MX190000A
Signal Quality Analyzer-R
Control Software
Operation Manual

23rd Edition

- **For safety and warning information, please read this manual before attempting to use the equipment.**
- **Additional safety and warning information is provided within the MP1900A Signal Quality Analyzer-R Operation Manual. Please also refer to it before using the equipment.**
- **Keep this manual with the equipment.**

ANRITSU CORPORATION

Document No.: M-W3913AE-23.0

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To prevent the risk of personal injury or loss related to equipment malfunction, ANRITSU CORPORATION uses the following safety symbols to indicate safety-related information. Ensure that you clearly understand the meanings of the symbols BEFORE using the equipment. Some or all of the following symbols may be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

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This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.



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These indicate that the marked part should be recycled.

MX190000A
Signal Quality Analyzer-R Control Software
Operation Manual

19 June 2017 (First Edition)
12 August 2026 (23rd Edition)

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Revision History:

February 29th, 2020
December 17th, 2021
March 11th, 2024

Cautions Against Computer Virus Infection

- Copying files and data
  Only files that have been provided directly from Anritsu or generated using Anritsu equipment should be copied to the instrument.
  All other required files should be transferred by means of USB flash drive or CompactFlash media after undergoing a thorough virus check.
- Adding software
  Do not download or install software that has not been specifically recommended or licensed by Anritsu.
- Network connections
  Ensure that the network has sufficient anti-virus security protection in place.
- Protection against malware (malicious software such as viruses).
  This equipment runs on Windows Operating System.
  To connect this equipment to network, the following is advised.
  - Activate Firewall.
  - Install important updates of Windows.
  - Use antivirus software.

Protection Against Computer Virus Infections

Prior to the software installation

Before installing this software or any other software recommended or approved by Anritsu, run a virus scan on your computer, including removable media (e.g. USB flash drive and CF memory card) you want to connect to your computer.

When using this software and connecting with the measuring instrument

- Copying files and data
  On your computer, do not save any copies other than the following:
  - Files and data provided by Anritsu
  - Files created by this software
  - Files specified in this document

  Before copying these files and/or data, run a virus scan, including removable media (e.g. USB flash drive and CF memory card).
- Connecting to network
  Connect your computer to the network that provides adequate protection against computer viruses.
- Protection against malware (malicious software such as viruses).
  To connect your computer to network, the following is advised.
  - Activate Firewall.
  - Install important updates of Windows.
  - Use antivirus software.

Cautions on Proper Operation of Software

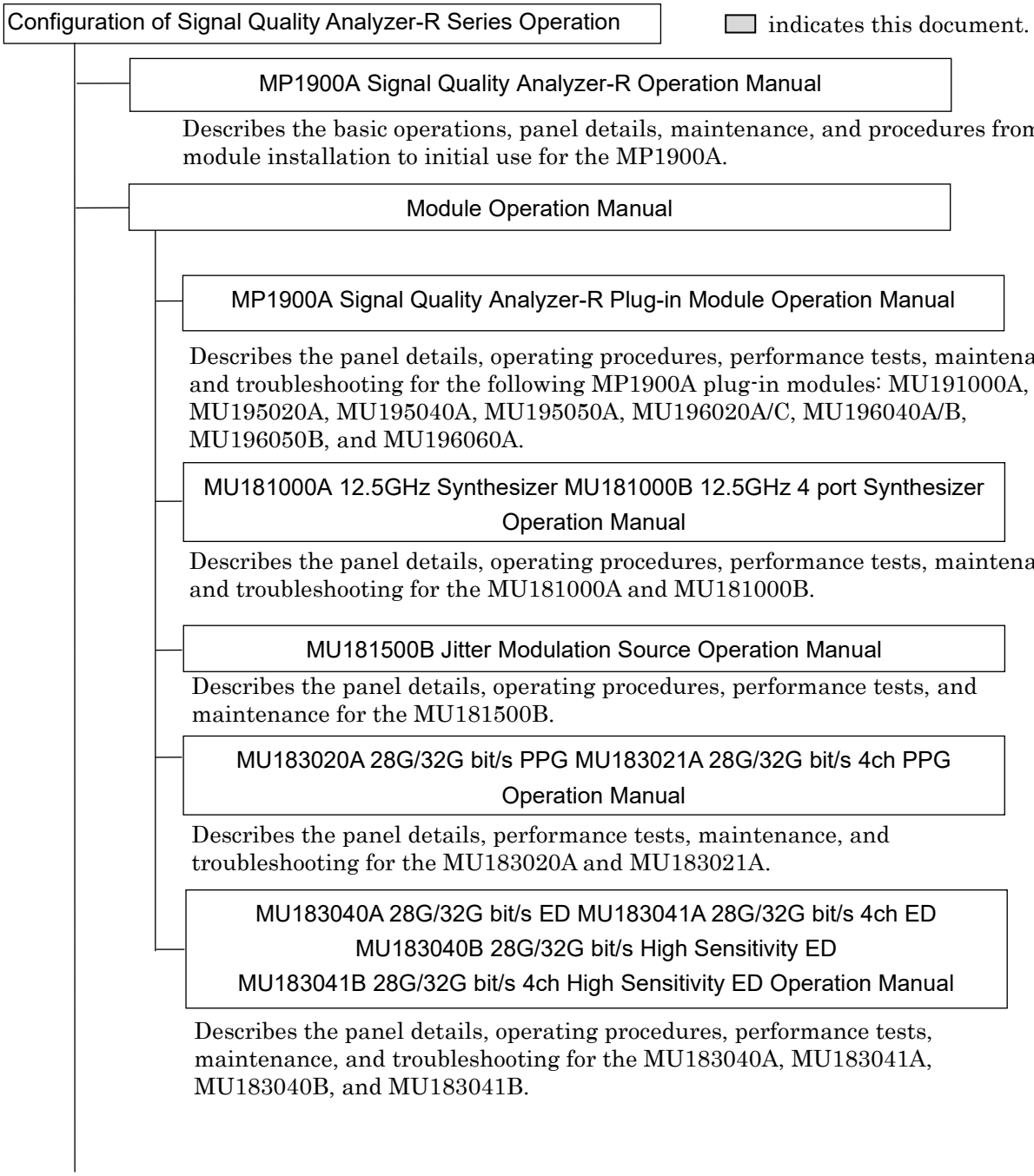
This software may not operate normally if any of the following operations are performed on your computer:

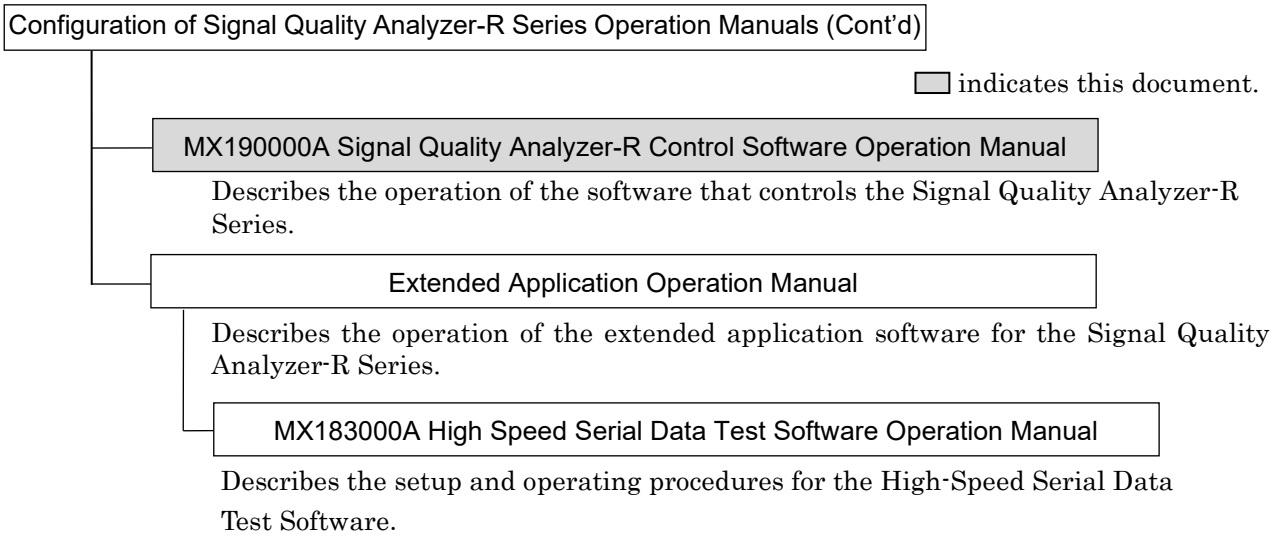
- Simultaneously running any software other than that recommended or approved by Anritsu
- Closing the lid (Laptop computer)
- Turning on the screen saver function
- Turning on the battery-power saving function (Laptop computer)

For how to turn off the functions, refer to the operation manual that came with your computer.

About This Manual

A test system consisting of an MP1900A Signal Quality Analyzer-R, modules, and control software is called the Signal Quality Analyzer-R Series. The Signal Quality Analyzer-R Series operation manuals are provided as separate documents for the MP1900A, the modules, and the control software, as shown below.




Configuration of Signal Quality Analyzer-R Series Operation Manuals (Cont'd)
indicates this document.
MX190000A Signal Quality Analyzer-R Control Software Operation Manual
Describes the operation of the software that controls the Signal Quality Analyzer-R Series.
Extended Application Operation Manual
Describes the operation of the extended application software for the Signal Quality Analyzer-R Series.
MX183000A High Speed Serial Data Test Software Operation Manual
Describes the setup and operating procedures for the High-Speed Serial Data Test Software.

This manual describes how to operate the MX190000A Signal Quality Analyzer-R Control Software.
The models and names of the modules are described using the following abbreviations.

Abbreviation	Model/Name
MU181000A	MU181000A 12.5GHz Synthesizer
MU181000B	MU181000B 12.5GHz 4 port Synthesizer
MU181000A/B	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4 port Synthesizer
MU181500B	MU181500B Jitter Modulation Source
MU183020A	MU183020A 28G/32G bit/s PPG
MU183021A	MU183021A 28G/32G bit/s 4ch PPG
MU183040A	MU183040A 28G/32G bit/s ED
MU183040B	MU183040B 28G/32G bit/s High Sensitivity ED
MU183041A	MU183041A 28G/32G bit/s 4ch ED
MU183041B	MU183041B 28G/32G bit/s 4ch High Sensitivity ED
MU191000A	MU191000A Synthesizer
MU195020A or SI PPG	MU195020A 21G/32G bit/s SI PPG
MU195040A or SI ED	MU195040A 21G/32G bit/s SI ED
MU195050A	MU195050A Noise Generator
MU196020A/C or PAM4 PPG	MU196020A PAM4 PPG MU196020C PAM4 PPG
MU196040A or PAM4 ED	MU196040A PAM4 ED
MU196040B or PAM4 ED	MU196040B PAM4 ED
MU196040A/B	MU196040A PAM4 ED or MU196040B PAM4 ED
MU196050B	MU196050B Noise Generator
MU196060A	MU196060A 32 G baud NRZ/PAM4 Re-Driver

"x" in an option number represents any numeral. For details of option numbers, refer to each of module operation manuals.

MU196020A-x11

Model Option number

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Chapter 1 Outline

This chapter provides an overview and describes the features of the MX190000A Signal Quality Analyzer-R Control Software (hereinafter referred to as "MX190000A").

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1.1 Overview

MX190000A allows users to create the same operation environment on a Windows 7 or Windows 10 PC as the operation functions of the MP1900A Signal Quality Analyzer-R (hereinafter, referred to as “MP1900A”). MX190000A is factory-installed on the MP1900A.

When MX190000A is installed on the external PC, it runs in a mode that emulates MP1900A behavior.
It is useful when you check how to operate the screen and see descriptions of on-screen items and their remote commands via on-screen help even if MP1900A is not available.

1.2 Features

MX190000A allows users to operate modules installed in MP1900A and to perform measurements using the modules.

MX190000A provides the following features:

- BER measurement using modules
- Auto measurement of Eye Margin and Eye Contour
- Test pattern capture
- Test pattern editing
- Configuration of synchronized operation of multiple modules
- MP1900A software update
- On-screen help providing detailed explanations of UI items and their corresponding remote commands
- Symbol error rate (SER) measurements for PAM4 signals using modules
- Measurement of uncorrectable codewords and FEC symbol errors in RS-FEC Scrambled Idle patterns using modules
- Measurement of Flit errors and FEC symbol errors in PCIe6 NOP Flit Layout patterns
- PAM3 pattern output using modules
- USB4 Gen4-compliant pattern output
- PCIe/CXL-compliant sequence pattern output includes:
  - Sequence pattern editing
  - Synchronized operation across multiple modules
  - BER measurement for patterns compliant with 8b/10b, 128b/130b, and 1b/1b encoding schemes
  - Idle Flit and NULL Flit pattern output

GPIB and LAN are supported as the remote control interfaces. Also, the remote control commands conform to the SCPI (Standard Commands for Programmable Instruments).

Note:

When MX190000A is installed on the external PC, the GPIB interface is not available.

1.3 Operating Environment

Use a PC with at least the performance shown below.

Table 1.3-1 Operating Environment

Item	Specifications
Device type	IBM-PC or compatible PC
CPU	2 GHz or faster, 64-bit (x64) Processor
OS	Windows 10 Pro/Enterprise (64-bit) or Windows 7 Professional/Enterprise/Ultimate (64 bit)
Memory	At least 4 GB
Monitor resolution	At least 1600 × 900 dots
Display colors	At least 65536 colors
Hard disk	At least 5 GB disk space for full installation
Remote interface	At least 100BASE-TX

⚠ CAUTION

The MX190000A may not operate normally if any of the following operations are performed on your computer:

- **Simultaneously running any software other than that recommended or approved by Anritsu**
- **Closing the lid (Laptop computer)**
- **Turning on the screen saver function**
- **Turning on the battery-power saving function (Laptop computer)**

For how to turn off the functions, refer to the operation manual that came with your computer.

1.4 Module Selection Guide

Each function is offered by a separate module or option so that the MP1900A can meet customer requirements flexibly. By selecting modules and options, the MP1900A can be used with the configuration optimal for the customer's investment timing, and if needed in the future, new functions can be easily expanded or installed.

For details on the functional descriptions and selection criteria of modules and options and the functions that are different depending on combination, refer to the Selection Guide shown below.

Signal Quality Analyzer-R MP1900A series Selection Guide

https://www.anritsu.com/en-US/test-measurement/support/downloads/brochures-datasheets-and-catalogs/dwl18629

Chapter 2 Preparation

This chapter describes how to install, uninstall, start and shut down the MX190000A.

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2.1 Installation and Uninstallation

MX190000A can be used in two installation modes.

- Installation on MP1900A
  Users can perform measurement by controlling the MP1900A.
- Installation on an external PC
  Users can display measurement result files and edit patterns even if it is not connected to the MP1900A. (Emulation mode)

2.1.1 Installation

This section explains how to install MX190000A on the MP1900A or on an external PC.

1. If MX190000A is running, shut down it.
   In the system control area located at right-bottom of the screen, tap the **Close** button ( ). Then, in the **Shutdown/Close** dialog box, select **Shut down the software completely** and tap **OK**.

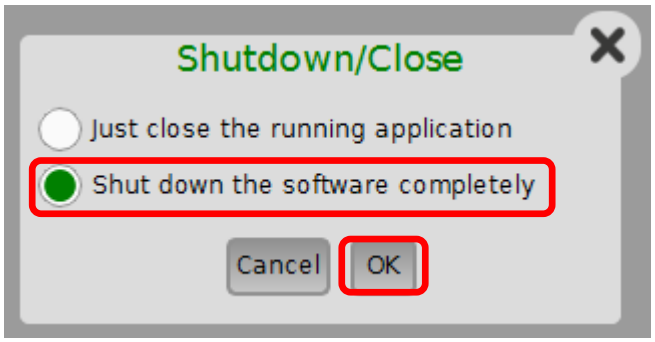


Figure 2.1.1-1 Shutdown/Close Dialog Box

2. Install MX190000A.
   On the MP1900A or on the external PC, execute the following file supplied by Anritsu.

   MX190000A_VER_x_xx_xx.exe

   x_xx_xx above indicates the software version.

   To newly install MX190000A

   On the welcome page of the InstallShield Wizard, tap **Next**.

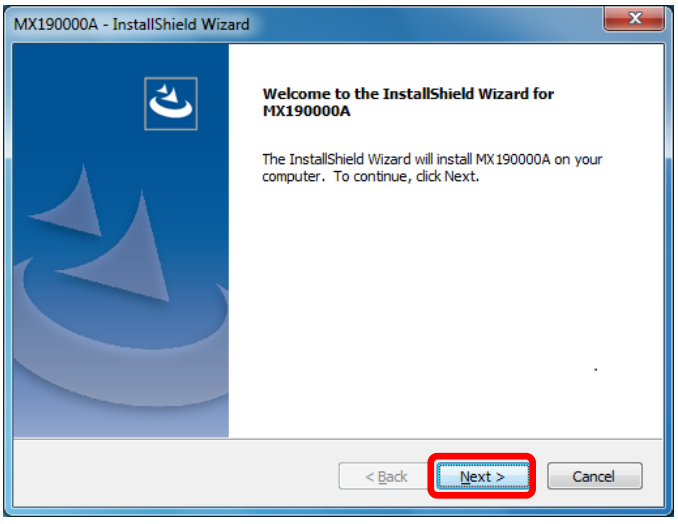


Figure 2.1.1-2 Welcome Page

If MX190000A is already installed

To continue the installation, tap **Yes** when you receive the following prompt: Reinstall all program features installed by the previous setup.
Skip Steps 3 to 7 and proceed to Step 9.

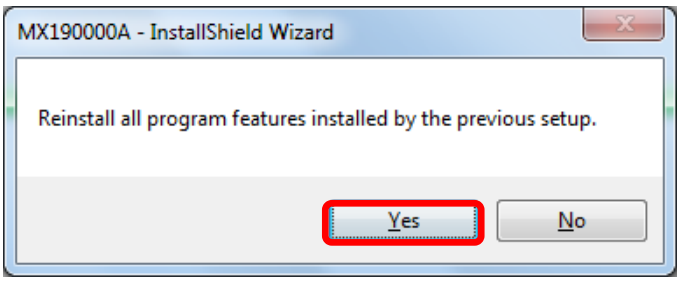


Figure 2.1.1-3 Confirming Reinstallation

Note:

To downgrade MX190000A, tap **No** and cancel the installation. Then, uninstall MX190000A and start the procedure again. For how to uninstall, refer to 2.1.2, “Uninstallation”,

3. Enter the user name, company name, and serial number, and then tap **Next**.

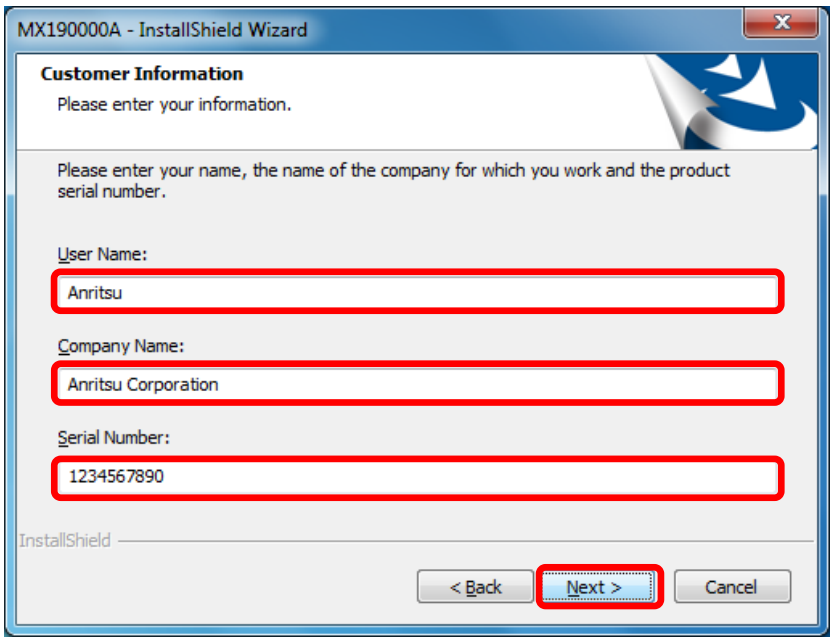


Figure 2.1.1-4 Customer Information Page

4. Select the setup type and tap **Next**.
To install MX190000A on the MP1900A, select **MP1900A**. To install MX190000A on an external PC, select **External PC**.

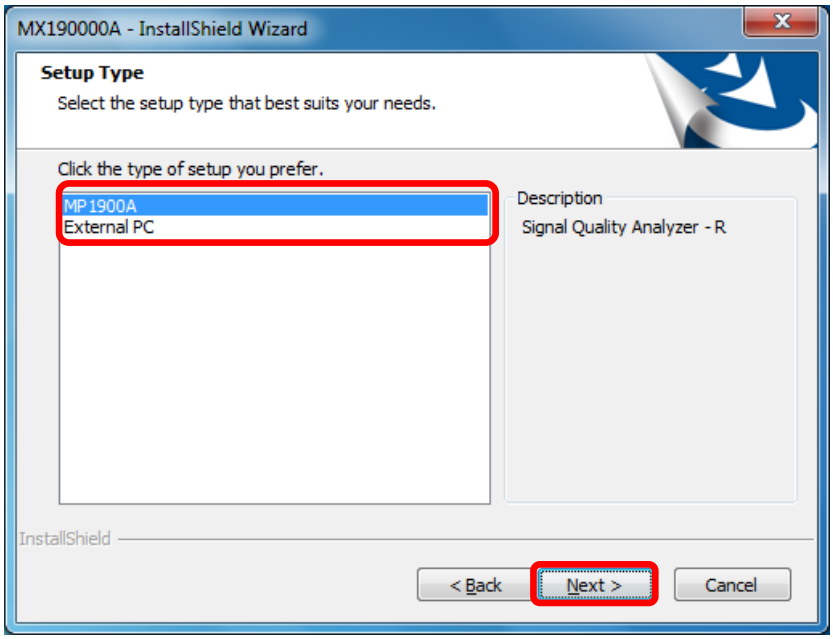


Figure 2.1.1-5 Setup Type Page

5. When **External PC** has been selected on the Setup Type Page, the installation destination folder can be changed.
   If you don't want to change it, tap **Next**.
   If you want to change it, tap **Change** and input the destination folder, and then tap **Next**.

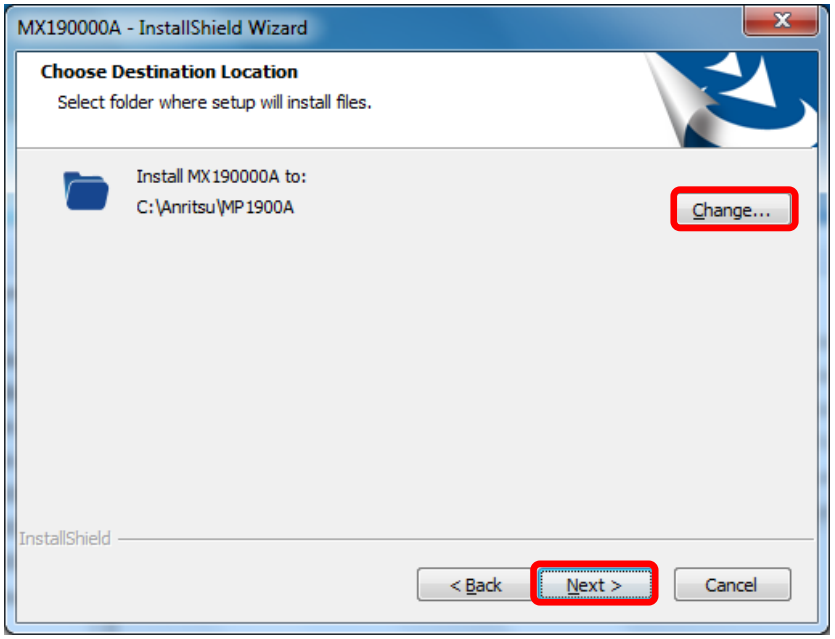


Figure 2.1.1-6 Choose Destination Location Page

6. When **External PC** has been selected on the Setup Type Page, select whether to operate MX190000A in Emulation mode.
To operate it in Emulation mode, select the **Install / unit modules emulator** check box and tap **Next**.

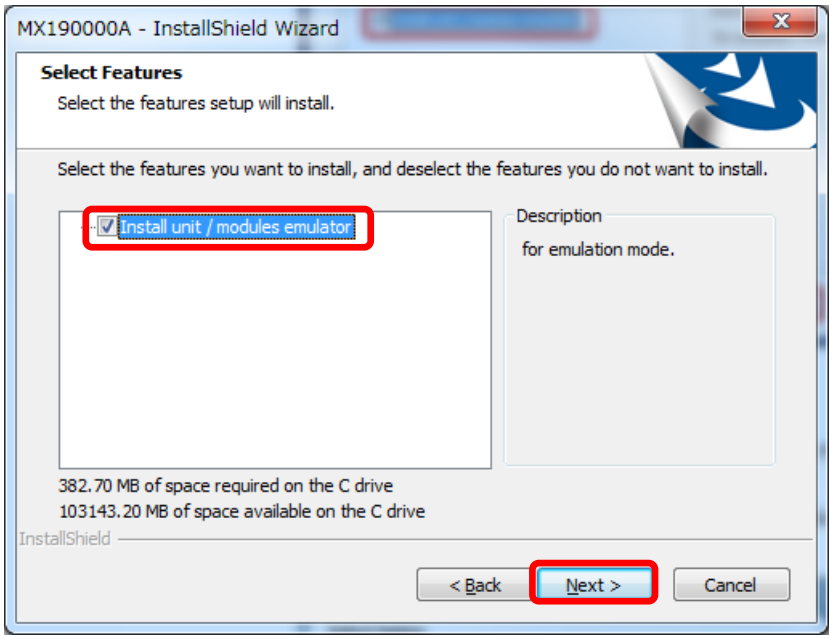


Figure 2.1.1-7 Select Features Page

7. When **External PC** has been selected on the Setup Type Page, select whether to create a shortcut on the desktop.
   To create a shortcut on the desktop, select the **Make a shortcut on Desktop.** check box and tap **Next**.

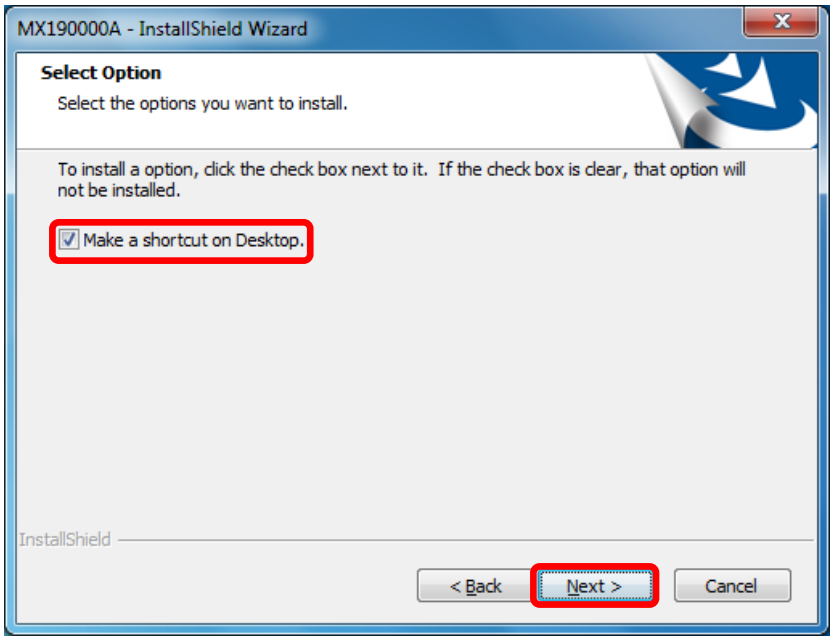


Figure 2.1.1-8 Select Option Page

8. Tap **Install**.

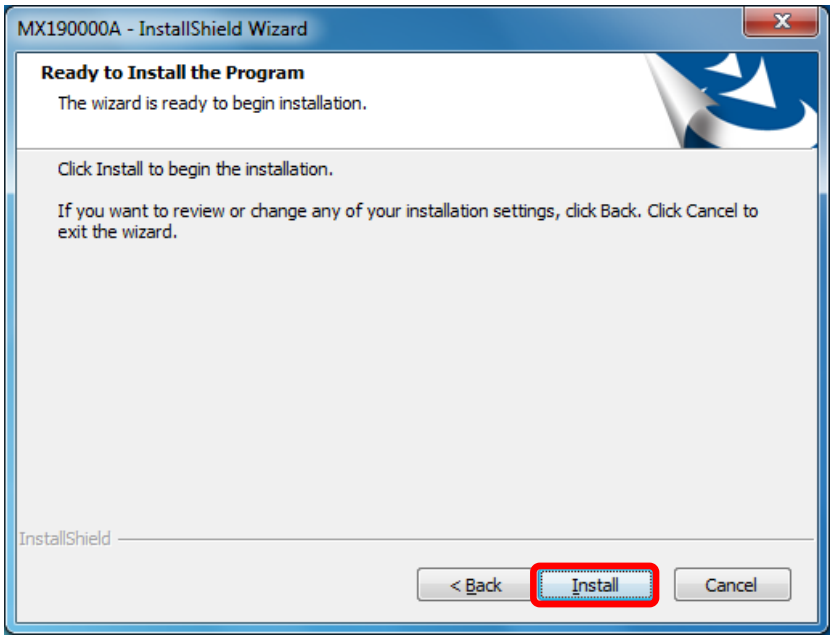


Figure 2.1.1-9 Ready to Install the Program Page

9. When the installation completes successfully, the following dialog box appears. Tap **Finish** to end the installation.

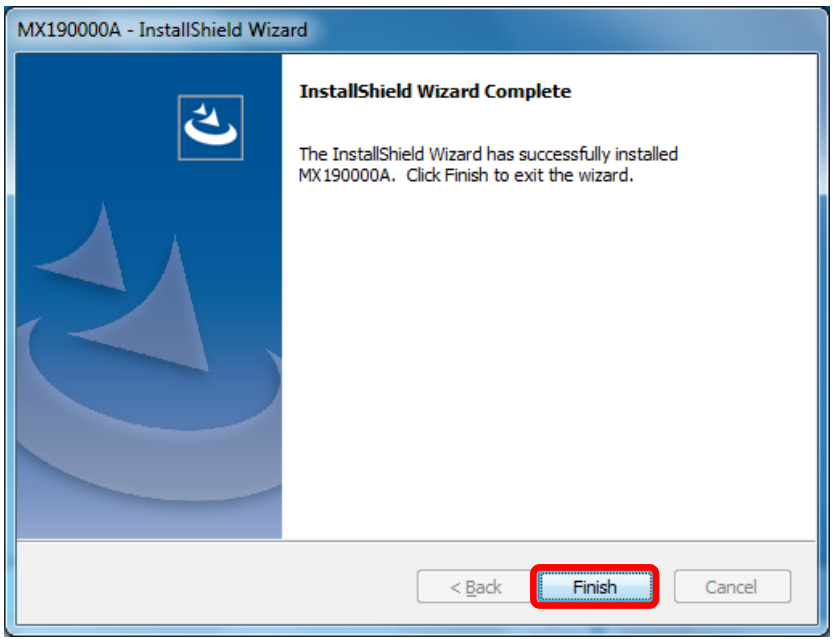


Figure 2.1.1-10 InstallShield Wizard Complete Page

2.1.2 Uninstallation

This section describes how to uninstall MX190000A . On the MP1900A or external PC, perform the following procedure.

1. On the **Start** menu, select **Control Panel**.

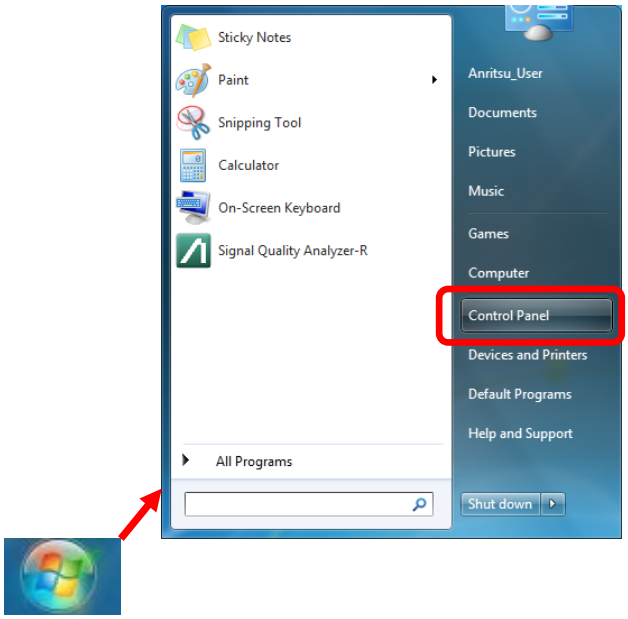


Figure 2.1.2-1 Control Panel

2. In Control Panel, tap **Programs and Features**.

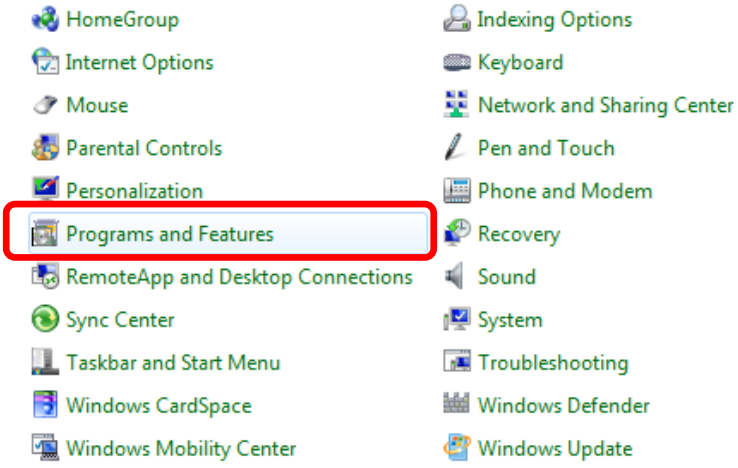


Figure 2.1.2-2 Programs and Features

3. In Programs and Features, double-tap **MX190000A**. In the Programs and Features window, touch **MX190000A** twice.

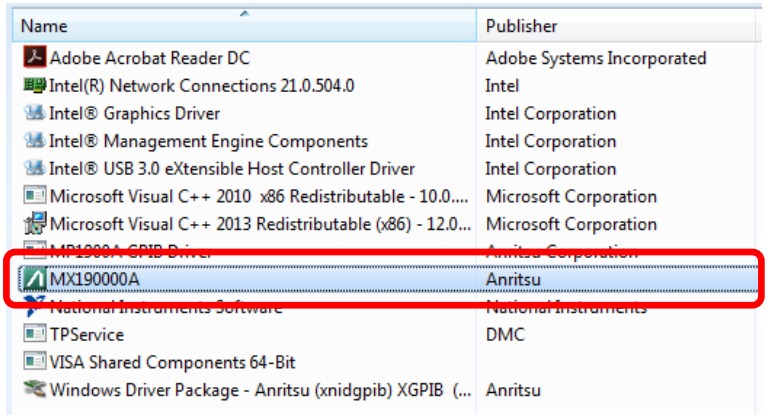


Figure 2.1.2-3 Uninstallation

4. When the following dialog box page appears, tap **Yes**.

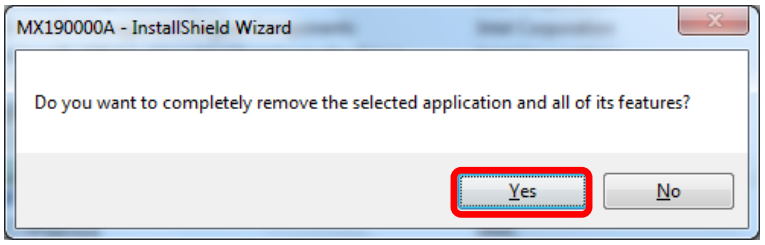


Figure 2.1.2-4 Confirming Uninstallation

5. Tap **No** if you don't want to delete files in the installation folder.
Tap **Yes** if you want to delete all files in the installation folder.

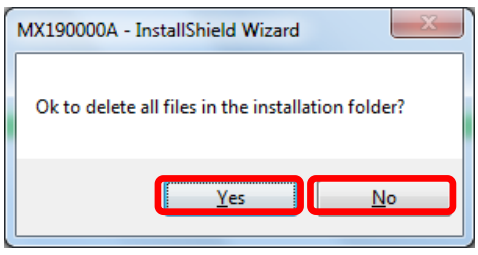


Figure 2.1.2-5 Confirmation of Deleting Folder

6. Upon completion of uninstallation, the following dialog box appears. Tap **Finish** to end the installation.

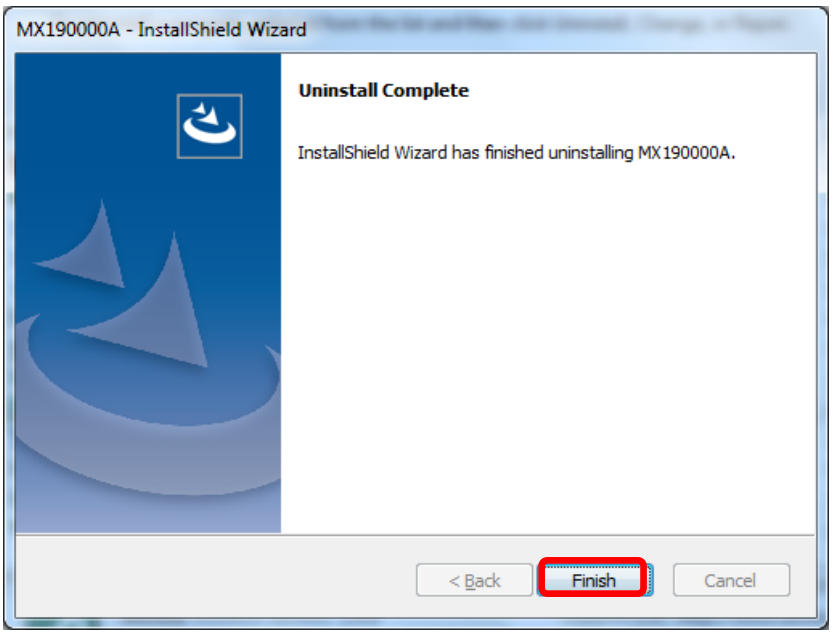


Figure 2.1.2-6 Completion of Uninstallation

2.2 Starting MX190000A

This section describes how to start the MX190000A.

2.2.1 When installed on MP1900A

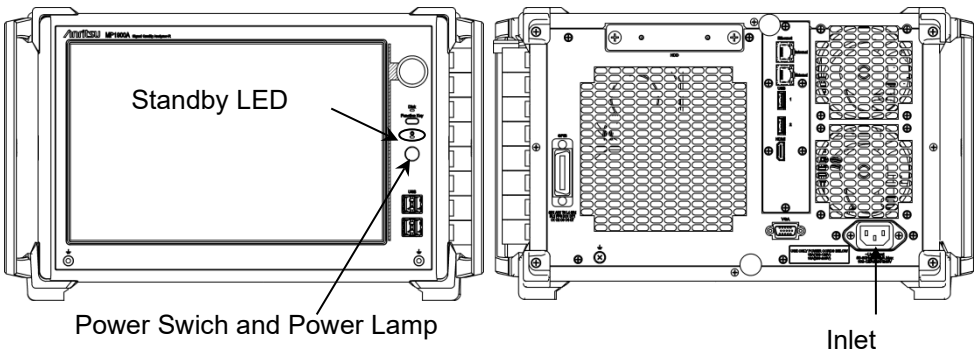


Figure 2.2.1-1 Standby LED and Power Cord Connector of MP1900A

1. Connect the power cord to the inlet on the MP1900A's rear panel. The Standby LED on the front panel lights.

CAUTION

When the Standby LED stays off even if the power cord is connected, the power may have been forcibly turned off due to a system error. In this case, MP1900A cannot be turned on even if the power switch is pressed. Unplug the power cord from the inlet and remove the cause of the system error. Then, reconnect the power cord to the inlet and press the power switch.

2. Turn on the MP1900A power switch, and the Power lamp lights and Windows starts.

3. In the Application Selector screen, tap the icon of the application you wish to start. For details of the Application Selector screen, refer to 3.1.4 “Application Selector”.

Note:

When the **Enable Auto-launch** check box is selected in Auto-launch of 3.1.6.2 “General Settings”, the selected application starts automatically.

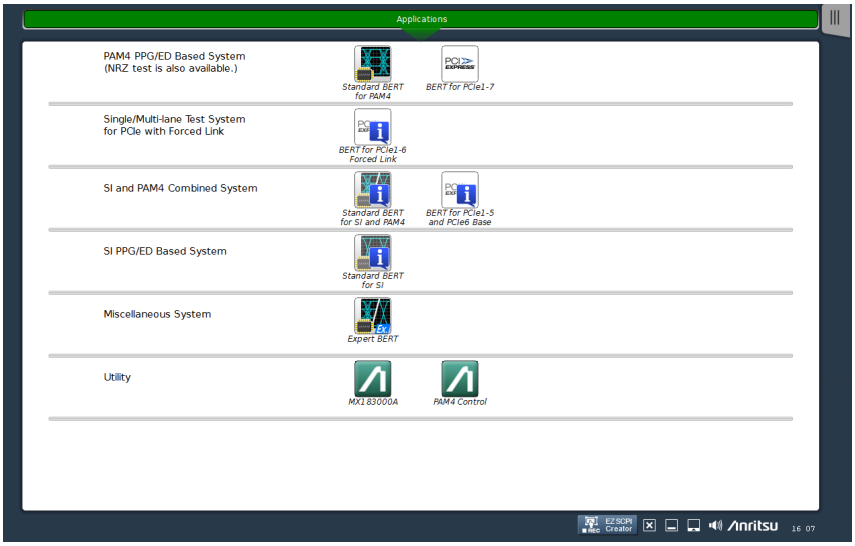


Figure 2.2.1-2 Application Selector Screen

2.2.2 When installed on external PC

1. Turn on the external PC and start Windows.
2. On the **Start** menu, point to **All Programs, MX190000A**, and then click **MX190000A**.
3. In the Application Selector screen, click the icon of the application you wish to start. For details of the Application Selector screen, refer to 3.1.4 “Application Selector”.

Note:

When the **Enable Auto-launch** check box is selected in Auto-launch of 3.1.6.2 “General Settings”, the selected application starts automatically.

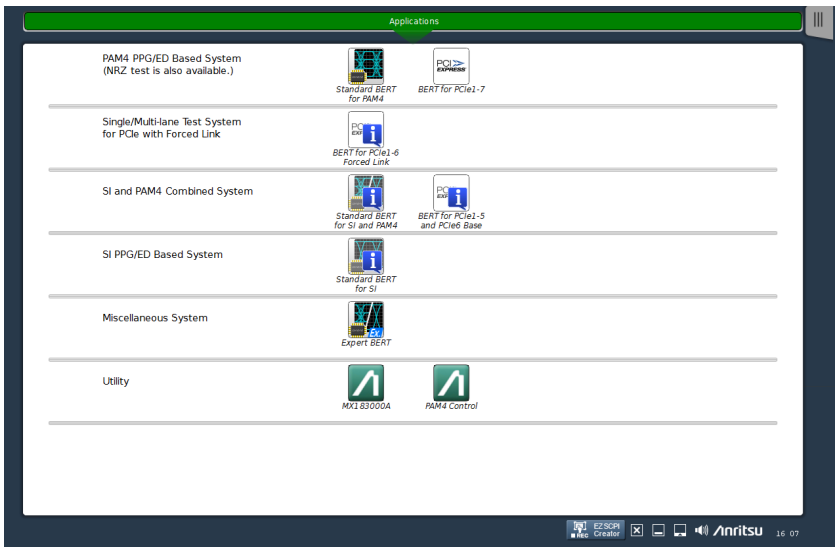


Figure 2.2.2-1 Application Selector Screen

Note:

Go to **Settings** > **System** > **Display**, and then in the **Scale and layout** box, select **100%**. If any other magnification is selected, the MX190000A may not be able to display text correctly.

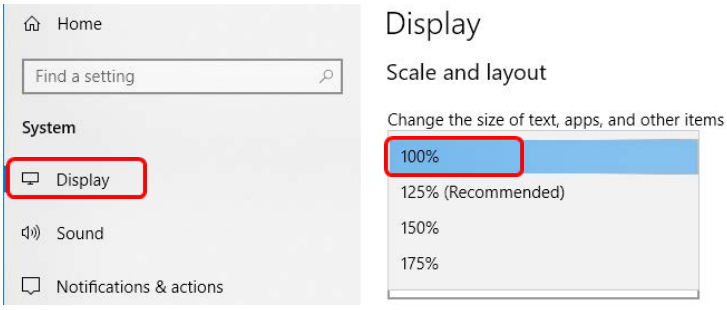


Figure 2.2.2-2 Windows Display Settings

2.2.3 Switching emulation modes

When installed on an external PC, MX190000A provides you a tool to switch the following two emulation modes.

- SI PPG/ED Based System
  Emulates a BERT system with a module configuration based on the MU195020A 21G/32G bit/s SI PPG and the MU195040A 21G/32G bit/s SI ED.
- PAM4 PPG/ED Based System
  Emulates a BERT system with a module configuration based on the MU196020A/C PAM4 PPG and the MU196040B PAM4 ED.
- SI and PAM4 Combined System
  Emulates a BERT system with a module configuration based on the MU196020A/C PAM4 PPG and the MU195040A SI ED.

Note:

If the **Install unit/modules emulator** check box is not selected in installation, emulation modes cannot be switched by the tool.

To switch the emulation mode, click the **Start** menu, point to **All Programs**, **MX190000A**, **Configure**, and then click **Emulation Mode**. The Configure the Emulation Mode tool opens as shown below.

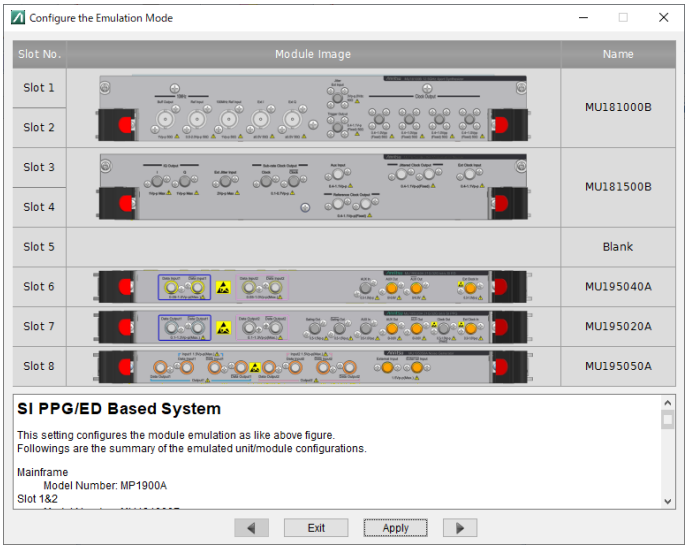


Figure 2.2.3-1 Configure the Emulation Mode Tool

On the tool, use ◀ and ▶ to select the emulation mode, and then click Apply to confirm the setting.
When you start MX190000A with the new mode setting, it starts as a BERT system with a selected module configuration. For how to start MX190000A, refer to 2.2.1 “When installed on MP1900A” and 2.2.2 “When installed on external PC”.

2.3 Shutting Down MX190000A

MX190000A can be shut down in three ways below:

- On the MP1900A's front panel, press the power switch. The power lamp goes off and the Standby LED lights up (MP1900A will be in standby state).
- In the system control area located at the right-bottom of the screen, tap the **Close** button ( ). Select **Shut down the software completely** and tap **OK**.
- On the Application Tool bar at right-hand of the screen, tap . Select **Shut down the software completely** and tap **OK**.

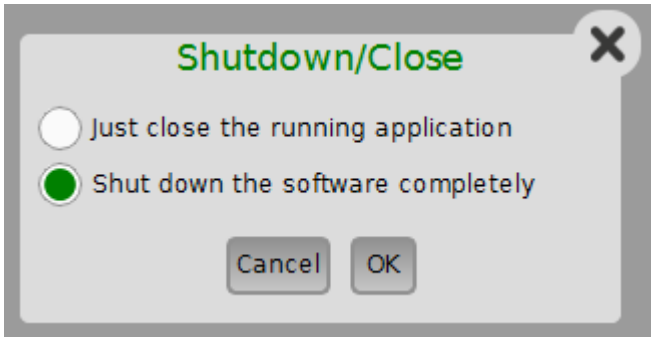


Figure 2.3-1 Shutdown/Close Dialog Box

Note:

Windows does not shut down when exiting MX190000A in the **Shutdown/Close** dialog box.
To be in standby state, press the power switch or shut down Windows.

2.4 Activating Plug-In Module License

This section explains how to activate plug-in module licenses using option keys.

2.4.1 Purchasing option key

The option keys are divided into two types: permanent license and timed license. Their purchasing and acquiring methods are different by type.

Notes:

- Depending on which option is activated the licenses, the version of the MX190000A required for operation of its functions is different.
- Relevant options may be required for operation of the option that activates licenses. For details, refer to 1.2.2, “Options” in each of the Module Operation Manuals, and make sure that the other necessary options are on hand before purchasing an option key.
- After purchasing the option key, it is required to update the MX190000A to the version that is guaranteed for operation of the option that activates the license.

2.4.1.1 Purchasing permanent license

1. Check the label on the top of the plug-in module for its serial number. Alternatively, start the MP1900A and check it in the System Information screen.



Figure 2.4.1.1-1 System Information Screen Example

2. Tell an Anritsu sales staff the serial number of the target plug-in module, and place an order.
3. The option key certificate*1 label and the option key label*2 are delivered. Use a 25-digit option key described in the Option Key License Certificate to activate the option. For details, refer to 2.4.2, “Activating Licenses with Option Key”.

*1: The option key certificate is your purchase and shipping records. Please keep it carefully.

*2: The label contains the information required to reconfigure the settings for the purchased options when repairing the plug-in module. Be sure to place the labels on the plug-in module according to 2.4.2, “Activating Licenses with Option Key”.

2.4.1.2 Acquiring timed license

When you want to purchase an option key for a timed license, contact an Anritsu Sales and Office and provide us with the following information on your plug-in module.

- Model name
- Serial number
- Option number

2.4.2 Activating Licenses with Option Key

This section explains how to activate the option licenses of the plug-in modules to install on the MP1900A. This procedure applies only to options whose module names are followed by -3xx (xx: a two-digit number).
If the license is activated, it is displayed below **Module(s) Information** in 3.1.6.1, "System Information". Calibration and other functional tests are not required for the functions whose licenses are activated by the option key.

Notes:

- Depending on which option is activated the licenses, the version of the MX190000A required for operation of its functions is different.
- Relevant options may be required for operation of the option function that activates licenses. For details, refer to 1.2.2, "Options" in each of the Module Operation Manuals, and make sure that the other necessary options are on hand before purchasing an option key.
- After purchasing the option key, it is required to update the MX190000A to the version that is guaranteed for operation of the option that activates the license.

2.4.2.1 Launching license activation tool

The license activation tool needs to be launched before activating your license.

For details on the license activation tool, refer to 2.4.2.2 “Activating permanent license using option key”.

To launch the license activation tool, follow the procedure below:

To launch the tool via OptKey on the desktop:

1. In the system control area located at the right-bottom of the screen, tap the **Close** button ( ). Select **Shut down the software completely** and tap **OK**.

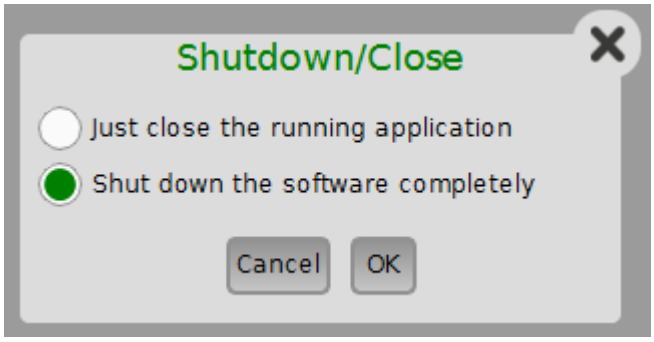


Figure 2.4.2.1-1 Shutdown/Close Dialog Box

2. Make sure the MX190000A is closed, and then on the desktop, double-tap **OptKey** to launch the license activation tool.

To launch the tool via the MX190000A's License Information screen:

1. In the system control area located at the right-bottom of the screen, tap the **Close** button ( ). Select **Just close the running application** and tap **OK**.

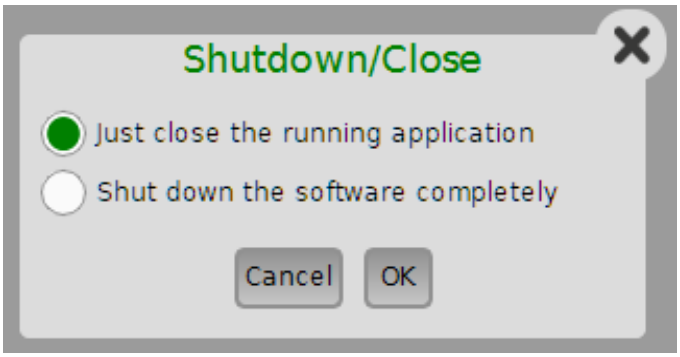


Figure 2.4.2.1-2 Shutdown/Close Dialog Box

2. When the application closes, wait until the Application Selector screen is displayed, and then on the system toolbar, select **General Setting** > **License**.

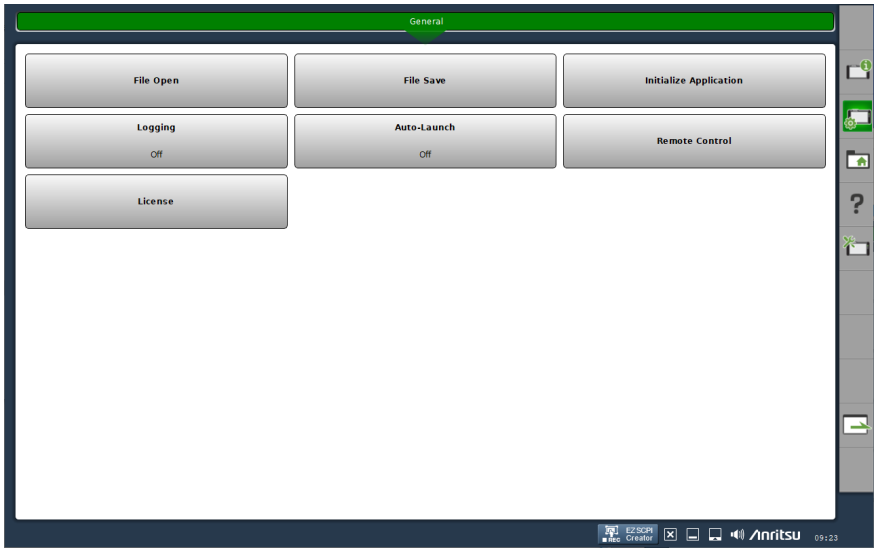


Figure 2.4.2.1-3 License Button

3. The **License Information** dialog box appears, displaying the model number, options, license status, and expiration date. Tap **Activate License** to launch the license activation tool.

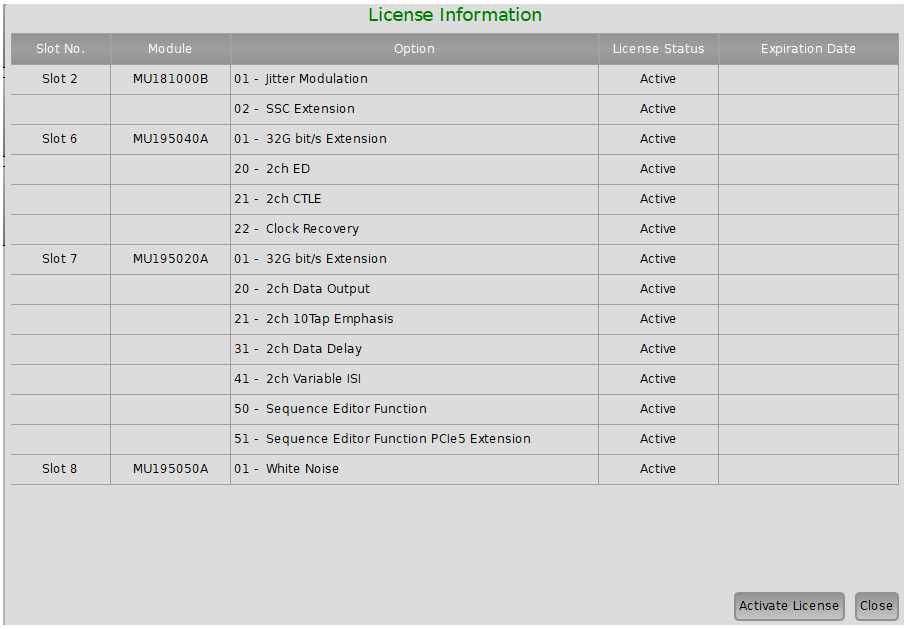


Figure 2.4.2.1-4 License Information Dialog Box

The **Activate License with Option Key** dialog box is described below.

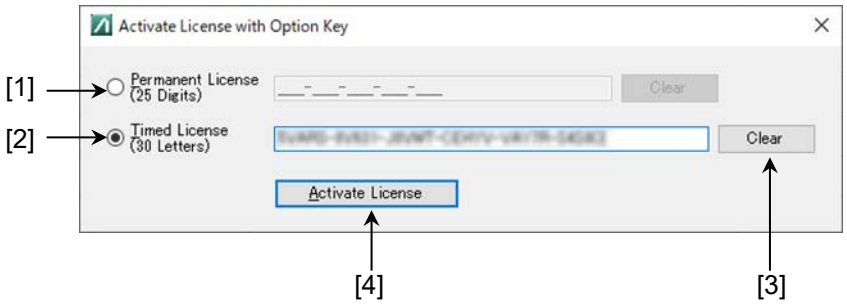


Figure 2.4.2.1-5 Activate License with Option Key Dialog Box

[1] Permanent License
Select to activate a permanent license. When selected, you can enter a string in the text box. Enter the 25-digit numeric option key provided by Anritsu.

[2] Timed License
Select to activate a timed license. When selected, you can enter a string in the text box. Enter the 30-digit alphanumeric option key provided by Anritsu.

[3] Clear
Clears the option key entered.

[4] Activate License
Activates the selected license. This button becomes available when a valid option key is entered

Note:
To enter an option key, connect a USB keyboard or double-tap the On-Screen Keyboard icon on the desktop to launch the On-Screen Keyboard.

2.4.2.2 Activating permanent license using option key

1. Select **Permanent License**, enter the option key consisting of 25-digit numbers, and tap **Activate License**.
   The option key can be found in the *Option Key License Certificate* provided by Anritsu.

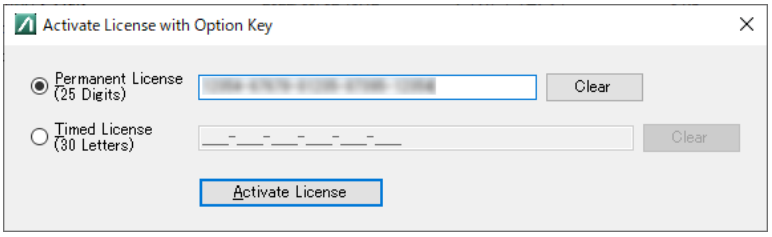


Figure 2.4.2.2-1 Activate License with OptionKey Dialog Box

2. Tap **OK**.

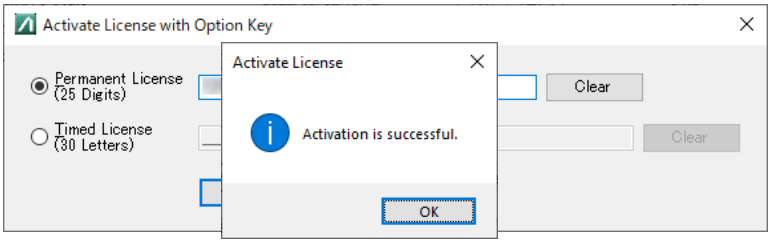


Figure 2.4.2.2-2 Information Dialog Box

3. Turn off the MP1900A, and then pull out the plug-in module whose license is activated by the option key.

4. With reference to Figure 2.4.2.2-3, place the labels (OPT Label / OPT KEY CODE Label) on the top panel of the plug-in module. If already placed, go to step 5.
   On the top panel, existing labels are already placed. Without removing existing labels, place the option labels below them with horizontally aligned. Be sure to place this label as it contains important information for future support.

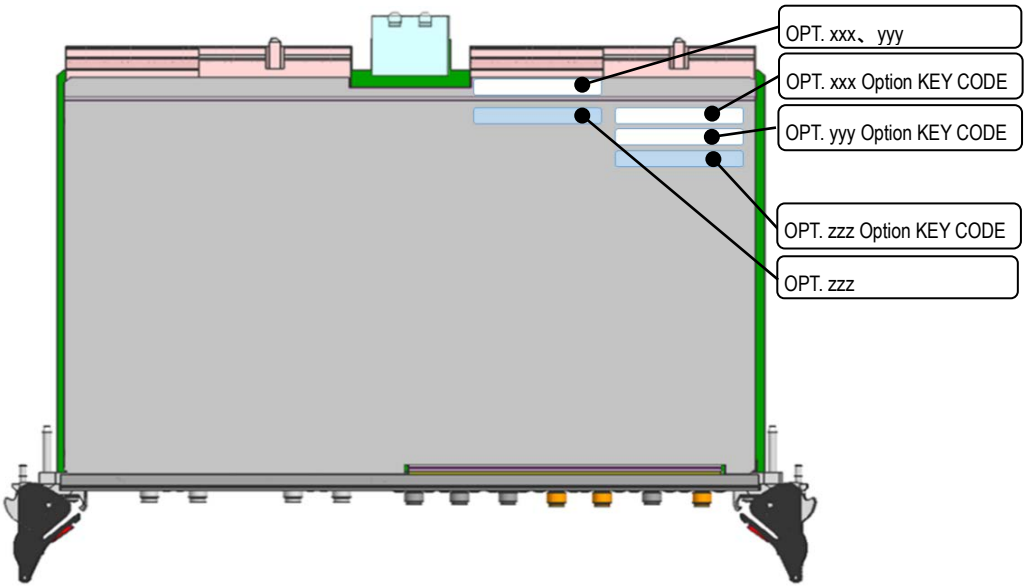


Figure 2.4.2.2-3 Where to Place Labels

Note:

Without removing existing labels, place delivered labels below them. Figure 2.4.2.2-3 illustrates an example of adding OPT. zzz to a module with OPT. xxx and yyy installed.

5. Install the plug-in module to the MP1900A, and then turn on the MP1900A.

   At Module(s) Information as described in 3.1.6.1, "System Information", check that the plug-in module option is activated.

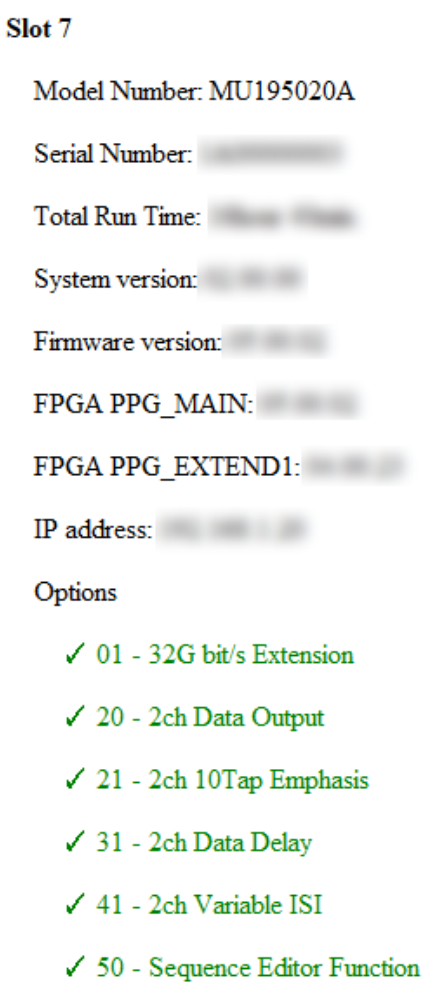


Figure 2.4.2.2-4 Example of How Options are Displayed

2.4.2.3 Activating timed license using option key

1. Select **Timed License**, enter the option key consisting of 30-digit alphanumeric characters, and tap **Activate License**.



Figure 2.4.2.3-1 Activate License with Option Key Dialog Box

2. Tap **OK**.

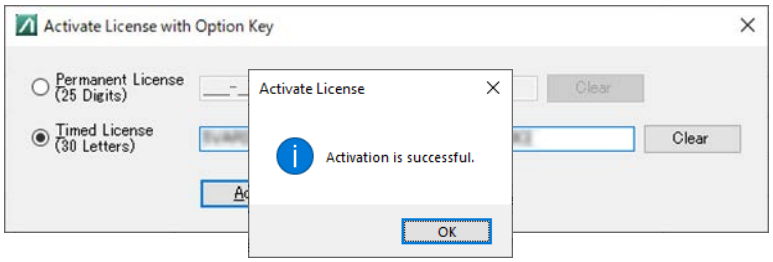


Figure 2.4.2.3-2 Information Dialog Box

3. Start MX190000A.

   After MX190000A startup, confirm that the plug-in module option is activated, referring to Module(s) Information explained in 3.1.6.1, “System Information”.

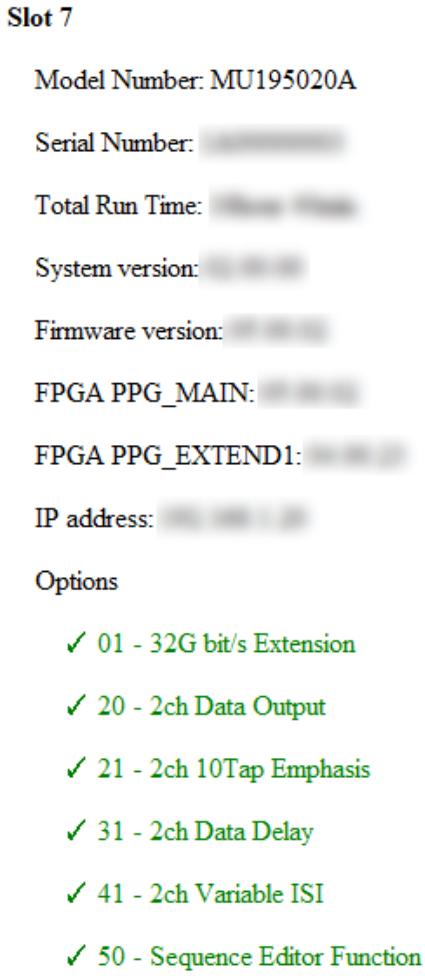


Figure 2.4.2.3-3 Example of How Options are Displayed

4. On the system toolbar, select **General Setting** > **License**, and then check the expiration date of the timed license for the relevant option at **Expiration Date** shown in "Figure 2.4.2.1-4 License Information Dialog Box". When the MP1900A is restarted after the expiration date, the expired options are inactivated.

Chapter 3 Basic Operations

This chapter explains the composition of the screens and the operation method.
In this chapter and Chapter 4, the following modules are correctively referred to as “PPG”.

- MU195020A 21G/32G bit/s SI PPG
- MU196020A PAM4 PPG
- MU196020C PAM4 PPG
- MU183020A 28G/32G bit/s PPG
- MU183021A 28G/32G bit/s 4ch PPG

Also, the following modules are correctively referred to as “ED”.

- MU195040A 21G/32G bit/s SI ED
- MU196040A PAM4 ED
- MU196040B PAM4 ED
- MU183040B 28G/32G bit/s High Sensitivity ED
- MU183041B 28G/32G bit/s 4ch High Sensitivity ED

Unless otherwise specified, MU195020A and MU195040A are used for explanation of screens.

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3.1 Basic Screen Operations

The MP1900A is equipped with a touch-screen display, which includes all operation keys except for the power switch and function keys. This section explains basic screen operations including how to use the operation keys on the touch-screen display.

3.1.1 GUI operation concept

The MP1900A's GUI consists of two functional spaces: Application Selector and workspace.

- The Application Selector is the screen that appears after MX190000A is started, and that consists of two areas:
  Applications area: use for starting an application
  Utility area: use for starting other software than MX190000A (hereinafter, external software)
  For details, refer to 3.1.4 "Application Selector".
- In the workspace, you can operate the application you started from the Application Selector.

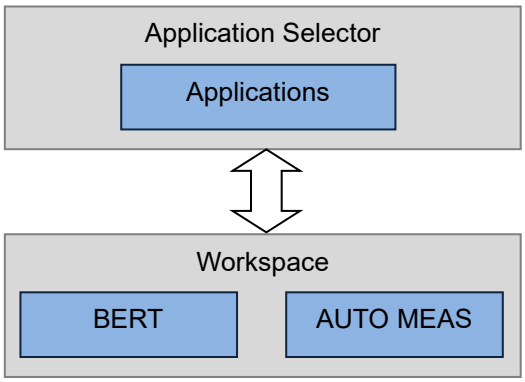


Figure 3.1.1-1 Two Functional Spaces

Note:

Multiple applications cannot be started at the same time from Application Selector.

3.1.2 Display switching screens

Switching to Application selector from Workspace

Workspace and Application Selector are switched in vertical direction. Touching a tab displayed at top of each screen in Workspace switches the screen display from Workspace to Application selector.

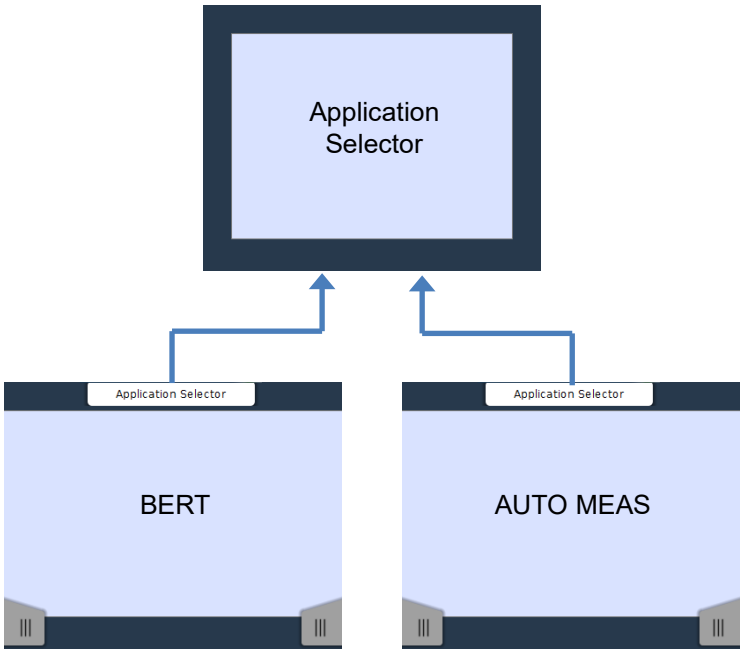


Figure 3.1.2-1 Vertically Switching to Application Selector from Workspace

Switching to Workspace from Application selector

When an application is currently running, the tab appears at bottom center of Application selector. Touching this tab switches the screen display to Workspace.

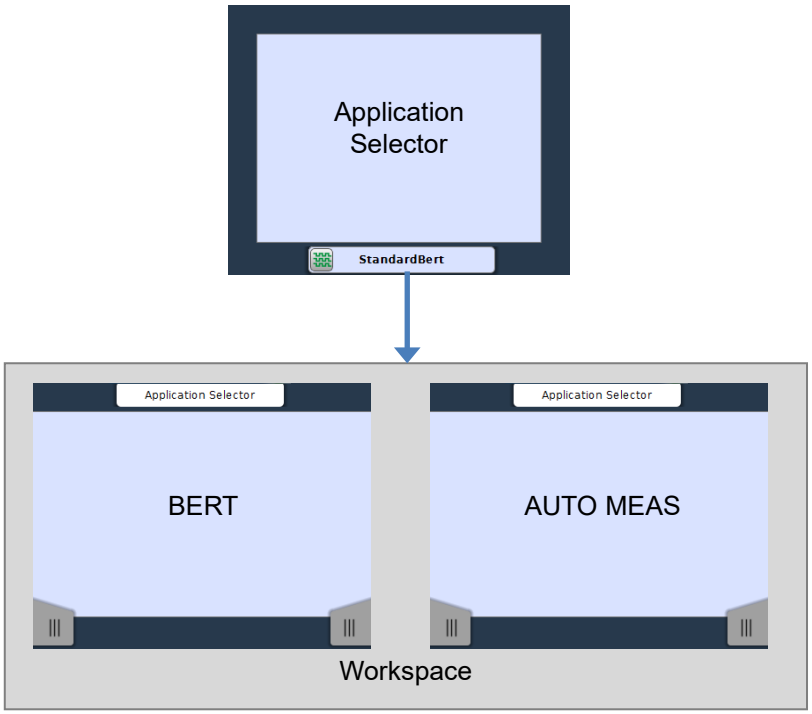


Figure 3.1.2-2 Switching to Workspace from Application Selector

Switching screens within a Workspace

An application has several screens, and these screens are switched horizontally within Workspace.

In the workspace you can switch between BERT screen and AUTO MEAS screen by touching the navigation tabs displayed at the bottom corners of the screen.

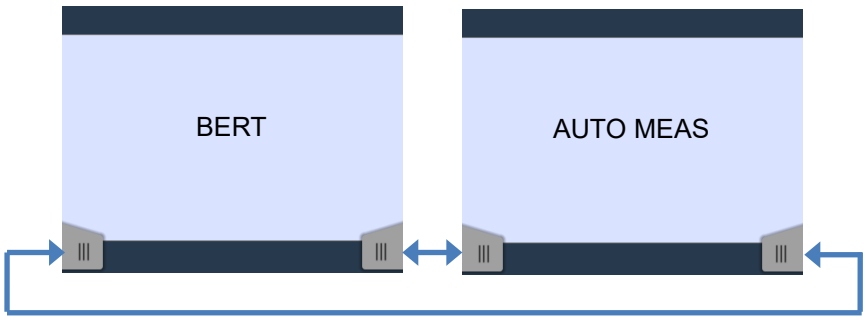


Figure 3.1.2-3 Horizontally Switching by Using Navigation Tabs

The screen name (hereinafter, "screen indicator") is displayed at bottom of the screen. Screen can be switched by touching the screen indicator.

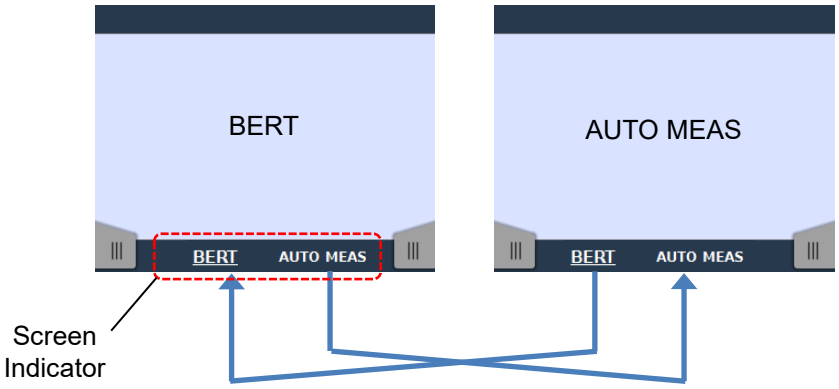


Figure 3.1.2-4 Switching Between Screens by Touching the Screen Indicator

3.1.3 System control area

System control area is located at right bottom of the screen. In this area, buttons which control basic function of the system are placed.

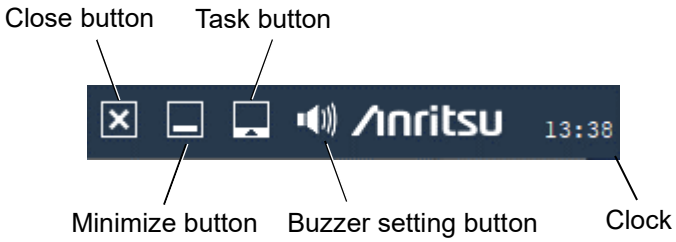


Figure 3.1.3-1 System Control Area

3.1.3.1 Clock

Displays the current time. Touching the clock displays year, month, day, and time.

3.1.3.2 Buzzer setting button

Touching  displays the **Buzzer Settings** dialog box.

Set buzzer volume or on or off of System Alarm, Measurement Alarm, and Measurement Error.

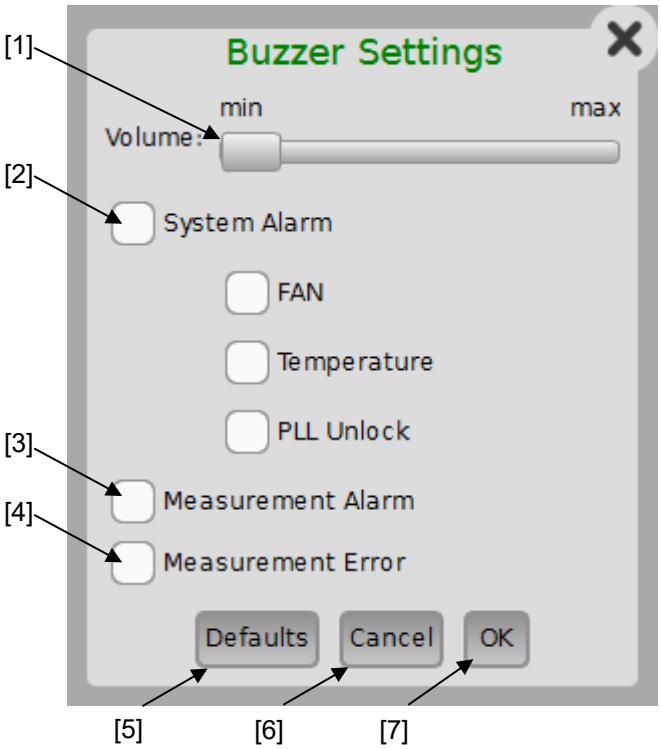


Figure 3.1.3.2-1 Buzzer Settings Dialog Box

[1] Volume
Set buzzer volume.

[2] System Alarm
Turn system alarm buzzer on or off and set items of system alarm. PLL Unlock is enabled and able to set when MU181000A/B or MU191000A is installed.

[3] Measurement Alarm
Turn buzzer on or off for measurement alarm occurrence.

[4] Measurement Error
Turn alarm buzzer on or off for measurement error occurrence.

[5] Defaults
Resets the settings to default.

[6] Cancel
Aborts settings and closes the dialog box.

[7] OK
Sets settings effective and closes the dialog box.

3.1.3.3 Task button

Touching  displays the taskbar. For the taskbar, refer to 3.1.5 “Taskbar”.

3.1.3.4 Minimize button

Touching  minimizes the screen and hides it.

3.1.3.5 Close button

Touching  displays the dialog box below.

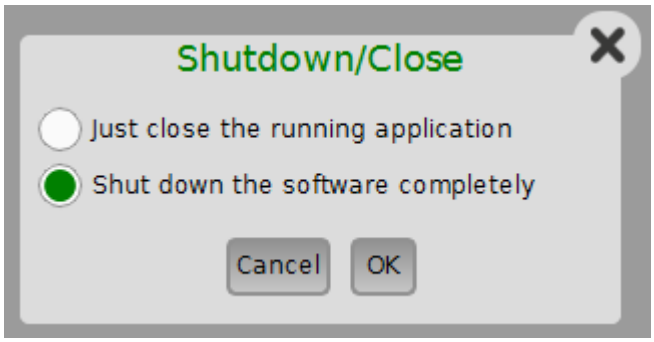


Figure 3.1.3.5-1 Shutdown/Close Dialog Box

Just close the running application:
Closes the running application.

Shut down the software completely:
Exits MX190000A completely including Application Selector.

3.1.4 Application Selector

The Application Selector is the screen that appears after MX190000A starts. It consists of the following areas: PAM4 PPG/ED Based System, Single/Multi-lane Test System for PCIe with Forced Link, SI and PAM4 Combined System, SI PPG/ED Based System, Miscellaneous System, and Utility. You can launch applications from the first four areas, and launch external software from the Utility area.
For details, refer to 4.1, “Application Selector screen”.

3.1.5 Taskbar

The taskbar allows users to switch a task to be displayed. Tasks which can be switched are Application selector, the running application, and the running utility.
The taskbar appears by touching  on the system control area or by pressing MP1900A **Function Key**.
For Application, refer to 4.1.1 “PAM4 PPG/ED Based System area”, 4.1.2 “Single/Multi-lane Test System for PCIe with Forced Link area”, 4.1.3 “SI and PAM4 Combined System area”, 4.1.4 SI PPG/ED Based System area” and 4.1.5 “Miscellaneous System area”. For Utilities, refer to 4.1.6 “Utility area”.

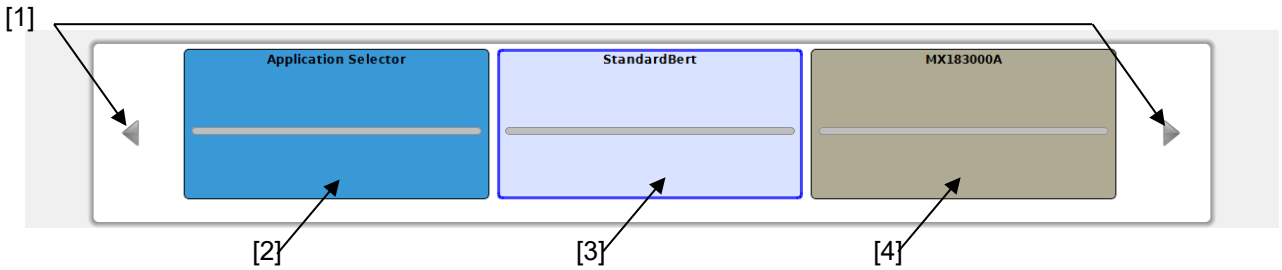


Figure 3.1.5-1 Taskbar

[1] Scroll buttons
These buttons are enabled when there are four or more tasks. Touching a scroll button slides displayed tasks.

[2] Application Selector Task
Touching this task button changes screen display to Application selector.

[3] Application Task
The name of the application running on Workspace is displayed on a task button. When no applications are running on Workspace, Application Task does not appear. Touching this task button changes screen display to the running application.

[4] Utility Task
The name of the running utility is displayed on the task button. When no utilities are running on Workspace, Utility Task does not appear. Touching this task button changes screen display to the running utility.

3.1.6 System Toolbar

Touching the navigation tab displayed at top right-hand corner of the screen displays the System Toolbar by sliding.

System Toolbar contains screens of System Information, General Settings, File Explorer, Help, and Module Setting.

Note:

Do not use the system toolbar while an application is launching from the application selector, as this may cause the launch process to fail.

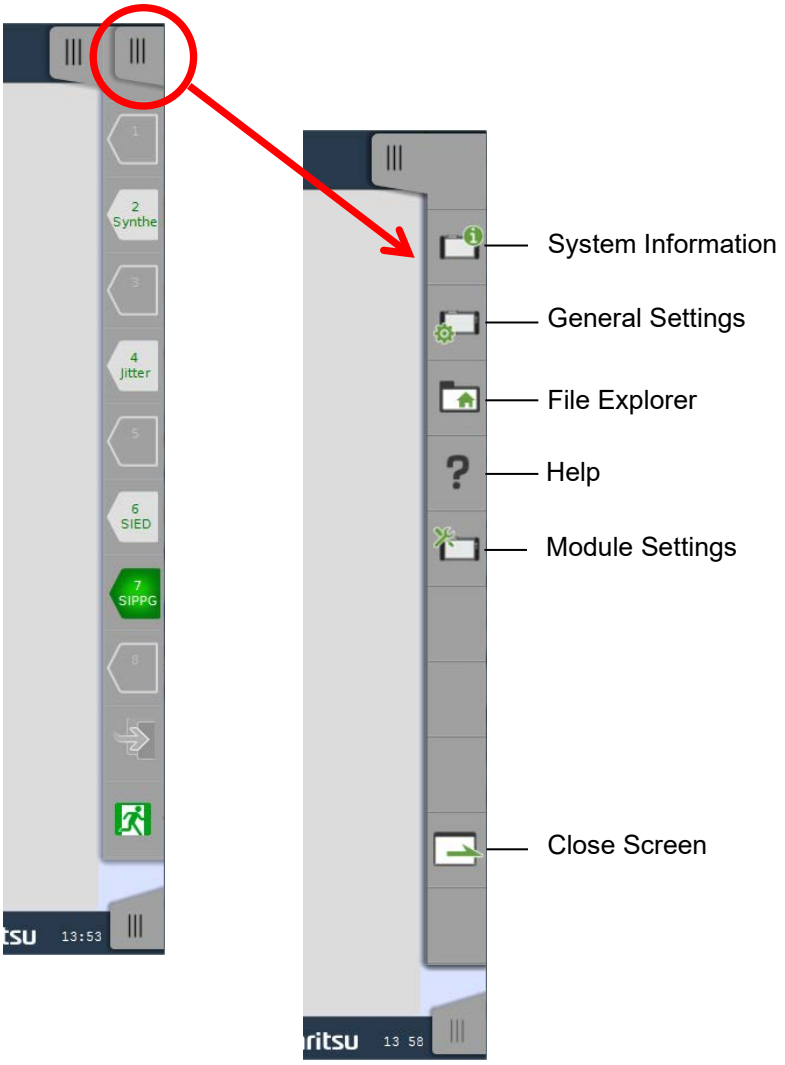


Figure 3.1.6-1 How to Display System Toolbar and Icon Names

3.1.6.1 System Information

Touching  displays System Information. Touching **Update About Info** updates System Information to latest one.



Figure 3.1.6.1-1 System Information

Button changes to  while System Information is displayed.

Touching  or  closes System Information.

System Information displays the following information.

- System Information
  Version number of the current system.
- Module(s) Information
  For MP1900A and each module inserted into slot: Model name, serial number, total running hours, version, IP address, option information.
- Software Information
  For application and utility: version.

Note:

The total operation time is updated when the application is started or **Update About Info** is touched.

The contents displayed in System Information can be saved in HTML format.

Touching **Save To File** opens the **Save System Information** dialog box and you can specify the destination file name and the destination folder.

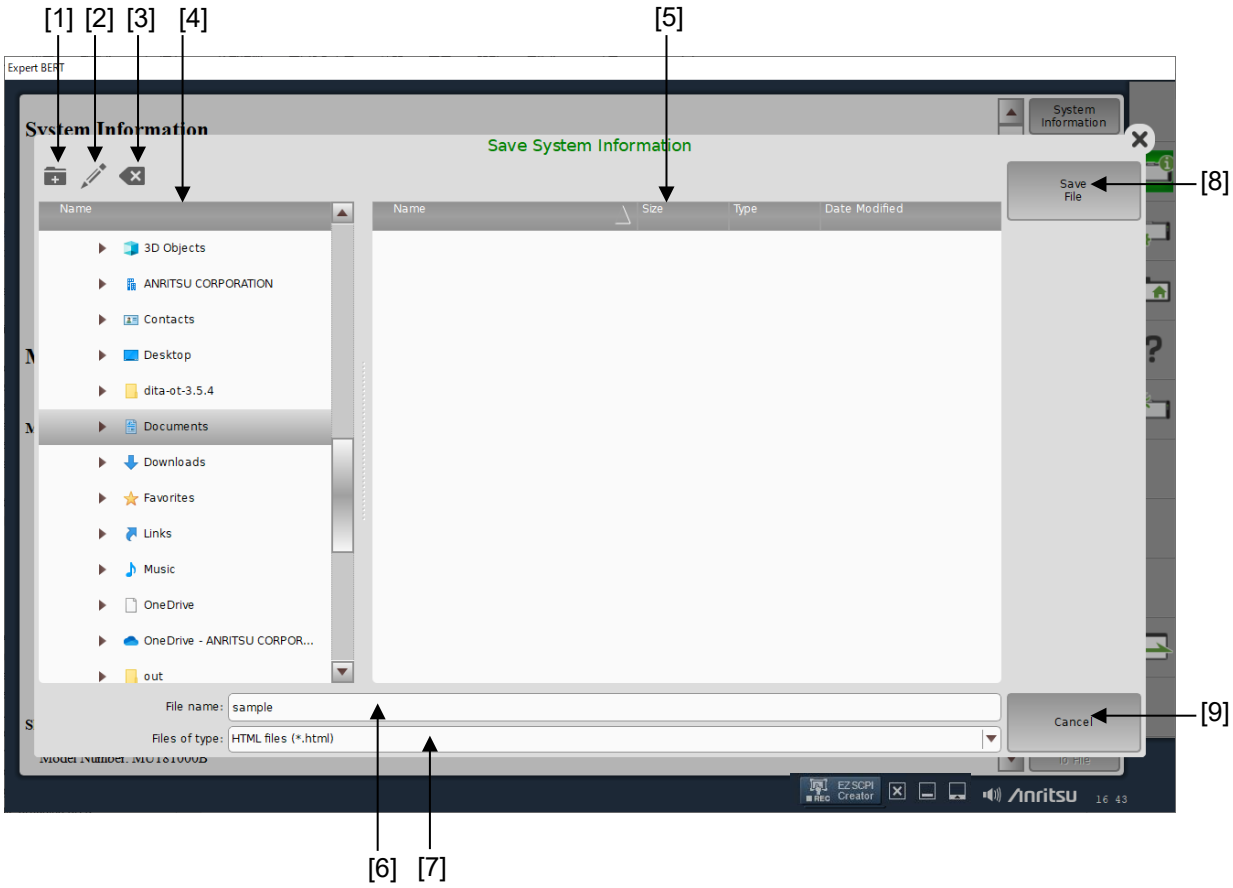


Figure 3.1.6.1-2 Save System Information Dialog Box

[1] Create Folder
Touching this icon creates a folder.

[2] Rename
Touching this icon renames the selected file or folder.

[3] Delete
Touching this icon deletes the selected files or folder.

[4] Folder View
Folders are displayed in a tree format.

[5] File View
Displays file names.

[6] File name
Enter the name for the file to save.

[7] Files of type
Specify a file format.

[8] Save File
Saves a file by the specified file name.

[9] Cancel
Closes the **Save System Information** dialog box.

3.1.6.2 General Settings

Touching  displays General Settings.

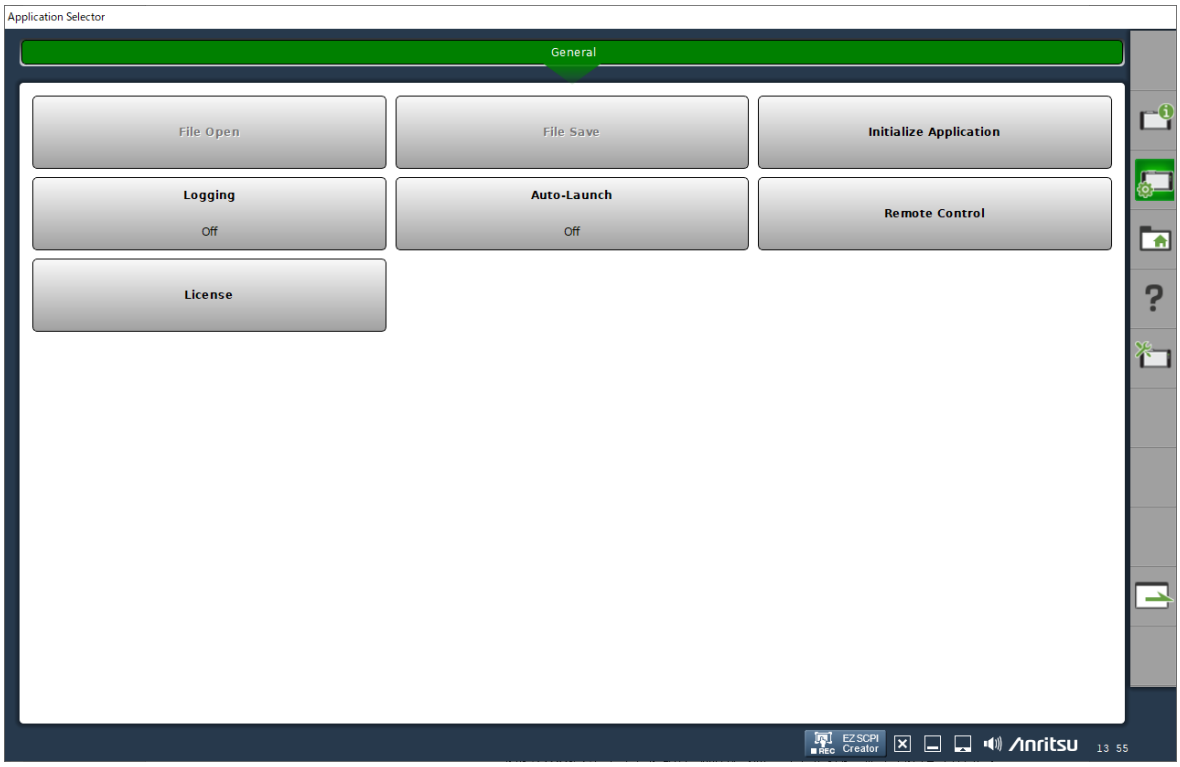


Figure 3.1.6.2-1 General Settings Screen

Button changes to  while General Settings is displayed. Touching  or  closes General Settings.

The following items can be set on General Settings screen.

- File Open
  Displays the **Open Setting File** dialog box.
  For details, refer to 3.1.7 “Loading a file”.
- File Save
  Displays the **Save Setting File** dialog box.
  For details, refer to 3.1.8 “Saving to files”
- Initialize Application
  Sets all modules installed in MP1900A to default settings at factory shipment.

Note:

When the Initialize function is executed while PPG and ED are in Combination or Channel Synchronization status, Independent, which is the initial status, is restored.

- Logging
  Logging allows users to set levels which are output into the log. Always set to **Off**. Other options are reserved for maintenance.

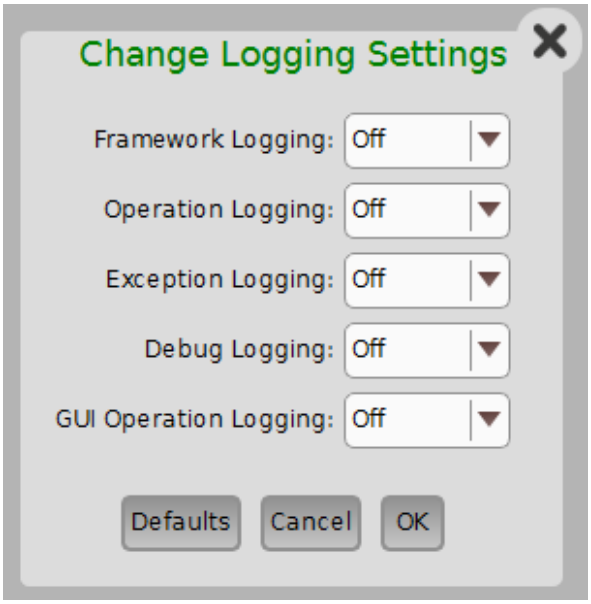


Figure 3.1.6.2-2 Change Logging Settings Dialog Box

- Auto-Launch
  Auto-Launch allows users to set the application which launches automatically after MX190000A has started.

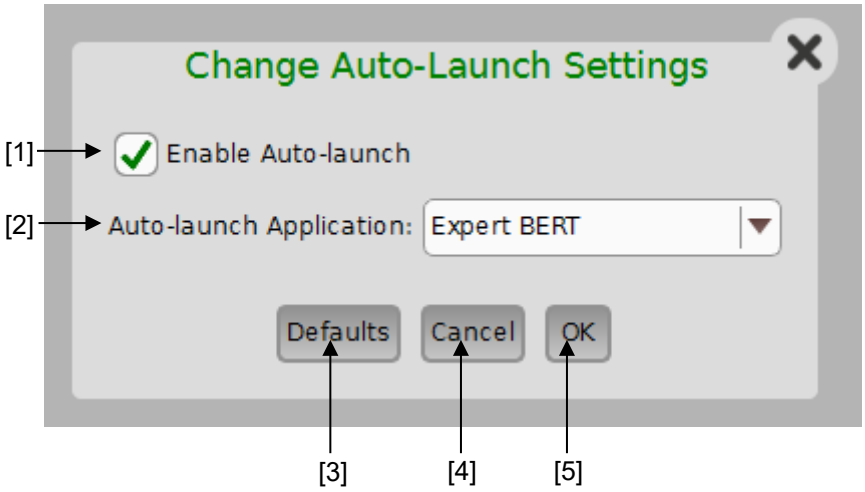


Figure 3.1.6.2-3 Change Auto-Launch Settings Dialog Box

[1] Enable Auto-launch
Selecting the check box enables to launch the application specified at Auto-launch Application after starting MX190000A.
If the check box is cleared, Application selector appears after starting MX190000A.

[2] Auto-launch Application
Specify an application to launch after starting MX190000A.

[3] Defaults
Resets the settings to defaults.

[4] Cancel
Closes the dialog box.

[5] OK
Establishes settings and closes the dialog box.

- Remote Control
  Set port and address for remote controlling MX190000A from an external PC.

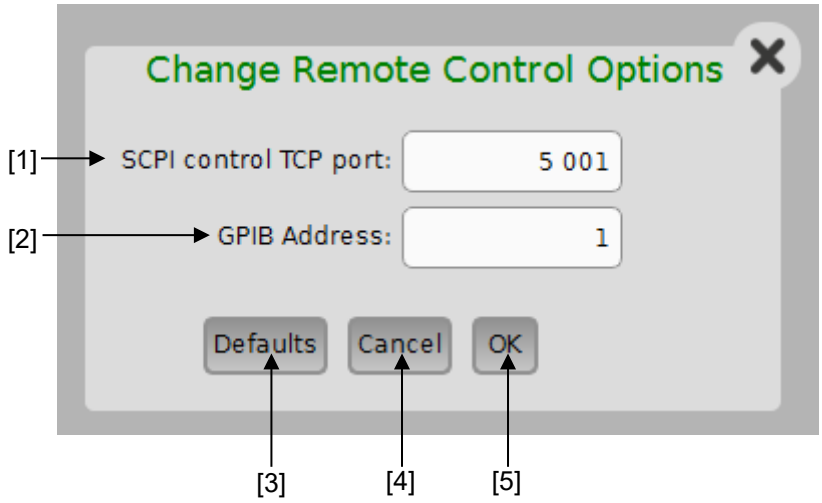


Figure 3.1.6.2-4 Change Remote Control Options Dialog Box

[1] SCPI control TCP port
Set a TCP port number when remote controlling MX190000A with Ethernet interface.
Set the same TCP port number with the controller such as an external PC. As for the socket type, MX190000A behaves as TCP server.

For details of IP address setting, refer to 5.2 "Using Ethernet" in the *MP1900A Signal Quality Analyzer-R Operation Manual*.

[2] GPIB Address
Set a GPIB address when remote controlling MX190000A with GPIB interface.

[3] Defaults
Resets the settings to defaults.

[4] Cancel
Closes the dialog box.

[5] OK
Establishes settings and closes the dialog box.

Note:

TCP port number and GPIB address are not reflected to MP1900A even if you have touched **OK**. Quit MX190000A once and these settings are actually reflected after rebooting MP1900A.

- License
  Check the module license information and activate timed or permanent licenses.

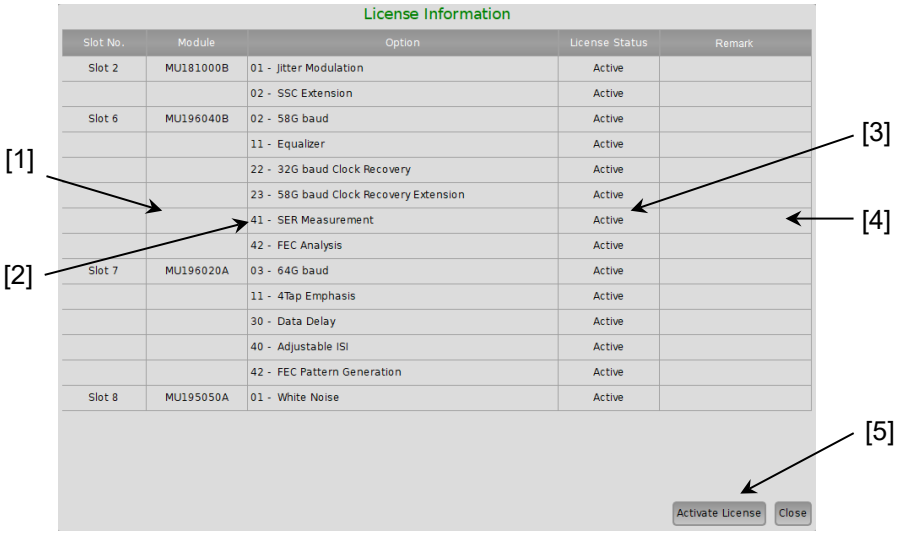


Figure 3.1.6.2-5 License Information Dialog Box

[1] Module
Displays the model names of the modules installed in the MP1900A. For model names of modules, refer to 1.2.1, "Standard Configuration" in the *MP1900A Signal Quality Analyzer-R Operation Manual*.

[2] Option
Displays option information of the modules installed in the MP1900A.

[3] License Status
Displays the activation status of the module option licenses, as follows:

- **Active**
  The corresponding option is active.
- **Inactive**
  The corresponding option is inactive.

[4] Remark
Displays remarks.

[5] Activate License
Activates timed or permanent licenses, which are provided by Anritsu.

3.1.6.3 File Explorer



The File Explorer icon launches the file manager screen.

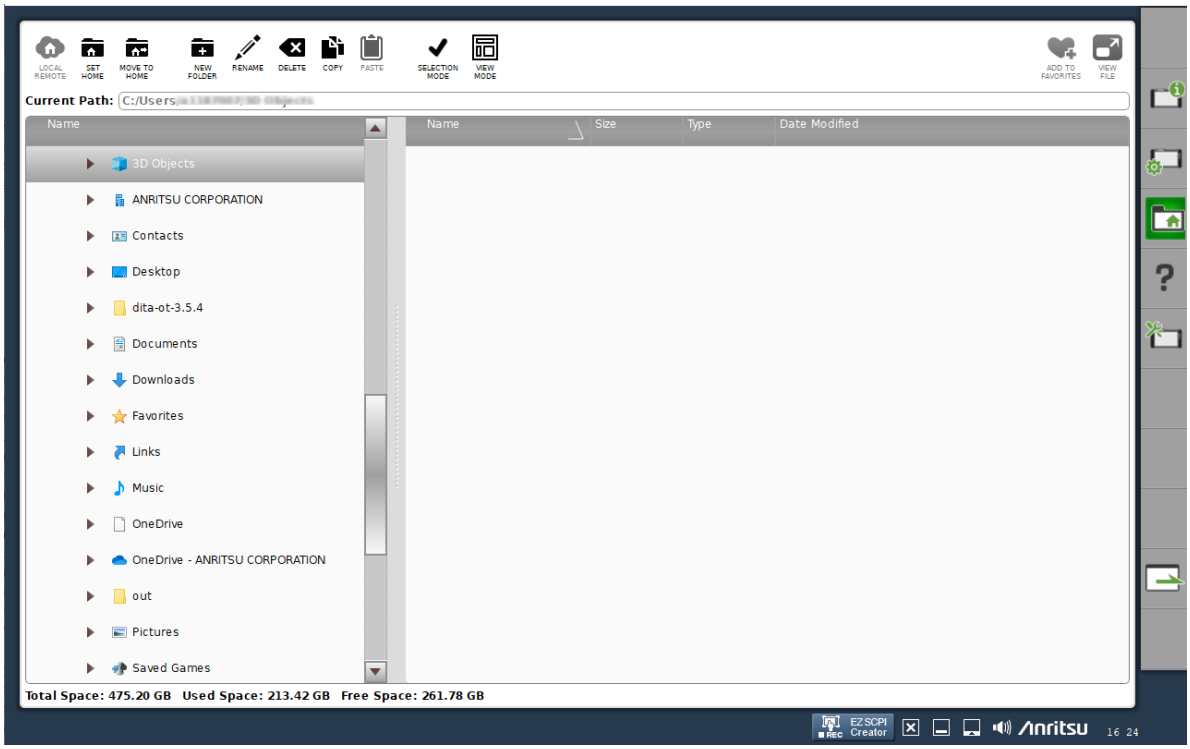


Figure 3.1.6.3-1 File Explorer Screen

Button changes to  while File Explorer is displayed.

Touching  or  closes File Explorer.

File Explorer provides file or folder operation functions, referring to the internal storage and the external storage connected to MP1900A. Details are as below.

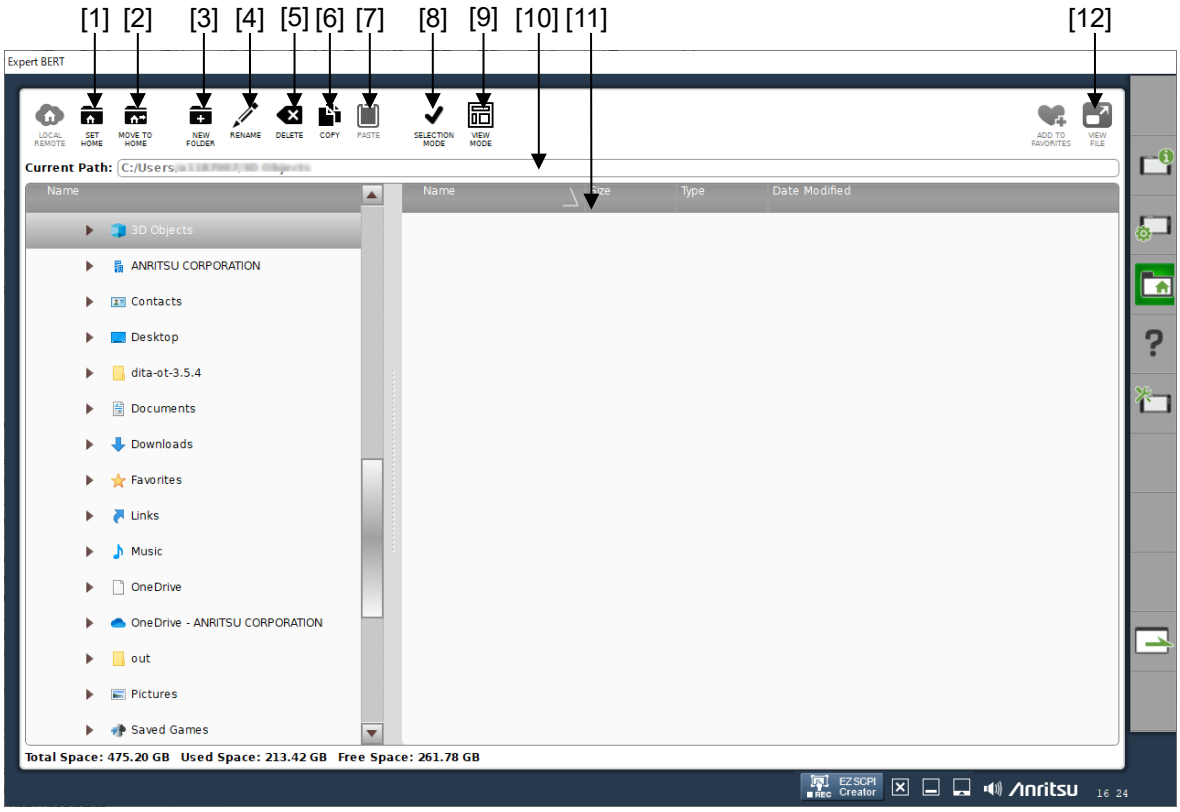


Figure 3.1.6.3-2 File Explorer Screen

[1] SET HOME
Sets the current folder to the home folder.

[2] MOVE TO HOME
Moves to the home folder.

[3] NEW FOLDER
Creates a new folder.

[4] RENAME
Edits the file name or the folder name.

[5] DELETE
Deletes the selected file(s) or folder(s).

[6] COPY
Copies the selected file(s) or folder(s).

[7] PASTE
Pastes the file(s) or folder(s).

[8] SELECTION MODE
Switches between single selection and multiple selection for files or folders.

[9] VIEW MODE
Switches the GUI layout.

[10] Current Path
Displays the path of currently selected folder.

[11] Tree View
Files or folders are displayed in a tree format.

[12] VIEW FILE
Shows contents of a text file.

3.1.6.4 Help

Touching  icon displays the English operation manual in PDF.

3.1.6.5 Module Settings

Touching  displays Module Settings.

Also, Touching 

in application screen displays Module Settings.

In Module Settings screen, status of modules installed in MP1900A appears. Modules Settings screen also allows users to updated FPGA and firmware. Furthermore, the **Combination Setting** dialog box, **Grouping** dialog box, and **Multi Channel Calibration** dialog box can be opened from the Module Settings screen.

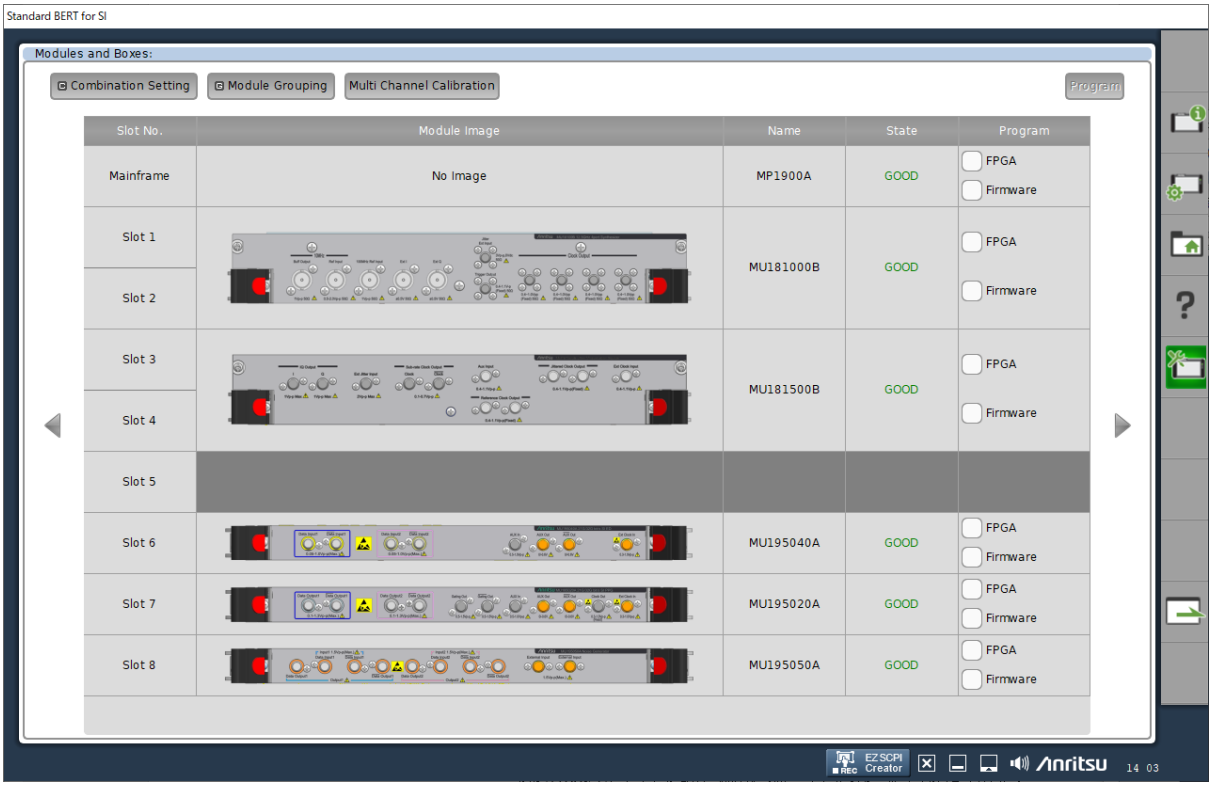


Figure 3.1.6.5-1 Module Settings Screen

 changes to  while Module Settings is displayed. Touching  or  closes Module Settings.

If the trouble has occurred in the module,  changes to  and  changes to  .

And 

changes 

.

Details of Module Settings screen are shown below.



Figure 3.1.6.5-2 Modules Settings Screen

[1] Combination Setting
Touching this button displays the **Combination Setting** dialog box. For details, refer to 3.3 “Multi Channel Function”.

[2] Module Grouping
Touching this button displays the **Grouping** dialog box. For details, refer to 3.4 “Module Grouping Function”.

[3] Multi Channel Calibration
Touching this button displays the **Module Channel Calibration** dialog box. For details, refer to 3.5 “Multi Channel Calibration Function”.

[4] Program
Touching this button updates the FPGA or the firmware in the module specified by selecting (✓) in the Program column. Before updating the firmware, close the running application.

For instructions on how to close the application, refer to 3.1.3.5 “Close button”.

[5] Slot No. column
Slot numbers in MP1900A are displayed.

[6] Module Image column
Panel images of module installed in the slot are displayed.

[7] Name column
Models of modules installed in the slot are displayed.

[8] State column
Models of modules installed in the slot are displayed.

- **Blank**
  Module is not installed.
- **GOOD**
  Module is in normal state.
- **Version Mismatch**
  FPGA or firmware of the module does not match the version which MX190000A is requiring.
  In case of **Version Mismatch,** the check box of the FPGA or firmware which is required to update in the Program column is automatically selected (☑).

[9] Program column
To update FPGA or firmware of the module installed in the slot, select each check box (☐ → ☑) and touch **Program**.
When **Version Mismatch** is displayed in the State column, the check box of FPGA or firmware which should be updated is automatically selected (☑). Perform update by touching **Program**.

⚠ CAUTION

Do not turn off while updating FPGA or firmware is in progress. Turning off while updating FPGA or firmware is in progress may cause that the module does not work properly.

3.1.7 Loading a file

In the **Open Setting File** dialog box displayed from **File Open** in 3.1.6.2 "General Settings", load a setting information file (.CND).

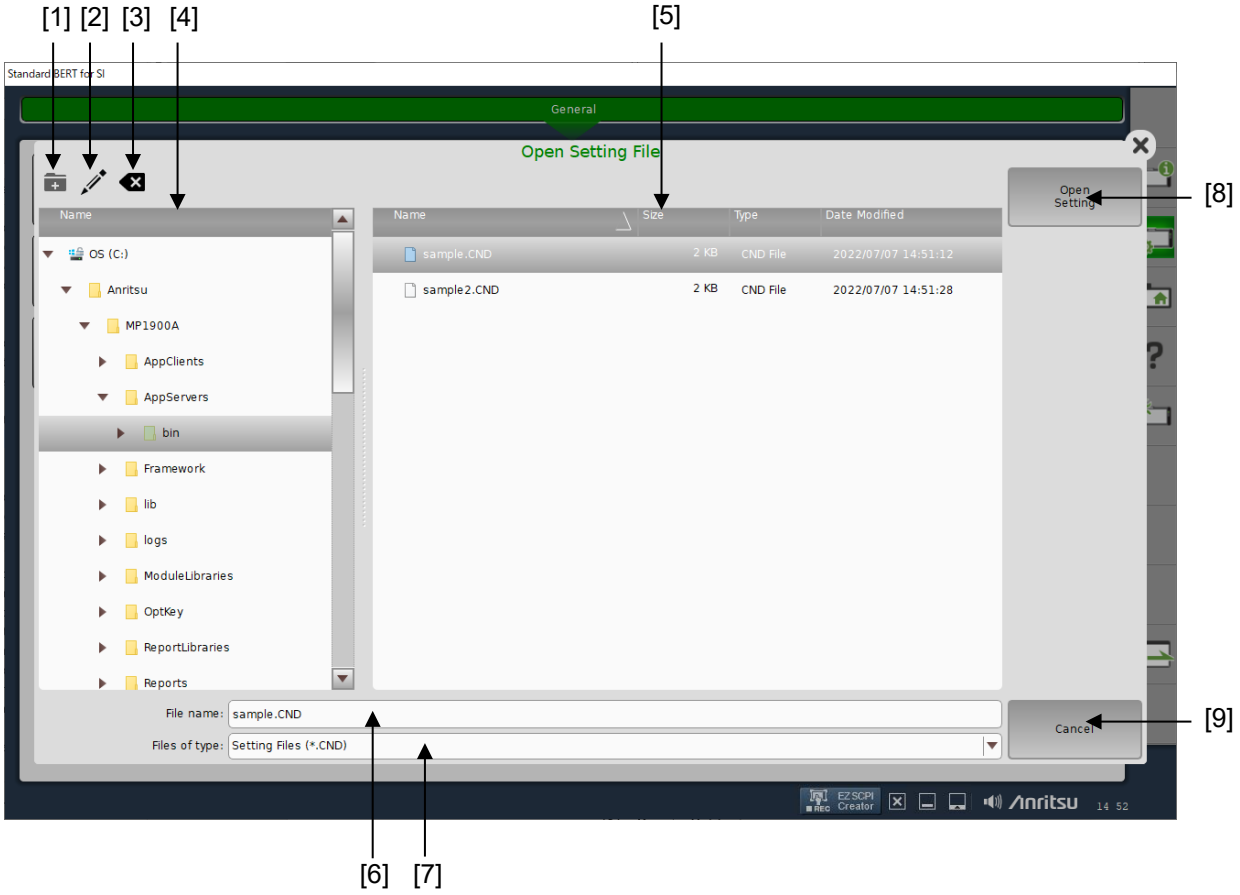


Figure 3.1.7-1 Open Setting File Dialog Box

[1] Create Folder
Creates a new folder.

[2] Rename
Edits the file name or the folder name.

[3] Delete
Deletes the selected file(s) or folder(s).

[4] Folder View
Displays folders in a tree format.

[5] File View
Displays files.

[6] File name
Specify a setting information file name.

[7] Files of type
Specify a file format.

[8] Open Setting
Opens a specified setting file.

[9] Cancel
Closes the **Open Setting File** dialog box.

3.1.8 Saving to files

In the **Save Setting File** dialog box displayed from **File Save** in 3.1.6.2 "General Settings", save a setting information file (.CND).

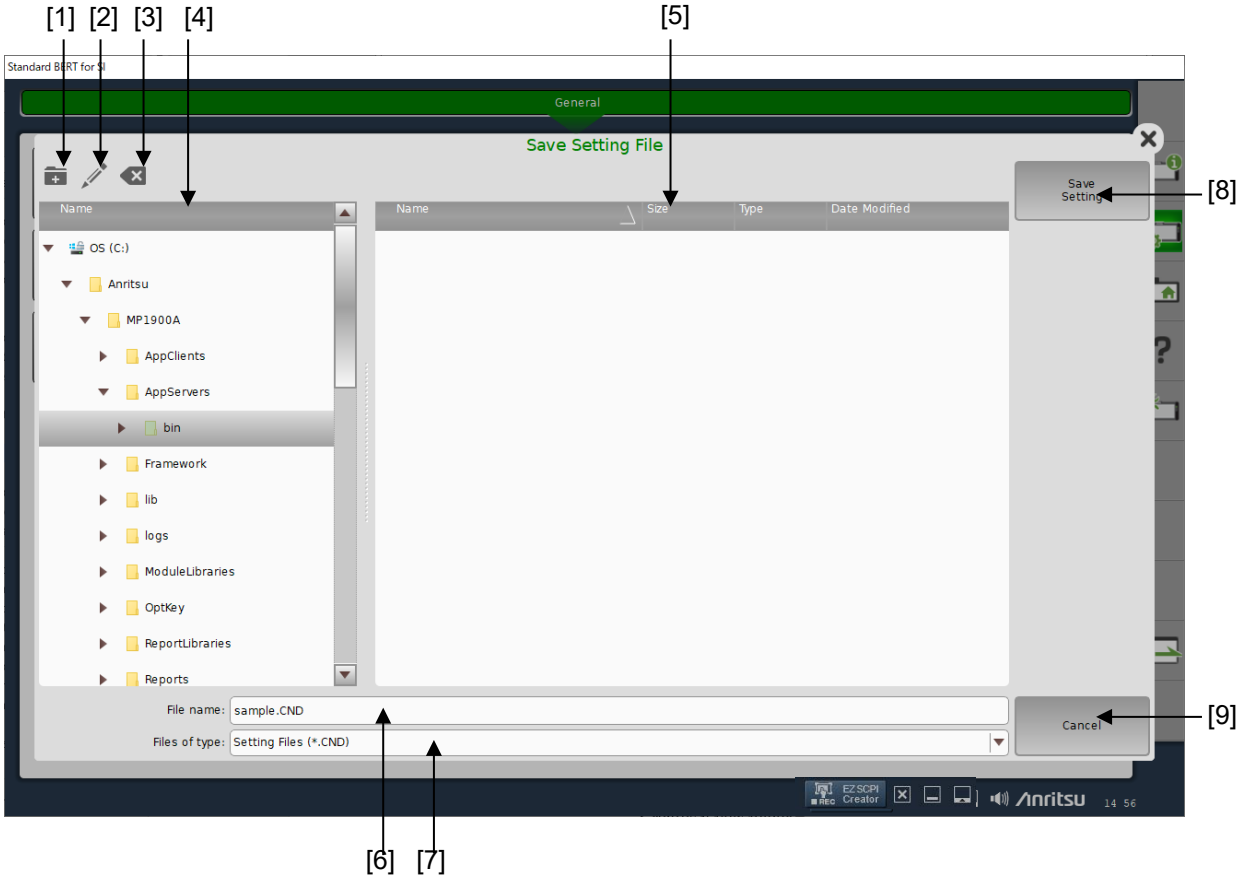


Figure 3.1.8-1 Save Setting File Dialog Box Explanation

[1] Create Folder
Creates a new folder.

[2] Rename
Edits the file name or the folder name.

[3] Delete
Deletes the selected file(s) or folder(s).

[4] Folder View
Displays folders in a tree format.

[5] File View
Displays files.

[6] File name
Specify a setting file to save.

[7] Files of type
Specify a setting file format.

[8] Open Setting
Saves a specified setting file.

[9] Cancel
Closes the **Save Setting File** dialog box.

3.1.9 Changing numeric value

To change numeric value in MX190000A operation, use numeric value input controller or numeric value input pad. Touching the parameter that you wish to change value displays numeric value input controller or numeric value input pad. This section describes how to use numeric value input controller or numeric value input pad.

3.1.9.1 Numeric value input controller

Touching the parameter to be changed displays numeric value input controller by sliding to left. It is convenient for adjusting a parameter by using numeric value input controller and MP1900A rotary knob together.

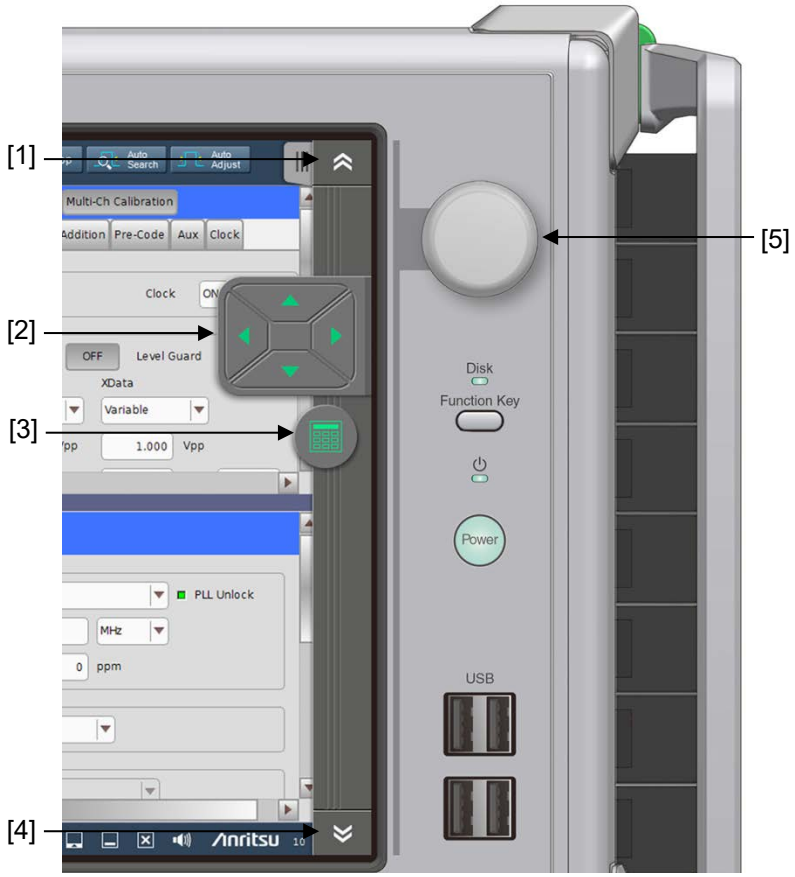


Figure 3.1.9.1-1 Numeric Value Input Controller Explanation

[1] Controller move button (upper)
Touching this button moves numeric value input controller upper direction.

[2] Up-down and left-right buttons
Function differs between up-down buttons and left-right buttons as shown below.

- Up-down buttons
  Touching up-down buttons increase or decrease the value in digit where cursor is positioned.

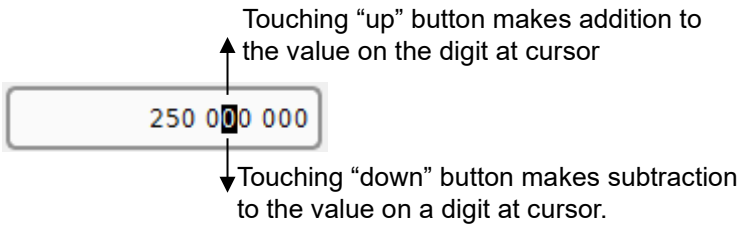


Figure 3.1.9.1-2 Increasing and Decreasing on Digit at Cursor

- Left-right buttons
  Touching left or right button moves cursor left or right.

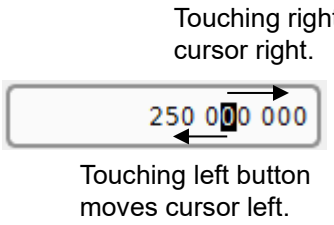


Figure 3.1.9.1-3 Moving Cursor

[3] Numeric value input pad display button
Touching this button displays numeric value input pad.

[4] Controller move button (lower)
Touching this button moves numeric value input controller lower direction.

[5] Rotary knob
Rotating the rotary knob anticlockwise makes subtracting the value on the digit at cursor.
Rotating the rotary knob clockwise makes addition the value on the digit at cursor.

If a USB mouse with center wheel has been connected to USB port of MP1900A, operating numeric value input pad by using the center wheel is available instead of using up-down, left-light buttons and rotary knob.

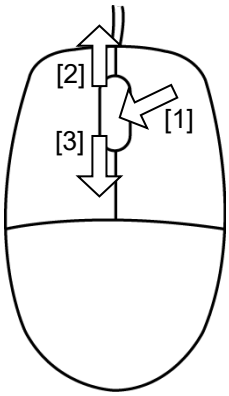


Figure 3.1.9.1-4 How to Use Center Wheel of Mouse

[1] Clicking center wheel
Clicking center wheel switches between "add-subtract mode" which makes addition or subtraction the value on the digit at cursor and "cursor move mode" which allows cursor to move left or right.

[2] Rotating center wheel upward

- In case of "add-subtract mode"
  Rotating center wheel upward increases a number directly under the cursor.

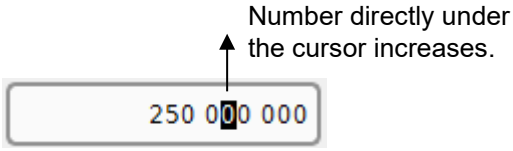


Figure 3.1.9.1-5 Increase a Number under Cursor by Center Wheel Operation

- In case of "cursor move mode"
  Rotating center wheel upward moves cursor left.

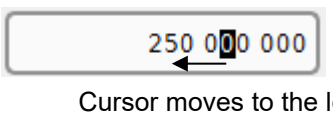


Figure 3.1.9.1-6 Moving Cursor to Left by Center Wheel Operation

[3] Rotating center wheel downward

- In case of "add-subtract mode"
  Rotating center wheel downward decreases a number directly under the cursor.

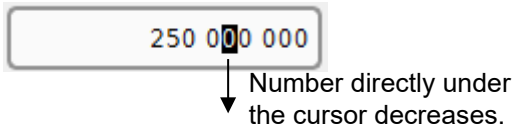


Figure 3.1.9.1-7 Decrease Number under Cursor by Center Wheel Operation

- In case of "cursor move mode"
  Rotating center wheel downward moves cursor right.

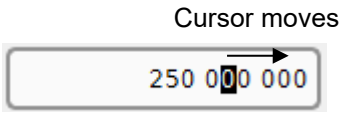


Figure 3.1.9.1-8 Moving Cursor to Right by Center Wheel Operation

3.1.9.2 Numeric value input pad

Touching the parameter to be changed displays numeric value input pad depending on the settings.

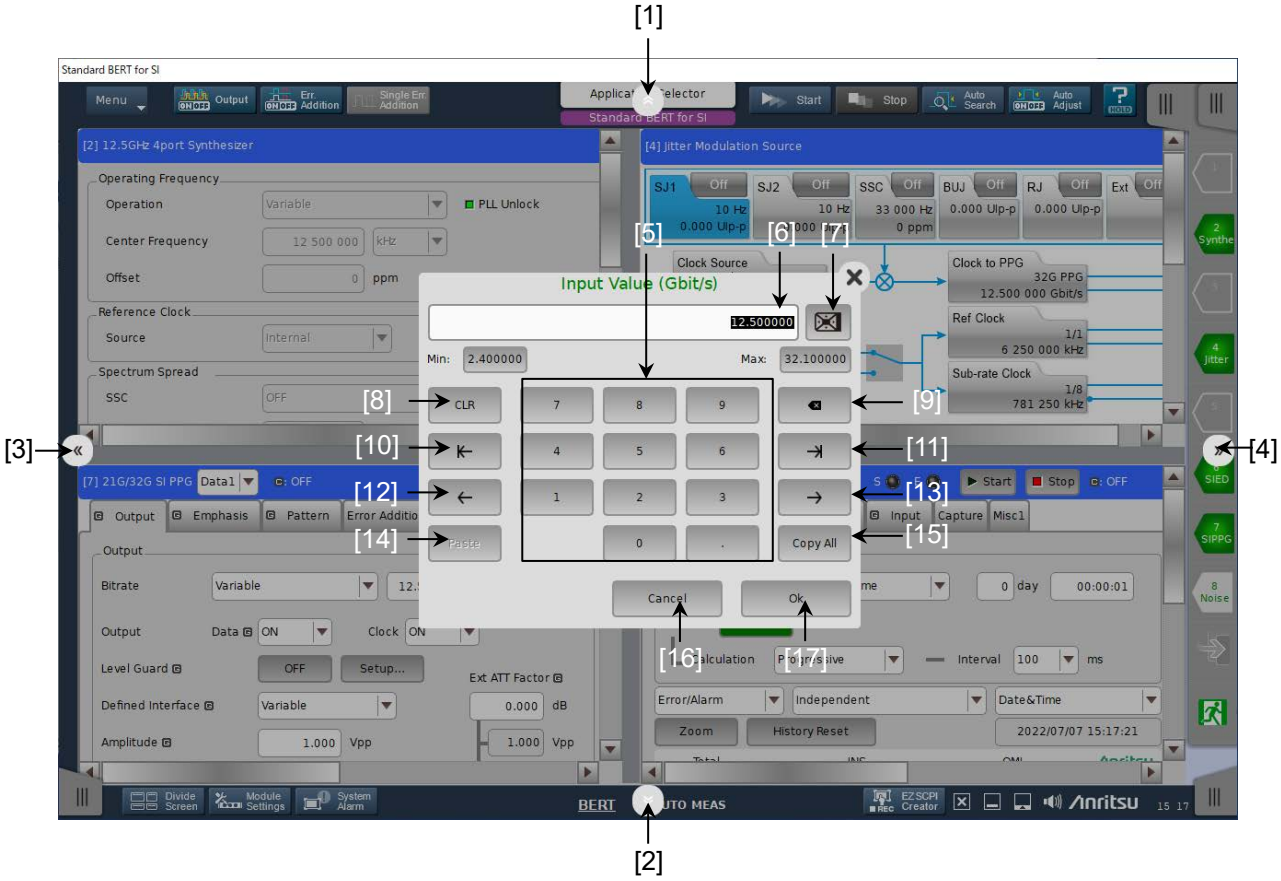


Figure 3.1.9.2-1 Numeric Value Input Pad Explanation

[1] Numeric value input pad move button (upper)
Touching this button moves numeric value input pad upper direction.

[2] Numeric value input pad move button (lower)
Touching this button moves numeric value input pad lower direction.

[3] Numeric value input pad move button (left)
Touching this button moves numeric value input pad in left direction.

[4] Numeric value input pad move button (right)
Touching this button moves numeric value input pad in right direction.

[5] Numeric key
Available to input numeric value 0 to 9.

[6] Numeric value display area
Numeric value to be edited appears here.

[7] Numeric Value Input Controller Display button
Touching this button displays numeric value input controller.

[8] CLR
Deletes all numeric characters displayed in the numeric value display area.

[9] Back Space button
Deletes a numeric character displayed in the numeric value display area. When multiple numeric characters are selected, all of them will be deleted.

[10] Home button
Moves cursor to the most left digit in Numeric value display area.

[11] End button
Moves cursor to the rightmost digit in Numeric value display area.

[12] Left button
Moves cursor left.

[13] Right button
Moves cursor right.

[14] Paste
Pastes a value and cursor position information copied in Clip board to Numeric value display area.

Note:

The cursor position information is pasted only when it is copied using **Copy All** in the numeric value input pad.

[15] Copy All
Copies a value displayed in Numeric value display area and cursor position information to Clip board.

[16] Cancel
Closes numeric value input pad.

[17] Ok
Establishes the value and closes numeric value input pad.

3.2 Operation on Workspace

This section describes basic window operation on the workspace.

3.2.1 Basic operation on overall of workspace

Application toolbar is displayed at right-hand of the screen once an application has started.

3.2.1.1 Application Toolbar

Application toolbar is displayed at right-hand of the workspace. Details are shown below.

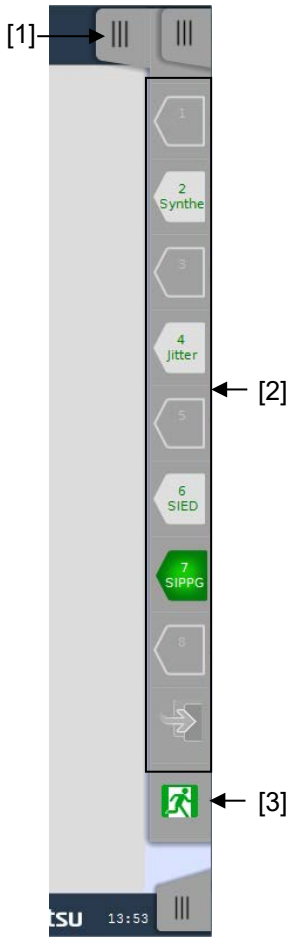


Figure 3.2.1.1-1 Application Toolbar

[1] Navigation tab (Application Toolbar)
Touching this tab displays Extended Application Toolbar.
For details, refer to 3.2.1.2 “Extended application”.

[2] Application Function buttons
Buttons appear that provide function depending on the application.
For details, refer to 3.2.2.1 “Slot selector buttons” or 3.2.3.1 “Auto Measurement selector buttons”.

[3] Application Exit button
Touching this button displays the **Shutdown/Close** dialog box. To exit the application, touch **Just close the running application** and touch **OK**.

3.2.1.2 Extended application

Touching the navigation tab of application toolbar displayed at right-top of the screen displays Extended Application Toolbar by sliding toward left.

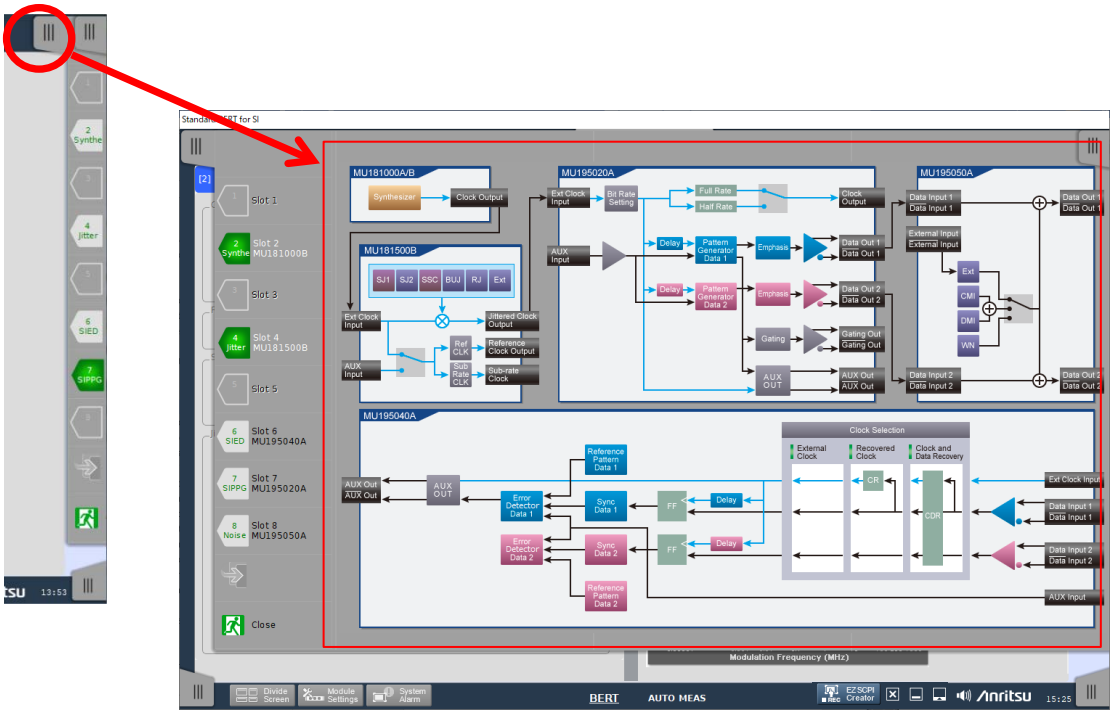


Figure 3.2.1.2-1 How to Display Extended Application

Extended Application provides extended function unique to the application.

Figure 3.2.1.2-1 shows whole block diagram of Standard BERT for SI application as an example of Extended Application.

3.2.1.3 Help

On-screen help provides explanations for the buttons and parameter functions on the application screen, and corresponding remote commands.

Displaying Help by Icon Operation

1. In the upper-right of the screen, touch 

to change it to 

, which indicates “Help mode”.
2. To display a help, touch a button, a text box, a list box, or other parts in the window.

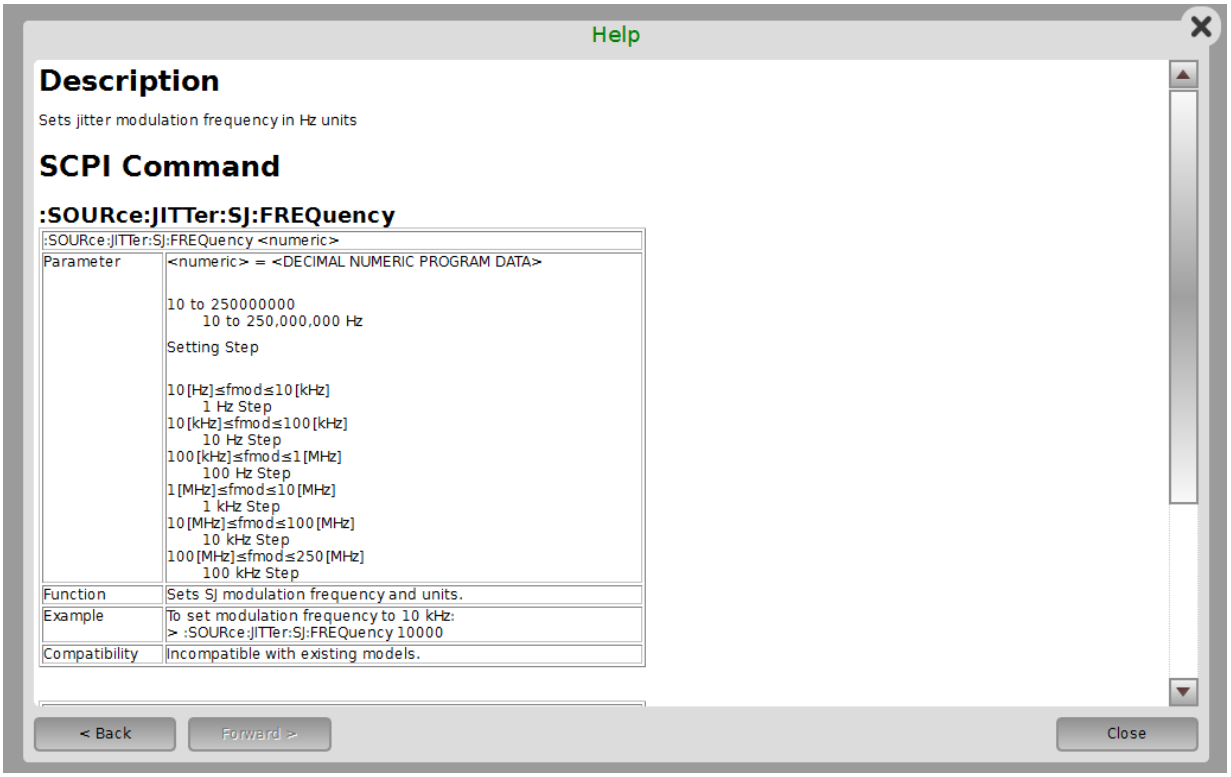


Figure 3.2.1.3-1 On-Screen Help Example

After closing the on-screen help, the button color returns to blue (

) and the application leaves “Help mode”.

Touching 

twice, the button changes to green (

) and “Help mode” is held. In this state, “Help mode” is kept even if closing the on-screen help. This is convenient function when you want to see helps consecutively.

Touching 

exits “Help mode”.

Displaying Help by Mouse Operation

For mouse operation, right-click the screen item you need help with.

3.2.2 Basic operations on BERT screen

In BERT screen, application of modules installed in each slot (hereinafter, module application) is displayed.
This section describes basic operation in BERT screen.

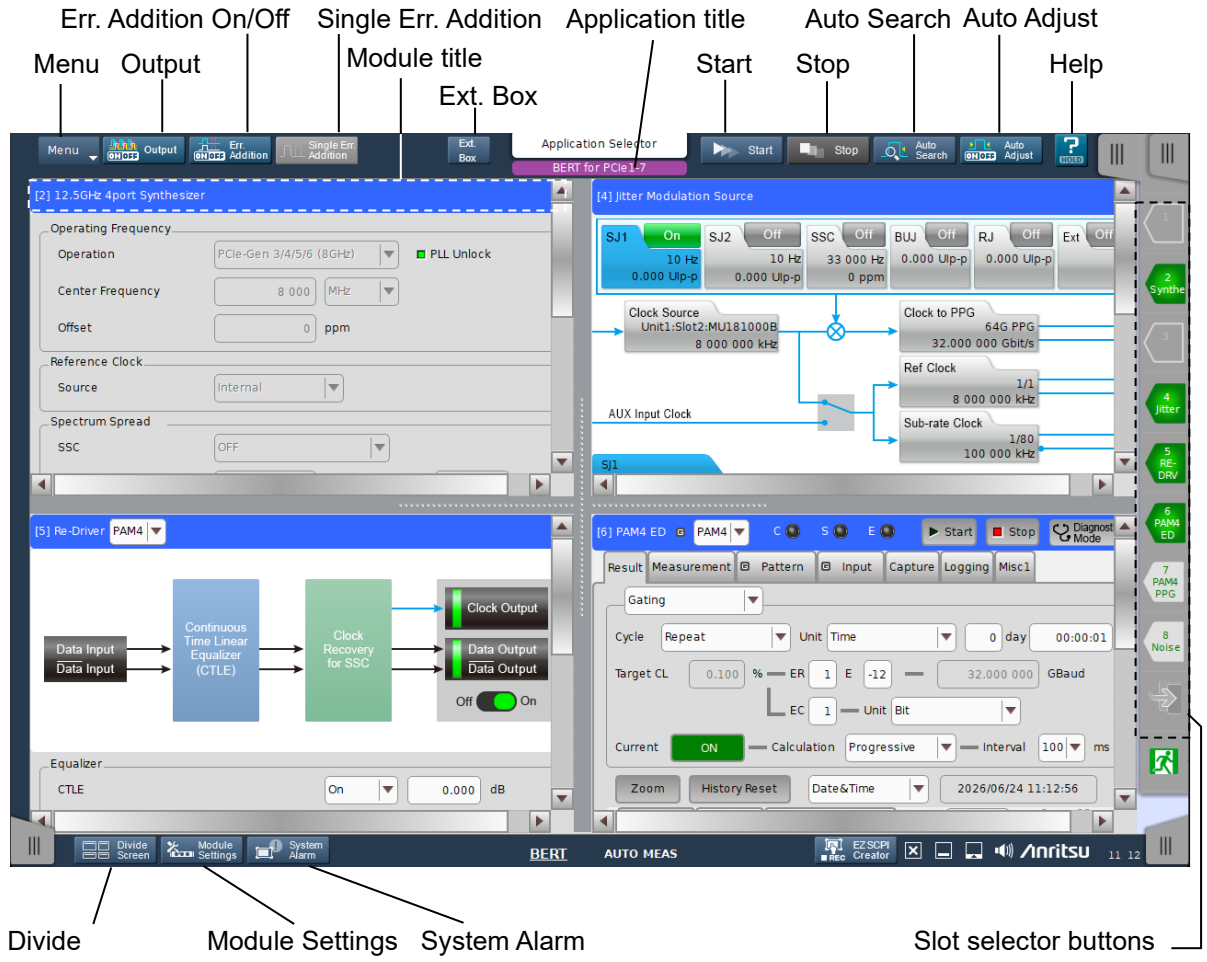


Figure 3.2.2-1 BERT Screen

3.2.2.1 Slot selector buttons

Slot selector buttons appear on Application Toolbar.

Slot number is displayed upper half in the slot selector button and the button color changes according to three states below.

Table 3.2.2.1-1 Slot Selector Button Indication

Slot Selector Buttons	Description
	No Modules Module is not installed in the slot. No action even if touching the button.
	Module is installed, not selected A module is installed in the slot but its module application has not displayed. Abbreviation of the installed module is displayed on lower half of the button.
	Module is installed and selected A module is installed in the slot and its module application has been displayed. Abbreviation of the installed module is displayed on lower half of the button.

Correspondence between module abbreviation and model is shown below.

Synthe	MU181000A/B, MU191000A
SIPPG	MU195020A
SIED	MU195040A
PAM4PPG	MU196020A, MU196020C
PAM4ED	MU196040A, MU196040B
Jitter	MU181500B
Noise	MU195050A, MU196050B
32GPPG	MU183020A, MU183021A
32GED	MU183040B, MU183041B
RE-DRV	MU196060A

When the module is in the slot, the behavior after touching the button varies depending on screen division state as below. For the screen splitting, refer to 3.2.2.12 “Divide Screen”.

- When the screen division is not set, the module application of the module installed in the slot is not displayed in divided.
- When the left-right division has been set, the screen selector as following will be displayed.



Figure 3.2.2.1-1 Screen Selector (Left-Right Division)

In this example, the module application of Slot7 SIPPG is displayed in left half of the screen and nothing is displayed in right half of the screen.

If you touch left side of the screen selector, the screen selector disappears and the module application of Slot6 SIED is displayed in left half of the screen.

If you touch right side of the screen selector, the screen selector disappears and the module application of Slot6 SIED is displayed on right half of the screen.

- When the up-down screen division has been set, the screen selector as following will be displayed.

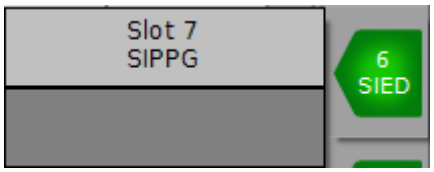


Figure 3.2.2.1-2 Screen Selector (Up-Down Division)

In this example, the module application of Slot7 SIPPG is displayed on upper half of the screen and nothing is displayed on lower half of the screen.

If you touch upper side of the screen selector, the screen selector disappears and the module application of Slot6 SIED is displayed on upper half of the screen.

If you touch lower side of the screen selector, the screen selector disappears and the module application of Slot6 SIED is displayed in lower half of the screen.

- When screen has been set to quarters division, the screen selector as the following will be displayed.

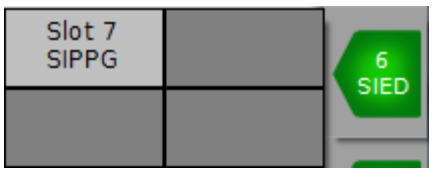


Figure 3.2.2.1-3 Screen Selector (Quarters Division)

In this example, the module application of Slot7 SIPPG is displayed in upper left of the screen and nothing is displayed in other areas.

If you touch left upper part of the screen selector, the screen selector disappears and the module application of Slot6 SIED is displayed on left upper part of the screen.

If you touch right lower part of the screen selector, the screen selector disappears and the module application of Slot6 SIED is displayed on right lower part of the screen.

3.2.2.2 Application title

Under **Application Selector**, you will see the names of the applications that have already been started. For details of the application, refer to 4.1 Application Selector".

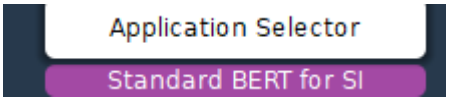


Figure 3.2.2.2-1 Application Title

3.2.2.3 Module title

The module title is displayed on top of each module application window.

