

APPENDIX F: IWX4XX HARDWARE MANUAL

Overview

The iWorx/4xx hardware in combination with LabScribe recording software provides a system that allows coordinated control of both analog and digital inputs and outputs. The hardware offers many benefits including low noise, high speed, range, resolution, and easy connections using the industry standard BNC connector. The iWorx/4xx interfaces with LabScribe software via the popular USB port. The USB port is the most current computer peripheral interface, and the iWorx/4xx 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.

Quick-view Specification Table

Analog Input:

Number of Inputs	4 (404) or 8 (408) or 16 (416)
Input Impedance	1Mohm
Input Range	± 10 Volt
Noise	~ 1mVolt Typical
Input Type	Single Ended BNC

Analog Output or Stimulator (408 and 416 only):

Number Of DACs	1
DAC Resolution	16 Bit
DAC Speed	100ks/S (Independent Of Sample Speed)
DAC Output Range	± 10 Volt
DAC Noise	< 1mVolt Typical
DAC Modes	Pulse, Train, Step, DC, Ramp, Triangle

Digital i/o

Digital Inputs	4
Digital Outputs	4

A/D Converter:

Sample Speed	100k samples/s aggregate for 408/416 10K samples/s per channel for 404
Resolution	16 Bit
Interface	USB

Power:

Wall Adaptor	5V DC, 1Amp (408 and 416)
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IX/404 is USB powered.

Included Items

The iWorx/4xx is shipped with the following:

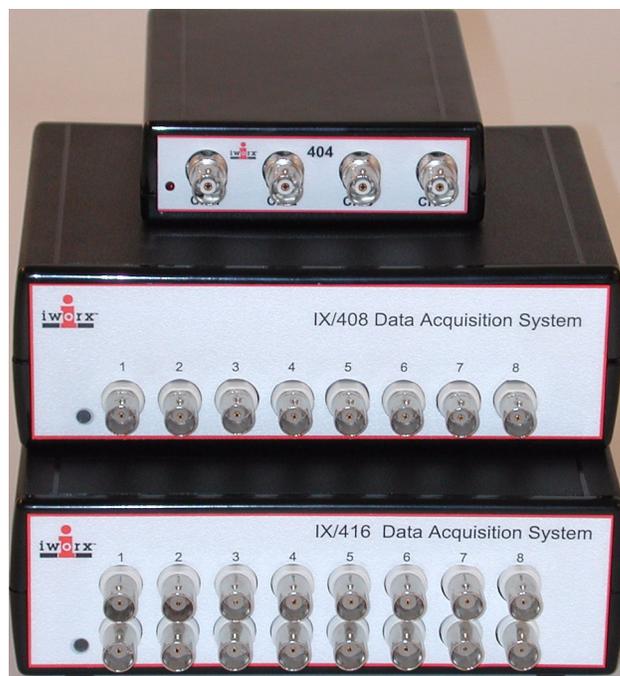
- 1 iWorx/4xx Hardware (1)
- 2 USB A-To-B Cable (1)
- 3 Power Adaptor (1)
- 4 BNC-To-BNC Cable (1)
- 5 LabScribe software CD (1)

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 power cable (408/416).
- 3 Connect the iWorx/4xx hardware to the computer via the USB cable.

Front Panel



Analog Inputs

The iWorx/4xx hardware contains 4/8/16 channels of analog input. These are single ended inputs, meaning that each signal is referenced to ground.

The input signal range is ± 10 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 -10 volts, 32,767 maps to 0 volts,



and 65,535 maps to +10 volts. One bit of resolution, often referred to as an LSB (Least Significant Bit), is then the total range (+10 volts minus –10 volts equals 20 volts) divided by 65,535 or 305 μ V.

The iWorx/4xx 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 $305 \pm 10 \mu$ V; as it is sampled, the digital output varies between 1 and 2 as the analog signal moves above and below 305 μ V with consecutive samples. In this case, $\pm 10 \mu$ V of noise appears as $\pm 305 \mu$ V because of the LSB size. The iWorx/4xx system noise is typically less than 1.2 mVolt, or 4 LSBs. This is measured with the input shorted to ground to eliminate external noise

The input impedance of each analog channel is 1 Mohm in parallel with 10pF to ground. This is typical of many data acquisition systems and most oscilloscopes and thus works well with many commonly available amplifiers and transducers. It should be noted that when running the hardware with an open input, the baseline voltage will be around 60 mVolt, not zero, because of the voltage developed across the input impedance by the input bias current of the input buffer. This baseline will not be present once a low impedance ($R_{IN} \ll 1$ Mohm) input to the buffer exists.

The aggregate sampling speed of the analog channels of the IX/408 or IX/416 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

IX/404 has a maximum sampling speed of 10ks/s on each channel.

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.

Analog Outputs (408/416 only)

The IX/408 and IX/416 hardware contains one analog or DAC (Digital to Analog Converter) output channel. The Stimulator output is with reference to ground. The connector is a single ended BNC connector located at the rear of the Box.

The output signal range is ± 10 Volts. The Stimulator is typically capable of sourcing and sinking up to 5 mAmperes of current when feeding a low impedance load. As with all Stimulator, compliance is a factor—simply put, driving 5 mAmperes through any load impedance greater than 2 kohms would, according to Ohm's law, generate a voltage larger than 10 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 two analog outputs is 10mV.

The noise on the stimulator outputs 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 channels 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 maximum rate of 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. 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 outputs of the iWorx/4xx hardware are 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.

Digital Inputs And Outputs

The iWorx/4xx Hardware contains 4 lines of digital input and 4 outputs. All digital inputs and outputs are TTL compatible and operate on a 5 Volt range. The digital outputs can each deliver up to 20 mAmperes.

Digital output scripts are defined in the LabScribe software and sent to the hardware as needed. Output changes are defined to occur on the order of seconds.