Electronic Instruments for the Life Sciences

made to measure

SHORT DESCRIPTION FOR THE

FOM-III

FIBEROPTOMETER

With 470 nm and 565 nm LEDs
And built-in lowpass filter with gain and offset control

Version 1.1
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1. Safety Regulations

<u>VERY IMPORTANT</u>: Instruments and components supplied by npi electronic are NOT intended for clinical use or medical purposes (e.g. for diagnosis or treatment of humans), or for any other life-supporting system. npi electronic expressively disclaims any warranties for such purpose. Equipment supplied by npi electronic shall be operated only by selected, trained and adequately instructed personnel. For details please consult the GENERAL TERMS OF DELIVERY AND CONDITIONS OF BUSINESS of npi electronic, D-71732 Tamm, Germany.

1) GENERAL: This system is designed for use in scientific laboratories and should be operated by trained staff only. General safety regulations for operating electrical devices are to be considered.

2) AC MAINS CONNECTION: While working with the npi systems, always adhere to the appropriate safety measures for handling electronic devices. Before using any device please read manuals and instructions carefully.
The device is to be operated only at 115/230 Volt 60/50 Hz AC. Please check for appropriate line voltage before connecting any system to mains.
Always use a three-wire line cord and a mains power-plug with a protection contact connected to ground (protective earth).
Before opening the cabinet disconnect mains power-plug.
Disconnect mains power-plug when replacing the fuse or changing line voltage. Replace fuse only with an appropriate specified type.

3) STATIC ELECTRICITY: Electronic equipment is sensitive to static discharges. Some devices such as sensor inputs are equipped with very sensitive FET amplifiers, which can be damaged by electrostatic charge and must therefore be handled with care. This can be avoided by touching a grounded metal surface when changing or adjusting sensors. **Always turn power off when adding or removing modules, connecting or disconnecting sensors, headstages or other components from the instrument or 19” cabinet.**

4) TEMPERATURE DRIFT / WARM-UP TIME: All analog electronic systems are sensitive to temperature changes. Therefore, all electronic instruments containing analog circuits should be used only in a warmed-up condition (i.e. after internal temperature has reached steady-state values). In most cases a warm-up period of 20-30 minutes is sufficient.

5) HANDLING: Please protect the device from moisture, heat, radiation and aggressive chemicals.

6) **SPECIAL WARNING:** THIS INSTRUMENT HAS A HIGH POWER OPTICAL OUTPUT.

2. Special Safety Notice for Instruments with high optical irradiation

HIGH OPTICAL IRRADIATION!
RISK TO EYES AND SKIN!

Observe extreme caution when working with this instrument!

1) Always attach the provided plug to the fiber output, if the fiber is not connected.

2) Collimated light emitted from the unit does pose a potential risk to eyes and skin if viewed directly or skin is left exposed to the light.

3) Protect your eyes and skin from fiber output and collimator output.

4) Do not wear any reflective items like watches or rings when working with the instrument.

5) Servicing should be only done by qualified personnel aware of the hazards!

6) If in doubt, return to supplier for servicing!

3. System Description

3.1. General description

The FiberOptoMeter FOM-III is built into a desktop housing. It is equipped with an internal power supply.

This FiberOptoMeter can be used for fiber coupled optical stimulation with two different wavelengths and fluorescent recordings in two wavelength bands through the same fiber. The fiber is connected with an SMA connector (FC/PC on request).

There are two independent LED controls on the front panel as well as two outputs of the corresponding detectors. Channel A controls a royal blue LED (470 nm) and channel B controls a lime-green LED (565 nm).

3.2. Modes of operation

The FiberOptoMeter LED channels work independently and can be controlled in three different modes: CONT, TTL and ANALOG. LEDs next to the control elements will light up, to show, which of the inputs and potentiometers is active:

- CONT: the LED of the respective channels is continuously on, the output power is set with the ANALOG 10-turn potentiometers
- TTL: the LED is controlled by the TTL inputs: a TTL HIGH signal switches the LED on. The output power is set with the ANALOG 10-turn potentiometers.
- ANALOG: the LED is controlled by an analog input voltage at the ANALOG IN BNC connector. Input range is 0 … 2 V.
- OFF: The LED is off, independent of any analog or TTL input signal or potentiometer setting.

