User's Manual

AQ23011A, AQ23012A Multi Application Test System Features Guide

YOKOGAWA
Yokogawa Test & Measurement Corporation

IM AQ23011A-01EN
3rd Edition

Thank you for purchasing the AQ23011A or AQ23012A Multi Application Test System (Frame). The AQ2300 Series consists of the AQ23011A/AQ23012A Frame and several modules. The frame can control the source and measure modules installed in the frame.
This user's manual explains the features of the AQ2300 Series, including its modules. To ensure correct use, please read this manual thoroughly before operation. Keep this manual in a safe place for quick reference.
The manuals for this instrument are listed on page iii. Please read all manuals.

Contact information for YOKOGAWA offices worldwide is provided on the following sheet.

Document No.	Description
PIM 113-01Z2	List of worldwide contacts

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements to the product's performance and functionality. Refer to our website for the latest versions of the manuals.
- The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, if you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
- Copying or reproducing all or any part of the contents of this manual without the permission of YOKOGAWA is strictly prohibited.

Trademarks

- Microsoft and Windows are registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.
- Adobe and Acrobat are either registered trademarks or trademarks of Adobe Systems Incorporated.
- In this manual, the ® and TM symbols do not accompany their respective registered trademark or trademark names.
- Other company and product names are registered trademarks or trademarks of their respective holders.

3rd Edition: March 2026 (YMI)
All Rights Reserved. Copyright © 2024 Yokogawa Test & Measurement Corporation

Revisions

- 1st Edition: October 2024
- 2nd Edition: June 2025
- 3rd Edition: March 2026

Manuals

The following manuals, including this one, are provided for this instrument. Please read all manuals.

Manuals included with the product

Manual title	Manual No.	Description
AQ23011A, AQ23012A Multi-Application Test System Getting Started Guide	IM AQ23011A-03EN	Provided as a printed manual. Explains the handling precautions, common operations, troubleshooting measures, and specifications of this instrument.
AQ23011A, AQ23012A Frame	IM AQ23011A-92Z1	Document for China
Safety Instruction Manual	IM 00C01C01-01Z1	Safety manual (European languages)

Manuals included in the internal storage of the frame

The following manuals are included in the internal storage of the frame (AQ23011A, AQ23012A). Download them to your PC for use. For information on how to download them, see “How to View the User’s Manual” in the Getting Started Guide (IM AQ23011A-03EN).
You can also download them from the YOKOGAWA website.

Manual Title	Manual No.	Description
AQ23011A, AQ23012A Multi-Application Test System Features Guide	IM AQ23011A-01EN	This document. Explains all the instrument’s features including its modules but excluding the remote control features. This single PDF file contains both the Features Guide and the User’s Manual.
AQ23011A, AQ23012A Multi-Application Test System User’s Manual	IM AQ23011A-02EN	Explains how to operate this instrument. This single PDF file contains both the Features Guide and the User’s Manual.
AQ23011A, AQ23012A Multi-Application Test System Communication Interface User’s Manual	IM AQ23011A-17EN	This manual explains the instrument’s remote control features, how to configure it, and the commands used to control this instrument from a PC through the interface.

The “EN and “Z1” in the manual numbers are the language codes.

Conventions used in this manual

Prefixes k and K

Prefixes k and K used before units are distinguished as follows:

k:	Denotes 1000.	Example: 12 kg, 100 kHz
K:	Denotes 1024.	Example: 720 KB (file size)

Contents

1.1 Overview

Description of this chapter

This chapter explains the SMU features.

SMU

The following SMUs can be installed in the AQ2300 frame (AQ23011A or AQ23012A).

AQ23811A Source Measure Unit (2CH)

This is a 2-channel SMU.

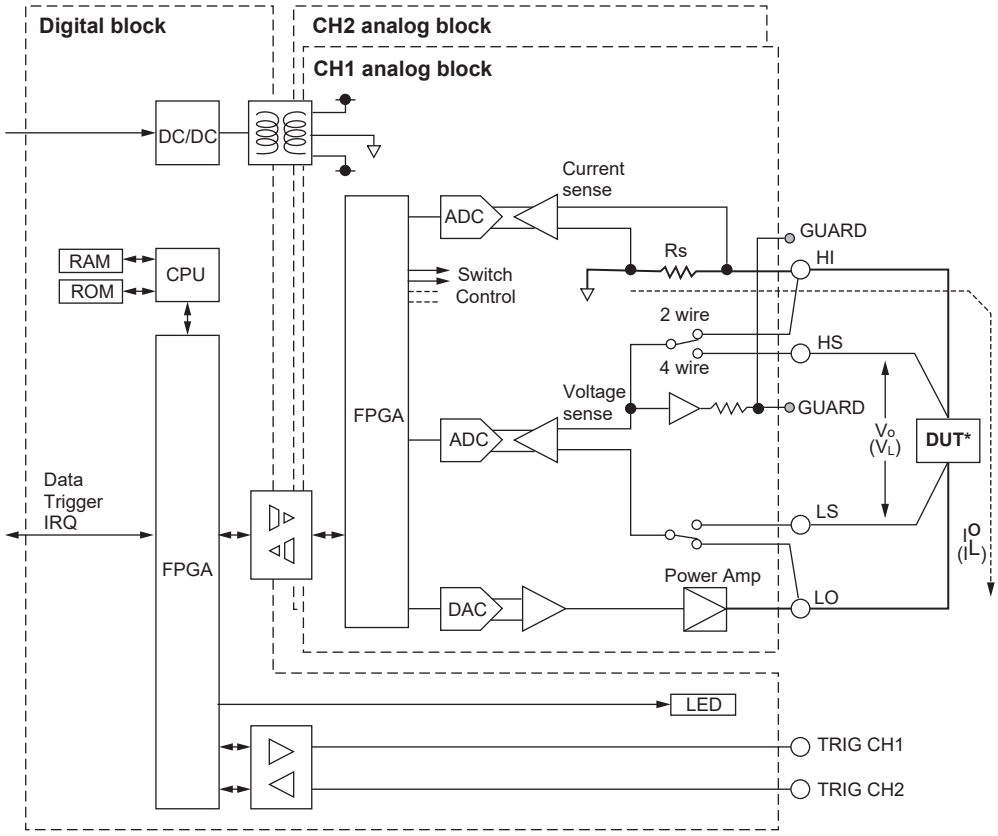
Each channel can source or measure voltage or current.

The voltage source/measurement range is 6 V.

The current source/measurement range is 200 nA, 2 µA, 20 µA, 200 µA, 2 mA, 20 mA, 200 mA, and 600 mA.

Sourcing and measurement start in response to their individually configured triggers.

Block Diagram



* DUT: device under test

The SMU consists of a digital block at ground potential and an isolated analog block. CH1 and CH2 of the analog block are mutually isolated. The frame supplies a single power source. The power is supplied to the digital block. The power is also supplied to the analog block but through an isolated power supply.

The digital block consists of a CPU, FPGA, memory, and various interface circuits.

The CPU and FPGA transfer the settings and trigger signals received from the frame to the analog block and send the measurement information from the analog block to the frame.

The analog block consists of high-speed, high-precision op amps, highly stable resistors, and other components.

The FPGA, responsible for feedback and limiter control of the source function, processes the A/D and D/A converters, switches circuit signal paths, and exchanges data with the digital block's FPGA.

During voltage sourcing, measured voltages are fed back to the output, and the limiter operates according to the results of the measured currents. Likewise, during current sourcing, measured currents are fed back to the output, and the limiter operates according to the results of the measured voltages.

Local sense and remote sense can be switched to perform two-wire or four-wire voltage sensing. Also, if you want to improve the deterioration in response caused by transient leakage current due to capacitive components when the output changes, or if you want to reduce leakage current, shield the cable with the GUARD terminal.

1.2 Source

Feature overview

Each channel can source voltage or current. Sweep operation can also be performed to source voltage or current while changing its level.
This section explains the source feature.
Details on sweeping are provided in section 1.4, “Sweep.”
When a source trigger is detected, sourcing starts. Sourcing is executed after the source delay.
There are two source waveforms: DC and pulse. To source pulse signals, set the pulse base and pulse width in addition to the source level.
The output of each channel can be turned on and off. When turned off, neither sourcing nor measurement is possible.

Source mode (Source Mode)

There are two modes: normal source and sweep.
Normal source mode: Mode used to set the source value and apply it to DC sourcing or pulse sourcing
Sweep mode: Mode to source with sweeping (linear sweep, log sweep, program sweep)

Source range (Range)

Voltage Ranges

Source range	Lower	Upper	Setting resolution	Max. Load Current
6 V	–6.0000 V	+6.0000 V	100 µV	±600 mA / ±200 mA*

* The maximum sink load current for voltages exceeding ±2 V is up to ±200 mA.

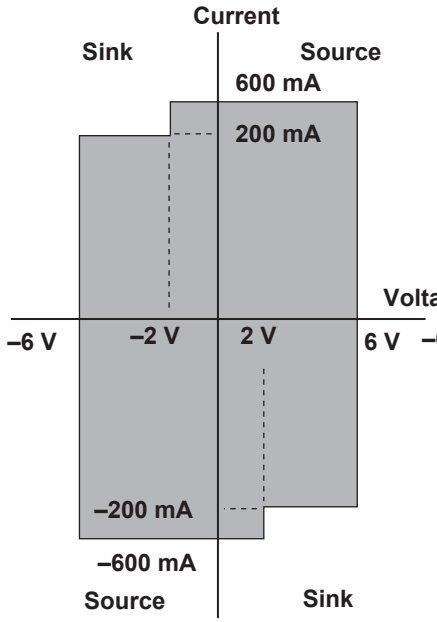
Current Ranges

Source range	Lower	Upper	Setting resolution	Max. Load Voltage
200 nA	–200.000 nA	+200.000 nA	1 pA	±6 V
2 µA	–2.00000 µA	+2.00000 µA	10 pA	±6 V
20 µA	–20.0000 µA	+20.0000 µA	100 pA	±6 V
200 µA	–200.000 µA	+200.000 µA	1 nA	±6 V
2 mA	–2.00000 mA	+2.00000 mA	10 nA	±6 V
20 mA	–20.0000 mA	+20.0000 mA	100 nA	±6V
200 mA	–200.000 mA	+200.000 mA	1 µA	±6 V
600 mA	–600.00 mA	+600.00 mA	10 µA	±6 V / ±2 V*

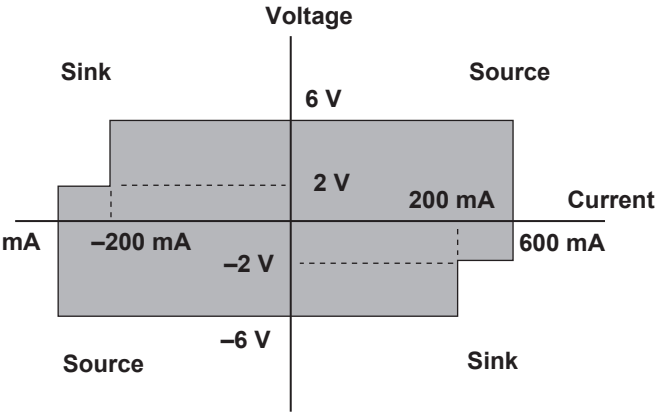
* The maximum sink load voltage for the 600 mA range is is up to ±2 V.

Source range

Voltage source mode



Current source mode



Operation after changing the source range or level

When the source trigger source is set to None, changing the source value immediately changes the source level.

Otherwise, the source level changes when a source trigger is detected.

Fixed source range and auto source range

There are two types of source ranges: fixed range and auto range.

Fixed source range

The target range is specified manually. You can set the source level within the specified range.

Auto source range

The range is changed automatically to the appropriate setting according to the source level. You can set the source level without thinking about the range. However, the output may be temporarily discontinuous when the range switches. This is valid when the source mode is set to normal.

For AQ23811A voltage sourcing, there is no difference between fixed source range and auto source range because 6 V is the only range available.

Source waveform (Shape)

You can set the source shape to DC or pulse.

DC: The signal is sourced at the specified level until the end.

Pulse: The signal is sourced at the specified level for the specified time period (pulse width).

Load resistance/load capacitance/load inductance (Load Resistance, Load Inductance, Load Capacitance)

By setting values appropriate for the target load, the source value can converge smoothly to the specified output value.

- Load resistance: Valid for voltage sourcing and current sourcing.
- Load capacitance: Valid for voltage sourcing.
- Load inductance: Valid for current sourcing.

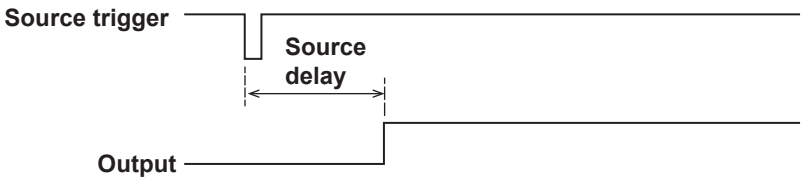
The minimum value is set by default. Change it when adjusting the source waveform.

Source trigger (Source Trigger)

When a source trigger is detected, sourcing starts.
A signal received through a bus trigger (BUS Trigger1 to 9) or the module's trigger terminal (Front) can be assigned as a source trigger.
You can also disable the source trigger and start sourcing from a control on the screen or a communication command.

Source delay (Source Delay)

You can adjust the amount of time to wait after a source trigger is detected until sourcing starts. This can also be used to adjust the timing between channels.



Limiter (Limiter)

The limiter protects the device under measurement. When you set a limit, the source value is controlled so that it does not exceed the limit. This is also valid during sweeping. The upper limit of this setting is the maximum load current or maximum load voltage, mentioned earlier.
The voltage limiter operates during current sourcing and the current limiter during voltage sourcing.
When Absolute is ON, the limiter is set within a ± range centered on zero.

