Go to www.ni.com/iworx to download software and courseware for your sensors.

Bioinstrumentation Sensor Package (P/N IXBIK)

GPSN-100 Gas Pressure Sensor
BP-220 Blood Pressure Sensor
FT-220 Hand Dynamometer
PTN-104 Pulse Sensor
TMN-100 Temperature Sensor
SPN-304 Spirometer (with flow head)
IX-ELADP NI ELVIS Sensor Breadboard Adapter
IX-MYDAQ myDAQ Sensor Adapter

Bioinstrumentation Sensor Add-On Package

HSMN-300 Heart Sounds Sensor
RMN-204 Respiration Belt
EMN-100 Event Marker
PHRMN-100 Polar Heart Rate Monitor
GNN-100 Goniometer

Chemistry/Ecology Sensor Package (P/N IXCEK)

CMN-100 Conductivity Probe
DCN-100 Drop Counter
TMN-100 Temperature Probe
GPSN-100 Gas Pressure Sensor
PHN-100 pH Sensor
CTSN-100 Colorimeter & Turbidity Sensor
DO2N-300 Dissolved Oxygen Probe
HSN-100 Humidity Sensor
IX-ELADP NI ELVIS Sensor Breadboard Adapter
IX-MYDAQ myDAQ Sensor Adapter

Physics Sensor Package (P/N IXPK)

FTN-5K Force Sensor
MSN-100 Microphone Sensor
MGN-100 Magnetic Field Sensor
TMN-100 Temperature Sensor
LSN-100 Light Sensor & Laser x 2
IX-ELADP NI ELVIS Sensor Breadboard Adapter
IX-MYDAQ myDAQ Sensor Adapter

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Intended Use

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BP-220 Blood Pressure Cuff

Overview

The BP-220 is a blood pressure cuff that can be used with the GSPN-100 gas pressure sensor to record the pressures in the cuff as it is inflated and deflated. The output of the pressure sensor is a voltage that is recorded by a data acquisition unit and converted into units of pressure (mmHg) by calibration.

After the blood pressure cuff of the BP-600 is placed on the upper arm of a subject, it is inflated to occlude the flow of blood in the subject's arm. As the pressure in the cuff is released, the return of blood flow in the arm can be monitored by either of two methods. In one method, an observer uses a stethoscope to listen for two characteristic sounds from the brachial artery that correspond to the systolic and the diastolic pressures of the subject. In the other method, a pulse plethysmograph is placed around the tip of a finger on the occluded arm. The recorded output of the transducer indicates the systolic pressure occurs when the pulse wave reappears and the diastolic pressure occurs when the pulse amplitude reaches a maximum.

Specifications

Input Range	0 – 300 mmHg
Output Range	0V to 0.7341V
Calibration	Required every use
Default scaling Value	1V = 408.6mmHg 0.2447V = 100mmHg

Calibration & Measurement

1. See GPSN-100 instructions.

CMN-100 Conductivity Probe

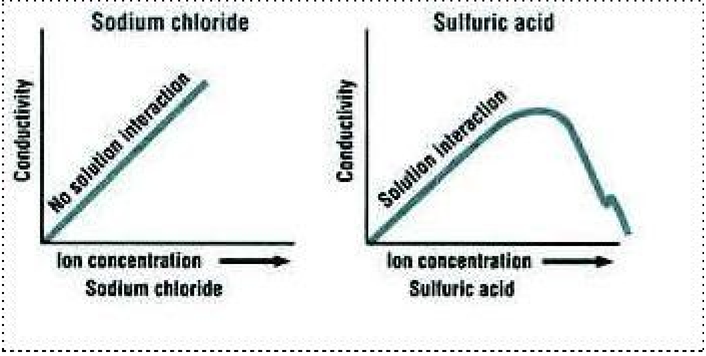
Overview

The CM-100 Conductivity Probe is intended for water quality testing, general chemistry and ecology experiments. It has two switch selectable ranges of 0-200 and 0-20,000 microsiemens. Exercises may include relating conductivity to temperature, measuring the conductivity of water samples from a variety of sources, and correlating conductivity to pH.

Conductivity is the ability of a substance to conduct an electric current. The principle by which conductivity is measured is fairly easy - two electrodes are placed in the solution, a potential is applied across the electrodes, and the current is measured. Conductivity (G) is the inverse of resistivity (R). This can be determined from the voltage and current values according to Ohm's law:

G = I/R = I (amps) / E (volts)

Since the ions in a solution facilitate the conductance of an electrical current, the conductivity of a solution is proportional to its ion concentration. Conductivity is generally measured in microsiemens (uS). Microsiemens are the modern units of the inverse of resistivity or mho.



In some situations, however, conductivity may not correlate directly to concentration. The graphs below illustrate the relationship between conductivity and ion concentration for two common solutions. Notice that the graph is linear for the sodium chloride solution, but not for a highly concentrated sulfuric acid solution. Ionic interactions can alter the linear relationship between conductivity and concentration in some highly concentrated solutions.

Ions that move through solution easily are better conductors. Small, fast moving ions like hydrogen (H+) have a greater conductivity than do larger ions like bromide ion (Br-), or heavily hydrated ions like the sulfate ion (SO42-).

Conductivity is a useful method for measuring how good a conductor a substance will be. Conductive substances are usually referred to as electrolytes. Thus, electrolytes are compounds that dissolve in water and dissociate into ions. In solutions of electrolytes, several different substances may be present, including complete, whole molecules and dissociated ions.

Strong electrolytes dissociate completely into ions. A 1.0 M solution of the strong ionic electrolyte “AB” contains 1.0 M “A+” ions, 1.0 M “B-” ions, and 0.0 M “AB” molecules. In other words, the ions are the only substances present in a solution of a strong electrolyte. Diluting a 1.0 M solution of “AB” with water to 0.50 M reduces the concentration of ions by one half, which also reduces the conductivity of the solution by one half.

Weak electrolytes dissociate incompletely, or do not fully separate into their respective ions. A 1.0 M solution of a weak electrolyte “CD” may contain less than 0.20 M “C+" ions, the same molarity of “D-” ions, and greater than 0.80 M “CD” molecules. In a solution of a weak electrolyte the main substance present is the entire molecule, not necessarily the dissociated ions.

The dissociation of a weak electrolyte is an equilibrium process, in which molecules are constantly dissociating, a forward reaction, and reforming, the reverse reaction, at identical rates. At equilibrium, the forward and reverse processes occur at the same rate, so molecules dissociate and reform at the same rate, and the concentrations of the molecule, its positive ions and its negative ions all remain constant.

