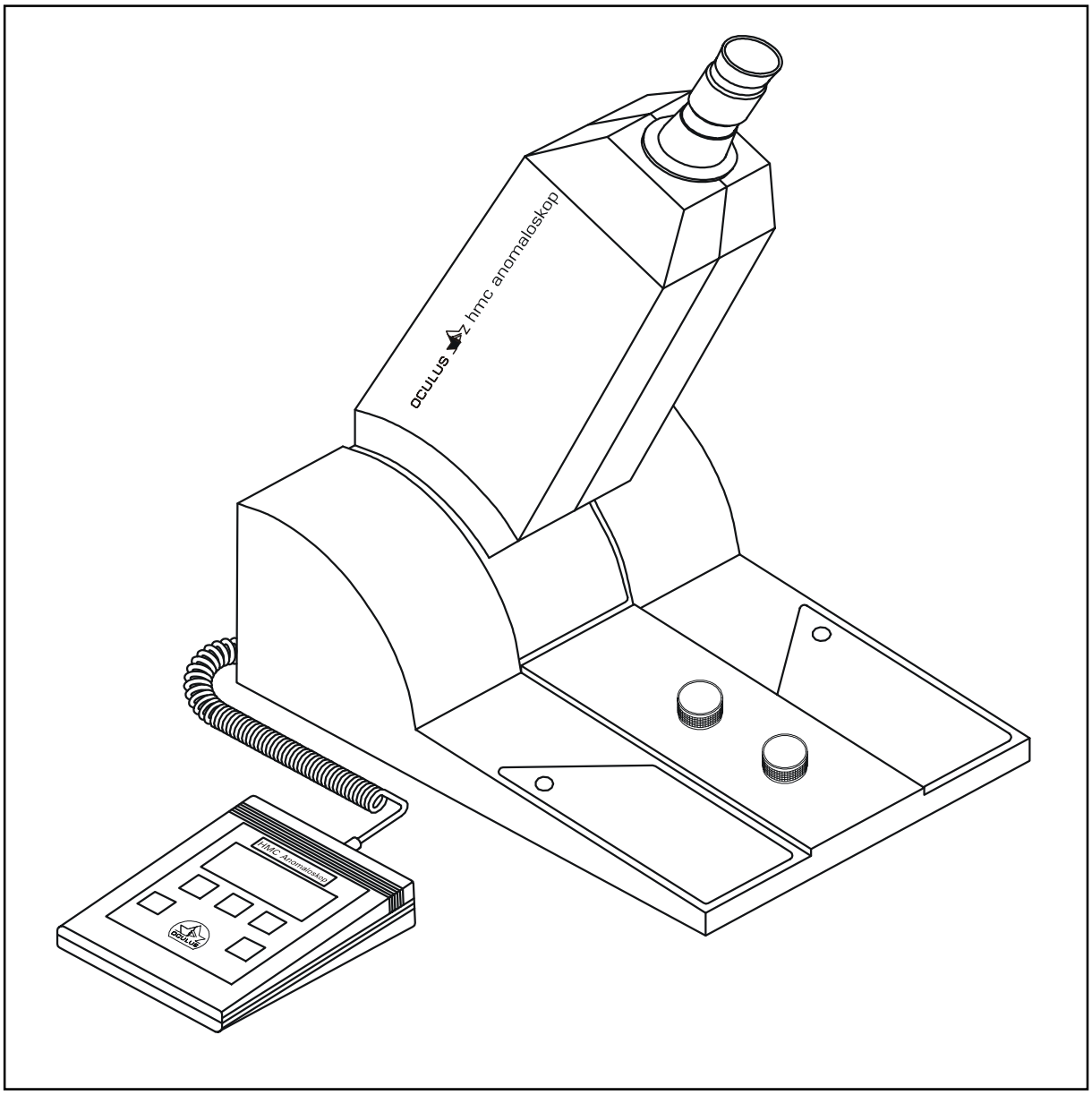


HMC Anomaloskop MR

Moreland and Rayleigh (Typ 47700)

HMC Anomaloskop R

Rayleigh (Typ 47720)

Instruction Manual

OCULUS

G/47700/0403/e

0. Foreword

Thank you for the confidence which you have placed in us by purchasing this OCULUS product. With this unit you have made your decision for a modern product which has been manufactured and tested according to the highest standards of quality.

Ongoing research and development at OCULUS, which are certainly in your interests, may lead to changes in the design and scope of standard equipment. The illustrations in this Instruction Manual may therefore differ in some respects from the unit as delivered.

Our company can look back on a history extending more than 100 years into the past.
OCULUS today is a middle-sized company whose sole focus is to provide top-quality products for the support of physicians and optometrists as they go about their demanding tasks of ocular examination and surgery.

Your HMC (Heidelberg-Multi-Color) Anomaloskop is a microprocessor-controlled unit with integrated, automatic neutral adaptation for the precise diagnosis of color vision in the red-green range (Rayleigh equation) and the blue-to-blue-green range (Moreland equation).

OCULUS incorporated the Rayleigh red-green equation several years ago when developing the Heidelberg Anomaloskop together with Prof. Krastel of the University of Heidelberg.
The newest generation, the HMC Anomaloskop, has now been enhanced with the Moreland (blue-green) equation. Here we worked directly with Prof. Moreland.
Use and control of the unit by the examinee have been greatly simplified by an improved ergonomic design, a hinged tube, and a strategic combination of keys and control knobs.
The examiner can input information either via a control unit and an display or with a PC. When used with a PC, the unit's program is capable of storing, managing and comparing patient data and examination results.

The new FeV (German Driver's License Ordinance), which went into effect on January 1, 1999, prescribes that a complete ophthalmological examination be carried out for automobile drivers with special visual requirements.
In the area of color vision, only anomaloscopes which fulfill the requirements of DIN-Norm No. 6160 may be used for this purpose.
The HMC Anomaloskop complies with this norm.

Proper use is indispensable for safety in working with the unit. For this reason, please familiarize yourself thoroughly with the contents of this Manual before using the unit for the first time.
Should you have questions or desire further information about your unit, please contact us by telephone or send us a telefax message. Our service team will be happy to assist you.

OCULUS Optikgeräte GmbH -
The Management and the Staff

1. Table of Contents

2. Standard Equipment List

- HMC Anomaloskop MR or
  HMC Anomaloskop R

- Control Unit With Display

- Test Notepad (100 pages)

- Mains cable

- This Instruction Manual

- Dust cover

- 2 spare fuses 0.2 A T
  (for 230 V-version)
  or
- 2 spare fuses 0.4 A T
  (for 115 V-version)

If you have also selected the software module for the HMC Anomaloskop (Order-No. 47703), you will find it included with the device.
If you have selected only the software module with or without a PC, the control unit, the monitor, and the test notepad are not included in standard delivery.

Please give careful attention to the instruction manuals which correspond to each of these products and their accessories, depending on the technical equipment which you have received (i.e. control unit with display or the software module and PC).

We reserve the right to change the scope and design of standard equipment during the course of ongoing technical development and improvement.

3. Safety Precautions

The manufacturer is required by law to provide the user with explicit information about safety aspects involved in dealing with this unit. This chapter contains a summary of the most important information which should be noted regarding these points of technical safety.

Further safety instructions are found in the text of this Instruction Manual and are designated by the symbol: 
Please pay special attention to the instructions in these passages.
Store this Instruction Manual carefully in a place where it is accessible for persons using the unit at all times; also, give due attention to instruction manuals for the unit's other accessories as required.
The unit may be used only for its intended purpose, as described in Chapter 5 of this Instruction Manual, and by persons whose proper use of the unit is ensured by their training and practical experience.
Use the unit only with original parts and accessories delivered by us and in a technically flawless condition. Do not attempt to use the unit should it become damaged; rather, contact your supplier.

Please abide by accident prevention laws where applicable, and pay special heed to the printed instructions and information on the unit itself.
The unit may be used in medical areas only if these areas are equipped according to the VDE 0107 norms of the Association of German Electrotechnical Engineers or their equivalent.

Always disconnect all mains plugs from their power outlets before carrying out maintenance or cleaning work.
Do not connect any electrical plug and socket by main force. If it is not possible to connect them, verify whether the plug is correct for the socket. If you find damage in either the plug or the socket, have them repaired by our service personnel.

Do not disconnect electric plugs from their sockets by pulling on the cable, but rather on the plug in each case.

