![Bridgelux logo — Bridging Light and Life™]

Bridgelux Vesta® Flex

April 2020

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Human Centric Lighting: Definition

- Human centric lighting is broadly defined as:
  - Lighting that can benefit the biological, emotional, health, or wellbeing of people

- This is typically achieved through:
  - Providing high quality light sources for visual appeal
    - Full spectrum emission over the visual range with high CRI and R values
  - Enabling personalization and control
    - Supporting individual preferences for lighting intensities, colors and styles
    - Circadian adjustable to mimic the levels of sunlight throughout the day
  - Ensuring the light delivered is as close to that provided by nature
    - Emulating the spectrum of the sun under which humans have evolved for millions of years, sunlight during the day and firelight at night
    - Avoiding deviations from natural light that may disrupt the circadian rhythm

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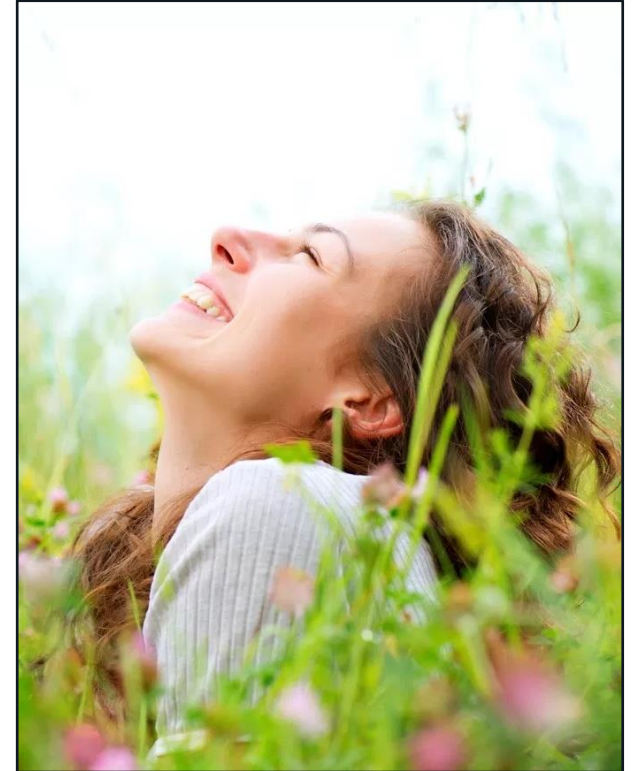
Lighting Market: Dynamics And Challenges

- The lighting market is in the early stages of human-centric lighting adoption
  - Tunable white lighting systems are an important part of this evolution with strong growth potential

- The lighting component market is siloed
  - This forces luminaire manufacturers to source building blocks (LEDs, drivers, and controls) from multiple suppliers
  - Unfortunately, this often results in challenges as the sourced components may not work together out of the box

- Most tunable white opportunities are project based
  - The control system decisions may be made outside of the luminaire manufacturers control, driven by the installation

- To accelerate the adoption of tunable white lighting a flexible, future ready solution is needed
  - Enabling lighting manufacturers to quickly react to projects with a solution that works together, seamlessly and reliably

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Vesta® Flex: Dual Channel LED Driver and Control Module Family

- Bundled system from one manufacturer guaranteed to work together out of the box

- Control module and driver family enables application flexibility and interoperability with third party systems
  - Includes WiZ Wi-Fi, WiSilica BLE mesh, DALI2 DT8 and 0-10V
  - Casambi and Silvair BLE modules under development
  - Flexible, future-proof solution

- 30W and 60W Brick and 60W Linear options
  - Smooth CCT tuning and dimming to 0.1% and dim-to-off
  - NFC programmable features

- Robust RJ45 digital communication interface
  - Direct open protocol digital PWM communication
  - Simple, standard, keyed, robust solution

- Sampling now, production shipments May 2020

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Vesta® Flex: Architecture And Ecosystem

Vesta Flex enables you and your customers to connect to third party data management, control systems, and ecosystems smart lighting management

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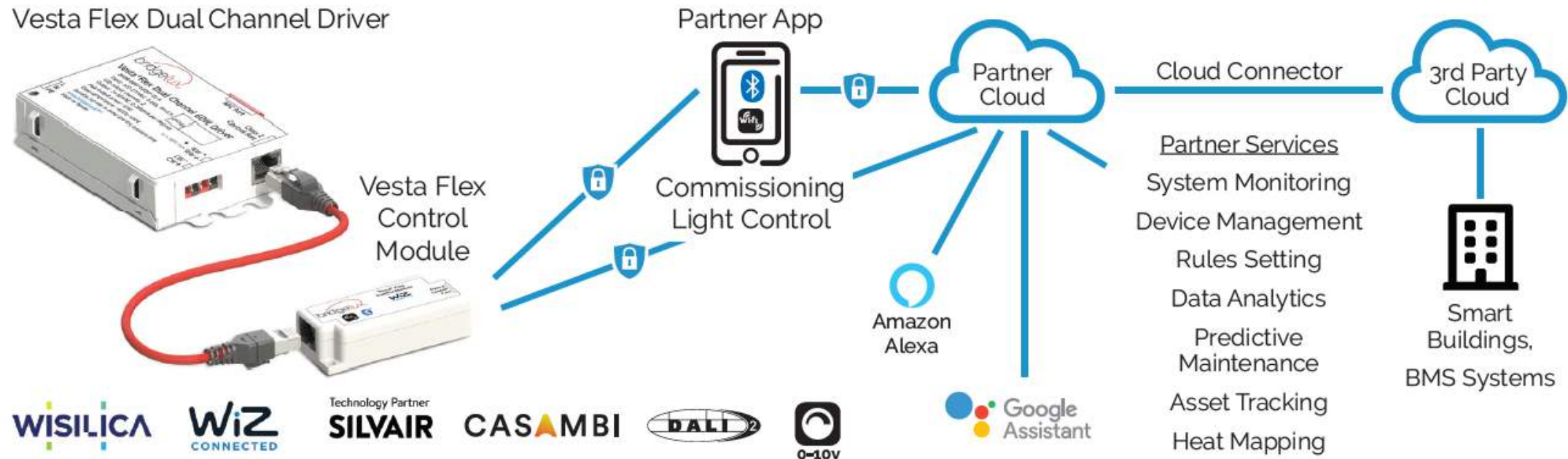
Vesta® Flex Drivers: Features and Specifications

