

FEDERAL STATE UNITARY ENTERPRISE  
PA "NOVOSIBIRSK INSTRUMENT-MAKING PLANT"



# OPTICAL QUADRANT KO-60

Registration certificate

3.817.001 PS

**Due to continuous product improvements, in its design can be brought a minor alterations which are not reflected in the present edition.**

## **1 PURPOSE**

The optical quadrant KO-60 with the division value of 60" (hereinafter - quadrant) is intended for measuring angles of inclination of flat and cylindrical surfaces and for setting them at a given angle to the horizontal plane.

Field of application - laboratories, scientific-research institutes, machine-building enterprises, construction and other branches of national economy.

The device operates both under natural and artificial illumination.

The range of operating temperatures is from -50°C to +50°C (under condition of protection against precipitations).

## 2 SPECIFICATIONS

Table 1

Name of main characteristics and dimensions	Standard
Range of absolute error of quadrant, ..."	$\pm 30$
Division value of reading device scale, ..."	60
Angle measuring range on limb, ...°	$\pm 120$
Division value of main level scale, ..."	30
Division value of cross level scale, ...'	4
Division value of limb scale, ...'	60
Division value of external scale, ...°	1
Length of base, mm, not less	148
Overall dimensions, mm, not more	155×97×131
Weight, kg, not more: quadrant	2,5
complete set packed	4,0
Specified complete resource, hours, not less	6000
Specified total service life, years, not less	6

### 3 DELIVERY LIST

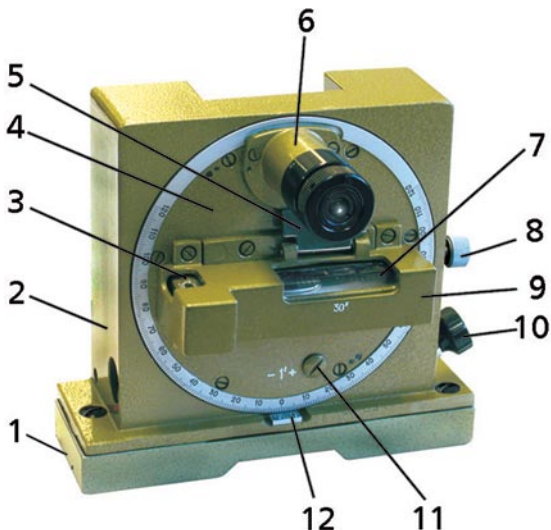
Table 2

Designation	Name	Quantity	Note
3.817.001	Optical quadrant KO-60	1	
<b>Tool and Accessories</b>			
8.679.008	Wrench	1	
8.890.001-01	Napkin	1	
<b>Consumer Package</b>			
4.103.004	Box	1	
<b>Service documentation</b>			
3.817.001 PS	Certificate	1	

### 4 DESIGN AND PRINCIPLE OF OPERATION

#### 4.1 Design

The quadrant (figure 1) consists of the base 1, body 2, cover 4, indicating microscope 6, mirror 5, lengthway (main) level 7, cross level 3, casing 9, clamping screw 8, guiding screw 10, vernier 12.



1 – base; 2 – body; 3 – cross level; 4 – cover;  
 5 – mirror; 6 – indicating microscope;  
 7 – main level; 8 – clamping screw; 9 – casing;  
 10 – guiding screw; 11 – stopper; 12 – vernier

Figure 1 – **Quadrant (front view)**

**Base 1** is a hardened steel plate of the rectangular form. It is intended for fastening the quadrant and for its installation on a measuring surface. There is a long angular slot for installation on a cylindrical surface in the lower part of the base.

**Body 2** is connected with base 1 by three screws. Inside the body is mounted the axis system on which a limb device and a disk with the cover 4 are rigidly fixed. The back part of the body is covered with a shield 2 (figure 2).

