User Manual for LTME-01 Series

2D Laser Scanners

(Ver. 1.8)

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1. Overview

LTME-01 series devices from LiTech Power offer a cost-effective yet high performance solution for 2D laser rangefinding applications. The device works on the principle of pulsed time-of-flight (ToF) to measure target distance; during its operation, the internal sensor core rotates at a constant speed, and makes over 1500 measurements for each revolution, covering a horizontal field of 270 degrees; upon completion of this ranging sequence, measurement results are assembled into a scan frame and transmitted over the device's output interface, and a new round starts over again as rotation continues. These features make LTME-01 an ideal choice for scenarios where object profile measurement or environmental monitoring is needed, such as localization and navigation control of autonomous vehicles or mobile robots.

LTME-01 series come in two variants: LTME-01B and LTME-01C. Most specs are shared among the two except that LTME-01B features a scanning frequency of 10 Hz, transmits data over USB and requires 5 V DC power supply, while LTME-01C boosts the frame rate to 15 Hz, switches to Ethernet as data interface and requires a 12 V DC power supply. Please refer to ***2. Specifications*** for more details.

> ***Note****: As LTME-01B is reaching end-of-life, it's strongly recommended that users move to LTME-01C for new designs.*

2. Specifications

Model	LTME-01B	LTME-01C
Wave Length	905 nm	
Scanning Frequency	10 Hz	15 Hz
Measurement Rate[1]	20 kHz	30 kHz
Ranging Mechanism	Pulsed ToF	
Horizontal FOV	270°	

Angular Resolution	0.18°	
Working Range	0 m … 30 m (70% Remission)	
	0 m … 10 m (10% Remission)[2]	
Resolution	1 cm	
Precision[3]	±2 cm	
Digital Interface	USB 2.0 (Type B)	10/100 Ethernet
Supply Voltage	5 V DC	12 V DC
Power Consumption	< 5 W	
Ambient Temperature (Operation)	-10 … 55 ℃	
Ambient Temperature (Storage)	-20 … 75 ℃	
Enclosure Rating	IP65	
Weight	Approx. 250 g	
Dimension	See ***5.3 Dimensional Drawings***	

[1] Effective measurement rate as calculated with a 360 deg. FOV

[2] Typical value for targets with 10% remission

[3] Typical value for a range of 2 to 15 meters and targets with 70% remission

3. Installation

3.1 Preparations

LTME-01 series are designed for in-door use only. Please avoid exposure to di-

rect sunlight for best device performance. It's also essential to keep the protective cover (especially laser transmission/reception area indicated in **Figure 1**) from heavy dusts or contact with rough surfaces, as contamination or scratches might block sensor's view and/or cause spurious measurement results.

As LTME-01 works by making optical distance measurements, it should be mounted in a way such that a clear field-of-view is maintained. **Figure 1** shows the part of the device's protective cover where internal sensor's optical window is located. Host platform should leave an opening at least of the same height, plus an additional margin of 5 mm on each side, for the emitted light to pass through.

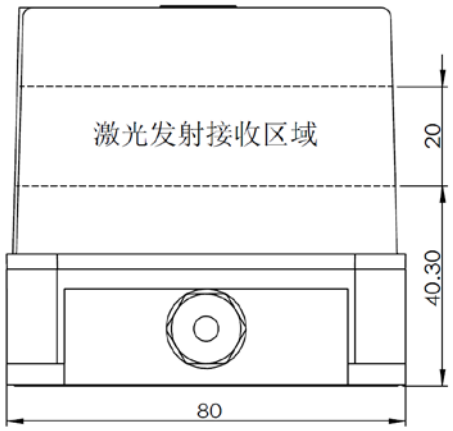


Figure 1 Optical Window Position

Another consideration for mounting is horizontal field-of-view. LTME-01's sensor core adopts a paraxial design, where optical axes for light transmission/reception are coplanar and located on different sides of the rotational center as shown in **Figure 2**. With this configuration, the ray of outgoing or incoming light doesn't coincide with radial direction from rotational center, but is off by a small distance. As a result, the opening on host platform should be designed with extra margin to account for the displaced light rays. Otherwise, blockage of outgoing or incoming light might occur at either ends (**Figure 3**); even if this is acceptable for the specific application, users are still advised to screen measurement data corresponding to occluded area in software.

