MSR Rotator Calibration and Verification

1 MSR Part Number Information

NOTE:

Before performing calibration and verification of your MSR rotator, first identify the part number of the instrument. This document contains separate instructions for the legacy AFMSRCE (pre-2025 model), as well as the AFMSR24A1 (MSR evo).

Section 2 contains the steps for AFMSRCE, and Section 3 contains the steps for AFMSR24A1. Be sure you are following the appropriate instructions for your specific MSR rotator model.

2 AFMSRCE Calibration and Verification

2.1 Required Tools

Gather the following tools prior to beginning the calibration procedure:

- Digital laser tachometer (included in the MSR Rotation Rate Calibration Kit, AKMSRCAL)
- Potentiometer adjustment tool (included in the MSR Rotation Rate Calibration Kit, AKMSRCAL)
- Traceable, digital voltmeter (can use a potentiostat if one is not available)
- Traceable DC voltage source (at least $0 - 5\ \mathrm{V}$) (can use a potentiostat if one is not available)
- Phillips-head screwdriver

2.2 AFMSRCE Calibration Procedure

STOP:

Ensure the brush contacts have been adequately worn prior to calibration. Run the AFMSRCE Rotator, without an electrode tip installed, at $3200\ \mathrm{RPM}$ for at least two (2) hours prior to calibration.

1. Switch off power to the rotator and disconnect the power cord.
2. With the power cord disconnected, remove the cover from the control unit (see Figure 2-1).

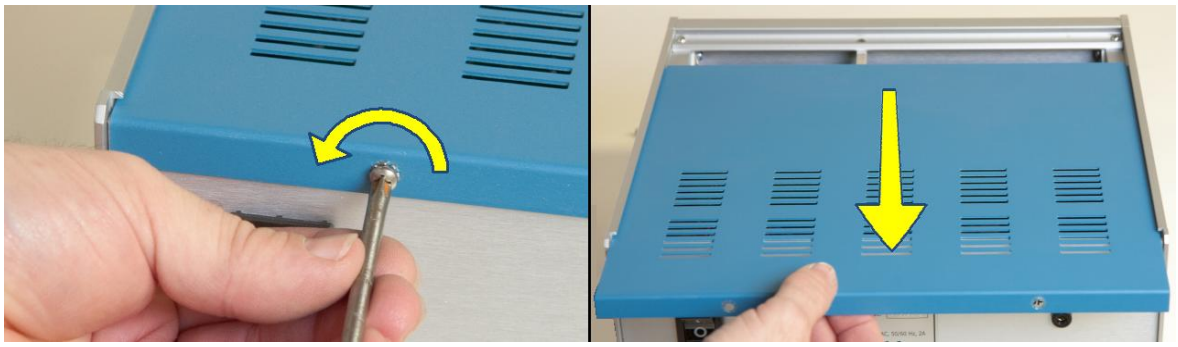


Figure 2-1. Removing AFMSRCE Control Unit Cover

3. While the power is switched off, note the positions of the various trimmers located along the top of the main circuit board (see Figure 2-2). A trimmer adjustment tool (or a flathead screwdriver) is required to adjust these trimmers.

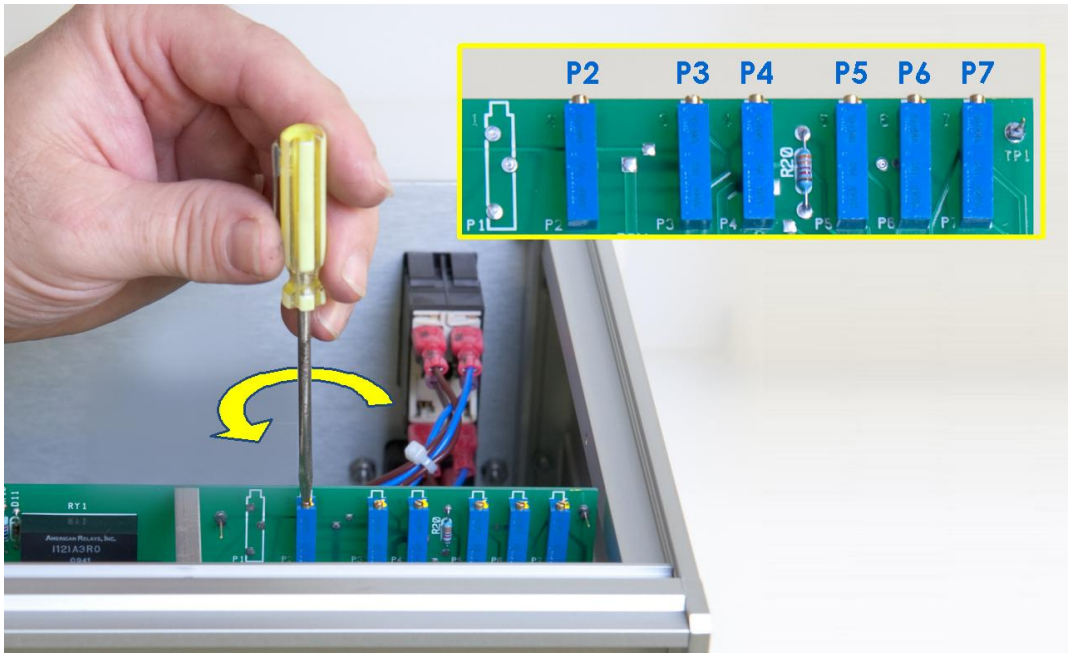


Figure 2-2. Location of Trimmer Potentiometers on the AFMSRCE Control Unit Circuit Board

4. While the power is switched off, install the tachometer target shaft into the motor coupling on the motor unit. This target should be a metal rod with the appropriate diameter ($1/4$" or 6.35 mm), which is included with the MSR Rotation Rate Calibration Kit (AKMSRCAL). Many tachometers require that a piece of reflective tape be attached to the end of the shaft, which has already been done to the calibration shaft included with the kit (see Figure 2-3).
5. Turn the rotation rate knob fully counter-clockwise. This is the position that corresponds to a nearly zero rotation rate.
6. Reconnect the power cord and carefully switch on the rotator.
7. Using the tachometer to monitor the actual rotation rate, slowly adjust the rotation rate knob on the front panel until the tachometer indicates a rotation rate of approximately 2800 RPM.

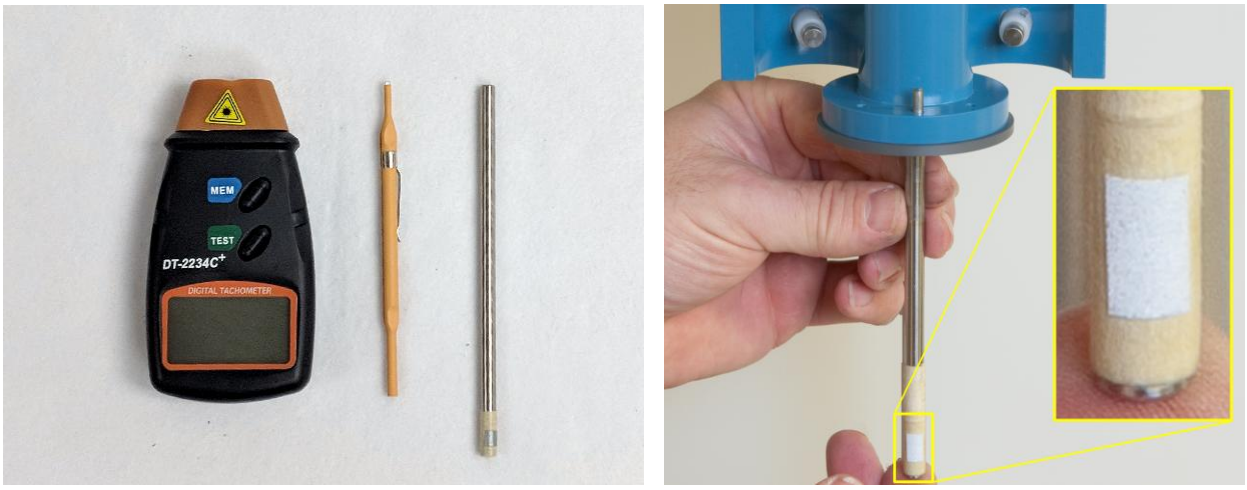


Figure 2-3. MSR Calibration Kit Tools (left) and Installation of Calibration Shaft (right)

WAIT:

Allow the rotator to rotate at 2800 RPM for one (1) hour before continuing with the calibration process. This waiting period permits all electronic and mechanical components of the rotator system to equilibrate and reach a steady state.

8. After the one hour waiting period, turn the rotation rate knob fully counterclockwise. This is the position that corresponds to a nearly zero rotation rate.
9. Locate test points **TP2** and **TP3** on the circuit board. These test points are accessible without the need to remove the circuit board from the control unit (see Figure 2-4).

