APPENDIX E: IWX214 HARDWARE MANUAL

Overview

The iWorx/214 hardware in combination with LabScribe recording software provides a system that allows coordinated control of both analog inputs and outputs. The hardware offers many benefits including low noise, high speed, range, resolution. The iWorx/214 interfaces with LabScribe software via the popular USB port. The USB port is the most current computer peripheral interface, and the iWorx/214 capitalizes on three of its features: high speed, built in error checking, and 'Plug and Play' connectivity. All of this is packaged in a low profile aluminum enclosure that provides both durability and increased noise immunity.

Included Items

The iWorx/214 is shipped with the following:

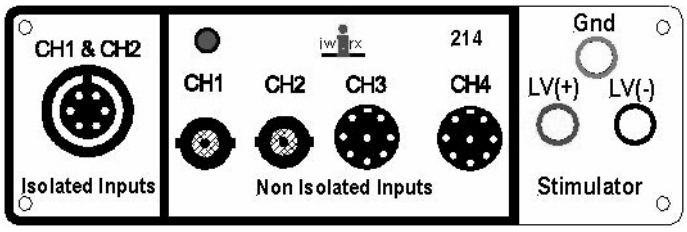
1. iWorx/214 Hardware (1)
2. USB A-To-B Cable (1)
3. Power Supply 12VDC 800mA(1)
4. LabScribe software CD (1)
5. Hardware/Software Manual (1)

If any items are missing, they should be reported to iWorx within 10 days of receipt.

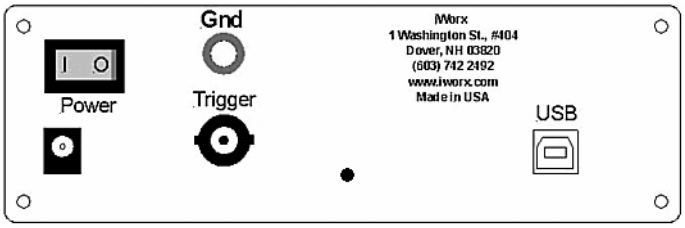
Setting Up

1. Load the LabScribe software from the provided CD onto the computer. Be sure to install the software before connecting the hardware
2. Connect the iWorx/214 hardware to the computer via the USB cable.
3. Connect the power supply and switch the hardware On.

Front Panel



Rear Panel



Quick-view Specification Table

Analog Inputs	2 isolated differential biopotential and 2 single-ended/differential transducer
Biopotential Amplifier	Safe for use on human subjects; includes optically isolated input and AAMI input cable
Input Impedance	10 Gohm
Amplifier Frequency Response	50KHz
ADC Resolution	16 Bit
System Noise	+/- 1 LSB (<1mV)
Sampling Rate	100,000 samples/second aggregate continuous
Input Range	+/-5V
Excitation Voltage	+/-5V
Analog Output	1 (differential)
Output Range	+/-5V
Output Current	5 mA
Output Resolution	12 Bit
Trigger	1 (TTL)
Warranty and Upgrades	The iWorx 214 hardware is protected by a three-year warranty. Software and firmware upgrades are free, and are automatically delivered to registered users via the Web. LabScribe software may be freely distributed to students.
Part Number	IX/214

Analog Inputs

The iWorx/214 hardware contains four channels of analog input. The iWorx/214 includes a dual-channel biopotential amplifier designed for use on human subjects. Two additional channels accept practically any sensor you're likely to encounter, as well as voltage output of pH meters, spectrophotometers and other laboratory devices.

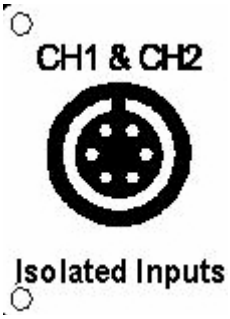
The input signal range is ± 5 Volts. The signals are digitized to 16-bit resolution. In simple terms this means that the input signal is passed to the software as a number between 0 and 65,535 where 0 maps to –5 volts, 32,767 maps to 0 volts, and 65,535 maps to +5 volts. One bit of resolution, often referred to as an LSB (Least Significant Bit), is then the total range (+5 volts minus –5 volts equals 10 volts) divided by 65,535 or 150 µV.

