

## MICROCOMPUTER-CONTROLLED SPIRAL PHOTOMETER FOR MEASURING THE LUMINOUS FLUX AND LUMINOUS INTENSITY DISTRIBUTION OF LAMPS AND LUMINAIRES

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The luminous flux of lamps and luminaires is determined by microcomputer-controlled electronics of integration. For this reason, up to 16200 measuring values of illumination are evaluated by a light sensor rotating spirally around the light source. Variable mechanic scanner systems are explained and possible measurements of the curves of intensity distribution are shown.

Principally, two methods of luminous flux measurement can be applied.

1. Measurement with an integrating sphere according to Ulbricht. Measuring can be performed relatively fast. The exact determination of the luminous flux - measuring error < 5% - is problematic, since normal luminous flux lamps having a relative spectral energy distribution that is as uniform as possible and nearly the same spatial intensity distribution as the light sources to be measured are necessary. It is another disadvantage that measuring errors may occur due to the selectivity and non-uniform reflexion of coatings, and the absorption of the light source and the screen. Measurement is complicated by aging of the sphere paint as well as soiling. It is an essential disadvantage that the luminous flux cannot be measured absolutely but only in relation to the luminous flux of expensive separately calibrated normal lamps.

2. Determination of the luminous flux from the luminous intensity or illumination distribution. In this case, the surface of an imaginary sphere around the light source is scanned with a light-sensitive sensor. Generally, the following applies for the luminous flux:

$$\Phi = r^2 \int_{\vartheta=0}^{\pi} \int_{\varphi=0}^{2\pi} E(\varphi, \vartheta) \cdot \sin \vartheta \cdot d\varphi d\vartheta \quad (1)$$

In the case of true light sources, the luminous flux integral according to equation (1) cannot be resolved completely since  $E(\varphi, \vartheta)$  is no analytical function. Numerical integration e.g. can be performed with the aid of the following approximation equation

$$\Phi \approx 4\pi r^2 \cdot \sin \frac{\Delta\vartheta}{2} \sum_{m=1}^k \sin \vartheta_m \cdot \frac{1}{n} \sum_{i=1}^n E(\varphi_i, \vartheta_m) \quad (2)$$

Scanning of the surface of intensity distribution is mostly carried out discontinuously on parallel circles (lateral areas of a cone). Expensive computer-controlled positioning systems for both axes of rotation with digital encoders are necessary - cf. computerized rotating mirror systems [1].

The spiral photometer [2] combines the advantages of the methods mentioned - high accuracy and short duration of measurement - by passing the light sensor continually around the light source on a spiral course. This procedure requires a simultaneous direct or virtual rotation of the receiver around two axes intersecting at a right angle with constant angular speed.