1.3 Measure

Feature overview

This feature measures voltage or current.
When a measurement trigger is detected, measurement operation starts. Measurement is executed after the measurement delay for the specified integration time.
Power or resistance can also be calculated based on the measurement results.

Local sense and remote sense (Wire)

Two wiring systems, 2wire (two-terminal connection or local sense) and 4wire (four-terminal connection or remote sense) are available.
Four-terminal connection (4wire) is effective to measure voltage at high precision when the running current is large and the voltage appearing at the device under measurement is small, such as during low-resistance measurement.

Integration time (Integ Time)

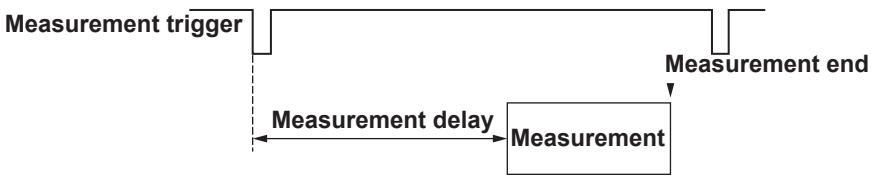
You can set the integration time in units of seconds or integer multiple of the power line cycle (PLC). If you set a long integration time, the measurement takes longer, but the stability of the measured values increases. Setting the integration time to an integer multiple of the power line cycle (nPLC) has the effect of eliminating noise in the power supply frequency components. For high precision measurement, use an integer value (integer multiple of the power line cycle).

Measurement trigger (Measure Trigger)

When a measurement trigger is detected, measurement operation starts.
A signal received through a bus trigger (BUS Trigger1 to 9), a signal received through the module's trigger terminal (Front), the time at which the source value changes (Src Change), or repetition (Cyclic) can be assigned as a measurement trigger.
You can also disable the measurement trigger and start measurement from a control on the screen or a communication command.

Measurement delay (Measure Delay)

You can adjust the amount of time to wait after a measurement trigger is detected until measurement starts. Measurement operation includes jitter of ±1 µs. Measurements made when the waveform of the device under measurement (DUT) is in a transient state will not be stable due to the effects of jitter. Set the measurement delay so that measurement starts after the waveform of the device under measurement becomes sufficiently stable.



Offset (Offset)

Unwanted DC component in measurements can be offset.
The offset can be specified separately for voltage measurement and current measurement.

Math (Math)

This feature calculates power or resistance from the measurement results and shows it on the screen.
If the offset is set to ON, the offset value is also reflected in the calculation.

Storage feature

Measurement data for the specified number of points is saved in internal storage.
The available save formats are binary and ASCII.
Measurement data can also be saved automatically in the specified folder.

1.4 Sweeping

Feature overview

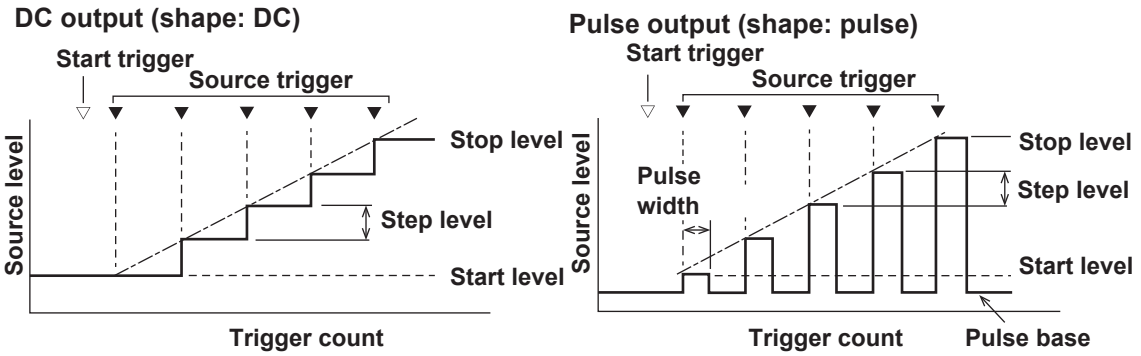
Each channel can source voltage or current by sweeping.
Three types of sweeping are available: linear, log, and program.
When a start trigger is detected, sweeping starts.
Sweep sourcing is also possible by using Sweep in Application.
For details on sweeping, see section 4.1, “Sweep”.

Source mode (Source Mode)

Set the source mode to Sweep to use sweep sourcing.

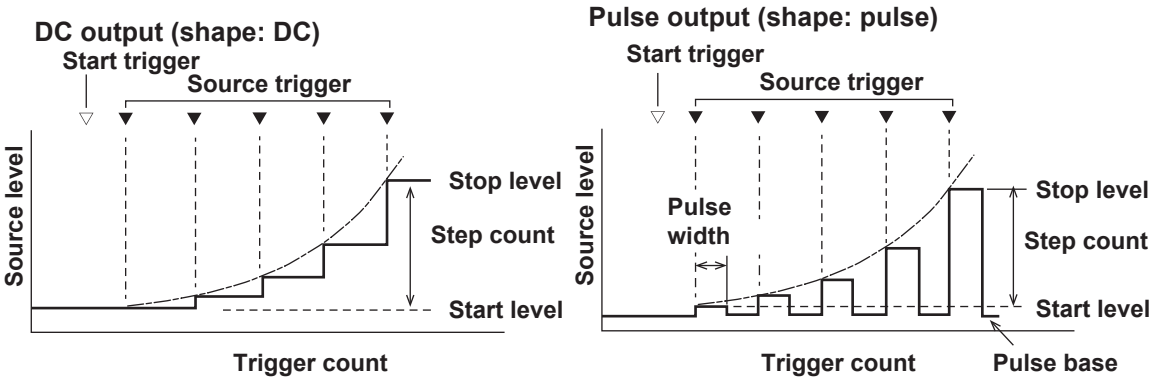
Linear sweep

With the horizontal scale set to trigger count and the vertical scale to the source level, sweeping is performed from the specified start level to the stop level at the specified step-level steps.



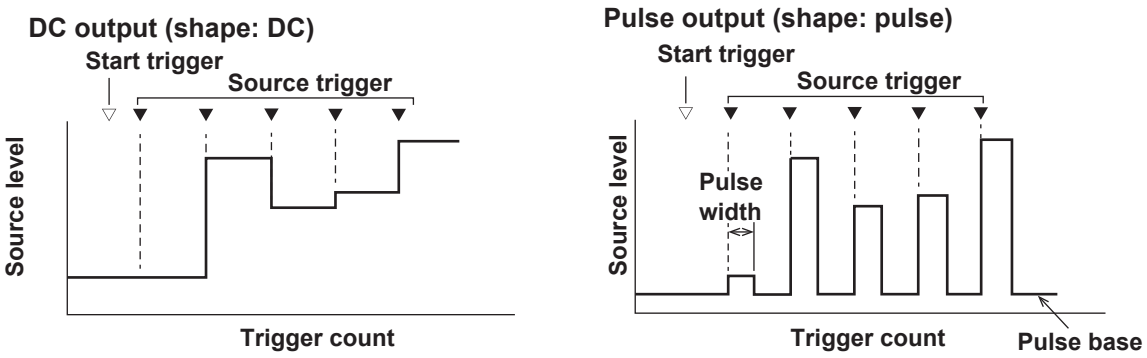
Log sweep

With the horizontal scale set to trigger count and the vertical scale to the source level, sweeping is performed exponentially in a step pattern obtained by dividing the source levels from the start level to the stop level by the specified step count.



Program sweep

A program file (sweep pattern file in CSV format) created on a PC is loaded into the instrument, and sweeping is performed according to its pattern.
You can set the step count up to 100001.



For how to create program files, see section 4.1, “Sweep.”

Start trigger (Start Trigger)

The start trigger is used to start sweeping.
You can select a signal received through a bus trigger (BUS Trigger1 to 9) or the module’s trigger terminal (Front), None, or Disable.
If you select None, sweeping starts without the start trigger.
If you select Disable, you can start sweeping using the START TRIG button or a communication command.

Repeat count (Repeat Count)

Set the sweep repeat count.
The available range is 1 to 1000. You can also specify Infinity. Sweeping starts at the start trigger timing for each repetition.
If you set the count to 5, sweeping will be repeated five times at the start trigger timing, and then the instrument will return to the start-wait state.
If you select Infinity, after sweeping starts, sweeping will be repeated at the start trigger timing until sweeping is stopped or output is turned off.
When repeating a sweep, if the timing of the start trigger for the next sweep after the end of the previous sweep is too early, a start sampling error may occur. In this case, delay the start trigger timing.

1.5 Trigger

Feature overview

The SMU has the following triggers.

- Source trigger
- Measurement trigger
- Sweep start trigger

Trigger settings are available separately for the frame and SMU. The frame trigger settings and SMU trigger settings are not automatically synchronized.

If the trigger settings specified on the frame and those specified on the SMU are in conflict, the settings that are specified last are valid.

Source trigger (Source Trigger)

This trigger initiates voltage or current sourcing. Select any of the following trigger sources.

BUS Trigger1 to 9

The external signal received through the trigger input terminal on the frame's rear panel or the frame's internal timer (oscillator) can be assigned to Bus Trigger1 to 9. The aforementioned signal can be used as a trigger by selecting BUS Trigger1 to 9 on the module side.

Signal received through the module's trigger terminal (Front)

A TTL level signal (negative logic). The falling edge is used for the source trigger. This can be used when the module's trigger terminal is set to input.

None

The source value changes simply by changing the setting, without applying a trigger (for DC waveform sourcing when sweeping is off).

Disable

Sourcing starts with the TRIG button on the panel or a communication command.

Measurement trigger (Measure Trigger)

The measurement trigger starts a voltage measurement or a current measurement. Select any of the following trigger sources.

Bus Trigger1 to 9

The external signal received through the frame's trigger input terminal or the frame's internal timer can be assigned to Bus Trigger1 to 9. The aforementioned signal can be used as a measurement trigger by selecting Bus Trigger1 to 9 on the module side.

Signal received through the module's trigger terminal (Front)

A TTL level signal (negative logic). The falling edge is used for the measurement trigger. This can be used when the module's trigger terminal is set to input.

When the source value changes (Src Change)

A measurement trigger occurs when a source trigger is detected.

Cyclic measurement (Cyclic)
A measurement trigger occurs when a measurement is finished. The minimum cycle is approximately 1 ms.

Disable
Measurement starts with the TRIG button on the panel or a communication command.

Start trigger (Start Trigger)

The start trigger starts a sweep operation. Select any of the following trigger sources.

Bus Trigger1 to 9
With the settings on the frame side, the external signal received through the trigger input terminal on the frame's rear panel or the frame's internal timer can be assigned to Bus Trigger1 to 9. The aforementioned signal can be used as a trigger by selecting Bus Trigger1 to 9 on the module side.

Signal received through the module's trigger terminal (Front)
A TTL level signal (negative logic). The falling edge is used for the sweep start trigger. This can be used when the module's trigger terminal is set to input.

None
Sweeping starts without applying a start trigger.

Disable
Sweeping starts with the START TRIG button on the panel or a communication command.

Trigger output (Trigger Output)

Trigger signals can be transmitted through the SMU's front output terminal or the frame.

Front output terminal (Front Output CH1, Front Output CH2)
SMU's front output terminals. Can be assigned to CH1 and CH2. This can be used when the module's trigger terminal is set to output.

Trigger output through the frame connection terminal (Trigger Output1 CH1, Trigger Output2 CH1, Trigger Output1 CH2, Trigger Output2 CH2)
Trigger signals are transmitted through the frame. The logical OR of the signal assigned to CH1 or CH2 is transmitted from Trigger Output1 or Trigger Output2.

Output signal
The following status signals can be transmitted.

- Sweep busy signal (Swp Busy)
- Source busy signal (SrcBusy)
- Measure busy signal (MeasBusy)
- Measure start signal (MeasStart)

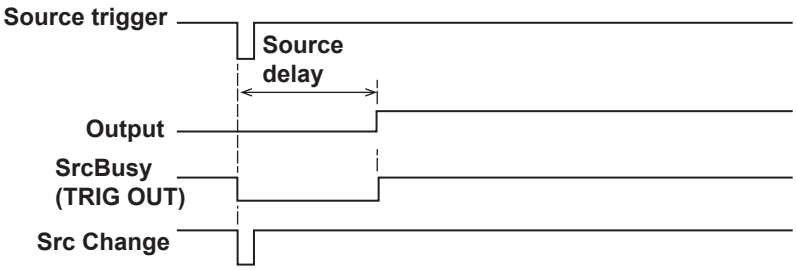
The measure start signal can be transmitted from Front Output CH1 or Front Output CH2.

Status signals

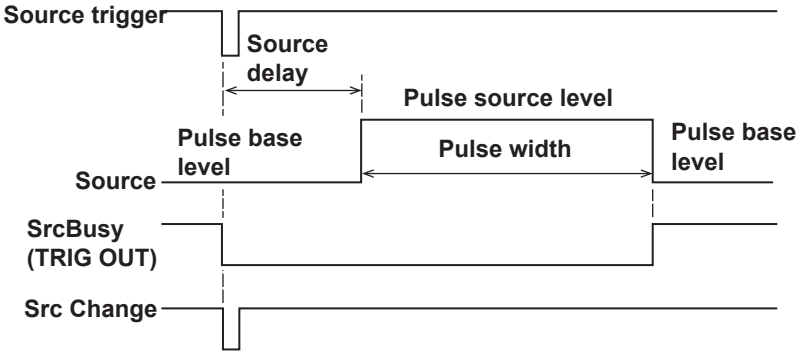
The status signals transmitted from each output terminal are negative-logic signals with a minimum pulse width of 10 µs. The output timings of SrcBusy, SwpBusy, and MeasBusy are as follows.

