



# INSTRUCTION MANUAL

**A385**

Constant Current Stimulus Isolator



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WARNING! THIS DEVICE IS NOT INTENDED FOR HUMAN USE.

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## INTRODUCTION

All WPI stimulus isolators are designed to supply constant current because current threshold (not voltage) is the most quantitatively reproducible parameter for stimulation of nerve and muscle. Stimulus isolation assures the precise localization of stimulus current and prevents current flow from the stimulation site to ground. Current amplitudes up to 100 milliamperes may be needed if stimulating nerve or muscle tissue perfused by electrolyte which may shunt much of the stimulus current. A385, a "photon coupled" isolated current source, can generate up to 100 milliamperes of unipolar or biphasic constant current pulses or DC. Pulse duration is controlled manually or by an external 5-volt command. Output current amplitude is determined by a 3-digit 10-turn potentiometer. Maximum output voltage between the stimulating electrodes is +36 volts. Thus the instrument is unlikely to cause accidental transcutaneous electrical shocks (and may be inappropriate for stimulation on the surface of dry skin). Since A385 can generate large currents, large electrodes should be used to prevent electrolysis and to reduce the voltage drop caused by electrode polarization. Current amplitude is "constant", that is, load resistance independent, provided that the  $I \times R$  (load) product does not exceed the available battery supply voltage. An audible alarm (the compliance alarm) will sound if  $I \times R$  reaches this limit. The amplitude of the current will be as set as long as the voltage drop across the load (stimulus electrode path) does not reach the magnitude of the supply voltage. The compliance alarm would then be heard. The user would then know that (a) too much current was set for a given load or (b) inter-electrode resistance was too high or the electrode circuit path was open (this is illustrated by the Quick Instrument Test below). The instrument is powered by heavy duty rechargeable lead-calcium batteries. Colored indicator lamps and an audible alarm indicate the battery's charge status while the instrument is in use.

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## SPECIFICATIONS

Output Waveform.....	Current pulses or DC
Output Polarity.....	Unipolar or electronically switched bipolar
Output Current Ranges.....	1, 10 and 100 milliamperes
Current Amplitude Error.....	0.5 % of full scale, max.
Current Resolution.....	0.1% of full scale
Output Load Voltage Range.....	36 volts
External Command Volts.....	+2.2 V. min.,18 V. max.
Current Rise Time + Delay.....	2 $\mu$ s, typ.(100 $\Omega$ load) + 2 $\mu$ s
Current Fall Time + Delay.....	2 $\mu$ s, typ.(100 $\Omega$ load) + 5 $\mu$ s
Impedance to Ground.....	10 <sup>12</sup> $\Omega$ shunted by < 15 pF
Optocoupler Rated Breakdown Volts.....	2500 VAC, input to output
Power.....	Six rechargeable lead acid batteries

**A385 requires a companion battery charger, model A382.**

## CONTROLS

### Input

An external command voltage level of approximately 5 volts applied to this connector enables current flow from the OUTPUT. Do not apply a continuous DC input voltage greater than 18 volts.

### DC/Test: DC

Current can be manually generated by toggling this switch. MOM (momentary) position allows push-release operation. On provides a sustained DC.

### Audio

With the AUDIO switch is on, an audible tone will sound whenever a stimulus current is being generated. A higher pitched audible signal will also sound, independent of the AUDIO switch, if the OUTPUT voltage amplitude approaches that of the battery power stack (the compliance alarm).

### Biphasic

When this switch is On, every pulse applied to the input will cause the polarity of the output current to reverse. Thus, any sequence of pulses applied results in alternating plus and minus current pulses at the Output terminals. In the Off position pulse

polarity will be as indicated by the red Polarity lamps above the red and black Output terminals.

## Polarity Select

A polarity reversing push button switch sets the red or black OUTPUT terminal to be plus. A red lamp lights above the Output terminal selected to be positive.

