Digital Stimulus Isolator

2300

INSTRUCTION MANUAL

FOR

DIGITAL STIMULUS ISOLATOR

MODEL 2300

Serial #_____

Date_____

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Contents

Each Amplifier
is delivered complete with:

Battery Charger
Operator's Manual

NOTE

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

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General Description

The Model 2300 Digital Stimulus Isolator is designed for a wide variety of stimulus applications. It provides opto-electrical isolation for TTL-compatible digital signals controlling the timing of preset levels. These levels are set by calibrated ten-turn potentiometers. Scaled according to the *Range* switch setting, these levels can result in an output up to 650V or 65mA. Up to five different output levels can be produced: (+ and -) Pulse; (+ and -) Baseline, and Zero, depending on the *Control* logic levels. If for any reason the instrument cannot follow the input signal, an *Error* indicator lights.

The isolated output section is battery-powered and optically-coupled to the input section, for the ultimate in clean isolation. The battery is adequate to provide full function for at least 8 hours of continuous use. An internal battery tester is provided. A charger is supplied, and an overnight charge cycle is all that is required to ready the 2300 for another day's use. It is easy to swap a freshly charged pair of batteries if extended use is necessary.

There are several features to make this instrument highly useful in a computer-driven environment via the **Control** port. The instrument is well suited to accepting digital timing signals generated under computer control, isolating these signals from the noisy electrical environment associated with a computer, and coupling them to biological tissue. The error detection circuitry generates a TTL-level *Control*/Error signal if the instrument is unable to deliver the required signal. It is also possible to detect a low battery condition at any time, without altering the isolation or interrupting an ongoing experiment.

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

WARNING the Model 2300 can produce potentially dangerous voltages (up to 70V) at the output The isolated output is not connected internally to safety (earth) ground in any way. Some part of the external circuit should be connected to safety ground. Use caution in handling any wires, connectors, or electrodes which may be directly or indirectly attached to the Model 2300 output. Some kinds of connectors (e.g. BNC connectors) have exposed metal parts which may float at dangerous potentials unless externally connected to safety ground. **For greatest safety, turn the Model 2300 off before handling connections to the output.**

Operating Instructions

The instrument is very simple to operate. First check the battery condition: set the *Power* switch set to Off, and push the Battery/Test push-button. The test light should come on, indicating an adequate charge. Connect your controlling signal(s) to the *Control* connector. Connect the *Output* to the stimulation electrode (or other load you wish to drive) and set the *Range* switch to the correct scale. Now turn the *Power* switch to *On*.

The Error indicator should remain unlit during normal operation. The Error LED will light when the computer interface battery test is in operation. Be aware, however, that the Error LED cannot light if the batteries are completely dead! The LED may turn on briefly when the front panel controls are switched.

To recharge the batteries, connect the battery charger to the rear Charger input, and set the *Power* switch to Charge. Note that if the switch is left in the Charge position without any incoming electrical power, the batteries will very slowly, but certainly, become discharged. The charger should be disconnected during normal operation to minimize power line noise.

Output Levels

Set the *Range* control to achieve the type (voltage or current) and amplitude of output required. The output power is limited to 100V and 10mA. For the most challenging cases, you may double the output power by combining two units.

Set the *Level/Pulse* and *Level/Baseline* potentiometers to the desired levels. The Pulse potentiometer multiplies the *Range* by a factor between 0 (in the fully counter-clockwise position) and 1.00 (in the fully clockwise position). Note, however, the maximum output capabilities as noted above. The Baseline potentiometer multiplies the *Range* by a factor between 0 and 0.10. For the greatest accuracy, use the smallest *Range* setting possible for the output that you need. For example, if you need to develop a pulse with an amplitude of 80µA, use the 100µA *Range* setting and *Level* of 0.80, rather than 1mA *Range* and Level of 0.08.

Five output levels may be generated: (+ and -) Pulse; (+ and -) Baseline, and Zero. The *Control* signals are DC coupled across the optical isolation barrier, so virtually any timing is possible. Three logic levels are required if it is necessary to produce all five of these levels; only one logic level is required (for example) to switch between Zero and +Pulse. Creating a biphasic pulse requires at least two logic control signals. A complete description of the relationship between the control lines and the output levels is in the Signal Description on page 5.

Timing Sources

There are many possible sources of timing signals. If all you require is a simple pulse, you can use a single TTL-compatible pulse set to the desired output timing parameters. This pulse can be connected to the Pulse/Baseline or On/Off logic line, depending on whether you want a nonzero baseline or not (see page 5). For more complex waveforms, including biphasic waveforms, you will need at least two bits of information. These can be derived from a multi-channel timing generator, or from a computer. If your durations are long enough (greater than a few milliseconds, depending on the computer's clock speed), you may use the included "IsoStim" computer program to directly control the unit. This software also generates appropriate signals for handling battery testing and error checking.

