

*made to measure*

# OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

## EXT-16DX

# EXTRACELLULAR AMPLIFIER



VERSION 1.4  
npi 2020

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## Table of Contents

1. Safety Regulations.....	3
2. EXT-16DX .....	4
2.1. System Description.....	4
2.2. Signal Flow Diagram.....	4
2.3. Description of the Front Panel.....	5
2.4. Description of the Rear Panel.....	7
2.5. Headstages .....	9
Headstage Assembly Elements.....	9
3. Literature .....	12
4. Technical Data.....	13

## 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. EXT-16DX

### 2.1. System Description

The EXT-16DX is an extracellular amplifier with up to 16 channels to be operated in single-ended or referenced (differential) configuration. In referenced configuration one of the electrodes can be selected to function as reference for all other electrodes. All channels are equipped with highpass filter, lowpass filter and gain. Corner frequencies and gain are customized and the same for each channel. Digital displays show the selected corner frequencies and gain. These displays can be dimmed for use of the amplifier combined with fluorescence measurements.

The recorded signals are available at BNC connectors and an SCSI connector (option) for direct connection to a data acquisition board. The signals are also linked to a SubD connector for connecting the optional R/I-T1DX for electrode resistance measurement and current injection. The EXT-16DX can be operated manually by the controls at the front panel or remotely by a digital I/O board (option)

An external power supply (PWR-03DX) guarantees low noise operation.

### 2.2. Signal Flow Diagram

The signal is passed through the EXT-16DX as shown below.

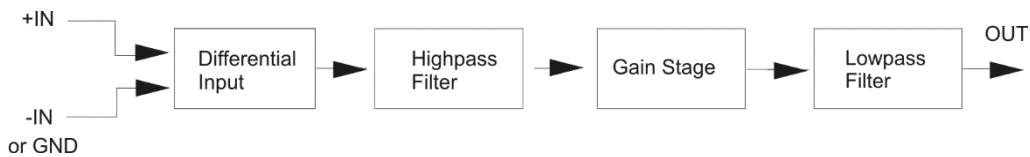


Figure 1: EXT-16DX signal flow (shown for one channel only)

The extracellular signal is linked from the headstage to +IN of the differential input. -In is either the signal from the reference electrode or GND depending on the setting of switch #2, Figure 2. The difference is then passed through highpass filter, gain and lowpass filter and linked to the output (BNC connector or SCSI/SubD connector).

