



SI-BAM21-LC

KG Optical Force Transducer Amplifier

INSTRUCTION MANUAL

Serial No. _____

072111

www.wpiinc.com

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ABOUT THIS MANUAL

The following symbols are used in this guide:



This symbol indicates a CAUTION. Cautions warn against actions that can cause damage to equipment. Please read these carefully.



This symbol indicates a WARNING. Warnings alert you to actions that can cause personal injury or pose a physical threat. Please read these carefully.

NOTES and TIPS contain helpful information.



Fig. 1—SI-BAM21-LC KG Optical Force Transducer Amplifier

INTRODUCTION

The **SI-BAM21-LC** KG Optical Force Transducer Amplifier is used in conjunction with the SI-H Muscle Bath system and the related line of SI-Heidelberg muscle physiology products. The **SI-BAM21-LC** powers the force transducer and outputs an analog voltage proportional to the force applied to the force transducer. The force feedback signal can be multiplied by a factor of 1, 2, 5 or 10 to provide better resolution for a minimal change in applied force.

NOTE: An optional factory setting increases the multiplier by a factor of 10, allowing the signal to be multiplied by 10, 20, 50 and 100.

Features

The **SI-BAM21-LC** is a KG optical force transducer amplifier that:

- Supplies an analog output (-10VDC to +10VDC) representing the force applied to the tissue sample.
- Delivers a DC power supply voltage to the force transducer.

How the Amplifier Works

In a typical setup, a muscle is held by a force transducer and suspended in a tissue bath. The force transducer is connected to the **SI-BAM21-LC**. As the muscle contracts or releases, the force transducer converts the force into an electrical current signal which is proportional to the force applied to the force transducer.

Before initiating an experiment, the **SI-BAM21-LC** must first be zeroed. This sets the baseline for measurements to follow.

The output signal is buffered and multiplied by 1, 2, 5 or 10, depending on the front panel **Gain** switch setting. The X10 setting is useful when output signals are extremely small. Finally, the force proportional signal is sent through the output amplifier circuit.

The analog output has a range of -10V to +10V that drives a data acquisition system, multimeter or oscilloscope.

Notes and Warnings

NOTE: This system is designed for use exclusively with the SI-H line of KG force transducers. It is not configured for use with the SI-H MicroTweezer or other types of force transducers.

Parts List

After unpacking, verify that there is no visible damage to the instrument. Verify that all items are included:

- (1) **SI-BAM21-LC** KG Optical Force Transducer Amplifier
- (1) Universal input (100-120VAC to 200-240VAC) AC adapter
- (1) Power cord
- (1) **13661** Potentiometer Adjustment Tool
- (1) Instruction Manual

Unpacking

Upon receipt of this instrument, make a thorough inspection of the contents and check for possible damage. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed damage should be reported at once to the carrier and an inspection requested. Please read the section entitled "Claims and Returns" on page 15 of this manual. Please contact WPI Customer Service if any parts are missing at 941.371.1003 or customerservice@wpiinc.com.

Returns: Do not return any goods to WPI without obtaining prior approval (RMA # required) and instructions from WPI's Returns Department. Goods returned (unauthorized) by collect freight may be refused. If a return shipment is necessary, use the original container, if possible. If the original container is not available, use a suitable substitute that is rigid and of adequate size. Wrap the instrument in paper or plastic surrounded with at least 100mm (four inches) of shock absorbing material. For further details, please read the section entitled "Claims and Returns" on page 15 of this manual.

INSTRUMENT DESCRIPTION

Front Panel

The front panel of the **SI-BAM21-LC** is shown in **Fig. 2**.

