AIB-2941M

User Manual

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Warranty

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E-mail：service@icpdas.com

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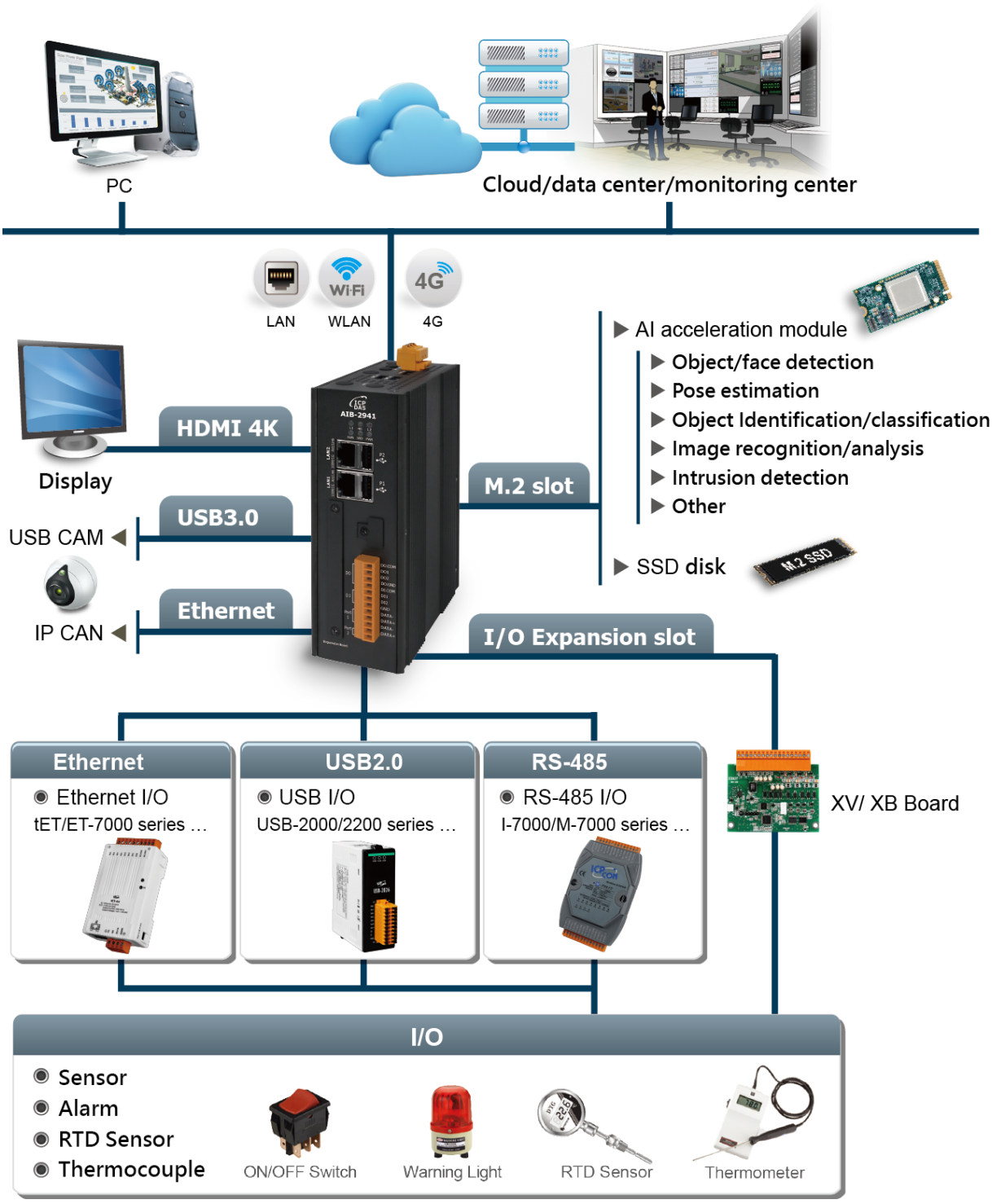
1. Introduction

This chapter provides an overview of the AIB-2941M series modules and their equipped components, and introduces basic concepts to help users become familiar with the AIB-2941M module.



AIB-2941M is a fan less, secure, compact, low-power edge AI controller featuring ARM-based Cortex R-A72 processor. Provides M.2 slots to expand different AI accelerator modules, implements scalable, high-efficiency and low-power artificial intelligence functions at the edge, expands AI computing capabilities, and introduces AI and edge computing into industrial applications.
In terms of I/O expansion, the highly protective XV-Board/XB-Board is available for purchase and use. It also provides a microSD slot and M.2 slots with M/B+M key (used for expansion of NVEM SSD cards), which can store commonly used applications, images and data, as well as storage tools that are convenient for portability and expansion.

AIB-2941M edge AI controller can be equipped with GbE LAN, HDMI, USB 3.1, DIO and 4G Wireless connectivity and other peripherals. The rugged metal housing and heat dissipation make it suitable for environments from -20 to +70 °C.

1.1. Features

AIB-2941M has comprehensive system configuration functions and convenient remote system update services, which can provide a variety of uses to meet the various needs of users. The main features of AIB-2941M are listed below.

Ubuntu

Ubuntu is an easy-to-use operating system that is ideal for both beginners and experienced users. It has an intuitive interface, rich functions, and multiple uses. It is currently the most widely used Linux version. Applied to AIB-2941M, you can take full advantage of its functions and performance. (Ubuntu installs the OS as factory default)

- Good user experience
- Ease of use, versatility, security
- Rich community support
- Embedded services: Web Server, FTP Server, Telnet Server, SSH Server
- Rich software support and development tools: exclusive SDK, Perl, Java, GUI software ... etc.

Raspberry Pi OS

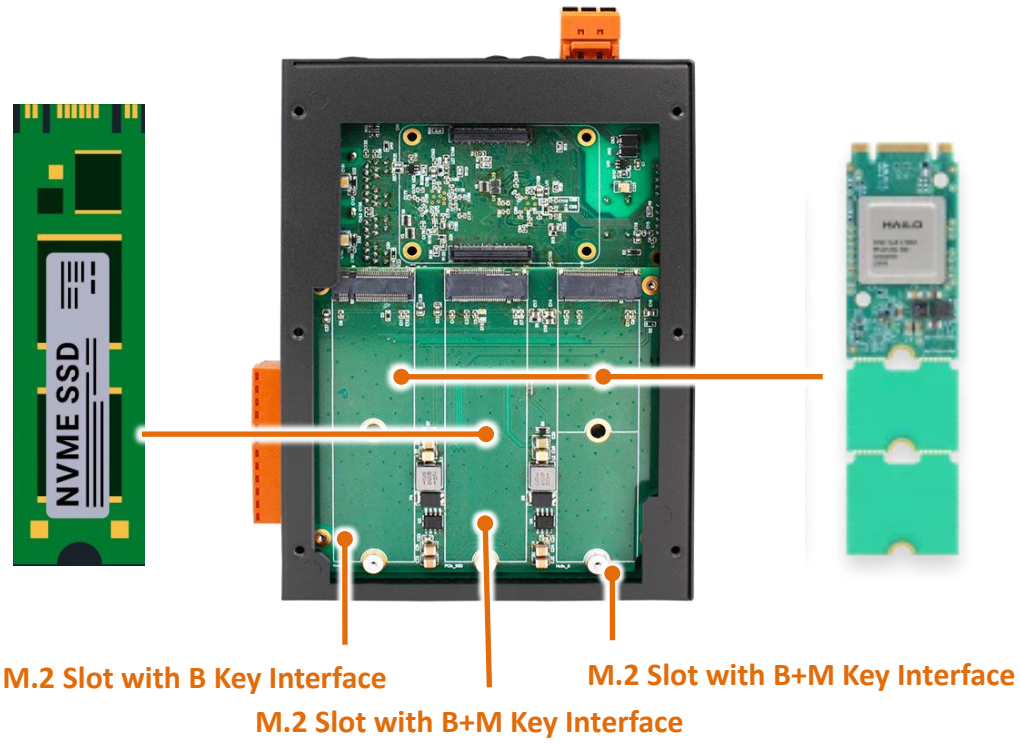
EdgeAI controller has a built-in Raspberry Pi 64 -bit operating system. Raspberry Pi OS is based on Debian Linux and uses text line commands to operate, which is suitable for users who are familiar with Linux operations. Also suitable for users who are familiar with Windows , Raspberry Pi OS runs a simplified desktop interface familiar to Windows users, displaying a tablecloth, taskbar, shortcuts, application menus, etc.

- Rich Raspberry Pi software ecosystem
- More than 35,000 software packages are easy to install
- Multiple applications pre-installed - Python3/Python IDE/ etc.
- Many ready-made applications are available online

Artificial intelligence module

- M.2 Slot with B Key for expanding AI Acceleration
- M.2 Slot with B+M Key for expanding SSD
- M.2 Slot with B+M Key for expanding AI Acceleration

Provides M.2 Key M/Key B connector to flexibly expand different artificial intelligence modules



Hardware serial number lock protection software

AIB-2941M provides a 64 -bit hardware lock to provide anti-software copy protection technology.

Various disk storage interfaces to expand storage space

AIB-2000 provides a variety of reliable storage devices, such as microSD . Users can choose storage devices according to their needs.

- a microSD slot (Does not ship with microSD card)
- One M.2 Key M slot (used to expand M.2 NVEM SSD card) (SSD card is not included in the shipment)

Since there are many brands of SSDs, the following two are industrial-standard SSDs that we have tested and can operate normally.

Innodisk M.2 (P80) 3TE4

https://www.innodisk.com/tw/products/flash-storage/m2-pcie/m2-p80-3te4-b-m-key

APacer PV220-M280

https://www.apacer.com/en/product/industrial-product/detail/industrial_ssd/pv220-m280

Other brands and models of SSDs may have various problems and are not recommended for use.

Supports various I/O expansion cards

AIB-2000 series is equipped with an I/O expansion bus, allowing users to purchase an XV-board or XB-board expansion card. It can be used to develop various I/O functions, such as: DI , DO , A/D , D/A , Timer/Counter and various communication interfaces, such as: RS-232/422/485... etc.

For more information about XV-board I/O modules, please refer to

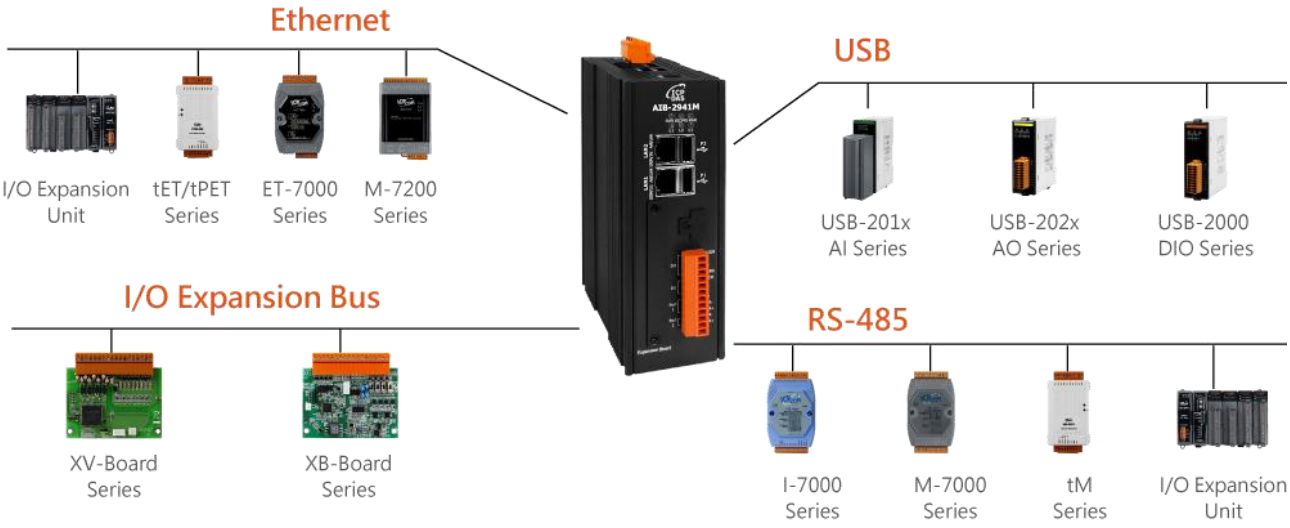
https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XV-board

For more information about XB-board I/O modules, please refer to

https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XB-board

Rich I/O communication interface

AIB-2000 is equipped with multiple RS-485 serial communication ports, two Ethernet and USB ports, which can expand I/O and connect external devices.



For more information about Ethernet interface I/O modules, please refer to
https://www.icpdas.com/en/product/p02.php?root=537&kind=539

For more information about USB interface I/O modules, please refer to
https://www.icpdas.com/en/product/p02.php?root=537&kind=541

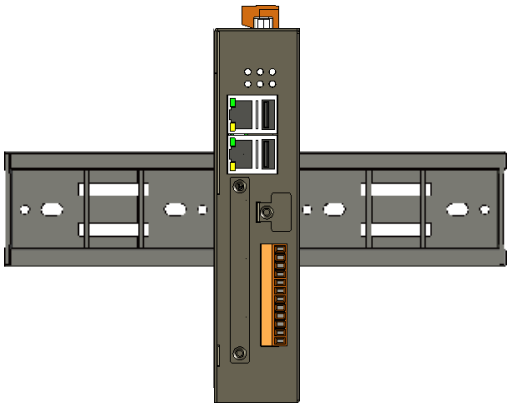
For more information about RS-485 interface I/O modules, please refer to
https://www.icpdas.com/en/product/p02.php?root=537&kind=538

Design options for metal casings

AIB-2000 is equipped with a metal casing.

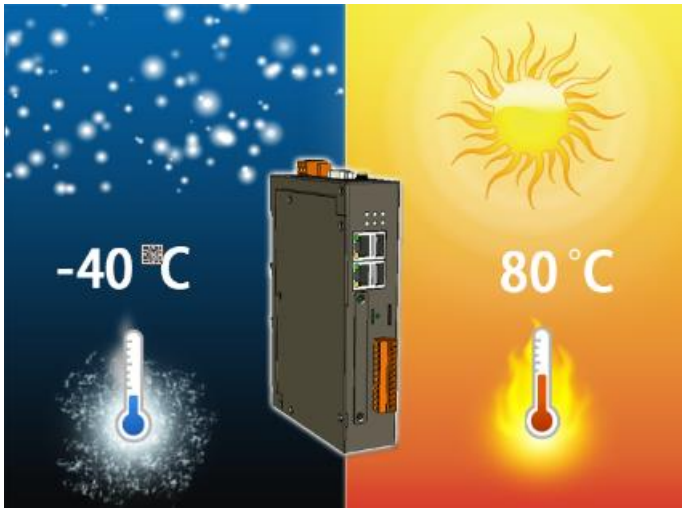
Lightweight design and easy installation

AIB-2000 is compact and lightweight, and can be used with guide rails (DIN-Rail) to be installed in narrow spaces



Operates in harsh environments and still maintains high reliability and stability

AIB-2000 has the ability to operate in extreme temperatures and humidity.



- Operating ambient temperature: -20 °C to +70 °C
- Storage ambient temperature: -40 °C to +80 °C
- Operating environment relative humidity: 10% to 90% RH , no condensation

1.2. Specifications

The following table is the specification table of AIB-2941M.

System software	
OS	Ubuntu (default) / Standard Raspberry PI 4 64-bit OS
SDK Provided	C / python library
Multilanguage Support	English, Simplified Chinese, Traditional Chinese
CPU Module	
CPU	Quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
GPU	VideoCoreVI (OpenGL ES 3.0), H.265 (up to 4Kp60fps decode), H.264 (up to 1080p60fps, 1080p30 encode)
SDRAM	4GB LPDDR3
Storage	32GB eMMC
Other Periphery	
Other Storage	1*M.2 Key M connector (PCIe 2.0 interface), supports the installation of PCIe SSD 2230/2242/2260/2280 (M.2 SSD card not included)
FRAM	16 KB
RTC (Real Time Clock)	Provide second, minute, hour, date, day of week, month, yea
Watchdog	Yes
LED Indicator	1 power LED, 1 system operation LED, and 3 programmable LEDs
AI Accelerator Module	
M.2connector Key M	1*M.2 Key M connector x (PCIe 2.0 interface) Supports installation of Hailo-8L M.2 AI acceleration module 2230/2242/2260/2280 (optional) Frameworks: TensorFLow/Lite, ONNX, Keras, & Pytorch
M.2connector Key B	1*M.2 Key B connector x (USB 3.0 interface) Supports installation of Kneron M.2 AI acceleration module 2230/2242/2260/2280 (optional) Frameworks: TensorFLow/Lite, Caffe, Keras, & Pytorch

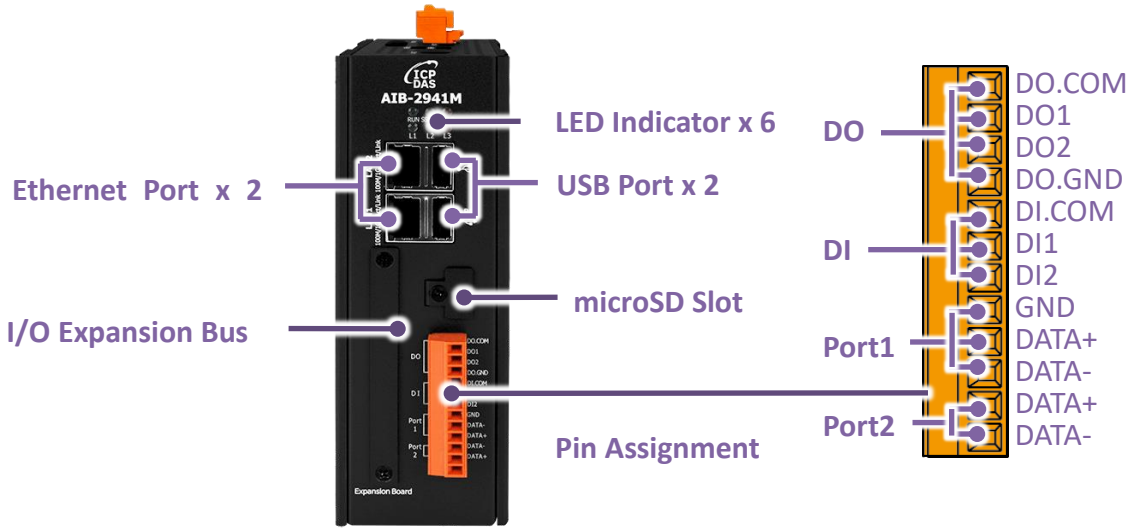
VGA & Communication Ports	
Display	HDMI Port* 1 (4Kp 60fps with audio)
Dual Ethernet Port	RJ-45 x 2, 10/100/1000 Base-TX (Auto-negotiating, Auto MDI/MDI-X, LED indicators)
USB 2.0 (host)	2
USB 3.0 (host)	2
Port 1	RS-485 (Data+, Data-); 2500 VDC isolated
Port 2	RS-485 (Data+, Data-); 2500 VDC isolated
Wireless communication	1 expansion connector, install 4G module (USB2.0 interface) (optional) And Nano SIM slot * 1 (optional)
Digital Input	
Channel	2
Type	Wet Contact
Sink/Source (NPN/PNP)	Sink/Source
ON Voltage Level	+19 VDC ~ +24 VDC
OFF Voltage Level	+11 VDC Max.
Digital Output	
Channel	2
Type	Isolated Open Collector
Load Voltage	+24 VDC
Load Current	100 mA/channel
Overvoltage Protection	60 VDC
Overload protection	1.1 A
Short circuit protection	Yes
I/O Expansion	
I/O Type	XV-board/XB-board (Option)

Power	
Input Range	+12 ~ +48 VDC
Consumption	4.8 W (0.2 A @ 24 VDC)
Mechanical	
Shell	metal
Dimensions (W x L x H), unit: mm	52 mm x 177 mm x 128 mm
Installation	DIN-Rail or Wall Mounting
Environmental	
Operating Temperature	-20 ~ +70 °C
Storage Temperature	-40 ~ +80 °C
Ambient Relative Humidity	10 ~ 90 % RH (non-condensing)

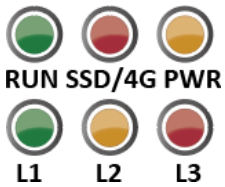
1.3. Overview

AIB-2941M has a variety of transmission components and can connect to external devices for integration through Ethernet, USB, RS-232/RS-485 and other interfaces. The following is an overview and brief description of the external components of AIB-2941M and its transmission components.

Front View



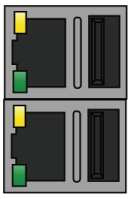
LED Indicator



AIB-2941M series modules have 6 LED indicators:

LED indicator light	color	Message description
RUN	green	System is running
PWR	red	The power supply is normal
4G/SSD	Orange	4G communication/SSD storage disk access
L1	green	User program control
L2	Orange	
L3	red	

Ethernet port



AIB-2941M supports 10/100/1000 Based-TX (Auto-negotiating LED indicator and automatic MDI/MDI-X LED indicator) network, which is connected by
The light signal can tell you the network speed currently used by AIB-2941M .

LED indicator	status (color)	Meaning
1G	Always bright (orange)	1G speed connection
	Eternal destruction	10/100 M speed connection
Lin/Act	Always bright (green)	Network communication connection established
	Eternal destruction	No network communication connection established
	Flashing (green)	Data packet is being transmitted

USB port

AIB-2941M provides two USB 2.0 ports to connect USB devices such as mice, keyboards or other USB devices.

microSD card slot

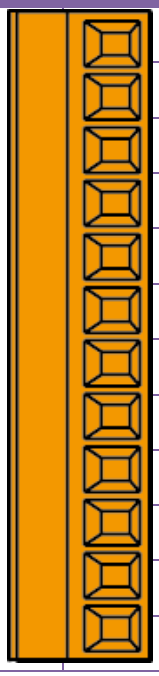
microSD slot is configured to allow users to use microSD memory cards for system recovery and storage expansion. MicroSD memory card expansion supports up to 32 GB .

XV-Board /XB-Board slot

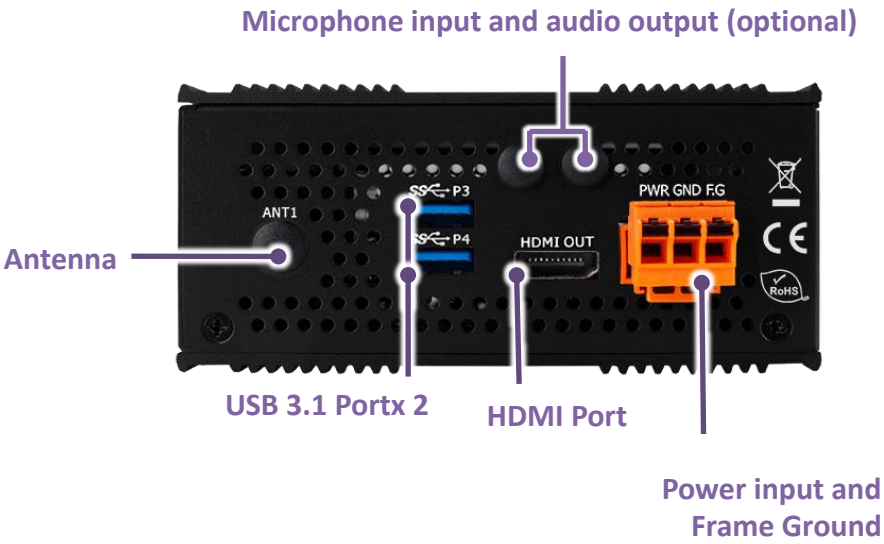
The location of the connecting terminals after installing the XV-board / XB-Board I/O expansion module.

For the installation process, please refer to pages 25~27, Chapter 2.2.2. Installing XV-Board/XB-Board

Pin Assignment

Pin		Signal	Description
	1	DO.PWR	Digital Output x 2
	2	DO0	
	3	DO1	
	4	DO.GND	
	5	DI.COM	Digital input x 2
	6	DI0	
	7	DI1	
	8	RS485.GND	Serial port 2 (RS485)
	9	D2-	
	10	D2+	
	11	D1-	Serial port 1 (RS485)
	12	D1+	

Top view



HDMI port

HDMI output port x 1 (4Kp 60fps with audio)

Resolution formats include: 1920x1080, 1680x1050, 1600x1200, 1440x900, 1440x576, 1440x480, 1400x1050, 1280x1024, 1280x960, 1280x800, 1280x720, 1152x864, 102 4x768, 832x624 and 800x600.

USB 3.1 port

AIB-2941M provides two USB 3.1 ports for connecting USB high-speed devices.

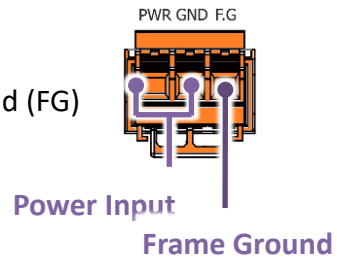
Antenna (optional)

One antenna hole, used with 4G module (optional)

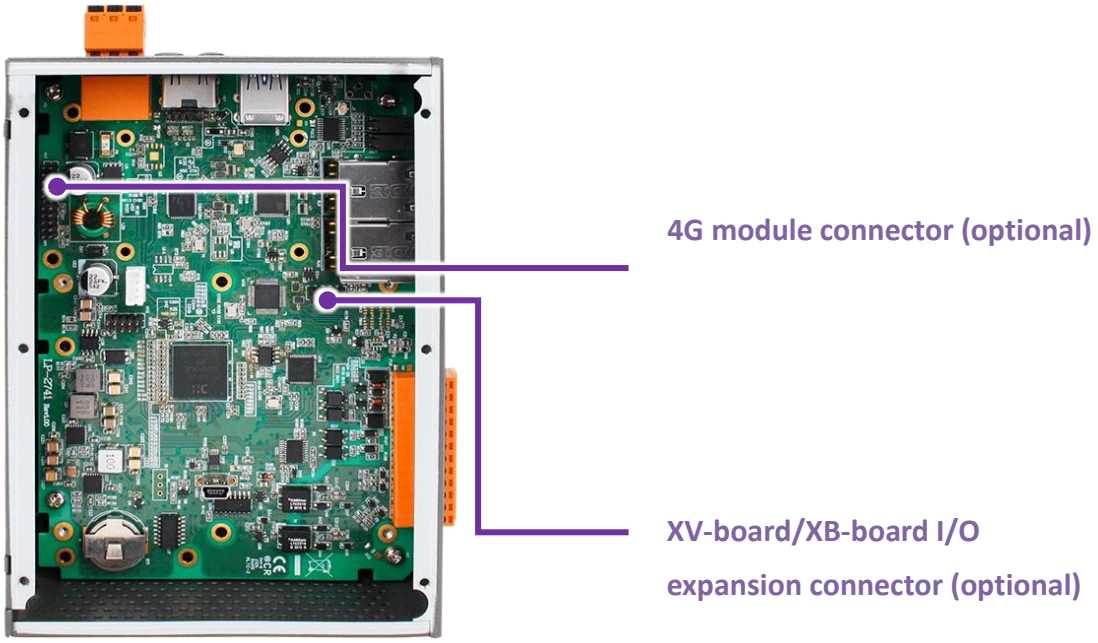
Microphone input and audio output (optional)

Power input and Frame Ground

3 Pin connector. Pin 2 is the power input and Pin 1 is ground (FG)



Left View



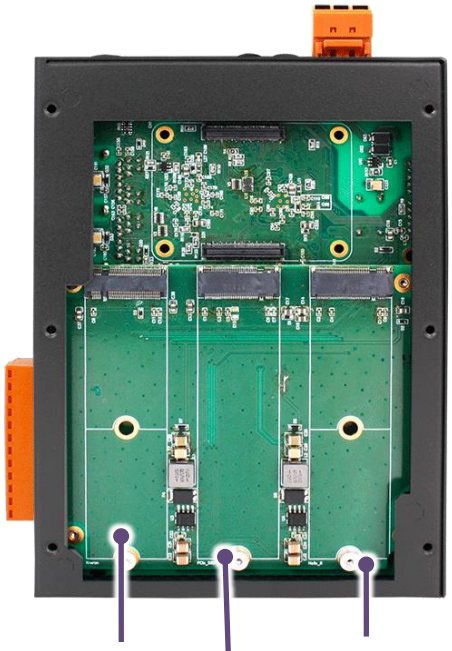
4G module connector (optional)

Install 4G module (USB2.0 interface) and Nano SIM slot x 1 (optional)

XV-board/XB-board I/O expansion connector (optional)

I/O expansion slot, please refer to " 2.2.2. Installing XV-Board/XB-Board "

Right View



M.2 Key B connector

1 M.2 Key B connector (USB3.0 interface) , install M.2 Key B AI acceleration module 2230/2242/2260/2280

M.2 Key M connector

2 M.2 Key M connectors (PCIe x1 2.0 interface) , install M.2 Key M AI acceleration module or M.2 NVEM SSD 2230/2242/2260/2280 (M.2 SSD card not included)

Recommended use of SSD

Standard SSDs that we have tested and can operate normally.

Innodisk M.2 (P80) 3TE4

https://www.innodisk.com/tw/products/flash-storage/m2-pcie/m2-p80-3te4-bm-key

APacerPV220 -M280

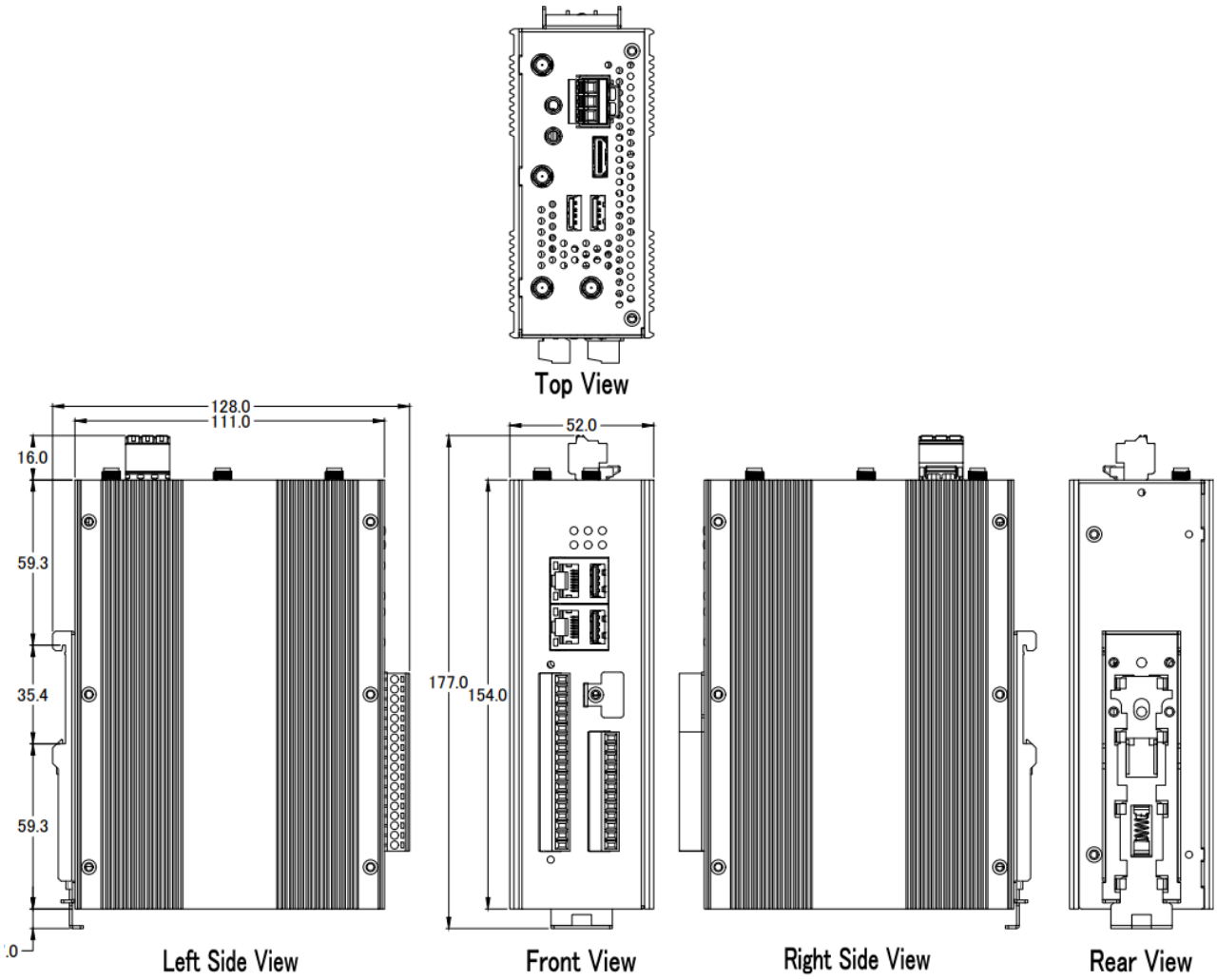
https://www.apacer.com/en/product/industrial-product/detail/industrial_ssd/pv220-m280

Other brands and models of SSDs may have various problems and are not recommended for use.

1.4. Dimension

The picture below shows the dimensions of the AIB-2941M. When installing it into the chassis, please reserve enough space for heat dissipation.

All dimensions are in mm.



2. Getting Started

This chapter explains the installation and setting operations of AIB-2941M, and will guide first-time users of AIB-2941M step by step.
Learn about installing, set ting up and implementing the AIB-2941M.

Before starting to use AIB-2941M, please check whether the product content includes the following items. If there is a shortage or the goods are damaged due to transportation, please contact the dealer you purchased from as soon as possible.

AIB-2941M

44 mm rail mount

screwdriver (1C016) 2.4mm

M3x6L screw *4

European style crimp terminal * 16

Optional mobile network expansion module: antenna installation kit

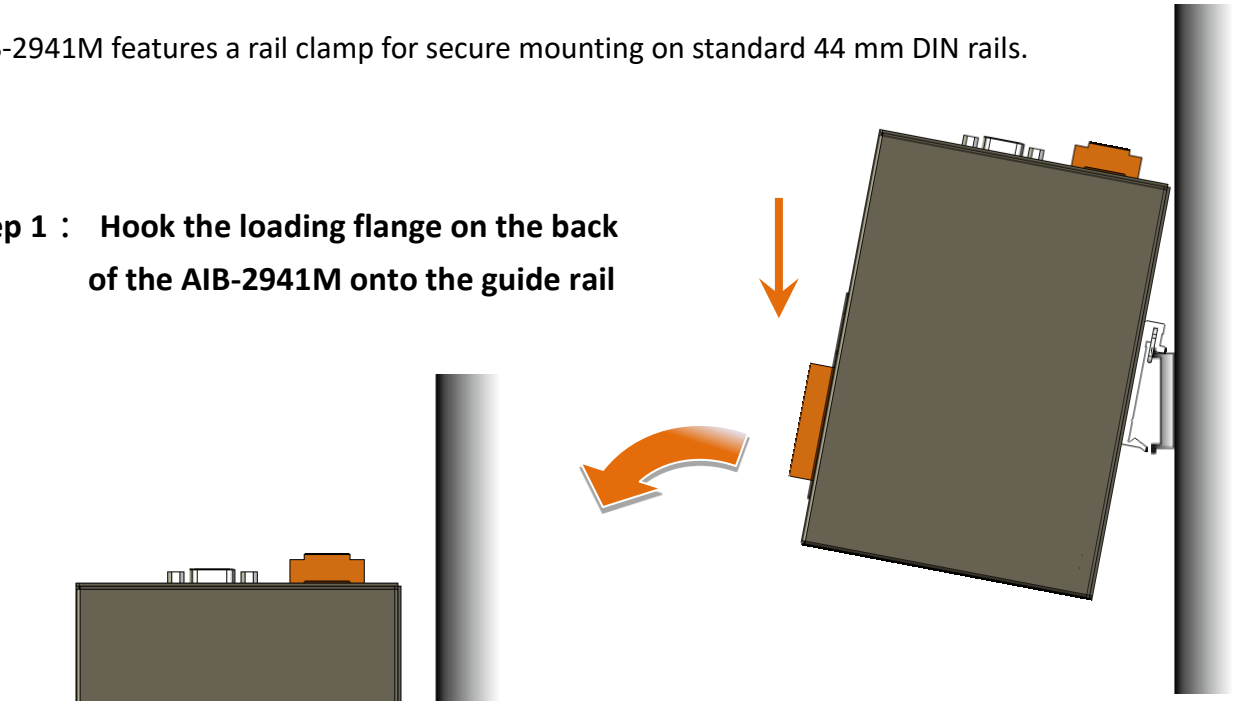
GSM/GPRS antenna (ANT-421-04)

GPS Active Antenna (ANT-115-03)

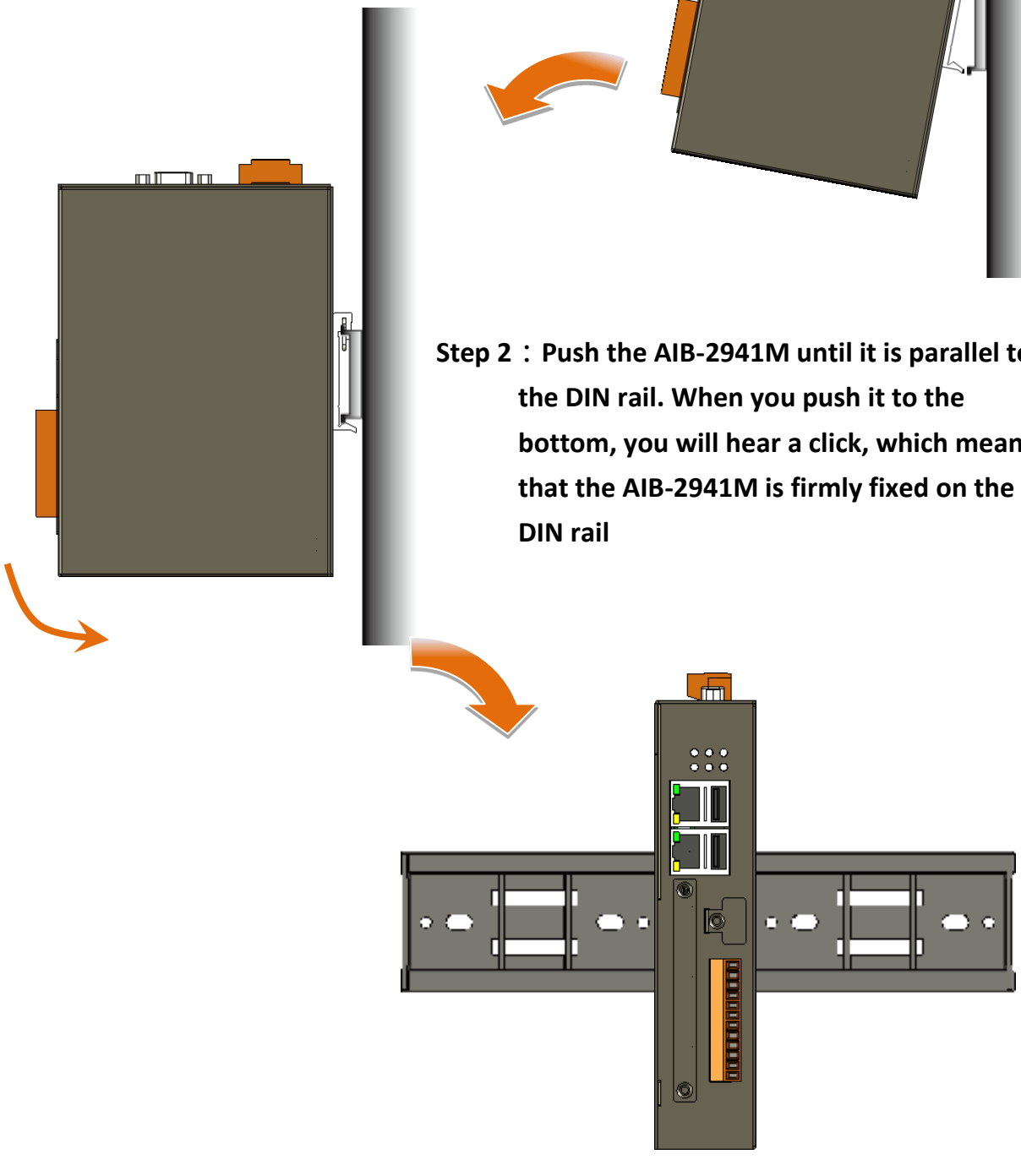
2.1. Installing the AIB-2941M

AIB-2941M features a rail clamp for secure mounting on standard 44 mm DIN rails.

