ION OPTIX

KoForce

KFA100

User Manual

rev. 3

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Research Use Only

This product is intended for research purposes only. It is not certified for clinical applications (including diagnostic purposes). Use of this product in uncertified applications is in violation of FDA regulations.

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Safety Precautions

To ensure reliability and safety, we recommend using the instrument according to the guidelines described in this manual. All safety and operating instructions should be read and understood before use.

Electric shock risk! Do not remove instrument cover. There are no user-serviceable parts inside. Refer servicing to IonOptix technical support (support@ionoptix.com). Static electricity can damage electronic components. Take care to discharge yourself before handling the device.

Please adhere to the following safety guidelines:

- Unplug the instrument from the wall before cleaning.
- Keep the instrument free from moisture, water, and dust.
- Do not place instrument on unstable surface and do not drop the device.
- If ventilation slots are present on instrument panels, keep clear of obstructions.
- All cables and power supply cords should be routed so as to not cause a hazard. Use only supplied or approved/recommended cables.
- Ensure instrument is not situated near a heat source.

Statement of Conformity

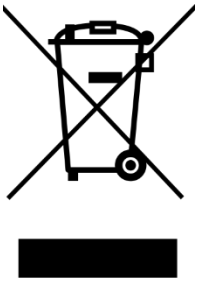
This instrument carries the CE mark and meets the appropriate EU directives.

Intended Use

This product is intended for **research purposes only**. It is not certified for clinical applications (including diagnostic purposes). Use of this product in uncertified applications is in violation of FDA regulations.

IonOptix products are intended to be installed, used, and operated under the supervision of an appropriately qualified life-science researcher.

Disposal



Forward to recycling center or return to manufacturer. Unwanted equipment bearing the Waste Electrical and Electronic Equipment (WEEE) Directive symbol requires separate waste collection. For a product labeled with this symbol, either forward to a recycling center or contact your nearest IonOptix representative for methods of disposal at the end of its working life.

Warranty

This IonOptix instument is warrantied for a period of one (1) year from delivery under normal use and conditions, and will operate in material conformance with applicable IonOptix specifications or standards.

This warranty does not apply to any defect caused by failure to provide a suitable operating environment, any other excluded use, or any other abuse, misuse, or neglect off the instrument.

Performance Specifications

Name	Value		Units
	Resolution	Normal Range	
Force	0.015*	0.015 – 200	mN
Frequency Response		750 – 850	Hz

**3x standard deviation of noise at 5X gain*

Components

Item	Description	QTY	Image
KoForce Amplifier	Single-channel bridge amplifier designed to interface with KoForce force transducers	1	
KoForce Force Transducer	Mechanically robust force transducer designed for experiments requiring high resonance frequency and resolution	1	

Introduction

Thank you for choosing the IonOptix KoForce Force Transducer. This instument has been engineered to complement IonOptix MyoClamp Systems. When operated properly, it will provide high-speed, high-resolution force measurements from small tissue such as cardiac slices and papillary muscle.

The force transducer arrives preassembled. The KoForce headstage has a length of stainless-steel tubing that holds a platinum rod bent to form a hook.

IMPORTANT: Make sure the hook is oriented such that a pull on the hook will be recorded as a positive deflection by the force transducer. The wire that extends from the body is visible from the front.

The force transducer was designed by Dr. Konrad Güth at Myotronic, Heidelberg, Germany. Dr. Güth developed many of the techniques and instruments used in the field of muscle research.

The Güth force transducer is especially useful for two reasons. First, it is based on detecting the deflection of a mechanical lever using an LED light source and light sensor. It is that simple. It is also electrically isolated from the cantilever, which can now be used to pass current for stimulation of the muscle sample. Second, this design is robust, meaning the force transducer is difficult to physically break. That is an important feature when you consider that the experimentalist must load the muscle sample delicately.

Assembly

The following describes device transducer, signal output, and power connections. For mounting the force transducer to the system chamber and mounting preparations to the force transducer, refer to the IonOptix MyoClamp system guide.

1- Transducer interface

Plug the force transducer's 5-pin radial connector into the Force Transducer Input on the KoForce front panel.	

2- Output voltage

Plug the BNC cable into the Signal Voltage Output on the KoForce front panel. *Note: connect the opposite end of the BNC cable to a suitable analog-to-digital interface, such as the IonOptix FSI800, to collect force data.*	

3- Power

Plug the region-specific power cord on the KoForce back panel and a suitable wall outlet.	

