



MX2000 Pro

LED Display Controller



User Manual

Change History

Document Version	Release Date	Description
V1.1.1	2023-10-13	Updated input cards information
V1.1.0	2023-09-28	Added information for DP 1.2, HDMI 2.1 and 12G-SDI input cards
V1.0.0	2023-09-08	First release

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1 Introduction

The MX2000 Pro is a large professional 8K LED display controller from Xi'an NovaStar Tech Co., Ltd. (hereinafter referred to as NovaStar), designed as part of the COEX control system series. Its remarkable features include 12-bit color depth, 360 Hz capability, real-time multi-screen scaling, 0-frame latency, and HDR supportability, providing precise brightness control, true-to-life color fidelity, and an excellent image quality. Its card-based modular design is specifically tailored for future LED displays, allowing for flexible input and output card configurations that are stable and easy to maintain. With a compact 2U size, it supports up to 8x 4K or 4x 8K video inputs, with a maximum load capacity of 35.38 million pixels, making it ideal for large-screen configurations.

The MX2000 Pro supports up to 5 types of 8K/4K input cards. Additionally, it supports seamless backup and automatic switching between devices and cards. In case of any malfunction, it promptly switches over while issuing automatic alerts, ensuring stable output on-site. It can also work with the brand-new software VMP (Vision Management Platform) to provide a better operation and control experience.

The MX2000 Pro offers many advantages such as highly integrated design, premium image quality, powerful performance, tremendous load capacity, and easy control. It is widely used in rental services for large events, xR/VP studios, large fixed installation applications, TV production, e-sports events, exhibition halls, and other application scenarios.

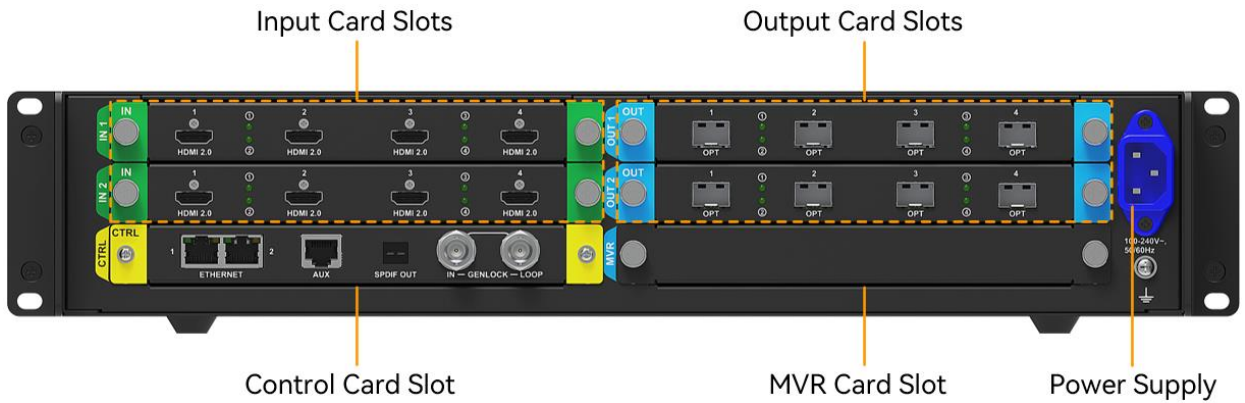
2 Appearance

2.1 Front Panel



Description	Function
Running indicator	<ul style="list-style-type: none"> • Solid red: The device is in standby mode. • Solid blue: The device is being powered on. • Solid green: The device is running normally. • Flashing red: The device is running abnormally.
Standby button	<ul style="list-style-type: none"> • Press the button to power on or power off the device. • Hold down the button for 5s to 10s to restart the device.
USB 2.0	<ul style="list-style-type: none"> • For exporting the device diagnostic result to a USB drive only. • Only the NTFS and FAT32 file systems are supported. Others are not supported.
IPS Touchscreen	A 5-inch screen that is for displaying the device status, configuring settings, and sending commands.
Knob	<ul style="list-style-type: none"> • On the home screen, press the knob to enter the main menu screen. • On the main menu screen, rotate the knob to select a menu item or adjust the parameter value. Press the knob to confirm the operation. • Hold down the knob and BACK button simultaneously for 5s or longer to lock or unlock the buttons and screen.
BACK	Go back to the previous menu or cancel the current operation.

2.2 Rear Panel



All product pictures shown in this document are for illustration purpose only. Actual product may vary.

Note

Markings on the rear panel card slot:

- The card slot marked with "IN x" only supports the installation of input cards, where x is the slot number. For example, IN 1 indicates the first input card slot.
- The card slot marked with "OUT x" only supports the installation of output cards, where x is the slot number. For example, OUT 2 indicates the second output card slot.
- The card slot marked with "MVR" only supports the installation of MVR output card. (Reserved)
- The card slot marked with "CTRL" only supports the installation of control cards.

Input Card			
MX_4×HDMI 2.0 input card			
Type	Qty	Description	
HDMI 2.0	4	Resolution	Max resolution: 4096×2160@60Hz or 8192×1080@60Hz (Forced) Min resolution: 800×600@60Hz
		Max width/height (Forced)	Max width: 8192 pixels (8192×1080@60Hz) Max height: 8192 pixels (1080×8192@60Hz)
		Frame rates	23.98 / 24 / 25 / 29.97 / 30 / 47.95 / 48 / 50 / 59.94 / 60 / 71.93 / 72 / 75 / 100 / 119.88 / 120 / 143.86 / 144 / 240 Hz

	HDR	Support HDR10 and comply with the SMPTE ST 2084 and SMPTE ST 2086 standards. Support HLG.
	EDID management	Support standard resolutions, up to 3840×2160@60Hz. Support custom input resolutions.
	HDCP	HDCP 2.3 compliant, backwards compatible with HDCP 2.2/HDCP 1.4/HDCP 1.3.
	Interlaced signal inputs	Not supported

MX_2×HDMI 2.1 input card



Type	Qty	Description	
HDMI 2.1	2	Resolution	Max resolution: 8192×4320@30Hz (Forced) Min resolution: 800×600@60Hz
		Max width/height (Forced)	Max width: 8192 pixels (8192×4320@30Hz) Max height: 8192 pixels (4320×8192@30Hz)
		Frame rates	23.98 / 24 / 25 / 29.97 / 30 / 47.95 / 48 / 50 / 59.94 / 60 / 71.93 / 72 / 75 / 100 / 119.88 / 120 / 143.86 / 144 / 240 Hz
		HDR	Support HDR10 and comply with the SMPTE ST 2084 and SMPTE ST 2086 standards. Support HLG.
		EDID management	Support standard resolutions, up to 3840×2160@60Hz. Support custom input resolutions.
		HDCP	HDCP 2.3 compliant, backwards compatible with HDCP 2.2/HDCP 1.4/HDCP 1.3.
		Interlaced signal inputs	Not supported

MX_4×DP 1.2 input card



Type	Qty	Description	
DP 1.2	4	Resolution	Max resolution: 4096×2160@60Hz or 8192×1080@60Hz (Forced) Min resolution: 800×600@60Hz
		Max width/height (Forced)	Max width: 8192 pixels (8192×1080@60Hz) Max height: 8192 pixels (1080×8192@60Hz)
		Frame rate	23.98 / 24 / 25 / 29.97 / 30 / 47.95 / 48 / 50 / 59.94 / 60 / 71.93 / 72 / 75 / 100 / 119.88 / 120 / 143.86 / 144 / 240 Hz
		HDR	Support HDR10 and comply with the SMPTE ST 2084 and SMPTE ST 2086 standards. Support HLG.
		EDID management	Support standard resolutions, up to 3840×2160@60Hz. Support custom input resolutions.
		HDCP	Support HDCP 2.3, backwards compatible with HDCP2.2/ HDCP 1.4/ HDCP 1.3.
		Interlaced signal inputs	Not supported.

MX_2×DP 1.4 input card



Type	Qty	Description	
DP 1.4	2	Resolution	Max resolution: 7680×4320@30Hz (Forced) Min resolution: 800×600@60Hz
		Max width/height (Forced)	Max width: 8192 pixels (8192×4320@25Hz) Max height: 8192 pixels (4320×8192@25Hz)
		Frame rates	23.98 / 24 / 25 / 29.97 / 30 / 47.95 / 48 / 50 / 59.94 / 60 / 71.93 / 72 / 75 / 100 / 119.88 / 120 / 143.86 / 144 / 240 Hz
		HDR	Support HDR10 and comply with the SMPTE ST 2084 and SMPTE ST 2086 standards. Support HLG.

	EDID management	Support standard resolutions, up to 3840×2160@60Hz. Support custom input resolutions.
	HDCP	HDCP 2.3 compliant, backwards compatible with HDCP 2.2/HDCP 1.4/HDCP 1.3.
	Interlaced signal inputs	Not supported

MX_4×12G-SDI input card




Type	Qty	Description	
12G-SDI	4	Standards	Support ST-2082 (12G), ST-2081 (6G), ST-424 (3G) and ST-292 (HD) standard video inputs. Support 3G-Level A/Level B (DS mode).
		Resolution	Max resolution: 4096×2160@60Hz
		Frame rate	Support frame rates up to 60 Hz.
		HDR	Support HDR10 and comply with the SMPTE ST 2084 and SMPTE ST 2086 standards. Support HLG.
		Interlaced signal inputs	Support converting interlaced signals to progressive signals.
		Others	Belden 12G SDI standard cables are recommended. Cables up to 50 meters are supported.

Output Card

MX_4×10G_Fiber output card



Type	Qty	Description	
OPT 1-4	4	10G optical ports	<ul style="list-style-type: none"> Support single-mode and multi-mode optical fiber modules, with a maximum transmission distance of 10km.

		<ul style="list-style-type: none"> • A single optical port has the same load capacity of 10x 1G Ethernet ports, and a single card supports up to 40x Ethernet port outputs. • The maximum load of a single 1G Ethernet port is as follows, please refer to 8 Ethernet Port Load Capacity for more details: <ul style="list-style-type: none"> – 8bit@60Hz: 659,722 pixels – 10bit@60Hz: 494,791 pixels (available only with the A10s Pro receiving card) – 10/12bit@60Hz: 329,861 pixels
Control card		
		
Type	Qty	Description
ETHERNET	2	Gigabit Ethernet control ports. Support TCP/IP and star connection. They have the same functions without priority and order, and can be connected to VMP software. No switch or router is needed to deploy multiple devices on the same LAN via device cascading as the network switching function is already built in. Up to 20 units of MX2000 Pro can be cascaded.
GENLOCK	1	A pair of Genlock signal connectors. Support Bi-Level and Tri-Level. <ul style="list-style-type: none"> • IN: Accept the sync signal. • LOOP: Loop the sync signal. For standard Genlock signal generators, up to 20 units of MX2000 pro can be cascaded.
AUX	1	An auxiliary connector that connects to the central control device (RS232) (Reserved)
SPDIF	1	A digital audio output (Reserved)
Power		
Connector	Qty	Description
100-240V~, 50/60Hz	1	An AC power input connector.

3 Applications

3.1 Solution Build

Based on the installed output cards (MX_4x10G_Fiber output card/CX_1x40G_Fiber output card), users can build 1G/5G solutions with different models of fiber converters and receiving cards. 1G/5G refers to the output bandwidth of a single Ethernet port. For more detailed information, please refer to [8 Ethernet Port Load Capacity](#).

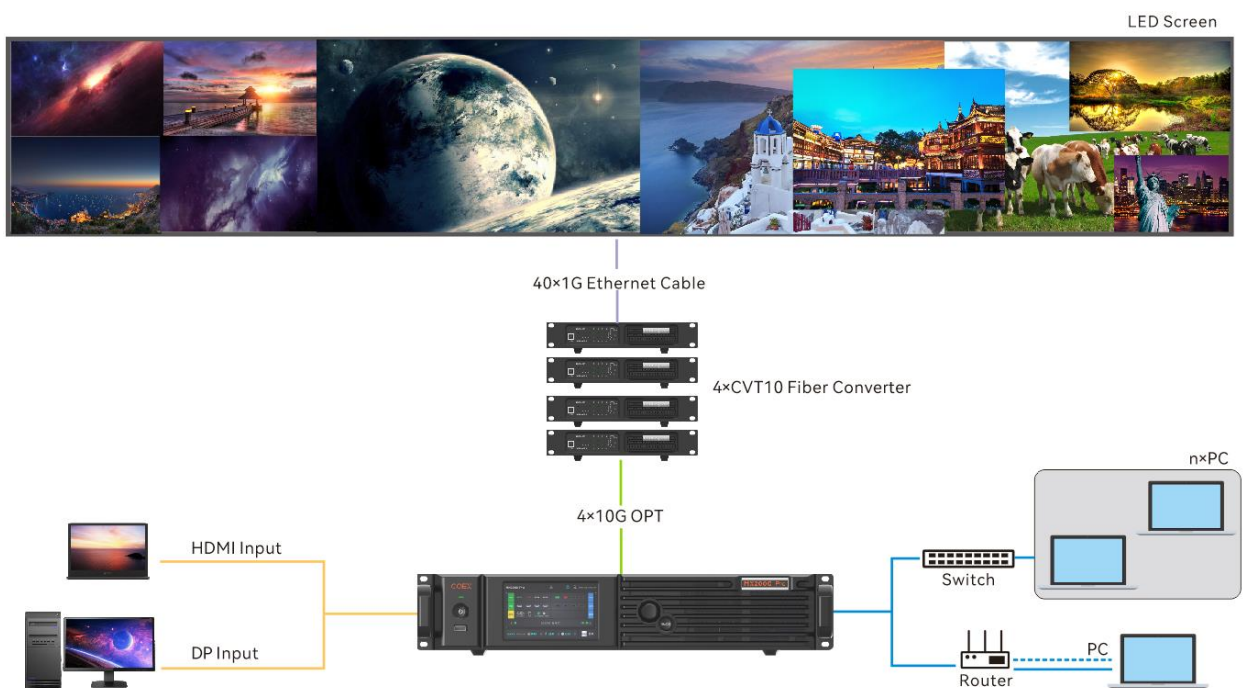
Table 3-1 COEX system build

Solution	Output Card	Fiber Converter	Receiving Card
1G Solution	MX_4x10G_Fiber output card	CVT10, CVT10 Pro	1G receiving cards such as A10s Pro
5G Solution	CX_1x40G_Fiber output card	CVT8-5G	5G receiving cards such as CA50E

Note

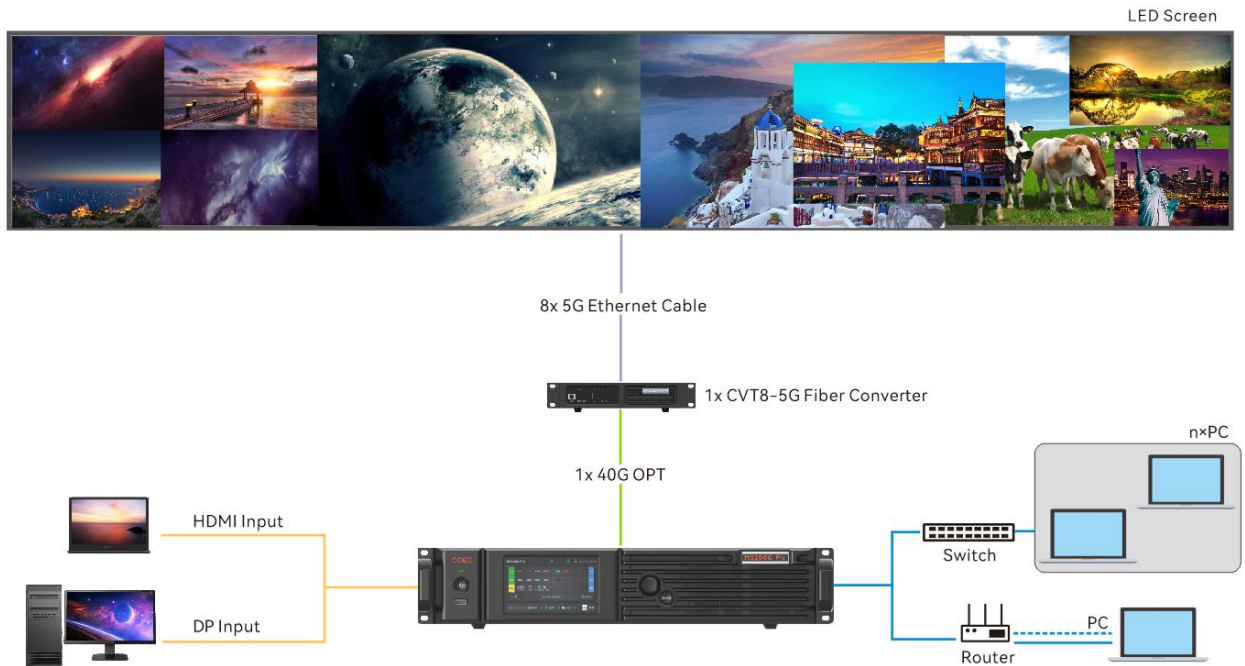
It is not possible to build 1G and 5G solutions with an MX2000 Pro at the same time.

3.2 1G Solution (MX_4x10G_Fiber Output Card)



This diagram is an example of two input cards and one MX_4x10G_Fiber output card installed on a MX2000 Pro. The actual application may vary.

3.3 5G Solution (CX_1x40G_Fiber Output Card)



This diagram is an example of two input cards and one CX_1x40G_Fiber output card installed on a MX2000 Pro. The actual application may vary.

4 VMP Operations

Users can only perform some basic operations on the MX2000 Pro LCD screen. To perform more operations, please install Vision Management Platform (VMP) on the control PC.

4.1 Device Connection

Ethernet Cable

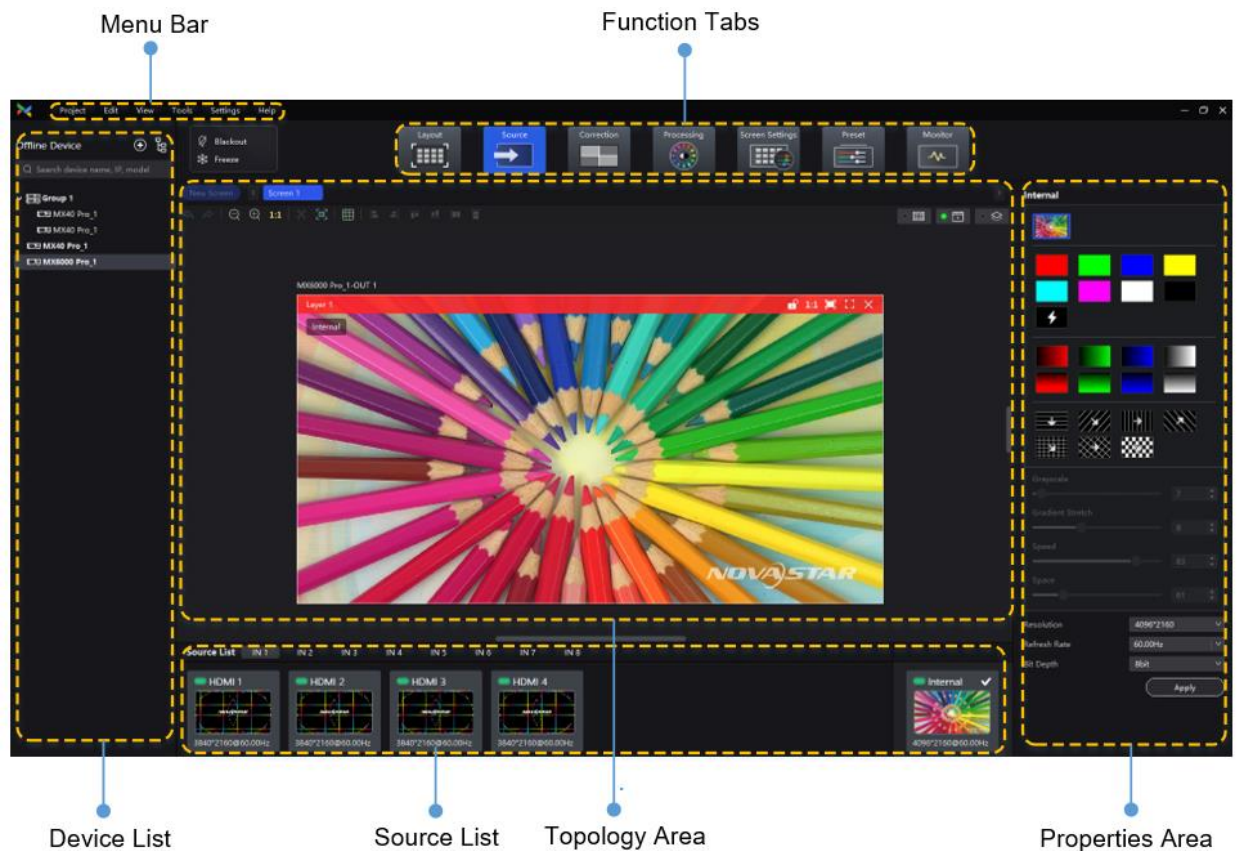
Connect the controller and the control PC directly via Ethernet cable and set a static IP address for the controller to let the controller and control PC be on the same network segment.

Via LAN

Connect the controller and the control PC to the same LAN and set the controller to automatically obtain an IP address.

4.2 UI Introduction

Figure 4-1 UI Introduction



Note:

All the figures in this document use operations in Windows10 as examples.

You can refer to section [4.6.3 Lock and Unlock Correction Page](#) to lock the Correction page to avoid changing the display content due to misoperation.

4.3 Device Management

4.3.1 4.1 Export and Import Project Files

Export the project files (.nprj) of devices or device groups so that you can import the files to apply the configuration data to the same kind of devices, improving the configuration efficiency.

Notice

The project file can be imported to the device that is of the same model and share the first two digits of the firmware version.

For example, the project file of V1.3.0 can be imported to the devices whose firmware version is V1.3.1.

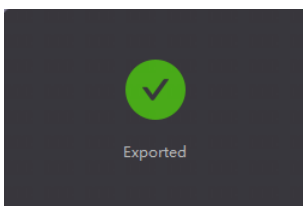
Export Project Files

Step 1 From the menu bar, choose **Project > Export** and select a device or device group.

You can also right-click a device or device group in the device list and select **Export** from the pop-up menu.

Step 2 Select a local directory and click **Save**.