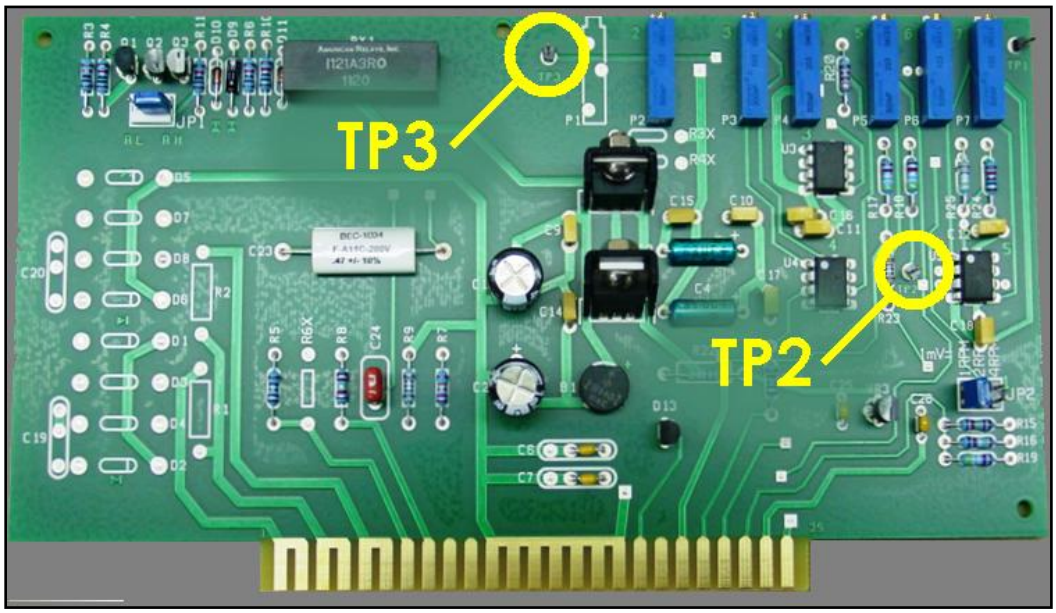


Figure 2-4. Location of Test Points on the AFMSRCE Control Unit Circuit Board

10. Connect the black lead of the digital voltmeter to one of the two black banana jacks (DC common) on the front panel of the control unit. In the next several steps of the procedure, the red lead on the voltmeter is connected to various test points, but the black lead should remain connected to the DC Common jack on the front panel.
11. Connect the red lead of the digital voltmeter to test point **TP3** on the circuit board. Adjust trimmer **P3** until the voltmeter reads $0.0000\ \text{VDC} \pm 0.0005\ \text{VDC}$.
12. Connect the red lead of the digital voltmeter to test point **TP2** on the circuit board. Adjust trimmer **P2** until the voltmeter reads $0.0000\ \text{VDC} \pm 0.0005\ \text{VDC}$.
13. Keep the red lead of the digital voltmeter connected to test point **TP2** on the circuit board. Adjust trimmer **P3** until the voltmeter reads approximately $0.0125\ \text{VDC}$. At this point, the motor should be rotating at a very slow rate. The direction of this slow rotation should be counterclockwise when looking down on the motor unit from above.
14. Turn the rotation rate control knob very slowly until the motor comes to a complete stop. Adjust trimmer **P7** until the rotation rate display on the front panel reads 0000 ± 1.
15. Connect the red lead of the digital voltmeter to the OUTPUT signal jack on the front panel. Confirm that the signal level at this jack is $0.000\ \text{VDC} \pm 0.001\ \text{VDC}$.
16. Using the tachometer to monitor the actual rotation rate, slowly adjust the rotation rate knob on the front panel until the tachometer indicates a rotation rate of $3000\ \text{RPM} \pm 1\ \text{RPM}$.
17. While the shaft is rotating at $3000\ \text{RPM}$, adjust trimmer **P6** until the rotation rate display on the front panel of the control unit reads 3000 ± 1.
18. Connect the red lead of the digital voltmeter to the OUTPUT signal jack on the front panel. Confirm that the signal level at this jack is $3.000\ \text{VDC} \pm 0.001\ \text{VDC}$.
19. Slowly turn the rotation rate control knob counterclockwise until the motor comes to a complete stop.
20. Switch off power to the rotator and disconnect the power cord.
21. Use a small $(5/64")$ hex key to loosen the hex screws in the motor coupling and remove the shaft from the rotator.
22. Use the hex key to securely retighten the hex screws into the motor coupling.
23. Close the clamshell doors on the brush chamber and secure the latch.
24. Secure the enclosure around the rotator motor unit (see Figure 2-5).

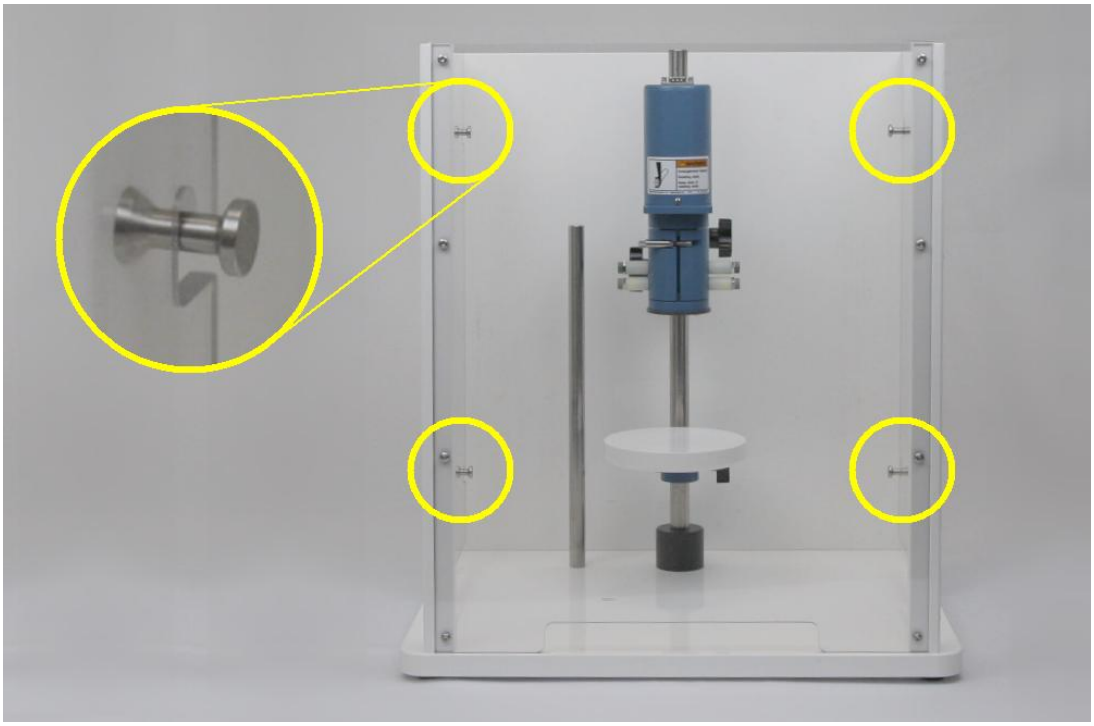


Figure 2-5. Secure Position of the AFMSRCE Rotator Enclosure

25. Turn the rotation rate knob fully counterclockwise. This is the position that corresponds to a nearly zero rotation rate.
26. Reconnect the power cord and carefully switch on the rotator.
27. Slowly turn the rotation rate control knob fully clockwise to the fastest rotation rate. The rotation rate display on the front panel of the control unit should read approximately $10050\ \mathrm{RPM}$. Adjust trimmer **P4** until the rotation rate display on the front panel of the control unit reads $10050 \pm 10\ \mathrm{RPM}$.
28. Turn the rotation rate knob fully counterclockwise. This is the position that corresponds to a nearly zero rotation rate.
29. Switch off power to the rotator and disconnect the power cord.
30. Replace the cover on the control unit (see Figure 2-6).

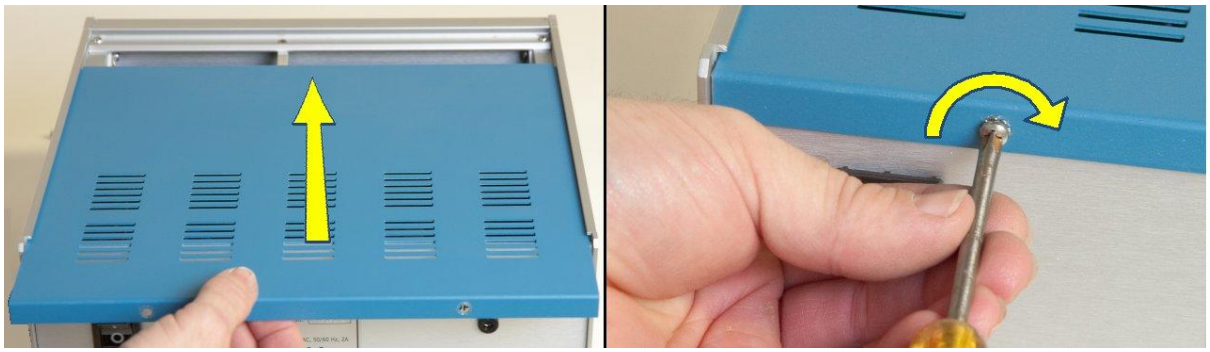


Figure 2-6. Installing AFMSRCE Control Unit Cover

2.3 AFMSRCE Verification Procedure

Following calibration (see Section 2.2), verify the input to and output from the AFMSRCE Electrode Rotator.

Prior to verifying the calibration, it is necessary to verify the input ratio of the AFMSRCE Rotator. Determine the setting for the input rotation rate ratio $(1, 2, \text{or } 4\ \text{RPM/mV})$ by carefully examining the position of jumper **JP2** on the circuit board (see Figure 2-7). From the production facility, Pine Research AFMSRCE Electrode Rotators are set to the $1\ \text{RPM/mV}$ input ratio.