Calibration

The force transducer has been calibrated at our factory location. Refer to force calibration spreadsheet provided with the bridge amplifier for the actual values of the calibration in units of mN / V. We recommend that the user recalibrates the force transducer at least once per year, or more often if it is subject to frequent use. The section in this manual entitled Calibrating the Force Transducer will guide the user through the recalibration when needed.

Operation

This section details the proper use of the device.

1- Sensitivity Adjustment

The gain setting knob allows the user to choose the amplification (1-50 X) applied to the force signal. When the overload indicator light is on, the gain is too high to record the force. The best remedy is to reduce the gain setting.

Rotate knob to achieve the desired signal gain (signal amplification).

Note: larger forces will require lower gain and smaller forces will require higher gain.

2- Zero Balance and Coarse Offset

At the start of making a measurement, it is important to set the offset that corresponds to zero force. Typically, the muscle is placed on the hooks, but slack with no tension. The offset indicator lights guide the proper setting. If the indicator lights show 'low', then turn the knob up (clockwise) until neither light is on or until the 'high' light comes on. At that point, adjust the fine offset setting. If the indicator lights show 'high' at the start, then turn the knob down until neither light is on or the 'low' light comes on. Again, at that point, adjust the fine offset setting.

3- Fine Offset

The fine offset knob is adjusted to assure that the force transducer is indicating zero force when force transducer has a muscle loaded, but there is no contractile force applied. After having adjusted the coarse offset, adjust the fine offset until zero volts are registered. The user will need some way to detect the voltage, either a voltmeter, oscilloscope, or IonWizard.

4- Power and Fuse

The power cord is plugged into the receptacle. The factory will have set the receptacle for 120 V or 240 V depending on your country. The fuse housing holds a 1.6 A fuse.	

Calibrating the Force Transducer

There may come a time when you want to double-check the force transducer calibration. This may happen if the force transducer has been bumped calling the calibration into question, or if it has been used frequently or for an extended period of time.

1- Creating Calibration Weights

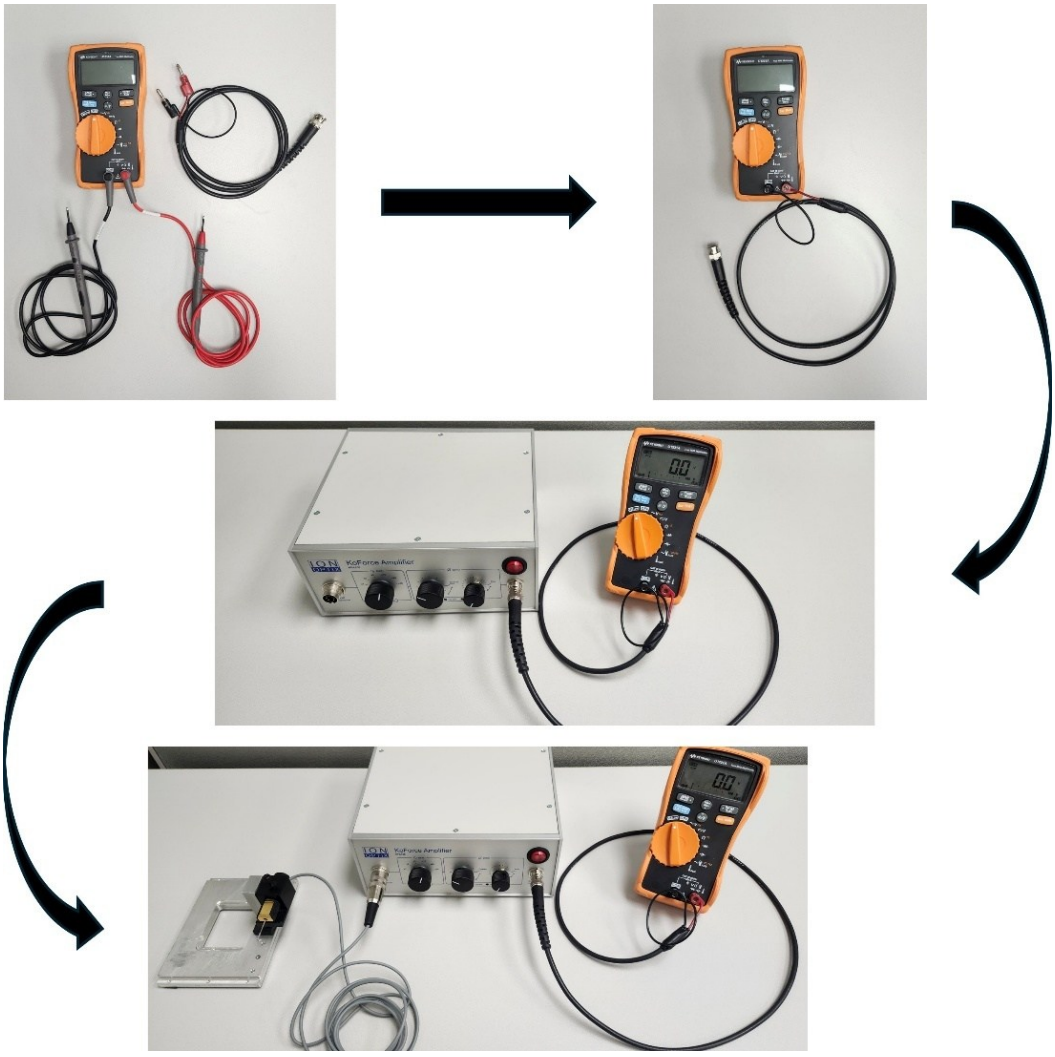
Take a standard paper clip and cut into different lengths from 5-30 mm long. Straighten and bend the pieces to make at least five different sized 'shepherd crooks'.	