Figure 4-2 Successful export



Import Project Files

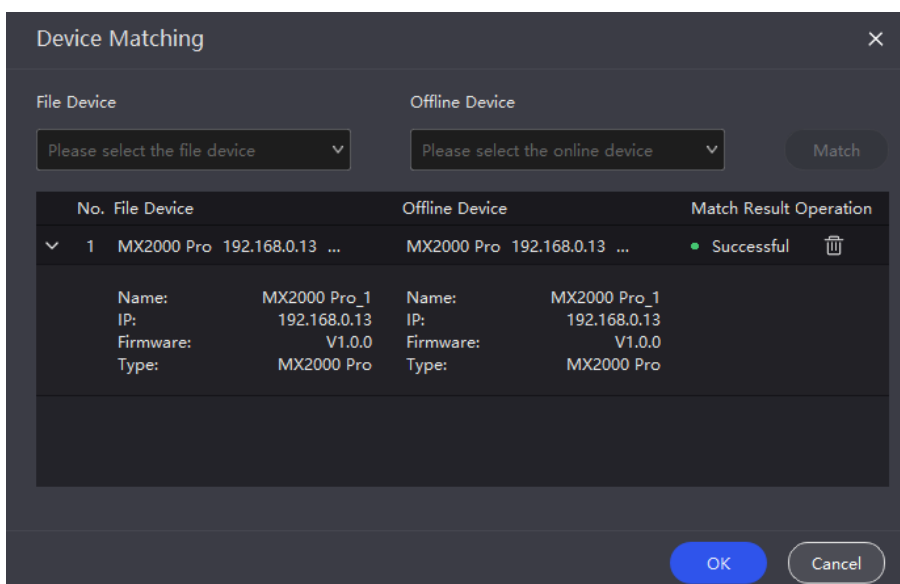
Step 1 From the menu bar, choose **Project > Import to** and select a device or device group.

You can also right-click a device or device group in the device list and select **Import** from the pop-up menu.

Step 2 Select a local project file and click **Open**.

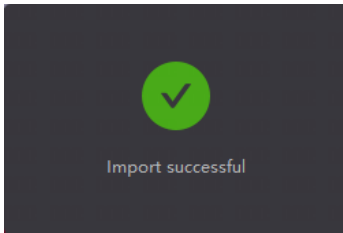
After successful device matching, a dialog box as shown in [Figure 4-3](#) is displayed.

Figure 4-3 Matching devices



Step 3 Click **OK**.

Figure 4-4 Successful import



4.3.2 Manage Device Groups

Create a group and add devices to manage the grouped devices uniformly and perform some batch operations.

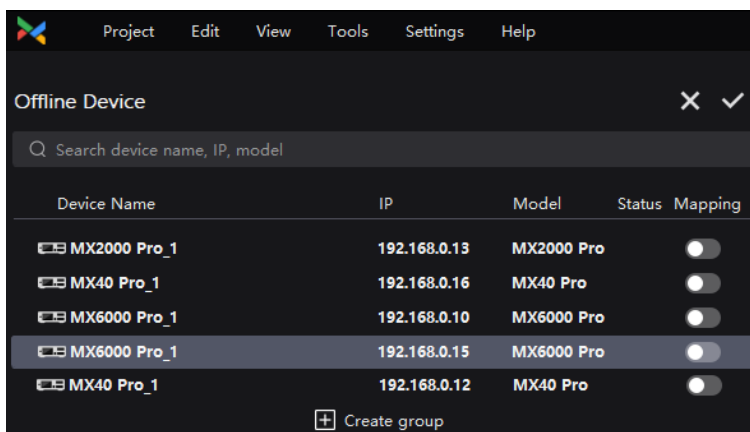
Notice


Only devices of the same model and same firmware version can be added to the same group.

Operating Procedure

Step 1 In the device list area, click  to enter the group management page.

Figure 4-5 Group management




Step 2 Click  to create a group, enter a group name and press **Enter** or click on the other position on the page.

To rename a group, right-click the group, select **Rename** from the pop-up menu and enter a new group name.

Step 3 Drag the target devices to the created group.

Controllers of different models or firmware versions cannot be grouped.

Step 4 After the settings, click .

- To delete a device in a group, drag the device out of the group.
- To delete a group, right-click the group, select **Remove group** from the pop-up menu.

Note

You can set the Mapping switch to  to enable the mapping function

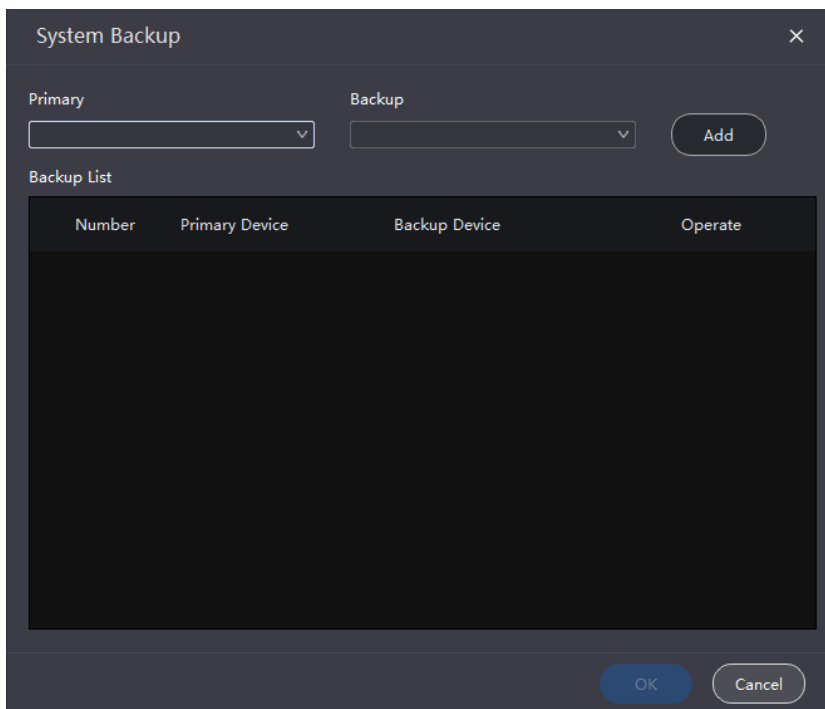
4.3.3 Set Backup Device

Enhance system reliability by establishing a primary controller and backup controller, allowing the backup controller to take over responsibility in case of primary controller failure.


Step 1 From the menu bar, choose **Tools > System Backup** to open the **System Backup** dialog box.

You can also right-click a device or device group in the device list and select **System backup** from the pop-up menu to open the **System Backup** dialog box.

Figure 4-6 System backup



Step 2 Select a primary controller and a backup controller from the drop-down options respectively, and then click **Add**.

The backup list will display the added backup information. To delete the backup information, click .

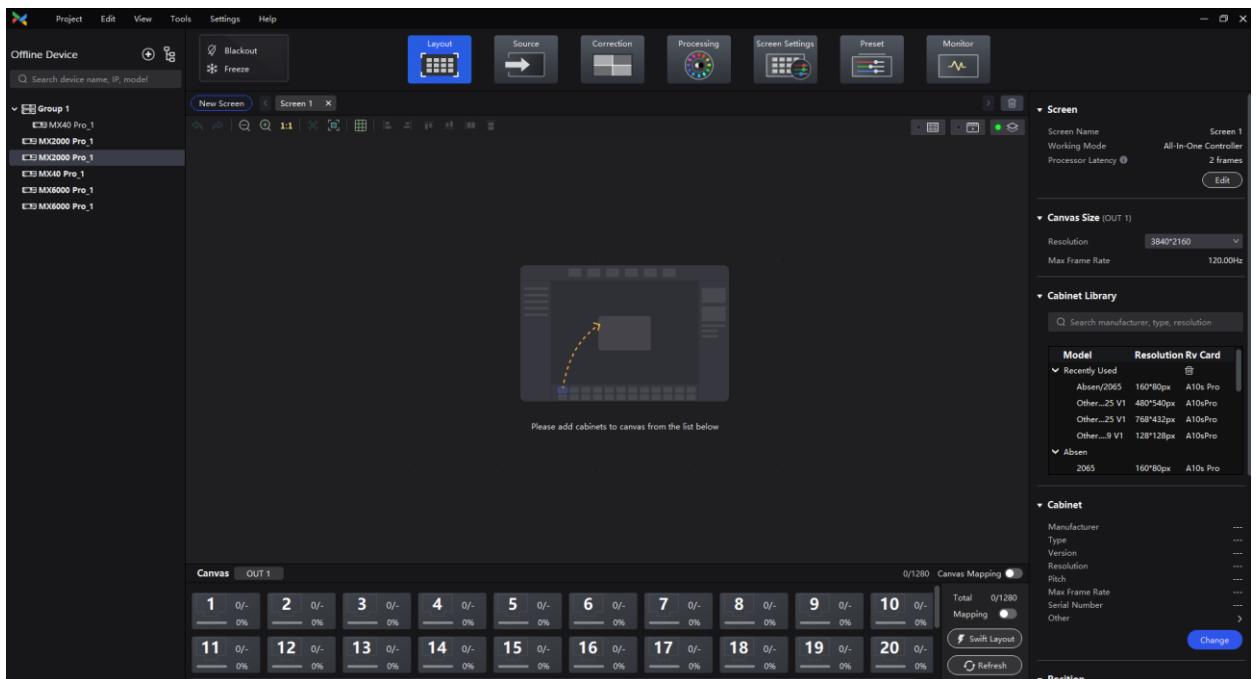
Step 3 After the settings, click **OK**.

4.4 Screen Configuration

4.4.1 Create Screens

Step 1 Select the controller from the device list and then select **Layout**.

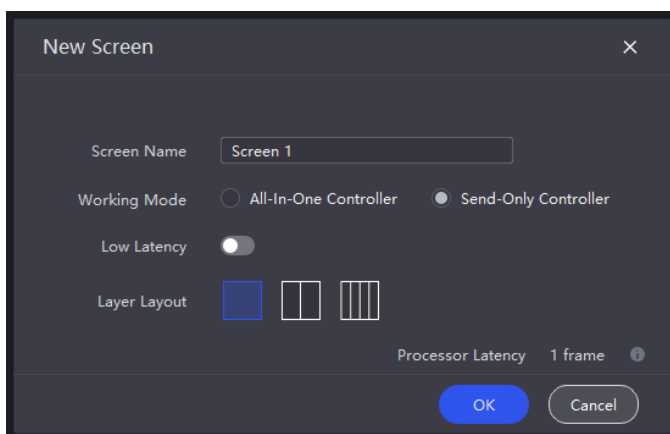
Figure 4-7 Layout



Step 2 Click **New Screen**.

Step 3 Enter a screen name on the pop-up window.


Figure 4-8 Create Screens



Step 4 Select a Working Mode. When operating as a Send-Only Controller, please configure the layer layout as well.



- **All-In-One Controller** supports free layer layout;
- **Send-Only Controller** is subject to fixed layer layout.

Step 5 Set Low Latency.

When low latency is set to , the latency at the data sending end is reduced by 1 frame.

Step 6 Click **OK** once you are done.




Related Operations:

- Edit screen: Click **Edit** in the **Screen** section of the properties area.
- Delete screen: click  on the right side of the screen tab or  in the top right corner of the topology area.
- Select multiple screens: Hold down **Ctrl** and click on the screen names.

4.4.2 Configure Screen Topology

Step 1 Select the controller from the device list and then select Layout.

Step 2 Select a view by clicking one of the following icons at top right of the topology area.

- : Show the cabinets only.
- : Show the preview image of the input source only.
- : Show the cabinets and preview image of the input source at the same time.

Note

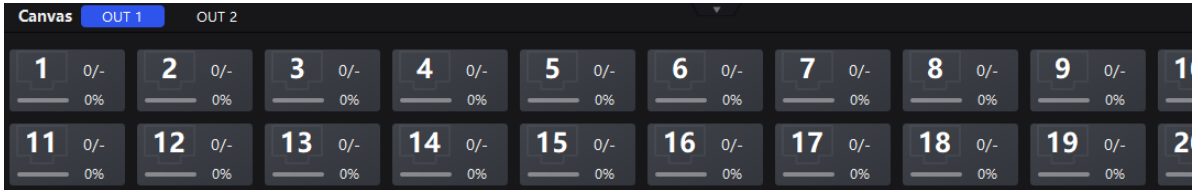
You can also select a view from the menu bar > **View** > **Display** and choose the content to be displayed, including cabinet topology, cabinet status, group names, source tags, and overlapping cabinets.

Step 3 Select a screen.

Step 4 Select a canvas at the bottom of the page. First click on any output port of the canvas, and then click on the topology area to place the canvas.

Each canvas corresponds to an output card. For example, the two canvases OUT 1 and OUT 2 in [Figure 4-9](#) correspond to three output cards respectively.

Figure 4-9 Canvas



Related Operations:

- Set canvas resolution: Select a canvas at the bottom of the page and then set the canvas resolution in the properties area.
- Move Canvas: Click and hold the name at the top left of the canvas in the topology area, then drag it to the desired position.
- Delete: Canvas: Click on the name at the top left of the canvas in the topology area to select it, then press **Delete**.
- Locate Canvas: Set **Canvas Mapping** to , so that the canvas position can be quickly viewed on the LED screen.

Step 5 After placing a canvas, you can drag or click the mouse in the topology area to add cabinets.

The cabinets will be automatically connected when you are adding them, as shown in [Figure 4-10](#). The Ethernet port's load capacity information will be displayed, as shown in [Figure 4-11](#). The properties area will display the cabinet information, as shown in [Figure 4-12](#).

Figure 4-10 Cabinets connected automatically

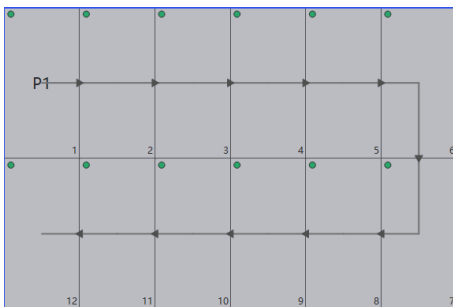
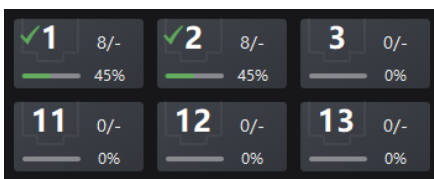
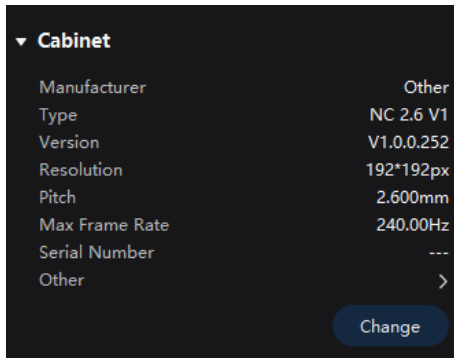


Figure 4-11 Ethernet port capacity



- 8/-: Indicates that 8 cabinets are connected to the Ethernet port.
- 45%: Indicates these 8 cabinets have used 45% of the Ethernet port's capacity.

Figure 4-12 Cabinet Information



Note

If all the cabinets loaded by the Ethernet ports have the same size, you can use the swift layout function to quickly add and connect the cabinets for all the Ethernet ports.

The operations are as follows:

Click **Swift Layout** and then drag the mouse on the canvas to add cabinets that match the actual requirements. In the properties area, select a layout and click **Done**.

Step 6 Select another Ethernet port and continue to add cabinets until all cabinets are connected.

To change the cabinet model, simply select the cabinet and then click **Change** in the property area.

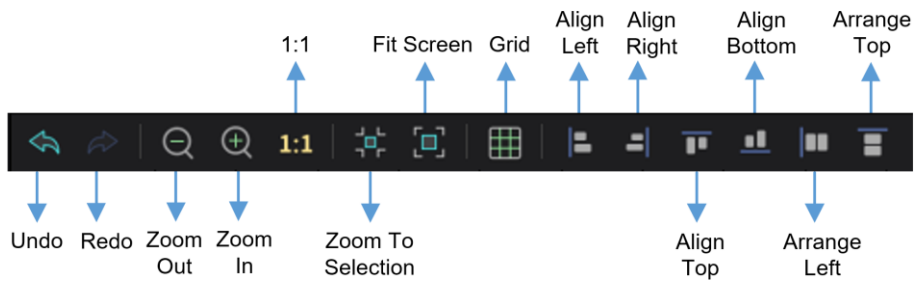
Step 7 For cabinets that have the same size and consecutive serial numbers, if you want to change the cabinet connection topology, select the cabinets and then select a quick topology under **Quick topo** in the properties area, as shown in [Figure 4-13](#) . For other cabinets, skip this step.

Figure 4-13 Quick topology




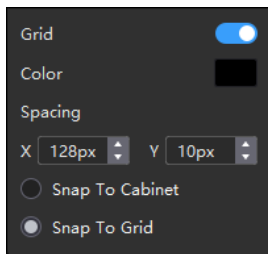
Step 8 Do any of the following to arrange and align the cabinets to let the cabinet positions meet the display requirements.



✚ **Use the function buttons**



- 1:1: The canvas size equals to the input source resolution.
- Zoom To Selection: The selected element is zoomed and displayed in the center of the canvas.
- Fit Screen: The canvas size is automatically adjusted to fit the topology area size.

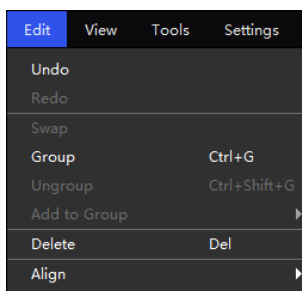
Click  to show its drop-down menu shown below. The menu can be used to set the canvas grid.



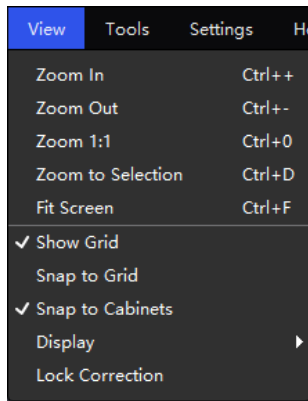
- Grid: When toggled on () , a grid is displayed on the canvas. If you do not need to display the grid, set the switch to .
- Color: Set the grid color.
- Spacing: Set the spacing of horizontal and vertical lines of the grid. The spacing is set to the resolution of the first cabinet by default.
- Snap to Cabinet: When positioning a cabinet near another one, the cabinet being moved will automatically align and snap to the edge of the adjacent cabinet, effectively eliminating gaps.
- Snap to Grid: The cabinet will be snapped to the grid.

+ Use the function menus on the menu bar

- **Edit** menu

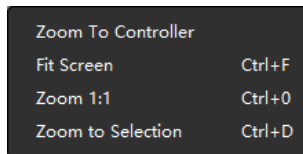


- **View** menu



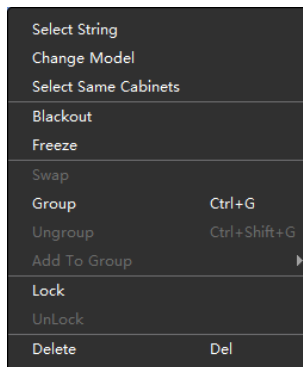
✦ Use the right-click function menus

- Right-click the canvas



Zoom to Controller: The selected controller is zoomed and displayed in the middle of the topology area.

- Right-click the cabinet



Select String: Select all the cabinets on the connection line of the current cabinet.

Swap: Swap the positions of the two selected cabinets.

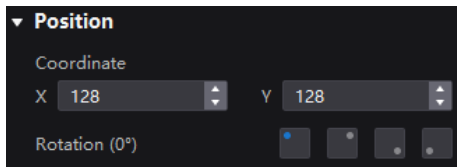
Group: Group the selected cabinets. To set the group name and color, please select the group and set them in the properties area.

Ungroup: Ungroup the cabinets.

Add to Group: Add the selected cabinets to a group.

✦ Set cabinet coordinates and rotation

Select a cabinet and set its coordinates and rotation angle in the properties area. After the cabinet is rotated, the input source will be rotated by the set angle and displayed.



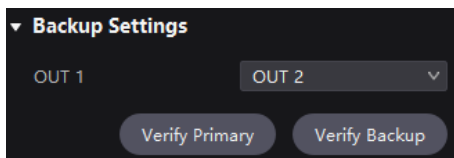
Step 9 Set the cabinet topology for other canvases.

4.4.3 Set Card Backup

Step 1 Select the controller from the device list and then select Layout.

Step 2 In the properties area, select a backup for the card.

Figure 4-14 Backup settings



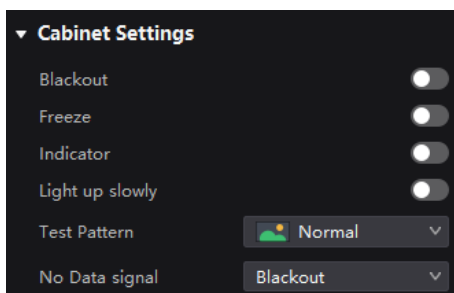
Step 3 Click **Verify Primary** or **Verify Backup** to examine whether the channel is working properly.

- **Verify Primary:** Disconnect the backup channel and examine whether the primary channel is working properly.
- **Verify Backup:** Disconnect the primary channel and examine whether the backup channel is working properly.

4.4.4 Set the Cabinet

Select the controller from the device list and then select Layout. Select one or more cabinets and do any of the following operations in the properties area.


Figure 4-15 Cabinet settings




Control Display Status

Set the **Blackout** or **Freeze** switch to .

Enable Indicator

Set the **Indicator** switch to  to enable the running status indicator of the cabinet.

Enable the Light Up Slowly Function

Set the **Light up slowly** switch to  so that after the screen is powered on, the display brightness will slowly change from 0 to the target value.

Set Test Pattern

Select a test pattern from the drop-down list of **Test Pattern** to perform screen aging test and troubleshoot problems.

Set Image for Abnormal Situations

Select an option from the **No Data signal** drop-down list.

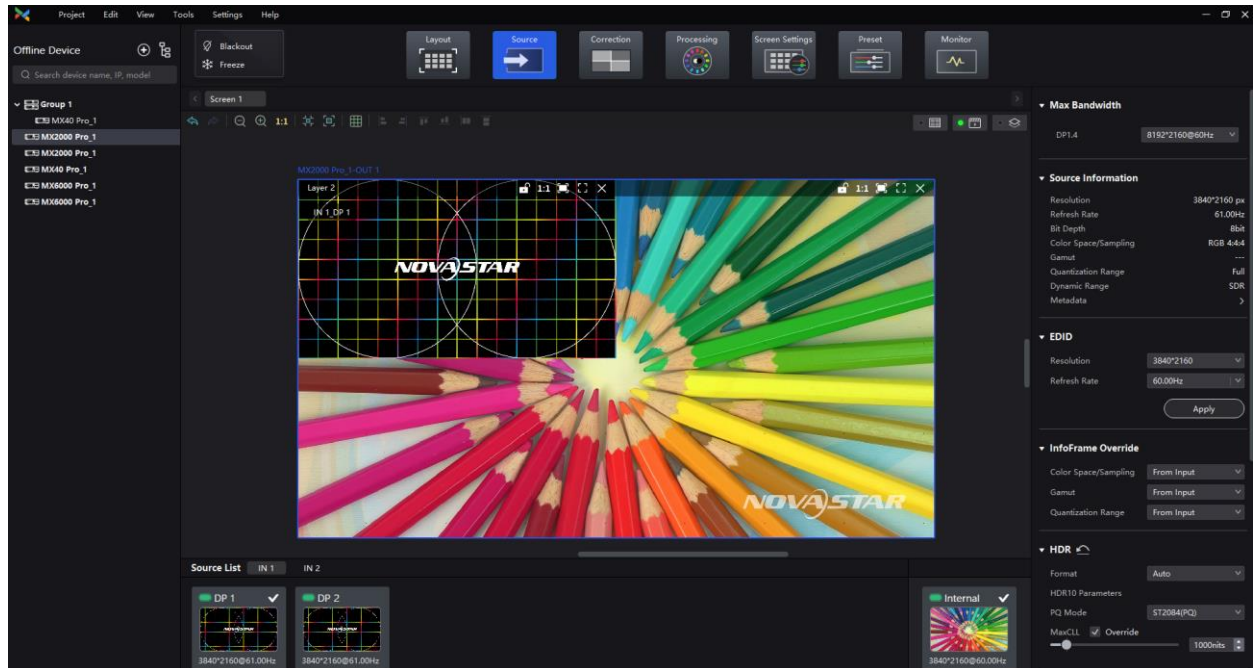
- Blackout: The screen displays a black image.
- Last Frame: The screen always displays the last frame.

