SA200 Series Fabry Perot Interferometer

User Guide

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Chapter 1 Warning Symbol Definitions

Below is a list of warning symbols you may encounter in this manual or on your device.

Symbol	Description
	Direct Current
	Alternating Current
	Both Direct and Alternating Current
	Earth Ground Terminal
	Protective Conductor Terminal
	Frame or Chassis Terminal
	Equipotentiality
	On (Supply)
	Off (Supply)
	In Position of a Bi-Stable Push Control
	Out Position of a Bi-Stable Push Control
	Caution: Risk of Electric Shock
	Caution: Hot Surface
	Caution: Risk of Danger
	Warning: Laser Radiation
	Caution: Spinning Blades May Cause Harm

Chapter 2 Safety

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly. Please read the following warnings and cautions carefully before operating the device.

WARNING

Take appropriate measures for eye safety.
Never look directly into the beam, not even at the output of the SA200.

SHOCK WARNING

Never touch the output of the SA200 PZT driving unit.

Chapter 3 Fabry-Pérot Interferometry

The SA200 is a high finesse Spectrum Analyzer used to examine the fine structures of the spectral characteristics of CW lasers. The spectrum analyzer consists of a confocal cavity that contains two high reflectivity mirrors; by varying the mirror separation with a piezoelectric transducer the cavity acts as a very narrow band-pass filter. Knowing the free spectral range of the SA200 allows the time-base of an oscilloscope to be calibrated to facilitate quantitative measurements of a laser line shape. The confocal cavity design, for which the mirror spacing, *d*, and radius, *r*, are identical, allows for an easy alignment procedure. Mirrors shown below are AR coated on the outer surfaces and HR coated on the inner surfaces.

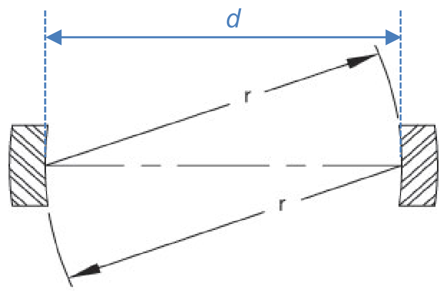

Figure 1 ***Illustration of the confocal cavity design, where the mirror spacing is chosen equal to the radius of curvature of the mirrors.***

3.1. Free Spectral Range

To scan the spectra of the laser beam entering the Scanning Fabry-Pérot interferometer, a small displacement is applied to one of the cavity mirrors mounted on the piezoelectric transducers. This is done by fine tuning the ramp voltage applied to the piezoelectric elements using the controller SA201. When the mirror spacing becomes equal to an integral number of half the wavelength of the laser, constructive interferences occur. That spectral response of the signal can be visualized with a scope. A series of periodical peaks appear on the screen of the scope. The distance between consecutive peaks is called the free spectral range (FSR) of the instrument.

From a user's perspective, the free spectral range of a confocal cavity is given by

$$FSR = c/4d,$$

where *c* is the speed of light and *d* is the cavity length, instead of *c/2d* as would be the case for a plano-plano cavity; the factor of 2 in the denominator can be understood by inspecting the ray trace shown on the next page in Figure 2. Note that a ray entering the cavity at a height '*H*' parallel to the optical axis of the cavity makes a triangular figure eight pattern as it traverses the cavity. From this pattern it is clear that the ray makes four reflections from the cavity mirrors instead of the two that would result in a plano-plano cavity. Hence the total round-trip path through the cavity is given as *4d* instead of *2d*.

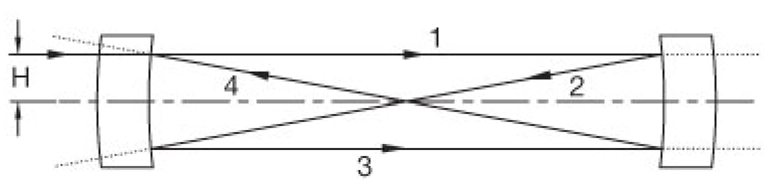

Figure 2 ***This figure shows a simplified ray-trace for a ray entering the cavity at height 'H'. The curvature of the mirrors 'r' and the separation being set precisely to 'r' ensures that the input ray is imaged back onto itself after traveling a distance of approximately 4r.***

Additionally, in this configuration if a paraxial ray is traced through the system as shown Figure 2, it is apparent that in the confocal configuration each mirror serves to image the other mirror back onto itself so that a ray entering the cavity will, after four traverses of the cavity, fall back onto itself (keep in mind that the focal length of a spherical mirror is *r/2*). This imaging of the beam back onto itself greatly simplifies the alignment of the cavity; just align your input to within a few tenths of a millimeter to the center of the mirror set and restrict your input angles to less than a few degrees. The SA200 series interferometer has two iris diaphragms that simplify this alignment requirement.

