




# Stimulators, Isolators

STIMULATORS, ISOLATORS

	FEATURE	INPUT	OUTPUT	COMPATIBLE STIMULATOR:
<b>DLS100</b> 	Biphasic, Digital Analog Modeling	Digital from DS8000	0-100 V 1 $\mu$ A to 10 mA	
<b>A320</b> 	SIU/built-in stimulator	TTL	0-100 V 1 $\mu$ A to 10 mA	  
<b>A365</b> 	Mono/Biphasic	TTL	$\pm$ 100 V 1 $\mu$ A to 10 mA	  
<b>A385</b> 	High Current	TTL	$\pm$ 36 V 10 $\mu$ A to 100 mA	  
<b>A395</b> 	Analog	Analog $\pm$ 10 volts	$\pm$ 70 V 1 $\mu$ A to 10 mA	  
<b>DUO 773</b> 	Intracellular Amplifier	Analog 0-1 volt	$\pm$ 500 nA	  

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

# A310 Accupulser™

Stimulus Isolator  
(A360)



Optional footswitch #3259

## Combining the accuracy of digital electronics with the convenience of analog controls

A pulse generator/stimulator combining the reproducibility and accuracy of digital electronics with the fine resolution and continuous adjustment possible with analog circuitry. All timing parameters are entered with ten-turn readable potentiometers and six-position range switches. Outputs are accurate to within 1% of the set value.

**Pulses** can be created in continuous run, single-shot, or train/burst modes. Duration of the train/burst is easily controlled using the onboard envelope generator or by using either of two external gating inputs. Used in conjunction with the A360, A365, A385, or A395, bipolar pulses or trains may be easily produced. Output stimulus can be fed through the Duo 773 for iontophoresis. Footswitch allows hands-free operation.

**Three separate outputs** are available on the front panel. A Monitor output provides 10-15 V signals (up to 50 mA) for viewing the output on an oscilloscope or for controlling other devices. The stimulator's signal, simultaneously available at the Isolator output, is sufficient to drive any WPI A300 Series stimulus isolator (A360, A365, or A385) and is also TTL and CMOS compatible. The Variable output can provide signals varying between  $\pm 10$  V with a resolution of 1 mV. Separate variable outputs are provided for positive and negative signals.

**SYS-A310** Accupulser™ Signal Generator

*Specify line voltage*

### OPTIONAL ACCESSORIES

**3259** Footswitch for A310

**2933** Rack Mount Kit, 5 1/4 in. high

## A310 ACCUPULSER™ SPECIFICATIONS

### TIMING PARAMETERS

EVENT INTERVAL	100 $\mu$ s to 1000 s*
EVENT DELAY	10 $\mu$ s to 100 s*
PULSE WIDTH	10 $\mu$ s to 100 s*
TRAIN DURATION (ENVELOPE)	100 $\mu$ s to 1000 s*
PULSE INTERVAL	20 $\mu$ s to 100 s*

### OUTPUTS

SYNC	5 $\mu$ s, TTL, and 5 V CMOS compatible, 20 mA max.	
MONITOR	10-15 V, 50 mA max.	
ISOLATOR	TTL & 5 V CMOS compatible, 20mA max.	
VARIABLE (Pos or Neg)		
PULSED/DC	LOW RANGE	HIGH RANGE
Range	0 to $\pm 1$ V	0 to $\pm 10$ V
Resolution	1 mV	10 mV

### NOISE

Pulsed at 100 kHz bandwidth	<500 $\mu$ V
DC Wide Band	<500 $\mu$ V

### OUTPUT IMPEDANCE

<1  $\Omega$

### INPUTS

EXTERNAL SYNC	Accepts 1- $\mu$ s minimum pulses TTL, CMOS compatible
EXTERNAL GATE	Accepts 1- $\mu$ s pulse to continuous TTL, CMOS compatible

### POWER

95-130 V or 190-260 V, switch selectable

single phase, 50/60 Hz

**DIMENSIONS** 17 x 5.25 x 10 in. (43 x 13 x 25 cm)

### SHIPPING WEIGHT

14 lb (6.4 kg)

\*Continuously variable in six ranges. All accuracies better than 1% of set value. 50kHz maximum pulse frequency.

# A300 Pulsemaster™ Multi-Channel Stimulator



**An integrated five-channel pulse generator/stimulator including one interval generator, five pulse or train channels, two mixer channels and one very quiet variable voltage output stage**

The Pulsemaster™ (Model A300) is WPI's third generation, multichannel, pulse/train generator/stimulator that combines the superb accuracy of digital electronics with the "you-see-what-you-get" displays only available on single-channel products. In one compact rack mountable enclosure, the Pulsemaster contains an event interval generator, five pulse train channels, two mixing channels and a very quiet variable voltage output channel. System timing is accurate to 100 ppm; output timing is continuously variable in 0.1% of full scale increments over a range of eight orders of magnitude. Bright, three-digit LED displays continuously and simultaneously show all the variable timing parameters.

The Pulsemaster is designed for ease of use and flexibility. Each channel can be operated synchronized with the onboard event interval generator, triggered manually from any other channel or external source, and as an independent asynchronous pulse generator. Except for the external source, all channel interconnections are accomplished on the panel, without the use of cables. The output from each channel is compatible with standard digital circuitry and is also designed to drive WPI's A300 series stimulus isolators. If desired, any channel's output may be internally connected to the variable channel, whose amplitude can be continuously adjusted from millivolts to ten volts.

