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User's Guide

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Contents

Precautions

CAUTION - USE OF THIS PRODUCT MAY INDUCE AN EPILEPTIC SEIZURE IN THOSE PRONE TO THIS TYPE OF ATTACK.

CAUTION - 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 AND DO NOT TOUCH THE TARGET.

CAUTION - THERE ARE LETHAL VOLTAGES PRESENT INSIDE THIS PRODUCT. REFER TO THE SECTION ON LAMP REPLACEMENT BEFORE ATTEMPTING TO OPEN THIS PRODUCT.

CAUTION - DO NOT ALLOW LIQUIDS OR METALLIC OBJECTS TO ENTER THE VENTILATION HOLES ON THE STROBOSCOPE AS THIS MAY CAUSE PERMANENT DAMAGE.

1.0 INTRODUCTION

All descriptions in this manual apply to both the battery powered strobe and AC mains powered strobe except where noted.

The strobe is a sophisticated instrument with many features, yet remains simple to operate. Use only the features required for your application. The strobe's internal microprocessor and digital encoder knob ensures precise settings and measurement. Each Strobe comes with a NIST Traceable Certificate of Calibration.

The strobe stores and recalls six user programmable flash rate settings and the last used settings in non-volatile memory so that the strobe "remembers" all the settings when the power is turned off.

1.1 Direct Digital Synthesis

"Direct Digital Synthesis" is the method by which the strobe's internal microprocessor generates all the signals required to set internal flash rates. In analog stroboscopes, these values are adjusted using a single or multiple turn potentiometer (knobs) and these generally lack sensitivity

ACCESSORIES

Model	Description
R-115	Charger 115 Vac 50/60 Hz (14 hour) for battery operated Nova-Strobes
R-230	Same as above except 230 Vac 50/60 Hz
HHT32-SPC	Splash proof Protective Cover for Battery Powered Strobe
L-1903	Digital Stroboscope replacement lamp.
HHT20-ROS	Remote Optical Sensor with 8 ft. cable for Stroboscopes
HHT-RT-5	Reflective tape.

6.0 SPECIFICATIONS

Internal Mode	
Flash Range Flash Range	30.0 - 14,000.0 FPM (Flashes per Minute) 0.5 - 233.33 FPS (Flahes per Second)
Flash Rate Resolution (Setting)	–0.1 FPM
Flash Rate Accuracy (Setting)	The greater of –0.5 FPM or –0.01% of reading
Update Rate	Instantaneous
External Mode	
Flash Range and Display	5.0 to 14,000.0 FPM 0.08 to 233.33 FPS External flash rates to 0 are acceptable
Update Rate	1 Second Typical
Tachometer Measurements	5.0 to 9999.9 FPM –0.1 FPM Resolution –0.2 FPM Accuracy 10,000 to 200,000 FPM –0.1 FPM Resolution –0.01% of reading Accuracy
Time Base	Ultra stable Crystal Oscillator
Light Power	
Average	(Battery Powered) 10W (AC Powered) 15W
Instantaneous (per flash)	220mJoule
Flash Duration	10 - 30 microseconds typical
Memory	6 preset user programmable Flash Rates. 100, 500, 1000, 3600, 7200, 14000 FPM Last settings befor power down remembered and restored on next power up.
Knob Adjusment - all ranges and modes	Rotary Switch with 36 detents per rev.
Display	6 digit alphanumeric backlit LCD display. Low Battery Indication (Battery powered only). Individual chevrons for mode display.
Input Power	(Battery powered) Internal Rechargable Batteries 6VDC. External AC fast charge. (AC powered) 115VAC or 230VAC
Input Pulse Trigger to Flash Delay	20 sec min positive pulse, TTL to 24VDC max < 5 sec
Output Pulse	100 sec positive pulse, 5VDC typical
Remote Sensor Power Supply	5VDC @50mA
Weight	(Battery powered) 2‰lbs (1.2 kg) including batteries (AC powered) 1‰lbs (0.68 kg)

and tend to drift with time. It is very difficult to set absolute values on analog stroboscopes.

The strobe synthesizes all signals digitally, in small, very precise steps. These signals are derived from a stable crystal oscillator. There is no user calibration or adjustment required to ensure an accurate reading. In the internal flash mode, these steps are as small as 0.1 flashes per minute. Thus absolute values may be dialed in very easily and accurately. The strobe's adjustment knob is actually a digital encoder that is connected directly to the microprocessor. This knob has 36 definite steps or clicks per revolution allowing very definite adjustment and can be turned continuously. This is equivalent to having a 100 turn potentiometer in an analog unit. Of course you are not expected to turn this knob that many times to get from the slowest flash rate to the fastest.