- Smooth, flicker free CCT tuning and dimming to 0.1% with dim-to off
- High resolution linear, square and logarithmic dimming curves
- NFC programmable dimming curves and maximum output currents
- Built-in overvoltage, over-temperature and short circuit protection
- Driver autodetects and powers control module and adjusts behavior accordingly
- Available in 30W and 60W brick and 60W linear options
- 88% efficiency at full load
- Compatible with Bridgelux Vesta® tunable white light sources
- Flicker free per IEEE P1789, CEC Title 24
- Universal input voltage range of 120V – 277V
- UL Class P
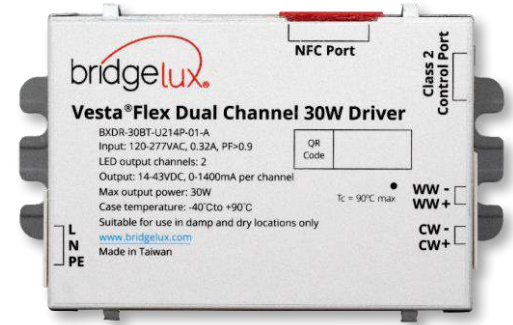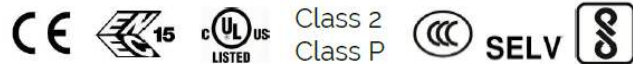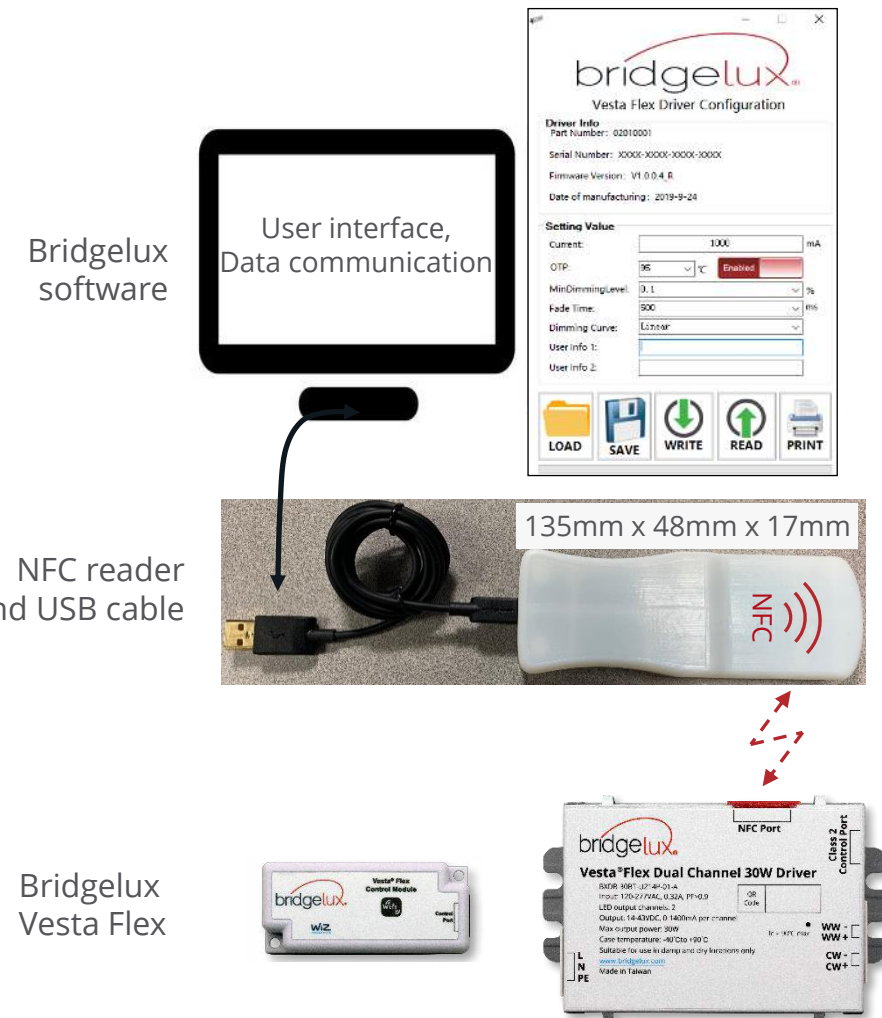
130mm x 77mm x 30mm (L x W x H)
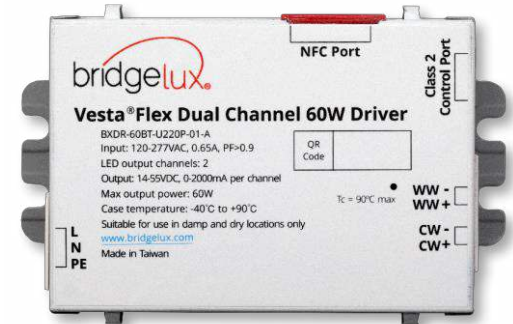
130mm x 77mm x 30mm (L x W x H)