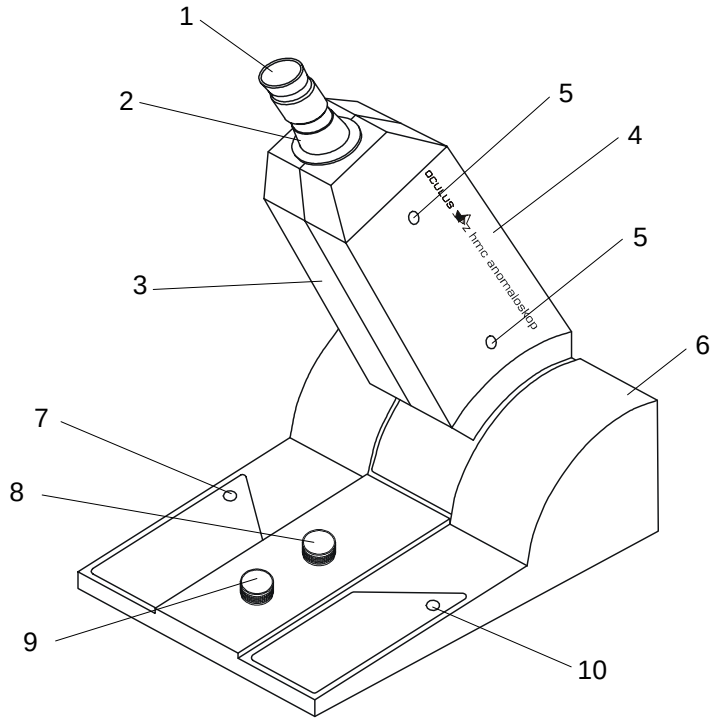
Auxiliary equipment which is connected to the analog or digital interfaces of the unit must meet the respective EN and/or IEC technical specifications of these interfaces.
Under no circumstances may a coupling of the HMC Anomaloskop with non-medical electric devices (e.g. data processing equipment) for purposes of creating an integrated electric medical system lead to a degree of patient safety which is below that required by IEC Norm 601-1.
Safety equipment in the form of a disconnecting device must be present if it is possible that permissible values for leakage current could be exceeded due to this coupling.
In addition, all configurations must conform to IEC Systems Norm 601-1-1.

Do not use the items named in the above Standard Equipment List in the following situations:
- Where there is danger of explosion.
- In the presence of flammable anesthetics or volatile solvents such as alcohol, benzine or the like.

Do not store or use the unit in damp rooms. Avoid placing the unit near dripping, gushing, or splashing water, and make certain that no fluid can enter the unit. For this reason, please do not place any containers full of liquid on or near the unit. When cleaning the unit with a damp cloth, take care that no fluid gets into the unit. Do not cover the air vents.
This unit is a high-quality technical product. To ensure that it performs flawlessly and safely, we recommend having the unit inspected regularly every two years by our service personnel. Should any problem arise which you cannot solve with the enclosed troubleshooting list, label the unit as "Out of Order" and contact our service department.

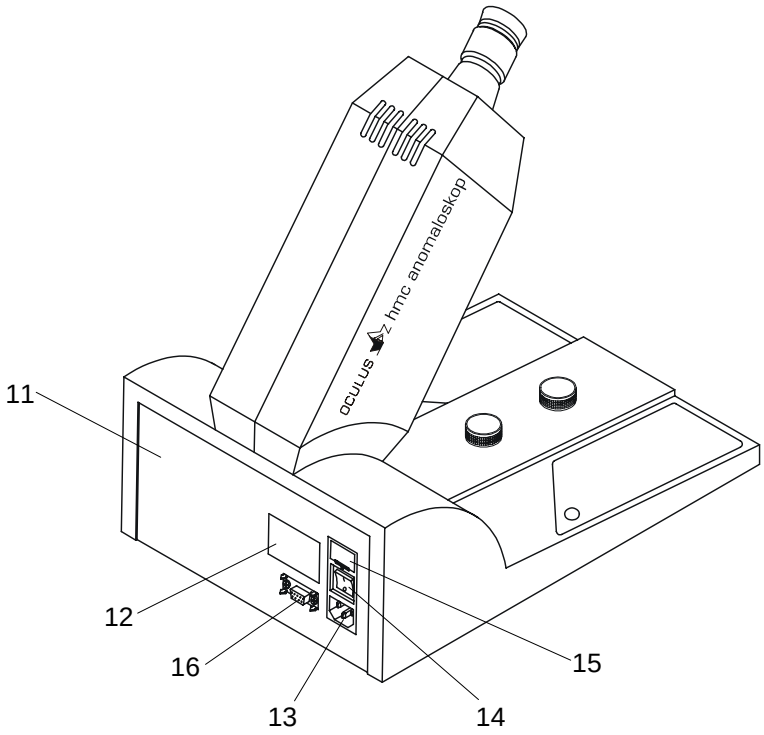
4. Description of the Unit and Its Functions

4.1. Components of the Unit



No.1 - Eyepiece
No.2 - Housing cover
No.3 - Upper housing, left-hand
No.4 - Upper housing, right-hand
No.5 - Housing caps
No.6 - Lower housing
No.7 - Left key (dissimilar colors)
No.8 - Control knob, Mixed light
No.9 - Control knob, Comparison light
No.10 - Right key (identical colors)

Figure 1 - HMC Anomaloskop, front view



No.11 - Reverse of lower housing
No.12 - Type plate
No.13 - Mains connection
No.14 - Mains switch
No.15 - Fuse drawer
No.16 - Serial interface

Figure 2 - HMC Anomaloskop, reverse view

4.2. Description of the Unit

The HMC Anomaloskop does more than merely allow you to carry out a qualitative and quantitative diagnostic analysis of congenital color vision deficiencies. It can also be of valuable assistance in clarifying the nature of maculopathy or optic nerve damage whenever biomicroscopic or perimetric findings do not lead to a clear-cut diagnosis.
Most anomaloscopes can be used only to examine red-green vision. This range quite frequently contains congenital color vision deficiencies (8% of males, 0.4% of the female population).
The HMC Anomaloskop MR and R also meets this standard by using the Rayleigh equation:

Green (549 nm) + Red (666 nm) =
Yellow (589 nm)

In addition, blue vision can also be examined with the HMC Anomaloskop MR. For this the HMC Anomaloskop MR uses the Moreland equation:

Blue (436 nm) + Green (490 nm) =
Cyan (480 nm) + Yellow (589 nm)

In the case of green, the actual color is blue-green (turquoise).
The color yellow is used here only for desaturation of cyan.
We selected the Moreland-type equation for the HMC Anomaloskop MR because it has proven itself to be both the most sensitive and the most specific.

The HMC Anomaloskop utilizes the principles of additive color mixing and metamerism.
Two spectral color stimuli are overlapped in the upper half of the circular viewing test field, so that the additive color mixture appears identical with the spectral color stimulus presented in the lower hemifield.
The ratio of the light mixture at the top is variable, and the brightness of the lower light is varied for comparison until the viewer subjectively experiences an identity of the two hemifields in color and brightness.
In order to achieve reproducible and comparable results, the following viewing conditions and modes of presentation were employed in the HMC Anomaloskop:

- Observation of the viewing test field at an angle of 2 degrees.
- Sharp focus of the viewing test field by adjustment of the eyepiece (No. 1, figure 1)
- Presentation of the viewing test field in an absolutely dark surrounding.
- Adherence to the wavelength and bandwidth requirements of the color stimulus (DIN Norm No. 6160 for the Rayleigh-type equation).
- Separation of the two halves of the viewing test field by a thin line; this is designed to disappear as far as possible in case of identity.
- Homogeneity of the colored areas was achieved by mixing the colors in Ulbricht spheres.
- Neutral adaptation of the eye.

An important prerequisite for carrying out examinations with the HMC Anomaloskop is neutral adaptation of the examinee's eye. Neutral adaptation is achieved in this unit automatically by fading in white light from a light source comparable with standard type C (6770 K) in place of the viewing test field. Neutral adaptation occurs at two different intervals, depending on the selected matching range. Neutral adaptation is important because adaptation (accommodation) can occur when the viewing test field is regarded for a longer period of time, and this distorts the examination results.
The upper part of the HMC Anomaloskop's housing is swivel-mounted in order to provide the examinee with the best possible sitting position and thus the best possible and most non-fatiguing angle of view.
For downward adjustment, simply press down on the upper part of the housing to swivel it downwards. When adjusting it upwards, hold the bottom part of the housing lightly at the front in order to prevent the device from lifting up off the surface on which it rests.

