Intel's Open IP Immersion Cooling Reference Solutions – Single Phase – 2U and 4U AAIC

User Guide

February 2024

Revision 1.0

Document Number: 816305

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Revision History

Revision Number	Description	Date
1.0	Initial release of the document	February 2024

1 2U/4U AAIC Brief

Intel has already introduced the 2U/4U Air Assisted Immersion Cooling (AAIC) for Intel's Open IP Immersion Cooling. This AAIC is a stand-alone system and easy to deploy in any kind of environment, especially in harsh environments. This 2U/4U AAIC with a 3/7 kW cooling capacity shares the same uniform flow field design and modular scalable features.

Intel's 2U/4U AAIC integrates the tank, the Cooling Distribution Unit (CDU), and the monitoring system. The tank refers to the container for the server and the coolant, which is made of stainless steel and provides anti-rust and anti-corrosion protection. The flip-up top cover of the tank could be sealed to avoid coolant evaporation. The CDU is integrated into the tank with a 3/7 kW cooling capacity. The cooled coolant of the 2U/4U AAIC inlets from the bottom of the tank through the CDU pump, and the cooled coolant dissipates heat from the high Thermal Design Power (TDP) components of the server. The heated coolant moves up, driven by the thermal buoyancy effect, and then the hot coolant is drawn from the top of the tank through the CDU pump and enters the radiator for heat exchange with fans to complete the entire cooling cycle.

The 2U/4U AAIC has a monitoring system providing two operation modes to monitor the tank and the CDU by sensors. To understand the performance of the immersion server, coolant, electronic components, cable, optical module, heat sink, and so on, this 2U/4U AAIC with the monitoring system can be used to verify with either manual or automatic operation mode for long-term reliability.

Figure 1-1. 2U/4U AAIC Overview

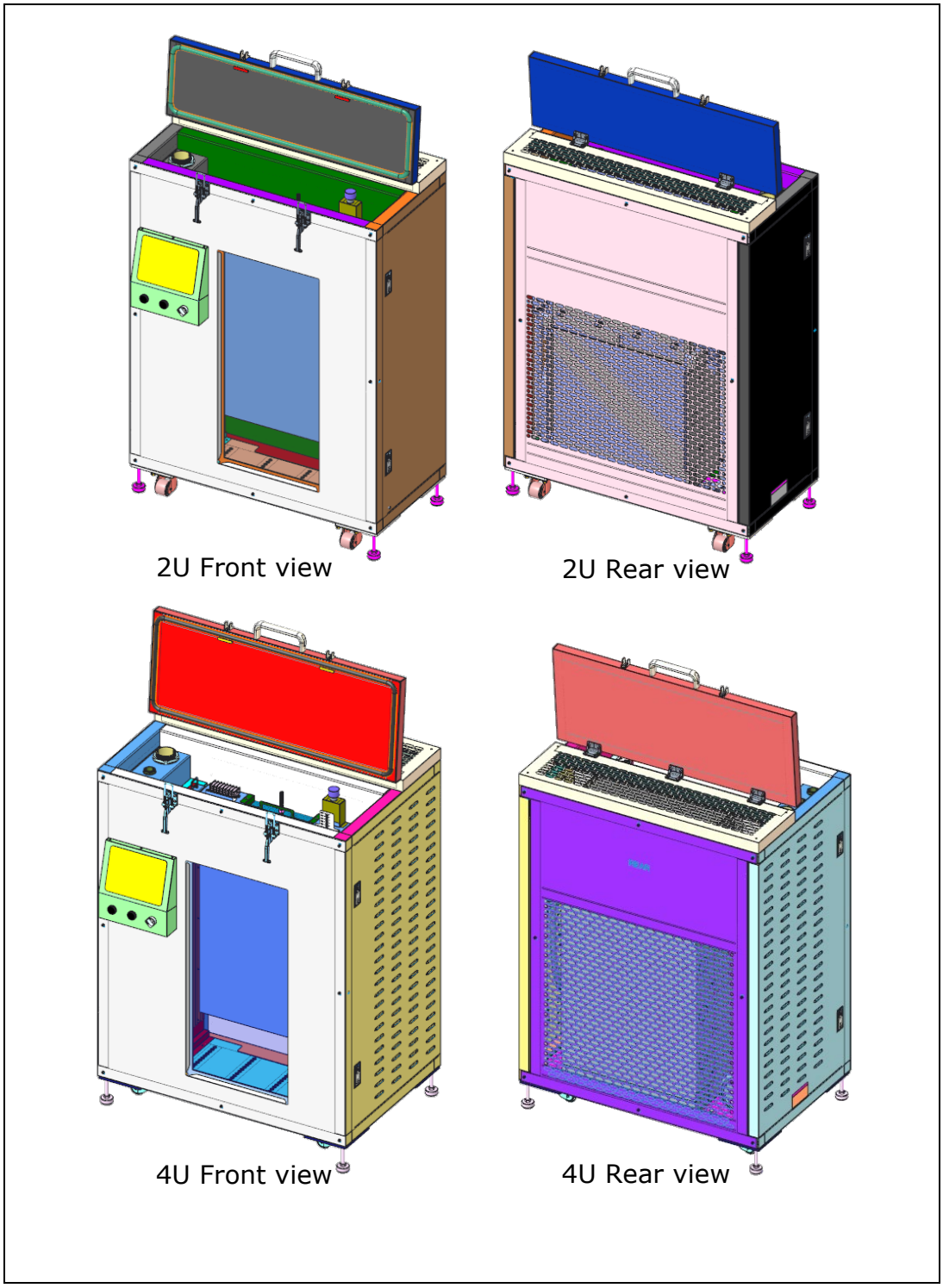


Figure 1-2. 2U/4U AAIC Product Picture

2U AAIC

4U AAIC

2 2U/4U AAIC Overview

The 2U and 4U AAICs have the same key outer and inner parts. The only difference between 2U and 4U is the dimensions mentioned in section 2.2.

2.1 2U/4U AAIC Key Parts

Figure 2-1. 2U/4U AAIC Key Outer Parts

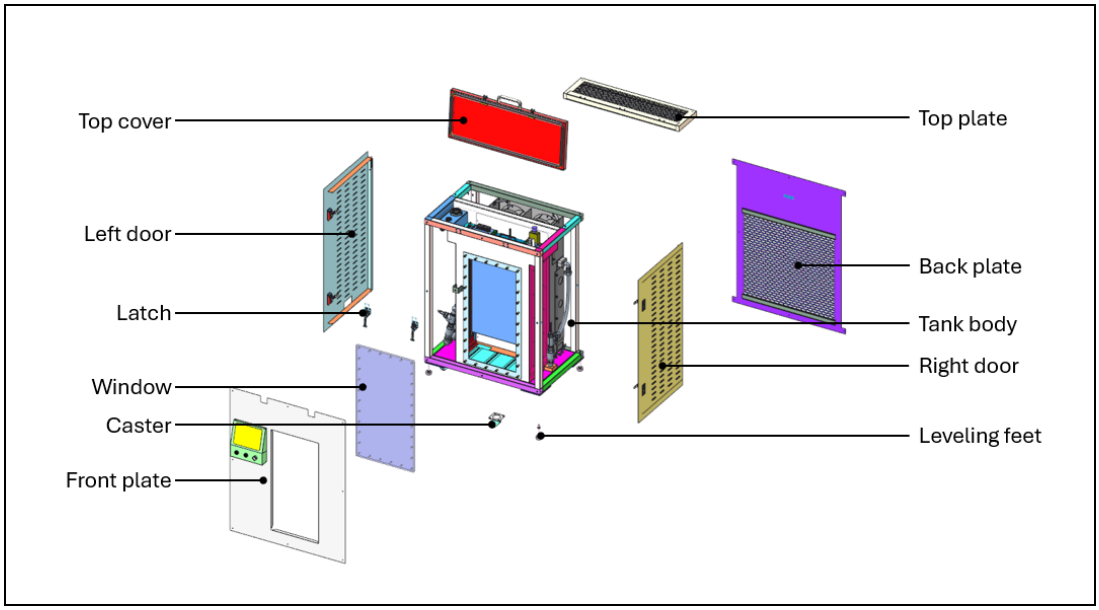
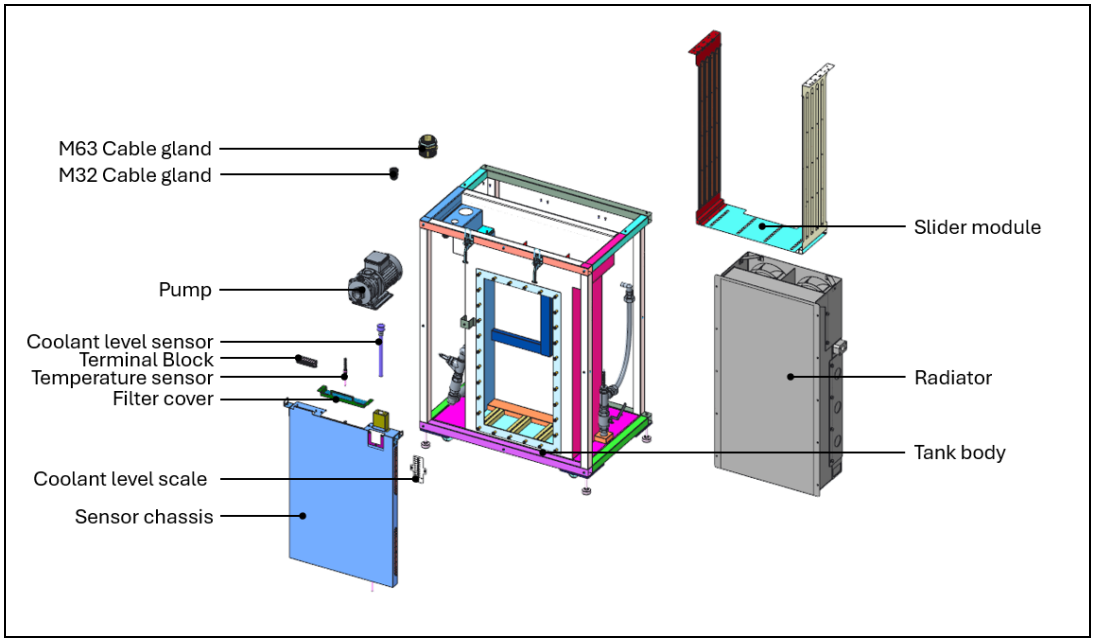