## The Event Interval

The EVENT INTERVAL is the heartbeat of the Pulsemaster. Based on

a highly accurate and stable crystal oscillator, the EVENT INTERVAL generates synchronization pulses at regular intervals. The width of the sync pulses is fixed at approximately 6  $\mu$ s, but their repetition interval is panel adjustable from 10  $\mu$ s to 999 s, using the display and its associated switches. Sync pulses may also be generated at random or irregular intervals by using the SINGLE EVENT or the EXTERNAL SYNC mode. The sync pulses are internally distributed to the five PULSE TRAIN channels and are also available externally through the SYNC OUT connector.

## The Pulse Train

There are five PULSE TRAIN channels in the Pulsemaster. Except for sharing a common power supply, each is an independent instrument. Each channel has two adjustable timing parameters, DELAY and WIDTH, which in combination with internal or external signals may be used to create a variety of pulse and train waveforms. DELAY and WIDTH parameters can be changed while the instrument is operating.

The basic difference between PULSE and TRAIN modes is the number of pulses that can be generated per sync pulse. In PULSE mode, only one pulse is generated for each sync pulse. As the sync pulse is received from one of the selected input sources, the leading rising edge of the pulse is recognized and a DELAY time/pulse WIDTH pair is generated. In TRAIN mode, multiple pulses can be generated per sync pulse. As in PULSE mode, as the leading rising edge of the sync pulse is recognized, a pulse WIDTH/DELAY pair is generated.

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

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## A300 PULSEMASTER SPECIFICATIONS

Pulses (WIDTH/DELAY pairs) are continuously produced as long as the sync pulse is still "high" at the conclusion of the DELAY time.

By means of the INPUT SELECT switch, sync pulses can be received from an external source through the EXT SYNC connector, manually by the SINGLE switch, from any of the other PULSE TRAIN channels, or one of the MIXER channels. The channel may also be disabled by switching to one of the OFF positions.

**EXT SYNC position:** permits control of the PULSE TRAIN channel by other instruments and computers.

**SELF SYNC position:** the channel becomes a free running pulse generator. The symmetry of the waveform can be adjusted by varying the DELAY and/or the WIDTH times.

**SINGLE EVENT position:** pulses are generated at your discretion. Every time the SINGLE button is pressed, one and only one DELAY/WIDTH sequence is generated.

**EI position:** connects the output of the EVENT INTERVAL generator to the input of the PULSE TRAIN channel. For every output sync pulse from the EVENT INTERVAL generator, one DELAY/WIDTH pair is generated.

**PT positions (4):** internally connect the outputs from the respective PULSE TRAIN channels to the input of this PULSE TRAIN channel. In the PULSE mode, for every OUTPUT pulse from the other selected PULSE TRAIN channel, one DELAY/WIDTH pair is generated from this channel. In the TRAIN mode, pulses are generated from this channel as long as the pulse from the other channel remains "high."

**MIX positions (2):** internally connect the outputs from the respective MIXER channels to the input of this PULSE TRAIN channel. In the PULSE mode, for every OUTPUT pulse from the MIXER channel, one DELAY/WIDTH pair is generated from this channel. In TRAIN mode, pulses are generated from this channel as long as the pulse from the MIXER channel remains "high."

**OUTPUT connector:** supplies the waveforms generated by the PULSE TRAIN channel. This OUTPUT is designed to drive WPI's A300 series stimulus isolators. It is also useful for synchronizing other instruments (recorders, oscilloscopes, computers, etc.) with the pulses generated from the Pulsemaster.

### The Mixer

The MIXER does what its name implies, it combines any or all of the outputs of the PULSE TRAIN channels with external signals into one waveform. It can also provide a continuous (DC ON) or momentary (DC MOM) "high" level signal. The Mixer OUTPUT connector supplies the combination waveforms generated by the MIXER channel to drive WPI's A300 series stimulus isolators or to synchronize the operation of other instruments with the Pulsemaster.

### The Variable Channel

The VARIABLE channel can replicate the OUTPUT waveforms from any of the PULSE TRAIN or MIXER channels at amplitudes that can be varied from millivolts to ten volts. The channel also provides a very low noise, adjustable DC voltage source: the DC mode which converts the VARIABLE channel into a constant voltage source. The OUTPUT connector supplies the amplitude modified waveform or the DC voltage level of the VARIABLE channel.