The HMC Anomaloskop has been provided with control knobs for improved use of the unit. These knobs are equipped with a fine notching mechanism and have no limit stop. For this reason, an acoustic signal

signals that the end of the color scale has been reached.
The control knobs are positioned above each other, corresponding to the viewing test fields, to facilitate orientation.
The lower control knob (No. 9 in figure 1 on page 6) is used to adjust the brightness of the comparison light. The upper knob (No. 8) is used to adjust the mixed light.
A softer material has been used for the blue hand rests next to the control knobs in order to make contact between the hands and the unit more pleasant.
Note that keys have been integrated into these hand rests (Nos. 7 + 10). The right key is used during the examination to confirm identity of colors, the left is pressed in case of dissimilarity.
Here too, an acoustic signal confirms that a key has been pressed.
At the back of the unit, you will find the type plate (No. 12, figure 2 in page 6), the mains connection (No. 13), the mains switch - illuminated with a green light- (No. 14), and the fuse drawer at the top (No. 15).
For best use of the HMC Anomaloskop, connect our OCULUS PC with its specially developed Windows™-compatible software to the serial interface of the unit (No. 16). You can then electronically store, manage and compare both, patient data and examination results.
This software can also be integrated into most of the widely-used software modules, which are commonly found in medical practices.
A less comfortable, but also lower-priced alternative is offered by the control unit. The dialogue with the program is then carried out by means of a 4-line liquid crystal display with keys, which are arranged accordingly.
You will find an exact description of the software modules in the corresponding instruction manual.

4.3. Description of the Control Unit

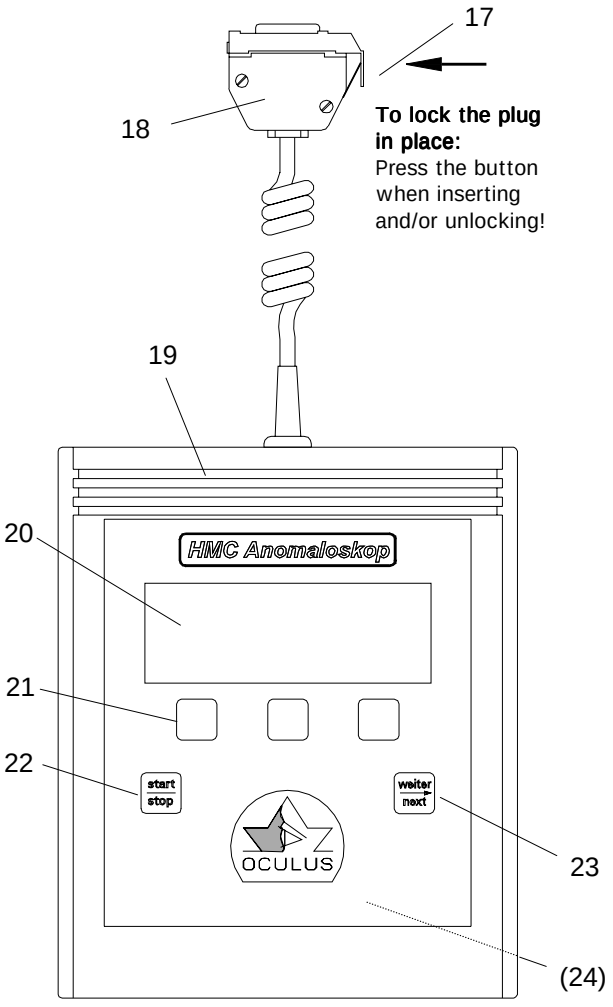


Figure 3 - Control unit with display

The basic equipment for operating the HMC Anomaloskop consists of the control unit with display.
The program dialogue is carried out via the keys and the 4-line display (LCD). During this dialogue, the row of keys below the display (Figure 3, No. 21) is always related directly to the text on the screen (Figure 3, No. 20). These keys change their allocations/functions during the examination.
The "Start/Stop" key (Figure 3, No. 22) is used to start and stop the examination which is shown in the upper lines of the display.
The "Next" key (Figure 3, No. 23) is used to page through the rest of the examination programs when settings are being selected.

No. 17 - Locking mechanism
No. 18 - Plug for the serial interface
No. 19 - Housing
No. 20 - Display, 4-line LCD
No. 21 - Row of keys (Allocations change according to display)
No. 22 - "Start/Stop" key
No. 23 - "Next" key
No. 24 - Type plate (at the back of the unit)

4.4. Displays on the Screen of the Control Unit

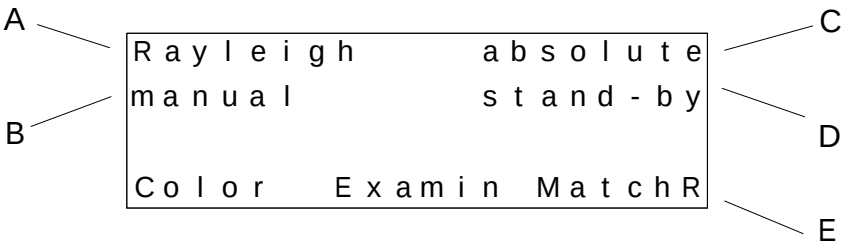


Figure 4 - Structure of the display

A) Display of the Selected Color Vision Test
Options: *Rayleigh* (Red-Green) or *Moreland* (Blue-Green) (only HMC-MR)

B) Display of Selected Examination Rayleigh:
Options: *Manual*, *Screening*
or the specific examinations *Normal* (person with normal vision), *Deuteranopia*, *Deuteranomaly*, *Protanopia* or *Protanomaly*

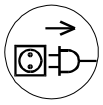
Display of Selected Examination Moreland (only HMC-MR)**:**
Options: *Manual*, *Screening*
or specific examination *Normal* (person with normal vision)

C) Display of Matching Range
Options: *Relative* (neutral adaptation after 15 seconds), *Absolute* (neutral adaptation after 5 seconds) or *NeutOff* (without neutral adaptation)

D) Display of Examination Status
(shows whether an examination is currently in progress)
Options: *Standby* or *Aktive*

E) Display of Current Keyboard Allocations
Options: *Color*, *Examin* (Examination), *MatchR* (Matching Range), *Menu* or *all possibilities under A) to D)*

4.5. Warnings and Printed Instructions on the Unit



Caution! / Always disconnect the mains plug before opening the unit.

Important! / Please read the accompanying printed material carefully.

5. Appropriate Use

This unit may be used only for the purposes described in this Instruction Manual.
This unit has been designed for precise qualitative and quantitative diagnosis of color vision of the human eye in the red-green range (HMC Anomaloskop R) and in the red-green and blue-green ranges (HMC Anomaloskop MR).

This unit may be used only by persons whose training and practical experience ensure that they will work with the unit in an appropriate manner.

The diagnoses displayed must be individually verified, since it is quite possible for false diagnoses to occur due to adjacent and overlapping defects in color vision or through input errors on the part of the patient.

Please use the unit only with original parts delivered by us and in a technically flawless condition.

Operate the unit only with an electric power supply system whose supply voltage is within the range limits given on the rating plate.

Please abide by the safety precautions given above.

6. First Use of the Unit

6.1. Before First Use of the Unit

Remove the unit and its accessories from their packing materials and store the latter. You can then send or transport the unit correctly should service or repairs ever be required. In this way you will avoid unnecessary damage and costs.

Please read this Instruction Manual carefully.

Before connecting the unit to the electric power supply system, check whether the supply voltage of the electric power supply system is within the range given on the Type plate (No. 12, figure 2 on page 6).

This optical device should be treated with care. Do not subject it to vibration, impacts, soiling or high temperatures.

6.2. Setup and Adjustment

Please set up the HMC Anomaloskop on a firm, clean and level surface (e.g. a table surface) in such a way that the air vents on the bottom of the unit are not covered. Also avoid setting up the unit near heating units or moisture which might make its way into the unit.

In preparation for using the unit for the first time, connect the control panel (or the serial cable of the PC) to the jack of the serial interface (No. 16, Figure 2 on page 6). Use the mains cable to connect the mains connection (No. 13) with the electric power supply. The latter must be equipped with a protective earth conductor which is in flawless working condition.

6.3. Information about Transport and Storage

Please use the original packing material if you must transport the unit. In this way you will avoid unnecessary costs and damage.

Avoid unnecessary impacts when transporting the unit to another location. These may have a negative effect on the optical and electronic components as well as on the adjustment of the unit.

Inspect the unit for damage whenever it is relocated. Under no circumstances should you put the unit into operation if it has been damaged; instead, please contact our service representative.

If you keep the unit in a vehicle during the cold season of the year, its optical parts may become fogged with condensation after abrupt changes in temperature from cold to warm.
Please give the unit time to acclimatize to its new surroundings before using it for the first time.

The proper conditions for transporting and storage according to IEC Norm No. 601-1 are:
- Ambient temperature: -40°C to +70°C
- Relative humidity: 10% to 100%, including condensation
- Air pressure: 500 hPa to 1060 hPa

These values apply in the unit's original packaging materials for a period of 15 weeks at most.