3.2. Finesse and Resolution

The finesse, *F,* of the Scanning Fabry-Perot interferometer is a quantity which characterizes the ability of the interferometer to resolve closely spaced spectral features, and it is determined solely by the reflectivity of the mirrors involved. For an infinitely narrow input spectrum, the finesse determines the width of the measured spectrum. In combination with the mirror spacing and its resulting free spectral range, the finesse defines the resolution of the instrument by

$$\Delta = FSR/F.$$

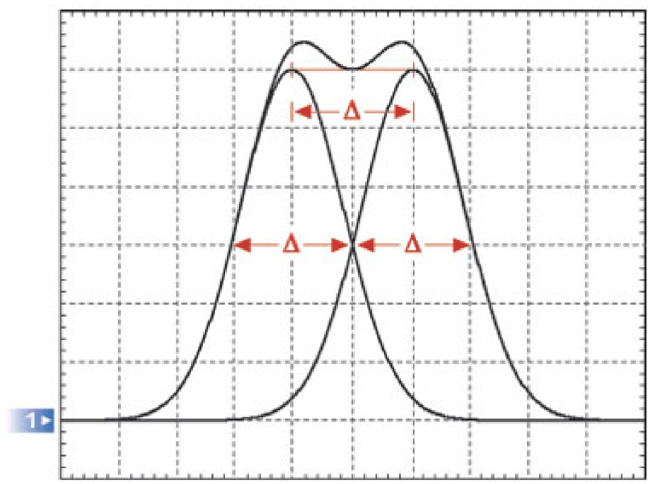

Figure 3 When two equal Gaussian lineshapes just meet the Taylor criteria for being resolvable, they are separated by their common FWHM (Δ) as shown in the plot.

High finesse means high resolution capability, and high finesse is obtained by increasing the reflectivity of the cavity mirrors. However, highly reflective mirrors reduce the transmission of the interferometer. Still, typical peak-transmission values are in the range from 20-60% of the input power, depending on both the SA200 model and the particular set of mirrors used.

Chapter 4 Setup and Procedures

4.1. Recommended Setup For SA200 Interferometers Except SA200-30C

The SA200 should be mounted in a Ø2" kinematic mirror mount, such as Thorlabs' KM200, so that it can be easily adjusted. In many applications, it is useful to direct the beam into the Fabry-Perot interferometer with the use of a mirror in a kinematic mirror mount, on a flip platform mount. A lens with focal length of 250 mm can be used, with the focus set roughly at the center of the housing, approximately 30 mm past the flange. If the detector is connected directly to the scope, a 5 kΩ terminator is needed.

In a typical application, the SA200 Interferometer is used in conjunction with a signal generator and an oscilloscope, as shown below. The signal generator should be able to produce either a triangle or saw-tooth wave with an adjustable frequency (5 to 50 Hz), an adjustable amplitude, and an adjustable offset (Thorlabs SA201 Fabry-Perot Controller is used for generating the required scan signals for obtaining the data in this document). The maximum voltage on the piezo (ramp in) is not to exceed 150 V. The signal generator is used to repeatedly scan the length of the cavity in order to sweep through the transmission spectrum of the interferometer. An oscilloscope is typically used to view the spectrum and make quantified measurements of spectral features.

