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POCKET-STROBE Portable, Digital Stroboscope
Models PK2X, PK2X-OT, PK2X-AC

ABQINDUSTRIAL
PRECISION. RELIABILITY. QUALITY.

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18.0 WARRANTY

The manufacturer warrants to the original purchaser that this product is of merchantable quality and confirms in kind and quality with the descriptions and specifications thereof. Product failure or malfunction arising out of any defect in workmanship or material in the product existing at the time of delivery thereof which manifests itself within one year from the sale of such product, shall be remedied by repair or replacement of such product, at the manufacturer's option, except where unauthorized repair, disassembly, tampering, abuse or misapplication has taken place, as determined by the manufacturer. All returns for warranty or non-warranty repairs and/or replacement must be authorized by the manufacturer, in advance, with all repacking and shipping expenses to the address below to be borne by the purchaser.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY AND FITNESS FOR ANY PARTICULAR PURPOSE OR APPLICATION. ELECTROMATIC SHALL NOT BE RESPONSIBLE NOR LIABLE FOR ANY CONSEQUENTIAL DAMAGE, OF ANY KIND OR NATURE, RESULTING FROM THE USE OF SUPPLIED EQUIPMENT, WHETHER SUCH DAMAGE OCCURS OR IS DISCOVERED BEFORE, UPON OR AFTER REPLACEMENT OR REPAIR, AND WHETHER OR NOT SUCH DAMAGE IS CAUSED BY MANUFACTURER'S OR SUPPLIER'S NEGLIGENCE WITHIN ONE YEAR FROM INVOICE DATE.

Some State jurisdictions or States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. The duration of any implied warranty, including, without limitation, fitness for any particular purpose and merchantability with respect to this product, is limited to the duration of the foregoing warranty. Some states do not allow limitations on how long an implied warranty lasts but, not withstanding, this warranty, in the absence of such limitations, shall extend for one year from the date of invoice.

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— Please Note —

The internal battery fully recharges in about two hours.
However, for best results, please charge the battery
for at least three hours prior to its first use.

1.0 INTRODUCTION

Congratulations on your purchase of a PK2X Series portable stroboscope.

You can use the Pocket-Strobe in a variety of industrial, laboratory, R&D and academic environments.

Most commonly, the Pocket-Strobe is used to make objects which are moving at high speeds appear to be moving in slow motion. When this occurs, you can then safely and easily analyze their motion, check for proper registration, determine sources of unwanted vibration, etc.

Also, you can use the Pocket-Strobe to apparently "freeze" an object's movement. Without making contact, you can accurately measure the object's rotational speed or reciprocation rate.

Unlike other portable stroboscopes, the Pocket-Strobe takes only one hand to operate—and because it is the world's smallest industrial stroboscope—it is very convenient and portable.

Typical applications include use with:

- High speed assembly lines, conveyor systems, bottling operations, etc.
- Printing presses and cloth looms
- Motors, fans, pumps and turbines
- Calibration and inspection equipment
- Monitoring laboratory & research applications

Models Available

- **PK2X**: operates from Internal Rechargeable Battery or AC-Power.
- **PK2X-OT**: same as above but includes optional external trigger output
- **PK2X-AC**: supplied without internal battery for use with AC-Power ONLY.

— Caution —

Although objects may appear to be moving slowly or frozen, NEVER touch any rotating or reciprocating element during testing.

17.0 SAFETY PRECAUTIONS

WARNING: Stroboscopes give the illusion of stopped motion. Do not touch the machine or object being observed.

The use of stroboscopes may induce an epileptic seizure in those persons predisposed to this type of attack.

Explosion hazard. Do not use this product in the presence of an explosive environment.

CAUTION: Do not use this product in wet or condensating environments.

Do not allow liquids or metallic objects to enter into the ventilation holes.

Wear adequate eye protection when using this product. Failure to do so could result in serious injury.

