A-M Systems

Intracellular Electrometer

3100

INSTRUCTION MANUAL

FOR

Intracellular Electrometer

MODEL 3100

Serial #__________

Date____________

A-M Systems, Inc.
PO Box 850
Carlsborg, WA 98324
U.S.A.

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FAX: 360-683-3525

http://www.a-msystems.com

Version 6.0
May 2025

Contents

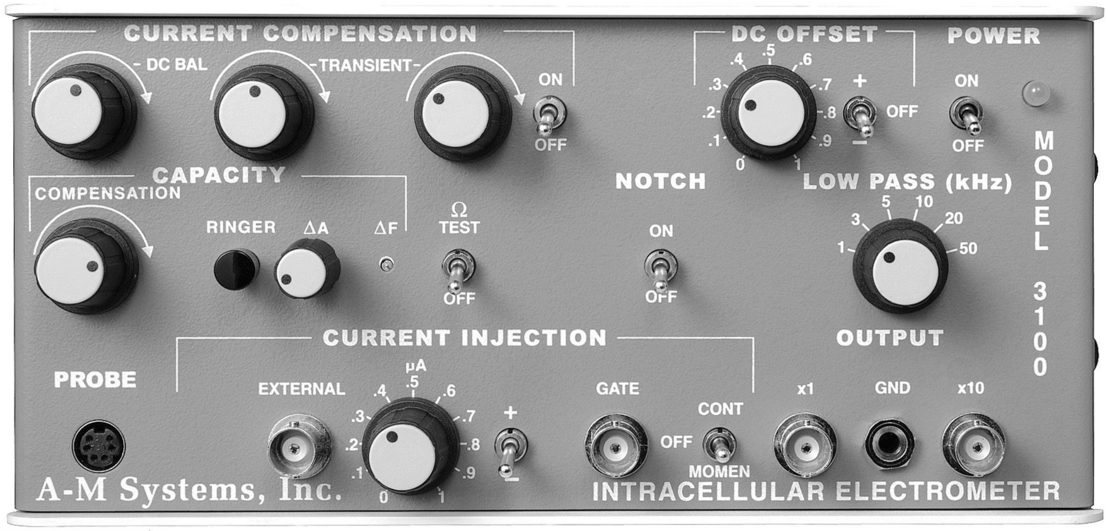
Each Intracellular Electrometer is delivered complete with:

One Head Stage with 5 Foot Cable ***(purchased separately)***
Rack Mount Hardware
Power Supply Cord
Power Supply

NOTE

This instrument is not intended for clinical measurements using human subjects. A-M Systems, Inc. does not assume responsibility for injury or damage due to the misuse of this instrument.

General Description



Instrument Features

The Model 3100 Intracellular Electrometer is a simple to use, low-cost, intracellular amplifier. It comes equipped with a small size and light weight probe. Its dimensions are (1.1 cm diameter, 5.6 cm length), and its weight is 15 grams.

The dual-transient control provides extremely precise adjustments to transient suppression membrane recordings during current injection. The DC balance control eliminates the need for external bridge or a differential input oscilloscope. The DC offset provides electrode offset control up to ±1V. An internal square-wave generator supplies a 100 Hz current pulse to determine electrode resistance. It is also useful to adjust Capacity Compensation. Capacity compensation can adjust up to 35pF of electrode capacitance. Additional stray capacitance can be reduced by using the driven shield connector on the headstage probe.

The Model 3100 has an advanced capacitance “Ringer” control for clearing electrodes tips and enhancing the membrane penetration of neurons. The Ringer’s amplitude (0-10V biphasic) and frequency (2-8kHz) of the pulsed oscillations that are sent to the electrode can be adjusted on the front panel.

A six-position, low-pass filter and a 60 Hz notch filter are available for the researcher to diminish extraneous frequencies and external line noise.

The current injection systems allows for both internally generated current and externally generated current. This current can be set for continuous or momentary injection. The sum of the current can be gated by an external TTL logic signal source.

The small size of the amplifier and its remote power supply offer the advantage of placing the amplifier near to the experimental set up. For example, the amplifier can be placed within a Faraday cage with minimal power-line interference.