Step 1： Hook the loading flange on the back of the AIB-2941M onto the guide rail



Step 2：Push the AIB-2941M until it is parallel to the DIN rail. When you push it to the bottom, you will hear a click, which means that the AIB-2941M is firmly fixed on the DIN rail

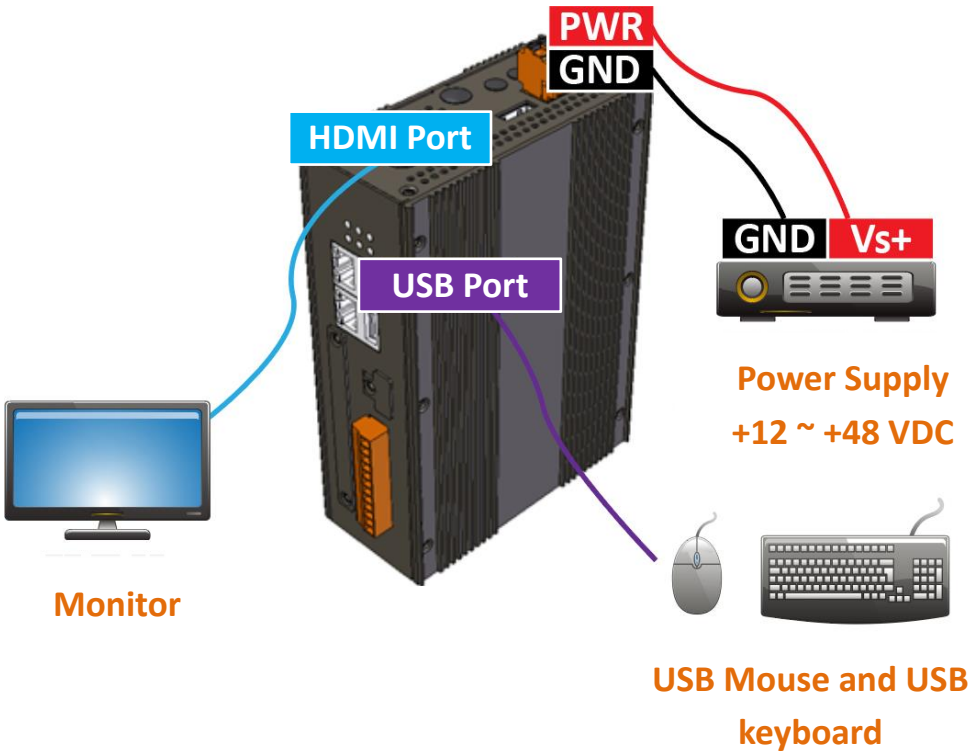


Step 3：Set up power and connect PC and USB device

i . Connect USB mouse or USB keyboard to USB port

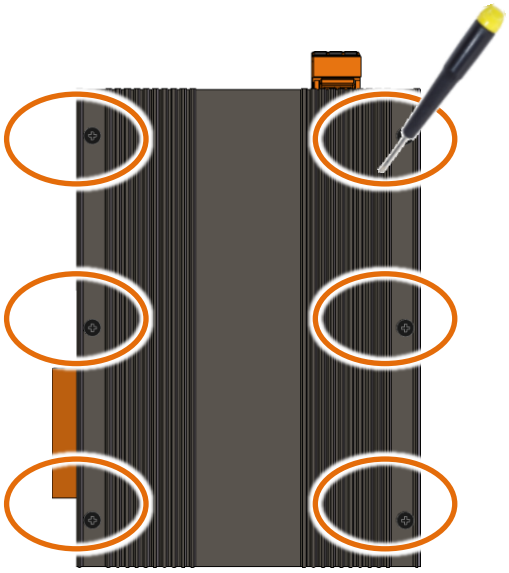
ii. Connect the monitor to the HDMI port

iii. Connect a +12 to +48 VDC power supply to the PWR and GND terminals of the connector



2.2. Installing the Expansion Accessory

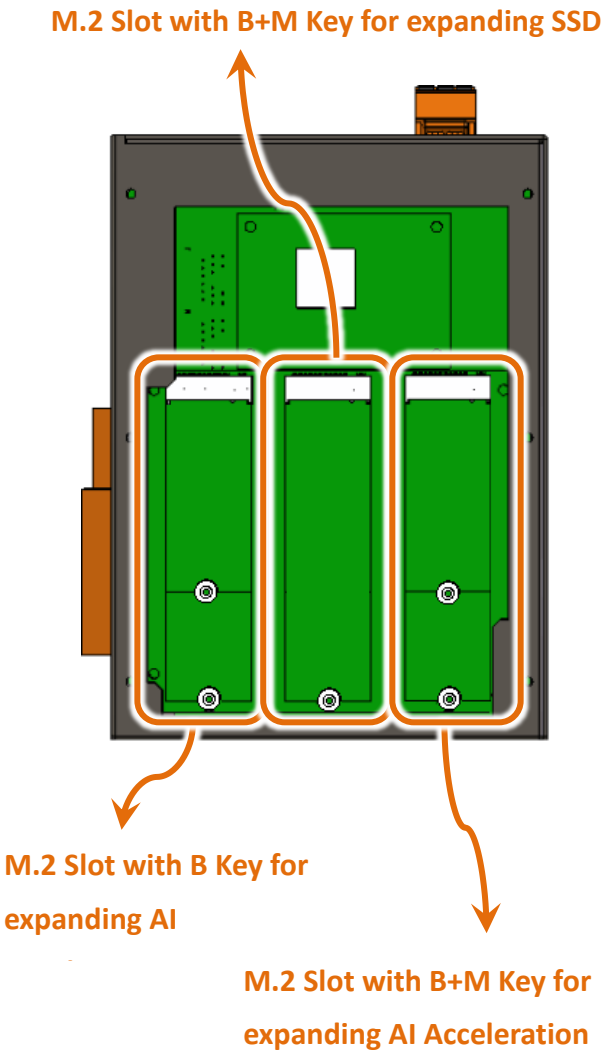
2.2.1. Install the AI Module/SSD



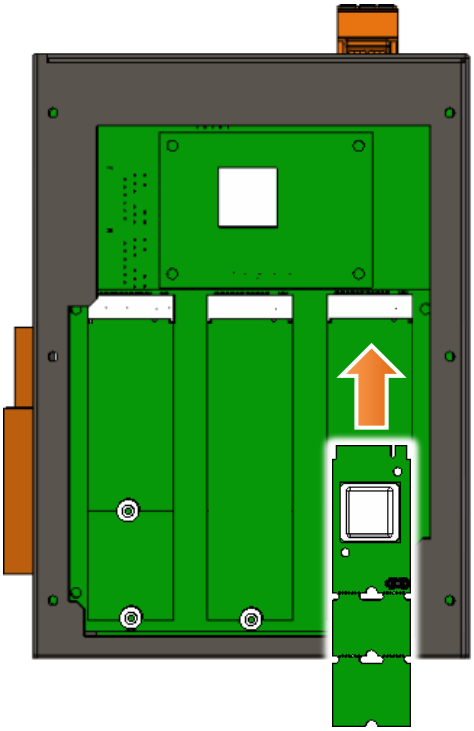
Step 1：Use a screwdriver to remove the screws on the right side cover

Step 2：Remove the right side cover

Step 3：Confirm the available M.2 slots for the AI module and SSD

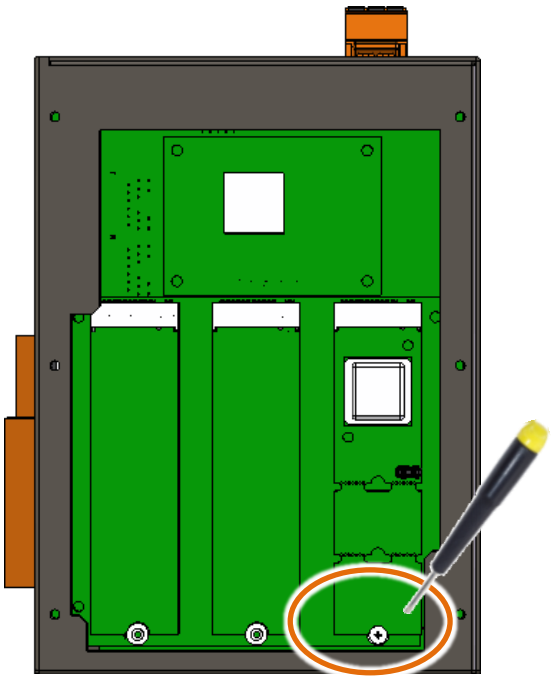


Step 4：Insert AI module/SS



Step 5：Use the included M2 x 3L screws to secure the AI module/SSD

Step 6：Close the right side cover and tighten the screws



Step 7：Close the right side cover and tighten the screws

2.2.2. Install XV-Board/XB-Board

AIB-2941M has an I/O expansion slot that can support an XV-Board/XB-Board expansion module. For information on the specifications of XV-Board/XB-Board , please refer to

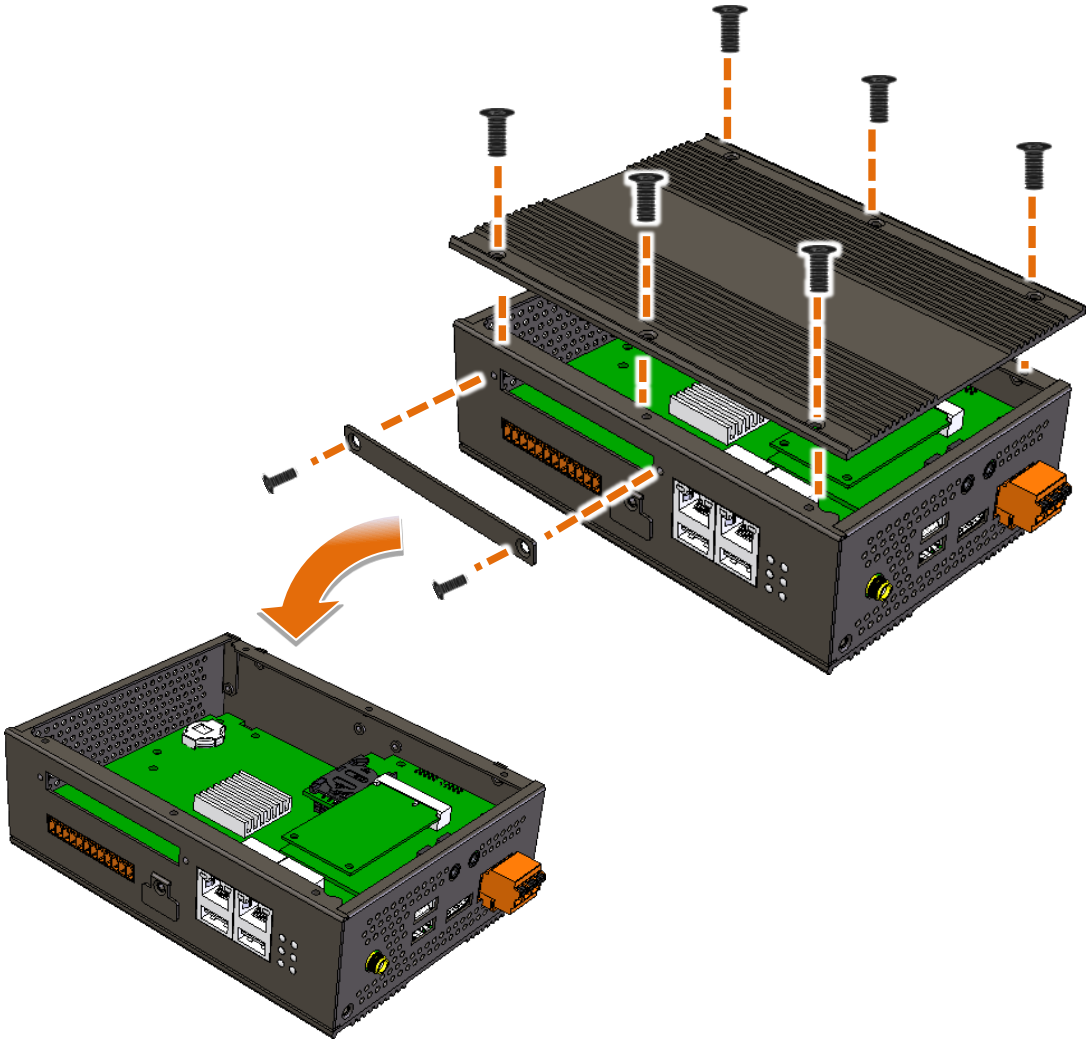
XV-board I/O module (optional)

https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XV-board

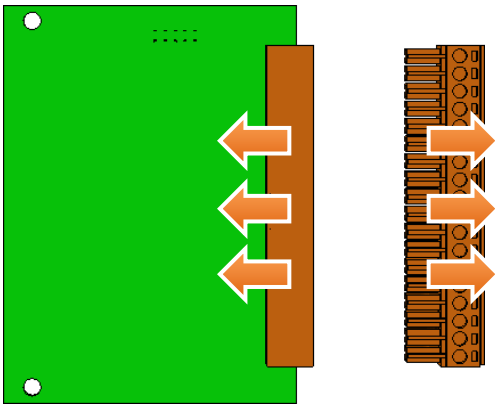
XB-board I/O module (optional)

https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XB-board

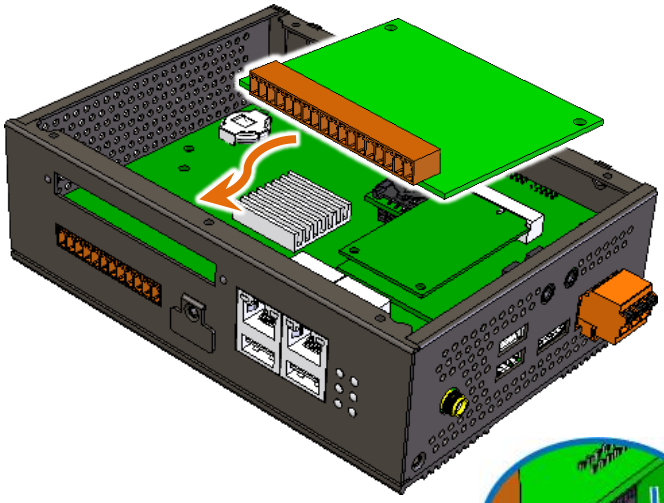
Step 1: Remove stripped screws and then remove the cover



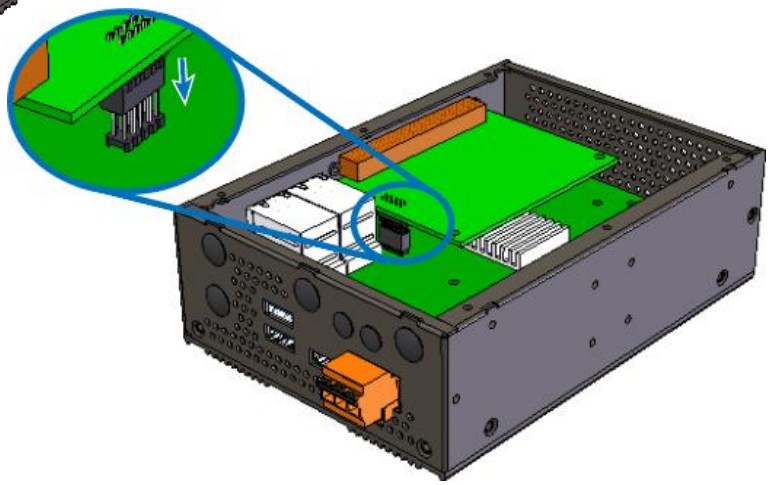
Step 2: Separate the XV-board/XB-board from the I/O terminals



Step 3：Hold the XV -board/XB- board vertically and align it with the I/ O slot, then carefully press the XV-board /XB- board onto the I/O expansion slot



Step 4: Fasten the XV -board/XB- board using the screws supplied

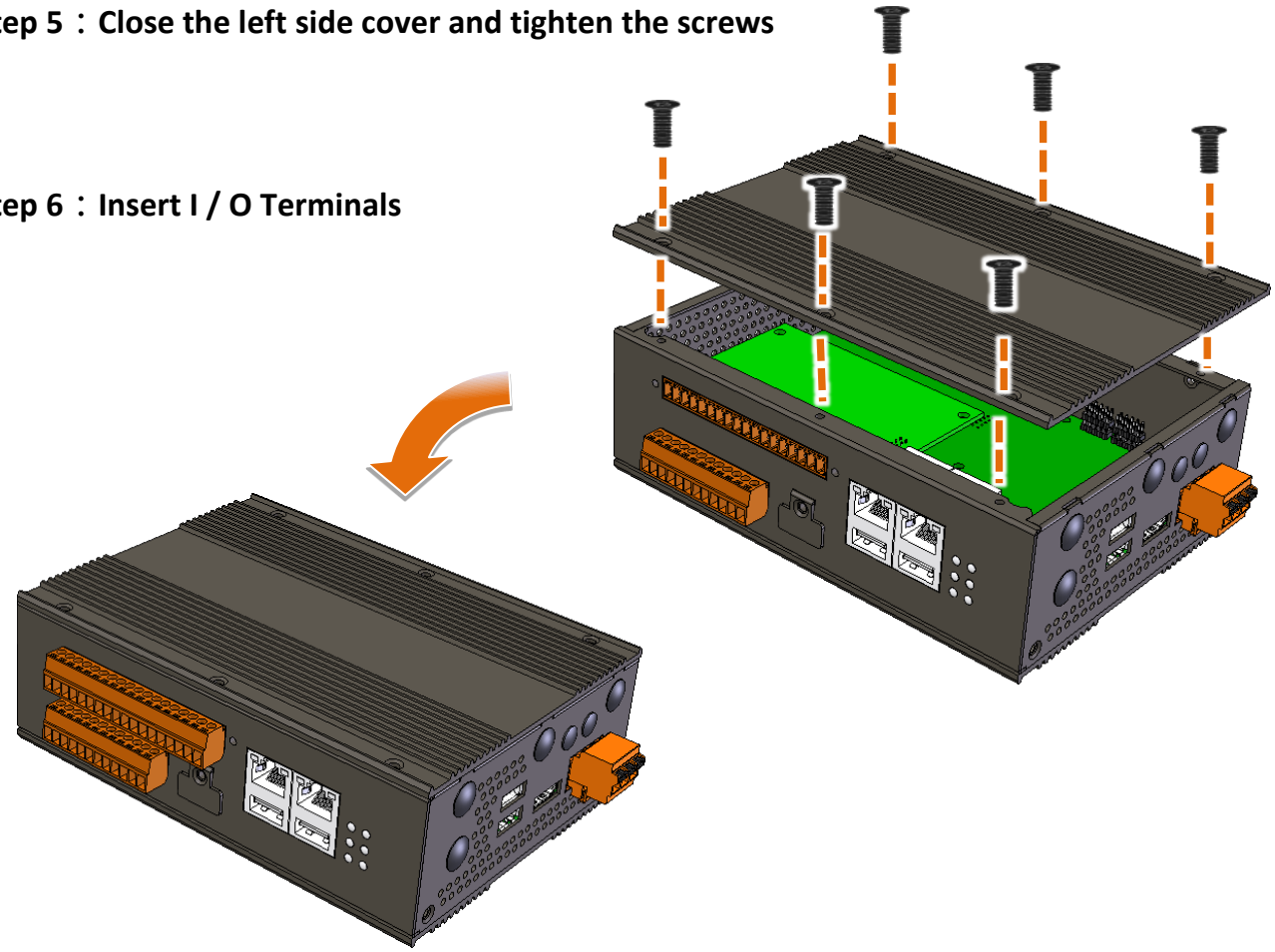


Tips & Warnings

For installing the XV-board/XB-board expansion module, make sure that the pin header on the XV-board/XB-board expansion module is aligned with the pin header on the AIB -2941M PCB, and then push it in.

Step 5：Close the left side cover and tighten the screws

Step 6：Insert I / O Terminals

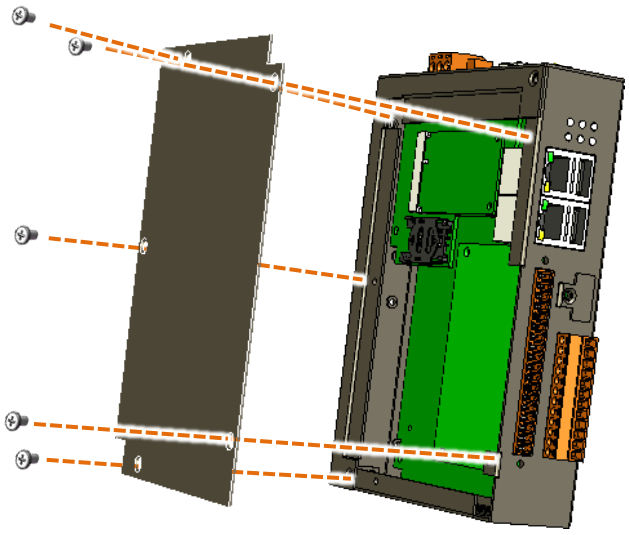


2.2.3. Insert SIM card

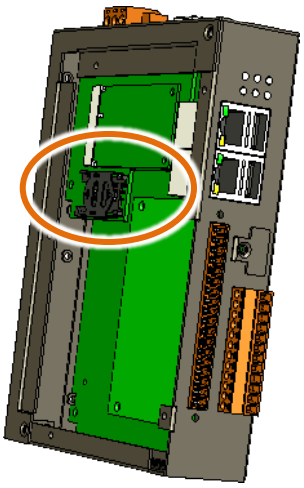
(Only applicable if 4G module is installed)

SIM card slot is located on the side of the module.

Step 1 : Use a screwdriver to remove the screws on the side, then remove the cover



Step 2 : Insert the SIM card into the SIM card slot



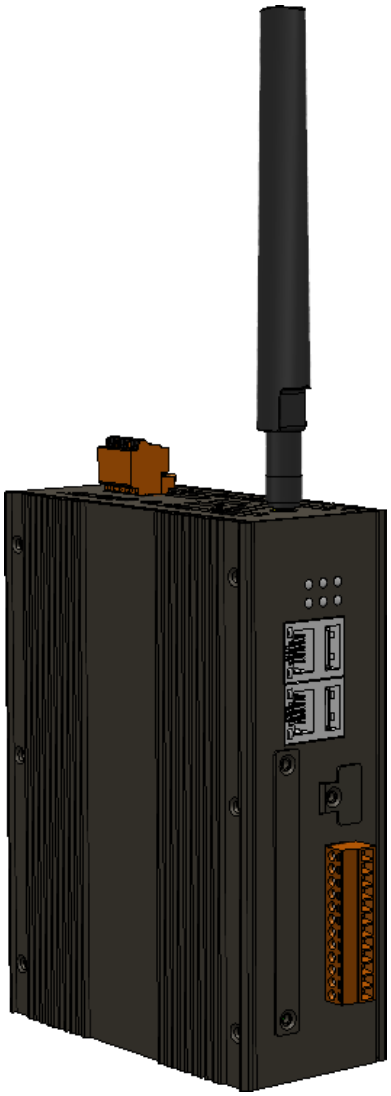
Tips & Warnings

Before installing or ejecting the SIM card, make sure that the AIB-2941M is powered off. Be careful not to bend or scratch the SIM card.

2.2.4. Install antenna

(Only applicable if 4G module is installed)

The mobile network module has an antenna connector that can be used to connect a 3G/4G antenna. When installing the antenna, simply insert the antenna tightly into the connector and place the antenna in the appropriate location.

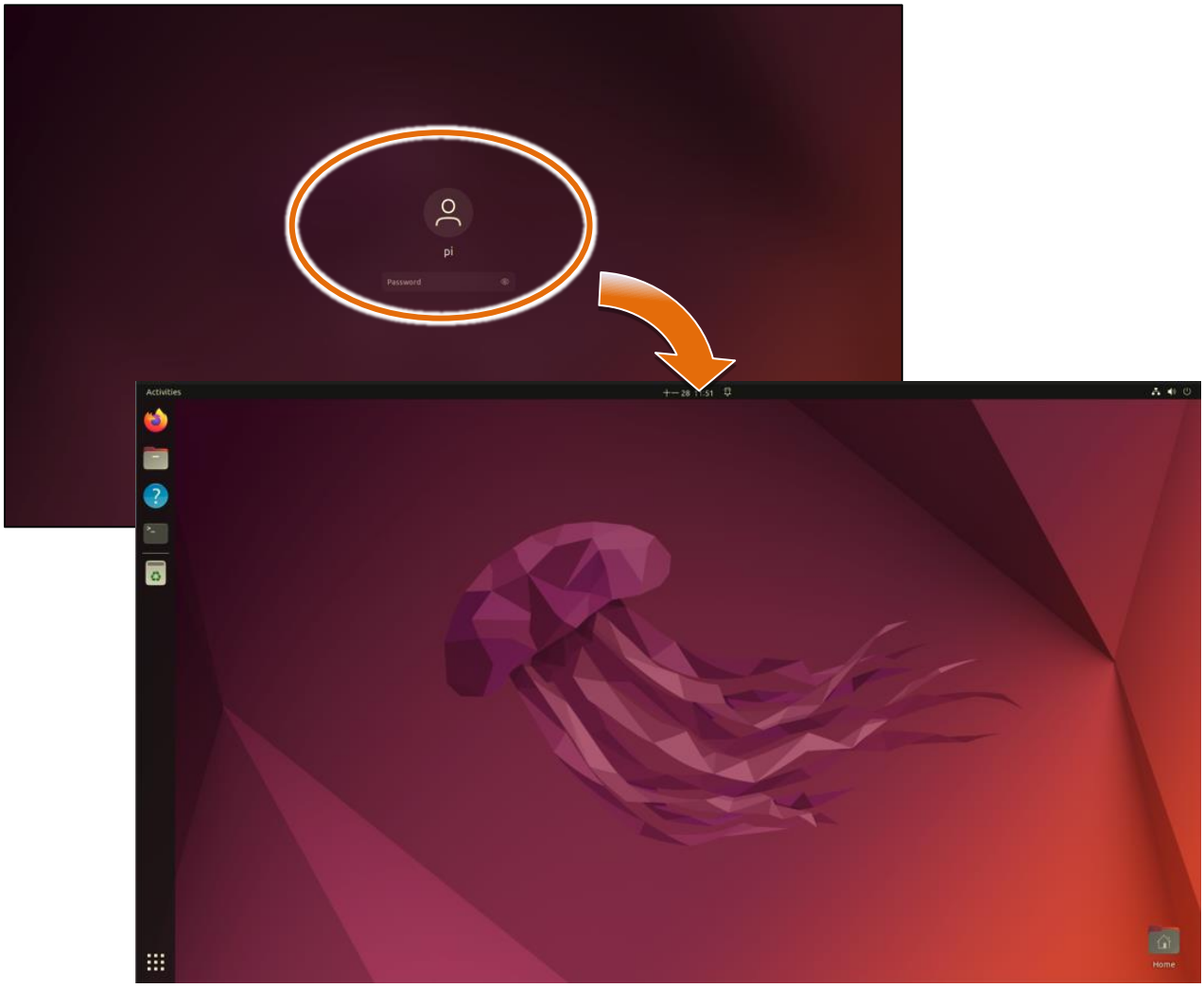


2.3. Logging in the AIB-2941M

After the installation is completed, start AIB-2941M to enter the administrator login screen.

The following table shows the default administrator accounts and passwords:

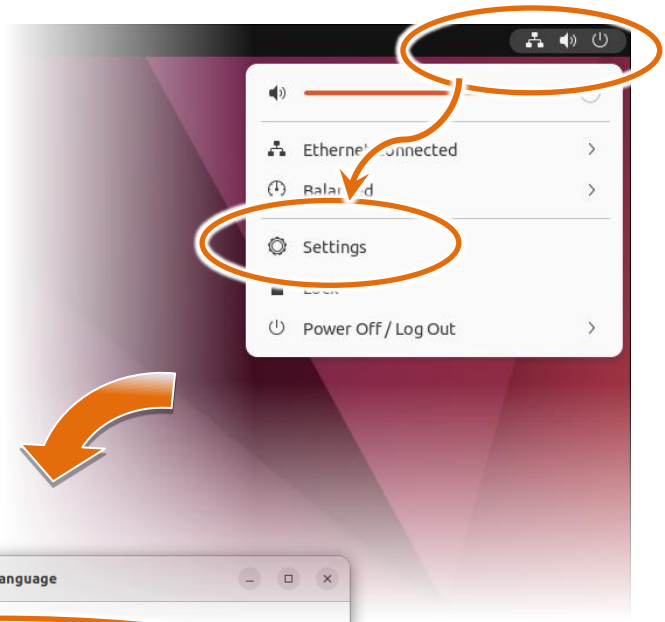
Item	Default
ID	pi
Password	icpdas



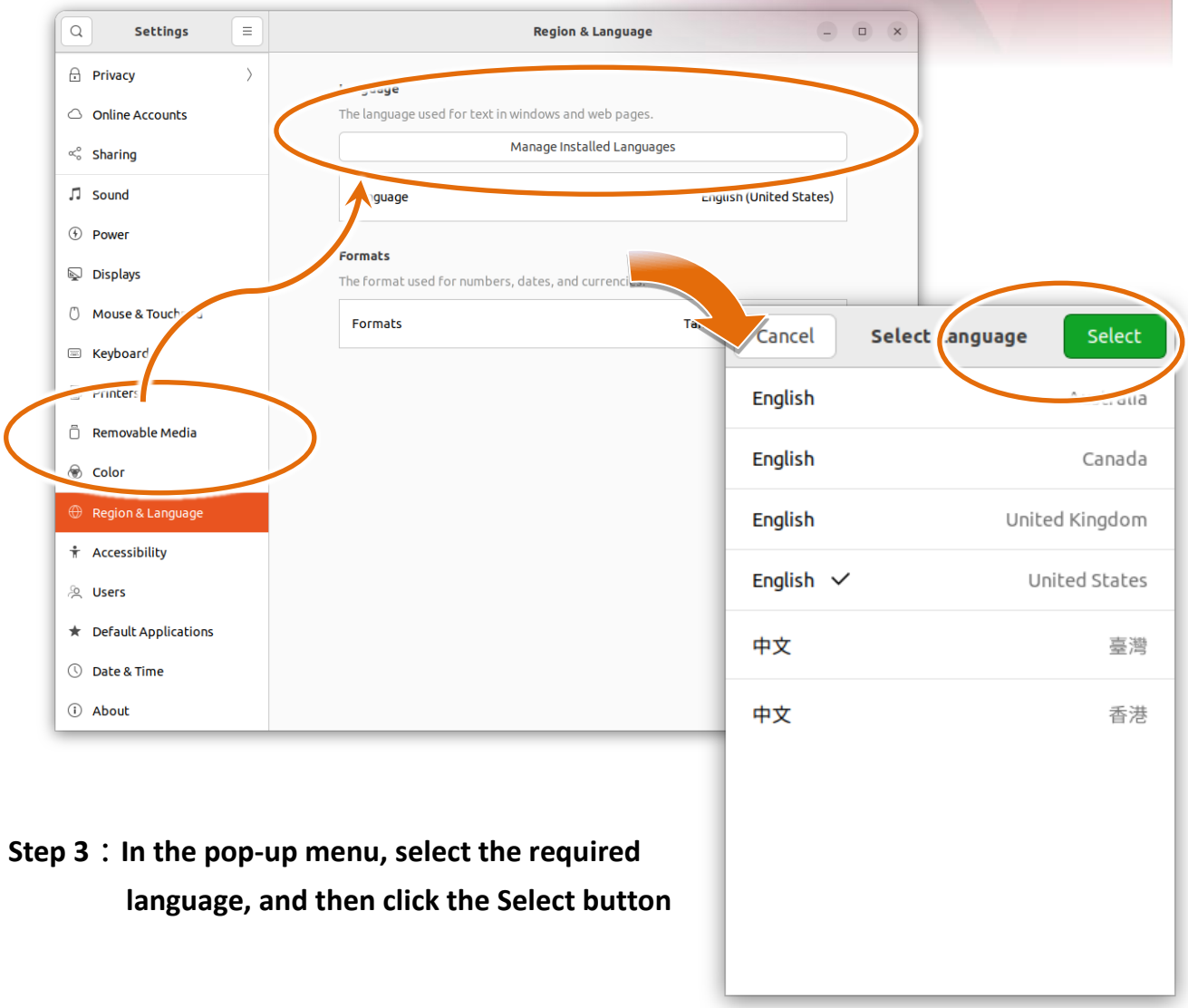
2.4. Changing the User interface Language

Regional Settings is a built-in function of Ubuntu, which allows users to easily change the user interface language of AIB-2941M. Please follow the steps below to change the language interface.

Step 1：Click the icon in the upper right corner of the desktop, then click Settings in the pop-up menu



Step 2：Click the Region & Language, and then click the Language item

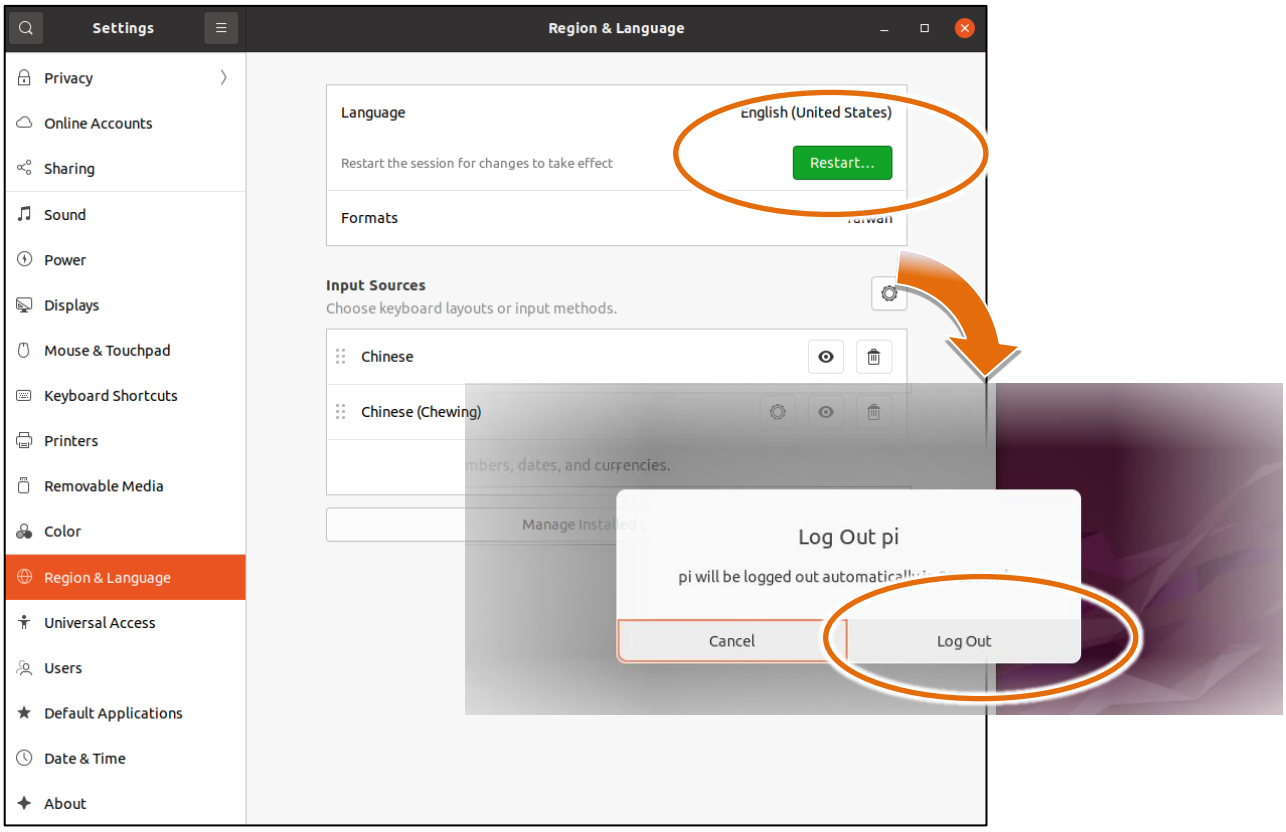


Step 3：In the pop-up menu, select the required language, and then click the Select button

Step 4：Click the Restart button to restart for the settings to take effect

When selecting a different language, a Restart button will appear in the Language item.

