BIOS SkyBlue®

Technology Overview • Ordering Guide

axis + bios ILLUMINATED

BIOS SkyBlue®

Circadian lighting made simple

A circadian lighting partnership

Axis is partnering with BIOS to assist lighting professionals in designing circadian-effective lighting. A broad range of Axis luminaires seamlessly integrate SkyBlue technology with the aim to create environments that improve alertness and promote better sleep, health and well-being.

What is BIOS SkyBlue?

Life is all about contrast, perhaps none as important as light and dark, day and night. As humans, we have evolved with blue sky and daylight as natural cues to keep our body clocks aligned with the 24-hour day. This healthy contrast between daylight and darkness allows our circadian rhythms to function as designed.

BIOS SkyBlue communicates with the body on a biological level by providing a specific wavelength of light that stimulates our circadian system. It works in conjunction with traditional white light LEDs, so it maintains the appearance of white light in familiar color temperatures. SkyBlue lighting systems can deliver the benefits of natural light without compromising light quality.

Why BIOS SkyBlue?

- ✓ **Better sleep by night, improved alertness by day**
- ✓ **"Invisible" 490 nm blue boost to circadian system without changing appearance of white light**
- ✓ **No color tuning or CCT adjustments required**
- ✓ **Wide choice of Axis luminaires with SkyBlue option**
- ✓ **Compatible with standard 0-10V dimming**

Disclaimer

While Axis makes the BIOS SkyBlue technology available, the ultimate decision of where, when and how to use it is at the discretion of the designer.

BIOS SkyBlue®

About the technology

Solutions to simplify circadian lighting in everyday applications

BIOS SkyBlue light engines align with our natural biological rhythms – circadian rhythms, which repeat every 24 hours. SkyBlue emulates the natural blue sky signal that we as humans have experienced in our evolution over millennia, working quietly behind the scenes to deliver circadian-supportive light.

- ✓ **Office**
- ✓ **Classroom**
- ✓ **Healthcare (acute & continuum of care)**
- ✓ **Hospitality**
- ✓ **Behavioral Health Facilities**
- ✓ **Wellness/Fitness Centers**
- ✓ **Transportation Control Centers**
- ✓ **Military Operations & Training Centers**

How does it work?

BIOS SkyBlue lighting solutions deliver the health-enhancing blue wavelength of the light spectrum. Recently discovered photoreceptors in the human eye – photosensitive retinal ganglion cells or ipRGCs – contain the protein melanopsin, which is highly sensitive to that blue wavelength. When melanopsin is stimulated by light, the ipRGCs send a signal to the body's master clock, telling it to re-set its cycle for the next 24 hours. That signal triggers a variety of biological processes, including essential hormone production (e.g. early morning cortisol for alertness and nighttime melatonin to promote sleep).

Key Features

Peaks at 490 nm to target melanopsin, the light-sensitive protein contained in our non-visual photoreceptors

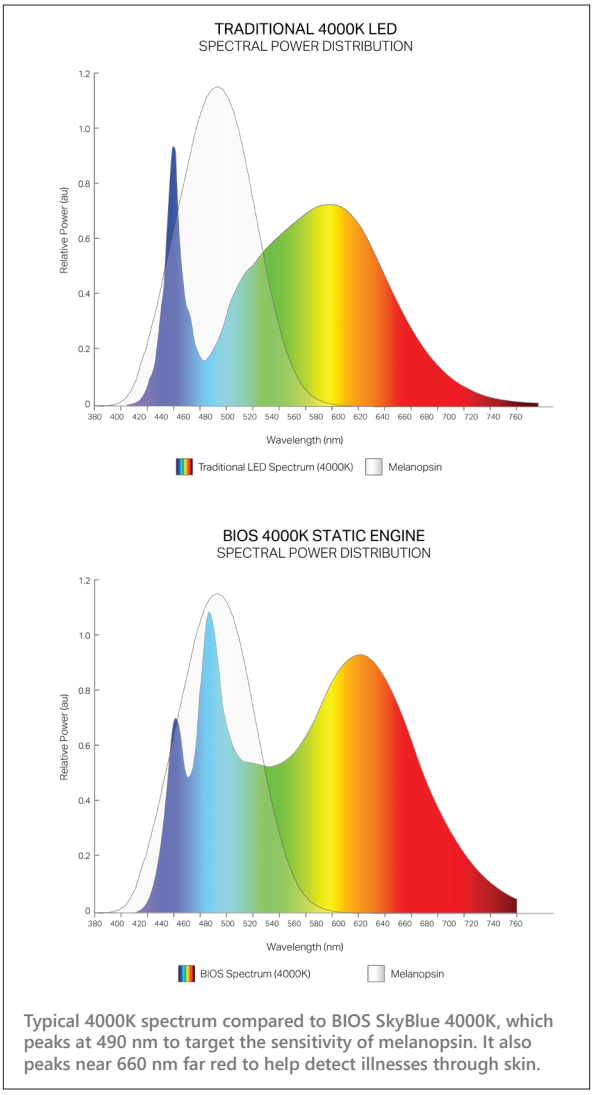
- ✓ Delivered light does not appear blue
- ✓ Maintains appearance of white light
- ✓ Choice of correlated color temperatures (CCTs): 3000K, 3500K and 4000K

