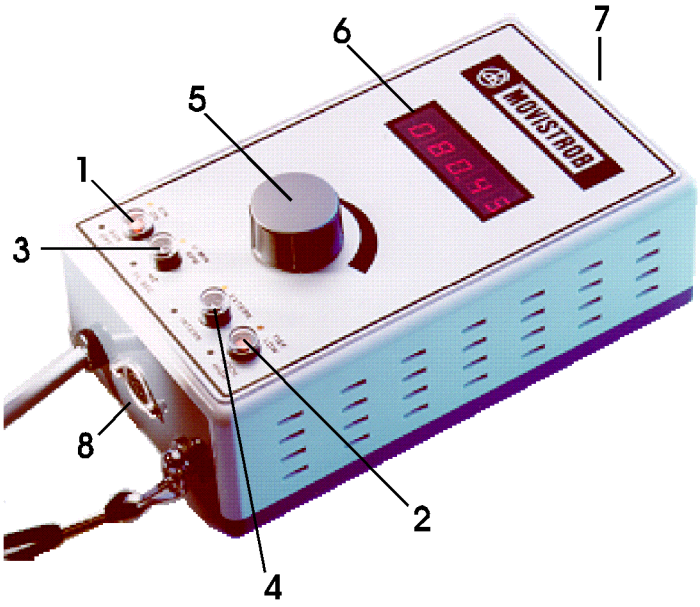
MINISTROB 2100 / 2150

Instruction Manual



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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 inapprobiate handling or operation nor in case of unauthorized electronical or mechanical actions or alterations to the unit.

2. General Description and Application

Both small format MINISTROB type 2150 and 2100 with 5 luminous digits, 7-segment LED-display and highly integrated CMOS/IC components are equipped with Xenon flash tubes.
The Xenon flash bulb is a source of intermittent white light with high light intensity and long lifetime.
Its flash rate is continuously adjustable in the range from 120 to 21000 flashes/min, corresponding to 2 to 350Hz.
The average flash duration is about 5 µs.
The flash frequency is controlled by quartz stabilization over the entire range to an accuracy of ± 1 revolution, or, in case digital readout is set in Hz (flashes/sec), to 1/100 ± 1 digit (rounded off to two decimal places).
The display indicates the flash frequency even when controlled by external triggering.
The measuring time is 1 s for a measurement cycle of 2 s.
The stroboscope is housed in an unbreakable plastic case (190 x 110 x 60 mm). Owing to its small weight, compact design and the neat arrangement of its controls, the unit can be easily carried and conveniently operated.
The instrument is provided with a 2 m long cord with safety plug for connection to the AC line.
The stroboscope is a combination of a high light intensity stroboscope and a digital frequency meter.
The instrument serves for the optical observation of fast periodic or quasi-periodic motions, such as moving parts in machinery under certain operating conditions: e.g. rotating shafts, gear wheel blades, valves in operation etc.
The digital readout always shows the exact value measured, and eliminates the misreadings in case of analogue scales.
The flash frequency of the stroboscope can be adjusted infinitely and synchronised to the motion frequency of the object under observation. This provides an optical slow motion effect to enable visual examination of mechanical distortions or displacements at high motion speeds. Moreover, the stroboscope may be used to identify the number of revolutions per minute or second of rotating parts.
By means of external triggering, irregularly occurring processes can also be examined.
The display indicates the flash frequency during this mode, too.
The external triggering can be activated by contact closing, voltage impulse, or light impulse with suitable equipment.

CAUTION!

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 staionary 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 manufactureres only.

3. Controls and Indicators

The instrument carries the following controls and functional components (see figure):

3.1 Signal Mains Pushbutton
Switches on the instrument by depressing the pushbutton,
Red signal appears when ready to work

3.2 Signal Flash Frequency Range Selector Pushbutton
for selection of desired flash frequency range.
When depressed (red signal), instrument operates in low flash frequency range.
Button not pressed (black signal), instrument operates in high flash frequency range.

	FLASHES/MIN = RPM	FLASHES/SEC = Hz
Low frequency range:	150 - 4000	2.5 - 66.67
High frequency range	4000 - 21000	66.67 - 350
	both ranges overlapping	

3.3 Signal Readout Pushbutton
Depressed button (red signal) indicates the flash frequency per minute = RPM.
Unpressed button (black signal) produces the flash frequency per seconde = Hz.
(up to two decimal places).

3.4 Signal Mode Selector Pushbutton (does not apply for type 2100)
Serves to select the desired mode of synchronization.
The button must be depressed (red signal) when the flash frequency is to be controlled by an external source via "Trigger Input **3.8**".
When the button is not depressed (black signal) the flash rate can be adjusted by means of "Control Knob **3.5**" (10-turn spiral potentiometer) within the selected range.

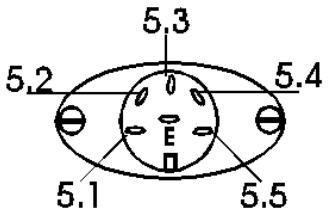
3.5 Control Knob for Flash Frequency Adjustement
for continuous fine adjustment of the flash frequency within the pre-selected range (**3.2**) by means of the 10-turn precision spiral potentiometer.
Turning the Control Knob in clockwise direction, indicated by a curve, increases the flash frequency. The opposite direction lowers the flash rate. The 10-turn spiral potentiometer enables the operator to adjust the flash frequency very precisely.