### EVENT INTERVAL CHANNEL

Operating Modes	EXTERNAL SYNC, SINGLE EVENT, CONTINUOUS ON
Input	EXT SYNC accepts $\geq 1 \mu\text{s}$ pulses; TTL, CMOS, RS232C compatible
Timing	EVENT INTERVAL 10 $\mu\text{s}$ to 999 s (100 kHz - 0.001 Hz), $\pm 0.1\%$ of full scale, continuously variable in 0.1% of full scale increments, through three orders of magnitude, in six ranges
Output	SYNC OUT pulse of $\approx 6 \mu\text{s}$ , TTL, 5 V CMOS compatible

### PULSE TRAIN CHANNEL (5 provided)

Operating Modes	EXTERNAL SYNC, SELF SYNC, manual SINGLE event, sync from Event Interval, sync from any of other four Pulse Trains, sync from one of the MIXERS, off, TRAIN/PULSE
Input	EXT SYNC accepts $\geq 1 \mu\text{s}$ pulses; TTL, CMOS, RS232C compatible
Timing	DELAY and WIDTH 10 $\mu\text{s}$ to 999 s, $\pm 0.1\%$ of full scale, continuously variable in 0.1% of full scale increments, through three orders of magnitude, in six ranges (.0005 Hz to 50 kHz in the SELF SYNC mode)
Output	OUTPUT PULSE/TRAIN of preset timing, TTL, 5 V CMOS compatible, 4 mA sink and source

### MIXER CHANNEL (2 provided)

Inputs	Any combination of an EXTERNAL pulse, the outputs of the five Pulse Train channels, and DC continuous ON/DC MOMENTARY EXT INPUT accepts $\geq 1 \mu\text{s}$ pulses; TTL, CMOS, RS232C compatible
Output	OUTPUT, TTL, 5V CMOS compatible, 4 mA sink and source

### VARIABLE CHANNEL

Inputs	Output from any one PULSE TRAIN channel or one of the two MIXER channels or DC
Output	0 to +1 V low range, 1 mV resolution 0 to +10 V high range, 10 mV resolution 5 mA max sink and source
Output Impedance	<1 ohm
Noise	<500 $\mu\text{V}$ peak @ 100 kHz bandwidth, PULSED mode <500 $\mu\text{V}$ , wide band, DC mode
Signal Ground	Floating, i.e., not connected to chassis

**POWER** 95-135 V or 220-240 V, 50/60 Hz

**BATTERIES** Three 1.2 V DC, size AA, NiMH batteries

**DIMENSIONS** 8.5 x 19 x 8.75 in. (22 x 45 x 22 cm)

**SHIPPING WEIGHT** 21 lb (9.5 kg)

**SYS-A300** Pulsemaster™ Multi-Channel Stimulator

*Specify line voltage*

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

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# Isostim™ Stimulator/Isolator

Combining the ease of use and accuracy of WPI's 300 Series stimulators with the power output of a stimulus isolator



## Timing

Pulse interval and width are set with single-turn continuously variable controls from 5 ms to 5.5 s in three ranges. Pulse width is continuously variable from 50  $\mu$ s to 550 ms in four ranges.

## Modes of operation

In FREE RUN, Isostim™ generates continuous square waves. In EXT GATE or EXT SYNC modes, externally applied pulses can generate trains or single events. Single pulses of finite duration can be produced using a push-button on the instrument's front panel. EXT/DC mode converts Isostim to a passive stimulus isolator.

## Dual tone audible alarm

A tone sounds when an open circuit is detected or when system compliance is reached. A second tone, which sounds when a signal is applied to the input, can only be heard if the batteries have sufficient charge to operate the isolator. A violation light advises when pulse width exceeds the interval.

## Current delivery

Stimulus currents up to 10 mA can be set on the front panel with a control knob and a two-position range switch. Output current is load-independent.

## Power

Isostim model A320D is powered by readily obtainable 9-volt alkaline batteries (included). Under average use these will last several months before replacement is required. The rechargeable A320R is supplied with a nickel metal hydride battery stack which provides 10-12 hours of operation before recharge is required. **The A362 Battery Charger must be used with the A320R.**

## ISOSTIM™ SPECIFICATIONS

### TIMING PARAMETERS

Interval	5 ms to 5.5 s continuously variable in three ranges (0.18 to 200 Hz)
Pulse width	50 $\mu$ s to 550 ms continuously variable in four ranges

### INPUT

External sync	Accepts 1 $\mu$ s minimum pulses
External gate	Accepts 1 $\mu$ s pulse to continuous
External command voltage	5.0 V at 3.0 mA (TTL level), 10 V max.
Trigger threshold	2.0 V at 0.5 mA

### OUTPUT

Waveform	DC, pulse from internal timing or externally generated pulse
Current ranges	0-1 mA, 0-10 mA
Load voltage excursion (compliance)	100 V nom., 150 V max.
Output polarity	Reversible, manual switch
Current rise time and delay	8 $\mu$ s, typical (1 K $\Omega$ load)
Current fall time and delay	10 $\mu$ s, typical (1 K $\Omega$ load)
Leakage resistance, output to ground	10 <sup>12</sup> Ohms
Optocoupler	2500 V rated min. breakdown voltage

### POWER

Dry Cell (Version D)	16 alkaline 9V batteries included
Rechargeable (Version R)	16 rechargeable NiMH 9V batteries incl

### DIMENSIONS

	8.5 x 3.5 x 4.9 in (22 x 9 x 12 cm)
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### SHIPPING WEIGHT

	4 lb (1.8 kg)
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## A362 Battery Charger

Required for A320R, A365R and A395R

Recharges the high-voltage nickel-cadmium or NiMH battery stack in the A320R, A365R or A395R. LED lamp indicates charging status. Full charge overnight. Dimensions: 2.8 x 4.1 x 5 in. (7 x 10 x 13 cm). Shipping weight: 4 lb (1.8 kg).

