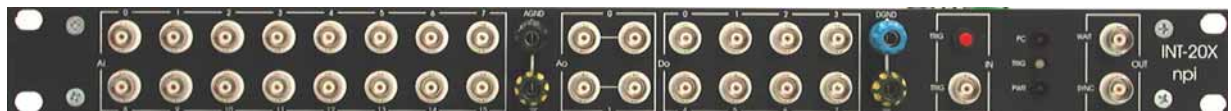


OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION FOR THE

INT-20X-USB

BREAKOUT BOX FOR RECORDING AND GENERATING ELECTRICAL SIGNALS



VERSION 1.2
npi 2014

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.....	5
2.3. Description of the Front Panel.....	5
2.4. Description of the Rear Panel.....	9
3. Hardware Connections.....	12
4. Technical Data	13
Index	13

1. Safety Regulations

VERY IMPORTANT: Instruments and components supplied by npí 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. npí electronic disclaims any warranties for such purpose. Equipment supplied by npí 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 npí 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 npí 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. 2 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 software package CellWorks E, but it is also possible to write own programs for example with the program development application *LabVIEW* from National Instruments. The popular Strathclyde Electrophysiology Software, WINWCP and WinLTP (<http://www.winltp.com/>) are supported as well. Please contact npf for more information on CellWorks.

A digital POWER OUTPUT port with 8 lines, e.g. to control the magnetic valves of perfusion systems, is also available.

The INT-20X-USB also provides a TRIG IN connector for triggering CellWorks from an external device and two TRIG OUT signals (WAIT and SYNC). WAIT indicates that the software is waiting for a trigger (only in PULSE mode) and SYNC can be used to synchronize external devices with the data acquisition rate.

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
- Breakout box User Manual

Optional accessories:

- 4 or 8 Channel Bath Perfusion System (ALA) for CellWorks
- Filter modules (to avoid aliasing or to reduce noise)
- Amplifiers
- CellWorks E

2.3. Description of the Front Panel

Figure 1 shows the INT-20X-USB front panel. Table 1 includes a short description of all front panel elements. The names in brackets are the signal denotations used in the User Manuals from National Instruments.

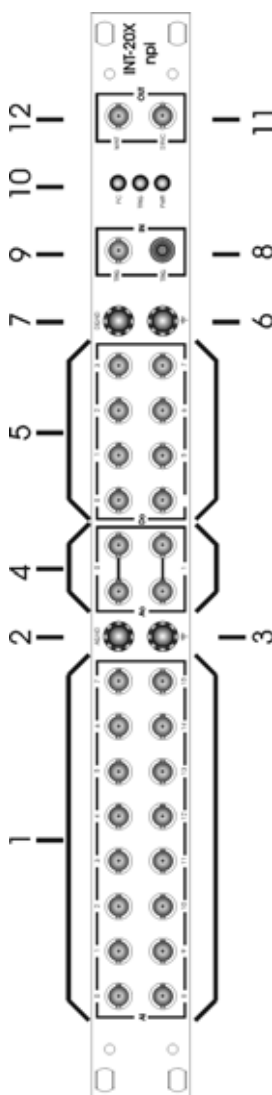


Figure 1: front panel of the INT-20X-USB breakout box

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 and the resolution is 250 kS/s.

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. 2 input signals and 2 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.