7. General Remarks on the Color Vision Tests

Impairments in color vision are usually classified as either anomalies or anopia. "Anomaly" in this case refers to a color vision deficiency, and "Anopia" refers to color blindness.
"Protanomaly" and "Protanopia" always involve the color red, "Deuteranomaly" and "Deuteranopia" the color green, "Tritanomaly" and "Trianopia" the color blue.
Both congenital and acquired anomalies of color vision can be diagnosed qualitatively and quantitatively with the Red-Green and Blue-Green color vision tests of the HMC Anomaloskop.
Examinations of congenital impairments in color vision, such as protanopia, deuteranopia, tritanopia, achromatopsia or similar deficiencies, are usually required for written evaluative reports and are often a prerequisite for acquiring licenses (e.g. a driver's license).
These impairments of color visions may be evoked by genetic deficiencies or heredity. However, they always affect both eyes and remain unchanged during the course of time.
In patients with congenital color vision deficiencies, the type of impairment can be identified immediately inasmuch as the findings are displayed with absolute matching range and brightness of the comparison field.
In the case of congenital protanopia or deuteranopia, the red-green equation has a characteristic value which depends on the respective color vision deficiency. The blue-green equation, on the other hand, is usually normal, often somewhat enhanced.
Exactly the opposite is true in congenital tritanomaly.
Acquired color vision deficiencies have numerous features in common; these distinguish them from congenital color vision deficiencies. The former are usually the consequence of illness or poisoning, but may also be related to other visual impairments, e.g. visual deterioration or visual field defects. This may make it more difficult for the examinee to locate the viewing test field in the anomaloscope. Impaired adaptation to brightness and darkness may also make their appearance.
Examination in this case can serve primarily the purpose of recognizing and monitoring these disorders.
In contrast to the congenital type, such color vision deficiencies may affect one eye alone or both eyes to different degrees and may also change during the course of time.
The onset of a deterioration in color vision manifests itself in the form of a shift or an increased adjustment of the color equation in only one of the two color vision tests.
In addition, disorders such as glaucomatous damage, diabetic retinopathy, retinal damage in cystoid macular edema, macula pucker, macular degeneration or central serous retinopathy as well as drug damage or toxic retinopathy can be detected and confirmed.
Both types of color vision deficiencies are described quantitatively by the Anomaly Quotient.

7.1. The Anomaly Quotient

The Anomaly Quotient gives the ratio of the color mixture in the form of a numeric value and must be determined when the eye is neutrally adapted, i.e. with relation to the absolute matching range during the course of the examination.
The quotient is 1.0 with the mean normal equation.
The Anomaly Quotient is derived from the formula:

$$A_Q = \frac{\frac{E-P}{P}}{\frac{E-M}{M}}$$

The abbreviations here have the following meanings:

- A_Q: Anomaly Quotient
- E: End value of the light mixture scale.
- P: Adjustment value on the light mixture scale.
- M: Color vision adaptation of an observer with normal color vision.

The examination results are given in the form of a pair of numbers, since the Anomaly Quotient alone provides no information on the luminance of the comparison field. In each pair of numbers, the Anomaly Quotient is given first, followed by a semicolon and then the respective value of the comparison field (e.g. 0.9 ; 14).

7.2. The Mean Normal Equation

The color adjustment of the mixed color field of a colorimetric 2°- normal observer is designated as the mean normal equation (cf. also German DIN-Norm No. 5033-2).
In the Red-Green Test, this setting is about (55 ± 5)% of the upper limit of the scale, which is 73, i.e. about 40/15.
The ± 5% here indicates the permissible matching range of a normal observer.

The number "15" is related to the value on the brightness adjustment scale of the comparison field.

The matching range differs in the two color vision tests (Red-Green and Blue-Green), inasmuch as it lies somewhat higher in the Blue-Green Test.

7.3. The Matching Range

The range of different color mixtures in the mixed color field, which can be brought into equilibrium with the comparison field, is designated as the "matching range".
The matching range provides an estimate of the ability to distinguish colors in the mixed color field. Higher sensitivity in differentiating between wavelengths is therefore present whenever the matching range is low.

The absolute matching range is the basis for aptitude tests in written evaluations and certificates. It must be determined when the eye is neutrally adapted, i.e. during 5-second cycles of observation of the colored area. The white fluorescent surface for neutral adaptation is shown intermittently.

The relative matching range, on the other hand, is derived during observation of the viewing test field for a period of at least 15 seconds. It is usually greater than the absolute matching range, since adaptation (or accommodation) takes place when the viewing test field is regarded for a longer period of time, and this influences the examination result.
The relative matching range has special diagnostic importance in diagnosing acquired color vision deficiencies. However, the eyes of some examinees with congenital color vision deficiencies are also capable of adaptation.

7.4. The Different Examination Programs

The examination programs which are available to you are described in the following.

Note: false examination results nearly always result when the examinee presses the "Same" key erroneously.

After completion of the different examination programs, a diagnosis is made for you. If there is uncertainty about the diagnosis or no color equation was recognized as "Same", a message reports to you that no diagnosis is possible.

The diagnoses which are displayed must be individually verified, since adjacent and overlapping color vision defects or input errors by the patient can easily lead to false diagnoses.

7.4.1. The Screening Test

This examination program, with its rapid and uncomplicated procedure, can be used only as a preliminary test in order to uncover defects in color vision.
The examinee is shown 6 different color equations in succession by the program; he must evaluate them as identical or different. All known defects in color vision can be discovered and screened out with these color equations.
Since it is not desirable here that the examinee undertake a color adjustment in the upper mixed color field, only the lower control knob is put in readiness for him. He can use this knob, if necessary, to change the brightness of the lower comparison field.
If the examinee has evaluated a color equation as identical or different, a neutral adaptation is always carried out prior to the next color equation.
The diagnosis which has been reached is shown to you at the end of the program. You must then turn to the manual or specific tests if more precise information is required, such as quotients of anomaly and matching ranges.

7.4.2. The Manual Test

This examination program requires that the examinee bring the two hemifields into mutual correspondence by using both control knobs to adjust them. He uses the upper control knob to adjust colors in the mixed field and the lower knob to adjust the brightness of the comparison light.
We recommend that you first let the examinee adjust the mixed color field with the upper control knob, so that he can acquire a feeling for the adjustment procedure. After approximate correspondence has been reached, he must attempt to arrive at the best possible correspondence by adjusting the brightness of the comparison light (lower control knob). It is quite normal for him to correct the mixed light adjustment repeatedly during this time.
The examination starts with the mean normal equation.
If the examinee confirms a setting as identical with the right key, the program keeps this setting. In order to get an indicative matching range, the value of the color setting must be changed a little bit before proceeding with the examination. The adjustment procedure described above must then be repeated by the examinee.
You can interrupt the program at any time; however, please remember that a matching range can be only determined after at least two successful settings by the examinee.
The test repeats itself endlessly until you exit from the examination program.

7.4.3. Specific Tests

Specific tests are recommended whenever a precise defect in color vision is known or has been diagnosed by means of the Screening Test.
The following specific Rayleigh Red/Green tests can be selected: Normal, Deuteranopia, Deuteranomaly, Protanopia and Protanomaly.
Only "Normal" can be selected as a specific Moreland Blue/Green Test (only HMC-MR) for examinees with normal vision.
These examination programs are even more precise than the Manual Test, since they determine each of the two threshold equations through a process of elimination.
For this purpose, the program selects a color vision adaptation which lies beyond the limit of the clinical syndrome in question (or of the normal range). The examinee must then evaluate the correspondence of the colored fields. Since this is carried out in the same way as with the Screening Test, he can only influence the brightness of the comparison field. After his evaluation (i.e. as identical or different), the program springs to the opposite limit of the clinical syndrome (or of the normal range).

In this way, the program narrows down the specific threshold equations precisely, using large steps at the beginning. These increments grow steadily smaller during the course of the examination.
Since the steps at the end are so small that the color display in the test field changes only minimally, the examinee often does not notice this change at all and reports that the mixture in the color field remains constant. Even so, he must carry the examination to its conclusion, since the sameness of the color display is illusive, and it is precisely the final options which deliver the most exact results.

7.5. Preliminary Test before the Red-Green Test

First examine the patient with pseudoisochromatic charts. In doing so, please observe the manufacturer's recommendations regarding proper illumination and observation distance. We recommend the use of two chart systems due to differences in the quality of print.
The sensitivity of these search-and-find tests is generally above 95% when the Ishihara plates are used together with a second series of charts.
Color vision deficiency is very likely the correct diagnosis if some charts are seen erroneously or not at all during the test.
It is nearly impossible to differentiate between protanopia and deuteranopia with such charts, much less between anomaly and anopsia. This is possible only with an anomaloscope.

