THE PRODUCT, PRODUCT ACCESSORIES, OR ANY PORTION OF THE PRODUCT, OR ANY MATERIALS, WILL BE UNINTERRUPTED, SECURE, OR FREE OF ERRORS, VIRUSES, OR OTHER HARMFUL COMPONENTS, AND DOES NOT WARRANT THAT ANY OF THOSE ISSUES WILL BE CORRECTED. NO ADVICE OR INFORMATION, WHETHER ORAL OR WRITTEN, OBTAINED BY YOU FROM THE PRODUCT, PRODUCT ACCESSORIES, OR ANY MATERIALS WILL CREATE ANY WARRANTY REGARDING LIVES OR THE PRODUCT THAT IS NOT EXPRESSLY STATED IN THESE TERMS.

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WARNINGS

1. Be careful when using Luvox HAPTM in conditions with low visibility such as foggy or stormy weather. In such conditions, the detection range may be reduced. For detection range in conditions with high visibility, refer to the Specifications section.
2. When mounting Livox HAP, allow a space of at least 10 mm around Livox HAP to avoid poor airflow affecting heat dissipation, and make sure the waterproof breather valve is not blocked. It is normal for the temperature of Livox HAP to increase during use.
3. DO NOT touch the optical window of Livox HAP. Dust and stains on the optical window can negatively affect the performance. Use compressed air, isopropyl alcohol, or a lens cloth to clean the optical window correctly. Refer to Livox HAP User Manual for more information on how to clean the optical window.
4. When customizing Livox HAP power cables, make sure the current-carrying capacity of the cable can support the power requirement of Uvox HAP. Otherwise, the product may become a fire hazard or be damaged permanently.
5. In order to avoid electric shocks or radiation exposure, DO NOT disassemble Livox HAP. If an accessory or

product part needs to be replaced, contact Uvox for support.

6. Luvox HAP is classified as a Class 1 Laser Product (IEC/EN 60825-1: 2014) and is safe under all normal conditions of use.
7. Liquid damage is not covered under warranty.
8. DO NOT drop Livox HAP.
9. The Livox HAP Quick Start Guide contains important information. Make sure to read it before first use and keep it for reference.

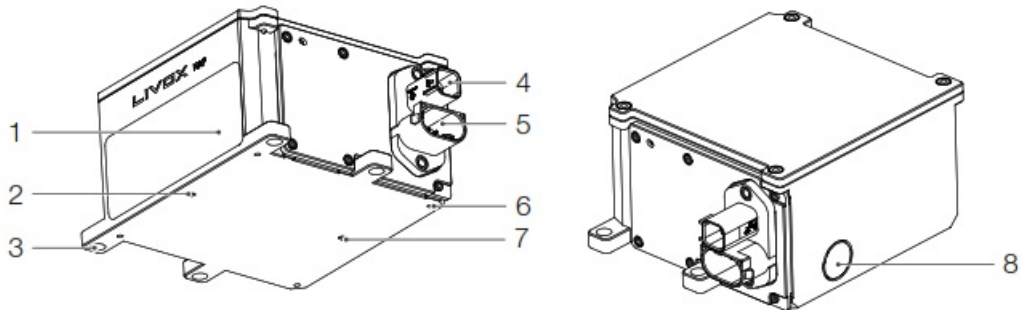
Introduction

As the next-generation product of Livox Horizon, Livox HAP is a high-performance LiDAR sensor with a compact design and superior precision. It can be used for multiple applications including autonomous driving, robotic navigation, dynamic path planning, and high-precision mapping. Compared to Uvox Horizon, Uvox HAP features a FOV of 120° (horizontal) and 25° (vertical), a longer detection range of 150 m (at 10% reflectivity, 100 Klux), and a higher point rate of 452K points/s. Users can check real-time point clouds using Livox Viewer 2, and a software development kit (Livox SDK) is provided to help you develop customizable applications using 3D data acquired from point clouds. Univox HAP has two models which are HAP (T1) and HAP (TX). This document is intended for HAP (T1).
HAP (T1)