Step 5：Click Log Out to confirm the restart process

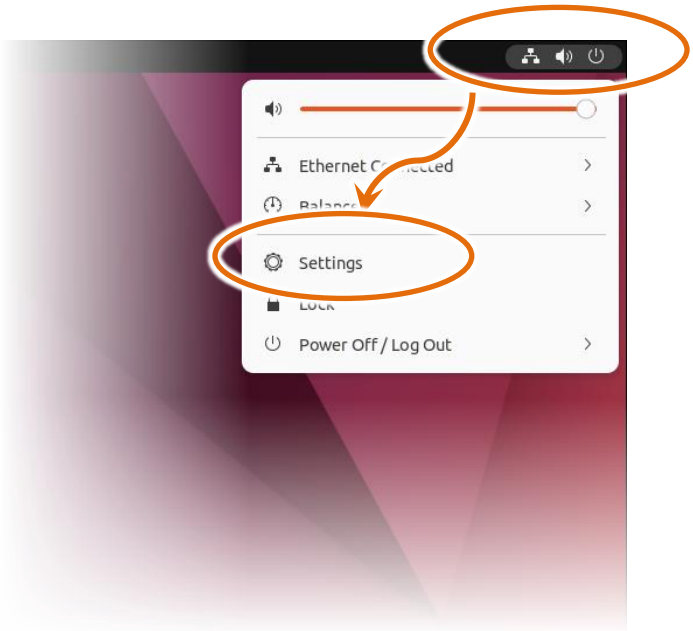


Step 6：Enter the password on the administrator login screen and log in again to complete the system language change process

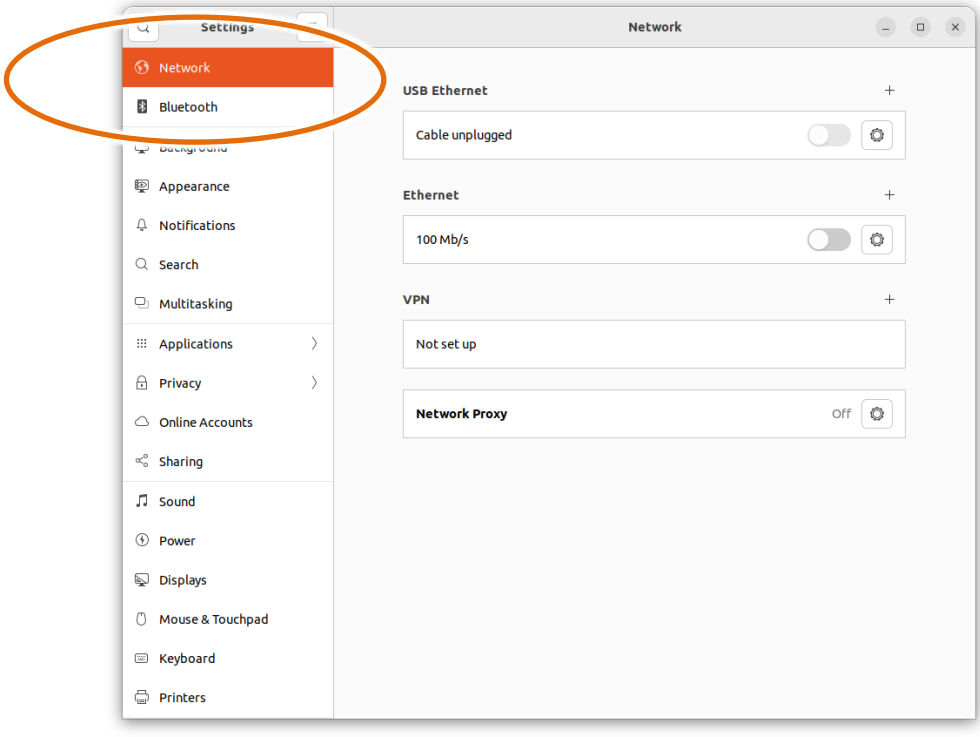
2.5. Configuring the IP Settings

Ubuntu has built-in IP setting function. Please follow the steps below to set the IP .

Step 1：Click the icon in the upper right corner of the desktop, then click Settings in the pop-up menu



Step 2：Click Network



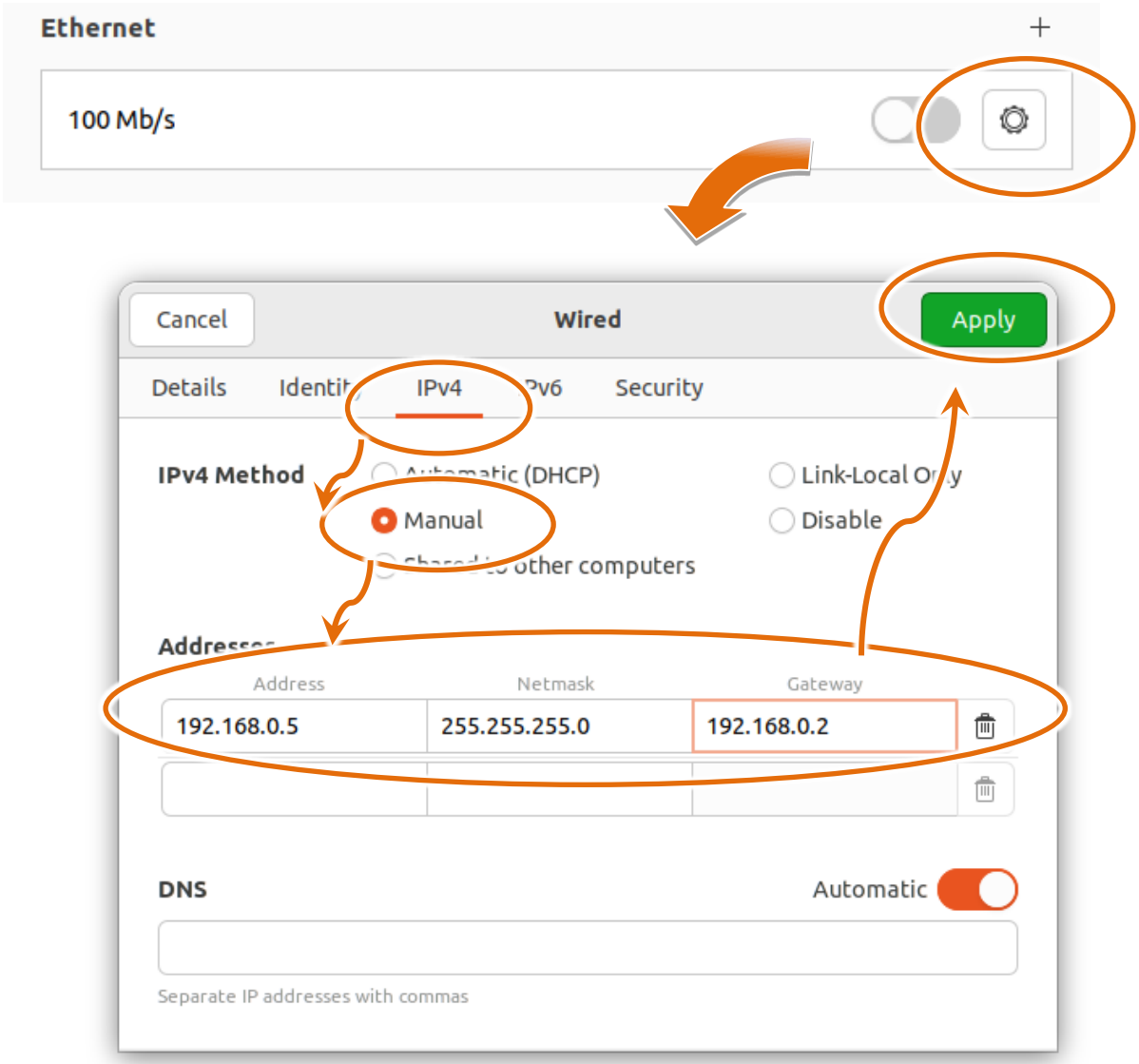
Step 3: Set IP

Assign IP address using DHCP

Simply click the switch button to enable it

Manually assign IP addresses

Click the  Settings button, click the IPv4 tab in the pop-up dialog window, select the Manual option, set the IP address, and click the Apply button when finished.

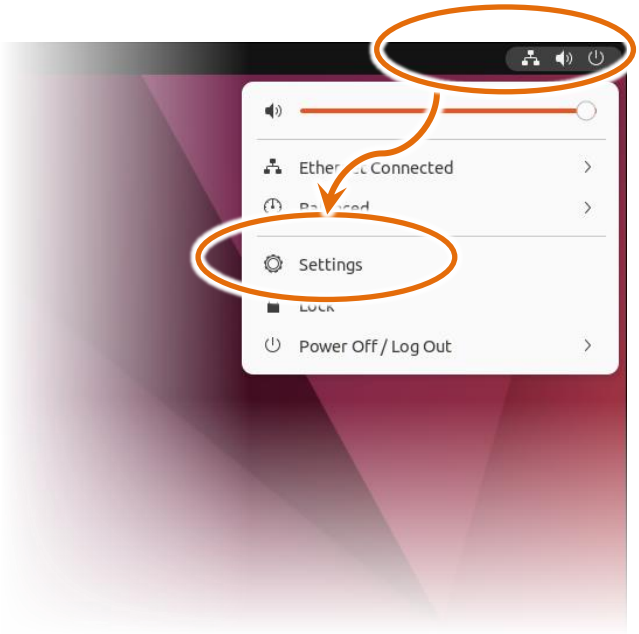


3. Tools and Tasks

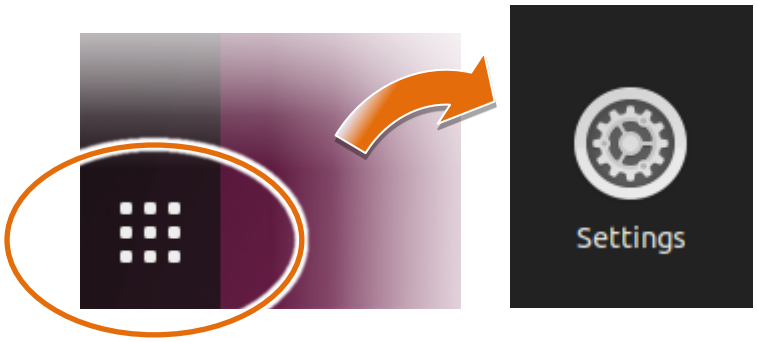
This chapter briefly introduces the commonly used, software tools and advantages of AIB-2941M. AIB-2941M also has some software tools specially designed for AIB-2941M.

3.1. System tools

System tools can be set by clicking the icon in the upper right corner of the desktop and then clicking Settings.



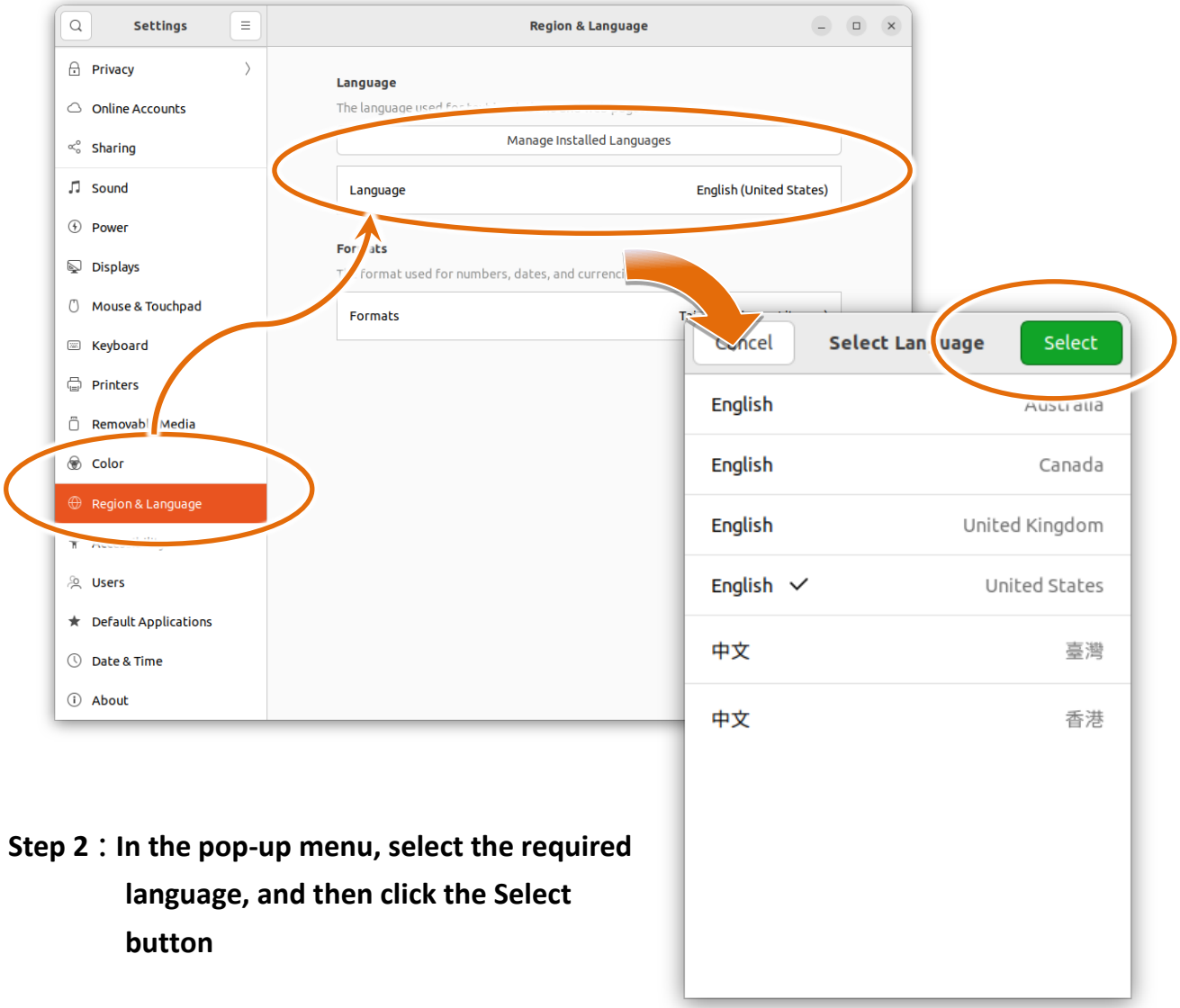
You can also click the icon  in the lower left corner and then click Settings to enter settings.



3.1.1. Regional & Language Settings

Regional Settings is a built-in function of Ubuntu, which allows users to easily change the user interface language of AIB-2941M. Please follow the steps below to change the language interface.

Step 1：Click Region & Language, and then click the Language item

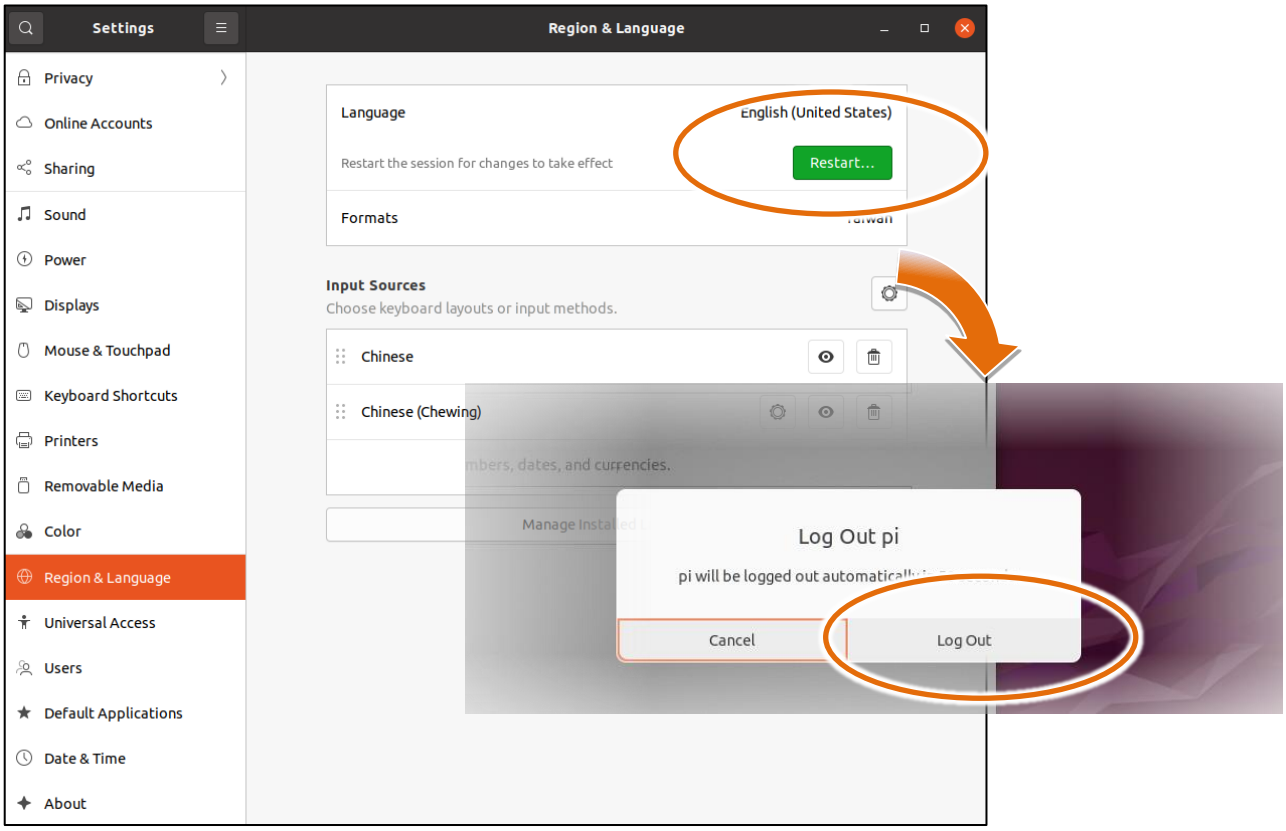


Step 2：In the pop-up menu, select the required language, and then click the Select button

Step 3：Click the Restart button to restart for the settings to take effect

Return to the Region & Language dialog window. When selecting a different language, a Restart button will appear in the Language item.

Step 4：Click Log Out to confirm the restart process

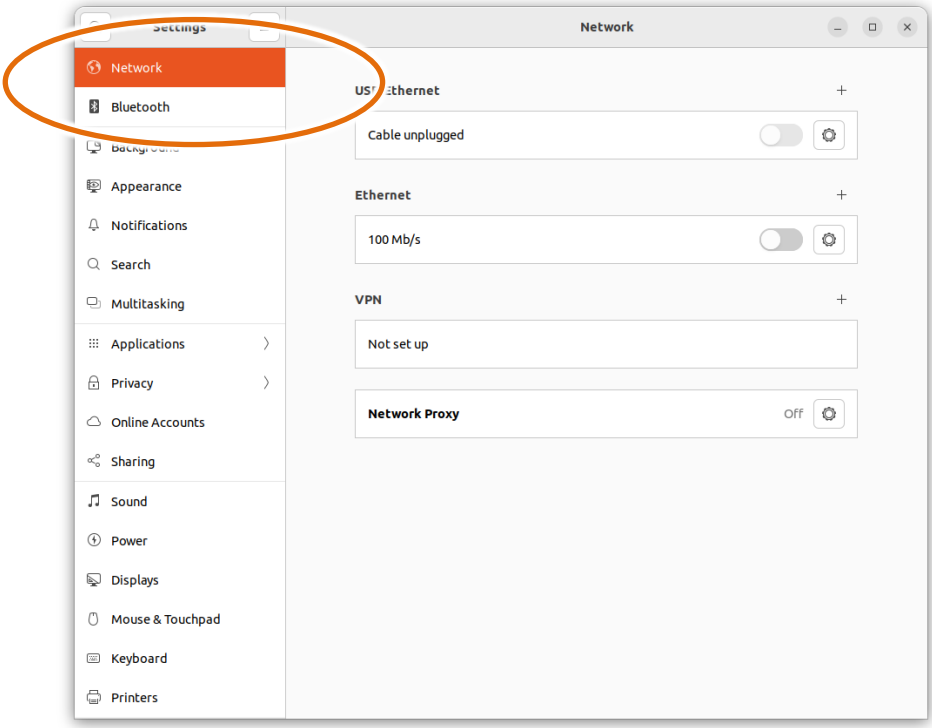


Step 5：Enter the password on the administrator login screen and log in again to complete the system language change process.

3.1.2. IP Settings

Ubuntu has built-in IP setting function. Please follow the steps below to set the IP.

Step 1：Click Network



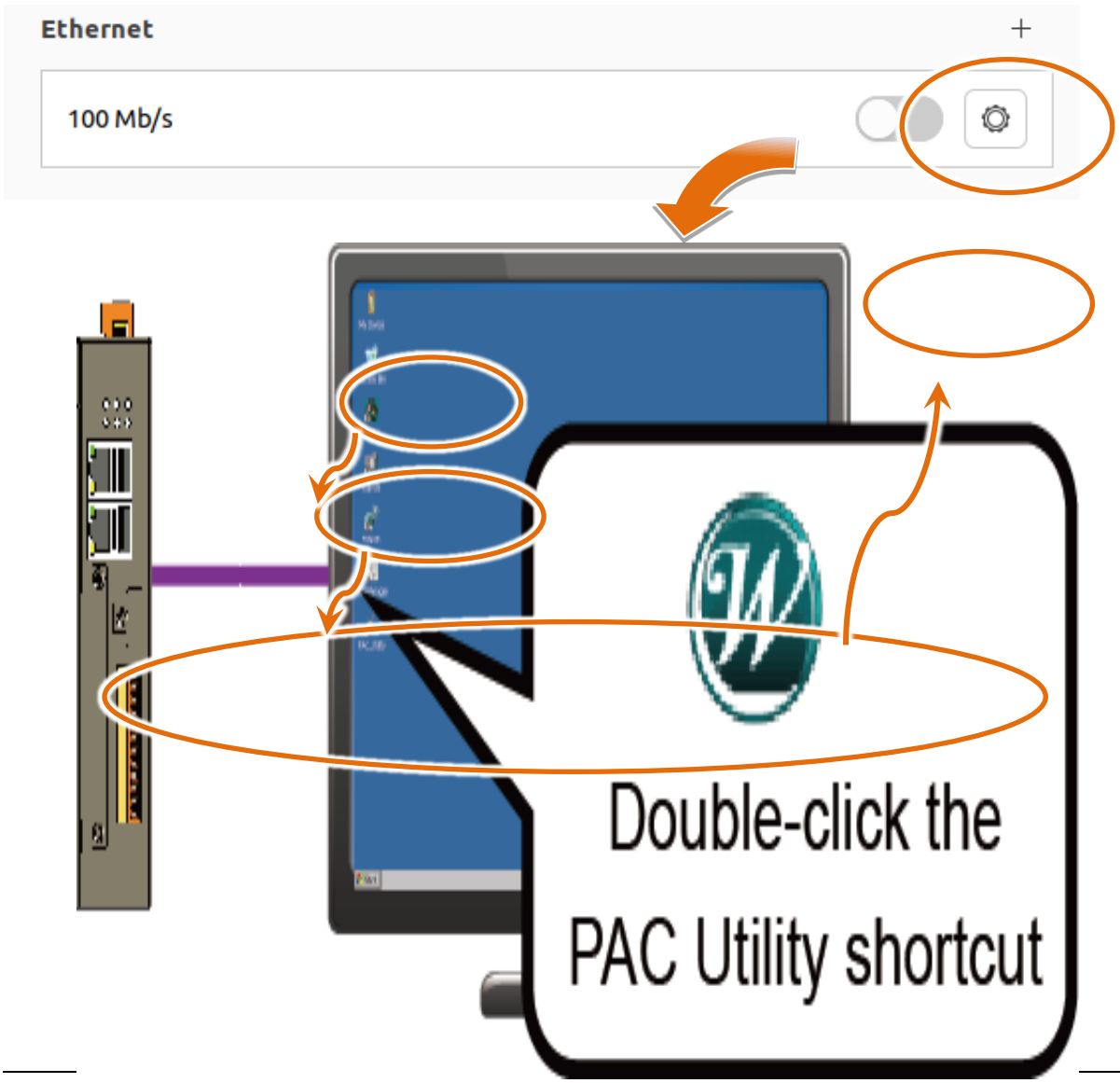
Step 2: Set IP

Assign IP address using DHCP

Simply click the switch button to enable it

Manually assign IP addresses

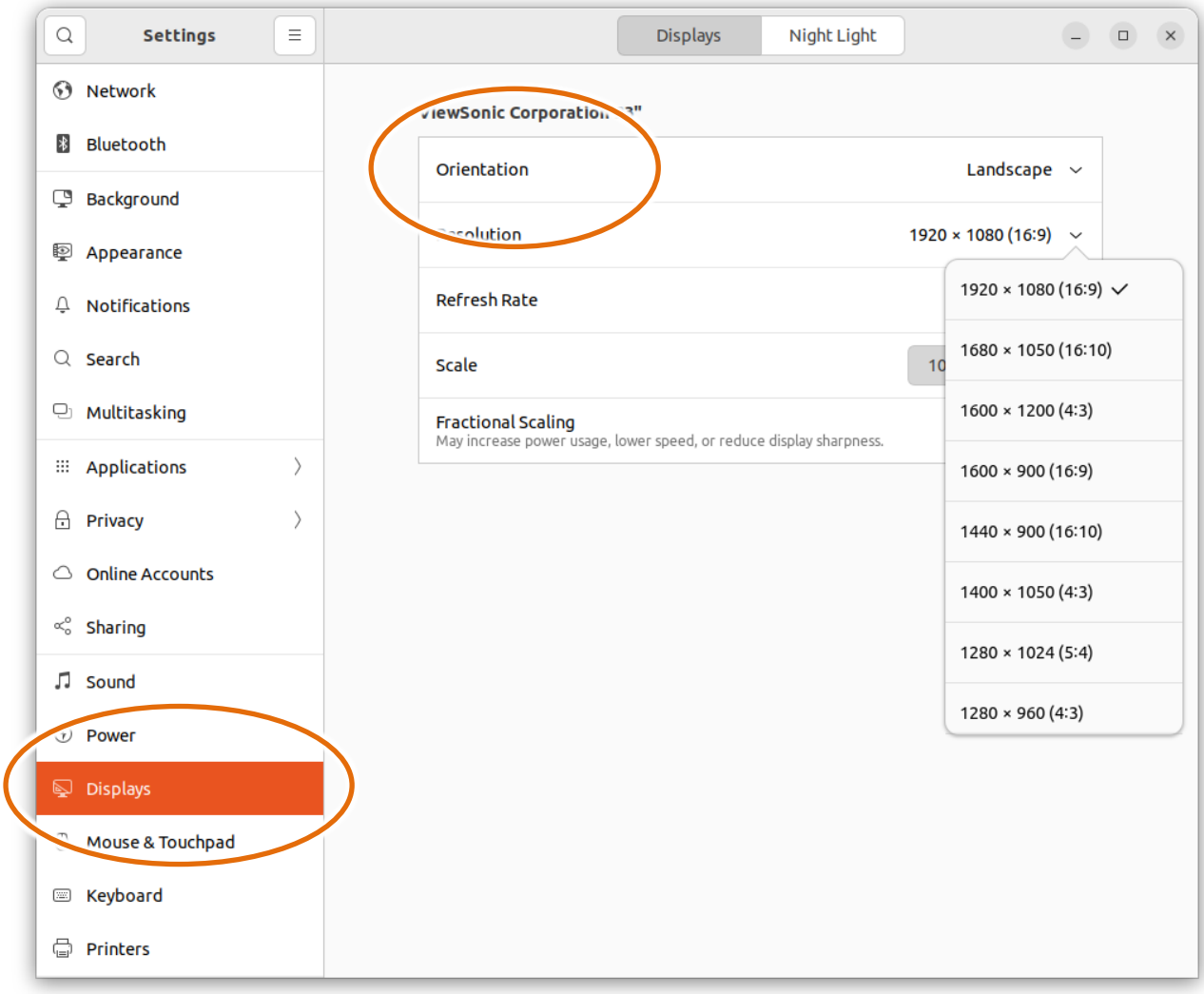
Click the  Settings button, click the IPv4 tab in the pop-up dialog window, select the Manual option, set the IP address, and click the Apply button when finished.



3.1.3. Resolution Settings

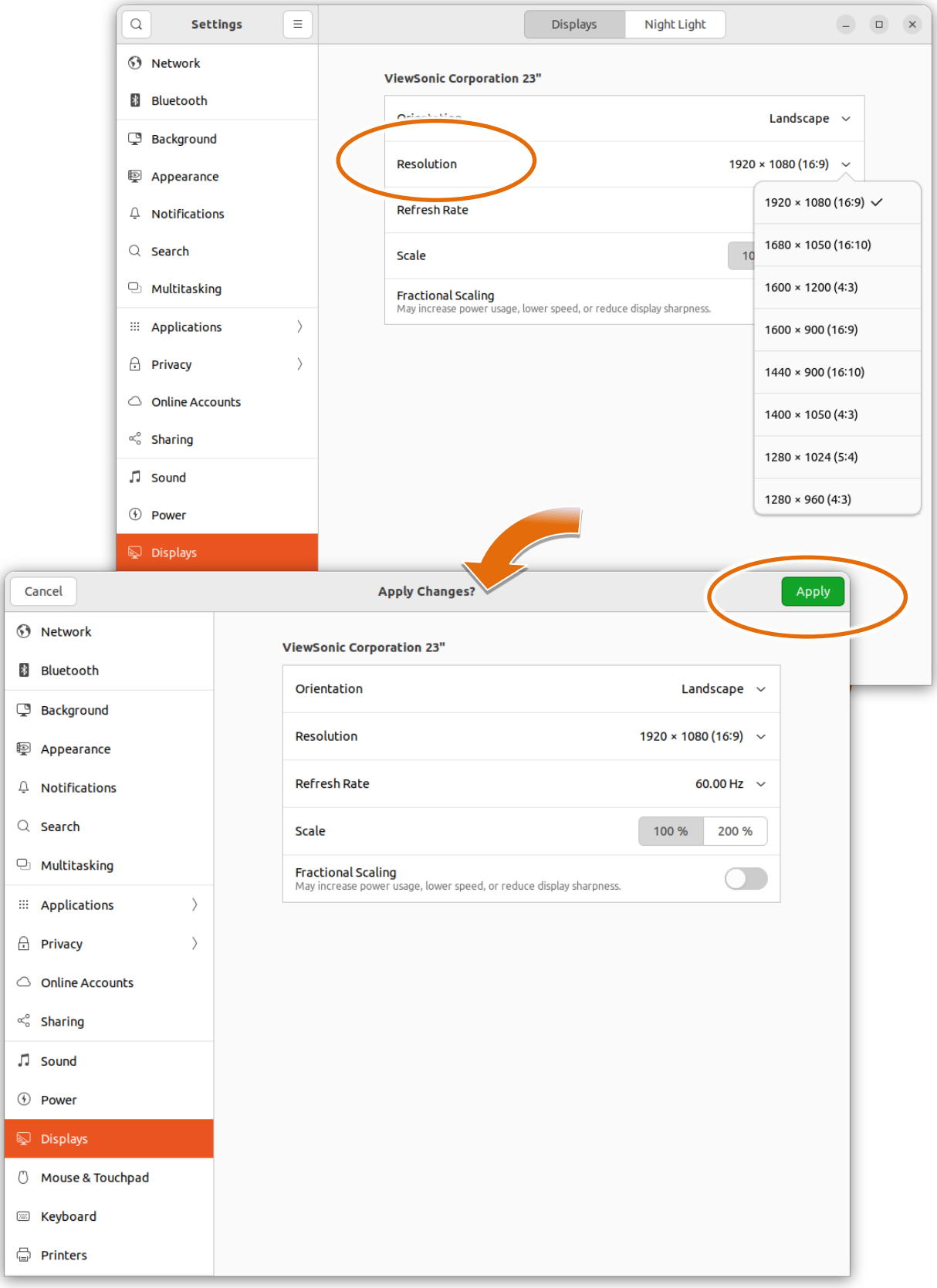
Ubuntu has a built-in resolution setting function. The resolution range can be set from 800*600~3410*2160 (4K). Please follow the steps below to set the maximum resolution of the monitor.

Step 1：Click the Display item

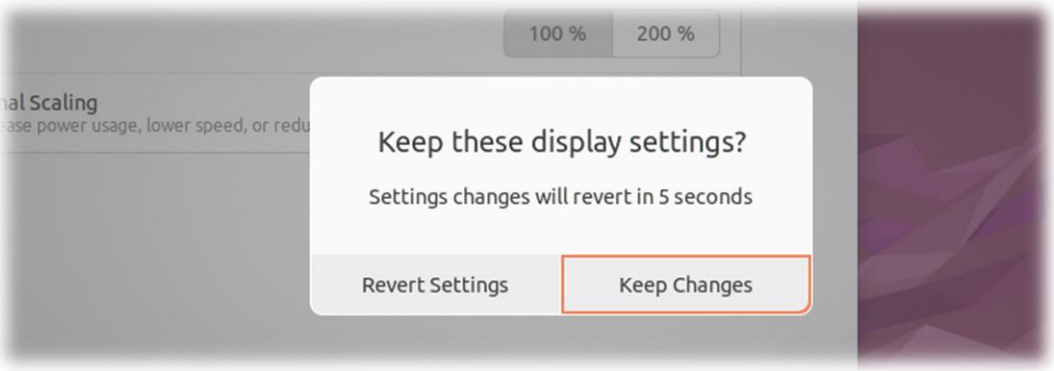


Step 2：Click on the Resolution item to set the resolution

Step 3：After setting is complete, click the Apply button



Step 4：If the selected resolution can be displayed normally, click Keep Changes in the pop-up dialog message. If it cannot be displayed normally, click Revert Settings or wait 20 seconds and it will return to the previous setting value.

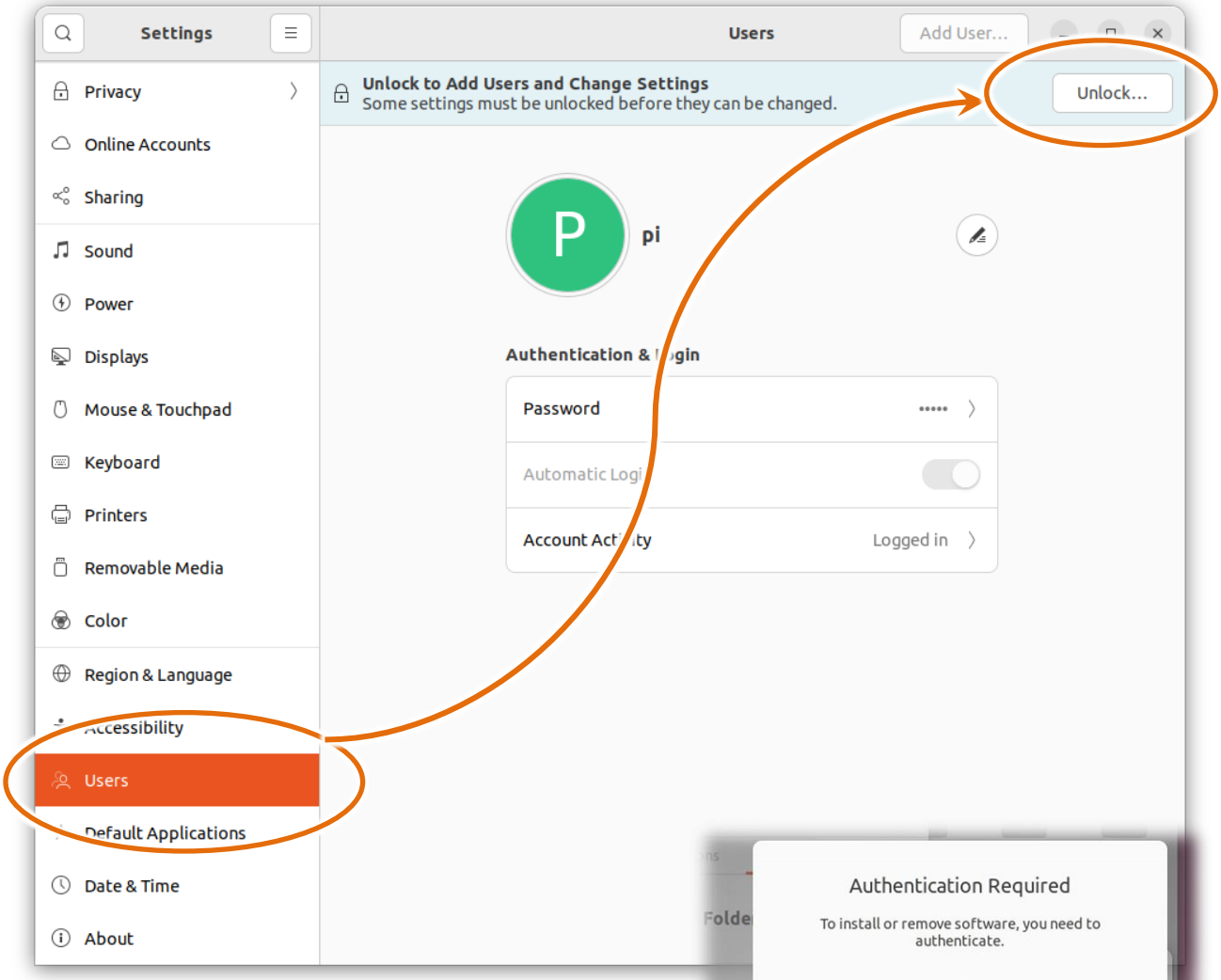


3.1.4. User account management

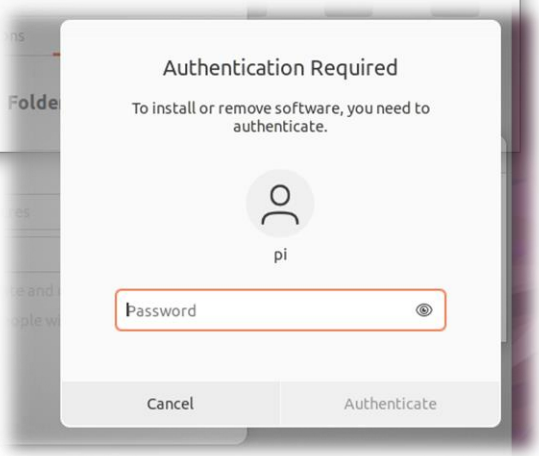
User Account Management is a security feature that helps prevent unauthorized system changes to the AIB-2941M.