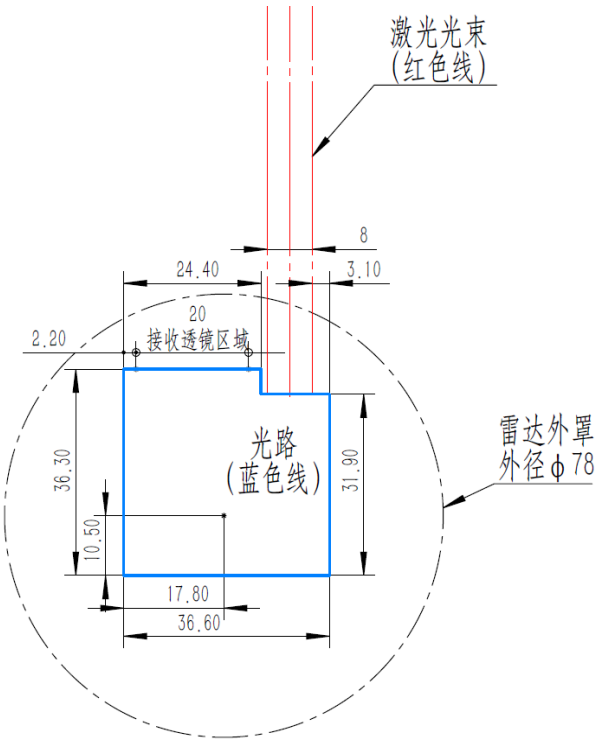


Figure 2 Paraxial Optics Structure of LTME-01

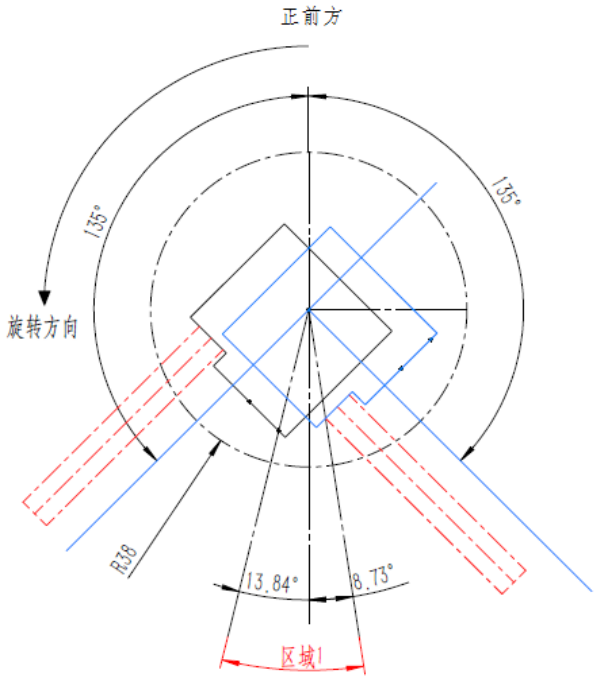


Figure 3 Possible Occlusion of Light At Either End of FOV

3.2 Mounting

The device is mounted to host platform by 4 equispaced through holes (Φ3.2)

located to the bottom as shown in **Figure 4**.

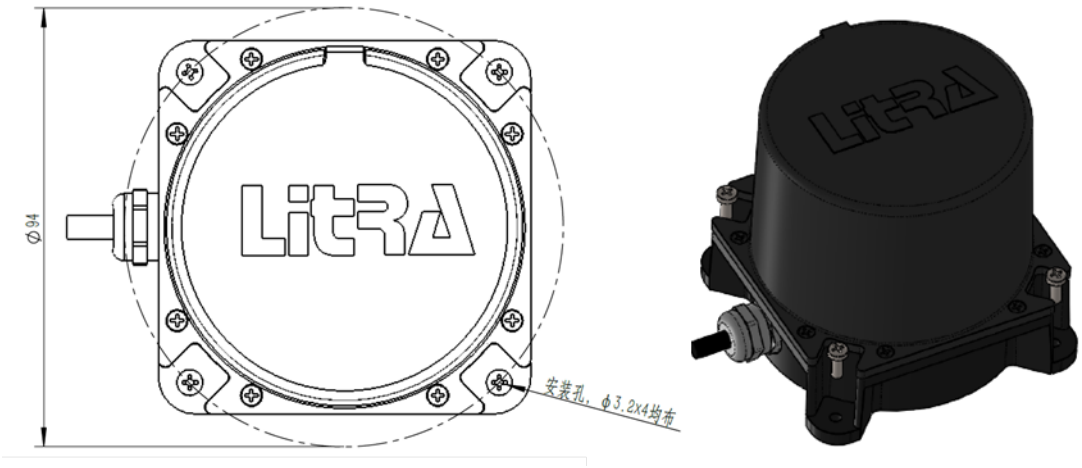


Figure 4 Through Holes To The Bottom of Device

3.3 Electrical Connection

3.3.1 LTME-01B

The cable attached to LTME-01B is terminated with an interface box, hosting a DC power socket (5.5 mm / 2.1 mm) and a USB 2.0 Type B socket as shown in **Figure 5**. You should plug a 5 V power supply capable of 1 A or higher into the power jack, then attach a USB cable with Type B male head to access data from the device.