Figure 2-2. 2U/4U AAIC Key Inner Parts



2.2 2U/4U AAIC Dimensions

Figure 2-3. Dimensions - Top Cover Closed

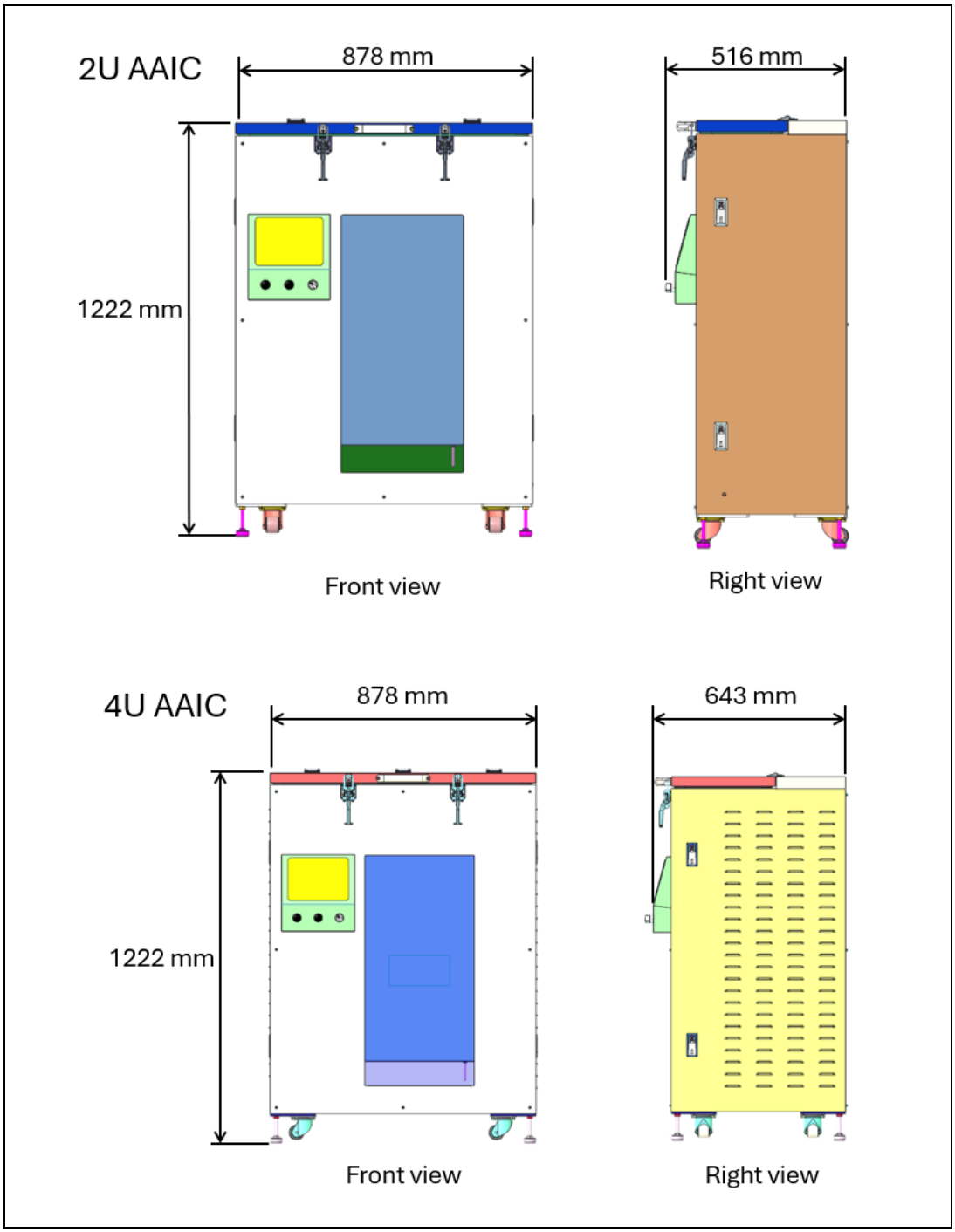
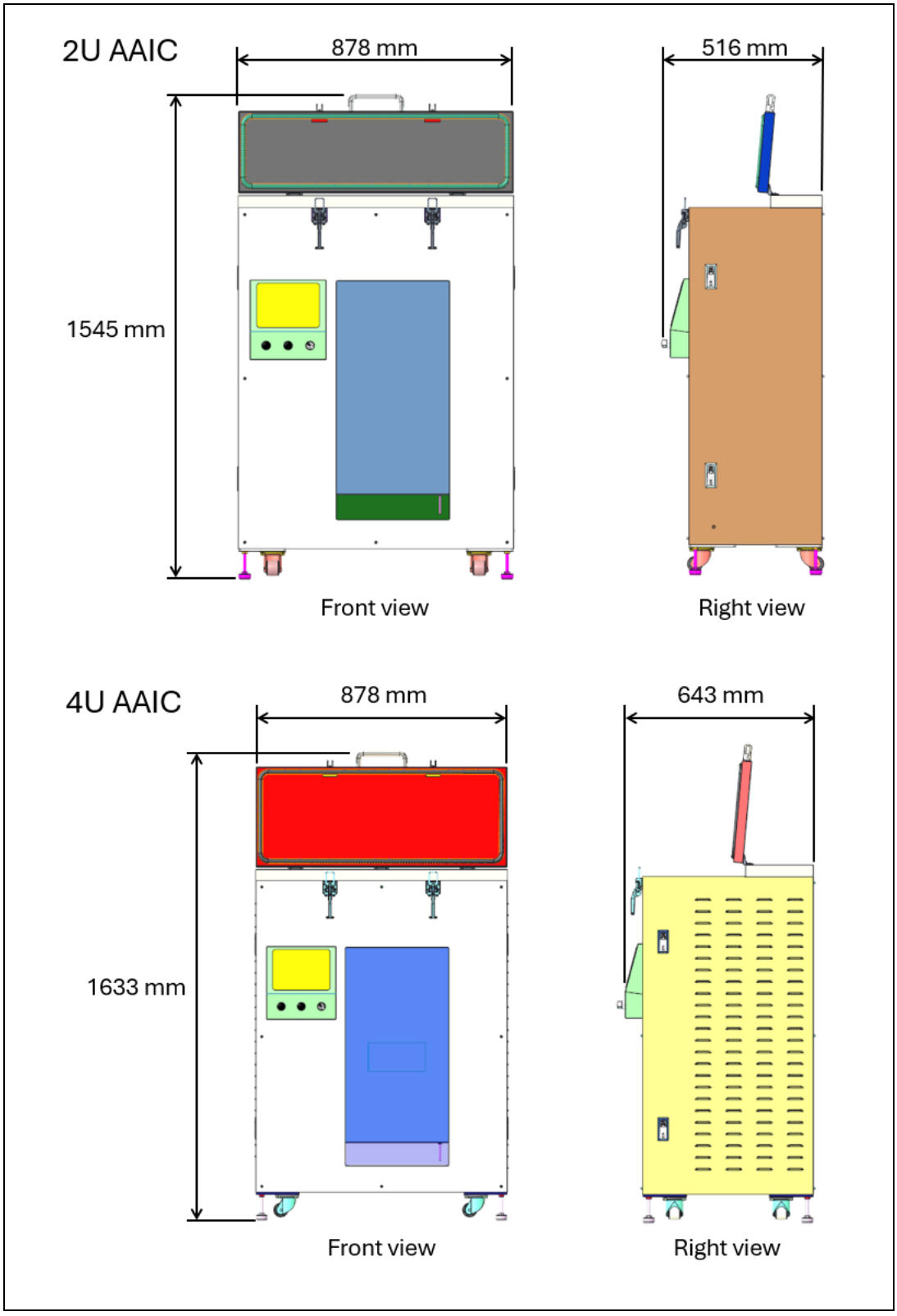


Figure 2-4. Dimensions - Top Cover Opened



3 Server Chassis Dimensions

3.1 1U Server Chassis

3.1.1 1U Server Chassis Dimension

Figure 3-1. 1U Server Chassis Dimension (Top View)

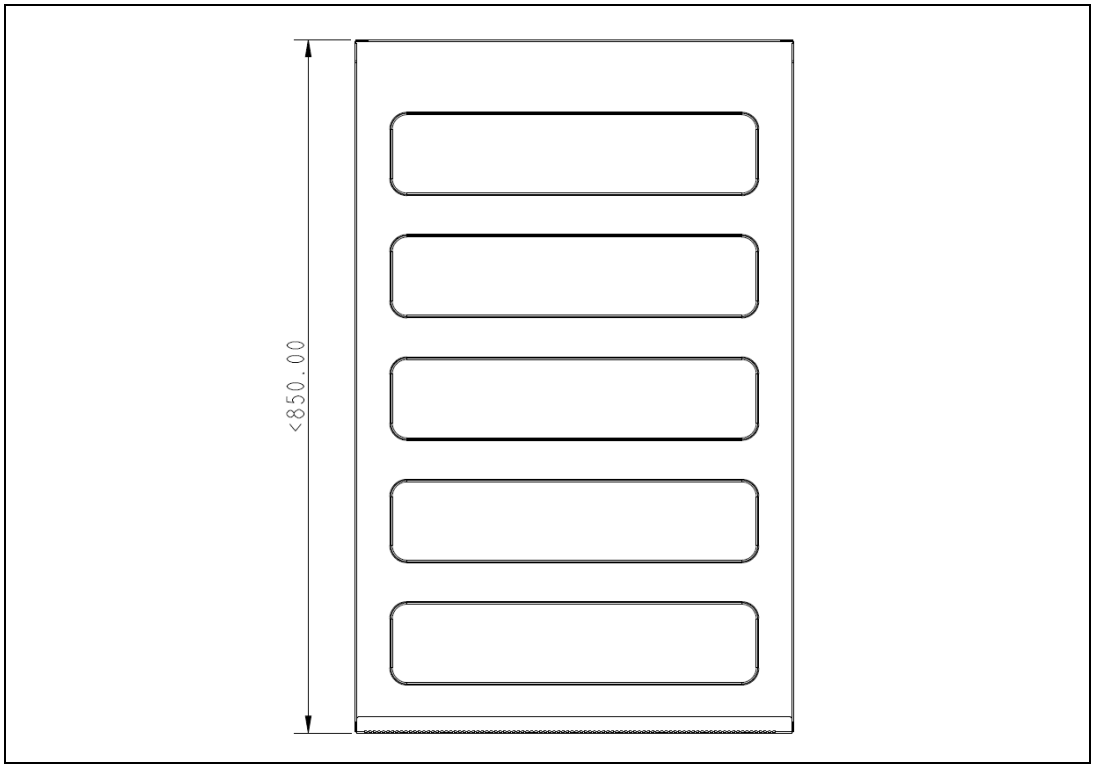
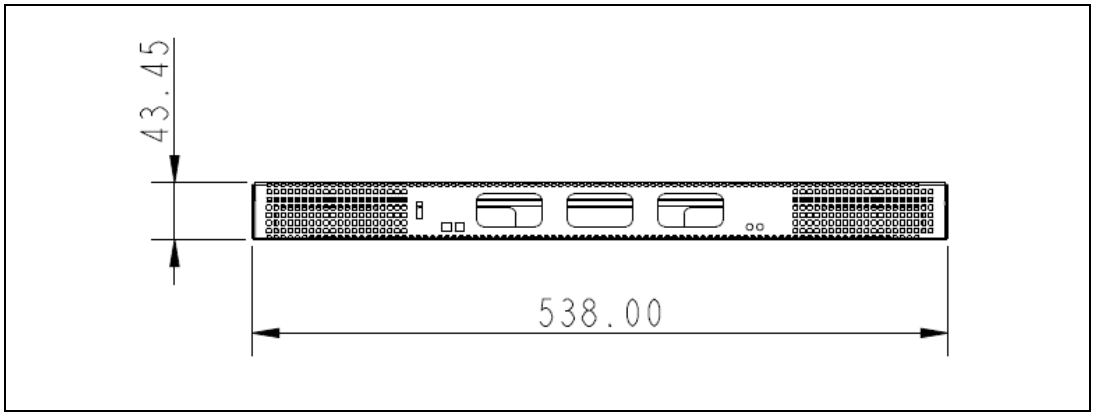


Figure 3-2. 1U Server Chassis Dimensions (Front View)



3.1.2 1U Server Chassis with Ear

Figure 3-3. 1U Server Chassis Dimensions with Ear (Front View)

