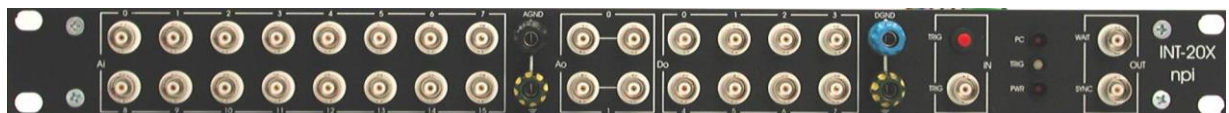


OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

INT-20X-USB

BREAKOUT BOX FOR RECORDING AND GENERATING ELECTRICAL SIGNALS



VERSION 1.6
npi 2023

Table of Contents

1. Safety Regulations	3
2. INT-20X-USB Breakout Box	4
2.1. System Description.....	4
2.2. Parts Shipped with the Breakout Box.....	4
2.3. Description of the Front Panel.....	5
2.4. Description of the Rear Panel.....	9
3. Technical Data	11
Index	11

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 only by trained staff. 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.
- 6) **I/O BOARDS:** This breakout box can be used only with computer boards from National Instruments. These I/O boards must be installed and configured first. For the correct installation and configuration read the user manual of the appropriate board (shipped with the board).
- 7) **VERY IMPORTANT:** Always turn power off when connecting or disconnecting components at the rear panel of the breakout box to avoid any damage.

2. INT-20X-USB Breakout Box

2.1. System Description

The INT-20X-USB is a universal multifunction I/O interface with a built-in USB board (NI USB-6221 OEM) from National Instruments.

The standard data acquisition system consists of the INT-20X-USB breakout box and software to record up to 16 analog signals with 16 bit resolution and store the data on hard disk. Two analog output channels with 16 bit resolution to generate analog signals and a digital port with 8 digital lines to write digital signals (TTL) are available as well.

Usually this breakout box is used with the popular Strathclyde Electrophysiology Software, WinWCP/WinEDR (https://spider.science.strath.ac.uk/sipbs/software_ses.htm) and WinLTP (<https://www.winltp.com/>), but it is also possible to write own programs, for example with the program development application *LabVIEW* from National Instruments or *MatLab*.

Optional, a POWER OUTPUT port for 8 digital lines is also available. It can be used for direct connection of electric valves to control perfusion systems. Please contact npi electronic for further information.

Important: You must install the NIDAQmx driver and runtime library first before you connect the breakout box.

2.2. Parts Shipped with the Breakout Box

- Breakout box INT-20X-USB
- External power supply for the USB board
- USB cable
- Breakout box User Manual

Front panel			
Number	Short name	Signal name	Description
1	Ai0...Ai15 (ACH0...ACH15)	Analog input channels (Analog Input)	16 BNC connectors providing the 16 analog input channels of the USB-6221 OEM board.
2	AGND (AISENSE)	Analog input ground (Analog Input Sense)	Reference point for all analog input channels.
3	GND	Ground	Chassis potential.
4	Ao0...Ao1 (DAC0...DAC1)	Analog output channels (Analog Outputs)	These BNC connectors provide the 2 analog output channels of the USB-6221 OEM board.
5	Do0...Do7	Digital output ports (Digital I/O)	These output ports provide the 8 digital lines from the USB board.
6	GND	Ground	Compare to number 3.
7	DGND (DGND)	Digital ground (Digital Ground)	This connector supplies the reference point for all digital signals.
8	TRIG	Manual trigger	This push button triggers the B or E series board manually
9	TRIG (TRIG1)	Trigger input	This BNC connector for connecting an external trigger device.
10	PC, TRIG, PWR	PC connection, Trigger, Power supply connection	LED PC indicates the connection between the computer and the breakout box (computer must be switched on). LED TRIG indicates the Trigger status (green = trigger active, red = waiting for trigger). LED PWR indicates that an external power supply is plugged in.
11	WAIT (GPCTR1_OUT)	“Wait for Trigger” signal (only in PULSE mode)	LOW (0 V) by default. Gets HIGH (+5 V) if CellWorks waits for a trigger and remains high until STARTSCAN has been started (see Figure 2). Note: GPCTR1_OUT is set by software and therefore not very precise (a few ms).
12	SYNC (STARTSCAN)	Synchronization signal	LOW (0 V) by default. Gets HIGH (+5 V) for ~500 ns before each scan, i.e. during data acquisition this signal has the same frequency as the sample rate set in CellWorks (see Figure 2). Note: STARTSCAN is set by hardware and therefore precise.

