



95350/95351 SI-MB4/8 Electronics

Signal Conditioning Amplifier System for the SI-MB Systems

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INSTRUCTION MANUAL

Serial No. _____

062311

World Precision Instruments

Signal Conditioning Amplifier System



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Signal Conditioning Amplifier System



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 Signal Conditioning Amplifier System configured for the SI-MB4 Muscle Bath

Signal Conditioning Amplifier System

INTRODUCTION

The Signal Conditioning Amplifier System provides a flexible electronic platform intended to process force transducer outputs. The system consists of an 8-channel, rack-mountable frame that includes an ultra quiet, shielded power supply. The system has a small footprint and may be stacked to provide as many channels as you need.

When the system is ordered with an:

- **SI-MB4**, it includes four **SI-BAM21-LCB** amplifier modules and four expansion slots
- **SI-MB8**, the system includes eight **SI-BAM21-LCB** amplifier modules.

NOTE: The system is flexible and configurable. A variety of modules are available for the chassis, and you can mix and match the modules to suit your requirements.

Features

This system offers eight expansion slots, configured at the factory to meet your requirements.

NOTE: The system for the **SI-MB4** or **SI-MB8** is configured at the factory. If you need to add additional modules, contact Technical Support at 941.371.1003 or TechnicalSupport@wpiinc.com.

Parts List

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

- (1) **Signal Conditioning Amplifier System** with the appropriate number of amplifier modules
- (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



Fig. 2 The front panel of a 95350 (chassis configured for an SI-MB4) has four SI-BAM21-LCB cards.

Optical Transducer Amplifier—The **SI-BAM21-LCB** powers the force transducer and converts the output of the transducer to an amplified analog voltage that is proportional to the force applied to the transducer. The output signal can be multiplied by a factor of 1, 2, 5 or 10 to provide better resolution for a minimal change in applied force.

Expansion Slots—These empty slots allow room for four other **Signal Conditioning Amplifier System** modules to be added in the future.

Power Switch—This system has two power switches, one on the back panel and one on the front. Both switches must be on to power the system.

Signal Conditioning Amplifier System

Back Panel



Power Connector Fuse Housing Master Power Switch

Fig. 3 The back panel of the SI-BMFA chassis has a master power switch that is usually left on.

Power Connector—Insert the power cord into the power connector, and plug the cord into a standard wall AC outlet.

Fuse Housing—This housing contains the fuse for the chassis system.

Master Power Switch—The signal conditioning chassis distributes sub-regulated DC power (12V) to the individual modules through a backplane of the chassis. For convenience, the unit has two power switches, and both must be on to power the system. All the modules power on/off simultaneously. When your system is set up, just leave this power switch in the on (I) position

NOTE: The 16 plugs marked with A or B are for future development. They are not used at this time.



SI-BAM21-LCB

The **SI-BAM21-LCB** KG Optical Force Transducer Amplifier is used in conjunction with the SI-H tissue bath and muscle physiology systems. The **SI-BAM21-LCB** powers the force transducer and converts the output of the transducer to an amplified analog voltage that is proportional to the force applied to the force transducer. The output 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.

NOTE: The **SI-BAM21-LC** is the standalone version of this optical force transducer amplifier.

Features

The **SI-BAM21-LCB** amplifier works with KG optical force transducers to:

- Generate an analog output (-10VDC to +10VDC) that is proportional to the force applied to the tissue sample.
- Supply a DC voltage that powers the KG force transducer to which it is connected.

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-LCB**. 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. The **SI-BAM21-LCB** converts the current signal into a voltage signal that can be displayed on the screen of the recording device.

Before initiating an experiment, the **SI-BAM21-LCB** 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 Gain switch setting on the front panel of the amplifier module. 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: The **SI-BAM21-LCB** is only designed for use with KG optical force transducers. Use with any other type of transducer may cause damage to either the transducer or the amplifier, or both.

Signal Conditioning Amplifier System

Front Panel

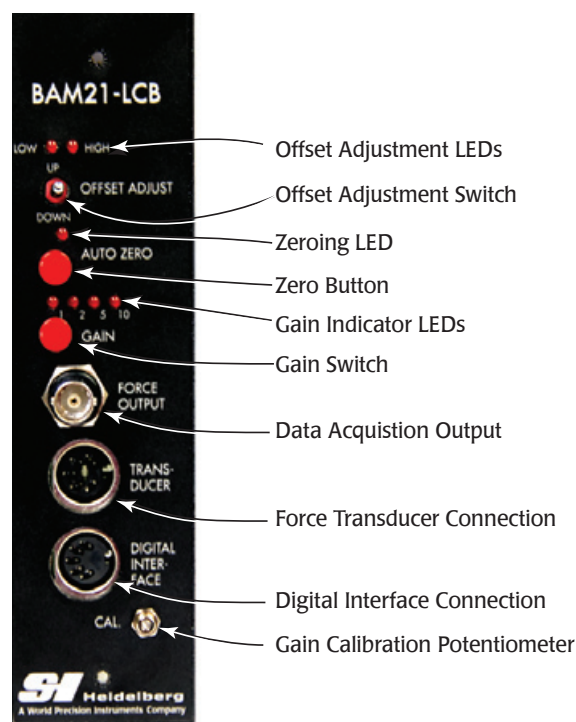


Fig. 4 SI-BAM21-LCB KG Optical Force Transducer Amplifier

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

Offset Adjustment Switch—This toggle switch permits the position of the baseline to be adjusted after the baseline is zeroed. 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 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— This potentiometer can be used to maximize the output of the amplifier for the anticipated range of forces to be measured. Use the provided potentiometer adjustment tool (WPI#13661) to calibrate the output of the amplifier to the



range of forces that will be measured by the transducer. See "Calibrating the SI-BAM21-LCB" on page 8.