3.6 Display Window
Within the frame of the display window inserted in the control panel, the 8 mm high 7-segment LED figures are easily readable. When readout in flashes per second = Hz is selected a red decimal point appears automatically. Readout in Hz is carried out to 2 decimal places.

3.7 Flash Bulb with Transparent Fibreglass Reflector Cover
The Xenon longlife gas discharge tube is mounted within a reflector which is protected by a transparent fibreglass cover. Changing the transparent cover for a red filter cover type **2000.11**, the fiberglass cover can easily be removed by unscrewing the two screws holding the cover on the housing. The red filter supplies a selective contrast to daylight and prevents the human eye from early stress and symptoms of fatigue in case of longtime observations. However the red filter will definitely reduce the light intensity. Within the selected frequency range the shape of the light pulses is virtually independent of the frequency; however, when changing over from high to low range, the pulse amplitude and duration are increased to a certain extent. Since the average pulse duration is only about 5 µs, the object will appear always sharply defined at high speeds.

3.8 Input for External Control (does not apply for type 2100)
Five contact receptacle for connection of an external source for controlling the flash rate (270° input socket), located on the narrow side underneath the row of buttons.

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) Infrared Sensor / Pole 5.5 = Minus (Vss) IR Sensor

Make sure that "Signal Mode Selector **3.4**" is depressed (red signal) when 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 Selection Button (**3.2**) for the flash frequency range in which the external synchronization frequency lies. In any case if the control impulse frequency exceeds the selected low range the higher range should be selected as a working range. However, we recommend you initally select the highest range (66,67 to 350 Hz) in such cases.

4. Installation

Check whether the instrument is adapted to the nominal AC voltage as given on the type plate. After switching on by pressing the signal pushbutton **"3.1"** it is instantly ready for operation. Illuminate the object under test with the strobe and set the flash rate so that a stationary or slowly moving object is visible.

5. Operation with Internal Control

The mode of operation mainly used is to control the flash rate by the internal frequency generator. The desired flash rate is set by the controls on the control panel. Select the flash rate range by pressing push button **"3.2"**. Make the fine adjustment within the selected range by turning control knob **"3.5"**. Readout per minute or seconde can be selected by push button **"3"**.

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**:

$$T = Tn = nr$$

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

$$f = fn = 1\ v \div n$$

The highest flash frequency **(n = 1)** which produces a stopped image of the object, i.e. the mark equals the revolutions: **f1 = v** (stopped images in which the mark appears more than once still result from flash frequency **f > f1**).

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 in 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 (does not apply for MINISTROB series 2000).

6.2 Measurement of RPM and frequencies

To measure the RPM v either the highest flash frequency **f1 = v** which results in a stopped image of the object can be determined, or two neighbouring flash frequencies **fn** and **fn+1** can be determined and from these the rotational frequency computed. For the periods for **f** and **fn+1** in the flash frequency the equation is:

$$\mathbf{r = Tn+1 - Tn}$$

From this we derive the frequencies:

$$\mathbf{v = fn \bullet fn+1 \div fn - fn+1}$$

6.3 Slow-motion cycle

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

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

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:

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

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

$$\mathbf{w' = (e \div n) \bullet w}$$

For **e > 0** (i.e. **T > Tn** and/or **f > fn**) **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 **2πe** 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 **Tn = 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:

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

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

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

In addition, stopped images of phantom objects also occur for

$$\mathbf{T = (n \div k) \bullet (r \div m)} \quad \text{and / or} \quad \mathbf{f = (k \div n)\ (m \bullet v)}$$

(**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 Fuses

If there is repeated flash failure or complete breakdown, the tube must be replaced. For this purpose the transparent plastic cover to protect the reflector must be removed by unscrewing the 2 screws. 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 2 minutes before attempting to change the lamp. The 3-pin tube must be gently 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 very tight the cover of the housing has to be taken off by unscrewing four screws. Loosen the tube with a screwdriver applied as a lever between tube base and socket and pull the tube out. Only after the housing has been closed, should the instrument be put into operation again.
It may take up to one hour before a new tube produces an uninterrupted flash sequence.

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.

After the cover of the plastic housing has been removed, the fuse (0.5 A for 230V AC and 0.63 A for 110 V AC unit) is accessible and can 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 demage, 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 Data

MINISTROB 2100

This model corresponds in presentation, technical data and operation to the MINISTROB 2150, except that there is no possibility of external control of the flash frequency.

MINISTROB 2150

Supply voltage	230 ...250V AC, 30 ...60 Hz = cy/sec (other voltages on request)
Light source	Xenon white light tube, 3-pin plug-in type
Peak light intensity	approx. 450 lux
Flash duration	approx. 2 - 6 microseconds
Frequency range	2.5 ...350 cy/sec
Range divisions	2.5 66.67 Hz = 150 4.000 RPM 66.67 350 Hz = 4.000 21.000 RPM
Digital read-out	5-place 7-segment LED, red, 10 mm high
Read-out switching	in Hz or RPM
Frequency fine tuning	10-turn spiral potentiometer
Accuracy	for RPM read-out: ± 2 RPM for Hz read-out: ± 1/00 ± 1 digit
Measuring time	1 sec
Measuring cycle	every 2 seconds
Control	internal, contact switch, and pulse triggering
Casing	shatterproof plastic
Dimensions	195 x 75 x 110 mm
weight	1000 grs.

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