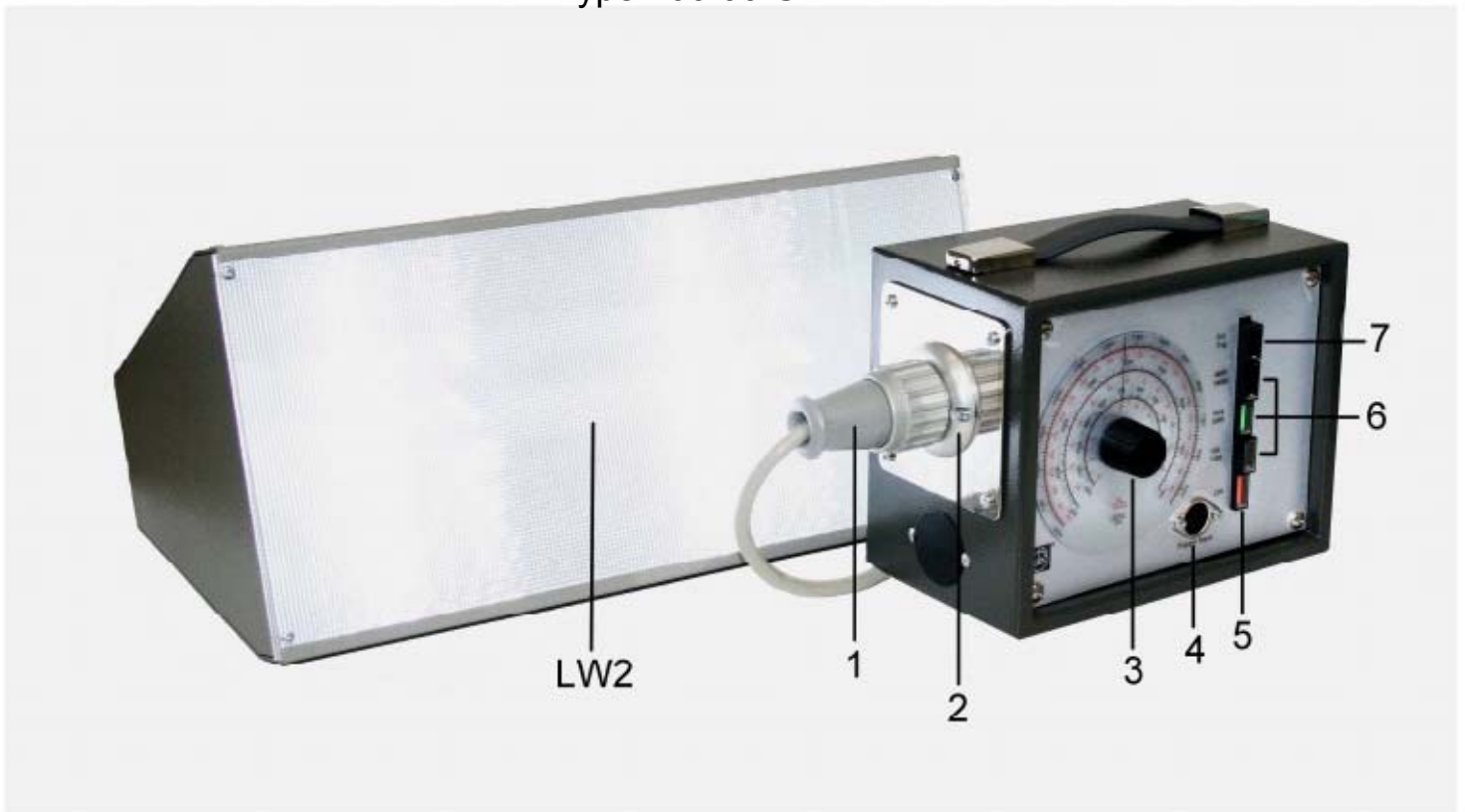




# INSTRUCTION MANUAL

MOVISTROB® Series 400

Type 400.00-S/LW 2



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## 1. Introduction

Each MOVISTROB® product has to pass through various controls during its production phases and must also undergo very strict and conscientious function and quality tests before leaving the factory for delivery to our clients.

We can assure you that the MOVISTROB® product you received is in strict conformity with our high quality standards and it fully meets all safety and performance requirements.