### 2.3. Description of the Front Panel

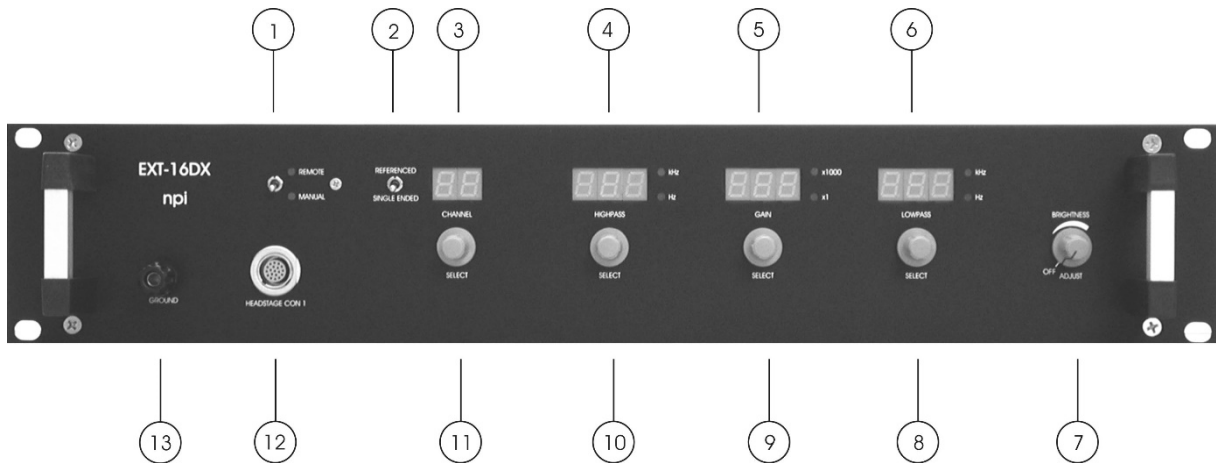


Figure 2: EXT-16DX front panel view

In the following description of the front panel elements each element has a number that is related to that in Figure 2. 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) REMOTE / MANUAL switch

Switch for selecting manual operation by the controls at the front panel or remote operation by a digital I/O board. This switch is functional only if the remote control option is installed.

#### (2) REFERENCED / SINGLE ENDED switch

Switch to select recording either in referenced or in single ended mode. In SINGLE ENDED mode recording with up to 16 electrodes with reference to ground is possible. In REFERENCED mode the signal of the reference electrode is subtracted from the recording electrode resulting in reduction of noise. The electrode acting as reference is selected by switch #11. The signal of the reference electrode can be recorded at the respective BNC connector at the rear panel in phase (see also below)

**Important:** When selecting REFERENCED mode the channel acting as reference must not be left open. The amplifier is in an undefined state, if the reference channel is left open, and can go into saturation making reliable measurements impossible.

#### (3) CHANNEL display

Display indicating the CHANNEL (electrode) that is selected for reference (0..15). In single ended mode SE is displayed.

#### (4) HIGHPASS display

Display showing the value of the selected corner frequency for the highpass filter. Possible corner frequencies: DC, 0.1, 0.3, 0.5, 1, 3, 5, 10, 30, 50, 100, 300, 500, 800, 1k, 3k Hz.

**(5) GAIN display**

Display showing the value of the selected amplification of the recorded signal. Possible factors: 10, 20, 50, 100, 200, 500, 1k, 2k, 5k, 10k.

**(6) LOWPASS display**

Display showing the value of the selected corner frequency for the lowpass filter. Possible corner frequencies: 20, 50, 100, 200, 300, 500, 700, 1k, 1,3k, 2k, 3k, 5k, 8k, 10k, 13k, 20k Hz.

**(7) BRIGHTNESS ADJUST potentiometer**

Potentiometer for dimming the displays, e.g. during fluorescence measurements. In OFF position all displays and LEDs are switched off, except the decimal point of display #4 that indicates that the amplifier is still powered on.

**(8) LOWPASS SELECT switch**

Rotary switch for choosing the corner frequency for the lowpass filter. The selected corner frequency is shown at display #6.

**(9) GAIN SELECT switch**

Rotary switch for choosing the amplification factor (gain) for the extracellular signal. The selected gain is shown at display #5.

**(10) HIGHPASS SELECT switch**

Rotary switch for choosing the corner frequency for the highpass filter. The selected corner frequency is shown at display #4.

**(11) CHANNEL SELECT switch**

Rotary switch for choosing the electrode (channel) to function as reference. The selected channel is shown at display #3.

**(12) HEADSTAGE CON 1 connector**

Connector for connecting the recording headstage.

**(13) GROUND connector**

Connector providing system ground.