Peaks also at 660 nm in the far-red spectrum

- ✓ Facilitates detection of illnesses through skin, such as cyanosis and sepsis
- ✓ Meets the cyanosis observation index (COI)* recommended threshold of < 3.3

More efficient at reaching circadian metric targets than traditional LED systems

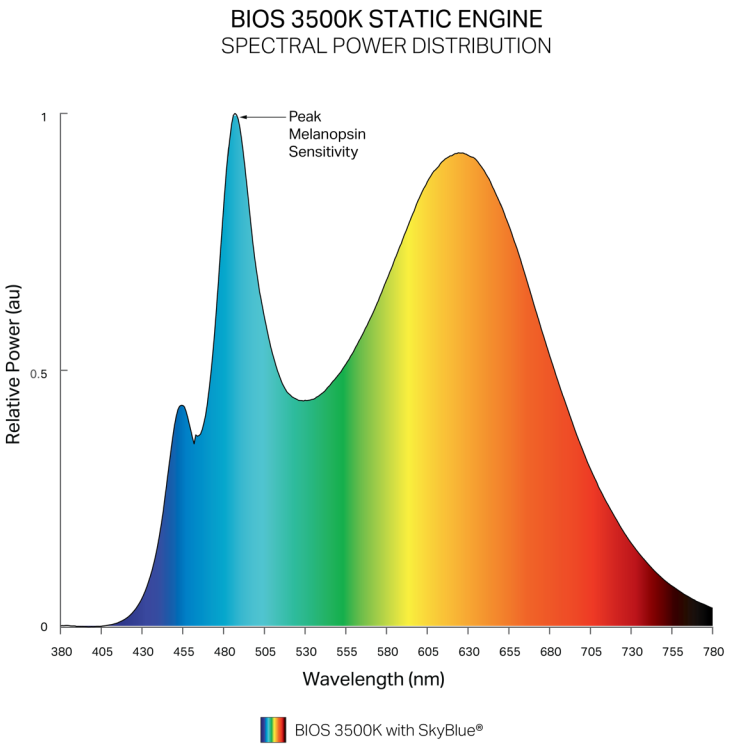
- ✓ Circadian stimulus (CS)
- ✓ Equivalent melanopic lux (EML)



Typical 4000K spectrum compared to BIOS SkyBlue 4000K, which peaks at 490 nm to target the sensitivity of melanopsin. It also peaks near 660 nm far red to help detect illnesses through skin.

* Interior Lighting Standard AS/NZS 1680 2.5:1997 Section 7.2, superseded by 2018, introduces COI as a measure of the ability of a light source to aid the detection of cyanosis in a patient: '"where cyanosis observation is necessary the lighting should have a color temperature of between 3300K and 5300K and a COI of 3.3 or less". Cyanosis can present itself as a 'bluing' of the skin, indicating low skin oxygen saturation which may suggest cardiac or respiratory problems. Color rendering and light quality are important.

Two systems: Static and Dynamic



M/P Ratios* and Nominal Performance

	BIOS Static Solutions		
CCT	3000K	3500K	4000K
CRI	82	83	83
R9	94	91	91
COI	3.0	3.1	3.1
SkyBlue Melanopic (M/P) Ratio	**0.70**	**0.80**	**0.90**

* M/P (melanopic to photopic) ratio indicates the ability of a light source to stimulate melanopsin, the protein contained in our non-visual photoreceptors that activates our circadian systems; it is used to help calculate EML (equivalent melanopic lux), one of the metrics used for circadian lighting in the WELL Building Standard.

