



# A300 Pulsemaster™

*Multi-channel pulse/train generator/stimulator*

[www.wpiinc.com](http://www.wpiinc.com)

## **INSTRUCTION MANUAL**

Serial No. \_\_\_\_\_

032907

**World Precision Instruments**



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## INTRODUCTION

The Model A300 Pulsemaster™ is WPI's third generation, multi-channel, 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 enclosure, the A300 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 A300 is designed for ease of use and flexibility. Each channel can be operated synchronized with the on-board 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 a variable channel, whose amplitude can be continuously adjusted from millivolts to ten volts.





## **SAFETY**

### **Terminology**

**WARNING** statements identify conditions or practices that could result in personal injury or loss of life.

**CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property. When marked on the instrument, it also indicates a personal injury hazard not immediately accessible as you read the marking.

### **Do Not Use With Humans**

**WARNING: THIS INSTRUMENT IS FOR INVESTIGATIONAL USE ONLY IN ANIMALS OR OTHER TESTS THAT DO NOT INVOLVE HUMAN SUBJECTS.**

### **Power Source**

This instrument is intended to operate from a power source that will not apply more than 250 volts rms between the supply (mains) conductors or between either supply conductor and ground. A protective (safety) ground connection by way of the grounding conductor (green with yellow stripe) in the power cord is essential for safe operation.

### **Grounding the Instrument**

This instrument is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the instrument input and output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

**WARNING: YOU MUST NOT REMOVE OR IN ANY WAY BYPASS THE GROUNDING PIN OF THE POWER CORD.**

### **Use the Proper Power Cord**

Use only the power cord specified for your instrument and locale. Use only a power cord that is in good condition.



### **Use the Proper Fuse**

To avoid a fire hazard, use only the fuse specified for your instrument. Replacement fuses shall be identical in type, voltage rating, and current rating. Line fuses must match the selected voltage source of AC power and must be changed when the nominal voltage range is changed.

### **Do Not Operate in Explosive Atmospheres**

To avoid explosion, do not operate this instrument in an atmosphere of explosive gases.

### **Do Not Remove Covers or Panels**

To avoid personal injury, do not remove covers or panels from this instrument. Do not operate the instrument without properly installed covers or panels.



# INSTALLATION

## Input Power

**CAUTION:** The Model A300 may be damaged if the Line Voltage Selector switch is not set to match the applied AC power source or the wrong line fuse is installed.

This instrument operates from either a 120 V or 240 V nominal AC power source. The rear panel is marked at the factory with the user's expected mains power. Before connecting the power cord, verify that, in fact, the correct mains power setting was provided and the appropriate line fuse is installed. If any doubt remains, the internal Line Voltage Selector switch may be adjusted.

**WARNING: BEFORE REMOVING THE COVER, DISCONNECT THE INSTRUMENT FROM THE AC POWER SOURCE.**

The switch is located inside the instrument. To verify the voltage setting:

1. Remove the four screws (two on each side) on the side panels of the enclosure.
2. Remove the instrument panel by sliding it straight outward and rest it on its face.
3. Find the power supply printed wiring board on the right wall of the instrument.
4. Locate the slide switch on the board and slide to the appropriate voltage setting. The actuator is marked and the visible marking is the actual voltage setting, i.e. 115 V (120 V) or 230 V (240 V).
5. Reassemble the instrument by reversing the order of the above steps.

## Line Fuse

**WARNING: BEFORE ATTEMPTING FUSE REPLACEMENT, DISCONNECT THE INSTRUMENT FROM THE AC POWER SOURCE.**

The instrument contains one fuse, located in the fuseholder on the back panel. The fuseholder is opened by inserting a screwdriver in the slot, pressing lightly, and twisting the cap 1/8-turn counterclockwise. Verify that the fuse contained in the fuseholder matches the desired line voltage. If necessary, replace the fuse with the type and rating specified on the back panel.



## **CONTROLS, INDICATORS AND CONNECTORS**

### **POWER**

A two-position switch (ON/I and OFF/O) is used to apply mains power to the instrument.

### **EVENT INTERVAL**

**Display** – A three-digit LED, with decimal points, indicates the EVENT INTERVAL time selected by the user.

**s/ms** – Two lamps are used to indicate the unit of measure (seconds or milliseconds) of the EVENT INTERVAL time selected by the user.

**push switches** – Six push button switches are used to change the value of the EVENT INTERVAL time. The pair of buttons under each digit control the value of the digit. The top button increases the value of the digit, the bottom button decreases the value. When a digit is increased above 9 or decreased below 0, carry and borrow functions are automatically performed. If a button is pressed continuously, the value of the digit changes approximately three times a second.

**range** – A six-position rotary switch is used to select the range of the EVENT INTERVAL time that may be adjusted on the display. Each position permits a range of three orders of magnitude. This switch automatically moves the display's decimal point and switches the s/ms lamps.

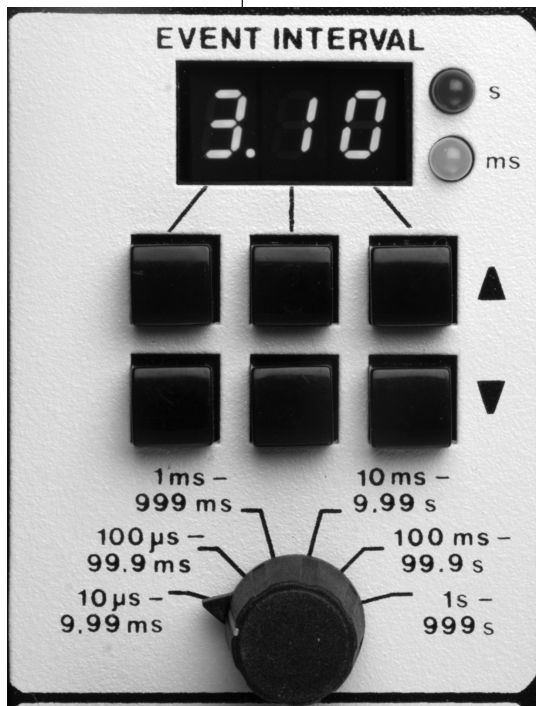


Fig. 1



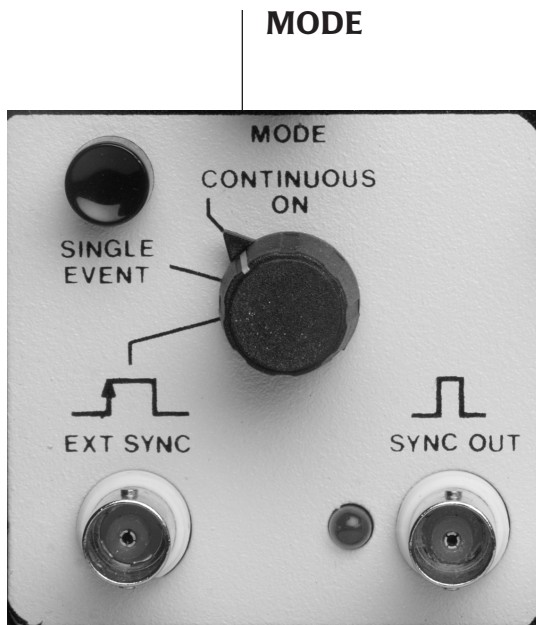


Fig. 2\

A three-position rotary switch is used to select the operating mode of the EVENT INTERVAL generator. The positions result in the following functions:

**EXT SYNC** – The leading edge of each positive going pulse received at the EXT SYNC connector generates one EVENT INTERVAL pulse that is distributed to the five PULSE TRAIN channels and is also regenerated at the SYNC OUT connector.