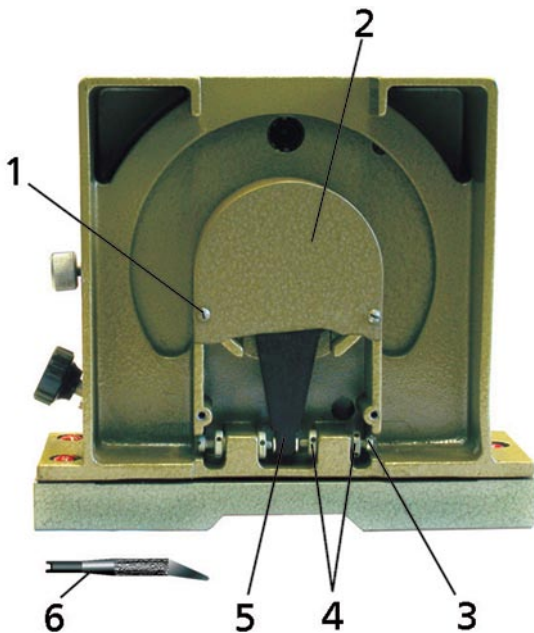
**Cover 4** is attached to the ring by six screws and two pins and has the working hole closed by a stopper 11. There is an engraved scale with division value  $1^\circ$ , numbered at each  $10^\circ$  on both sides from zero up to  $120^\circ$  on the cover.

Indicating microscope 6, levels 3, 7 and casing 9 with mirror 5 are fastened to the cover.

**Mirror 5** serves for convenience in observation of the bubble position of main level 7. It turns round its own axis, fixed in casing 9.

**Indicating microscope 6** is intended for observing the field of view and for taking readings from the limb scale.

The microscope consists of an objective, reticle with collecting lens and an eyepiece.



1 – screw; 2 – shield; 3 – adjusting screw;  
4 – nuts; 5 – lever; 6 – wrench

Figure 2 – **Quadrant (rear view)**



**Main (lengthway) level 7** (hereinafter – lengthway) is an ampoule in mount. The ampoule is marked with scale divided 30". It is intended for determination an angle of inclination of a tested surface to the horizontal plane.

**Cross level 3** is an ampoule in mount. The ampoule is marked with scale divided in 4'. It is intended for orientating the lengthway level along the inclined plane and the instrument when setting it on a cylindrical surface.

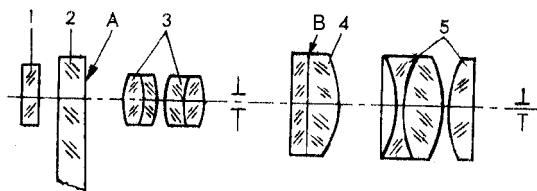
**Casing 9** is intended to fix the mirror, protect levels 3 and 7 against external mechanical damage and simultaneously serves as a handle for turning the cover 4.

## **4.2 Operating principle**

The operating principle of the quadrant lies in taking reading of the angle of inclination of the base relative to the level by the glass limb with the help of indicating microscope.

### 4.3 Optical scheme

The beam of rays reaches light filter 1 (figure 3), passes further through the optical limb 2, the lenses of the objective 3, reticle with collecting 4 and the lenses of eyepiece 5. The field of view is seen in green light.



A – plane of limb division;  
B – plane of reticle division

Figure 3 – **Optical scheme**

## **5 PREPARING FOR OBSERVATION**

### **5.1 General instructions**

While operating with the quadrant, it is prohibited:

- to open the box with the device in a warm room earlier than in three hours after work in the frost;

- to carry the device from place to place and transport it without the box;

- to apply excess efforts while rotating the eyepieces and screws;

- to touch the optical parts with hands;

- to eliminate the troubles of adjustment by unexperienced persons.

### **5.2 Unpacking and installation**

It is necessary to keep the quadrant packed not less than 8 hours after receiving and not less than 6 hours after unpacking at the temperature  $(20 \pm 2)$  °C and relative humidity not more than 80 %.