The iWorx/214 like all analog to digital converters, displays some digitizing noise. One common source of digitizing noise can be easily understood by considering an analog voltage of 150 ± 10 µV; as it is sampled, the digital output varies between 1 and 2 as the analog signal moves above and below 150 µV with consecutive samples. In this case, ± 10 uV of noise appears as ± 150 µV because of the LSB size. The iWorx/214 system noise is typically less than 1 mVolt. This is measured with the input shorted to ground to eliminate external noise

The aggregate sampling speed of the analog channels of the iWorx/214 is 100 ks/S. Thus for single channel operation the maximum sampling speed is 100 ks/S, for two channels the maximum sampling speed is 50 ks/S. The sampling speed is user configured in the LabScribe software. Note that not all combinations are possible—for example when recording three channels of data, the maximum sampling speed for each channel is 20 ks/S, not 33.33 ks/S. Furthermore, the chosen sampling speed applies to all selected channels. For more information on setting the sampling rate in the Sample Rate section of Chapter 4 in this manual.

The analog input channels are single pole filtered at 50 kHz. This is designed to remove noise existing above the highest possible frequency of interest. Simply stated, the highest frequency able to be sampled is 50 kHz when sampling at 100 ks/S, so any signal above 50 kHz is noise.

Dual Bio Channels



iWorx/214 includes a dual-channel biopotential amplifier designed for use on human subjects. Each channel has 3 Bio settings with 1K gain each.

1) 0.03 Hz to 150Hz: : Suitable for resting ECG

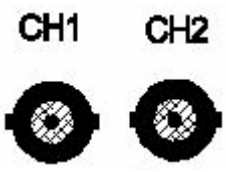
2) 0.3 Hz to 35 Hz: suitable for ambulatory ECG and EEG

3) 3Hz to 10KHz: : suitable for EMG

The dual bio-inputs are optically isolated and are safe for use on human subjects.

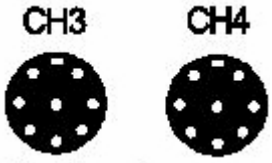
A 5 lead cable is provided which terminates in a yoke. 5 snap leads are provided that plug into the yoke. We also make alligator cables that will plug into the yoke for use with animals.

BNC Inputs

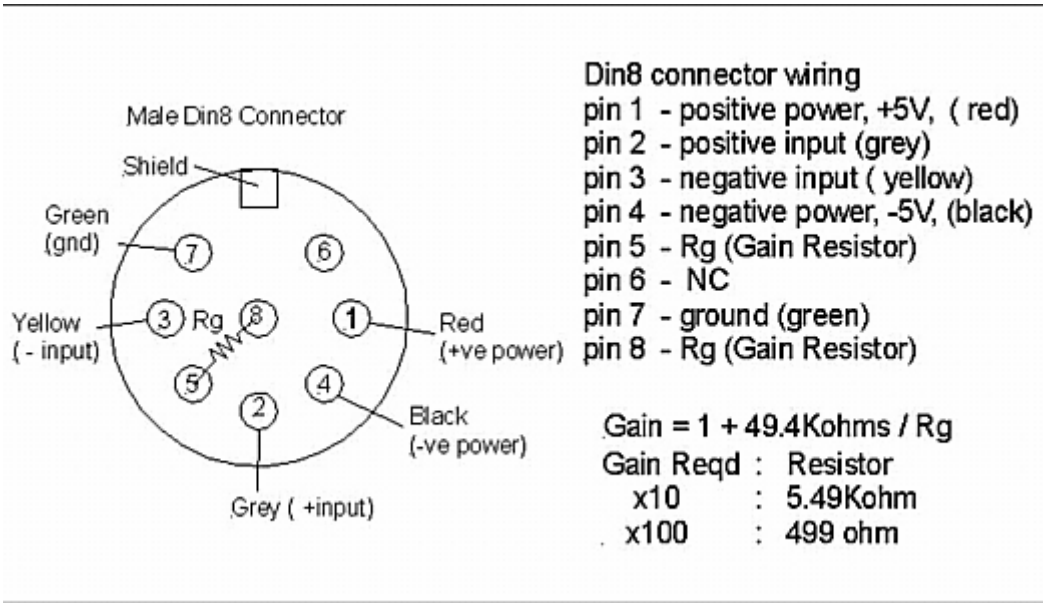


iWorx/214 also includes 2 BNC inputs for Channels 1 and 2 which can be used instead of the Bio inputs. The imput impedance of these two channels is 1 Mohm. You can switch between the above Bio modes or BNC mode using the Labscribe software's input mode menu in the right-click for channels 1 and 2

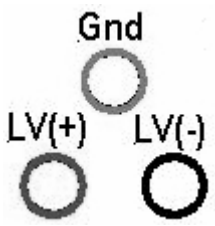
DIN8 Transducer Inputs



Two DIN8 transducer inputs accept practically any sensor you're likely to encounter. The DIN8 input connector provides +/- 5V excitation voltage for various transducers. iWorx transducers can set the appropriate gain automatically using the Gain set resistor.



