BIO-DIMMING LEARNING OVERVIEW

WHAT TO EXPECT FROM BIOS BIO-DIMMING MACHINE LEARNING SYSTEM

The overall purpose of the BIOS Bio-Dimming controller is to provide the highest melanopic to photopic ratio when a *BIOS-enabled dynamic lighting system* is set to full output and remove the SkyBlue wavelengths of light as the fixtures are dimmed.

The Bio-Dimming controller is a small device that fits into most light fixtures, is intended for use with BIOS Dynamic Light Engines, and uses a software algorithm designed to learn from occupant preferences. The Bio-Dimming controller is also controls agnostic and intended for use with any standard dimming protocol such as 0-10V and ELV.

The Bio-Dimming controller achieves seamless integration by monitoring the dimming behavior of the lighting system as determined by the occupant(s). The Bio-Dimming controller monitors the light level as it changes through the day and using that data, determines the set-point for maximum melanopic to photopic ratio (m/p ratio) while providing the new 'learned' maximum luminous flux.

Feature characteristics of the BIOS Bio-Dimming controller are outlined below and are intended to help engineers, designers, contractors, end-users better understand the BIOS Bio-Dimmer capabilities.

Note: Light fixtures equipped with BIOS Dynamic Light Engines contain two (2) different types of LEDs – BIOS' SkyBlue® (high EML) LEDs and traditional white (low EML) LEDs.

BIO-DIMMING FEATURE CHARACTERISTICS

- Upon initial startup of a BIOS-enabled dynamic spectrum lighting system, there is a 30-minute window within which the designer/contractor/engineer/occupant can establish the desired maximum light level setpoint. At startup, the m:p ratio (for light fixtures that contain BIOS dynamic boards) will be fixed; this means the BIOS SkyBlue content will be at maximum output independent of the dimmer setting.

- Dimming from the established maximum setpoint will remove the BIOS SkyBlue LED content (and thus the melanopic content) at twice the rate of the standard white LED; the BIOS SkyBlue LED contribution should be nearly absent as the dimmer setting moves down beyond 50% of the new 'learned' setpoint maximum.

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BIO-DIMMING FEATURE CHARACTERISTICS

- When dimming from 100% down to approximately 50%, it should be noted that the lumen output of the fixtures will remain relatively constant as the BIOS SkyBlue content is removed. Dimming from 50% and lower, total lumen output of the fixture will then decrease more linearly as the standard white LED channel becomes the primary contributor

DIMMER SETTINGS WITH BIOS TECHNOLOGY

DIMMER SETTING*	BIOS® SKYBLUE®	LIGHT OUTPUT	
100%* (Full On)	100%	100%	BIOS SkyBlue spectrum is maintained for maximum circadian impact, while light output remains relatively constant.
99%-51%	100%-0%	100%-90%	
50%	NO BIOS	~90%	BIOS SkyBlue spectrum is removed to provide minimal circadian impact, while light output dims linearly.
49%-0%	NO BIOS	LINEAR DIMMING	

- **Very important:** Once a maximum lumen output has been set, dimming up from the 'learned' maximum will increase the light fixtures' lumen output but it will not increase the m:p ratio. Once a maximum lumen output is set, the m:p ratio is essentially capped or set to be maximized for that lumen output, therefore the m:p ratio cannot be increased until the system 'learns' a new higher setpoint.

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BIO-DIMMING FEATURE CHARACTERISTICS

- BIOS' Bio-Dimming controller learns new setpoints by capturing the LED driver current measurements and analyzing them over time. The rate at which the Bio-Dimming controller identifies and adjusts the setpoint differs if you are increasing or decreasing the light level relative to the existing setpoint. BIOS Bio-Dimming controller will perform a bi-hourly analysis of the historical data (using a moving window that analyzes approximately the last 24 hours of ON time) and will then tune the new setpoint.

    * **Dimming Lights Down** - A decrease in the light level setpoint will occur if the light levels have been lowered below the existing setpoint for at least 24 hours. This means that if the light levels do not stay lowered (below the existing setpoint) for 24 hours, a new set point will not be established. However, if they stay lowered for 24 hours, then a new lower setpoint will be established.
        » **Note:** Quick adjustments to the light levels will not interfere with the setpoint historical data. This means trying different light levels for several minutes up to an hour will not override the system data such that it prevents the Bio-Dimming controller from establishing a new setpoint.
    * **Dimming Lights Up** - An increase in the light level setpoint requires less time for adjustment than decreasing them. If light levels are increased above the existing setpoint for a minimum of 2 hours and up to a maximum of 4 hours (as long as the current remains relatively constant), a new setpoint will be established. If light levels are increased for short intervals, the existing setpoint will be maintained.

- The historical data acquired during the 24-hour sliding window and the setpoint are non-volatile. BIOS' Bio-Dimming controller will preserve both sets of information at power down and recover it at power up.

COMMISSIONING

- The machine learning system can be manually overridden temporarily to establish a new setpoint. This is done by adjusting the current (dim setting) by at least 50% as follows: up-down-up-down-up. This sequence must be completed within 5 seconds, set mode begins when all LEDs flash OFF for 1 sec. Then, the dynamic array will provide maximum m:p independent of the measured current, allowing adjustment to find the desired light level. Set mode will terminate after approximately 15 seconds, after which the light level will be saved as the new the setpoint. The LEDs will then flash 3 times indicating the end and normal machine learning will resume.

- This document is intended to supplement the information included in the BIOS Bio-Dimming Specification Sheet -