## 2.4. Description of the Rear Panel

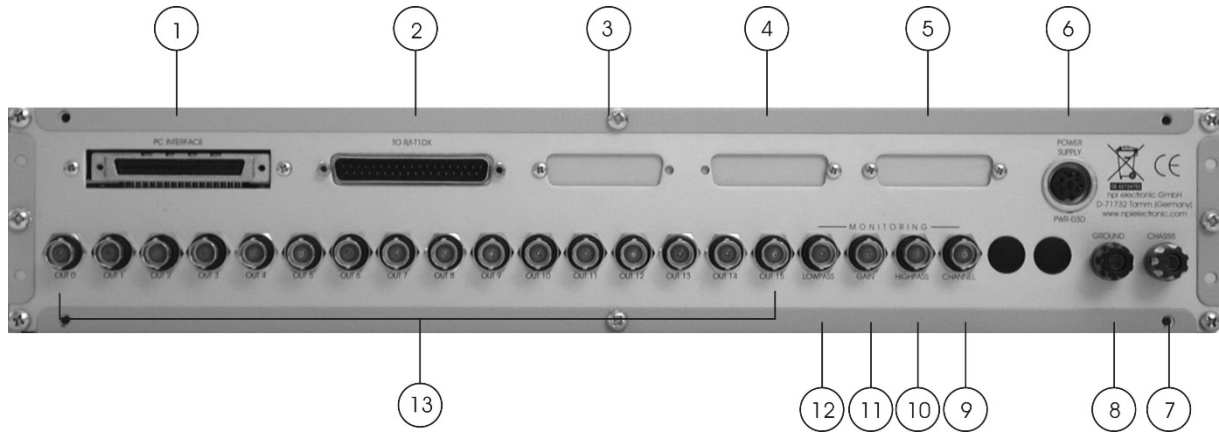


Figure 3: EXT-16DX rear panel view

The following connectors are located at the rear panel.

**(1) PC INTERFACE connector (optional)**

Male SCSI connector for attaching a data acquisition board, e.g. from National Instruments or Data Translation.

**(2) IO R/I-T1DX connector (optional)**

SubD connector for connecting a R/I-T1M electrode resistance test/current injection device.

**(3) AUX connector (optional)**

Customized auxiliary connector.

**(4) AUX connector (optional)**

Customized auxiliary connector.

**(5) AUX connector (optional)**

Customized auxiliary connector.

**(6) POWER SUPPLY connector**

Connector for npi power supply PWR-03DX.

**Note:** This power supply is must be used with **one** npi EXT-16DX system only.

**(7) CHASSIS connector**

Connector for grounding the cabinet.

**(8) GROUND connector**

Connector providing system ground.

**MONITORING UNIT**

The monitoring unit shows the selected channel, gain or corner frequency as a DC voltage.

**(9) CHANNEL monitor connector**

BNC connector providing the monitor signal for the selected channel for reference (range: -8 V...+7 V), e.g. channel 0 is monitored by -8 V or channel 9 is monitored by +1 V. In single ended mode the monitor output is +9 V.

**(10) HIGHPASS monitor connector**

BNC connector providing the monitor signal for the selected corner frequency of the highpass filter (range: -8 V...+7 V).

**(11) GAIN monitor connector**

BNC connector providing the monitor signal for the selected gain (range: +1 V...+10 V).

**(12) LOWPASS monitor connector**

BNC connector providing the monitor signal for the selected corner frequency of the lowpass filter (range: -8 V...+7 V).

**(13) OUT connectors**

BNC connectors providing the extracellular recorded signal. The signal is filtered with the selected corner frequencies and amplified with the selected gain. In referenced recording mode one channel shows the reference signal (amplified and filtered).

***Important:*** The signal of the reference electrode at the OUT connector is filtered and amplified as well. All other OUT connectors provide the differential signal (IN – REF, filtered and amplified). The raw input signals are not available at these outputs. .



