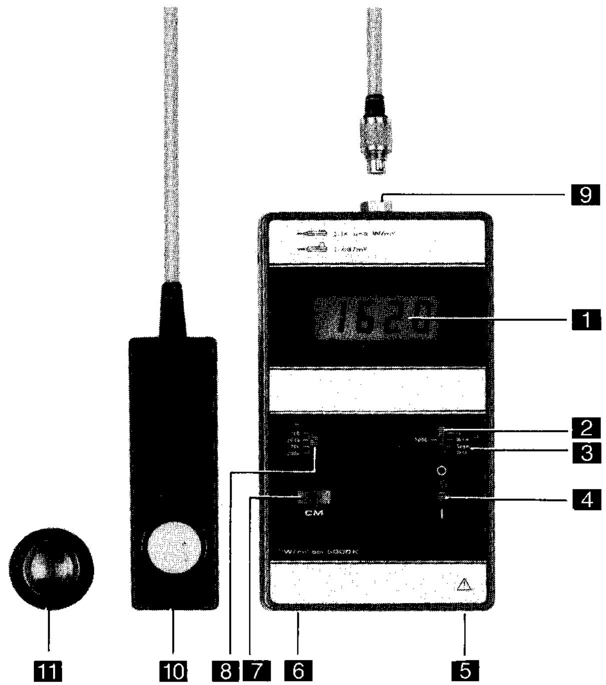
Bedienungsanleitung
Operating instructions

MAVOLUX digital

7905 1025Y0
3/3.96

Contents Page



1 Anzeige-Display
2 Meßart-Schiebeschalter
3 Segment-Test
4 Ein-Aus-Schalter
5 Ladebuchse für Akku [1])
6 Buchse für Schreiber-Ausgang [2])
7 Meßwert-Speichertaste (Hold Taste)
8 Meßbereich-Schiebeschalter
9 Buchse für Anschluß der Meßsonde
10 Meßsonde
11 Leuchtdichte-Vorsatz

1 Readout display
2 Measuring-mode switch
3 Segment test
4 On/off switch
5 Battery charging socket[1])
6 Socket for pen-recorder output[2])
7 Reading storage button (hold key)
8 Measuring-range switch
9 Connecting socket for measuring probe
10 Measuring probe
11 Luminance attachement

1) nur Ladegerät mit Sicherheitstransformator verwenden!
2) entspricht Schutzklasse III.

1) Only use a charger with a safety transformer!
2) Conforming to protection class III.

1. Description of instrument

The digital-readout instrument is easy to operate and provides accurate measurement of:

- illumination in Lux (footcandle see page 45);
- luminance in cd/m², using a luminance attachment screwed onto the probe (see page 24);
- solar radiation intensity in W/m² for 6000-K sunlight;

also used to determine

- exposure data for cinefilm and photographic applications (see page 8 onwards).

The meter is **colour-corrected,** i. e., its spectral sensitivity matches the eye's sensitivity curve V (λ). The correction filters are incorporated in the measuring probe. All the important kinds of light can therefore be correctly measured, without having to take correction factors into account.

The instrument has a **built-in cosine-correction facility.** Light with an oblique angle of incidence can thereby be correctly measured in accordance with the cosine law.

Even the most brilliant light (daylight, spotlights) can be measured without having to use a special accessory.

By virtue of its **pen-recorder output**, the meter is particularly suitable for monitoring duties, for checking technical acceptance conditions and in all cases where a permanent record is required.

2. What you need to know to use the meter (Brief Instructions)

First of all, insert the battery supplied into the compartment at the rear of the instrument. To open the compartment, turn the screw through 45° with a coin, so that the lid springs up.

2. 1 Battery check

This is automatic. If a flashing arrow appears on the display [1], the battery needs replacing.

When a rechargeable battery (IEC 6 LF 22) is used, it should be charged via the charging socket [5]. Only chargers with a safety transformer should be used.

2.2 Prior to measurement

Connect the measuring probe [10] to the meter. Then switch the instrument on at the on/off switch [4] and conduct a segment test.