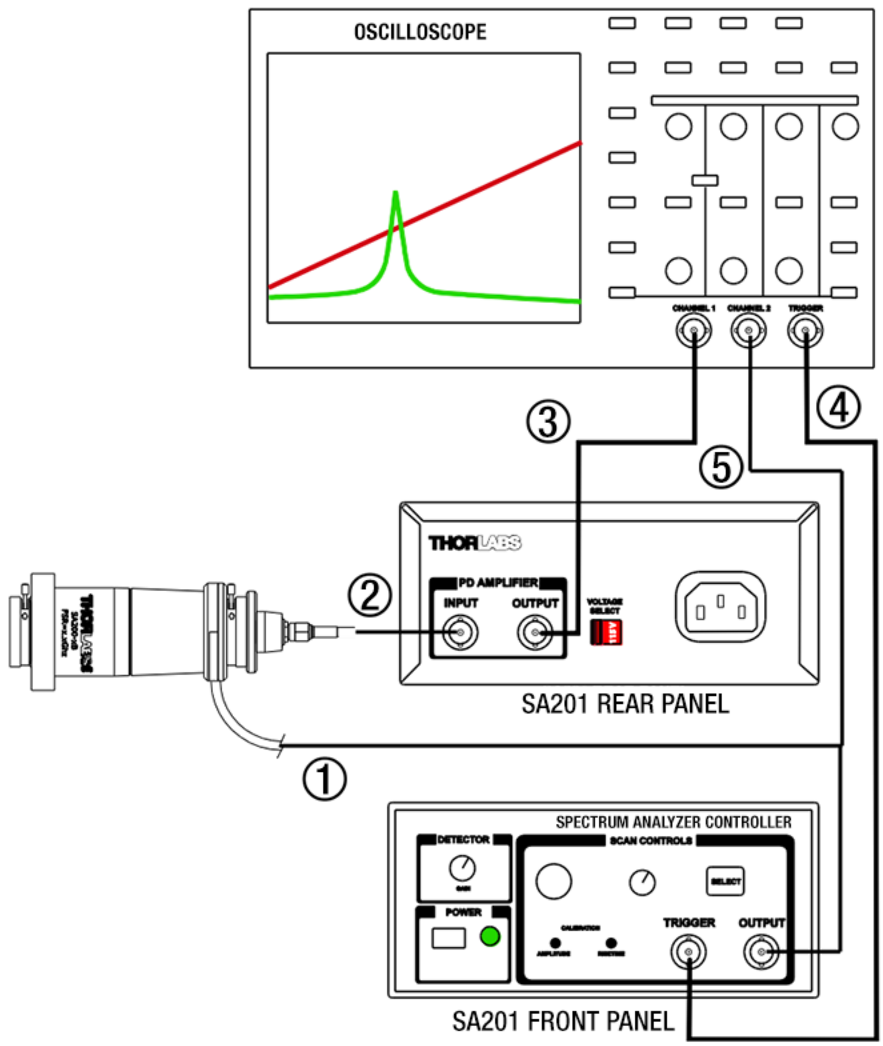

Figure 4 ***Schematic of a recommended setup for using an SA200 series interferometer in combination with a SA201 controller (not for the SA200-30C; see below).***

4.2. Recommended Setup for the SA200-30C Interferometer

The SA200-30C is recommended to be used in combination with the PDAVJ5 detector. To get started, remove the protection cap from the detector and mount the detector onto the output iris thread of the SA200-30C. Note that the PDAVJ5 already provides a transimpedance amplification stage; therefore, the output of the detector can be directly connected to an oscilloscope and must not be connected to the "PD amplifier input" port of the SA201 controller. For details on the use of the PDAVJ5, please refer to its manual, which can be found on the Thorlabs website. Due to saturation effects of the diode inside the PDAVJ5 detector, the optical power entering the SA200-30C should be kept below 200 µW in order to avoid saturation.