SrcBusy, Src Change

SrcBusy indicates that a signal is being sourced. It is set to low with a source trigger. It is also set to low when sourcing is started with a communication command.
During DC sourcing, SrcBusy is set to high after the source delay. Even when the source delay is set to 1 µs, the pulse width of the status signal is maintained for at least 10 µs.
Src Change is a signal that is generated when a source trigger is detected. It is an internal signal used as a measurement trigger and cannot be transmitted from a terminal.

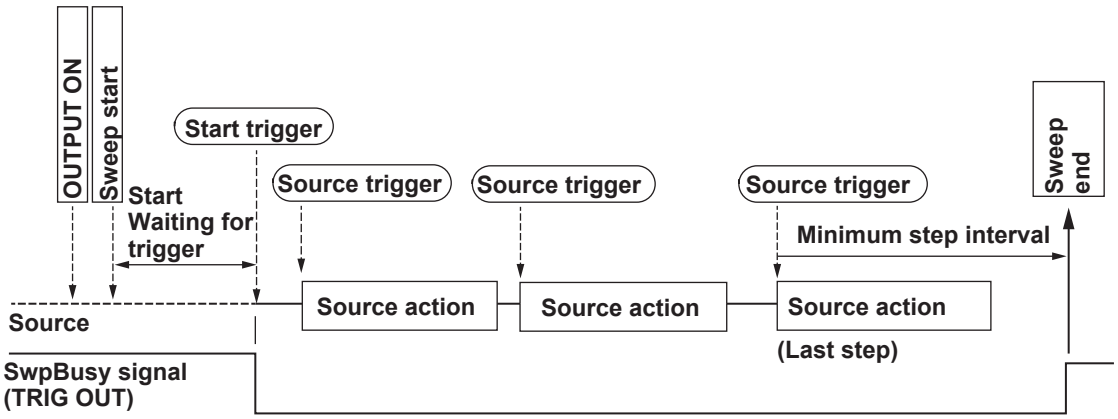


During pulse sourcing, SrcBusy is set to high at the end of a pulse.



SwpBusy

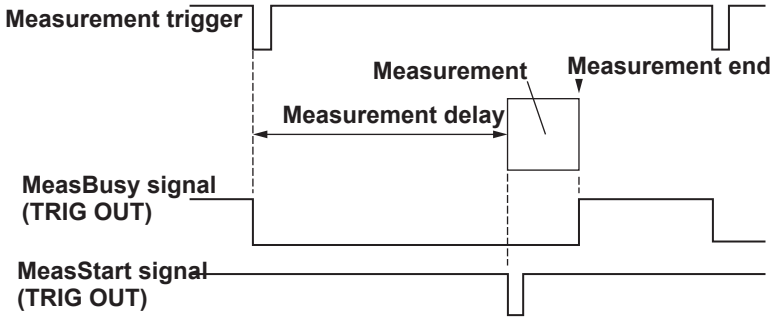
SwpBusy indicates that sweeping is in progress. It is set to low with a start trigger. It is set to high when the minimum step interval, which is an internal instrument setting, elapses after producing the last step.



MeasBusy, MeasStart

MeasBusy indicates that a measurement is in progress. It goes low on the measure trigger and returns high when measurement is complete (that is, when the number of measurements specified by the integration count has been acquired).

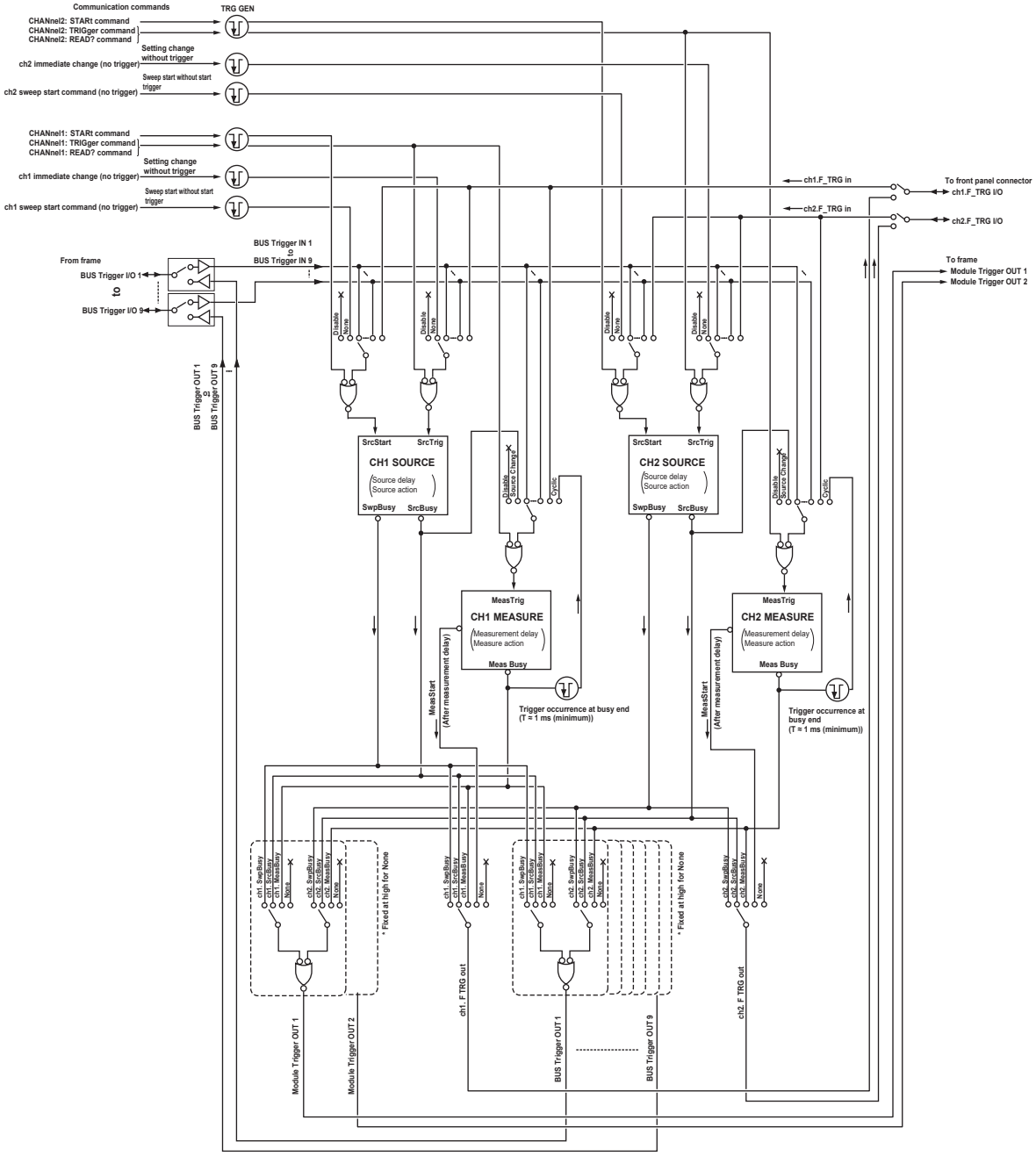
MeasStart is a negative-logic signal with a pulse width of 10 µs. It is generated when a measurement starts.



Synchronizing modules

Signals can be generated or measurements can be started in sync by assigning the same trigger source for the source and measurement start triggers of multiple modules.

Trigger block diagram



1.6 Other Functions

Setup file save/load feature

Settings of each SMU can be saved and loaded from files.

Zero-set function

The zero-set function is used to calibrate the source level offset drift caused by temperature changes and other factors for each SMU channel.

Module preset (Module preset)

Resets the settings of the module currently shown in the detailed settings view to their default values.
Modules installed in other slots are not initialized.

Reset all modules (Reset all modules)

Resets the settings of all modules installed in the frame slots to their default values.

Module information (Module information)

You can view the model, option configuration, version, and other product information.
Displays the following information.

- Module name
- Model code
- Serial No.
- Special code
- Option
- Firmware version
- FPGA version

2.1 Overview

Description of this chapter

This chapter explains the OPM features.

OPM

The following OPMs can be installed in the AQ2300 frame (AQ23011A or AQ23012A).

AQ23211A Optical Power Meter (1CH)

This is a 1-channel OPM with analog output. The measurable wavelength range is 800 nm to 1700 nm.
You can set the wavelength of the input light to be measured and measure the input light level.
The measurement range can be set automatically (auto range).
You can either measure continuously or take a single measurement at a specified time (measurement mode).
The analog signal output terminals on the front panel of the module can output a voltage corresponding to the input light level.

AQ23212A Optical Power Meter (2CH)

This is a 2-channel OPM. The measurable wavelength range is 800 nm to 1700 nm.
You can set the wavelength of the input light to be measured for each channel and measure the input light level.
The measurement range can be set automatically (auto range).
You can either measure continuously or take a single measurement at a specified time (measurement mode).

AQ23221A Optical Power Meter (1CH)

This is a 1-channel high-power OPM with analog output.
The measurable wavelength range is 970 nm to 1660 nm.
You can set the wavelength of the input light to be measured and measure high-power input light up to +30 dBm.
The measurement range can be set automatically (auto range).
You can either measure continuously or take a single measurement at a specified time (measurement mode).
The analog signal output terminals on the front panel of the module can output a voltage corresponding to the input light level.

AQ23202A Interface Module (2CH)

AQ23291A Optical Sensor Head

AQ23295A Optical Sensor Head

This is a two-channel OPM that is used with an optical sensor head connected to the interface module.

The measurable wavelength range depends on the connected optical sensor head, as follows:

AQ23291A: 800 nm to 1700 nm

AQ23295A: 400 nm to 1100 nm

You can set the wavelength of the input light to be measured for each channel and measure the input light level.

The measurement range can be set automatically (auto range).

You can either measure continuously or take a single measurement at a specified time (measurement mode).

The analog signal output terminals on the front panel of the interface module can output a voltage corresponding to the input light level.

The optical sensor head cannot be connected or disconnected while the power is on.

The AQ2200-232/242 optical sensor heads can also be used.

2.2 Optical Power Meter

Measurement Mode (Meas Mode)

There are three measurement modes. Set the mode according to your measurement application.

- Normal: Measurement is performed continuously, and the measured value is updated as needed.
- Single: One measurement is performed, and the measured value is updated after the measurement is complete.
- Input Trigger: Measurement is performed by trigger input, and the measured value is updated after the measurement is complete.

Note

- For details on the trigger input method, see chapter 3 of IM AQ23011A-02EN.
- Even during measurement in Single mode or Input Trigger mode, a new measurement start command is accepted.
- In Single mode and Input Trigger mode, only one measurement is performed. After that, measurement does not start until Normal mode or Single mode is started, or a trigger is input.

Measurement range (Range)

You can select the measurement range from the following two modes.

- AUTO range: The optimum range is set automatically according to the input optical power. Normally, use this mode.
- HOLD range: The measurement range can be set manually.
  +13 dBm (*), +10 dBm, 0 dBm, –10 dBm, –20 dBm, –30 dBm, –40 dBm, –50 dBm
- HOLD range (AQ23221A): +30 dBm, +20 dBm, +10 dBm, 0 dBm, –10 dBm, –20 dBm, –30 dBm

When using the HOLD range, pay attention to the optical input power within the selected range.
(*) Cannot be set on the AQ23295A.

Display resolution (Disp Resolution)

You can set the number of decimal places displayed for the measurement result.
4, 3, 2, or 1 decimal places

Display unit (Unit)

You can select one of the following four units for the optical power display.

dBm, dB, W(abs), W(rel)

dBm is a logarithmic display of the absolute value (measured value). Use this when the measurement range is wide.
W (abs) is a linear display of the absolute value (measured value). The relationship between logarithmic and linear display is as follows:

0 dBm = 1 mW

dB is a logarithmic display of relative values. W(rel) is a linear display of relative values.
A relative value is the difference between the value registered using the reference function described below and the absolute value (actual measured value).

Reference function (Reference)

When measuring optical output levels, the level may vary depending on the light source or measurement system used (wavelength dependence). Therefore, when measuring the loss level of the target under measurement, you can register the optical output level of the light source or measurement system in advance as a reference value, and display the difference value (relative value) obtained by subtracting the reference value from the actual measured value (absolute value).

You can switch the display between relative and absolute values.

Offset (Offset)

You can set the displayed value to the value obtained by adding the power offset value (–180.0000 dB to +200.0000 dB) to the measured value.

Maximum/Minimum Measurement (MaxMin Mode)

When measuring polarization-dependent loss and similar characteristics, the maximum and minimum values are measured, and the difference between them is calculated. You can select the measurement interval used to update the maximum/minimum values from the following four modes.

- Continuous: From immediately after this mode is set until the mode is turned off, the maximum value, minimum value, and (maximum value – minimum value) are updated each time the measured value is updated.
- Window: The maximum value, minimum value, and (maximum value - minimum value) are calculated using the measured values for the number of samples specified by Data Points. The data is updated continuously by taking in the latest measured values and discarding older measured values.
- Refresh: This is the same as Continuous mode, but measurement stops after the specified number of samples in Data Point has been acquired.
- Event Trigger: An event occurs when the value crosses the Power Thresh value set in Event. According to the Event Position setting, measurement stops after the number of samples specified by Data Point have been measured.
  0%: Measurement is performed so that the first data point becomes the trigger point, and the maximum and minimum values are calculated.
  50%: Measurement is performed so that the center of the Data Point becomes the trigger point, and the maximum and minimum values are calculated.
  100%: Measurement is performed so that the last data point becomes the trigger point, and the maximum and minimum values are calculated.
- Off: Turns off the selected mode.
  The selected mode remains enabled until you set it to Off.

Maximum/minimum measurement cannot be used when the averaging time is 20 us or 50 us.

Measurement Wavelength (Wavelength)

The photodetector has wavelength-dependent sensitivity. By setting the wavelength of the light to be measured, the OPM's wavelength correction function corrects for wavelength-dependent sensitivity, thereby reducing variations in measured values and enabling accurate optical power measurement.

Zero-set function (ZeroSet)

By performing ZeroSet, you can adjust the electrical offset inside the sensor and measure accurate absolute values.