Remove the seals from the locks and open the cover of the case for unpacking. Take the quadrant out of the case, remove the wrapping

paper from the eyepiece of the microscope, wipe the working surfaces of the base with clean napkin to remove the lubricant, wipe the external optical details with the clean degreased cotton wool, wound around wooden stick and wetted with alcohol-ether mixture. The cotton wool should be changed after each wiping.

Before operating with the quadrant, it is necessary to check up the following:

- safety of the device coating;

- smooth rotation of cover 4 (figure 1);

- proper operation of the clamping and guiding screws;

- smooth rotation of the microscope eyepiece;

- serviceability of the levels;

- condition of the optical details (there should not be any cracks, drops, thin coats);

- correctness of the quadrant zero reading. If the deviation from zero level is found, eliminate inaccuracy as it is specified in 5.3 and 5.4.

### **5.3 Checking the correctness of zero reading of the quadrant**

When mounting the quadrant on the horizontal plane and bringing the bubble of the main level ampoule to the mid-position, the reading by the limb should be equal to zero.

Place the quadrant on a smooth, steady, approximately horizontal surface. Loosen the clamping screw 8 (figure 1).

Set the bubble of the lengthway level 7 approximately in the mid-position by rotation of the cover 4. Secure the dial with the screw 8. Set the bubble of the lengthway level precisely in the mid-position by the guide screw 10. Take the limb reading through the indicating microscope.

Turn the quadrant around 180°.

Set the bubble of the lengthway level 7 precisely in the mid-position using the guide screw 10.

Take the reading from the reading scale of the microscope.

If the quadrant is regulated correctly, both readings will be equal in absolute values and differ in signs.

The inequality of readings under absolute values indicates deviation from zero setting of the device. Algebraic half-sum of these readings gives deviation from zero setting.

Half-difference of the readings gives a real deviation of a surface on which the device is tested from the horizontal plane.

For example:

first reading —  $+ 1^{\circ}20'$ ,

second reading — minus  $1^{\circ}04'$ .

Deviation from zero setting of the device will be:

$$\frac{1^{\circ}20' + (-1^{\circ}04')}{2} = +8'.$$

The real deviation of the bearing surface from the horizontal plane is:

$$\frac{1^{\circ}20' - (-1^{\circ}04')}{2} = +1^{\circ}12'.$$

## **5.4 The way of elimination deviation from zero setting**

In case when the deviation from zero setting of the device exceeds  $\pm 20''$ , it should be adjusted.

Adjustment is done in the following sequence:

- undo screws 1 (figure 2);

- remove shield 2;

- loosen with special wrench 6 nuts 4 on adjusting screws 3. Serial rotation by a screw-driver adjusting screws 3 and turn of the lever 5 combine the zero lines of the limb and the reticle of the microscope. Repeat such adjustment until the limb readings will be equal in absolute values when turning for  $180^\circ$ ;

- tighten nuts 4 of adjusting screws 3;

- check up the alignment of the limb lines and reticle of the microscope, in case of lines discrepancy repeat adjustment;

- install shield 2 in its place and secure with screws 1.

## **6 OPERATING SEQUENCE**

### **6.1 Taking readings**

The number of grades is determined by the figures of the limb line which image is within the limits of the scale of microscope reticle.

Figure 4 shows the reading value equal  $12^{\circ}$ .

Minutes are read on the same lines of the limb from the scale of the microscope reticle.

The angles are measured conditionally: on the upper scale is negative with the sign “-”, on the lower scale – positive angles with the sign «+».

Figure shows the reading equal to minus  $30'$ .

Fractions of a minute are determined approximately, as a part of division of the reticle scale.

The full reading, given in figure 4, is equal to minus  $12^{\circ}30'$ .



