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MONARCH INSTRUMENT

Instruction Manual



Phaser-Strobe

Portable Stroboscopes



Safeguards and Precautions



1. Read and follow all instructions in this manual carefully, and retain this manual for future reference.
2. Do not use this instrument in any manner inconsistent with these operating instructions or under any conditions that exceed the environmental specifications stated.
3. Use of this product may induce an epileptic seizure in persons prone to this type of attack.
4. Objects viewed with this product may appear to be stationary when in fact they are moving at high speeds. Always keep a safe distance from moving machinery and do not touch the target.
5. There are lethal voltages present inside this product. Refer to the section on Lamp Replacement before attempting to open this product.
6. Do not allow liquids or metallic objects to enter the ventilation holes on the stroboscope as this may cause permanent damage and void the warranty.
7. Do not allow cables extending from unit to come into contact with rotating machinery, as serious damage to the equipment, or severe personal injury or death may occur as a result.
8. Do not direct strobe flash toward certain data collectors, as it may temporarily interrupt data collector operation, and could result in loss of stored data.
9. This instrument may not be safe for use in certain hazardous environments, and serious personal injury or death could occur as a result of improper use. Please refer to your facility's safety program for proper precautions.
10. This product contains sealed lead acid batteries which must be disposed of in accordance with Federal, State, & Local Regulations. Do not incinerate. Batteries should be shipped to a reclamation facility for recovery of the metal and plastic components as the proper method of waste management. Contact distributor for appropriate product return procedures.
11. This instrument is not user serviceable. For technical assistance, contact the sales organization from which you purchased the product or Monarch Instrument directly.

LIMITED WARRANTY

SELLER warrants hardware products to be free from any defect in materials or workmanship for a period of one (1) year from date of shipment to BUYER. SELLER's entire liability and BUYER's sole and exclusive remedy resulting from any defect in workmanship or material in the hardware product covered by this limited warranty shall be limited to and fully discharged by the SELLER's option of replacement or repair of such item without charge. The limited warranty provided in this clause is in lieu of all other warranties, expressed or implied, arising by law or otherwise. ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED. This limited warranty shall not be modified except by an arrangement signed by both parties specifically referencing this clause.

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This limited warranty does not extend or apply to consumables (including, but not limited to, lamps and batteries, if applicable) or equipment, instruments or accessories which are warranted separately by the original manufacturer of these items.

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10.0 OPTIONS AND ACCESSORIES	
C-4040	Set of mating 1/8 inch (3.5mm) male phone plugs for external input / output
CA-4044-6	6 foot (1.8M) input / output cable, 1/8 inch (3.5mm) male phone plug to male BNC connector
CA-4045-6	6 foot (1.8M) input / output cable, 1/8 inch (3.5mm) male phone plug to 1/8 inch (3.5mm) male phone plug for daisy chaining strobes together
CC-7	Latching carrying case for Strobe with provision for accessories
PSC-3	AC Power Supply/Charger, 115 VAC - 50/60 Hz; Allows continuous operation from AC mains or charges batteries
PSC-4	Same as above except 230 Vac - 50/60 Hz
R-5	Standard recharger, 115 Vac - 50/60 Hz (14 hour)
R-6	Same as above except 230 Vac - 50/60 Hz
L-1903	Digital Stroboscope replacement lamp
SPC-1	Splash proof Protective Cover for battery model Stroboscopes
ROS-5P	Remote Optical Sensor with 8 foot (2.5 m) cable for triggering strobe
T-5	Reflective tape, 5 foot (1.5 m) roll, 0.5 inch wide
MT-190P	Magnetic Sensor/Amplifier with 8 foot (2.5 m) cable for triggering strobe
IRS-5P	Infrared Sensor for use without reflective target at 0.5 inch (12 mm) gap with 8 foot (2.5 m) cable for triggering strobe
RLS-5P	Remote Laser Sensor with 8 foot (2.5 m) cable for triggering strobe

