THORLABS

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SA201

Spectrum Analyzer Controller
Operating Manual

Related Products

Model	Description
SA200-5A	525 – 650nm Scanning Fabry Perot
SA200-6A	650 – 800nm Scanning Fabry Perot
SA200-7A	780 – 930 nm Scanning Fabry Perot
SA200-9A	900 – 1100nm Scanning Fabry Perot
SA200-12A	1250 – 1400nm Scanning Fabry Perot
SA200-14A	1450 – 1625nm Scanning Fabry Perot

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Waste Electrical and Electronic Equipment Directive

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabs electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see fig. 1)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

As the WEEE directive applies to self contained operational electrical and electronic products, this “end of life” take back service does not refer to other Thorlabs products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e.g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

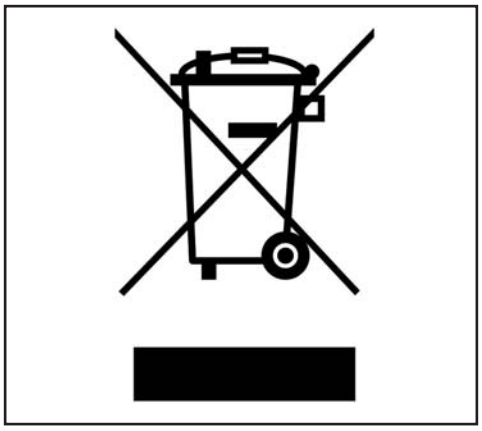
Waste treatment on your own responsibility

If you do not return an “end of life” unit to Thorlabs, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

Ecological background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of live products will thereby avoid negative impacts on the environment.



Crossed out “wheelie bin” symbol

Section 1.0 Specifications

Physical Features:

Dimensions (W x H x D):	5.8" x 2.8" x 12.5" (147mm x 71mm x 317.5mm)
Input and Output Connectors:	BNC's
Offset Control:	10-turn Potentiometer
Amplitude Control:	10-turn Trim pot
Risetime Control:	10-turn Trim pot
Sweep Expansion Control:	7-Position Rotary Switch
Photodiode Gain Control:	3-Position Rotary Switch
Waveform Select:	Pushbutton w/ illuminated indicators
PD Amp. Features:	Blanking with Sawtooth Waveform Falling Edge
Operating Temperature:	10ºC to 40ºC
Storage Temperature:	0ºC to 85ºC

Power Supply:

Supply Type:	Linear
Voltage Selection:	Switch Selectable between 115 / 230V_{AC}
Input Voltage:	100 / 115 / 230V_{AC}
Line Frequency:	50 – 60Hz
Input Power:	15W max
Fuse Ratings:	125mA @ 100 / 115V_{AC}
	63mA @ 230V_{AC}
Fuse Type:	Slow Blow Type 'T'

Output Characteristics:

Waveform:	Sawtooth / Triangle
Default Waveform:	Sawtooth
Sawtooth Fall Time:	1ms typ.
Output Voltage Range:	1 to 45V (offset + amplitude)
Max Supply Current [1]:	15mA
Short Circuit Current [2]:	26mA max.
Short Circuit Duration[2]:	Continuous
Offset Adj. Range:	0 to 15V_{DC}
Amplitude Adj. Range:	1 to 30V
Risetime Adj. Range [3]:	0.01 to 0.1s @ 1X Sweep Exp.
	1 to 10s @ 100X Sweep Exp.
Sweep Expansion Settings:	1X, 2X, 5X, 10X, 20X, 50X, 100X
Sweep Scale Error [4]:	+/- 0.5%
Output Noise [5]:	1mV_{RMS} (~6.6mV_{PP})

Trigger Characteristics:

Trigger Output Voltage:	TTL levels
VOH (RL = 50W):	2V min.
VOL (RL = 50W):	0.5V max.
Trigger Load Impedance:	50W / Hi-Z
Trigger Rising Edge[6]:	Ramp Start
Trigger Falling Edge[6]:	Ramp Midpoint

Photo Diode Amplifier Characteristics:

Gain Steps:	0, 10, 20dB
Transimpedance Gain (Hi-Z):	10K, 100K, 1M V/A
Transimpedance Gain (50Ω) [7]:	5K, 50K, 500K V/A
Gain Error[7]:	+/- 0.1% @ 10K (+/- 0.12%)
	+/- 0.12% @ 100K (+/- 0.15%)
	+/- 0.14% @ 1M (+/- 0.3%)
Output Impedance:	50Ω
Load Impedance:	50Ω / Hi-Z
Output Voltage (Hi-Z load):	0-10V min.
Output Voltage (50Ω load):	0-5V min.
Max Output Current[8]:	100mA
Bandwidth[8]:	250KHz
Noise (RMS) [8]:	<0.1mV @ 10K
	0.2mV @ 100K
	1.5mV @ 1M
Offset [8]:	+/- 1mV @ 10K
	+/- 5mV @ 100K
	+/- 20mV @ 1M

SA200-5A, 6A, and 7A Detector Characteristics:

Detector:	Silicon
Active Area:	13mm^2 (3.6 x 3.6mm)
Spectral Range:	400 to 1100nm
Junction Cap (0V Bias):	110pF typ.
NEP (@ 980nm):	1.2 x 10-14 W/√Hz

SA200-9A, 12A, and 14A Detector Characteristics:

Detector:	InGaAs
Active Diameter:	ϕ1mm
Spectral Range:	700 to 1700nm
Junction Cap (0V Bias):	120pF (80pF typ.)
NEP (@ 980nm):	1 x 10^{-14} W/√Hz

Section 1.0 Specifications *continued*

Notes:

1. Achieved during the sawtooth waveform fall time. This is calculated by I (mA) = C_{piezo} (μF) x ΔV_{max} / Δt_{fall}
2. The output drive amplifier will current limit the load to 26mA max. Although the unit may operate continuously under these conditions, it is not recommended since the unit will heat up causing stress to the electronics.
3. The risetime adjustment range for each sweep setting is as follows:
   Risetime Adj. Range = (0.01 x sweep expansion setting) to (0.1 x sweep expansion setting).
4. Defined as the scaling error between 1X and any other gain settings (ex. 2X +/- 0.5%).
5. Measures with SA200 series scanning head connected to output.
6. 'Ramp' refers to the rising, or scanning, edge of the 'Output' waveform.
7. The gain error does not apply when using a 50Ω load since the user-installed output terminator will probably have a resistance tolerance greater than the gain errors above. Also note that the 50W output series resistance is 49.9W +/-1%. This will also factor into gain error when using a 50Ω load.
8. Test performed with a 50Ω terminator and a 6' (~1.8m) 50Ω coax cable.

Section 2.0 Overview

The SA201 is specifically designed to control Thorlabs SA200 Series Fabry Perot Interferometers. The controller generates a voltage ramp, which is used to scan the separation between the two cavity mirrors. The controller provides adjustment of the ramp voltage and scan time, allowing the user to choose the scan range and speed. An offset control is provided to allow the spectrum displayed on the oscilloscope to be shifted right or left. Another convenient feature of the controller is a zoom capability that provides a 1X, 2X, 5X, 10X, 20X, 50X and 100X increase in the spectral display resolution. The output TTL level trigger allows the user to externally trigger an oscilloscope on either the beginning or midpoint of the ramp waveform.

The SA201 also includes a high precision photodetector amplifier circuit used to monitor the transmission of the cavity. The amplifier provides an adjustable transimpedance gain of 10K, 100K, and 1M V/A when driving a high impedance load, such as an oscilloscope. Using the output sync signal from the controller, an oscilloscope can be used to display the spectrum of the input laser. The detector circuitry incorporates a blanking circuit, which disables the photodiode response during the falling edge of the sawtooth waveform.

Section 3.0 Parts List

Below is a list of all components shipped with the SA201 Spectrum Analyzer Controller.

