

OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

EXT 10-2F

EXTRACELLULAR AMPLIFIER / FILTER MODULE FOR EPMS SYSTEMS



VERSION 2.0

npi 2007

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1. Safety Regulations

VERY IMPORTANT: 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 disclaims any warranties for such purpose. Equipment supplied by npi electronic must 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 must be operated by trained staff only. General safety regulations for operating electrical devices should be followed.
- 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, unplug the instrument.
Unplug the instrument 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. Electrostatic discharge 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 corrosive chemicals.

2. EPMS-07 Modular Plug-In System

2.1. Components of the EPMS-07 Housing

The following items are shipped with the EPMS-07 housing:

- ✓ EPMS-07 cabinet
- ✓ Power cord
- ✓ Fuse 0.8 / 0.4A, slow
- ✓ Front covers

2.2. General System Description / Operation

The npf – EPMS-07 is a modular system for processing of bioelectrical signals in electrophysiology (see Figure 1). The system is housed in a 19” rackmount cabinet (3U) containing a power supply and has room for up to 7 plug-in units. The plug-in units are connected to power by a bus at the rear panel.

The plug-in units must be kept in position by four screws (M 2,5 x 10). The screws are important not only for mechanical stability but also for proper electrical connection to the system housing. Free area must be protected with covers.

In order to avoid induction of electromagnetic noise the power supply unit, the power-switch and the fuse are located at the rear of the housing.



Figure 1: Example of a measurement system located in an EPMS housing with two channel iontophoresis and balance module (MVCS-02, MVCC-02), bridge amplifier module (BRAMP-01R) and an extracellular amplifier module (EXT-01C)

2.3. System Grounding

The 19" cabinet is grounded by the power cable through the ground pin of the mains connector (= protective earth, see chapter 1). In order to avoid ground loops the internal ground is isolated from the protective earth. The internal ground is used on the BNC connectors or GROUND plugs of the modules that are inserted into the EPMS-07 housing. The internal ground and mains ground (= protective earth) can be connected by a wire using the ground plugs on the rear panel of the instrument. It is not possible to predict whether measurements will be less or more noisy with the internal ground and mains ground connected. We recommend that you try both arrangements to determine the best configuration.

2.4. Technical Data

- 19" rackmount cabinet, 3U high (1U=1 3/4" = 44.45 mm), for up to 7 plug-in units
- Power supply: 115/230 Volts AC, 60/50 Hz, fuse 0.8/0.4 A slow, 45-60 W

3. EXT 10-2F

3.1. EXT 10-2F Components

The following items are shipped with the EXT 10-2F system:

- ✓ Amplifier module for the EPMS-07 system
- ✓ GND- (2.6 mm banana plug) and REF. (SMB) connectors for headstage
- ✓ Headstage
- ✓ User manual

3.2. System Description

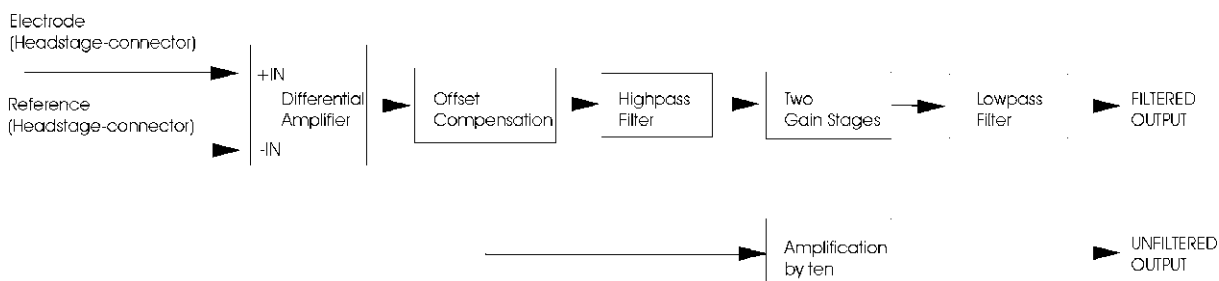
The EXT 10-2F was designed for performing low noise recordings of small extracellular signals in slices or *in vivo* preparations using fine tipped glass or metal microelectrodes. The system consists of a module for the npI EPMS-07 modular system and a small headstage with a holding bar.

The EXT 10-2F has a differential input with high input resistance to avoid noise and the incoming signal can be processed in several ways, optionally including elimination of 50 Hz or 60 Hz noise respectively using a four pole notch filter. The output voltage signal is available either filtered with variable gain (AC) or unfiltered with an amplification factor of ten (DC).