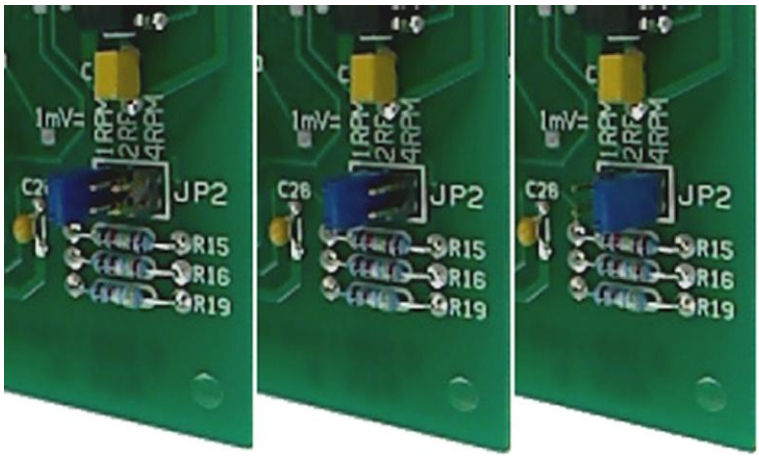


Figure 2-7. Input Ratio Setting Jumper on AFMSRCE Control Unit Circuit Board

2.3.1 Verification and Calibration of Input Signal

1. Using a DC voltage source, apply $1.000 \pm 0.001\ \text{VDC}$ to the rotation rate INPUT signal and observe the reading on the front panel display. The proper reading will depend upon the position of jumper **JP2** as follows:
    a. If **JP2** is set for $1\ \text{RPM/mV}$, the display should read $1000 \pm 1\ \text{RPM}$.
    b. If **JP2** is set for $2\ \text{RPM/mV}$, the display should read $2000 \pm 1\ \text{RPM}$.
    c. If **JP2** is set for $4\ \text{RPM/mV}$, the display should read $4000 \pm 1\ \text{RPM}$.
2. Remove the cover of the control unit following the steps shown in Section 2.2, steps 1-3. Record the tachometer reading and control unit display readings (see Table 2-1). Adjust trimmer **P5** until the rotation rate display on the front panel is within the ± 1 RPM tolerance.
3. Repeat steps 1-2 for a series of voltage inputs (see Table 2-1).
4. Disconnect the voltage source from the INPUT jacks on the front panel.

Input Signal (V)	Expected Rotation Rate (RPM)	Tachometer Reading (RPM)	Control Unit Display Reading (RPM)
0.100	100 ± 1.0		
0.200	200 ± 2.0		
0.500	500 ± 5.0		
1.000	1000 ± 10.0		

Table 2-1. AFMSRCE Input Signal Verification Data

INFO:

For a good calibration, the Tachometer Reading will be equal to the Expected Rotation Rate (within the stated tolerance) and to the Control Unit Display Reading as a function of the applied input signal.

2.3.2 Verification of Output Signal

Verify the calibration at the several different rotation rates.

1. Prepare the AFMSRCE Rotator by connecting it to its power supply, adjusting the power switch to the on position, and applying a piece of reflective tape to the shaft. Ensure the shaft is installed and secured by tightening the hex screws in the motor coupling using the 5/64" hex key.
2. Connect the voltage carrying lead (typically red lead for a digital voltmeter, or the Working/Working Sense leads of a potentiostat) to the OUTPUT port on the MSR Control Unit. Connect the ground/common lead (typically black lead for digital voltmeter, or the Counter/Reference leads of a potentiostat) to the black port on the AFMSRCE Control Unit.
3. Set the rotation rate of the AFMSRCE Rotator by turning the knob to the desired rate (see Table 2-2).
4. Record the tachometer reading and output voltage measurement.
5. Repeat steps 3-4 for a series of voltage inputs (see Table 2-2).

AFMSRCE Control Unit Display Reading (RPM)	Expected Rotation Rate (RPM)	Tachometer Reading (RPM)	Output Signal (V)
100	100 ± 1.0		
200	200 ± 2.0		
500	500 ± 5.0		
1000	1000 ± 10.0		
2000	2000 ± 20.0		
5000	5000 ± 50.0		

Table 2-2. AFMSRCE Output Signal Verification Data

INFO:

For a good calibration, at each rotation rate, the rotation rate display on the front panel, the rotation rate indicated by the optical tachometer, and the rotation rate indicated at the OUTPUT jack on the front panel should all agree to within one percent ($1.0\,\%$). The readings noted during this step should be recorded in a log book or on a certification sheet.

2.3.3 AFMSRCE Calibration and Verification Finalization

After completing calibration and verification tasks, turn the AFMSRCE Control Unit power switch to the off position and disconnect the power supply. Remove the shaft with reflective tape. Use a screwdriver to secure the panel to the top of the Control Unit. Make final notations in a calibration record, as appropriate.

3 AFMSR24A1 (MSR evo) Calibration and Verification

The MSR evo rotation rate is controlled by a tunable analog feedback circuit located inside the control unit. This circuit is tuned and calibrated at the factory prior to shipment, but if the rotator needs to be recalibrated by the owner at a later date, the procedure below describes the best method for calibrating and verifying the rotation rate control circuit.

The most important tool required for calibrating the MSR evo rotator is a non-contact **optical tachometer**. Pine Research offers such a simple tachometer (see Figure 3-1) as part of the MSR Calibration Kit, AKMSRCAL, and this simple tachometer is suitable for routine verification or calibration of the rotation rate by the owner.

Figure 3-1. Rotator Calibration Toolkit AKMSRCAL (including simple handheld digital tachometer)

In the event that the rotation rate must be rigorously traceable to a national or international standards organization, a more sophisticated and professional tachometer with traceable certification should be used (see Figure 3-2). When an MSR evo rotator is manufactured at the factory (or when a rotator is returned to the factory for service), recalibration is performed using a traceable tachometer.

Figure 3-2. Professional Optical Tachometer with Traceable Calibration

The tachometer reads the rotation rate when it is pointed at a rotating shaft equipped with a **reflective target** (see Figure 3-3). The MSR Calibration Kit includes a shaft suitable for use as a reflective target. Alternately, a stainless steel rod ($1/4$ OD x 5" L; 6.35 mm OD x 100 mm L) may be mounted in the motor coupling, and a mark can be made on the rod with a marker.

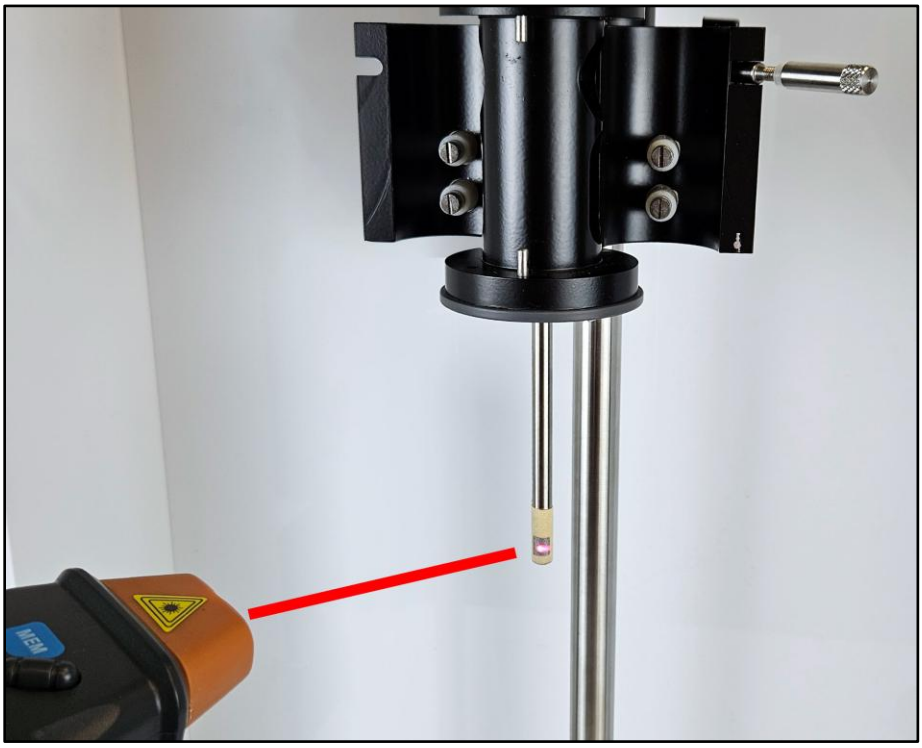


Figure 3-3. Use of Optical Tachometer with Reflective Target

The calibration process involves making adjustments to various trimmer potentiometers (trimmers) on the circuit board. The MSR Calibration Kit includes a **trimmer adjustment tool** for this purpose. Alternately, a small flathead screwdriver can be used to make these adjustments.

A calibrated **digital voltmeter** is required to confirm certain signal levels on the circuit board. It is recommended that a 4 ½-digit voltmeter be used for this purpose. The calibration process also requires a **known voltage source** (1000 mV). This known source can be a power supply or waveform generator, and the value of the known voltage (1000 mV) should be verified using the calibrated digital voltmeter.

Other tools required are a **#1** and **#2 Pozidriv screwdriver** (alternatively, a medium-sized **Phillips screwdriver** may be used instead), a $3/16$" **(5 mm) hex driver**, $9/32$" **(7 − 8 mm) hex driver**, and a $5/64$" **(2 mm) hex driver** (to turn the hex screws on the motor coupling when installing or removing a shaft). This small hex key is included with the purchase of a new rotator and it is also available at many retail hardware supply stores.

Note that in all cases where a Pozidriv screwdriver is recommended, a Phillips screwdriver may be used as an alternative. However, be advised that the specific screws used with Pozidriv screwdrivers can become damaged or stripped over long periods of time if Phillips screwdrivers are used. Caution should be exercised when repeatedly using a Phillips screwdriver to loosen and tighten these screws.

