

# FMS400

## Photometric flicker measurement system



Recent reports have demonstrated that some SSL systems, particularly those paired with dimming controls, demonstrate significant photometric flicker, thought to cause photosensitive epilepsy, migraines, headaches, eye strain and non-specific malaise.

Bentham have developed a fully automated time-resolved photometric detection for the measurement of flicker.

- DH400-VL Precision photometer with NMI traceable calibration
- FMS400 high-speed amplifier and data acquisition
- Fully automated measurement through Windows application and USB 2.0 interface
- Reporting of flicker percent, flicker index and flicker frequency

### Definition and sources of flicker

Flicker is the term used for the rapid and repeated modulation of light output from a source. The principle source of flicker is the periodic variation in AC mains operated lamp output, at twice the AC frequency.

Flicker was a concern in the pre-mid 90's, in the specific case of fluorescent lamps with magnetic ballasts. As the lamps aged, light output generated in one current direction may become less than that generated in the other, resulting in flicker at the mains supply frequency. This problem was rectified with the use of electronic ballasts. Flicker has largely been forgotten until recently, when the effect of SSL lamp drive circuitry and phase-cut dimming circuits have caused concern once again.

### Potential effects of flicker

The health effects of flicker are generally divided into those due to visible flicker and those due to invisible flicker. In the visible domain, frequencies in the range ~3 to 70 Hz represent a risk of seizure in those with photosensitive epilepsy, whilst in the invisible domain, at higher frequencies, migraines, headaches, eye strain and non-specific malaise may result.

### Quantifying flicker

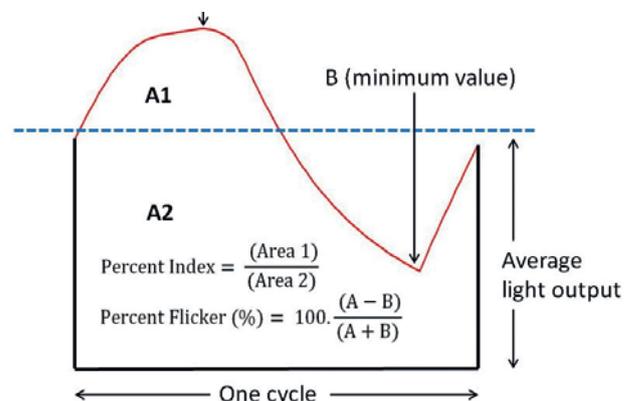
Two metrics are currently defined for the evaluation of flicker, percent flicker, and flicker index, the latter being generally preferred since it takes account of difference in waveform shape or duty cycle. As standards for the evaluation of flicker are developed, account may also be taken of flicker frequency.

### Bentham FMS400

Whilst flicker is essentially a luminance-based property, one can use any input optic to perform this measurement – a telescope, diffuser or integrating sphere. The Bentham flicker measurement system comprises close-match photometric detector, high-speed amplifier and data acquisition to determine the time-resolved source emission, which is captured by software and upon which calculation of the flicker percent and flicker index are performed.

### Flicker standards

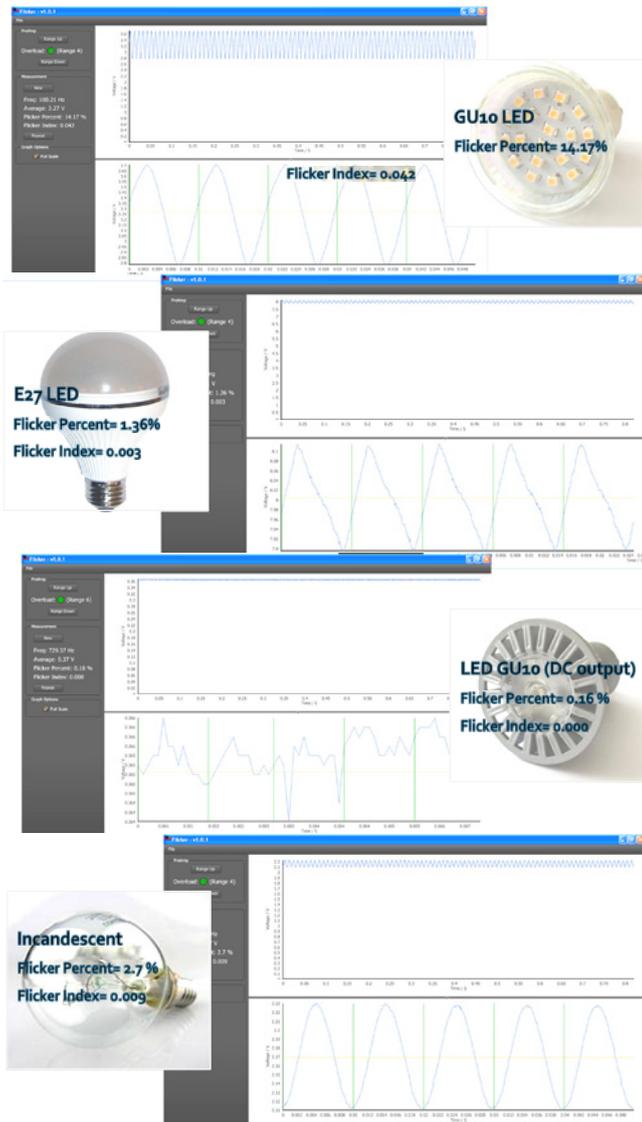
At present, the only country having published normative standards regulating the level of photometric flicker in light sources is Russia, through a range of Sanitary Norms and Regulations (SanPiN) and GOST R 54945-2012 "Buildings and structures. Methods for measuring of illuminance pulsation factor".



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### Example flicker results



### Specification

| B-DH400-VL Photometer               |                                                                                      |
|-------------------------------------|--------------------------------------------------------------------------------------|
| Spectral function                   | CIE 1924 V( $\lambda$ )<br>Spectral luminous efficiency function for photopic vision |
| Spectral response range             | 380 - 780 nm                                                                         |
| Photopic match, $f_1$               | <3%                                                                                  |
| Angular response, $f_2$             | <1.5%                                                                                |
| Linearity, $f_3$                    | < 0.2%                                                                               |
| Diffuser diameter                   | 7 mm                                                                                 |
| Connector                           | BNC                                                                                  |
| Mounting                            | M6 threaded hole                                                                     |
| B-FMS400 Flicker measurement system |                                                                                      |
| Inputs                              | 2, remotely/ manually selected                                                       |
| Amplifier gain ranges               | $10^{10}$ - $10^5$ V/A                                                               |
| Maximum input                       | 10 mA                                                                                |
| Frequency response                  | Gain range dependent,<br>most restrictive <4 kHz                                     |
| Input Impedance                     | Virtual ground                                                                       |
| Gain accuracy                       | $\pm 1\%$                                                                            |
| Gain stability                      | 200 ppm/ $^{\circ}$ C                                                                |
| Output stability                    | 5 ppm/ $^{\circ}$ C to 500 ppm/ $^{\circ}$ C dependent on gain range                 |
| Data acquisition                    | 12 bit ADC resolution,<br>20M samples/s                                              |
| Interface                           | USB 2.0                                                                              |
| Power supply                        | 12 V provided by external transformer                                                |