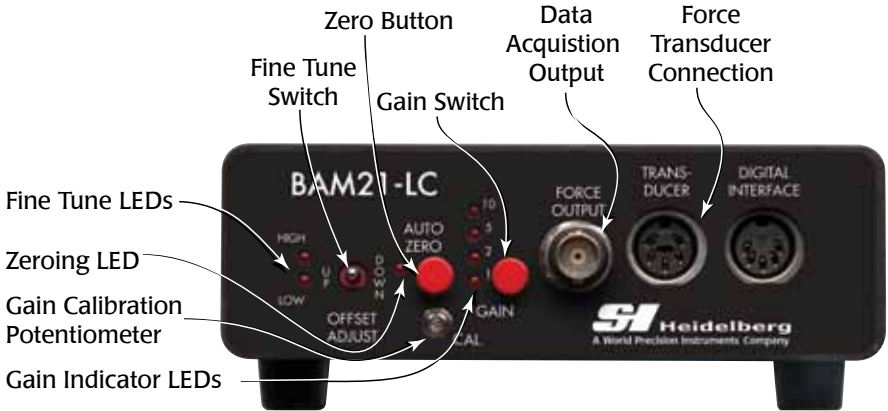


Fig. 2—Front panel of the SI-BAM21-LC

Zero Button—When pressed, the **SI-BAM21-LC** output comes close to zero and the **Zeroing LED** illuminates. Before any measurements are taken, the **SI-BAM21-LC** should be zeroed to establish a baseline value for the force transducer.

Fine Tune Switch—This toggle switch allows you to fine tune the system after zeroing. Press and hold the toggle switch to the left if you want to raise the baseline. Or, press and hold the toggle switch to the right to lower the baseline. If the baseline is more than 0.3V above zero, the High LED illuminates, and if it is less than -0.3V, the Low LED illuminates. When the baseline is within 0.3V of zero, the LEDs are off.

Gain Switch—Under normal conditions, the **Gain** switch is set to X1. The current output of the force transducer can be amplified by a factor of 2, 5 or 10. Press the **Gain** switch to toggle between the gain settings. A **Gain Indicator LED** illuminates to show which gain factor is applied. Larger gains are essential when working with extremely small forces.

Gain Calibration Potentiometer—Adjusting this potentiometer defines the gain applied. Use the provided potentiometer adjustment tool (WPI #13661) to calibrate the output voltage scale factor to the force transducer current. See “Calibrating the **SI-BAM21-LC**” on page 6.

Data Acquisition Output—Connect a data acquisition system like WPI’s **Lab-Trax** to this BNC connector to record the **SI-BAM21-LC** voltage output. For test purposes, a multi-meter or oscilloscope may be connected using a standard BNC cable (WPI #2851).

Force Transducer Connection—A SI-KG series force transducer is plugged into this DIN connector. Align the pins, and insert the connector until it is fully seated.

Digital Interface—This connection is reserved for future use with an anti-oscillation unit.

Back Panel

The back panel of the **SI-BAM21-LC** is shown in **Fig. 3**.

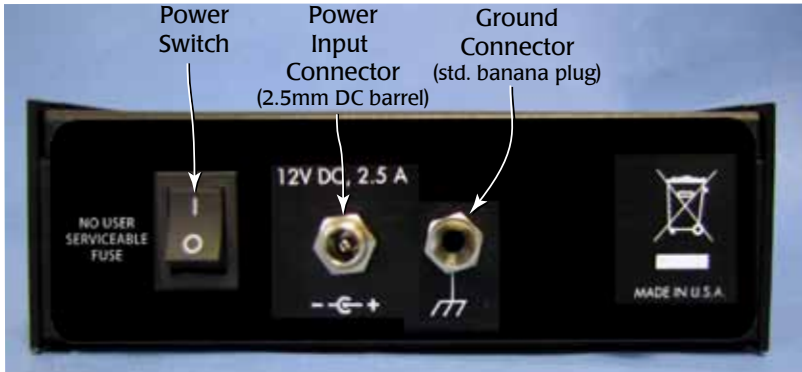


Fig. 3—Back panel of the SI-BAM21-LC

Power Switch—This toggle switch turns the power off (0) and on (I).

Power Input Connector—Plug the power cord into this connector.

Ground Connector—Use a ground wire with standard banana plug connector in this socket to ground the entire unit to the desired reference.

Setup

Once the instrument has been inspected and accessories accounted for, make the cable connections for system interfaces as shown in **Fig. 4**.