Now, weigh each of these pieces using the laboratory scale. The pieces should range from 20 mg to as much as 200 mg, which corresponds to roughly 0.2 mN to 2 mN of force, respectively. If you expect higher forces from your muscle samples, then make additional heavier weights.	

2- Setup to Monitor KoForce Output

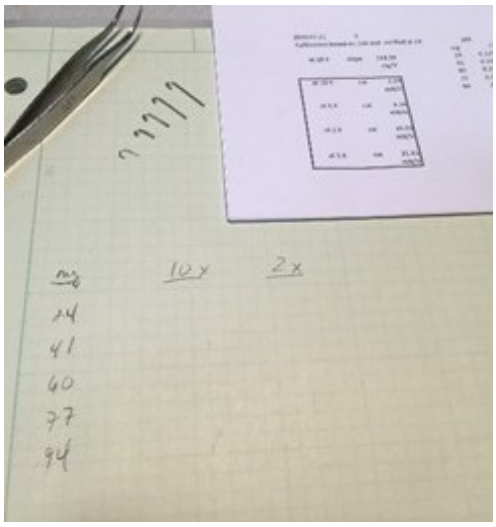
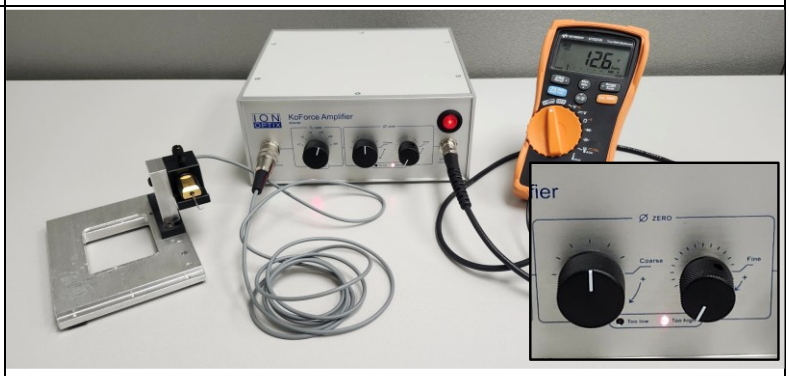
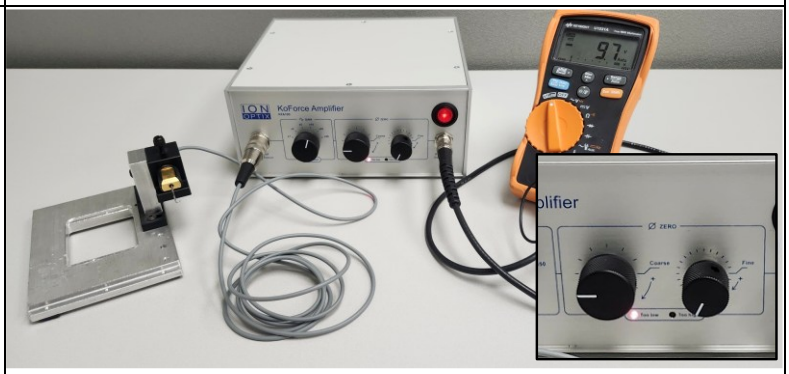
Use a voltmeter to monitor the output signal voltage from the KoForce amplifier (see pics below).