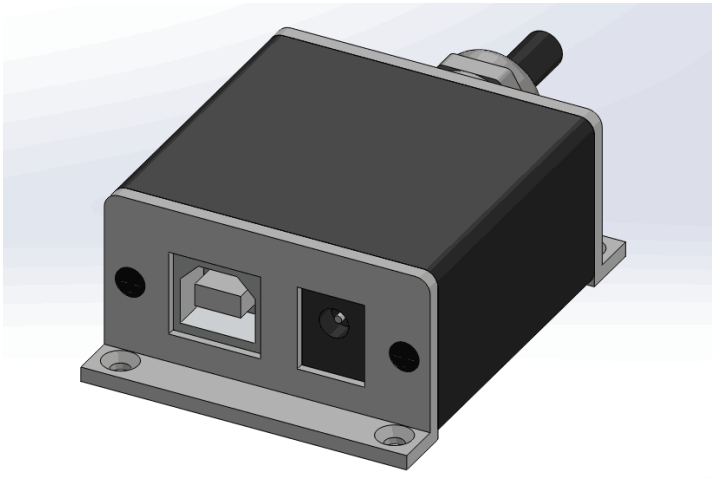


Figure 5 LTME-01B's Interface Box

3.3.2 LTME-01C

The cable attached to LTME-01C is terminated with an interface box, hosting a DC power socket (5.5 mm / 2.1 mm) and an RJ45 socket as shown in **Figure 6**. You should plug a 12 V power supply capable of 1 A or higher into the power jack, then attach an Ethernet cable (with the other end attached to a network switch or directly to computer) to access data from the device.

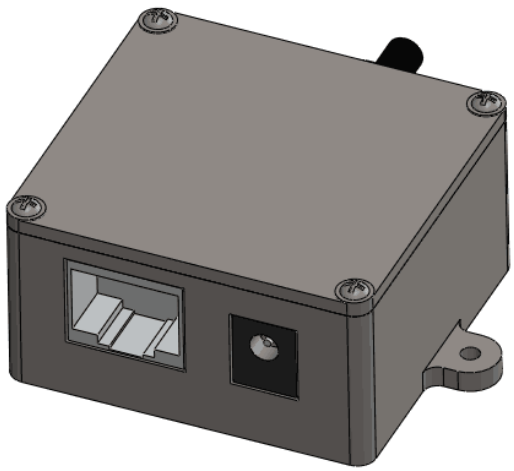


Figure 6 LTME-01C's Interface Box

4. Usage Guides

4.1 Driver Installation

4.1.1 LTME-01B

As LTME-01B adopts a custom protocol based on USB, you might need to install proper driver before using the device.

4.1.1.1 Linux

LTME-01B works out of box under Linux. After attaching device to your comput-

er, open up a terminal and run:

```
dmesg
```

If the last few lines look similar to those shown in **Figure 7**, the device is correctly setup and ready for use.

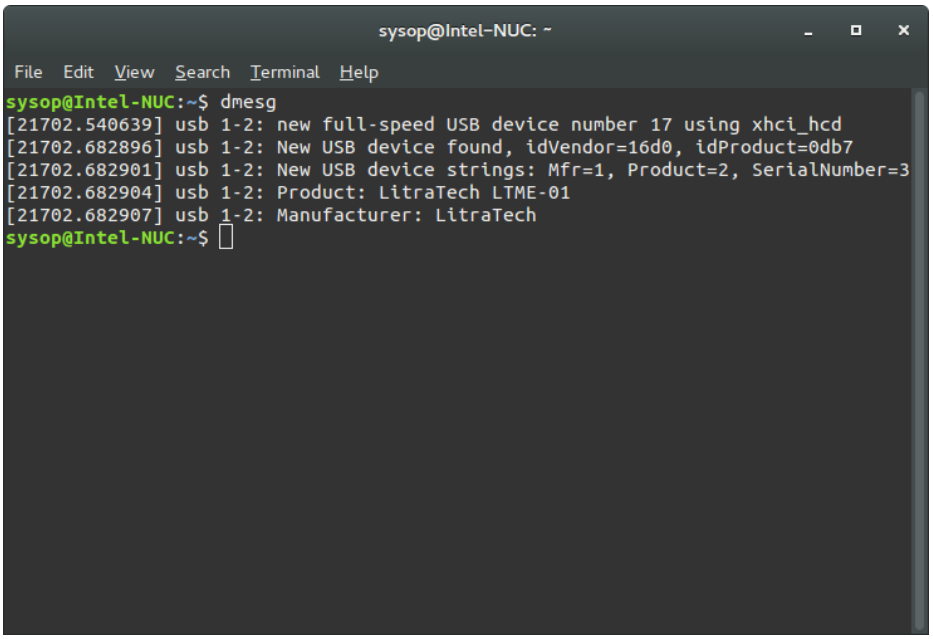


Figure 7 System Log Messages After LTME-01B Attached and Identified

With Linux's default system settings, USB device node corresponding to LTME-01B is only accessible to root user. To lift this restriction, you should add a udev rule that grants access to normal users. This can be done by creating a file named **`ltme01.rules`** under **`/etc/udev/rules.d`** with the following lines:

```
SUBSYSTEM=="usb", ATTRS{idVendor}=="16d0", ATTRS{idProduct}=="0db7",
MODE:="0666", SYMLINK+="ltme01"
```

