sonopan

CONTACT LUMINANCE METER

LMC-10

INSTRUCTION MANUAL

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1. CHARACTERISTICS

The SONOPAN LMC-10 contact luminance meter is designed for the luminance measurement of the self-luminescent surfaces such as monitor matrices, TV sets, negatoscopes, reading panels, etc. The meter ensures the accurate measurement, regardless of the spatial distribution of the measured luminance and the backlight system of the surface being tested. **It is indispensable for the control of the medical imaging monitors and negatoscopes.** Its unique optical and measurement systems in combination with the advanced algorithms of the measured signal processing guarantee high accuracy and repeatability of measurements.
Owing to its technical parameters, the LMC-10 meter is classified as a **class A** meter according to DIN 5032-7 and TC-2.2 CIE.
The meter consists of the measurement probe cooperating directly with the SONOPAN P-200 control unit and with the SONOPAN RF-200C and the USB with a PC or a tablet. The measurement probe is equipped with the multifunctional key that is used to trigger a measurement, save results and operate the chosen measurement procedure e.g. to test the reproduction of the grayscale of monitors according to DICOM GSDF [1)] function. The function of the key can be dependent on the running application of the control unit.

1.1. Equipment

1.1.1. Basic accessories

Components of set	Set with P-200 control unit	Set with PC
LMC-10 measurement probe	+	+
Stabilizing cap Ø50mm	+	+
P-200 control unit	+	–
RF-200C interface	–	+
USB cable	–	+
RF200C software	–	+
Instruction manual	+	+
CE Declaration of Conformity	+	+
Warranty card	+	+
Carrying case	+	+

1.1.2. Additional accessories

Tablet 10" (concerning the set with a PC).

1.2. CONFIGURATION

The SONOPAN P-200 control unit or the RF200C software can be used to control the LMC-10 contact luminance meter and read the measured values. In the former case, the probe is connected directly to the control panel while in the latter case, it is attached to the USB 2.0 port with the use of the RF-200C interface. As far as PCs are concerned, it is required to use Windows XP or higher. As for tablets, they should be equipped with Windows 10. The RF200C does not work yet with such systems as Windows CE, Android or iOS.

[1)] DICOM GSDF: Grayscale Standard Function according to PS 3.14-2011 Digital Imaging and Communications in Medicine (DICOM) Part 14: Grayscale Standard Display Function.

The LMC-10 meter is powered with the use of the control unit.
Both configurations are shown in Fig. 1 and Fig. 2.

Fig. 1. Configuration of the LMC-10 measurement probe with the P-200 control panel.

