

VarioLED™ Flex Tapes

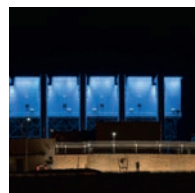
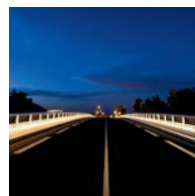


The new standard of light.
Made in Germany.

VarioLED™ Flex Tapes

As varied as your applications

Choose between different lumen packages, wattages, color temperatures, color renderings or step dimensions, the right lamp for your application. Brilliant and sharply drawn, contrasting colors can be reached by using our LED tapes with CRI > 95 (TM-30-15: Rf > 95, Rg ~ 100). The versions LD (125 mm) and HD (62.5 mm) differ in cut lengths and component density (LD = Low Density, HD = High Density).



WHEN?

- In the morning
- At midday
- In the evening
- At night

White

HYDRA LD

Intended for cove and accent lighting and other indirect view applications.

HYDRA HD

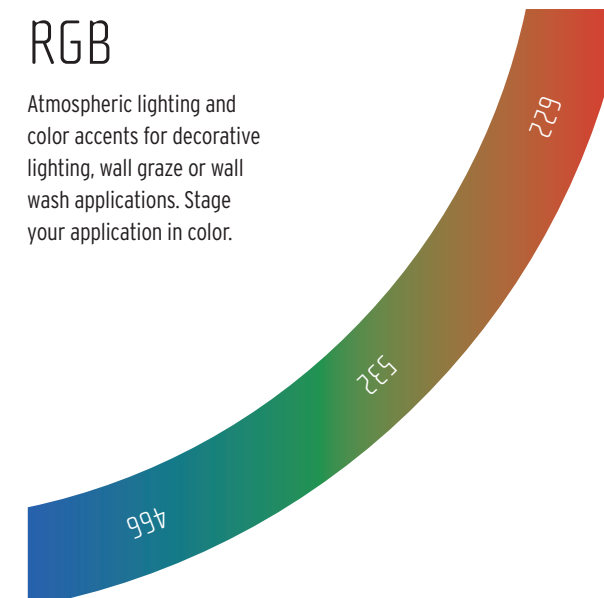
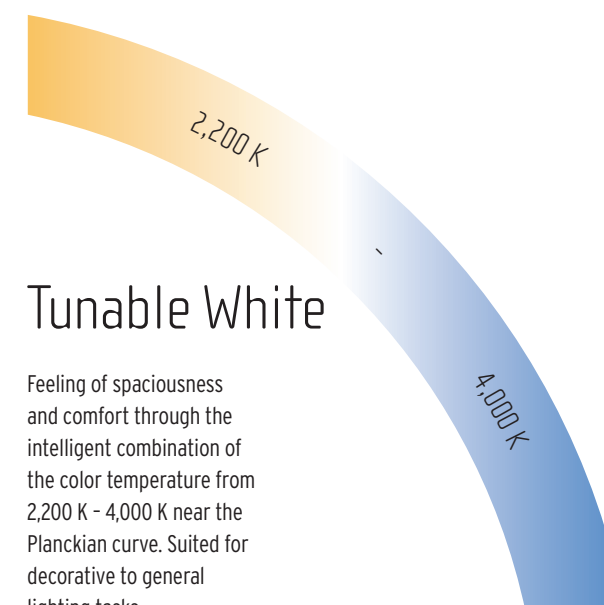
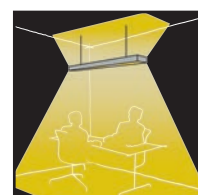
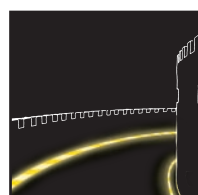
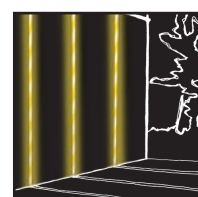
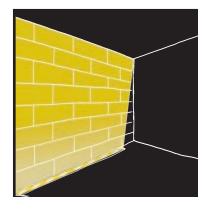
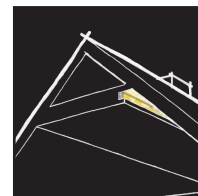
Intended for direct view applications with homogeneous output and the addition of a variety of lenses.