**SINGLE EVENT** – Each press of the SINGLE EVENT push button generates one EVENT INTERVAL pulse that is distributed to the five PULSE TRAIN channels and is also regenerated at the SYNC OUT connector.

**CONTINUOUS ON** – In this position of the switch, EVENT INTERVAL pulses are generated continuously at the interval set on the display. The pulses are distributed to the five PULSE TRAIN channels and are also regenerated at the SYNC OUT connector. The lamp adjacent to the SYNC OUT connector is pulsed synchronously with the SYNC OUT pulse.

**SINGLE EVENT** – This momentary push-button switch is used to provide a single EVENT INTERVAL each time the switch is pressed. The switch is only active when selected by the MODE switch.

**EXT SYNC** – This BNC connector is used to input an externally provided signal to replace the internal EVENT INTERVAL time base. The signal must be positive on the center pin, referenced to the shell. The connector is only active when selected by the MODE switch.

**SYNC OUT** – This BNC connector is used to provide a narrow pulse at the beginning of each EVENT INTERVAL. The signal on the center pin is positive relative to the connector shell. The SYNC OUT lamp briefly flashes each time an EVENT INTERVAL pulse is generated in the CONTINUOUS ON mode.





## PULSE TRAIN

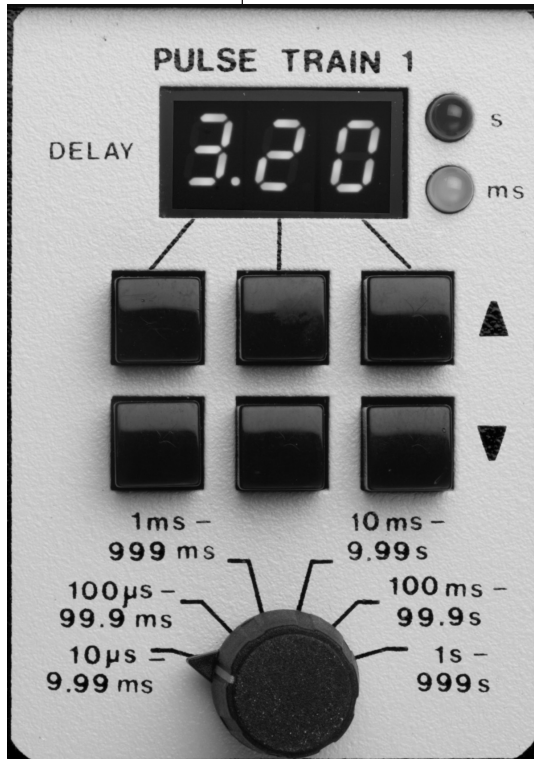


Fig. 3

There are five identical PULSE TRAIN channels in the A300. The following descriptions apply to all five.

**DELAY display** – A three-digit LED, with decimal points, indicates the DELAY time selected by the user.

**s/ms** – Two lamps are used to indicate the unit of measure (seconds or milliseconds) of the DELAY time selected by the user.

**push switches** – Six push button switches are used to change the value of the DELAY time. The pair of buttons under each digit control the value of the digit. The top button increases the value of the digit, the bottom button decreases the value. When a digit is increased above 9 or decreased below 0, carry and borrow functions are automatically performed. If a button is pressed continuously, the value of the digit changes approximately three times a second.

**DELAY range** – A six-position rotary switch is used to select the range of the DELAY time that may be adjusted on the display. Each position permits a range of three orders of magnitude. This switch automatically moves the display's decimal point and switches the s/ms lamps.

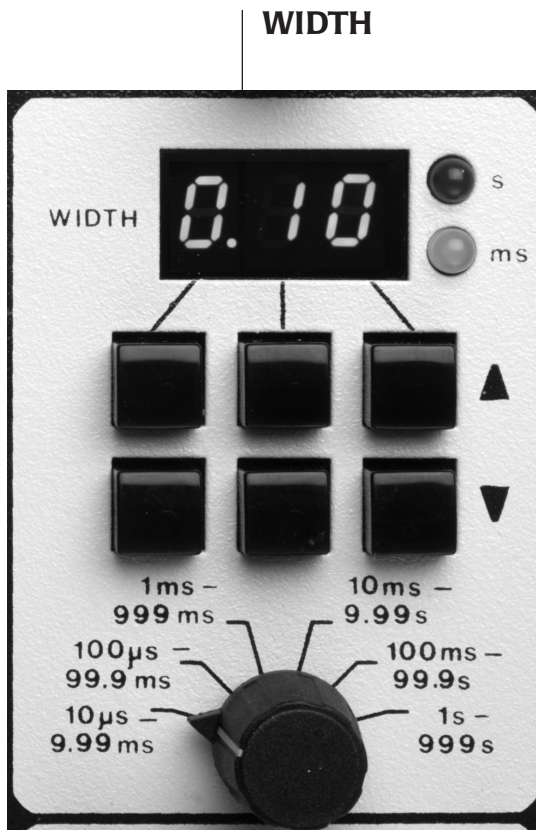


Fig. 4

**WIDTH display** – A three-digit LED, with decimal points, indicates the WIDTH time selected by the user.

**s/ms** – Two lamps are used to indicate the unit of measure (seconds or milliseconds) of the WIDTH time selected by the user.

**push switches** – Six push button switches are used to change the value of the WIDTH time. The pair of buttons under each digit control the value of the digit. The top button increases the value of the digit, the bottom button decreases the value. When a digit is increased above 9 or decreased below 0, carry and borrow functions are automatically performed. If a button is pressed continuously, the value of the digit changes approximately three times a second.

**WIDTH range** – A six-position rotary switch is used to select the range of the WIDTH time that may be adjusted on the display. Each position permits a range of three orders of magnitude. This switch automatically moves the display's decimal point and switches the s/ms lamps.