The probability of spontaneous dissociation of a molecule is constant, but the probability of reformation of the molecule from its ions depends on the concentration of ions present; low concentration makes reformation infrequent which makes the reverse reaction slower. This means that diluting a weak electrolytic solution slows down the reverse reaction more than it slows down the forward reaction. After dilution, dissociation outpaces reformation until the concentrations of the ions rise, their reformation rate increases, and the rate of the reverse reaction rises to match that of the forward reaction. As a result, dilution leads to dissociation of additional molecules before equilibrium is reached again. So diluting a 1.0 M solution of a weak electrolyte to 0.50 M with water reduces the conductivity, but by less than the 50% expected with strong electrolytes.

Specifications

Input Range	Range: 0-200 and 0-20,000 microsiemens
Output Range	0V to 4V
Calibration	Required every use
Default scaling Value	**20 mS range:** -1.03 V is approximately 8.974 mS -1.43 V is approximately 15 mS **200 uS range:** -0.2 V is approximately 0.5 uS -0.8V is approximately 84 uS

Calibration Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.
2. Connect the MINIDIN7 connector of the CMN-100 to the IX-ELVIS board.
3. Open the recording software, select the channel that the CMN-100 is plugged into and ensure the range is set to 0V to 5V.
4. The CMN-100 should be calibrated within the expected range. For example: If the expected range is 500uS to 1000uS perform a 2 point calibration with the first point (SP1) at 400uS and the second point (SP2) at 1000uS.

Measurement Instructions

The Effect of Concentration on the Conductivity of Solutions

Aim: To determine the effect of concentration on the conductivity of various solutions.

Note: Always begin testing samples with the conductivity selector switch in the 0-200 uS range. While recording the conductivity of each test sample, toggle the switch to the 0-20,000 uS position. This is especially important for measuring solutions with higher conductivities.

Procedure:

1. Follow the calibration procedure above.
2. Add 50 ml deionized water to a 100 ml beaker.
3. Place the CMN-100 conductivity meter in the beaker and click Record.
4. When the recording on the Conductivity channel reaches a stable baseline, record that it is DI Water.
5. Add 1 drop of 1.0 M NaCl solution to the deionized water. Carefully swirl the CMN-100 to ensure thorough mixing. Record the event.
6. Add a second drop of 1.0 M NaCl solution to the beaker. Record the event as it reaches a stable value.
7. Add a third drop of 1.0 M NaCl solution to the beaker. Record the event as it reaches a stable value.
8. Continue following these steps until 10 drops of 1.0 M NaCl have been added to the beaker.
9. Click Stop to halt the recording.
10. Save the File.
11. Remove the conductivity meter from the beaker. Hold the meter over the beaker used for collecting waste deionized water, and rinse it with a wash bottle. Blot any drops of DI water from the meter and place the meter in the beaker containing fresh DI water.
12. Repeat steps 1 through 11 for both 1.0 M $CaCl_2$ and 1.0 M $AlCl_3$
13. Discard the contents of each beaker as directed by your instructor

Appendix

Cole parmer has a variety of these standards.
EW-00653-23: Oakton® conductivity solution 1 pint, 23 µS,
EW-00653-16: Oakton® conductivity solution 1 pint, 84 µS,
EW-00653-89: Oakton® conductivity solution 1 pint, 8974 µS,
EW-00653-50: Oakton® conductivity solution 1 pint, 15,000 µS,

CTSN-100 Colorimeter and Turbidity Sensor

Overview

The CTSN-100 Colorimeter and Turbidity Sensor performs two functions in one device. First the user can measure the absorption of the sample at the three different wavelengths provided by the Red, Green, and Blue emitters. Second, the user can measure the turbidity of the sample, using the infrared emitter to determine the turbidity of the sample.

Specifications

Blue Peak Wavelength	460nm
Green Peak Wavelength	520nm
Red Peak Wavelength	640nm
Infrared Peak Wavelength	880nm

Colorimeter-Mode:	
Input Range in Absorption	0 - 1.398
Input Range in Transmittance	100 - 4%
Output Range	2.5 VDC – 0.1 VDC
Calibration	25mV/(% transmittance)
Default scaling Value	0V – 0 % transmittance 2.5V – 100% transmittance

Turbidity-Mode:	
Input Range in NTU	50 - 1000 NTU
Output Range	0.1 VDC - 2.5 VDC
Calibration	Required with known standards
Default scaling Value	1.85mV/NTU

Background

Note *The cuvettes have an arrow marked on one side as a “key”, and the CTSN100 has a mark so that the cuvette may be inserted with the same alignment to ensure the alignment does not contribute to the measurement.*

The Red, Green, and Blue LED emitters are factory calibrated to generate +2.5 Volts (±1%) at the output for a cuvette filled with distilled water. Absorption equals 0% for +2.5 Volts at the output.

The light-sensor exhibits a “Dark Voltage”, which can be determined by blocking the light to the sensor through the cuvette cavity mechanically, and observing the output voltage when no light passes to the sensor. The device is specified to exhibit up to 100mV of “Dark Voltage”.

Absorption is not linear with output voltage. To calculate the Absorption, divide the nominally +2.5 Volt output—measured with a cuvette filled with distilled water—by the output voltage measured through the sample, and then take the LOG10 of that value.

Absorption = LOG10 (2.5 Volts / V_measured)

For V_measured equal to V_distilled_water, this results in Absorption equal to zero.

Assuming a worst case “Dark Voltage” of 100mV, the maximum absorption that the device is guaranteed to be able to resolve is:

Absorption = LOG10 (2.5 Volts / 0.1 Volts) = 1.398

Assuming a best case “Dark Voltage” of 0mV, the maximum Absorption that the device is practically capable of resolving is limited by the resolution of the data-acquisition system, typically no better than 1mV:

Absorption = LOG10 (2.5 Volts / 0.001 Volts) = 3.398

Transmittance—the ratio of the light at the input to the sample divided by the light at the output of the sample is related to Absorption according to the equation:

%Transmittance = 100*V_measured/2.5 = 10(2-Absorption)

Absorption = 2-LOG10 (%Transmittance)

For example, if the Transmittance equals 30%, then Absorption is:

Absorption = 2-LOG10 (30) = 0.523

Alternately, if the Absorption is known to be 0.25, then Transmittance can be calculated as:

%Transmittance = 10(2-0.25) = 10(1.75) = 56.23%

The three LED emitters provide options for measuring the absorption of a sample. The "Absorption Versus Wavelength" of any sample has some characteristic, known or unknown. In a simple case, the sample will absorb light at all wavelengths other than in a narrow band—typically exhibiting a "Bell Curve" or Gaussian shape—where it does pass light.

