INSTRUCTION MANUAL

Model 701A

Stimulator

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*** WARNING ***

SAFE OPERATING PROCEDURES AND PROPER USE OF THE EQUIPMENT ARE THE RESPONSIBILITY OF THE USER OF THIS SYSTEM.

Aurora Scientific Inc. provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation and safety practices.

ALL PERSONNEL WHO WORK WITH OR ARE EXPOSED TO THIS EQUIPMENT MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS AND/OR FATAL BODILY INJURY.

NOT FOR HUMAN USE.

1.0 Safety

The high voltage/high current nature of this device dictates the use of caution when operating or servicing this equipment.

OBSERVE ALL SAFETY PRECAUTIONS LISTED BELOW. FAILURE TO DO SO COULD RESULT IN SERIOUS INJURY.

Precautions

1) The 701A stimulator should be serviced only by personnel experienced in high voltage pulsed power systems.
2) Service personnel should be instructed to observe all safety precautions as stated in the operating instructions, and those safety precautions standard to the high voltage pulsed power community. Failure to do so could result in serious injury.
3) Do not handle the load or terminations, or remove the input or output cables, while the stimulator is in operation. Ensure that the high voltage power supplies have fully discharged before handling the load. Failure to observe these precautions can result in potential electric shock to personnel, arcing, and damage to the connectors and system.
4) The stimulator contains reference planes that are elevated to the potential of the output pulse. Extreme caution should be exercised when servicing the equipment.
5) Pulsed power systems are capable of random triggering via transients and therefore when the stimulator is turned on, or high voltage is present in the module, assume it is possible to get a pulse on the output cable.

2.0 Introduction

The model 701A is a high power, bi-polar, current pulse stimulator that can provide either positive, negative or alternating voltage pulses of up to 80V at up to 1 ampere of current. The high power output of the unit is available at the front panel BNC connector labeled Output. For safety the outer sleeve of this connector and the outer ground braid of the co-ax cables you connect to it are at chassis ground.

The stimulator can be configured to provide output currents from 1 milliamp (mA) to 1000 milliamps (1 amp) in three ranges. The output current is set using a current multiplier switch in combination with a current adjustment potentiometer both of which are located on the front panel.

A current monitor BNC connector is provided on the front panel that allows the actual output current of each pulse to be examined. The output will produce 1 mV for each 1 mA of output current. Note that the voltage output has the opposite polarity to that of the pulse, i.e., if a 100 mA positive pulse is issued then the current monitor will produce –100 mV output. If the Output is not connected to a load, the current monitor will always read zero.

The stimulator also includes a Synch Output BNC connector that will issue a +5V pulse each time an output pulse of either polarity is issued. The length of the Synch pulse is identical to the Output Pulse Width.

The stimulator provides three trigger modes for complete control flexibility of how and when each output pulse is issued. The three modes are:

1) Free Run – output pulses are issued continuously; pulses per second and pulse width are set by the front panel controls.
2) Follow – the output is active whenever and for as long as the Trigger Switch is held or at any time the External Trigger Input is above 2 Volts. The Follow mode is especially useful when the stimulator is to be controlled by a computer. In this mode the width and frequency of the stimulator's output pulses follow the width and frequency of the External Trigger Input.
3) Gated – pulses are issued as long as the Manual Trigger Switch is held, or as long as the External Trigger Input is maintained above 2 Volts. A momentary push or trigger will issue just a single pulse. Pulse Width and Pulses per second are set by the front panel controls.

Aurora Scientific Inc. has two software products available (the 600A Digital Controller and the Dynamic Muscle Control (DMC) software) that include a module that allows the stimulator to be controlled via simple on-screen controls. Precise timing and synchronization of stimulation and muscle lever control is assured with our software control programs and a 701A stimulator. Each program provides complete control of all parameters affecting muscle stimulation including: pulse width, pulse frequency, frequency duration, train, train frequency, and train duration.

The front panel includes controls to set pulse width and pulses per second. These controls are active when the Trigger Mode is set to either Free Run or Gated mode. Pulse widths of 100μsec, 500μsec and 1 msec can be selected. The number of pulses per second can be set at any value in the range from 1 to 200.

