Test&Measurement

YOKOGAWA

Scalable SMU Maximize Density, Productivity & Precision

AQ2300 Series
Source Measure Unit

Precision Making

Bulletin AQ2300-01EN

SMU (Source Measure Units) is an essential instrument when precise power supply and accurate voltage or current measurements are required. In recent years, In addition to the Recently, alongside the proliferation of smartphones and tablets, the rise of AI, and the expansion of autonomous vehicles have increased the need for communication infrastructure to enhance speeds and address future power demands. In this context, an easily scalable density SMU to keep up with the miniaturization of next-generation devices has become essential. As a result, the demand for power supplies and the complexity of measurements required for evaluation and manufacturing continues to rise.

YOKOGAWA has developed a modular SMU to address varying density needs for both optical and electronics devices. Not only does it provide high-precision source and measurement, it also saves time and space.

Productivity – By accelerating communication within the frame and between a PC, the AQ2300 series SMU can help you significantly improve your work efficiency by improving data transfer speeds.

Interoperability – SMUs have independent trigger I/O ports for each channel and also support synchronization between SMUs within a frame.
The frame can also be equipped with a digital I/O interface that enables cooperation with external devices.
The AQ2300 series SMU provide flexible measurement timing control, effectively improving the overall system performance.

Expandability – Modular SMUs allow you to select the number of channels required to meet system needs within a limited space, supporting efficient facility operation.

Outline (SMU AQ23811A)

Source & Measurement range

±6 V/±600 mA, 2-channel

Resolution

Minimum measurement resolution: 100 µV/1 pA
Minimum source resolution: 100 µV/1 pA

Accuracy

Voltage: ±0.02%
Current: ±0.03% (20 µA to 200 mA range)

Function

- Voltage source & Current limit
- Current source & Voltage limit
- Voltage measurement & Current measurement

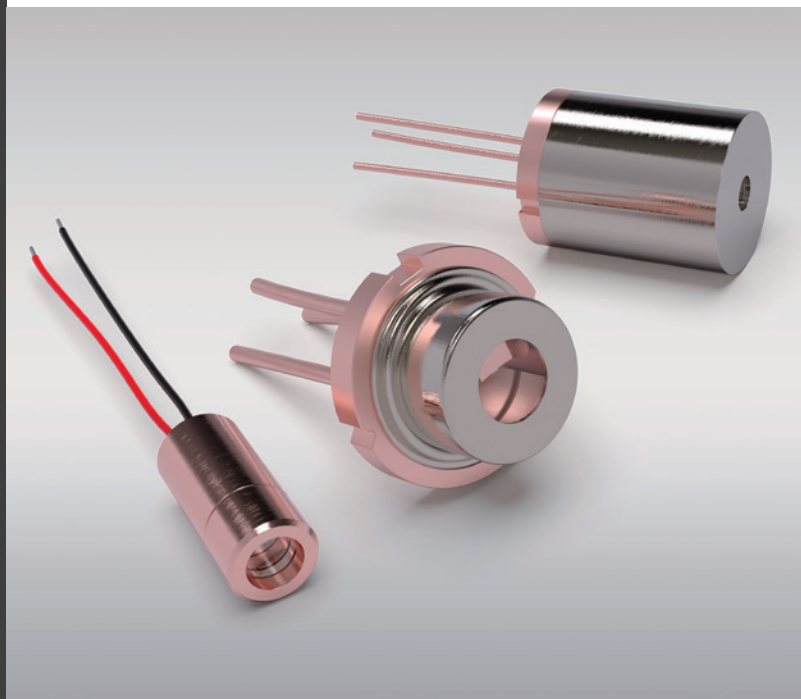
Note: Selectable per channel. Simultaneous measurement of voltage and current is possible.

Output Waveform

DC, Pulse (50 µs to 1 s)