7.6. General Remarks on the Rayleigh Red-Green Test

The Red-Green Test of the HMC Anomaloskop uses the Rayleigh equation for examinations of normal color vision:

Green (549 nm) + Red (666 nm) =
Yellow (589 nm)

In the horizontally divided viewing test field, the mixed color field of green and red is in the upper part and the comparison field with yellow is below.
The mixed color field can be set from 0 to 73; for example, 73 means a setting of the mixed color field without the color green. Persons with normal vision have a setting of 34 to 46 on the scale here. The mean value of 40/15 is taken as the mean normal equation.
The comparison field has a value of 15 on the scale and can be adjusted from 0 to 45 in brightness.
The Anomaly Quotient with the mean normal equation is 1.0.

According to the Board of Professional Norms for Color, examinees with an Anomaly Quotient of

0 to < 0,7	are	Protanomalous
0,7 to 1,4	are	Normal
> 1,4 - ∞ (infinity)	are	Deuteranomalous.

Total color blindness (achromatopsia) is characterized by an extreme loss of brightness in the direction of red and an increase of brightness in the direction of green. Possible adjustment values here are, for example:
73/1; 60/25; 50/40

The program will show you the results of evaluation after the examination.

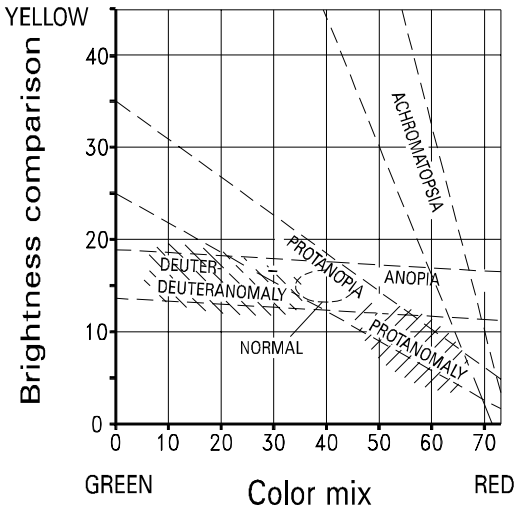


Figure 5 - The Rayleigh Red-Green Color Test

7.6.1. Typical Results In Congenital Color Vision Deficiencies

A) Anomalies

Anomalies may result from a deficiency in cone pigment sensitivity to medium or long wavelengths. The mean normal equation and the threshold equations are usually rejected (an exception: extreme anomalies).

1. Deuteranomaly

"Deuteranomaly" is the most frequent congenital color vision deficiency. The green part of the mixture is perceived as reduced. This is indicated by a designation of the mean normal equation as "up to red". Finding an accepted equation by mixing green into the mixed color field.
Anomaly Quotient: 1.7 to 20.
Extreme deuteranomaly:
Anomaly Quotient: 1.0 to infinity.

2. Protanomaly

Also called "protanomalopia". The red part of the mixed color field is perceived as diminished. This is expressed by a designation of the mean normal equation as "up to green". Finding an accepted equation by mixing red into the comparison field and reducing its brightness. The loss of brightness is a characteristic feature of protanomaly.
Anomaly Quotient: 0.6 to 0.11.
Extreme protanomaly:
Anomaly Quotient: 0 to 1.0.

B) Anopia

Anopia is due to the absence of a cone pigment, so that only a single pigment is present for the long wavelength half of the visible spectrum. For this reason there is no possibility of differentiating between red and green, and red-green blindness is the result.
The mean normal equation is accepted. Both threshold equations are also accepted, but with different distributions of light intensity depending on the type of anopia. Anopia has no Anomaly Quotient.

1. Deuteranopia

Red-green blindness due to an absence of cones which are sensitive to medium wavelengths.
The mean normal equation and both threshold equations are accepted, but both tend towards yellow light intensities of about 15. The absence of major differences in brightness between the threshold equations is characteristic.

2. Protanopia

Red-green blindness due to the absence of cones which are sensitive to long wavelengths.
The mean normal equation and both threshold equations are accepted, but a very bright yellow (about 30 increments on the scale) is selected for the green threshold equation (0 on the scale) and a very dark yellow (about 5 on the scale) for the red threshold equation (73 on the scale). This loss of brightness in the direction of red is characteristic of protanopia. Differences in brightness may be designated by the patient as differences in color. Brightness adaptation should always be carried out first for this reason, and the patient should then be asked about identity of colors.

C) Achromatopsia

Congenital, total color blindness, absence of all cone functions: rod monochromatism.
In spite of a poor visual acuity of about 0.1, the viewing test field of the HMC Anomaloskop is easily found by the examinee. The red threshold equation (73 on the scale) is perceived as extremely dark (darker than in protanopia).
There is an extreme increase of brightness toward green: A yellow of about 40 on the scale is selected for a mixed light of 50 on the scale. This corresponds to the perception of brightness by the rods.

7.6.2. Typical Results in Acquired Color Vision Deficiencies

A) Widening of the Setting Range

During progressive retinal and optic nerve diseases which affect either the central visual field either alone or together with other areas, the matching range increases on the HMC Anomaloskop. The relative matching range (observation of the viewing test field > 15 s) may be particularly enhanced in patients with acquired color vision deficiencies.

A symmetric widening of the matching range, starting within normal limits, or a tendency towards an increase toward green, is frequently found in conductivity disorders of the optic nerve. This initially proceeds without loss of brightness, which then appears in the advanced stages. Typical examples: retrobulbar optic neuritis, other optic nerve injuries (e.g. toxic: ethambutol).

B) Pseudo-Protanomaly

The equation of the HMC Anomaloskop typically shifts towards red in the case of inflammatory, toxic and hereditary macular diseases. In the process, there is also a loss of brightness. For this reason the findings may be identical to those of protanomaly with regard both to the position of the equation and the reduced brightness of the control yellow.
Typical examples: central serous retinopathy, chloroquine maculopathy, Stargardt's macular degeneration.
As the disorder progresses, particularly in the case of degenerative macular processes, there is an increase in the red shift, a widening of the setting range, and a loss of brightness towards red, possibly to the point of scotopia.

C) Scotopia

A complete loss of cone function may result if there is pronounced cone damage in the tested visual field. The examinee then uses the rods, i.e. his own scotopic system, for the evaluation of color vision adaptation. We speak of "scotopia" in this case. The examination result resembles that of congenital achromatopsia. The extremely abrupt increase of brightness towards green in the accepted equations, and the extreme loss of brightness towards red, correspond to the long wavelength flank of the rhodopsin wavelength, i.e. rhodopsin, the visual substance of the rods.

7.7. General Remarks on the Moreland Blue-Green Test (only HMC-MR)

The Blue-Green Test of the HMC Anomaloskop uses the Moreland equation to evaluate normal color vision:

Blue (436 nm) + Green (490 nm) =
Cyan (480 nm) + Yellow (589 nm)

The horizontally divided, two-part viewing test field consists of an upper, mixed color field of green and blue and a lower comparison field with cyan and desaturation with yellow.
The mixed color field can be adjusted from 0 to 100; 100, for example, results in a setting of the mixed color field without the color blue.
The comparison field can be adjusted in brightness from 0 to 100.
The mean value of 50/50 has been selected as the mean normal equation.
The Anomaly Quotient is 1.0 with the mean normal equation as well.

Congenital impairments in the blue area (tritanomaly) have a frequency of ca. 0.003 % and are therefore much less common than congenital impairments in the red-green area. Men and women are affected equally often by tritanomaly. Confirmation of these impairments is much more difficult than that of red-green impairments due to pronounced individual differences in macular pigmentation, which heavily affects the perception of blue.

In contrast, the Blue-Green Test is very important for the examination of acquired color vision deficiencies and for early detection of progressive diseases and intoxication of the retina and the optic nerve. These may be macular diseases, retinitis pigmentosa, diabetes mellitus, dominant hereditary optic nerve atrophy, or various types of optic nerve and retinal damage.

If an acquired color vision deficiency displays a shift of the blue-green equation towards blue (0 on the scale), we speak of pseudo-tritanomaly.

You should suspect glaucoma, diabetes, achromatopsia, or monochromasy of the retinal blue photoreceptors if the adjustments made by the examinee are located in the areas shown in Figure 6.

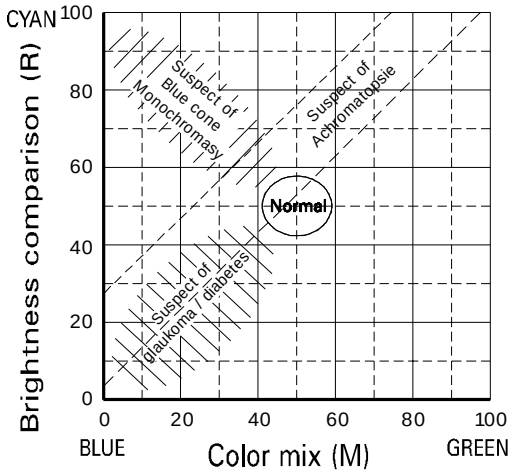


Figure 6 - The Moreland Blue-Green Color Scale

The clinical importance has become increasingly clear with the availability of the Blue-Green Test. All disorders which undermine spatial organization in the retina and the optic nerve increase the likelihood that the Blue-Green Test will reveal early pathologic changes.

