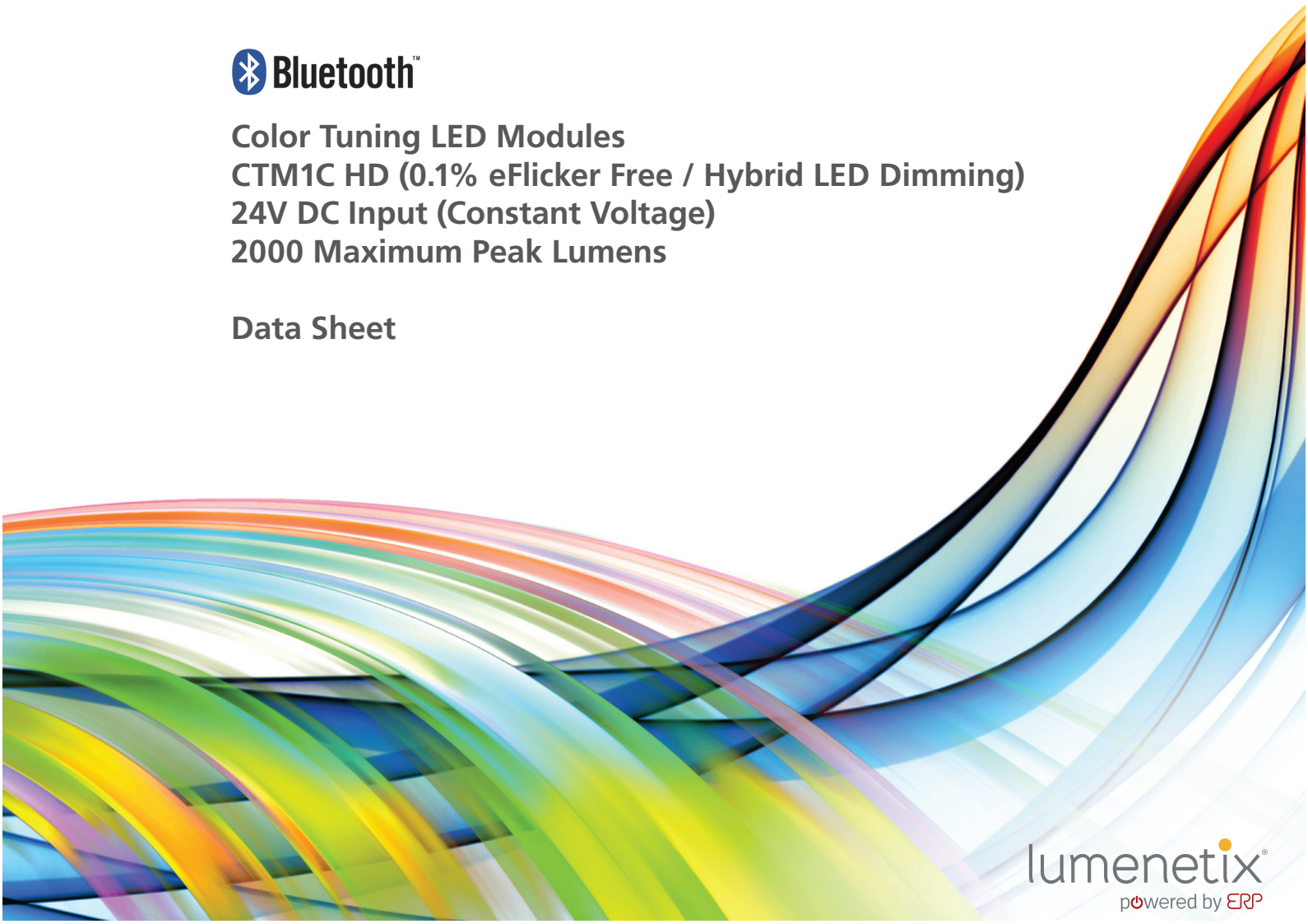
lumenetix-araya™

TUNABLE COLOR

Bluetooth™

Color Tuning LED Modules
CTM1C HD (0.1% eFlicker Free / Hybrid LED Dimming)
24V DC Input (Constant Voltage)
2000 Maximum Peak Lumens

Data Sheet



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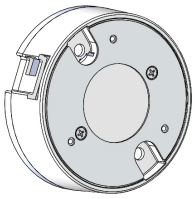


CTM1C 19 HD (2000 / 1500 LM)
CTM1C 19 HD E (1700 LM)

Description

Lumenetix-araya Color Tuning Modules (CTM1C HD) mix five colors of LEDs—or six colors with the Saturated Green "Entertainment" (E) option—to deliver tunable and dimmable white light at 90+ CRI* and color consistency of <2 MacAdam ellipse across a tuning range of 1650 - 8000K. Light can be dimmed from 100 - 0.1%**, while maintaining constant CCT. Gradients of saturated colors from 1 - 100% can be added to color points within the tuning range.

The modules integrate the driver electronics for precise control of current and PWM inputs and LED light output. On board closed loop thermal feedback compensates each color channel for thermally induced variations in optical output due to tuning, dimming or ambient temperatures. On board closed loop optical feedback measures the lumen depreciation of each channel and re-balances the color model to ensure color consistency over the 50,000 hour life of the module. An in-line manufacturing process captures the spectral characteristics of each LED under multiple conditions, generating a unique color model for each color tuning module.

The CTM1C HD modules are compatible with traditional 0 - 10V wired controls, feature on-board DMX512-A-RDM, and also Bluetooth Low Energy (BLE) for commissioning. Lutron® EcoSystem compatibility is achieved by using the optional Lumenetix Digital Control Adapter. Modules can be paired with Legrand's Wattstopper® Digital Light Management (DLM) interface via an external adapter, to allow automatic fixture commissioning. For simple deployment, scene set allows up to five scenes to be pre-programmed into the module during production and recalled at the venue using a 0 - 10V recommended dimmer.

Commissioning of the module, re-programming of scenes, and configuration of DMX channels is done via RDM or the wireless Tunable Color 2.0 iOS app that connects to the embedded radio. The CTM1C HD series features a nominal light emitting surface (LES) of 19 mm.

Key Features

- Tunable range: 1650 - 8000K
- 90+ CRI*
- eFlicker Free / Hybrid Dimming from 100% - 0.1%** at constant CCT
- Color gamut control: gradients of saturated colors from 1 - 100% can be added to color points
- Saturated Green / Expanded Gamut "Entertainment" (E) option available - see Section-12 for description
- Integrated driver electronics
- On board thermal and optical feedback for color consistency of <2 MacAdam ellipse over 50,000 hour life
- In-line spectral capture creates unique color model for each module, resulting in consistent CRI and CCT across all modules
- On board thermal turndown
- Compatible with 0 - 10V wired controls
- On-board Bluetooth Low Energy (BLE) for commissioning
- On-board DMX512-A-RDM, with DMX slots set by RDM or via wireless Lumenetix-araya Tunable Color 2.0 iOS app
- Lutron EcoSystem compatibility via optional Digital Control Adapter
- Wattstopper DLM compatibility via an optional adapter
- Scene set enables up to five scenes to be preprogrammed and recalled using a 0 - 10V recommended dimmer
- Light emitting surface (LES): 19 mm (nominal)
- Zhaga compliant footprint and front heat sink mounting
- Provisions for reflector mounting

Photometrics and Ordering Codes (CTM1C HD; CTM1C HD E)

Tunable Range: 1650 - 8000K	Nominal Wattage	CTM1C 19 HD		CTM1C 19 HD E	
		Typical Peak Lumens	Ordering Code	Typical Peak Lumens	Ordering Code
Specifications***	35W	2000	80.002.098.01	1700	80.012.001.01
	25W	1500	80.002.099.01	N/A	N/A
	18W	1000	80.002.100.01	1000	80.012.003.01
	12W	750	80.002.101.01	N/A	N/A
CRI (Ra) Across Tuning Range	>90*				
Dimming	100% to 0.1%**				
Nominal Color Consistency	<2 MacAdam ellipse (±0.002 Duv from ANSI C78.377-2008 curve)*				
Color Consistency Over Life	Calibration maintains original color points over life*				
Lumen Maintenance	L70 (70% of initial lumens) at 50,000 hours				

araya TUNABLE COLOR 2.0

Tunable Color 2.0 iOS App
(for commissioning only)

*From 2000 - 6000K, down to 5% dim level.

**eFlicker-Free 100 - 0.1% LED dimming is available when connected to 0.1% dimming-capable digital controls. 100 - 1% dimming is available with analog 0 - 10V control.

***Lumen and wattage range is within +/- 10% of the nominal value. Peak efficacy is not necessarily at typical peak lumens.

2 ELECTRICAL & MECHANICAL SPECIFICATIONS

2.1 Electrical Specifications

Input Voltage	24V DC
Nominal Power Input	35, 25, 18 and 12 Watts
Nominal Current Input	35W: 1.46A; 25W: 1.04A; 18W: 0.75A; 12.5W: 0.5A
Power Supply Classification	Class 2
Power Connector	Molex 874380243 (requires Molex 874390200)
Control Connector	Molex 874370543 (requires Molex 874390700)
Control Options[1]	0 - 10V, DMX512-A-RDM[2], Lutron® EcoSystem, Wattstopper® DLM
CCT and Dimming Control Connections	Connector harness, 24 gauge leads

1. DMX channel configuration is done via RDM or wireless Tunable Color iOS app. Lutron EcoSystem requires optional Digital Control Adapter. Wattstopper DLM compatibility requires optional external adapter from Wattstopper.
2. Remote Device Management or RDM is a protocol enhancement to DMX512-A that allows bi-directional communication between a lighting or system controller and attached RDM compliant devices over a standard DMX line.

2.1a Control Specifications

PROTOCOL	1 DIMMING*	2 CCT	3 SAT	4 HUE	NOTES
DMX512-A-RDM [1]	0.1%	1650 - 8000K	Yes	Yes	1. Refer to the separate DMX Lookup Tables for specific programming values and information.
0 - 10V	~1% [2]	1650 - 8000K	*	*	2. 1 - 10V signal dims module to approximately 1%. In-line power relay required to achieve 0% output.
LUTRON ECOSYSTEM [3, 4]	0.1%	1650 - 8000K	N/A	N/A	3. Requires external Digital Control Adapter. 4. Refer to the separate Lutron EcoSystem Lookup Tables for specific programming values and information.
WATTSTOPPER DLM [5]	0.1%	1650 - 8000K	N/A	N/A	5. Requires external LMFC-LXI adapter by Wattstopper.

*100 - 0.1% eFlicker Free / Hybrid dimming is available when connected to 0.1% dimming-capable digital controls.
100 - 1% dimming is available with analog 0 - 10V control.

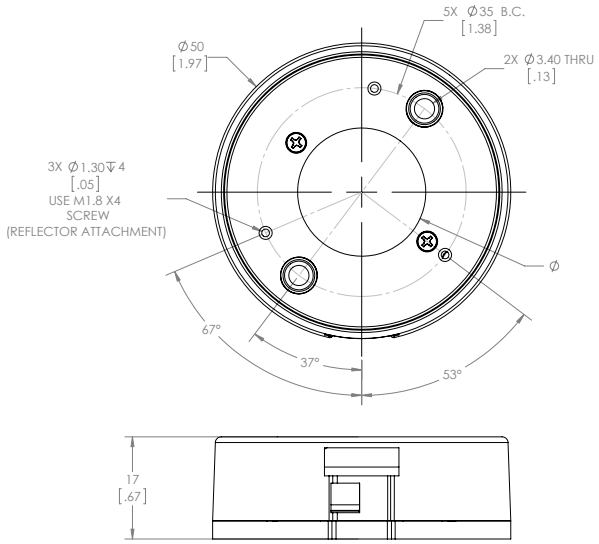
**Two 0-10V lines can be used to control DIM and CCT independently, or program Scenes — in any combination of DIM, CCT, HUE and SAT — and recall them with five 0-10V presets.