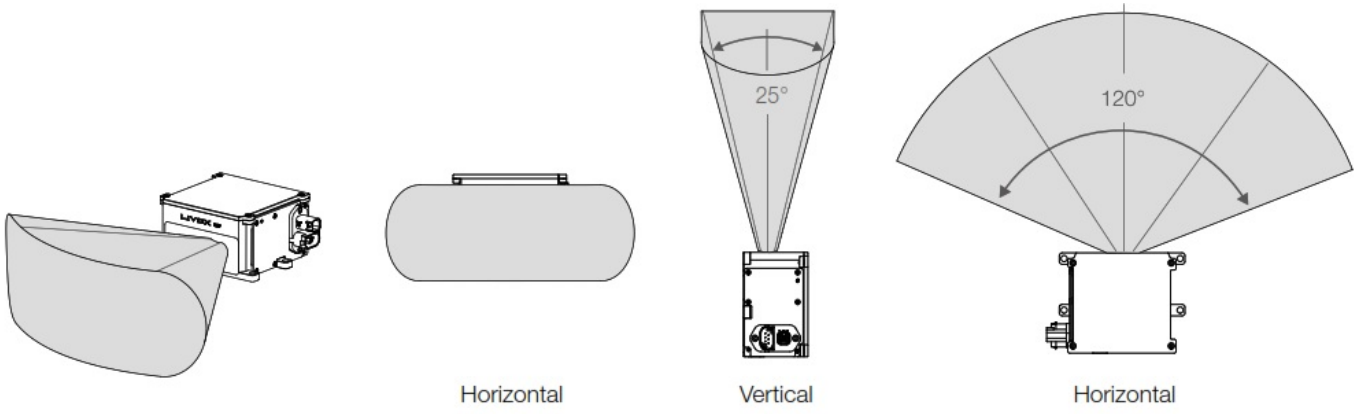
1. Optical Window
2. Locating Hole 1
3. M6 Mounting Hole (06.5) x
4. Automotive Ethemet Connector (100BASE-T1)
5. Power Connector
6. M3 Mounting Hole x4
7. Locating Hole 2
8. Waterproof Breather Valve

HAP (T1)

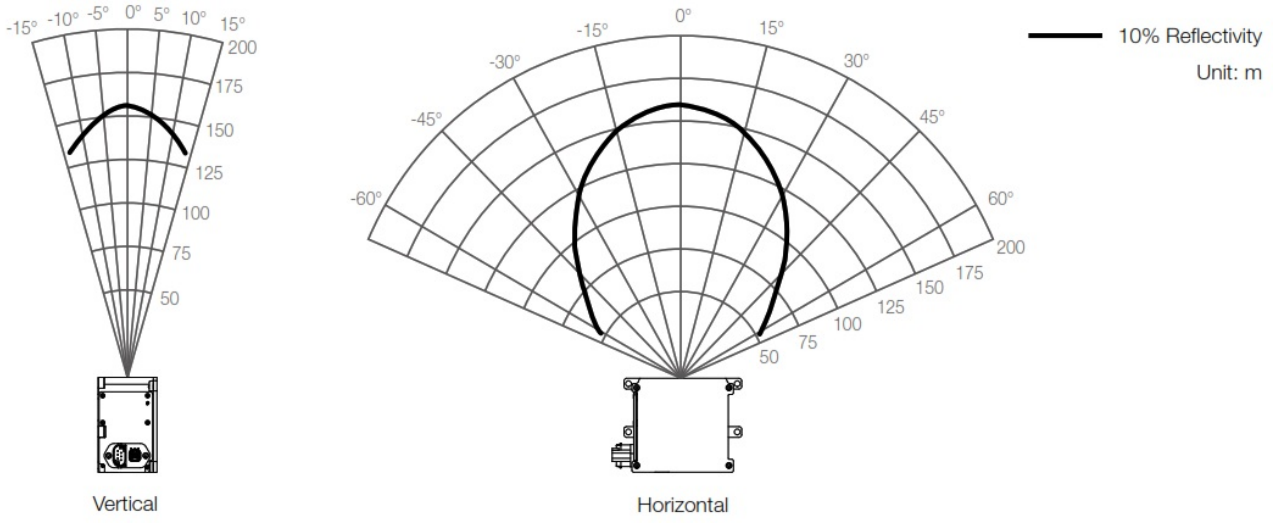
1. Optical Window
2. Locating Hole 1
3. M6 Mounting Hole (06.5) x4
4. Automotive Ethernet Connector (100BASE-T1)
5. Power Connector
6. M3 Mounting Hole x4
7. Locating Hole 2
8. Waterproof Breather Valve



Installation and Connection Effective FOV Range HAP (T1) has a FOV of 120° (horizontal) x 25° (vertical) as shown below. When mounting HAP (T1), make sure that the FOV is not blocked by any objects. Visit **www.livoxtech.com/hap** to download the 3D models of HAP (T1) and its FOV.