Two LEDs indicate whether the amplifier is running out of its linear range and an analog balance monitor makes the control of offsets easy.

3.3. Signal Flow Diagram

The signal is passed through the EXT 10-2F as shown below.



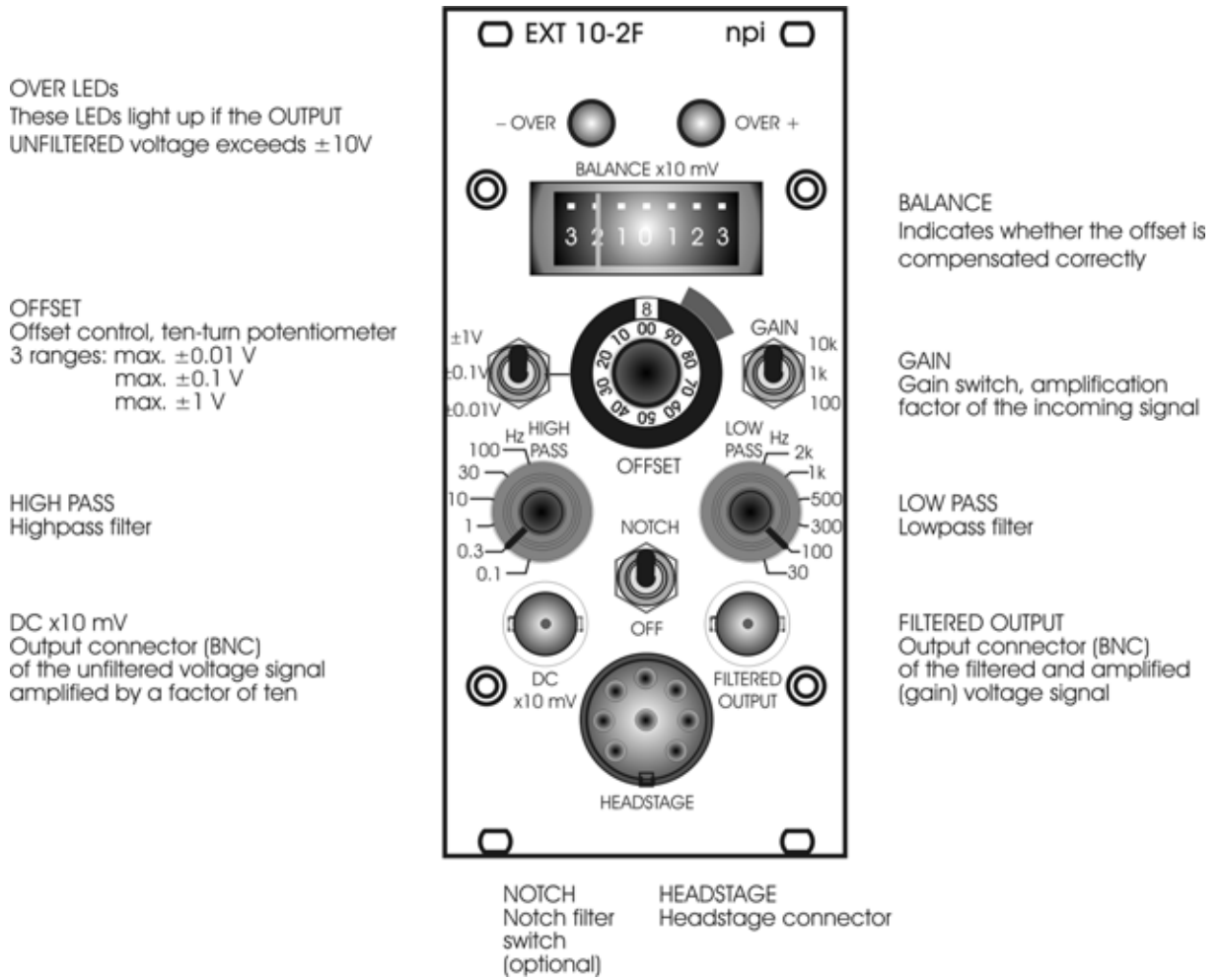


Figure 2: EXT 10-2F front panel view

3.4. *Description of the Front Panel*

HEADSTAGE

The HEADSTAGE cable is connected to the unit at the 8-pin connector in the center of the module.