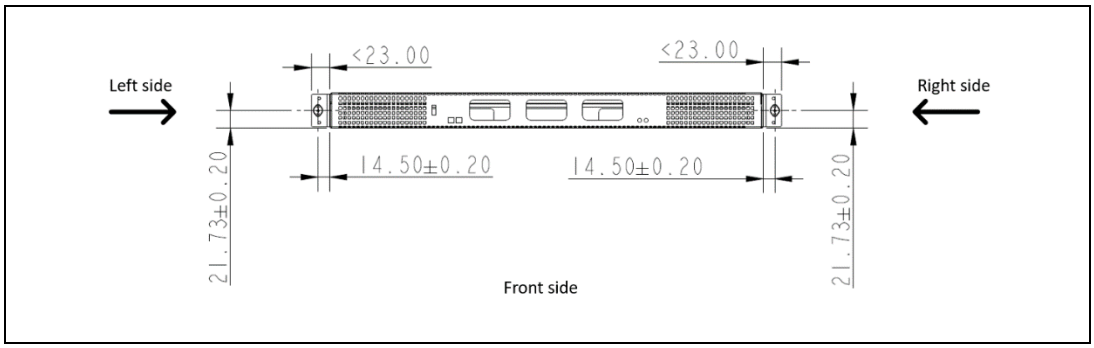


Figure 3-4. 1U Server Chassis Dimensions with Ear (Right-Side View)

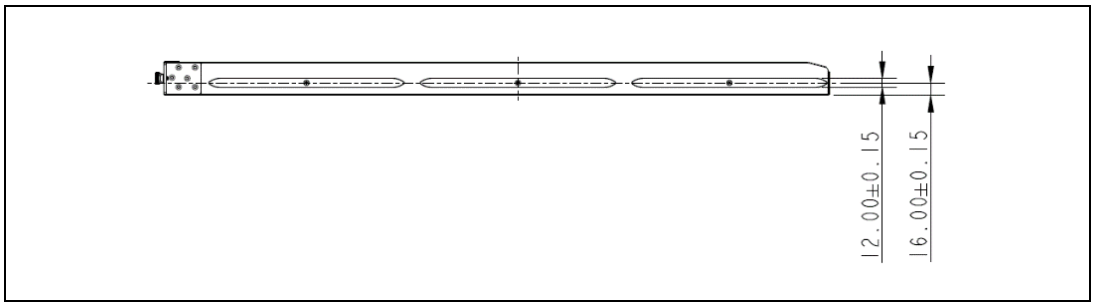


Figure 3-5. 1U Server Chassis Dimensions with Ear (Left-Side View)

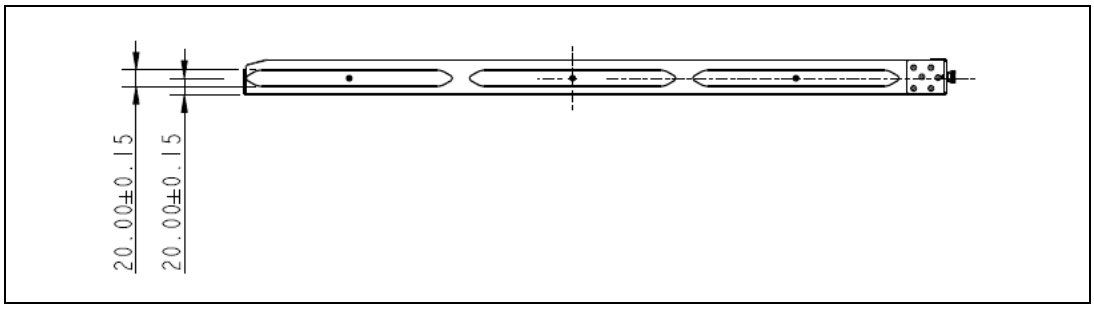
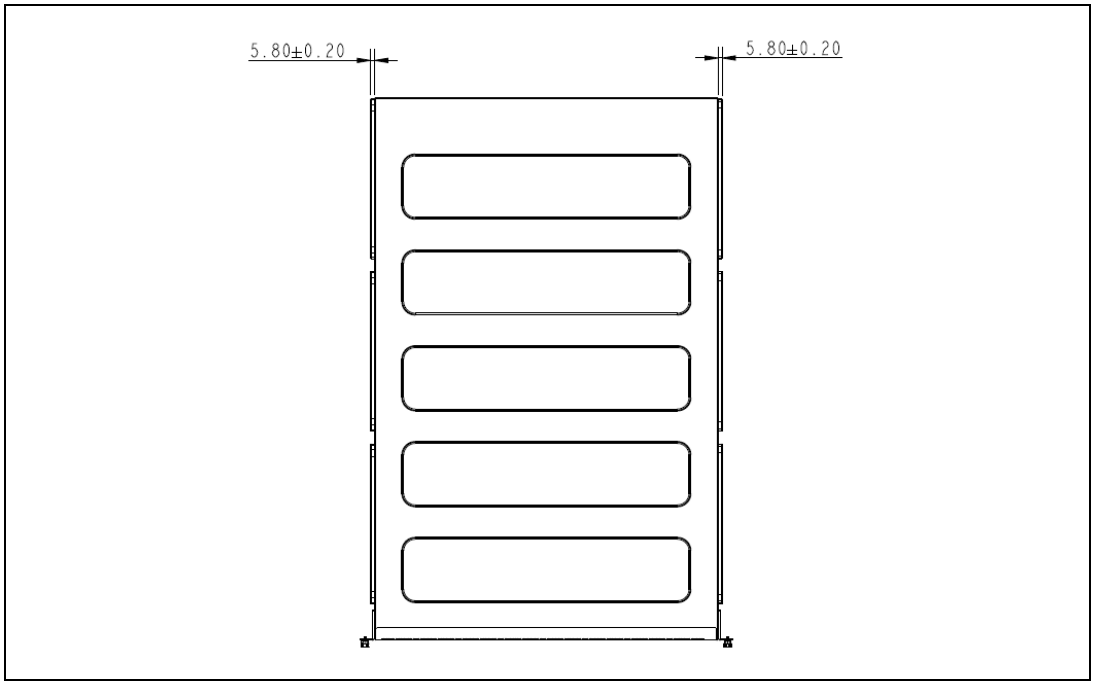


Figure 3-6. Slid Thickness for 1U Server



3.2 2U Server Chassis Dimensions

3.2.1 2U Server Chassis Dimensions

Figure 3-7. 2U Server Chassis Dimension (Top View)

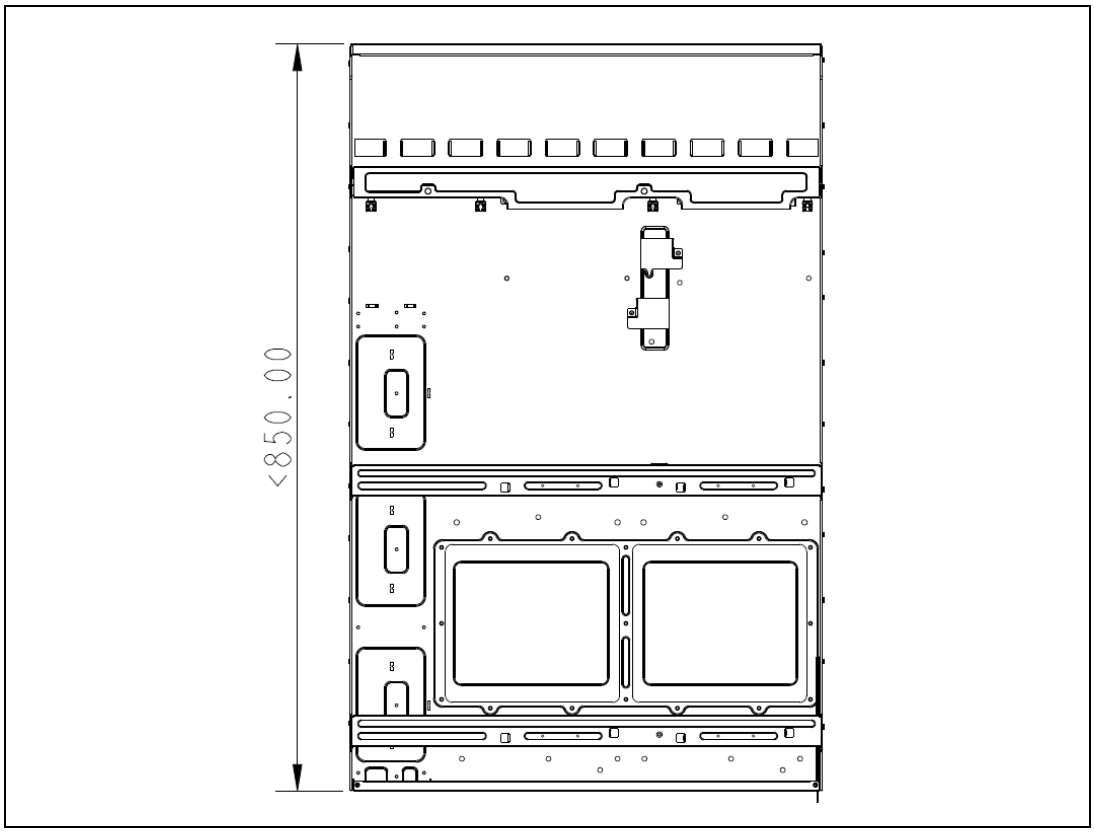
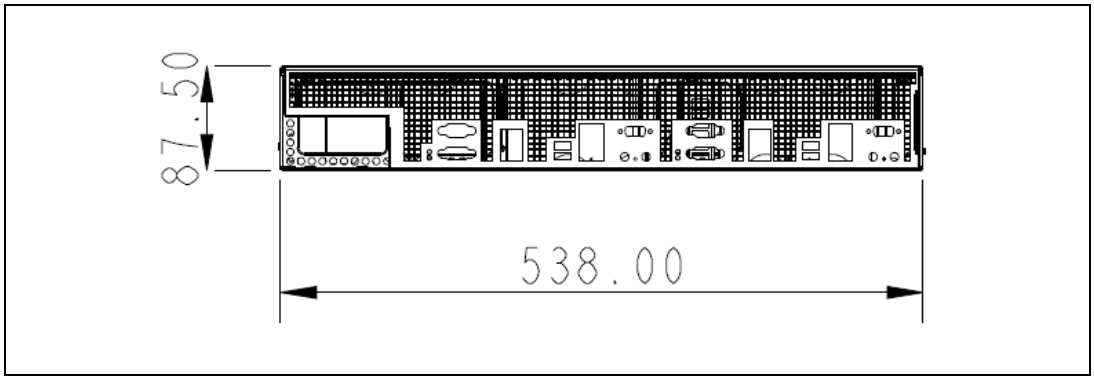


Figure 3-8. 2U Server Chassis Dimensions (Front View)



3.2.2 2U Server Chassis with Ear

Figure 3-9. 2U Server Chassis Dimensions with Ear (Front View)

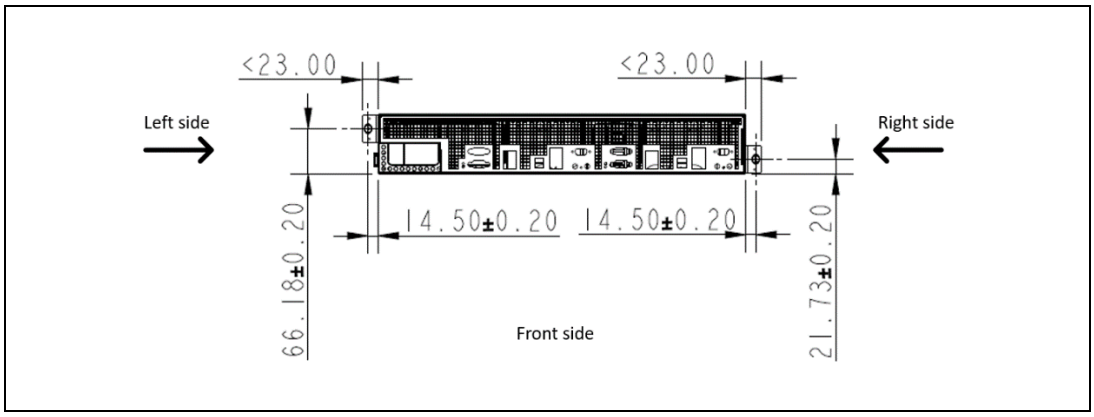


Figure 3-10. 2U Server Chassis Dimensions with Ear (Right-Side View)