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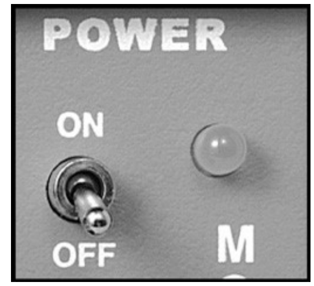
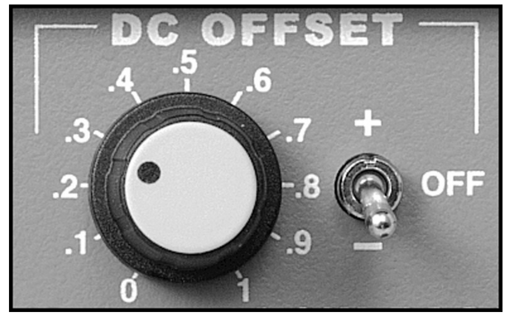
Controls and Connectors



POWER

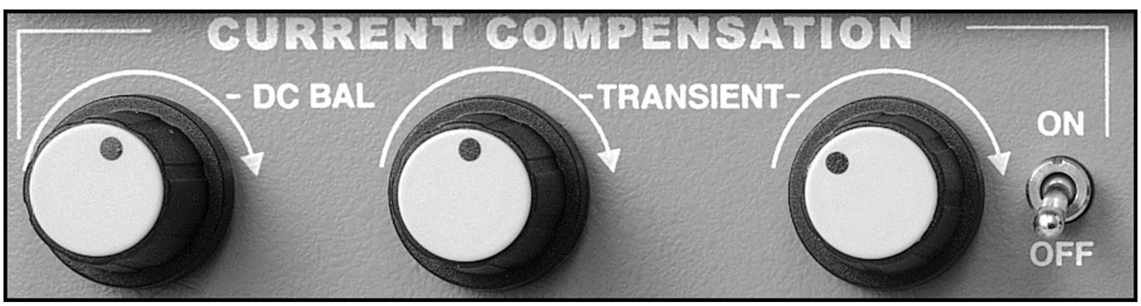
This toggle switch is the power switch controlling the DC power input to the main circuit of the instrument. The led to the right of the switch is lit when the instrument is **ON**. This switch does not control the AC power input to the remote international power supply.



DC OFFSET

DC OFFSET KNOB: This knob sets the variable DC offset voltage, which is summed with the input voltage. This feature may be used to compensate for electrode potentials and to position the signal trace on an oscilloscope recording device. An offset range of 0.0 V to ±1.0 V is available at the **X1 OUTPUT** and 0.0 V to ±10 V at the **X10 OUTPUT**.

DC OFFSET SWITCH (+ OFF -): This switch sets the DC offset polarity or alternately turns the feature **OFF**.



CURRENT COMPENSATION

ON-OFF: This knob will turn current compensation on or off. The off position is the preferred setting for any experiment not involving current injection, as the balance circuit creates a slight increase in noise level.

TRANSIENT: These two knobs form a dual-function transient control which adjusts the transient response of the balance circuit to duplicate that of the Headstage Probe, allowing maximum suppression of the transient when balancing out the electrode response for current injection. The left knob controls one time constant that effects the slope of the waveform, while the right knob will effect the peaks of the waveform. The effect of both controls is increased as they are rotated clockwise.

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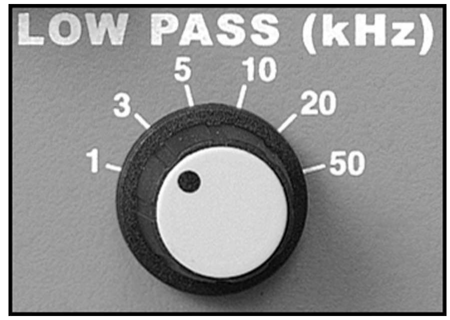
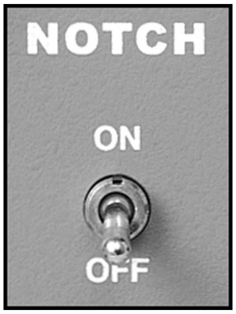
Low Pass Filter



LOW PASS: This knob controls a low pass filter which provides adjustable bandwidth limiting. Attenuation above the cutoff frequency is -12 dB/octave.