Battery Testing and Maintenance

There are two batteries inside the unit: a small 9V "transistor" nickel-cadmium battery used to power the input section; and a larger gelled-electrolyte 12V battery used to power the output. Both are rechargeable. The internal batteries are designed to last at least 8 operating hours on a full charge, and up to 16 hours in a no-signal, no-error condition. Brand-new batteries often have a slightly reduced capacity, which improves after a few charge-discharge cycles.

There are two methods to test the state of the batteries. From the front panel, simply turn the **Power** to Off, and push the Battery/Test push-button. The Battery/OK LED will light if both battery voltages are sufficiently high. Warning: this light does not indicate how long the charge will remain high. It is up to the user to maintain an adequate proper battery charge.

To preserve maximum battery life, use the full battery capacity. Do not routinely discharge the battery beyond the point at which the **Control** -port battery test succeeds (this is a slightly lower threshold than the front-panel test); the gelled-electrolyte (12V) battery life will eventually deteriorate if you discharge it too far. At the other extreme, do not frequently discharge the batteries to a small fraction of their capacity: shallow discharging of the unit may lead to diminished charge life of the input-side (9V) battery. If this should occur, its charge life can be largely restored by removing the 9V battery from the unit, and discharging the 9V battery to 5 or 6V with a 330 ohm resistor. Now charge the battery again. It may be necessary to go through several discharge/charge cycles to fully restore the battery's function. DO NOT deeply discharge the 12V battery!

If battery charge life is a problem, there are two alternative "solutions". The simplest solution is to keep on hand a supply of one or more sets of fully charged replacement batteries in addition to the internal set. It is easy to change the batteries: turn the *Power* switch O*ff*, turn the unit upside-down, and unscrew the two recessed phillips-

head bolts (see figure 1). While holding the unit together, turn the unit right-side up. The top side of the case comes off with a easy vertical pull. The 9V battery is in a battery holder on the horizontally-mounted circuit board; simply pry the discharged unit out (pull on the attached tab), and replace with another battery. Disconnect the wire from the larger 12V battery at the connector to the circuit board. Now pull the battery from the Velcro® pad that is sitting on. Replace the battery, making sure that it is firmly pressed into the pad. Reconnect the new battery to the circuit board, making certain that the keyed connector is locked together with the correct orientation!. If the connector does not go together easily, you may have it upside-down. Reinstall the top cover and tighten the two bolts. Pushing the test push button should now light up the Battery OK LED.

If for some reason it is necessary to store the 2300 for more that a few months, it is recommended that the unit (or at least the batteries) be kept at a low temperature (<158C). Before storing for longer than a year, it is advisable to remove the batteries from the unit; store the batteries separately in a cool location.

Control Port

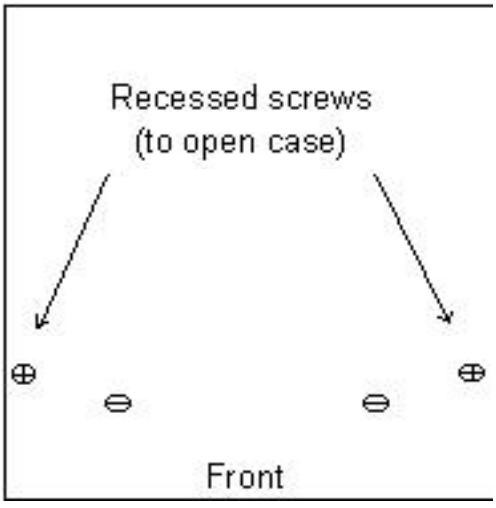

Figure 1. Bottom view of case: screw locations

Digital control is performed via the subminiature DB-9 connector on the instrument. Signal output control, battery testing, and output error detection all occur via this port.

Signal Description

The output levels are controlled by three logic lines. The default (open circuit) condition is a logical “0” for the On/Off line (the output is normally Off), and a logical “1” for the Sign and Pulse/Baseline bits (+Pulse).

Output Level	On/Off	Pulse/Baseline	+Sign/ -Sign
Default (Zero)	0	1	1
Zero	0	any	any
- Baseline	1	0	0
+ Baseline	1	0	1
- Pulse	1	1	0
+ Pulse	1	1	1

Output errors may be detected via the Error line. Normally at a logical “0”, this line goes high for at least 500ms if the output amplifier cannot drive the load satisfactorily, even if the error is less than 1ms long. For example, this would occur if the amplifier were trying to drive a nonzero voltage into a short circuit, or drive a nonzero current into an open circuit; or if the output range were exceeded, such as trying to obtain 200V from the unit.