Analog Output (stimulator)



The iWorx/214 hardware contains one stimulator output channel. The stimulator output is with reference to ground. Two complementary outputs are provided. The output connectors are banana connectors. The stimulator output is available between the red and the green banana connectors. The inverted (complementary) stimulator output is available between the black and the green connectors. For example if the stimulator voltage is set at 1Volt, there is 1V between the red and the green connectors, -1V between the black and the green connector, and 2V between the red and the black connectors.

The output signal range is ± 5 Volts. The stimulator is capable of sourcing and sinking up to 5 mAmperes of current when feeding a low impedance load. As with all stimulators, compliance is a factor—simply put, driving 5 mAmperes through any load impedance greater than 1 Kohms would, according to Ohm's law, generate a voltage larger than 5 Volts, or greater than the voltage output range of the stimulator. Therefore, the largest current output possible will be the smaller of either the stimulator output amplitude divided by the impedance of the load, or 5 mAmperes.

The resolution of the analog output is 5mV. The noise on the stimulator output is typically less than 1 mVolt. What noise is seen will typically be focused around 100 kHz, and is a result of feed-through from the sampling activity of the analog to digital converter.

The output impedance of the stimulator will typically be around 60ohms and should never exceed 100 ohms. Note that with very low load impedances (RLOAD < 600ohms), loading will occur. This means the actual stimulator output voltage will be a portion of the set stimulator output voltage.

The stimulator is updated independently of analog acquisition speed, at a rate between 0.2 Hz and 10 kHz. This means that in pulse mode, the fastest output frequency would occur by turning the stimulator on and then off at 10 kHz, resulting in a pulse frequency of 5 kHz. At lowest speed this would result in an output frequency of 0.1 Hz. LabScribe software determines the actual stimulator protocols allowed. For more information on setting the stimulator rate and protocol, consult the LabScribe user manual.

The stimulator output of the iWorx/214 hardware is designed primarily for output protocols involving pulses and steps, where sharp transitions are not only acceptable, but are desired. Therefore, the stimulator outputs are single pole filtered at 50 kHz. This is a best compromise filter value that allows the maximum output frequency of 5 kHz to pass with sharp transitions while limiting the overall noise bandwidth.

Trigger

On the iWorx/214 rear panel, is an edge triggered input, . When configured in Trigger Mode, the LabScribe software starts analog data acquisition upon detecting a trigger impulse. While awaiting the trigger impulse, the hardware is actually acquiring data, and so pre-triggering is allowed. This is useful when the data of interest is known to coincide or slightly precede the trigger impulse, or when the trigger impulse is too short to resolve at the sampling speed appropriate for capturing the data of interest. Though the trigger input is edge triggered, it must remain high long enough for the hardware to detect it—this requires approximately 10 micro seconds.

Relative Timing Of Analog Inputs and Analog Outputs

Within the iWorx/214 hardware exists a digital control system that processes the analog inputs and outputs and communicates with the LabScribe computer software. In some instances the relative timing is important, so here is a definition of the relative timing between these subsystems.

The first consideration is sample time. When running multiple channels of data acquisition, the channels are NOT simultaneously sampled. In fact, regardless of sampling speed the conversions occur at 100 k samples/Second. Thus, if we define a sample in time, SN, while recording eight channels of analog data at a speed of 1 k sample/Second, channel two will lag channel one by 10 µSeconds. Channel three will lag channel two by 10 µSeconds, and so on… The subsequent sample, SN-1, will follow 1 mSecond later. In summery, for each channel the sample period between its own samples is defined by the analog input sampling frequency, but a temporal offset of 10 µSeconds will exist between ‘same time’ samples on consecutive channels.

The second consideration is stimulator timing. The stimulator updates occur 2.92 µSeconds after an analog data sample is collected. This ensures that the stimulator is not changing during the time that the Analog To Digital converter is sampling data.

It is best to keep in mind that these are constant temporal offsets, and in most instances should be ignored. The very concept of sampling data relies on the idea that the waveform of interest is not changing significantly between samples.