### INPUT SELECT

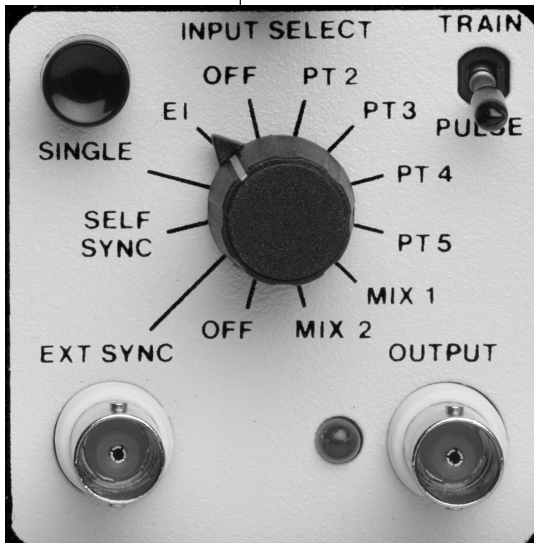


Fig. 5

This twelve-position switch is used to select the source of the signal used to start the DELAY time. The following choices are provided:

**OFF** – A stand-by mode that disables the OUTPUT but permits changes to the DELAY and WIDTH times.

**EXT SYNC** – The leading edge of each positive going pulse received at the EXT SYNC connector starts the DELAY time.

**SELF SYNC** – The channel is self-triggered; the falling edge of the pulse WIDTH starts the next DELAY time. Functions only in the TRAIN mode.

**SINGLE** – Each press of the SINGLE push button starts one DELAY time. Functions only in the PULSE mode.

**EI** – The channel's input is connected to the EVENT INTERVAL generator. A DELAY time is initiated every time an EVENT INTERVAL pulse is generated.

**PT** – The channel's input is connected to one of the other four PULSE TRAIN channels. The leading edge of the other channel's pulse WIDTH starts the DELAY time of this channel.

**MIX** – The channel's input is connected to one of the two MIXER channels. The leading edge of the MIXER channel's pulse output starts the DELAY time of this channel.

**SINGLE** – This momentary push-button switch is used to provide a single DELAY plus WIDTH sequence each time the switch is pressed. The switch is only active when selected by the INPUT SELECT and PULSE switches.

**TRAIN/PULSE** – This two-position is used to select either pulse or pulse train outputs from the channel. In the PULSE position, the leading edge of each trigger input generates one pair of DELAY and WIDTH times. In



the TRAIN position, the leading edge of the trigger input starts to generate DELAY and WIDTH times. The falling edge of the trigger input stops the OUTPUT after any currently started WIDTH has been completed. The switch is functional when the INPUT SELECT switch is in the EXT SYNC, SELF SYNC, PT or MIX positions.

**EXT SYNC** – This BNC connector is used to input an externally provided trigger signal for the DELAY time. The signal must be positive on the center pin, referenced to the shell. The connector is only active when selected by the INPUT SELECT switch.

**OUTPUT** – This BNC connector is used to provide the pulse(s) established by the times set on the channel. The signal on the center pin is positive relative to the connector shell. The OUTPUT lamp remains lit for the duration of each pulse WIDTH generated by the channel.

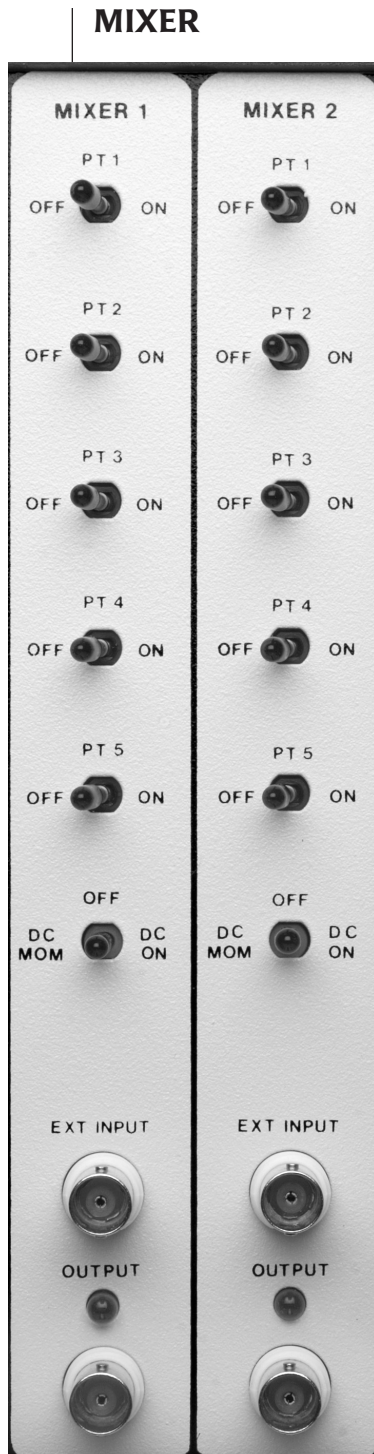


Fig. 6

There are two identical MIXER channels in the A300. The following descriptions apply to both. (See Figure 2.)

**PT OFF/ON** – Each of these five switches connects the OUTPUT of a PULSE TRAIN channel to the input of the MIXER channel. Any combination of these switches may be ON.

**DC MOM/OFF/DC ON** – This three-position switch controls the input of the MIXER channel. In the momentary DC MOM position, the channel OUTPUT is forced into a continuous pulse mode as long as the switch is held. In the OFF position the switch has no effect on the OUTPUT. In the DC ON position, the channel OUTPUT is forced into a continuous pulse mode.

**EXT INPUT** – This BNC connector is used to input external pulses to the MIXER channel. The signal must be positive on the center pin, referenced to the shell. The connector is always active.

**OUTPUT** – This BNC connector is used to provide the pulse(s) established by the combination of all the inputs to the channel. The signal on the center pin is positive relative to the connector shell. The OUTPUT lamp remains lit for the duration of each pulse WIDTH generated by the channel.