**SYS-A362** Battery Charger for A320R, A365R, A395R

**A320RC** A320R with Charger (A362)

**SYS-A320D** Isostim™ Stimulator/Isolator

**SYS-A320R** Isostim™ Stimulator/Isolator (rechargeable)

### Specify line voltage

### OPTIONAL ACCESSORIES

**DRL** Dummy Load Resistor Kit (set of 3)

**13347** BNC-to-Double Banana Adapter

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

# Stimulus Isolator / Precision Current Source



**Model A365** includes the same features and specifications as A360 but with the added capability for automated bipolar pulsing for zero net charge on biological preparations.

**Polarity** — Output polarity is determined by a push switch on the front panel. Bipolar current is toggled by the command waveform, setting alternating pulses as positive or negative.

## A365 SPECIFICATIONS

OUTPUT WAVEFORM	DC or current pulse
OUTPUT CURRENT RANGES	0.1, 1.0, and 10 mA
CURRENT AMPLITUDE ERROR	0.5% of full scale, max.
CURRENT RESOLUTION	0.1% of full scale, typical
OUTPUT LOAD VOLTAGE	
EXCURSION (COMPLIANCE)	100 V
EXTERNAL COMMAND VOLTAGE	5.0 V at 3.0 mA (TTL level), 10 V max.
TRIGGER THRESHOLD	2.0 V at 0.5 mA
OUTPUT POLARITY	Reversible, manual switch or automatic
CURRENT RISE TIME & DELAY	6 µs, typical (1 KΩ load)
CURRENT FALL TIME & DELAY	10 µs, typical (1 KΩ load)
OUTPUT TO GROUND RESISTANCE	10 <sup>12</sup> Ω
OPTOCOUPLER	2500 V, rated min. breakdown voltage
POWER	
Model A365D (dry cell)	16 alkaline 9 V batteries, included
Model A365R (rechargeable)	16 rechargeable NiMH 9 V batteries incl.
DIMENSIONS	8.5 x 3.5 x 5 in (22 x 9 x 12 cm)
SHIPPING WEIGHT	4 lb (1.8 kg)

**SYS-A365D** High Voltage Isolator, Bipolar, alkaline batteries

**A365RC** A365R with charger (A362)

**SYS-A365R** High Voltage Isolator, Bipolar, rechargeable

**SYS-A362** Battery Charger for A320R, A365R, A395R

*Specify line voltage*

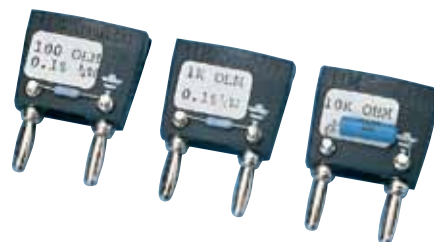
## OPTIONAL ACCESSORIES

**DRL** Dummy Load Resistor Kit (set of 3)

**3468** Dual Rack Mount Kit for A365

**3469** Single Rack Mount Kit for A365

**13347** BNC-to-Double Banana Adapter



**DRL — Dummy Load Resistor Kit**  
Converts current output to precise voltages.

STIMULATORS, ISOLATORS

**Combines optical isolation with a  $\pm 100$  mA current generator**



## A385 High Current Stimulus Isolator

Delivers positive, negative, or bipolar currents. For bipolar delivery, polarity of the output is toggled to the opposite state with each pulse presented to the input. Pulse duration is controlled by an externally applied voltage. Input connector is a standard BNC, allowing signals from any source — such as computer D/A or I/O lines — to be used.

Output amplitude is set on a 3-digit, ten-turn dial as a percentage of the range selected: for example, a setting of 45.6 in the 0-10 mA range translates to 4.56 mA at the output. Accuracy and repeatability are excellent. Designed for subcutaneous stimulation, maximum output voltage at the stimulating electrodes is 36 volts, reducing the possibility of serious accidental transcutaneous shocks. A compliance/output alarm sounds

when the 36-volt limit is reached. Internal circuitry maintains electrodes short-circuited during inactive periods ("electrode exhauster" feature). A385 is not appropriate for transcutaneous stimulation.

The 1.2 amp-hour rating of the six heavy-duty lead-acid rechargeable batteries ensures that experiments will not be interrupted by dead batteries — even at peak currents. Indicator lights and audible alarms keep the user constantly apprised of battery charge status. These batteries must be recharged by the A382 System Charger designed especially for the A385.

<b>A385RC</b>	A385R with A382 Charger
<b>SYS-A385R</b>	High Current Isolator, rechargeable
<b>SYS-A382</b>	Battery Charger for A385 (see below)

*Specify line voltage*

### OPTIONAL ACCESSORIES

<b>3468</b>	Dual Rack Mount Kit
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### A385 SPECIFICATIONS