All relevant data on this instrument are electronically stored and can be recalled at any time.

Upon delivery, the instrument complies with the required safety regulations.

To maintain this condition and to ensure safe operation, it is absolutely essential to follow the instructions below.

### **Advice**

We therefore highly recommend to study the following Operating Instructions very thoroughly prior to first use of the stroboscope. Besides technical informations the instructions contain also important hints for use and application as well as special cautions against damage or injury.

Please note that we feel not responsible for any kind of damages or defects caused to the instrument by inappropriate handling or operation nor in case of unauthorized electrical or mechanical actions or any kind of alterations to the unit.

## 2. General Description

A stroboscope is used for studying rapid periodic motions. For this purpose, it generates short flashes of light with a frequency corresponding to that of the motion of the viewed object.

In this way, the motion can be made to appear to slow down or stop and therefore visible.

This is possible, because the human eye is unable to distinguish the timing of interval images above a certain frequency.

It is similarly possible to photograph linear motions viewed by the light of the stroboscope.

A further and important application in addition to this stroboscopic retarded action is the measurement of speed. It is possible to measure the speed of small motors without loading them mechanically, as it would be the case with measurement using a tachometer for example.

MOVISTROB® model 400.00-S/LW 2 consists of two elements:

- a) Control Unit type 400.00-S and
- b) Trough Light Fitting type LW 2

The IC/CMOS-controlled unit 400.00-S is a high-precision control system equipped with control and functional components.

The Trough Light Fitting LW 2 is a light source equipped with two Xenon longlife flash tubes, sources of intermittent white light with high luminance, uniform light distribution and maximum homogeneous illumination of the observation sector due to the grid screen cover of the fitting.

The flash rate is continuously adjustable from 150 to 18000 flashes/minute, equivalent to 2.5 to 300 Hz.

The average flash duration is about  $6 \mu\text{s}$ .

The Control Unit and the Light Fitting are housed in sheet-steel metal casings

Owing to its compact and solid design and the neat arrangement of its controls, the unit can be easily handled and conveniently operated

### CAUTION!

Persons with limited physical, sensorial or mental abilities are not allowed to use the unit, unless they are supervised for their safety by a qualified person or are briefed by the responsible person how to use the unit.

Use of this product may induce an epileptic seizure in those prone to this type of attack.

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.

There are high voltages present inside this product. Refer to the section on lamp replacement before attempting to open this product.

Do not allow liquids or metallic objects to enter the ventilation holes on the stroboscope as this may cause permanent damage.

The instrument may be operated by trained personnel only. Maintenance and repairs may also be carried out by qualified personnel or by the manufacturers only

### 3. Controls and Indicators of Control Unit 400.00-S

The Control Unit carries the following controls and functional components (see fig.):

#### 3.1 SIGNAL MAINS PUSHBUTTON "ON" ( 5 )

switches on the instrument by depressing the pushbutton.  
Red signal appears when ready to work.

#### 3.2 SIGNAL FLASH FREQUENCY RANGE SELECTOR PUSHBUTTONS ( 6 )

for selection of desired flash range:

Push Button Flashes/Min = RPM Flashes/Sec = Hz

Low range (green signal indicated) 150 - 1200 2.5 - 20

Medium range (green signal indicated) 1000 - 5000 16.66 - 83.33

High range (green signal indicated) 4800 - 18000 80 - 300.

(overlapping ranges)

When changing over from one range into the next the previously pressed button will automatically be released.

**CAUTION!**

Never push two buttons (nor three) at the same time or leave locked-down, otherwise the unit can be badly damaged.

#### 3.3 CONTROL KNOB with DIAL (3)

for continuous adjustment of flash frequency within the range selected by the range buttons (3).

The transparent dial provides three linear scales with double graduation.

The outer graduation of each scale gives the number of flashes per minute (RPM).

The inner (red scale) indicates the number of flashes per second (Hz.).

An index line on the front panel serves as a reading mark.

#### 3.4 SIGNAL PUSH BUTTON for EXTERNAL CONTROL "Ext Trig" (7)

serves to select the desired mode of synchronization.

When the flash frequency is to be controlled by an external source via

"Trigger Input" (4) the switch has to be depressed (signal indication: yellow).