LUMINARIS

Intended for applications where cost savings are desired, without significantly impacting quality and performance. Perfect for decorative lighting applications in mill work, furniture and backlighting applications.

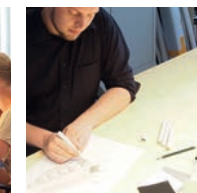
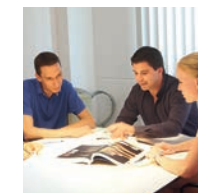
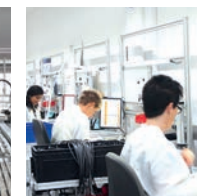
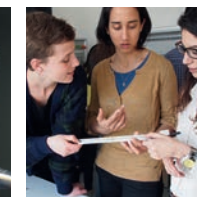
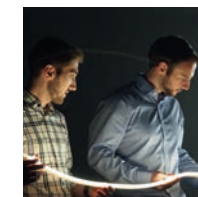
FOR WHAT?

- General lighting
- Cove lighting
- Accent lighting
- Decoration lighting
- Wall washing
- Wall grazing
- Contour lighting
- Orientation lighting
- Task lighting



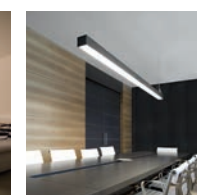
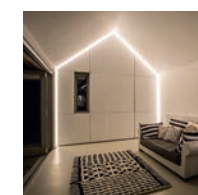
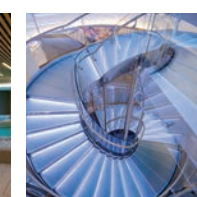
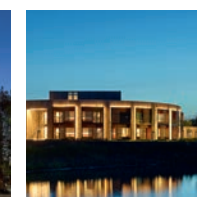
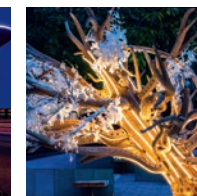
FOR WHOM?

- Pupils, Students
- Senior citizens
- Hotel guests
- Employees
- Pedestrians
- Artists



WHERE?

- Outdoors
- Hospitality
- Industrial
- Office
- Educational institutions
- Residential
- Shop, Retail
- Architectural, Façade
- Art, Culture
- Spa, Wellness





VarioLED™ Flex Tapes

Flexible light from the reel
for architecture and interior design

VarioLED™ Flex tapes enables new application fields through innovation and technology. Depending on the step length this linear LED lamp can be cut from the reel to the desired length in multiples of the step measurement. A reflective white surface ensures maximum reflection of light. A thermally enhanced 3M tape on the back ensures a reliable connection of the lamp on surfaces and profiles with superior heat management.

The 3 pillars of VarioLED™ Flex series:

- Japanese LED
- American standards
- German engineering

The VarioLED™ Flex Tapes deliver up to 7,200 lm/m and 168 lm/W and a high color rendering up to CRI > 95 in. Also available in IP67 and in aluminum profile. The small cross-section of 9.5 mm x 1.4 mm (W x H) allows the use in almost all applications with limited space.



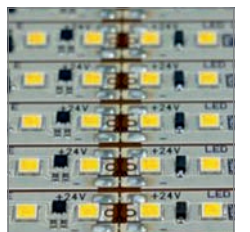
VarioLED™ Flex Tapes

Europe's state-of-the-art reel to reel assembly
for flexible printed circuit boards

Currently, VarioLED™ Flex Tapes are manufactured in Germany on the most modern assembly plant in Europe for reel to reel processing. Reel to reel means an unwinding of the flexible substrate at the process start and direct reeling of the finished product after cutting the equipped, soldered and tested product into the desired strips. This highly automated process allows the assembly of up to 45,000 components per hour, meeting the highest demands on the quality of VarioLED™ Flex series at the same time.