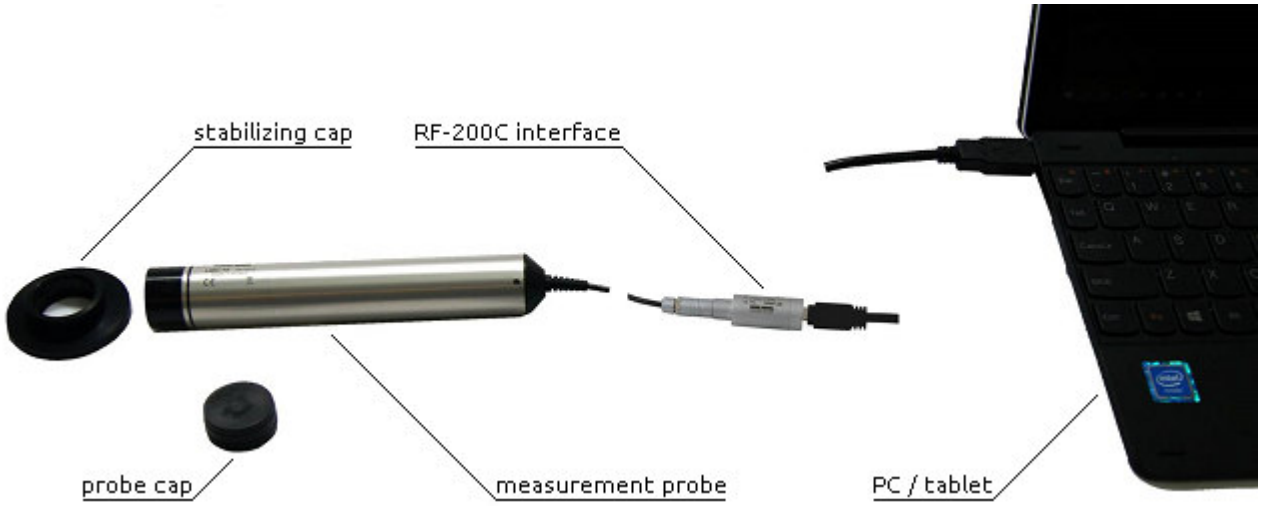

Fig. 2. Configuration of the LMC-10 measurement probe with a PC.

1.2.1. Components of luminance meter

configuration with P-200 control unit	configuration with a PC / tablet
• LMC-10 measurement probe • P-200 measurement module	• LMC-10 measurement probe • RF-200C interface • RF200C measurement module

Each of the above-mentioned components of the measurement system is identifiable according to the requirements of ISO/IEC 17025 standard. The LMC-10 measurement probe, RF-200C converter and the P-200 control unit have unique serial numbers. The measurement modules of the P-200 control unit and RF200C software are marked with their own numbers of their software versions.

The P-200 control panel and the RF200C software are functionally corresponding to each other.

1.2.2. Measurement module

The measurement module of the P-200 control unit and the RF200C software constitute a distinct part of the software and contain the procedures that calculate the measurement result on the basis of the data downloaded from the meter. These include, among others, the averaging and rounding-off of the result.

1.3. Technical data

Spectral sensitivity:	V(λ) CIE
Measurement field angle:	1°
Measurement field:	Ø 10mm
Spectral matching:	f_1' [2] ≤ 3%
Directional response index:	f_{2g} [2] ≤ 3%
Effect of the surrounding field:	f_{2u} [2] ≤ 1,5%
Linearity:	f_3 [2] ≤ 0,5%
Temperature coefficient:	K_T ≤ 0,02%/K
Measurement ranges [3]:	500 cd/m^2 50 000 cd/m^2
Measurement resolution:	0.01 cd/m^2 (range 500 cd/m^2) 1 cd/m^2 (range 50 000 cd/m^2)
Total error [4]: +10°C – +40°C	2.5%
-10°C – +50°C	3.0%
Power supply:	with control unit (5V, 25mA)
Environmental conditions - temperature: - relative humidity:	 -10°C ÷ +50°C ≤90% (without condensation)
Dimensions	
- measurement probe: - interface:	Ø25 x 160mm Ø15 x 42mm
Measurement probe weight:	150g
RF-200C interface weight:	15g

1.3.1. Spectral characteristics

Very good spectral matching of the detector to the spectral sensitivity V(λ) is realised with the use of the set of glass absorption filters. Such a solution guarantees high long-term and temperature stability, especially in comparison with the cheaper realisations in which interference filters are used. The quality of this kind of matching ensures the accurate measurement, regardless of the spectral distributions of the measured luminous flux, which in the used systems of matrix backlights vary to a great extent from the spectral efficiency of the calibration illuminant and are the main source of errors.

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[2] ISO/CIE 19476 Characterization of the performance of illuminance meters and luminance meters (this standard replaces CIE publication 69/1987).
DIN 5032-7 Photometry; Classification of illuminance meters and luminance meters

[3] The specified measuring ranges are the minimum values guaranteed by the manufacturer. The actual values depend on the sensitivity of the detector and the calibration factor and can be even twice as high.

[4] The percentage deviation of the measured value for white light sources with any spectral distribution in the given operating temperature range. It takes into account all the factors affecting the accuracy of the measurement (spectral and directional mismatch, temperature influence and others). It does not include the uncertainty of calibration.