4.5 Input Source Configuration

4.5.1 Add Layers

Step 1 Select the controller from the device list and then select Source.

Figure 4-16 Input source



Step 2 Select an input card at the bottom of the page.

Step 3 Double-click the thumbnail of the input source or drag the input source to the target position to add a layer. (Remember to select a canvas first if there are multiple canvases).

- **All-In-One Controller** supports free layer layout;
- Send-Only Controller is subject to fixed layer layout and when adding a layer, it will automatically fill the canvas and the size and position of the layer cannot be adjusted.

You can check the source status according to the source indicator:

- Green: The input source is connected.
- Red: The input source is being used for the screen but not connected.
- Gray: The input source is not connected.

Step 4 Make layer adjustments as needed.

✦ Lock layer



✦ Switch source

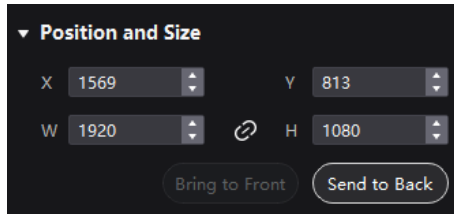
- Select a layer and select another source in the properties area.




- Right-click a layer, select Source from the displayed menu, and select another source.


✦ Adjust layer size and position


- Select a layer and set the layer size and coordinates in the properties area. You can also bring the layer to front or send it to back.




- Right-click a layer and select **Bring to Front**, **Send to Back**, **Bring Forward** or **Send Backward** from the displayed menu.
- At the top right of a layer, click a function icon to set the layer.


: Lock the layer.

: Unlock the layer.

: The layer size is the same as the input source resolution.

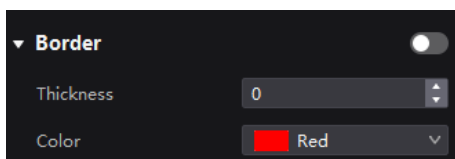
: The layer automatically fill the screen.

: The layer size changes automatically according to the canvas size.


: Delete the layer.

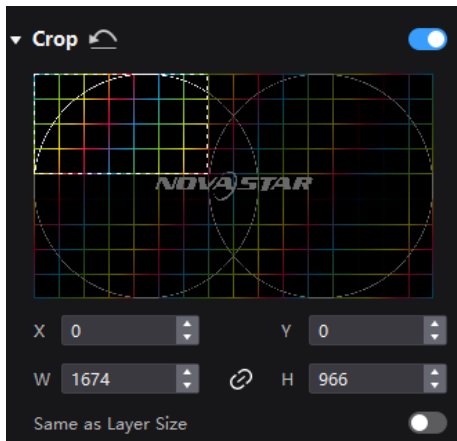
✦ Set borders

Select a layer and enable or disable the layer borders function in the properties area. After enabling the function, you can set the border thickness and color.



✦ Crop the input source

Select a layer and enable or disable the **Crop** function in the properties area. Then, you can set the crop size and position on the thumbnail of the layer. You can also make adjustments by setting the parameter values below the thumbnail. When **Same as Layer Size** is set to , the input source image will be cropped according to the layer size.



4.5.2 Set External Sources

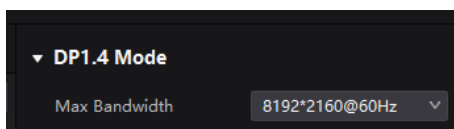
Select the controller from the device list and then select Source. Select an external source from the source list and do the following as required.

Set Maximum Load Capacity

Select an option from the drop-down list to calculate the layer resources for the DP 1.4 connector.

- 8192*2160@60Hz: Up to 2 layers can be added.
- 4096*2160@60Hz: Up to 4 layers can be added.

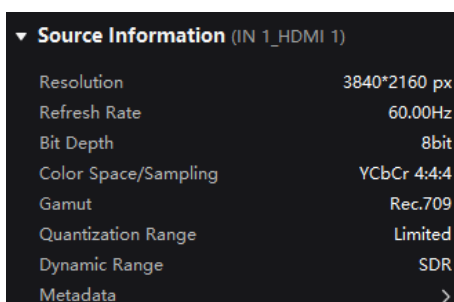
Figure 4-17 Maximum Load Capacity



View Source Information

View the resolution, frame rate, bit depth, and other information of the external source.

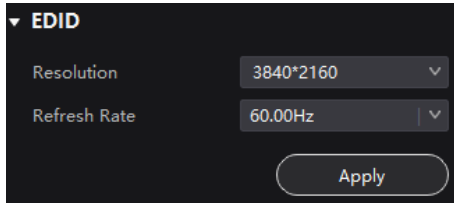
Figure 4-18 Source information



Set EDID

Select a value from the drop-down lists of **Resolution** and **Refresh Rate** and click **Apply**.

Figure 4-19 EDID



Adjust Color

In the **InfoFrame Override** area, select a value from the drop-down lists of **Color Space/Sampling**, **Gamut** and **Quantization Range**. Then, in the **Color** area, drag the sliders to adjust the parameter values.

The override parameter will be used in the calculation of color adjustment. Select **From Input** and the software will read the attribute value that comes with the input source.

Figure 4-20 InfoFrame Override

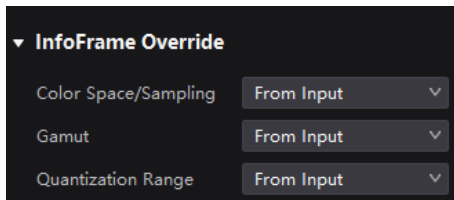


Figure 4-21 Color adjustment



Table 4-1 Descriptions of color adjustment parameters

Parameter	Description
Black Level	It is used to adjust the brightness of the dark areas of the image. The smaller the value, the darker the dark part of the screen.
Contrast	It is used to adjust the brightness of the highlight areas of the image. The greater the value, the brighter the highlight part of the screen. Contrast and black level together affect the overall contrast of the image.
Saturation	It is used to adjust the color purity of the image. The greater the value, the more vivid the color.
Hue	It is used to adjust the color effect of the displayed image color. Generally, it is divided into warm, cool and intermediate tones.
Red Shadow/Green Shadow/Blue Shadow	It is used to adjust the brightness of the dark areas of the image. The principle is the same as that of black level, but only the RGB components are adjusted.
Red Highlight/Green Highlight/Blue Highlight	It is used to adjust the brightness of the highlight areas of the image. The principle is the same as that of contrast, but only the RGB components are adjusted.

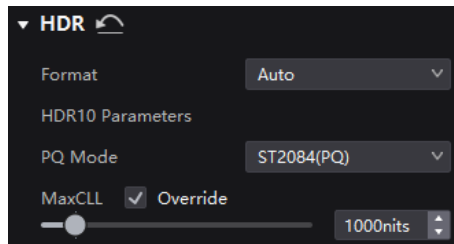
Set HDR Parameters

Note

To set HDR parameters, the hardware must support HDR and the HDR10 or HLG sources must be prepared.

Select an HDR format from the drop-down list of **Format** and set related parameters. Select **Auto** and the software will read the attribute value that comes with the input source.

Figure 4-22 HDR



HDR10 parameters:

- PQ Mode: The mapping method of video source brightness.
 - ST2084 (PQ): This mode 1:1 maps the brightness of the video source. The part that exceeds the maximum screen brightness will still be displayed as the maximum screen brightness.
 - ST2086 (Linear mapping): This mode linearly maps the brightness of the video source. It globally adjust the video source brightness according to the maximum screen brightness to ensure that the ratio of the brightness of the entire source content remains unchanged.
- MaxCLL: The override value of the maximum video source brightness. MaxCLL takes effect when **Override** is selected.

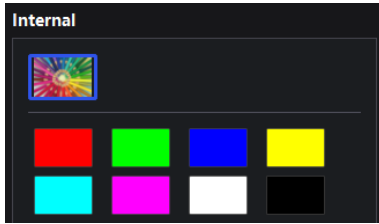
4.5.3 Set Internal Sources

The internal sources can be used for screen testing and troubleshooting. Select the controller from the device list and then select Source. Select an internal source from the source list and do the following as required.

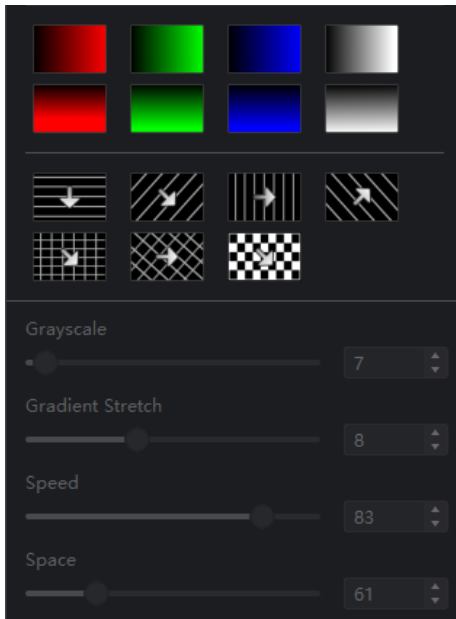
Set the Image

Select an image and set the **Grayscale**, **Gradient Stretch**, **Speed**, and **Space**. The adjustable parameters for each image may vary based on the interface.

- Static images



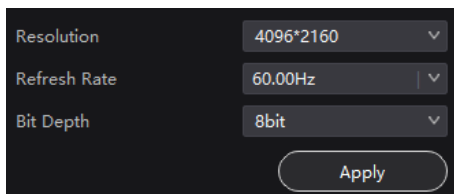
- Dynamic images



Set the Resolution, Refresh Rate, and Bit Depth

Select a value from the drop-down lists of **Resolution**, **Refresh Rate**, and **Bit Depth** and then click **Apply**.

Figure 4-23 Internal source parameters



4.6 Display Correction

4.6.1 Correct Seams

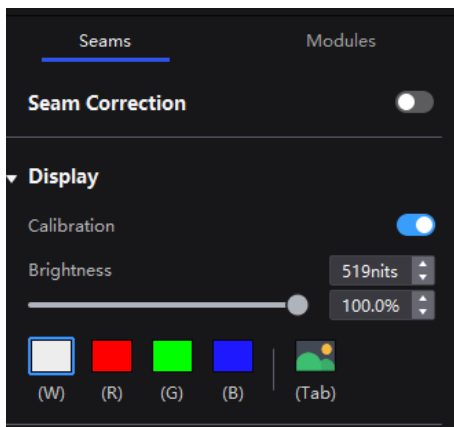
Adjust brightness of the seams between cabinets or modules to improve the visual experience. If brightness correction has been done for the screen, the screen brightness can be adjusted in nits. Otherwise, it can be adjusted only in percentage.



Step 1 Select the controller from the device list and then select **Correction**.

Step 2 On the **Seams** tab page in the properties area, set the **Seam Correction** switch to .

Step 3 Set the parameters in the **Display** area.

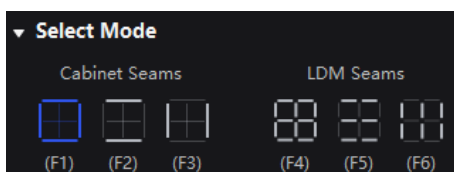
Figure 4-24 Display content (seams)



- Calibration: Set the **Calibration** switch to  to make the screen apply the calibration effect made by the calibration platform.
- Brightness: Adjust the display brightness.
- Display image: Set the image displayed on the screen. To display the current source image, click and hold .

Step 4 Select a correction mode.

Figure 4-25 Select mode (seams)



- Cabinet Seams: Correct the seams of cabinets.

- Module Seams: Correct the seams of the the modules.


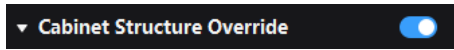
Step 5 When correcting the module seams, if you need to override the numbers of module columns and rows, set the Cabinet Structure Override switch to . Otherwise, skip this step.

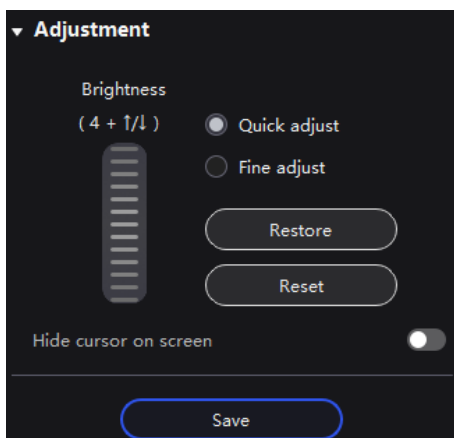
Figure 4-26 Cabinet structure override




Step 6 In the topology area, click or click and drag the mouse to select the seams to be corrected.

Step 7 Set the adjustment parameters.

Figure 4-27 Set the parameters.



- Quick adjust: Has a large range of adjustment.
- Fine adjust: Has a small range of adjustment.
- Hide cursor on screen: When this is set to , use the keyboard shortcuts to adjust the seams and the cursor will not be displayed on the screen.

Step 8 Place the mouse on the scroll wheel icon and adjust the brightness by dragging the wheel icon up or down, scrolling the mouse wheel, or using the keyboard shortcuts **4+ ↑ / ↓**.

- Restore: Restore the configuration to the last saved.
- Reset: Reset the configuration to the status before adjustment.

Step 9 After the settings, click **Save**.

4.6.2 Correct Multi-Batch Cabinets/Modules

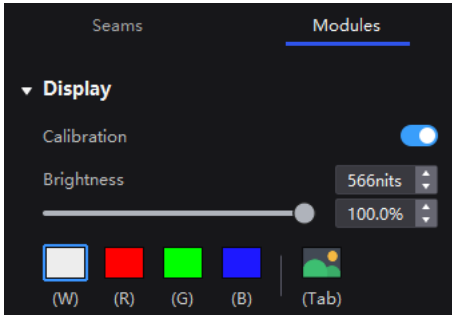
Adjust the chroma of cabinets or modules from multiple batches to make the overall chroma of the display more balanced and uniform. If brightness correction has been done for the screen, the screen brightness can be adjusted in nits. Otherwise, it can be adjusted only in percentage.


Step 1 Select the controller from the device list and then select **Correction**.

Step 2 Select the **Modules** tab in the properties pane.

Step 3 Set the display content.

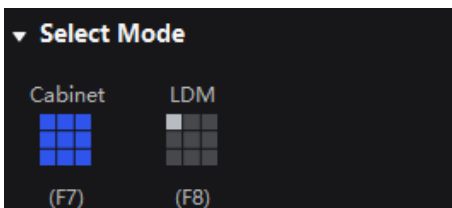
Figure 4-28 Display content (multiple-batch)



- Calibration: Set the **Calibration** switch to to make the screen apply the calibration effect made by the calibration platform.
- Brightness: Adjust the display brightness.
- Display image: Set the image displayed on the screen. To display the current source image, click and hold .

Step 4 Select a correction mode.

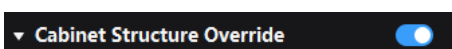
Figure 4-29 Select mode



- Cabinet: Correct the multi-batch cabinets.
- Module: Correct the multi-batch modules.

Step 5 When correcting the multi-batch modules, if you need to overwrite the numbers of module columns and rows, set the Cabinet Structure Override switch to . Otherwise, skip this step.

Figure 4-30 Cabinet structure override



Step 6 In the topology area, click or click and drag the mouse to select the cabinets or modules to be corrected.

Step 7 Drag the slider to adjust chroma.

Figure 4-31 Adjustment



- Restore: Restore the configuration to the last saved.
- Hide cursor on screen: When this is set to , use the keyboard shortcuts to adjust chroma and the cursor will not be displayed on the screen.

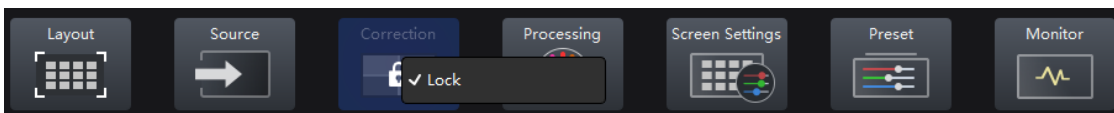
Step 8 After the settings, click **Save**.

4.6.3 Lock and Unlock Correction Page

After the screen correction is finished, you can lock the Correction page by either of the following methods to avoid changing the display content due to misoperation.

- Right-click the **Correction** icon and click **Lock**. Clicking **Lock** again unlocks the page.
- From the menu bar, choose **View > Lock Correction**. Clicking **Lock Correction** again unlocks the page.

Figure 4-32 Correction icon



Note

After the **Correction** page is locked and you have entered another page, if you want to go back to the **Correction** page, you must manually unlock the page first.

4.7 Color Processing

4.7.1 Color Replacement

Replace a color with another color according to the settings.

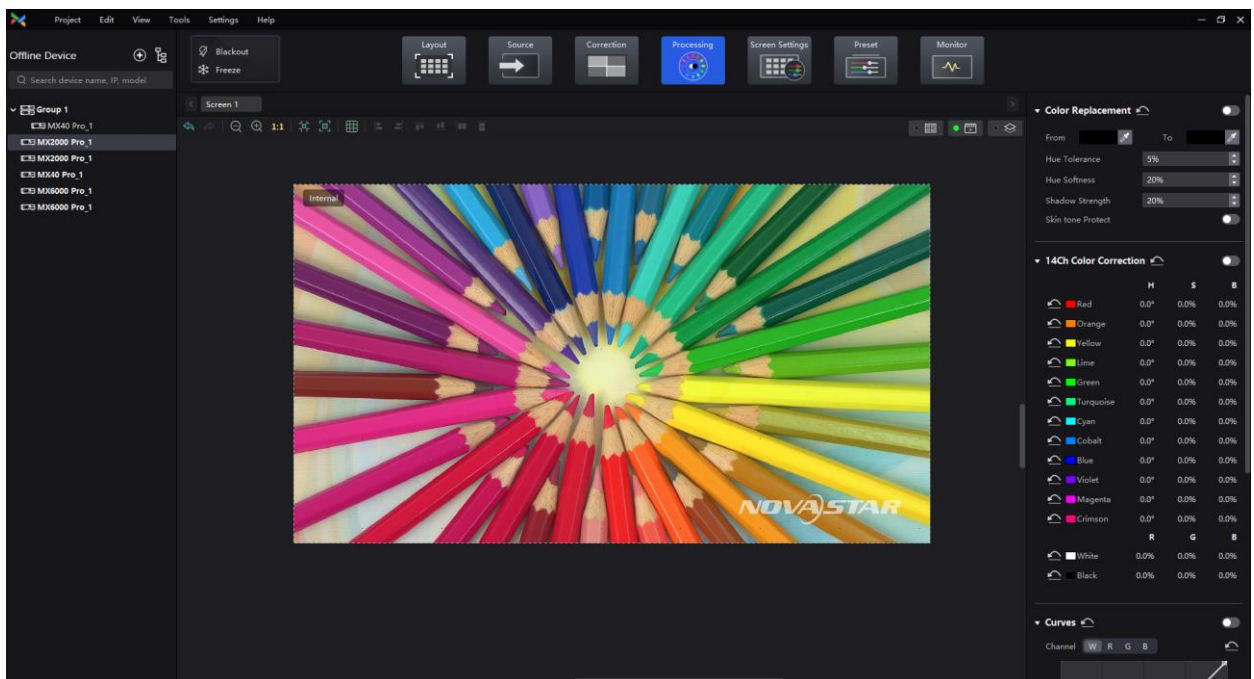
Notice

It is recommended to choose color with higher saturation for replacement to achieve better outcome.

Operating Procedure

Step 1 Select the controller from the device list and then select **Processing**.

Figure 4-33 Color Processing



Step 2 Set the Color Replacement switch to .

Step 3 Set the colors before and after replacement.



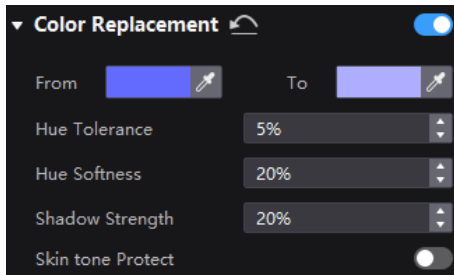
- Method 1: Click the color area in  to open the color palette and set a color.
- Method 2: Click the eyedropper in  and select a color in the topology area.

Figure 4-34 Color Replacement



Step 4 Set **Hue Tolerance**, **Hue Softness**, **Shadow Strength**, and **Skin Tone Protect**.

- Hue Tolerance: Indicates the hue range of the color to be replaced. The larger the value, the larger the replacement area
- Hue Softness: Indicates the hue softness of the transition area.
- Shadow Strength: Indicates the gradient parameter of the highlight or shadow area. The larger the value, the smoother the gradient.
- Skin Tone Protect: Keeps the skin tone as original as possible.

4.7.2 14Ch Color Correction

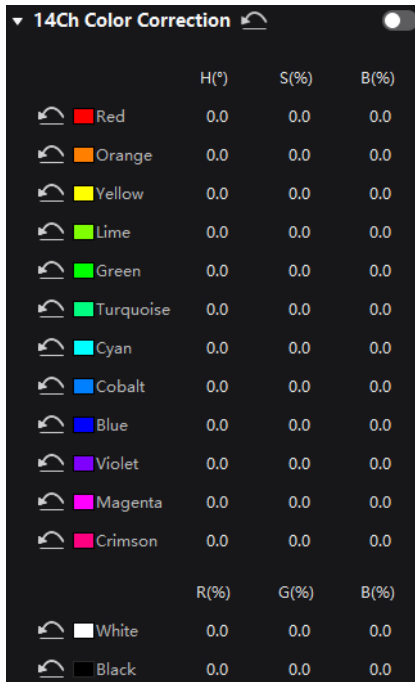
Precisely adjust the hue, saturation and brightness of black, white, and the 12 derived standard colors of the red, green and blue primary colors.