The output of the internal photodetectors is provided at the OUTPUT BNC connector. Range is 0 … 5 V (Gain = x1). The output signal can be corrected for offsets, amplified and low-pass filtered.

3.3. Front panel elements:

Figure 1: FOM-III front panel view.

POWER ON LED

LED indicating that the FOM-III is switched on.

All front panel elements below are identical for both channels (see Figure 1). Following are the descriptions for channel A.

CHANNEL LED A and B

LED indicating that the respective channel is active i.e. that the mode switch is either in CONT, TTL or ANALOG position. The LED will not light up in OFF mode.

Note: the color of the LED does not correspond to the actual color of the stimulation LED inside the FOM-III housing.

All front panel elements below are identical for both channels (see Figure 1). Following are the descriptions for channel A.

10-turn potentiometer

Potentiometer for control of the LED output power. The red LED next to it indicates that the amplitude is controlled by the potentiometer (only in CONT and TTL mode, see chapter 3.2).

MODE rotary switch

Switch for selecting the mode of operation (see chapter 3.2)

ANALOG IN BNC connector

An analog input signal (0 … 2 V) can be used to control the LED output power. The red LED next to it indicates that this input is active (only in ANALOG mode).

ANALOG IN BNC connector

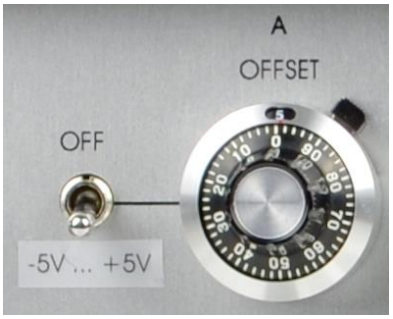
A TTL signal (0 … 5 V) can be used to control the LED on and off switching. The red LED next to it indicates that this input is active (only in TTL mode). The output power is controlled by the 10-turn potentiometer (see above).

DETECTOR OUTPUT BNC connector

The output signal from the detectors is provided at this BNC connector. Range is 0 … 5 V. The green LED next to it indicates that the PMT is ready.

Note: The PMT takes about 30 s upon startup to get into the active state. For recordings, make sure to wait until the LED next to the output lights up.

OFFSET unit



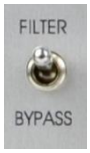
The OFFSET unit consists of OFFSET potentiometer and OFFSET range switch

OFFSET potentiometer
10-turn potentiometer for compensating for a DC OFFSET

OFFSET range switch
2-position switch for selecting the OFFSET range,
-5 V … +5 V, or for setting the OFFSET compensation to OFF

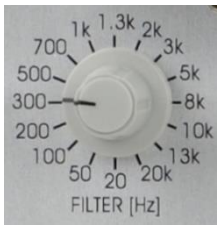
Important: Position 5 of the OFFSET potentiometer corresponds to 0 mV offset in the ±5 V range.

FILTER / BYPASS switch



Switch for bypassing the lowpass Bessel filter

FILTER switch



16-position rotary switch for selecting the corner frequency of the lowpass Bessel FILTER (range: 20 Hz to 20 kHz). The LOWPASS FILTER can be bypassed using the FILTER / BYPASS switch (see above).

GAIN switch

7-position rotary switch for selecting the GAIN factor, x1, x2, x5, x10, x20, x50 or x100.

FILTERED OUTPUT connector

BNC connector that provides the processed signal

FIBER OUT SMA connector

The optical fiber is connected to this SMA port (FC/PC port available on request).

3.4. Rear panel elements:

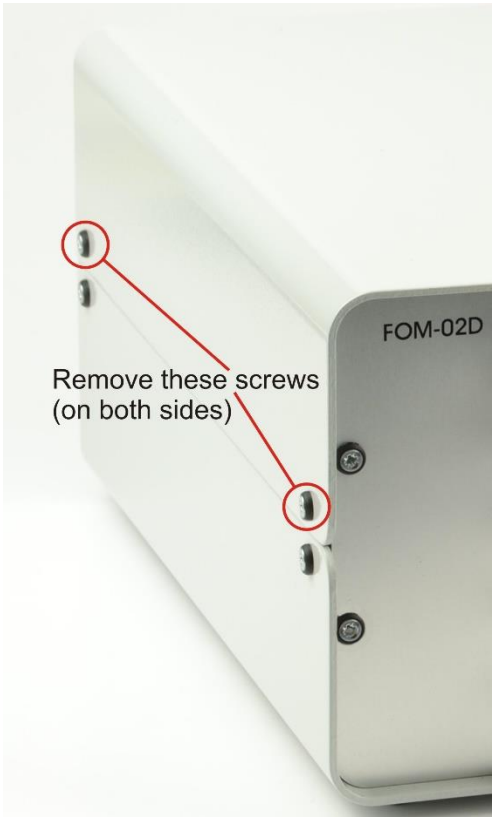
Figure 2: FOM-III rear panel view.