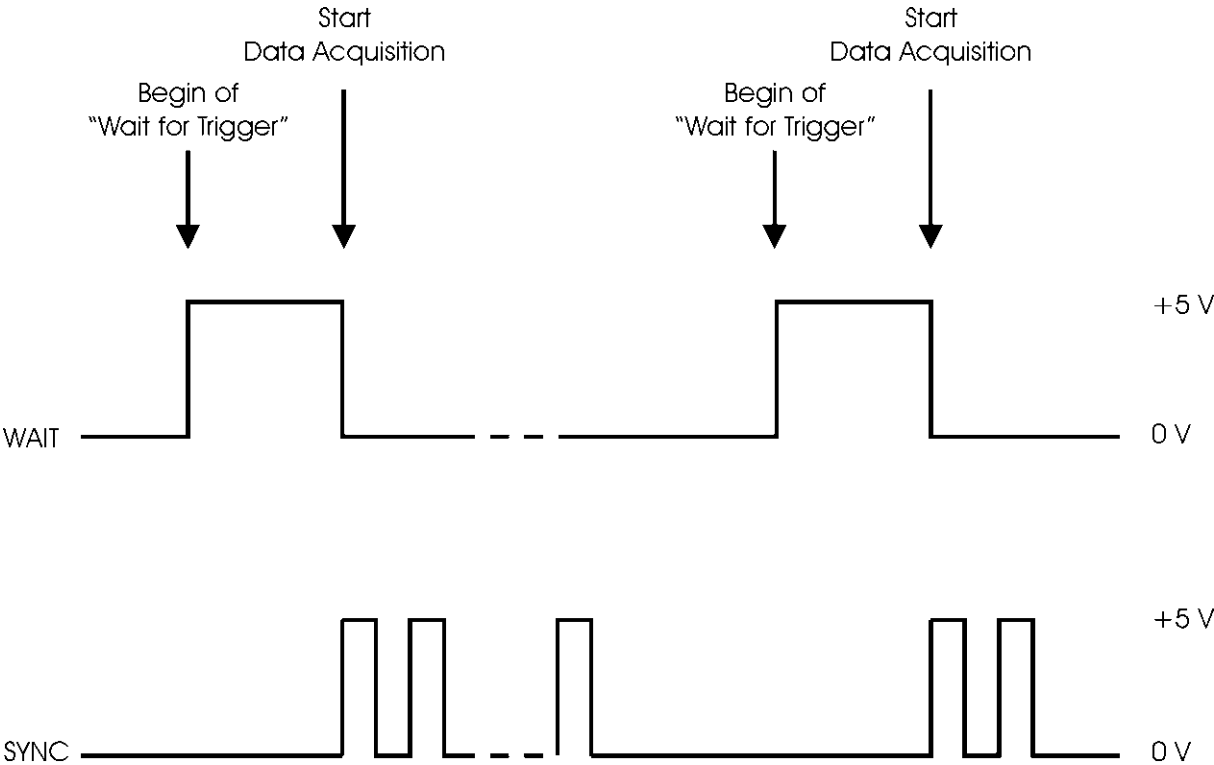


Figure 2: time course of trigger out signals

2.4. Description of the Rear Panel

Figure 3 shows the INT-20X-USB rear panel Table 2 gives a short description of the INT-20X-USB rear panel elements.