Sweep

Linear sweep, Log sweep, Program sweep

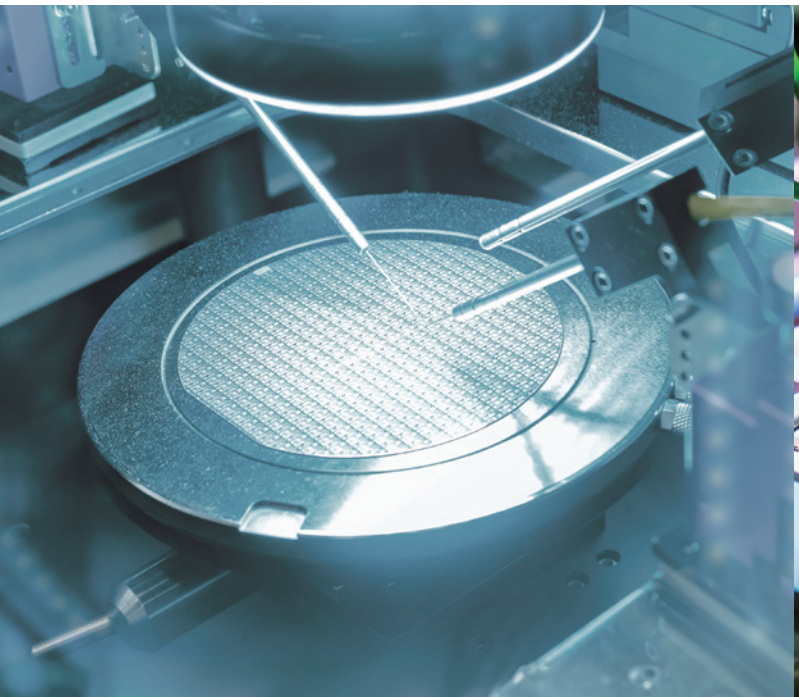


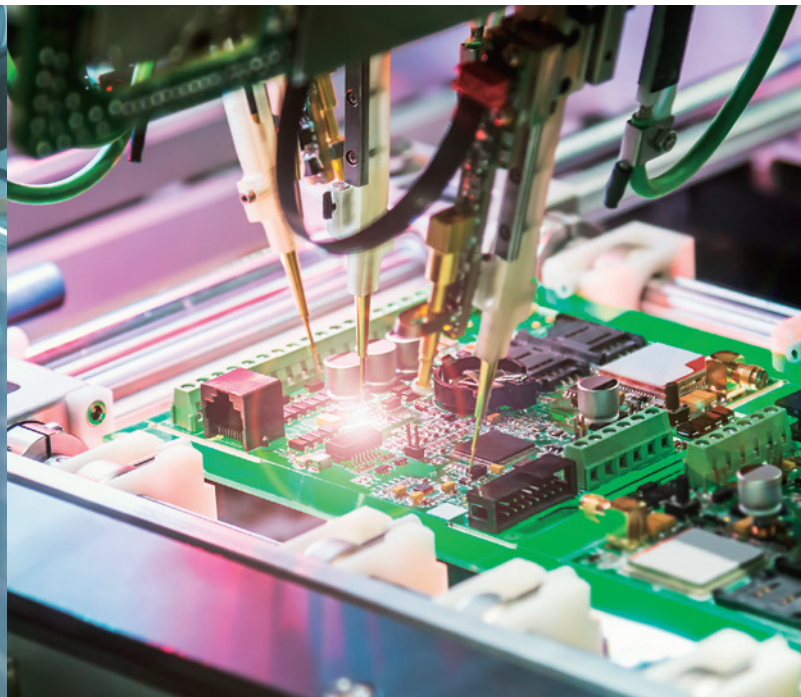
Modular SMU

higher density and speeds

AQ2300 Series

For information on products and firmware updates, please visit:
https://tmi.yokogawa.com/p/aq2300/





Covered from R&D applications to production line applications

Frame and SMU features

The frames are available in 3-slot or 9-slot types and can be flexibly adapted to small and medium-sized measurement systems.

- Expandable up to 18 channels with 2-channel SMU
- Digital I/O interface can be selected
- 3 trigger synchronization systems
  (See illustration on the right)
- Simultaneous measurement of voltage and current possible
- Simplified response adjustment
- High-speed data transfer
- Measurement data storage of up to 100 k points per channel
- Channel-to-channel and module-to-module isolation
- Hot Swappable Modules

Digital I/O (Factory option)

The Digital I/O interface can receive the start-of-operation signal from the external equipment and send the end-of-operation signal to the external equipment.

Digital I/O interface port configurations

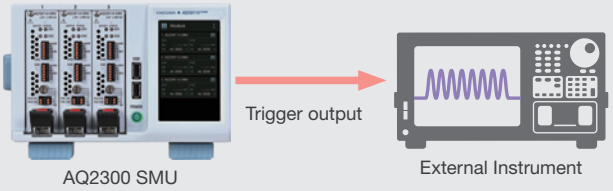
I/O	8 ports	• Selectable input or output (CMOS level) • Selectable rising or falling edge
Vcc	2 ports	• 5 V-CMOS or 3.3 V (Maximum 300 mA/2 ports)
GND	2 ports	

This interface feature helps to save polling operations to monitor the timing of the start and end of SMU voltage or current generation.

Various trigger synchronization functions

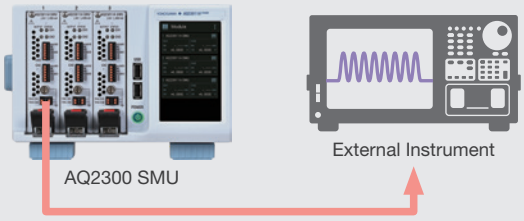
The AQ2300 series SMU have trigger ports not only on the frame side, but also on each channel of the SMU.
In addition, In-frame synchronization functionality is also provided, allowing flexible selection of the connection method.

Synchronization of frames with external equipments



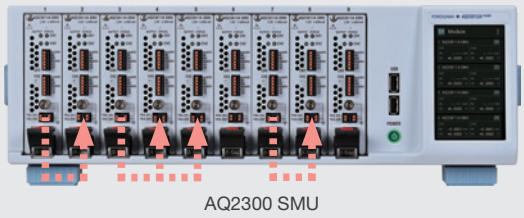
Note: It is possible to select the SMU channels to be synchronized.