Turn the knob counter clockwise to increase the flash rate and clockwise to decrease it. The knob is velocity sensitive. Turn the knob slowly to have each "click" is equal to 0.1 FPM. Turning the knob more quickly will adjust the FPM by larger steps. When adjusting flash rate, quickly turn the knob (or use the **x2** or **÷2** buttons) to coarsely change the FPM. Then slowly turn the knob for fine adjustments. Turn slower still for very fine adjustments.

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 14,000 FPM. If you are adjusting the rate and you reach a value which on the next increment would exceed 14,000 FPM, the display will not increment. The same is true if you try to adjust the flash rate below 30 FPM.

In addition to the Knob, there are two buttons on the back panel marked **x2** and **÷2.** This enables the user to instantly double or halve the reading on the display to the maximum or minimum values allowed. This feature is useful for checking harmonics in the internal flashing mode. (Refer to section 4.0)

1.2 Preparation For Use

The strobe may be hand held or mounted on a tripod or other user supplied bracket using the ¼-20 UNC bushing at the base of the handle.

The AC powered must have its power cord plugged into an AC outlet (115VAC or 230VAC).

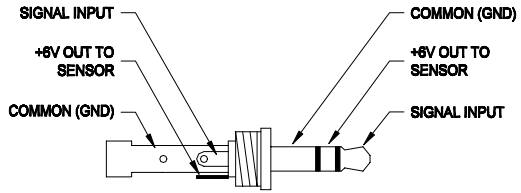
The battery powered strobe has internal rechargeable batteries. The unit should be charged before use. This model can operate continuously in excess of 60 minutes at 6000 flashes per minute from fully charged batteries. The strobe has a protection feature that prevents the strobe from operating if the battery voltage is low. This condition is indicated by no flash and the display shows “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.

To charge the battery powered strobe with the charger, the trigger must be OFF (released). Plug the charger cable into the socket located below the display panel, and behind the handle. Then plug the charger into the mains wall outlet. The unit may be left on charge overnight and it requires 14 hours to charge fully from a low battery condition. The unit starts with a fast charge that will restore 90% of the battery capacity in approximately 3 hours. Once the fast charge mode is completed, the unit will enter the float charge mode (indicated by all the chevrons on the display coming on) and the stroboscope can be used at this time. The unit may be recharged at any time. You do not need to wait until the low battery condition is indicated. **The strobe should not be left on the charger for more than 36 hours at a time.**

NOTE: USE OF RECHARGERS OTHER THAN THE ONE SUPPLIED MAY DAMAGE THE STROBOSCOPE AND VOID THE WARRANTY.

1.3 Input / Output Connections

The strobe has input and output jacks on the left side of the stroboscope. 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. The input jack also has a middle connection which provides power to an input sensor. The input and output are TTL compatible.



INPUT CONNECTOR - CONNECTION DETAIL

Figure 1

The input jack is the one with the arrowhead pointing toward it (▲ closest to the black knob) and enables an external signal to

5.4 Fuse

There is a 5 x 20mm fuse inside the unit. It may be accessed by removing the lens and reflector - refer to section 5.1. Replace only with a fuse of the same type and value. Under normal operating conditions, the fuse should never blow.

Battery Powered:
Slow Blow - 3.15A fuse

AC Powered:
Fast Blow - 750mA fuse

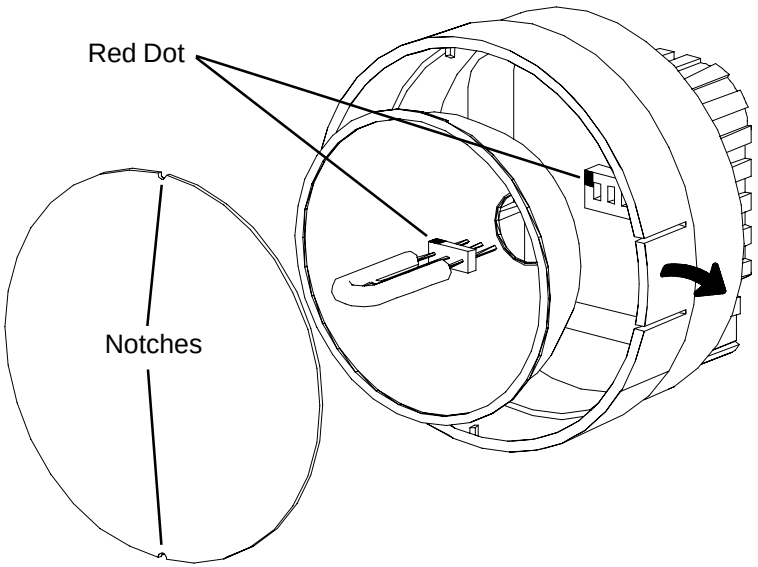


Figure 4

the lens notches onto the two small tabs to prevent lens rotation. Push the tabs on the front rim outward and press the lens into place.