It should be noted that some strategy is required in choosing which LED emitter to use to measure a given sample. For example, if the sample appears red, the blue or green LED emitters are better choices than the red for performing the measurement on that sample. This is because the red sample appears red because it absorbs very little of the red portion of the light spectrum. An "idealized" red sample, centered at 640nM—the same wavelength as the red emitter, would have an "Absorption Versus Wavelength" graph that would have an Absorption equal to zero at 640nM, which would increase for the wavelength below and above 640nM to some larger value. Under this circumstance, regardless of the concentration of the sample, no significant amount of the light generated by the red-emitter will be absorbed, and so it is not useful to attempt to measure absorbance for this sample using this emitter. Assume however that the absorption increases to a value of 0.6 for wavelengths below and above 640nM—including at the 460nM and 520nM wavelengths of the blue or green emitters, and now the concentration of that color in the solution causes measurable absorption.

The Turbidity-Mode utilizes an infra-red LED emitter mounted at 90 degrees to the output-sensor, and the amount of light that couples through the sample is linearly proportional to the amount of particulate matter contained within the sample. The IR LED emitter is calibrated by measuring the voltage at the output-sensor for the 100 NTU and 400 NTU reference (National Turbidity Units) solutions provided, and performing a two-point calibration in software.

With no particulate matter within the solution, the output voltage is nominally zero—again, limited to the value of the "Dark Voltage" of the output-sensor, to within 100mV of zero. As the particulate matter increases, the amount of light that is reflected onto the output-sensor increases, and the output voltage increases.

Output-sensor values are in the range of 1.5 to 2.5 mV per NTU are not atypical.

Calibration:

Turbidity Mode:

1. Connect the iWorx Sensor Adapter to the myDAQ edge connector.
2. Connect the CTSN-100 to the iWorx Sensor Adapter
3. Connect myDAQ to your computer using a USB cable.
4. Set the sensor to Turbidity mode
5. Prepare a clean cuvette with the 100NTU standard. Label the cuvette.   Click Set for SP1
6. Prepare a different cuvette with the 400NTU standard. Label the cuvette. Click Set for SP2.

Colorimeter Mode:

1. Use default calibrations for colorimeter to measure transmittance.

Measurement Instructions

Colorimeter:

1. Prepare a clean, dry cuvette with the solution to be analyzed. Place in the CTSN-100 and close the cover.
2. Record Data. Use the red, green, and blue settings to analyze the concentration of the sample.
3. When the experiment is complete empty the cuvette, rinse and leave to dry.
4. Convert the transmittance value into absorption.

Turbidity:

1. Follow the calibration procedure above.
2. Prepare a clean, dry cuvette with the solution to be tested.
3 Record and determine the turbidity of the sample.
4. After the experiment is complete put the standard samples back into the vials. Ensure the standards are going into the correct vials.
5. Rinse out all cuvettes and leave to dry.

Appendix

Calibration Solutions

Hach: http://www.hach.com/

2660249 - StablCal® Turbidity Standard, 100 NTU, 500 mL,
7121649 - Turbidity Standard, StablCal®, 400.0 NTU, 500 mL,

Testing Beers Law:

The Beer–Lambert law, also known as Beer's law, the Lambert–Beer law, or the Beer–Lambert–Bouguer law relates the attenuation of light to the properties of the material through which the light is traveling. The law is commonly applied to chemical analysis measurements and used in understanding attenuation in physical optics.

*Great Value^{tm} brand food dyes used to color distilled water.

1. Four Base-Mixes were created, each with 50 mL Distilled water and 0.1 mL of Red, Blue, Green, and Yellow Dyes.

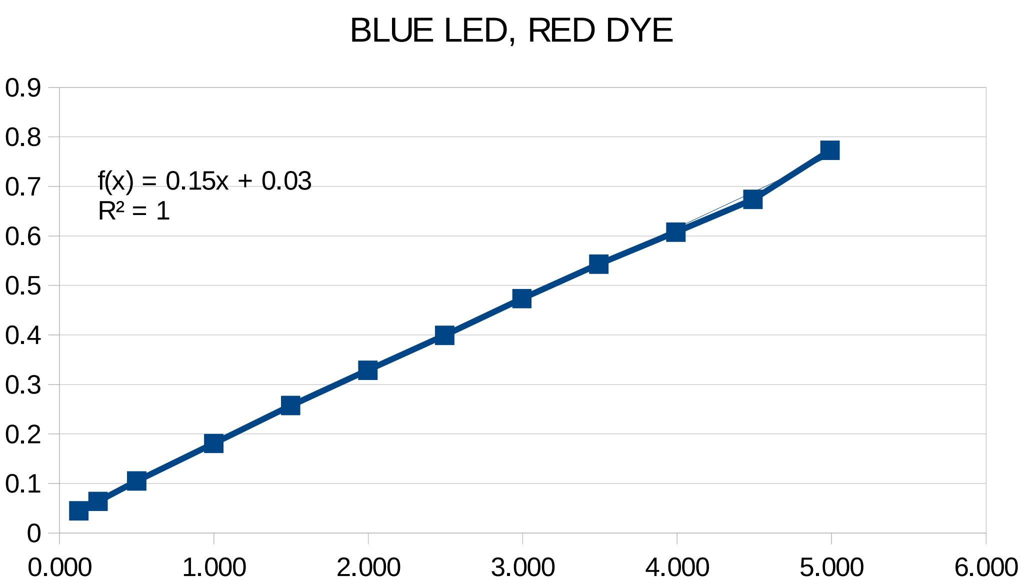
2. Separate 3 mL graduated syringes were used to draw from the Base-Mixes, and to draw from a beaker of distilled water to create the various concentrations of Base-Mixes diluted with Distilled Water at different concentrations from 100% down to 5%.

3. The “Dye Volume” column is calculated as (0.1 mL / 50.1 mL) x (1000 uL / 1 mL) x Base-Mix.

4. The Output-Sensor amplitude is measured for each of the three LED emitters, for each Dye color. Distilled-water measures 2.500 VDC after trimming. This is the reference amplitude. The 2.500 VDC reference-amplitude is divided by the resultant amplitudes measured for the various concentrations of dye and distilled-water. The LOG of that result is then graphed against the concentration of dye, and the result is linear.

5. The results of an typical experiment using Red Dye and the Blue LED are shown below

Dye (uL)	Blue Log (1/T)
4.990	0.6981022828
4.491	0.6523447922
3.992	0.6011922698
3.493	0.5432003228
2.994	0.4762535332
2.495	0.3970722871
1.996	0.3001622741
1.497	0.1752235375
0.998	-0.0008677215
0.499	-0.3018977172
0.250	-0.6029277129
0.125	-0.9039577085



DCN-100 Drop Counter

Overview

The Drop Counter is an optical sensor that accurately records the number of drops passing through the optical slot.

Specifications

Output Range	+/-5V
Calibration	N/A
Default scaling Value	N/A
Infrared Source	940nm
Drip Rate	2 Seconds or slower

Measurement Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the DCN-100 to the IX-ELVIS board.

