

OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

EXT 10-2F

EXTRACELLULAR AMPLIFIER / FILTER MODULE FOR EPMS SYSTEMS



VERSION 2.9
npi 2020

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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. General System Description / Operation

The npI EPMS-07 is a modular system for processing of bioelectrical signals in electrophysiology. The system is housed in a 19" rack-mount cabinet (3U) 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.

2.2. EPMS-07 Housing

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

- ✓ EPMS-07 cabinet with built-in power supply
- ✓ Mains cord
- ✓ Fuse 2 A / 1 A, slow (inserted)
- ✓ Front covers

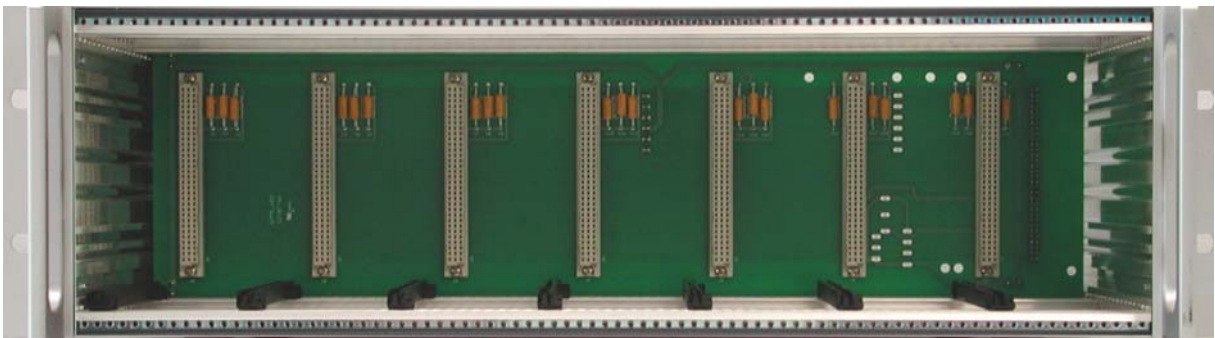


Figure 1: Left: front view of empty EPMS-07 housing.

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 (see Figure 2, right).

2.3. EPMS-H-07 Housing

In addition to the standard power supply of the EPMS-07, the EPMS-H-07 has a built-in high voltage power supply. This is necessary for all MVCS / MVCC modules, the HVA-100, HV-TR150 and HVC-03M modules. The output voltage depends on the modules in use.

2.4. EPMS-E-07 Housing

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

- ✓ EPMS-E-07 cabinet
- ✓ External Power supply PWR-03D
- ✓ Power cord (PWR-03D to EPMS-E-07)
- ✓ Mains chord
- ✓ Fuse 1.6 A / 0.8 A, slow (inserted)
- ✓ Front covers

The EPMS-E-07 housing is designed for low-noise operation, especially for extracellular and multi-channel amplifiers with plugged in filters. It operates with an external power supply to minimize distortions of the signals caused by the power supply.

2.5. EPMS-03

The following items are shipped with the EPMS-03 housing:

- ✓ EPMS-03 cabinet with built-in power supply
- ✓ Mains cord
- ✓ Fuse 034 A / 0,2 A, slow (inserted)
- ✓ Front covers



Figure 2: Left: front view of EPMS-03 housing. Right: rear panel detail of EPMS-03 and EPMS-07 housing.

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 (see Figure 2, right).

2.6. PWR-03D

The external power supply PWR-03D is capable of driving up to 3 EPMS-E housings. Each housing is connected by a 6-pole cable from one of three connectors on the front panel of the PWR-03D to the rear panel of the respective EPMS-E housing. (see Figure 3, Figure 4). A POWER LED indicates that the PWR-03D is powered on (see Figure 3, left). Power switch, voltage selector and fuse are located at the rear panel (see Figure 3, right).

Note: The chassis of the PWR-03D is connected to protective earth, and it provides protective earth to the EPMS-E housing if connected.



Figure 3: Left: PWR-03D front panel view. Right: PWR-03D rear panel view.

Note: This power supply is intended to be used with npi EPMS-E systems only.

2.7. System Grounding

EPMS-07/EPMS-03

The 19" cabinet is grounded by the power cable through the ground pin of the mains connector (= protective earth). 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.