Synchronization of SMU channel with external equipments



Note: Input or output can be selected for each channel.

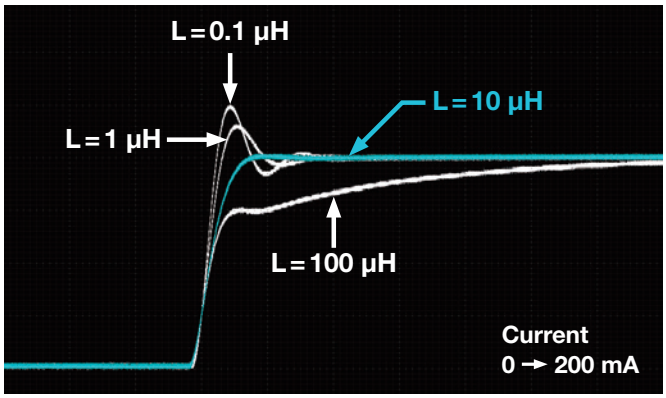
Synchronization between the SMU channels



Note: Can be internally synchronized between any channels (no cable connection required).

More optimized response adjustments

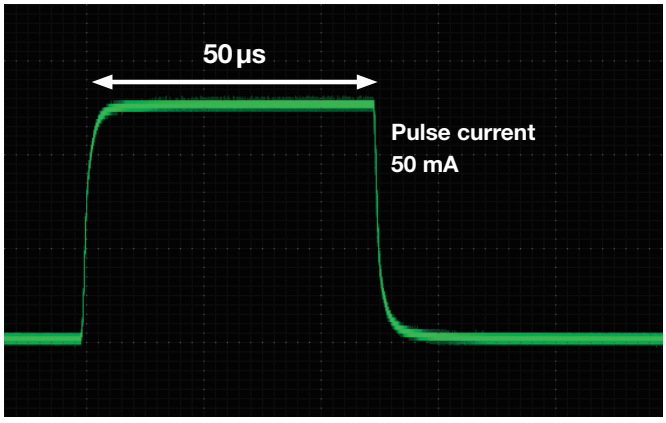
The AQ2300 series SMU can be adjusted to reduce rising edge overshoot and ripple.
Adjustments can be made easily by entering the R, L and C values for the load.



High-quality pulse generation and measurement

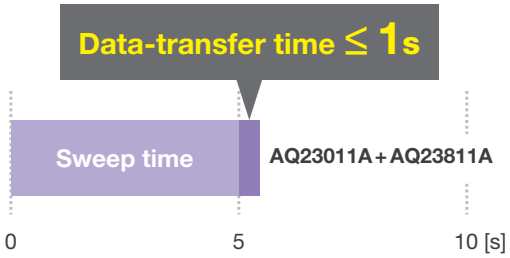
The AQ2300 series SMU can generate high-quality pulse signals thanks to the response adjustment function and digital feedback technology.

- Minimum pulse width: 50 µs
- Minimum cycle: 100 µs



Faster data transmission speeds

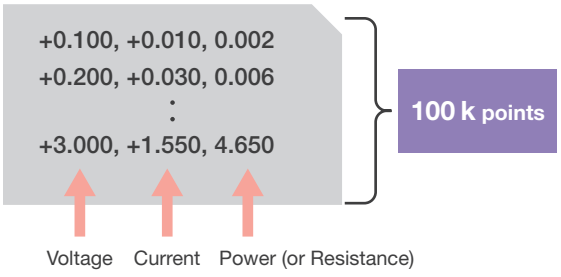
Fast data transfer reduces the number of measurements and significantly improves operational efficiency.



50001 points I/V Measuring time (using Ethernet)

Reduced number of measurement divisions

Measurement data can be stored in storage up to 100 k points per channel, reducing the number of measurement divisions.



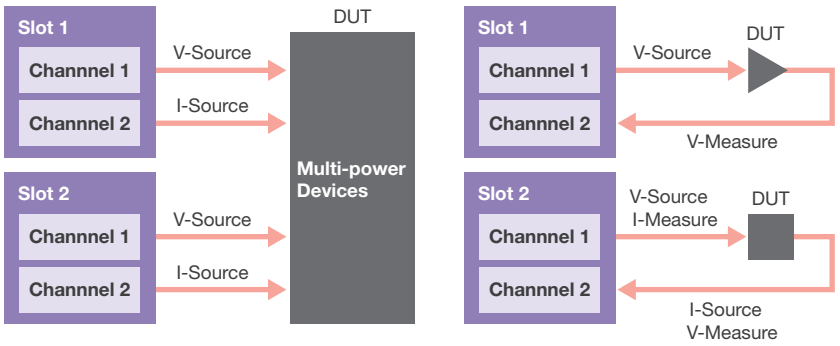
Example of stored data

Note: Please refer to the manual for the actual format.