DANGER:

High voltage. Risk of electric shock.

This procedure must be performed by an electrician or a qualified technician. This procedure requires working inside the control unit while the control unit is powered on and operating.

High voltages are present inside the control unit at the power entry module and on the two internal power supply modules as shown in the shaded and outlined portion of the image below.

KEEP HANDS AND TOOLS AWAY FROM THE POWER ENTRY MODULE AND THE TWO POWER SUPPLY MODULES!

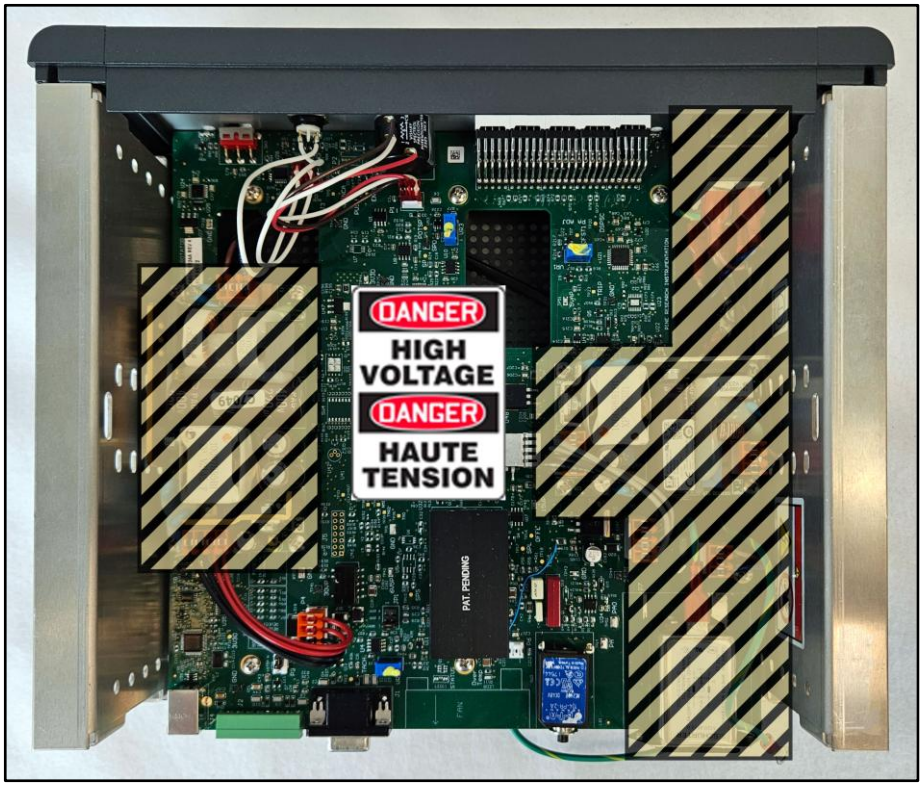
DANGER:

Haute Tension. Risque de décharge électrique.

Cette procédure doit être confiées à un électricien ou un technicien qualifié. Cette procédure requiert de travailler à l'intérieur de l'unité de commande lorsque cette dernière est alimentée et en fonctionnement.

Des tensions élevées sont présentes dans l'unité de commande au niveau du module d'entrée d'alimentation et sur les deux modules d'alimentation internes tel qu'indiqué dans la portion grisée et mise en évidence de l'image ci-dessous.

GARDEZ VOS MAINS ET VOS OUTILS ÉLOIGNÉS DU MODULE D'ENTRÉE D'ALIMENTATION ET DES DEUX MODULES D'ALIMENTATION!



CAUTION:

Static electricity may damage electronic components.

Ensure proper grounding when handling static sensitive components by wearing a grounding strap.

ATTENTION:

L'électricité statique est susceptible d'endommager les composants électriques.

Veillez à disposer d'une mise à la terre appropriée lorsque vous manipulez des composants sensibles en portant un ruban de mise à la terre.

Note:

When performing a traceable rotation rate calibration, verify the dates on the calibration certificates for the tachometer and voltmeter and confirm that the certificates have not expired.

3.1 Removing Top Panel of AFMSR24A1 Control Unit

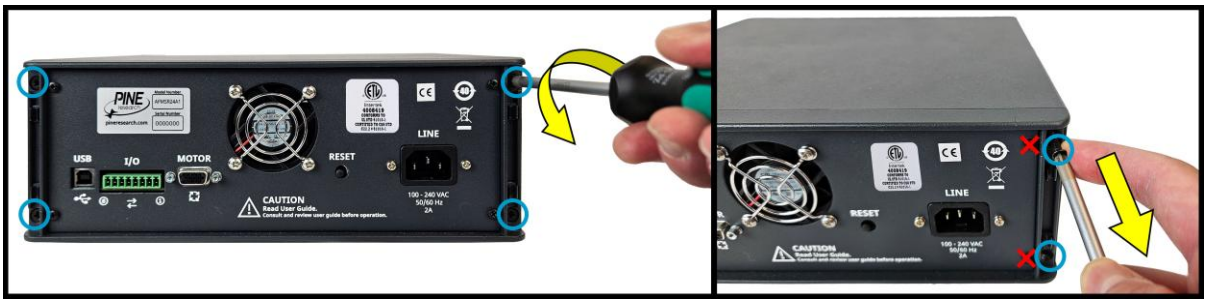
Turn the power switch on the front panel of the control unit off and disconnect the power cord.

Disconnect the motor control cable from the control unit, as well as any other auxiliary cables.

With the power cord disconnected, first remove the two corner panel protectors located on the edges of the back panel of the control unit. This can be done by hand, or using a flathead screwdriver or similar tool if needed to pry the panels loose.

Using a #2 Pozidriv screwdriver (or a Phillips screwdriver), loosen and remove the four screws in the corners of the back panel.

Note: **Do not remove** the four screws near the corners that are slightly inset, as shown in the right image below with red Xs. The correct screws to remove are the ones that were underneath the previously-removed corner panel protectors.



Using a #1 Pozidriv screwdriver (or a Phillips screwdriver), loosen and remove the two screws on either side of the power cord connector.

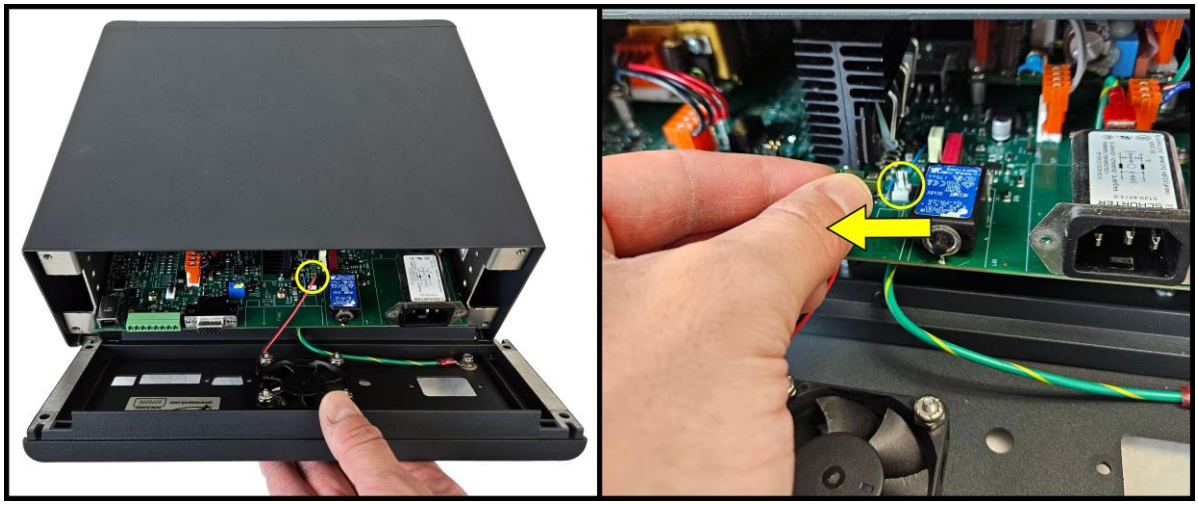
Using a $3/16$" (5 mm) hex driver, loosen and remove the two screws on either side of the motor cable connector.

Using a #1 Pozidriv screwdriver (or a Phillips screwdriver), loosen and remove the centrally-located black screw on the bottom of the control unit near the back panel.

Do not remove the silver screw underneath the black screw (marked with a red X in the right image below).

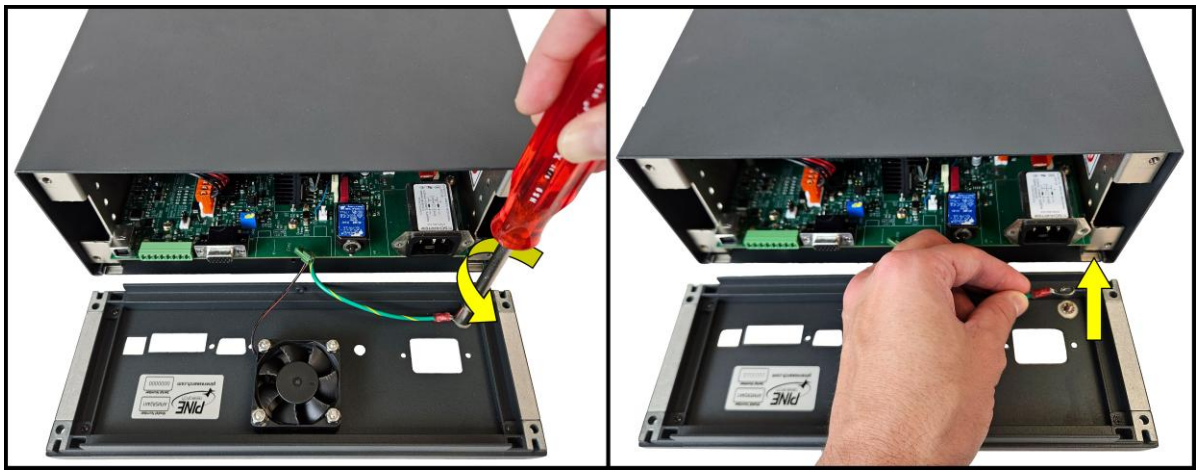
Loosen and then pivot the top of the back panel down, but **DO NOT FULLY PULL IT AWAY OR REMOVE IT FROM THE CONTROL UNIT YET**, as there are still several connections linking the back panel to the control unit.