2 ELECTRICAL & MECHANICAL SPECIFICATIONS

2.2 Mechanical Specifications

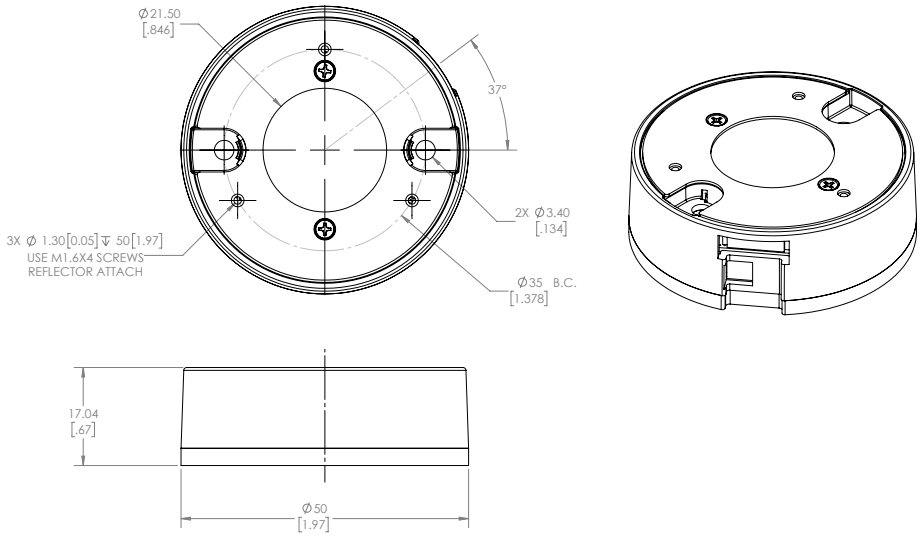
Dimensions	Diameter:	1.97 inches (50 mm)
	Height:	0.67 inches (17 mm)
Light Emitting Surface	19 mm (nominal)	
Weight	0.12 pounds (0.06kg)	
Heat Sink Attachment	Front mount, M2.5 or 4-40 Screws	
Max Case Temperature	≤90°C	

CTM1C 19 HD (1000 / 750 lumens)
CTM1C 19 HD E (1000 lumens)



Model	LES Diameter
CTM1C 19 HD / CTM1C 19 HD E	22 mm (0.87 inches)

CTM1C 19 HD (2000 / 1500 lumens)
CTM1C 19 HD E (1700 lumens)



3 POWER SUPPLY REQUIREMENTS

3.1 Electrical Specifications

Description and Nominal Power Input	CTM1C 19 HD, 12W	CTM1C 19 HD, 18W CTM1C 19 HD E, 18W	CTM1C 19 HD, 25W	CTM1C 19 HD, 35W CTM1C 19 HD E, 35W
Input Voltage	24V DC	24V DC	24V DC	24V DC
Nominal Current Input	12.5W: 0.52A	18W: 0.75A	25W: 1.04A	35W: 1.46A
Power Supply Classification	Class 2 (UP TO 100W)	Class 2 (UP TO 100W)	Class 2 (UP TO 100W)	Class 2 (UP TO 100W)

IMPORTANT

The Color Tuning Module has on-board drive electronics, including dimming. A dimming driver should NOT be used.

3.2 Recommended Power Supplies (Constant Voltage)

Manufacturer	Part Number	Rated Power	12W Module	18W Module	25W Module	35W Module
Mean Well	APV-25-24	25W	✓	✓		
High Perfection Tech HK (MagTech)	LP1026-24	30W	✓	✓		
Mean Well	APV-35-24	35W	✓	✓		
Efore / Roal	Strato RSLP035-24	36W	✓	✓		
ERP	VLM40W-24	40W	✓	✓		
Inventronics	EUV-042S024PS	42W			✓	✓
ERP	VLM60W-24	60W			✓	✓
Mean Well	IRM-60-24ST	60W			✓	✓
Efore / Roal	Strato RSLP070-24	72W			✓	✓
Mean Well	HLG-120H-24A **	120W	✓	✓		
Gre Alpha	XLD200-2-24V-FC	200W	✓	✓	✓	

CAUTION:

- Using a constant current power supply will damage the module, and will void the Lumenetix warranty.
- Using a triac or dimming driver will damage the module, and will void the Lumenetix warranty.
- The power supply MUST be evaluated with the module(s) that it will be operated with.
- If a recommended power supply from the above list is not used, it will void the Lumenetix warranty.
- If unqualified power supplies are used in a fixture, it will void the Lumenetix warranty.
- It is the responsibility of the fixture manufacturer to ensure that the power supply performance does not change over time. The Lumenetix warranty is void if problems occur as a result of such changes.
- **DO NOT HOT PLUG THE LIGHT FIXTURES.**

*TESTED WITH A QUANTITY OF THREE 25W MODULES.

**U.L. CLASS 1 — NON-NORTH AMERICA ONLY.

NOTES:

- Recommendations are subject to change. Consult your Lumenetix representative for the most updated list.
- Please contact the power supply manufacturer to verify that the current version of the listed power supply still meets the latest Lumenetix testing approvals / qualifications.
- Power supply qualification process:: if a power supply that is not part of the above list is submitted for testing to Lumenetix (during the design-in phase), it will be qualified or disqualified within two weeks of submission.

4 HEAT SINKING RECOMMENDATIONS

The Color Tuning Module requires an external heat sink in order to ensure proper operating temperature of the LEDs. The CTM has a conductive aluminum case and an efficient thermal path to the LED array. These features promote efficient thermal management and allow for a simple heat sink design in most applications.

Examples of heat sinking methods are cast or extruded heat sinks. Both carbon and stainless steel are much less efficient at transferring heat than aluminum and therefore are not recommended as heat sink materials. The heat sink mounting surface should be flat and smooth. Metal-to-metal contact surfaces will result in best performance; anodized or unfinished mounting surfaces are recommended. Mounting the CTM on a painted aluminum surface will reduce the performance of the heat sink material.

In many fixtures, the air flow to the heat sinks is obstructed or the heat sink is in an enclosed container with no path to reject heat. The thermal design of the fixture must be optimized so that the maximum temperature is less than the Tc_{max} (maximum case temperature) as indicated in the drawings in the following section. If the Tc_{max} is exceeded in the application, the junction temperature of the LEDs will be higher than that required to meet the L70 life, and the Lumenetix warranty will be void.

IMPORTANT: Most heat sinks are qualified in "free air" at an approximate ambient temperature of 25°C. If the CTM is installed in an insulated can fixture (IC Can), the module may exceed the recommended operating temperature. The heat sink must be evaluated and temperature tested in the fixture at applicable ambient temperatures for the desired application.

5 CASE TEMPERATURE MEASUREMENT POINTS

The thermal management characteristics of the heat sink used with the CTM1 should be validated by measuring its case temperature. This test should be done with the CTM1 installed in the fixture at ambient temperature and air flow conditions similar to the end-use installation.

The power draw of the CTM1C family varies by approximately one watt over the CCT range with peak power draw occurring at the CCT shown in the following table. The case temperature should be measured at the following CCT setting.

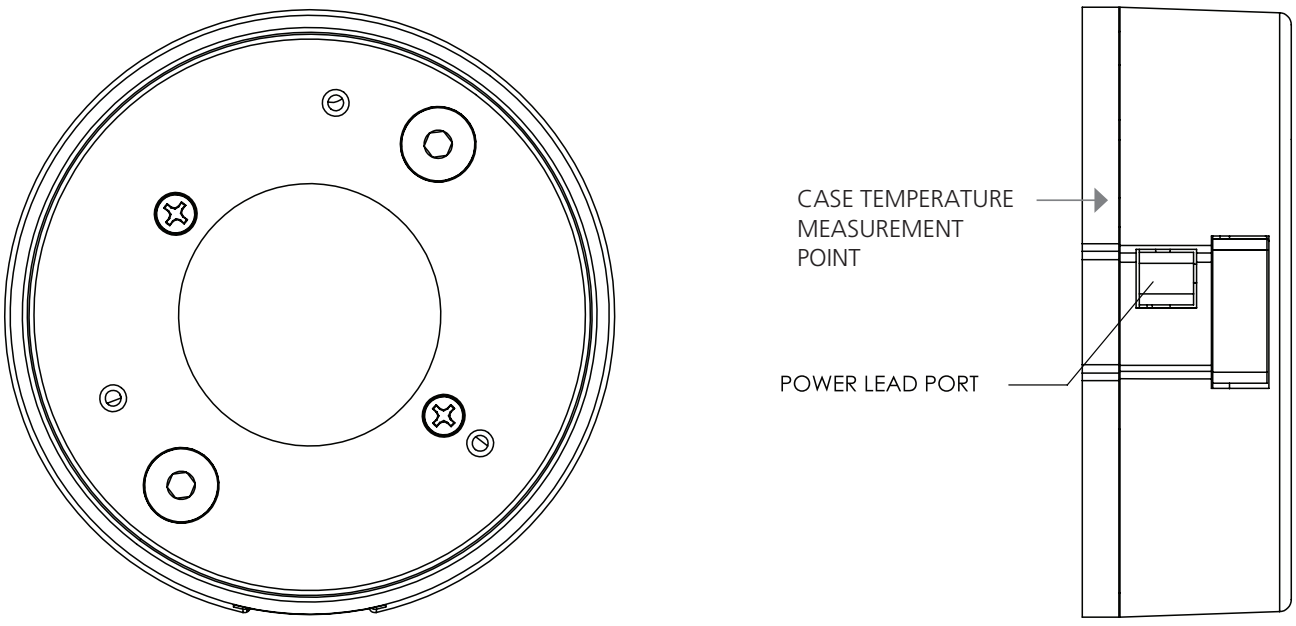
CCT Setting for Case Temperature (T_c) Measurement

CCT range	CCT Setting to Measure T_c
1650 – 8000K	3500K

The proper case temperature measurement location is on the narrow metal band, next to the power lead port; see figure below. The case temperature reading should be made after the unit has reached steady state, where the case temperature levels out. It is recommended to design the thermal management system for a case temperature of 90˚C.

Maximum case temperature: 90˚C

The Color Tuning Module has on-board thermal protection to reduce the current to the LEDs when the maximum case temperature is exceeded. This prevents unacceptably high LED junction temperatures by slightly dimming the module.



Case Temperature Measurement Point

6 SECONDARY OPTICS

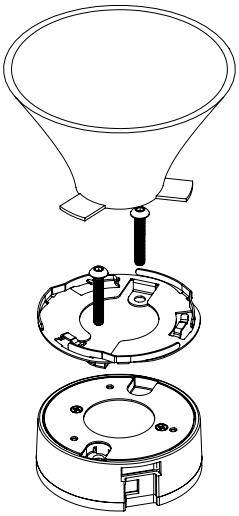
6.1 Attaching Compatible CTM1C HD Reflectors

CTM1C 19 HD (2000 / 1500 lumens) and the CTM1C 19 HD E (1700 lumens) accepts either twist-to-lock reflectors with the Xicato XSA-242 adapter ring, or reflectors for direct attachment to the module. CTM1C 19 HD (1000 / 750 lumens) and CTM1C 19 HD E (1000 lumens) has provisions for TE Type-2 clip reflectors.

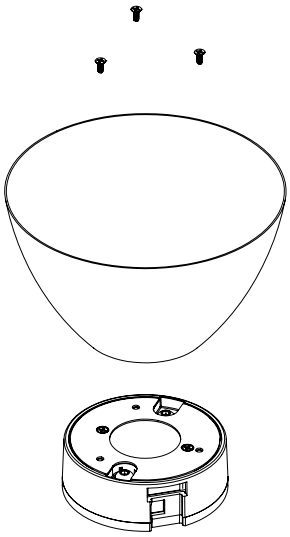
The fastener specifications are shown in the following table while mounting hole locations are shown in the figures below.