320mm x 32mm x 28mm (L x W x H)

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Vesta® Flex: Wireless NFC Programming Tool

- NFC Programming of Vesta Flex
  - Vesta Flex Driver NFC port requires BLX NFC programming tool
  - Vesta Flex Driver NFC port may not be compatible with 3rd party NFC programming tools
- Vesta flex programming tool kit includes:
  - Bridgelux NFC Reader with micro USB connector, USB cable
  - Bridgelux proprietary software
- NFC programmable settings include
  - Linear, square, or logarithmic dimming curves
  - Maximum output currents
  - Over temperature protection overwrite
  - Minimum dim levels (0.1%, 1%, 5%, 10%)
  - Fade time
- Samples available now

Bridgelux software

User interface, Data communication

NFC reader and USB cable

135mm x 48mm x 17mm

Bridgelux Vesta Flex

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Vesta® Flex: Wireless Control Modules

WiSilica Enabled BLE Control

75mm x 32mm x 20mm (L x W x H)

- Connect lighting fixtures to an intelligent non-flooding BLE mesh network
- Commission and manage lighting fixtures via iOS and Android apps or web portal
- Interoperated with beacons and sensors via BLE
- Large ecosystem of compatible sensors, switches, gateways, and 3rd party clouds
- Cloud services such as system monitoring, device management, predictive maintenance, asset tracking, and data analytics

WiZ Enabled Wi-Fi Control

75mm x 32mm x 20mm (L x W x H)

- Connect lighting fixtures to the internet via Wi-Fi, no hub needed
- Interoperates with sensors via BLE
- Commission and manage lighting fixtures via iOS and Android apps or web portal
- Large ecosystem of compatible sensors, switches, gateways, and cloud platform
- Cloud services such as system monitoring, device management, predictive maintenance, asset tracking, and data analytics

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Vesta® Flex: Wireless Control Modules

Casambi Enabled BLE Control

75mm x 32mm x 20mm (L x W x H)

- Connect lighting fixtures and accessories to Casambi's proprietary BLE mesh network
- Commission and manage lighting fixtures via iOS and Android apps or a web portal
- Build-in iBeacon technology enabling location awareness
- Large ecosystem of compatible, sensors, switches, and DALI or 0-10V compatible controllers
- Cloud services for device configuration and access management, system monitoring, and connecting to 3rd party cloud systems for services such as data analytics

## Silvair Enabled BLE Control

75mm x 32mm x 20mm (L x W x H)

- Connect lighting components to Silvair's open BLE SIG compatible mesh network
- Commission and manage lighting fixtures via an iOS app or a web portal
- Interoperable with any 3rd party BLE SIG compatible device
- Large ecosystem of compatible sensors, switches, and DALI or 0-10V compatible controllers
- System services for device, configuration and access management, system monitoring, and optimization of energy consumption

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Vesta® Flex: Wireless Application User Interfaces
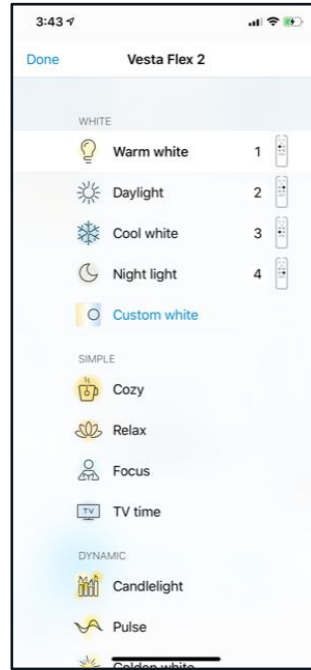
WiSilica
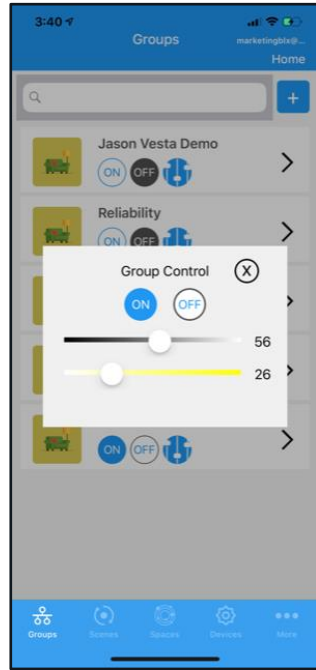
Dimming
CCT tuning
Commissioning
Groups, Scenes