Averaging time (Average)

Averages the data measured within the specified time period.
When the measurement mode is Normal, the first measured value becomes available after the set averaging time has elapsed. After that, the measured value is updated using a moving average.
When the measurement mode is Single or Input Trig, the measured value becomes available after the set averaging time has elapsed following the start of Single measurement or receipt of a trigger input.
When Max/Min measurement is executed, the measured value is updated at each averaging time.
Setting range: 20 µs, 50 µs, 100 µs, 200 µs, 500 µs, 1 ms, 2 ms, 5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s

Hold (Hold)

Stops updating the display of the measurement data. Use this when viewing recorded measurement data. Note that display updating stops, but measurement continues in Normal mode.

2.3 Analog Output

Analog output (Analog Output)

The analog output function outputs a voltage from the front-panel analog output terminal according to the selected analog output mode. Real-time analog output (2 V or 5 V) corresponding to the input optical power is available.
This function cannot be used when the averaging time is set to 20 µs or 50 µs.

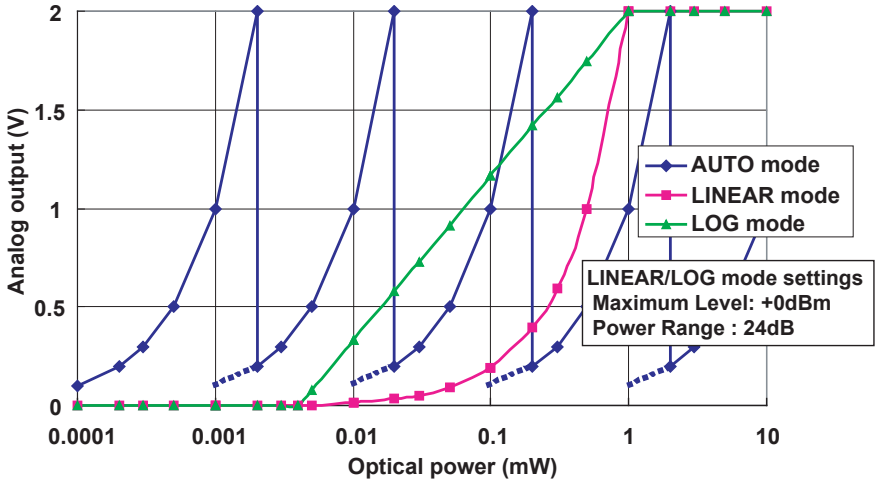
Auto mode
Outputs 2 V or 5 V for each measurement range.

Linear mode
Outputs a voltage proportional to the optical input power (W) within the set range.

Log mode
Outputs a voltage proportional to the optical input power (dB) within the set range.

Trigger mode
Outputs a trigger signal according to the settings from the analog out terminal.

Analog output example (when maximum voltage is 2 V)



The AQ23212A is not supported.

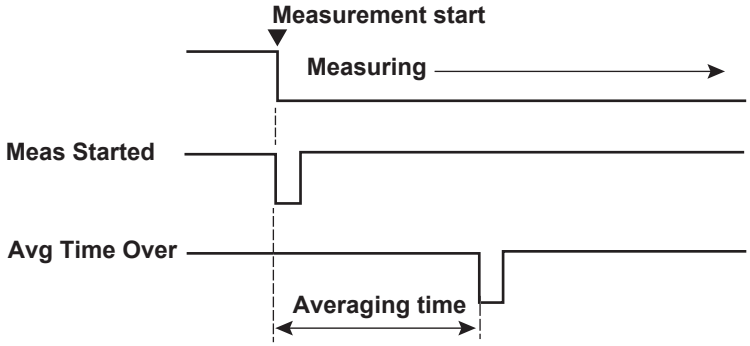
2.4 Trigger

Trigger (Trigger Output)

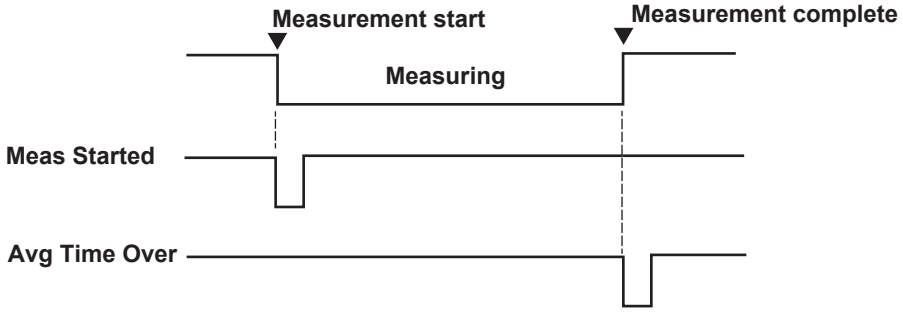
You can select the signal to be output from the frame via Trigger Output1, Trigger Output2, or the BUS Trigger set to Output.

- Disable: Disabled
- Avg Time Over: Outputs a trigger signal when measurement is completed. When the measurement mode is Normal, a trigger signal is output when the first measurement is completed after measurement starts (when the averaging time has elapsed).
- Meas Started: Outputs a trigger signal when measurement starts.
- Event Detect: Outputs a trigger signal when an event is detected.
- Meas Busy: Outputs an asserted trigger signal while measurement is in progress. When the measurement mode is Normal, the trigger signal is not asserted even during measurement.

Avg Time Start and Meas Started signals when the measurement mode is Normal



Avg Time Start and Meas Started signals when the measurement mode is Single or Input Trigger



2.5 Other Functions

Setup file save/load feature

Settings of each OPM can be saved and loaded from files.

Module preset (Module preset)

Resets the settings of the module currently shown in the detailed settings view to their default values.
Modules installed in other slots are not initialized.

Reset all modules (Reset all modules)

Resets the settings of all modules installed in the frame slots to their default values.

Module information (Module information)

You can view the model, option configuration, version, and other product information.
Displays the following information.

- Module name
- Model code
- Serial No.
- Special code
- Option
- Firmware version
- FPGA version

3.1 Overview

Description of this chapter

This chapter explains the VOA features.

VOA

The following VOAs can be installed in the AQ2300 frame (AQ23011A or AQ23012A).

AQ23311A Variable Optical Attenuator

This VOA model does not have an output monitor, but it has a monitor output port (/MP option). You can attenuate optical power by specifying the attenuation. You can also specify the wavelength to set the attenuation more accurately.
With the /MP option, the attenuated optical signal can be output from the optical signal monitor port on the front panel of the module.

AQ23321A Variable Optical Attenuator

This VOA is a model with an output monitor. You can attenuate optical power by specifying the attenuation. You can also specify the wavelength to set the attenuation more accurately.

AQ23332A Variable Optical Attenuator

This is a 2-channel VOA with an output monitor. You can attenuate optical power by specifying the attenuation. You can also specify the wavelength to set the attenuation more accurately. The optical output power can be kept constant by automatically adjusting the attenuation according to changes in the input optical power.

3.2 Variable Optical Attenuator

Optical attenuation (Attenuation)

You can set the optical power attenuation.

- AQ23311A, AQ23321A: 0 dB to 60 dB
- AQ23332A: 0 dB to 40 dB

The attenuation and offset have the following relationship:

Attenuation (dB) = Attenuation display value (dB) − Attenuation offset value (dB)

Attenuation offset (Offset)

You can set the attenuation display value to the value obtained by adding the attenuation offset value (−200.000 dB to +200.000 dB) to the attenuation value.

Setting the attenuation display value to the attenuation offset value (D->Aoffs)

You can set the attenuation offset value to the negative of the value displayed in the Attenuation box.

Wavelength (Wavelength)

With the VOA module, you can set the attenuation more accurately by specifying the wavelength of the input light.

Optical output setting at power-on (Output Start)

You can turn the optical output on or off when the module is started.

Attenuation and power tracking settings (APC)

This function automatically adjusts the attenuation setting so that, when the input optical power changes, the optical output value (Power) matches the power value set in section 3.3.
This setting is available only on the AQ23332A.

Attenuation change rate setting

You can set the attenuation change rate when setting the attenuation (Attenuation), optical output value (Power), or attenuation and power tracking (APC). When the speed setting status is ON, you can set the attenuation change rate. When the speed setting status is OFF, the attenuation change rate operates at the maximum speed.
Setting range: 4 dB/s to 80 dB/s
Resolution: 0.01 dB
This setting is available only on the AQ23332A.

3.3 Optical Output Monitor

With the AQ23321A and AQ23332A, you can monitor the current optical output.

Display unit (Unit)

For the optical power display, you can select either of the following units:

dBm, W(abs)

dBm is a logarithmic display of the absolute value (measured value). Use this when the measurement range is wide.
W (abs) is a linear display of the absolute value (measured value). The relationship between logarithmic and linear display is as follows:

0 dBm = 1 mW

Display resolution (Disp Resolution)

You can set the number of decimal places displayed for the measurement result.
3, 2, or 1 decimal places

Averaging time (Average)

Averages the data measured within the specified time period.
Setting range: 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s

Offset (Offset)

You can set the displayed value to the value obtained by adding the power offset value (–200.0000 dB to +200.0000 dB) to the measured value.

Optical output setting (Power Set)

Automatically adjusts the optical attenuation so that the Power monitor value can be set to any desired value.
This optical output value includes the power offset value.

P (dBm) = Pset (dBm) − Poffset (dB)

Pset: Set output power (dBm)

Zero-set function (ZeroSet)

By performing ZeroSet, you can adjust the electrical offset inside the sensor and measure accurate absolute values.

Hold (Hold)

Stops updating the display of the measurement data. Use this when viewing recorded measurement data. Note that although the display update stops, measurement continues.

Maximum/Minimum Measurement (MaxMin Mode)

When measuring polarization-dependent loss and similar characteristics, the maximum and minimum values are measured, and the difference between them is calculated. You can select the measurement interval used to update the maximum/minimum values from the following two modes.

- Continuous: From immediately after this mode is set until the mode is turned off, the maximum value, minimum value, and (maximum value – minimum value) are updated each time the measured value is updated.
- Off: Turns off the selected mode.
  The selected mode remains enabled until you set it to Off.

3.4 Other function

Setup file save/load function

Settings of each VOA can be saved and loaded from files.

Module preset (Module preset)

Resets the settings of the module currently shown in the detailed settings view to their default values.
Modules installed in other slots are not initialized.

Reset all modules (Reset all modules)

Resets the settings of all modules installed in the frame slots to their default values.

Module information (Module information)

You can view the model, option configuration, version, and other product information.
Displays the following information.

- Module name
- Model code
- Serial No.
- Special code
- Option
- Firmware version
- FPGA version

4.1 Optical Switch

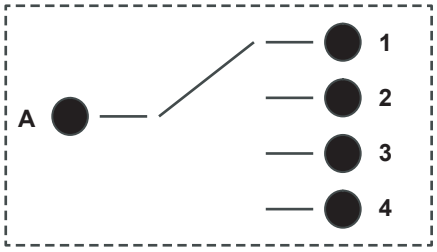
Description of this chapter

This chapter explains the OSW features.

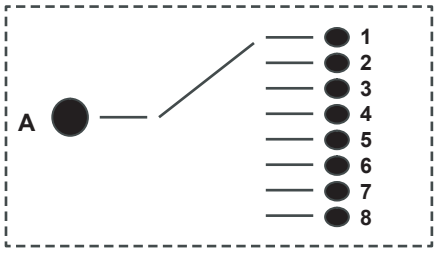
OSW

The OSW (Optical Switch) module switches the optical path between multiple DUTs connected to the module. OSW modules are available in two types: a single type with one OSW and a dual type with two OSWs.
The following OSWs can be installed in the AQ2300 frame (AQ23011A or AQ23012A).

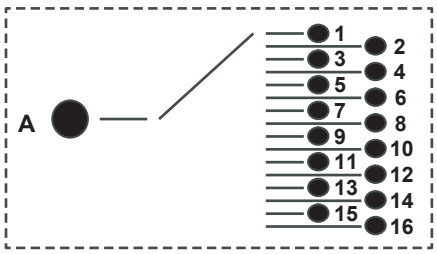
AQ23411A Optical Switch
A single-type 1 × 4 OSW module.



AQ23412A Optical Switch
A single-type 1 × 8 OSW module.

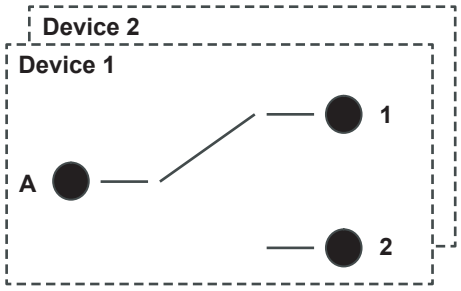


AQ23413A Optical Switch
A single-type 1 × 16 OSW module.



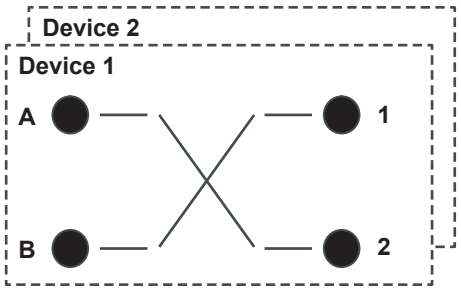
AQ23421A Optical Switch

A dual-type 1 × 2 OSW module.



AQ23422A Optical Switch

A dual-type 2 × 2 OSW module.



4.2 Other Functions

Setup file save/load function

Settings of each OSW can be saved and loaded from files.

Module preset (Module preset)

Resets the settings of the module currently shown in the detailed settings view to their default values.
Modules installed in other slots are not initialized.

Reset all modules (Reset all modules)

Resets the settings of all modules installed in the frame slots to their default values.

Module information (Module information)

You can view the model, option configuration, version, and other product information.
Displays the following information.