First, with the back panel laying flat, unplug the connector to the cooling fan.



Using a $9/32$ " ($7-8$ mm) hex driver, loosen and remove the nut and lock washer connecting the grounding wire to the inside of the back panel.

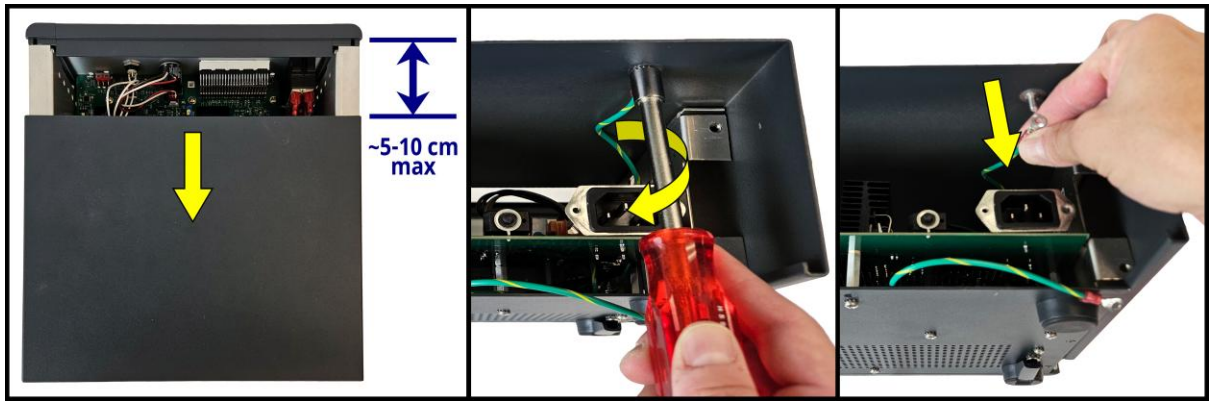
At this point, the back panel can now be completely removed from the control unit and placed carefully aside on the lab bench.



Carefully slide the top panel back around $5-10$ cm, but **DO NOT FULLY SLIDE IT BACKWARDS OR REMOVE IT COMPLETELY YET**.

Using a $9/32$ " ($7-8$ mm) hex driver, loosen and remove the nut and lock washer connecting the grounding wire to the under side of the top panel.

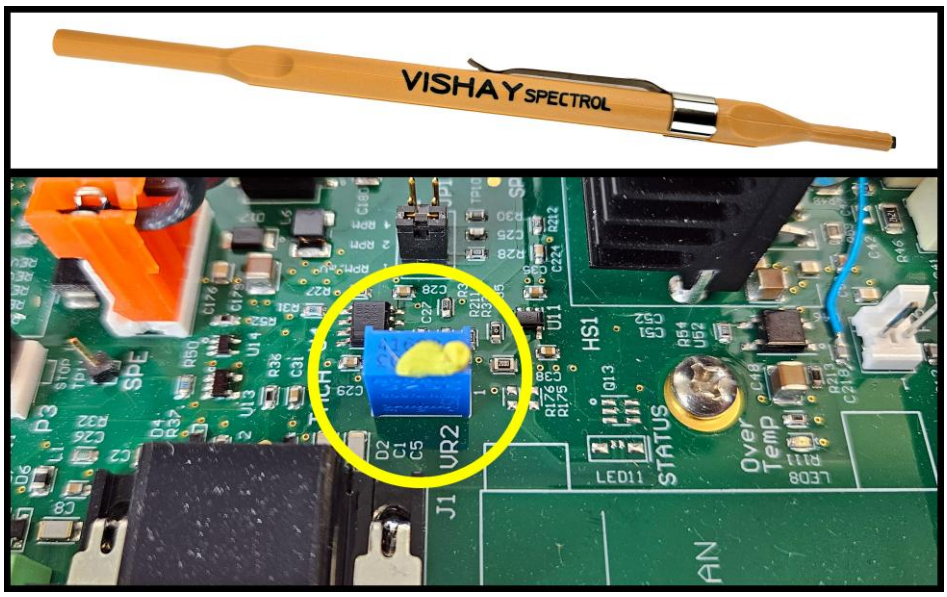
At this point, the top panel can now slide back and be completely removed from the control unit, then placed carefully aside on the lab bench.



While the power is still switched off, the power cord unplugged, and the top panel removed, note the position of the three blue trimmers on the main circuit board. They are labeled "**VR1**," "**VR2**," and "**VR3**." A trimmer adjustment tool (or a small flathead screwdriver) is required to adjust the small screw on the top of these trimmers.

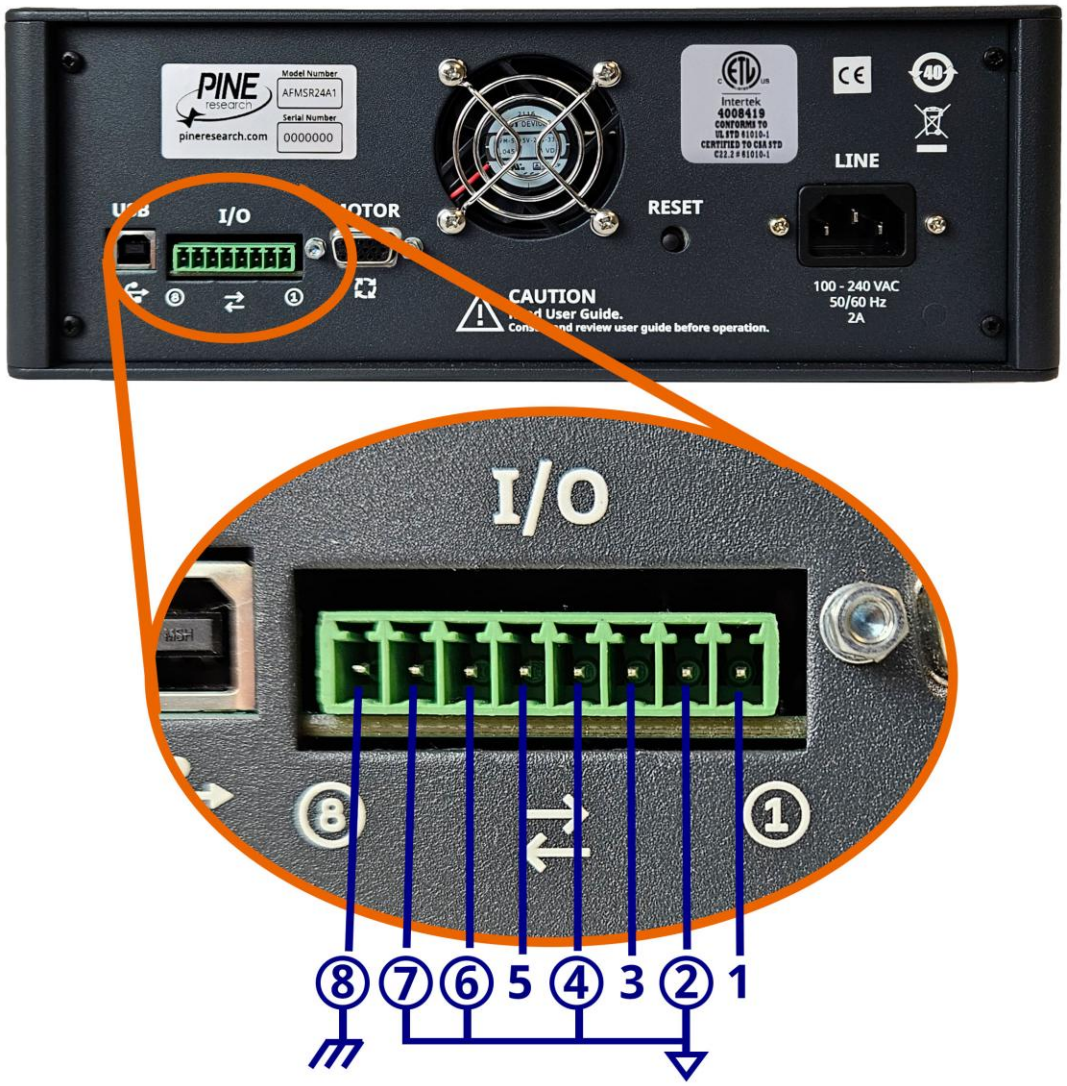
Note that there may be a threadlock layer on the top of the trimmers blocking access to the screw. This typically yellow, paint-like film is often applied in the factory to prevent the trimmers from losing calibration during shipment or minor vibrations.

Prior to performing a calibration procedure, these films should be scraped away so the screws on each trimmer can be adjusted as needed.



