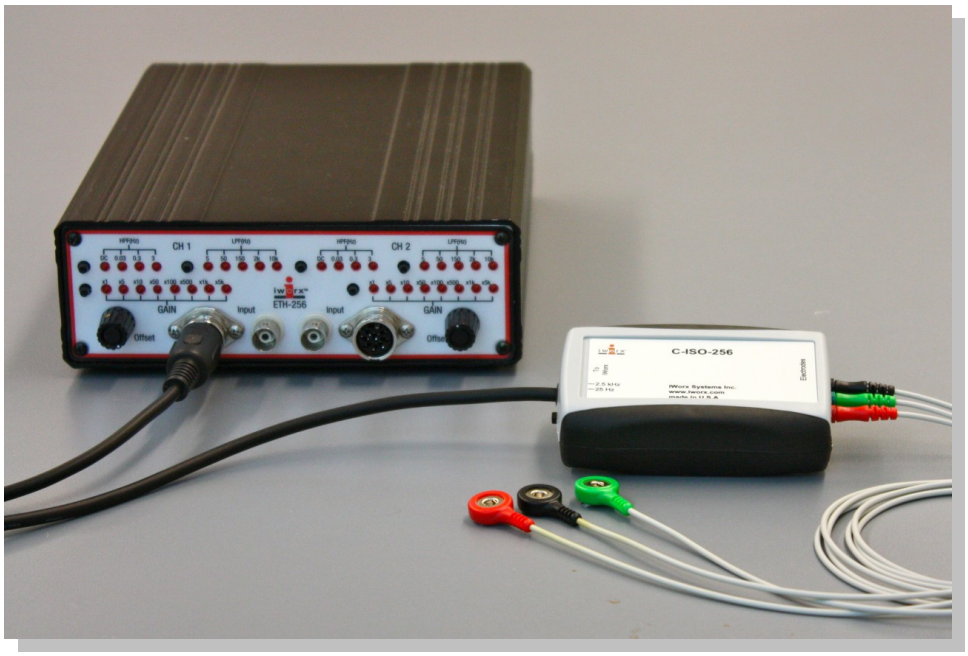
ETH-256 Amplifier with Isolated Headstage

Hardware Manual

ETH-256



ETH-256C

Overview

The ETH-256 is a high performance general-purpose life science research amplifier. Its high input impedance and high Common Mode Rejection allows low noise recording of biopotential signals, as well as outputs from strain gauge type transducers, including force, displacement, and pressure transducers. The ETH-256C includes the C-ISO-256 isolated headstage for recording ECG, EMG, and EEG signals from humans.

The ETH-256 offers eight gain settings: x1, x5, x10, x50, x100, x500, x1k, and x5k. Signals may be further conditioned using high- and low-pass frequency filters. All

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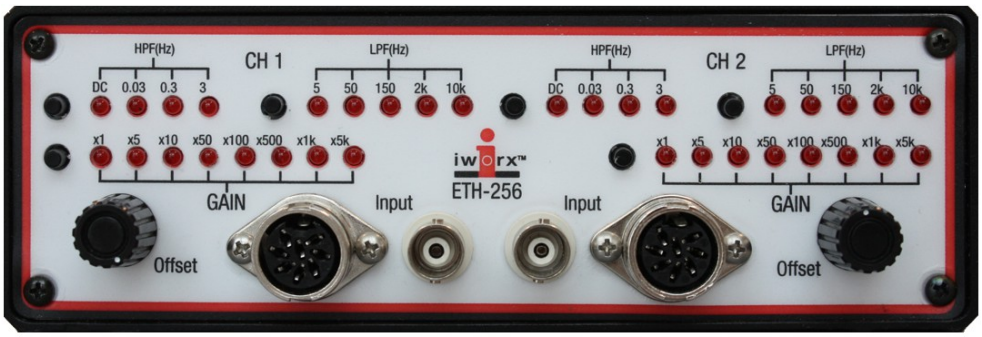
filters are four-pole active design with sharp roll-offs. High-pass filter cuts, useful for biopotential measurements, are available at DC, 0.03 Hz, 0.3 Hz, and 3 Hz. Low-pass filters, for limiting high frequency noise, are available at 5 Hz, 50 Hz, 150 Hz, 2k Hz, and 10k Hz.

Either of the ETH-256 amplifier's channels may be configured as a bridge-style transducer amplifier or as a biopotential amplifier. In Bridge mode the ETH-256 amplifier's 10 gigohm input impedance and differential input allow it to accept input from force, displacement, or pressure transducers. In addition, input from many thermistors, pH electrodes, and other variable resistance devices is possible. In the Biopotential mode, the ETH-256 functions as a low noise AC-coupled preamplifier.