- Module name
- Model code
- Serial No.
- Special code
- Option
- Firmware version
- FPGA version

5.1 Overview

Description of this chapter

This chapter explains the LS features.

LS

The following LSs can be installed in the AQ2300 frame (AQ23011A or AQ23012A).

AQ23111A Light Source

This is a one-channel DFB-LD LS model. Depending on the suffix code, it can output optical signals at four wavelengths: 1310 nm, 1550 nm, 1625 nm, and 1650 nm.

AQ23112A Light Source

This is a two-channel DFB-LD LS model. Depending on the suffix code, it can output optical signals at four wavelengths: 1310 nm, 1550 nm, 1625 nm, and 1650 nm. You can use different wavelengths for each channel.

AQ23191A Light Source

This is a one-channel ASE LS model. Depending on the suffix code, it can output optical signals in the wavelength range of 1530 nm to 1600 nm.

5.2 Optical Output Level

Optical output setting (Power)

You can set the output level of the optical signal.

This optical output value includes the power offset and attenuation.

Optical output (dBm) = Maximum optical output (dBm) − Attenuation (dB)

Optical output display (dBm) = Optical output (dBm) + Optical output offset value (dB)

This setting is available only on the AQ23111A and AQ23112A.

Offset (Offset)

Sets an offset for the optical output value display.

Setting range: −80.00 dB to +80.00 dB

Resolution: 0.01 dB

This setting is available only on the AQ23111A and AQ23112A.

Optical attenuation (Attenuation)

Sets the attenuation from the maximum optical output value.

Setting range: 0.00 dB to 6.00 dB

Resolution: 0.01 dB

This setting is available only on the AQ23111A and AQ23112A.

Spectral line width (Linewidth)

When measurements are affected by interference from the measurement system and the DUT, you can reduce the interference by modulating the output light to control the spectral line width.

Wide: Outputs low-coherence light by modulating the optical output.

Narrow: Outputs high-coherence light.

This setting is available only on the AQ23111A and AQ23112A.

5.3 Other Functions

Setup file save/load feature

Settings of each LS can be saved and loaded from files.

Module preset (Module preset)

Resets the settings of the module currently shown in the detailed settings view to their default values.
Modules installed in other slots are not initialized.

Reset all modules (Reset all modules)

Resets the settings of all modules installed in the frame slots to their default values.

Module information (Module information)

You can view the model, option configuration, version, and other product information.
Displays the following information.

- Module name
- Model code
- Serial No.
- Special code
- Option
- Firmware version
- FPGA version

6.1 Trigger Overview

Trigger signals can be used to start a measurement, sourcing, or sweeping. They can also be used to output the frame's internal timer (oscillator) signal or measurement-in-progress or sourcing-in-progress status signals to synchronize with other devices.
The available trigger signals include external signals received through the frame's trigger input terminals, the frame's internal timer (oscillator), and external signals received through a module's input terminal.
Bus triggers (BUS Trigger1 to BUS Trigger9) and trigger outputs (Trigger Output) are used to exchange trigger signals between the frame and the modules.

Frame

On the frame, the input signals received through the Trig IN1 and Trig IN2 trigger input terminals on the rear panel and the timer (oscillator) can be assigned to the bus triggers (BUS Trigger1 to BUS Trigger9). On a module, this bus trigger can be used as a trigger signal.

SMU

SMU modules can use the following signals as triggers.

Measurement trigger (Measure Trigger)
Measurement starts when one of the following signals is used as the trigger source.
- BUS Trigger1 to BUS Trigger9: Bus trigger
- Front: Input signal received through a module's trigger input terminal
- Src Change: Source trigger detection
- Cyclic: Measurement completion signal (when measuring continuously). The minimum cycle is approximately 1 ms.

Source trigger (Source Trigger)
Sourcing starts when one of the following signals is used as the trigger source. When Source Mode is set to Sweep, it functions as a step trigger.
- BUS Trigger1 to BUS Trigger9: Bus trigger
- Front: Input signal received through a module's trigger input terminal

Sweep start trigger (Start Trigger)
Sweeping starts when one of the following signals is used as the trigger source.
- BUS Trigger1 to BUS Trigger9: Bus trigger
- Front: Input signal received through a module's trigger input terminal

OPM

OPM modules can use the following signals as triggers.

Measurement trigger (Measure Trigger)
Measurement starts when one of the following signals is used as the trigger source. This can be used when the measurement mode is Input Trig.
- BUS Trigger1 to BUS Trigger9: Bus trigger

6.2 Trigger Signal (SMU)

Signals that can be used as triggers

The following signals can be used as triggers.

External signal received through the Trig IN1 or Trig IN2 terminal on the frame's rear panel (Trig IN1, Trig IN2)

A TTL level signal (negative logic).

In the application sweep settings, this signal can be selected as a source start trigger or step trigger. In the module settings, this signal can be assigned to BUS Trigger1 to 9 and selected as a bus trigger.

It can be used as a source trigger, measurement trigger, sweep start trigger, or sweep step trigger.

In addition, this signal can be transmitted from the trigger output terminals (Trig OUT1, Trig OUT2) on the frame's rear panel.

External signal received through a module's front-panel terminal (Front)

A TTL level signal (negative logic).

In the module settings, this signal can be used as a source trigger, measurement trigger, sweep start trigger, or sweep step trigger.

Source value change (Src Change)

This signal is an internal signal that indicates changes in the SMU source value. It is an internal signal used as a measurement trigger and cannot be transmitted from a terminal.

Internal timer (oscillator)

The frame's internal timer can be used as a trigger.

In the application sweep settings, this signal can be selected as a step trigger. In the module settings, this signal can be assigned to BUS Trigger1 to 9 and selected as a bus trigger.

It can be used as a source trigger, measurement trigger, sweep start trigger, or sweep step trigger.

External output signals

The following signals can be transmitted from the output terminals of the frame and modules.

External signal received through the Trig IN1 or Trig IN2 terminal on the frame's rear panel (Trig IN1, Trig IN2)

The signal received through the frame's Trig IN1 or Trig IN2 terminal can be transmitted from the frame's Trig OUT1 or Trig OUT2 terminal via the bus trigger.

Internal timer

The frame's internal timer (oscillator) signal can be transmitted from the frame's Trig OUT1 or Trig OUT2 terminal via the bus trigger.

Status signals

The status signals of a module's channels can be transmitted.

- Sweep busy signal (SwpBusy)
- Source busy signal (SrcBusy)
- Measure busy signal (MeasBusy)
- Measure start signal (MeasStart)

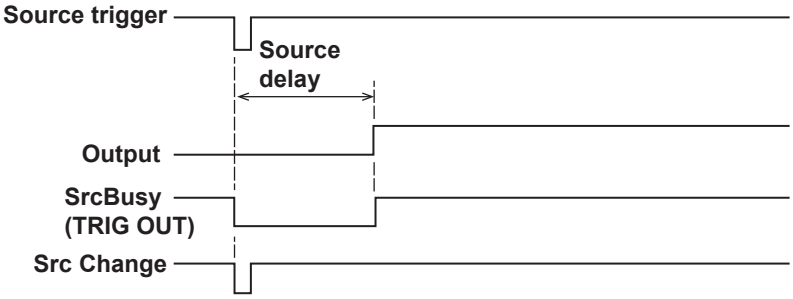
Status signals can be transmitted from the module's front terminal or the frame's Trig OUT1 or Trig OUT2 terminal. Note that measurement start signals can only be transmitted from the module's front terminal.

Status signals

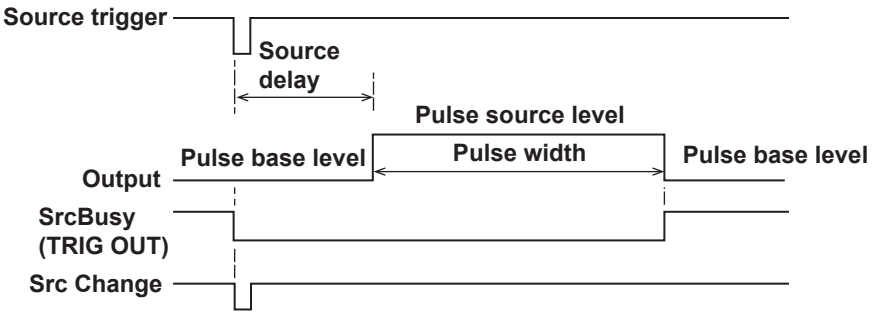
The status signals transmitted from each output terminal are negative-logic signals with a minimum pulse width of 10 µs. The output timings of SwpBusy, SrcBusy, and MeasBusy are as follows.

SrcBusy, Src Change

SrcBusy indicates that a signal is being sourced. It is set to low with a source trigger. It is also set to low when sourcing is started with a communication command.
For DC sourcing, it is set to high after the source delay has elapsed. Even when the source delay is set to 1 µs, the pulse width of the status signal is maintained for at least 10 µs.
Src Change is a signal that is generated when a source trigger is detected. It is an internal signal used as a measurement trigger and cannot be transmitted from a terminal.

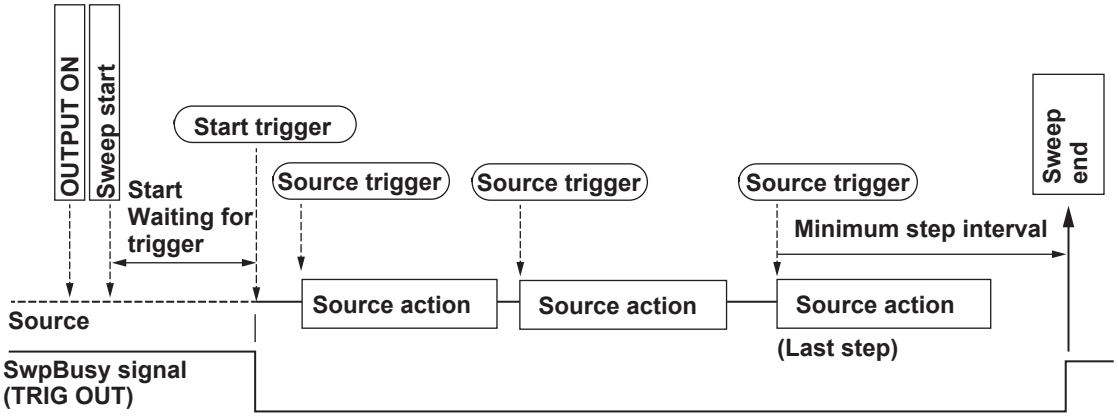


During pulse sourcing, it is set to high at the end of a pulse.



SwpBusy

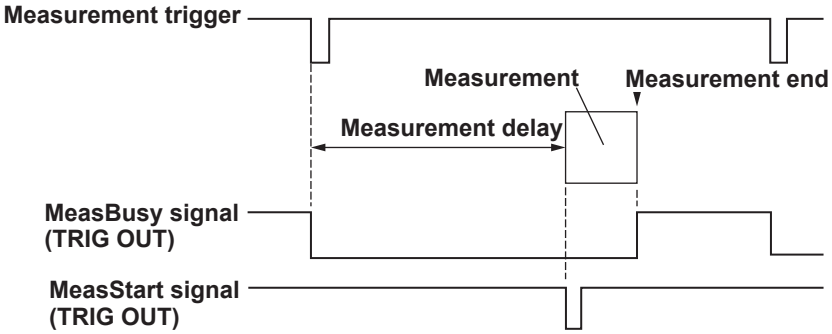
SwpBusy indicates that sweeping is in progress. It is set to low with a start trigger. It is set to high when the minimum step interval, which is an internal instrument setting, elapses after producing the last step.



MeasBusy, MeasStart

MeasBusy indicates that a measurement is in progress. It goes low on the measure trigger and returns high when measurement is complete (that is, when the number of measurements specified by the integration count has been acquired).

MeasStart is a negative-logic signal with a pulse width of 10 µs. It is generated when a measurement starts.



Synchronizing modules

Signals can be generated or measurements can be started in sync by assigning the same trigger source to the source and measurement triggers of multiple modules.

6.3 Trigger Signal (OPM)

Signals that can be used as triggers

The following signals can be used as triggers.

External signal received through the Trig IN1 or Trig IN2 terminal on the frame's rear panel (Trig IN1, Trig IN2)

A TTL level signal (negative logic).

In the application's stability measurement and logging measurement, this can be selected directly as the Input Trigger.

In the module settings, this signal can be assigned to BUS Trigger1 to 9 and selected as a bus trigger.

It can be used as a measurement trigger.

In addition, this signal can be transmitted from the trigger output terminals (Trig OUT1, Trig OUT2) on the frame's rear panel.

External output signals

The following signals can be transmitted from the output terminals of the frame and modules.

External signal received through the Trig IN1 or Trig IN2 terminal on the frame's rear panel (Trig IN1, Trig IN2)

The signal received through the frame's Trig IN1 or Trig IN2 terminal can be transmitted from the frame's Trig OUT1 or Trig OUT2 terminal via the bus trigger.

Status signals

The status signals of a module's channels can be transmitted.

- Averaging time elapsed signal (Avg Time Over)
- Measurement start signal (Meas Started)
- Event detection signal (Event Detect)
- Measurement busy signal (Meas Busy)

The status signals can be output from the module's analog out terminal or from the frame's Trig OUT1 or Trig OUT2 terminal. However, the Meas Busy signal can be output only from the frame's Trig OUT1 or Trig OUT2 terminal.

Status signals

The status signals output from the Trig OUT1 and Trig OUT2 terminals are negative-logic signals with a minimum pulse width of 10 µs. The status signal output from the analog out terminal is a positive-logic signal.