9.0 SPECIFICATIONS

Adjustment Knob all ranges and models	Rotary knob with 32 detents per rev. Any value can be changed in decade steps (powers of 10) from 0.0001 per detent to 10,000 per detent (depends on mode selected).
Time Base	Ultra stable Crystal Oscillator Controlled
INTERNAL MODE	
Flash Range	30.0 - 32,500.0 FPM (Flashes per Minute) 0.5 - 541.67 FPS (Flashes per Second)
Update Rate	Instantaneous
Flash Rate Resolution and Accuracy (setting)	100.00 to 2999.95 FPM (Flashes per Minute) 3000.0 to 32500.0 FPS (Flashes per second)
EXTERNAL MODE	
Flash Range and Display	External flash rates to 0 are acceptable 0.0833 to 541.67 ±0.01% Accuracy - FPS 5.0000 to 9999.9 ±0.01% Accuracy - FPM 10,000 to 32,500 ±0.01% Accuracy - FPM 33,000 to 200,000 ±0.01% Accuracy - FPM 550.00 to 3,333.3 ±0.01% Accuracy - FPS
Display only (no flash)	
Update Rate	0.5 Seconds typical
Delay - Degrees * (and display)	0 to 359 ± 0.1 100 to 3499.9 FPM 0 to 355 ± 0.1 3500 to 9999.9 FPM 0 to 350 ± 0.1 10000 to 32000 FPM
Delay - Time *	0 to 8500 milliseconds ± 0.0001 seconds
Auto Step Mode	
-Step Size	0.0 - 180° -see note
-Step Rate	0.0001 to 8.5 seconds per step
Memory	Store three full settings in non-volatile memory. Last settings before power down remembered and restored on next power up.
Display	8-digit alphanumeric display shows information in English. Battery charge and low battery indication. Individual chevrons for mode display.
Light Power - Average	10W
Instantaneous (per flash)	150 mJoule Low Flash Rate
(auto change over)	50 mJoule High Flash Rate
Flash Duration	10 - 30 microseconds typical
Input Power	Internal Rechargeable Batteries. External 7VDC 18W
Weight	2.1/2 lbs (1.2 kg) including batteries
Options	Line Powered Supply / Charger Interface Cables, Remote Optical Sensor.
Output Pulse	500µsec 5VDC typical
Input Pulse	20µs min. TTL to 24VDC max
Sensor Power Supply	8VDC @ 50mA
Calibration	NIST traceable calibration certificate. (standard)
Note *	Minimum delay is 50µsec in all delay modes

1.0 INTRODUCTION

The Phaser-Strobe is an extremely sophisticated instrument with many features never before available in a stroboscope, yet remains simple to operate. Select only the features you need. Its internal microprocessor with "Direct Digital Synthesis" enables precise settings and measurement which are unique to the Phaser-Strobe, providing the widest flash range of any stroboscope.

The unit can store and recall three full, user programmed settings in non-volatile memory, as well as last used settings so that the unit "remembers" all the settings when the power is turned off.

The Auto Step mode enables the user to view high speed moving parts in slow motion, with both the rate and step size user programmable.

1.1 Direct Digital Synthesis

"Direct Digital Synthesis" is the method by which the Phaser-Strobe's internal microprocessor generates all the signals required to set internal flash rates, time delays and phase shifts. In analog stroboscopes, these values are adjusted using a single or multiple turn potentiometer (knob), which generally lack sensitivity and tend to drift with time. It is very difficult to set absolute values on analog stroboscopes. The Phaser-Strobe, however, synthesizes all signals digitally, in small, very precise steps, all derived from a stable crystal oscillator. In the internal flash mode, these steps are as small as 0.05 flashes per minute. Thus absolute values may be dialed in very easily and accurately. See section 3.1 Using the Knob for more details.

1.2 Display Panel

The display panel consists of a backlit display with six alphanumeric digits that indicate modes, flash rates, delays, etc. (see Figure 1). Below the six digits are five small chevrons (▼) which indicate the present mode of value displayed, and are described below:

- AUTO** Indicates Auto mode is active
- PHASE** Indicates Phase Delay is on the display
- TIME** Indicates Time Delay is on the display
- FPS** Flashes Per Second (hertz) is on the display
- FPM** Flashes Per Minute is on the display

Other icons in the display include the following:

- ⊙ On Target Indicator - Blinks at input frequency
- Indicates input frequency exceeds the limit of the stroboscope
- LO BAT** Flashes on display when the battery is getting low. It is on steady when the strobe must be recharged.