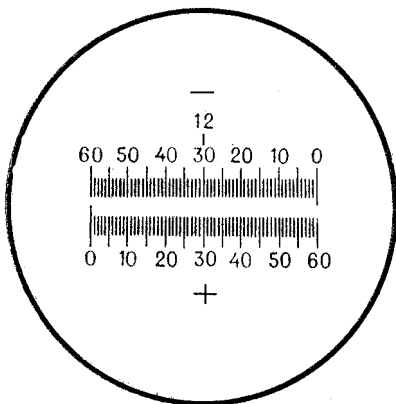


Figure 4 – **Field of view of the microscope**

## **6.2 Measuring angles**

### **6.2.1 Measuring angles of plane or cylindrical surface inclination**

For measuring angles of surface inclination install the device on a plane cylindrical surface, which angle of inclination to the horizontal plane should be measured.

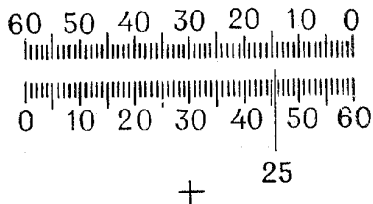
At the quadrant installation on a plane surface it is necessary to turn the device in such a way to orient the lengthway level along the surface inclination.

At the quadrant installation on a cylindrical surface it is necessary to bring the cross level bubble in the middle position by turning the quadrant round the axis of the cylindrical surface. Loosen clamping screw 8 (figure 1) and turn cover 4 with the scale so that the lengthway level bubble occupies the middle position. Then tighten screw 8 and with the adjusting screw 10 bring the lengthway level 7 bubble right in the middle, thus the cross level bubble also should be in the middle. Observing through the microscope, take the readings as it is specified in 6.1. The obtained angle is an angle of inclination of the checked surface to the horizontal plane.

### 6.2.2 Setting the surfaces at given angle to the horizontal plane

Let the given surface should be inclined counter-clockwise at an angle of  $25^{\circ}45'30''$  (figure 5). For this purpose it is necessary to loosen the clamping screw 8 (figure 1) and to turn cover 4 clockwise for an angle equal approximately to the given angle. Then tighten clamping screw 8, with the adjusting screw 10 bring the microscope scale to the limb line so that this line occupies the position in the middle between divisions 45 and 46.

The readings on the scale of the microscope will be  $+25^{\circ}45'30''$ .



**Figure 5 – View of the scale in the field of vision of microscope at the reading of the angle  $25^{\circ}45'30''$**

Then install the quadrant on the given surface and incline it so that the bubbles of the lengthway and cross levels occupy the middle position.

As a result, the surface will be inclined for an angle  $25^{\circ}45'30''$ .

## **7 MAINTENANCE**

For supporting of the quadrants, which are in operation, and also in stock, in good state, for providing non-failure operation, for increasing the time between repairs and also for duly revealing and elimination of the reasons causing premature deterioration and damage, it is necessary to conduct checkup and maintenance.

Maintenance includes following types:  
daily maintenance (ETO maintenance);  
maintenance 1 (TO-1);  
maintenance 2 (TO-2).

For providing non-failure operation of quadrants it is necessary to hold them clean, to protect them from mechanical damages and entering moisture inside.

## **7.1 Daily maintenance (ETO maintenance)**

Daily maintenance (ETO maintenance) is conducted before and after operation with the quadrant, but not less than every two weeks. Descriptions of works are given in the table 3.

Table 3

Objects of maintenance and their description	Technical requirements	Devices, instrument and materials, which are necessary for maintenance
<p>Wipe the quadrant from the dust and dirt</p> <p>Wipe achromatic metal surfaces</p> <p>Clean the external surfaces of optical details and limb (if it's necessary) by spirit-ether mixture (15% of alcohol and 85% of ether) or by spirit</p>	<p>The quadrant should be clean</p> <p>Achromatic metal surfaces shouldn't have the traces of corrosion</p> <p>The surfaces of external optical details and limb should be clean</p>	<p>The napkin from single maintenance kit</p> <p>Napkin. Aviation spirit or spirit-ether mixture</p> <p>Dry clean napkin.</p> <p>Absorbent optical wool</p>