☐ SA201 Spectrum Analyzer Controller
☐ Operating Manual
☐ US Power Supply Line Cord
☐ 63mA Fuse for use at 230VAC operation (125mA fuse installed in unit)

The following items are sold separately:

☐ SA200-5A: 525-650nm Scanning Fabry Perot with Silicon Photodetector
☐ SA200-6A: 650-800nm Scanning Fabry Perot with Silicon Photodetector
☐ SA200-7A: 780-930nm Scanning Fabry Perot with Silicon Photodetector
☐ SA200-9A: 900-1100nm Scanning Fabry Perot with InGaAs Photodetector
☐ SA200-12A: 1250-1400nm Scanning Fabry Perot with InGaAs Photodetector
☐ SA200-14A: 1450-1625nm Scanning Fabry Perot with InGaAs Photodetector

Section 4.0 Descriptions

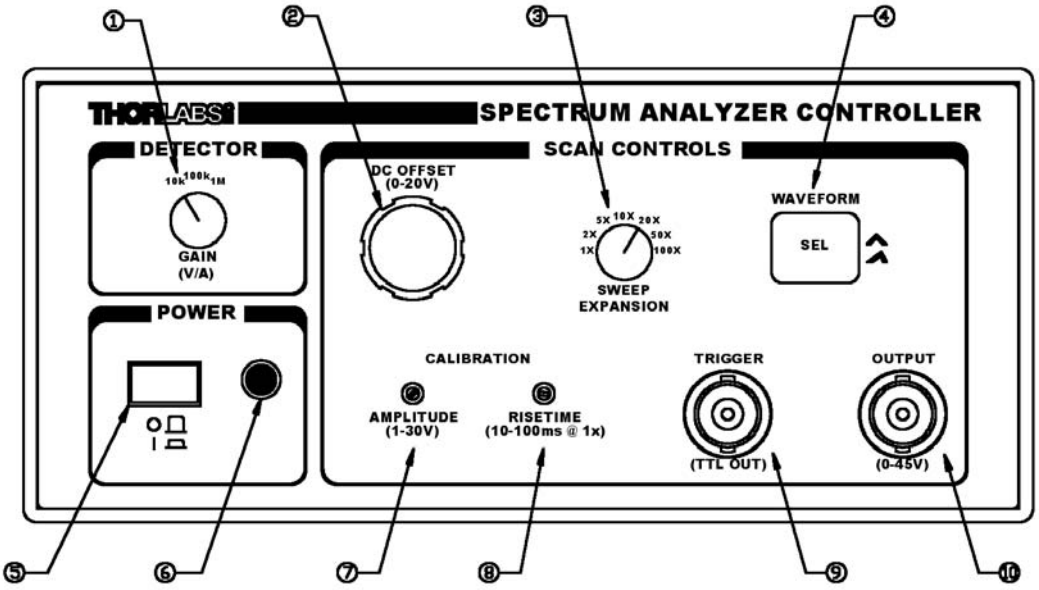


Figure 1- SA201 Front Panel

Detector Gain Adjustment (1)
The SA201 includes a built in photodiode amplifier circuit. This amplifier is designed specifically to operate with the detector provided with the SA200 series Fabry Perot Interferometer, allowing the user to monitor the transmission of the cavity. While any photodetector may be connected to the amplifier the specifications,
listed in Section 1, apply only to detectors supplied with the SA200 series. The amplifier provides a transimpedance gain (current to voltage gain) of 10K, 100K, and 1M V/A while driving a Hi-Z load, such as an oscilloscope. For better noise and performance characteristics it is recommended that a 50W coax cable with a 50Ω terminating resistor be used. The Photodetector input and output BNC's are located on the rear panel.

DC Offset Control (2)
The DC Offset provides a continuously adjustable offset voltage over the range of 0 to 15V using a 10-turn potentiometer. This offset adds directly to the ramp signal. The DC offset control is used to adjust the waveform from left to right across an oscilloscope viewing window, without affecting the calibration of the cavity.

Sweep Expansion Control (3)
The sweep expansion provides a zoom capability to increase the spectral display resolution by a factor of 1x, 2x, 5x, 10x, 20x, 50x, and 100x. This is achieved by scaling the ramp rise time be the sweep expansion.

