Product Catalogue

OPTON LASER | WWW.OPTONLASER.COM

01 69 41 04 05

contact@optonlaser.com

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1. Fiberized Receivers

1.1. Quartet

The Quartet is based on our Multi-Channel Random Quadrature technology (MCRQ) which takes advantage of the scattering effect of less-than-mirrorlike surfaces to collect many speckles. It features **two detector arrays**. The mixed beam (result of the reference and sample beams interfering in the optical fiber) travels through a first polarization beam splitter, which directs the vertically polarized components onto a first detector array. The rest of the beam passes through a Faraday rotator, halfwave plate, and a second polarization beam splitter--the combination serving as an optical isolator--before being directed onto the second detector array as the vertically polarized component. (See appendix for a schematic of the optical layout)

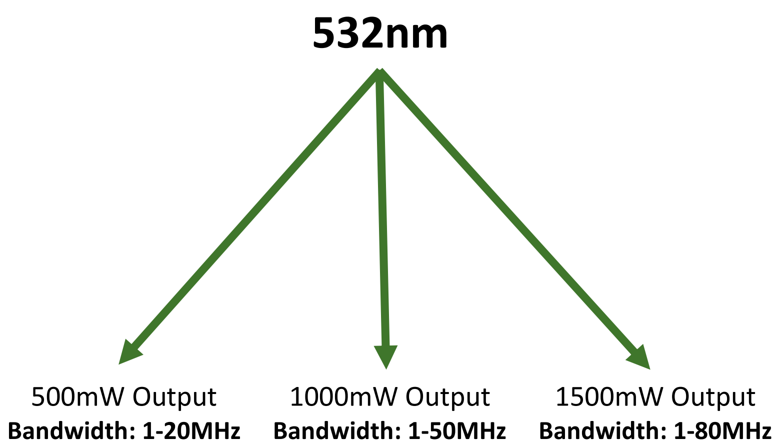
A Quartet can be fitted with an internal laser power of up to 3W, making it **well suited for industrial R&D**. More laser power means a **high bandwidth, up to 100MHz**.

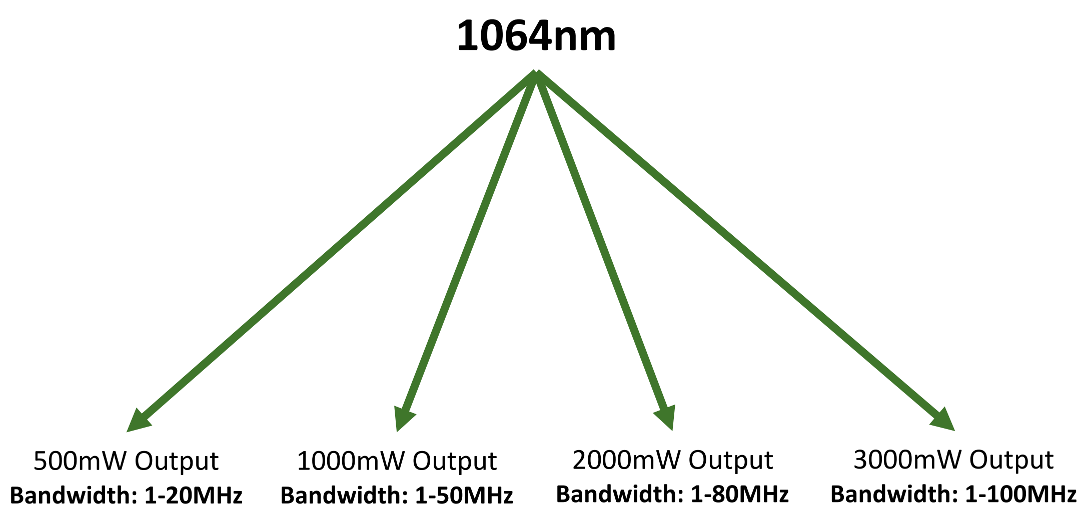
Figure 1: Quartet

Wavelength and Bandwidth Options

For inspection on metals, the 532nm wavelength exhibits the highest interference sensitivity.

On the other hand, carbon-fiber composites, non-metallic materials, and dark colored materials reflect the 1064nmn infra-red wavelength better, and so it is recommended for such applications.