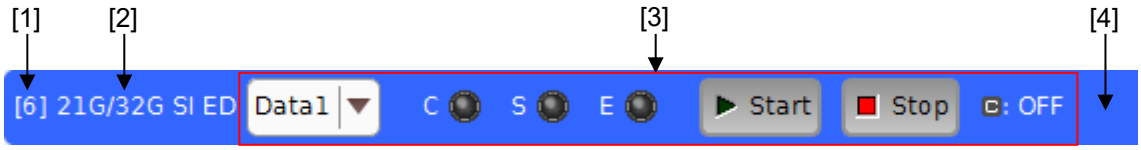


Figure 3.2.2.3-1 Module Title Explanation

[1] Slot Number
Displays slot number of the module.

[2] Module name
Displays the module name.

[3] Module unique function
Module unique function is displayed. Nothing is displayed if the module has no unique function.

[4] Module Title Bar Color

- When the module has only one Data interface, the color is blue.
- When the module has multiple interfaces, the color will be as below.

  Data 1: Blue
  Data 2: Pink

3.2.2.4 Menu

Touching **Menu** at top of the screen displays function.

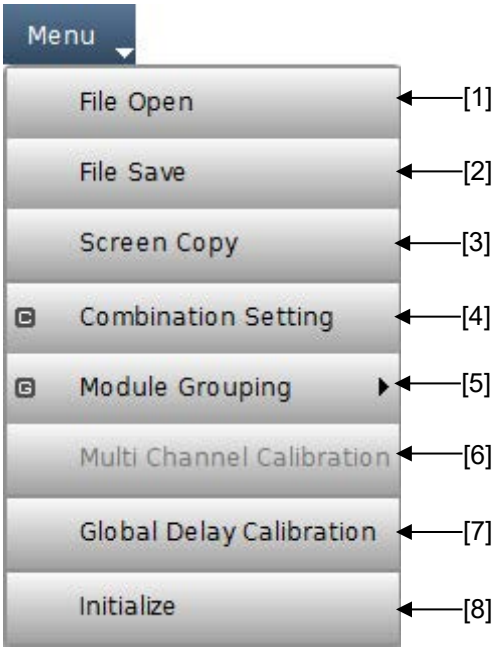


Figure 3.2.2.4-1 Menu Items

[1] File Open
Displays the **Open Setting File** dialog box.
For details, refer to 3.1.7 “Loading a file”.

[2] File Save
Displays the **Save Setting File** dialog box.
For details, refer to 3.1.8 “Saving to files”.

[3] Screen Copy
Copies a screen copy into Windows clipboard.

[4] Combination Setting
Displays the **Combination Setting** dialog box.
For details, refer to 3.3 “Multi Channel Function”.

[5] Module Grouping
Displays the **Grouping** dialog box.
For details, refer to 3.4 “Module Grouping Function”.

[6] Multi Channel Calibration
Displays the **Multi Channel Calibration** dialog box.
For details, refer to 3.5 “Multi Channel Calibration Function”.

[7] Global Delay Calibration

Displays the **Global Delay Calibration** dialog box.

In the **Global Delay Calibration** dialog box, you can perform delay calibrations of all PPGs and EDs installed in the MP1900A collectively.

For details, refer to on-screen help in the **Global Delay Calibration** dialog box. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

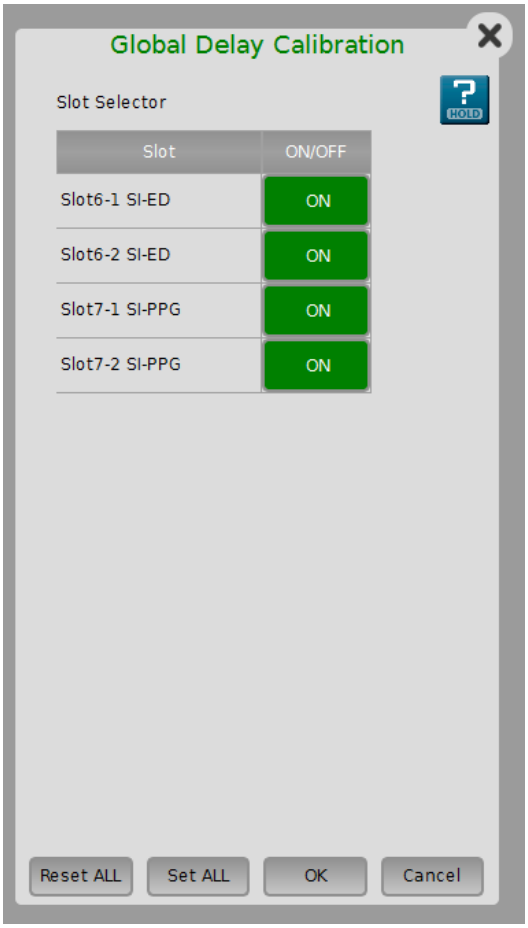


Figure 3.2.2.4-2 Global Delay Calibration Dialog Box

Note:

Delay calibration is not performed on the data interface whose jitter input is On.

[8] Initialize

Sets all modules installed in MP1900A to default settings at factory shipment.

Note:

When the Initialize function is executed while PPG and ED are in Combination or Channel Synchronization status, Independent, which is the initial status, is restored.

3.2.2.5 Output

Output function turns Data and Clock output of all modules on or off simultaneously.
Data and Clock are not output until this button is set to On even if Output of each application is set to On.

If touching 

, the button changes to green (

) and Data and Clock output is set to On.

If touching 

, the button changes to blue and Data and Clock output is set to Off (

).

3.2.2.6 Err. Addition On/Off

Err. Addition On/Off function inserts consecutive errors from all PPGs in according to settings in **Error Addition** tab of PPG module application. For details, refer to the on-screen help in **Error Addition** tab of PPG module application. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

If touching 

, the button changes to green (

) and Error addition is set to On.

If touching 

, the button changes to blue (

) and Error addition is set to Off

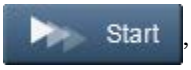
3.2.2.7 Single Err. Addition

Single Err. Addition function inserts an error in output of all PPGs in according to settings in **Error Addition** tab of PPG module application. For details, refer to the on-screen help in **Error Addition** tab of PPG module application. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Touching 

inserts an error in output of all PPGs.

3.2.2.8 Start

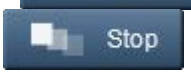
Start function starts measurements of all module applications.
If touching 

, the button changes to green (

) and all module applications start measurement.

3.2.2.9 Stop

Stop function stops measurements of all module applications.
If touching 

, all module applications stop measurement.
Note that 

is effective only while measurement is in processing.

3.2.2.10 Auto Search

Auto Search function adjusts threshold voltage and phase to optimum point depending on the input data. This function sets Threshold and Phase Delay of Data, XData to an optimum point.
This function is useful when performing the measurement, such as BER measurement, in which the threshold voltage and phase are fixed to the optimum values.

Note:

The Auto Search function cannot be performed when:

- The **Input** tab of the ED module application has been grouped.
- The ED is performing the Auto Adjust function.
- In the PAM4 ED application, **Pre Coder** is set to **ON**.

Also, the Auto Search function is terminated unsuccessfully when:

- PAM4 ED receives a signal having a bit phase shift of more than 47 bits between MSB and LSB
- The input pattern is not PRBS or equivalent to Mark Ratio 1/2.
- Each of 0/1, 1/2 and 2/3 levels is not equal.
- A random pattern with a specific cycle is repeatedly specified in the **Pattern Editor** dialog box.

When the MU196040B is installed, **Advanced Mode** is available in the **Auto Search** dialog box. This function adjusts the following settings of the MU196040B and MU196060A optimally for the input signal.

- MSB/LSB Pattern (PRBS inv, Logic, Gray Coder, Inverse Gray Coder) However, Pre Coder is excluded.
- Middle/Upper/Lower Eye Threshold
- Delay
- Equalizer (LFEQ, DFE) (Only when the MU196040B-x11 Equalizer is installed.)
- Equalizer (CTLE) (Only when the MU196060A module is built into the MP1900A.)

Note:

Advanced Mode is subject to the following restrictions in addition to *Note* for Auto Search (Advanced: OFF).

- **MSB Pattern**, **LSB Pattern**, **Upper**, and **Lower** can be auto-searched only when PAM4 is selected.
- **MSB Pattern** and **LSB Pattern** can be auto-searched only when

Test Pattern is set to anything other than **Data** or **QPRBS13**.

Touching 

displays the **Auto Search** dialog box.

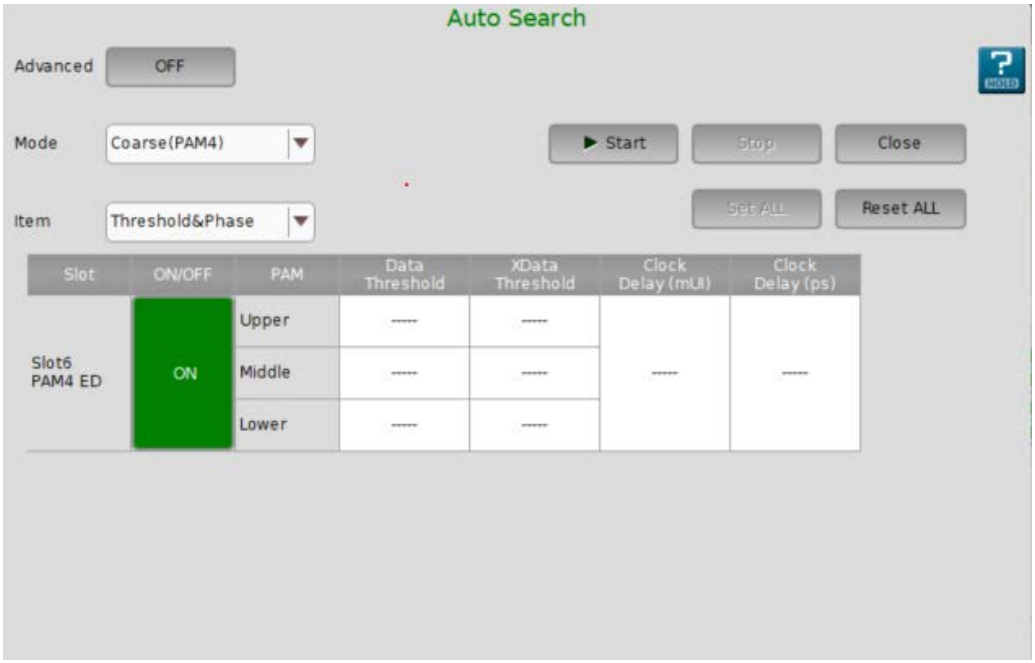


Figure 3.2.2.10-1 Auto Search Dialog Box

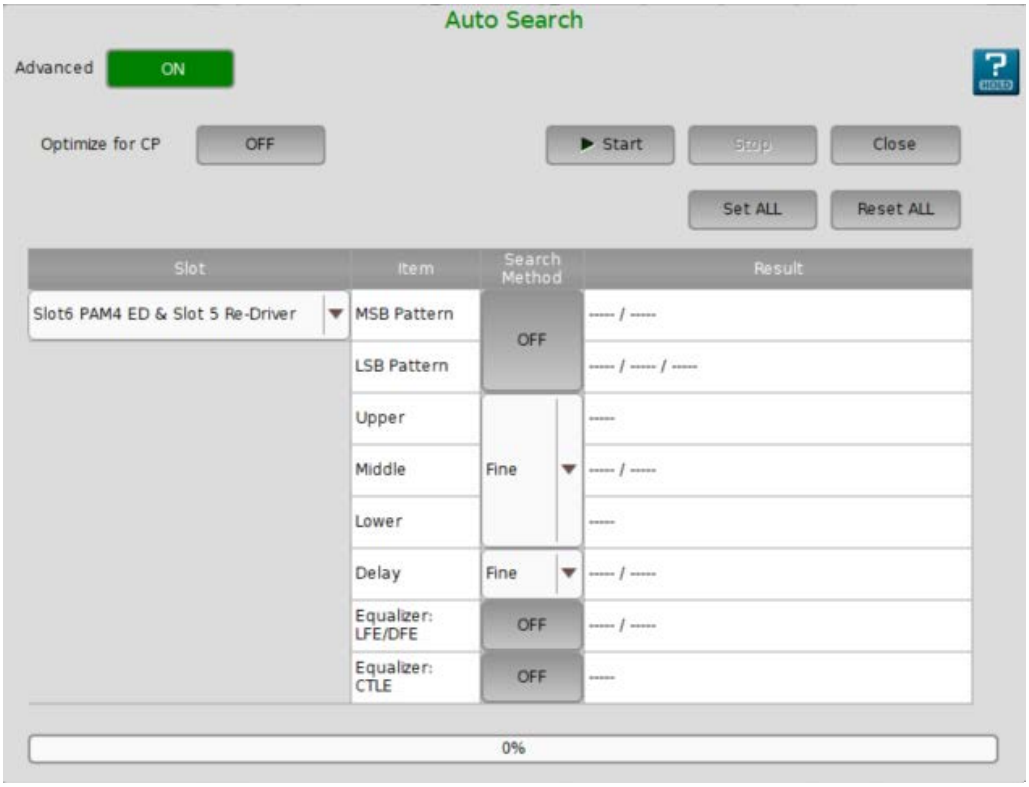


Figure 3.2.2.10-2 Auto Search (Advanced) Dialog Box

For explanation of the **Auto Search** dialog box, refer to the on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 "Help".

3.2.2.11 Auto Adjust

Auto Adjust function keeps to set the best phase and threshold voltage by following the fluctuation of signal input to ED.
This function is useful when the bit rate of the input signal and the threshold voltage are changed dynamically.

Notes:

- Auto Adjust cannot be performed when the **Input** tab of the ED module application has been grouped.
- The PAM4 ED can perform the Auto Adjust function only in the threshold voltage direction.

Touching 

displays the **Auto Adjust** dialog box.

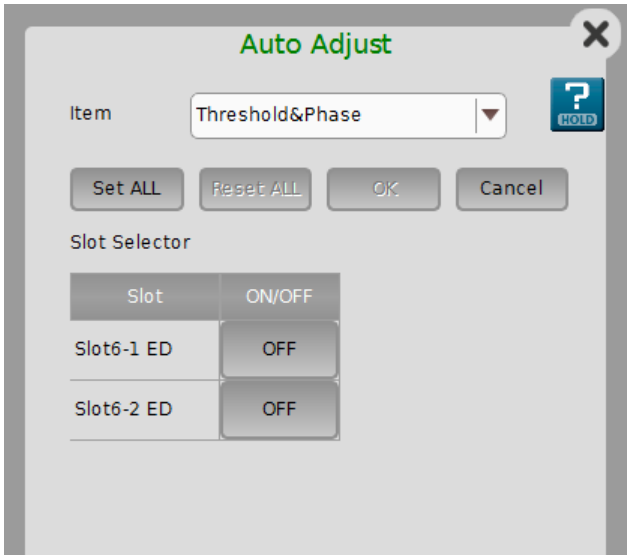


Figure 3.2.2.11-1 Auto Adjust Dialog Box

For details, refer to the on-screen help in the **Auto Adjust** dialog box. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

If touching 

, the button changes to blue (

) and Auto Adjust function stops its operation.

3.2.2.12 Divide Screen

Divide Screen function provides displaying two or four module applications by dividing the screen.

- Single (No dividing)
  Screen is used without being divided as the following figure.

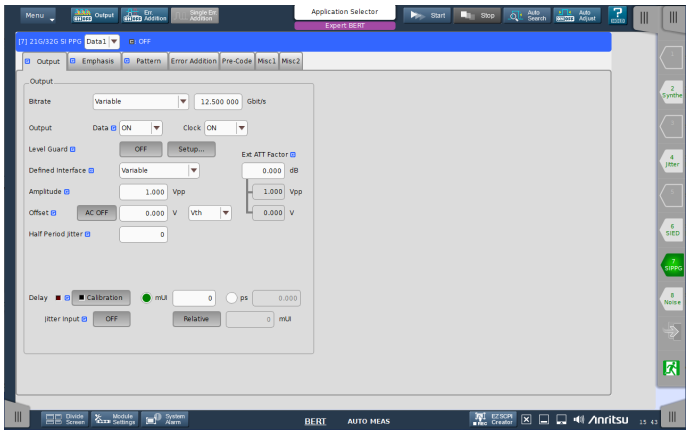


Figure 3.2.2.12-1 No Dividing

- Left-Right (left-right division)
  Screen is divided into left and right parts as the following figure.

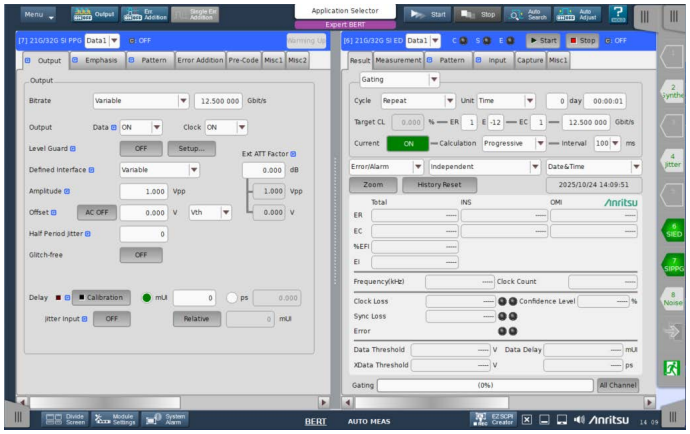


Figure 3.2.2.12-2 Left-Right Division

- Up-Down (up-down division)
  Screen is divided into upper and lower parts as the following figure.

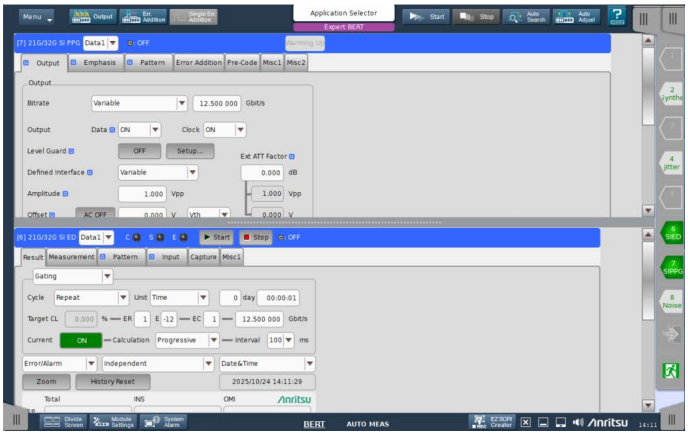


Figure 3.2.2.12-3 Up-Down Division

- Quarters (Quarters division)
  Screen is divided into four parts as the following figure.

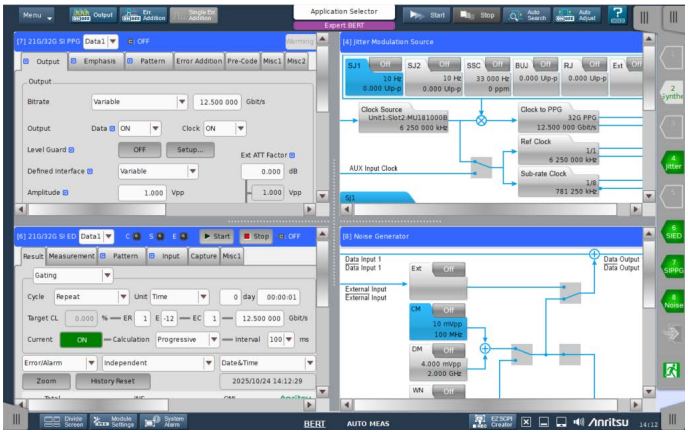


Figure 3.2.2.12-4 Quarters Division

A modules application can be assigned to each screen divided by Divide Screen function by using slot selector buttons.
For details, refer to 3.2.2.1 “Slot selector buttons”.

Touching 

displays the **Divide Screen** dialog box shown below.

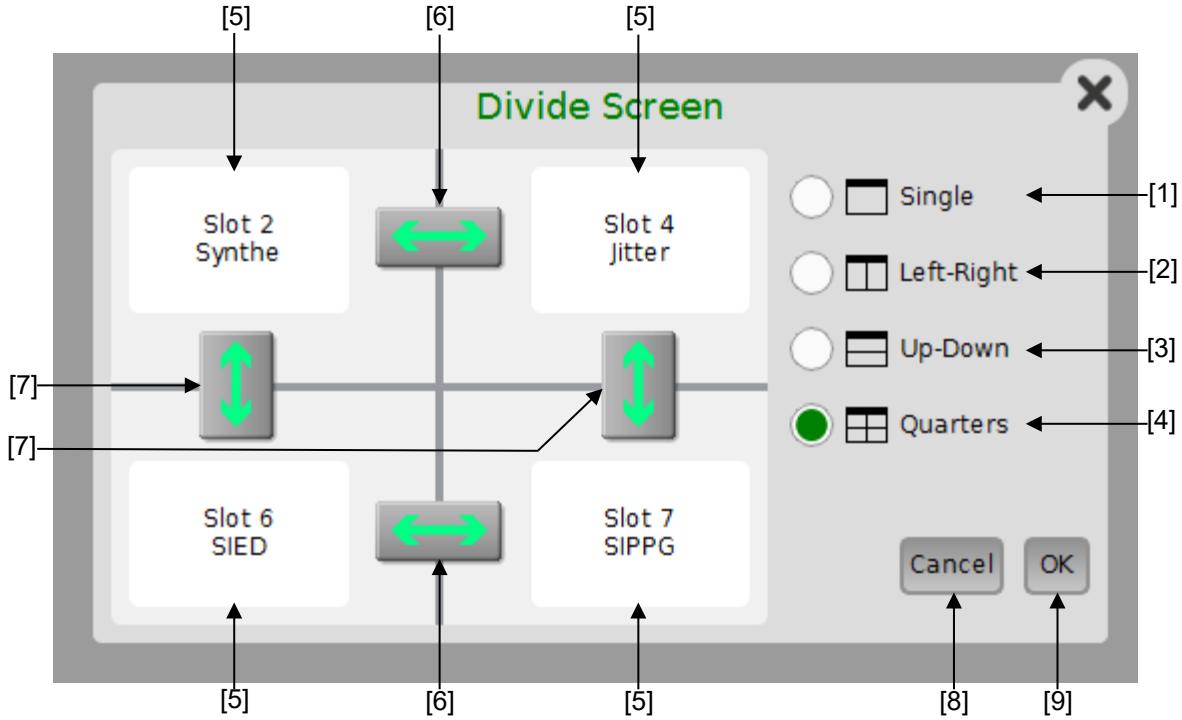


Figure 3.2.2.12-5 Divide Screen Dialog Box

[1] Single
Uses the screen without division.

[2] Left-Right
Uses the screen with left-right division.

[3] Up-Down
Uses the screen with up-down division.

[4] Quarters
Uses the screen with quarters division.

[5] Module Application Preview
Information of module application assigned to the divided screen is displayed. The slot number is displayed in the upper line and the module name abbreviation is displayed in the lower line.

[6] Module application swap button (left and right)
Swaps module applications assigned to the left and right sides of the screen.

[7] Module application swap button (up and down)
Swaps module applications assigned to the upper and lower sides of the screen.

[8] Cancel
Closes the dialog box.

[9] OK
Establishes settings and closes the dialog box.

Horizontal separator or Vertical separator appears when the screen division has been set.

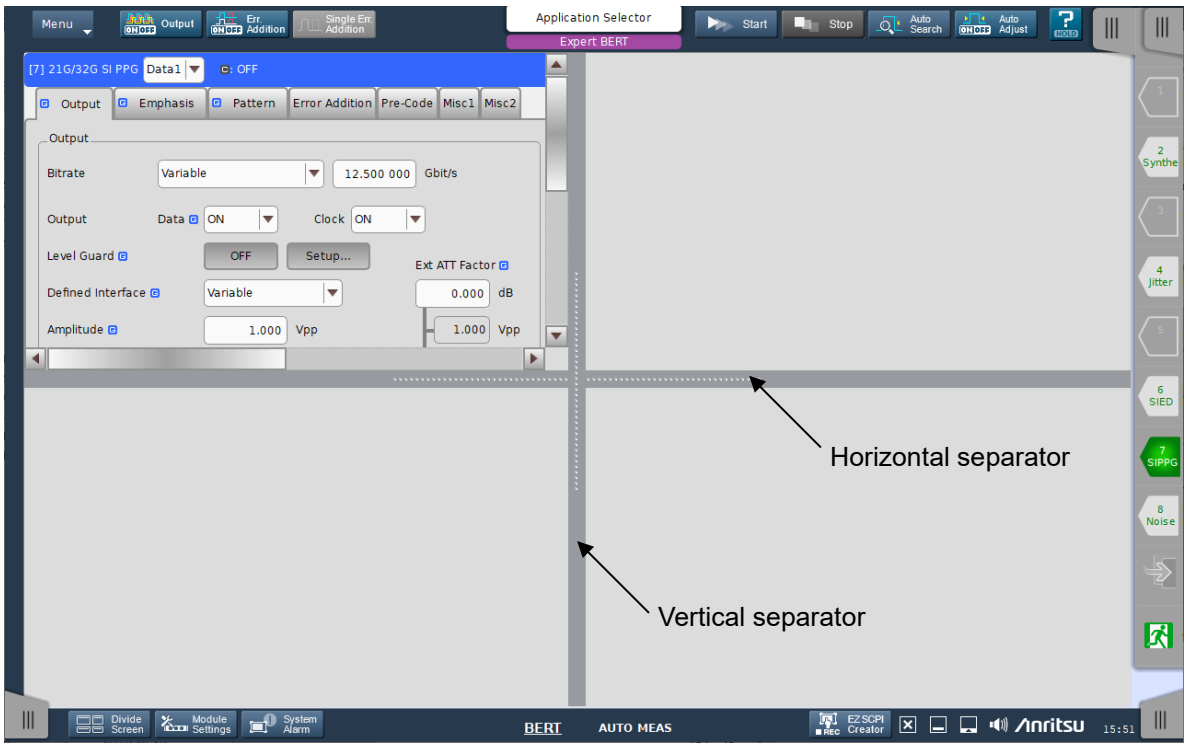


Figure 3.2.2.12-6 Horizontal Separator and Vertical Separator

Dragging the Horizontal separator or the Vertical separator moves its position.
Vertical separator controller appears by touching the Vertical separator.
Vertical separator controller disappears if touching the Vertical separator again.

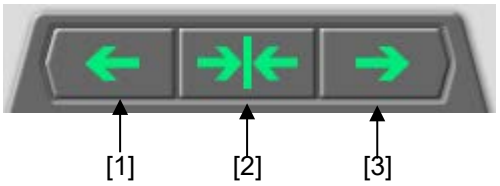


Figure 3.2.2.12-7 Vertical Separator Controller

[1] Vertical Separator Move button (left)
Moves Vertical separator to the left.

[2] Vertical Separator Reset button
Moves Vertical separator to the screen center.

[3] Vertical Separator Move button (right)
Moves Vertical separator to the right.

Horizontal separator controller appears by touching the Horizontal separator. Horizontal separator controller disappears if touching the Horizontal separator again.

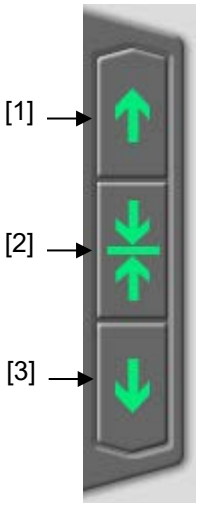


Figure 3.2.2.12-8 Horizontal Separator Controller

[1] Horizontal Separator Move button (up)
Moves Vertical separator up.

[2] Horizontal Separator Reset button
Moves Horizontal separator to the screen center.

[3] Horizontal Separator Move button (down)
Moves Horizontal separator down.

3.2.2.13 Module Settings

Touching 

displays Module Settings Screen.

For description of Module Setting window, refer to 3.1.6.5 “Module Settings”.

If the trouble has occurred in the module, the button indication changes to red (

).

3.2.2.14 System Alarm

Touching 

on the bottom left of the screen displays the **System Alarm** dialog box.

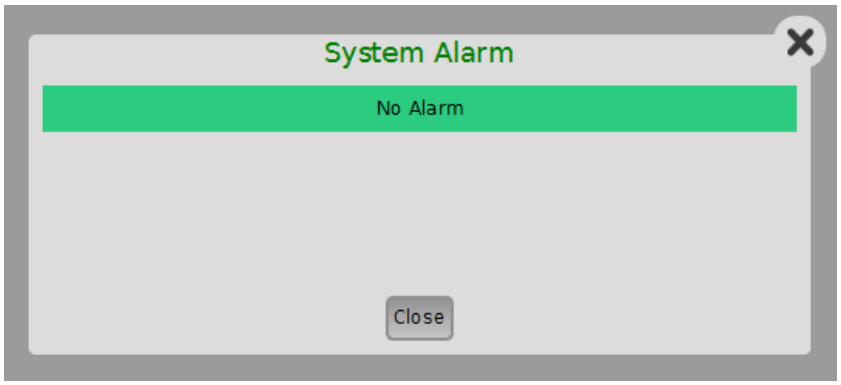


Figure 3.2.2.14-1 System Alarm Dialog Box (No System Errors)

When the system alarm has occurred in MP1900A or in a module, the button indication changes to red (System Alarm). Touching the button in this status displays the hardware where errors have occurred and details of system errors.

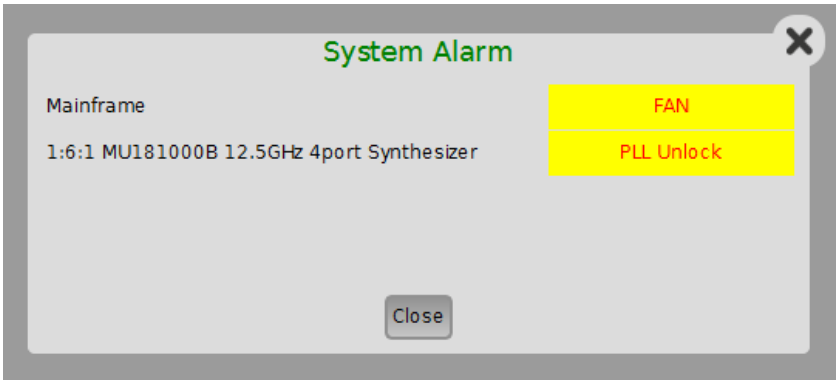


Figure 3.2.2.14-2 System Alarm Dialog Box (FAN Error and PLL Unlock Error)

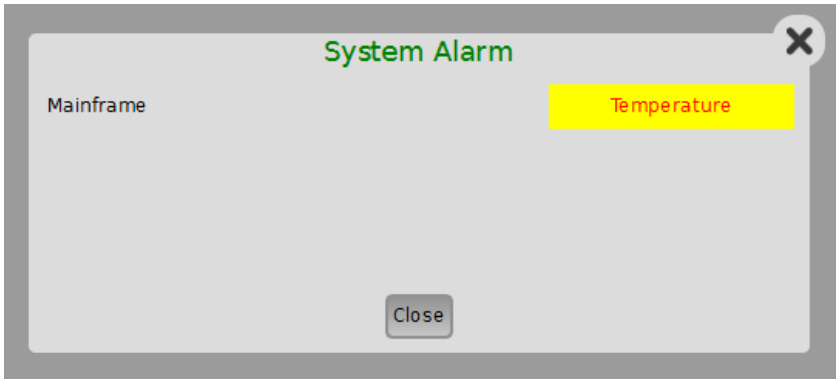


Figure 3.2.2.14-3 System Alarm Dialog Box (Temperature Error)

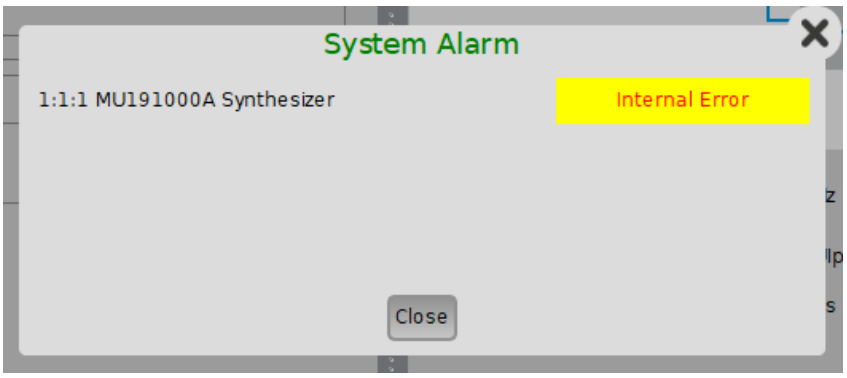


Figure 3.2.2.14-4 System Alarm Dialog Box (Internal Error)

Contents of MP1900A system errors are listed in Table 3.2.2.14-1.

Table 3.2.2.14-1 System Error

Name	Description
Fan	Raises when MP1900A detected that the fan is abnormal.
Temperature	Raises when MP1900A detected that temperature of an installed module and MP1900A is out of range.
PLL Unlock	Raises when the MU181000A or MU191000A detects PLL Unlock.
Internal Error	Occurs when the MU191000A detects a module fault.

Note:

The System Alarm dialog box is automatically displayed when a fan, temperature, or module abnormality has occurred.
When these abnormalities have been raised for 30 seconds or more, MP1900A turns power off.

3.2.2.15 Ext. Box

The Ext. Box function controls the external device (G0447A).

Touch Ext. Box in the upper-left of the screen to open the following dialog box.

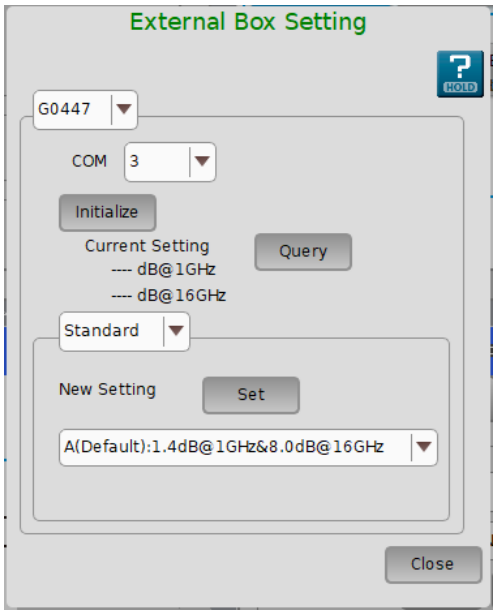


Figure 3.2.2.15-1 Ext. Box Dialog Box (G0447A Standard Mode)

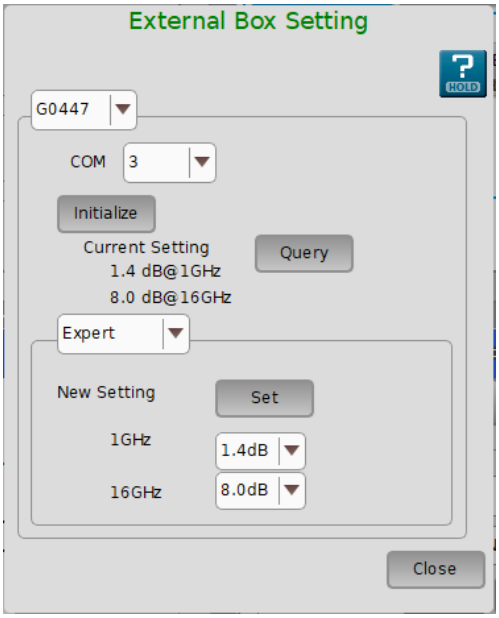


Figure 3.2.2.15-2 Ext. Box Dialog Box (G0447A Expert Mode)

For details about the **Ext. Box** dialog box, refer to the on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

3.2.3 Basic operation in AUTO MEAS screen

AUTO MEAS screen provides measurement function using ED.

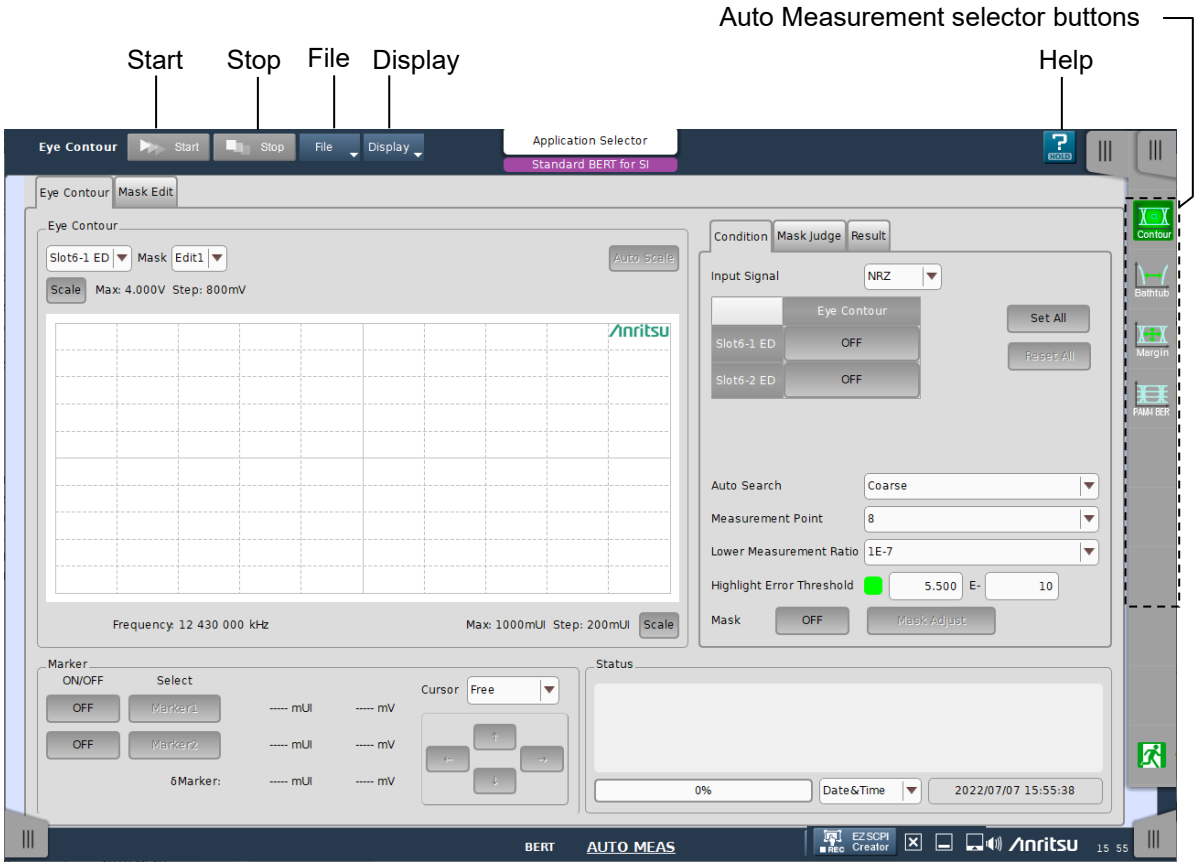


Figure 3.2.3-1 AUTO MEAS Screen

3.2.3.1 Auto Measurement selector buttons

Auto Measurement selector buttons are displayed on the Application toolbar by touching **AUTO MEAS** at the bottom center of the screen shown in Figure 3.2.3-1.

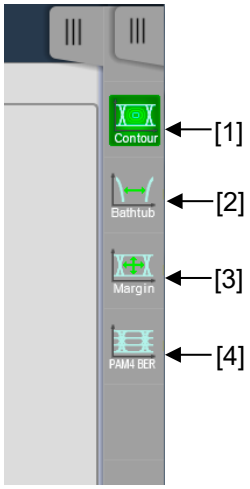


Figure 3.2.3.1-1 Auto Measurement Selector Buttons

There are four Auto Measurement Selector Buttons.

[1] Contour
Touching this buttons displays Eye Contour screen.
For the explanation of Eye Contour screen, refer to 4.4.1 “Eye Contour Measurement”.

[2] Bathtub
Touching this button displays Bathtub screen.
For explanation of Bathtub screen, refer to 4.4.2 “Bathtub Measurement”.

[3] Margin
Touching this buttons displays Eye Margin screen.
For the explanation of Eye Margin screen, refer to 4.4.3 “Eye Margin Measurement”.

[4] PAM4 BER
Touching this button displays PAM BER screen.
For the explanation of PAM BER screen, refer to 4.4.4 “PAM BER Measurement”.

3.2.3.2 File

Touching **File** at top of the screen displays functions.

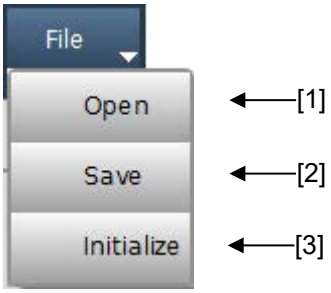


Figure 3.2.3.2-1 File Menu Items

[1] Open
Opens the dialog box, where you can select an auto-measurement related file to open.
For details of operations, refer to 3.1.7 “Loading a file”.
Files of type options vary depending on the kind of auto measurement.

[2] Save
Opens the dialog box, where you can save an auto-measurement related file.
For details of operations, refer to 3.1.8 “Saving to files”.
Files of type options vary depending on the kind of auto measurement.

[3] Initialize
Initializes all modules installed in MP1900A to factory default settings.

3.2.3.3 Display

Display is displayed only on the Eye Contour screen. You can select a phase display unit from the list.

3.3 Multi Channel Function

The PPG has a Multi-Channel function that generates data by combing data of multiple channels. The Multi Channel function can be categorized into Combination and Channel Synchronization. Available functions vary depending on model and its option.

Notes:

- MU196020A will support the Multi Channel function, in Version 3.01.00 or later.
- The Multi-Channel function of the MU196020A Sequence Editor will be supported starting from Version 10.05.00 or later.

Table 3.3-1 Model Which Multi Channel Can Be Applied

Model/Option	2ch/4ch Combination	Inner Module Ch Synchronization	Inter Module Ch Synchronization	Inter Module 2ch Combination Synchronization	64G × 2ch Combination
MU195020A-x20/x31	2ch	✓	Two to four modules	Two to four modules	Two modules
MU195020A-x10/x30	–	–	–	–	–
MU183020A-x2x/x31	2ch	✓	Two to four modules	Two to four modules	Two modules
MU183020A-x1x/x30	–	–	–	–	–
MU183021A-x30	2ch/4ch	✓	–	–	✓
MU196020A-x30/x50, MU196020C-x30/x50	–	–	Two to four modules*2	✓*1	–
MU196020A-x30/x50/z51/z52, MU196020C-x30/x50	–	–	Two to four modules*2, *3	–	–

*1: MU196020A/C is capable of 2ch Combination using two PPG modules in NRZ mode.

*2: Inter Module Ch Synchronization requires a configuration consisting of either MU196020A modules only or MU196020C modules only.

*3: The BERT for PCIe1-6 Forced Link application allows synchronization of two to four modules.

3.3.1 Combination function

Combination function synchronizes the generation and reception of patterns between the channels of a PPG or an ED, to evaluate 40 Gbit/s and 50 Gbit/s applications.
By combining two channels of 20 Gbit/s data, 40 Gbit/s serial data that is bit rate of 40GbE or OTU3 can be generated.

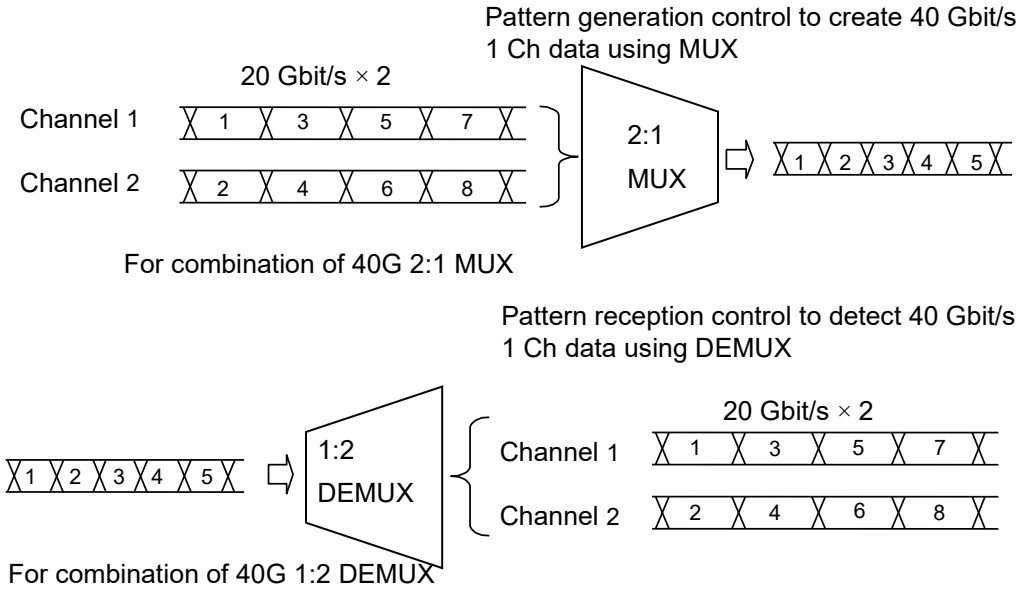


Figure 3.3.1-1 2ch Combination Pattern Generation/Reception

By using the 64G × 2 ch Combination function, it is possible to generate four sets of 32G data combining up to two sets of 64G data. These two data patterns can be serialized with an external MUX.
This function is available when two modules of MU195020A-x20 + x31 are installed.

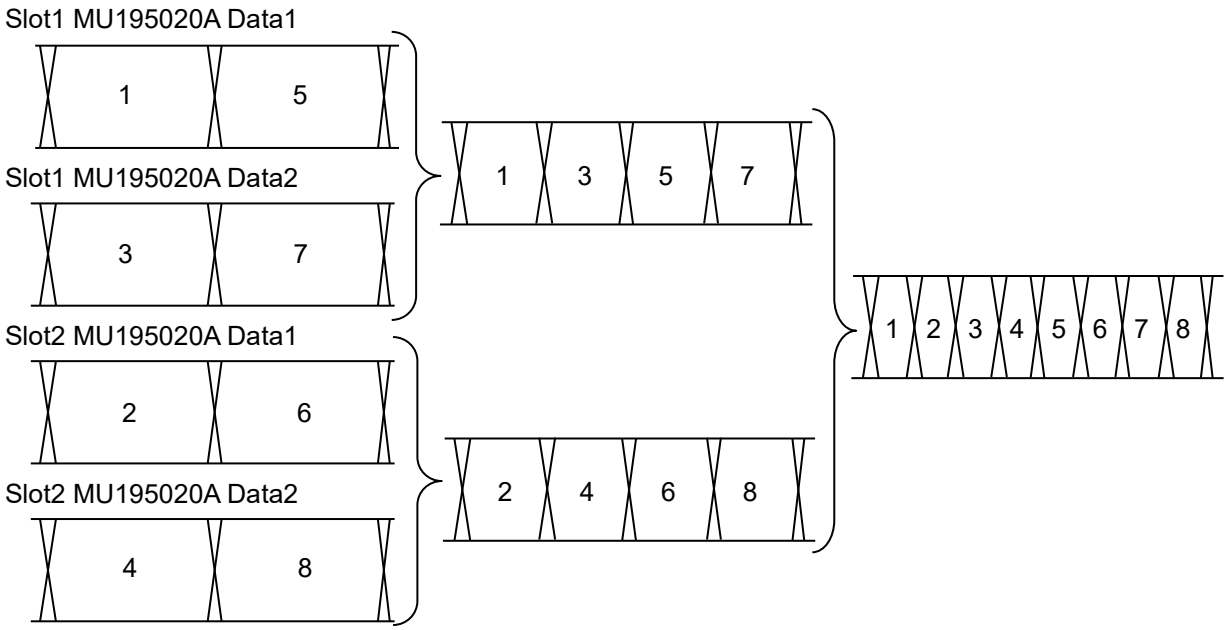


Figure 3.3.1-2 64G × 2ch Combination Pattern Generation (Using 2 Modules of MU195020A)

3.3.2 Channel Synchronization function

Channel Synchronization function synchronizes the timing of data of multiple channels. Timing synchronization is available even among PPGs. In addition, you can adjust the time delay between channels by setting the skew.

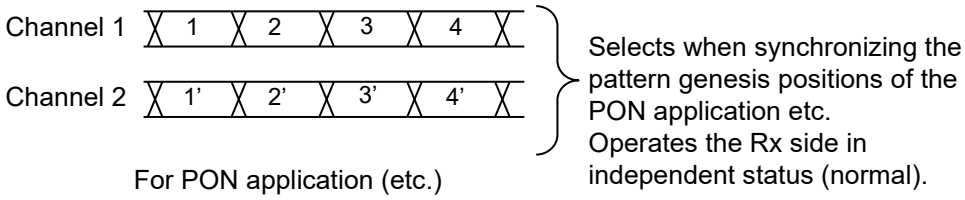


Figure 3.3.2-1 Channel-Synchronized Pattern Generation

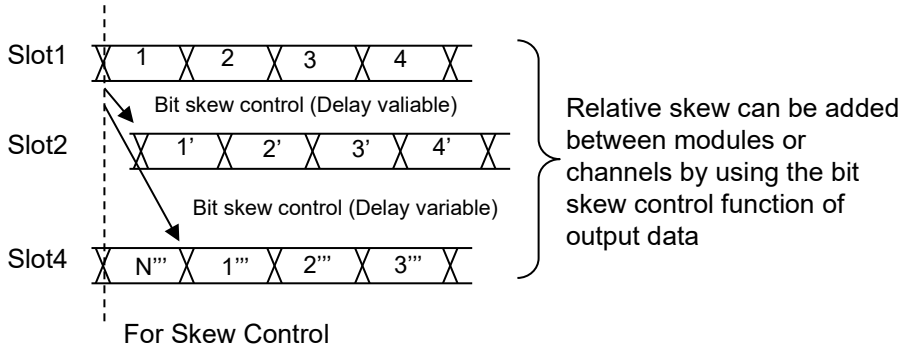


Figure 3.3.2-2 Skew Control for Channel-Synchronized Pattern Generation

It is possible to Ch Synchronize the two signals of Combination 1 - 2 using two modules of PPG and synthesized by 2 ch Combination.

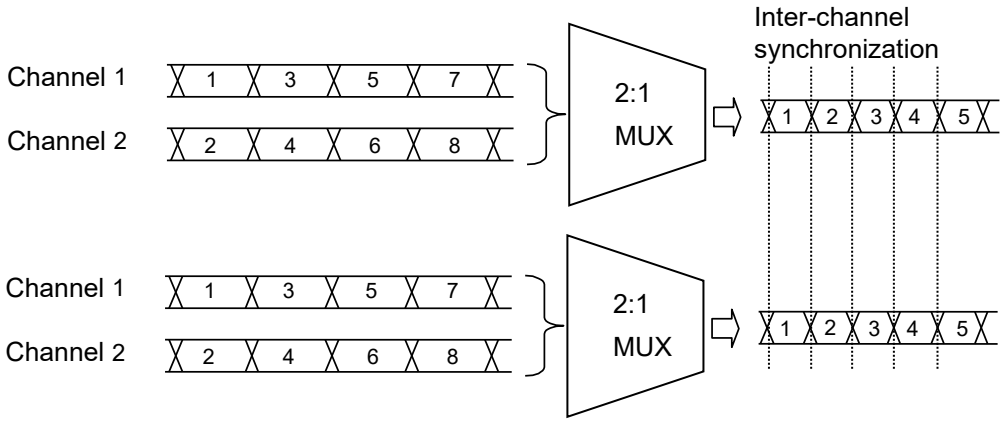


Figure 3.3.2-3 Ch Synchronization of 2ch Combination

3.3.3 Combination Setting dialog box

Touching **Combination Setting** on the top left of Module Settings screen in 3.1.6.5 "Module Settings" displays the **Combination Setting** dialog box.

The **Combination Setting** dialog box consists of the following areas:

Inter module combination: Sets inter modules synchronization function.

Inner module combination: Sets inner module synchronization function.

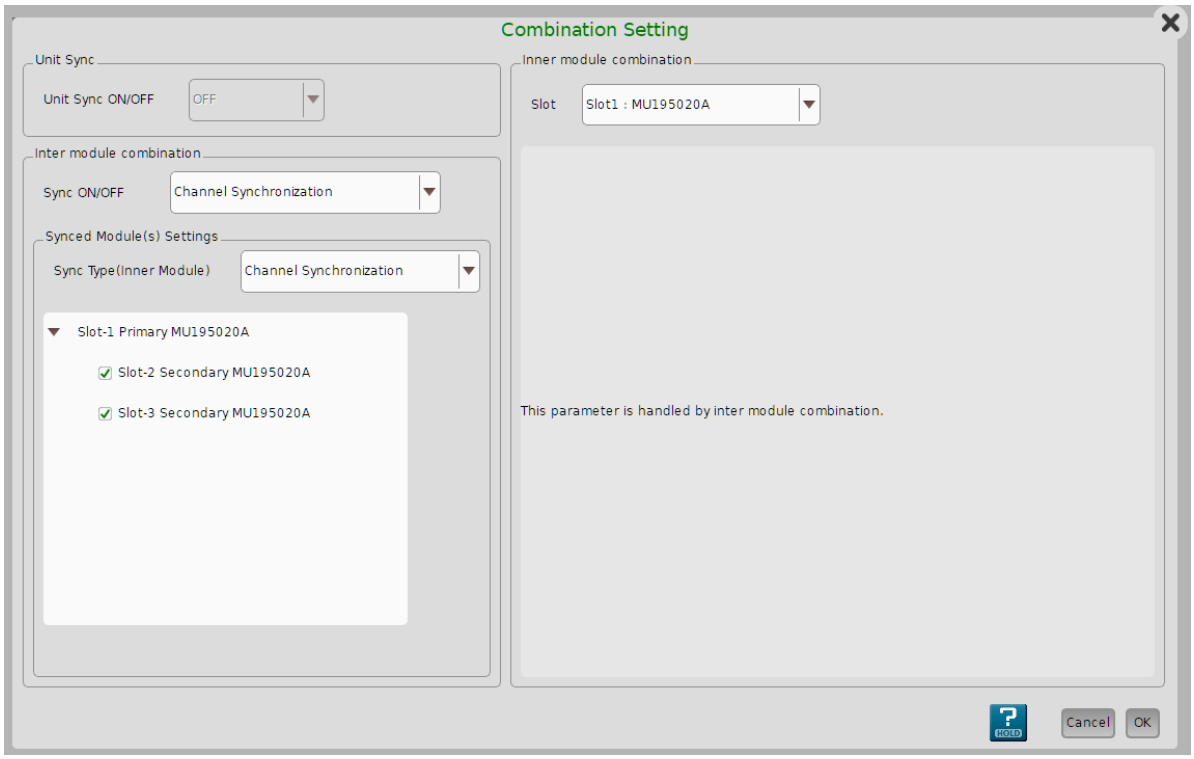


Figure 3.3.3-1 Combination Setting Dialog Box

3.3.3.1 Inter module combination area

In Inter module combination area, set a method to synchronize patterns among modules.

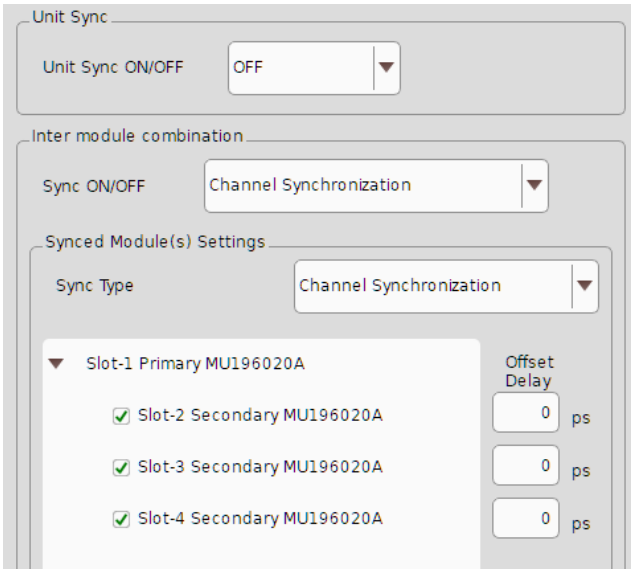


Figure 3.3.3.1-1 Inter module combination area

Table 3.3.3.1-1 Inter Module Combination Settings

Sync ON/OFF	Synced Module(s) Settings	Description
OFF		Does not synchronize pattern with other modules.
Channel Synchronization	Channel Synchronization	Sets Channel Synchronization to all channels of selected modules.
	2CH Combination	Sets selected modules to 2ch Combination and sets Channel Synchronization among modules.
	64G × 2ch Combination	Sets two target MU195020A or MU183020A modules to 2ch Combination to make them to generate patterns with an inter-module delay of 1/4 cycle. (This option is available when two MU195020A or MU183020A modules are installed.) When using this setting, sets the same pattern for each of the two MU195020A.
	Inter-Module 2ch Combination	Set 2ch Combination when two MU196020A or MU196020C modules are installed. When using this setting, sets the same pattern for each of the two MU196020A or MU196020C.

Note:

When setting Multi Channel function, a message dialog box appears if setting Multi Channel Calibration is required. Refer to 3.5.2 “Multi Channel Calibration ”.

Touch **OK** to enable the inter-module combination function. The icons on the module titles change from (gray): **OFF** to (green): **ON** when they are synchronized. When the inter-module combination function is released, the icon returns from (green): **ON** to (gray): **OFF**.

Offset Delay

When using the Channel Synchronization function, phase-matched cables are required to adjust the phase of clocks input to the PPG. MU196020A/C requires finer phase adjustment as it is used at high rate (64.2 Gbaud). This setting is used to compensate the phase difference between cables for inputting clocks to MU196020A/C units. Measure the electrical length of the cables to use in advance, and set the phase difference of each of cables to connect to MU196020A/C units in Slot2 to Slot4 with reference to the length of cable to connect to MU196020A/C in Slot1.

Range: –20 to +20 ps, 1 ps step

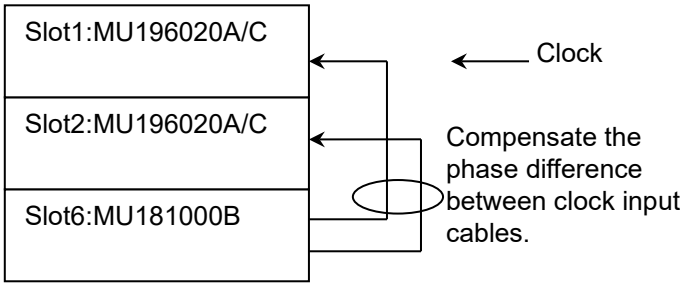


Figure 3.3.3.1-2 Clock Cable Connection

3.3.3.2 Inner module combination area

In Inner Module combination area, set inner modules function.

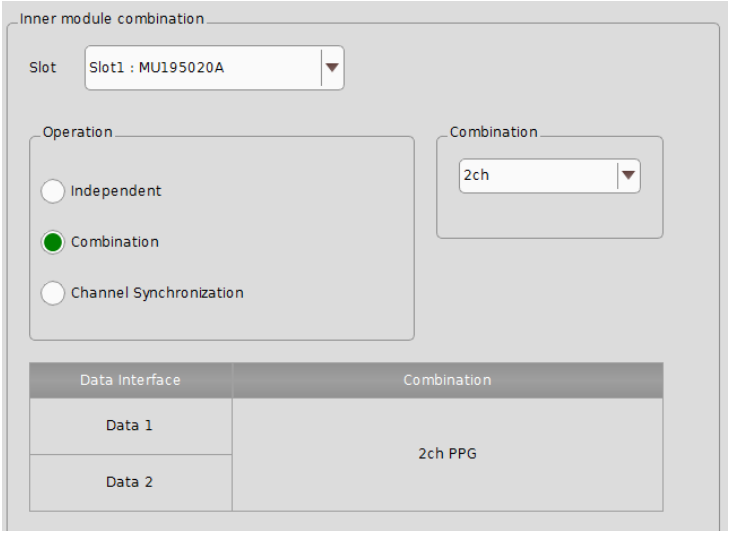


Figure 3.3.3.2-1 2ch Combination Settings

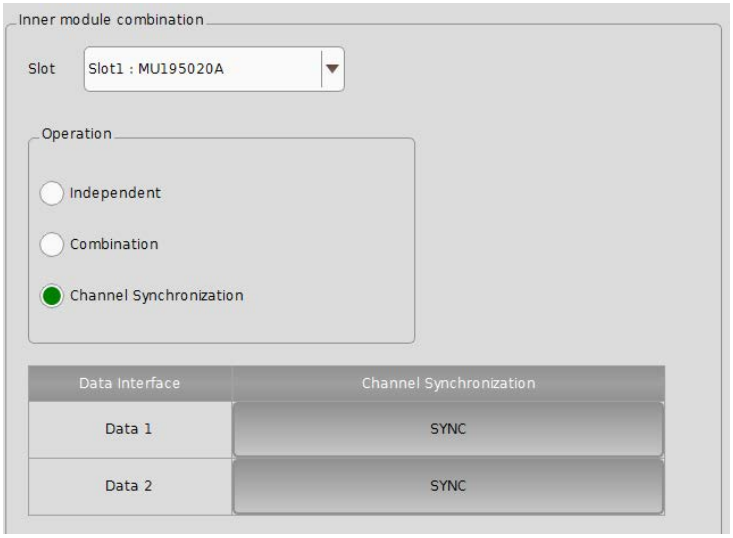


Figure 3.3.3.2-2 Channel Synchronization Settings

Table 3.3.3.2-1 Setting Items for Inner Module Combination Area

Operation	Description
Independent	Does not synchronize pattern within the modules. This operation works channels in the module independently.
Combination	Sets Combination to two channels or four channels.
Channel Synchronization	Sets Channel Synchronization to all channels in the module. Select one of the channel synchronization combinations from Data1 to 2, Data1 to 3 and Data1 to 4.

Touch **OK** to enable the inner-module combination function. The icons on the module titles change from (gray): **OFF** to (green): **ON** when they are synchronized. When the inner-module combination function is released, the icon returns from (green): **ON** to (gray): **OFF**.

3.4 Module Grouping Function

Touching **Module Grouping** on the top left of Module Settings screen in 3.1.6.5 "Module Settings" displays the **Grouping** dialog box.
Module Grouping function is the function that makes parameters whose mark is displayed change together. This function is able to vary parameters together between channels in the module or among different modules.

- MU195020A Output tab
- MU195020A Emphasis tab
- MU195020A Pattern tab
- MU195040A Input tab
- MU195040A Pattern tab
- MU196020A Output tab
- MU196020A Emphasis tab
- MU196020A Pattern tab
- MU196020C Output tab
- MU196020C Emphasis tab
- MU196020C Pattern tab
- MU196040A Input tab
- MU196040B Input tab
- MU196040A Pattern tab
- MU196040B Pattern tab
- MU183020A Output tab
- MU183020A Pattern tab
- MU183021A Output tab
- MU183021A Pattern tab
- MU183040B Input tab
- MU183040B Pattern tab
- MU183041B Input tab
- MU183041B Pattern tab

In the **Grouping** dialog box, you can set parameters changing together based on a tab.

Note:

When Module Grouping function is working in **Input** tab, **Output** tab, **Pattern** tab, and **Emphasis** tab the values displayed in the tabs change together, but taking time to set parameters to each module will be longer in proportion to the number of channels to be grouped.

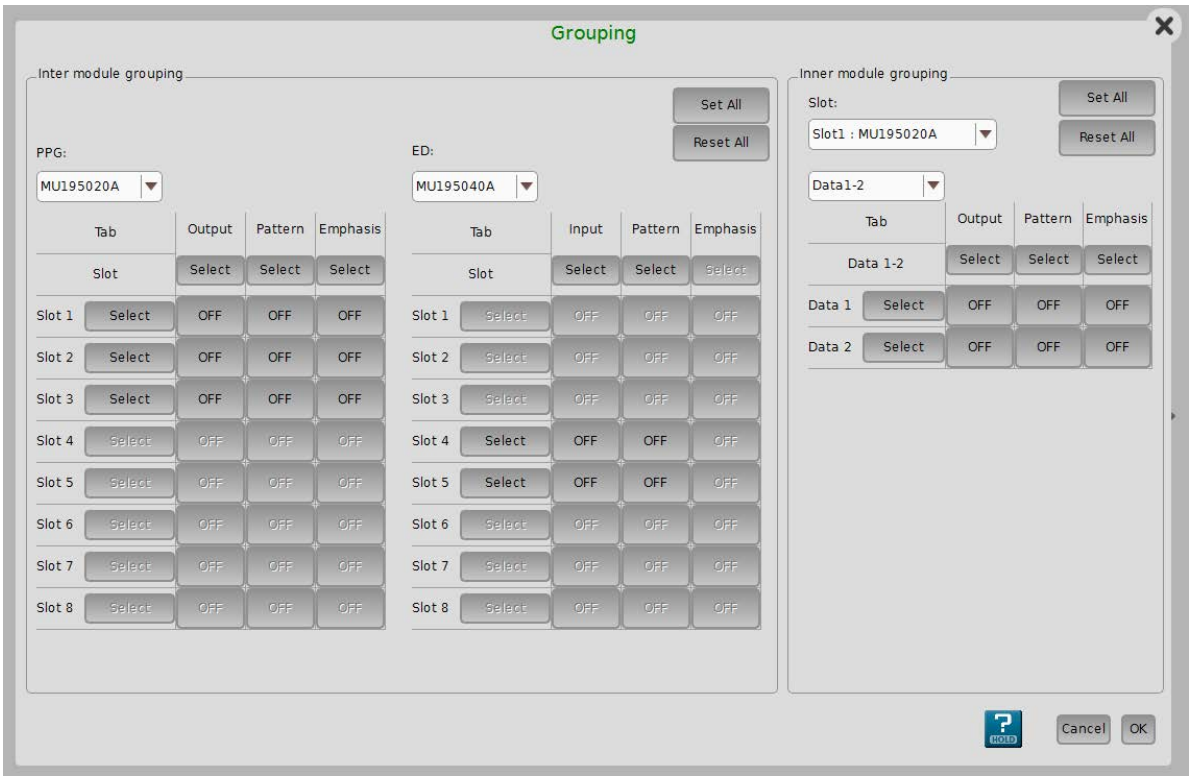


Figure 3.4-1 Grouping Dialog Box

3.4.1 Inter module grouping area

In Inter module grouping area, set the scope of parameters changing together across modules.



Figure 3.4.1-1 Inter module grouping area

Select a module slot number and the tab which contains parameters to be changed together. Touching **Set All** selects all buttons, and touching **Reset All** cancels all buttons.

When modules are grouped in the Inter module grouping area, the module with the smallest slot number becomes Primary, whose parameter settings are reflected to Secondary. The parameter settings for Primary are reflected to Secondary at one of the following times:

- When touching **OK** in the **Grouping** dialog box.
- When touching **Menu** > **Module Grouping** > **Execute** at the upper left of the BERT screen.

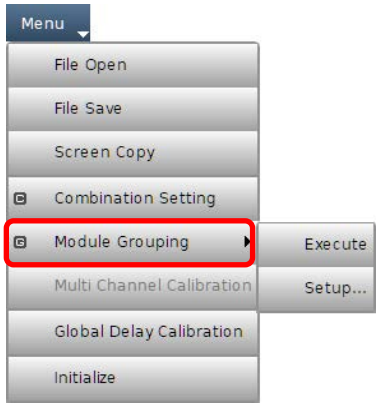


Figure 3.4.1-2 Menu > Module Grouping

The following shows an example of how to group PPG Slot1 to Slot3 in the Inter module grouping area.

1. In the Inter module grouping area, set Output, Pattern, and Emphasis of PPG Slot1 to Slot3 to **ON**.
2. In the **Grouping** dialog box (Figure 3.4-1), touch **OK**. This reflects the Slot 1 parameters subject to grouping to Slot2 and Slot3.
3. On the Application Toolbar of the BERT screen, select PPG Slot1, and on the **Output** tab, the **Pattern** tab, and the **Emphasis** tab, change the parameters.
4. To reflect the parameter settings for Slot1 to Slot2 and Slot3, touch **Menu** > **Module Grouping** > **Execute** at the upper left of the BERT screen.

Notes:

- Module Grouping function across modules is effective for modules whose model, options are the same.
- Module Grouping function across modules is effective when two or more buttons of each tab are set to **ON**.
- To reflect the parameter settings for Primary to Secondary, touch **OK** in the **Grouping** Dialog Box, or touch **Menu** > **Module Grouping** > **Execute** at the upper left of the BERT screen. Just making changes to the parameter settings for Primary does not reflect to Secondary.

3.4.2 Inner module grouping area

In Inner module grouping area, set the scope of parameters changing together in the module.

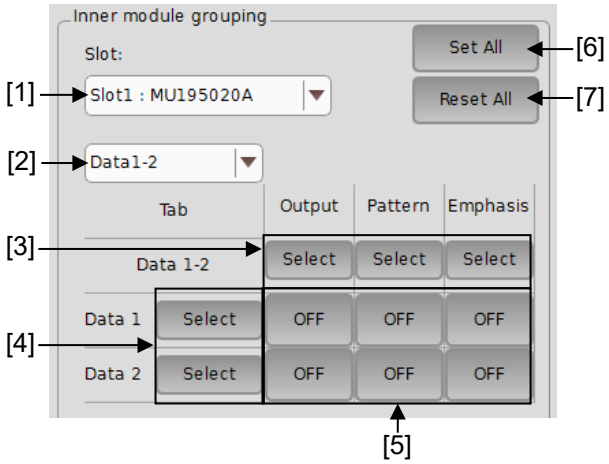


Figure 3.4.2-1 Inner module grouping area

[1] Slot
Select a module to set grouping.

[2] Data Interface Selection
Select a combination of interfaces to be grouped.

[3] Tab Selection button
Set the button on the tab changing parameters together to **ON** or **OFF**.

[4] Data Interface Selection Button
Set the Data Interface button of parameters changing together to **ON** or **OFF**.

[5] Grouping Setting button
ON: Sets so that parameters change together with those on other tab.
OFF: Sets so that parameters do not change together with those on other tab.

[6] Set All
Sets all buttons to **ON**.

[7] Reset All
Sets all buttons to Sets all buttons to **OFF**.

Once grouping has set by touching **OK**, Data Interface settings of the primary are set to those in grouped Data Interface. And mark of parameters that grouping has set turns to (light blue). If grouping setting is canceled, mark of parameters turns to (gray).

3.5 Multi Channel Calibration Function

When two or more PPGs have been installed in MP1900A, the time difference between data output from PPGs needs to be calibrated.
Perform Multi Channel Calibration in the following cases:

- PPG has been replaced.
- Slot position of PPG has changed.
- Another PPG has been added.
- Changes have been made to the installed module(s) other than PPG.
- MP1900A installed with PAM4 PPG has been powered on. (Version 3.01.00 or later)
- The ambient temperature of PAM4 PPG has changed from the time of calibration. (Version 3.01.00 or later)

At setting Multi Channel function, the dialog box appears if performing Multi Channel Calibration is required.
If Multi Channel Calibration was performed once, it does not need to perform again until module configuration installed in MP1900A is changed. Whether calibration has performed or not can be confirmed in "Figure 3.5.3-1 Calibration Execution Verification".

Note:

MX190000A Version 3.01.00 or later opens the dialog box recommending that you perform Multi Channel Calibration when powering on MP1900A with the Multi Channel function turned on.

3.5.1 Precautions

Read the following thoroughly before performing Multi Channel Calibration.

- Do not add jitter to the clock which is input to PPG.
- When the MU181000A/B or MU191000A and the MU181500B are installed in the same MP1900A as the PPG, the PPG Misc2 Clock Setting is automatically changed to use the MU181000A/B or MU191000A as the clock source. Confirm Clock Setting after Multi Channel Calibration has finished.
- For instructions on how to connect clock signals of PPG, refer to the following:
  3.2 “Inter-Module Connection” in the *MU183020A 28G/32G bit/s PPG MU183021A 28G/32G bit/s 4ch PPG Operation Manual*
  3.2 “Inter-Module Connection” in the *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*
- When multiple PPG have been installed, set **CH Sync** of **Channel Synchronization** referring 3.3.3 “Combination Setting dialog box”. In this case, connect between the clock source and Ext Clock Input of each PPG using coaxial cables with the same length.
- Perform the calibration where ambient temperature of MP1900A is in range of 20 to 30 °C.

3.5.2 Multi Channel Calibration procedure

1. When performing calibration is required, the following dialog box appears if Inter Module combination or Channel Synchronization and Combination in 3.3.3 “Combination Setting dialog box” has selected. To execute calibration, touch the **Yes**.

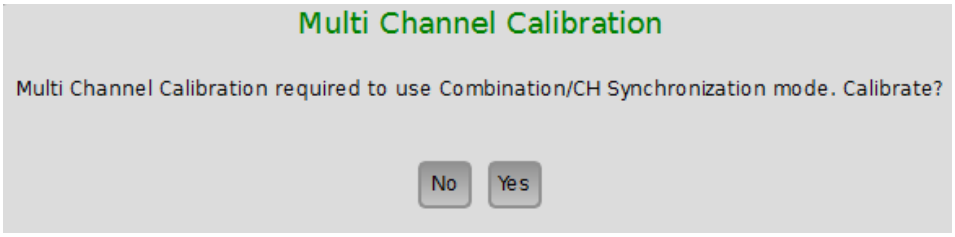


Figure 3.5.2-1 Multi Channel Calibration Dialog Box

When **No** is touched, the dialog shown in below is displayed; if the check box is selected, this calibration-required dialog box will not appear again when calibration is required in future.

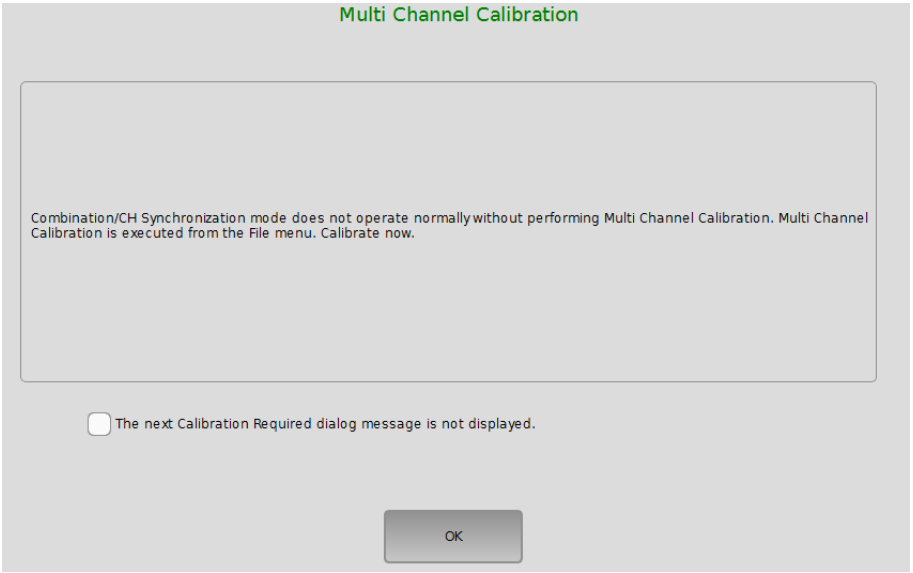


Figure 3.5.2-2 Multi Channel Calibration Dialog Box

For the operation to perform Multi Channel Calibration later, refer to 3.5.3 “Operation from Menu or Module Settings”.

2. Touch **Next** after confirming the explanation.

   Estimated time for the calibration is as follows:

   - SI/32G PPG: about 2 to 3 minutes
   - PAM4 PPG:

     When linked to synthesizer:

     Number of Secondary modules × 10 minutes

     When not linked to synthesizer:

     Number of Secondary modules × 15 minutes



Figure 3.5.2-3 Multi Channel Calibration Dialog Box (1/4)

3. If the following dialog box has appeared, input the clock to PPG.
   - When the MU181000A/B or MU191000A is installed in the same MP1900A as the PPG, input the clock from the MU181000A/B or MU191000A to each PPG. (Refer to Figure 3.5.4-1 “Example Clock Connection 1”.)
   - In other cases, connect between the clock source and PPG using a coaxial cable, input the clock at the frequency displayed in the dialog box to PPG.



Figure 3.5.2-4 Multi Channel Calibration Dialog Box (2/4)

- On MX190000A Version 3.02.00 or later, the following dialog box is open if MU181000A/B or MU191000A is not installed in the MP1900A in which PPG is installed. Select whether to use an external clock supply source or the MU181000A/B or MU191000A installed in another MP1900A, as the clock source. Refer to 3.5.4 (3) for details.

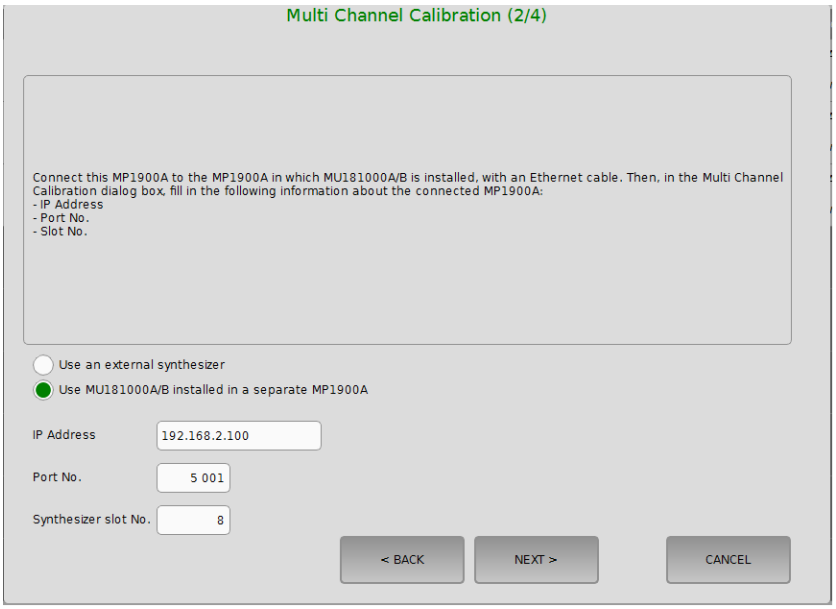


Figure 3.5.2-5 Multi Channel Calibration Dialog Box 2/4

4. Touch **Next**. The Multi Channel Calibration progress is displayed.



Figure 3.5.2-6 Multi Channel Calibration Dialog Box (3/4)

5. If the message dialog box shown in Figure below is displayed during calibration, change the input clock frequency as indicated and touch **OK**.
   When the PPG and the MU181000A/B or MU191000A synthesizer are installed in the same MP1900A, there is no need to change the frequency.

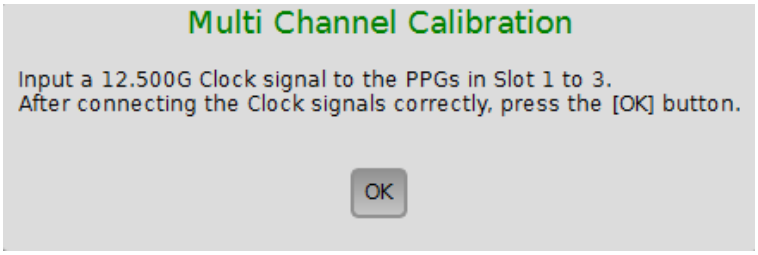


Figure 3.5.2-7 Multi Channel Calibration Dialog Box

6. Touch **Finish** when the screen shown below is displayed to complete the calibration.

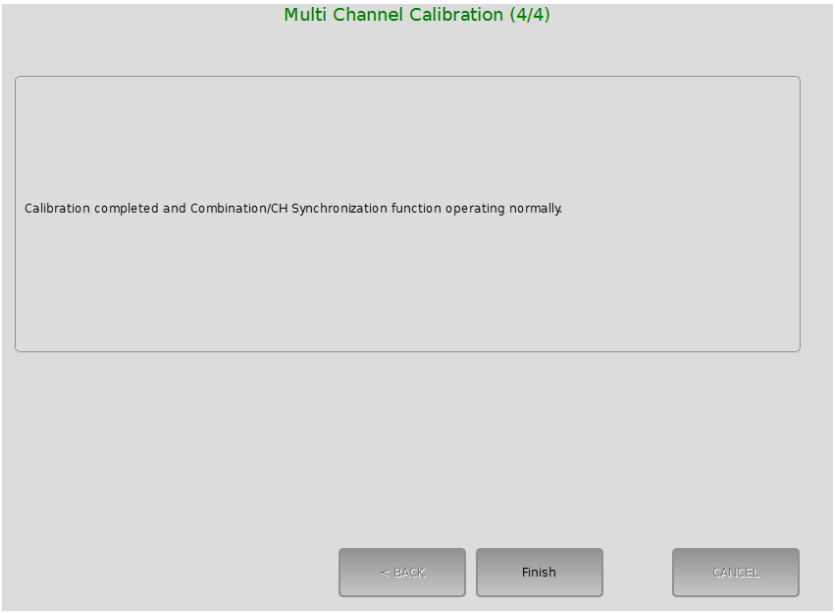


Figure 3.5.2-8 Multi Channel Calibration Dialog Box (4/4)

3.5.3 Operation from Menu or Module Settings

When No was touched in step 1 in 3.5.2 “Multi Channel Calibration procedure”, perform Multi Channel Calibration following the method below.

- Touch **Multi Channel Calibration** in 3.2.2.4 “Menu”.
- Touch **Multi Channel Calibration** in 3.1.6.5 “Module Settings”.

The following dialog box appears. For operation from this, refer to step 2 or later in 3.5.2 “Multi Channel Calibration procedure”.

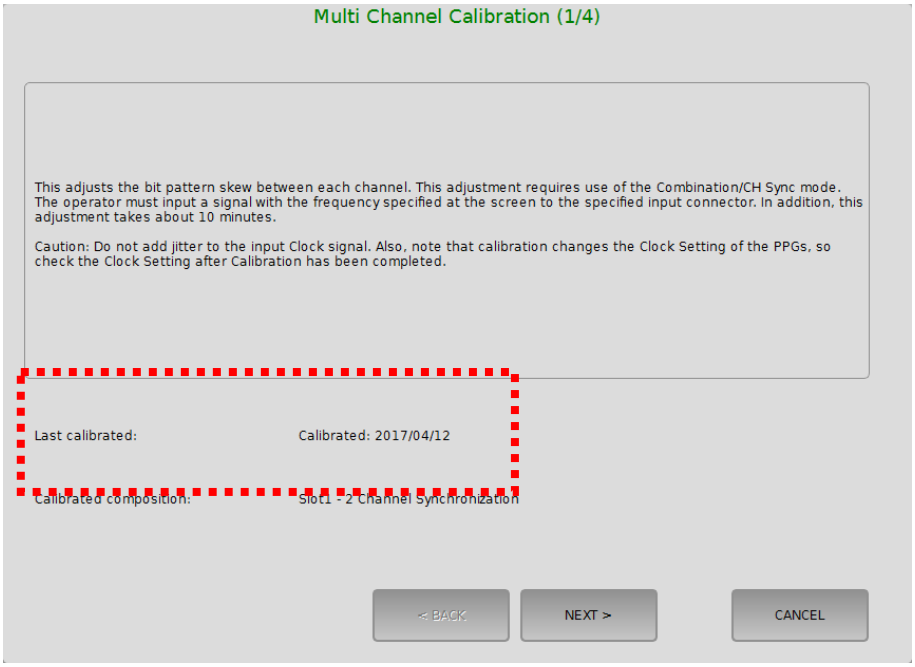


Figure 3.5.3-1 Calibration Execution Verification

If Multi Channel Calibration has ever performed, Last calibrated data is shown.

3.5.4 Performing Multi Channel Calibration example

This section describes Multi Channel Calibration procedure using typical module configuration. For the detail clock signal connection, refer to Multi Channel in 3.2.4 “Synchronizing Multiple Channels of PPG” in the *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*. The following explanations are the procedures when the initialization has done before performing Multi Channel Calibration.

(1) Two MU195020A modules and MU181000B

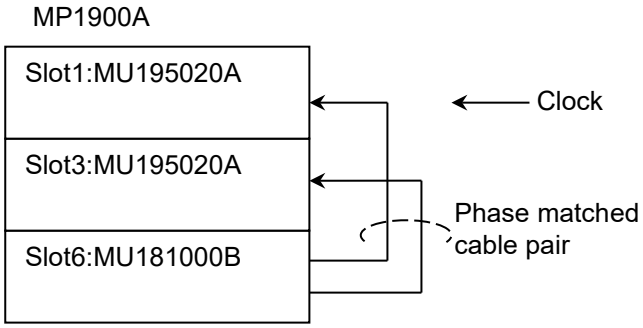
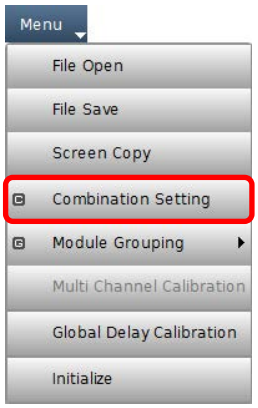
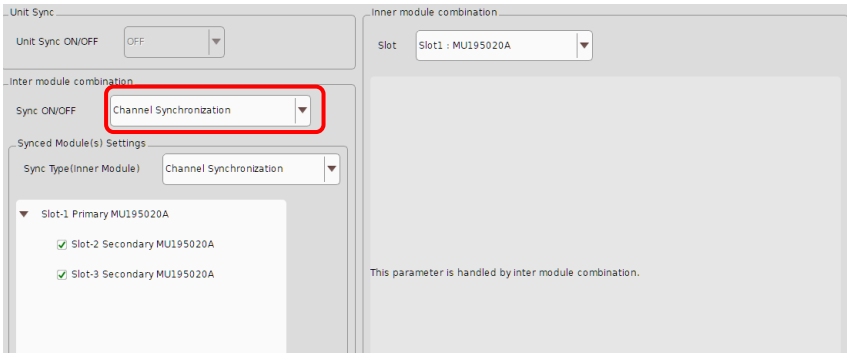


Figure 3.5.4-1 Example Clock Connection 1

1. Touch **Combination Setting** in the Menu.



2. In the **Combination Setting** dialog box, click **Channel Synchronization**.



3. When the Multi Channel Calibration Dialog Box appears as shown in Figure 3.5.2-1, perform the calibration according to the description of step 2 through step 6 in 3.5.2.

(2) Two MU195020A (with MU195020A-x20), MU181500B, and External Synthesizer

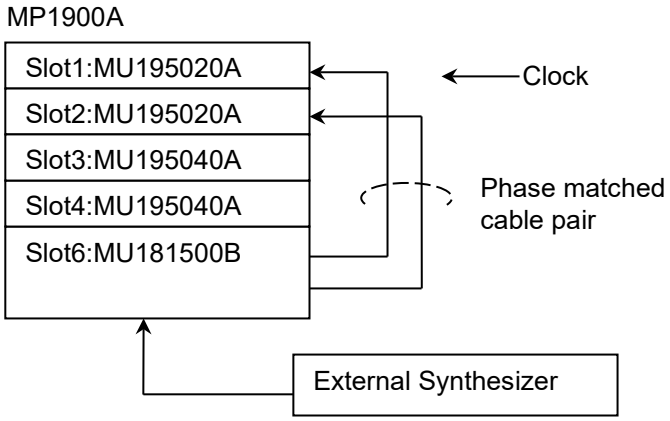
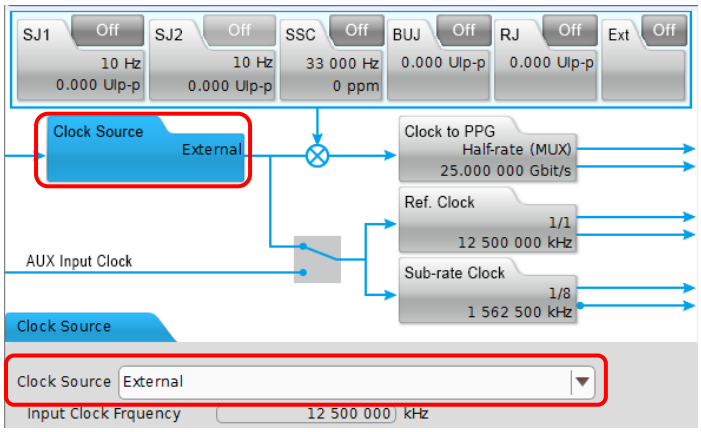
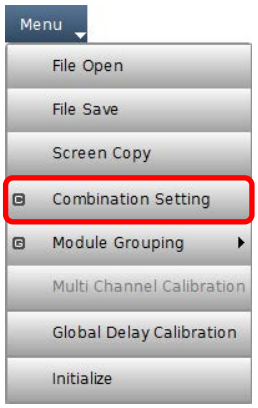


Figure 3.5.4-2 Example Clock Connection 2

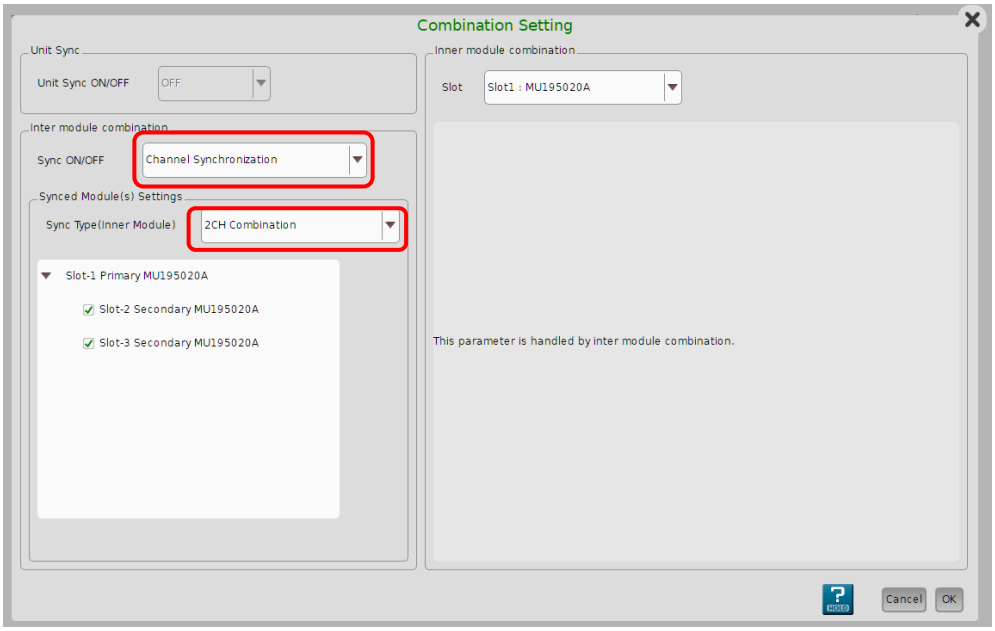
1. Select **External** at Clock Source setting of MU181500B in slot6.



2. Touch **Combination Setting** in Menu.



3. In the **Combination Setting** dialog box, select **Channel Synchronization**, and then select **Channel Synchronization**.



4. When the Multi Channel Calibration Dialog Box appears as shown in Figure 3.5.2-1, perform the calibration according to the description of step 2 through step 6 in 3.5.2.

(3) Four MU196020A/C units (with MU196020A/C-x30/x50) + One MU181500B + MU181000B installed in another MP1900A

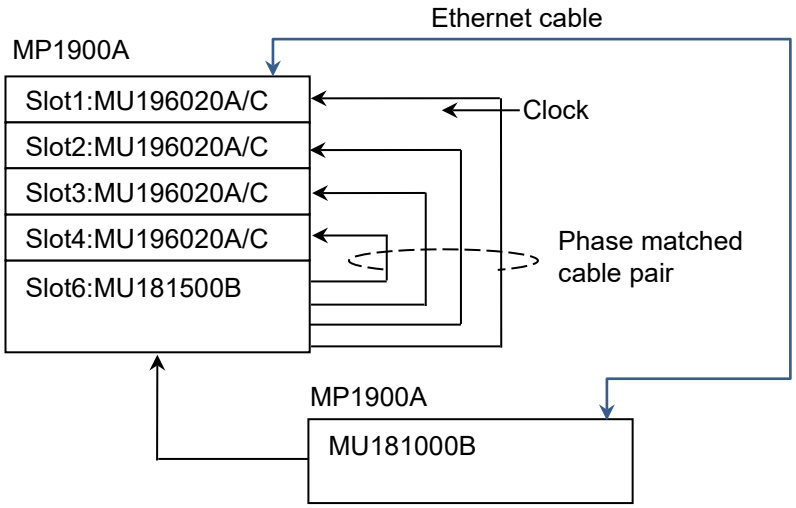
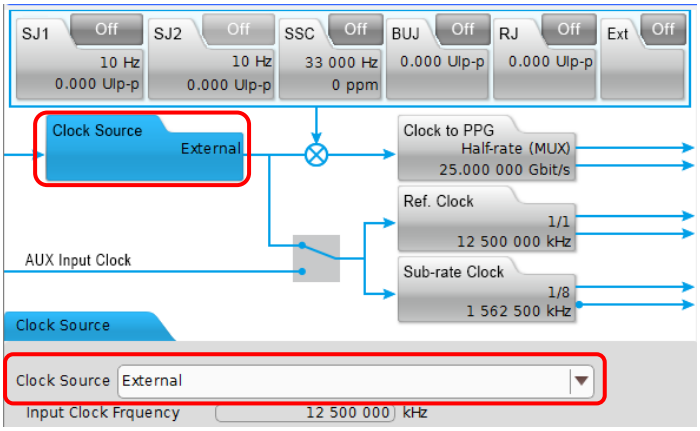
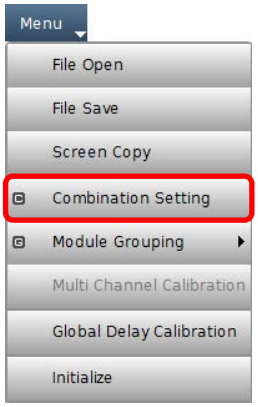


Figure 3.5.4-3 Example Clock Connection 3

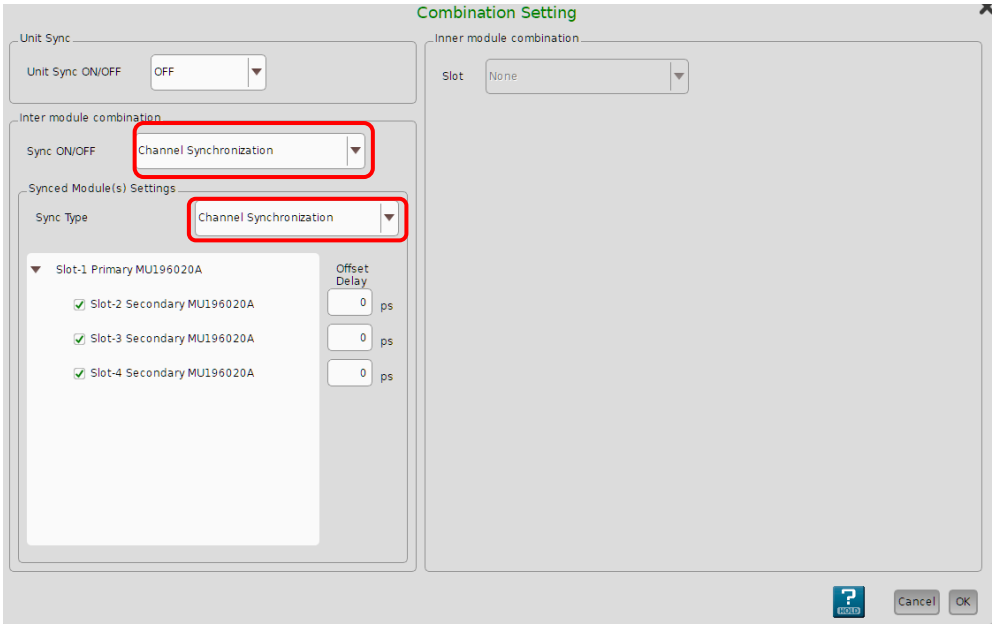
1. Select **External** at Clock Source setting of MU181500B in slot6.



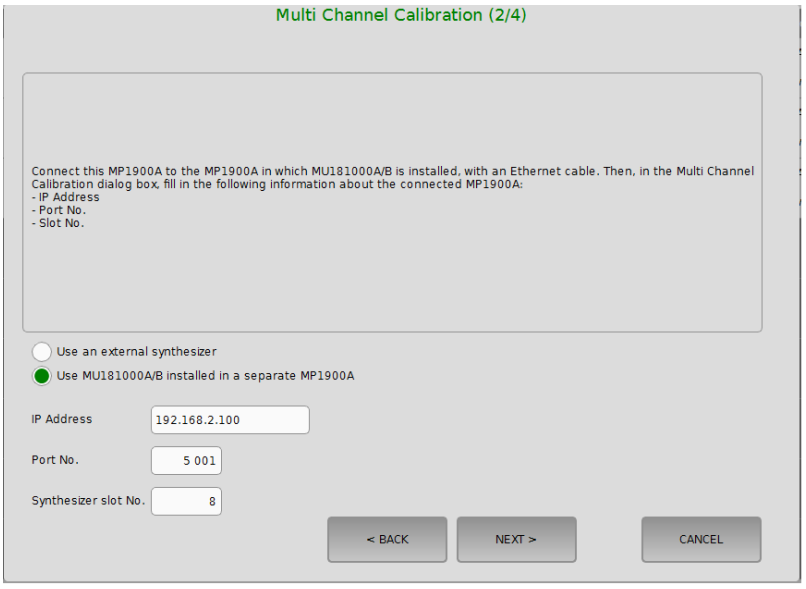
2. Touch **Combination Setting** in Menu.



3. In the **Combination Setting** dialog box, make inter module combination settings as follows:
   Sync ON/OFF: **Channel Synchronization**
   Sync Type: **Channel Synchronization**



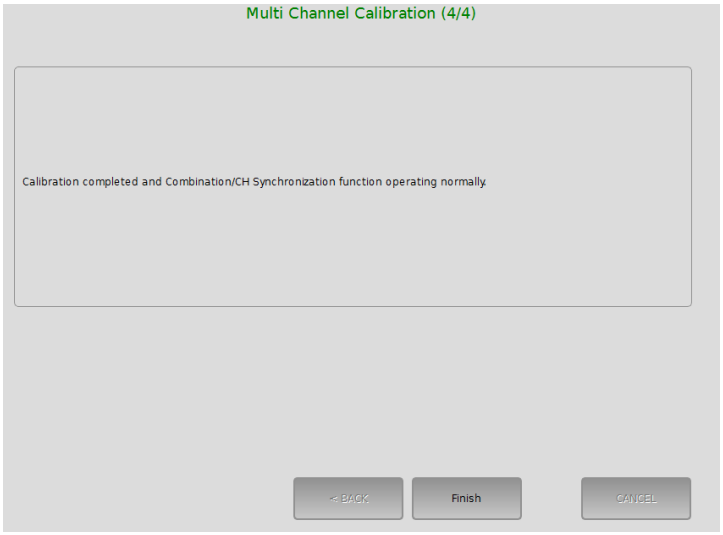
4. The **Multi Channel Calibration** dialog box opens. (Figure 3.5.2-1) In MX190000A Version 3.02.00 or later, the calibration can be performed using MU181000B installed in another MP1900A. As shown in Figure 3.5.4-3, connect MP1900As with an Ethernet cable, fill in the information about the connected MP1900 (**IP Address**, **Port No.** and **Synthesizer slot No.**), and touch **Next**.



5. The progress of Multi Channel Calibration is displayed.



6. When the following dialog box page appears, touch **Finish**.



3.5.5 Bit shift adjustment when MU196020A/C operates at 32 Gbaud or more

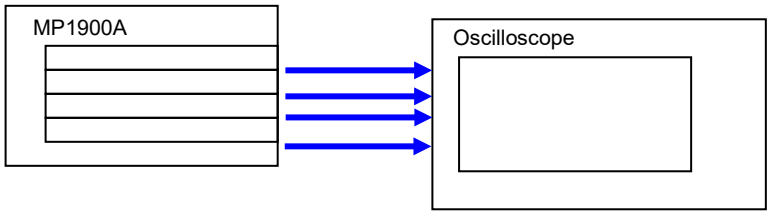
This section explains a bit adjustment procedure when using the Multi Channel function of MU196020A/C at the operating rate of 32 Gbaud or more.

When MU196020A/C operates at 32 Gbaud or more, its Multi Channel function causes up to ±5 bits of phase shift to the modules in Slots 2 to 4, respectively, with respect to the reference PPG in Slot 1. Adjust the inter-module bit shift according to the following procedure.

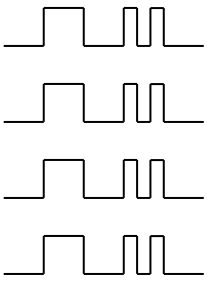
For details on how to connect clock signals, refer to 3.2.4 "Synchronizing Multiple Channels of PPG" in the *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*. Note that perform Multi Channel Calibration before proceeding with the following procedure.

Four MU196020A/C modules + (MU181000B or MU191000A)

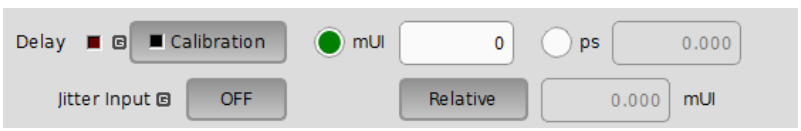
1. Connect the output connectors of Slots 1 to 4 to the oscilloscope using cables of the same length.



While monitoring four data outputs on the oscilloscope, adjust the phase shift using **Delay** (2-mUI steps) for each Slot.



2. On the oscilloscope, check the waveform, and then on the **Output** tab for each slot, set the value for **Delay** and perform bit shift adjustment.



3.6 Unit Sync Function

The Unit Sync function is used to synchronize multiple MP1900A units to generate the same pattern. This section explains how to set the Unit Sync function as well as the operations and restrictions when using this function.

3.6.1 Unit Sync operation and restrictions

The Unit Sync function synchronizes two MP1900As by sharing a timing signal between them.
Up to 8ch patterns can be generated in sync with each other by using the Channel Synchronization function that performs inter-module synchronization of modules installed in MP1900As and the Unit Sync function that performs inter-MP1900A synchronization.

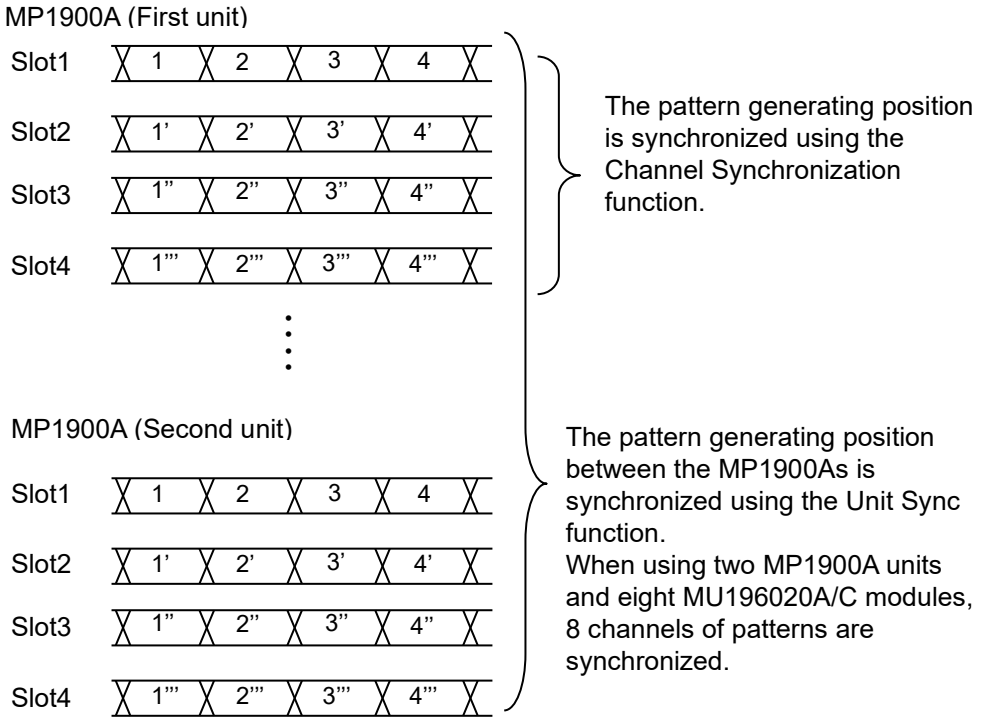


Figure 3.6.1-1 Channel Synchronization Pattern Generation

Furthermore, there are following restrictions when using the Unit Sync function:

- This function is available only when either MU196020A/C PAM4 PPG (Option x30/50) or MU195020A SI PPG (Option x20/x31) is installed, and Unit Sync is supported.
- Cannot use the Burst function
- Cannot add error using the external signal
- Sequence cannot be used with Test Pattern.

- This function is not available with the MU183020A/21A 32G PPG.
- The application that supports the Unit Sync function is Expert BERT.

3.6.2 Unit Sync setting

Touching **Combination Setting** on the top left of Module Settings screen in 3.1.6.5 "Module Settings" displays the **Combination Setting** dialog box.

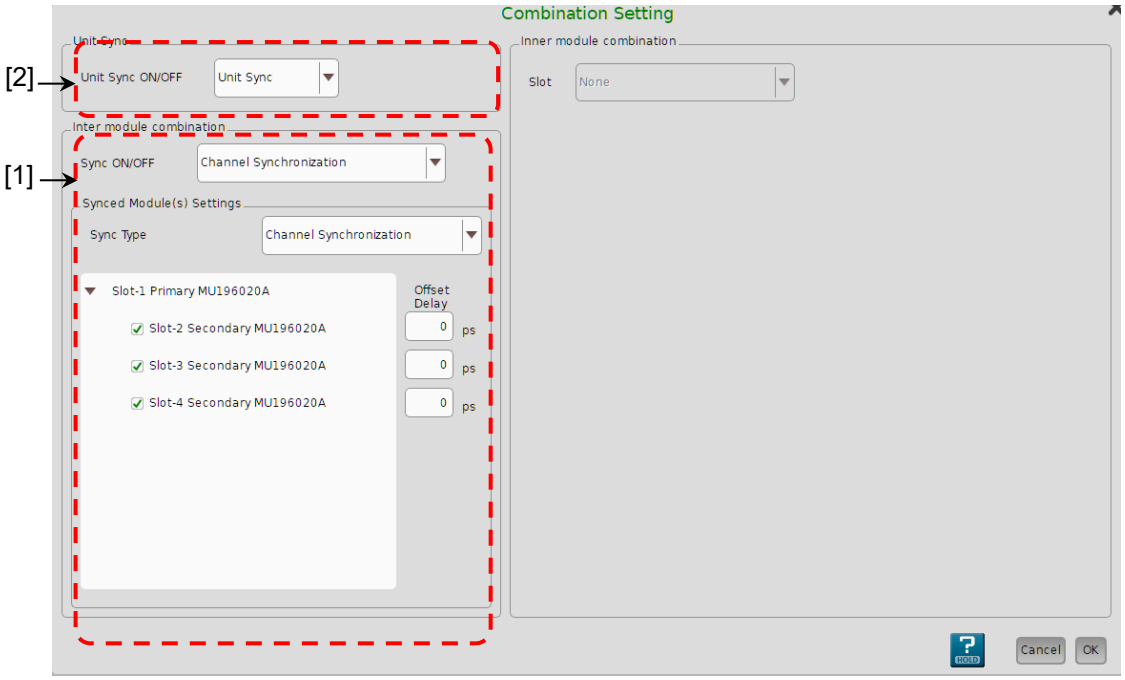


Figure 3.6.2-1 Combination Setting Dialog Box

[1] Turning on the Inter Module Combination function
In the **Sync ON/OFF** box of the **Inter module combination** area, select **Channel Synchronization**, and the **Unit Sync ON/OFF** drop-down list becomes available.

Table 3.6.2-1 lists the combinations available for the Unit Sync function.

Table 3.6.2-1 Combination Settings for Unit Sync

Sync ON/OFF	Sync Type
Channel Synchronization	Channel Synchronization
	Inter-Module 2ch Combination

[2] Turning ON/OFF the Unit Sync function
To enable the function, in the **Unit Sync ON/OFF** list, touch **Unit Sync**, and then touch **OK**. When you receive the message that the settings were changed according to the restrictions given in 3.6.1 "Unit Sync operation and restrictions", touch **OK** to confirm. (Figure 3.6.2-2, Figure 3.6.2-3)



Figure 3.6.2-2 Notification Message for Changes to Settings When Unit Sync Is ON (PAM4 PPG)

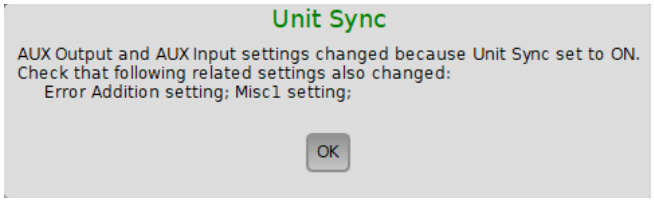


Figure 3.6.2-3 Notification Message for Changes to Settings When Unit Sync Is ON (SI PPG)

3.6.3 How to use Unit Sync function

This section explains how to use the Unit Sync function. For details on how to connect MP1900As when using the Unit Sync function, refer to 3.6.4.1 “Connecting equipment”.

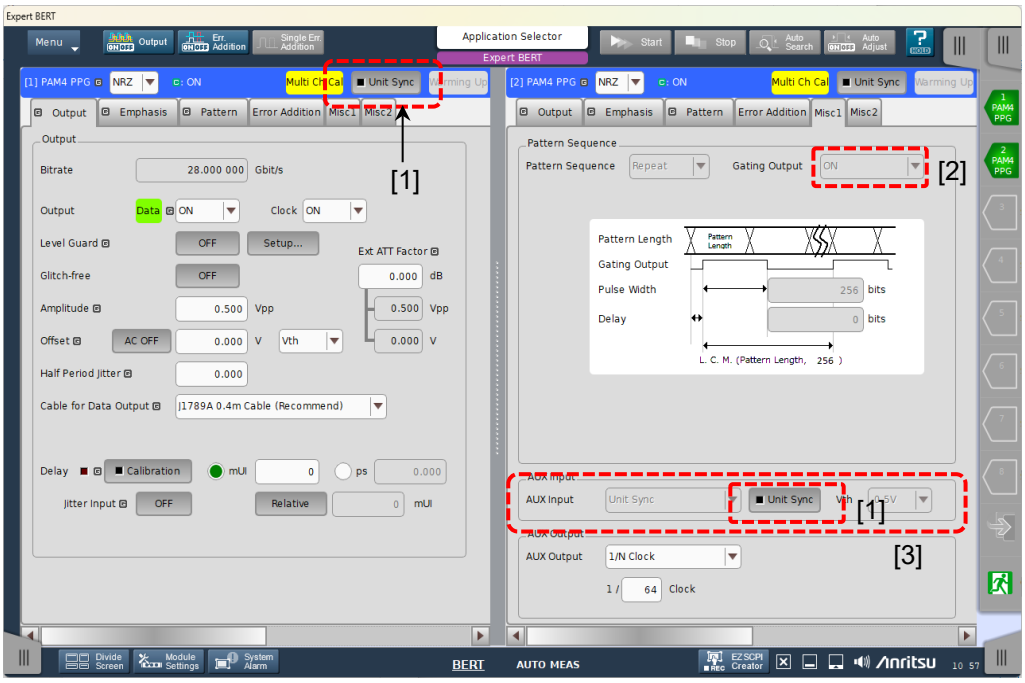


Figure 3.6.3-1 MX190000A Screen (PAM4 PPG)

[1] **Unit Sync**

Outputs the timing signal for synchronization with the MP1900A. This button is available only when **Unit Sync** is set to **ON**.

Note:

The status indicator turns orange when there is an interruption or change in the operation clock input. In this case, you need to touch the button to synchronize again.

[2] Gating Output of Pattern Sequence

When **Unit Sync** is **ON**, this is dedicated to output a timing signal for inter-MP1900A synchronization.

[3] AUX Input

When **Unit Sync** is **ON**, this is dedicated to input a timing signal for inter-MP1900A synchronization.

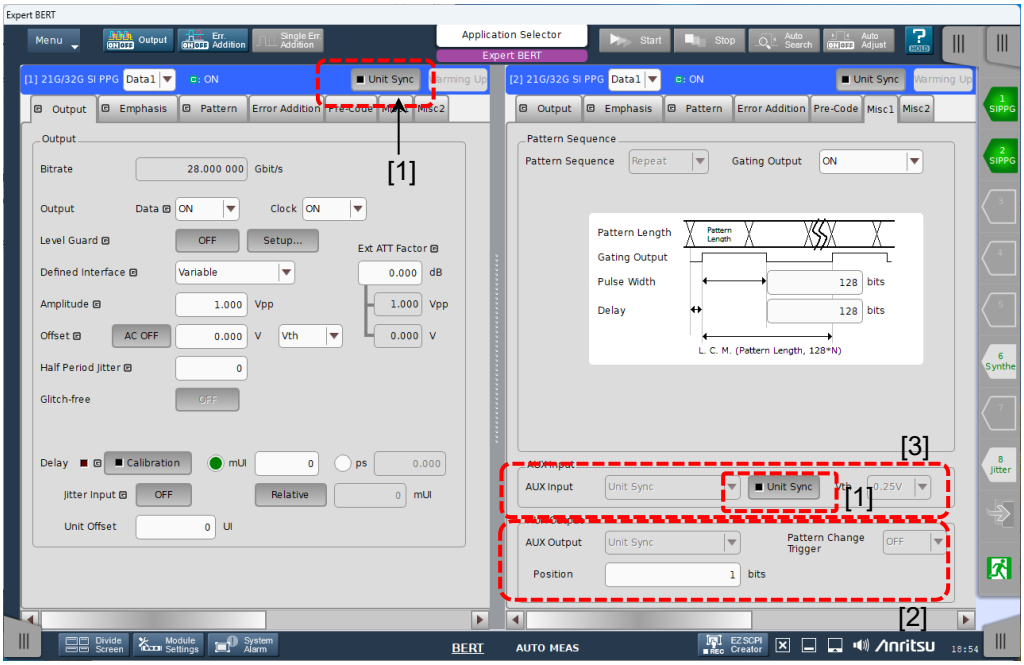


Figure 3.6.3-2 MX190000A Screen (SI PPG)

[1] **Unit Sync**

Outputs the timing signal for synchronization with the MP1900A. This button is available only when **Unit Sync** is set to **ON**.

Notes:

- The status indicator turns orange when there is an interruption or change in the operation clock input. In this case, you need to touch the button to synchronize again.
- When Delay Calibration is performed or Jitter Input is turned ON/OFF, the LED may not light up.

[2] AUX Output

When **Unit Sync** is **ON**, this is dedicated to output a timing signal for inter-MP1900A synchronization.

[3] AUX Input

When **Unit Sync** is **ON**, this is dedicated to input a timing signal for inter-MP1900A synchronization.

3.6.4 Performing the Unit Sync function (PAM4 PPG)

This section explains how to perform the Unit Sync function.
Here, an example is explained using two MP1900As each installed with four MU196020A/C PAM4 PPGs.

Equipment configuration:

MP1900A:	2
MU196020A/C PAM4 PPG (MU196020A/C-001/x30/x50):	8*
MU181500B Jitter Modulation Source:	2
MU181000B 12.5GHz 4port Synthesizer: (or MU191000A Synthesizer)	1

*: For the UnitSync function, at least two PAM4 PPGs must be installed in both the MP1900A (Primary) and the MP1900A (Secondary). All installed PAM4 PPGs must be of the same model, either MU196020A or MU196020C. Examples of configurations with fewer than eight PAM4 PPGs are shown below.

Example 1:
Installing five PAM4 PPGs
MP1900A (Primary): MU196020A × 3
MP1900A (Secondary): MU196020A × 2

Example 2:
Installing seven PAM4 PPGs
MP1900A (Primary): MU196020C × 4
MP1900A (Secondary): MU196020C × 3

3.6.4.1 Connecting equipment

This section explains how to connect equipment for using the Unit Sync function.

- Connect the MU181000B (or MU191000A) and the MU181500B to supply a clock signal to the MU196020A/C.
- Connect the Gating Out and AUX In connectors of MU196020A/C. As shown in Figure 3.6.4.1-1, connect the Gating Out and AUX In connectors of modules.

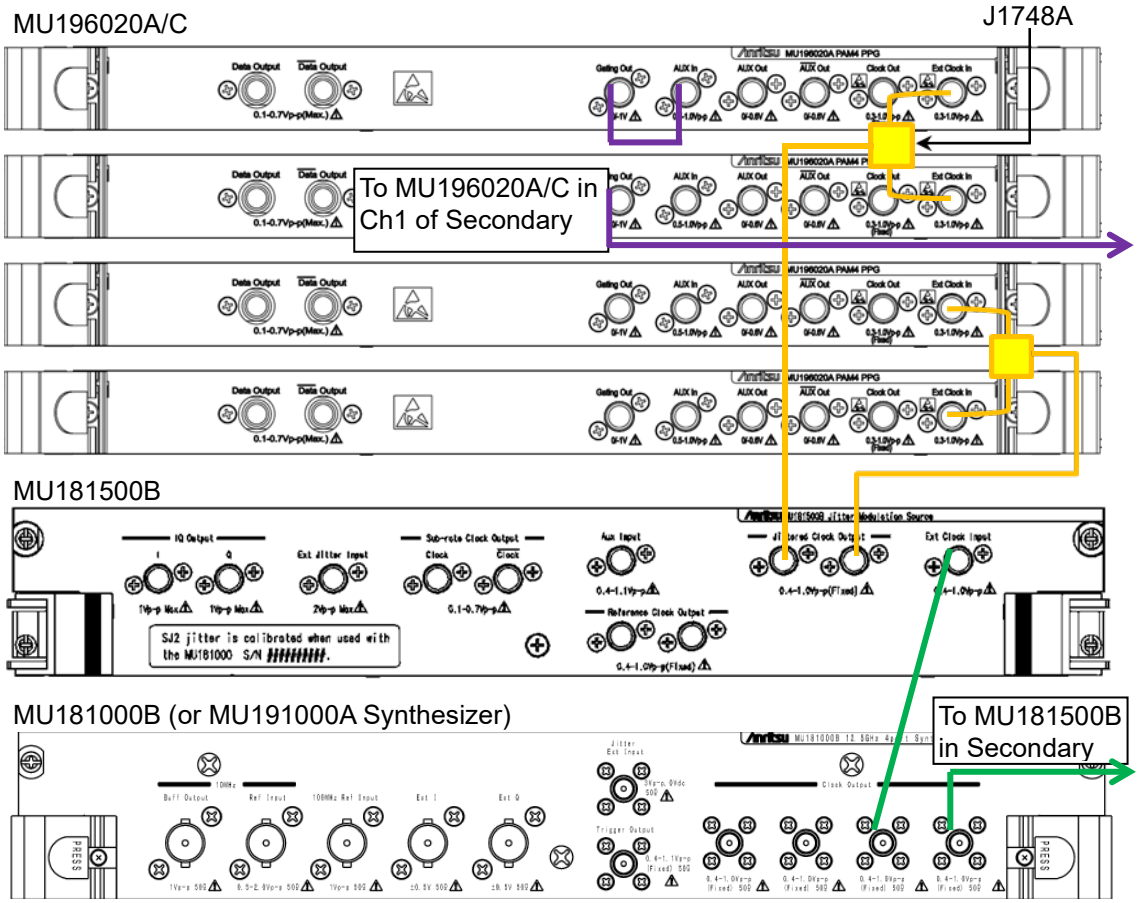


Figure 3.6.4.1-1 Connection Example of MP1900A (Primary)

- Connect two MP1900A units with an Ethernet cable to execute Multi Channel Calibration, which calibrates the Multi Channel operation of the MU196020A/C units installed in the MP1900A units.
- Set the IP address and port number of each MP1900A.

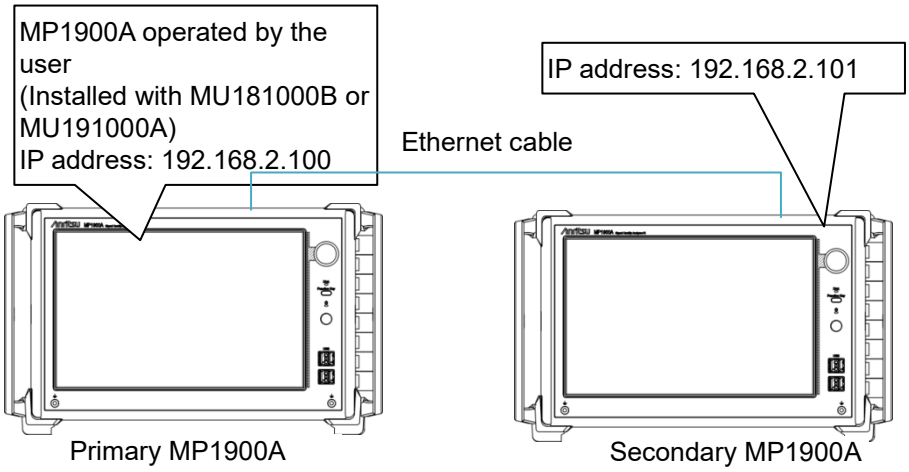


Figure 3.6.4.1-2 Ethernet Cable Connection and IP Address Setting of MP1900As

Of the two MP1900As, one in which MU181000B or MU191000A is installed is defined as Primary, and the other as Secondary. Connect the clock signal of MU196020A/C installed in each of Primary and Secondary.

1. Connect the Clock Output connector of MU181000B or MU191000A installed in Slot 7 and 8 of Primary and the Ext. Clock Input connector of MU181500B installed in Slot 5 and 6 of Primary and Secondary by using the J1625A coaxial cables (optional accessories).
2. Connect the Jittered Clock Output connector of MU181500B installed in Slot 5 and 6 of Primary and Secondary and the Clock In connector of MU196020A/C each installed in Slot 1 to 4 of Primary and Secondary by using the J1624A cables and J1748A dividers (optional accessories, respectively).
3. Connect the Gating Out and AUX In connectors of MU196020A/C installed in Slot 1 of Primary by using the J1625A cable (optional accessory).
4. Connect the Gating Out connector of MU196020A/C installed in Slot 2 of Primary and the AUX In connector of MU196020A/C installed in Slot 1 of Secondary by using the J1625A cable (optional accessory).
5. Connect Primary and Secondary with an Ethernet cable. Be sure to connect the External ports on the rear of Primary and Secondary MP1900As.

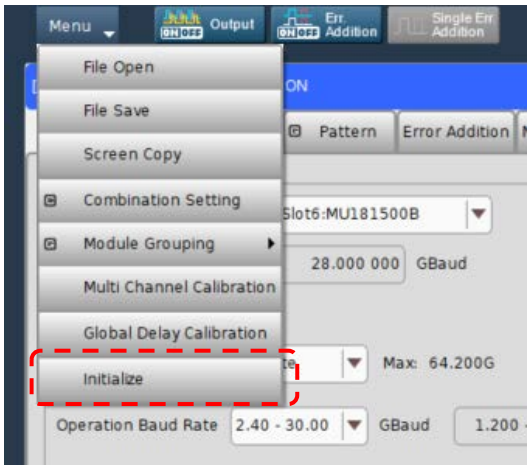
6. Set the IP address and port number of each of Primary and Secondary. Here, set as follows.

IP Address (Primary):	192.168.2.100
IP Address (Secondary):	192.168.2.101
Port No. (Primary/Secondary):	5001

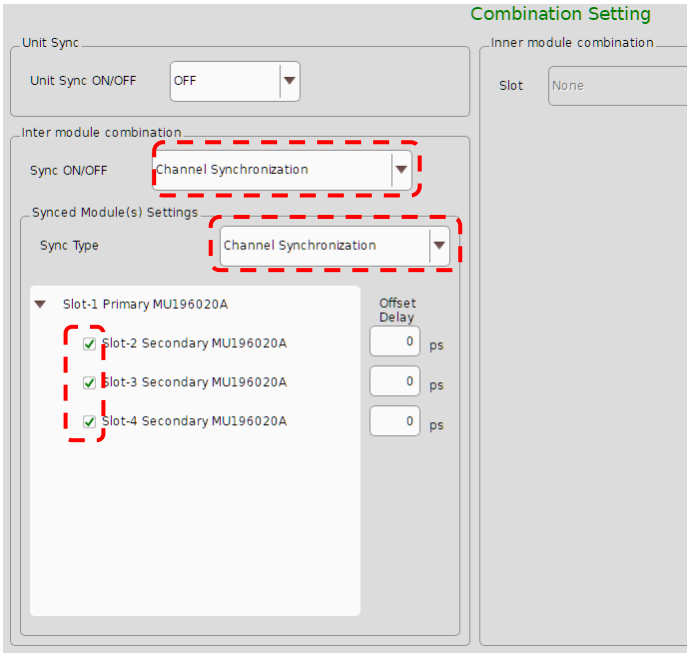
3.6.4.2 How to perform inter-MP1900A pattern synchronization

This section explains how to perform inter-MP1900A pattern synchronization of initialized Primary and Secondary.

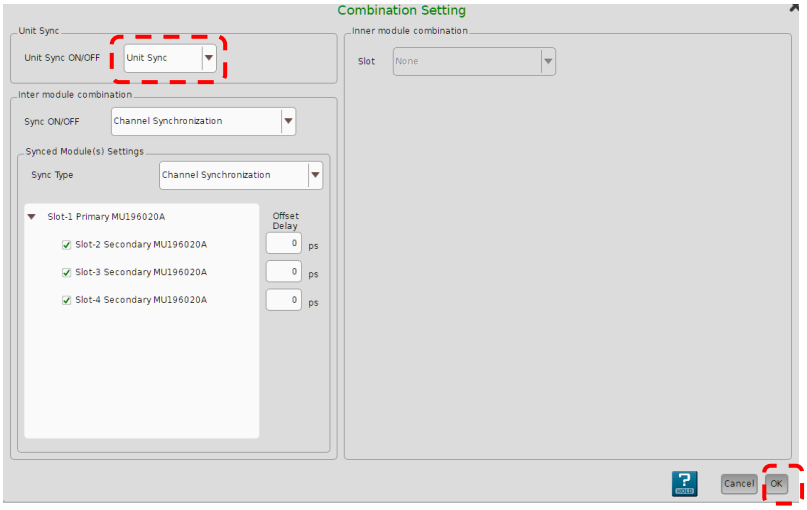
1. In the **Menu** list of each of Primary and Secondary, touch **Initialize**. On initialized Primary and Secondary, touch **Output** to switch data output to OFF for prevention of unintentional data output during calibration.



2. In the **Menu** list of Secondary, touch **Combination Setting**, and make settings for Inter module combination as follows:
   Sync ON/OFF: **Channel Synchronization**
   Sync Type: **Channel Synchronization**
   Select the check boxes for Slot-2 to Slot-4.



3. In the **Unit Sync ON/OFF** list, touch **Unit Sync**, and then touch **OK**.

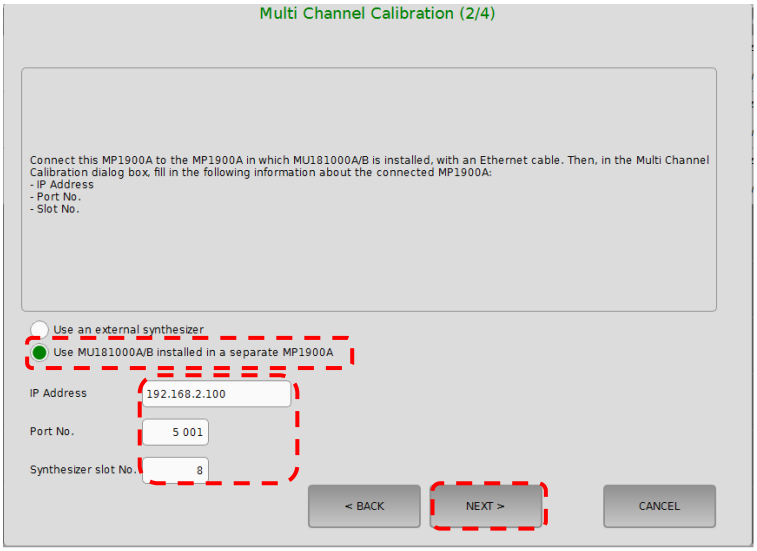


4. When Secondary prompts for multi channel calibration, touch **Next**.

5. Select **Use MU181000A/B installed in a separate MP1900A**, and fill in as follows:

   IP Address (Primary): 192.168.2.100
   Port No.: 5001
   Synthesizer slot No.: 8

   Then, touch **Next**, and wait until the calibration is complete.



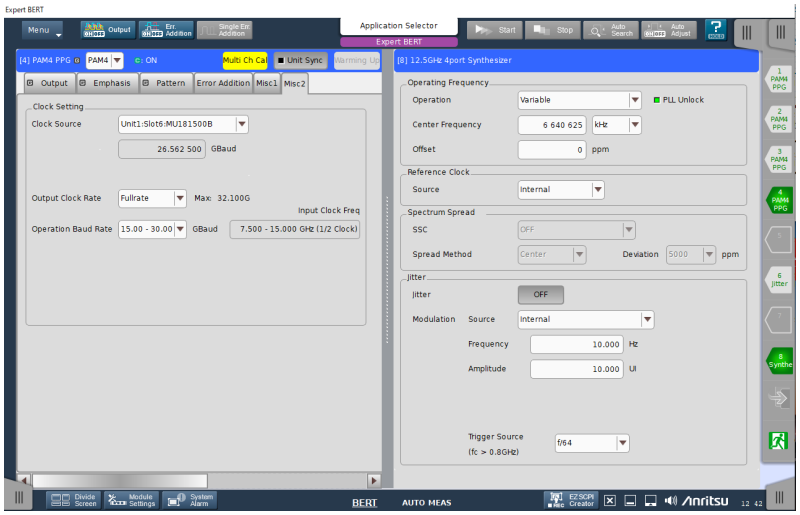
6. On Primary, make settings for Inter module combination as in step 2. In the **Multi Channel Calibration** page (2/4), touch **Next**, and wait until the calibration is complete.



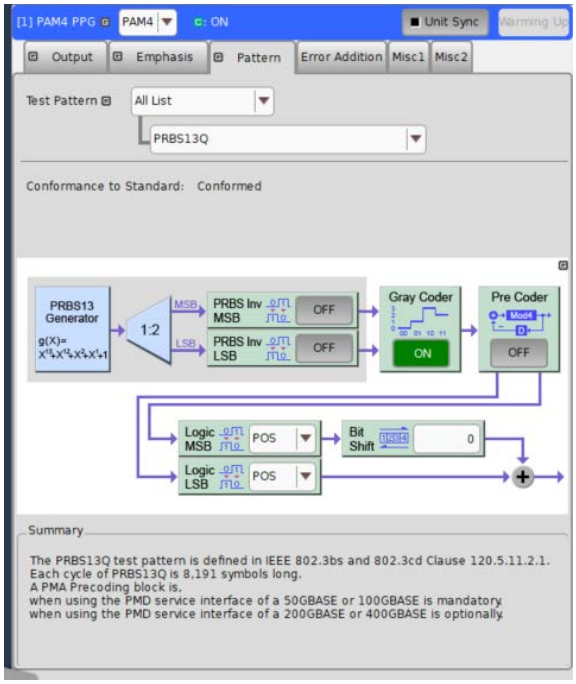
7. On each of Primary and Secondary, make the necessary settings for PPG. Here, make Baudrate and pattern settings, and settings for interlocking with MU181500B.
   In this example, Baudrate is set to 26.5625 GBaud, and pattern is set to PRBS13Q.

   (a) On the **Misc2** tab for MU196020A in Slot 1 of each of Primary and Secondary, set as follows:
   Clock Source: **MU181500B**
   Output Clock Rate: **Fullrate**
   Operation Baud Rate: **25.00-32.10 GBaud**

   (b) Set MU181000B in Slot 8 of Primary as follows:
   Center Frequency: **6640625 kHz** (1/4 of 26.5625G)

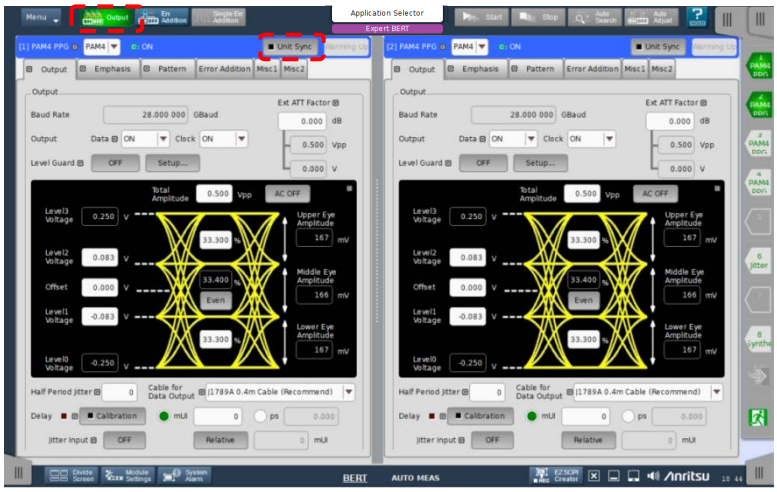


(c) Set Test Pattern to PRBS13Q for MU196020A in Slot 1 to 4 of each of Primary and Secondary.



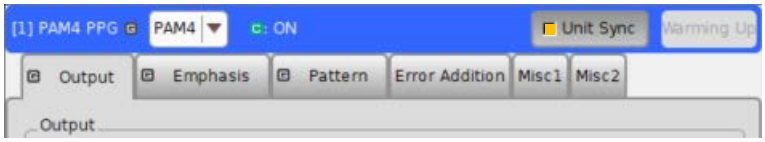
8. Touch **Unit Sync** for MU196020A in Slot 1 of Primary. No matter in which of slot screens 1 to 4, **Unit Sync** functions the same when touched. However, **Unit Sync** on Secondary cannot perform pattern synchronization. Be sure to touch **Unit Sync** on Primary.

9. On Primary and Secondary, touch **Output** to switch data output to **ON**.



Observe the outputs (total 8 channels) of MU196020As installed in Primary and Secondary with an oscilloscope, and you can now confirm that the bit phase difference of each channel is within ±1024 UI.

After that, if you change the Baudrate or pattern, the Unit Sync indicator turns orange. This means that Primary and Secondary are not synchronized, so touch **Unit Sync** on Primary again. Synchronization can be performed again by touching **Unit Sync** even if its indicator is off.



3.6.5 Performing the Unit Sync function (SI PPG)

This section explains how to perform the Unit Sync function.
Here, an example is explained using two MP1900As each installed with four MU195020A SI PPGs.

Equipment configuration:

MP1900A:	2
MU195020A SI PPG (MU195020A-001/x20/x31):	8*1
MU181500B Jitter Modulation Source*2:	2
MU181000B 12.5GHz 4port Synthesizer:	1

*1: For the UnitSync function, at least two SI PPGs must be installed in both the MP1900A (Primary) and the MP1900A (Secondary). Examples of configurations with fewer than eight SI PPGs are shown below.

Example 1:
Installing five SI PPGs
MP1900A (Primary): MU195020A × 3
MP1900A (Secondary): MU195020A × 2

Example 2:
Installing seven SI PPGs
MP1900A (Primary): MU195020A × 4
MP1900A (Secondary): MU195020A × 3

*2: The Unit Sync function works even in configurations without the MU181500B jitter signal source.

3.6.5.1 Connecting equipment

This section explains how to connect equipment for using the Unit Sync function.

- Connect MU181000B and MU181500B for inputting a clock signal to MU195020A.
- Connect the AUX Out and AUX In connectors of MU195020A. As shown in Figure 3.6.5.1-1, connect the AUX Out and AUX In connectors of modules.

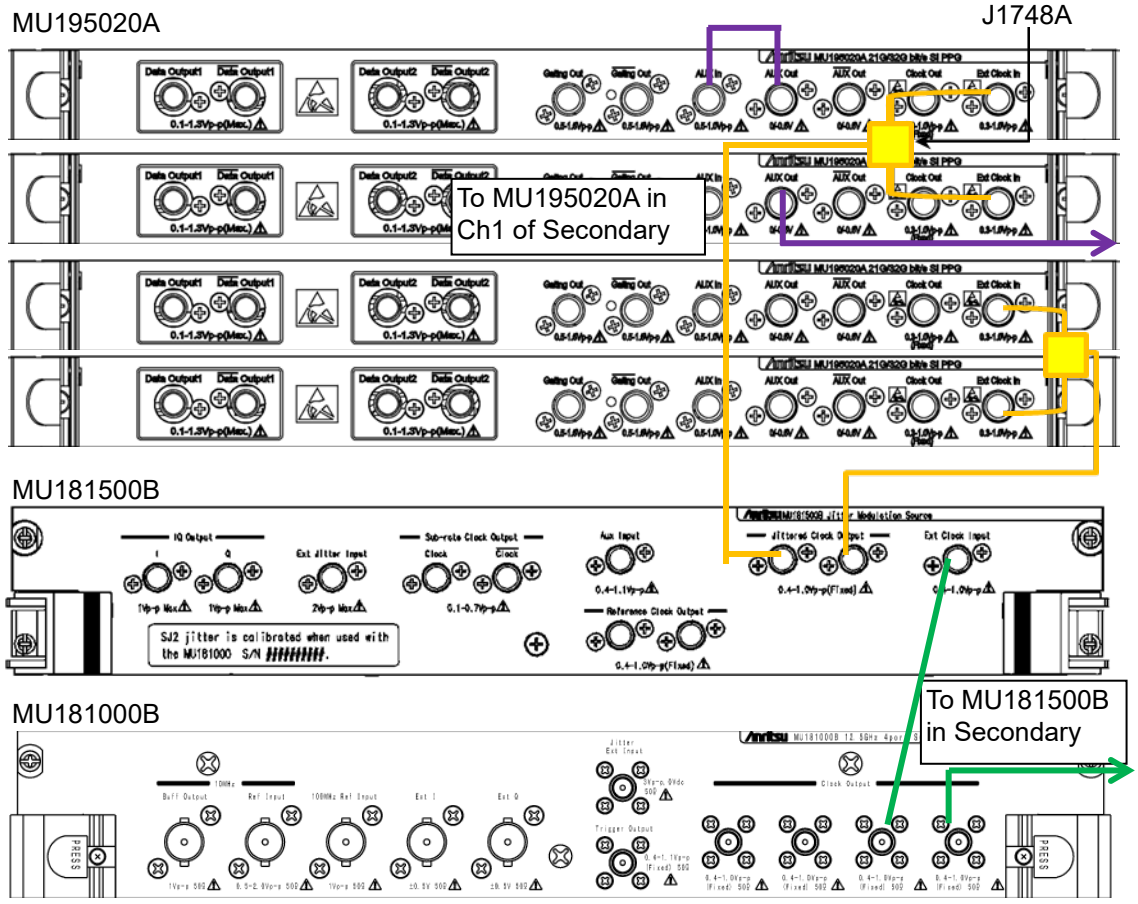


Figure 3.6.5.1-1 Connection Example of MP1900A (Primary)

- Connect two MP1900As with an Ethernet cable to execute Multi Channel Calibration, which calibrates the Multi Channel operation of the MU195020As installed in the MP1900As.
- Set the IP address and port number of each MP1900A.

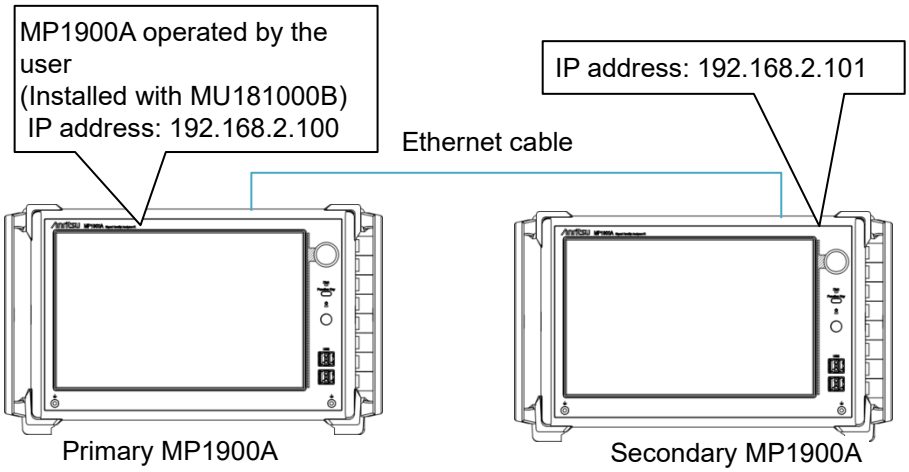


Figure 3.6.5.1-2 Ethernet Cable Connection and IP Address Setting of MP1900As

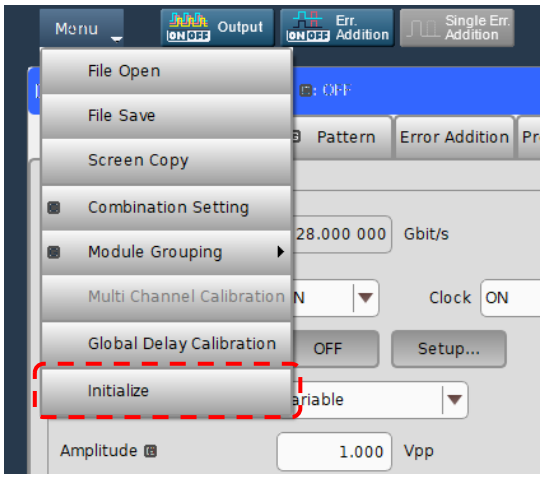
Of the two MP1900As, one in which MU181000B is installed is defined as Primary, and the other as Secondary. Connect the clock signal of MU195020A installed in each of Primary and Secondary.

1. Connect the Clock Output connector of MU181000B installed in Slot 7 and 8 of Primary and the Ext. Clock Input connector of MU181500B installed in Slot 5 and 6 of Primary and Secondary by using the J1625A coaxial cables (optional accessories).
2. Connect the Jittered Clock Output connector of MU181500B installed in Slot 5 and 6 of Primary and Secondary and the Clock In connector of MU195020A each installed in Slot 1 to 4 of Primary and Secondary by using the J1624A cables and J1748A dividers (optional accessories, respectively).
3. Connect the AUX Out and AUX In connectors of MU195020A installed in Slot 1 of Primary by using the J1625A cable (optional accessory).
4. Connect the AUX Out connector of MU195020A installed in Slot 2 of Primary and the AUX In connector of MU196020A installed in Slot 1 of Secondary by using the J1625A cable (optional accessory).
5. Connect Primary and Secondary with an Ethernet cable. Be sure to connect the External ports on the rear of Primary and Secondary MP1900As.
6. Set the IP address and port number of each of Primary and Secondary. Here, set as follows.
   IP Address (Primary): 192.168.2.100
   IP Address (Secondary): 192.168.2.101
   Port No. (Primary/Secondary): 5001

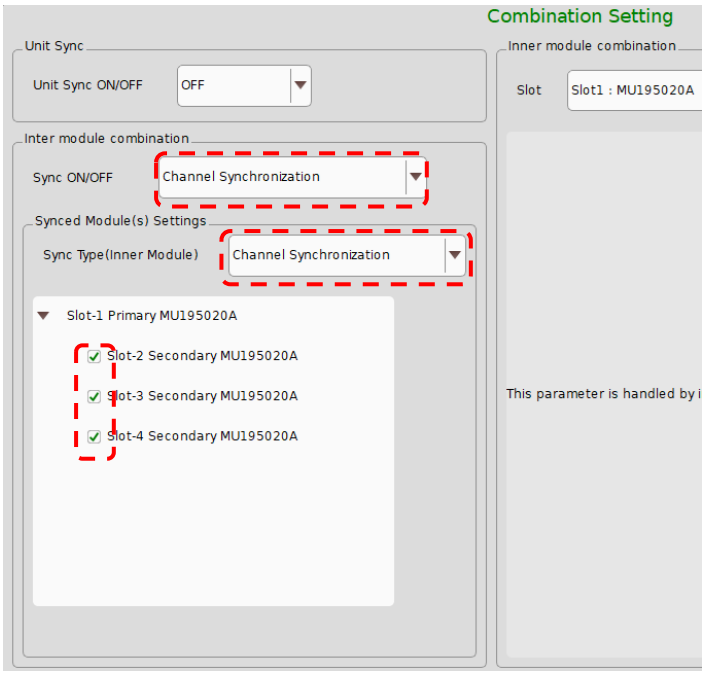
3.6.5.2 How to perform inter-MP1900A pattern synchronization

This section explains how to perform inter-MP1900A pattern synchronization of initialized Primary and Secondary.

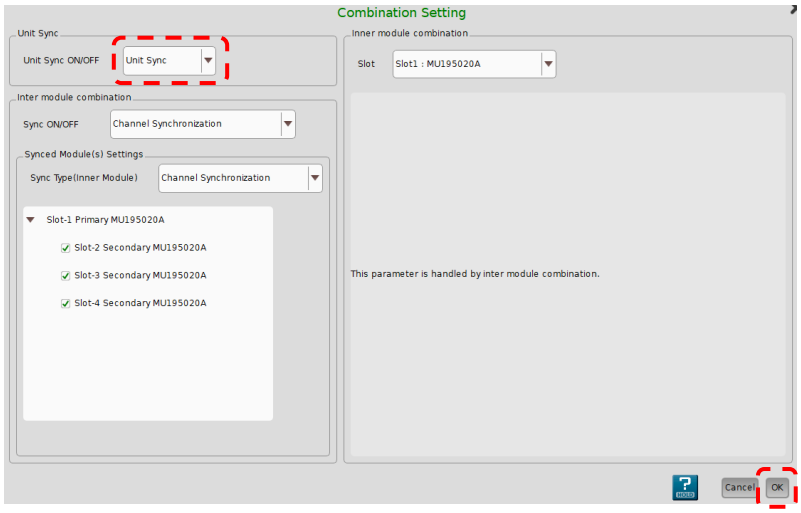
1. In the **Menu** list of each of Primary and Secondary, touch **Initialize**. On initialized Primary and Secondary, touch **Output** to switch data output to OFF for prevention of unintentional data output during calibration.



2. In the **Menu** list of Secondary, touch **Combination Setting**, and make settings for Inter module combination as follows:
   Sync ON/OFF: **Channel Synchronization**
   Sync Type: **Channel Synchronization**
   Select the check boxes for Slot-2 to Slot-4.



3. In the **Unit Sync ON/OFF** list, touch **Unit Sync**, and then touch **OK**.

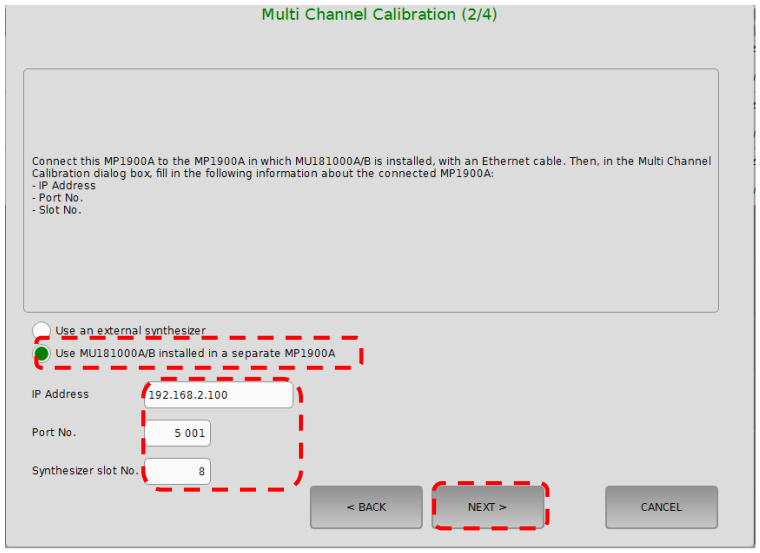


4. When Secondary prompts for multi channel calibration, touch **Next**.

5. Select **Use MU181000A/B installed in a separate MP1900A**, and fill in as follows:

   IP Address (Primary): 192.168.2.100
   Port No.: 5001
   Synthesizer slot No.: 8

   Then, touch **Next**, and wait until the calibration is complete.



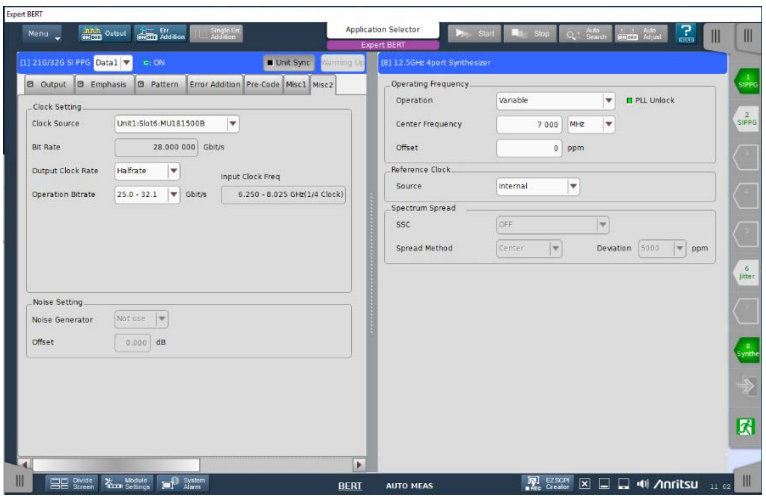
6. On Primary, make settings for Inter module combination as in step 2. In the **Multi Channel Calibration** page (2/4), touch **Next**, and wait until the calibration is complete.