WiZ

Dimming
CCT tuning
Commissioning
Groups

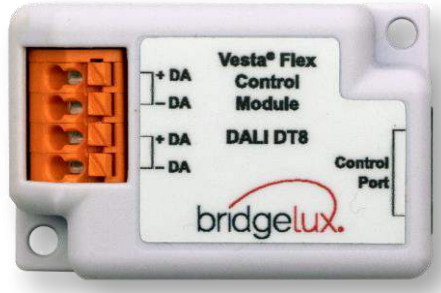Pre-Sets
Scenes

Circadian
Rhythm
Programmability

Casambi

Dimming
CCT tuning
Commissioning
Groups, Scenes

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Vesta® Flex: Wired Control Modules

DALI2 DT8 Control Module

50mm x 32mm x 20mm (L x W x H)

- DALI2 DT8 certified
- Two-channel control of color temperature and intensity
- Compatible with industry standard DALI2 DT8 devices
- Commission and manage lighting fixtures via any DALI2 certified controller
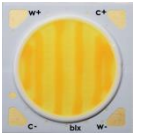
0-10V Control Module

50mm x 32mm x 20mm (L x W x H)

- 0-10V control protocol
- Two-channel control of color temperature and intensity
- Compatible with industry standard 0-10V current sourcing of current sinking wired control devices
- Dim-to-off hysteresis with turn off at 0.6V and turn on at 0.8V

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Bridgelux Vesta® COB Portfolio: Tunable White and Dim To Warm

Vesta Product	Technology	Sample Image	Part Numbers	LES / Dimensions	Tunable / Dimming CCT Range	CRI	Typ. Flux (lm) at coolest CCT (25°C)	Drive Current (mA)	Voltage (V) (25°C)	Efficacy (lm/W) (25°C)	Application Highlights
Dim-To-Warm Arrays	Dispensed phosphor		BXRV-DR-18xxG-0600-A-13	6mm (7W)	1800K-2700/3000K[1]	90	660	350	17.0	111	Residential, Hospitality, Lowest system cost
			BXRV-DR-18xxx-1000-G-13	9 mm (4W)		90, 95	490	250	17.0	115	
			BXRV-DR-18xxx-1000-A-13	9 mm (6W)			684	350	17.0	115	
			BXRV-DR-18xxx-1000-B-13	9 mm (12W)			1360	350	33.8	115	
			BXRV-DR-18xxx-2000-A-13	13 mm (21W)			2312	600	33.5	115	
			BXRV-DR-18xxx-3000-A-13	15 mm (33W)			3725	950	34.1	115	
			BXRV-DR-18xxG-4000-A-13	18mm (47W)		90	5350	1300	36.0	115	
			BXRV-DR-18xxG-1K00-A-13	29mm (113W)			13000	2350	48.0	115	
Tunable White Arrays	CSP		BXRV-TR-2750G-1000-A-2x	9 mm (12W)	2700K-5000K[2]	90	1385	700	18.1	106	High color angular uniformity (CAU) optical performance
			BXRV-TR-2750G-2000-A-2x	13 mm (25W)			2750	700	36.0	106	
Tunable White Arrays	Dispensed phosphor		BXRV-TR-27xxG-06A0-A-23	6mm (5.5W)	2700K-5000/6500K[2]	90	600	150	36.0	110	Higher efficacy, Higher lm/$ options
			BXRV-TR-xxxxG-10A0-x-23	9 mm (9W)	2700K-5000/6500K[2]		1190	500 / 250	18.0 / 34.8	137	
			BXRV-TR-xxxxG-20A0-A-23	13mm (18W)	1800K-3000/4000K[2]		2250	500	36.3	124	
			BXRV-TR-2750G-30A0-A-23	15mm (21W)	2700K-5000/6500K[2]		2884	650	35.5	125	
			BXRV-TR-2750G-40A0-A-23	18mm (25W)			4026	900	35.3	127	
			BXRV-TR-2750G-65A0-A-23	22mm (44W)			6106	900	53.0	128	
			BXRV-TR-2750G-1KA0-A-23	29mm (54W)			7043	1050	52.4	128	

Notes:
1. Tc = 25°C;
2. Tc = 85°C

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Bridgelux Vesta® SE Portfolio: Tunable White and Dim To Warm

Vesta Product	Sample Image	Part Numbers	LES Diameter	Integrated Array Diameter	Tunable / Dimming CCT Range	CRI	Typ. Flux (lm) at coolest CCT (25°C)	Drive Current (mA)	Voltage (V) (25°C)	Peak Efficacy (lm/W) (25°C)	Application Highlights
Dim-To-Warm Integrated Arrays		BXRV-DR-18xxG-0600-A-13-SE	6mm (7W)	30.8mm	1800K-3000/2700K[1]	90	627	350	17.0	105	Hole positions and dimensions are compatible with those of the Vero SE array Zhaga compliant Alignment holes for secondary optics
		BXRV-DR-18xxx-1000-G-13-SE BXRV-DR-18xxx-1000-A-13-SE BXRV-DR-18xxx-1000-B-13-SE	9 mm (4W) 9 mm (6W) 9 mm (12W)	30.8mm		90, 95	467 650 1292	250 350 350	17.0 17.0 33.8	109 109 109	
		BXRV-DR-18xxx-2000-A-13-SE BXRV-DR-18xxx-3000-A-13-SE	13 mm (21W) 15 mm (33W)	36.2mm		90, 95	2220 3576	600 950	33.5 34.1	110 110	
		BXRV-DR-18xxG-4000-A-13-SE	18mm (47W)	TBD		90	5350	1300	36.0	115	
		BXRV-DR-18xxG-1K00-A-13-SE	29mm (113W)	TBD		90	13000	2350	48.0	115	
Tunable White Integrated Arrays		BXRV-TR-27xxG-06A0-A-23-SE	6mm (5.5W)	36.2mm	2700K-5000/6500K[2]	90	582	150	36.0	108	
		BXRV-TR-xxxxG-10A0-x-23-SE BXRV-TR-xxxxG-20A0-A-23-SE	9 mm (9W) 13mm (18W)	36.2mm	2700K-5000/6500K[2] 1800K-3000/4000K[2]	90	1154 2205	500 / 250 500	18.0 / 34.8 36.3	133 121	
		BXRV-TR-2750G-30A0-A-23-SE BXRV-TR-2750G-40A0-A-23-SE BXRV-TR-2750G-65A0-A-23-SE	15mm (21W) 18mm (25W) 22mm (44W)	45.0mm	2700K-5000/6500K[2]	90	2826 3945 5984	650 900 900	35.5 35.3 53.0	122 124 125	
		BXRV-TR-2750G-1KA0-A-23-SE	29mm (54W)	49.2mm		90	6902	1050	52.4	125	