CTM1C HD Secondary Optics Fastener Specifications

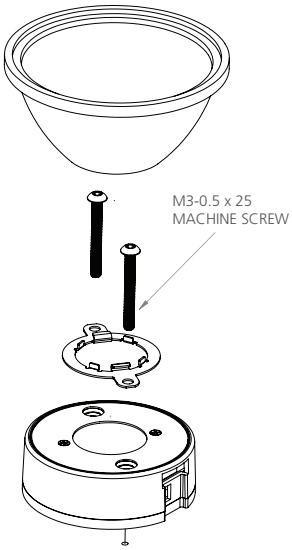
CTM1C HD Reflector	Fastener specifications	Screw length	Notes
Twist Lock w/ XSA-242 Adapter Ring	M3-0.5 x 18	18 mm	Machine screws; attach to heat sink (not directly to module)
Direct Attachment	M1.6 x 4	4 mm	Thread forming; use flat head screws
TE Type 2 Clip	M3-0.5 x 25	25 mm	Machine screws; attach to heat sink (not directly to module)



CTM1C 19 HD (2000 / 1500 lm) & CTM1C 19 HD E (1700 lm)
Twist-Lock Style Reflectors with Xicato XSA-242 Adapter Ring



CTM1C 19 HD (2000 / 1500 lm) & CTM1C 19 HD E (1700 lm)
Direct Attachment Reflectors



CTM1C 19 HD (1000 / 750 lm) & CTM1C 19 HD E (1000 lm)
TE Type 2 Clip Reflectors (by Khatod)

6 SECONDARY OPTICS

6.2 Compatible Reflectors for CTM1C 19 HD (1000 / 750 lm) & CTM1C 19 HD E (1000 lm)

Manufacturer	M. Part Number	beam angle (deg)	outer dim (mm)	height (mm)	optical finish	optical finish 2	attach method
JORDAN	11324 10 10101	25	111	66	specular	super facet	none
JORDAN	11324 00 10101	40	111	66	specular	super facet	none
Khatod EASY	KCLP 1858ME		72	52	honeycomb lens	none	Zhaga Screw 35mm
Khatod EASY	KCLP 1858WI		72	52	bugeye lens	none	Zhaga Screw 35mm
Khatod EASY	KCLP 1799 CR	asym			specular	none	Zhaga Screw 35mm
Khatod	KCLP 1682 CR (1429CR)	11	65	35	specular	none	TE Type II
Khatod	KCLP 1682 ST (1429ST)	20	65	35	diffuse	none	TE Type II
Khatod	KCLP 1683 ST (1430ST)	24	65	35	diffuse	none	TE Type II
Khatod	KCLP 1432 CR		65	35	specular	none	TE Type II
Khatod	KCLP 1685 ST (1432ST)	32	65	35	diffuse	none	TE Type II
Khatod	KCLP 1684 ST	28	65	35	diffuse	none	TE Type II
Khatod	KCLP 1687 CR	27	65	35	specular	none	TE Type II
Khatod	KCLP 1687 ST	31	65	35	diffuse	none	TE Type II
Khatod	KCLP 1688 CR	37	65	35	specular	none	TE Type II
Khatod	KCLP 1688 ST	38	65	35	diffuse	none	TE Type II
Khatod	KCLP 1689 ST	42	65	35	diffuse	none	TE Type II
Khatod	KCLP 1690 ST	50	65	35	diffuse	none	TE Type II
Khatod	KCLP 1691 ST	56	65	35	diffuse	none	TE Type II
Khatod	PLJT 1521				diffuser ball white		TE Type II
Nata	3990-E	24	75	43	diffuse	super facet	none
Nata	3991-E	36	75	43	diffuse	super facet	none
Nata	3992-E	25	85	50.5	diffuse	super facet	none
Nata	3993-E	40	85	50.5	diffuse	super facet	none
Nata	4-1149E2	39	111	65	m-diffuse	super facet	none
Nata	4-1150E5	39	111	65	m-diffuse	super facet	none
Nata	4-1405E	16	98	66.4	specular	facets	none
Nata	4-1406E				diffuse	super facet	none
Nata	2-1535E		75	44	m-diffuse	super facet	none
Nata	4-1536E	20	110	65.3	m-diffuse	super facet	none
Nata	4-1537E	30	110	62	diffuse	super facet	none
Nata	4-1664E	24	111	65	m-diffuse	super facet	none / 3 tabs
Nata	4-1666E	38	111	65	diffuse	super facet	none / 3 tabs
Nata	4-1667E	45	111	61.3	m-diffuse	super facet	none
Nata	4-1820E	60	111	65	diffuse	super facet	none / 3 tabs
Widegerm	3150-CZ	~14	82	45	m-specular	faceted	none
Widegerm	3158-CZ	15	91.5	47	diffuse	faceted	none
Widegerm	3163-CZ	22	91.5	47	m-specular	faceted	none
Widegerm	3205-BL	36	82	45	diffuse	faceted	none
Widegerm	2094-CZ	15	72	45	m-specular	faceted	none
Widegerm	2095-CZ	23	72	45.5	m-specular	faceted	none
Widegerm	2202-medium LES	36	72	43	m-specular	faceted	none

NOTE: Reflectors have been recommended based on independent optical tests conducted by Lumenetix, and should be used as guidelines.
Final reflector evaluation should be made by fixture manufacturers with all optics in place.

6 SECONDARY OPTICS

6.3a Compatible Reflectors for CTM1C 19 HD (2000 / 1500 lm) & CTM1C 19 HD E (1700 lm) - Part-1

Manufacturer	M. Part Number	beam angle (deg)	outer dim (mm)	height (mm)	optical finish	optical finish 2	attach method
JORDAN	11324 10 10101	25	111	66	specular	super facet	none
JORDAN	11324 00 10101	40	111	66	specular	super facet	none
Khatod	KCLP 1682 ST (1429ST)	20	65	35	diffuse	none	XSA242 + KE1950W
khatod	KCLP 1683 CR (1430CR)	26	65	35	specular	none	XSA242 + KE1950W
khatod	KCLP 1683 ST (1430ST)	24	65	35	diffuse	none	XSA242 + KE1950W
khatod	KCLP 1685 ST (1432ST)	32	65	35	diffuse	none	XSA242 + KE1950W
khatod	KCLP 1688 CR	37	65	35	specular	none	XSA242 + KE1950W
khatod	KCLP 1688 ST	38	65	35	diffuse	none	XSA242 + KE1950W
khatod	KCLP 1689 ST	42	65	35	diffuse	none	XSA242 + KE1950W
khatod	KCLP 1690 ST	50	65	35	diffuse	none	XSA242 + KE1950W
khatod	KCLP 1691 ST	56	65	35	diffuse	none	XSA242 + KE1950W
khatod	PLJT 1866	n/a			diffuse ball		T/L XSM242
Nata	3990-E	24	75	43	diffuse	super facet	none
Nata	3991-E	36	75	43	diffuse	super facet	none
Nata	3992-E	25	85	50.5	diffuse	super facet	none
Nata	3993-E	40	85	50.5	diffuse	super facet	none
Nata	2-1050A	25	65	44	satin	none	XSA242
Nata	2-1131E	18	68	51	m-diffuse	facets	XSA242
Nata	2-1132E	30	68	51	m-diffuse	super facet	XSA242
Nata	2-1133E	45	68	51	m-diffuse	super facet, flare	XSA242
Nata	4-1149E2	39	111	65	m-diffuse	super facet	none
Nata	4-1150E5	39	111	65	m-diffuse	super facet	none
Nata	4-1405E	16	98	66.4	specular	facets	none
Nata	4-1406E				diffuse	super facet	none
Nata	2-1535E		75	44	m-diffuse	super facet	none
Nata	4-1536E	20	110	65.3	m-diffuse	super facet	none
Nata	4-1537E	30	110	62	diffuse	super facet	none
Nata	4-1664E	24	111	65	m-diffuse	super facet	none / 3 tabs
Nata	4-1666E	38	111	65	diffuse	super facet	none / 3 tabs
Nata	4-1667E	45	111	61.3	m-diffuse	super facet	none
Nata	4-1820E	60	111	65	diffuse	super facet	none / 3 tabs
Nata	3-1903M	40	79	51	m-diffuse	super facet	XSA242
Nata	4-1983E	24	110	65	specular	super facet	XSA242
Nata	2834A	43	70	43.5	satin	none	XSA242
Nata	4-1966E	7	111	65	m-diffuse	super facet	XSA242

NOTE: Reflectors have been recommended based on independent optical tests conducted by Lumenetix, and should be used as guidelines.
Final reflector evaluation should be made by fixture manufacturers with all optics in place.

6 SECONDARY OPTICS

6.3b Compatible Reflectors for CTM1C 19 HD (2000 / 1500 lm) & CTM1C 19 HD E (1700 lm) - Part-2

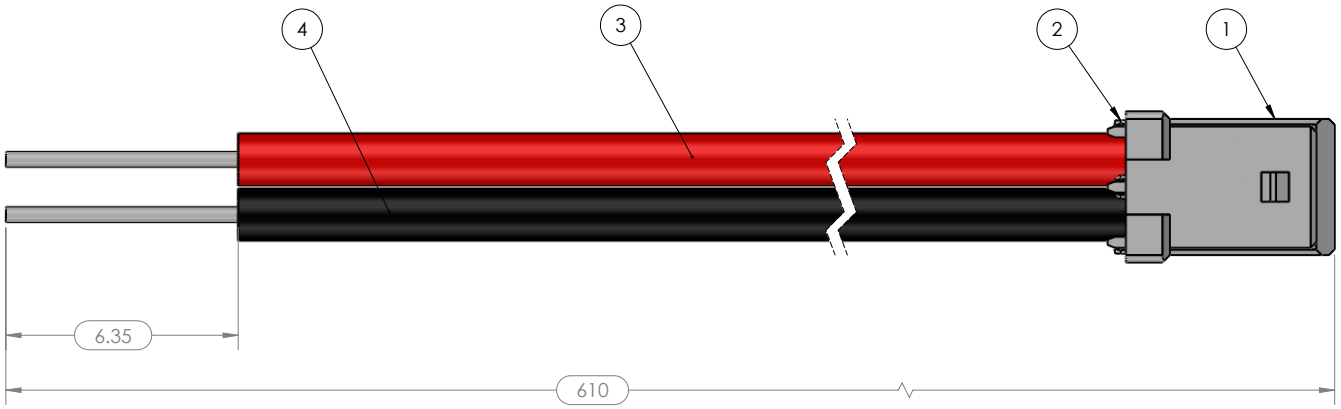
Manufacturer	M. Part Number	beam angle (deg)	outer dim (mm)	height (mm)	optical finish	optical finish 2	attach method
Widegerm	1009T-XC	38	49	30.5	specular	faceted	XSA242 T/L
Widegerm	208x-XM		71.5	54	satin	lightfaceted	XSA242 T/L
Widegerm	2087-XM	19	71.5	54	m-specular	faceted	XSA242 T/L
Widegerm	2096T-XM	50	72	45.5	satin	lightfaceted	XSA242 T/L
Widegerm	2202T-XM	35	72	44	m-diffuse	faceted	XSA242 T/L
Widegerm	3204T-XM	27	82	46	m-diffuse	faceted	XSA242 T/L
Widegerm	3205T-XM	36	82	46	specular	faceted	XSA242 T/L
Widegerm	3207T-XC	-	82	46	satin	none	XSA242 T/L
Widegerm	4219T-XM	20	111	36	diffuse	faceted	XSA242 T/L
Widegerm	4220T-XM	37	111	36	m-specular	faceted	XSA242 T/L
Widegerm	4221T-XM	47	111	36	m-specular	faceted	XSA242 T/L
Widegerm	4201T-XC	15	111	69	diffuse	faceted	XSA242 T/L
Widegerm	4301T-XM	36	111	69	m-diffuse	faceted	XSA242 T/L
Widegerm	4401T-XM	43	111	69	m-diffuse	faceted	XSA242 T/L
Widegerm	3158-CZ	15	91.5	47	diffuse	faceted	none
Widegerm	3159-CZ	34	91.5	47	m-specular	faceted	none
Widegerm	3163-CZ	22	91.5	47	m-specular	faceted	none
Widegerm	3205-BL	36	82	45	diffuse	faceted	none
Widegerm	2094-CZ	15	72	45	m-specular	faceted	none
Widegerm	2095-CZ	23	72	45.5	m-specular	faceted	none
Widegerm	2202-medium LES	36	72	43	m-specular	faceted	none

NOTE: Reflectors have been recommended based on independent optical tests conducted by Lumenetix, and should be used as guidelines.
Final reflector evaluation should be made by fixture manufacturers with all optics in place.