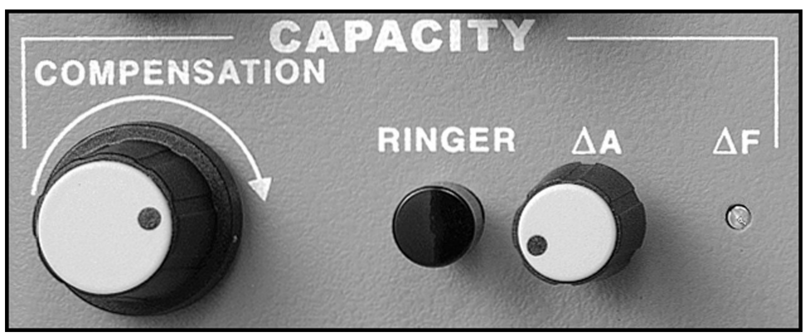
Notch Filter

NOTCH: This toggle switch activates filtering of power line frequency interference from the signal. Use this filter only when absolutely necessary,
since it can cause signal distortion if the frequency of the recorded signal lies in the rejection band of the Notch Filter (50 or 60 Hz). Adequate shielding and grounding procedures should always be used.

Electrode Impedance Measurement

Ω TEST: This toggle switch activates a 100 Hz square-wave current source used to test electrode resistance and to adjust the capacitance compensation. With the **Ω TEST** activated, the **OUTPUT** gives the electrode resistance in 10 mV/MΩ. *(Note: Recording and reference electrodes should be in a saline solution for resistance testing.)*

Capacity



COMPENSATION: This knob is used to adjust an active feedback circuit to compensate for up to 30 pF of electrode capacitance. The capacitance compensation can be accurately adjusted with the electrode in the experimental preparation using the internal squarewave generator and an oscilloscope connected to either the **X1 OUTPUT** or the **X10 OUTPUT**. This control should be adjusted to obtain the sharpest corners possible on the square-wave with very little overshoot. Clockwise rotation of this control increases the capacity compensation.

RINGER: While this button is depressed it sends a biphasic signal to the electrode causing it to vibrate. This is commonly called a “tickler.” When the electrode vibrates rapidly it sometimes will aid in the penetrating the cell membrane, or clearing a clogged electrode. The amplitude and frequency of the **RINGER** can be adjusted using the **ΔA** and **Δf** controls.

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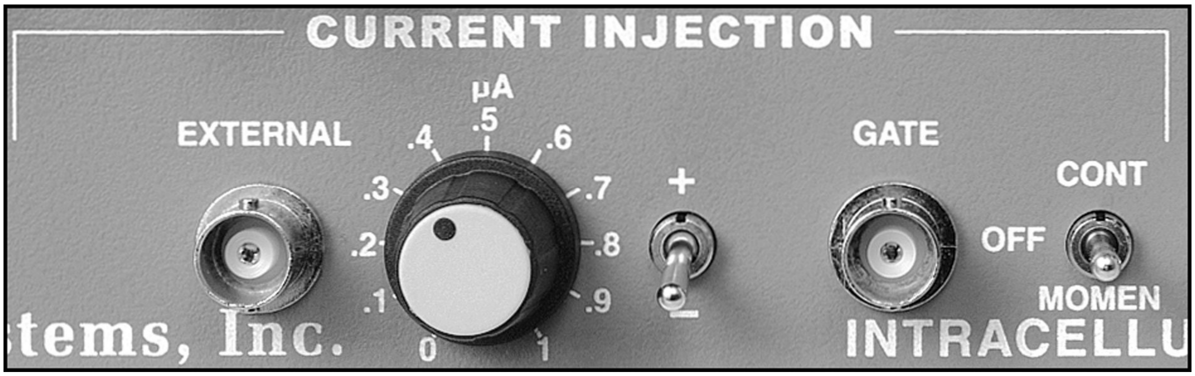
ΔA: This knob adjusts the amplitude of the ringer signal from 0 to 10V. Clockwise rotation increases the amplitude.

ΔF: This knob adjusts the frequency of oscillations of the ringer signal between 2 and 8 kHz. Clockwise rotation increases the frequency of the signal.

CURRENT INJECTION



EXTERNAL: This BNC connector provides control over the magnitude of the injected current via an external signal applied at this input. The current applied here is summed with the current set by the **μA** knob. Sensitivity is 100 nA/V. Current injection is triggered via the **CURRENT INJECTION (CONT-OFF-MOMEN)** switch or the **CURRENT GATE** connector.

CURRENT GATE: This BNC connector provides control over the timing of current injection. A signal greater than +2.5 V (optimal results will be obtained with a signal of +5 V) at this input triggers injection of the preset current and a signal less than +0.6 V (optimal results will be obtained with a signal of 0.0 V) turns the injection current off. When not connected, the current gate is in an off state and current gating is manually controlled via the **CURRENT INJECTION (CONT-OFF-MOMEN)** switch.