Functions

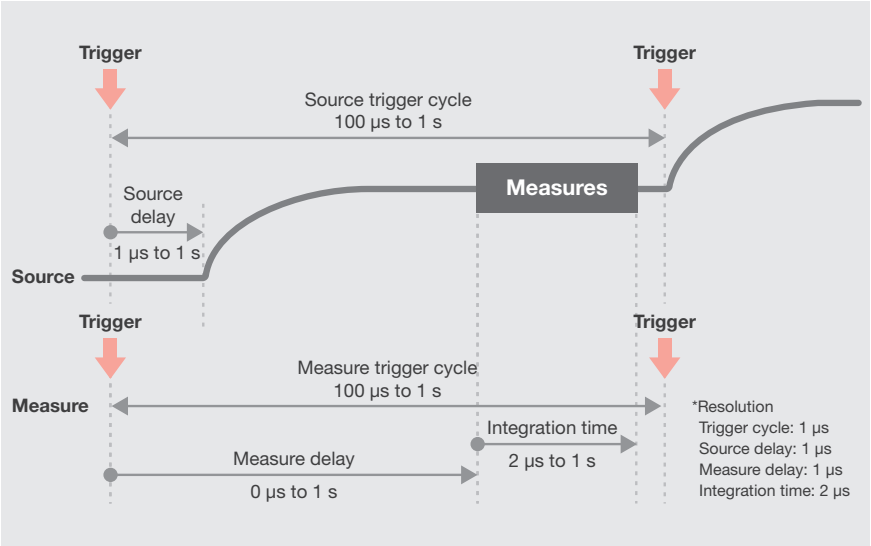
Source and measurement functions

For each channel in each slot, the AQ2300 series SMU offer a choice of voltage or current, generation or measurement, and generation and measurement, to accommodate different combinations.



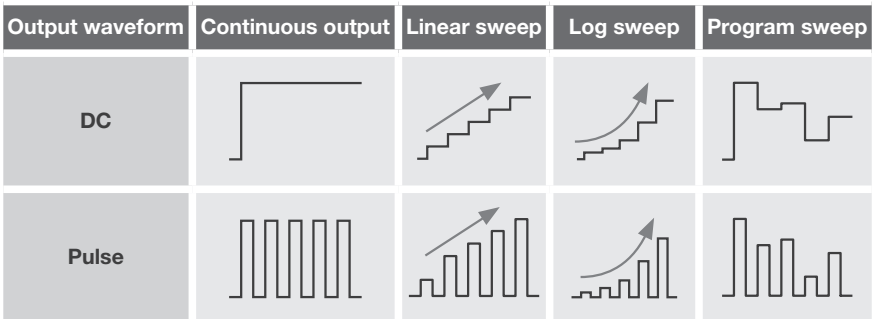
Source and measurement timing

The SMU generate and measure starting from a trigger input such as an internal timer or external input signal.
The SMU starts to generate after the source delay time has elapsed, and performs a measurement with a set integration time when the major delay time has elapsed. This allows measurements to be taken avoiding the unstable timing immediately after an output change.



Sweep

SMU output waveforms are available in DC and pulse, with continuous output, linear sweep, log sweep, and program sweep.



Applications

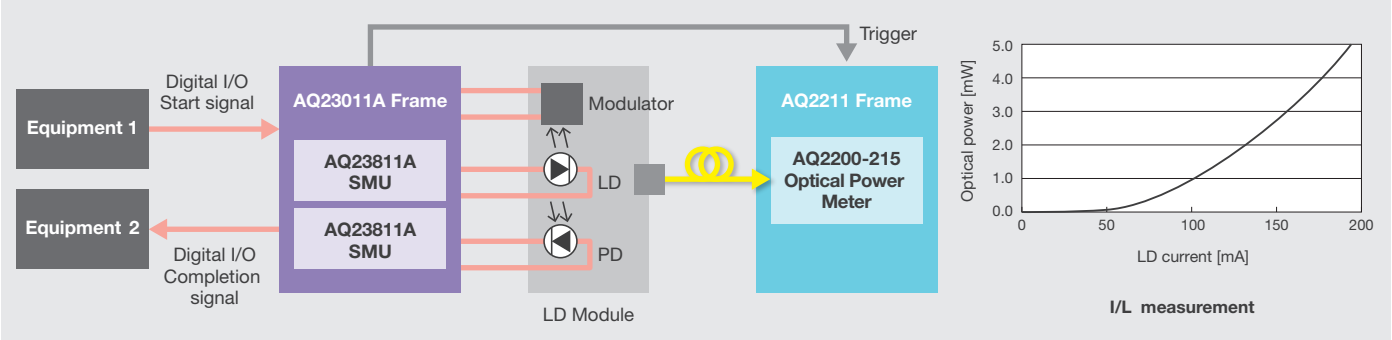
The AQ2300 series SMU can be used for the evaluation and inspection of optical semiconductor components such as LD, PD, LED and modulator, and semiconductor components such as transistors and FET.

Static testing of laser diode modules

SMU can generate different voltages or currents from several channels and use the sweep synchronization function to measure the I/V or I/L characteristics of the LD.

Features

- Synchronisation of LD current sweep with PD current measurement and optical power measurement
- Micro current measurement with a minimum resolution of 1 pA (200 nA range)
- Measurement data format in CSV or binary format
- The Digital I/O interface supports SMU operation start and end response communication.