OUTPUT WAVEFORM	DC or current pulse
OUTPUT CURRENT RANGES	1, 10, and 100 mA
CURRENT AMPLITUDE ERROR	0.5% of full scale, max
CURRENT RESOLUTION REPEATABILITY	0.1% of full scale, typical
OUTPUT LOAD VOLTAGE EXCURSION (COMPLIANCE)	36 V
EXTERNAL COMMAND VOLTAGE	5.0 V at 3.0 mA (TTL level), 10 V max.
TRIGGER THRESHOLD	2.0 V at 0.5 mA
OUTPUT POLARITY	Reversible, manual switch, or electronically switched bipolar delivery
CURRENT RISE TIME AND DELAY	6 $\mu$ s, typical (1 K $\Omega$ load)
CURRENT FALL TIME AND DELAY	10 $\mu$ s, typical (1 K $\Omega$ load)
OUTPUT TO GROUND RESISTANCE	10 <sup>12</sup> $\Omega$
OPTOCOUPLER	2500 V, rated minimum breakdown voltage
POWER	Six rechargeable lead-acid batteries (Requires companion charger A382)
DIMENSIONS	8.5 x 3.5 x 5 in. (22 x 9 x 12 cm)
SHIPPING WEIGHT	5 lb (2.3 kg)

## A382 Battery Charger



An innovative three-step charger, A382 employs fast, medium, and trickle charges at a safe, low current, greatly extending battery life. After a fast initial phase, the charger automatically switches to a constant voltage mode. When charging is complete, the charger switches to the trickle-charge mode. LED lamps indicate charging status. (For use only in charging batteries installed in the A385.)

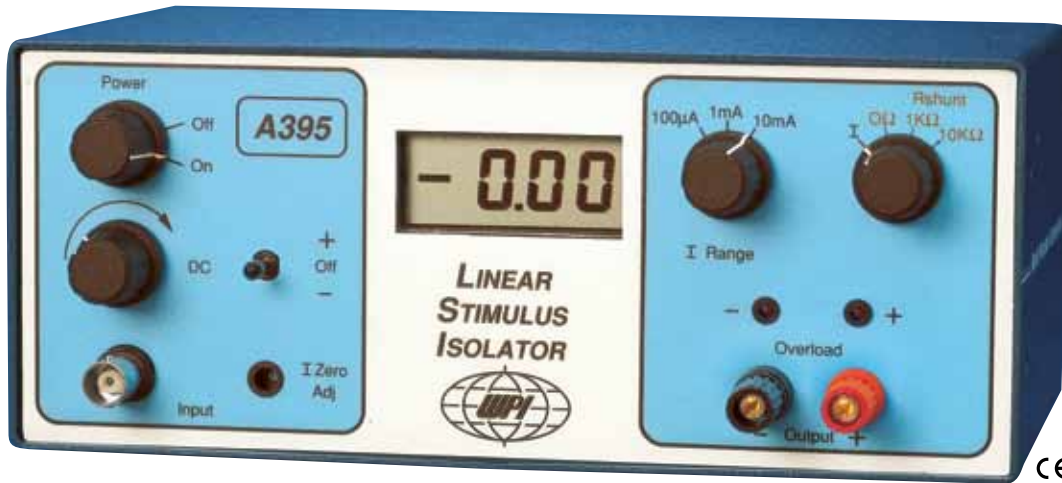
### A382 SPECIFICATIONS

POWER	95-135 V or 220-240 V, 50/60 Hz
DIMENSIONS	8.5 x 3.5 x 5 in. (22 x 9 x 12 cm)
SHIPPING WEIGHT	5 lb (2.3 kg)

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# A395 Linear Stimulus Isolator

Replicates a programmed waveform of any shape or polarity

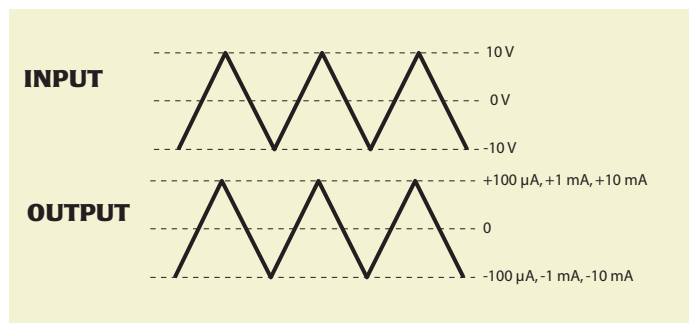


**Current Delivery** — A 10 V input produces the maximum output current for the current range selected, i.e., 100  $\mu$ A, 1 mA, or 10 mA. Front panel controls allow DC current to be generated. Externally applied signals can be superimposed simultaneously (DC offset). Warning lamps indicate open circuit or excessive current conditions.

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. Model A395 dispenses current reproducibly from its Output terminals; the amplitude being determined by the selected current RANGE and the input voltage. 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. A visual indicator (the compliance LEDs) displays if  $I \times R$  reaches this limit. When the unit is out of compliance, one of the two LEDs (labeled - and +) illuminate, depending in which direction the current is flowing. Model A395 D can generate a voltage of 70 volts or more across its OUTPUT terminals. Thus, the user can be sure that the amplitude of the current will be as dialed as long as the voltage drop across the load (stimulus electrode path) does not reach the magnitude of the supply voltage. The compliance LEDs will then be visible. The user would then know that (a) too much current was dialed for a given load or (b) inter-electrode resistance was too high or the electrode circuit path was open.

Model A395 generates an output current of arbitrary (user-defined) wave shape; DC, AC, pulse, and combinations thereof. Battery operated, and photoelectrically-isolated from the input voltage drive, the instrument regenerates output currents which are linearly proportional to the analog voltage waveforms provided by your D/A converter or signal generator (see diagram below).