Demodulation Options

MCRQ can be fitted with **two possible demodulation schemes**, a rectified demodulation, and a linear demodulation. Rectified demodulation rejects background noise allowing for single shot measurements on fast-moving objects, but the information on the direction of displacement is lost. Linear demodulation involves a logic control which detects the signal phase by monitoring the pilot signal. Depending on whether the signal is in-phase or out-of-phase, the logic switches between the two, summing amplifiers to add the appropriate signals constructively. The low-frequency signal is separated from the high-frequency signal and used to switch the summation logic circuit based on the low-frequency sign. In this way, the displacement direction of the signal is accurately recovered. (See appendix for a schematic)

Linear	Or	**Rectified**	Or	**Dual**
Bandwidth: as listed above No additional cost.		**Bandwidth: Limited to 20MHz** No additional Cost		**Both Linear and Rectified**

Quartet Beam Chopper (Add-on Option)

The Quartet Beam Chopper add-on consists of a top cover into which is built a synchronized laser beam chopper. The chopper serves to effectively “chop” the probe beam into bursts in order to prevent continuous laser exposure of sensitive workpiece materials. Fitted with the chopper the Quartet can be operated in two different modes: Chopper and CW beam (Continues Wave) modes.

Single Slotted Wheel	**Double Slotted Wheel**
Frequency Range 2-100Hz	**Frequency 4-200Hz**

Figure 2: Quartet with Beam Chopper

1.2. Modulo Uno

The Modulo features a **streamlined version of MCRQ technology**. The mixed beam is directed straight onto a **single detector array** which collects both the vertically and horizontally polarized components. The noise equivalent surface displacement (NESD) is similar to that of its big brother, the Quartet, but because the probe beam does not need to be split in half, the Modulo can operate using a lower laser power output. This more recent design makes the instrument not only **less expensive** to build but ideal for testing on sensitive materials such as biological tissue as prolonged laser exposure is not prohibitive (and the instrument still collects a large number of speckles / is optimized for less-than-mirrorlike surfaces). (See appendix for a schematic of the optical layout)

This new model also features a **digital output** in addition to the standard analogue output, meaning it can be plugged straight into a computer using an ethernet cable (Output Rate 1Gbit/s). It has an 8bit resolution and 125 Ms/s sampling rate. The digital out and its software makes the instrument easier to use and eliminates the need for an acquisition care or oscilloscope.

Figure 3: Modulo Uno

Wavelength Options:

532nm	1064nm	Modulo Uno Skin 1064nm
100mW Output **Bandwidth: up to 20MHz**	100mW Output **Bandwidth: up to 20MHz**	30mW Output **Bandwidth: up to 15MHz Skin safe with Maximum Permissible Exposure (MPE) of 1W/cm^2**

Note: In the Modulo Uno the outgoing beam can be limited to suit application requiring low-beam power, as in the Skin version.

Demodulation Options

MCRQ can be fitted with **two possible demodulation schemes**, a rectified demodulation, and a linear demodulation. Rectified demodulation rejects background noise allowing for single shot measurements on fast-moving objects, but the information on the direction of displacement is lost. Linear demodulation involves a logic control which detects the signal phase by monitoring the pilot signal. Depending on whether the signal is in-phase or out-of-phase, the logic switches between the two, summing amplifiers to add the appropriate signals constructively. The low-frequency signal is separated from the high-frequency signal and used to switch the summation logic circuit based on the low-frequency sign. In this way, the displacement direction of the signal is accurately recovered. (See appendix for a schematic)

Linear	Or	Rectified	Or	Dual
Bandwidth: as listed above No additional cost.		**Bandwidth: Limited to 20MHz** No additional Cost		**Both Linear and Rectified**

1.3. Optical Fibers

MCRQ takes advantage of a naturally occurring partial reflection at the fiber output interface (about 4-5%) to create the interferences necessary for interferometry. Because the interferences are not dependent on the length of the fiber, **there are no limitations for the distance between the optical head and the demodulator**. Optical fibers can be made as long or as short as necessary. Greater than standard lengths will result in additional costs.

Quartet Standard Fiber Length: 5 meters.

Modulo Standard Fiber Length: 2 meters.

We offer two standard and one non-standard option for optical fiber housing.

Standard Options (included in purchase price)

- Crush Resistant **Plastic Housing**

- Highly flexible **Mesh Housing**

Non-Standard Option (additional cost)

- Industrial **Steel Housing**

1.4. Optical Heads

Our fiberized receivers come with one of two standard optical heads. We can also build customized heads to suit specific applications.