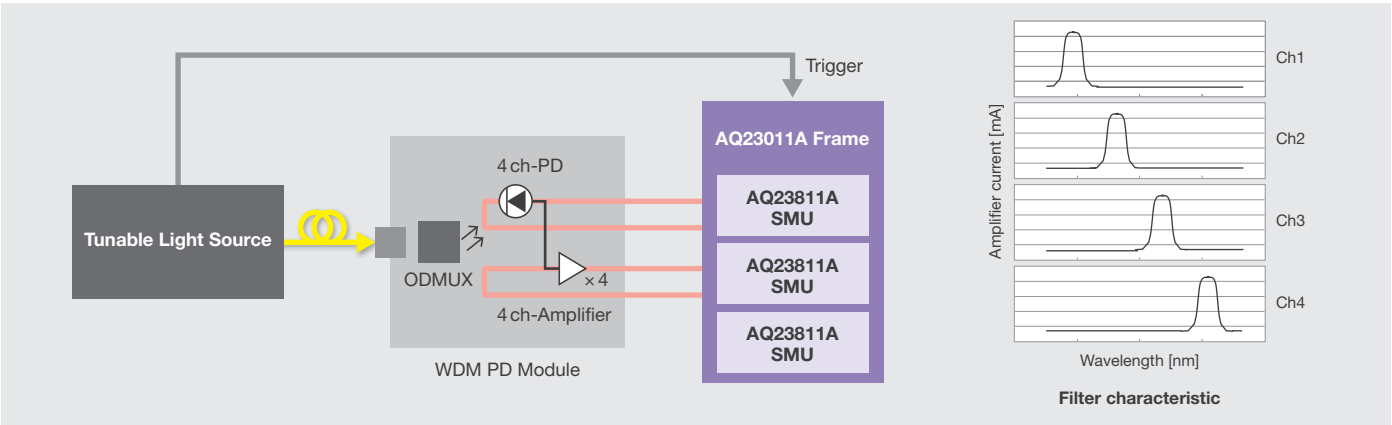


Filter characteristic tests of WDM photo-diode modules

SMU can generate different voltages or currents from several WDM (Wavelength Division Multiplexing) channels and use the sweep synchronization function to measure filter characteristics of each individual channel as shown below.

Features

- Synchronization of wavelength sweep and amplifier IC current measurement
- Micro current measurement with a minimum resolution of 1 pA (200 nA range)
- Measurement data format in CSV or binary format



Specification

Source Measure Unit AQ23811A (±6 V/±600 mA)

Items	Specifications
Number of channels (Slot widths)	2 channels (1 slot)
Function	Voltage, Current
Output waveform	DC, Pulse (Pulse width: 50 µs to 1 s)
Sweep mode	Linear, Logarithmic, Program (up to 100001 steps)
Trigger	BUS Trigger 1 to 9, Front panel trigger per channel [5 V TTL (Low active), push-in connection plug: AWG26 to 20]
Source delay	1 µs to 1 s
Measure delay	0 µs to 1 s (Jitter: ±1 µs)
Integration time	2 µs to 1 s
Voltage sense	2-wire, 4-wire
Calculation	Electric power (V×I), Resistance (V÷I)
Protection	Overvoltage and overcurrent (Output disconnected when detected), overheating (Power disconnected when detected)
Reference operating conditions	Temperature: 23 ±5°C, Humidity: 20 to 80% RH (non-condensing), Warm-up time: 30 min.
Operating conditions	Temperature: 5 to 40°C, Humidity: 20 to 80%RH (non-condensing), Altitude: less than 2000 m
Storage conditions	Temperature: –15 to 60°C, Humidity: 20 to 80% RH (non-condensing)°F
Maximum allowable input voltage	OUTPUT (Hi) to OUTPUT (Lo): ±6 V SENSE (Hi) to OUTPUT (Hi): ±0.25 V SENSE (Lo) to OUTPUT (Lo): ±0.25 V
Maximum common-mode voltage	All Terminal 42 Vpeak
Calibration cycle	1 year
Dimensions (excluding protrusions), Weight	106.5 (H) × 31 (W) × 321.5 (D), 800 g

DC Voltage Source

Range	Source Range	Resolution	Max. Load Current	Accuracy (1 year) ±(% of setting + V)	Temperature Coefficient ±(% of setting + V)/°C
6 V	±6.0000 V	100 µV	±600 mA/±200 mA*1	0.02 + 500 µV	0.002 + 30 µV

Note: Accuracy is at reference operating conditions and with output open. Temperature coefficients are added for 5 to 18°C and 28 to 40°C.
*1: Sink maximum load currents exceeding ±2 V are allowed up to ±200 mA.