Step 1 Select the controller from the device list and then select **Processing**.

Step 2 Set the **14h Color Correction** to .

Step 3 Click a value of a color to enable the editing and change the value, , for example.

Figure 4-35 14CH Color Correction



	H(°)	S(%)	B(%)
Red	0.0	0.0	0.0
Orange	0.0	0.0	0.0
Yellow	0.0	0.0	0.0
Lime	0.0	0.0	0.0
Green	0.0	0.0	0.0
Turquoise	0.0	0.0	0.0
Cyan	0.0	0.0	0.0
Cobalt	0.0	0.0	0.0
Blue	0.0	0.0	0.0
Violet	0.0	0.0	0.0
Magenta	0.0	0.0	0.0
Crimson	0.0	0.0	0.0
	R(%)	G(%)	B(%)
White	0.0	0.0	0.0
Black	0.0	0.0	0.0

4.7.3 Set Color Curves

Adjust the color curves.

- Step 1 Select the controller from the device list and then select **Processing**.
- Step 2 Set the Curves switch to .

Figure 4-36 Curves





- Step 3 Select the white, red, green or blue channel.
- Step 4 Drag the slider at the bottom of the curve diagram to set the curve adjustment range.

Step 5 Click anywhere on the curve to add an adjustment point and drag the point to adjust the curve.

Input and **Output** indicate the absolute coordinates of the adjustment point in the curve diagram.

To delete the adjustment point, drag the point outside the curve diagram, or select the point and press **Delete**.

Click the  icon at the right of Channel to reset the curve of the current channel. Click the  icon next to Curves to reset all the curves.

4.7.4 Enable 3D LUT

A set of mapping relationships are defined in the 3D LUT file (.cube) to adjust the colors of the video source.

Prerequisites

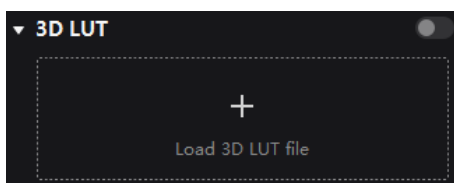
A 17×17×17 3D LUT file must be prepared in advance.

Operating Procedure

Step 1 Select the controller from the device list and then select **Processing**.

Step 2 Click anywhere in the **Load 3DLUT File** area, select a file and open it.

Figure 4-37 Loading 3D LUT file




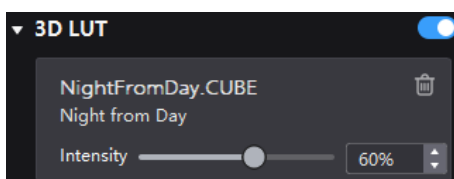

Step 3 Set the **3D LUT** to  and drag the slider to adjust the strength of the 3D LUT.

Figure 4-38 Adjusting intensity



To delete the file, click .

4.8 Screen Settings

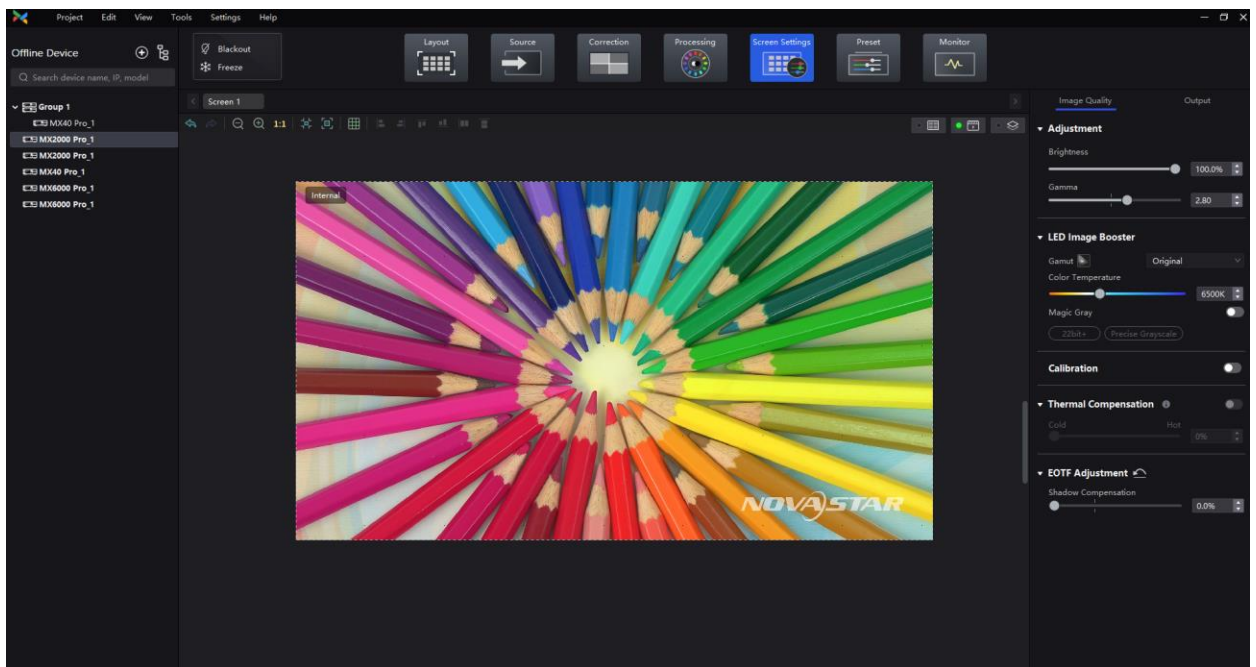
4.8.1 Adjust Image Quality

4.8.1.1 Adjust Brightness and Gamma

If brightness correction has been done for the screen, the screen brightness can be adjusted in nits. Otherwise, it can be adjusted only in percentage.

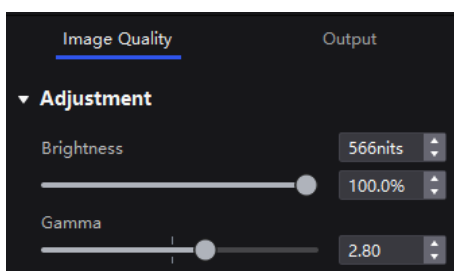
Step 1 Select the controller from the device list and then select **Screen Settings**.

Figure 4-39 Screen Settings



Step 2 In the **Image Quality** tab, set the brightness and gamma value.

Figure 4-40 Brightness and gamma adjustments



4.8.1.2 Set LED Image Booster

Set the LED Image Booster function to improve the precision and accuracy of the image color and gradation and realize free switching of the display color gamut.

Prerequisites


Before the operation, color gamut and brightness correction by using the CA410-VP427, CA410-P427 or EYE2-400 color analyzer must be done.

Operating Procedure

Step 1 Select the controller from the device list and then select **Screen Settings**.

Step 2 In the **LED Image Booster** section of the **Image Quality** tab, select an output color gamut from the **Gamut** drop-down list.

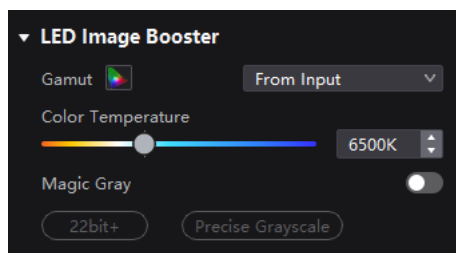
The output gamut options include standard gamuts, custom gamuts, the original screen gamut and the input gamut (**From input**).

To set the custom gamut, click , select a gamut in the properties area on the color gamut diagram, and adjust the red, green, blue and white parameters based on the selected gamut. The custom gamut name can be changed.

Step 3 Drag the slider to adjust color temperature.

Step 4 Enable or disable **Magic Gray** as needed.

Figure 4-41 LED Image Booster



4.8.1.3 Apply Calibration Effect

Check the effects before and after screen calibration.

Prerequisites

Before operation, screen calibration must be done and calibration coefficients must be uploaded.

Related Information

When the A10s Pro receiving card is used, the seam correction can be performed separately. This means even if the calibration switch is turned off, the seam correction effect is still kept.

Operating Procedure


- Step 1 Select the controller from the device list and then select **Screen Settings**.
- Step 2 In the Image Quality tab, set the **Calibration** switch to  to make the screen apply the calibration effect made by the calibration platform.

Figure 4-42 Calibration



4.8.1.4 Set Thermal Compensation

Adjust the application intensity of the thermal coefficients.

Prerequisites

Before the operation, thermal calibration must be done and thermal coefficients must be uploaded.

Operating Procedure


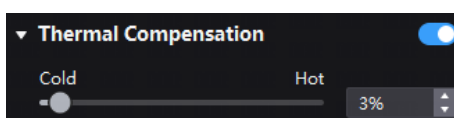
- Step 1 Select the controller from the device list and then select **Screen Settings**.
- Step 2 In the Image Quality tab, set the **Thermal Compensation** switch to .

Figure 4-43 Thermal compensation



- Step 3 Drag the slider to adjust the application intensity of the thermal coefficients.

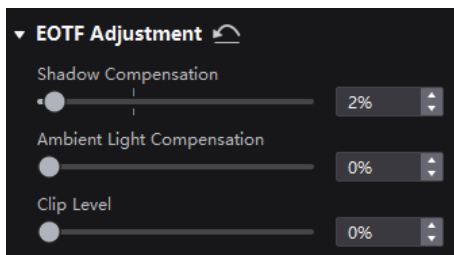
4.8.1.5 Adjust EOTF

Note

The supported adjustment parameters depend on the HDR settings.

- Step 1 Select the controller from the device list and then select **Screen Settings**.
- Step 2 In the Image Quality tab, drag the sliders to adjust the values of **Shadow Compensation**, **Ambient Light Compensation** and **Clip Level**.

Figure 4-44 EOTF Adjustment



4.8.2 Set Output

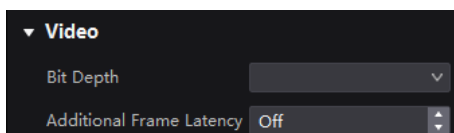
4.8.2.1 Set Output Bit Depth and Additional Frame Latency

Note

When the controller works with high-latency devices, you can set additional frame latency.

- Step 1 Select the controller from the device list and then select **Screen Settings**.
- Step 2 In the Output tab, select an option from the drop-down list of **Bit Depth**.
If **Auto** is selected, the output bit depth is the same as the input bit depth.

Figure 4-45 Output bit depth



- Step 3 Set a value for **Additional Frame Latency**.

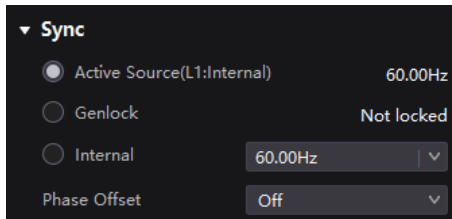
4.8.2.2 Set Sync Parameters

Step 1 Select the controller from the device list and then select **Screen Settings**.

Step 2 Select the **Output** tab.

Step 3 Select a synchronization signal for the display frame rate and set the phase offset.

Figure 4-46 Sync



- Active Source: Sync with the frame rate of the active source.
- Genlock: Sync with the frame rate of the Genlock signal. When the shutter fit function of the controller is effective, please select this option. In addition, the controller and the camera need to use the same Genlock signal generator.
- Internal: Sync with the frame rate of the controller's internal clock.

4.8.2.3 Set Frame Multiplication

Frame multiplication can make the screen output multiple frames within the original one frame time and provide them to different cameras.

Notice

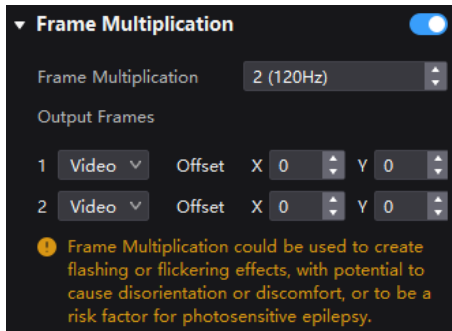
- When the A10s Pro, CA50E, CA50C, or XA50 receiving cards are used, the supported frames rate is up to 240 Hz.
- For other Armor series receiving cards, the supported frame rate is up to 120 Hz.

Operating Procedure

Step 1 Select the controller from the device list and then select **Screen Settings**.

Step 2 In the **Output** tab, set **Frame Multiplication** to .

Figure 4-47 Frame Multiplication



Step 3 Set the number of frames and the display mode of each frame.

Take the above [Figure 4-47](#) as an example. The parameters are described as follows:

- **Frame Multiplication:** After the current frame rate (59.94) is multiplied by 3, it is 179.82 Hz. Three frames are output in 1/59.94 second.
- **Video:** The first and second frames display the input source image. The first frame displays the image from the coordinates (0, 0) and the second frame displays the image from the coordinates (1920, 0).
- **Color:** The third frame displays a pure white image.

4.8.2.4 Set Shutter Fit

Adapt the screen and camera shutter to produce better filming results.

Prerequisites

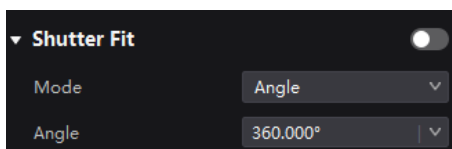
It requires that the sync signal must be Genlock and the controller and camera need to use the same Genlock signal generator.

Operating Procedure

Step 1 Select the controller from the device list and then select **Screen Settings**.

Step 2 In the **Output** tab, set **Shutter Fit** to .

Figure 4-48 Shutter Fit



Step 3 Set the relevant parameters.

4.8.2.5 Enable 3D Function

Enable the 3D function and set the related parameters for users wearing 3D glasses to view stereoscopic images.

Notice

- The 3D function and the low latency or frame multiplication function cannot be enabled at the same time.
- Only the main layer supports 3D effect.

Related Information

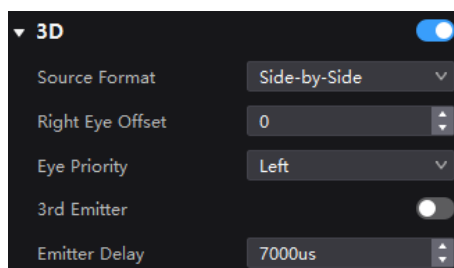
To use the 3D function, specified 3D glasses are needed. Please contact NovaStar technical support.

Operating Procedure

Step 1 Select the controller from the device list and then select **Screen Settings**.


Step 2 In the **Output** tab, set **3D** to .

Figure 4-49 3D



Step 3 Set the relevant parameters.

- **Source Format:** Set the format of the 3D video source. Set the format to **Side-by-side**, **Top-and-bottom** or **Frame sequential** according to the format of the accessed video source.
- **Right Eye Offset:** Set the start position of the right eye image. When the video source format is side-by-side or top-and-bottom and the left and right eye images are provided, this parameter can be set.

- **Eye Priority:** Set which image is sent first, the right eye image or the left eye image. Wear the 3D glasses to watch the display. If the display is abnormal, set the parameter value to the other one. If the display is normal, the setting is done.
- **3rd Emitter:** When a third-party 3D signal emitter is used, set the switch to .
- **Emitter Delay:** Set the delay time of sending the synchronization signal from the 3D signal emitter to the 3D glasses. This setting ensures that the switching between left and right eye images of the 3D glasses is in sync with the switching between the left and right eye images on the display. This parameter is applicable to both the NovaStar and third-party emitters.

4.8.2.6 Check the Load

Step 1 Select the controller from the device list and then select **Screen Settings**.


Step 2 In the **Output** tab, click  next to the device information to check the usage of the controller's load capacity.

Figure 4-50 Port load



4.9 Preset Management

4.9.1 Save Presets

After completing the display effect adjustment, you can save the data on the **Source**, **Layout**, **Processing** and **Screen Settings** pages as presets so that these data can be directly applied in the future. Up to 128 presets can be saved in VMP.

Notice

The preset of a specific device can only be applied by this device itself and the preset of a group can be applied by all the devices in the group.

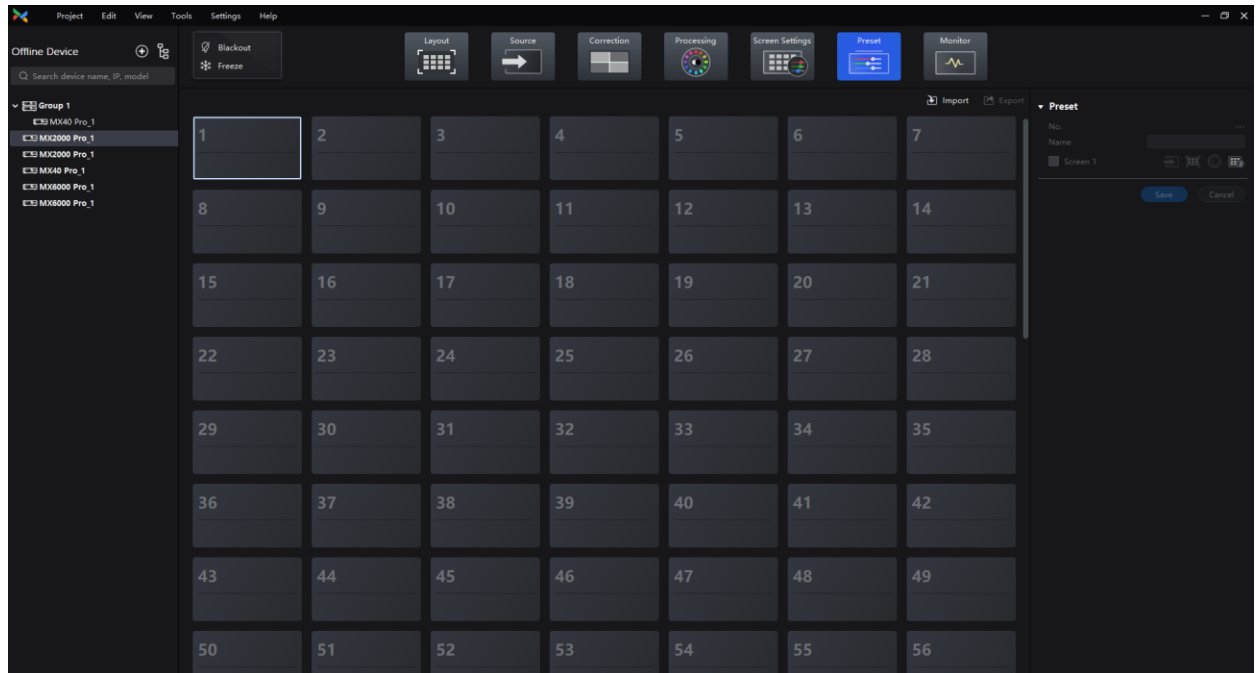
Operating Procedure

Step 1 Select the controller from the device list and then select Preset.

Step 2 On the preset management page, click  to enter the page shown in [Figure 4-51](#) .

To go back to the preset management page, click a blank area in the properties area.

Figure 4-51 Preset management



Step 3 Click the icon of a preset.

Step 4 In the properties area, set a name for the preset and select the screen and data you need to save.

If the preset you selected is not empty, the original data will be overwritten.

Step 5 Click Save.

4.9.2 Apply Presets

Apply a saved preset to quickly complete settings of the parameters on the **Source**, **Layout**, **Processing** and **Screen Settings** pages.

Notice

The preset of a specific device can only be applied by this device itself and the preset of a group can be applied by all the devices in the group.

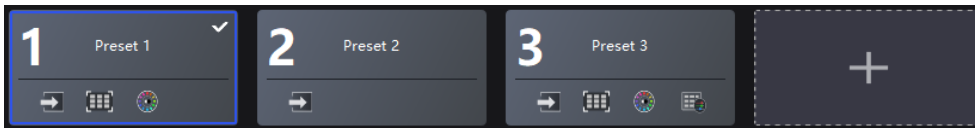
Operating Procedure

Step 1 Select the controller from the device list and then select Preset.

Step 2 On the preset management page, double-click a preset and wait it to finish loading.

The preset that is being used has a at the top right.

Figure 4-52 Apply presets



4.9.3 Manage Presets

Select the controller from the device list and then select **Preset** and do the following operations as needed.

Modify a Preset

Select a preset. In the properties area, change the related information and click Save.

Delete a Preset

- Right-click a preset and select **Delete** from the pop-up menu.
- On the preset management page, select a preset and click **Delete** in the properties area.

Clear Presets

Right-click a preset and select **Delete All** from the pop-up menu.

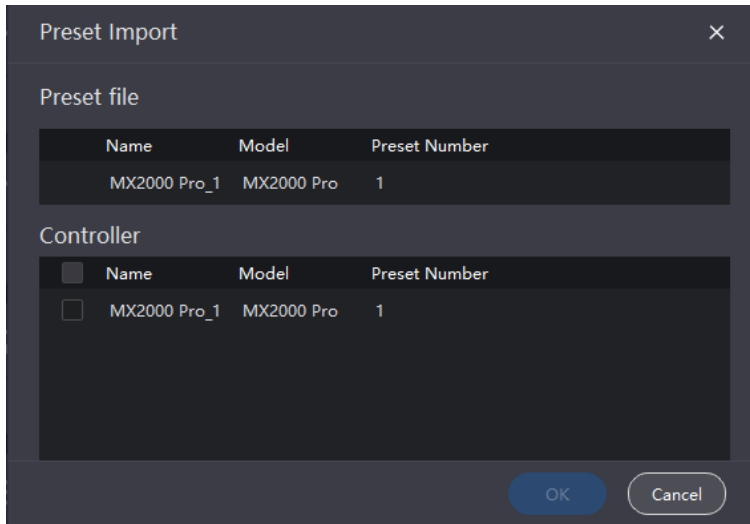
4.9.4 Import and Export Presets

Select the controller from the device list and then select **Preset** and do the following operations as needed.

Import Presets

Click **Import**, select a preset file (.nprt) and click **Open**. In the displayed dialog box, select the device to which you want to import the file and click **OK**.