Static Spectrum

The static spectrum does not change spectral qualities throughout the day. It delivers a steady but invisible blue-light boost to white light throughout the day, maximizing circadian impact.

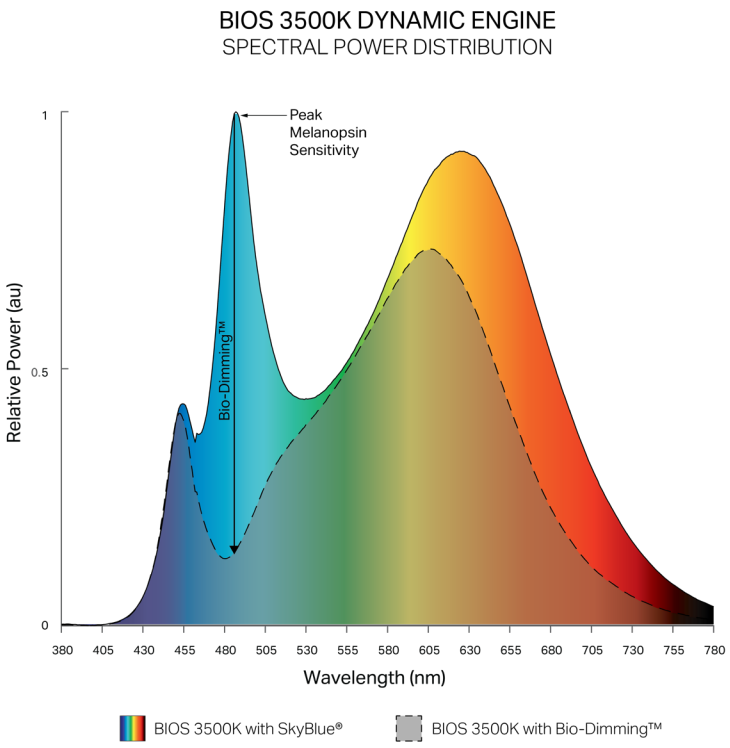
Applications

Suitable for day-active applications, such as schools and offices.

Static Light Engine

- ✓ **Supports daytime circadian stimulus**
- ✓ **No color tuning or correlated color temperature (CCT) adjustment required**
- ✓ **Color of light remains constant throughout the day:**
  - 490 nm 'blue boost' does not reduce during the day
  - Apparent CCT of 3000K, 3500K or 4000K remains constant
- ✓ **High melanopic to photopic (m/p) ratio**
  - While m/p ratio will remain constant if light level is dimmed, EML and CS values will be affected due to reduced vertical illuminance
- ✓ **CRI >80; R9 >75 at each CCT**
- ✓ **Simple controls**
  - Works with all LED drivers
  - Compatible with standard 0-10V dimming

Two systems: Static and Dynamic



M/P Ratios* and Nominal Performance

	BIOS Dynamic Solutions		
CCT	3000K	3500K	4000K
CRI	83	83	83
R9	90	90	90
COI	3.3	3.3	3.3
SkyBlue Melanopic (M/P) Ratio	**0.74**	**0.83**	**0.95**

* M/P (melanopic to photopic) ratio indicates the ability of a light source to stimulate melanopsin, the protein contained in our non-visual photoreceptors that activates our circadian systems; it is used to help calculate EML (equivalent melanopic lux), one of the metrics used for circadian lighting in the WELL Building Standard.

Dynamic Spectrum

BIOS dynamic light engines use easy-to-program Bio-Dimming™ to provide high SkyBlue content during the day and remove SkyBlue content at night. The integral Bio-Dimming module allows the luminaire to deliver a steady but invisible boost of SkyBlue melanopic content to white light for daytime applications. The Bio-Dimming module then reduces the SkyBlue light over a specified amount of time, as programmed through lighting controls, while maintaining a constant light level. Once SkyBlue reaches its reduced level, light levels can be changed.