Save this file, restart udev, then detach and attach LTME-01B again. Now any user is able to open the device node of LTME-01B and read its data output.

4.1.1.2 Windows 10 / 8.1 / 8

Windows 10 / 8.1 / 8 has required driver preinstalled. As you power up the device and attach it, Windows will detect new hardware automatically and install ap-

propriate driver for it. After installation is complete, you may find the device in Device Manager as shown in **Figure 8**:

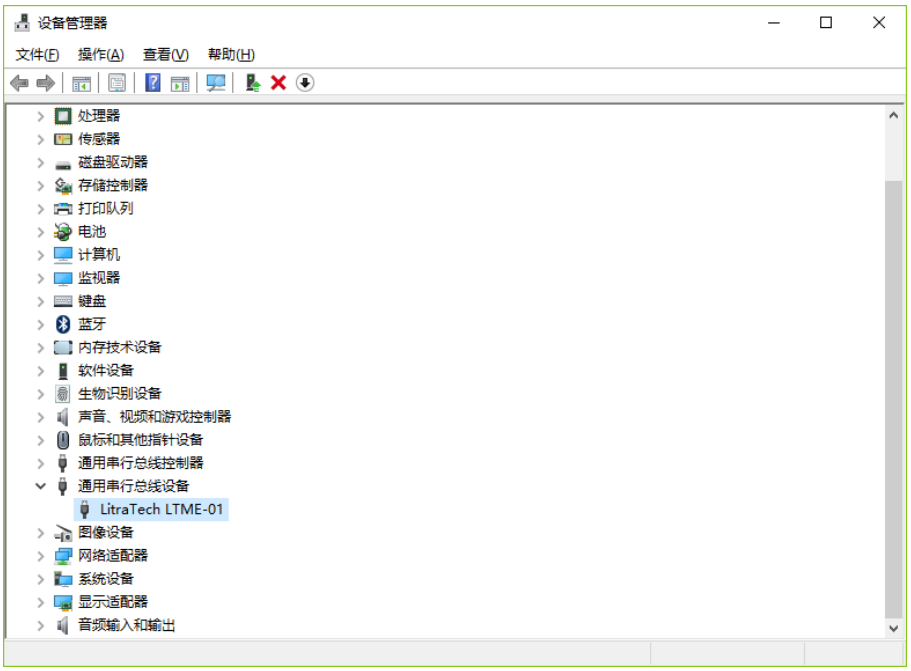


Figure 8 Device Entry for LTME-01B Under Windows 10 / 8.1 / 8

4.1.1.3 Windows 7

You may choose either of the following to install driver for LTME-01B:

(1) Install driver through Windows Update

The driver required by LTME-01B isn't bundled with Windows 7. However, it can be installed through Windows Update automatically. Before you do this, please make sure that Windows Update is enabled and the computer is connected to Internet. After attaching LTME-01B to computer, Windows will search Windows Update for suitable driver automatically, as shown in **Figure 9**:

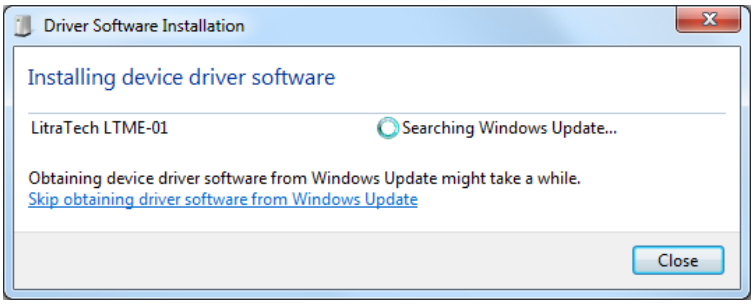


Figure 9 Windows Searches for Suitable Driver Automatically

As the driver is found and installed, a prompt as shown in **Figure 10** will be displayed:

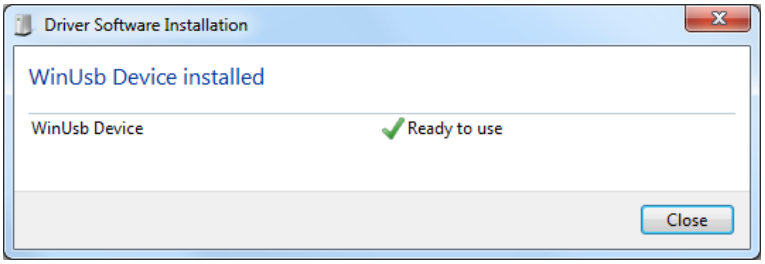


Figure 10 Driver Installation Completes Successfully

If installation fails due to network problems, please find in Device Manager's "Other Devices" the entry corresponding to LTME-01B, open up its Properties page and click on "Update Driver" button to retry the above process.