CURRENT INJECTION (CONT-OFF-MOMEN): This switch triggers injection of the preset injection current. The **CONT** setting triggers continuous current injection which lasts until the switch is manually returned to the **OFF** position. The **MOMEN** setting triggers continuous current injection which lasts only as long as the switch is held in this position. The switch will automatically return to the **OFF** position after being released from the **MOMEN** position.

μA: This knob sets the level of the injection current supplied by the internal source.

+,-: This switch sets the output polarity of the internal current source.

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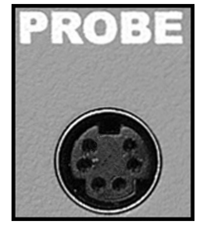
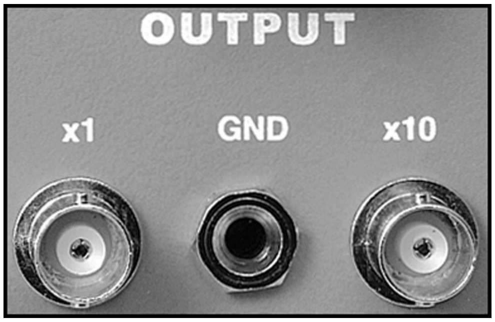
Headstage Probe Input



PROBE: This mini-din connector receives the input signal from the Headstage Probe.



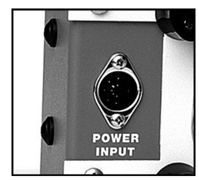
Outputs

X1 OUTPUT: This BNC connector provides the measured signal (plus any DC offset) for recording on a chart recorder or oscilloscope.

X10 OUTPUT: This BNC connector provides 10 times the measured signal (plus any DC offset) for recording on a chart recorder or oscilloscope.

GND: This connector provides a ground or reference point for measuring probe potential.

Rear Panel



POWER INPUT: This DIN connector is used to connect the international power supply to the Model 3100 Intracellular Electrometer.

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Operating Instructions

Typical Set-Up Procedure

This is a generalized procedure for setting up the *Intracellular Electrometer Model 3100* for intracellular recording and stimulation. Portions of this procedure may need to be modified for your specific application.

1. Connect the Headstage Probe cable to the **PROBE** connector.
2. Set the instrument controls as follows:

DC OFFSET knob	counterclockwise
DC OFFSET (+ OFF -)	**OFF**
TRANSIENTS:	counterclockwise
DC BALANCE	counterclockwise
LOW PASS	**50kHZ**
NOTCH FILTER	**OFF**
Ω TEST	**OFF**
CAPACITY COMP.	counterclockwise
CURRENT INJECTION (CONT-OFF-MOMEN)	**OFF**
μA	counterclockwise

3. Turn on power to the *Model 3100* and allow it to warm up for 5 minutes.
4. Mount a micropipette in a micropipette half-cell type holder, which in turn is connected to the Headstage. Clamp the Headstage in a micromanipulator.
5. Connect the reference electrode to the **GND** connector.
6. Connect an oscilloscope to either the **X1** or **X10 OUTPUT**, with the horizontal sweep rate set to 2ms/division.
7. Dip the micropipette and the reference electrode into a beaker of physiological saline solution (or the solution in which the tissue will be bathed). The solution should have the same temperature and ionic strength as that in which measurements will be made. *Note: immerse the micropipette to approximately the same depth as will be used during the measurement.*
8. Observe the offset potential between the two electrodes displayed on the oscilloscope. Set the **DC OFFSET (+ OFF -)** switch to the appropriate polarity and adjust the **DC OFFSET** knob to zero the digital display and amplifier outputs.
9. Switch on the Ω **TEST** button to inject a 100 Hz square-wave current through the electrode. The **X1 OUTPUT** now indicates electrode resistance in 10mV/MΩ.