Standard Options (included in purchase price):

In the graph below, **stand-off distance** corresponds to the distance between the sample and the front of the Optical Head (the front edge of the lens sleeve). The **stand-off position** is a function of the focal length selected **[A]** and the focus adjustment **[B]**. Both the Modulo and Quartet are optimized for a highly speckled signal beam. Examples of stand-off distances with corresponding **spot sizes** (of the beam on the sample surface) are given in the table below. For exact stand-off distance values, check the provided Datasheet.

* Stand-off distance is measured from the front of the lens mount.

Note: The focus position corresponds to the greatest speckle size scattered back from the workpiece.

Large collection Optical Head - 2” Aperture

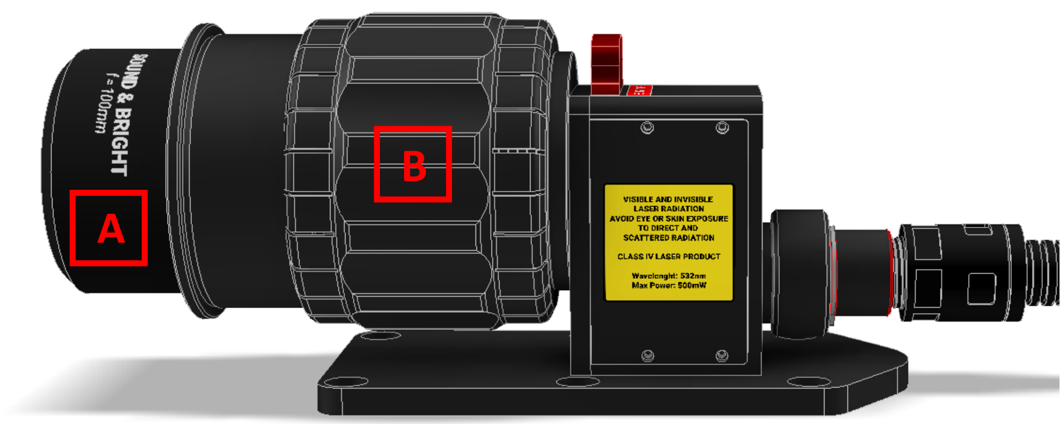


Figure 4: 2" Aperture Optical Head

[A]	[B]
Focusing lens (F=100, 200 or 500mm)	Manually adjustable focus (20mm travel range)

Focusing Lens	Stand-off distance* (mm)	Nominal spot size (µm)
F=100mm	80 – 105	50
F=200mm	175 – 311	100
F=500mm	460 – >4000	250

High-Definition Optical Head - 1” Aperture

Figure 5: 1" Aperture Optical Head

[A]	[B]
Focusing lens (F=30, 50, 100 or 200mm)	Manually adjustable focus (11mm travel range)

Focusing Lens	Stand-off distance* (mm)	Nominal spot size (µm)
F=30mm	20 – 25	9
F=50mm	40 – 50	15
F=100mm	95 – 120	30
F=200mm	190 – 250	52

Custom Options (may require development costs):

Below is an example of a custom-built miniature optical head with a ½” aperture, intended for scans in tight spaces.

Ultra-compact Optical Head - ½” Aperture

Figure 6: 1/2" Aperture Optical Head

Focusing Lens	Stand-off distance* (mm)	Depth of Focus (mm)
F=19mm	15	1.5
F=25mm	21	2.7
F=30mm	28	3.5
F=50mm	50	8