BIOS Bio-Dimming Settings with Dynamic Light Engine

DIMMER SETTING	BIOS SKYBLUE®	LIGHT OUTPUT		
100% (Full On)	100%	100%	Bio-Dimming™	BIOS SkyBlue® maintained for maximum circadian impact. Light output remains relatively constant.
99%-51%	100%-0%	100%-90%		
50%	NO BIOS	~90%	Intensity Dimming	BIOS SkyBlue® removed to provide minimal circadian impact. Light output dims down linearly.
49%-0%	NO BIOS	LINEAR DIMMING		

Applications

Suitable for 24-hour working environments such as hospitals, adult care facilities, laboratories, transportation control centers and applications involving shift work.

Dynamic Light Engine

- ✓ **Supports daytime circadian stimulus, reduces nighttime stimulus, based on user-defined schedule**
- ✓ **No color tuning or CCT adjustment required**
- ✓ **Uses the integral BIOS Bio-Dimming module to regulate SkyBlue stimulus**
- ✓ **SkyBlue content can be removed (via Bio-Dimming™) as day progresses, reducing melanopic impact while keeping light levels for visual tasks constant**
- ✓ **High melanopic to photopic (m/p) ratio**
- ✓ **CRI >80; R9 >75 at each CCT**
- ✓ **Simple controls:**
  - Uses any single-channel constant current LED driver with 0-10V dimming interface

BIOS SkyBlue®

Performance comparisons

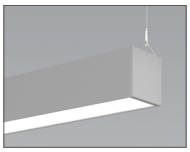
SkyBlue compared to traditional white LEDs

To the naked eye, the white light produced by an Axis luminaire with SkyBlue option may appear identical to the white light from traditional LEDs, but the actual spectrum is different.

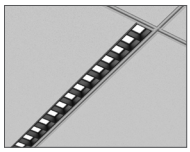
Greater melanopic content

Axis luminaires with SkyBlue deliver greater melanopic content. The resulting higher melanopic ratios contribute to higher equivalent melanopic lux (EML) and circadian stimulus (CS) calculations, two important circadian lighting metrics.

Slim SurroundLite® Pendant



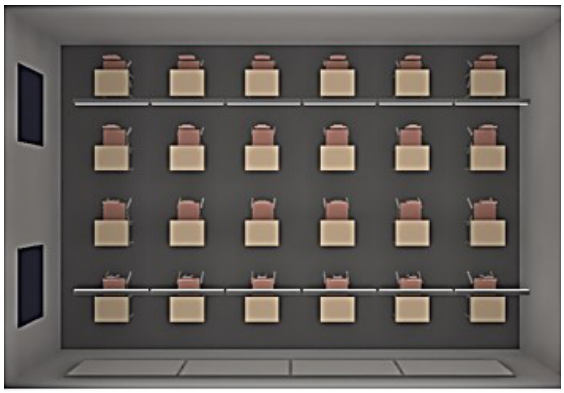
Beam 4 pendant

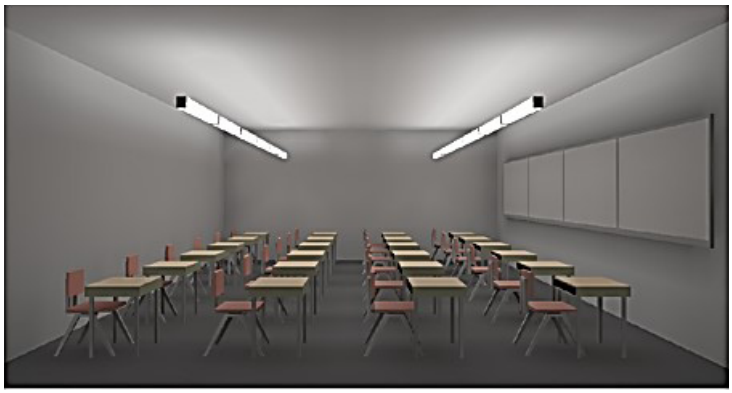


Sculpt™ Recessed with MikroLite™

Better visual comfort

When compared to traditional LEDs, SkyBlue technology can also achieve equivalent circadian impact at lower illuminance levels, resulting in better visual comfort.