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10. Adjust the oscilloscope for a good display of the square-wave.
11. Increase the **CAPACITY COMPENSATION** to “square-up” the corners of the waveform. Avoid overcompensation, which will cause ringing, excessive noise, and high frequency oscillation.
12. Turn off the Ω **TEST** button to stop the test signal.
14. Set the **CURRENT INJECTION +/-** switch to the desired current polarity and adjust the **µA** knob to the maximum current level which will be injected during the experiment.
15. Connect the current gating signal to the **CURRENT INJECTION GATE** input and adjust the signal source for a repetitive waveform with a pulse duration similar to that which will be used in the experiment.
16. Adjust the **DC BALANCE** knob to remove the electrode voltage drop from the output signal.
17. Adjust the **TRANSIENT** controls to minimize transients occurring when the current is gated on and off.
18. If the injection current magnitude is to be controlled by an external signal, connect this signal to the **EXTERNAL** connector. Remember this signal will be summed with the setting of the **CURRENT** knob. The current is injected only when triggered by the **CURRENT INJECTION (CONT-OFF-MOMEN)** switch or by the signal applied to the **CURRENT GATE** input.
19. Connect the desired recording device to the output connector(s).
20. Apply the electrodes to the experimental preparations.
21. If needed, connect an electrode shield to the driven shield ring on the Headstage.
22. Apply the **LOW PASS** filter and **NOTCH FILTER** if necessary.

Headstage and Microelectrode Operation

Headstage Cable Connections

The Headstage cable is connected to the **PROBE** connector on the front panel of the instrument. ***Note: Always connect and disconnect the* PROBE *cable with the* POWER OFF*.***

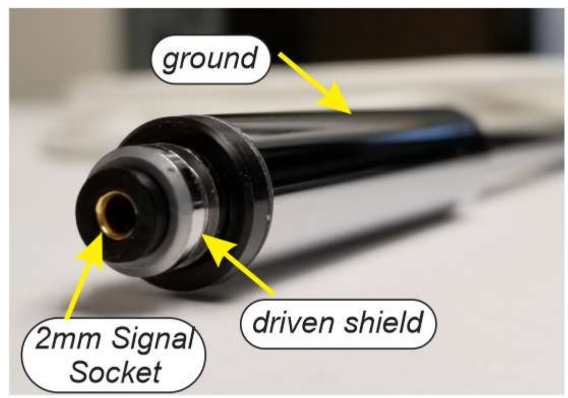
Headstage Care

To preserve the high input impedance, the connector end of the headstage must be kept meticulously clean and dry. Contamination on the insulation between the input connector, driven shield and case (even from contact with fingers) can cause current leakage particularly in the humid environment surrounding most experimental preparations. Use tissue paper to wipe this area clean and ensure that all micropipette holders are clean and dry before attaching them to the Headstage. Also, observe the ±10 V limit at the Headstage input. The input FET is protected against static charge however there is no overvoltage protection since such circuitry would result in a loss of input impedance. Be particularly careful near high voltage stimulators.

MOUNTING MICROPIPETTES

The easiest way to mount a micropipette is with a half-cell type holder (Catalog #'s 671440-671449). This holder should have a 0.08 inch (2.0 mm) diameter pin connector to fit the headstage. Fill the holder with the same solution as the micropipette, typically 3M KCl. If using a pellet version, be sure there are no air gaps which could cause discontinuity in the electrical connection between the micropipette and holder.

DRIVEN SHIELD AND GROUND CONNECTIONS



The Headstage circuitry is enclosed by a driven shield maintained at the same potential as the input connectors, thus there is no electric field between the input connections and shield, and therefore, no capacitive shunting. This shield is brought out of the Headstage case through the gold ring surrounding the input connector. This connecting ring may be used to extend the driven shield to the micropipette holder and micropipette. Shielding the electrode and holder is recommended since this portion of the circuit is particularly sensitive to stray electric fields, due to the high impedance of the electrode tip and the Headstage input. Using a driven shield for this purpose has the advantage of not introducing any additional shunt capacitance nor a path for current leakage to ground.

A shield can be made from a coil of wire wrapped around the shield ring and extended along the length of the electrode holder and electrode. Foil or other conductive coatings on the electrode surface can also be used for shielding. *Note: Make certain that the driven shield does not contact either the Headstage case or the experimental preparation, as both are at ground or reference potential and such contact will prevent proper circuit operation.*

The Headstage case and **GND** connector are both connected to the circuit ground. This can be used for connecting the reference electrode in situations where it is inconvenient to run a separate reference cable to the experimental preparation.

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MOUNTING THE HEADSTAGE IN A MICROMANIPULATOR

The Headstage should be clamped in the micromanipulator by means of the mounting rod attached to the end of the headstage.

Electrode Calibration

To inject currents and measure membrane potentials accurately, compensation must be made for the characteristics of each individual electrode. Electrodes have three key properties: offset potential, resistance, and capacitance.