3. Open the recording software, select the channel that the DCN-100 is plugged into and ensure the range is set to +/-5V.

4. Set the sensor so that drops fall directly through the center of the hole and are about 1" above the optical slot.

5. Test your system by sending a few drops through the sensor so

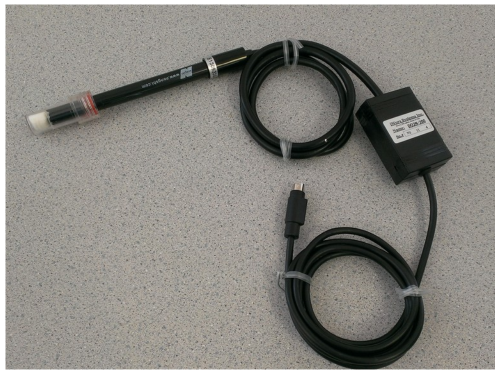
you see the signal on the waveform chart. A pulse will represent each drop.

6. Set the drip rate to 2 seconds per drop or slower.

7. Set the Threshold so that the voltage signal rises above it when a drop is detected but well above the baseline of the signal.

DO2N-300E Dissolved Oxygen Sensor

Overview



The DO2N-300E is a current to voltage adapter designed to work with a Clark-style oxygen electrode. This adapter delivers a polarizing voltage of -0.8V to the electrode to create a current, or flow of electrons, between the silver and platinum elements in the electrode. The flow of electrons between these elements increases and decreases as the concentration of oxygen in the polarograph chamber increases and decreases, respectively. The adapter then converts the changes in current to changes in voltage that can be recorded.

Specifications

Output Range	+/-5V
Calibration	Required every use
Default scaling Value	Water = 20% Diet Soda = 0%

Calibration Instructions

Warning!!! : *Hold the clear cap, when unscrewing the clear vial at the bottom of the electrode. You can also slide the clear vial off the electrode without unscrewing it.* ***DO NOT UNSCREW THE BLACK ELECTRODE****. Doing so may cause the electrode solution inside the electrode to spill. The composition of the electrode solution is listed in the appendix.*

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the

computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the DO2N-200E to the IX-ELVIS board. Wait 15 mins for the sensor to warm up.

3. Open the recording software, select the channel that the DO2N-200E is plugged into and ensure the range is set to +/-5V.

4. Prepare 2 beakers, 1 with diet soda and 1 with tap water. Ensure the volumes are the same.

5. Place the electrode of the DO2N-200E in the beaker with the water. Once the trace settles click Set for SP2 for 20 % dissolved oxygen.

6. Place the electrode in the beaker with the diet soda. Once the trace settles click Set for SP1 for 0 % dissolved oxygen.

Measurement Instructions

1. Follow the calibration procedure above.

2. Set up desired experiment and press record.

Appendix

The solution in the probe is :

95% Ethylene Glycol
0.3 Sodium Bicarb
0.01 KCl

you can buy replacement solutions from iWorx systems inc.

EMN-100 Event Marker

Overview

The EMN-100 is a hand-held, push button switch. When the button is pressed, the EMN-100 delivers a TTL pulse, which is displayed on the selected channel of the recording software.

Specifications

Input Range	N/A
Output Range	0V to 4.3V
Calibration	N/A
Default scaling Value	N/A

Measurement Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the EMN-100 to the IX-ELVIS board.

3. Open the recording software, select the channel that the EMN-100 is plugged into and ensure the range is set to 0V to 5V.

4. Press record and push the button when the desired event occurs.

FTN-5K Force Sensor

Overview

The FTN-5K utilizes load cell technology. A load cell is a force-sensing unit and is designed to measure a specific force ignoring other forces being applied. The FTN-5K is equipped with two ranges, 0-5kg and 0-500 grams.

The FTN-5K can be used in various experiments to study topics such as harmonic motion, friction, centripetal force, etc.

Specifications

Input Range	0 to 5Kg
Output Range	0.5V to 4.5V
Calibration	Required every use
Default scaling Value	Range 5kG: 0.3976 mV / gram Range 500 gm: 3.976mV /gram

Calibration Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the FTN-5K to the IX-ELVIS board.

3. Open the recording software; select the channel that the FTN-5K is plugged into and ensure the range is set to 0 to 5V.

4. Select the force range you would like to use (500g or 5Kg).

5. Start with no load on the force transducer and press Set for SP2 Voltage this will 'tare' the device for no load.

6. Hang a known mass from the force transducer, enter the value of the mass in SP1 Value, then press Set for SP1 Voltage.

7. If you change the force range you will need to recalibrate.

Measurement Instructions

1. Follow the calibration procedure outlined above.

2. Set up the desired experiment and press record.

FT-220 Hand Dynamometer

Overview

The FT-220 is used with the GPSN-100 Gas pressure sensor to measure grip strength.

Specifications

Calibration	N/A
Default scaling Value	N/A
Diameter	2"
Length	4.25"

Calibration Instructions

1. See GPSN-100 instructions.

Measurement Instructions

1. See GPSN-100 instructions.

GNN-100 Single-axis Goniometer

Overview

The flexibility of joints in the body can be determined by simple range of motion (ROM) tests. These ROM exercises can aid physical therapists, athletic trainers, and physicians when they are examining joint dysfunction.

Athletes and individuals who participate in physical activities generally are classified as being flexible due to the fact that their joints function over wide ranges of movement. Good flexibility may improve body position and awareness, enhance athletic performance, and help prevent injuries during and soreness after exercise. A joint's range of motion is expressed as the number of degrees of rotation that occur when the joint goes from its starting position, which is usually full flexion, through its full range of motion to its end position, which is usually full extension. The most common device used to measure range of motion is the single-axis goniometer. Examples of the types of movements that can be measured include: flexion/extension/hyperextension, abduction/adduction, and plantar flexion and dorsiflexion.

The GN-100 has two arms, one stationary and one moving, and a sensor which generates a voltage output which is proportional to the number of degrees of rotation that occur in the joint to which the goniometer is mounted. The stationary arm, which holds the sensor, is placed parallel to the stationary portion of the joint. The movable arm is placed along the moveable side of the joint. The axis of the goniometer is placed directly over the joint so that accurate measurements of the range of motion of the joint can be made along a single axis.

Specifications

Input Range	45° to 180°
Output Range	-2V to 3.5V
Calibration	Required every use
Default scaling Value	180° = 3.43V 90° = 0V 45° = -1.94

Calibration Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the GNN-100 to the IX-ELVIS board.

3. Open the recording software; select the channel that the GNN-100 is plugged into and ensure the range is set to +/-5V.

4. Use a textbook to set the GNN-100 to an angle of 90°, type 90 for the SP1 Angle and press set to record the voltage in SP1 Voltage.