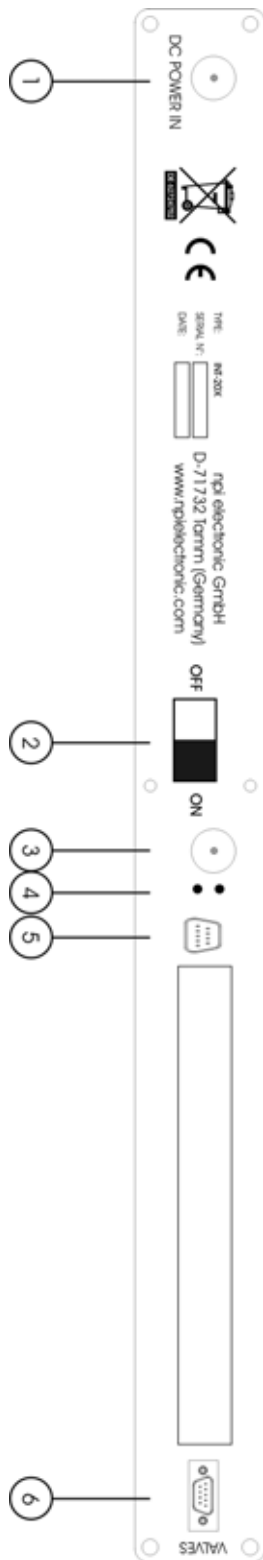


Figure 3: rear panel of the INT-20X-USB breakout box

Rear panel		
Number	Name	Description
1	DC POWER IN	Connector for the external power supply for a perfusion system (optional)
2	ON / OFF switch	Switch to switch the INT-20X ON or OFF
3	PWR-SUP	Connector for the external power supply for the USB-6221 OEM board.
4	Status LEDs	Green READY LED, yellow ACTIVE LED
5	USB connector	USB connector for connecting the breakout box to a USB 2.0 port of the computer.
6	VALVES	SUBD 9 female connector to control directly valves of a perfusion system (optional)

Table 2: rear panel elements of the INT-20X-USB breakout box

Six 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) DC POWER IN (for valve manifold)

An external power supply must be connected to the left connector DC POWER IN. Power supplies up to a maximum voltage of 36V can be plugged in.

Important: Attention to the right polarity: The core pine is positive and the coat is negative.

(2) ON/OFF switch

Switch to switch the INT-20X ON or OFF

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

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

Important: Attention to the right polarity: The core pine is positive and the coat is negative.

(4) 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.

(5) 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)

(6) VALVES

Some applications need more power (more current and higher voltage) than a ordinary TTL-output can supply. The SUBD 9 female connector VALVES supplies 8 digital power output channels. The voltage value depends on the external power supply plugged in DC POWER IN (usually 12 V). Thus, direct valve switching is possible. The digital port0/line0-7 of the USB-6221 OEM board is linked and powered up to this output. The pinout of this connector is shown in Table 3 and Table 4.

Pins 1 to 8 are linked directly to the SUBD 9 female connector of a valve manifold and are going to the respective valves. Pin 9 is linked to Pin 9 of the SUBD 9 female connector of the valve manifold and provides power (usually 12V). All are switched open collectors.

Pin	Name
1	POWC0
2	POWC1
3	POWC2
4	POWC3
5	POWC4
6	POWC5
7	POWC6
8	POWC7
9	+V

Table 3: pinout of the SUBD 9 female connector POWER OUTPUT

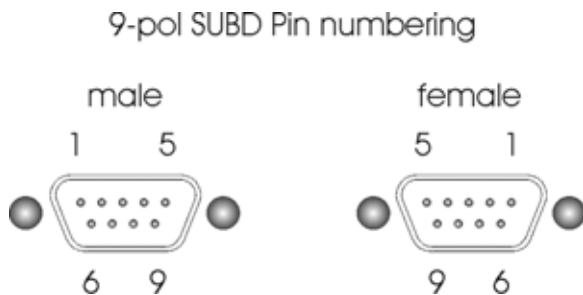


Table 4: numbering of SUBD 9 connectors

3. Hardware Connections

Usually, this universal breakout box is used in electrophysiological and pharmacological experiments. Figure 4 shows how to connect the INT-20X-USB breakout box to the computer with the I/O boards and, optionally, a perfusion system with 8 valves.