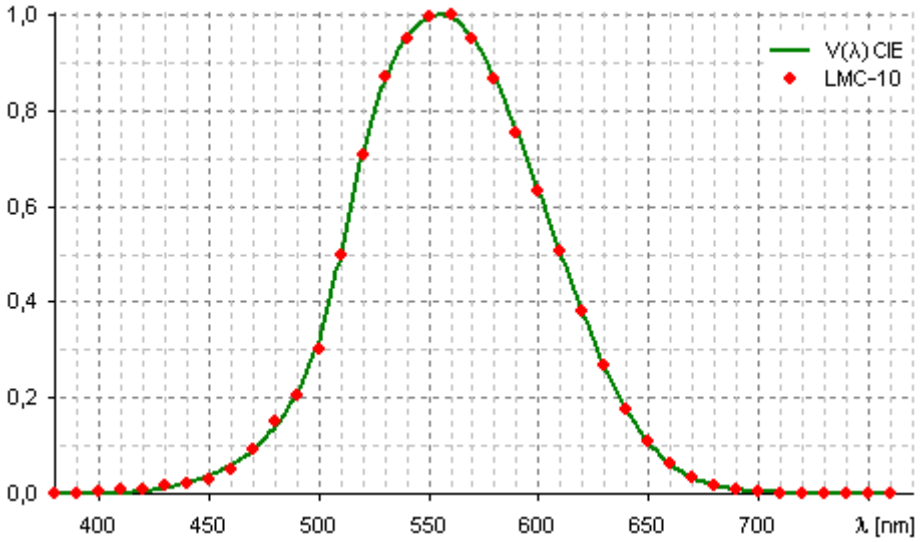


Fig. 3. Typical spectral sensitivity of the L 200 probe.

1.3.2. Directional characteristics

The unique optical system of the measurement probe ensures an identical assessment of every point of the tested surface. The special attention should be paid to the fact that the countersink angle for the cone of rays reaching the detector from every point of the tested object is identical with the measurement field angle, which is unachievable for standard luminance meters and can become the source of serious measurement errors for them. Such shape of the beam of rays is the main attribute for the LMC-10 measurement probe and its enormous advantage over other meters available on the market. Therefore, the influence of luminance irregularity of the monitor matrix for various directions of observations is negligible in the case of the LMC-10 meter.

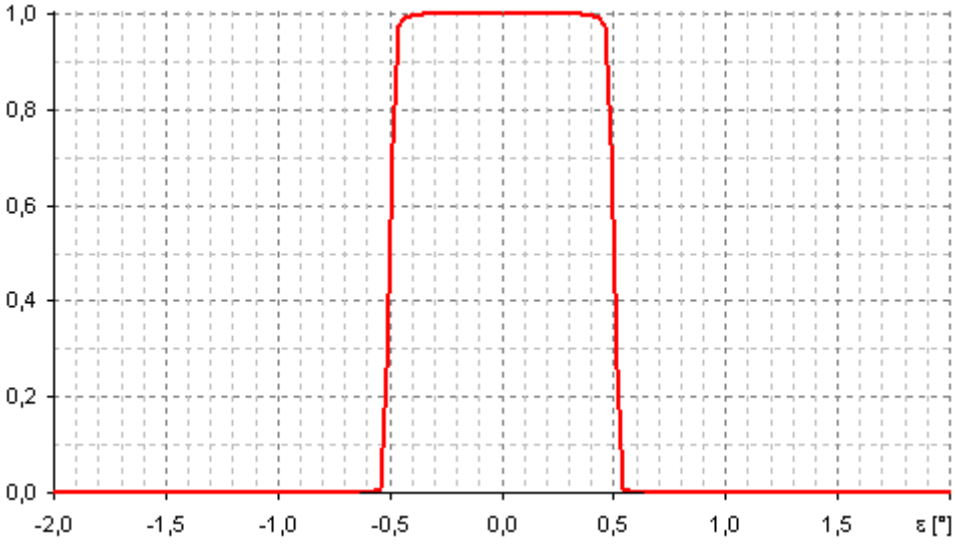


Fig. 4. Directional response of the LMC 10 probe.

1.4. Temperature compensation

The change in the temperature of the probe influences the measurement result. Due to the temperature change, the other parameters also change and they are as follows :

- detector dark current - shift of zero indication,
- offset voltage of the measuring circuit - shift of zero indication,
- responsivity of a detector - change of measured quantity value,

- gain of the measuring circuit - change of measured quantity value.

Measuring probes are equipped with the temperature sensor and functions that minimise the influence of the above-mentioned factors on the measured value.