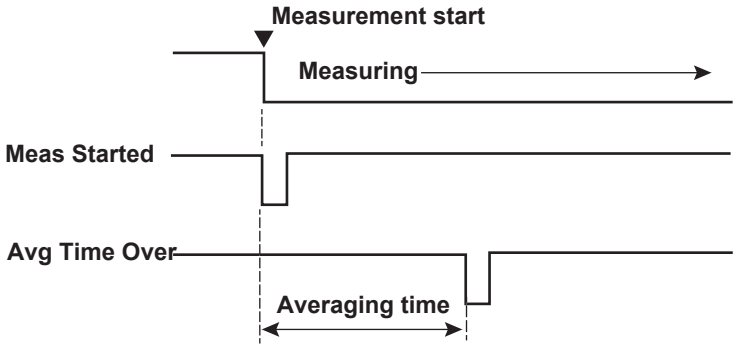
Avg Time Over
Outputs a trigger signal when measurement is completed. When the measurement mode is Normal, a trigger signal is output when the first measurement is completed after measurement starts (when the averaging time has elapsed).

Meas Started
Outputs a trigger signal when measurement starts.

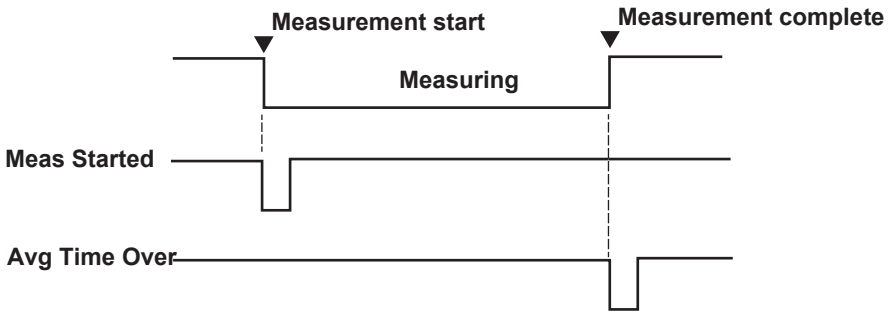
Event Detect
Outputs a trigger signal when an event is detected.

Meas Busy
Outputs an asserted trigger signal while measurement is in progress. When the measurement mode is Normal, the trigger signal is not asserted even during measurement.

Avg Time Start and Meas Started signals when the measurement mode is Normal

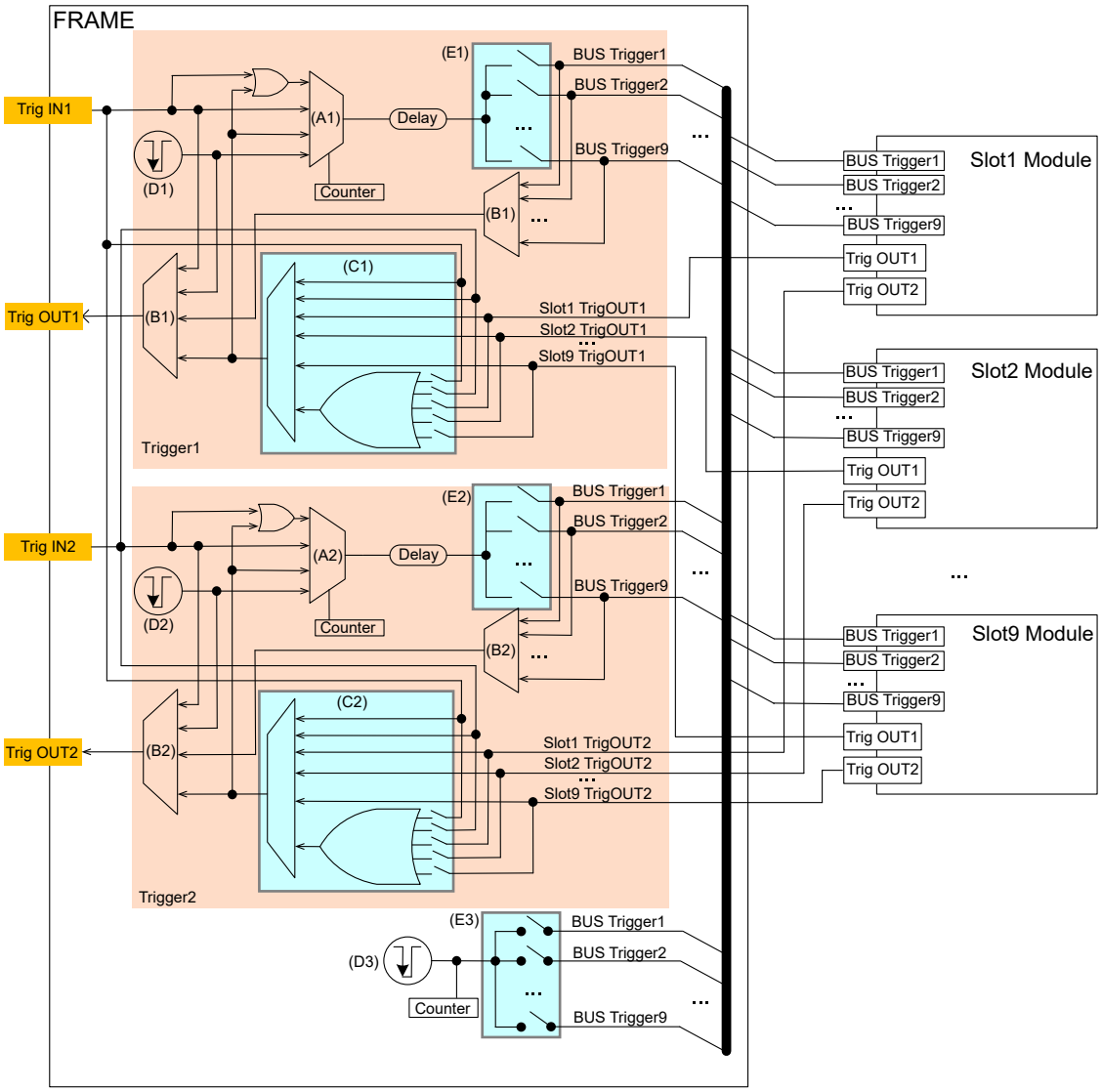


Avg Time Start and Meas Started signals when the measurement mode is Single or Input Trigger



6.4 Trigger System Schematic

The instrument's trigger system is shown below.



Frame

Trig IN1/Trig IN2: the frame's trigger input terminals

Trig OUT1/Trig OUT2: the frame's trigger output terminals

Module

BUS Trigger1 to BUS Trigger9: connected to the frame through slot connection terminals

Trig OUT1/Trig OUT2: connected to the frame through slot connection terminals

7.1 Sweeping

The Sweep application provides a simple way to configure synchronized operation between SMU sweeping and measurement on other channels. To configure the sweep operation in more detail, use the module settings.

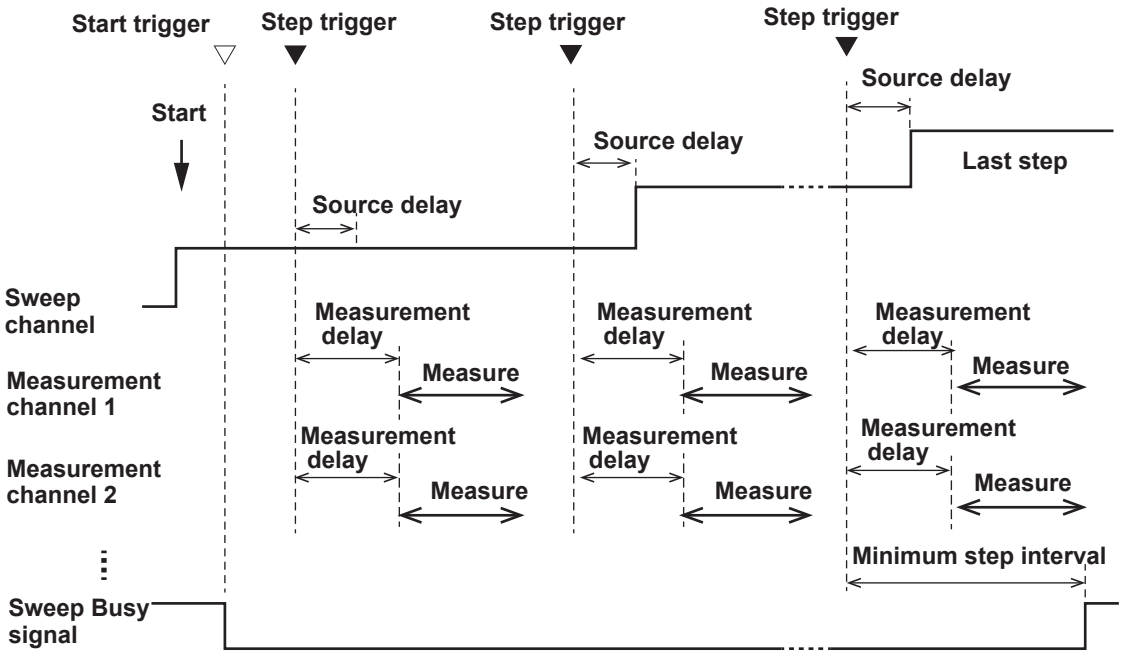
Overview

A sweep is an operation in which the source action is repeated using a single source trigger. This requires a start trigger for starting the sweep operation (see chapter 2, “Trigger”) in addition to the source trigger for starting the source operation.

When sweeping starts, the instrument enters the start-trigger wait state. When it receives a start trigger, it enters a step trigger wait state. After sweeping starts, the instrument repeats the source action for the specified number of counts (1 to 1000, or infinity) while changing the source level every time a step trigger (Step Trigger or Source Trigger) is received. When sweeping finishes, the instrument enters the sweep start wait state once again. To stop sweeping and return the instrument to the start-trigger wait state, use the STOP SWEEP button.

The SwpBusy (Sweep Busy) signal can be transmitted from a module’s output terminals (Front Output1 and Front Output2) or the frame’s output terminals (Trig OUT1 and Trig OUT2). When this signal is low, it indicates that sweeping is in progress. You can use this signal to synchronize other devices with the SMUs’ sweep operations.

One sweep channel and multiple measurement channels on SMUs installed in different slots can be operated in synchronization.

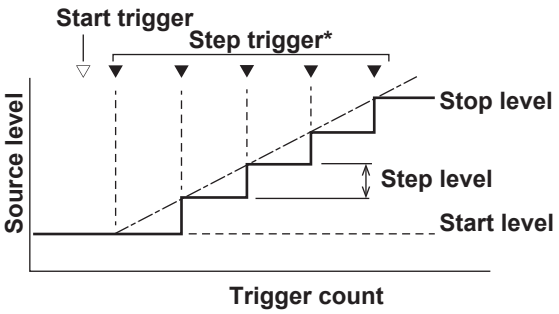


When started, the sweep channel outputs the start level value or pulse base value.

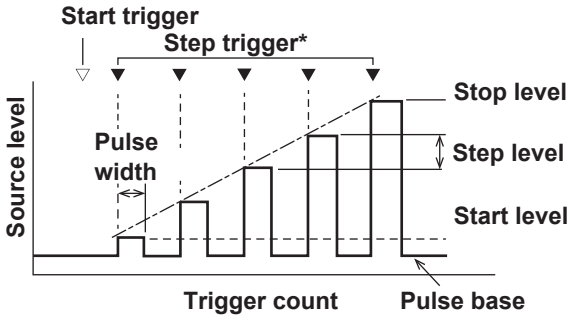
Linear sweep

With the horizontal scale set to trigger count and the vertical scale to the source level, sweeping is performed from the specified start level to the stop level at the specified step-level steps.

DC output (shape: DC)



Pulse output (shape: pulse)

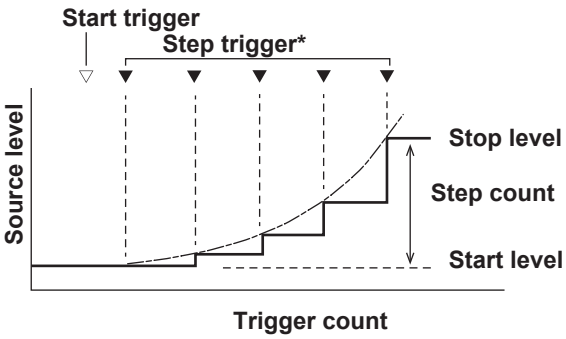


*** Set with Source Trigger when using module settings**

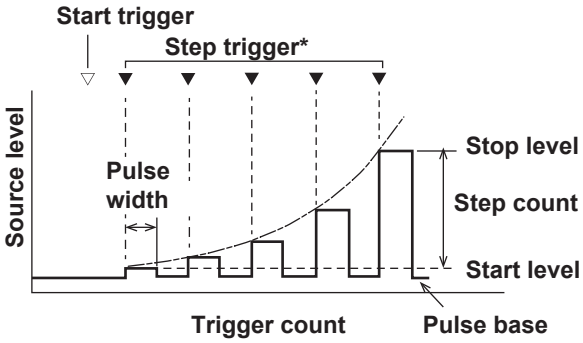
Log sweep

With the horizontal scale set to trigger count and the vertical scale to the source level, sweeping is performed exponentially in a step pattern obtained by dividing the source levels from the start level to the stop level by the specified step count.

DC output (shape: DC)



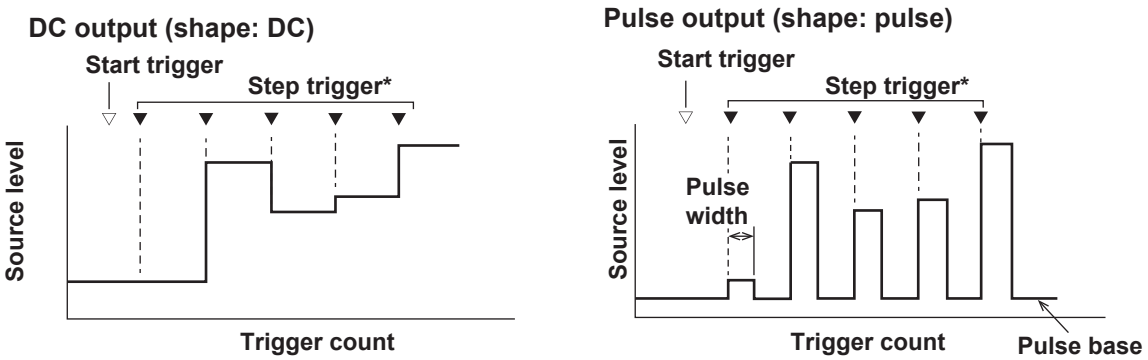
Pulse output (shape: pulse)



*** Set with Source Trigger when using module settings**

Program sweep

A program file (a sweep pattern file in CSV format) created on a PC is loaded into the instrument, and sweeping is performed according to that pattern.
You can set the step count up to 100001. If the number of sweep pattern steps exceeds 100001, only the first 100001 steps are loaded.