Notes:
1. Tc = 25°C;
2. Tc = 85°C

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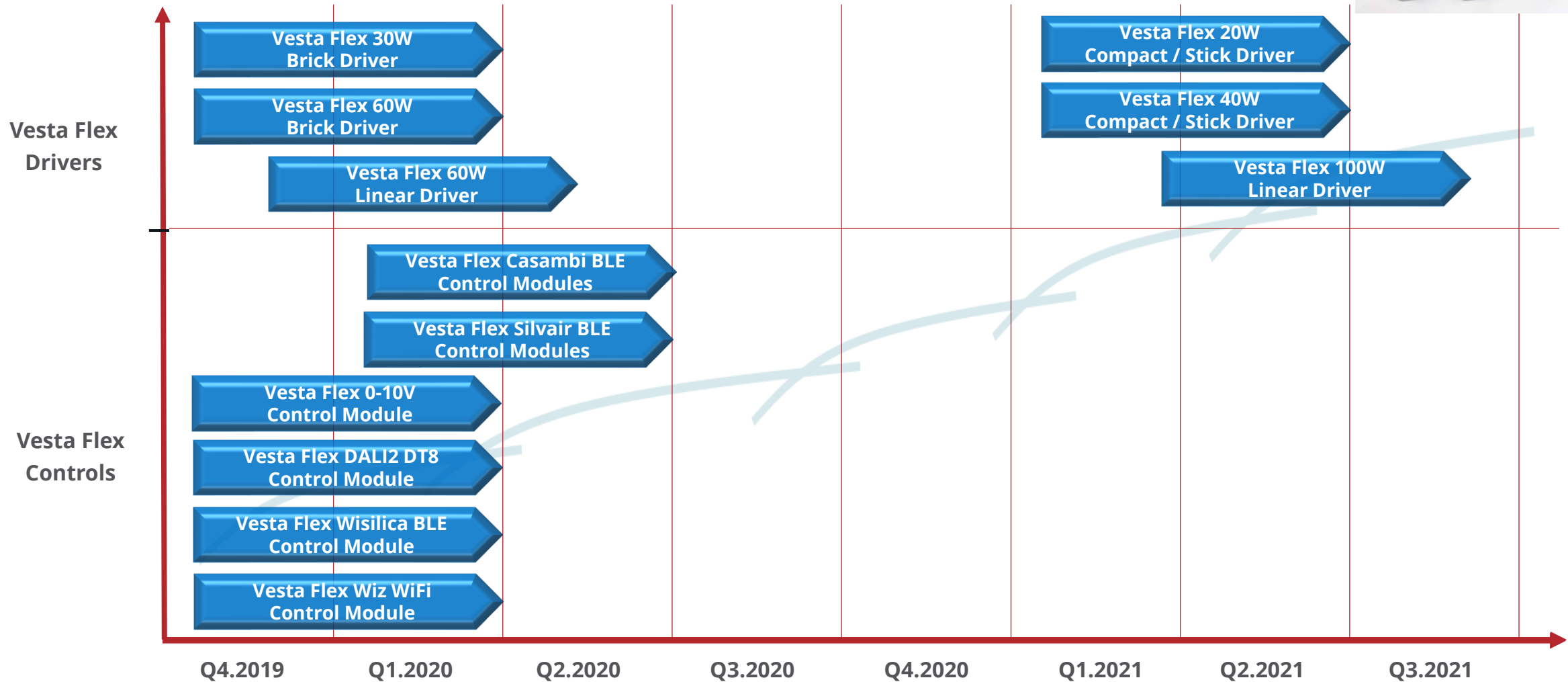
Bridgelux Vesta® Linear Portfolio: Tunable White Solutions