Included Items

ETH-256 Two-channel Combination Bridge/ECG/EMG/EEG Amplifier
ETH-256C includes an Isolated Headstage (C-ISO-256)
Two10 ft. BNC-BNC cables (C-BNC)
Two-conductor 12 VAC power supply with a 3.5mm output plug (A-P12-AC-3.5)
Package of 50 disposable electrodes (A-GC-7165)

Front Panel



The ETH-256 is divided into two units or channels with identical functions that are capable of making low noise, AC-coupled recordings of bioelectric potentials, or DC-coupled transducer recordings.

Each channel can provide ±5.0V of excitation at 50 mA, adequate for most commonly used transducers. In addition, customers may specify adapter cables to accommodate Grass, Gould, or HP sensors.

High-Pass Filter [HPF(Hz)]

The high-pass filter has four positions. Each time the button is pushed, the filter advances, in step-wise fashion, to the next filter as indicated by the LEDs. The DC position directly couples the input to the amplifier and is used for measuring from wheatstone bridge-style transducers or other ground-referenced sensors requiring impedance conversion, such as pH electrodes or ion-selective electrodes (ISEs).

There are three AC-coupled, high-pass filter settings: 0.03, 0.3, and 3 Hz. For ECG, EEG, and EOG recordings, 0.3 Hz is normally used; for EMGs, 3 Hz is commonly used. The result of using a high-pass filter with a higher value is the creation of a more stable recording baseline; contributions from body movement or breathing can be removed with high-pass filter settings.

Low-Pass Filter [LPF(Hz)]

The low-pass filter control sets the upper limit of frequencies measurable by the ETH-256. The setting labeled 10k offers a maximum frequency response of about 10k Hz. Other settings may be chosen to limit noise. For example, the 50 Hz filter removes signals above 50 Hz. AC noise at 60 Hz, the most common source of electrical interference, would be filtered from the recording along with any other frequencies above 50 Hz. For very slow (low frequency) signals, such as the output of a force or pressure transducer, the 5 Hz setting will provide the quietest recording.

Gain

The gain of each channel on the ETH-256 can be adjusted independently. This allows very small signals to be amplified before presentation to the display device. The gain control push-button allows you to select among eight preset multipliers: x1, x5, x10, x50, x100, x500, x1k, and x5k.

Input Offset

The position of the recording baseline, in either Bridge (DC) or Bio (0.03, 0.3 and 3 Hz) mode, can be moved up or down by using the Input Offset knob. This control is very important in Bridge mode where the output of a transducer may need to be zeroed, or the maximum height of the recording display area may need to be set.

Input

The input connectors are either BNC connectors for single-ended devices, or DIN8 connectors for transducers, isolation pods, headstages, and current-to-voltage adapters.

Rear Panel

ETH-256 Amplifier with Isolated Headstage

The BNC output connectors for the ETH-256 are located on the rear panel. They can be cabled to your data acquisition system using a BNC-BNC cable. The power transformer input and the power switch are also found on the rear panel of the ETH-256.

The C-ISO-256 Isolated Headstage

The ETH-256C comes with a 3-lead isolated headstage (C-ISO-256). This cable may be used on either channel of the ETH-256. The C-ISO-256 contains an optically isolated output stage.

The C-ISO-256 amplifies the signal x400, and the output should be between 0.5 and 5VDC. There is a switch on the isolation unit that sets the low-pass filter to 25 Hz (useful in ECG and EEG recordings) or 2.5k Hz (useful when recording EMGs).

Technical Data and Specifications

SPECIFICATIONS - ETH-256	
Number of channels	2
Operational Modes	Bridge, Biopotential (ECG, EMG, EOG, EEG)
Gain	x1, x5, x10, x100, x500, x1K, x5K (push-button selectable)
Low-pass Filter	4-pole active filters at 5, 50, 150, 2K and 10K Hz
High-pass Filter	4-pole active filters at DC, 0.03, 0.3, and 3 Hz
Input Impedance	10 gigohm
Output Impedance	10 ohm
CMR	100dB @ 60 Hz
Offset Range	± 5VDC
Input Range	± 5VDC
Input Connectors	DIN8 and BNC
Isolation	Optical with optional C-ISO-256C headstage
Noise	<10mV (RTI) / < 2µV (RTO)
Transducer Excitation Voltage	± 5VDC
Current	50mA / channel
Interface	12VAC wall adapter
Power	5VDC, 2.6 amp
Enclosure	Aluminum (CE compliant)
Dimensions	17 cm W, 28 cm D(including connectors), 6 cm H
Part Number	ETH-256, ETH-256C (with C-ISO-256)