Any conductive material placed in an ionic solution has a potential with respect to that solution known as the half-cell potential. This potential is a function of the material composition of the electrode, the ions in the solution, ionic activity, and temperature. The potential between two electrodes in a solution is equal to the difference between their half-cell potentials. Ideally, two identical electrodes should have zero potential between them, but small differences in surface properties usually are noticed as a small potential difference.

Most intracellular measurements are made with 3M KCl filled micropipettes which contain or contact Ag/AgCl to form an electrolyte to metal junction. A second Ag/AgCl electrode is generally used as a reference. If the micropipette and reference electrodes are placed in physiological saline, which duplicates the chloride concentration of most biological fluids, a potential difference will be observed. This potential occurs because the Ag/AgCl electrode in the micropipette "sees" the Cl concentration of the 3M KCl, which is much higher than that of the saline surrounding the reference electrode. There should be no significant potential due to concentration gradients at the electrode tip, since potassium and chloride ions have approximately the same ionic mobilities. Thus, to accurately measure the potential across a cell membrane, it is necessary to null the electrode potential using the **DC OFFSET** control. Alternately, one may use an Ag/AgCl electrode surrounded by 3M KCl as a reference electrode. To accomplish this, use an agar bridge or standard pH reference electrode with an Ag/AgCl internal (Catalog # 533000).

The micropipette resistance, which normally ranges from 10 to several hundred MΩ, is normally of little concern for measuring potentials, due to the high input impedance of the *Model 3100*. However, when injecting currents through a recording electrode, voltage drop will appear across the electrode resistance and be recorded along with the membrane response. Since the membrane response alone is desired, the electrode response must be subtracted from the signal. This is accomplished through the **DC BALANCE**.

The electrode also has capacitance, which is in parallel with the resistance. This capacitance acts as a shunt which attenuates the higher frequency components of the

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signal. The **CAPACITY COMPENSATION** is adjusted to accentuate these higher frequencies, thus compensating for the loss.

waveform is adjusted with the **TRANSIENT** controls. *Note: some types of micropipettes exhibit nonlinear impedance characteristics. When these are severe, the amplifier cannot fully compensate for them and the result is a transient signal upon current injection. The magnitude and shape of this transient should be recorded during initial setup, then later manually subtracted from the recorded signals to obtain the true membrane response.*

Current Injection

The *Model 3100* offers several options for controlling injection current to allow for a variety of experimental preparations.

The basic configuration requires no additional instrumentation. The injection current magnitude is established with the **μA** knob, and injection takes place when the **CURRENT INJECTION (CONT-OFF-MOMEN)** switch is set to either **CONT** or **MOMEN**. In the **MOMEN**tary position, the current is injected only as long as the switch is held down. This mode of stimulation is generally useful for sub threshold membrane conductivity studies using continuous DC stimulation.

Most studies, however, require precise control of injection current pulse duration and repetition rate in addition to magnitude. The easiest configuration for this type of experiment includes a function generator or another signal source to control the pulse duration and repetition rate, and the **μA** knob to set the injection current magnitude. The signal source is applied to the current **GATE** connector. This input requires a signal greater than +2.5 V to turn the injection current on and less than +0.6 V to turn the injection current off. The maximum voltage limit for this connector is +15 V.

When external control of current magnitude is also required, a control signal may be applied to the **EXTERNAL** current connector. The injection current is proportional to the voltage of the control signal. The final injection current is obtained by adding the control signal current to any current set by the **μA** knob. Current switching remains under the control of the **CURRENT INJECTION (CONT-OFF-MOMEN)** switch or the **GATE** connector as discussed above. When complete control over current magnitude and timing is desired through only one signal, the **CURRENT INJECTION (CONT-OFF-MOMEN)** switch may be set to **CONT** and the **μA** knob rotated fully counterclockwise. These settings zero the internal current source and provide continuous injection of the current applied to the **EXTERNAL** current connector. Thus, current magnitude, polarity, and duration are all controlled by the signal applied to the **EXTERNAL** current connector, with current injection stopped when the input signal is zero.

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The current control capabilities of the *Model 3100* may be combined in various ways to simplify otherwise complex control situations. For example, if it is necessary to modulate the amplitude of a train of current pulses, a pulse signal can be applied to the current **GATE** connector which will establish the duration and repetition rate, while the amplitude modulation signal (frequently a ramp or triangle waveform) is applied to the **EXTERNAL** current connector. As another example, if a continuous injection current, interrupted by pulses of differing magnitudes and polarity is desired, the base injection current level can be established by the **µA** knob and the **+/-** switch. A signal applied at the **EXTERNAL** current connector can provide the pulses of differing magnitude and polarity which will be summed with the internal injection current source.