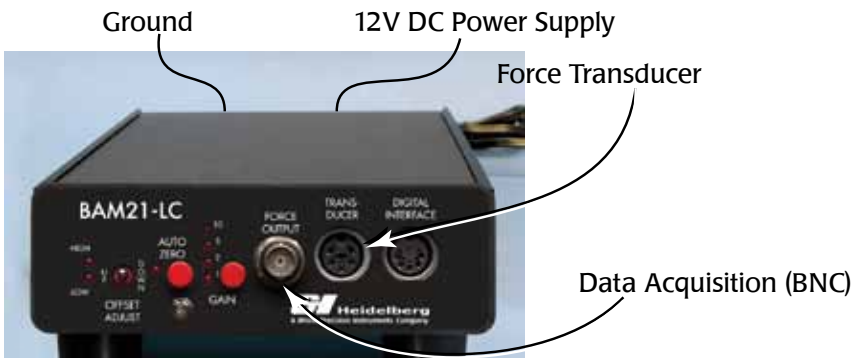


Fig. 4—SI-BAM21-LC Connections

1. Connect the force transducer cable to the **Force Transducer** connection port (labeled **Transducer**) on the front of the **SI-BAM21-LC**. Align the pins and insert the connector.
2. Connect a BNC cable from the data acquisition system input to the **Output** on the front panel of the **SI-BAM21-LC**.
3. Connect the AC power adapter to the **Power Input** (labeled **12V DC, 2.5A**) on the back panel of the **SI-BAM21-LC**.
4. Turn the **Power** switch on the back panel on (I).

OPERATING INSTRUCTIONS

Calibrating the SI-BAM21-LC

Before taking measurements, the **SI-BAM21-LC** must be calibrated. The SI-KG force transducers shown in the table below respond linearly within their respective measurement ranges. Consequently, the **SI-BAM21-LC** can be calibrated using only two reference points.

Force Transducer	Force Range	Range (g)	Noise (μN)	Compliance (nm/mN)	Resonance Frequency
SI-KG2	0-2N	0-200	250	150	1.3kHz
SI-KG2A	0-0.5N	0-50	300		
SI-KG4	0-50mN	0-5	15	0.5	1.2kHz
SI-KG4A	0-20mN	0-2	4	1	1.2kHz
SI-KG7	0-5mN	0-0.5	0.2	10	250Hz
SI-KG7A	0-5mN	0-0.5	0.4	5	500Hz
SI-KG7B	0-10mN	0-1.0	1	1.5	550Hz
SI-KG20	0-0.2N	0-20	80 μN		590Hz

The basic procedure for calibrating the **SI-BAM21-LC** involves:

1. Setting a zero reference point with the force transducer un-loaded.
2. Applying a load to the transducer with a known mass.
3. Adjusting the amplifier's output to achieve a value that EITHER: (choose one)
 - Maximizes the resolution for the intended measurement range.
 - Numerically correlates the force with a voltage output.

Using the **Gain Calibration Potentiometer**, adjust the amplifier's output range. This allows you to choose the calibration method that best serves your application.

- For the greatest precision, maximize the resolution of the **SI-BAM21-LC** by calibrating so that the 10.0V output is set a little above the maximum expected force (~5%). For example, if your maximum expected value is 4.75g, set the **SI-BAM21-LC** so that a 5g mass yields a 10.0V output. The maximum expected output would then be 9.5V, with a 4.75g applied load.

- On the other hand, for quick visualization, you might choose to establish a numerical correlation by calibrating the **SI-BAM21-LC** so that a force like 1.0g generates a 1.0V output.

Although each of the SI-KG force transducers has a fixed load range, the design of the **SI-BAM21-LC** offers four levels of amplification using the **Gain** switch (X1, X2, X5 and X10). You can choose to use the full-load range of the transducer (X1) or, if higher resolution is desired, one of the other multipliers (X2, X5, X10). For example, using X10 uses 1/10th of the full-load range of the transducer. Under ideal conditions, the **Gain** switch is set to an amplification factor of X1 using an SI-KG force transducer with a force range that is no more than 120% of the maximum force anticipated. In general, it is best to choose a gain factor that will not need to be changed during an experiment. This is because each gain factor can have slight variances in offset. However, if it is necessary to switch between gain ranges during an experiment, check the offsets in each of the ranges to be used. Then, use the fine tune switch (offset adjust) to set the minimum average offset between the ranges.

The following calibration procedure may be used with any SI-KG force transducer. For illustration purposes a SI-KG4 force transducer is used in the example. Note that a 0.5g mass is about 10% of the total range of the SI-KG4 force transducer, and a 5g mass is the maximum force the SI-KG4 can measure. If we intend to use the X10 mode, 0.5g is the largest mass we can use with this force transducer.