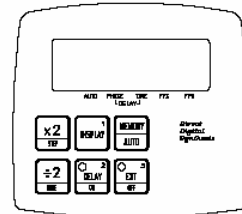


Figure 1 Display Panel

Below the display are six membrane buttons that control the operation of the Stroboscope. The operation of these buttons is explained within section 3.0 Operation. The red LEDs in the top left corner of the DELAY and EXT buttons and the chevrons above AUTO, PHASE and TIME indicate the operating mode.

2.0 PREPARATION FOR USE

The Strobe may be hand held or mounted on a tripod or other user supplied bracket using the 1/4-20 UNC bushing at the base of the handle.

2.1 Power

The Phaser-Strobe has internal rechargeable batteries and may also be powered by an optional external AC power supply. The unit should be charged before use (see section 8.3 Charging the Batteries), or can be run continuously from the AC mains with the optional power supply (PSC-3 or PSC-4, see section 8.4 External Power Supply/Charger). The Phaser-Strobe can operate continuously in excess of 60 minutes at 6000 flashes per minute from fully charged batteries. The strobe has a protection feature that prevents the strobe from operating if the battery voltage is low. This condition is indicated by no flash and the display starts blinking "LO BAT". At this time the batteries must be recharged. The actual operating time of the stroboscope depends on the flash rate and duty cycle of operation. Slower flash rates increase the operating time.

2.2 Input / Output Connections

The Phaser-Strobe has input and output jacks on the left side of the stroboscope (see Figure 2). These can be used for external triggering or synchronization (daisy chaining two or more strobes). These jacks accept 1/8" (3.5mm) phone plugs (input - stereo, output - mono). The jacks' outer connection (barrel) is common and the inner or center connection is the signal (see Figure 3). The input jack also has a middle connection which provides power to an input sensor. The input and output are TTL compatible. Refer to section 10.0 Options and Accessories for interface cables.

The optional ROS-SP (Remote Optical Sensor), MT-190P (Magnetic), IRS-5P (Infrared), or RLS-5P (Laser) sensors may also be used to trigger the unit.

NOTE: When using external sensors that are powered by the Phaser-Strobe, i.e. Remote Optical Sensor (ROS-SP), the sensor must be plugged in before the stroboscope is turned on, or the remote sensor may not be powered up.

The input jack (▲ pointing into socket) enables an external signal to trigger the strobe. In order to use the external signal you have to ensure that the strobe is in the External mode. Press the EXT button until the red LED in the top left of the EXT button comes on. The

range for triggering is from dc to 542 flashes per second (32,500 flashes per minute). There is typically a 5 μsec delay from trigger input to flash. The trigger source should provide a pulse with a minimum duration of 1 μsec.



Figure 2 Input/Output Jacks

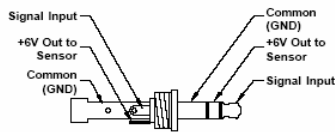


Figure 3 Input Connector Connection Detail

To power the strobe with the external power supply/charger (PSC-3 or PSC-4):

1. Plug the power supply/charger cable into the recharger socket (located below the display panel behind the handle).
2. Plug the power supply/charger into an AC mains wall outlet.
3. Move the switch on the power supply/charger to "RUN".

The stroboscope may operate in the "CHARGE" setting, but will in fact be drawing power from its internal batteries. An LED (light emitting diode) on the front of the power supply indicates the unit is on.

NOTE: If the batteries are depleted, they will need to be charged for about 10 minutes before trying to run the strobe from the power supply/charger.

WARNING: Do not leave the power supply/charger plugged into the Phaser-Strobe if there is no AC applied to the power supply/charger.

8.5 Battery Disposal

Prior to disposing of the Phaser-Strobe, the user must remove the sealed lead acid batteries. To do this, remove the lens, reflector and lamp as detailed in the Lamp Replacement section. This will expose 4 screws that must be removed so the reflector housing can be dismantled. There are four additional screws in the case half opposite the input and output jacks that must be removed. The case halves can now be separated, exposing the batteries. Remove the cables from the batteries and place tape over the battery terminals to prevent them from shorting. The batteries should be sent to a recycling center or returned to the factory. The rest of the parts may now be disposed of.