5. Set the GNN-100 straight, enter '0' for SP2 Angle, and then press Set to record the voltage in SP2 Voltage.

You can download a calibration template from:
http://iworx.com/documents/technotes/GN-100-calibration.pdf

Measurement Instructions

1. Follow the above calibration instruction.
2. Prepare the experiment and record.

GPSN-100 Gas Pressure Sensor

Overview

The Gas Pressure Sensor can be used to measure pressure within a range of 20 to 250 kPa. It is used with the BP-220 for blood pressure experiments and with the FT-220 for grip strength experiments.

Specifications

Input Range	20 – 250 kPa
Output Range	0.2V to 4.8V
Calibration	Required every use
Default scaling Value	Vout for 760mm Hg is 1.86V Vout for 860mm Hg is 2.13V
Pressure range	20 - 250kPa
Connector	MINIDIN 7

Calibration Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the GPSN-100 to the IX-ELVIS board.

3. Connect the BP-200 using the A-BT-220 tubing to the GPSN-100.

4. Open the recording software, select the channel that the GPSN-100 is plugged into and ensure the range is +/-5V.

5. Ensure the manometer on the blood pressure cuff is at 0mmHg. Press record. Stop after a few seconds.

6. Using the manometer apply 200mmHg ensure it is steady and record for a few seconds.

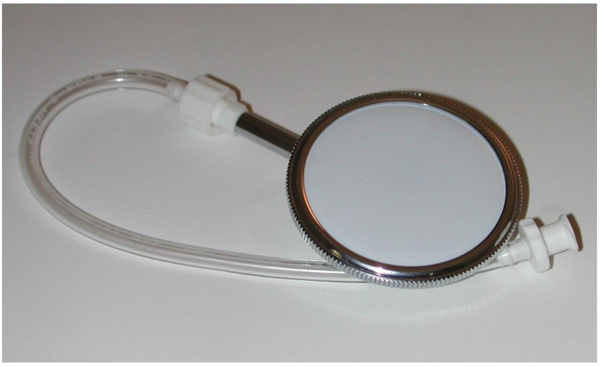
7. Perform a 2pt calibration using the lower voltage as 0mmHg and the higher as 200mmHg.

Measurement Instructions

Follow the calibration procedure outlined above.

HSMN-300 Heart Sounds Microphone

Overview



HSMN-300 hearts sound microphone plugs into the white connector of the SPN-304.

The spirometer unit contains a differential air pressure sensor that measures the difference in air pressure between the two ports. The HSMN-300 is connected to the white connector. When the heart beats it causes a small change in the volume of the chest cavity, which is picked up by the HSMN-300. The heart beat pushes the HSMN-300 membrane in, increasing the pressure in the HSMN-300. This increase in pressure is measured by the pressure sensor in the SPN-304. The SPN-304 will produce a voltage, which is directly proportional to this pressure. It is this voltage that is recorded.

Specifications

Length of Tubing	6"
Connector	Luer
Calibration	N/A
Default scaling Value	N/A

Measurement Instructions

1. Place the SPN-304 in the HeartSounds mode, using the switch.

2. Connect the HSMN-304 to the white connector of the SPN-304.

Please refer to the SPN-304 Instructions.

HSN-100 Relative Humidity Sensor

Overview

The HSN-100 can provide measurements of relative humidity from 20 to 85% (+/-5%) over a temperature range from 0°C to +50°C.

The HSN-100 is a sensor designed for measuring the relative humidity (RH) in environmental chambers, plant growth chambers, model ecosystems, or the atmosphere.

Specifications

Input Range	20% to 85% RH (+/- 5%)
Output Range	0.2V to 0.85V
Calibration	0 %RH = 0 100 %RH = 1V

Measurement Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the HSN-100 to the IX-ELVIS board.

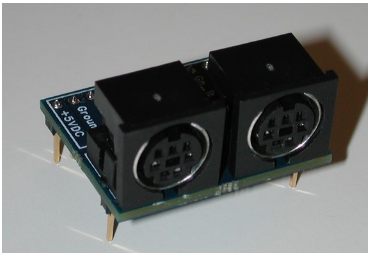
3. Open the recording software; select the channel that the HSN-100 is plugged into and ensure the range is set to 0V to 1V.

4. Multiply the output voltage in Volts by 100 to get the %RH.

IX-ELADP Adapter Board for Use with the IX-ELVIS

Overview

The IX-ELADP is a small adapter board used to interface iWorx Systems transducers to breadboards on the stock NI ELVIS II SERIES PROTOTYPING BOARD component of the NI ELVIS system manufactured by National Instruments.



It is an open PCB with 2 MINIDIN7 connectors that allow access to the analog outputs from the transducers.

Specifications

Input Range	+/- 5V
Output Range	+/- 5V
Calibration	N/A
Default scaling Value	N/A
Input connectors	MINIDIN 7 (x2)
Pin dimensions	1.225"L X 1"W
Height above breadboard	0.737"

Using the IX-ELADP

There are many configurations to utilize this adapter. The below outlines a few:

Inserting the IX-ELADP into the breadboard:

The IX-ELADP connects to the breadboard with a 0.1" pitch, 12-pin SIP connector and 2 single-pin mechanical support pins. The support pins are located under the MINIDIN7 connectors at the PCB corners located 0.7" from the 12-pin SIP connector. The mechanical support pins are not connected to any electrical node, this limits the opportunity to inadvertently cause an electrical short on the breadboard.

Power Supply Overview:

The topside of the adapter is populated with the two MINIDIN7 connectors, and the silkscreen describing the pin functionality of the electrical nodes on the 12-pin SIP connector. There are 3 sections, power, channel 1, and channel 2. The power section has two Ground pins, a +5 VDC pin, and a -15 VDC pin. These connections allow the adapter to be powered from the NI ELVIS +5V and -15V supplies. A negative linear regulator on the bottom of the adapter PCB is powered by the ELVIS -15V supply, and outputs -5V to the coupled transducers. The ELVIS +5V supply is simply channeled directly to the channel 1 and channel 2 transducers.

The PCB bottom side linear regulator is populated with a SOT223-4 packaged component capable of dissipating the heat generated by the 10V input-output differential multiplied by the current drawn by the channel 1 and channel 2 transducers. Typical transducers are limited to less than 40mA, providing a likely maximum heat dissipation of 800mW (2 x 40mA x 10V). The PCB sinks heat from the linear regulator into the ELVIS -15V copper plane. The plane has the solder mask removed to maximize heat transfer, and it is important that this plane is not shorted to GROUND or other nodes while prototyping. When properly used, the exposed heat sink is inaccessible.