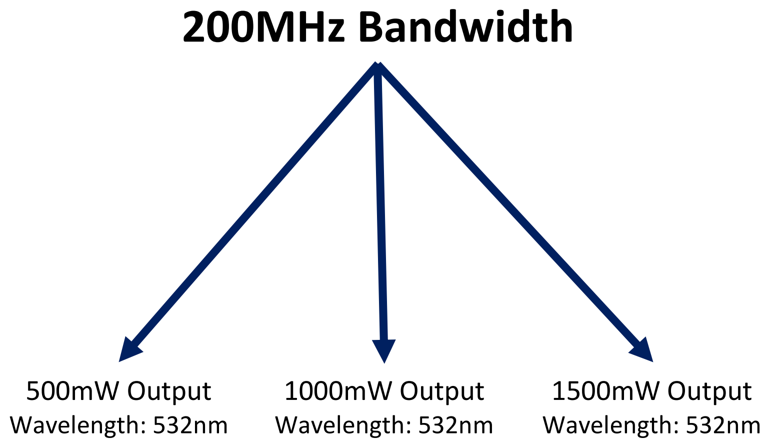
2. Tempo Receivers

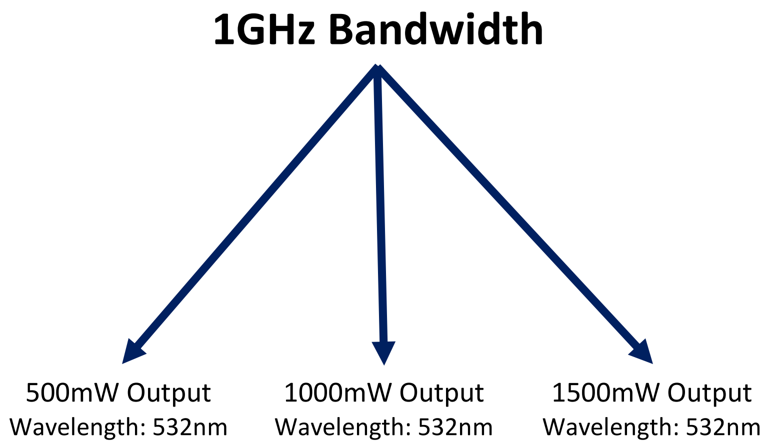
2.1. Tempo 1D

The Tempo 1D is an ultra-high frequency (UHF) laser interferometer. With adaptive reference beam interferometry and a detection scheme based on two-wave mixing in a photorefractive crystal, it can detect surface displacements of up to 1GHz. A piezoelectric mirror is used to provide an internal source of surface displacement for alignment and calibration while a detector produces a time-varying analog voltage that is proportional to the instantaneous surface displacement at ultrasonic frequencies. Like our fiberized receivers, it is optimized to process highly speckled beams. The Tempo 1D measures the out-of-plane component.

Figure 7: Tempo 1D

Wavelength and Bandwidth Options





2.2. Tempo 2D

The 2D is capable of simultaneously measuring two components of the surface displacement—the out-of-plane and in-plane motions—using a single laser probe and a single collecting optic. The detection of the in-plane component allows for efficient detection of shear waves, particularly when the direction of ultrasounds propagation is normal to the surface of inspection. The optical setup is based on the TEMPO 1D but with a customized linear array photo-detector capable of detecting both the in-plane and out-of-plane contributions of the surface displacement. The system is capable of reconstructing the complete ultrasonic field.