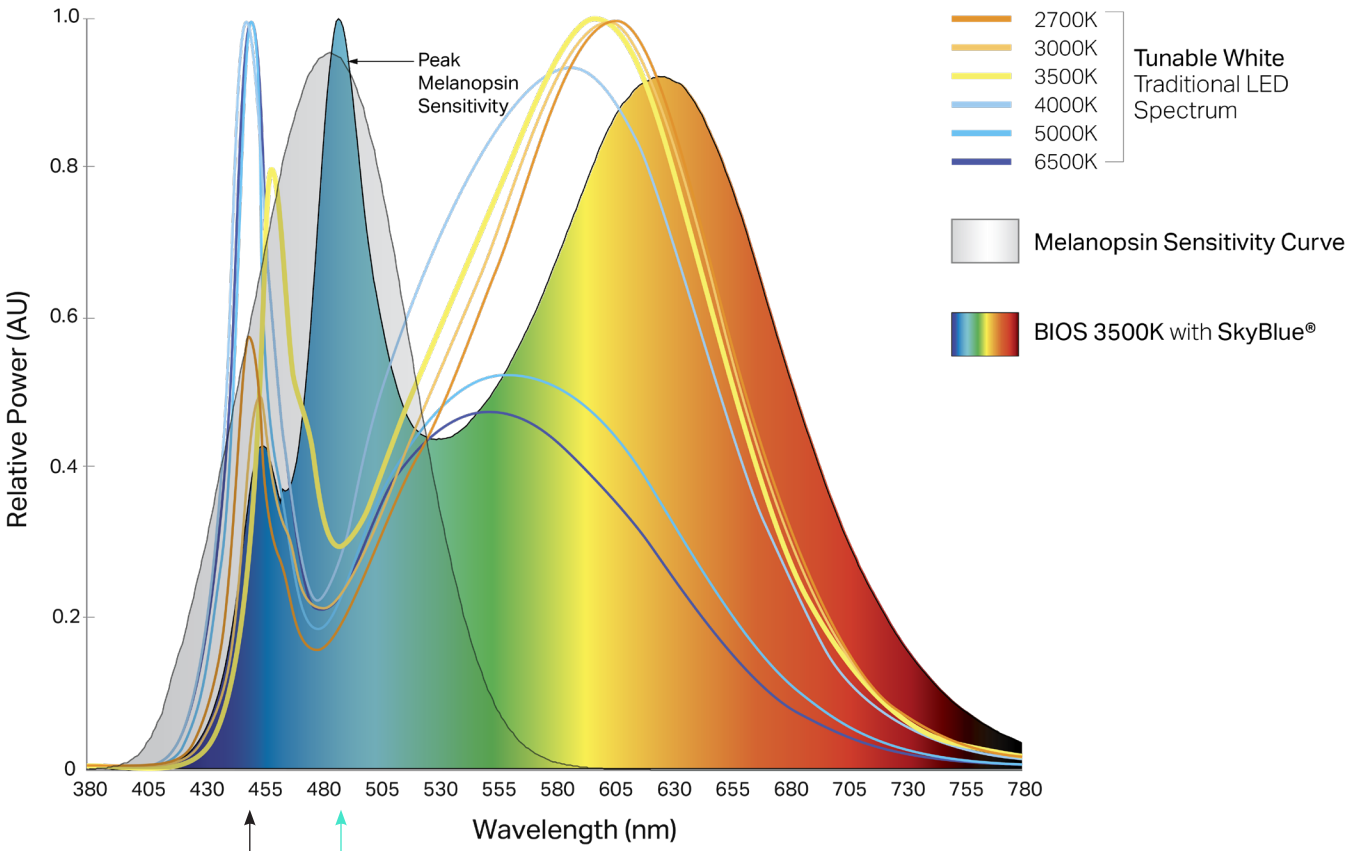
Lighting Strategy	Light Source	Equivalent Melanopic Lux (EML) Avg	Horizontal Illum E_h Avg	Vertical Illum E_v Avg	Lumen Output	Total Design Watts	LPD
Indirect/Direct Pendant (80 up/20 down)	Traditional LED Technology	220	596lx/55fc	366lx/34fc	852lm/ft	418W	0.70 W/ft²
	Circadian LED Technology		**430lx/40fc**	**265lx/25fc**	**616lm/ft**	**302W**	**0.50W/ft²**

The illuminance values in the chart above represent the average light level across the room; individual calculation points are higher or lower depending on where they were taken. Light levels and EML values account for electric lighting only and do not consider daylight contribution.

