NATIONAL PHYSICAL LABORATORY

METROLOGY CENTRE

Ref: MOY/SCMI/98 (Issue 1) **SPECIFICATION OF ACCURACY**

for

A PHOTO-ELECTRIC MICROMETER MICROSCOPE

Type: A screw-type micrometer microscope TM 23 (millimetre micrometer) or TM 22 (in micrometer) incorporating a photo-electric detector together with an electric display unit.

Made by: Hilger and Watts Ltd.

		LIMITING VALUE OR MAXIMUM PERMISSIBLE ERROR
1.	**GENERAL**	
1.1	Both the microscope and display unit shall bear nameplates engraved with the catalogue and serial number and the maker's name or trade mark.	
1.2	The construction and finish shall be in keeping with a precision instrument fulfilling the requirements of this specification.	
1.3	All adjustments (e.g. micrometer screw knobs, gain control knobs, illumination unit rotation, etc.) shall operate smoothly and positively.	
2.	**MICROSCOPE**	
2.1	The drum shall be clearly divided and the width of the lines shall be the same as the width of the index mark.	
2.2	The numerical value of a drum division and a drum revolution shall be clearly engraved on the side of a drum.	
3.	**GRATICULE**	
3.1	The graticule pattern shall be clearly defined.	
3.2	The measuring pattern shall be square to its direction of travel to	5 minutes of arc
3.3	The longitudinal line (perpendicular to the pair of parallel setting lines) shall pass through the mechanical axis of the tube to within	0.25 mm (0.01 in)
4.	**TURN COUNTER**	
4.1	The pitch of the turn counter shall match the pitch of the micrometer screw to within	±1%
5.	**MICROMETER SCREW**	
5.1	The feel of he micrometer screw shall be smooth and be free from shake in its bearing.	

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5.2	The pitch of the micrometer screw measured at the object plane over the working range of the screw shall be uniform to	±0.3 μm (±10 μin)
5.3	The total periodic error in the micrometer screw and its mounting (measured at the object plane) shall not exceed	±0.3 μm (±10 μin)

6. **OBJECTIVE**

6.1	The image of a flat object shall itself be in one plane over the field of view.	
6.2	The value and uniformity of the magnification shall be such that the instrument shall photo-electrically measure any length within its working range to within	±1.5 μm (±60 μin)

7. **BODY TUBE**

7.1	The outside diameter of the body tube shall be 25.4 mm (1.0 inch)	+0 -25 μm (-0.001 in)

8. **EYEPIECE**

8.1	The focussing movement of the eyepiece shall be smooth.	
8.2	The eyepiece shall have an adequate focussing range.	±5 dioptres

9. **ILLUMINATION**

9.1	The intensity and uniformity of illumination of the field of view, with the microscope focussed on a highly polished chromium surface, shall give at the same time both comfortable viewing and satisfactory photo-electric sensitivity as specified in Clause 11.5 below.	

10. **PHOTO-ELECTRIC DETECTOR**

10.1	The centre of the photo-electric field shall be coincident (measured transversely to the graticule travel) with the longitudinal line of the graticule, measured at the object plane, to within	±0.05 mm (±0.002 in)
10.2	At any position over the working range the photo-electric setting and visual setting shall agree when the microscope is mounted vertically to	±5 μm (±0.0002 in)
10.3	The visual and photo-electric measurements of any length within the working range shall agree to within	±1 μm (±0.000 04 in)

11. **DISPLAY UNIT**

11.1	The mechanical zero of the meter must be capable of fine adjustment.	
11.2	The electrical zero of the meter must be capable of adjustment.	
11.3	The ‘noise’ or random meter movement occurring with the microscope focussed on a specularly polished surface and measured at the object plane shall be equivalent to not more than	0.03 μm (1 μin)

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11.4	As the amplifier sensitivity control is rotated from minimum to maximum sensitivity the electrical zero of the meter shall not change by more than	1 ½ divisions
11.5	With the microscope focussed on a line about 4 µm wide and 1.3 mm long ruled on a specularly polished surface and with the sensitivity control at a maximum, one meter division shall represent	0.25 µm (10 µin) maximum
11.6	With the microscope focussed on a line about 4 µm wide and 1.3 mm long ruled on a specularly polished surface, rotation of the amplifier sensitivity control from maximum to its half-way position shall increase the value of any one meter division by at least half its previous value.	
11.7	With the amplifier sensitivity suitably adjusted (when the microscope is focussed on a line as in 11.6) so that 1 meter division is equivalent to 0.25 µm (10 µin), the micrometer readings shall bear a linear relationship to the meter readings over the central ten divisions of the meter as the line is traversed. Variations from the mean linear relationship over the central ten divisions of the meter shall be no greater than	0.4 of a meter division per 1 µm (40 µin) change in micrometer reading 0.1 µm (4 µin) over 4 adjacent meter divisions.

12. **CHANGES IN SENSITIVITY AND SETTING WITH MAINS VOLTAGE**

12.1	Changes in mains input voltage of ±10% shall not cause a change in null-setting position greater than	0.03 µm (1 µin) per 1% change in voltage
12.2	Changes in mains input voltage of ±10% shall not cause a change in sensitivity greater than	5% per 1% change in voltage

13. **CHANGES IN SENSITIVITY AND SETTING WITH TIME**

13.1	After a warming-up time of 15 minutes, any change in the null-setting position with time due to the construction of the microscope, electronic system and/or illuminating unit shall not be greater than	0.1 µm (4 µin) per 10 minutes
13.2	After a warming-up time of 15 minutes, any change in the sensitivity with time due to the construction of the microscope, electronic system and/or illuminating unit shall be greater than its initial value (after warming-up time) by more than	10% per hour

14. **REPEATABILITY OF READING**

14.1 The range of reading obtained from 10 to 15 consecutive settings of the microscope on a single line shall be 0.3 µm (13 µin) maximum
and the standard deviation shall be 0.05 µm (±2 µin) maximum

(Signed)

for Director

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