Add user account

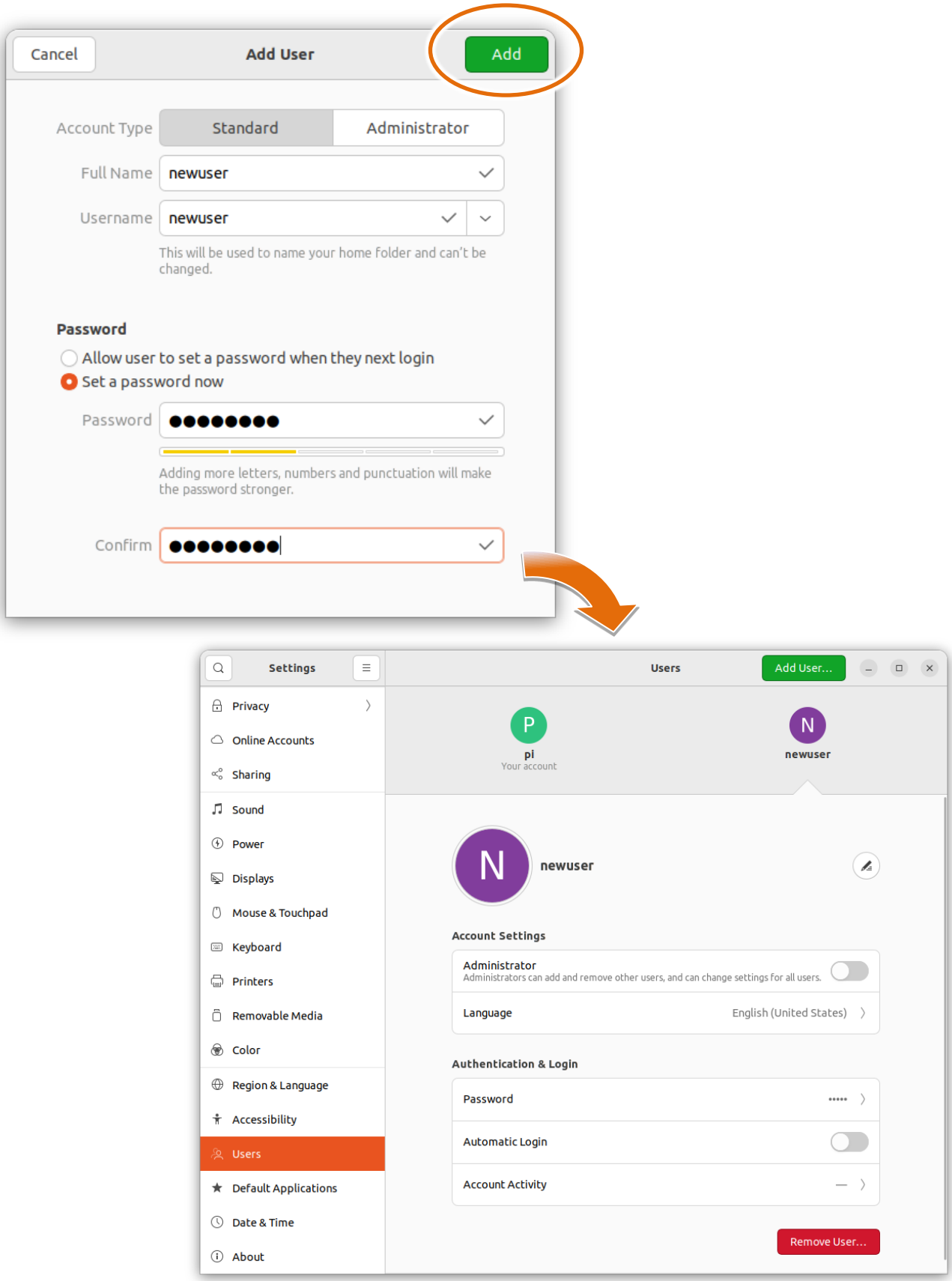
Step 1: Click the Users item, and then click the "Unlock …" button



Step 2: In the pop-up dialog window, enter the password to open user permissions

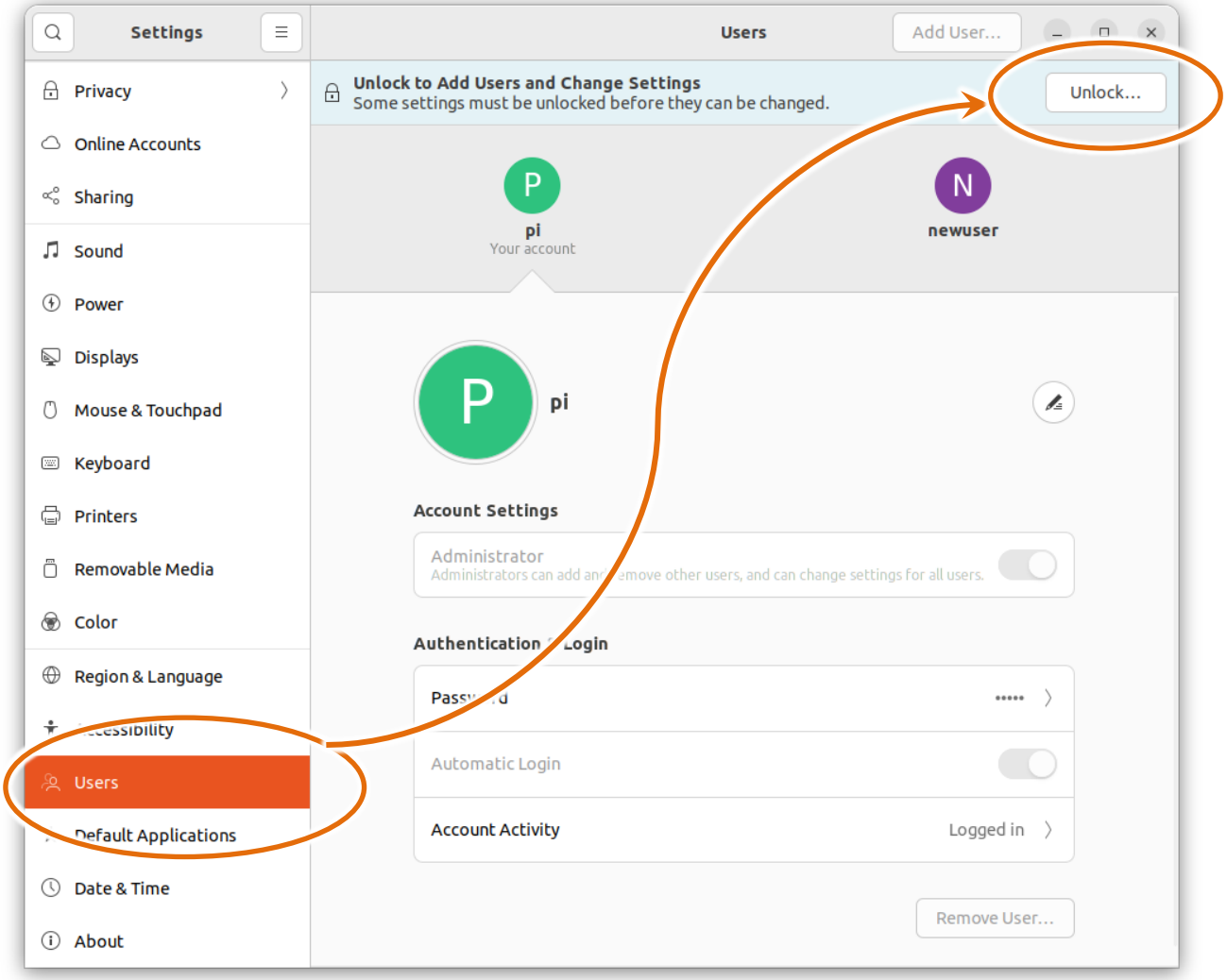


Step 3：In the Add User dialog window, after entering the user account information, click the Add button to complete the user creation

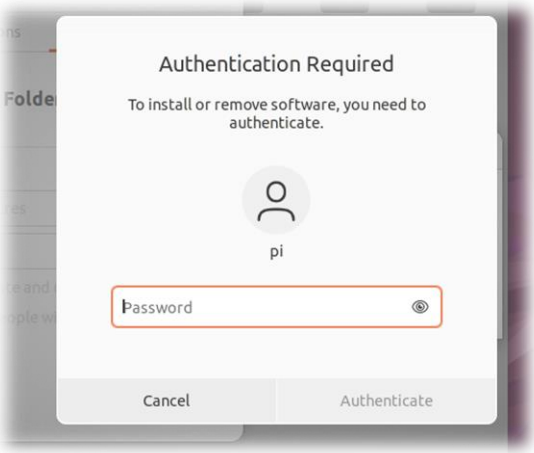


Delete user account

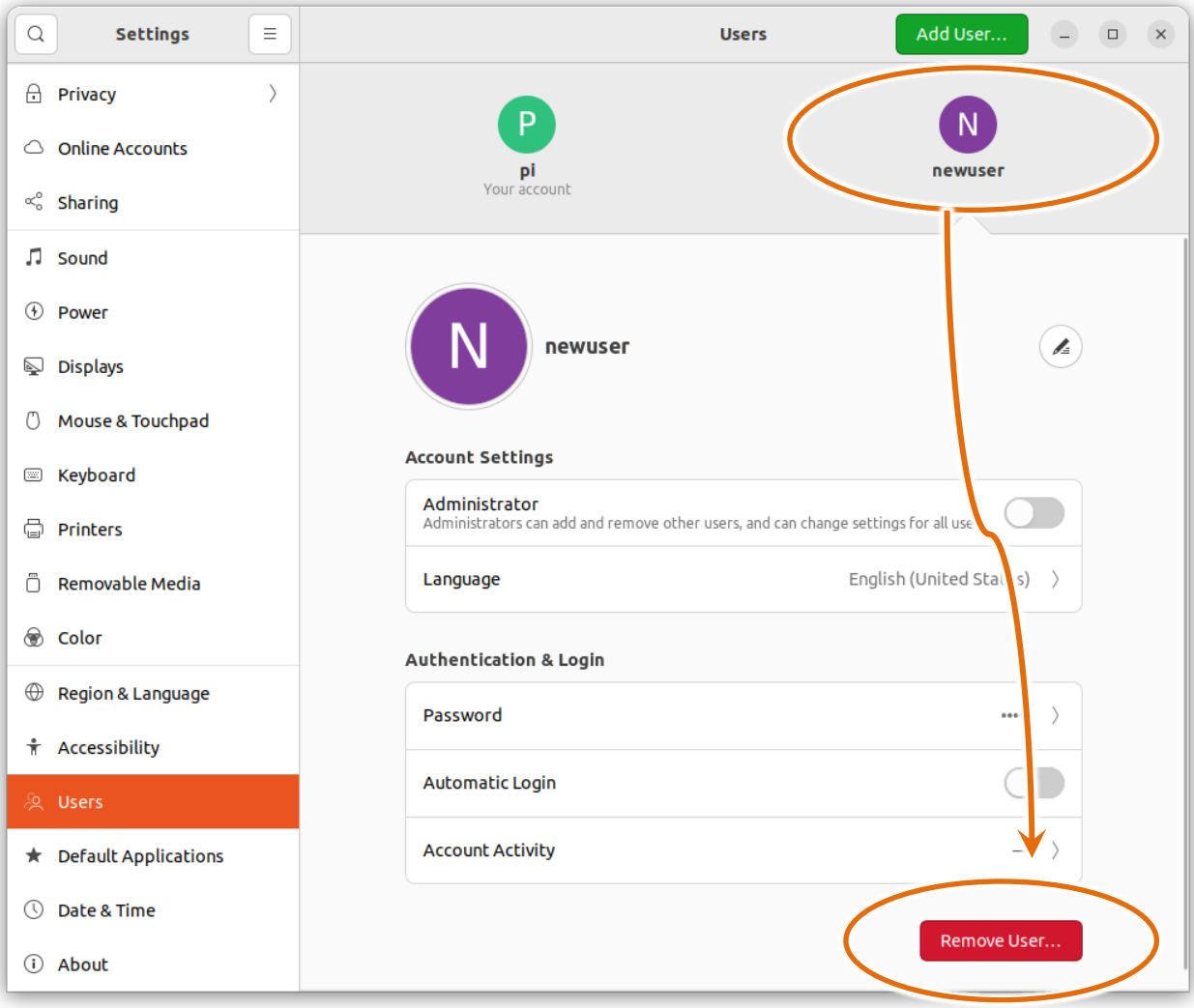
Step 1: Click the Users item, and then click the “Unlock …” button



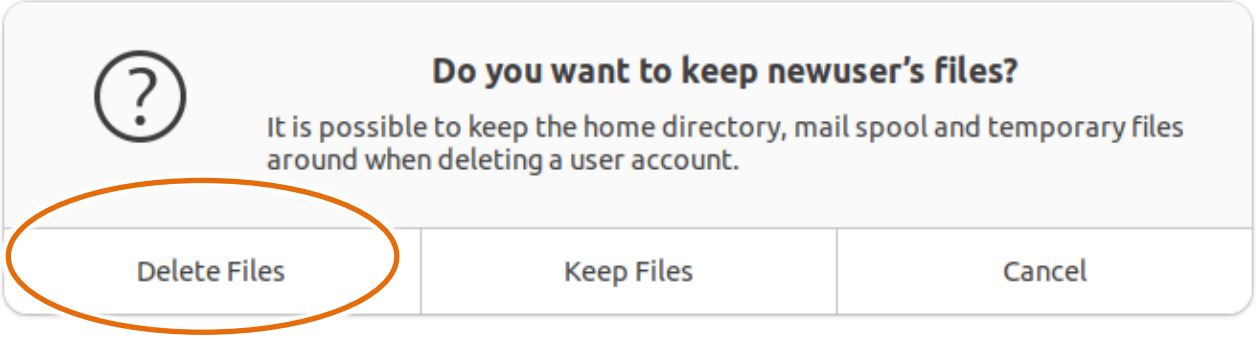
Step 2: In the pop-up dialog window, enter the password to open user permissions



Step 3: Select the user account you want to delete, and then click “Remove User …” button

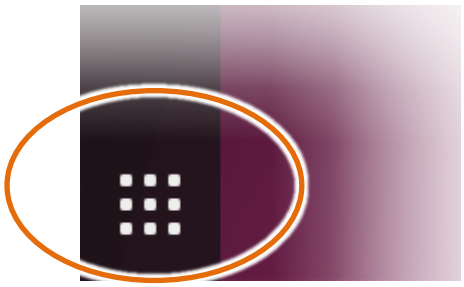


Step 4 : In the pop-up warning dialog window, click the Delete Files button to confirm the deletion of the user



3.2. Software tools

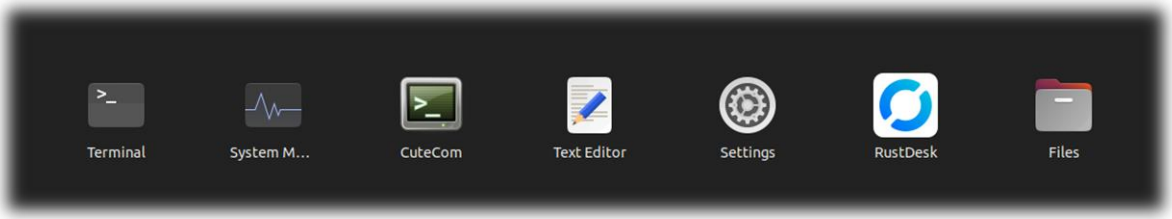
Software tools can be accessed and inspected by clicking on the icon  in the lower left corner. This section introduces some commonly used software tools.



3.2.1. Utility – View System information

Utility integrates several applications into one to facilitate management and control of the systems and functions in AIB-2941M.

Click the Utility shortcut



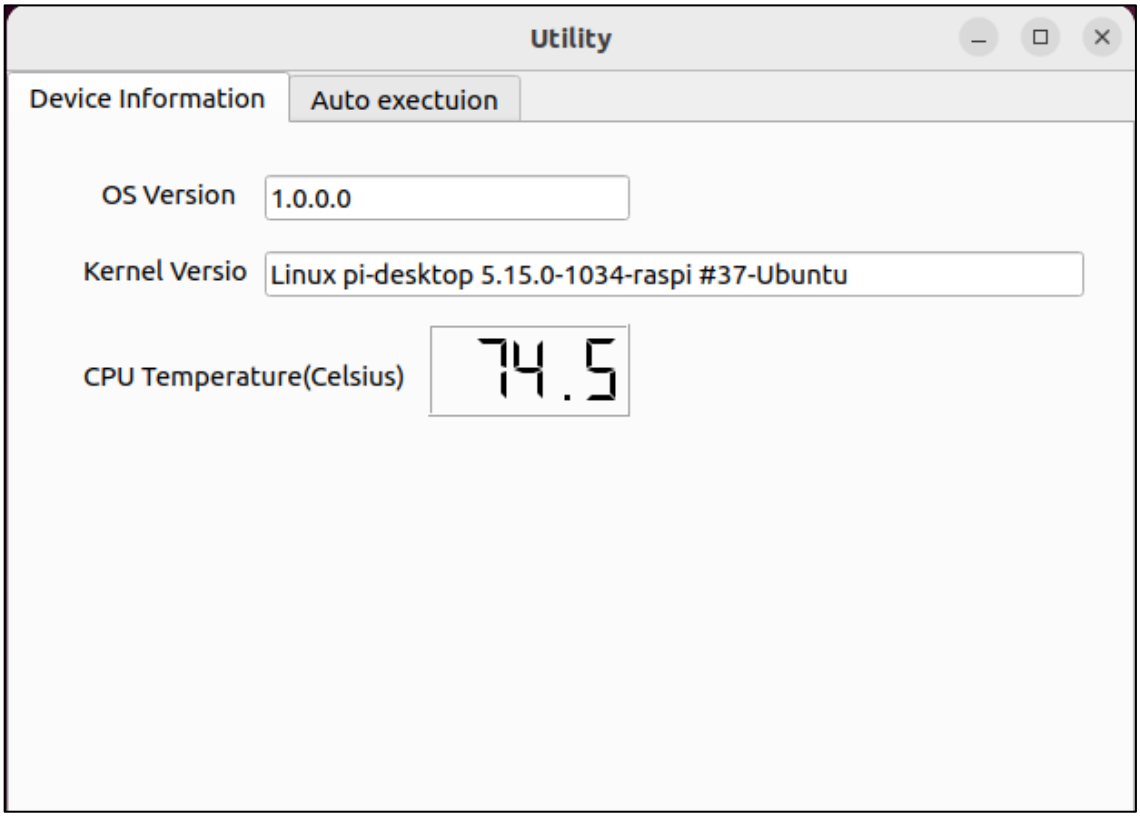
The following is a description of the Utility system tabs and their functions.

tab	Function description
Device Information	Check OS version, kernel version and CPU temperature
Auto Execution	Set startup program

System version, CPU temperature view

Device Information tab provides system information such as AIB-2941M OS version, CPU temperature, etc.

The system information provided by Utility is shown in the figure below.



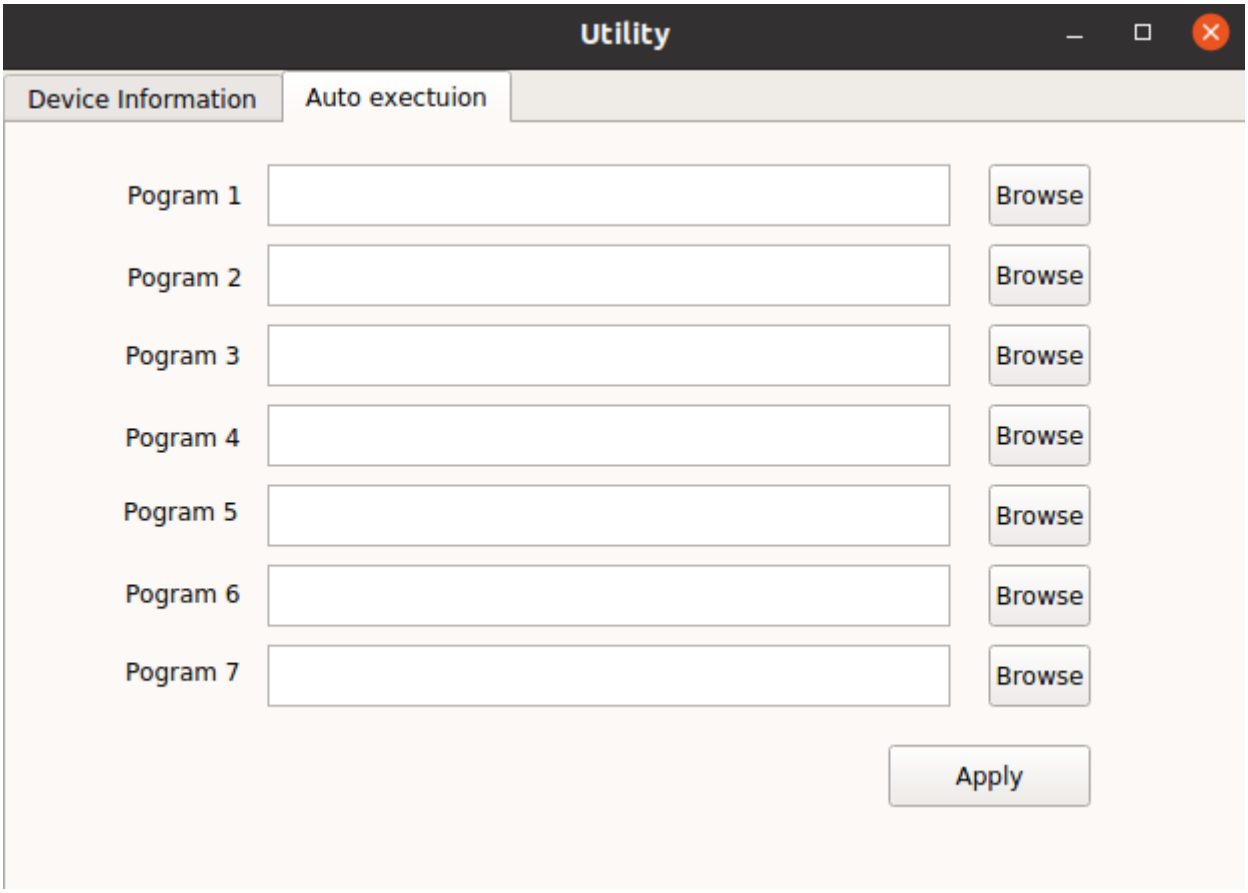
Manage startup programs

Auto Execution tab provides the function of managing automatically executed programs after booting. Up to 7 programs can be automatically executed.

Tips & Warnings

The automatically executed program attachment file name is .py and executable files, the order of execution starts from program 1 Go to program 7.

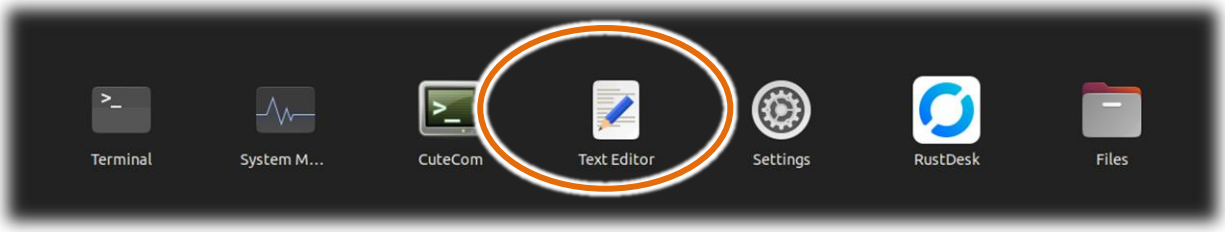
After specifying the path, click the Apply button to complete the setting.



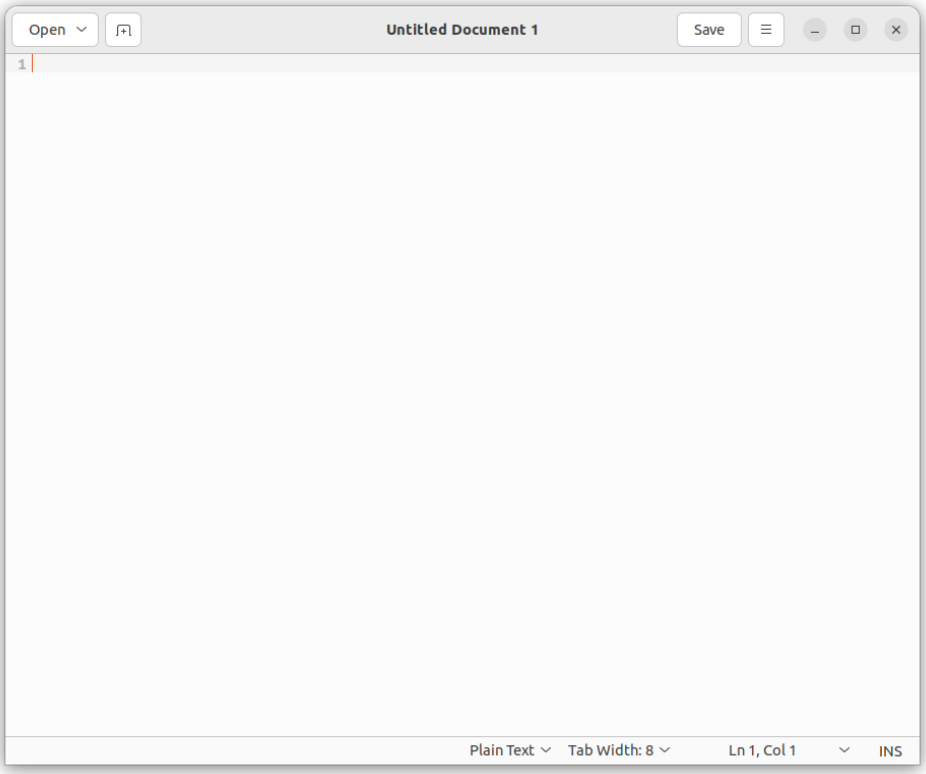
3.2.2. Text Editor

Text Editor is a simple text editor that archives content without any formatting tags or styles. Please select Text Edit in the program bar and execute it.

Click the Text Editor shortcut



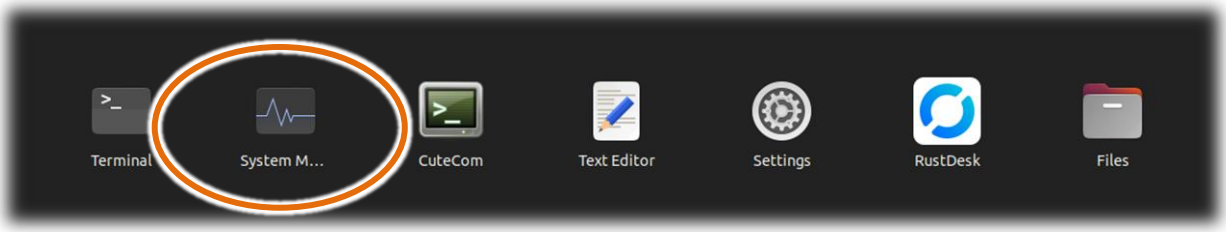
After Text Edit is turned on, the execution screen is as follows



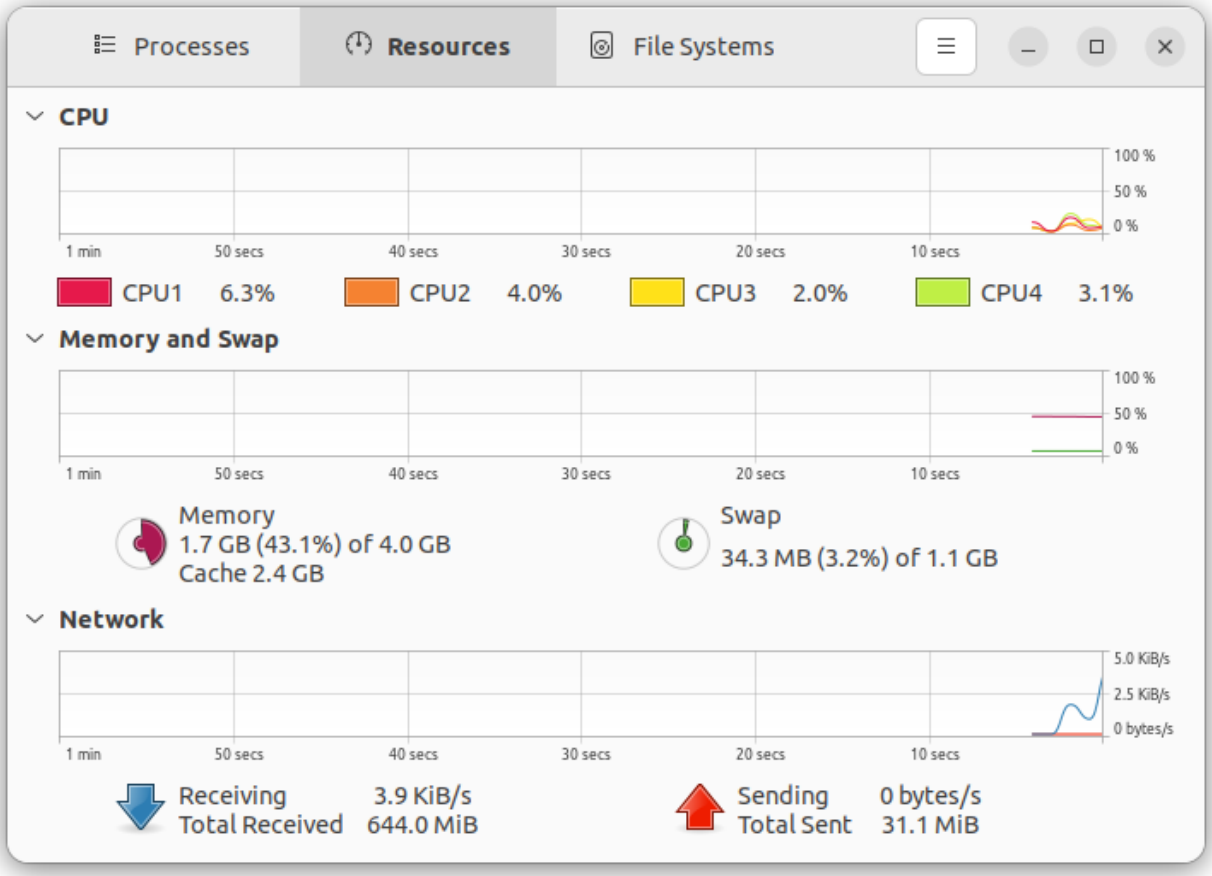
3.2.3. Performance monitoring and management

System Monitor provides real-time information on all programs and system execution procedures. It is similar to the work manager of Windows. Ubuntu has built-in this software. The steps to open it are as follows

Click the System Monitor shortcut



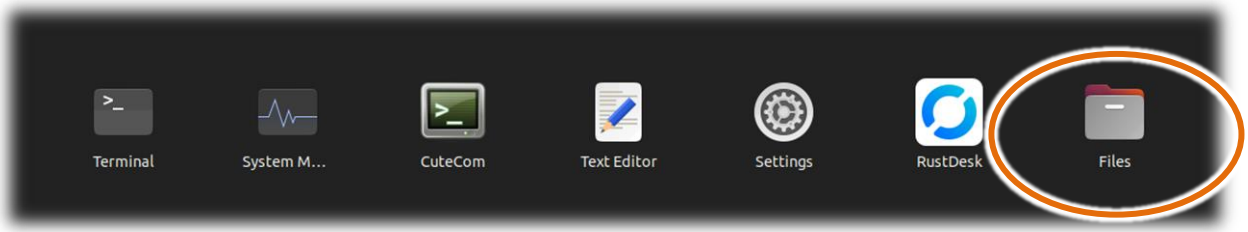
After System Monitor is turned on, the execution screen is as follows



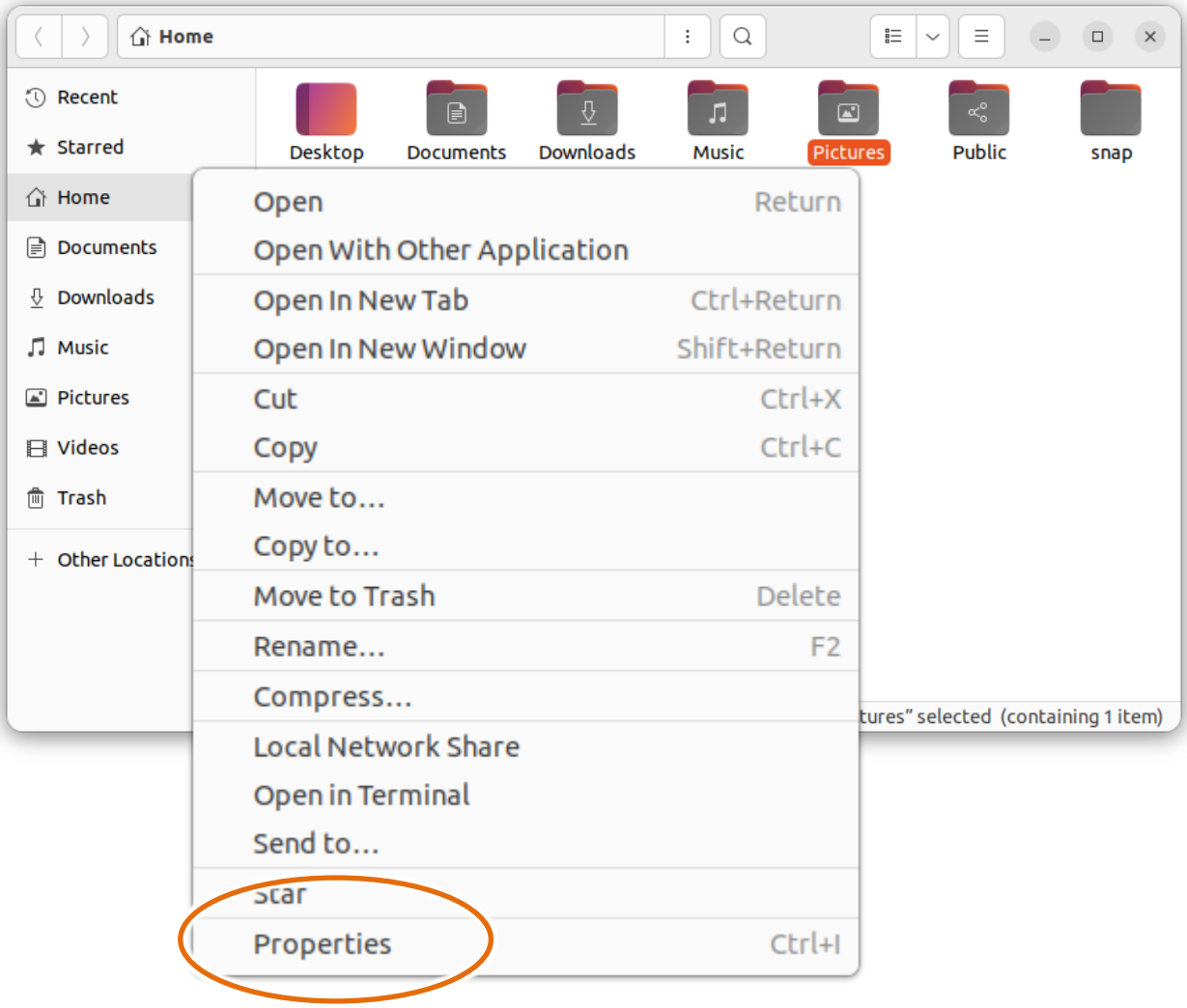
3.2.4. Network Neighborhood Settings

AIB-2941M also supports the Network Neighborhood function. Please follow the steps below to set it up.

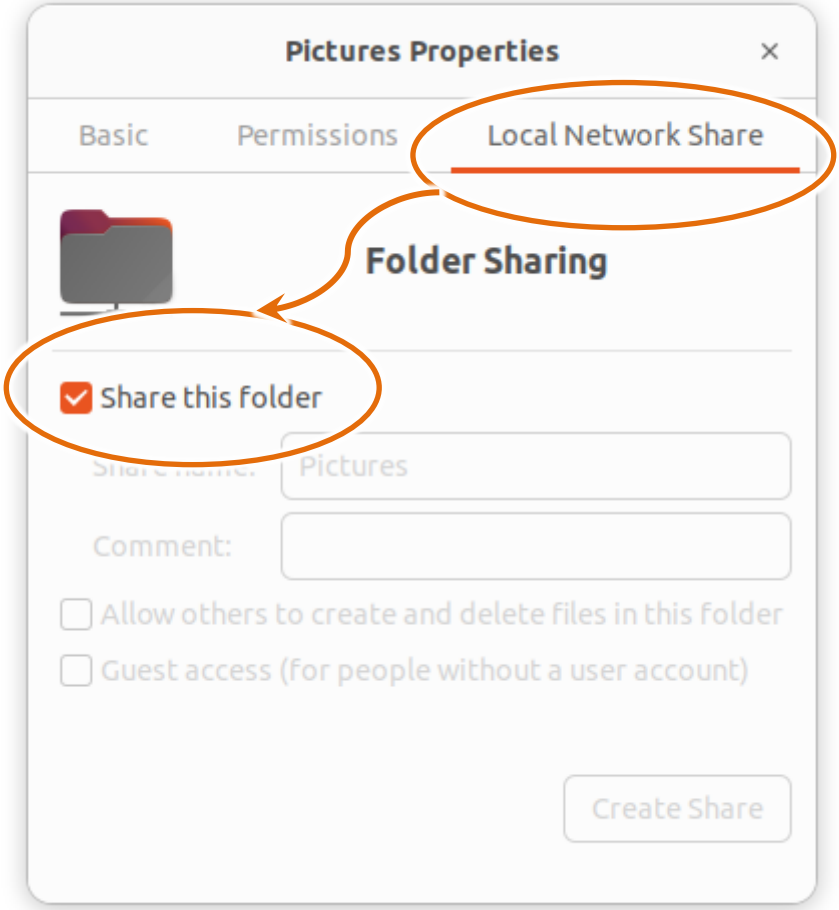
Step 1 : Click the Files shortcut



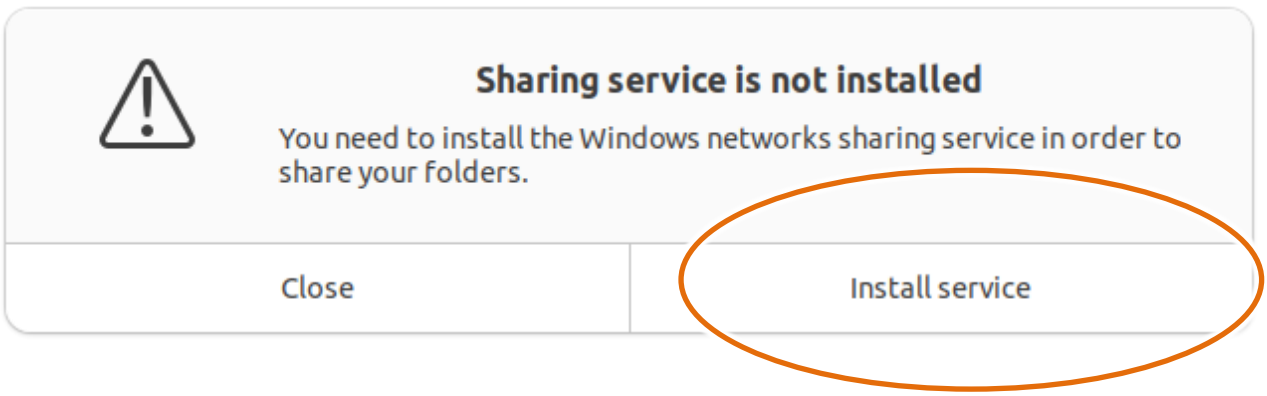
Step 2 ：Right-click the directory you want to share, and then click " Properties "



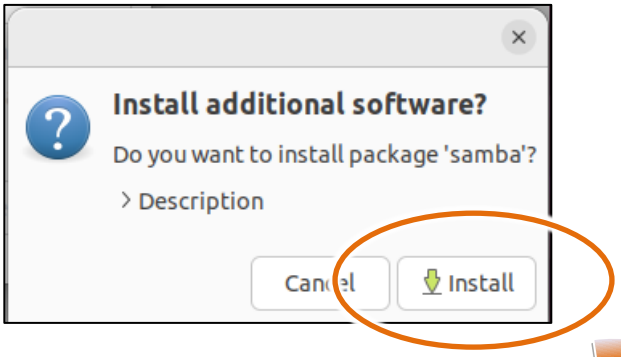
Step 3：In the Properties dialog window that pops up , click the Local Network Share tab, then click Share this folder



Step 4：In the pop-up warning dialog window, click Install service to install the Windows Network Neighborhood service

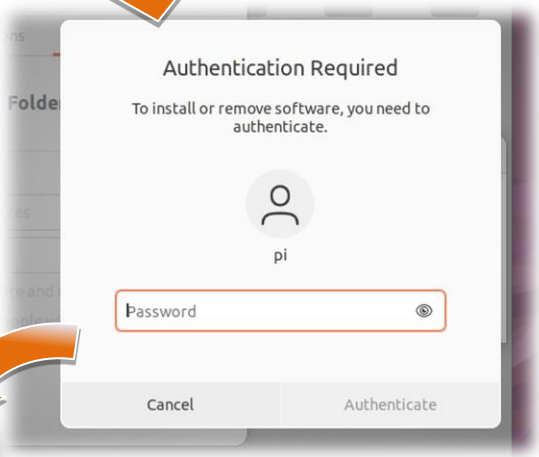


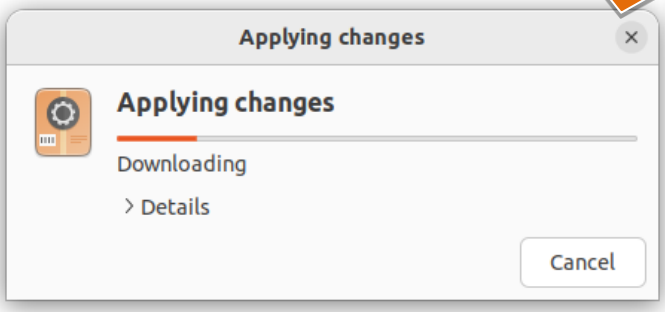
Step 5：In the pop-up dialog window, click Install to install.