2.3 Segment test

To do so, slide the measuring-mode switch [2] to the "Segm.-Test" position [3]. The display is working correctly if the figures 1888 appear for 1.5 seconds (followed by an undefined reading). Should this not be the case, the instrument should be checked over by our Service Department.

2.4 Measuring

Use the mode selector-switch [2] to choose the quantity you wish to measure:

Position "lx"	for illumination;
Position "lx"	for luminance, for which a luminance attachment [11] has to be screwed onto the measuring probe. The reading, multiplied by 10, gives the corresponding luminance value in cd/m².
Position "2000-W/m²"	for radiation intensity for sunlight with a colour temperature of 6000 K.

2.5 Overflow

When a measuring range is exceeded, just a 1 appears in the left-hand position, while the other figures remain unilluminated. The measuring-range switch [8] should then be used to switch to the next highest range. The measuring-range switch does not work in the "2000-W/m²" position.

2.6 Measured-value storage

After the measured-value storage button [7] has been pressed, the instantaneous reading is retained. The stored value is not cancelled until the button is pressed again, preparing the instrument for another measurement.

2.7 Pen-recorder connection

At each measuring-range end-value there is 1.00 V across the pen-recorder output [6]. In order to obtain accurate plots, the connected pen-recorder should have a direct-voltage measuring range of 0 to 1.00 V. The input impedance of the recorder must be $\geqq$ 500 kΩ. The socket meets protection class III.

2.8 Instructions for correct measurement

Depending on the task, the measuring probe should be:

- held parallel to the surface being evaluated;
- or be laid on the surface if the illumination of that surface is to be measured (e. g., workplace illumination);
- or be held horizontal 0.85 m from the ground if the illumination of a room is to be measured;
- or be held pointing from the subject of the photograph towards the camera, if you are measuring for photography (e. g., on the stage or in a studio).

Further details are given later in these operating instructions.

When taking measurements, always ensure that the diffuser of the measuring probe is fully exposed and is not shaded by your hand or body. It is often advisable to lay or hold the probe at the point of measurement and to arrange the meter as far away as the connecting cable allows.

The instrument should be stored in dry and dust-free conditions, and the probe should not be unnecessarily exposed to the light. The carrying case is the best place to keep it.

It should be borne in mind:

- that artificial light sources do not reach their full output until they have been burning for some time. You should consequently, when possible, switch on some 15 minutes before measuring;
- that the output from light sources is dependent on the mains voltage. Where appropriate, the mains voltage should be checked with a voltmeter.

2.9 Solar radiation intensity

Measuring solar radiation is becoming increasingly important for sun collectors and solar cells in the energy conservation context. The measuring range from 0...1999 W/m^2 is appropriate to sunlight with a colour temperature of 6000 K.

In the range of 6000...7500 K the influence of the colour temperature on the measuring accuracy is small. The additional deviation is less than 3% related to the measuring value.

It is recommended to measure possibly at open sky in midday time (measuring procedure see page 28).

2.10 Carrying case

The case will serve for carrying the meter and for protecting it. It is designed in such a way that while measuring the meter and the measuring probe need not be taken out. The case also contains an extension carrying strap, a small note book and a pencil, and a loop for placing the luminance attachemet there (optional accessory).

3. For the cameraman and the professional photographer

Measuring the illumination of a surface

(e.g., in reproduction and projection work)

Measurements should be made at as many places as possible, with the probe laid parallel on the surface or held parallel to it.

When reproducing flat copy, arrange the lamps to achieve the desired uniform illumination, i.e., in general so that the difference between the maximum and minimum measurement is no more than 5%.

Satisfactory projection of pictures calls for illumination values of around 60 to 140 Lux at the screen.