3.2 AFMSR24A1 Control Unit External I/O Port Pinout

There are eight pins on the MSR evo External I/O Port (see Figure 3-4). This port is used throughout the calibration and verification procedure in the subsequent sections of this document.



1	Rate Control (input)	Input voltage signal used to control rotation rate
3	Rate Monitor (output)	Output voltage signal used to monitor rotation rate
5	Motor Stop	Digital signal used to turn motor off
2, 4, 6, and 7	DC Common	0 V reference point on control unit circuit board
8	Chassis Ground	Connection to metal case surrounding unit circuitry

Figure 3-4. Pinout of External I/O Port on MSR evo Control Unit Back Panel

3.3 AFMSR24A1 Offset Calibration

Reconnect the power cord and motor control cable to the back of the control unit. Connect the other end of the motor control cable to the top of the motor unit. Turn the rate control knob fully counterclockwise. This is the position that corresponds to a nearly zero rotation rate.
Ensure the control switch on the front panel is toggled to the left position. Turn the power switch on. Ensure the motor does not rotate and that the status indicator LED is red.
Toggle the control switch to the right position. The status indicator LED should remain red. The external control indicator LED should turn yellow. The rotation rate display should read **0 RPM**. Toggle the control switch to the left position. The status indicator LED should remain red. The external control indicator LED should turn off.
Confirm the rate control knob is still turned fully counterclockwise. Using a trimmer adjustment tool (or a small flathead screwdriver), adjust the top screw on trimmer **VR3** until the rotation rate display shows **0 RPM**.
Press the Run/Pause button. The status indicator LED should turn green.
Using a trimmer adjustment tool (or a small flathead screwdriver), adjust the top screw on trimmer **VR1** until the rotation rate display shows **0 RPM**. Ensure that the motor is at a complete stop or moving very slowly.
Press the Run/Pause button. The status indicator LED should turn red. Confirm the motor is still at a complete stop.

While in the “pause” state, measure the voltage between pins 3(+) and 6(-) of the green 8-pin external I/O port (see Figure 3-4). The measured voltage should be $\mathbf{0.0 \pm 0.1\ mV}$.

3.4 AFMSR24A1 Manual Speed Calibration

WARNING:

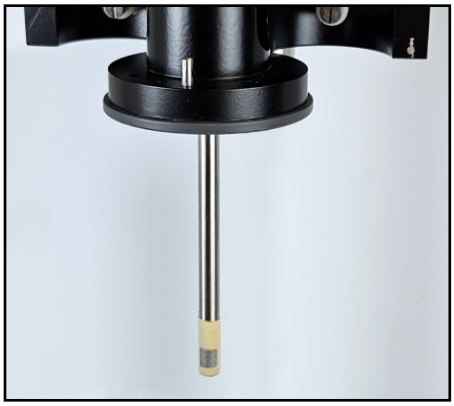
Laser radiation.

Many optical tachometers use a laser beam as a light source. Do not look directly at the laser beam. Do not point the laser beam into the eye.

AVERTISSEMENT:

Rayonnement laser.

Un grand nombre de tachymètres optiques utilisent un faisceau laser comme source de lumière. Ne regardez pas directement le faisceau laser. Ne pointez pas le faisceau laser dans l’œil.



Turn the power switch off. Install the tachometer target shaft into the motor coupling on the motor unit.

This target should be a metal rod with the appropriate diameter ($1/4$" or 6.35 mm).

Many tachometers require that a piece of reflective tape be attached to the end of the shaft as shown.

Turn the power switch on. The status indicator LED should be red, and the rotator should be in the "pause" state.

Adjust the rate control knob on the front panel of the control unit until the rotation rate display reads **3000 RPM**. Ensure the rotator remains stationary while in the "pause" state.

Press the Run/Pause button. The status indicator LED should turn green, and the shaft will begin to rotate. The rotation rate display should continue to read **3000 ± 3 RPM**.

Point an **optical tachometer** at the reflective shaft and monitor the reading. Using a trimmer adjustment tool (or a small flathead screwdriver), adjust the top screw on trimmer **VR2** until the tachometer measures within **±1 RPM** of the control unit display.

Measure the voltage between pins 3(+) and 6(-) of the green 8-pin external I/O port (see Figure 3-4). It should read **3000 ± 5 mV**, which corresponds to **±5 RPM** of the control unit display and tachometer reading.

Verify the manual speed calibration at several different rotation rates (suggested rates are **200**, **500**, **1000**, **2000**, and **5000 RPM**), following the previous steps described in this section. At each rotation rate, the rotation rate display on the front panel, the rotation rate measured by the **optical tachometer**, and the voltage measured between pins 3(+) and 6(-) of the green 8-pin external I/O port (see Figure 3-4) should all agree to within one percent (1%). The readings noted during this step should be recorded in a log book or on a certification sheet (see Section 3.6 for example certification sheet).

Note:

A convenient example certification sheet that can be used to record the verification readings can be found in Section 3.6.

3.5 AFMSR24A1 External Input Speed Calibration

WARNING:

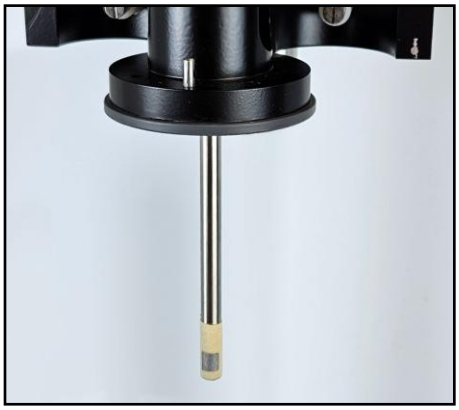
Laser radiation.

Many optical tachometers use a laser beam as a light source. Do not look directly at the laser beam. Do not point the laser beam into the eye.

AVERTISSEMENT:

Rayonnement laser.

Un grand nombre de tachymètres optiques utilisent un faisceau laser comme source de lumière. Ne regardez pas directement le faisceau laser. Ne pointez pas le faisceau laser dans l'œil.



Skip this step if the tachometer target shaft is already installed. If it is not already installed, continue as follows.

Turn the power switch off. Install the tachometer target shaft into the motor coupling on the motor unit.

This target should be a metal rod with the appropriate diameter ($1/4$" or 6.35 mm).

Many tachometers require that a piece of reflective tape be attached to the end of the shaft as shown.

Turn the power switch on. The status indicator LED should be red, and the rotator should be in the "pause" state.

Toggle the control switch to the right position. The status indicator LED should remain red. The external control indicator LED should turn yellow. The rotation rate display should read $\mathbf{0\ RPM}$.

Connect a DC voltage source to pins 1(+) and 6(-) of the green 8-pin external I/O port on the back of the control unit (see Figure 3-4). Apply $\mathbf{3.000\ V}$ using the DC voltage source. Press the Run/Pause button. The status indicator LED should turn green, and the shaft will begin to rotate. The rotation rate display should read $\mathbf{3000 \pm 3\ RPM}$.

Point an **optical tachometer** at the reflective shaft and monitor the reading. Verify the tachometer measures $\mathbf{3000 \pm 5\ RPM}$.

Verify the external input speed calibration at several different rotation rates (suggested rates are $\mathbf{200}$, $\mathbf{500}$, $\mathbf{1000}$, $\mathbf{2000}$, and $\mathbf{5000\ RPM}$, which correspond to DC voltage source inputs of $\mathbf{0.200}$, $\mathbf{0.500}$, $\mathbf{1.000}$, $\mathbf{2.000}$, and $\mathbf{5.000\ V}$, respectively), following the previous steps described in this section. At each rotation rate, the rotation rate display on the front panel and the rotation rate measured by the **optical tachometer** should agree to within one percent (1%). The readings noted during this step should be recorded in a log book or on a certification sheet (see Section 3.6 for example certification sheet).

Note:

A convenient example certification sheet that can be used to record the verification readings can be found in Section 3.6.

3.6 Example MSR evo Certification and Calibration Report

Rotation Rate Certification and Calibration Report

AFMSR24A1 Rotator Model and Serial Number	Technician (sign and date here)
Tachometer Make, Model, and SN	Tachometer Calibration Date
Voltmeter Make, Model, and SN	Voltmeter Calibration Date

Control Unit Display and Output Signal Calibration

Control Unit Display Reading	Expected Rotation Rate (RPM)	Tachometer Reading (RPM)	Output Signal (V)
200	200 ± 2.0		
500	500 ± 5.0		
1000	1000 ± 10.0		
2000	2000 ± 20.0		
3000	3000 ± 30.0		
5000	5000 ± 50.0		

Control Unit Input Signal Calibration

Input Signal (V)	Expected Rotation Rate (RPM)	Tachometer Reading (RPM)	Control Unit Display Reading
0.200	200 ± 2.0		
0.500	500 ± 5.0		
1.000	1000 ± 10.0		
2.000	2000 ± 20.0		
3.000	3000 ± 30.0		
5.000	5000 ± 50.0		

Note:

Above 200 RPM, rotation rate is certified to be within ±1% of the value on the control unit display. From 100 to 200 RPM, the rate is certified to be within ±2 RPM of the display reading.

Note:

The control unit and motor unit must be calibrated together as a system. This certification is valid only for the particular motor and control units with the serial number listed above.