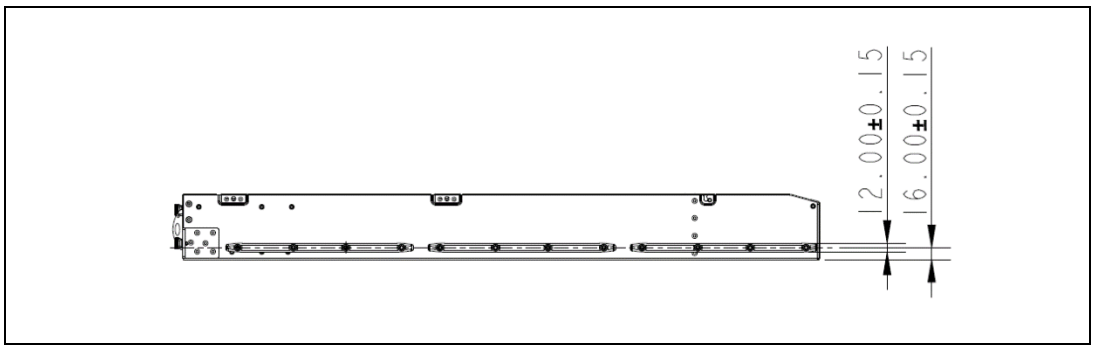


Figure 3-11. 2U Server Chassis Dimension with Ear (Left-Side View)

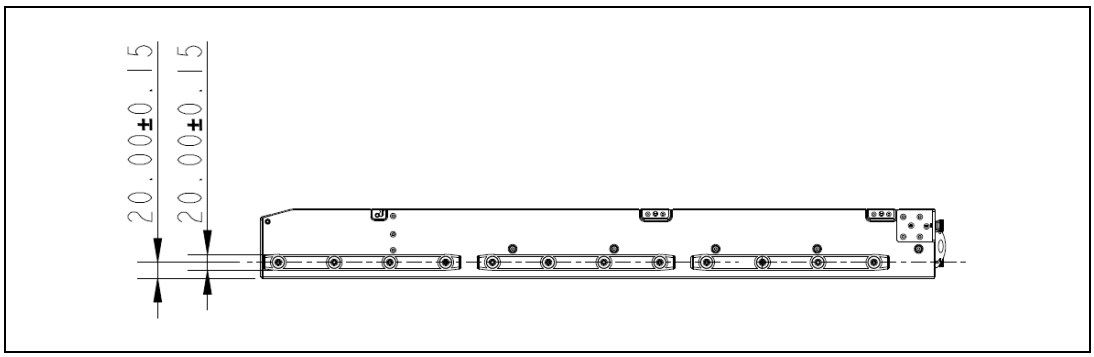
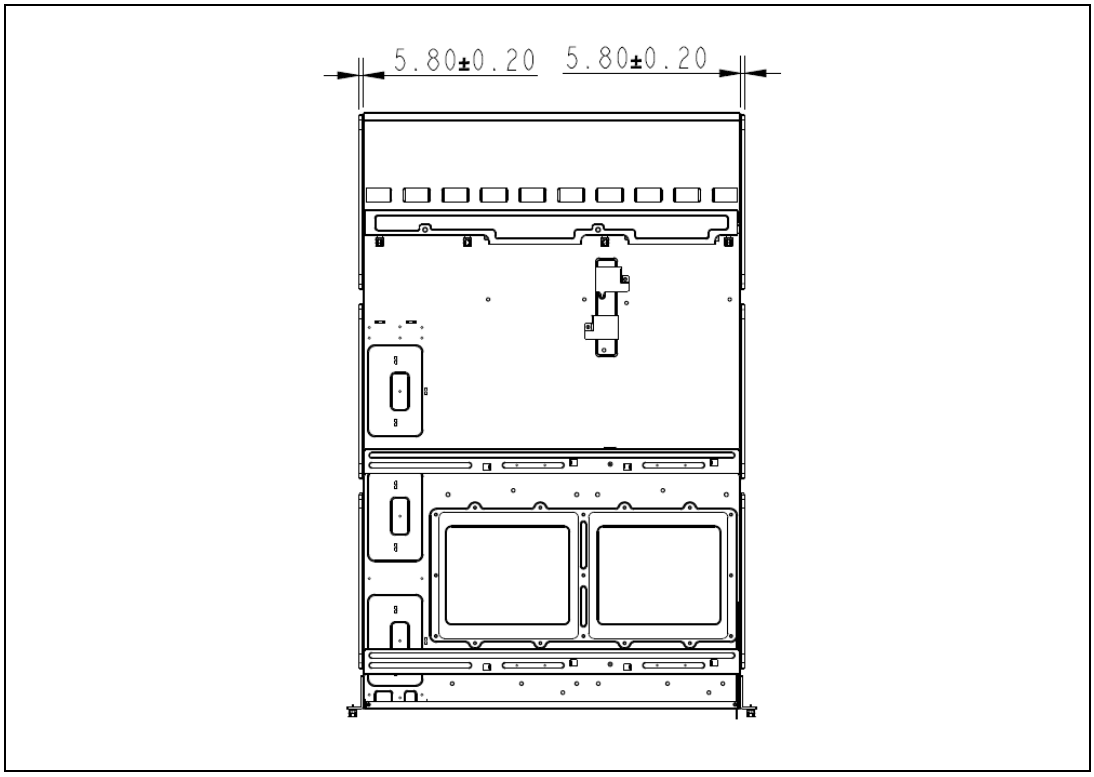


Figure 3-12. Slid Thickness for 2U Server

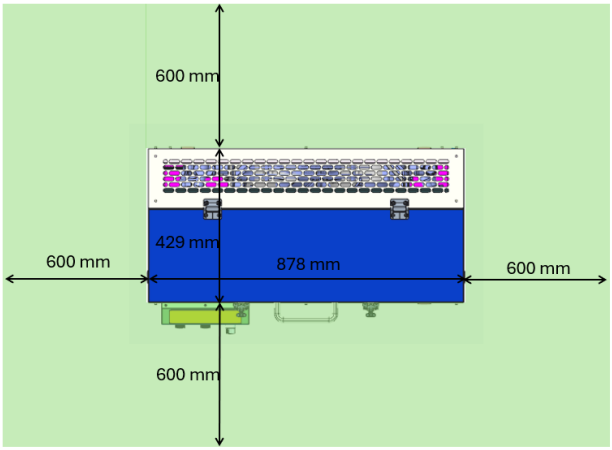


4 2U/4U AAIC Installation

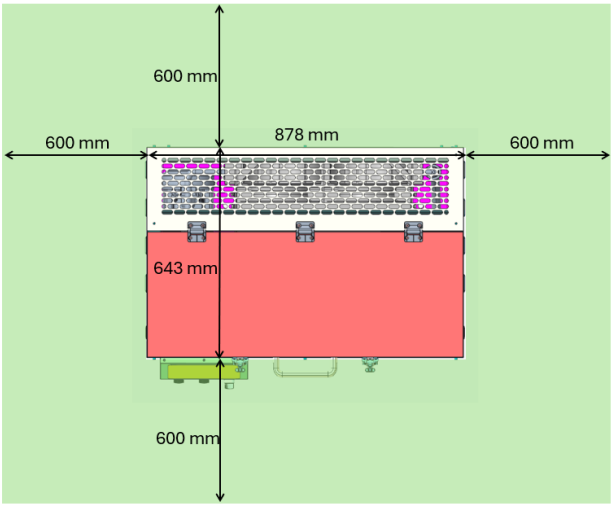
4.1 Precautions of 2U/4U AAIC Installation

1. Ensure that there is at least 2000 mm (W) × 2100 mm (L) space for the 2U/4U AAIC and ensure at least 1800 mm of height to ensure you can safely open with the top cover. See Figure 4-1 and Figure 4-2.

Figure 4-1. Space Requirements for the 2U/4U AAIC (Top View)