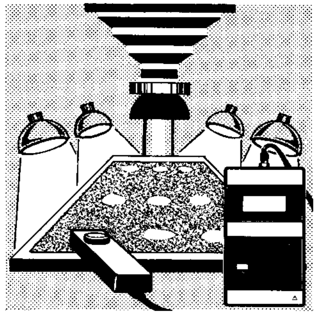


Fig 3.1

Measurements in photographic and film studios or on stage

To check the illumination of a scene being photographed, measurements should be made at as many points as possible. The measuring probe should be held so that the surface of the diffuser is perpendicular to the line from the measuring point to the camera.

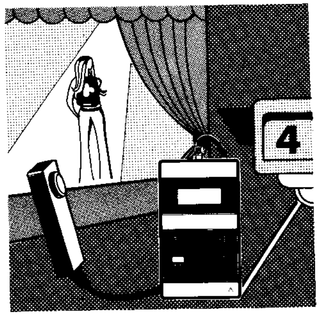


Fig. 3.2

Exposure table for daylight photography*

Measured illumination		f-numbers for DIN 18 film					
		Shutter speed in sec.					
lx	fc	1/8	1/15	1/30	1/60	1/125	1/250
45	4.3	**1**					
57	5.4	1.13					
72	6.8	1.27					
90	8.5	**1.4**	**1**				
115	10.5	1.6	1.13				
145	13.5	1.8	1.27				
180	17	**2**	**1.4**	**1**			
230	21.5	2.2	1.6	1.13			
290	27	2.5	1.8	1.27			
360	34	**2.8**	**2**	**1.4**	**1**		
450	43	3.2	2.2	1.6	1.13		
570	54	3.6	2.5	1.8	1.27		
720	68	**4**	**2.8**	**2**	**1.4**	**1**	
900	85	4.5	3.2	2.2	1.6	1.13	
1 150	105	5	3.6	2.5	1.8	1.27	
1 450	135	**5.6**	**4**	**2.8**	**2**	**1.4**	**1**
1 800	170	6.3	4.5	3.2	2.2	1.6	1.13
2 300	215	7.1	5	3.6	2.5	1.8	1.27
2 900	270	**8**	**5.6**	**4**	**2.8**	**2**	**1.4**

3 600	340	9	6.3	4.5	3.2	2.2	1.6
4 500	430	10	7.1	5	3.6	2.5	1.8
5 700	540	**11**	**8**	**5.6**	**4**	**2.8**	**2**
7 200	680	12.5	9	6.3	4.5	3.2	2.2
9 000	850	14.5	10	7.1	5	3.6	2.5
11 500	1 050	**16**	**11**	**8**	**5.6**	**4**	**2.8**
14 500	1 350	18	12.5	9	6.3	4.5	3.2
18 000	1 700	20	14.5	10	7.1	5	3.6
23 000	2 150	**22**	**16**	**11**	**8**	**5.6**	**4**
29 000	2 700	25	18	12.5	9	6.3	4.5
36 000	3 400	29	20	14.5	10	7.1	5
45 000	4 300	**32**	**22**	**16**	**11**	**8**	**5.6**
57 000	5 400	36	25	18	12.5	9	6.3
72 000	6 800	41	29	20	14.5	10	7.1
90 000	8 500	**45**	**32**	**22**	**16**	**11**	**8**
115 000	10 500	51	36	25	18	12.5	9
145 000	13 500	58	41	29	20	14.5	10

The above lx and fc values and the f-numbers are listed in 1/3 increments.

* **Artificial light:**
Because of the nature of the sensitization of black-and-white negative film, photographs in artificial light require exposure about 1/3 of a stop greater.

The contrast ratio is the ratio $\frac{\text{main light + fill-in light}}{\text{fill-in light only}}$

The main light and fill-in light (also the background light) are measured from the most important subject in the scene, pointing in the direction giving the highest reading with all the lamps switched on. The main light should then be switched off and the fill-in light should be measured from the subject in the direction of the camera.

Depending on the photographic or filming task concerned, the are certain limits which the contrast ratio should not exceed if a well-balanced result (on slide, paper or film) is to be achieved. In black-and-withe photography the ratio should not exceed 8:1, and in colour photography 3:1. Other situations may demand even narrower limits, e.g., colour photographs for television transmission, or photographs on litho-film for photo-masters, must be no more than 2:1.