7 POWER / CONTROL CABLE ASSEMBLIES

7.1 Power Cable Assembly

Provides power to each module.
Lumenetix part #: 28.002.001.01



Note: All dimensions are in millimeters.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	874390200	MOLEX CONNECTOR	1
2	874210000	CRIMP	2
3	A2015R-100-ND	24 AWG WIRE, RED	1
4	A2015B-100-ND	24 AWG WIRE, BLACK	1

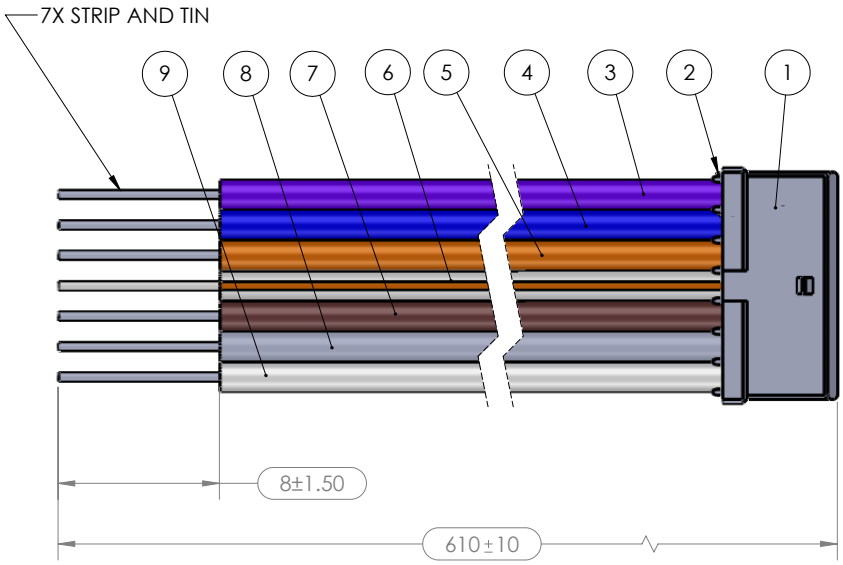
7.1.2 Pin Allocation Chart for Power Cable Assembly

Pin #	Lead Color	Input
Pin 1	Red	Power 24V DC
Pin 2	Black	Power Common

7 POWER / CONTROL CABLE ASSEMBLIES

7.2 Control Cable Assembly (7-Wire)

Provides 0-10V and Lutron EcoSystem (with the Digital Control Adapter) control, and RS-485 signals to each module.
Lumenetix part #: 28.002.002.01



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	874390700	MOLEX CONNECTOR	1
2	874210000	CRIMP	7
3	VIOLET WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG VIOLET	1
4	BLUE WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG BLUE	1
5	ORANGE WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG ORANGE	1
6	WHITE WITH ORANGE STRIPE WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG WHITE WITH ORANGE STRIPE	1
7	BROWN WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG BROWN	1
8	GREY WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG GREY	1
9	WHITE WIRE 24AWG	HOOK-UP WIRE STRANDED 7/32 24AWG WHITE	1

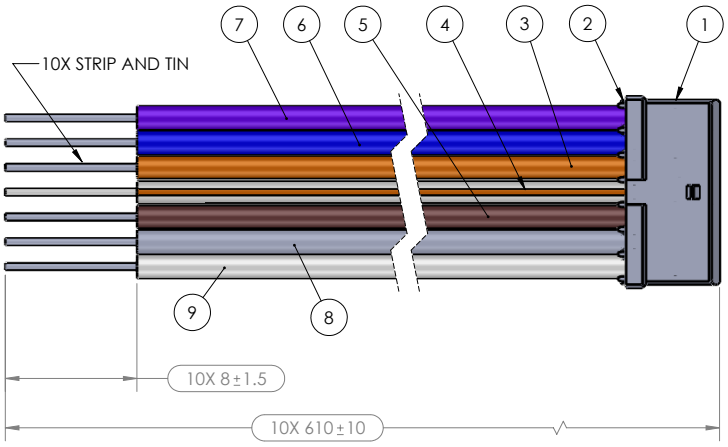
7.2.2 Pin Allocation Chart for Control Cable Assembly

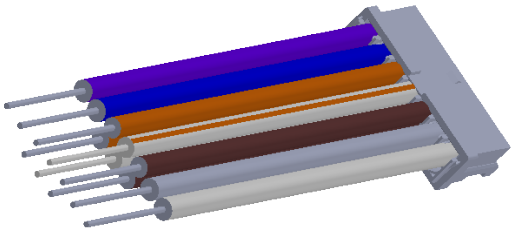
Pin #	Lead Color	Input
Pin 1	Violet	0-10V Dimming (+)
Pin 2	Blue	0-10V Color (+)
Pin 3	Orange	Data (-)
Pin 4	White with Orange Stripe	Data (+)
Pin 5	Brown	Digital Common
Pin 6	Gray	Signal Common for 0-10V Dimming (-)
Pin 7	White	Signal Common for 0-10V Color (-)

7 POWER / CONTROL CABLE ASSEMBLIES

7.3 Control Cable Assembly (7+3 Wire)

Provides dual-DMX control and RS-485 signals to each module.
Lumenetix part #: 28.002.002.05





Note: All dimensions are in millimeters.

ITEM NO.	PART NUMBER	QTY.
1	CONNECTOR MOLEX 874390700	1
2	CRIMP MOLEX 874210000	7
3	HOOK-UP WIRE STRANDED 7-34 26 AWG ORANGE	2
4	HOOK-UP WIRE STRANDED 7-34 26 AWG WHITE WITH ORANGE STRIPE	2
5	HOOK-UP WIRE STRANDED 7-34 26 AWG BROWN	2
6	HOOK-UP WIRE STRANDED 7-32 24AWG BLUE	1
7	HOOK-UP WIRE STRANDED 7-32 24AWG VIOLET	1
8	HOOK-UP WIRE STRANDED 7-32 24 AWG GREY	1
9	HOOK-UP WIRE STRANDED 7-32 24AWG WHITE	1

7.3.2 Pin Allocation Chart for Control Cable Assembly

Pin #	Lead Color	Input
Pin 1	Violet	0-10V Dimming (+)
Pin 2	Blue	0-10V Color (+)
Pins 3a / 3b (TOP / BOTTOM)	Orange	Data (-) IN / OUT
Pins 4a / 4b (TOP / BOTTOM)	White with Orange Stripe	Data (+) IN / OUT
Pin 5a / 5b (TOP / BOTTOM)	Brown	Digital Common IN / OUT
Pin 6	Gray	Signal Common for 0-10V Dimming (-)
Pin 7	White	Signal Common for 0-10V Color (-)

8 0-10V PROTOCOL & WIRING DIAGRAMS

8.1 0-10V Best Wiring Practice

Any manufacturer that makes a dimmer that sinks will work with Lumenetix modules since we source the voltage.

0-10V is a topology defined by the International Electrotechnical Commission (IECR) 60929 Annex E standard and uses a varying DC voltage between 1 and 10V to determine the lighting level. The fixture outputs a minimum light level below 1V which is defined as low-end. Between 1 and 10V, the signal corresponds to levels between the minimum and maximum output level. A signal above 10V corresponds to the maximum light level. Sometimes it is referred to as 1-10V, as that is the actual range in which the light levels will vary. Each dimmer will have their own distinct dimming profile.

Best practice is to limit the distance run for the analog control wiring from the controller to the last driver to 300', as a common 0-10V DC wiring type is stranded-copper twisted-pair 18AWG wiring. The wiring is stranded copper because it provides a more stable current path (as DC signals tend to be transferred by the outer edges of the conductor) while being relatively easy to work with; solid wire is usually acceptable in low-voltage systems that use AC control power.

Whenever any part of the control circuit (the driver, dimer, or wire used) is designed for use in a Class 2 installation, it is critical that the entire control circuit be kept separate from Class 1 line voltage wiring per the requirement of National Electric Code, section 725.136. The electrical drawings must be very clear that class 1 and class 2 wiring cannot be combined. There must be separation because: a) it is possible for higher voltage wiring to induce an AC voltage in to the low voltage signal wiring; and, b) undesirable visual artifacts in the dimmed lighting can be caused when the line and low voltage wiring is run together (especially for long distances). We do not recommend installing the low voltage signal wiring in the same conduit or raceway as line voltage wiring even when all elements of the control circuit are listed for Class 1 wiring methods.

NOTE: Lumenetix modules operate between 1-10V. All dimmers that have minimum and maximum trim pots should be set at a minimum of 1 volt and a maximum of 10 volts, measuring the voltage at the end of the line.

0-10V Dimmers (recommended list)*

Crestron

ETC

Fresco

Legrand

Leviton

Lutron

Nexlight

N-Light

Pass & Seymour

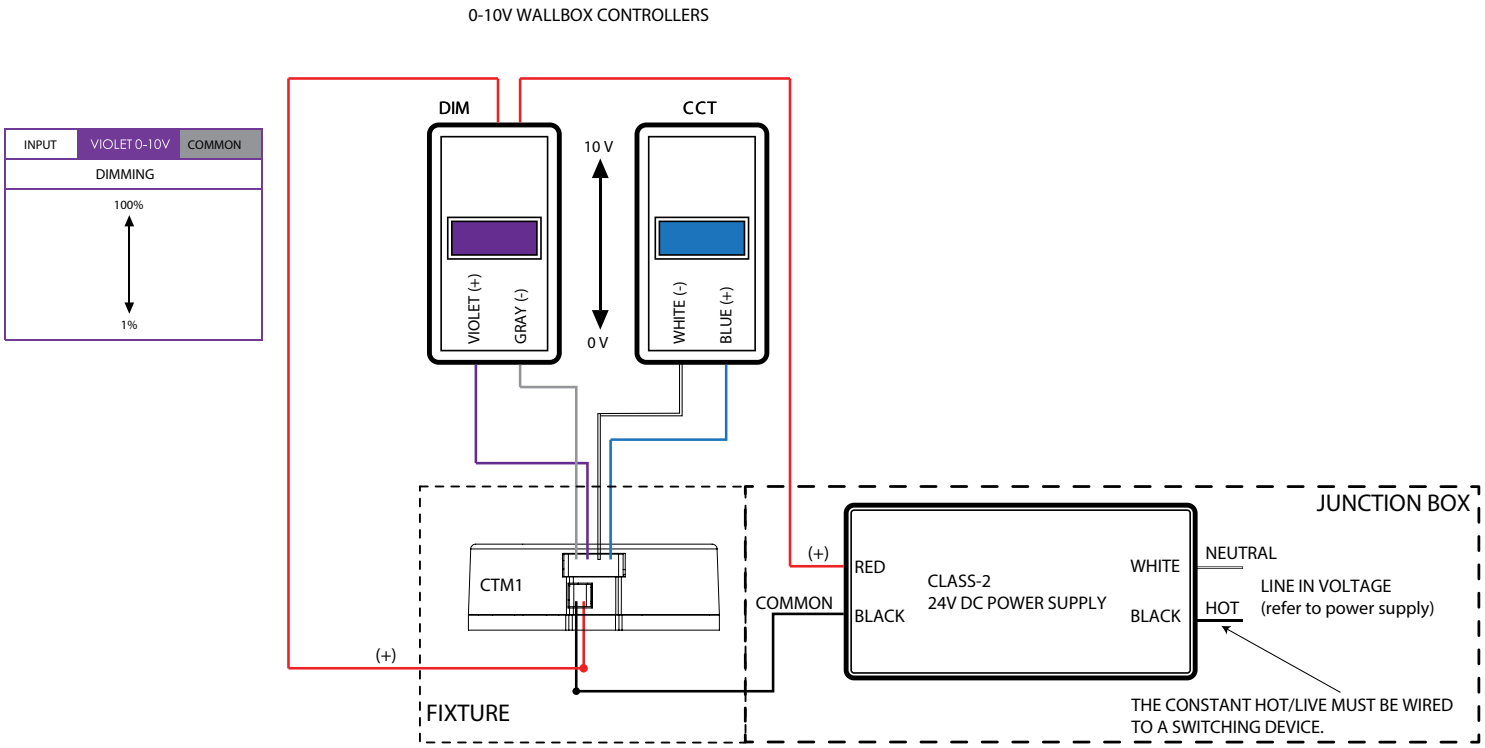
Vantage

Wattstopper

*Recommendations are subject to change. Consult your Lumenetix representative for the most updated list.