1.4.1. Compensation of zero indication

Compensation of zero indication occurs after zeroing of the detector or the measuring circuit. It is realised with the aid of the functions which the LMC-10 probe is equipped with. For compensation of zero indication it is necessary to use the following commands of the control device:

- Zeroing of detector. The zeroing procedure of the detector consists in the measurement of the dark current of the measurement probe detector and its corresponding temperature. It can be conducted only with the covered reception field of the probe. The value of the dark current and the temperature of the zeroing are saved to the memory of the measurement probe.
- Zeroing of measurement system. The zeroing procedure of the measurement system consists in the direct measurement of the correction that results from the measuring circuit offset voltage which is deducted from the result. It is automatically conducted after the probe is connected to the control unit and whenever the detector is zeroed. The value of the correction and the temperature of the zeroing are saved to the memory of the probe.

1.4.2. Temperature compensation of the result

Alongside the use of the high-class elements in the design of the meter, the LMC-10 probe is equipped with the automatic compensation system of the influence of the environmental temperature on the measurement value. The temperature in which the calibration is conducted is the reference to the correction factor being then calculated for the current temperature. The influence of the ambient temperature on the measurement value is virtually possible to be omitted for typical usage.

2. THE LMC-10 METER OPERATION

2.1. Preparations

- Connect the LMC-10 probe to the control unit according to its instruction manual.
- Start the measurement.
- Check the zero indication with the covered reception field of the probe and alternatively, conduct zeroing of the detector.
- Remove the cap from the probe. The instrument is ready to operate.

2.2. Measurement

- The stabilising cap should be put on the probe when larger surfaces are tested.
- Set the result averaging time in the control unit. The more unstable in time the value of the measured quantity is, the longer the time should be. In most applications the sufficient averaging time amounts to 1s
- Choose the automatic or manual change of the measurement range. It is recommended by the manufacturer to turn on the automatic change of the range. The manual control is intended for the procedures of checking linearity during calibration or in specific conditions of measurement when the value of the measured quantity changes in time to such an extent that the control unit cannot determine the proper measurement range.
- Place the measurement probe perpendicular to the measured surface.

- Trigger the measurement with the key on the probe or with the certain key on the control unit.

In the case of the tested medical imaging monitors it is necessary to use the application of the control unit intended for this kind of measurement.

3. BASIC FUNCTIONS OF CONTROL UNIT

The basic functions of the P-200 control unit and the RF200C software are the following ones:

- Choice of the measurement probe, which concerns the RF200C software.
- Zeroing of the detector.
- Zeroing of the measurement system.
- Manual or automatic choice of the measurement range.
- Choice of the single or continuous measurement mode.
- Choice of the averaging time in range from at least 1-10s [5)]. The measurement result is the moving average that is refreshed every 1s.
- Triggering and stopping the measurement.
- Presentation of the measurement result.
- Calibration and adjustment of the meter.

All the detailed information is included in the instruction manuals for the control units.

4. EXTENDED FUNCTIONS OF CONTROL UNIT

The control devices are equipped with applications or functions that extend the range of the probe usage. All the applications have the possibility of archiving of the measurements results to an external drive. In the case of the P-200 it is a microSD card while in the case of the RF200C software it is a PC disc. The data is saved in text files, where tabs are separation signs. Such a file format enables the User to open it directly with the help of the spreadsheet. The access rights to the certain application depend on the type of the attached measurement probe.

4.1. Access to extended functions of control unit

The access of the LMC-10 probe to applications and functions of the P-200 control unit and RF200C software:

Application	Access to application
Medical monitors	YES
Measurements memory	YES
Advanced - relative measurement - integration - statistics	YES

The applications specified in the above-placed table concern the RF200C software. In the P-200 unit advanced applications such as measurement storage, relative measurement, integration and statistics are the extended functions of the control unit.

[5)] The range of values of the result averaging time depends on the control unit.

