

Polarization Analyzers Series SK010PA-...

Universal measurement and test system for free beam applications and polarization-maintaining fiber optics

- Interface: **USB 2.0** • Power supply via USB

Multiple wavelength ranges:

UV	375 – 450 nm
UVIS	400 – 700 nm
VIS	450 – 800 nm
NIR	700 – 1100 nm
IR	1100 – 1600 nm

Polarization Analyzer Series SK010PA

1 Application:
Laser Beam Coupling and PM Fiber Evaluation

0°
-45° 45°
-90° 90°
-135° 135°

Fiber Output Connector

- Measurement of Connector Key Alignment

Connector key
Polarization Direction

Good Bad

Application:

0°
-45° 45°
-90° 90°
-135° 135°

2 Fiber Input Connector

- Alignment of incoming polarization
- Measurement of resulting Polarization Extinction Ratio

Connector key
Polarization Alignment

Good Bad

4 Application:
Adjustment and Evaluation of Quarter-Wave Plates

Adjustment of left-handed and right-handed circular polarization.

45°

Laser beam coupling and polarization maintaining fiber evaluation **1 + 2**

PM fibers maintain the polarization state of a linearly polarized input beam if the polarization direction is precisely aligned with either the slow or fast axis of the fiber **2**. Any discrepancies cause the state of polarization to fluctuate with temperature or with fiber placement.

The Polarization Analyzer SK010PA provides sophisticated procedures for the alignment of the incoming polarization direction to the PM fiber axis and for the measurement of the resulting Polarization Extinction Ratio (PER) **2**. Simultaneously, at the output side, the alignment of the connector key to the polarization axis of the emerging beam is measured **1**.

Adjustment and evaluation of quarter-wave plates **4**

Quarter wave plates have to be adjusted at either +45 or -45 degrees to the polarization axis to achieve either left or right handed circular polarization. Fiber collimators of series 60FC-Q have an integrated quarter wave plate which can be rotated. The degree of left or right polarization is set with the polarization analyzer. Full rotation of the quarter wave plate produces a figure-of-eight on the Poincaré sphere.

The Polarization Analyzer SK010PA-... is a universal measurement and test system for free beam applications and polarization-maintaining fiber optics. It determines, e.g., the state of polarization (SOP) with all four Stokes parameters, the degree of polarization (DOP), and the ellipticity of the beam. The polarization state is displayed online on a Poincaré sphere and as a polarization ellipse.

The polarization analyzer connects to a USB 2.0 port of a standard computer. It does not need an additional power supply.

Sample applications are

- Laser beam coupling to polarization maintaining singlemode fibers **1 + 2**
- Free beam measurements **3**
- Adjustment and evaluation of quarter-wave plates **4**.

Polarizationsanalyzer Series SK010PA-...

Multiple Wavelength Ranges 370 – 1600 nm
• Interface: USB 2.0 • Power supply via USB

UV	375 – 450 nm
UVIS	400 – 700 nm
VIS	450 – 800 nm
NIR	700 – 1100 nm
IR	1100 – 1600 nm

The **polarization analyzer series SK010PA-...** is a comprehensive universal measurement and test system for free beam applications and laser beam sources with polarization-maintaining fiber optics. It was developed for ease of use by experts in the field.

- USB 2.0-powered device
- Compatible with microbench for free beam applications, FC-APC adapter included for fiber applications
- Determination of the state of polarization (SOP), with all four Stokes parameters, degree of polarization (DOP), ellipticity, etc.
- Display of the SOP on Poincaré sphere or as polarization ellipse
- Special routines for PM fiber evaluation and alignment

The polarization analyzer is a plug&play device and connects to the USB port of a standard computer. The compact design of SK010PA, with the communication and power supply via USB 2.0, enables its easy integration within existing systems. Alignments and measurements are

performed rapidly. A real-time interactive display shows the state of polarization and the oscillating axis of the linearly polarized fraction, as well as the orientation of the connector key index when a fiber cable is attached.

The radiation coupled to the polarization analyzer is collimated, passed through a rotary quarter-wave plate and polarizer before being recorded by a photodetector. The software SKPolarization Analyzer evaluates the components of the Stokes Vector and displays them as points on the Poincaré Sphere and as a Polarization Ellipse.

The standard delivery includes the polarization analyzer, compatible with the microbench system as well as a fiber adapter for FC-APC connectors. Other connector adapters (FC-PC, DIN-AVIO, F-SMA, SMA-905 High Power 5°/8°, E2000) and/or microbench adapters for different diameter optics (12, 25, 32, 45 and 55 mm) can also be supplied.