(2) Install driver manually

Please download the following file and extract to a local folder:

http://download.windowsupdate.com/msdownload/update/driver/drvs/2012/05/20484220_5f2718fc6d44c5ae61d4275d679bbf1ededf58e5.cab

Find in Device Manager the device entry corresponding to LTME-01B, open its Properties page and click on "Update Driver". In the dialog opened, click on "Browse my computer for driver software" and specify the path where extracted files reside, as shown in **Figure 11**:

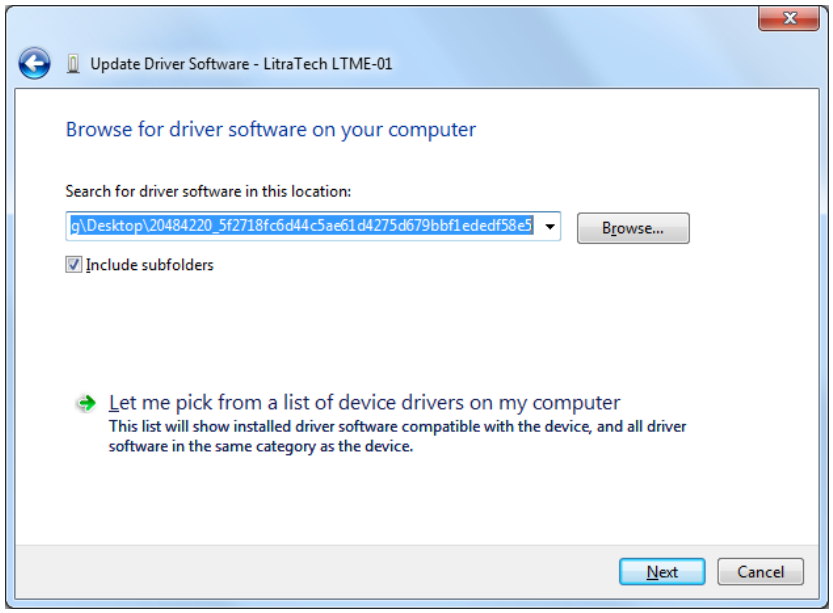


Figure 11 Install Device Driver Manually

After clicking on “Next”, Windows will find the driver and complete installation process.

4.1.1.4 Windows XP And Earlier

Those systems are not supported. Please upgrade to newer Windows version to use LTME-01B.

4.1.2 LTME-01C

LTME-01C transmits data through Ethernet and UDP. Any operating system with a standard TCP/IP stack is able to interact with it, and there is no need to install any additional drivers.

4.2 Network Setup

***Note 1**: The following descriptions are specific to LTME-01C. LTME-01B is USB only and no network setup is necessary.*

LTME-01C communicates through Ethernet and UDP. With factory default settings, the device’s IP address is 192.168.10.160 and subnet mask 255.255.255.0. Eve-

ry time the device completes scanning a slice of its FOV (i.e., a sector, see **5.1 Data Format**), measurement results for this slice will be encapsulated in a UDP datagram and broadcasted to 255.255.255.255 targeting port 8100.

***Note 2**: You can modify most network parameters of LTME-01C, including device's IP address/network mask, as well as datagram's target IP address/subnet mask/port. Please contact technical support for how to customize these parameters.*

To receive datagrams from LTME-01C, you should configure your computer's network settings, change IP address to 192.168.10.X (where X stands for an integer between 2 and 254), and also change subnet mask to 255.255.255.0. Alternatively, you may keep current network settings and add an additional IP address as configured above. This approach may be advantageous to the first one as it doesn't interfere with existing network applications.

If you'd like to view real-time plotting of scan results with LVS2D (see **4.3 Data Visualization**), there is an additional step to configure the computer's firewall and add LVS2D to the list of allowed applications. Please refer to the manual of your operating system or firewall software for detailed instructions.