NOTICE: The Pocket-Strobe is designed for battery operation only. Do not operate the instrument while it is recharging. Failure to do so will damage the unit and void its warranty.

Recharge the battery using only the original battery charger supplied with the PK2X.

DANGER HIGH VOLTAGE!

To reduce risk of an electronic shock, do not open the Pocket-Strobe. To replace the flash tube, refer to the section entitled "Replacing the Flash Tube." There are no user-serviceable parts inside.

16.0 Specifications

Flash Range	30 – 12,500 FPM
Flash Brightness	1200 Lux (8"/20cm distance @ 4500 fpm)
Accuracy	± 0.01% over entire range +1 LSD ± 0.04 Hz
Resolution	± 1 FPM over entire range
Display	5-digit LCD
Display Update	0.5 seconds
Flash Energy	170 mJ
Flash Duration	< 9 µs
Flash Tube Life	200 million flashes (at 6,000 fpm)
Flash Color Temp	6,000K – 6500K
External Trigger	0-5 volt, DTL/TTL compatible 1/8" jack
Optional Trigger Signal Output *(PK2X-OT Only)*	0-5 volt, DTL/TTL compatible 1/8" jack
Operating Time	*Battery,* 2 hours *AC-Power*, continuous
Battery Type	Lithium Ion (Li-Ion)
Battery Charger	*AC Power Required*, 100-240 VAC, 50/60 Hz *DC-Output*, 9 VDC @ 2000 mA max *Charging Time,* 4-5 hours
Overcharge Protection	Yes
CE Certification	Yes
Weight	0.9 lbs (415 grams) including battery
Housing Material	High Impact ABS Plastic
Reflector Material	Aluminum
Tripod Mount	1/4-20, female insert
Operating Temp.	32 to 104° F (0 to 40° C)
Dimensions	9–3/4" x 2–3/4" x 1–3/4" *(240 x 65 x 40 mm)*
Warranty	1 year

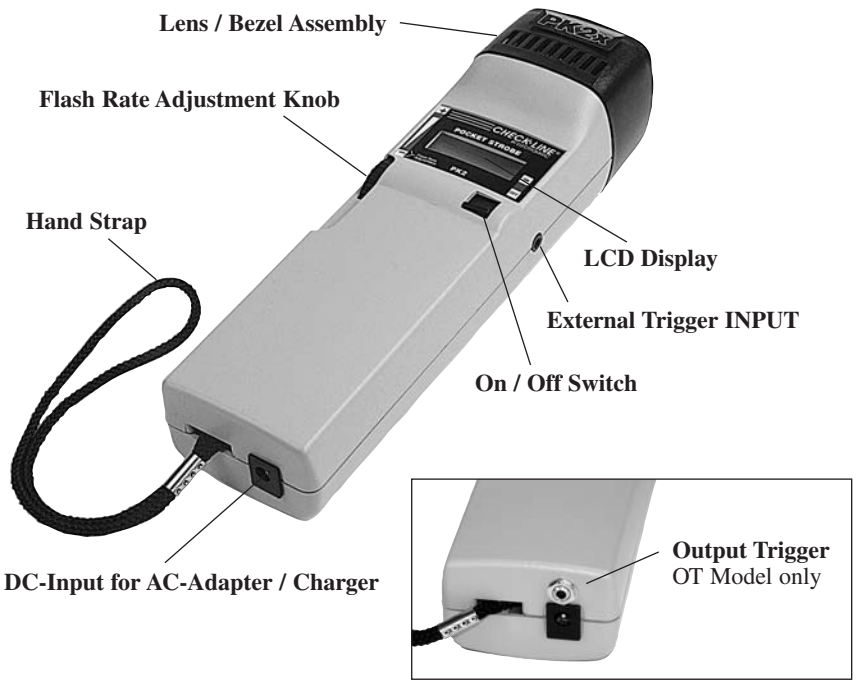
2.0 CONTENTS

Your Pocket-Strobe portable stroboscope comes with the following items:

- PK2X, PK2X-OT, PK2X-AC Stroboscope
- Universal AC-Adapter/Charger (100–240 VAC)
- External Triggering Jack
- Carrying Case
- Traceable Calibration Certificate
- Instruction Manual

3.0 OVERVIEW

3.1 Front Side



Lens/Bezel Assembly	Removed for flash tube replacement.
LCD Display	Shows flash rate, low battery indicator and error messages.
Flash Rate Adjustment Knob	Adjusts the flash rate. The speed with which the flash rate changes is controlled by how quickly the knob is rotated. *Quick rotation = flash rate changes in large increments.* *Slow rotation = flash rate changes in small increments.*
Hand Strap	Used as wrist trap (if desired).
External Trigger INPUT	Used for control of flash rate via external sensor or controller.
On/Off Switch	Turns on power and flashing.
DC-Input Jack for AC-Adapter/Charger	Used to recharge internal battery or operate via AC-Power.

15.0 OPTIONAL & REPLACEMENT ACCESSORIES

PK2X-TBE	Spare Xenon flash tube for PK2X (different tube then PK1 or PK2).
PK2X-BAT .	Replacement Lithium Battery Pack for PK2X. (Requires minor soldering for replacement.)
PK2X-AC-BC	Replacement Universal AC-Adapter/Charger for PK2X and PK2X-AC (100–240 VAC, worldwide use).
PK2-HLT	Padded-vinyl & leather belt-clip holster.
PK2-PHONO	Connection jack for external trigger input or optional trigger output signal
PK2-TRI	Tripod for PK2X.
PK2-BNC	External Trigger Cable, 6 feet in length, 1/8" to BNC male.
PK2-8M	External Trigger Cable, 6 feet in length, 1/8" male to 1/8" male.

Helpful Hints

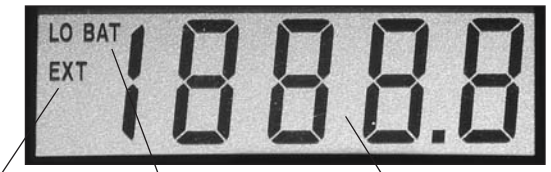
- The most commonly used formulas are indicated by an asterisk.
- The values for “X,” “Y” and “Z” are taken in descending order. For example, the value for “X” is greater than the value for “Y”
- The values are for successive singular harmonic images. Do not use multiple images.
- If two points are recorded, equation (1 Y gives only approximate results. Equations (2) with (4) and (3) with (5) are more precise, but error can be introduced due to the rounding.
- If three points are found, Equation (6) is the most commonly-used formula.
- For completeness, equations (9) through (21) offer mathematical derivations and condensed versions of Equation (6). Also included are the formulas for calculating S_x, S_y and S_z.

3.2 Back Side

Bezel Screw: Remove this screw to release the bezel as needed when replacing flash tube.

¼-20 Threaded Insert: Used when fix-mounting strobe on optional tripod, articulating arm or other mounting fixture,

3.3 LCD Display



Low Battery Indicator

Flash Rate # or Error Message

External Trigger Indicator: Used when external sensor is connected, controlling the flash rate via trigger input rate.

4.0 CHARGING THE BATTERY (BATTERY MODELS ONLY)

Charge the battery before first use or whenever the Low Battery Indicator is shown. The Low Batter Indicator can be flashing on/off or remain on, with the following explanation for each condition:

LO BAT continuously lit - Approximately 6 minutes of operating time remain

LO BAT flashing on/off - Operation will stop momentarily

Plug the Charger/AC-Adapter into and appropriate AC output, selecting and installing the appropriate plug adapter for the country of use (N. America, Europe, UK and Australia plug-in adapter provided). Refer to Charger Set-up below. Plug the other end of the charger (A) into the DC-Input receptacle located in the bottom of the handle on the strobe housing (refer to Section 3.1, page 4)

After insertion into the AC power outlet, the Red LED will turn on (upper left side of the charger housing) indicating that the AC-Adapter/Charger is powered and operating properly. The battery will now be in the process of recharging. A full recharge cycle will take about 4-5 hours. There is no specific indication when charging is completed, however you can not overcharge the battery.