Data Acquisition Output—Connect a data acquisition system like WPI's **Lab-Trax** to this BNC connector to record the raw **SI-BAM21-LCB** 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 a legacy interface for classic SI-H equipment.

Setup

1. Connect the 5-pin connector on the force transducer cable to the **Force Transducer** connection port (labeled **Transducer**) on the front of the **SI-BAM21-LCB**. Align the pins and insert the connector.
2. Connect a BNC cable from the data acquisition system input to the **Force Output** port on the front panel of the **SI-BAM21-LCB** to capture the voltage output from the **SI-BAM21-LCB**.
3. Verify that the **Power** switches on the back panel and on the front panel of the **Signal Conditioning Amplifier System** are in the on (I) position.

Signal Conditioning Amplifier System

OPERATING INSTRUCTIONS

Calibrating the SI-BAM21-LCB

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

Force Transducer	Force Range	Range (g)	Noise (μ N)	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 μ N		590Hz
SI-KG7-TWE	0-5mN	0-0.5	0.2	10	150Hz

Methodology

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

1. Setting a zero reference point with the force transducer unloaded.
2. Applying a load to the transducer with a known mass.
3. Use the **Gain Calibration Potentiometer** to adjust the amplifier's output range. Choose a value that EITHER (choose one):
 - Maximizes the resolution for the intended measurement range.
 - Numerically correlates the force with a voltage output.

This allows you to choose the calibration method that best serves your application.

- For the greatest precision, maximize the resolution of the **SI-BAM21-LCB** 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-LCB** 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-LCB** 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-LCB** 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 **Offset Adjustment** switch to set the minimum average offset between the ranges.

Procedure

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-LCB**. 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-LCB**. 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 Offset Adjustment switch 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 **Offset Adjustment** 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.

NOTE: Once the baseline is zeroed to the desired position, do not touch the **Offset Adjustment** switch until the calibration procedure is completed.

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.

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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-LCB** 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-LCB** has been calibrated, measurements may be taken.

1. Turn the **SI-BAM21-LCB Power** switch on (I). The system needs to be powered on for 30 minutes before calibration. Leave it on while you prepare to take measurements.
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.

Setting System Gain Factor

The **SI-BAM21-LCB** 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. Turn off the Signal Conditioning Amplifier System and unplug it from the power outlet.
2. Remove the two screws on the face of the **SI-BAM21-LCB** module.
3. Gently slide the module out of the **SI-BMFA** frame.
4. Locate the 3-pin jumper J16.
5. Jumper pins 1 and 2 to use the **SI-BAM21-LCB** with the **SI-MT** system, or jumper pins 2 and 3 for use with the **SI-MB** systems.
6. Reinstall the module into the frame and secure it with the screws.



MAINTENANCE

The **Signal Conditioning Amplifier System** chassis is maintenance free. However, to protect it, follow these guidelines:

- Place the system in a clean, dry location.
- Use only the power supply included.
- Keep liquids away from all the connections.

ACCESSORIES

Part Number	Description
13661	Potentiometer Adjustment Tool (Tweaker)
2851	BNC Cable
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

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TROUBLESHOOTING

Issue	Possible Cause	Solution
No power	One of the two power switches is off.	Verify that the power switch one the back of the chassis and the power switch on the front panel are both in the on (O) position.
	The power cord is loose or not connected properly to the AC wall outlet	Unplug the power cord from the wall and the chassis and re-install it.
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

Chassis

Maximum Power Consumption 1.3A at 115V 50/60Hz, 1.8A at 230V 50/60Hz

SI-BAM21-LCB

Input Configuration	Current to voltage converter
Gain	1X, 2X, 5X, 10X - Switch selectable
Output Impedance	470Ω
Power Requirements	12V DC provided by the chassis
Output Range	±10V DC



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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 one year* 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 10 days after receipt of shipment. Claims for lost shipments must be made within 30 days of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim settles. 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.
- WPI cannot be held responsible for items damaged in shipment en route to us. Please enclose merchandise in its original shipping container to avoid damage from handling. We recommend that you insure merchandise when shipping. The customer is responsible for paying shipping expenses including adequate insurance on all items returned.
- Do not return any goods to WPI without obtaining prior approval and instructions (RMA#) from our returns department. Goods returned unauthorized or by collect freight may be refused. The RMA# must be clearly displayed on the outside of the box, or the package will not be accepted. Please contact the RMA department for a request form.
- Goods returned for repair must be reasonably clean and free of hazardous materials.
- A handling fee is charged for goods returned for exchange or credit. This fee may add up to 25% of the sale price depending on the condition of the item. Goods ordered in error are also subject to the handling fee.
- Equipment which was built as a special order cannot be returned.
- Always refer to the RMA# when contacting WPI to obtain a status of your returned item.
- For any other issues regarding a claim or return, please contact the RMA department

Warning: This equipment is not designed or intended for use on humans.

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

World Precision Instruments, Inc.

International Trade Center, 175 Sarasota Center Blvd., Sarasota FL 34240-9258

Tel: 941-371-1003 • Fax: 941-377-5428 • E-mail: sales@wpiinc.com

UK: Astonbury Farm Business Centre • Aston, Stevenage, Hertfordshire SG2 7EG • Tel: 01438-880025 • Fax: 01438-880026 • E-mail: wpiuk@wpi-europe.com

Germany: Zossener Str. 55, 10961 Berlin • Tel: 030-6188845 • Fax: 030-6188670 • E-mail: wpide@wpi-europe.com

China & Hong Kong: Rm 20a, No8 Dong Fang Rd., Lu Jia Zui Financial District, shanghaai PRC • Tel: +86 688 85517 • E-mail: chinasalses@china.wpiinc.com