8.0 BATTERY AND POWER SUPPLY SPECIFICS

8.1 Displaying Battery Charge Percentage

To view the current battery charge percentage, press the DISPLAY button to cycle the display between FPM, FPS, PHASE, TIME, and the battery charge percentage. The battery charge percentage will display the current battery charge level from 0 to 100% for about 2 seconds and then automatically return to FPM. PHASE and TIME are skipped when not in an External Delay mode.

When the strobe is not flashing, the battery charge percentage represents the percentage of usable charge left in the batteries. When the strobe is flashing, the percentage value will be lower. The percentage value will generally decrease with increasing flash rates giving the user an indication of how much quicker the batteries will be discharged at the current flash rate.

8.2 Low Battery Indication

When the batteries are low, the display blinks "LO BAT" every half second. The strobe may still be used for a short time. When the battery charge is further depleted, the strobe will stop flashing, display "LO BAT" and then completely shut off. When "LOW BAT" is displayed, the unit needs to be recharged (section 8.3 Charging the Batteries) or powered by the power supply/charger (section 8.4 External Power Supply/Charger).

8.3 Charging the Batteries

The unit may be recharged at any time. You do not need to wait until the low battery condition is indicated.

CAUTION: Use of power supplies or rechargers other than the one supplied (R-5, R-6, PSC-3 or PSC-4) may damage the stroboscope and void the warranty.

To charge the battery with the standard recharger (R-5 or R-6):

1. Release the trigger so the strobe is off.
2. Plug the recharger cable into the recharger socket (located below the display panel behind the handle).
3. Plug the recharger into an AC mains wall outlet.

The recharger will fast charge the batteries for up to 5 hours (typically 3½ - 4 hours). Once the fast charge is completed, the recharger will trickle charge the batteries (as indicated by all the chevrons on the display coming on).

To charge the battery with the external power supply/charger (PSC-3 or PSC-4):

1. Release the trigger so the strobe is off.
2. Plug the power supply/charger cable into the recharger socket (located below the display panel behind the handle).
3. Plug the power supply/charger into an AC mains wall outlet.
4. Move the switch on the power supply/charger to "CHARGE". Charging takes approximately 16 hours.

WARNING: The unit may be left on to charge overnight, but the unit should not be left on charge indefinitely (more than 36 hours) as this will damage the lead acid batteries.

8.4 External Power Supply/Charger

The external power supply/charger (PSC-3 or PSC-4) can also be used to run the stroboscope continuously from the AC mains.

With no external input, the output jack (▼ pointing away from socket) provides a TTL compatible pulse from the strobe's internal oscillator. If an external input is applied, the output pulse mimics the input pulse delayed by whatever delay is active. This output pulse may be used to trigger a second stroboscope synchronously to illuminate larger areas. Many strobes can be "daisy chained". The output jack of the strobe is connected to the input jack of the next strobe causing all the strobes to flash together and be controlled by the first strobe in the chain.

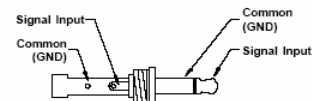


Figure 4 Output Connector Connection Detail

3.0 OPERATION

To turn on the stroboscope, depress and hold the trigger. The trigger may be locked in position using the side locking button. To lock the trigger on, hold the unit in the right hand, depress the trigger as far as it will go, and then use your thumb to press the locking button. You can release the trigger and the trigger will be held in place. To release the trigger lock, simply depress the trigger and then release.

When the strobe is powered up, it will operate in the last mode selected prior to turn off. The Phaser-Strobe is shipped from the factory in the Internal mode.

To display the software revision and then do a display test, press and hold the display button and then depress the trigger to turn on the strobe.

There are four operating modes for the Phaser-Strobe. These are Internal, External, External Phase Delay, and External Time Delay. All but the Internal mode require an external input signal.

In the Internal mode, the knob adjusts the flash rate from 30 to 32,500 Flashes Per Minute (FPM). In the External mode, an external signal pulse is used to trigger the flash and the knob has no effect. In the External Phase Delay mode, the flash is triggered 1 to 359 degrees after each external signal pulse. The knob sets the amount of delay in degrees. In the External Time Delay mode, the flash is triggered 0.0005 to 6.5 seconds after each external signal pulse. The knob sets the amount of delay in seconds.