Since it is possible that either or both of the internal batteries will be too low to provide a readable Error signal, it is strongly recommended that a periodic battery check be done in order to ensure proper operation. The most conservative battery test is done via the front panel (see page 4). Another test, adequate to ensure proper operation, is to set the Battery Test line high. Two things should occur on this event: the Battery OK line must go high, indicating that the 9V battery has an adequate charge; and the Error line must go high, indicating that the 12V battery is functional. Note that the Error line may stay high for up to 2 seconds as a result of this input.

Please note that the *Control*-port battery test will not work if the Error condition is already on.

Pinout

The pins are connected as follows. Note that while this is mechanically compatible with a 9-pin RS-232 connector, it is not electrically compatible. The 2300 is not smart enough to understand serial communication; and for most, the slow, erratic speed of serial communications; and for most, the slow, erratic speed of serial communications would compromise performance.

Pin Number	*In/Out*	*Pin Name*
1	O	Battery OK
2	O	Output Error
3		Ground
4	I	On/Off
5	O	VCC (do not connect to any external power supply)[1]
6	I	Battery Test
7		Ground
8	I	+/- Sign
9	I	Pulse/baseline

All signals are active-high. An optional cable is available for use with the Model 2300 that is configured to connect the 2300 to a standard PC-compatible parallel printer port:

2300 Meaning	2300 Pin #	Parallel Port Pin #	Parallel-Port Pin Name
Battery OK	1	10	Acknowledge
Output Error	2	15	I/O) Error
Ground	3,7	18-25	Ground
Gate	4	2	Data 0
Battery Test	6	5	Data 3
Sign (+/-)	8	3	Data 1
Pulse/Baseline	9	4	Data 2

In addition, pins 11 (Busy) and 12 (Paper Empty) of the parallel printer port are connected to ground. Some PC BIOS routines will not respond properly to parallel signals without this logical condition.

Do not connect the Battery/Test signal permanently low: this would reduce battery charge life, and prevent real output errors from being detected. Do not connect anything to pin 5 of DB-9 connector without consulting A-M Systems, or its representative.

1- **+5V (nominal) is available for external uses, but caution is required: this power comes from the small (9V) battery. Current drain may reduce the rated charge life.**

Examples and Applications

The first thing that should be done in any use of this instrument is to check the batteries using the internal battery test function. Set the Power switch set to Off, and push the Battery/Test push-button. The Battery OK light should come on, indicating an adequate charge. If the test light does not come on, the batteries need to be recharged. The following applications assume that this simple test has been passed first.

Simple (Monophasic Output Pulse)

An example of a simple application (and basic instrument test) is using a pulse generator, function generator, or other source of TTL-compatible voltages to provide an On/Off signal. The included "IsoStim" program may be used.

Control/Connector	*Setting*
Output	Connect a 10kV resistor to the output (please note the warning on page 2).
Control	Connect a TTL-compatible (100Hz) square wave to the On/Off input.
Range	10V
Level	0.50 (5 turns)
Power	On

You should observe the same timing in both input and output waveforms, and output should have a 0.0 to 5.0 output. Variations in the input levels should have no effect on the output, as long as the voltages meet TTL-logic requirements.

Change the Range control to 1mA. The waveform should stay the same. Now turn the Power off, disconnect the 10kV resistor, and turn the Power back on. The output waveform should be much larger, and the Error LED should light up as the 2300 fails to drive up to 500mA into high impedance of the oscilloscope input/load.

Controller-Driven Application

An example of a more complex application (and interface test) is using a computer to control the instrument. The control signals may be generated by computer (e.g. with the supplied “IsoStim” computer program) or other source of timing signals. Ideally it should also be able to check for an Error condition, and interact with the battery test mechanisms.

Control/Connector	Setting
Output	Connect a 10kQ resistor to the output (please note the warning on page 2). Connect an oscilloscope across the resistor.
Range	1mA
Level	0.50 (5 turns)
Control	Connect to a computer or other source of logic signals (TTL compatible), capable of setting the required signals (see page 5), and reading the Battery OK and Output Error outputs. The supplied “IsoStim” program works well here.
Power	On

As in the preceding test, you should observe the same timing in both input and output waveforms. If you are using the “IsoStim” program, you should measure the same pulse width and period as you have set up in the program, within the timing limitations of the PC.