## 2.5. Headstages

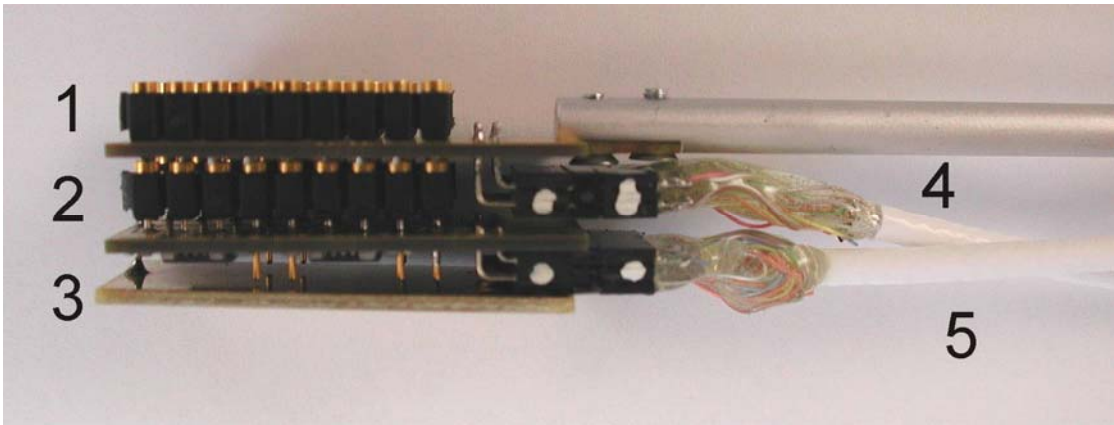


Figure 4: headstage assembly for EXT-16DX and R/I-T1DX

### *Headstage Assembly Elements*

- 1 stimulation headstage (EXT-MINI-RI-16-DIL), optional
- 2 recording headstage with electrode connector for Neuronexus electrode (EXT-MINI-SE-16-DIL)
- 3 shield
- 4 cable to R/I-T1DX (green connector)
- 5 cable to EXT-16DX (blue connector)

**Important:** The cables must be connected so that the white labels fit!

The recording headstage is attached to the EXT-16DX amplifier (HEADSTAGE CON 1 connector, blue). The optional stimulation headstage is connected to the R/I-T1DX (HEADSTAGE CON 2 connector, green). The recording headstage has also a connector for a Neuronexus electrode (standard A-series probe package, 16 channels).

**Caution:** The headstage is sensitive to electrostatic discharge and must be handled with care. Always ground yourself when touching the headstage.