3.1 Using the Knob

Although the knob on the Phaser-Strobe has an analog style, it is actually a digital encoder that is connected directly to the microprocessor. The knob has very definite steps or clicks (32 per revolution) allowing very definite adjustment, and it can be turned continuously. This is equivalent to having a 550-turn potentiometer in an analog unit. Of course you are not expected to turn the knob 550 times to get from the slowest flash rate to the fastest!

Each time the knob is turned, the blinking digit is either incremented (clockwise) or decremented (counter-clockwise). There is an automatic roll over to the next digit on the 0 to 9 or 9 to 0 change. It is possible to adjust from the lowest to highest values using a single digit adjustment. By selecting a different blinking digit, the user can select the step size to increment or decrement the flash rate (time delay or phase delay) of 0.05, 0.1, 0.5, 1, 10, 100, 1000 and 10,000 per 'click'. When adjusting the flash rate, choose an increment value that will quickly get you in the range you want to be, and then select smaller increments to fine tune the value.

NOTE: There are maximum and minimum values in each mode beyond which you cannot adjust. In the Internal Flash mode, the maximum flash rate is 32,500 FPM. If you are adjusting the rate in 1000 increments and you reach a value which on the next

increment would exceed the maximum, eg 32,000 to 33,000, the display will not increment. Select a lower digit to increment.

There are two ways/modes to select a new blinking digit:

Knob 1 mode:

Push and hold in the knob and turn to select a new digit. The next digit to blink is dependent upon the direction of the knob rotation.

Knob 2 mode (factory default):

Push and release the knob without turning it. The next digit to the right will be the blinking digit. If the right most digit is blinking when the knob is pressed, the blinking digit will wrap around to the left most digit. If the knob is turned when the knob is pressed in, the existing blinking digit will be incremented or decremented and a new blinking digit will not be selected.

To change between Knob 1 and Knob 2 modes, press and hold the **DISPLAY** and **x2** buttons together. The display will show Knob 1 or Knob 2 to indicate the new knob mode.

3.2 Internal Mode - Standard Strobe Operation

In the **Internal mode** the stroboscope generates it's own signals and functions like a regular stroboscope.

To put the strobe in **Internal mode**:

1. Press the **AUTO** button until the **AUTO** chevron in the display is off.
2. Press the **EXT** button until the **LED** in the top left of the **EXT** button is off.

In the **Internal mode** the flash rate can be adjusted using the black knob on the left of the unit (see section 3.1 Using the Knob). The current flash rate is shown on the display.

The flash rate can be doubled or halved instantly by pressing the **x2** or **+2** buttons respectively up to the maximum or minimum allowed.

The flash rate can be displayed (and adjusted) in Flashes per Minute or Flashes per Second (FPM or FPS). Press the **DISPLAY** button to cycle between FPM, FPS, and a display of the battery charge percentage that will automatically return to FPM after about 2 seconds. The chevrons on the display indicate which measurement is currently displayed. The unit automatically computes between FPM and FPMs so you can set the rate in FPM and then view it in FPS by pressing the **DISPLAY** button.

Since you can only delay in the External mode, pressing the **DELAY** button while in the Internal mode will cause the error message "EXT ->" to be displayed.

3.3 External Mode - External Input Required

In the **External mode** there are no adjustments the user can make. The flash rate is a function of the input signal. This mode is used to synchronize the flash to an external event (from an optical sensor, for example) to stop or freeze motion. The flash will be triggered on the falling edge of the external input pulse.

To put the strobe in **External mode**:

1. Press the **AUTO** button until the **AUTO** chevron in the display is off.
2. Press the **DELAY** button until the **LED** in the top left of the **DELAY** button is off.
3. Press the **EXT** button until the **LED** in the top left of the **EXT** button is on.

As in the Internal mode, the actual flash rate can be displayed in Flashes per Minute or Flashes per Second (FPM or FPS). Press the **DISPLAY** button to cycle between FPM, FPS, and a display of the battery charge percentage that will automatically return to FPM after about 2 seconds. The chevrons on the display indicate which measurement is currently displayed.

any more than is necessary to free the lens. The reflector is held in place by the front lens and will come loose, but is not necessary to remove the reflector.