Waveform Control (4)
The SA201 allows the user to select between a sawtooth and triangular waveform. The sawtooth waveform is desirable for most applications, however the triangle waveform is useful for cavity alignment. The SA201 will default to the sawtooth waveform during the system power-up. To change the waveform, simply press the 'WAVEFORM SEL' button. The selected waveform is indicated by the illuminated symbol to the right of the waveform select button.

Power Switch (5)
The power switch is used to toggle the unit on and off.

Power On Indicator (6)
The power on LED will light when the unit is powered up.

Amplitude Control (7)
The amplitude control allows the user to adjust the ramp amplitude from 1 to 30V peak to peak using a 10-turn trimpot. Note, the ramp signal is added to the DC offset. This means that when the offset is set to 0V, the ramp will start a 0V and increase to the amplitude limit setting. The amplitude is used to determine how far the mirror will be scanned, or to set the spectral range of the optical head.

Risetime Control (8)
The risetime control allows the user to continuously adjust the scan rate from 0.01ms to 0.1ms using a 10-turn trimpot. Note, the risetime setting may be scaled by the sweep expansion setting. For example: If the scan rate is set to 0.05s and the sweep expansion is adjusted from 1x to 100x then the scan rate will adjust to 5s. The scaling error is typically less than +/-0.5%, providing excellent measurement capabilities.

Trigger Output BNC (9)
This trigger output signal may be used to externally trigger the oscilloscope. The trigger is capable of driving 50Ω terminated cables, as well as Hi Z loads such as oscilloscopes. The trigger will provide an edge on the beginning and middle of the scanning ramp. See Figure 2 below.

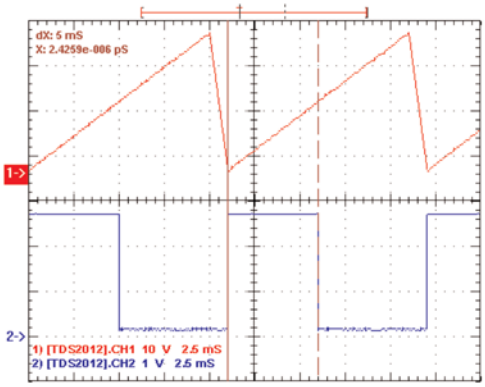


Figure 2, Trigger Logic

Output BNC (10)
The output BNC is used to drive the SA200 scanning piezos from 1V to 45V. The output is capable of driving 0.6μF piezo loads at a ramp rate of 1ms over the full voltage range. The output current is internally limited to prevent damage to the output drive. Note: the output performance specifications assume a Thorlabs Fabry Perot Interferometer module is connected.