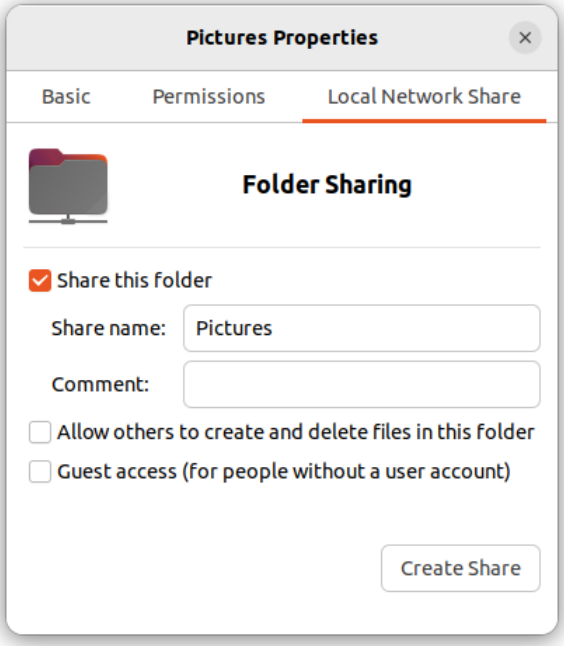
Step 6：In the pop-up dialog window, enter the password to open user permissions

The installation ends in about 10 seconds.





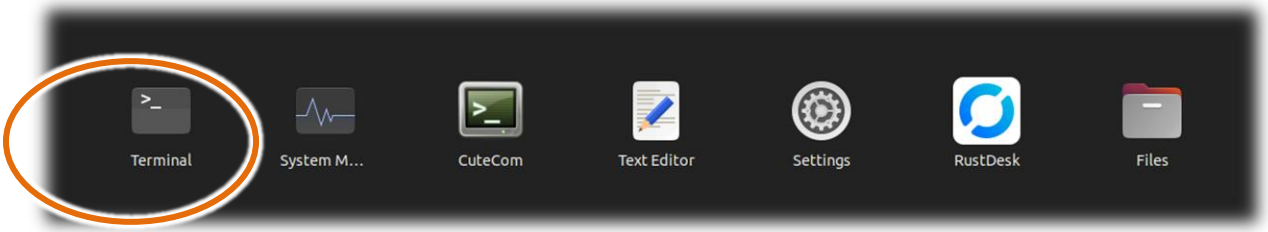
Step 7：After the installation is completed, the Network Places function has been enabled, and you can also set it yourself



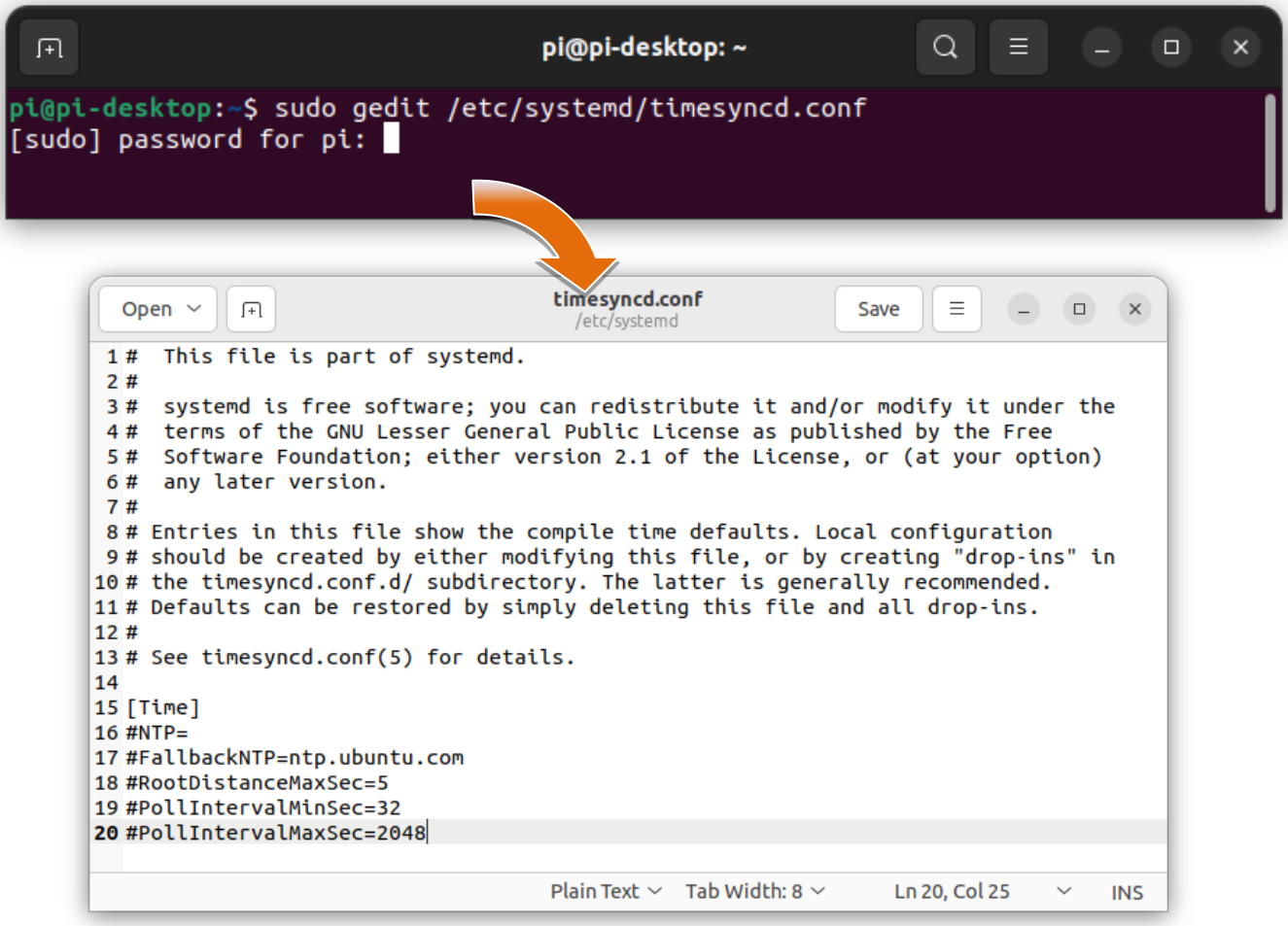
3.2.5. Automatic network time adjustment

Ubuntu has a built-in time correction function. Please follow the steps below to set it up.

Step 1：Click the Terminal shortcut

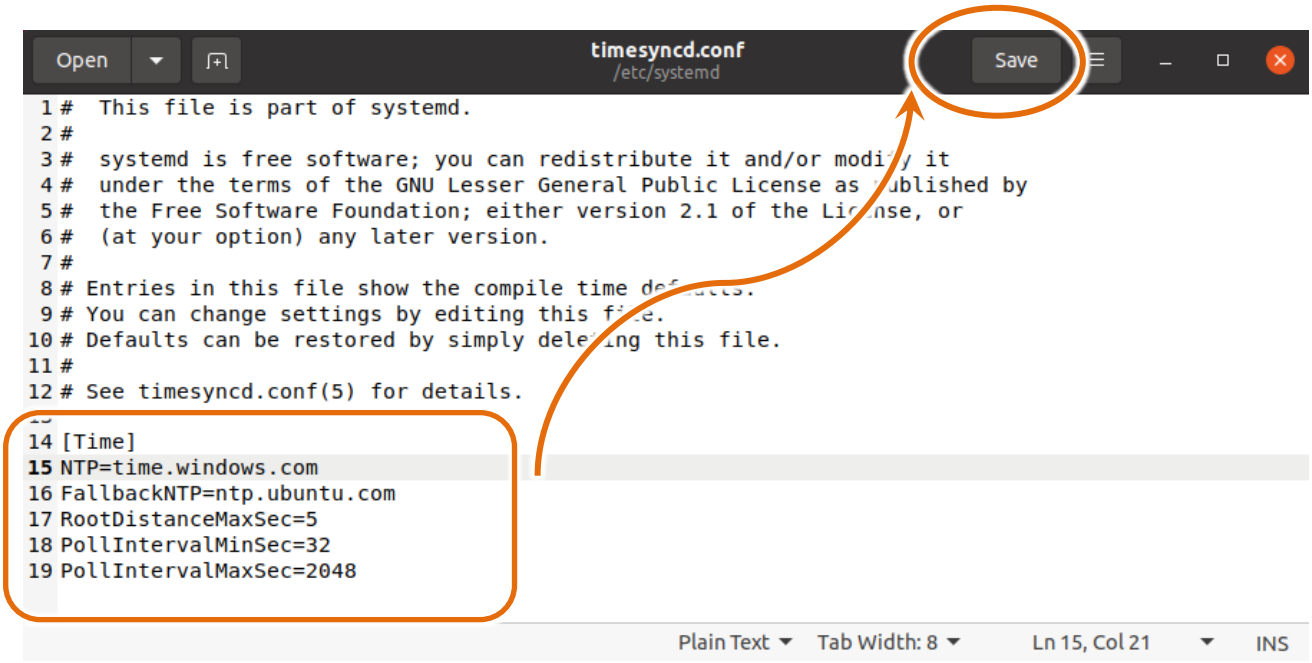


Step 2：After entering the command sudo gedit /etc/systemd/timesyncd.conf , enter the password



Step 3： Set the [time] parameter in the timesyncd.conf file

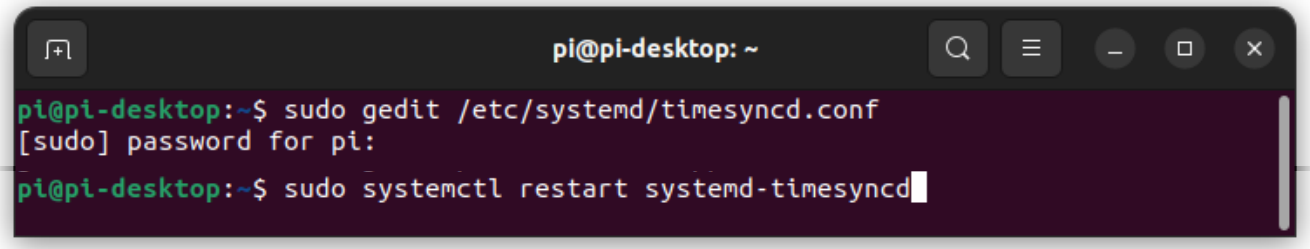
Step 4： After the settings are completed, click “Save” to save the settings.



Each parameter setting is as follows:

Item	Description
NTP	Main time server
FallbackNTP	Backup time server
RootDistanceMaxSec	What is the maximum time difference with the server (unit: seconds)
PollIntervalMinSec	Synchronize at least once every few seconds
PollIntervalMaxSec	Sync every few seconds at most

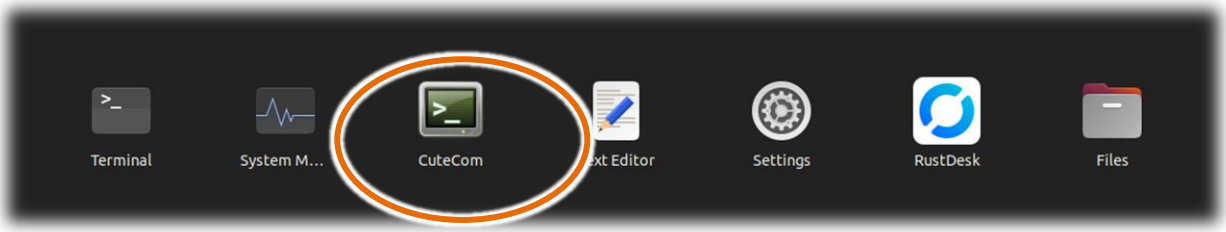
Step 5：Enter sudo in Terminal systemctl restart systemd-timesyncd , restart the time correction service to load new settings



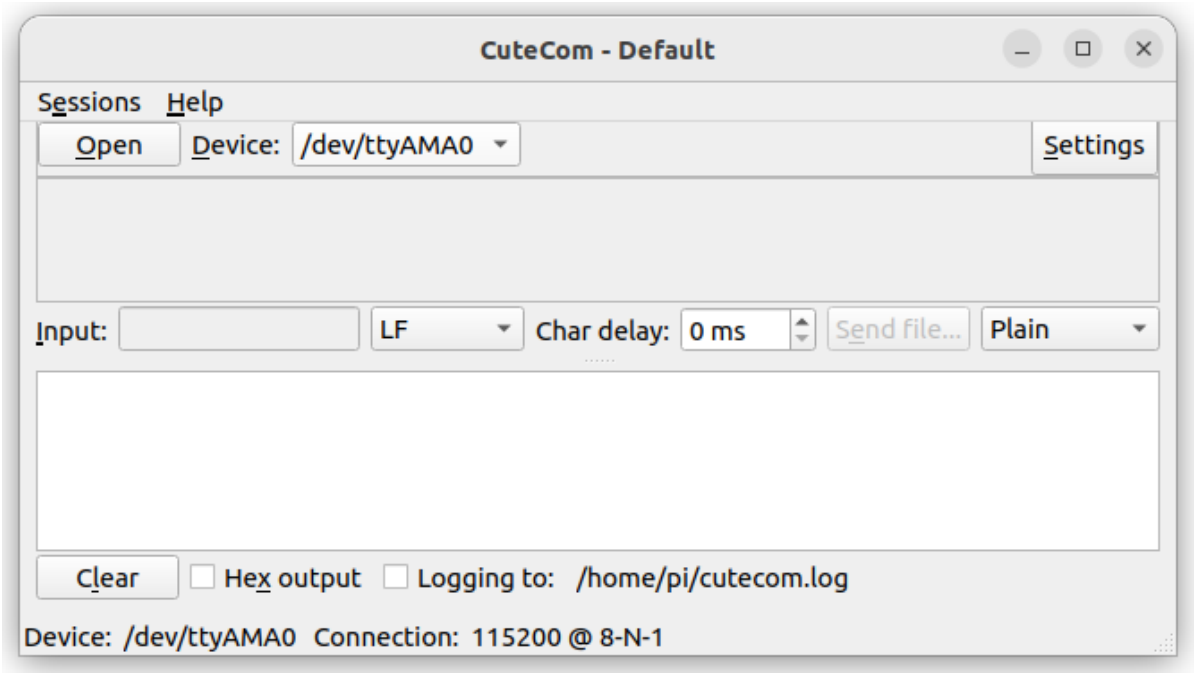
3.2.6. CuteCOM

CuteCom is Ubuntu 's graphical interface serial port communication software. It can send commands to external modules and receive data from external modules from the serial port .

Click the CuteCom shortcut



The execution screen after CuteCom is turned on is as follows:



For more communication commands of external modules, please refer to: http://www.icpdas.com/root/product/solutions/remote_io/rs-485/i-8k_i-87k/i-8k_i-87k_selection.html#b

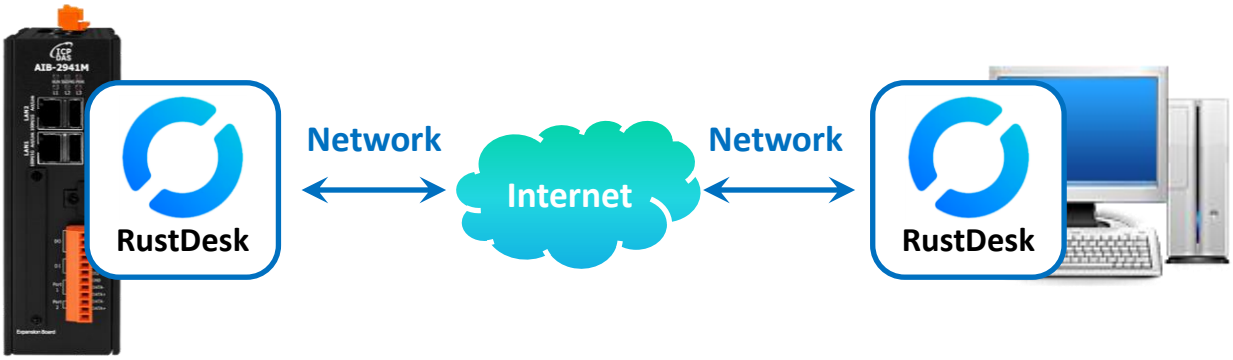
Because there is a permission issue when opening the serial port, please execute "sudo CuteCom" in Terminal to open CuteCom with root permissions, otherwise an error will occur when opening the com port.

3.3. Other support tools

3.3.1. Remote connection software

The remote desktop software has security issues, and the AIB-2941M is not pre-installed. Therefore, if there is a need for remote desktop tools, RustDesk has been tested and can function normally.

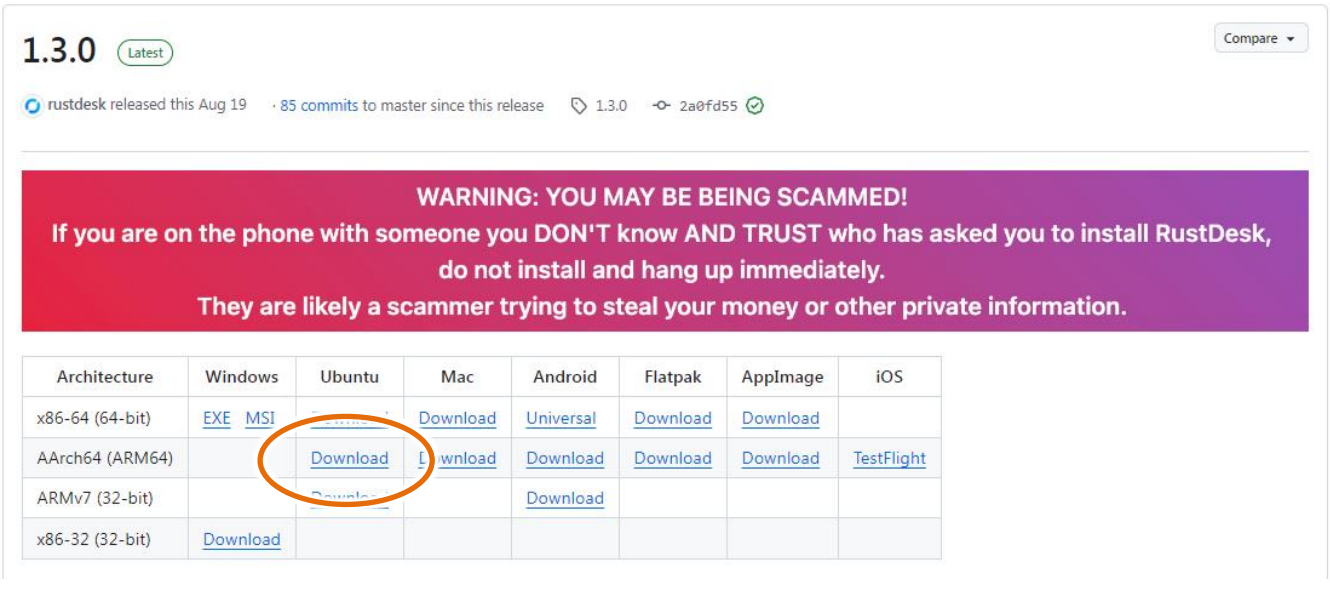
The architecture of RustDessk and AIB2941M is as shown below



Step 1：Enter Rustdesk official website on PC

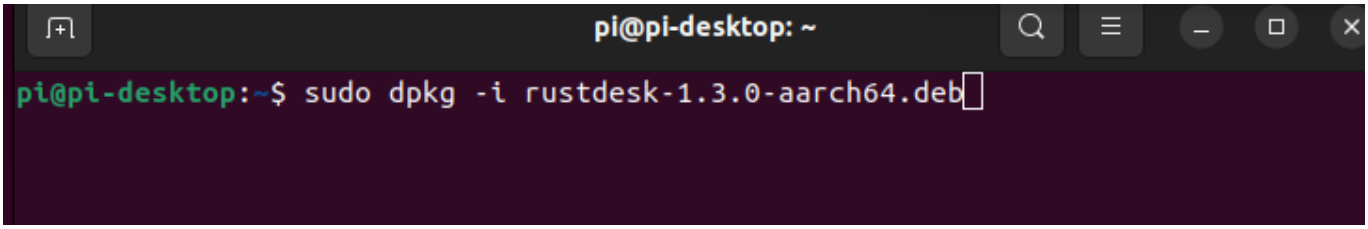
https://rustdesk.com/

Step 2：On the download page, click Ubuntu – Arm64 download version

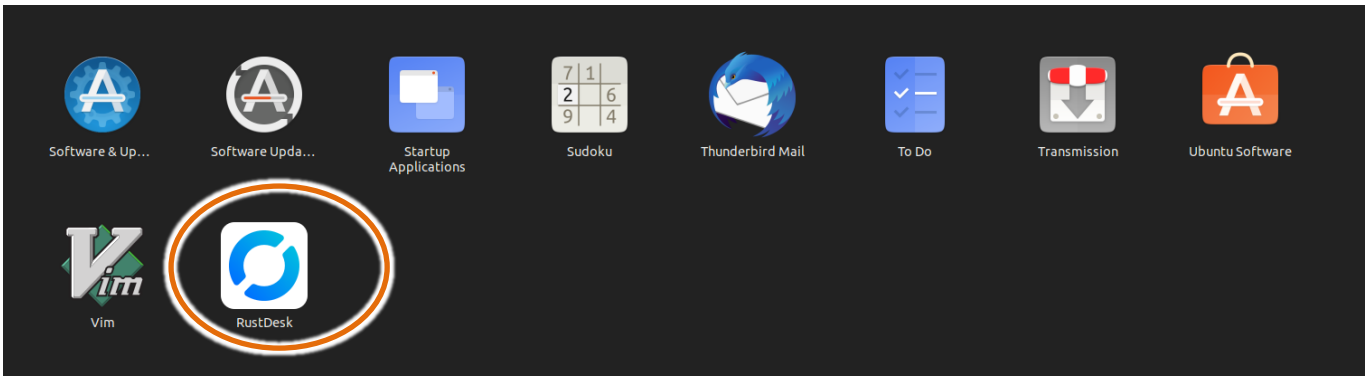


Step 3：After the download is completed, upload the downloaded rustdesk-1.3.0-aarch64.deb file (in this case, version 1.3.0) to AIB -2941M

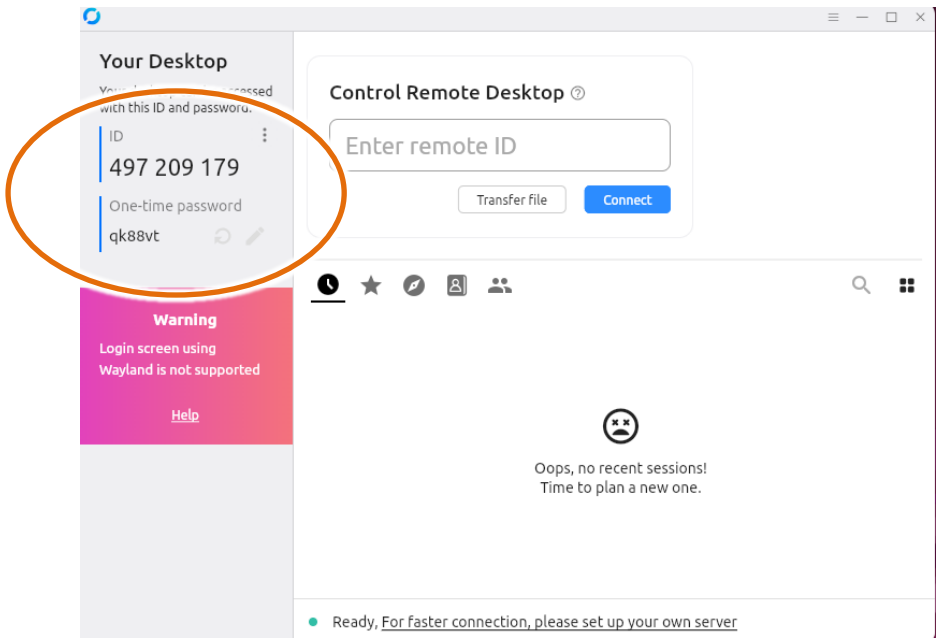
Step 4：Start Terminal on AIB-2941M , enter " sudo dpkg –i rustdesk-1.3.0-aarch64.deb " (this example is version 1.3.0) to install



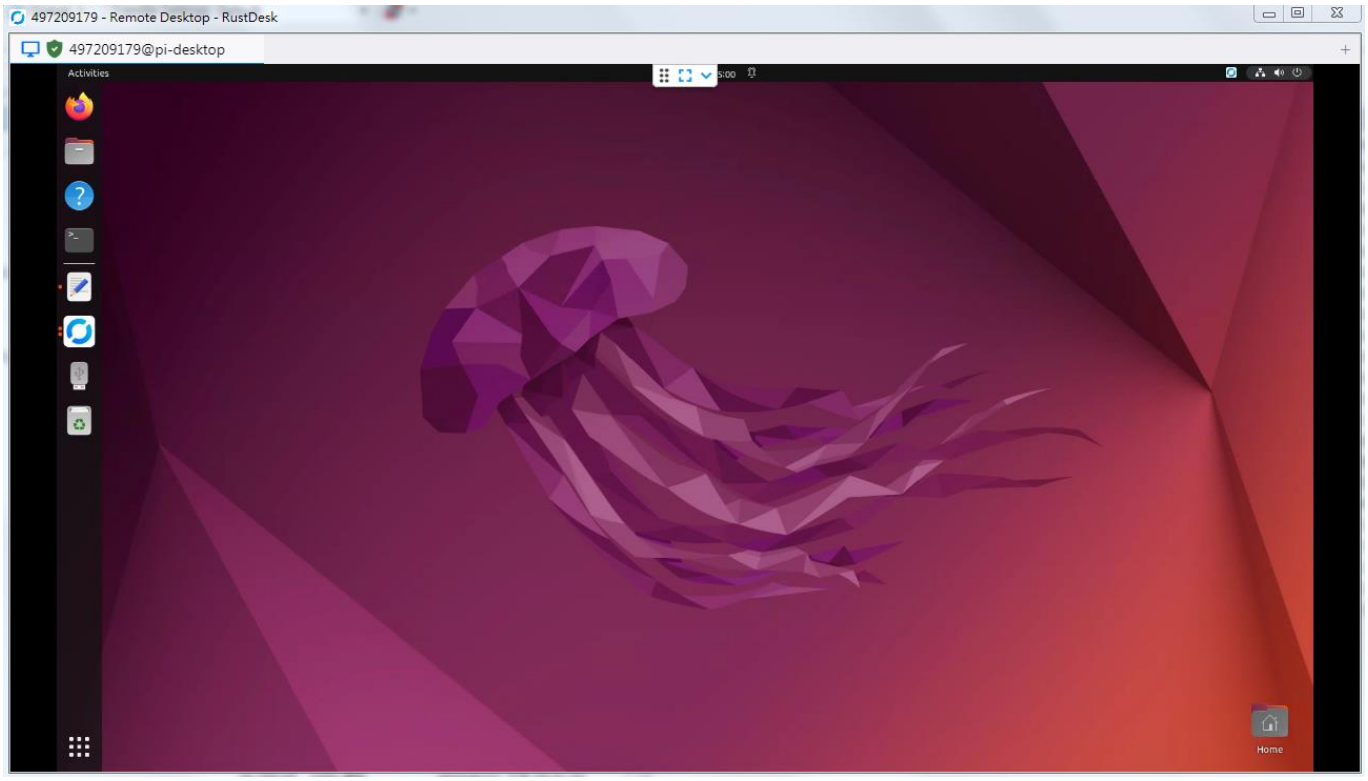
Step 6：After the installation is complete, you can see RustDesk in the program list



Step 7：The operation method of RustDesk is the same as that of TeamView. Run RustDesk on AIB-2941M and enter the ID and one-time password in the picture below into the RustDesk client program on the PC.



Step 8：RustDesk client program on the PC is successfully connected, the AIB-2941M desktop will be displayed as shown below

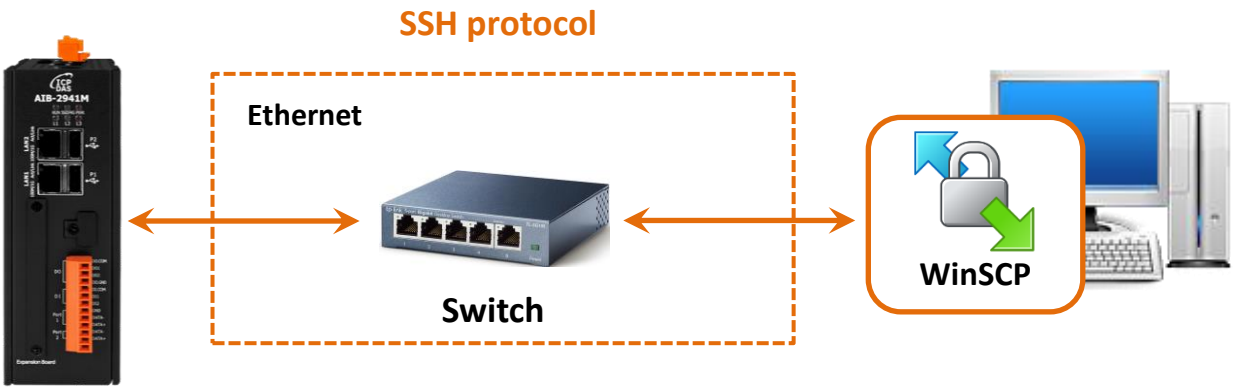


3.3.2. SSH file transfer

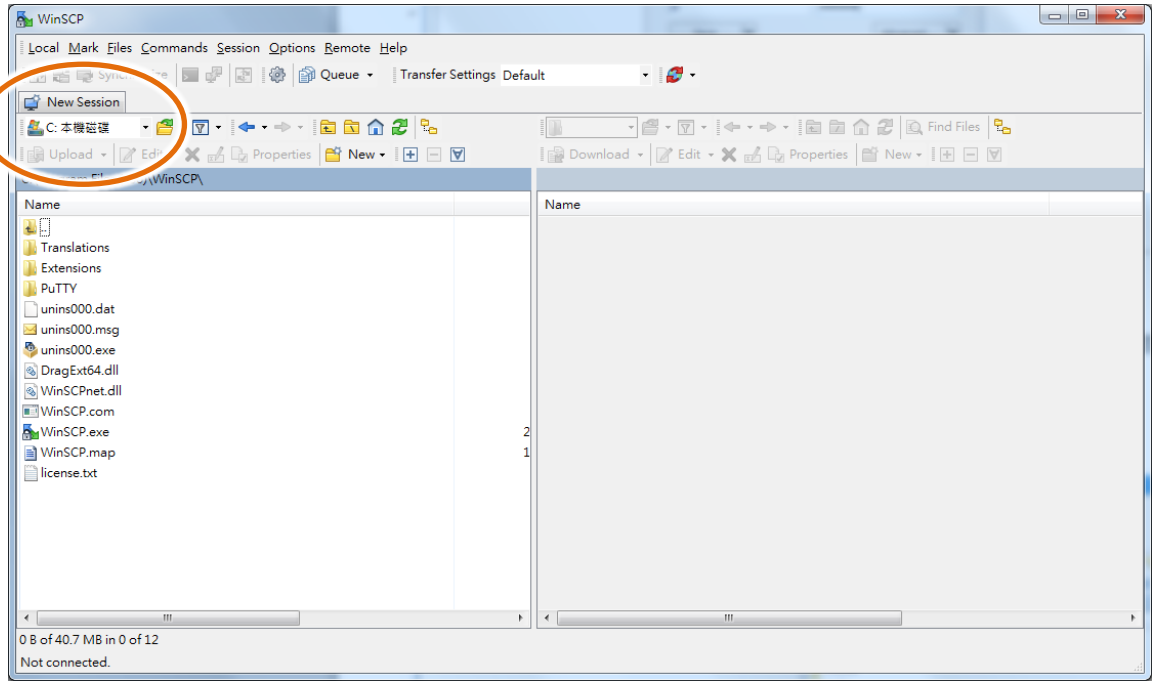
AIB-2941M has ssh connection enabled by default . To download files of AIB-2941M remotely , you need software that supports ssh to connect and download. This example uses the software WinSCP to demonstrate how to download AIB-2941M files remotely .

The latest version of WinSCP can be obtained from the path below:
https://winscp.net/eng/download.php

The architecture of WinSCP and AIB-2941M is as shown below



Step 1：Start WinSCP and click " New Session "



Step 2：In the Login dialog window, enter the following information and click the Login button

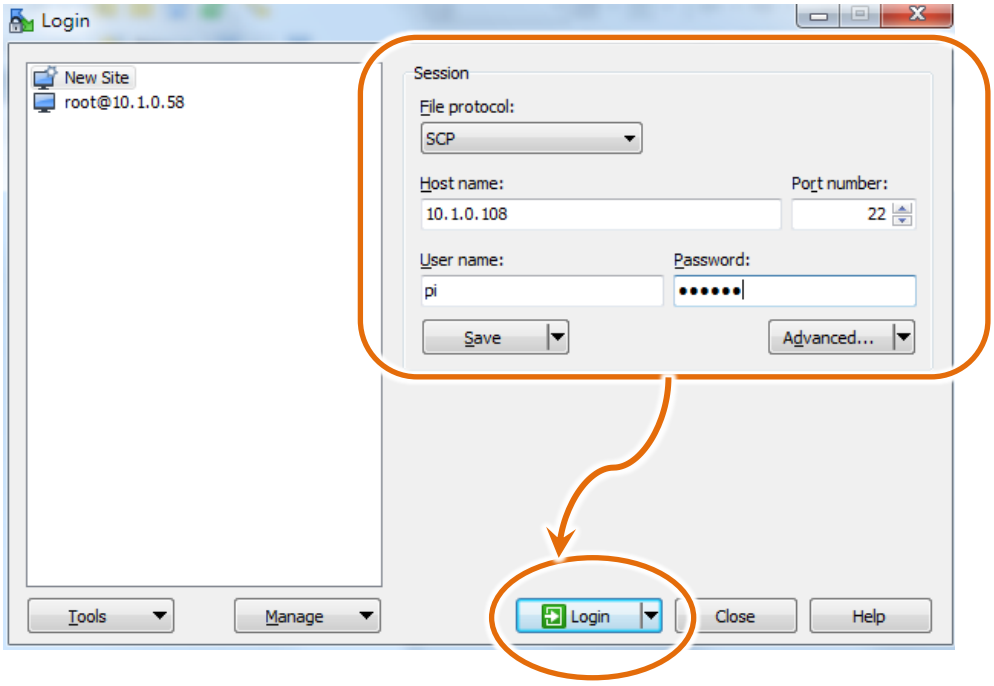
File protocol: SCP

Host name: Enter the IP address of AIB-2941M

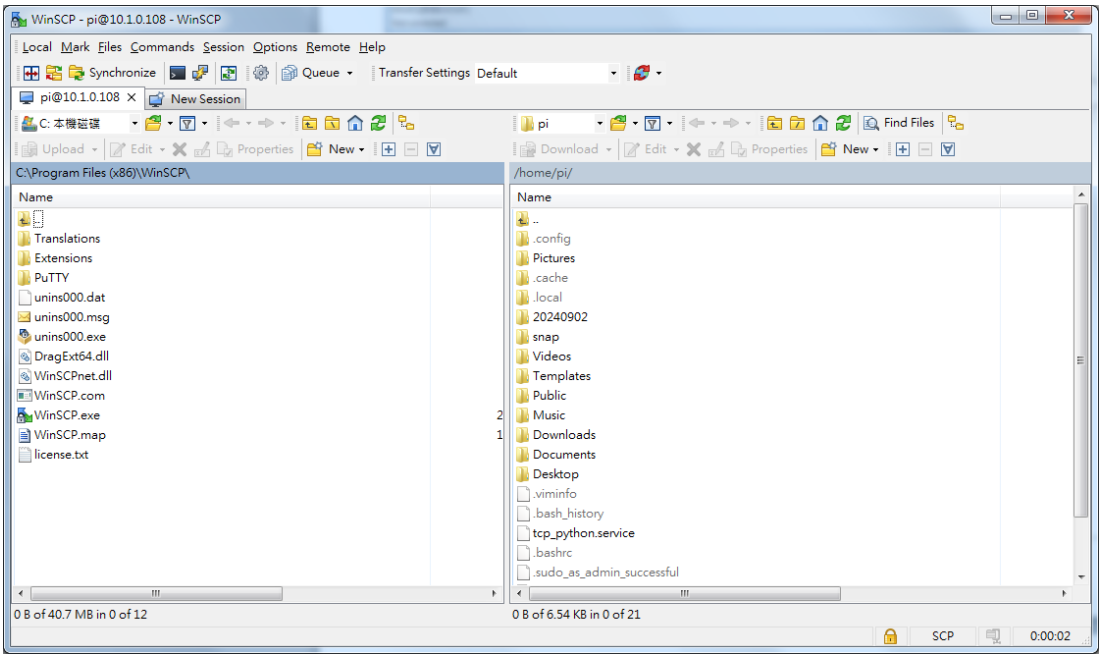
Port number: 22

User name: pi

Password: icpdas



Step 3： After successful connection, file transfer can be carried out



4. Your First Application

This chapter provides instructions on how to set up a development environment, download, install, and configure user programs on the AIB-2941M series module.