If the battery level is changed to a logical ‘1’, both Battery OK and Output Error output signals should go to a logical ‘1’. One or both of these will **Not** go high if the batteries are low. (With the “IsoStim” program, simply exercise Test Immediate from the Battery Test submenu). The isolated output should continue without alteration while this test proceeds[2]. Within one second of the Battery Test input signal returning to a ‘0’ state, the logical output signals should return to ‘0’.

Now turn the Power off, disconnect the 10kV resistor, and turn the *Power* back on. The output waveform should be much larger, switching between the power supply rails, and the Error LED should light up as the 2300 fails to drive up to 500mA into the high impedance of the oscilloscope’s input. At the same time, the Output Error level should go to the ‘1’ state. If the Gate is set to a logical ‘0’, the isolated signal output will go to ground, and the Output Error will return to the ‘0’ state. If the Gate is set to a logical ‘0’, the isolated signal output will go to ground, and the Output Error will return to the ‘0’ state. If you are using the “IsoStim” program, notification of the error condition will be displayed on screen.

Combing Two 2300's For Increased Output

If you require up to twice the maximum output voltage, connect two 2300 units in a series. If you require up to twice the maximum current of a single 2300, connect the 2300's in parallel. The Gate inputs may be connected (and driven) together, by the same timing source.

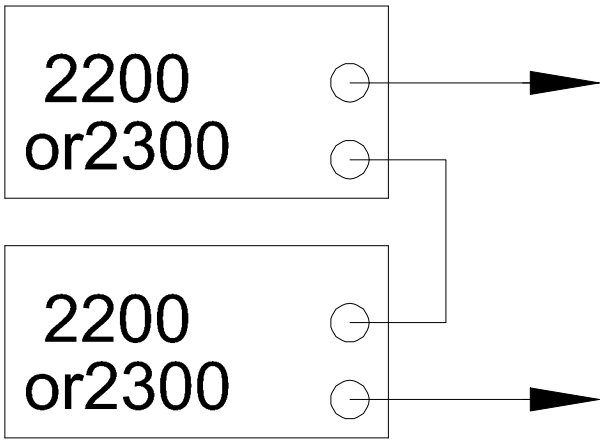

Figure 2. Extra voltage range through series connection

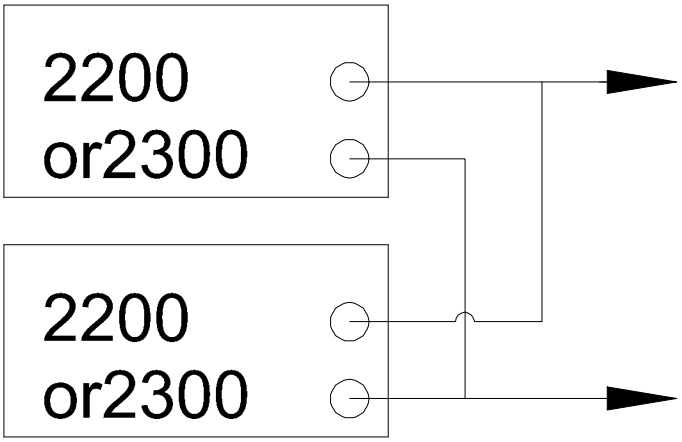

Figure 3. Extra current range through parallel connection

The Battery Test lines may be connected together, just as the Output Error lines may be connected together. This simplifies battery testing, though any computer or other controller reading the Battery Test and Output Error will not be able to distinguish which device is signaling. Use the front-panel Test push buttons and LED's to determine which device has the low battery. Contact A-M Systems if it is necessary to connect more than two units together.

2- If the batteries are at the end of their charge life, it is possible that the additional load posed by this charge test could reduce the output power available.

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Problem Solving

If the instrument appears to be not working properly, check all of the control settings and connections. The following brief summary of typical problems for the user (along with the most common solutions may help:

No output (and the Error LED does not light).	• One or both of the batteries are uncharged (test batteries: recharge as required. • The On/Off Control input is held low (must be high for an output to occur).
Battery OK LED does not light when pressing Test.	• Power switch is not set to Off (set to Off). • One or both of the batteries need recharging.
Battery OK LED does not light, but Battery OK and Error signals of port test positive.	• This indicates that the batteries are almost fully discharged. The front panel battery test requires a slightly greater battery level to operate successfully.
Error LED on, even with no input	• Low batteries (recharge).
Error LED lights when Gate is turned on	• Excessive drive: Unit is limited to ± 50V (reduce input drive or gain). • Current mode: load is disconnected (check wiring); or load impedance is too high for limited output voltage capability (cascade more than one unit). • Battery charge is low (recharge) • On/Off signal erroneously connected to Battery Test input (change connection).
Error LED lights when Battery Test signal is used	• This is normal.