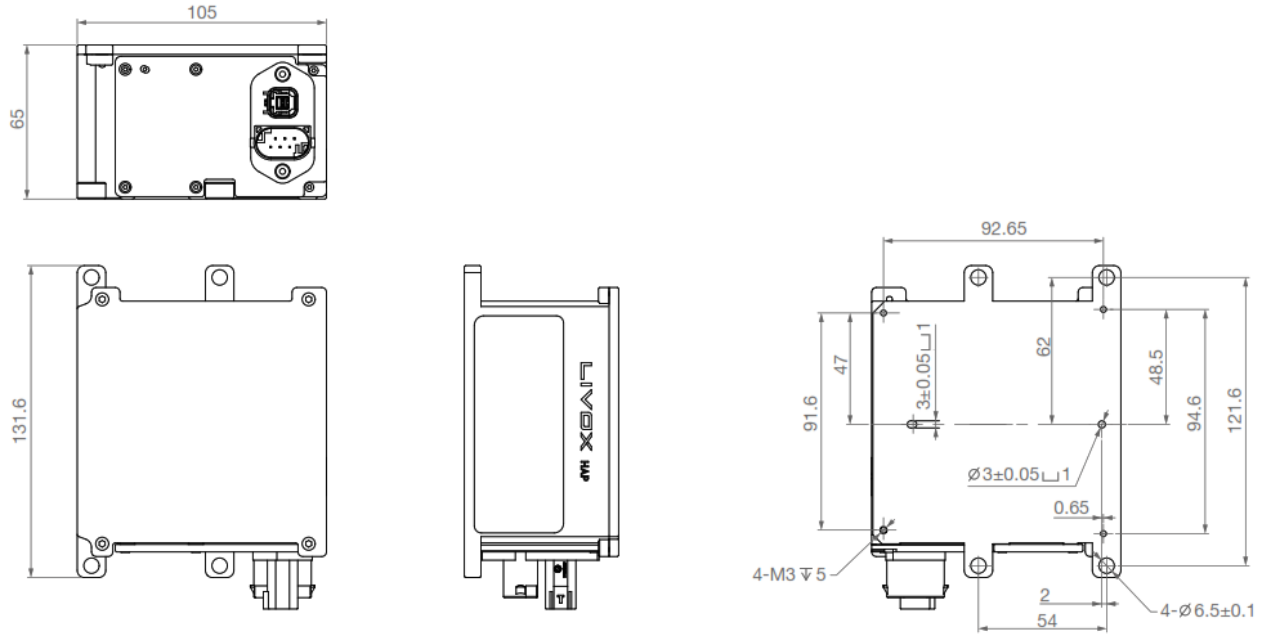


Note that the effective detecting distance of HAP (T1) varies based on where the object is within the FOV. The closer to the edge of the FOV, the shorter the effective detecting distance is. The closer to the center of the FOV, the further the effective detecting distance. Refer to the diagrams below.



Always pay attention to the effective detecting range when in use.

Mounting the HAP (T1) Refer to the dimensions and the mounting holes in the diagrams below to mount or embed HAP (T1) appropriately. Note that the corresponding screws should be purchased in advance.

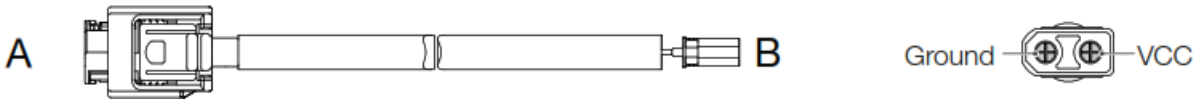


Connecting the Cables

The power cable and the automotive Ethernet cable are both optional accessories for HAP (T1). They need to be purchased separately.
Refer to diagrams below for the connector definitions for the cables. Make sure to connect the cables correctly based on the connector definitions.

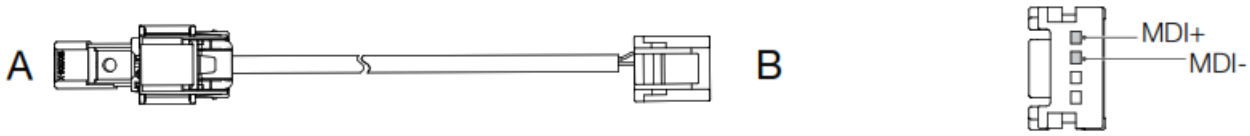
Power Cable

Connect A to the power connector of HAP (T1), and the connector type for A is TE 1-967616-1. Connect B to an external DC power supply, and the connector type for B is XT30.