EPMS-E-07



The 19" cabinet is connected to the CHASSIS connector at the rear panel. It can be connected to the SYSTEM GROUND (SIGNAL GROUND) on the rear panel of the instrument (see Figure 4).

The chassis can be linked to PROTECTIVE EARTH by connecting it to the PWR-03D with the supplied 6-pole cable **and** by interconnecting the GROUND and PROTECTIVE EARTH connectors on the rear panel of the PWR-03D (see Figure 3). Best performance is generally achieved without connection of the chassis to protective earth.

Important: Always adhere to the appropriate safety measures.

Figure 4: Rear panel connectors of the EPMS-E-07

2.8. Technical Data

EPMS-07, EPMS-E-07 and EPMS-H-07

19" rackmount cabinet, for up to 7 plug-in units

Dimensions: 3U high (1U=1 3/4" = 44.45 mm), 254 mm deep

EPMS-07 and EPMS-H-07

Power supply: 115/230 V AC, 60/50 Hz, fuse 2 A / 1 A slow, 45-60 W

EPMS-E-07

External power supply (PWR-03D) 115/230 V AC, 60/50 Hz, fuse 1.6/0.8 A, slow

Dimensions of external power supply: (W x D x H) 225 mm x 210 mm x 85 mm

EPMS-03

Power supply: 115/230 Volts AC, 60/50 Hz, fuse 0.4 A / 0.2 A slow

Maximum current supply: 500 mA

Dimensions: 3U high (1U=1 3/4" = 44.45 mm), 254 mm deep, 265 mm wide

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

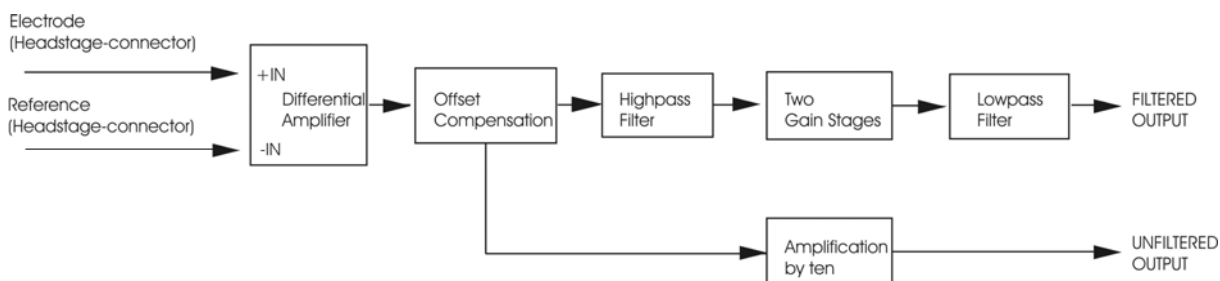
The EXT 10-2F was designed for performing low noise recordings of small extracellular signals in slices or *in vivo* preparations using fine tipped glass or metal microelectrodes. The system consists of a module for the npj EPMS-07 modular system and a small headstage with a holding bar.

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.