Performance comparisons

SkyBlue Compared to Tunable White

Spectral Power Composition and M/P Ratios



BIOS delivers higher melanopic content than traditional LEDs, regardless of correlated color temperature (CCT), as shown in graph above.

Spectral power distribution more accurately indicates whether a light source addresses the melanopsin sensitivity curve than CCT.

BIOS SkyBlue®

IALD / LIRC WELL v2™ Guidelines

The following information and tables have been adapted from the IALD/LIRC WELL Guidelines 2019 Document for BIOS Illuminated Partners. The information below represents the minimum required information as outlined in the IALD/LIRC Guidelines document. Please refer to the '**2019_IALD-LIRC_WELL-Guidelines.pdf**' for detailed information.

WELL™ | Light | Feature L03 - Circadian Lighting Design

CIRCADIAN LIGHTING DESIGN (1pt / 3pt Max)	BIOS Dynamic Engine			BIOS Static Engine		
	3000K	3500K	4000K	3000K	3500K	4000K
	83	83	83	83	83	83
Luminous Flux Multiplier (consult your Axis representative for values)						
Melanopic Ratio (R)*	0.74	0.83	0.95	0.70	0.80	0.90

Requirements for this feature:

Electric lighting is used to achieve light levels shown in the table below as measured on the vertical plane at eye level of the occupant. The light levels are achieved at least between the hours of 9 A.M. and 1 P.M. and may be lowered after 8 P.M.
For tabulated spectral power distribution (SPD) data please go to www.bioslighting.com

*Melanopic Ratio (R) is used to determine EML values. EML stands for Equivalent Melanopic Lux, and is defined by the photopic lux multiplied by a melanopic ratio, EML = LxR. For more information see "Measuring and Using Light in the Melanopsin Age" by Lucas, RJ et al.

WELL™ | Light | Feature L04 - Glare

GLARE CONTROL CRITERIA (3pt Max)	COMPLIANT	VALUE
a. Indirect (100% emission above horizontal)		
b. Unified Glare Rating (UGR)		
c. Shielding Angle		
d. Max. Luminance / Max. Intensity (45°C-90°C)		
e. Not Applicable		

Requirements for this feature:

For each luminaire type, manufacturers must provide a statement of compliance for one of the four methods or exclusion from the standard, plus supporting values as defined in the compliance category.

WELL™ | Light | Feature L07 - Part 1: Color Rendering

ELECTRIC LIGHT QUALITY PART 1 - ENSURE COLOR RENDERING QUALITY (1pt Max)		COMPLIANT	VALUE
CRI	CRI > 90	--	
CRI, R9	CRI >80 with R9>50	☐	CRI = 83 R9 >75
IES TM-30-18	IES Rf ≥ 78, IES Rg ≥ 100, -1% ≤ IES Rcs, h1 ≤ 15%	--	
Not Applicable	Decorative, emergency, other	--	

WELL™ | Light | Feature L07 - Part 2: Flicker

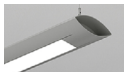
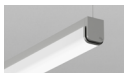
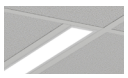
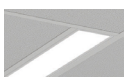
ELECTRIC LIGHT QUALITY PART 2- MANAGE FLICKER (1pt Max)	COMPLIANT	VALUE
Meets IEEE 1789-2015 Standard Recommended Practice		

Energizing the office environment

Axis Slim SurroundLite® Pendant D/I shown above could be used with BIOS SkyBlue Static Spectrum (CCT at 3500K or 4000K). The lighting quality would appear constant during work hours as blue boost - and daytime stimulus - remain steady.

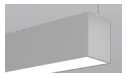
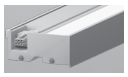
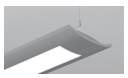
BIOS SkyBlue®