Figure 4-53 Import presets



Export Presets

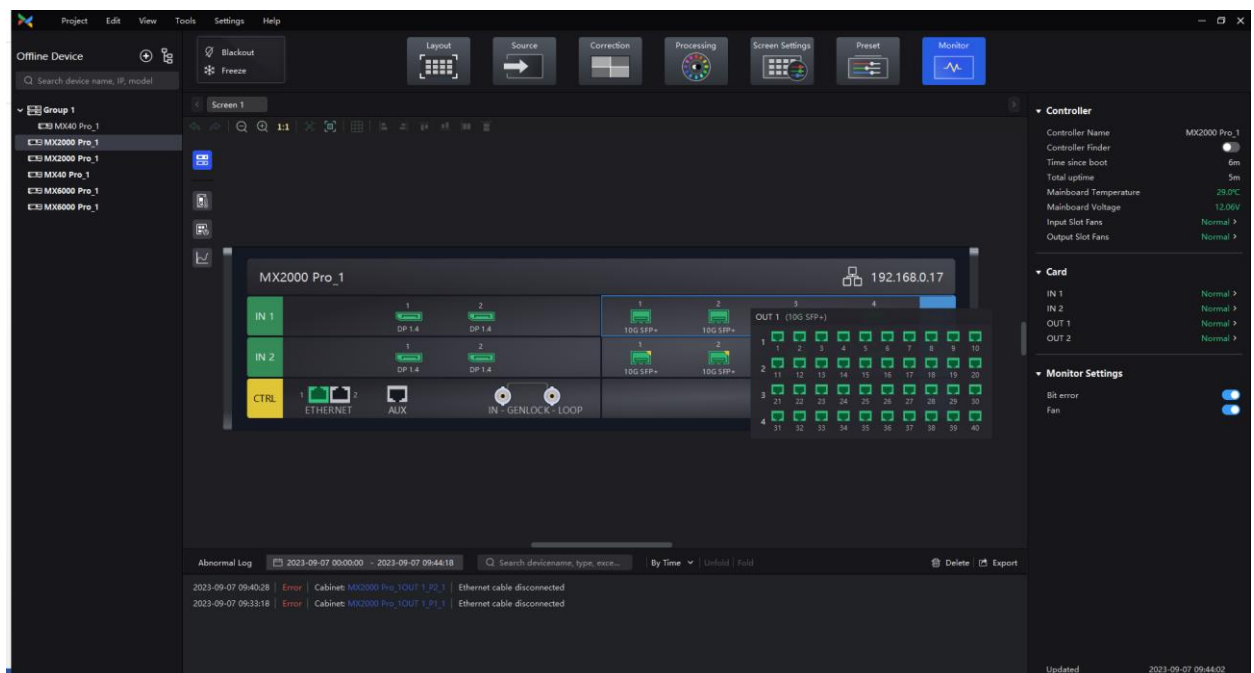
Click **Export**, select a file page, set a file name, and click **Save**.










4.10 Screen Monitoring

4.10.1 Check device status




Select the controller from the device list and then select **Monitor**. Click the function icons on the left to check the related information

Figure 4-54 Screen monitoring



- : The controller.
 - Check the status of the connectors on the rear panel of the controller.
 - Check the controller's name, current uptime, total uptime, mainboard temperature, mainboard voltage, and fan status.
 - Check the temperature and voltage of the cards.
 - Set on/off of the **Controller Finder** switch. When set to , you can locate the controller.
 - Set on/off of the **Total Errors** switch. When set to , you can monitor the errors.
 - Set on/off of the **Fan** switch. When set to , you can monitor the fan status and display it in the **Controller** area.
- : The receiving card temperature. In the properties area, you can check the temperature information.
- : The cabinet voltage. In the properties area, you can check the voltage information.
- : The total bit errors. In the properties area, you can check the detailed information of the errors. Click  to clear the errors and click  to check the error information in a specified time range.

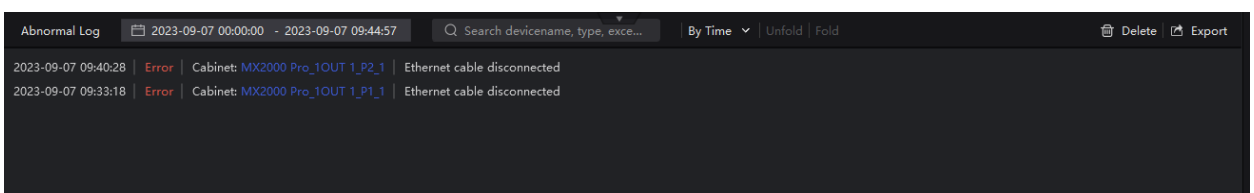
Note

Selecting , , or  enables you to check the cabinet position, voltage, total uptime, and current uptime under the **Cabinet** section of the properties area. You can also blackout, freeze, or enable test patterns for cabinets under the **Cabinet Settings** section.

4.10.2 Check Monitoring Records

Select the controller from the device list and then select **Preset**. At the bottom of the page, do the operation as needed.

Figure 4-55 Monitoring records



Search records

Enter the key words in the search box.

✦ Query records

Click the time widget and set the start and end time. If you select **Now**, the monitoring records will be updated in real time.

✦ Set how the records are displayed

From the drop-down list, select **Sort by time**, **Order by controller**, **Order by type**, and **Order by level**. If the latter three are selected, the records can be expanded or collapsed.

✦ Clear records

Click **Delete** and then click **OK**.

✦ Export records

Click **Export**, select a file page, set a file name, and click **Save**.

4.11 Calibration Coefficient Management

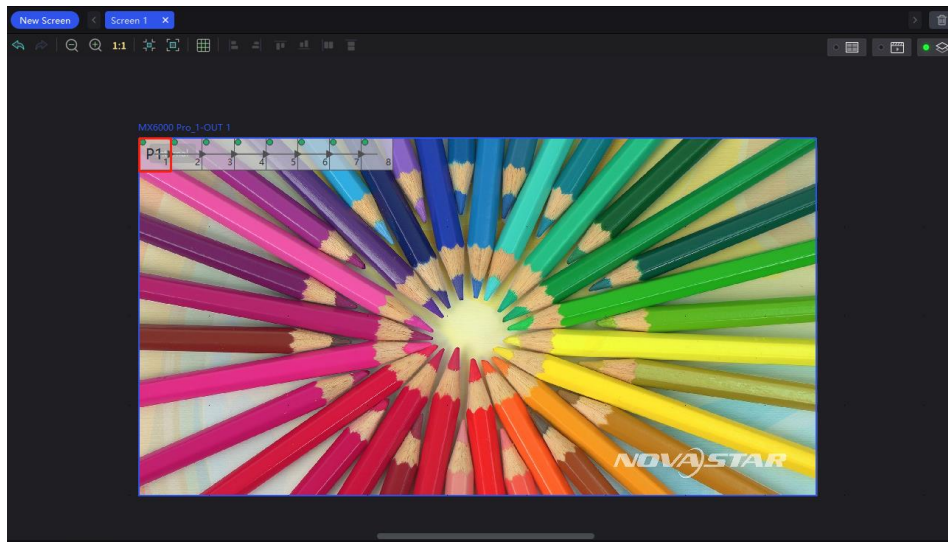
Upload, save, adjust, and read back calibration coefficients.

4.11.1 Upload Calibration Coefficients

Upload the local calibration coefficient file to the current screen, cabinet or module and apply the coefficients to the display effect.

Prerequisites

- To upload screen coefficients, make sure:
 - The screen configuration is done, the cabinets are not rotated, and there are no cabinet gaps or overlapping.
 - The configured screen must be rectangular, and the cabinet on the top left corner (as shown in the figure below) must be at the (0, 0) point of the canvas.



- To use the database file, you should prepare it in advance, and the resolutions of the configured screen and the screen in the database must be the same.
- To upload cabinet coefficients, make sure:
 - The target cabinets must have cabinet IDs.

Notice

During coefficient uploading, if the controller and/or receiving cards go offline, the uploading will fail.

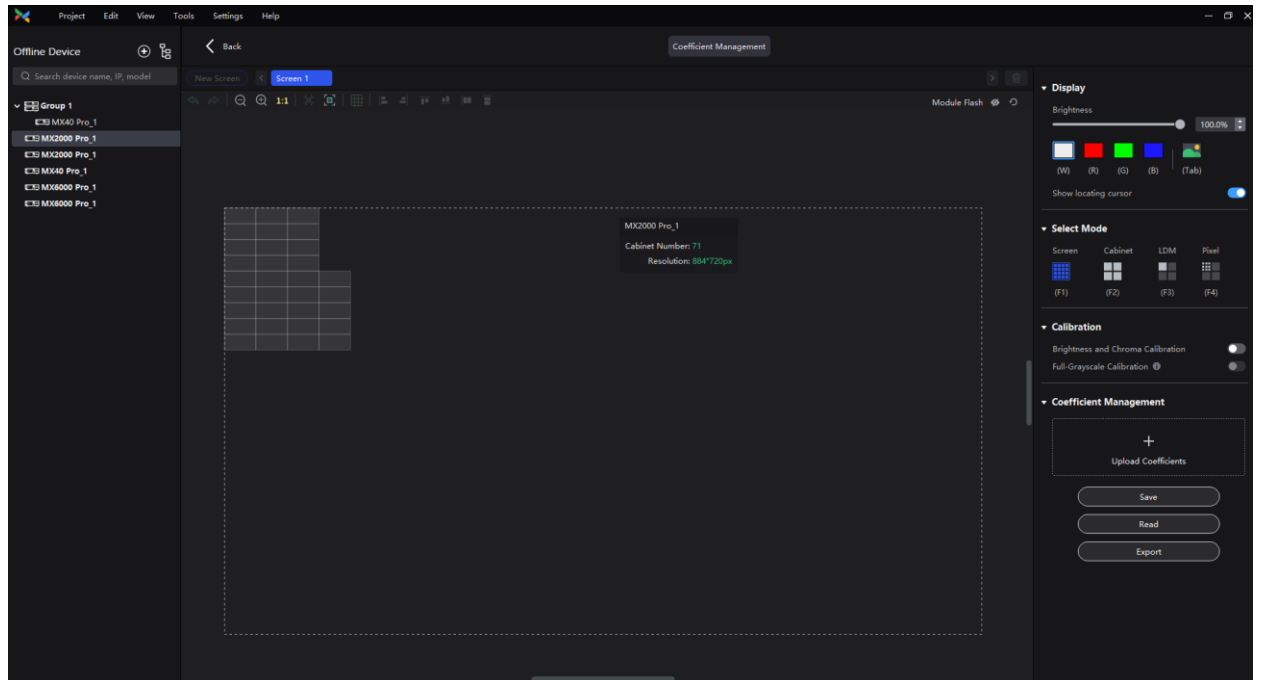
If the coefficient uploading fails, the coefficients will not be saved automatically. You can manually save them as needed.

Operating Procedure

Step 1 In the device list on the left, select the desired controller.

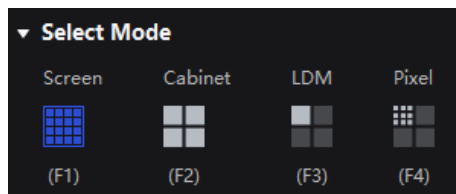
Step 2 From the menu bar, choose **Tools > Coefficient Management**.

Figure 4-56 Calibration coefficient management



Step 3 In the **Select Mode** area, select the uploading range. The options include **Screen**, **Cabinet** and **LDM**.

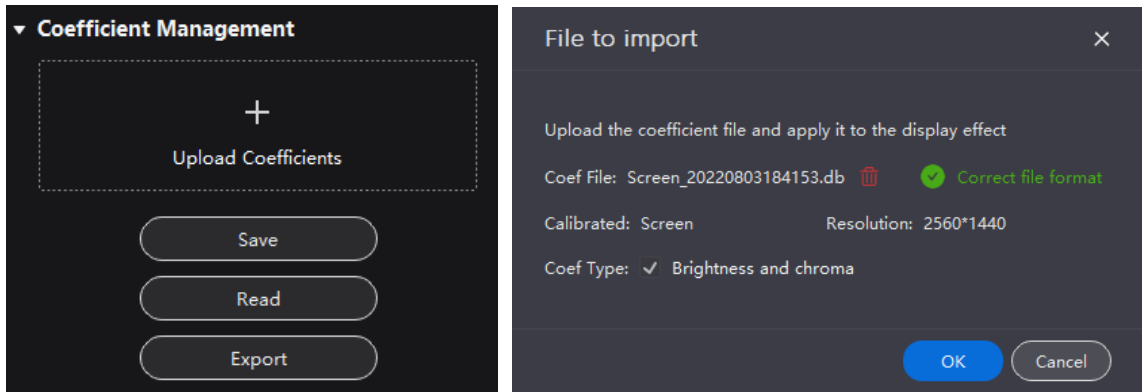
Figure 4-57 Select mode



Step 4 In the **Coefficient Management** area, click **+** and select the target calibration data file (.db) from the local computer.

The coefficient types in the file will be read automatically. You can select the range of coefficient types as needed.

Figure 4-58 Upload calibration coefficients



Step 5 Click OK to upload the coefficients to receiving cards.

4.11.2 Edit Calibration Coefficients

Prerequisites

- Calibration coefficients are available.
- Cabinet configuration is done and the cabinets stay online.

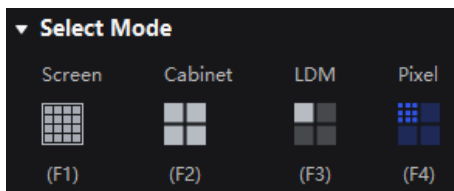
Operating Procedure

Step 1 In the device list on the left, select the desired controller.

Step 2 From the menu bar, choose **Tools > Coefficient Management**.

Step 3 In the **Select Mode** area, select **Pixel**.

Figure 4-59 Select mode



Step 4 In the topology, click to select a cabinet.

Step 5 In the displayed window, select the target pixels and enter the parameters in the **Coefficient Management** area to adjust the proportion relationship of the red components, green components and blue components in RGB.

The calibration coefficients of the selected pixels will be overridden and changed to the values you set.

Figure 4-60 Pixel calibration coefficients

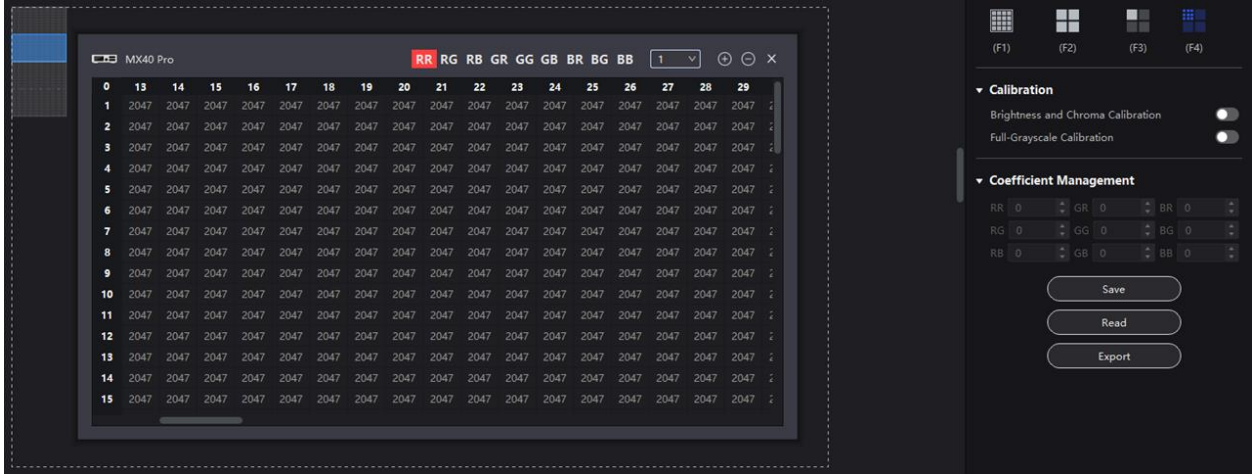


Table 4-2 Table 12-1 Parameter relationship and value range

/	Red-R	Green-G	Blue-B
Red-R	RR (512 ~ 2047)	GR (0 ~ 255)	BR (0 ~ 127)
Green-G	RG (0 ~ 255)	GG (512 ~ 2047)	BG (0 ~ 255)
Blue-B	RB (0 ~ 127)	GB (0 ~ 127)	BB (512 ~ 2047)

Table 4-3 Icon description

Icon	Description
	The step of single increase or decrease. Use it together with
	Increase or decrease the coefficient value of the selected pixel.
	Click to close the pixel topology.

4.11.3 12.3 View Calibration Effect

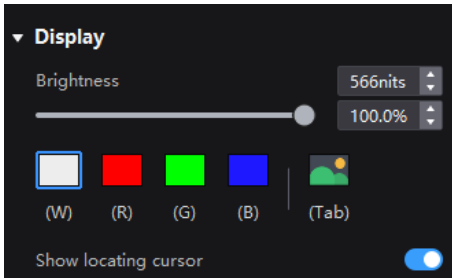
Notice



If brightness correction has been done for the screen, the screen brightness can be adjusted in nits. Otherwise, it can be adjusted only in percentage.

Set the Display Content

In the Display area, you can adjust the screen brightness to clearly see the actual calibration effect change at each grayscale. You can also switch the color to see the uniformity of a single color and the entire display image.

Figure 4-61 Set display content



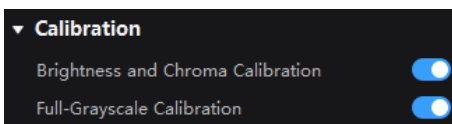
- **Brightness:** Adjust the screen brightness.
- **Display image:** Set the image displayed on the screen. To display the current source image, click and hold .
- **Show locating cursor:** When the switch is set to , the selected area on the screen will display blue borders. This helps you quickly locate the cabinets, modules or pixels that you are currently operating.

Enable and Disable Calibration Effect

In the **Calibration** area, you can turn on or off the sub-calibration switches and then view the display effects before and after the calibration.

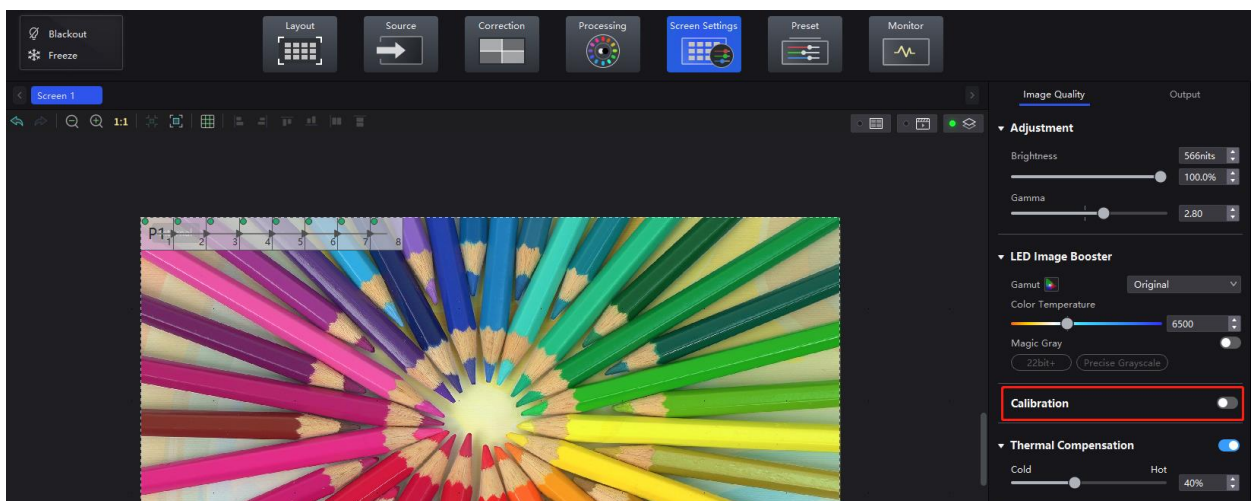
The sub-calibration switches include **Brightness and Chroma Calibration**, **Full-Grayscale Calibration** and **Low-Grayscale Calibration**. The actual displayed switches depend on the existing coefficient types of the screen.

Figure 4-62 Sub-calibration switches



The main calibration switches are on the **Correction** and **Screen Settings** pages. When the main calibration switches are turned on or off, all the sub-calibration switches will be turned on or off simultaneously.

Figure 4-63 Main calibration switches



4.11.4 Save Calibration Coefficients

Notice

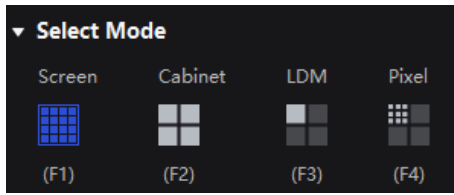
During coefficient saving, if the receiving cards go offline, the saving will fail.

Operating Procedure

Save the calibration coefficients of the current screen, cabinet or module to the receiving card to avoid calibration effect loss due to power failure.

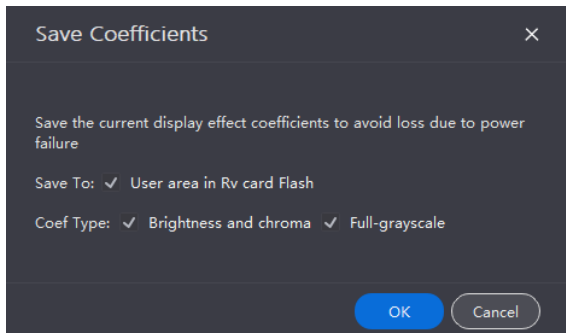
- Step 1 In the device list on the left, select the desired controller.
- Step 2 From the menu bar, choose **Tools > Coefficient Management**.
- Step 3 In the **Select Mode** area, select the saving range as needed, including **Screen, Cabinet, LDM** and **Pixel**.

Figure 4-64 Select mode



Step 4 In the **Coefficient Management** area, click **Save**.

Figure 4-65 Save Calibration Coefficients



Step 5 In the pop-up dialog box, set the relevant parameters and click **OK** to save the current coefficients to the receiving cards.

4.11.5 Read back coefficients

Read back the calibration coefficients saved in the receiving card and apply them to the current screen.

Notice

During coefficient readback, if the receiving cards go offline, the readback will fail.

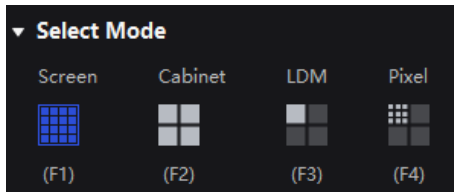
Operating Procedure

Step 1 In the device list on the left, select the desired controller.

Step 2 From the menu bar, choose **Tools > Coefficient Management**.

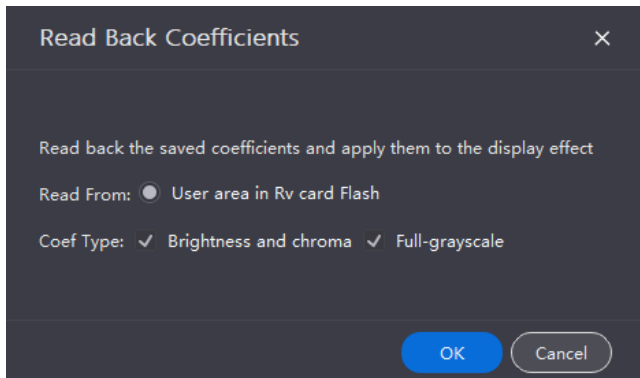
Step 3 In the **Select Mode** area, select the reading range as needed, including **Screen**, **Cabinet**, **LDM** and **Pixel**.

Figure 4-66 Select mode



Step 4 In the **Coefficient Management** area, click **Read**.

Figure 4-67 Read back coefficients



Step 5 In the pop-up dialog box, set the relevant parameters and click **OK** to read the coefficients and apply them to the screen.

4.11.6 Export coefficients

Export the calibration coefficients of the current screen, cabinet or module to the local computer. When the receiving card is replaced or the new screen has the same specifications, you can upload the exported calibration coefficients directly to use.