Application:
RGBV
PM-Fiber with
End Caps

RGBV
PM Fibers
with end caps
Reduced power density
at fiber end-face
(factor 100)

Spectral range: 633, 561, 488, 405

Standard
fiber

RGBV
PM-Fiber
with
End Caps

Application:
Laser Beam Coupling and
PM Fiber Evaluation

1 Fiber Output Connector
• Measurement of Connector
Key Alignment

Application:

2 Fiber Input Connector
• Alignment of incoming polarization
• Measurement of resulting Polarization Extinction Ratio

4 Application:
Adjustment and Evaluation
of Quarter-Wave Plates

Adjustment of Quarter-Wave Plates
Adjustment of left-handed and right-handed circular polarization.

- A Polarization Analyzer Series SK010PA-...
- B Adapter for fiber connectors
- C Fiber Connector
- D PM singlemode fiber PMC-...
- E Fiber Collimator 60FC-T-...
- F Laser Beam Source
- G Fiber Collimator 60FC-Q-...

Application RGBV fibers w. End Caps

Fiber end-caps (see pages 15ff) are used at high laser powers or shorter wavelengths to reduce the risk of fiber destruction or fiber photo-contamination. Particular care is required when polarization-maintaining fibers are to be equipped with end-caps. Any mechanical stress induces birefringence and disturbs the polarization maintenance. The Polarization Analyzer SK010PA series provides optimized test and evaluation routines for standard and end-cap fibers. For **RGBV fibers** operated in the full visible spectrum (400-680 nm, see page 20 ff) the type SK010PA-VIS is used.

- Accessories (included):**
- USB cable
 - Adapter for fiber connectors of type FC-APC
 - Adapter for post-mounting**
 - Analysis software: SKPolarimeter for WINDOWS 7, Vista/XP (32/64 Bit)
 - **LabView® DLL** included

Specifications

Type: Polarization Analyzer (Stokes) for fiber and free space applications

Interface: USB 2.0 or 1.1

Power Supply: via USB

Fiber adapter: FC-APC (standard), optional: FC-PC, DIN AVIO, and ST

Free beam diameter: max. 4 mm

Power range: 0.01 – 50 mW

Sampling rate: 15 Hz

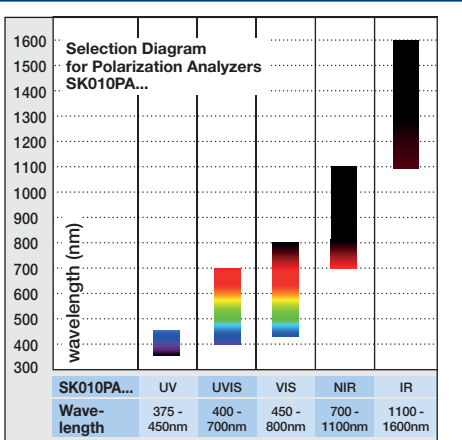
SOP accuracy: ±0.2° on Poincaré sphere

PER accuracy: 0.5 dB

DOP accuracy: 5%

Warm-up time: 5 min

Housing: 40x70x82 mm (WxLxH)



Order options for Polarization Analyzer Series SK010PA-...

Order Code	SK010PA - VIS	Wavelength range:
		UV 375 – 450 nm
		UVIS 400 – 700 nm
		VIS 450 – 800 nm
		NIR 700 – 1100 nm
		IR 1100 – 1600 nm

Software applications: PM fiber alignment

PM fiber adjustment with coherent sources

The polarization extinction ratio PER of fiber-coupled radiation is the ratio of the optical power coupled to the two main axes of a polarization-maintaining fiber. The polarization analyser is used to optimize the coupling alignment of polarization-maintaining fibers.

A When linearly polarized radiation is not coupled exactly to one of the fiber polarization axes, the actual state of polarization fluctuates with temperature and with physical displacement of the fiber.

The measured states of polarization are mapped as a circle on the Poincaré sphere. The center of this circle represents the mean extinction ratio for the particular alignment. For an ideal linear birefringent fiber, the center is on the equator of the sphere. The circle of data points farthest away from the equator represents the lowest extinction ratio that can occur with this particular alignment.

The radius of the circle is a measure of the misalignment angle of the fiber, with smaller radii indicating an improvement in the coupling alignment of the PM fiber. For perfect coupling of linear polarized radiation to one of the main axes of a polarization-maintaining linear birefringent fiber, the circle converges to a single point located on the equator of the Poincaré sphere.