5.2 Low Battery Indication (Battery Powered Model Only)

When the batteries are low, the display blinks “LO BAT” every 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. The unit needs to be recharged. Remember to release the trigger switch.

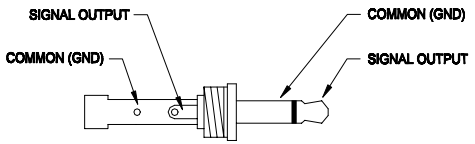
5.3 Battery Recharger (Battery Powered Model Only)

The unit should not be left on charge indefinitely as this will damage the lead acid batteries.

TO AVOID SERIOUS DAMAGE TO THE STROBOSCOPE, USE ONLY THE PROVIDED AND APPROVED RECHARGERS.

See Charger Mode Section 3.4 above.

trigger the strobe. Inserting a plug into the input jack will put the strobe into the External mode. The range for triggering is from 0 flashes per second to 233 flashes per second (14,000 flashes per minute). The display will only display down to 0.08 FPS (5 FPM). There is typically a 5 msec delay from trigger input to flash. The trigger source should provide a pulse with a minimum duration (width) of 20 µsec.



OUTPUT CONNECTOR - CONNECTION DETAIL

Figure 2

The output jack is the one with the arrowhead pointing away from it (➤ closest to the reflector). With no external input this output provides a TTL compatible pulse from the strobe’s internal oscillator. If an external input is applied, the output pulse mimics the input pulse. 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 one 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.

2.0 LCD PANEL DISPLAY SYMBOL DEFINITION

Ext	—	External Mode active.
Tach	—	Tachometer Mode active (strobe won’t flash).
Alt Function	—	Indicates second function of each button and knob will be used.
FPS	—	Flashes Per Second is on the display.
FPM	—	Flashes Per Minute is on the display.
⊙	—	Remote Sensor On Target Indicator.
- - - - -	—	Indicates input frequency exceeds the limit of the stroboscope.
LO BAT	—	**(Battery Powered Model Only)** Flashes on display when the battery is getting low. It is on steady when strobe must be recharged.

3.0 OPERATION

To turn on the stroboscope, depress the trigger. The trigger may be locked in position using the side locking button. To do this while holding the unit in the right hand, depress the trigger as far as it will go, and then using the thumb press the locking button. You may release the trigger and the trigger will be held in place. To release, simply depress the trigger and then release.

When the strobe is powered up, it will begin flashing immediately. It will remember the last internal flash rate and whether to display in FPM or FPS.

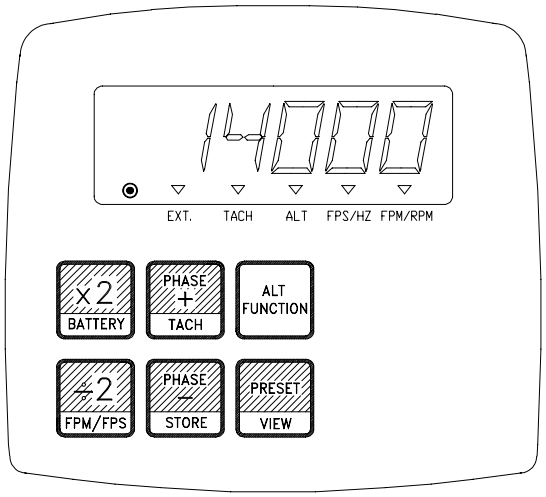


Figure 3

The back panel consists of a backlighted liquid crystal display with six alphanumeric digits which indicate modes, flash rates, etc. (Fig 3). Below the six digits are five small chevrons (⩔) which indicate the present mode or value currently indicated - Ext (External mode), Tach, Alt function, FPS (Flashes Per Second), and FPM (Flashes Per Minute). The External Chevron is on whenever the strobe is in the external mode. That is when it has an external signal plugged into the external input jack. The Tachometer chevron is on whenever the tachometer only (no flashing) mode is selected. The Alt Function chevron toggles whenever the Alt function button is pressed. When this chevron is on, the buttons will perform their alternate function listed in the white (lower) section of each button. The FPS chevron is on when the display is displaying Flashes Per Second or Hertz (Hz). FPS = FPM ÷ 60. The FPM chevron is on when the display is displaying Flashes Per Minute.

