LMT LICHTMESSTECHNIK GMBH BERLIN

LMT-Goniophotometer GO-H 1400

Goniophotometer System for Measurement of Automotive Lamps

Description and Technical Specification of the Equipment

List of Contents:

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0 Introduction

0.1 Principle

The goniophotometer GO-H 1400 is a well designed system for measurements of headlamps and other lighting equipment for motor vehicles and other means of transport.
Applications:

- test of lighting devices for development, quality control, and regulation fulfillment for certifying laboratories, automotive and automotive lighting industry, traffic signal, bus, train, ship, and aircraft lighting test houses

The complete goniophotometer consists of the following components:

- mechanical system
- driving and control system
- angle measurement system
- photometer
- interface to computer
- computer system
- firmware
- special Software

With the aid of the automatic goniophotometer, the spatial luminous intensity distribution of light sources can be determined by swiveling in two planes and measuring the illuminance outside the so-called photometric limiting distance.
From the spatial light distribution, it is possible to derive all light technical parameters.
Automatic measurements to all relevant national and international standards can be made on all suitable automotive headlamps and signal lamps.
Further LMT test equipment can be integrated in the system:

- retro-reflective material measurement with RETRO 1000 or RETRO 2000
- license plate lamp measurement with luminance meter L 1003 or L 1009
- color measurement with colorimeters C 1210/C 2210/C 3300
- luminous flux measurement with integrating spheres UL 1000/UL 1500/UL 2000

0.2 Overall specifications

0.2.1 Accuracy of the system

The mechanical system and the angle measurement system provide an accuracy of the angle measurements of 0.01°. The overall deviation of photometric measurements is a combination of several single deviations which are not only caused by the measuring device but also by the ambient and measurement conditions. The following instrument characteristics are relevant for the accuracy of the measurement:
a) for the photometer head

- the approximation to the V(λ)-function
- the linearity
- the temperature coefficient
- frequency influences
- the calibration

b) for the display unit

- the linearity
- the error of the digital display
- the temperature coefficient
- the calibration

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The photometer, part of the GO-H 1400, fulfills the requirements of the highest and best accuracy class "L" according to the German standard DIN 5032 part 7. Its individual characteristics are smaller than the values given for best available commercial illuminance meters acc. to CIE Publ. No. 69 (1987).
The calibration of the instrument is made by using a luminous intensity standard lamp which was certified by the German National Test Institute PTB (Physikalisch-Technische Bundesanstalt). NIST traceability is acknowledged.

0.2.2 Time consumption for measurements

The software routines for the automatic measurements in combination with the high movement and measurement speed allow measurements to be carried out in a minimum of time. The movements of the goniometer during the measurements are optimized for every single measurement procedure. The temporary separation of measurement and evaluation allows shifting procedures like plotting of Isolux-curves to other times or to different computers.

0.2.3 Flexibility

The use of the structured programming allows changing measurement routines for adaptation to new demands easily.

0.2.4 Handling

The automatic measurement system can be operated after a short training period because of the menu-driven operating system and a very comprehensive instruction set. Errors by the user like reading errors, wrong calibrations or misalignments are practically excluded with the GO-H 1400.

0.3 System arrangement

The components of the goniophotometer are delivered in the following devices

- goniometer with test sample table, motor drives, angle encoders and internal wiring
- electronic rack containing
    - Photometer-Unit (display of photometric values)
    - Goniometer-Unit (display of angles)
    - Control-Unit (switches for manual movement control)
    - Safety-Unit (main switch and safety circuits)
    - two Power-Units (for goniometer motors)
    - power supply
- photometer head (typically for 25 m)
- stray light tube (typically for 25 m)
- set of configured cables to connect goniometer, electronic rack, photometer head, and computer
- tripod or wall mounting device (for stray light tube and photometer head)
- special Software

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1 LMT Goniometer GO-H 1400

1.1 Basic mechanical system

The basic mechanical system (goniometer) is used to rotate the test sample mounted to the mounting table to an exactly defined pair of angles around a horizontal and a vertical axis.
The measuring object can be moved as follows:

- rotation around a horizontal axis more than 180° (-100° to +100°)
- rotation around a vertical axis more than 360° (-200° to +200°)

Positioning of angles are made with a resolution of ± 0.01°.
The rotations are limited by switches to approximately ± 100° in vertical direction and approximately ± 200° in horizontal direction.
The maximum rotation speed during measurement is optimized to the following values:

- Horizontal speed approx. 40 °/s
- Vertical speed approx. 20 °/s

The maximum load for a limited operation range of ± 20° is 75 kg.
The maximum load for operation in the total angular range is 50 kg.
The base frame of the goniometer has wheels for easy movement during the installation and adjustable legs for alignment.
The design of the goniometer ensures vibration-free operation in all situations. The mechanical design is such that even with the test sample table extended to its most unfavorable position and at its nominal load of 50 kg, wind-up is less than 0.03°.
The goniometer is painted black. Those components which could reflect light to the photometer head are either painted or anodized matt-black.
The weight of the goniometer is approx. 850 kg.
The height of the measurement axis is 1 150 mm (± 50 mm).
The overall height of the goniometer is ≤ 2 000 mm.
The attached drawing shows the mechanical construction and main dimensions of the goniometer GO-H 1400.

1.2 Adjustable test sample table

The test sample table is designed as a crossway table. To adjust the measuring object, the test sample table can be adjusted from -50 to -400 mm with its upper surface referred to the measuring axis. When mounted on this table, the test samples can be shifted ± 300 mm along the longitudinal axis and ± 100 mm along the transversal axis in order to bring the reference point of the object under test to the measuring axis. All adjustments into the three directions are made by motoric drives and can be performed by push buttons on a switch board located at the goniometer. Scales allow accurate adjustments.
The dimensions of the mounting surface for the test sample are 400 x 500 mm.
The objects under test are attached to the clamping grooves or the threads of the test sample table (see attached drawing of the sample table).

1.3 Computer-controlled table

Adjustments of the sample table can be made by computer control with linear encoder systems and software LMT LIMES 2000 Module CCT. Manual control of movement is also possible by push buttons on a switch board at the goniometer.

1.4 Alignment laser

The horizontal axis has a built-in alignment laser that allows easy and repeatable alignment of the test sample.

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1.5 Driving and Control system

The driving and control system consists of the following units, located in the electronic rack:

- Control-Unit
- Safety-Unit
- 2 Power-Units

The GO-H 1400 is motor-driven and controlled by the Control-Unit. The rotations of the goniometer on the horizontal and vertical axes are done by DC electric motors with tacho-generators.
High precise DC Power-Units together with automatic control circuits guarantee smooth starts and stops and jerk-free turns at low speeds.
The Power-Units are protected against short circuit and overload so that no damages within the power supply can occur.
Various engine speeds adapt the specific rotation speed according to the measurement demands.
An emergency switch system can shut down the equipment immediately from various locations. An electric safety circuit avoids damages of the cable harness in case of rotations exceeding 360°.
Manual control of movement is possible by knobs and switches at the electronic rack, by telecontrol as per item 1.7, and by a joystick built-in the control panel at the goniometer.
A TÜV certificate is available, confirming the safe operation of the goniometer.

1.6 Angular measurement system

The angular measurement system consists of the following components:

- 2 angle encoders mounted to the axes of the goniometer
- Goniometer-Unit located in the electronic rack

The precise measurement and display of the angular position is mandatory for accurate control of the goniometer's movement and to have an exact correlation between the measuring values and the angular positions.
The angles are measured with an accuracy of ± 0.01° by high-precise absolute optical angle encoders.
The values are shown at the 5-digit display within the Goniometer-Unit.

- Display scope of angle values - 200.00° to + 200.00°.

The advantages of absolute angle measurements compared to the simple incremental measurements are

- immediately after switching on the equipment, the angular positions are displayed
- no zero-setting necessary
- transmitted errors from interference fields, e.g. during measurement of discharge lamps, are impossible

1.7 Joystick

The industrial type heavy-duty joystick is built-in the switch board located at the goniometer. The joystick is operated under software control of the LMT LIMES 2000 software and is connected to the USB port of the control PC. The joystick allows a manual movement of the goniometer in both horizontal and vertical axes.

1.8 Telecontrol

The Telecontrol is a hand-held device which is connected to the electronic rack by a flexible cable with a standard length of approx. 10 m. It is used for remote operation of the goniophotometer system and attached other devices and has these characteristics:

- Remote control unit with illuminated LCD panel and buttons
- connected to electronic rack and control PC by serial interface
- for remote operation of goniophotometer movement, table control, lamp voltage or current control
- display of angular position and photometric readings

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2 Photometric Measurement Systems

2.1 Photometric measurement system I for test distance 25 m

2.1.1 System-Photometer head SP 30 S0T-GO I (for 25 m)

The system-photometer head consists of a thermostatic stabilized V(λ)-Si-photoelement (planar element of top quality and extremely high internal resistance).
The relative spectral sensitivity s(λ)rel of the element is corrected with accuracy

- f1 < 0.6 % in order to guarantee outstanding accuracy also for measurement of signalling devices with LEDs.