*** Set with Source Trigger when using module settings**

How to create program files

Create program files in CSV format.
A program file consists of a condition block that defines sweep conditions and a level definition block that defines the source levels.

```
ProgramSweepFile
Func, V
SrcRange, 6
Limit, 0.2, -0.2
Shape, PULSE
PlsWidth, 0.05
Base, 0.1

1.23
2.34
5.45
```

Condition block

Level definition block

Condition block

Enter the following items in the condition block.

Label	Meaning	Value	Required	Notes
Func	Source function	V or I	✓	
SrcRange	Source range	Range in units of volts when Func is V Range in units of amperes when Func is I	✓	
Limit	Limiter	Limiter value in units of amperes when Func is V Limiter value in units of volts when Func is I The first value is the upper limiter, and the second value is the lower limiter.		When omitted, the limiter is off.
Shape	Source waveform	DC or PULSE		DC when omitted
PlsWidth	Pulse width	Pulse width in units of seconds		Required when Shape is PULSE
Base	Pulse sweep base level	Level in units of volts when Func is V Level in units of amperes when Func is I		Required when Shape is PULSE

Level definition block

Source levels are defined.

- Include the source level of a single step in each row.
- Up to 100001 levels can be defined.
- The level is in units of volts when the source function is V and amperes when the source function is I.

Notes on creating program files

- Case-insensitive.
- Use CR+LF or LF for the line feed code.
- The first row is fixed to “ProgramSweepFile.” If this is not followed, an error will occur.
- Lines that only contain a line feed are ignored.
- If required items are not present, an error will occur.

Source level setting range and resolution (AQ23811A)

Voltage sweep level

Source range	Setting range	Setting resolution
6 V	–6.0000 V≤X≤6.0000 V	100 µV

Current sweep level

Source range	Setting range	Setting resolution
200 nA	–200.000 nA≤X≤200.000 nA	1 pA
2 µA	–2.00000 µA≤X≤2.00000 µA	10 pA
20 µA	–20.0000 µA≤X≤20.0000 µA	100 pA
200 µA	–200.000 µA≤X≤200.000 µA	1 nA
2 mA	–2.00000 mA≤X≤2.00000 mA	10 nA
20 mA	–20.0000 mA≤X≤20.0000 mA	100 nA
200 mA	–200.000 mA≤X≤200.000 mA	1 µA
600 mA	–600.00 mA≤X≤600.00 mA	10 µA

Sweep shape (Shape)

The two available sweep shapes are DC and pulse.

DC: A constant value is sourced until a step trigger occurs.

Pulse: A pulse waveform is sourced with the specified pulse width.

Load capacitance, load inductance, and load resistance (Capacitance/Inductance/Resistance)

By setting values appropriate for the target load, the source value can converge smoothly to the specified output value.

- Load capacitance: Valid for voltage sourcing.
- Load inductance: Valid for current sourcing.
- Load resistance: Valid for voltage and current sourcing.

The minimum value is set by default. Change it when adjusting the source waveform.

Start trigger (Start Trigger)

Sweeping starts when an external signal received through Trig IN1 or Trig IN2 on the frame's rear panel is used as the trigger.

When no start trigger is assigned, sweeping starts when measurement is started from the panel.

This is the same setting as the Sweep Start Trigger in the module settings. However, in the module settings, the start trigger is specified using the bus trigger assigned to Trig IN1 or Trig IN2. If you want to assign BUS Trigger1 to 9 or a module's trigger input to the start trigger, configure Sweep in the module settings.

Step trigger (Step Trigger)

The step trigger specifies when the sweep moves to the next step. The following signals can be assigned to the step trigger.

- External signal received through the frame's Trig IN1 or Trig IN2
- The frame's internal timer (Cyclic)
- Internal signal indicating measurement completion (Fastest)

In the module settings, the step trigger is specified using the bus trigger assigned to Trig IN1, Trig IN2, or Timer.

Fastest is only available in the application.

Measure (Measure)

Measurement starts when a step trigger is detected.

In the application sweep settings, up to 17 channels can be assigned as measurement channels (when nine 2-channel modules are installed in a 9-slot frame).

Measurement with the SMU (Measure)

You can set the bias current, bias voltage, integration time, measure delay, and limiter.

Bias function (Bias Function, Bias Level)

The bias function can be used to source a bias current or bias voltage across the measurement terminals.

However, since using the bias function affects the measured value, turn it off unless bias current or bias voltage is required.

Integration time (Integ Time)

If you set a long integration time, the measurement takes longer, but the stability of the measured values increases. Setting the integration time to an integer multiple of the power line cycle (nPLC) has the effect of eliminating noise in the power supply frequency components. For high-precision measurements, use an integer value.

Measurement delay (Measure Delay)

Measurement delay is the wait time from detection of the measure trigger to the start of measurement. You can adjust the timing between the measurement trigger and the measurement operation by changing this setting. Measurement operation includes jitter of ±1 µs. Measurements made when the waveform of the device under measurement (DUT) is in a transient state will not be stable due to the effects of jitter. Set the measurement delay so that measurement starts after the waveform of the device under measurement becomes sufficiently stable.

Limiter (Limiter)

The limiter can be turned on to control the source value so that measured values do not exceed the specified upper or lower limits.

The setting range and resolution for each range are as follows.

Setting	Measurement range	Setting range	Setting resolution
Voltage limiter upper limit	6 V	0.0050 V to 6.0000 V	100 µV
Voltage limiter lower limit	6 V	–6.0000 V to –0.0050 V	100 µV
Current limiter upper limit	200 nA	10.000 nA to 200.000 nA	1 pA
	2 µA	0.20001 µA to 2.00000 µA	10 pA
	20 µA	2.0001 µA to 20.0000 µA	100 pA
	200 µA	20.001 µA to 200.000 µA	1 nA
	2 mA	0.20001 mA to 2.00000 mA	10 nA
	20 mA	2.0001 mA to 20.0000 mA	100 nA
	200 mA	20.001 mA to 200.000 mA	1 µA
	600 mA	200.01 mA to 600.00 mA	10 µA
Current limiter lower limit	200 nA	–200.000 nA to –10.000 nA	1 pA
	2 µA	-2.00000 µA to -0.20001 µA	10 pA
	20 µA	-20.0000 µA to -2.0001 µA	100 pA
	200 µA	-200.000 µA to -20.001 µA	1 nA
	2 mA	–2.00000 mA to –0.20001 mA	10 nA
	20 mA	–20.0000 mA to –2.0001 mA	100 nA
	200 mA	–200.000 mA to –20.001 mA	1 µA
	600 mA	–600.00 mA to –200.01 mA	10 µA

Measurement with the OPM (Measure)

You can set the averaging time, wavelength, measurement range, unit, and measurement delay.

Averaging time (Average)

Displays the average of the measurement results obtained during the set time.

Wavelength (Wavelength)

Sets the wavelength of the DUT.

Measurement range (Range)

- AUTO range: The optimum range is set automatically according to the input optical power. Normally, use this mode.
- HOLD range: The measurement range can be set manually.
  +13 dBm (*), +10 dBm, 0 dBm, –10 dBm, –20 dBm, –30 dBm, –40 dBm, –50 dBm
- HOLD range (AQ23221A): +30 dBm, +20 dBm, +10 dBm, 0 dBm, –10 dBm, –20 dBm, -30 dBm

When using the HOLD range, pay attention to the optical input power within the selected range.
For the VOA module's output monitor, the range is fixed to AUTO.
(*) Cannot be set on the AQ23295A.

Display unit (Unit)

You can select one of the following four units for the optical power display.
dBm, dB, W(abs), W(rel)

dBm is a logarithmic display of the absolute value (measured value). Use this when the measurement range is wide.
W (abs) is a linear display of the absolute value (measured value). The relationship between logarithmic and linear display is as follows:
0 dBm = 1 mW
dB is a logarithmic display of relative values. W(rel) is a linear display of relative values.
A relative value is the difference between the value registered using the reference function described below and the absolute value (actual measured value).

Measurement delay (Measure Delay)

Measurement delay is the wait time from detection of the measure trigger to the start of measurement. You can adjust the timing between the measurement trigger and the measurement operation by changing this setting. Measurement operation includes jitter of ±1 µs. Measurements made when the waveform of the device under measurement (DUT) is in a transient state will not be stable due to the effects of jitter. Set the measurement delay so that measurement starts after the waveform of the device under measurement becomes sufficiently stable.

Repeat count (Repeat)

Set the sweep repeat count.

The available range is 1 to 1000. You can also specify Infinity. If set to 0, the value is set to infinity. For example, if you set the count to 5, sweeping will be repeated five times, and then the instrument will return to the start-wait state. If you select Infinity, after sweeping starts, sweeping will be repeated until sweeping is stopped or output is turned off.

Automatic saving of measured results

Results measured with the sweep function are saved automatically.

The file format is binary (.bin) or CSV (.csv).

An example of the CSV format is provided below.

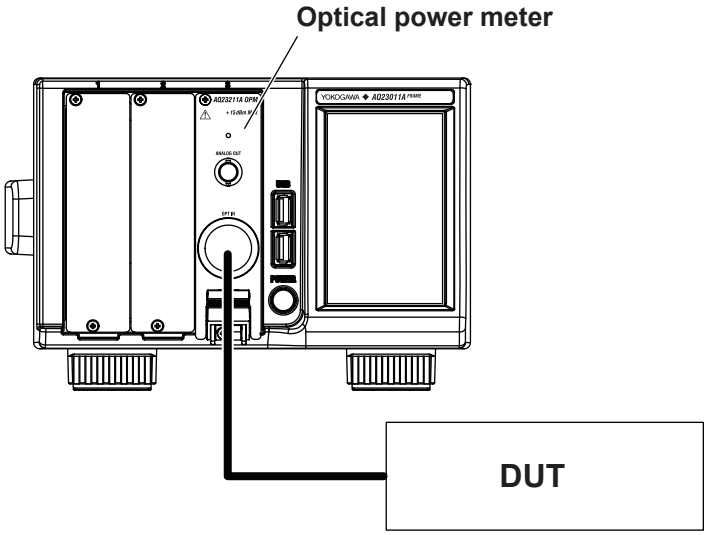
```
Sweep Application Result Data
Date Time, 2024/08/14 16:37:05                                  ← Date and time

Slot-Chan,          Slot 1-1,                  Slot 1-2         ← Slot number, channel number
Model,              AQ23811A,                  AQ23811A,····    ← Module model
SerialNo, 9018C6443,9018C6444                                   ← Serial No.
Integral Time(S),   +1.00000000E-00E,          +1.00000000E-00E ← Integration time (SMU), averaging time (OPM)
Limiter Function, Voltage, Current
Upper Limit (V/A), +3.4500000000E-001,         +3.4500000000E-001
Lower Limit (V/A), -3.4500000000E-001,         -3.4500000000E-001   ← Limit
Data Points,        100

,           ,          Slot1-1,                 ,  ,                                  Slot1-2,
Sweep No,   Data No,   Voltage(V),              Current(A),          Power(W),        Voltage(V), ····
0,          0,         +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
,           1,         +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
,           2,         +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
····
,           99,        +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
1,          0,         +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
,           1,         NaN,                     NaN                  NaN,              +1.23400000E-001,····
,           2,         +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
····
,           99,        +1.23400000E-001,        +2.3400000E-002,     +2.87820000E-003, +1.23400000E-001,····
                                                                                                              ← Data block
```

7.2 Stability Measurement

You can check optical power stability by measuring fluctuations in the optical signal over a long period.



Averaging time (Average)

Displays the average of the measurement results obtained during the set time.

Setting range: 20 µs, 50 µs, 100 µs, 200 µs, 500 µs, 1 ms, 2 ms, 5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s

For the VOA module's output monitor, you can set this from 10 ms.

Measurement time (Total Time)

Sets the total measurement time.

- The setting range for time is 0 hours 0 minutes 1 second to 23 hours 59 minutes 59 seconds.
- The setting range for the number of days is 1 to 99.

Number of measurement samples (Data Points)

Sets the number of samples for stability measurement.

Measurement Wavelength (Wavelength)

Sets the wavelength of the DUT. You can set the OPM in each slot individually, or set all OPMs in all slots at once.

When Apply setting to all CHs is set to ON, you can apply the settings to all channels at once.

Measurement range (Range)

You can select the measurement range from the following two modes.

- AUTO range: The optimum range is set automatically according to the input optical power. Normally, use this mode.
- HOLD range: The measurement range can be set manually.
  +13 dBm (*), +10 dBm, 0 dBm, –10 dBm, –20 dBm, –30 dBm, –40 dBm, –50 dBm
- HOLD range (AQ23221A): +30 dBm, +20 dBm, +10 dBm, 0 dBm, –10 dBm, –20 dBm, -30 dBm

When using the HOLD range, pay attention to the optical input power within the selected range.
For the VOA module's output monitor, the range is fixed to AUTO.
(*) Cannot be set on the AQ23295A.

Reference function (Reference)

When measuring optical output levels, the level may vary depending on the light source or measurement system used (wavelength dependence). Therefore, when measuring the loss level of the target under measurement, you can register the optical output level of the light source or measurement system in advance as a reference value, and display the difference value (relative value) obtained by subtracting the reference value from the actual measured value (absolute value). Select one of the following three modes.