A unique feature of the 701A stimulator is the Pulse Phase Switch that is used to set the polarity of the output pulses. The stimulator can be set to generate only positive pulses, only negative pulses, or pulses of alternating (positive then negative) bi-phase polarity. These pulses are all referenced to the chassis ground. Operation in the Bi-Phase mode allows the net current through the muscle bath to be zero. This minimizes corrosion of the electrodes and the release of heavy metals into the bath.

The 701A stimulator is housed in a 2U (3.4") high, 19" rack-mount steel and aluminum enclosure. All controls are located on the front panel along with an LED that indicates the power is on. A second LED is provided that flashes each time an output pulse is issued, this provides an easy verification of correct operation.

3.0 Specifications

Model 701A

Output Pulse Electrical Characteristics

Output Voltage:	0 to +/-80V
Output Current:	1mA to 1A.
Output Current Adjustment:	Front panel-mounted Current Adjust potentiometer and Current Multiplier Switch.
Pulse Width:	100μsec, 500μsec, or 1 msec (controlled by Pulse Width Switch) or 10μsec to DC (controlled by External Trigger when Trigger Mode set to Follow).
Pulse Rise and Fall Time:	≤10 μsec, 10-90%.
Pulse Recurrence Frequency:	Single Shot to 100kHz (Follow mode), 1 to 200 pulses per second (Free Run or Gated mode).
Maximum Duty Cycle:	20%.
Pulse Output Connector:	BNC, front panel

Trigger

External Trigger Input:	+2V to +15V (unit protected from damage for input signals between –50 and +50 volts).
Trigger Modes:	Free Run, Follow and Gated.
Input Connector:	BNC, front panel

Monitor Output

Current Monitor:	1 mV per 1 mA of output current.
Synch Monitor:	+5V pulse generated for each output pulse. Monitor pulse length identical to output pulse length.

General

Dimensions (Excluding Connectors):	19” W (rack-mount) x 10” D x 3.4” H (2U) (48cm W x 25cm D x 8.6cm H)
Weight (Approximate):	4.4 lb (2 kg)
Power Requirements:	110 VAC @ 60 Hz
Fuse:	IEC 127-III. 5x20 mm
Rating:	250 VAC – T2.0A

4.0 Operating Instructions

*** WARNING ***

1) Do not remove the input or output cables while the stimulator is in operation. Never intentionally short-circuit the high voltage output of the stimulator. Failure to observe these precautions can result in potential electric shock to personnel, arcing, and damage to the connectors and system.
2) Pulsed power systems are capable of random triggering via transients and therefore when the stimulator is turned on, or high voltage is present in the chassis, assume it is possible to get a pulse on the output connector.

4.1 Output Cabling

The high current, high voltage output of the 701A is provided at a BNC connector on the front panel. ASI recommends that the shortest length of cable possible be used to ensure the fastest possible rise times and best pulse fidelity. Either 50Ω or 75Ω coaxial cable can be used to connect the output of the stimulator to the load.

4.2 Load Interconnection

For optimal waveform fidelity, the ends of the coaxial cable should be connected directly to the load to minimize interconnection inductance and impedance mismatches. If it is necessary to use wire leads between the coaxial cable and the load, the leads should be kept as short as possible. Twisting the leads together (i.e., using twisted pair wire) will reduce the lead inductance and help to preserve waveform fidelity.

4.3 Controls

The location of all of the controls is shown on the front panel drawing located at the end of this manual.

The **TRIGGER MODE** Switch determines how and when each output pulse will be issued. There are three Modes:

1) **Free Run:** Output pulses are issued continuously.
2) **Follow:** The Output current will be set to the value of the Current Adjust pot whenever and for as long as the TRIGGER Switch is held, or at any time the EXTERNAL TRIGGER Input is above 2V. An externally generated stimulate sequence can be fed to the 701A with the desired pulse width, repetition rate, and duration. 10 microseconds is the minimum time recommended between each input transition.