If, on the other hand, soft lighting without any contrast is required, (e.g., "high key" photography), the lamps should be arranged so that identical readings are obtained at different points of the subject and background. This can be particularly important in colour photography.

Lighting effects – Illumination and the "art of measurement"

Very attractive results can be obtained by lighting effects, i.e., by deliberately and dramatically increasing or reducing contrasts. In such instances greater contrasts are permitted, but they should not be overdone, otherwise the film will not be able to cope with them.

Using the instrument as an exposure meter to determine stop and shutter-speed

The image-forming light is measured in the usual way from the major subject in the picture. The illumination is indicated in Lux. The stop and shutterspeed can be obtained from the table on pages 34 and 35 or from the CALCULATOR, which you are advised to acquire.

The image-forming light is generally the main light, but bright lateral light can also be important to the measurement. In this case the mean value of the two measurements should be used.

CALCULATOR

When used in conjunction with the CALCULATOR (see page 45), the illumination meter constitutes a highly accurate exposure meter.

Most manufacturers of film for professional purposes provide information about exposure data derived from illumination measurements.

4. For lighting and illumination technicians

Illumination measurements are necessary when planning and installing lightind installations for which checking and monitoring will be required in order to define illumination conditions for reasons relating to health, physiological, psychological or safety aspects. Areas of application, terms used, tasks, requirements and practical guidelines are largely covered by DIN Standards. Here are a few definitions:

General lighting

Uniform illumination of a room, producing roughly the same conditions of visibility in all parts of the room.

General working-area lighting

General illumination with a specific relationship between lighting fittings and certain work-places (for definition of work-place see DIN 33400).

Individual work-place lighting

Illumination of individual work-places in addition to the general lighting.

The following examples may be quoted of applications of illumination measurements using the meter

planning and installation of lighting installations and their monitoring with respect to ageing, pollution and profitability;
indoor lighting by daylight (DIN 5034);
checking safety lighting (according to German regulations the minimum illumination should be 1 Lux);
street and vehicle lighting for traffic and transportation facilities (DIN 5044);
testing vehicle headlights (DIN 5037);
gymnasia (DIN 18032, part 1);
stadium lighting (DIN 67526);
lighting of building sites, railway sidings, airport aprons and other outdoor areas;
floodlighting of buildings, towers and chimneys;
lighting of greenhouses and nurseries.

Indoor lighting using artificial light (DIN 5035)

This Standard applies to the artificial lighting of indoor areas; where relevant, it can also cover the artificial lighting of areas out of doors, provided they serve the same purpose as the corresponding indoor areas. The Standards Commission have worked in close collaboration with all interested parties in an attempt to establish minimum lighting requirements which are technically acceptable but at the same time do not place excessive financial demands on the user. In conjunction with ASR 7/3, this Standard represents the recognized obligatory specification, the application of which satisfies the stipulations of German workplace regulations ArbStättVo of March 1975, § 7, para. 3.

The following definition appears in part 1 of DIN 5035 with the sub-title "Terms and general requirements":

Illumination rating

Illumination ratings for indoor areas are 20/50/100/200/300/500/750/1000/1500/2000 Lux.

The illumination rating is related to an average aged-condition of the installation.

The illumination rating, which is assigned to a particular kind of room or activity, is related to the difficulty of the visual task. This presupposes that the influence of this illumination value on visibility is not affected by outside influences, such as direct glare, reflected glare, reduced contrast, unsuitable lamp-colour or colour rendering.

The allocation of a specific illumination rating to a visual task is related to persons with normal eyesight. A sight defect which cannot be fully corrected by aids to vision can be wholly or partially compensated by a higher illumination level.

Illumination at a workplace

A rated illumination of **at least 200 Lux** should be provided at permanently-occupied workplaces in buildings, unless operational or physiological/optical requirements call for a deviation. In rooms or areas of rooms which are regular stopping-places for employees, a rated illumination level of **at least 100 Lux** is required.

