WHITEPAPER

Photometric measuring system quickly sheds light on luminaire quality

LED and OLED technology for automotive

LED/OLED technology opens up completely new possibilities for automotive designers around the globe. At the same time, the era of autonomous cars attaches increasing importance to the lighting of both the vehicles and their surroundings. As the lighting possibilities grow more diverse, so do the demands on the quality of the LED luminaires used – and thus on the technology needed to measure them. While speed and reliability are of utmost concern when measuring the various light parameters of a finished luminaire, especially for safety-relevant applications, it's critical that the measured values be stored so that, later on, compliance with the luminaire's predefined specifications can be shown. Until now, the reason why companies often failed in this respect was the lack of suitable measuring instruments; although there are very reliable and precise measuring methods for recording individual photometric parameters, these are often time-consuming and require complex structures.

All-in-one measurement of LED luminaires

The presentation of the first Ophir FluxGage system at the 2016 LED professional Symposium in Bregenz set off a small revolution: The boxy photometric system determined main quality parameters of a finished LED luminaire in just a few seconds. An ideal solution for developers and quality managers alike. But back then, although FluxGage was suited to a variety of applications, it wasn't ideal for measuring automotive LED lights like turn signals, brake lights or reversing lights.

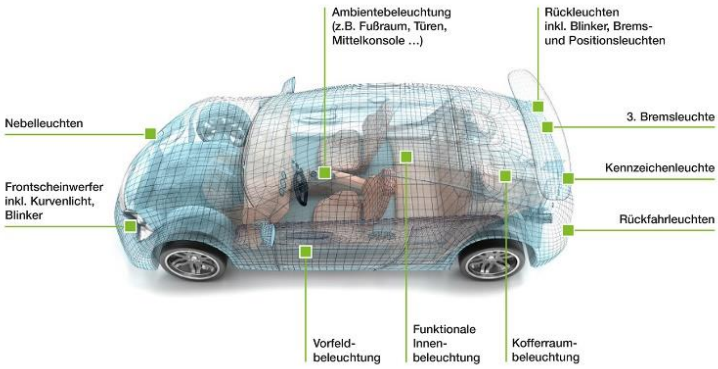

Figure 1 (car with lettering based on photo © iStock.com/alex-mit): LED technology is already being used widely in today's vehicles, as the image shows. Autonomous cars will only further push the envelope for new applications.

Especially for colored luminaires, the total luminous flux can be significantly lower than 500 lumens. The first FluxGage model could not yet measure such low values. In the meantime, MKS Instruments has successively added new models to the Ophir FluxGage product family and introduced the FluxGage HR: A high-resolution version, it measures white and colored LED luminaires with luminous flux down to 20 lumen – and it's fast and compact. These characteristics make it particularly suitable for quality testing of LED and OLED luminaires in the automotive industry.

Solar modules used for LED measurement

The principle behind the entire FluxGage series is photometric measurement based on solar modules. All five inner surfaces of the measuring device are equipped with photovoltaic cells for this purpose. On top of that are placed a diffusor layer and a finely perforated black foil to minimize reflections. The luminaire to be

measured is placed directly above the instrument so that the light radiates into the device's interior. The light thus passes through the perforations onto the solar modules, where it is measured and converted into electrical signals. In combination with a spectrometer – in the HR version a CCD one – the FluxGage software determines the total luminous flux. With a spectrometer at the bottom of the measuring device, also various color parameters such as color coordinates and color rendering values are determined. A photodiode – also integrated at the bottom of the instrument – additionally takes flicker measurements. A key advantage of the FluxGage system for the automotive industry: Due to its 2π measuring cavity, even curved luminaires can be measured quickly and easily. A task that's much harder to accomplish with either a goniometer or an integrating sphere!

Figure 2: The FluxGage photometric system for LED luminaires

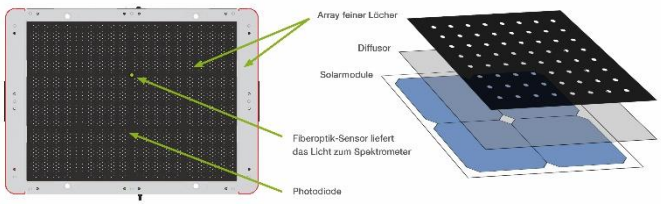

Figure 3: Components and structure of the Ophir FluxGage system

Changing light output, constant measurement technology

In the days of incandescent lamps, new models were mostly concerned with the shape of the bulb; halogen and xenon lamps offered some additional possibilities. Today, LED and OLED technology allows manufacturers to work with a palette of parameters that includes different luminous flux, color of light and light frequencies. OLED technology even enables three-dimensional lighting effects in novel shapes. But it's precisely this design freedom that poses major challenges for quality assurance. How does one measure the different parameters quickly and efficiently? While checking an individual value of an LED or OLED module with a certain degree of precision is no problem, it is if you want to measure a completely assembled luminaire in all its respective operating states. This is where the advantages of a photometric measuring device come into play. For example, the various functions of an OLED combination rear light can be tested with a FluxGage measurement setup, regardless of the color or the number of active OLED layers. Quality assurance is particularly important for those functions that affect safety: The latest brake lights from several manufacturers not only indicate the fact that the driver is braking, but also how hard. These different stages with their respective values can also be tested directly within the measurement setup.

Many light parameters captured in a single measurement

A FluxGage system can detect a wide variety of photometric and spectral parameters for a given luminaire, including:

- Total luminous flux
- Illuminance
- Spectral power distribution
- Color space coordinates
- Correlated color temperature of white light sources – (CCT)
- Color rendering indices (CRI, TM-30-15)
- Flicker

During the quality inspection of LED and OLED rear and daytime running lights (DRL) for vehicles, the focus is on determining the total luminous flux and the exact color space location. Unpleasant perceived flicker can occur in both daytime running lights and reversing lights, so it is an important parameter to be measured as well.

With large-area OLEDs, as already being seen in prototypes today, the level of brightness (the measurement of luminance) and uniformity are of particular consequence. However, for smaller OLED layers – e.g. as a component of the rear lights – the exact luminous flux values and color are more important to be controlled. With regard to safety, contrast also plays a crucial role. When it's dark at night or when going through a tunnel, the brake lights should be adapted to the ambient lighting conditions – that is, less bright than during the day – to avoid blinding the drivers in following vehicles. All in all, external lighting must comply with the color definitions of the standards set by each respective country. In the USA, for example, these are laid down in the SAE J578 standard and include precise specifications for the external lighting of vehicles, including luminaires and reflectors.

Fast comparison measurements in series

For the user who wants to quickly compare the LED lights of the same series after being switched on, there is a logging function. The sample luminaire is tested over a longer period of time, e.g. five or ten minutes; measurements are taken at a freely selectable intervals, e.g. every 30 seconds. The values obtained are compared with predefined reference values. This makes it possible to assess how the luminaire behaves in comparison with the reference luminaire after being switched on. If the parameters of one luminaire differ significantly from those of the others, it can be sorted out directly.

Figure 4: LED luminaire is placed directly above the FluxGage system for measurement

In summary

LED and OLED technology is used in vehicles for more than just external lighting, as Figure 1 shows. In the future, particularly for self-driving cars, ambient light inside the vehicle, like shadow-free distributed surface lighting, will continue to gain in importance. The photometric measurement concept of the FluxGage system is also suitable for fast measurement of these LED/OLED luminaires – both in development and in quality testing settings.

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