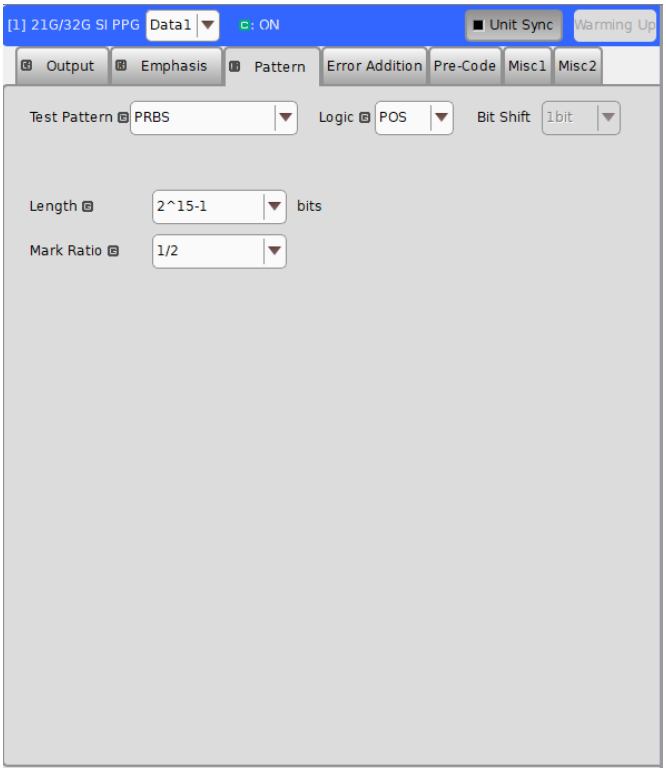
7. On each of Primary and Secondary, make the necessary settings for PPG. Here, make Bitrate and pattern settings, and settings for interlocking with MU181500B.
   In this example, Bitrate is set to 28.0000 Gbit/s, and pattern is set to PRBS15.

   (a) On the **Misc2** tab for MU195020A in Slot 1 of each of Primary and Secondary, set as follows:
   Clock Source: **MU181500B**
   Operation Bit Rate: **25.00-32.10 Gbit/s**

   (b) Set MU181000B in Slot 8 of Primary as follows:
   Center Frequency: **7000 MHz** (1/4 of 28.0000 G)

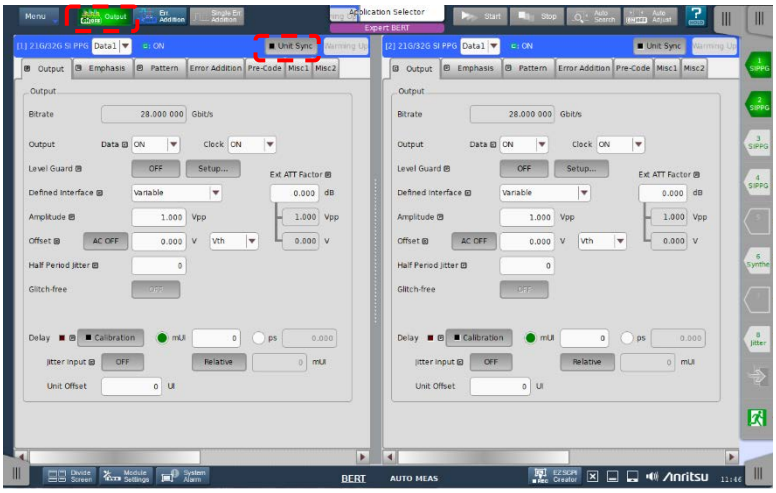


(c) Set Test Pattern to PRBS15 for MU195020A in Slot 1 to 4 of each of Primary and Secondary.



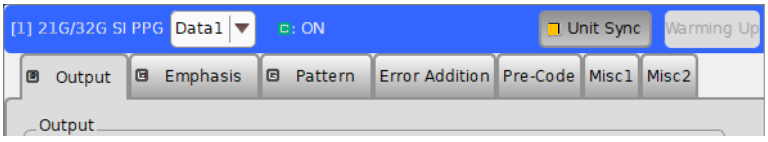
8. Touch **Unit Sync** for MU195020A in Slot 1 of Primary. No matter in which of slot screens 1 to 4, **Unit Sync** functions the same when touched. However, **Unit Sync** on Secondary cannot perform pattern synchronization. Be sure to touch **Unit Sync** on Primary.

9. On Primary and Secondary, touch **Output** to switch data output to **ON**.



Observe the outputs (total 8 channels) of MU195020As installed in Primary and Secondary with an oscilloscope, and you can now confirm that the bit phase difference of each channel is within ±256 UI.

After that, if you change the Baudrate or pattern, the Unit Sync indicator turns orange. This means that Primary and Secondary are not synchronized, so touch **Unit Sync** on Primary again. Synchronization can be performed again by touching **Unit Sync** even if its indicator is off.



10. Adjust the bit phase difference between the primary and secondary channels using AUX Output Position, Unit Offset, and Delay. The connection for adjustment is shown in Figure 3.6.5.2-1. Use the Gating Output as a trigger for the real-time oscilloscope.
Adjust the phase by performing steps a and b. If the phase condition in step a is already satisfied, proceed to step b.

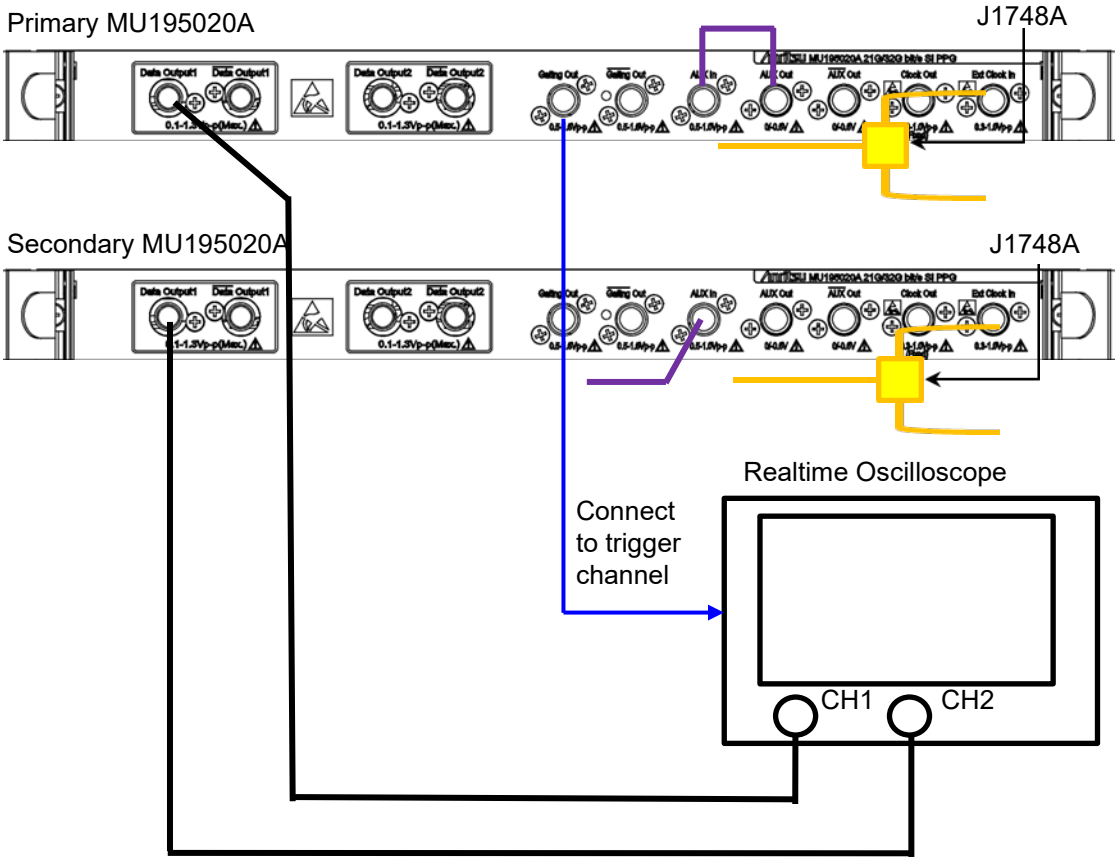


Figure 3.6.5.2-1 Connection for Bit Phase Adjustment Between Units

a. If tapping **Unit Sync** causes the primary and secondary output phases to change:

a-1. Output a pattern that makes it easier to check the pattern phase between MP1900A units.
Example: PRBS7

a-2. Increase the AUX Output Delay on Slot 2 of the primary MP1900A.
Adjust from the state where both Phase A and Phase B are output to a state where only Phase A or only Phase B is output (in this example, adjust to output only Phase B).

a-3. On the primary MP1900A, increase the AUX Output Delay in Slot 2 until Phase C is output.

a-4. On the primary MP1900A, configure the AUX Output Delay for Slot 2 to the midpoint of the values adjusted in steps a-2 and a-3.

a-5. Repeat steps a-2 to a-4 for Slot 1 of the primary MP1900A in the same way.

a-6. When tapping **Unit Sync** does not change the output phase of the primary and secondary, proceed to step b.

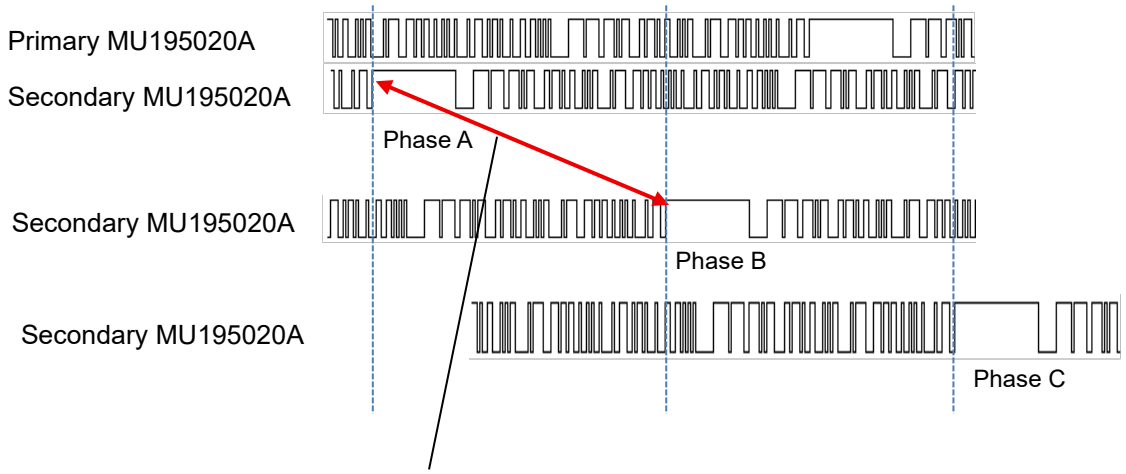
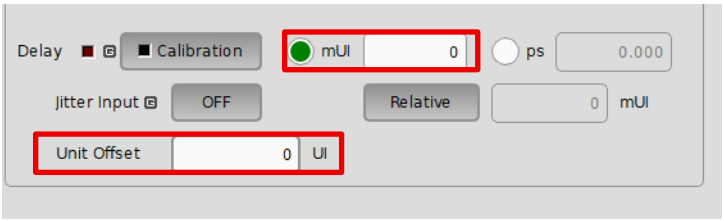


Figure 3.6.5.2-2 Bit Shift Adjustment Between Units

b. If tapping **Unit Sync** does not cause the primary and secondary output phases to change:

b-1. Output a pattern that makes it easier to check the pattern phase between MP1900A units.
Example: PRBS7

b-2. Adjust the output phase using Unit Offset and Delay.



Notes:

- When the Unit Offset is changed, the setting is applied to all slots in the MP1900A.
- Delay can be adjusted for each slot.
- Performing Delay Calibration or turning the Jitter Input ON/OFF may cause a bit phase shift. If a bit phase shift occurs, readjust the Delay value.

3.7 EZ SCPI Creator Function

The EZ SCPI Creator function records GUI operations, converts them to SCPI commands, and saves them to a text file. To start the function, touch 

shown in Figure 3.7-1.

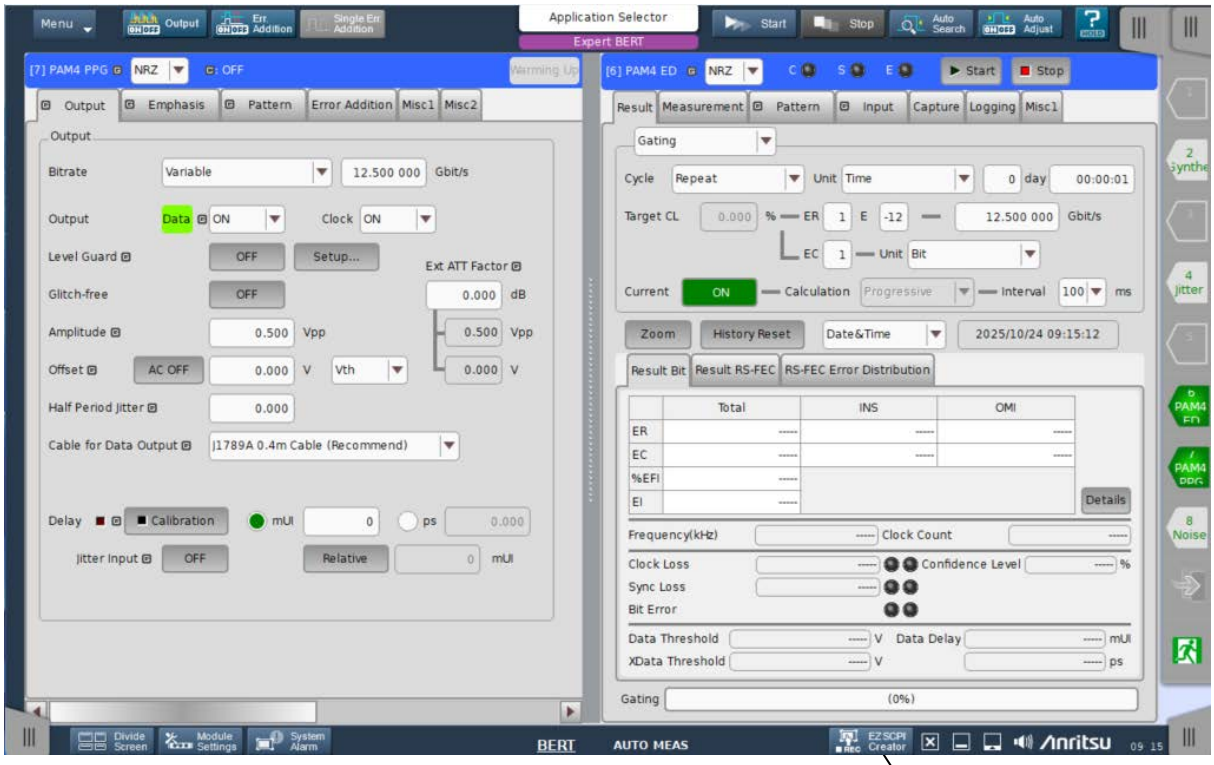


Figure 3.7-1 EZ SCPI Creator Button

3.7.1 EZ SCPI Creator operation

To start EZ SCPI Creator:

Touch 

and the following information dialog box appears.

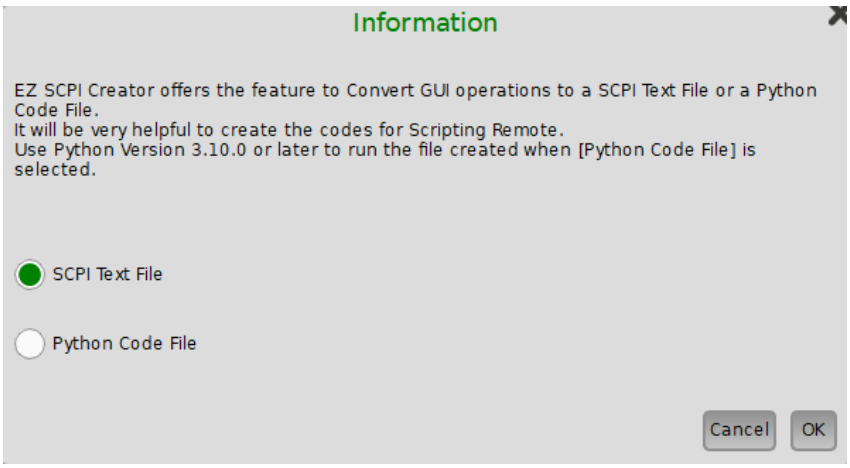


Figure 3.7.1-1 EZ SCPI Creator Information Dialog Box

Select **SCPI Text File**, touch **OK**, and you will see the **Save SCPI File** Dialog Box shown in Figure 3.7.1-2.

To cancel EZ SCPI Creator, touch **Cancel**.

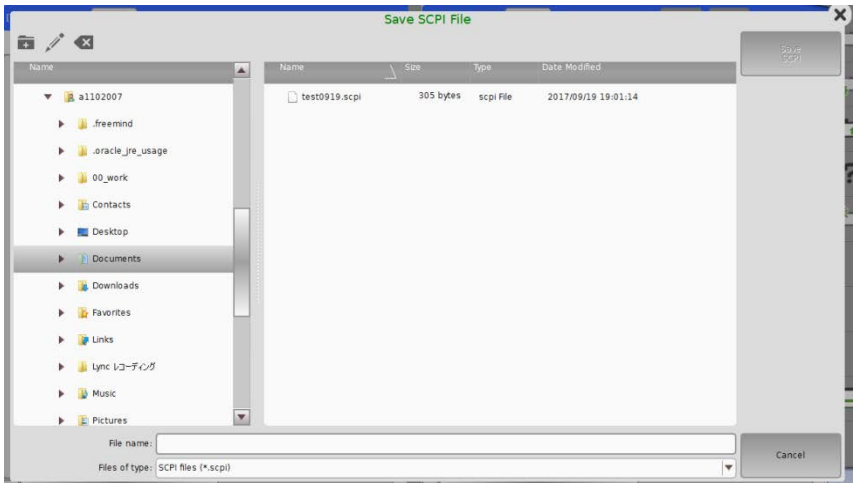


Figure 3.7.1-2 Save SCPI File Dialog Box

To start the EZ SCPI Creator function, specify the folder and file name and touch **Save SCPI**. When the button's background color changes to green (

), the function begins recording GUI operations.

To stop EZ SCPI Creator:

When you touch 

, the button's background color changes to blue (

), and EZ SCPI Creator stops recording GUI operations, converts them to SCPI commands, and saves them to a file with a specified file name.

Note that if a remote command is received when the function is running, it stops recording GUI operations and makes a transition to Remote status.

Then, 

changes to 

, and the function converts GUI operations, which have been recorded until the recording is stopped, to SCPI commands, and saves them to a file with a specified file name.

3.7.2 EZ SCPI Creator's function: Output Python code

EZ SCPI Creator records GUI operations, converts them to SCPI commands, and embeds them in Python code. The Python code with embedded SCPI commands can be saved as a file (hereafter, a Python file).

Notes:

- Python is a programming language provided by the Python Software Foundation (hereafter, PSF). To run Python code, it is necessary to download a Python interpreter installer provided by PSF from the URL below and install it on the MP1900A or external PC.
  https://www.python.org/downloads/
- Python files output by EZ SCPI Creator are compatible with Python 3.10.00 or later.

To start EZ SCPI Creator:

Touch 

and the following **information** dialog box appears.

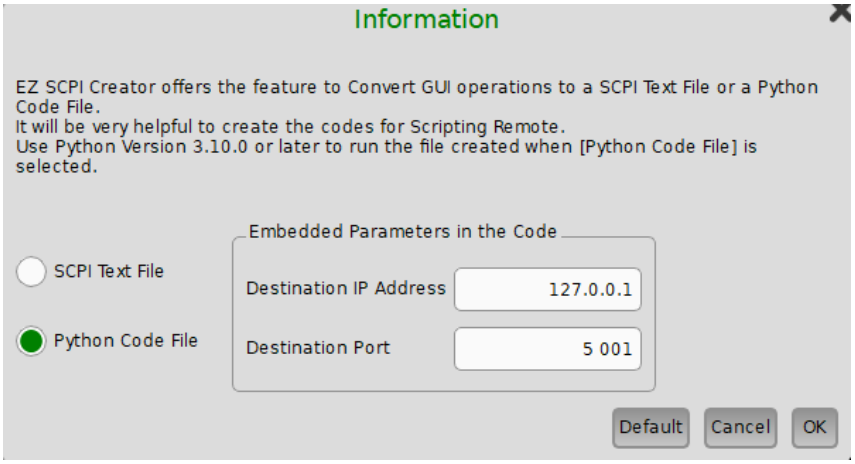


Figure 3.7.2-1 EZ SCPI Creator Information Dialog Box

When you select **Python Code File**, you will see the **Embedded Parameters in the code** area, where you can specify the IP address and port number described in the table below.
The specified IP address and port number are embedded in the Python code when it is saved to a Python file. When the Python code is run, a connection is made using the specified IP address and port number to send SCPI commands.

Table 3.7.2-1 EZ SCPI Creator Information Parameters

Parameter Name	Description
Destination IP Address	Specify the IP address of the MP1900A, the destination of SCPI commands. When sending SCPI commands from an external PC, it is necessary to change the IP address from the initial value to that of the MP1900A to be controlled. For details, refer to 5.2.3.3, "Setting Ethernet port". Default: 127.0.0.1
Destination Port	Specify the port number of the MP1900A, the destination of SCPI commands. For details, refer to 5.2.3.3, "Setting Ethernet port". Default: 5001

When you touch **OK**, the **Save Python File** dialog box is displayed as shown in "Figure 3.7.2-2 Save Python File Dialog Box".

To cancel EZ SCPI Creator, touch **Cancel**.

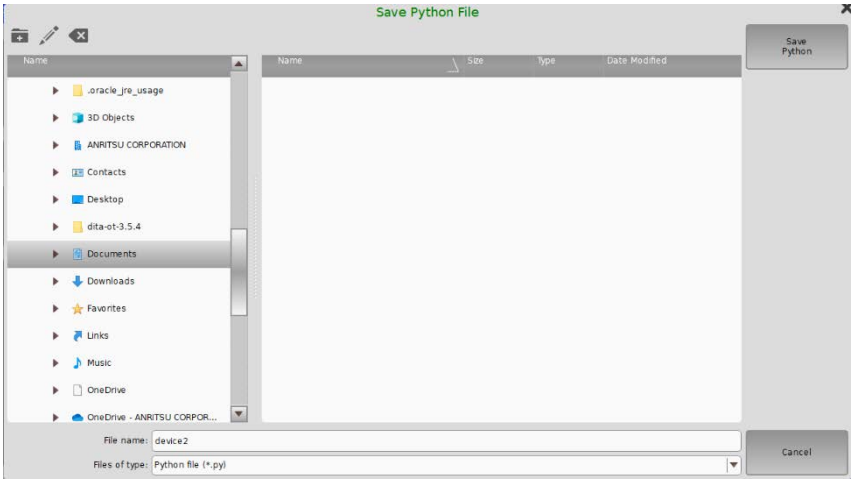


Figure 3.7.2-2 Save Python File Dialog Box

To start the EZ SCPI Creator function, specify the folder and file name and touch **Save Python**. When the button's background color changes to green (EZ SCPI Creator REC), the function begins recording GUI operations.

To stop EZ SCPI Creator:

When you touch 

, the button's background color changes to blue (

), and EZ SCPI Creator stops recording GUI operations, converts them to SCPI commands, and saves them as Python code with a specified file name.

Note that if a remote command is received when the function is running, it stops recording GUI operations and makes a transition to Remote status.

Then, 

changes to 

, and the function converts GUI operations, which have been recorded until the recording is stopped, to SCPI commands, and saves them as Python code with a specified file name.

To run a saved Python file, follow the procedure below:

1. Connect the MP1900A to be controlled (SCPI command destination) and an external PC (SCPI command source) installed with a Python interpreter, using an Ethernet cable.
   For details, refer to 5.2.3.2, "Connecting via Ethernet cable".
   Note that this step is not necessary when running a Python file on the MP1900A to be controlled.
2. Install a Python interpreter on the MP1900A or external PC that runs Python files if a Python interpreter is not installed on it.
3. In Application Selector on the controlled MP1900A, touch the BERT application icon so that it can receive SCPI commands.
4. In File Explorer, double-click the Python file, and you can send the SCPI commands of GUI operations converted in EZ SCPI Creator to the controlled MP1900A.

Note:

If the Python file cannot be run by double-clicking, follow the procedure below:

1. In File Explorer, right-click the Python file.
2. Select **Open With**, and then select **Python**.
3. Select the **Always use this app to open .py files** check box, and then click **OK**.

3.8 Confidence Level Function

The Confidence Level function calculates the Confidence Level for BER measurement.

The confidence level represents the probability, expressed as a percentage (%), that the measured BER is less than a specified threshold. The longer the measurement time (amount of data), the closer the confidence level approaches 100%. If a specific confidence level is required for BER measurement, this function can also calculate the measurement time needed to achieve that level.

$$CL = 1 - e^{-N \times BER_S} \times \sum_{k=0}^{E} \frac{(N \times BER_s)^k}{k!}$$

Figure 3.8-1 Confidence Level Calculation Formula

N: Bitrate × Measurement Time

BER_s: Target Error Rate

E: Target Error Count

CL: Confidence Level [%]

3.8.1 How to use Confidence Level function

This section explains how to use the Confidence Level function.
The Confidence Level settings are available in the **Result** tab and the **Misc1** tab.
The settings shown in Figure 3.8.1-1 and Figure 3.8.1-2 can also be configured in the **Measurement** tab.

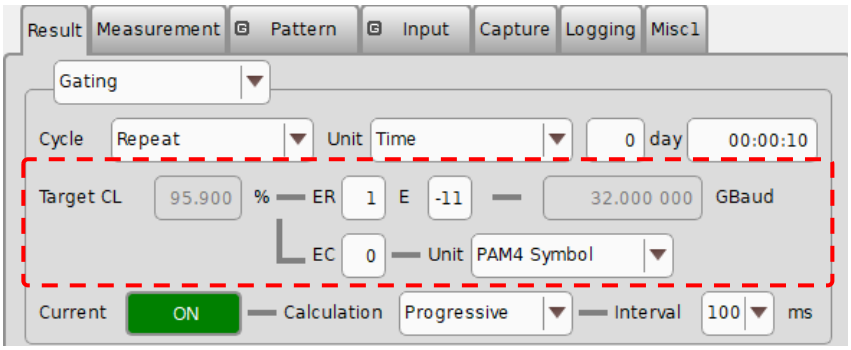


Figure 3.8.1-1 Setting Screen of Result Tab (PAM4 ED)

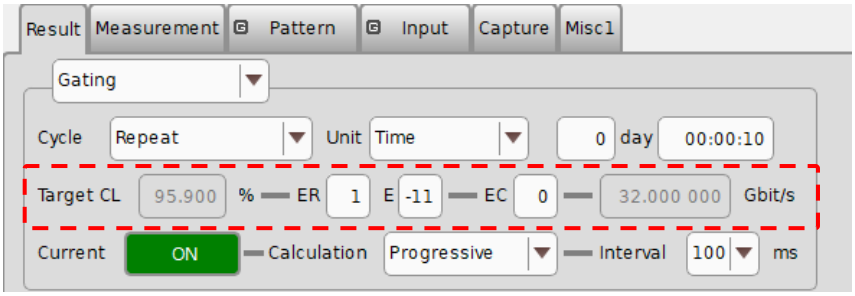


Figure 3.8.1-2 Setting Screen of Result Tab (SI ED)

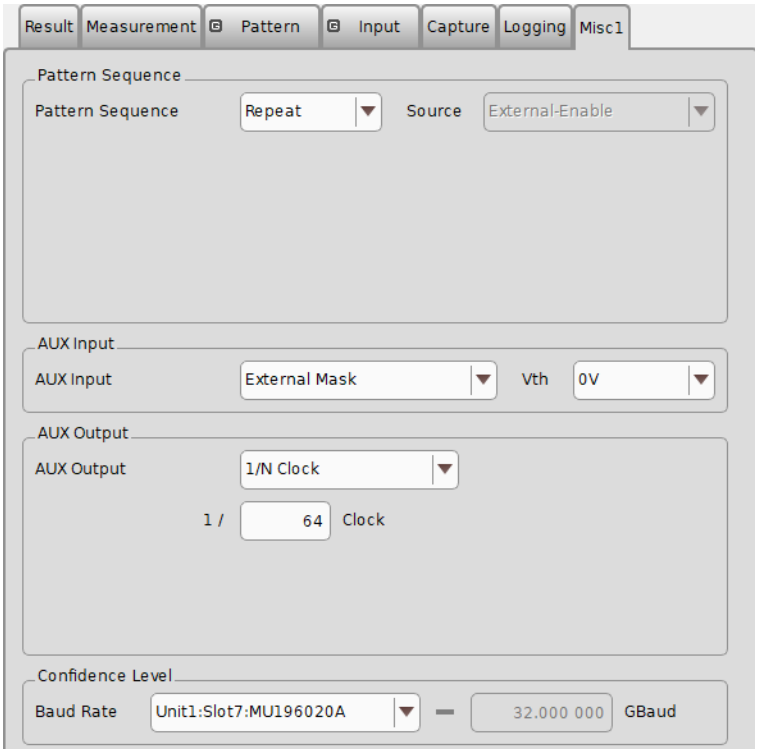


Figure 3.8.1-3 Setting Screen of Misc1 Tab

3.8.1.1 Calculating Confidence Level from Measurement Results

The Confidence Level is calculated based on the BER measurement results and displayed in the **Results** pane.

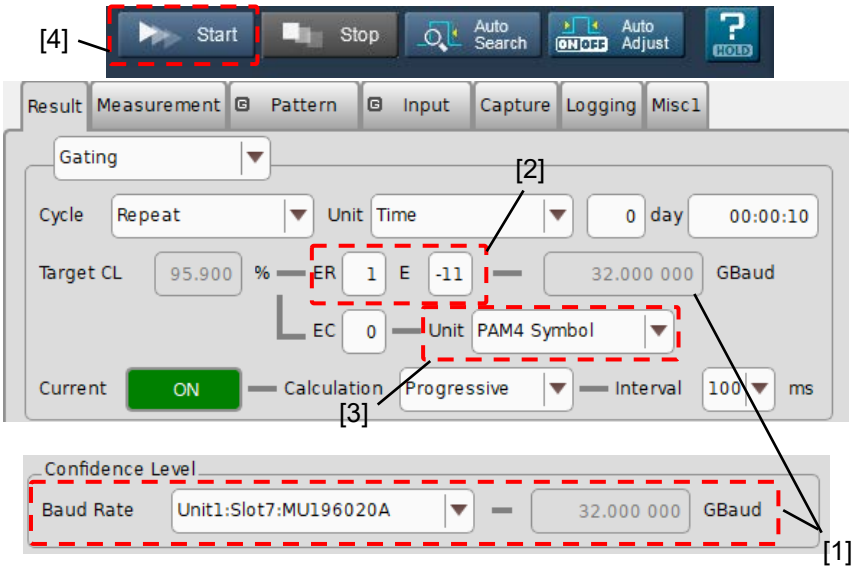


Figure 3.8.1.1-1 Calculating Confidence Level from Measurement Results

[1] Set the Bitrate.
Selecting the linked PPG in the Confidence Level area of the **Misc1** tab, enables configuration using the PPG's bitrate.

[2] Set the Target ER.
Set the reference BER level for Confidence Level calculation.

Example:

When a confidence level is required for a BER smaller than 10^{-11}, Set the ER input value to **1E-11**.

[3] Set the Target Unit (PAM4 ED only).
Select the type of Error Count (EC) value to be used for calculating the Confidence Level.

Example:

When calculating the Confidence Level based on the EC value of the PAM4 Symbol in the results pane (Figure 3.8.1.1-2), select **PAM4 Symbol** from Unit.

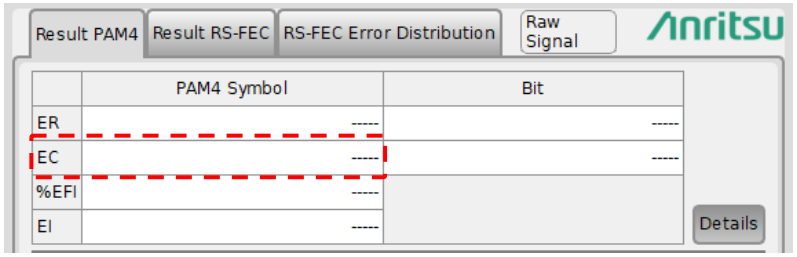


Figure 3.8.1.1-2 EC Display for PAM4 Symbol

Note:

In SI ED, only one EC value type (Bit) is available, so selection is not required.

[4] Start the BER measurement.

The Confidence Level is calculated based on the EC value obtained from BER measurement (or the PAM4 Symbol EC value when the Unit is set to PAM4 Symbol) and the actual measurement elapsed time. The results pane displays the calculation result (Figure 3.8.1.1-3).

Example:

The Confidence Level calculated from the following measurement results is 95.9%.

BER Measurement Time: 10 s

EC Value: 0

This means that, based on the measurement results, the BER is less than 10^{-11} with 95.9% confidence.

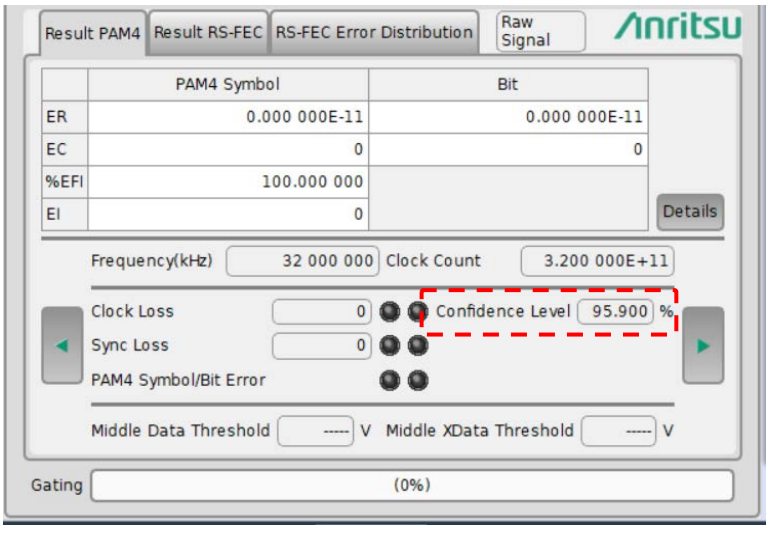


Figure 3.8.1.1-3 Confidence Level Result Display

3.8.1.2 Calculating Target CL

The Target CL is calculated by setting the Target EC without performing a BER measurement.

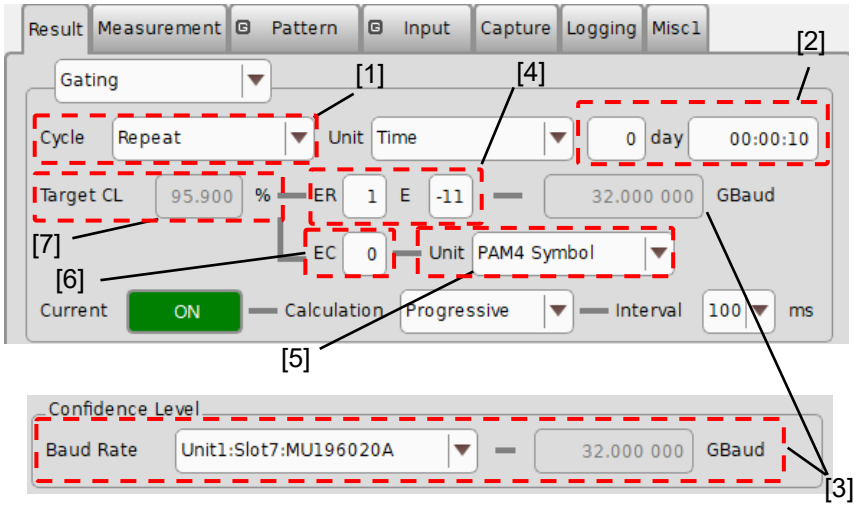


Figure 3.8.1.2-1 Calculating Target CL

[1] Set to **Single** or **Repeat**.

[2] Set the Gating Time.
When calculating the Target CL for a 10-second measurement, set the Gating Time to **00:00:10**.

[3] Set the Bitrate.
Selecting the linked PPG in the Confidence Level area of the **Misc1** tab enables configuration using the PPG's bitrate.

[4] Set the Target ER.
Set the reference BER level for Confidence Level calculation.

Example:

When a confidence level is required for a BER smaller than 10^{-11}, set the ER input value to **1E-11**.

[5] Set the Target Unit (PAM4 ED only).
Select the type of Error Count value to use for Confidence Level calculation.
Example:
When calculating the Target CL based on the EC value of the PAM4 Symbol, select **PAM4 Symbol** from Unit.

Note:

In SI ED, only one EC value type (Bit) is available, so selection is not required.

[6] Set the Target EC.
Enter the value corresponding to the EC value used for BER measurement.
Example:
If the time set for Gating Time results in an EC of zero after measurement, enter **0** for EC.

[7] The calculation result for Target CL is displayed.

3.8.1.3 Calculating Gating Time from Target CL

This step calculates the Gating Time required to meet the Target CL under the specified conditions.

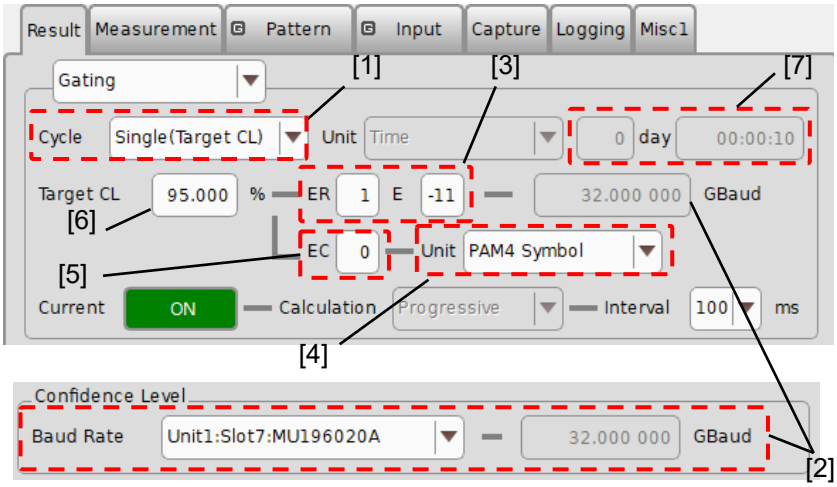


Figure 3.8.1.3-1 Calculating Gating Time from Target CL

[1] Set to **Single (Target CL)**.

[2] Set the Bitrate.
Selecting the linked PPG in the Confidence Level area of the **Misc1** tab enables configuration using the PPG's bitrate.

[3] Set the Target ER.
Set the reference BER level for Confidence Level calculation.

Example:

When a confidence level is required for a BER smaller than 10^{-11}, set the ER input value to **1E-11**.

[4] Set the Target Unit (PAM4 ED only).
Select the type of Error Count value to use for Confidence Level calculation.

Example:

When calculating the Gating Time to meet the Target CL based on the EC value of the PAM4 Symbol, select **PAM4 Symbol** from Unit.

Note:

In SI ED, only one EC value type (Bit) is available, so selection is not required.

[5] Set the Target EC.
Enter the value corresponding to the EC value used for BER measurement.

Example:

If the EC of the Gating Time to be calculated is zero, enter **0** for EC.

[6] Set the Target CL.

Example:

When calculating the Gating Time to achieve a Confidence Level of 95.0%, enter **95.0** in Target CL.

[7] The calculated Gating Time is displayed.
A single BER measurement can be performed using the calculated time.

Chapter 4 Operation of Applications

This chapter describes how to operate the applications, by module.
Refer to the module operation manuals listed below for the product performance and specifications (1.3, “Specifications”) and for options and related products (1.2, “Product Configuration”).
To display BERT screen which provides module application function, refer to 3.1.2 “Display Switching Screens” or 3.2.2 “Basic Operations on BERT Screen”. For how to operate MU183020A, MU183021A, MU183040B and MU183041B, refer to the operation manuals that came with them.

- MU181000A 12.5GHz Synthesizer
- MU181000B 12.5GHz 4port Synthesizer
- MU191000A Synthesizer
- MU181500B Jitter Modulation Source
- MU195020A 21G/32G bit/s SI PPG
- MU196020A PAM4 PPG
- MU196020C PAM4 PPG
- MU195040A 21G/32G bit/s SI ED
- MU196040A PAM4 ED
- MU196040B PAM4 ED
- MU195050A Noise Generator
- MU196050B Noise Generator
- MU196060A 32G baud NRZ/PAM4 Re-Driver

- MU183020A 28G/32G bit/s PPG
- MU183021A 28G/32G bit/s 4ch PPG
- MU183040B 28G/32G bit/s High Sensitivity ED
- MU183041B 28G/32G bit/s 4ch High Sensitivity ED

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4.1 Application Selector

The Application Selector is the screen that appears after MX190000A is started, and that consists of the PAM4 PPG/ED Based System, Single/Multi-lane Test System for PCIe with Forced Link, SI and PAM4 Combined System, SI PPG/ED Based System and Miscellaneous System areas for starting the applications, and the Utility area for starting external software.

The appearance of each application icon depends on the module configuration as follows.

Table 4.1-1 Appearance of Application Icons

Application Icon	Description
	Not-ready-to-start application The application is not ready to start because the required module is not installed in the specified slot. To check the required module configuration (which module should be installed in which slot), touch this icon.
	Ready-to-start application The application is ready to start because the required module is installed in the specified slot. To start the application, touch the icon.

Note:

This icon is not available when an application is already started.

4.1.1 PAM4 PPG/ED Based System area

The PAM4 PPG/ED Based System area provides the icons of the applications that operate in module configurations based on the MU196020A/C PAM4 PPG and the MU196040B PAM4 ED. To start the application, touch the icon.

4.1.1.1 Standard BERT for PAM4 application

Standard BERT for PAM4 provides general purpose BERT (bit error rate test) measurement functions.
Use this application to perform the PAM4 and NRZ BERT measurement, the RS-FEC measurement, etc.

Notes:

- This application uses the PAM4 module but can also evaluate the NRZ signal.
- The MU195050A Noise Generator is guaranteed to work properly only when using at a baud rate of 32.1 Gbaud or less.
- The MU195050B Noise Generator is guaranteed to work properly only when using at a baud rate of 64.2 Gbaud or less.
- The MU196020A/C PAM4 PPG can output PAM3 signals and USB4 Gen4 compliance patterns.

To use this application, install modules to MP1900A slots listed in Table 4.1.1.1-1. This application does not start for other than this module configuration.

Table 4.1.1.1-1 Required Module Configuration for Standard BERT for PAM4 Application Use

Slot Number	Module Name	Module Name
1	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4port Synthesizer	MU191000A Synthesizer
2		MU181500B Jitter Modulation Source
3	MU181500B Jitter Modulation Source	
4		Blank
5	Blank or MU196060A 32G baud NRZ/PAM4 Re-Driver	
6	MU196040A/B PAM4 ED	
7	MU196020A/C PAM4 PPG	
8	Blank or MU195050A Noise Generator or MU196050B Noise Generator	

To start this application, touch the Standard BERT for PAM4 icon displayed in Application selector.

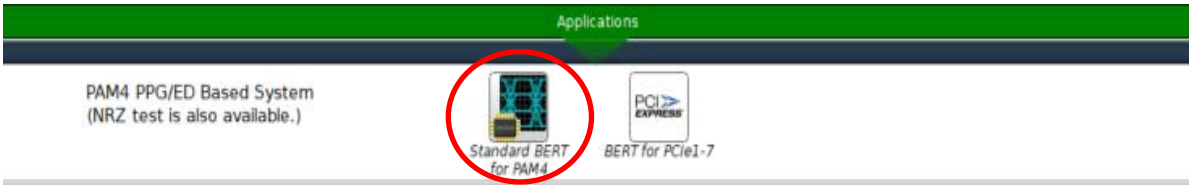


Figure 4.1.1.1-1 How to Start Standard BERT for PAM4 Application

How to Display Overall Block Diagram

In this application, extended application displays overall block diagram.

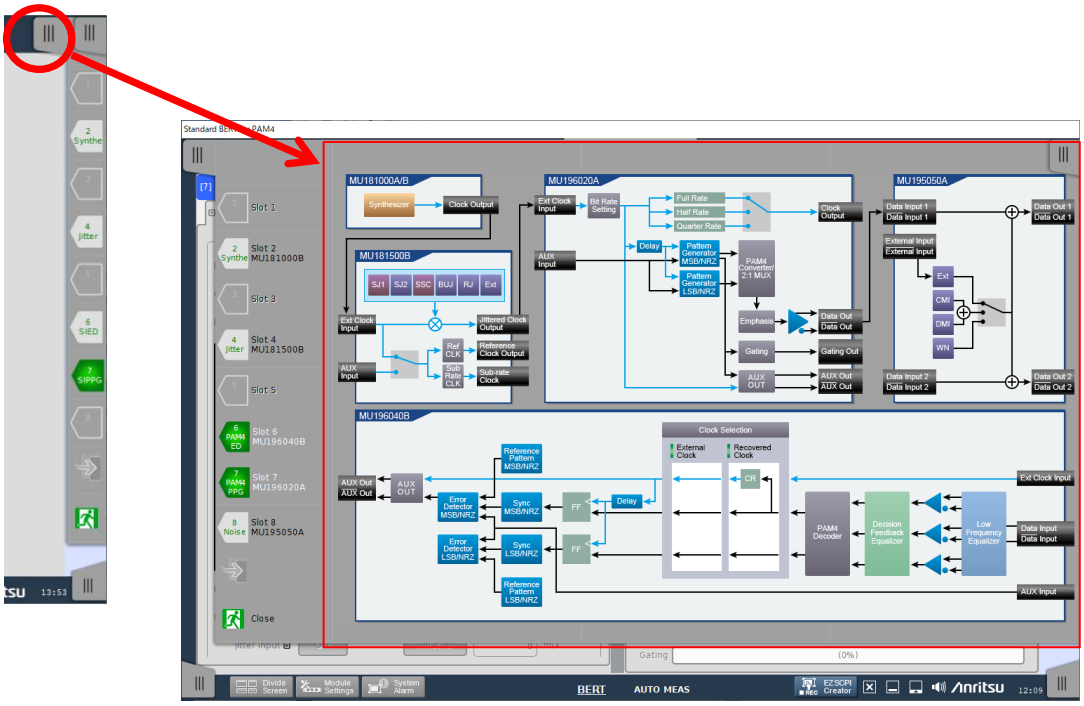


Figure 4.1.1.1-2 How to Display Overall Block Diagram

Touching a part in the overall block diagram displays the setting window of corresponding module application.

This makes it easy to understand whole BERT system because you can see where the parameters can be set for each part in the overall block diagram.

4.1.1.2 BERT for PCIe1-7 application

BERT for PCIe1-7 provides BERT measurement functions specifically for the PCIe standards.

Notes:

- This application uses the PAM4 module but can also evaluate the NRZ signal
- The MU195050A Noise Generator is guaranteed to work properly only when using at a baud rate of 32.1 Gbaud or less.
- The MU196050B Noise Generator is guaranteed to work properly only when using at a baud rate of 64.2 Gbaud or less.
- The operating baud rate of the MU196020A and MU196040B is 32.1 Gbaud at maximum, common in NRZ and PAM4 modes.
- Patterns that can be selected for the MU196020A are only as follows: PRBS, Data, and patterns used for PCIe1-6.
  Patterns for PRBS, Data, and PCIe1 through PCIe7 can be selected in MU196020C.
- Patterns that can be selected for the MU196040B are only as follows: PRBS, and patterns used for PCIe1-6.
  When the MU196040B-005 is installed, the patterns used for PRBS and PCIe1 through PCIe7 can be selected.
- The MU196060A 32G baud NRZ/PAM4 Re-Driver is guaranteed to operate properly only when using at a baud rate of 32.1 Gbaud or less.
- The MU196020A/C PAM4 PPG can output PAM3 signals and USB4 Gen4 compliance patterns.

To use this application, install modules to MP1900A slots listed in Table 4.1.1.2-1 This application does not start for other than this module configuration.

Table 4.1.1.2-1 Required Module Configuration for BERT for PCIe1-7 Application Use

Slot Number	Module Name	Module Name
1	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4port Synthesizer	MU191000A Synthesizer
2		MU181500B Jitter Modulation Source
3	MU181500B Jitter Modulation Source	
4		Blank
5	Blank or MU196060A 32G baud NRZ/PAM4 Re-Driver	
6	MU196040B PAM4 ED	
7	MU196020A/C PAM4 PPG	
8	Blank or MU195050A Noise Generator or MU196050B Noise Generator	

To start this application, touch the BERT for PCIe1-7 Base icon displayed in Application selector.

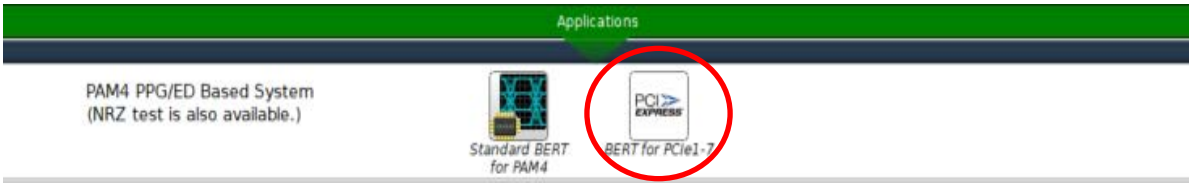


Figure 4.1.1.2-1 How to Start BERT for PCIe1-7 Application

How to Display Overall Block Diagram

In this application, extended application displays overall block diagram.

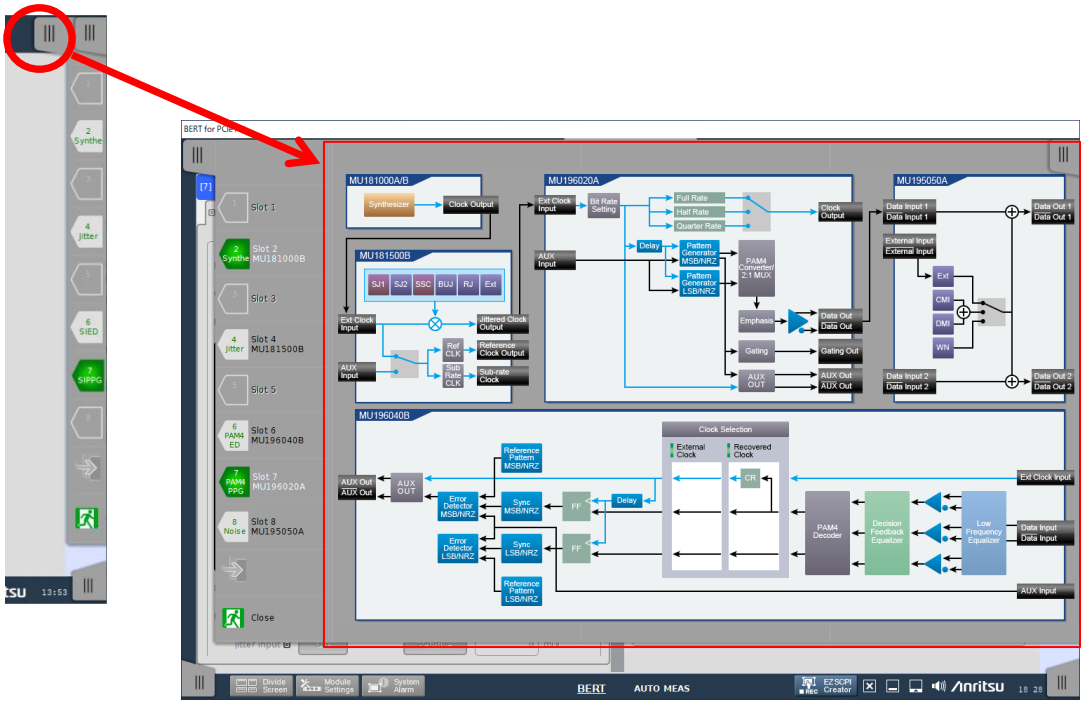


Figure 4.1.1.2-2 How to Display Overall Block Diagram

Touching a part in the overall block diagram displays the setting window of corresponding module application.

This makes it easy to understand whole BERT system because you can see where the parameters can be set for each part in the overall block diagram.

4.1.2 Single/Multi-lane Test System for PCIe with Forced Link area

The **Single/Multi-lane Test System for PCIe with Forced Link** area displays the icon of a PCIe-compliant application that runs with a specific module configuration. To launch an application, touch its icon.

4.1.2.1 BERT for PCIe1-6 Forced Link application

The BERT for PCIe1-6 Forced Link application provides BERT measurement and sequence pattern output functions specifically designed for the PCIe standards.

The following option is required to launch this application.

- MU196020A-z51 Sequence Editor Function

Notes:

- This application uses the PAM4 module but can also evaluate NRZ signals.
- The MU195050A Noise Generator is guaranteed to work properly only at baud rates of 32.1 Gbaud or lower.
- The MU196050B Noise Generator is guaranteed to work properly only at baud rates of 64.2 Gbaud or lower.
- The MU196020A and MU196040B have a maximum operating baud rate of 32.0 Gbaud, which is common to both NRZ and PAM4 modes.
- Only the following patterns can be selected for the MU196020A: PRBS, Data, patterns used by PCIe1 to PCIe6, and patterns that comply with the PCIe standard encoding schemes (8b10b, 128b130b, 1b1b).
- Only the following patterns can be selected for the MU196040B: PRBS, Data, patterns used by PCIe1 to PCIe6, and patterns that comply with the PCIe standard encoding schemes (8b10b, 128b130b, 1b1b). The MU196040B-z51 PCIe Sequence Editor Pattern Analysis is required to analyze patterns that comply with the PCIe standard encoding schemes.
- The MU196060A 32G baud NRZ/PAM4 Re-Driver is guaranteed to operate properly only at baud rates of 32.1 Gbaud or lower.
- The MU196020A PAM4 PPG includes the Sequence Editor function, which supports editing test patterns compliant with PCIe standards, generating output pattern sequences, and transmitting them.

It also enables linked operation of multiple modules and synchronization of sequence pattern output timing. The MU196020A-z52 Sequence Editor Function for Multi-Channel option is required for inter-module linking. For details on how to use the Multi Channel Function, refer to 3.3 “Multi Channel Function”.

The application is typically used in two configurations.

- When the MU196040B is installed:
  Install the modules as shown in Table 4.1.2.1-1. The application starts only when the modules are configured as shown in the table.

- When the MU196040B is not installed:
  This application starts regardless of the module configuration, including the one shown in Table 4.1.2.1-1. Therefore, it is suitable for used with any module configuration.

Table 4.1.2.1-1 Required Module Configuration for BERT for PCIe1-6 Forced Link Application (When MU196040B is Installed)

Slot Number	Module Name	Module Name
1	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4 Port Synthesizer	MU191000A Synthesizer
2		MU181500B Jitter Modulation Source
3	MU181500B Jitter Modulation Source	
4		Blank
5	Blank or MU196060A 32G baud NRZ/PAM4 Re-Driver	
6	MU196040B PAM4 ED	
7	MU196020A PAM4 PPG	
8	Blank or MU195050A Noise Generator or MU196050B Noise Generator	

To launch this application, tap the BERT for PCIe1-6 Forced Link icon in the Application Selector.



Figure 4.1.2.1-1 Launching BERT for PCIe1-6 Forced Link Application

Note:

In this application, tapping the navigation tab on the application toolbar in the upper-right corner of the screen does not display the extension applications.

4.1.3 SI and PAM4 Combined System area

The SI and PAM4 Combined System area provides the icons of the applications that operate in a module configuration combining the MU196020A/C PAM4 PPG and the MU195040A 21G/32G bit/s SI ED. To start the application, touch the icon.

4.1.3.1 Standard BERT for SI and PAM4 application

Standard BERT for SI and PAM4 provides general purpose BERT measurement functions.
Use this application to perform the PCIe Gen1-5 Base/CEM (Card Electromechanical) Specification measurement, the NRZ BERT measurement, etc.
Also, the PAM4 BERT measurement is available when the MU196040A/B is installed in Slot 5.

Notes:

- To use this application for evaluation of the PAM4 signal as well as the NRZ signal, install the MU196040A/B in Slot 5.
- The MU195050A Noise Generator is guaranteed to work properly only when using at a baud rate of 32.1 Gbaud or less.
- The MU196050B Noise Generator is guaranteed to work properly only when using at a baud rate of 64.2 Gbaud or less.
- In this application, tapping the navigation tab on the application toolbar in the upper-right corner of the screen does not display the extension applications.
- The MU196020A/C PAM4 PPG can output PAM3 signals and USB4 Gen4 compliance patterns.

To use this application, install modules to MP1900A slots listed in Table 4.1.3.1-1. This application does not start for other than this module configuration.

Table 4.1.3.1-1 Required Module Configuration for Standard BERT for SI and PAM4 Application Use

Slot Number	Module Name	Module Name
1	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4port Synthesizer	MU191000A Synthesizer
2		MU181500B Jitter Modulation Source
3	MU181500B Jitter Modulation Source	
4		Blank
5	MU196040A/B PAM4 ED or MU196060A 32G baud NRZ/PAM4 Re-Driver or blank	
6	MU195040A 21G/32G bit/s SI ED	
7	MU196020A/C PAM4 PPG	
8	Blank or MU195050A Noise Generator or MU196050B Noise Generator	

To start this application, touch the Standard BERT for SI and PAM4 icon displayed in Application selector.

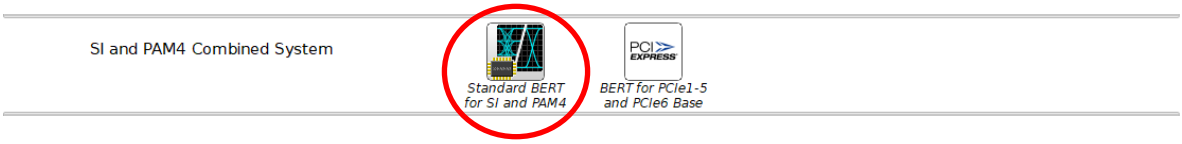


Figure 4.1.3.1-1 How to Start Standard BERT for SI and PAM4 Application

4.1.3.2 BERT for PCIe1-5 and PCIe6 Base application

BERT for PCIe1-5 and PCIe6 Base provides BERT measurement functions specifically for the PCIe standards.
It supports the PCIe Gen1-5 Base/CEM Specification measurement as well as the PCIe Gen6 Base Specification measurement.

Notes:

- This application uses the PAM4 module but can also evaluate the NRZ signal.
- The MU195050A/MU196050B Noise Generator is guaranteed to work properly only when using at a baud rate of 32.1 Gbaud or less.
- The operating baud rate of the MU196020A/C and MU196040B is 32.1 Gbaud at maximum, common in NRZ and PAM4 modes.
- Patterns that can be selected for the MU196020A/C are only as follows: PRBS, Data, and patterns used for PCIe1-6.
- Patterns that can be selected for the MU196040B are only as follows: PRBS, and patterns used for PCIe1-6.
- In this application, tapping the navigation tab on the application toolbar in the upper-right corner of the screen does not display the extension applications.
- The MU196020A/C PAM4 PPG can output PAM3 signals and USB4 Gen4 compliance patterns.

To use this application, install modules to MP1900A slots listed in Table 4.1.3.2-1. This application does not start for other than this module configuration.

Table 4.1.3.2-1 Required Module Configuration for BERT for PCIe1-5 and PCIe6 Base Application Use

Slot Number	Module Name	Module Name
1	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4port Synthesizer	MU191000A Synthesizer
2		MU181500B Jitter Modulation Source
3	MU181500B Jitter Modulation Source	
4		Blank
5	MU196040B PAM4 ED	
6	MU195040A 21G/32G bit/s SI ED	
7	MU196020A/C PAM4 PPG	
8	Blank or MU195050A Noise Generator or MU196050B Noise Generator	

To start this application, touch the BERT for PCIe1-5 and PCIe6 Base icon displayed in Application selector.



Figure 4.1.3.2-1 How to Start BERT for PCIe1-5 and PCIe6 Base Application

4.1.4 SI PPG/ED Based System area

The SI PPG/ED Based System area provides the icon of the application that operates in a module configuration based on the MU195020A 21G/32G bit/s SI PPG and the MU195040A 21G/32G bit/s SI ED. To start the application, touch the icon.

4.1.4.1 Standard BERT for SI application

Standard BERT for SI provides general purpose BERT measurement functions.
Use this application to perform the NRZ BERT measurement, the PCIe Gen1-5 Base/CEM Specification measurement, the USB3.2 and USB4 Gen2-3 measurement, etc.

If installed in Slot 5, the MU196020A PAM4 PPG can output PAM3 signals and USB4 Gen4 compliance patterns.

Note:

This application can evaluate PAM4 signals by using the following peripherals.

- G0374A 64 Gbaud PAM4 DAC
- G0375A 32 Gbaud Power PAM4 Converter
- G0376A 32 Gbaud PAM4 Decoder
- MZ1834A/MZ1834B 4PAM Converter

To use this application, install modules to MP1900A slots listed in Table 4.1.4.1-1. This application does not start for other than this module configuration.

Table 4.1.4.1-1 Required Module Configuration for Standard BERT for SI Application Use

Slot Number	Module Name	Module Name
1	MU181000A 12.5GHz Synthesizer or MU181000B 12.5GHz 4port Synthesizer	MU191000A Synthesizer
2		MU181500B Jitter Modulation Source
3	MU181500B Jitter Modulation Source	
4		Blank
5	Blank or MU196060A 32G baud NRZ/PAM4 Re-Driver or MU196020A PAM4 PPG	
6	MU195040A 21G/32G bit/s SI ED	
7	MU195020A 21G/32G bit/s SI PPG	
8	Blank or MU195050A Noise Generator	

To start this application, touch the Standard BERT for SI icon displayed in Application selector.

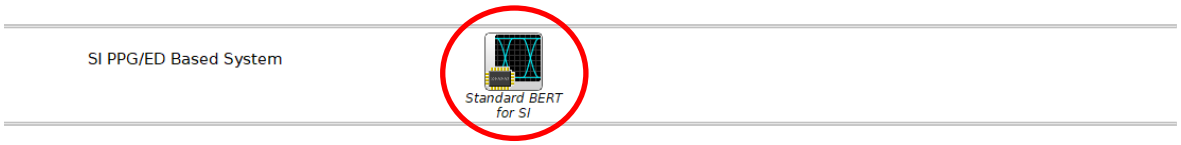


Figure 4.1.4.1-1 How to Start Standard BERT for SI Application

How to Display Overall Block Diagram

In this application, extended application displays overall block diagram.

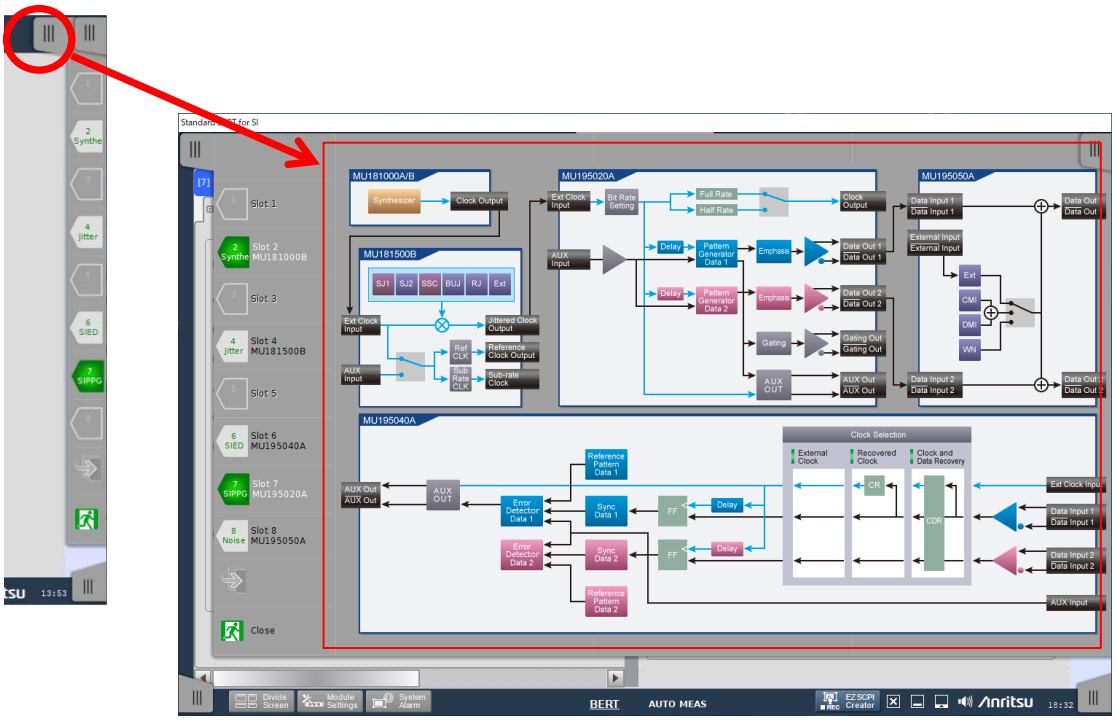


Figure 4.1.4.1-2 How to Display Overall Block Diagram

Touching a part in the overall block diagram displays the setting window of corresponding module application.
This makes it easy to understand whole BERT system because you can see where the parameters can be set for each part in the overall block diagram.

4.1.5 Miscellaneous System area

The Miscellaneous System area provides the icon of the application that operates in any module configuration.
To start the application, touch the icon.

4.1.5.1 Expert BERT application

Expert BERT provides the BERT measurement functions that require a special module configuration and measurement functions other than BERT such as pattern generator.
Unlike applications such as Standard BERT described in previous sections, this application is not limited to a specific module configuration. Therefore, it can be used for any module configuration.
To start this application, touch the Expert BERT icon displayed in Application selector.

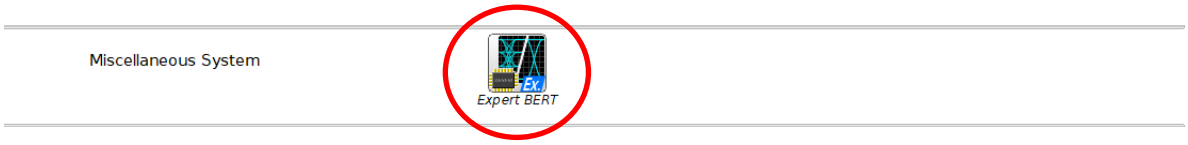


Figure 4.1.5.1-1 How to Start Expert BERT Application

Note:

In this application, no extended application appears even if touching the navigation tab displayed on right top of the screen.

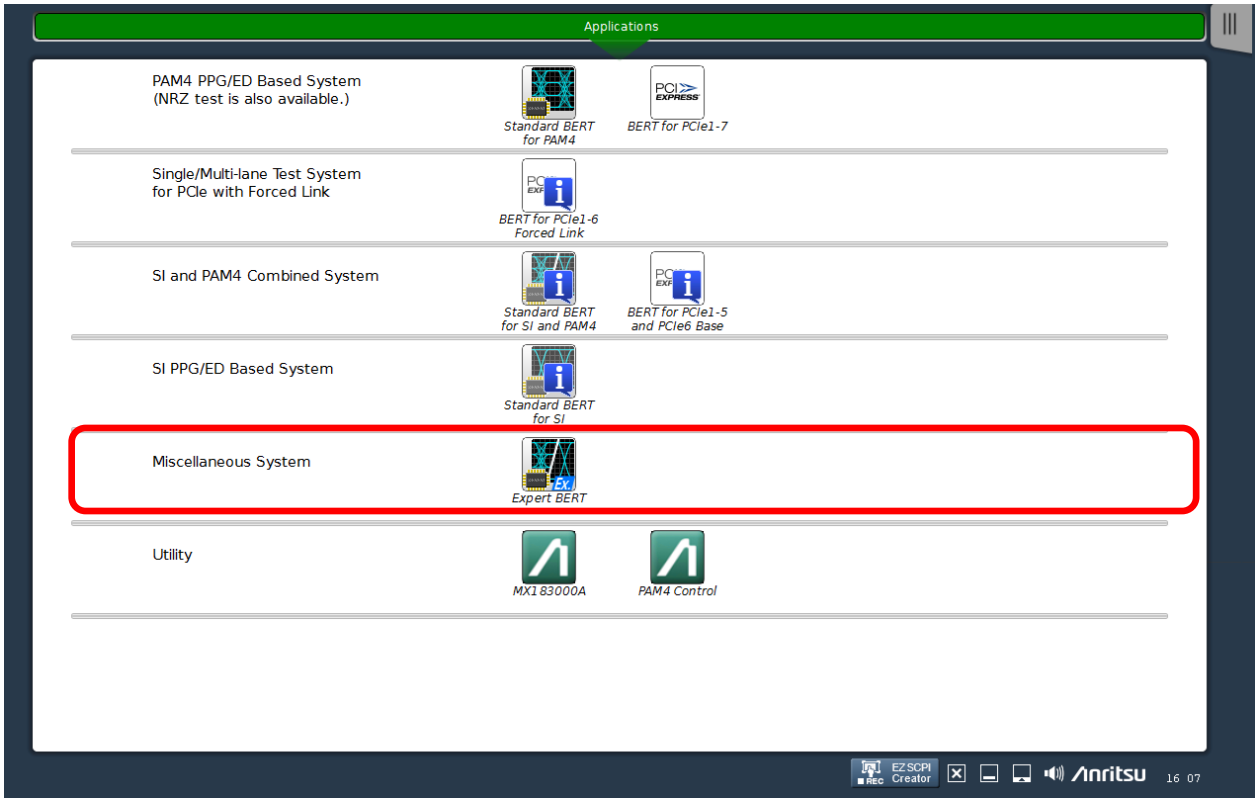


Figure 4.1.5.1-2 Miscellaneous System area

4.1.6 Utility area

In Utility area, you can start external software which works cooperating with MX190000A. In the current version, MX183000A and PAM4 Control are available as Utilities.

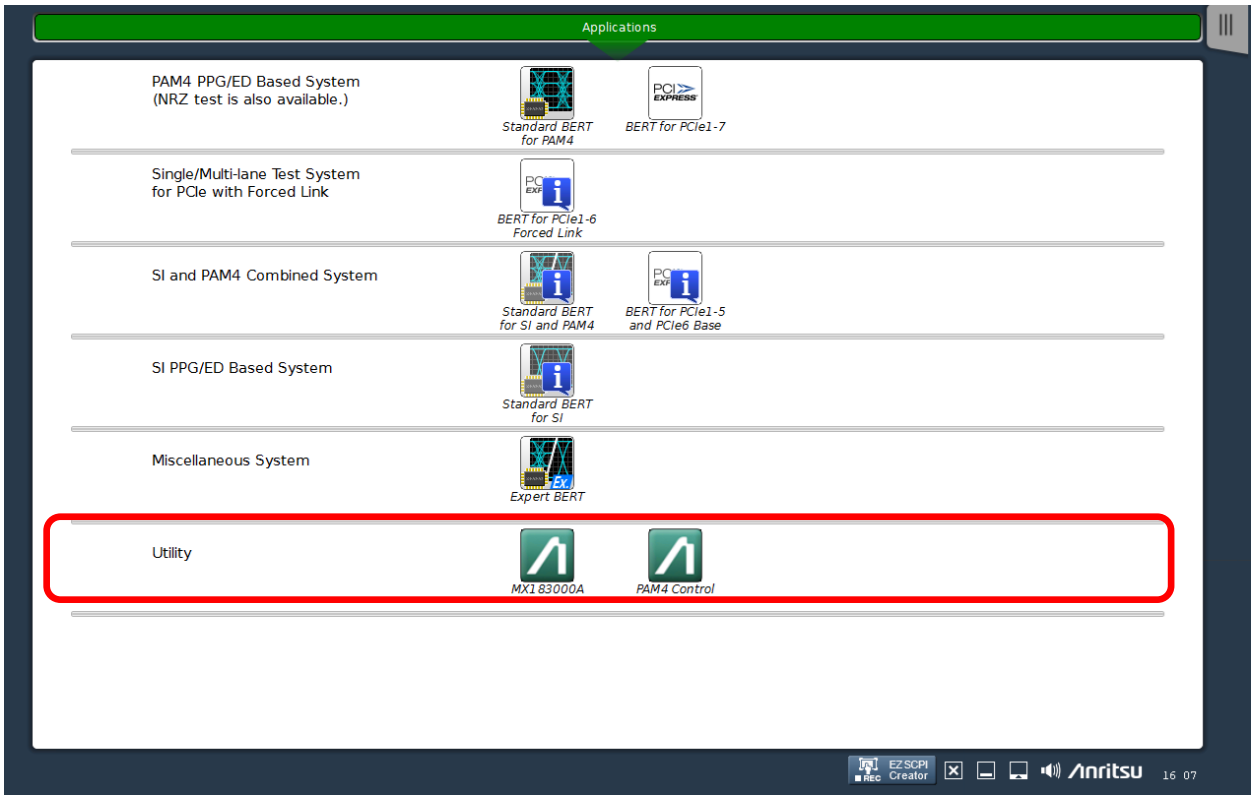


Figure 4.1.6-1 Utility area

4.2 Synthesizer

4.2.1 MU181000A/B

The MU181000A 12.5GHz Synthesizer and MU181000B 12.5GHz 4port Synthesizer (hereafter, MU181000A/B) are plug-in modules that can be built into MP1900A.

It outputs clock signals of 100 MHz to 12.5 GHz to be input to the MU195020A 21G/32G bit/s SI PPG, MU195040A 21G/32G bit/s SI ED, MU196020A/C PAM4 PPG, MU196040A/B PAM4 ED.

The MU181000A/B outputs a 10 MHz reference signal to synchronize an external device with it. The MU181000A/B can also be synchronized with an external device by inputting a 10 MHz reference signal output from that device.

Control window for MU181000B is shown in Figure 4.2.1-1. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

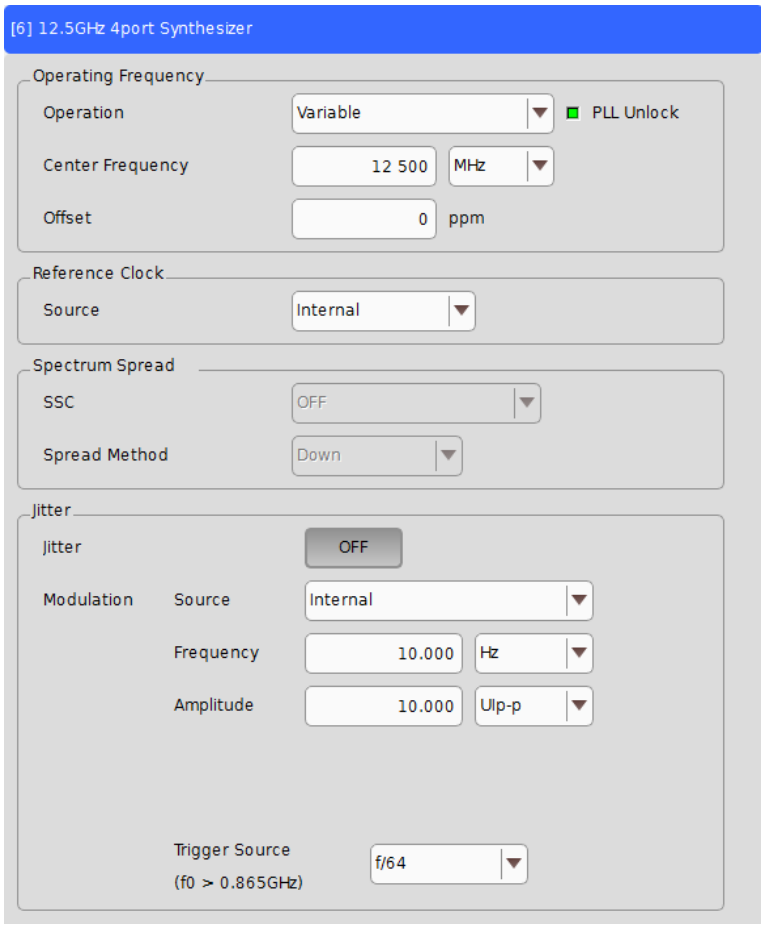


Figure 4.2.1-1 MU181000B Control Window

4.2.2 MU191000A

The MU191000A Synthesizer (hereafter, MU191000A) is plug-in module that can be built into MP1900A.

It outputs clock signals of 100 MHz to 16.05 GHz to be input to the MU195020A 21G/32G bit/s SI PPG, MU195040A 21G/32G bit/s SI ED, MU196020A/C PAM4 PPG, MU196040A/B PAM4 ED.

The MU191000A outputs a 10 MHz reference signal to synchronize an external device with it. The MU191000A can also be synchronized with an external device by inputting a 10 MHz reference signal output from that device.

Control window for MU191000A is shown in Figure 4.2.2-1. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

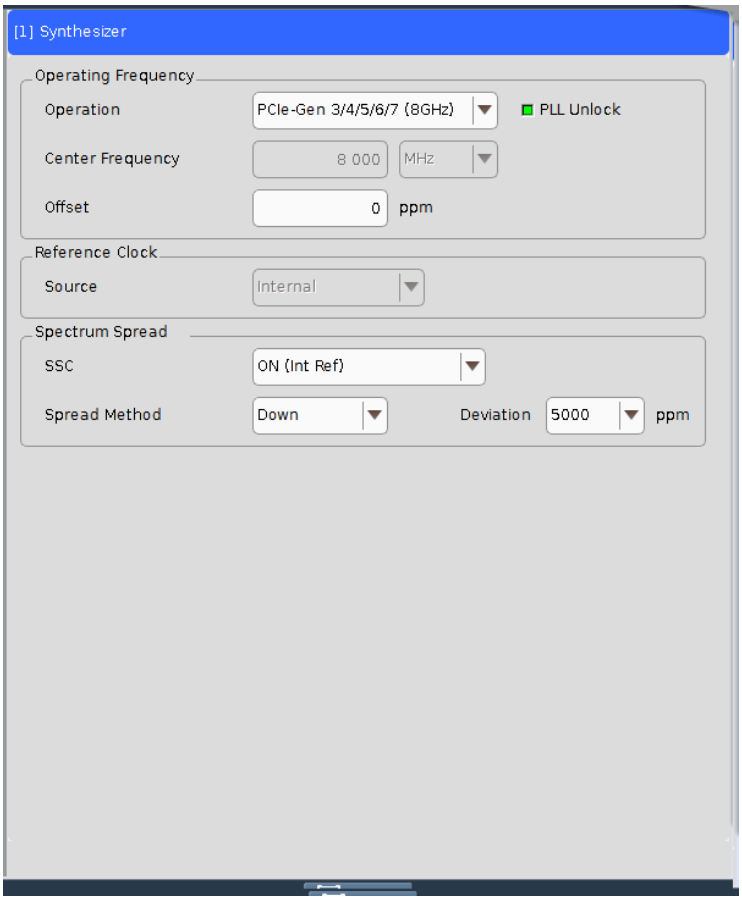


Figure 4.2.2-1 MU191000A Control Window

4.3 Jitter Modulation Source

4.3.1 MU181500B

The MU181500B Jitter Modulation Source (hereafter, MU181500B) is a plug-in module that can be built into MP1900A.

MU181500B generates the following jittered clocks for input and built-in clocks.

- SJ: Sinusoidal Jitter
- SSC: Spread Spectrum Clocking
- BUJ: Bounded Uncorrelated Jitter
- RJ: Random Jitter
- Ext: External Jitter

Connecting the output clock of this module to the input of the PPG supports bit error measurement of the jittered signals. The features of this module are listed below:

- Adds separate SJ, SSC, BUJ, and RJ to clocks from 800 MHz to 15 GHz.
- Supports linked operation with the MU181000A/B or MU191000A installed in the same MP1900A.
- Outputs unmodulated divided clocks required by DUT and measurement system.

At top of MU181500B operation window, buttons corresponding to each jitter and clock are placed. When touching one of the buttons, corresponding setting items are displayed lower part of the window.

The following sections explain each button placed in the MU181500B operation window. For details, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

SJ1, SJ2 buttons

Provides setting Sinusoidal Jitter. Setting items are shown in Table 4.3.1-1. Figure 4.3.1-1shows setting windows for SJ1 and SJ2.

Table 4.3.1-1 Setting Items of MU181500B SJ1 and SJ2

Item	Function
SJ2 Mode	Switches the jitter generation mode of SJ2.
Frequency	Sets jitter modulation frequency in Hz units.
Amplitude	Sets amplitude in UIp-p units.

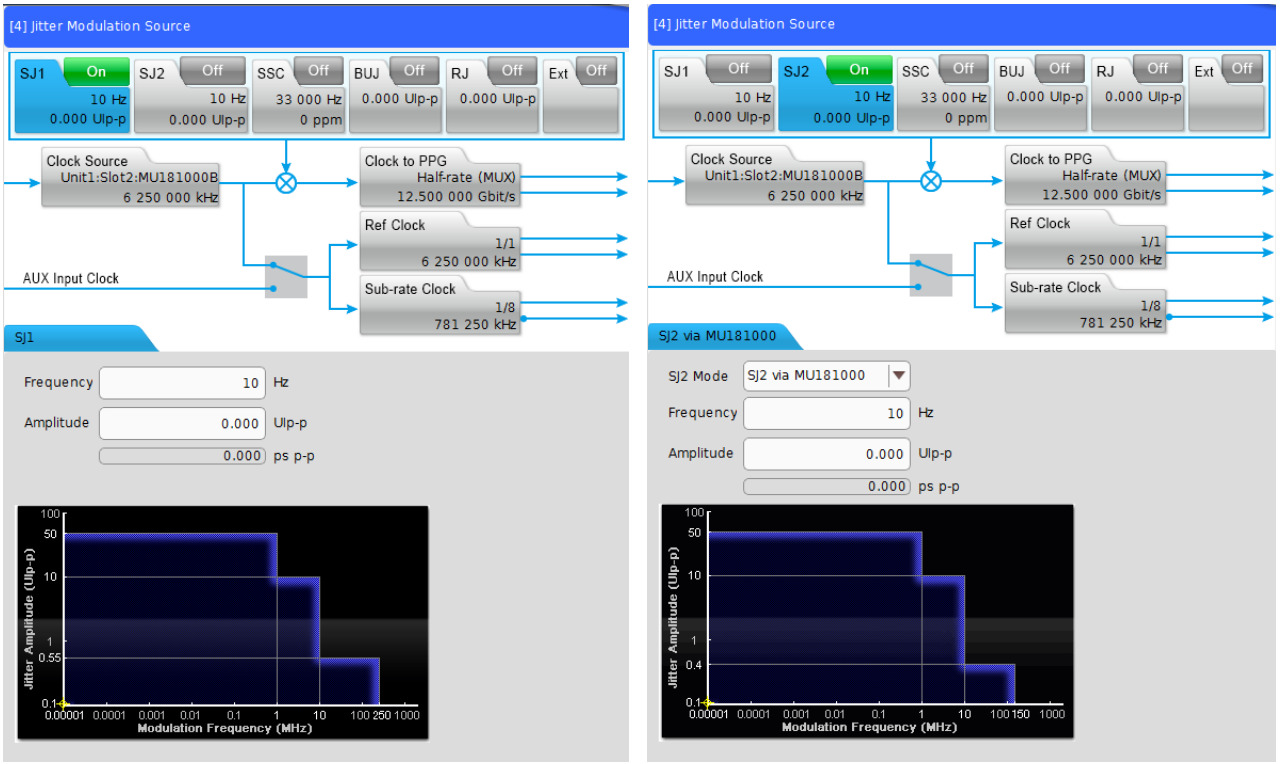


Figure 4.3.1-1 MU181500B Setting Window SJ1 (Left), SJ2 (Right)

SSC button

Provides setting the spread spectrum clock. Setting items are shown in Table 4.3.1-2. SSC setting window is shown in Figure 4.3.1-2.

Table 4.3.1-2 MU181500B SSC Setting Items

Item	Function
Profile	Sets the modulation profile.
Type	Sets spread method.
Frequency	Sets modulation frequency.
Deviation	Sets frequency deviation.
Offset	Sets the frequency offset of the MU181000A/B or MU191000A in ppm.

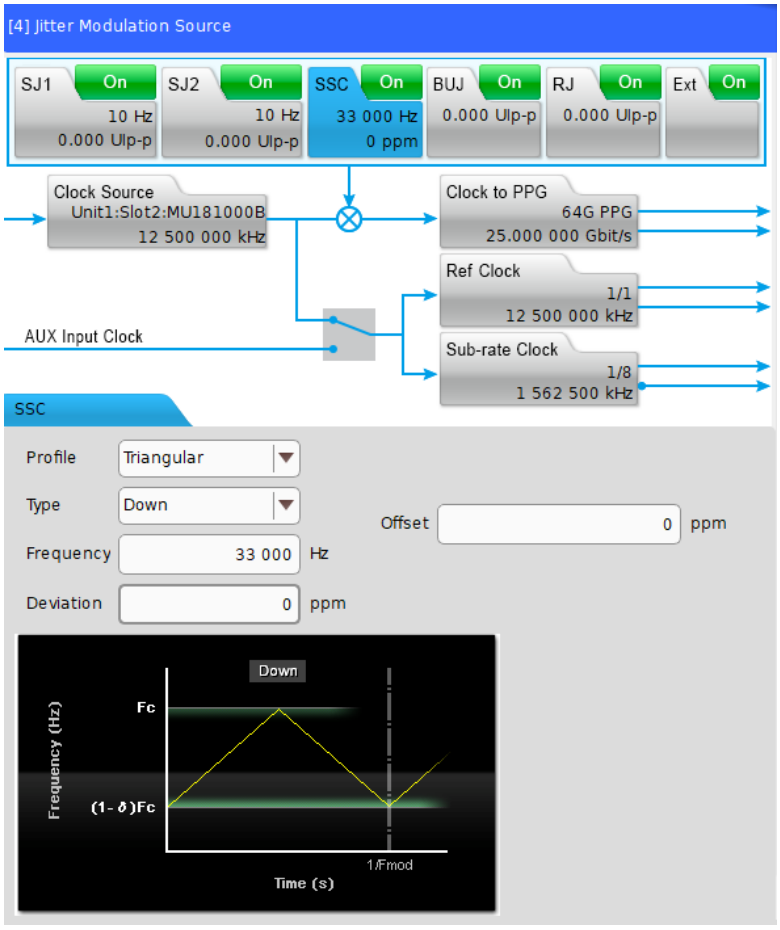


Figure 4.3.1-2 MU181500B SSC Setting Window

BUJ button

Provides setting Bounded Uncorrelated Jitter. Setting items are shown in Table 4.3.1-3. BUJ setting window is shown in Figure 4.3.1-3.

Table 4.3.1-3 MU181500B BUJ Setting Items

Item	Function
BUJ/SJ3 Mode	Switches the jitter generation mode (BUJ or SJ3).
PRBS	Sets the PBRS type.
Amplitude	Sets the maximum deviation in UIp-p units.
Bitrate	Sets BUJ modulation bit rate.
LPF	Sets low-pass filter.

Table 4.3.1-4 MU181500B SJ3 Setting Items

Item	Function
BUJ/SJ3 Mode	Switches the jitter generation mode (BUJ or SJ3).
Amplitude	Sets the maximum deviation in UIp-p units.

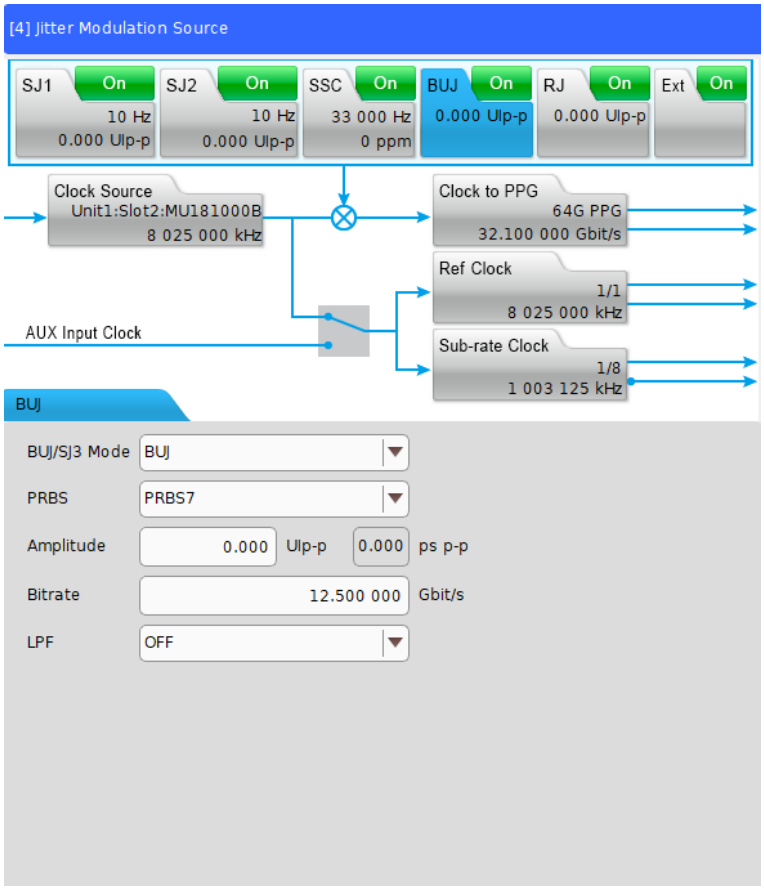


Figure 4.3.1-3 MU181500B BUJ Setting Window

RJ button

Provides setting Random Jitter. Setting items are shown in Table 4.3.1-5. RJ setting window is shown in Figure 4.3.1-4.

Table 4.3.1-5 MU181500B RJ Setting Items

Item	Function
Filter	Sets filter for controlling jitter frequency.
HPF	Sets high-pass filter.
LPF	Sets low-pass filter.
Amplitude	Sets the maximum deviation in UIp-p units.
RMS Convert	Sets a coefficient for peak-to peak value and rms value conversion according to the specified BER.
Amplitude LF	When the Filter setting is PCIe, the maximum deviation at the low-frequency side is set.
Amplitude HF	When the Filter setting is PCIe, the maximum deviation at the high-frequency side is set.
Default	When the Filter setting is PCIe, the Amplitude LF and Amplitude HF are set to the default values.

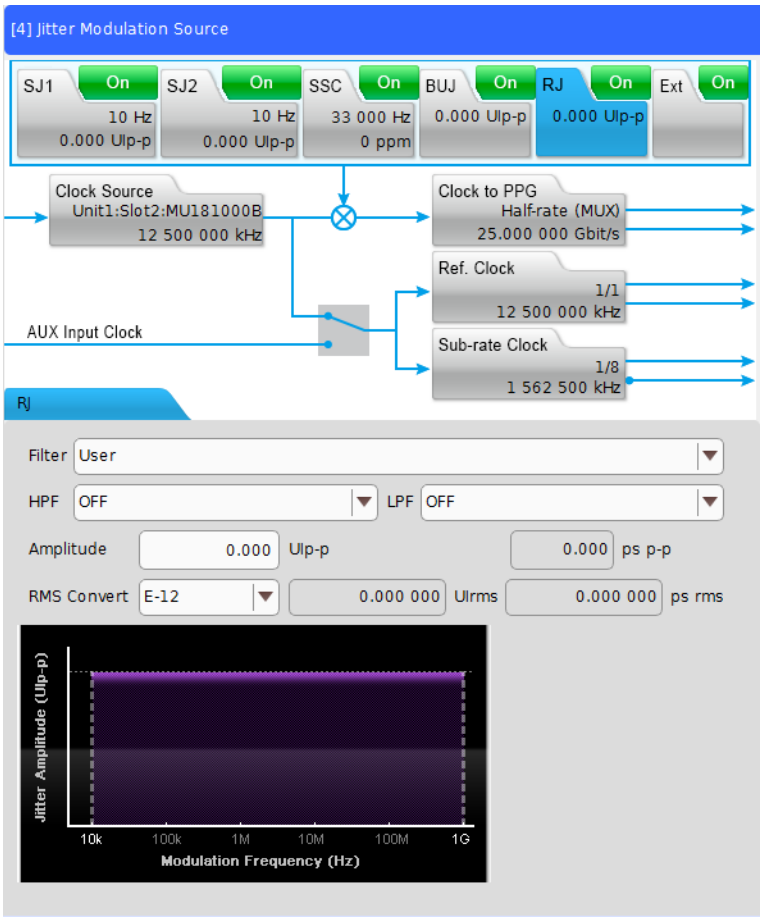


Figure 4.3.1-4 MU181500B RJ Setting Window

Clock Source button

Provides setting a clock source to apply the jitter modulation. Setting items are shown in Table 4.3.1-6. Clock Source setting window is shown in Figure 4.3.1-5.

Table 4.3.1-6 MU181500B Clock Source Setting Items

Item	Function
Clock Source	Selects clock signal source.
Center Frequency	Sets the frequency of the MU181000A/B or MU191000A in kHz.
Offset	Sets the frequency offset of the MU181000A/B or MU191000A in ppm.
Reference Clock	Selects the reference clock for the MU181000A/B or MU191000A.

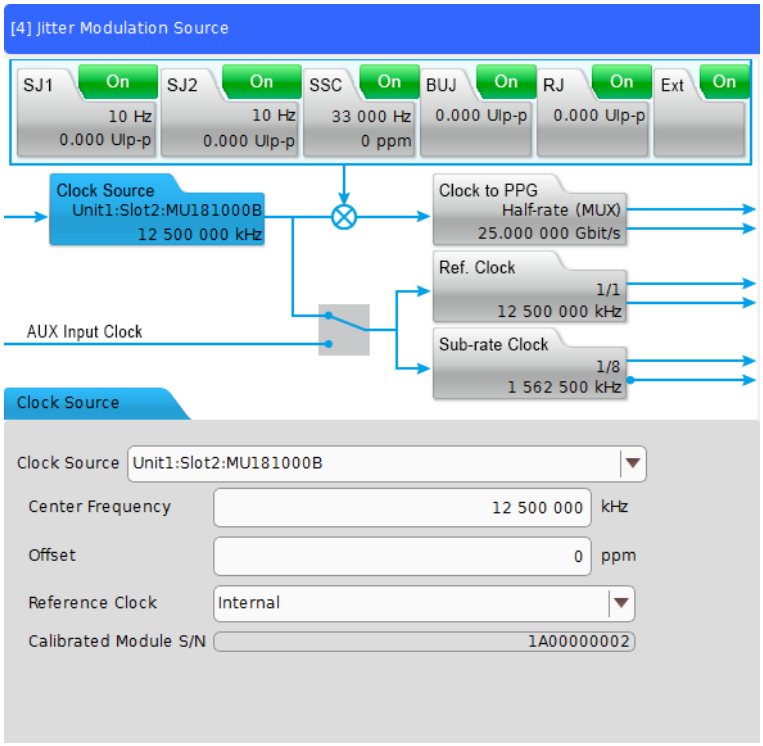


Figure 4.3.1-5 MU181500B Clock Source Setting Window

Clock to PPG button

When the PPG (MU195020A or MU196020A/C) and the MU181500B are linked, select the clock to be supplied to the PPG. Clock to PPG setting window is shown in Figure 4.3.1-6.

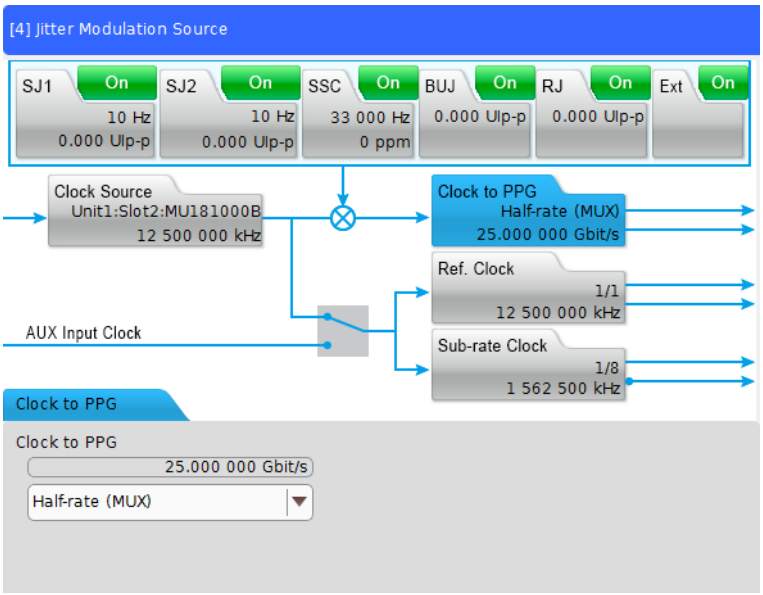


Figure 4.3.1-6 MU181500B Clock to PPG Setting Window

Ref. Clock button

Select a clock to be output to Reference Clock Output connector. Setting items are shown in Table 4.3.1-7. Ref .Clock setting window is shown in Figure 4.3.1-7.

Table 4.3.1-7 MU181500B Ref. Clock Setting Item

Item	Function
Divider	Sets clock division rate.

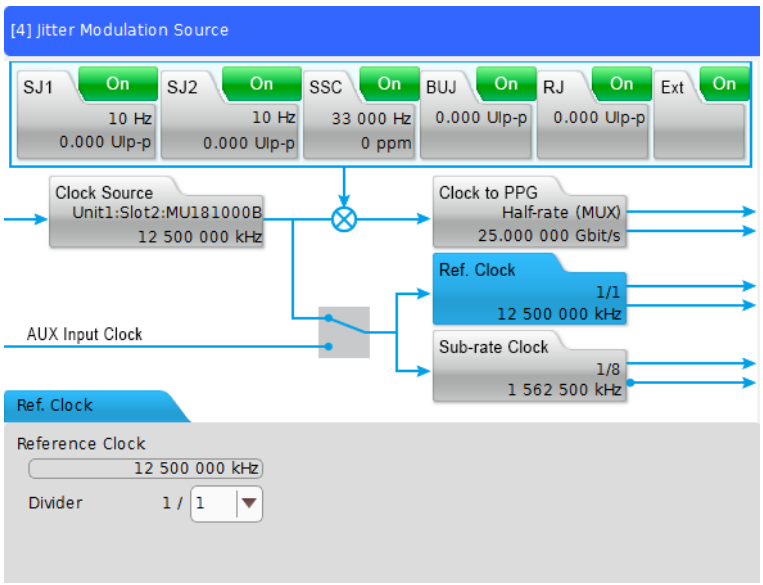


Figure 4.3.1-7 MU181500B Ref. Clock Setting Window

Sub-rate Clock button

Select a clock to be output to AUX Output connector. Setting items are shown in Table 4.3.1-8. Sub-rate Clock setting window is shown in Figure 4.3.1-8.

Table 4.3.1-8 MU181500B Sub-rate Clock Setting Items

Item	Function
Divider	Sets clock division rate.
Amplitude	Sets amplitude.

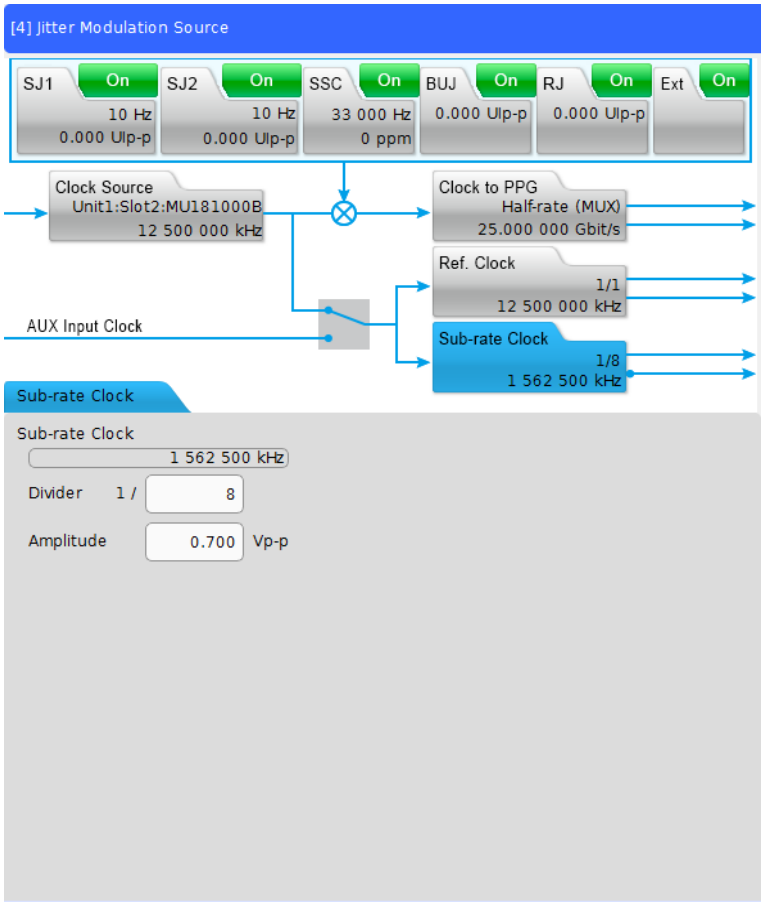


Figure 4.3.1-8 MU181500B Sub-rate Clock Setting Window

4.4 PPG

4.4.1 MU195020A

The MU195020A 21G/32G bit/s SI PPG (hereafter, MU195020A) is a plug-in module that can be built into MP1900A. It can generate a variety of patterns within the operating frequency range, including PRBS, DATA, ZeroSubstitution, Alternate, Mixed, PAM4, and Sequence patterns.

Various option configurations are available for the MU195020A. This module is therefore useful for research, development, and production of various types of digital communication equipment, modules, and devices.

This section describes the function of each tab of the MU195020A operation screen. For details of the tabs, refer to on-screen help.
On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

4.4.1.1 Equipment Composition

4.4.1.1.1 Output tab

On the **Output** tab, configure the settings for Data output and Clock output. Data signal is output from the DATA Output1 or DATA Output2 connector of MU195020A and Clock signal is output from the Clock connector. On this tab, Data and Clock signals, Output on or off, Amplitude, and Bit rate can be set. The **Output** tab is shown in Figure 4.4.1.1.1-1.

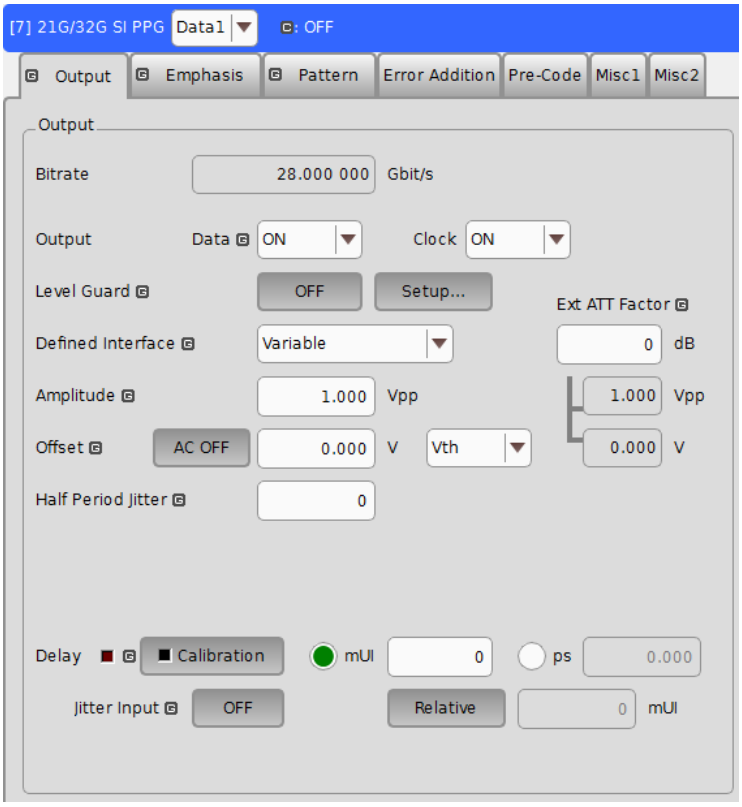


Figure 4.4.1.1.1-1 MU195020A Output Tab

4.4.1.1.2 Emphasis tab

On the **Emphasis** tab, you can configure the settings for the emphasis to be added to Data signal and can turn on and off the emphasis waveforms that comply with various specifications.

The **Emphasis** tab is shown in Figure 4.4.1.1.2-1.

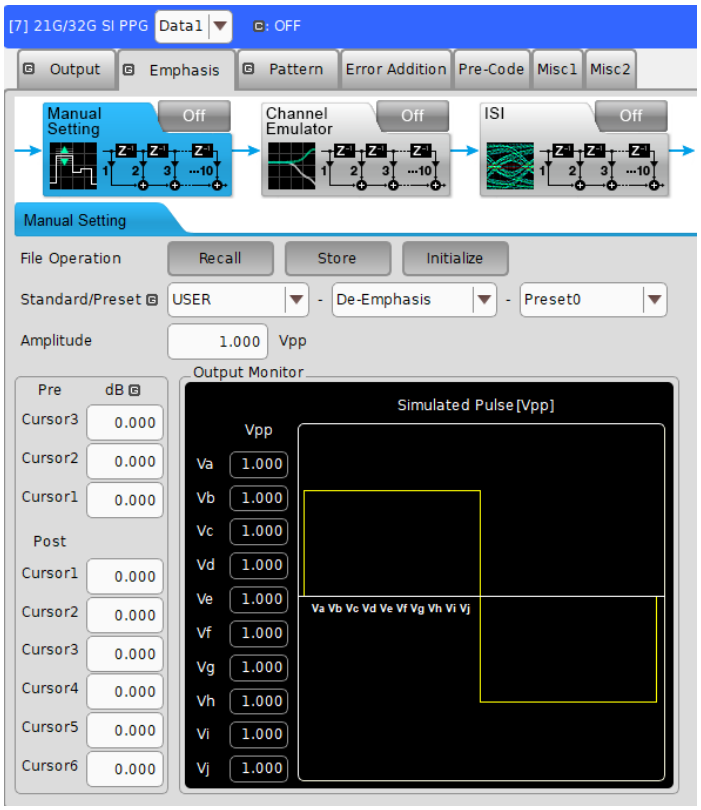


Figure 4.4.1.1.2-1 MU195020A Emphasis Tab

4.4.1.1.3 Pattern tab

On the **Pattern** tab, you can select a test pattern and can configure the settings for it. The following six test patterns are available.

- PRBS*
- ZeroSubstitution
- Data*
- Mixed
- PAM4 (When in the Combination Setting screen, **Inner module combination** is set to **Combination**.)
- Sequence (When MU195020A-x50 Sequence Editor Function is installed.)

*: When, after the application is started, **Data** is selected in Test Pattern and loaded successfully, the test pattern output from PPG is switched without pattern loading immediately even if switched between **PRBS** and **Data**.

The **Pattern** tab is shown in Figure 4.4.1.1.3-1.

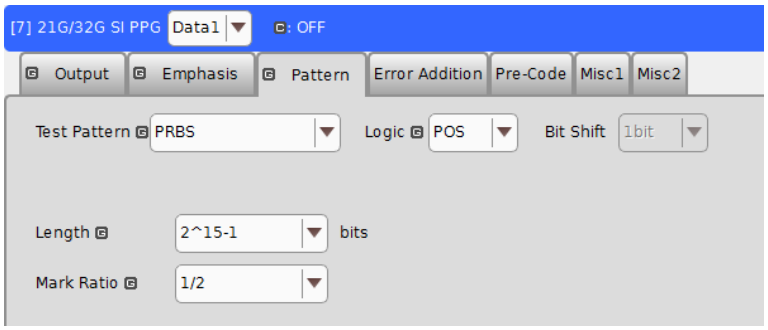


Figure 4.4.1.1.3-1 MU195020A Pattern Tab

4.4.1.1.4 Error Addition tab

On the **Error Addition** tab, you can turn on and off error addition to Data signal and can set error rate.

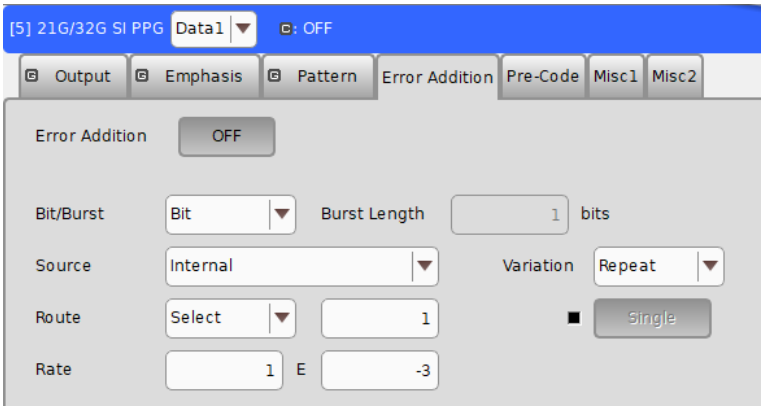


Figure 4.4.1.1.4-1 MU195020A Error Addition Tab

4.4.1.1.5 Pre-Code tab

On the **Pre-Code** tab, you can configure the settings for calculating and outputting DATA according to the Pre-Code logical diagram shown in Figure 4.4.1.1.5-1. The **Pre-Code** tab is available when in the Combination Setting screen, **Inner module combination** is set to **Combination**.

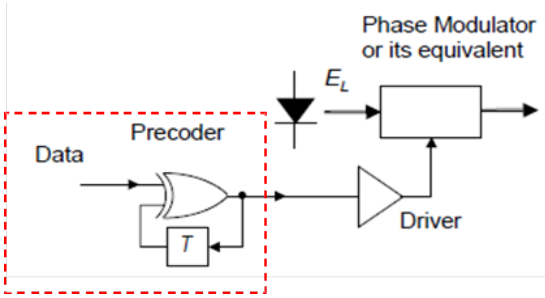


Figure 4.4.1.1.5-1 Pre-Code Logical Diagram (DQPSK)

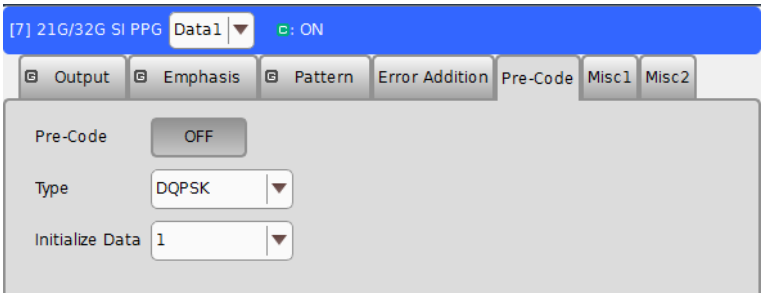


Figure 4.4.1.1.5-2 MU195020A Pre-Code Tab

4.4.1.1.6 Misc1 tab

On the **Misc1** tab, you can configure the signal generation method, synchronization signal output, auxiliary input and output, and other settings. Setting items on the **Misc1** tab are shown in Table 4.4.1.1.6-1. **Misc1** tab settings are common settings for MU195020A Data1 to Data2. The setting related to pattern length depends on that in Data1.

Table 4.4.1.1.6-1 Setting items

Item	Description
Pattern Sequence	Set the test pattern generating method.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.
Gating Output	Set the timing signal output.

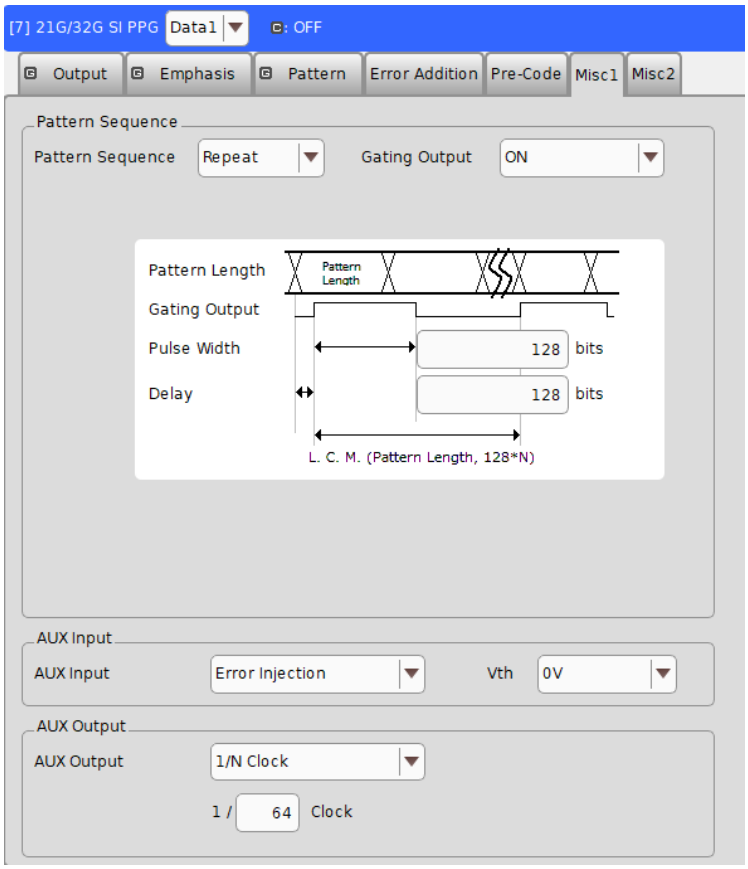


Figure 4.4.1.1.6-1 MU195020A Misc1 Tab

4.4.1.1.7 Misc2 tab

On the **Misc2** tab, you can configure the clock source, bitrate, and other settings.

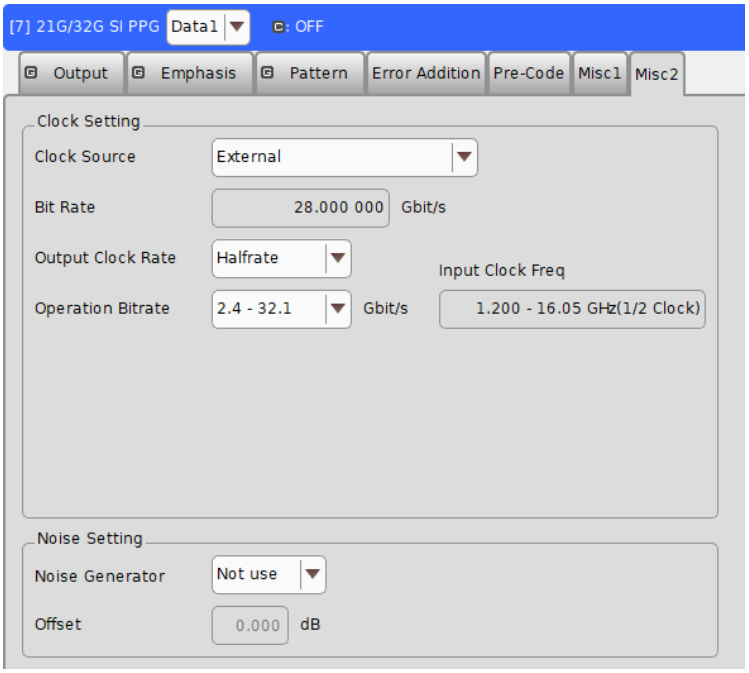


Figure 4.4.1.1.7-1 MU195020A Misc2 Tab

4.4.1.2 Setting Output Interface

To set the output interface, touch the **Output** tab of the MU195020A operation window.

On the **Output** tab, the settings for the Data and Clock can be configured. The Data signal is output from the Data connector of the MU195020A, and the XData signal is output from the $\overline{\text{Data}}$ connector. Also, the Clock signal is output from the Clock connector.

4.4.1.2.1 Setting the data

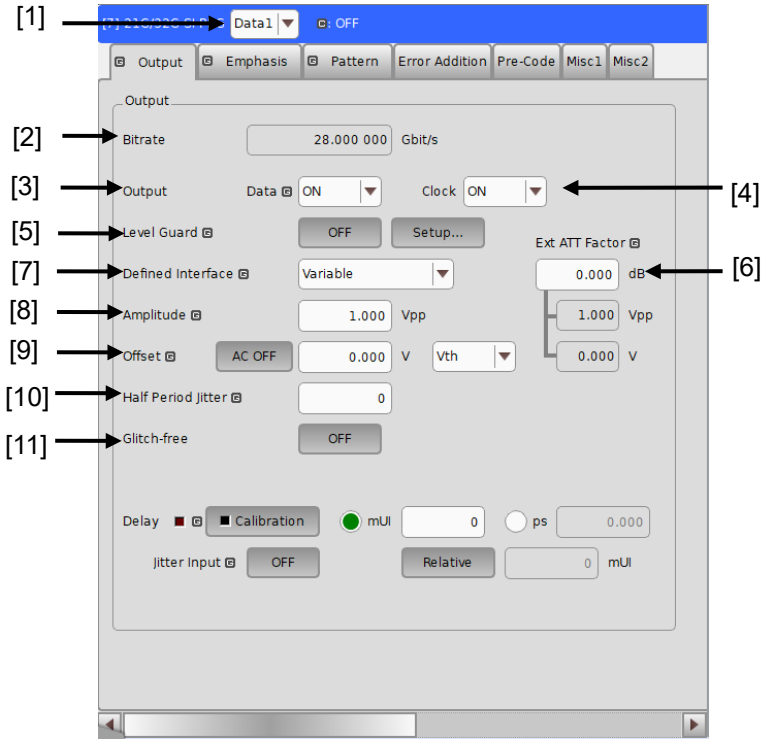


Figure 4.4.1.2.1-1 Output Tab

Delay appears when the MU195020A-x30 or x31 is added.

[1] Selects a channel for which you set up data.

[2] When clock supply source is **Externa**l, the data bit rate is displayed. When the clock source is **MU181000A/B** or **MU191000A**, the data bit rate can be configured. For details, refer to 4.4.1.2.4 “Setting bit rate” and 4.4.1.8.1 “Setting clock”.

[3] Sets data output.
This is data output setting concerning the selected MU195020A. To turn the output signal to On, turn On the output of the entire equipment (

) on the menu bar in addition to this setting.

Notes:

- The DUT may be damaged if the output setting is configured incorrectly. To prevent damage to the DUT, confirming the interface condition with the DUT, or configuring the level guard setting before making the output setting is recommended.
- When PCML, LVPECL, or NECL is selected for Defined Interface, the voltage corresponding to the DUT's termination voltage is applied to the output side of the MU195020A. In this event, the DUT may be damaged if the interface conditions do not match. Be sure to confirm the interface conditions.
- Waveforms may be distorted (what is known as a ringing phenomenon) when a commercially-available ECL terminator is used to observe output waveforms. This is, however, caused by the characteristics of the ECL terminator; the waveform output from the mainframe is not distorted.
- Be sure to confirm that a fixed attenuator is connected between the MU195020A and the DUT before setting the external ATT factor. If the external ATT factor is set when no fixed attenuator is connected or when the fixed attenuator has an attenuation value less than that set in the External ATT Factor area, the DUT may be damaged.

[4] Set the clock output.

Note:

Depending on the operating bit rate, some clock signals of several tens of mV may be output even if the clock output is set to Off.

[5] Configure the level guard settings.
Touch **Setup** to open the setup dialog box, and set the maximum amplitude (Amplitude), maximum offset (Offset Max (Voh); maximum value of the offset high level), and minimum offset (Offset Min (Vol); minimum value of the offset low level) for level guard, so that an excessively high voltage is not applied to the DUT.

When the external ATT factor is set (see [6] below), the level guard settings limit the output level of Amplitude, Offset Max (Voh), and Offset Min (Vol) after passing through the fixed attenuator connected between the MU195020A and the DUT. Thus, if use the equipment without a fixed attenuator, the signals above the set values are output.

[6] Set the external ATT Factor.
When a fixed attenuator is connected to the Data/XData output connector of the MU195020A, the attenuation of the attenuator is added to the value for the DUT and displayed. A value from 0 to 40 dB can be set in 1-dB steps. When Defined Interface is not set to other than **Variable**, the setting is reset to 0 and becomes invalid. Values displayed in the External ATT Factor-Amplitude and Offset display areas indicates the amplitude and offset value after passing through the attenuator, respectively.

[7] Set the Defined interface.
Note that it may not be possible to select some items, depending on the level guard setting.

Table 4.4.1.2.1-1 Amplitude Setting Values

Item	Amplitude	Offset Vth
Variable	–	–
PCML	0.5 V	+3.05 V
NCML	0.5 V	–0.25 V
SCFL	0.9 V	–0.45 V
NECL	0.8 V	–1.3 V
LVPECL	0.8 V	+2.0 V

[8] Set the common amplitude for Data and XData.
The setting range varies depending on the level guard setting, and offset setting.

[9] Set the common offset for Data and XData.
Range is $-2.000-\frac{\text{Amp.}}{2}$ to $+3.300-\frac{\text{Amp.}}{2}$ V, 0.001 V step.
Touching to change **AC OFF** to **AC ON** enables AC-coupled output.

[10] Set the Half Period Jitter for the data output signal. The Cross Point time axis can be adjusted as shown in Figure 4.4.1.2.1-2 using this setting while observing the Eye pattern. Adjacent Eye patterns become equal at default 0.

Table 4.4.1-2 Half Period Jitter Setting Range

Setting values	Resolution
–100 to 100	1

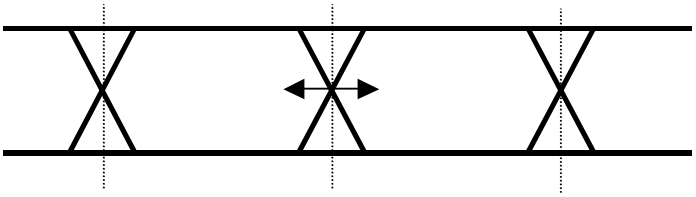


Figure 4.4.1.2.1-2 Setting Half Period Jitter

Notes:

- The data amplitude of MU195020A output with the following patterns may be attenuated by around 50 % or the offset voltage (Vth) may be fluctuated.
  - The pattern in the period of approximately 5 µs which follows continuous “0” or “1” with 5 µs or more. This kind of pattern may be generated by inserting continuous “0” or “1” or by a burst pattern.
  - The pattern other than its mark ratio of 1/2.
- If Half Period Jitter is set to 21 or higher or –21 or lower, waveforms may not be output correctly. In this case, it is recommend to use while observing waveforms with an oscilloscope, or to use calibrated waveforms.

[11] Turn ON and OFF the glitch-free switching between patterns. Normally, SSC modulation causes the frequency to fluctuate, resulting in an instantaneous interruption of the output pattern. Turning ON this function enables pattern switching without instantaneous interruption before and after SSC modulation.

4.4.1.2.2 Setting the delay

The Data output phase can vary relative to the Clock output when any of the following is installed:

- MU195020A-x30
- MU195020A-x31

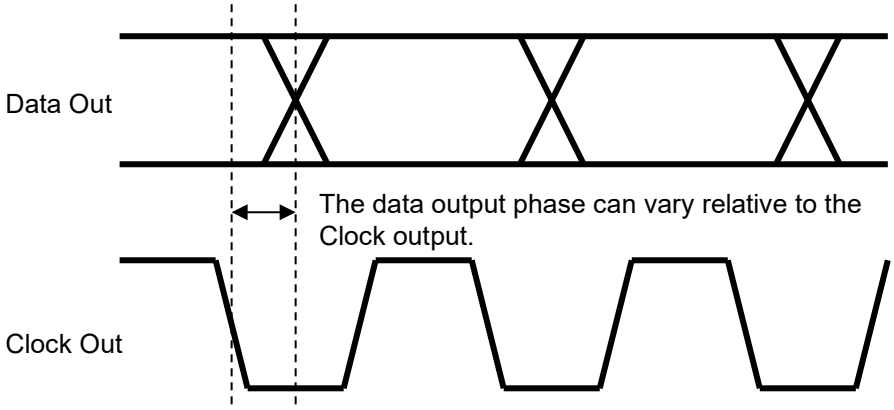


Figure 4.4.1.2.2-1 Delay Setting

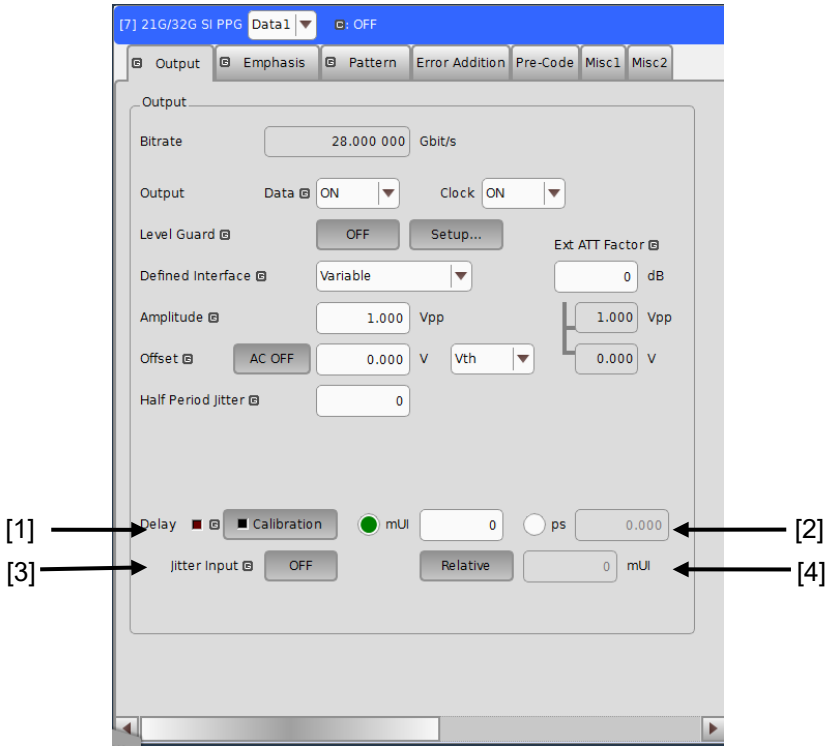


Figure 4.4.1.2.2-2 Output Tab When Setting the Delay

[1] Touch **Calibration** to perform calibration of a phase variable function. When the power is supplied, the frequency is changed, or the ambient temperature fluctuates, the calibration prompting alarm LED lights up. In such a case, touch this button to perform calibration. Calibration will finish within 1 second.

[2] Set the delay in mUI or ps units.

<In the case of mUI units>

The delay can be set from –1000 to 1000 mUI, in 2-mUI steps. When the 2ch Combination or Channel Synchronization Option is installed, setting is supported from –64 000 to 64 000 mUI in 2-mUI steps.

<In the case of ps units>

The delay can be set in steps of ps units, equivalent to 2 mUI. The setting range is the range converting –1000 to 1000 mUI in ps units. During 2ch Combination or Channel Synchronization, the setting range is equivalent to the range when the unit is mUI (–64 000 to 64 000 mUI), converted into ps units.

Table 4.4.1.2.2-1 Delay Setting Range

Bit Rate	Setting Range	
	Normal	2ch Combination Channel Synchronization
32.1 Gbit/s	–31.14 to 31.14 ps	–1 993.74 to 1 993.74 ps
25 Gbit/s	–40 to 40 ps	–2 560 to 2 560 ps
2.4 Gbit/s	–416 to 416 ps	–26 665.6 to 26 665.6 ps

[3] Set the Jitter Input.

When inputting jitter-modulated clocks, set Jitter Input of Delay to **ON**.

[4] Touch **Relative** to use the current set phase value as the reference of relative 0 for delay setting.

Notes:

- When the frequency or the temperature condition is changed, the LED on the **Calibration** lights, prompting performance of calibration. If calibration is not performed at this time, the error in the phase setting may be greater than at a normal phase setting.

- Values displayed in ps units vary as the frequency changes, because the MU195020A sets phases in mUI units as an internal standard.

Delay setting in the case of Combination or CH Synchronization

In the case of Combination or Channel Synchronization when multiple MU195020A modules are mounted, the delay between two or more channels can be changed relatively, as shown in Figure 4.4.1.2.2-3.

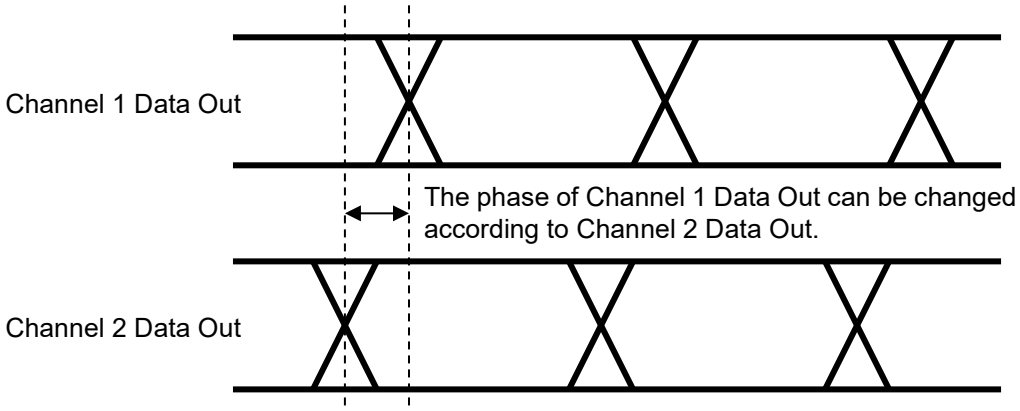


Figure 4.4.1.2.2-3 Delay Setting in the Case of Combination

4.4.1.2.3 When setting jitter-modulated signals

- When inputting a jitter-modulated clock, use the MU181000A/B or MU191000A together with the MU181500B. For inter-module connection, refer to 3.2.3 "Adding Jitter to Output Signal" in *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*.
- Set Jitter Input of Delay to **ON**.
- Set the jitter modulation for input signals to non-modulation when executing calibration of Delay.
- When configuring Combination Setting, set the jitter modulation to non- modulation before setting Combination or Channel Synchronization.
- When changing the input frequency while Combination or Channel Synchronization is set, be sure to set Jitter Input of Delay for the MU195020A to **ON** and then set the jitter modulation to **ON**, in this order, after changing the frequency for measurement.

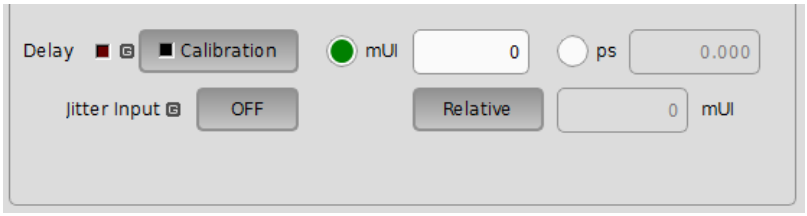


Figure 4.4.1.2.3-1 Delay Setting Items in the Output Tab (Close up)

Notes:

- When jitter-modulated clock is input while Jitter Input of Delay is set to **OFF**, the phase may become unstable.
- The Delay lamp may light up when a jitter-modulated clock signal is input. In addition, phase setting error may increase.

4.4.1.2.4 Setting bit rate

When the clock source is MU181000A/B, MU191000A or MU181500B, the bit rate of data output can be set. For how to set the clock source, refer to 4.4.1.8.1 “Setting clock”.

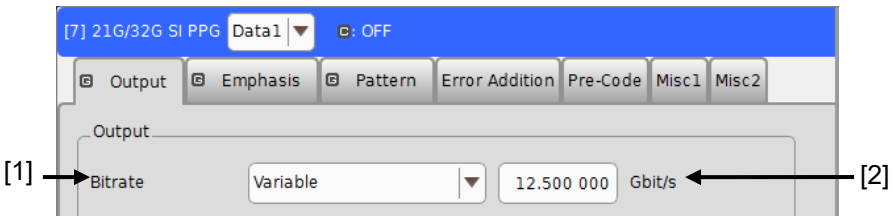


Figure 4.4.1.2.4-1 Output Tab—Bit Rate Setting Area

[1] When the clock source is MU181000A/B, MU191000A or MU181500B, select a bit rate from the preset standard list (Table 4.4.1.2.4-1 Preset Standard of Bit Rate) or set to **Variable** to specify an arbitrary value.

[2] A corresponding bit rate is displayed when a preset standard is selected. When set to **Variable**, an arbitrary bit rate can be specified.

Note:

A bit rate can be set only when the MU181500B clock source is MU181000A/B or MU191000A. When using an external clock source for MU181500B, the PPG bit rate cannot be set.

Table 4.4.1.2.4-1 Preset Standard of Bit Rate

Preset Standard	Bit Rate [Gbit/s]
OC-48/STM-16	2.488320
PCIe 1	2.500000
InfiniBand SDR	2.500000
OTU1	2.666060
DisplayPort HBR	2.700000
SATA 3Gb/s	3.000000
XAUI	3.125000
4G FC	4.250000
USB3.0	5.000000
InfiniBand DDR	5.000000
PCIe 2	5.000000
DisplayPort HBR2	5.400000
SATA 6Gb/s	6.000000
HSBI	6.250000
PCIe 3	8.000000
DisplayPort HBR3	8.100000
8G FC	8.500000
OC-192/STM-64	9.953280
InfiniBand QDR	10.000000

Table 4.4.1.2.4-1 Preset Standard of Bit Rate (Cont'd)

Preset Standard	Bit Rate [Gbit/s]
USB3.1 Gen2	10.000000
USB4 Gen2	10.000000
DisplayPort UHBR 10	10.000000
Thunderbolt1	10.312500
10GbE	10.312500
10G FC	10.518750
G975 FEC	10.664228*2
OTU2	10.709225*2
10GbE over FEC	11.095700
10GFC over FEC	11.316800
SAS3	12.000000
DisplayPort UHBR 13.5	13.500000
16G FC	14.025000
InfiniBand FDR	14.062500
PCIe 4	16.000000
USB4 Gen3	20.000000
DisplayPort UHBR 20	20.000000
Thunderbolt2	20.625000
SAS4	22.500000*1
SAS	24.000000*1
InfiniBand EDR	25.781250*1, *2
100GbE(25.78x4)	25.781250*1, *2
100G OTU4	27.952496*1, *2
32G FC	28.050000*1
PCIe 5	32.000000*1
100G ULH	32.100000*1

*1: Only when the MU195020A-x01 is installed.

*2: The bit rate resolution is automatically set to 0.000002 Gbit/s or 0.000004 Gbit/s interlinking with the output clock rate of the 32G PPG Misc2 and the current bit rate. Thus, the bit rate may not be set to the exact standard value.

Table 4.4.1.2.4-2 Bit Rate Setting Range for [Variable]

Preset Standard	Bit Rate [Gbit/s]
Variable	2.400000 to 21.000000 Gbit/s (32.100 000 Gbit/s with MU195020A-x01 installed) Can be set in increments of 0.000002 Gbit/s.*

*: When it cannot be set by the Output Clock Rate set for the interlinked 32G PPG Misc2 and the current bit rate, the bit rate resolution is set to 0.000004 Gbit/s.

4.4.1.3 Setting Emphasis and ISI

When MU195020A-x11 or MU195020A-x21 is installed, Emphasis can be added to the output data. To set Emphasis, touch the **Emphasis** tab on the MU195020A operation screen and select and set up Preset. ISI can be added to the output data when the MX190000A version is 2.0.0 or later and the MU195020A-x40 or MU195020A-x41 is installed.
ISI can be configured on **Emphasis** tab. It's same as Emphasis configuration.

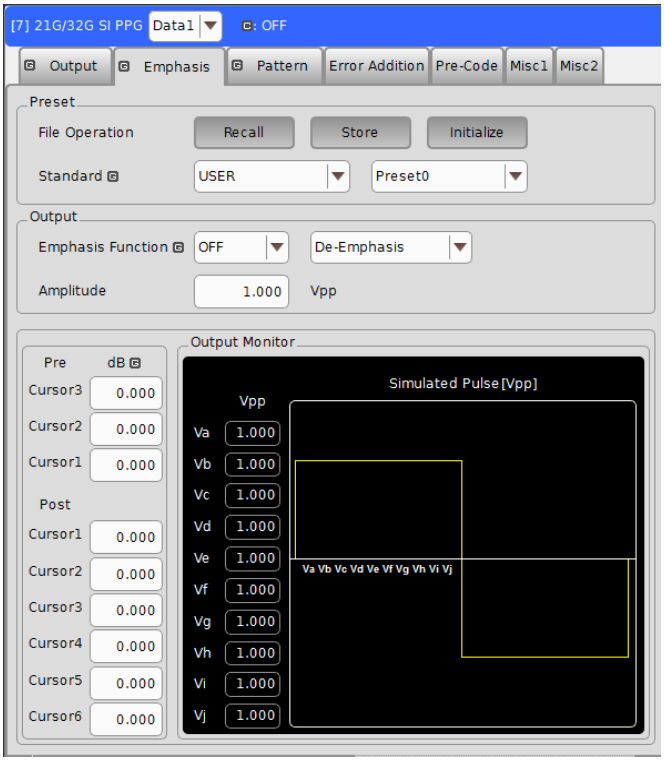


Figure 4.4.1.3-1 Emphasis Tab (MX190000A Earlier Than Version 2.0.0)

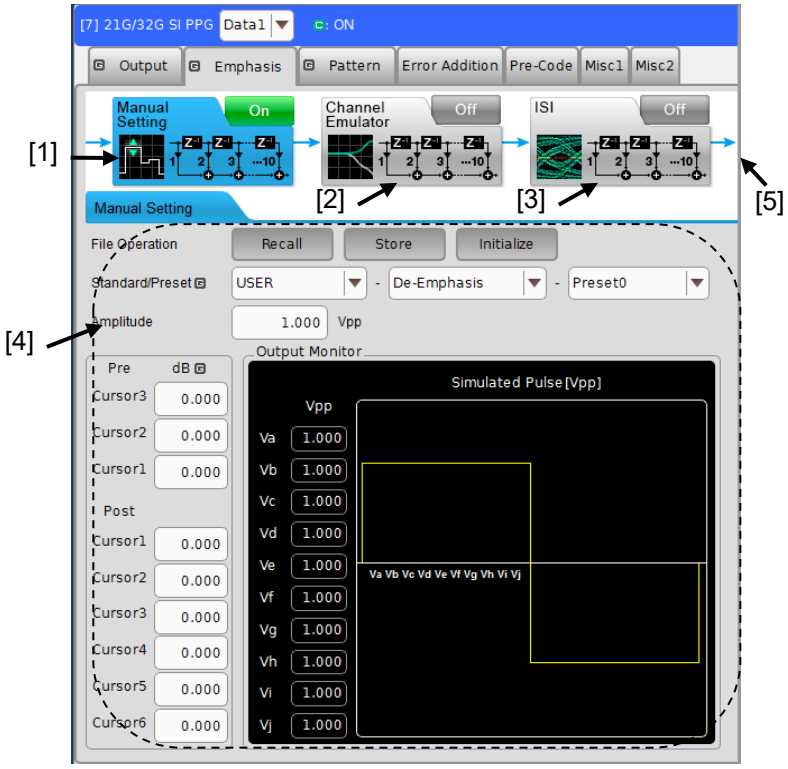


Figure 4.4.1.3-2 Emphasis Tab When Manual Setting Is Selected (MX190000A Version 2.0.0 or Later)

[1] Touching this icon configures the manual setting of Emphasis.

[2] Touching this icon emulates the transmission channel.

[3] Touching this icon configures ISI.

[4] Advanced setting is configurable by selecting an item from [1] to [3].

[5] The Emphasis and the Emulated Responses set on the tabs with ON of [1] to [3] are combined and output.

4.4.1.3.1 Setting Emphasis Preset

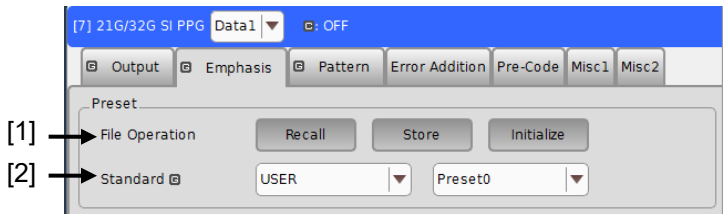


Figure 4.4.1.3.1-1 Preset Setting on Emphasis Tab

[1] **File Operation** to store, recall, and initialize preset setting.

Table 4.4.1.3.1-1 File Operation Buttons

Button	Function
Recall	Recalls the saved setting and set Preset.
Store	Stores Preset setting.
Initialize	Restores defaults.

[2] **Standard** can be selected from the preset standard list (table below) or set to an arbitrary preset value. Usable preset types are limited by standard.

Table 4.4.1.3.1-2 Emphasis Preset Standard

Preset Standard	Preset
PCIe 3	Preset0 to 10
PCIe 4	Preset0 to 10
PCIe 5	Preset0 to 10
USB3.0	Preset0
USB3.1 Gen2	Preset0 to 1
TBT3	Preset0 to 15
USB4 Gen2/3	Preset0 to 15
USER	Preset0 to 15

4.4.1.3.2 Setting Emphasis Function



Figure 4.4.1.3.2-1 Function Setting on Emphasis Tab

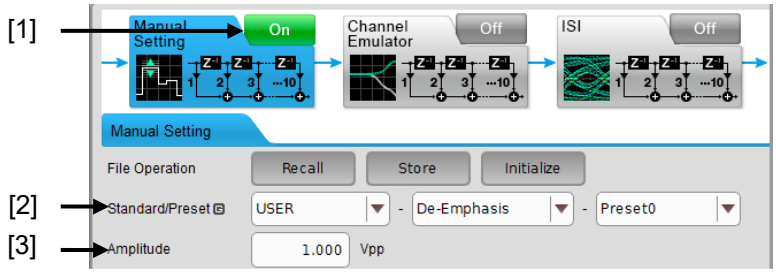


Figure 4.4.1.3.2-2 Emphasis Tab Function Selector (MX190000A Version 2.0.0 or Later)

[1] Sets Emphasis ON, OFF.

OFF: Although the emphasis waveform can be edited, the signal output from the front panel has no emphasis applied

ON: The signal output from the front panel has emphasis applied.

When using version 2.0.0 or later, set this by Manual Setting ON, OFF.

[2] Selects the type of Emphasis Function.
There are three selections: Coefficient, Pre-Emphasis, and De-Emphasis.
However, available functions are limited by preset standard.

Table 4.4.1.3.2-1 Emphasis Function According to Standard

Preset Standard	Emphasis Function
PCIe 3	De-Emphasis
PCIe 4	De-Emphasis
PCIe 5	De-Emphasis
USB3.0	De-Emphasis
USB3.1 Gen2	De-Emphasis
TBT3	Coefficient
USB4 Gen2/3	Coefficient
USER	Coefficient, Pre-Emphasis, De-Emphasis

[3] Specifies Amplitude.
The setting is linked with the amplitude setting on the Output tab (see Figure 4.4.1.2.1-1 Output Tab). Either tab allows you to set amplitude.

4.4.1.3.3 Setting cursor voltage

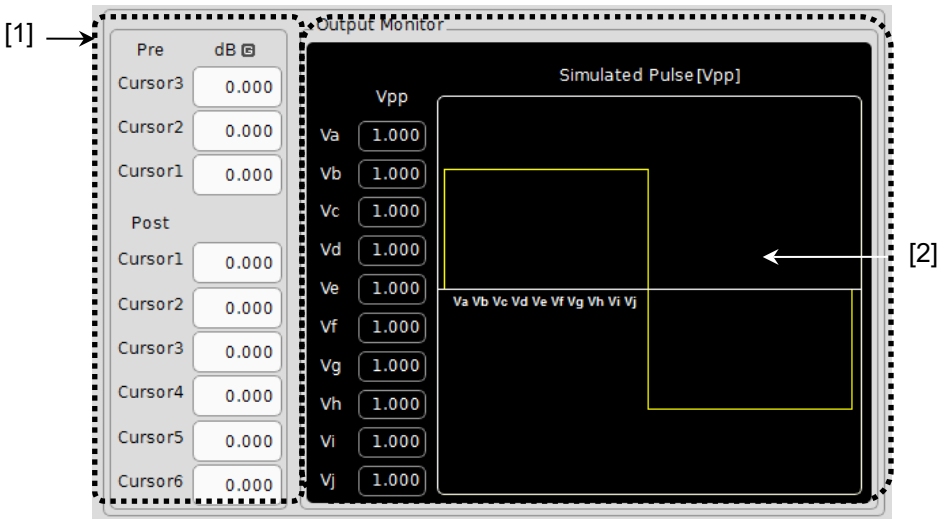


Figure 4.4.1.3.3-1 Cursor Setting on Emphasis Tab

[1] Sets the cursors.
3 Pre cursors and 6 Post cursors are available for Pre-Emphasis or De-Emphasis.
C3 to C6 cursors are available for Coefficient.

[2] Displays voltage of each cursor.
If **Channel Emulator** tab and **ISI** tab are ON, the Emulated Responses on each tab are combined and displayed on the monitor.

Note:

The setting range of cursor coefficients is limited so that the cursor voltage stays in the range of 0.1 to 1.5 V by the following settings.

- Amplitude
- Other cursor coefficients.

4.4.1.3.4 Channel Emulator setting

MU195020A can load the S parameter file of the DUT and calculate optimum Emphasis setting for the DUT from the inverse characteristics of the loaded S parameter. Moreover, it can emulate the characteristics of transmission channel from its S parameter characteristics. The S parameters (s2p, s4p files) saved on the next models can be loaded.

- MICROWAVE NETWORK ANALYZER MS4640 Series
- BERTWave MP2100A/B Series

Notes:

- Channel Emulator is enabled only when MU195020A-x40 or MU195020A-x41 is installed.
- The FIR filter by 10Tap Emphasis cannot realize sharp attenuation and amplitude characteristics. Thus, this function cannot simulate the Normal and Inverse characteristics of S parameter that have steep filter characteristics.

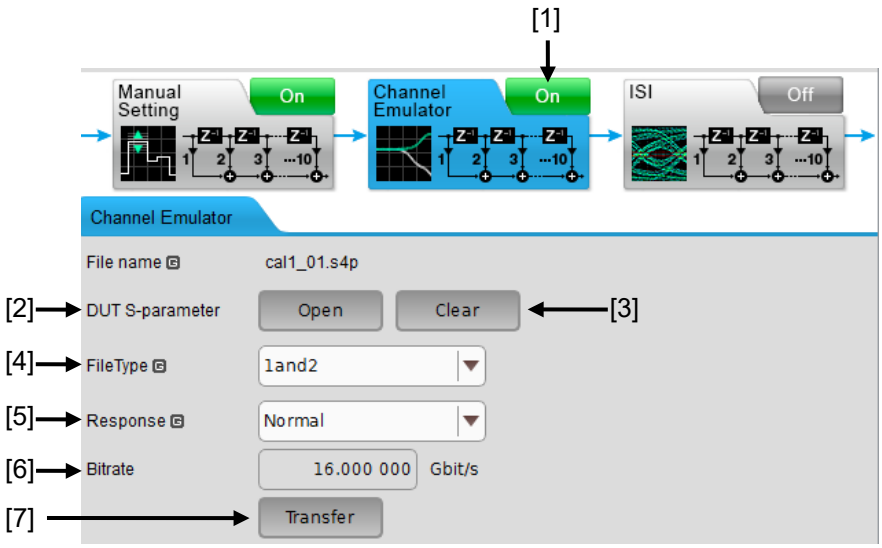


Figure 4.4.1.3.4-1
Emphasis Tab Channel Emulator Configuration

[1] Set Channel Emulator on or off.
When this function is On, the Output Monitor in **Manual Setting** tab graphs the emulated results of S parameter characteristics and outputs the waveforms.

Off: Turns Off Emulator.
On: Turns On Emulator.

[2] Load the S parameter file of the DUT. Touch **Open** to display the file loading dialog box, "**Open S-Parameter File**". By selecting the S parameter file on this dialog box, Emphasis according to **Response** setting is set.

[3] Touch **Clear** to clear the currently loaded S parameter file.

[4] Selects a file type for s4p files.
This item is displayed when the loaded file in [2] is an s4p file.

1and3: Select this when the loaded s4p file has been assigned input port and output port as below.
Input Port: Port 1, Port 3
Output Port: Port 2, Port 4

Note:

Select this to open an s4p file of MICROWAVE NETWORK ANALYZER, MS4640.

1and2: Select this when the loaded s4p file has been assigned input port and output port as below.
Input Port: Port 1, Port 2
Output Port: Port 3, Port 4

[5] Select how to emulate impulse response from S parameter file.

Normal: Emulate Non-Inverse impulse response.
Select this to emulate channel characteristics.

Inverse: Emulate inverse impulse response.
Select this to compensate for channel loss.

Note:

If **Inverse** is selected, inverse characteristics of channel are emulated.
Inverse characteristics of the channel can be computed by inverse Fourier transform of an inverse number of channel frequency characteristics (inverse number of channel transfer function).
Thus, channel inverse response exceeding the hardware limit can be emulated depending on S parameter file.
Not to exceed the hardware limit, Channel Emulator normalizes the maximum value of the output (Va-Vj) to 1.000 Vpp when the amplitude setting is 1.000 Vpp.
Therefore, it is not guaranteed to compensate channel response of any S parameter file without lowering the output level by normalization, when Channel Emulator is used for compensating Channel.

[6] The Bitrate of the MU195020A is displayed.

[7] By touching **Transfer**, the emulated results of Channel Emulator are transferred to the **Manual Setting** tab.
The transferred emulated results are overwritten as coefficient parameters. Also, when the transfer is completed, Channel Emulator is turned Off.