On the rear panel of the FOM-III housing there is a fan outlet, the mains connection, a fuse box, and the power switch (see Figure 2).

4. Exchangeable Filters

Figure 3: Filter cube insert for FOM-III.

This FOM-III is equipped with special filter cubes for easy exchange of filters and dichroics (see Figure 3). The filter cubes consist of an outer frame and a removable inner cube, which is held by magnets. These cubes are self-centering and can be removed and inserted by hand - no tools are required.



To access the cubes, disconnect from mains power, remove the four lid screws (see Figure 4 on the left) using a suitable screwdriver and remove the lid. Afterwards, reinstall the lid and fix it with the four screws.

Figure 4: Lid screws to be removed to open the FOM-III lid.

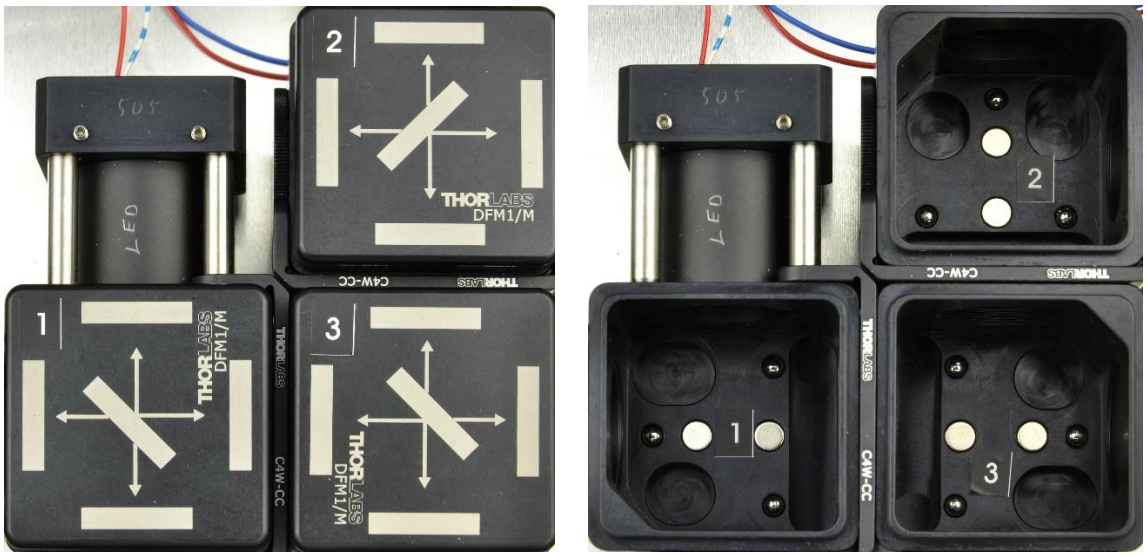


Figure 5: Filter cubes inside the FOM-III housing. Left: inner cubes inserted into frames (note the numbers in the upper left corner of the cubes). Right: inner filter cubes removed (note the numbers on the bottom of each frame).

The inner filter cubes are numbered (1 to 3) and so are the outer frames (see Figure 5, left). Make sure to insert the correct filter cubes into the corresponding frames (see Figure 5, right).

To exchange the filters and dichroics in the inner cubes, please follow the instructions provided by this video:
https://www.youtube.com/watch?v=qWIfiwuL-gQ

Note: A tool kit is provided for exchange of the filters and dichroics. It consists of a hex key, a screw driver, a filter ring fastening tool and cotton gloves. It is highly recommended to wear these gloves while handling the filters to avoid scratches and contamination (e.g. finger prints).

You can find further information on these cubes via the Thorlabs website: search for DFM1/M, there is also the above mentioned video embedded.

Note: To prevent damaged filters during transportation, the FOM-III may be shipped without the filter cubes inserted. These cubes are then packed in a small box which is also part of the shipment.