3.4. Description of the Front Panel

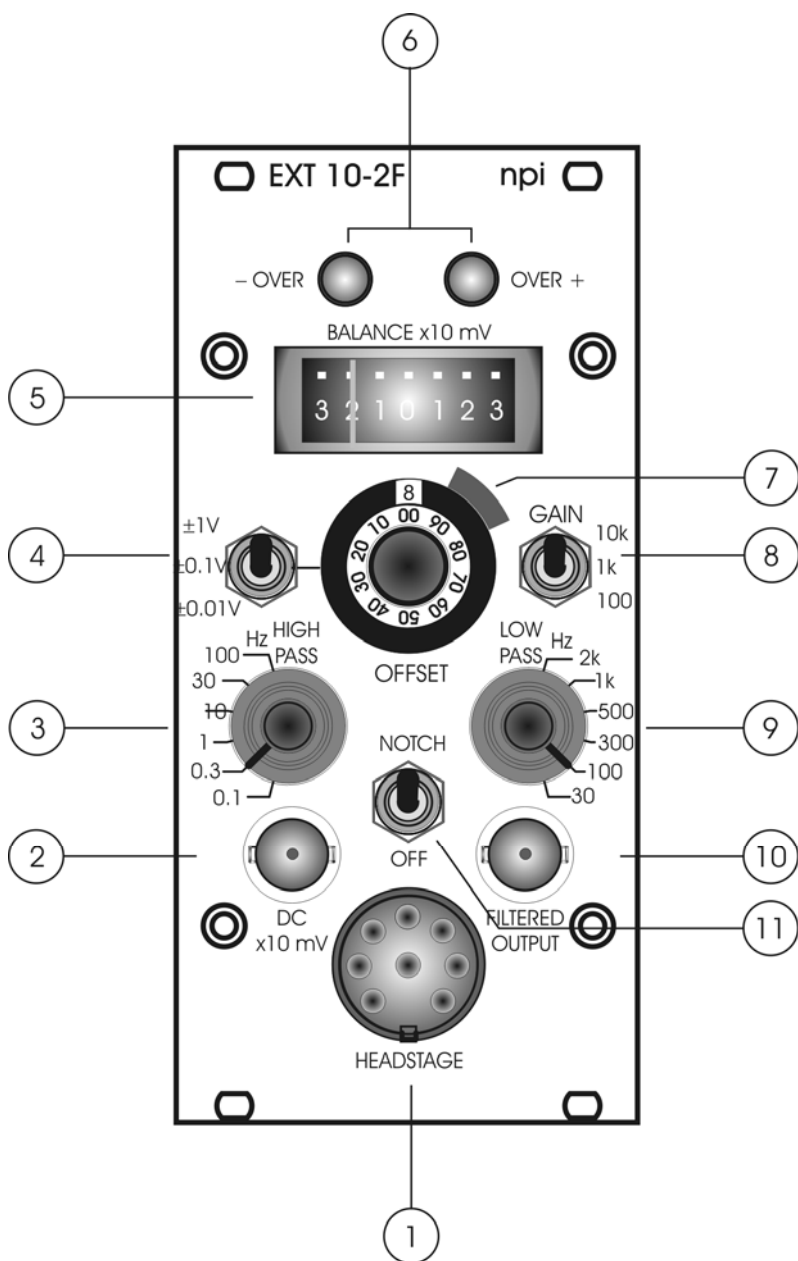


Figure 5: EXT 10-2F front panel view

In the following description of the front panel elements each element has a number that is related to that in Figure 5. The number is followed by the name (in uppercase letters) written on the front panel and the type of the element (in lowercase letters). Then, a short description of the element is given.

(1) HEADSTAGE connector

8-pin connector for connecting the HEADSTAGE.

**(2) DC x10mV connector**

BNC connector providing the amplified (x10) signal DC coupled. The DC OUTPUT is always unfiltered.

**(3) HIGH PASS filter switch**

Rotary switch for setting the corner frequency of the HIGH PASS filter; 0.1, 0.3, 1, 10, 30 or 100 Hz.



Note: A combination of HIGH PASS and LOW PASS filter forms a filter with bandpass characteristics.

(4) $\pm 0.01V$ / $\pm 0.1V$ / $\pm 1V$ switch

3-position switch for selecting the OFFSET range, ± 0.01 V, ± 0.1 V or ± 1 V.

**(5) BALANCE x10mV meter**

Analog BALANCE monitor that displays the OFFSET in the range of ± 30 mV and is used for optimal cancellation of the OFFSET.

**(6) OVER LEDs**

LEDs indicating that the amplifier is 10% below its positive or negative limit (± 10 V).

**(7) OFFSET potentiometer**

10 turn potentiometer for canceling possible OFFSETs. The range is selected by switch # 4. 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.

(8) GAIN switch

3-position switch for selecting the GAIN; 100, 1k or 10k.



(9) LOW PASS filter switch

Rotary switch for setting the corner frequency of the LOW PASS filter; 30, 100, 300, 500, 1k, 2k Hz.

Note: A combination of HIGH PASS and LOW PASS filter forms a filter with bandpass characteristics.

(10) FILTERED OUTPUT connector

BNC connector providing the filtered output signal. The filters can be set by switches #3, #9 and #11.

(11) NOTCH / OFF switch (optional)

Switch for turning the 50 Hz (60 Hz) on (NOTCH position) or off (OFF position).