Excessive noise on the output	• Charger is still plugged in (unplug/ disconnect. • In the lowest current range: stray electrical interference can degrade noise performance if it mostly couples into the output pin. (Try operating the 2300 within a Faraday (electrostatic shilding) cage. Match or reduce the stray capacitance to each output pin. Shorted the output connections. If these are inadequate, reverse the output banana connector, and invert the Sign logic signal).
Large, brief glitch on transition	• The pulse amplitude is set nearly zero, but the Baseline amplitude is set nearly to its maximum. (Reduce the Baseline setting, or reverse the roles of Pulse and Baseline amplitudes).

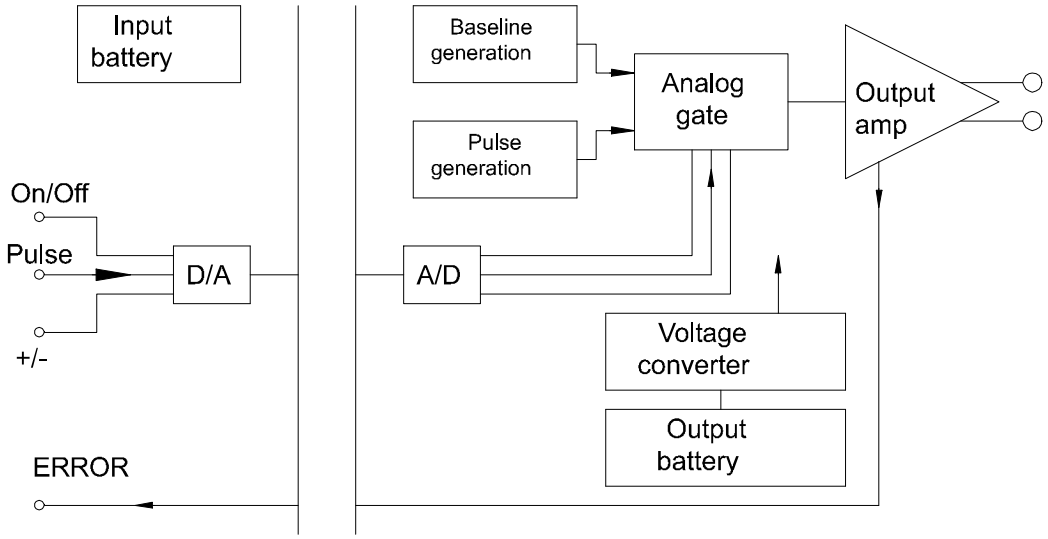
If you suspect the Model 2300 may have failed, we recommend checking the basic level of functionality.(see page 9). If the instrument fails at this basic level, the instrument is defective and must be recalibrated or repaired.

If these “simple” tests work as described buy your application still does not work properly: then either your experimental setup is incompatible or inconsistent with the capabilities of the Model 2300; or there is a more subtle flaw in your instrument. Contact A-M Systems, Inc., or your dealer. Telephone numbers for A-M Systems, Inc., are listed on the cover page of this manual. We will first attempt to solve the problem over the telephone, so have an exact description of your problem, the model number, and the serial number of the instrument available when you call. You do not need to be within the warranty period to obtain over-the-phone assistance - we are always ready to help our customers.

Theory of Operation

The logic control inputs are muliplexed with a D/A converter, optically coupled over a single analog channel to the output side, and demultiplexed with a A/D converter to provide the logic control to the output side. The pulse and baseline levels originate in the output side. An analog switch, controlled by the demuliplexed control signals, connects the appropriate level to the output amplifier.

The output amplifier scales the switched level (possibly converting the voltage to a current) according to the *Range* setting. In the current mode, the same amplifier is used to fix a virtual ground within the instrument. The two currents connected to this virtual ground are the set current, determined by the range switch and input signal amplitude; and the load, driven by the amplifier output



Output errors are detected by sensing the output amplifier's differential input voltage. Under normal conditions, this voltage in negligible. If for any reason this amplifier fails to deliver the requested signal, a window comparator testing this voltage sends this message (via another optoisolator) to the input section, turning on a warning LED and setting the Error output to a TTL-high level.