Compatible Axis luminaires

		Static Engine	Dynamic Engine
		B(CCT) DPB(STC)	B(CCT) DPB(DYN)
CCT range		3000K	3000K w/ Bio-Dimming™
		3500K	3500K w/ Bio-Dimming™
		4000K	4000K w/ Bio-Dimming™
Available CRI		80+	80+
R9		>90 at all CCTs	>90 at all CCTs
	**202** Pendant, Wall	✓	✓
	**Arc** Pendant, Wall	✓	✓
	**Air** Pendant, Surface, Wall	✓	✓
	**Aura, Dia, Day, Plano, Wave** Troffers	✓	✓
	**Beam 2 Square Direct** Pendant, Wall, Surface	✓	✓
	**Beam 2 Square Indirect** Pendant, Wall	✓	✓
	**Beam 2** Recessed	✓	✓
	**Beam 2 Direct/Indirect, Direct** Pendant, Wall, Surface	✓	✓
	**Beam 2 Indirect** Pendant, Wall	✓	✓
	**Beam 2 MikroLite™ 1.5** Pendant Combined, MikroLite Only	✓	✓
	**Beam 3 Direct/Indirect, Direct** Pendant, Wall, Surface	✓	✓
	**Beam 3 Indirect** Pendant, Wall	✓	✓
	**Beam 3** Recessed, Perimeter Recessed	✓	✓
	**Beam 4 Direct/Indirect, Direct** Pendant, Wall, Surface	✓	✓

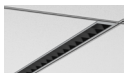
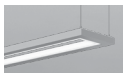
BIOS SkyBlue®

Compatible Axis luminaires

		Static Engine	Dynamic Engine
		B(CCT) DPB(STC)	B(CCT) DPB(DYN)
CCT range		3000K	3000K w/ Bio-Dimming™
		3500K	3500K w/ Bio-Dimming™
		4000K	4000K w/ Bio-Dimming™
Available CRI		80+	80+
R9		>90 at all CCTs	>90 at all CCTs
	**Beam 4 Indirect** Pendant, Wall	✓	✓
	**Beam 4 MikroLite™ 1.5** Pendant Combined	✓	✓
	**Beam 4** Recessed, Perimeter Recessed	✓	✓
	**Beam 6 Direct/Indirect, Direct** Pendant, Wall, Surface	✓	✓
	**Beam 6** Recessed, Perimeter Recessed	✓	✓
	**Cove Perfekt™** Ceiling Hi-Output, Lo-Output	✓	✓
	**Cove Perfekt™** Wall Hi-Output, Lo-Output	✓	✓
	**Geometric™** Recessed	✓	✓
	**Graze Perfekt™** Perimeter, Pendant, Surface	✓	✓
	**LT SurroundLite®** Pendant, Wall	✓	✓
	**Mini Box** Pendant, Wall, Wall Vertical, Surface	✓	✓
	**Prime** Pendant, Wall, Surface	✓	✓
	**Sculpt™ Direct/Indirect, Direct** Pendant, Wall, Surface	✓	✓
	**Sculpt™ Indirect** Pendant, Wall	✓	✓

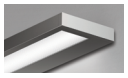
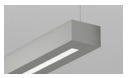
BIOS SkyBlue®

Compatible Axis luminaires

		Static Engine	Dynamic Engine
		B(CCT) DPB(STC)	B(CCT) DPB(DYN)
CCT range		3000K	3000K w/ Bio-Dimming™
		3500K	3500K w/ Bio-Dimming™
		4000K	4000K w/ Bio-Dimming™
Available CRI		80+	80+
R9		>90 at all CCTs	>90 at all CCTs
	**Sculpt™** Recessed, Perimeter Recessed	✓	✓
	**Sculpt™ MikroLite™ 1.5** Pendant Combined, Direct MikroLite Only, Direct/Indirect MikroLite Only	✓	✓
	**Sculpt™ MikroLite™ 1.5** Recessed Combined, MikroLite Only	✓	✓
	**Sculpt™ MikroLite™ 1.5** Surface Combined, MikroLite Only	✓	✓
	**Sculpt SoftZone® Pendant** Direct/Indirect, Direct, Indirect	✓	✓
	**SideStep™** Pendant	✓	✓
	**Sketch®** Recessed	✓	✓
	**SkyeFall Recessed** 2x2	✓	✓
	**SkyePool Recessed** 2x2	✓	✓
	**SkyePlane Regressed** 1x1, 1x2, 1x4, 2x2, 2x4	✓	✓
	**SkyeScape Recessed** 2x2	✓	✓
	**SkyeView Recessed** 2x2	✓	✓
	**SkyeView Recessed** 1x4	✓	✓
	**Slim Pendant** Direct, Semi-Direct, Indirect, Semi-Indirect	✓	✓