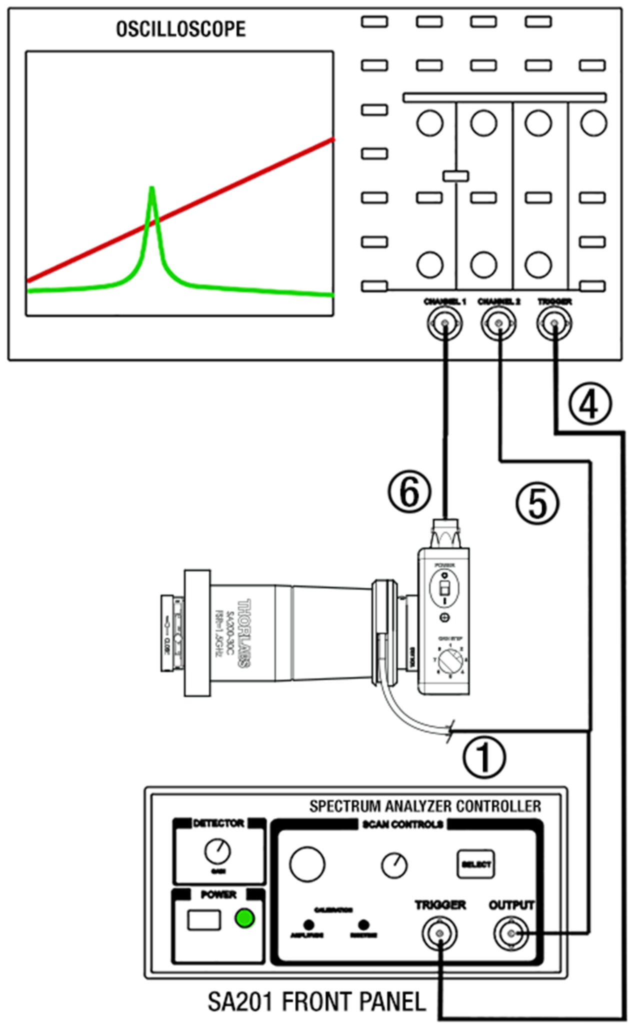

Figure 5 ***Schematic of a recommended setup for using an SA200-30C interferometer in combination with a SA201 controller***

4.3. Alignment

To align the SA200 Series Fabry-Perot interferometer, follow the steps for the recommended setup as described in Section 4.1 or 4.2 above. Next, close the input iris to its minimum aperture and center the beam on the iris opening, which most conveniently is achieved by aligning the beam via two folding mirrors onto the input iris. Leave the back iris completely open and start to scan the unit. Make sure that a full sweep is visible on the oscilloscope, as well as that the signal from the detector is displayed; for ignition alignment adjust the oscilloscope gain to maximize sensitivity.

Use the mirror mount's tip/tilt adjustment until the beam is centered through the body of the SA200, i.e. until you start to see modes on the oscilloscope. Slowly close the back iris while adjusting the mirror mount to keep the beam in the center of the device. Once the beam is centered, the alignment can be fine tuned with the two input mirrors by monitoring the shape and size of the transmission modes on the oscilloscope. The interferometer will then be ready for measurements.

4.4. Calibration of the time scale

Knowing the free spectral range (FSR) of the SA200 allows the time-base of an oscilloscope to be calibrated to facilitate quantitative measurements of laser line shape. Due to the interferometers' resolution of 7.5 MHz, the fine structure resulting from multiple longitudinal modes of a laser line can be resolved.

4.5. Spectrum Analyzer Controller

The SA201 controller generates a voltage ramp, which is used to scan the separation between the two cavity mirrors. A photodiode is used to monitor transmission of the cavity. Using the output sync signal from the controller, an oscilloscope can be used to display the spectrum of the input laser. The controller provides adjustment of the ramp voltage (1 to 30 V), offset (0 to 15 VDC), and scan-time (0.01 - 10 s) to allow the user to choose the scan range and speed. Offset control is provided to allow the spectrum displayed on the oscilloscope to be shifted right or left, and zoom capability provides up to 100X increase in spectral resolution.

Chapter 5 Specifications

Optical Performance Specifications	
Maximum Input Voltage	150 V
Free Spectral Range[1]	1.5 GHz
Minimum Finesse	>200 (minimum), 250 (typical)
Resolution	7.5 MHz
Outer Housing Material	Black Anodized Aluminum
Fabry-Perot Cavity Material[2]	Low Thermal Expansion Invar®
Dimensions (SA200 Models Except SA200-30C)	Ø2" Flange Total Length: 5.85"
Dimensions (SA200-30C)	Ø2" Flange Total Length: 4.07"

Available Coating Ranges for the SA200 series	
Item #	**Coating Wavelength Range**
SA200-2B	290 - 355 nm & 520 - 545 nm (Dual Band)
SA200-3B	350 - 535 nm
SA200-5B	535 - 820 nm
SA200-8B	820 - 1275 nm
SA200-12B	1275 - 2000 nm
SA200-18C	1800 - 2600 nm
SA200-30C	3000 - 4400 nm

[1] FSR is set by the length of the confocal cavity and is given by: FSR = c/4d, where d is the radius of curvature of the mirrors; in this case d = 50 mm.
[2] A thermal design balances the small coefficient of thermal expansion of the Invar body with the negative coefficient of thermal expansion of the piezo actuators.