In the software modus PER, a series of measurements are performed and the data logged. For the modulation of the polarization state, the fiber is stressed either by mechanical displacement or heating, which generates a circular cloud of data points on the Poincaré sphere. After acquisition, the data is automatically fitted to a circle.

The aim of the subsequent adjustments is to encourage the convergence of these data points to the center of this circle, by rotating the linear input state of polarization with respect to the fiber main axes.

As an additional aid, the reciprocal distance from the center is displayed continuously by means of a red->green bar plot with either a linear or a logarithmic scale.

B A second measurement of the extinction ratio has been performed.

This reduced radius indicates that the fluctuation of the current state of polarization is reduced.

For the final PER measurement, the mean and minimum PER values are displayed on the linear or logarithmic bar plot.

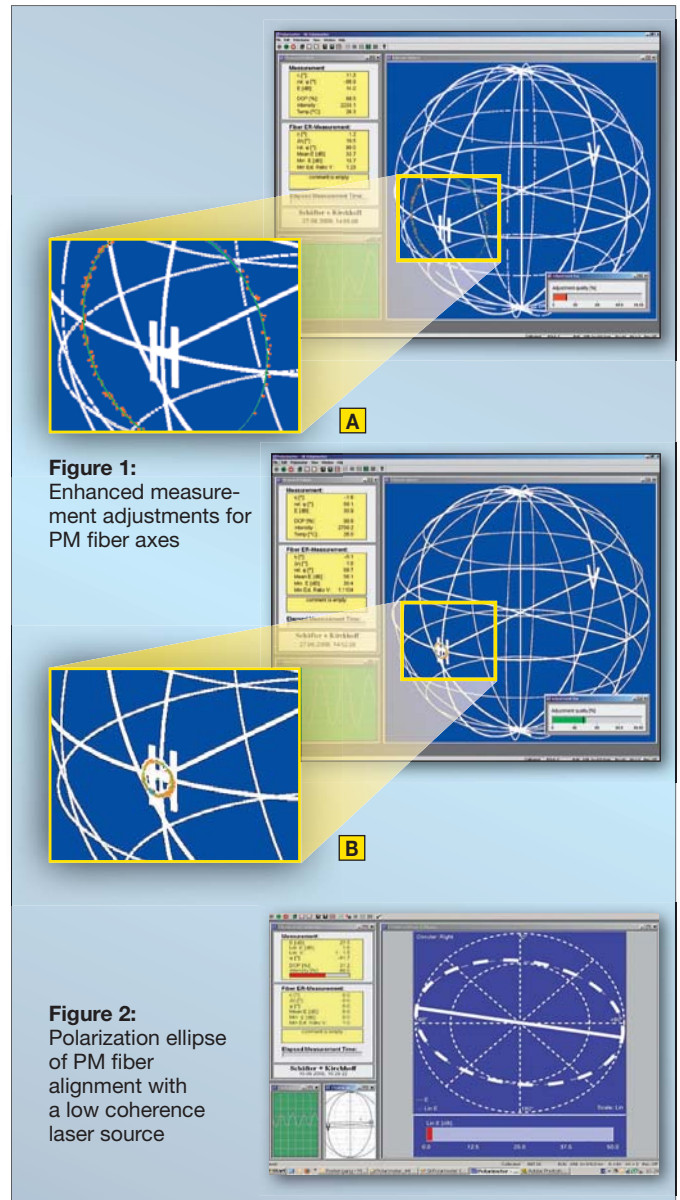


Figure 1: Enhanced measurement adjustments for PM fiber axes

Figure 2: Polarization ellipse of PM fiber alignment with a low coherence laser source

PM fiber adjustment with low coherent sources

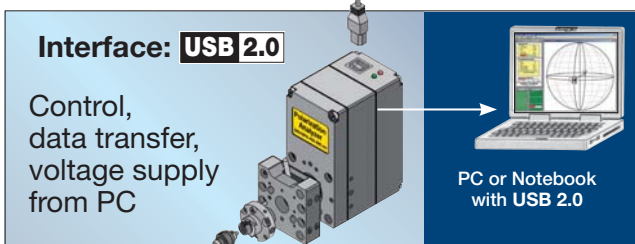
The described PER measurement procedure only applies to a coherent laser source with a degree of polarization close to 100%.

For low coherence sources, the light not coupled to the main axis of the fiber contributes to the unpolarized light, which produces an extinction ellipse, see figure 2.