Prerequisites

- To export screen coefficients, make sure:
 - The screen configuration is done, the cabinets are not rotated, and there are no cabinet gaps or overlapping.
 - The configured screen must be rectangular, and the top-left-corner coordinates of the circumscribed rectangle of the configured screen must be (0, 0).
- To export cabinet coefficients, make sure:
 - The target cabinets must have cabinet IDs.

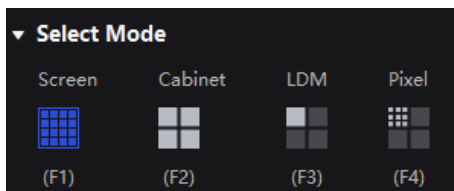
Notice

During coefficient exporting, if the controller and/or receiving cards go offline, the exporting will fail.

Operating Procedure

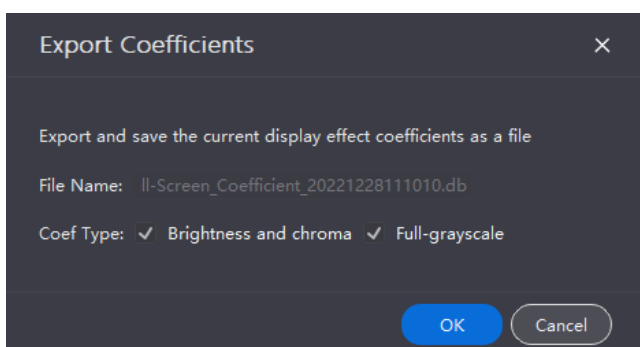
- Step 1 In the device list on the left, select the desired controller.
- Step 2 From the menu bar, choose **Tools > Coefficient Management**.
- Step 3 In the **Select Mode** area, select the export range as needed, including **Screen**, **Cabinet**, **LDM** and **Pixel**.

Figure 4-68 Select mode



- Step 4 In the **Coefficient Management** area, click **Export**.
- Step 5 Select a file path on the pop-up dialog box and click **Save**.
- Step 6 In the pop-up **Export Coefficients** window, set the relevant parameters and click **OK** to export the coefficients of the screen to a file (.db).

Figure 4-69 Export coefficients

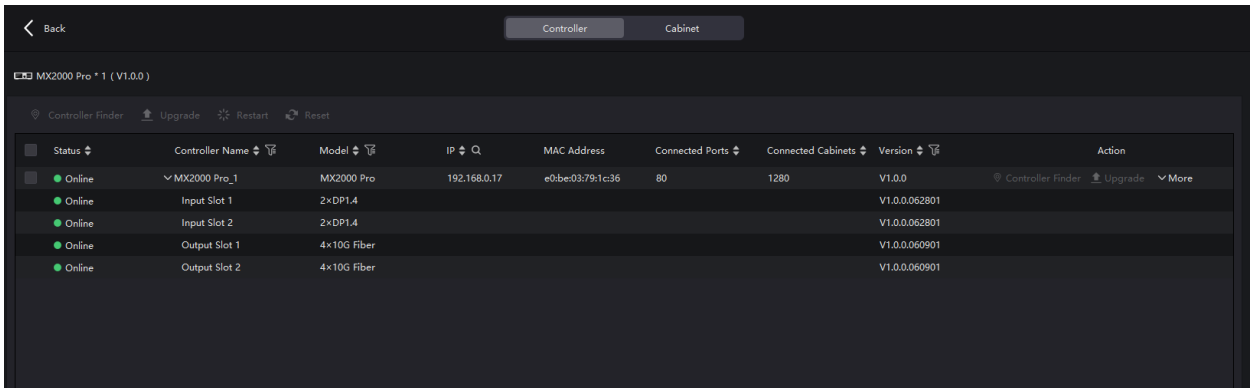


4.12 Screen Maintenance

4.12.1 Maintain Controllers

From the menu bar, choose **Tools > Maintain** and do the following operations as needed.

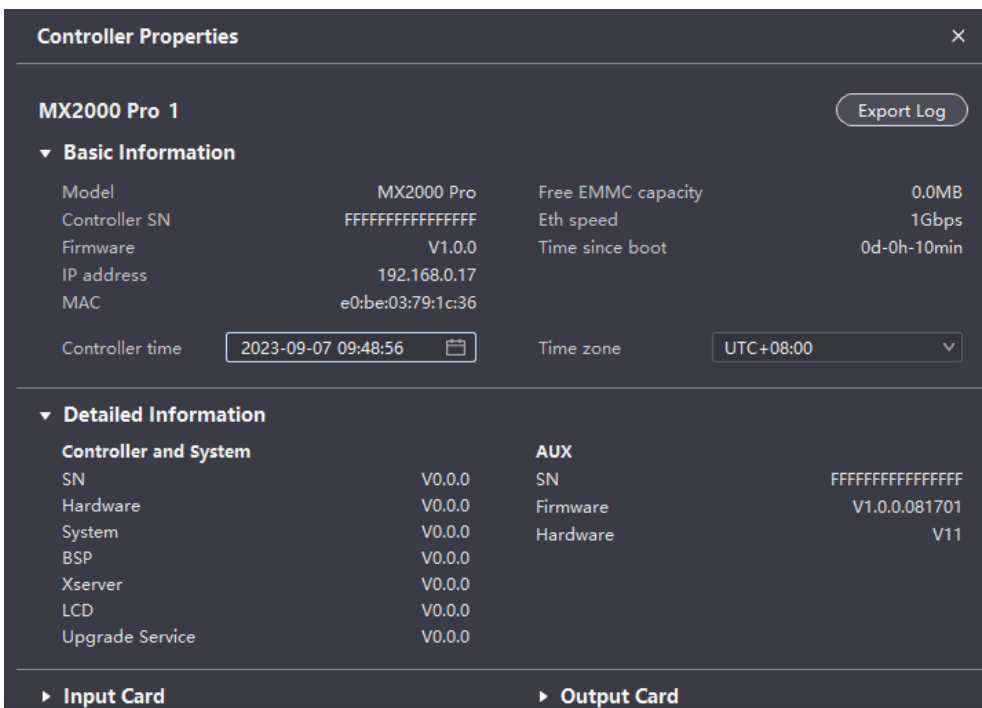
Figure 4-70 Controller maintenance



Operations in Device List

In the device list, right-click a controller. In the pop-up menu, select **Controller Properties** to open its dialog box.

Figure 4-71 Controller properties



✦ Check the device Information

Check the basic information, detailed information, input card information and output card information of the controller.

✦ Change the time

Click the time widget and change the time.

✦ Change the time zone

Select a time zone from the **Time zone** drop-down list.

✦ Export Logs

Click **Export Log**, select a location, set the file name, and click **Save**.

After you right click a controller in the device list, you can also perform the following operations:

✦ Rename the controller

In the pop-up menu, select **Rename** and rename the controller name and IP Address.

✦ Enabling Mapping

In the pop-up menu, select **Mapping** to enable the Mapping function. It allows users to easily obtain the locations and connection topology of receiving cards.

Figure 4-72 Edit controller

Operations on Controller Maintenance Page

In the device list on the left, select a controller or a group. On the **Controller** page, select the target controllers and then perform the operations.

✦ Find the controller

Click **Controller Finder** to mark the area loaded by the controller on the LED screen and the LCD screen of the controller becomes green, which helps you find the controller quickly.

✦ Upgrade the firmware program

Click **Upgrade**, select the firmware program file (.img) or .zip file and click **Open**. On the displayed window, double-check the uploaded file name and version and click **Update** to start upgrading.

Note

All cards must be updated at the same time.

During the upgrade process, the controller will automatically restart. In addition, please do not close VMP or switch to another controller until the upgrade is complete.

+ Restart the controller

Click **Restart** and click **OK**.

+ Reset settings (operate with caution)

Click **Reset** and click **OK**.

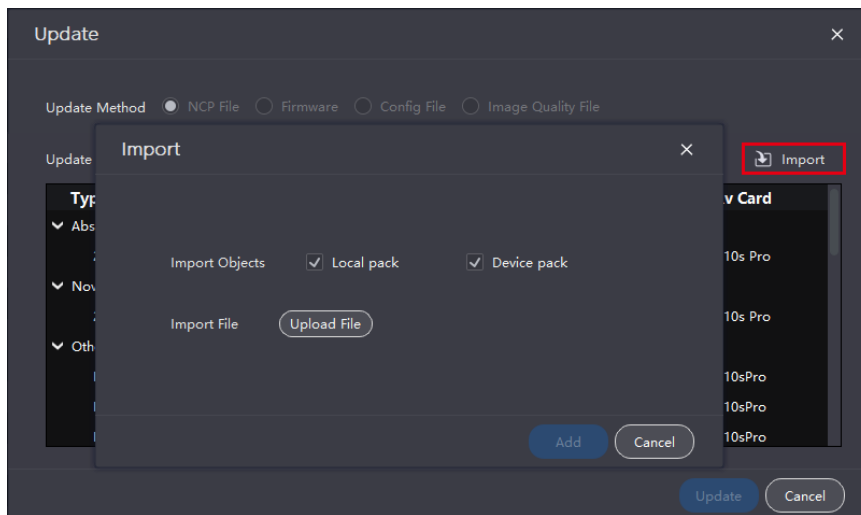
4.12.2 Maintain Cabinets

Related Information

For the cabinet painter operation, the configuration parameters of the cabinet to be copied can be saved to local computer as an .rpkg file for future use.

Operating Procedure

From the menu bar, choose **Tools > Maintain** and select the **Cabinet** tab. In the device list, select the target controllers and perform the following operations on the cabinets as needed.



- b. Click **Import** and upload the file.
 To upload NCP file, select **NCP File**.
 To upload firmware program, select **Firmware**.
 To upload configuration file, select **Config File**.
 To upload image quality file, select **Image Quality File**.
- c. Select the target row of cabinet data and click **Update**.
- d. After the file is uploaded, click **Save Rv-card config**.

✦ Refresh information

Click **Refresh**.

✦ Find the cabinet

Click **Cabinet Finder** in the **Action** column. This function helps you find the cabinet on the screen quickly.

4.13 Software Settings

4.13.1 Offline Mode

You can add offline devices without connecting to a device to perform operations in VMP.

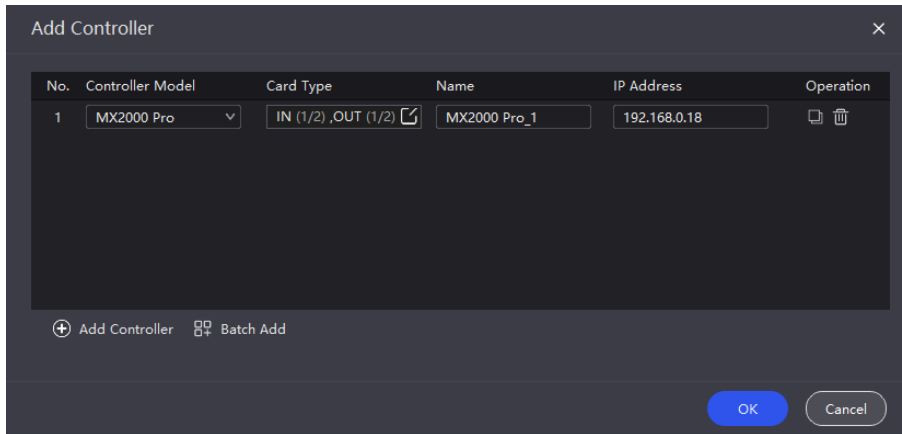
Step 1 From the menu bar, choose **Tools > Offline Mode > Enter Offline Mode**.

Step 2 Click **+** on the top of the device list.

Step 3 Click **Add Controller** in the pop-up dialog box.

To add multiple devices of the same model, click **Batch Add**.

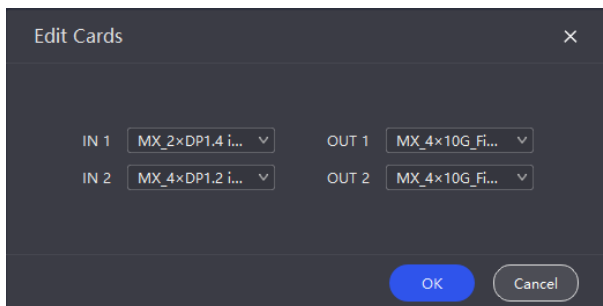
Figure 4-74 Add controller



Step 4 Select **MX2000 Pro** from the drop-down list of **Controller Model**.

Step 5 Click and then select input and output cards in the pop-up window. Click **OK** once you are done.

Figure 4-75 Edit cards



Step 6 Fill in the IP address and controller name.

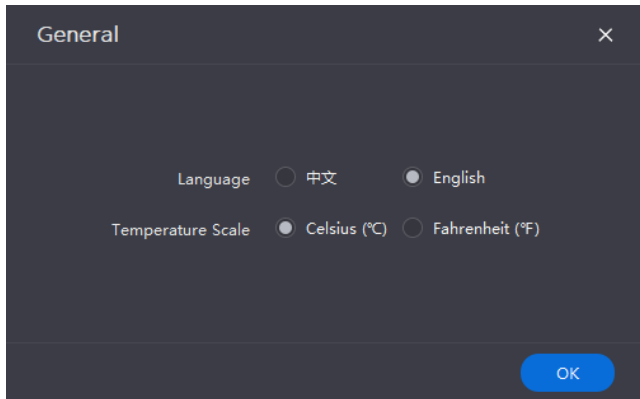
Step 7 Click OK once you are done.

Click to copy the current device and click to delete it.

4.13.2 14.1 Change Language and Temperature Scale

From the menu bar, choose **Settings > General**, select the target language and temperature scale, and click **OK**.

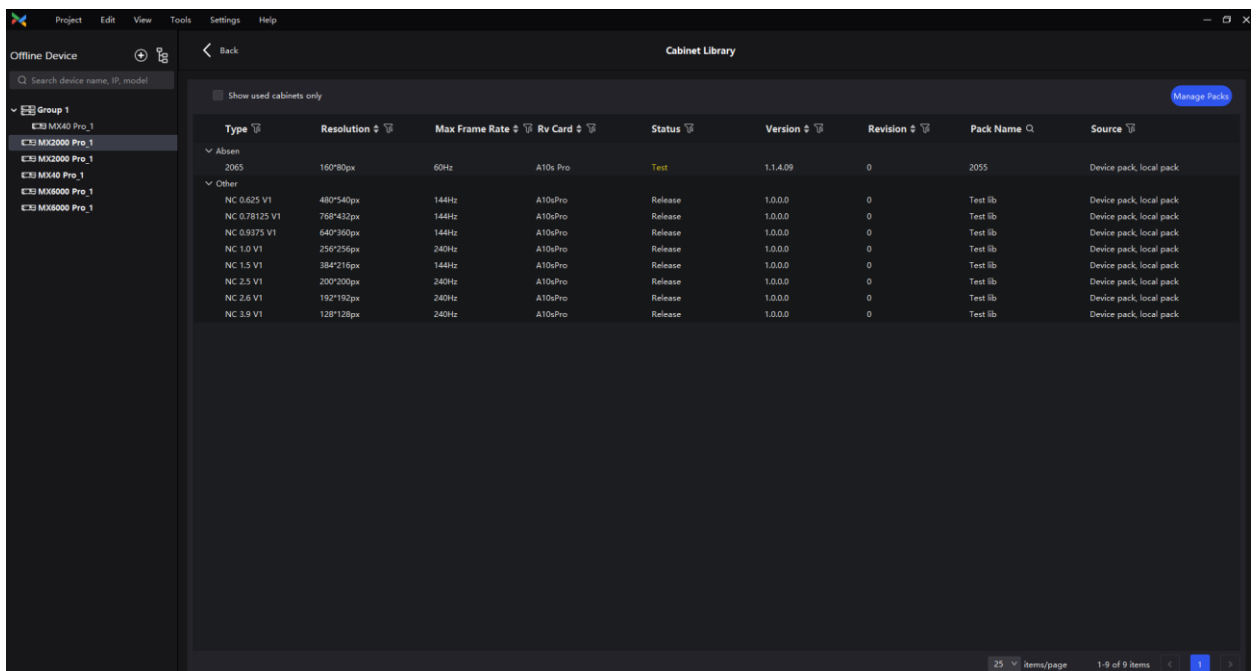
Figure 4-76 Changing the display language



4.13.3 Manage Cabinet Library

From the menu bar, choose **Settings > Cabinet Library**. Click **Manage Packs** and do the following operations as needed to manage the cabinet library files.

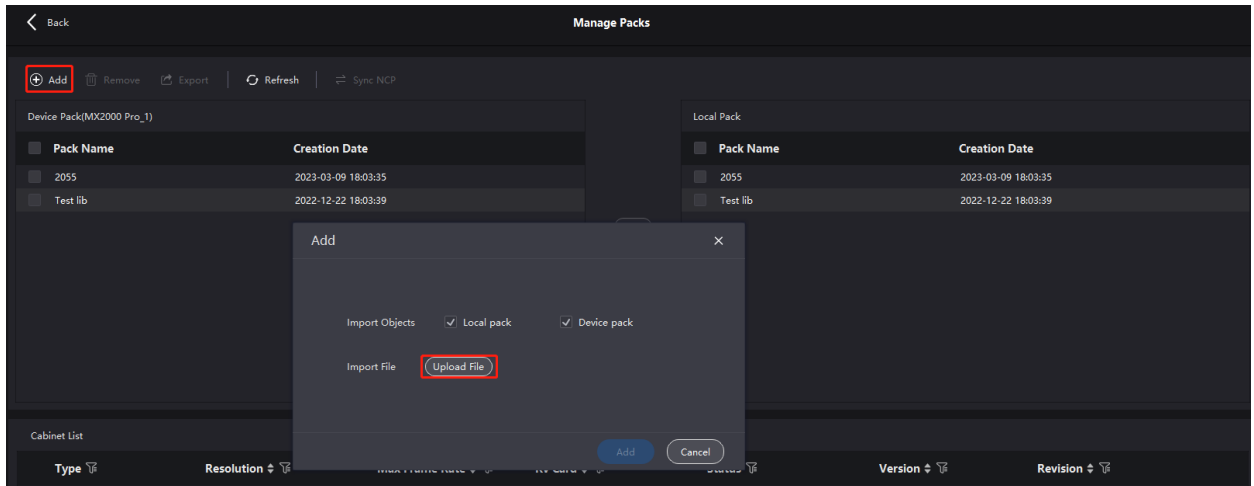
Figure 4-77 Cabinet library



Upload NCP File

Step 1 Click **Add**. On the displayed window, click **Upload File**.

Figure 4-78 Adding NCP file



Step 2 Select the targets to be imported (multiple targets can be selected).

- When Local pack is selected, the imported NCP file will be saved under the VMP installation directory.
- When Device pack is selected, the imported NCP file will be saved in the LED controller's storage space.

Step 3 Select the .ncp file to be imported from the local computer and click Add.

After the file is selected, you can click Delete to delete the uploaded file.

You can also click Refresh to refresh the NCP file list.

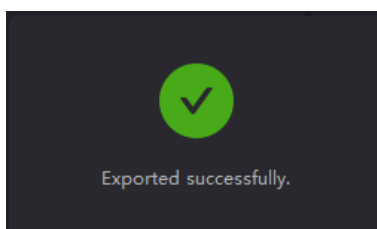
Export NCP File

Step 1 Select one or more files on the **Manage Packs** screen and then click **Export**.

For batch export, multiple files will be compressed as a .zip file and exported.


Step 2 Select a local directory and click **Save**.

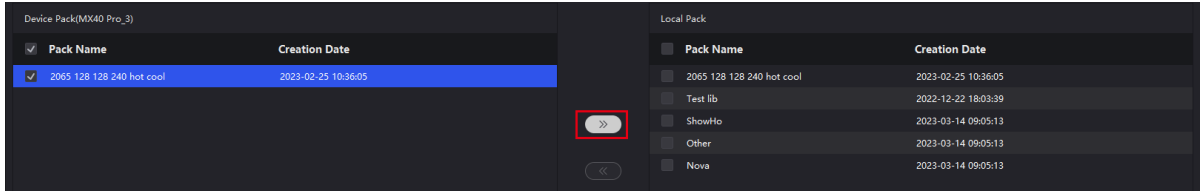
Figure 4-79 Successful export



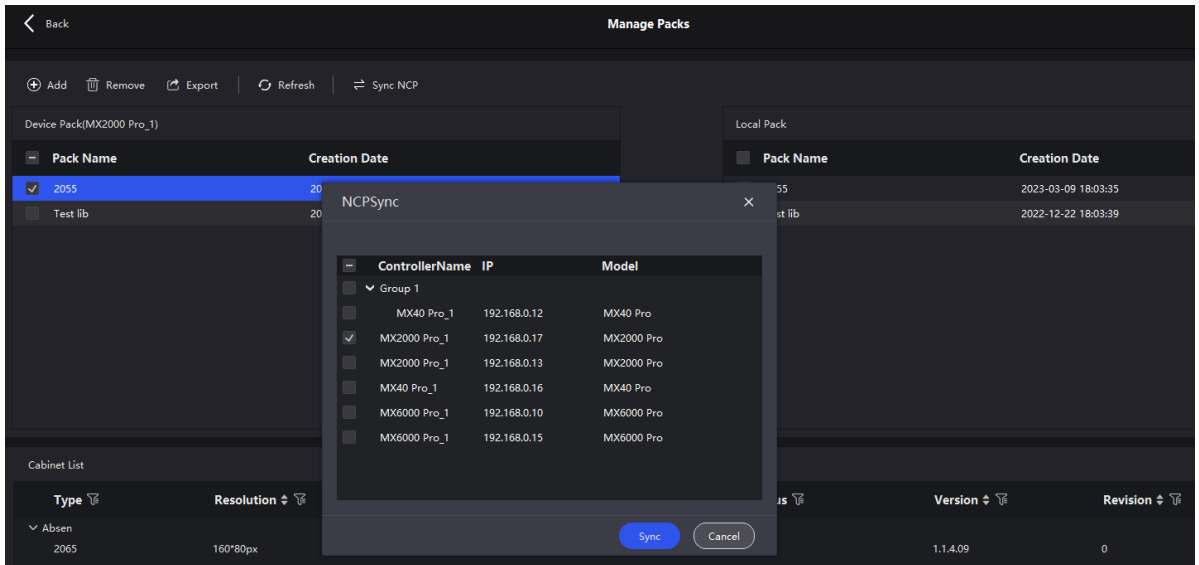
Sync NCP File

- Sync NCP files between the device and local computer

Select the files to be synced (multiple files can be selected), and click .