8 0-10V PROTOCOL & WIRING DIAGRAMS

8.2 0-10V Analog Control of CCT and Dimming



Lead Color and Input

Lead Color	Input
Red	Power 24V DC (+)
Black	Power Common (-)
Violet	0-10V Dimming (+)
Gray	Signal Common for 0-10V Dimming (-)
White	Signal Common for 0-10V Color (-)
Blue	0-10V Color (+)

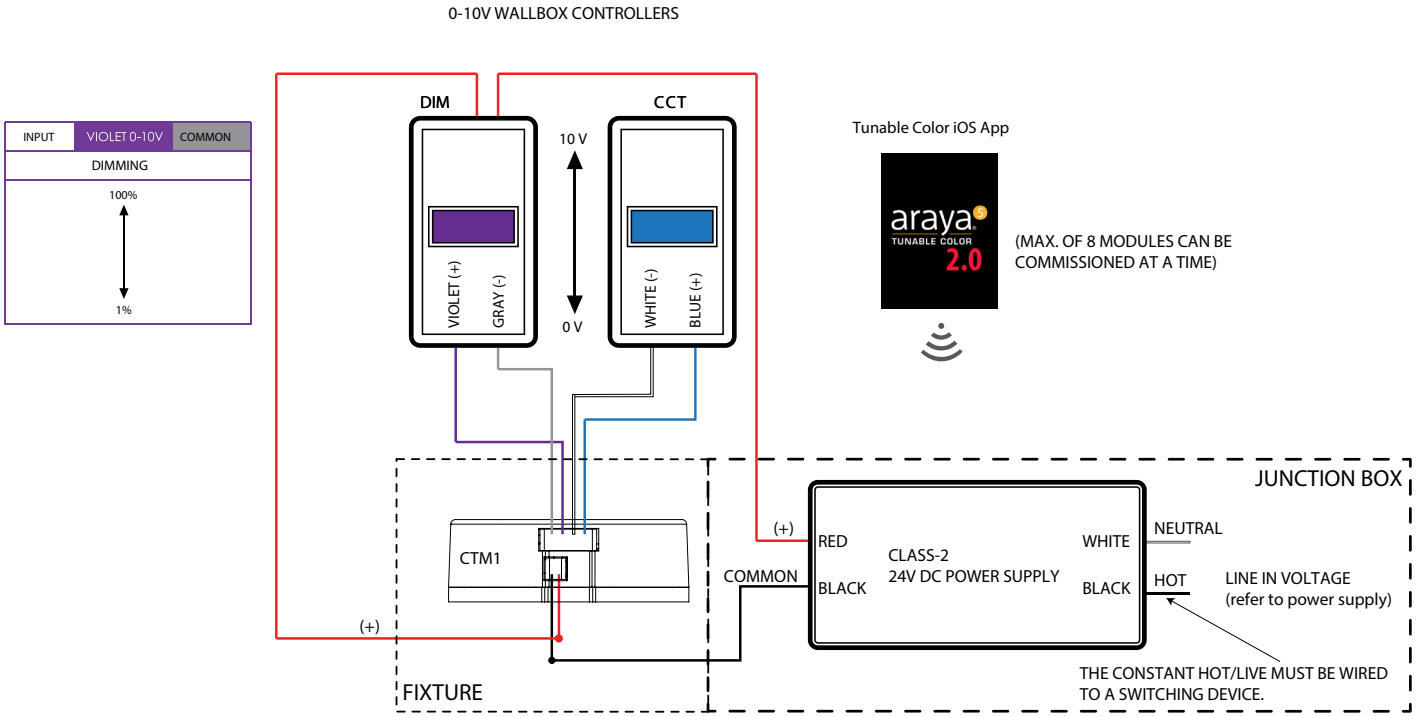
Lumenetix part #s:
28.002.001.01 (power cable assembly)
28.002.002.01 (control cable assembly)

Notes:

1. If 0-10V control is not being used for dimming, the violet control lead must be grounded to gray common lead.
2. CTM sources current to 0-10V control at 0.2mA nominal capacity.
3. *If using a wall box dimmer, power only the DIM unit. The CCT unit does not get line-in voltage.

8 0-10V PROTOCOL & WIRING DIAGRAMS

8.3 0-10V Analog Control of Scenes / Tunable Color iOS App to Set or Amend Scenes



Lead Color and Input

Lead Color	Input
Red	Power 24V DC (+)
Black	Power Common (-)
Violet	0-10V Dimming (+)
Gray	Signal Common for 0-10V Dimming (-)
White	Signal Common for 0-10V Color (-)
Blue	0-10V Color (+)

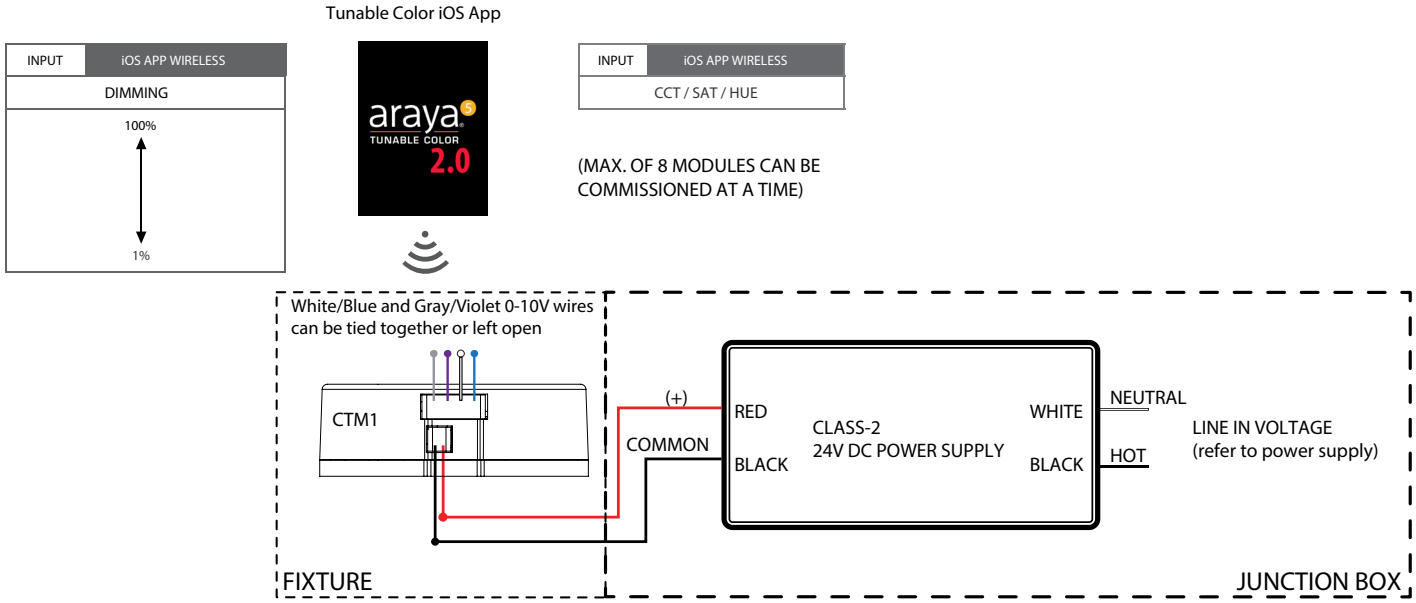
Lumenetix part #s:
28.002.001.01 (power cable assembly)
28.002.002.01 (control cable assembly)

Notes:

1. When the lamp is connected to a 0-10V line, the default is control of the continuous CCT range. The 0-10V line can instead be set to control scene set by sliding the Stored Scenes button to the "on" position in the araya[5] Tunable Color iOS App. In this mode, the 0-10V control will toggle the light between up to 5 preset scenes. A scene is comprised of a CCT, Dim, Saturation & Hue level. Individual preset scenes can also be modified and activated with the iOS app. See Lumenetix-araya Tunable Color Instruction Manual for more instructions.
2. If 0-10V control is not being used for dimming, the violet control lead must be grounded to gray common lead.
3. CTM sources current to 0-10V control at 0.2mA nominal capacity.
4. *If using a wall box dimmer, power only the DIM unit. The CCT unit does not get line-in voltage.

9 BLUETOOTH LE OPERATION

9.1 Bluetooth Operation using the Tunable Color iOS App



Lead Color and Input

Lead Color	Input
Red	Power 24V DC (+)
Black	Power Common (-)
Violet	0-10V Dimming + (left open)
Gray	Signal Common for 0-10V Dimming (-)
Blue	0-10V Color + (left open)
White	Signal Common for 0-10V Color (-)

Lumenetix part #s:
28.002.001.01 (power cable assembly)
28.002.002.01 (control cable assembly)

Notes:

1. Maximum of 8 modules can be commissioned at a time.
2. Bluetooth operation should be used only for commissioning modules, NOT controlling them.
3. See Lumenetix-araya Tunable Color Instruction Manual for more details.

10 DMX512 PROTOCOL & WIRING DIAGRAMS

10.1 DMX512-A Protocol Specifications

DMX512-A is an acronym for Digital Multiplex, a communication protocol used to remotely control lighting dimmers and intelligent fixtures. It is designed to provide a common communications standard between these lighting devices regardless of the manufacturer. The 512-A after the DMX refers to the number of control channels used on one network segment (often called a 'universe') of devices. In a simple dimming system, one channel controls the intensity of the fixture. A single intelligent fixture such as the araya[5] requires several channels to control its various parameters (one channel each for DIM, CCT, SAT, HUE).

DMX512A Specifications:

- DMX 512-A (Controller).
- A universe is 512 Channels.
- DMX value is between 0 and 255, where 0 is off and 255 is full on.
- The maximum number of devices in a daisy-chain wire run is 32, which include the controller and opto-splitter.
- The maximum network wire run is a distance of up to 1600 feet for non-RDM systems and up to 1000 feet for RDM systems.
- One device functions as the master (DMX controller) on a network, while the rest function as slaves (mergers, splitters, intelligent fixtures, etc.).
- Only the controller (master) transmits over the network, and all fixtures receive the same data.
- The final device in the daisy-chain must be terminated with a 120 ohm resistor between DMX+ and DMX- pins.
- It is recommended that the terminator for the final device be located in the control panel, if it falls within the recommended wiring distance.
- All wiring must be in a continuous run and daisy-chained.
- Star wiring is only allowed in conjunction with an opto-splitter.
- Do not run DMX control cable in close proximity to AC power lines. EM spikes from switching of high-current devices such as HVAC equipment or generators will induce noise into the DMX cable.
- The shield must be carried through between modules and properly grounded at one point only.
- Connections to DMX512-A-RDM accessory board: wire size to be 24AWG, and solid or stranded cables may be used. Stranded wire used must be tinned or installed with ferule connector.

RDM

DMX512-A control protocol that enables Remote Device Management for two-way communications for configuration, monitoring and system setup. Allows two way communication between lighting controller and the fixtures. Allows for remote setting of DMX start addressing. RDM signals are sent back the other way, but not constantly. Controller can ask one or more devices for query feedback. RDM packets are inserted in-between the existing DMX data packets being used to control the lighting. The DMX Control Console will broadcast up to 512 channels over one DMX cable (max. run of 1000 feet for RDM). Some of these channels may not be used, but will still be transmitted, as required by the protocol. It must be set to a desired channel (001, 002. 003. 004, etc.) to control the connected light fixture. This is usually accomplished using RDM. This desired 'channel' is commonly known as the DMX address. When addressing fixtures, it is not recommended to skip addresses.