3.5. Headstage

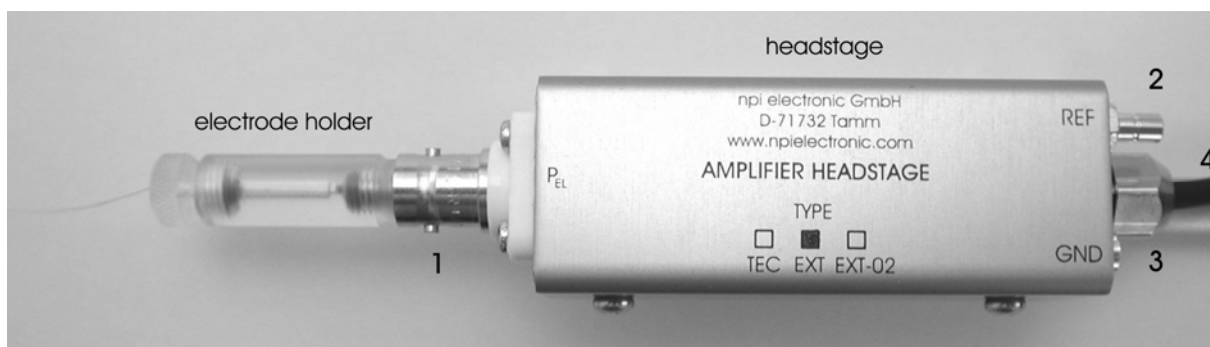


Figure 6: electrode holder (optional) and headstage of the EXT 10-2F

Headstage Elements

- 1 P_{EL} : BNC connector for the electrode holder (measuring electrode)
- 2 REF: SMB connector for the reference electrode
- 3 GND: Ground connector
- 4 Holding bar

On request, P_{EL} can be implemented using 1 m m or 2 m m banana jacks or using SMB connectors.

Very Important: EXT 10-2F headstages are always labeled “EXT” (see Figure 6) and must not be exchanged with headstages from npi electronic’s desktop EXT amplifiers, e.g. the EXT-2F which is labeled “EXT-02”!

Also Important: The shield of the BNC connector of the headstage is connected to driven shield, and must not be connected to ground.

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 7).

Important: If differential measurement is not required (single-ended measurement configuration), the REF input must be connected to ground (GND, see Figure 7). The amplifier is in an undefined state, if the REF is left open, and can go into saturation making reliable measurements impossible.

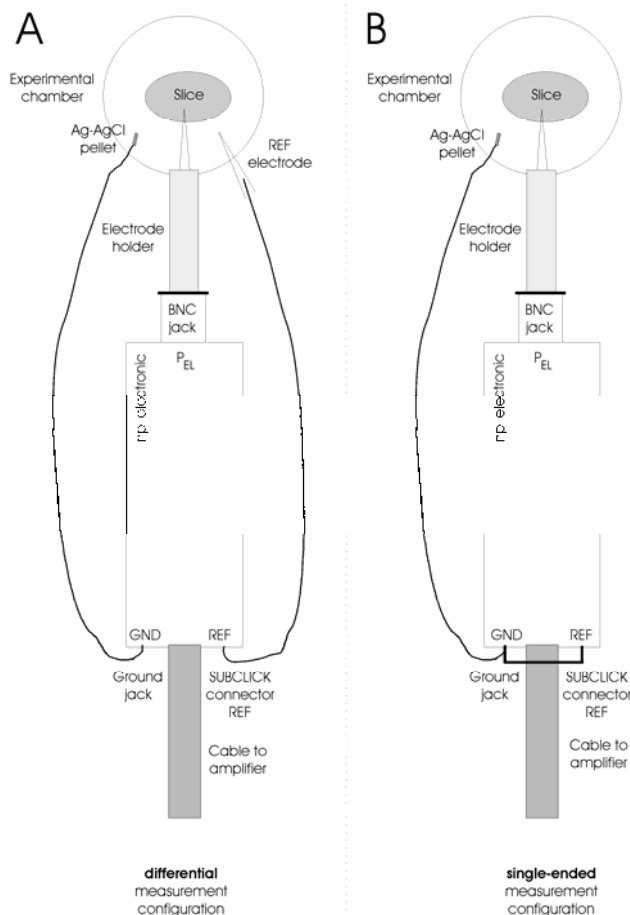


Figure 7: headstage connections, **A**: differential measurement, **B**: single-ended measurement

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
Headstage Size:	70 x 26 x 26 mm
Holding Bar:	length: 150 mm; diameter: 8 mm.