THORLABS

SA210 Series
Fabry Perot Interferometer

User Guide

Table of Contents

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 SA210.

SHOCK WARNING

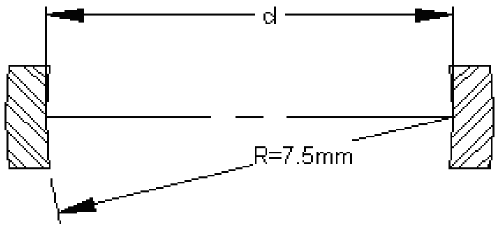
Never touch the output of the SA210 PZT driving unit.

Chapter 3 Description

The SA210 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 SA210 allows the time-base of an oscilloscope to be calibrated to facilitate quantitative measurements of a laser line shape.

3.1. Confocal Cavity Configuration

Mirrors shown below are AR coated on the outer surfaces and HR coated on the inner surfaces.



FSR=c/4d

Available Coating Ranges	
Item #	**Wavelength Range**
SA210-3B	350 - 535 nm
SA210-5B	535 - 820 nm
SA210-8B	820 - 1275 nm
SA210-12B	1275 - 2000 nm
SA210-18C	1800 - 2600 nm

Chapter 4 Fabry-Perot Interferometry

4.1. Free Spectral Range

To scan the spectra of the laser beam entering the Scanning Fabry–Perot interferometer small displacement is applied to one of the cavity mirror mounted on piezoelectric transducers. This operation 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 users perspective a confocal cavity has a FSR that is given by c/4d instead of c/2d (where c is the speed of light and d is the cavity length) 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 below in Figure 1. 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.

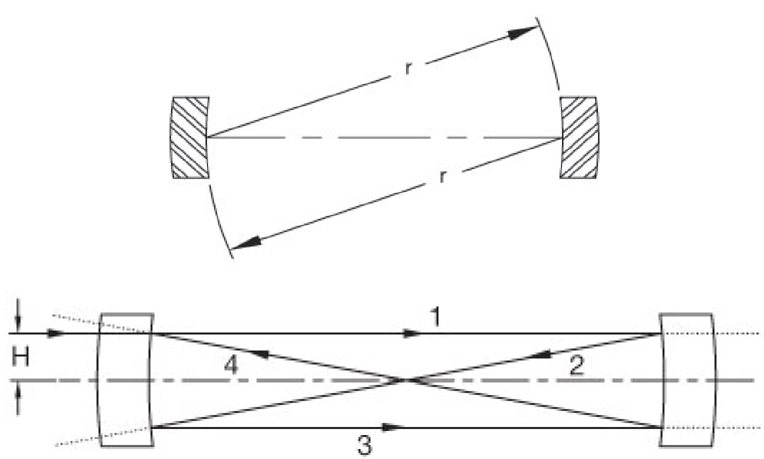


Figure 1 *This figure shows a simplified ray-trace for a ray entering the cavity at height 'h'. The curvature of the mirrors 'R' and the separation being set precisely to 'R' ensures that the input ray is imaged back onto itself after traveling a distance of approximately 4R.*

Additionally, in this configuration if a paraxial ray is traced through the system as shown in Figure 1, 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, (note 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 of 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.

4.2. Finesse

The finesse of the Scanning Fabry-Perot interferometer is a quantity which characterizes the ability of the interferometer to resolve closely spaced spectral features, it defines the resolution of the instrument. For an infinitely narrow input spectrum, the finesse determines the width of the measured spectrum.

High finesse means high resolution capability, high finesse is obtained by increasing the reflectivity of the cavity mirrors. However, high reflective mirrors reduce the transmission of the interferometer.