## Range

1, 10 or 100 milliamperes can be selected as a maximum current. % of Range: This variable ten turn digital indicator control sets the exact current amplitude as a percentage of the selected maximum current selected by the Range switch.

## Output

Current output terminals. Output voltage depends on load resistance. An audible warning sounds when the maximum load voltage occurs. When the Output switch is Off, Output terminals are disconnected.

## Power On/Off

Switch connects battery power to the isolator.

## Battery Status

Green lamp, high, indicates battery is charged. Yellow lamp, low, indicates battery stack should be charged. Red lamp, depleted, indicates battery is discharged. An audible tone will sound at 10 second intervals. Permanent damage to the battery stack can result if battery cells are depleted without being promptly recharged.

TURN POWER SWITCH OFF WHEN INSTRUMENT IS NOT IN USE TO AVOID BATTERY DRAIN

## QUICK INSTRUMENT TEST

Switch Output to OFF, Range to 1 mA, Output to Off, Biphasic to Off and AUDIO to ON. Turn POWER switch to ON. A Battery Status lamp and one red lamp above one of the Output terminals should be lit. When DC/Test switch is toggled to MOM, an audible tone should be heard (an externally applied +5 volt command applied to the Input connector will have the same effect). Sound will cease when TEST is OFF. Turn Audio Off. Push Polarity Select button and confirm that red lamps above the red and black terminals switch back and forth when the button is pushed. Switch Output to On. A high pitched tone should sound. This is the "compliance" limit alarm which sounds

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when the full battery supply voltage is across the output terminal pair, for example, when the output leads are open-circuited. Turn Output to Off. The instrument is operational.

## OPERATION

Operation of the A385 is controlled by applying an external voltage command to the Input or by manually operating the DC/Test switch. Any source such as WPI's **A300**, **A310** pulse generators or equivalent generator will be an appropriate source of command and trigger sync pulses for oscilloscope viewing of bioelectric responses. Connect an appropriate pair of stimulating electrodes from the experimental site to the red and black OUTPUT terminals respectively. Keep the Output switch in the OFF position to avoid accidental stimulation. Turn POWER to ON. Select Biphasic Off (*i.e.*, unipolar current) and toggle Polarity Select so that the stimulating electrode pair will exhibit the desired polarity (usually, the negative electrode stimulates). Toggling the AUDIO switch ON will allow the user to hear the advent of the command pulse. Turn the % of Range knob to zero and Range switch to 1 mA. Switch the Output switch to On. This connects the electrodes to the current source. Arriving at an optimal stimulation current level is usually an empirical procedure in which the user increases the current gradually from sub-threshold values until a desired stimulus response is achieved. Always toggle the Output switch to OFF while connecting electrodes. When this switch is toggled to Off, the output terminals are disconnected from the stimulus current source and the source is short circuited internally.

## Biphasic Currents

To effect electrical stimulation, current must flow across a metal-electrode/fluid-electrolyte interface. At high current density, this can result in undesirable electrochemical action at the metal-electrolyte interface as well as large voltage gradients. Redox effects include metal-electrolyte plating and deplating and electrolysis. These effects can be diminished by (a) using large electrode surface area so as to reduce current density and (b) biphasic (*i.e.*, zero net charge) stimulus current. A385's biphasic mode enables the user to alternate the polarity of successive current pulses so that the net DC current flow is zero. When using the biphasic mode note that the first command pulse will result in an output pulse opposite in polarity to that indicated by the polarity lamp prior to the pulse, since the leading edge of each command pulse reverses the polarity of the output current. The user can confirm this by toggling the MOM (momentary) switch briefly in the Biphasic mode. Note that the polarity lamp will switch position. Therefore, if the polarity of the first pulse is of importance, the user can preset the polarity with the push button switch to the complementary state of that required. For example, if one wants the first pulse at the red output terminal to be negative, toggle the Polarity button so as to light the red lamp over the red terminal. With the receipt of the leading edge of the first command pulse, the lamp will switch to the black terminal. Thus the first current pulse would have a polarity of red negative. If a burst of pulses is used, the polarity at the end of the burst will depend on whether an odd or even number of pulses were generated.