3) **Gated:** Pulses are issued as long as the MANUAL TRIGGER Switch is held, or as long as the EXTERNAL TRIGGER Input is maintained above 2V. A momentary push or trigger will issue just a Single Pulse.

The **EXTERNAL TRIGGER** Input BNC allows remote triggering of the unit, depending on the MODE Setting (above). A logic Low Signal is from 0V to +2V, and a High is from +2V to +15V. Damage will not occur for any signal between –50V and +50V.

The **SYNCH OUTPUT** BNC will issue a +5V pulse each time an output pulse of either polarity is issued. The length of this Synch pulse is identical to the Output Pulse Width

The **PULSE WIDTH** Switch determines the length of time (100µS, 500µS, or 1mS) that the output is active during each pulse. The Rise and Fall times of the Current Output are less than 10µS.

The **PULSE PHASE** Switch is used to set the output polarity. It can be set to issue only positive pulses, only negative pulses, or pulses of alternating (positive, then negative) bi-phase polarity. These pulses are all referenced to chassis ground.

The **PPS MULTIPLIER** Switch and the **PPS RATE ADJUST** Potentiometer together determine how many output pulses are issued per second. Thus, the PPS rate can be selected in three overlapping ranges from 1 to 10 (x1 PPS MULT, Pot set from 1 to 10), 5 to 50 (x5 PPS MULT, Pot set from 1 to 10) and 20 to 200 (x20 PPS MULT, Pot set from 1 to 10)

The **CURRENT MULTIPLIER** Switch and the **CURRENT ADJUST** Potentiometer are similarly configured to provide output currents from 1 milliamp to 1000 milliamps (1 Amp) in three ranges. The unit will attempt to put out +/-80 Volt pulses unless the loading of the output bath is greater than the Current set point. When this set point is reached during each pulse, the output voltage will be adjusted to maintain that output current.

The **MAIN POWER** Switch applies the 110VAC line power to the transformer-isolated internal supplies. The unit is protected with a 2 Amp fuse at its 110VAC power connector. There is also a spare fuse inside the fuse holder.

The **POWER LED** lights when the internal supplies are operating properly.

The **PULSES LED** lights each time an output pulse is issued as an easy verification of correct operation. At higher pulse rates the LED will appear to stay on.

The **OUTPUT PULSES** BNC Connector is the high power output of the unit. For safety, the outer sleeve of this connector and the outer ground braid of the co-ax cables you connect to it are at chassis ground.

The **CURRENT MONITOR** BNC allows examination of the actual output current pulses being delivered by the unit. The output will produce 1mV for each 1mA of output current.

The output polarity is opposite to that of the pulses (i.e., for a positive 100 mA pulse the monitor will show –100 mV). Note that if the output is not connected to a load, this current monitor will always read Zero.

4.4 Power-up Procedures

The unit should be powered up using the following procedure.

1) Connect the stimulator output to an appropriate load, prior to turning the power on.
2) Set the desired output current using the Current Multiplier switch and the Current Adjust potentiometer.
3) Set the desired pulse width using the Pulse Width switch.
4) Set the desired pulses per second using the PPS Multiplier switch and the PPS Rate Adjust potentiometer.
5) Select the Pulse Phase, either positive, negative or Bi-Phase.
6) Connect an external trigger device to the External Trigger BNC connector. Set the Trigger Mode to Free Run, Follow or Gated. If using the 600A Digital Controller or the DMC control software you should set the Trigger Mode to Follow. If some other instrument or another computer program is to trigger the stimulator then set the Trigger Mode to Gated. If you intend to use the stimulator as a stand-alone instrument then select the Free Run mode and you won't need to connect an external device to the External Trigger connector.
7) If it is desired to record the timing and length of all output pulses then connect an external recording device (A/D card, oscilloscope, chart recorder, etc.) to the Synch Output BNC connector.
8) If it is desired to monitor the actual current delivered to the muscle then connect an external recording device (A/D card, oscilloscope, chart recorder, etc.) to the Current Monitor BNC connector.
9) **At this point check the Output cabling to the muscle bath to ensure that no one can come in contact with the central conductor when the unit is operating. The Output's center conductor produces momentary hazardous potentials above 80 Volts**.
10) Switch on the power switch.
11) At this point the 701A will output pulses based on the switch settings. In Free Run mode the 701A will commence issuing pulses as soon as it is turned on. In Follow and Gated modes the 701A stimulator will issue pulses when triggered either by the External Trigger connector or by the Manual Trigger switch.
12) If there is no output from the stimulator refer to the Troubleshooting Section of this manual.