1. Attach the desired force transducer to the **Transducer** port on the front panel of the **SI-BAM21-LC**. For this example, use a SI-KG4 force transducer.
2. Connect a data acquisition system or a digital multi-meter to the **Output** (BNC connection) on the front panel of the **SI-BAM21-LC**. The analog BNC output on the front panel can be connected to a multi-meter for DC voltage measurements between -10.0 and +10V DC. Alternatively, a data acquisition system with analog data tracking, recording and analysis can be connected to a PC to provide a record of the analog output (WPI #LAB-TRAX-4).
3. Set the **Gain** switch to the amplification factor you intend to use.
4. With no weight suspended from the transducer, press and release the **Zero** button and monitor the output. You should see a reading of 0.0V DC \pm 50mV. Keep in mind that for higher gain settings the zeroing error is larger and requires the use of the fine tune switch (offset adjust) if a smaller error is desired.

NOTE: When the **Zero** button is pressed, the zeroing LED illuminates to indicate that the zeroing function is processing.

5. Use the fine tuning switch to adjust the baseline to zero. Press and hold the toggle switch to the left if you want to raise the baseline. Or, press and hold the toggle switch to the right to lower the baseline. If the baseline is more than 0.3V above zero, the High LED illuminates, and if it is less than -0.3V, the Low LED illuminates. When the baseline is within 0.3V of zero, the LEDs are off.

-
6. From the transducer, suspend a known mass that is close to the maximum range for the amplification factor and force transducer. For the SI-KG4 force transducer, use a less than 5.0g for X1 or less than 0.5g for X10.

NOTE: Mass in grams is not equal to force in newtons. Since force equals mass times acceleration ($F = ma$), a 0.5g weight is equal to 4.9mN. ($0.0005\text{kg} * 9.8\text{m/s}^2 = 0.0049\text{N}$) The mass you choose must exert a force that falls within the operating range of the force transducer and amplification factor you select.

7. After the suspended mass becomes motionless, monitor the output while adjusting the **Gain Calibration Potentiometer**. The output voltage may be set to almost any arbitrary value up to 10.0V. Use a potentiometer adjustment tool (WPI #13661) to adjust the **Gain Calibration Potentiometer** for the desired output voltage.
8. If you intend to use multiple amplification factors, cross-check your calibration. Set the **Gain** switch to X1 and verify that the output is one tenth of the value recorded in the X10 gain setting. If a 0.5g mass is used and the **SI-BAM21-LC** is calibrated as close as possible 10.0V in X10, then in X1, the monitor should display very close to 1.0V.

Making Measurements

After the **SI-BAM21-LC** has been calibrated, measurements may be taken.

1. Turn the **SI-BAM21-LC Power** switch on (I).

NOTE: Allow the system to stabilize for about 30 minutes. This allows all the components to reach thermal equilibrium, minimizing measurement changes due to thermal variations.

2. Turn on the data acquisition system.
3. Press the **Zero** button to set the baseline value for the measurements.

NOTE: When the **Zero** button is pressed, the zeroing LED illuminates to indicate that it is functioning properly.

4. Measurements may be taken.

MAINTENANCE

The **SI-BAM21-LC** is maintenance free. However, to protect your **SI-BAM21-LC**, follow these guidelines:

- Place the **SI-BAM21-LC** in a clean, dry location.
- Use only a 12V DC, 2.5A power supply.
- Keep liquids away from the **SI-BAM21-LC** connections.

ACCESSORIES

Part Number	Description
13661	Potentiometer Adjustment Tool (Tweaker)
2851	BNC Cable
801513	Universal Input Power Supply AC Adapter
801514	Power Cord for AC Adapter, US plug
SI-DAS	SI-H Data Acquisition/Analysis System
SI-KG2	0-2N Force Transducer
SI-KG2A	0-0.5N Force Transducer
SI-KG4	0-50mN Force Transducer
SI-KG4A	0-20mN Force Transducer
SI-KG7	0-5mN Force Transducer
SI-KG7A	0-5mN Force Transducer
SI-KG7B	0-10mN Force Transducer
LAB-TRAX-4	4-Channel Data Acquisition System
SI-MT-L	Muscle Tester with long cuvette
SI-MT-S	Muscle Tester with short cuvette
SI-MT-O	Muscle Tester with optical cuvette
SI-FS	Electrode for field stimulation

TROUBLESHOOTING

Issue	Possible Cause	Solution
No output Signal (0.0V DC)	Poor force transducer connection	Verify that the cables are securely connected.
	BNC cable is bad	Try substituting a different BNC cable to troubleshoot the cause.
	Transducer failed	Try substituting a different force transducer to troubleshoot the cause.