## Viewing the current pulses

To view pulses of current on an oscilloscope it is first necessary to convert current pulses to voltage pulses by using a dummy electrode pair. Therefore connect a resistor of 1 K Ohm across the OUTPUT terminals. Connect the two OUTPUT terminals to the input of an oscilloscope. Oscilloscope settings: 200 mV per cm, vertical sensitivity, DC coupled and 1 millisecond per cm sweep speed. Set the frequency of a pulse generator to 200 Hertz (INTERVAL= 5 ms) and pulse WIDTH to 1 millisecond. Set the controls as follows: RANGE to 1 mA, AUDIO to OFF, POLARITY to RED +. Dial % of Range to maximum and turn the POWER switch to ON. When the oscilloscope is synchronized, 1 Volt pulses (5 cm on the scope) should be observed. Note the shape and speed of the rising and falling edges. They should be fast and smooth. The true speed of a current pulse generator can be best seen using low values of shunt resistance, as in the example above. As the load resistance increases to 10 K $\Omega$  and larger, the effect of shunt capacity will be to slow the rising and falling edges of the voltage waveform. It should be noted that in connecting the oscilloscope to view the A385 output, one output terminal usually will be connected to ground (thus, one cannot view or measure the output waveform without compromising A385's isolation from ground).

The user may check the accuracy of the setting on the % of Range dial by connecting a milliammeter directly across the OUTPUT connectors and pushing the DC/TEST switch. The direction of current flow is determined by which OUTPUT connector has been designated as the anode, *i.e.*, RED + or BLACK + on the POLARITY switch. AUDIO monitoring of the pulses can be switched ON or OFF at the user's option.

## Voltage

A385 can approximate a constant voltage source by placing a low resistance "dummy" load across the OUTPUT terminals as in the paragraph above. Resistors such as 10, 100, and 1000 Ohms when placed across the OUTPUT terminals convert the generated constant current amplitudes to defined voltage levels. For example 10 milliamperes flowing through 100 $\Omega$  will produce 1 volt across the OUTPUT terminal pair. Thus, model A385 can be used as low noise sources of reproducible voltage pulses. To keep the output voltage "constant" under load, assure that the OUTPUT dummy resistor not be shunted by loads less than 100 times its own resistance value.

## CHARGING THE BATTERIES

To recharge the battery stack of the A385, a companion charger, model A382 is designed to charge 385's batteries rapidly and safely. The charger cable plug inserts into the charging receptacle on the rear panel of the A385 isolator. Connect the charger's power cord to the power line. The POWER switch on A385 must be OFF to enable charger operation. Three red lamps on the charger panel (one lamp for each pair of batteries in the isolator) will light during an initial rapid charge phase. As the batteries accept charge, the red lamps will extinguish and the charger then continues to charge at a lower current. The A385 battery stack will usually recharge in a few

hours from a completely discharged state.

Disconnect the battery charging cable from the A385 while the instrument is in use. This avoids the possibility that power line noise will be introduced via the charger cable.

To preserve battery life, turn power switch off when instrument is not in use. Do not allow batteries to remain in a depleted state without recharge.



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### DECLARATION OF CONFORMITY CE

We: World Precision Instruments, Inc.  
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as the manufacturer/distributor of the apparatus listed, declare under sole responsibility that the product(s):

### A385R

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

**Low Voltage Directive (Safety) 2014/35/EU:**

- EN 61010-1:2010+A1:2019

**EMC Directive 2014/30/EU:**

- EN IEC 61326-1:2021
- EN IEC 61326-2-3:2021

  
Cory Boyes / Director of Design and  
Development

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## WARRANTY

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

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

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

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

## Claims and Returns

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

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

## Repairs

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

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



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