The flash rate can be adjusted by means of the Control Knob with Dial (3) within the preselected range (6) when the push button is not pressed (signal indication: grey).

#### 3.5 INPUT for EXTERNAL CONTROL "Trigger Input" (4)

A 5-contact receptacle is used for connection to an external source for controlling the flash rate (270° input socket).

#### Contacts of Trigger Input:

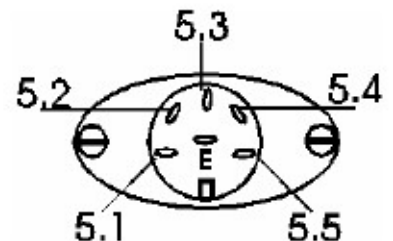
Pole 5.1/5.2 provide an AC voltage of 5 V / 0.6A (line frequency)

Pole 5.3/5.4 are for connection of a closing contact.  
flash will be released on closing

Pole 5.4/5.5 are for connection of an electrical pulse generator  
within a range from 2 to 100 V.

5.4 = Plus ( + ) Trigger / 5.5 = Minus ( - ) Trigger

Pole E = Plus ( Vdd ) IR or Induktiv Sensor / Pole 5.5 = Minus ( Vss ) Sensor



Make sure that "External Control Push Button" (7) is depressed on Position "Ext.Trig" if flash frequency is to be controlled by an external source.

When triggering via closing contacts, control circuit resistance should not exceed 100 Kohm when contacts are closed. Back-to-back operation is permissible. The short-circuit current is under 20 µA, i.e. below the 100 µA allowable limit current. The power circuit may not contain an external current source. When triggered by external current the flash is triggered along the positively-directed edge of an impulse. The impulse current (maximum) should not exceed 100 V. The response cycle lies at 2,5 V (TTL).

Caution:

Always press the proper "Frequency Range Selector Button" (6) for the flash frequency range in which the external synchronization frequency lies. In any case if the control impulse frequency exceeds the preselected low range the next higher range should be selected as a working range. However, we recommend you initially select the highest range (80 to 300 Hz) in such cases.

3.6 BC-RECEPTACLE for EXTERNAL LIGHT SOURCE (2)

The connection terminal for the Trough Light Fitting LW 2 is situated on the small side of the housing. When connecting the Light Fitting to the Control Unit, please make sure that the mains pushbutton (5) is in switch-off position (grey colour).

4. Trough Light Fitting LW 2

The Trough Fitting is equipped with 2 Xenon high-energy longlife tubes connected in parallel. The operating voltage is supplied by the Control Unit 400.00-S via a power cable with special BC screwing type plug.

An "ON/OFF" switch on the head side of the fitting enables the operator to cutoff the supply voltage. The grid screen cover of the Trough Fitting ensures uniform light distribution and maximum homogeneous illumination of the observation sector.

5. General Instructions

Connect the Light Fitting LW 2 to the Control Unit 400.00-S via the BC screw type plug and the Control Unit to the nominal AC line stated on the type plate . Switch on by pressing pushbutton „5“. Make sure that the "ON/OFF" snap switch on the head side of the light fitting is set on position "ON".

The stroboscope is now ready for operation. Illuminate the object under test with the stroboscope and set the flash rate so that a stationary or slowly moving object is visible. To protect the flash tube, it is advisable to switch the light fitting off when an interruption occurs for a longer observation period.

5.1 Operation with Internal Control

The most common mode of operation is to control the flash rate by the internal flash frequency generator. The desired flash rate has to be set by the controls on the control panel. Select the flash rate range by pressing range selector pushbutton „6“, and make the exact adjustment within the preselected range by means of control knob „3“.

Caution

Do not press two (or even three) range selector pushbuttons at the same time or keep some depressed by use of force.

5.2 Operation with External Control

If the flash rate is to be controlled externally by closing a contact, magnetic impulses, light impulses or other pulse signals pushbutton "Ext.Trig." (7) must be pushed in "ON" position (signal indicating yellow). Connection of the pulse generator to the control unit is to be effected through a trigger cable which must be connected to the "Trigger Input" (4).

Select the proper frequency range ( pushbuttons „6“ ) in which the external synchronizing frequency presumably takes place.

If the control impulse frequency exceeds the selected range the next higher range should be selected as a working range. However, in order to avoid an overloading of the flash bulb we recommend you initially select the highest range (80 Hz to 300 Hz) in such cases.