**VARIABLE**

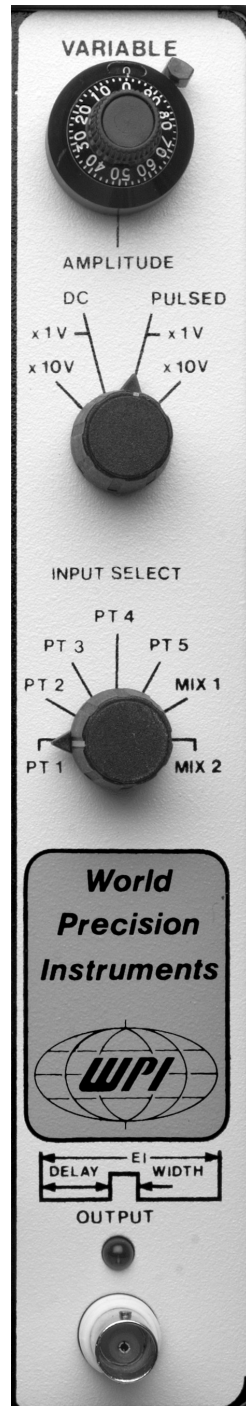


Fig. 7

**AMPLITUDE** – A ten-turn dial associated with a four-position rotary switch are used to control the amplitude of the OUTPUT signal of the VARIABLE channel. The number set on the dial is the actual value of the voltage, depending on the full scale value selected by the position of the AMPLITUDE switch. For example, 10.00 on the dial and DC x1V on the switch, represents a constant 1V output.

The DC positions represent a non-switching DC output even when the input is a pulsed signal. The PULSED positions provide switched outputs, synchronously with the selected input signal. A DC output with the least amount of “noise” is obtained by switching the EVENT INTERVAL out of CONTINUOUS ON and the PULSE TRAIN channels to OFF.

**INPUT SELECT** – This seven-position rotary switch is used to select the source of the input signal to the VARIABLE channel from among the PULSE TRAIN or MIXER channel outputs.

**OUTPUT** – This BNC connector is used to provide the regenerated input pulse, adjusted to the desired AMPLITUDE. The signal on the center pin is positive relative to the connector shell. The OUTPUT lamp remains lit for the duration of each pulse WIDTH generated by the channel.



**REAR PANEL**

Connector

A polarized, 3-conductor, cable, terminated with a NEMA 5-15P connector is used for line (mains) power input to the instrument. An alternate cordset may be supplied when local circumstances dictate different mains voltages and connections.

Fuseholder

Used for protective fuse in series with the high side (brown or black wire) of the mains. Holder accepts 1/4 by 1-1/4 inch (6.35 mm x 31.8 mm) fuses of the type indicated on the rear panel.





## Operating Directions

### Preliminary Test

Before the A300 Pulsemaster™ is initially placed in operation, it is recommended that the instrument is operated under simulated conditions. For this purpose, a procedure is provided in the Maintenance section of this manual that effectively tests the instrument and familiarizes the user with typical operations.

### The Displays

The most prominent feature of the A300 is the displays. These illuminated, three-digit, numeric displays are used to program the timing parameters of the instrument. Associated with each display are lamps and switches that are used to change and interpret the time.

To demonstrate the operation of a display, the EVENT INTERVAL will be adjusted to 12 ms. The other displays operate in exactly the same manner.

Set the rotary switch to one of the three ranges that encompasses 12 ms: 100  $\mu$ s-99.9 ms, 1 ms-999 ms or 10 ms-9.99 s. If there will be a need to closely trim this value, select the 100  $\mu$ s-99.9 ms range, which permits adjustments in 0.1 ms increments. The 1 ms-999 ms range permits changes up or down an order of magnitude. The 10 ms-9.99 s range skews the adjustments toward increasing the value. The accuracy of the time is the same in all three ranges. Note that as the ranges are switched, the decimal point is shifted and the s or ms lamp is selected to reflect the proper magnitude on the display.

There are two push switches associated with each digit of the display. The upper switch is used to increment the value of the digit, while the lower switch is used to decrement it. Once a switch is pressed, the value of the digit changes approximately three times a second. To speed-up the adjustment process, digits may be changed individually or simultaneously. The digits are interlocked when the change is through zero. For example, assume that the display is set for 8.7 and the "ones" digit is being incremented. The consecutive numbers that will be shown are 8.8, 8.9, 9.0, 9.1, etc. The number following 9.9 will be 10.0. However, if the "tens" digit is being incremented, the numbers following 8.7 will be 9.7, 10.7, 11.7, etc. Incrementing the "hundreds" digit will result in 8.7, 18.7, 28.7, etc. Decrementing numbers through zero operates the same way.



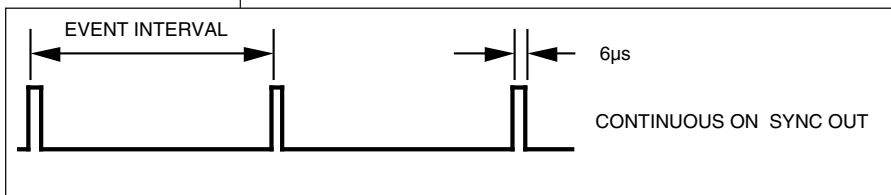
### The Event Interval

The EVENT INTERVAL is the heart beat of the A300. 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 of operations. The sync pulses are internally distributed to the five PULSE TRAIN channels and are also available externally through the SYNC OUT connector.

To operate the EVENT INTERVAL, first determine what type of timing cycles are required. The A300 has three modes of operations, that satisfy all possibilities.

In the CONTINUOUS ON mode, sync pulses are generated at intervals determined by the time shown on the display. See Figure 8. The display may be changed while the instrument is operating. If the up/down switches are used, the currently running interval will be automatically adjusted to the new value. For example, if 10 seconds have elapsed in the currently set interval of 45 seconds when the display is

Fig. 8



incremented to 52 seconds, the current interval will be extended to the 52 seconds. If the display is decremented to 17 seconds, the current interval would terminate in 7 additional seconds,

after which a new interval of 17 seconds would be started. This feature simulates a continuously adjustable timing control. Note that if the range switch is changed, the current interval is immediately terminated and the newly set interval is started. In the above example, if the range switch is changed from 100 ms-99.9 s to 1 s-999 s, the current interval would be stopped at 10 seconds and a new interval of 450 seconds would be started. Actuating the mode switch, also resets the EVENT INTERVAL time. Switching into the continuous mode immediately starts a new interval of the length shown on the display. Switching out of CONTINUOUS ON mode, stops the output of sync pulses.



In the SINGLE EVENT mode, sync pulses are generated at the discretion of the user. Every time the SINGLE EVENT button is pressed, one and only one sync pulse is

generated. See Figure 9. This mode is useful for testing the experimental set-up, as well as a convenient “off” switch to stop the outputs, without having to switch off the whole instrument.

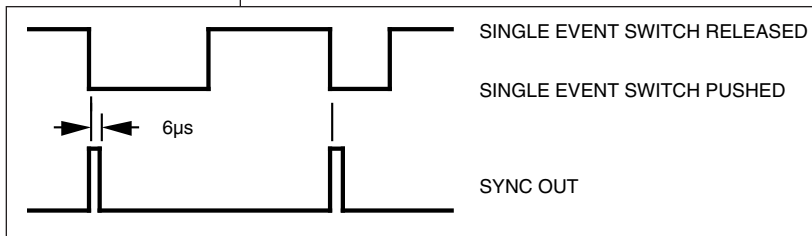


Fig. 9

The EXT SYNC mode permits the control of the A300 by other instruments and computers. The input signal level requirements are not only compatible with standard digital interfaces (TTL, CMOS, etc.), but also fully meet the voltage and impedance requirements of RS232C. For each positive going edge of a compatible input signal applied to the EXT SYNC connector, a regenerated sync pulse is distributed in the instrument. See Figure 10.