Minimum planning values

When planning an installation, the value of the rated illumination should be multiplied by a planning factor of at least 1.25.

Irrespective of the state of ageing of the lighting installation, the arithmetical mean value of the illumination at the workplaces must not be less than 0.8 times the rated illumination.

At no time must the illumination at a workplace fall below 0.6 times the value of the rated illumination.

Part 2 of DIN 5035 bears the sub-title "Guideline values for workplaces" and includes a comprehensive table, stipulating the illumination, colour of light, colour-rendering properties and degree of limitation of direct glare for the nature of the room or the activity. A further column gives important information concerning special lighting-installation requirements, e.g., when supplementary individual workplace lighting is advisable or even necessary.

5. Technical data

Measuring ranges	
Illumination	0.1 to 199.9/1,999/19,990/199,900 lx
Luminance	1 to 1,999,000 cd/m^2
Solar radiation intensity (6000 K)	0 to 1,999 W/m^2 All ranges protected by overflow indication. When a measuring range is exceeded, a 1 appears in the highest place, the other figures remaining dark.
Accuracy	With incandescent lamplight and a perpendicular angle of incidence of the light, the error of the reading is ± (2.5 % related to the measuring value + 1 digit). At all angles of incidence the integral cosine error is less than ± 3 % related to the measuring value. Additional deviations with other kinds of light are max. ± 3 % related to the measuring value.
Pen-recorder output	0 to 1.00 V for each range. The input impedance required for the pen-recorder is ≧ 500 kΩ. The socket for pen-recorder output 6 corresponds to protection class III.

Light-collecting area of diffuser	approx. 20 mm diam.
Display	LCD 3½ digits
Figure height	12.7 mm
Housing	plastic
Dimensions	meter: 86×153×25 mm probe (incl. diffuser) : 32×105×29 mm lead 1.5 m long carrying case: 140×200×40 mm
Weight	with carrying case approx, 0.65 kg
Power supply	9-V battery IEC 6 F 22 (e.g., Mallory MN 1604 (alkali) or Varta Super 438) rechargeable battery IEC 6 LF (e.g., Varta 4002)
Accessories	Luminace attachement (Page 44) CALCULATOR (Page 45) Rechargeable battery IEC 6LF 22 Charger 9V/9mA Ordering numbers see back over

6. Accessories

By separate accessories the instrument can be used for additional tasks.

6.1 Luminance attachment

This is an accessory for measuring luminance.

The luminance attachment measures the reflected light, i. e., the brightness of a surface, in an aperture angle of $\varepsilon\ ^1/_{10}{}^* = 20°$ or, depending on the exposure-meter definition, a measuring angle of 16°.

The value measured by the device, multiplied by 10, gives the luminance in Candela per square metre, i.e., reading 1 lx ≙ 10 cd/m².

The following measuring ranges are thus available:
1 to 1,999/19,990/199,900/1,999,000 cd/m².

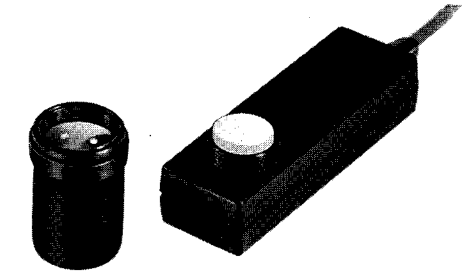


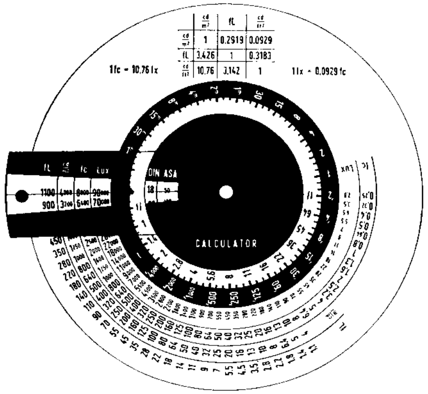
Fig. 6.1

*) According to DIN 5032 Pt. 6: "The tenth-angle $\varepsilon\ ^1/_{10}$ in a plane through the optical axis is the angle within which the sensitivity is equal to or greater than 1/10 of the sensitivity when light is incident in the optical axis".