Development tools

AIB-2941M series is a finished product based on Ubuntu. Ubuntu is a mature Linux operating system that can develop rapidly .

The following table lists the development environments and development languages that support the development of AIB-2941M applications.

Language / Development Tools	Python	C/C++
Qt5	√	√

4.1. Development tool preparation

AIB-2941M is based on Ubuntu, a mature Linux operating system that can develop rapidly. The standard development tool is a highly integrated tool and fully supports AIB-2941M applications developed with Ubuntu.

Qt 5

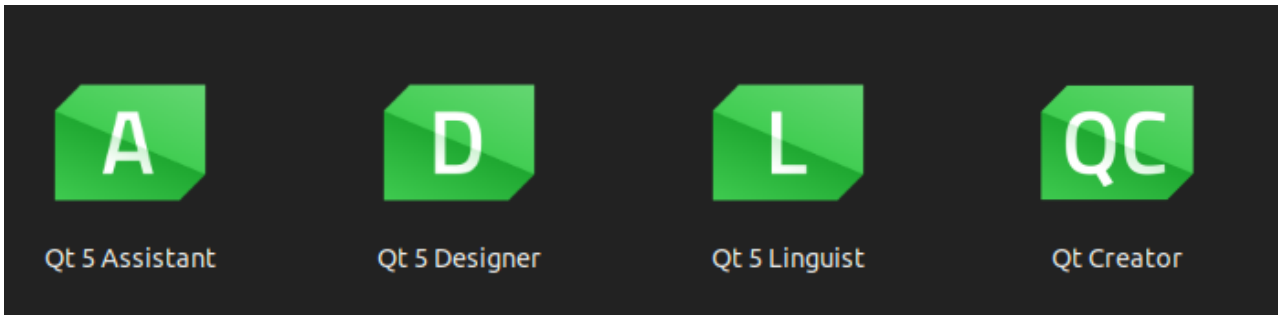
AIB-2941M itself has Python 3 installed, version number is 3.10 . Qt5 is a tool software for developing graphical interfaces on Ubuntu. It can make full use of the advantages of Python and integrate new and existing applications through public Internet standards to make them run. on any platform.

Installation steps

1. **Qt5**

   Please enter “sudo apt-get install qtcreator” in the Terminal interface

   The Qt5 installation software will be downloaded. After the Qt5 installation is completed, there will be 4 new Qt software as shown below.



The functions of these four software are as follows

- Qt 5 Assistant: Qt5 Instruction Manual
- Qt 5 Designer: Qt5 graphical interface setting software
- Qt 5 Linguist: Translation tool for Qt 5
- Qt Creator: The main development tool for Qt 5

2. PyQt

Please enter “sudo apt-get install python3-pyqt5 qttools5-dev-tools qttools5-dev” in the Terminal interface

PyQt is Qt 's python graphical interface development tool. After installation, you can develop python graphical interface programs in Qt.

3. Pyside

Please enter “sudo apt-get install python3-pyside2.qt3dcore python3-pyside2.qt3dinput python3-pyside2.qt3dlogic python3-pyside2.qt3drender python3-pyside2.qtcharts python3-pyside2.qtconcurrent python3-pyside2.qtcore python3-pyside2.qtgui python3-pyside2.qthelp python3-pyside2.qtlocation python3-pyside2.qtmultimedia python3-pyside2.qtmultimediawidgets python3-pyside2.qtnetwork python3-pyside2.qtopengl python3-pyside2.qtpositioning python3-pyside2.qtprintsupport python3-pyside2.qtqml python3-pyside2.qtquick python3-pyside2.qtquickwidgets python3-pyside2.qtscript python3-pyside2.qtscripttools python3-pyside2.qtsensors python3-pyside2.qtsql python3-pyside2.qtsvg python3-pyside2.qttest python3-pyside2.qttexttospeech python3-pyside2.qtuitools python3-pyside2.qtwebchannel python3-pyside2.qtwebsockets python3-pyside2.qtwidgets python3-pyside2.qtx11extras python3-pyside2.qtxml python3-pyside2.qtxmlpatterns” in the Terminal interface

PySide is Qt 's python graphical interface development tool. After installation, you can develop python graphical interface programs in Qt.

4.2. Build your first AIB-2941M application in Python

The best way to learn to program the AIB-2941M is to actually create an AIB-2941M program directly.

The following example demonstrates how to use python to create a display program on AIB-2941M.

To create a python program requires the following main steps:

1. Create a new project
2. Add control item to the window
3. Add event for control item
4. Execute the compiled program

All major steps are detailed in sub-chapters.

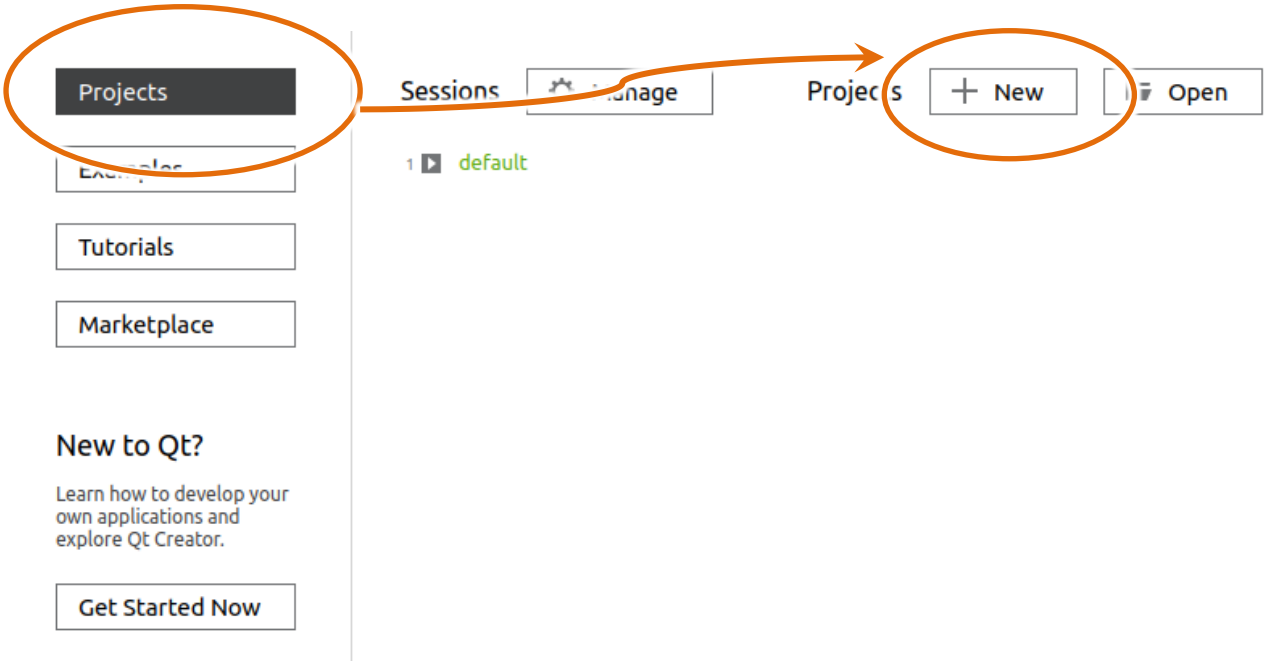
In the tutorial, we will assume that you have Qt 5, PyQt and Pyside installed on the AIB-2941M.

4.2.1. Create a new project

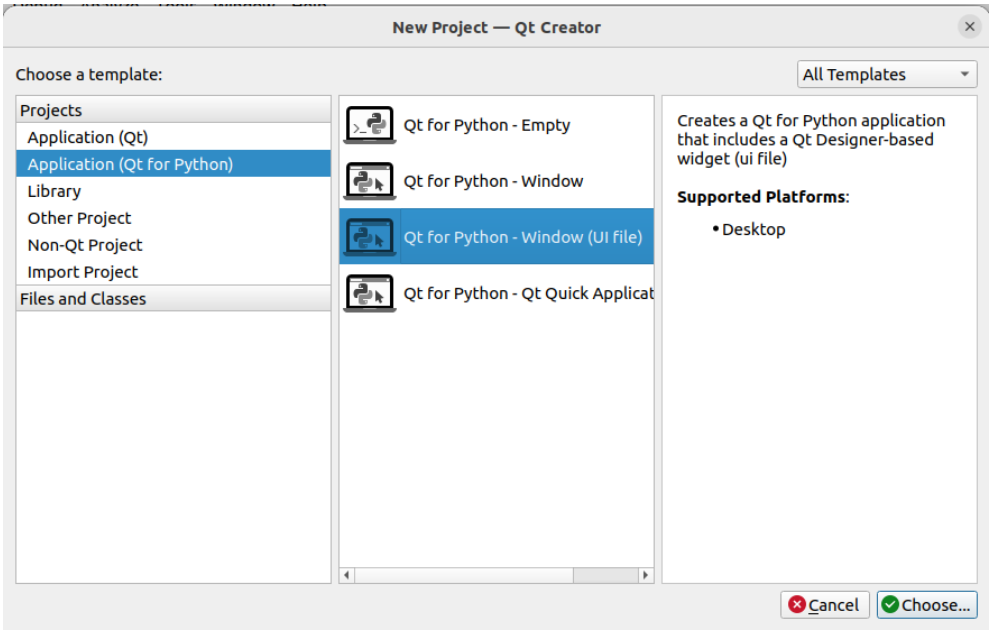
This example is used to create a new composite control project and user control sample program.

Step 1：Execute the Qt Creator

Step 2：Click “NEW” in the “Project”

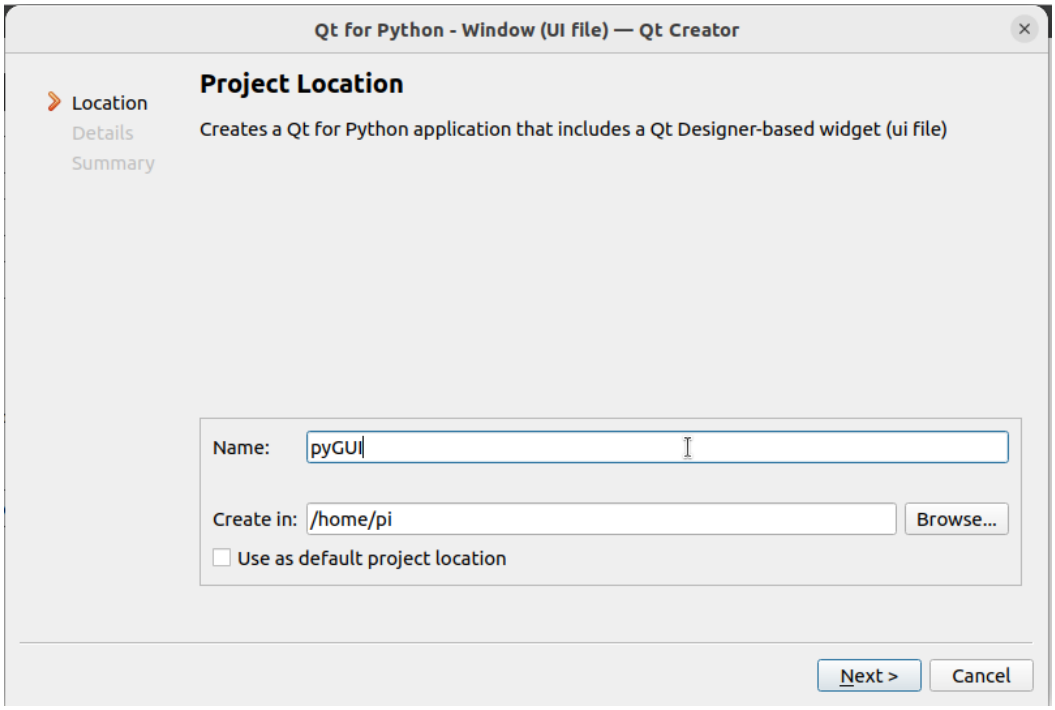


Step 3：Select the “Application (Qt for Python) ” option under Project and click Qt for Python – windows (UI file)

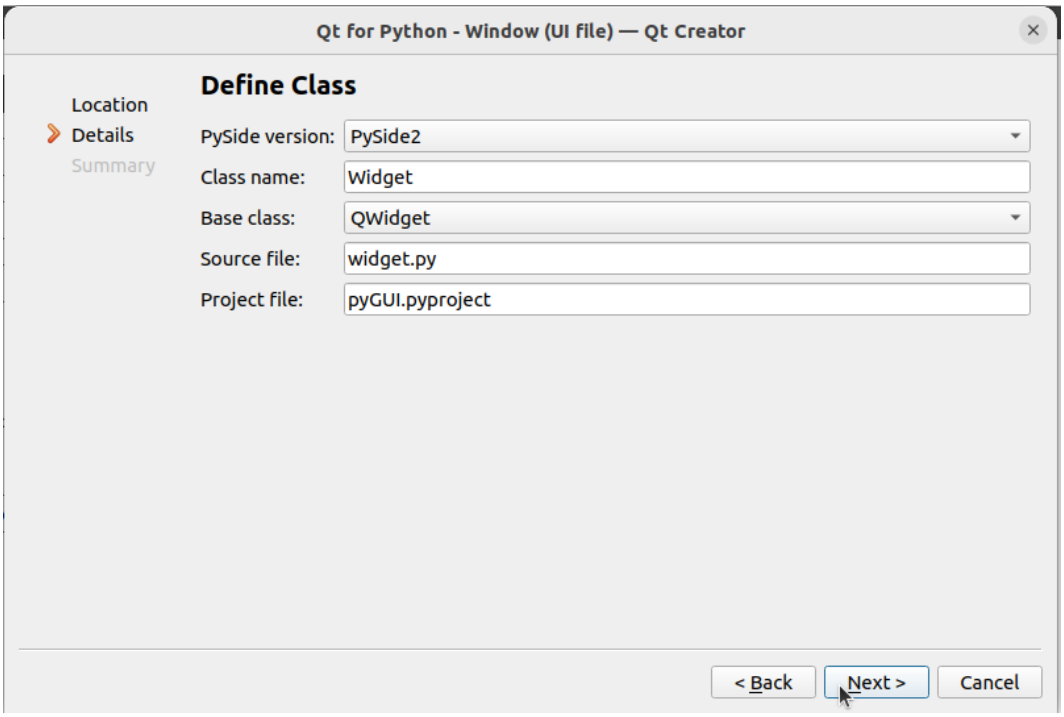


Step 4：Fill in the name in the name field and click the OK button

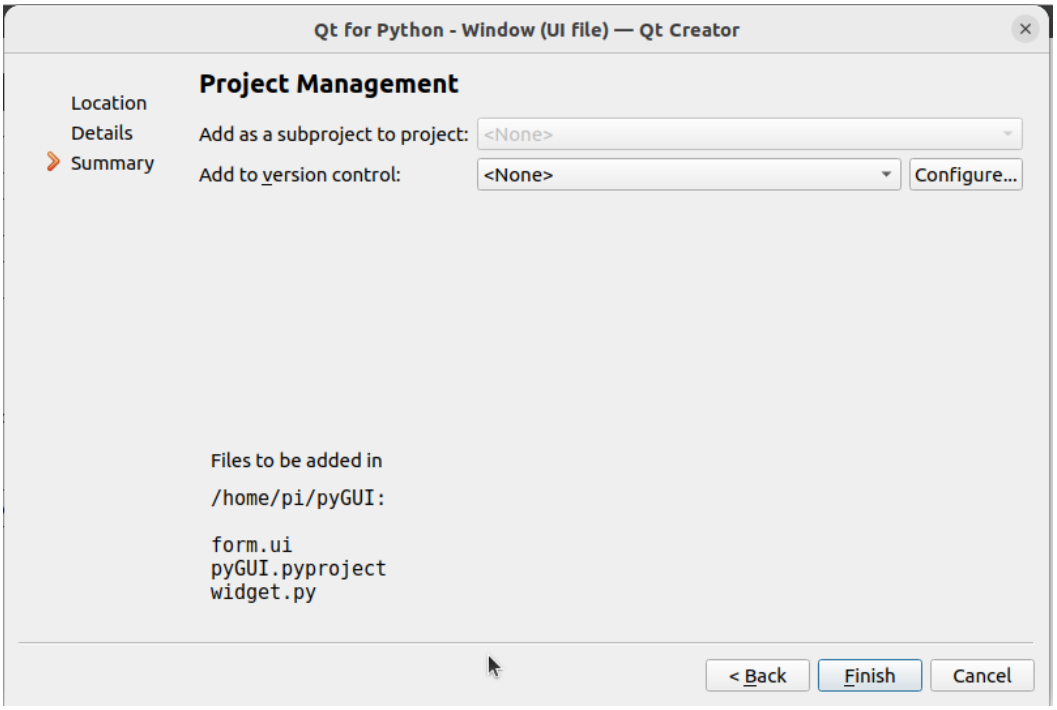
Here we enter pyGUI , you can also choose to press the " Browse " button to select different Project placement locations



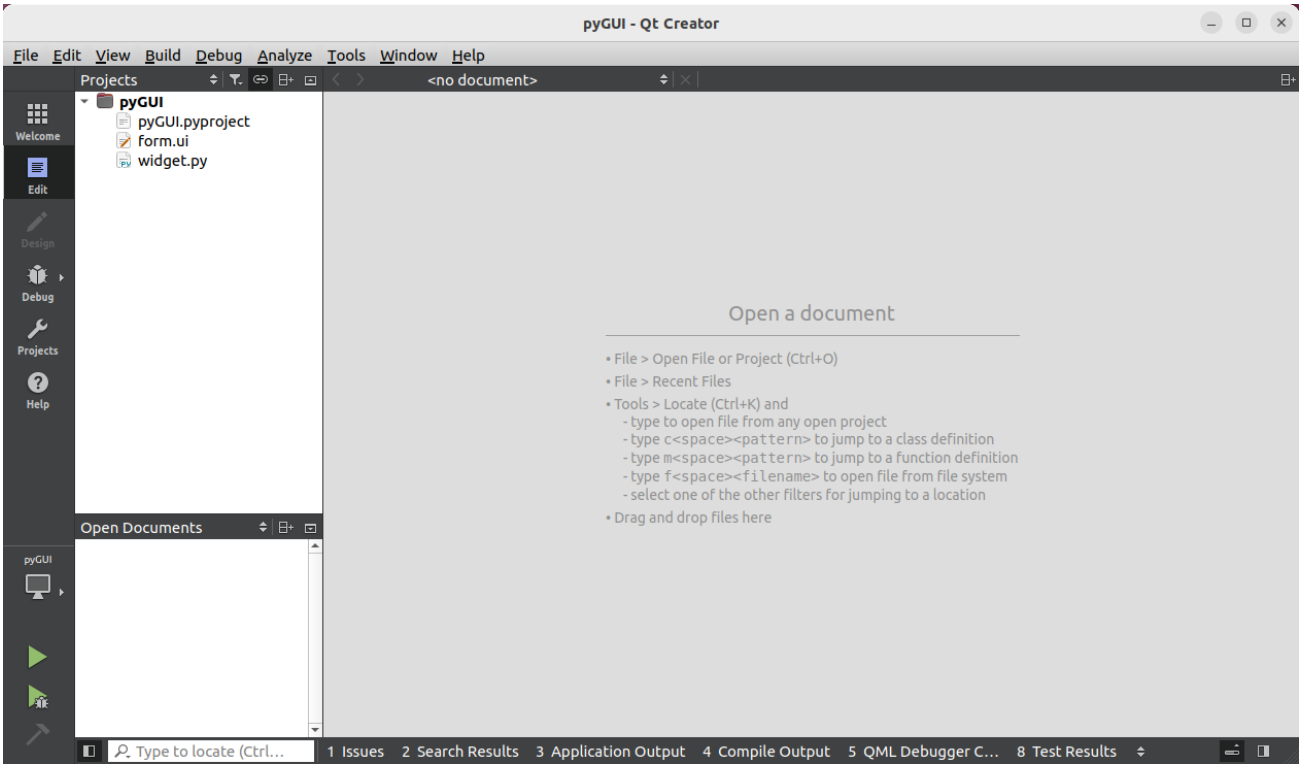
Step 5：In the PySide version field, select the PySide version. In this example, select PySide2



Step 6：In In the Add to version control field, if you need to perform version management, you can select git by default . In this example, select " None " and press " Finish " to complete the creation of the Project



Step 7：The created Project will have three files, form.ui, widget.py and <project name>.pyproject , as shown below



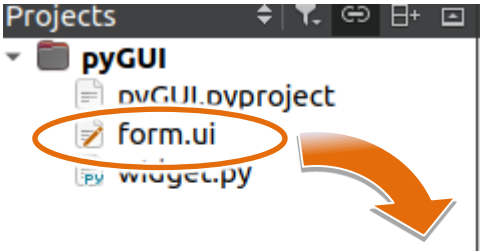
4.2.2. Add control item to the window

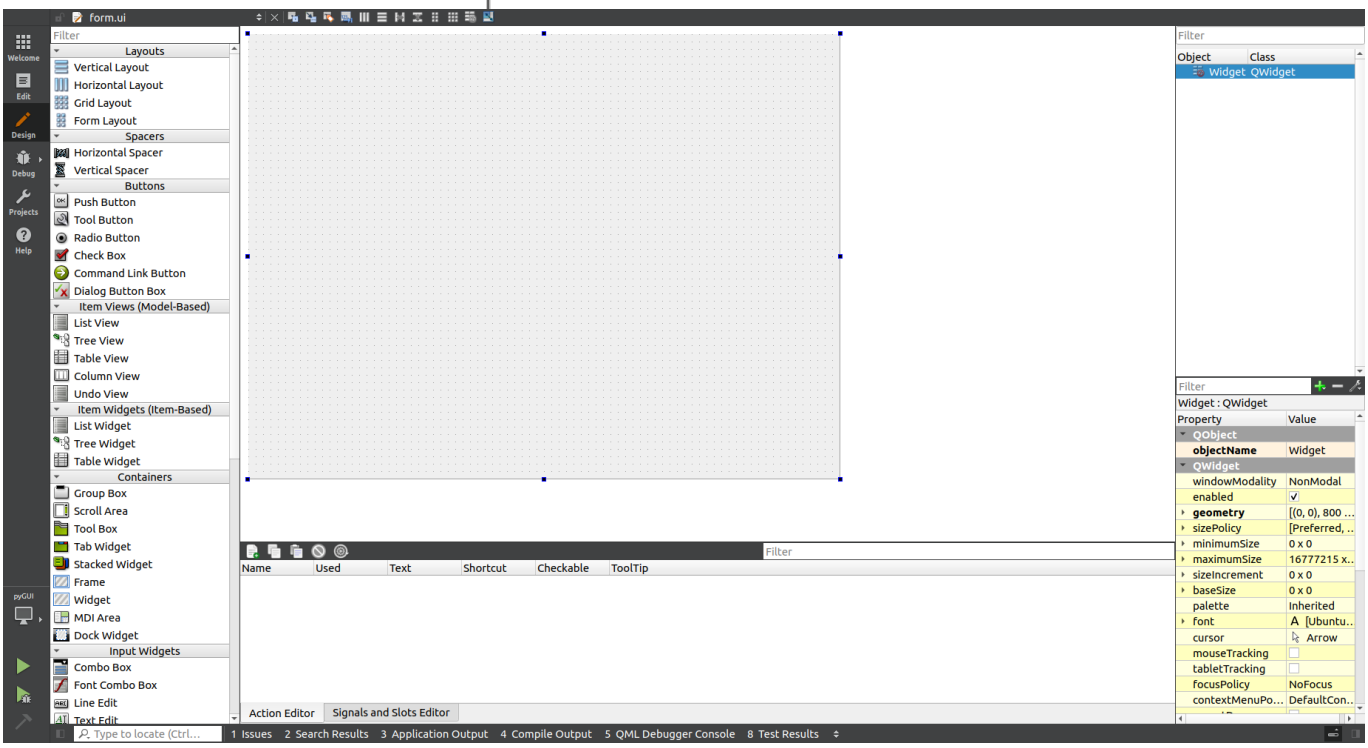
You can add control item in the Toolbox to the form at will, and adjust the desired position by dragging in the form.

After adding control items to the window, you can adjust the corresponding properties, such as background color or default display text, from the Properties window.

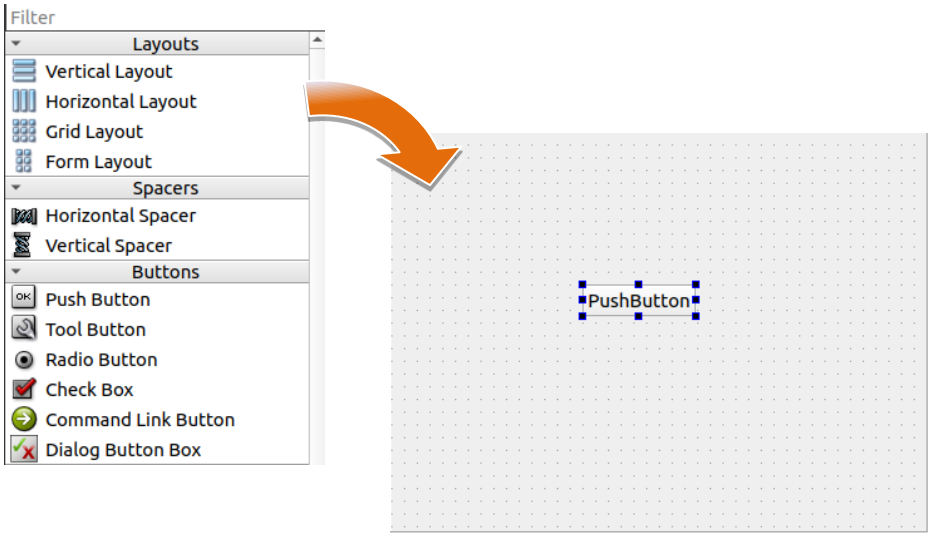
These properties set in the property window will be set in the corresponding fields in the form of initialization values when the program is running.

Step 1：Open the Project form page and open the form.ui file

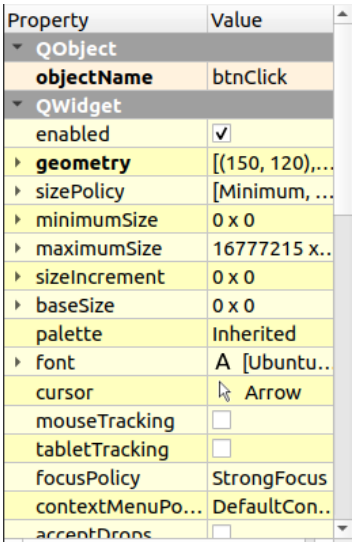


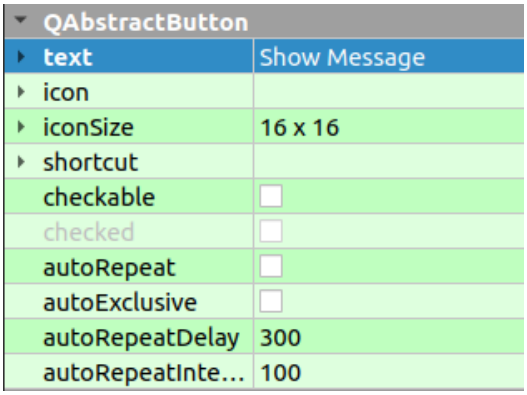


Step 2：In the Toolbox , drag the Push Button control component to the window



Step 3：In the properties window, enter btnClick in the ObjectName property bar and enter Show Message in the Text property bar

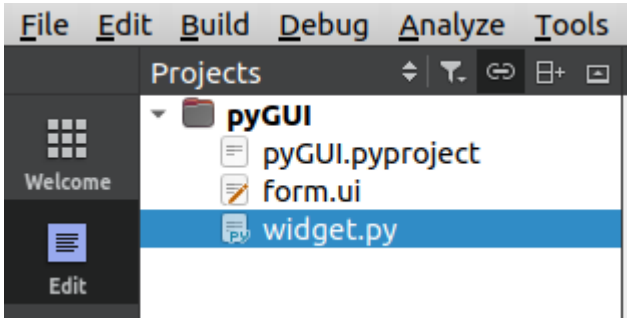




4.2.3. Add events to the control item

Now that you've finished designing your application's windows, you can start writing functional code for your application.

Step 1：Select Edit mode and open widget.py



The code shown below will be displayed

widget.py

```
# This Python file uses the following encoding: utf-8
import os
from pathlib import Path
import sys

from PySide2.QtWidgets import QApplication, QWidget
from PySide2.QtCore import QFile
from PySide2.QtUiTools import QUiLoader


class Widget(QWidget):
    def __init__(self):
        super(Widget, self).__init__()
        self.load_ui()

    def load_ui(self):
        loader = QUiLoader()
        path = os.fspath(Path(__file__).resolve().parent / "form.ui")
        ui_file = QFile(path)
        ui_file.open(QFile.ReadOnly)
        loader.load(ui_file, self)
        ui_file.close()


if __name__ == "__main__":
    app = QApplication([])
    widget = Widget()
    widget.show()
    sys.exit(app.exec_())
```

Step 2：Add the following code to widget.py

```
from PyQt5 import QtWidgets

def __init__(self):
    super(Widget, self).__init__()
    self.load_ui()
    self.load_event()

def load_event(self):
    self.loader.btnClick.clicked.connect(self.Message)

def Message(self):
    Form = QtWidgets.QWidget()
    mbox = QtWidgets.QMessageBox(Form)
    mbox.information(Form, 'info', 'first program')
```

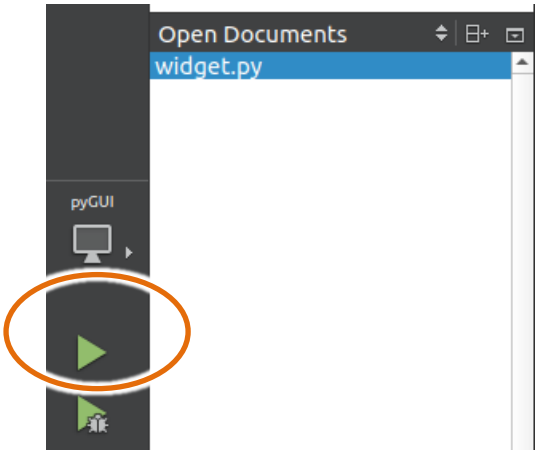
The completed program code is as shown below

widget.py*

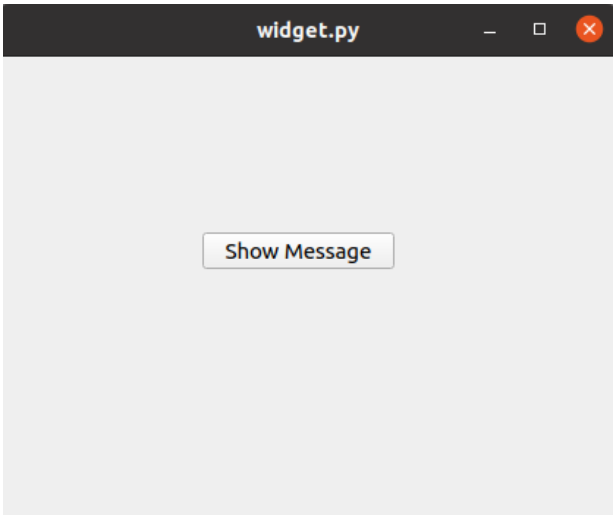
```
# This Python file uses the following encoding: utf-8
import os
from pathlib import Path
import sys

from PyQt5 import QtWidgets
from PySide2.QtWidgets import QApplication, QWidget
from PySide2.QtCore import QFile
from PySide2.QtUiTools import QUiLoader


class Widget(QWidget):
    def __init__(self):
        super(Widget, self).__init__()
        self.load_ui()
        self.load_event()

    def load_ui(self):
        loader = QUiLoader()
        path = os.fspath(Path(__file__).resolve().parent / "form.ui")
        ui_file = QFile(path)
        ui_file.open(QFile.ReadOnly)
        self.window = loader.load(ui_file, self)
        ui_file.close()

    def load_event(self):
        self.window.btnOSVer.clicked.connect(self.Message)

    def Message(self):
        Form = QtWidgets.QWidget()
        mbox = QtWidgets.QMessageBox(Form)
        mbox.information(Form, 'info', 'first program')




if __name__ == "__main__":
    app = QApplication([])
    widget = Widget()
    widget.show()
    sys.exit(app.exec_())

```

4.2.4. Execute the compiled application

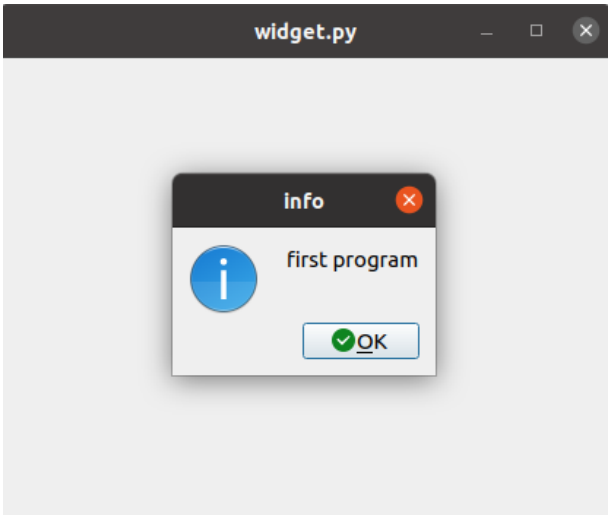
In the lower right corner of Qt , click widget.py, indicating that widget.py will be executed next. Click the  icon to start executing the program.



The program operates as shown on the right



Pressing the " Show Message " button will pop up the following MessageBox message



4.2.5. Python example

Examples used in the Python language environment. The latest version can be downloaded from the ICP DAS website.

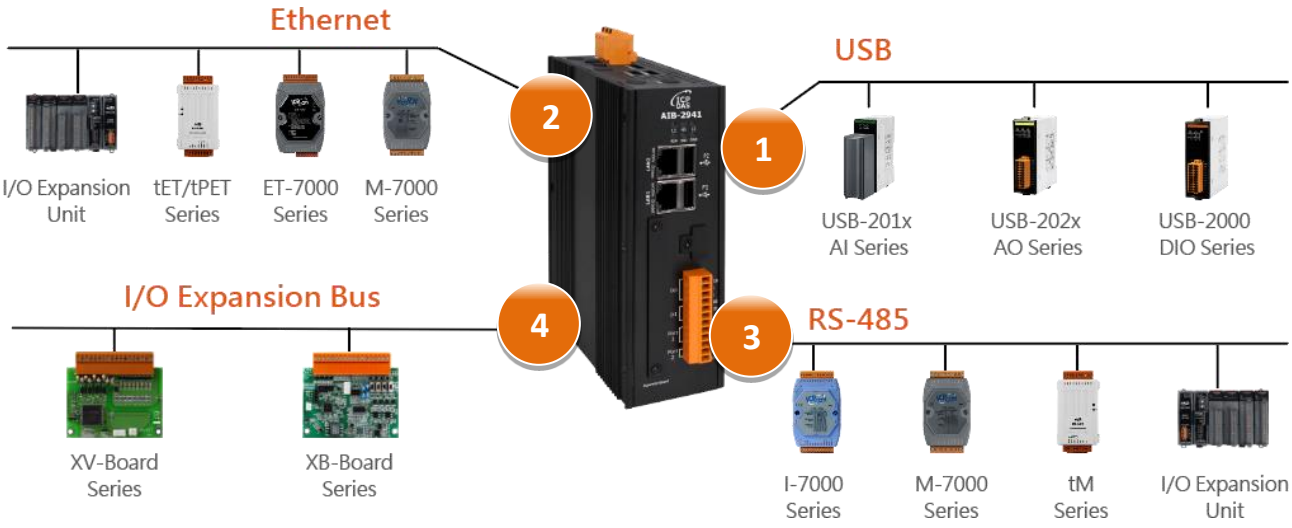
Sample programs for Python are available at the following address:
https://www.icpdas.com/tw/download/index.php?model=AIB-2941 M

The sample programs include the following four
di.py : Read the DI Port status on AIB-2941M
do.py : Output ON/OFF to the DO Port on AIB-2941M
led.py : Output ON/OFF for LED1~3 on AIB-2941M
ser.py : Read and write Port1~2 on AIB-2941M

5. I/O Expansion Modules and SDKs Selection

This chapter will introduce how to choose a suitable I/O expansion module and its corresponding SDK , so that users can use AIB-2941M more flexibly and develop AIB-2941M programs more comprehensively.

AIB-2941M provides the following I/ O expansion configurations



❶ USB (USB-2000 series and USB-87Pn series)

AIB-2941M can connect USB-2000 and USB-87Pn via USB with high-card I-87k series I/O modules.