The timing of the external signal may be asynchronous to any other signal in the A300.

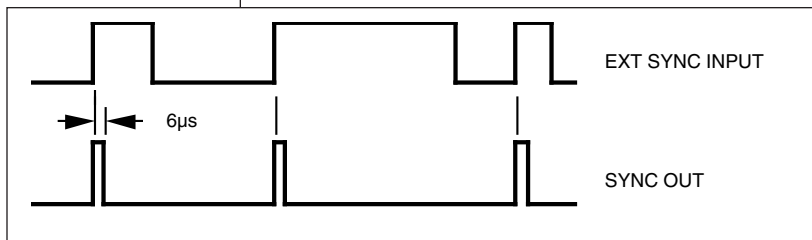


Fig. 10

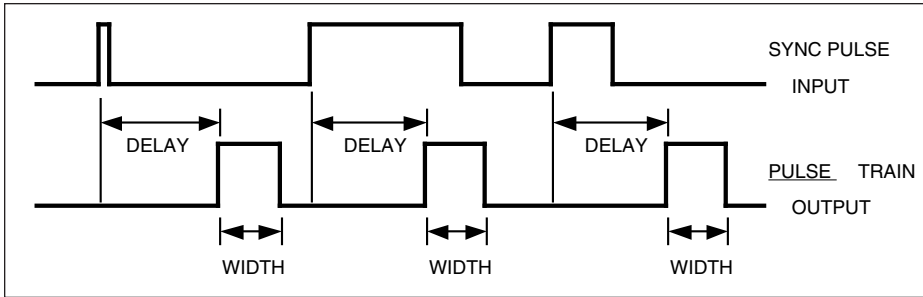
The SYNC OUT connector supplies a regenerated copy of the EVENT INTERVAL sync pulse. This output is useful for synchronizing the

operation of other instruments (recorders, oscilloscopes, computers, etc.) with the pulses generated from the A300. The lamp next to the connector is lit in the CONTINUOUS ON mode and is off in the SINGLE EVENT and EXT SYNC modes.

### The Pulse Train

There are five PULSE TRAIN channels in the A300. Each one is an independent instrument, except for the sharing of a common power supply. Operating instructions for one channel are the same for the other four channels. 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.

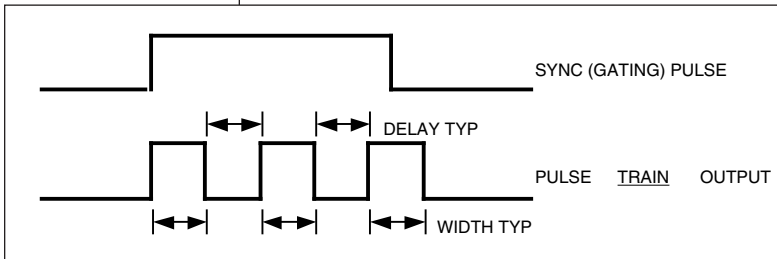
To operate the PULSE TRAIN channel, three questions must be answered. What are the timing parameters, DELAY and WIDTH, of the desired output waveform? Will the output be a pulse or a train? Which internal or external synchronization signal will control the beginning and the end of the output waveform?



The definition of the DELAY depends on the operating mode of the channel. In the PULSE mode, the DELAY is the time between the beginning of the sync pulse and the beginning of the pulse WIDTH.

Fig. 11

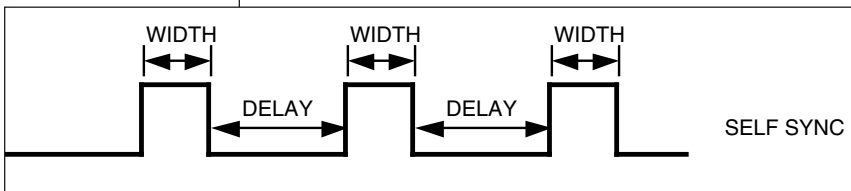
See Figure 11. In the TRAIN mode, the DELAY is the time between the end of the pulse WIDTH and the beginning of the next pulse WIDTH. See Figure 12. In the SELF SYNC mode, the DELAY is also the time between the end of the pulse WIDTH and the beginning of the next pulse WIDTH. See Figure 13. The DELAY time is set on the display as described above.



The WIDTH is always defined as the time between the beginning and the end of a pulse. See Figures 11 and 12. In the TRAIN mode, the WIDTH is the length of the individual pulse within the train. See Figure 12. The WIDTH time is set on the display as described above.

Fig. 12

Both the DELAY and the WIDTH may be changed while the instrument is operating. If the up/down switches are used, the currently running DELAY and/or WIDTH will be automatically adjusted to the new value. For example, if 2 seconds have elapsed in the currently set DELAY of 10 seconds when the display is incremented to 15 seconds, the current DELAY will be extended to the 15 seconds. If the display is



decremented to 8 seconds, the current DELAY would terminate in 6 additional seconds, after which a new DELAY of 8 seconds would be started. If the DELAY is changed during the WIDTH time, the next

Fig. 13

DELAY will last for the new time setting. If the WIDTH is changed during the DELAY



time, the next WIDTH will last for the new time setting. This feature simulates a continuously adjustable timing control. Note that if the range switch is changed, the current DELAY or WIDTH is immediately terminated and the currently set DELAY is started. Actuating the INPUT SELECT switch, results in the current DELAY and pulse to finish timing out according to the settings, after which the new input mode takes control of the channel.

The basic difference between pulse and train mode of operation is the number of pulses that may be generated per sync pulse.

In the PULSE mode, one and 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, followed by a pulse WIDTH are generated. See Figure 11. As long as the duration of the sync pulse is equal or greater than 1  $\mu$ s, it is of no consequence as to when it ends.

In the TRAIN mode, one or more pulses may be generated per sync pulse. As in the PULSE mode, the leading rising edge of the sync pulse is recognized. Immediately a pulse WIDTH is generated, followed by a DELAY. See Figure 12. If at the end of the last DELAY time, the sync pulse is still "high", a second pulse WIDTH is generated. Pulses are continuously produced as long as the sync pulse is still "high" at the conclusion of the DELAY time. The sync pulse is thus acting as a "gate" permitting a series of pulses while the gate is open. The sync pulse may end at any time, but once a pulse is started, it is always permitted to continue for the full WIDTH time. The TRAIN mode is meaningful for all INPUT SELECT positions except SINGLE and EI. The SINGLE input is specifically designed to produce only one DELAY/WIDTH sequence for each depression. The EVENT INTERVAL sync pulse is only 6  $\mu$ s long and the shortest pulse WIDTH is 10  $\mu$ s, thus it is impossible to have the sync pulse "high" for longer than one pulse.