OUTPUT unit

OUTPUT from the amplifier can be obtained at BNC connector labeled DC x10 mV (ten times magnified) or at the FILTERED OUTPUT BNC connector. The filtered output signal can be conditioned using either the built-in HIGHPASS filter or the built-in LOWPASS filter. A combination of both leads to a filter with bandpass characteristics. The NOTCH switch (**optional**) is used set the NOTCH filter (50 Hz or 60 Hz) or to bypass the NOTCH filter (switch position OFF).

GAIN switch

The GAIN of the filtered output signal is controlled by a 3-position switch that selects gains of 100, 1k or 10k.

OFFSET potentiometer

The OFFSET is controlled by a 10 turn potentiometer and a range selection switch that sets the range to ± 1 V, ± 0.1 V or ± 0.01 V. Note that position 5 corresponds to 0 V offset. The analog BALANCE monitor displays the offset in the range of ± 30 mV and is used for optimal cancellation of the offset.

Important: Position 5 of the OFFSET control corresponds to 0 mV offset.

BALANCE x10mV meter

The analog BALANCE monitor displays the offset in the range of ± 30 mV and is used for optimal cancellation of the OFFSET.

OVERLOAD LEDs

LEDs that indicate if the amplifier 10% below its positive or negative limit (± 10 V). The linear range of the amplifier is ± 12 V.

3.5. Headstage

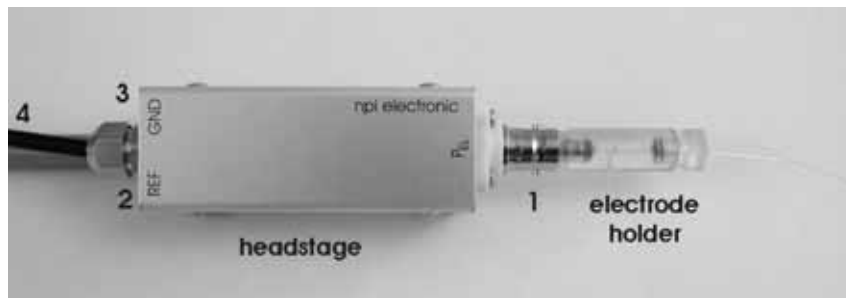


Figure 3: electrode holder (optional) and headstage of the EXT 10-2F

Headstage Elements

- 1 BNC connector for the electrode holder
- 2 REF: not connected
- 3 GND: Ground connector
- 4 holding bar

On request, P_{EL} can be implemented using 1 mm or 2 mm banana jacks or using SMC SUBCLIC connectors.

3.6. Operation

Extracellular measurements are mostly done in slices or *in vivo*, where distortions of the signal caused by other instruments and the animal itself are very common. Additionally, extracellular signals are very small and have to be amplified enormously. The drawback is that noise is amplified as well. Therefore, the headstage of the EXT 10-2F is equipped with a differential input that minimizes noise pick-up. Differential means, that the signal for the amplifier is the difference between the positive (+) (P_{EL}) and negative (-) (REF.) input of the headstage. This results in canceling of all signals which both electrodes record, e.g. noise.

For differential measurements, both inputs of the headstage (REF. and P_{EL}) are connected to microelectrodes using cables with grounded enclosure or electrode holders. P_{EL} is connected to the measuring electrode and REF. to the reference electrode. The experimental chamber is grounded by an Ag-AgCl pellet (or an AGAR bridge) connected to GND of the headstage (see Figure 4).

Important: If differential measurement is not required (single-ended measurement configuration), the REF input must be connected to ground (GND, see Figure 4). The amplifier is in an undefined state, if the REF is left open, and can go into saturation making reliable measurements impossible.