Problem Solving

If the *Model 3100* does not function properly, consult the following list which suggests solutions to the most common problems. If you need further assistance, please contact customer service at A-M Systems, Inc. at the numbers listed in the footer of this manual.

Problem	Cause / Solution
Excessive offset potential	Instrument oscillates due to excessive capacitance compensation. Turn **CAPACITY COMPENSATION** counterclockwise.
Incorrect potential reading	Ensure that Ω **TEST** is **OFF**, **CURRENT INJECTION** is **OFF**, **DC OFFSET** and **DC BALANCE** are **OFF** or properly adjusted. Also, see above.
Incorrect response to injected current	Electrode impedance may be too great for desired current level. Also, see above.
Electrode impedance incorrect or unstable	Excessive noise included in signal. Shield electrodes if necessary
DC BALANCE cannot be set	Check electrode impedance. Also, see above.
Transients cannot be balanced out	Check setting of **CAPACITY COMPENSATION.** Also some transients are due to nonlinear electrode impedance characteristics and cannot Be fully corrected. Most problems are due to control settings. See the section "Typical Set-Up Procedure" in this manual for further assistance.

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Specifications

Current Input

Impedance	$10^{11}\Omega$
Capacitance	Adjustable to zero
Working range	± 2.5 V
Maximum range	± 10 V

Current Injection

EXTERNAL SOURCE

Input impedance	20 kΩ
Frequency range	DC to 50 kHz
maximum current	100 nA/V
maximum voltage	lesser of ±10 V and (± 2.5 x 10^7 MΩ)/(electrode resistance)

INTERNAL SOURCE

current range	lesser of ± 1000 nA and 2.5 V/(electrode resistance)

Current Gate

ON signal	+ 2.5V (step with risetime 10 µsec)
OFF signal	+ 0.6 V
Maximum input	± 15 V
Input impedance	20 kΩ

Electrode Test

Signal	100 Hz square wave
scale factor (X1 OUTPUT)	10 nA peak-to-peak = 10 mV/MΩ

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Signal Processing

INPUT BIAS CURRENT

Optimal	Adjustable to zero
Maximum without adjustment	3 x 10^{-11} Amp
Drift versus temperature	1 x 10^{-12} Amp/ºC
Drift versus time	3 x 10^{-12} Amp/12 hours

FREQUENCY RESPONSE

Frequency range	DC to 50 kHz

RISE TIME

Square wave (500 mV)	<10.0 µsec, 10% to 90%

(Compensation set for 10% overshoot)

ZERO STABILITY

Stability versus temperature	200 µV/ºC
Stability versus time	1 mV/12 hours

LOW PASS FILTER

Cut-off frequencies (-3dB)	1, 2, 5, 10, 20, and 50 kHz
Slope	-40 dB/decade

NOTCH FILTER

Center frequency	50 Hz or 60 Hz (factory preset)
Q	10
Rejection	-50 dB

CAPACITANCE COMPENSATION

Range	-4 pF to +30 pF

NOISE

0 Ω source	18 µV RMS (10 Hz to 50 kHz)
1 MΩ source	90 µV RMS (10 Hz to 50 kHz)
20 MΩ source	350 µV RMS (10 Hz to 50 kHz)

DC BALANCE

up to 100 MΩ

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Outputs

X 1 OUTPUT

Voltage gain	1.00 ± 0.1%
Maximum voltage	± 10 V
Impedance	220 Ω
DC Offset range	0.0 V to ± 1.0 V

X 2 OUTPUT

Voltage gain	10.0 ± 1.0%
Maximum voltage	± 10 V
Impedance	220 Ω
DC Offset range	0.0 V to ± 10.0 V

Physical Dimensions

AMPLIFIER

Width	8.5 inches (22 cm)
Height	4.25 inches (11 cm)
Depth	2.5 inches (7 cm)
Weight	4 lbs.

HEADSTAGE PROBE

Input connector	0.08 inch (2.0 mm) female pin
Case diameter	0.45 inch (1.1 cm)
Case length	2.20 inches (5.6 cm)
Mounting rod diameter	0.22 inch (5.7 mm)
Mounting rod length	3.75 inches (9.5 cm)
Weight	0.5 ounces (15 g)
Input cable	5 feet (1.5 m)

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Warranty and Service

LIMITED WARRANTY

What does this warranty cover?