DC Current Source

Range	Source Range	Resolution	Max. Load Voltage	Accuracy (1 year) ±(% of setting + A)	Temperature Coefficient ±(% of setting + A)/°C
200 nA	±200.000 nA	1pA	±6 V	0.05 +100 pA	0.003 + 5 pA
2 µA	±2.00000 µA	10 pA	±6 V	0.04 + 300 pA	0.002 + 20 pA
20 µA	±20.0000 µA	100 pA	±6 V	0.03 + 3 nA	0.002 + 200 pA
200 µA	±200.000 µA	1nA	±6 V	0.03 + 30 nA	0.002 + 2 nA
2 mA	±2.00000 mA	10 nA	±6 V	0.03 + 300 nA	0.002 + 20 nA
20 mA	±20.0000 mA	100 nA	±6 V	0.03 + 3 µA	0.002 + 200 nA
200 mA	±200.000 mA	1 µA	±6 V	0.03 + 30 µA	0.002 + 2 µA
600 mA	±600.00 mA	10 µA	±6 V/±2 V*2	0.05 + 300 µA	0.003 + 10 µA

Note: Accuracy is at reference operating conditions and with output short-circuit. Temperature coefficients are added for 5 to 18°C and 28 to 40°C.
*2: The sink maximum load voltage in the 600 mA range is allowed up to ±2 V.

Current Limiter

| Setting |*3	Range	Resolution	| Min. Setting |*4
10.000 nA to 200.000 nA	200 nA	1 pA	10 nA
0.20001 µA to 2.00000 µA	2 µA	10 pA	10 nA
2.0001 µA to 20.0000 µA	20 µA	100 pA	100 nA
20.001 µA to 200.000 µA	200 µA	1 nA	1 µA
0.20001 mA to 2.00000 mA	2 mA	10 nA	10 µA
2.0001 mA to 20.0000 mA	20 mA	100 nA	100 µA
20.001 mA to 200.000 mA	200 mA	1 µA	1mA
200.01 mA to 600 mA	600 mA	10 µA	1mA

*3: The current range is determined by the greater of the High and Low limiters.
*4: Minimum setting when tracking is OFF.

Voltage Limiter

| Setting |	Range	Resolution	| Min. Setting |
0.0050 V to 6.0000 V	6 V	100 µV	5 mV

Maximum capacity/Inductive Load*5

Capacity Load	Inductive Load
100 µF	10 µH

*5: Response adjustments may be required.

Output Noise (Typical)

20 mVp-p	For 10 Hz to 20 MHz, 6 V Voltage source range, Output liberation

Response time (Typical)

Voltage Range	Limit Setting	Response Time*6	Load Conditions		RC Setting	
			R	C	R	C
6 V	±200 nA	2.5 ms	>1 GΩ	25 pF	100 MΩ	25 pF
	±2 µA	0.5 ms				
	±20 µA	50 µs				
	±200 µA	10 µs				
	±2 mA					
	±20 mA					
	±200 mA					
	±600 mA					

*6: Time from the start of the output voltage change to within 0.1% of the final value when the output voltage is varied from 0 V to 6 V.

Current Range	Limit Setting	Response Time*7	Load Conditions		RL Setting	
			R	L	R	L
200 nA	6 V	150 µs	1 MΩ	20 nH	1 MΩ	20 nH
2 µA			100 kΩ		100 kΩ	
20 µA		20 µs	10 kΩ		10 kΩ	
200 µA			1 kΩ		1kΩ	
2 mA			100 Ω		100 Ω	
20 mA		15 µs	10 Ω		10 Ω	
200 mA			1 Ω	200 nH	1 Ω	200 nH
600 mA						

*7: The time from the beginning of the change to within 0.1% of the final value when the output current is varied from 0 A to the full scale current of the set range.

DC Voltage Measurement

Range	Measurement Range	Resolution	—	Accuracy ±(% of reading + V)	Temperature Coefficient ±(% of reading + V)/°C
6 V	±6.3000 V	100 µV	—	0.02 + 500 µV	0.002 + 30 µV

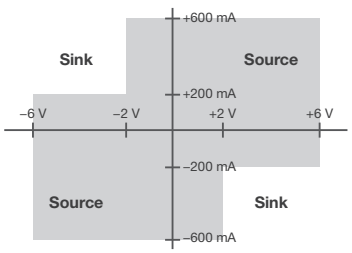
*Note: If the integration time is less than 1 PLC, an additional value must be added. Please refer to the manual for details.

DC Current Measurement

Range	Measurement Range	Resolution	Detection resistance	Accuracy ±(% of reading+A)	Temperature Coefficient ±(% of reading+A)/°C
200 nA	±210.000 nA	1 pA	5 MΩ	0.05 + 100 pA	0.003 + 5 pA
2 µA	±2.10000 µA	10 pA	1 MΩ	0.04 + 300 pA	0.002 + 20 pA
20 µA	±21.0000 µA	100 pA	100 kΩ	0.03 + 3 nA	0.002 + 200 pA
200 µA	±210.000 µA	1 nA	10 kΩ	0.03 + 30 nA	0.002 + 2 nA
2 mA	±2.10000 mA	10 nA	1 kΩ	0.03 + 300 nA	0.002 + 20 nA
20 mA	±21.0000 mA	100 nA	100 Ω	0.03 + 3 µA	0.002 + 200 nA
200 mA	±210.000 mA	1 µA	10 Ω	0.03 + 30 µA	0.002 + 2 µA
600 mA	±630.00 mA	10 µA	1 Ω	0.05 + 300 µA	0.003 + 10 µA

*Note: If the integration time is less than 1 PLC, an additional value must be added. Please refer to the manual for details.