Table 1: front panel elements of the INT-20X-USB breakout box

The signals at the front panel can be divided into 5 groups: **Ai, Ao, Do, TRIG IN, TRIG OUT**. Each group is indicated at the front panel by a surrounding white line.

Analog input (Ai0...Ai15)

The 16 analog input lines from the USB-6221 OEM board are linked to BNC connectors at the front panel. These channels have a maximum voltage range of ± 10 V and can be configured by software. The maximum sample rate is 250 kS/s. Input channels are always multiplexed.

The shields of all Ai BNC connectors are linked to the AISENSE signal and the AISENSE is connected to the AIGRND signal from the USB-6221 OEM board.

Analog output (Ao0...Ao1)

The two analog outputs from the USB-6221 OEM board are available at the front panel. Each channel has two BNC connectors. With these ports it is possible to generate analog voltage signals in a range of ± 10 V. The resolution and the maximum update rate is 833 kS/s. For further information please read the technical data of the USB-6221 OEM board.

Digital output (Do0...Do7)

The 8 digital I/O (Input/Output) lines of the USB-6221 OEM board are linked to the front panel. The signals are **fixed in output direction** and buffered. Driving several TTL inputs of external devices is possible.

Control inputs and control outputs (TRIG IN, TRIG OUT)

The USB-6221 OEM board provides a lot of timing signals and PFI signals (**P**rogrammable **F**unction **I**nput) to control the board by external devices or vice versa. Two input signals and two output signals are linked to BNC connectors at the front panel. The following table shows the default configuration.

Note: The GPCTR1_OUT signal is linked to the BNC WAIT connector only in PULSE mode operation of CellWorks and therefore, the trigger status LED is in CHART mode operation always green.

Signal from USB board	to	Front panel BNC
PFI0/TRIG1		Input BNC TRIG
PFI0/TRIG1		Input push button TRIG
GPCTR1_OUT (only in PULSE mode)		Processed and linked to output BNC WAIT
STARTSCAN		Output BNC SYNC

Front panel LEDs (PC, TRIG, PWR)

There are three LEDs PC, TRIG and PWR which are used to indicate proper connections to the computer or to external devices and the trigger status. If the LED PC is on (red) the breakout box is connected properly (the computer must be switched on). The LED in the middle, TRIG, indicates the trigger status (green = trigger active, red = waiting for trigger, also indicated in CellWorks by the red field in the Execution Module). If the LED PWR is red an external power supply (optional) is properly connected.