2. Hold the lamp with a cloth between your forefinger and thumb and rock it back and forth gently while pulling out. Do not attempt to rotate the lamp. The lamp is socketed and will come out easily when pulled.

WARNING: Do NOT touch the new lamp with bare fingers.

3. The lamps are polarized and must be put into the socket matching polarity. Using a lint free cloth, match up the red dot on the plug with the red dot on the socket and gently rock the lamp back and forth while pushing it into place (see Figure 6). Make sure the lamp is in straight and centered in the reflector hole.

CAUTION: Do NOT allow the reflector to contact the lamp.

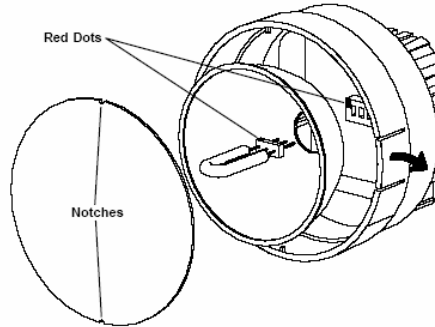


Figure 6 Lamp Replacement

4. Reinstall the reflector and then position the front lens in place matching up the notches on the lens with the two small tabs on the housing to prevent lens rotation (see Figure 6). Push the tabs on the front rim outward and press the lens into place.

7.2 Fuse Replacement

There is a 5 x 20 mm fuse inside the unit which may be accessed by removing the lens and reflector (refer to section 7.1 Lamp Replacement). Under normal operating conditions, the fuse should never blow. Examples of abnormal operating conditions would be foreign materials entering the strobe, such as water, ink, etc. If the fuse needs to be replaced, replace only with a fuse of the same type and value: Slow Blow - 3.15A fuse (part# 1062-3004-001).

For a two-point calculation the actual speed is given by:

$$\text{RPM} = \text{AB}/(\text{A}-\text{B})$$

For a three-point calculation:

$$\text{RPM} = 2XY(X+Y)/(X-Y)^2 \text{ where}$$
$$X = (\text{A}-\text{B}) \text{ and}$$
$$Y = (\text{B}-\text{C})$$

If a Remote Optical Sensor or Magnetic Sensor is used to sense one pulse per revolution (External mode), the readout will display directly in RPM (FPM) without any adjustment required.

In instances when you can shut down the device and install a piece of reflective tape, then an optical tachometer is easier to use for RPM measurement. Stroboscopes should only be used when you can't shut down the device. The human eye is not easily tricked into seeing a stopped image by a stroboscope when the flash rate is slower than 300 FPM. Therefore, stroboscopes should not be used below 300 FPM for inspection or to measure RPM.

6.0 LIMITATIONS OF REMOTE OPTICAL SENSORS (ROS-5P)

Remote Optical Sensors (ROS-5P) have a limitation when used with the Phaser-Strobe because they sense not only the reflective marker but the strobe flash as well. If the ROS is positioned near the strobe, the light from the strobe may cause the ROS to trigger the stroboscope at the wrong time, especially when using a delayed flash mode. The Phaser-Strobe has an "Input Blanking" feature to allow it to ignore this false trigger.

Even with the Input Blanking, large delays cannot be obtained using an ROS if the strobe's flash is triggering the ROS. The duration of the ROS pulse in response to the strobe's flash is about 0.5 milliseconds to 1.1 milliseconds depending on the flash rate. This limits the largest delay possible because the flash swamps the signal from the ROS, and consequently it will not provide the pulse from the reflective marker. If large delays are desired, reposition the ROS so it is away from the strobe's flash or use a magnetic sensor.

The Input Blanking feature itself limits the maximum delay, which is detrimental to non-optical sensors. It is possible to disable (or enable) the blanking in the Phaser-Strobe.

To toggle the Input Blanking on or off, press and hold the x2 button and then press the +2 button. The display will show "BLANK" when Input Blanking is on and "NO BLK" when it is off.

7.0 LAMP AND FUSE REPLACEMENT

7.1 Lamp Replacement

WARNING: Before attempting to remove the lamp, make sure the stroboscope is turned off and any mains cord is removed from the AC outlet. Allow the lamp to cool waiting at least 1 minute.

The stroboscope is designed to discharge the internal high voltages within 30 seconds. However, caution should be exercised when replacing the lamp.