Chapter 6 Mechanical Drawing

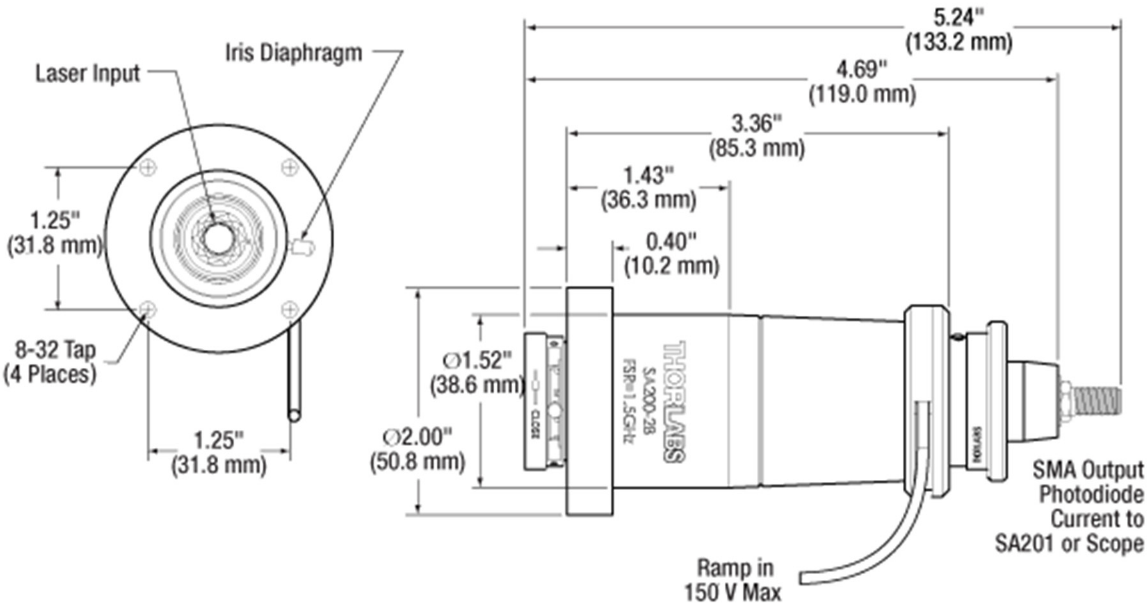

Figure 6 All SA200 models share the same housing, except for the SA200-30C (see below).

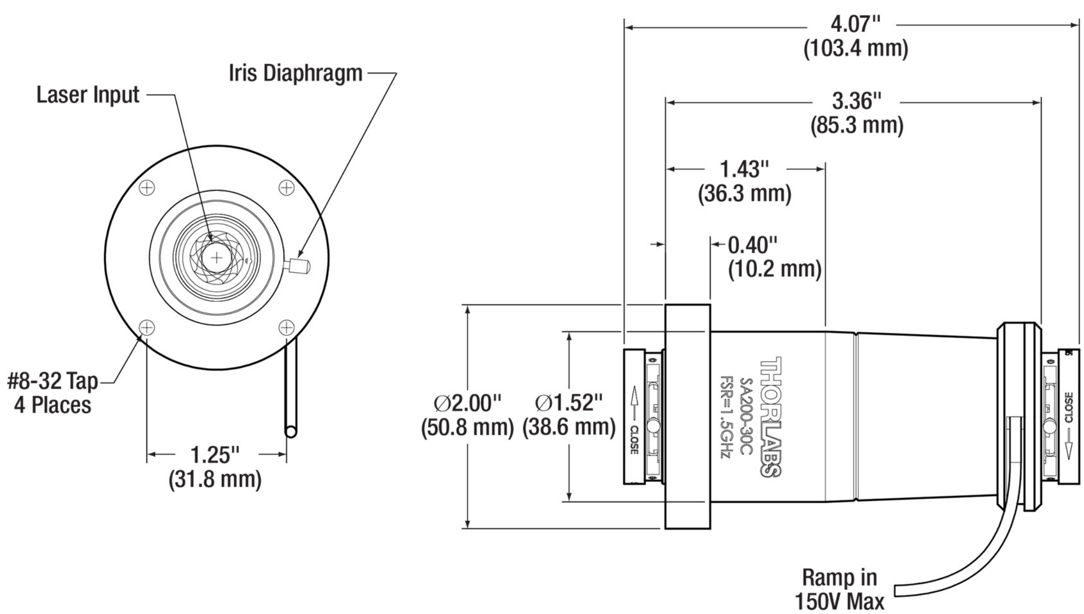

Figure 7 SA200-30C Mechanical Drawing

Chapter 7 Regulatory

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 13, 2005
- Marked correspondingly with the crossed out "wheelie bin" logo (see right)
- 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 is 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 life products will thereby avoid negative impacts on the environment.

Chapter 8 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.

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