BIOS SkyBlue®

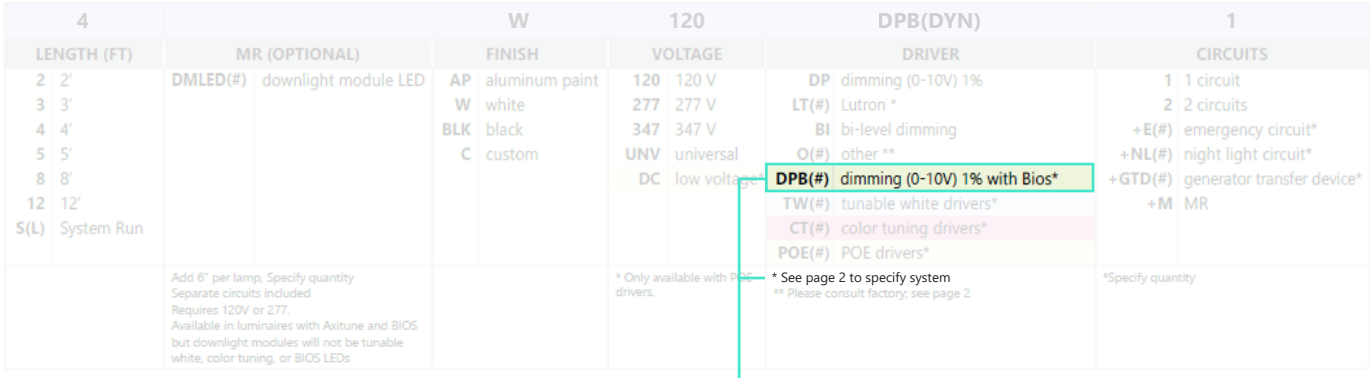
Compatible Axis luminaires

		Static Engine	Dynamic Engine
		B(CCT) DPB(STC)	B(CCT) DPB(DYN)
CCT range		3000K	3000K w/ Bio-Dimming™
		3500K	3500K w/ Bio-Dimming™
		4000K	4000K w/ Bio-Dimming™
Available CRI		80+	80+
R9		>90 at all CCTs	>90 at all CCTs
	**Slim Wall** Indirect, Semi-Indirect	✓	✓
	**Twig Semi-Indirect** Pendant, Wall	✓	✓
	**Flexible Ambient** 1x1, 1x4, 2x2, 2x4	✓	✓
	**Multi-Function Overbed** 2x2, 2x4	✓	✓
	**Sconces** Box, Open Book, Closed Book	✓	✓

How to order

Spec sheet sample order, Dynamic Light Engine

Description: Beam 4 Wall Direct LED at 1000lm/ft, with 80 CRI, BIOS 3500K with Bio Dimming™, Ultra blend lens, 4ft length, white finish, 120 volts, dimming 0-10V (SkyBlue enabled 100% to 50%, static white from 49% to 1%) with BIOS Dynamic Spectrum engine, 1 circuit



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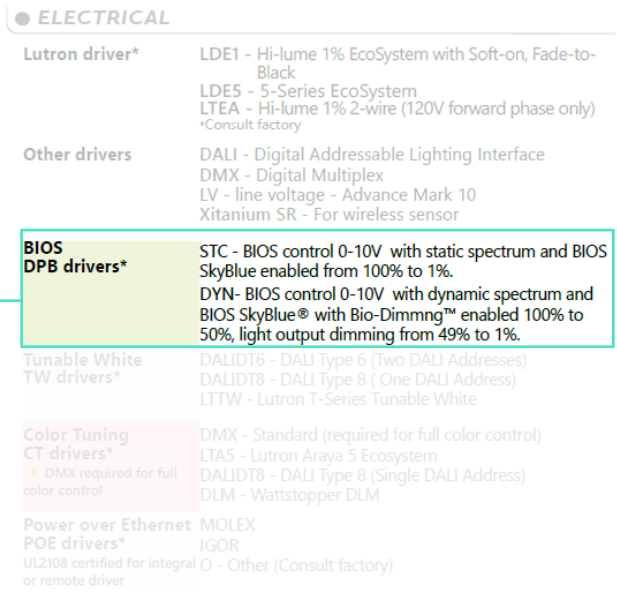

NOTES

Regarding IES files: Standard product IES files can be used for BIOS products at this time, as the photometric curve will not change. For power density calculations, consult your Axis Lighting representative.