When RDM is not available with the control system, it is permissible to use the Lumenetix commissioning tool (the araya[5] Tunable Color 2.0 iOS App) to set the address of the slots. The instructions to configure the DMX channels can be found in the separate araya[5] Tunable Color Instruction Manual.

The DMX512-A interface follows the ANSI E1.11-2008 (R21013) standard. Four address slots are allocated to each interface board and control the Dim level, CCT, Saturation and Hue of the araya[5] modules connected to the board.

Default DMX512-A Slot Allocation:

Slot	Function
1	Dim Level
2	CCT
3	Saturation Level
4	Hue

10 DMX512 PROTOCOL & WIRING DIAGRAMS

10.2 DMX512-A Electrical Specifications

Parameter	Range	Remarks
ESD Protection	±15KV (air), ±8KV (conducted)	Per IEC 61000-4-2
Termination	Recommended	The DMX512 bus termination rules apply
Directionality	Receive only	
Frequency stability	±20ppm	
Load per port	1/256	1/8 of Nominal RS-485
Isolation	$3KV_{rms}$	

DMX512-A Control Systems (recommended list)

Choreo
Cognito
Crestron Greenlight System
Entec
ETC Mosaic
ETC Paradigm
Fresco
Interactive Technologies
Lutron HomeWorks QS
Lutron Quantum
Nicolaudie
Pathway Connectivity
Pharos
Traxon Ecue
Vantage Controls

*Recommendations are subject to change. Consult your Lumenetix representative for the most updated list.

DMX512-A Recommended Internal / Field Wiring

TMB Cable ProPlex DMX

PC224T: 2-pair DMX512 cable, overall foil and braid shielding with drain wire. UV and fungus resistant. Fully rated for installations, yet easy handling for light duty portable applications.

PC224TW: Same as above, with white jacket.

For use as DMX in/out under one jacket:

PC244T: Two individually shielded pairs and drain wires. UV resistant. Color coded foil shielding for easy reference.

10 DMX512 PROTOCOL & WIRING DIAGRAMS

10.3 DMX512-A Recommended Field Wiring

Liberty 24-2P-485 (Non-Plenum), 24 AWG, 2 pair dual 120 ohm, 11.2 pf/ft low capacitance (Wago, XLR and PHX connectors)
Liberty 24-2P-P485 (Plenum), 24 AWG, 2 pair dual 120 ohm, 11.2 pf/ft low capacitance (XLR and PHX connectors)
Belden #9842 (Non-Plenum), 24 AWG, 2 pair dual shielded 120 ohm, 12.8 pf/ft low capacitance (XLR and PHX connectors)
Belden #89842 (Plenum), 24 AWG, 2 pair dual shielded 120 ohm, 12.8 pf/ft low capacitance (XLR and PHX connectors)

Please refer to wire manufacturer's lighting catalog for and/equals as required by code.

Category Wire or Equal

The Entertainment Services and Technology Association (ESTA) does not define a maximum run length for DMX over Cat5 since many factors will affect the maximum run length, such as number of devices, number of splices in the cable, the strength of the DMX transmitter(s), if Remote Device Management (RDM) is being used, and sources of interference. ESTA does state (again, in ANSI E1.21-2):

"A properly selected and installed DMX512 cable should provide acceptable signal strength for runs of 300m (1000ft). Please note that the technical requirements, such as run-length and topology for other networking technologies, such as Ethernet, should be considered if using the installed cable for another networking technology in the future is anticipated."

Cat5 or equivalent is not preferred as a portable cable since it is not as rugged as other DMX cables. Male RJ45 connectors are especially prone to breakage over repeated re-connections.

LUMENETIX RECOMMENDATION:

CAT 5E -150 FEET
CRESTRON
DM-CBL-8G-NP
DM-CBL-8G-P

CAT 7- 330 FEET
CRESTRON
DM-CBL-ULTRA-NP
DM-CBL-ULTRA-P

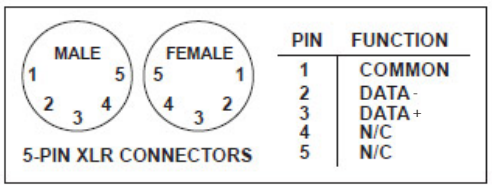
DMX512-A Recommended Field Connectors (or Equal)

WAGO 221
PHOENIX CONTACT
XLR NEUTRIK
CRESTRON
RJ45 DM -8G-CONN
RJ45 IDC DM-CONN

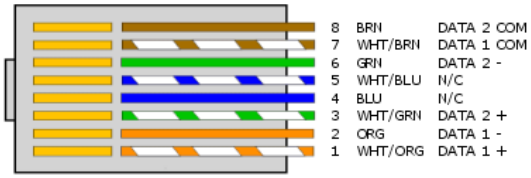
DMX512-A Wiring Connections

Signal	Description	Pin Colors (4-Pair Cable)	Pin Colors (2-Pair Cable)	3-pin XLR connector	5-Pin XLR connector	5-Pin PHX connector
Signal Common		White/Brown and Brown	White/Blue and Blue	1	1	1
Data (-)	Primary Data Link	Orange	Orange	2	2	2
Data (+)	Primary Data Link	White/Orange	White/Orange	3	3	3
Data2 (-), or not used	Optional Secondary Data Link				4	4
Data2 (+), or not used	Optional Secondary Data Link				5	5

XLR Connectors (5-Pin)

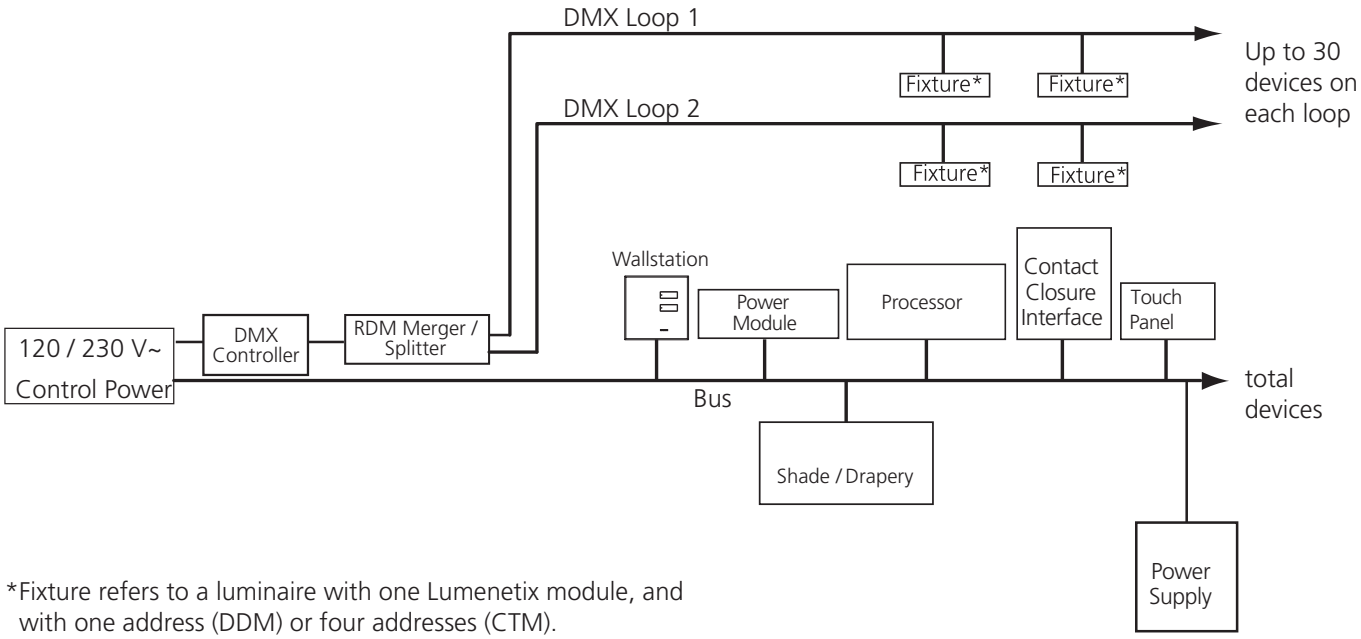


RJ-45 Connector Pin-Out (T568B)



10 DMX512 PROTOCOL & WIRING DIAGRAMS

10.4 DMX512-A Controller Example



*Fixture refers to a luminaire with one Lumenetix module, and with one address (DDM) or four addresses (CTM).

DMX512-A Drain Wire Connections

Drain wire connections are required as follows.

Shielding

To add another level of protection from electromagnetic noise, a grounded shield is added over the twisted pair wires. When this is enclosed in a protective jacket, to avoid ground loops and electromagnetic contamination of the ground system, all control ground wiring, including cable shields and drain wires, should be treated like sensitive current-carrying conductors. All control ground wires should be insulated (not bare) and the same wiring practices should be observed with ground wires as with other sensitive signals. Care must also be taken when designing control wiring to ensure that each shield is connected to only a single ground point. You should establish this point at a central location, like a control panel or cabinet, and avoid all connection to grounds in the field. A control ground is sometimes referred to as an isolated ground (an oxymoron) for this reason, but the term single-point ground is more accurate.

Method-1

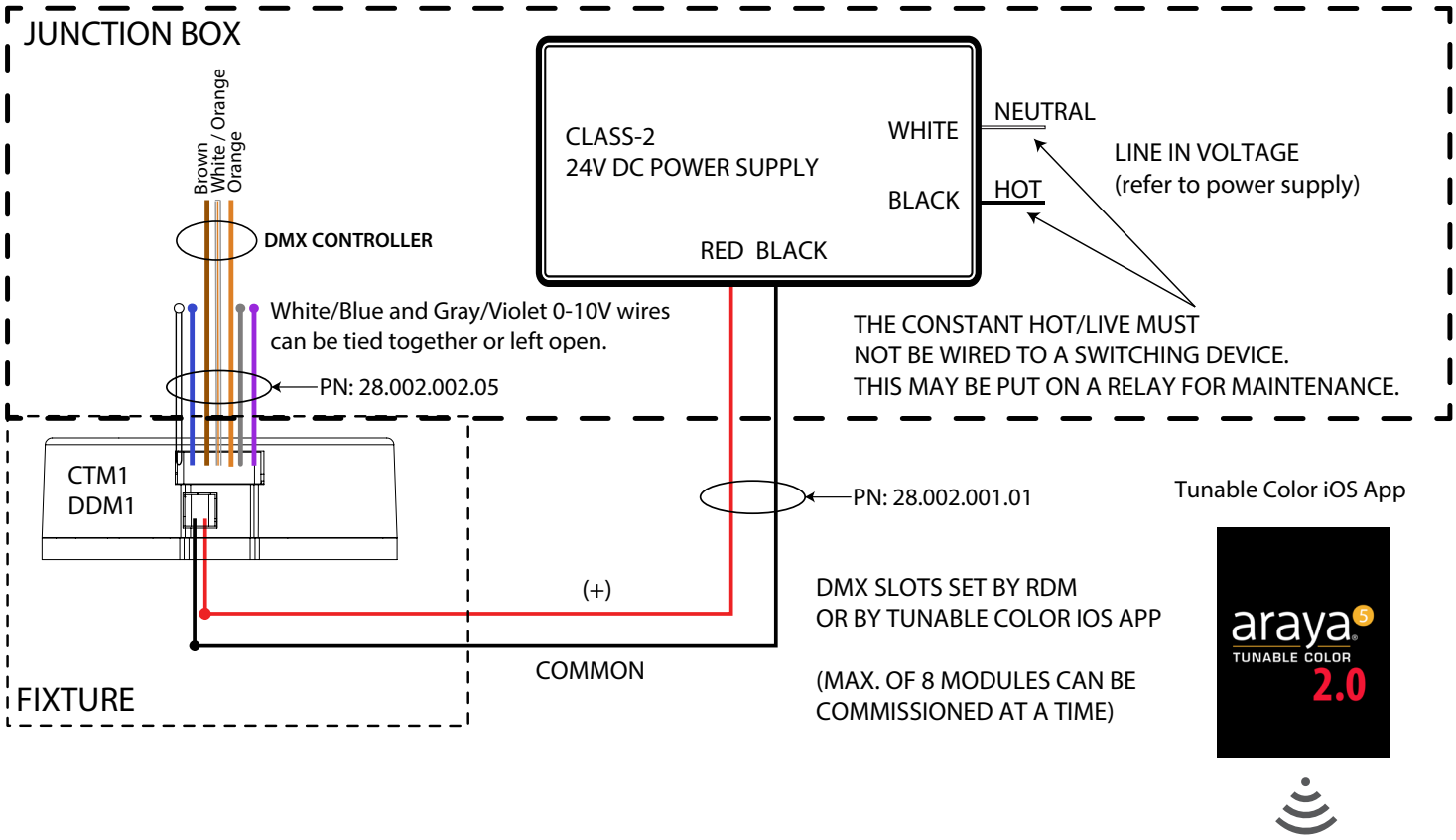
A typical two-pair shielded cable can be prepared for termination to the terminals with the drain wire cut off. This is usually done at the field end of the cable where no shield grounding is desired. You will then use insulating tape or heat-shrink tubing to protect the cable from contamination and to prevent accidental grounding of the shield or drain wire. An accidental ground at this point would almost certainly create an undesirable ground loop.