The A395 is ideally suited for data acquisition and stimulator generators. It can be easily daisy-chained for multiple channel requirements.



Accepts analog input

**Digital Meter** — Measures DC or average output current.

**Overload Lamps** — Indicate when output voltage has reached positive or negative compliance voltage limit.

<b>A395RC</b>	A395R with Charger (A362)
<b>SYS-A395D</b>	Linear Stimulus Isolator
<b>SYS-A395R</b>	Linear Stimulus Isolator, Rechargeable
<b>SYS-A362</b>	Battery Charger

#### Specify line voltage

#### OPTIONAL ACCESSORIES

<b>3468</b>	Dual Rack Mount Kit
<b>3469</b>	Single Rack Mount Kit

#### A395 SPECIFICATIONS

OUTPUT CURRENT, $I_{max}$	3 ranges: 100 $\mu$ A, 1 mA, and 10 mA
OUTPUT VOLTAGE RANGE	$\pm$ 70 V
OUTPUT BANDWIDTH	10 kHz (measured across 1K $\Omega$ load R)
INPUT RESISTANCE	> 20 M $\Omega$
INPUT VOLTAGE @ $I_{max}$	$\pm$ 10 volts
INPUT/OUTPUT LINEARITY ERROR	< 0.5%
RISE, FALL TIME	26 $\mu$ s @ 10 K $\Omega$
POWER	
Model A395D	17 alkaline 9 V batteries
Model A395R	17 rechargeable NiMH 9 V batteries
DIMENSIONS	6.5 x 4 x 3.5 in. (16 x 10 x 9 cm)
SHIPPING WEIGHT	4 lb (1.8 kg)

#### A362 Battery Charger

Required for A320R, A365R and A395R

Recharges the high-voltage nickel-cadmium or NiMH battery stack in the A320R, A365R or A395R. LED lamp indicates charging status. Full charge overnight.

Dimensions: 2.8 x 4.1 x 5 in. (7 x 10.5 x 12.7 cm).

Shipping weight: 4 lb (1.8 kg).



Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

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# DS8000 8-Channel Digital Stimulator



- Single board computer w/ LCD touch screen
- Scope mode displays waveforms
- 8 banks of 3 timers, synchronous / asynchronous
- 8 internal and 8 external trigger inputs
- 32 separate outputs ( 24 BNC's front panel )
- Lifetime firmware upgrades via serial / Ethernet
- Unipolar, bipolar, paired pulse, sine, ramp, custom
- Custom upload of real biopotentials
- 2 independent full parameter memory banks
- GLP / GCP compliant w / password protection

The DS8000 represents a quantum leap in the performance of the research stimulator, and is the most advanced stimulator on the market. With a built-in computer, the entire waveform is generated digitally with precision timing. The DS8000 can generate stimulating wave patterns of a complexity unmatched by any other instrument on the market. A built-in digital oscilloscope allows the user to preview waveforms on the LCD. An Ethernet connection allows the user to transfer custom waveforms and upgrade the software using TCP/IP protocol via remote access.

The DS8000 has 8 analog outputs, 8 TTL outputs and 8 combined analog or TTL outputs. Each combined output can be comprised of a combination of any of 1 to 8 channels. Eight independent internal timers and eight independent external triggers are offered. The built-in waveforms include unipolar, bipolar, and paired pulse, as well as step, sine, ramp and custom. An external trigger, internal analog channel, internal TTL channel, or any of the eight built-in timers can be assigned to control each output channel.

A unique feature of the DS8000 is the capability to stimulate with a waveform that is identical or similar to real biopotential wave patterns associated with ECG, EEG or action potentials. A biopotential waveform captured by a data acquisition system may be transferred to an Excel spreadsheet for editing or modification, then loaded into the DS8000.

One of the main problems of designing a stimulator is that a user might want very different stimulating patterns for different research applications. In order to satisfy all of these needs, traditional logical circuit based stimulators have control panels that use buttons and knobs to give the user as much control options as possible. However, even with a full panel of buttons, the selection of the stimulating pattern is still very limited. These types of stimulators can not generate complicated waveforms, such as combination pulses at varying interpulse intervals and amplitudes. Although microprocessor-based stimulators have made a significant step in solving these problems, certain complex waveforms are still impossible to generate.

In fact, this decade old technology has serious limitations since each control button has been programmed to perform multiple functions. Moreover, it can only display limited lines of scrolled text—no graphics! To complicate matters, it is almost impossible to upgrade the software with new functions once the instrument has been manufactured; even the programming is awkward.

The DS8000 overcomes the hardware limitations of other types of stimulators by being reliant on a flexible software-timing interface. The user can then apply this dynamically to almost any kind of stimulation protocol without being restricted by the hardware limitations of the traditional logical circuit based stimulators. In order to suit complex custom protocols, the DS8000 is designed to offer a unique flexibility by simply reprogramming the pattern output using a few keystrokes under pull-down menus.