Advantages:

- High through put
- Capacity of up to 750 km LED tape annually
- Highly efficient due to 8 simultaneous processes
- Entire control of all production processes
- Batch traceability through QR-Information
- Delivery reliability
- Flexible substrates
- Customized products on request

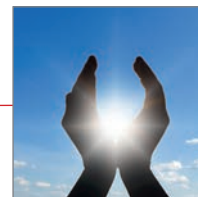


VarioLED™ Flex HYDRA

All benefits at a glance

Circuit board (Tj-Away®)

Optimized heat transfer from the LED to the support material by the linear, flexible printed circuit board with Tj-Away® technology (Thermal Junction Away).



Brightness

Outstanding lumens per meter across all available light colors and color renderings.



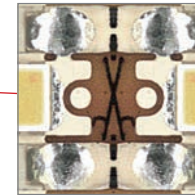
Reflective Surface

The unique coating ensures a high quality reflection of the emitted light and protects the printed circuits.



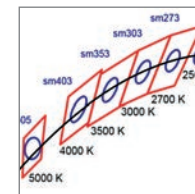
From the reel

VarioLED™ Flex is available in lengths from 2 m to 33 m and can be cut to the desired length depending on the step measurement.



Customer assembly depending on step measurement

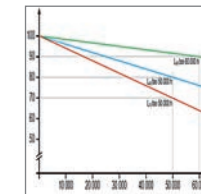
- Low density: LD (125 mm / 4.92")
- High density: HD (62.5 mm / 2.46")



One Bin Only

OBO (One Bin Only)

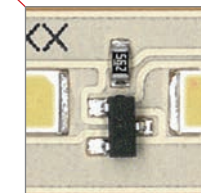
Impressive color consistency with within 3-step MacAdam ellipses. The "One Bin Only" agreement guarantees consistency between applications and project phases.



Lifetime

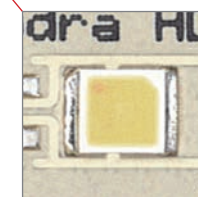
- > 60,000 h @ L90 B10, for all VarioLED™ Flex HYDRA

L/B Lifetime



CC driver

Uniform brightness from the first to the last LED guarantees a finely adjusted constant current regulator on each step. A uniform control of the LEDs ensures constant light output and has a positive effect on the lifetime.



LED

High quality Japanese LED packages selected for long lifetime, efficiency and outstanding light quality. Certain packages offer CRI up to 95 and R9 values up to 65.

VarioLED™ Flex Tapes

Description of the components

Flexible printed circuit board (Tj-Away®)

Heat management is in the focus during the whole development process of the flexible circuit board technology.

The Tj-Away® (Thermal Junction Away) - Technology is characterized by large copper areas below the LED, which ensure rapid heat dissipation and heat spread away from the LED.

Due to Tj-Away® we achieve thermal power densities less than 0.42 W/cm^2 with our high performance tapes such as Flex HYDRA LD40 with electrical input power of 40 W/m . The $30 \mu\text{m}$ thin adhesive tape with superior heat conduction guarantees rapid heat transfer into aluminum profiles.