Vesta Product	Sample Image	Part Numbers	Dimensions	Tunable CCT Range	CRI	Typical Flux (lm)	Drive Current (mA)	Voltage (V)	Peak Efficacy (lm/W)	Application Highlights
TL Gen 3 1 SMD Row		BXEB-TL-L0280Z-xxxxy1000-B-C3 BXEB-TL-L0560Z-xxxxy2000-B-C3 BXEB-TL-L1120Z-xxxxy4000-B-C3	280 mm x 24 mm 560 mm x 24 mm 1120 mm x 24 mm	1800K-3000K 1800K-4000K 2700K-5000K 2700K-6500K	80 90 Thrive	1360 2725 5450	375 750 750	19.7 19.7 39.4	184	Same form factor as standard EB modules
TL Gen 3 2 SMD Rows		BXEB-TL-L0280Z-27xxy1000-A-C3 BXEB-TL-L0560Z-27xxy2000-A-C3 BXEB-TL-L1120Z-27xxy4000-A-C3	280 mm x 31 mm 560 mm x 31 mm 1120 mm x 31 mm	2700K-5000K 2700K-6500K	80 90 Thrive	1835 3670 7340	500 1000 1000	19.7 19.7 39.4	189	Highest flux and highest efficacy
Edge		BXEB-TL-L0570A-2750G-2000-E-A3	570 mm x 6 mm	2700K-5000K	90	2730	600	34.6	132	Ideal for edge lit panel lighting
TL 2 SMD Rows		BXEB-TL-2750G-1000-A-13 BXEB-TL-2750G-3000-A-13	280 mm x 31 mm 560 mm x 31 mm	2700K-5000K	90	1680 3350	500 1000	24.8	135	Original Vesta TL

Note: Performance data measured at 5000K, 80 CRI, and 25C (90 CRI for bottom two products)

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Bridgelux Roadmap: Vesta® Flex

Vesta Flex Drivers

- Vesta Flex 30W Brick Driver
- Vesta Flex 60W Brick Driver
- Vesta Flex 60W Linear Driver
- Vesta Flex 20W Compact / Stick Driver
- Vesta Flex 40W Compact / Stick Driver
- Vesta Flex 100W Linear Driver

Vesta Flex Controls

- Vesta Flex Casambi BLE Control Modules
- Vesta Flex Silvair BLE Control Modules
- Vesta Flex 0-10V Control Module
- Vesta Flex DALI2 DT8 Control Module
- Vesta Flex Wisilica BLE Control Module
- Vesta Flex Wiz WiFi Control Module

| Q4.2019 | Q1.2020 | Q2.2020 | Q3.2020 | Q4.2020 | Q1.2021 | Q2.2021 | Q3.2021 |

Unless otherwise specified point of arrow indicates target market launch date. Alpha engineering samples typically available 4-6 weeks prior to market launch, productions samples typically available 2-4 weeks prior to market launch.

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Market Applications Vesta® Flex

- Retail & Hospitality
- Office & Education
- Residential
- Healthcare
- Architectural
- Museums
- Entertainment

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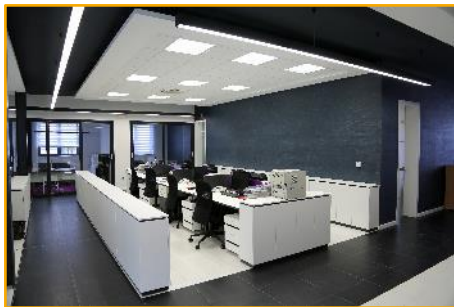
Review: Vesta Flex Key Features, Benefits and Products

| Features / Differentiation	Benefits
Specification grade two-channel drivers with dimming to 0.1% and dim-to-off	High resolution CCT tuning and dimming
Compatible with multiple control protocols including 0-10V, DALI2 DT8, Wi-Fi, and multiple Bluetooth mesh control options	Future-ready flexible solution to support project-based requirements without recertification
Bundled light source, driver and controls solutions from one supplier	Guaranteed to work together seamlessly out of the box
NFC programmable output parameters	Adjustability to support a wide range of applications and installations

Samples Available Now

Under Development

Vesta® Flex
60W Brick Driver

Vesta® Flex
60W Brick Driver

Vesta® Flex
WiSilica BLE Control
WiZ Wi-Fi Control

Vesta® Flex
0-10V Control
DALI2 Control

Vesta® Flex 60W Linear Driver

Vesta® Flex
Casambi BLE Control

Vesta® Flex
Silvair BLE Control

Note: Images not show to scale

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Summary: The Vesta® Flex Advantage

- **With Vesta® Flex, Bridgelux delivers a bundled tunable white solution guaranteed to work together out of the box**
  - Plug and play compatibility

- **The flexibility to work with up to 6 different control systems supports the ability to respond to project-based control system requirements**
  - 0-10V, DALI2 DT8, WiSilica BLE, WiZ Wi-Fi available now
  - Casambi and Silvair BLE available by end of Q2