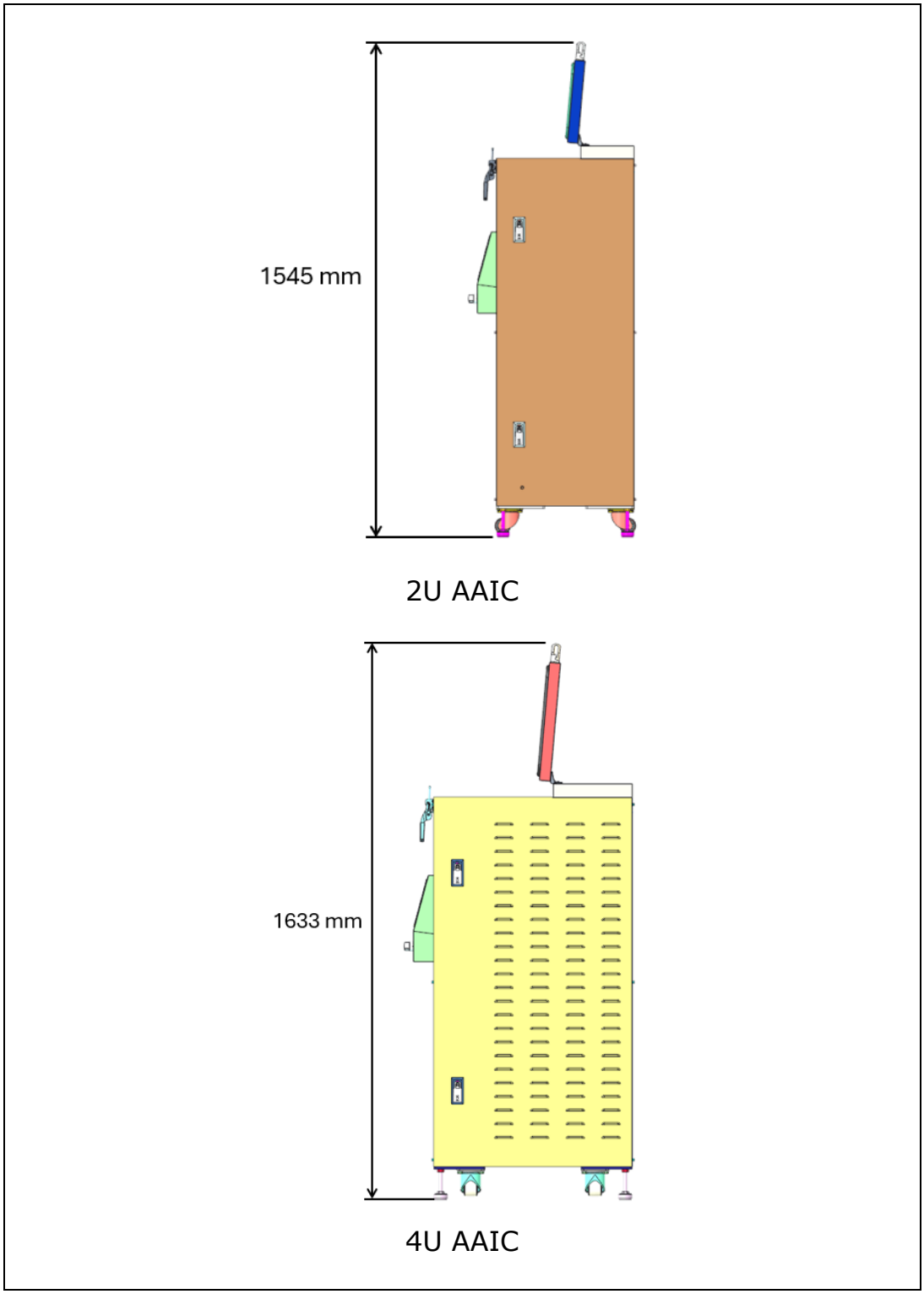


2U AAIC



4U AAIC

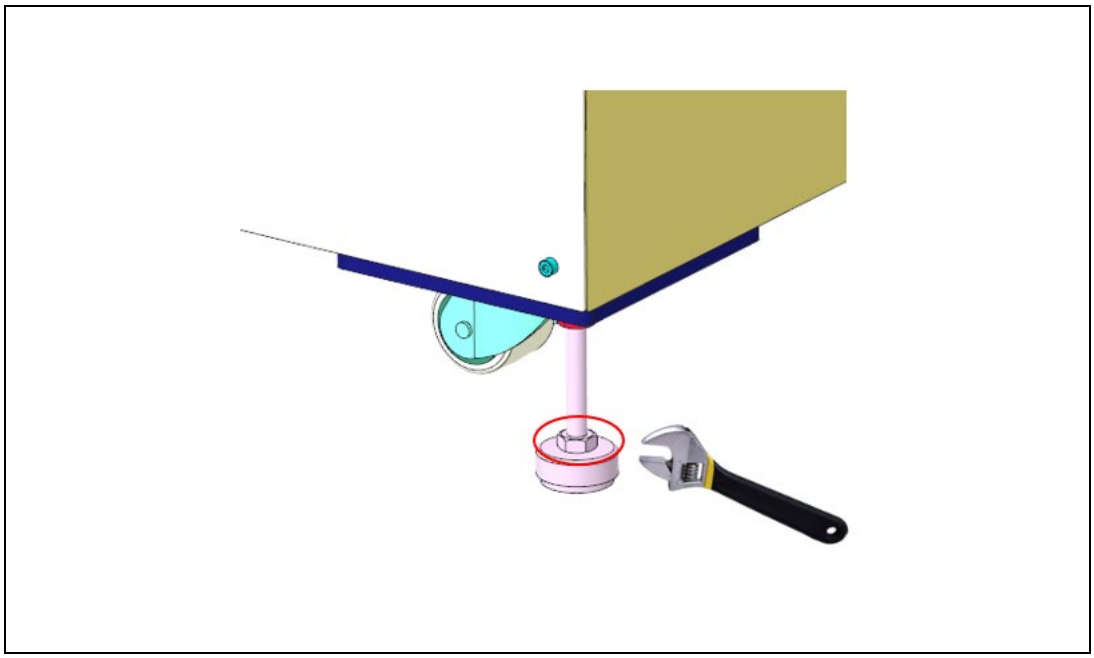
Figure 4-2. Space Requirements (Height) for the 2U/4U AAIC (Side View)



2. Ensure that the power can supply at least 30 kW.

3. Ensure that there is enough space (1000 mm [L] × 700 mm [W] × 1300 mm [H]) and no obstacles or doorsill higher than 30 mm when moving this 2U/4U AAIC.
4. After fixing the location of the 2U/4U AAIC, use a wrench to raise the 2U/4U AAIC until the casters do not touch the ground by adjusting the leveling feet.

Figure 4-3. Adjust Leveling Feet with a Wrench



5. Use the spirit levels placed in the two corners inside of the 2U/4U AAIC to confirm if it is horizontal or not and adjust it using the leveling feet.

Figure 4-4. Spirit Levels Placed in the Two Corners Inside of the 2U/4U AAIC (Top View)

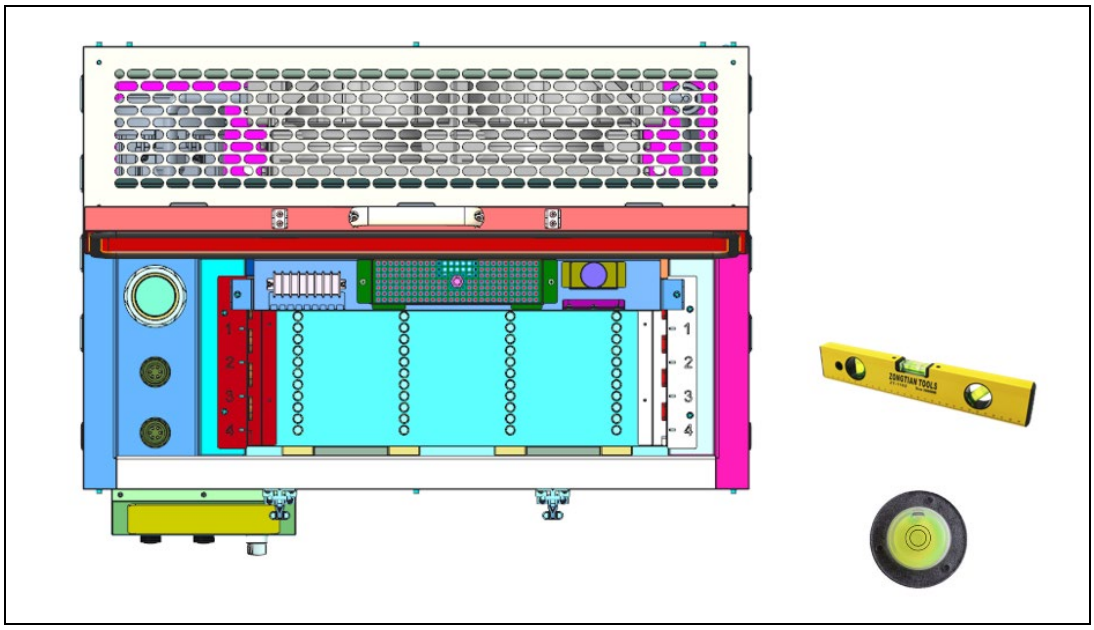


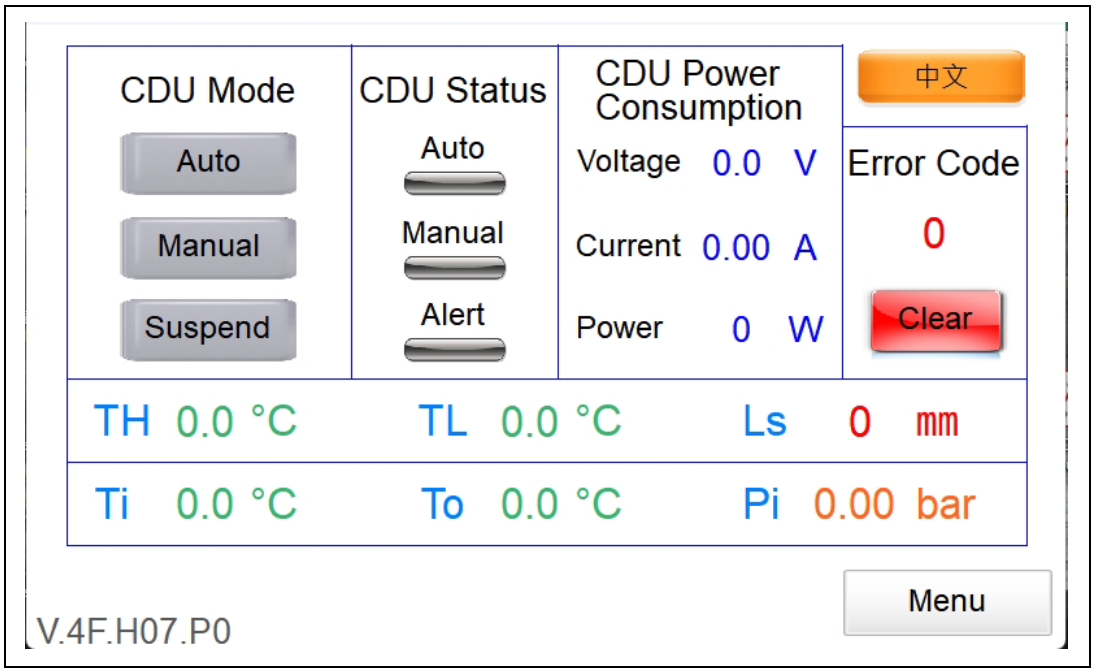
Figure 4-5. Spirit Level

5 Monitoring System Instruction

Note: The primary side (water side) must be operational before the system power on.

5.1 Home

Figure 5-1. Home Page

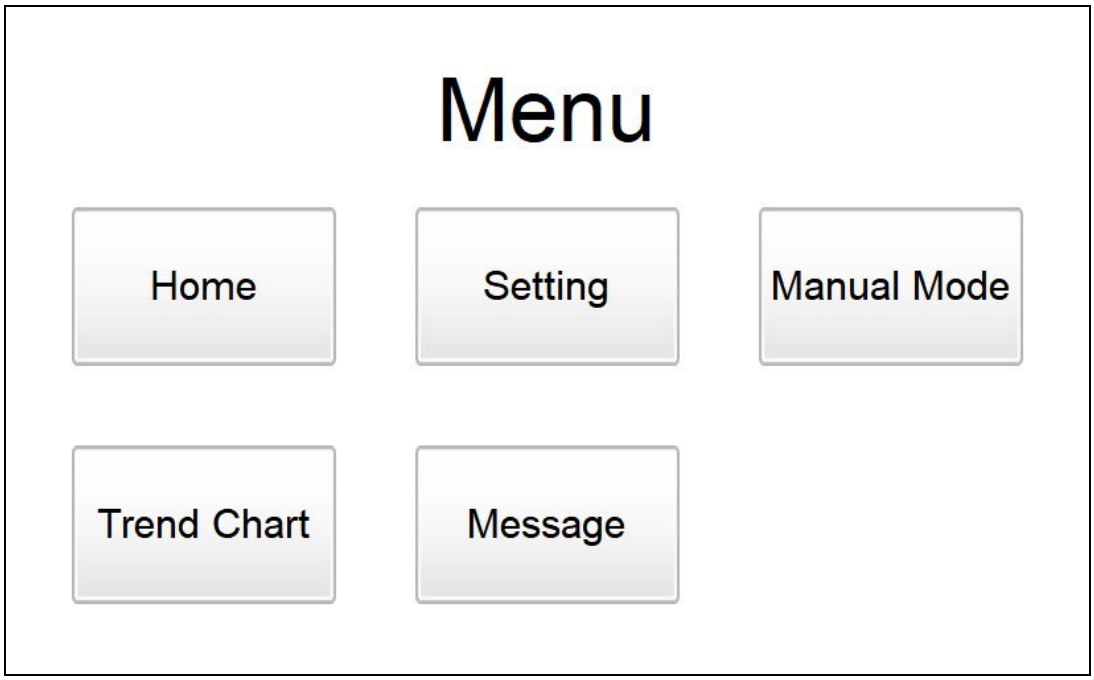


1. **CDU Operation Mode**: Use to switch CDU operation mode to **Automatic** or **Manual** or **Suspend.**
2. **CDU Status**: CDU's current operation mode.
3. **CDU Power Consumption**: Including the Voltage, Current, and Power information of the CDU.
4. **Error Code**: Displays the error code.
5. **Clear** button: Press to clear the error code.
6. **TH**: Displays the temperature of the coolant outlet from the tank.
7. **TL**: Displays the temperature of the coolant inlet to the tank.
8. **Ls**: Displays the coolant level.
9. **Ti**: Displays the inlet temperature of the plate heat exchanger.
10. **To**: Displays the outlet temperature of the plate heat exchanger.