NOTE: It is safe to operate the strobe while it is plugged into the charger.

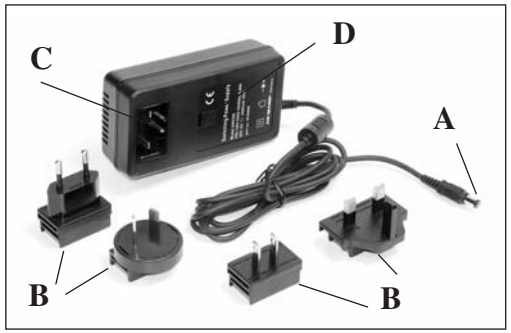
If the strobe is operated while being recharged, the complete charging cycle will be extended beyond the typical 4-5 hours, as most of the power is being used to operate the strobe and only a small portion is being used to recharge the battery.

4.1 Battery Charger (AC-Adapter) Set-up

When first using the battery charger, select the appropriate plug connector for use in the AC power outlet (several styles provided) and align the holes in the rear side of the plug connector “B” with the pins in the receptacle in the battery charger body “C” and push. When properly seated, you will hear a click and the plug connector will not move. The charger is now ready for use.

To Change the Plug Connector

To remove the connector from the battery charger, slide the switch on the battery charger “D” up and the connector will pop out. To insert a different plug connector follow the procedures described in Battery Charger Setup.



Step 2: As the flash rate was lowered, three singular harmonic images were found. (The first image at 9,600 RPM is rejected because it is a double image). Point "X" is 7,200, point "Y" is 4,800 and Point "Z" is 3,600.

Step 3: To calculate the true RPM, enter these values into one of the equations shown on the next page. For this example, we will use equation (6).

RPM = 2AB(A+B)/(A-B)2
= 2x2,400x1,200x(2,400+1,200)/ (2,400-1,200)2
= **14,400**

Where A = (X-Y)
= 7,200 - 4,800
= 2,400

And B = (Y-Z)
= 4,800 – 3,600
= 1,200

Therefore, the true speed of the object is 14,400 RPM. To help further illustrate this point, the figure below shows the harmonic relationship of the four images found in this example:

Harmonic	1/4	1/3	1/2	2/3	5/6	1/1
FPM/RPM	3,600	4,800	7,200	9,600	12,000	14,400

Depending on the accuracy desired, either two or three harmonic points can be found. These points are used in one of the following equations:

If TWO points, “X” and “Y” are recorded:

(1) *RPM = XY/(X-Y)
(2) *RPM =S_x(Sx+1)(X-Y)
(3) RPM =S (S -1)(X-Y)
(4) *S_x = Y/(X-Y), rounded
(5) S_y = X/(X-Y), rounded

If THREE points, “X,” “Y” and “Z” are recorded:

(6) *RPM = 2AB(A+B)/(A-B)^2
(7) *A= (X-Y)
(8) *B (Y-Z)

Variations of THREE point formulas:

(9) *RPM = 2PS/D2
(10) P = Product, (A*B)
(11) S = Sum, (A+B)
(12) D = Difference, (A-B)
(13) *S_x = 2(Y-Z)/(X+Z-2Y)
(14) Sy = (X-Z)/(X+Z-2Y)
(15) S_z = 2(X-Y)/(X+Z-2Y)
(16) *S_x = 2B/(A-B)
(17) S_y = (A+B)/(A-B)
(18) S_z = 2A/(A-B)
(19) S_x = 2B/D
(20) S_y = S/D
(21) S_z = 2A/D

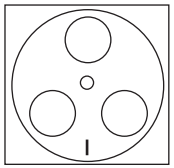
Formulas for calculating “Out of Range” RPMs.