ETH-256 Amplifier with Isolated Headstage

SPECIFICATIONS - C-ISO-256	
Isolation	Optical
Gain	X400
High-pass Filter	0.05 Hz
Low-pass Filter	25 Hz or 2.5k Hz selectable
Amplifier Connector	DIN8
Signal Connectors	DIN 42-802 Type ST
Part Number	C-ISO-256

How to Use the ETH-256

Operation in Bridge Mode

Input

On the ETH-256, the input for transducers, pods, and adapters is a standard eight-pin DIN socket located on the front panel of the unit. A list of wiring schemes for iWorx DIN8s and other common connectors is found in Tech Center of the User Area of the iWorx website: www.iworx.com.

Offset

Use the 10-turn offset knob on the front panel of the ETH-256 to control the precise position of the baseline, while allowing inherent offsets of the transducer to be nulled.

Operation of devices with excitation voltages

Once transducers, pods, or adapters are wired for the correct configuration of the input of the ETH-256, these devices will be supplied with excitation voltages (±5VDC), inputs (+ or -) for the differential amplifier, and a circuit ground.
The output of the transducer can now be viewed (at the selected gain) from the BNC connector of the output on the rear panel. Adjust the offset as necessary.

Using a strain gauge transducer with the ETH-256:

1) After the transducer has been correctly fitted with a DIN8 connector and attached to the appropriate input socket on the amplifier, connect the output BNC on the ETH-256 to the input of your iWorx data acquisition device.
2) Set the ETH-256 gain to x1, the low-pass filter to 5 Hz, and the high-pass filter to DC.
3) Observe the output of the ETH-256 on your computer. Confirm that the baseline position can be changed by turning the input offset knob for this channel. Adjust the baseline to zero volts.
4) If you cannot see the baseline move when you turn the input offset knob, try increasing the amplifier gain. A word about increasing gain: it's possible that your software will also amplify and/or position a signal. To avoid confusion, use only one set of controls to adjust gain or offset once the signal is positioned.

5) Continue to increase the gain until you can easily position the line with the input offset control. If you cannot see a signal on your recorder or if the signal is “pegged” all the way to the top or bottom of the software range, disconnect the transducer immediately and refer to the troubleshooting section of this manual.
6) Now that you have your signal positioned, deflect your transducer by an amount appropriate to your experiment. For example, if you have connected a blood pressure transducer, apply approximately 250mmHg, or if you have connected a force transducer, hang a weight from it which is approximately equal to the maximum force you expect to see.
7) Does the trace go off the screen? If so, reduce the gain. If the deflection on the screen appears small (less than 20% of the full screen or paper), increase the gain. You are now ready to calibrate the transducer. Refer to the manual that came with your iWorx data acquisition system for the best procedure to accomplish this.

Operation of devices without resistive bridges, or excitation voltages

The high input impedance of the ETH-256 in Bridge mode makes it useful for transducer types other than transducers with resistive bridges. Piezoelectric, pH, or any device with a signal output less than ±5VDC can be applied to the inputs in differential or single-ended modes. Be careful to shield the cable and source when using high-impedance devices.

Using a pH sensor with the ETH-256:

1) Set the ETH-256 gain switch to x1 and the low-pass filter setting to 50 Hz.
2) Put the electrode in pH7.0 buffer. Observe the output of the ETH-256 on your recording device. Use the input offset to adjust the output to zero.
3) Use a pH10 buffer to do the second measurement. Select a gain on the ETH-256 that allows the deflection from zero produced by the change of buffer to be seen. Refer to the manual that came with your iWorx data acquisition device for the best procedure to accomplish this.

Operation in Bio Mode

With the LED of the 0.03, 0.3, or 3 Hz high-pass filter illuminated, the amplifier is ready to record biopotentials. Any of these three settings will AC-couple the input to the amplifier. AC-coupling selectively removes the DC component of signals being recorded. For example, when recording an ECG, the electrodes placed on the surface of the skin will generate a relatively small galvanic (steady state) potential between them. This small galvanic potential is many times the amplitude of the ECG signal being recorded. If the input is AC-coupled to the amplifier, the galvanic potential is selectively removed from the complete signal and the ECG signal remains. All the gain required to record the ECG can now be used. The 0.03, 0.3, or 3 Hz filters will also remove low frequency AC signals, like the artifacts due to breathing or movement.

Control/Setup

Advance the high-pass filter selection so that the 0.3 Hz LED is illuminated and set the gain to x10. As with the Bridge mode, it is a good idea to use the gain or the offset adjustments of the ETH-256 to adjust the size and position of the signal appearing on the screen. Select the 150 Hz low-pass filter if you are recording an ECG, or 10k Hz if you are recording an EMG.