4.4.1.3.5 ISI setting

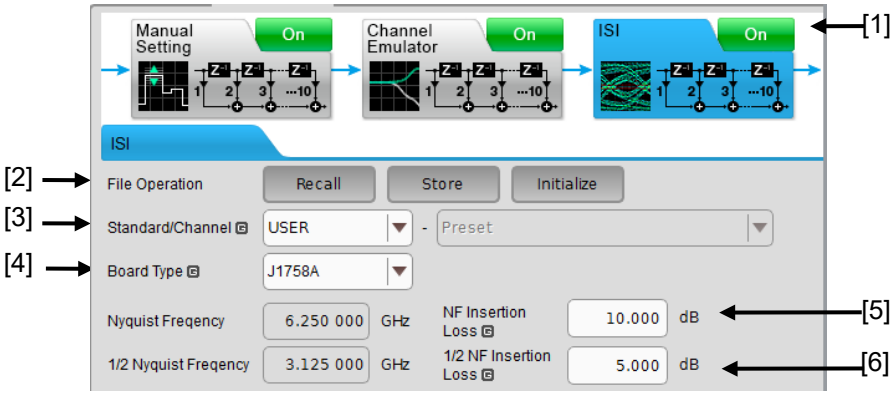


Figure 4.4.1.3.5-1 Emphasis Tab ISI Setting

Note:

ISI is enabled only when MU195020A-x40 or MU195020A-x41 is installed.

[1] Set ISI on or off.

Off: ISI can be set, but the value cannot re reflected to the waveform.

On: ISI is added to the waveform output from the front panel.

[2] **File Operation** to store, recall, and initialize preset setting.

Table 4.4.1.3.5-1 File Operation Buttons

Button	Function
Recall	Recalls the saved setting and set Preset.
Store	Stores Preset setting.
Initialize	Restores defaults.

[3] Set the standard to be referenced and the Calibration channel. When they are set, the Insertion Loss is automatically configured.

Table 4.4.1.3.5-2 Available Standards and Calibration Channel

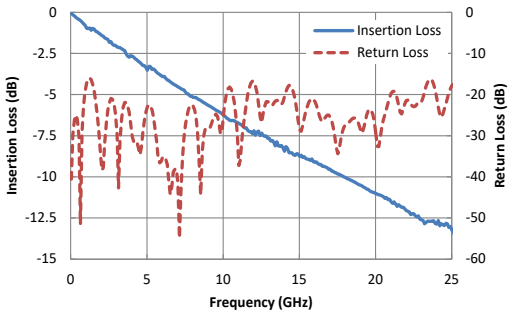
Preset Standard	Calibration Channel
CEI-28G	Short Reach 300 mm
	Medium Reach
	Very Short Reach
CEI-25G	Long Reach 686 mm
USER	The user can set arbitrary insertion loss.

[4] Select the ISI Board to use. To use the ISI Board not on this list and add loss to it, select **Not Specified**.

When **J1758A** is selected, the settings in [5] and [6] are treated as absolute values. It means that the output after passing J1758A is equivalent to the Insertion Loss that are set in [5] and [6] and the output in Nyquist frequency is in the range of the Insertion Loss (1.5 to 25.0 dB).

When **Not Specified** is selected, the settings in [5] and [6] are treated as relative values. It means that the loss of the used ISI board itself and the Insertion Loss set in [5] and [6] are added to the output through the board. And the output in Nyquist frequency is in the range of the Insertion Loss (1.5 to 25.0 dB) + xxdB (loss of board itself).

Table 4.4.1.3.5-3 Board Type List

Board Type	Frequency Characteristics (Typical)
J1758A	

[5] Set the Insertion Loss at Nyquist frequency. When setting Standard to **USER**, Nyquist frequency is automatically set from the Bit Rate. When other than **USER** is selected, the frequency corresponding to various standards are displayed.

[6] Set the Insertion Loss at half the frequency of the Nyquist frequency. The Insertion loss here should be equal to or below the Insertion Loss at Nyquist frequency.

4.4.1.4 Setting Test Patterns (MU195020A)

To set the PPG pattern, touch the **Pattern** tab on the MU195020A operation screen. Select a test pattern and set other items.

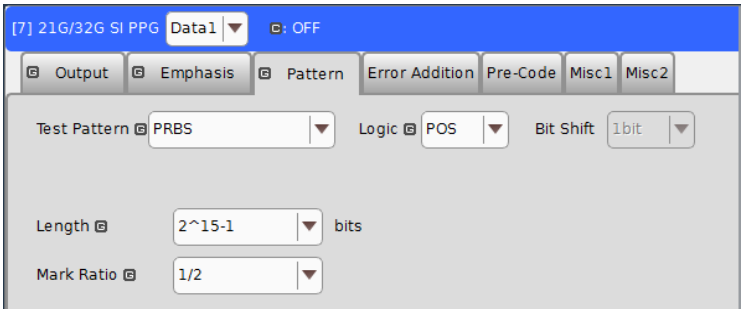


Figure 4.4.1.4-1 Pattern Tab

4.4.1.4.1 Test Pattern type

The following six test patterns can be selected.

- PRBS
- ZeroSubstitution
- Data
- Mixed
- PAM4
- Sequence

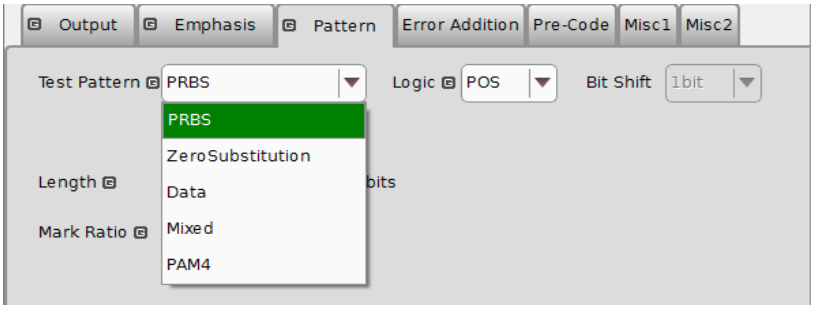


Figure 4.4.1.4.1-1 Selecting Test Pattern

How to set each test pattern is described in the subsequent sections.

4.4.1.4.2 Setting PRBS pattern

This section describes how to set the parameters required when **PRBS** is selected as the test pattern.

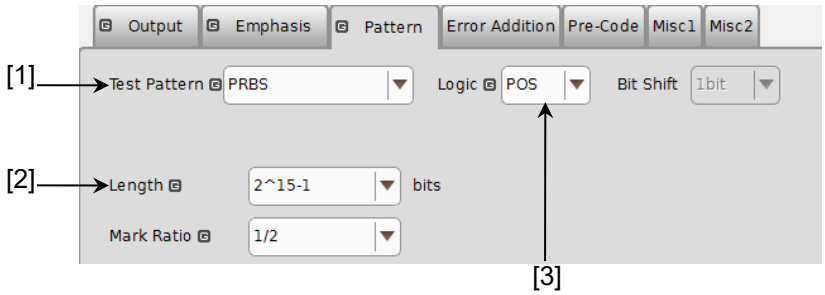


Figure 4.4.1.4.2-1 Setting Items for Test Pattern (PRBS)

[1] Select **PRBS**.

[2] Set the number of the PRBS pattern stages.
Set the PRBS pattern length in the format of 2^n-1 (n = 7, 9, 10, 11, 13, 15, 20, 23, 31).

[3] Set the logic of the test pattern.

Table 4.4.1.4.2-1 Test Pattern Logic Setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as “0”.
NEG (negative logic)	The high level of a signal is defined as “1”.

Refer to Appendix A “Pseudo-Random Pattern” for the PRBS pattern generation principle.

4.4.1.4.3 Setting ZeroSubstitution pattern

This section describes how to set the parameters required when **ZeroSubstitution** is selected as the test pattern.

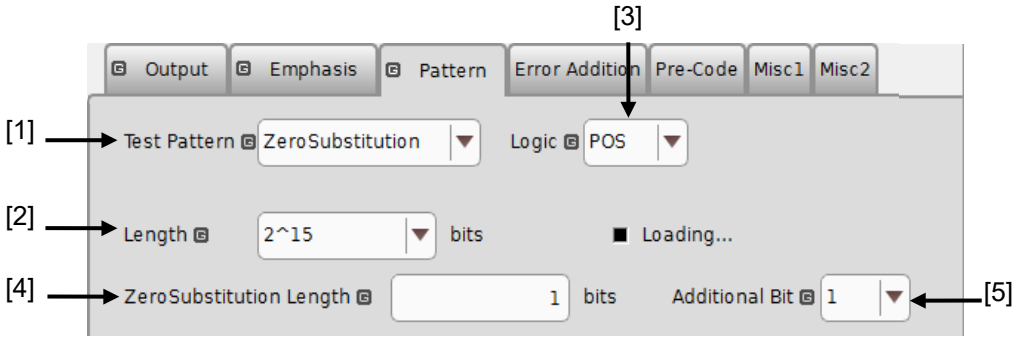


Figure 4.4.1.4.3-1 Setting Items for ZeroSubstitution Pattern

[1] Select **ZeroSubstitution** from the **Test Pattern** list.
Test pattern loading starts and the **Loading...** LED lights.

[2] Set the configuration (number of stages) of the zero-insertion pattern test signal.

Select either of the following test pattern signals.
2^n (n = 7, 9, 10, 11, 15, 20, or 23) [Compatible with the MP1800A]
2^n–1 (n = 7, 9, 10, 11, 15, 20, or 23) [Pure PRBS signal]

[3] Set the logic of the test pattern.

Table 4.4.1.4.3-1 Test Pattern Logic Setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as “1”.
NEG (negative logic)	The high level of a signal is defined as “0”.

[4] Set the number of 0-insertion (substitution) bits. The number of available 0-insertion bits varies depending on the pattern test signal selected from the **Length** list ([2] in Figure 4.4.1.4.3-1) as follows.

(a) When 2^n–1 is set for Length: 1 to 2^n–2, in 1-bit steps

(b) When 2^n is set for Length: 1 to 2^n–1, in 1-bit steps

[5] Set the final bit of the zero-insertion pattern.
Note that this setting is invalid when Length is set to 2^n–1.

Table 4.4.1.4.3-2 Setting of Last Bit of Zero-Insertion Pattern

Setting	Description
1	The 2^nth bit is set to "1" (compatible with the MP1800A).
0	In order to make an M-series signal, 1 bit of "0" is added to the last of consecutive 0 strings to configure a zero-insertion pattern.

Note:

The data amplitude of MU195020A output with the following patterns may be attenuated by around 50 % or the offset voltage (Vth) may be fluctuated.

- The pattern in the period of approximately 5 μs which follows continuous "0" or "1" with 5 μs or more.
  This kind of pattern may be generated by inserting continuous "0" or "1" or by a burst pattern.
- The pattern other than its mark ratio of 1/2.

When MU195040A receives the data with such a pattern, the optimum threshold voltage may not match the offset voltage of MU195020A.

This mismatch may cause bit errors. In this case, check the data signal using an oscilloscope etc. to adjust the threshold voltage.

4.4.1.4.4 Setting Data pattern

This section describes how to set the parameters required when **Data** is selected as the test pattern.

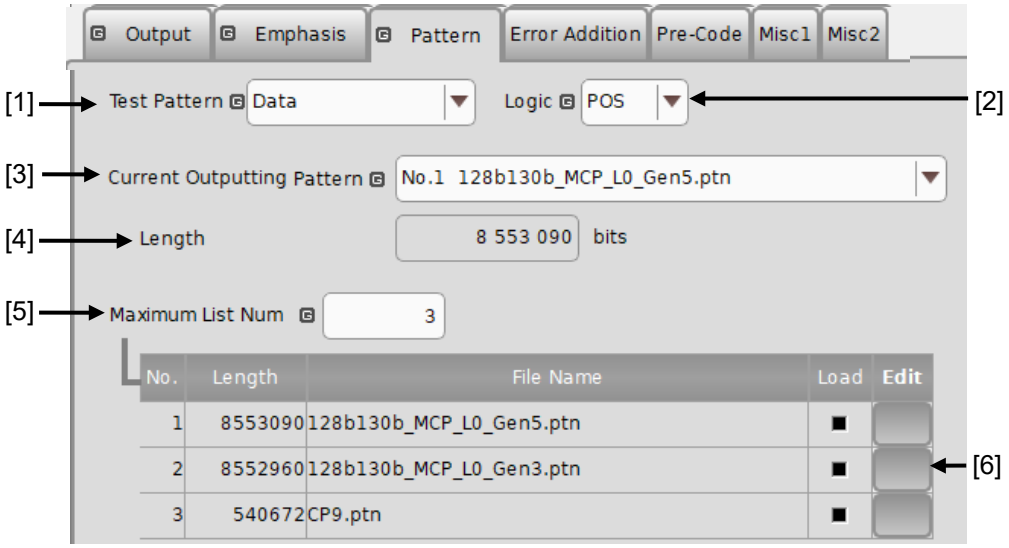


Figure 4.4.1.4.4-1 Setting Items for Data Pattern

[1] Select **Data** from the **Test Pattern** list.
Test pattern loading starts and the **Loading...** LED lights.

[2] Set the logic of the test pattern.

Table 4.4.1.4.4-1 Test Pattern Logic Setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as "1".
NEG (negative logic)	The high level of a signal is defined as "0".

[3] Select a test pattern to output.
From the test patterns loaded by [5] and [6], select one to actually output. If the test pattern is changed here, the MU195020A can switch test patterns without interruption.

[4] The length of the test pattern data currently set is displayed.

Notes:

- It may take a long time to load a test pattern when the data length is long.

  Refer to the following reference loading time values, for the cases where the data length is set to maximum. These values are only references and do not guarantee the Loading time.

  Maximum loading time for 1ch: Around 4 minutes
  Maximum loading time for 2ch: Around 8 minutes.

- The data amplitude of MU195020A output with the following patterns may be attenuated by around 50 % or the offset voltage (Vth) may be fluctuated.

  (a) The pattern in the period of approximately 5 μs which follows continuous "0" or "1" with 5 μs or more.
  This kind of pattern may be generated by inserting continuous "0" or "1" or by a burst pattern.
  (b) The pattern other than its mark ratio of 1/2.

  When MU195040A receives the data with such a pattern, the optimum threshold voltage may not match the offset voltage of MU195020A.

  This mismatch may cause bit errors. In this case, check the data signal using an oscilloscope etc. to adjust the threshold voltage.

- When the Test Pattern is Data or Mixed, if the MU195040A receives a signal that is a combined signal of "PRBS pattern after continuous **0** bits (shown in (a))" and "PRBS pattern after continuous **1** bits", then the optimum threshold voltages of them are each different. Due to this difference, bit errors in all patterns may not be measured.

[5] Select the maximum number of test patterns that can be loaded to the MU195020A.
When, after the application is started, Data is selected in Test Pattern, the selected number of test patterns are loaded. When an already loaded test pattern is selected at [3], you can switch to it without loading again.

[6] Touch **Edit** to open the **Pattern Editor** dialog box in which test patterns can be edited.
When editing of a test pattern is finished, touch **OK** to close the **Pattern Editor** dialog box. The edited test pattern is then loaded to the hardware. The **Loading...** LED lights during Data pattern loading. Refer to "4.4.1.4.7 Editing test pattern in Pattern Editor dialog box" for details on how to edit test patterns in the **Pattern Editor** dialog box.

4.4.1.4.5 Setting Mixed pattern

When **Mixed** is selected, a block consisting of programmable test patterns and PRBS patterns can be set.

A programmable test pattern added with a PRBS pattern is defined as "row", one block is composed of two or more rows. A mixed data test pattern is set by configuring multiple blocks.

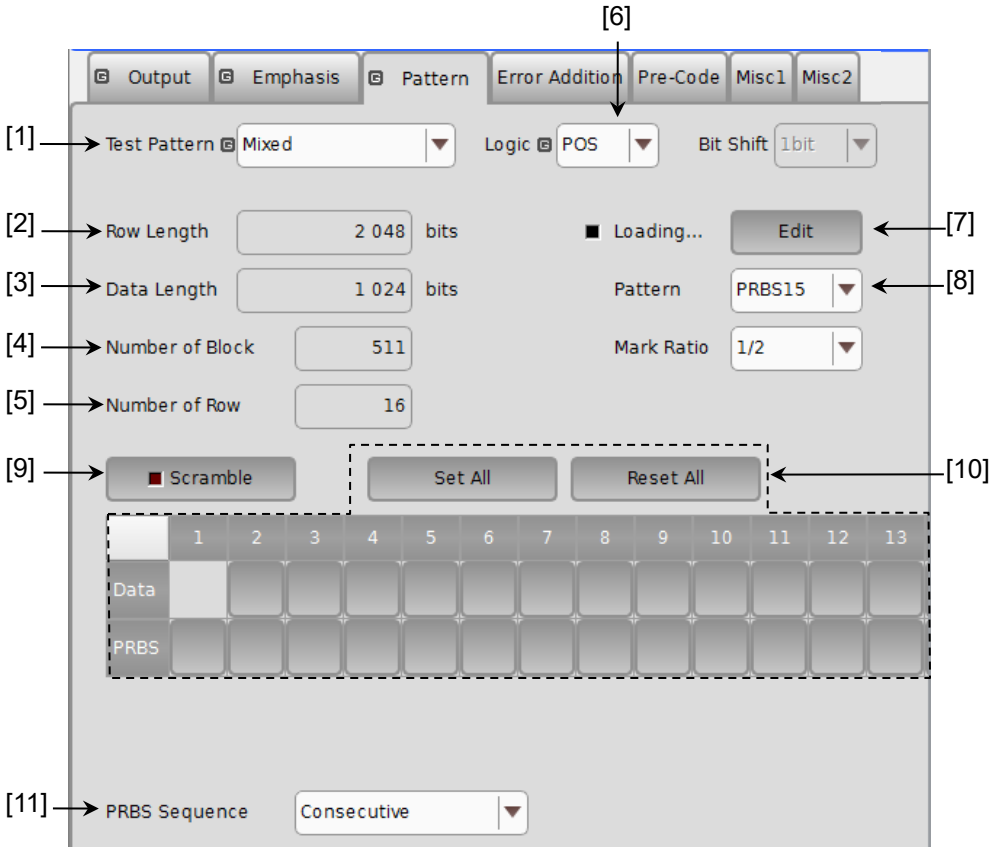


Figure 4.4.1.4.5-1 Setting Items for Test Pattern (Mixed Data)

[1] Select **Mixed**.

[2] The length of rows edited in the **Pattern Editor** dialog box is displayed.

[3] The length of the Data pattern edited in the **Pattern Editor** dialog box is displayed.

[4] The number of all blocks in the pattern data edited in the **Pattern Editor** dialog box is displayed. The maximum number of blocks is 511.

[5] The length of 1 row of the pattern data edited in the **Pattern Editor** dialog box is displayed.

[6] Set the logic of the test pattern.

Table 4.4.1.4.5-1 Test Pattern Logic Setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as "1".
NEG (negative logic)	The high level of a signal is defined as "0".

[7] Touch **Edit** to open the **Pattern Editor** dialog box in which test patterns can be edited.
When editing of a test pattern is finished, touch **OK** to close the **Pattern Editor** dialog box. The edited test pattern is then loaded to the hardware (Loading). The **Loading...** LED lights during test pattern loading. Refer to "4.4.1.4.7 Editing test pattern in Pattern Editor dialog box" for details on how to edit test patterns in the **Pattern Editor** dialog box.

Notes:

- It may take a long time to load a test pattern when the data length is long.

  Refer to the following reference loading time values, for the cases where the data length is set to maximum. These values are only references and do not guarantee the Loading time.

  Maximum loading time for 1ch: About 1 min.
  Maximum loading time for 2ch: About 2 min.

- The data amplitude of MU195020A output with the following patterns may be attenuated by around 50 % or the offset voltage (Vth) may be fluctuated.

  - The pattern in the period of approximately 5 μs which follows continuous "0" or "1" with 5 μs or more.
    This kind of pattern may be generated by inserting continuous "0" or "1" or by a burst pattern.
  - The pattern other than its mark ratio of 1/2.

  When MU195040A receives the data with such a pattern, the optimum threshold voltage may not match the offset voltage of MU195020A.

  This mismatch may cause bit errors. In this case, check the data signal using an oscilloscope etc. to adjust the threshold voltage.

- When the Test Pattern is Data or Mixed, if the MU195040A receives a signal that is a combined signal of "PRBS pattern after continuous **0** bits" and "PRBS pattern after continuous **1** bits", then the optimum threshold voltages of them are each different. Due to this difference, bit errors in all patterns may not be measured.

[8] Set the number of the PRBS pattern stages.
Set the PRBS pattern length in the format of 2^n-1 (n = 7, 9, 10, 11, 15, 20, 23, 31).

[9] Set scramble ON/OFF.

Scramble of PRBS7 can be set for the area specified by the setting of [10].

When **Scramble** is touched while the LED on the button is off, the LED lights and scramble is executed for the output signal. The scramble area is displayed red in the block configuration display area. When **Scramble** is touched while the LED on the button is on, the LED goes off and scramble for the output signal is stopped.

[10] Configure the scramble settings.

Touch **Set All** to enable all area. Touch **Reset All** to disable all area. Select at least one desired area to enable scramble individually.

Note:

Scramble cannot be set for the data area of the first row in each block.

[11] Set the PRBS signal generation method.

Set the continuity of the PRBS pattern strings in a Mixed pattern.

Table 4.4.1.4.5-2 PRBS Signal Generation Method Setting

Setting	Description
Restart	The end of the PRBS of the specified last block and the start of the PRBS of the next subsequent block are not continuous.
Consecutive	The end of the PRBS of the specified last block and the start of the PRBS of the next subsequent block are continuous.

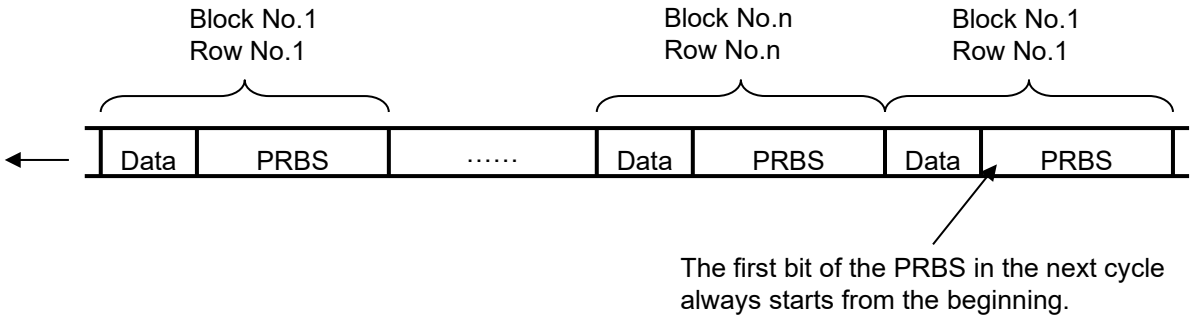


Figure 4.4.1.4.5-2 Continuity of PRBS Pattern Strings (Restart)

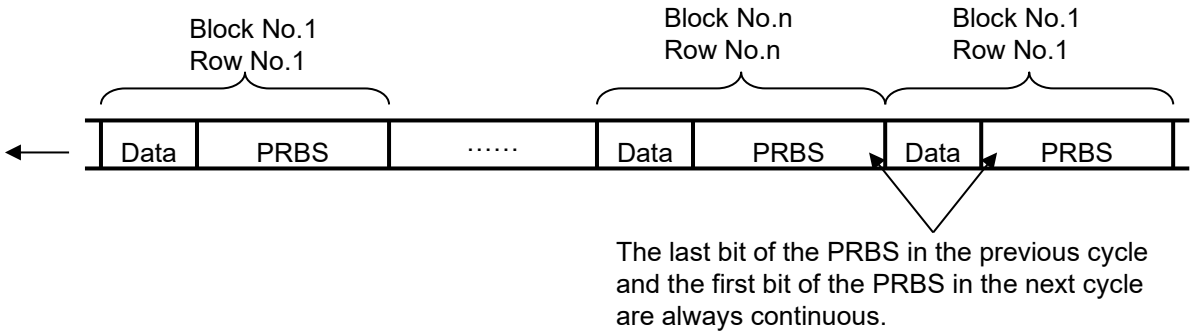


Figure 4.4.1.4.5-3 Continuity of PRBS Pattern Strings (Consecutive)

4.4.1.4.6 Setting PAM4

Set various parameters when **PAM4** is selected for Test Pattern.
PAM4 is displayed when **2 ch Combination** or **64 G × 2 ch Combination** is set using the inter-module synchronization function.
For details of the inter-module synchronization function, see 4.4.1.10 "Inter-Module Synchronization Function".

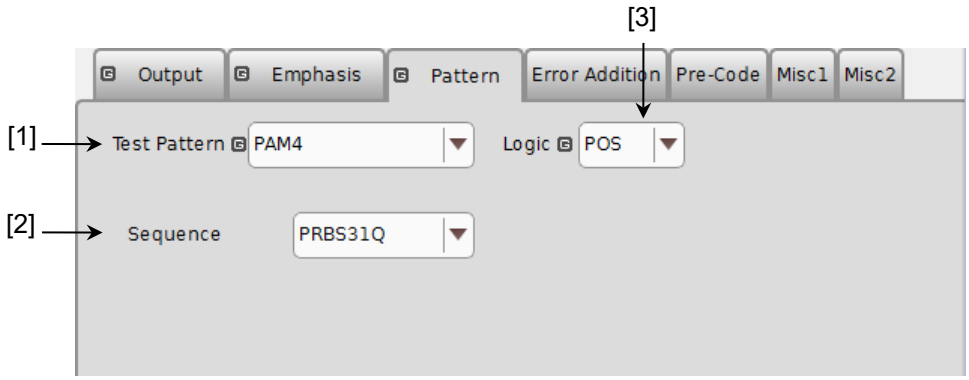


Figure 4.4.1.4.6-1 Test Pattern (PAM4) Setting Dialog Box

[1] Select **PAM4**.

[2] Set the sequence of the test pattern.

[3] Set the logic of the test pattern.

Table 4.4.1.4.6-1 Test Pattern Logic Setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as "1".
NEG (negative logic)	The high level of a signal is defined as "0".

When Sequence is selected as **User Define**, it is possible to set arbitrary number of PRBS steps and user defined patterns.

By setting **PRBS** to Raw Data, it is possible to generate a test pattern based on the PRBS pattern.

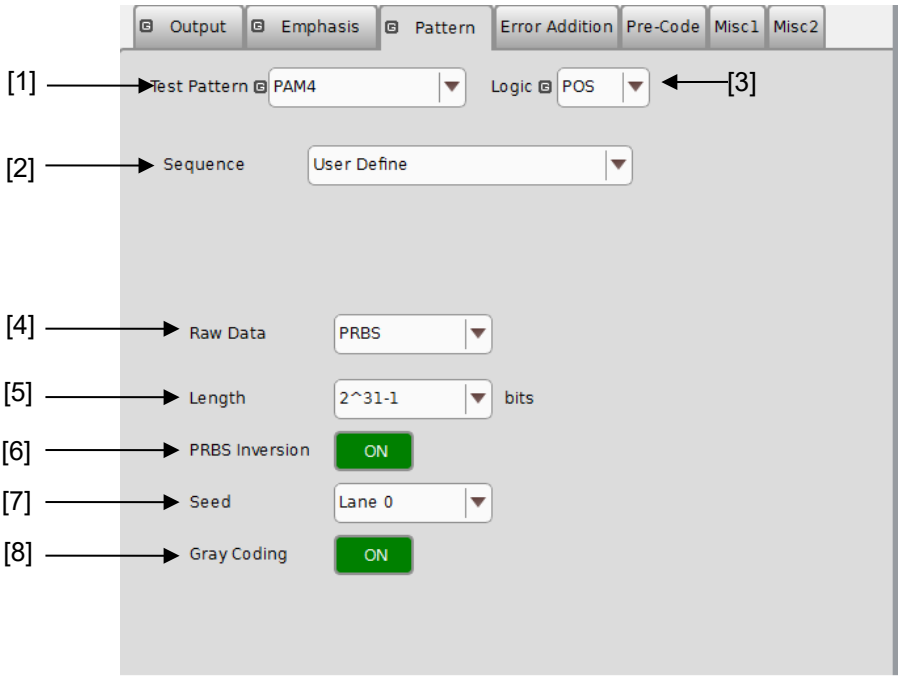


Figure 4.4.1.4.6-2 Setting Items for Test Pattern (PAM4-PRBS)

[1] Select **PAM4**.

[2] Set the sequence of the test pattern.

[3] Set the logic of the test pattern.

[4] Select the Raw Data **PRBS**.

[5] Set the number of the PRBS pattern stages (Length).
Set the PRBS pattern length in the format of 2^n-1 (n = 7, 9, 10, 11, 15, 20, 23, 31).

[6] Set the logic (PRBS Inversion) of ON or OFF.

The relationship of PRBS Inversion, test pattern logic and Gray Coding is as the figure below.

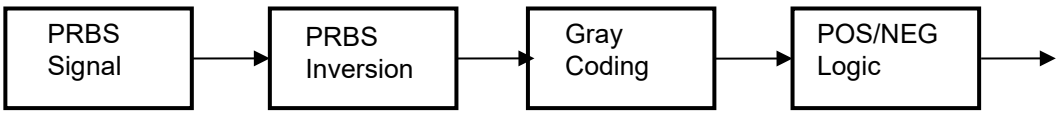


Figure 4.4.1.4.6-3 Block Diagram of Pattern Generation

[7] Set the initial value (Seed) of the PRBS.

Considering that multiple PAM4 signals may be used (Lane0 to 3), a phase between lanes can be shifted by changing the initial value (Seed) of PRBS pattern.

[8] Set the Gray Coding ON or OFF.

Gray Coding is as the following table. And the PAM4 pattern waveform is as the following figure.

Table 4.4.1.4.6-2 Gray Coding Chart

Binary Code	Gray Code
00	00
01	01
10	11
11	10

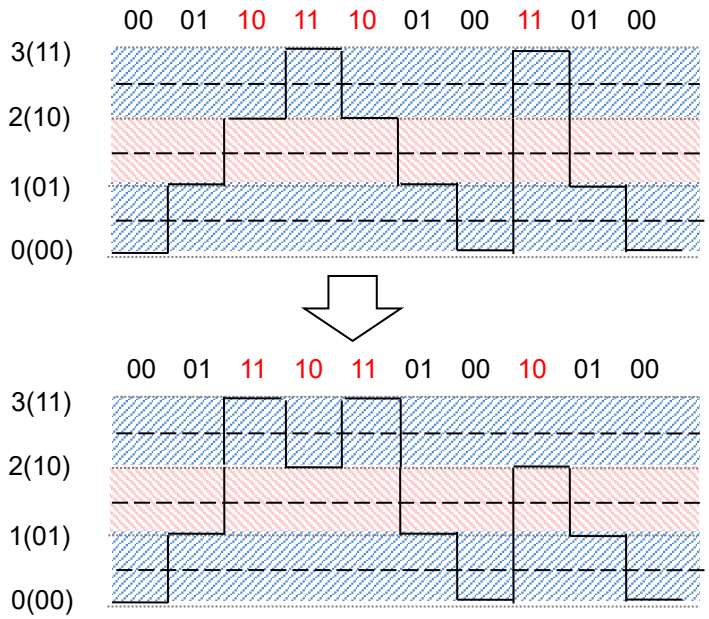


Figure 4.4.1.4.6-4 Gray Coding PAM4 Pattern Waveform

Refer to Appendix A “Pseudo-Random Pattern” for PRBS generation principle.

It is possible to generate a test pattern based on an editable pattern file by setting **Data** to Raw Data.

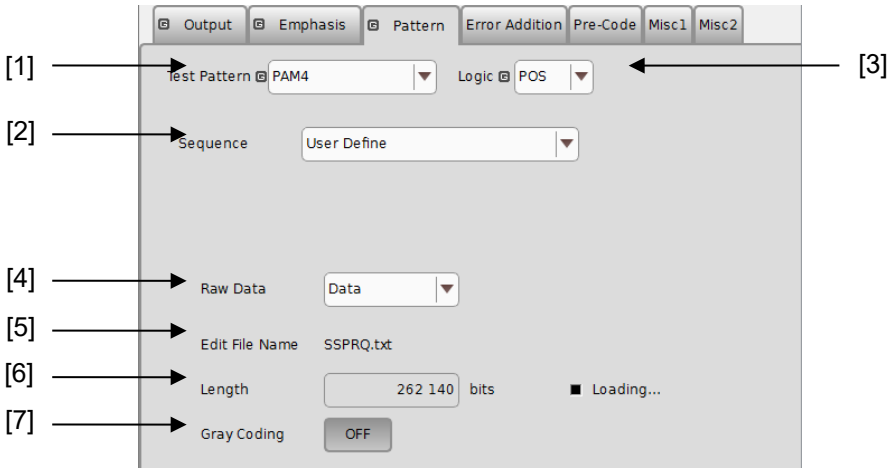


Figure 4.4.1.4.6-5 Test Pattern (PAM4-Data) Setting Dialog Box

[1] Select **PAM4**.

[2] Set the sequence of the test pattern.

[3] Set the logic of the test pattern.

[4] Set the Raw Data to **Data**.
Test pattern loading starts and the **Loading...** LED lights.

[5] The name of set pattern file is shown here.
If file name is not set, "---" is displayed.

[6] The data length of the set test pattern is displayed.

[7] Set the Gray Coding ON or OFF.

Notes:

- It may take a long time to load a test pattern when the data length is long.

  Refer to the following reference loading time values, for the cases where the data length is set to maximum. These values are only references and do not guarantee the Loading time.

  The maximum loading time: Around 8 minutes

- The data amplitude of MU195020A output with the following patterns may be attenuated by around 50 % or the offset voltage (Vth) may be fluctuated.

  - The pattern in the period of approximately 5 μs which follows continuous "0" or "1" with 5 μs or more.
    This kind of pattern may be generated by inserting

continuous “0” or “1” or by a burst pattern.

- The pattern other than its mark ratio of 1/2.

When MU195040A receives the data with such a pattern, the optimum threshold voltage may not match the offset voltage of MU195020A.

This mismatch may cause bit errors. In this case, check the data signal using an oscilloscope etc. to adjust the threshold voltage.

4.4.1.4.7 Editing test pattern in Pattern Editor dialog box

This section describes how to edit test patterns with the following patterns selected on the **Pattern** tab.

- Data
- Mixed

4.4.1.4.7.1 Common setting items

Touch **Edit** on the **Pattern** tab to display the **Pattern Editor** dialog box.

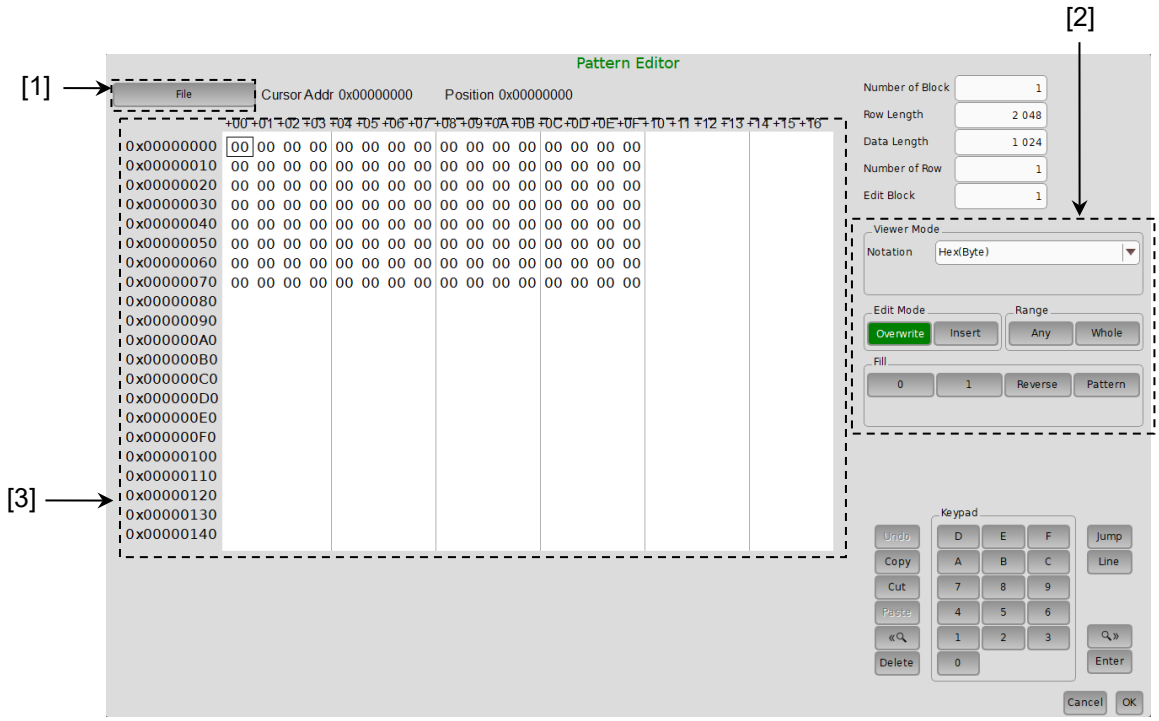


Figure 4.4.1.4.7.1-1 Pattern Editor Dialog Box

[1] Menu items on menu bar

Table 4.4.1.4.7.1-1 Menu Bar Configuration

Button	Menu Item	Description
File	Open	Opens a setup file saved in the binary pattern, binary text pattern, or hexadecimal text pattern format. For file compatibility, refer to 4.4.1.4.7.7 “Compatibility with test pattern files of existing models”.
	Save	Saves a setting file in the binary pattern (Binary Pattern), binary text pattern (BIN Text Pattern), or hexadecimal text pattern (HEX Text Pattern) format. ***Note:*** The settings will not be read from the saved file if the file name is changed.
Undo		Restores the previous state.
Copy		Copies the pattern selected in the Pattern View area into the internal memory.
Cut		Over write: Cuts the pattern selected in the Pattern View area and transfers it onto the clipboard. The area that has been cut out becomes 0. Insert: Cuts the selected pattern with its address domain. After cutting, zero pattern with the same amount of the cut domain is added instead at the end of pattern length.
Paste		Pastes the pattern copied in the internal memory to the cursor position.
Jump		Moves the cursor to a specified address or pattern.
	Head	Moves the cursor to the start of the editing pattern.
	Tail	Moves the cursor to the end of the editing pattern.
	Address	Opens the **Input Address** dialog box. The cursor can be moved to the specified address position.
	Pattern	Opens the **Input Pattern** dialog box. Specifies a pattern string to search by binary digits. If a pattern matching the search condition is found in the editing pattern, the cursor moves to that position. Both forward search and backward search are supported. The search pattern can be specified in the **Input Pattern** dialog box. **Set ALL**: Set all the bits to “1”. **Reset ALL**: Set all the bits to “0”. Select the search direction by touching **Forward** or **Backward**, and then touch **OK**.

Table 4.4.1.4.7.1-1 Menu Bar Configuration (Cont'd)

Button	Menu Item	Description
Jump (Cont'd)	Forward Next	Searches for a pattern that matches the search pattern set in the **Input Pattern** dialog box in the forward direction. If a matching pattern is found, the cursor moves to that position.
	Backward Next	Searches for a pattern that matches the search pattern set in the **Input Pattern** dialog box in the backward direction. If a matching pattern is found, the cursor moves to that position.
Line		Specifies the number of characters per line in the Pattern View area. This is available when the pattern setting item Display is set to **Table**.

[2] Pattern setting items

Table 4.4.1.4.7.1-2 Pattern Setting Items

Setting Item	Description
Notation	Specify the pattern display format in the Pattern View area. Bin: Binary Hex: Hexadecimal
Edit Mode	Specify the pattern editing method. This must be specified in advance when executing Paste from the Edit menu or when performing direct editing in the Pattern View area (except for the Fill setting area). Overwrite: The selected pattern is overwritten. Insert: The editing pattern is inserted into the position of the selected pattern. Note that Data Length is not changed when Insert is selected. The inserted pattern therefore exceeds the Data Length value, and becomes invalid.
Range	Specify the pattern editing range. Whole: All editing patterns are selected as the editing range. Any: The Input Range Dialog Box (see Figure 4.4.1.4.7.1-2) is displayed when this button is touched. The editing range can be specified by an address. Direct: Select an arbitrary area by specifying addresses. Use the cursor to specify addresses. Refer to 4.4.1.4.7.5 “Editing ” for details.
Fill	Edits the pattern part highlighted by the cursor. 0: The highlighted part in the Pattern View area is set to “0”. 1: The highlighted part in the Pattern View area is set to “1”. Reverse: The highlighted part in the Pattern View area is logically inverted. Pattern: The Input Pattern Dialog Box (see Figure 4.4.1.4.7.1-3) is displayed. The highlighted part in the Pattern View area can be edited in this dialog box. Repeat: The edited pattern for which the highlighted address is set to the first is repeated for the number of times specified here. Length: Specify the number of edit bits from the start address of the highlighted part. Set All: Sets all the bits selected by Length to “1”. Reset All: Sets all the bits selected by Length to “0”.

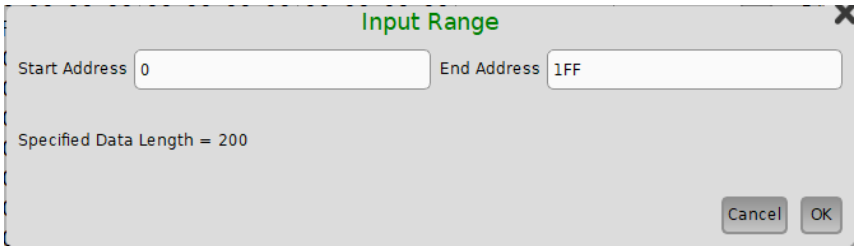


Figure 4.4.1.4.7.1-2 Input Range Dialog Box

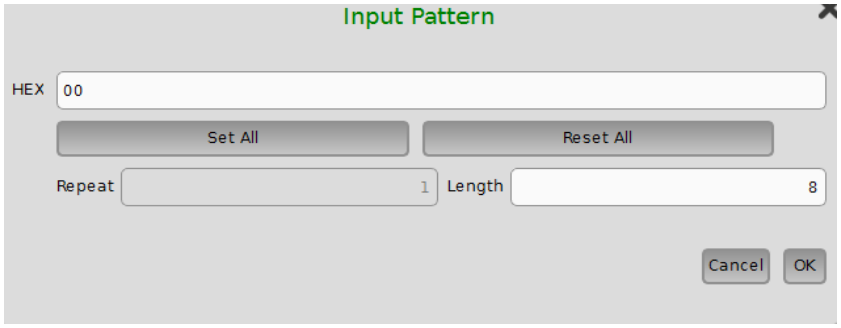


Figure 4.4.1.4.7.1-3 Input Pattern Dialog Box

[3] Pattern View area

The edited pattern is displayed in this area.
Touching a pattern enables the bit value to be changed.

4.4.1.4.7.2 Editing Data pattern

When **Edit** is touched while **Data** is selected for the test pattern, the **Pattern Editor** dialog box shown in Figure 4.4.1.4.7.2-1 is displayed.

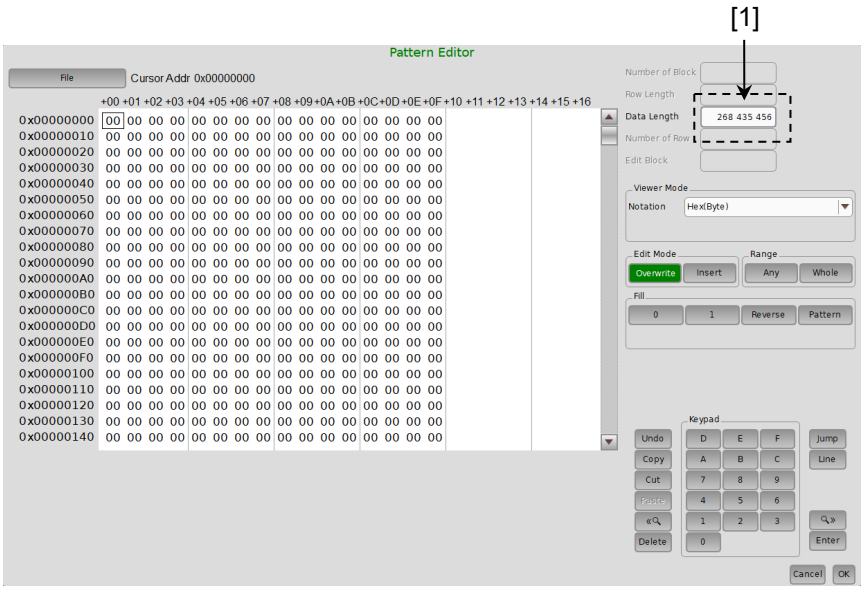


Figure 4.4.1.4.7.2-1 Pattern Editor Dialog Box for Data Pattern

[1] Pattern setting item

Table 4.4.1.4.7.2-1 Pattern Setting Items (when Data is selected)

Setting Item	Description
Data Length	Set the length of the Data pattern. The setting unit is one bit. 2 to 268 435 456 bits can be set, in 1-bit steps. In the case of 2ch Combination, 4 to 536 870 912 bits can be set, in 2-bit steps.

4.4.1.4.7.3 Editing Mixed pattern

When **Edit** is touched while Mixed is selected for the test pattern, the **Pattern Editor** dialog box shown in Figure 4.4.1.4.7.3-1 is displayed.

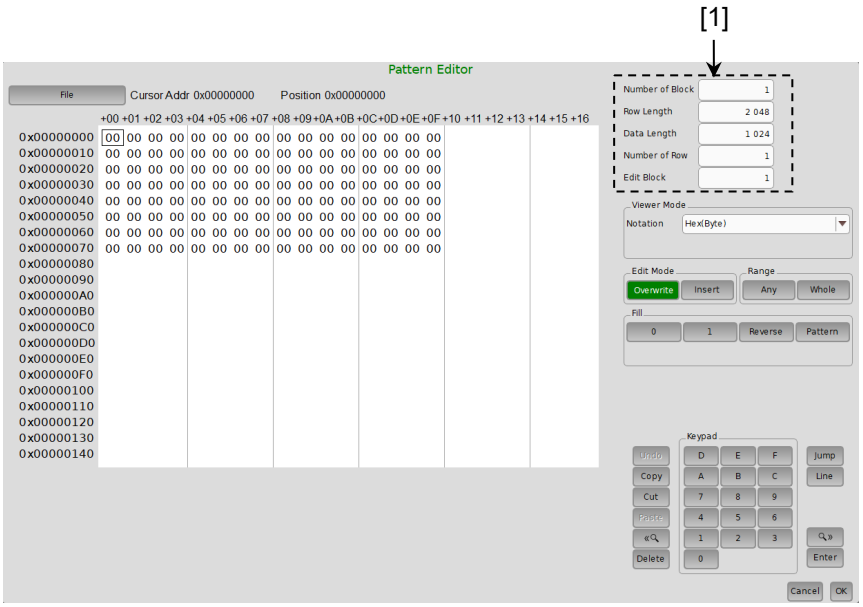


Figure 4.4.1.4.7.3-1 Pattern Editor Dialog Box for Mixed Pattern

[1] Pattern setting items

Table 4.4.1.4.7.3-1 Pattern Setting Items (When Mixed Is Selected)

Setting Item	Description
Number of Block	Set the number of blocks from 1 to 511, in 1-block steps.
Row Length	Set the row length. Can be set from 2 048 to 2 415 919 104 bits, in 256-bit steps. In the case of 2ch Combination, set from 4 096 to 4 831 838 208 bits in 512-bit steps.
Data Length	Set the pattern length. Can be set from 1 024 to 268 435 456 bits, in 1-bit steps. In the case of 2ch Combination, set from 2 048 to 536 870 912 bits in 2-bit steps.
Number of Row	Set the number of rows from 1 to 16, in 1-row steps.
Edit Block	Specify the number of blocks to be edited.

Note:

The number of blocks and the number of rows are restricted as follows.

Number of blocks

1 to the smallest number among a to d, below, in 1-block steps

a) 511

b) INT ($\frac{256\,\text{Mbits} \times x}{\text{Number of rows} \times \text{Data Length}'}$)

where Data Length' is:

- When Data Length is indivisible by (256 × x)

  = (INT($\frac{\text{Data Length}}{256 \times x}$) +1) × 256 × x

- When Data Length is divisible by (256 × x)

  = Data Length

Maximum Block number should satisfy:

Data Length' x Number of Rows × Number of Blocks ≤ 256 Mbits

c) INT ($\frac{(256\,\text{Mbits} + 2^{31}) \times x}{\text{Row Length} \times \text{Number of rows}}$)

where x is:

1 for Independent

2 for 2ch Combination

d) (Row Length – Data Length) × Number of blocks

≥2^31(2147483648)

Number of Rows

1 to the smallest number among a to c, below, in 1-row steps

a) 16

b) INT ($\frac{256\,\text{Mbits} \times x}{\text{Data Length}'}$)

where Data Length' is:

- When Data Length is indivisible by (256 × x)

  = (INT ($\frac{\text{Data Length}}{256 \times x}$) + 1) × 256 × x

- When Data Length is divisible by (256 × x)

  = Data Length

Maximum Row number which meets:

Data Length' × Number of Rows × Number of Blocks ≤ 256 Mbits

c) INT ($\frac{(256\,\text{Mbits} + 2^{31}) \times x}{\text{Row Length}}$)

where x is:

1 for Independent

2 for 2ch Combination

4.4.1.4.7.4 Creating and editing test pattern

This section describes how to create and edit a test pattern in the **Pattern Editor** dialog box.

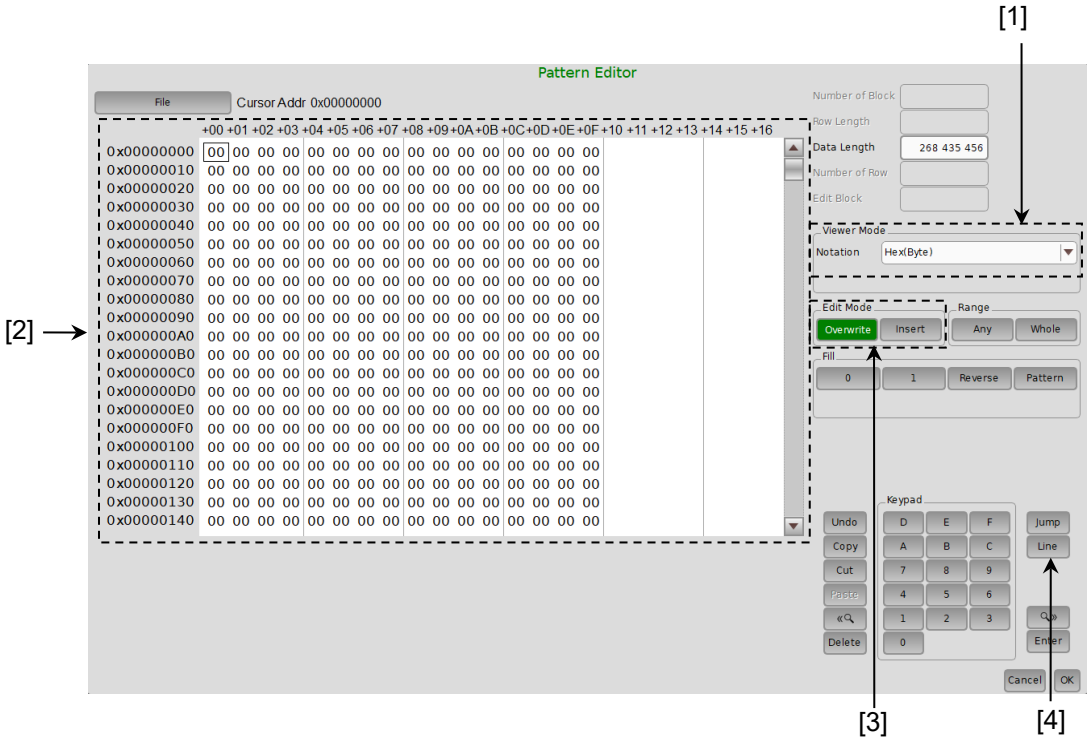


Figure 4.4.1.4.7.4-1 Pattern Editor Dialog Box

[1] Select the display format.

Table 4.4.1.4.7.4-1 Display Format Setting

Setting Item	Description
Bin	A test pattern is displayed and edited in binary.
Hex	A test pattern is displayed and edited in hexadecimal format.

[2] Use the 0 and 1 buttons for pattern input when the display format is binary. Use 0 to 9 and A to F buttons when the display format is hexadecimal.

[3] Set the editing mode.
Editing is performed in the insertion mode when **Insert** is touched, and is performed in the overwriting mode when **Overwrite** is touched.

[4] The amount of data to be displayed in one line can be changed.
Touch **Line** to open the **Line** dialog box. Enter the number of bytes per line in the textbox, and then touch **OK**.

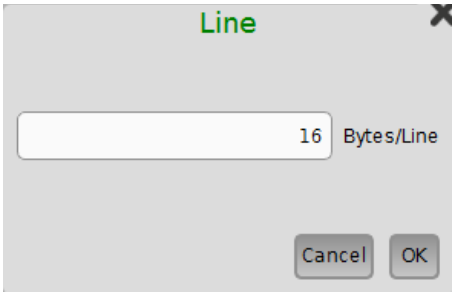


Figure 4.4.1.4.7.4-2 Line Dialog Box

4.4.1.4.7.5 Editing area

In the **Pattern Editor** dialog box, batch editing is possible for an area by selecting it consisting of multiple bits. In this area, perform replace input using the buttons in the Fill frame, or use Cut, Copy, and Paste editing commands.
The selection area setting procedure by using buttons in the Range frame is described below.

The function of each button is as follows:

Table 4.4.1.4.7.5-1 Area Specification Buttons

Button	Function
Whole	Specifies entire of the pattern as the selection area.
Any	Sets an arbitrary area as the selection area by specifying addresses. The address is specified by entering values in the **Input Range** dialog box.
Direct	Sets an arbitrary area as the selection area by specifying addresses. The address is specified by using a cursor.

How to specify the selection area using the **Any** is as follows.

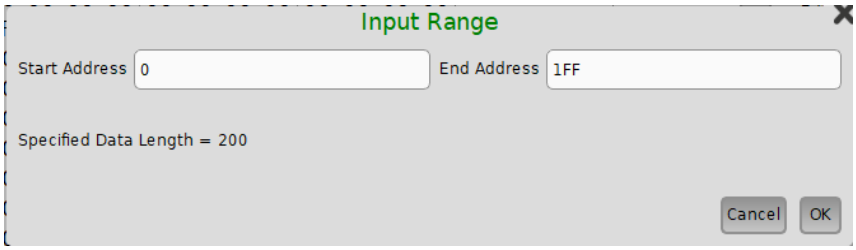


Figure 4.4.1.4.7.5-1 Input Range Dialog Box

1. Enter the start address of the selection area in the **Start Address** box.
2. Enter the end address of the selection area in the **End Address** box.
3. Touch **OK** to set the specified area as the selection area. The selection area is highlighted in the **Pattern Editor** dialog box.

How to specify the selection area using the **Direct** is as follows.

1. Touch **Direct**.
   The color of the button turns green and the operation changes to **Direct**. Note that pattern input and editing cannot be performed in the **Direct**.
2. Specify the start position of the selection area by touching twice the desired position.
3. Specify the end position of the selection area by touching once the desired position.
4. The selection area is now completely set.

The selection area can also be specified by dragging the mouse.

4.4.1.4.7.6 Inputting pattern

How to input a pattern by using the buttons in the Fill frame is described below. The function of each button is as follows:

Table 4.4.1.4.7.6-1 Fill Button Functions

Button	Function
0	Replaces the bit of the cursor position or the bits in the selection area to “0”.
1	Replaces the bit of the cursor position or the bits in the selection area to “1”.
Reverse	Inverts the bit of the cursor position or the bits in the selection area.
Pattern	Inputs an arbitrary pattern repeatedly.

■ How to input a pattern using the **Pattern** is as follows.

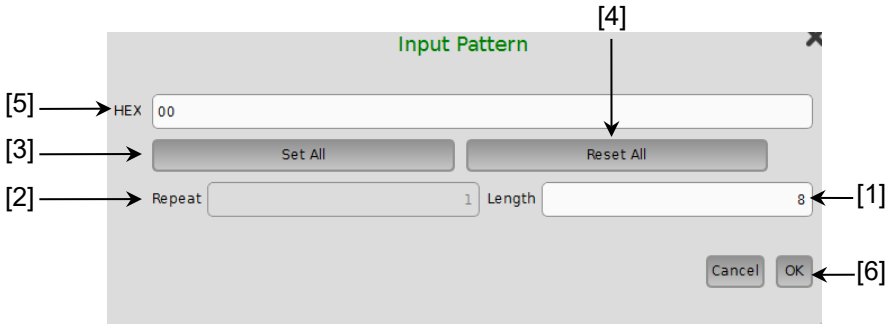


Figure 4.4.1.4.7.6-1 Input Pattern Dialog Box

[1] Enter the number of bits to be input.

[2] Enter the number of specified pattern repetition times.

[3] Touch **Set All** to set all the bits to “1”.

[4] Touch **Reset All** to set all the bits to “0”.

[5] Input a pattern into the BIN or HEX textbox.

[6] Touch **OK** to input the pattern to the cursor position.

Note:

When the **Input Pattern** dialog box is displayed while the selection area is specified, a repetition of the specified pattern is applied to the selection area, regardless of the number of repetition times specified in the Repeat spin box.

4.4.1.4.7.7 Compatibility with test pattern files of existing models

Pattern files (.PTN) created for the following existing models can be loaded into the **Pattern Editor** dialog box of the MU195020A.

MP1632C	Digital Data Analyzer
MP1761A/B/C	Pulse Pattern Generator
MP1762A/C/D	Error Detector
MP1775A	Pulse Pattern Generator
MP1776A	Error Detector
MU181020A/B	Pulse Pattern Generator
MU181040A/B	Error Detector
MU183020A	Pulse Pattern Generator
MU183021A	Pulse Pattern Generator
MU183040A/B	Error Detector
MU183041A/B	Error Detector

4.4.1.4.8 Setting sequence

This section describes how to use the MU195020A-x50 Sequence Editor Function.

Setup

Launch the MX190000A, in the Module and Boxes screen, select the **FPGA** and **Firmware** check boxes for MU195020A, and touch **Program** at the top right of the screen.

Note:

When you touch **Program** for the first time after MU195020A-x50 addition, the **FPGA** check box will remain selected even after the FPGA has been programmed. In this case, touch **Program** again. It takes about 20 minutes to complete programming the FPGA twice.

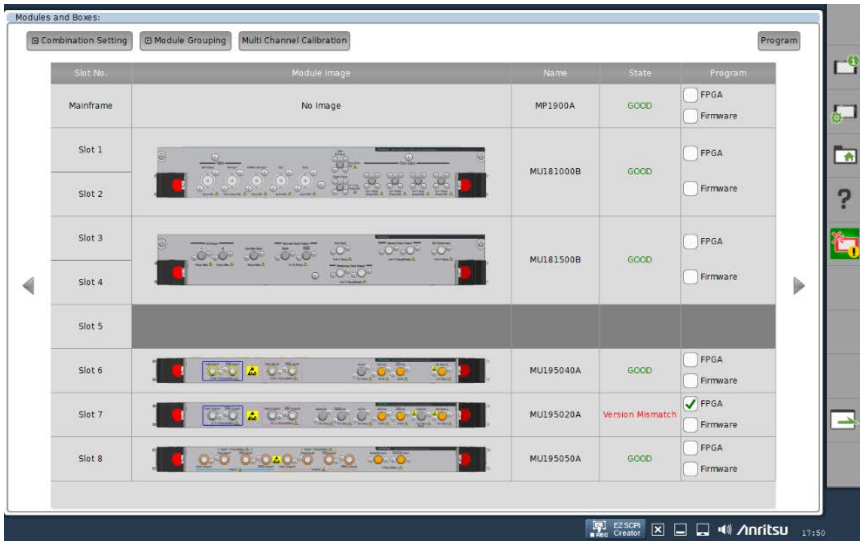


Figure 4.4.1.4.8-1 Module and Boxes Screen (After Completion of 1st Time Program Processing)

When **Sequence** is selected in the Test Pattern box, set parameters as follows.

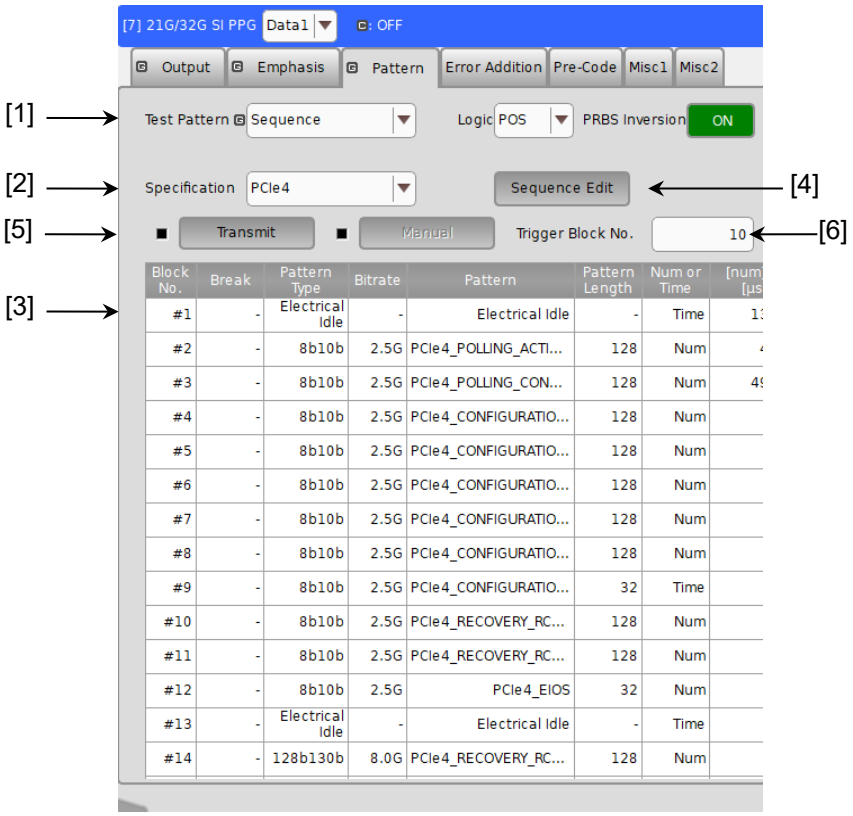


Figure 4.4.1.4.8-2 Parameters on the Pattern Tab (When Sequence is Selected)

[1] On the **Pattern** tab for MU195020A, select **Sequence** in the Test Pattern box.

[2] Select a test specification.

When MU181000A/B or MU191000A and MU181500B are configured as the Clock Source on the **Misc2** tab, the bitrate is set automatically.
When on the **Misc2** tab, **External** is selected in the Clock Source box, set the Clock Source frequency so that the bitrate becomes the value as specified in the selected specification. The Sequence Editor function cannot be used with bitrates other than the selected specification.

[3] Depending on the selected specification, the prepared sequence (hereinafter “the default sequence”) is displayed. The default sequence describes a typical pattern for making the DUT enter the Loopback.Active state.

[4] Touch **Sequence Edit** to open the Sequence Editor.
In the Sequence Editor, set the block parameters.

[5] Touch **Transmit** to start outputting the sequence pattern.

[6] Set the block No. of the block to output a trigger signal from the AUX Output connector. In the AUX Output box of the **Misc1** tab, select **LTSSM Trigger**.

4.4.1.4.9 Editing test pattern in Sequence Editor dialog box

This section describes how to edit the test pattern when the following pattern is selected on the **Pattern** tab.

- Sequence

4.4.1.4.9.1 Common setting items

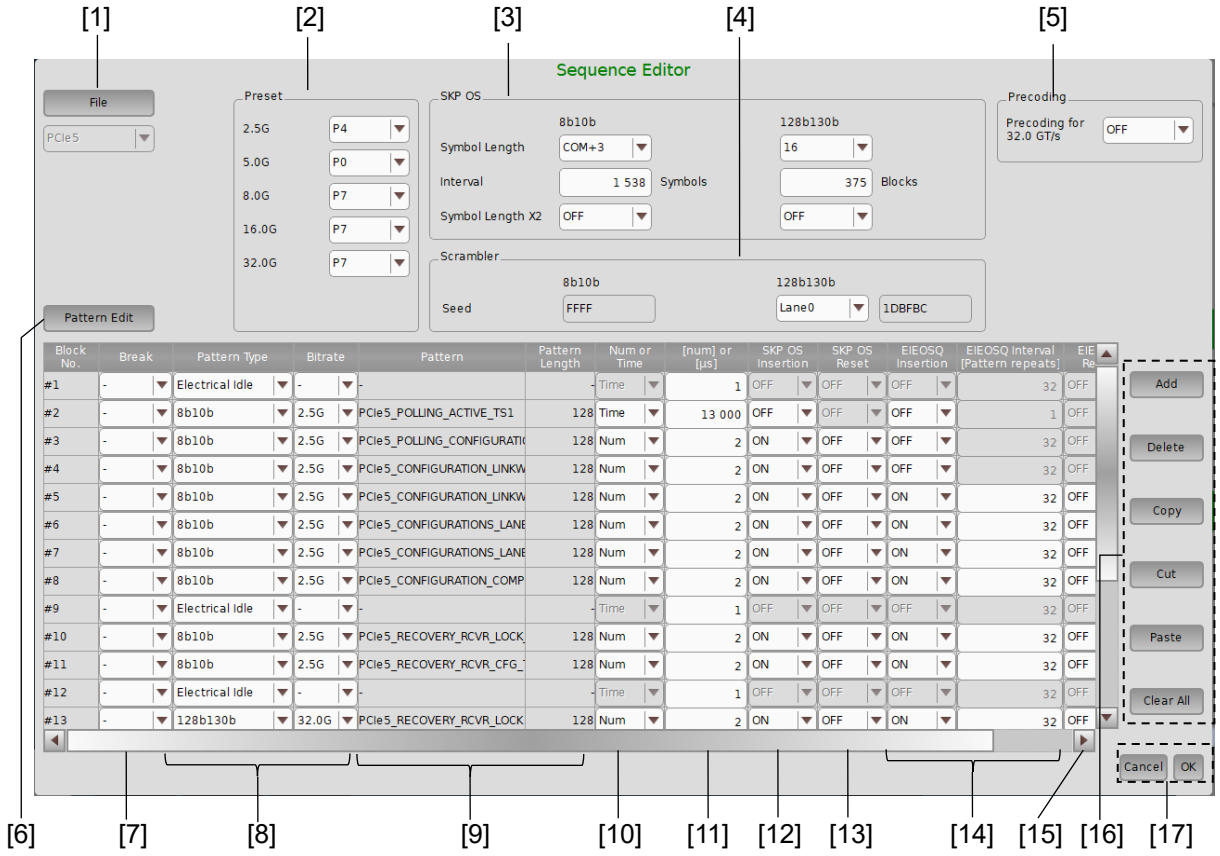


Figure 4.4.1.4.9.1-1 Sequence Editor Setting Items

Table 4.4.1.4.9.1-1 Sequence Editor Setting Items

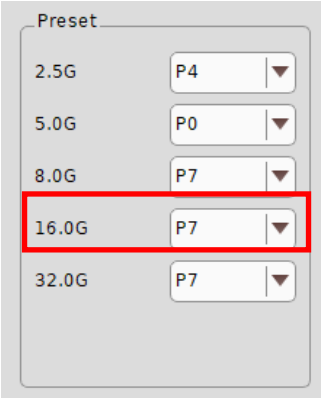
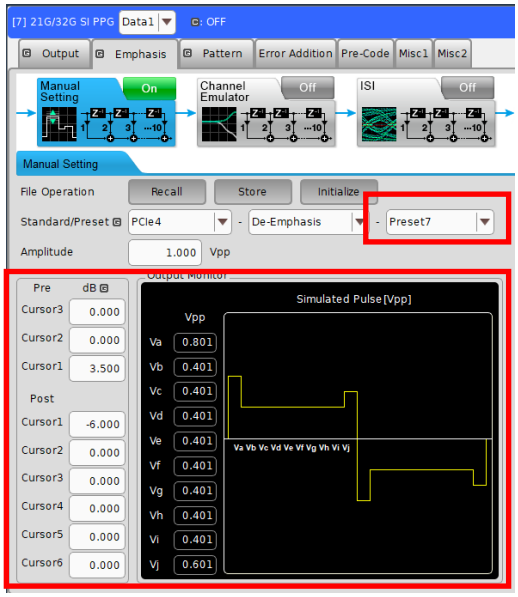
No.	Item	Description
[1]	File	Saves all the editions, including the edited patterns, made in the Sequence Editor to a file. Touch **File** → **Save** to save to any directory.
[2]	Preset	Sets the Preset value of Emphasis used for each bitrate. P0 to P10 correspond to Preset0 to 10 on the **Emphasis** tab for MU195020A. In the following example, the emphasis set in Preset7 is used for outputting a 16G signal.  
[3]	SKP OS	Sets the conditions for SKP insertion interval and length for each encoding rule.
[4]	Scrambler	Displays the Scrambler seed value for each encoding rule. For 128b130b (PCIe3/4), the seed value varies by Lane. The generator polynomial for each encoding rule is shown below. • 8b10b (PCIe1, 2, USB3.0) $G(X) = X^{16}+X^5+X^4+X^3+1$ • 128b130b (PCIe3, 4, 5) / 128b132b (USB3.1 Gen2) $G(X) = X^{23}+X^{21}+X^{16}+X^8+X^5+X^2+1$
[5]	Precoding for 32.0 GT/s	This is available only when **PCIe5** is selected for Specification. When set to **ON**, Precoding is applied to symbols subject to scrambler (the **Scrambler Enable** check selected) when outputting a 32 GT/s pattern.
[6]	Pattern Edit	Opens the **Pattern Editor** dialog box.

Table 4.4.1.4.9.1-1 Sequence Editor Setting Items (Cont'd)

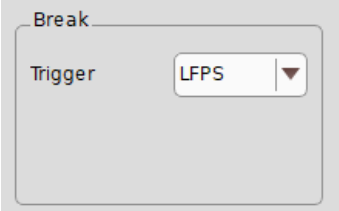
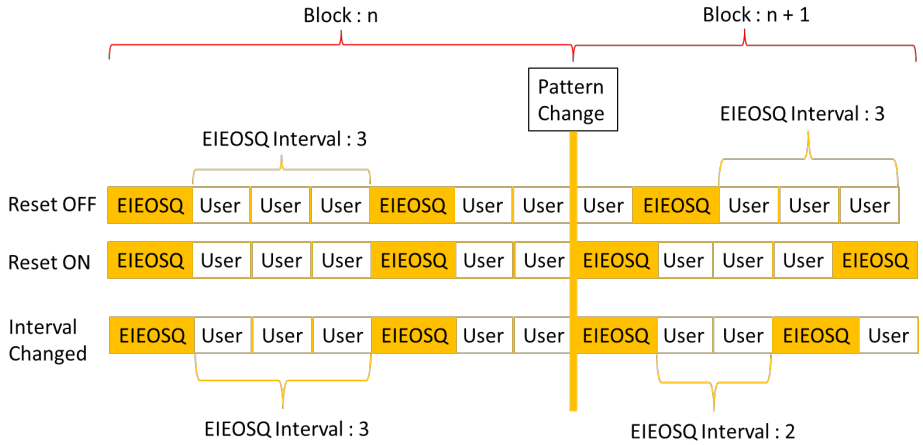
No.	Item	Description
[7]	Break	Sets the conditions for suspending and resuming the pattern transition. When Break is set to **Manual**, the sequence transits from the block at which it paused to the next block if you touch **Manual** on the **Pattern** tab. When Break is set to **External**, the sequence transits from the block at which it paused to the next block upon detection of a trigger signal at the AUX Input connector of the MU195020A. When a USB standard is selected in the **Specification** box of the **Pattern** tab, you can select a trigger condition for External from LFPS signal reception or Edge detection. 
[8]	Pattern Type, Bitrate	To change the bitrate, insert Electrical Idle between blocks. (See Block No. 12 to 14 shown in Figure 4.4.1.4.9.1-1.) If Electrical Idle is not inserted between 2 consecutive Blocks, an unexpected pattern may be output when Bitrate is changed. Pattern Type can be set to **General** for the last block only. When **General** is selected, an available PRBS or Data pattern can be set.
[9]	Pattern / Pattern Length	By touching **Pattern Edit** with any block selected, the Pattern Editor displayed according to the pattern type. For details on how to use Pattern Editor, refer to 4.4.1.4.9.2 "Editing 8b10b data pattern" through 4.4.1.4.9.4 "Editing 128b132b data pattern".
[10]	Num or Time	Sets the repeated transmission mode of the selected block pattern to Num (number of repetitions) or Time (period of time).
[11]	[num] or [µs]	Sets the number or times or the period of time according to the setting made in the Num or Time box.
[12]	SKP OS Insertion	Inserts SKP OS into the pattern according to the Symbol Length and Interval settings under SKP OS at the top right of the Sequence Editor screen when set to **ON**.
[13]	SKP OS Reset	Inserts SKP OS at the beginning of the block after the block transition when set to **ON**.

Table 4.4.1.4.9.1-1 Sequence Editor Setting Items (Cont'd)

No.	Item	Description
[14]	EIEOSQ Insertion / Interval*	Inserts EIEOSQ into the pattern according to the EIEOSQ Interval setting when set to **ON**. Basically set to **ON** because EIEOSQ is required in pattern synchronization for 128b/130b.
[15]	EIEOSQ Reset*	Inserts EIEOSQ at the beginning of the block after the block transition when set to **ON**. Even when set to **OFF**, if the EIEOSQ Interval differs among blocks, EIEOSQ is inserted at the beginning. EIEOSQ consists of one EIEOS for the bit rate of 8 Gbit/s and 16 Gbit/s, or two consecutive EIEOS for 32 Gbit/s. 
[16]	Add, Delete, Copy, Cut, Paste, Clear All	Used for editing blocks.
[17]	Cancel, OK	**OK**: Sets the created sequence. **Cancel**: Discards the created sequence.

*: SYNCOS when USB3.1 Gen2 is selected.

4.4.1.4.9.2 Editing 8b10b data pattern

Using the on-screen keypad at the right bottom or the keyboard, set a pattern per 8-bit symbol. Set patterns with K and D codes.

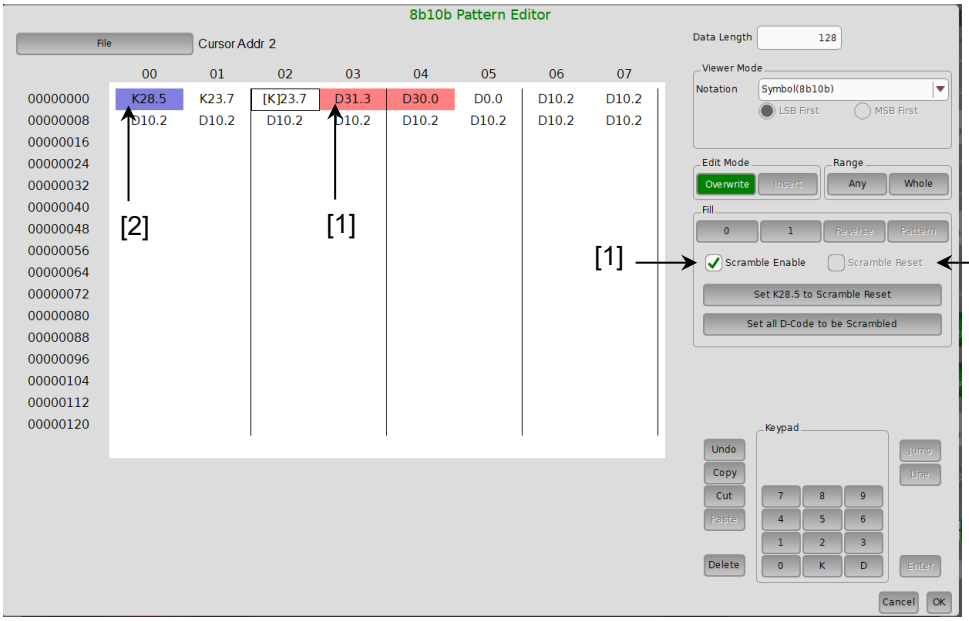


Figure 4.4.1.4.9.2-1 8b10b Pattern Editor

[1] To use a scrambler, select the **Scrambler Enable** check box, select (touch) at least one pattern symbol where to enable the scrambler, and touch **1** under **Fill**. The symbols displayed with red background are subject to scrambler. Scrambling is applied only to D codes.

[2] LFSR is initialized upon transmission of a symbol(s) with **Scrambler Reset** turned on. LFSR is also initialized when a COM symbol (K28.5) is sent. LFSR is initialized at the symbol displayed with blue background.

4.4.1.4.9.3 Editing 128b130b data pattern

Set a pattern for each 128bit pattern + Sync Header.

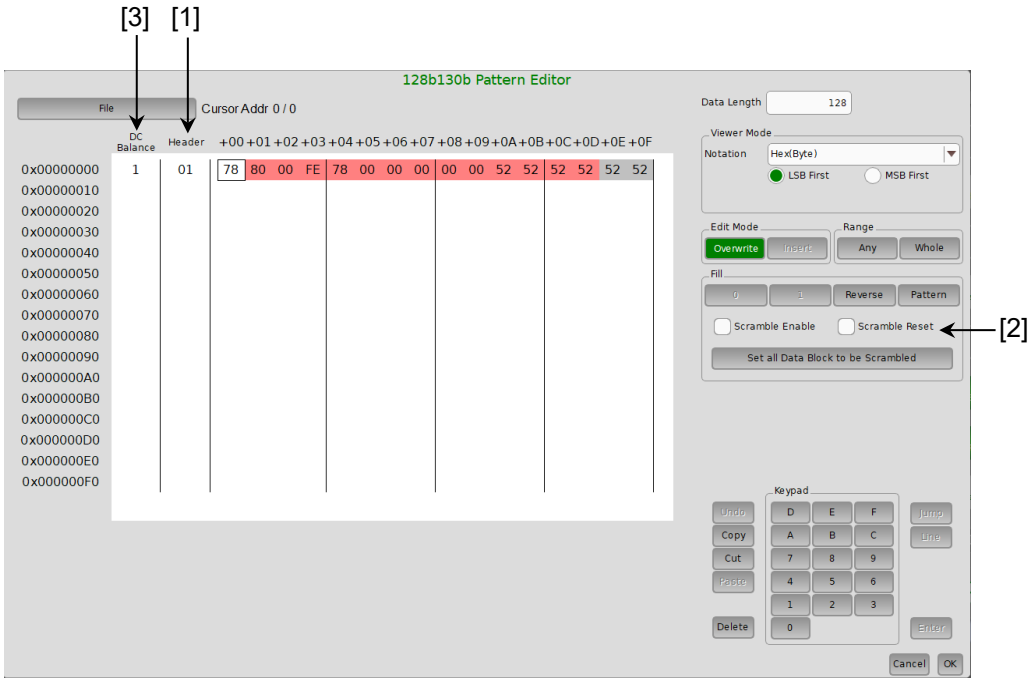


Figure 4.4.1.4.9.3-1 128b130b0 Pattern Editor

[1] Set Sync Header for each Data and Ordered Set as shown in the table below.

Table 4.4.1.4.9.3-1 Sync Headers for 128b130b Pattern Editor

	Sync Header	
	10	**01**
LSB First	Data	Ordered set
MSB First	Ordered set	Data

[2] Scrambler Enable and Scrambler Reset can be set in the same way as 8b10b.

[3] When DC Balance is set to 1, the transmission pattern of Symbol 14 and Symbol 15 is determined by the following rule.

Table 4.4.1.4.9.3-2 Rule on Determination of Transmission Pattern

DC Balance at the End of Symbol 11 of the TS Ordered Set	Transmission Pattern of Symbol 14 and Symbol 15
> 31	Transmit DFh for Symbol 14 and F7h for Symbol 15 to reduce the number of 0s, or 20h for Symbol 14 and 08h for Symbol 15 to reduce the number of 1s.
≤31 and >15	Transmit F7h for Symbol 15 to reduce the number of 0s, or 08h for Symbol 15 to reduce the number of 1s. Transmit the normal TS Identifier Symbol (scrambled) for Symbol 14.
≤15	Transmit the normal TS Identifier Symbol (scrambled) for Symbols 14 and 15.

4.4.1.4.9.4 Editing 128b132b data pattern

Except that the number of Sync Header bits is 4, it is used in the same way as the 128b130b Pattern Editor in ii.

Set Sync Header for each Data and Ordered Set as shown in the table below.

Table 4.4.1.4.9.4-1 Sync Headers for 128b132b Pattern Editor

	Sync Header	
	1100	0011
LSB First	Ordered set	Data
MSB First	Data	Ordered set

4.4.1.5 Adding Errors

An error can be added to output data by configuring the error occurrence settings on the **Error Addition** tab of the MU195020A operation window.

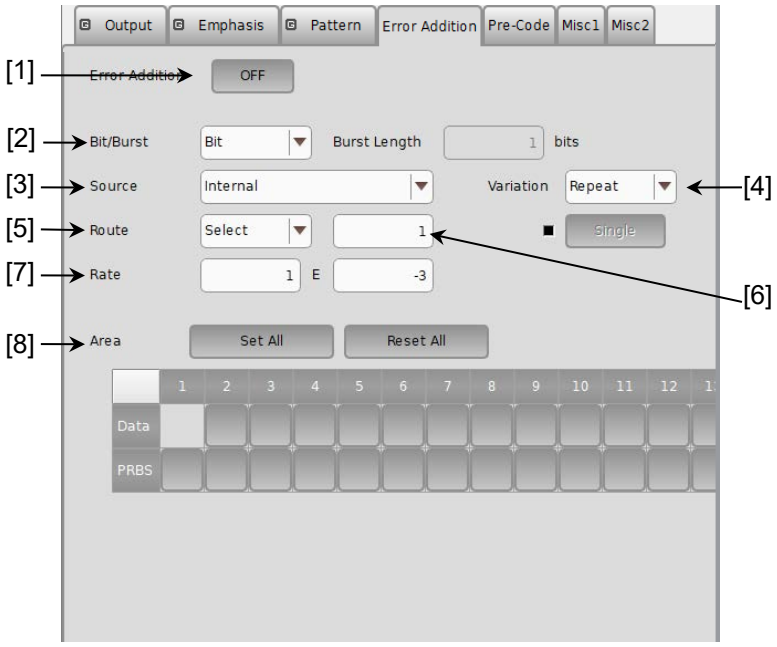


Figure 4.4.1.5-1 Error Addition Tab

[1] Enables/disables generating a bit error for the test pattern.

ON: Enables the error addition function.
OFF: Disables the error addition function.

Note that this setting affects all error addition functions. When set to **OFF**, bit error addition triggered by an external error signal is also disabled.

[2] Select an error addition mode from **Bit** and **Burst**. When **Burst** is selected, up to 127 consecutive errors can be added.

[3] Selecting error adding source

Select the method for generating the timing to add a specified bit error to the test pattern.

This can be set when Error-Injection is set for AUX Input on the **Misc1** tab.

Table 4.4.1.5-1 Error Addition Source Setting

Selection item	Description
Internal	The error addition timing is generated by the internal circuit.
External-Trigger	The error addition timing is generated in synchronization with the trigger edge of the external signal input from the Auxiliary Input connector.
External-Disable	The error addition timing is generated by the internal circuit, but an error is not added when the external signal input from the Auxiliary Input connector is low.

[4] When Internal or External-Disable for Source, error-addition variation can be selected. Select the error addition method when adding an error (internal Gating).

Table 4.4.1.5-2 Error Addition Method Setting

Selection item	Description
Repeat	An error is continuously added.
Single	An error is added once when the button is touched. In Combination function, errors as many as the number of Combined channels are added once when the button is touched.

[5] Select the method for adding an error addition route

MU195020A outputs test pattern synthesizing by multiplexer.

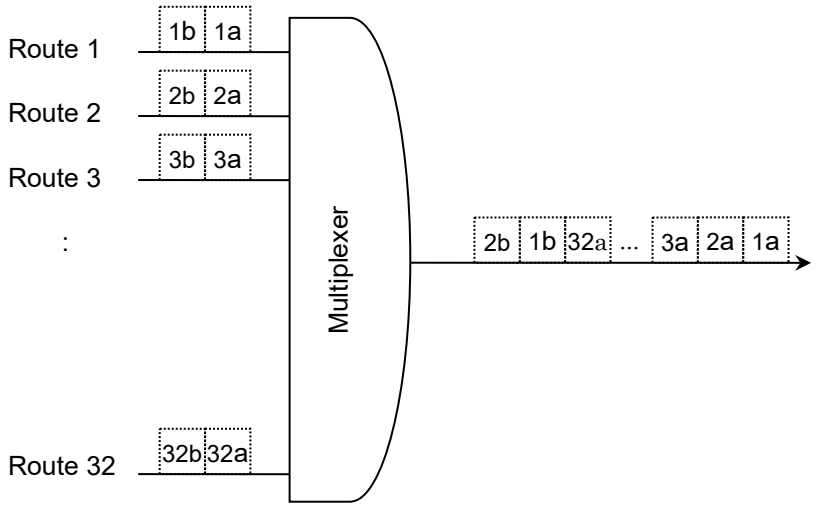


Figure 4.4.1.5-2 Parallel-Serial Conversion of Test Pattern

Input signal from the multiplexer is called “Route”. MU195020A has 32 routes.

Table 4.4.1.5-3 Error Addition Route Setting

Selection item	Description
Scan	Changes a route to add an error by turns.
Select	An error is added to the specified route.

[6] Specify a route to generate a 1-bit error for the test pattern. The route can be specified from 1 to 32, in single steps.

Note that the following restrictions apply.

(a) This setting is valid even when the error addition function is set to **OFF**.

(b) This setting is invalid when **Scan** is selected in the **Route** down list.

[7] Select the bit error rate to generate a 1-bit error for the test pattern.

xE–n: x can be set to 1 to 9, in single steps.
n can be set to 3 to 12, in single steps.

Note that the following restrictions apply.

(a) The setting is valid even when the error addition function is set to **OFF**.

(b) This setting is invalid when the error addition variation setting is set to Single.

(c) This setting is invalid when the error addition source is set to External-Trigger.

(d) x can be set to 1 to 5 when n is set to 3.

(e) Maximum insertion bit rate is 5E–3.

[8] For the Mixed pattern, select the block (Data, PRBS and Block No.) where a bit error is to be added.

4.4.1.6 Setting Pre-Code Function

Pre-Code function can be set when Combination in 4.4.1.9 “Multi-Channel Function” is selected for the MU195020A-x20.

Since this function supports DQPSK, it can calculate and output Data as shown in the following Pre-Code logic diagram.

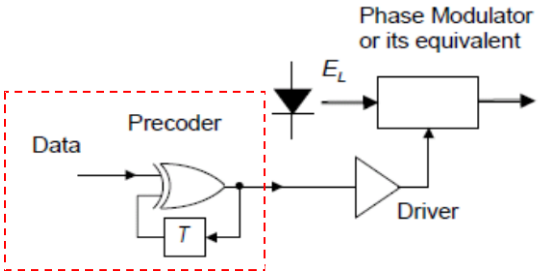


Figure 4.4.1.6-1 Pre-Code Logic (DQPSK) Diagram

To set the Pre-Code function, touch the **Pre-Code** tab of the MU195020A application.

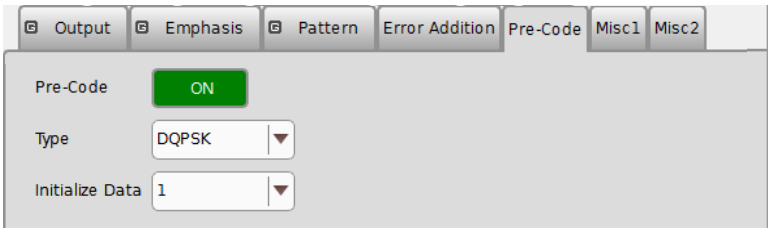


Figure 4.4.1.6-2 Pre-Code Tab

Note:

Pre-Code Settings are common to all channels where Combination function is set.

4.4.1.6.1 Pre-Code setting

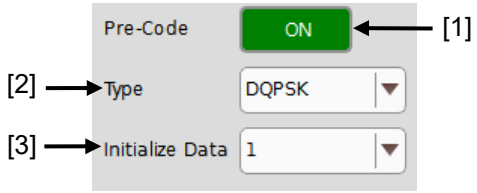


Figure 4.4.1.6.1-1 Pre-Code Setting Area

Table 4.4.1.6.1-1 Pre-Code Setting Items

No.	Item	Function
[1]	Pre-Code	Sets Pre-Code ON, OFF
[2]	Type	Sets Pre-Code modulation method When 2ch Combination selected: DQPSK
[3]	Initialize Data	Sets Pre-Code to default values (Default: 1)

4.4.1.7 Misc1 Function (MU195020A)

The settings of the signal generating method, synchronized output, and auxiliary input/output can be configured.
Touch the **Misc1** tab of the MU195020A operation window to configure the Misc function.

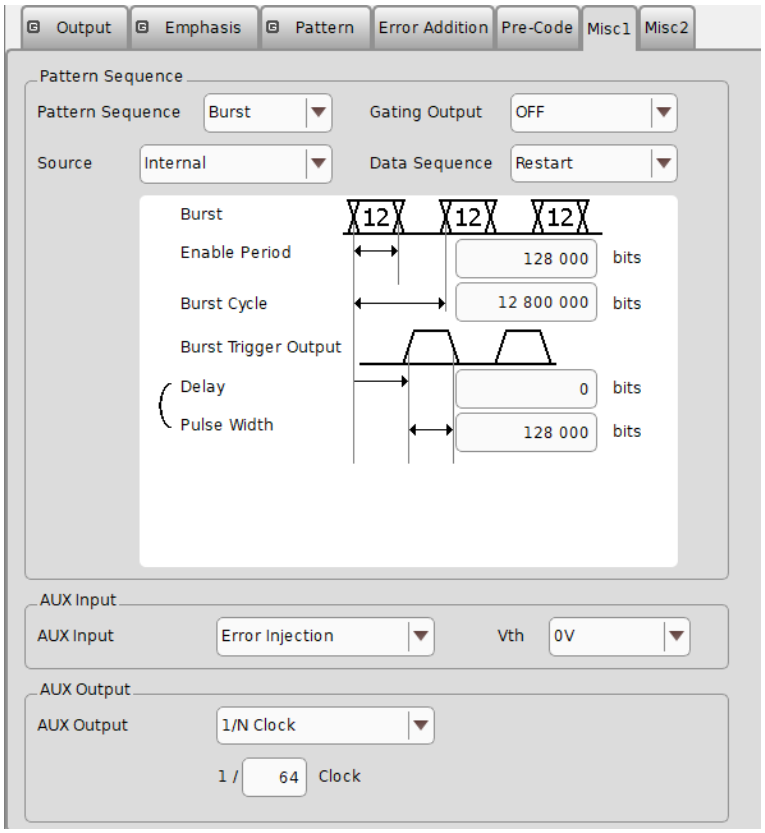


Figure 4.4.1.7-1 Misc1 Tab

Table 4.4.1.7-1 Setting Items

Setting Area	Description
Pattern Sequence	Set the test pattern generating method.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.
Gating Output	Set the timing signal output.

Settings on the **Misc1** tab are common to Data 1 to Data 2 of MU195020A.
Settings related to the pattern length depend on the Data1 settings.

4.4.1.7.1 Setting Pattern Sequence

Select the signal generating method.

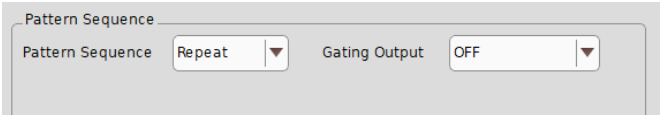


Figure 4.4.1.7.1-1 Selecting Pattern Sequence

Table 4.4.1.7.1-1 Pattern Sequence Setting

Selection Item	Description
Repeat	Select when transmitting the test pattern Repeat data. Mainly used for electric device evaluation.
Burst	Select when transmitting the test pattern Burst data. Mainly used for long-distance optical transmission tests such as an optical circulating loop test, and packet communications evaluation. The target test patterns are PRBS, ZeroSubstitution, Data, and Mixed (Data).

4.4.1.7.1.1 Setting Repeat pattern

Select **Repeat** from the **Pattern Sequence** list to transmit the test pattern Repeat data.

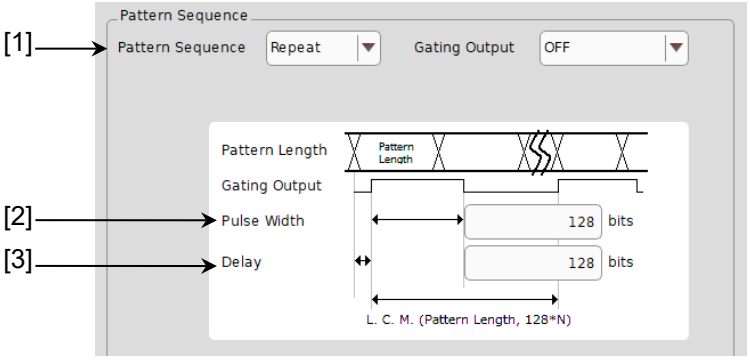


Figure 4.4.1.7.1.1-1 Setting Items for Repeat Pattern Sequence

[1] Select **Repeat** from the **Pattern Sequence** list, and generate continuous test patterns and data signals.

[2] In the Pulse Width textbox, specify the high level pulse width of the synchronization signal that is output from the Gating Out connector on the MU195020A front panel. The pulse width should be a multiple of 8. The Pulse Width value can be calculated by the expression in Table 4.4.1.7.1.1-1.

Table 4.4.1.7.1.1-1 Pulse Width Setting Range

Periodic Signal	Setting Range
PRBS, Data, ZeroSubstitution	128 to (Least common multiple of Pattern length and 128) – 128* (The maximum settable number is 34 359 738 240) Setting step: 8 bit In the case of 2ch Combination (the target test patterns are PRBS, Data, and ZeroSubstitution) is 256 to (Least common multiple of Pattern Length and 256) – 256 and the setting step becomes 16 bits. (The maximum settable number is 68 719 476 480)
Mixed	128 to (Row length × Number of Rows × Block count) – 128 (The maximum settable number is 2 415 918 976) Setting step: 8 bit In the case of 2ch Combination is 256 to (Row length × Number of rows × Block count) – 256, and the setting step becomes 16 bits.

*: The pattern length described here is the number multiplied by an integer so that it becomes 512 bits or more, when the length on the Figure 4.4.1.4-1 Pattern Tab is 511 bit or less.

At 2ch Combination, the pattern length described here is the number multiplied by an integer so that it becomes 1024 or more, when the length on the Figure 4.4.1.4-1 Pattern Tab is 1023 or less.

[3] In the Delay textbox, specify the number of bits the high level pulse output is delayed from the beginning of the data pattern.
The delay should be a multiple of 8 and is calculated by the expression in Table 4.4.1.7.1.1-2.

Table 4.4.1.7.1.1-2 Delay Setting Range

Periodic Signal	Setting Range
PRBS, Data, ZeroSubstitution	128 to (Least common multiple of Pattern length and 128) – 128* (The maximum settable number is 34 359 738 240) Setting step: 8 bit In the case of 2ch Combination (the target test patterns are PRBS, Data, and ZeroSubstitution), is 256 to (Least common multiple of Pattern Length and 256) –256 and the setting step becomes 16 bits. (The maximum settable number is 68 719 476 480)
Mixed	128 to (Row length × Number of Rows × Block count) –128 (The maximum settable number is 2 415 918 976) Setting step: 8 bit In the case of 2ch Combination is 256 to (Row length × Number of rows × Block count) –256, and the setting step becomes 16 bits.

*: The pattern length described here is the number multiplied by an integer so that it becomes 512 bits or more, when the length on the Figure 4.4.1.4-1 Pattern Tab is 511 bit or less.

At 2ch Combination, the pattern length described here is the number multiplied by an integer so that it becomes 1024 or more, when the length on the Figure 4.4.1.4-1 Pattern Tab is 1023 or less.

4.4.1.7.1.2 Setting Burst pattern

Select **Burst** from the **Pattern Sequence** list to transmit the test pattern Burst data.

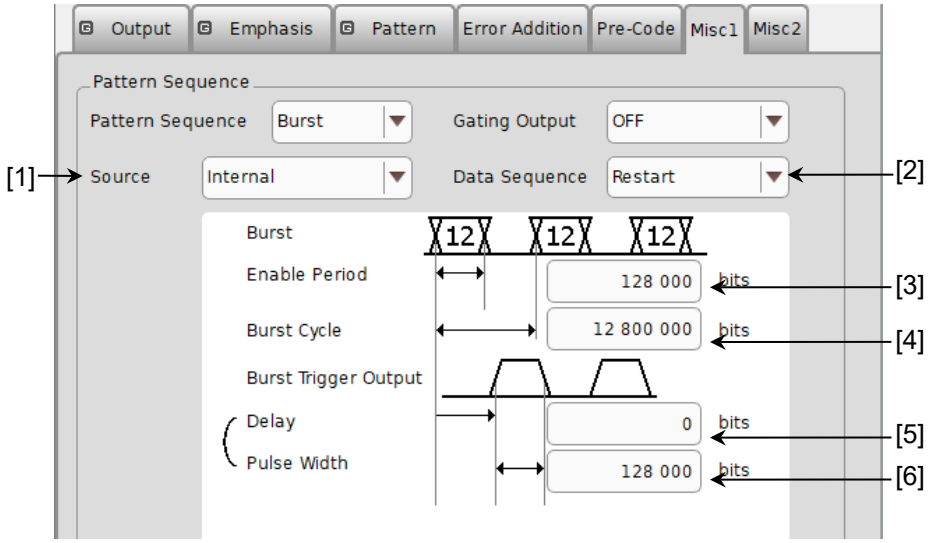


Figure 4.4.1.7.1.2-1 Setting Items for Burst Pattern Sequence

Note:

The Burst Trigger Output signal is output from the Gating Out connector.

[1] Select the timing to generate test patterns with the Burst signal.

Table 4.4.1.7.1.2-1 Burst Setting Items

Selection Item	Description
Internal	The Burst signal occurrence timing is generated by the internal circuit.
External-Trigger	The Burst signal occurrence period is generated based on the gate signal input from the AUX In connector. Burst signal generation starts at the rising edge of the input gate signal.
External-Enable	The Burst signal occurrence period is generated based on the gate signal input from the AUX In connector. The Burst signal is generated when the gate signal is high, and is not generated when the gate signal is low.

[2] Specify the burst pattern generating sequence.

Table 4.4.1.7.1.2-2 Burst Pattern Generation Sequence Settings

Selection Item	Description
Restart	The specified test pattern is restarted from the beginning each time a Burst signal occurs.
Consecutive	The specified test pattern is continuously output between Burst signals.
Continuous	The specified test pattern is continuously output, and outputs other than during the Burst signal occurrence are masked.

[3] When **External-Trigger** or **Internal** is selected from the **Source** list, set the continuous signal generation period for the Burst cycle of the test pattern to be input to the AUX Input connector, by entering the number of bits in the **Enabled Period** box.

The setting ranges for Enable Period are shown in Table 4.4.1.7.1.2-3.

[4] When **Internal** is selected from the **Source** list, set the Burst cycle (one cycle of the Burst signal of the test pattern to be input) by entering the number of bits in the **Burst Cycle** box.

The setting ranges for Burst Cycle are shown in Table 4.4.1.7.1.2-3.

Table 4.4.1.7.1.2-3 Setting Ranges for Enable Periods and Burst Cycles

No. of Channel Combinations	Enable Period (bit)	Burst Cycle (bit)	Setting Steps (bit)
1	When **Internal** is set: 12 800 to 2 147 483 392	25 600 to 2 147 483 648	256
	When **External-Trigger** is set: 12 800 to 2147 483 648		
2	When **Internal** is set: 25 600 to 4294 966 784	51 200 to 4 294 966 296	512
	When **External-Trigger** is set: 25 600 to 4294 967 296		

Note:

A Disable period of at least 512 bits is required between Burst Cycle and Enable Period.
The Disable period is doubled at 2ch Combination.

[5], [6]

Set the Burst timing signal that is output from the Burst Trigger Output connector.

Delay: Specify how many bits the data output is delayed from the beginning of the Burst data pattern.

Pulse Width: Specify the high level pulse width of the synchronization signal that is output from the Burst Trigger Output connector.

The setting ranges for Delay and Pulse Width are shown in Table 4.4.1.7.1.2-4.

Table 4.4.1.7.1.2-4 Setting Ranges for Delay and Pulse Width

No. of Channel Combinations	Delay (bit)	Pulse Width (bit)	Setting Steps (bits)
1	0 to (Burst cycle – 128)	0 to (Burst cycle – 128)	8
2	0 to (Burst cycle – 256)	0 to (Burst cycle – 256)	16

4.4.1.7.2 Setting AUX Input

Use the AUX Input connector when adding an error based on the externally-generated timing signal.
The following table shows the functions that use AUX Input connector.

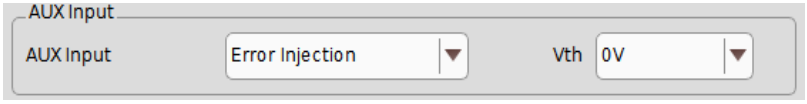


Figure 4.4.1.7.2-1 Setting Items for AUX Input

Table 4.4.1.7.2-1 Setting Items

Selection Item	Description
Error Injection	Select when adding an error based on the timing of an external signal. This is used when **External-Trigger** or **External-Disable** is selected from the **Source** list on the **Error Addition** tab (refer to 4.4.1.5 "Adding Errors" for details).
Burst	Select when **Burst** is selected from the **Pattern Sequence** list, and **External-Trigger** or **External Enable** is selected from the **Source** list. Refer to 4.4.1.7.1.2 "Setting Burst pattern" for details.
Vth	Select input threshold from 0V, –0.25V, or –0.5V.

4.4.1.7.3 Setting AUX Output

The output settings of auxiliary signals, such as the synchronization signal, can be configured.

4.4.1.7.3.1 Setting 1/N Clock

When **1/N Clock** is selected from the **AUX Output** list, a clock can be output from the AUX Output connector in synchronization with the test pattern.

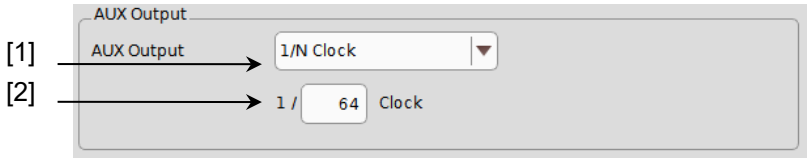


Figure 4.4.1.7.3.1-1 Setting Items for AUX Output Clock

[1] When **1/N Clock** is selected from the **AUX Output** list, a clock can be output from the AUX Output connector in synchronization with the test pattern.

[2] The frequency dividing ratio for the synchronization clock (N) can be set.
The setting range for the setting frequency is 4 to 512, stepping 2.

4.4.1.7.3.2 Setting Pattern Sync

When **Pattern Sync** is selected from the **AUX Output** list, a timing signal can be generated in synchronization with the test pattern period.

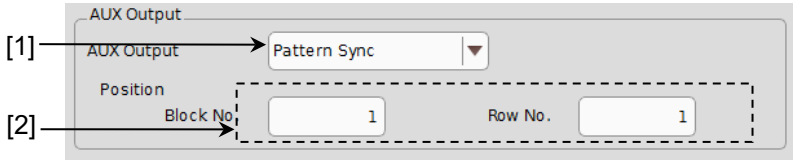


Figure 4.4.1.7.3.2-1 Setting Items for AUX Output Pattern Sync (Mixed)

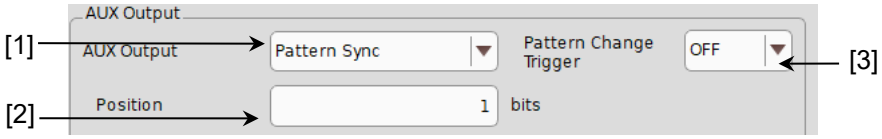


Figure 4.4.1.7.3.2-2 Setting Items for AUX Output Pattern Sync (Other Than Mixed)

[1] When **Pattern Sync** is selected from the **AUX Output** list, a pulse signal can be output from the AUX Output connector in synchronization with the set data pattern period.

[2] The synchronization signal pulse generation position can be set. The setting method varies depending on the test pattern.

[3] When **ON** is selected, a trigger signal is output from the AUX Output connector at test-pattern changeover.

Table 4.4.1.7.3.2-1 Synchronization Signal Pulse Generation Position Setting

Test Pattern	Description
PRBS, Data, ZeroSubstitution	A signal pulse is generated in a pattern period. The pulse position can be specified within the range below, starting from the beginning of the pattern. 1 to {(Least common multiple of Pattern Length* and 128)–135}, in 8-bit steps. The maximum settable number is 34 359 738 105 In the case of 2ch Combination: 1 to {(Least common multiple of Pattern Length* and 256) –287}, in 16-bit steps. The maximum settable number is 68 719 476 209
Mixed (Data)	A signal pulse is generated during the entire block generation pattern period. The pulse position can be specified by the positions of Block and Row.

*: The pattern length described here is the number multiplied by an integer so that it becomes 512 bits or more, when the length on the Figure 4.4.1.4-1 Pattern Tab is 511 bit or less.

At 2ch Combination, the pattern length described here is the number multiplied by an integer so that it becomes 1024 or more, when the length on the Figure 4.4.1.4-1 Pattern Tab is 1023 or less.

4.4.1.7.3.3 Setting pattern Burst Output2

When **Burst** is selected from the **Pattern Sequence** list, a timing signal similar to the Burst Trigger Output signal can be outputted from the AUX Output connector.

Table 4.4.1.7.3.3-1 Burst Output2 Setting

Setting Item	Description
Delay	Specify how many bits the data output is delayed from the beginning of the Burst data pattern. The setting range is similar to Table 4.4.1.7.1.2-4 Setting Ranges for Delay and Pulse Width.
Pulse Width	Specify the high level pulse width of the synchronization signal that is output from the Burst Trigger Output connector. The setting range is similar to Table 4.4.1.7.1.2-4 Setting Ranges for Delay and Pulse Width.

4.4.1.7.3.4 Setting output to Off

When set to OFF, the AUX Output connector does not output signals.

4.4.1.7.4 Setting Gating Output

Set the output from the Gating Output connector to On or Off.

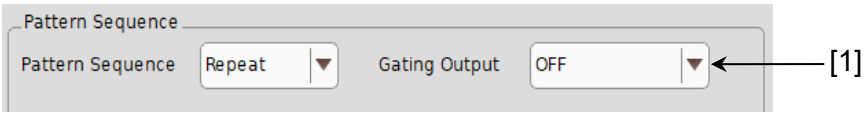


Figure 4.4.1.7.4-1 Gating Output Setting

Table 4.4.1.7.4-1 Gating Output Setting

Selection Item	Description
ON	The Gating Output connector outputs synchronization signals set by pattern sequence.
OFF	The Gating Output connector does not output signals.

4.4.1.8 Misc2 Function

On the **Misc 2** tab, you can perform the Clock Setting and Combination Setting of multiple channels.

To set up Misc2, touch the **Misc2** tab on the MU195020A operation screen.

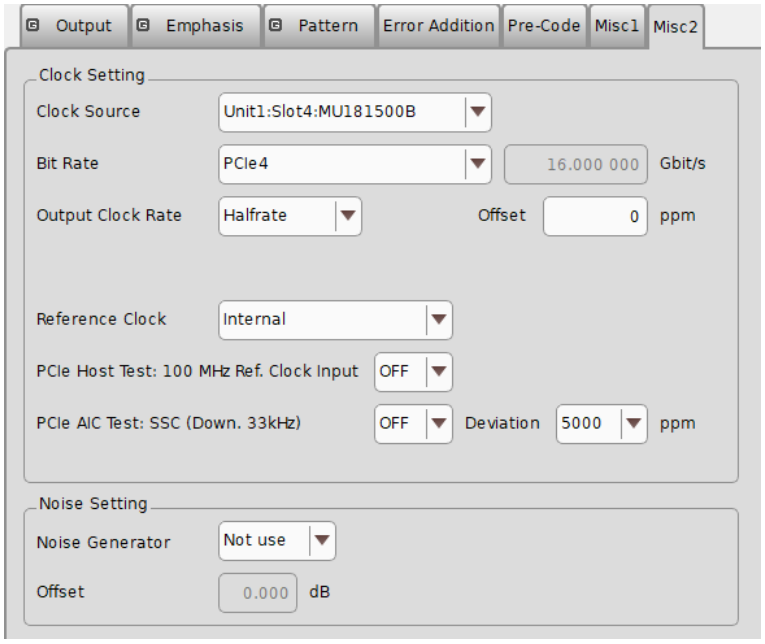


Figure 4.4.1.8-1 Misc2 Tab

4.4.1.8.1 Setting clock

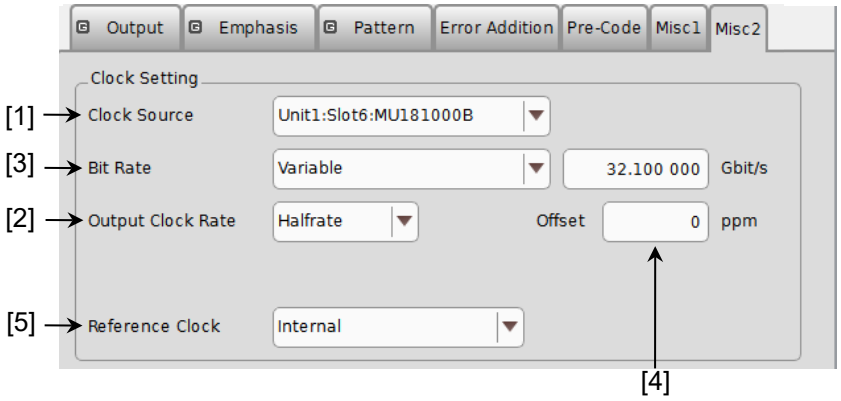


Figure 4.4.1.8.1-1 Setting Items for Clock Setting (When MU181000B Is Selected)

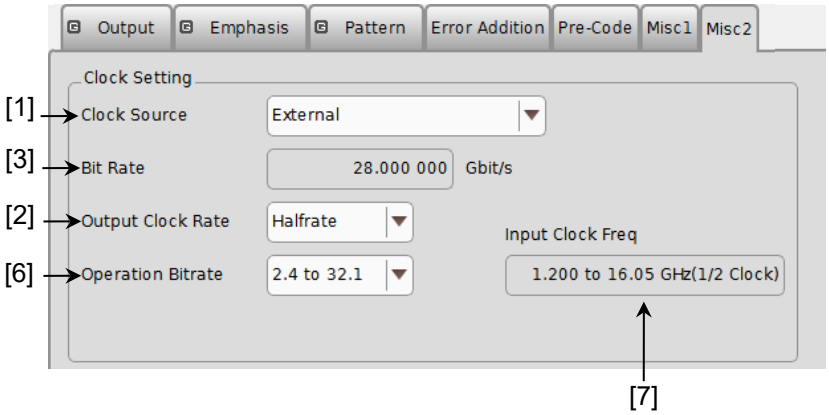


Figure 4.4.1.8.1-2 Setting Items for Clock Setting (When External Is Selected)

[1] Clock source can be selected from the drop-down list

Table 4.4.1.8.1-1 Clock Source Setting Items

Selection Item	Description
External	The clock input into Ext Clock Input connector of MU195020A.
MU181000A	The clock of an MU181000A that is installed in MP1900A.
MU181000B	The clock of an MU181000B that is installed in MP1900A.
MU191000A	The clock of an MU191000A that is installed in MP1900A.
MU181500B	The clock of an MU181500B that is installed in MP1900A.

[2] Set the clock rate to be output to the Clock Out connector.
Fullrate: Clock frequency is same as output data rate.
Halfrate: Clock frequency is half of output data rate.

When Clock Source is MU181000A/B or MU191000A

[3] Set the output bit rate. Select **Variable** or a preset standard value. For details, refer to 4.4.1.2.4 “Setting bit rate”.

[4] Set the frequency offset of the synthesizer module within the range from –1000 to 1000 ppm.

Offset is not displayed when Clock source is **External**.

[5] Set the reference clock of MU181000A/B or MU191000A.

When Clock Source is External

[3] Bit rate of output data is displayed.

[6] Output clock frequency range of MU195020A is displayed.

[7] Frequency of clock input to Input connector of MU195020A is displayed.

If “MU181500B” is selected in the **Clock Source** list [1], the frequency of the clock input to the MU181500B is displayed.
The relationship between operation bitrate and input clock frequency that vary depending on the options selected in the list boxes [2] and [6] is shown below. The values enclosed in parentheses apply when the 32G bit/s Extension MU195020A-x01 is not installed.

Table 4.4.1.8.1-2 Relationship Between Operation Bitrate and Input Clock Frequency (When Using External Clock)

Output Clock Rate Setting	Operation Bitrate Setting (Range)	Input Clock Freq Value (Display)	Relationship Between Bitrate and Clock Frequency
Full Rate Clock	2.4 to 16.0 Gbit/s	2.4 to 16.0 GHz	Operate at 1/1 clock
	16.0 to 20.0 Gbit/s	8.0 to 10.0 GHz	Operate at 1/2 clock
	20.0 to 32.1 (21.0) Gbit/s	10.0 to 16.05 (10.5) GHz	Operate at 1/2 clock
	25.0 to 32.1 Gbit/s	6.25 to 8.025 GHz	Operate at 1/4 clock
Half Rate Clock	2.4 to 32.1 (21.0) Gbit/s	1.2 to 16.05 (10.5) GHz	Operate at 1/2 clock
	25.0 to 32.1 Gbit/s	6.25 to 8.025 GHz	Operate at 1/4 clock

Table 4.4.1.8.1-3 Relationship Between Operation Bitrate and Input Clock Frequency (When Using MU181500B and External Clock)

Output Clock Rate Setting	Operation Bitrate Setting (Range)	Input Clock Freq Value (Display)	Relationship Between Bitrate and Clock Frequency
Full Rate Clock	2.4 to 15.0 Gbit/s	2.4 to 15.0 GHz	Operate at 1/1 clock
	15.0 to 20.0 Gbit/s	7.5 to 10.0 GHz	Operate at 1/2 clock
	20.0 to 30.0 (21.0) Gbit/s	10.0 to 15.0 (10.5) GHz	Operate at 1/2 clock
	25.0 to 32.1 Gbit/s	6.25 to 8.025 GHz	Operate at 1/4 clock
Half Rate Clock	2.4 to 30.0 (21.0) Gbit/s	1.2 to 15.0 (10.5) GHz	Operate at 1/2 clock
	30.0 to 32.1 Gbit/s	7.5 to 8.025 GHz	Operate at 1/4 clock

Clock connection and screen settings

Depending on the used clock source, change both clock connection with MU195020A and settings in the screen. The procedure for connecting MU195020A, clock source, and jitter source and setting the screen items that varies by used clock source is described below.

Note:

When MU181000A/B or MU191000A is used together with MU181500B in the configuration described here, these modules must be installed in the same MP1900A as the MU195020A.

Connection and setting of MU195020A used by the following configurations are described.

(1) MU195020A, MU181000A/B (or MU191000A), and MU181500B

(2) MU195020A and MU181000A/B (or MU191000A)

(3) MU195020A, MU181500B, and external clock source

(4) MU195020A and external clock source

Description is given according to the following configuration of MP1900A:

- MU181500B is installed to Slot1-2.
- MU195020A is installed to Slot3.
- MU181000B is installed to Slot6-7.

In addition, the procedure is described from the state that the clock source setting for each MU195020A and MU181500B is External (Default).

4.4.1.8.1.1 MU195020A, MU181000A/B Synthesizer, and MU181500B Jitter Modulation Source

Connecting to the clock

For connecting the MU195020A, MU181000A/B, and MU181500B to the clock, refer to the connection diagram and description in 3.2.3 “Adding Jitter to Output Signal” in *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*.

Setting in the screen

1. Select **Unit1:Slot6: MU181000B** from the **Synthesizer Clock Source** list in the MU181500B screen to make MU181500B and MU181000B track each other. (Refer to Figure 4.4.1.8.1.1-1.)
2. Select **Unit1:Slot2: MU181500B** from the **Clock Source** list in the MU195020A screen to make MU195020A and MU181500B track each other. (Refer to Figure 4.4.1.8.1.1-2.)
3. Now, you can set the bit rate of the output data to the Bit Rate box in the MU195020A screen. Figure 4.4.1.8.1.1-2 shows an example when the output data is set to 32.1 Gbit/s.

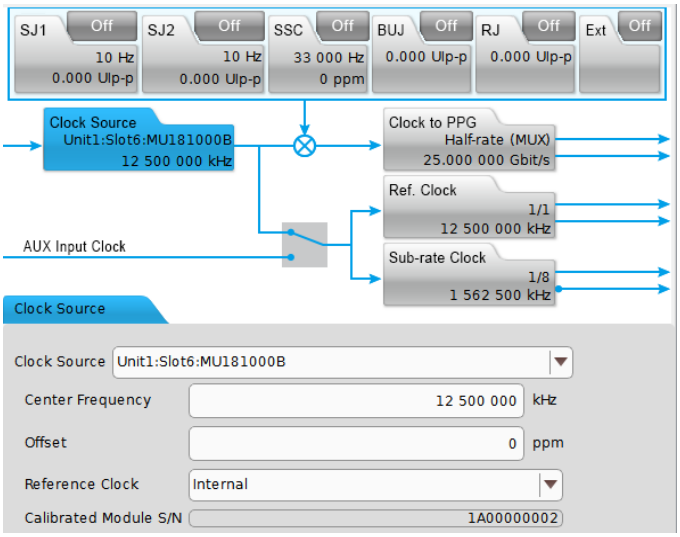


Figure 4.4.1.8.1.1-1 MU181500B Clock Source Settings

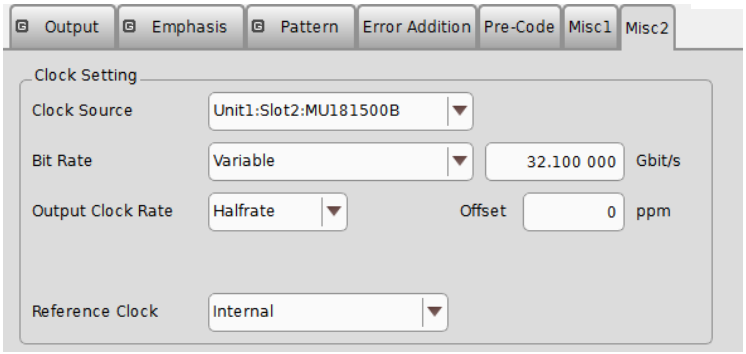


Figure 4.4.1.8.1.1-2 Clock Source Settings (When Tracking Operation of Jitter and Synthesizer)

Note:

Follow the above-mentioned procedure and set to make MU181500B and MU181000B track each other. If the steps are performed in the wrong order, a **Warning** dialog box appears as shown in Figure 4.4.1.8.1.1-3.

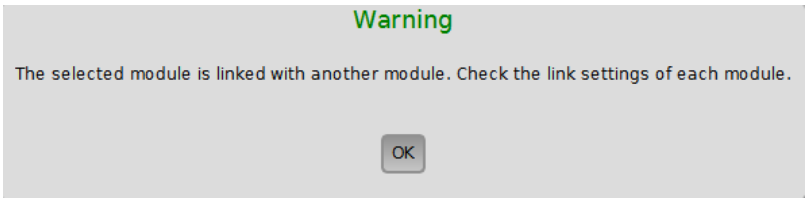


Figure 4.4.1.8.1.1-3 Warning Dialog Box for Module-Tracking Operation

4.4.1.8.1.2 MU195020A and MU181000A/B Synthesizer

Connecting to the clock

For the clock connection between the MU195020A and MU181000A/B, refer to the connection diagram and description in 3.2.1 “Measuring Errors” in *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*.

Setting in the screen

1. Select **Unit1:Slot6: MU181000B** from the **Clock Source** list in the MU195020A screen to make MU195020A and MU181000B track each other.
2. Now, you can set the bit rate of the output data to the Bit Rate box in the MU195020A screen. Figure 4.4.1.8.1.2-1 shows an example when the output data is set to 32.1 Gbit/s.

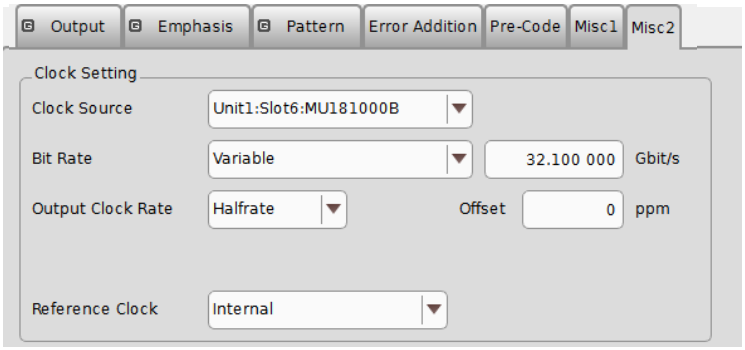


Figure 4.4.1.8.1.2-1 Clock Source Settings (When Tracking with Synthesizer)

4.4.1.8.1.3 MU195020A, MU181500B Jitter Modulation Source, and external clock source

Connecting to the clock

For connecting MU195020A and MU181500B to the external clock, refer to the connection diagram and description in 3.2.3 “Adding Jitter to Output Signal” in *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*, replacing MU181000A with “external clock source”.

Setting in the screen

1. Select **Unit1:Slot2: MU181500B** from the **Clock Source** list in the MU195020A screen to make MU195020A and MU181500B track each other.
2. In the MU195020A screen, select a bit rate of data to output from the **Operation Bitrate** list. To output 28 Gbit/s data, select **2.4 to 30.0** as shown in the example of Figure 4.4.1.8.1.3-1.
3. To the Ext Clock Input connector of the MU181500B, input the clock of the frequency displayed in the Input Clock Freq box in the MU195020A screen. In the example in Figure 4.4.1.8.1.3-1, 14 GHz clock is input to output 28 Gbit/s data.
4. The Bit Rate box in the MU195020A screen displays the bit rate of the output data. Check that the clock that is input in step 3 can change the bit rate of the output data.

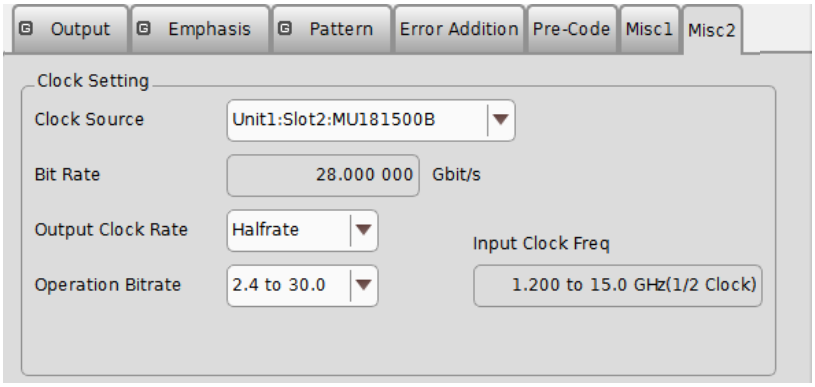


Figure 4.4.1.8.1.3-1 Clock Source Settings (When Using Jitter and External Clock Source)

4.4.1.8.1.4 MU195020A and external clock source

Connecting to the clock

For connecting MU195020A to the clock, refer to 3.2.1 “Measuring Errors” in *MP1900A Signal Quality Analyzer-R Plug-in Module Operation Manual*, replacing MU181000A in the explanation by external clock source.

Setting in the screen

1. In the MU195020A screen, select **External** from the **Clock Source** list.
2. In the MU195020A screen, select a bit rate band of data to output from the **Operation Bitrate** list. In the example in Figure 4.4.1.8.1.4-1, select **2.4 to 32.1** to output 28 Gbit/s data.
3. To the Ext Clock Input connector of the MU195020A, input the clock of the frequency displayed in the Input Clock Freq box in the MU195020A screen. In the example in Figure 4.4.1.8.1.4-1, 14 GHz clock is input to output 28 Gbit/s data.
4. The Bit Rate box in the MU195020A screen displays the bit rate of the output data. Check that the clock that is input in step 3 can change the bit rate of the output data.

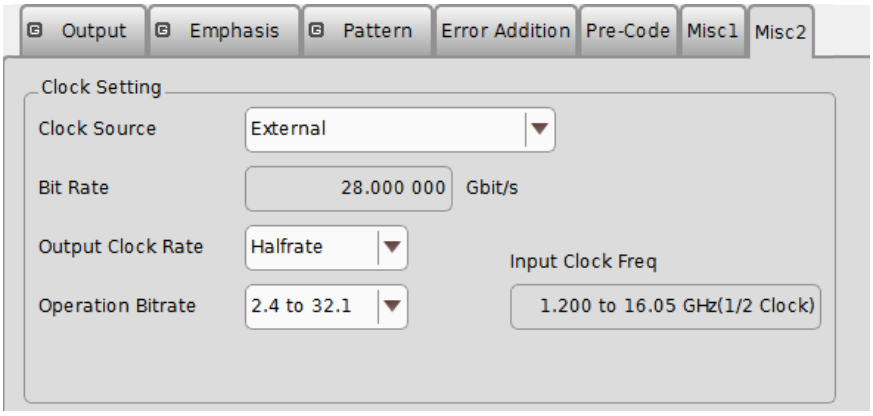


Figure 4.4.1.8.1.4-1 Clock Source Settings (When Using External Clock Source)

4.4.1.8.2 Setting noise

Configure whether to use the MU195050A or the MU196050B.



Figure 4.4.1.8.2-1 Noise Setting Items

[1] Sets whether to use the Noise Generator or not.

Table 4.4.1.8.2-1 Noise Generator Setting

Selection Item	Description
Not Use	Does not use the Noise Generator.
Use	Uses the Noise Generator. The amplitude value on the Output and Emphasis tabs is calculated using the attenuation by the Noise Generator.

[2] Sets the offset value.

4.4.1.9 Multi-Channel Function

The MU 195020A has a Multi-Channel function that generates data by combining data of multiple channels. The Multi Channel function can be categorized into Combination and Channel Synchronization. Available functions vary depending on model and its option.

For details of setting Multi Channel, refer to the *MX190000A Signal Quality Analyzer-R Control Software Operation Manual*.

Combination Function Types

(1) 2ch Combination: MU195020A-x20

(2) 64G × 2ch Combination: MU195020A-x20 × 2 modules

Channel Synchronization Function Types

(1) CH Synchronization: MU195020A-x20

(2) 2ch CH Synchronization: MU195020A-x20

(3) Inter modules CH Synchronization: MU195020A

Table 4.4.1.9-1 Multi-Channel Functions That the Respective Models Support

Model/Option	2ch Combination	Ch Synchronization	Inter-module Ch Synchronization	64G × 2ch Combination
MU195020A	One module or more	One module or more	Two modules or more	Two modules or more
MU195020A-x10	–	–	–	–
MU195020A-x20	✓	✓	✓	✓
MU195020A-x30/x31	-x31	-x31	✓	-x31

4.4.1.9.1 Combination function

The Combination function enables MU195020A or MU195040A to evaluate the 40 Gbit/s and 50 Gbit/s applications by synchronizing pattern generations or receptions between the channels.

By combining two channels of 20 Gbit/s data, 40 Gbit/s serial data that is bit rate of 40GbE or OTU3 can be generated.

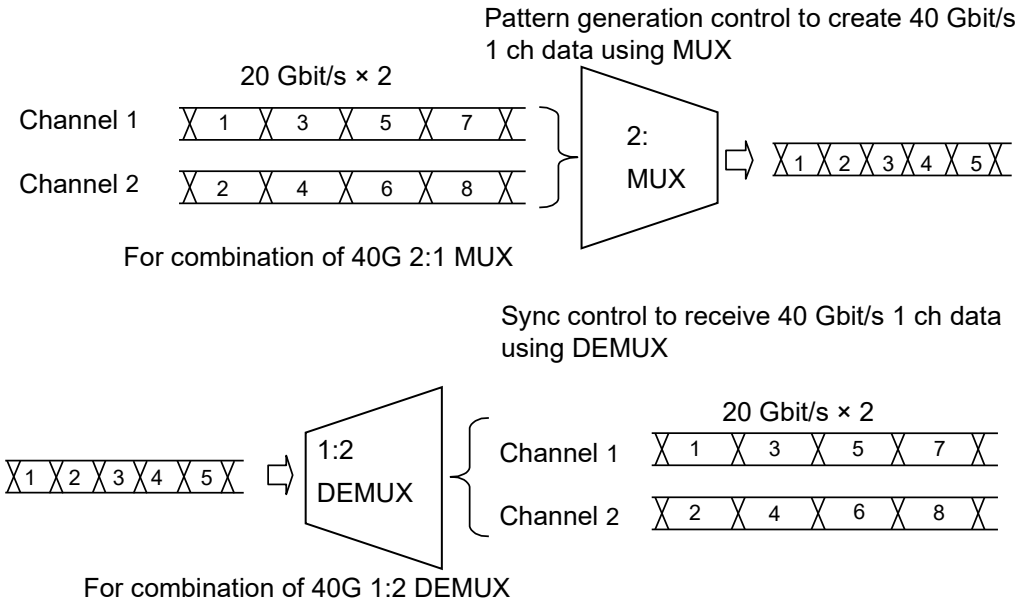


Figure 4.4.1.9.1-1 2ch Combination Pattern Generation/Reception

By using the 64G × 2ch Combination function, it is possible to generate four sets of 32 G data combining up to two sets of 64 G data. These two data patterns can be serialized with an external MUX.

This function is available when two modules of MU195020A-x20 + x31 are installed.

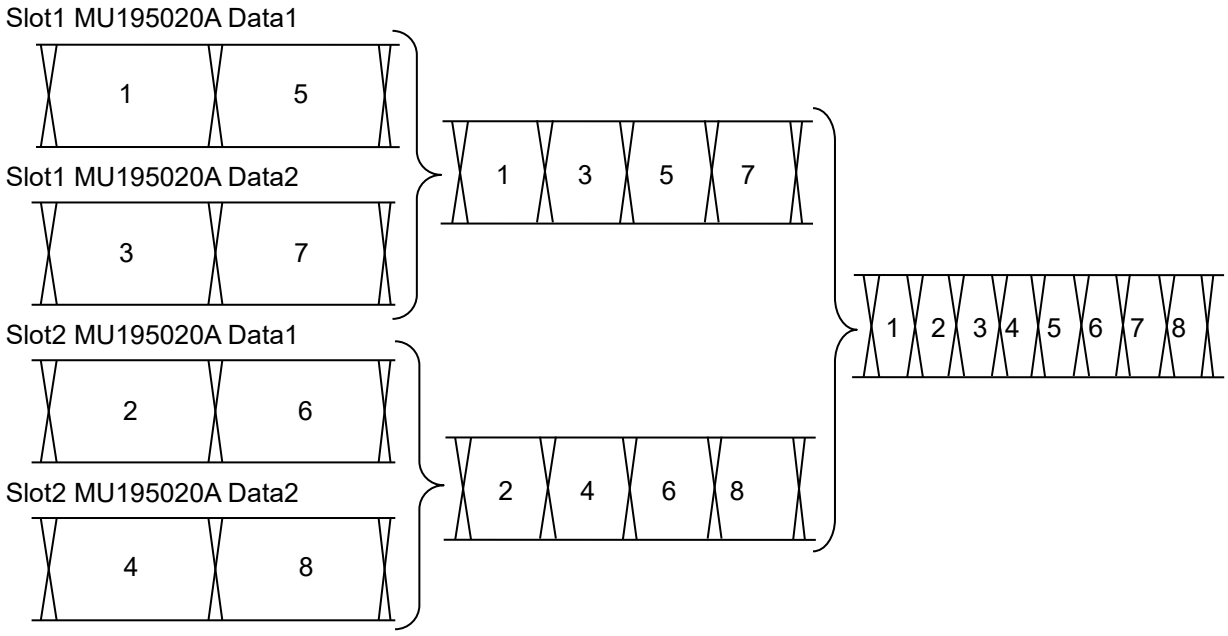


Figure 4.4.1.9.1-2 64G x 2ch Combination Pattern Generation (Using 2 Modules of MU195020A)

4.4.1.9.2 Synchronization function

Channel Synchronization function synchronizes the timing of data of multiple channels.
This function can also synchronize the timing of inter-modules (MU195020As). In addition, you can adjust the time delay between channels by setting the skew.

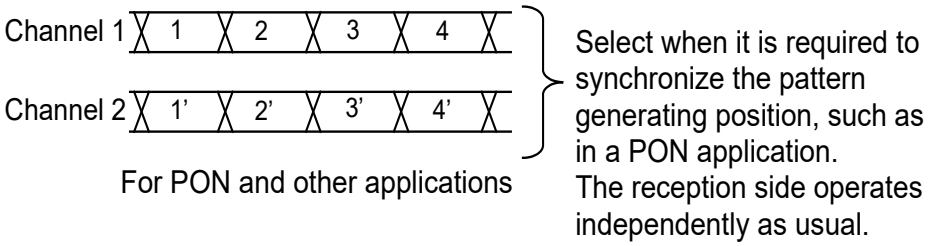


Figure 4.4.1.9.2-1 Channel Synchronization Pattern Generation/Reception

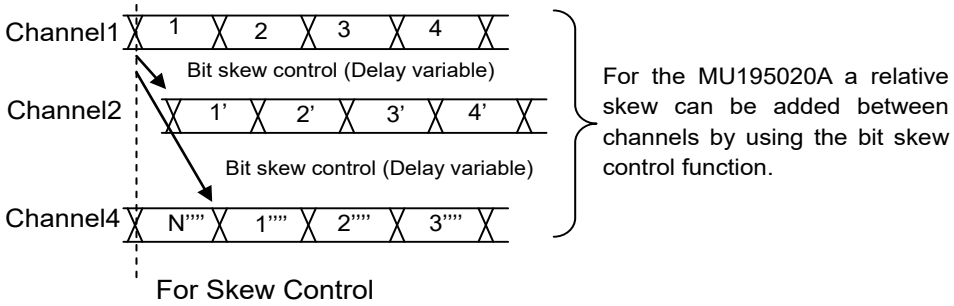


Figure 4.4.1.9.2-2 Skew Channel Synchronization Pattern

It is possible to Ch Synchronize the two signals of Combination 1 - 2 using two modules of MU195020A-x20 and synthesized by 2 ch Combination.

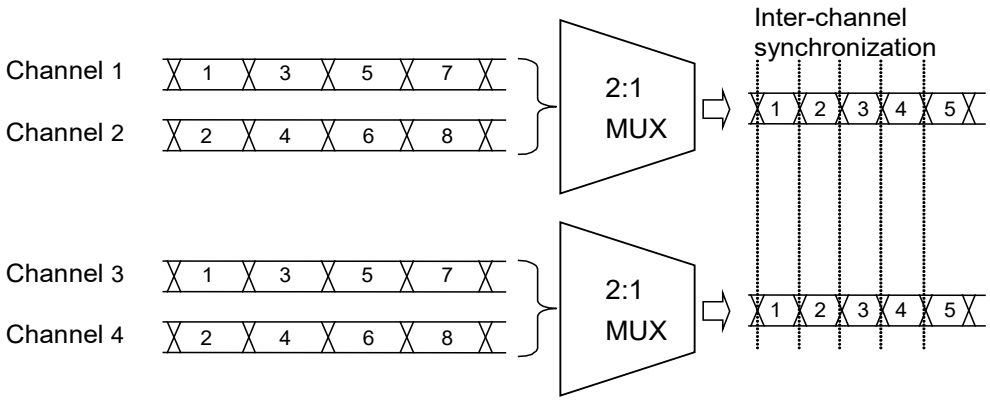


Figure 4.4.1.9.2-3 Channel Synchronization of 2ch Combination

4.4.1.10 Inter-Module Synchronization Function

To use the Inter-module synchronization function, touch the **Combination Setting** on the menu and set the parameters on the Combination Setting screen.

Table 4.4.1.10-1 Setting Items for Combination Setting

Operation Settings		Description
Independent		Select when operating the MU195020A independently.
Channel Synchronization	CH Sync*1,*2	Sets the Channel Synchronization function to all channels of the target modules.
	2ch Combination*1,*2	Sets the 2ch Combination to the target modules and sets the Channel Synchronization between modules.
	64G × 2ch Combination*1,*2	Install two modules of MU195020A. Set the 2ch Combination to the target modules, And then the pattern between modules are shifted by 1/4 pattern cycle each other. When using this setting, set the same pattern for each of the two MU195020A.

*1: MU195020A-x30 or MU195020A-x31 is required.

*2: MU195020A-x20 is required.

4.4.1.11 Unit Sync Function

The Unit Sync function enables synchronized pattern generation across multiple MP1900A units. To use the Unit Sync function, select **Combination Setting** from the menu, and in the **Unit Sync ON/OFF** list, select **Unit Sync**.

For details of Unit Sync Function, refer to 3.6 “Unit Sync Function”.

4.4.1.12 Multi Channel Calibration Function

Calibration must be executed to use the Multi Channel function or the Inter-module Synchronization function under the optimum conditions. These functions are required when changing the configuration such as rearranging the MU195020A installed in the MP1900A.

4.4.2 MU196020A

The MU196020A PAM4 PPG (hereafter, MU196020A) is a plug-in module that can be built into MP1900A. It can generate a variety of patterns within the operating frequency range, including PRBS, DATA, and ZeroSubstitution (NRZ mode only) patterns.

The MU196020A supports various option configurations and can switch the signal modulation mode between NRZ, PAM4, and PAM3. Additionally, the Sequence Editor function allows users to edit and output the patterns that comply with PCIe-standard encoding schemes, including 8b10b, 128b130b, and 1b1b, which makes this function well-suited for research, development, and manufacturing of a wide range of digital communication equipment, modules, and devices.

This section describes the function of the tabs of the MU196020A operation screen. For details of the tabs, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

Switch the signal modulation mode to NRZ, PAM4, or PAM3 by selecting it in the NRZ/PAM4/PAM3 list at the module title bar shown in the following figure before using the module.



Figure 4.4.2-1 MU196020A NRZ/PAM4/PAM3 List

4.4.2.1 Equipment Composition

4.4.2.1.1 Output tab

On the **Output** tab, configure the settings for Data output and Clock output. Data signal is output from the DATA Output connector of MU196020A and Clock signal is output from the Clock connector. On this tab, Data and Clock signals, Output on or off, Amplitude, and Bit rate can be set.

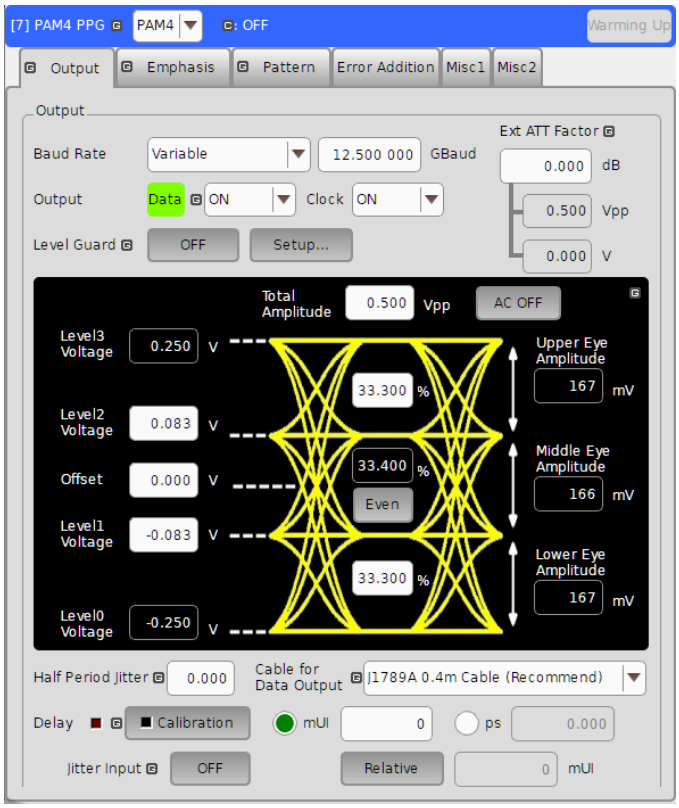


Figure 4.4.2.1.1-1 MU196020A Output Tab (PAM4 Mode)

4.4.2.1.2 Emphasis tab

On the **Emphasis** tab, you can configure the settings for the emphasis to be added to Data signal and can turn on and off the emphasis waveforms that comply with various specifications.

When the following option is installed, signal integrity evaluation using 4TAP Emphasis is available.

- 4Tap Emphasis Expansion (MU196020C-x11)

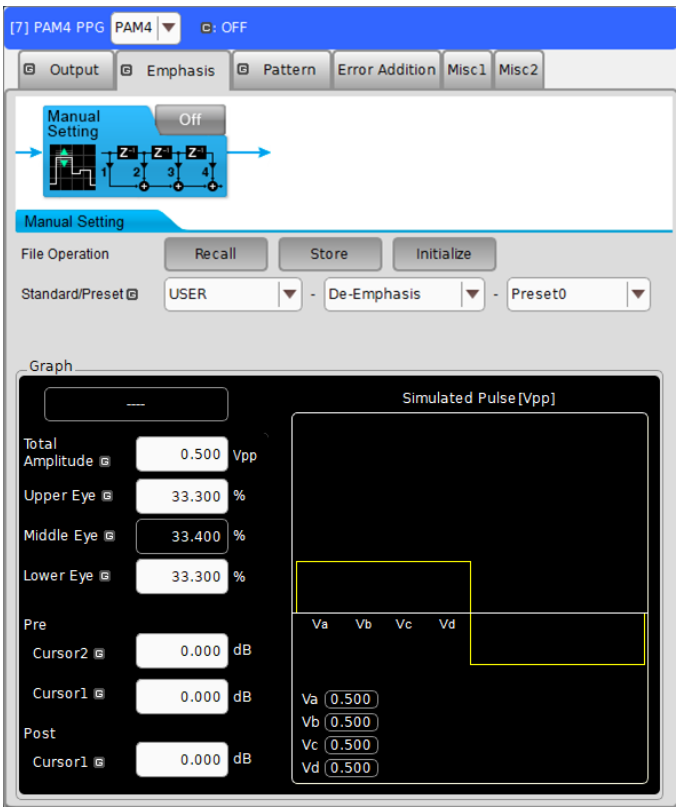


Figure 4.4.2.1.2-1 MU196020A Emphasis Tab (PAM4 Mode)

When the MU196020A-x40 Adjustable ISI is installed, you can use the Channel Emulator and ISI functions.

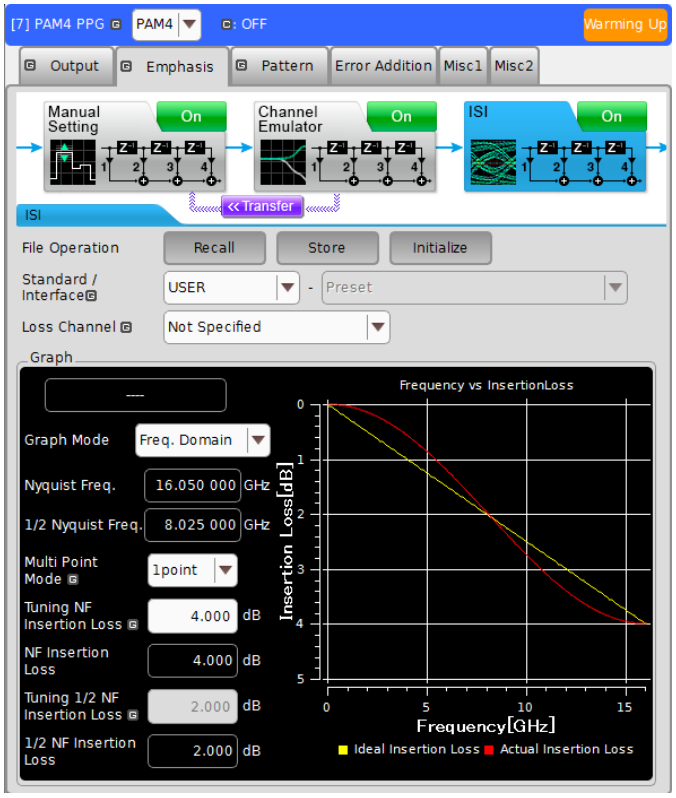


Figure 4.4.2.1.2-2 MU196020A Emphasis Tab (PAM4 Mode with MU196020A-x40)

4.4.2.1.3 Pattern tab

On the **Pattern** tab, you can select a test pattern and can configure the settings for it. The following six test patterns are available.

- PRBS
- ZeroSubstitution (NRZ mode only)
- Data
- PRTS (PAM3 mode only)
- Specification compliance patterns
- Sequence (When the BERT for PCIe1-6 Forced Link application is launched in PAM4 or NRZ mode)

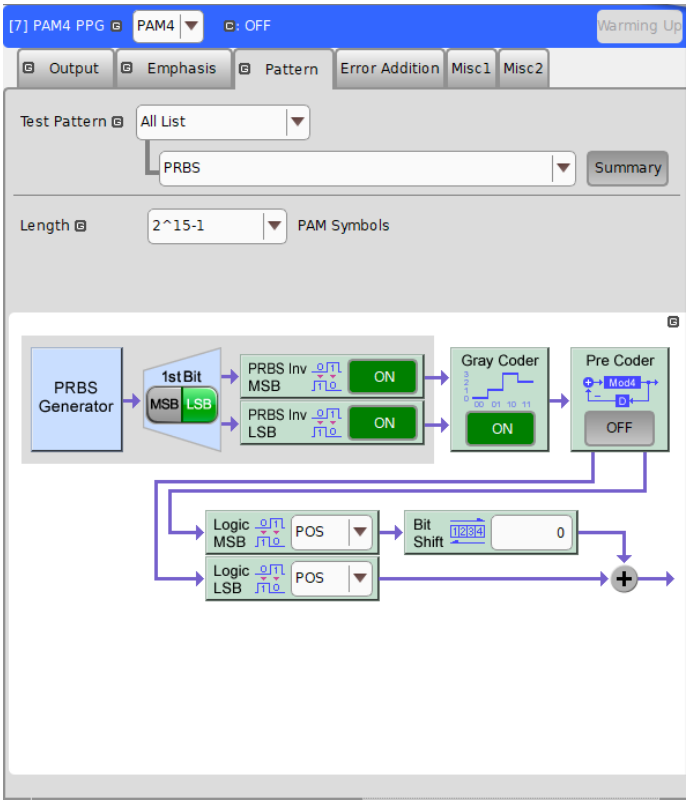


Figure 4.4.2.1.3-1 MU196020A Pattern Tab (PAM4 Mode)

If you select **Data**, you can edit the test pattern with Patten Editor. For explanation of Pattern Editor, refer to Table 4.5.2.1.3-1.

When the following options are installed, you can set IEEE-802.3 or PCIe-6 FEC patterns.

- MU196020A-z42 FEC Pattern Generation
- MU196020A-w43 Error Insertion for PCIe6

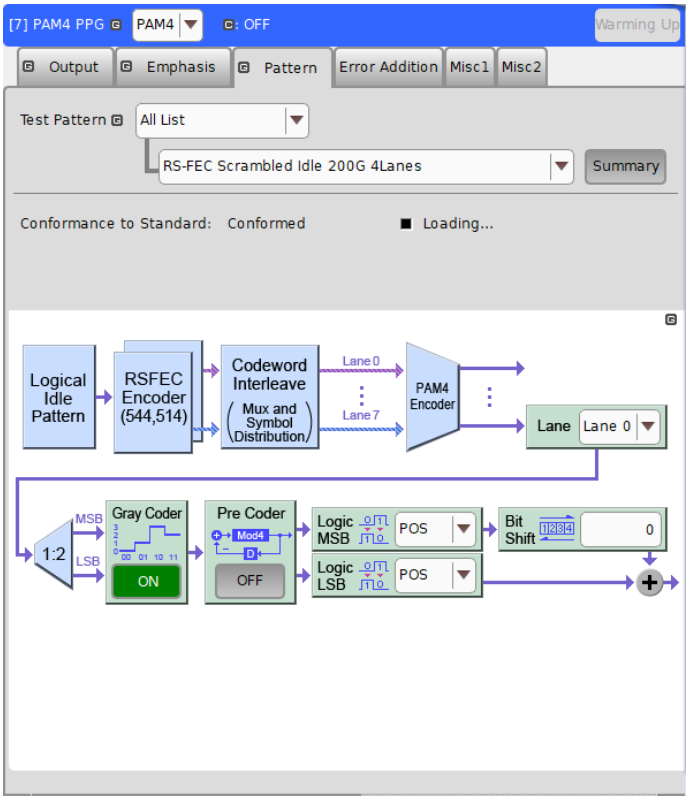


Figure 4.4.2.1.3-2 MU196020A Pattern Tab (With MU196020A-z42)

When the following option is installed, you can set the USB4 Gen4 compliance patterns.

- MU196020A-z45 USB4 Gen4 Pattern Generation

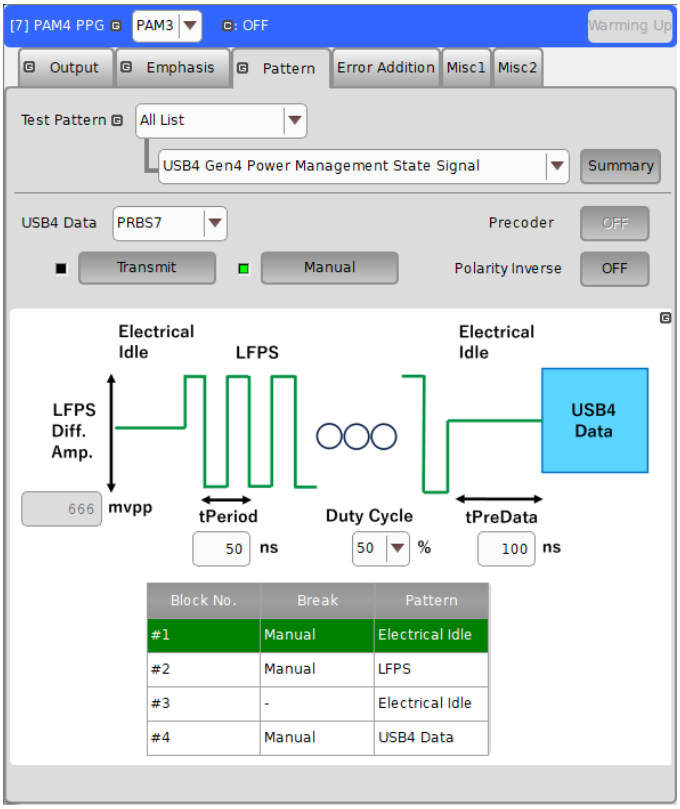


Figure 4.4.2.1.3-3 MU196020A Pattern Tab (With MU196020A-z45)

When the following option is installed, you can configure PCIe-compliant sequence patterns.