11. **Pi**: Displays the pump outlet pressure.
12. **Menu** button: Press to go to the Menu page.
13. 中文 button: Press to switch from English to Chinese-Traditional.

5.2 Menu

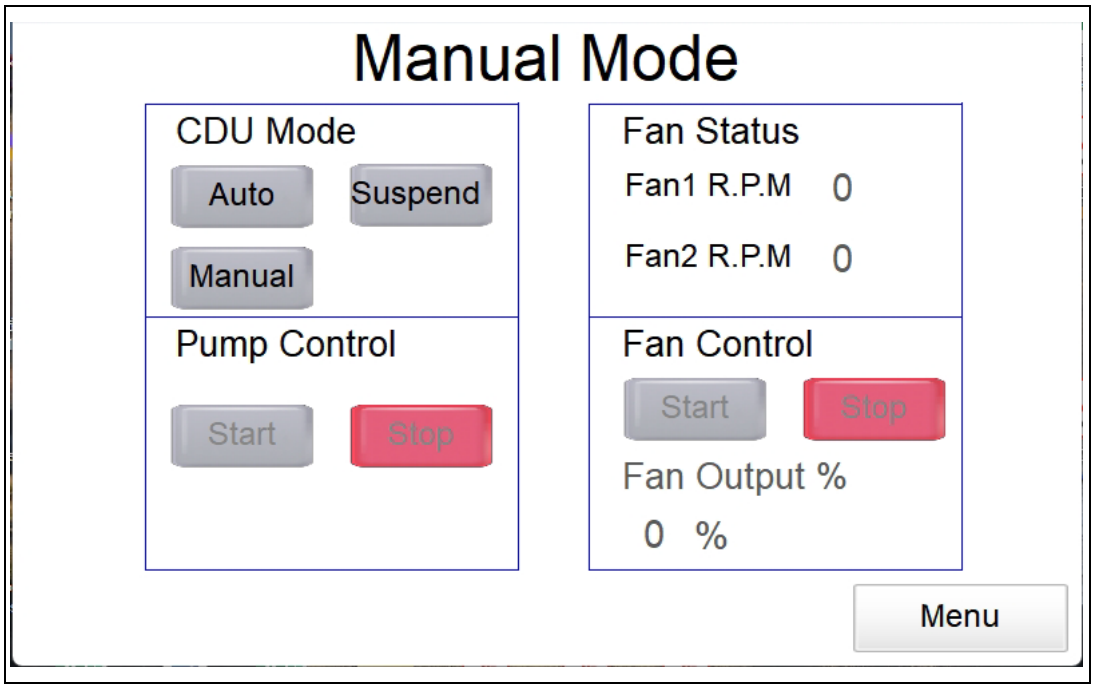
Figure 5-2. Menu Page



1. **Home**: Press to go to the **Home** page.
2. **Setting**: Press to go to the **Setting** page.
3. **Manual Mode**: Press to switch to the **Manual Mode** page.
4. **Trend Chart**: Press to see to **Trend Chart** page.
5. **Message**: Press to go to the **Message** page.

5.3 Manual Mode

Figure 5-3. Manual Mode Page

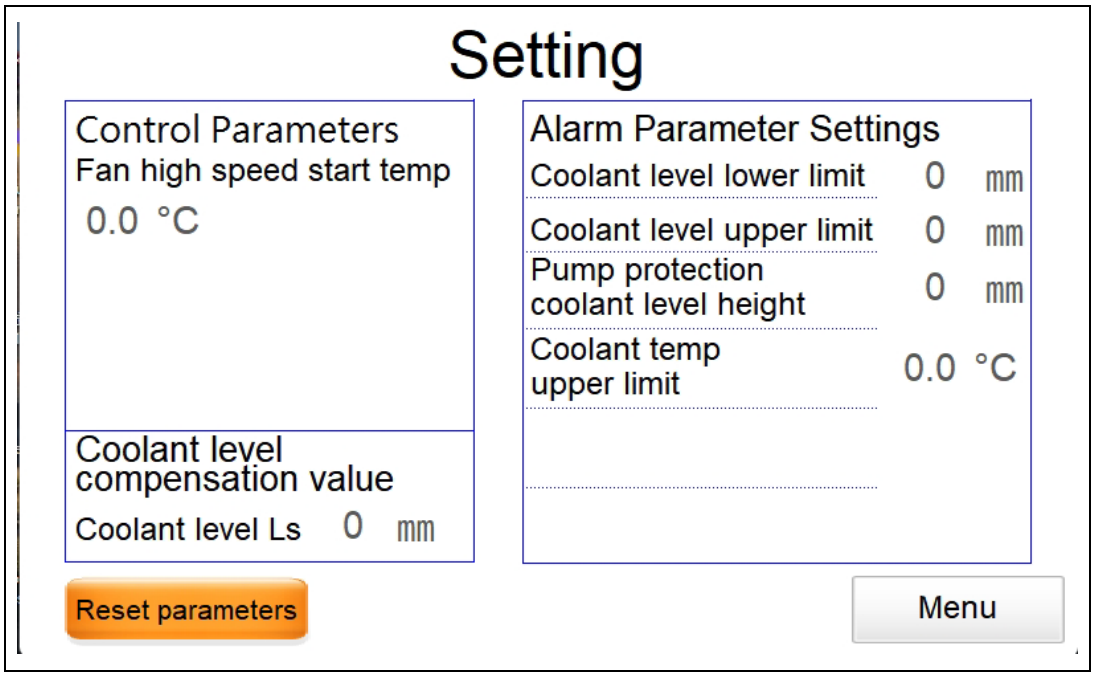


1. **CDU Operation Mode**: Switch CDU operation mode to **Automatic**, **Manual**, or **Suspend.**
2. **Pump Control**: Use this to set the pump frequency and start or stop the pump.
   a. Note: This can only be controlled in CDU manual mode.
   b. Note: The range of pump frequency is from 50 Hz to 200 Hz.
3. **Fan Status**: Press to display the fan status.
4. **Fan Control**: Press to start the fan control.
5. **Menu**: Press to go to the Menu page.

Note: Any modification of manual settings must be followed by entering your actual test results.

5.4 Setting

Figure 5-4. Setting Page

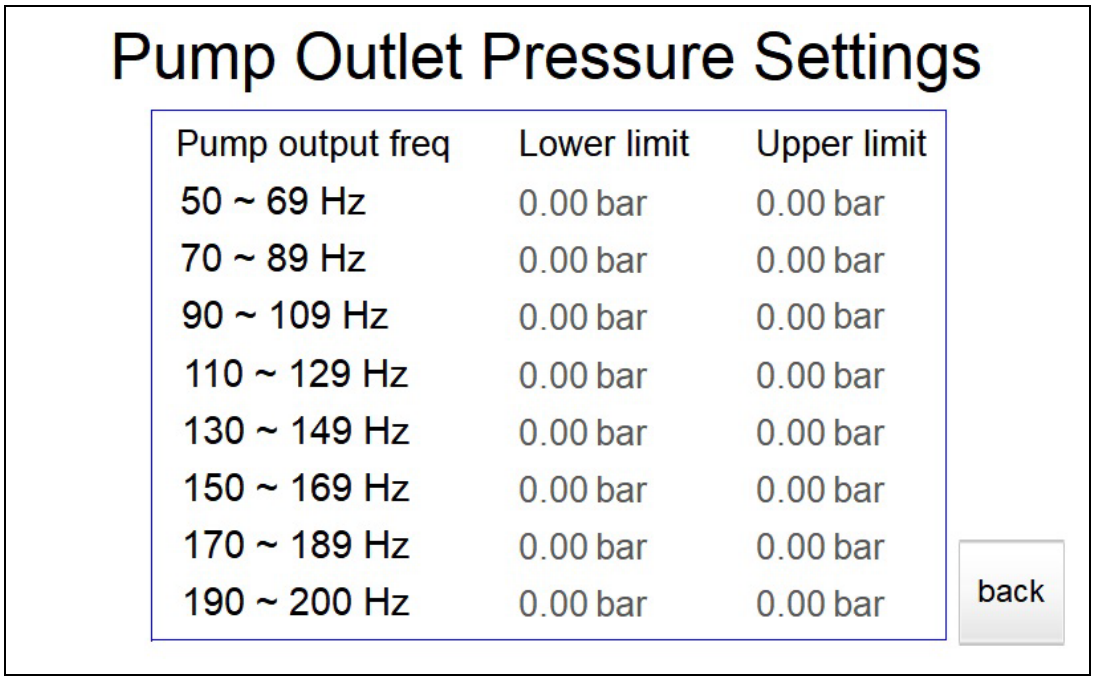


1. **Control Parameters Fan high speed start temp**: Read TH temperature; if it is above the setting value, the pump frequency starts to change. The default value is 40 °C.
2. **Coolant Level Compensation Value**: Calibration level sensor between Ls and tank inner scale. The default value is 766 mm.
3. **Alarm Parameter Settings**:
   a. **Coolant Level Lower Limit**: Alarm triggers when Ls is lower than the setting value. The default value is 910 mm.
   b. **Coolant Level Upper Limit**: Alarm triggers when Ls is higher than the setting value. The default value is 940 mm.
   c. **Pump Protection Coolant Level Height**: Alarm triggers when Ls is lower than the setting value and shuts down the pump operation. The default value is 900 mm.
   d. **Coolant Temperature Upper Limit**: Alarm triggers when TH, TL, Ti, or To are higher than the setting value. The default value is 50 °C.
   e. **Menu** button: Press to go to the Menu page.

Note: Any modification to the manual settings must be followed by entering your actual test results, and they are responsible for the side effects caused by themselves.

5.5 Pump Outlet Pressure Settings

Figure 5-5. Pump Outlet Pressure Settings Page



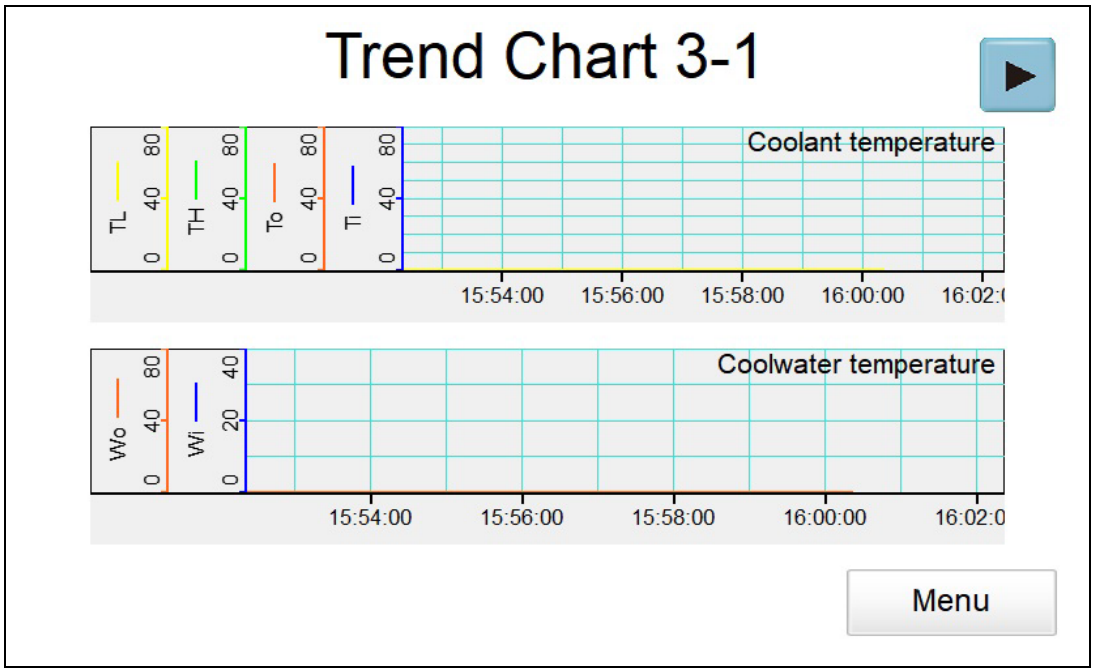
1. Set the pump operating frequency range; the pump outlet Pi pressure value is too low and too high to monitor the set value.
2. The pump outlet Pi pressure value is below the set value to trigger an alarm.
3. The pump outlet Pi pressure value is above the high set value to warn.