***Note 3**: If you use LVS2D under Linux and it can't discover networked LTME-01C automatically, this might be caused by missing default gateway. Set a default gateway for your network interface and restart LVS2D to check if the issue is resolved.*

4.3 Data Visualization

After attaching LTME-01 to computer and completing installation of device drivers, you can view real-time plot of measurement data with LVS2D software, as shown in **Figure 12**:

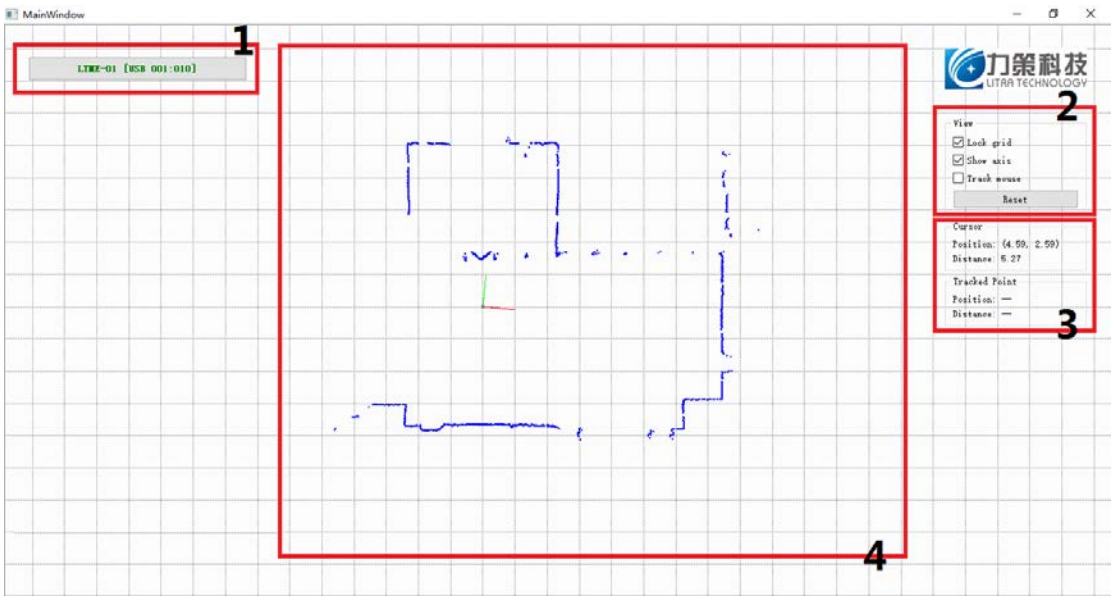


Figure 12 Main User Interface of LVS2D

The interface consists of the following regions:

1. **Device list region**: This region displays all attached LTME-01 devices as found by the software. LVS2D supports automatic discovery of LTME-01; as long as the device functions properly and its driver (if applicable) has been installed, LVS2D will detect the presence of newly attached LTME-01 and add it to the list. You may click on a list entry to switch between multiple attached devices. Currently selected device will be marked by bold green text, and its measurement data will be visualized in real-time.

2. **View control region**: This region provides several options to control the way plot area is displayed, including:

- **Lock grid**: If enabled, background grid lines will keep its horizontal/vertical orientation while user rotates the view by clicking and dragging left mouse button. Defaults to ON.
- **Show axis**: If enabled, the coordinate axis of currently selected LTME-01 device will be displayed in the plot area, with X axis in red and Y axis in green. Defaults to ON.
- **Track mouse**: If enabled, the point of plotted scatter series in the direction of mouse cursor will be marked by larger size and red fill. Defaults to OFF.

- **Reset**: Clicking on this button will reset the whole view to its initial state, therefore undoing any previous rotation, panning or scaling. It will also reset all configuration options described above to their default values.

3. **Coordinate display region**: This region shows coordinates of the mouse cursor, as well as that of highlighted point if "Track mouse" is enabled, in device coordinate frame, in meters.

4. **Plot graph region**: This region displays real-time plotting of scan frames from selected device. It supports the following user interactions:

- **Rotation**: Click left mouse button and drag;
- **Panning**: Press Shift, then click left mouse button and drag; alternatively, you can press mouse wheel and drag to the same effect;
- **Scaling**: Scroll forward (zoom in / enlarge plot) or backward (zoom out / shrink plot).