- **Vesta® Flex is a future ready solution, able to quickly adapt to new control systems without requiring luminaire recertification**
  - New control modules can be developed as new control protocols emerge
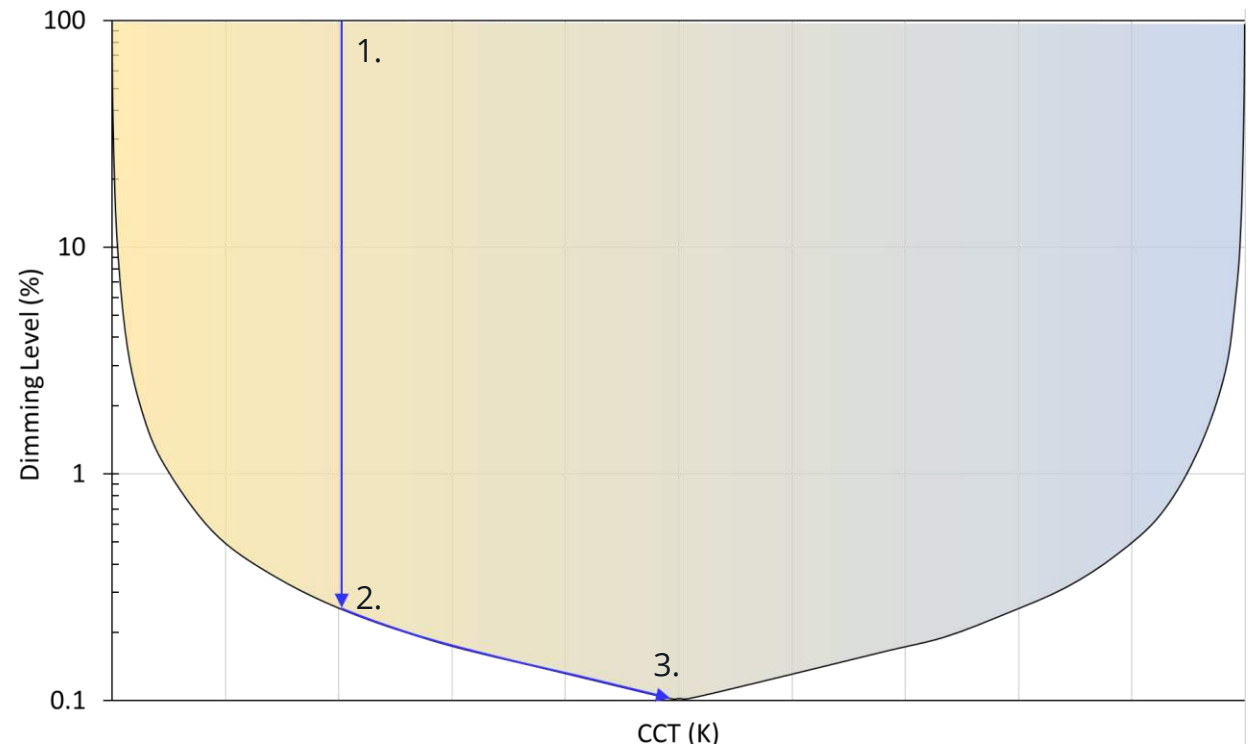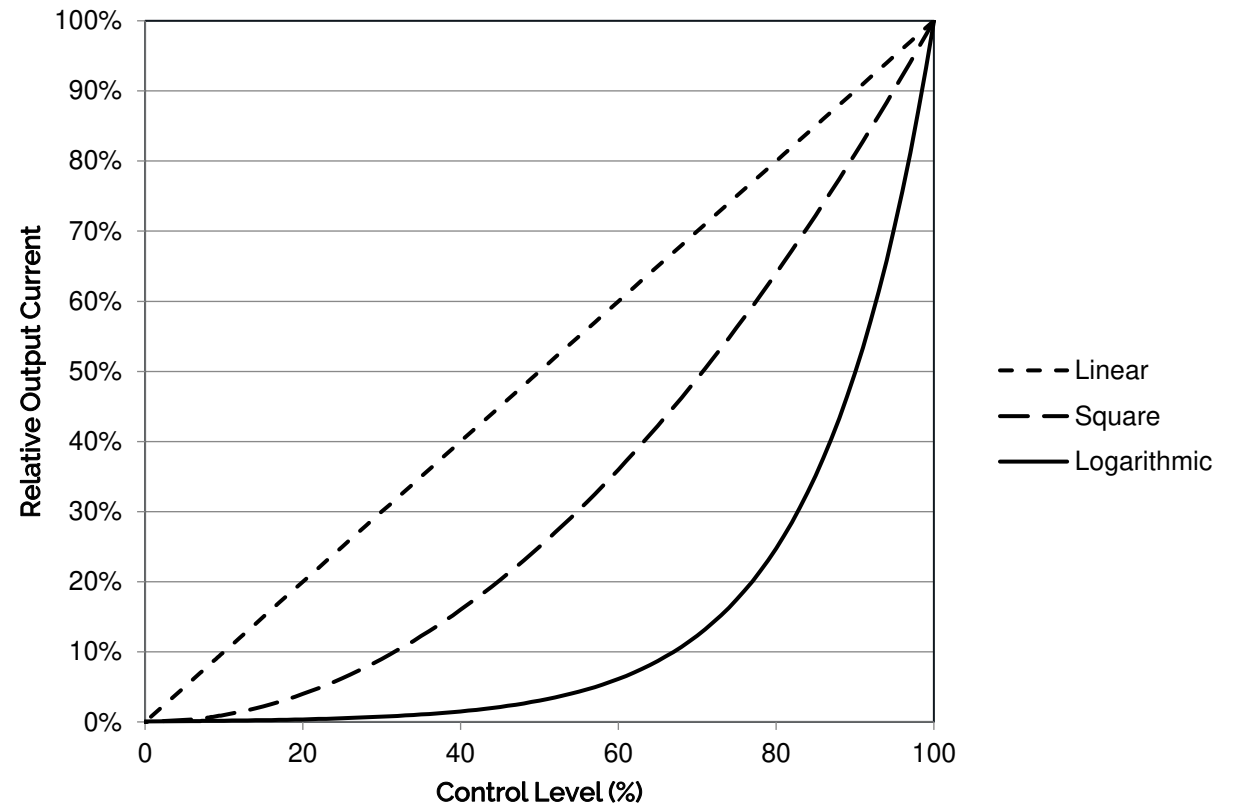
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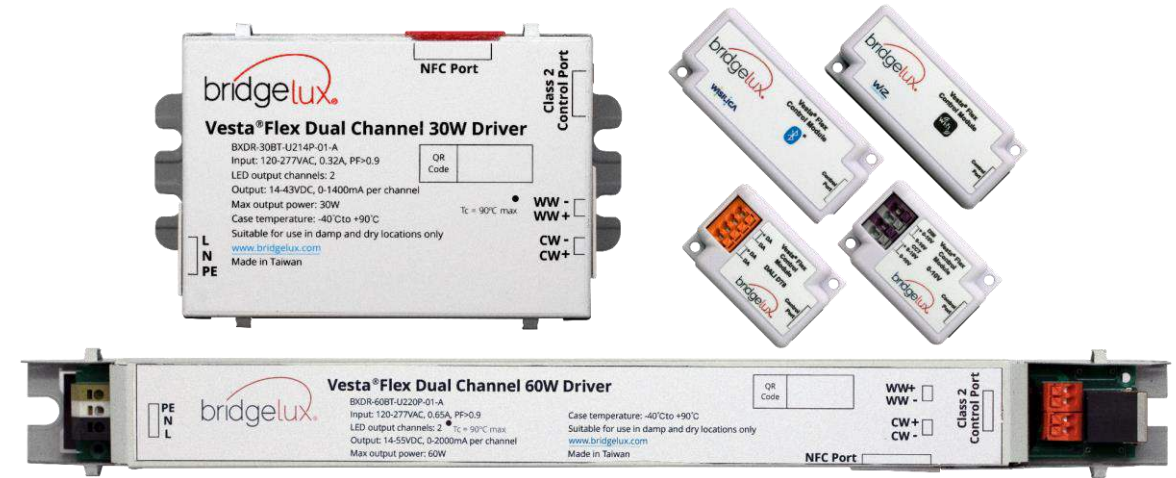
Back Up Material