Care must be exercised to ensure that the prototyping loads do not overload the ELVIS power supplies. The ELVIS ii Hardware User Manual “Appendix A” specifies that the +5V supply provide +5 V at ±5% no load, limited to 2A. The -15V supply provides -15 V at ±5% no load, and combined with the -15V variable supply is limited to 500mA. It is advised that the user read the ELVIS ii Hardware User Manual to understand the capabilities and limitations of the provided power supplies, including the load regulation specifications.

Using the gain capability:

Each Channel provides four electrical node connections, differential analog outputs, and connections to both nodes of a gain set resistor embedded in transducers that typically require gain from an instrumentation amplifier. Many transducer outputs are single-ended, and for these, one of the differential analog outputs will be internally grounded in the transducer.

For transducers that do provide a differential output, it may be driven into the NI ELVIS differential ADC analog inputs without gain, or it may first be routed to a gain block on the breadboard. If the gain set resistor

(Rgs) provided in some transducers is to be used, the gain-block should conform to a nominal gain equation of G=((50K/Rgs)+1) as is typical of AD620 or LT1167 instrumentation amplifiers in order for the transducer gain set resistor to appropriately configure the gain applied to the transducer output.

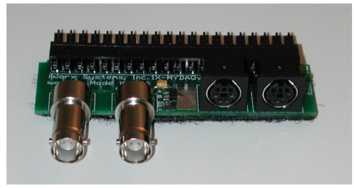
PCB pin out

Pin	Pin Function	Description
A_+	Ch 1 Positive Analog Input	Output to ELVIS Breadboard
A_-	Ch 1 Negative Analog Input	Output to ELVIS Breadboard
Gn_1A	Ch 1 Gain-Set Resistor End "A"; No polarity	Output to ELVIS Breadboard
Gn_1B	Ch 1 Gain-Set Resistor End "B" No polarity	Output to ELVIS Breadboard
A_2+	Ch 2 Positive Analog Input	Output to ELVIS Breadboard
A_2-	Ch 2 Negative Analog Input	Output to ELVIS Breadboard
Gn_2A	Ch 2 Gain-Set Resistor End "A" No polarity	Output to ELVIS Breadboard
Gn_2B	Ch 2 Gain-Set Resistor End "B" No polarity	Output to ELVIS Breadboard
Ground	Ground connection	Connection to ELVIS System ground
-15VDC	Negative 15 Volt DC supply	Input from ELVIS System power supply
Ground	Ground connection	Connection to ELVIS System ground
+5VDC	Positive 5 Volt DC supply	Input from ELVIS System power supply

The ground connections are equivalent

IX-MYDAQ Breakout board for NI myDAQ

Overview



The IX-MYDAQ is a breakout board that enables connection of iWorx transducers to the National Instruments NI myDAQ data acquisition device via mini DIN 7 connectors. Also, the IX-MYDAQ utilizes the NI myDAQ analog outputs via two BNC connectors.

Specifications

Input Range	+/- 5V
Output Range	+/- 5V
Excitation voltage	+/- 5V
Default scaling Value	N/A
Analog Inputs	MINIDIN7(x2)
Analog Outputs	BNC (x2)

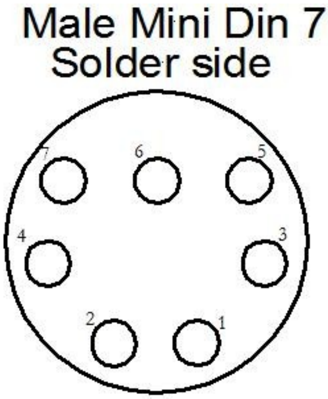
Measurement Instructions

1. Connect the IX-MYDAQ to the NI myDAQ. Plug a USB cable into the top of the NI myDAQ and the other end into the computer being used.

2. Connect the desired transducer to the IX-MYDAQ and record.

3. See the individual transducer instructions for detailed calibration and use procedures.

MINI DIN 7 Connector Wiring



Pin Descriptions:
1: Positive Power
2: Negative Power
3: Ground
4: Gain
5: Positive Signal
6: Negative Signal
7: Gain

Gain Equation
Gain = (49.4kΩ/Rg)+1
Rg = Gain set resistor

Typical Gain set resistor values
Gain = x10 = 5.49kΩ resistor
Gain = x100= 499Ω resistor

*Note: The IX-ELVIS board has gain connections on it, however the IX-MYDAQ does not.

LSN-100 Light and Laser Sensor

Warning: Laser Radiation – Avoid Direct Eye Exposure

Overview

The LSN-100 light and laser sensor combines a laser and a light sensor in the same unit. Each LSN-100 will come with reflective tape, which the laser will be focused onto. The sensor can be placed up to 1 foot away from the tape. When the beam between the laser and tape is broken a corresponding signal will appear in the recording screen.

The student can use just one sensor to study objects such as a pendulum, or two can be used for a variety of other experiments.

Specifications

Output Range	+/-5V
Laser power	< 5mW
Laser class	IIIa
Laser Wavelength	650nm
Laser color	Red

Measurement Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform.
2. plug the LSN-100 to the adaptor board.
3. Open the recording software; select the channel that the LSN-100 is plugged into and ensure the range is set to +/-5V.
4. Set up the sensor and the tape so that the laser is focused on the tape and the object is in between the tape and the sensor.
5. For a pendulum, set the beam in the path at the lowest point of the swing.
6. The voltage goes up when the laser is shined on the light sensor and down when the path is blocked.

MGN-100 Magnetic Sensor

Overview

The MGN-100 Magnetic Field Sensor is a hall-effect sensor that outputs a voltage linear with magnetic fields in the range of -420G to +420G. It can be used in a variety of experiments that involve magnetic fields, such as studying the field around coils and permanent magnets.

Specifications

Voltage Output	0V-4.6V
Magnetic Range	-420G to +420G
Default scaling Value	0G = 2.5V; +420G = 4.6V; -400G = 0.4V
Typical Sensitivity	5.0 mV

Measurement Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the MGN-100 to the IX-ELVIS board.

3. Open the recording software; select the channel that the MGN-100 is plugged into and ensure the range is set to 0V to 5V.

MSN-100 Microphone

Overview

The MSN-100 microphone can be used to record, display and study the waveforms of various sounds such as voices and musical instruments.

Specifications

Calibration	N/A
Default scaling Value	N/A

Measurement Instructions

1. Connect the NI myDAQ to your computer using a USB cable.

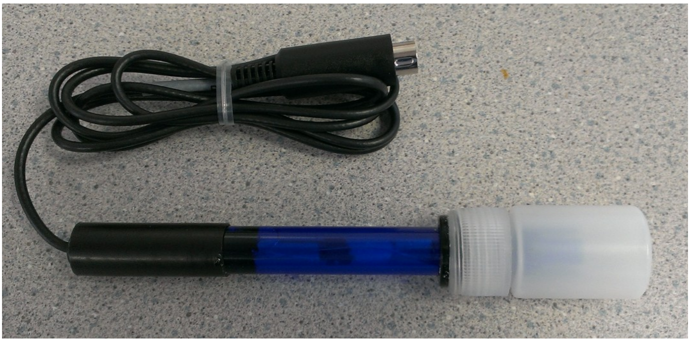
2. Connect the MSN-100 microphone to the Audio In port on the NI myDAQ.