The lamp can be replaced by using just a pocket screwdriver. It is not necessary to remove any screws to replace the lamp. A new spare lamp is supplied with each new Phaser-Strobe Kit.

To change the lamp:

1. Push apart the two tabs on the side of the reflector housing and remove the front lens using a small screwdriver to help pry one tab and lift the lens. Take care not to pry the tab

Pressing the x2 or +2 buttons has no effect on operation.

Pressing the DELAY button will put the unit into one of the two External Delay modes as explained in the next section.

3.4 External Delay Modes – External Input Required

There are two External Delay modes: Phase Delay and Time Delay. In order to activate these modes, the strobe must be in the External mode as indicated in the previous section.

To put the strobe in the Phase Delay mode or Time Delay mode:

1. Make sure the strobe is in External mode (see previous section).
2. Press the DELAY button. The display will show PHASE – TIME – OFF sequentially as the DELAY button is pressed. When the display shows PHASE the strobe is in the Phase Delay mode. When the display shows TIME the strobe is in the Time Delay mode. When the display shows OFF the unit is in the External mode as described in section 3.3. The LED in the top left of the DELAY button will be on when the strobe is in the Phase Delay mode or Time Delay mode.

The display is extremely versatile in the External Delay modes. The flash rate can be displayed in FPM or FPS, the Phase delay in degrees or the equivalent Time delay in seconds. The internal microprocessor automatically computes between Phase delay and Time delay. Press the DISPLAY button to cycle the display between FPM, FPS, PHASE, TIME, and a display of the battery charge percentage that will automatically return to FPM after about 2 seconds. The chevron below the display indicates which measurement is currently being displayed.

3.4.1 External Phase Delay Mode

In the External Phase Delay mode the user can delay the flash from 1 to 359 degrees after a trigger from the external input. This enables the user to vary the stopped motion image at any position (angle) without having to move the trigger source.

The user can vary the phase delay in increments as small as 0.1° using the black knob on the left of the strobe. Changing the Phase is done in the same manner as changing the flash rate (refer to section 3.1 Using the Knob.) There are some limitations to the Phase delay at higher flash rates (refer to section 9.0 Specifications).

The Phase delay can be doubled or halved instantly by pressing the x2 or -2 buttons respectively up to the maximum or minimum allowed.

3.4.2 External Phase Delay Mode – Auto Operation

There is a special mode of operation in the External Phase Delay mode called the Auto mode. In this special mode, the user can set a phase step and a rate of increment and have the Stroboscope automatically increase the phase delay at the set rate. This has the effect of causing the object being viewed to appear to rotate in steps, giving a slow motion effect to something that is rotating extremely fast. This effect is unique to the Phaser-Strobe and opens new possibilities in the inspection and maintenance fields.

The External Phase Delay Auto mode is used to automatically change phase delay in steps periodically to give a slow motion effect. A value stored in step determines the step size in degrees. A value stored in rate determines the length of time between steps. Once these values have been set, use the ON button to turn on the stepping. Using a small phase step (<1 degree) and a small step rate (about 0.0100 seconds), a good slow motion effect can be achieved.

To put the strobe in the External Phase Delay Auto mode:

1. Put the strobe in the External Phase Delay mode as explained in section 3.4.

2. Press the MEMORY/AUTO button until "AUTO" is displayed. (When in the Auto mode, the 'AUTO' chevron is displayed.)

When the "AUTO" chevron displayed, the secondary (white) button functions are active. These are STEP, RATE, ON, and OFF.

To adjust the step size, press the STEP button. The display will show "STEP" for a second and then show the current step size in degrees (phase delay). The blinking digit is the one affected by turning the knob. Adjust the step size using the knob in the same manner you would adjust the flash rate (see section 3.1 Using the Knob).

To adjust the rate in seconds, press the RATE button. The display will show "RATE" for a second and then show the current update rate in seconds. The blinking digit is the one affected by turning the knob. Adjust the step size using the knob in the same manner you would adjust the flash rate (see section 3.1 Using the Knob).

To begin the Auto Phase Delay, press the ON (DELAY) button.

To stop or freeze the motion at any time, press the OFF (EXT) button.