Two sets of batteries are used to power the 2300. At no setting of the *Power* switch are the input and output sections connected together. In the *Power*/On mode, the batteries provide independent power to their respective side of the isolation barrier. In the *Power*/ Charge mode, the batteries are disconnected from each side, and are reconnected to a battery-test circuit through the Battery Test push button. Note that the tester only detects the present state of batteries, and does not indicate how long the charged batteries will be able to support the load. The batteries used in the 2300 vary more from unit to unit

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than from near-fully charged to near-discharged, making it impractical to measure the charge state. It is recommended that you, the user, keep track of battery usage to ensure that the battery does not become exhausted at a critical time. You may also use the *Control* port to automatically monitor battery condition (as well as Error state) during an experiment. Optional DOS based “IsoStim” software provides one way of achieving this end.

Figure 4. Instrument block diagram

Specifications

There are three classes of specifications. Class a specifications are tested in all units, and are guaranteed. Class B specifications are inherent in the design; they are indirectly tested, and are guaranteed. Class C specifications are typical operating values which are occasionally tested; these are typical values, given for your information but not guaranteed. The class for each specification is noted in the center column of the following sections. All specifications require that the batteries are adequately charged, and the instrument if fully warmed up (at least 15 minutes.

Input

(Gate and Battery Test)

Logical ‘0’	B	<0.8 V
Logical ‘1’	B	>2.4 V
Input equivalent circuit	C	>400kV in parallel with no more than 35pF.
On/Off	A	active high (default is low = off)
Pulse/baseline	A	active high (default is high = pulse)
Sign +/-	A	active high (default is high = +)
Control to output delay	C	approx 6µs
Control timing jitter	C	<0.1µs
Battery Test polarity	A	active high (default is low = off)
Battery Test to output delay	C	<0.1 ms (turning on); < 1 sec (turning off)

Outputs

(Battery OK and Error)

Logical ‘0’	B	0 to 0.5 V (sense circuit current <300µA)
Logical ‘1’	B	2.4 to 4.2 V

Maximum output capability	A	±50 V or ±5mA. Both limits apply to all Range settings.
Accuracy	A	within ±(0.25% of setting + 0.15% of range) at dc. Accuracy is reduced for high output currents in voltage modes due to output impedance.
Transient response (pulse amplitude dial set to 2.50)	A	<10µs risetime with <4% overshoot in the 100 V range) into 20kV in parallel with less than 47 pF.
Slew rate	C	At least 2V/µs

Note: Risetime in current modes is slower than in voltage modes if the wiring capacitance approaches or exceeds 4.5 x 10^6R^{-1}pF (R in ohms). This is an inevitable consequence of driving an RC circuit with an true constant-current source.

Offset	A		within ±0.0025% of full scale (plus additional ±nA offset in current modes) at 25°C.	
Output impedance	C	MODE	OUTPUT RESISTANCE (typ)	
		100V, 10V	»50 ohms	
		10 mA	>1.GV (>10^{10})	
		1mA	>50GV (>10^{11})	
		100µA	>50GV (>10^{12})	
		10µa	>50GV (>10^{12})	
Noise, typical (voltage modes: open circuit load; current modes: 100kV load) 10 Hz - 100 kHz	C	MODE	RMS	% FULL SCALE
		100V	<1mV	0.001
		10 V	<1mV	0.01
		10µA	<5nA	0.05
		100µA	<5nA	0.005
		1mA	<5nA	0.0005
		10m	<30na	0.0003
Isolation resistance	A	>>200MV		

Isolation capacitance	C	<20pF
Overload error response time	C	Flat to approx. 10ms duration. Decreasing sensitivity for shorter pulses.

Miscellaneous

Battery load life (from full charge)	B	At least 8 hours (Control/Battery Test onless than 100 seconds, total)
Battery charge time	B	No more than 14 hours
Battery charge life (unit off)	B	At least 2 months
Operating temperature range		10-30°C
Operating humidity		5-80% RH
Storage temperature range		0-40°C
Dimensions		6.35 cmH x 15.4 cmW x 15.9 cmD
Weight		1.15kg

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Calibration

Full instrument calibration requires several pieces of test equipment. These are: a digital multimeter with at least 0.05% accuracy, capable of measuring resistance to atleast 20OMK2 and currents with lOOpA resolution; an oscilloscope with at least 5OMHz bandwidth; and a pulse generator capable of providing digital signals of varying amplitudes and timing. A few resistors are needed: a IMK2 1% resistor, and a 20@ 0.25W resistor. Ad ustment, integrated circuit, and test point locations are shown in the following -figures. A breakout cable providing convenient access to the control port pins is recommended. A PC with the included “IsoStim” software may be helpful.