NOTE: If you have a problem/issue with that falls outside the definitions of this troubleshooting section, contact the WPI Technical Support team at 941.371.1003 or technicalsupport@wpiinc.com.

SPECIFICATIONS

The **SI-BAM21-LC** conforms to the following specifications:

Input Configuration	Current to voltage converter
Gain	1X, 2X, 5X, 10X - Switch slectable
Output Impedance	470 Ohm
Power Requirements	12V DC at 2.5A (wall adaptor included– WPI # 801513), 2.5mm DC barrel
Output Range	±10V DC

APPENDIX A: SETTING SYSTEM GAIN FACTOR

The SI-BAM21-LC gain multiplier setting is selected with an internal jumper that is configured at the factory for use with either an SI-MT muscle tester system or an SI-MB tissue bath system. The SI-MT setting allows for 1X, 2X, 5X and 10X gains. The SI-MB setting allows for 10X, 20X, 50X and 100X gains.

1. Remove the four screws on the top of the SI-BAM21-LC box.

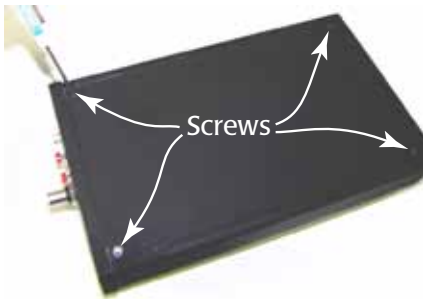


Fig. 5—The screws are identified on the top of the box.

2. Remove the lid from the box.



Fig. 6—If you tip the box upside down, the back end of the lid opens and you can slide it off the box.

3. Locate the 3-pin jumper J16. Jumper pins 1 and 2 to use the SI-BAM21-LC with the SI-MT system, or jumper pins 2 and 3 for use with the SI-MB systems.
4. Reinstall the lid and secure it with the screws.

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DECLARATION OF CONFORMITY

We: World Precision Instruments, Inc.
175 Sarasota Center Boulevard
Sarasota, FL 34240-9258 USA

As the manufacture of the apparatus listed, declare under sole responsibility
that the product(s):
SI-BAM21-LC KG Optical Force Transducer Amplifier

To which this declaration relates is/are in conformity with the following standards
or other normative documents:

Safety: EN 61010-1:2010
Emc: EN 61326-2-3:2006
EN 61326:1997+A1:1998+A2:2001+A3:2003

And therefore conform(s) with the protection requirements of Council Directive
2004/108/EC relating to electromagnetic compatibility and Council Directive
2006/95/EC relating to safety requirements:

Issued on: July 7th, 2011


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WARRANTY

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of 30 days* from the date of receipt. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within ten (10) days after receipt of shipment. Claims for lost shipments must be made within thirty (30) days of receipt of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim is settled. In some instances, photographic documentation may be required. Some items are time-sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container

Do not return any goods to us without obtaining prior approval and instructions from our Returns Department. Goods returned (unauthorized) by collect freight may be refused. Goods accepted for restocking will be exchanged or credited to your WPI account. Goods returned which were ordered by customers in error are subject to a 25% restocking charge. Equipment which was built as a special order cannot be returned.

Repairs

Contact our Customer Service Department for assistance in the repair of apparatus. Do not return goods until instructions have been received. Returned items must be securely packed to prevent further damage in transit. The Customer is responsible for paying shipping expenses, including adequate insurance on all items returned for repairs. Identification of the item(s) by model number, name, as well as complete description of the difficulties experienced should be written on the repair purchase order and on a tag attached to the item.

** Electrodes, batteries and other consumable parts are warranted for 30 days only from the date on which the customer receives these items.*



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