3. Record desired sound.

PHN-100 pH Electrode

Overview

The PHN-100 pH Electrode is an easy-to-use pH electrode that is capable of measuring the acidity of solutions with pH values from 0 to 12. PHN-100 is a combination electrode with the recording and reference electrodes included in the same housing. The plastic housing at the end of the electrode protects the glass membrane and reduces the probability of the electrode breaking as it is handled.



Specifications

Input Range	pH range 0-12
Output Range	+/- 500 mV
Calibration	0 mV = 7 pH
Default scaling Value	59 mV/pH
Length	3.5 inches
Diameter	0.49 inches

Measurement Instructions

1. Connect the iWorx Sensor Adaptor to myDAQ.
2. Connect the pH sensor to the iWorx Sensor Adaptor
3. Connect the myDAQ to your computer using a USB cable.

***Note**:Before and after the electrode is placed in the solution being measured, rinse the electrode and its housing with deionized water from a wash bottle. Blot any drops of water from the probe with laboratory wipes.*

4. Place the electrode in the solution being measured. Set the stirrer that mixes the solution to a speed that allows the stir bar to rotate smoothly.

5. Once the recording of the pH level in the solution has reached a stable line, mark the recording with a comment to indicate the pH of the solution.

Appendix

The liquid in the vial of the pH probe is : 3M KCl.

It is available from Cole Parmer EW-58905-82 : 3M KCL Fill Solution, 250 mL (Reference Fill Solutions)

The following calibration solutions can be used for calibrating the pH Probe:

Omega:

1) PHA-4 - 4.01 pH buffer solution 500 ml (1 pint) bottle

2) PHA-7 – 7.00 pH buffer solution 500 ml (1 pint) bottle

3) PHA-10 - 10.01 pH buffer solution 500 ml (1 pint) bottle

Coleparmer:
1) EW-05942-10 - Oakton buffer 3 pack, 500-ml each of 4.01, 7.00, and 10.00 buffer

PHRMN-100 Polar Heart Rate Monitor

Overview

The PHRMN-100 PolarTM Heart Rate Monitor incorporates technology developed by Polar Electro, the leader in heart rate monitoring for the fitness industry, into the myDAQ system.

With the PHRMN-100, the voltage changes that take place during an electrocardiogram are picked up by two electrodes on the inside of a band around the subject's chest. These voltages are transformed into simple coded signals by the transmitter connected to the electrodes. The transmitter broadcasts the coded signals to a receiver that is connected to the data recording system. Since the frequency of the coded signals from the transmitter correspond to the heart rate of the subject, a periodic rate function in the recording software is used to convert the frequency of the coded signals into a display of the subject's heart rate. This technology enables relatively noise-free heart rate determination to be made from resting or exercising subjects.

Specifications

Calibration	N/A
Default scaling Value	N/A
Water Resistance	Water resistant up to 100 feet/30 meters
Battery Type	CR 2025
Battery Life	Average 2 years (1h/day, 7 days/week)

Measurement Instructions

1. Detach the WearLink™ coded transmitter from the sensor band.

2. Moisten the electrode areas of the sensor band under warm running water. Make sure these areas are well moistened.

3. Adjust the length of the sensor band to fit snugly and comfortably around the chest of the subject. Secure the sensor band around the subject's chest so that the electrodes are just below the chest muscles.

4. Attach the transmitter to the sensor. The PolarTM logo should be upright. Adjust the sensor band so that the transmitter is in the center of the chest.

5. Check that the wet electrode areas of the sensor band are firmly against the subject's skin.

6. Set up the receiver so that it is no more than 1 meter away from the transmitter. Use the supplied extension cable if necessary.

7. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

8. Connect the MINIDIN7 connector of the PHRMN-100 to the IX-ELVIS board.

9. Open the recording software, select the channel that the PHRMN-100 is plugged into and ensure the range is set to +/-5V.

10. Press record. Once you see the heart signal on the waveform chart, press the Calibrate button to automatically set the threshold.

PTN-104 Pulse Plethysmograph

Overview

The PTN-104 plethysmograph, with MINI DIN 7 connector, is a sensitive, rugged, non-magnetic accelerometer, ideal for classroom use. It is small in size and plugs directly into the IX-MYDAQ or IX-ELVIS recorder inputs requiring no auxiliary power. When used as a pulse sensor, the PTN-104 produces a signal from which rates and relative pressure information can be computed. The real-time integral of this signal is identical to volume pulse signals recorded with more expensive infrared pulse plethysmographs.

Applications include measurement of peripheral pressure pulses and Korotkoff sounds and small animal respiratory activity. Because the PTN-104 is self-powered, it does not require a conditioning amplifier.

Specifications

Typical pulse output	200mV
Calibration	N/A
Default scaling Value	N/A
Connector	MINIDIN 7

Measurement Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.
2. Connect the MINIDIN7 connector of the PTN-104 to the IX-ELVIS board.
3. Open the recording software, select the channel that the PTN-104 is plugged into and ensure the range is set to +/-0.5V.
4. Wrap the velcro around the PTN-100 and the finger snugly.
5. Press record, relax the hand and observe the pulse.

RMN-204 Respiration Monitor

Overview

The RMN-204 Respiration Monitor is a transducer used to measure the relative depth and frequency of breathing in a human subject during experiments where it is impractical to monitor breathing with a spirometer.

For example, the use of a spirometer to monitor breathing during a psychological test could be a distraction that affects the results of the test. If the subject is not familiar or comfortable with breathing through a spirometer, the subject cannot focus on completing the test. The RMN-204 permits breathing rates and relative amplitudes to be measured easily, accurately, and unobtrusively while the subject performs another task.

Specifications

Calibration	N/A
Default scaling Value	N/A

Measurement Instructions

1. Take the RMN-204 and hold the belt up, it should be orientated so that the pouch velcroed to the belt is facing the subject. Place the sensor so that it is resting on the subjects' sternum and wrap the belt around the subject. The belt should be tight enough to resist falling, but not so tight as to restrict the subjects' ability to breathe comfortably.

2. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

3. Connect the MINIDIN7 connector of the RMN-204 to the IX-ELVIS board.

4. Open the recording software, select the channel that the RMN-204 is plugged into and ensure the range is set to +/-5V.

5. Record and monitor the subjects breathing. As the subject breathes in the voltage should rise, and as the subject breathes out the voltage should fall.