- MU196020A-z51 Sequence Editor Function

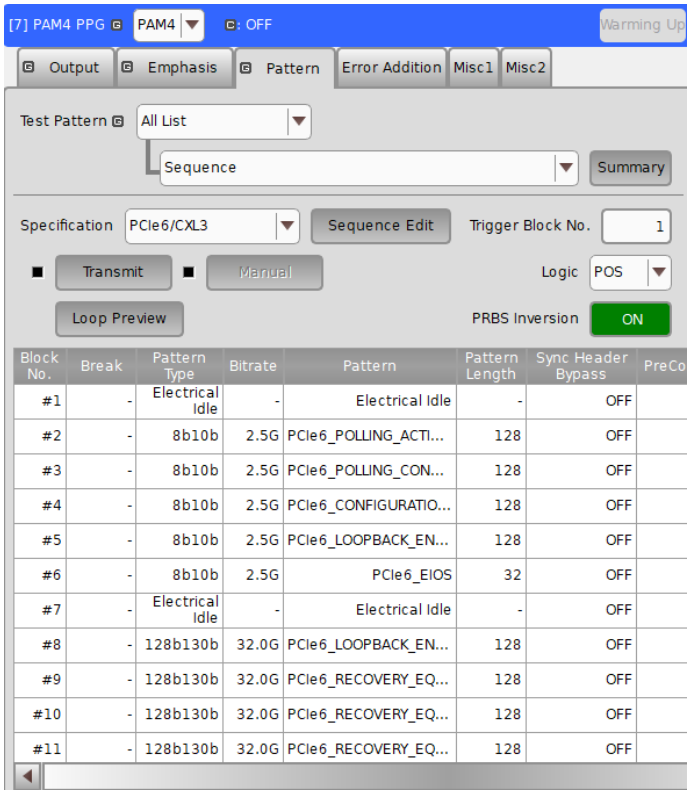


Figure 4.4.2.1.3-4 MU196020A Pattern Tab (With MU196020A-z51)

If you select **Sequence**, you can edit the test pattern in the Sequence Editor.

If the following option is installed, two to four modules can be synchronized to output sequence patterns.
For details on how to set up synchronized output, refer to 3.3 “Multi Channel Function”.

- MU196020A-z52 Sequence Editor Function for Multi-Channel

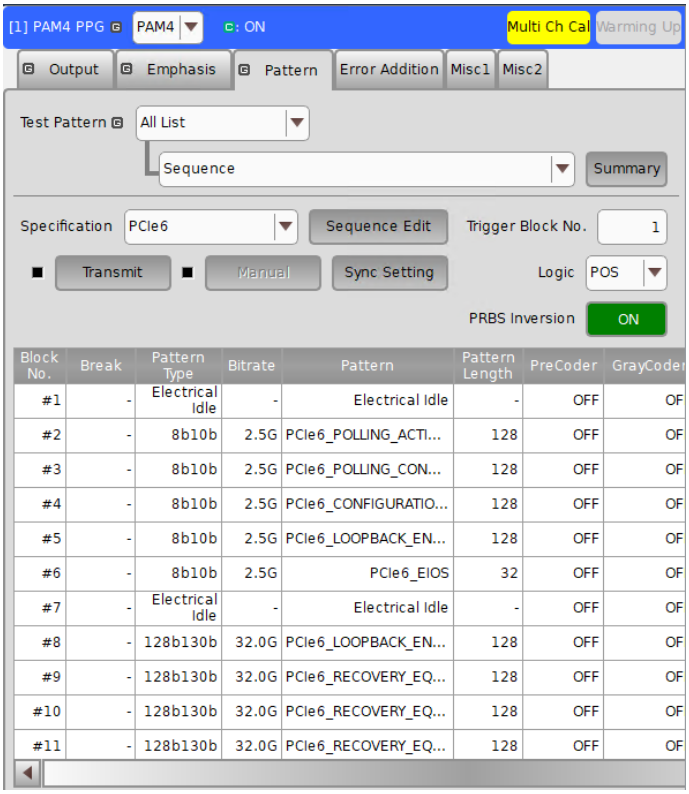


Figure 4.4.2.1.3-5 MU196020A Pattern Tab (With MU196020A-z51/z52)

Regardless of the Inter module grouping settings, when the Inter module combination is set to a synchronization type other than **OFF**, all modules are synchronized to use either the **Sequence** pattern or a different pattern.

By selecting **Sync Setting**, the Manual Trigger timing can be synchronized.

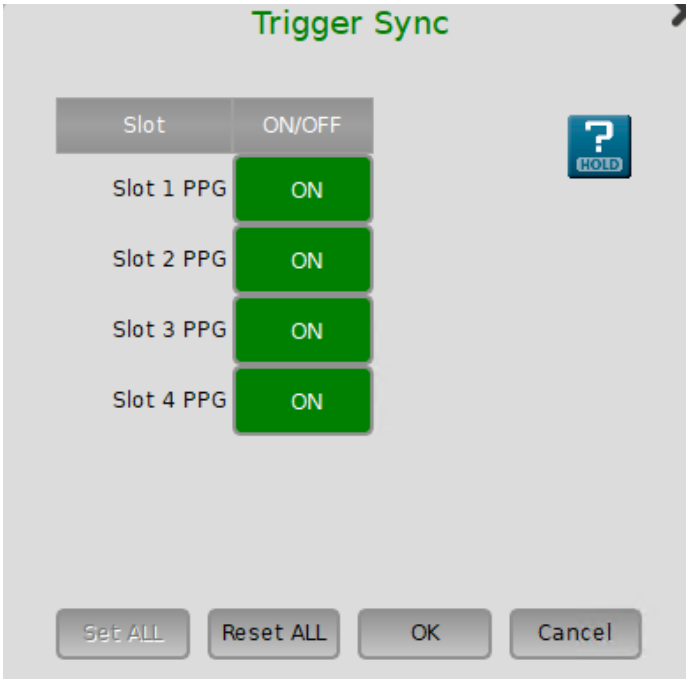


Figure 4.4.2.1.3-6 Trigger Sync Setting screen

4.4.2.1.3.1 Setting sequence

This section describes how to use the MU196020A-z51 Sequence Editor Function.

Setup

After launching the MX190000A, open the Module and Boxes screen, select the **FPGA** and **Firmware** checkboxes for the MU196020A, and select **Program** at the top right of the screen.

Note:

When you select **Program** for the first time, the **FPGA** checkbox will remain selected even after the FPGA programming is complete. In this case, touch **Program** again. Programming the FPGA twice takes approximately 20 minutes.

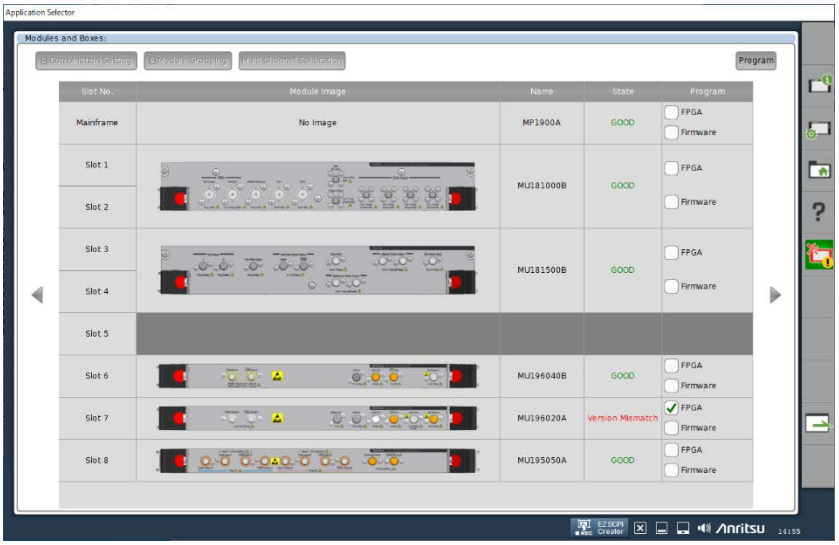


Figure 4.4.2.1.3.1-1 Module and Boxes Screen (After Completion of First Programming)

For basic operations of the Sequence Editor, refer to 4.4.1.4.8 “Setting sequence” and 4.4.1.4.9 “Editing test pattern in Sequence Editor dialog box”.

For details on the differences from the Sequence function of the MU195020A SI PPG, refer to 4.4.2.1.3.2 “Editing test patterns in the Sequence Editor dialog box (Common setting items)”.

4.4.2.1.3.2 Editing test patterns in the Sequence Editor dialog box (Common setting items)

This section describes how to edit test patterns (common setting items) when **Sequence** is selected as Test Pattern on the **Pattern** tab.

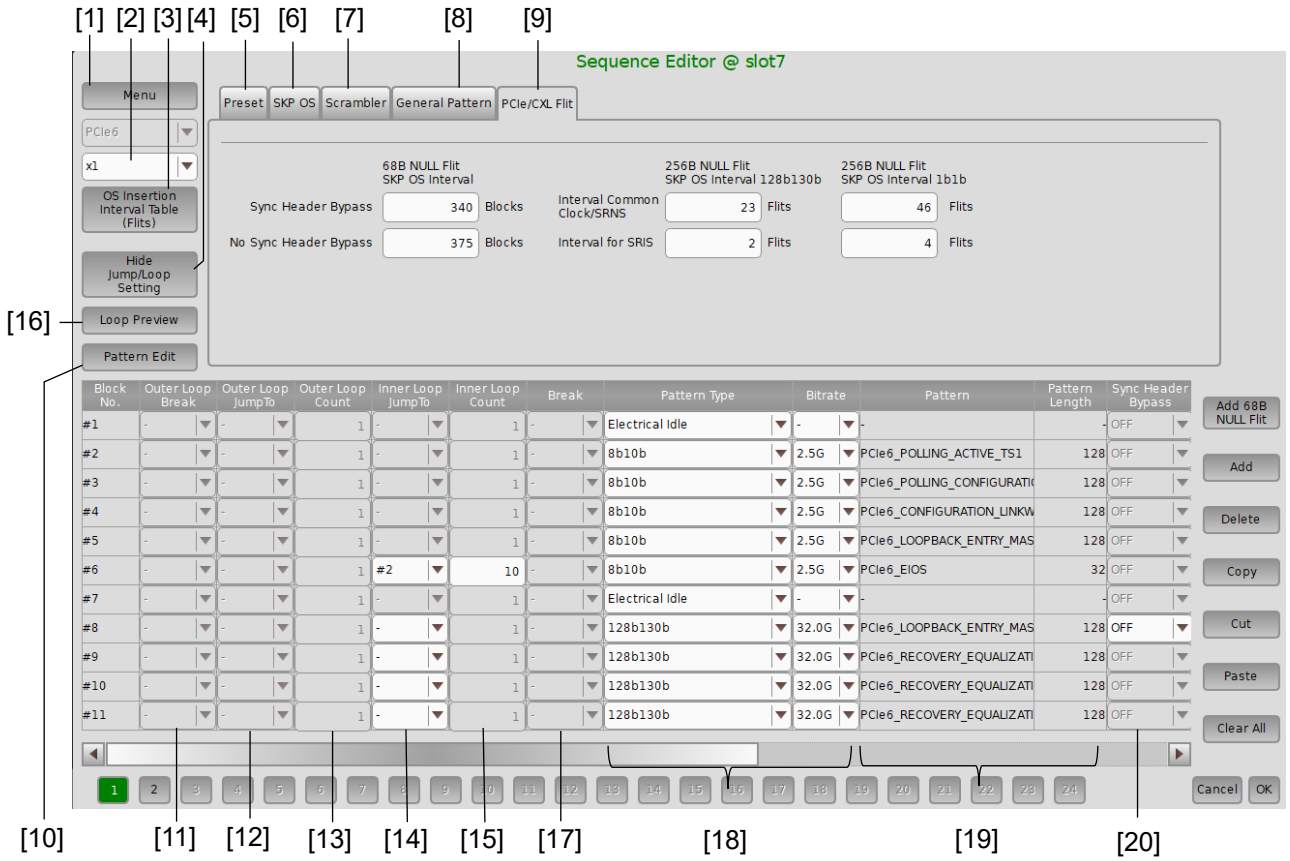


Figure 4.4.2.1.3.2-1 Sequence Editor Setting Items (1)

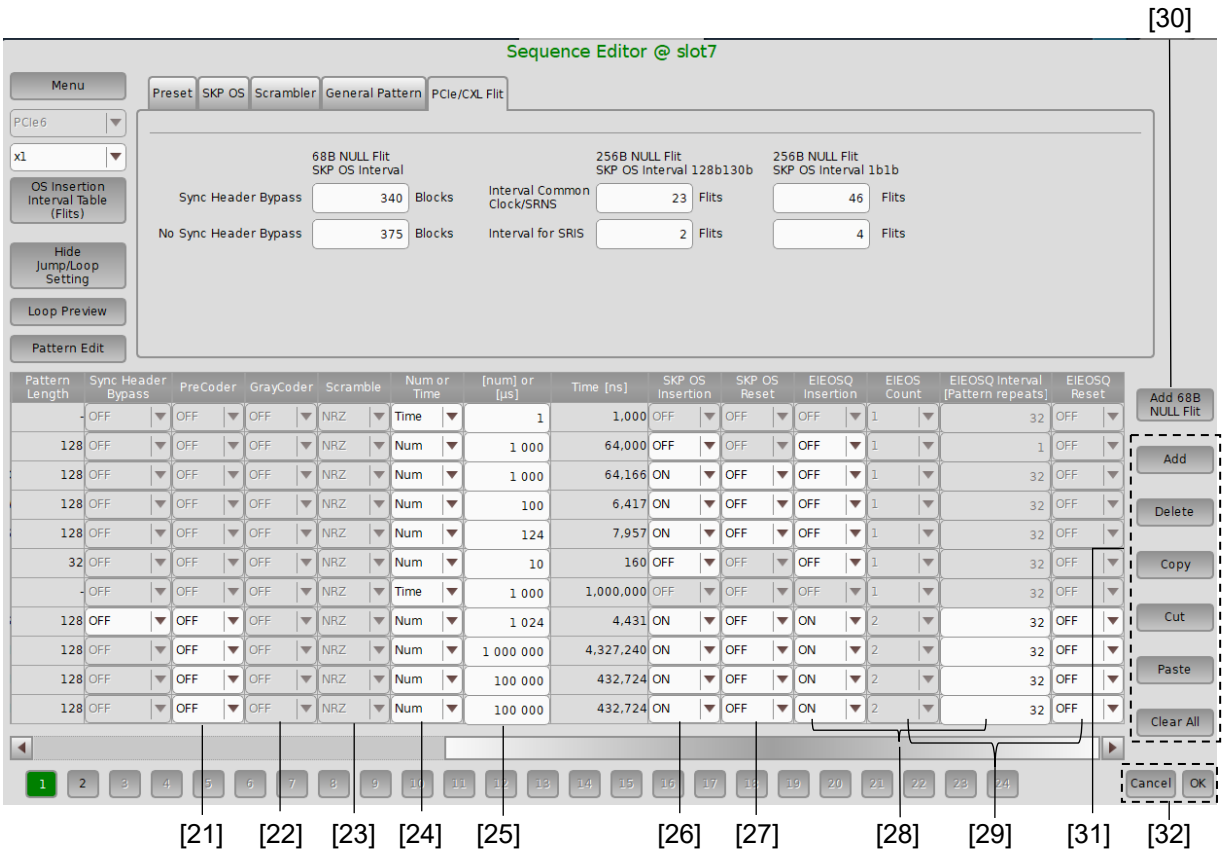


Figure 4.4.2.1.3.2-2 Sequence Editor Setting Items (2)

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items

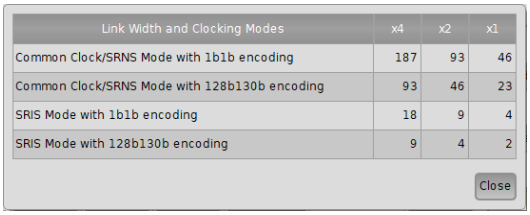
No.	Item	Description
[1]	Menu	This section describes how to edit test patterns (common setting items) when **Sequence** is selected as Test Pattern on the **Pattern** tab. To save the file in any directory, tap **Menu** > **Save**.
[2]	Link Width	Specifies the total number of transmission lanes.
[3]	OS insertion Interval Table	When **Idle Flit 128b130b** or **Idle Flit 1b1b** is selected for Pattern Type, the SKP OS insertion interval is automatically determined based on the **SRIS**, **Link Width**, and **Encoding** settings. Use this table as a reference when setting the number of pattern transmissions. 
[4]	Hide Jump/Loop Setting	Hides the following setting items: Outer Loop Jump to, Outer Loop Count, Outer Loop Break, Inner Loop Jump to, Inner Loop Count

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

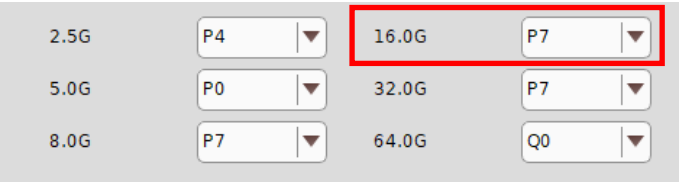
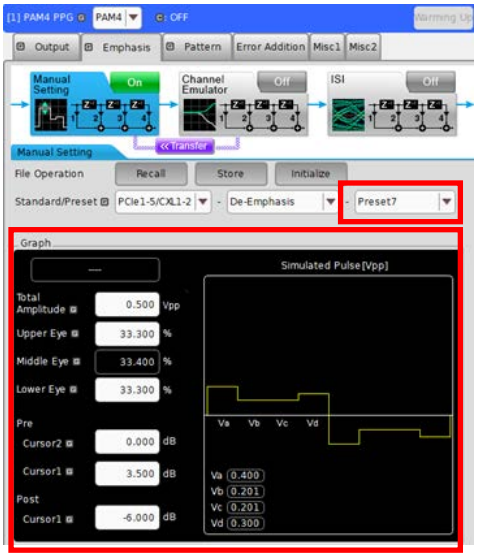
No.	Item	Description
[5]	Preset	Sets the Preset value of Emphasis used for each bitrate. P0 to P10 correspond to Preset0 to 10 when Standard is set to **PCIe1-5/CXL1-2** on the Emphasis tab of the MU196020A. Q0 to Q10 correspond to Preset0 to 10 when Standard is set to **PCIe6/CXL3** on the Emphasis tab of the MU196020A. In the following example, the emphasis set in Preset7 is used to output a 16G signal.  

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

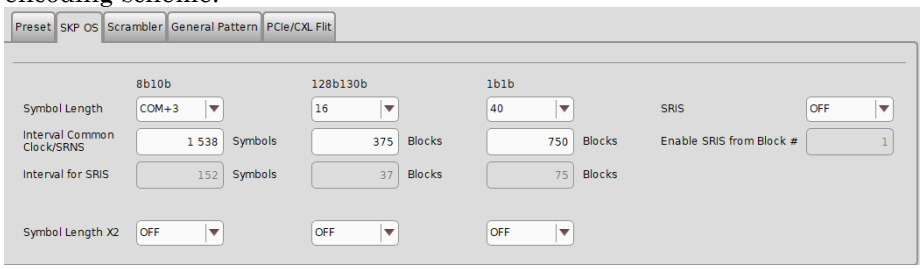
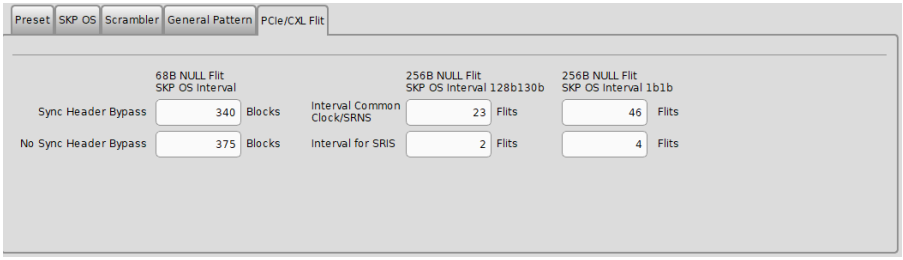
No.	Item	Description
[6]	SKP OS	Sets the conditions for SKP OS insertion interval and length for each encoding scheme. 
	Symbol Length	Specifies the SKP OS length. When there is a large speed difference between the measuring instrument and the DUT, such as when operating in Separate Reference Clock mode, increase this value.
	Interval for Common Clock/SRNS	Specifies the SKP OS interval. When there is a large speed difference between the measuring instrument and the DUT, such as when operating in Separate Reference Clock mode, decrease this value.
	Interval for SRIS	Specifies the SKP OS interval when SRIS is **ON**. Available when SRIS is **ON**.
	Symbol Length x2	Inserts two consecutive SKP OS symbols when set to **ON**.
	SRIS	Sets the SRIS (clock with SSC) measurement to **ON** or **OFF**.
	Enable SRIS from Block #	Specifies the block number from which the SRIS setting takes effect. Available when SRIS is **ON**.

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>[7]</td><td>Scrambler</td><td>Displays the Scrambler Seed value for each encoding scheme. For 128b130b (PCIe3/4/5, CXL1-2) and 1b1b (PCIe6, CXL3), the seed value varies by lane. The generator polynomial differs for each encoding scheme and is shown below.
● 8b10b (PCIe1, 2)
$G(X) = X^{16} + X^5 + X^4 + X^3 + 1$
Initial seed value: FFFF
● 128b130b/1b1b (PCIe3, 4, 5, 6, CXL1, CXL2, CXL3)
$G(X) = X^{23} + X^{21} + X^{16} + X^8 + X^5 + X^2 + 1$
<table><tr><th>Lane</th><th>Initial Seed Value</th></tr><tr><td>Lane0</td><td>1DBFBC</td></tr><tr><td>Lane1</td><td>0607BB</td></tr><tr><td>Lane2</td><td>1EC760</td></tr><tr><td>Lane3</td><td>18C0DB</td></tr><tr><td>Lane4</td><td>010F12</td></tr><tr><td>Lane5</td><td>19CFC9</td></tr><tr><td>Lane6</td><td>0277CE</td></tr><tr><td>Lane7</td><td>1BB807</td></tr></table></td></tr>
<tr><td>[8]</td><td>General Pattern</td><td>This tab is available only when General is selected for Pattern Type.
When the selected General Pattern is output, Gray coding, Precoding and other settings configured here are applied.</td></tr>
<tr><td>[9]
*1</td><td>PCIe/CXL Flit</td><td>Configures the SKP OS Interval for Flit patterns defined in the PCIe/CXL specifications, according to each encoding type and Flit type.
 
</td></tr>
<tr><td></td><td>68B NULL Flit SKP OS Interval</td><td>Configures the OS insertion interval for 68B NULL Flits according to the Sync Header Bypass (ON/OFF) setting.
This setting automatically configures the number of Inner Loop Blocks assigned to 68B NULL Flits.</td></tr>
<tr><td></td><td>256B NULL Flit SKP OS Interval</td><td>Configures the OS insertion interval for 256B NULL Flits according to the 128b/130b or 1b/1b encoding type and the SRIS setting.</td></tr>
<tr><td>[10]</td><td>Pattern Edit</td><td>Opens the Pattern Editor dialog box.</td></tr>
</table>

*1: The MU196020A-z56 Sequence Editor Function PCIe6 and CXL3 Flits Extension is required.

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

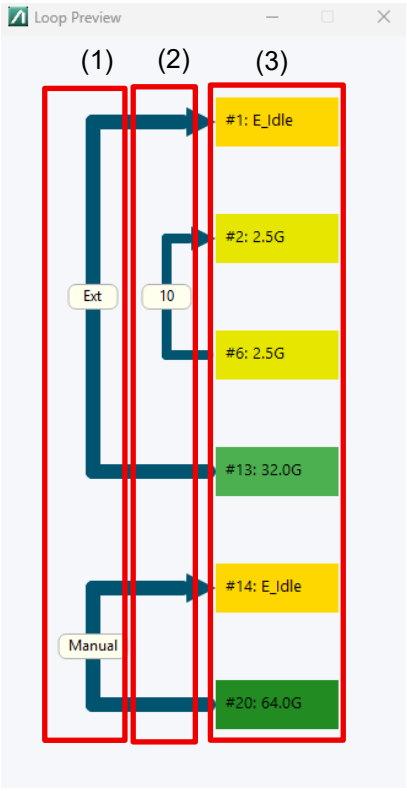
No.	Item	Description
[11]	Outer Loop Break	Configures the condition for exiting the outer loop. When Break is set to **Manual**, tapping **Manual** on the **Pattern** tab transitions to the end Block of the outer loop, and then to the next Block. When Break is set to **External**, the instrument transitions to the final Block of the outer loop when a trigger signal is detected at the MU196020A AUX Input connector, and then transitions to the next Block.
[12]	Outer Loop Jump To	Configures the jump destination for the outer loop.
[13]	Outer Loop Count	Configures the number of iterations for the outer loop.
[14]	Inner Loop Jump To	Configures the jump destination for the inner loop.
[15]	Inner Loop Count	Configures the number of iterations for the inner loop. For Blocks assigned to 68B NULL Flits, the value is automatically configured according to the **68B NULL Flit SKP OS Interval** setting.
[16]	Loop Preview	Displays the current loop settings.  (1) Displays the Outer Loop Break condition. If no Break condition is configured, the number of loop iterations is displayed. (2) Displays the number of iterations for the Inner Loop. (3) Displays Block information for the loop destination and loop source. The Block information includes the Block No. and either the Bitrate or Electrical Idle.
[17]	Break	Sets the conditions for suspending and resuming the pattern transition. When Break is set to **Manual**, the sequence transitions from the block at which it paused to the next block if you tap **Manual** on the **Pattern** tab. When Break is set to **External**, the sequence transitions from the block at which it paused to the next block upon detection of a trigger signal at the AUX Input connector of the MU196020A.

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

No.	Item	Description
[18]	Pattern Type, Bitrate	To change the bitrate, insert an Electrical Idle between blocks. (See Block No. 6-8 shown in Figure 4.4.2.1.3.2-1.) If an Electrical Idle is not inserted between two consecutive blocks with different bitrates, an unexpected pattern may be generated during the bitrate transition. Select Pattern Type from 8b10b, 128b130b, 1b1b, Idle Flit 8b10b, Idle Flit128b130b, Idle Flit 1b1b, 256B NULL Flit 128b130b, 256B NULL Flit 1b1b, SDS 128b130b, SDS 1b1b, General, or Electrical Idle. Tapping **Add 68B NULL Flit** selects 68B NULL Flit as the Pattern Type. Pattern Type can be set to **General** for the last block only. When **General** is selected, the following predefined patterns can be configured. 1. PRBS 2. Data 3. MCP 4. CP 5. NOP Flit (Only when set to **PCIe6/CXL3***2)
[19]	Pattern / Pattern Length	By touching **Pattern Edit** with any block selected, the Pattern Editor displayed according to the pattern type. For details on how to operate the existing 8b/10b and 128b130b Pattern Editors, refer to 4.4.1.4.9.2 "Editing 8b10b data pattern" and 4.4.1.4.9.3 "Editing 128b130b data pattern". For details on how to use the 1b1b Pattern Editor, refer to 4.4.2.1.3.3 "Editing test patterns in the Sequence Editor dialog box (1b1b Pattern Editor)".
[20] *1	Sync Header Bypass	Select whether to remove the Sync Header from the transmission pattern when using 128b/130b encoding. This setting can be applied only within the same bitrate section when it is enclosed by Electrical Idle. However, for Idle Flit 128b130b, Sync Header Bypass is set to OFF.
[21]	PreCoder	Applies pre-coding to blocks that are set to **ON**.
[22]	GrayCoder	Applies gray-coding to blocks that are set to **ON**.
[23]	Scramble	Select either **NRZ** or **PAM4** as the Scramble setting for blocks that are set to **ON**.
[24]	Num or Time	Sets the repeated transmission mode of the selected block pattern to Num (number of repetitions) or Time (duration).
[25]	[num] or [µs]	Sets the number of repetitions or the duration based on the **Num or Time** setting.
[26]	SKP OS Insertion	Inserts SKP OS into the pattern according to the Symbol Length and Interval settings under SKP OS at the top right of the Sequence Editor screen when set to **ON**.
[27]	SKP OS Reset	Inserts SKP OS at the First bit/symbol of the block after the block transition when set to ON.

*2: The MU196020A-w43 FEC Error Insertion for PCIe6 is required to select **NOP Flit** as the Pattern Type.

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

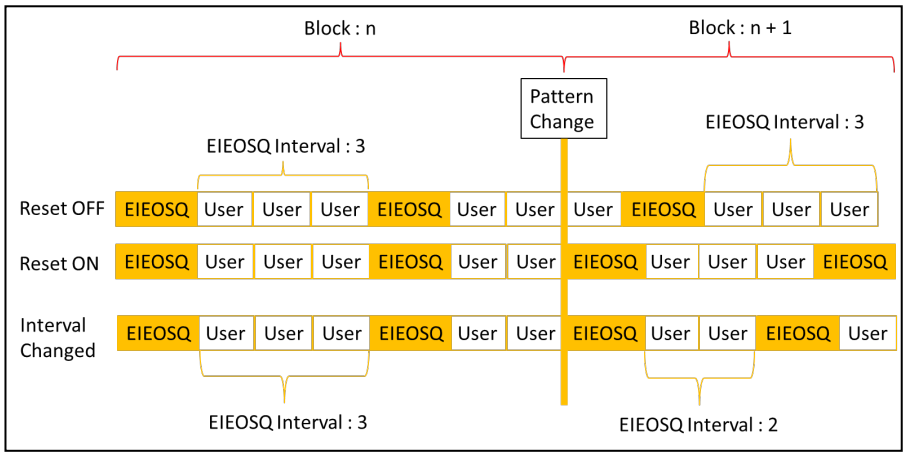
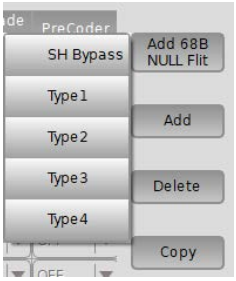
No.	Item	Description
[28]	EIEOSQ Insertion / Interval	Inserts EIEOSQ into the pattern according to the EIEOSQ Interval setting when set to **ON**. By default, it is set to **ON** as EIEOSQ is required for pattern synchronization for 128b/130b and 1b1b.
[29]	EIEOS Count / EIEOSQ Reset	Inserts EIEOSQ immediately before the first bit or symbol of the next block after the transition from the block set to **ON**. Even when set to **OFF**, if the EIEOSQ Interval differs among blocks, EIEOSQ is inserted at the beginning. The number of EIEOSQ insertions can be set using **EIEOS Count**. This value can be changed to 1 or 4 only when Specification is set to **PCIe6**. EIEOSQ consists of one EIEOS at 8 Gbit/s and 16 Gbit/s, two consecutive EIEOS units at 32 Gbit/s, and either one or four consecutive EIEOS units at 64 Gbit/s. 
[30] *1	Add 68B NULL Flit	Adds a 68B NULL Flit pattern group selected from SH Bypass, Type1, Type2, Type3, or Type4. The selected 68B NULL Flit pattern group is added automatically. The pattern group added here operates as a 68B NULL Flit, and SKPs are inserted at intervals defined by the 68B NULL Flit SKP OS Interval.  SH Bypass: Select this option to bypass the Sync Header for 68B NULL Flits. Flits. All Blocks within the same bitrate section must have Sync Header Bypass set to ON. Type1: SKP OS is inserted at intervals of 68 × 4(N+1) + 16 bytes. Type2: SKP OS is inserted at intervals of 68 × 4(N+1) + 80 bytes. Type3: SKP OS is inserted at intervals of 68 × 4(N+1) + 144 bytes. Type4: SKP OS is inserted at intervals of 68 × 4(N+1) + 208 bytes. N: The Inner Loop Count for 68B NULL Flits, which varies depending on the 68B NULL Flit SKP OS Interval setting.

Table 4.4.2.1.3.2-1 Sequence Editor Setting Items (Cont'd)

No.	Item	Description
[31]	Add, Delete, Copy, Cut, Paste, Clear All	Used for editing blocks.
[32]	Cancel, OK	**OK**: Sets the created sequence. **Cancel**: Discards the created sequence.

4.4.2.1.3.3 Editing test patterns in the Sequence Editor dialog box (1b1b Pattern Editor)

The following explains how to edit test patterns in the 1b1b Pattern Editor when **Sequence** is selected as Test Pattern on the **Pattern** tab.

For details on how to operate the 8b10b and 128b130b Pattern Editors, refer to 4.4.1.4.9.2 “Editing 8b10b data pattern” and 4.4.1.4.9.3 “Editing 128b130b data pattern”

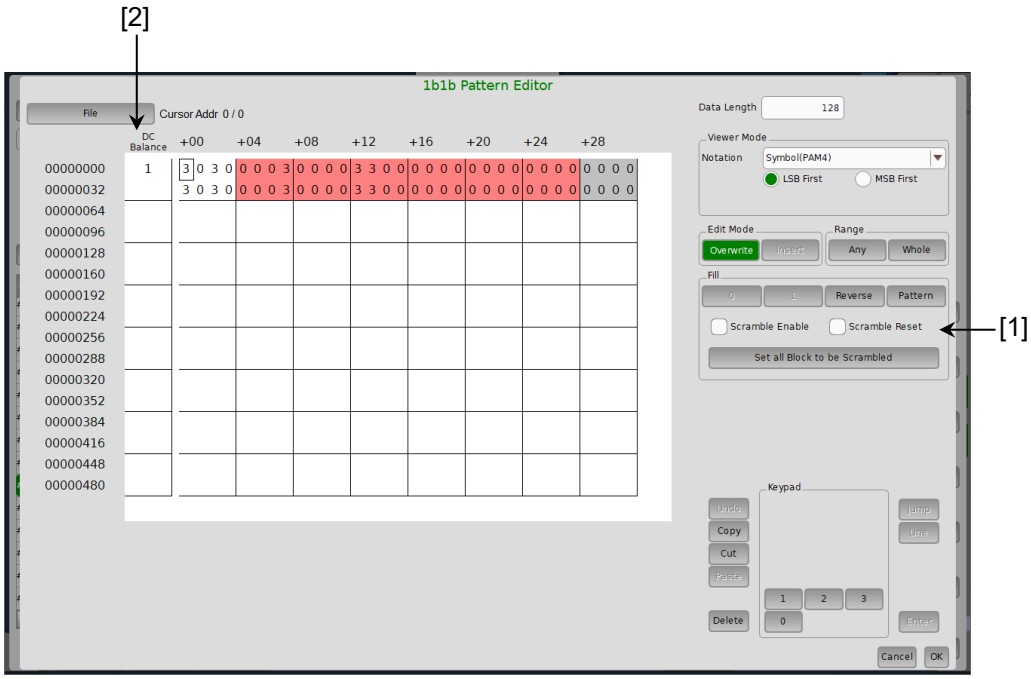


Figure 4.4.2.1.3.3-1 1b1b Pattern Editor

[1] Scrambler Enable and Scrambler Reset can be set in the same way as 8b10b and 128b130b.

[2] When DC Balance is set to 1, the transmission pattern of Symbol 7 and Symbol 15 is determined by the following rule.

Table 4.4.2.1.3.3-1 Rule on Determination of Transmission Pattern

DC Balance at Start of TS Ordered Set	Transmission Pattern of Symbol 7 and Symbol 15
> +47	Converts Symbols 7 and 15 to 00h and transmits them without scrambling.
< –47	Converts Symbol 7 and Symbol 15 to FFh and transmits them without scrambling.
≤+47 and ≥ –47	Outputs the even byte parity of Symbols 0 to 6 (before scrambling) to Symbol 7 and 15, with scrambling enabled.

4.4.2.1.3.4 Editing test patterns in the Sequence Editor dialog box (Jump/Loop)

The following explains how to configure Jump/Loop settings when **Sequence** is selected as the Test Pattern on the **Pattern** tab.

This function allows repeated transmission of a sequence spanning multiple blocks for a specified number of iterations, and enables the loop transmission to be terminated based on an external trigger timing.

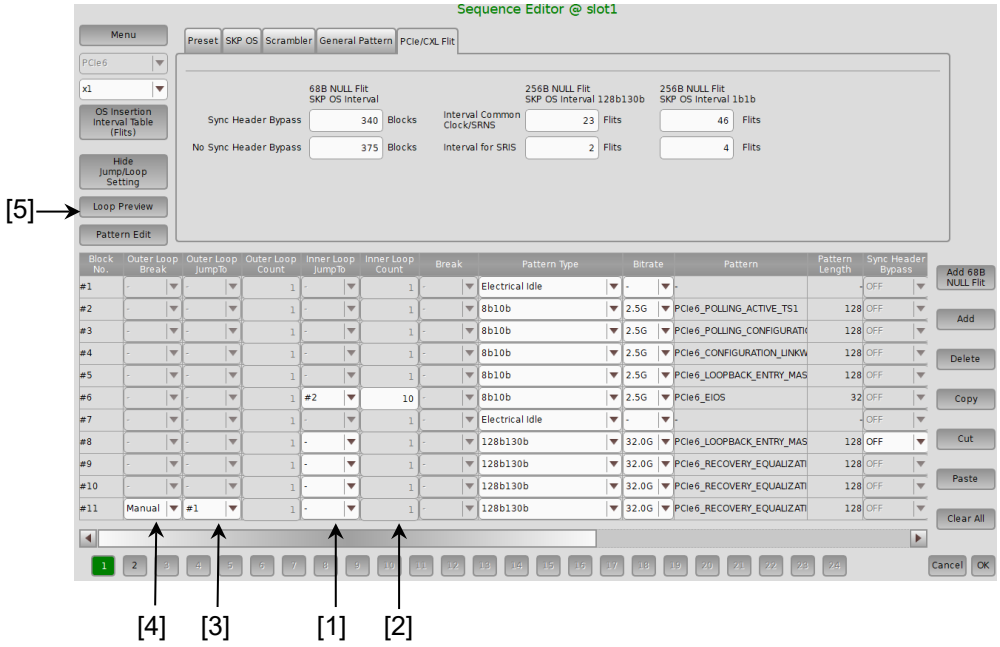
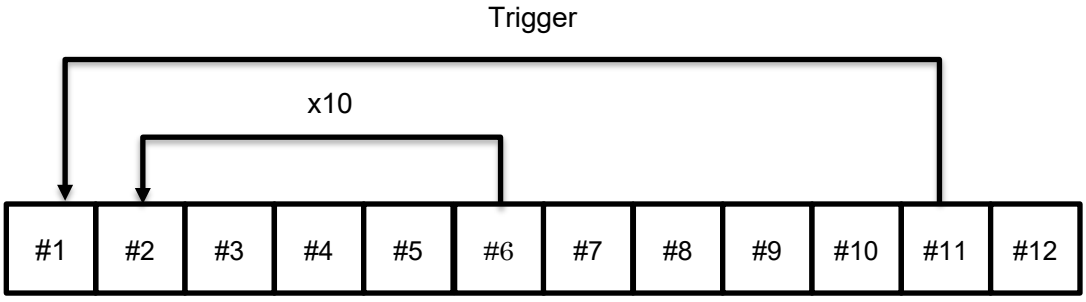


Figure 4.4.2.1.3.4-1 Sequence Editor Setting Screen

This section provides the following examples:

- Repeating the sequence from Block #2 to Block #6 ten times.
- Repeating the sequence from Block #1 to Block #11 until a manual trigger is applied.



[1] Select Block #6 and set **Inner Loop Jump To** to **#2**.

[2] Select Block #6 and set **Inner Loop Count** to **10**.

[3] Select Block #11 and set **Outer Loop Jump To** to **#1**.

[4] Select Block #11 and set **Outer Loop Break** to **Manual**.

[5] Tap **Loop Preview** to check the loop settings.

The Outer Loop and Inner Loop are subject to the following restrictions:

- The Inner Loop must be completely contained within the Outer Loop. A loop cannot extend outside the Outer Loop range.
- The Inner Loop and Outer Loop cannot be configured over the same section. The Outer Loop must always cover a wider range.
- Blocks within a section where an Inner Loop or Outer Loop is configured cannot have a **Break** condition assigned.
- The Inner Loop or Outer Loop must satisfy one of the following conditions:
  - The start and end Blocks must have the same bitrate.
  - The start or end Block, or both, must be Electrical Idle.
- When all Blocks in the Outer Loop use the 1b1b pattern, one of the following conditions must be satisfied:
  - At least one Block must use a time-based transmission count.
  - At least one Block must have Pattern Length × transmission count ≥ 384 bits.
  - At least two Blocks must have Pattern Length × transmission count ≥ 256 bits.

- When a loop contains a Pattern Type set to **General** and all Blocks in the loop have a Bitrate of **64.0G**, one of the following conditions must be satisfied:
  - At least one Block must use a time-based transmission count.
  - The total bit length of Blocks other than **General** must be ≥ 512 bits (Pattern Length × transmission count ≥ 512 bits).
- When a loop contains a Pattern Type set to **General** and all Blocks in the loop have a Bitrate of **2.5G** or **5.0G**, the following condition must be satisfied:
  - The jump destination must be **Electrical Idle**.

4.4.2.1.3.5 Editing test patterns in the Sequence Editor dialog box (68B NULL Flit)

This section explains how to configure 68B NULL Flit pattern when **Sequence** is selected as the Test Pattern on the **Pattern** tab.

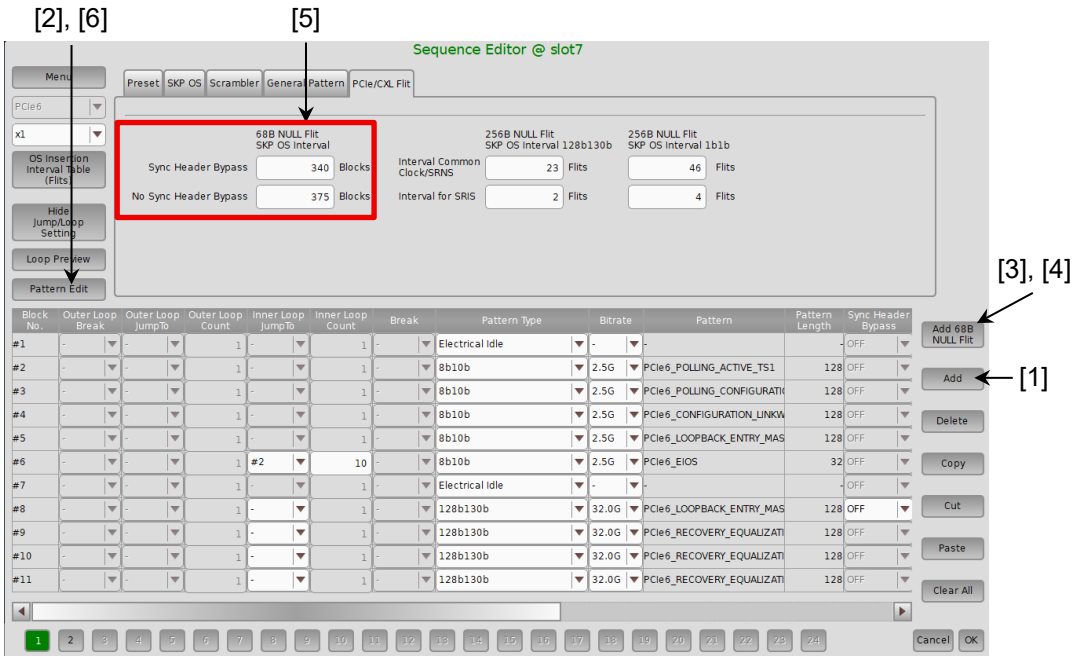


Figure 4.4.2.1.3.5-1 Sequence Editor Setting Screen

[1] Tap **Add** and select **SDS 128b130b** for Pattern Type.

[2] Edit the SDS pattern according to the bitrate in use. Refer to Table 4.4.2.1.3.5-1 to edit the pattern.

Table 4.4.2.1.3.5-1 SDS Pattern Settings for Bitrate

	8.0G	16.0G	32.0G
Pattern File	SDS_8G_16G	SDS_8G_16G	SDS_32G
SKP Insertion	OFF	ON	ON

[3] Tap **Add 68B NULL Flit**.

[4] Select the 68B NULL Flit pattern group to insert from **SH Bypass**, **Type1**, **Type2**, **Type3**, or **Type4**.

[5] Configure the 68B NULL Flit SKP OS Interval on the **PCIe/CXL Flit** tab. The configuration item differs depending on whether Sync Header Bypass is set to **ON** or **OFF**. This setting automatically configures the number of Inner Loop Blocks assigned to 68B NULL Flits. SKP OS is inserted at the end of a NULL Flit w/Implied EDS Block.

[6] Edit the 68B NULL Flit test pattern as needed. Tap **Pattern Edit** to modify any Block. For details on how to edit the Pattern Editor, refer to 4.4.1.4.9.3 “Editing 128b130b data pattern”.

4.4.2.1.3.6 Editing test patterns in the Sequence Editor dialog box (256B NULL Flit)

This section explains how to configure 256B NULL Flit pattern when **Sequence** is selected as the Test Pattern on the **Pattern** tab.

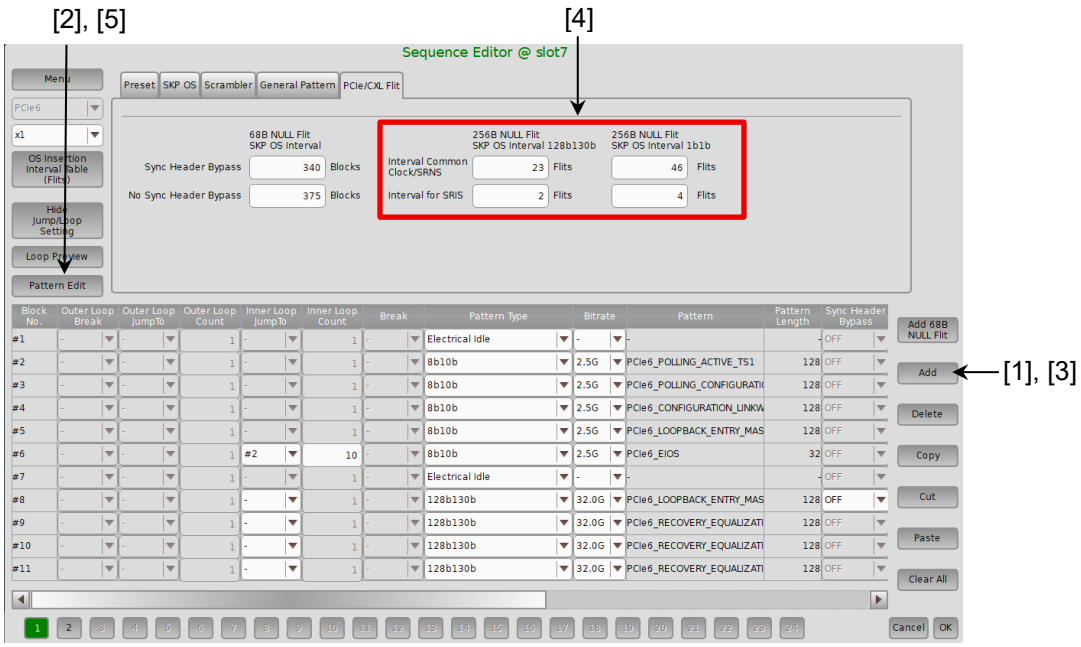


Figure 4.4.2.1.3.6-1 Sequence Editor Setting Screen

[1] Tap **Add**, and select **SDS 128b130b** or **SDS 1b1b** for Pattern Type.

[2] Edit the SDS pattern according to the bitrate in use. Refer to Table 4.4.2.1.3.6-1 to edit the pattern.

Table 4.4.2.1.3.6-1 SDS Pattern Settings for Bitrate

	8.0G or 16.0G	32.0G	64.0G
Pattern File	SDS_8G_16G	SDS_32G	SDS_64G
SKP Insertion	OFF	OFF	OFF
Num	1	1	2

[3] Tap **Add**, and select **256B NULL Flit 128b130b** or **256B NULL Flit 1b1b** for Pattern Type. Set the 256B NULL Flit pattern length according to the Link Width setting.

Table 4.4.2.1.3.6-2 Pattern Length for Each Encoding

Link Width	128b130b	1b1b
x1	1024 bit*	2048 bit
x2	1024 bit	1024 bit
x4	512 bit	512 bit

*: Since one Flit is transmitted every two transmission counts, an even pattern length must be used.

[4] Configure the 256B NULL Flit OS Interval on the **PCIe/CXL Flit** tab. SKP OS is inserted according to the configured Flit interval.

[5] Edit the 256B NULL Flit test pattern. Tap **Pattern Edit** to modify any Block. For details on how to edit the Pattern Editor, refer to 4.4.1.4.9.3 “Editing 128b130b data pattern” or 4.4.2.1.3.3 “Editing test patterns in the Sequence Editor dialog box (1b1b Pattern Editor).

4.4.2.1.4 Error Addition tab

On the **Error Addition** tab, you can turn on and off error addition to Data signal and can set error rate.

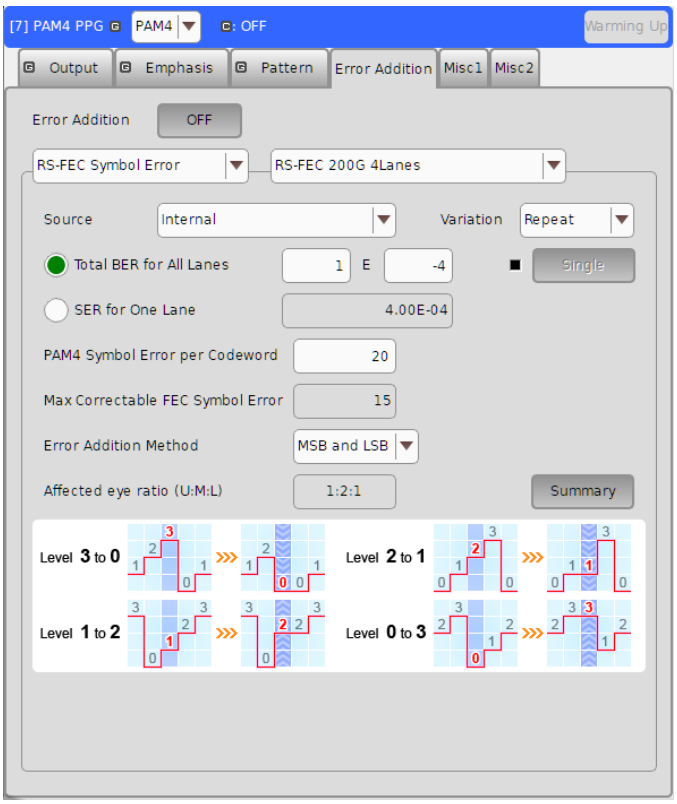


Figure 4.4.2.1.4-1 MU196020A Error Addition Tab (PAM4 Mode)

When the following options are installed, you can enable the IEEE-802.3 or PCIe-6 FEC error addition feature.

- MU196020A-z42 FEC Pattern Generation
- MU196020A-w43 Error Insertion for PCIe6

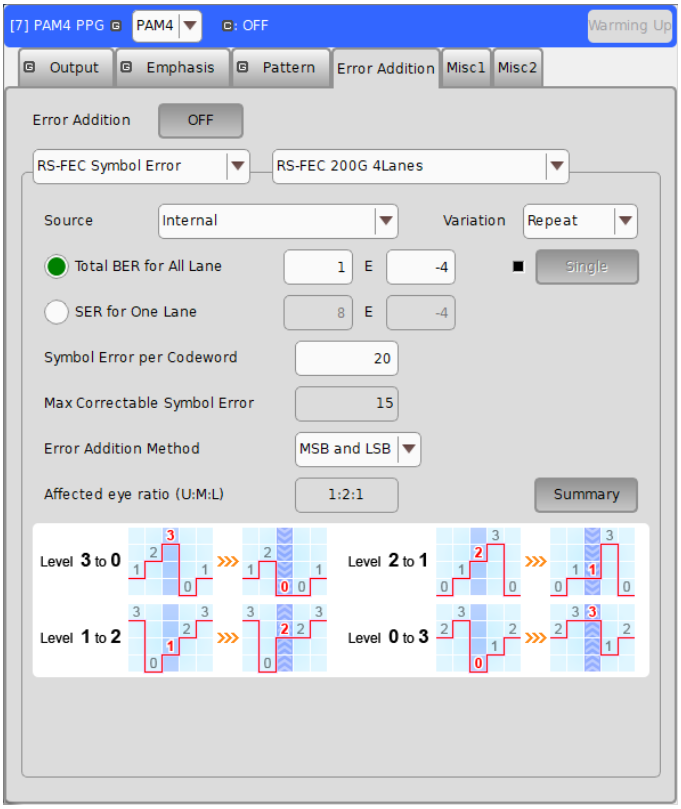


Figure 4.4.2.1.4-2 MU196020A Error Addition Tab (PAM4 Mode With MU196020A-z42)

4.4.2.1.5 Misc1 tab

On the **Misc1** tab, you can configure the signal generation method, synchronization signal output, auxiliary input and output, and other settings. Setting items on the **Misc1** tab are shown in Table 4.4.2.1.5-1.

Table 4.4.2.1.5-1 Setting Items

Item	Description
Pattern Sequence	Set the test pattern generating method. Gating Output can also be set.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.

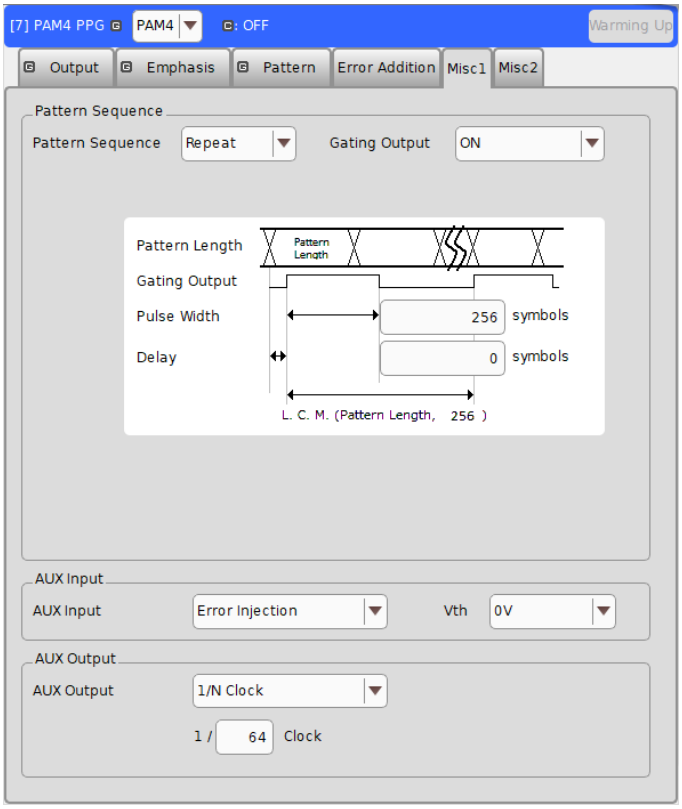


Figure 4.4.2.1.5-1 MU196020A Misc1 Tab (PAM4 Mode)

4.4.2.1.6 Misc2 tab

On the **Misc2** tab, you can configure the clock source, bit rate, baud rate, and other settings.

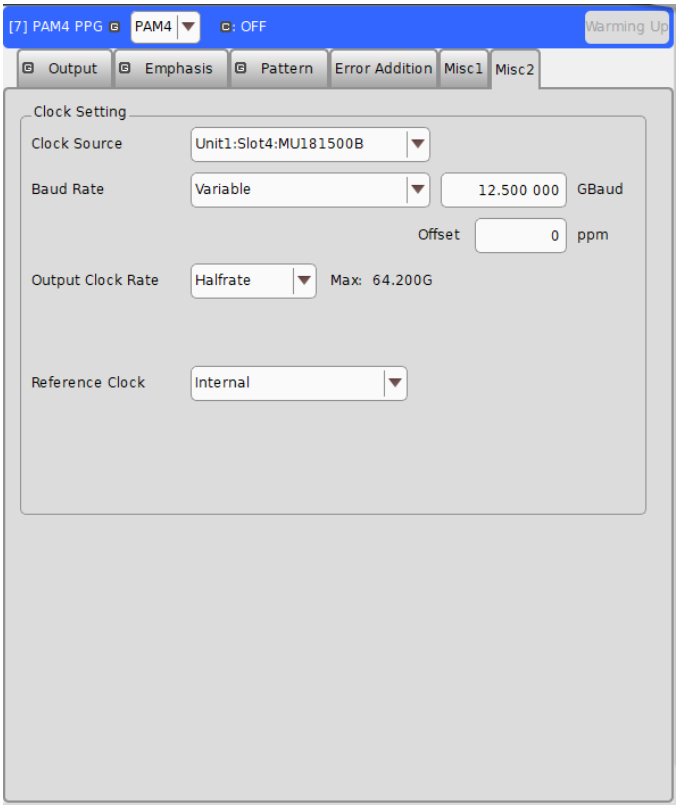


Figure 4.4.2.1.6-1 MU196020A Misc2 Tab (PAM4 Mode)

4.4.3 MU196020C

The MU196020C PAM4 PPG (hereafter, MU196020C) is a plug-in module that can be built into MP1900A. It can generate a variety of patterns within the operating frequency range, including PRBS, DATA, and ZeroSubstitution (NRZ mode only) patterns.

The MU196020C supports various option configurations and allows switching between NRZ, PAM4, and PAM3 signals, making it suitable for the development and production of digital communication equipment, communication modules, and devices.

This section describes the function of the tabs of the MU196020C operation screen. For details of the tabs, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

Switch the signal modulation mode to NRZ, PAM4, or PAM3 by selecting it in the NRZ/PAM4/PAM3 list at the module title bar shown in the following figure before using the module.



Figure 4.4.3-1 MU196020C NRZ/PAM4/PAM3 List

4.4.3.1 Equipment Composition

4.4.3.1.1 Output tab

On the **Output** tab, configure the settings for Data output and Clock output. Data signal is output from the DATA Output connector of MU196020C and Clock signal is output from the Clock connector. On this tab, Data and Clock signals, Output on or off, Amplitude, and Bit rate can be set.

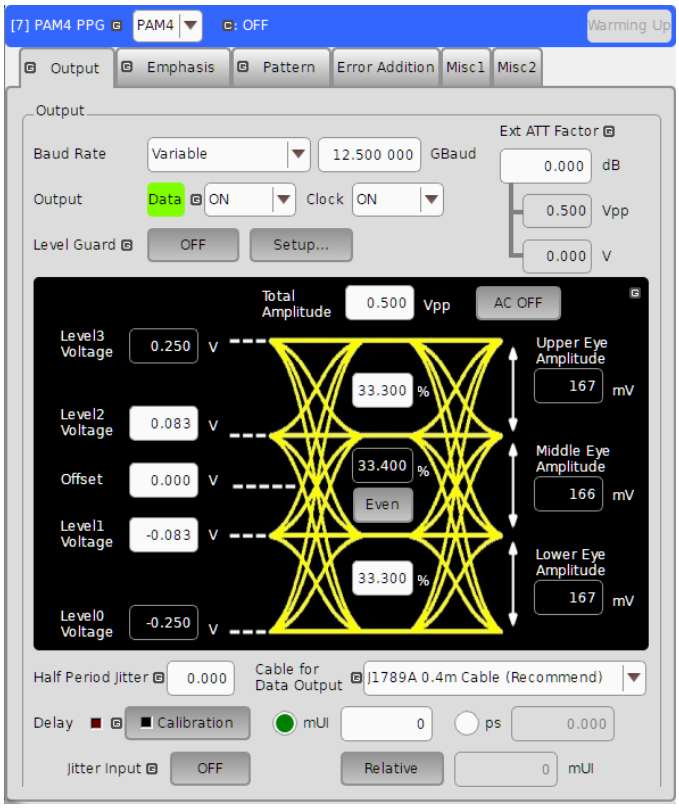


Figure 4.4.3.1.1-1 MU196020C Output Tab (PAM4 Mode)

4.4.3.1.2 Emphasis tab

On the **Emphasis** tab, you can configure the settings for the emphasis to be added to Data signal and can turn on and off the emphasis waveforms that comply with various specifications.

When the following option is installed, signal integrity evaluation using 4TAP Emphasis is available.

- 4Tap Emphasis Expansion (MU196020C-x11)

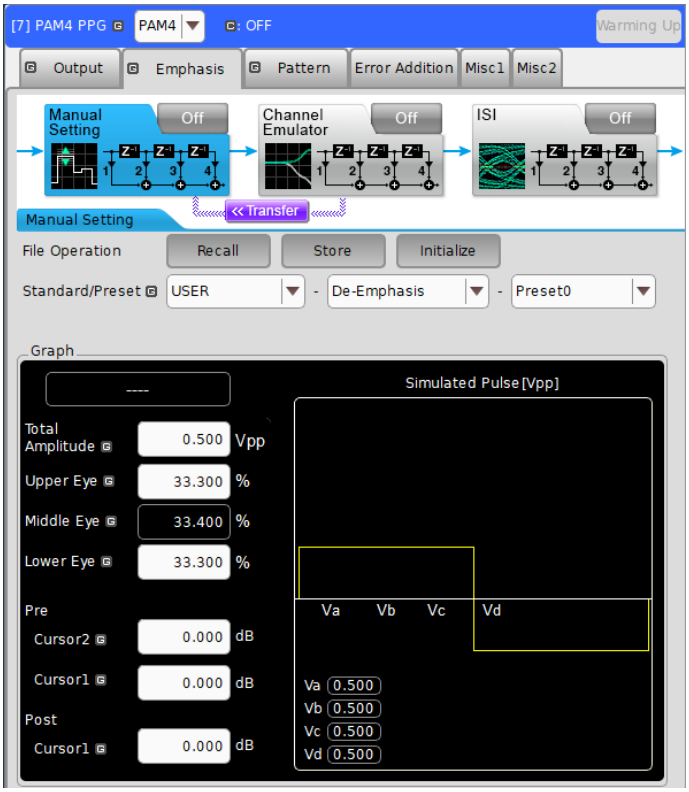


Figure 4.4.3.1.2-1 MU196020C Emphasis Tab (PAM4 Mode)

When the MU196020C-x40 Adjustable ISI is installed, you can use the Channel Emulator and ISI functions.

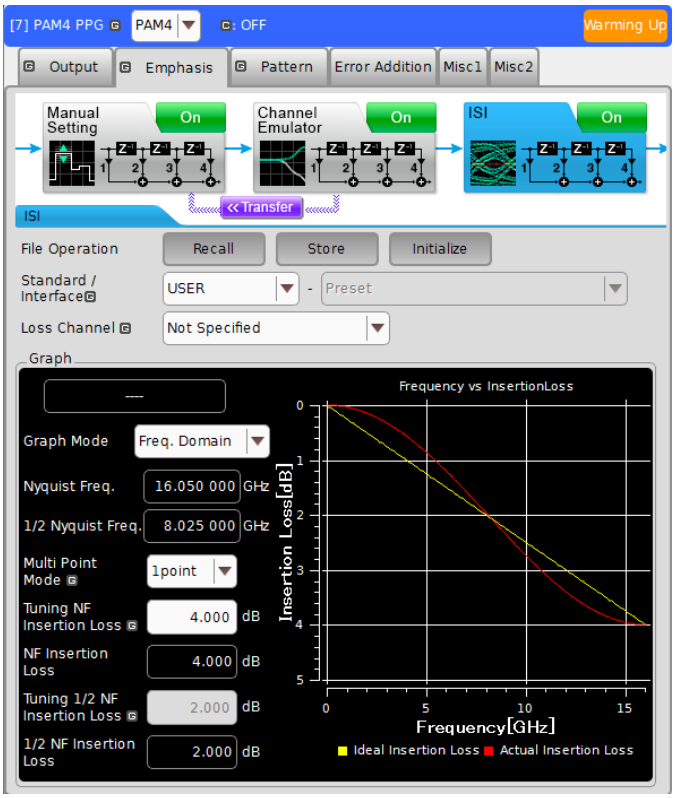


Figure 4.4.3.1.2-2 MU196020C Emphasis Tab (PAM4 Mode with MU196020C-x40)

4.4.3.1.3 Pattern tab

On the **Pattern** tab, you can select a test pattern and can configure the settings for it. The following five test patterns are available.

- PRBS
- ZeroSubstitution (NRZ mode only)
- Data
- PRTS (PAM3 mode only)
- Specification compliance patterns

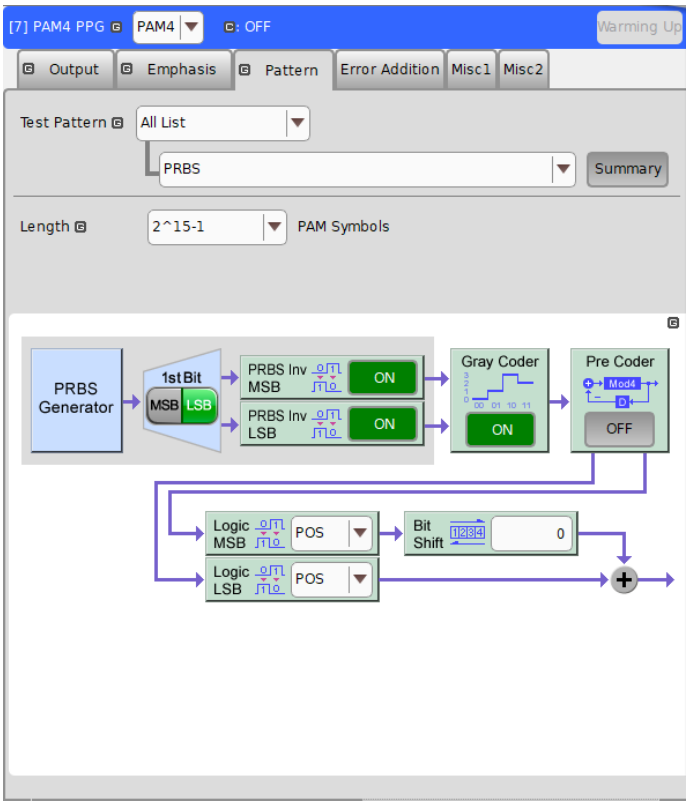


Figure 4.4.3.1.3-1 MU196020C Pattern Tab (PAM4 Mode)

If you select **Data**, you can edit the test pattern with Patten Editor. For explanation of Pattern Editor, refer to Table 4.5.2.1.3-1.

When the following options are installed, you can set IEEE-802.3 or PCIe-6 FEC patterns.

- MU196020C-z42 FEC Pattern Generation
- MU196020C-w43 Error Insertion for PCIe6

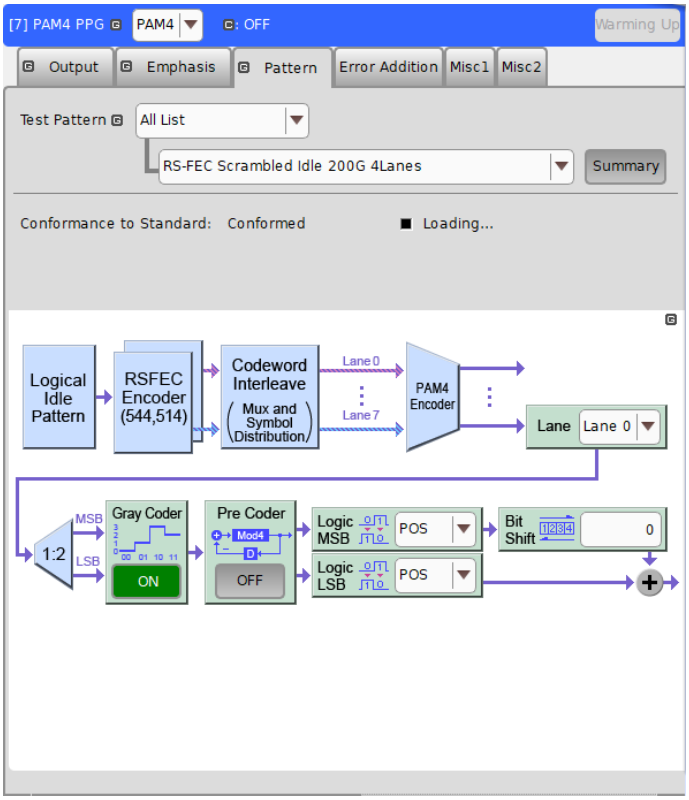


Figure 4.4.3.1.3-2 MU196020C Pattern Tab (With MU196020C-z42)

When the following option is installed, you can set the USB4 Gen4 compliance patterns.

- MU196020C-z45 USB4 Gen4 Pattern Generation

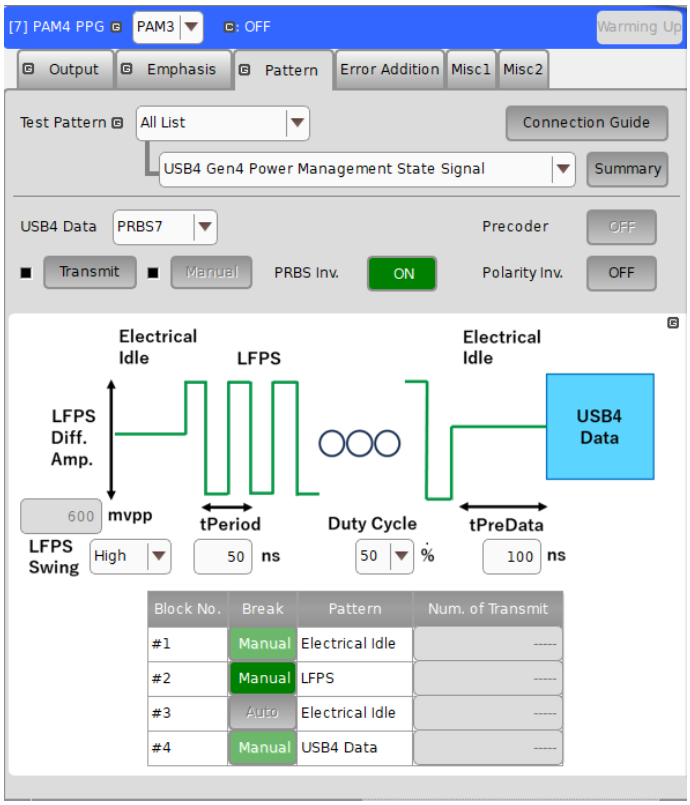


Figure 4.4.3.1.3-3 MU196020C Pattern Tab (With MU196020C-z45)

4.4.3.1.4 Error Addition tab

On the **Error Addition** tab, you can turn on and off error addition to Data signal and can set error rate.

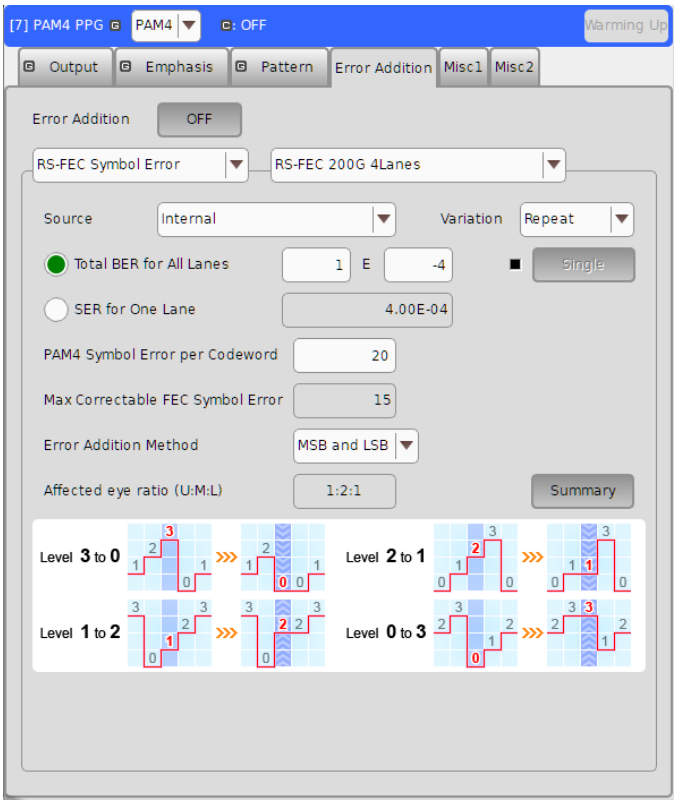


Figure 4.4.3.1.4-1 MU196020C Error Addition Tab (PAM4 Mode)

When the following options are installed, you can enable the IEEE-802.3 or PCIe-6 FEC error addition feature.

- MU196020C-z42 FEC Pattern Generation
- MU196020C-w43 Error Insertion for PCIe6

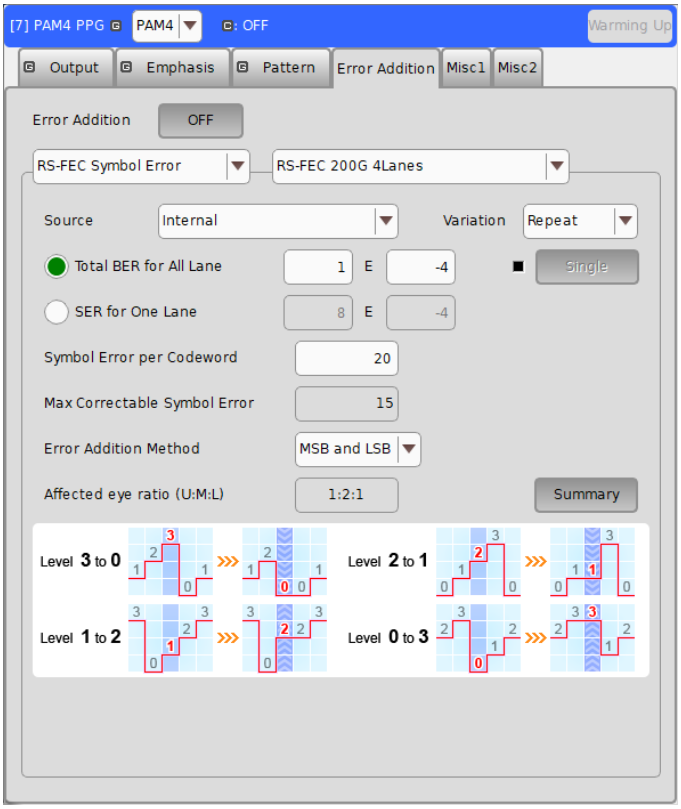


Figure 4.4.3.1.4-2 MU196020C Error Addition Tab (PAM4 Mode With MU196020C-z42)

4.4.3.1.5 Misc1 tab

On the **Misc1** tab, you can configure the signal generation method, synchronization signal output, auxiliary input and output, and other settings. Setting items on the **Misc1** tab are shown in Table 4.4.3.1.5-1.

Table 4.4.3.1.5-1 Setting Items

Item	Description
Pattern Sequence	Set the test pattern generating method. Gating Output can also be set.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.

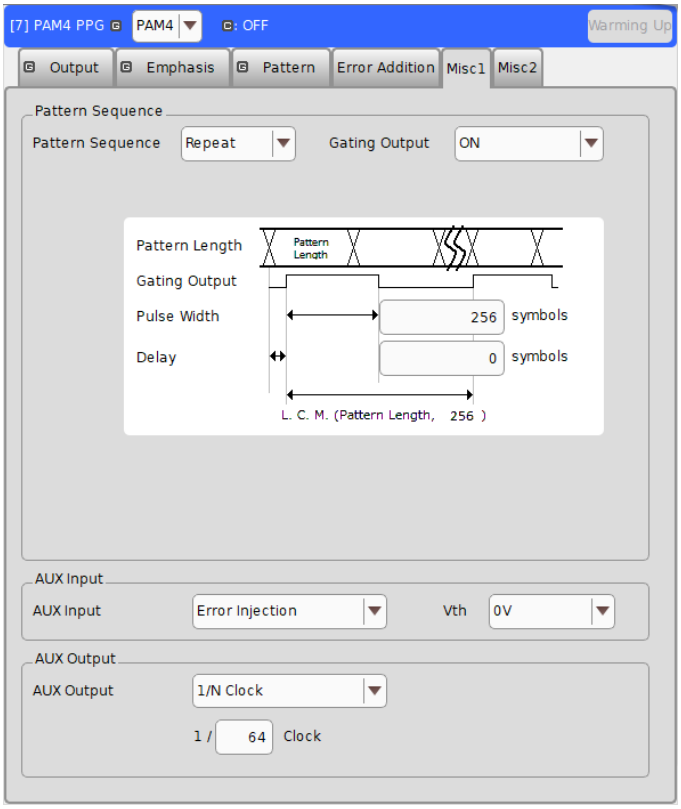


Figure 4.4.3.1.5-1 MU196020C Misc1 Tab (PAM4 Mode)

4.4.3.1.6 Misc2 tab

On the **Misc2** tab, you can configure the clock source, bit rate, baud rate, and other settings.

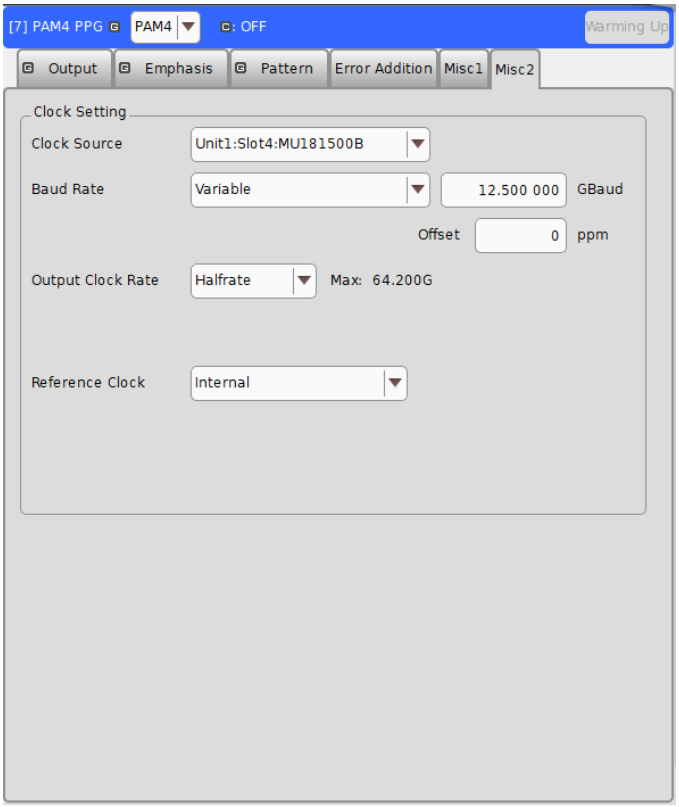


Figure 4.4.3.1.6-1 MU196020C Misc2 Tab (PAM4 Mode)

4.5 ED

4.5.1 MU195040A

The MU195040A 21G/32G bit/s SI ED (hereafter, MU195040A) is a plug-in module that can be built into MP1900A. It can measure a variety of patterns within the operating frequency range, including PRBS, Data, ZeroSubstitution, Mixed, and HSSB Data patterns.

This section describes function of the tabs of the MU195040A operation screen. For details of the tabs, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

4.5.1.1 Equipment Composition

4.5.1.1.1 Result tab

On the **Result** tab, you can check the BER results in the lower portion of the tab while changing the settings in the upper portion. To change the items to set, select an item in the list box at the module title bar. Setting items and description are shown in Table 4.5.1.1.1-1.

Table 4.5.1.1.1-1 Setting Items in Result Tab

Item	Description
Input	Select to configure the settings related to the input signal interface.
Gating	Select to configure the settings related to the measurement period. Select to configure the settings related to Confidence Level calculation.
Condition	Select to configure the settings related to the measurement conditions.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.

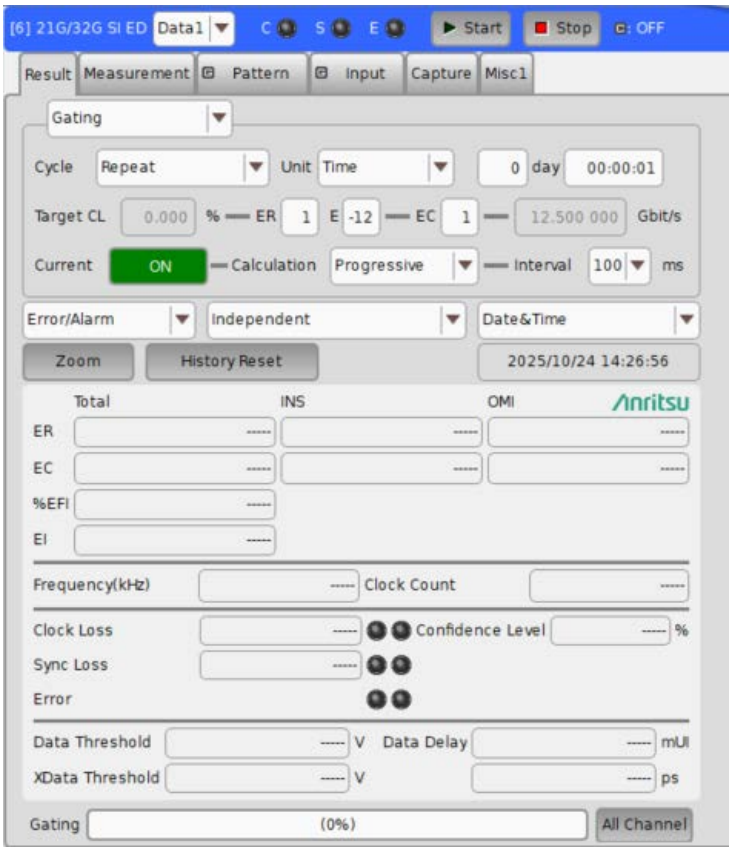


Figure 4.5.1.1.1-1 MU195040A Result Tab

Set the input signal Baud Rate/Bitrate and the ER used as the target criterion for BER in order to calculate the Confidence Level from the BER measurement results.



Figure 4.5.1.1.1-2 Confidence Level Settings

4.5.1.1.2 Measurement tab

On the **Measurement** tab, you can set the measurement conditions. The **Measurement** tab consists of five setting groups listed in Table 4.5.1.1.2-1. These items can be also set on the **Result** tab. Additionally, the advanced settings of Sync Control and Error/Alarm Condition are available on this tab.

Table 4.5.1.1.2-1 Setting/Display Items in Measurement Tab

Item	Description
Gating	Select to configure the settings related to the measurement period. Select to configure the settings related to Confidence Level calculation.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
SKP Ordered Set	Select to configure the settings related to the SKP Ordered Set filtering.
Sync Control	Select to configure the settings related to the synchronization establishment method.
Error/Alarm Condition	Select to configure the setting related to the error/alarm detection method.

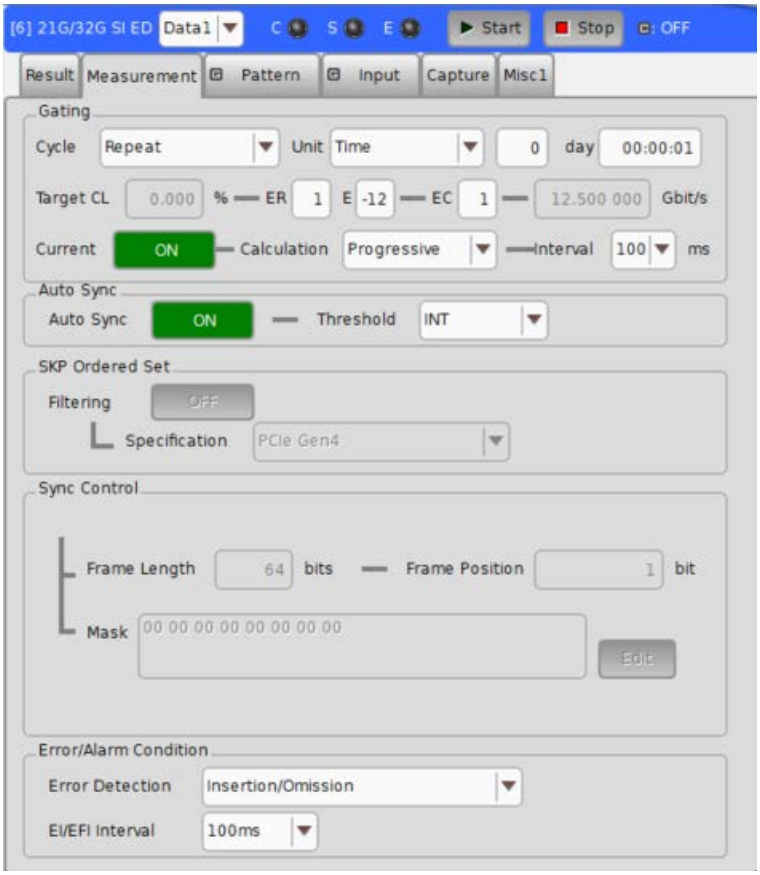


Figure 4.5.1.1.2-1 MU195040A Measurement Tab

4.5.1.1.3 Pattern tab

On the **Pattern** tab, you can select a test pattern and can configure the Mask settings. The following six test patterns are available. Setting items vary depending on the selected pattern.

- PRBS
- ZeroSubstitution
- Data
- Mixed
- PAM4 (When in the Combination Setting screen, **Inner module combination** is set to **Combination**)
- HSSB Data

By configuring Mask settings, a received test pattern is masked to prevent detected errors from being counted into the measurement results. **Pattern** tab is shown in Figure 4.5.1.1.3-1.

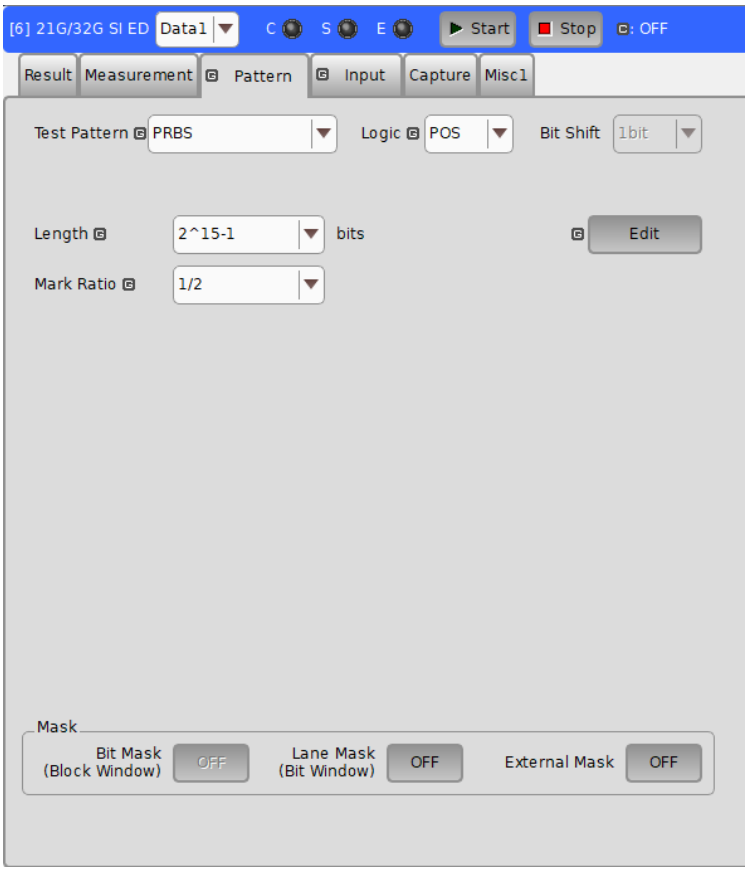


Figure 4.5.1.1.3-1 MU195040A Pattern Tab

4.5.1.1.4 Input tab

On the **Input** tab, you can configure the settings for the input interface. The **Input** tab consists of three setting areas: Data, Clock and Measurement Restart. Figure 4.5.1.1.4-1 lists the items to set in each area.

Table 4.5.1.1.4-1 Setting Items in Input Tab

Item	Description
Data	Differential or Single-Ended input setting and termination voltage setting
Clock	Clock source setting
Measurement Restart	Select an item to restart measurement when changes are made to settings.

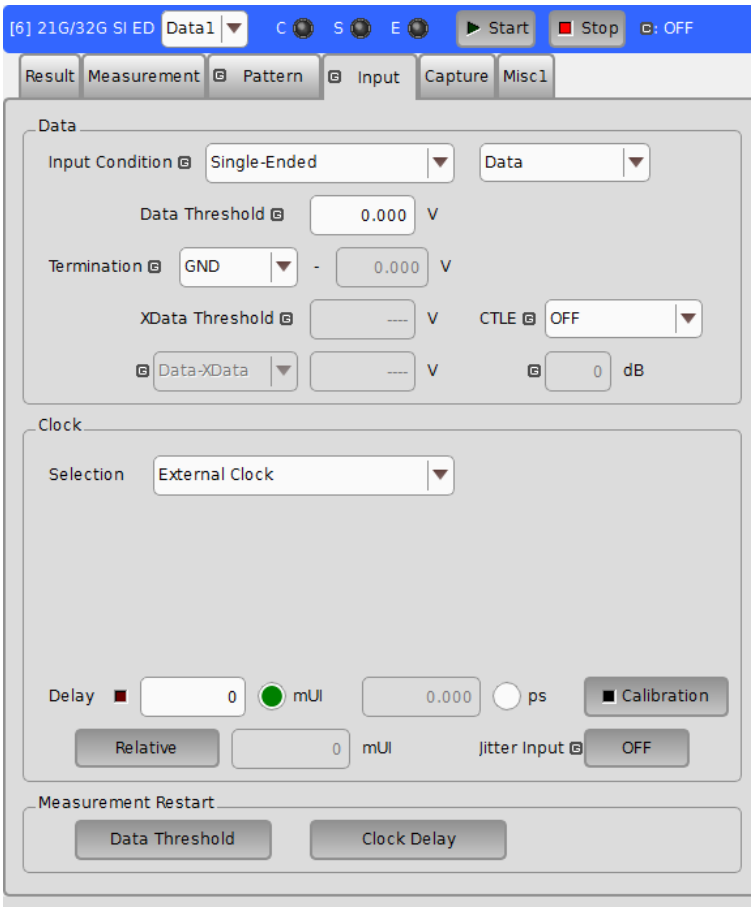


Figure 4.5.1.1.4-1 MU195040A Input Tab

4.5.1.1.5 Capture tab

On the **Capture** tab, you can capture the input test pattern and analyze it. Also, you can start and stop capturing pattern data and display captured pattern.

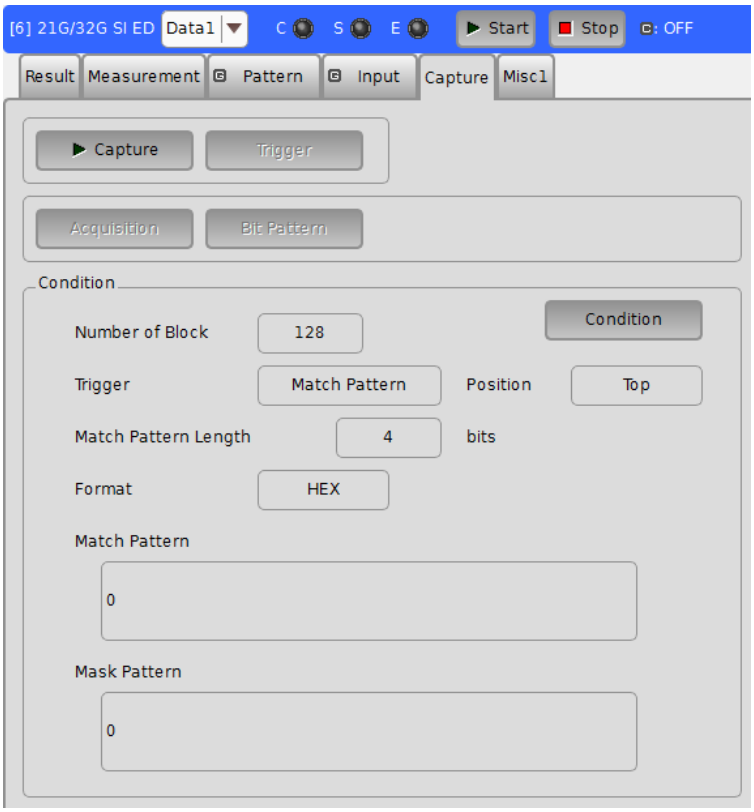


Figure 4.5.1.1.5-1 MU195040A Capture Tab

4.5.1.1.6 Misc1 tab

On the **Misc1** tab, you can configure the settings for pattern sequence and auxiliary input and output. Setting items on the **Misc1** tab are shown in Table 4.5.1.1.6-1.

Table 4.5.1.1.6-1 Setting Items of Misc1 Tab

Item	Description
Pattern Sequence	Set the test pattern receiving method.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.
Confidence Level	Set Bitrate for calculation.

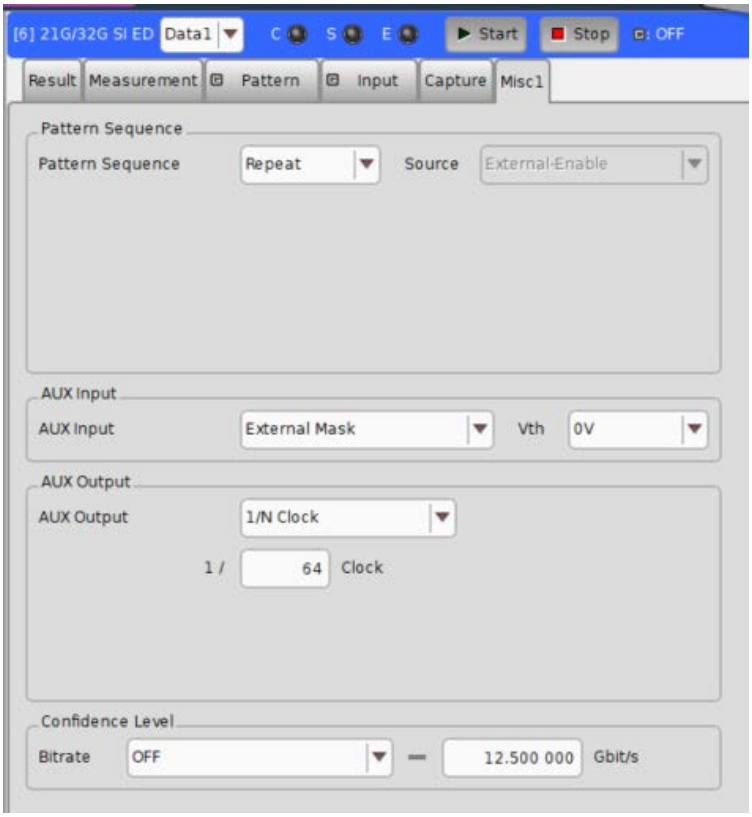


Figure 4.5.1.1.6-1 MU195040A Misc1 Tab

4.5.1.2 Displaying Measurement Results

To see the measurement results, touch the **Result** tab on the MU195040A operation screen.

The **Result** tab consists of the item setting area (upper) and the result display area (lower). Measurement results can be viewed while changing the setting items of the MU195040A.

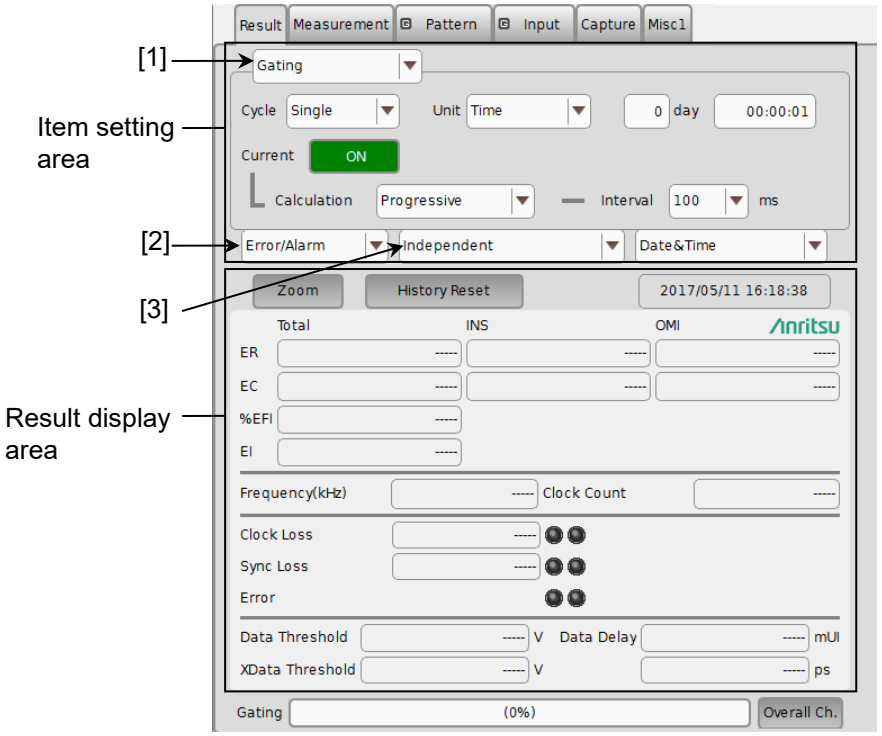


Figure 4.5.1.2-1 Result Tab

The setting items change according to the item selected in the list box ([1] in the figure above) in the item setting area.

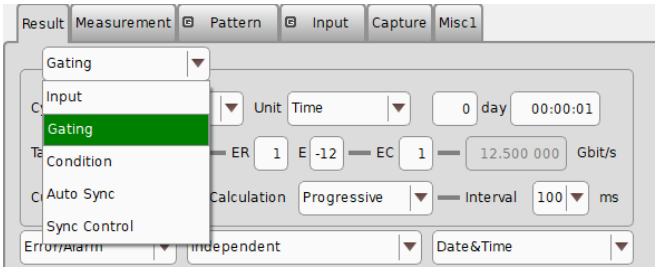


Figure 4.5.1.2-2 Item Setting Area

Table 4.5.1.2-1 Setting Items of List Box in Item Setting Area

Item	Description
Input	Select to configure the settings related to the input signal interface.
Gating	Select to configure the settings related to the measurement period. Configure the settings for Confidence Level calculation.
Condition	Select to configure the settings related to the measurement conditions.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.

The display items change according to the item selected in the list box ([2] in the Figure 4.5.1.2-1) in the result display area.
Note that the current version provides only **Error/Alarm** results.



Figure 4.5.1.2-3 Result Display Area

Table 4.5.1.2-2 Setting Items of List Box in Result Display Area

Item	Description
Error/Alarm	Select to display the Error/Alarm measurement results.

Display of channel combination can be switched by selecting from the list box ([3] in the Figure 4.5.1.2-1) result display area.

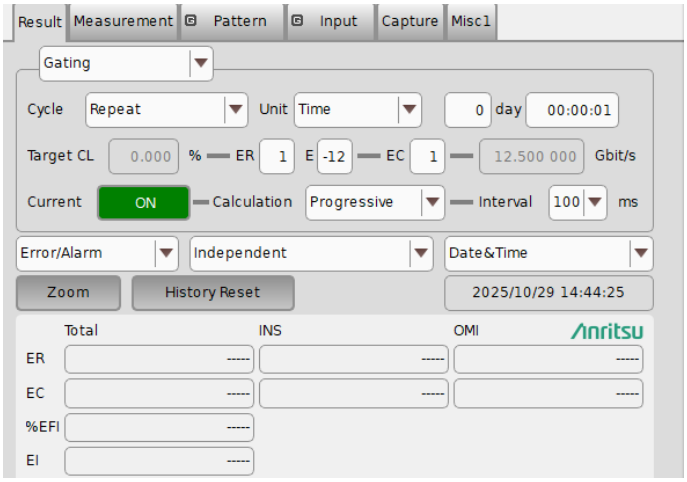


Figure 4.5.1.2-4 Result Display Area

Table 4.5.1.2-3 Setting Items in List Box in Result Display Area

Item	Description
Independent	Single channel measurement result.
2ch Combination 1-2*	2ch combination measurement result of Data 1/2.

*: MU195040A-x20 has this item.

4.5.1.2.1 Setting when Input is selected

Set [1] to **Input** in the item setting area (Figure 4.5.1.2-1).

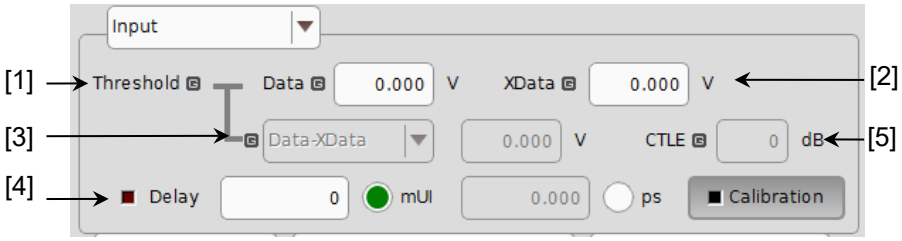


Figure 4.5.1.2.1-1 Items When Input Is Selected

[1] [2] Set the threshold voltage for Data input and XData input.

The Data signal is input from the Data Input connector of the MU MU195040A, and the XData signal is input from the $\overline{\text{Data}}$ Input connector. Hereinafter, the settings for the XData Input connector are described as the settings for $\overline{\text{Data}}$.

The threshold voltage can be set within the range from –3.500 to +3.300 V, in 0.001 V steps.

Note, however, that the absolute difference between the threshold values set for Data and XData inputs is limited to 3.000 V or less if **Input Condition** is set to **Differential 50Ohm** or **Differential 100Ohm** on Figure 4.5.1.5.1-1 Input Tab between the threshold voltages for Data and XData inputs.
This item is enabled when **Input Condition** is set to **Differential 50Ohm** or **Differential 100Ohm,** and **Alternate** is selected on Figure 4.5.1.5.1-1 Input Tab.

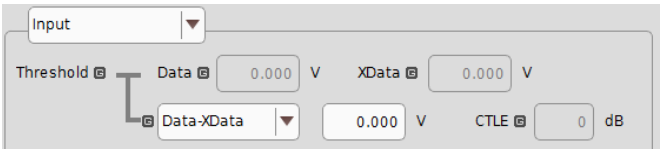


Figure 4.5.1.2.1-2 Input Voltage Threshold Difference Setting Items

Select **Data-XData** or **XData-Data**. Set a value within the range from –3.000 to +3.000 V, in 0.001 V steps.

[4] Set the clock phase unit and phase variable.



Figure 4.5.1.2.1-3 Clock Phase Setting Item

Select the unit from mUI or ps by touching the radio button.

<When mUI is selected>

The setting range is from –1000 to +1000 mUI, in 2 mUI steps

<When ps is selected>

Delay time can be set by ps step that is equivalent to 2 mUI.

The setting range is equivalent to the range when the unit is mUI (–1000 to +1000 mUI), converted into ps units.

Table 4.5.1.2.1-1 Clock Phase Setting (in ps units)

Frequency	Setting Range
32.1 GHz	–31.14 to 31.14
25 GHz	–40 to 40
2.4 GHz	–416 to 416

Notes:

- When the frequency or the temperature condition is changed, the LED on the **Calibration** lights, prompting performance of calibration. If calibration is not performed at this time, the error in the phase setting may be greater than at a normal phase setting.
- Values displayed in ps units vary as the frequency changes, because the MU195040A sets phases in mUI units as an internal standard.

[5] When MU195040A-x11/x21 is installed, set the CTLE gain. The value can be set in the range of 0 to –12 dB, in 0.1 dB steps.



Figure 4.5.1.2.1-4 CTLE Setting

Select the CTLE Band on the **Input** tab.

Refer to the description in 4.5.1.5.1 “Input setting items”.

4.5.1.2.2 Setting when Gating is selected

Set [1] to **Gating** in the item setting area (Figure 4.5.1.2-1).

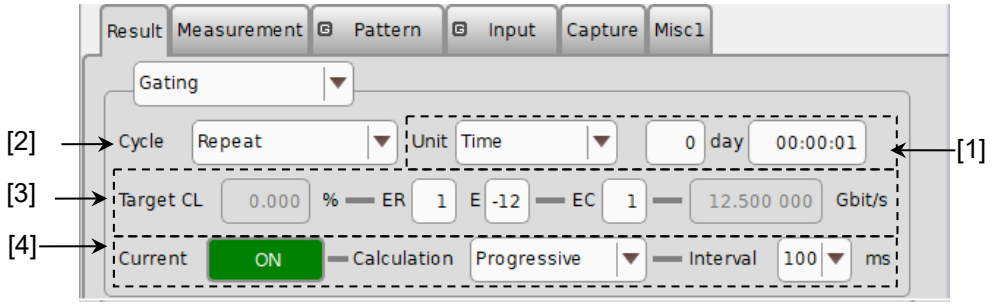


Figure 4.5.1.2.2-1 Gating Setting Items

[1] Select the unit of the measurement period in the **Unit** list, then enter the measurement period in the text box at the upper right.

Notes:

- When [2] **Cycle** is set to **Untimed**, the measurement period settings are ignored.
- When [2] **Cycle** is set to **Single (Target CL)**, **Unit** is fixed to **Time**.

Table 4.5.1.2.2-1 Measurement Period Setting

Unit	Description
Time	Time can be set from 1 second to 99 days 23 hours 59 minutes 59 seconds in second units.
Clock Count	The setting range is from E+4 to E+16, in E+1 units. The minimum measurement time resolution is 1 second, so the measurement will end at the end of the 1-second period in which the clock count reaches the number specified by this parameter (refer to Figure 4.5.1.2.2-2).
Error Count	The setting range is from E+4 to E+16, in E+1 units. The minimum measurement time resolution is 1 second, so the measurement will end at the end of the 1-second period in which the error count reaches the number specified by this parameter (refer to Figure 4.5.1.2.2-2).
Block Count	The number of blocks to be executed is set to Gating when the test pattern is Mixed Pattern. The setting range is from E+2 to E+14, in E+1 units. The minimum measurement time resolution is 1 second, so the measurement will end at the end of the 1-second period in which the block count reaches the number specified by this parameter (refer to Figure 4.5.1.2.2-2).

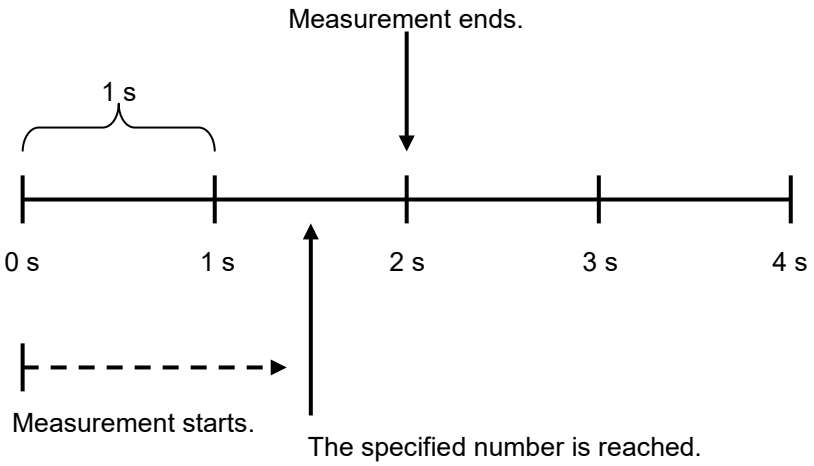


Figure 4.5.1.2.2-2 Measurement End Timing

[2] Select the measurement operation in the **Cycle** list box.

Table 4.5.1.2.2-2 Setting Measurement Operation

Cycle	Description
Repeat	Specified-period measurement is performed repeatedly.
Single	Measurement ends when it is performed once for the specified period.
Untimed	Measurement is performed continuously from the measurement start instruction to the measurement end instruction.
Single (Target CL)	Single measurement ends when it is performed once for the specified period. The required measurement time is calculated based on the target values for **Error Rate**, **Error Count**, and **Confidence Level**.

[3] Set the parameters for Confidence Level calculation. **Target CL** is configurable only when **Cycle** is set to **Single (Target CL)**.

Table 4.5.1.2.2-3 Setting Measurement Operation

Target	Description
Target CL	Set the target value for Confidence Level.
Target ER	Set the BER level to be used as a reference for Confidence Level calculation.
Target EC	Set the value that corresponds to the EC value for BER measurement.
Target Bitrate	Set the bitrate for Confidence Level calculation.

[4] Set the measurement progress display method.

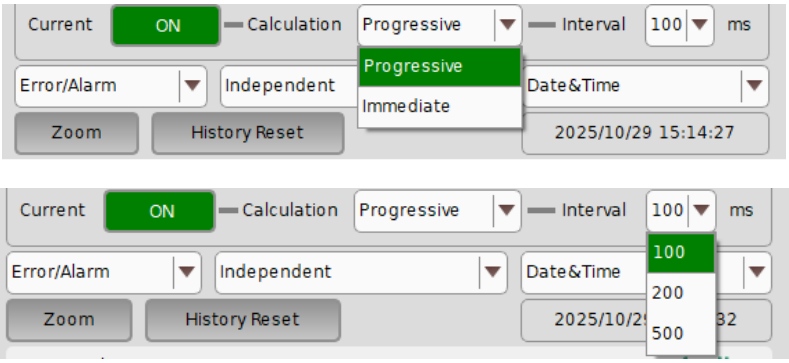


Figure 4.5.1.2.2-3 Measurement Progress Display Setting Items

Table 4.5.1.2.2-4 Measurement Progress Display Setting

Current	Description
ON	The accumulated measurement result, up to the current time, is displayed in the specified interval (cycle time). Select 100 (ms), 200 (ms) or 500 (ms)* in the **Interval** list for the cycle time. Select **Progressive** or **Immediate** in the **Calculation** list for the method to display measurement results in the middle of the measurement. In the Progressive mode, the measurement result accumulated from the measurement start is displayed. In the Immediate mode, the immediate-value result for each cycle time is displayed.
OFF	The measurement result in the last measurement period is displayed. The display remains until the measurement ends for the next measurement period.

*: 500 (ms) is available only during 2ch Combination.

The following figure shows a correspondence between the selection in the **Calculation** list (Progressive/Immediate) and the measurement result when the measurement period is 1 second and Interval is set to 200 ms.

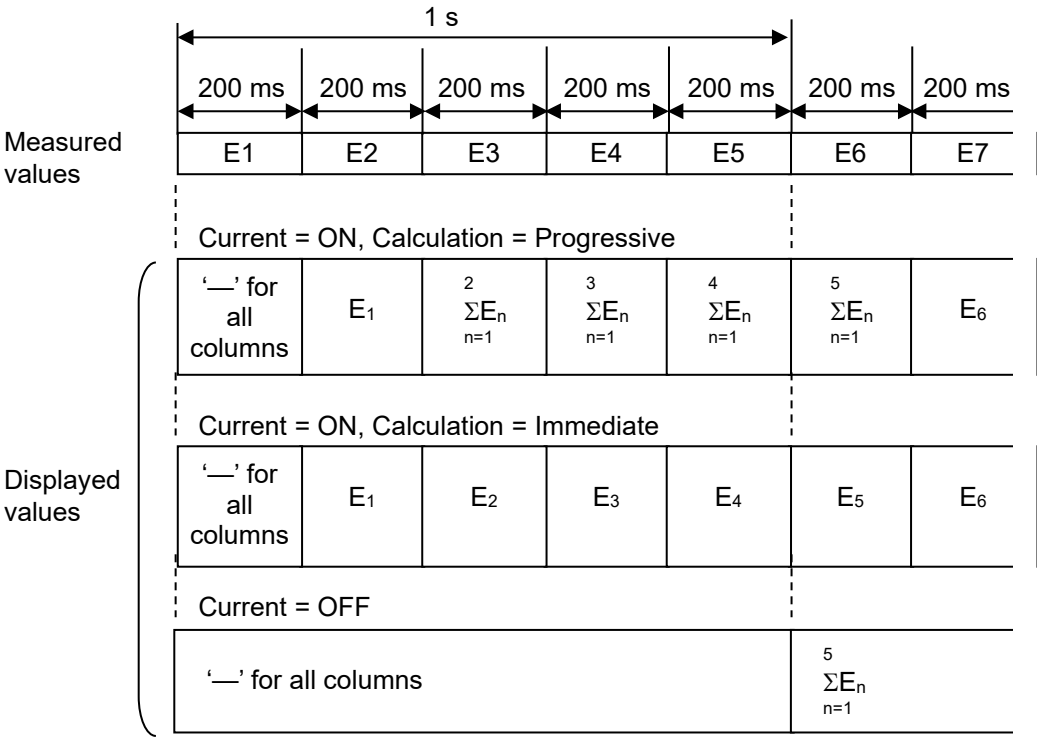


Figure 4.5.1.2.2-4 Relationship Between Measured Values and Displayed Values

4.5.1.2.3 Setting when Condition is selected

Set [1] to **Condition** in the item setting area (Figure 4.5.1.2-1).

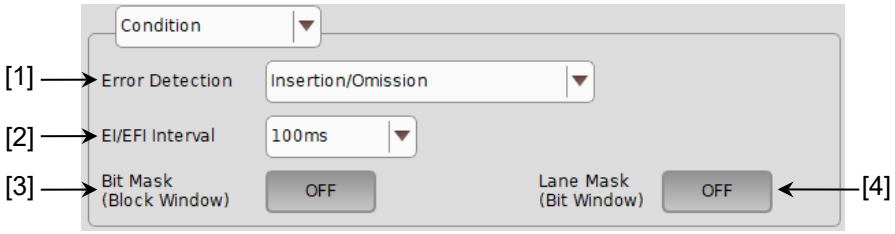


Figure 4.5.1.2.3-1 Items When Condition Is Selected

[1] Select the error detection method in the **Error Detection** list.

Table 4.5.1.2.3-1 Error Detection Method Setting

Error Detection	Description
Insertion/Omission	Counts errors where the bit pattern changes between 0 and 1. Insertion error: An error where the bit pattern changes from 0 to 1 Omission error: An error where the bit pattern changes from 1 to 0
Transition/Non Transition	Counts errors that occur in a transition or non-transition bit. Cannot be selected for Combination.

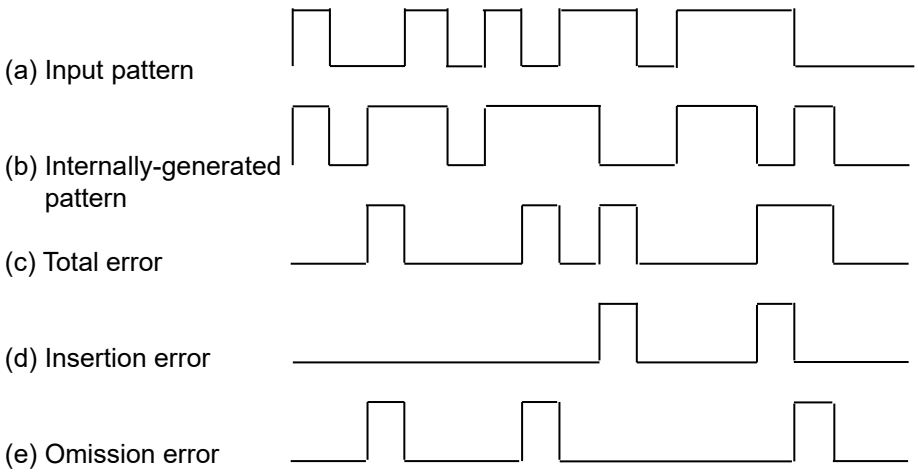


Figure 4.5.1.2.3-2 Error Detection (Total, Insertion, and Omission Errors)

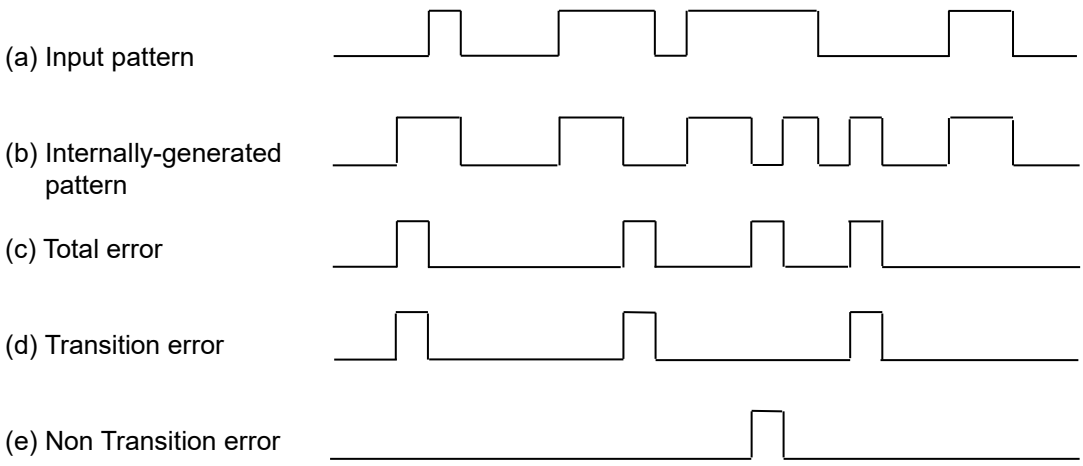


Figure 4.5.1.2.3-3 Error Detection (Total, Transition, and Non Transition Errors)

[2] Select the interval for error interval and error free interval measurements in the **EI/EFI Interval** list.

Table 4.5.1.2.3-2 Interval Time Setting

EI/EFI Interval	Description
1ms	Sets the interval to 1 ms. The interval counter value indicates the number of intervals.
10ms	Sets the interval to 10 ms. The interval counter value indicates the number of intervals.
100ms	Sets the interval to 100 ms. The interval counter value indicates the number of intervals.
1s	"1" is applied if the result of 1-second accumulation of interval counter values is not 0.

[3] Specify whether to enable the Block Window function.
The Block Window function masks errors in the set area by setting a mask area for the patterns occurring internally. Refer to 4.4.1.4.7 "Editing test pattern in Pattern Editor dialog box" for details.

Table 4.5.1.2.3-3 Block Window Function Setting

Block Window	Description
ON	Enables the Block Window function. Error measurement is masked for bits for which the Block Window setting is set to "1".
OFF	Disables the Block Window function.

Note that Block Window cannot be set in the following cases:

- When the test pattern is **PRBS** or **Mixed**
- When capturing has started

[4] Specify whether to enable the Bit Window function. The Bit Window function enables/disables measurement for every 32 bits of the test pattern. Refer to 4.4.1.4.7 “Editing test pattern in Pattern Editor dialog box” for details.

Table 4.5.1.2.3-4 Bit Window Function Setting

Bit Window	Description
ON	Enables the Bit Window function.
OFF	Disables the Bit Window function.

4.5.1.2.4 Setting when Auto Sync is selected

Set [1] to **Auto Sync** in the item setting area (Figure 4.5.1.2-1).

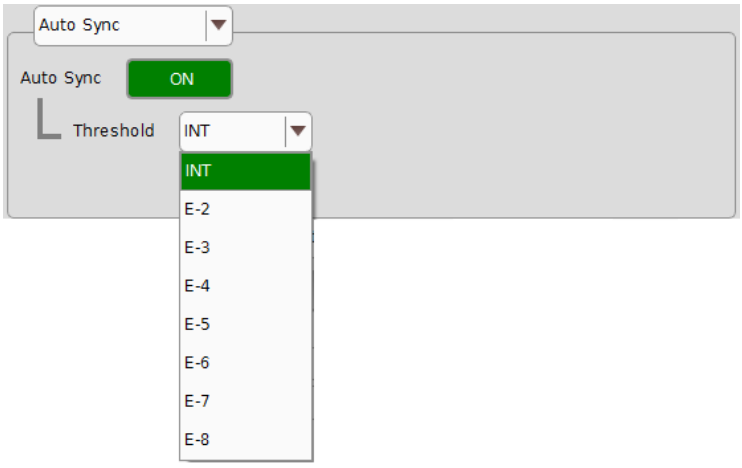


Figure 4.5.1.2.4-1 Items When Auto Sync Is Selected

[1] Specify whether to start resynchronization automatically when the synchronization threshold is exceeded from Sync Gain to Sync Loss.

Table 4.5.1.2.4-1 Auto Sync Setting

Auto Sync	Description
ON	Automatically starts resynchronization.
OFF	Does not start resynchronization automatically.

[2] Select the error rate threshold to execute resynchronization when Auto Sync is set to **ON**. In the **Threshold** list, 10^{-N} (N = 2 to 8) or **INT** can be set.
When **INT** is set, whether the synchronization is established (Sync Gain) or lost (Sync Loss) is judged according to the synchronization threshold. If the error rate exceeds the synchronization threshold in the Sync Gain state, it is judged as a Sync Loss. On the other hand, if the error rate falls to the synchronization threshold or below in the Sync Loss state, it is judged as a Sync Gain.
For details on the synchronization threshold, refer to Table 4.5.1.2.4-2 for **INT** and Table 4.5.1.2.4-3 for 10^{-N} (N = 2 to 8).

Table 4.5.1.2.4-2 Synchronization Thresholds When INT Is Set

Sync Control	Test Pattern	Data Length	Threshold Error Rate = [Error Count / Clock Count]	
			Sync Gain → Sync Loss	Sync Loss → Sync Gain
–	PRBS, Mixed Pattern, PRBS part of Mixed Pattern	$2^n - 1$ (n=7, 9, 10, 11, 15, 20, 23, 31)	$\frac{(128)\times 2{,}000}{(2{,}048)\times 5{,}000} = \frac{1}{40}$ = 2.5 E – 2	$\frac{(128)}{(2{,}048)\times 4} = \frac{1}{64}$ = 1.56 E – 2
Frame ON, Quick	Mixed Data Part, ZeroSubstitution Data	128 to 5,120	$\frac{(128)\times 200}{(2{,}048)\times 64{,}000} = \frac{1}{5{,}120}$ = 1.95 E – 4	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		5,121 to 10,240	$\frac{(128)\times 200}{(2{,}048)\times 128{,}000} = \frac{1}{10{,}240}$ = 9.77 E – 5	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		10,241 to 51,200	$\frac{(128)\times 200}{(2{,}048)\times 640{,}000} = \frac{1}{51{,}200}$ = 1.95 E – 5	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		51,201 to 102,400	$\frac{(128)\times 200}{(2{,}048)\times 1{,}280{,}000} = \frac{1}{102{,}400}$ = 9.77 E – 6	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		102,401 to 204,800	$\frac{(128)\times 200}{(2{,}048)\times 2{,}560{,}000} = \frac{1}{204{,}800}$ = 4.88 E – 6	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		204,801 to 307,200	$\frac{(128)\times 200}{(2{,}048)\times 3{,}840{,}000} = \frac{(256)\times 200}{(4{,}096)\times 3{,}840{,}000} = \frac{1}{307{,}200}$ = 3.26 E – 6	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}} = \frac{(512)\times 1}{(8{,}192)\times \frac{\text{DataLength}}{128\times 8}}$

Table 4.5.1.2.4-2 Synchronization Thresholds When INT Is Set (Cont'd)

Sync Control	Test Pattern	Data Length	Threshold Error Rate = [Error Count / Clock Count]	
			Sync Gain → Sync Loss	Sync Loss → Sync Gain
Frame ON, Quick (cont'd)	Mixed Data Part, ZeroSubstitution Data (cont'd)	307,201 to 409,600	$\frac{(128)\times 200}{(2{,}048)\times 5{,}120{,}000} = \frac{(256)\times 200}{(4{,}096)\times 5{,}120{,}000} = \frac{1}{409{,}600} = 2.44\ \mathrm{E}-6$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\mathrm{DataLength}}{128\times 8}} = \frac{(512)\times 1}{(8{,}192)\times \frac{\mathrm{DataLength}}{128\times 8}}$
		409,601 to 524,288	$\frac{(128)\times 200}{(2{,}048)\times 6{,}553{,}600} = \frac{(256)\times 200}{(4{,}096)\times 6{,}553{,}600} = \frac{1}{524{,}288} = 1.91\ \mathrm{E}-6$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\mathrm{DataLength}}{128\times 8}} = \frac{(512)\times 1}{(8{,}192)\times \frac{\mathrm{DataLength}}{128\times 8}}$
		524,289 to 1,048,576	$\frac{(128)\times 200}{(2{,}048)\times 13{,}107{,}200} = \frac{(256)\times 200}{(4{,}096)\times 13{,}107{,}200} = \frac{1}{1{,}048{,}576} = 9.54\ \mathrm{E}-7$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\mathrm{DataLength}}{128\times 8}} = \frac{(512)\times 1}{(8{,}192)\times \frac{\mathrm{DataLength}}{128\times 8}}$
		1,048,577 to 2,097,152	$\frac{(128)\times 200}{(2{,}048)\times 26{,}214{,}400} = \frac{(256)\times 200}{(4{,}096)\times 26{,}214{,}400} = \frac{1}{2{,}097{,}152} = 4.77\ \mathrm{E}-7$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\mathrm{DataLength}}{128\times 8}} = \frac{(512)\times 1}{(8{,}192)\times \frac{\mathrm{DataLength}}{128\times 8}}$
		2,097,153 to 4,194,304	$\frac{(128)\times 200}{(2{,}048)\times 52{,}428{,}800} = \frac{(256)\times 200}{(4{,}096)\times 52{,}428{,}800} = \frac{1}{4{,}194{,}304} = 2.38\ \mathrm{E}-7$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\mathrm{DataLength}}{128\times 8}} = \frac{(512)\times 1}{(8{,}192)\times \frac{\mathrm{DataLength}}{128\times 8}}$

Table 4.5.1.2.4-2 Synchronization Thresholds When INT Is Set (Cont'd)

Sync Control	Test Pattern	Data Length	Threshold Error Rate = [Error Count / Clock Count]	
			Sync Gain → Sync Loss	Sync Loss → Sync Gain
Frame ON, Quick (cont'd)	Mixed Data Part, ZeroSubstitution Data (cont'd)	4,194,305 to 8,388,608	$\frac{(128)\times 200}{(2{,}048)\times 104{,}857{,}600} = \frac{1}{8{,}388{,}608} = 1.19\ E-7$	$\frac{(128)\times 1}{(2{,}048)\times \frac{DataLength}{128\times 8}}$
		8,388,609 to 16,777,216	$\frac{(128)\times 200}{(2{,}048)\times 209{,}715{,}200} = \frac{1}{16{,}777{,}216} = 5.96\ E-8$	$\frac{(128)\times 1}{(2{,}048)\times \frac{DataLength}{128\times 8}}$
		16,777,217 to 33,554,432	$\frac{(128)\times 200}{(2{,}048)\times 419{,}430{,}400} = \frac{1}{33{,}554{,}432} = 2.98\ E-8$	$\frac{(128)\times 1}{(2{,}048)\times \frac{DataLength}{128\times 8}}$
		33,554,433 to 67,108,864	$\frac{(128)\times 200}{(2{,}048)\times 838{,}860{,}800} = \frac{1}{67{,}108{,}864} = 1.49\ E-8$	$\frac{(128)\times 1}{(2{,}048)\times \frac{DataLength}{128\times 8}}$
		67,108,865 to 134,217,728	$\frac{(128)\times 200}{(2{,}048)\times 1{,}677{,}721{,}600} = \frac{1}{134{,}217{,}728} = 7.45\ E-9$	$\frac{(128)\times 1}{(2{,}048)\times \frac{DataLength}{128\times 8}}$
		134,217,729 to 268,435,456	$\frac{(128)\times 200}{(2{,}048)\times 3{,}355{,}443{,}200} = \frac{1}{268{,}435{,}456} = 3.73\ E-9$	$\frac{(128)\times 1}{(2{,}048)\times \frac{DataLength}{128\times 8}}$

Table 4.5.1.2.4-3 Synchronization Thresholds When One of E-2 to E-8 Is Set

Sync Control	Threshold Error Rate = [Error Count / Clock Count]	
	Sync Gain → Sync Loss	Sync Loss → Sync Gain
E–2	$\frac{(128) \times 2{,}000}{(2{,}048) \times 5{,}000} = \frac{1}{40} = 2.5\text{E–}2$	$\frac{(128)}{(2{,}048) \times 4} = \frac{1}{64} = 2.5\text{E–}2$
E–3	$\frac{(128) \times 2{,}000}{(2{,}048) \times 50{,}000} = \frac{1}{400} = 2.5\text{E–}3$	$\frac{(128)}{(2{,}048) \times 40} = \frac{1}{640} = 1.56\text{E–}3$
E–4	$\frac{(128) \times 2{,}000}{(2{,}048) \times 500{,}000} = \frac{1}{4{,}000} = 2.5\text{E–}4$	$\frac{(128)}{(2{,}048) \times 400} = \frac{1}{6{,}400} = 1.56\text{E–}4$
E–5	$\frac{(128) \times 2{,}000}{(2{,}048) \times 5{,}000{,}000} = \frac{1}{40{,}000} = 2.5\text{E–}5$	$\frac{(128)}{(2{,}048) \times 4{,}000} = \frac{1}{64{,}000} = 1.56\text{E–}5$
E–6	$\frac{(128) \times 2{,}000}{(2{,}048) \times 50{,}000{,}000} = \frac{1}{400{,}000} = 2.5\text{E–}6$	$\frac{(128)}{(2{,}048) \times 40{,}000} = \frac{1}{640{,}000} = 1.56\text{E–}6$
E–7	$\frac{(128) \times 200}{(2{,}048) \times 50{,}000{,}000} = \frac{1}{4{,}000{,}000} = 2.5\text{E–}7$	$\frac{(128)}{(2{,}048) \times 400{,}000} = \frac{1}{6{,}400{,}000} = 1.56\text{E–}7$
E–8	$\frac{(128) \times 20}{(2{,}048) \times 50{,}000{,}000} = \frac{1}{40{,}000{,}000} = 2.5\text{E–}8$	$\frac{(128)}{(2{,}048) \times 4{,}000{,}000} = \frac{1}{64{,}000{,}000} = 1.56\text{E–}8$

4.5.1.2.5 Setting when Sync Control is selected

Set [1] to **Sync Control** in the item setting area (Figure 4.5.1.2-1).

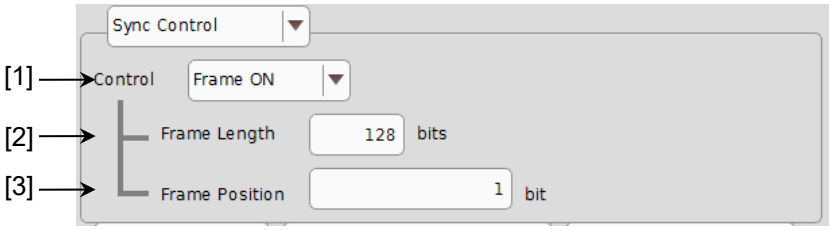


Figure 4.5.1.2.5-1 Items When Sync Control Is Selected

[1] Select the test pattern synchronization method.

Table 4.5.1.2.5-1 Sync Control Setting

Control	Description
Frame ON	Selects the frame synchronization method. This can be selected when the test pattern is ZeroSubstitution, Data, or Mixed. Synchronization is established upon frame pattern detection.
Quick	Selects the quick synchronization method. This can be selected when the test pattern is ZeroSubstitution or Data. Error measurement is performed using the pattern that has been saved into the internal memory as the reference pattern.

The test pattern synchronization methods selectable in the **Control** list vary depending on the test pattern selected on the **Pattern** tab. Refer to the Table 4.5.1.2.5-2.

Table 4.5.1.2.5-2 Synchronization Method Setting

Test Pattern	Control setting	
	Frame ON	Quick
PRBS	Not available	Not available
ZeroSubstitution	Available	Available
Data	Available	Available
Mixed	Available	Not available

[2] Set the frame pattern length when **Frame ON** is selected in the **Control** list. In the **Frame Length** box, 4 to 64 can be set in 4-bit steps.

The number of frame bits increases by N times (N ch Combi) when a Channel Combination is set.

Note:

If synchronization is hardly achieved during the combination, set the frame pattern length to 64 bits.

[3] Set the start position of the pattern for frame detection when **Frame ON** is selected in the **Control** list. The setting range of Frame Position is shown below:

- In case of Independent:
  1 to {(Length of pattern for frame detection) – (Frame Length + 1)} in 1-bit steps.
- In case of 2ch Combination:
  1 to 1+2n, in 2-bit steps
  Maximum value of n = INT((Length of pattern for frame detection – Frame Length) / 2)

The length of the pattern for frame detection varies depending on the test pattern selected on the **Pattern** tab. Refer to the table below.

Table 4.5.1.2.5-3 Setting of Pattern Length for Frame Detection

Test Pattern	Length of Pattern for Frame Detection
ZeroSubstitution	Pattern length
Data	Pattern length
Mixed	Pattern length of Row1 of Block1

Note:

When **Frame ON** is set, synchronization may take a long time if there is another pattern that is the same as the set frame pattern. The frame pattern is therefore recommended to be specific.
The pattern length described here is the number multiplied by an integer so that it becomes 512 bits or more, when the length on the "Figure 4.4.1.4-1 Pattern Tab" is 511 bit or less.

4.5.1.2.6 Setting items when Error/Alarm is selected

Set [2] to **Error/Alarm** in the item setting area (Figure 4.5.1.2-1).

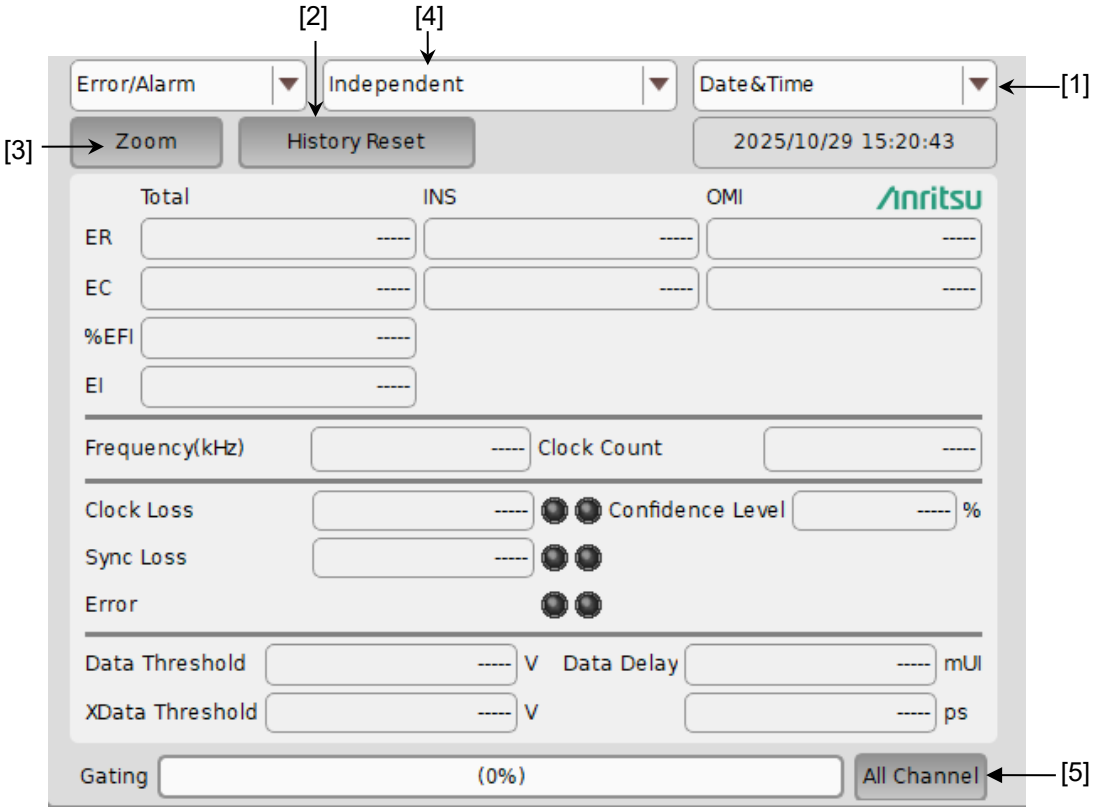


Figure 4.5.1.2.6-1 Items When Error/Alarm Is Selected

[1] Select the measurement time display type.

Date&Time: Select to display the current time.

Start Time: Select to display the measurement start time.

Elapsed Time: Select to display the elapsed time in the measurement period.

Remaining Time: Select to display the remaining time in the measurement period.

[2] Reset Error/Alarm history data.

History Reset: Touch to reset the history data of the error/alarm display.

[3] Enable or disable enlarged display of Error/Alarm measurement result.

Zoom: Touch to enlarge the display of the error count, error rate, error interval count, Clock Loss interval count, Sync Loss interval count, Clock Loss occurrence state, Sync Loss occurrence state, and error occurrence state.

When the enlarged display is disabled (Zoom is not selected), the items shown in Table 4.5.1.2.6-1 are displayed in the result display area with Error/Alarm selected.

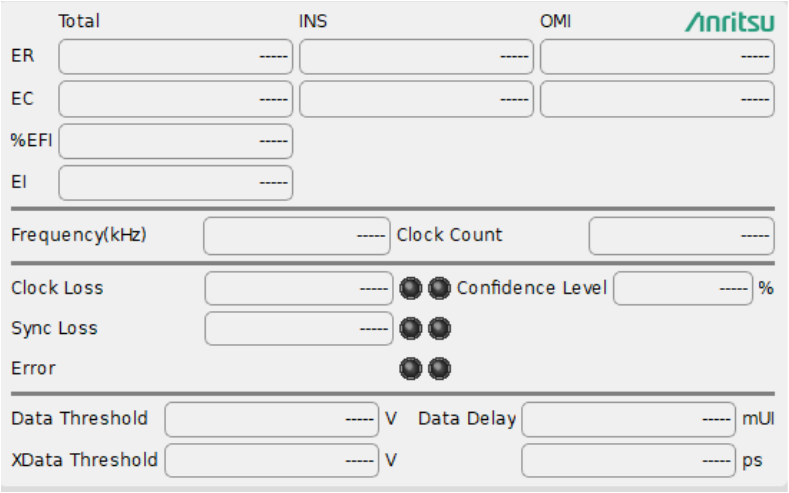


Figure 4.5.1.2.6-2 Items When Zoom Is Not Selected

Total/INS/OMI or Transition/Non Transition is displayed according to the error detection method set in the setting item area when Condition is selected (refer to Section 4.5.1.2.3).

Table 4.5.1.2.6-1 Items (controls) When Zoom Is Not Selected

Item		Function
ER	Total	Displays the total error rate.
	INS	Displays the insertion error rate.
	OMI	Displays the omission error rate.
	Transition	Displays the transition bit error rate.
	Non Transition	Displays the non-transition bit error rate.
EC	Total	Displays the total error count.
	INS	Displays the insertion error count.
	OMI	Displays the omission error count.
	Transition	Displays the transition bit error count.
	Non Transition	Displays the non-transition bit error count.
%EFI		Displays the error free interval rate.
EI		Displays the number of intervals where an error occurs.
Frequency(kHz)		Displays the frequency.
Clock Count		Displays the clock count.
Confidence Level		Displays the Confidence Level value.
Clock Loss		Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Sync Loss		Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Error		Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data
Data Threshold		Displays the Data Threshold voltage when Auto Adjustment is executed.
XData Threshold		Displays the XData Threshold voltage when Auto Adjustment is executed.
Data Delay		Displays the Delay value when Auto Adjustment is executed.

When the enlarged display is enabled (Zoom is selected), the items shown in Table 4.5.1.2.6-2 are displayed in the result display area with Error/Alarm selected.

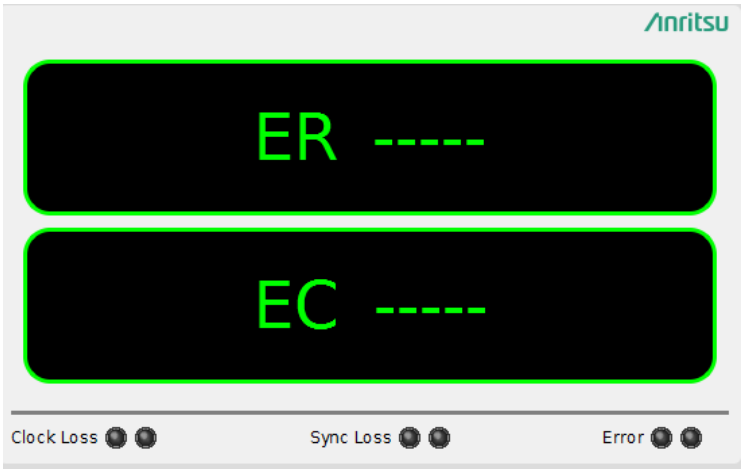


Figure 4.5.1.2.6-3 Items When Zoom Is Selected

Table 4.5.1.2.6-2 Items (Controls) When Zoom Is Selected

Item	Function
ER	Displays the error rate.
EC	Displays the error count.
Clock Loss	Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Sync Loss	Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Error	Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data

[4] Combination display
Select Combination condition of result display.

[5] Open/close All Channel Error/Alarm display.

Open/close test result dialog box.

Table 4.5.1.2.6-3 shows All Channel contents.

Table 4.5.1.2.6-3 Overall Ch Contents

Item		Function
ER	Total	Displays the total error rate.
	INS	Displays the insertion error rate.
	OMI	Displays the omission error rate.
	Transition	Displays the transition bit error rate.
	Non Transition	Displays the non-transition bit error rate.
EC	Total	Displays the total error count.
	INS	Displays the insertion error count.
	OMI	Displays the omission error count.
	Transition	Displays the transition bit error count.
	Non Transition	Displays the non-transition bit error count.
Clock Loss		Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Sync Loss		Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Error		Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data

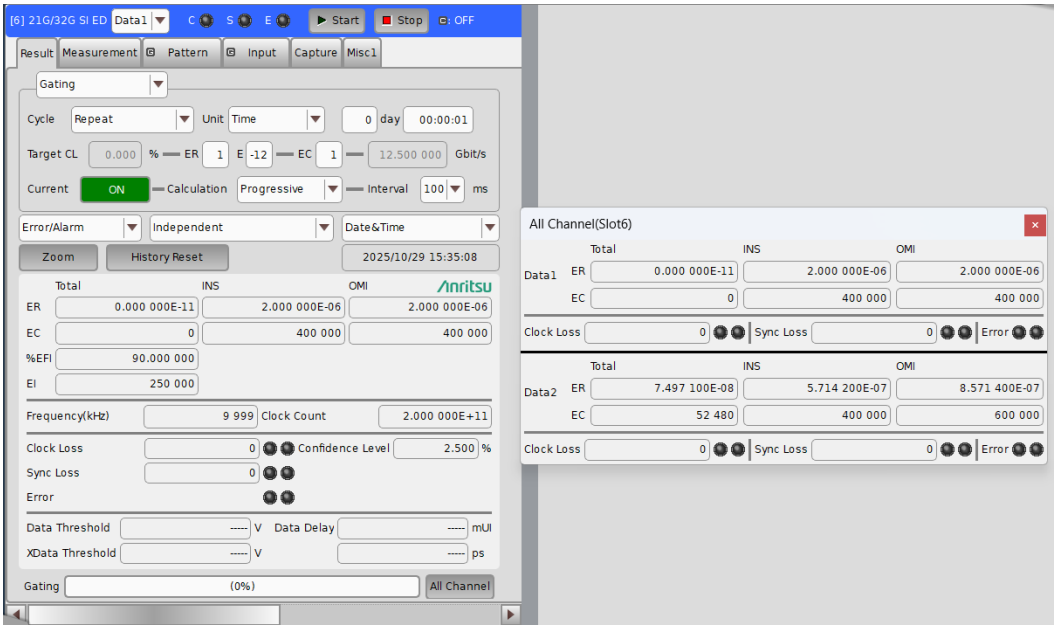


Figure 4.5.1.2.6-4 Result Sub Display Window (2ch Combination)

4.5.1.2.7 When inputting jitter-modulated signals

- When executing jitter tolerance test, etc. by inputting jitter-modulated clock, set **Jitter Input** of Delay to **ON** to avoid malfunction of Delay caused by excess jitter modulation. (Refer to Figure 4.5.1.2.7-1.) When using the MU181000A/B (with Option 001 Jitter Modulation) or MU181500B, set **Jitter Input** of Delay to **ON**, and then set **Jitter Modulation** of the MU181000A/B or MU181500B to **ON**.
- When executing Calibration of Delay, set jitter modulation of input signal to non-modulation.



Figure 4.5.1.2.7-1 Clock Delay Setting Items

Notes:

- When jitter-modulated clock is input while **Jitter Input** of Delay is set to **OFF**, the phase may become unstable.
- The Delay lamp may light up when a jitter-modulated clock signal is input. In addition, phase setting error may increase.
- The Delay function has feedback process to improve its setting accuracy at default setting (**Jitter Input** is set to **OFF**.). However, if **Jitter Input** is set to **ON**, the setting accuracy is lowered because the feedback process is stopped. Set Jitter Input according to the use as shown in the table below.

Jitter Input	Use
ON	Jitter Tolerance Measurement BER measurement when jitter amount applied to clock signal is big. (Delay is unstable when **Jitter Input** is **OFF**.)
OFF	Phase margin measurement Eye Margin measurement, Eye Diagram measurement, Bathtub measurement

4.5.1.3 Setting Measurement Conditions

Set the measurement conditions on the **Measurement** tab on the MU195040A operation screen.

The **Measurement** tab consists of five setting and displaying areas. Figure 4.5.1.3-1 and Table 4.5.1.3-1 show the configuration of the **Measurement** tab.

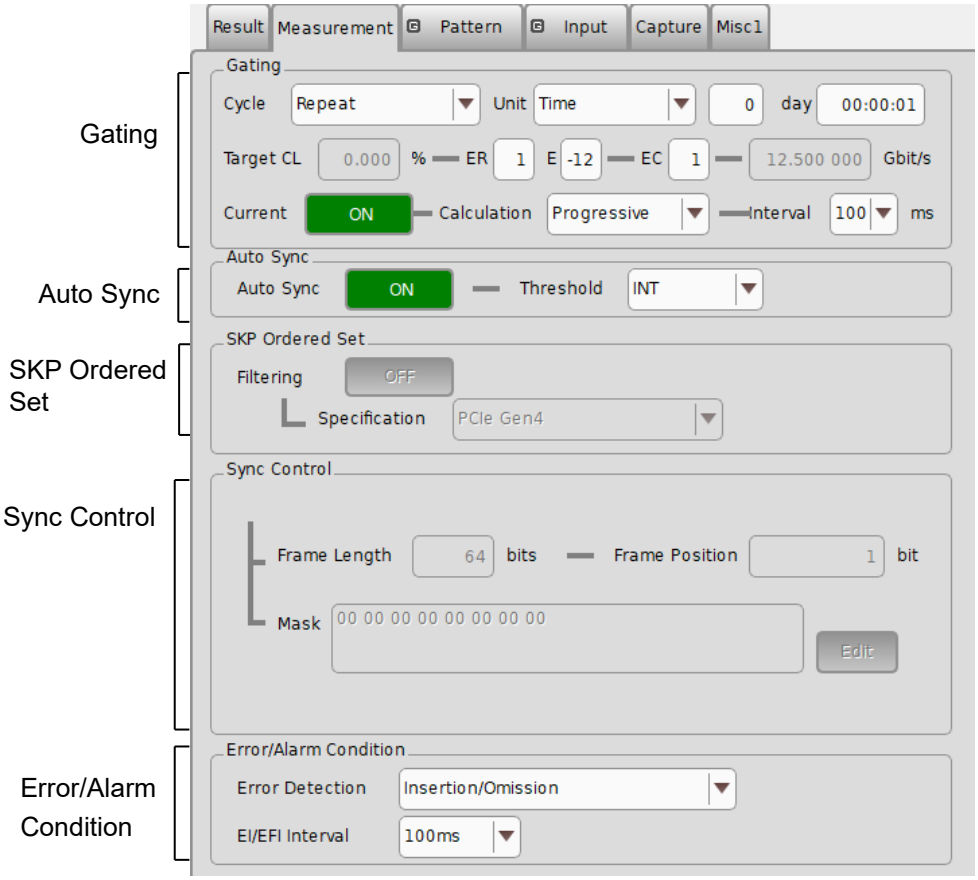


Figure 4.5.1.3-1 Measurement Tab

Table 4.5.1.3-1 Setting/Displaying Areas of Measurement Tab

Area	Description
Gating	Contains items for configuring the settings related to the measurement period. Configure the settings for Confidence Level calculation.
Auto Sync	Contains items for configuring the settings related to the automatic synchronization establishment function.
SKP Ordered Set	Contains items for configuring the settings related to the SKP Ordered Set filtering.
Sync Control	Contains items for configuring the settings related to the synchronization establishment method.
Error/Alarm Condition	Contains items for configuring the settings related to the measurement method.

Although similar settings can be configured on the **Result** tab, more detailed settings are possible from the Sync Control and Error/Alarm areas on the **Measurement** tab.

4.5.1.3.1 Gating area

The setting operations in the Gating area are the same as those in the setting item area of the **Result** tab when **Gating** is selected. Refer to 4.5.1.2.2 “Setting when Gating is selected” for details.