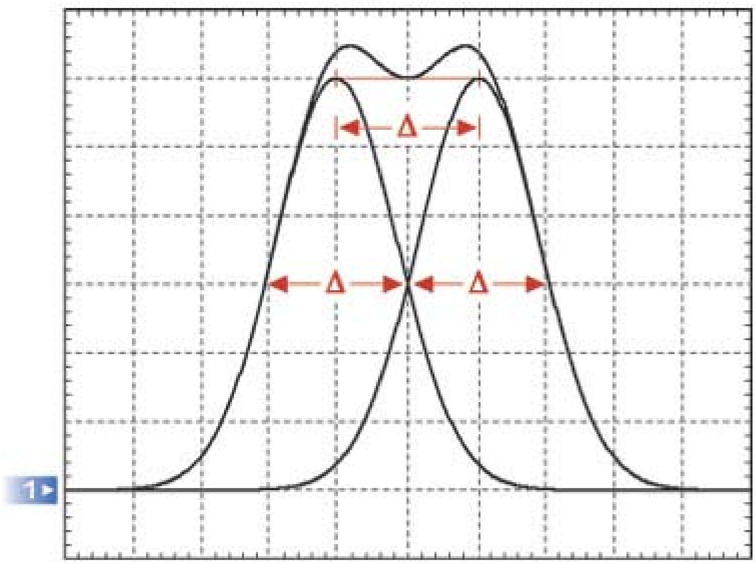


Figure 2 *When two equal Gaussian lineshapes just meet the Taylor criteria for being resolvable, they are separated by their common FWHM (Δ) as shown in the plot.*

4.3. Spectrum Analyzer Controller and Other Accessories

- 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) and scan-time (1 ms to 5 s) to allow 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, zoom capability provides up to 100X increase in spectral resolution.
- Thorlabs' **KM100**, Ø2" kinematic mount can be used to mount the SA210 Scanning Fabry Perot Interferometer.

Chapter 5 Setup

Knowing the free spectral range (FSR) of the SA210 allows the time-base of an oscilloscope to be calibrated to facilitate quantitative measurements of laser line shape. With a resolution of 67 MHz, the fine structure resulting from multiple longitudinal modes of a laser line can be resolved. Note: A saw tooth wave (0 - 20 V) would provide approximately 2 FSR.

The SA210 should be mounted, so that it can be easily adjusted. It is recommended that Thorlabs 1-inch Kinematic Mount **KM100** be used to mount the interferometer at the 1-inch diameter flange.

The apparent beam size should be approximately 1 mm. It is recommended that a fold mirror be used to direct the beam into the Fabry-Perot interferometer. A lens with focal length of 100 mm can be used, with the focus set roughly at the center of the housing, approximately 25 mm in from the flange.

The maximum voltage on the piezo (ramp in) is not to exceed 150 V.

If the detector is connected directly to the scope, a 5 kΩ terminator is needed. Offset adjustment (SA201) is used to center the output on the scope.

5.1. Recommended Set-up

In a typical application the SA210 Interferometer is used in conjunction with a signal generator and an oscilloscope, as shown below. A signal generator (Thorlabs SA201 Fabry-Perot Controller is used for generating the required scan signals for obtaining the data in this document) that can produce either a triangle or saw-tooth wave with an adjustable frequency (5 to 50 Hz), an adjustable amplitude (15 to 40 V), and an adjustable offset. The signal generator is used to repetitively scan the length of the cavity by λ/4 in order to sweep through one FSR of the interferometer. An oscilloscope is typically used to view the spectrum and make quantified measurements of spectral features.