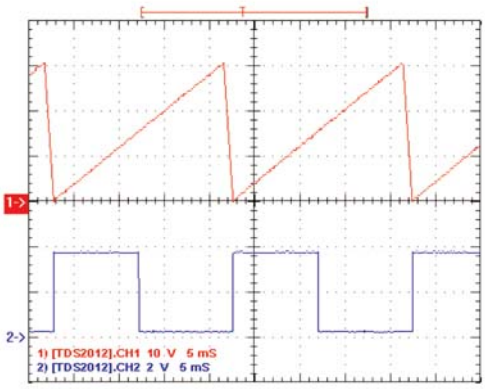


Figure 3, Sawtooth Waveform

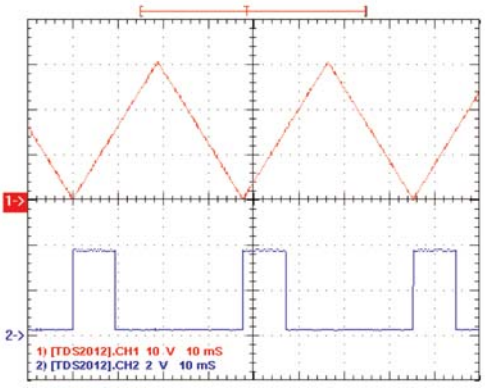


Figure 4, Triangle Waveform

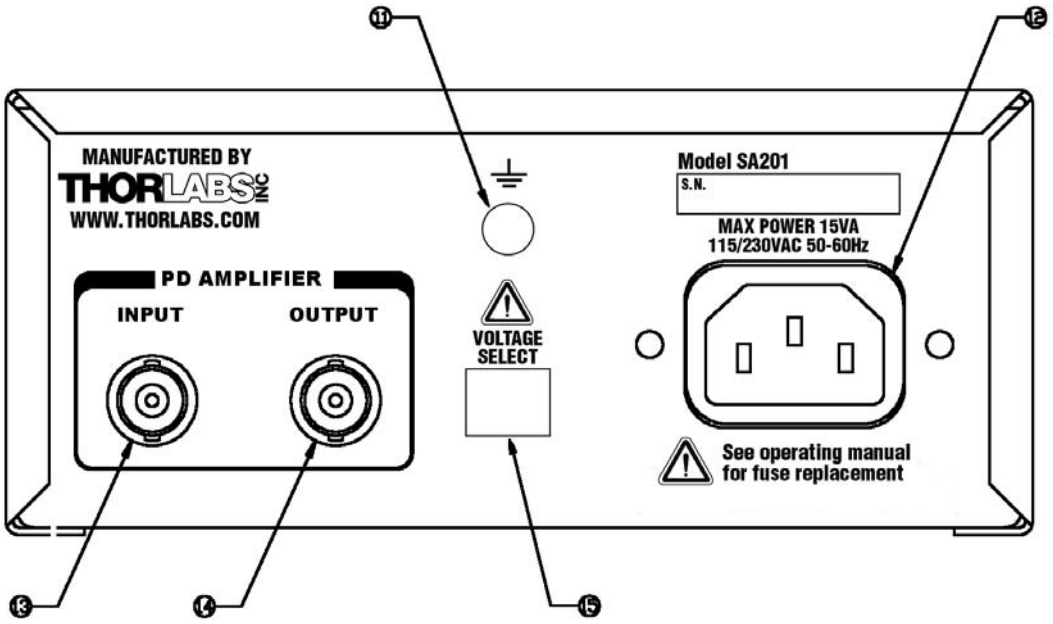


Figure 5- SA201 Rear Panel

Ground Plug (11)
This ground plug is for use as a general-purpose ground connection. It is connected directly to the earth ground connection of the input power plug.

AC Input Connector (12)
This is the line voltage input connection. **IMPORTANT**: The unit is configured for 100 / 115VAC, 50-60Hz from the factory. To operate at 230VAC see Section 5.

PD Amplifier Input BNC (13)
This input BNC is used to interface the photodetector, provided with the SA200 scanning heads, to the amplifier circuit. The photodiode amplifier is configured to operate with the Thorlabs supplied photo detectors; however it is possible to operate user supplied photo detectors. To do so, the BNC center contact must be connected to the photo detector cathode and the BNC shell must be connected to the photodiode anode (unbiased operation). If a biased detector is to be used the BNC shell must be connected to the bias ground and the bias voltage must be negative for the circuit to operate properly.

PD Amplifier Output BNC (14)
This BNC is the amplifier output and may be connected directly to an oscilloscope to view the cavity spectrum. The amplifier gain will be set using the front panel 'DETECTOR' control knob. The amplifier output includes a 50Ω series resistor to minimize noise when operating with a 50Ω coax cable. For best results, a 50Ω load resistor is recommended at the oscilloscope. Note, the amplifier gain will be halved with a 50Ω load connected.

Voltage Selector Switch (15)
The voltage selector switch allows the user to select the input line voltage they will be operating the system at. the factory default setting is 100 / 115V_{AC} as shown in figure 2. To operate at 230V_{AC}, this switch will have to be moved to the 230V position. The line fuse will also need to be changed to properly protect the unit. See section 5 for detailed instructions.