Method-2

A typical two-pair shielded cable can be prepared for termination to the terminals with the drain wire cut off. The drain wire, which is an uninsulated conductor, is sleeved with a insulating tubing to prevent accidental grounding. The crimp-on lug is valuable in this instance to retain the tubing. Insulating tape or heat-shrink tubing is again used to protect the cable from contamination and to prevent accidental grounding, since any accidental connection between the drain wire and a chassis, frame, or enclosure would almost certainly create a ground loop.

10 DMX512 PROTOCOL & WIRING DIAGRAMS

10.5 DMX512-A-RDM Control



Lead Color and Input

Lead Color	Input
Red	Power 24V DC (+)
Black	Power Common (-)
Violet	0-10V Dimming (+); Left Open
Gray	Signal Common for 0-10V Dimming (-); Left Open
Blue	0-10V Color (+); Left Open
White	Signal Common for 0-10V Color (-); Left Open
Orange (TOP / BOTTOM)	Data (-) IN / OUT
White with Orange Stripe (TOP / BOTTOM)	Data (+) IN / OUT
Brown (TOP / BOTTOM)	Digital Common IN / OUT

Lumenetix part #s:
28.002.001.01 (2-wire power cable assembly)
28.002.002.05 (7-wire control cable assembly)

Notes:

1. The DMX channels can be set by RDM or by using the araya[5] Tunable Color iOS App.
2. Maximum of 8 modules can be commissioned at a time using the app.
3. Bluetooth operation should be used only for commissioning modules, NOT controlling them.
4. The DMX control system should first be powered OFF, and only modules that are connected to the DMX system should be powered on.
5. If more than one line of DMX is needed, then a DMX Splitter must be used to create multiple independent branches of a DMX signal and/or to extend the usable distance of each branch. Each of the splitter's 4, 6, 8, or 16 output ports generates an independently protected DMX signal.
6. See Lumenetix-araya Tunable Color Instruction Manual for more details.

11 LUTRON ECOSYSTEM & WIRING DIAGRAMS

11.1 Lutron® EcoSystem Protocol

EcoSystem technology is a control method for LEDs that provides addressing of individual fixtures and status feedback. This makes it easy to digitally assign one or many fixtures without complicated wiring. This opens up an entire suite of energy-saving, system-monitoring and system-control schemes where the design, setup and rezoning are all done within software, making the electrical and control design simple.

The araya$^{5}_{®}$ modules attached to different interface boards can be controlled independently or assigned to a single group by the EcoSystem controller.

The EcoSystem control is responsible for saving any configuration settings. Once an interface board is assigned a pair of addresses, assigned addresses are saved in NVRAM. During the EcoSystem discovery process, the user pairs the desired dimming control in the controller to the Dim channel address in the interface board. The same applies for the CCT channel.

- 1 pair 16AWG Eco Loop, 900 feet (**field wiring**).
- Maximum of 64 addresses on each loop.

EcoSystem Control Systems (recommended list)*

Quantum System

HomeWorks QS

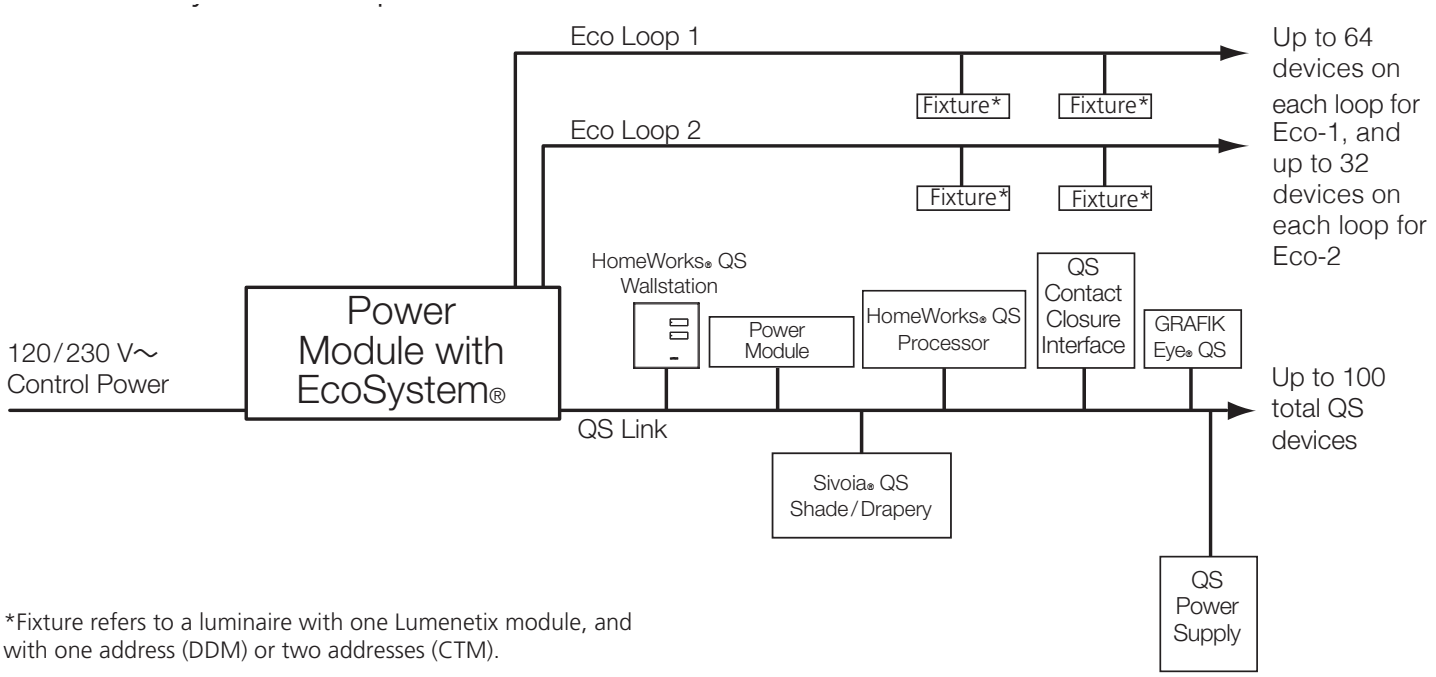
Grafik Eye QS Control Unit with EcoSystem

EnergiSavr Node with EcoSystem

Power Module with EcoSystem

*Recommendations are subject to change. Consult your Lumenetix representative for the most updated list.

Lutron EcoSystem Controller Example



*Fixture refers to a luminaire with one Lumenetix module, and with one address (DDM) or two addresses (CTM).

11 LUTRON ECOSYSTEM & WIRING DIAGRAMS

11.2 Lutron® EcoSystem Field Wiring

- EcoSystem Digital Loop can be wired as Mains voltage or IEC PELV/NECR Class 2 for maximum wiring flexibility..
- The Loop is polarity insensitive and can be wired in any topology..
- Consult all national and local electrical codes for separation requirements..

Wire Gauge	Maximum EcoSystem-Compliant Loop Wire Length
4.0 mm^2 (12 AWG)	671 m (2200 ft)
2.5 mm^2 (14 AWG)	427 m (1400 ft)
1.5 mm^2 (16 AWG)	275 m (900 ft)
1.0 mm^2 (18 AWG)	175 m (570 ft)

Drain Wire Connections

Drain wire connections are required as follows.

Shielding

To add another level of protection from electromagnetic noise, a grounded shield is added over the twisted pair wires. When this is enclosed in a protective jacket, to avoid ground loops and electromagnetic contamination of the ground system, all control ground wiring, including cable shields and drain wires, should be treated like sensitive current-carrying conductors. All control ground wires should be insulated (not bare) and the same wiring practices should be observed with ground wires as with other sensitive signals. Care must also be taken when designing control wiring to ensure that each shield is connected to only a single ground point. You should establish this point at a central location, like a control panel or cabinet, and avoid all connection to grounds in the field. A control ground is sometimes referred to as an isolated ground (an oxymoron) for this reason, but the term single-point ground is more accurate.

Method-1

A typical two-pair shielded cable can be prepared for termination to the terminals with the drain wire cut off. This is usually done at the field end of the cable where no shield grounding is desired. You will then use insulating tape or heat-shrink tubing to protect the cable from contamination and to prevent accidental grounding of the shield or drain wire. An accidental ground at this point would almost certainly create an undesirable ground loop.

Method-2

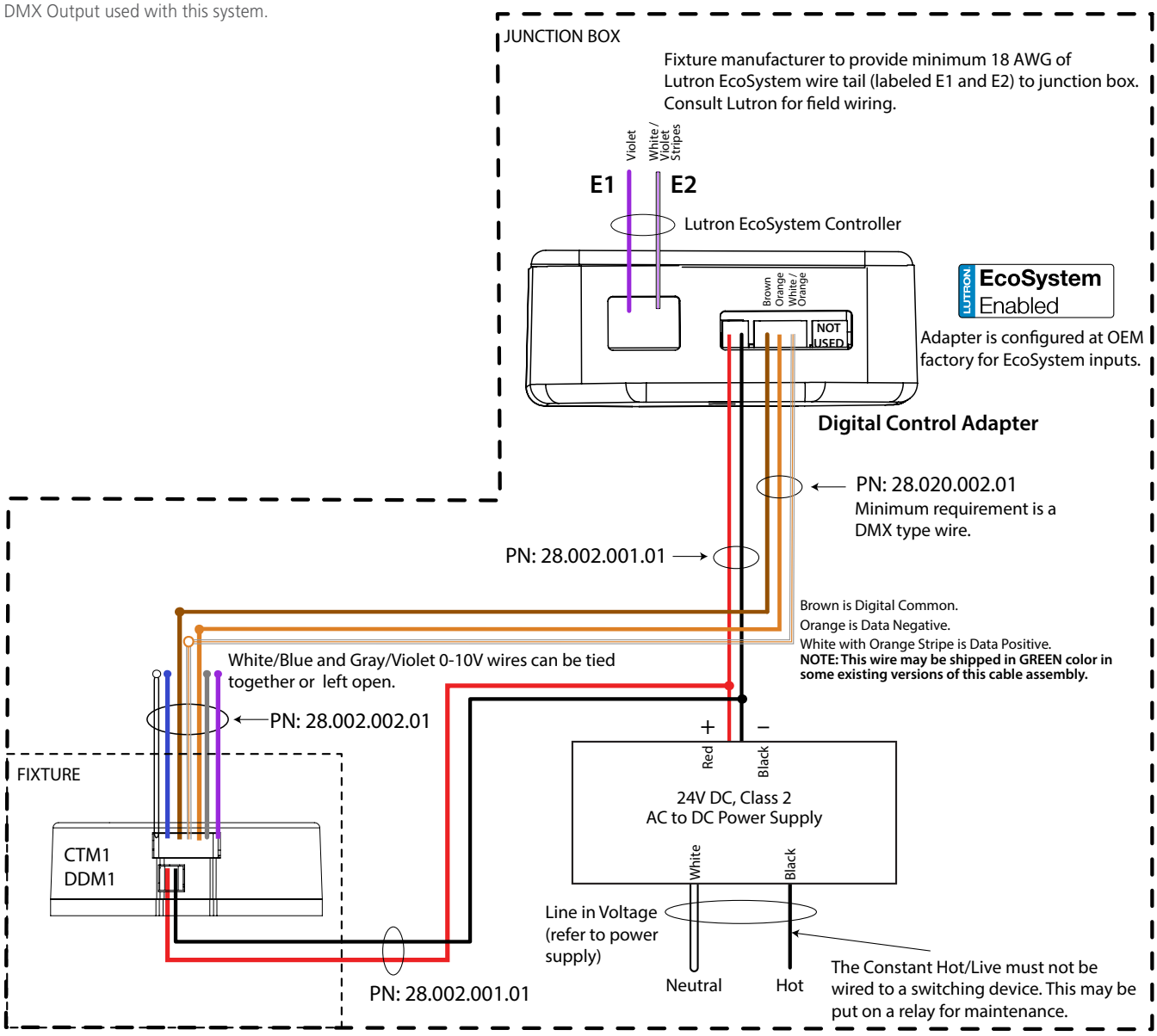
A typical two-pair shielded cable can be prepared for termination to the terminals with the drain wire cut off. The drain wire, which is an uninsulated conductor, is sleeved with a insulating tubing to prevent accidental grounding. The crimp-on lug is valuable in this instance to retain the tubing. Insulating tape or heat-shrink tubing is again used to protect the cable from contamination and to prevent accidental grounding, since any accidental connection between the drain wire and a chassis, frame, or enclosure would almost certainly create a ground loop.