The diameter of the light sensitive area is 30 mm.
A specially designed front diffuser provides uniform local sensitivity. This unique feature eliminates completely any influence of non-uniform illumination, e.g. at measurements of low beam headlamps near to the cut-off line.
The temperature of the element is thermostatic stabilized with an accuracy of ± 0.1°. Therefore, no influence from variations of the surrounding temperature is possible.
The photometer, part of the GO-H 1400, fulfills the requirements of the highest and best accuracy class "L" according to the German standard DIN 5032 part 7. Its individual error quantities are smaller than the values given for best available commercial illuminance meters acc. to CIE Publ. No. 69 (1987).
The photocurrent amplifier is responsible for short circuit operation of the V(λ)-Si-photoelement and delivers an impressed current proportional to the illuminance which can be transmitted over long cords without difficulties.
The precision operational amplifier is calibrated for the specific measuring ranges by switchable feedback resistors over 6 to 8 decades.
The basic calibration of the measurement signal is done within the photometer head, which contains the photocurrent amplifier as well.
The output signal of the photometer head is an impressed current which can be led via long cables of up to 100 m to the electronic rack (Photometer-Unit) without problems.
The system-photometer head can be easily inserted into the fixture built-in the stray light tube.

2.1.2 Photometer-Unit (Display-unit)

The current delivered from the photocurrent amplifier is led to the analog-digital converter by a current-voltage converter. The analog-digital converter transforms the analog values to digital values.
The integration time is selected for optimal results regarding the measuring rate.
The measuring value is displayed in 4-digits together with the selected measuring range (exponent base 10).
Measuring ranges:

- For illuminance: 0.0001 lx to 80.000 lx
- For luminous intensity at 25 m: 0.1 cd to 80.000.000 cd
- The measured value can be displayed either in lx or cd.

The measuring range setting can be done manually or in automatic mode.
A data input for external programming of the measuring range and the calibration is available.
The Photometer-Unit also holds a data output to connect peripheral devices.
For further technical details, please refer to the following documents attached:

- Manual S 1000 07/2000
- Test report for system-photometer head SP 30 S0T (Example)
- PTB calibration certificate for system-photometer S 1000 (Example)
- PTB/NIST agreement concerning recognition of equivalence.

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2.1.3 Stray light tube I (for 25 m)

The photometer head is arranged within a tube, also carrying baffles for stray light reduction. The apertures of the baffles are designed according to the measuring distance.

2.1.4 Tripod I (adjustable)

The tripod I is used for photometer head I with stray light tube and has the following characteristics:

- Heavy-duty construction.
- Height of the measuring axis adjustable.
- Tripod segments with spindles for height adjustment, connecting plates
- Equipped with adjustment device for accurate positioning and fixing to the floor.

2.1.5 Wall mounting device I (adjustable)

The wall mounting device I can be delivered instead of the tripod I for mounting the photometer head I with stray light tube if a stable concrete or brick wall is available at the test distance I or if the photometer head shall be mounted pendant from the laboratory ceiling. It has the following characteristics:

- Heavy-duty construction.
- Height of the measuring axis adjustable.
- Equipped with adjustment device for accurate positioning and fixing to the wall.

2.2 Photometric measurement system II for test distance approx. 3,16 m

2.2.1 System-Photometer head S 30 S0T-GO II (for approx. 3,16 m)

An additional photometer head SP 30 S0T-GO II (for test distances approx. 3.16 m) can be supplied with the goniophotometer. The advantage is that it can be exchanged with the photometer head I belonging to the system without changing any calibration. This exchange might be useful if one of the heads is not available during recalibration periods, or for comparison checks to prove the proper function of the system. Additionally, two fixed measurement distances can be used without changing the position of the photometer head.

Measuring ranges

- for illuminance: 0.0001 lx to 80.000 lx
- for luminous intensity at 3,16 m: 0.001 cd to 800.000 cd

With the Photometer-Unit (item 2.1.2), the measured value can be displayed either in lx or cd.

2.2.2 Stray light tube II (similar to item 2.1.3)

2.2.3 Tripod II (similar to item 2.1.4)

2.2.4 Wall mounting device II (similar to item 2.1.5)

2.3 Photometric measurement system III for gradient measurements

2.3.1 System-Photometer head S 10 S0T-GO III (for 10 m)

An additional photometer head SP 10 S0T-GO III (for test distances approx. 10 m) can be supplied with the goniophotometer. The diameter of the light sensitive area is 10 mm to match the requirements for the maximum diameter for gradient measurements at the cutoff line at 10 m distance according to SAE regulations (e.g. SAE J 583 of April 2001).