3.7 Replacing Top Panel of AFMSR24A1 Control Unit

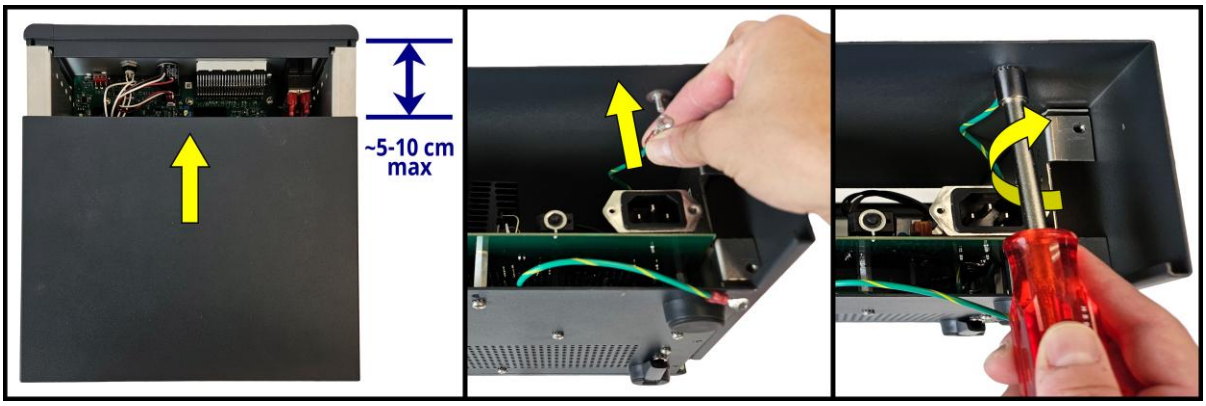
Turn the power switch on the front panel of the control unit off and disconnect the power cord.

Disconnect the motor control cable from the control unit, as well as any other auxiliary cables.

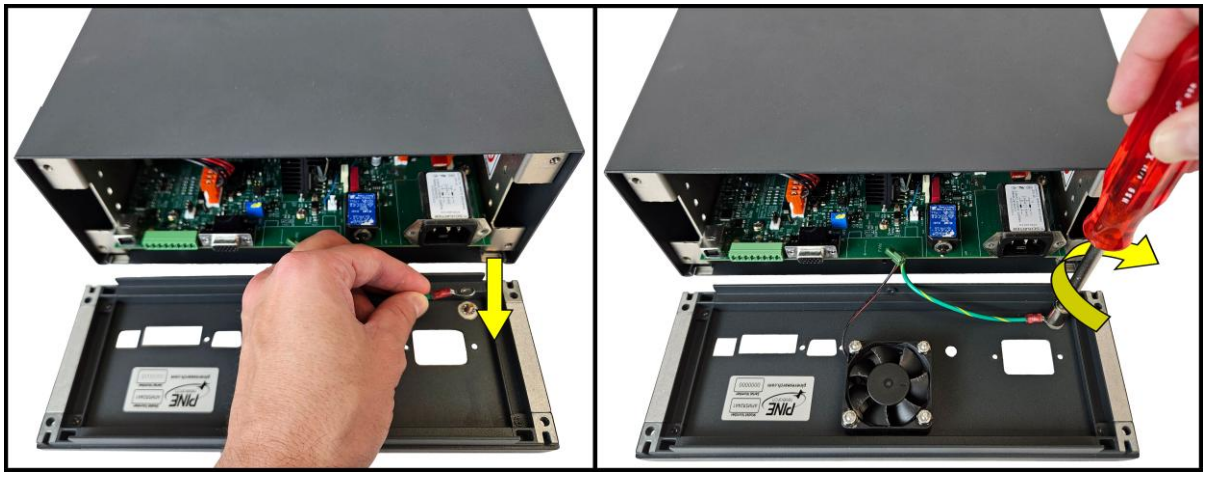
Carefully slide the top panel back onto the control unit until there is about $5 - 10$ cm gap remaining, but **DO NOT FULLY SLIDE IT ALL THE WAY ON YET**.

Using a $9/32$" ($7 - 8$ mm) hex driver, replace and tighten the nut and lock washer connecting the grounding wire to the under side of the top panel.

Once this grounding wire is secured, slide the top panel completely back onto the control unit.

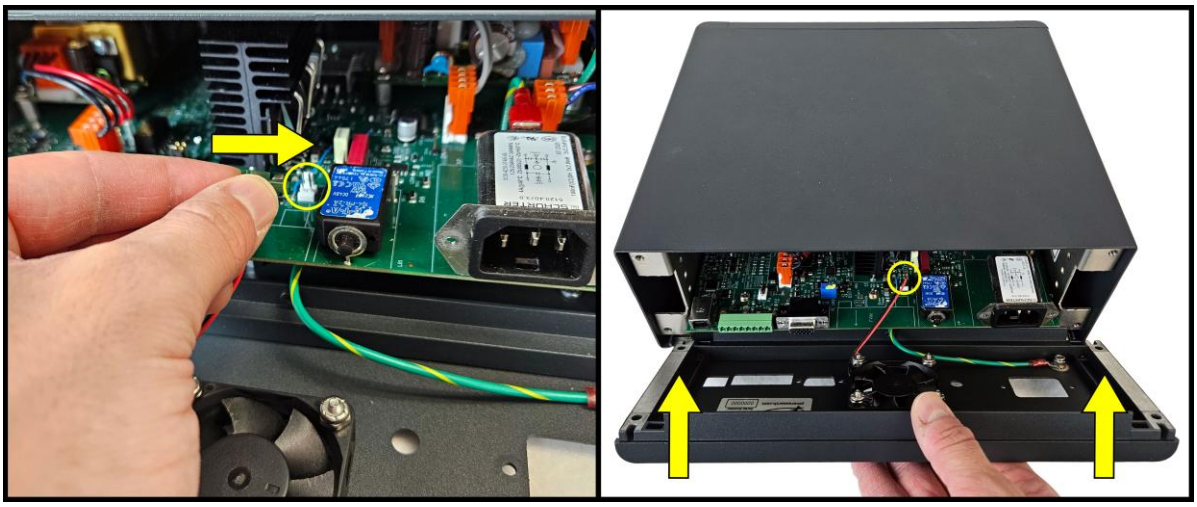


Obtain the back panel and move it until it is laying flat and near the back of the control unit. Using a $9/32$" ($7 - 8$ mm) hex driver, replace and tighten the nut and lock washer connecting the grounding wire to the inside of the back panel.



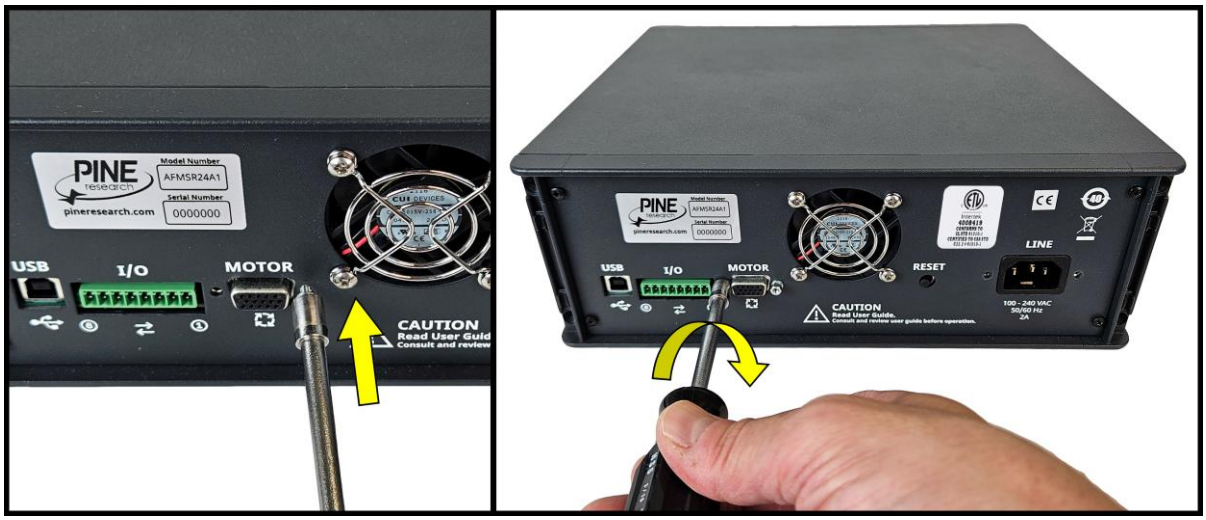
Plug the connector to the cooling fan back into the main circuit board. Note the orientation of the plug and the pins on the circuit board. Ensure the tab on the plug faces the locking tab on the circuit board connector. The plug can mistakenly be inserted onto only a single pin instead of both pins if placed improperly. Be certain the connector is inserted properly onto both pins.

Replace the back panel of the control unit once the cooling fan connector is reattached.



Using a #1 Pozidriv screwdriver (or a Phillips screwdriver), replace and tighten the centrally-located black screw on the bottom of the control unit near the back panel.

Using a $3/16$" (5 mm) hex driver, replace and tighten the two screws on either side of the motor cable connector.



Using a #1 Pozidriv screwdriver (or a Phillips screwdriver), replace and tighten the two screws on either side of the power cord connector.

Using a #2 Pozidriv screwdriver (or a Phillips screwdriver), replace and tighten the four screws in the corners of the back panel.

Replace the two corner panel protectors located on the edges of the back panel of the control unit.

3.8 Changing the AFMSR24A1 Input Rotation Rate Ratio

The rotation rate can be controlled by applying an external voltage signal to the external I/O port on the back panel of the control unit. The proportionality ratio used to convert the applied voltage signal to the rotation rate can be set to one of three different values: $\mathbf{1}$, $\mathbf{2}$, or $\mathbf{4\ RPM/mV}$.