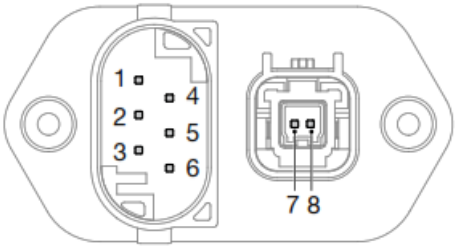


Automotive Ethernet Cable

Connect A to the automotive Ethernet connector of HAP (T1), and the connector type for A is TE 1802105-1. Connect B to the automotive Ethernet connector of an automotive Ethernet converter, and the connector type for B is MOLEX 347910040.



Power Connector and Automotive Ethernet Connector of HAP (T1) See below for more information on the power connector and the automotive Ethernet connector of HAP (T1).

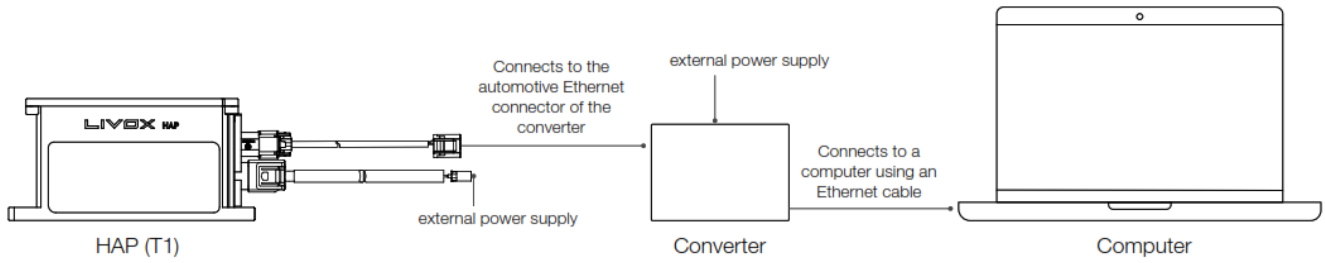


Pin	Signal	Type	Description	Function
1	Power+	Power	DC VCC	Power Cable (connects to DC power supply)
4	Ground	Power	Ground	
7	MDI+	input/Output	1 00Base-T1	Automotive Ethernet Cable (connects to au tomotive Ethernet devices)
8	MDI-	input/Output	1 00Base-T1	
2	N/A	N/A	N/A	Function Cable (Not in use. DO NOT conne ct with other power cable or signal cable to avoid short circuit.)
3	N/A	N/A	N/A	
5	N/A	N/A	N/A	
6	N/A	N/A	N/A	

Connecting the HAP (T1)

All HAP (T1) are set to static IP address mode by default with an IP address of 192.168.1.100. The default subnet masks of HAP (T1) are 255.255.255.0 and their default gateways are 192.168.1.1. To connect with a computer for testing and debugging, users need to purchase a converter that can convert from 100BASE-T1 automotive Ethernet to standard 100BASE-TX Ethernet, and the automotive Ethernet module of the converter needs to work in Master mode when connected to HAP (T1). Make sure the converter you purchase meets the specified requirements.

1. Before connecting, set the IP address of the computer to static IP address mode. Set the IP address of the computer to the same network subnet as the IP address of HAP (T1) (example: 192.168.1.50), and set the subnet mask of the computer to 255.255.255.0.
2. Connect HAP (T1) as shown below.



   a. Connect one end of the automotive Ethernet cable to the automotive Ethernet connector of HAP (T1), and connect the other end to the automotive Ethernet connector of the converter

   b Connect one end of the power cable to the power connector of HAP (T1), and connect the other end to an external power supply.

   c. Connect the converter to an external power supply.

   d. Connect the converter to the computer using an Ethernet cable.
3. Set the automotive Ethernet module of the converter to Master mode. For the specific setup method, refer to the usage instructions for the purchased converter.

- ⚠ Refer to the Livox HAP User Manual on how to set the IP address of the computer.
- When multiple HAP (T1) LiDAR sensors are connected to one computer in static IP address mode, make sure all sensors connected have different static IP addresses. Refer to Livox HAP User Manual for more information on how to set the IP address for each LiDAR sensor.

- The working voltage of HAP (T1) is 9 to 18 V DC. Therefore, when connecting the Livox HAP directly to an external power source, make sure the voltage range of the external power source is within the allowable range. Make sure the positive and negative ends of the power cable are connected correctly.