The findings in older persons depend on the thickness of the lens. In spite of normal visual acuity levels, a slight shift towards blue in the blue-green equation appears here with increasing thickness of the lens. This must be taken into account when assessing the results.

7.8. Overview of Clinical Syndromes: Acquired Color Vision Deficiencies

The following interrelationships between specific categories of disease and changes in color vision were determined by Hermès, Roth and Borot (1989).

Acquired Color Vision Deficiencies

		Early Stages		Advanced Stages		
Color vision deficiencies		Midpoint of Matching Range	Matching Range	Midpoint of Matching Range	Matching Range	Results
Red/Green	R	Pseudo-Protanomaly	Normal	Pseudo-Protanomaly	Wider	a)
	M	Normal	Normal	n. green shift	Wider	
Red/Green + Blue	R	Normal	Normal	Normal	Wider (R < M)	b)
	M	Normal	Wider	Normal	Wider	
Blue	R	Pseudo-Protanomaly	Normal	Pseudo-Protanomaly	Wider	c)
	M	Normal	Normal	Normal	Wider	
Blue + Red/ Green	R	Normal		Pseudo-Protanomaly	Wider	d)
	M	Pseudo-Tritanomaly	Normal	Normal	Wider	

R: Rayleigh equation, M: Moreland equation (only HMC-MR)

The following disease categories were found:

a) Progressive cone degeneration (Stargardt's disease and others)
b) Disorders of the optic nerve (optic nerve neuropathy)
c) Choroidal disease (serous chorioretinitis), central macular edema with venous thrombosis
d) Cataract (diabetic retinopathy), pigment degeneration (retinitis pigmentosa), glaucoma, macular edema

7.9. Color Vision Testing According to the New FeV (German Driver's License Ordinance)

Minimum legal visual requirements on the part of those who apply for a driver's license are described in § 12 of the FeV (German Driver's License Ordinance) of January 1, 1999 and in Appendix 6 of the same.
Color recognition provides automobile drivers with valuable and important additional information in many traffic situations. A person with impaired color vision can make only partial use or none at all of information which the trichromatic person perceives. Especially important here is a good recognition of red signal lights, e.g. the position and brake lights of vehicles ahead, especially under poor conditions of visibility.
Poor conditions of visibility can occur during driving in fog, in heavy rain, during a snowstorm, against the sun when it is low on the horizon, or when there is dirt on the headlights.
Limited perception in the red range (protanopia and protanomaly) is therefore relevant for automobile traffic. For this reason, legal restrictions are required for this area.
The signal colors of traffic lights, on the other hand, can usually be correctly recognized and classified even by persons with impaired color vision.
The test of color vision must be carried out with suitable color panel systems or with color vision test disks. Two different systems must always be used for the examination, since slight deviations in color can result from different qualities of print.
If errors occur during the test, §§ 12 and 48, Paragraphs 4 and 5 of the above-named ordinance prescribe an examination with the anomaloscope as mandatory for applicants for driver's licenses in categories C, C1, CE, C1E, D, D1, DE, D1E and the Driver's License for Transport of Passengers. Appendix 6 requires in paragraph 2.2.2 a quotient of anomaly of at least 0.5 with an absolute matching range.
If an anomaly is found, AQ is evaluated as the value which deviates farthest from the mean normal equation as a result of examination with the anomaloscope.

An impairment in color vision does not constitute a reason for disqualification for driver's licenses in categories A, A1, B, BE, M, L and T. The person affected must merely be made aware of the possible dangers of this situation in automobile traffic.
According to the FeV (Driver's License Ordinance), the quotient of anomaly for categories C, C1, CE, C1E must be determined with an anomaloscope. As before, however, it suffices to inform the affected person about the possible dangers. The person must be made aware of the fact that he must always maintain a greater safety distance from the vehicle in front of him in order to compensate for his handicap. It is to be noted in passing that this regulation contradicts the recommendations of the German Ophthalmological Association in Heidelberg.
Driver's licenses in the categories D, D1, DE, D1E and the Driver's License for Transport of Passengers are not permitted in case of protanopia and protanomaly with an AQ of less than 0.5.

8. Operation of the Unit

8.1. Before Every Use

Before each use, please check to make sure that:

- The unit is in flawless technical condition.
- All cables and plugs are in flawless working condition.
- You are using the unit with the mains cable designed for the unit.
- You have inserted the mains plug into a power outlet, which is equipped with a protective earth conductor in flawless working condition.

When using the unit with a PC, please turn on the PC first and then the HMC Anomaloskop.

Always comply with the appropriate instruction manuals which are found included with the software module and the PC.

Use the green mains switch on the back side of the unit to turn on the unit before using it to carry out an examination.

8.2. Preparing the Examinee

Ask the examinee to sit in a relaxed manner in front of the unit.
The upper part of the HMC Anomaloskop's housing has been provided with a swivel-mount to ensure both the best sitting position, i.e. a non-fatiguing posture, and the best possible angle of view for the examinee.

Always make sure that nothing can interfere with the unit's rotation and that your own fingers and those of the examinee are out of the way.

To adjust the unit downwards, simply press down on the upper part of the housing.
When adjusting the unit upwards, lightly hold the bottom part of the housing at the front to keep the unit from lifting up off the surface on which it stands.

Explain the positions, function and arrangement of the control knobs and push buttons to the examinee.

Inform the examinee which eye will be examined first. The examinee should relax as much as possible and look into the middle of the aperture with this eye, so that the viewing test field is exactly centered in his gaze. The examinee can keep the unexamined fellow eye open or closed, whichever he finds easier.

Alert the examinee to the fact that a white, luminous field will appear during the examination and that during this phase he must continue to gaze into the eyepiece in order to maintain neutral adaptation of his eye.

If the examinee reports an absence of either neutral adaptation or the viewing test field, please interrupt the examination and follow the instructions in Chapter 9.3. (Troubleshooting).

Best results are obtained when the examinee sees the viewing test field with its border in sharp focus. To achieve this, he can correct his own visual acuity at the eyepiece at the beginning of the examination. The unit is capable of a correction of ±6 diopters. If this diopter adjustment range is insufficient, the examinee can use his own eyeglasses or contact lenses.

Under no circumstances should the eyeglasses or contact lens be tinted, since this affects the results of measurement.

8.3. Examination Procedure With the Control Unit

The HMC Anomaloskop carries out a self-test as soon as it is turned on with the mains switch (Figure 2, No. 14 on page 6). During this period, two black bars can appear on the screen. The following interim display appears briefly on the screen immediately following this self-test (Figure 7).

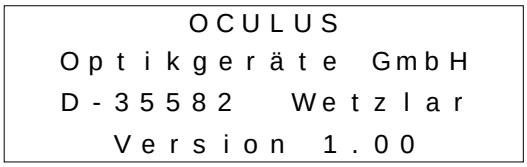


Figure 7 - Interim display after the unit is turned on

The number of the program version is found in the last line (here: 1.00). Please give this number when making inquiries.
Above this interim display, the program automatically proceeds on to the following basic settings (Figure 8).

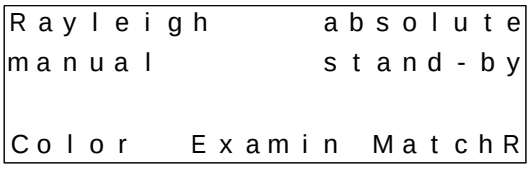


Figure 8 - Display of basic settings

This set of basic settings appears each time the unit is turned on, even if the program was previously ended with other settings.
Press the "Start/Stop" key of the control unit in order to carry out an examination with these settings, (Figure 3, No. 22 on page 8).

Press the key below "*Color*" in order to reset the unit to the other color vision test. You can then set the unit for the desired test of color vision (Figure 9).

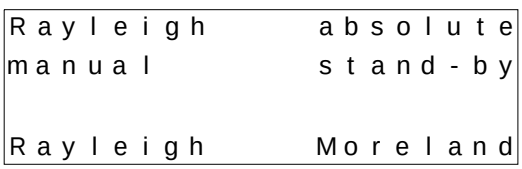


Figure 9 - Selection of color vision tests

Use the left key to select the Rayleigh Red/Green test and the right key to select the Moreland Blue/Green test (only HMC-MR).