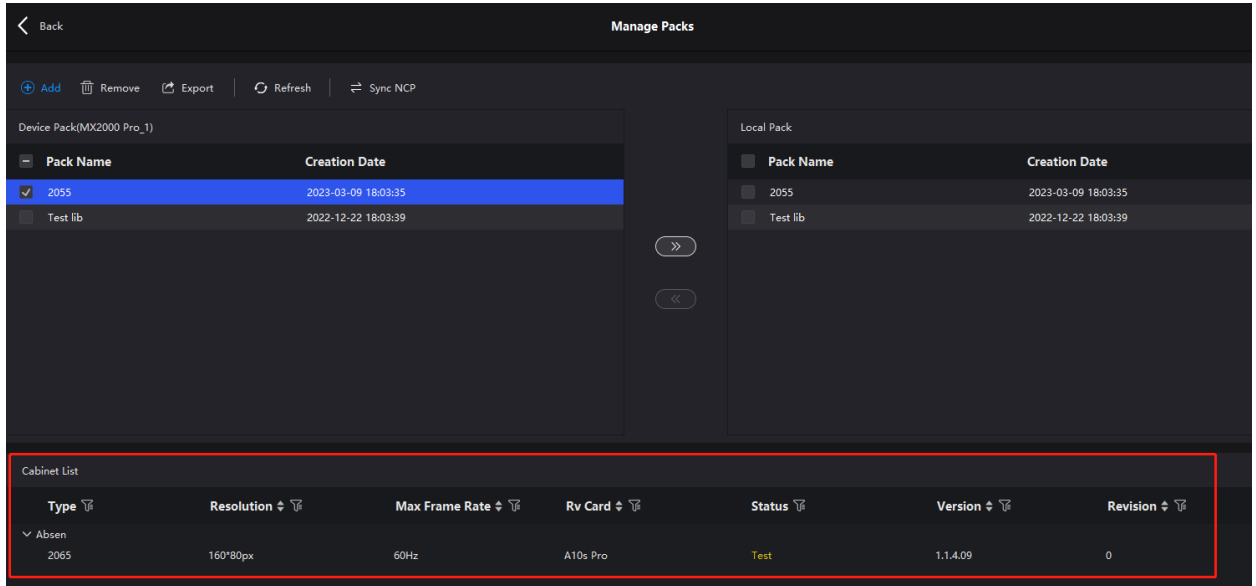
- Sync NCP files between devices
 - Select the files to be synced (multiple files can be selected), and click **Sync NCP**.
 - On the displayed window, select the devices to which the files are synced (multiple devices can be selected).
 - Click **Sync**.



Check NCP File Information

Select an NCP file, and the information about all the cabinets that use this NCP file will be displayed in the **Cabinet List** area below. The information includes cabinet type, resolution, maximum frame rate, receiving card type, release status, version and revision.

Figure 4-80 NCP file information



4.13.4 14.3 Check User Manual

From the menu bar, choose **Help** > **User Manual** to open and check the VMP user manual.

4.13.5 View Software Information

From the menu bar, choose **Help** > **About** and check the software information.

4.13.6 Check Keyboard Shortcuts

From the menu bar, choose **Help** > **Keyboard Shortcuts** and check the commonly used software operation shortcuts.

5 Front Screen Panel

5.1 UI Introduction

5.1.1 Home Screen

After the device is powered on, the home screen showing device related information is displayed as [Figure 5-1](#) . Rotate the knob to select an input or output card to view its details, as shown in [Figure 5-2](#) .

Figure 5-1 Home screen

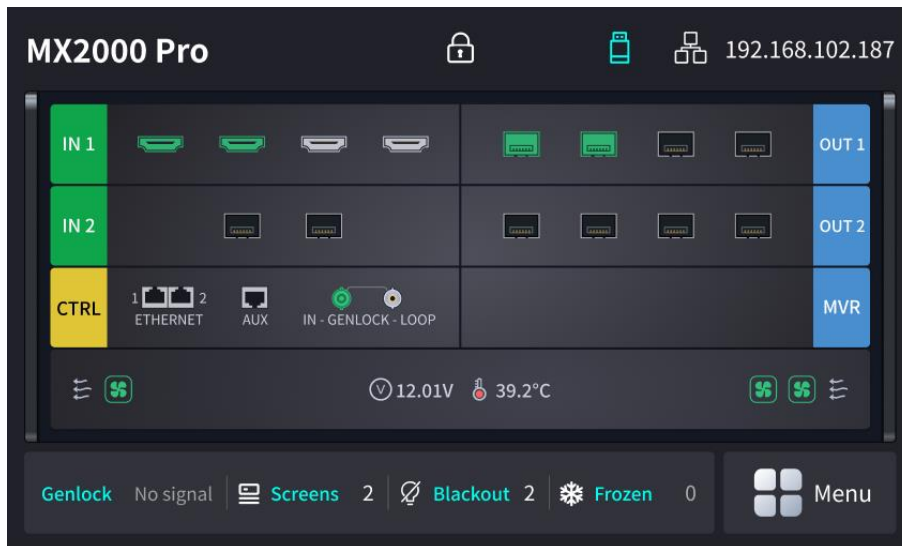
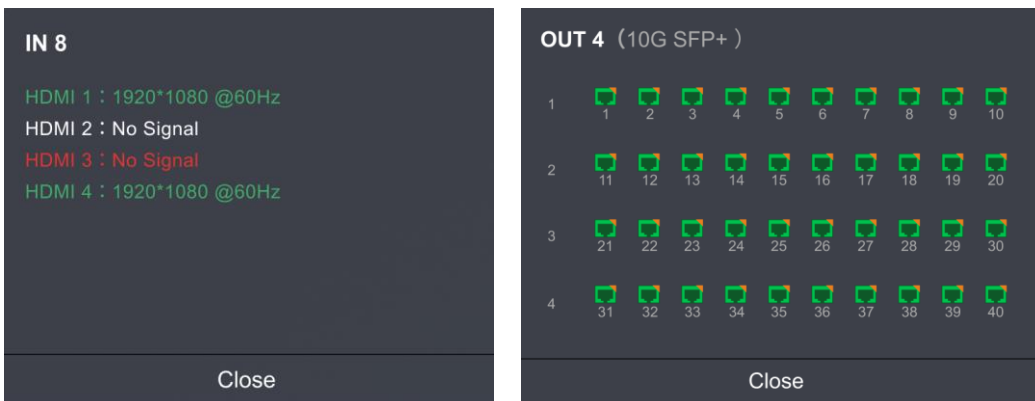







Figure 5-2 Input and output card details



The home screen is shown in [Figure 5-1](#) and the home screen descriptions are shown in [Table 5-1](#).

Table 5-1 Home screen descriptions

Area	Content	Description
Top line	MX2000 Pro	The device name. The name can be changed in VMP software.
		The device button and touchscreen lock status. <ul style="list-style-type: none"> • When the icon is displayed: The buttons are locked. • When the icon is not displayed: The buttons are unlocked Hold down the knob and BACK button simultaneously for 5s or longer to lock or unlock the buttons and screen.
		The connection status of the USB drive <ul style="list-style-type: none"> • Green: Connected • When the icon is not displayed: Disconnected
	192168102187	The device IP address
Input / Output	IN 1 to 2	The device input source type and status. <ul style="list-style-type: none"> • Green: The input source is connected. • Red: The input source is being used for the screen but not connected. • Gray: The input source is not connected.
	OUT 1 to 2	The status of the output Ethernet ports. <ul style="list-style-type: none"> • Green: The Ethernet port is connected and working normally. • Red: The Ethernet port is connected but working abnormally. • Gray: Disconnected When the Ethernet port, associated card, or associated device is used as a backup, you will see an orange triangular icon displayed in the top-right corner.
	MVR (Reserved)	The status of the MVR card ports.
Control	CTRL	The status of the control Ethernet port, AUX port, and GENLOCK port. <ul style="list-style-type: none"> • Green: Connected • Gray: Disconnected
Monitoring		The chassis fan speed <ul style="list-style-type: none"> • Green: The fan speed is normal.

Area	Content	Description
		<ul style="list-style-type: none"> • Yellow: Fan speed alarm. The speed exceeded the threshold range. • Yellow: Fan speed alarm. The speed exceeded the threshold range significantly.
		<p>The supply voltage of the mainboard.</p> <p>Meaning of numerical colors:</p> <ul style="list-style-type: none"> • Green: The voltage is normal. • Yellow: Voltage alarm. The voltage has exceeded the threshold range. • Red: Voltage alarm. The voltage exceeded the threshold range significantly.
		<p>The temperature inside the chassis</p> <p>Meaning of numerical colors:</p> <ul style="list-style-type: none"> • Green: The temperature is normal. • Yellow: Temperature alarm. The temperature exceeded the threshold range. • Red: Temperature alarm. The temperature exceeded the threshold range significantly.
Bottom line	Genlock	The sync signal currently used.
	Screens	The number of screens with load.
	Blackout	The number of screens that are blacked out.
	Frozen	The number of screens that are frozen.
	Menu	The device main menu.

5.1.2 Main Menu

On the home screen, touch the icon at the bottom right or press the knob to enter the main menu page.

Figure 5-3 Main menu

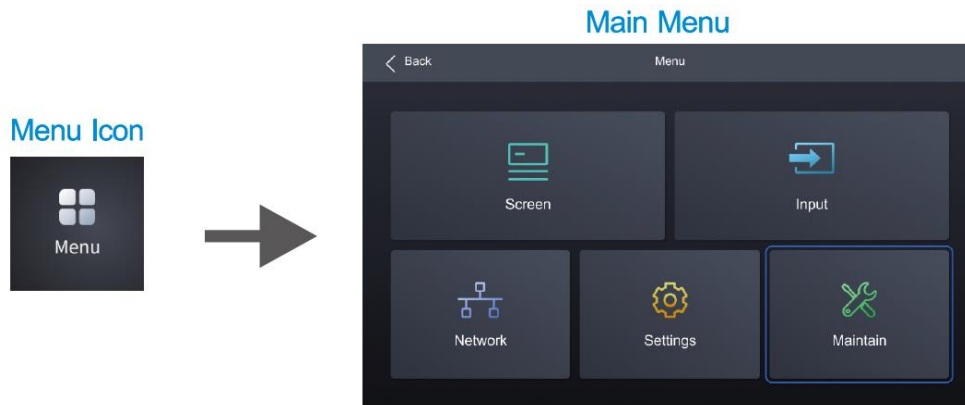







Table 5-2 Main menu description

Module	Description
	Show screen name, sync signal source, and brightness; Set brightness, color temperature, gamma; Enable/Disable black screen or freeze screen.
	Set internal source, check external input source information, and configure EDID and HDR parameters for external input sources.
	Configure network settings.
	Set LCD screen timeout and brightness; Set system language and temperature scale; Check firmware information, and restore factory settings.
	Perform device diagnostics, view and export logs, and check device status.

5.2 Screen

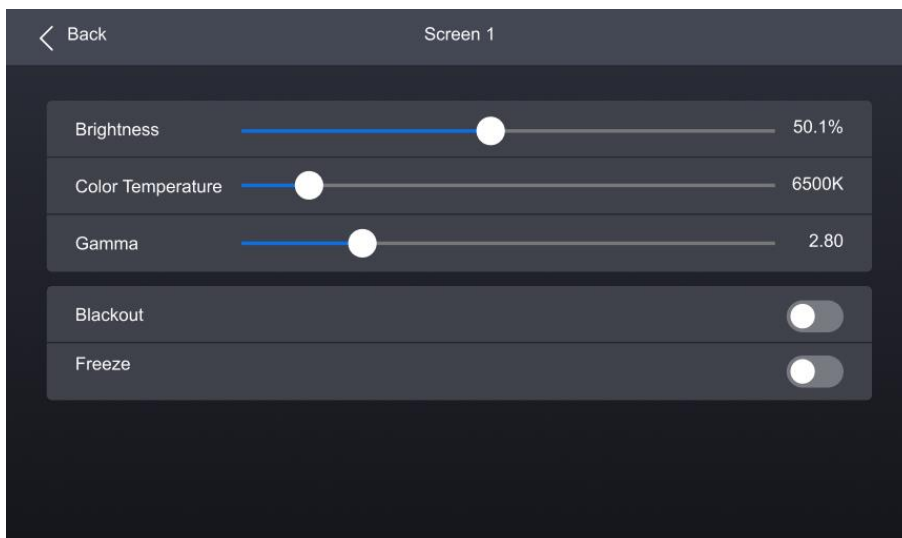
5.2.1 Set Brightness, color temperature and gamma

Step 1 Select **Screen** from the main menu to access the screen list.

The list displays screen names, sync signal sources, and brightness.

Step 2 Select a screen to open the parameter settings.

Figure 5-4 Set Brightness, color temperature and gamma



Step 3 Adjust the values for brightness, color temperature and gamma.

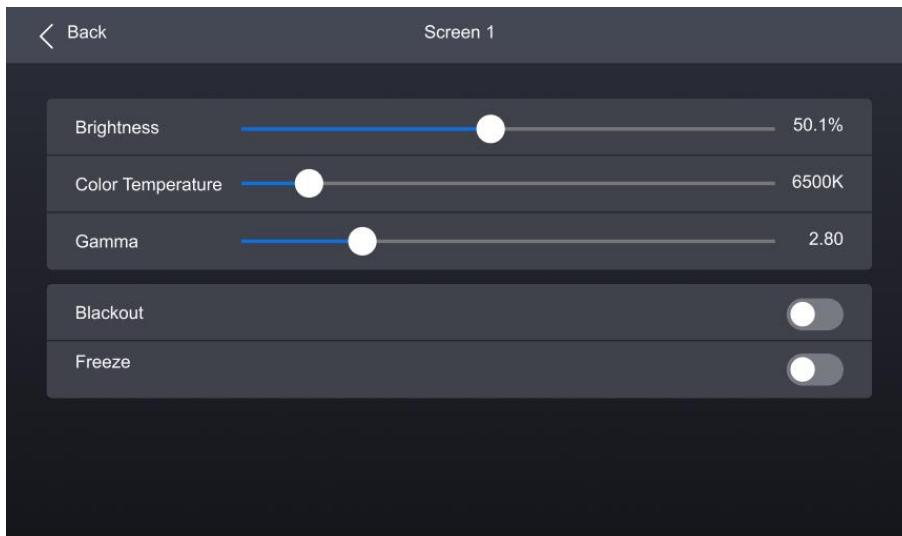
5.2.2 Set screen status

Step 1 Select **Screen** from the main menu to access the screen list.



The list displays screen names, sync signal sources, and brightness.

Step 2 Select a screen to open the parameter settings.

Figure 5-5 Set screen status



Step 3 Select **Blackout** or **Freeze** and then press the knob to toggle on or off the switch.

- : Enabled. The screen display will turn black or freeze, but the playback will not be interrupted.
- : Disabled.

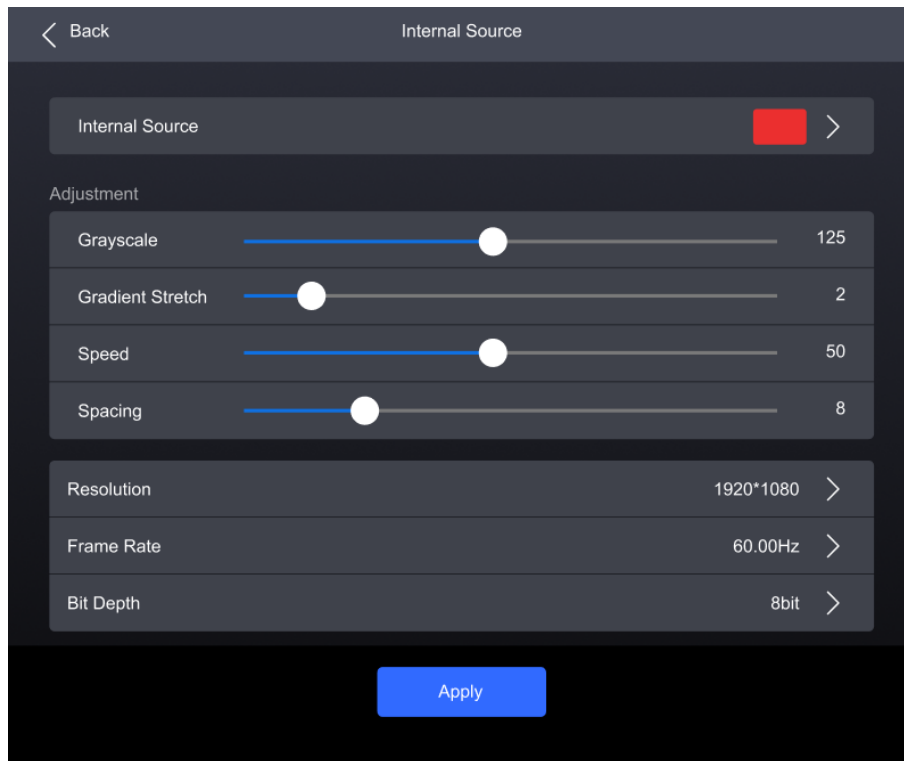
5.3 Input

5.3.1 Set Internal Source

Step 1 Select **Input** from the main menu to access the input source list.

Step 2 Select **Internal source** to open the parameter settings.

Figure 5-6 Internal source



- Step 3 Select **Internal Source**, navigate to the sub-interface, and then select an image.
- Step 4 Press **BACK** to return to the parameter settings.
- Step 5 Set the **Grayscale**, **Gradient Stretch**, **Speed**, and **Space**. The adjustable parameters for each image may vary based on the interface.
- Step 6 Select **Resolution**, **Frame Rate**, and **Bit Depth** in sequence and set a value for each in the pop-up dialog box.
- Step 7 After the settings are done, click **Apply**.

5.3.2 Check Input Source Information

- Step 1 Select **Input** from the main menu to access the input source list.
- Step 2 Select an input source to access the **Information** tab.

Figure 5-7 Input source information

Parameter	Value
Resolution	1920*1080
Frame Rate	60.00 Hz
Bit Depth	8 bit
Colour Space/Sampling	RGB 4:4:4
Gamut	BT.709
Quantization Range	Full (0-255)
Dynamic Range	SDR
MinDML	-
MaxDML	-
MaxCLL	-
MaxFALL	-
White Point	-

Step 3 Check the input source information.

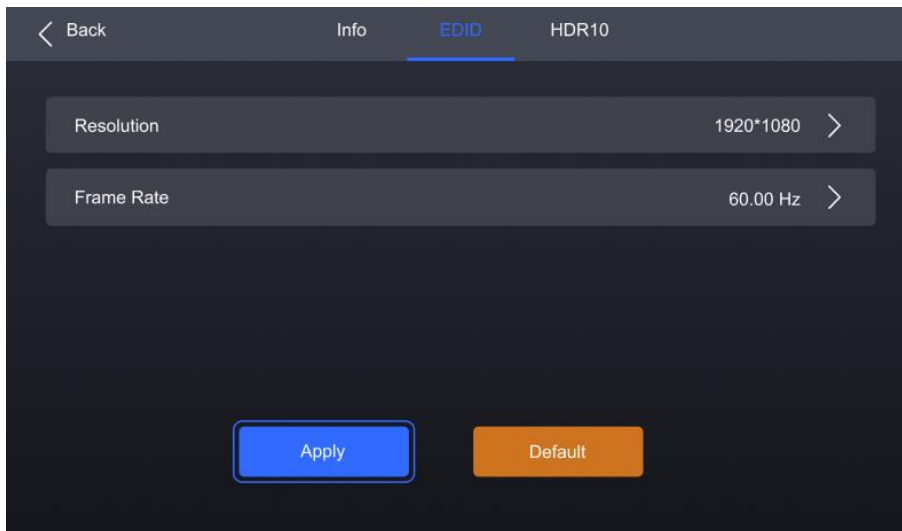
5.3.3 Set EDID

Step 1 Select **Input** from the main menu to access the input source list.

Step 2 Select an input source to open the parameter settings.

Step 3 Navigate to the **EDID** tab.

Figure 5-8 EDID



Step 4 Select **Resolution** and **Frame Rate** in sequence and set a value for each in the pop-up dialog box.

Step 5 After the settings are done, click **Apply**.

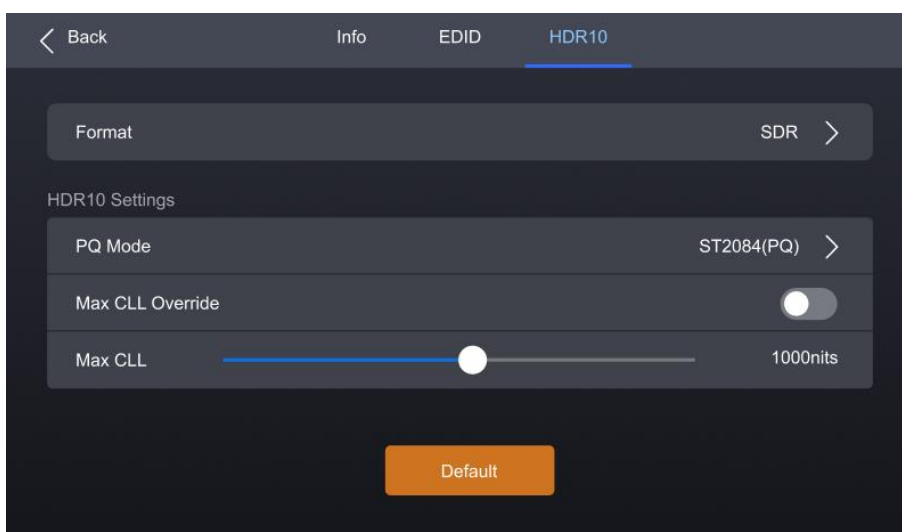
5.3.4 Set HDR

Step 1 Select **Input** from the main menu to access the input source list.

Step 2 Select an input source to open the parameter settings.

Step 3 Navigate to the **HDR10** tab.

Figure 5-9 HDR10



Step 4 Select Format and then select **Auto**, **HDR10**, **HLG**, or **Close** from the pop-up dialog box.

Step 5 For HDR10, please set the relevant parameters.

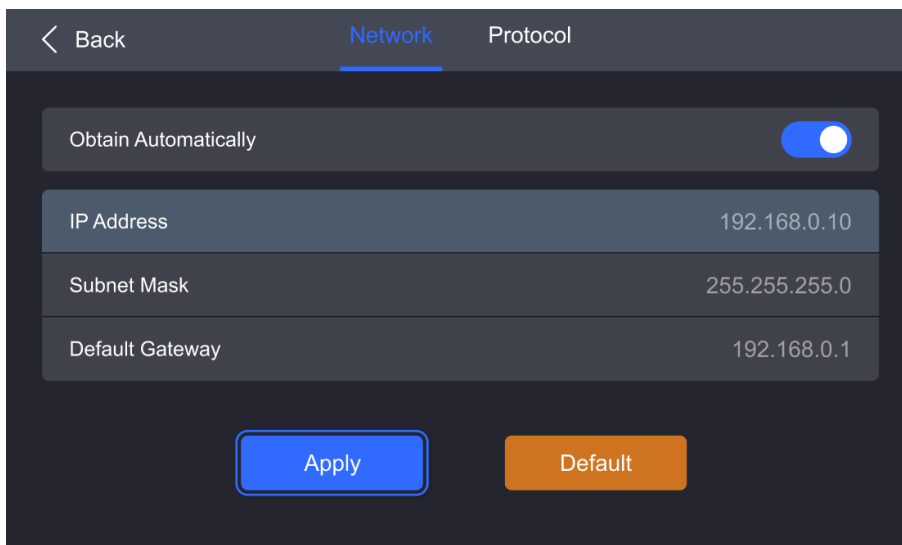
- PQ Mode: The mapping method of video source brightness.
 - ST2084 (PQ): This mode 1:1 maps the brightness of the video source. The part that exceeds the maximum screen brightness will still be displayed as the maximum brightness.
 - ST2086 (Linear mapping): This mode linearly maps the brightness of the video source. It globally adjust the video source brightness according to the maximum screen brightness to ensure that the ratio of the brightness of the entire source content remains unchanged.
- **Max CLL Override:** Enable or disable Max CLL override.
- Max CLL: The max content light level.