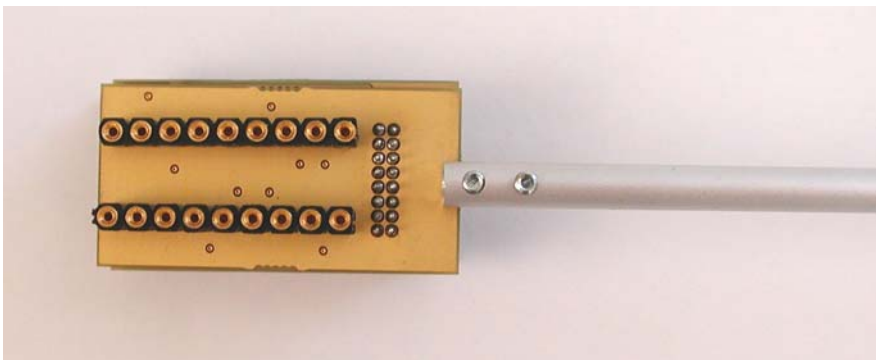


Figure 5: headstage assembly top view

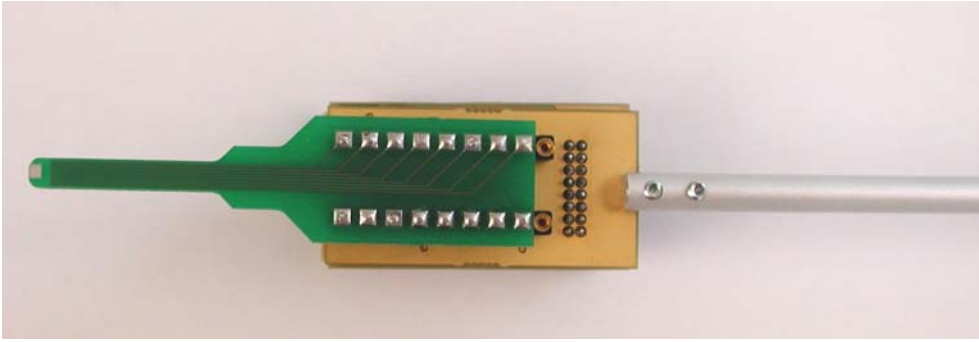


Figure 6: headstage assembly with NeuroNexus electrode

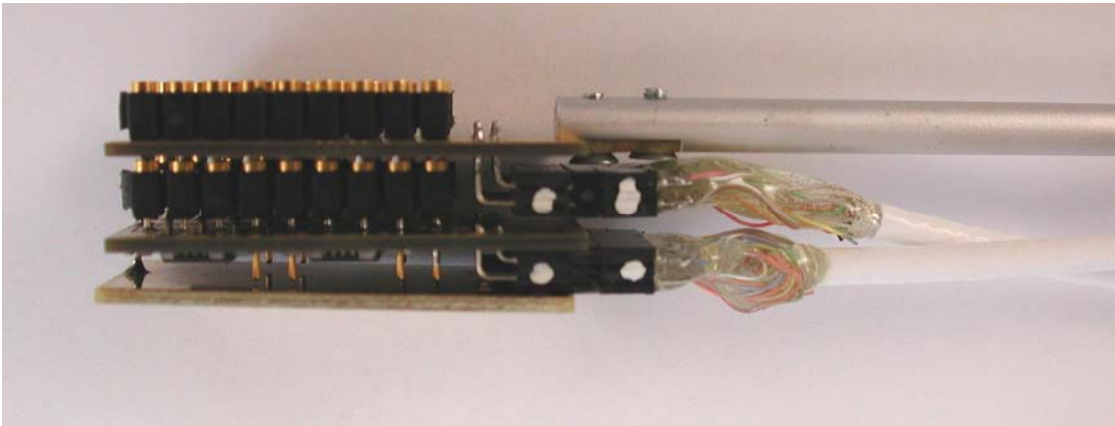


Figure 7: side view of the headstage assembly with cables connected

**Important:** The cables must be connected so that the white labels fit!

Figure 8 shows a schematic of the top view of the headstage assembly with the connector for the test array or the NeuroNexus electrode, respectively.

The test array is for testing purposes of the R/I-T1DX only. It consists of resistors (1 M $\Omega$ ) mimics the unit of the NeuroNexus electrode. The two plugs (0.5 mm diameter) next to the connector of the cable are labeled by a point (orientation label). They provide system ground and should be used to ground the preparation.

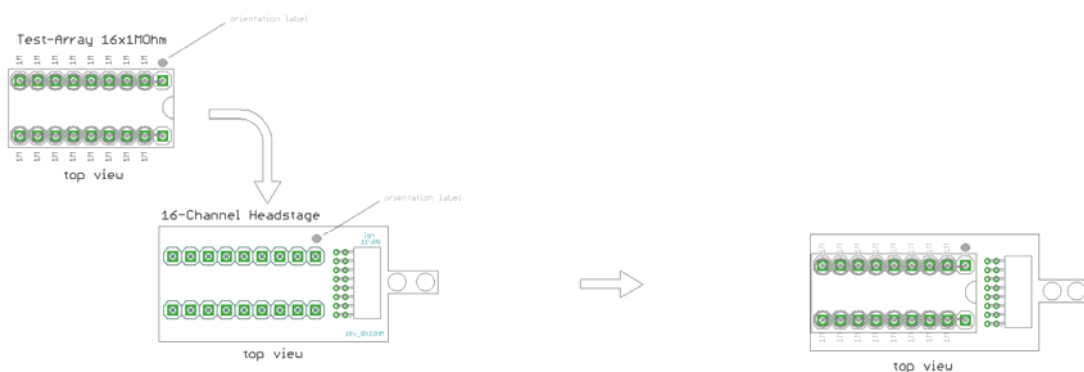


Figure 8: positioning of the test array on top of the headstage assembly (top view)

The NeuroNexus electrode has only 8 pairs of connectors for 16 recording/stimulation sites and is plugged into the headstage as shown in Figure 9. The 9<sup>th</sup> pair next to the cable connector (GND) is left open since the electrode has no sites for grounding.