11 LUTRON ECOSYSTEM & WIRING DIAGRAMS

11.3 Lutron® EcoSystem Input; DCA-2 (24V DC) Digital Control Adapter

Notes:

1. 24V power (red/black) is Class-2 rated.
2. Module Data +/- (white with orange stripe/orange) to araya[5]® modules is Class-2 rated.
3. Adapter is configured at factory for EcoSystem inputs. The araya[5] Tunable Color 2.0 iOS App should be turned on, and the DMX channels should be set to 2, 4, 6, 8.
4. DCA may be installed in the luminaire only.
5. One EcoSystem address (1 channel for warm-dim) per DDM module/DCA kit.
6. Two EcoSystem addresses (1 channel for CCT control and 1 channel for dimming control) per CTM module/DCA kit.
7. EcoSystem Channel 1 is always Intensity control. EcoSystem Channel 2 is always CCT control.
8. In the EcoSystem programming mode, EcoSystem Channel 1 controls the intensity from 100%-1%. EcoSystem Channel 2 controls the CCT range from 1650 - 8000K.
9. CAUTION: The power cable should ONLY be plugged into the 2-pin power receptacle provided. Insertion of the cable into any other slot will damage the Digital Control Adapter unit.
10. DMX Output used with this system.



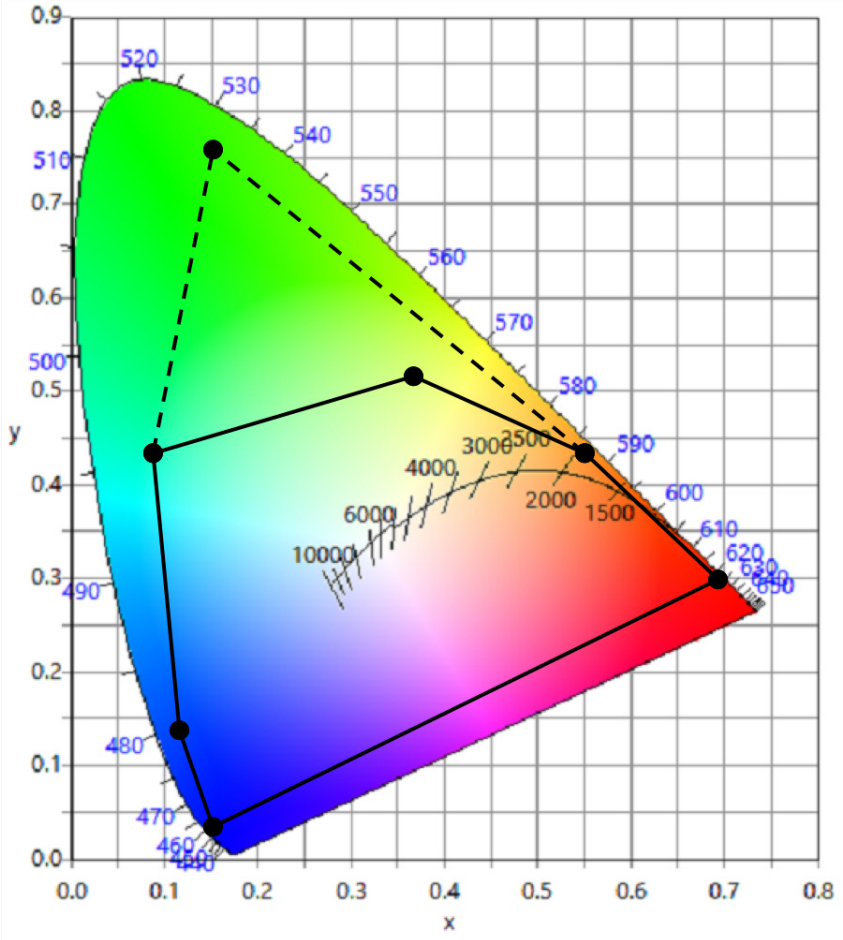
12 SATURATED GREEN / EXPANDED GAMUT CAPABILITY

Lumenetix-araya modules typically mix 5 different colors of LEDs to achieve industry-leading spectral and color rendering performance, by delivering tunable and dimmable white light at 90+ CRI and a color consistency of <2 MacAdam ellipse across a tuning range of 1650 - 8000K. Full color access to millions of colors within the gamut area is created by these 5 LEDs in the CIE color space, enabling tailored light in a range of shades from pastels to saturates. This high-quality LED mix includes using a Mint colored LED, which provides superior spectral coverage, color rendering and efficacy compared to a Green color LED.

For applications that require an expanded gamut capability with saturated green color, Lumenetix offers a modified 6-color LED arrangement that includes both Mint and Green colored LEDs. While this option does result in a minimal reduction of the products' performance in terms of CRI and efficacy (lumens per watt), it does allow the user to experience a more intense green in their lighted installations.

The ordering codes for these saturated green / expanded gamut options include the suffix 'E' (for "Entertainment") in the product name.

The CIE 1931 color space diagram below shows a solid line indicating the gamut area potential of the standard product, using a Mint colored LED in the 5-color mix. The dashed line indicates the expanded gamut area potential—specifically in the green area of the color space — of the "Entertainment" (E) option.



13 EFLICKER FREE / HYBRID LED DIMMING

Hybrid Dimming is a technique of controlling the brightness and color of Lumenetix modules / arrays using two common circuit methods mixed together – pulse width modulation (PWM) and dynamic current control. Each has its advantages and disadvantages in terms of consistency, control, efficiency and complexity / cost. But when applied in correct proportions, the advantages of each can be made to stand out. For example, PWM has the advantage of simple circuitry and consistent linear control, whereas current control excels in producing flicker-free dimming and higher LED power efficiency.

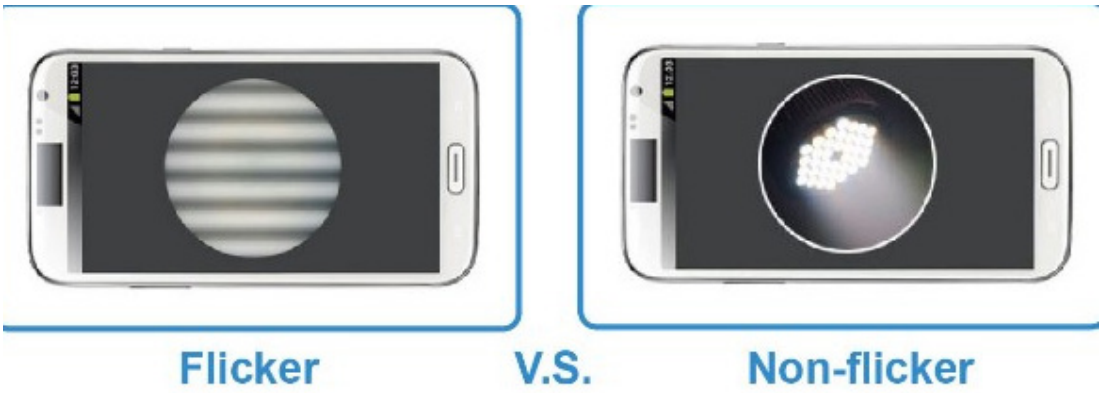
Lumenetix has developed proprietary electronics and LED characterization techniques that use a blend of each technique to produce a luminaire with zero flicker over most of the dimming and color ranges. The control aspects are all handled by the ALM microprocessor and verified by detailed spectrometer testing on each product before shipment.

On products featuring Hybrid Dimming, adjustable LED drive current is used from maximum brightness down to approximately 10%. Then the current setting is held constant and PWM is introduced at a rate up to 25 kHz, which continues down to very low dim levels (0.1% on some models). While this technique is ordinary for single / dual color LED luminaires, Lumenetix is the only company to have perfected the technique on 6 channels of LED color, and has blended the results in a way that produces no eflicker and provides up to 10% more lumens per watt (at select CCT / Dim settings).

Health and IEEE Standards for Lumenetix CTM1C HD:

CTM1C HD runs in the safe zone with the lowest carrier frequency of 1 KHz plus a modulation averaging 50%, given that the modulation depth is spread over 5 channels.

CTM1C HD is largely based on current control with areas of 25 KHz modulation, making it also inherently safe.



14 OPERATION SUMMARY

Color Tuning Modules (CTM1C HD) utilize standard 0-10V building controls and/or a wireless Tunable Color iOS app for controlling on-Planckian correlated color temperatures (CCT), dimming values, off-Planckian color points (color tinting) using the Saturation & Hue feature, and commissioning and activating Scene presets. This document describes how to control the CTM1C utilizing 0-10V controls, the iOS Bluetooth app or a combination of the two.

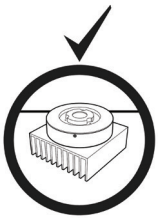
Lumenetix-araya Tunable Color iOS App. The Lumenetix-araya Bluetooth app wirelessly controls the CTM. The app is primarily intended to commission the CTM after installation. A MAXIMUM OF 8 MODULES CAN BE CONTROLLED AT A TIME. Each CTM has a unique address and the operator uses the app to select the desired CTM, turn power on/off and then set CCT, Dim, Saturation & Hue, and set Scene Presets. Consult the Lumenetix-araya Tunable Color instruction manual for detailed instructions.

0-10V Control of CCT. The CTM has 0-10V blue (+) and white (ground) control wire pairs to control CCT (instead of iOS app control of CCT).

0-10V Control of Stored Scenes. The iOS app can set up to 5 Scene Presets which are recalled using a wired 0-10V controller. A scene is comprised of a CCT, Dim, Saturation & Hue level. Individual preset scenes also can be modified and activated with the iOS app.

DMX Channel Configuration. The CTM1C modules are provided with on board DMX512-A-RDM, with DMX slots set by RDM or via wireless Lumenetix-araya Tunable Color 2.0 iOS app.

On-Off Control. The CTM may be turned on/off by switching the input power from the 12V supply. To store the settings, the lamp needs to remain on for at least 45 seconds after the CTM is initially set using the iOS app. When Scene Presets are activated using the app, the settings are stored immediately and no wait time is needed. The lamp may also be turned on/off using the app without switching the power supply, but a power draw of about 1W will remain.



For long term reliable operation, proper heat sinking is critical.

The CTM diffuser is fragile. Avoid touching the diffuser during handling and assembly.

Do not rest or operate the CTM face down against a table or other solid surface.

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