The final choice is the source of the sync pulse that will control the channel. By means of the INPUT SELECT switch, sync pulses may 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.

The EXT SYNC position permits the control of the PULSE TRAIN channel by other instruments and computers. The input signal level requirements are not only compatible with standard digital interfaces (TTL, CMOS, etc.), but also fully meet



the voltage and impedance requirements of RS232C. For each positive going edge of a compatible input signal applied to the EXT SYNC connector, a DELAY/WIDTH sequence is generated in the PULSE mode. In the TRAIN mode, pulses are generated until the input goes “low.” The timing of the external signal may be asynchronous to any other signal in the A300.

In the SELF SYNC position, the channel becomes a free running pulse generator. The symmetry of the waveform may be adjusted by varying the DELAY and/or the WIDTH times. The frequency is equal to the reciprocal of the sum of the DELAY and the WIDTH. For example, a 10 ms DELAY and a 30 ms WIDTH provide a 25 Hz waveform. Note that the TRAIN/PULSE switch must be in the TRAIN position *before* switching into the SELF SYNC position, otherwise the output will not start. It is also possible to switch into the SELF SYNC position without starting the output, if the switch is still moving during the DELAY. This phenomena is more common in the high frequency range and is resolved by simply switching out and then back to the SELF SYNC position to start the output.

In the SELF SYNC mode, by definition, the falling edge of the WIDTH starts the beginning of the next DELAY. As a result, there are several operating modes that stop the SELF SYNC output. This is the result of temporarily setting either the DELAY or the WIDTH to zero, and thus, violating the operating requirements. The following actions will stop the output:

- Switching the range during operation.
- Stepping the DELAY or the WIDTH displays through zero or changing the display during the falling edge of the WIDTH.

In the SINGLE EVENT mode, pulses are generated at the discretion of the user. Every time the SINGLE button is pressed, one and only one DELAY/WIDTH sequence is generated. The TRAIN/PULSE switch must be in the PULSE position.

The 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 sequence is generated.

In the OFF position the input of the PULSE TRAIN channel is disabled and the OUTPUT is constantly off, i.e. no pulses.

The four PT positions 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 PULSE TRAIN channel, one DELAY/WIDTH sequence 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.”

The two MIX positions 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 sequence is generated from this channel. In the TRAIN mode, pulses are generated from this channel as long as the pulse from the MIXER channel remains “high.”

The 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 the operation of other instruments (recorders, oscilloscopes, computers, etc.) with the pulses generated from the A300. The lamp next to the connector is lit for the duration of each pulse. Note that with short OUTPUT pulses at infrequent intervals, the lamp appears to be off. With short intervals between pulses, the lamp appears to be on all the time.

### The Mixer

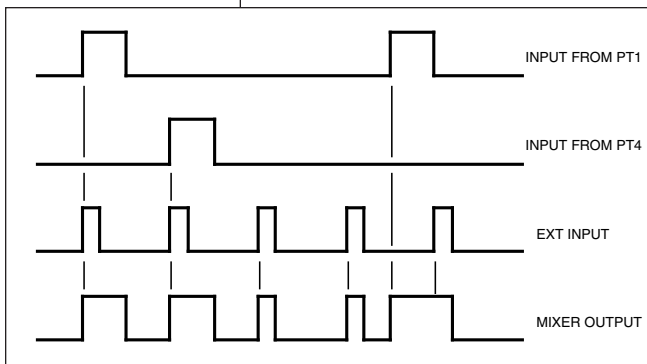
The MIXER does what its name implies, it combines the outputs of the PULSE TRAIN channels with external signals into one waveform. It can also provide a continuous “high” level signal. See Figure 14. Note that the combination occurs in the time domain not in amplitude.

To select from the choice of input signals, there is a PT switch for each of the five PULSE TRAIN channels. Setting the switch to ON, adds that particular channel’s signal to the OUTPUT of the MIXER. Signals applied to the EXT INPUT connector are also added to the OUTPUT. The DC MOM/OFF/DC ON switch can be used to superimpose

a continuous pulse over the other inputs. In the DC MOM position, the pulse is applied as long as the switch is displaced. In the DC ON position the pulse is applied continuously.

The OUTPUT connector supplies the combination waveforms generated by the MIXER channel. This OUTPUT is designed to drive WPI’s A300 series stimulus isolators. It is also useful for synchronizing the operation of other instruments

Fig. 14







(recorders, oscilloscopes, computers, etc.) with the pulses generated from the A300. The lamp above the connector is lit for the duration of each pulse. Note that with short OUTPUT pulses at infrequent intervals, the lamp appears to be off. With short intervals between pulses, the lamp appears to be on all the time.

### **Variable**

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.

To operate the channel in the PULSED mode, i.e. reproducing the waveform of another channel, set the AMPLITUDE switch into PULSED x1V or x10 V. Using the AMPLITUDE dial, the x1 V range allows OUTPUT voltage adjustments from zero to one volt. In the x1 V range, 10.0 on the dial represents 1 V at the OUTPUT. The x10 V position extends the range to ten volts. Switch the INPUT SELECT to one of the Pulse Train or MIXer positions to select the source of the waveform.

The DC mode of operation converts the VARIABLE channel into a constant voltage source. Select either the x1 V or the x10 V range for the desired OUTPUT amplitude and resolution. Adjust the AMPLITUDE dial to the desired OUTPUT voltage. To minimize any noise on the OUTPUT, switch any unused PULSE TRAIN channels OFF and the EVENT INTERVAL to SINGLE EVENT.

The OUTPUT connector supplies the amplitude modified waveform or the DC voltage level of the VARIABLE channel. The lamp above the connector is lit for the duration of each pulse and is continuously on in the DC mode. Note that with short OUTPUT pulses at infrequent intervals, the lamp appears to be off. With short intervals between pulses, the lamp appears to be on all the time.

### **Violation**

In the PULSE mode it is possible to adjust the pulse delay and pulse width so that their cumulative time exceeds the EVENT INTERVAL. This improper condition is termed a "VIOLATION." This condition can be avoided by carefully comparing the sum of delay + width indicators against the EVENT INTERVAL settings.

At long pulse duration settings a violation may result in latching of the output of the channel. In this case, change the time setting to a valid value and momentarily alter the delay or width range switch to unlatch the channel.