Notes:

- Pump outlet pressure monitoring alarm, in automatic mode only.
- Any modification of manual settings must be followed by entering your actual test results.

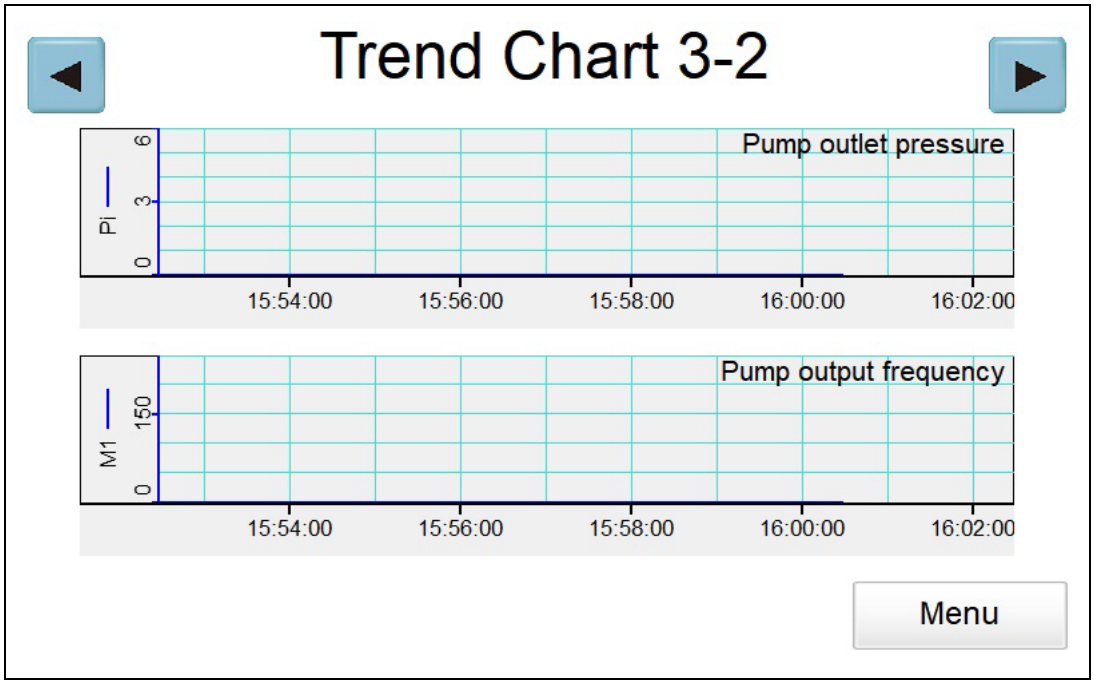
5.6 Trend Chart

Figure 5-6. Trend Chart 3-1



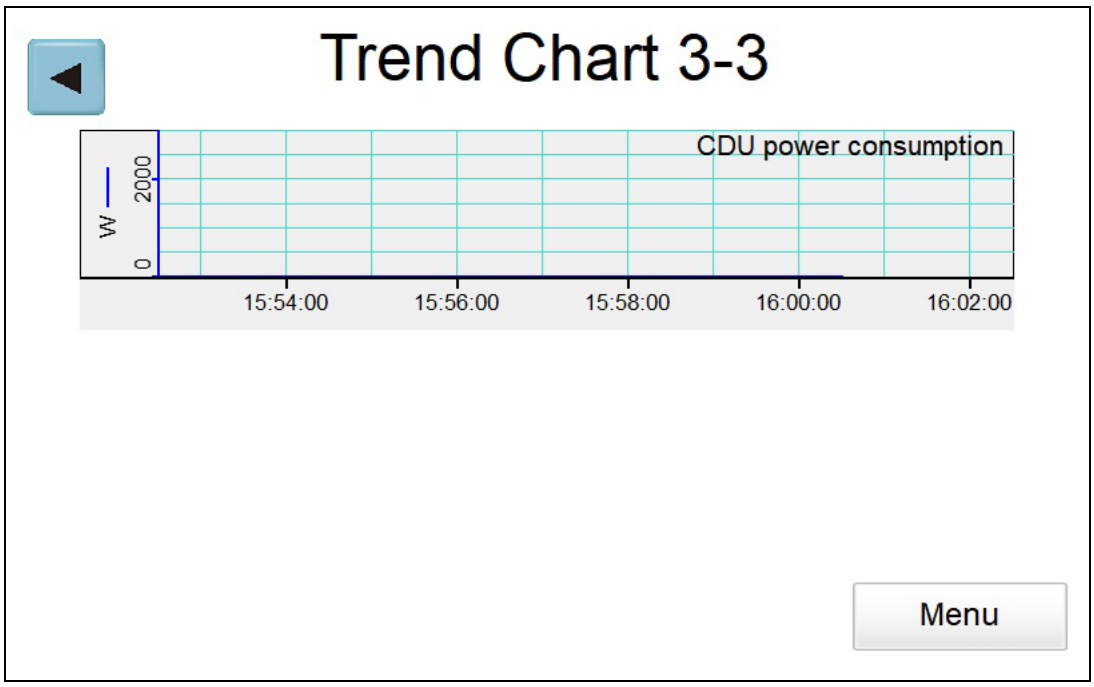
1. **Coolant temperature** trend chart: Displays coolant temperature (TL, TH, Ti, and To).
2. **Coolwater temperature** trend chart: Displays cooling water temperature (Wi and Wo).
3. **Menu** button: Press to go to the Menu page.

Figure 5-7. Trend Chart 3-2



1. **Pump outlet pressure** trend chart: Displays pressure value (Pi).
2. **Pump output frequency** trend chart: Displays Pump output frequency (M1).
3. **Menu** button: Press to go to the Menu page.

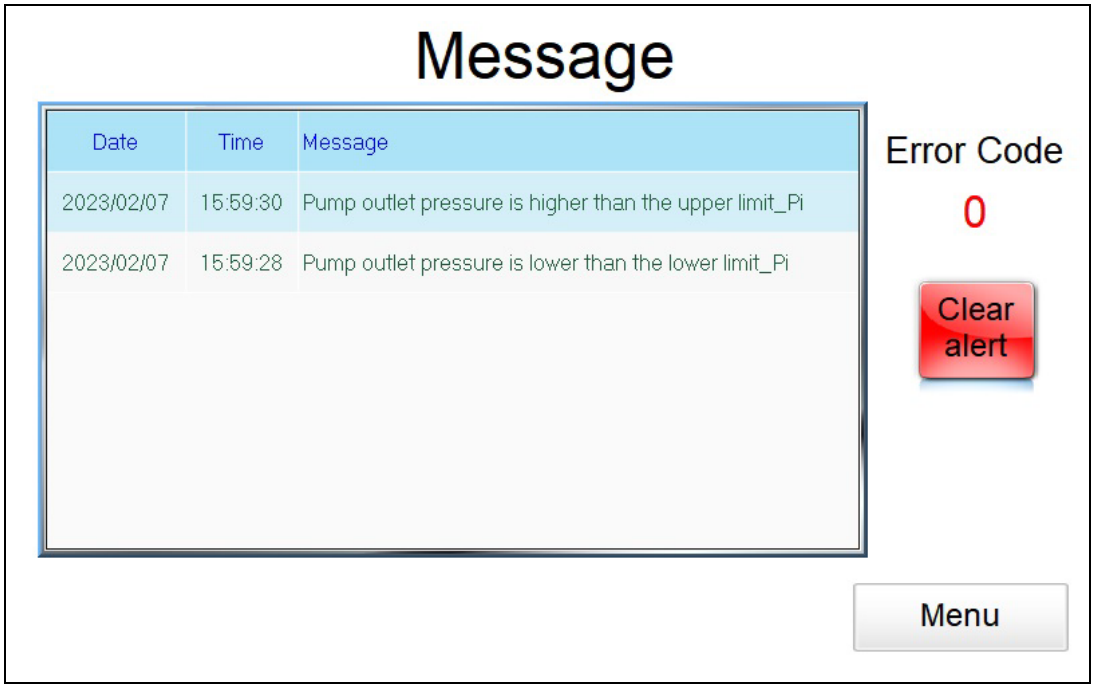
Figure 5-8. Trend Chart 3–3



1. **CDU power consumption** trend chart: Displays CDU power consumption.
2. **Menu** button: Press to go to the Menu page.

5.7 Message

Figure 5-9. Message Page



1. **Message**: Displays the system error alert message.
2. **Error Code**: Displays the system error code.
3. **Clear Alert** button: Press to dismiss the alert and clear the error code.
4. **Menu** button: Press to go to the Menu page.

5.8 Error Code

Table 5-1. Summary Table of Alert Messages

Error Code	Message	Alert	Stop Pump	Stop Running
1	EMO	v	v	v
20	Low coolant level warning	v		
21	High coolant level warning	v		
25	Pump protection liquid level height warning	v	v	v
32	Pi pressure sensor abnormal	v	v	
50	Pump inverter warning	v	v	v

Error Code	Message	Alert	Stop Pump	Stop Running
55	Pump overload warning	v	v	
60	TH temperature sensor is abnormal	v		
61	TL temperature sensor abnormal	v		
62	Ti temperature sensor abnormal	v		
63	To temperature sensor abnormal	v		
80	Upper limit coolant temperature	v		
90	The power meter is abnormal	v		

5.9 Default Value

Table 5-2. Summary Table of Default Value

Control Item	Default Value	Unit
Fan high-speed temperature setting	40	°C
Fan maximum speed output percentage (cannot be modified)	90	%
Fan minimum speed output percentage (cannot be modified)	15	%
Coolant-level compensation value	766	mm
Coolant level lower limit	910	mm
Coolant level upper limit	940	mm
Pump protection coolant level height	900	mm
Coolant Temperature Upper Limit	50	°C
Pump pressure lower limit (cannot be modified)	0.0	bar
Pump pressure upper limit (cannot be modified)	4.0	bar

Note: Users can freely modify the setting values, but they are responsible for any side effects caused by these modifications.

6 Common Troubleshooting

6.1 2U/4U AAIC Inside Sensors Alarm

6.1.1 Coolant Level Sensor Alarm

6.1.1.1 Coolant Height Limit Warning

1. The sensor will trigger the warning and pop-up warning window.
2. Confirm whether the coolant exceeds the limit. If the coolant exceeds the limit, go to step 3. If the coolant does not exceed the limit, then check section 6.1.1.2.
3. If the coolant level is below the lower limit, refill the coolant directly. If it exceeds the upper limit, we need to determine whether the CDU system is abnormal.

6.1.1.2 Coolant Level Sensor Failure Warning

1. Check whether the sensor wire is abnormal. If the sensor wire is functional, go to step 2.
2. Check whether the monitoring system is abnormal. If the monitoring system is functional, go to step 3.
3. Replace the coolant level sensor.

6.1.2 Temperature Sensor Monitoring and Alarm

6.1.2.1 Temperature of the Coolant Exceeds the Limit

When the coolant temperature reaches the upper limit:

1. Increase the CDU Pump frequency.
2. If the temperature keeps increasing, check whether the circulation system and various parts are abnormal.