Source Range



Connection Interface

- GUARD Guard terminal
- HI Output terminal (High)
- HS Sense input terminal (High)
- GUARD Guard terminal
- LS Sense input terminal (Low)
- LO Output terminal (Low)

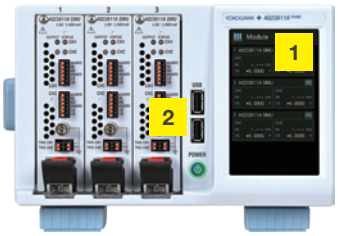
Frame AQ23011A/AQ23012A

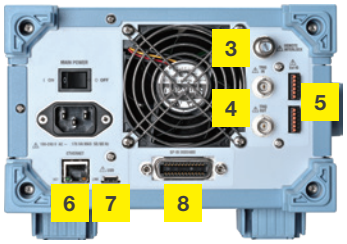
Items		Specifications	
Model		**AQ23011A**	**AQ23012A**
Number of slots		3	9
Display		Color LCD (Touchscreen)	
Remote interface	Ethernet	IEEE-802.3 compatible, connector: RJ-45 × 1, transmission method: Ethernet (1000BASE-T), protocol: TCP/IP, DHCP	
	USB	USB Rev2.0 compatible, connector: type-C × 1, protocol: Mass Storage, USB-TMC (Separate driver installation required.)	
	GP-IB*1	IEEE-488 compatible, protocol: IEEE-488.2 compatible, Factory-installed option	
Interlock function (safety function)		Contact input, connector: BNC	
External storage interface		USB Rev2.0 compatible, connector: USB type-A × 2, Power supply: 5 V/500 mA	
External control interface*2	Trigger I/O 1, 2	TTL level (Low active), connector: BNC, Trigger I/O 2: Factory-installed option	
	Digital I/O	CMOS level (5 V/3.3 V) × 8 ports, connector: push-in connection plug × 2, Factory-installed option	
Power requirement		100 to 240 VAC, 50/60 Hz	
Power consumption		170 VA (including modules)	470 VA (including modules)
Withstand voltage (between power supply cases)		1.5 kVAC for 1 minute (Insulation resistance: 500 VDC, >10 MΩ)	
Operating conditions		Ambient temperature: +5 to +40℃, Ambient humidity: 20 to 80%RH (no condensation), Altitude: 2000 m or less	
Storage conditions		Ambient temperature: –20 to +60℃, Ambient humidity: 20 to 80%RH (no condensation), Altitude: 3000 m or less	
Safety standard		EN61010-1, EN IEC 61010-2-030, Overvoltage category (installation category) II, Pollution degree 2	
Emissions		EN61326-1 Class A, EN55011 Class A Group1, EN61000-3-2. EN IEC 61000-3-2, EN61000-3-3	
Immunity		EN61326-1 Table2 (for industrial locations)	
Dimensions (excluding protrusions)		213 (W) × 132 (H) × 420 (D) mm	426 (W) × 132 (H) × 470 (D) mm
Weight		Approx. 6 kg	Approx. 10 kg

*1: Factory-installed option (Cannot be retrofitted)
*2: Choice External Trigger I/O 2 or Digital I/O (Cannot be retrofitted)

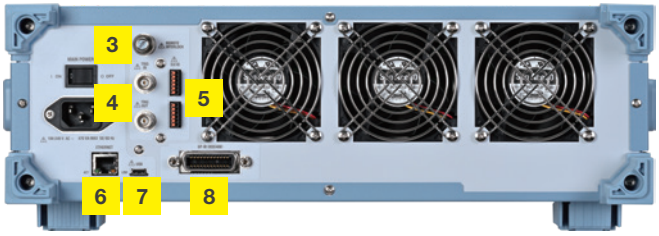
Functions and connection interfaces

AQ23011A

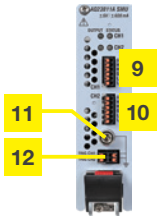




AQ23012A



AQ23811A



---

1 **LCD touchscreen**

2 **USB Type-A port**
Compatible with data storage devices and keyboards

3 **Interlock**
For safety functions

4 **External trigger input 1 and output 1**

5 **External trigger input 2 and output 2 or Digital I/O interface**

6 **Ethernet (10/100/1000BASE-T)**
For network interface, remote control and data transfer