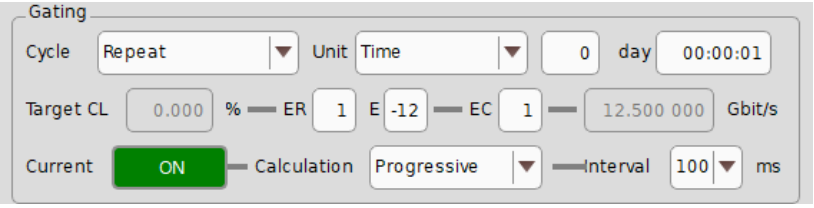


Figure 4.5.1.3.1-1 Measurement Period Setting Items in Gating Area

4.5.1.3.2 Auto Sync area

The setting operations in the Auto Sync area are the same as those in the setting item area of the **Result** tab when **Auto Sync** is selected. Refer to 4.5.1.2.4 “Setting when Auto Sync is selected” for details.

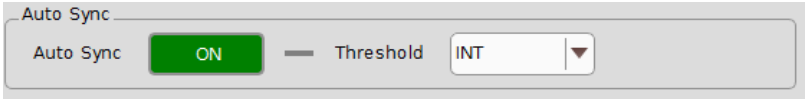


Figure 4.5.1.3.2-1 Measurement Period Setting Items in Auto Sync Area

4.5.1.3.3 SKP Ordered Set area

Contains items for configuring the settings related to the SKP Ordered Set filtering.

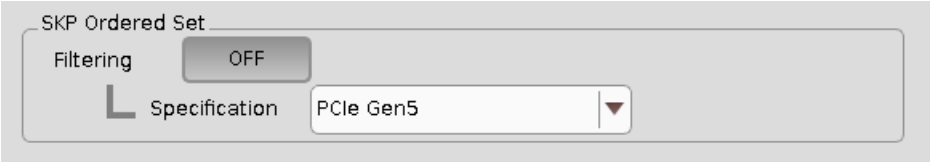


Figure 4.5.1.3.3-1 Filtering Setting Items in SKP Ordered Set Area

Table 4.5.1.3.3-1 Items to Set in the SKP Ordered Set Area

Item	Description
Filtering	Sets whether to filter the SKP Ordered Set . The filtered Ordered Set is not included in the error count. ON: Filters the SKP Ordered Set. OFF: Does not filter the SKP Ordered Set.
Specification	Select one of the PCIe Gen1 to PCIe Gen5 standards. This is not available when **Filtering** is set to **ON**.

The following are the restrictions applicable when using the SKP Filtering function.

- The MU195040A interface uses Data1.
- The MU195040A is installed with the MU195040A-x22.
- On the **Input** tab, **Clock and Data Recovery** is set for the clock source.
- In the **Combination Setting** dialog box, MU195040A is set to **Independent**.
- The pattern is set to **Data**, and the selected test pattern includes the SKP Ordered Set adhering to the encoding rule defined in the specifications.
  In the SKP Ordered Set area, Filtering cannot be turned **ON** if Test Pattern is set to PRBS, ZeroSubstitution or Mixed.

The following shows examples of test patterns to set.

Table 4.5.1.3.3-2 Test Pattern Recommended for SKP Ordered Set Filtering

Spec.	Test Pattern to Set for MU195020A	Test Pattern to Set for MU195040A
PCIe1	8b10b_CP_L0_SKP.ptn	8b10b_CP_L0.ptn
PCIe2	8b10b_CP_L0_SKP.ptn	8b10b_CP_L0.ptn
PCIe3	128b130b_MCP_L0_Gen3.ptn	128b130b_MCP_L0_Gen3_SRIS_NOSKP.ptn
PCIe4	128b130b_MCP_L0_Gen4.ptn	128b130b_MCP_L0_Gen4_SRIS_NOSKP.ptn
PCIe5	128b130b_MCP_L0_Gen5.ptn	128b130b_MCP_L0_Gen5_SRIS_NOSKP.ptn
USB3.0	CP0_RD+_skp_withSKPOS.ptn CP0_RD+_Lane1_withSKPOS.ptn CP0_RD-_withSKPOS.ptn CP0_RD-_Lane1_withSKPOS.ptn	CP0_RD+.ptn CP0_RD+_Lane1.ptn CP0_RD+.ptn CP0_RD+_Lane1.ptn
USB3.1 Gen2	CP9_withSKPOS.ptn CP9_Lane1_withSKPOS.ptn	CP9.ptn CP9_Lane1.ptn

4.5.1.3.4 Sync Control area

In the Sync Control area, the setting operations for the test pattern synchronization method, frame length, and start position of the pattern for frame detection are the same as those in the setting item area of the **Result** tab when **Sync Control** is selected.

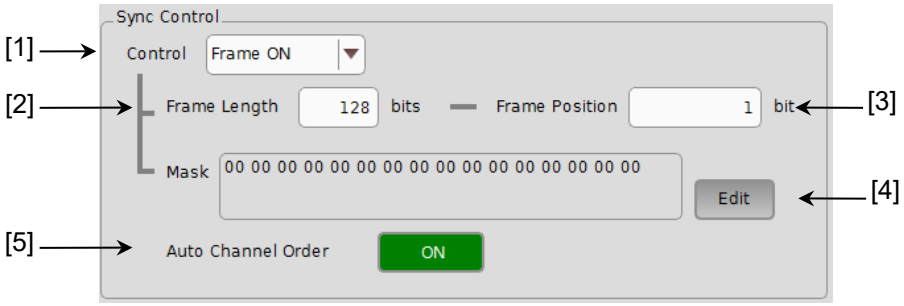


Figure 4.5.1.3.4-1 Synchronization Establishment Method Setting Items in Sync Control Area

[1] Select the test pattern synchronization method.

[2] Set the frame pattern length. (Available when **Frame ON** is selected in the **Control** list.)

[3] Set the start position of the pattern for frame detection. (Available when **Frame ON** is selected in the **Control** list.) Refer to 4.5.1.2.5 "Setting when Sync Control is selected" for details.

[4] Edit the mask pattern.
(Available when **Frame ON** is selected in the **Control** list.)

[5] Automatically arranges the 2 input channels in right order at 2ch Combination.
When this is On, it automatically detects the demultiplexed data at 2ch Combination and synchronize it.
When it is Off, the measurement is not performed properly if the 2 data channels are not arranged in right order.

4.5.1.3.5 Error/Alarm Condition area

In the Error/Alarm Condition area, the setting operations for the error detection method, error interval, and error free interval are the same as those in the setting item area of the **Result** tab when **Condition** is selected.



Figure 4.5.1.3.5-1 Measurement Setting Items in Error/Alarm Condition Area

[1] Select the error detection method. Refer to 4.5.1.2.3 “Setting when Condition is selected” for details.

[2] Select the error interval and error free interval. Refer to 4.5.1.2.3 “Setting when Condition is selected” for details.

4.5.1.4 Setting Test Patterns (MU195040A)

To set the ED pattern, touch the **Pattern** tab on the MU195040A operation screen. Select a test pattern and set other items.

The operation is common with MU195020A, so refer to 4.4.1.4 “Setting Test Patterns (MU195020A)".

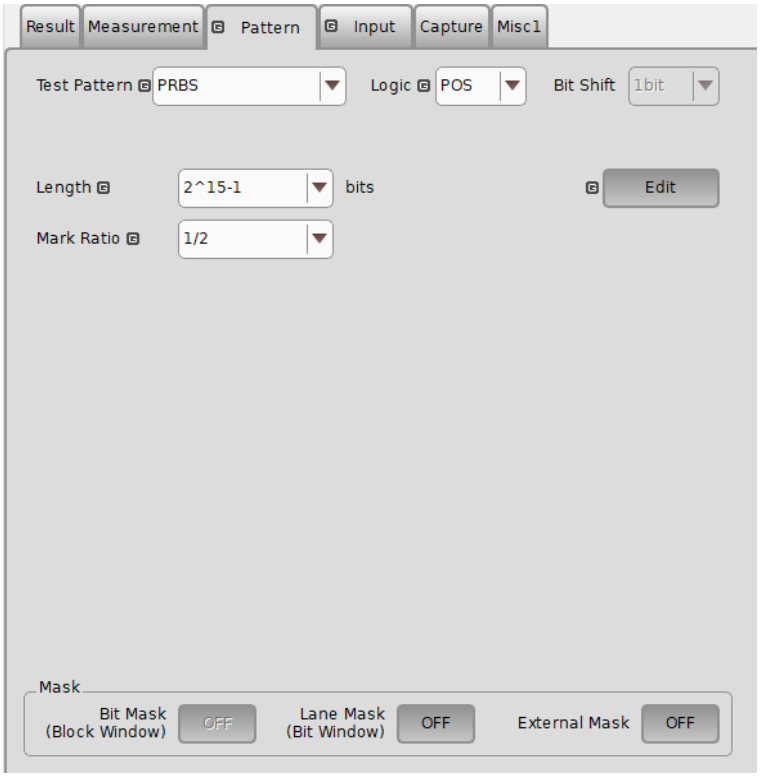


Figure 4.5.1.4-1 Pattern Tab

Table 4.5.1.4-1 Setting/Displaying Areas in Pattern Tab

Area	Description
Test Pattern	Select a test pattern. The setting items vary depending on the selected test pattern. The following five test patterns, are the same as 4.4.1.4.1 “Test Pattern type”. ● PRBS ● ZeroSubstitution ● Data ● Mixed ● PAM4
Mask	Contains items for setting Bit Mask, Lane Mask, and External Mask.

4.5.1.4.1 Mask selection

This section describes the controls in the mask area, which are used to mask a route and bit for the test pattern.
The mask positions can be set in the **Pattern Editor** dialog box.



Figure 4.5.1.4.1-1 Controls in Mask Area

[1] Enables (ON) or disables (OFF) the Block Window function.
The Block Window function specifies whether to enable or disable measurement (measurement mask) for each bit of the test pattern to be received. The mask positions can be set in the **Pattern Editor** dialog box.

Table 4.5.1.4.1-1 Block Window ON/OFF Setting

Block Window	Description
ON	Enables the Block Window function.
OFF	Disables the Block Window function.

Note that the following restrictions apply:

- The Block Window cannot be executed when the test pattern is **PRBS** or **Mixed**.

In Block Window function, the bit which 1 bit of Block Window takes charge of with pattern length changes as follows.
N is number of Combination. At the time of Combination, Pattern Length and Step increase N times.

Pattern Length setting		Block Window step
2*N to	2,097,152*N bits	1*N bits
2,097,153*N to	4,194,304*N bits	2*N bits
4,194,305*N to	8,388,608*N bits	4*N bits
8,388,609*N to	16,777,216*N bits	8*N bits
16,777,217*N to	33,554,432*N bits	16*N bits
33,554,433*N to	67,108,864*N bits	32*N bits
67,108,864*N to	134,217,728*N bits	64*N bits
134,217,729*N to	268,435,456*N bits	128*N bits

Example:

When Control is 2ch Combination and Pattern length is 4,194,300 bits, the Block Window Step is set to 2 bits.

[2] Enables (ON) or disables (OFF) the Bit Window function.

While test pattern measurement is usually performed using 32 error counters, the Bit Window function can mask measurement of the specified counter (route).

The following figure shows an example where the test pattern is a 32-bit length Data pattern and the error counters 2 and 4 are masked.

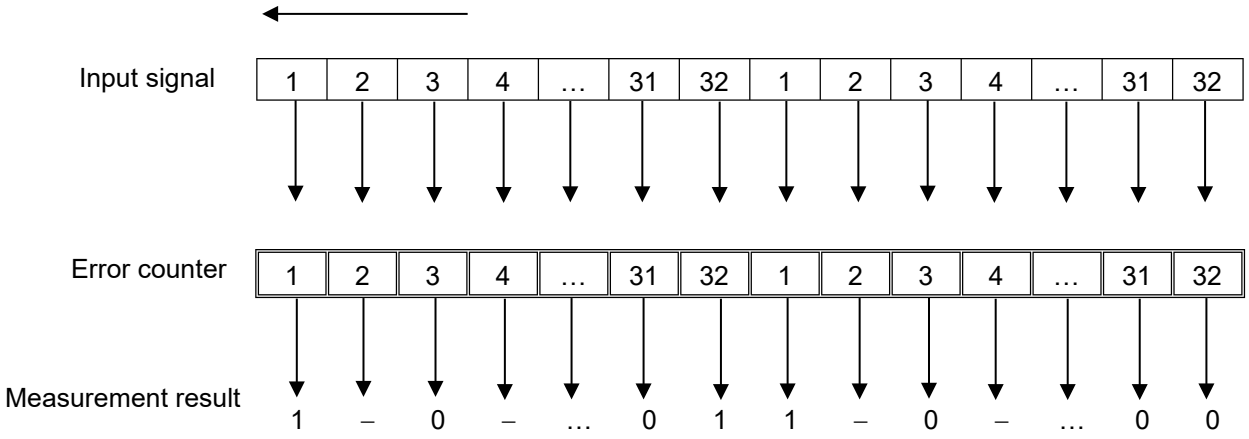


Figure 4.5.1.4.1-2 Bit Window Function

In this example, even if an error is detected by the masked counter 2 or 4, it is not included in the measurement result.

The mask position can be set in the **Pattern Editor** dialog box.

Table 4.5.1.4.1-2 Bit Window ON/OFF Setting

Bit Window	Description
ON	Enables the Bit Window function.
OFF	Disables the Bit Window function.

[3] Enables (ON) or disables (OFF) the External Mask signal.

This control is available only when **External Mask** is selected in the **AUX Input** list on the **Misc1** tab in the MU195040A window.

Table 4.5.1.4.1-3 External Mask ON/OFF Setting

External Mask	Description
ON	Enables the External Mask signal.
OFF	Disables the External Mask signal.

4.5.1.4.2 Setting HSSB Data

MU195040A can measure BER by loading the 8b10b, 128b130b, and 128b132b patterns set using the SI PPG Sequence Editor.

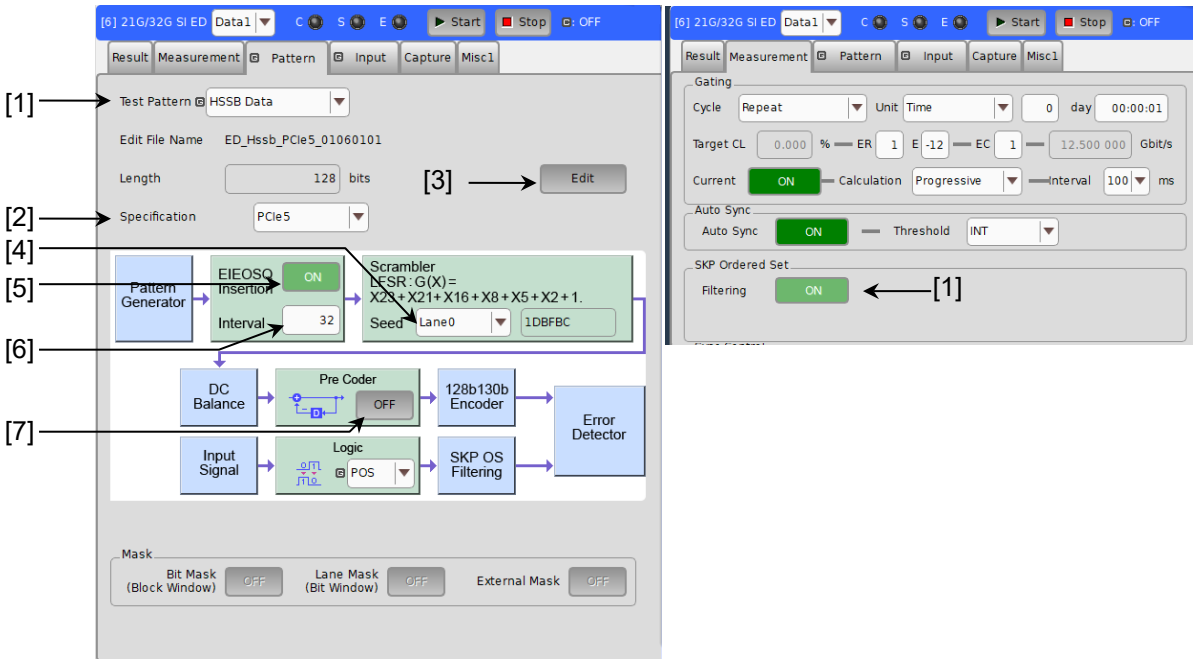


Figure 4.5.1.4.2-1 Setting HSSB Data

[1] On the **Pattern** tab for MU195040A, select **HSSB Data** in the Test Pattern box. When HSSB Data is selected, Filtering under SKP Ordered Set is always set to **ON**.

[2] Select a test specification.

[3] When **Edit** is touched, the pattern for the selected specification is displayed in the Editor screen. The following table shows the correspondence between specifications and encoding rules.

Table 4.5.1.4.2-1 Specification and Encoding Rules

Specification	Encoding Rule
PCIe1	8b10b
PCIe2	8b10b
PCIe3	128b130b
PCIe4	128b130b
PCIe5	128b130b
USB3.0	8b10b
USB3.1 Gen2	128b132b

[4] When **PCIe3**, **PCIe4**, or **PCIe5** is selected, the Scrambler Seed value depends on the selected Lane No. Select a lane and determine the Seed value.

[5] To receive the pattern containing EIEOSQ, select **ON**. Otherwise, select **OFF**.

[6] Set the interval of EIEOSQ inserted into the pattern. Unit: Pattern Repeats

[7] Turns on or off the Pre Coder. If the pattern is precoded, select **ON**. Otherwise, select **OFF**.

4.5.1.4.3 Example of how to configure BER measurement settings

This chapter describes how to measure BER using a DUT.
As examples, BER measurement procedures for the following patterns are described.

- TS pattern in the PCIe4.0 Recovery.Equalization Phase 1 state for PCIe4
- MCP pattern

4.5.1.4.3.1 Example 1: PCIe4.0 Recovery EQ Phase1-TS1

1. On the **Pattern** tab forMU195020A, select **Sequence** in the Test Pattern box.
2. In the **Specification** box, select **PCIe4**.
3. To set 128b130b for the last block of the default sequence, touch **Sequence Edit**. Touch **File** → **Open** to load the following file:

   C:\Anritsu\MP1900A\AppServers\bin\Pattern Files\Sequence_Default\PCIe4

   PCIe4_RECOVERY_EQUALIZATION_PHASE1.ptn128b130b
4. Set **Manual** for Break of the added block.
5. Set “32” for EIEOSQ Interval of the added block.
6. Touch **OK**.
7. On the **Pattern** tab for MU195020A, touch **Transmit** to make the DUT to enter the Loopback.Active state.
   The DUT enters a state where it loops back the TS pattern of the PCIe4.0 Recovery EQ Phase1 state output by the MU195020A.
8. On the **Pattern** tab for MU195040A, select **HSSB Data** in the **Test Pattern** box.
9. In the **Specification** box, select **PCIe4**.
10. Touch **Edit** → **File** → **Open** to load the same pattern file loaded to MU195020A.

    C:\Anritsu\MP1900A\AppServers\bin\Pattern Files\Sequence_Default\PCIe4

    PCIe4_RECOVERY_EQUALIZATION_PHASE1.ptn128b130b
11. Set “32” for EIEOSQ Interval.
12. Touch **Start** to start BER measurement.

4.5.1.4.3.2 Example 2: PCIe4.0 MCP

Steps 1 and 2 are the same as Example 1 in Section 4.5.1.4.3.1.

3. No changes are required from the default sequence. The default sequence can be restored by one of the following procedures:
   - Touch Menu → **Initialize**.
   - In Sequence Editor, touch **File** → **Open** to load the following file:

     C:\Anritsu\MP1900A\AppServers\bin\Pattern Files\Sequence_Default\PCIe4

     dB-PCIe4_Default.seqpcie4
4. Touch **Transmit** to make the DUT to enter the Loopback.Active state. The DUT enters a state where it loops back the MCP pattern output by the MU195020A.
5. On the **Pattern** tab for MU195040A, select **Data** in the **Test Pattern** box.
6. Touch **Edit**. Touch **File** → **Open** to load the following pattern file:

   C:\Anritsu\MP1900A\AppServers\bin\Pattern Files\PCIe 128b130b_MCP_L0_Gen4_SRIS_NOSKP.ptn
7. On the **Measurement** tab, under **SKP Ordered Set**, set Specification to **PCIe4** and set Filtering to **ON**.
8. Touch **Start** to start BER measurement.

4.5.1.4.4 Restrictions on SI PPG Sequence Editor and SI ED HSSB Data

This chapter explains new restrictions on MU195020A and MU195040A.

- To measure BER for PCIe1 and PCIe2, set SKP OS Symbol Length x2 to ON in the Sequence Editor of the MU195020A. This is to prevent the running disparity of the pattern from varying depending on where SKP Ordered Sets are inserted when SKP Ordered Set is inserted an odd number of times during BER measurement for PCIe.

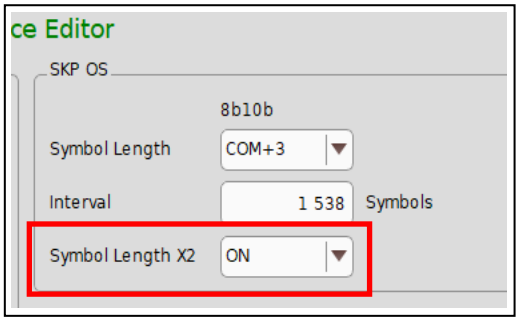


Figure 4.5.1.4.4-1 Setting for Symbol Length x2

- Combination, Channel Sync, and Grouping cannot be performed when **Sequence** is selected in the Test Pattern box on the **Pattern** tab for MU195020A.
- When **PCIe2**, **PCIe3**, **PCIe4**, or **PCIe5** is selected in the Specification box on the **Pattern** tab for MU195020A, the Error Addition function cannot be used for blocks with bitrate lower than the specified bitrate. The following table shows options available in the Specification box and their bitrates.

Table 4.5.1.4.4-1 Specification and Bitrate

Specification	Bitrate
PCIe2	5.0 Gbit/s
PCIe3	8.0 Gbit/s
PCIe4	16.0 Gbit/s
PCIe5	32.0 Gbit/s

- When measuring BER, set EIEOSQ Interval of EIEOSQ/SYNCOS to be inserted to the same value as EIEOSQ Interval in the Sequence Editor screen of the MU195020A.
  In the following example, set EIEOSQ Interval to 32.

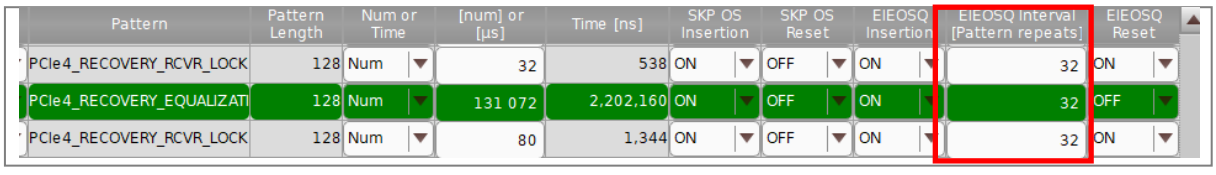


Figure 4.5.1.4.4-2 EIEOSQ Interval in the Sequence Editor Screen

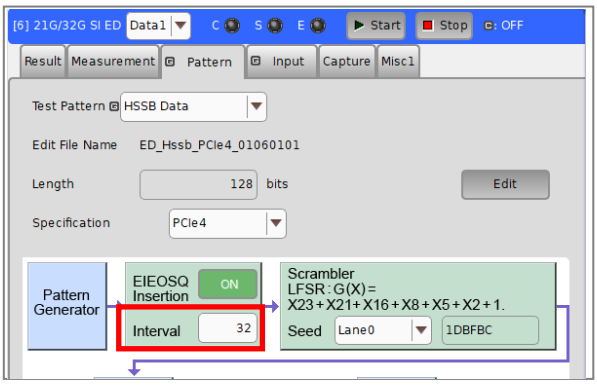


Figure 4.5.1.4.4-3 EIEOSQ Interval Setting for MU195040A

- To place the MU195040A in an error-free state when loading a 8b10b pattern file, perform one of the following:
  - On the **Input** tab of the MU195040A, adjust the Delay value.
- **HSSB Data** is available for Data1 only, not for Data2.
- BER of HSSB Data can be measured at the following bitrate only

Table 4.5.1.4.4-2 Bitrates at Which BER of HSSB Data Can Be Measured

Specification	Bitrate
PCIe1	2.5 Gbit/s
PCIe2	5.0 Gbit/s
PCIe3	8.0 Gbit/s
PCIe4	16.0 Gbit/s
PCIe5	32.0 Gbit/s
USB3.0	5.0 Gbit/s
USB3.1 Gen2	10.0 Gbit/s

- **Combination** cannot be selected when on the **Pattern** tab of the MU195040A, **HSSB Data** is selected for MU195040A. Similarly, **HSSB Data** cannot be selected for Data2 when in the **Grouping** dialog box, Pattern is set to **ON**.
- **Eye Contour**, **Bathtub**, and **Eye Margin** cannot be used when on the **Pattern** tab of the MU195040A, **HSSB Data** is selected for Test Pattern.

4.5.1.5 Setting Input Interface

To set input interface, touch the **Input** tab on the MU195040A operation screen.

4.5.1.5.1 Input setting items

The **Input** tab consists of three areas: Data setting area, Clock setting area and Measurement Restart setting area.

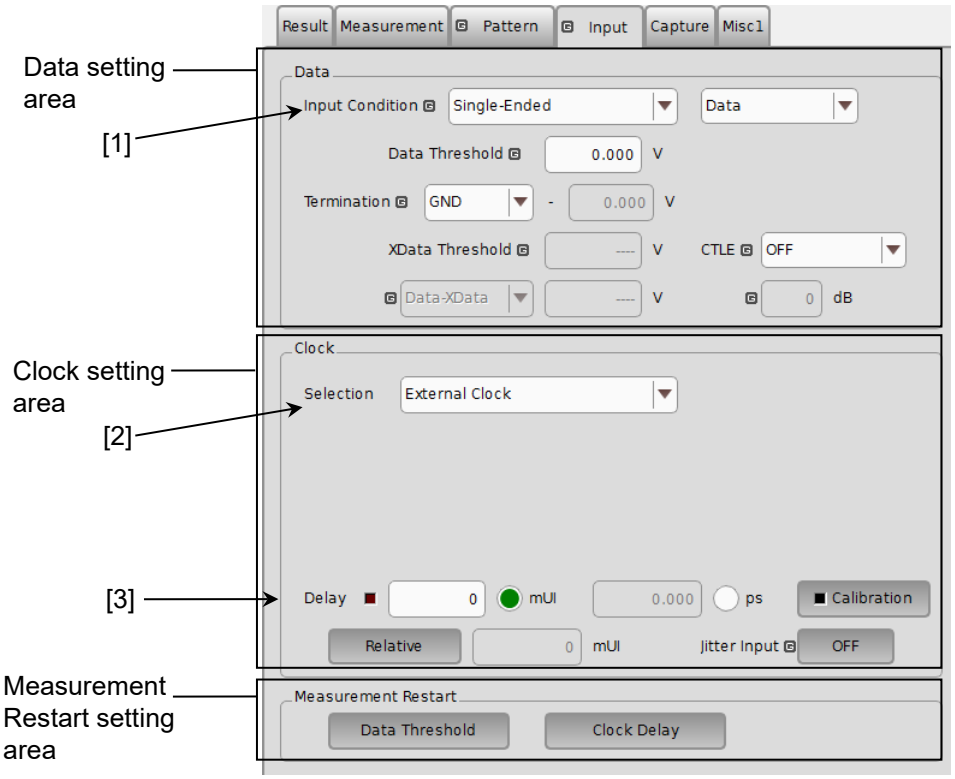


Figure 4.5.1.5.1-1 Input Tab

[1] Set the data input conditions.

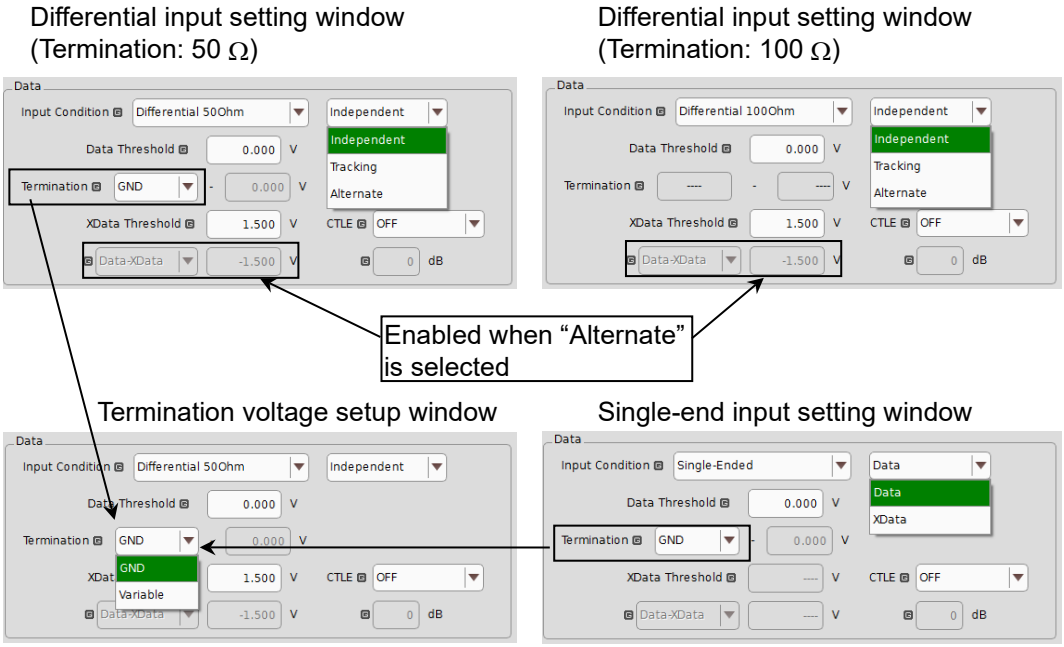


Figure 4.5.1.5.1-2 Setting Data Input Conditions

Table 4.5.1.5.1-1 Data Input Condition Setting Items (Input Condition)

Data Input Condition Setting Items			Description
Differential 100Ohm, Differential 50Ohm	Independent		Uses Data and XData as the differential input. Thresholds for Data and XData can be changed independently.
	Tracking		Uses Data and XData as the differential input. Thresholds for Data and XData can be changed while tracking each other.
	Alternate	Data-XData	Uses Data and XData as the differential input. The Data threshold and XData threshold can be changed interrelatedly, in conjunction with a difference between Data and XData (Data-XData).
		XData-Data	Uses Data and XData as the differential input. The Data threshold and XData threshold can be changed interrelatedly, in conjunction with a difference between XData and Data (XData-Data).
Single-Ended	Data		Used the Data side as single-ended input.
	XData		Used the XData side as single-ended input.

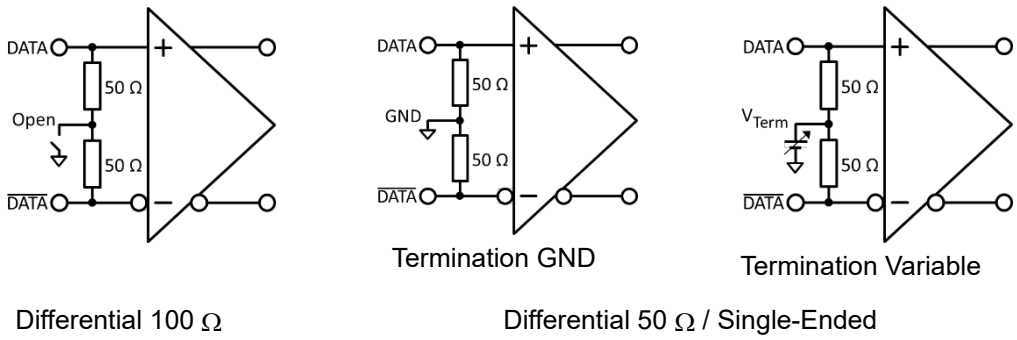
CAUTION

When data input condition is set to single-ended input, be sure to connect a standard accessory Open (J1341A) of Accessory to unused side of data input connector.

Operating while signal is inputting to unused side connector causes malfunction.

Table 4.5.1.5.1-2 Setting Items in Data Termination Setting Dialog Box (Data Termination)

Data Termination Setting Item		Description
Differential 100Ohm	None	Releases 50 Ω terminations of Data and XData sides from GND, and connects 50 Ω terminations so that the resistance between Data and XData becomes 100 Ω. For protection of equipment, the 50 Ω terminations at the Data and XData sides are fixed to the ground potential via a high resistor when input connectors are open.
Differential 50Ohm Single-Ended	GND	50 Ω terminations at the Data and XData sides are terminated to GND.
	Variable	Terminates to 50 Ω and an arbitrary set voltage within the range from –2.5 to +3.5 V. The voltage can be set in 10 mV steps.



Differential 100 Ω

Termination GND

Termination Variable

Differential 50 Ω / Single-Ended

Figure 4.5.1.5.1-3 Termination Methods in Different Setups

CAUTION

- **Do not allow an excessively large current to flow to the terminator in the MU195040A. Otherwise, performance may become degraded or failure may occur.**
- **If a differential signal is input via the Data or XData connector when Single-Ended is selected, the threshold margin becomes double.**

When the MU195040A-x11/x21 is installed, the CTLE (Continuous Time Linear Equalizer) band can be set. The range is as follows:

OFF, 8-10Gbit/s, 16-20Gbit/s, 25-28Gbit/s, PCIe3, PCIe4, PCIe5

When the CTLE is set to other than **OFF**, set the band in the range of Gain 0 to –12 dB, in 0.1 dB steps.

[2] The installation of MU195040A-x22 allows you to select the clock source from the following: External Clock, Recovered Clock, and Clock and Data Recovery. If the option is not installed, this is fixed to **External Clock**.

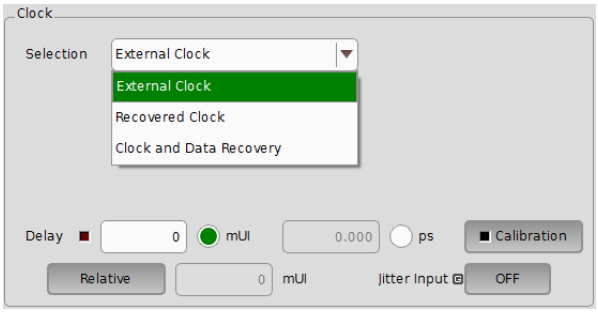


Figure 4.5.1.5.1-4 Clock Setting Area

If **Recovered Clock** or **Clock and Data Recovery** is selected when MU195040A-x22 is installed, the clock recovered from Data1 by built-in clock recovery circuit is used as system clock. **Recovered Clock** (Figure 4.5.1.5.1-5) allows Eye analyses such as Bathtub, Eye Margin, and Eye Contour using the recovered clock. **Clock and Data Recovery** (Figure 4.5.1.5.1-6) allows the BER measurement of the recovered data. Select this clock source to perform the BER measurement of stressed signals such as SSC, for it enables jitter or noise resistance test.

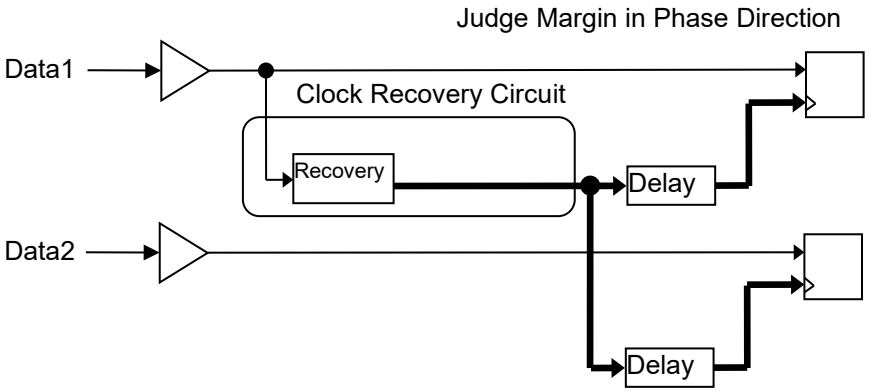


Figure 4.5.1.5.1-5 Recovered Clock Circuit

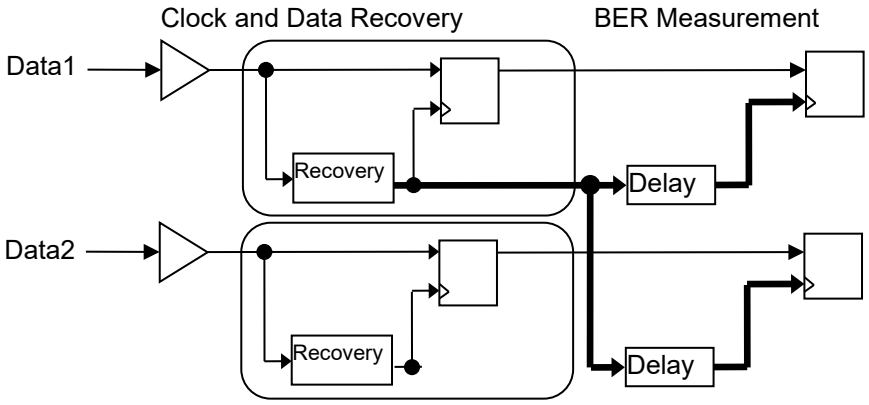


Figure 4.5.1.5.1-6 Clock and Data Recovery Circuit

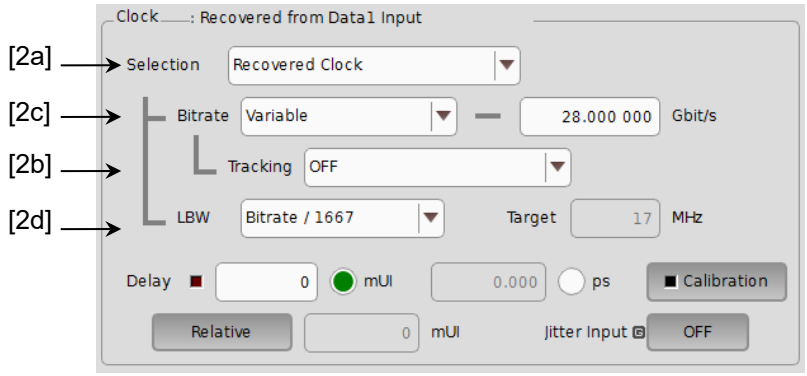


Figure 4.5.1.5.1-7 Clock Setting Area (When Recovered Clock Is Selected with MU195040A-x22 Installed)

[2a] Touch **External Clock**, **Recovered Clock**, or **Clock and Data Recovery**. **Recovered Clock** and **Clock and Data Recovery** are available only when MU195040A-x22 is installed on MU195040A. The setting items in the **Clock** area differ according to your option.

Note:

When your option is MU195040A-x22, check that the data signal is being input to the Data Input 1 connector because the clock is recovered from the data signal.

External clock and recovered clock have difference in waveform quality. So the following measurements may have inaccurate results.

- Sensitivity Measurement
- Phase Margin Measurement
- Eye Margin Measurement
- Bathtub Measurement
- PAM BER Measurement
- Eye Contour Measurement

When using output clock of MU195020A as external clock, the residual jitter is smaller compared with the case where recovered clock is used as external clock. Thus, the measurement result decrease due to clock quality is minimized.

When **Recovered Clock** is selected, SSC-modulated data may not be measured properly. When inputting SSC-modulated data into the MU195040A for stress input tests of PCI Express, USB3.1, and Thunderbolt receivers, etc., select **External Clock** or **Clock and Data Recovery**.

[2b] When selecting the MU195020A mounted on the same MP1900A, the recovered clock tracks MU195020A's operation bit rate setting.

Note:

When the bit rate setting of the MU195020A is out of the operating range of the Clock Recovery option, the bit rate of the recovery clock will be set to the upper or lower limit of the operating range.

[2c] In the **Bitrate** box, touch one of the preset standards listed in the following tables or touch **Variable**. When touching **Variable**, enter the bit rate in the **Gbit/s** box according to the input signal.

Table 4.5.1.5.1-3 When the MU195040A-x22 Is Installed

Preset Standard	Bit Rate [Gbit/s]
OC-48/STM-16	2.488320
PCIe 1	2.500000
InfiniBand SDR	2.500000
OTU1	2.666060
DisplayPort HBR	2.700000
SATA 3Gb/s	3.000000
XAUI	3.125000
4G FC	4.250000
USB3.0	5.000000
InfiniBand DDR	5.000000
PCIe 2	5.000000
DisplayPort HBR2	5.400000
SATA 6Gb/s	6.000000
HSBI	6.250000
PCIe 3	8.000000
DisplayPort HBR3	8.100000
8G FC	8.500000
OC-192/STM-64	9.953280
USB3.1 Gen2	10.000000
USB4 Gen2	10.000000
DisplayPort UHBR 10	10.000000
InfiniBand QDR	10.000000
Thunderbolt1	10.312500
10GbE	10.312500
10G FC	10.518750
G975 FEC	10.664228
OTU2	10.709225
10GbE over FEC	11.095700
10GFC over FEC	11.316800
SAS3	12.000000
DisplayPort UHBR 13.5	13.500000
16G FC	14.025000
InfiniBand FDR	14.062500
PCIe 4	16.000000
Thunderbolt2	20.625000
PCIe 4	16.000000
USB4 Gen3	20.000000
DisplayPort UHBR 20	20.000000

Table 4.5.1.5.1-3 When the MU195040A-x22 Is Installed (Cont'd)

Preset Standard	Bit Rate [Gbit/s]
Thunderbolt2	20.625000
SAS4	22.500000*
SAS	24.000000*
InfiniBand EDR	25.781250*
100GbE(25.78x4)	25.781250*
100G OTU4	27.952496*
32G FC	28.050000*
PCIe 5	32.000000*
100G ULH	32.100000*
Variable	2.400000 to 21.000000 Gbit/s 2.400000 to 32.100000 Gbit/s*

*: Available only when MU195040A-x01 is installed.

[2d] You can select a loop band (Loop band width).
When **Variable** is touched in the **LBW** box, you can set a loop band in the range that corresponds to the bit rate.

Operation Bitrate [Gbit/s]	Range [MHz] (Step: 1 MHz)
2.400000 to 5.500000	Fixed to 3 MHz
5.500001 to 7.500000	3 to 4 MHz
7.500001 to 9.500000	3 to 5 MHz
9.500001 to 10.500000	3 to 6 MHz
10.500001 to 12.500000	3 to 7 MHz
12.500001 to 14.500000	3 to 8 MHz
14.500001 to 15.500000	3 to 9 MHz
15.500001 to 17.500000	3 to 10 MHz
17.500001 to 19.500000	3 to 11 MHz
19.500001 to 20.500000	3 to 12 MHz
20.500001 to 22.500000	3 to 13 MHz
22.500001 to 24.500000	3 to 14 MHz
24.500001 to 25.500000	3 to 15 MHz
25.500001 to 27.500000	3 to 16 MHz
27.500001 to 29.500000	3 to 17 MHz
29.500001 to 31.500000	11 to 18 MHz
31.500001 to 32.100000	11 to 19 MHz

When **Bitrate/1667** or **Bitrate/2578** is selected in the **LBW** box, the value obtained by the following formula will be set: (Bitrate/1667 or 2578) MHz.
When **Jitter Tolerance** is touched, the loop band is set to the maximum value for the Jitter Tolerance measurement.

[3] MU195040A can vary delay time of clock output.

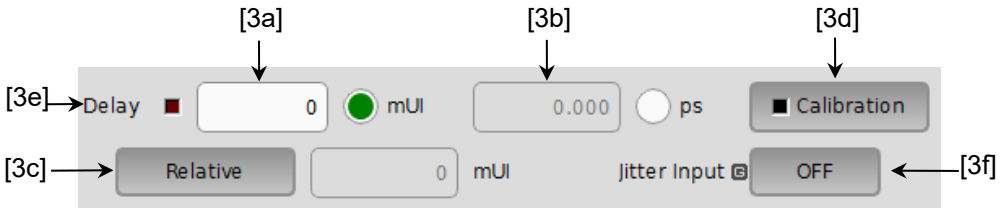


Figure 4.5.1.5.1-8 Clock Delay Setting Items

[3a] Touch this radio button to set the clock delay in 2 mUI units. The MU195040A operates based on the UI units. Setting a greater value increases the clock delay.

[3b] Delay time can be set by ps unit. The frequency counter value is converted into ps units, based on the 2 mUI units. If the value read from the frequency counter is out of the range, "----ps" is displayed.

[3c] When **Relative** is touched and green, the text box on the right becomes enabled. The clock delay can be set in this text box by a relative value in 2 mUI units, based on the current delay as 0 mUI. When **Relative** is touched again to be gray, the clock delay is calculated from the set relative value and set.

[3d] Touching **Calibration** starts a short-time self-calibration. When the LED on the Calculation button glows red, it indicates that calibration should be performed. When it glows green, it indicates that the operation is normal and calibration is not required. Note that the delay fluctuates greatly during calibration.

[3e] This LED glows red while the "Delay" is being changed.

[3f] Set the jitter input. When executing jitter tolerance test by inputting jitter-modulated clock, set **Jitter Input** of Delay to **ON**. Refer to 4.5.1.2.7 "When inputting jitter-modulated signals".

Notes:

- When the frequency or the temperature condition is changed, the LED on the "Calibration" lights, prompting performance of calibration. If calibration is not performed at this time, the error in the phase setting may be greater than at a normal phase setting.
- Values displayed in ps units vary as the bit rate changes, because the MU195040A sets phases in mUI units as an internal standard.
- When setting **Pattern Sequence** to **Burst** on the **Misc1** tab, the phase setting is less accurate than it is when setting to **Repeat**.

- During Auto Adjust execution, the delay amount of **Delay** is always changed in order to drive the clock phase to the optimum point. Therefore, the LEDs of **Delay** and **Calibration** light up in red continuously. This is not abnormal.

Refer to 4.5.1.2.7 “When inputting jitter-modulated signals” for operation and precautions in case of Combination or inputting jitter-modulated signals.

4.5.1.5.2 Measurement Restart area

The items to restart the measurement when its setting is changed can be selected.

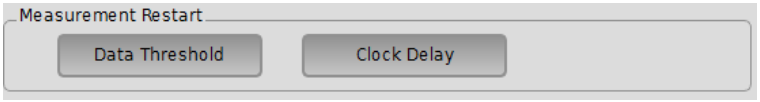


Figure 4.5.1.5.2-1 Selecting Measurement Restart Item

Table 4.5.1.5.2-1 Items in Measurement Restart Area

Setting Item	Description
Data Threshold	Measurement is restarted when the Data/XData Threshold on the **Input** tab is changed.
Clock Delay	Measurement is restarted when Delay on the **Input** tab is changed.

4.5.1.6 Capturing Test Patterns

To capture the input test pattern data, touch the **Capture** tab on the MU195040A operation screen.

4.5.1.6.1 Setting items on the Capture tab

This section describes how to capture and analyze a test pattern on the Capture tab.

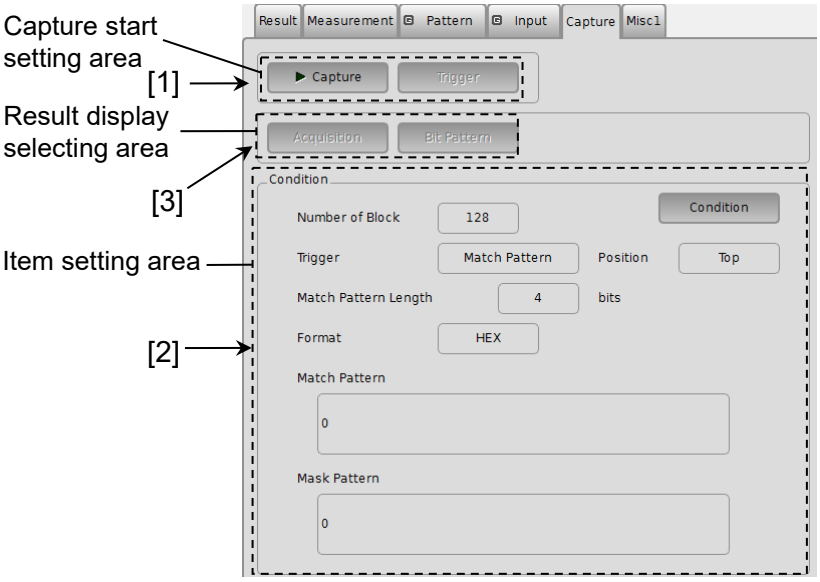


Figure 4.5.1.6.1-1 Capture Tab

[1] Start capturing a test pattern. Manual trigger can be executed when **Manual** is selected in the **Trigger** list of the **Condition Setting** dialog box.

Note:

Capture cannot be executed in the following settings.

- **Pattern Sequence** of **Misc1** tab is set to **Burst**, or **Sync Control** is set to **Quick**.
- Sync Loss is generated in BER measurement.
- Capture has been already executed by other data interface.



Figure 4.5.1.6.1-2 Buttons in Capture Start Setting Area

Table 4.5.1.6.1-1 Capture/Trigger Buttons

Buttons	Description
Capture	Starts capturing a test pattern. Its LED turns green during test pattern capturing. The MU195040A enters and stays in the standby state until the trigger conditions match. When the trigger conditions match and the test pattern has been captured into the internal memory, the capturing operation is stopped and the LED on **Capture** turns off.
Trigger	When **Manual** is selected in the **Trigger** list of the **Condition Setting** dialog box, test pattern capturing can be started manually by touching this button (manual trigger).

[2] When **Condition** in the item setting area is touched, the **Condition Setting** dialog box is displayed. Be sure to set the trigger conditions before starting test pattern capturing. When the trigger conditions are set, touch **OK** to apply the set conditions. When **Cancel** is touched instead, the set conditions are canceled and the **Condition Setting** dialog box is closed.



Figure 4.5.1.6.1-3 Condition Button in Item Setting Area

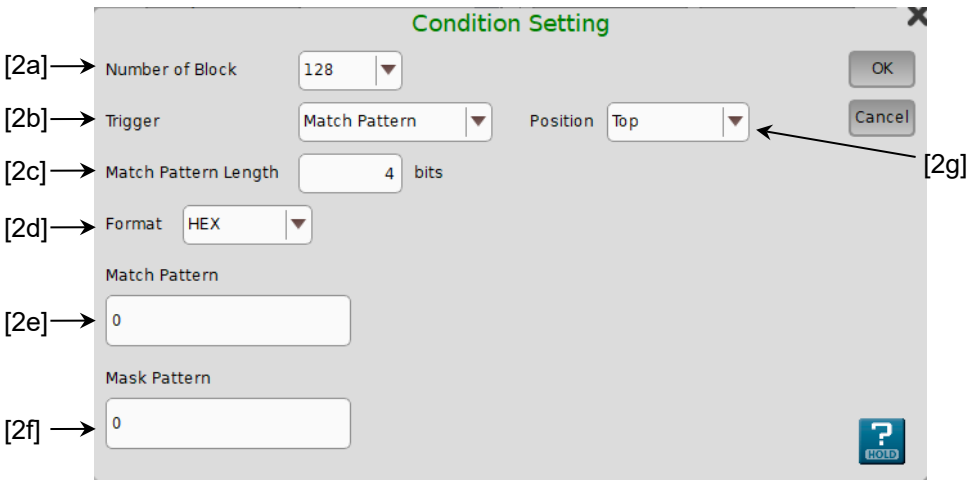


Figure 4.5.1.6.1-4 Condition Setting Dialog Box

[2a] Select the number of blocks of the test pattern to be captured into the MU195040A, from 1, 2, 4, 8, 16, 32, 64, or 128. The size of each block to be captured can be calculated from the following expression:

Block size = 8 Mbits / Number of Block

[2b] Select the type of the trigger to capture the test pattern.

Table 4.5.1.6.1-2 Trigger Setting

Item	Description
Error Detect	Capturing starts when an error is detected.
Match Pattern	Capturing starts when a pattern that matches the set specific pattern is detected.
Manual	Capturing of one block starts when **Trigger** in the capture start setting area (refer to Figure 4.5.1.6.1-2) is touched. To perform capturing for all the blocks, touch **Trigger** for the number of times equal to the number of blocks set in the **Number of Block** list of the **Condition Setting** dialog box.
External	Capturing starts at the falling edge of the signal input to the AUX Input connector.

[2c] Set the length of the pattern used for match detection from 4 to 64 bits, in 4-bit units. This is enabled when **Match Pattern** is selected in the **Trigger** list.

[2d] Select the display format of the pattern used for match detection. This is enabled when **Match Pattern** is selected in the **Trigger** list.

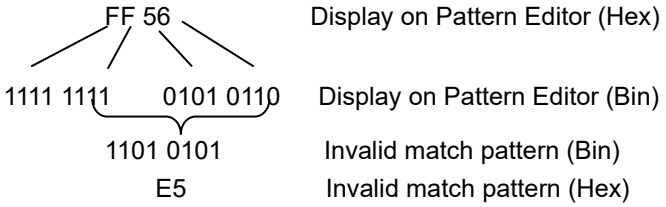
Table 4.5.1.6.1-3 Format Setting

Item	Description
BIN	The match pattern is displayed in binary format.
HEX	The match pattern is displayed in hexadecimal format.

[2e] Set the pattern used for match detection when **Match Pattern** is selected for **Trigger**.

Note:

When setting a match pattern while the 2Ch Combination is configured, set it in 4-bit units, as displayed in the **Pattern Editor** dialog box of the MU195040A in hexadecimal. If the match pattern that is displayed in hexadecimal format crosses bit boundaries, it becomes invalid and cannot be captured.



[2f] Set the bits to be masked in the pattern used for match detection. To mask a bit for match detection, set "1" for that bit. This is enabled when **Match Pattern** is selected in the **Trigger** list.

[2g] Set the capturing start position based on the trigger position.

Table 4.5.1.6.1-4 Capture Start Position Setting

Item	Description
Top	Captures a test pattern after the trigger position.
Middle	Captures a test pattern around the trigger position.
Bottom	Captures a test pattern before the trigger position.

[3] The capture result display format can be specified using the buttons in the result display selecting area.



Figure 4.5.1.6.1-5 Buttons in Result Display Selecting Area for Selecting Capture Result Display Format

Table 4.5.1.6.1-5 Buttons for Selecting Capture Result Display Format

Button	Description
Acquisition	Touch to open the **Capture Acquisition** dialog box to acquire the results of capturing a test pattern to the MU195040A. The captured results can be viewed in three display formats: Bit Pattern, Bitmap, and Block. When **Acquisition** is touched and the test pattern capture results are acquired, **Bit Pattern**, **Bitmap**, and **Block** on the right become available and the display format can be switched.
Bit Pattern	The captured test pattern is displayed in a bit pattern string, so that Insertion Error and Omission Error can be distinguished.

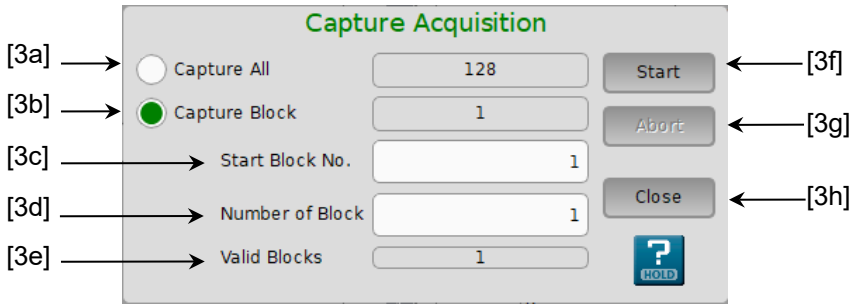


Figure 4.5.1.6.1-6 Capture Acquisition Dialog Box

[3a] Select to display all the captured blocks.

[3b] Select to display the specified captured blocks only.

[3c] Specify the block number to be displayed first (**Start Block No.**).

[3d] Specify the number of blocks to be displayed following the **Start Block No.** specified in [3c].

[3e] Displays the number of blocks that have been captured.

[3f] Touch **Start** to start loading the captured data of the blocks specified in Step [3a] to [3d]. The loading time depends on the number of blocks.

[3g] Touch **Abort** to abort loading the captured data. When aborted, the block results that are already loaded can be displayed.

[3h] Touch **Close** to close the screen.

4.5.1.6.2 Displaying captured test pattern (Bit Pattern)

After the captured data is acquired by touching **Acquisition**, touching **Bit Pattern** (refer to Figure 4.5.1.6.1-5) displays the Bit Pattern window. In this window, the captured test patterns are displayed in a bit pattern string so that Insertion Error and Omission Error can be distinguished.

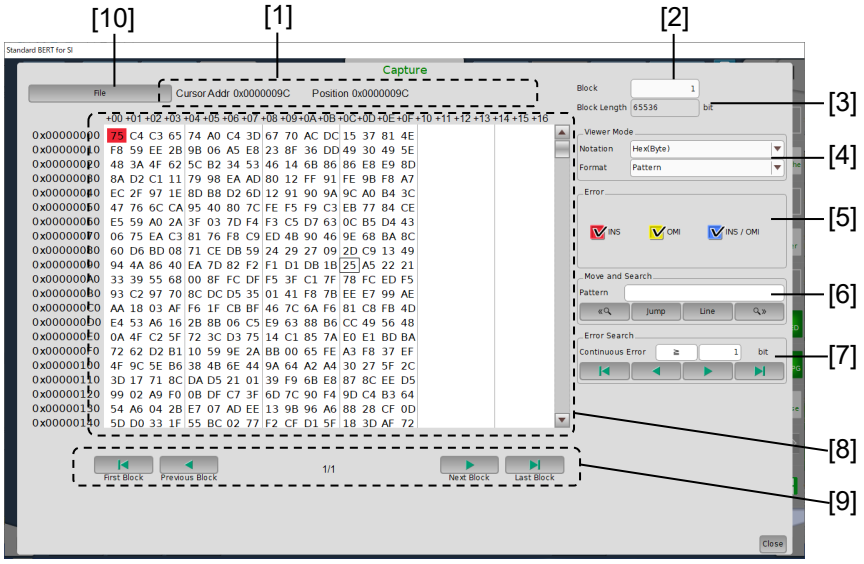


Figure 4.5.1.6.2-1 Bit Pattern Window

Note:

The bit pattern display is based on the positive logic, with H = "1" and L = "0".

Table 4.5.1.6.2-1 Description of Screen Items

No.	Item	Description
[1]	Cursor Addr/ Position	Cursor Addr: Displays the cursor position within the current block. Position: Displays the position within the entire captured data (all blocks).
[2]	Block	Sets the block number to display.
[3]	Block Length	Displays the block length. Block Length = 8M bits/ Number of Block
[4]	Viewer Mode	Notation: Bin Hex(Byte) Format: Select a view mode of the Capture Data display area. Pattern: String of binary (0, 1) or hexadecimal (0 to 9, A to F) numbers Pattern + Waveform: String of binary (0, 1) numbers and image of NRZ signal

Table 4.5.1.6.2-1 Description of Screen Items (Cont'd)

No.	Item	Description
[5]	Error	Displays the legend (color sample) for each of error bits. INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow INS / OMI: Insertion and Omission Error Blue ***Note:*** The captured results are displayed as a bit pattern. The MU195040A reference pattern is displayed in binary (0, 1) or hexadecimal (0 to 9, A to F), and its background color depends on the error type. Bits where no error occurred are displayed without background color. To show/hide each error in the Capture Data display area, select/clear its check box.
[6]	Move and Search	Searches for the string specified by binary (0, 1) or hexadecimal (0 to 9, A to F) numbers from the captured data. Pattern: Searches any pattern using «🔍 and 🔍». Jump: Move the cursor to the specified address or pattern. Head: Moves the cursor to the head of the captured data pattern. Tail: Moves the cursor to the tail of the captured data pattern. Address: Moves the cursor to the specified address position. Forward Next: Searches forward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Backward Next: Searches backward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Line: Sets how many characters to display per line, in the Capture Data display area.
[7]	Error Search	Performs an error search, specifying the number and type of continuous errors. Continuous Error: Specifies the number of continuous errors to search for. 1 to 256 bits, 1-bit step In the **Search Condition** box, select = (Exact match) or ≥ (Greater than or equal to).
[8]	Capture Data display area	Displays the captured results (including error information) by binary (0, 1) or hexadecimal (0 to 9, A to F) numbers. The background colors of bits where errors occurred depend on the error types. When displayed in binary format, select **Pattern + Waveform** in the **Notation** list of the **Viewer Mode** area, and you will view a pattern image.

Table 4.5.1.6.2-1 Description of Screen Items (Cont'd)

No.	Item	Description
[9]	Block scroll buttons	Scrolls the block view.
[10]	File	Saves the captured results and pattern data to a file. Also, opens the saved pattern data file. Save: Saves the captured results and pattern to a file. The available file types are as follows: Binary, BIN Text, HEX Text: Select when redisplaying the results in the Bit Pattern window. Binary(export), BIN Text(export), HEX Text(export): Select when saving a pattern file including error information. The saved file can be loaded by Pattern Editor of the PPG and ED. Open: Loads the saved captured result data (Binary, BIN Text, HEX Text) to display the results.

4.5.1.7 Misc1 Function (MU195040A)

The Misc1 function configures the pattern sequence, AUX input and output, and the bitrate for Confidence Level calculation.
On the **Misc1** tab of the MU195040A operation window, you can set the Misc1 function.

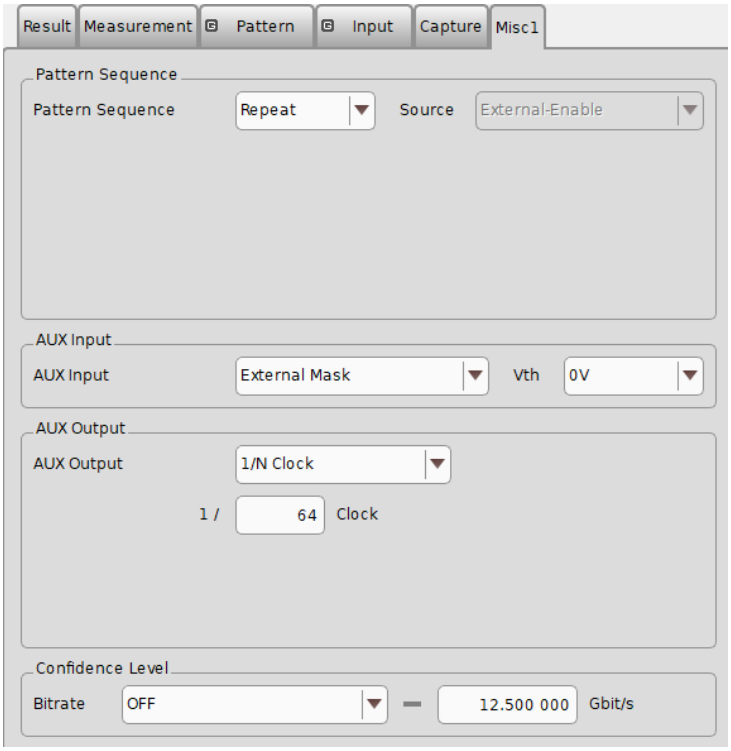


Figure 4.5.1.7-1 Misc1 Tab

Table 4.5.1.7-1 Misc1 Setting Items

Item	Description
Pattern Sequence	Set the method for receiving test patterns.
AUX Input	Set the auxiliary input function.
AUX Output	Set the auxiliary output function.
Confidence Level	Set the bitrate for Confidence Level calculation.

Note:

AUX Input settings are common to Data1 and Data2 at MU195040A-x20.

4.5.1.7.1 Setting Pattern Sequence

Select the method for generating test patterns to be measured.

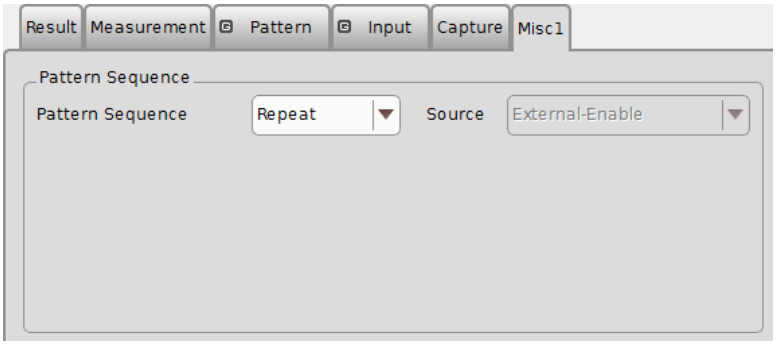


Figure 4.5.1.7.1-1 Selecting Pattern Sequence

Table 4.5.1.7.1-1 Selecting Pattern Sequence

Selection Item	Description
Repeat	Select when receiving Repeat data of the test pattern. Mainly used for electric device evaluation.
Burst	Select when receiving Burst data of the test pattern. Mainly used for long-distance optical transmission tests such as an optical circulating loop test, and packet communications evaluation. The target test patterns are PRBS, ZeroSubstitution, Data, and Mixed.

4.5.1.7.1.1 Setting Repeat pattern

Select **Repeat** in the **Pattern Sequence** list to receive Repeat data of the test pattern. No setting items are required.

4.5.1.7.1.2 Setting Burst pattern

Select **Burst** in the **Pattern Sequence** list to receive Burst data of the test pattern.

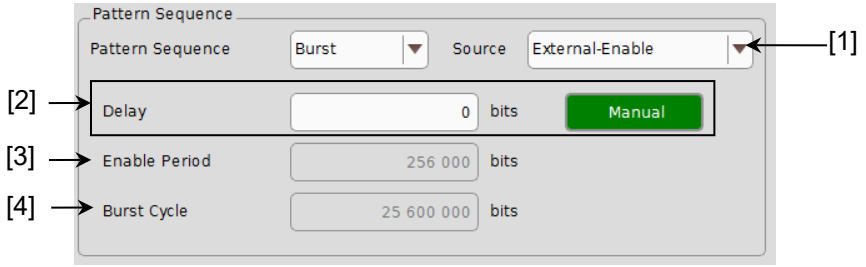


Figure 4.5.1.7.1.2-1 Pattern Sequence Area When Burst Is Selected

[1] Select the definition method for the switching timing between the input test pattern valid period and invalid period.

Table 4.5.1.7.1.2-1 Burst Setting Items

Setting Item	Description
Internal*	Select this item when setting the gate signal that determines the measuring period of the intermittently-input test pattern within the MU195040A, instead of inputting it from external equipment. Select this item when the input signal valid period and the repetition cycle are known.
External-Trigger*	Select this item when defining the start timing of the input test pattern valid period. The length of the valid period can be set by the Enable Period text box (refer to [3] below).
External-Enable	Select this item when defining the start timing and the length of the input test pattern valid period.

*: When the test patterns of Burst Cycle and Enable Period are not constant, select **External-Enable**.

[2] Set the **Delay** for the input test pattern and source signal (selected by [1]). When **Auto** is selected, the delay is automatically adjusted within the MU195040A.

When having chosen **Auto** and Enable Period of [3] is changed, operate **Manual** → **Auto** once.

When **Manual** is selected, set the number of relative delay bits used in the MU195040A. At this time, the signal input from the AUX Input connector indicates the period during which the test pattern is valid.

The setting range is as follows.

In the case of Independent:
0 to 2 147 483 640 bits, 8 bit step
In the case of 2ch Combination:
0 to 4 294 967 280 bits, 16 bit step

[3] When **External-Trigger** or **Internal** is selected from in **Source** list, specify the period during which Burst cycle signals of the test pattern to be input to the AUX Input connector are continuously generated by the number of bits.

The setting ranges for Enable Period are shown in Table 4.5.1.7.1.2-2.

[4] When **Internal** is selected in the **Source** list, set the Burst cycle (one cycle of the Burst signal of the input test pattern).
The setting ranges for Burst Cycle are shown in Table 4.5.1.7.1.2-2.

Table 4.5.1.7.1.2-2 Setting Ranges for Enable Period and Burst Cycle

No. of Channel Combinations	Enable Period (bits)	Burst Cycle (bits)	Setting Steps (bits)
1	When **Internal** is set: 12800 to 2147482624	25600 to 2147483648	256
	When **External-Trigger** is set: 12800 to 2147483392		
2	When **Internal** is set: 25600 to 4294965248	51200 to 4294967296	512
	When **External-Trigger** is set: 25600 to 4294966784		

Notes:

- A Disable period of at least 512 bits is required between Burst Cycle and Enable Period.
  The Disable period is doubled at 2ch Combination.

- When **Auto** is selected for the delay setting, set **Sync Control** to **Frame ON**.
  If any of the following items is changed when **Auto** is selected for the delay setting, change the delay setting to **Manual** and set to **Auto** again.
  - **Burst Cycle** or **Enable Period** of the test pattern
  - **Burst Cycle** when **External - Trigger** is selected
  - **Burst Cycle** or **Enable Period** when **External - Enable** is selected

4.5.1.7.2 Setting AUX Input

Set the use of timing signal to input the AUX Input connector.
Input signal to the AUX Input connector can be used for synchronizing the timing of receiving Burst signal.
The setting items for AUX Input are shown in the table below.

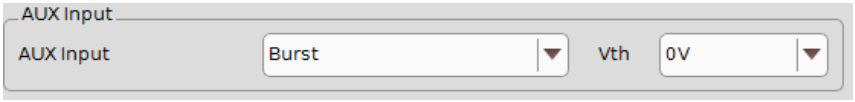


Figure 4.5.1.7.2-1 Selecting Auxiliary Input

Table 4.5.1.7.2-1 AUX Input Setting Items

Setting Item	Description
Burst	Select when **Burst** is selected in the **Pattern Sequence** list, and **External-Trigger** or **External Enable** is selected in the **Source** list. External-Trigger: Data is valid for the set Enable period after a rising edge is detected. External-Enable: Data is valid when the level of the signal is high.
External Mask	Measurement is masked when a low-level signal is input.
Capture External Trigger	Inputs the Capture start trigger when set to **External**.
Vth	Select input threshold from 0V, –0.25V, or –0.5V.

4.5.1.7.3 Setting AUX Output

The output settings of auxiliary signals, such as the synchronization signal, can be configured.

4.5.1.7.3.1 Setting 1/N Clock

When **AUX Output** is set to **1/N Clock**, frequency dividing clock is generated in synchronization with generation pattern.

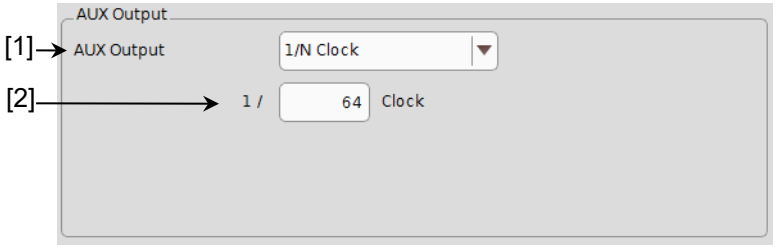


Figure 4.5.1.7.3.1-1 Setting Items for AUX Output Clock

[1] Select **1/N Clock** in the **AUX Output** list.

[2] The division ratio for the synchronization clock can be set.
The setting division ratio (N) can be set from 4 to 512, in even numbers.

4.5.1.7.3.2 Setting Pattern Sync

When **AUX Output** is set to **Pattern Sync**, a timing signal from the AUX Output connector is generated in synchronization with the test pattern period.

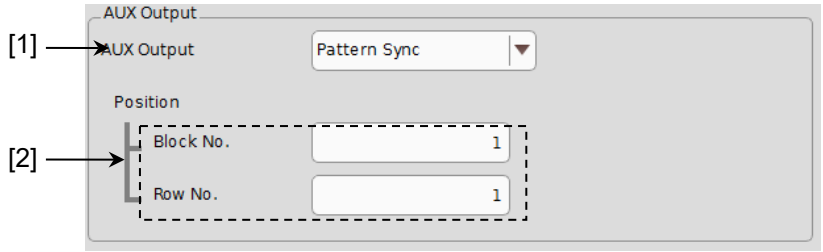


Figure 4.5.1.7.3.2-1 AUX Output Pattern Sync Setting Items

[1] Select **Pattern Sync** in the **AUX Output** list.

[2] The synchronization signal pulse generation position can be set.
The setting method varies depending on the test pattern.

Table 4.5.1.7.3.2-1 Synchronization Signal Pulse Generation Position Setting

Test pattern	Description
PRBS, Data, ZeroSubstitution	A signal pulse is generated in a pattern period. The pulse position can be specified within the range below, starting from the beginning of the pattern. 1 to {(Least common multiple of Pattern Length* and 128) – 135}, in 8-bit steps. The maximum settable number is 34359738105. In the case of 2ch Combination: 1 to {(Least common multiple of Pattern Length* and 128) – 271}, in 16-bit steps. The maximum settable number is 68719476209.
Mixed	A signal pulse is generated during the entire block generation pattern period. The pulse position can be specified in the positions of Block and Row.

*: The pattern length described here is the number multiplied by an integer so that it becomes 512 bits or more, when the length on the Figure 4.5.1.4-1 Pattern Tab is 511 bit or less.

At 2ch Combination, the pattern length described here is the number multiplied by an integer so that it becomes 1024 or more, when the length on the Figure 4.5.1.4-1 Pattern Tab is 1023 or less.

4.5.1.7.3.3 Setting Sync Gain

A signal indicating synchronization establishment can be output. When this signal is high, it indicates that synchronization is established.

4.5.1.7.3.4 Setting Error Output

A signal indicating an error detected by MU195040A is output to the AUX Output connector. No setting items are required.
When the voltage of the AUX Output connector is high, it indicates that an error is detected.

4.5.1.7.4 Setting Confidence Level

Set the bitrate for Confidence Level calculation.

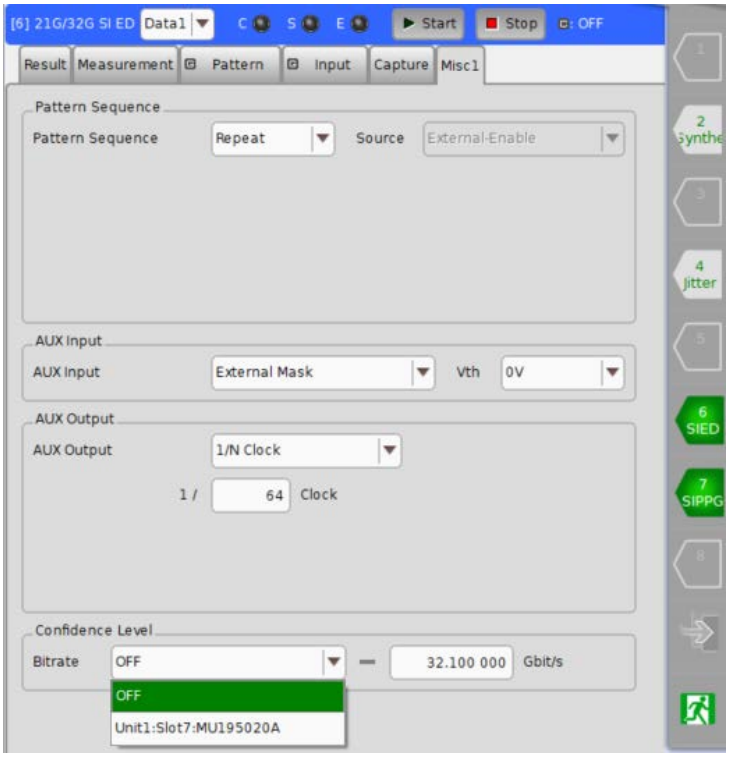


Figure 4.5.1.7.4-1 Confidence Level Area

The Confidence Level settings are described below.

Table 4.5.1.7.4-1 Confidence Level Settings

Setting Item	Description
Tracking	If an MU195020A unit is installed in the same MP1900A, **MU195020A** can be selected. When **MU195020A** is selected, the recovered clock tracks the operating bit rate setting of MU195020A.
Bitrate	Set the bitrate only when **Tracking** is set to **OFF**. Range: 2.4 to 21.0 Gbit/s*

*: The upper limit is 32.1 Gbit/s when MU195020A-x01 is installed.

4.5.1.8 Auto Search Function

The Auto Search function is used to optimize the threshold voltage and phase for the input data.
To display Auto Search setting items, touch **Auto Search** on the top right of the screen.
The Auto Search function optimizes the threshold voltage, and phase delay of the Data and XData input signals.

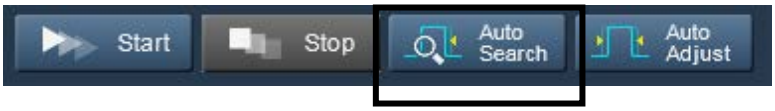


Figure 4.5.1.8-1 Auto Search

Note:

When grouping the **Input** tab, Auto Search cannot be executed.

4.5.1.8.1 Input setting items in Auto Search dialog box

The **Auto Search** dialog box consists of the Auto Search operation setting area (upper of the dialog box, including [1], [2], [4], [5] and [7] in Figure 4.5.1.8.1-1 below), operation target slot and result display area (lower left of the dialog box, indicated by [3] and [6] in Figure 4.5.1.8.1-1).

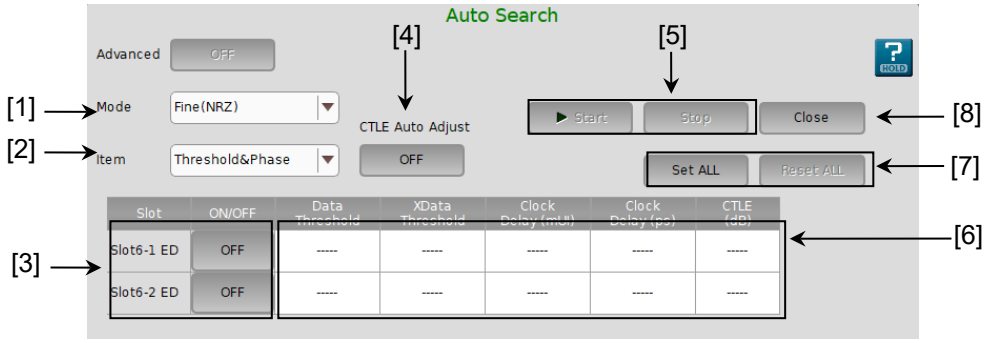


Figure 4.5.1.8.1-1 Auto Search Dialog Box

Advanced is not available for MU195040A.

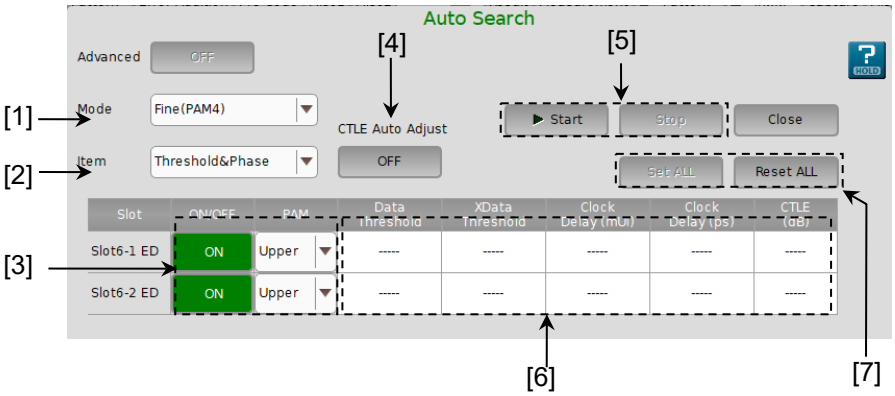


Figure 4.5.1.8.1-2 Auto Search Dialog Box (PAM Mode)

[1] Select the Auto Search execution method in the **Mode** list.

Table 4.5.1.8.1-1 Execution Method Setting

Mode	Description
Coarse (NRZ)	Coarse adjustment is executed by the hardware. Adjustment will be finished faster than by **Fine (NRZ)** adjustment. The obtained result will be almost the same as that after the Auto Adjust function is executed and finished.
Fine (NRZ)	In addition to coarse adjustment by the hardware, fine adjustment is executed with a software algorithm. It takes longer to finish the adjustment compared to **Coarse (NRZ)** adjustment.
Coarse (PAM4)	Searches for an optimum threshold point of each level (Top, Middle, Bottom) of PAM4 (Pulse-Amplitude Modulation) waveforms by detecting High and Low levels of the waveforms input.
Fine (PAM4)	Performs fine adjustment by software algorithm in addition to auto search in **Coarse (PAM4)** mode. It takes longer to finish the adjustment compared to **Coarse (PAM4)** adjustment.

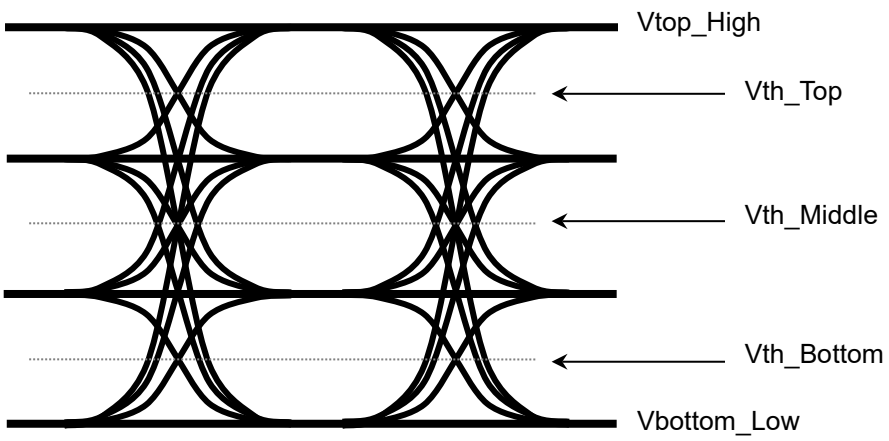


Figure 4.5.1.8.1-3 Vth Image of PAM4 Waveform

[2] Select the Auto Search target item in **Item** list.

Table 4.5.1.8.1-2 Execution Target Setting

Item	Description
Threshold&Phase	Auto Search is executed for both Threshold and Phase.
Threshold	Auto Search is executed for Threshold.
Phase	Auto Search is executed for Phase.

[3] Turn **ON** the button of interface on which Auto Search is executed. When **PAM Coarse** or **PAM Fine** is selected in the **Mode** list, select a level (**Top**, **Middle**, or **Bottom**) of the PAM waveform to search.

[4] This is available when CTLE is set to other than **OFF** on the **Input** tab.
When set to **ON**, the gain of CTLE is searched.

[5] Touch **Start** to start Auto Search on the slot(s) whose buttons are turned **ON**. Auto Search can be started when a button or more are turned **ON**. Touching **Stop** stops Auto Search.

[6] Auto Search results are displayed.

Table 4.5.1.8.1-3 Result Display Items

Displayed Result	Description
----	Indicates items for which Auto Search is not executed.
Failed	Indicates items for which Auto Search has failed.
XXXX mV	Indicates the result of Data/XData Threshold Auto Search in mV units.
XXXX mUI	Indicates the result of Phase Auto Search in mUI units.
XXXX ps	Indicates the result of Phase Auto Search in ps units. Data Delay in ps units is converted from that in mUI units, using the frequency counter value.

[7] Touch **Set All** to turn **ON** all slot buttons.
Touch **Reset All** to turn **OFF** all slot buttons.

[8] Touching **Close** closes the **Auto Search** dialog box. The **Close** becomes disabled during Auto Search.

4.5.1.9 Auto Adjust Function

The Auto Adjust function automatically adjusts the threshold voltage and phase to the optimum values when the interface conditions for the signals to be input to the MU195040A have changed.
To display the Auto Adjust setting items, touch **Auto Adjust** on the menu. Start or stop Auto Adjust by operating this button.

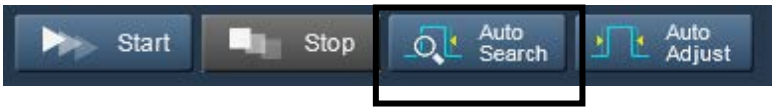


Figure 4.5.1.9-1 Auto Adjust

Note:

When grouping the **Input** tab, Auto Adjust cannot be executed.

4.5.1.9.1 Input setting items in Auto Adjust dialog box

The **Auto Adjust** dialog box consists of the Auto Adjust operation setting area (upper of the dialog box, including [1], [3], and [4] in Figure 4.5.1.9.1-1 below) and operation target slot setting area (lower of the dialog box, indicated by "[2]" in Figure 4.5.1.9.1-1).

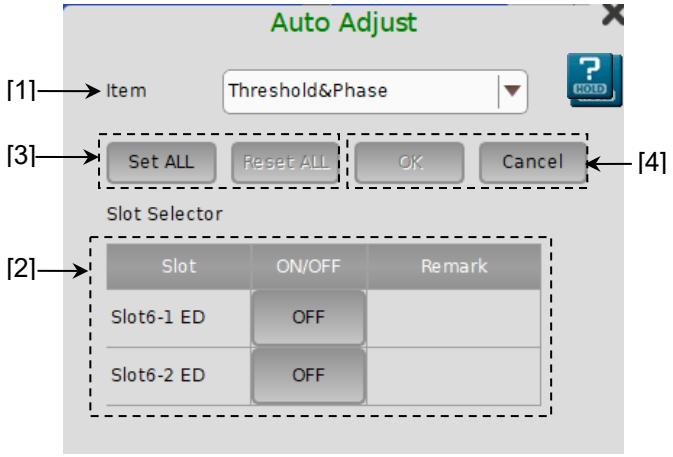


Figure 4.5.1.9.1-1 Auto Adjust Dialog Box

[1] Select the Auto Adjust target item in the **Item** list.

Table 4.5.1.9.1-1 Execution Target Setting

Item	Description
Threshold&Phase	Auto Adjust is executed for both Threshold and Phase. Threshold and Delay in **Input** tab of Table 4.5.1.5.1-1 cannot be changed during Auto Adjust.
Threshold	Auto Adjust is executed for Threshold. Threshold in **Input** tab of Table 4.5.1.5.1-1 cannot be changed during Auto Adjust.
Phase	Auto Adjust is executed for Phase. Delay in Input tab of Table 4.5.1.5.1-1 cannot be changed during Auto Adjust.

[2] Turn **ON** the slot number(s) to be targeted for Auto Adjust in the **Slot** list. In case of MU195040A-x20, turn **ON** the channel number(s).

[3] Touch **Set ALL** to turn **ON** all slot buttons.
Touch **Reset ALL** to turn **OFF** all slot buttons.

[4] Touching **OK** starts Auto Adjust for the specified slots. Auto Adjust can be started when a button or more of valid slots are turned **ON**. Touching **Cancel** stops Auto Adjust and closes the **Auto Adjust** dialog box.

The Auto Adjust executing status is displayed in the lower part of the **Result** tab. "----" is displayed when the Auto Adjust is stopped, and displayed for items that are not targeted for Auto Adjust. Threshold is displayed in XXXX V units, and Data Delay is displayed in XXXX mUI or XXXX ps units. Data Delay in ps units is converted from that in mUI units, using the frequency counter value.

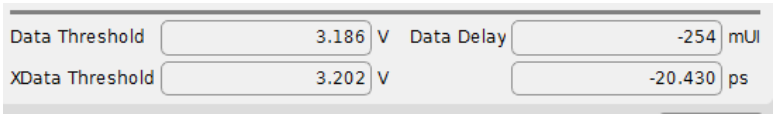


Figure 4.5.1.9.1-2 Auto Adjust Executing Status on the Result Tab

Note:

Input the signal that makes the cross points at 50 % when using the Auto Adjust. If inputting the signal that does not make the cross points at 50 %, the Auto Adjust may not function properly.

4.5.1.10 Auto Measurement

MU195040A has automatic measurement function that judges and detects the margin in the clock phase direction (phase margin) and in the threshold voltage direction (threshold margin).

- Eye Margin Measurement
- Bathtub Measurement
- PAM BER Measurement
- Eye Contour Measurement

For details of Auto Measurement, refer to 4.8 “Auto Measurement”.

4.5.1.11 Confidence Level Function

The Confidence Level function calculates the confidence level for BER measurement.

The confidence level represents the probability, expressed as a percentage(%), that the measured BER is less than a specified threshold. The longer the measurement time (amount of data), the closer the confidence level approaches 100%. If a specific confidence level is required for BER measurement, this function can also calculate the measurement time needed to achieve that level.

For details of Auto Measurement, refer to 3.8 “Confidence Level Function”.

4.5.2 MU196040A

The MU196040A PAM4 ED (hereafter, MU196040A) is a plug-in module that can be built into MP1900A. It can measure a variety of patterns within the operating frequency range, including PRBS, Data, and ZeroSubstitution (NRZ mode only) patterns.

The MU196040A supports various option configurations and can switch the signal modulation mode between NRZ and PAM4, so it is suitable for research and development and manufacture of various digital communication equipment, digital communication modules and devices.

This section describes function of the tabs of the MU196040A operation screen. For details of the tabs, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

Switch the signal modulation mode to NRZ or PAM4 by selecting it in the NRZ/PAM4 list at the module title bar shown in the following figure before using the MU196040A.



Figure 4.5.2-1 MU196040A NRZ/PAM4 List

4.5.2.1 Equipment Composition

4.5.2.1.1 Result tab

On the **Result** tab, you can check the BER results in the lower portion of the tab while changing the settings in the upper portion. To change the items to set, selecting an item in the list box at the module title bar. Setting items and description are shown in Table 4.5.2.1.1-1.

Table 4.5.2.1.1-1 Setting Items in Result Tab

Item	Description
Input	Select to configure the settings related to the input signal interface.
Gating	Select to configure the settings related to the measurement period.
Condition	Select to configure the settings related to the measurement conditions.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.

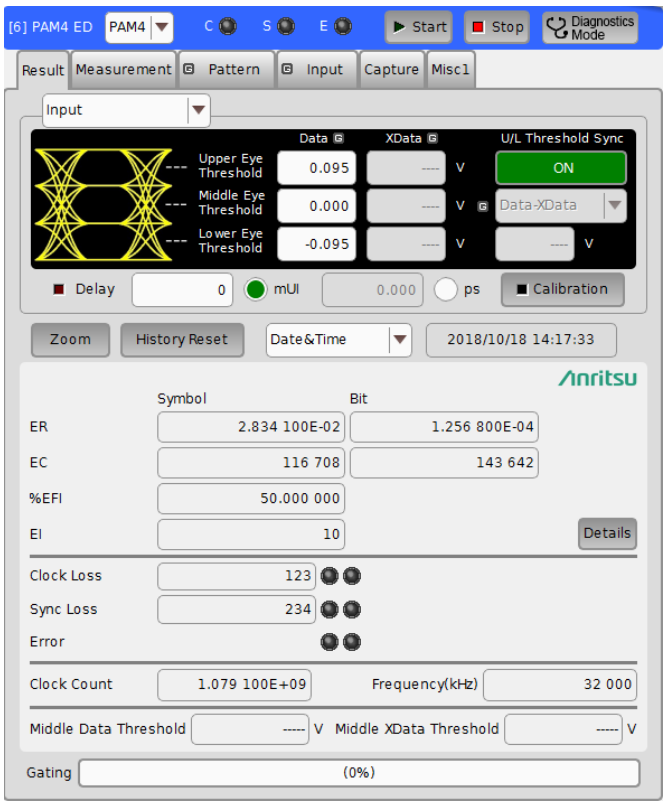


Figure 4.5.2.1.1-1 MU196040A Result Tab (PAM4 Mode)

Also, in PAM4 mode, touch the **Diagnostic Mode** button in the module title bar shown below, and you can switch to PAM4 Signal Diagnostics mode.



Figure 4.5.2.1.1-2 MU196040A Diagnostic Mode Button

The PAM4 Signal Diagnostic mode is useful for troubleshooting when the PAM4 signal cannot be synchronized as PAM4 symbols.
In PAM4 Diagnostics mode, MSB and LSB bit errors can be measured separately. This allows you to check which of MSBs and LSBs include errors or Sync Loss. Also, in the **MSB/LSB Diff** box, you can check the phase bit shift (between MSB and LSB), which causes Sync Loss in symbol error measurement.

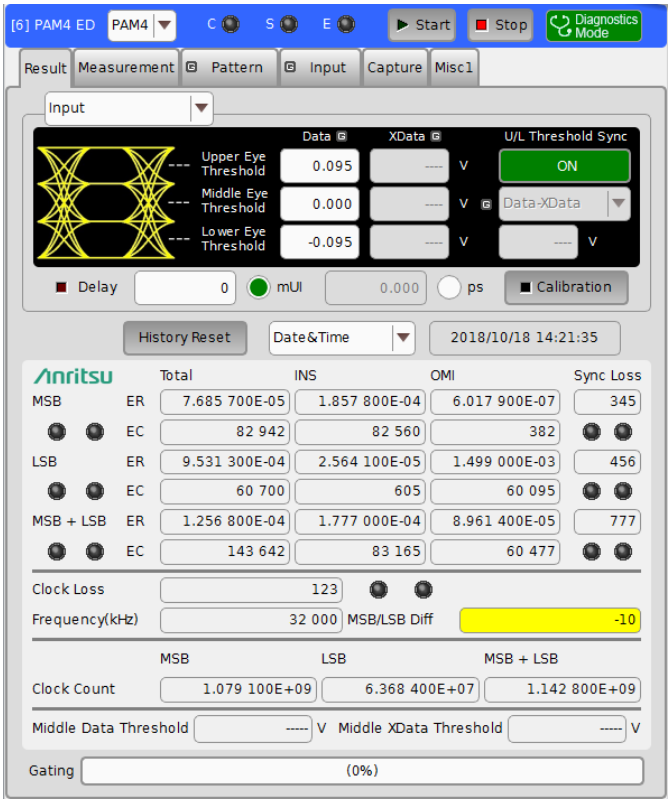


Figure 4.5.2.1.1-3 MU196040A Result Tab (PAM4 Diagnostics Mode)

Note:

To perform accurate SER measurement, observe the signal input to the MU196040A with the oscilloscope, and make sure the Lower Eye Threshold and Upper Eye Threshold are appropriate.

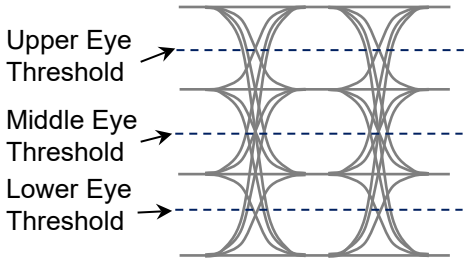


Figure 4.5.2.1.1-4 Example of Signal with Appropriate Upper Eye Threshold and Lower Eye Threshold

Make sure that the Lower Eye Threshold and Upper Eye Threshold do not go outside the PAM4 waveform range ((a) in (Figure 4.5.2.1.1-5) or go within the Middle Eye range ((b) in Figure 4.5.2.1.1-5).

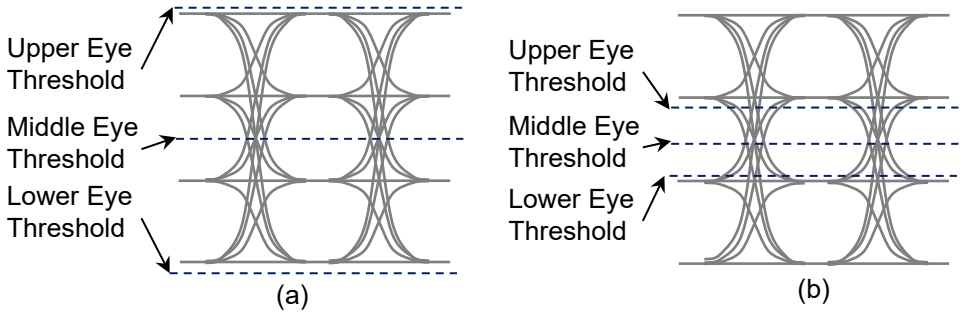


Figure 4.5.2.1.1-5 Example of Signal with Inappropriate Upper Eye Threshold and Lower Eye Threshold

Symbol ER in Figure 4.5.2.1.1-1 becomes **Sync Loss**, and when the Diagnostics Mode is started, "---- " is displayed in **LSB/MSB Diff**.

When set as shown in Figure 4.5.2.1.1-5 (a), the result measured by inverted logic of MSB is displayed in **LSB** for Diagnostics Mode.

When set as shown in Figure 4.5.2.1.1-5 (b), the measured MSB is displayed in **LSB** for Diagnostics Mode.

These phenomena are likely to occur when **PRBS** is set on the **Pattern** tab.

4.5.2.1.2 Measurement tab

On the **Measurement** tab, you can set the measurement conditions. The **Measurement** tab consists of four setting groups listed in Table 4.5.2.1.2-1. These items can be also set on the **Result** tab. Additionally, the advanced settings of Sync Control and Error/Alarm Condition are available on this tab.

Table 4.5.2.1.2-1 Setting/Display Items in Measurement Tab

Item	Description
Gating	Select to configure the settings related to the measurement period.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.
Error/Alarm Condition	Select to configure the setting related to the error/alarm detection method.

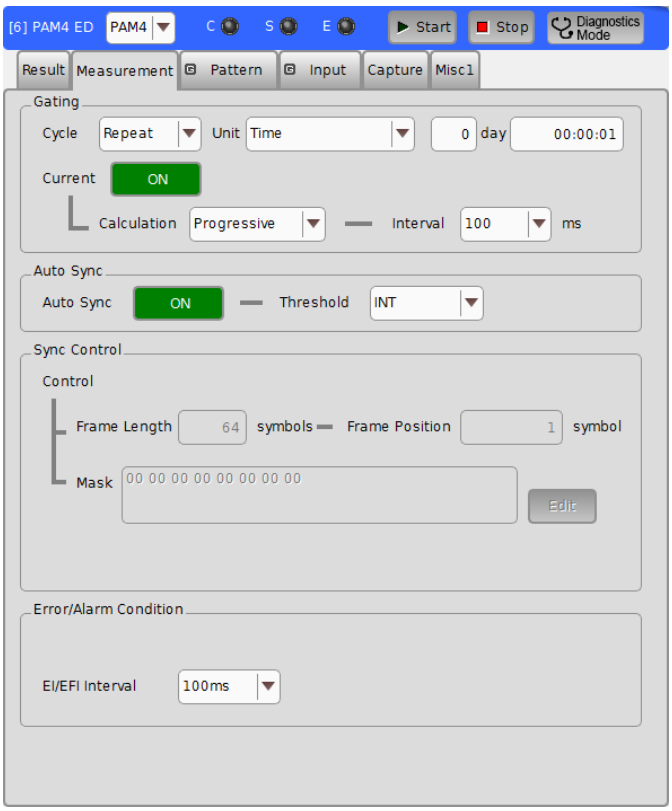


Figure 4.5.2.1.2-1 MU196040A Measurement Tab (PAM4 Mode)

4.5.2.1.3 Pattern tab

On the **Pattern** tab, you can select a test pattern and can configure the Mask settings. The following four test patterns are available. Setting items vary depending on the selected pattern.
If you select **Data**, you can edit the test pattern with Patten Editor.

- PRBS
- ZeroSubstitution (NRZ mode only)
- Data
- Specification compliance patterns

By configuring Mask settings, a received test pattern is masked to prevent detected errors from being counted into the measurement results.

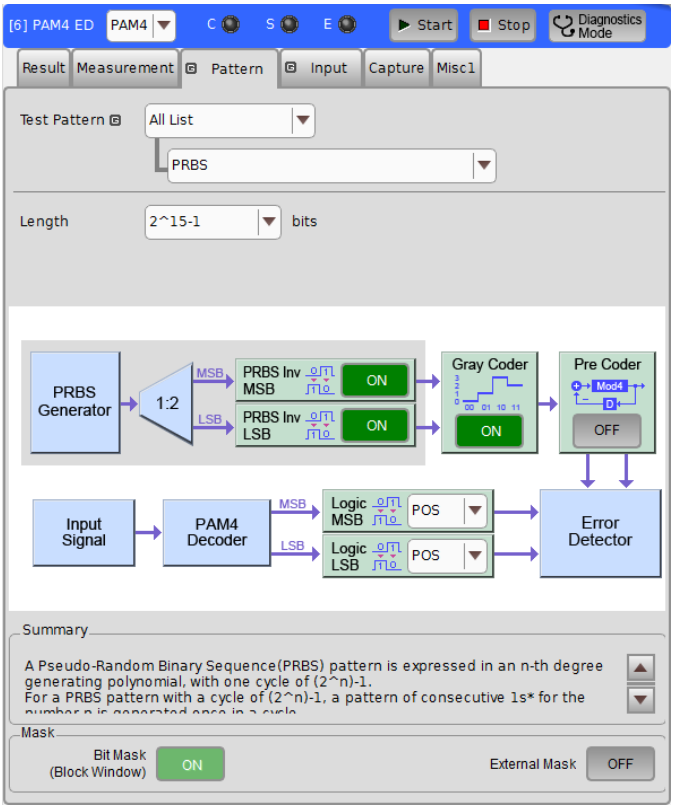


Figure 4.5.2.1.3-1 MU196040A Pattern Tab (PAM4 Mode)

When you select **Data** for **Test Pattern**, touch **Edit**, and you will see the following dialog box.

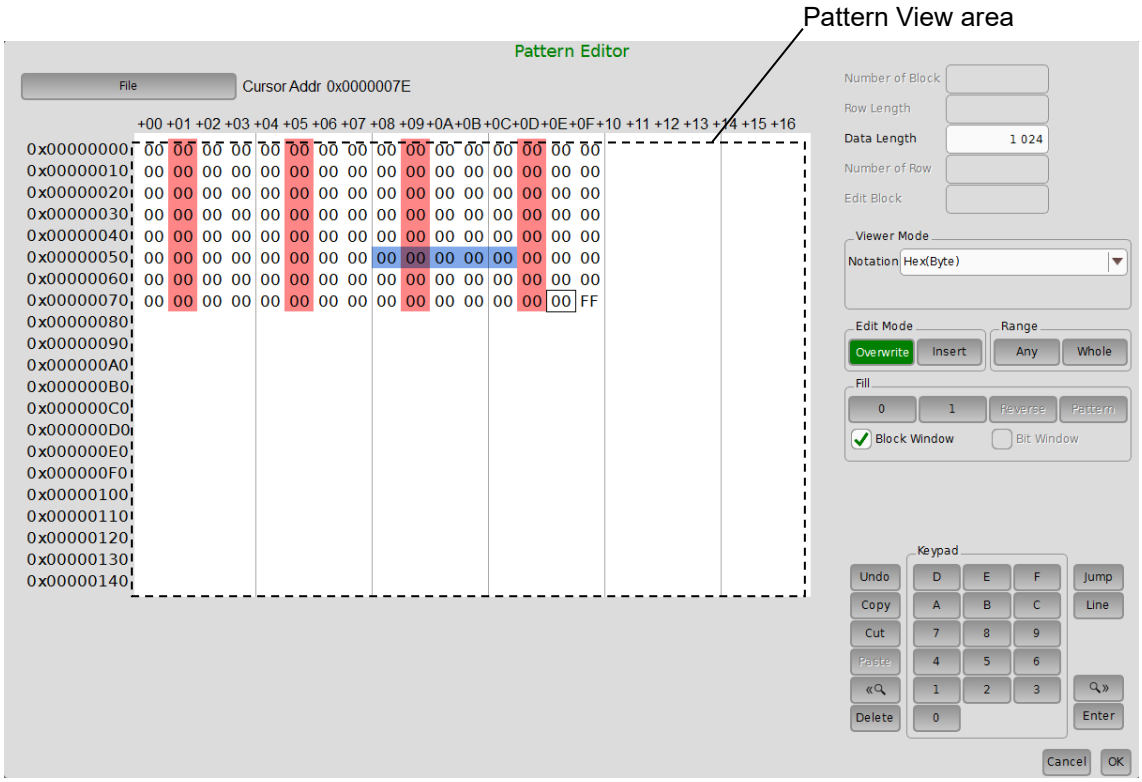


Figure 4.5.2.1.3-2 MU196040A Pattern Editor (NRZ Mode)

Table 4.5.2.1.3-1 Setting Items for Pattern Editor

Item	Description
File	Open: Opens the configuration file saved in the following format: Binary Pattern, BIN/HEX Text Pattern*1, BIN/HEX/PAM4 Text Pattern*2
	Save: Saves the configuration file in the following format: Binary Pattern, BIN Text Pattern, HEX Text Pattern, Symbol(PAM4) Text Pattern*2 ***Note:*** The settings will not be read from the saved file if the file name is changed.
Number of Block	This is currently not available.
Row Length	This is currently not available.

*1: For NRZ

*2: For PAM4

Table 4.5.2.1.3-1 Setting Items for Pattern Editor (Cont'd)

Item	Description
Data Length	Sets the data length (bit).
Number of Row	This is currently not available.
Edit Block	This is currently not available.
Viewer Mode	Switches the data view format. Notation: Hex(Byte) Hexadecimal Bin Binary Symbol(PAM4)*2 0, 1, 2, 3 Coding: This is available when **Notation** is set to **Symbol(PAM4)**. Options are **No Coding** and **Gray**. When **Gray** is selected, the gray-coded pattern is displayed in the View area. Changes in the pattern due to gray coding can be checked. The data can be gray coded by turning on **Gray Coder** on the **Pattern** tab.
Edit Mode	Specify the pattern edit mode. Overwrite: The selected pattern is overwritten. Insert: The editing pattern is inserted into the position of the selected pattern. Note that Data Length is not changed when Insert is selected. The inserted pattern therefore exceeds the Data Length value, and becomes invalid.
Range	Specify the range to edit. Whole: Selects the whole editing patterns. Any: Displays the **Input Range** dialog box, where you can specify the editing range by an address.
Fill	0: Replaces the bits in the selected range with "0". 1: Replaces the bits in the selected range with "1". Reverse: Reverses the bits in the selected range. Pattern: Replaces the bits in the selected range with the set pattern. Block Window*3: If you select the check box and click **1**, the selected range is set as the block window and is displayed in blue. To cancel the block window, select the block window range and click **0**. Bit Window*3: This check box is available when the modulation mode is NRZ. If you select the check box and click **1**, the selected range is set as the bit window and is displayed in red. To cancel the bit window, select the bit window range and click **0**.
Undo	Cancels the previous operation and restores the previous state.

*3: It is displayed for MU196040A and MU196040B only.

Table 4.5.2.1.3-1 Setting Items for Pattern Editor (Cont'd)

Item	Description
Cut	Overwrite: Cuts the pattern selected in the Pattern View area and transfers it onto the clipboard. The area that has been cut out becomes 0. Insert: Cuts the selected pattern with its address domain. After cutting, zero pattern with the same amount of the cut domain is added instead at the end of pattern length.
Copy	Copies the pattern selected in the Pattern View area into the internal memory.
Jump	Moves the cursor to a specified address or pattern.
Head	Moves the cursor to the start of the editing pattern.
Tail	Moves the cursor to the end of the editing pattern.
Marker	Moves the cursor to a position specified by the marker when set to ON.
Address	Opens the **Input Address** dialog box. The cursor can be moved to the specified address position.
Pattern	Opens the **Input Pattern** dialog box. Specifies a pattern string to search by binary digits, and a pattern to be masked by an "x". If a pattern matching the search condition is found in the editing pattern, the cursor moves to that position. Both forward search and backward search are supported. To specify the search pattern, click one of the following buttons in the **Input Pattern** dialog box. **Set All** Sets all the bits selected by Length to "1". **Reset ALL** Sets all the bits selected by Length to "0". **ALL X** Sets all bits to **Don't Care**. Select the search direction by clicking **Forward** or **Backward**, and then click **OK**.
Forward Next	Searches for a pattern that matches the search pattern set in the **Input Pattern** dialog box in the forward direction. If a matching pattern is found, the cursor moves to that position.
Backward Next	Searches for a pattern that matches the search pattern set in the **Input Pattern** dialog box in the backward direction. If a matching pattern is found, the cursor moves to that position.
Line	Specifies the number of bits/bytes/symbols per line to display in the Pattern View area.
	The waveform displayed in the Pattern View area can be enlarged or reduced by changing Zoom. The selectable scale is 1/8, 1/4, 1/2, 1, 2, 4, and 8.

4.5.2.1.4 Input tab

On the **Input** tab, you can configure the settings for the input interface. The **Input** tab consists of three areas: Data, Clock and Measurement Restart. Table 4.5.2.1.4-1 lists the items to set in each area.

Table 4.5.2.1.4-1 Setting Items in Input Tab

Item	Description
Data	Differential or Single-Ended input setting and termination voltage setting
Clock	Clock source setting
Measurement Restart	Select an item to restart measurement when changes are made to settings.

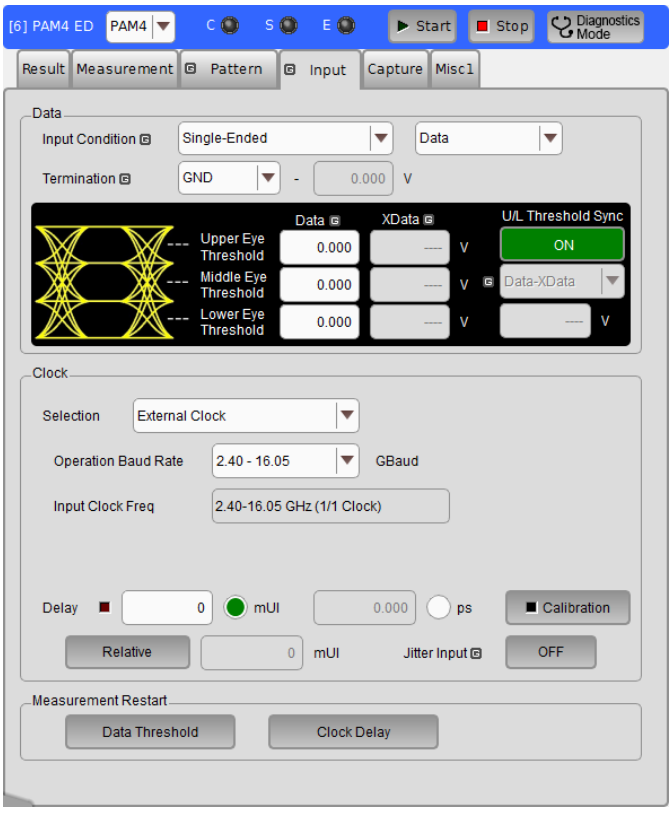


Figure 4.5.2.1.4-1 MU196040A Input Tab (PAM4 Mode)

4.5.2.1.5 Capture tab

On the **Capture** tab, you can capture the input test pattern and analyze it. Also, you can start and stop capturing pattern data and display captured pattern.

Note:

The MU196040A does not support this function, which is supported by the MU196040B.

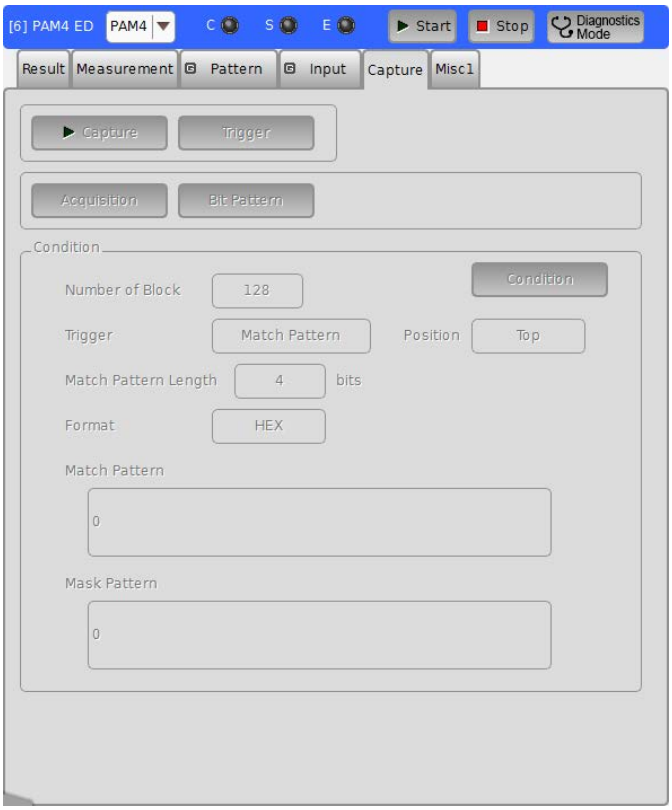


Figure 4.5.2.1.5-1 MU196040A Capture Tab (PAM4 Mode)

4.5.2.1.6 Misc1 tab

On the **Misc1** tab, you can configure the settings for pattern sequence and auxiliary input and output. Setting items on the **Misc1** tab are shown in Table 4.5.2.1.6-1.

Table 4.5.2.1.6-1 Setting Items in Misc1 Tab

Item	Description
Pattern Sequence	Set the test pattern receiving method.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.

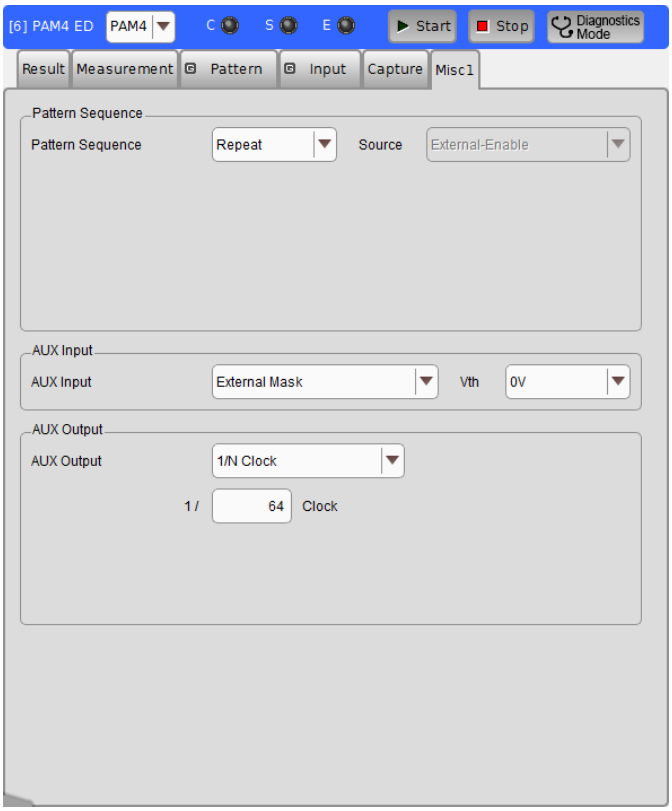


Figure 4.5.2.1.6-1 MU196040A Misc1 Tab (PAM4 Mode)

4.5.3 MU196040B

The MU196040B PAM4 ED (hereafter, MU196040B) is a plug-in module that can be built into MP1900A. It can measure a variety of patterns within the operating frequency range, including PRBS, Data, and ZeroSubstitution (NRZ mode only) patterns.

The MU196040B supports various option configurations and can switch the signal modulation mode between NRZ and PAM4, so it is suitable for research and development and manufacture of various digital communication equipment, digital communication modules and devices.

The features of the MU196040B are listed below:

- Also, with the MU196040B-w42 FEC Analysis installed, you can carry out RS-FEC Scrambled Idle pattern measurement and RS-FEC signal analysis. (To analyze RS-FEC signals, use Standard BERT for PAM4 or Expert BERT. BERT for PCIe1-7 does not support the RS-FEC measurement.)
- When the MU196040B-w43 FEC Analysis for PCIe6 is installed, you can analyze PCIe-6 NOP Flit Layout signals. (Can be measured with the BERT for PCIe1-7 application.)
- When the MU196040B-z51 PCIe Sequence Editor Pattern Analysis is installed, you can analyze signals that comply with the PCIe standard encoding schemes: 8b10b, 128b130b, and 1b1b. (Measurement can be performed using the BERT for PCIe1-6 Forced Link application.)

This section describes function of the tabs of the MU196040B operation screen. For details of the tabs, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

Switch the signal modulation mode to NRZ or PAM4 by selecting it in the NRZ/PAM4 list at the module title bar shown in the following figure before using the MU196040B.

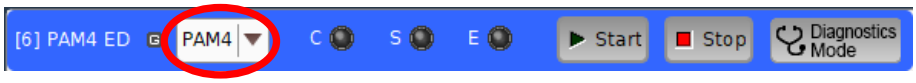


Figure 4.5.3-1 MU196040B NRZ/PAM4 List

This section omits the descriptions of the same functions as the MU196040A. Refer to the description in Section 4.5.2 “MU196040A”.

4.5.3.1 Equipment Composition

4.5.3.1.1 Result tab

On the **Result** tab, you can check the BER results in the lower portion of the tab while changing the settings in the upper portion. To change the items to set, selecting an item in the list box at the module title bar. Setting items and description are shown in Table 4.5.3.1.1-1.

Table 4.5.3.1.1-1 Setting Items in Result Tab

Item	Description
Input	Select to configure the settings related to the input signal interface. When the MU196040B-x11 Equalizer is installed, set the **Low Frequency Equalizer** and **DFE** (Decision Feedback Equalizer) values.
Gating	Select to configure the settings related to the measurement period. Select to configure the settings related to Confidence Level calculation.
Condition	Select to configure the settings related to the measurement conditions.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.
RS-FEC Symbol	Select to configure the settings related to the RS-FEC Symbol measurement conditions.
PCIe6 FEC Symbol	Select to configure the settings related to the PCIe-6 FEC symbol measurement conditions.

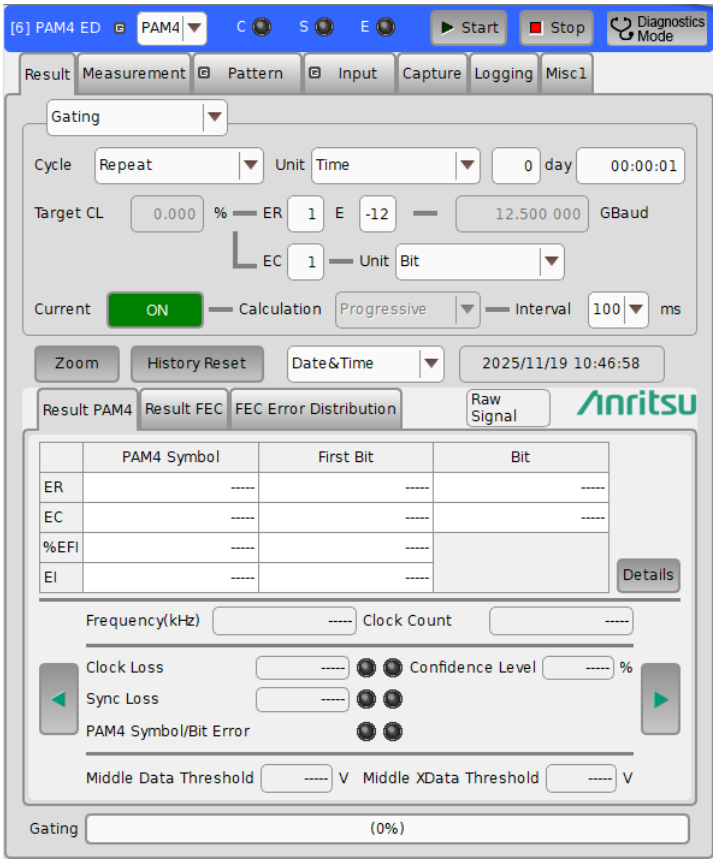


Figure 4.5.3.1.1-1 MU196040B Result Tab

Set the input signal Baud Rate/Bitrate and the ER used as the target criterion for BER in order to calculate the Confidence Level from the BER measurement results. Select the type of Error Count value in Unit.

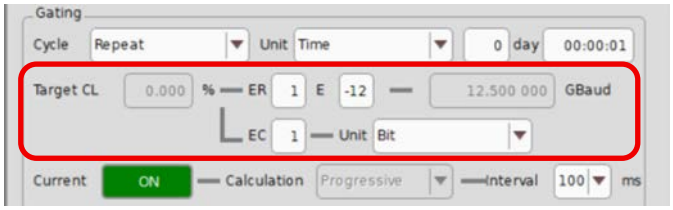


Figure 4.5.3.1.1-2 Confidence Level Settings

In PAM4 mode, the coding status of the data input in symbol error measurement is available on the input signal decoder indicator.

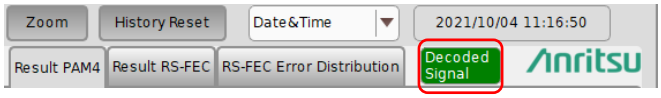


Figure 4.5.3.1.1-3 Input Signal Decoder Indicator

Table 4.5.3.1.1-2 shows the items to be displayed on it.

Table 4.5.3.1.1-2 Items to be Displayed on Input Signal Decoder Indicator

Item	Description
Decoded Signal	Displays error measurement results of decoded input data.
Raw Signal	Displays error measurement results of input data without decoding it.

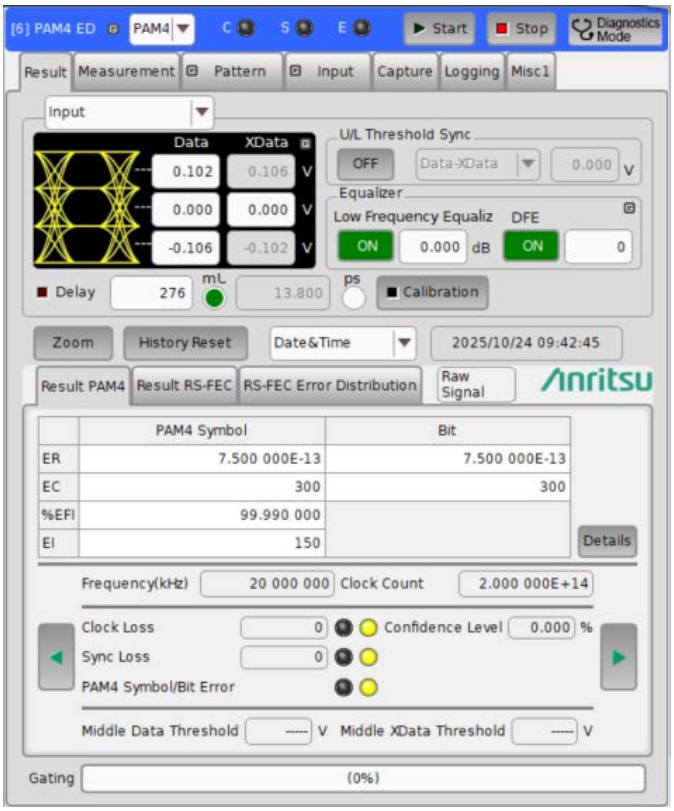


Figure 4.5.3.1.1-4 MU196040B Result Tab - Result PAM4 Tab (PAM4 Mode)

When the MU196040B-w42 FEC Analysis is installed, RS-FEC-related measurement results are displayed on the **Result RS-FEC** tab. RS-FEC can be measured with the following applications:

- Standard BERT for PAM4
- Expert BERT

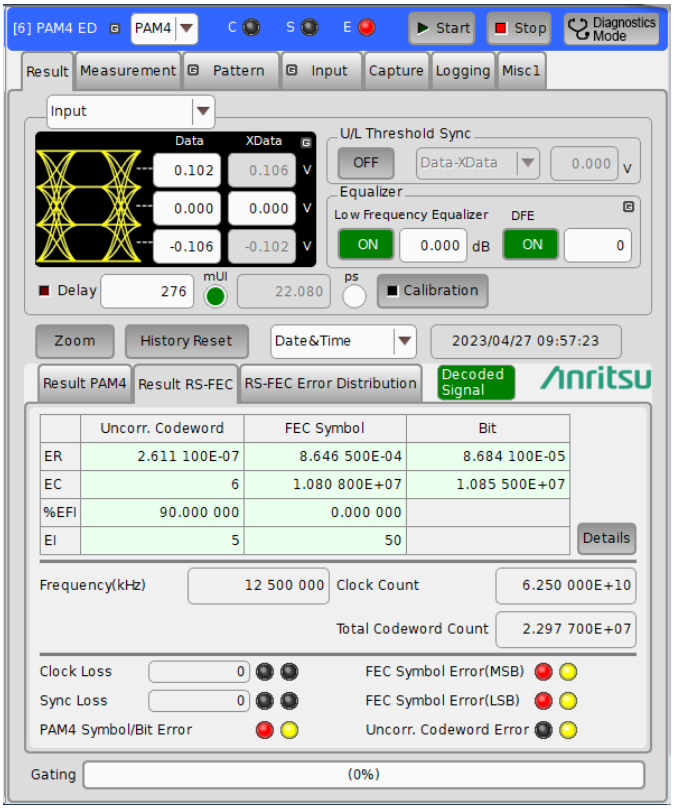


Figure 4.5.3.1.1-5 MU196040B Result Tab - Result RS-FEC Tab (PAM4 Mode)

Also, in the RS-FEC Error Distribution screen, the number of codewords in which FEC symbol errors occurred is displayed in a graph by the number of FEC symbol errors.
In the graph, the vertical bar at 0 on the horizontal axis shows the number of codewords without FEC symbol errors.
In the graph, the vertical bar at Uncorr. on the horizontal axis shows the number of codewords with FEC symbol errors equal to or greater than the error threshold.

Green: Codewords with FEC symbol errors less than the threshold

Red: Codewords with FEC symbol errors equal to or greater than the error threshold

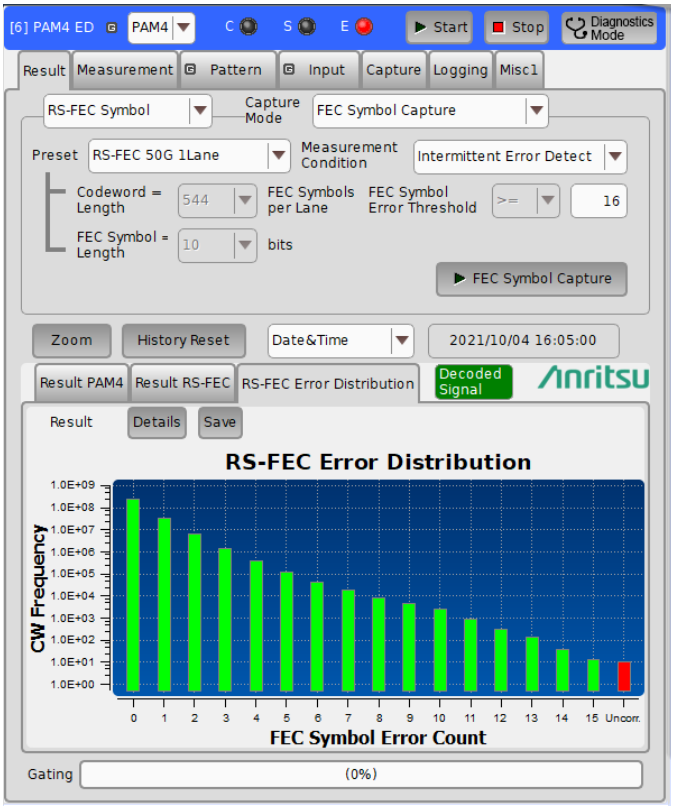


Figure 4.5.3.1.1-6 MU196040B Result Tab - RS-FEC Error Distribution Tab (PAM4 Mode)

When the MU196040B-w43 FEC Analysis for PCIe6 is installed, PCIe-6 FEC related measurement results are displayed on the **Result FEC** tab. PCIe6 FEC can be measured with the following application:

- BERT for PCIe1-7
- BERT for PCIe1-6 Forced Link

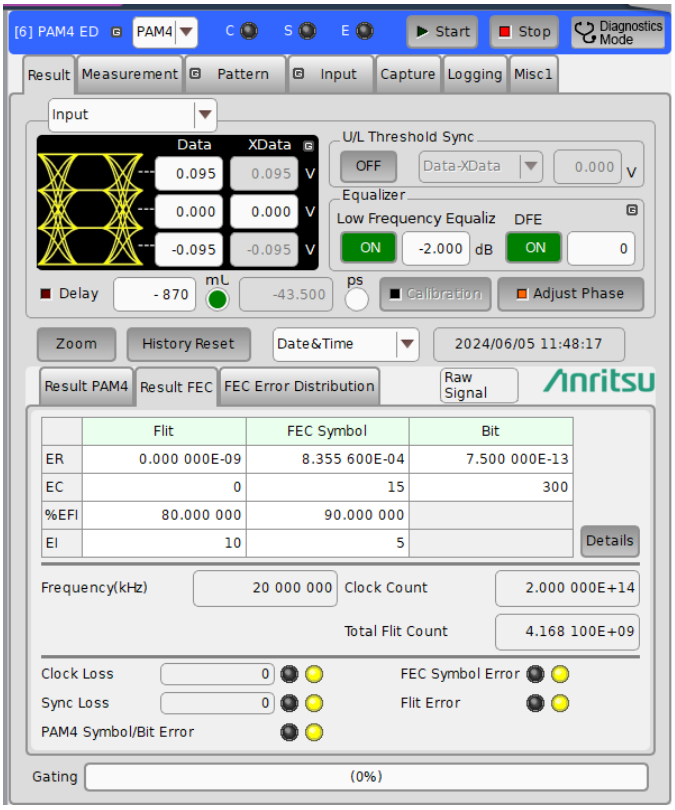


Figure 4.5.3.1.1-7 MU196040B Result Tab - Result FEC Tab (PAM4 Mode)

Also, in the FEC Error Distribution screen, the number of Flits in which FEC symbol errors occurred is displayed in a graph by the number of FEC symbol errors.
In the graph, the vertical bar at 0 on the horizontal axis shows the number of Flits without FEC symbol errors.
In the graph, the vertical bar at Flit Error on the horizontal axis shows the number of Flits with FEC symbol errors equal to or greater than the error threshold.

Green: Flits that contain FEC symbol errors less than the threshold and that never be judged as Flit Error

Yellow: Flits that contain FEC symbol errors less than the threshold but that may be judged as Flit Error depending on FEC symbol error occurrence

Red: Flits that contain FEC symbol errors more than the threshold and that are always judged as Flit Error

Dark red: Flits counted as flit errors

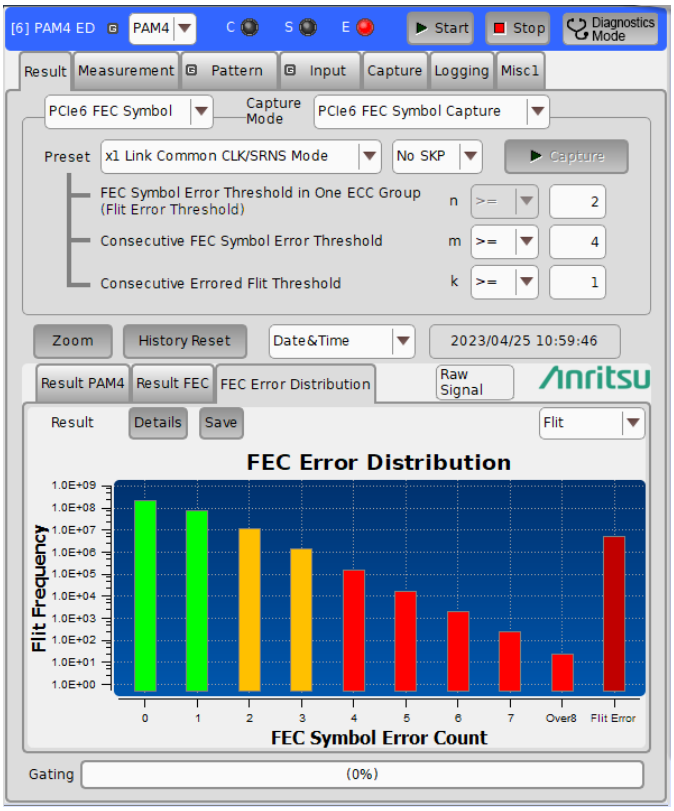


Figure 4.5.3.1.1-8 MU196040B Result Tab - FEC Error Distribution Tab (PAM4 Mode)

4.5.3.1.2 Measurement tab

On the **Measurement** tab, you can set the measurement conditions. The **Measurement** tab consists of five setting groups listed in Table 4.5.3.1.2-1. The items in the following areas can be set also on the **Result** tab: **Gating**, **Auto Sync**, **Sync Control** and **Error/Alarm Condition**. Additionally, the advanced settings of Sync Control and Error/Alarm Condition are available on this tab.

Table 4.5.3.1.2-1 Setting/Display Items in Measurement Tab

Item	Description
Gating	Select to configure the settings related to the measurement period. Select to configure the settings related to Confidence Level calculation.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.
Error/Alarm Condition	Select to configure the setting related to the error/alarm detection method.
Measurement Restart	Select an item to restart measurement when changes are made to settings.

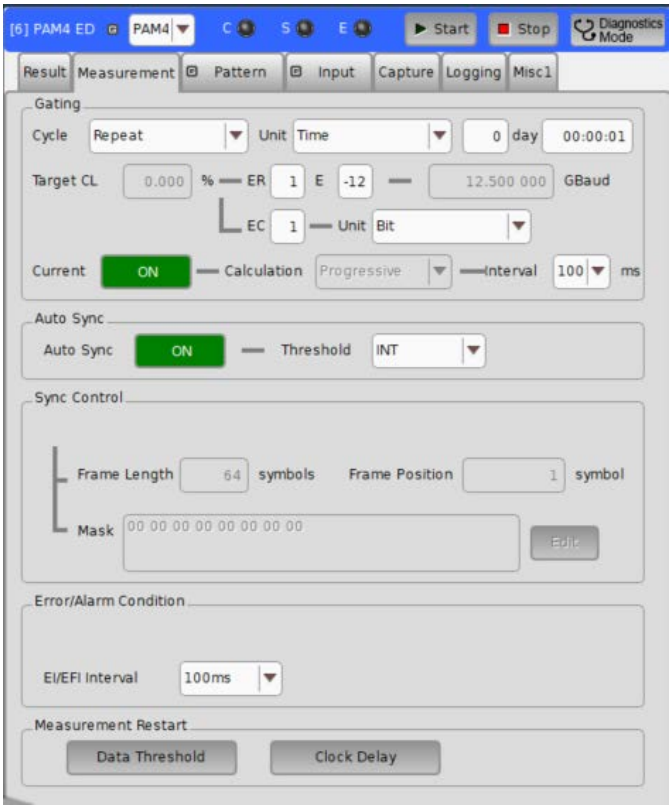


Figure 4.5.3.1.2-1 MU196040B Measurement Tab (PAM4 Mode)

4.5.3.1.3 Pattern tab

On the **Pattern** tab, you can select a test pattern and can configure the Mask settings. For explanations of the **Pattern** tab, refer to 4.5.2.1.3 “Pattern tab”.

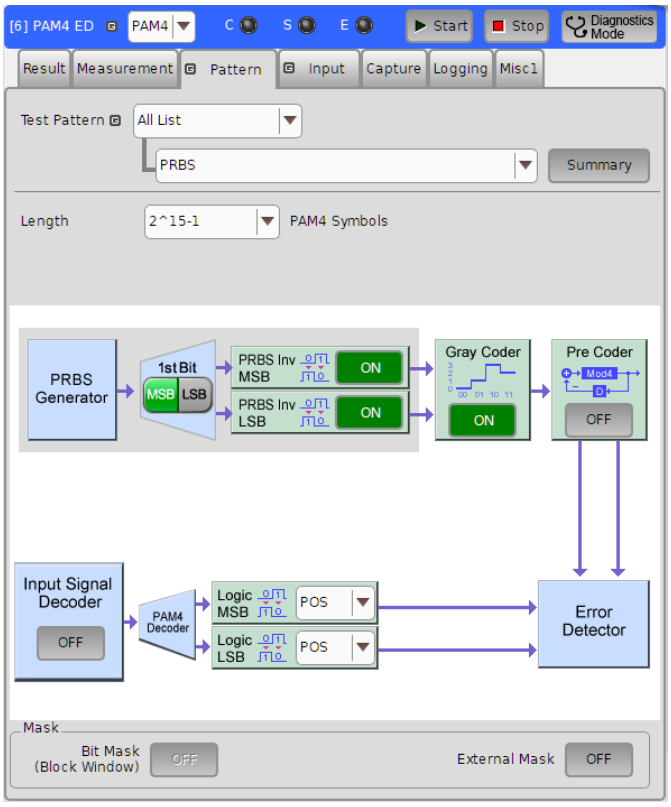


Figure 4.5.3.1.3-1 MU196040B Pattern Tab (PAM4 Mode)

When the MU196040B-w42 FEC Analysis is installed, you can set FEC patterns. RS-FEC can be measured with the following applications:

- Standard BERT for PAM4
- Expert BERT

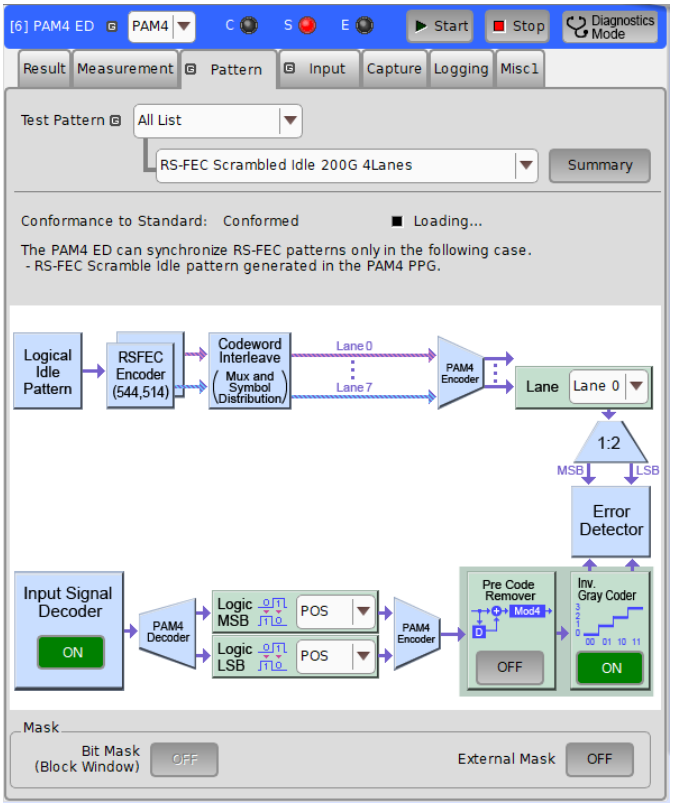


Figure 4.5.3.1.3-2 MU196040B Pattern Tab (With MU196040B-w42)

When the MU196040B-w43 FEC Analysis for PCIe6 is installed, you can set PCIe6 FEC patterns. PCIe6 FEC patterns can be measured with the following application:

- BERT for PCIe1-7
- BERT for PCIe1-6 Forced Link

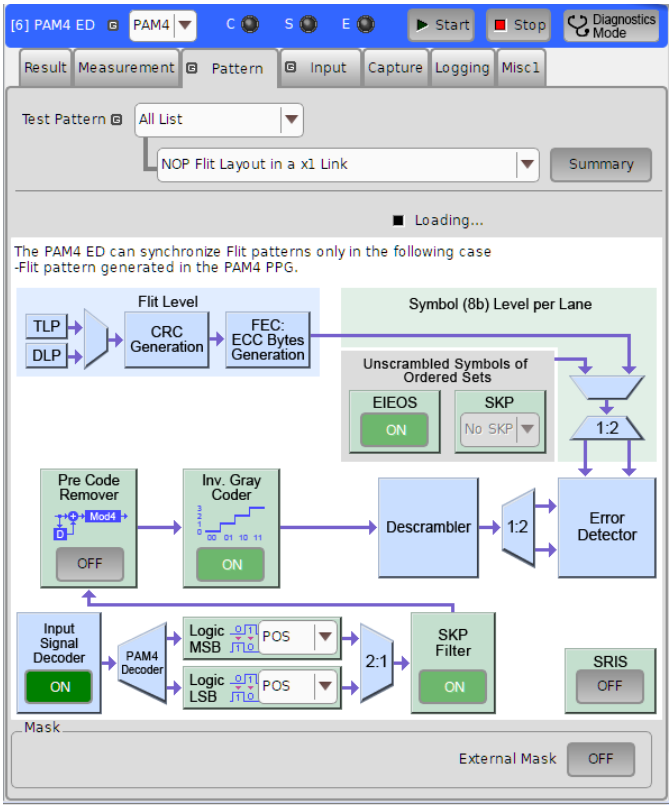


Figure 4.5.3.1.3-3 MU196040B Pattern Tab (With MU196040B-w43)

When the MU196040B-z51 PCIe Sequence Editor Pattern Analysis is installed, you can analyze signals that comply with the PCIe standard encoding schemes: 8b10b, 128b130b, and 1b1b. You can perform the measurement using the following application.

- BERT for PCIe1-6 Forced Link

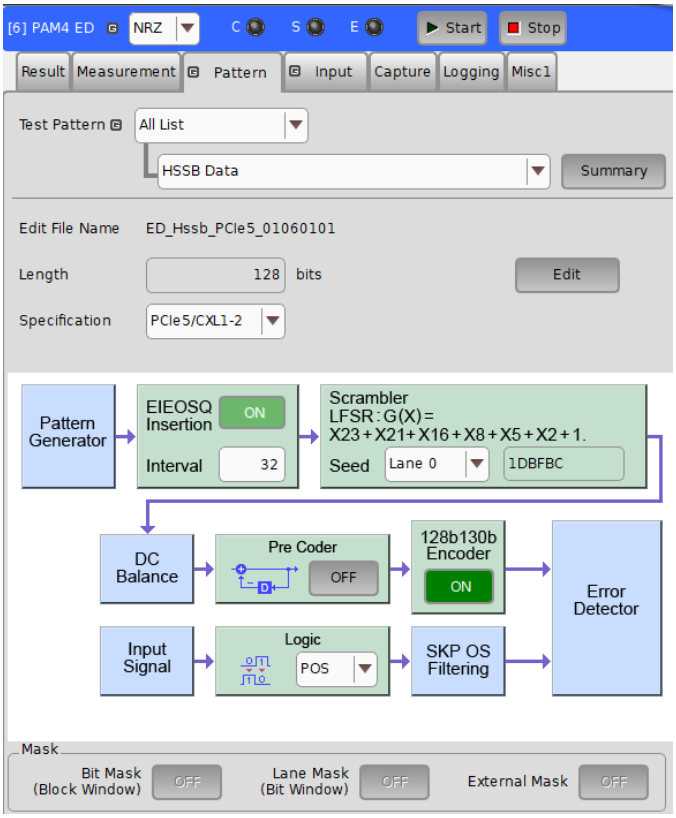


Figure 4.5.3.1.3-4 MU196040B NRZ Pattern Tab (With MU196040B-z51)

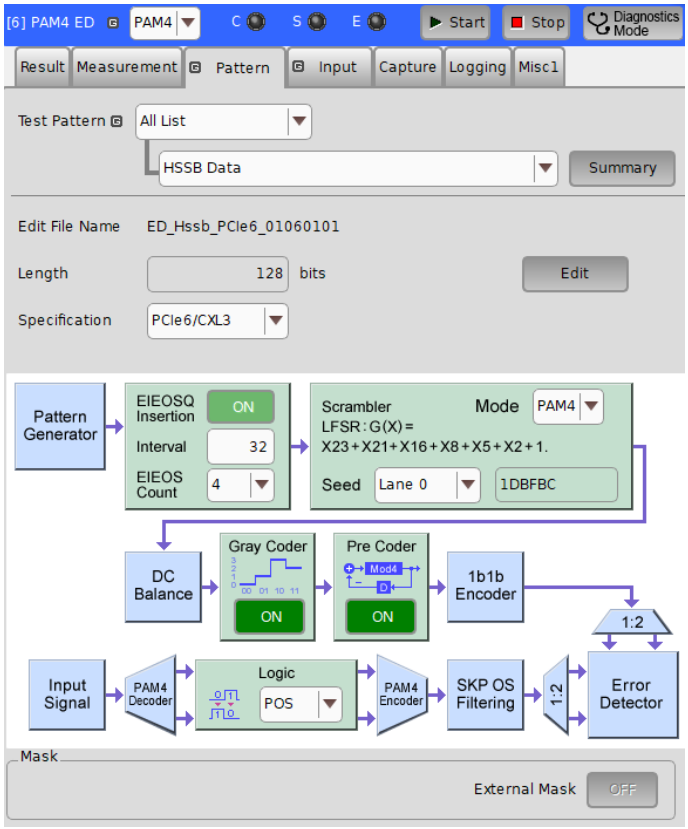


Figure 4.5.3.1.3-5 MU196040B PAM4 Pattern Tab (With MU196040B-z51)

The restrictions for PAM4 PPG Sequence Editor and PAM4 ED HSSB Data are described below.

- To measure BER for PCIe1 and PCIe2, set Symbol Length x2 to **ON** on the MU196020A **SKP OS** tab. This setting prevents variations in the running disparity of the pattern caused by the insertion points of SKP Ordered Sets, especially when an odd number of SKP Ordered Sets is inserted during BER measurement for PCIe.

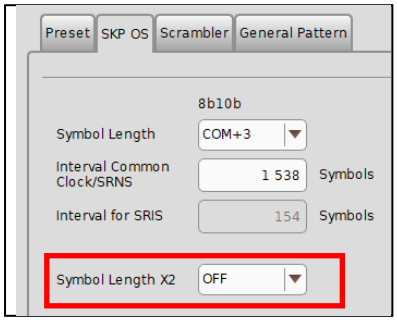


Figure 4.5.3.1.3-6 Setting for Symbol Length x2

- When performing BER measurements on PCIe3/CXL1-2, PCIe4/CXL1-2, or PCIe5/CXL1-2, configure the Sync Header Bypass setting on the MU196020A and the 128b130b Encoder setting on the MU196040B according to Table 4.5.3.1.3-1.

Table 4.5.3.1.3-1 Settings According to Presence of Sync Header

Presence of Sync Header during 128b/130b Encoding	MU196020A Sync Header Bypass Setting	MU196040B 128b/130b Encoder Setting
Present	OFF	ON
Not present	ON	OFF

- When measuring BER, set the EIEOSQ Interval of EIEOSQ/SYNCOS to be inserted, to the same value as the EIEOSQ Interval in the Sequence Editor screen of the MU196020A. For PAM4, set EIEOS Count to match the value shown on the Sequence Editor screen of the MU196020A. In the following example, set EIEOSQ Interval to 32.

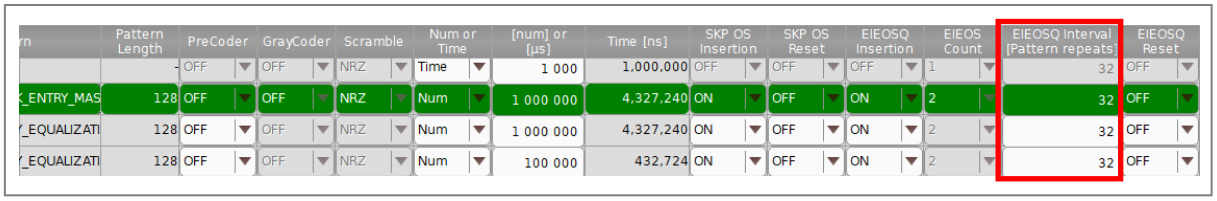


Figure 4.5.3.1.3-7 EIEOSQ Interval in the Sequence Editor Screen

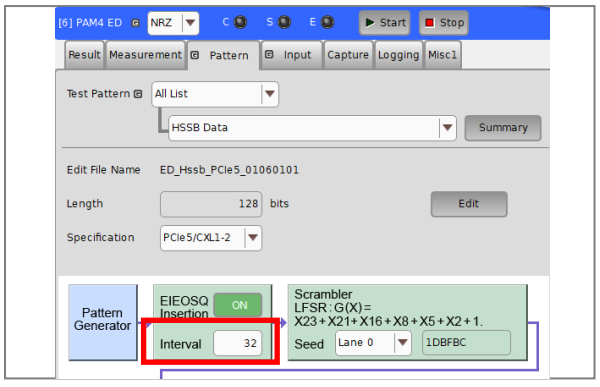


Figure 4.5.3.1.3-8 EIEOSQ Interval Setting for MU196040B NRZ

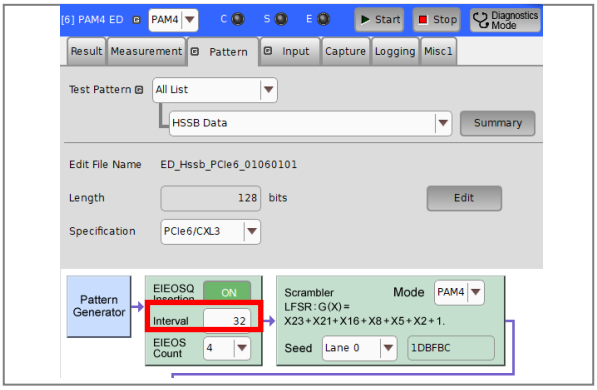


Figure 4.5.3.1.3-9 EIEOSQ Interval Setting for MU196040B PAM4

- **Eye Contour**, **Bathtub**, and **Eye Margin** cannot be used when **HSSB Data** is selected for Test Pattern on the **Pattern** tab of the MU196040B.

4.5.3.1.4 Input tab

On the **Input** tab, you can configure the settings for the input interface. The **Input** tab consists of three areas: Data, Equalizer, and Clock. Table 4.5.3.1.4-1 lists the items to set in each area.