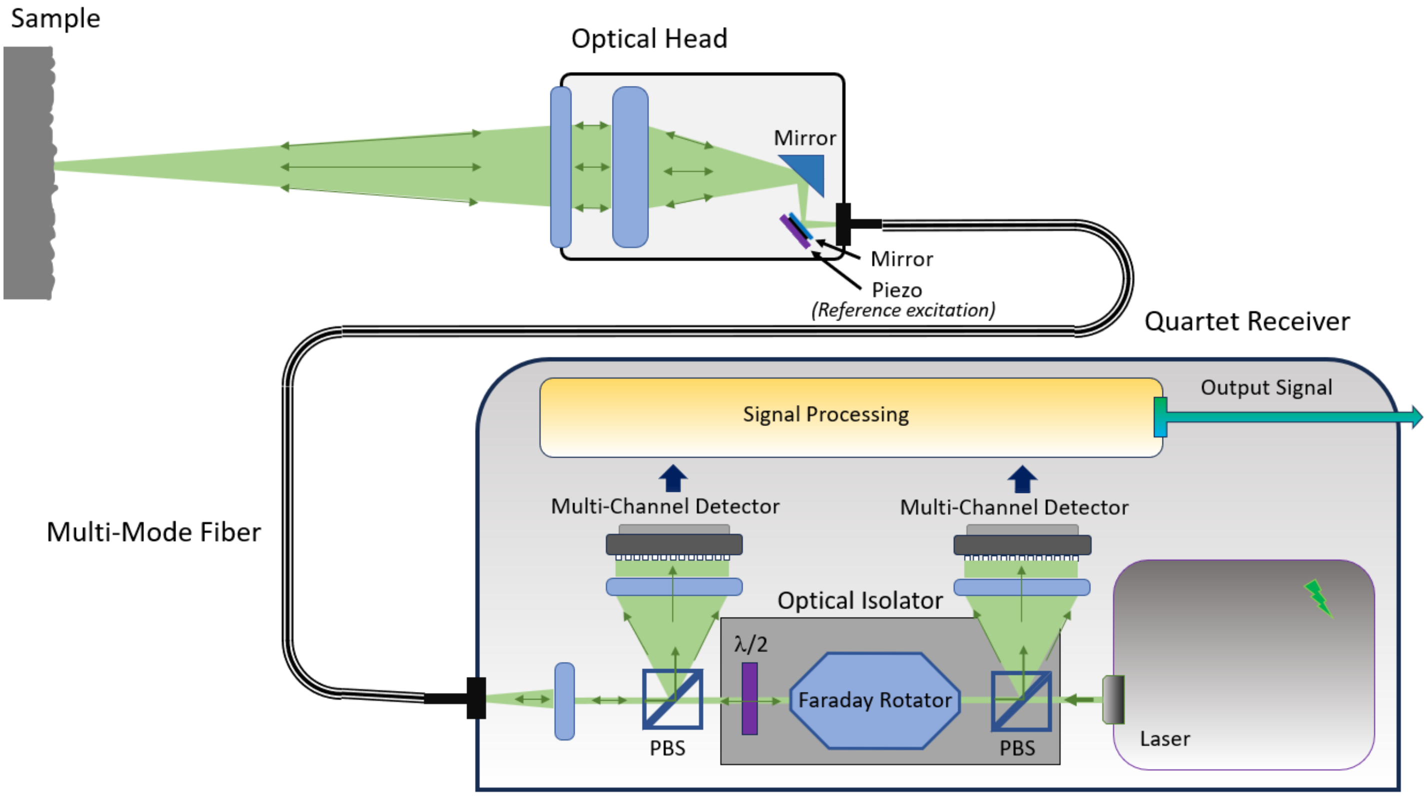
Figure 8: Tempo 2D

Wavelength and Bandwidth

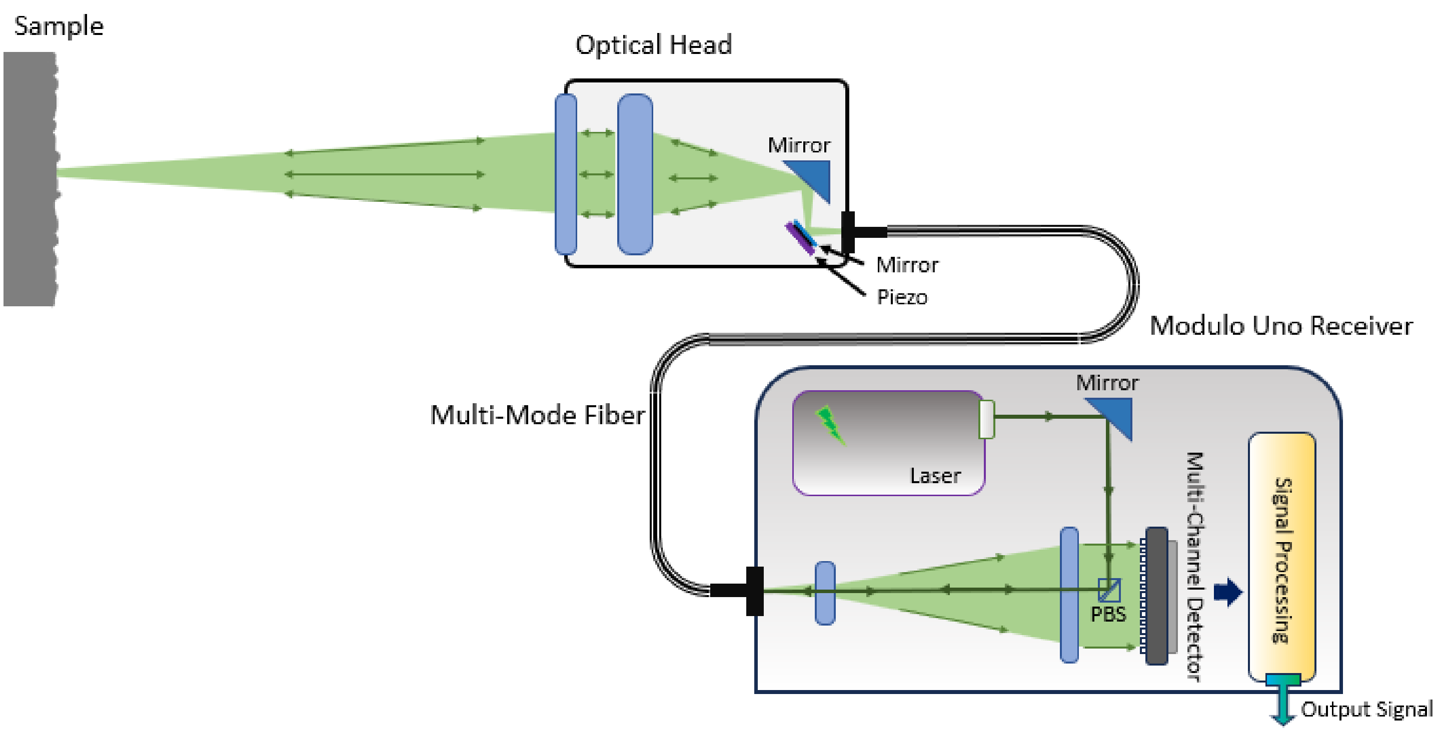
20MHz Bandwidth → 500mW Output
Wavelength: 532nm