PD Blanking Circuit

The detector amplifier includes a blanking circuit, which blocks any photo detector response during the falling edge of the sawtooth waveform. This is very useful when triggering on the photo diode spectral response, because unwanted signals while the cavity resets will be removed. The blanking is not available when using the triangle waveform, since it is useful to see the rising and falling response overlapped during system alignment. This feature may be disabled as described below:

1. **Important** – Disconnect the scanning head or any piezo device from the SA201 output.
2. **Important** – Disconnect the power cord. Do not open the unit if the power cord is connected.
3. Remove the two screws securing the enclosure cover with a Phillips head screwdriver. The screws are located on the bottom side, rear corners of the unit. Do not lose the screws.
4. Carefully remove the cover by sliding toward the rear of the unit.
5. Locate the JP3 header. It is positioned in front of the heat sink and will have a shorting jumper on pin 1.
6. Remove the shorting jumper and place across (Shorting) the JP3 pins to disable the blanking circuit. The default setting will be blanking enabled. The jumper will not be shorting the pins.
7. Replace the enclosure cover and secure with the enclosure screws.

Section 5.0 Maintenance & Troubleshooting

DANGER! – The Thorlabs Spectrum Analyzer Controller, SA201, must be powered off, unplugged from the AC input source, and disconnected from any piezo elements prior to replacing the fuse or removal of the cover. Failure to do so may cause SERIOUS INJURY to the user, since high voltages exist within the unit.

WARNUNG! - Sicherheitsanweisungen für den Thorlabs Spectrum Analyzer Controller (SA201). Bevor die Sicherung gewechselt oder die Gehäuseabdeckung entfernt werden darf, muß das Gerät abgeschaltet und das Spannungsversorgungskabel von der Netzspannung getrennt werden. Das nicht befolgen dieser Anweisungen, kann zu lebensgefährlichen Verletzungen führen, da das Gerät intern unter Hochspannung steht.

Materials Needed

- SA201 Operating Manual – The most recent version of this operating manual will be available on Thorlabs web site.
- 63mA Type 'T' Slow Blow Fuse – The 63mA fuse is required for 230V operation only. Thorlabs supplies a 63mA fuse with all of its SA201 units and must be installed when operating at 230VAC.
- 125mA Type 'T' Slow Blow Fuse – The 125mA fuse is installed from the factory. This must be installed when operating the unit at 100 / 115VAC.
- Phillips Head Screwdriver (#2 Preferred) – We do not recommend using electrically powered screwdrivers.

Fuse Replacement

1. **Important** – Disconnect the scanning head or any piezo device from the SA201 output.
2. **Important** – Disconnect the power cord. Do not open the unit if the power cord is connected.
3. Remove the two screws securing the enclosure cover with a Phillips head screwdriver. The screws are located on the bottom side, rear corners of the unit. Do not lose the screws.
4. Carefully remove the cover by sliding toward the rear of the unit.
5. Locate the fuse box between the input line voltage connector and the transformer.
6. Remove the fuse cover and slide the old fuse out.
7. Install the new fuse into the fuse cover and place back into the fuse box. (125mA @ 100/115V_{AC} and 63mA @ 230V_{AC})
8. Replace the enclosure cover and secure with the enclosure screws.

Selecting the Line Voltage

1. Important – Replace the line fuse as described above.2. Locate the voltage selector switch on the rear panel. See Figure 5 leader 15.
3. Switch to the appropriate line voltage.
4. Install the appropriate line cord and turn the unit on.

Cleaning

The SA201 should only be cleaned with a soft cloth and a mild soap detergent or isopropyl alcohol. Do not use a solvent-based cleaner.

Technical Support

You may use any of the following methods to contact Thorlabs in case of difficulty or if you have questions regarding the SA201.

www.thorlabs.com	Thorlabs web site will have up to date application notes and frequently asked questions regarding our products.
Techsupport@thorlabs.com	Send a detailed email message and one of our application engineers will respond promptly (within 1 business day).
Mail:	Thorlabs, Inc.
	435 Route 206N
	Newton, NJ 07860
	Phone: (973) 579-7227
	Fax: (973) 300-3600

Appendix A: Recommended Setup