Electronic Instruments for the Life Sciences

made to measure

OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

R/I-T1DX

ELECTRODE RESISTANCE TEST CURRENT INJECTION

VERSION 1.4
npi 2013

npi electronic GmbH, Bauhofring 16, D-71732 Tamm, Germany
Phone +49 (0)7141-9730230; Fax: +49 (0)7141-9730240
support@npielectronic.com; http://www.npielectronic.com

Table of Contents

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 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. R/I-T1DX Resistance Test / Current Injection

The R/I-T1DX device allows measurement of the resistance of electrodes connected to an EXT-16DX amplifier. It can function also for injection of current (up to ±100 nA) through a single electrode or through all electrodes simultaneously. The functions are selected by a switch and indicated by an LED. It can be operated manually or remotely using a TTL signal. The two functions can be applied to up to sixteen electrodes.

The resistance is determined by application of a fixed pulse of approx. ±10 nA with 200 Hz. The current injection pulses are variable in both frequency and amplitude and symmetric around the baseline.
Test and current injection pulses are a triangle-shaped signal fed into the headstage of the EXT amplifier. With the capacitor in the headstage the triangle is differentiated resulting in a rectangular current signal at the electrode. For electrode resistance test the voltage drop at the electrode caused by the current signal is measured and the electrode resistance is calculated due to Ohm's law: $I = R \times C$.
Frequency and amplitude of current injection are dependent on each other according to

$$I_C = C \times \frac{dU}{dt}$$

where I_c is the capacitive current, C is the capacitor in the amplifier headstage, dU/dt is the change of the voltage amplitude of the triangle over time.

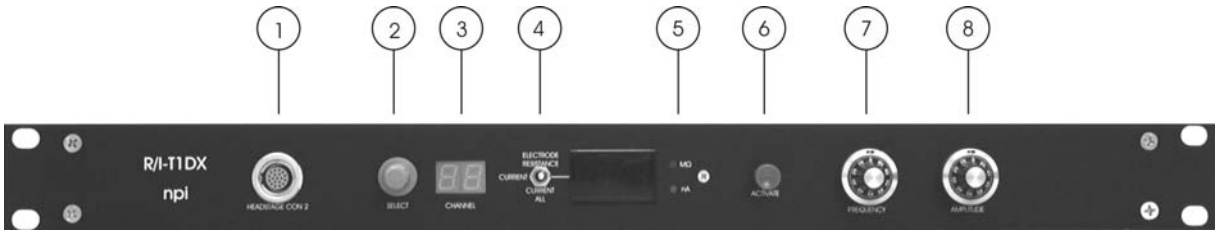

Figure 1: R/I-T1DX front panel view

In the following description of the front panel elements each element has a number that is related to that in Figure 1. 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 CON2

Connector for the current injection headstage. The current injection headstage is usually sandwiched with the recording headstage of the EXT-16DX.

(2) CHANNEL SELECT switch

Rotary switch for selecting the electrode for current injection or to be tested for resistance. Starting at electrode 0 (CHANNEL 00 indicated by #**3**) turning clockwise increases the electrode number until electrode 15. Turning clockwise further starts at CHANNEL 0 again.

(3) CHANNEL SELECT indicator

LED (XX) indicating the selected CHANNEL for current injection or to be tested for resistance. The indicator starts at 00, e.g. 02 indicates function at CHANNEL 3 (see also #**2**).

(4) ELECTRODE RESISTANCE / CURRENT / CURRENT ALL switch

Switch for selecting ELECTRODE RESISTANCE test, CURRENT injection for the selected channel or CURRENT injection for all channels. The unit of the selected function is indicated by #**5**.

(5) RESISTANCE / CURRENT display

Digital display showing the electrode resistance (XX.XX MΩ, range: 0.01 MΩ…10 MΩ) or the amplitude of the injected current (XXX nA, range: 0…100 nA).