Image No.:	1	2	3	4
				
Flash Rate:	**6,000**	**4,000**	**3,000**	**1,500**

The harmonic images at 6,000 and 4,000 RPM are not singular, but double and quadruple. A singular image does appear at 3,000 and again at 1,500 RPM. 1,500 is one half of 3,000. Therefore, the rate is 3,000 RPM.

Example 3: (Out of Range)

This final example shows how speeds faster than 12,000 RPM (the upper limit of the Pocket-Strobe) can be calculated.



This is the object which is rotating. Its speed is known only to be greater than 12,000 RPM. Because it has a uniform shape, an orientation mark is added.

To determine its speed, three steps are required:

1 . Starting from the maximum speed of the strobe, slowly reduce the flash rate. Look for singular frozen harmonic images.

2. Find at least two images. (For greater accuracy, find three). Label these rates as "X," "Y' (and possibly "Z").

3. Plug these values into a suitable equation (see page 19) and calculate the object's RPM.

Step 1: As the speed is reduced, the following images appear:

Image No:	1	2	3	4
				
Flash Rate:	**9,600**	**7,200 Point "X"**	**4,800 Point "Y"**	**3,600 Point "Z"**

5.0 OPERATING FROM AC-POWER (PK2X-AC MODEL ONLY)

Plug the AC-Adapter into and appropriate AC output, selecting and installing the appropriate plug adapter for the country of use (N. America, Europe, UK and Australia plug-in adapter provided). Refer to Charger Set-up (Section 4.1, page6). Plug the other end of the AC-Adapter into the DC-Input receptacle located in the bottom of the handle on the strobe housing (refer to Section 3.1, page 4)

After inserted into the AC power outlet, the Red LED will turn on (upper left side of the AC-Adapter housing) indicating that the AC-Adapter is powered and operating properly. It is now possible to turn on and operate the PK2X.

6.0 INFORMATION ON BATTERY MANAGEMENT

Several factors effect the battery life:

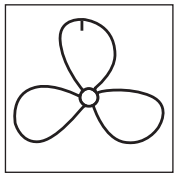
- The warmer the operating environment, the shorter the battery life; the cooler the environment, the longer the battery life.
- The more times the battery is completely drained, the shorter the battery life.

Helpful Hints:

To maximize the life of the battery:

- Shut the instrument off intermittently in order to allow the battery to recover.
- Allow the instrument to cool down if the outside temperature is hot.
- Keep the battery fully charged. Do not allow it to completely drain between charges.
- When storing the unit at room temperatures, charge/discharge it once every three months.

What is the actual rate of the fan? Images 1, 3, 5, 7, and 8 are all "frozen," so the rate could be taken as 3,300. 1,100, 825, 660 or 550. Which is correct?



In order to determine the fan's actual speed, a mark is added to one of the blades and the test is run again.

Image No.:	**1**	**2**	**3**	**4**
				
Flash Rate:	**3.300**	**1,650**	**1,100**	**916.6**

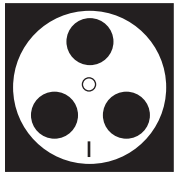
Image No.:	**5**	**6**	**7**	**8**
				
Flash Rate:	**825**	**733.3**	**660**	**550**

Using the orientation mark, it is now clear that the images appearing at 3,300, 825 and 660 RPM are multiple-image harmonics. In each of these cases, three identification marks appear. On the other hand, a singular image appears at 1,100 and again at 550.

Here, only one mark appears. Recall that "a singular image always appears at exactly one half of the object's true RPM." 550 is one half of 1, 100. Therefore, the rate of the fan must be 1,100 RPM.

Example 2: (Within Range No Mark Needed)

This example illustrates how the actual speed of an object can be determined without the use of an orientation mark—provided that the object has a suitable shape.