5. Technical Information

5.1 Data Format

> ***Note 1**: An accompanying SDK for LTME-01 is hosted at https://github.com/LitraTech/ltme01_sdk, which supports both Windows and Linux and requires C++11 to build. Users are advised to develop their applications based on this SDK. The following descriptions are for reference purposes only.*
>
> ***Note2**: LTME-01B and LTME-01C adopt the same data format and the following is applicable to both models.*

LTME-01 measures distance to obstacle along each direction in its view and outputs collated range measurements in the form of data packets. An overhead view of the scanned area is shown in **Figure 13**:

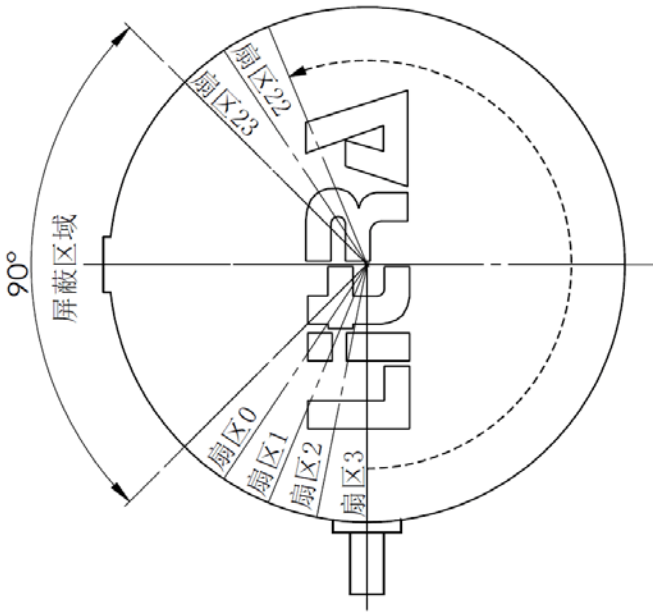


Figure 13 Scanned Area of LTME-01 (Overhead View)

LTME-01 is designed to have a field-of-view of 270° ; the rest 90° is inactive zone and no measurement data are generated for this area. The active zone of 270° is subdivided into 24 sectors, numbered sector 0, sector 1, …, sector 23 in counter-clockwise order. When the internal sensor core rotates to the end position of each sector, measurement data corresponding to that sector will be assembled into a data packet and transmitted out of the device.

Each data packet generated by LTME-01 is of the following format:

signature	index	count	reserved	flags	timestamp	checksum	ranges (1…64)
2 Bytes	1 Byte	1 Byte	1 Byte	1 Byte	4 Bytes	2 Bytes	2 Bytes for Each Value

- **signature**: 16-bit unsigned integer with a fixed value of 0xFFFF, used to identify packet boundaries in the output data stream;
- **index**: 8-bit unsigned integer indicating sector index. The value of this field is always in the range of 0-23 and increases in counter-clockwise direction;
- **count**: 8-bit unsigned integer with a fixed value of 64, representing number of range measurements in this packet;
- **reserved**: 8-bit unsigned integer with a fixed value 0;
- **flags**: 8-bit unsigned integer, consisting of flags describing packet properties. Currently the following flags are defined:

- **0x01**: timestamp valid flag. If this bit is set, timestamp field in this packet is valid.

- **timestamp**: 32-bit unsigned integer:
  - If timestamp valid flag is set, this field has the value of device's internal timestamp counter when the first measurement in this packet is to be carried out, in unit of us or 10^{-6} second;
  - Otherwise this field is set 0.
- **checksum**: 16-bit unsigned integer, used to detect data corruption possibly happened during transmission. The value is obtained by treating the whole packet as an array of 16-bit unsigned integer (with checksum field filled by 0), adding each integer in this array and keeping the least significant 16 bits of the result;
- **ranges (1…64)**: 64 values each being 16-bit unsigned integer and representing measured distance along corresponding direction in current sector, arranged in counter-clockwise order. Each value is in unit of cm and only valid in the range of 0 to 3000. Apart from normal range values, this filed could also take on the following special value: 0x544F (measurement timed out) and 0x4E44 (invalid data and should be ignored).

All multi-byte fields mentioned above are represented in little-endian, i.e., individual bytes are ordered such that least significant bytes come first.

5.2 Communication Interface

5.2.1 LTME-01B

LTME-01B transmits measurement data through USB. Each time a sector is scanned, the device will output data packet for that sector through USB configuration 0, interface 0, endpoint 0x81. Client software running on a USB host can read this packet through a USB BULK IN transfer, then parse the data according to packet structure described in **5.1 Data Format**.