Measuring ranges

- for illuminance: 0.001 lx to 800.000 lx
- for luminous intensity at 10 m: 0.01 cd to 8.000.000 cd

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With the Photometer-Unit (item 2.1.2), the measured value can be displayed either in lx or cd.

2.3.2 Stray light tube III (similar to item 2.1.3)

2.3.3 Tripod III (similar to item 2.1.4)

2.3.4 Wall mounting device III (similar to item 2.1.5)

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3 Power supply and display unit for samples

3.1 DC power supply with display unit

The DC power supply with display unit for the operation of test lamps consists of

- Model NTN 700-65-M-LMT, 0-65V, 0-10A
- IEEE 488-16bit Interface, built-in capacitor ignition circuit for gas discharge lamps
- Built-in display unit with 4 ¾digit DVM for voltage, 4½digit for current
- Manufacturer: FuG, Made in Germany

Further details see Technical Description for Power Supply.

3.2 Connection-Unit and multiplexer for connection of up to 7 lamps

The Connection-Unit is used as switch board between the built-in power supply, the lamp multiplexer, or other devices connected to the system, e.g. integrating spheres or license plate lamp holders. It can also be used to connect other external operated power supplies to the test lamps.
The lamp multiplexer allows the manual switching at up to 7 lamps, each lamp can be switched on and off individually. It is directly attached to the goniometer's adjustable sample table and rotates with the table to provide the shortest connections at lamps to the power supply. The lamp multiplexer switches the supply line as well as the sense line to provide precise measurements of lamps voltage at the lamp sockets.
The lamp multiplexer can be manually controlled by

- knob at the multiplexer
- knob at the Connection-Unit at the electronic rack.

The lamp multiplexer allows the LIMES software (item 4)

- to operate 2 or more lamps at the same time as required by ECE or SAE regulation
- to operate and test 2 or more (up to 7) lamps automatically within one single test
- to perform multiple test procedures including individual stabilization without any necessary interaction by the operator, e.g. for complete measurements of front or rear combination lamps.

3.3 Rack mounting and system integration

The power supply is mounted in the electronic rack. The rear outlets are connected to the terminals of the Connection-Unit. Special cables are supplied to provide the connections between the Connection-Unit, the lamp multiplexer or other devices like integrating spheres or license plate lamp holders.

3.4 Software LMT LIMES 2000 Module POWER

Detailed description see enclosures

- Specification for DC Power Supply NTN 700-65-M-LMT
- Software Description LMT LIMES 2000 Automotive Lighting

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4 Software

4.1 LMT LIMES 2000 Program Package for GO-H 1400

LMT LIMES 2000 for Windows measurement and evaluation software for automotive lighting
Detailed description see enclosure

- Software Description LMT LIMES 2000 Automotive Lighting

4.2 LMT LIMES 2000 Module ISOLUX and ISOROAD

Software extension of LMT LIMES 2000 for evaluation of light distributions
Detailed description see enclosure

- Software Description LMT LIMES 2000 Automotive Lighting

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5 Computer and Printer

5.1 Computer

IBM-compatible PENTIUM PC
Detailed description see enclosure

(The actual version will be selected in cooperation with the purchaser.)

5.2 Printer

Detailed description see enclosure

(The actual version will be selected in cooperation with the purchaser.)

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6. Mounting, Instructions, Training

6.1 Mounting

Mounting, installation, adjustment, calibration and performance tests at place of installation

6.2 Instructions on site

Instructions for use of the measurement equipment for 2 working days, immediately after mounting, at place of installation

6.3 Additional Instructions on site

Additional instructions for use of the measurement equipment, immediately after mounting and instructions, at place of installation

6.4 Training at LMT's training center, Berlin

Training for up to 3 trainees is provided for a standard period of 5 working days. A complete automotive lighting laboratory with all relevant measurement systems will be provided at LMT's Training Center in Berlin, Germany.
The individual training will be performance by experts fully familiar with all theoretical and practical aspects of automotive lighting testing.

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7 Documentation and Manuals

Documentation and operation manuals are provided in printed volumes and in electronic format in English language. User manuals are also available in several other languages, e.g. Chinese. The following documentation and manuals are available:

- Hardware manual GO-H 1400
- Software manual LIMES 2000

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