Press the key under "*Examin*" if you wish to set the unit for a different examination program. You will then be shown the following display (Figure 10) on the screen.

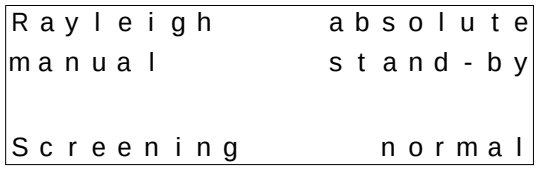


Figure 10 - Selection of examinations

Now you can use the left key to select the Screening Test or the right key to select a specific examination for a person with normal vision.
Please use the "Next" key of the control unit (Figure 3, No. 23 on page 8) to select other examinations. The following display on the screen is intended to serve as an example for the other specific examination programs (Figure 11).

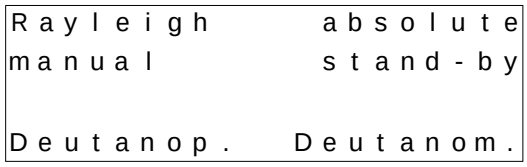


Figure 11 - Selection of other examinations

Other examinations are shown when the "Next" key is pressed repeatedly. After all available examinations have been paged through, the series of selections begins again from the start.
Use the key under "*MatchR*" to select the matching range. You then have a choice of Relative (*rel.*) or Absolute (*abs.*) matching range and an examination without neutral adaptation (*NeutOff*), as shown in Figure 12.

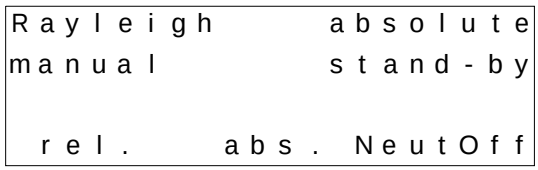


Figure 12 - Selection of matching range

After selecting all basic settings, you can start the examination with the "Start/Stop" key of the control unit (Figure 3, No. 22, on page 8).
The test field of the unit switches from black to the currently selected color equation when the examination starts; you can see this equation and follow the examinee's adjustments in the last line of the display (Figure 13). The display of the examination status changes from "*standby*" to "*active*". On the right side of the third line you get than the information (two stars), when the neutral adaptation for the patient is working.

```
Rayleigh          absolute
manual              active
                          **
M00.0    R16.0    AQ99.9
```

Figure 13 - Display during an examination

The three keys under the display remain inactivated during the examination.

If the examinee accepts at least one color equation as identical during the manual examination, you can stop the examination program by pressing the "Start/Stop" key of the control unit (Figure 3, No. 22).
However, at least two color equations should be accepted in order to arrive at an upper and lower threshold equation.
A display like that in Figure 14 is shown on the screen after the Manual Test has been stopped with the "Start/Stop" key.
Such a display appears automatically and shows the end of the examination after completion of the Screening Test or the specific tests.

```
M39.0    R14.5    AQ1.04
M41.0    R15.5    AQ0.93
Diag: normal
  Menu     Menu     Menu
```

Figure 14 - Display of the examination findings

The HMC Anomaloskop changes again to Standby Mode at the end of the examination in order to avoid wear and tear on the technical components, and the test field switches again to black.
The two threshold equations which have been determined then appear on the screen, subdivided into: mixed light setting (M), comparison light setting (R), and quotient of anomaly (AQ).
Note down the results on the special form sheet for examination results of the HMC Anomaloskop (Order-No. 47717), since the results are not stored and cannot be recalled to the screen subsequently.
The diagnosis which results from the options of the examinee is shown in the third line.

The diagnoses which are displayed must be individually verified, since adjacent and overlapping color vision defects or input errors by the patient can easily lead to false diagnoses.

The following diagnoses may be suggested by the examination program as a result of the Red-Green Test:

Normal,
Deuteranopia,
Deuteranomaly,
Extr. Deuteranomaly,
Protanopia,
Protanomaly,
Extr. Protanomaly,
Achromatopsia, and
Diagnosis Not Possible.

The following diagnoses may be suggested by the examination program as a result of the Blue-Green test (only HMC-MR):

Normal and
Diagnosis Not Possible

The three keys below *Menu* in Figure 14 bring you back to the initial menu from which you started this examination program.

8.4. After Every Use

Turn off the unit after using it and use the dust cover to protect it against damage.

9. Maintenance

9.1. Care, Cleaning and Disinfection

General Remarks

Always disconnect the mains plug before cleaning the unit!

Do not clean the unit with agents which are aggressive, contain chorine, are abrasive, or have sharp edges.

Always take care to observe the product descriptions and instruction manuals of agents and equipment which you use for the care, cleaning and disinfection of the unit or its accessories.

Cleaning painted surfaces or the housing of the unit.

Do not permit cleansing fluids to make their way into the unit.
In general, we recommend that a cleaning agent with antistatic effect (low static attraction of dust particles) be used to clean plastic surfaces.
If this is not possible, you can clean the outer surfaces of the unit by wiping them off with a damp cloth.

To remove traces of dirt, wipe off the unit with a mixture of equal parts of alcohol and distilled water. You can also add a few drops of a standard commercial dishwashing liquid to this liquid.

Cleaning the eyepiece lens

Soiling in the form of dust or a fingerprint can have a negative effect on the examination.

If the eyepiece lens requires cleaning, use a soft cloth or a lens brush, with a bit of alcohol or a lens cleaning agent as required.

Cleaning the elastic cup of the eyepiece

A material which is pleasant to the touch was selected for the elastic cup of the eyepiece.

Use mild soapsuds to clean the eye cup.
We recommend the use of alcohol or spirits for disinfection.

9.2. Replacing the Fuses

Disconnect the mains plug before replacing the fuses!

The unit's two fuses are located in a small fuse drawer (No. 15, figure 2 on page 6).
Open the drawer by inserting a small screwdriver into the narrow slit at its bottom and then levering it upwards in direction of the arrow marker. This unlocks the drawer, which moves a bit forward from its mounting. Now pull the drawer outward with your fingers.

Always use the type of fuse which is named on the Type plate (No. 12, figure 2 on page 6).
Repeated burnout of the fuses indicates a defect in the unit. In this case, get in touch with our service representative.

To close the drawer, push it back into its receptacle until the tab of the drawer clicks into place.

9.3. Troubleshooting

If a problem occurs which you cannot solve with the following troubleshooting table, please mark the unit "Out of Order" and get in touch with our service representative.

Impairment	Possible Cause	Remedy
No function after the mains switch is turned on, the mains switch does not light up.	The HMC Anomaloskop is not connected to the mains supply.	Plug the mains cable into the power outlet or the inlet connector for non-heating appliances on the HMC Anomaloskop.
	There has been a power failure or the power outlet is not active.	Inform the electrician.
No function after turning on the mains switch, but the mains switch lights up.	The control panel unit or the serial cable of the PC is not correctly connected.	Check that the plug has been correctly connected.
	The unit was turned on and immediately off again.	Wait ca. 5 seconds between turning the unit on and off again.
	Program "crash".	Turn off the HMC Anomaloskop and if necessary the PC as well and start them again (in case of the PC version start the PC first, then the unit).
	The unit's fuses are defective.	Replace the fuses. (cf. Chap. 9.2.)
The examinee is unable to recognize anything.	No examination has been started.	Start the examination.
	The unit is in "Stand-By" mode.	Activate any key or control knob.
	Program "crash".	Turn off the HMC Anomaloskop and if necessary the PC as well and start them again (in case of the PC version start the PC first, then the unit).
Two black bars on the screen of the control unit.	Initialization Error.	Turn off the HMC Anomaloscop and restart it after ca. 5 seconds.
Display on the screen of the PC: "No Communication".	The serial cable of the PC is incorrectly connected.	Connect the plug correctly, restart the unit.
	The wrong interface of the PC has been used or selected in the program.	Select the correct interface on the PC or in the program (in the "Settings" menu under ["System->"] in the "Data transmission" field).

9.4. Maintenance Instructions and Service Intervals

The HMC Anomaloskop is constructed in such a way that no special maintenance is required.
For safety's sake, however, we recommend a check of the unit's photometric values every 2 years. Please contact your OCULUS service representative for this purpose.

10. Terms of Warranty and Service

10.1. Terms of Warranty

In purchasing this unit you have acquired an OCULUS quality product.

The unit was built with care, using high-quality materials and modern production techniques.

Warranty is granted according to legislative regulations on this system, beginning from the date of delivery. This warranty includes all defects and malfunctions caused by materials or construction.

Not included in this warranty are malfunctions and defects due to improper use and outside influences.

However, should you have reason for justified complaints within the warranty period, they will be repaired without charge.