5. References

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Justus D, Dalügge D, Bothe S. et al.: Glutamatergic synaptic integration of locomotion speed via septoentorhinal projections. **Nat Neurosci.** 2016 Nov 28; 20(1):16-19. doi: 10.1038/nn.4447.

Fuhrmann F, Justus D, Sosulina L, Kaneko H, Beutel T, Friedrichs D, Schoch S, Schwarz MK, Fuhrmann M, Remy S.: Locomotion, Theta Oscillations, and the Speed-Correlated Firing of Hippocampal Neurons Are Controlled by a Medial Septal Glutamatergic Circuit. **Neuron**. 2015 Jun 3; 86(5):1253-64. doi: 10.1016/j.neuron.2015.05.001

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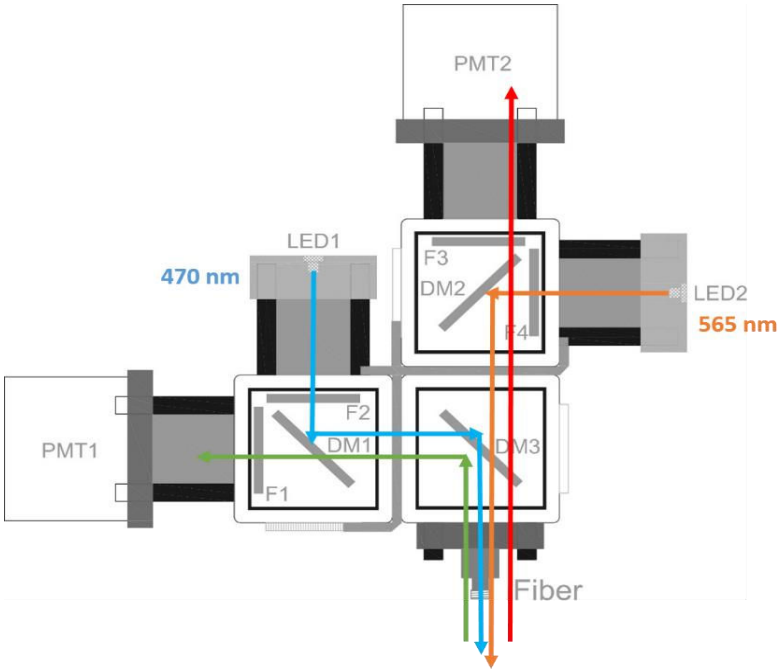
Adelsberger H, Grienberger C, Stroh A, Konnerth A.: In vivo calcium recordings and channelrhodopsin-2 activation through an optical fiber. **Cold Spring Harb Protoc.** 2014 Oct 1; 2014(10):pdb.prot084145. doi: 10.1101/pdb.prot084145.

6. Technical Data



F1: 511/20
F2: 472/30
F3: 609/57
F4: 556/20
DM1: BS 495
DM2: BS 573
DM3: BS 526
LED1: 565nm
LED2: 470nm

Figure 6: Schematic drawing of optical components with description of filter and dichroic wavelengths.

Signal Outputs:

OUTPUT A:	Filter F1: 511/20nm
OUTPUT B:	Filter F3: 609/57nm
OFFSET compensation:	set by ten-turn potentiometer, range ±5V, or OFF, selected by toggle switch,
LOWPASS Filter:	eight pole Bessel filter, attenuation: -48dB/octave, corner frequencies (Hz): 20, 50, 100, 200, 300, 500, 700, 1k, 1,3k, 2k, 3k, 5k, 8k, 10k, 13k, 20k, bypass switch
GAIN:	rotary-switch: 1-2-5-10-20-50-100
Output:	range: ±12V into 1kΩ / ±1V into 50Ω
Dimensions**:**	(WxDxH) 365mm x 260mm x 130mm

Detector characteristics:

Spectral response λ:	320nm - 900nm
Peak sensitivity λ_p:	500nm
Photoelectric sensitivity	0.7×10^9V/W – 1.3×10^9V/W
Cutoff frequency f_c:	DC-4Mhz (-3 dB, sine wave)
Rise time t_r:	5ns (10 % to 90%, 1.p.e)
Minimum detection limit:	0.25pW-0.5pW rms (Dark state)
Noise equivalent power:	0.1fW/√Hz (Dark state)