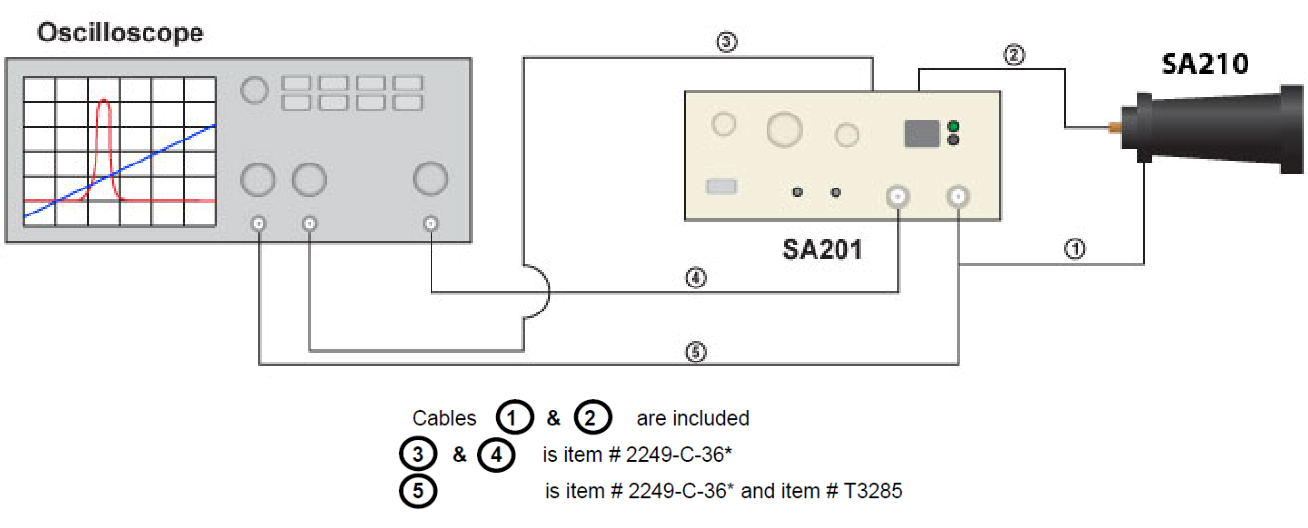


Figure 3 *This figure shows a schematic diagram of a typical setup that is used to measure the spectrum of a laser source. Please note that for this device to be useful the linewidth of the source must be less than the FSR of the interferometer.*

Chapter 6 Alignment

To set up the SA210 Series Fabry-Perot, first mount the unit into a tip/tilt mirror mount (item # KM100). Attach all of the connections according the drawing on page 6. Next, remove the detector from the back of the unit and mount it in a separate mount; this will aid in the alignment. Close the input iris to its minimum aperture and center the beam on the iris opening. Leave the back iris completely open and start to scan the unit. Use the mirror mount's tip/tilt adjustment until the beam is centered through the body of the SA210.

Adjust the oscilloscope gain to maximize sensitivity, position the detector close to the rear opening, and slowly close the back iris while adjusting mirror mount to keep the beam in the center of the device. Once the beam is centered, attach the detector to the main body once more. The interferometer will then be ready for measurements.

Chapter 7 Specifications

Optical Performance Specifications	
Maximum Input Voltage	150 V
Free Spectral Range[1]	10 GHz
Minimum Finesse	>150
Resolution	67 MHz
Outer Housing Material	Black Anodized Aluminum
Fabry Perot Cavity Material[2]	Low thermal expansion Invar®
Dimensions:	Ø1" Flange Total Length: 2.93"

[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 = 7.5 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 8 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.

8.1. 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.

8.2. 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 9 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.

USA, Canada, and South America
Thorlabs, Inc.
sales@thorlabs.com
techsupport@thorlabs.com

Europe
Thorlabs GmbH
europe@thorlabs.com

France
Thorlabs SAS
sales.fr@thorlabs.com

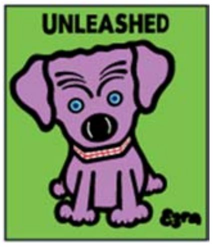
Japan
Thorlabs Japan, Inc.
sales@thorlabs.jp

UK and Ireland
Thorlabs Ltd.
sales.uk@thorlabs.com
techsupport.uk@thorlabs.com

Scandinavia
Thorlabs Sweden AB
scandinavia@thorlabs.com

Brazil
Thorlabs Vendas de Fotônicos Ltda.
brasil@thorlabs.com

China
Thorlabs China
chinasales@thorlabs.com


UNLEASHED