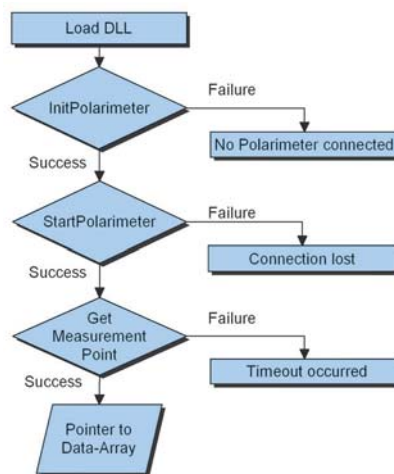
For each measured degree of polarization lower than 80%, an additional dotted polarization ellipse depicts the ratio between linearly polarized light and the sum of circular and unpolarized light. The dotted ellipse becomes smaller for improved alignments between the fiber axes and the linearly polarized fraction of the light.

Analysis Software SKPolarimeter

- Polarization extinction ratio (PER) measurement
- Adjustment support for PM fiber coupling of high and low coherent sources
- Measurement results can be logged and saved
- Log file of measurements over a designated time
- Calibration of polarization zero phase and resetting to the original factory settings
- Integration of the polarimeter in customizable software with LabVIEW VI-library and DLL



External programming



Only three functions are needed from the SKPolarimeter DLL when integrating the Polarization Analyzer into a customized software application.

The initialization step is performed by calling the DLL, although earlier settings from previous measurements can also be kept. Continuous measurement by the polarization analyzer is started using the next function. Only one function call is required to obtain a measurement point from the constant stream of data produced by the polarization analyzer.

There is no restriction on the inclusion of any of the SKPolarimeter software features in a software project produced by or for a customer. This applies to all dialog boxes for the input of different parameters, all graphical displays and the measurement of the extinction ratio of the polarization-maintaining singlemode fibers.