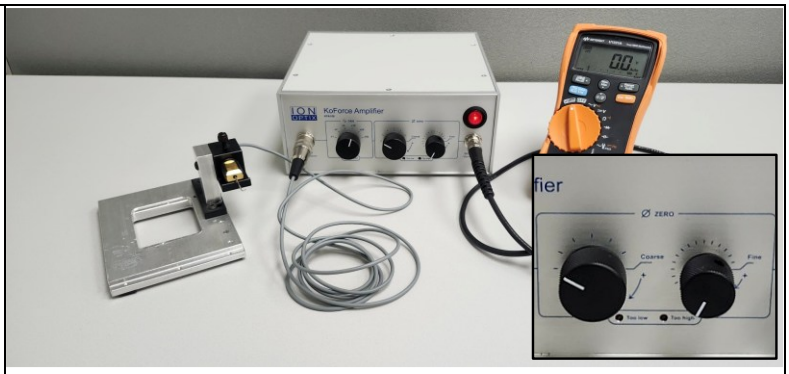
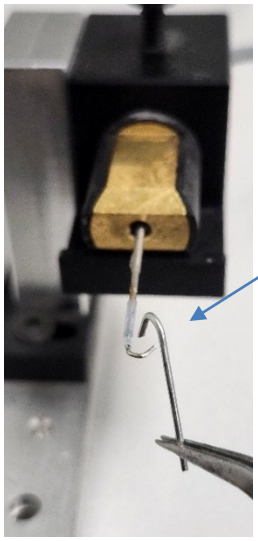
The following is the setup for calibrating the force transducer. Place the force transducer so that gravity pulls on the hook in the same direction that a muscle would pull on the hook. You do not need a special jig like that shown in the photos. The force transducer just needs to be flat and stabilized. A book could be used to stabilize the body of the force transducer.

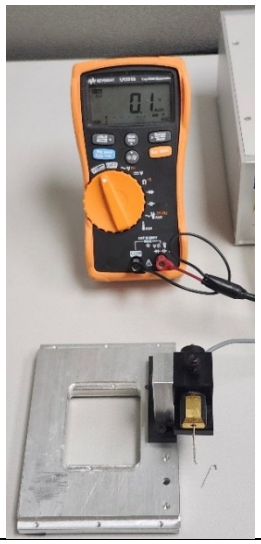


It is particularly important that the transducer is oriented as shown to ensure a positive voltage. Note that the hook is flat and pointed to the right. The wire at the top is also oriented to the right.	

3- Measuring Weight Standards

Get out the weight standards and write the weights on the piece of paper. Create columns for the appropriate gains.	
Set the KoForce gain to the appropriate setting (typically 5x and 10x). When the red light indicates HIGH, the offset is too high.	
When the red light indicates LOW, the offset is too low.	