These warranty services are valid only if the bill of sale with the date of purchase is included.
If manipulations of the unit are undertaken by non-authorized persons, all warranty claims are cancelled, since considerable danger to the user and the patient can arise from incorrect changes and maintenance.

In case of damage during shipment, please lodge a complaint with the shipping company immediately thereafter and have them confirm the damage on the bill of lading, in order that the damage can be correctly processed and repaired.

Our terms of business and delivery apply in the version which is valid on the date of purchase.

10.2. Liability for Malfunction or Damage

OCULUS considers itself responsible for the safety, reliability and serviceability of the unit only if the unit is used in accordance with this Instruction Manual.

The unit contains no parts which require maintenance or repair by the user.
Only the exchange of the fuses can be carried out by you.
No liability whatever is possible on the part of OCULUS if assembly work, additions to the unit, readjustments, maintenance work, alterations, or repairs are carried out on the unit by non-authorized persons or if the unit is improperly cared for or handled.

If the above-mentioned work is carried out by authorized persons, these persons must certify the type and extent of their repair work, including details on changes made in the ratings or the capacities of the unit if required. The certification must bear the date on which the work was carried out as well as the name of the service company and must be signed.
If desired, OCULUS will provide authorized persons with circuit diagrams, replacement parts lists, additional descriptions, and adjustment instructions for this purpose.

Use only original parts from OCULUS for repairs.

10.3. Manufacturer's and Service Address

You can receive additional information from our service department or from our authorized representatives.

Manufacturer's and Service Address:

OCULUS Optikgeräte GmbH
Münchholzhäuser Str. 29
D - 35582 Wetzlar

Tel.: + + 49/ 641 / 2005-0
Fax: + + 49/ 641 / 2005-255
E-Mail: sales@oculus.de

11. Appendix

11.1. Literature

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- Moreland, J.D. and J. Kerr
Mod. Probl. Ophthal., vol. 19, pp. 162-166
Karger, Basel 1978
Optimization of Stimuli for Trit-Anomaloscopy

11.2. Declaration of Compliance

We declare in our own responsibility that this product complies with the following norms or normative documents:

- DIN 6160
- DIN 5031-6
- DIN 5033-2
- IEC 601-1
- IEC 601-1-2

CE

as stipulated by Guideline No. 93/42/EEC for medical devices.

Diploma'd.-Engineer Rainer Kirchhübel

Managing Director
OCULUS Optikgeräte GmbH

11.3. Order Information, Accessories, Replacement Parts

47700	HMC Anomaloskop MR
47701	Control unit with LCD-module
47702	Test notepad (100 sheets) for the HMC Anomaloskop
47703	HMC Software module, Windows™-compatible, for patient examination and guidance of the HMC Anomaloskop, incl. interface cable
47715	HMC Anomaloskop MR, 115 V-version
47716	Control unit with English display
47717	English test notepad (100 sheets) for the HMC Anomaloskop
47720	HMC Anomaloskop R
47750	PC with monitor and keyboard
47760	Printer for printout of results (only possible with a PC)
05 100 060	Fuse T 0.2 A (for 230 V-version)
05 100 090	Fuse T 0.4 A (for 115 V-version)
05 200 320	Mains cable
05 200 360	Data transfer cable, for PC-interface
05 110 900	Adapter RS 232, Sub D
60100|05|001	Dust cover
On request	Various electrical elevating platforms

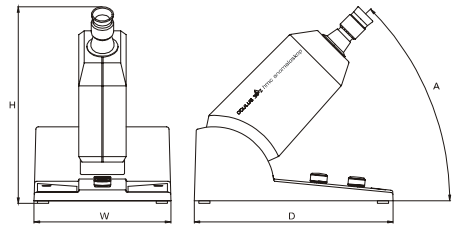
11.4. Technical Data

Mains connection
115 or 230 V AC
50 - 60 Hz
30 VA

Fuses
2x T 0.2 A, 230 V-version
2x T 0.4 A, 115 V-version

Weight
approx. 5.5 kg, without accessories

Dimensions
(WxDxH) 245 x 356 x 315-410 mm



Control unit with display:
(not shown here)
(WxDxH) 82 x 152 x 45 mm

Unit viewer angle
(A) 35-55 degrees
by adjustment of the housing

Control by the examiner
through an external control unit with LCD-module; connection via cable to the serial interface
Or: operation of the unit via PC

Interface
RS 232 / V 24 , Sub D

Control by the examinee
Adjustment of colors and brightness by means of control knobs; confirmation of options via keyboard

Viewing aperture
Elastic eye cup of pleasant-feeling material

Diopter compensation
± 6 D.

Light source for neutral adaptation
White light from a light source comparable standard type C (6770 K)

Viewing test field
Horizontal, two-part
Created by two Ulbricht spheres, thus very homogeneous

Viewing angle of the viewing test field
2 degrees

Color vision tests used
Rayleigh red-green color vision test
Moreland blue-green color vision test (only HMC-MR)

Light sources of the viewing test field
LEDs in the corresponding colors, combined with interference filters

Wavelengths of the viewing test field colors:

Moreland (only HMC-MR):		
Blue	436 ± 2 nm	(10 ± 2 nm)
Cyan	480 ± 2 nm	(10 ± 2 nm)
Blue-Green	490 ± 2 nm	(10 ± 2 nm)
Rayleigh:		
Green	549 ± 2 nm	(10 ± 2 nm)
Yellow	589 ± 2 nm	(10 ± 2 nm)
Red	666 ± 4 nm	(10 ± 2 nm)

(Half-widths in parentheses)

Classification acc. to IEC Norm No. 601-1
Type of protection against electric shock: Safety class 1
Degree of protection against electrical shock: Type B
Degree of protection against harmful entry of water: IP 20

Operating conditions

Temperature	+10°C to +40°C,
Humidity	30 % to 75 %
Air pressure	700 hPa to 1060 hPa

Transport and setup conditions
(acc. to IEC Norm No. 601-1)

Ambient temperature	-40°C to +70°C
Relative humidity	10% to 100%, incl. condensation
Air pressure	500 hPa to 1060 hPa

11.5. Test Sheet for the Control Unit

OCULUS Optikgeräte GmbH D-35549 Wetzlar Tel.: + +49/641/20 05-0	HMC Anomaloskop	Test sheet 47717

Name: _____ Examiner: _____

Street, House No.: _____ City, Date: _____

Zip Code, City: _____

Date of birth: _____

Name of Employer: _____

Profession: _____

Complaints: _____ If examined with untinted lenses

Special remarks: _____ Type of lens: ☐ Normal corrective lenses

☐ Contact lenses

Last eye examination: _____

Red-Green Color Vision

Matching Range
(Assumed equations From - To)

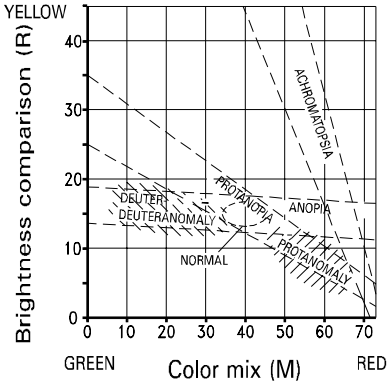
R: M1_____ - M2_____
R1_____ - R2_____

L: M1_____ - M2_____
R1_____ - R2_____

Quotient of Anomaly
(absolute matching range)

R: AQ1_____ - AQ2_____

L: AQ1_____ - AQ2_____



Norm 34 - 46 / 15
Mean norm 40 / 15

☐ Standard examination
ABS = absolute matching range

☐ Additional examination
REL = relative matching range (especially for acquired color vision defects)

☐ Driver's license handicap acc. to FeV in case of protanopia or protanomaly and AQ below 0,5.

Evaluation: _____

Blue-Green Color Vision

Matching Range
(Assumed equations From - To)

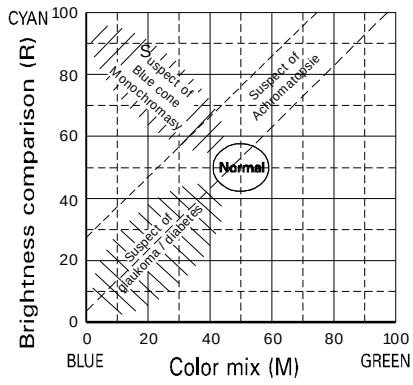
R: M1_____ - M2_____
R1_____ - R2_____

L: M1_____ - M2_____
R1_____ - R2_____

Quotient of Anomaly
(absolute matching range)

R: AQ1_____ - AQ2_____

L: AQ1_____ - AQ2_____



Norm 42 - 58 / 50
Mean norm 50 / 50

☐ Standard examination
ABS = absolute matching range

☐ Additional examination
REL = relative matching range (especially for acquired color vision defects)

Evaluation: _____