7 **USB Type-C port**
For remote control

8 **GP-IB Interface (Optional)**
For remote control

9 **SMU I/O port (channel 1)**

10 **SMU I/O port (channel 2)**

11 **Functional ground terminal**

12 **Trigger port**

Models and suffix codes

AQ23011A

Model	Suffix Code	Description
AQ23011A		AQ23011A Frame (3 slots)
External interface	-ETP	No Digital I/O, ExtTrigger I/O 2 per port (Not for retrofitting)
	-EDP	Digital I/O 8 ports, ExtTrigger I/O 1 port
GP-IB interface	-N01	No GP-IB interface included (Not for retrofitting)
	-C01	Equipped with GP-IB interface
Power cord	-D	UL/CSA Standard and PSE compliant, 125 V
	-F	VDE/Korean standard, 250 V
	-H	Chinese standard, 250 V
	-N	Brazilian standard, 250 V
	-Q	British standard, 250 V
	-R	Australian standard, 250 V
	-T	Taiwanese standard, 125 V
	-B	Indian standard, 250 V
	-U	IEC plug Type B, 250 V

Accessories: Blank panel × 3

AQ23012A

Model	Suffix Code	Description
AQ23012A		AQ23012A Frame (9 slots)
External interface	-ETP	No Digital I/O, ExtTrigger I/O 2 per port (Not for retrofitting)
	-EDP	Digital I/O 8 ports, ExtTrigger I/O 1 port
GP-IB interface	-N01	No GP-IB interface included (Not for retrofitting)
	-C01	Equipped with GP-IB interface
Power cord	-D	UL/CSA Standard and PSE compliant, 125 V
	-F	VDE/Korean standard, 250 V
	-H	Chinese standard, 250 V
	-N	Brazilian standard, 250 V
	-Q	British standard, 250 V
	-R	Australian standard, 250 V
	-T	Taiwanese standard, 125 V
	-B	Indian standard, 250 V
	-U	IEC plug Type B, 250 V

Accessories: Blank panel × 9

AQ23811A

Model	Suffix Code	Description
AQ23811A		AQ23811A Source Measure Unit (±6 V/±600 mA)
Spec code	-10	Standard model

*Packaging: SMUs are shipped with frames inserted.

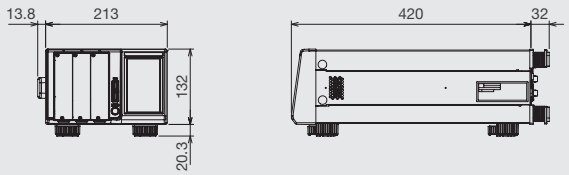
Accessories

Model	Description
735186	Blank panel for AQ2300 series frames
735183-03	Rackmount kit for AQ23011A
735183-09	Rackmount kit for AQ23012A

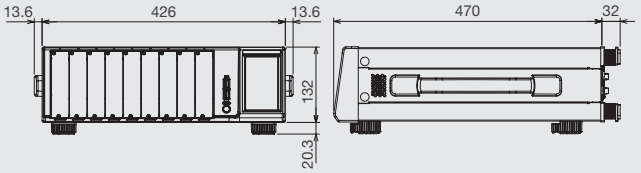
External Dimension

Unit: mm

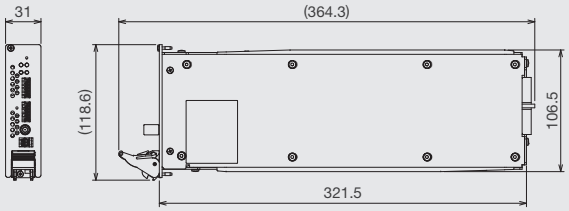
AQ23011A Frame



AQ23012A Frame



AQ23811A SMU (±6 V/±600 mA)



NOTICE

● Before operating the product, read the user's manual thoroughly for proper and safe operation.

Yokogawa's approach to preserving the global environment

- Yokogawa's electrical products are developed and produced in facilities that have received ISO14001 approval.
- In order to protect the global environment, Yokogawa's electrical products are designed in accordance with Yokogawa's Environmentally Friendly Product Design Guidelines and Product Design Assessment Criteria.

This is a Class A instrument based on Emission standards EN61326-1 and EN55011, and is designed for an industrial environment.
Operation of this equipment in a residential area may cause radio interference, in which case users will be responsible for any interference which they cause.

YOKOGAWA

https://tmi.yokogawa.com/

YMI-N-MI-M-E03

YOKOGAWA TEST & MEASUREMENT CORPORATION
Global Sales Dept. /E-mail: tm@cs.jp.yokogawa.com

[Ed: 01/b] Printed in Japan, 409(KP)

YOKOGAWA CORPORATION OF AMERICA https://tmi.yokogawa.com/us/
YOKOGAWA EUROPE B.V. https://tmi.yokogawa.com/eu/
YOKOGAWA TEST & MEASUREMENT (SHANGHAI) CO., LTD. https://tmi.yokogawa.com/cn/
YOKOGAWA ELECTRIC KOREA CO., LTD. https://tmi.yokogawa.com/kr/
YOKOGAWA ENGINEERING ASIA PTE. LTD. https://tmi.yokogawa.com/sg/
YOKOGAWA INDIA LTD. https://tmi.yokogawa.com/in/
YOKOGAWA ELECTRIC CIS LTD. https://tmi.yokogawa.com/ru/
YOKOGAWA AMERICA DO SUL LTDA. https://tmi.yokogawa.com/br/
YOKOGAWA MIDDLE EAST & AFRICA B.S.C(c) https://tmi.yokogawa.com/bh/