Limb should be cleaned when screw technological cup 11 (figure 1) on the one side, on the other side – the light filter, which is found on the back side of the device opposite to the eyepiece 6, are unscrewed. The tampon, which is wrapped round the wood stick, should be changed after every single cleaning. It's necessary to avoid surplus of spirit-ether mixture and not to afford it comes under the frame

Clean the external surfaces from dust, dirt by a little bit oiled napkin, to leave the thin oil covering , after work is done. The working surfaces of baseplate cover anticorrosion lubricant

The quadrant should be clean and protected from corrosion

Ether anesthetic EN.  
Technical rectified ethyl spirit of first-class

Oiled napkin.  
Preserving lubricant for optomechanical devices

Continue of the table 3

Objects of maintenance and their description	Technical requirements	Devices, instrument and materials, which are necessary for maintenance
Place the quadrant into the case. Before placing of quadrant into the case, set reading scales into zero position, screw in the eyepiece up to the stop, set the	If the quadrant isn't used, it should be kept in the case	



**Notes:**

1 Do not clean the optical surfaces by the napkin, which is used for cleaning the metal surfaces.

2 Clean the optical surfaces with maximum care.

3 If you can't clean the limb at place, send the device into the repair shop. If it's necessary, the cleaning can be made by manufacturing plant as a technical support.

**7.2 Maintenance № 1 (TO-1)**

Maintenance № 1 (TO-1) is held not less than one time in six month and when the quadrant is set on the short-time storage according to the table 4.

It is necessary not more than 2 man-hours to make a TO-1.

Table 4

Objects of maintenance and their description	Technical requirements	Devices, instrument and materials, which are necessary for maintenance
<p>Check if the storage and exploitation conditions of quadrant are kept</p> <p>Check the proper functioning of the case and its packing</p>	<p>See the paragraph 10</p> <p>The quadrant and accessories should be fixed strongly in their places. The pressure of the case's cover shouldn't deform the quadrant</p>	<p>Psychometer aspirating</p> <p>By sight</p>
<p>Check the preservation</p>	<p>Preservation lubricant shouldn't be dry, wrapping paper should be intact</p>	<p>By sight</p>

Depressurate the quadrant	There shouldn't be any lubricant on the details for operation	See the paragraph 7.4
Check the proper working order of the quadrant mechanisms: cover, adjusting screw, clamping screw, eyepiece and mirror	The rotation of all moving elements should be smooth, without any jumps and jamming. External disk shouldn't turn when clamping device is fixed	By testing
Color metal surfaces of damaged paint coat	The quadrant shouldn't have any traces of corrosion and damage of external surfaces	Pale grey and black enamel
Clean the external surfaces of optical details and limb by spirit-ether mixture (see table 3)	See table 3	See table 3

## Continue of the table 4

Objects of maintenance and their description	Technical requirements	Devices, instrument and materials, which are necessary for maintenance
Set the reading scales into zero position, screw the eyepiece up to the stop, set adjusting screw in about a middle position, fix the clamping screw, preserve the quadrant, place in the case and fix it there. Close the case and place it on shelf on the stand	The device should be preserve before placing for storage	See the paragraph 7.4

### **7.3 Maintenance № 2 (TO-2)**

Maintenance № 2 (TO-2) is held not less than one time in two years, including:

- 1) based on results TO-1;
- 2) when the quadrant is being prepared for a long-term storage.

Maintenance № 2 (TO-2) is made in specialized repair stores, where defect parts of quadrant are changed, lubrication of rubbing surfaces by lubrication AC-1, lubrications of axis by oil 132-08.

The maintenance № 2 takes not more than 4 man-hours.

Material consumption rates during the maintenance are shown in the table 5.