The maximum permissible permanent flash rate (18000 RPM) may be exceeded for short periods (not more than 1 minute) up to maximum flash rate of 30000 RPM.

Do not allow the flash bulb to burn constantly. Also, as with the internal control, two (or even three) range pushbuttons must not be pressed at the same time or kept in depressed position.

6. Stroboscopic Principle

With stroboscopy, high-speed periodic motion which cannot be followed by unassisted eyes can be made accessible for observation and its frequency measured. For this purpose the oscillating or rotating object is illuminated in a periodic series of light impulses (flashes) which are as brief as possible. The object then appears (at the appropriate flash frequency) to be motionless (stopped image) or slowed (slow-motion).

The object's behavior and motion can thus be observed in all their details. At low frequencies in the flash rate (below about 30 Hz) a certain flickering of the image is unavoidable. To make the visual perception appear real requires a solid-colored disc with a single eccentric mark.

### 6.1 Stopped Image of the Object

If the rotating object (or the mark) is to appear to the observer as a stopped image under stroboscopic light, the period  $T$  of the flash frequency must be a whole-number multiple  $n$  of the rotation period  $r$ :

$$T = T_n = nr$$

For the corresponding frequencies  $f = 1/T$  and revolutions  $v = 1/r$  the relationship is:

$$f = fn = v | n$$

The highest flash frequency ( $n = 1$ ) which produces a stopped image of the object, i.e. the mark equals the revolutions:  $f_1 = v$  (stopped images in which the mark appears more than once still result from flash frequency  $f > f_1$ ).

The observed phase of the rotation in stopped image, i.e. the rotational angle at the moment of the flash, is purely accidental. Through brief changes of the flash frequency however the desired phase position can be adjusted approximately. In the same way, RPM fluctuations can cause a change in phase position. Exact phase stability, i.e. sharply stopped image, can be achieved when the flash frequency is controlled externally by the moving object.

### 6.2 Measurement of RPM and Frequencies

To measure the RPM  $v$  either the highest flash frequency  $f_1 = v$  which results in a stopped image of the object can be determined, or two neighbouring flash frequencies  $f_n$  and  $f_{n+1}$  can be determined and from these the rotational frequency computed. For the periods for  $f$  and  $f_{n+1}$  in the flash frequency the equation is:

$$r = T_{n+1} - T_n$$

From this we derive the frequencies:

$$v = f_n \square f_{n+1} | f_n - f_{n+1}$$

### 6.3 Slow-Motion Cycle

If the period  $T$  of the flash frequency deviates slightly from a whole-number multiple  $T_n = nr$  of the rotation time  $r$  of the object, i.e.

$$T = (n + e) r \text{ with } |e| < 1$$

then the object no longer appears stopped, but has rotated through the angle  $2e$  between two succeeding flashes. If  $|e|$  is sufficiently small the eye perceives a constant slow-motion cycle. Angular speed  $w'$ , at which the object appears to rotate, is given by:

$$w' = 2 v' = \frac{2 \square e}{T(n+e) r} = \frac{2 \square e}{nr}$$

If we compare this with the true angular speed of the object, we obtain:

$$w' = (e | n) \square w$$

For  $e > 0$  (i.e.  $T > T_n$  and/or  $f > f_n$ )  $w$  and  $w'$  have the same sign, so that true and apparent rotation are in the same direction.

The opposite holds for  $e < 0$ . With increasing  $|e|$  the angular speed  $w'$  of the apparent rotation rises. Finally the angle  $2\pi e$  becomes so large that the mark on the rotating disc appears at two different places during two succeeding flashes. Other phenomena (described below) also occur.