Below the display are six membrane buttons which control the operation of the Stroboscope.

There are three major operating modes for the Strobe. These are Internal, External and Charging (Battery powered model only). In the **Internal mode**, the knob adjusts the flash rate from 30 to 14,000 Flashes Per Minute (FPM). In the **External mode,** an external signal from a remote sensor is used to trigger the flash and the knob has no effect. The **Charging mode** (Battery powered model only) is when the strobe has the battery charger plugged into it. The strobe will continuously display the state of the battery charge while being recharged.

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 must 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 are just about impossible to use below 300 FPM for inspection or to measure RPM.

5.0 MISCELLANEOUS

5.1 Lamp Replacement

The replacement of the lamp can be accomplished by using only a pocket screwdriver.

THERE IS NO NEED TO REMOVE ANY SCREWS TO REPLACE THE LAMP.

BEFORE ATTEMPTING TO REMOVE THE LAMP MAKE SURE THE STROBOSCOPE IS TURNED OFF AND ANY MAINS CORD REMOVED FROM THE AC OUTLET. ALLOW THE LAMP TO COOL BUT WAIT AT LEAST 1 MINUTE BEFORE ATTEMPTING TO CHANGE THE LAMP.

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

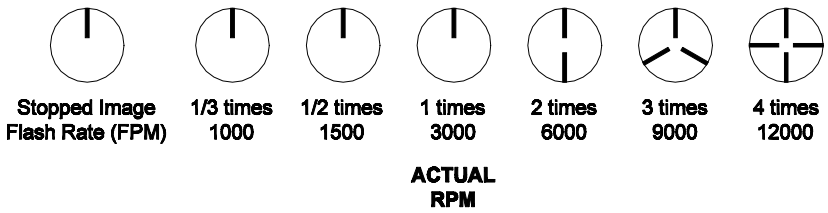
To change the lamp it is necessary only to remove the front lens. The lens is held in place by two tabs on the sides of the reflector housing. These must be pushed apart and the lens removed. A small screwdriver can be used to help pry one tab and lift the lens. Take care not to pry the tab any more than is necessary to free the lens. The reflector is held in place by the front lens and will come loose. It is not necessary however to remove the reflector. The lamp should be held with a cloth between forefinger and thumb and rocked gently while pulling out. Do not attempt to rotate the lamp. The lamp is socketed and will come out easily when pulled.

DO NOT TOUCH THE NEW LAMP WITH BARE FINGERS. The new lamp is fitted by locating the plug pins into the socket. The lamps are polarized. **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 while pushing it into place. Make sure the lamp is in straight and centered in the reflector hole. **Caution - Do <u>NOT</u> allow the reflector to contact the lamp.** Reinstall the reflector and then position the front lens in place. Position

If the speed of rotation 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. Note that 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 1/2,1/3,1/4, etc, of the actual speed. You will see 2 images of the key way at 2 times the actual speed, 3 key way at 3 times, etc. The FPM equals the shafts Revolutions Per Minute (RPM) at the highest flash rate that gives only one stationary image of the key way.

Example: object rotating at 3000 RPM



If the speed is outside the full scale range of the stroboscope (14,000 FPM), it can be measured using the method of harmonics and multipoint calculation. Start at the highest flash rate and adjust the flash rate down. You will encounter multiple images so be aware of these. Note the flash rate of the first SINGLE image you encounter, call this speed “A”. Continue decreasing the flash rate until you encounter a second SINGLE image. Note this speed as “B”. Continue decreasing the speed until you reach a third SINGLE image at speed “C”. For a two point calculation the actual speed is given by

$$RPM = AB/(A-B)$$

For a three point calculation

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

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.

3.1 Internal Mode - Standard Strobe Operation

In the INTERNAL Mode the stroboscope generates it’s own signals and functions like a tunable stroboscope. The strobe is in the internal mode when nothing is plugged into the input jack.

The flash rate can be adjusted using the black knob on the left of the unit. The current flash rate is displayed. Turn the knob counter clockwise to increase the flash rate and clockwise to decrease it. If an attempt to change a value would cause the flash rate to exceed the minimum or maximum, the value remains unchanged. Refer to section 1.1 above for more detail on changing flash rates.