Vesta® Flex Driver: Superior CCT Tuning Dynamic Range

▪ Minimum dimming level is 0.1%
  • 2000mA x 0.1% = 2mA
  • 1000mA x 0.1% = 1mA
  • Minimum output current per channel is <1mA
  • Output current resolution is 1mA

▪ When dimming brightness at a set CCT (1.) and the dimming level reaches the minimum dimming level at the set CCT (2.), then the CCT will shift and follow the graph until the dimming level reaches 0.1% (3.)

▪ Below the 0.1% dimming level, the driver dims-to-off and the current in both channels goes to 0mA

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Vesta® Flex Driver: Programmable Dimming Curve Options

- Linear, square and logarithmic dimming curve options are available

- Dimming characteristics may be programmed via the driver NFC port and Bridgelux NFC programming tool

- Programmability enables flexibility to match personal preferences or industry standards

Vesta Flex®: Competitive Comparison

Supplier	Bridgelux	Tridonic	Osram	Helvar	Moons	EldoLED (Acuity)	Advance (Signify)
Product Description	Dual Channel Driver, 60W (30W)	Driver LCA 50W (85W, 100W) 350–1050mA DT8 lp PRE	OPTOTRONIC Intelligent Tunable White – Dimmable DALI (non-isolated), (35W) 75W	35 W Dimmable two channel driver	Intelligent indoor LED driver, 50W	50W DALI-2 'Dim to Dark' LED Driver	XITANIUM 40W 0.10-1.1A 54V 120-277V SR
Control protocol options	DALI2 DT8, 0-10V, BLE-mesh, Wi-Fi	DALI DT8	DALI2 DT8	DALI DT8	DALI DT8, 0-10V, DMX RDM	DALI-2 DT6	SR
Form Factor options	Brick/Linear, separate control modules	Brick/Linear	Linear	Brick/Linear	Brick/Linear	Brick, Linear	Linear
Strain relief option	Yes	Yes	No	Yes	No	Yes	No
Stud mounting option	Yes	No	No	No	No	No	No
Input Voltage (VAC)	120-277	220-240	220-240	198-264	100-277	120-277	120-277
Efficiency, max load	88%	89%	91%	88%	87%	87%	86%
Output Rated Power	60W (30W)	50W / (85W/100W)	75W (35W)	35W	50W	50W	40W
Output Voltage (V)	14 to 54 (14 to 43)	20 to 50	50 to 240	12 to 50	8 to 55	1.5 to 55	16 to 50
Max Output Current	2.0A (1.4A)	1.05A	0.7A	0.7A	1.5A	1.4A	1.1A
Output Current Range	0 to 2.0A (0 to 1.4A)	0.35A to 1.05A	0.15A to 0.7A	0.35A to 0.7A	0.15A to 1.5A	0.15A to 1.4A	0.1A to 1.1A
Minimum dim level	0.1%	3%	1%	2%	0.1%	0.1%	1%
Minimum dim current	<1 mA	31 mA				1 mA	
Dim to off	Yes	No	Yes	No	Yes	Yes	No
CCT Tuning Range	<0.3% to 100%	3% to 100%		2% to 100%			
Surge protection	6 kV	2 kV	2 kV	2 kV	2 kV	2 kV	2.5 kV

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