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

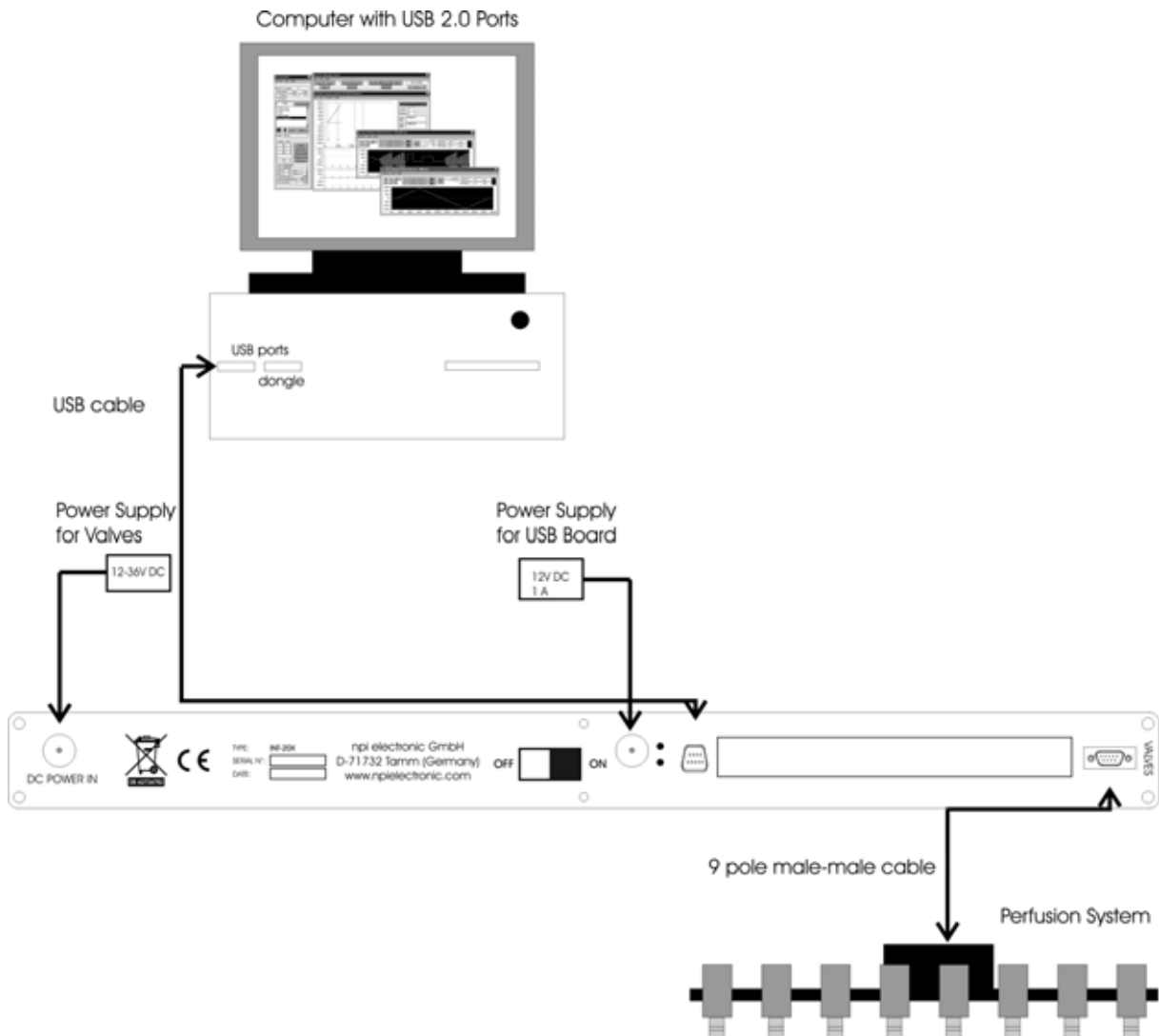


Figure 4: sample hardware connection of the INT-20X-USB

4. Technical Data

Analog Input			
Number of channels	in	NRSE Mode	16
Input resistance			1M Ω
Max. Input range		bipolar	$\pm 10V$
		unipolar	0...10V
Input coupling			DC
Analog Output			
Number of channels			2
Voltage range			$\pm 10V$
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
Fuse(for USB board)			T 2A, 250 V (5 \times 20 mm)
External Power Input (for valve control)			12...36 V
Power Output			
Maximum Voltage			Input voltage – 0.5V
Maximum Current (per channel, only one channel active)			500 mA

Index

analog input	7	perfusion system	12
analog output	7	power output	11
CellWorks	4	power supply	10
digital output	7	rear panel elements	10
front panel	5	SUBD 9 connector	11
front panel elements	7	technical data	13
Optional accessories	5	trigger	8