## MAINTENANCE

### Batteries

The A300 Pulsemaster™ is provided with batteries to preserve the timing parameters set by the user. Without the batteries, the information would be lost whenever instrument POWER is switched OFF. While mains POWER is ON the batteries are automatically recharged. If it becomes necessary to replace the batteries, use the following procedure:

**WARNING: BEFORE REMOVING THE COVER, DISCONNECT THE INSTRUMENT FROM THE AC POWER SOURCE.**

1. Remove the four screws (two on each side) on the side panels of the enclosure.
2. Remove the instrument panel by sliding it straight outward and rest it on its face.
3. Locate the batteries on the EVENT INTERVAL printed wiring board, the leftmost board connected to the panel board.
4. The three batteries are inside a sleeve and are snapped into the battery holder. Remove the batteries.

**CAUTION:** When replacing the batteries, observe their polarity. The battery holder is keyed and the board is marked to assist you. Inserting the batteries in reverse may permanently damage the instrument.

5. Replace all three batteries with the parts specified in the Introduction of this manual.
6. Reassemble the instrument by reversing the order of the above steps.

### Test

The A300 Pulsemaster™ can be readily tested to verify that its principal functions are operational. The following procedures require an oscilloscope to monitor time and amplitude. Other test instruments (chart recorder, voltmeter, frequency counter) may be substituted to accomplish the same results.

### General

Switch the instrument POWER to ON.

Note that all eleven LED displays are lit and that each display shows a three-digit



number. Under one of the displays press an up  $\Delta$  button and verify that the digit increments properly, approximately three times a second.

### Event Interval

Set the Range switch to each of its six positions and verify that the decimal point and the ms/s lamps are lit in accordance with the following table.

switch position	display	ms	s lamp
10 $\mu$ s–9.99 ms	X.XX	on	off
100 $\mu$ s–99.9 ms	XX.X	on	off
1 ms–999 ms	XXX	on	off
10 ms–9.99 s	X.XX	off	on
100 ms–99.9 s	XX.X	off	on
1 s–999 s	XXX	off	on

Set the EVENT INTERVAL time to 20  $\mu$ s and the MODE to CONTINUOUS ON.

Connect the oscilloscope to the SYNC OUT connector and observe a  $\approx 4.5$  V,  $\approx 6$   $\mu$ s wide pulse, repeated at 20  $\mu$ s intervals. The SYNC OUT lamp should be lit. Switch to the SINGLE EVENT MODE to stop the output. Press the SINGLE EVENT switch several times and observe one and only one sync pulse for each actuation. The lamp is inoperative in this mode and will not be lit.

Switch back to the CONTINUOUS ON MODE. Vary the EVENT INTERVAL time by changing the display and the range. The oscilloscope should confirm the time settings.

Set the six MIXER 1 switches to OFF. Connect the MIXER 1 OUTPUT to the EVENT INTERVAL EXT SYNC input. Switch the EVENT INTERVAL to the EXT SYNC MODE. Switch the MIXER 1 DC switch ON and OFF. For each actuation observe one or more sync pulses on the oscilloscope.



### **Pulse Train**

The following tests should be repeated for all five PULSE TRAIN channels.

Set the DELAY Range switch to each of its six positions and verify that the decimal point and the ms/s lamps are lit in accordance with the following table.

<b>switch position</b>	<b>display</b>	<b>ms</b>	<b>s lamp</b>
10 $\mu$ s–9.99 ms	X.XX	on	off
100 $\mu$ s–99.9 ms	XX.X	on	off
1 ms–999 ms	XXX	on	off
10 ms–9.99 s	X.XX	off	on
100 ms–99.9 s	XX.X	off	on
1 s–999 s	XXX	off	on

Set the WIDTH Range switch to each of its six positions and verify that the decimal point and the ms/s lamps are lit in accordance with the following table.

<b>switch position</b>	<b>display</b>	<b>ms</b>	<b>s lamp</b>
10 $\mu$ s–9.99 ms	X.XX	on	off
100 $\mu$ s–99.9 ms	XX.X	on	off
1 ms–999 ms	XXX	on	off
10 ms–9.99 s	X.XX	off	on
100 ms–99.9 s	XX.X	off	on
1 s–999 s	XXX	off	on

Set the DELAY time to 2 ms, the WIDTH to 3 ms, the TRAIN/PULSE switch to PULSE and the INPUT SELECT to EXT SYNC. Set the EVENT INTERVAL time to 10 ms and its MODE to CONTINUOUS ON. Connect the EVENT INTERVAL SYNC OUT to the PULSE TRAIN channel EXT SYNC input.

Connect the oscilloscope to the OUTPUT connector and observe a  $\approx 4.5$  V, 3 ms wide pulse, repeated at 10 ms intervals. The OUTPUT lamp should be lit. Switch INPUT SELECT counterclockwise to OFF and the OUTPUT should stop.



Switch the TRAIN/PULSE switch to TRAIN, the INPUT SELECT to SELF SYNC and observe a 3 ms wide pulse, repeated at 5 ms intervals. You may have to repeat this step to start the output.

Switch the INPUT SELECT to SINGLE to stop the OUTPUT. Switch the TRAIN/PULSE switch to PULSE, press the SINGLE switch several times and observe one and only one OUTPUT pulse for each actuation. The lamp will not be lit because of the infrequent and short duration of the pulses.

Switch the INPUT SELECT to EI and observe a 3 ms wide pulse, repeated at 10 ms intervals. Switch INPUT SELECT clockwise to OFF and the OUTPUT should stop.

Set the other four PULSE TRAIN channels' times to 6 ms DELAY, 14 ms WIDTH and their INPUT SELECTs to TRAIN and SINGLE. Switch the PULSE TRAIN channel under test to TRAIN and its INPUT SELECT to each of the PT positions. As each of the PT positions is selected, switch the matching channel's INPUT SELECT from SINGLE to SELF SYNC and observe the OUTPUT of the channel under test change from off to three 3 ms pulses with 5 ms periods repeated every 20 ms.

Set the six MIXER 1 switches to OFF. Switch the PULSE TRAIN channel under test to TRAIN and its INPUT SELECT to MIX 1. Switch the MIXER 1 DC switch to ON. Observe the OUTPUT of the channel under test change from off to 3 ms pulses, at 5 ms intervals.

Set the six MIXER 2 switches to OFF. Switch the PULSE TRAIN channel under test to TRAIN and its INPUT SELECT to MIX 2. Switch the MIXER 2 DC switch to ON. Observe the OUTPUT of the channel under test change from off to 3 ms pulses, at 5 ms intervals.



### Mixer

The following tests should be repeated for both MIXER channels.