(6) Current nA / resistance MΩ LED

LEDs showing that CURRENT injection or ELECTRODE RESISTANCE test is selected. The amplitude of the injected CURRENT (single electrode or all electrodes) is shown in display #**5** in nA. The measured ELECTRODE RESISTANCE is shown in display #**5** in MΩ.

(7) ACTIVATE push button

Push button for activating current injection or electrode resistance test.

(8) FREQUENCY potentiometer

10-turn Potentiometer for setting frequency of the current injection pulses
(range: 200 Hz…2 kHz).

Important: Changing the frequency will also change the amplitude of the current pulse !

(9) AMPLITUDE potentiometer

10-turn Potentiometer for setting the current amplitude at a selected frequency.

2.1. Description of the Rear Panel

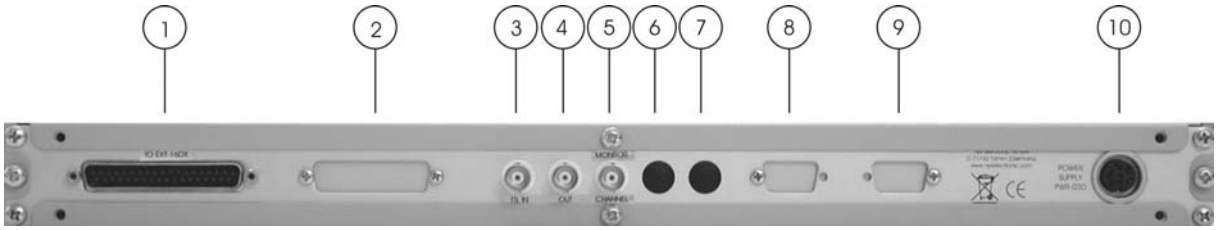

Figure 2: R/I-T1DX rear panel view

The following connectors are located at the rear panel.

(1) TO EXT-16DX connector

SubD connector for connecting the sixteen channel extracellular amplifier EXT-16DX. The EXT-16DX amplifier provides also the operating voltage for the R/I-T1DX through this cable.

(2) AUX connector (optional)

Customized auxiliary connector.

(3) TTL IN connector

BNC connector for remote control of operation with a TTL signal. As long as the signal is HI (> +2.5V) operation (electrode resistance test or current injection) takes place.

(4) OUT connector

BNC connector monitoring the amplitude of the injected current (1 V / 10 nA) or the resistance (1 V / 1 MΩ).

(5) MONITOR CHANNEL connector

BNC connector providing the monitor signal for the selected channel (range: -8V…+7V), e.g. channel 0 is monitored by –8V or channel 9 is monitored by +1 V.

(6) AUX connector (optional)

Customized auxiliary connector.

(7) AUX connector (optional)

Customized auxiliary connector.

(8) AUX connector (optional)

Customized auxiliary connector.

(9) AUX connector (optional)

Customized auxiliary connector.

(10) POWER SUPPLY PWR-03DX connector

Not connected.

2.2. Frequency and Amplitude of Current Injection Pulse

Frequency and amplitude of current injection are dependent on each other according to

$$I_C = C \times \frac{dU}{dt}$$

where I_c is the capacitive current, C is the capacitor in the amplifier headstage (3.3 pF) , dU/dt is the change of the voltage amplitude of the triangle over time.

Example for frequency with fixed amplitude of the triangle (±10 V i.e. 20 V amplitude)

$$I_C = C \times \frac{dU}{dt}$$

or

$$dt = \frac{(C \times dU)}{I_C}$$

$$dt = \left(\frac{3.3 \times 10^{-12}\ F \times 20\ V}{100\ nA} \right) = 660\ \mu s$$

because of having a biphasic pulses this has to be multiplied by 2 to get the frequency

660 µs *2 = 1.32 ms → 758 Hz

3. Technical Data

R/I-T1DX

Resistance measurement:	0.01…10 MΩ, display: XX.XX MΩ
Current injection:	0…±280 nA, symmetrical around baseline; display: XXX nA
Output scaling:	1 V / MΩ or 1 V / 10 nA
Output:	resistance: 50 Ω, range ±10 V