Module	Native SDK	Python example
USB-2000 series	USB I/O demo for Linux	Python example
USB-87Pn series	USB I/O demo for Linux	Python example

❷ Ethernet (ET-7000 series and I-8KE4/8-MTCP)

AIB-2941M can connect ET-7000 and I-8KE4/8-MTCP with high-card I-87k series I/O modules through Ethernet, and supports Modbus/TCP communication protocol. .

Module	Native SDK	Python example
ET-7000	Modbus example	Modbus example
I-8KE4/8-MTCP	Modbus example	Modbus example

❸ RS-485 (I-7000 series and M-7000 series)

AIB-2941M can connect I-7000, M-7000 and RU-87Pn with high-card I-87k series I/O modules via RS-485 . The RS-485 network uses twisted pair as the transmission medium, and the transmission rate can reach up to 115.2 Kbps.

- **I-7000 series I/O modules**

Module	Native SDK	Python example
I-7000 series	libAIB.so	libAIB.py
I-7000 series with I-7088 (D)	libAIB.so	libAIB.py

For more information about I-7000 series I/O modules and examples, please see: https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+RS-485_I_O_Modules+I-7000

- **M-7000 series I/O modules**

Module	Native SDK	Python example
M-7000 series	Modbus example	Modbus example

For more information about M-7000 series I/O modules and examples, please refer to: https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+RS-485_I_O_Modules+I-7000

- **RU-87Pn + I-87K series I/O module**

Module	Native SDK	Python example
RU-87Pn + I-87K	libAIB.so	libAIB.py

- **Other designated I/O**

Module	Native SDK	Python example
I-7088W	libAIB.so	libAIB.py

❹ Local I/O expansion module (XV-Board)

AIB-2941M can support one XV-Board/XB-Board.

- **XV-Board**

module	Native SDK	Python example
XV-Board	Modbus Demo	Modbus Demo

For more support module information , please see :
https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XV-board

- **XB-Board**

module	Native SDK	Python example
XB-Board	USB I/O demo for Linux	USB I/o library

For more support module information , please see :
https://www.icpdas.com/tw/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XB-board

6. Updates and Upgrade

This section provides the steps required to update the AIB-2941M OS.

ICP DAS will continue to add additional features to the AIB-2941M OS in the future, so we recommend that you check the ICP DAS website regularly for the latest information.

AIB-2941M It is burned through Raspberry Pi Imager to update the OS. Raspberry Pi Imager needs to be installed on the PC. Before updating the OS, please install Raspberry Pi Imager on the PC first .

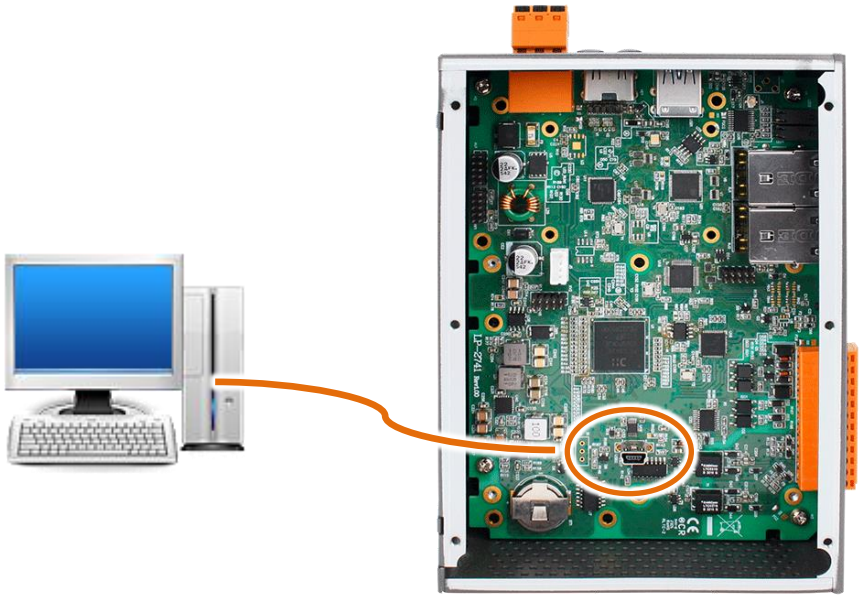
The latest version of the OS update installation file can be downloaded from the ICP DAS website.
https://www.icpdas.com/tw/download/index.php?model=AIB-2941M

Step 1：Install Raspberry Pi Imager & rpiboot

The latest version of Raspberry Pi Imager can be downloaded from the following link
https://www.raspberrypi.com/software/
The latest version of rpiboot can be downloaded from the following link
https://github.com/raspberrypi/usbboot/raw/master/win32/rpiboot_setup.exe

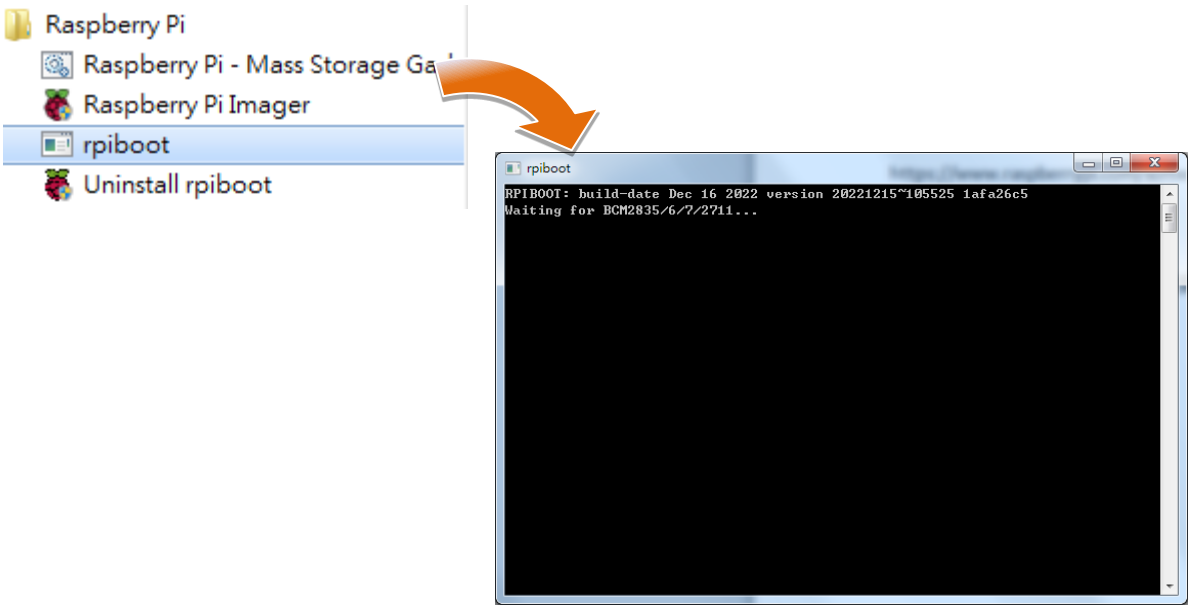
If you have already installed Raspberry Pi Imager & rpiboot, you can skip this step.

Step 2：Connect AIB-2941M mini USB to PC



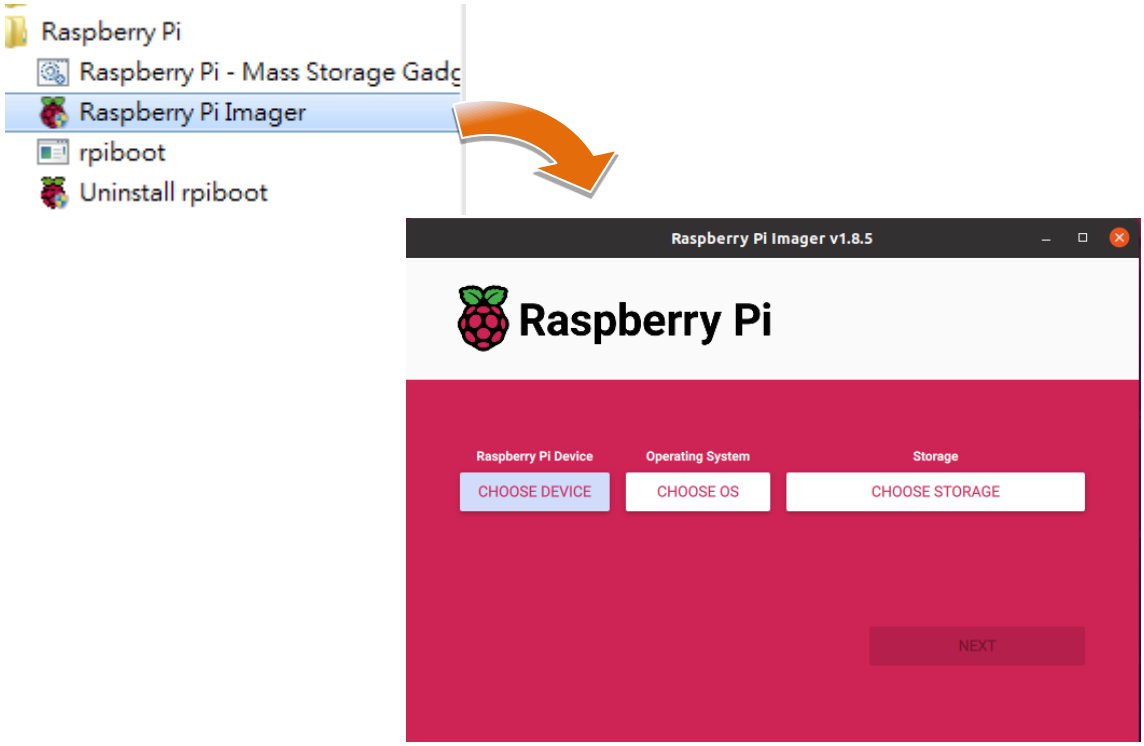
Step 3：Start rpiboot of PC

Wait for rpiboot to mount the eMMC. After the mounting is completed, start Raspberry Pi Imager to burn the OS.

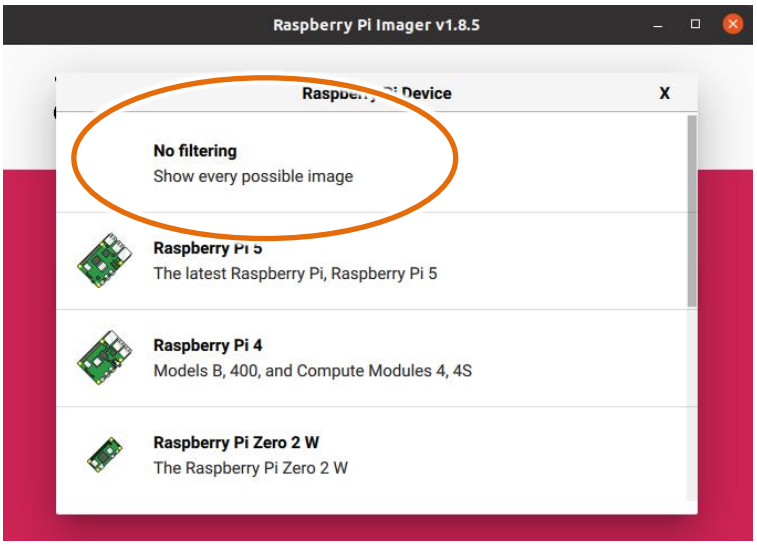


Step 4：Start Raspberry Pi Imager

Raspberry Pi Imager has three items that need to be configured. Please follow the steps below.



Step 5：Select "No Filtering" for the Raspberry Pi Device project

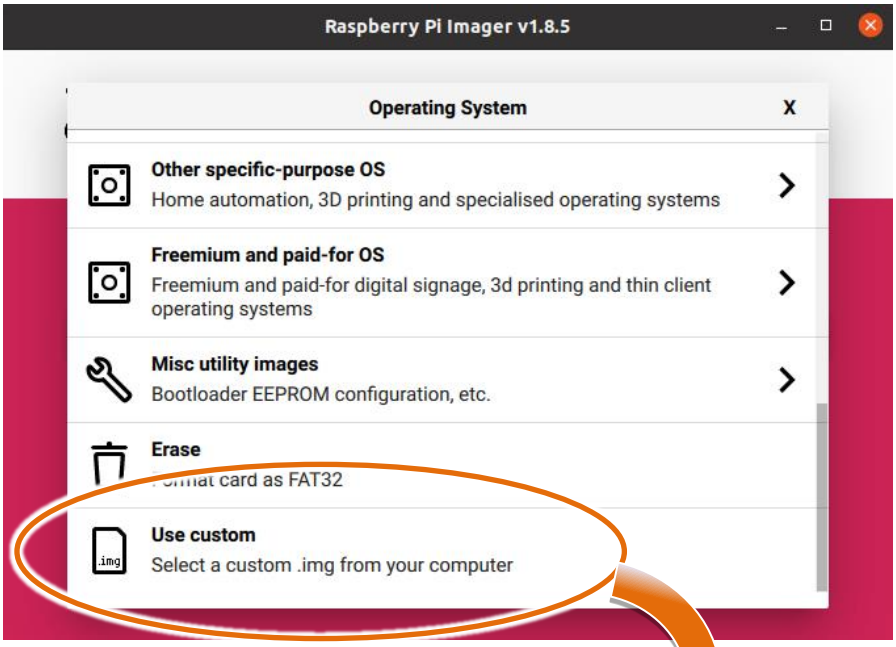


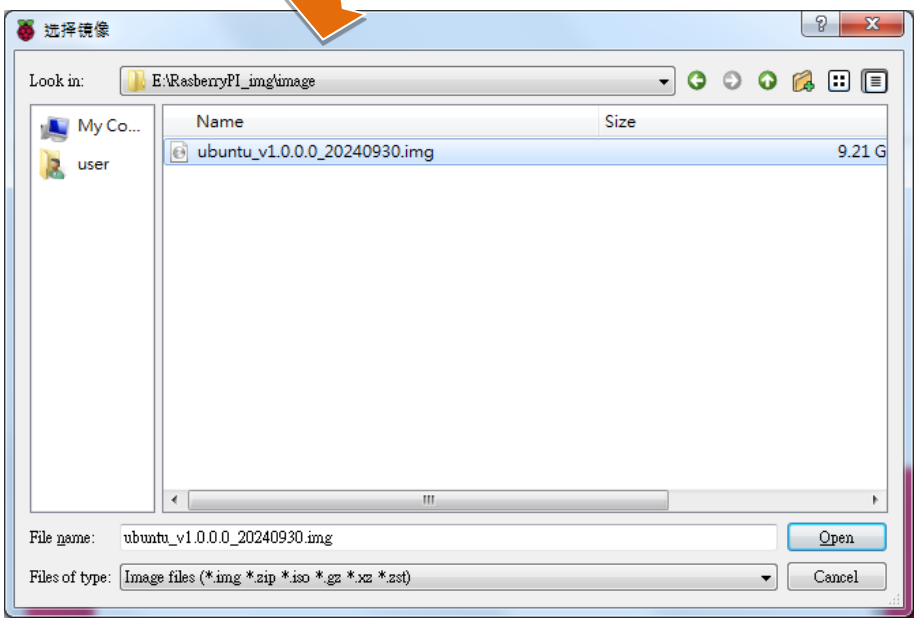
Step 6：Operating system select “ Use custom ”

Select the OS image downloaded from

https://www.icpdas.com/tw/download/show.php?num=5555&model=AIB-2941M

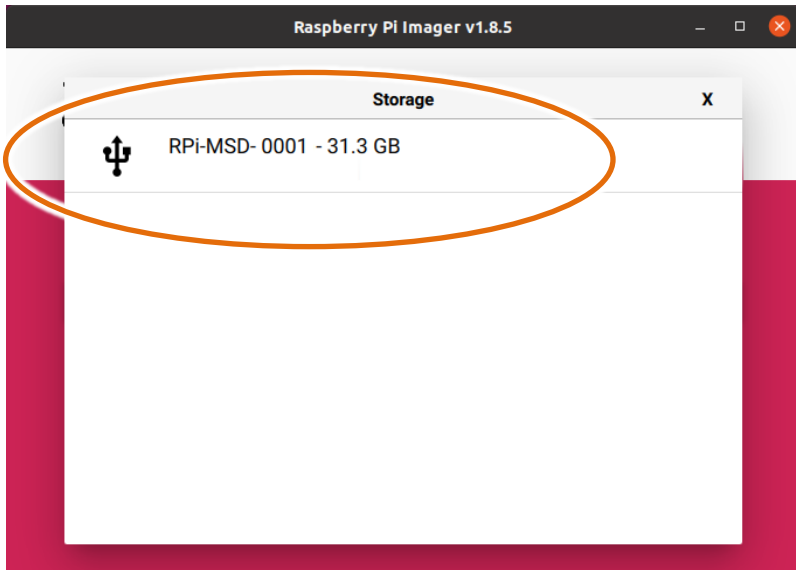
This example is the first version of the OS image "ubuntu_v1.0.0.0_20240930.img"



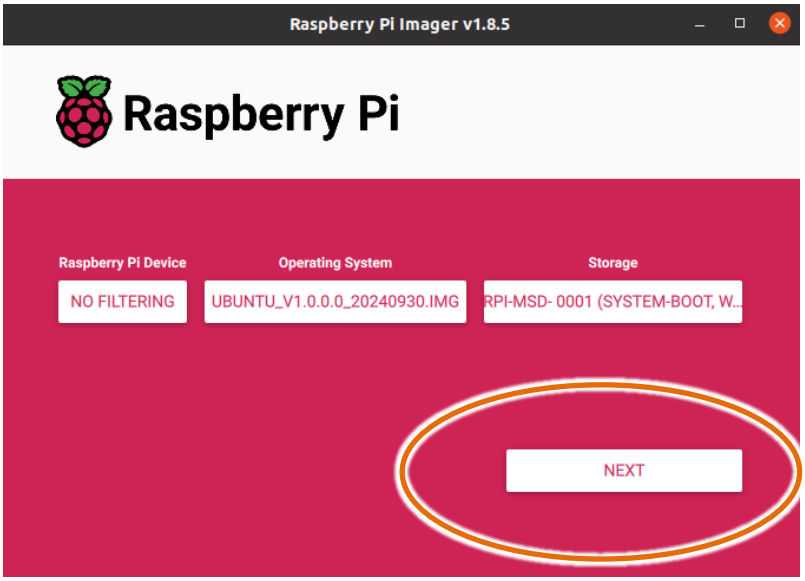


Step 7：Select "RPI-MSD-0001" for Storage

“ RPI-MSD-0001" is the name of rpiboot to mount eMMC,

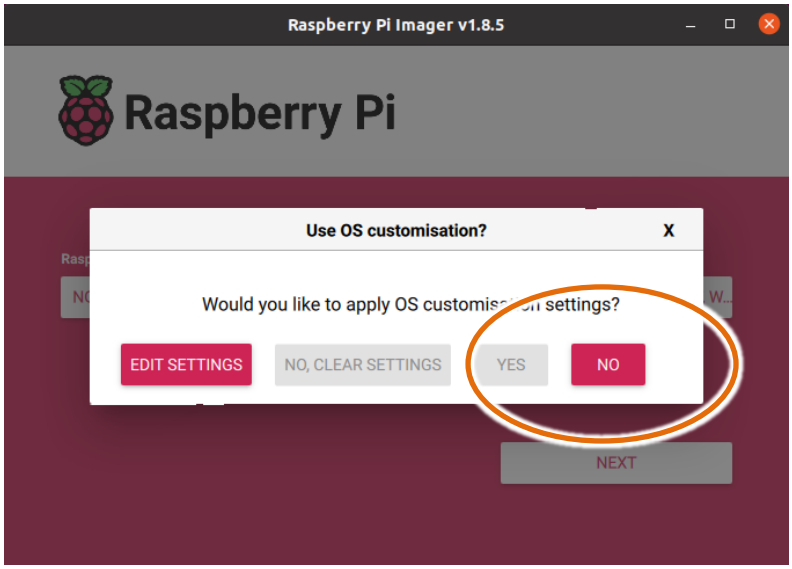


Step 8：Press “ Next ” to proceed to the next step



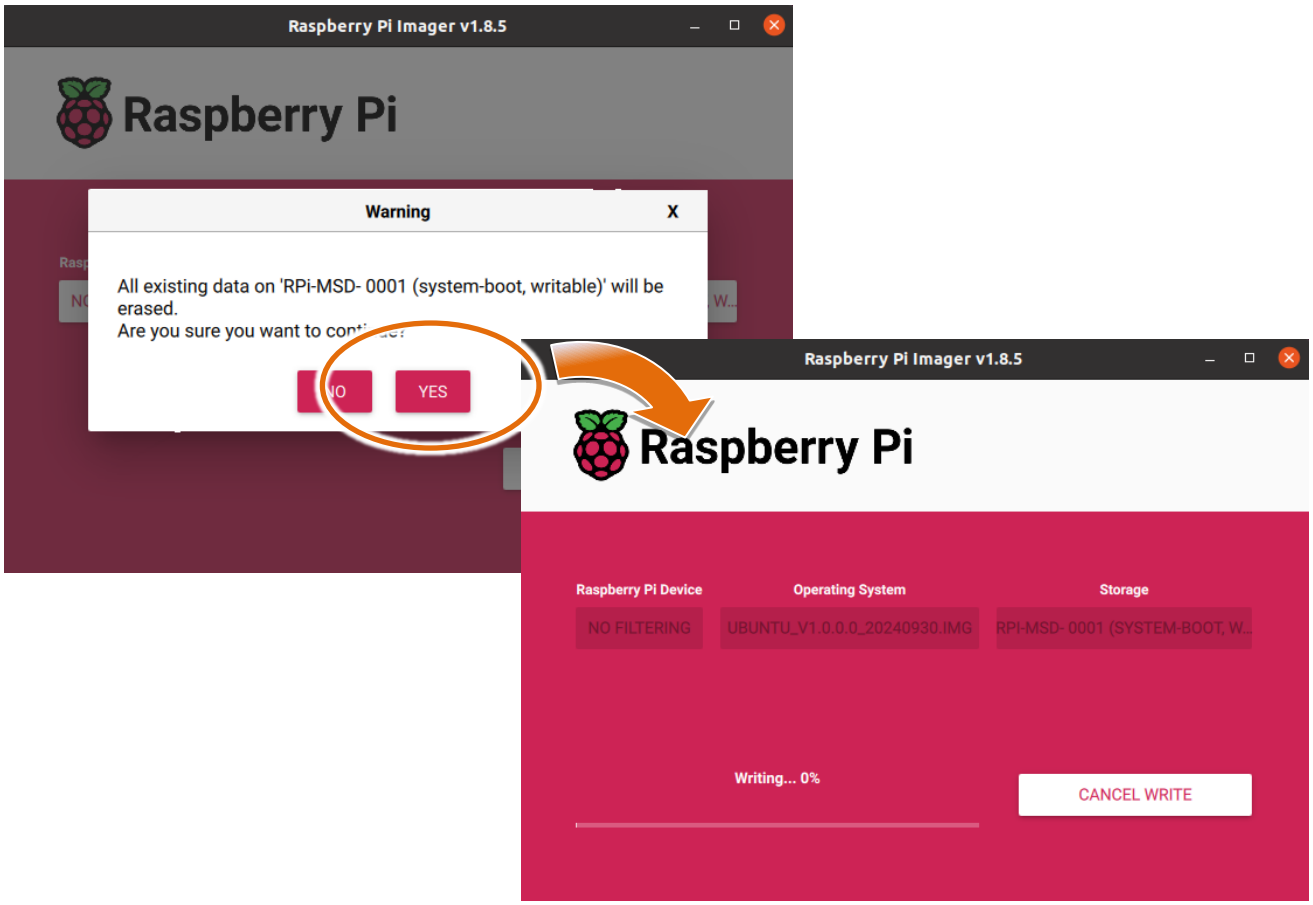
Step 9：Final settings before burning

This option asks if there are other OS customization settings. Please select " NO " to proceed to the next step.



Step 10：Warning that the disk will be cleared. If you have backed up data, please select " YES " and the OS will start to be burned.

Wait about 30~40 minutes after burning the OS



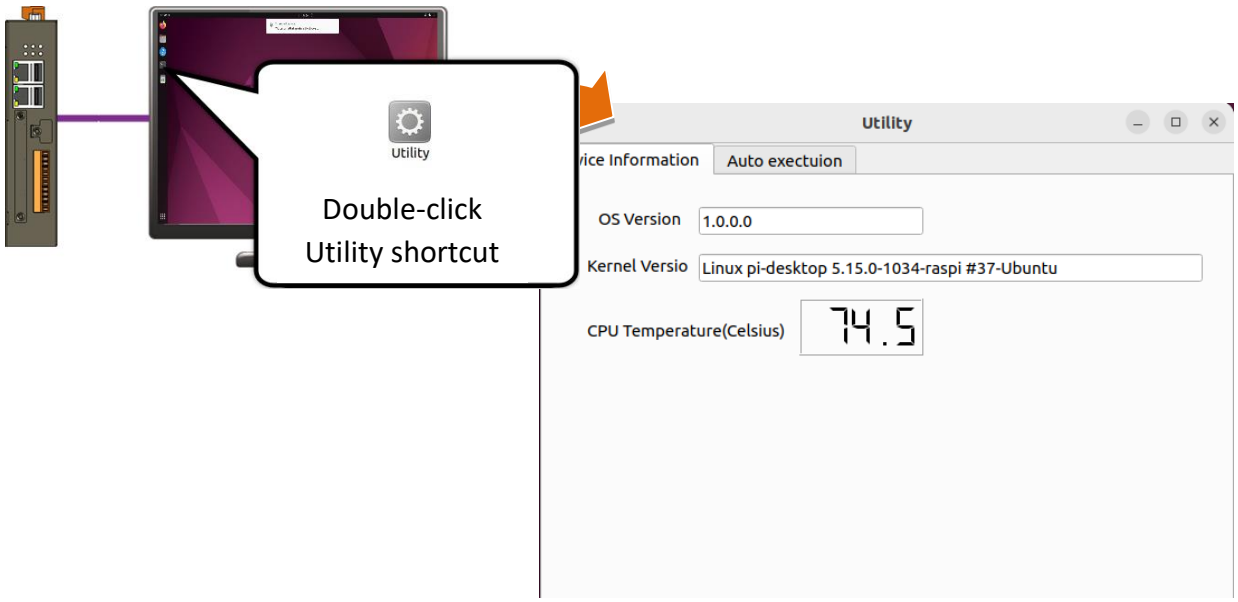
Step 10：OS burning completed

The picture after the OS burning is completed is as follows:

Step 11：Turn off the power of AIB-2941M and remove the mini USB cable connected to AIB-2941M

Step 12：Check OS version

After burning is completed, power on again, execute Utility, and select Device Information tab checks the OS version.



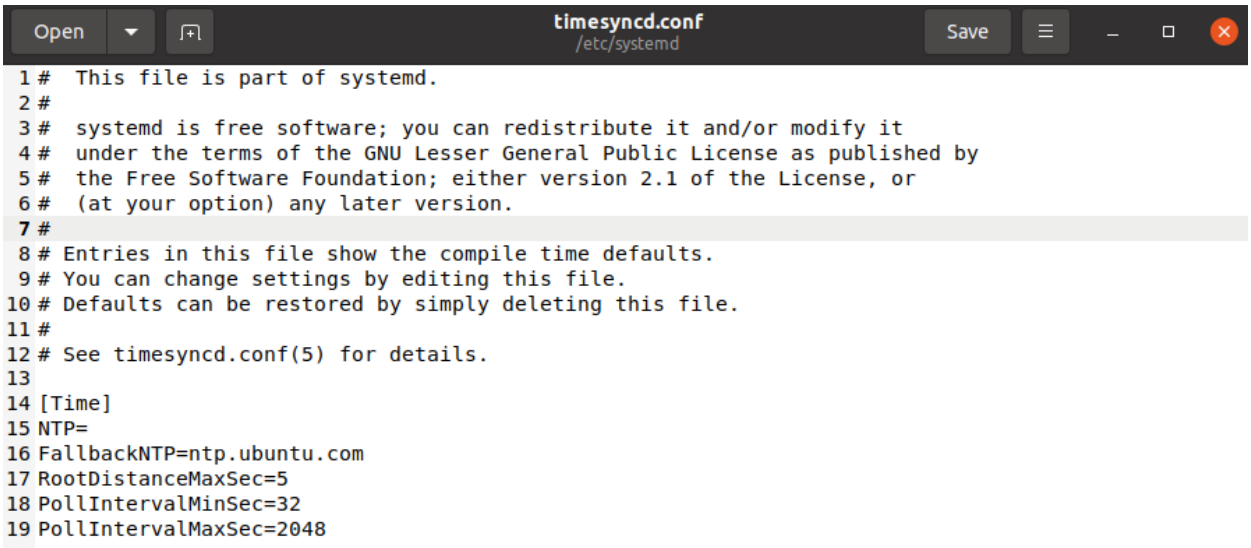
Appendix A. Tips – practical tips

This chapter provides some tips for using and maintaining the AIB-2941M.

A.1. How to set AIB-2941M automatic network time adjustment

You can synchronize the system time of AIB-2941M through a time server.
If synchronization is enabled, the AIB-2941M's system time will be synchronized with the network time server.

Step 1：Open Terminal and enter sudo gedit / etc / systemd / timesyncd.conf . Open the settings as shown below



Each parameter setting is as follows:

Item	Description
NTP	Main time server
FallbackNTP	Backup time server
RootDistanceMaxSec	What is the maximum time difference with the server (unit: seconds)
PollIntervalMinSec	Synchronize at least once every few seconds
PollIntervalMaxSec	Sync every few seconds at most

Step 2：After the setting is completed, press SAVE to save the setting.

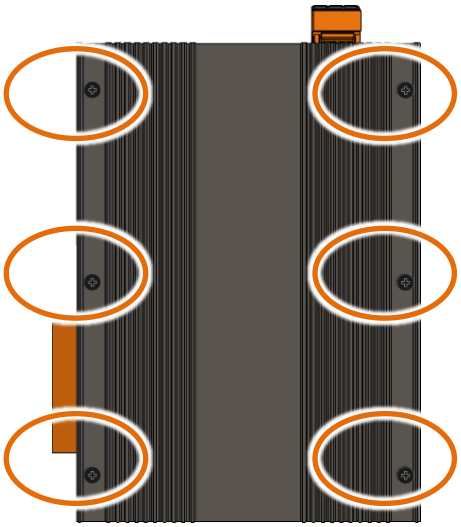
Step 3：Enter sudo systemctl restart systemd-timesyncd in Terminal to restart the time correction service and load the new settings.

A.2. How to replace RTC battery

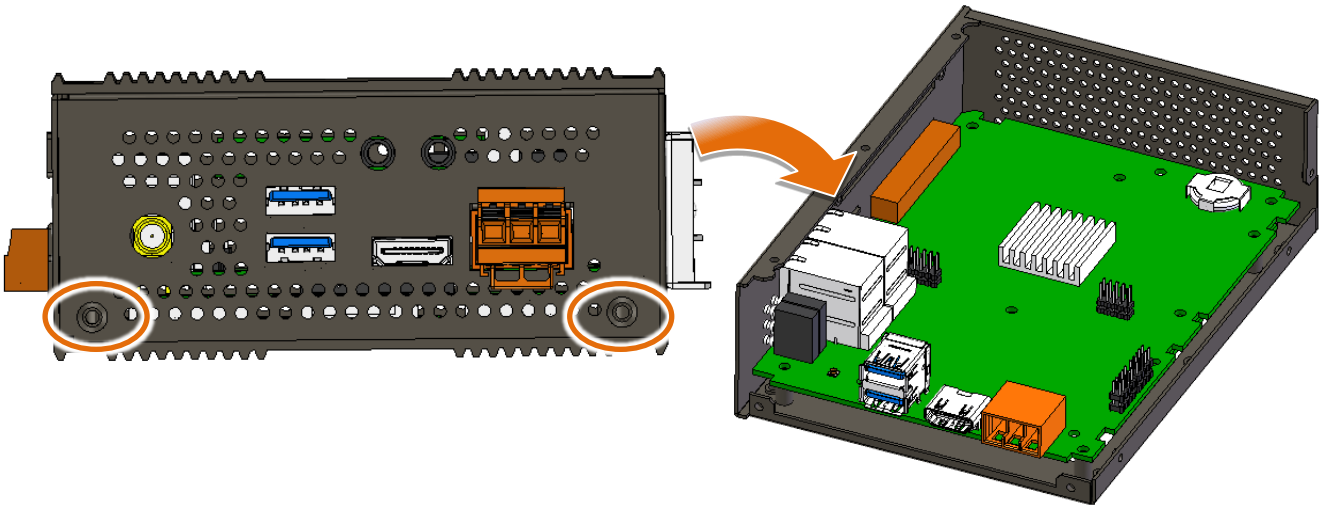
RTC chip uses lithium batteries that can provide power for 10 years. The picture below shows the location of the battery mounted on the AIB-2941M PCB board.

Step 1: Turn off the power to the AIB-2941M device.

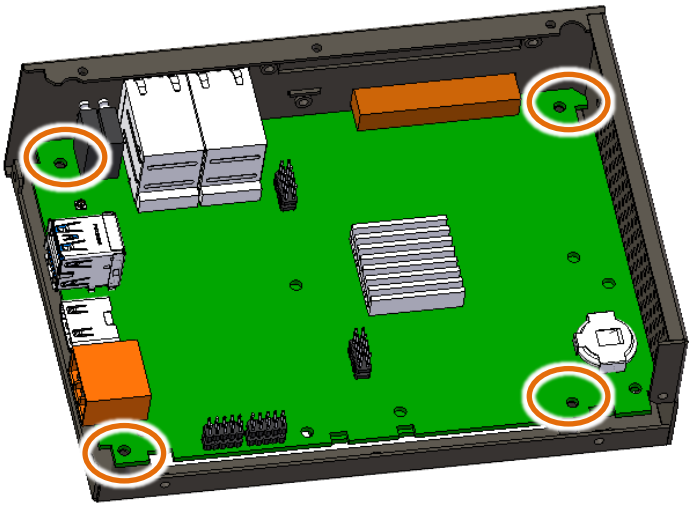
Step 2：Use a screwdriver to remove the screws on the left side cover, and remove the left side cover



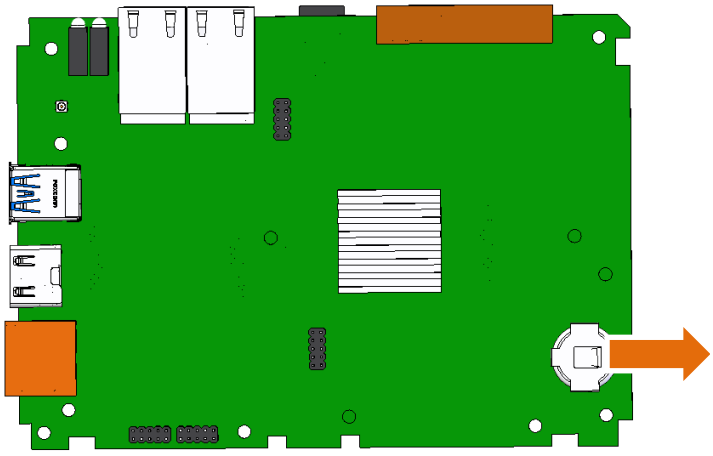
Step 3：Remove the screws on the top side cover, and remove the top side cover



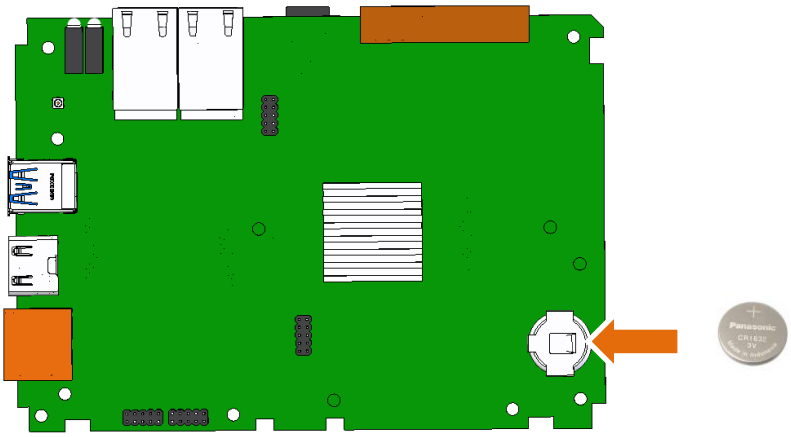
Step 4：Remove the screws on the PCB board



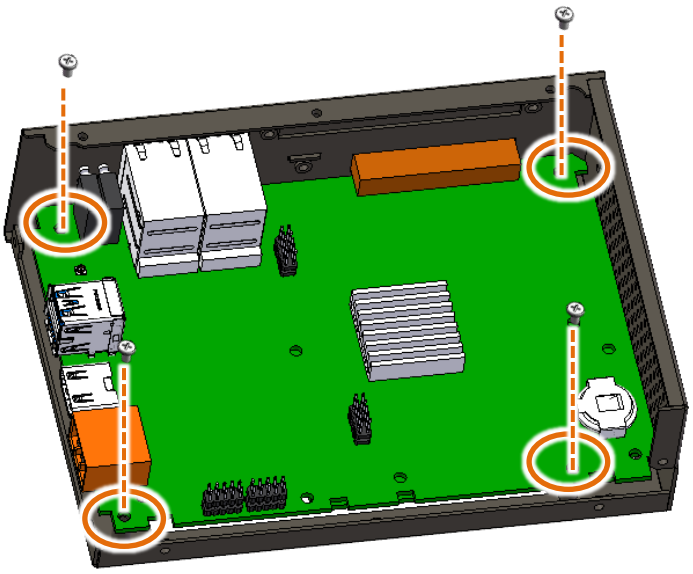
Step 5：Remove the weak battery from the battery compartment



Step 6：Insert new battery



Step 7：Install the PCB board back and tighten the screws



Step 8：Install the left side cover and the top side cover and tighten the screws

Step 9：Set the RTC time

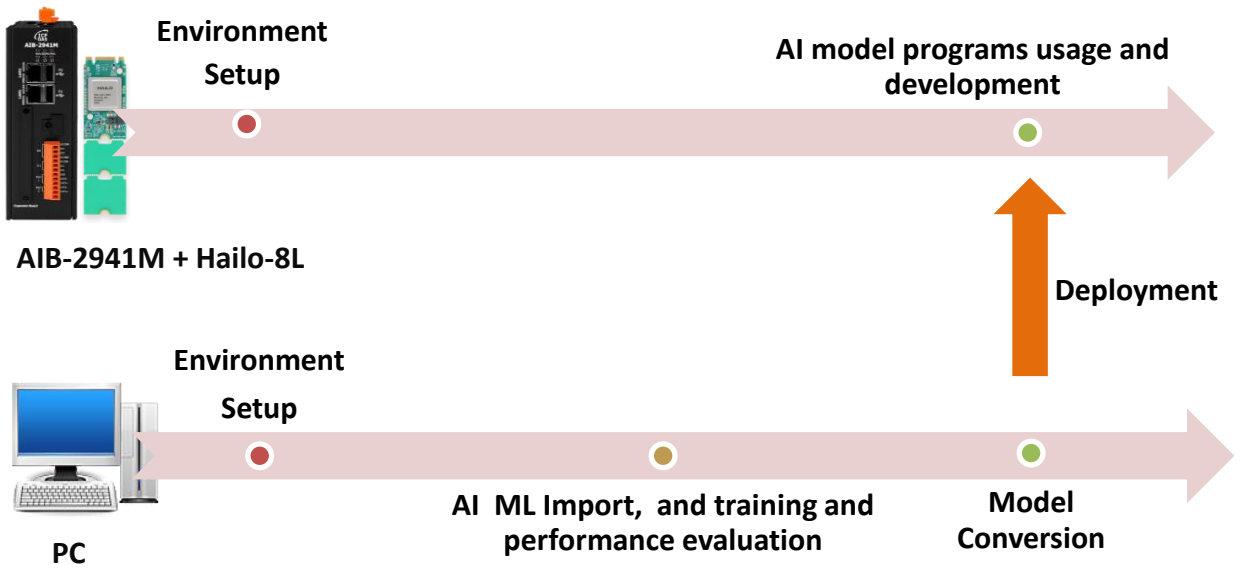
Ordering information

Battery type: BR1632 (model number for ICP DAS is 2LB010)

For more details, please contact your local sales office or distributor.