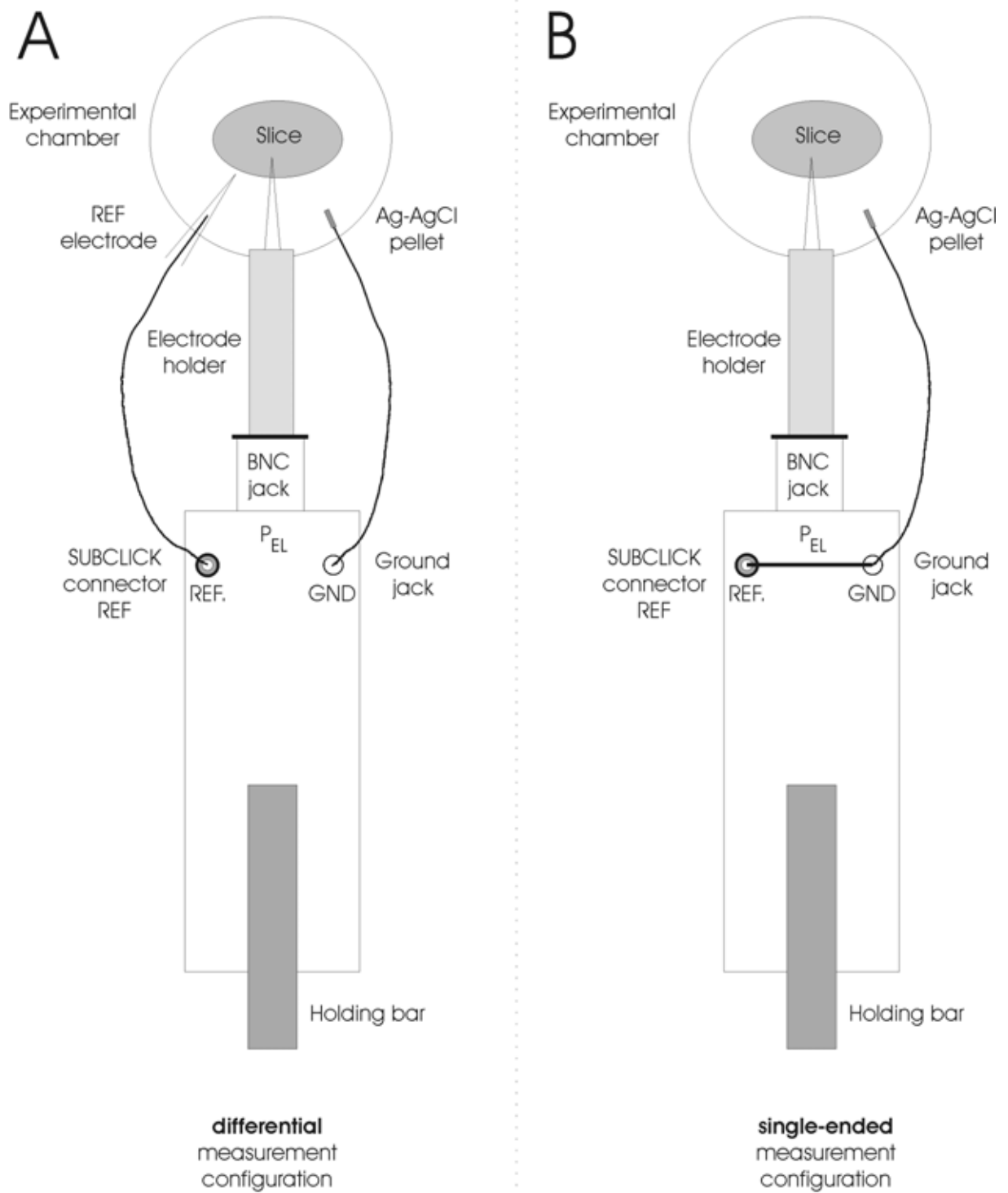


Figure 4: headstage connections, A: differential measurement, B: single-ended measurement

4. Literature

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5. Technical Data

Differential Input:	CMR >90 dB at 1 kHz (tested with 0 Ω input resistance)
Input resistance:	>10 ¹² Ω , range ± 1 V
Output x10mV DC:	gain x10 Output range: ± 12 V into 1 k Ω / ± 1 V into 50 Ω load
Output filtered:	selectable gain (x100, x1k, x10k) Output range: ± 12 V into 1 k Ω / ± 1 V into 50 Ω load corner frequency 10 Hz
Low pass filter:	30, 100, 300, 500, 1k, 2k Hz
High pass filter:	0.1, 0.3, 1, 10, 30, 100 Hz
Offset compensation:	± 1 V switch position, 10 turn potentiometer ± 0.1 V switch position, 10 turn potentiometer ± 0.01 V switch position, 10 turn potentiometer
Potential monitor:	analog display for the electrode offset, range ± 30 mV
Size:	front panel 12 HP (60.6 mm) x 3U (128,5 mm), 7" (175 mm) deep

EPMS-07 SYSTEM

Power Requirements:	115/230 V AC, 60/50 Hz, fuse 0.8/0.4 A, slow, 45-60 W (dependent on the modules plugged in)
Dimensions:	19" rackmount cabinet, 3U high (1U = 1 3/4" = 44.45 mm)