When the coolant temperature reaches the lower limit:

1. Suspend the CDU cooling water entering the tank.

6.1.2.2 Alarm when the Temperature Sensor Fails

When the temperature sensor signal is abnormal:

1. Check whether the temperature sensor wire is abnormal. If the sensor wire is functional, go to step 2.

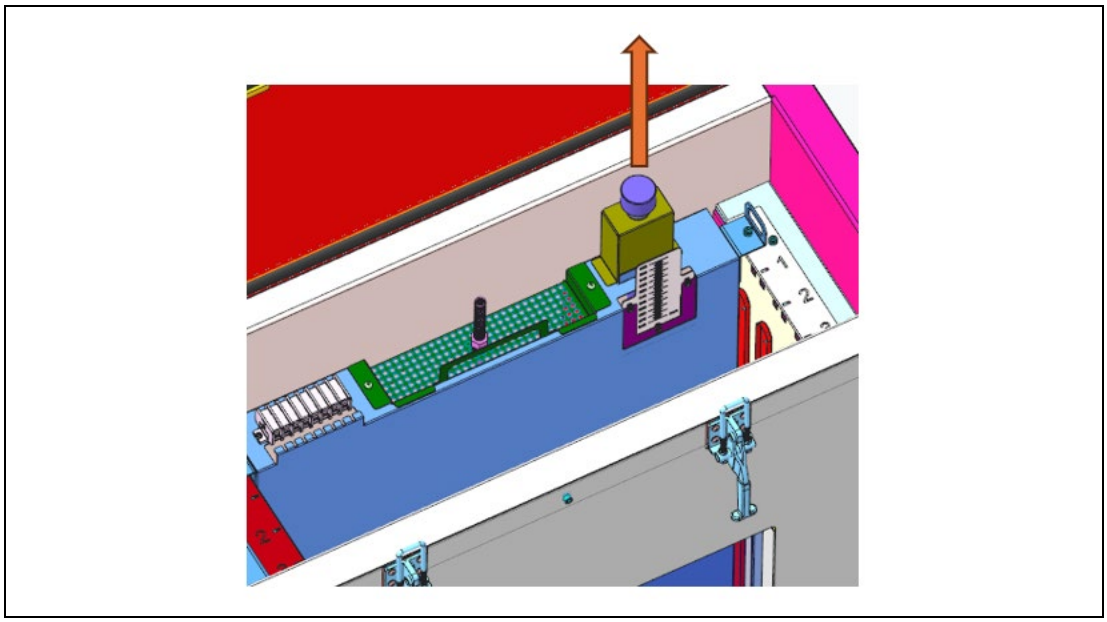
2. Confirm whether the monitoring system is functional. If the monitoring system is functional, go to step 3.
3. Replace the temperature sensor.

6.1.3 Replace the Coolant Level Sensor or Temperature Sensor

6.1.3.1 Coolant Level Sensor Replacement Procedure

1. Verify the failed coolant level sensor.
2. Disconnect the coolant level sensor wire from the terminal blocks.
3. Turn the level sensor counterclockwise to remove it.

Figure 6-1. Take Out the Level Sensor



4. Replace with a new liquid level sensor.
5. Plug the signal wires back into the terminal blocks.
6. Test the coolant level sensor function.

6.1.3.2 Temperature Sensor Replacement Procedure

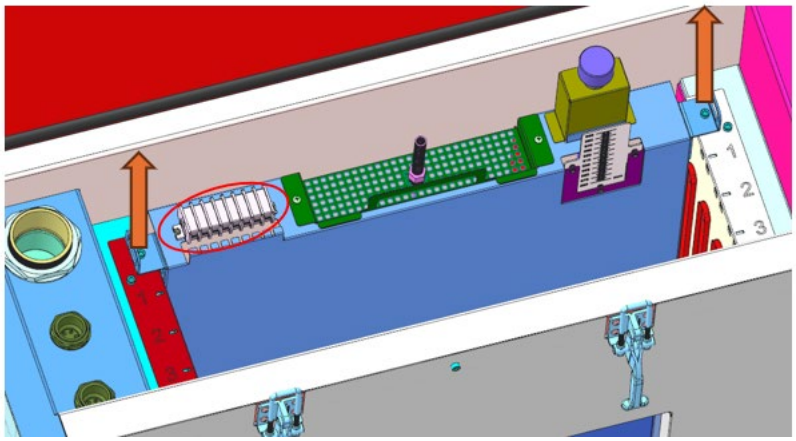
1. Identify the failed temperature sensor since there are two conditions: a) and b).

a) If the failed temperature sensor is a coolant inlet temperature sensor:

2. Disconnect the temperature sensor wire from the terminal blocks, as shown in the red circle in the following figure.

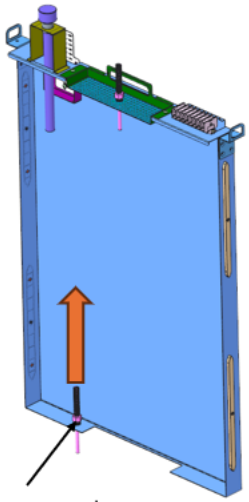
3. Remove the sensor tray fixing screws and take the sensor tray out of the tank.

Figure 6-2. Take Out the Sensor Tray



4. Use the hexagon wrench to remove the screw of the coolant inlet temperature sensor.

Figure 6-3. Remove the Screw of Coolant Inlet Temperature Sensor



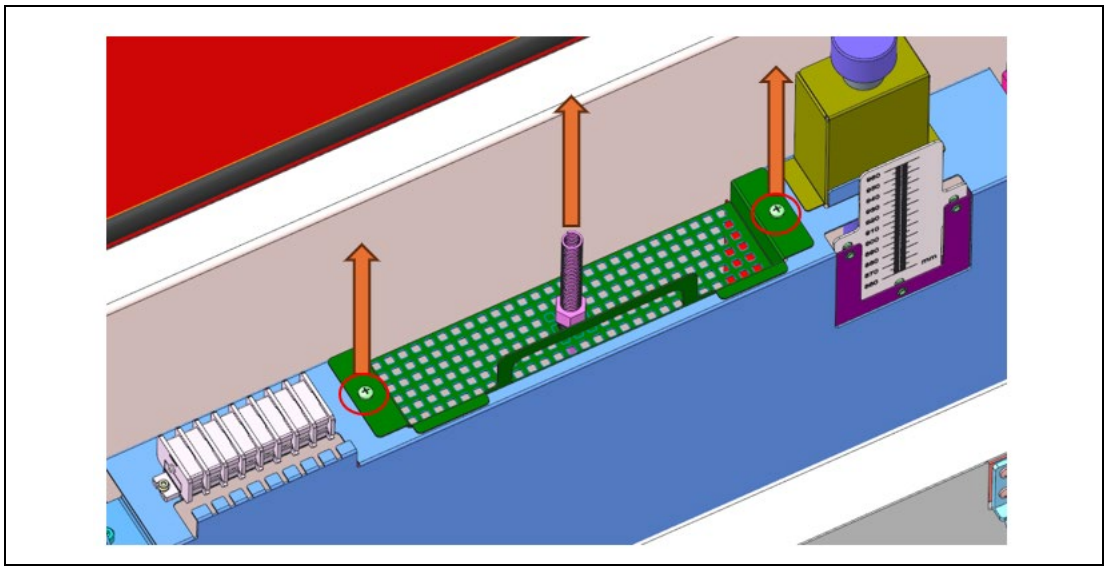
5. Replace with a new temperature sensor.
6. Insert the sensor tray back into the tank and tighten the screws.
7. Plug the temperature sensor signal wire back into the terminal blocks.
8. Check that the temperature sensor works correctly.

b) If the failed temperature sensor is a coolant outlet temperature sensor:

2. Disconnect the temperature sensor wire from the terminal blocks.

3. Remove the screws on the filter cover and remove the filter cover from the tank.

Figure 6-4. Remove the Screw and Take Out the Filter Cover



4. Screw out the failed temperature sensor and replace it.
5. Put the replaced filter of the temperature sensor back into the tank and lock it.
6. Plug the temperature sensor signal wire back into the terminal blocks.
7. Check that the temperature sensor works correctly.

6.2 2U/4U AAIC Maintenance

6.2.1 Coolant Recycle

1. Prepare a container of coolant.
2. Turn off the CDU and make sure that the CDU's pump has stopped functioning.
3. Then, pump the coolant into the coolant recycle container.

6.2.2 Coolant Refill

1. Refill the coolant directly from above to the desired coolant height.
2. Turn on the CDU and run it to ensure coolant refills above the filter cover.

6.2.3 Replace the Top Cover Sealant Strip

1. Open the top cover and use scissors to remove the top cover strip firmly.
2. Take an appropriate length strip and remove the adhesive backing.

3. Glue the strip to the top cover.
4. Finally, Shin-Etsu* glue is used to glue the breaking point of the rubber strip.
5. Test the top cover is closed at least three times and opened to see if the adhesive bead is normal.

6.2.4 Replace the Cable Gland

1. Open the top cover.
2. Remove the cable gland on the server side that needs to be replaced.
3. Remove the cable from the cable gland.
4. Replace with a new cable gland.
5. Put the new cable gland back in place.
6. Plug the cable back into the appropriate server.

6.3 Troubleshooting

Table 6-1. Troubleshooting

Fault Phenomenon	Inspection	Implication	Action
Coolant inlet temperature abnormality	1. Check if the wiring is loose. 2. Is the fluid temperature too high?	1. Caused by maintenance or vibration. 2. Exceeding system cooling capacity. 3. Cooling system fails. 4. The temperature sensor is damaged.	1. Reconnect loose wires. 2. Select the appropriate server system. 3. Check the cooling system. 4. Replacement parts.
Coolant outlet temperature abnormality	1. Check if the wiring is loose. 2. Is the fluid temperature too high?	1. Caused by maintenance or vibration. 2. Primary side cooling system abnormality. 3. The coolant level is too low, and the pump stops. 4. The temperature sensor is damaged.	1. Reconnect loose wires. 2. Replenishing coolant. 3. Replacement Parts.
Coolant level abnormality	1. Confirm that the system is powered on. 2. Is there a warning on the man-machine interface? 3. Is the pipeline leaking?	1. Power supply or wiring abnormality. 2. Insufficient coolant in tank or pipeline. 3. The pipeline is loose or broken.	1. Reconnect loose wires or replace parts. 2. Replenishing coolant. 3. Reconnect the pipeline or replace the pipe fittings.

Fault Phenomenon	Inspection	Implication	Action
Pump outlet pressure abnormality	1. Check if the wiring is loose. 2. Is the pump running?	1. Caused by maintenance or vibration. 2. Fluctuating or low liquid level causes the pump to start and stop frequently. 3. The pressure gauge is damaged.	1. Reconnect loose wires. 2. Replenishing coolant. 3. Replacement parts.
Pump will not start	1. Check if the wiring is loose. 2. Coolant level is too low.	1. Power supply or wiring abnormality. 2. Loss of coolant.	1. Reconnect loose wires. 2. System normal protection mechanism.
Temperature sensor abnormality	1. Check if the wiring is loose. 2. Is the sensor damaged?	1. Caused by maintenance or vibration. 2. The temperature sensor is damaged.	1. Reconnect loose wires. 2. Replacement parts.
Fan of CDU abnormality	1. Check if the wiring is loose. 2. Is the fan of CDU running?	1. Power supply or wiring abnormality. 2. The fan of CDU is damaged.	1. Reconnect loose wires. 2. Replacement parts.