- Value: Relative measurement using an arbitrary reference value set in Reference
- Sensor: Relative measurement using the measured value of the specified sensor
- First: Relative measurement using the first measured value of the same sensor

Input trigger mode (Input Trigger)

Stability measurement can be started by an external input trigger. If the input trigger is enabled, measurement cannot start unless an external trigger is input.

- Ignore: Ignores external trigger input.
- Compl: Starts stability measurement by an external trigger input.

Input trigger selection (Input Trigger Select)

Selects the input trigger. You can set this when the input trigger mode is Compl.

- Ext Trig1: External signal input to the Trig IN1 terminal on the frame's rear panel
- Ext Trig2: External signal input to the Trig IN2 terminal on the frame's rear panel

Display unit (Unit)

You can select one of the following four units for the optical power display.

dBm, dB, W(abs), W(rel)

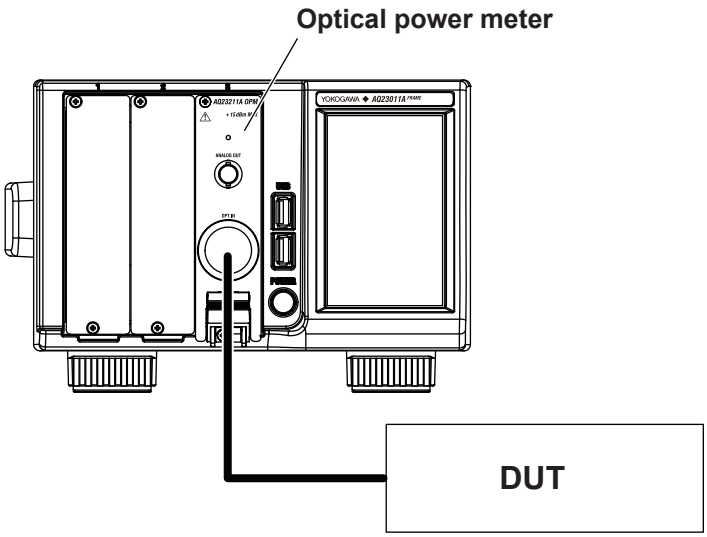
dBm is a logarithmic display of the absolute value (measured value). Use this when the measurement range is wide.
W (abs) is a linear display of the absolute value (measured value). The relationship between logarithmic and linear display is as follows:

0 dBm = 1 mW

dB is a logarithmic display of relative values. W(rel) is a linear display of relative values.
A relative value is the difference between the value registered using the reference function described below and the absolute value (actual measured value).

7.3 Logging Measurement

You can check transient characteristics by measuring changes in optical signals that vary over very short periods of time.



Averaging time (Average)

Displays the average of the measurement results obtained during the set time.
Setting range: 20 µs, 50 µs, 100 µs, 200 µs, 500 µs, 1 ms, 2 ms, 5 ms, 10 ms, 20 ms, 50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s

Number of measurement samples (Data Points)

Sets the number of samples for logging measurement.

Measurement Wavelength (Wavelength)

Sets the wavelength of the DUT. You can set the OPM in each slot individually, or set all OPMs in all slots at once.

When Apply setting to all CHs is set to ON, you can apply the settings to all channels at once.

Measurement range (Range)

You can set the measurement range in HOLD range (manual mode).

- Setting range: +13 dBm (*), +10 dBm, 0 dBm, –10 dBm, –20 dBm, –30 dBm, –40 dBm, –50 dBm
- Measurement range (AQ23221A): +30 dBm, +20 dBm, +10 dBm, 0 dBm, –10 dBm, –20 dBm,–30 dBm

When using the HOLD range, pay attention to the optical input power within the selected range.
When making this setting, pay attention to the optical input power within the selected range.
(*) Cannot be set on the AQ23295A.

Reference function (Reference)

When measuring optical output levels, the level may vary depending on the light source or measurement system used (wavelength dependence). Therefore, when measuring the loss level of the target under measurement, you can register the optical output level of the light source or measurement system in advance as a reference value, and display the difference value (relative value) obtained by subtracting the reference value from the actual measured value (absolute value). Select one of the following three modes.

- Value: Relative measurement using an arbitrary reference value set in Reference
- Sensor: Relative measurement using the measured value of the specified sensor
- First: Relative measurement using the first measured value of the same sensor

Input trigger mode (Input Trigger)

Logging measurement can be started with an external input trigger. If the input trigger is enabled, measurement cannot start unless an external trigger is input.

- Ignore: Ignores external trigger input.
- Single: Performs one measurement for each external trigger received.
- Compl: Starts logging measurement according to the specified settings in response to an external trigger input.

Input trigger selection (Input Trigger Select)

Selects the input trigger. You can set this when the input trigger mode is Compl.

- Ext Trig1: External signal input to the Trig IN1 terminal on the frame's rear panel
- Ext Trig2: External signal input to the Trig IN2 terminal on the frame's rear panel

Display unit (Unit)

You can select one of the following four units for the optical power display.

dBm, dB, W(abs), W(rel)

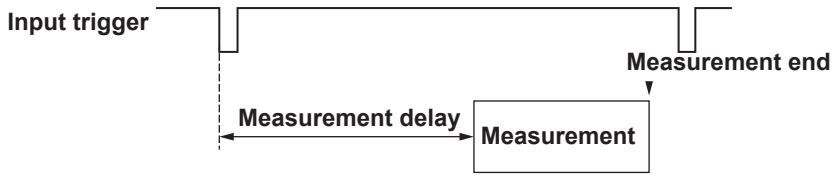
dBm is a logarithmic display of the absolute value (measured value). Use this when the measurement range is wide.
W (abs) is a linear display of the absolute value (measured value). The relationship between logarithmic and linear display is as follows:

0 dBm = 1 mW

dB is a logarithmic display of relative values. W(rel) is a linear display of relative values.
A relative value is the difference between the value registered using the reference function described below and the absolute value (actual measured value).

Measurement delay (Measure Delay)

You can adjust the time from detection of the input trigger to the start of logging measurement. Set the measurement delay so that measurement starts after the waveform of the DUT has become sufficiently stable.



8.1 Data That Can Be Saved

The instrument can save the following types of data in its internal storage or on USB storage.

- Measured data
- Program files for program sweep
- Error log
- Frame setup data and module setup data
- Screen image

Measured data

Measurement data can be saved for each module and application.

- **SMU**
  The available save formats are binary (.BIN) and CSV (.CSV).
- **OPM**
  The available save format is CSV (.CSV).
- **Sweep application**
  The available save formats are binary (.BIN) and CSV (.CSV).
- **Logging and stability applications**
  The available save format is CSV (.CSV).

Program files for program sweep

The format is CSV (.CSV). Program files created on a PC or similar device can be saved to storage and used.

For information on how to create program files, see section 4.1, “Sweep.”

Error log

Any errors that occur are automatically saved to a log file.

The save format is text.

The extension is .LOG.

Setup Data

Settings for the frame and modules can be saved.

Saved setup data can also be loaded.

The extensions are as follows:

AQ23811A(SMU): .811	AQ23321A(VOA): .321
AQ23111A(LS): .111	AQ23332A(VOA): .332
AQ23112A(LS): .112	AQ23411A(OSW): .411
AQ23191A(LS): .191	AQ23412A(OSW): .412
AQ23202A(OPM): .202	AQ23413A(OSW): .413
AQ23211A(OPM): .211	AQ23421A(OSW): .421
AQ23212A(OPM): .212	AQ23422A(OSW): .422
AQ23221A(OPM): .221	Frame: .FRM
AQ23311A(VOA): .311	

The file name can be set as desired.

Screen capture data

Screen images can be saved in PNG format (.PNG).

File name: AQ2300_SC_xxx.PNG

xxx: automatically assigned sequential number (000 to 999)

8.2 File Operations

The following file operations can be performed on the instrument's internal storage and USB storage connected to the instrument via USB.

- Creating folders
- Renaming and deleting folders and files
- Copying files

Creating folders

You can create folders with names of your choice.
Measurement data and setup data can be saved in the created folders.

Renaming folders and files

Folders and files can be renamed.
Note that changing the extension may result in the instrument not being able to recognize the file.

Copying and deleting folders and files

Folders and files can be copied to a different folder or be deleted.

9.1 Remote Connection

The instrument can be connected to and controlled from a PC.
HiSLIP, GPIB, and USB cannot be used simultaneously.

RawSocket

Direct transmission and reception are possible through a TCP socket connection.
A single instrument can be connected to a single PC.
IPv4 and IPv6 are supported.

Item	Specification
Simultaneous connections	1
Port	Variable
Protocol	IPv4/TCP, IPv6/TCP

HiSLIP

A protocol mainly used for instrument control.
A single instrument can be connected to a single PC.
IPv4 and IPv6 are supported.

Item	Specification
Simultaneous connections	1
Standard	IVI High-Speed LAN Instrument Protocol 1.1
Protocol	IPv4/TCP, IPv6/TCP
Communication library	Tmctl, NI-VISA

GP-IB

You can control the instrument using GP-IB.

Address (Address)

- You can set the value in the range of 0 to 30.
- Each device that can be connected via GP-IB has a unique address within the GP-IB system. This address is used to distinguish between different devices. Therefore, you must assign a unique address to the instrument when connecting it to a PC or other device.
- When the controller is communicating with the instrument or with other devices through GP-IB, do not change the address.

Notes on Connection

- Multiple cables can be used to connect multiple devices. However, no more than 15 devices, including the controller, can be connected on a single bus.
- When connecting multiple devices, you must assign a unique address to each device.
- Use cables that are 2 m or shorter in length to connect devices.
- Keep the total length of the cables under 20 m.
- When devices are communicating, have at least two-thirds of the devices on the bus turned on.
- To connect multiple devices, use a star or daisy-chain configuration. Loop and parallel configurations are not allowed.

USB

You can control the instrument using USB.
A USB driver is required to connect the instrument to a PC through a USB port.
• Install the YOKOGAWA USB driver on your PC.
• Do not use USB drivers (or software) supplied by other companies.
For information about how to obtain the YOKOGAWA USB driver, contact your nearest YOKOGAWA dealer. You can also access the YOKOGAWA USB driver download page from our member site (https://myportal.yokogawa.com/) and download the driver.

Item	Specification
USB Class	USB TMC(Test and Measurement Class)
Protocol	USB 2.0
Communication library	Tmctl
Other	Device search feature support

Web Remote

You can control the instrument using HTTP. You can display the instrument screen on a PC and control the instrument using the PC mouse or touch panel.

Remote control

You can set measurement conditions on the PC screen and send them to the instrument, or receive and display the instrument's measurement conditions on the PC screen.

Trigger control

You can set trigger conditions while checking the trigger paths in the frame and modules.

Remote viewer

You can display the same screen as the instrument display on a PC and control the instrument using the PC mouse or touch panel.

Downloading files

You can download data stored in the instrument's internal memory.

9.2 Network Configuration

You can connect the instrument to a network using Ethernet.

This instrument supports IPv4 and IPv6.

DHCP servers are also supported.

If DHCP is set to ON, you do not need to set the IP address, subnet mask, or default gateway.

Item	Specification
Speed	10M/100M/1000M
Protocol	IPv4, IPv6, HiSLIP, SMB, SSH, TCP(RawSocket)

9.3 Other Functions

Interlock (Inter Lock)

Locks (disables) the output from the modules installed in the instrument.
The modules do not produce output if the included interlock connector plug (A1288JA) is not connected to the remote interlock connector on the rear panel of the instrument or if Inter Lock is set to Lock.
Connect the interlock connector plug to the remote interlock connector, and set Inter Lock to Unlocked.
A password is required to release the interlock. The default password is 12345.

Setting the date and time (Time/Date)

You can set the date and time of this instrument.

Turning the beep sound on and off (Volume)

You can turn the beep sound on or off when operating the touch panel.

Display (Display)

You can set the LCD backlight brightness and theme (screen background brightness).

LCD

The LCD backlight brightness can be adjusted in the range of 0 (darkest) to 8 (brightest).
Setting it to 0 turns off the backlight.

Theme

The screen theme can be set to light or dark.

File sharing (File Sharing)

The instrument's internal storage and any external storage connected to the instrument can be read from or written to from a PC or similar device over a network.
User authentication is performed using a username and password.

System information (System Information)

You can view system information such as the instrument's firmware version and hardware version.

Viewing and saving log information (System Log)

The following information can be saved internally as a log and viewed later. Log information can also be zipped and saved to USB and other storage connected to the instrument.

System log

- Firmware startup time and power frequency
- Firmware shutdown time
- Restart time
- Update time and version
- Module update time, module type, and firmware version
- Network connection time and configuration
- Clock setting time and configured time
- Time of remote operation and configuration
- Fan alarm occurrence time
- Time when the temperature alarm occurred and the temperature
- Time when the interlock state changed and the state
- Time when the beep setting was changed and the setting
- Backlight setting time and setting
- Self-test execution time and test results
- Module installation time, slot number, module type, and serial number (S/N)
- Module removal time and slot number

User log

- Time when the operation error occurred, error code, and error location (frame or slot number)
- Application start time and application type
- Application end time and application type

Self-test (Self Test)

Self-tests can be carried out on the DRAM, file system, and battery, and the results can be viewed.

Initializing settings

The frame settings and module settings can be initialized.
There are two modes for initializing the frame settings: one that also initializes the network settings and internal storage, and one that does not.

Reset all Module

Initializes the settings of all modules.

Reset Frame Setting

Initializes the frame settings. All module settings are also initialized.
Remote settings and network settings are not initialized.

Reset Frame to factory default

The frame settings are restored to their factory default values, and the frame is restarted. Remote settings and network settings are also initialized. All data stored in the internal storage is also deleted.
All module settings are also initialized.

Index

T

U

V