5.2.2 LTME-01C

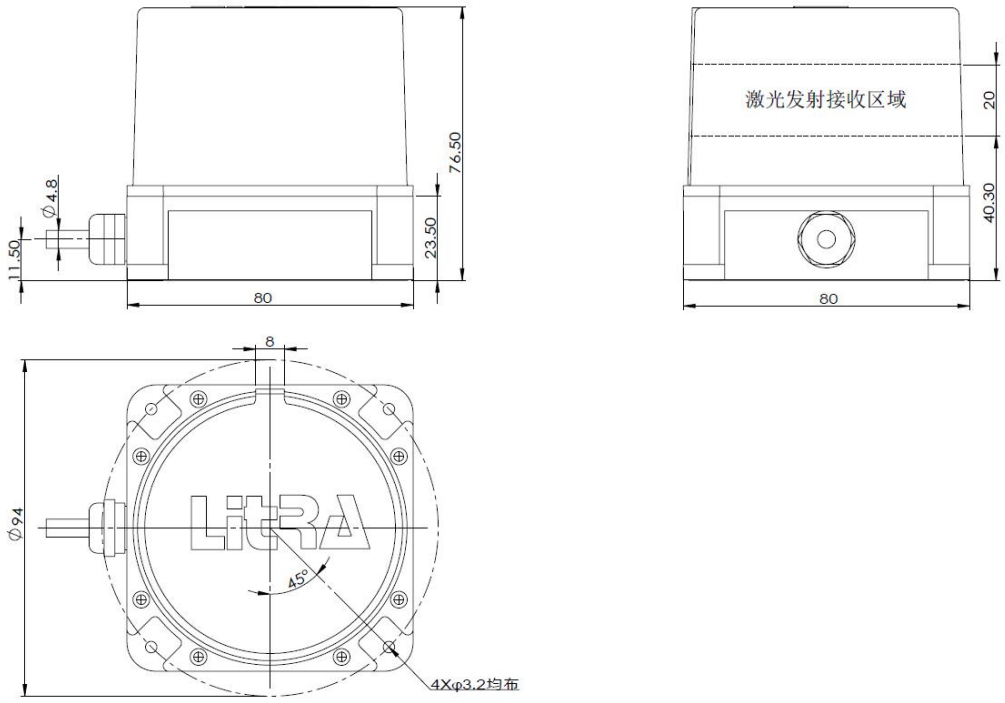
LTME-01C transmits measurement data through Ethernet. By default the device is configured with IP address 192.168.10.160 and network mask 255.255.255.0. Each time a sector is scanned, the device will output data packet for that sector in the form of UDP datagram destined to port 8100 of 255.255.255.255, i.e. the broadcast address. Client software running on a networked host can read this packet by listening on UDP port 8100 and receiving datagrams directed to this port, then parse the data according to packet structure described in **5.1 Data Format**.

***Note**: If multiple LTME-01C is to be connected to the same network, their network configurations should be modified to avoid confliction. LTME-01C supports customizing network configurations such as device's IP address/subnet mask, as well as data packet's destination IP/subnet mask/port. Please contact technical support for how to customize these parameters.*

5.3 Dimensional Drawings

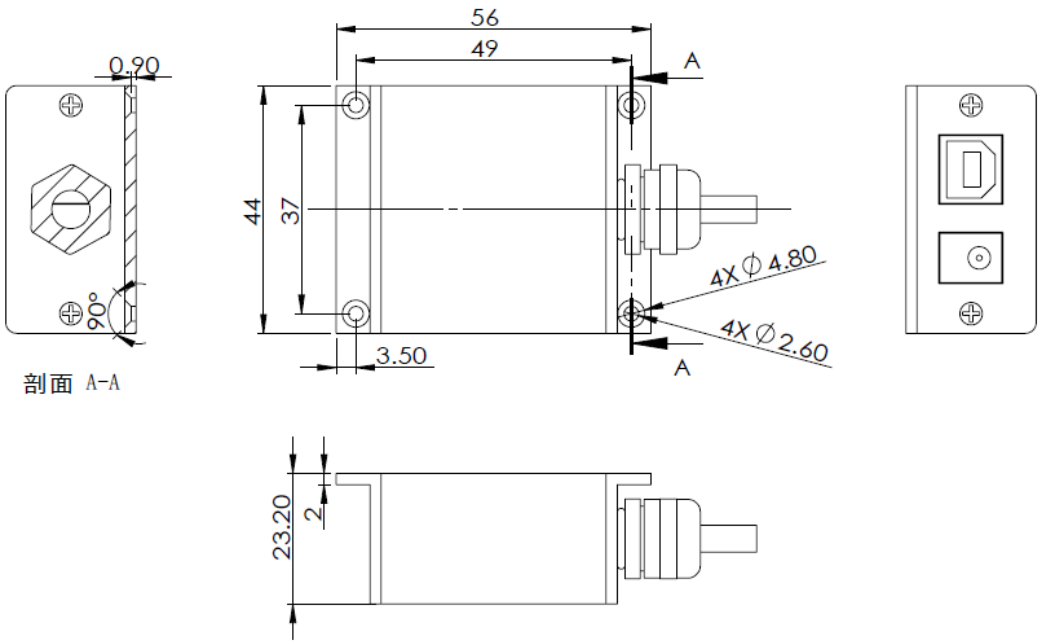
5.3.1 Device Body

***Note**: As LTME-01B and LTME-01C share the same appearance and dimensions for the main body part, the following specifications are applicable to both models.*



5.3.2 Interface Box

5.3.2.1 LTME-01B



5.3.2.2 LTME-01C