Assume that the speed of this cam is known only to be less than 7,000 RPM. Because it has a unique shape, it does not need an identifying mark. As the flash rate is lowered from 7,000, the following harmonic images (see page 18) appear.

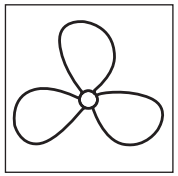
14.0 DETERMINING AN OBJECT'S TRUE RPM

The Pocket-Strobe can be used as a digital tachometer to determine the true RPM and/or the reciprocation rate of an object. This is done by visually "freezing" the object's movement and then reading the LCD display. As with all stroboscopes, it is important to verify that this frozen image is not a harmonic of the object's actual rate.

Helpful Hints

- Knowing the approximate rate of the object in advance gives you a useful starting point.
- If the object has a uniform shape, like a multi-blade fan or motor shaft, you must give it an identifying mark (using paint or reflective tape or equivalent) in order to differentiate its orientation.
- A singular image always appears at exactly one half of the object's true RPM.
- Mathematical harmonic techniques can be used to determine an object's true RPM if it is greater than 12,500 (the upper limit of the Pocket-Strobe).
See Example 3 on page 16.

Example 1 (Within Range):
This example shows why identifying marks are important.



Suppose you want to determine the true RPM of this fan. The only thing you know is that its speed is less than 3,500 RPM. If you slowly decrease the flash rate starting from 3,500 FPM, the following "frozen" images appear:

Image No.:	1	2	3	4
				
Flash Rate:	**3.300**	**1,650**	**1,100**	**916.6**

Image No.:	5	6	7	8
				
Flash Rate:	**825**	**733.3**	**660**	**550**

7.0 PK2X Operation

1. Be sure to charge the battery before first use (assuming you plan on operating using the internal battery). Otherwise, connect the strobe to the AC-Adapter/ Charger and plug it into an AC output to operate.
2. Aim the PK2X at the moving object and turn it on. There will be a delay of 1–2 seconds before the flash begins to operate. If the LOW BAT symbol in the display is illuminated, charge the battery.
3. Adjust the flash rate by rotating the Flash Adjustment Knob until the image appears motionless (as you approach the movement frequency, the image appears to move more slowly). This value will be shown in the LCD display.

IMPORTANT: Motionless images do not only appear when the movement frequency is reached, but also when multiples and fractions of the movement frequency are reached.

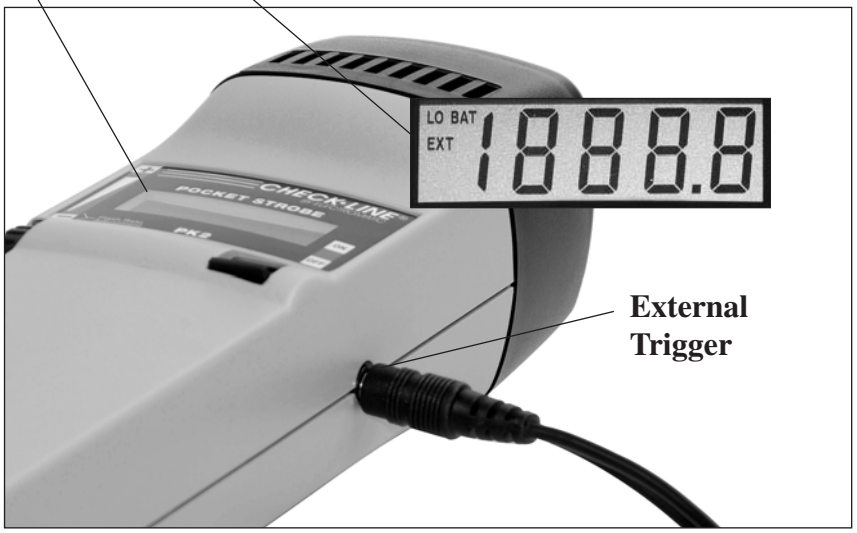
For additional information on visually slowing down the motion of an object as well as using your Pocket-Strobe as a tachometer, please refer to the appropriate section(s) later in this manual.