Table 4.5.3.1.4-1 Setting Items in Input Tab

Item	Description
Data	Differential or Single-Ended input setting and termination voltage setting
Equalizer	When the MU196040B-x11 Equalizer is installed, set the **Low Frequency Equalizer** and **Decision Feedback Equalizer** values.
Clock	Clock source setting

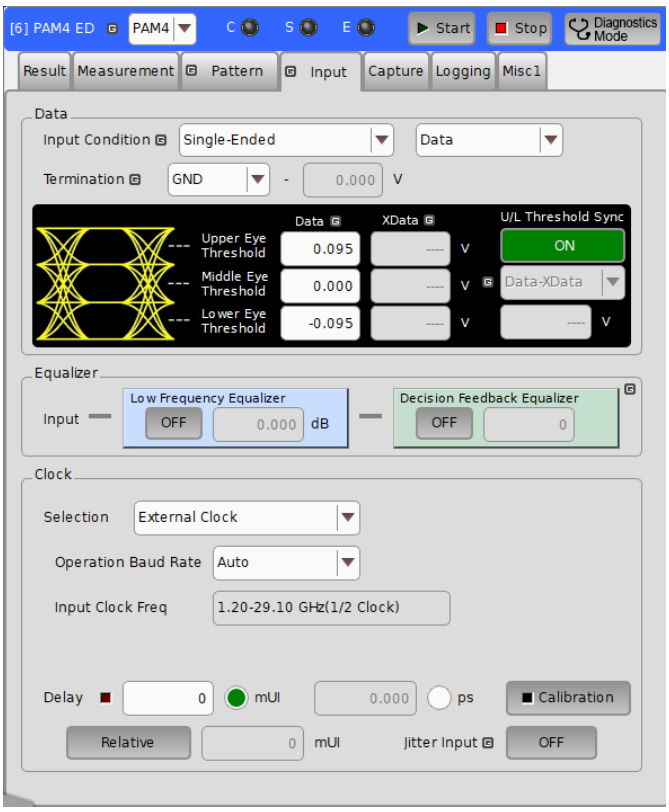


Figure 4.5.3.1.4-1 MU196040B Input Tab (PAM4 Mode)

4.5.3.1.5 Capture tab

On the **Capture** tab, you can capture the input test pattern and analyze it. Also, you can start and stop capturing pattern data and display captured pattern.
The size of pattern data to be captured is 4 Msymbols (4 194 304 symbols) in PAM4 mode and 8 Mbits (8 388 608 bits) in NRZ mode. The captured pattern data is divided into groups by the value set at **Number of Blocks** to display the pattern data by block.

Table 4.5.3.1.5-1 Setting Items on the Capture Tab

Item	Description
Capture Mode	Configure the settings for the pattern data capturing mode.
Capture Result Display	Configure the settings for displaying the pattern after the pattern data is captured.
Condition	Configure the conditions for starting the pattern data capturing.
FEC Symbol Capture Setting	Configure the settings for capturing and displaying the pattern data in FEC Symbol Capture mode.
PCIe6 FEC Symbol Capture Setting	Configure the settings for capturing and displaying the pattern data in PCIe6 FEC Symbol Capture mode.

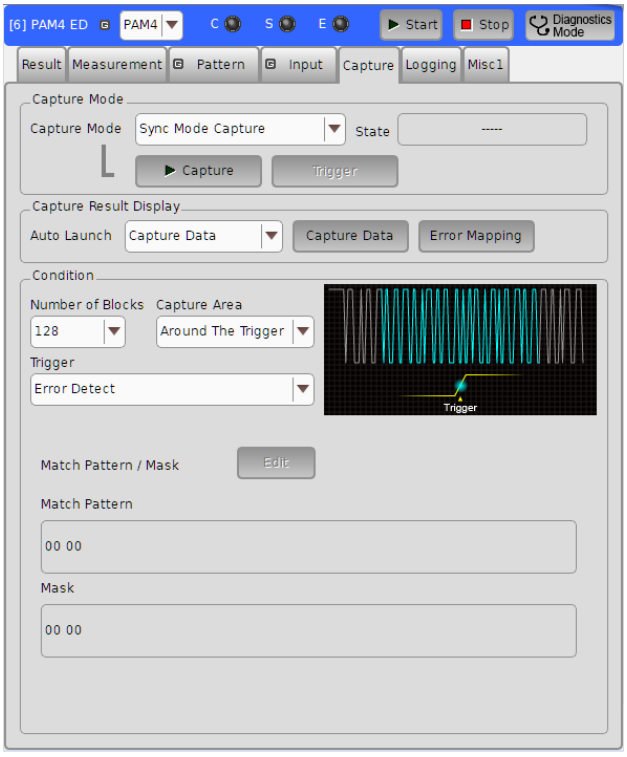


Figure 4.5.3.1.5-1 MU196040B Capture Tab (Sync Mode Capture) (PAM4 Mode)

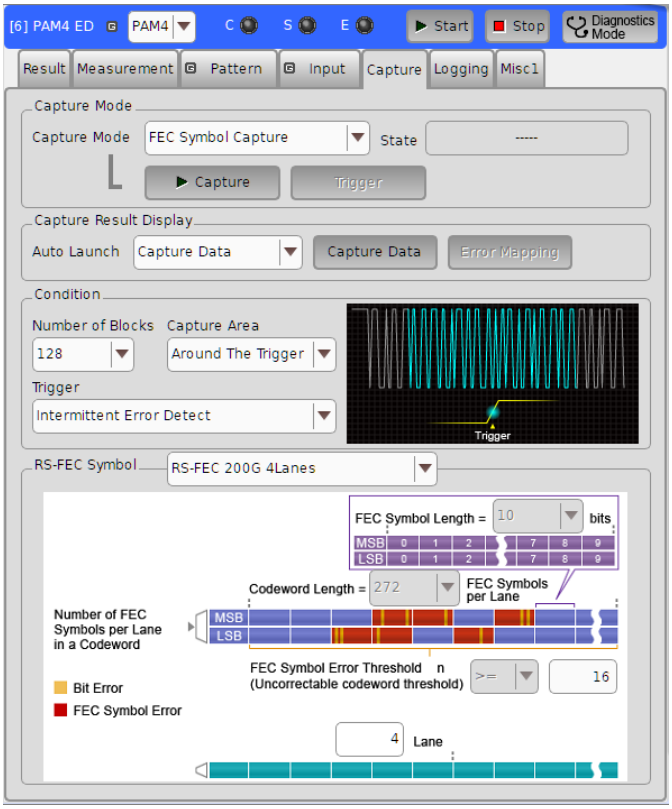


Figure 4.5.3.1.5-2 MU196040B Capture Tab (FEC Symbol Capture) (PAM4 Mode)

Each time a trigger occurs, 1 block of pattern is captured. If **128** is selected in the **Number of Blocks** list, the pattern data capturing ends when a trigger has occurred 128 times.

Capture Data screen

- For Sync Mode Capture, Raw Data Mode Capture mode

When the data is captured, touch **Capture Data**, and you can display the Capture Data screen. The errors detected in the captured test pattern are displayed in different colors, which help you identify error types.
The data is displayed by symbol (0, 1, 2, 3) or binary numbers in PAM4 mode and displayed by binary or hexadecimal numbers in NRZ mode.

Note:

The following explanation is based on the result display screen when **Capture Mode** is **Sync Mode Capture**. In the Raw Data Capture results screen, some functions are hidden or not valid.

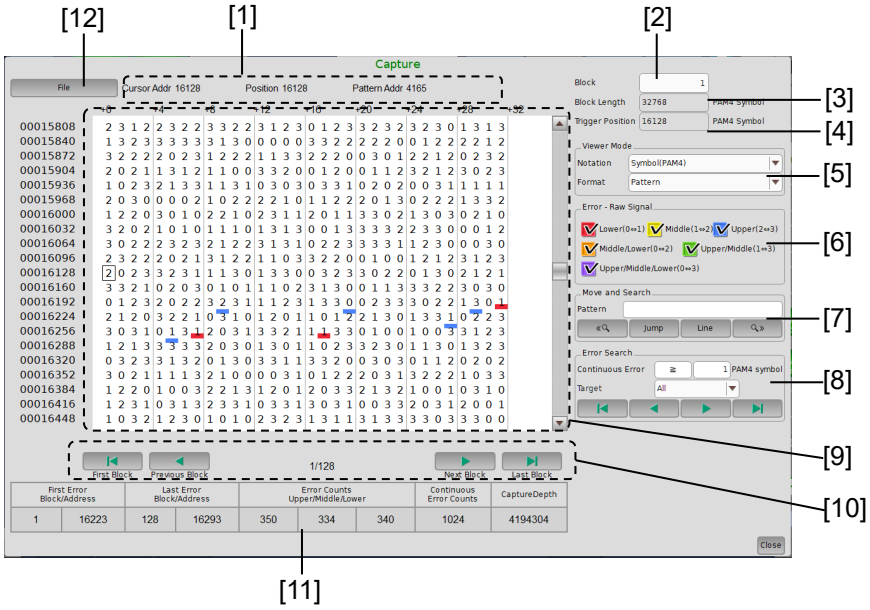
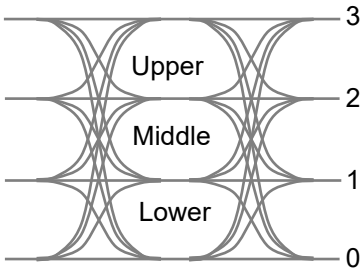


Figure 4.5.3.1.5-3 Capture Data Screen (PAM4 Mode)

In PAM4 mode, the background color of each symbol is different, depending on between which levels the error occurred.



Lower	Between levels 0 and 1
Middle	Between levels 1 and 2
Upper	Between levels 2 and 3
Middle/Lower	Between levels 0 and 2
Upper/Middle	Between levels 1 and 3
Upper/Middle/Lower	Between levels 0 and 3

Figure 4.5.3.1.5-4 Names and Occurrence Levels of Errors (PAM4 Mode)

Table 4.5.3.1.5-2 Description of Screen Items (PAM4 Mode)

No.	Item	Description
[1]	Cursor Addr/ Position/ Pattern Addr	Cursor Addr: Displays the cursor position within the current block. Position: Displays the position within the entire captured data (all blocks). Pattern Addr: Displays the position in the pattern. Data pattern: Displays the position from the first symbol of the pattern. PRBS pattern: Displays the position from the consecutive 0 bits. ***Note:*** For the data captured when **Capture Mode** is **Raw Data Capture**, "---" is displayed at **Pattern Addr**.
[2]	Block	Sets the block number to display. The maximum value is the value in the **Number of Blocks** list in Figure 4.5.3.1.5-1.
[3]	Block Length	Displays the block length. Block Length = $\frac{\text{4M symbols}}{\text{Number of Blocks}}$
[4]	Trigger Position	Displays the trigger detected position, in the range of 0 to block length.
[5]	Viewer Mode	Notation: Symbol(PAM4), fixed, BIN(MSB/LSB) Format: Select the view mode of the Capture Data display area. Pattern: Displays symbols 0, 1, 2 and 3, or binary (0, 1) numbers. Pattern + Waveform: Displays "symbols" + "image of PAM4 signal of four values".

Table 4.5.3.1.5-2 Description of Screen Items (PAM4 Mode) (Cont'd)

No.	Item	Description
[6]	Error*	Displays the legend (color sample) for each of error symbols or error bits. Legends (color samples) and titles of PAM4 symbol errors are different, depending on whether the input signal decoder is on / off. When the input signal decoder is **OFF**, Raw Signal is displayed. When the input signal decoder is **ON**, Decoded Signal is displayed. ● For Symbol(PAM4): When the input signal decoder is **OFF** Lower Eye Error (0 ↔ 1): Red Middle Eye Error (1 ↔ 2): Yellow Upper Eye Error (2 ↔ 3): Blue Middle/Lower Eye Error (0 ↔ 2): Orange Upper/Middle Eye Error (1 ↔ 3): Green Upper/Middle/Lower Eye Error (0 ↔ 3): Purple When the input signal decoder is **ON** MSB Error: Red LSB Error: Yellow MSB+LSB Error: Orange ● For BIN(MSB/LSB): INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow ***Note:*** To show/hide each error in the Capture Data display area, select/clear its check box.

*: For the data captured when **Capture Mode** is **Raw Data Capture**, this item is not displayed.

Table 4.5.3.1.5-2 Description of Screen Items (PAM4 Mode) (Cont'd)

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>[7]</td><td>Move and Search</td><td>Searches the captured data for the string.
Pattern: Searches any pattern of the string specified with symbols (0, 1, 2 and 3) by using «🔍 and 🔍».
Jump: Moves the cursor to the specified address or pattern.
Head: Moves the cursor to the head of the captured data pattern.
Tail: Moves the cursor to the tail of the captured data pattern.
Address: Moves the cursor to the specified address.
Trigger Position: Moves the cursor to the address where the trigger was detected.
Forward Next: Searches forward for a pattern that matches the pattern set in the Pattern box. If found, the cursor is placed at the position.
Backward Next: Searches backward for a pattern that matches the pattern set in the Pattern box. If found, the cursor is placed at the position.
Line: Sets how many characters to display per line, in the Capture Data display area.</td></tr>
<tr><td>[8]</td><td>Error Search*</td><td>Performs an error search, specifying the number and type of continuous errors.
Continuous Error: Specifies the number of continuous errors to search for.
<table>
<tr><th>Search Mode</th><th>Range</th></tr>
<tr><td>PAM4 Symbol</td><td>1 to 256 PAM4 symbols, 1 PAM4 symbol step</td></tr>
<tr><td>Bit</td><td>1 to 256 bits, 1 bit step</td></tr>
</table>
In the Search Condition box, select = (Exact match) or ≥ (Greater than or equal to).
Target: Select the type of errors to search, from the following:
• When the input signal decoder is OFF: Upper Eye, Middle Eye, Lower Eye, All
• When the input signal decoder is ON: MSB, LSB, All</td></tr>
<tr><td>[9]</td><td>Capture Data display area</td><td>Displays the captured data (including error information) by symbols (0, 1, 2 and 3) or binary numbers (Bin). The background color of each symbol where an error occurred is different depending on the error type.
When in the Viewer Mode area, Pattern + Waveform is selected in the Format list, a PAM4 pattern image is displayed.
Note:
For the results captured when Capture Mode is Raw Data Capture, error information is not displayed.</td></tr>
<tr><td>[10]</td><td>Block scroll buttons</td><td>Scrolls the block view.</td></tr>
</table>

Table 4.5.3.1.5-2 Description of Screen Items (PAM4 Mode) (Cont'd)

No.	Item	Description
[11]	Capture result display*	Displays the error detection results of the entire captured data. First Error: Displays the block number and address of where the first error was detected. Last Error: Displays the block number and address of where the last error was detected. Error Counts: For Symbol(PAM4): When the input signal decoder is **OFF** Displays the number of errors counted in all blocks (Upper/Middle/Lower Eye), separately. ***Note:*** One error may be counted in multiple eyes. Example: Middle/Lower (0 ↔ 2) errors are counted as both Middle Eye Error and Lower Eye Error. When the input signal decoder is **ON** Displays the number of errors counted in all blocks by type (MSB / LSB / MSB+LSB(Total)). For BIN(MSB/LSB): Displays the number of errors counted in all blocks by type (Insertion / Omission / Total). Continuous Error Counts: Displays the number of times an error search detected continuous errors that match the number of symbols set in the **Continuous Error** box of the **Error Search** area. Capture Depth: Displays the number of symbols in the entire captured data.

Table 4.5.3.1.5-2 Description of Screen Items (PAM4 Mode) (Cont'd)

No.	Item	Description
[12]	File	Saves captured results and pattern to a file and loads the captured result file. Save: Saves the captured results and pattern to a file. The types of saved files are as follows: Symbol(PAM4) Capture File (*.scap): Select when redisplaying the results in the Capture Data screen. Symbol(PAM4) Capture File (export) (*.txt): Select when saving a pattern file including error information. The saved file can be loaded by Pattern Editor of the MU196020A, MU196040A, and MU196040B. Open: Loads a result file to redisplay the captured results. The results are displayed by loading the captured data (Symbol(PAM4) Text) from the scap file. ***Note:*** If **Capture Mode** is **Sync Mode Capture**, the error information cannot be displayed correctly when you open the file of the pattern captured in **Raw Data Capture** mode.

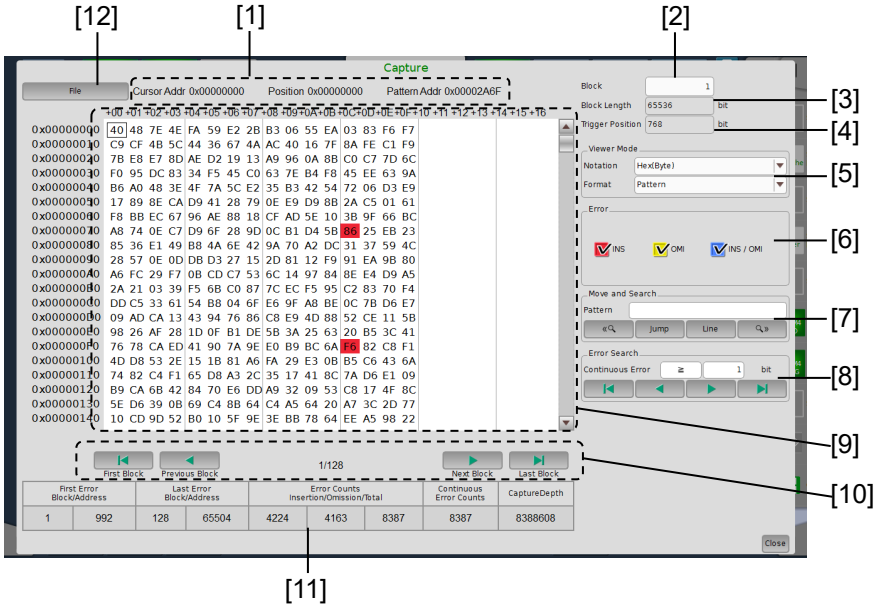


Figure 4.5.3.1.5-5 Capture Data Screen (NRZ Mode)

Table 4.5.3.1.5-3 Description of Screen Items (NRZ Mode)

No.	Item	Description
[1]	Cursor Addr/ Position/ Pattern Addr	Cursor Addr: Displays the cursor position within the current block. Position: Displays the position within the entire captured data (all blocks). Pattern Addr: Displays the position in the pattern. Data pattern: Displays the position from the first symbol of the pattern. PRBS pattern: Displays the position from the consecutive 0 bits. ***Note:*** For the data captured when **Capture Mode** is **Raw Data Capture**, "---" is displayed at **Pattern Addr**.
[2]	Block	Sets the block number to display. The maximum value is the value in the **Number of Blocks** list in Figure 4.5.3.1.5-1.
[3]	Block Length	Displays the block length. $\text{Block Length} = \frac{\text{8M bits}}{\text{Number of Blocks}}$
[4]	Trigger Position	Displays the trigger detected position, in the range of 0 to block length.
[5]	Viewer Mode	Notation: Bin Hex(Byte) Format: Select the view mode of the Capture Data display area. Pattern: String of binary (0, 1) or hexadecimal (0-9, A-F) numbers Pattern + Waveform: String of binary (0, 1) numbers and image of NRZ signal

Table 4.5.3.1.5-3 Description of Screen Items (NRZ Mode) (Cont'd)

No.	Item	Description
[6]	Error*	Displays the legend (color sample) for each of error bits. INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow INS/OMI: Insertion and Omission Error Blue ***Note:*** If **Hex (Byte)** is selected in the **Notation** list of the **Viewer Mode** area, bits where both INS and OMI occurred are displayed on blue background. To show/hide each error in the Capture Data display area, select/clear its check box.
[7]	Move and Search	Searches the captured data for the string specified by binary (0, 1) or hexadecimal (0-to 9, A-to F) numbers. Pattern: Searches any pattern using «🔍 and 🔍». Jump: Moves the cursor to the specified address or pattern. Head: Moves the cursor to the head of the captured data pattern. Tail: Moves the cursor to the tail of the captured data pattern. Address: Moves the cursor to the specified address position. Trigger Position: Moves the cursor to the address where the trigger was detected. Forward Next: Searches forward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Backward Next: Searches backward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Line: Sets how many characters to display per line, in the Capture Data display area.
[8]	Error Search*	Performs an error search, specifying the number and type of continuous errors. Continuous Error: Specifies the number of continuous errors to search for. 1 to 256 bits, 1 bit step In the **Search Condition** box, select **=** (Exact match) or ≥ (Greater than or equal to).

*: For the data captured when **Capture Mode** is **Raw Data Capture**, this item is not displayed.

Table 4.5.3.1.5-3 Description of Screen Items (NRZ Mode) (Cont'd)

No.	Item	Description
[9]	Capture Data display area	Displays the captured results (including error information) by binary (Bin) or hexadecimal (Hex) numbers. The background color of each bit where an error occurred is different depending on the error type. When displayed in binary format, select **Pattern + Waveform** in the **Notation** list of the **Viewer Mode** area, and you will view a pattern image. ***Note:*** For the results captured when **Capture Mode** is **Raw Data Capture**, error information is not displayed.
[10]	Block scroll buttons	Scrolls the block view.
[11]	Capture result display*	Displays the error detection results of the entire captured data. First Error: Displays the block number and address of where the first error was detected. Last Error: Displays the block number and address of where the last error was detected. Error Counts: Displays the number of errors counted in all blocks by type (Insertion, Omission, Total). Continuous Error Counts: Displays the number of times an error search detected continuous errors that match the number of bits set in the **Continuous Error** box of the **Error Search** area. Capture Depth: Displays the number of bits in the entire captured data.
[12]	File	Saves captured results and pattern to a file and loads the captured result file. Save: Saves the captured results and pattern to a file. The types of saved files are as follows: BIN(NRZ) Capture File, HEX(NRZ) Capture File (*.ncap): Select when redisplaying the results in the Capture Data screen. BIN(NRZ) Capture File (export), HEX(NRZ) Capture File (export) (*.txt): Select when saving a pattern file including error information. The saved file can be loaded by Pattern Editor of the MU195020A, MU195040A, MU196020A, MU196040A, and MU196040B. Open: Loads a result file to redisplay the captured results. The results are displayed by loading the captured data (BIN Text, HEX Text) from the ncap file. ***Note:*** If **Capture Mode** is **Sync Mode Capture**, the error information cannot be displayed correctly when you open the file of the pattern captured in **Raw Data Capture** mode.

- For FEC Symbol Capture mode

When the data is captured, touch **Capture Data**, and you can display the Capture Data screen. The errors detected in the captured test pattern are displayed in different colors, which help you identify error types.

The data is displayed by symbol (0, 1, 2, 3) or binary numbers in PAM4 mode, and by binary or hexadecimal numbers in NRZ mode.

Notes:

- The following explanation is based on the result display screen when Capture Mode is **FEC Symbol Capture**. The descriptions of the same functions as Sync Mode Capture mode are omitted.
- The MU196040B-w42 FEC Analysis must be installed to use this mode. This mode is not available when the BERT for PCIe1-7 application is active.

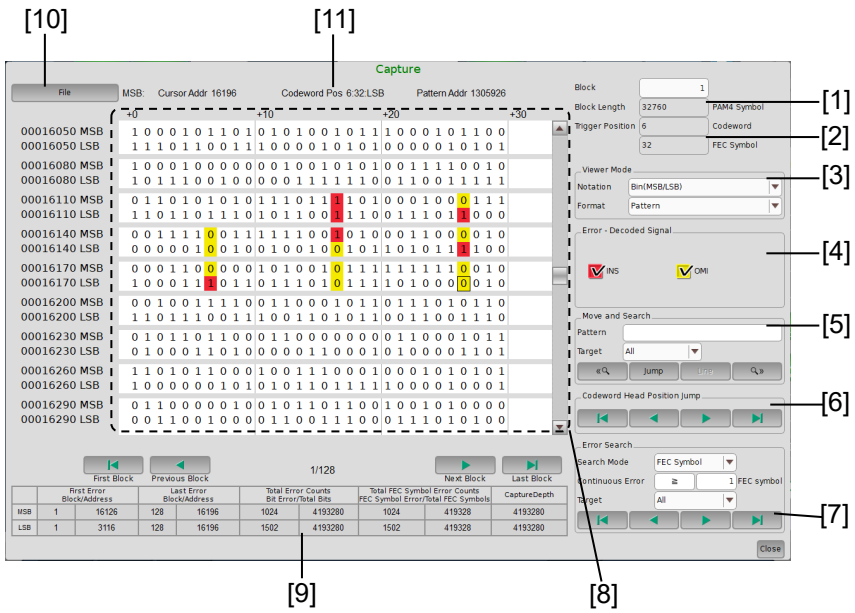


Figure 4.5.3.1.5-6 Capture Data Screen Items (FEC Symbol Capture in PAM4 Mode)

Table 4.5.3.1.5-4 Description of Capture Data Screen Items (FEC Symbol Capture in PAM4 Mode)

No.	Item	Description
[1]	Block Length	Displays the block length. Bits shorter than 1FEC Symbol length are discarded. Block Length = $\frac{\text{4M symbols}}{\text{Number of Blocks}}$
[2]	Trigger Position	Displays the trigger detected position, in the range of 0 to block length.
[3]	Viewer Mode	Notation: Symbol(PAM4), BIN(MSB/LSB) Format: Select the view mode of the Capture Data display area. Pattern: Displays symbols 0, 1, 2 and 3, or binary (0, 1) numbers. Pattern + Waveform: For Symbol(PAM4): Displays "symbols" + "image of PAM4 signal of four values". For BIN(MSB/LSB): String of binary (0, 1) numbers and image of NRZ signal
[4]	Error	Displays the legend (color sample) for each of error symbols or error bits. Legends (color samples) and titles of PAM4 symbol errors are different, depending on whether the input signal decoder is on / off. When the input signal decoder is **OFF**, Raw Signal is displayed. When the input signal decoder is **ON**, Decoded Signal is displayed. ● For Symbol(PAM4): When the input signal decoder is **OFF** Lower Eye Error (0 ↔ 1): Red Middle Eye Error (1 ↔ 2): Yellow Upper Eye Error (2 ↔ 3): Blue Middle/Lower Eye Error (0 ↔ 2): Orange Upper/Middle Eye Error (1 ↔ 3): Green Upper/Middle/Lower Eye Error (0 ↔ 3): Purple When the input signal decoder is **ON** MSB Error: Red LSB Error: Yellow MSB+LSB Error: Orange ● For BIN(MSB/LSB): INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow ***Note:*** To show/hide each error in the Capture Data display area, select/clear its check box.

Table 4.5.3.1.5-4 Description of Capture Data Screen Items (FEC Symbol Capture in PAM4 Mode) (Cont'd)

No.	Item	Description
[5]	Move and Search	Searches the captured data for the string. Pattern: Searches any pattern of the string specified with symbols (0, 1, 2 and 3) by using «🔍 and 🔍». Jump: Moves the cursor to the specified address or pattern. Head: Moves the cursor to the head of the captured data pattern. Tail: Moves the cursor to the tail of the captured data pattern. Address: Moves the cursor to the specified address. Trigger Position: Moves the cursor to the address where the trigger was detected. Forward Next: Searches forward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Backward Next: Searches backward for a pattern that matches the pattern set in the Pattern box. If found, the cursor is placed at the position. Line: Sets how many characters to display per line, in the Capture Data display area. Target: Select the type of errors to search, from the following: For BIN(MSB/LSB): MSB, LSB, All
[6]	Codeword Head Position Jump	Searches the captured data for the beginning of codeword.

Table 4.5.3.1.5-4 Description of Capture Data Screen Items (FEC Symbol Capture in PAM4 Mode) (Cont'd)

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>[7]</td><td>Error Search</td><td>
Performs an error search, specifying the number and type of continuous errors.
Search Mode: Specify the search mode.
FEC Symbol: Searches for errors in units of FEC symbols.
Symbol: Searches for errors in units of PAM4 symbols.
Bit: Searches for errors in units of bits.
Continuous Error:
Specifies the number of continuous errors to search for.
<table>
<tr><th>Search Mode</th><th>Range</th></tr>
<tr><td>FEC Symbol</td><td>1 to 256 FEC symbols,
1 FEC symbol step</td></tr>
<tr><td>PAM4 Symbol</td><td>1 to 256 PAM4 symbols,
1 PAM4 symbol step</td></tr>
<tr><td>Bit</td><td>1 to 256 bits, 1 bit step</td></tr>
</table>
In the Search Condition box, select = (Exact match) or ≥ (Greater than or equal to).
Target: Select the type of errors to search, from the following:
The options vary depending on the setting for Notation in the Viewer Mode area.
• When the input signal decoder is OFF:
For Symbol(PAM4)*: Upper Eye, Middle Eye, Lower Eye, All
For BIN(MSB/LSB): MSB, LSB, All
• When the input signal decoder is ON:
For Symbol(PAM4) and BIN(MSB/LSB): MSB, LSB, All
</td></tr>
</table>

*: Not displayed when **FEC Symbol** is selected for Search Mode.

Table 4.5.3.1.5-4 Description of Capture Data Screen Items (FEC Symbol Capture in PAM4 Mode) (Cont'd)

No.	Item	Description
[8]	Capture Data display area	Displays the captured data (including error information) by symbols (0, 1, 2 and 3) or by bits (0, 1). The background color of each symbol or bit where an error occurred is different depending on the error type. When in the **Viewer Mode** area, **Pattern + Waveform** is selected in the **Format** list, a PAM4/NRZ pattern image is displayed.
[9]	Capture result display	Displays the error detection results of the entire captured data. First Error: Displays the block number and address of where the first error was detected. Last Error: Displays the block number and address of where the last error was detected. Total Error Counts: Displays the total number of errors and symbols counted in all blocks. Total FEC Symbol Error Counts: Displays the total number of FEC Symbol errors and symbols counted in all blocks. Capture Depth: Displays the number of symbols in the entire captured data.
[10]	File	Saves captured results and pattern to a file and loads the captured result file. Save: Saves the captured results and pattern to a file. The types of saved files are as follows: Symbol(PAM4) Capture File (*.fscap): Select when redisplaying the results in the Capture Data screen. Symbol(PAM4) Capture File (export) (*.txt): Select when saving a pattern file including error information. The saved file can be loaded by Pattern Editor of the MU196020A, MU196040A, and MU196040B. Open: Loads a result file to redisplay the captured results. The results are displayed by loading the captured data from the fscap file.
[11]	Codeword Position	Codeword Pos: Displays the position from the beginning of the codeword in the captured pattern.

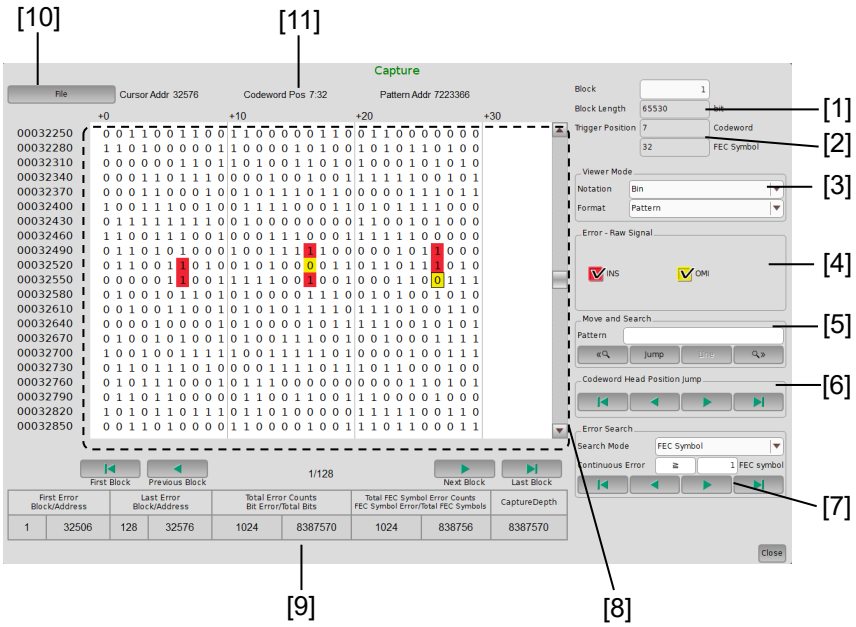


Figure 4.5.3.1.5-7 Capture Data Screen Items (FEC Symbol Capture in NRZ Mode)

Table 4.5.3.1.5-5 Description of Capture Data Screen Items (FEC Symbol Capture in NRZ Mode)

No.	Item	Description
[1]	Block Length	Displays the block length. Bits shorter than 1FEC Symbol length are discarded. Block Length = $\frac{\text{8M bits}}{\text{Number of Blocks}}$
[2]	Trigger Position	Displays the trigger detected position, in the range of 0 to block length.
[3]	Viewer Mode	Notation: Bin Format: Select the view mode of the Capture Data display area. Pattern: String of binary (0, 1) numbers Pattern + Waveform: String of binary (0, 1) numbers and image of NRZ signal
[4]	Error	Displays the legend (color sample) for each of error bits. INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow ***Note:*** To show/hide each error in the Capture Data display area, select/clear its check box.:

Table 4.5.3.1.5-5 Description of Capture Data Screen Items (FEC Symbol Capture in NRZ Mode) (Cont'd)

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>[5]</td><td>Move and Search</td><td>Searches the captured data for the string specified by binary (0, 1) numbers.
Pattern: Searches any pattern using «🔍 and 🔍».
Jump: Moves the cursor to the specified address or pattern.
Head: Moves the cursor to the head of the captured data pattern.
Tail: Moves the cursor to the tail of the captured data pattern.
Address: Moves the cursor to the specified address position.
Trigger Position: Moves the cursor to the address where the trigger was detected.
Forward Next: Searches forward for a pattern that matches the pattern set in the Pattern box. If found, the cursor is placed at the position.
Backward Next: Searches backward for a pattern that matches the pattern set in the Pattern box. If found, the cursor is placed at the position.
Line: Sets how many characters to display per line, in the Capture Data display area.</td></tr>
<tr><td>[6]</td><td>Codeword Head Position Jump</td><td>Searches the captured data for the beginning of codeword.</td></tr>
<tr><td>[7]</td><td>Error Search</td><td>Performs an error search, specifying the number and type of continuous errors.
Search Mode: Specify the search mode.
FEC Symbol: Searches for errors in units of FEC symbols.
Bit: Searches for errors in units of bits.
Continuous Error: Specifies the number of continuous errors to search for.
<table><tr><th>Search Mode</th><th>Range</th></tr><tr><td>FEC Symbol</td><td>1 to 256 FEC symbols, 1 FEC symbol step</td></tr><tr><td>Bit</td><td>1 to 256 bits, 1 bit step</td></tr></table>In the Search Condition box, select = (Exact match) or ≥ (Greater than or equal to).</td></tr>
</table>

Table 4.5.3.1.5-5 Description of Capture Data Screen Items (FEC Symbol Capture in NRZ Mode) (Cont'd)

No.	Item	Description
[8]	Capture Data display area	Displays the captured results (including error information) by binary (Bin) or hexadecimal (Hex) numbers. The background color of each bit where an error occurred is different depending on the error type. When displayed in binary format, select **Pattern + Waveform** in the **Notation** list of the **Viewer Mode** area, and you will view a pattern image.
[9]	Capture result display	Displays the error detection results of the entire captured data. First Error: Displays the block number and address of where the first error was detected. Last Error: Displays the block number and address of where the last error was detected. Total Error Counts: Displays the total number of errors and symbols counted in all blocks. Total FEC Symbol Error Counts: Displays the total number of FEC Symbol errors and symbols counted in all blocks. Capture Depth: Displays the number of symbols in the entire captured data.
[10]	File	Saves captured results and pattern to a file and loads the captured result file. Save: Saves the captured results and pattern to a file. The types of saved files are as follows: BIN(NRZ) Capture File, HEX(NRZ) Capture File (*.fncap): Select when redisplaying the results in the Capture Data screen. BIN(NRZ) Capture File (export), HEX(NRZ) Capture File (export) (*.txt): Select when saving a pattern file including error information. The saved file can be loaded by Pattern Editor of the MU195020A, MU195040A, MU196020A, MU196040A, and MU196040B. Open: Loads a result file to redisplay the captured results. The results are displayed by loading the captured data from the fncap file.
[11]	Codeword Position	Codeword Pos: Displays the position from the beginning of the codeword in the captured pattern.

- For PCIe6 FEC Symbol Capture mode (Available in PAM4 mode only)

When the data is captured, touch **Capture Data**, and you can display the Capture Data screen. The errors detected in the captured test pattern are displayed in different colors, which help you identify error types.

In PAM4 mode, the data is displayed by symbol values (0, 1, 2, 3) or by binary numbers.

Notes:

- The following explanation is based on the result display screen when Capture Mode is **PCIe6 FEC Symbol Capture**. The descriptions of the same functions as Sync Mode Capture mode are omitted.

- This mode is available when the following conditions are all met.
  - The MU196040B-w43 FEC Analysis for PCIe6 is installed.
  - The BERT for PCIe1-7 or BERT for PCIe1-6 Forced Link application is running in PAM4 mode.

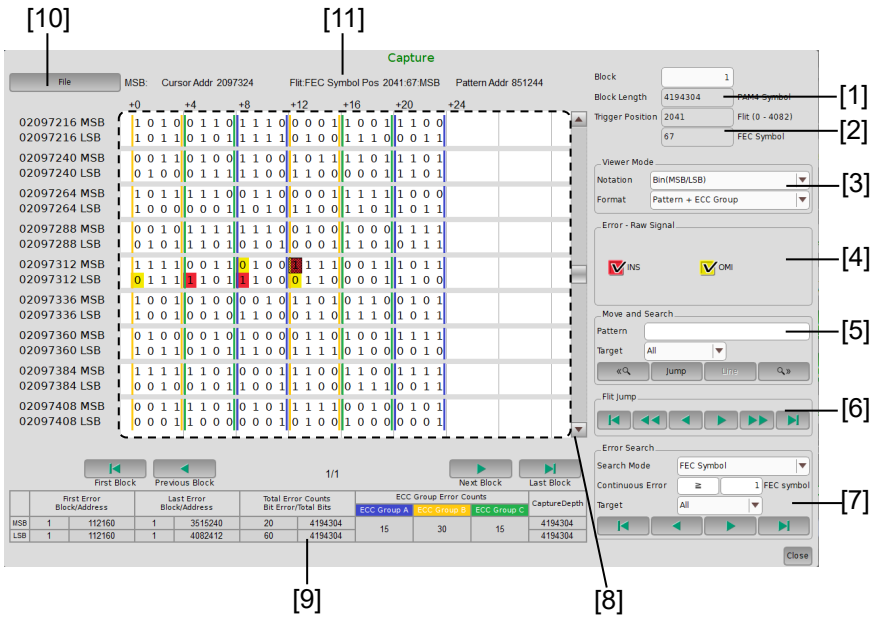


Figure 4.5.3.1.5-8 Capture Data Screen (PCIe6 FEC Symbol Capture)

Table 4.5.3.1.5-6 Description of PCIe6 FEC Symbol Capture Data Screen Items

No.	Item	Description
[1]	Block Length	Displays the block length. Bits shorter than 1FEC Symbol length are discarded. Block Length = $\frac{\text{4M symbols}}{\text{Number of Blocks}}$
[2]	Trigger Position	Displays the trigger detected position in units of Flit and FEC Symbols calculated in the range of 0 to block length. Also, the total number of Flits in the displayed Block.
[3]	Viewer Mode	Notation: Symbol(PAM4), BIN(MSB/LSB) Format: Select the view mode of the Capture Data display area. Pattern: Displays with symbols 0, 1, 2 and 3, or binary numbers (0, 1). Pattern + Waveform: For Symbol(PAM4): Displays "symbols" + "image of PAM4 signal of four values". For BIN(MSB/LSB): String of binary (0, 1) numbers and image of NRZ signal Pattern + ECC Group: For Symbol(PAM4): Symbol display and three ECC Group image display For BIN(MSB/LSB): String of binary (0, 1) numbers, and three ECC Group image

Table 4.5.3.1.5-6 Description of PCIe6 FEC Symbol Capture Data Screen Items (Cont'd)

No.	Item	Description
[4]	Error	Displays the legend (color sample) for each of error symbols or error bits. Legends (color samples) and titles of PAM4 symbol errors are different, depending on whether the input signal decoder is on / off. When the input signal decoder is OFF, Raw Signal is displayed. When the input signal decoder is ON, Decoded Signal is displayed. ● For Symbol(PAM4): When the input signal decoder is OFF Lower Eye Error (0 ↔ 1): Red Middle Eye Error (1 ↔ 2): Yellow Upper Eye Error (2 ↔ 3): Blue Middle/Lower Eye Error (0 ↔ 2): Orange Upper/Middle Eye Error (1 ↔ 3): Green Upper/Middle/Lower Eye Error (0 ↔ 3): Purple When the input signal decoder is ON MSB Error: Red LSB Error: Yellow MSB+LSB Error: Orange ● For BIN(MSB/LSB): INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow ***Note:*** To show/hide each error in the Capture Data display area, select/clear its check box.

Table 4.5.3.1.5-6 Description of PCIe6 FEC Symbol Capture Data Screen Items (Cont'd)

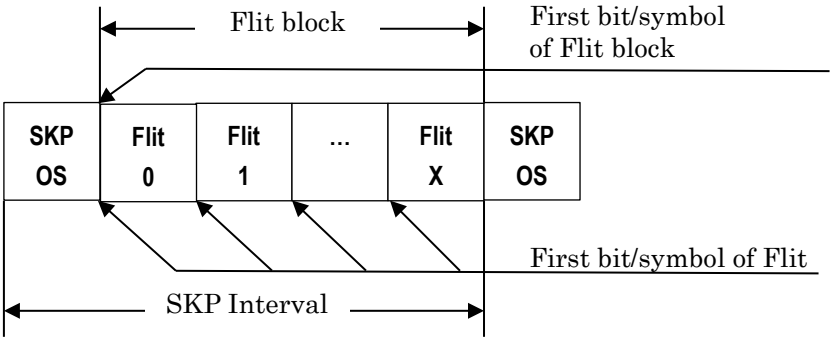
No.	Item	Description
[5]	Move and Search	Searches the captured data for the string. Pattern: Searches any pattern using «🔍 and 🔍». Searches for a string specified with symbols (0, 1, 2 and 3). Jump: Moves the cursor to the specified address or pattern. Head: Moves the cursor to the head of the captured data pattern. Tail: Moves the cursor to the tail of the captured data pattern. Address: Moves the cursor to the specified address. Trigger Position: Moves the cursor to the address where the trigger was detected. Forward Next: Searches forward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Backward Next: Searches backward for a pattern that matches the pattern set in the **Pattern** box. If found, the cursor is placed at the position. Line: Sets the number of characters per line to display in the Capture Data display area. Target: Select the type of errors to search, from the following: MSB, LSB, All
[6]	Flit Jump	Jumps to the first bit/symbol of a Flit, or that of a Flit block separated by SKP OS inserted at SKP Interval, in the captured data.  |<: Jumps to the first bit/symbol of the first Flit. <<: Jumps to the first bit/symbol of the previous Flit block. <: Jumps to the first bit/symbol of the previous Flit. >: Jumps to the first bit/symbol of the next Flit. >>: Jumps to the first bit/symbol of the next Flit block. >|: Jumps to the first bit/symbol of the last Flit.

Table 4.5.3.1.5-6 Description of PCIe6 FEC Symbol Capture Data Screen Items (Cont'd)

<table>
<tr><th>No.</th><th>Item</th><th>Description</th></tr>
<tr><td>[7]</td><td>Error Search</td><td>
Performs an error search, specifying the number and type of continuous errors.
Search Mode: Specify the search mode.
1b/1b Encoding: Searches for errors in units of 1b/1b Encoding Symbols.
FEC Symbol: Searches for errors in units of FEC symbols.
Symbol: Searches for errors in units of PAM4 symbols.
Bit: Searches for errors in units of bits.
Continuous Error:
Specifies the number of continuous errors to search for.
<table>
<tr><th>Search Mode</th><th>Range</th></tr>
<tr><td>1b/1b Encoding</td><td>1 to 256 1b/1b Encoding symbols,
1 1b/1b Encoding symbol step</td></tr>
<tr><td>FEC Symbol</td><td>1 to 256 FEC symbols,
1 FEC symbol step</td></tr>
<tr><td>PAM4 Symbol</td><td>1 to 256 PAM4 symbols,
1 PAM4 symbol step</td></tr>
<tr><td>Bit</td><td>1 to 256 bits, 1-bit step</td></tr>
</table>
In the Search Condition box, select = (Exact match) or ≥ (Greater than or equal to).
Target: Select the type of errors to search, from the following:
● When Search Mode is FEC Symbol or 1b/1b Encoding:
All
● When Search Mode is Bit:
MSB, LSB, All
● When Search Mode is PAM4 Symbol
When the input signal decoder is OFF
Upper Eye, Middle Eye, Lower Eye, All
When the input signal decoder is ON
MSB, LSB, All
</td></tr>
</table>

Table 4.5.3.1.5-6 Description of PCIe6 FEC Symbol Capture Data Screen Items (Cont'd)

No.	Item	Description
[8]	Capture Data display area	Displays the captured data (including error information) by symbols (0, 1, 2 and 3) or bits (0, 1). The background color of each symbol or bit where an error occurred is different depending on the error type. • When in the **Viewer Mode** area, **Pattern + Waveform** is selected in the **Format** list, a PAM4/NRZ pattern image is displayed. • When **Pattern + ECC Group** is selected in the **Format** box of the **Viewer Mode** area, an image color-coded by ECC Group is displayed in units of FEC Symbols. ECC Groups are color-coded as follows: ECC Group A: Blue ECC Group B: Yellow ECC Group C: Green
[9]	Capture result display	Displays the error detection results of the entire captured data. First Error: Displays the block and address of the position where the first error was detected. Last Error: Displays the block and address of the position where the last error was detected. Total Error Counts: Displays the total number of errors and symbols counted in all blocks. ECC Group Error Counts: Displays the total number of FEC Symbol errors counted in all blocks by ECC Group. Capture Depth: Displays the number of symbols in the entire captured data.
[10]	File	Saves captured results and pattern to a file and loads the captured result file. Save: Saves the captured results and pattern to a file. The types of saved files are as follows: Symbol(PAM4) Capture File (*.pcie6cap): Select when redisplaying the results in the Capture Data screen. Symbol(PAM4) Capture File (export) (*.txt): Select when saving a pattern file including error information. The saved file can be loaded by Pattern Editor of the MU196020A, MU196040A, and MU196040B. Open: Loads a result file to redisplay the captured results. The results are displayed by loading the captured data from the pcie6cap file.
[11]	Flit Position	Flit: FEC Symbol Pos: Displays the position of the captured pattern in units of Flits and FEC Symbols, considering the first Flit of each block to be Flit 0.

Error Mapping Screen

The Error Mapping screen is displayed when capturing the data with **Capture Mode** set to **Sync Mode Capture**.

When the data is captured, touch **Error Mapping**, and you can display the Error Mapping screen. The overall view of the captured block is displayed so that the user can easily understand the error distribution in the captured test pattern.
In PAM4 mode, symbol errors are displayed, and in NRZ mode, bit errors.

Note:

This function is available when **Capture Mode** is set to **Sync Mode Capture**. It is not available when set to **Raw Data Capture**, **FEC Symbol Capture** or **PCIe6 FEC Symbol Capture**.

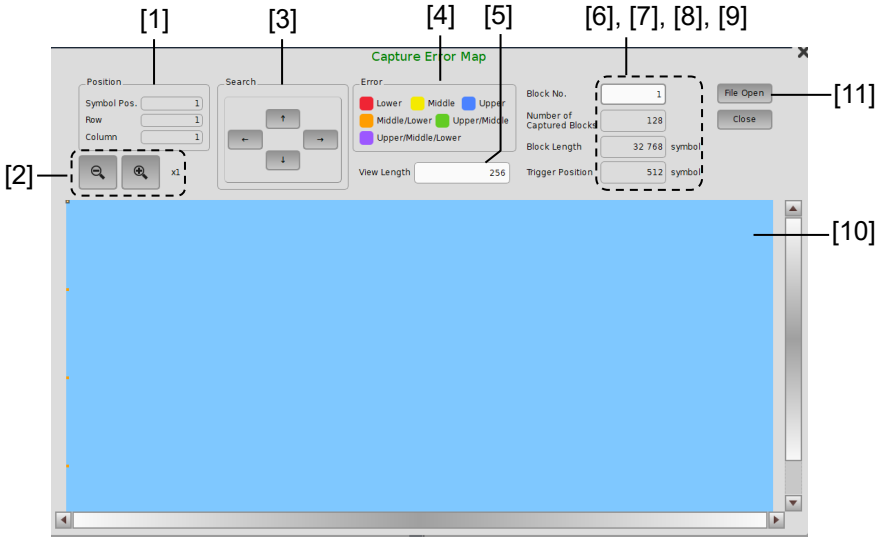


Figure 4.5.3.1.5-9 Error Mapping Screen (PAM4 Mode)

Table 4.5.3.1.5-7 Description of Error Mapping Screen Items (PAM4 Mode)

No.	Item	Description
[1]	Position	Displays the cursor position information. Symbol Pos.: Displays the cursor position from the head of the block by the number of symbols. Row: Displays the vertical position of the cursor in the Error Mapping display area by the row count. Column: Displays the horizontal position of the cursor in the Error Mapping display area by the column count.
[2]	Zoom in/out	Zooms in and out the result display screen. Zoom in ( ): 2x, 4x, 8x magnification Zoom out ( ): 1/2, 1/4, 1/8 ***Note:*** In 1x view, each dot represents 1 symbol. In 1/2 view, each dot represents 2 symbols.
[3]	Search	Searches the position of an error from the cursor position. Up button ( ): Searches up for the error nearest from the current position. Down button ( ): Searches down for the error nearest from the current position. Right button ( ): Searches right for the error nearest from the current position. Left button ( ): Searches left for the error nearest from the current position.
[4]	Error	Displays the legend (color sample) for each of error symbols. Symbols with no errors are displayed in light blue. When the input signal decoder is **OFF** Lower Eye Error (0 ↔ 1): Red Middle Eye Error (1 ↔ 2): Yellow Upper Eye Error (2 ↔ 3): Blue Middle/Lower Eye Error (0 ↔ 2): Orange Upper/Middle Eye Error (1 ↔ 3): Green Upper/Middle/Lower Eye Error (0 ↔ 3): Purple When the input signal decoder is **ON** MSB Error: Red LSB Error: Yellow MSB+LSB Error: Orange ***Note:*** When the Error Mapping display area is displayed with zoomed out, each dot containing two or more types of errors is displayed in gray.

Table 4.5.3.1.5-7 Description of Error Mapping Screen Items (PAM4 Mode) (Cont'd)

No.	Item	Description
[5]	View Length	Sets where to wrap (view length) in the Error Mapping display area. 256 symbols to Block Length, 8 symbols step
[6]	Block No.	Sets the block number to display. The maximum value is the value in the **Number of Blocks** list in Figure 4.5.3.1.5-1.
[7]	Number of Captured Blocks	Displays the number of captured blocks.
[8]	Block Length	Displays the block length. Block Length = $\frac{4M}{\text{Number of Blocks}}$
[9]	Trigger Position	Displays the trigger detected position, in the range of 0 (head of block) to block length.
[10]	Error Mapping display area	Displays the error detected positions in each block by color.
[11]	File Open	Loads a result file saved in the Capture Data screen to map the error results. The results are displayed by loading the captured data (Symbol(PAM4) Text) from the scap file. ***Note:*** If **Capture Mode** is **Sync Mode Capture**, the error information cannot be displayed correctly when you open the file of the pattern captured in **Raw Data Capture** mode.

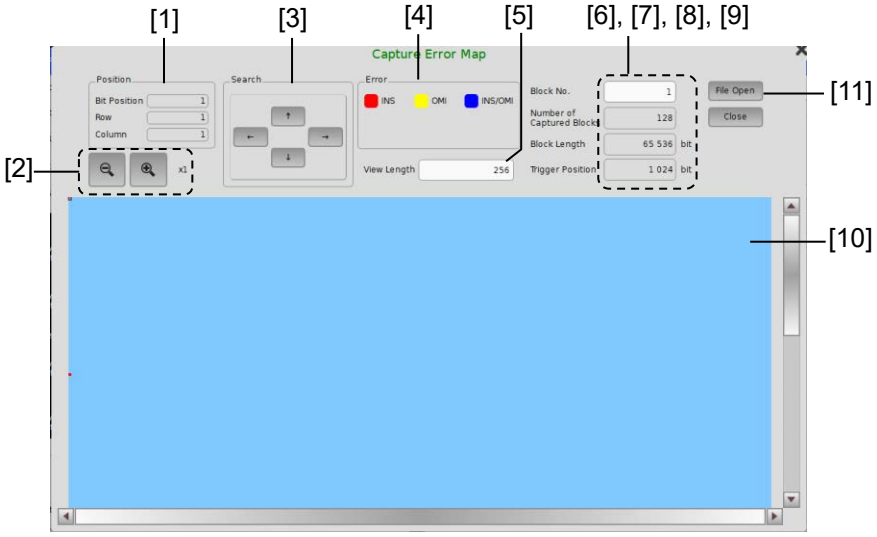


Figure 4.5.3.1.5-10 Error Mapping Screen (NRZ Mode)

Table 4.5.3.1.5-8 Description of Error Mapping Screen Items (NRZ Mode)

No.	Item	Description
[1]	Position	Displays the cursor position. Bit Position: Displays the cursor position from the head of the block by the number of bits. Row: Displays the vertical position of the cursor in the Error Mapping display area by the row count. Column: Displays the horizontal position of the cursor in the Error Mapping display area by the column count.
[2]	Zoom in/out	Zooms in and out the result display screen. Zoom in (🔍): 2x, 4x, 8x magnification Zoom out (🔍): 1/2, 1/4, 1/8 ***Note:*** In 1x view, each dot represents 1 bit. In 1/2 view, each dot represents 2 bits.
[3]	Search	Searches the position of an error from the cursor position. Up button (↑): Searches up for the error nearest from the current position. Down button (↓): Searches down for the error nearest from the current position. Right button (→): Searches right for the error nearest from the current position. Left button (←): Searches left for the error nearest from the current position.

Table 4.5.3.1.5-8 Description of Error Mapping Screen Items (NRZ Mode) (Cont'd)

No.	Item	Description
[4]	Error	Displays the legend (color sample) for each of error bits. Bits with no errors are displayed in light blue. INS: Insertion Error (0 → 1) Red OMI: Omission Error (1 → 0) Yellow INS/OMI: Insertion and Omission Error Blue ***Note:*** When the Error Mapping display area is displayed with zoomed out, each dot containing both INS and OMI errors is displayed in blue.
[5]	View Length	Sets where to wrap (view length) in the Error Mapping display area. 256 bits to Block Length, 8 bits step
[6]	Block No.	Sets the block number to display. The maximum value is the value in the **Number of Blocks** list in Figure 4.5.3.1.5-1.
[7]	Number of Captured Blocks	Displays the number of captured blocks.
[8]	Block Length	Displays the block length. Block Length = $\frac{8M}{\text{Number of Blocks}}$
[9]	Trigger Position	Displays the trigger detected position, in the range of 0 (head of block) to block length.
[10]	Error Mapping display area	Displays the error detected positions in each block by color.
[11]	File Open	Loads a result file saved in the Capture Data screen to map the error results. The results are displayed by loading the captured data (BIN Text, HEX Text) from the ncap file. ***Note:*** If **Capture Mode** is **Sync Mode Capture**, the error information cannot be displayed correctly when you open the file of the pattern captured in **Raw Data Capture** mode.

4.5.3.1.6 Logging tab

On the **Logging** tab, error and alarm information can be logged. Specified bit and symbol errors are logged at the time intervals specified in **Cycle**.

Table 4.5.3.1.6-1 Setting Items on the Logging Tab

Item	Description
Logging	OFF, ON: Starts logging when set to **ON**. Clear: Clears the logged results displayed in the **Log** area. Save: Saves the logged results to a file.
Cycle	Sets the log display cycle in the range of 5 seconds to 1 hour.
Measurement items	Turn on and off logging of the measurement items. You can check the remaining logging time calculated from the number of selected measurement items and the cycle.
Log display	Displays the occurrence time and result of each of selected measurement items. Up to 100 000 logs can be displayed.

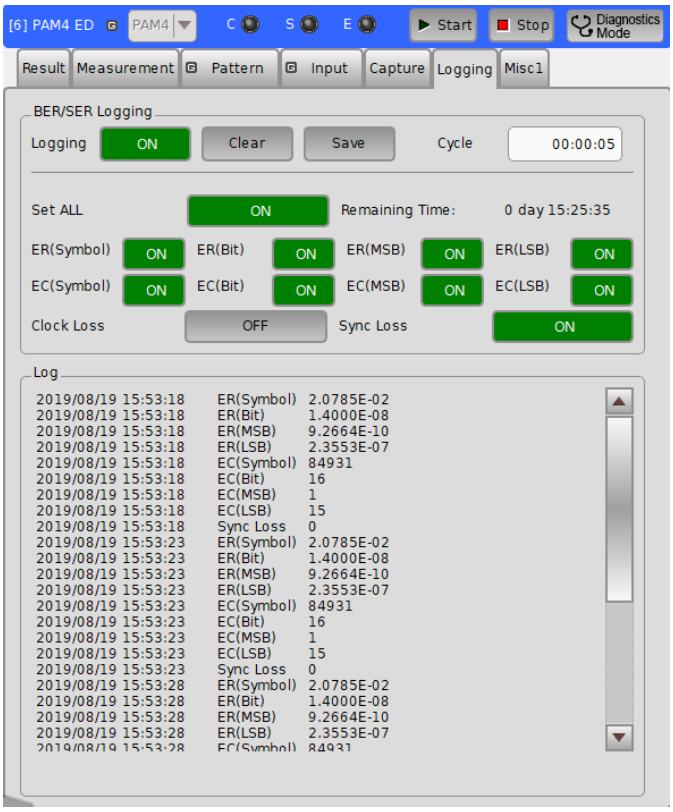


Figure 4.5.3.1.6-1 MU196040B Logging Tab (PAM4 Mode)

4.5.3.1.7 Misc1 tab

On the **Misc1** tab, you can configure the settings for pattern sequence and auxiliary input and output. Each area on the screen and its configuration items are shown in Table 4.5.3.1.7-1.

Table 4.5.3.1.7-1 Misc1 Tab Setting Items

Item	Description
Pattern Sequence	Set the test pattern receiving method.
AUX Input	Configure the settings for the auxiliary input function.
AUX Output	Configure the settings for the auxiliary output function.
Confidence Level	Set Bitrate for calculation.

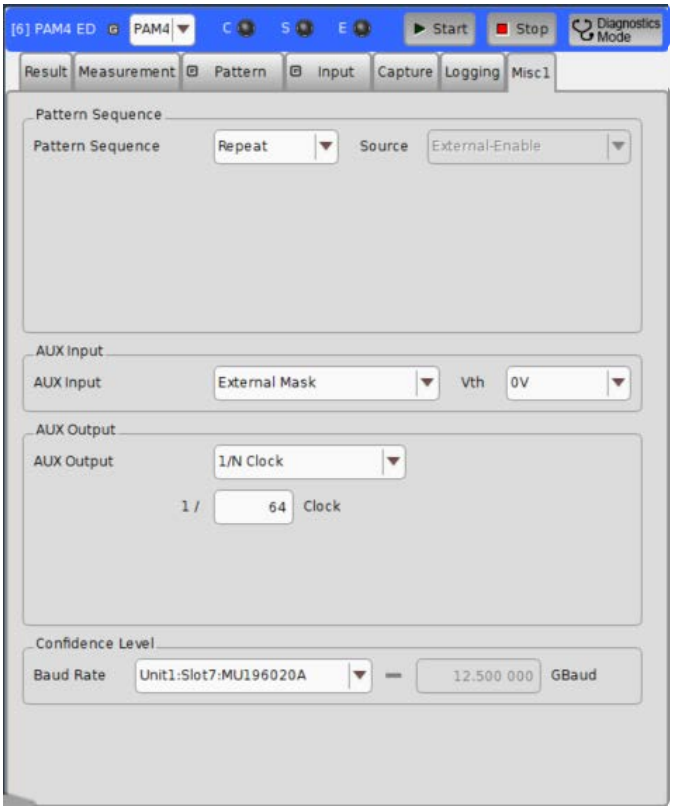


Figure 4.5.3.1.7-1 MU196040B Misc1 Tab (PAM4 Mode)

4.6 Noise Generator

4.6.1 MU195050A

The MU195050A Noise Generator (hereafter, MU195050A) is a plug-in module that can be built into MP1900A. MU195050A is able to generate white noise or the sinusoidal noise of Common Mode and Differential Mode. By switching MU195050A External Input connector, MU195050A adds generated noise to the input data and outputs it.

Control window for MU195050A is shown in Figure 4.6.1-1. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

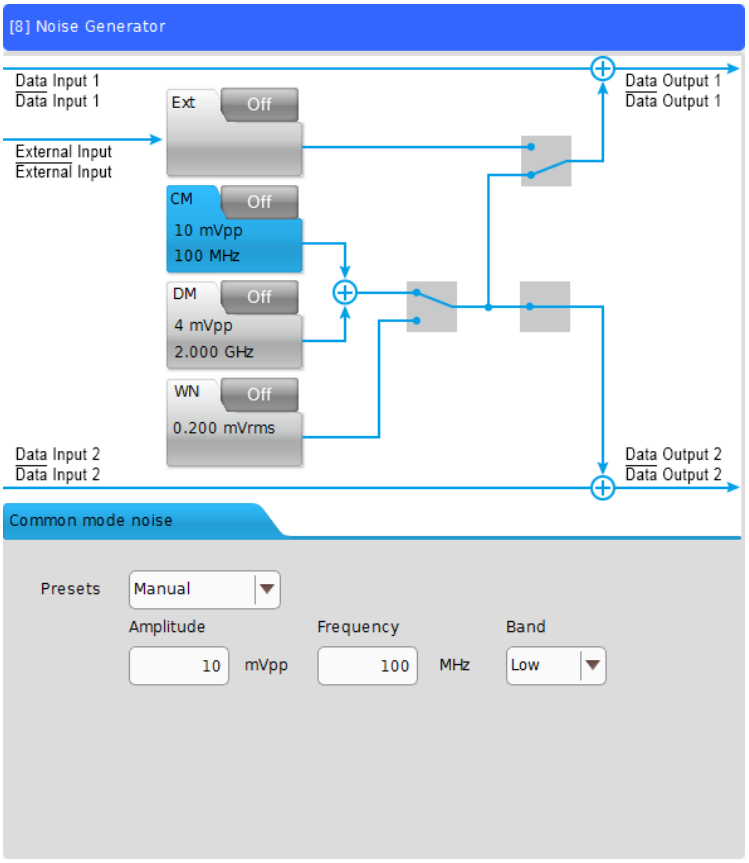


Figure 4.6.1-1 MU195050A Control Window

4.6.1.1 Operation window

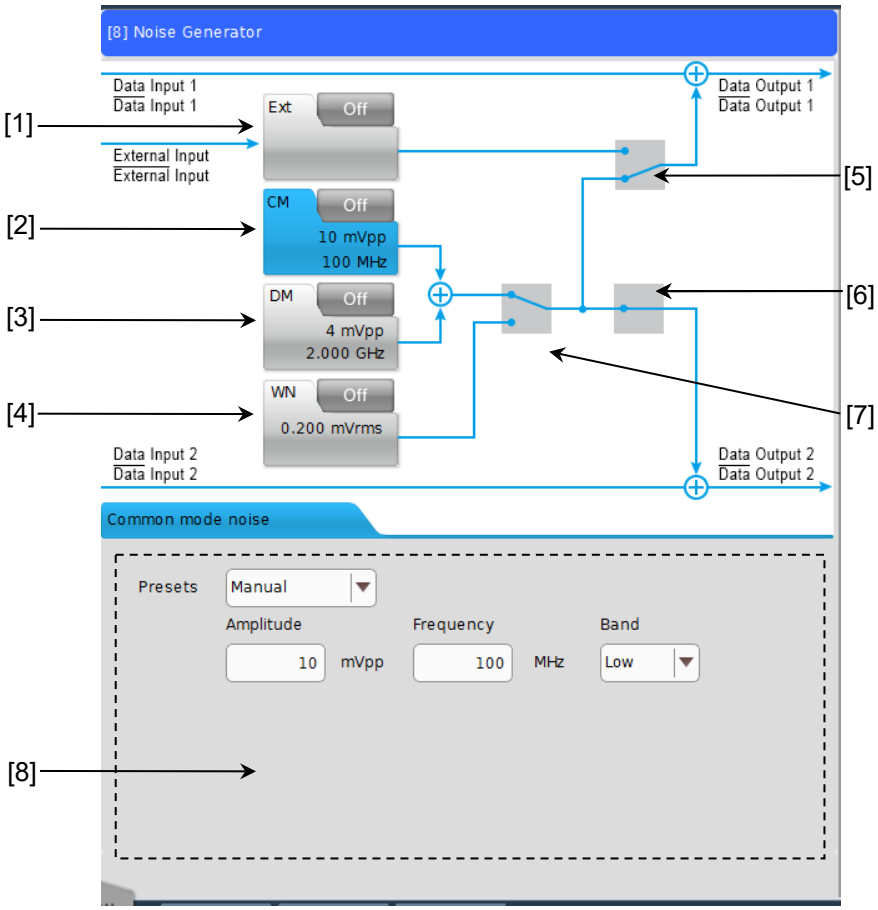


Figure 4.6.1.1-1 MU195050A Operation Window

Table 4.6.1.1-1 Items on MU195050A Operation Window

No.	Item	Function	
[1]	Ext button	Turns On or Off External Input.	
[2]	CM button	Turns On or Off Common mode noise and displays the setting items in [8].	
		Presets	Select a value from the preset standard list of Common mode noise or select **Manual** and enter a numerical value. Manual: Allows numerical values for amplitude and frequency. TBT3: Amplitude 100 mV, Frequency 400 MHz PCIe4: Amplitude 150 mV, Frequency 120 MHz PCIe5: Amplitude 150 mV, Frequency 120 MHz PCIe6: Amplitude 76 mV, Frequency 120 MHz
		Amplitude	Available when Presets is set to **Manual**. Setting range: 0 to 250 mV, 2 mV step
		Frequency	Available when Presets is set to **Manual**. Setting range: 100 to 1000 MHz, 1 MHz step @Low Band 1 to 6 GHz, 10 MHz step @High Band
[3]	DM button	Turns On or Off Differential mode noise and displays the setting items in [8].	
		Presets	Select a value from the preset standard list of Differential mode noise or select **Manual** and enter a numerical value. Manual: Allows numerical values for amplitude and frequency. PCIe3: Amplitude 16 mV, Frequency 2.1 GHz PCIe4: Amplitude 16 mV, Frequency 2.1 GHz PCIe5: Amplitude 10 mV, Frequency 2.1 GHz PCIe6: Amplitude 15 mV, Frequency 2.1 GHz
		Amplitude	Available when Presets is set to **Manual**. Setting range: 0 to 200 mV, 0.1 mV step
		Frequency	Available when Presets is set to **Manual**. Setting range: 2 to 10 GHz, 10 MHz step
[4]	WN button*	Turns On or Off White noise and displays the setting items in [8].	
		Amplitude	Setting range: 0.2 to 25 mVrms, 0.2 mVrms step
[5] [6]	Noise Selector per CH	Controls noise selection to add to Data1 and Data2. They are linked in operation.	
[7]	Noise Selector	Selects CM/DM or WN for noise type to add to Data1 and Data2.	
[8]	Advanced Setting Area	Advanced setting is allowed by selecting a desired item from [1] to [4].	

*: When the MU195050A-x01 is installed.

4.6.2 MU196050B

The MU196050B Noise Generator (hereafter, MU196050B) is a plug-in module that can be built into MP1900A. MU196050B is able to generate the sinusoidal noise of Common Mode and Differential Mode. By switching MU195050A External Input connector, MU196050B adds generated noise to the input data and outputs it.

Control window for MU196050B is shown in Figure 4.6.1-1. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

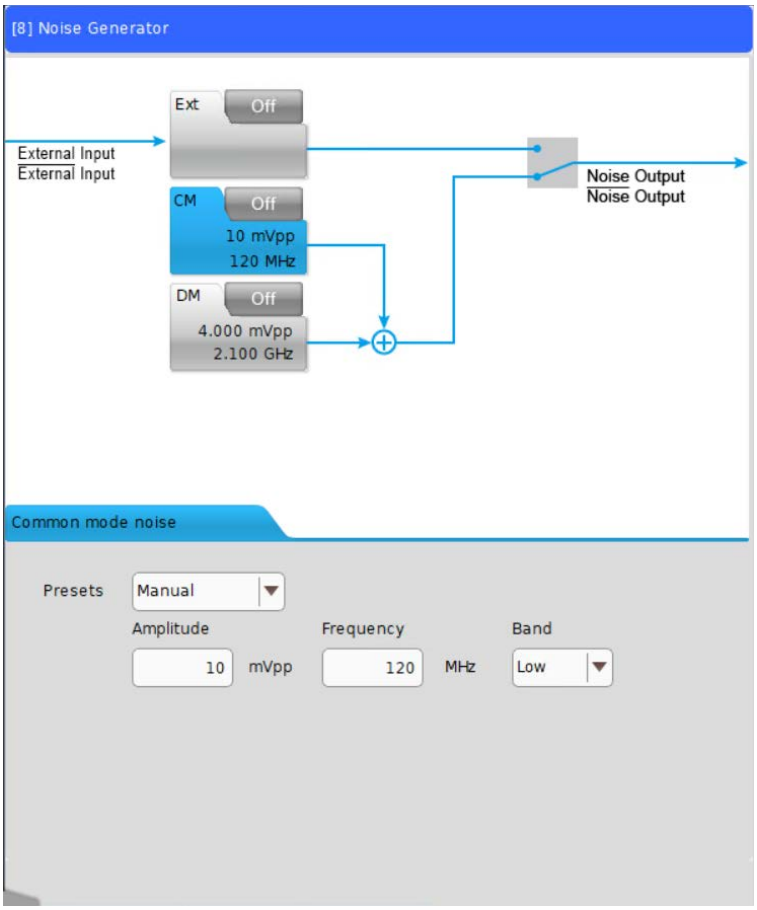


Figure 4.6.2-1 MU196050B Control Window

4.6.2.1 Operation window

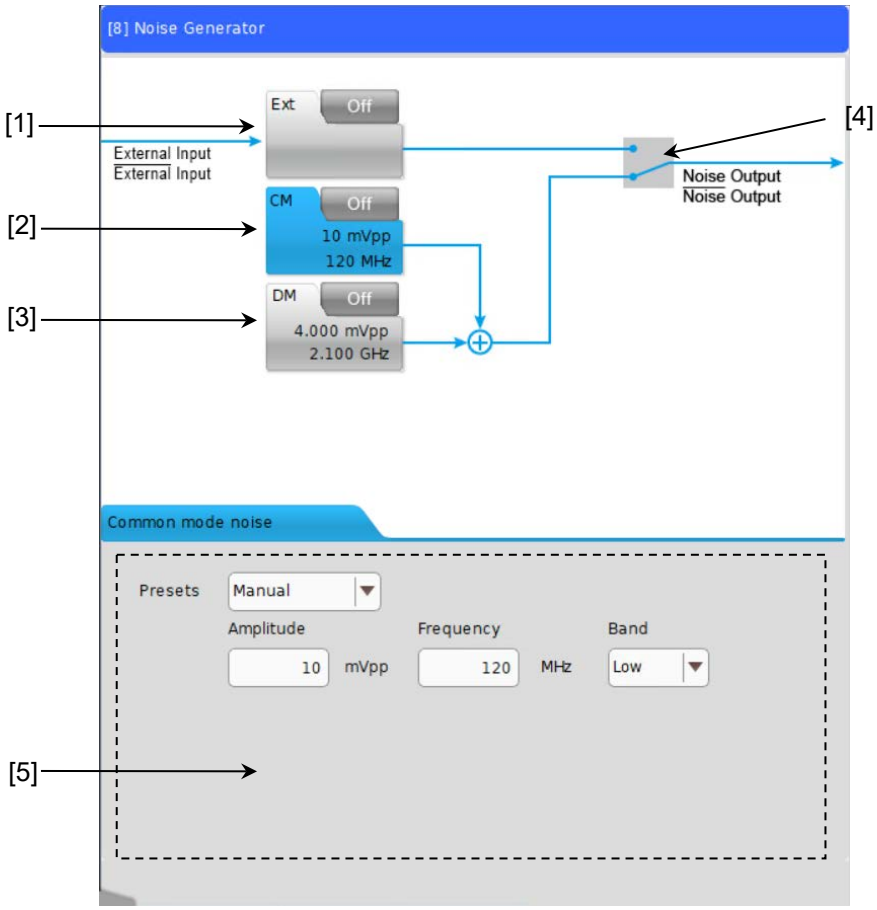


Figure 4.6.2.1-1 MU196050B Operation Window

Table 4.6.2.1-1 Items on MU196050B Operation Window

No.	Item	Function	
[1]	Ext button	Turns On or Off External Input.	
[2]	CM button	Turns On or Off Common mode noise and displays the setting items in [5].	
		Presets	Select a value from the preset standard list of Common mode noise or select **Manual** and enter a numerical value. Manual: Allows numerical values for amplitude and frequency. TBT3: Amplitude 100 mV, Frequency 400 MHz PCIe4: Amplitude 150 mV, Frequency 120 MHz PCIe5: Amplitude 150 mV, Frequency 120 MHz PCIe6: Amplitude 76 mV, Frequency 120 MHz PCIe7: Amplitude 76 mV, Frequency 120 MHz
		Amplitude	Available when Presets is set to **Manual**. Setting range: 0 to 250 mV, 2 mV step
		Frequency	Available when Presets is set to **Manual**. Setting range: 100to 1000 MHz, 1 MHz step @Low Band 1 to 6 GHz, 10 MHz step @High Band
[3]	DM button	Turns On or Off Differential mode noise and displays the setting items in [5].	
		Presets	Select a value from the preset standard list of Differential mode noise or select **Manual** and enter a numerical value. Manual: Allows numerical values for amplitude and frequency. PCIe3: Amplitude 14 mV, Frequency 2.1 GHz PCIe4: Amplitude 14 mV, Frequency 2.1 GHz PCIe5: Amplitude 20 mV, Frequency 2.1 GHz PCIe6: Amplitude 15 mV, Frequency 2.1 GHz PCIe7: Amplitude 7.5 mV, Frequency 2.1 GHz
		Amplitude	Available when Presets is set to **Manual**. Setting range: 0 to 200 mV, 0.1 mV step
		Frequency	Available when Presets is set to **Manual**. Setting range: 2 to 10 GHz, 10 MHz step
[4]	Noise Selector per CH	Controls the selection of the noise to be applied.	
[5]	Advanced Setting Area	Advanced setting is allowed by selecting a desired item from [1] to [3].	

4.7 Re-Driver

4.7.1 MU196060A

The MU196060A 32G baud NRZ/PAM4 Re-Driver (hereafter, MU196060A) is a plug-in module that can be built into MP1900A. Being intended to enhance the equalizer performance of ED, the MU196060A enables PCIe Gen5 and Gen6-compliant measurement, when combined with PAM4 PPG and PAM4 ED or SI ED.

Control window for MU196060A is shown in Figure 4.7.1-1. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

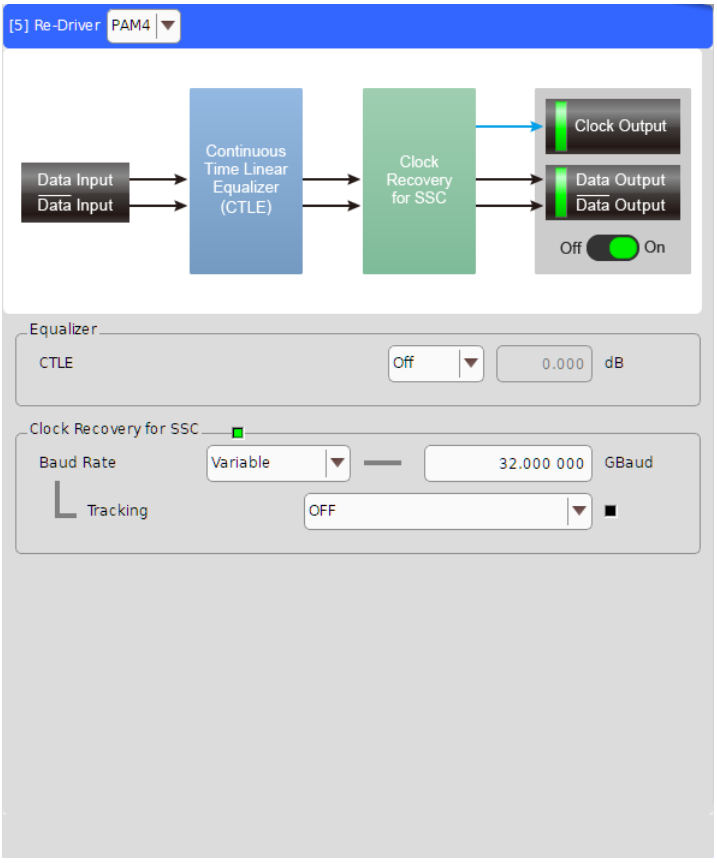


Figure 4.7.1-1 MU196060A Control Window

4.8 Auto Measurement

The Auto Measurement provides various measurement functions that use PPG and ED. Unless otherwise specified, MU195020A and MU195040A are used for explanation of screens.
To display the AUTO MEAS Screen, refer to 3.1.2 “Display Switching Screens”.

4.8.1 Eye Contour measurement

The Eye Contour measurement is a function that plots bit-error-rate contours. Contours of bit error rates (1E–6 to 1E–20) are plotted by using measurement results for a number of bit error rates and estimating contours of the other bit error rates.

Notes:

Eye Contour measurement cannot be performed for the following cases.

- When the module being used is MU196040A
- When MU196040B-z41 is not installed in the module being used
- When **Burst** is selected for **Pattern Sequence** on the **Misc1** tab (4.4.1.1.6 “Misc1 tab”)
- When **Auto Adjust** is set to **ON**
- When **OFF** is selected for **Auto Sync** on the **Result** tab (4.5.1.1.1 “Result tab”)
- When the **Input** tab (4.5.1.1.4 “Input tab”) is grouped together with the other tab
- When **CDR** is selected for **Clock Input** on the **Input** tab (4.5.1.1.4 “Input tab”)
- When **HSSB Data** is selected for Test Pattern on the **Pattern** tab of the MU195040A and MU196040B.

Touching 

on Application toolbar displays Eye Contour screen.

Eye Contour screen is shown below. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

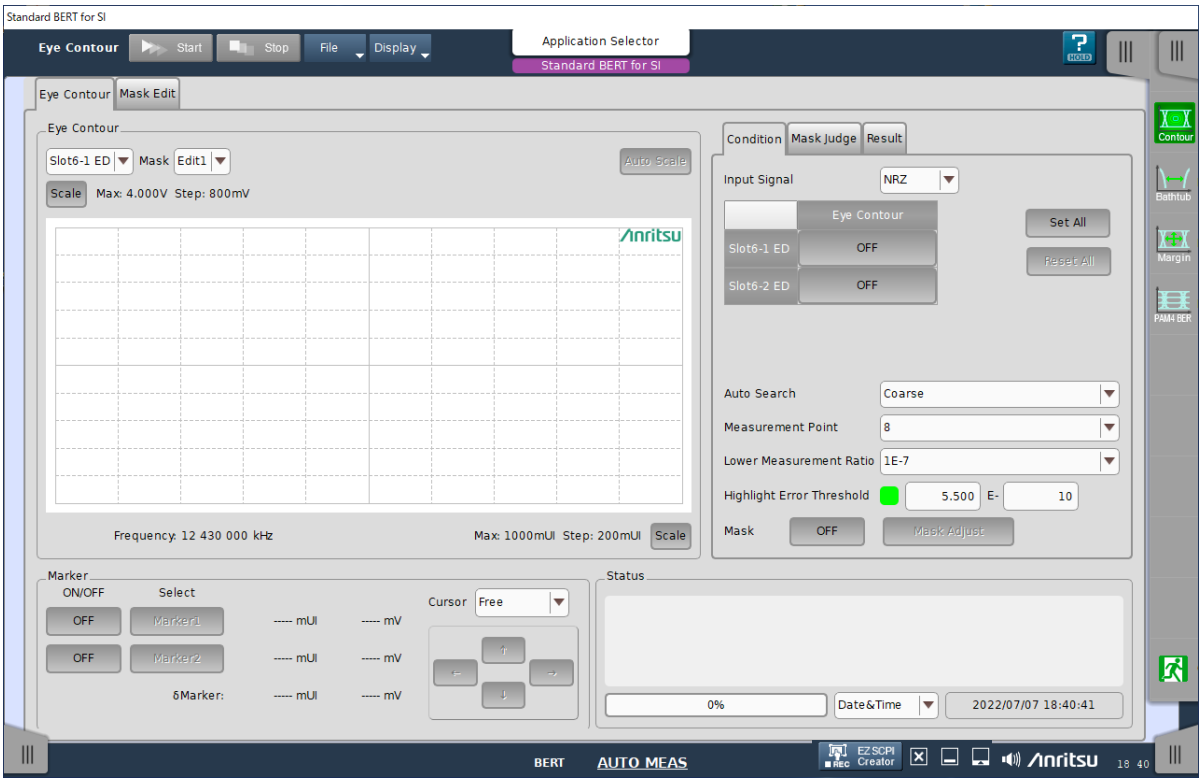


Figure 4.8.1-1 Eye Contour Tab

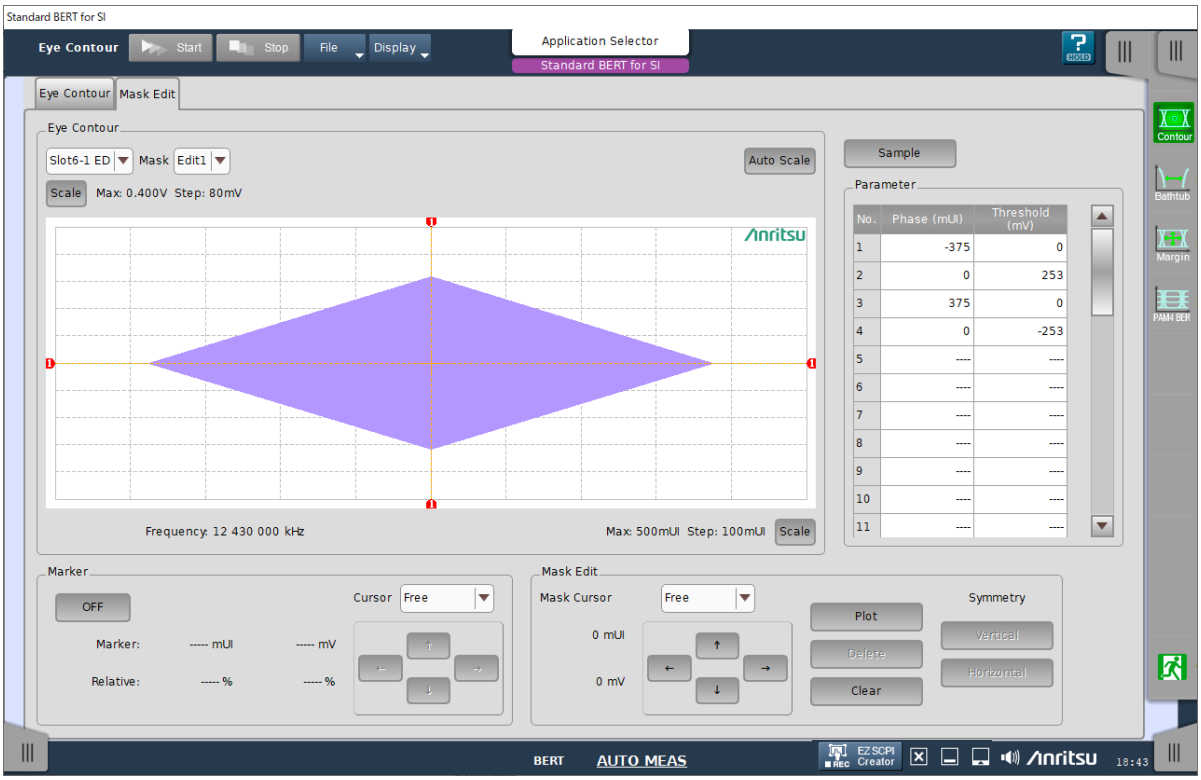


Figure 4.8.1-2 Mask Edit Tab

4.8.2 Bathtub measurement

The Bathtub function has the following features.

- Provides rich graph displaying modes.
- Calculates TJ, DJ, RJ, as well as optimum phase and optimum bit error rate.
- Calculates J2 and J9.

The followings are notes of caution for Bathtub measurement.

Notes:

- Bathtub measurement cannot be performed for the following cases.
  - When the module being used is MU196040A
  - When MU196040B-z41 is not installed in the module being used
  - When **Burst** is selected for **Pattern Sequence on** the **Misc1** tab (4.4.1.1.6 “Misc1 tab”)
  - When **Auto Adjust** is set to **ON**
  - When **OFF** is selected for **Auto Sync** on the **Result** tab (4.5.1.1.1 “Result tab”)
  - When the **Input** tab (4.5.1.1.4 “Input tab”) is grouped together with the other tab
  - When **CDR** is selected for **Clock Input** on the **Input** tab (4.5.1.1.4 “Input tab”)
  - When **HSSB Data** is selected for Test Pattern on the **Pattern** tab of the MU195040A and MU196040B.
- For accuracy, start Bathtub measurement after the operations below.
  - Execute **Output** tab / **Delay** / **Calibration** of PPG.
  - Turn off **Output** tab / **Delay** / **Jitter Input** of PPG.

Touching 

on Application toolbar displays Bathtub screen.

Bathtub screen is shown below. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch 

, and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

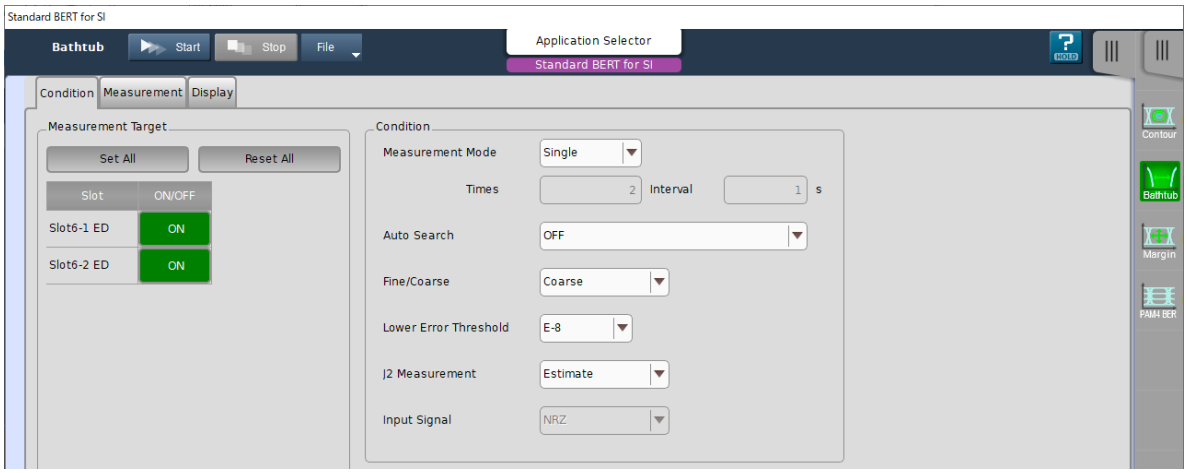


Figure 4.8.2-1 Condition Tab

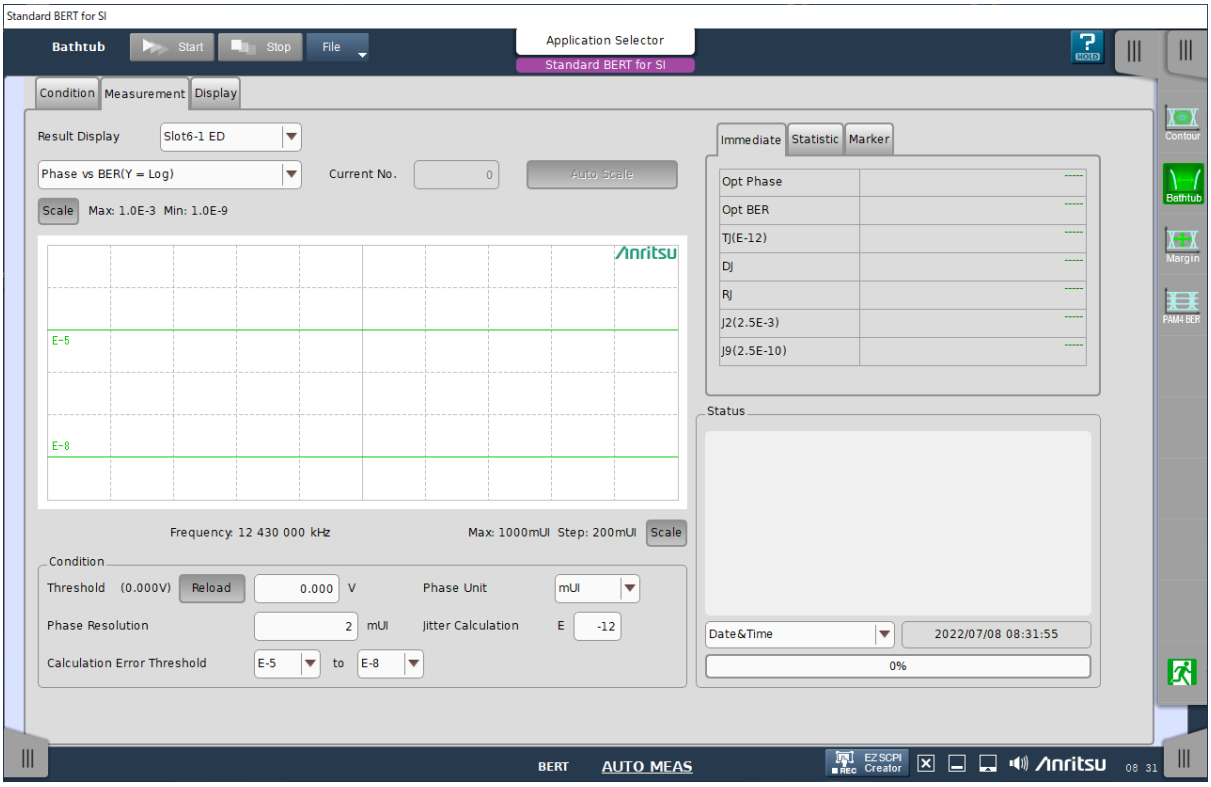


Figure 4.8.2-2 Measurement Tab

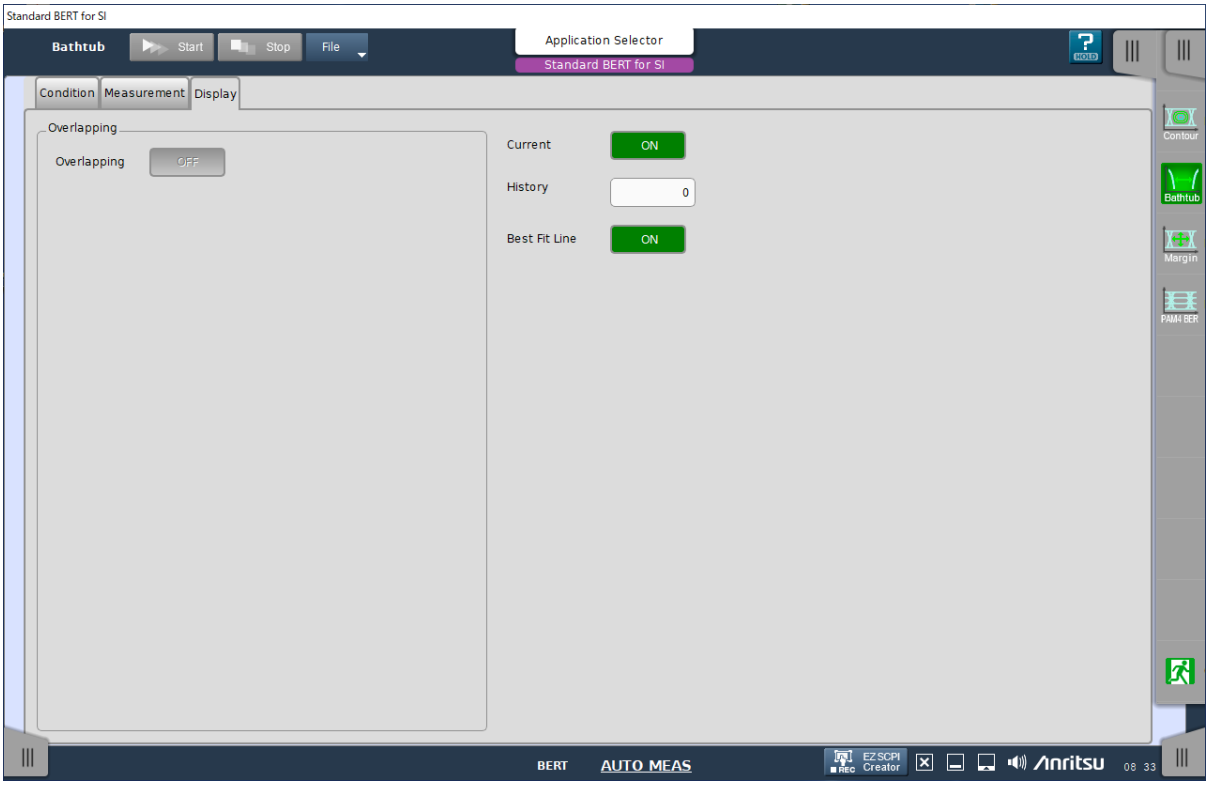


Figure 4.8.2-3 Display Tab

4.8.3 Eye Margin measurement

Eye Margin measurement measures a phase margin and threshold voltage margin in an eye pattern from the current position.

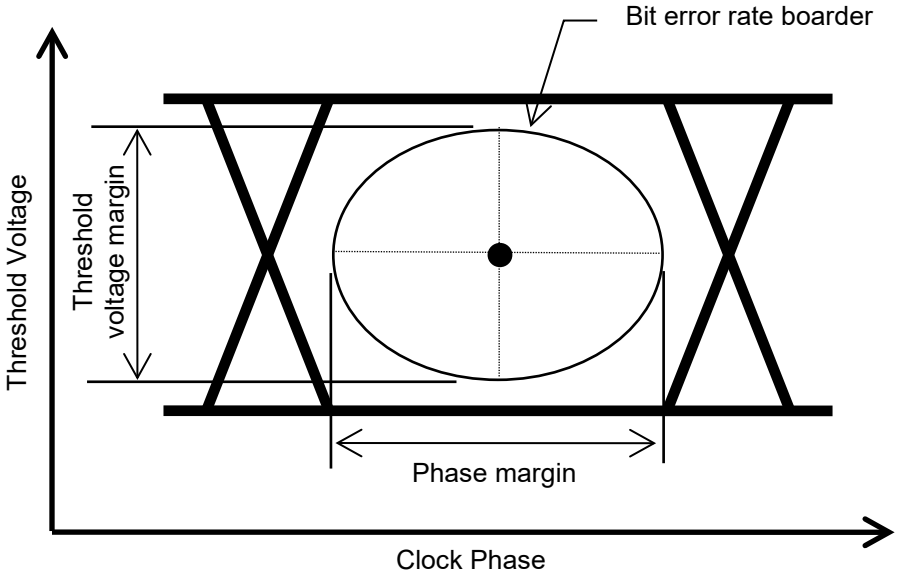


Figure 4.8.3-1 Schematic Diagram of Eye Margin Measurement

The margin in the clock phase direction (phase margin) and margin in the threshold voltage direction (threshold margin) are measured. The bit error rate to be a margin boarder can be selected from E–3 to E–12.
The bit error rate for the clock phase and threshold voltage at the start of Eye Margin measurement must be less than the specified rate, in order to obtain valid results.
Also, synchronization with the ED must be established (i.e., without Sync Loss) before the start of Eye Margin measurement.

Notes:

Eye Margin measurement cannot be performed for the following cases.

- When the module being used is MU196040A/B
- When **Burst** is selected for **Pattern Sequence** on the **Misc1** tab (4.4.1.1.6 “Misc1 tab”)
- When **Auto Adjust** is set to **ON**
- When **OFF** is selected for **Auto Sync** on the **Result** tab (4.5.1.1.1 “Result tab”)
- When the **Input** tab (4.5.1.1.4 “Input tab”) is grouped together with the other tab
- When **CDR** is selected for **Clock Input** on the **Input** tab (4.5.1.1.4 “Input tab”)

Touching  on Application toolbar displays Eye Margin screen.

Eye Margin screen is shown in Figure 4.8.3-2. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

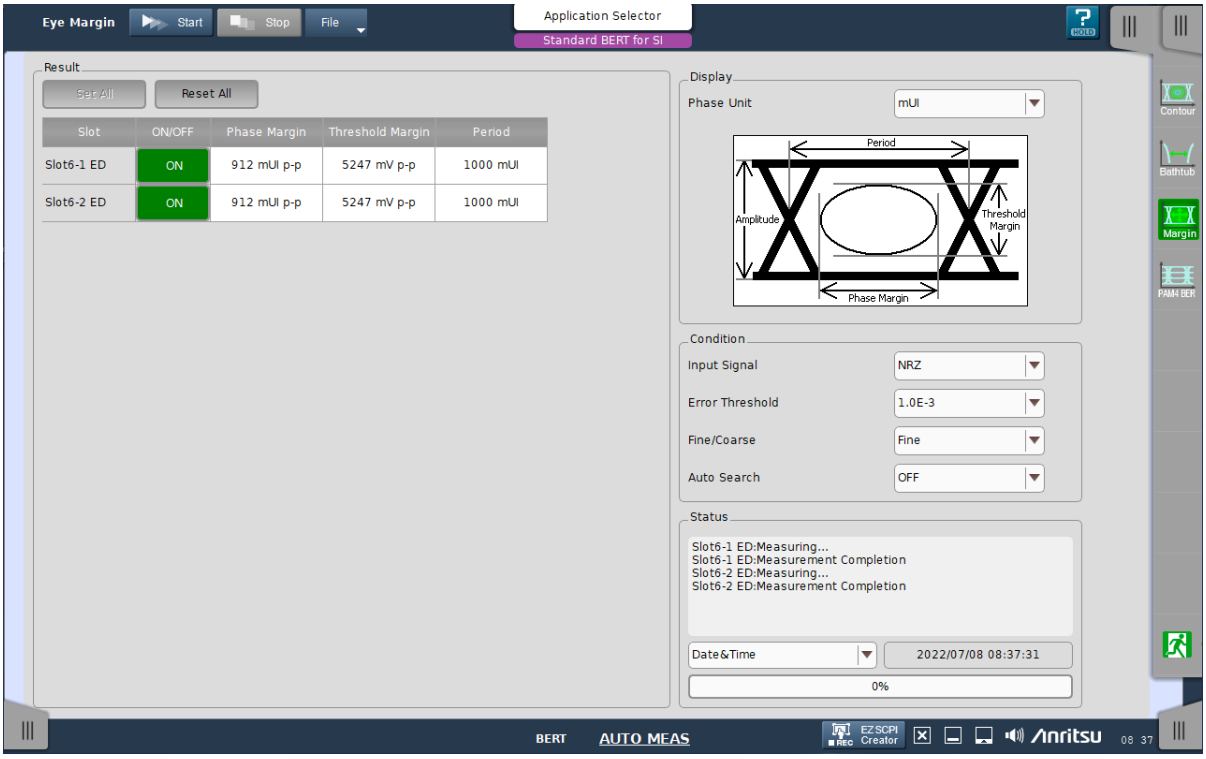


Figure 4.8.3-2 Eye Margin Screen

4.8.4 PAM BER measurement

PAM BER measurement enables the total BER to be measured by measuring the BER for each PAM4 signal level using 1ch or 3ch for ED.

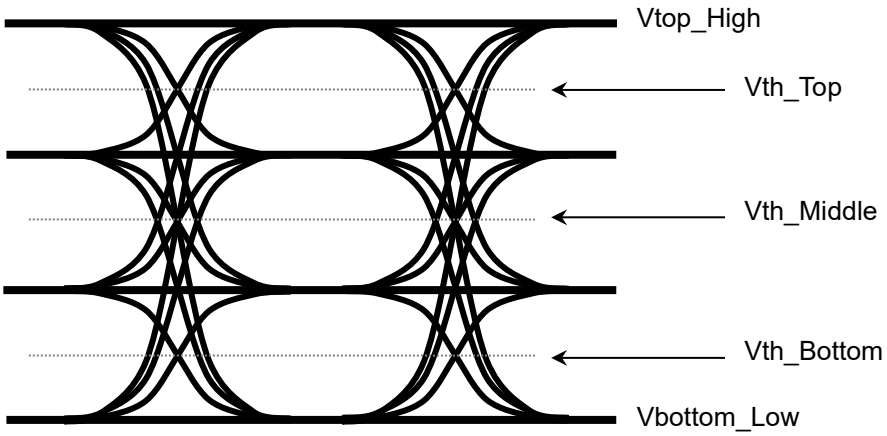


Figure 4.8.4-1 PAM BER Measurement

In the 3 Eye Serial mode, BER of Vth_Top/Vth_Middle/Vth_Bottom is measured respectively using 1 channel of ED. BER measurement is repeated 3 times while changing the threshold. From 3-time measurement results, the PAM4 total BER result is calculated and displayed.

Notes:

PAM BER measurement cannot be performed for the following cases.

- When the module being used is MU196040A/B
- When **Auto Adjust** is set to **ON**
- When **OFF** is selected for **Auto Sync** on the **Result** tab (4.5.1.1.1 "Result tab")
- When the **Input** tab (4.5.1.1.4 "Input tab") is grouped together with the other tab
- When **CDR** is selected for **Clock Input** on the **Input** tab (4.5.1.1.4 "Input tab")

Touching 

on Application toolbar displays PAM BER screen.

PAM BER screen is shown in Figure 4.8.4-2. For details of the window, refer to on-screen help. On-screen help can be displayed by the following methods.

- Touch  , and then touch the screen item you need help with.
- For mouse operation, right-click the screen item you need help with.

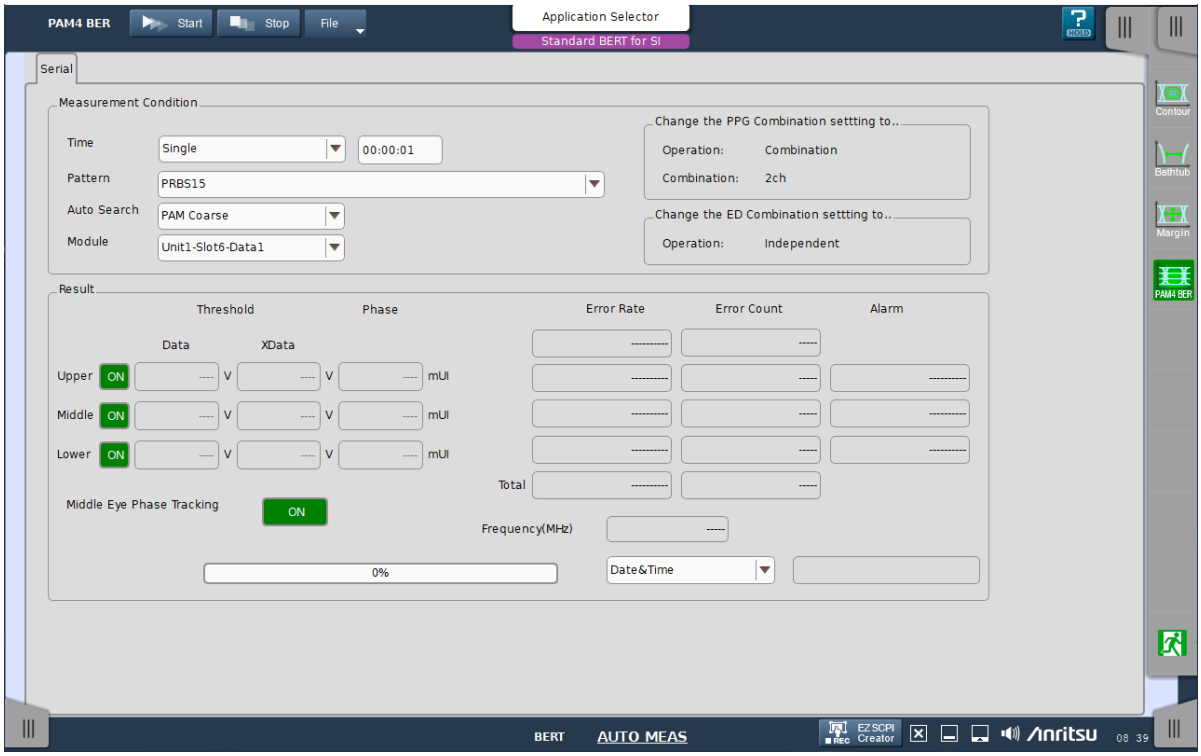


Figure 4.8.4-2 PAM BER Screen

Chapter 5 Remote Commands

This chapter describes remote control of MX190000A.

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5.1 Overview

The MP1900A that is controlled by the MX190000A are capable of performing automatic measurements when connected to an external controller. Either the GPIB or Ethernet interface may be used for connection. In addition, the SCPI standard, which is becoming the global standard, is used for the remote control commands. Refer to *SCPI 1999.0 (SCPI Consortium)* for details on SCPI.

The general conditions for using the SCPI standard are described below:

- Commands for GPIB and Ethernet are standardized.
- **General Settings** () and **File Explore** () on the system toolbar are not supported.
- The above conditions can all be read by the command.

5.2 Connections

This section describes the connections of the equipment for using the remote control function and the settings for using the GPIB and Ethernet interfaces.

5.2.1 Connecting MP1900A

The remote control function of the MP1900A is implemented by remotely controlling the MP1900A from a PC for remote control (remote control PC). Use the GPIB or the 100M, 1G Ethernet interface to connect the MP1900A and a remote control PC. An example is shown on "Figure 5.2.1-1 Configuration for Remote Control of MP1900A from the Remote Control PC".

Note:

Direct connection without using hub is recommended for the Ethernet connection. Use a crossover cable for direct connection.

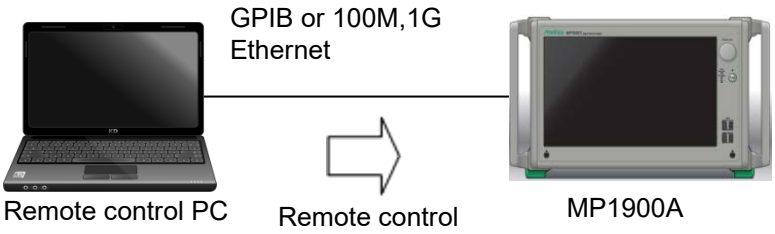


Figure 5.2.1-1 Configuration for Remote Control of MP1900A from the Remote Control PC

5.2.2 GPIB interface

This section describes the GPIB interface functions and settings using the GPIB interface of the MP1900A.

5.2.2.1 GPIB interface function

The MP1900A has device functions but no controller function. Therefore, its interface functions are as shown on "Table 5.2.2.1-1 Interface Function" according to the IEEE 488.2 standard.

Table 5.2.2.1-1 Interface Function

Code	Interface Function	IEEE 488.2 Standard
SH1	All functions for source handshake	All functions are standardly equipped
AH1	All functions for acceptor handshake	All functions are standardly equipped
T5	Basic talker functions Talk only mode functions Talker reset functions via MLA	The device must have a subset T5, T6, TE5, or TE6.
L4	Basic listener functions No listen-only mode function Listener reset functions via MTA	The device must have a subset L3, L4, LE3, or LE4.
SR1	All functions for service request	All functions are standardly equipped
RL1	All functions for remote/local	All remote/local functions of RL0 (no function) or RL1 (all functions)
PP0	No parallel poll function	PP0 (no function) or PP1 (all functions)
DC1	All functions for device clear	All functions are standardly equipped
DT1	All functions for device trigger	DT1 (all functions)
C1*1 C2*2 C3*3 C4*4 C7*5	Controller functions except parallel poll	C0 (no function), C4 and C5, or any of C7, C9, or C11

*1: System controller

*2: IFC transmission, controller in charge

*3: REN transmission

*4: Response to SRQ

*5: Interface message transmission, reception and passing of the control, and passing of the control to itself

5.2.2.2 Device message list

Device messages are data messages that are transmitted and received between the remote control PC and the MP1900A via the system interface when the bus mode is the data mode (when the ATN line is "H"). Device messages consist of program messages and response messages.

Program messages are ASCII data messages transferred from the controller to the device. Response messages are data messages transferred from the device to the controller.

Program messages and response messages have the following types.

Table 5.2.2.2-1 Device Message

Program Message (See Section 5.3.1.2)	Response Message (See Section 5.3.2.2)
Program instruction • Device-unique command (See 5.6 "SCPI Commands" .) • IEEE 488.2 common command (See 5.4 "IEEE 488.2 Common Commands".)	Program query • Status message (See 5.5 "Status Report".) • Response message

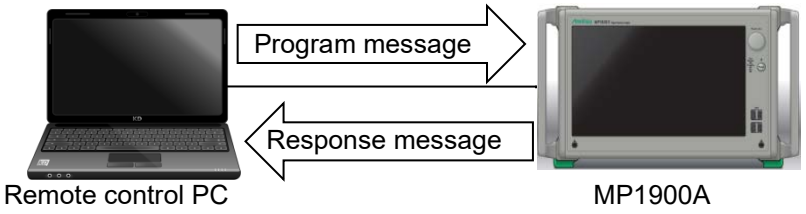


Figure 5.2.2.2-1 Device Message

The messages are exchanged via the I/O buffer of the device. The table below briefly describes the I/O buffer.

Table 5.2.2.2-2 I/O Buffer

Input Buffer	Output Queue
FIFO (First in First out) type memory area that temporarily stores DABs (program messages and query messages) before syntax analysis. The input buffer size of the MP1900A is 1 Kbytes.	FIFO type queue memory area. All the DABs (response messages) outputted from the device to the controller are stored in this memory until the controller finishes reading them.

5.2.2.3 Bus commands

Bus commands are used for internal communications of the interface transmitted while the bus mode is the command mode (when the ATN line is "L"). The "Table 5.2.2.3-1 Bus Commands" lists the bus commands.

Table 5.2.2.3-1 Bus Commands

Bus Command	Operation
DCL (Device Clear)	Initializes message exchange of all devices connected to the GPIB bus.
SDC (Selected Device Clear)	Initializes message exchange of the addressed MP1900A. The operation is the same as the DCL.
IFC (Interface Clear)	Initializes the interface.

5.2.2.4 Connecting GPIB cable

Connect the GPIB cable to the GPIB connector on rear back panel of the MP1900A.
Systems using GPIB have the following restrictions:

Number of connectable devices ≤ 15 units
Total cable length ≤ 2 m × Number of devices (20 m, max.)

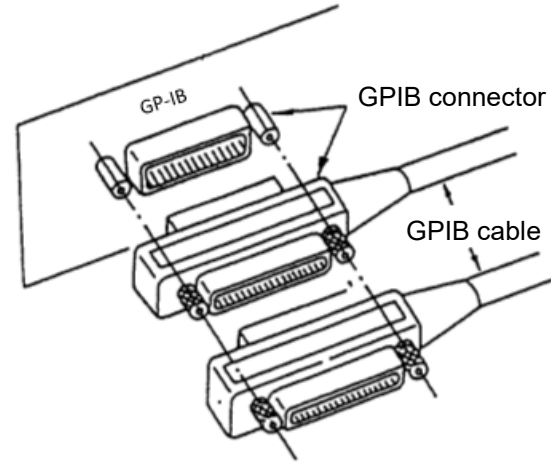


Figure 5.2.2.4-1 GPIB Cable Connection

5.2.2.5 Setting GPIB

To use the GPIB as a remote interface, set the MP1900A to Local, and perform the following settings on the Remote Control of the Instrument Tool bar.

Table 5.2.2.5-1 Setting GPIB

Setting Detail	Setting Item	Setting Value
Address setting	GPIB Address	1 to 30

Setting procedure:

(1) Touch the Instrument Tool bar tab, and touch **Remote Control**.

(2) Input GPIB address and touch **OK**.

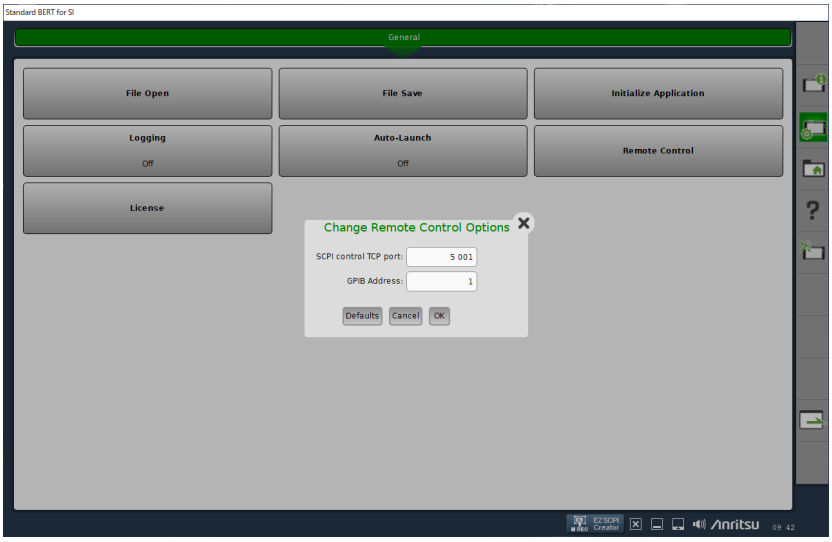


Figure 5.2.2.5-1 Remote Control Setting Example

5.2.2.6 System initialization

IEEE 488.2 defines system initialization in three levels: bus initialization, message initialization, and device initialization.

Table 5.2.2.6-1 Device Initialization

Level	Initialization Type	Description
1	Bus initialization	Initializes all interface functions connected to the bus with IFC message from the controller.
2	Message initialization	Disables function to report completion of initialization of message exchange or operation of all devices on the GPIB with the GPIB bus command DCL or the device specified with the bus command SDC, to the controller.
3	Device initialization	Recovers the known state that is specific to the device with the *RST command regardless of the past use conditions.

Bus initialization

IFC Initializes the bus with IFC statement.

Function Activates the IFC line for about 100 μs to initialize interface functions of all devices connected to the GPIB bus line. Only the system controller can transmit IFC.

Message initialization

DCL, SDC Message exchange initialization using the DCL/SDC bus command

DCL: Initializes message exchange for all devices on the GPIB.

SDC: Initializes message exchange for the specified device.

Function Initializes message exchange for all devices on the GPIB or only the specified device. Initialize message exchange when change of the panel setting state is not required, but if the parts related to message exchange inside the device are in a state that is not suitable for control from the controller due to execution of other programs. When message exchange is initialized, new instructions can be transmitted from the controller.

Device initialization

*RST	Initializes the device with the *RST command.
Function	Resets the device-unique function to a known state, regardless of the past use history. For the MP1900A, the factory-shipped settings are restored.

Device state upon application startup

When the application of the MP1900A starts up, it enters the following state:

- The state in which the application was terminated is set.
- The input buffer and output queue are cleared.
- The syntax analyzer, execution controller, and response creator are reset.
- Messages can be transmitted and received only when the application is running.

5.2.3 Ethernet interface

This section describes the settings for using the Ethernet interface of the MP1900A.

5.2.3.1 Device message list

Device messages are data messages that are transmitted and received between the controller and device via the system interface. Device messages consist of program messages and response messages.

Program messages are ASCII data messages transferred from the controller to the device. Response messages are data messages transferred from the device to the controller.

Program messages and response messages have the following types.

Table 5.2.3.1-1 Device Message

Program message (See Section 5.3.1.2)	Response message (See Section 5.3.2.2)
Program instruction • Device-unique command (See 5.6 “SCPI Commands”.) • IEEE 488.2 common command (See 5.4 “IEEE 488.2 Common Commands”.)	Program query • Status message (See 5.5 “Status Report”.) • Response message

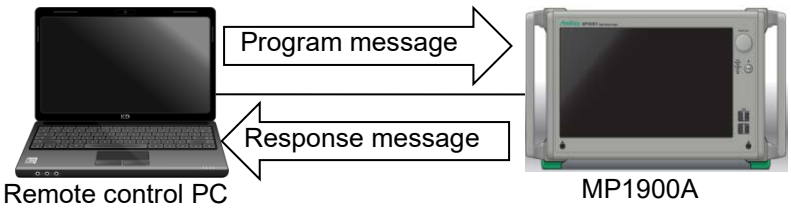


Figure 5.2.3.1-1 Device Messages

The messages are exchanged via the I/O buffer of the device. The table below briefly describes the I/O buffer.

Table 5.2.3.1-2 I/O Buffer

Input Buffer	Output Queue
FIFO (First in First out) type memory area that temporarily stores DABs (program messages and query messages) before syntax analysis. The input buffer size of the MP1900A is 1 Kbytes.	FIFO type queue memory area. All the DABs (response messages) outputted from the device to the controller are stored in this memory until the controller finishes reading them.

The MP1900A must be connected to the TCP/IP network, for the Ethernet interface to be used. In this instance, the MP1900A works as the server.

5.2.3.2 Connecting via Ethernet cable

Connect an Ethernet cable to an external connector installed on the rear panel. The Internal connector is reserved for future use. Do not connect to any network.

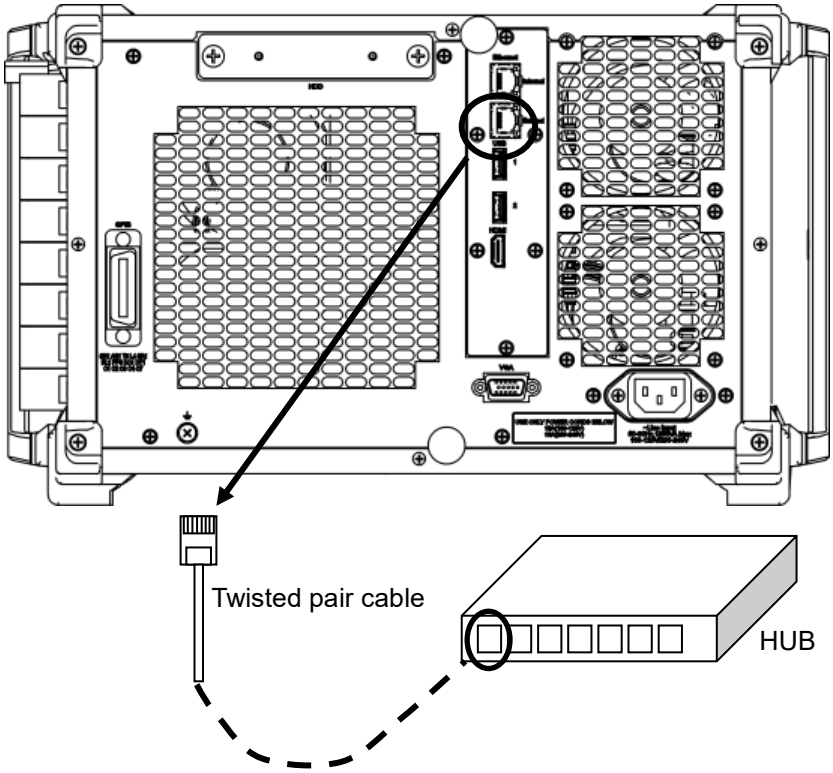


Figure 5.2.3.2-1 Connection via Ethernet Cable

Notes:

- Set an IP address other than "192.168.1.xxx" for the remote interface. The address of "192.168.1.xxx" has already been assigned to the module. Otherwise, the module may not work correctly.

- Do not change the Ethernet 2 (Do Not Change) settings. When the settings are changed, the application is not started normally. If changes are made to Ethernet 2 (Do Not Change), restore them to the default settings shown in the table below.

Table 5.2.3.2-1 Default Settings for Ethernet 2 (Do Not Change)

Item	Settings
IP address	192.168.1.101
Subnet mask	255.255.255.0
Default gateway	Blank (not set)

5.2.3.3 Setting Ethernet port

To use the Ethernet as a remote interface, set the MP1900A to Local, set a port number in the dialog box of Figure 5.2.2.5-1 in accordance with Table 5.2.3.3-1 by key operation.

Setting procedure:

(1) Touch the Instrument Tool bar tab, and touch **Remote Control**.

(2) Input an integer in range of 1024 to 65535 to SCPI control TCP port.

Notes:

- For the IP address of the remote interface, set the address other than “192.168.1.xxx”. The “192.168.1.xxx” address is used for the module address. If this address is set, the module may not operate properly.

- IP address

  In a network using TCP/IP, devices connected to the network are identified by IP addresses. An IP address must therefore be assigned to each device. An IP address is a 32-bit number, and expressed as four 8-bit portions separated by dots (called dot notation).

  IP addresses include network information in addition to the device (host) information. The data lengths of the network part and host part of an IP address is defined depending on the network class. Class C has 24-bit network part and 8-bit host part, and up to 254 hosts can be connected. Classes A through E are available; however, only Classes A through C are normally used.

Table 5.2.3.3-1 IP Address

Class	Network part length	Host part length	Number of hosts that can be assigned
A	8 bits	24 bits	16 777 214 units
B	16 bits	16 bits	65 534 units
C	24 bits	8 bits	254 units

- Subnet mask
  The subnet mask is used to indicate the network part in the IP address when the network is divided into subnets. The network part of the IP address above (including the extended subnet part) is indicated by "1", and the host part is defined by "0". Unless they are set correctly, IP packets are not sent and received correctly when connecting to a network that uses subnets.

- Gateway
  A device called a gateway is used to connect networks. Gateways include dedicated devices such as routers. In a TCP/IP network, IP packets can be directly exchanged within the same network. To exchange IP packets among different networks (i.e., terminals that have IP addresses with different network parts), however, communication with a device connecting to other network connected to the gateway via the gateway is required.

5.2.3.4 Network connection and data flow

Connect the Ethernet cable to the MP1900A to connect to the network. The communication with MP1900A is data communication via the TCP connection. For communication, creating a communication program (socket client) at the remote control PC side is required.
For the socket interface used for communication, see the operation manuals of the remote control PC, the network interface board installed, and the driver software.

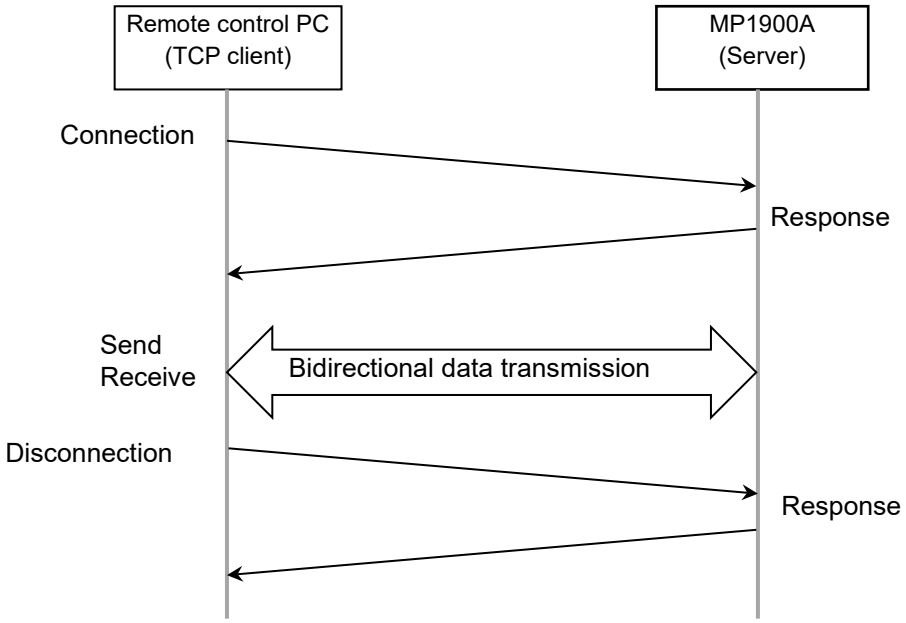


Figure 5.2.3.4-1 Data Flow

Data communication

The data from the client is saved in the reception buffer. Flow control of TCP occurs when the internal buffer is full, and no command-level response may return to the client. Some applications may be abnormally terminated due to timeout. In this case, the connection with the client is not disconnected. In some cases, you need to protect application operations by re-transmission.

5.3 SCPI Format

This section describes the SCPI command system.

5.3.1 SCPI lister input format

This section describes the format of program messages received by the listener (MP1900A) from the talker (remote control PC).

The device-unique commands of the MP1900A comply with the SCPI, so the SCPI commands are used in the examples in this section .

5.3.1.1 SCPI listener input program message format

The following figure shows a sample program message, which sets the data output to ON and sets the test pattern to PRBS.

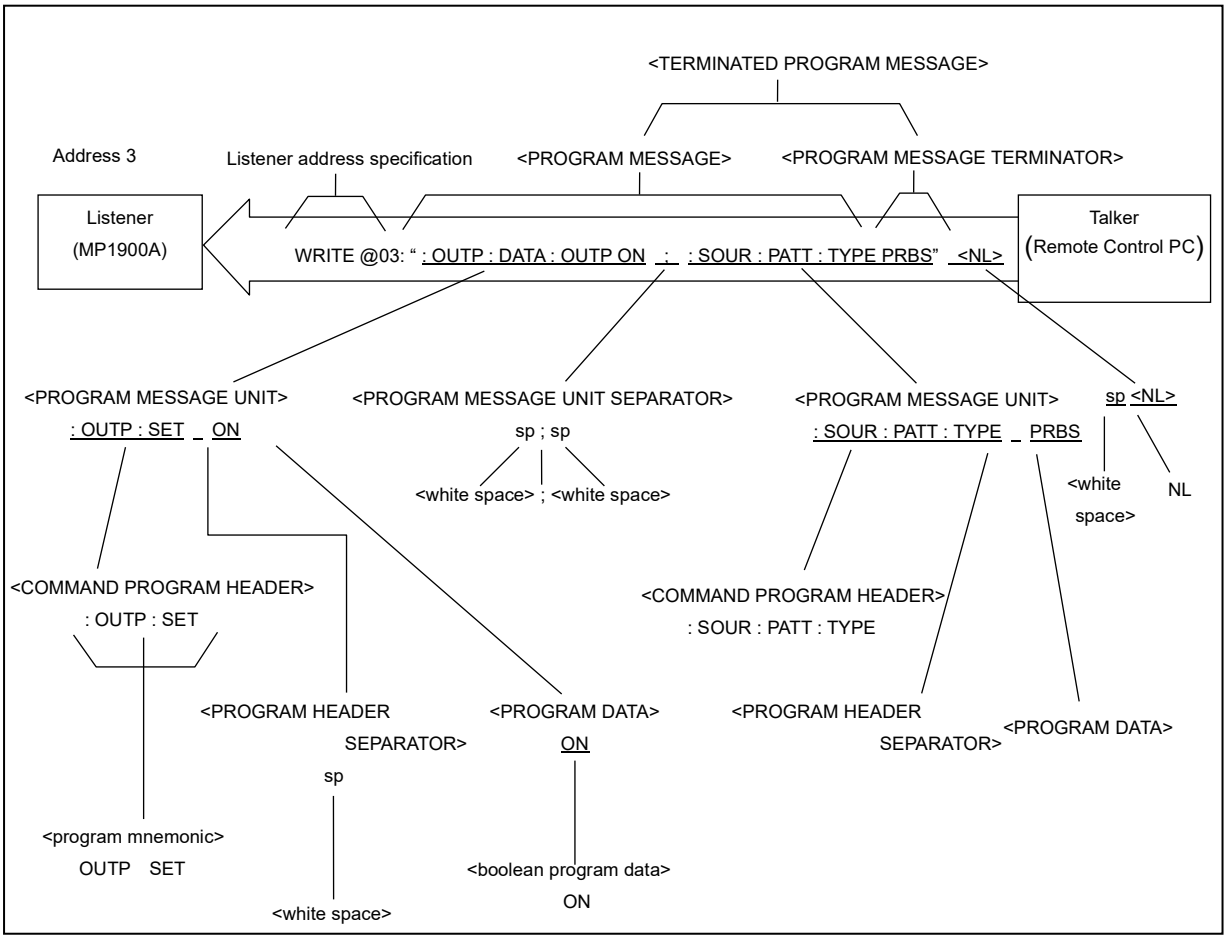


Figure 5.3.1.1-1 SCPI Listener Input Program Message

The program message format consists of a sequence of functional elements, which are the minimum level units to indicate a function. In the figure above, the words written in uppercase alphabetical characters enclosed within brackets (< >) indicate examples of functional elements.

The WRITE and READ commands have the following formats.

WRITE @
Outputs data to the MP1900A.
★Format

WRITE @Device number: Data

Data→ | Mathematical expression
String expression |

Example: The same as the previous page

WRITE @
Outputs the data to the MP1900A
★Format

WRITE @Device number: Data

Data→ | Mathematical expression
String expression |

Example: The same as the example on the previous page
WRITE @03: " : OUTP : DATA : OUTP ON ; : SOUR : PATT : TYPE PRBS"

Listener address (When the GPIB address of MP1900A is 3)

READ @
Substitutes the data inputted from the MP1900A into the variable.
★Format

READ @Device number: Variable

Example: data input from the MP1900A (input connector setting) to the variable A$.

WRITE @03: " :OUTP : DATA : OUTP?" ←— Queries the input connector setting.

READ @03: A$

Listener address (when the GPIB address of MP1900A is 3)

5.3.1.2 Functional elements of program messages

MP1900A receives a program message by detecting the terminator at the end of the program message. The functional elements of program messages are described below.

(1) <TERMINATED PROGRAM MESSAGE>

The following figure shows a <TERMINATED PROGRAM MESSAGE> that transmits two instructions.

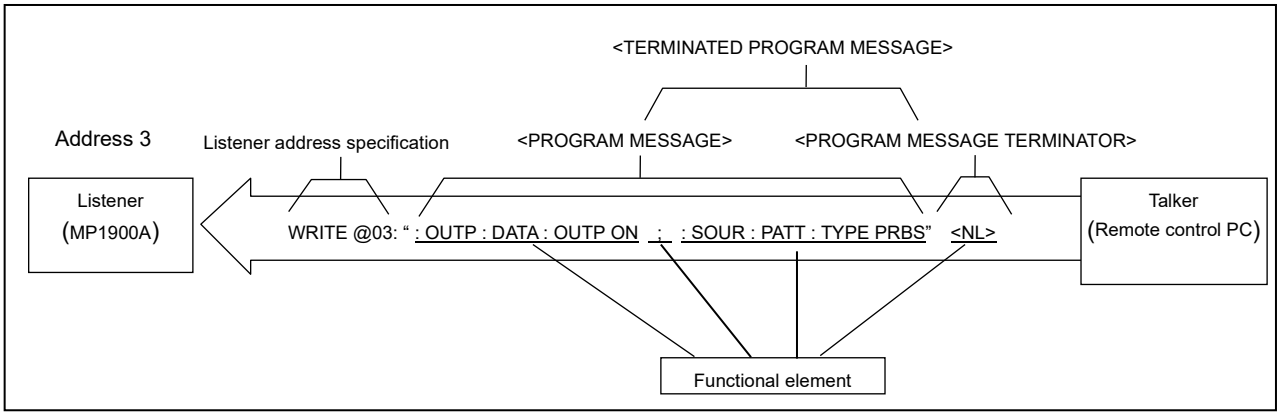
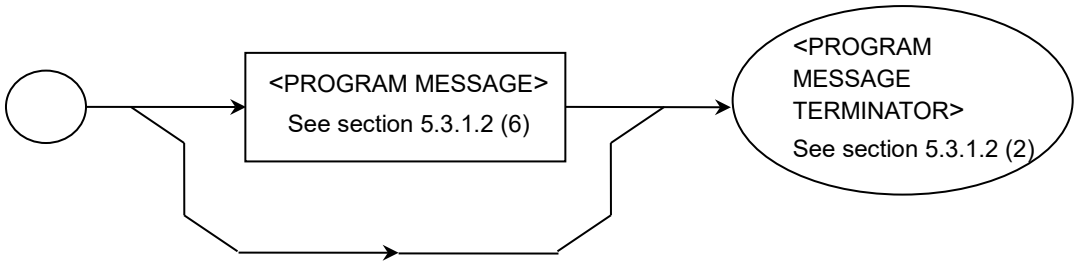


Figure 5.3.1.2-1 <TERMINATED PROGRAM MESSAGE>

<TERMINATED PROGRAM MESSAGE> is defined as follows:

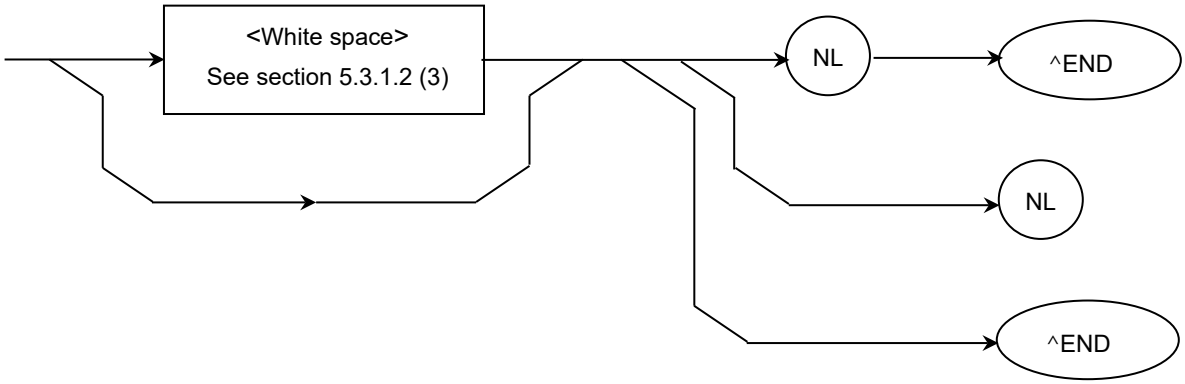


<TERMINATED PROGRAM MESSAGE> is a data message containing all the functional elements required for transmitting the message from the remote control PC to the MP1900A. A <PROGRAM MESSAGE TERMINATOR> is added to the end of a <PROGRAM MESSAGE> to complete transmission of the <PROGRAM MESSAGE>.

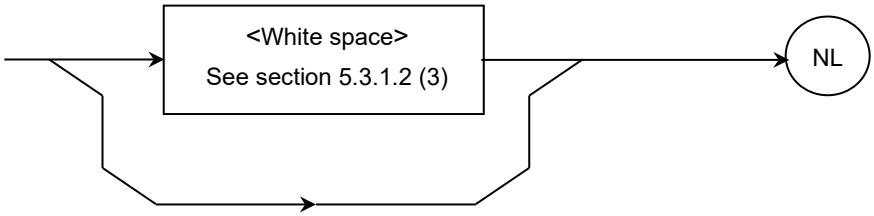
(2) <PROGRAM MESSAGE TERMINATOR>

<PROGRAM MESSAGE TERMINATOR> is placed to terminate a sequence of one or more <PROGRAM MESSAGE UNIT> elements. The definition of the <PROGRAM MESSAGE TERMINATOR> differs according to the used interface.

(a) For GPIB interface



(b) For Ethernet interface

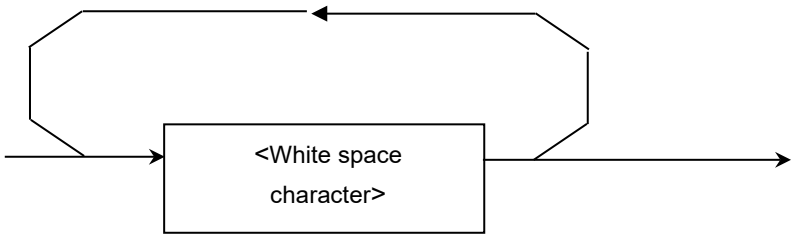


NL Defined as a single ASCII code byte 0A (decimal number 10), i.e. the ASCII control character LF (Line Feed) that performs the carriage return operation bringing the print position to the same character position in the next line. It is also called NL (New Line) because it starts from a new line.
For line feed, the CR + LF code may be used instead of the LF code. If the remote control PC runs on MS-DOS or Windows, line feed is done with “CR + LF”, while it is done with only “LF” for UNIX.

END Generates an EOI signal by setting the EOI (End-or-Identify) line of the GPIB control bus to TRUE (low level).

(3) <White space>

<White space> is defined as follows:



<white space Character> is defined as a single ASCII code byte within the range of the ASCII code bytes 00 to 09 and 0B to 20 (decimal numbers 0 to 9 and 11 to 32). The range includes the ASCII control symbols and space signals except New Line. The MP1900A processes these ASCII symbols simply as spaces or just ignores them, instead of interpreting them as ASCII control symbols.

(4) <PROGRAM MESSAGE>

The following figure shows a setting example, which activates the alarm when an error occurs and sets the test pattern to PRBS.

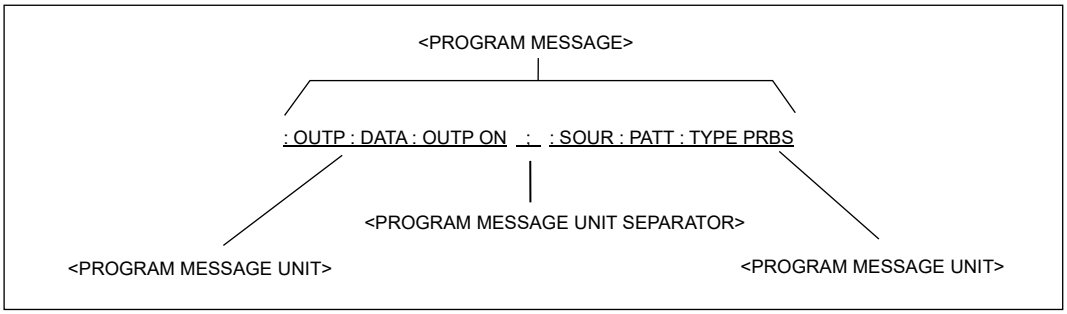
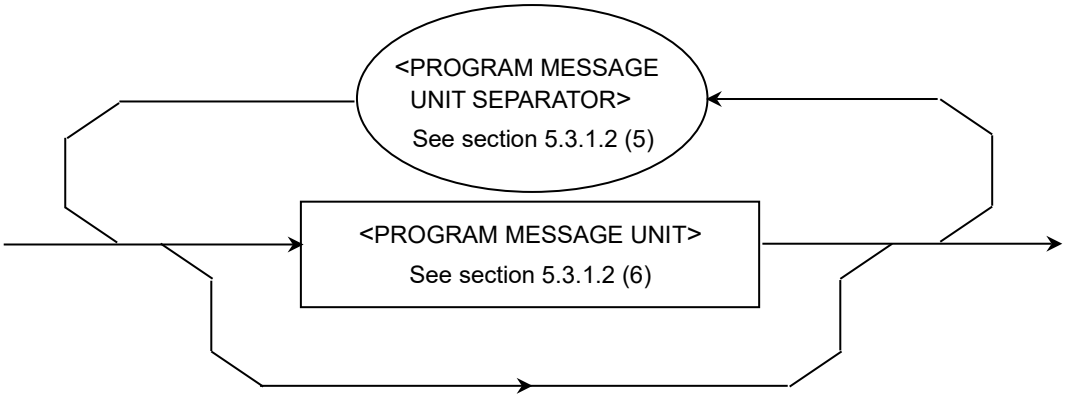


Figure 5.3.1.2-2 <PROGRAM MESSAGE>

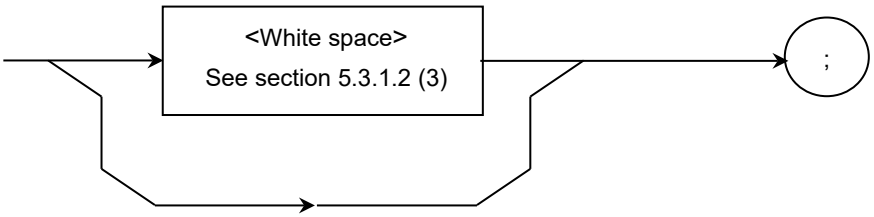
<PROGRAM MESSAGE> is defined as follows:



<PROGRAM MESSAGE> is a sequence of zero, one or more <PROGRAM MESSAGE UNIT> elements. The <PROGRAM MESSAGE UNIT> element indicates a programming instruction or data to be sent from the remote control PC to the MP1900A. <PROGRAM MESSAGE UNIT SEPARATOR> is used to separate two or more <PROGRAM MESSAGE UNIT> elements.

(5) <PROGRAM MESSAGE UNIT SEPARATOR>

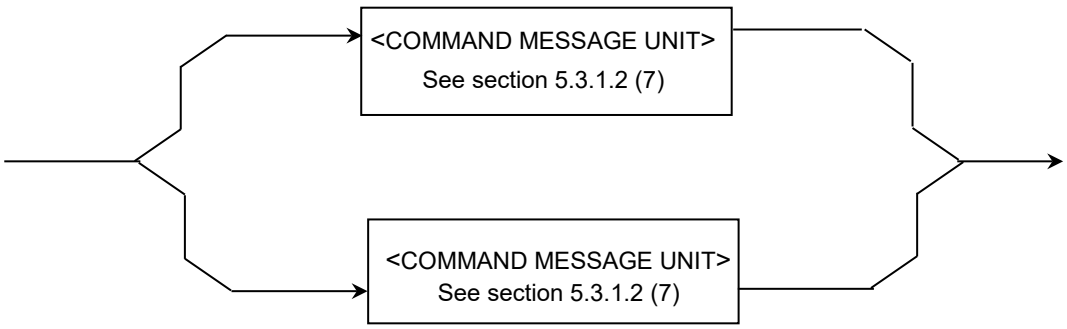
<PROGRAM MESSAGE UNIT SEPARATOR> is defined as follows:



<PROGRAM MESSAGE UNIT SEPARATOR> separates a sequence of two or more <PROGRAMMESSAGE UNIT> elements into <PROGRAM MESSAGE> elements. The MP1900A interprets a semicolon (;) as the separator of the <PROGRAM MESSAGE UNIT>. The <white space character> elements before and after the semicolon are therefore ignored. The <white space character> is useful, however, to make the program readable.

(6) <PROGRAM MESSAGE UNIT>

<PROGRAM MESSAGE UNIT> is defined as follows:



<PROGRAM MESSAGE UNIT> consists of <COMMAND MESSAGE UNIT>, a single command message received by the MP1900A, or <QUERY MESSAGE UNIT>, a single query message. Setting and query can be performed for the MP1900A in units of <PROGRAM MESSAGE UNIT>.

(7) <COMMAND MESSAGE UNIT> and <QUERY MESSAGE UNIT>

For both <COMMAND MESSAGE UNIT> and <QUERY MESSAGE UNIT>, when program data follows the program header, one space must be inserted as a separator between them. The program header identifies the application, function, and operation of the program. If no program data is added, the header alone indicates the application, function, and operation for the MP1900A.

Among program headers, <COMMAND PROGRAM HEADER> is a command used to control the MP1900A from the remote control PC. <QUERY PROGRAM HEADER> is a query command to be transmitted from the remote control PC to the MP1900A in advance for the remote control PC to receive response messages from the MP1900A. A query indicator (?) is added to the end of the header.

(a) <COMMAND MESSAGE UNIT>

Example: The following shows a date setting command.

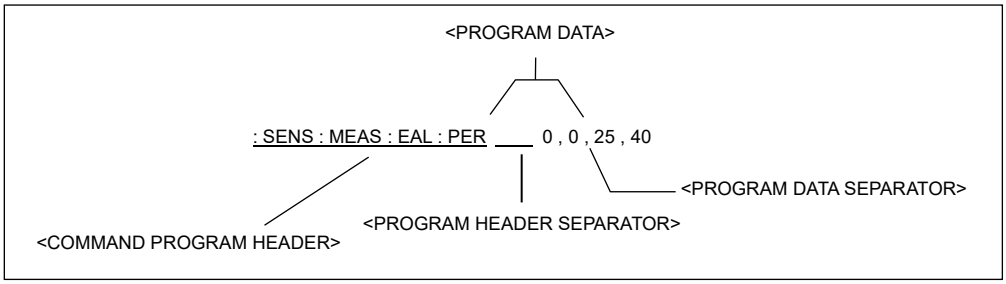
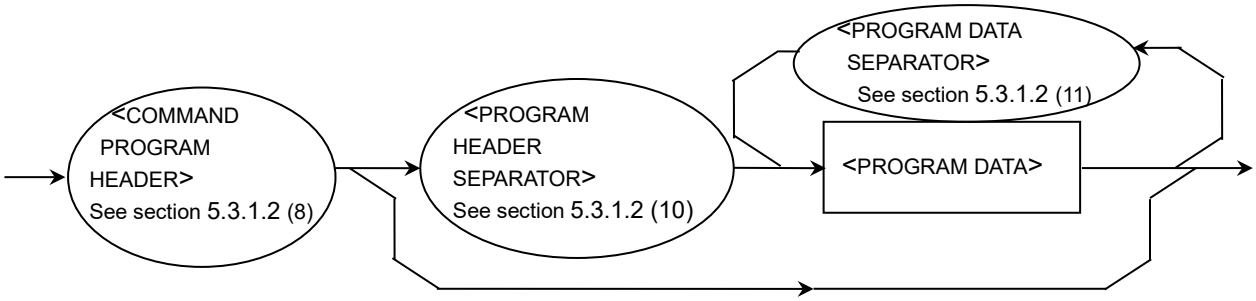


Figure 5.3.1.2-3 <COMMAND MESSAGE UNIT>

<COMMAND MESSAGE UNIT> is defined as follows:



(b) <QUERY MESSAGE UNIT>

Example: The following shows a query that queries the area to add a bit error.

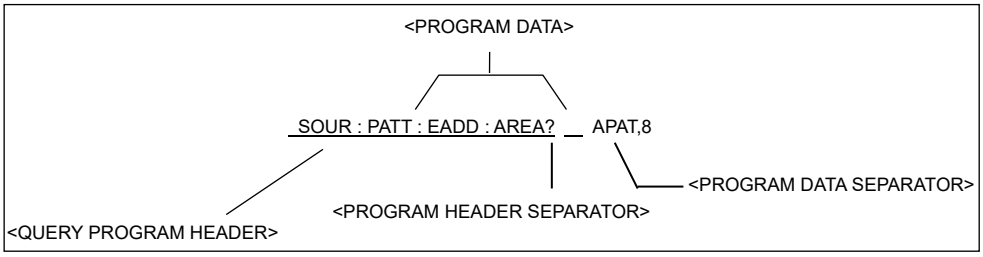
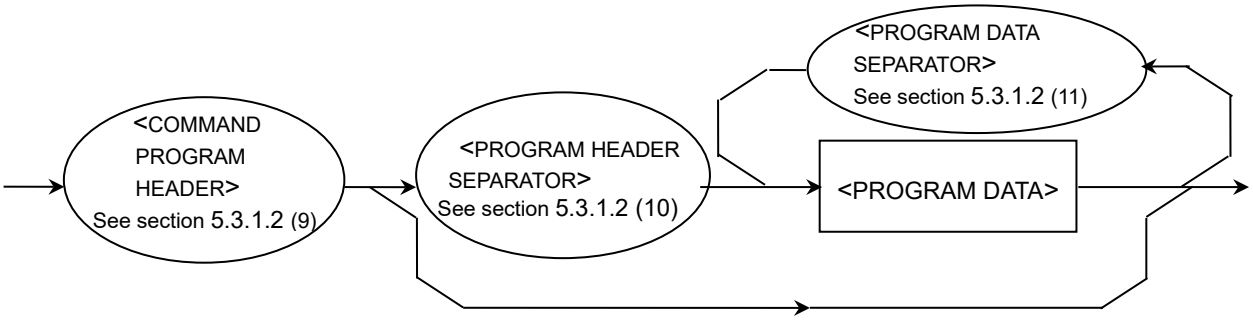


Figure 5.3.1.2-4 <QUERY MESSAGE UNIT>

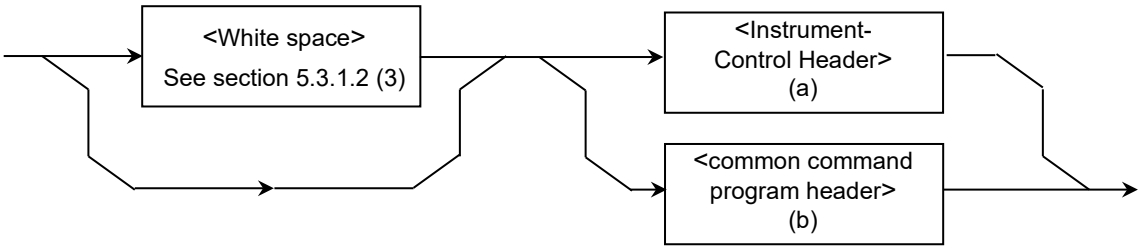
<QUERY MESSAGE UNIT> is defined as follows:



(8) <COMMAND PROGRAM HEADER>

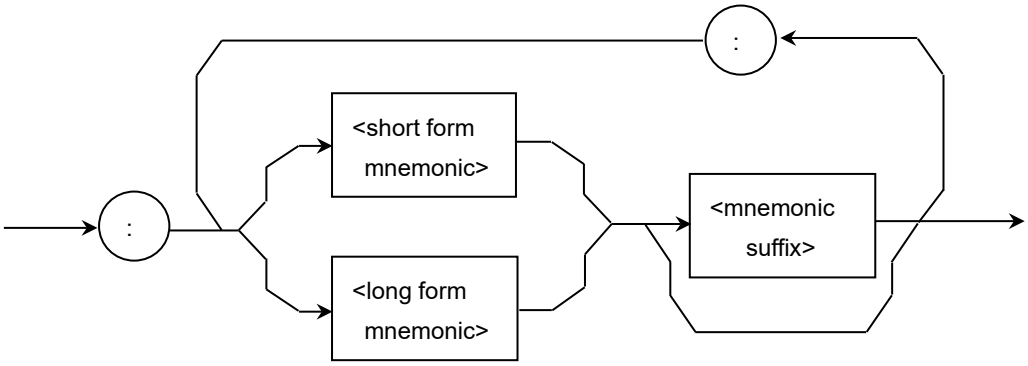
<COMMAND PROGRAM HEADER> indicates the application, function, and operation of the program data executed by the MP1900A. If no program data is added, the header alone indicates the application, function, and operation for the MP1900A. <program mnemonic> expresses the meaning in ASCII code characters, and is generally just called a mnemonic.