Table 5

Material name	Consumption rate
Anesthetic ether EN, kg	0,4
Nefras C2 80/120, kg	0,5
Optical absorbent cotton, kg	0,3
Preserving lubricant for optomechanical devices, kg	0,3
Lubrication AC-1, kg	0,2
Oil 132-08, kg	0,2
Technical rectified ethyl spirit of first-class, kg	0,1

## **7.4 Preservation and depreservation of devices**

Before shipping to a customer the quadrants should be preserved. The mirror and the baseplate are subject to conservation.

Used preservative agents guarantee the protection from corrosion for three years. The devices are subject to re-preservation if it's necessary. Preserved details are wiped by clean napkin, than by napkin, that wetted a bit in the spirit-ether mixture or in aviation spirit, and are preserved again.

The quadrants are preserved by the lubrication. In that case can be used another preserving lubrications.

Preservation works should be done only in dry, clean premises under the temperature not less than 15 °C.

The details that are subject to exploitation should be freed from surplus oiling by clean napkin, than they should be wiped with napkin, wetted in spirit-ether mixture or aviation spirit.

The preserving lubrication is heated up to 25–30 °C and its thin layer is applied to surfaces with the help of a tampon.

The preservation lubricant should not penetrate on the optical details of the quadrant. The external optical details of the quadrant (eyepieces) should be protected with clean fat-extracted cotton wool, wrapped up in a tissue paper and tied round with threads. After preservation, the metal details included in the STA kit are wrapped up in clean oiled paper before packing.

The surplus layer of lubricant should be removed from the details of the quadrant, subjected to service, and then wipe the details with napkin, wet with ethyl spirit mixture or aviation spirit.



## 8 POSSIBLE MALFUNCTION AND WAYS OF THEIR ELIMINATION

Table 6

Malfunction, external manifestation and additional signs	Possible reason	The way of elimination
Deviation from zero point	Precise limb relatively longitudinal level was spoiled	See the paragraphs 5.3; 5.4
<b>Note</b> – The indicated malfunction isn't the reason for quadrant reclamation.		

## 9 TRANSPORTATION AND STORAGE

### 9.1 Transportation

The quadrant complete set is transported and stored in the case (consumption package).

The quadrant can be transported by all kinds of transport, except air planes, in covered carriers at the temperature not more than +50° and not less –50 °C.

During the transportation and storage the quadrant should be protected from hits and shakings, moisture penetration and heating under direct sun rays, do not place the case on the snow or wetted surface.

## **9.2 Storage in the storehouses**

The quadrant, packed in the case, should be stored in closed, heated and ventilated storehouses at the temperature from 5°C up to 40 °C and relative humidity not more than 80% at +25 °C. Diurnal temperature variation should not be cause of moisture condensation on the metal details of the package. The storehouse aria should be free of acid's, alkali's and other substance's fumes that can damage quadrant.

It is prohibited to store the cases with the quadrants close to windows, ovens or heaters.

## **10 ACCEPTANCE CERTIFICATE**

Optical quadrant KO-60, serial number \_\_\_\_\_, is manufactured and accepted in accordance with obligatory requirements of state standards, technical documentation and it is found serviceable.

Primary checking is done.

Date of acceptance \_\_\_\_\_

Signatures \_\_\_\_\_

\_\_\_\_\_

## **11 PRESERVATION**

Preservation of the quadrant is made in accordance with prescribed requirements, noted in technical documentation. Preservation time is 3 years.

Date of preservation \_\_\_\_\_

Signatures \_\_\_\_\_

\_\_\_\_\_

## **12 PACKING CERTIFICATE**

Optical quadrant KO-60, serial number\_\_\_\_\_, is packed in FSUE PA "Novosibirsk Instrument-Making Plant" according to requirements, noted in technical documentation.

Date of packing \_\_\_\_\_

Signatures \_\_\_\_\_

\_\_\_\_\_

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Квадрант оптический КО-60.  
Паспорт на английском языке.