Helpful Hints:

- Dim the ambient lights for best results.
- The flash frequency for which the image of the object appears with the greatest contrast is the movement frequency.

8.0 EXTERNAL TRIGGERING

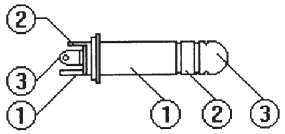
EXT illuminates when the External Trigger function is activated.



The Pocket-Strobe can be externally triggered.

The EXTERNAL TRIGGER jack (**F**) is DTL/ TTL compatible. It detects a square-wave signal of 0 to +5 volts which is at least 800 nsec in duration. The signal delay (the time it takes for the signal to cause the strobe to flash) is less than 5 µsec.

The EXTERNAL TRIGGER jack uses a standard 1/ 8" phono plug with the configuration shown below:



1. The outer connection (barrel) is common.
2. The middle connection provides a +5 V DC output to drive external sensors which are not self-powered.
3. The center connection is the input signal, which triggers the flash.

NOTES: Turn the Pocket-Strobe off when inserting or removing a trigger cable. Whenever an external trigger is used, the ON/OFF switch and the Flash Adjustment Knob are disabled.

WARNING: Do not trigger the device with signals over 208 Hz.

13.0 HARMONICS

If you continuously increase the flash rate while strobing an object, it may appear to freeze, slow down, speed up, go forward, freeze again, go backwards, form multiple images, etc. These images appear at mathematically determined multiples or harmonics of the object's actual speed.

Example: Assume you wish to slow the motion of the fan used in the last example, but you want it to be brighter.

Technique: Starting from 1,000 FPM, slowly increase the flash rate. At 1,500 FPM the image will appear to freeze again. Continue to increase the rate. The image will appear to freeze again at 3,000 FPM. At this rate, the fan appears to be very bright. You can now use the FINE ADJUSTMENT knob to vary the rate above and below'3,000 to make the fan appear to move both clockwise and counterclockwise.

Helpful Hint:

- Harmonic images appear at both whole number multiples as well as fractional intervals of the object's actual rate. For example, a fan rotating at 1,000 RPM will appear to be frozen at the whole number multiples of 2,000 (2x), 3,000 (3x), 4,000 (4x) etc., as well as at the fractional rates of 500 (1/2x), 750 (3/4x), 833 (5/6x) and 1,500 (1 1/2x), etc.
- Some of the harmonic images are "singular" in appearance while others are "multiple." This becomes important if you want to determine the objects actual rate as discussed in section 12.

12.0 SLOWING DOWN MOTION

As discussed, the primary use of the Pocket-Strobe is to slow down or "freeze" the apparent motion of moving objects. This allows you to analyze their run-time performances safely and easily.

To make an object appear to move in slow motion, you need to strobe it at a rate slightly above or slightly below its actual speed (or any harmonic of its speed as discussed below). Simply use the COARSE/FINE ADJUSTMENT knob until you achieve the desired apparent movement.

Helpful Hints:

The speed at which the object appears to move can be determined by subtracting the flash rate from the object's actual rate.

Example: If an object is rotating at 1,000 RPM and you strobe it at a rate of 1,005 flashes per minute (FPM), the object will appear to be moving at a rate of 5 RPM.

Speed = Actual Rate minus Flash Rate
= 1,000 –1,005 = 5
= **5 RPM**

The direction (clockwise vs. counterclockwise or forward vs. backward) at which the object appears to move is determined by the flash rate, the object's actual direction of movement and the orientation of the stroboscopic beam to the object.

Example: Assume you wish to visibly slow down the movement of a fan which is rotating clockwise at 1,000 RPM.

Case 1: If you stand in front of it and strobe it at a rate of 1,005 flashes per minute (FPM), the object will appear to be moving at a rate of 5 RPM in a counterclockwise direction.