We synonymously use the terms “Wgh” and “ I “ to indicate the logic voltage from 2.8 to 4.9V, and “low” or “O” for logic voltages from 0 to 0.5V. The lirnits on the =-compatible input and output voltages are specified in the preceding section. When not otherwise stated, the CONTROL port levels are the default (open circuit) values: On=O, Pulse=l, and Sign— 1.

When it states within this procedure that a voltage is to be minimized, @s means that the adjustment should be made such that the measured voltage is as close to zero volts as possible. Specifications which reveal how close this must be are given [§3.2]. CW means clockwise; CCW means counter-clockwise.

The calibration interval is the lesser of. 1500 hours of operation; or 6 months. Somewhat greater drift can be expected in the first 100 hours of operation as the semiconductors age. Adjustrnents should only be made a.fter the instniment is fully, warmed up (at least 15 minutes).

The sequence of tWs procedure is important. If any adjustment is made, all adjustments following that must be made in order to ensure that the specifications will be met.

Note: if you are turning the unit on for the first tirne, or the instrument has just been repaired, turn R801 fully CCW before applying power.

WARNING

The Model 2300 has dangerous voltages throughout the instrument. There is no explicit connection to earth ground, so conducting surfaces may be raised to dangerous potentials. Servicing should be done only by qualified service personnel. Use caution in handling any wires, connectors, or electrodes which may be directly or indirectly attached to the Model 2300 input or outpul Do not touch exposed connections or components.

Power supply

Charger check (remove batteries)

CONTROLS	INPUTS / OBSERVATIONS	ADJUST/CHECK
Disconnect both batteries. POWER: Charge Connect charger.	Measure the voltage and current at the battery connectors with . the DMM	Approx. 13.8V, l6OmA at B400 (amplifier board); approx. 10.3V, 13mA at B680 (power supply board).

Power supply (R601) (re-install batteries)

The remaining tests require that the batteries be adequately charged.

CONTROLS	INPUTS / OBSERVATIONS	ADJUST/CHECK
CONTROL: open OUTPUT.- open RANGE: IOV POWER: On	Measure the voltage at J475(2) with respect to the black output terminal with the D@.	Adjust R601 (PS Adj) for : +15.OV. Check odier voltages. -15V ± 0.25V (J475-4) +57V -3+8V (J475-5) -57V -7+3V7) (J475-7)