5.4 Communication



5.4.1 Setting an IP Address

Step 1 Select **Communication** from the main menu to access the settings interface.

Figure 5-10 Network



Step 2 Toggle on or off **Obtain Automatically**.

- : The device automatically obtain an IP address.
- : You need to manually set an IP address for the device.

Step 3 If **Obtain Automatically** is disabled, you need to set an **IP Address**, **Subnet Mask** and **Default Gateway** and. If it is enabled, this step is not required.

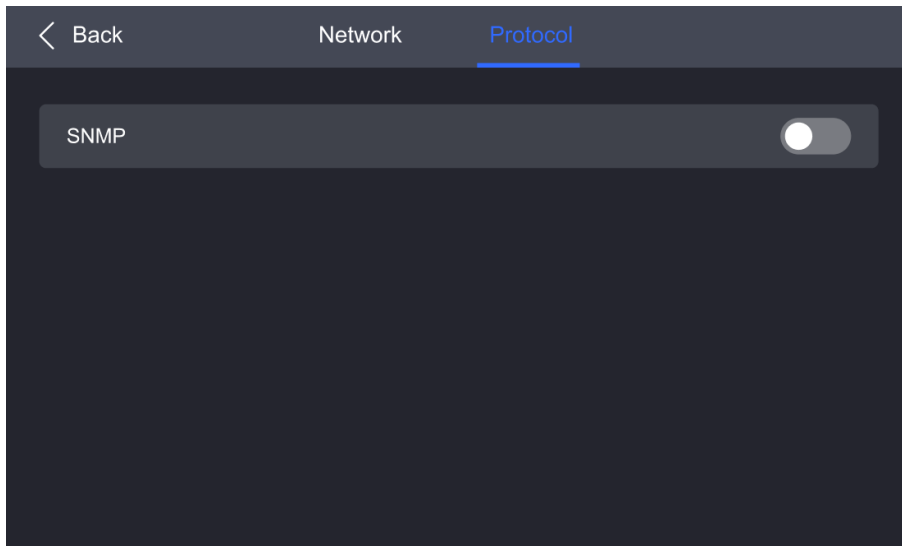
Step 4 After the settings are done, click **Apply**.

5.4.2 Set SNMP



Step 1 Select **Communication** from the main menu to access the settings interface.

Step 2 Select the **Protocol** tab.

Figure 5-11 Protocol



Step 3 Toggle on or off SNMP.

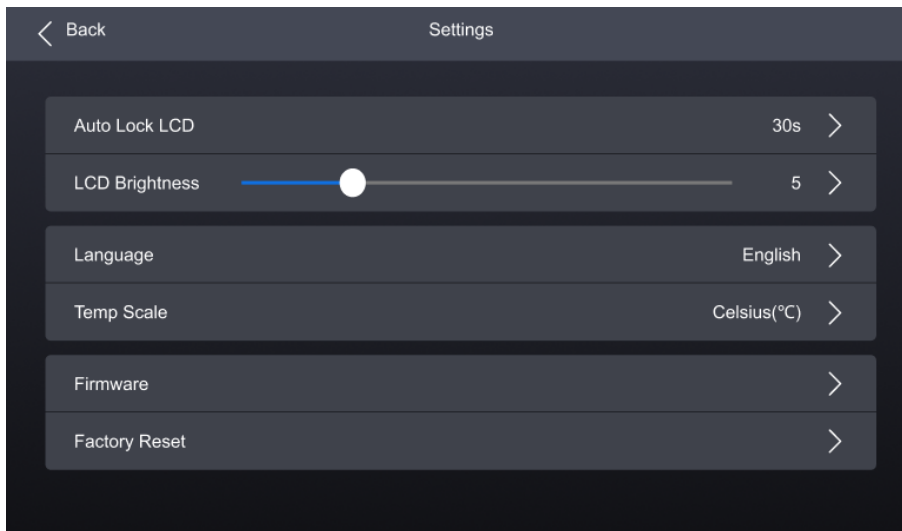
- : Enable the device to use SNMP for communication.
- : Disable SNMP.

5.5 Settings

5.5.1 Configure LCD screen

Step 1 Select **Settings** from the main menu to access the settings interface.

Figure 5-12 Configure LCD screen



Step 2 Select **Auto Lock LCD** and set a value in the pop-up dialog box.

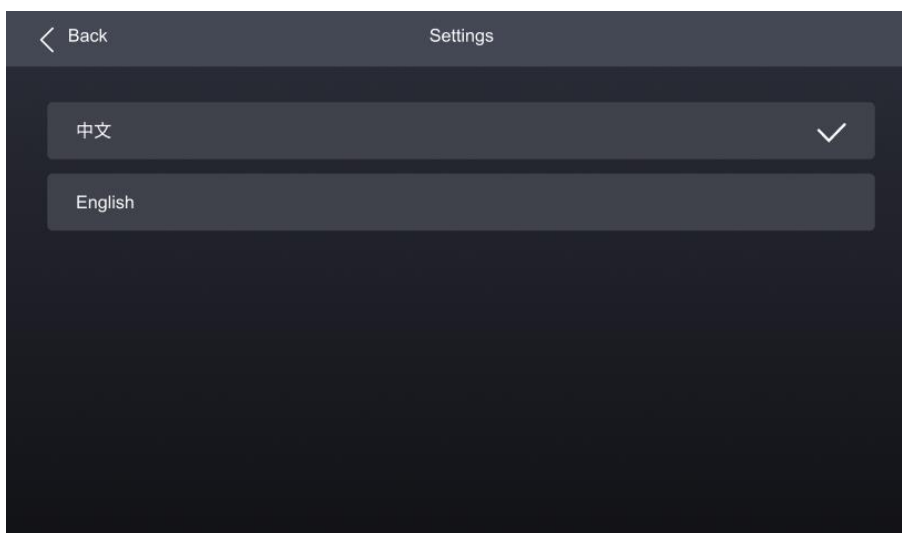
Step 3 Select **LCD Brightness** and adjust the value.

5.5.2 Setting Language

Step 1 Select **Settings** from the main menu to access the settings interface.

Step 2 Select **语言/Language** to open the sub-interface.

Figure 5-13 Language settings

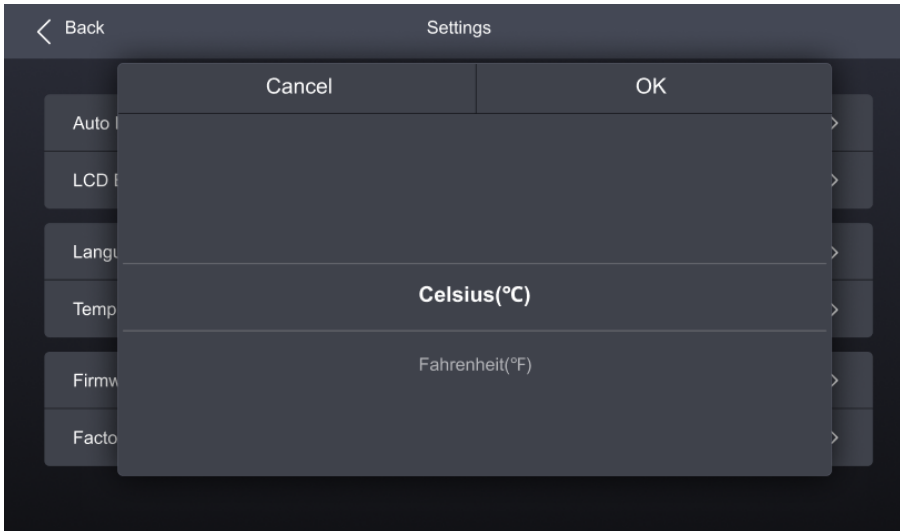


Step 3 Select **中文** or **English**.

5.5.3 Set Temperature Scale

- Step 1 Select **Settings** from the main menu to access the settings interface.
- Step 2 Select **Temp Scale** and then select **Celsius(°C)** or **Fahrenheit(°F)** from the pop-up dialog box.

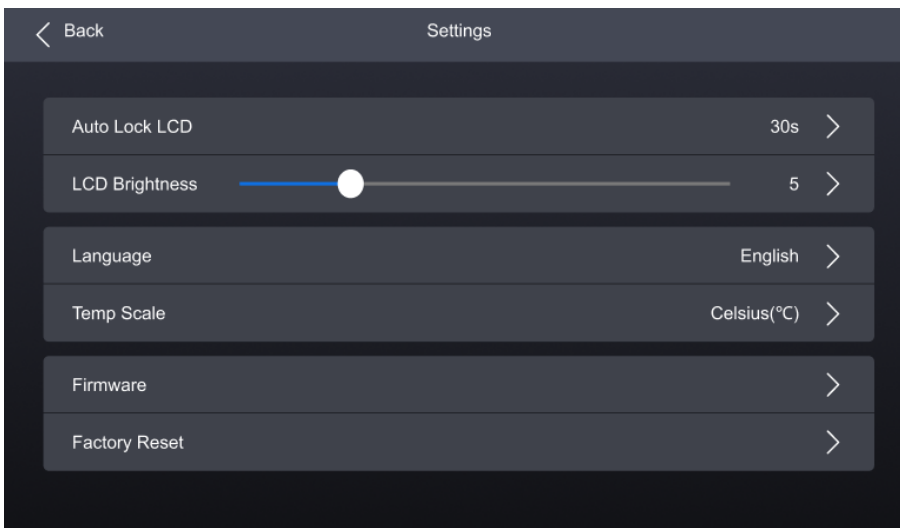
Figure 5-14 Set Temperature Scale



5.5.4 Check Firmware Information

- Step 1 Select **Settings** from the main menu to access the settings interface.

Figure 5-15 Check firmware information

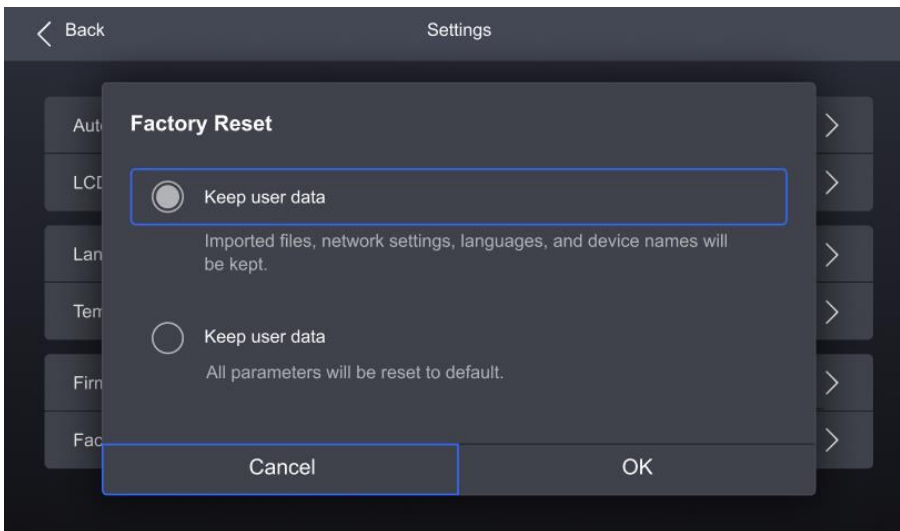


- Step 2 Select **Firmware** to open the sub-interface.
- Step 3 Select **Controller**, **Input Card**, and **Output Card** tab to check the related information.

5.5.5 Factory reset

- Step 1 Select **Settings** from the main menu to access the settings interface.
- Step 2 Select **Factory Reset** and then select **Keep user data** or **Reset All** from the pop-up dialog box. Finally, select **OK**.

Figure 5-16 Factory Reset



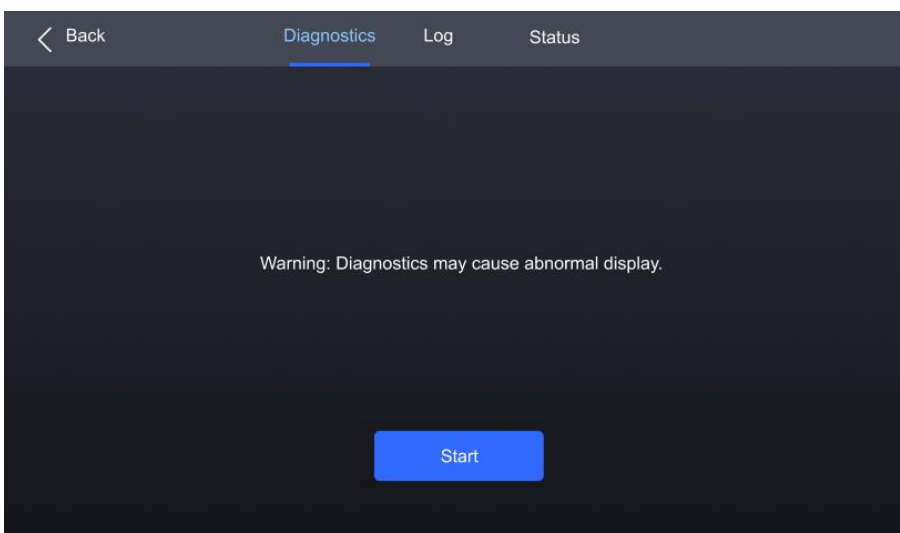
5.6 Maintenance

5.6.1 Diagnostics

To export the diagnostics log, insert a USB drive to the USB port on the front panel of the device.

- Step 1 Select **Maintain** from the main menu to access the settings interface.

Figure 5-17 Diagnostics



Step 2 Navigate to the **Diagnostics** tab and select **Start**.

Step 3 Once the diagnostic process is completed, select **Details** to check the diagnostic result. You can also select **Export** to export the result into a USB drive.

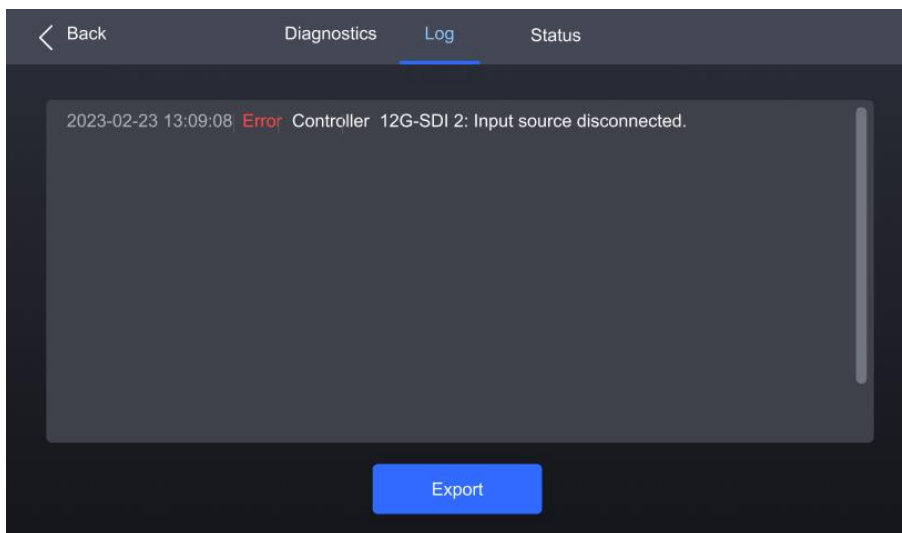
5.6.2 View and Export Logs

To export the logs, insert a USB drive to the USB port on the front panel of the device.

Step 1 Select **Maintain** from the main menu to access the settings interface.

Step 2 Navigate to the **Log** tab to check the device logs.

Figure 5-18 Device log



Step 3 Select **Export** to export the logs into a USB drive.

5.6.3 Check device status




Step 1 Select **Maintain** from the main menu to access the settings interface.

Step 2 Navigate to the **Status** tab to check the device status.

Figure 5-19 Check device status

The screenshot displays the 'Status' page of the MX2000 LED Display Controller. The navigation bar at the top includes 'Back', 'Diagnostics', 'Log', and 'Status' (which is highlighted with a blue underline). Below the navigation bar is a table with three columns: 'Item', 'Voltage (V)', and 'Temperature (°C)'. The table contains six rows of data. Below the table is a section titled 'Input Fan' and 'Output Fan' which displays three fan status cards: 'Chassis Fan 1', 'Chassis Fan 2', and 'Chassis Fan 3', each with a fan icon and a speed of 700r/m.

Item	Voltage (V)	Temperature (°C)
Mainboard	12.12	36.1
IN1	1.51	36.1
IN2	1.19	36.1
OUT1	1.06	36.1
OUT2	1.01	36.1

Input Fan	Output Fan
 Chassis Fan 1 700r/m	 Chassis Fan 3 700r/m
 Chassis Fan 2 700r/m	

6 Specifications

Electrical Specifications	Power supply	100–240V~, 50/60Hz
	Max power consumption	260W
Operating Environment	Temperature	0°C to +45°C
	Humidity	0% RH to 80% RH, non-condensing
Storage Environment	Temperature	-10°C to +60°C
	Humidity	0% RH to 95% RH, non-condensing
Physical Specifications	Dimensions	482.6 mm × 94.6 mm × 529.7 mm (foot pad included)
	Weight	<ul style="list-style-type: none"> • Standard (1x control card, 1x input card, 1x output card) <ul style="list-style-type: none"> – Net weight: 12.0kg – Total weight: 12.5 kg • Fully installed (1x control card, 2x input cards, 2x output cards) <ul style="list-style-type: none"> – Net weight: 13.0kg – Total weight: 13.5kg <p>Note: Total weight refers to the weight of the product, accessories, and packing materials.</p>
Packing Information	Packing box	660.0 mm × 570.0 mm × 210.0 mm, kraft paper box
	Accessories	1x Power cord, 1x Ethernet cable 1x Quick Start Guide, 1x Customer Letter, 1x Safety Manual, 1x Certificate of Approval
IP Rating	IP20 Please prevent the product from water intrusion and do not wet or wash the product.	
Noise Level (typically at 25°C/77°F)	53 dB (A)	

The amount of power consumption may vary depending on various factors such as product settings, usage, and environment.

7 Video Source Specifications

Input	Bit Depth	Sampling Format	Max Input Resolution
HDMI 2.0	8bit	RGB 4:4:4	4096×2160@60Hz
		YCbCr 4:4:4	
		YCbCr 4:2:2	
	10bit	RGB 4:4:4	4096×2160@48Hz
		YCbCr 4:4:4	
		YCbCr 4:2:2	4096×2160@60Hz
	12bit	RGB 4:4:4	4096×2160@30Hz
		YCbCr 4:4:4	
		YCbCr 4:2:2	4096×2160@60Hz
DP 1.4	8bit	RGB 4:4:4	7680×4320@30Hz
		YCbCr 4:4:4	
		YCbCr 4:2:2	
	10bit	RGB 4:4:4	7680×4320@24Hz
		YCbCr 4:4:4	
		YCbCr 4:2:2	7680×4320@30Hz
	12bit	RGB 4:4:4	5120×2160@60Hz
		YCbCr 4:4:4	
		YCbCr 4:2:2	7680×4320@30Hz

8 Ethernet Port Load Capacity

8.1 1G Solution (MX_4x10G_Fiber Output Card)

When Working with A10s Pro Receiving Card

When working with the A10s Pro receiving card, the formula of calculating the load capacity per Ethernet port and the detailed parameters are as follows:

- 8bit: Load capacity $\times 24 \times$ Frame rate $< 1000 \times 1000 \times 1000 \times 0.95$
- 10bit: Load capacity $\times 32 \times$ Frame rate $< 1000 \times 1000 \times 1000 \times 0.95$
- 12bit: Load capacity $\times 48 \times$ Frame rate $< 1000 \times 1000 \times 1000 \times 0.95$

Max Load Capacity per Ethernet Port (Pixels)			
Frame Rate / Bit Depth	8bit	10bit	12bit
24Hz	1,649,306	1,236,979	824,653
25Hz	1,583,333	1,187,500	791,667
30Hz	1,319,444	989,583	659,722
50Hz	791,667	593,750	395,833
60 Hz	659,722	494,792	329,861
120Hz	329,861	247,396	164,931
144Hz	274,884	206,163	137,442
240Hz	164,931	123,698	82,465

When Working with Other Armor Series Receiving Cards

The formula of calculating the load capacity per Ethernet port and the detailed parameters are as follows.

- 8bit: Load capacity $\times 24 \times$ Frame rate $< 1000 \times 1000 \times 1000 \times 0.95$
- 10bit: Load capacity $\times 48 \times$ Frame rate $< 1000 \times 1000 \times 1000 \times 0.95$

- 12bit: Load capacity $\times 48 \times$ Frame rate $< 1000 \times 1000 \times 1000 \times 0.95$

Max Load Capacity per Ethernet Port (Pixels)			
Frame Rate / Bit Depth	8bit	10bit	12bit
24Hz	1,649,306	824,653	824,653
25Hz	1,583,333	791,667	791,667
30Hz	1,319,444	659,722	659,722
50Hz	791,667	395,833	395,833
60 Hz	659,722	329,861	329,861
120Hz	329,861	164,931	164,931
144Hz	274,884	137,442	137,442
240Hz	164,931	82,465	82,465

8.2 5G Solution (CX_1x40G_Fiber Output Card)

When working with the CA50E, CA50C, or XA50 receiving cards, the formula of calculating the load capacity per Ethernet port and the detailed parameters are as follows:

- 8bit: Load capacity $\times 24 \times$ Frame rate $< 5G \times 0.75$
- 10bit: Load capacity $\times 30 \times$ Frame rate $< 5G \times 0.75$
- 12bit: Load capacity $\times 36 \times$ Frame rate $< 5G \times 0.75$

Max Load Capacity per Ethernet Port (Pixels)			
Frame Rate / Bit Depth	8bit	10bit	12bit
24Hz	6,480,000	5,182,500	4,320,000
25Hz	6,220,800	4,975,200	4,147,200
30Hz	5,184,000	4,146,000	3,456,000
50Hz	3,110,400	2,487,600	2,073,600
60 Hz	2,592,000	2,073,000	1,728,000
120Hz	1,296,000	1,036,500	864,000
144Hz	1,080,864	864,441	720,576
240Hz	648,000	518,250	432,000

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