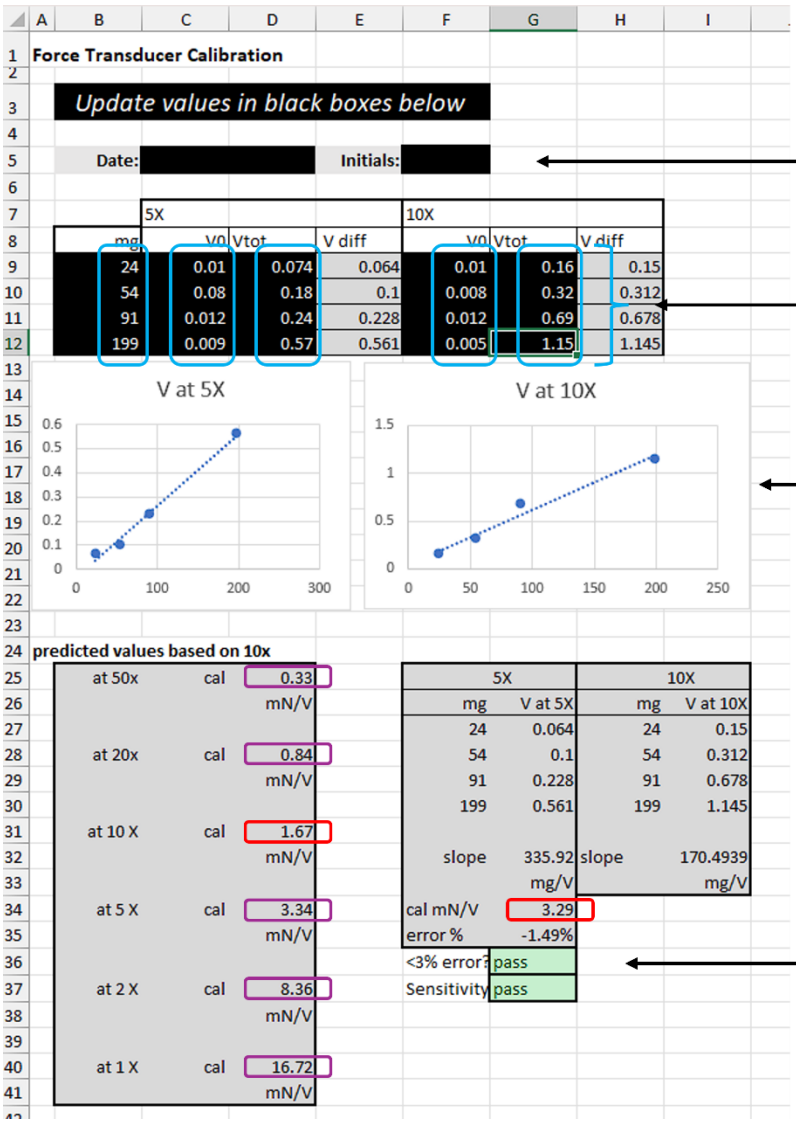
Turn the course knob until the indicator lights are off, or when one turn immediately switches the other indicator light. Adjust the fine offset until both red lights are off, and the voltmeter reads a value close to 0 V.	
Let everything sit for at least 20 min to reach a temperature equilibrium. When you return, check the voltage for stability. When stable, bring the first weight just above the hook. **DO NOT PLACE IT ON THE HOOK.** Retract the forceps and let it drop onto the hook.	
Read the voltage and write it down next to the relevant weight.	

Now take off the weight by pushing it off carefully with the forceps. **DO NOT GRAB THE WEIGHT** when it is on the hook. Let it fall to the table.	
Read the voltage with weight off and record the background voltage.	

Repeat for every weight at every gain setting. Note that the background voltage as well as each weight and measured voltage will be entered into the spreadsheet.

4- Recording Weights and Determining Calibration Values

Put these values into the KoForce Calibration Worksheet (click the previous link to download or go to the IonOptix Resource Library and search “calibration”). The spreadsheet will automatically create graphs for 5X and 10X. The plots should be straight lines. The absolute value of the error should be small, less than 3% error between the two measurements. If the graphs are not straight or the error is more than 3%, perform the calibration again.



Force Transducer Calibration

Update values in black boxes below

Date: Initials:

	5X				10X		
mg	V0	Vtot	V diff		V0	Vtot	V diff
24	0.01	0.074	0.064		0.01	0.16	0.15
54	0.08	0.18	0.1		0.008	0.32	0.312
91	0.012	0.24	0.228		0.012	0.69	0.678
199	0.009	0.57	0.561		0.005	1.15	1.145

predicted values based on 10x

at 50x	cal	0.33	mN/V
at 20x	cal	0.84	mN/V
at 10 X	cal	1.67	mN/V
at 5 X	cal	3.34	mN/V
at 2 X	cal	8.36	mN/V
at 1 X	cal	16.72	mN/V

5X		10X	
mg	V at 5X	mg	V at 10X
24	0.064	24	0.15
54	0.1	54	0.312
91	0.228	91	0.678
199	0.561	199	1.145
slope	335.92 mg/V	slope	170.4939 mg/V
cal mN/V	3.29		
error %	-1.49%		
<3% error?	pass		
Sensitivity	pass		

Put today’s date and your initials in the upper-left-hand corner.

Enter the weights, background voltages, and weighted voltages.

Plots are automatically generated.

Measured calibration values are shown in red; predicted calibration values are shown in purple.

Error is displayed as pass/fail (<3% = pass).

Save and print the spreadsheet sheet for later reference. Enter the calibration values into the appropriate corresponding tasks within IonWizard.

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