Polarization Analyzer Series SK010PA

PolarizationAnalyzer_FiberOpt_12-2015.indd • Page 73

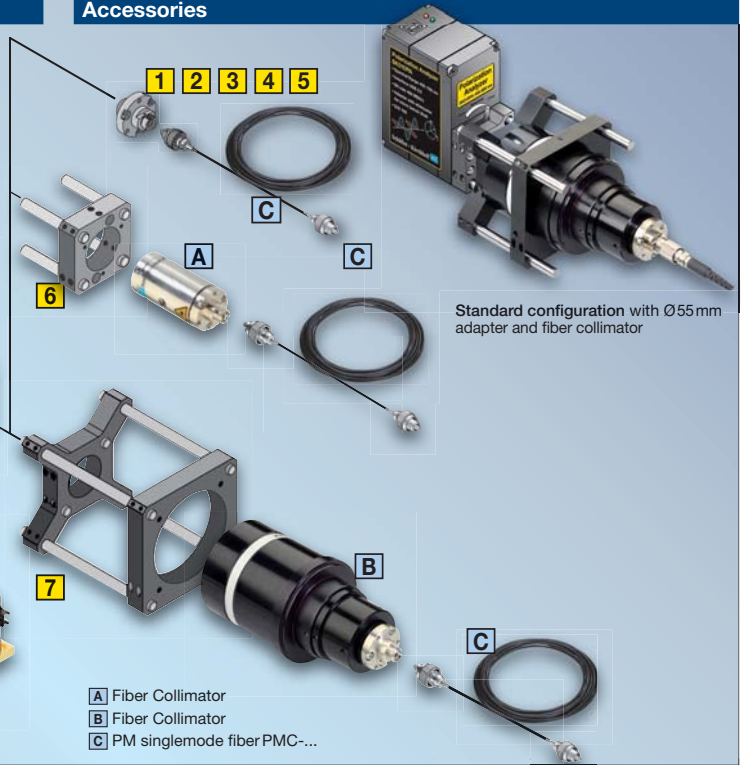
Configurations



Standard configuration with Ø12 mm fiber collimator

Application: Measurement of laser beam polarization in a free beam setup

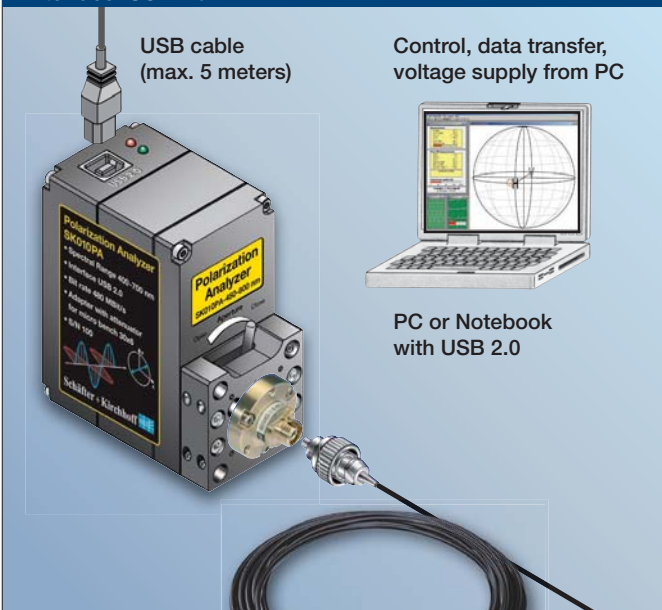
Accessories



A Fiber Collimator
B Fiber Collimator
C PM singlemode fiber PMC...

Standard configuration with Ø55 mm adapter and fiber collimator

Interface: USB 2.0



USB cable (max. 5 meters)

Control, data transfer, voltage supply from PC

PC or Notebook with USB 2.0

Adapters for fiber connectors

- 1 FC-APC (included with delivery) FC-PC
- 2 DIN-AVIO PC/APC
- 3 High Power SMA 905 5°/8°
- 4 F-SMA
- 5 E2000

Further fiber adapters on request.

Micro bench adapters

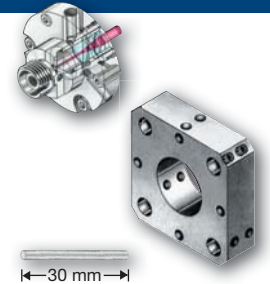
- 6 Adapter for Ø12, Ø25 and Ø32 mm optics incl. 4 Rods
Order Code PA-48MC-12
Order Code PA-48MC-25
Order Code PA-48MC-32
- 7 Adapters for Ø45 and Ø55 mm fiber collimators (Type 60FC-T... or 60FC-L..., page 36ff) incl. 8 Rods
Order Code PA-48MC-45
Order Code PA-48MC-55

Attachments

Adapter for different fiber connectors (see below)

Adapter plate For attaching beam optical components with Ø 19.5 mm system mount or with Ø 25 mm compatible with microbench systems
Order Code 48MC-MP-19.5 Ø 19.5 mm
48MC-MP-25 Ø 25 mm
Further adapters incl. rods, see page 62f

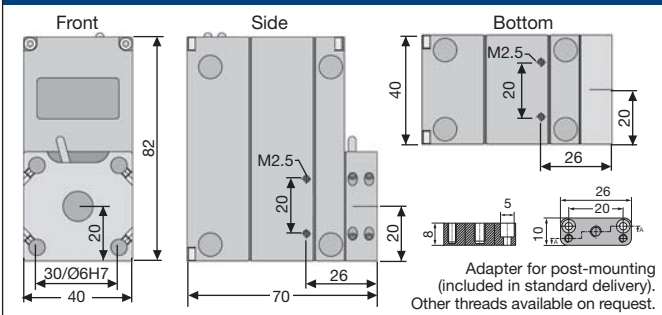
Rod for mounting to microbench system
Order Code 48MC-6-30



Order options for Polarization Analyzer Serie SK010PA-...

Order Code	SK010PA - VIS	Wavelength range:
		UV 370 – 450 nm
		UVIS 400 – 700 nm
		VIS 450 – 800 nm
		NIR 700 – 1100 nm
		IR 1100 – 1600 nm

Dimensions



Adapter without optics

Adapter without optics PA - FC-4

Order Code

- Connector Type:
FC-4 (FC-APC, inclined coupling axis)
FC-0 (FC-PC)
AVIM-4 (inclined coupling axis)
AVIM-0
SMA-4 (High Power SMA-905, 8°)
SMA-23 (High Power SMA-905, 5°)
F-SMA-0
E2000-4 (inclined coupling axis)
E2000-0

Adapter with optics

- Adapter with optics PA - FC-4 - A6.2S - 02
Connector Type:
FC-4 (FC-APC, inclined coupling axis)
FC-0 (FC-PC)
AVIM-4 (inclined coupling axis)
AVIM-0
SMA-4 (High Power SMA-905 8°)
SMA-23 High Power SMA-905 5°)
F-SMA-0
E2000-4 (inclined coupling axis)
E2000-0

Order Code

- Wavelength range:
01 370 – 600 nm
02 600 – 1050 nm
03 1050 – 1550 nm
Collimating optics:
A6.2S f' = 6.2 mm
A11 f' = 11 mm