**Important:** This 9<sup>th</sup> pair of connector has to be used to ground the preparation (animal, recording chamber) with a separate wire/pellet/ground screw or similar.

**Note:** If the test array is plugged-in with a wrong orientation, nothing will be damaged, but some electrodes are short-circuited and others show 2 M $\Omega$  instead of 1 M $\Omega$  resistance when using the electrode resistance test (with R/I-T1DX).

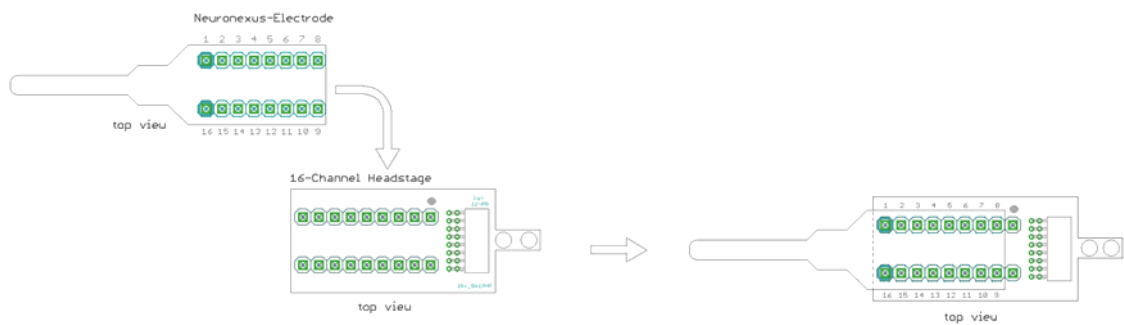


Figure 9: positioning of the NeuroNexus electrode on top of the headstage assembly (top view)

**Note:** Recording/stimulation site numbering at the headstage and NeuroNexus electrode is 1 to 16. Recording/stimulation site numbering at the amplifier is 0 to 15.

### 3. Literature

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## 4. Technical Data

Input:	$>10^{12} \Omega$ , range $\pm 2$ V
Differential Input:	CMR $>70$ dB at 1 kHz (tested with $0 \Omega$ input resistance)
Input Capacitance:	10 pF
CHANNEL Monitor:	-8V...+7V; +13V in single ended mode
HIGHPASS Filter:	single pole, attenuation: -6 dB / octave, corner frequencies (Hz): DC, 0.1, 0.3, 0.5, 1, 3, 5, 10, 30, 50, 100, 300, 500, 800, 1k, 3k; selected by rotary switch
HIGHPASS Monitor:	-8 V...+7 V
LOWPASS Filter:	single pole, attenuation: -6 dB/octave, corner frequencies (Hz): 20, 50, 100, 200, 300, 500, 700, 1k, 1,3k, 2k, 3k, 5k, 8k, 10k, 13k, 20k; selected by rotary switch
LOWPASS Monitor:	-8 V...+7 V
GAIN:	10, 20, 50, 100, 200, 500, 1k, 2k, 5k, 10k; selected by rotary switch
GAIN Monitor:	+1 V...+10 V
Output:	range: $\pm 10$ V into $1 \text{ k}\Omega$ / $\pm 1$ V into $50 \Omega$
External power supply:	115/230 Volt AC, 60/50 Hz, fuse 1.6/0.8 A, slow
Dimensions:	19" rackmount cabinet 19" (483 mm), 10" (250 mm), 3.5" (88 mm)

### Headstage

Headstage Size: without housing, approx. 40 mm x 18 mm, with holding bar