Normally, the value for the rotation rate ratio is selected to match the control signal provided by a particular potentiostat. When shipped from the factory, the MSR evo rotator is pre-configured with a ratio of $\mathbf{1\ RPM/mV}$ because this ratio is compatible with Pine Research potentiostat systems.

WARNING:

Risk of electric shock.

Disconnect all power before servicing the rotator.

AVERTISSEMENT:

Risque de décharge électrique.

Déconnectez toutes les sources d'alimentation avant de procéder à l'entretien du rotateur.

CAUTION:

Static electricity may damage electronic components.

Ensure proper grounding when handling static sensitive components by wearing a grounding strap.

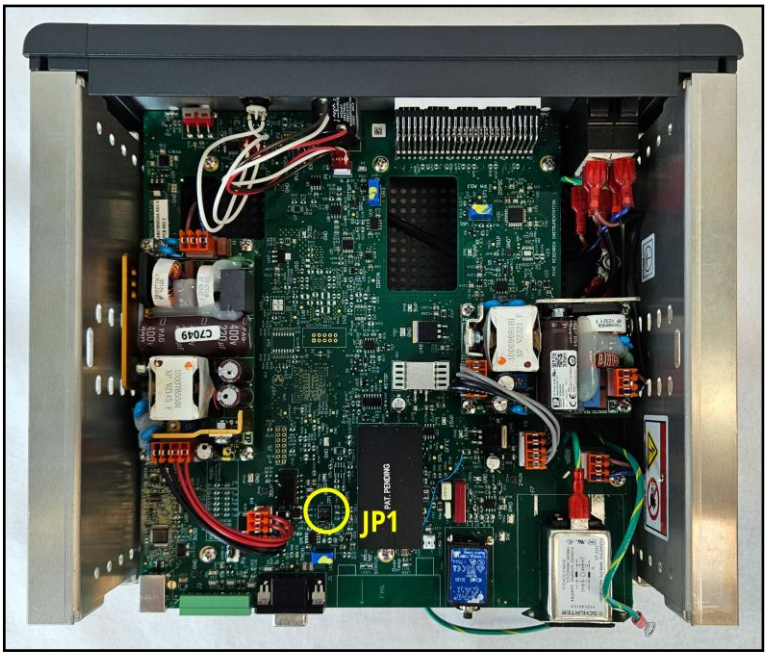
ATTENTION:

L'électricité statique est susceptible d'endommager les composants électriques.

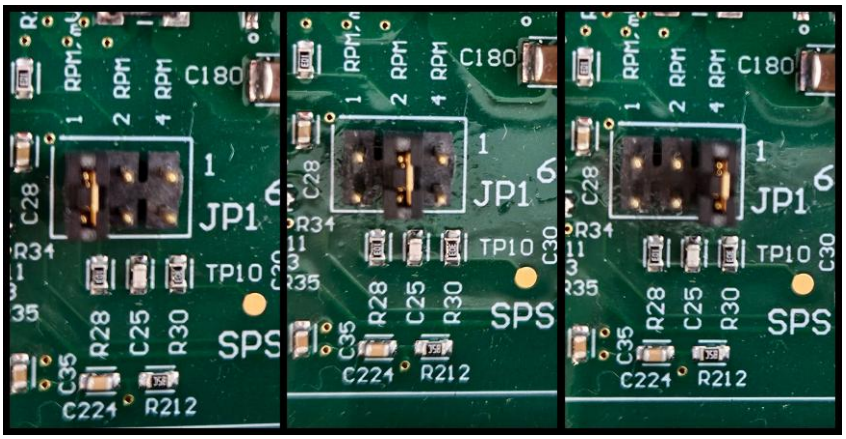
Veillez à disposer d'une mise à la terre appropriée lorsque vous manipulez des composants sensibles en portant un ruban de mise à la terre.

With the power cord removed from the control unit and the device powered off, remove the top panel of the control unit following the procedure shown in Section 3.1.

On the main circuit board, locate the configuration pins with the designation **JP1**. There is a small jumper that can be used to short together one of three pairs of pins.



Place the jumper across one of the three pairs of pins at **JP1**. Choose the ratio required for the particular potentiostat being used with the rotator.



1 RPM/mV **2 RPM/mV** **4 RPM/mV**

(Note: MSR evo rotator factory setting is **1 RPM/mV**)

Replace the cover on the control unit following the procedure shown in Section 3.7.

At this point the input ratio has been changed. Make a note in a log book or place a sticker on the control unit to indicate the new input ratio.

3.9 Changing the AFMSR24A1 Motor Stop Signal Logic

When operating in external control mode (external control switch on the front panel of the control unit in the right position), an external digital signal can be applied across the Motor Stop and DC Common pins on the external I/O port on the MSR evo control unit. This digital signal can be used by a potentiostat or other external instrument to assure that the rotation rate is exactly zero. The logic for this digital signal may be either "active HIGH" or "active LOW."

For the MSR evo, the motor stop is initially configured at the factory to use "active HIGH" logic. If desired, a jumper setting inside the control unit can be configured to use the opposite logic.

If the motor stop logic is configured to be "active HIGH," then the motor is allowed to rotate if a signal greater than 2.0 V is applied across the Motor Stop and DC Common pins. If the two pins are shorted together (*i.e.*, if the motor stop stop signal is driven to ground), then the motor stops rotating.

If the motor stop logic is configured to be "active LOW," then the motor will stop if a signal greater than 2.0 V is applied across the Motor Stop and DC Common pins. If the two pins are shorted together (*i.e.*, if the motor stop signal is driven to ground), then the motor is allowed to rotate.

Note:

When the control unit is configured for "active HIGH" logic and when no connections are made to the Motor Stop and DC Common pins, the motor is allowed to rotate. An internal "pull up" circuit assures that the motor stop signal remains "high" in this case.

Similarly, when the control unit is configured for "active LOW" logic and no connections are made to the Motor Stop and DC Common pins, the motor is allowed to rotate due to an internal "pull down" circuit.

Normally, the choice for the motor stop signal logic is selected to match the control signal provided by a particular potentiostat. When shipped from the factory, the MSR evo rotator is pre-configured with "active HIGH" logic because this logic is compatible with Pine Research potentiostat systems.

WARNING:

Risk of electric shock.

Disconnect all power before servicing the rotator.

AVERTISSEMENT:

Risque de décharge électrique.

Déconnectez toutes les sources d'alimentation avant de procéder à l'entretien du rotateur.

CAUTION:

Static electricity may damage electronic components.

Ensure proper grounding when handling static sensitive components by wearing a grounding strap.

ATTENTION:

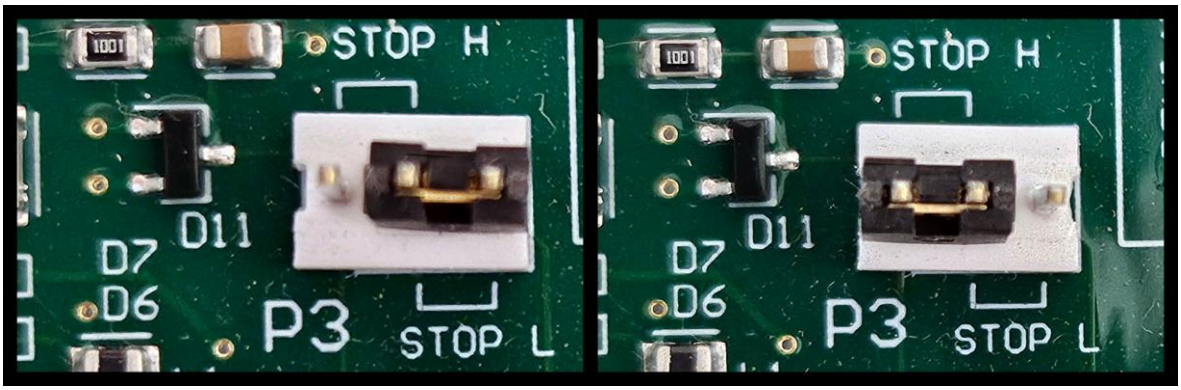
L'électricité statique est susceptible d'endommager les composants électriques.

Veillez à disposer d'une mise à la terre appropriée lorsque vous manipulez des composants sensibles en portant un ruban de mise à la terre.

With the power cord removed from the control unit and the device powered off, remove the top panel of the control unit following the procedure shown in Section 3.1.

On the main circuit board, locate the configuration pins with the designation **P3**. There is a small jumper that can be placed in one of two positions at this location.

Place the jumper across one of the two positions shown below. Choose the position required for the particular potentiostat being used with the rotator.



Active HIGH Position **Active LOW Position**

Replace the cover on the control unit following the procedure shown in Section 3.7.

At this point the motor stop signal logic has been changed. Make a note in a log book or place a sticker on the control unit to indicate the new logic.

4 Support

After reviewing the content of this document, please contact Pine Research Instrumentation should you have any issues or questions with regard to the use of the MSR rotator, accessories, or software. Contact us anytime by the methods provided below.

Online

Our website has a contact form that allows technical support requests to be sent directly to Pine Research. Visit www.pineresearch.com/contact.

Email

Send an email to pinewire@pineresearch.com. This is the general sales email, and our team will ensure your email is routed to the most appropriate technical support staff available. Our goal is to respond to emails within 24 hours of receipt.

Phone

Our offices are located in Durham, NC in the eastern US time zone. We are available by phone Monday through Friday from 9 AM EST to 5 PM EST. You can reach a live person by calling +1 (919) 782-8320.