4.2. Application: Medical monitors

The correct assessment of medical imaging monitors in a diagnostic station requires the use of the luminance meter whose technical solutions and metrological parameters comprise all aspects related to various designs of monitor matrices. The meter of this kind is the SONOPAN LMC-10 which is, above all, intended for this type of tests as it guarantees very high measurement accuracy. The LMC-10 contact luminance meter meets the guidelines of the American Association of Physicists in Medicine (AAPM) as well as the users' expectations.
The manufacturer still has assigned for the L-200 probe the rights to the application of medical monitors because its metrological parameters conform to the requirements of this type of tests. Another condition for luminance measurement is the use of the suitable adapter.

All the detailed information is included in the instruction manuals for the control units.

4.3. Application: Measurements memory

The control units are used to archive the measurements conducted with the use of the LMC-10 probe. It is possible to save one single measurement or chosen measurements as well as to create the measurement history log within any time interval.

All the detailed information is included in the instruction manuals for the control units.

4.4. Application: Advanced

4.4.1. Relative measurement

The control units enable to conduct and archive the measurements whose results are expressed as a percentage of any reference. It is possible to save one single measurement or chosen measurements as well as to create the measurement history log within any time interval.

All the detailed information is included in the instruction manuals for the control units.

4.4.2. Integration

The control units are used to conduct and archive the measurements which are the time integral of the partial results. The last result or the whole measurement history log can be saved to the memory.

All the detailed information is included in the instruction manuals for the control units.

4.4.3. Statistics

The control units enable to conduct and archive the measurements as well as to make simple statistical operations on the results. The last result or the whole measurement history log can be saved to the memory.

All the detailed information is included in the instruction manuals for the control units.

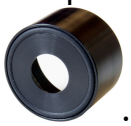
5. CALIBRATION AND ADJUSTMENT

Calibration is the comparison of the measured values with those of a calibration standard of known accuracy. On the basis of this comparison, the calibration factor is calculated and saved to the measuring probe. The control units allow the User to conduct the adjustment procedure of the LMC-10 measurement probe. The procedure should be conducted by a competent laboratory equipped with the suitable instruments

and the proper photometric standards that are indispensable for setting the reference illuminance in the reception field of the probe. It is necessary to take into account the fact that adjustment is related to all the components of the meter specified in Sec. 1.2.1.

All the detailed information is included in the instruction manuals for the control units.

6. MAINTENANCE RECCOMENDATIONS

- The LMC-10 measurement probe must be connected only to the devices described in the instruction manual.
- The device should not be exposed to falls, shocks or any other factors which can cause mechanical damage.
- It is necessary to protect the optical element of the reception field from dirt.
- The lens can be dusted with a clean, soft brush or with the airstream of the compressed dry air after unscrewing the element of the probe with an entry hole:  . It is recommended to rely on the latter method. Spray preparations that act as compressed air should be applied gently and very carefully. The container with such spray should be held in a vertical position.
- The probe cap should be removed only during the measurement.
- The probe should be removed and put on while turning it right clockwise, which prevents it from being untwisted by accident.
- The instrument should be kept and transported only in the carrying case provided by the manufacturer.
- All repairs of the instrument are performed by the manufacturer.

7. FIRMWARE

The User can deal with the firmware update by oneself. The number of the currently-installed version is displayed on the splash screen of the control unit:

- in the case of the P-200 panel: Menu→Head info,
- in the case of the RF200C software: View→About meter.

To update the instrument firmware you need to have a RF-200C converter and to follow the below-placed instructions:

- Download from the manufacturer’s website the SonBoot application.
- Download from the manufacturer’s website the firmware file for the LMC-10 meter.
- Connect the probe to the RF-200C interface and the latter to the USB port of the PC.
- Wait until the drivers are installed in the system.
- Run the SonBoot.exe application.
- Choose the LMC-10 from the Device Type drop-down list.
- Choose the RF-200C from the USB device drop-down list.
- Open the firmware data file.
- Press the Program key.

8. CE MARKING AND WEE DIRECTIVE

The product described in the instruction conforms to the following EU Council Directives:

2014/30/EC Electromagnetic compatibility

CE The conformance of the above-mentioned requirements is confirmed by CE mark.

This product cannot be thrown away with household waste. Deposit the product in an authorized electrical and electronic waste collection area for recycling. Contact the local authorities or the nearest waste disposal company to get more detailed information.