A-M Systems, LLC (hereinafter, "A-M Systems") warrants to the Purchaser that the Instruments manufactured by A-M Systems (hereinafter the "hardware"), and sold after June 1, 2025, is free from defects in workmanship or material under normal use and service for 5 years from date of purchase. Headstages manufactured by A-M Systems and sold after June 1, 2025, will be repaired under warranty only once per year. This warranty commences on the date of delivery of the hardware to the Purchaser.

For hardware sold prior to June 1, 2025, the warranty in effect at time of purchase applies.

What are the obligations of A-M Systems under this warranty?

During the warranty period, A-M Systems agrees to repair or replace, at its sole option, without charge to the Purchaser, any defective component part of the hardware provided that the defective part can be purchased from mainstream, common, electronic component distributors such as Digi-Key Electronics, Newark, or Mouser Electronics. To obtain warranty service, the Purchaser must return the hardware to A-M Systems or an authorized A-M Systems distributor in an adequate shipping container. Any postage, shipping and insurance charges incurred in shipping the hardware to A-M Systems must be prepaid by the Purchaser, and all risk for the hardware shall remain with Purchaser until A-M Systems takes receipt of the hardware. Upon receipt, A-M Systems will promptly repair or replace the defective unit and then return the hardware (or its replacement) to the Purchaser with postage, shipping, and insurance prepaid by the Purchaser. A-M Systems may use reconditioned or like-new parts or units at its sole option, when repairing any hardware. Repaired products shall carry the same amount of outstanding warranty as from original purchase. Any claim under the warranty must include a dated proof of purchase of the hardware covered by this warranty. In any event, A-M Systems liability for defective hardware is limited to repairing or replacing the hardware.

What is not covered by this warranty?

This warranty is contingent upon proper use and maintenance of the hardware by the Purchaser and does not cover batteries. Neglect, misuse whether intentional or otherwise, tampering with or altering the hardware, damage caused by accident, damage caused by unusual physical, electrical, chemical, or electromechanical stress, damage caused by failure of electrical power, or damage caused during transportation are not covered by this warranty. Further, no guarantee is made regarding software compatibility with future updated operating systems. Products may not be returned to A-M Systems for service, whether under warranty or otherwise, which are contaminated by infectious agents, radioactive compounds or other materials constituting a health hazard to employees of A-M Systems

What are the limits of liability for A-M Systems under this warranty?

A-M Systems shall not be liable for loss of data, lost profits or savings, or any special, incidental, consequential, indirect or other similar damages, whether arising from breach of contract, negligence, or other legal action, even if the company or its agent has been advised of the possibility of such damages, or for any claim brought against you by another party.

THIS EQUIPMENT IS NOT INTENDED FOR CLINICAL MEASUREMENTS USING HUMAN SUBJECTS.

A-M SYSTEMS DOES NOT ASSUME RESPONSIBILITY FOR INJURY OR DAMAGE DUE TO MISUSE OF THIS EQUIPMENT.

Jurisdictions vary with regard to the enforceability of provisions excluding or limiting liability for incidental or consequential damages. Check the provision of your local jurisdiction to find out whether the above exclusion applies to you.

This warranty allocates risks of product failure between the Purchaser and A-M Systems. A-M Systems hardware pricing reflects this allocation of risk and the limitations of liability contained in this warranty. The agents, employees, distributors, and dealers of A-M Systems are not authorized to make modifications to this warranty, or additional warranties binding on the company. Accordingly, additional statements such as dealer advertising or presentations, whether oral or written, do not constitute warranties by A-M Systems and should not be relied upon. This warranty gives you specific legal rights. You may also have other rights which vary from one jurisdiction to another.

THE WARRANTY AND REMEDY PROVIDED ABOVE IS IN LIEU OF ALL OTHER WARRANTIES AND REMEDIES, WHETHER EXPRESS OR IMPLIED. A-M SYSTEMS DISCLAIMS THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR USE, WITHOUT LIMITATION.

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Approved:

Revision History

Rev	Date	Description
2	6/30/06	Initial Document Control release
3	4/28/10	DCR 201200 Warranty and Company Info
4	1/18/19	DCR 202615 Update content, warranty.
5	3/19/20	DCR 203316. Update warranty
6	5/1/2025	DCR 204239. Update warranty