#### 6.4 Stopped Images of Phantom Objects

Stopped images of rotating objects results from flash frequency periods  $T_n = nr$ , and also at other flash frequencies. However, the latter represent phantom objects, not the real object. Using the example of the rotating disc with an eccentric mark, it is obvious that stopped images also occur when:

$$T=(n|k)r \quad \text{and / or } f = (k|n)v,$$

whereby  $n$  and  $k$  are whole relatively-prime numbers. The stopped image shows  $k$  marks, which are arranged in the corner of a regular  $k$ -angle. Only a very few of the theoretically infinite number of flash frequencies result in observable images, since at each corner of the  $k$ -angle there is only one mark for  $k$  sequential flashes, but  $(k - 1)$  times no marks. As  $k$  increases then the images have less and less contrast. The images of the real object ( $k = 1$ ) always appear sharpest. In addition, the images become more and more faint at a given  $k$  with increasing  $n$ . The interval in which the mark is illuminated at one corner of the  $k$ -angle amounts to  $n$  rotation periods. In conclusion, the  $k$  mark images must not overlap. Altogether we may expect observable images only with low values of  $n$  and  $k$ . In objects with a complicated texture the phantom objects mostly disappear in an untextured background.

#### 6.5 Objects with a Finite Rotational Symmetry

In many cases the axis of the rotating object is an  $m$ -number symmetrical axis, i.e. the object overlaps itself through a rotation about the angle  $2/m$ . In the example of the disc this is achieved through  $m$  equal marks which are arranged in the corners of a regular  $m$ -angle. In this case substitute  $r/n$  for the period  $r$  in the relationships derived above.

Stopped images of the real object therefore result from

$$T = (n + k) r \text{ and /or } f = (k + n) v,$$

In addition, stopped images of phantom objects also occur for

$$T = (n|k) \square (r|m) \text{ and / or } f = (k|n)(m \square v)$$

( $k, m, n$  are whole numbers). If  $k$  and  $n$  are selected relatively-prime,  $k.m$  marks appear in the corners of a regular  $k.m$ -angle.

## 7. Replacing Flash Tube and Fuse

If there is repeated flash failure or a complete breakdown, the tube must be replaced. For this purpose the gridded glassfibre cover which protects the reflector of the light fitting must be removed by unscrewing the two fastening screws and sliding the glassfibre cover gently out of the guide rail. Before attempting to remove the flash bulb make sure the stroboscope is turned off and the power cable removed from the AC outlet. Allow the bulb to cool down; but wait at least 2 minutes before attempting to change the lamp. The 4-pin plug-in flash bulb must be cautiously pulled out. Insert the new tube (incorrect insertion impossible) and, if necessary, remove fingerprints by means of a soft cloth. In case the flash tube fits in tightly a screwdriver applied as a lever between tube base and socket will help to work it loose.

Only after the glassfibre cover has been closed, the instrument may be put into operation again.

It may be up to one hour before a new bulbe produces an uninterrupted flash sequency.

Remark

Do not use the flash bulb needlessly, as its life is limited to approx. 350 hrs. You will achieve a much longer lifetime, if you switch the instrument off in cases of long intervals in between the measuring or motion control actions.

When the lid catch of the Control Unit 400.00-S mounted by 4 screws is removed, the fuse 0.5 A (in case of 110V AC = 0.63 A) can easily be replaced.

## 8. Maintenance and Repair

If the instrument is suspected of being unsafe, take it out of operation permanently.

This is usually the case when the unit shows physical damage, no sign of functioning or stress beyond the tolerable limits.

Repair, replacing parts, calibration ect. should be carried out by trained personnel only or preferably return it to the manufacturer for inspection and control.

In correspondence concerning the instrument, please quote the type number and serial number as given on the type plate underneath the bottom of the housing.

### Technical specifications

#### Control Unit 400.00-S

#### Trough Light Fitting LW 2

Flash bulb:

Xenon white light tube  
4-pin plug-in type (2 pcs.)

Light intensity:

approx. 650 lux

Flash duration:

approx. 7  $\mu$ s

Frequency range:

2.5 - 300 Flashes/sec = Hz  
equivalent to 150 x 18000  
flashes/min = RPM in three  
overlapping ranges.

Accuracy:

less than  $\pm$  2 % of dial reading

Control elements:

signal pushbuttons, operating mode  
displayed in colour

by contact or pulse signals

External triggering:

built-in on request or separate unit

Phase shifter:

230 - 250 V AC, 40 to 60 Hz

Operating voltage:

(110V AC on request)

supplied from Control Unit

sheet metal with handle

Housing:

2.7 kgs

Weight:

200 x 125 x 155 mm

Dimensions:

sheet metal with grip

2.0 kgs

350 x 170 x 195 mm (without grip)

350 x 170 x 230 mm (with grip)

Right of technical modification reserved