Appendix B. Hailo-8L Deployment and Development

Application development process of Hailo-8L's AI learning model is as follows

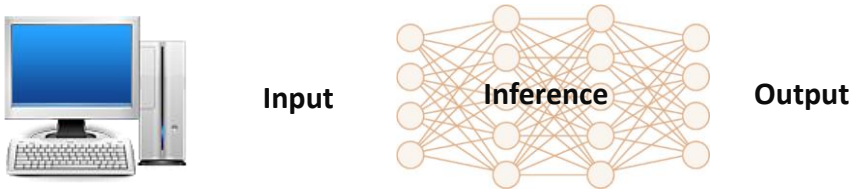


Environment Setup

- AIB-2941M runtime environment settings: HailoRT and Hailo PCIe driver installation (refer to Chapter B.1.1)
- PC environment settings for training AI models: CUDA and deep learning (DL) frameworks installation (refer to Chapter B.1.2)

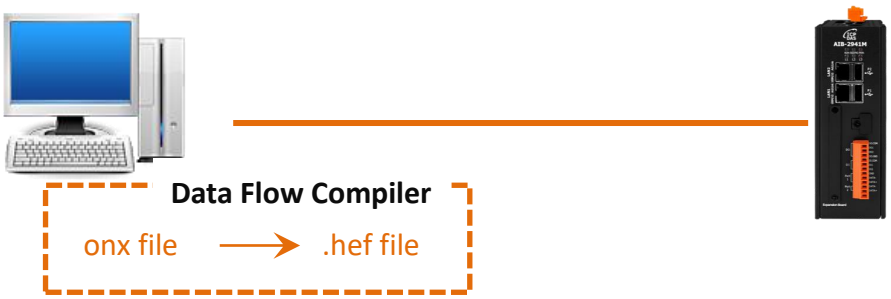
AI Model Learning Import, and Training and Performance Evaluation

Current AI models require users to provide a large amount of data for AI training so that AI can extract the characteristics of target objects for identification or prediction. The trained AI model also needs to be tested to evaluate its reasoning performance.



Model Conversion

The trained AI model needs to be converted into a file format that Hailo 8L can use through Hailo 's conversion tool. The model conversion tool installation and conversion process (refer to Chapter B.3)



AI Model Programs Usage and Development

The converted AI model is deployed on the AIB-2941M. A program is required to input the AI model and data into Hailo 8, and the program receives the recognition results of the AI model calculated in Hailo 8.

For more information about AI learning model import and training, please refer to Chapter B.4.

The installation and operation process sequence will be explained chapter by chapter. The OS used by the PC used in this operation is Ubuntu 20.04, and the GPU used is RTX 2060.

B.1. Environment Setup

B.1.1. AIB-2941M runtime environment settings: HailoRT and Hailo PCIe driver installation

If you want to operate Hailo's AI accelerator card on AIB-2941M, you need to install HailoRT and Hailo PCIe driver, the following is to install HailoRT and Hailo For the steps of PCIe driver, please go to the following Hailo website to download HailoRT and Hailo PCIe driver.
https://hailo.ai/developer-zone/software-downloads/

The following process is to install version 4.15 HailoRT and PCIe driver

Tips & Warnings

HailoRT and PCIe The driver version must be consistent. If the versions are inconsistent, problems may occur during the operation of HailoRT .

Step 1：Open Terminal , enter the command “ sudo apt-get install build-essential ” , and enter the password

Step 2： Open Terminal , switch to the Hail oRT installation file path , and enter “sudo dpkg - i hailort_4.15.0_arm64.deb” (this example is HailoRT version 4.15) to install the file .

The following screen appears to indicate that the installation is complete

```
pi@pi-desktop:~$ sudo dpkg -i hailort_4.15.0_arm64.deb
(Reading database ... 168833 files and directories currently installed.)
Preparing to unpack hailort_4.15.0_arm64.deb ...
Unpacking hailort (4.15.0) over (4.15.0) ...
Setting up hailort (4.15.0) ...
Do you wish to activate hailort service? (required for most pyHailoRT use cases) [y/N]:
Starting hailort.service
Created symlink /etc/systemd/system/multi-user.target.wants/hailort.service → /lib/systemd/system/hailort.
service.
```

Step 3：Open Terminal and switch to Hailo PCIe Driver installation file path , enter “sudo dpkg -i hailort-pcie-driver_4.15.0_all.deb” (this example is Hailo PCIe driver version 4.15) to execute the installation

The following screen appears to indicate that the installation is complete.

```
pi@pi-desktop:~$ sudo dpkg -i hailort-pcie-driver_4.15.0_all.deb
Selecting previously unselected package hailort-pcie-driver.
(Reading database ... 168833 files and directories currently installed.)
Preparing to unpack hailort-pcie-driver_4.15.0_all.deb ...
Could not test for SecureBoot, assuming SecureBoot is disabled on this machine.
Unpacking hailort-pcie-driver (4.15.0) ...
Setting up hailort-pcie-driver (4.15.0) ...

WARNING: apt does not have a stable CLI interface. Use with caution in scripts.

build-essential/jammy,now 12.9ubuntu3 arm64 [installed]
Do you wish to use DKMS? [Y/n]:
Please reboot your computer for the installation to take effect.
```

Step 4：Open Terminal and enter hailortcli scan to confirm whether Hailo hardware is detected

If Hailo hardware is detected, the Device ID will be listed. The Hailo hardware detected as shown in the picture below means that HailoRT and Hailo PCI Driver are successfully installed.

```
pi@pi-desktop:~$ hailortcli scan
Hailo Devices:
[-] Device: 0000:04:00.0
```

Tips & Warnings

The OS is divided into versions with Hailo related software installed (HailoRT and Hailo PCIe driver) and versions without related software installed. Users can download the OS Image from the following website.

https://www.icpdas.com/en/download/show.php?num=9388&model=AIB-2941M

B.1.2. PC environment settings: CUDA and deep learning framework installation

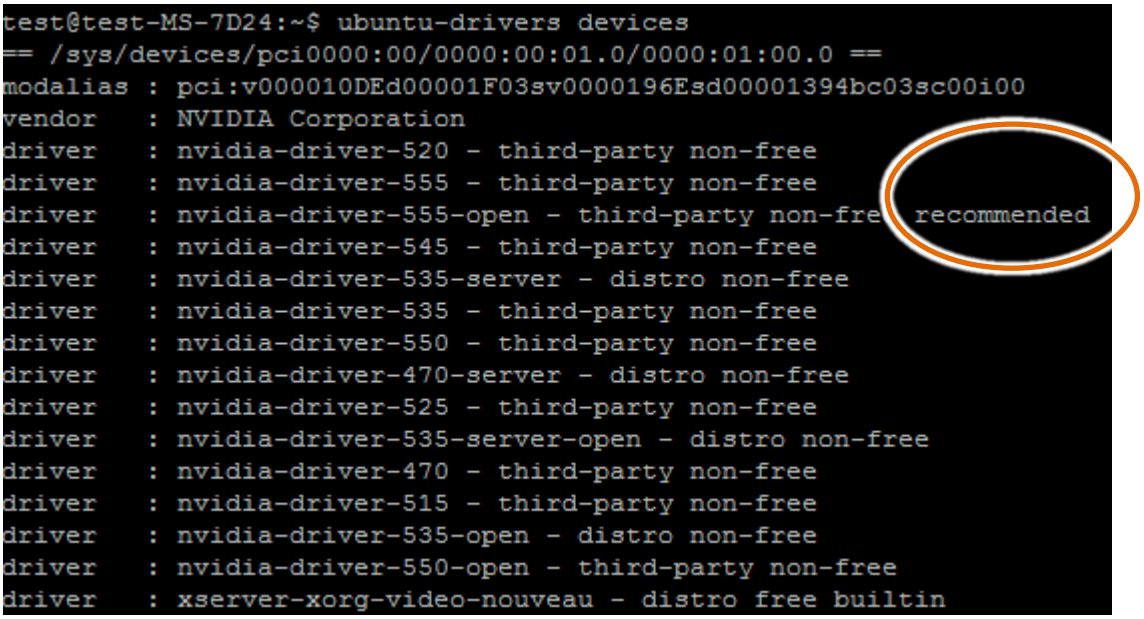
The PC environment requires the installation of CUDA and Deep Learning Framework , because the current mainstream GPUs are designed by Nvidia . The GPU API provided by Nvidia is CUDA. Most Deep learning architectures are built on CUDA, so CUDA must be installed.

The following will explain how to install CUDA and Deep learning architectures in the Ubuntu environment, and how to train the AI model.

CUDA installation

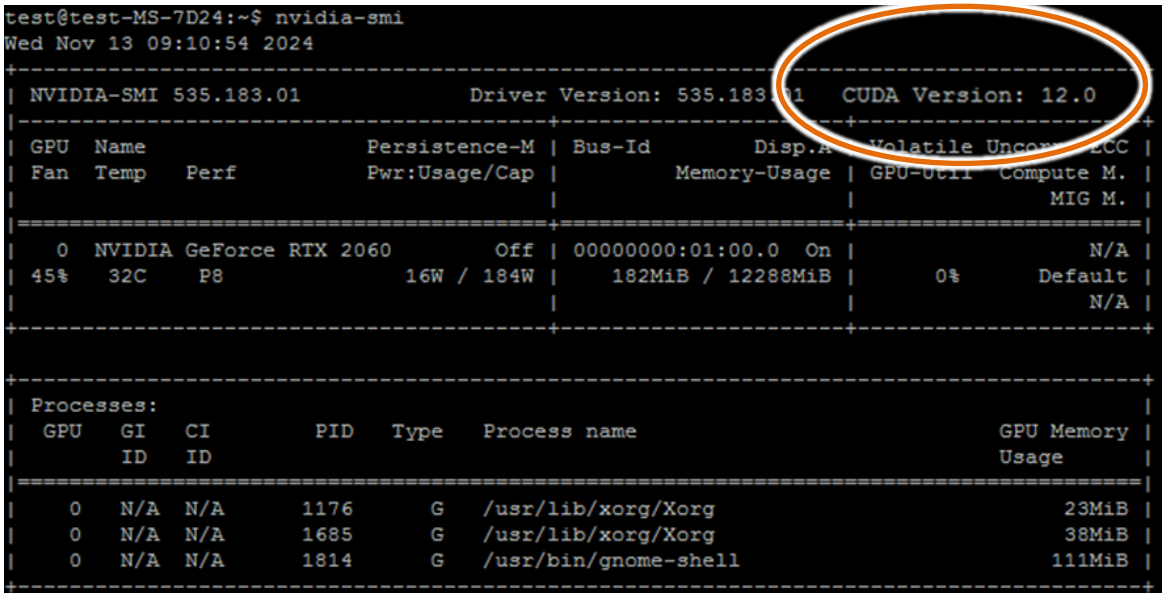
Step 1：In the ubuntu environment, please enter ubuntu-drivers devices in the terminal

GPU drivers that can be installed in the OS will be listed . It is recommended to install The driver prompted by " recommended " . This version of the driver has been verified by Nvidia and is less prone to problems.



Step 2：Install the GPU After driver, please enter nvidia-smi in the terminal

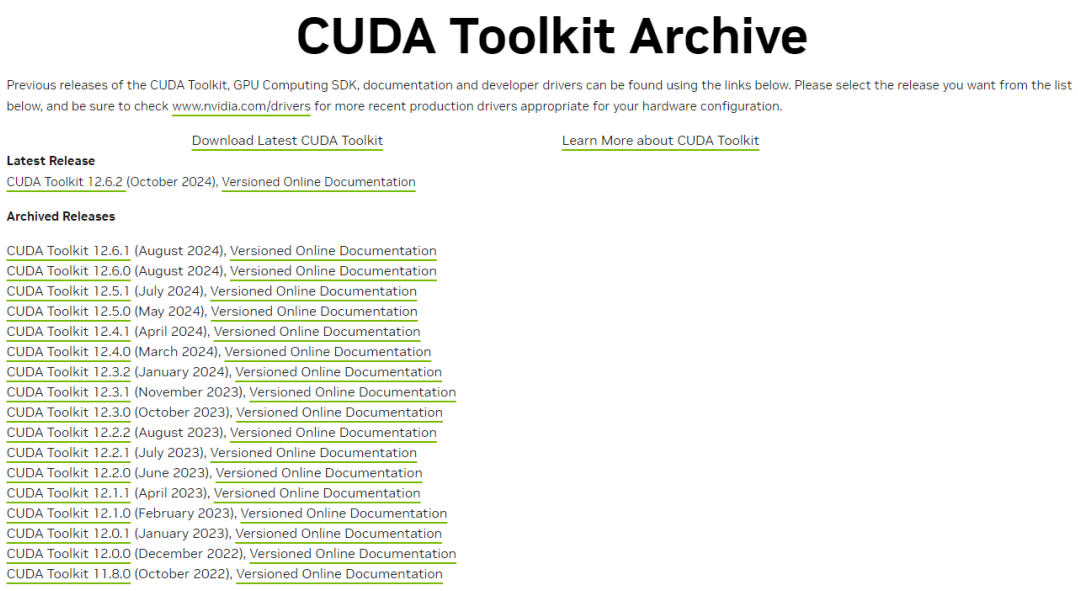
The “CUDA Version” in the upper right corner is the CUDA toolkit version you want to install in the subsequent steps. Please install the corresponding version, otherwise exceptions may occur.



Step 3：Please go to the following Nvidia website to download the corresponding CUDA toolkit installation file

https://developer.nvidia.com/cuda-toolkit-archive

The website is as shown below, this example corresponds to version 12.0



CUDA Toolkit Archive

Previous releases of the CUDA Toolkit, GPU Computing SDK, documentation and developer drivers can be found using the links below. Please select the release you want from the list below, and be sure to check www.nvidia.com/drivers for more recent production drivers appropriate for your hardware configuration.

Download Latest CUDA Toolkit Learn More about CUDA Toolkit

Latest Release

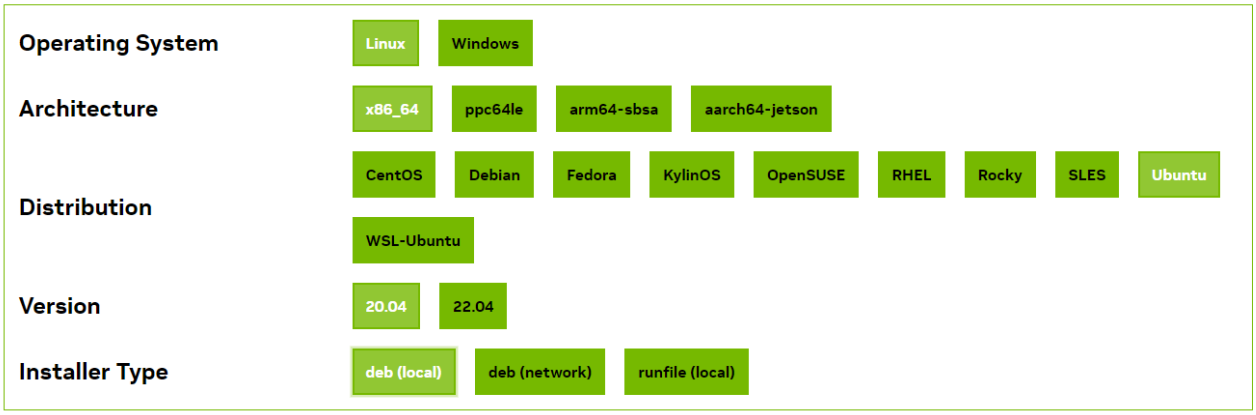
CUDA Toolkit 12.6.2 (October 2024), Versioned Online Documentation

Archived Releases

CUDA Toolkit 12.6.1 (August 2024), Versioned Online Documentation
CUDA Toolkit 12.6.0 (August 2024), Versioned Online Documentation
CUDA Toolkit 12.5.1 (July 2024), Versioned Online Documentation
CUDA Toolkit 12.5.0 (May 2024), Versioned Online Documentation
CUDA Toolkit 12.4.1 (April 2024), Versioned Online Documentation
CUDA Toolkit 12.4.0 (March 2024), Versioned Online Documentation
CUDA Toolkit 12.3.2 (January 2024), Versioned Online Documentation
CUDA Toolkit 12.3.1 (November 2023), Versioned Online Documentation
CUDA Toolkit 12.3.0 (October 2023), Versioned Online Documentation
CUDA Toolkit 12.2.2 (August 2023), Versioned Online Documentation
CUDA Toolkit 12.2.1 (July 2023), Versioned Online Documentation
CUDA Toolkit 12.2.0 (June 2023), Versioned Online Documentation
CUDA Toolkit 12.1.1 (April 2023), Versioned Online Documentation
CUDA Toolkit 12.1.0 (February 2023), Versioned Online Documentation
CUDA Toolkit 12.0.1 (January 2023), Versioned Online Documentation
CUDA Toolkit 12.0.0 (December 2022), Versioned Online Documentation
CUDA Toolkit 11.8.0 (October 2022), Versioned Online Documentation

Step 4：Please make your selection according to the software environment used by the module.

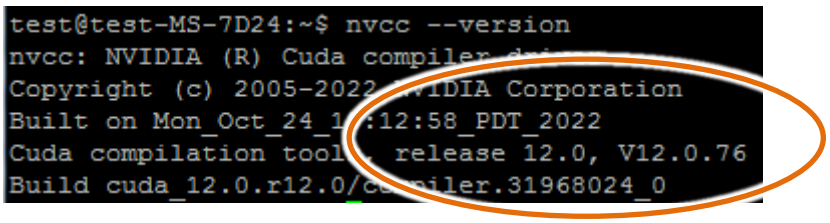
Select OS, hardware architecture, etc. in sequence. The hardware used in this example and module is x86 PC, and the OS used is Ubuntu 20.04. In terms of installation type, we use deb file installation, so select the one shown below.



Step 5：Follow the prompts and execute the instructions step by step on the terminal to complete the installation steps.

Step 6： After installing CUDA, please enter nvcc -- version in the terminal to confirm whether the installed CUDA version is correct.

This time the installation is version 12.0, the output screen is as follows



Deep Learning Architectures installation

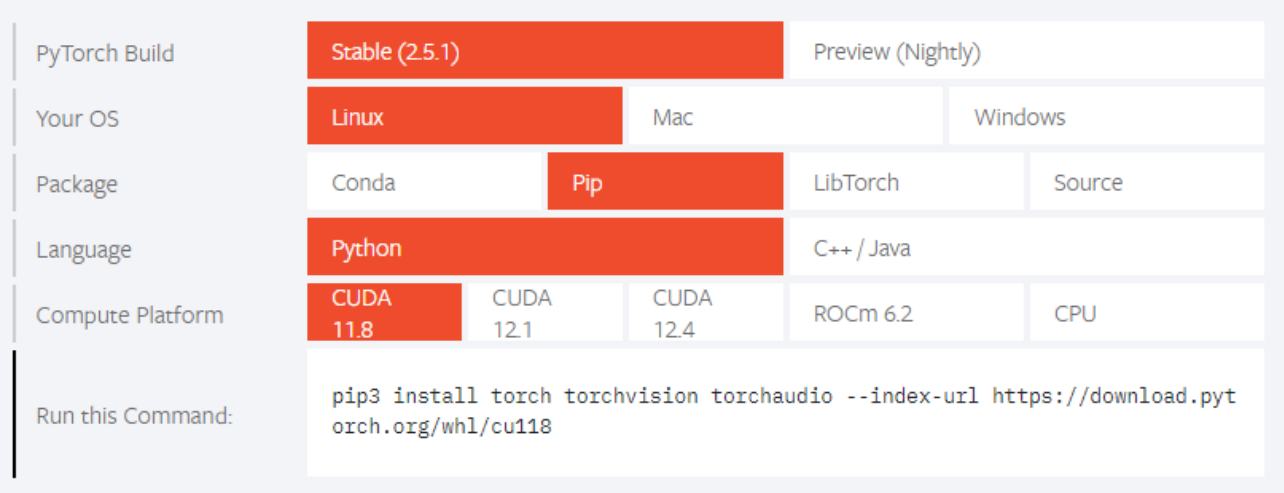
Deep learning architectures, such as Pytorch, tensorflow ... etc . They mainly correspond to the AI Model you want to use. Different AI Models will correspond to different Deep learning architectures , so please confirm the AI Model you want to use first to install the corresponding The corresponding Deep learning architectures , the AI model used in this example is yolov5, and the corresponding Deep learning architectures is Pytorch , so this chapter will focus on Pytorch installation.

Step 1：Please go to the Pytorch website https://pytorch.org/ for the installation process

click in order according to your PC environment.

This example uses pip to install under Ubuntu. Regarding the choice of CUDA version, CUDA can be downward compatible. Please choose a version older or equal to your current CUDA version. For example, the CUDA version installed in the previous chapter is 12.0, so choose 11.8. .

Since pip is used for installation this time, please enter it in the terminal. " Run this Command " Display the installation command .



Step 2：After the installation is complete, you can query it on pip. The query results are as follows, which means that Pytorch has been installed.

```
test@test-MS-7D24:~$ pip list | grep torch
torch                    2.0.1+cu118
torchaudio               2.0.2+cu118
torchvision              0.15.2+cu118
```

B.2. AI learning model training and performance evaluation

There are many AI models . Users should choose the AI model they want to use according to their own needs. This example takes yolov5 as an example. Yolov5 is an object recognition AI model developed by ultralytics based on yolov4. It is lighter than yolov4. The following process It is the AI Model training process and performance evaluation of yolov5 .

B.2.1. Model training

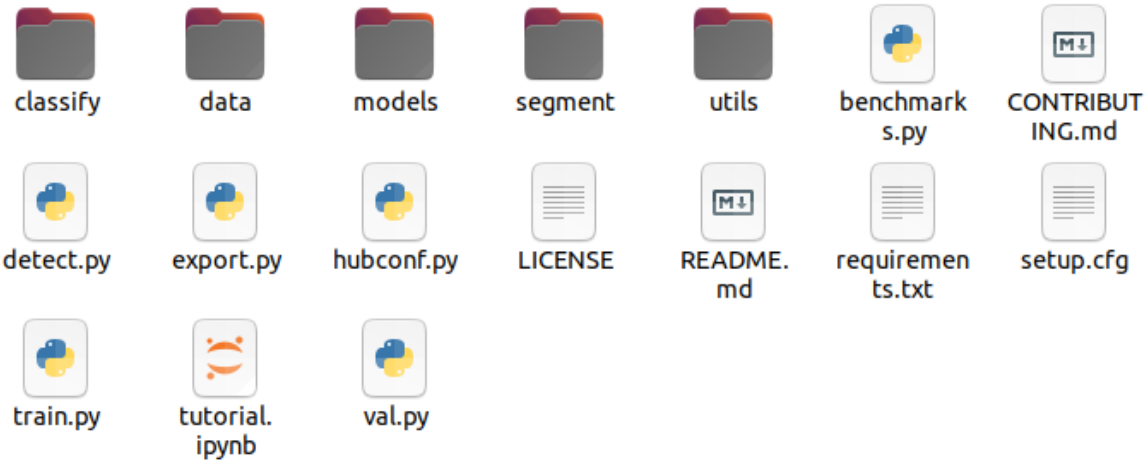
Step 1： Download yolov5 from ultralytic's github

The latest version of yolov5 can be downloaded from the following link:

https://github.com/ultralytics/yolov5

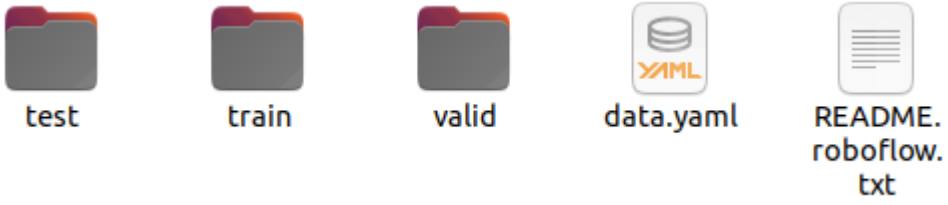
of yolov5 is v7.0. The following will take v7.0 as an example.

Step 2：The downloaded yolov5 is decompressed as shown below



Step 3：Add training data set, training data

There are currently many websites on the Internet that can share training images for free, such as coco, roboflow ...etc. The training data for this training is downloaded from roboflow . The goal of this training is to identify cars and license plates. The picture below is this training data set



Step 4：Open the terminal , switch to the folder of yolov5, and enter the following training instructions

python3 train.py --img-size 640 --batch 16 --epochs 300

--data ./car_License/data.yaml --weights yolov5s.pt

The following introduces several parameters

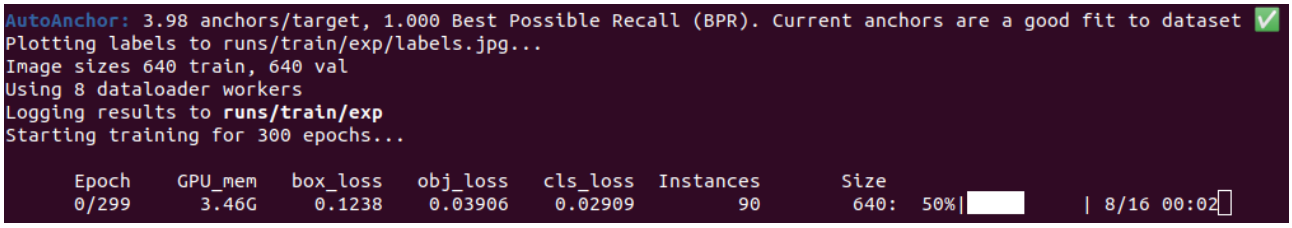
--data yaml file path in the data set

-- epochs It is a training cycle. If there are 100 pictures in your data set, one cycle is performed on these 100 pictures.

--batch How much data is input to the GPU for training each time. The larger the value, the larger the GPU memory used.

For other parameters, please enter “python3 train – help” for detailed instructions

In the terminal , training will start as shown below



Step 5：After training is completed, the information is displayed as shown below

The trained AI model will be in /runs/train/exp<number>/weights. Number is the number of times you have run training. This is the first training, so it will be exp. There will be two models in the weights folder, best.pt is the best trained model in all cycles, and last.pt is the model trained in the last cycle. The meaning of the training completion information shown in the figure below will be explained in the next chapter.

```
Validating runs/train/exp/weights/best.pt...
Fusing layers...
Model summary: 157 layers, 7015519 parameters, 0 gradients, 15.8 GFLOPs
                 Class     Images  Instances          P          R      mAP50   mAP50-95: 100%|          | 3/3 00:00
                   all         70        218      0.839      0.834      0.873      0.676
       license-plate'          70         84      0.888      0.893      0.941      0.705
               vehicle         70        134       0.79      0.776      0.805      0.646
Results saved to runs/train/exp
```

Tips & Warnings

There are about 300 images in the data set for this training. The GPU used for training is RTX 2060. The batch value is set to 16. The training time is about 2 to 3 hours.

B.2.2. Model performance evaluation

In "B.2. AI Learning Model Training and Performance Evaluation " , after the training is completed, the following figure is displayed:

```
Validating runs/train/exp/weights/best.pt...
Fusing layers...
Model summary: 157 layers, 7015519 parameters, 0 gradients, 15.8 GFLOPs
                 Class     Images  Instances          P          R      mAP50   mAP50-95: 100%|          | 3/3 00:00
                   all         70        218      0.839      0.834      0.873      0.676
       license-plate'          70         84      0.888      0.893      0.941      0.705
               vehicle         70        134       0.79      0.776      0.805      0.646
Results saved to runs/train/exp
```

The value of mAP50-95 is used to evaluate the model's recognition rate of objects in the image and the rate of correct frame selection. The higher the value, the stronger the model's ability to identify objects.

For the meaning of each parameter, please refer to Ultralytics instructions.

https://docs.ultralytics.com/guides/yolo-performance-metrics/#introduction

The trained AI model can be verified with detect.py to verify whether images outside the data set can be effectively identified. Enter python3 detect.py --source test.jpg –weight best.pt

The picture below shows the results of the trained AI model identifying cars and license plates.

--source for the picture or image you want to detect

–weight For the AI model you want to use for detection

B.3. Model conversion

B.3.1. Model conversion tool installation and model for use by Hailo-8L

Chapter B.2.3 has explained how to train the AI model, but the trained AI model cannot be used immediately on the AIB-2941M because HailoRT can only operate the AI model in Hailo format , so we still need to convert the AI model .

In addition to installing the Data flow compiler, the conversion of the AI model also needs to be written separately, because the conversion program will be modified according to the parameters used by the user during the training process, and the processing results after the conversion may be biased. It needs to be corrected, so there is no universal program version. This part requires the support of Hailo. You can submit your AI mode conversion problem to us, and we will help you contact Hailo for support. This chapter only explains the installation of the Data flow compiler. and preparatory work for converting AI models.

Model conversion tool Data Flow Compiler installation

Step 1： Please go to the following Hailo website to download the Data flow compiler.

https://hailo.ai/developer-zone/software-downloads/

Tips & Warnings

HailoRT and Data flow compiler have a corresponding relationship. The corresponding table is as follows

HailoRT	Data flow compiler
4.13	3.23
4.14	3.24
4.15	3.25

HailoRT 4.15 and later versions follow this table and so on.

1. The HailoRT version can be newer than the Data flow compiler, but the Data flow compiler cannot be newer than HailoRT. For example, if HailoRT is 4.15, Data flow compiler can be installed with versions 3.23~3.25. If HailoRT is 4.13, only versions below 3.23 can be installed.
2. If the installed version is incompatible, the converted AI model will not be able to operate in the runtime environment on the AIB-2941M.
3. Hailo related software installed (HailoRT and Hailo PCIe driver) and related software versions are not installed. OSs that have Hailo related software installed will have HailoRT version 4.19 and Hailo PCIe Driver pre-installed. Please install version 4.29 or an older version of the Data flow compiler.

Since HailoRT version 4.15 has been installed in the " 4.1.1 . AIB-2941M runtime environment establishment " chapter , the following instructions are for installing version 3.25 Data flow compiler .

Step 2：Enter pip install hailo_dataflow_compiler-3.25.0-py3-none-linux_x86_64.whl

Because the data flow compiler also requires the downloading and installation of multiple packages, the installation process takes time . When the installation is completed, the following information is displayed.

```
Successfully installed hailo-dataflow-compiler-3.25.0 keras-2.12.0 onnx-1.14.0 onnxsim-0
.4.17 protobuf-3.20.3 pydantic-1.10.8 setuptools-68.0.0 tensorboard-2.12.3 tensorflow-2.
12.0 tensorflow-estimator-2.12.0 tensorflow-probability-0.20.1 tflite-2.10.0
```

You can check the version of Data flow compiler we installed in pip list

```
test@test-VirtualBox:~$ pip list | grep dataflow
hailo-dataflow-compiler       3.25.0
```

Model conversion for use by Hailo-8L

Before starting the conversion, we need to convert the previous chapter "B.2.3. AI model training " The trained “best.pt ” Convert to onnx files. The files converted by the data flow compiler only support onnx and ckpt format files, so "best.pt " needs to be converted.

The export.py in Yolov5 can support conversion to onnx format. Please open the terminal , switch to the folder of yolov5 , and enter the following command
python3 export.py --weights best.pt --include torchscript onnx

conversion to onnx file format is as follows:

```
ONNX: export success □  0.4s, saved as best.onnx (27.2 MB)

Export complete (1.3s)
Results saved to /home/test/yolov5-7.0
Detect:          python detect.py --weights best.onnx
Validate:        python val.py --weights best.onnx
PyTorch Hub:     model = torch.hub.load('ultralytics/yolov5', 'custom', 'best.onnx')
Visualize:       https://netron.app
```

There are three steps required to convert to Hailo to support HEF format: Parsing, Quantization and Compilation. Each step requires writing a separate conversion program for conversion. We are unable to provide assistance in this step and require professional support from Hailo. You can contact us to forward your problem to Hailo.

B.4. Use and develop AI model programs

In the chapter " B.3. Convert the trained AI model into a file format that Hailo-8L can operate " , you have converted your AI model into a HEF format file. You will then need to develop an application to run on AIB-2941M.

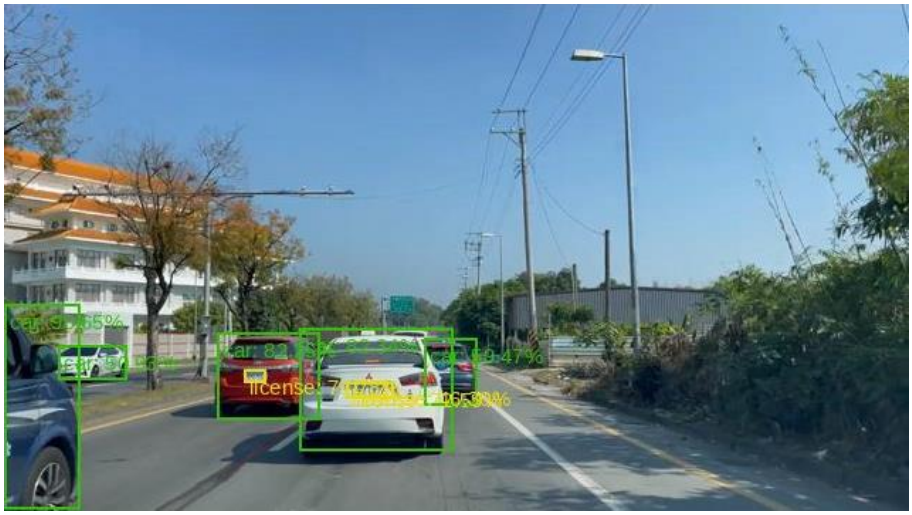
Hailo 's GitHub has provided relevant examples of applications. Please download them from the following GitHub website.

https://github.com/hailo-ai/Hailo-Application-Code-Examples

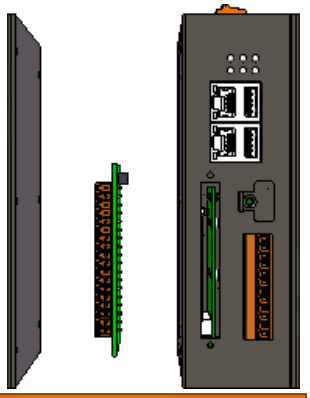
Hailo has provided python , C++ and C#...etc. examples for users' reference. Taking python as an example, hailo provides the following types of demo programs

APP	Description
depth_estimation	Depth estimation with StereoNet
detection_with_tracker	Object detection with tracking using ByteTracker and Supervision
hailo_onnxruntime	Inference with a Hailo device and postprocessing with ONNXRuntime
instance_segmentation	Instance segmentation with yolov5_seg/yolov8_seg
lane_detection	Lane detection with yolo, ssd or centernet
object_detection	Object detection with yolo, ssd or centernet
pose_estimation	Pose estimation with yolov8
streaming	Object detection on a streaming input from a camera using OpenCV
super_resolution	Super resolution with espcnx4 or srgan

The car and license plate recognition AI model trained in the previous chapter can be applied on object_detection. The picture below is an example of how it works on AIB-2941M after modifying the demo.



Appendix C. XV-Board and XB-Board Expansion Cards



XV-Board and XB-Board series I/O expansion cards are suitable for AIB-2941M series controllers. Each controller can be equipped with an XV-Board or X B -Board series I/O expansion card for expansion.

The following table shows the specifications of each XV-Board expansion module.

DIO expansion card

Module	DI			DO	
	Number of channels	type	Sink/Source	Number of channels	Sink/Source
XV107	8	Wet	Source	8	Sink
XV107A			Sink		Source
XV110	16	Dry/Wet	Sink/Source	-	-
XV111	-			16	Sink
XV111A					Source

Relay output expansion card

Module	DI			Relay output	
	Number of channels	type	Sink/Source	Number of channels	type
XV116	5	Wet	Sink/Source	2	Signal Relay
				4	Power Relay

Hybrid I/O expansion module

Module	AI	AO	DI			DO	
	Number of channels			type	Sink/Source	Number of channels	Sink/Source
XV308	8	-	DI+DO=8	Dry/Wet	Source	DI+DO=8	Sink
XV310	4	5	4		Sink		Source

For more detailed instructions on the XV-Board expansion module, please refer to:

http://www.icpdas.com/root/product/solutions/hmi_touch_monitor/touchpad/xv-board_selection.html

The following table shows the specifications of each X B -Board expansion module

Hybrid I/O expansion module

Module	AI	AO	DI			DO	
	Number of channels			type	Sink/Source	Number of channels	Sink/Source
XB310	4	4	4	Dry/Contact	Source	4	Sink

For more detailed instructions on the X B -Board expansion module, please see:
https://www.icpdas.com/en/product/guide+Remote_I_O_Module_and_Unit+PAC_I_O_Modules+XB-board

Appendix D. Revision History

This chapter provides the revision history of this manual.

The table below provides the date and description of each revision of this document.

Version	Release Date	Description
1.0.1	February 2025	Initial issue