6.2 CALCULATOR

The CALCULATOR is an exposure-calculating disc about 160 mm in diameter, on which the measured values from the digital meter are set and the corresponding shutter-speed/stop combinations can be read off.

In addition to that you can conveniently read off the corresponding values of Lux (lx) and footcandle (fc), Candela/m² (cd/m²) and footlambert (fL) directly.



7. Some theory

(Details in DIN 5031)

The illumination indicates the intensity with which a surface is illuminated; its unit of measurement is the Lux (abbreviated lx). According to its definition, a light source with a luminous intensity of 1 Candela (abbr. cd) generates an illumination of 1 Lux at a distance of 1 metre. 1 Candela is 1/60 of the luminous intensity emitted by 1 cm² of a black body (cavity radiator), at right angles to the surface, at the solidification point of platinum (2045 K or 1772°C).

Another common unit of illumination, particularly in England and America, is the footcandle. This represents the illumination at a distance of 1 foot from a light source of 1 cd. The Lux and footcandle are related as follows:

1 footcandle = 10.76 Lux
1 Lux = 0.0929 footcandle

In American literature the unit meter-candle will also be encountered. This is identical to the Lux.

For perfect measurements the light must be evaluated according to the eye's sensitivity, in accordance with the internationally agreed spectral-sensitivity curve (λ) of the light-adapted eye. This curve represents the mean value determined on a large number of human subjects.

The silicon photo-cell used in the meter has been matched to the spectral sensitivity of the eye with a correction filter. It almost fully achieves the V(λ) curve (see Fig. 7.1) and evaluates the light in nearly the same way as the eye does.

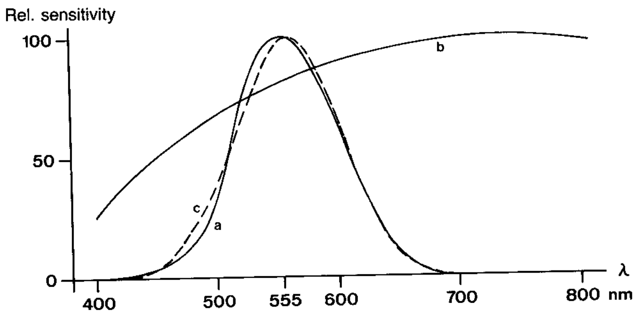


Fig. 7.1

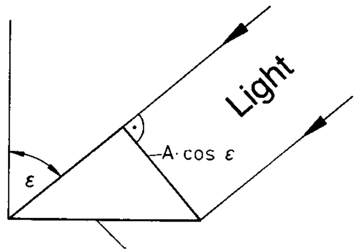
Relative spectral sensitivity (mean values)

a. Eye V (λ)
b. Silicon photo-cell without filter
c. Meter's measuring probe

The digital meter can be used to make correct measurements of all the major kinds of light, i. e., from incandescent lamps, fluorescent lamps, mercury-vapour and sodium-vapour lamps, etc., as well as natural daylight.

To measure light with an oblique angle of incidence, it is necessary for the evaluation by the receiver to be free from cosine error.

What does "free from cosine error" mean?



Let us assume that light falling on a receiving surface A has an illumination E_o. If the light is incident at an angle ε, the cross-section of the light-beam striking the receiving surface is reduced to A. cos. ε. The illumination E (ε) with an angle of incidence ε is consequently:

$$E(\varepsilon) = E_o \cdot \cos \varepsilon.$$

On the digital meter, the cosine correction is achieved by a diffuser projecting slightly from the cell housing.

Fig. 7.2

What does luminance mean?