The MEMORY/AUTO button enables you to exit the Auto mode, store the current settings or recall previously stored settings (see section 4.0 Memory).

3.4.3 External Time Delay Mode

In the External Time Delay mode the user can delay the flash from 0.0005 to 6.5 seconds after a trigger from the external input. This enables the user to vary the stopped motion image at any point in the cycle without having to move the trigger source.

The user can vary the time delay in increments as small as 0.0001 seconds (0.1 milliseconds) using the black knob on the left of the strobe. Changing the delay time is done in the same manner as changing the flash rate (see section 3.1 Using the Knob).

The Time delay can be doubled or halved instantly by pressing the x2 or -2 buttons respectively up to the maximum or minimum allowed.

4.0 MEMORY - STORING AND RECALLING

The Phaser-Strobe can store and recall up to three complete settings. This is exclusive of a fourth setting that is stored each time the strobe is powered down, and automatically restored each time it is powered up. Settings can be stored for comparative purposes or for special testing purposes. Storing and recalling can be done in any of the four modes described in section 3.0 Operation.

4.1 Storing Settings

To store settings:

1. Repeatedly press the MEMORY/AUTO button until the display shows "STORE". The unit is now ready to store the settings in one of the three memory locations.
2. The numbers 1, 2 and 3 in the top right corner of the DISPLAY, DELAY and EXT buttons respectively refer to the memory locations available. Press the 1, 2 or 3 button to save the setup for later recall.

Saved settings can be recalled at any time, even if the unit is powered down and left for years.

4.2 Recalling Settings

To recall previously stored settings:

1. Repeatedly press the MEMORY/AUTO button until the display shows "RECALL". The unit is now ready to recall the settings from one of the three memory locations.
2. The numbers 1, 2 and 3 in the top right corner of the DISPLAY, DELAY and EXT buttons respectively refer to the memory locations available. Press either the 1, 2 or 3 button to recall and restore the previously stored settings.

NOTE: When recalling previously stored settings, the Stroboscope may be put into a different mode that requires external inputs. Look at the EXT and DELAY button LEDs and the AUTO chevron on the display to determine which mode the strobe is in. The strobe can be put back in the Internal mode at any time by pressing the EXT button and the LED in the top left of the EXT button will go out.

5.0 USING THE STROBOSCOPE TO MEASURE RPM

The primary use for a stroboscope is to stop motion for diagnostic inspection purposes. However, the stroboscope can also be used to measure speed. In order to do this several factors need to be considered. First, the object being measured should be visible for all 360° of rotation (e.g. the end of a shaft). Second, the object should have some unique part on it, like a bolt, keyway or imperfection to use as a reference point. If the object being viewed is perfectly symmetrical, then the user needs to mark the object with a piece of tape or paint in a single location to be used as a reference point.

If the rotational speed is within the range of the stroboscope, start at the highest flash rate and adjust the flash rate down. At some point you will stop the motion with only a single image of the object in view. At a flash rate twice the actual speed of the image you will see two images. As you approach the correct speed you may see three, four or more images; at harmonics of the actual speed. The first single image you see is the true speed. To confirm the true speed, note the reading and adjust the stroboscope to exactly half this reading, or just press the -2 button. You should again see a single image (which may be phase shifted with respect to the first image seen).

For example, when viewing a shaft with a single key way you will see one stationary image of the key way at the actual speed and at 1/2, 1/4, etc. of the actual speed. You will see 2 images of the key way at 2 times the actual speed, 3 key ways at 3 times, etc. The FPM equals the shaft's Revolutions Per Minute (RPM) at the highest flash rate that gives only one stationary image of the keyway.

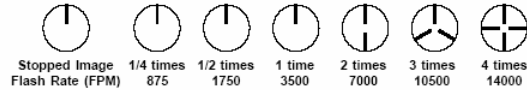


Figure 5 Object Rotating at 3500 RPM

If the rotational speed is outside the full-scale range of the stroboscope, it can be measured using the method of harmonics and multi-point calculation. Start at the highest flash rate and adjust the flash rate down. Be aware that you will encounter multiple images. Note the flash rate of the first single image you encounter, and call this speed "A". Continue decreasing the flash rate until you encounter a second single image, and call this speed "B". Continue decreasing the speed until you reach a third single image, and call this speed "C".