6. Clear the chart and breathe in and exhale 3 times, so three peaks are shown on the chart.

7. Press the Calibrate button to set the threshold limits.

SPN-304 Spirometer

Overview

The SPN-304 flow spirometer measures volumes and flows from normal breathing. It contains a differential air pressure sensor that measures the difference in air pressure between the front and rear sides of the mesh screen in the flow head. When the spirometer is assembled, blowing into the mouthpiece will produce a measurable pressure difference across the screen in the flow head. The sensor will produce a voltage, which is directly proportional to the pressure. It is this voltage that is recorded.

The SPN-304 Flow spirometer consists of three parts:
An electronic sensor and amplifier
A disposable or reusable flow head
Polyethylene tubing used to attach the flow head to the sensor

The SPN-304 has 2 modes of operation, the Spirometry mode and Heart Sounds mode. When placed in the Heart Sounds (HS) mode it can also be used with the HSMN-300 to record Heart Sounds.

Specifications

Input Range	-2 kPa to 2 kPa
Output Range	0.5V to 4.5V
Calibration	Required every use
Default scaling Value	Written on individual unit in mmH2O
Sensitivity	26.4mmHg/V
Connector	MINIDIN7

Volume Calculation

When used with the flowhead provided, the voltage recorded from spirometer can be converted to a flow in liters/sec as follows:

```
double uncalibrated_flow =  voltage from spirometer;

double abs_flow = fabs(uncalibrated_flow);

double fit = 6.7045 + 4.7257*abs_flow + -67.1598*abs_flow*abs_flow +
           343.273876*abs_flow*abs_flow*abs_flow +
-554.495238*abs_flow*abs_flow*abs_flow*abs_flow;

double calibrated_flow = uncalibrated_flow*fit;
```

calibrated_flow is in liters/sec, and this has to be integrated to get the volume.

```
volume += (m_last_value + calibrated_flow)/sampling_speed;
```

where m_last_value is the previous calibrated_flow value.

Measurement Instructions

Spirometer:

1. Follow the calibration procedure listed above.

2. Place the SPN-304 in the spirometer mode, using the switch.

Connect the flowhead to the spirometer using the included tubing.

3. Be sure to allow 15 minutes after you plug the spirometer in to warm up. After the warm-up period, when you blow into the mouthpiece you should see the air-flow trace move up or down.

4. The spirometer has an output of about 1Volt for 26.4 mmH2O pressure difference.

Heart Sounds:

1. Place the SPN-304 in the HeartSounds mode, using the switch.

2. Connect the HSMN-304 to the white connector of the SPN-304. Optionally, Plug the Red input of the SPN-304 using the RED blocking cap.

Cleaning the FlowHead

Every time a subject uses a spirometer, he or she should use a clean spirometer flowhead and clean tubing to prevent the potential transmission of respiratory infections from subject to subject. Use gloves while cleaning flowheads and tubing.

Start the cleaning process by disconnecting the tubing from the flowhead. Immerse the flowhead and tubing completely in a pan containing a 5% bleach solution for 5-10 minutes. Periodically, agitate the flowhead while it is submerged in the cleaning solution; swish it back and forth in the cleaning solution for 10-15 seconds every minute. After agitating the flowhead each minute, lift the tubing from the pan and let the tubing drain. Return the tubing to the pan, so that it fills with cleaning solution and soaks for another minute.

At the end of the cleaning period, remove the flowhead and tubing from the pan of cleaning solution. Set them on some paper towels to drain as you put on clean gloves. Rinse the flowhead and the tubing with deionized water at least 6 times. Use a squirt bottle of deionized water to rinse the lumen of the tubing and the crevices inside the flowhead. Drain the final rinse water from the flowhead and the tubing by setting them on some fresh paper towels.

For the flowhead to function properly, the flowhead and its tubing must be dry. Water on the screen in the flowhead or in the tubes impairs airflow. To dry the tubing more rapidly, use a can of compressed air to remove any moisture. If your laboratory has a compressed air system, do not use it unless the system has a filter to remove the oil that condenses in the air lines. To insure there is no moisture in the flowhead, dry the flowhead with a hair dryer. Reassemble the flowhead and tubing, and attach them to the spirometer.

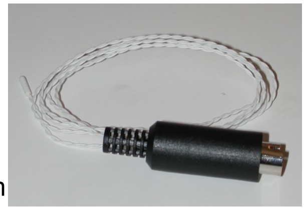
Do not clean the flowhead with alcohol. Alcohol degrades plastic and causes the flowhead to disintegrate. A well-cleaned and maintained plastic flowhead can last for years.

While disposable electrostatic bacterial filters can be used on flowheads, they do not guarantee the removal of respiratory viruses from the air entering the flowhead.

Most users purchase a second flowhead for each station so a clean flowhead is available for the next subject, as the other flowhead is being cleaned and dried. The whole cleaning process usually takes 20 minutes.

TMN-100 Temperature Sensor

Overview



The TMN-100 is a self-contained temperature transducer with a range of 0oC to 50oC. The TMN-100 is capable of responding to changes in temperature within a few seconds because of its small size (1mm x 3mm) and mass. The TMN-100 is suitable for monitoring the temperature of nasal airflow, changes in skin temperature that indicate evaporative cooling, and changes in atmospheric temperature and temperature in environmental chambers. Since the sensor element is water-resistant, the tip of the TMN-100 can be immersed in aqueous solutions, including saline solutions, for a few hours.

Specifications

Temperature Range	0 - 50°C
Calibration	Required every use
Default scaling Value	Temp in °C = 9.875*Volt + 31.98

**Note*: If the default scaling equation is used instead of the calibration procedure a look up table may need to be used as that equation is non-linear.*

Calibration Instructions

1. Plug the IX-ELVIS board into the National Instrument ELVIS platform. Connect the power supply to the ELVIS platform and connect to the computer via a USB cable. Ensure both of the switches are in the on position.

2. Connect the MINIDIN7 connector of the TMN-100 to the IX-ELVIS board.

3. Open the recording software, select the channel that the TMN-100 is plugged into and ensure the range is set to +/-5V.

4. Prepare two beakers of water, one at 30oC, and the other at 40oC. Measure the temperature of the cold water with a thermometer just before the TMN-100 temperature sensor is placed in the beaker.

5. Place the tip of the TMN-100 temperature sensor in the center of the beaker of cold water. Click the start button of the recording software and record for about 20 seconds.

7. Measure the temperature of the warm water with a thermometer just before the TMN-100 temperature sensor is placed in the beaker. Click the start button of the recording software and record for about 20 seconds.

8. Click stop and perform a 2 point calibration using the stable sections of the output signals.

Measurement Instructions

1. Follow the calibration procedure above.

2. Prepare the sample(s) and press record.