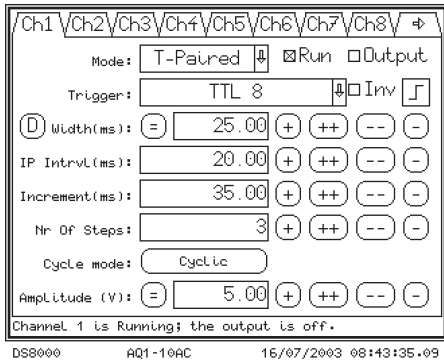
Although it may be argued that some functions of the DS8000 can be implemented on a standard PC, it is important to recognize that the inherent design of a PC operating system makes the accurate delivery of precision pulse protocols impossible. Despite the fact that PCs are very economical, they are simply not designed to generate highly accurate timing because the microprocessor resources are not prioritized for this function. In addition, analog waveform generation is not readily available without adding expensive output boards and the required programming is non-standard. The DS8000 platform is based on a powerful single board computer that is fully dedicated to the temporal accuracy and precision required in current biological and neurological research. Indeed, the DS8000 Digital Stimulator offers all of these solutions plus Good Laboratory Practices (GLP) compliance for research traceability.

DS8000 — there is no competition!

**DS8000** 8-Channel Digital Stimulator

Prices shown are in U.S. dollars. Actual charges will vary because of import duty, freight, and currency fluctuations. To obtain an exact quotation, contact your WPI office.

# A quantum leap in the performance of the research stimulator



**Fig. 1**  
Channel Settings

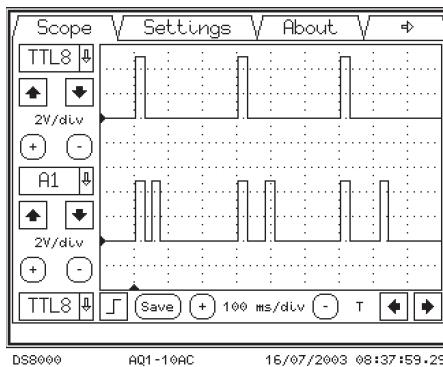
## Paired Pulse Protocol

The DS8000's Paired Pulse function allows the user to generate triggered paired pulses (including refractory period) from a single channel without the use of a train function. WPI's paired pulse algorithm simplifies the arduous repetitive task normally associated with manual resetting of interpulse intervals in refractory studies. Auto-increment eliminates the need to overlap train functions from multiple channels to generate a complete protocol. Thus, there is a significant reduction in setup time and a minimization of the potential for human error during interactive protocol modification.

Fig. 1 shows Channel 1 configured in the TRIGGERED PAIRED PULSE mode. In this example, a dual pulse event occurs synchronously with each trigger pulse from Channel 8, which is set to trigger every 300 ms. The initial interpulse interval is set to 20 ms. Subsequent interpulse intervals are automatically incremented by 35 ms for each three consecutive paired pulse events. The resulting paired pulse is displayed in the lower trace on the DS8000 scope (Fig. 2). The upper trace shows the master trigger pulse set up on Channel 8.

## Soft Keys and GUI interface

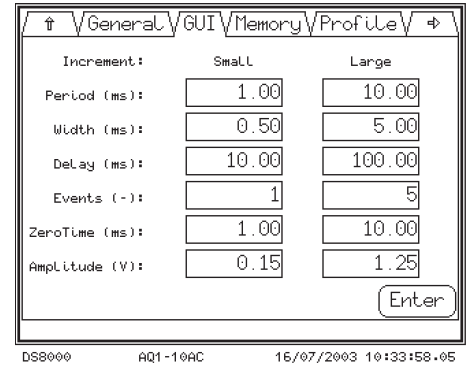
The DS8000 employs "soft keys", which are programmable controls widely used in several menu options to sequentially change the numerical value of any variable waveform parameter. The DS8000's soft keys are easily recognized as single or double "+" and "-" signs located adjacent to a parameter value box (Fig. 1). Soft keys provide quick and easy access to modify parameter values on the fly during an experiment. The GUI interface (Fig. 3) enables the user to assign the incremental value of the soft key to suit the needs of the experiment. Alternatively, a pop-up numeric keypad is accessible for each parameter to program a precise value that is not a multiple of the softkey-preset increment.



**Fig. 2**  
Scope Display

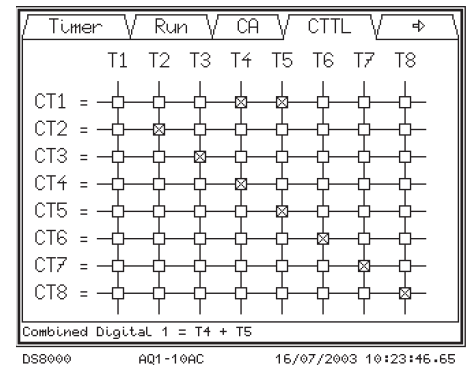
## Combined Channel Assignment matrices

The CTTL (COMBINED TTL matrix) and CA (COMBINED ANALOG matrix) screens permit the assignment of any combination of the 8 available TTL or Analog signals to any permutation of the respective (8) CTTL or (8)



**Fig. 3**  
Graphic User Interface

CA BNC outputs. The setup in Fig. 4 indicates that all TTL channels are assigned to their respective CTTL outputs with the exception of the output of CTTL 1, which is assigned a combination of the TTL signals from channels 4 and 5. Changing assignments is as easy as checking the associated box. The CA tab reveals an identical matrix for programming the COMBINED ANALOG BNC outputs.