Using the Isolated Headstage (C-ISO-256)

Connecting the leads

Attach the three color-coded lead wires to the Isolated Headstage. Attach surface electrodes to the subject. These electrodes should have a snap connector to be used with the supplied lead wires.

Operation

With the described settings, you should now see the trace slowly approach zero as the recording begins. This process can take 10 to 15 seconds if the amplifier circuit has been open for any length of time. Be patient and let the trace settle before you attempt to adjust the offset. If the trace is noisy or wanders, see the troubleshooting section of this manual. Note that the isolation unit has a switch on it that can set the low-pass filter to either 25 Hz or 2.5k Hz. Assuming the trace is stable and quiet, increase the gain until you can see an acceptable signal. When used with the C-ISO-256, a gain of x1 set on the front panel will produce an electrocardiogram of between 0.5 and 5VDC.

The ETH-256 can be used to record signals such as ECG, EMG, EOG, and EEG. It can also be used to measure potentials directly from muscles and nerves. Using the appropriate cables and electrodes, it is ideally suited for extracellular recordings from animal tissue with hook, pin, or suction electrodes.

Recording an ECG with the ETH-256C:

1) Plug the C-ISO-256 isolated headstage into the input socket for Channel 1.
2) Using an alcohol prep or alcohol-soaked cotton ball, lightly abrade the skin on the underside of each forearm and on the back of the calf near the ankle. After the skin dries, attach a disposable, adhesive-backed electrode to each of the sites.
3) Connect the green lead (ground) to the electrode on the right leg. Connect the red lead (+) to the right arm and the black lead (-) to the left arm.
4) Have the subject sit quietly in a chair with his or her forearm resting on a table with palm turned upward and finger flexor muscles relaxed.
5) Start recording. The output seen on Channel 1 is a “Lead 1" ECG. Increase the gain until the form of the ECG can be clearly seen.

Recording an EMG with the ETH-256C:

1) Plug the C-ISO-256 isolated headstage into the input socket for Channel 1.
2) Using an alcohol prep or alcohol-soaked cotton ball, lightly abrade the skin on the underside of one forearm. After the skin dries, attach disposable, adhesive-backed electrodes to the upper part of the forearm, the middle of the forearm, and the wrist.
3) Connect the green lead (ground) to the electrode on the wrist. Connect the red lead (+) to the upper portion of the forearm with the greatest diameter and the black lead (-) to the middle of the forearm.
4) Have the subject sit quietly in a chair with his or her forearm resting on a table with palm turned upward and finger flexor muscles relaxed.
5) Start recording. After five seconds, the subject should gently contract his or her finger flexor muscles to make a fist. The subject should hold this clench for two seconds, then relax again for two seconds.
6) Continue to record, as the subject alternates periods of progressively stronger contractions with relaxation. Stop recording when the contraction reaches a maximum.

Troubleshooting

Problem: In DC mode, the trace remains maxed at the top or bottom, and turning the offset control has no effect.
Solution: Check that the transducer is not overloaded and that the gain is not set too high. It may be that you are amplifying the signal too much. If, instead, your transducer is not reacting to a large pressure or force, the connector on the transducer may need to be checked to confirm that the wiring is correct and that there are no shorts.

Problem: In DC mode, when using the ETH-256 with data acquisition devices sampling at low speed, a slow sinusoidal drift appears.
Solution: Sinusoidal drift observed when using digital recording devices is almost always due to aliasing of higher frequency noise. The most likely cause in this case is the building AC. Use the 50 Hz low-pass filter on the ETH-256 and any AC notch filter that may be available on your recording software to minimize or remove this artifact.

Problem: When using a high-pass filter other than DC, the signal is noisy and wanders.
Solution: Noise in the recording of biopotentials is frequently from the power lines in the room. Normally the differential properties of the amplifier can remove it, but this becomes difficult if the electrode connection to the subject is of high or variable resistance. Make sure that surface electrodes are securely fastened to the subject by gently abrading the skin surface where the electrode will be attached with some nylon scrubbing material. Be sure to use enough electrode gel if you are using silver (reusable) electrodes.

Problem: The offset works and you can see the trace, but testing the transducer causes no change in the signal.
Solution: Make sure that you are using enough gain to see the changes produced by your transducer or by an ECG/EMG. Remember these signals can be just a few millivolts. If you are using the 10V scale you won't see small changes.

For any problem, don't overlook obvious causes. Are the amplifier and recorder connected to a working outlet? Are you adjusting the switches and controls on the correct channel? Are you sure about the connection to your data acquisition system?

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