Although projection is usually undertaken with reference to the illumination, the luminance is of particular importance. This is the lighting quantity which is perceived by the eye, and expresses the brightness of a surface. The luminance in a particular direction is the luminous-intensity density of the light-emitting surface, i. e., the quotient of the luminous intensity J in the direction concerned and the apparent area A. cos ε.

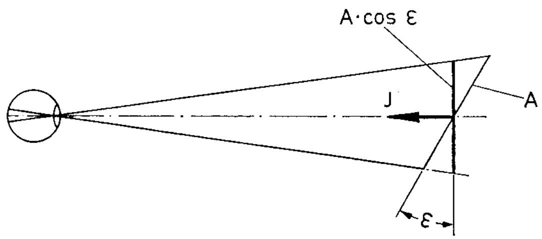


Fig. 7.3

The unit of luminance is the Candela per square centimetre (cd/cm^2), or for lesser luminances cd/m^2.

This used to be known as "Apostilb" (1 asb = 0.31831 cd/m^2).

Terms also known outside Germany include:

1 fL (foot-Lambert) = 3.426 cd/m^2

1 cd/ft^2 (Candela per square foot) = 10.76 cd/m^2

8. If you want to know more

The complete instrument consists essentially of a measuring probe **10**, which accommodates the silicon photo-cell and the correction filters, and the meter. The short-circuit current through the photo-cell, which is connected directly across the input of an integrated operational amplifier (IC), is measured by that operational amplifier. The advantage of this method of measurement is that it has a low temperature-dependence and produces linear measurements.

The measuring range is changed with a slide switch **8**. The "probe-matching" circuit component, in conjunction with the potentiometer in the probe, permits their interchangeability. This circuit component also generates the voltage for the pen-recorder output.

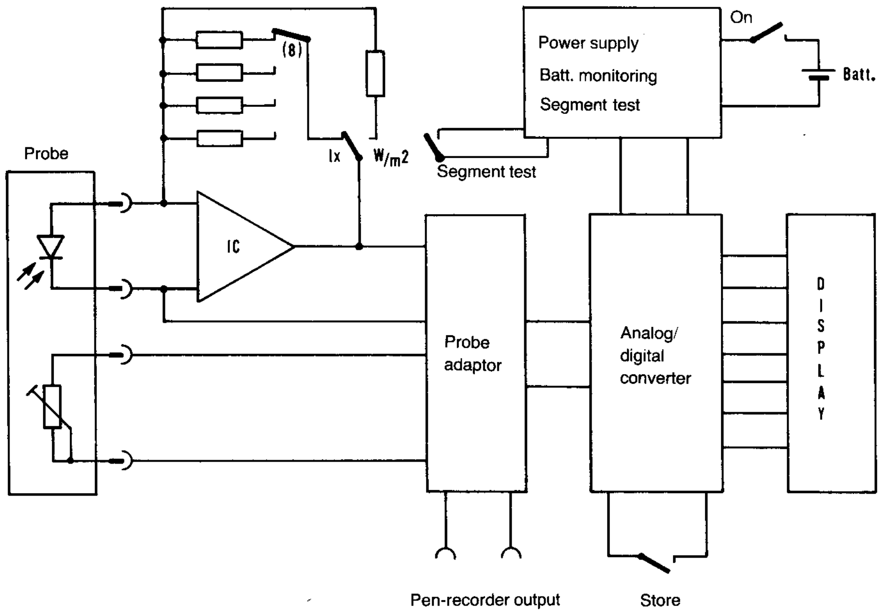


Fig. 8

Bestell-Nummern

MAVOLUX digital mit Bereitschaftstasche einschließlich Batterie	5024-Y0030
Leuchtdichte-Vorsatz	5908-V0120
CALCULATOR mit Etui	5999-V0380
Akku IEC 6 LF	5909-V0340
Steckerladegerät 9 V/9 mA	5909-V0350

Order numbers

MAVOLUX digital with carrying case and battery	5024-Y0030
Luminance attachment	5908-V0120
CALCULATOR with case	5999-V0380
Rechargeable battery IEC 6 LF	5909-V0340
Charger 9 V/9 mA	5909-V0350

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