Downloading and Using Livox Viewer 2

Visit **http://www.livoxtech.com** and download the latest Livox Viewer 2 to check the point cloud data. Luvox Viewer 2 supports WINDOWS® 10 (64 bit) and UBUNTUTM 18.04 (64 bit).

1. Download the file named “Livox Viewer 2”.
2. Unzip the Livox Viewer 2 file and click to open the .exe file named “Livox Viewer 2”. For Ubuntu users, unzip the Livox Viewer 2 file and click to open the “./livox_viewer_2.sh” file under the root directory.
3. If a system window with network authorization pops up when opening Livox Viewer 2, allow Livox Viewer 2 to access the network.
4. The device manager window is on the left side of Livox Viewer 2 and the main interface is on the right side. Click to display or hide the device manager window. In this device manager window, users can check all Livox LiDAR sensors in the local area network (LAN
5. Click “LiDAR” on the top of the device manager window.
6. Select the Livox HAP you want to check and click CD to connect. Alternatively, select the Livox HAP you want to check, right-click, and click “Connect”.
7. After connecting, click
8. or press the space key on the keyboard to view the point cloud data.

• For Windows users, Livox Viewer 2 may fail to detect LiDAR sensors if Windows Firewall is turned on. In this situation, go to the Control Panel to turn off Windows Firewall and restart Livox Viewer 2.

• Download and read the Livox Viewer 2 User Manual for more information on how to use Luvox Viewer 2.

Low Temperature Start-

Up The working temperature of HAP (T1) is from -40° to 85° C (-40° to 185° F). When the environment temperature is below 0° C (-32° F), HAP (T1) may enter self-heating mode when connecting to a power supply. The lower the temperature, the greater the self-healing power. The power in self-heating mode may reach a maximum of 40 W. Therefore, make sure the external power source is appropriate, especially in a low-temperature environment.

Model	HAP (T1)
Laser Wavelength	905 nm
Laser Safety’	Class 1 (IEC 60825-1:2014) (safe for eyes)
Detection Range (0100 klx) [2]	150 m @ 10% reflectivity
FOV	120° (horizontal) x 25° (vertical)
Distance Random Error (1 a) [3]	< 2 cm © 20 m (80% reflectivity)
Distance System Error	< ±3 cm @ 20 m
Angular Random Error (la)	< 0.1°
Beam Divergence	0.03° (horizontal) x 0.28° (vertical)
Point Rate	452,000 points/s
Data Port	100BASE-T1 Automotive Ethernet
Data Synchronization	gPTP
False Alarm Ratio (©100 klx) [4]	0.01%
Operation Temperature Range	-40°C to 85°C (-40° to 185°F)
Storage Temperature Range	-40°C to 95°C (-40° to 203°F)
IP Rating	IP67 [5]
Power [6]	Rated power 12 W Starting power 26 W Low-temperature heatin g power 40 W
Power Supply Voltage Range	9-18 V DC
Noise	< 45 dB(A) (40 cm omnidirectional)

Dimensions	105 x 131.6 x 65 mm
Weight	Approx 1120 g
IMU	Not supported.

1. The divergence of the embedded laser is approximately 25.2° (horizontal) x 8° (vertical), which was measured at full width at half maximum. The maximum power of the embedded laser may exceed 65 W. In order to avoid being injured by the laser, DO NOT disassemble HAP (T1).
2. HAP (T1) cannot precisely detect objects which are less than 0.5 m away.
3. Tested in an environment at a temperature of 25° C (77° F). The actual environment may differ from the testing environment. The figure listed is for reference only. The point cloud may distort to a varying extent when the target object is within the range of 0.5 to 2 m.
4. The false alarm ratio of the noise created by the stray light in a test environment of 100 klx at a temperature of 25° C (77° F).
5. HAP (T1) can achieve an IP rating of IP67 when connected with the power and automotive Ethernet cables. If not connected to the two cables, the IP rating for HAP (T1) is IP54

6. In low-temperature environments, HAP (T1) will first enter self-heating mode, and its power may reach a maximum amount of 40 W. Make sure the power supply is suitable based on the peak power value of the Livox HAP. Refer to HAP (T1) User Manual for more information.
7. Make sure the output voltage of the power supply is within this range at all times.

WE ARE HERE FOR YOU

https://ww.livoxtech.com/support	htpps://www.livoxtech.com/hap/downl

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Documents / Resources

	LIVOX T1 HAP High Performance LiDAR Sensor [pdf] User Guide T1 HAP, High Performance LiDAR Sensor, T1 HAP High Performance LiDAR Sensor