Case 2: If you stand in front of it and strobe it at a rate of 995 FPM, it will appear to move at a rate of 5 RPM in a clockwise direction.

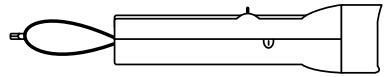
Case 3: If you stand behind it and strobe it at a rate of 1,005 FPM, it will appear to move in a clockwise direction at a rate of 5 RPM.

Case 4: If you stand behind it and strobe it at a rate of 995 FPM, it will appear to move in a counterclockwise direction at a rate of 5 RPM.

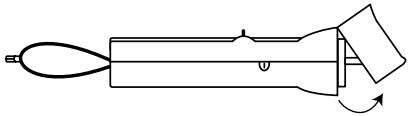
NOTE: Typically, stroboscopes are brightest (and can therefore illuminate an object the best) when the flash rate is between 2,000 and 6,000 FPM. Often, you can still make an object appear to be frozen or moving in slow motion within this range because of the effects of harmonics. This principle is explained section 13.

9.0 REPLACING THE FLASH TUBE

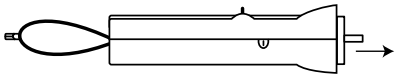
Step 1. Remove the front bezel screw located on the underside of the front bezel.



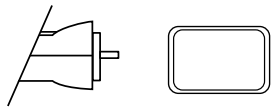
Step 2. Swing the bezel upwards and outward. Take care not to break the old flash tube. Ensure that the bezel hooks on the top edge are released. Remove the bezel.



Step 3. Firmly grasp the spent flash tube and pull it straight out.



Step 4. Using a lint and oil-free tissue, insert a new flash tube into the socket.

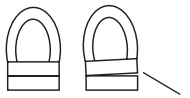


NOTE: Yellow colored edge of the connector should face up

Slide the front bezel over the new tube and rehinge it at the top. Rotate the bezel back towards the bottom of the case and reinsert the front bezel screw.

NOTE: As a safety precaution, the unit will not flash unless the bezel is in place. If the bezel is not secured properly, an emergency message "E1" will be shown in the display. Refer to page 12 for additional information.

WARNING:
Make sure that the flash tube is correctly installed in the socket. If it is crooked, the light output of the reflector is reduced.

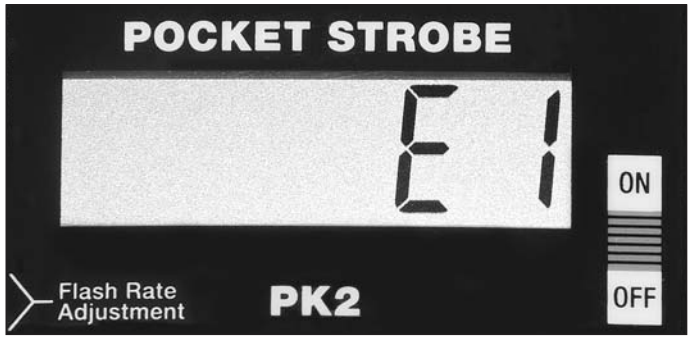


CAUTION :
Use only PK2X Flash Tube with the PK2X Pocket Strobe.

The PK1 or PK2 Flash Tube is not compatible with the PK2X instrument.

10.0 Error messages in the display

E1: Front bezel is not fastened correctly. If the E1message appears, the instrument must be switched off. Remove the front bezel screw, reseat the reflector and tighten the front bezel screw.



Front bezel screw is found on the underside of the PK2X

11.0 MAINTENANCE

Due to the high voltage contained within the Pocket-Strobe, the user should not attempt to service the device. If your Pocket-Strobe needs service or repair, including the replacement of its internal battery, please call one of our Technical Service Representatives.

Clean the external surfaces with a dry, lint free cloth only. DO NOT allow any liquids to enter into the instrument.