<COMMAND PROGRAM HEADER> is defined as follows:
A <white space> can be inserted in front of each header.



(a) <Instrument-Control Header>

<Instrument-Control Header> is defined as follows:



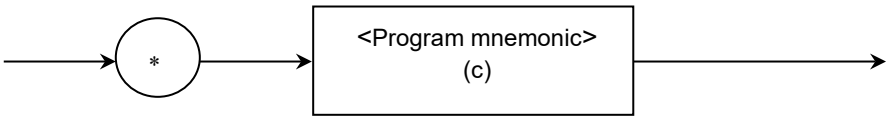
<Instrument-Control Header> is defined in the SCPI. The device-unique commands of the MP1900A comply with the SCPI, so the command format conforms to the SCPI.

<short form mnemonic> and <long form mnemonic>
Correspond to the short form and long form of the SCPI commands, respectively. For the specifications of mnemonics, the specifications of <program mnemonic> described earlier are applied as they are.

<numeric suffix>
Defined as a single ASCII code byte, within the range of the ASCII code bytes 30 to 39 (decimal numbers 48 to 57 = numerical values 0 to 9).

(b) <common command program header>

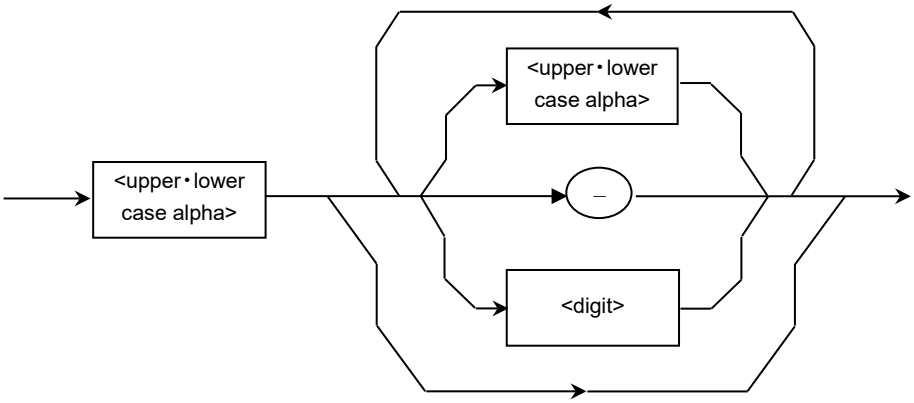
<common command program header> is defined as follows:



<common command program header> For <common command program header>, an asterisk (*) must be added before the <program mnemonic> (refer to 5.4 “IEEE 488.2 Common Commands” for details).

(c) <Program mnemonic>

<Program mnemonic> is defined as follows:



A mnemonic must start with an uppercase or lowercase alphabetic character, followed by any combination of uppercase alphabetic characters (“A” to “Z”), lowercase alphabetic characters (“a” to “z”), underbar (_), and numbers (“0” to “9”). The maximum length of a mnemonic is twelve characters. Space must not be inserted between characters.

<upper, lower case alpha>

Defined as a single ASCII code byte, within the range of the ASCII code bytes 41 to 5A and 61 to 7A (decimal numbers 65 to 90, 97 to 122 = uppercase alphabetic characters A to Z, lowercase alphabetic characters a to z).

<digit>

Defined as a single ASCII code byte, within the range of the ASCII code bytes 30 to 39 (decimal numbers 48 to 57 = numerical values 0 to 9).

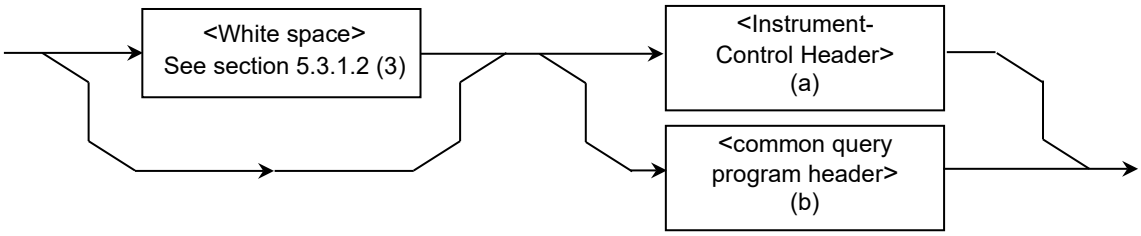
(_)

A Indicates the ASCII code byte 5F (decimal number 95 = underbar). It is defined as a single ASCII code byte.

Example: :SYSTem (The subsequent part is omitted.)

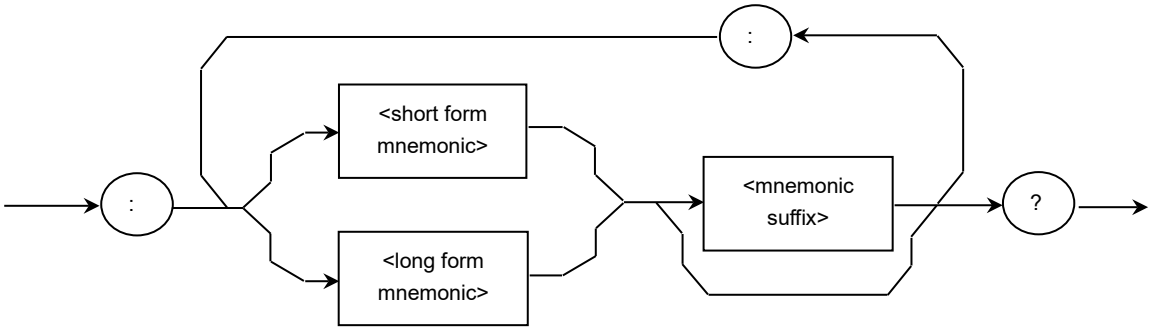
(9) <QUERY PROGRAM HEADER>

<QUERY PROGRAM HEADER> is defined as follows. A <white space> can be inserted in front of each header.



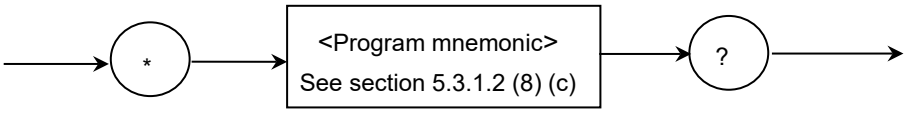
(a) <Instrument-Control Headers>

<Instrument-Control Headers> is defined as follows:



(b) <common query program header>

<common query program header> is defined as follows:



<QUERY PROGRAM HEADER> is a query command transmitted from the remote control PC to the MP1900A in advance for the remote control PC to receive response messages from the MP1900A. A query indicator (?) must be added to the end of the header.

Example: :SYSTem:DATE?

The format of <QUERY PROGRAM HEADER> above is the same as <COMMAND PROGRAM HEADER> except that the query indicator (?) is added to the end of the header. For details, refer to Section 5.3.1.2 (9) <QUERY PROGRAM HEADER>.

(10) <PROGRAM HEADER SEPARATOR>

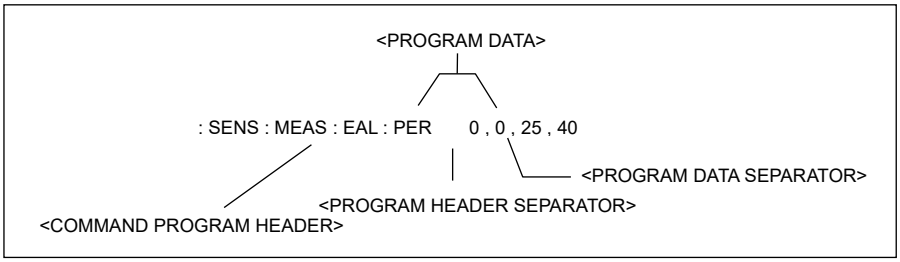
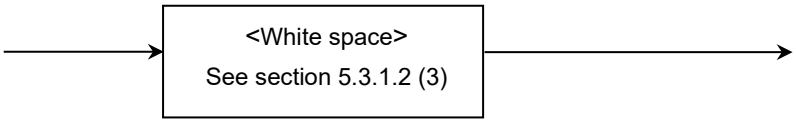


Figure 5.3.1.2-5 <PROGRAM HEADER SEPARATOR >

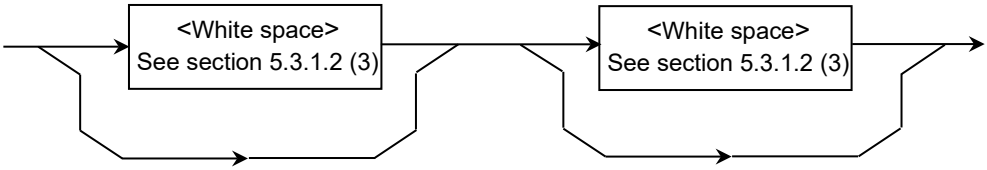
<PROGRAM HEADER SEPARATOR> is defined as follows.



<PROGRAM HEADER SEPARATOR> is used as a separator between <COMMAND PROGRAM HEADER> or <QUERY PROGRAM HEADER> and <PROGRAM DATA>. If there are two or more <white space character> elements between the program header and program data, only the first <white space character> is interpreted as a separator, and the others are ignored. The <white space character> is useful, however, to make the program readable. That is, only one header separator must exist between the header and data, which indicates the end of the program as well as the beginning of the program data.

(11) <PROGRAM DATA SEPARATOR>

<PROGRAM DATA SEPARATOR> is defined as follows:



If <COMMAND PROGRAM HEADER> or <QUERY PROGRAM HEADER> has many parameters, <PROGRAM DATA SEPARATOR> is used to separate them. Using this data separator requires commas, but no <white space character>. <white space character> before and after the comma are ignored. The <white space character> is useful, however, to make the program readable.

5.3.1.3 Program data format

Among the terminated program message formats described above, this section presents an example of the format of <PROGRAM DATA> shown in the functional grammar diagram in 5.3.1.3 “Program ”.

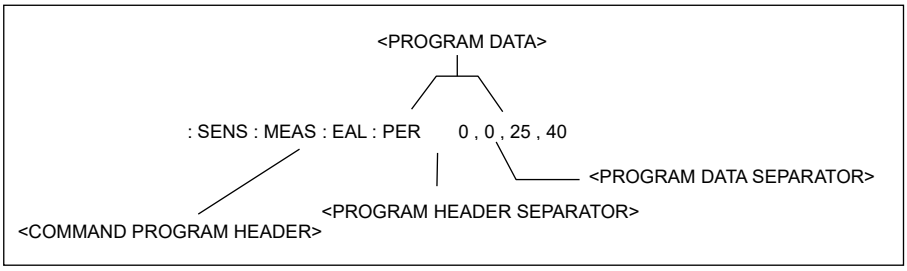


Figure 5.3.1.3-1 <PROGRAM DATA>

The functional elements of <PROGRAM DATA> are used to transmit the parameters of the type related to the program header. The following table lists the program data used by the MP1900A.

Table 5.3.1.3-1 Program Data Format

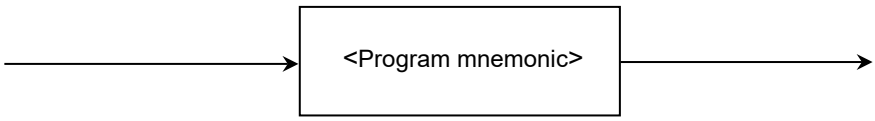
<PROGRAM DATA>	Type
<CHARACTER PROGRAM DATA>	Indicates short alphabetic or alphanumeric data.
<DECIMAL NUMERIC PROGRAM DATA>	Indicates a decimal numerical constant.
<NON-DECIMAL NUMERIC PROGRAM DATA>	Indicates an alphanumeric character other than a decimal.
<BOOLEAN PROGRAM DATA>	Indicates a theoretical value (defined in SCPI).
<STRING PROGRAM DATA>	Indicates a string enclosed within double quotation marks (" ") or single quotation marks (' ').

(1) <CHARACTER PROGRAM DATA>

<CHARACTER PROGRAM DATA> indicates short alphabetic or alphanumeric data.

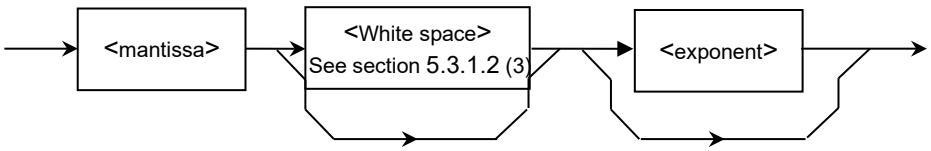
Example: :SENSe:PATTern:TYPE PRBS (Mnemonic data indicating PRBS)
:SENSe:MEASure:EALarm:UNIT CLOCk
(Mnemonic data indicating the measurement cycle in Clock Count units.)

The character data is the same as those described <Program mnemonic> in 5.3.1.2 (8) (c).

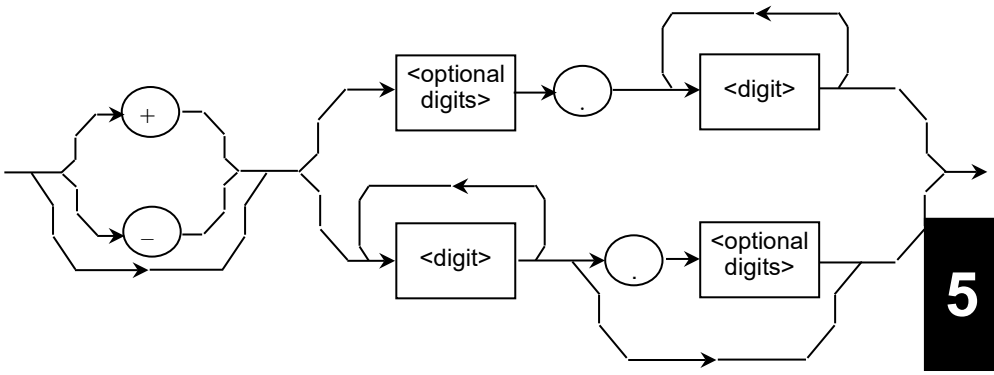


(2) <DECIMAL NUMERIC PROGRAM DATA>

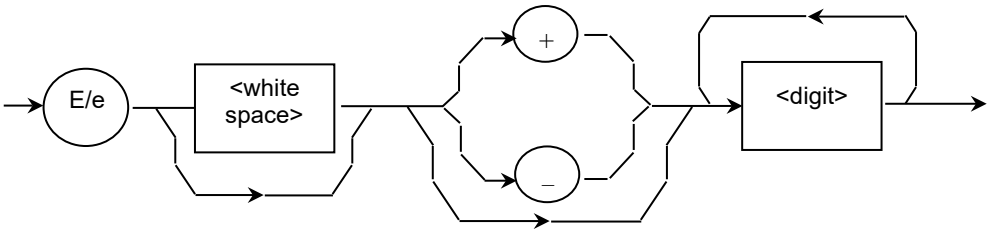
<DECIMAL NUMERIC PROGRAM DATA> indicates a decimal numerical value, and is defined as follows:



<mantissa> is defined as follows:



<exponent> is defined as follows:



The MP1900A uses the decimal integer format.

■ Integer format

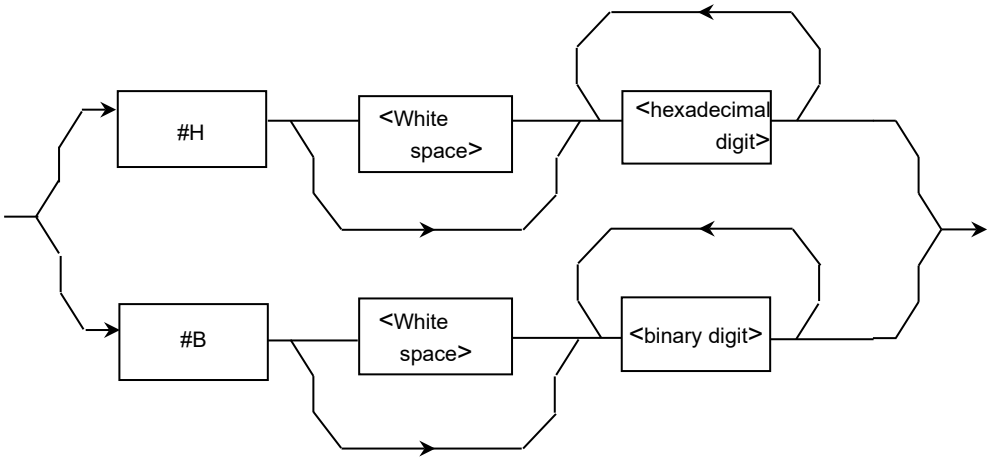
Δ represents a space.

- Indicates a decimal integer value.
- Zeros can be entered in the beginning. → 005
- No space can be inserted between the sign and the numerical value.→ +5 (applicable), +Δ5 (not applicable)
- Spaces can be inserted after the numerical value. → +5ΔΔ
- Positive sign (+) may be omitted. → +5, 5
- Commas cannot be used for separating digits. → 1,234 (not applicable)

Example:	: SOURce : PATTern : PRBS : LENGth 7

(3) <NON-DECIMAL NUMERIC PROGRAM DATA>

<NON-DECIMAL NUERIC PROGRAM DATA> indicates a numerical value other than a decimal (e.g., binary, hexadecimal), and is defined as follows:



<hexadecimal digit>: Hexadecimal format

The hexadecimal format consists of #H and the subsequent numbers (0 to 9) and/or alphabetic characters (A to F). Δ represents a space.

- Spaces can be inserted following #H.
  #H1234 → #HΔ1234
  #H00AF → #HΔΔΔ00AF
- Zeros can be omitted.
  #H00FF → #HFF
  #H0000 → #H0

Example:	:SOURce:PATTern:DREVerse:ADDRess #H0,#H1F

<binary digit>: Binary format

The binary format consists of #B and the subsequent 0s and/or 1s.
Δ represents a space.

- Spaces can be inserted following #B.
  #B11011011 → #BΔ11011011
  #B00100100 → #BΔΔΔ00100100

(4) <BOOLEAN PROGRAM DATA>

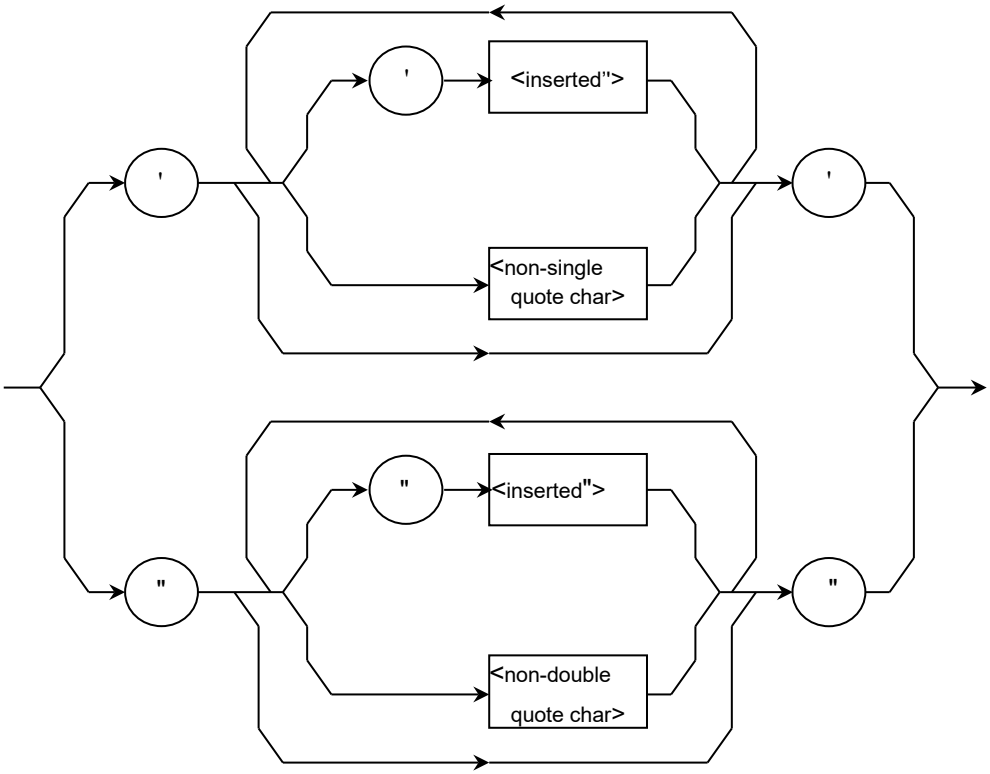
<BOOLEAN PROGRAM DATA> is the program data that is defined in the SCPI, and indicates a theoretical value. As the values corresponding to True and False, ON and OFF of <CHARACTER PROGRAM DATA> and 1 and 0 of <DECIMAL NUMREIC PROGRAM DATA> are defined.

Example:	:SOURce:PATTern:EADDition:SET ON :SOURce:PATTern:EADDition:SET 1

(5) <STRING PROGRAM DATA>

< STRING PROGRAM DATA> is character string data, enclosed within double quotation marks (" ") or single quotation marks (' '). If the character string includes a double (" ") or single quotation mark (' '), the same type of quotation mark must be described to enclose the string.

It is defined as follows:



(a) <inserted'> is defined as a single ASCII symbol of a value 27 (decimal number, 39 = ').

(b) <non-single quote char> is defined as a single ASCII symbol of a value other than 27 (decimal number, 39 = ').

(c) <inserted"> is defined as a single ASCII symbol of a value 22 (decimal number, 34 = ").

(d) <non-double quote char> is defined as a single ASCII symbol of a value other than 22 (decimal number, 34 = ").

<Example of description>

When a character string is enclosed within single quotation marks (' '):

'calculate'

'remote"control' (The double quotation mark (") between single quotation marks is regarded as a string.)

'"Jan. " "Feb. " ' (The double quotation marks (" ") between single quotation marks are regarded as a string.)

'remote"control' (The double quotation mark (") between single quotation marks is regarded as a string.)

When a character string is enclosed within double quotation marks (" "):

"calculate"

"It's a nice day. " (The single quotation mark (') between double quotation marks is regarded as a string.)

" 'Mar. "Apr. ' " ' (The single quotation marks (' ') and the double quotation mark (") between outer double quotation marks are regarded as a string.)

"program" "data" (The double quotation marks (" ") between outer double quotation marks are regarded as a string.)

As shown above, use the same type of quotation marks for enclosing a character string.

Actual commands are described as follows:

Example:	:CALCulate:ADATa:EALarm? "1-1", "CURRent:ER:TOTal" (The character string representing the slot of the module, the character string representing the display method and data type)

5.3.2 SCPI talker output format

This section describes the format of response messages returned from the talker (transmitter) to the listener (receiver).

5.3.2.1 SCPI talker output response message format

The following figure shows the response to a data output query command :OUTP:DATA:OUTP?, and test pattern selection query commands :SOUR:PATT:TYPE? and :OUTPut:RCLock:SeLect?. The SCPI response has no header, so the response contains only data.

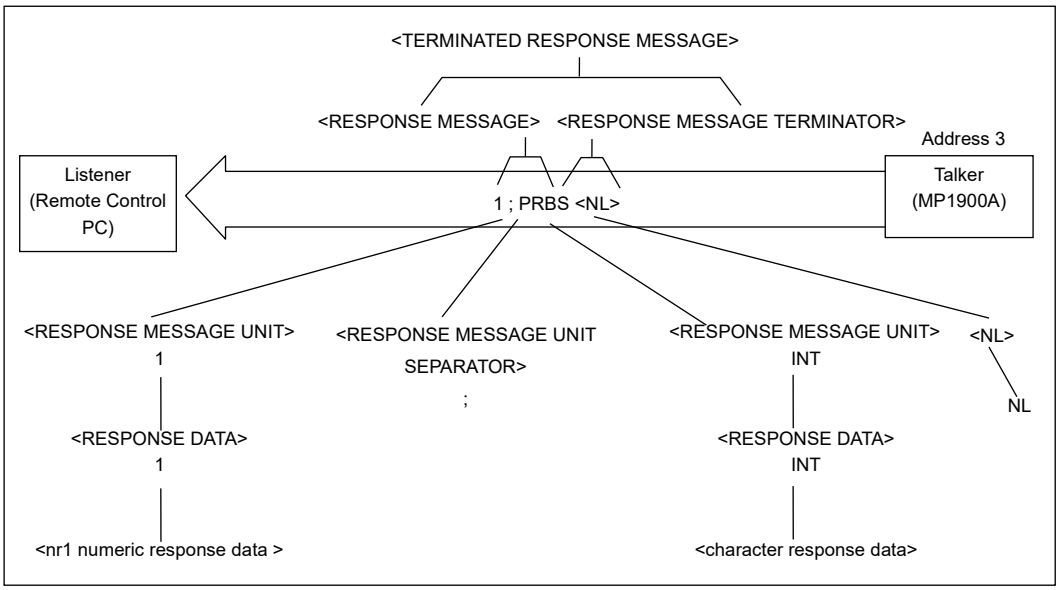


Figure 5.3.2.1-1 <TERMINATED RESPONSE MESSAGE>

As in the case of program messages, the format of response messages consists of a sequence of functional elements, which are the minimum level units to indicate a function. In the figure above, the words written in uppercase alphabetical characters enclosed within brackets (< >) indicate examples of functional elements. A functional element is further divided into coding elements. In this figure, the words written in lowercase alphabetical characters enclosed within brackets (< >) indicate examples of coding elements. Syntax notations are therefore the same for both the talker and listener.

5.3.2.2 Functional elements of response messages

(1) <TERMINATED RESPONSE MESSAGE>

The following figure shows a <TERMINATED RESPONSE MESSAGE> with two message units linked.

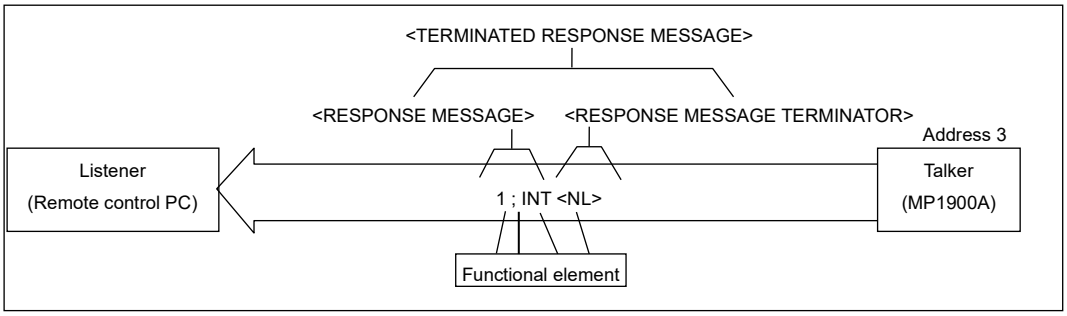
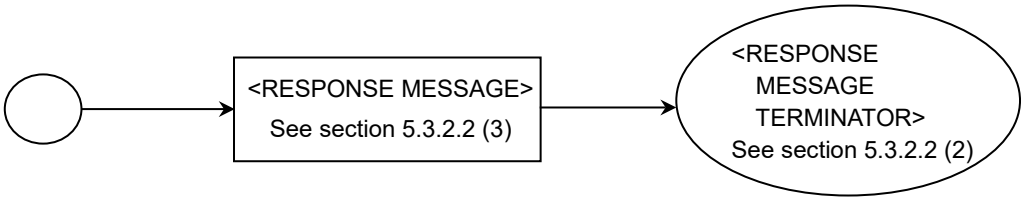


Figure 5.3.2.2-1 <TERMINATED RESPONSE MESSAGE>

<TERMINATED RESPONSE MESSAGE>is defined as follows:

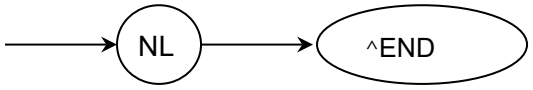


<TERMINATED RESPONSE MESSAGE> is a data message containing all the functional elements required for transmitting the message from the talker (MP1900A) to the remote control PC. A <RESPONSE MESSAGE TERMINATOR> is added to the end of a <RESPONSE MESSAGE> to complete transmission of <RESPONSE MESSAGE>.

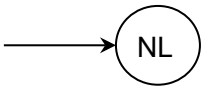
(2) <RESPONSE MESSAGE TERMINATOR>

<RESPONSE MESSAGE TERMINATOR> is placed after the last <RESPONSE MESSAGE UNIT> to terminate a sequence of one or more <RESPONSE MESSAGE UNIT> elements. The definition of <RESPONSE MESSAGE TERMINATOR> differs according to the used interface.

a. For GPIB interface



b. For Ethernet interface



NL Defined as a single ASCII code byte 0A (decimal number 10), i.e. the ASCII control character LF (Line Feed) that performs the carriage return operation bringing the print position to the same character position in the next line. It is also called NL (New Line) because it starts from a new line.
For line feed, the CR + LF code may be used instead of the LF code. If the remote control PC runs on MS-DOS or Windows, line feed is done with "CR + LF", while it is done with only "LF" for UNIX.

END Generates an EOI signal by setting the EOI (End-or-Identify) line of the GPIB control bus to TRUE (low level).

Example: A typical program that reads the state of the Synthesizer reference signal currently set is shown below.

```
10 WRITE @03:":OUTP:RCL:SEL?"
20 READ @03:A$
30 PRINT A$
40 END
```

(3) <RESPONSE MESSAGE>

The following figure shows an example of a response to a query command that queries the selected input connector and a query command that queries the bit rate set for reception signals.

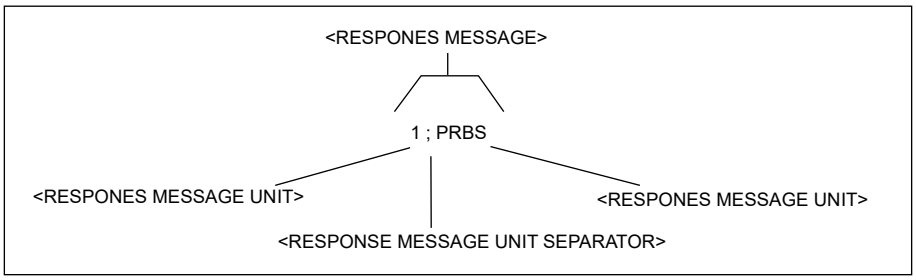
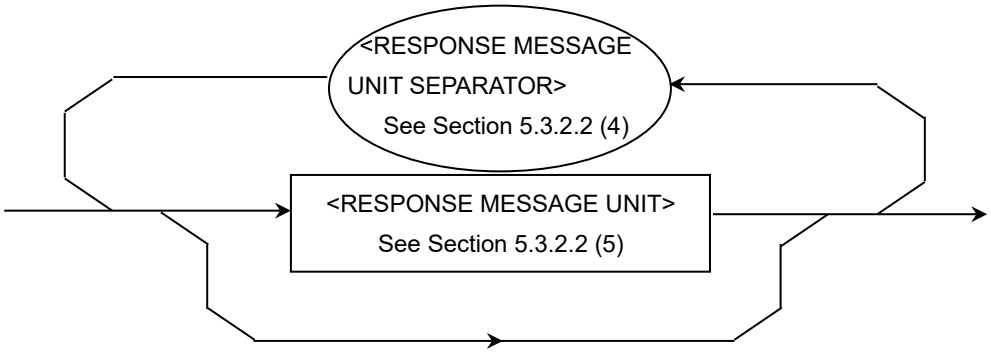


Figure 5.3.2.2-2 <TERMINATED RESPONSE MESSAGE>

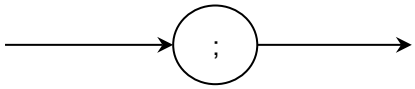
<RESPONSE MESSAGE> is defined as follows:



<RESPONSE MESSAGE> is a sequence of one or more <RESPONSE MESSAGE UNIT> elements. The <RESPONSE MESSAGE UNIT> element indicates a single message to be sent from the MP1900A to the remote control PC. The <RESONSE MESSAGE UNIT SEPARATOR> element is used to separate two or more <RESPONSE MESSAGE UNIT> elements.

(4) <RESPONSE MESSAGE UNIT SEPARATOR>

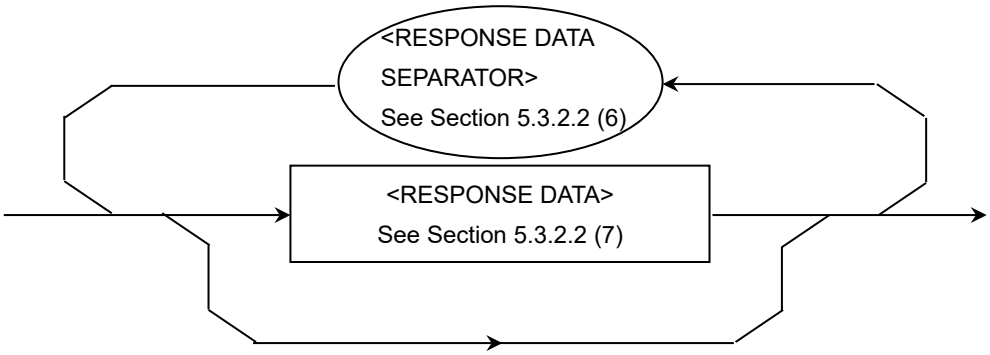
<RESPONSE MESSAGE UNIT SEPARATOR>is defined as follows:



<RESPONSE MESSAGE SEPARATOR> separates two or more <RESPONSE MESSAGE UNIT> elements with the <UNIT SEPARATOR> semicolon (;) when a sequence of them is output in one <RESPONSE MESSAGE>.

(5) <RESPONSE MESSAGE UNIT>

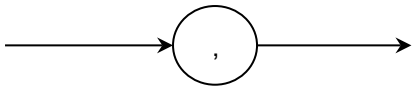
<RESPONSE MESSAGE UNIT> of the MP1900A is a response message unit with no header, and returns only the measurement result data. <RESPONSE MESSAGE UNIT>is defined as follows:



(6) <RESPONSE DATA SEPARATOR>

<RESPONSE DATA SEPARATOR> is used to separate data when two or more <RESPONSE DATA> elements are output.

<RESPONSE DATA SEPARATOR>is defined as follows:



(7) <RESPONSE DATA>

The <RESPONSE DATA> elements used in the MP1900A are described below. The response data to be returned depends on the query message.

Table 5.3.2.2-1 Response Data

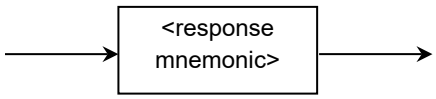
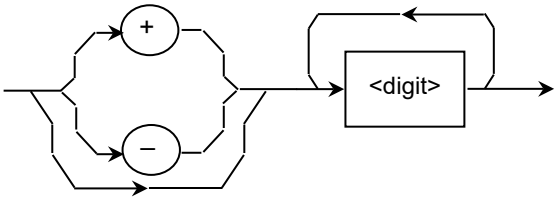
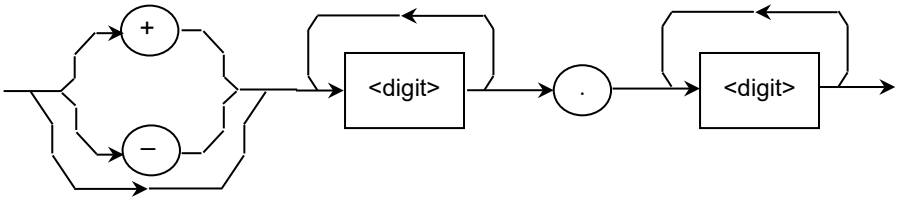
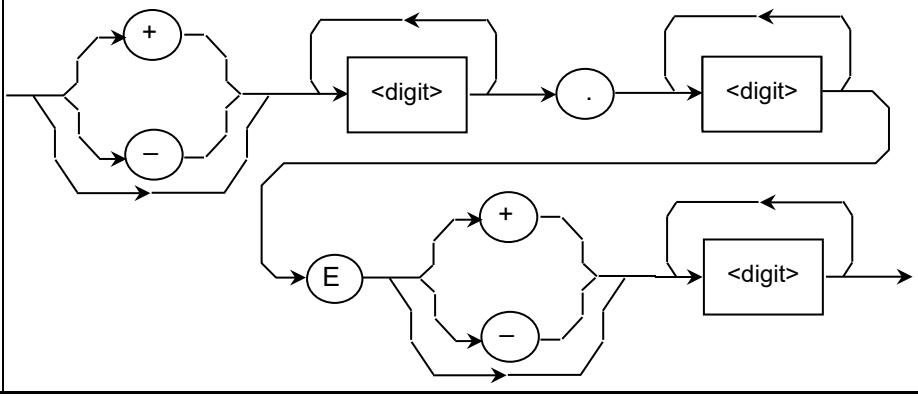
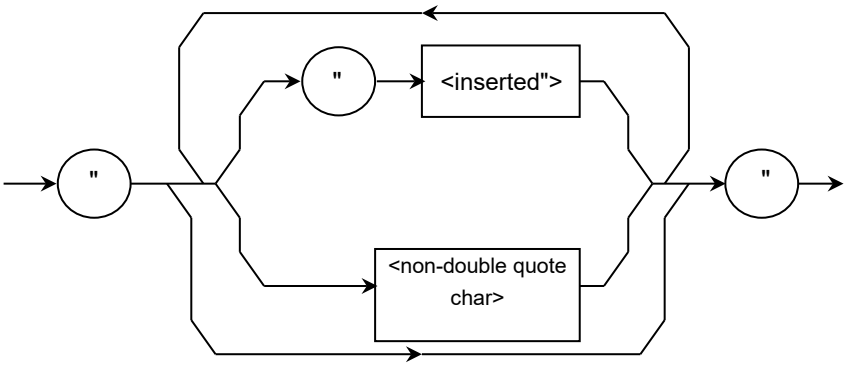
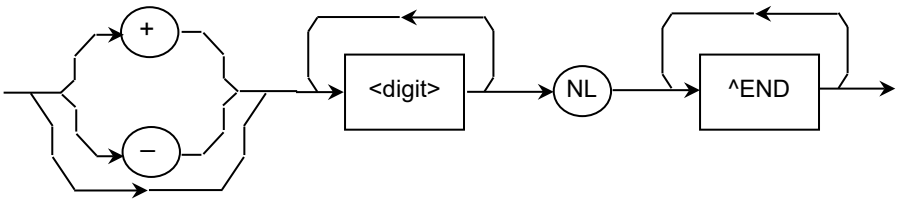
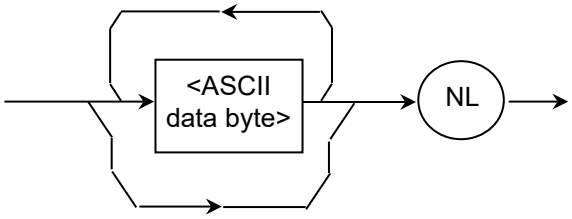
Element	Function
(1) CHARACTER RESPONSE DATA Example: ABC DEFG	Indicates short mnemonic data. 
(2) NR1 NUMERIC RESPONSE DATA Example: 123 +123 –1234	Indicates a decimal integer. 
(3) NR2 NUMERIC RESPONSE DATA Example: 12.3 +12.34 –12.345	Indicates a fixed-point numerical value. 
(4) NR3 NUMERIC RESPONSE DATA Example: 1.23E+45 –12.3E+45	Indicates a real decimal number with an exponent. 

Table 5.3.2.2-1 Response Data (Cont'd)

Element	Function
(5) STRING RESPONSE DATA Example: "1234" "ABCD" "1234.5"	Indicates a character string enclosed within double quotation marks(" "). 
(6) ARBITRARY ASCII RESPONSE DATA Example: <ASCII Byte><ASCII Byte>NL^END	Transmits an ASCII data byte without separation, excluding NL characters. The message is terminated without exit as NL^END (or NL only) is inserted next to the last data. (a) For GPIB interface  (b) For Ethernet interface 

5.3.2.3 Syntax differences between listener input format and talker output format

The differences in syntax between the listener input format and the talker output format are as follows:

Listener input format

A listener input message possesses flexibility so that the MP1900A can easily receive program messages from the remote control PC.
Easy-to-read programs can be created since uppercase and lowercase alphabetical are not identified (non case sensitive), and any <white spaces> can be added as desired to the separator or terminator in this format.

Talker output format

A talker output message is, on the other hand, transmitted strictly according to the syntax so that the remote control PC can easily accept response messages output from the MP1900A.
There is only one response message for one function.

Table 5.3.2.3-1 Syntax Difference

Item	Listener Input Program Message	Talker Output Program Message
Characteristics	Flexible	Strict
Alphabetic characters	Uppercase and lowercase characters have the same meanings (non case sensitive).	Uppercase characters only
Before and after the NR3 exponent part E	Δ+E, e+Δ (Δ is 0 or more)	Uppercase E only
Positive sign (+) of the NR3 exponent part	Can be omitted	Cannot be omitted
<white space> (: Δ)*1	Two or more <white space> can be added before and after the separator and before the terminator.	Not used
Unit separator	Δ + semicolon (Δ is 0 or more)	Semicolon only
Blank before header	Δ + header (Δ is 0 or more)	Header only
Header separator	Header + Δ (Δ is 1 or more)	Header + one $20*2
Data separator	Δ + comma + Δ (Δ is 0 or more)	Comma only
Terminator	Δ + {NL, EOI, or NL+EOI} (Δ is 0 or more)	NL+EOI*3

*1: Δ indicates <white space>.

*2: ASCII code byte 20 (decimal number 32 = ASCII character SP, space)

*3: "NL + EOI" and "CR + NL + EOI" can be switched by the SYSTem:TERMination command. CR is defined as the ASCII code 0D.

5.3.3 Command configuration

The SCPI commands have a hierarchic structure. The SCPI are grouped by the related functions, and each group forms a hierarchic structure called a “subsystem”. In this document, subsystems are expressed in a command tree, as shown below.

Table 5.3.3-1 Example of SCPI Command Tree

:INPut	:CLOCk	:SELection	<clock>
		:SELection?	
		:RECovery	<string>
		:RECovery?	

The same headers can exist in an SCPI command tree, and the position where the header exists corresponds to its function. Thus, a command must be described in full path to the header used.

5.3.4 Command syntax

Table 5.3.4-1 Example of SCPI Commands

:INPut:CLOCk:SELection <clock>
:INPut:CLOCk:SELection?
:INPut:CLOCk:RECovery <string>
:INPut:CLOCk:RECovery?

The SCPI command tree shown in 5.3.3 “Command ” contains the SCPI commands above. The following describes rules on SCPI command description.

<Command format>

A command always starts with a colon (:). A command consists of headers connected by colons (:).

<Abbreviated format for headers>

The headers are classified into short and long forms. The short form is an abbreviated form of the long form. The command is interpreted as the identical command, regardless whether it is described in the short form or in the long form. Short and long forms can also be used in combination. Although uppercase and lowercase characters are used to distinguish between the short and long forms (uppercase characters indicate the short form) in this document, they are not case sensitive when actually used.

Example:

Long form	> :INPUT:CLOCK:SELECTION RECOVERED
Short form	> :INP:CLOC:SEL REC
Long + short form	> :Inp:CLOC:SELECTION REC

<Optional node>

Square brackets ([ ]) indicate optional nodes.
A header enclosed within square brackets can be omitted; it is interpreted as being the same command, regardless of whether it is omitted.

Example:
:STATus:OPERation:[EVENt]?

When a header is not omitted	> :STATus:OPERation:EVENt?
When a header is omitted	> :STATus:OPERation?

<Header separator>

At least one space must be inserted between a command and parameter. Two or more parameters must be separated by commas (,).

5.3.5 Command combinations

Commands can be combined using a semicolon (;), as shown in the examples below. The second command is referred to as the same level as the lowest hierarchy of the first command. Thus, the second command can be described in full path, as shown in Example 1, or described omitting the higher-level headers than "SELection", as shown in Example 2.

Example 1: >:INPut:CLOCk:SELection
RECovered;:INPut:CLOCk:RECovery" "OC_3"
Example 2: :INPut:CLOCk:SELection RECovered;RECovery "OC_3"

Note:

Commands that handle some kind of binary data cannot be combined.

Example:
:SOURce:PATTern:BDATA:WHOLe
WRT, RED?

5.3.6 Parameters

The following table shows the parameter types used in the MP1900A. In this document, parameter types are indicated by the lowercase alphabetical characters within brackets (< >). The corresponding <PROGRAM DATA> types as defined in IEEE 488.2 (or SCPI) are indicated by uppercase alphabetical.

Table 5.3.6-1 Description of Parameter Types

Parameter Type	Description
<numeric> <DECIMAL NUMERIC PROGRAM DATA>	Indicates a decimal integer.
<numeric> <NON-DECIMAL NUMERIC PROGRAM DATA>	Indicates a numeric value other than a decimal (binary, octal, etc.).
<boolean> <BOOLEAN PROGRAM DATA>	Indicates a logical value. OFF or 0 corresponds to False, and ON or 1 corresponds to True. Either 0/1 or OFF/ON can be used for setting, but responses to a query use 0/1.
<string>,<display>...etc <STRING PROGRAM DATA>	Indicates a character string. It is an ASCII character string enclosed within single quotation marks (' ') or double quotation marks (" "). Example: 'SES_3:DM_6' or "SES_3:DM_6"
<brate>,<type>...etc <CHARACTER PROGRAM DATA>	Indicates character data. It is expressed as a short string corresponding to the setting details.
<bdata>...etc <ARBITRARY BLOCK PROGRAM DATA>	Used to transmit 8-bit binary data.

5.3.7 Responses

The following table shows the response types used in the MP1900A. In this document, response types are indicated by the lowercase alphabetical characters enclosed within brackets (< >). The corresponding <RESPONSE DATA> types as defined in IEEE 488.2 (or SCPI) are indicated by uppercase alphabetical.

Table 5.3.7-1 Description of Response Types

Response Type	Description
<numeric> <NR1 NUMERIC RESPONSE DATA>	The number of digits of the response is variable, and the maximum number of digits of the numerical value range is the maximum number of digits of the response. No space must be inserted between the sign and numerical value. > :SYSTem:DATE? < 2006,7,14
<numeric> <NR2 NUMERIC RESPONSE DATA>	The number of digits of the response is variable, and the maximum number of digits of the numerical value (including decimal numbers) range is the maximum number of digits of the response. A space must not be inserted between the sign and numerical value. > :OUTPut:DATA:AMPLitude? < 1.000
<brate>,<type>...etc <CHARACTER RESPONSE DATA>	Returns the short form of the character. > :SOURce:SYNThesizer:JITTer:MODulation:SELect? < INT
<string>,<display>...etc <STRING RESPONSE DATA>	Returns a string enclosed within double quotation marks (" "). If there are short and long forms for the string of the corresponding program command, the short form is returned. > :DISPlay:CUSTomize:BUTTon:NOW? < 1, "EADD" (The short form of "EADDition")
<ARBITRARY ASCII RESPONSE DATA>	Returns 7-bit ASCII text data without separation. The last data byte is terminated by NL^END or NL only. > *OPT? < OPT301,OPT302,MU181000A,OPT101,…

5.4 IEEE 488.2 Common Commands

This section describes IEEE 488.2 Common Commands support to MP1900A.
Common commands can be used commonly on any of the GPIB interface and Ethernet interface. All common commands supported by the MP1900A are sequential commands. Table 5.4-1 below lists the IEEE 488.2 common commands supported by the MP1900A.

Table 5.4-1 IEEE 488.2 Common Commands List

Mnemonic	Command's full spell
*IDN?	Identification Query
*RST	Reset Command
*OPC	Operation Complete Command
*OPC?	Operation Complete Query
*WAI	Wait Continue Command
*CLS	Clear Status Command
*ESE	Standard Event Status Enable Command
*ESE?	Standard Event Status Enable Query
*ESR?	Standard Event Status Register Query
*SRE	Service Request Enable Command
*SRE?	Service Request Enable Query
*STB?	Read Status Byte Query
*TRG	Trigger Command
*OPT?	Option Identification Query

*IDN? Identification Query

Parameter	None
Response	<Manufacturer>, <Model>, <Serial No.> <Manufacturer>, ANRITSU <Model> = <CHARACTER RESPONSE DATA> MP1900A <Serial No.> = <NR1 NUMERIC RESPONSE DATA> 0000000000 to 9999999999 Main frame Serial number
Function	Reports manufacture name, model, etc.
Example	> *IDN? < ANRITSU,MP1900A,0123456789

*RST Reset Command

Parameter	None
Function	Initializes entire system. Cancels the measurement and clear the contents. To reset to the factory default, perform SCPI command :SYSTem:MEMory:INITialize
Example	> *RST

*OPC Operation Complete Command

Parameter	None
Function	Sets bit 0 (operation complete bit) of standard event status register and sets SRQ to ON, when execution of preceding command is completed.
Example	> *OPC

*OPC? Operation Complete Query

Parameter	None
Response	<NR1 NUMERIC RESPONSE DATA> 1
Function	Returns 1 when preceding command is completed.
Example	> *OPC? < OPC 1

*WAI Wait to Continue Command

Parameter	None
Function	Waits to execute the succeeding command until execution of preceding command is completed. Executes overlapped commands as sequential commands. This function is enabled only for preceding command.
Example	`> *WAI`

*CLS Clear Status Command

Parameter	None
Function	Clear all event registers and queues, except output queue and MAV summary message. Reset of enable registers and transition filters for the device unique status registers is executed using the SCPI command :STATus:PRESet. Both output queue and MAV bits are also cleared when an *CLS is sent immediately after <PROGRAM MESSAGE TERMINATOR> and before <QUERY MESSAGE UNIT> element. Execution of succeeding commands is set to wait until execution of the preceding command is completed.
Example	`> *CLS`

*ESE Standard Event Status Enable Command

Parameter
<DECIMAL NUMERIC PROGRAM DATA>
An integer between 0 and 255
The parameter represents the total of bit digit values when bits to be enabled are selected from bits of standard event enable register.
The digit value for bit to be disabled is set to 0.
For the MP1900A, register settings are as listed below:

Bit 7 (2^7 = 128)	Power On
Bit 5 (2^5 = 32)	Command error
Bit 4 (2^4 = 16)	Execution error
Bit 3 (2^3 = 8)	Errors other than command, query and execution errors
Bit 0 (2^0 = 1)	Completion of operation

Function
Sets or clears standard event status enable register.

Example
To set bits 3 (= 8) and 4 (= 16) of enable register:

```
> *ESE 24
```

*ESE? Standard Event Status Enable Query

Parameter
None

Response
<NR1 NUMERIC RESPONSE DATA>

0 to 255:	Total of digit values of standard event status enable register bits.

For bit settings of standard status register, refer to the *ESE command.

Function
Queries current value of standard event status enable register.

Example

```
> *ESE?
< ESE 24
```

*ESR? Standard Event Status Register Query

Parameter
None

Response
<NR1 NUMERIC RESPONSE DATA>

0 to 255:	Total of digit values of standard event status register bits.

For bit settings of standard status register, refer to the *ESE command.

Function
Queries current value of standard event status register.

Example
When a command error exists:

```
> *ESR?
< ESR 32
```

*SRE Service Request Enable Command

Parameter
<DECIMAL NUMERIC PROGRAM DATA>
An integer between 0 and 255
Parameter represents the total of bit digit values when bits to be enabled are selected from bits of service request enable register. The digit value for a bit to be disabled is set to 0.
For the MP1900A, register settings are as listed below:

Bit 7 (2^7 = 128)	Operation status register summary
Bit 5 (2^5 = 32)	Event status register summary
Bit 4 (2^4 = 16)	Indicates that the output queue is not empty.
Bit 3 (2^3 = 8)	Questionable status register summary
Bit 2 (2^2 = 4)	Indicates that the error and event queues are not empty.

Function
Sets bits of service request enable register.

Example
To set bit 4 (= 16) of enable register:

```
> *SRE 16
```

*SRE? Service Request Enable Query

Parameter
None

Response
<NR1 NUMERIC RESPONSE DATA>

0 to 255:	Total of digit values of service request enable register bits.

For bit settings of service request enable register bits, refer to the *SRE command.

Function
Function Queries current value of service request enable register.

Example

```
> *SRE?
< SRE 16
```

*STB? Read Status Byte Query

Parameter	None
Response	<NR1 NUMERIC RESPONSE DATA>
	Bit 7 (2^7 = 128) Operation status register summary
	Bit 6 (2^6 = 64) MSS (Master Summary Status)
	Bit 5 (2^5 = 32) Event status register summary
	Bit 4 (2^4 = 16) Indicates that output queue is not empty.
	Bit 3 (2^3 = 8) Questionable status register summary
	Bit 2 (2^2 = 4) Indicates that error and event queues are not empty.
Function	Queries current value of status byte including MSS (Master Summary Status) bit.

Example	When the event status register summary is true:
	`> *STB?`
	`< STB 32`

*TRG Trigger Command

Parameter	None
Function	Operates the same as that of IEEE 488.2 GET (Group Execute Trigger bus command). It starts or restarts measurement when the MP1900A receives the *TRG command. This command is valid only for measurements in the Error and Alarm mode.
Example	`> *TRG`

*OPT? Option Identification Query

Parameter	None
Response	<ARBITRARY ASCII RESPONSE DATA> Characters (refer to Table below) corresponding to the name of an option or module installed.
Function	Queries the options installed in the MP1900A. All module options installed are returned in a comma-separated string. However, there are no available MP1900A options at present, so this query always returns a NULL.
Example	`> *OPT?` `<`

5.5 Status Report

This section describes Status Register configuration and bit definition of Status Register. For the MP1900A, installed Status Register is as below:

- IEEE 488.2 Regulated Register
  Standard Event Register, Status Byte Register
- SCPI Regulated Register
  OPERational Status Register
- Device-unique Status Registers
  Device-Unique Status Register (However, separated from Regulated Register)

5.5.1 Overview

For MP1900A, Status Register Configuration is as shown on the Figure 5.5.1-1.

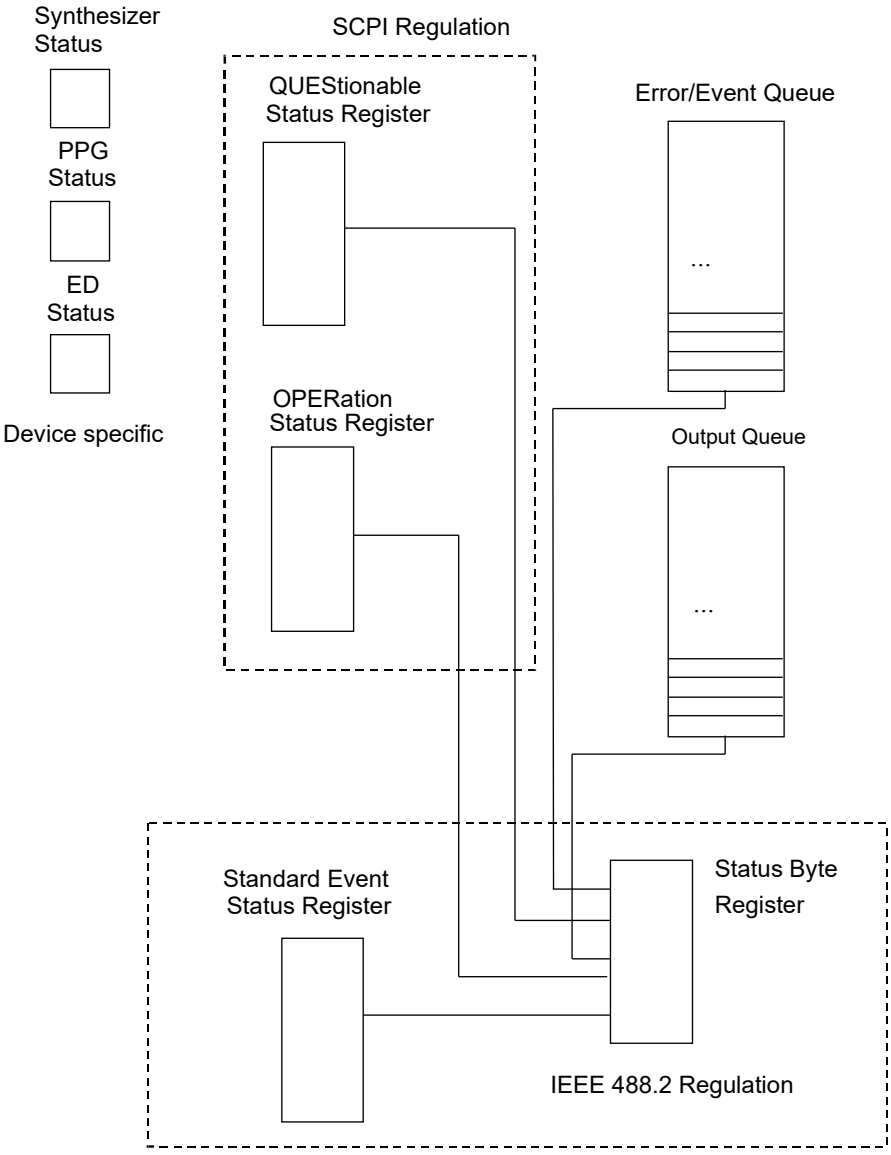


Figure 5.5.1-1 Status Register Configuration

5.5.2 IEEE 488.2 regulated register

The bits of the following two IEEE 488.2 regulated registers are defined as follows,

Table 5.5.2-1 IEEE 488.2 Regulated Register

Name	Description
Status byte register	This register can set RQS and 7 summary message bits. It is used as a pair with the service request enable register. When OR of both registers is not 0, RQS turns ON. RQS is programmed in bit 6. This bit is used to report to the remote control PC that a service request is given.
Standard event status register	Stores 8 events which the device encounters as the standard events. The logical OR output bit is summarized and displayed in bit 5 of the status byte register as an ESB (Event Status Bit) summary message.

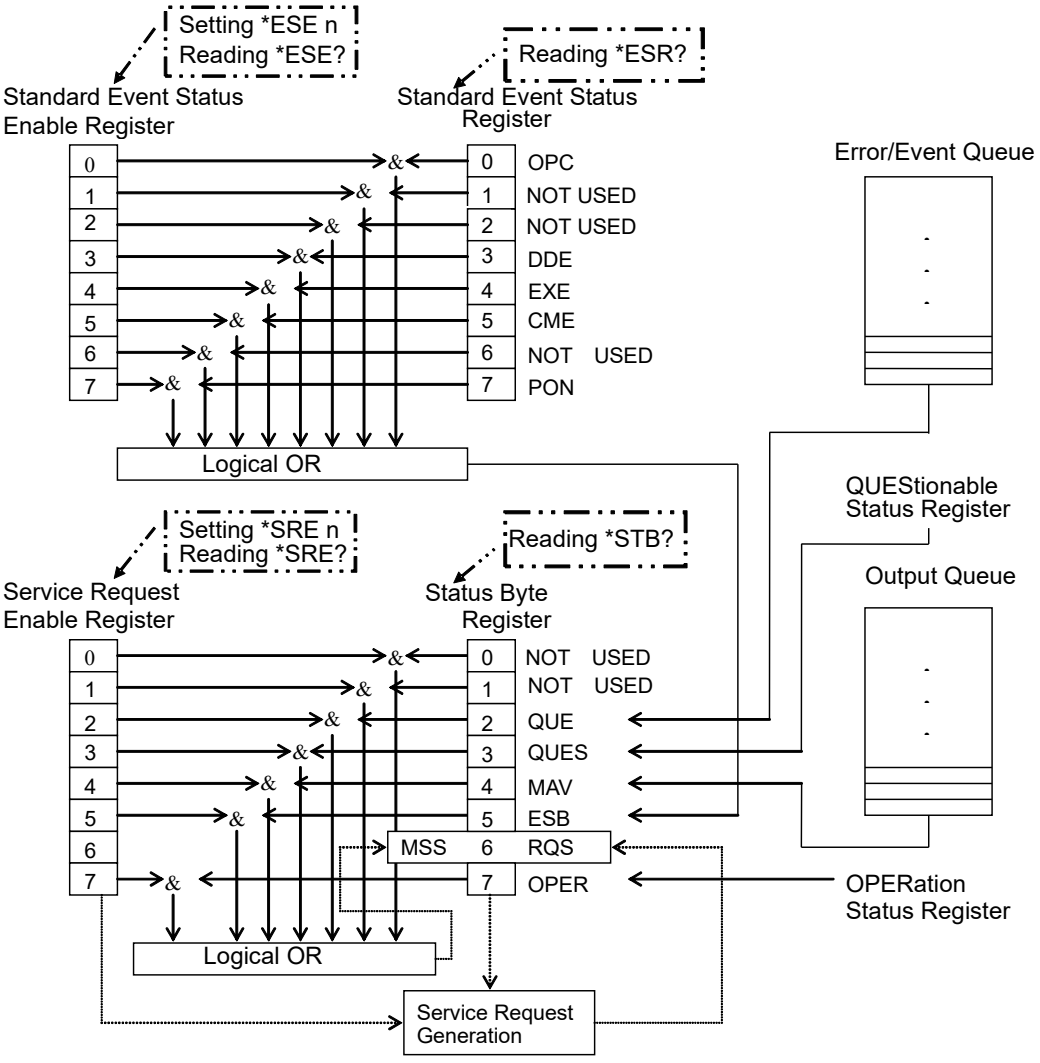


Figure 5.5.2-1 Status Register Configuration

Table 5.5.2-2 Status Byte Register Bit Definition

Bit	Mnemonic	Description
DB2	QUE (error/event QUEue)	Indicates that the error and event queues not empty.
DB3	QUES (QUEStionable status register summary)	QUEStionable status register summary.
DB4	MAV (Message AVailable)	Indicates that the output queue is not empty. When the device is ready to receive the response message send-out request from the controller, the MAV summary message bit is set to 1 (TRUE). This message can be used to allow the controller to send the queue command to the device and wait until MAV turns TRUE.
DB5	ESB (Event Summary Bit)	Standard event status register summary
DB6	RQS (ReQuest Service)	Returns a 7-bit status byte and this RQS to the controller in the serial pole mode.
	MSS (Master Summary Status)	Indicates that the MP1900A has reason to request at least one service. When inquiring the status byte by the *STB? command, this MSS summary message appears in bit 6 in place of the RQS message.
DB7	OPER (OPERation status register summary)	OPERation status register summary

Table 5.5.2-3 Standard Event Status Register Bit Definition

Bit	Mnemonic	Description
DB0	OPC (OPeration Complete)	Indicates that all the specified operations are completed.
DB3	DDE (Device-Dependent Error)	Indicates that an error other than command error or execution error occurs.
DB4	EXE (EXecution Error)	Indicates that an execution error occurs.
DB5	CME (CoMmand Error)	Indicates that a command error occurs.
DB7	PON (Power ON)	Indicates that the power supply turns from OFF to ON.

Note:

See 5.4 “IEEE 488.2 Common Commands” for the setting and query commands for the Status Byte Register and Standard Event Status Registers.

5.5.3 SCPI-regulated status register

SPCI regulates that the Instrument should contain the following registers in addition to those regulated in IEEE 488.2. Table 5.5.3-1 shows the SCPI regulated Status Registers definition.

Table 5.5.3-1 SCPI-Regulated Status Registers

Name	Description
QUEStionable Status register	Reports a signal status such as a measurement result. This register is used to send a service request to an external controller when an error occurs. Note that the MP1900A does not use this register.
OPERation Status register	Reports some MP1900A statuses.

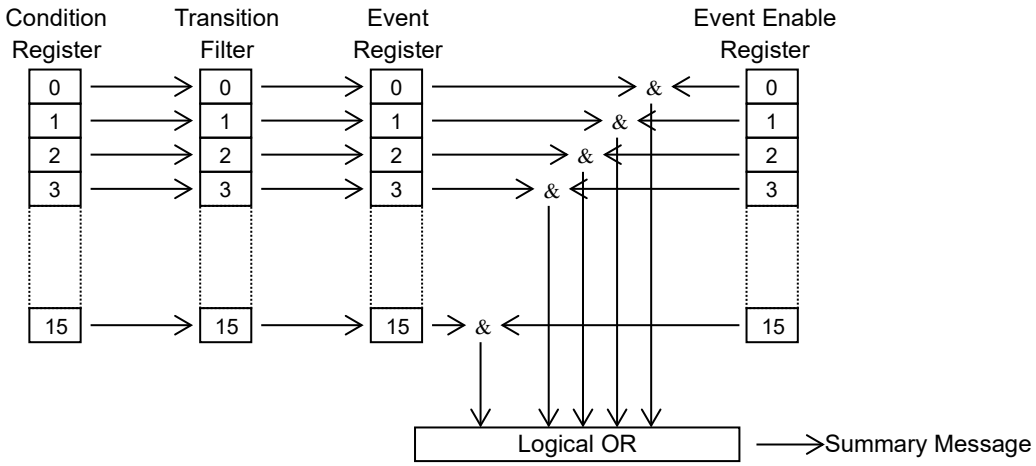


Figure 5.5.3-1 OPERation Status Register

Table 5.5.3-2 OPERation Status Register Bit Definition

Bit	Mnemonic	Description
DB3	BAT (BAThtub measuring)	Indicates that the Instrument is measuring Bathtub.
DB4	MEAS (MEASuring)	Indicates that the Instrument is measuring when any port is in execution.*
DB6	PAMB (PAM Ber)	Indicates that the Instrument is measuring PAM4 BER.
DB7	AAD (Auto ADjust)	Indicates that the Instrument is in Auto Adjust.
DB8	ASE (Auto SEarching)	Indicates that the Instrument is in Auto Search.
DB9	EMM (Eye Margin Measuring)	Indicates that the Instrument is measuring eye margin.
DB10	EDI (Eye Contour)	Indicates that the Instrument is measuring Eye Contour.
DB11	PSET (Pattern SETing)	Indicates that the Instrument is setting pattern.
DB12	INI (INItialize)	Indicates that the Instrument is in initialization.

*: When re-measurement is performed during measurement, DB4 becomes OFF and then ON again. DB4 bit becomes on at the same time when measurement is started.

5.5.4 How to read and write status register

Table 5.5.4-1 shows how to read and write status register.

Table 5.5.4-1 Reading and Writing the Status Register

Register	Reading	Writing
Status byte register	Read the register bits using the serial pole. A 7-bit status byte and a RQS message bit are returned. The status byte value does not change. *STB? Common query A numeric value composed of the statusbyte register value and the MSS summary message is returned. The Status register does not change at this time.	Disabled
Service request Enable register	*SRE? common query The register bits do not change.	*SRE common command
Standard status register	*ESR? common query The register bits are cleared after being read.	Disabled
Standard event status enable register	*ESE? common query The register bits do not change.	*ESE common command
SCPI event register	:STATus:...:EVENt? Device-unique command The register bits are cleared.	Disabled
SCPI enable register	:STATus:...:ENABle? The contents of the register do not change.	:STATus:...:ENABle
SCPI Transition filter	:STATus:...:PTRansition? :STATus:...:NTRansition? Device-unique command The contents of register bits do not change.	Device-unique command :STATus:...:PTRansition :STATus:...:NTRansition
Error/event queue	:SYSTem:ERRor?	Disabled

Note:

The SCPI event register, SCPI enable register, and SCPI Transition filter listed above indicate the SCPI-regulated status registers and an event or a transition filter in a device-unique status.

5.5.5 How to clear and reset status register

Table 5.5.5-1 shows how to clear and reset status register.

Table 5.5.5-1 Clearing and Resetting the Status Registers

Register	*RST	*CLS	Power ON	STATus:PRESet	Other method to clear register
Status byte register	No change	Clear	Clear	No change	
Service request enable register	No change	No change	Clear	No change	Executing *SRE 0
Standard event status register	No change	Clear	Clear*2	No change	Cleared when an event is read by *ESR?
Standard event status enable register	No change	No change	Clear*1	No change	Executing *ESE 0
SCPI event register	No change	Clear	Clear*1	No change	Cleared when an event is read by :STATus:...:EVENt?
SCPI enable register	No change	No change	Reset*1	Reset	Executing :STATus:...:ENABle 0
SCPI Transition filter	No change	Reset	Reset*1	Reset	Executing :STATus:...:PTRansition 0 and :STATus:...:NTRansition 0
Error/event queue	No change	Clear	Clear	No change	Reading all events by :SYSTem:ERRor?

*1: When power on as PSC (Power-ON Status Clear) flag is true, it will be cleared (or reset).

*2: To be 128 bits.

Note:

The SCPI event register, SCPI enable register, and SCPI Transition filter listed above indicate the SCPI-regulated status registers.

Table 5.5.5-2 shows the reset values of the registers influenced by the :STATus:PRESet command.

Table 5.5.5-2 Values Reset by the :STATus:PRESet Command

Register	Enable/filter	Reset value
OPERational status register	Enable register	All 0
	PTRansition filter	All 1
	NTRansition filter	All 0

5.5.6 Device-unique status

MP1900A supports each module status as device-unique status. Figure 5.5.6-1 shows Device-unique Status Configuration.

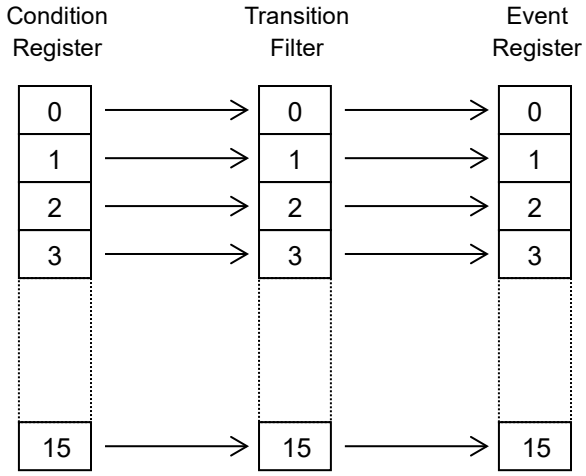


Figure 5.5.6-1 Each Status Configuration

Condition Register

Monitors the device status and changes real time in response to the device status. Thus, this register does not memorize the status.

Transition Filter

Sets the Condition Register data in the Event Register. The following three types of transition filters are available depending on which change of the Condition Register is to be evaluated.

Positive direction change:

The event becomes true only when the corresponding condition changes from false to true.

Negative direction change:

The event becomes true only when the corresponding condition changes from true to false.

Bi-directional change:

The event becomes true when a change arise either in the positive or negative direction.

Event Register

Memorizes output from Transition Filter.

The following show module status bit definition.

Table 5.5.6-1 Module Status

Status	Contents
Synthesizer Status	Reports Synthesizer status.
PPG Status	Reports PPG status.
ED Status	Reports ED status.

Table 5.5.6-2 Synthesizer Status Bit Definition

BIT	Contents
DB0	Indicates PLL Unlock occurred.

Table 5.5.6-3 ED Status Bit Definition

BIT	Contents
DB0	Indicates Insertion Error was detected.
DB1	Indicates Omission Error was detected.
DB2	Indicates Total Error was detected.
DB4	Indicates Pattern Sync Loss occurred.
DB5	Indicates Clock Loss occurred.
DB6	Indicates Delay Busy occurred.
DB8	Indicates Transition Error was detected.
DB9	Indicates Non Transition Error was detected.
DB10	Indicates CR Unlock occurred.
DB11	Indicates Delay Calibration Require occurred.

Table 5.5.6-4 PPG Status Bit Definition

BIT	Contents
DB1	Indicates CMU-MUX Unlock occurred.
DB2	Indicates Delay Busy occurred.
DB4	Indicates Delay Calibration Require occurred.

5.5.7 Status commands

This section explains about OPERational Status Register and each module-unique status commands.

When reading and writing each module-unique status, the following three commands must be transmitted before transmitting a status command.

(1) :UENTry:ID <unit_number>

(2) :MODule:ID <module_number>

(3) :PORT:ID <port_number>

These three commands identify the operating module, and any commands sent/received after them operate for the identified module. However, :PORT:ID <port_number> can be omitted.

5.5.7.1 Status preset

The following command initializes the Enable Register and filter of the OPERational Status Register.

:STATus:PRESet

Function	Initializes the event status register and filter.
Example	`> :STATus:PRESet`

5.5.7.2 Operation Status Register

The Operation Status Register is used to indicate an operation status such as "measurement in progress".

:STATus:OPERation[:EVENt]?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0 to 8184	Sum of all bits set in the event register (DECIMAL)
	Available bit	
	8 (Bit 3)	Bathtub measurement in progress
	16 (Bit 4)	Measurement in progress
	128 (Bit 7)	Auto Adjust in progress
	256 (Bit 8)	Auto Search in progress
	512 (Bit 9)	Eye Margin measurement in progress
	1024 (Bit 10)	Eye Contour measurement in progress
	2048 (Bit 11)	Pattern loading in progress
	4096 (Bit 12)	Initialization in progress
		PAM4 BER measurement in progress
Function	Queries events register at OPERation Status Register.	
Example	`> :STATus:OPERation:EVENt?`	
	or	
	`> :STATus:OPERation?`	
	`< 16`	

:STATus:OPERation:CONDition?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0 to 8184	Sum of all bits set in the condition register (DECIMAL)
	Available bit	
	8 (Bit 3)	Bathtub measurement in progress
	16 (Bit 4)	Measurement in progress
	128 (Bit 7)	Auto Adjust in progress
	256 (Bit 8)	Auto Search in progress
	512 (Bit 9)	Eye Margin measurement in progress
	1024 (Bit 10)	Eye Contour measurement in progress
	2048 (Bit 11)	Pattern loading in progress
	4096 (Bit 12)	Initialization in progress
		PAM4 BER measurement in progress
Function	Queries condition register at OPERation Status Register.	
Example	`> :STATus:OPERation:CONDition?`	
	`< 16`	

:STATus:OPERation:ENABle <numeric>

Parameter	<numeric> = <DECIMAL NUMERIC PROGRAM DATA>	
	0 to 8184	Sum of all bits that you want to enable in event enable register (DECIMAL)
	Available bit	
	8 (Bit 3)	Bathtub measurement in progress
	16 (Bit 4)	Measurement in progress
	128 (Bit 7)	Auto Adjust in progress
	256 (Bit 8)	Auto Search in progress
	512 (Bit 9)	Eye Margin measurement in progress
	1024 (Bit 10)	Eye Contour measurement in progress
	2048 (Bit 11)	Pattern load in progress
	4096 (Bit 12)	Initialization in progress
		PAM4 BER measurement in progress
	If set to 0, all bits are masked.	
Function	Sets mask value of event enable register at OPERation status register	
Example	To set event enable register to 16 at OPERation status register.	
	`> :STATus:OPERation:ENABle 16`	

:STATus:OPERation:ENABle?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0 to 8184	Sum of all bits set in the event enable register (DECIMAL)
Function	Queries enable register at OPERation status register.	
Example	`> :STATus:OPERation:ENABle?`	
	`< 16`	

:STATus:OPERation:PTRansition <numeric>

Parameter

<numeric> = <DECIMAL NUMERIC PROGRAM DATA>

0 to 8184	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)

Available bit

8 (Bit 3)	Bathtub measurement in progress
16 (Bit 4)	Measurement in progress
128 (Bit 7)	Auto Adjust in progress
256 (Bit 8)	Auto Search in progress
512 (Bit 9)	Eye Margin measurement in progress
1024 (Bit 10)	Eye Contour measurement in progress
2048 (Bit 11)	Pattern load in progress
4096 (Bit 12)	Initialization in progress
	PAM4 BER measurement in progress

Function

Sets the transition filter (positive direction change) of the OPERation status register.

Example

To set the transition filter (positive direction change) of the OPERation status register to 16.

```
> :STATus:OPERation:PTRansition 16
```

:STATus:OPERation:PTRansition?

Response

<numeric> = <NR1 NUMERIC RESPONSE DATA>

0 to 8184	Sum of all bits set in the transition filter (DECIMAL)

Function

Queries the transition filter (positive direction change) of the OPERation status register.

Example

```
> :STATus:OPERation:PTRansition?
< 16
```

:STATus:OPERation:NTRansition <numeric>

Parameter	<numeric> = <DECIMAL NUMERIC PROGRAM DATA>	
	0 to 8184	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit	
	8 (Bit 3)	Bathtub measurement in progress
	16 (Bit 4)	Measurement in progress
	128 (Bit 7)	Auto Adjust in progress
	256 (Bit 8)	Auto Search in progress
	512 (Bit 9)	Eye Margin measurement in progress
	1024 (Bit 10)	Eye Contour measurement in progress
	2048 (Bit 11)	Pattern load in progress
	4096 (Bit 12)	Initialization in progress
		PAM4 BER measurement in progress
Function	Sets the transition filter (negative direction change) of the OPERation status register.	
Example	To set the transition filter (negative direction change) of the OPERation status register to 16.	
	`> :STATus:OPERation:NTRansition 16`	

:STATus:OPERation:NTRansition?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0 to 8184	Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (negative direction change) of the OPERation status register.	
Example	`> :STATus:OPERation:NTRansition?`	
	`< 16`	

5.5.7.3 Synthesizer status

5.5.7.3.1 MU181000A/B

Synthesizer status displays faults at the MU181000A/B.

:INSTrument:SYG125[:EVENt]?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0 to 1	Sum of all bits set in the event register (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
Function	Queries events at Synthesizer.	
Example	`> :INSTrument:SYG125:EVENt?`	
	or	
	`> :INSTrument:SYG125?`	
	`< 1`	

:INSTrument:SYG125:CONDition?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0 to 3	Sum of all bits set in the condition register (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
	2 (Bit 1)	Module I/F Error occurs
Function	Queries condition at Synthesizer.	
Example	`> :INSTrument:SYG125:CONDition?`	
	`< 1`	

:INSTrument:SYG125:PTRansition <numeric>

Parameter	<numeric> = <DECIMAL NUMERIC PROGRAM DATA>	
	0 to 1	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
Function	Sets the transition filter (positive direction change) of the Synthesizer Status.	
Example	To set the transition filter (positive direction change) of the Synthesizer Status to 1.	
	`> :INSTrument:SYG125:PTRansition 1`	

:INSTrument:SYG125:PTRansition?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 to 1 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (positive direction change) of the Synthesizer Status.
Example	`> :INSTrument:SYG125:PTRansition?`
	`< 1`

:INSTrument:SYG125:NTRansition <numeric>

Parameter	<numeric> = <DECIMAL NUMERIC PROGRAM DATA>
	0 to 1 Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit
	1 (Bit 0) PLL Unlock occurs
Function	Sets the transition filter (negative direction change) of the Synthesizer Status.
Example	To set the transition filter (negative direction change) of the Synthesizer Status to 1.
	`> :INSTrument:SYG125:NTRansition 1`

:INSTrument:SYG125:NTRansition?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 to 1 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (negative direction change) of the Synthesizer Status.
Example	`> :INSTrument:SYG125:NTRansition?`
	`< 1`

:INSTrument:SYG125:RESet

Function	Initializes event at Synthesizer.
Example	`> :INSTrument:SYG125:RESet`

5.5.7.3.2 MU191000A

Synthesizer status displays faults at the MU191000A.

:INSTrument:SYG125[:EVENt]?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 1	Sum of all bits set in the event register (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
Function	Queries events at Synthesizer.	
Example	`> :INSTrument:SYG125:EVENt?`	
	or	
	`> :INSTrument:SYG125?`	
	`< 1`	

:INSTrument:SYG125:CONDition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 3	Sum of all bits set in the condition register (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
	2 (Bit 1)	Module I/F Error occurs
Function	Queries condition at Synthesizer.	
Example	`> :INSTrument:SYG125:CONDition?`	
	`< 1`	

:INSTrument:SYG125:PTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>	
	0 to 1	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
Function	Sets the transition filter (positive direction change) of the Synthesizer Status.	
Example	To set the transition filter (positive direction change) of the Synthesizer Status to 1.	
	`> :INSTrument:SYG125:PTRansition 1`	

:INSTrument:SYG125:PTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>
	0 to 1 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (positive direction change) of the Synthesizer Status.
Example	`> :INSTrument:SYG125:PTRansition?` `< 1`

:INSTrument:SYG125:NTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>
	0 to 1 Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit
	1 (Bit 0) PLL Unlock occurs
Function	Sets the transition filter (negative direction change) of the Synthesizer Status.
Example	To set the transition filter (negative direction change) of the Synthesizer Status to 1. `> :INSTrument:SYG125:NTRansition 1`

:INSTrument:SYG125:NTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>
	0 to 1 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (negative direction change) of the Synthesizer Status.
Example	`> :INSTrument:SYG125:NTRansition?` `< 1`

:INSTrument:SYG125:RESet

Function	Initializes event at Synthesizer.
Example	`> :INSTrument:SYG125:RESet`

:INSTrument:SYG[:EVENt]?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 1	Sum of all bits set in the event register (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
Function	Queries events at Synthesizer.	
Example	`> :INSTrument:SYG:EVENt?`	
	or	
	`> :INSTrument:SYG?`	
	`< 1`	

:INSTrument:SYG:CONDition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 3	Sum of all bits set in the condition register (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
	2 (Bit 1)	Module I/F Error occurs
Function	Queries condition at Synthesizer.	
Example	`> :INSTrument:SYG:CONDition?`	
	`< 1`	

:INSTrument:SYG:PTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>	
	0 to 1	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit	
	1 (Bit 0)	PLL Unlock occurs
Function	Sets the transition filter (positive direction change) of the Synthesizer Status.	
Example	To set the transition filter (positive direction change) of the Synthesizer Status to 1.	
	`> :INSTrument:SYG:PTRansition 1`	

:INSTrument:SYG:PTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>
	0 to 1 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (positive direction change) of the Synthesizer Status.
Example	`> :INSTrument:SYG:PTRansition?`
	`< 1`

:INSTrument:SYG:NTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>
	0 to 1 Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit
	1 (Bit 0) PLL Unlock occurs
Function	Sets the transition filter (negative direction change) of the Synthesizer Status.
Example	To set the transition filter (negative direction change) of the Synthesizer Status to 1.
	`> :INSTrument:SYG:NTRansition 1`

:INSTrument:SYG:NTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>
	0 to 1 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries the transition filter (negative direction change) of the Synthesizer Status.
Example	`> :INSTrument:SYG:NTRansition?`
	`< 1`

:INSTrument:SYG:RESet

Function	Initializes event at Synthesizer.
Example	`> :INSTrument:SYG:RESet`

:INSTrument:SYG:MODule:CONDition?

Response	<serial>=<STRING RESPONSE DATA>, <firm>=<STRING RESPONSE DATA>
Function	Queries the serial number and firmware version of the internal modules in the Synthesizer.

Example	`> :INSTrument:SYG:MODule:CONDition?`
	or
	`> :INST:SYG:MOD:COND?`
	`< 2522002,V2025.6.1`

5.5.7.4 ED status

ED status is used to indicate an alarm and error of MU195040A, MU196040A and MU196040B.
It is compatible with the MU183040A, MU183040B, MU183041A and MU183041B.

:INSTrument:EDG32[:EVENt]?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 16383	Sum of all bits set in the event register (DECIMAL)
	Available bit	
	1 (Bit 0)	Error (Data1)
	2 (Bit 1)	Error (Data2)
	16 (Bit 4)	Pattern Sync Loss (Data1)
	32 (Bit 5)	Pattern Sync Loss (Data2)
	256 (Bit 8)	Clock Loss
	1024 (Bit 10)	Delay Calibration Require (Data1)
	2048 (Bit 11)	Delay Calibration Require (Data2)
Function	Queries events at MU195040A, MU196040A, and MU196040B status	
Example	`> :INSTrument:EDG32:EVENt?`	
	or	
	`> :INSTrument:EDG32?`	
	`< 1`	

:INSTrument:EDG32:CONDition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 16383	Sum of all bits set in the condition register (DECIMAL)
	Available bit	
	1 (Bit 0)	Error (Data1)
	2 (Bit 1)	Error (Data2)
	16 (Bit 4)	Pattern Sync Loss (Data1)
	32 (Bit 5)	Pattern Sync Loss (Data2)
	256 (Bit 8)	Clock Loss
	1024 (Bit 10)	Delay Calibration Require (Data1)
	2048 (Bit 11)	Delay Calibration Require (Data2)
Function	Queries condition at MU195040A, MU196040A, and MU196040B status.	
Example	`> :INSTrument:EDG32:CONDition?`	
	`< 1`	

:INSTrument:EDG32:PTRansition <numeric>

Parameter

<numeric>=<DECIMAL NUMERIC PROGRAM DATA>

0 to 16383	Sum of all the transition filter bits you want to enable in the transition filter (DECIMAL)

Available bit

1 (Bit 0)	Error (Data1)
2 (Bit 1)	Error (Data2)
16 (Bit 4)	Pattern Sync Loss (Data1)
32 (Bit 5)	Pattern Sync Loss (Data2)
256 (Bit 8)	Clock Loss
1024 (Bit 10)	Delay Calibration Require (Data1)
2048 (Bit 11)	Delay Calibration Require (Data2)

Function

Sets transition filter (positive direction transition) at MU195040A, MU196040A, and MU196040B status.

Example

To set the transition filter (positive direction transition) at MU195040A, MU196040A, and MU196040B status to 1:

```
> :INSTrument:EDG32:PTRansition 1
```

:INSTrument:EDG32:PTRansition?

Response

<numeric>=<NR1 NUMERIC RESPONSE DATA>

0 to 16383	Sum of all bits set in the transition filter (DECIMAL)

Function

Queries contents of transition filter (positive direction transition) at MU195040A, MU196040A, and MU196040B status.

Example

```
> :INSTrument:EDG32:PTRansition?
< 1
```

:INSTrument:EDG32:NTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>	
	0 to 16383	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	Available bit	
	1 (Bit 0)	Error (Data1)
	2 (Bit 1)	Error (Data2)
	16 (Bit 4)	Pattern Sync Loss (Data1)
	32 (Bit 5)	Pattern Sync Loss (Data2)
	256 (Bit 8)	Clock Loss
	1024 (Bit 10)	Delay Calibration Require (Data1)
	2048 (Bit 11)	Delay Calibration Require (Data2)
Function	Sets transition filter (negative direction transition) at MU195040A, MU196040A, and MU196040B status.	
Example	To set the transition filter (negative direction transition) at MU195040A, MU196040A, and MU196040B status to 1: `> :INSTrument:EDG32:NTRansition 1`	

:INSTrument:EDG32:NTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 16383	Sum of all bits set in the transition filter (DECIMAL)
Function	Queries contents of transition filter (negative direction transition) at MU195040A, MU196040A, and MU196040B status.	
Example	`> :INSTrument:EDG32:NTRansition?` `< 1`	

:INSTrument:EDG32:RESet

Function	Initializes event at MU195040A, MU196040A, and MU196040B status.
Example	`> :INSTrument:EDG32:RESet`

5.5.7.5 PPG status

The PPG status is used to indicate an alarm and error of the MU195020A and MU196020A/C. It is compatible with the MU183020A and MU183021A.

:INSTrument:PPGG32[:EVENt]?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 15	Sum of all bits set in the event register (DECIMAL)
	Available bit	
	1 (Bit 0)	Delay Calibration Require (Data1)
	2 (Bit 1)	Delay Calibration Require (Data2)
Function	Queries events at MU195020A and MU196020A/C status.	
Example	`> :INSTrument:PPGG32:EVENt?`	
	or	
	`> :INSTrument:PPGG32?`	
	`< 4`	

:INSTrument:PPGG32:CONDition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 15	Sum of all bits set in the condition register (DECIMAL)
	Available bit	
	1 (Bit 0)	Delay Calibration Require (Data1)
	2 (Bit 1)	Delay Calibration Require (Data2)
Function	Queries condition at MU195020A and MU196020A/C status.	
Example	`> :INSTrument:PPGG32:CONDition?`	
	`< 4`	

:INSTrument:PPGG32:PTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>	
	0 to 15	Sum of all the bits that you want to enable in the transition filter (DECIMAL)
	Available bit	
	1 (Bit 0)	Delay Calibration Require (Data1)
	2 (Bit 1)	Delay Calibration Require (Data2)
Function	Sets transition filter (positive direction transition) at MU195020A and MU196020A/C status.	
Example	To set the transition filter (positive direction transition) at MU195020A and MU196020A/C status to 1:	
	`> :INSTrument:PPGG32:PTRansition 4`	

:INSTrument:PPGG32:PTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA>	
	0 to 15	Sum of all bits set in the transition filter (DECIMAL)
Function	Queries contents of transition filter (positive direction transition) at MU195020A and MU196020A/C status.	
Example	`> :INSTrument:PPGG32:PTRansition?`	
	`< 4`	

:INSTrument:PPGG32:NTRansition <numeric>

Parameter	<numeric>=<DECIMAL NUMERIC PROGRAM DATA>	
	0 to 15	Sum of all the transition filter bits you want to set in the transition filter (DECIMAL)
	1 (Bit 0)	Delay Calibration Require (Data1)
	2 (Bit 1)	Delay Calibration Require (Data2)
Function	Sets transition filter (negative direction transition) at MU195020A and MU196020A/C status.	
Example	To set the transition filter (negative direction transition) at MU195020A and MU196020A/C status to 1:	
	`> :INSTrument:PPGG32:NTRansition 4`	

:INSTrument:PPGG32:NTRansition?

Response	<numeric>=<NR1 NUMERIC RESPONSE DATA> 0 to 15 Sum of all bits set in the transition filter (DECIMAL)
Function	Queries contents of transition filter (negative direction transition) at MU195020A and MU196020A/C status.
Example	> :INSTrument:PPGG32:NTRansition? < 4

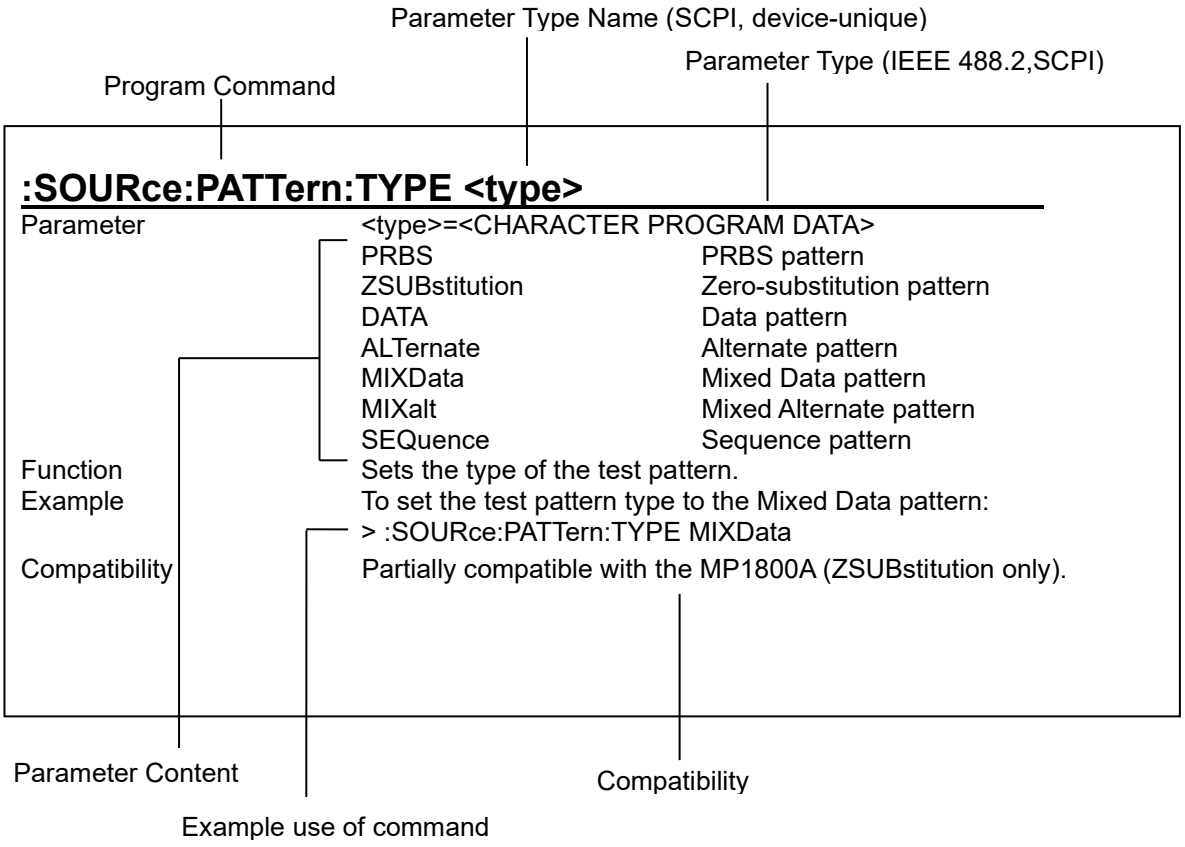
:INSTrument:PPGG32:RESet

Function	Initializes event at MU195020A and MU196020A/C status.
Example	> :INSTrument:PPGG32:RESet

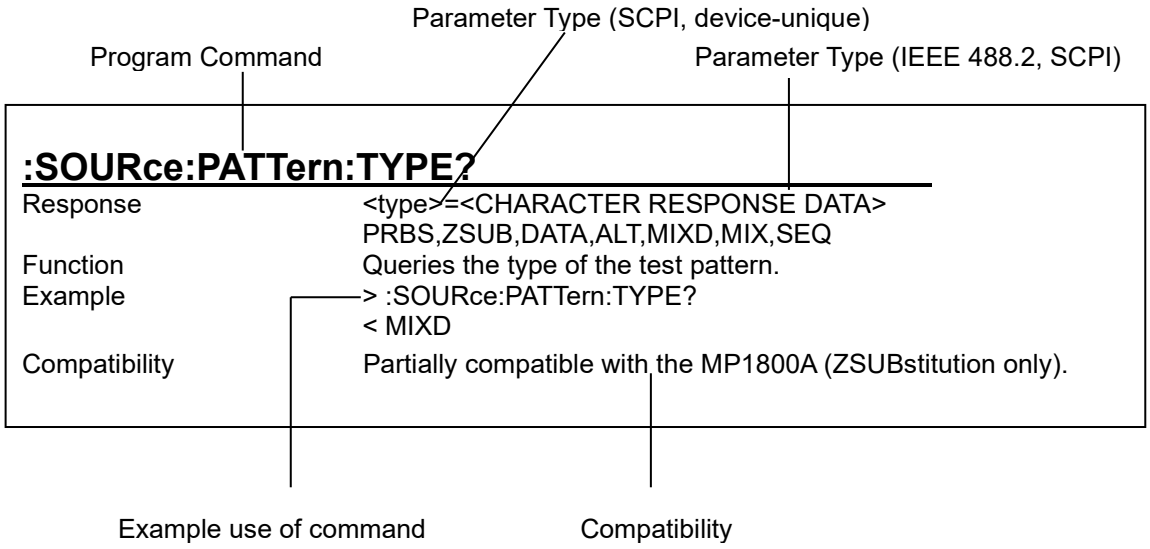
5.6 SCPI Commands

This section describes the SCPI commands.
Examples of command expression are shown below.

<Example of a Program Command>



< Example of a Query Command>



Notes:

- All the MP1900A commands are sequential commands.
- If a command affects other settings, the command may have restrictions. For setting parameters subject to be affected and command conditions to be restricted, see on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.
- The parameters of a query command may be omitted when they are the same as those of the corresponding program command.

5.6.1 Common commands

This section describes the commands related to common settings and functions of the control software. Some commands described in this section are also compatible with other models.

5.6.1.1 Commands for common settings

Table 5.6.1.1-1 Common Setting Commands

Setting Items	Commands
Number of the unit to be operated	:UENTry:ID
	:UENTry:ID?
Number of the module to be operated (slot position)	:MODule:ID
	:MODule:ID?
Automatic measurement function to be performed	:SYSTem:CFUNction
	:SYSTem:CFUNction?
Query for error message	:SYSTem:ERRor?
Query for SCPI version	:SYSTem:VERSion?
Query for software status	:SYSTem:CONDition?
Query for hardware system configuration	:SYSTem:ORGanization:HARDware?
Query for system error	:SYSTem:INFormation:ERRor?
Terminator type	:SYSTem:TERMination
	:SYSTem:TERMination?
Query for model name of mainframe and module	:SYSTem:CONDition:UNITs?
Query for mainframe information	:SYSTem:UNIT?
Query for module information	:SYSTem:MODule?
Measured Results Screen Drawing Settings	:SYSTem:DISPlay:RESult
	:SYSTem:DISPlay:RESult?
Module screen display	:DISPlay:ACTive

:UENTry:ID <unit_number>

Parameter	<unit_number> = <DECIMAL NUMERIC PROGRAM DATA> 1 to 4 Unit number
Function	Sets the number of the unit to be operated.
Example	To set the number of the unit to be operated to 2: `> :UENTry:ID 2`
Compatibility	Compatible with MP1800A.

:UENTry:ID?

Response	<unit_number> = <NR1 NUMERIC RESPONSE DATA> 1 to 4
Function	Queries the number of the unit being operated.
Example	`> :UENTry:ID?` `< 2`
Compatibility	Compatible with MP1800A.

:MODule:ID <module_number>

Parameter	<module_number> = <DECIMAL NUMERIC PROGRAM DATA> 1 to 8 Module number
Function	Sets the number of the module to be operated (slot position).
Example	To set the number of the module to be operated (slot position) to 6: `> :MODule:ID 6`
Compatibility	Compatible with MP1800A.

:MODule:ID?

Response	<module_number> = <NR1 NUMERIC RESPONSE DATA> 1 to 8
Function	Queries the number of the module being operated (slot position).
Example	`> :MODule:ID?` `< 6`
Compatibility	Compatible with MP1800A.

:SYSTem:CFUNction <function>

Parameter	<function> = <CHARACTER PROGRAM DATA>	
	ASE32	Auto Search
	EMAR32	Eye Margin measurement
	ECT	Eye Contour measurement
	BTUB32	Bathtub measurement
	AADJ32	Auto Adjust
	PAMB	PAM4 BER measurement
	OFF	Off
	Note: When "Off" is set, the operation returns to the port operation previously performed.	
Function	Sets the automatic measurement function to be performed.	
Example	To set the common function to be performed to Auto Search: `> :SYSTem:CFUNction ASE32`	
Compatibility	Compatible with MP1800A.	

:SYSTem:CFUNction?

Response	<function> = <CHARACTER RESPONSE DATA>	
	ASE32	Auto Search
	EMAR32	Eye Margin measurement
	ECT	Eye Contour measurement
	BTUB32	Bathtub measurement
	AADJ32	Auto Adjust
	PAMB	PAM4 BER measurement
	OFF	Off
Function	Queries the automatic measurement function being performed.	
Example	`> :SYSTem:CFUNction?` `< ASE32`	
Compatibility	Compatible with MP1800A.	

:SYSTem:ERRor?

Response
<error/event_number>,"<error/event_description>"
<error/event_number> = <NR1 NUMERIC RESPONSE DATA>
–32768 to 32767
"0" indicates that no error or event has occurred.
Other values return a general error reserved by SCPI or a device-unique error.
<error/event_description> = <STRING RESPONSE DATA>
This is an error message corresponding to <error/event_number>.
The maximum character-string length is 255 characters.

Function
Queries the error message in the error/event queue.

Example
```
> :SYSTem:ERRor?
< 0,"No error"
```

Compatibility
Compatible with the MP1632C Digital Data Analyzer (hereinafter, referred to as "MP1632C"), MP1776A Error Detector (hereinafter, referred to as "MP1776A") and MP1800A.

:SYSTem:VERSion?

Response
<version> = <NR2 NUMERIC RESPONSE DATA>

YYYY.V	YYYY:	Year
	V:	Revision number

Function
Queries the SCPI version to which the MP1900A conforms.

Example
```
> :SYSTem:VERSion?
< 1999.0
```

Compatibility
Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:CONDition?

Response
<mainframe>,<slot1>,...,<slot64>
<mainframe> = <serial>,<mver>,<hver>,<opt1>,<sbver>,<saver>,<opt2>
<serial> = <STRING RESPONSE DATA>

XXXXXXXXXX	0000000000 to 9999999999
	MP1900A serial number

Note:
Alphabetic characters may be included.

<mver> = <STRING RESPONSE DATA>

XXXX.XX.XX	1.00.00 to 9999.99.99
	MX190000A software version

<hver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
MP1900A hardware version

<opt1> = <STRING RESPONSE DATA>

OPTXXX Option number (MP1900A)
See "Table 5.6.1.1-2 Option Character Correspondence Table".

Note:

Outputs the numbers for all installed options.
NONE is output if no option is installed.

<sbver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
Sub application software version (Boot part)

<saver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
Sub application software version (Application part)

<opt2> = <STRING RESPONSE DATA>

<slot x> = <module>,<serial>,<fpga1>[,<fpga2>],<boot>,<application>,<opt>

x indicates a slot number. The slot number varies depending on the unit number as follows.

Unit 1: 1 to 16 Numbers from 1 to 8 correspond to actual slots.
Unit 2: 17 to 32
Unit 3: 33 to 48
Unit 4: 49 to 64

<module> = <STRING RESPONSE DATA>

XXXXXXXXX Module model name (e.g.: MU195020A)
See "Table 5.6.1.1-2 Option Character Correspondence Table".

Note:

NONE is output if no module is installed.
For a module that uses two slots, only the slot with the greater number is valid.

<serial> = <STRING RESPONSE DATA>

XXXXXXXXXX 0000000000 to 9999999999
Serial number

Note:

"----------" is output if no module is installed.
For a module that uses two slots, only the slot with the greater number is valid.

<fpga1>[,<fpga2>,.....] = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
FPGA version

<boot> = <STRING RESPONSE DATA>
XXXX.XX.XX 1.00.00 to 9999.99.99
Logic Boot version

Note:

"----------" is output if Logic boot is not installed.
For a module that uses two slots, only the slot with the greater number is valid.

<application> = <STRING RESPONSE DATA>
XXXX.XX.XX 1.00.00 to 9999.99.99
Logic Application version

Note:

"----------" is output if Logic Application is not installed.
For a module that uses two slots, only the slot with the greater number is valid.

<opt> = <STRING RESPONSE DATA>
XXXXXX/XXXXX Option number
OPTXXX: For MP1900A

Note:

Outputs the numbers for all installed options. NONE is output if no module is installed.
For a module that uses two slots, only the slot with the greater number is valid.

Function

Queries the software status of the MP1900A.

Example

```
> :SYSTem:CONDition?
<
6201234567,1.00.00,1.00.20,OPT302,1.00.00,1.00.00,OPT12,
OPT14,
MU181000A,6201234568,1.00.00,1.00.00,1.00.00,OPT101,
MU181020A,6201234569,1.00.00,1.00.00,1.00.00,OPT001,OPT2
20,
MU195040A,6201234571,1.00.00,1.00.00,1.00.00,OPT002,OPT2
20
```

Compatibility

Compatible with MP1800A.

Table 5.6.1.1-2 Option Character Correspondence Table

Model/Name	Option Number*	Option Name
MX190000A Signal Quality Analyzer-R Control Software	–	–
MU181000A 12.5GHz Synthesizer	OPTx01	Jitter Modulation
MU181000B 12.5GHz 4port Synthesizer	OPTx01	Jitter Modulation
	OPTx02	SSC Extension
MU191000A Synthesizer	-	-
MU195020A 21G/32G bit/s SI PPG	OPT001	32G bit/s Extension
	OPT010	1ch Data Output
	OPT020	1ch 10Tap Emphasis
	OPT011	2ch Data Output
	OPT021	2ch 10Tap Emphasis
	OPT030	1ch Data Delay
	OPT031	2ch Data Delay
	OPT040	1ch ISI Injection
	OPT041	2ch ISI Injection
	OPT050	Sequence Editor Function
	OPT051	Sequence Editor Function PCIe5 Extension
MU195040A 21G/32G bit/s SI ED	OPT001	32Gbit/s Extension
	OPT010	1ch ED
	OPT020	2ch ED
	OPT011	1ch CTLE
	OPT021	2ch CTLE
	OPT022	Clock Recovery
MU195050A Noise Generator	OPT001	White Noise

*: “x” in an option number represents any numeral.

Table 5.6.1.1-2 Option Character Correspondence Table (Cont'd)

Model/Name	Option Number*	Option Name
MU196020A PAM4 PPG	OPT001	32G baud
	OPT002	58G baud
	OPT003	64G baud
	OPTx11	4Tap Emphasis
	OPTx12	32G to 58G baud Extension
	OPTx13	32G to 64G baud Extension
	OPTx23	58G to 64G baud Extension
	OPTx30	Data Delay
	OPTx40	Adjustable ISI
	OPTx42	FEC Pattern Generation
	OPTx43	FEC Error Insertion for PCIe6
	OPTx45	USB4 Gen4 Pattern Generation
	OPTx50	Inter-Module Synchronization
	OPTx51	Sequence Editor Function
	OPTx52	Sequence Editor Function for Multi-Channel
	OPTx56	Sequence Editor Function PCIe6 and CXL3 Flits Extension
	OPTx60	PCIe6 LEQ
MU196020C PAM4 PPG	OPT001	32G baud
	OPT002	58G baud
	OPT003	64G baud
	OPTx11	4Tap Emphasis
	OPTx12	32G to 58G baud Extension
	OPTx13	32G to 64G baud Extension
	OPTx23	58G to 64G baud Extension
	OPTx30	Data Delay
	OPTx40	Adjustable ISI
	OPTx42	FEC Pattern Generation
	OPTx43	FEC Error Insertion for PCIe6
	OPTx45	USB4 Gen4 Pattern Generation
	OPTx50	Inter-Module Synchronization
MU196040A PAM4 ED	OPT001	32.1G baud Decoder
	OPTx22	25.5G to 32.1G baud Clock Recovery
	OPTx41	SER Measurement

Table 5.6.1.1-2 Option Character Correspondence Table (Cont'd)

Model/Name	Option Number*	Option Name
	OPTx41	SER Measurement
MU196040B PAM4 ED	OPT001	32.1G baud
	OPT002	58.2G baud
	OPT005	64G baud
	OPTx11	Equalizer
	OPTx12	32G to 58G baud Extension
	OPTx21	29G baud Clock Recovery
	OPTx22	32G baud Clock Recovery
	OPTx23	58G baud Clock Recovery Extension
	OPTx24	32G baud Clock Recovery Extension
	OPTx41	SER Measurement
	OPTx42	FEC Analysis
	OPTx43	FEC Analysis for PCIe6
	OPTx51	PCIe Sequence Editor Pattern Analysis
MU196050B Noise Generator	-	-
MU196060A 32G baud NRZ/PAM4 Re-Driver	OPT001	Clock Recovery for SSC
MU183020A 28G/32G bit/s PPG	OPTx01	32G bit/s Extension
	OPTx12	1ch 2V Data Output
	OPTx13	1ch 3.5V Data Output
	OPTx30	1ch Data Delay
	OPTx22	2ch 2V Data Output
	OPTx23	2ch 3.5V Data Output
	OPTx31	2ch Data Delay
MU183021A 28G/32G bit/s 4ch PPG	OPTx01	32G bit/s Extension
	OPTx12	4ch 2V Data Output
	OPTx13	4ch 3.5V Data Output
	OPTx30	4ch Data Delay
MU183040B 28G/32G bit/s High Sensitivity ED	OPTx01	32G bit/s Extension
	OPTx10	1ch ED
	OPTx20	2ch ED
	OPTx22	2.4G to 28.1G bit/s Clock Recovery
	OPTx23	25.5G to 32.1G bit/s Clock Recovery
MU183041B 28G/32G bit/s 4ch High Sensitivity ED	OPTx01	32G bit/s Extension
	OPTx22	2.4G to 28.1G bit/s Clock Recovery
	OPTx23	25.5G to 32.1G bit/s Clock Recovery

:SYSTem:ORGanization:HARDware?

Response

<slot1>,...,<slot64>
<slotx> =
<module>,<serial>,<fpga1>[,<fpga2>],<boot>,<application>,<opt>
x indicates a slot number. The slot number varies depending on the unit number as follows.
Unit 1: 1 to 16 Numbers from 1 to 8 correspond to actual slots.
Unit 2: 17 to 32
Unit 3: 33 to 48
Unit 4: 49 to 64
<module> = <STRING RESPONSE DATA>
XXXXXXXXX Module model name (e.g.,: MU195020A)
See "Table 5.6.1.1-2 Option Character Correspondence Table".

Note:

NONE is output if no module is installed.
For a module that uses two slots, only the slot with the greater number is valid.

<serial> = <STRING RESPONSE DATA>
XXXXXXXXXX 0000000000 to 9999999999
Serial number

Note:

"---------" is output if no module is installed.
For a module that uses two slots, only the slot with the greater number is valid.

<fpga1>[,<fpga2>,.....] = <STRING RESPONSE DATA>
XXXX.XX.XX 1.00.00 to 9999.99.99
FPGA version
<boot> = <STRING RESPONSE DATA>
XXXX.XX.XX 1.00.00 to 9999.99.99
Logic Boot version

Note:

"---------" is output if Logic Boot is not installed.
For a module that uses two slots, only the slot with the greater number is valid.

<application> = <STRING RESPONSE DATA>

XXXX.XX.XX	1.00.00 to 9999.99.99 Logic Application version

Note:

"---------" is output if Logic Application is not installed.

For a module that uses two slots, only the slot with the greater number is valid.

<opt> = <STRING RESPONSE DATA>

XXXXXX/XXXXX	Option number OPTXXX

Note:

NONE is output if no module is installed.

For a module that uses two slots, only the slot with the greater number is valid.

Function: Queries the hardware system configuration of the MP1900A.

Example:

```
> :SYSTem:ORGanization:HARDware?
< MU181000A,6201234568,1.00.00,1.00.00,1.00.00,OPT101,
MU195020A,6201234569,1.00.00,1.00.00,1.00.00,OPT001,OPT2
20,MU195040A,6201234571,1.00.00,1.00.00,1.00.00,OPT002,O
PT220
```

Compatibility: Partially compatible with the MP1632C and MP1776A. Compatible with the MP1800A.

:SYSTem:INFormation:ERRor? <unit>

Parameter: <unit> = <DECIMAL NUMERIC PROGRAM DATA>

1 to 4	1 to 4, 1 step

Response: <numeric> = <NR1 NUMERIC RESPONSE DATA>

0	NONE
1	PLL Unlock
2	Temperature
3	Fan
4	Internal Error

All the system errors that have currently occurred are displayed, delimited with a comma (,).

Function: Queries the System Error contents.

Example:

```
> : SYSTem:INFormation:ERRor? 3
< 1,2,3,4 (when a system error has occurred for PLL Unlock,
Temperature, Fan, or Internal Error)
< 0 (when no system error has occurred)
```

Compatibility: Compatible with MP1800A.

:SYSTem:TERMination <numeric>

Parameter	<numeric> = <DECIMAL NUMERIC PROGRAM DATA>
	0 LF + EOI
	1 CR + LF + EOI
Function	Sets the terminator type of the response data.
Example	To set the terminator type to LF + EOI:
	`> :SYSTem:TERMination 0`
Compatibility	Compatible with the MP1632C and MP1800A.

:SYSTem:TERMination?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 LF + EOI
	1 CR + LF + EOI
Function	Queries the terminator type of the response data.
Example	`> :SYSTem:TERMination?`
	`< 0`
Compatibility	Compatible with the MP1632C and MP1800A.

:SYSTem:CONDition:UNITs?

Response

<unit1>,...,<unit4>,<slot1>,...,<slot8>
="<mainframe1>,...,<mainframe4>,<module1>,...,<module6>"
<mainframe1> to <mainframe4> = <STRING RESPONSE DATA>
XXXXXXXXX Mainframe model name (e.g.,: MP1900A)
See“Table 5.6.1.1-2 Option Character Correspondence Table”.

Note:

NONE is output for mainframe2 to mainframe4, if no MP1900A is connected.

<module1> to <module64> = <STRING RESPONSE DATA>
XXXXXXXXX Module model name (e.g.,: MU195020A)
See“Table 5.6.1.1-2 Option Character Correspondence Table”.

Note:

NONE is output if no module is installed.
For a module that uses two slots, only the slot with the greater number is valid.

Function

Queries the model name of the MP1900A and module.

Example

```
> :SYSTem:CONDition:UNITs?
< "MP1900A,NONE,NONE,NONE,MU181000A,NONE,MU195020A,
MU195040A,NONE,…,NONE”
```

Compatibility

Compatible with MP1800A.

:SYSTem:UNIT? <numeric>

Parameter

<numeric> = <NR1 NUMERIC PROGRAM DATA>

1 to 4 MP1900A number

"1" for the MP1900A.

Response

<mainframe> =

<unit>,<serial>,<mver>,<hver>,<opt1>,<sbver>,<saver>,<opt2>

<unit> = <STRING RESPONSE DATA>

XXXXXXXXX Mainframe model name (e.g., : MP1900A)
See "Table 5.6.1.1-2 Option Character Correspondence Table".

Note:

NONE is output if no module is installed.
For a unit that uses two slots, only the slot with the lower number is valid.

<serial> = <STRING RESPONSE DATA>

XXXXXXXXXX 0000000000 to 9999999999
MP1900A serial number

Note:

Alphabetic characters may be included.

<mver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
MX190000A software version

<hver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
MP1900A hardware version

<opt1> = <STRING RESPONSE DATA>

OPTXXX Option number (MP1900A)
See "Table 5.6.1.1-2 Option Character Correspondence Table".

Note:

Outputs the numbers for all installed options.
NONE is output if no option is installed.

<sbver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
Sub application software version (Boot part)

<saver> = <STRING RESPONSE DATA>

XXXX.XX.XX 1.00.00 to 9999.99.99
Sub application software version (Application part)

<opt2> = <STRING RESPONSE DATA>

Function: Queries the MP1900A information including model and serial number.

Example:
```
> :SYSTem:UNIT? 1
< MP1900A,6201234568,1.00.00,1.00.00,1.00.00,1.00.00
```

Compatibility: Compatible with MP1800A.

:SYSTem:MODule? <numeric>

Parameter: <numeric> = <NR1 NUMERIC PROGRAM DATA>

1 to 8	Slot

1 to 8 when using the MP1900A.

Response: <slot> = <module>,<serial>,<fpga1>,<fpga2>,<boot>,<application>,<opt>

<module> = <STRING RESPONSE DATA>

XXXXXXXXX	Module model name (e.g.,: MU195020A) See "Table 5.6.1.1-2 Option Character Correspondence Table".

Note:

NONE is output if no module is installed.

For a module that uses two slots, only the slot with the greater number is valid.

<serial> = <STRING RESPONSE DATA>

XXXXXXXXXX	0000000000 to 9999999999 Serial number

Note:

"---------" is output if no module is installed.

For a module that uses two slots, only the slot with the greater number is valid.

<fpga1>,<fpga2> = <STRING RESPONSE DATA>

XXXX.XX.XX	1.00.00 to 9999.99.99 FPGA version

<boot> = <STRING RESPONSE DATA>

XXXX.XX.XX	1.00.00 to 9999.99.99 Logic Boot version

Note:

"---------" is output if Logic Boot is not installed.

For a module that uses two slots, only the slot with the greater number is valid.

<application> = <STRING RESPONSE DATA>

XXXX.XX.XX	1.00.00 to 9999.99.99 Logic Application version

Note:

"---------" is output if Logic Application is not installed.

For a module that uses two slots, only the slot with the greater number is valid.

<opt> = <STRING RESPONSE DATA>

XXXXXX/XXXXX	Option number OPTXXX: For MP1900A

Note:

Outputs the numbers for all installed options.

NONE is output if no option is installed.

For a module that uses two slots, only the slot with the greater number is valid.

Function: Queries the module information on the specified slot.

Example: To query the module information on Slot 3:

```
> :SYSTem:MODule? 3
< MU195020A,6201234568,1.00.00,--------
-,1.00.00,1.00.00,OPT001,OPT020,OPT021,OPT031
```

Compatibility: Compatible with MP1800A.

:SYSTem:DISPlay:RESult <boolean>

Parameter: <boolean> = <BOOLEAN PROGRAM DATA>

OFF or 0	Drawing Processing OFF
ON or 1	Drawing Processing ON (default)

Function: Sets measured results drawing processing ON/OFF

Example: Set measured results drawing processing to OFF

```
> :SYSTem:DISPlay:RESult OFF
```

Compatibility: Compatible with MP1800A.

Remarks: When measured results drawing processing is set to OFF, a dialog indicating drawing processing is stopped is displayed. Issue the command to set drawing processing to ON or Touch the **Remote** to restart measured results drawing processing.

:SYSTem:DISPlay:RESult?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 Drawing Processing OFF
	1 Drawing Processing ON (default)
Function	Sets drawing processing ON/OFF
Example	`> :SYSTem:DISPlay:RESult?`
	`< 0`
Compatibility	Compatible with MP1800A.

:DISPlay:ACTive <unit>,<slot>[,<tab>]

Parameter	<unit> = <DECIMAL NUMERIC PROGRAM DATA>
	1 to 4 MP1900A No.1 to 4
	<slot> = <DECIMAL NUMERIC PROGRAM DATA>
	1 to 8 Slot No.1 to 8
	[<tab>] = <DECIMAL NUMERIC PROGRAM DATA>
	1 to X Tab ID No.1 to X
	When [,<tab>] is omitted, 1 is specified.
	Tab ID is set to No.1 at the left side dialog box, and then the tab ID No. is set to 2, 3, 4…toward the right side.
	The maximum number (X) of the tab ID varies depending on the module options.
Function	Displays the specified module screen to the front.
	Note:
	When the screen processing for measurement result is Off, this function cannot be used. If using this function, set the screen processing to On using the :SYSTem:DISPlay:RESult .
Example	To display the Pattern tab of the MU195020A module:
	(when installing the MU195020A in the unit1 slot1)
	`> :DISPlay:ACTive 1,1,2`
Compatibility	Compatible with MP1800A.

5.6.1.2 Common functions

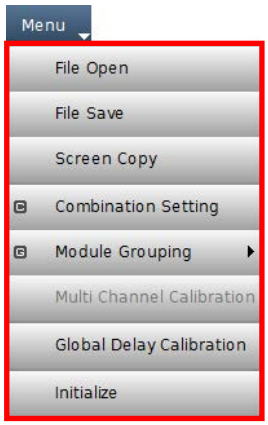


Figure 5.6.1.2-1 Common Functions

Table 5.6.1.2-1 Common Functions Commands

Setting Item	Command
Open	:SYSTem:MMEMory:QRECall
Save	:SYSTem:MMEMory:QSTore
	:SYSTem:MMEMory:STORe
Screen Copy Execute	:SYSTem:PRINt:COPY
Combination Setting	:COMBination:OPERation:ABILity:CHSYnc?
	:COMBination:OPERation:CHSetting
Initialize	:SYSTem:MEMory:INITialize
Output ON/OFF	:SOURce:OUTPut:ASET
	:SOURce:OUTPut:ASET?
Error Addition On/Off	:SOURce:PATTern:EADDition:ASET
	:SOURce:PATTern:EADDition:ASET?
Single Error Addition	:SOURce:PATTern:EADDition:ASINgle
Meas. Start	:SENSe:MEASure:ASTRt
Meas. Stop	:SENSe:MEASure:ASTP
(Query for measurement status)	:SENSe:MEASure:ASTate?
Error ON/OFF	:SYSTem:BEEPer:ERRor:SET
	:SYSTem:BEEPer:ERRor:SET?
Alarm ON/OFF	:SYSTem:BEEPer:ALARm:SET
	:SYSTem:BEEPer:ALARm:SET?
System Error ON/OFF	:SYSTem:BEEPer:SYSTem:SET
	:SYSTem:BEEPer:SYSTem:SET?
System Error	:SYSTem:BEEPer:SYSTem:TYPE
	:SYSTem:BEEPer:SYSTem:TYPE?

:SYSTem:MMEMory:QRECall <file_name>

Parameter
<file_name> = <STRING PROGRAM DATA>
"<drv>:\[<dir>]<file>"
<drv> = C, D, E, F
<dir> = <dir1>\<dir2>\... (Omitted for the root directory)
<file> = File name

Function
Opens all setting data.

Example
To read all setting files from the specified save destination.

```
> :SYSTem:MMEMory:QRECall "C:\Test\example"
```

Compatibility
Commands are compatible with the MP1632C.
Parameters are incompatible.
Commands and parameters are compatible with the MP1800A.

:SYSTem:MMEMory:QSTore <file_name>,<comment>

Parameter
<file_name> = <STRING PROGRAM DATA>
"<drv>: \[<dir>]<file>"
<drv> = C, D, E, F
<dir> = <dir1>\<dir2>\...(Omitted for the root directory)
<file> = File name
<comment> = <STRING PROGRAM DATA>
"XXXXXX..." Specify a comment of a character string within 60 characters into the file.

Function
Executes “Quick Save”.

Note:

The settings will not be read from the saved file if the file name is changed.

Example
To specify save destination for all setting files and save them with a comment and measurement result data:

```
> :SYSTem:MMEMory:QSTore "C:\Test\example","setup all"
```

Compatibility
Commands are compatible with the MP1632C.
Parameters are incompatible.
Commands and paramters are compatible with the MP1800A.

:SYSTem:MMEMory:STORe <file_name>,<module>,<data_type>,<file_type>

Parameter

<file_name> = <STRING PROGRAM DATA>
"<drv>:\[<dir>]<file>"
<drv> = C, D, E, F
<dir> = <dir1>\<dir2>\... (Omitted for the root directory)
<file> = File name
<module> = <STRING PROGRAM DATA>
"<unit>:<slot>:<port>:<module>"
<unit> = 1, 2, 3, 4
<slot> = 1, 2, 3, 4, …, 8
<port> = 1
<module> = Module model name
<data_type> = <CHARACTER PROGRAM DATA>

CAP	Saves the captured data.
CEX	Saves the captured pattern file.

<file_type> = <CHARACTER PROGRAM DATA>

TXT	Text File (Binary)
HEX	Text File (Hexadecimal)

Function

Saves the captured data and captured pattern file.

Example

To save the captured data to a text file in a binary format::

```
> :SYSTem:MMEMory:STORe "C:\Test\example","1:6:1
MU195040A",CAP,TXT
```

Compatibility

Compatible with the MP1800A commands. Parameters are incompatible.

:SYSTem:PRINt:COPY

Function

Takes a screen shot.

Example

```
> :SYSTem:PRINt:COPY
```

Compatibility

Compatible with the MP1632C, MP1776A and MP1800A.

:COMBination:OPERation:ABILity:CHSYnc? [<unit>]

Parameter

[<unit>] = <DECIMAL NUMERIC PROGRAM DATA>

1 to 4 MP1900A No. 1 to 4

Can be omitted. MP1900A No. 1 is specified when omitted.

Response

<numeric> = <NR1 NUMERIC RESPONSE DATA>

0 to 255 Total number of PPGs that can configure channel synchronization (decimal)

Available bits:

0 No PPG that can configure channel synchronization

1 (Bit 0) PPG in Slot 1

2 (Bit 1) PPG in Slot 2

4 (Bit 2) PPG in Slot 3

8 (Bit 3) PPG in Slot 4

16 (Bit 4) PPG in Slot 5

32 (Bit 5) PPG in Slot 6

64 (Bit 6) PPG in Slot 7

128 (Bit 7) PPG in Slot 8

Function

Queries the slot where PPG that can configure channel synchronization combination is inserted.

Example

To query the slot in Unit 3 where PPG that can configure channel synchronization is inserted:

```
> :COMBination:OPERation:ABILity:CHSYnc? 3
< 7
```

Compatibility

Compatible with MP1800A.

:COMBination:OPERation:CHSetting <configuration>[,<unit>]

Parameter

<configuration> = <NR1 NUMERIC RESPONSE DATA>

0 to 254	Total number of PPGs that can configure channel synchronization (decimal)

Available bits:

2 (Bit 1)	PPG in Slot 2
4 (Bit 2)	PPG in Slot 3
8 (Bit 3)	PPG in Slot 4
16 (Bit 4)	PPG in Slot 5
32 (Bit 5)	PPG in Slot 6
64 (Bit 6)	PPG in Slot 7
128 (Bit 7)	PPG in Slot 8

[<unit>] = <DECIMAL NUMERIC PROGRAM DATA>

1 to 4	MP1900A No. 1 to 4

Can be omitted. MP1900A No. 1 is specified when omitted.

Function

Specify the slot where the PPG for which channel synchronization is to be set is inserted.

Example

To set channel synchronization for the PPGs in Slots 1 through 4 of Unit 3:

```
> :COMBination:OPERation:CHSetting 14
```

Compatibility

Compatible with MP1800A.

:SYSTem:MEMory:INITialize

Function	Initializes the internal setting data to the initial settings at factory shipment.
Example	`> :SYSTem:MEMory:INITialize`
Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SOURce:OUTPut:ASET <boolean>

Parameter	<boolean> = <BOOLEAN PROGRAM DATA>	
	OFF or 0	Output OFF
	ON or 1	Output ON
Function	Sets Data and Clock outputs of optical output and PPG ON or OFF.	
Example	To set Data and Clock outputs of PPG to ON:	
	`> :SOURce:OUTPut:ASET ON`	
Compatibility	Compatible with MP1800A.	

:SOURce:OUTPut:ASET?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>	
	0	Output OFF
	1	Output ON
Function	Queries the ON/OFF state for Data and Clock outputs of optical output and PPG.	
Example	`> :SOURce:OUTPut:ASET?`	
	`< 1`	
Compatibility	Compatible with MP1800A.	

:SOURce:PATTern:EADDition:ASET <boolean>

Parameter	<boolean> = <BOOLEAN PROGRAM DATA>	
	OFF or 0	Error addition OFF
	ON or 1	Error addition ON
Function	Sets error addition for all valid modules ON/OFF.	
Example	To set error addition for all valid modules to ON:	
	`> :SOURce:PATTern:EADDition:ASET ON`	
Compatibility	Compatible with MP1800A.	

:SOURce:PATTern:EADDition:ASET?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 Error addition OFF
	1 Error addition ON
Function	Queries the error addition ON/OFF state for all valid modules.
Example	> :SOURce:PATTern:EADDition:ASET?
	< 1
Compatibility	Compatible with MP1800A.

:SOURce:PATTern:EADDition:ASINgle

Function	Adds a single error for all valid modules.
Example	> :SOURce:PATTern:EADDition:ASINgle
Compatibility	Compatible with MP1800A.

:SENSe:MEASure:ASTRt

Function	Starts measurement for all modules.
Example	> :SENSe:MEASure:ASTRt
Compatibility	Compatible with MP1800A.

:SENSe:MEASure:ASTP

Function	Stops measurement for all modules.
Example	> :SENSe:MEASure:ASTP
Compatibility	Compatible with MP1800A.

:SENSe:MEASure:ASTate?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 Measurement stops for all modules.
	1 During measurement
	Note:
	If any module is being measured, “1 (During measurement)” is returned.
Function	Queries the measurement state for all modules.
Example	> :SENSe:MEASure:ASTate?
	< 0
Compatibility	Compatible with MP1800A.

:SYSTem:BEEPer:ERRor:SET <boolean>

Parameter	<boolean> = <BOOLEAN PROGRAM DATA>
	OFF or 0 Buzzer OFF
	ON or 1 Buzzer ON
Function	Sets buzzer at error occurrence ON/OFF.
Example	To set buzzer at error occurrence ON: `> :SYSTem:BEEPer:ERRor:SET ON`
Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:BEEPer:ERRor:SET?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 Buzzer OFF
	1 Buzzer ON
Function	Queries the buzzer ON/OFF state at error occurrence.

Example	To query the buzzer ON/OFF state at error occurrence:
	`> :SYSTem:BEEPer:ERRor:SET?`
	`< 1`

Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:BEEPer:ALARm:SET <boolean>

Parameter	<boolean> = <BOOLEAN PROGRAM DATA>
	OFF or 0 Buzzer OFF
	ON or 1 Buzzer ON
Function	Sets buzzer at alarm occurrence ON/OFF.
Example	To set buzzer at alarm occurrence OFF: `> :SYSTem:BEEPer:ALARm:SET OFF`
Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:BEEPer:ALARm:SET?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 Buzzer OFF
	1 Buzzer ON
Function	Queries the buzzer ON/OFF state at alarm occurrence.
Example	`> :SYSTem:BEEPer:ALARm:SET?` `< 0`
Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:BEEPer:SYSTem:SET <boolean>

Parameter	<boolean> = <BOOLEAN PROGRAM DATA>
	OFF or 0 Buzzer OFF
	ON or 1 Buzzer ON
Function	Sets buzzer at system error occurrence ON/OFF.
Example	To set buzzer at system error occurrence ON:
	`> :SYSTem:BEEPer:SYSTem:SET ON`
Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:BEEPer:SYSTem:SET?

Response	<numeric> = <NR1 NUMERIC RESPONSE DATA>
	0 Buzzer OFF
	1 Buzzer ON
Function	Queries the buzzer ON/OFF state at system error occurrence.
Example	`> :SYSTem:BEEPer:SYSTem:SET?`
	`< 1`
Compatibility	Compatible with the MP1632C, MP1776A and MP1800A.

:SYSTem:BEEPer:SYSTem:TYPE <type>,<boolean>

Parameter	<type> = <CHARACTER PROGRAM DATA>	
	PUNLock	PLL unlock
	FAN	FAN
	TEMPerature	Temperature
	ALL	Selects all system errors
	<boolean> = <BOOLEAN PROGRAM DATA>	
	OFF or 0	
	ON or 1	
Function	Sets system error buzzer for the target item ON/OFF.	
Example	To set system error buzzer for "Temperature" ON:	
	`> :SYSTem:BEEPer:SYSTem:TYPE TEMPerature,ON`	
Compatibility	Partially compatible with the MP1632C.	
	Compatible with the MP1800A.	

:SYSTem:BEEPer:SYSTem:TYPE?

Response	<type> = <CHARACTER RESPONSE DATA>	
	PUNL, FAN, TEMP, ALL	
	XXX, XXX,	Errors for which buzzer is set to ON are delimited with commas (,) and returned.
	NONE	Buzzer is set to OFF for all items.
Function	Queries the ON/OFF state of system error buzzer for target items.	
Example	To query the ON/OFF state of system error buzzer for target items:	
	`> :SYSTem:BEEPer:SYSTem:TYPE?`	
	`< PUNL,TEMP`	
Compatibility	Compatible with the MP1632C and MP1800A.	

5.6.1.3 Auto Search

Auto Search setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the Auto Search by using the :SYSTem:CFUNction command.

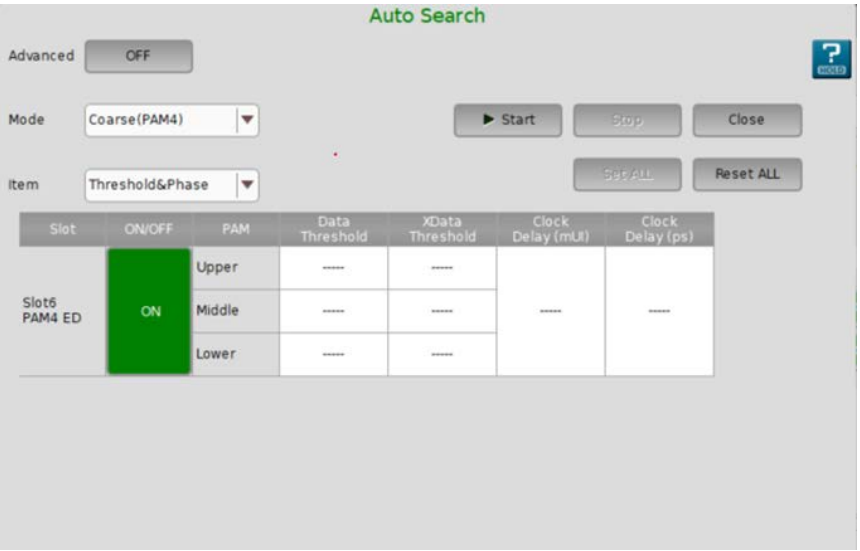


Figure 5.6.1.3-1 Auto Search Setting Screen

5.6.1.4 Auto Adjust

AutoAdjust setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the Auto Adjust by using the :SYSTem:CFUNction command.

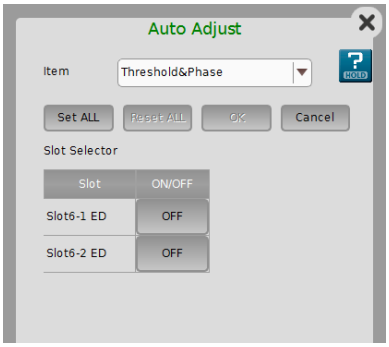


Figure 5.6.1.4-1 Auto Adjust Setting screen

5.6.1.5 Pattern Editor

This section describes the pattern file save/read commands for the PPG and the ED. Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command

Table 5.6.1.5-1 Pattern Editor Setting Commands

Setting Items	Commands
Open	:SYSTem:MMEMory:PATTern:RECall
Save	:SYSTem:MMEMory:PATTern:STORe

:SYSTem:MMEMory:PATTern:RECall <file_name>,<file_type>

Parameter
<file_name> = <STRING PROGRAM DATA>
"<drv>:\[<dir>]<file>"
<drv> = C, D, E, F
<dir> = <dir1>\<dir2>\... (Omitted for the root directory)
<file> = File name
<file_type> = <CHARACTER PROGRAM DATA>

BIN	Binary file
TXT	Text file

Function
Opens a pattern file.

Example
To open a pattern file in the specified file format from the specified destination:

```
> :SYSTem:MMEMory:PATTern:RECall "C:\Test\example",BIN
```

Compatibility
Compatible with MP1800A.

:SYSTem:MMEMory:PATTern:STORe <file_name>,<file_type>

Parameter
<file_name> = <STRING PROGRAM DATA>
"<drv>:\[<dir>]<file>"
<drv> = C, D, E, F
<dir> = <dir1>\<dir2>\... (Omitted for the root directory)
<file> = File name
<file_type> = <CHARACTER PROGRAM DATA>

BIN	Binary file
TXT	Text file

Function
Saves a pattern file.

Note:

The settings will not be read from the saved file if the file name is changed.

Example
To save a pattern file to the specified destination in the specified file format:

```
> :SYSTem:MMEMory:PATTern:STORe "C:\Test\example",TXT
```

Compatibility
Compatible with MP1800A.

5.6.1.6 Ext. Box

The Ext. Box setting and query commands are available in the on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

For instructions on how to connect the G0447A, refer to the supplied *G0447A Quick Start Guide*.

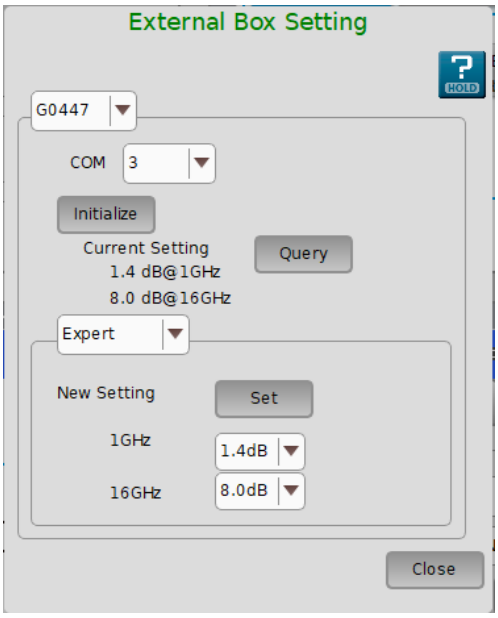


Figure 5.6.1.6-1 Ext. Box Setting Screen

5.6.2 Synthesizer commands

The setting and query commands for the MU181000A/B and MU191000A can be found in the on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command for the Synthesizer, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

5.6.3 Jitter commands

MU181500B setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command for the MU181500B, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

5.6.3.1 Commands list

Table 5.6.3.1-1 MU181500B Command List

No.	Command Header 1	Command Header 2	Command Header 3	Command Header 4	Command Header 5	Command Header 6	Command /Query	Remarks
1	:OUTPut	:AUX	:JCONdition				Q	
2			:REFClock				C/Q	
3				:MONitor			Q	
4			:SELect				C/Q	
5			:SUBRateclock				C/Q	
6				:AMPLitude			C/Q	
7				:MONitor			Q	
8		:CLOCk	:FREQuency				C/Q	*
9			:OFFset	:PPM			C/Q	*
10		:RCLock	:SELect				C/Q	*

*: Synthesizer compatible

Table 5.6.3.1-1 MU181500B Command List (Cont'd)

No.	Command Header 1	Command Header 2	Command Header 3	Command Header 4	Command Header 5	Command Header 6	Command /Query	Remarks
11	:SOURce	:JITTer	:BUJ	:AMPLitude			C/Q	
12				:BITRate			C/Q	
13				:ENABle			C/Q	
14				:LPFilter			C/Q	
15				:PRBS			C/Q	
16			:EXTJitter	:ENABle			C/Q	
17			:RJ	:AMPLitude			C/Q	
18				:DEFault			C	
19				:ENABle			C/Q	
20				:FILTer			C/Q	
21				:HFAMplitude			C/Q	
22				:HPFilter			C/Q	
23				:LFAMplitude			C/Q	
24				:LPFilter			C/Q	
25				:MONitor			Q	
26			:SJ[2]	:AMPLitude			C/Q	
27				:ENABle			C/Q	
28				:FREQuency			C/Q	
29			:SSC	:DEViation			C/Q	
30				:DISPlay			C/Q	
31				:ENABle			C/Q	
32				:FFRequency			Q	
33				:FREQuency			C/Q	
34				:IFRequency			C/Q	
35				:INITialize			C	
36				:LIST	:ADD		C	
37					:DELete		C	
38					:DEViation		Q	
39						:WAIT	Q	
40					:DEViation0		Q	
41					:DEViation1		C/Q	

Table 5.6.3.1-1 MU181500B Command List (Cont'd)

No.	Command Header 1	Command Header 2	Command Header 3	Command Header 4	Command Header 5	Command Header 6	Command /Query	Remarks
42	:SOURce	:JITTer	:SSC	:LIST	:DEViation2		C/Q	
43					:DEViation3		C/Q	
44					:DEViation4		C/Q	
45					:DEViation5		C/Q	
46					:DEViation6		C/Q	
47					:DEViation7		C/Q	
48					:GRAPh		C/Q	
49					:SHAPe		Q	
50						:WAIT	Q	
51					:SHAPe0		Q	
52					:SHAPe1		C/Q	
53					:SHAPe2		C/Q	
54					:SHAPe3		C/Q	
55					:SHAPe4		C/Q	
56					:SHAPe5		C/Q	
57					:SHAPe6		C/Q	
58					:SHAPe7		C/Q	
59				:MAXDeviation			Q	
60				:MINDeviation			C/Q	
61				:MODulation			C/Q	
62				:OPEak			C/Q	
63				:PROFile			C/Q	
64				:SLOPe			Q	
65					:WAIT		Q	
66				:SLOPe0			Q	
67				:SLOPe1			Q	
68				:SLOPe2			Q	
69				:SLOPe3			Q	
70				:SLOPe4			Q	
71				:SLOPe5			Q	
72				:SLOPe6			Q	
73				:SLOPe7			Q	

Table 5.6.3.1-1 MU181500B Command List (Cont'd)

No.	Command Header 1	Command Header 2	Command Header 3	Command Header 4	Command Header 5	Command Header 6	Command /Query	Remarks
74	:SOURce	:JITTer	:SSC	:ST1Deviation			C/Q	
75				:ST2Deviation			C/Q	
76				:STARt			C	
77				:STATe			Q	
78				:STOP			C	
79				:TIME			Q	
80				:TIME0			Q	
81				:TIME1			C/Q	
82				:TIME2			C/Q	
83				:TIME3			C/Q	
84				:TIME4			C/Q	
85				:TIME5			C/Q	
86				:TIME6			C/Q	
87				:TIME7			C/Q	
88				:TYPE			C/Q	
89				:CSTRigger			C/Q	
90				:WAIT			C/Q	
91		:OUTPut	:PATA	:JOVerload			Q	
92				:MONitor			Q	
93				:SELect			C/Q	
94	:SYSTem	:INPut	:CSELect				C/Q	
95				:MODule			Q	
96		:MMEMory	:RECall				C	
97			:STORe				C	
98			:JITTer	:SSC	:PRESet	:RECall	C	
99						:STORe	C	

5.6.4 21G/32G bit/s SI PPG commands

MU195020A setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

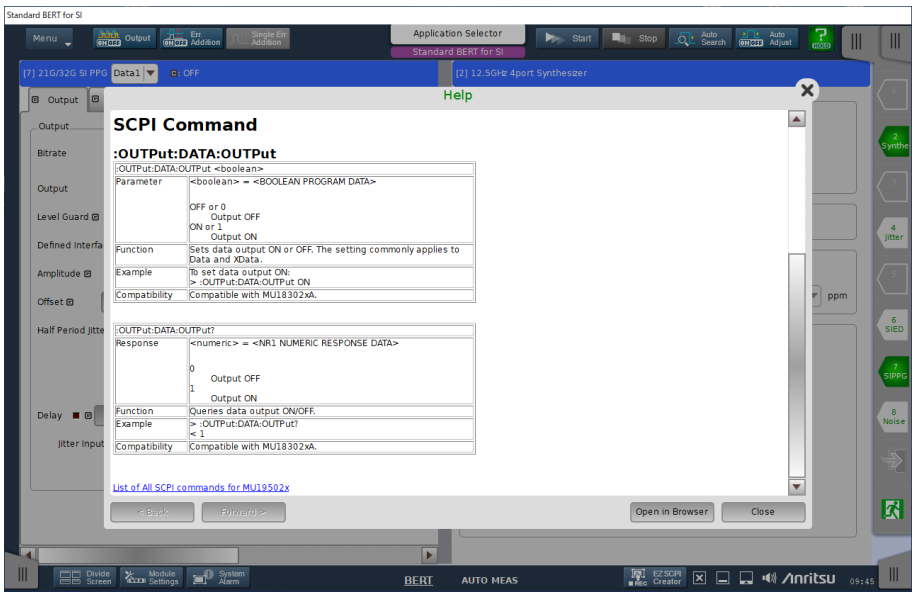


Figure 5.6.4-1 Example of On-Screen Help

5.6.5 21G/32G bit/s SI ED commands

MU195040A setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

5.6.6 Noise Generator commands

The setting and query commands for the MU195050A and MU196050B can be found in the on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

5.6.7 PAM4 PPG commands

MU196020A/C setting and query commands explanation can be referred to from on-screen help. For information on how to display the on-screen help, refer to 3.2.1.3 “Help”

Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

5.6.8 PAM4 ED commands

MU196040A/B setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

5.6.9 32G baud NRZ/PAM4 Re-Driver commands

MU196060A setting and query commands explanation can be referred to from on-screen help. For instructions on how to display the on-screen help, refer to 3.2.1.3 “Help”.

Before executing a setting/query command, specify the slot number of the module to be remotely controlled, by using the :MODule:ID command. Refer to 5.6.1.1 “Commands for common settings” for how to specify a slot number with the :MODule:ID command.

Appendix A Software Licenses

This product includes the software listed in the following table.

For the software details, refer to the Anritsu Web site at
https://www.anritsu.com

Package software in the table is not included our software licensing.

Table A-1 Packages and Corresponding Licenses

Package	License	Remarks
FreeRTOS8.2.3	Modified GPL (*1)	The FreeRTOS source code is licensed by a modified GNU General Public License - the modification taking the form of an exception.
FreeRTOS+CLI V1.0.4	MIT license (*2)	
Qt4.8.2	LGPL (*3)	
QRes1.0.9.7	BSD (*4)	QRes Source Code - Open Source License

(*1) Modified GPL:

The FreeRTOS open source license covers the FreeRTOS source files, which are located in the /FreeRTOS/Source directory of the official FreeRTOS download. It also covers most of the source files in the demo application projects, which are located in the /FreeRTOS/Demo directory of the official FreeRTOS download. The demo projects may also include third party software that is not part of FreeRTOS and is licensed separately to FreeRTOS. Examples of third party software includes header files provided by chip or tools vendors, linker scripts, peripheral drivers, etc. All the software in subdirectories of the /FreeRTOS directory is either open source or distributed with permission, and is free for use. For the avoidance of doubt, refer to the comments at the top of each source file. The FreeRTOS GPL Exception text on this page applies to FreeRTOS V8.2.3 up to the latest version. The FreeRTOS GPL exception text that applies to versions prior to V8.2.3 is very similar, and can be found in the relevant FreeRTOS distribution packages.

NOTE: The modification to the GPL is included to allow you to distribute a combined work that includes FreeRTOS without being obliged to provide the source code for proprietary components.

The FreeRTOS GPL exception text follows:
Any FreeRTOS *source code*, whether modified or in it's original release form, or whether in whole or in part, can only be distributed by you under the terms of the GNU General Public License plus this exception. An independent module is a module which is not derived from or based on FreeRTOS.

Clause 1:
Linking FreeRTOS with other modules is making a combined work based on FreeRTOS. Thus, the terms and conditions of the GNU General Public License V2 cover the whole combination.
As a special exception, the copyright holders of FreeRTOS give you permission to link FreeRTOS with independent modules to produce a statically linked executable, regardless of the license terms of these independent modules, and to copy and distribute the resulting executable under terms of your choice, provided that you also meet, for each linked independent module, the terms and conditions of the license of that module. An independent module is a module which is not derived from or based on FreeRTOS.

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FreeRTOS may not be used for any competitive or comparative purpose, including the publication of any form of run time or compile time metric, without the express permission of Real Time Engineers Ltd. (this is the norm within the industry and is intended to ensure information accuracy).

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Appendix B Precautions When Connecting via Remote Desktop

If you log in directly to the MP1900A controlled via Windows Remote Desktop Connection, the MP1900A display may not show the lower part of the MX190000A screen completely.

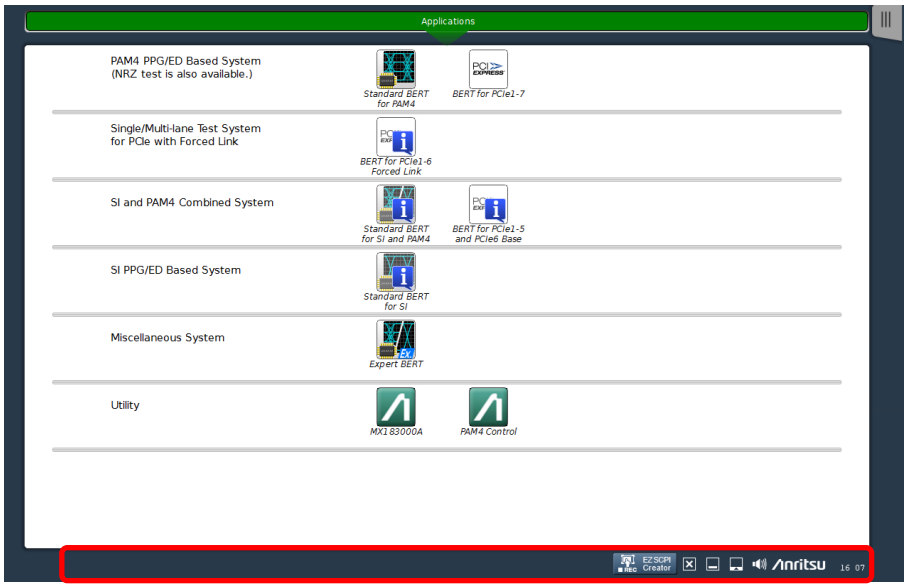


Figure B-1 Example of MX190000A Screen Not Shown Completely on the MP1900 Display

Via Remote Desktop Connection, the MX190000A can be started in window format. When you log directly in to the MP1900A controlled remotely, the screen settings are kept, causing the screen to be displayed as shown in the example. In this case, cancel the Window format display by operating the MP1900A panel to shut down the MX190000A.
To display the screen correctly, operate the MP1900A panel to restart the MX190000A according to the the following procedure:

1. Touch **Expert BERT** at Miscellaneous System.
2. When the Expert BERT application is launched, touch  on the application toolbar.

3. Select **Shut down the software completely**, and then touch **OK**.

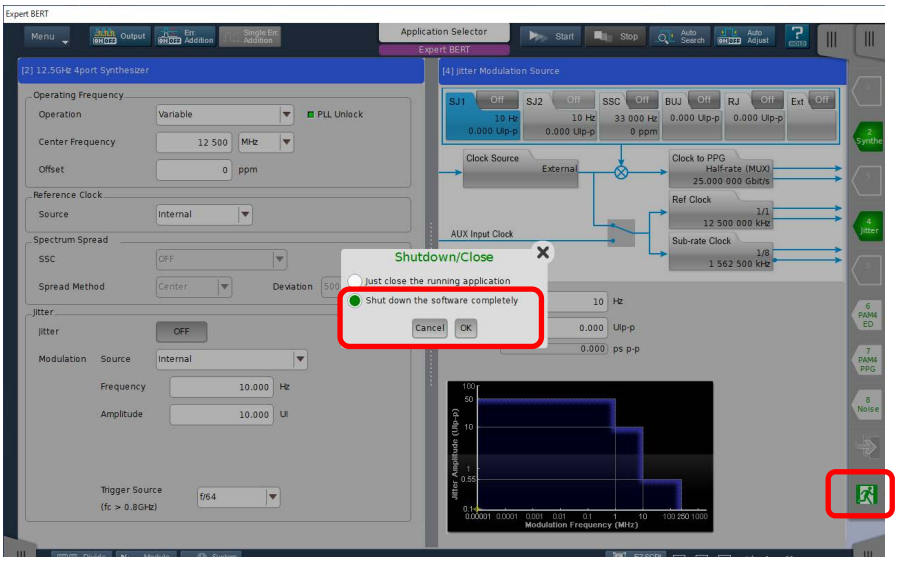


Figure B-2 Shutdown Operation in the Expert BERT Screen

4. Operate the MP1900A panel to start the MX190000A.

Note:

When controlling the MP1900A via Windows Remote Desktop, avoid performing screen operations immediately after the connection is established as the CPU load is temporarily high. If operations are performed at this time, the application may terminate.