3. Technology Appendix

3.1. Quartet

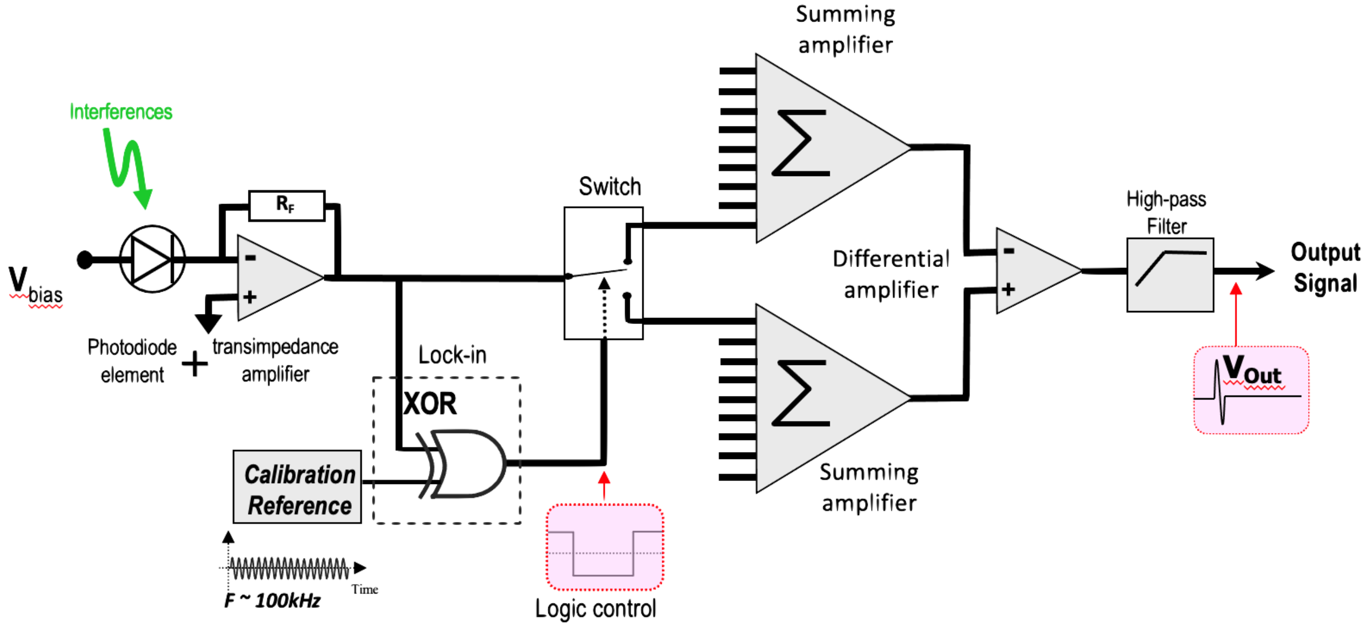


3.2. Modulo Uno



3.3. Demodulation Schemes for Fiberized Interferometers

Linear Demodulation



Rectified Demodulation