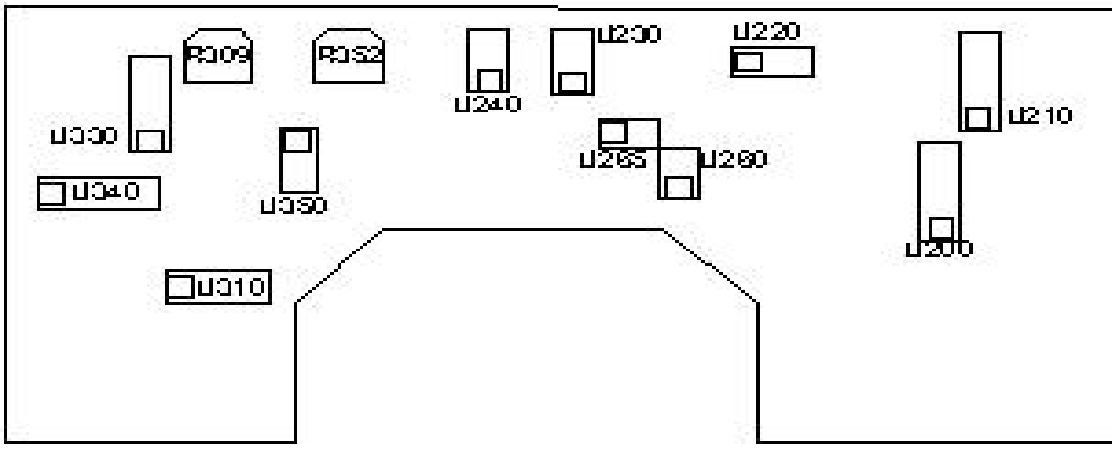

Figure 5. Input amplifier board: adjustment and test point locations

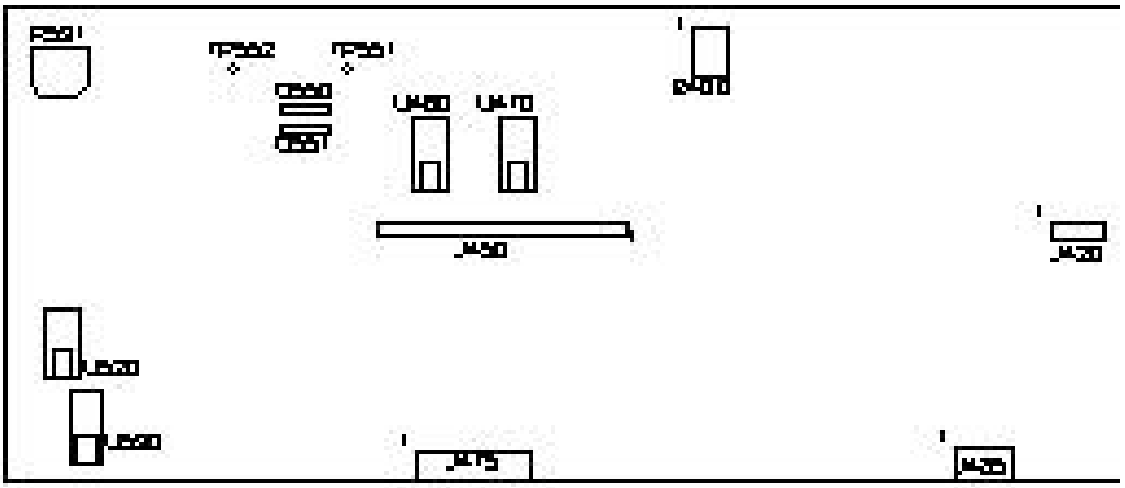

Figure 6. Output amplifier board: adjustment and test point locations

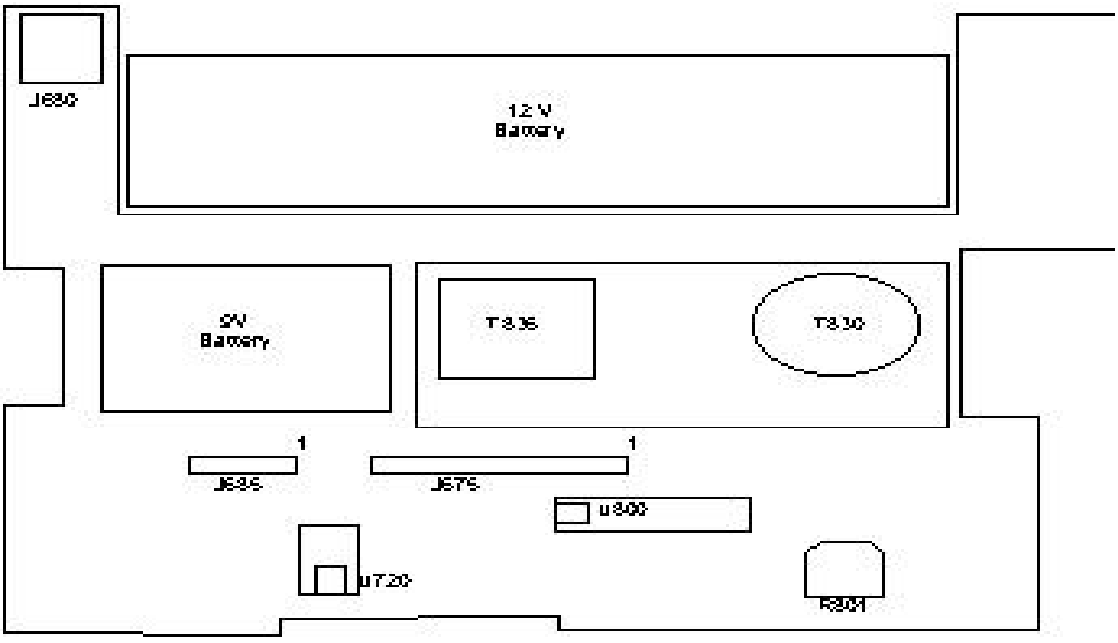

Figure7. Power suppy board: adjustment and test point locations

Warranty and Service

LIMITED WARRANTY

What does this warranty cover?

A-M Systems, LLC (hereinafter, "A-M Systems") warrants to the Purchaser that the Instrument, including cables, Headstage Probes and any other accessories shipped with the Instrument,(hereafter the "hardware") is free from defects in workmanship or material under normal use and service for the period of three (3) years. This warranty commences on the date of delivery of the hardware to the Purchaser.

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. 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 such time as 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, postage, shipping, and insurance prepaid. 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, or ninety (90) days which ever is greater. 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.

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 MERCHANTIBILITY AND FITNESS FOR A PARTICULAR USE, WITHOUT LIMITATION.

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Revision History

Rev	Date	Description
8	6/30/06	Initial Document Control release
9	4/28/10	DCR201200 Warranty and company name

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