**Fig. 4**  
Combined TTL Matrix

## DS8000 SPECIFICATIONS

### TIMING PARAMETERS

PERIOD (TOTAL SIGNAL WIDTH)	0.04 ms to 10,737,418.24 ms
PULSE WIDTH	0.02 ms to 10,737,418.24 ms
BIPOLAR GAP WIDTH	0.00 ms to 10,737,418.24 ms
OPERATING MODES	Free run, triggered, gated, Train, DC
TRIGGERS	8 External, manual, TTL 1-8, combined TTL 1-8, timer start or stop
TRAIN EVENTS	1-199
TRAIN PULSE WIDTH	0.02 ms to 10,737,418.24 ms (3 hours)
TRAIN PULSE DELAY	0.04 ms to 10,737,418.24 ms
TRAIN PERIOD	0.06 ms to 10,737,418.24 ms
BNC OUTPUT CONNECTORS	Analog, combined analog, combined digital (TTL)
WAVEFORMS	Unipolar, bipolar, rectangular, sine, ramp, step, paired pulse, custom defined
CUSTOM WAVEFORM	12 steps/ voltage point (1025 if remote controlled)
VARIABLE STEP WAVEFORM	100 points (1025 if remote controlled)

OUTPUT NOISE	< 5 mV rms
TIMING ACCURACY	< 100 ppm
OUTPUT VOLTAGE RESOLUTION	5 mV
MAX. OUTPUT VOLTAGE	+/-10V @ +/- 10 mA @ 0.005 V/step
OUTPUT IMPEDANCE	50 Ohm Analog, < 1 ohm Combined Analog
EXTERNAL TRIGGER SYNC	40 $\mu$ s minimum pulse TTL, CMOS 20 $\mu$ s glitch and spike protection
DIGITAL I/O	5V max 10 mA (input)
MAINS VOLTAGE	85-260 V AC, 45-65 Hz 50W
DIMENSIONS	13.3 cm x 42.5 cm x 25.4 cm 5.25" x 16.73" (19" rack) x 10"
SHIPPING WEIGHT	12 lb (5.5 kg)
AMBIENT TEMPERATURE	-10 to +40 °C; -20 to +50 °C (Internal)
HUMIDITY	Max. 95% relative humidity, non-condensing

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

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# Digital Linear Stimulus Isolator



**for use with DS8000 Digital Stimulator**



CE

Top View

The new DLS100 is preferentially optimized for applications in which the DS8000 digital stimulator is used.

DLS100 connects to the DS8000 via a flexible cable through which it receives power and stimulus signals in a digital format. Up to eight DLS100 isolators can be connected independently to one DS8000. Very high isolation is achieved through the use of optical coupling of the digital signal and a galvanically isolated DC power supply within the DLS100. Unlike some other multi-channel isolators, this digital isolator can be located at the site of the experiment, allowing the use of short connecting leads and thereby preserving high isolation and fast signal rise and fall times.

The DLS100 operates in two modes: current source or voltage source. In the current source mode, the output current is proportional to the amplitude and polarity of the signal generated by the DS8000. In the voltage source mode, the output voltage is proportional to the amplitude and polarity of the signal generated by the DS8000. The DLS100 has user-selectable push-button switches that select different current or voltage ranges (the full-scale current from 1 µA to 10 mA, or the 10V and 100V full-scale, respectively). Three status indicators on the DLS100 indicate power on, activity (presence of signal from DS8000) as well as an alarm (over-range condition) indicator. Over-range can occur when the resistance of the load (the experiment) is too high for the current or voltage that is demanded from the DLS100.

## DLS100 SPECIFICATIONS

### CURRENT SOURCE MODE

Full-scale Current	10 mA, 1 mA, 100 µA, 10 µA, 1 µA, bipolar
Compliance Voltage	± 100 volts
Output Impedance	Greater than 100 Megohms
Zero-signal Leakage	Less than 0.01% of full-scale range setting ≤ 100 V / 10,000 Ohms, 10 mA Scale = < 1 µA Leakage

Linearity	Better than 0.05% of full-scale range setting
Bandwidth	Range and load dependant: 20 kHz with 10K load and 100 µA or above range.

### VOLTAGE SOURCE MODE

Full-scale Voltage	± 100 volts
Maximum Current	10 mA
Output Impedance	Less than 1 ohm
Zero-signal Offset	Less than 1 mv
Linearity	Better than 0.05% of full-scale range setting

### ISOLATION

Resistance	Greater than 1000 Megohms
Capacitance	Less than 10 pF, from output terminals to DS8000 and earth ground

### POWER REQUIREMENTS

POWER REQUIREMENTS	+12 volts and +5 volts, supplied by DS8000
DIMENSIONS	14 x 9 x 3.5 cm (5.5 x 3.5 x 1.5 in.)
OUTPUT TERMINALS	Mini-banana jacks
CONNECTING CABLE	150 cm (5 ft)

<b>DLS100</b>	Digital Linear Stimulus Isolator
<b>501670</b>	Adapter, Dual Mini-Banana-to-BNC(F)
<b>83016</b>	Replacement Cable, DLS100-to-DS8000
<b>503301</b>	Cable, mini-DIN extension, 10-ft

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