5.0 Troubleshooting

***** WARNING *****

Assure that the power switch is off, the power cable removed from the stimulator and a shorting strap installed before any repairs or adjustments are attempted. Verify with a voltmeter that all circuits are de-energized before servicing. Dangerous voltages, floating ground planes and energy storage exist at several locations in the module. Touching connections or components could result in serious injury.

5.1 Troubleshooting Procedure

The table below summarizes potential problems and their solutions. If these recommendations do not resolve the problem please contact Aurora Scientific Inc. for further assistance.

Table 5.1 Troubleshooting Table

Problem	Recommended Action
701A does not switch ON, "Power" LED does not light.	1. Ensure AC power cord is firmly plugged into the wall receptacle and the power supply receptacle. 2. Ensure the power switch is in the ON position. 3. Ensure the line voltage is 110 VAC. 4. Ensure the power source you plugged the power supply into is energized. 5. Check the fuse located in the rear panel.
No Output Pulse.	1. 701A set to Follow or Gated Trigger Mode and there is no External Trigger input. Provide External Trigger or press Manual Trigger switch or change Mode to Free Run and then check for pulses 2. Input trigger voltage is too low. The External Trigger requires a signal greater than 2 Volts to trigger the stimulator. 3. Unit is in Follow Mode and the External Trigger pulse width is too short. Increase the width. 4. Input External Trigger frequency is too high. Reduce the frequency. 5. Output not connected correctly. Check all cables and connections.

5.2 Technical Assistance

Technical assistance is available by regular mail, email, phone, or fax. Use the information below to contact Aurora Scientific Inc.

Address:	Aurora Scientific Inc. Technical Assistance P.O. Box 2724 Richmond Hill, Ontario, CANADA L4E 1A7
Phone:	1-905-727-5161
Toll Free:	1-877-878-4784
FAX:	1-905-713-6882
E-mail:	info@AuroraSci.com
Web site:	www.AuroraScientific.com

6.0 Warranty

The 701A stimulator is warranted to be free of defects in materials and workmanship for three years from the date of shipment. Aurora Scientific Inc. will repair or replace, at our option, any part of the system that upon our examination is found to be defective while under warranty. Obligations under this warranty are limited to repair or replacement of the instrument. Aurora Scientific Inc. shall not be liable for any other damages of any kind, including consequential damages, personal injury, or the like. Damage to the system through misuse will void this warranty. Aurora Scientific Inc. pursues a policy of continual product development and improvement therefore we reserve the right to change published specifications without prior notice.

7. 0 Terms and Conditions for Returning Equipment

1. Aurora Scientific Inc. **will not** accept any equipment returned without prior authorization in the form of a return material authorization number.

1. **Please call Customer Service at (905) 727-5161 or toll free at 1-877-878-4784 to obtain an RMA#. Please specify the product line.**

2. Please package equipment properly. Goods that are damaged in shipment are the responsibility of the shipper.

3. **Aurora Scientific, Inc. withholds the right to assess charges for the repair or replacement of such damaged goods, regardless of warranty status.**

4. Warranty repairs will be shipped back to the customer via FedEx. If you require or request another form of shipment, the cost of such service is your full responsibility.

5. Aurora Scientific, Inc. **will not** be responsible for any return or replacement **shipping charges** incurred due to an incorrect order placed by the customer.

Return Shipping Address:

Aurora Scientific Inc.
360 Industrial Pkwy. S., Unit 4
Aurora, ON, Canada
L4G 3V7
Attn: RMA Returns

Drawings

This section consists of the following drawings:

1. 701A Front Panel AS701-002, Rev. 0