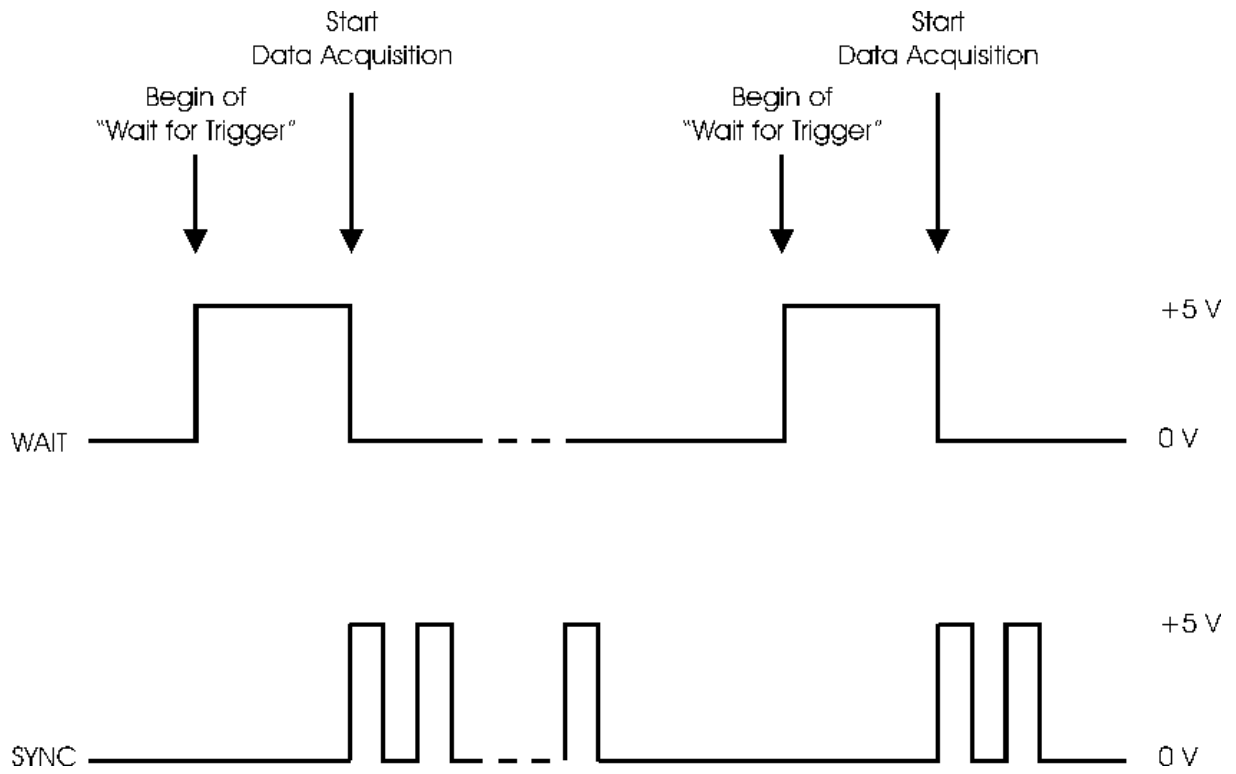


Figure 2: time course of trigger out signals

2.4. Description of the Rear Panel

Figure 3 shows the INT-20X-USB rear panel. The following paragraph describes these rear panel elements.

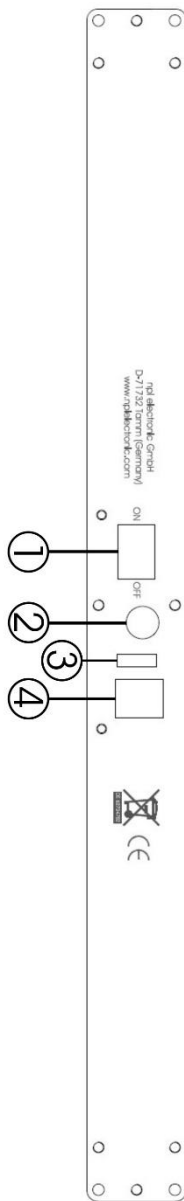


Figure 3: rear panel of the INT-20X-USB breakout box

Four elements located at the rear panel of the INT-20X-USB are necessary to interface the breakout box to the computer and to external devices, e.g. to a perfusion system.

(1) ON/OFF switch

Switch to power the INT-20X ON or OFF

(2) Power supply connector for USB-6221 OEM board

An external power supply must be connected to the right power supply connector (+12 V, 1 A, inner pin positive). A replaceable T 2 A 250 V (5 × 20 mm) fuse protects the device from overcurrent through the power connector. This fuse is only accessible inside the instrument.

Important: Attention to the right polarity: The core pin is positive and the shield is negative.



Figure 4: orientation of power supply connector

(3) Status LEDs

The green READY LED indicates when the device is powered on and configured as a USB device. The yellow ACTIVE LED indicates USB bus activity.

(4) USB connector

Standard USB connector for connecting the breakout box to a USB 2.0 port of the computer. (NIDAQmx driver has to be installed first)

3. Technical Data

Analog Input

Number of channels	16 (in NRSE Mode)
Input resistance	1 M Ω
Max. Input range	± 10 V (bipolar) 0...10 V (unipolar)
Input coupling	DC

Analog Output

Number of channels	2
Voltage range	± 10 V
Output coupling	DC

Digital I/O

Number of channels	8
Compatibility	TTL/CMOS

Power Input

External Power Input (for USB board)	12 V, 1 A
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Index

analog input	7	front panel elements	6
analog output	7	power supply	10
digital output	7	technical data	11
front panel	5	trigger	7