Set the six MIXER switches to OFF. Set the EVENT INTERVAL time to 20 ms, the MODE to CONTINUOUS ON, and connect the SYNC OUT to the MIXER EXT INPUT. Observe a  $\approx 6 \mu\text{s}$  pulse from the MIXER OUTPUT. Disconnect the EXT INPUT.

Set all five PULSE TRAIN channels to the following timing:

channel	DELAY	WIDTH
PULSE TRAIN 1	1 ms	1 ms
PULSE TRAIN 2	3 ms	1 ms
PULSE TRAIN 3	5 ms	1 ms
PULSE TRAIN 4	7 ms	1 ms
PULSE TRAIN 5	9 ms	1 ms

Switch the PULSE TRAIN channels to PULSE and then to EI.

Monitor the MIXER OUTPUT on the oscilloscope. Switch PT1 to ON and observe a  $\approx 4.5 \text{ V}$ , 1 ms wide pulse repeated at 20 ms intervals. Switch PT2 to ON and a 1 ms pulse should appear 1 ms after the first. Switch PT3 to ON and a third 1 ms pulse should appear 1 ms after the second pulse. Switch PT4 to ON and a fourth 1 ms pulse should appear 1 ms after the third pulse. Switch PT5 to ON and a fifth 1 ms pulse should appear 1 ms after the fourth pulse. The overall interval should remain at 20 ms.

Switch to DC MOM and the OUTPUT should change to a continuous  $\approx 4.5 \text{ V}$  level as long as the switch is held. Switch to DC ON and again the OUTPUT should change to a continuous  $\approx 4.5 \text{ V}$  signal.

### Variable

Set the AMPLITUDE dial to 10.00 and the switch to DC x10V. Monitor the OUTPUT and verify that the OUTPUT is a steady 10VDC. Vary the dial and note that the OUTPUT accurately follows the value on the dial. Turn the dial back to 10.00 and switch to DC x1 V. The OUTPUT should now be 1 V DC.

Switch the AMPLITUDE to PULSED x1V and INPUT SELECT to PT1. Monitor the



OUTPUT connector and observe that the OUTPUT waveform matches the timing set on the PULSE TRAIN 1 channel. The amplitude of the waveform should match the amplitude set on the dial. Switch to PULSED x10V and repeat for the other six INPUT SELECT switch positions. The OUTPUT lamp will be lit for the duration of each OUTPUT pulse.

### **Battery**

This test should be performed after the A300 mains power has been on for at least an hour or if the batteries are known to have been recently fully charged.

Observe the values set on the displays. Power OFF the A300 for at least one minute, then switch ON. Verify that the values on the displays have not changed.

### **Cleaning**

**CAUTION:** Do not use alcohol, aromatic hydrocarbons or chlorinated solvents for cleaning. They may adversely react with plastic materials used to manufacture the instrument.

The exterior of this instrument may be cleaned periodically to remove dust, grease and other contamination. There is no need to clean the inside. Use a soft cloth dampened with a mild solution of detergent and water. Do not use abrasive cleaners.





## **SPECIFICATIONS**

### **EVENT INTERVAL CHANNEL**

<b>Operating Modes</b>	EXTernal SYNC, SINGLE EVENT, CONTINUOUS ON
<b>Input</b>	EXT SYNC accepts $\geq 1 \mu\text{s}$ pulses TTL, CMOS, RS232C compatible
<b>Timing</b>	EVENT INTERVAL 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
<b>Output</b>	SYNC OUT pulse of $\approx 6 \mu\text{s}$ , TTL & 5 V CMOS compatible, 4 mA sink and source

### **PULSE TRAIN CHANNEL (5 provided)**

<b>Operating Modes</b>	EXTernal SYNC, SELF SYNC, manual SINGLE event, sync from Event Interval, sync from one of the other four Pulse Train channels, sync from one of the MIXers, off, TRAIN/PULSE
<b>Input</b>	EXT SYNC accepts $\geq 1 \mu\text{s}$ pulses TTL, CMOS, S232C compatible
<b>Timing</b>	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
<b>Output</b>	OUTPUT PULSE/TRAIN of preset timing, TTL & 5 V CMOS compatible, 4 mA sink and source

### **MIXER CHANNEL (2 provided)**

<b>Inputs</b>	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
<b>Output</b>	OUTPUT, TTL & 5V CMOS compatible, 4 mA sink and source



### VARIABLE CHANNEL

<b>Inputs</b>	Output from one of the five PULSE TRAIN channels or one of the two MIXER channels or DC
<b>Output</b>	0 to +1 V low range, 1 mV resolution 0 to +10 V high range, 10 mV resolution 5 mA max sink and source
<b>Output Impedance</b>	<1 ohm
<b>Noise</b>	<500 $\mu$ V peak @ 100 kHz band width, PULSED mode <500 $\mu$ V, wide band, DC mode
<b>Signal Ground</b>	Floating, i.e. not connected to the chassis
<b>Power</b>	95-130 V AC or 190-260 V AC, switch selectable single phase, 50/60 Hz, 60 V A
<b>Batteries</b>	Three 1.2 V DC, size AA, nickel-cadmium, WPI 2109. CAUTION: Do not use other than the specified batteries. Replace all three at the same time. Two years minimum life expectancy with internal recharging circuit. After 24 hours of charging, the panel settings are retained for 30 days minimum, with the instrument power disconnected.
<b>Temperature</b>	10°C (50°F) to 40°C (104°F)
<b>Dimensions</b>	Height 222 mm (8.73 in.) Width 447 mm (17.6 in.) Depth 224 mm (8.8 in.) plus front/rear panel controls Mountable in standard ANSI/EIA RS-310C 19 in. rack
<b>Weight</b>	7.7kg (17lb), 9.5kg (21lb) shipping



### 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 10 days after receipt of shipment. Claims for lost shipments must be made within 30 days of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim settles. 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.
- WPI cannot be held responsible for items damaged in shipment en route to us. Please enclose merchandise in its original shipping container to avoid damage from handling. We recommend that you insure merchandise when shipping. The customer is responsible for paying shipping expenses including adequate insurance on all items returned.
- Do not return any goods to WPI without obtaining prior approval and instructions (RMA#) from our returns department. Goods returned unauthorized or by collect freight may be refused. The RMA# must be clearly displayed on the outside of the box, or the package will not be accepted. Please contact the RMA department for a request form.
- Goods returned for repair must be reasonably clean and free of hazardous materials.
- A handling fee is charged for goods returned for exchange or credit. This fee may add up to 25% of the sale price depending on the condition of the item. Goods ordered in error are also subject to the handling fee.
- Equipment which was built as a special order cannot be returned.
- Always refer to the RMA# when contacting WPI to obtain a status of your returned item.
- For any other issues regarding a claim or return, please contact the RMA department

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

**Warning: This equipment is not designed or intended for use on humans.**

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