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

Once the flash rate has been adjusted to give a stopped motion image, the **Phase +** and **Phase -** buttons may be used to increase or decrease the phase of the image. Press and hold the **Phase +** button to have the image appear to slowing rotate in the direction the object is actually rotating. Press and hold the **Phase -** button to rotate the image in the opposite direction the object is actually rotating. Use the phase buttons to bring a reference mark , such as a key way, into your line of sight. The **Store** button stores the current flash rate into the last preset location viewed.

The **Preset** button will cycle through six different preset flash rates. These rates are set at the factory to be: 100, 500, 1000, 3600, 7200 and 14000 FPM. Each time this button is pressed, the flash rate and display is changed to the next preset. The presets can be changed by the user using the **Store** button. The **Store** button stores the current flash rate into the last preset location the user has viewed.

See section 3.3 for more features.

3.2 External Mode - External Input Required

The strobe is in the external mode whenever there is a plug in the input jack. The External chevron comes on automatically to indicate this mode.

In the EXTERNAL mode there are no flash rate 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 (for example, from an optical sensor) to stop or freeze motion. The flash will be triggered on the rising edge of the external input pulse. The Alt Function mode and chevron is automatically set in this mode, since the primary function of the buttons have no use in this mode.

3.3 Common Features for Both Internal and External Modes

The **Alt Function** button toggles the Alt Function chevron. When the Alt Function chevron is on, the buttons will perform their secondary function listed in the white section of each button. It also changes how the tuning knob works.

Below are all the Alternate functions of each button:

The **Battery** button (Battery powered model only) will display the current battery charge level from 0 to 100% for about 2 seconds. When the strobe is not flashing, this number represents the percentage of usable charge left in the batteries. When the strobe is flashing, this number will be lower. It will decrease with increasing flash rates. This will give the user, an indication of how much quicker the batteries will be discharged at a given flash rate.

The **FPM/FPS** button toggles the display between Flashes Per Minute(FPM) and Flashes Per Second (FPS). The FPM and FPS chevrons on the display indicate which way the flash rate is being displayed.

Note that the unit automatically converts between FPM and FPS so you can set the rate in FPM then view it in FPS by simply pressing the **FPM/FPS** button.

The **Tach** button toggles the Tach chevron on the display. When the chevron is on, the strobe is inhibited from flashing. In the external mode, the strobe can be used as a tachometer without having the strobe flash. In the internal mode, the strobe can be used as a frequency generator (outputting TTL pulses) without having the strobe flash.

The **Store** button stores the current flash rate into the last preset location the user has viewed.

The **View** button displays the next flash rate preset (one of six). It does **not** change the flash rate. This allows the user to select which preset to write over before storing the current flash rate by pressing the **Store** button.

When the Alt Function chevron is turned on, the current flash rate is used as an adder. Now as long as the Alt Function chevron remains on, the knob will add (counter clockwise) or subtract (clockwise) that initial flash rate for each “click” the knob is turned. This in effect allows the user to multiply the initial flash rate by 2, 3, 4, 5, etc up to the maximum flash rate. This is very helpful on fan blades. Using this feature, one can superimpose the blades on top of each other and check for blade tracking, bent blades, lead and lag tests, etc.

For example: A 3 bladed fan is spinning at 3600 RPM. The strobe is flashing at 3600 FPM. Press the Alt button to turn on the Alt chevron. Now turn the knob clockwise 2 clicks. The strobe is now flashing at 10,800 FPM (effectively 3600 times 3) The fans blades are all superimposed on each other. One can now see if the blades are out of alignment, bent, etc by viewing the blades from the front or viewing from the edge of the blades.

3.4 Charger Mode (Battery Powered Model Only)

When the charger plug is inserted into the charger jack, the strobe will go into the charger mode. Make sure the trigger switch is not depressed. The strobe will not do anything else when charging. (e.g. it will not flash and the buttons have no function)

When the charger plug is inserted the strobe will display the current battery charge percent and fast charge the batteries for up to 3 hours or until the batteries are mostly charged. It will then turn on all the chevrons to indicate it is now trickle charging the batteries. It should be allowed to trickle charge the batteries for a total of 14 hours for peak performance.

3.5 Power Up Features

First press and hold the one of the buttons listed below, then turn on the strobe using the trigger switch:

The **Store** button will restore the factory programmed presets. These are: 100, 500, 1000, 3600, 7200 and 14000 FPM

The **Alt Function** button will turn on all the display segments for two seconds. It will then show the software revision, “REV x.x”.

4.0 USING THE STROBOSCOPE TO MEASURE RPM

The primary use for a stroboscope is to stop motion for diagnostic inspection purposes. However the stroboscope can 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, key way 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 only, to be used as a reference point. Look only at the reference point.