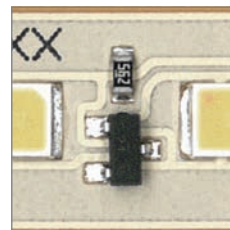
$$5 \text{ W/11.88 cm}^2 = 0.42 \text{ W/cm}^2$$



HYDRA LD40 (back side)

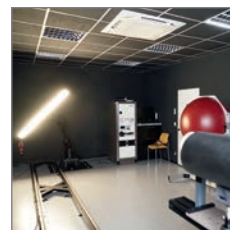
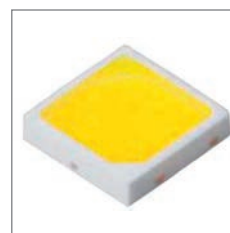
CC – constant current regulator

Uniform brightness from the first to the last LED. The use of integrated circuit electronics (constant current regulator) on our circuit boards ensures a consistent and precise ($\pm 0.5 \text{ mA}$) control of each LED. The constant direct current has a positive effect on the lifetime. The use of the constant current regulator minimizes voltage fluctuations in the lamp system.



LED (= Light Emitting Diode)

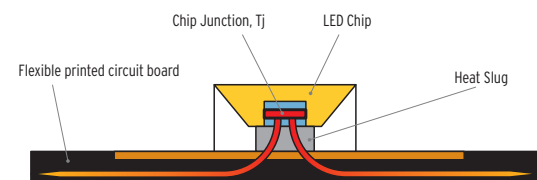
Japanese LEDs of the highest quality in 8 different color temperatures (2,000 K - 5,000 K) with strictly selected CIE bins within 3 step MacAdams Ellipse. For perfect brightness uniformity the LED forward voltage V_f and lumen flux Φ are carefully selected and adopted to the electrical circuit design. The natural emission spectra of the LED mimic the wavelength composition of the sun and ensures extraordinary color rendition capabilities (CRI 85 up to 95, TM-30-15: $R_f > 95$, $R_g \sim 100$). The LEDs have an integrated ESD protection, which protects the device against short-term surges and increases the lifetime.



TjAway®
Thermal
Management

Record breaking brightness

LED Linear offers the brightest CV-based flex tape portfolio on the market. Up to $5,300 \text{ lm/m}$ @ W850 are unmatched in this area and thus even suitable for use in high-bay applications.



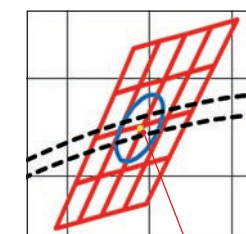
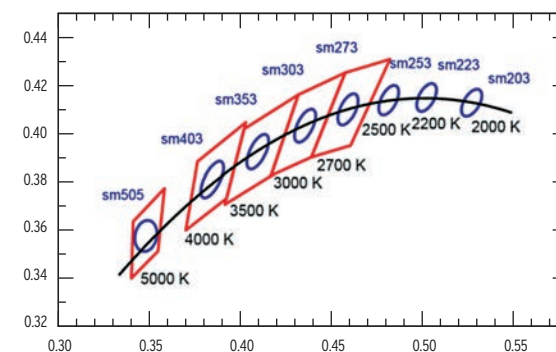
VarioLED™ Flex Tapes

Superior features and benefits

One Bin Only

One Bin Only and Color Consistency

One Bin Only stands for true color consistency within a 3 step MacAdams Ellipse located in the center ANSI bin. During the standardized LM80 test cycle time of 10,000 hours the maximum color shift $\Delta u'v'$ is better than 0.001 ($< 1 \text{ SDCM}$) which guarantees impressive color consistency. The absolute CIE (x,y) drift stays well within a 3 step MacAdams ellipse and cannot be recognized by the human eye.



16 ANSI binnings with 3 step MacAdams ellipses and limits of the color shift ($\Delta u'v'$) @ 2,700 K



Maximum anticipated Color Shift of the reference LED @ 2,700 K



Initial color measuring tolerances of the LED

LED Manufacturers also perform primary measurements on their LEDs after production with a given tolerance. These measurements evaluate the initial color space within the CIE 1931 and the color variation range with respect to the CIE reference. LED Linear only uses the highest quality LEDs available on the market with a tight initial color space tolerance of CIE (x,y) = ± 0.003 .

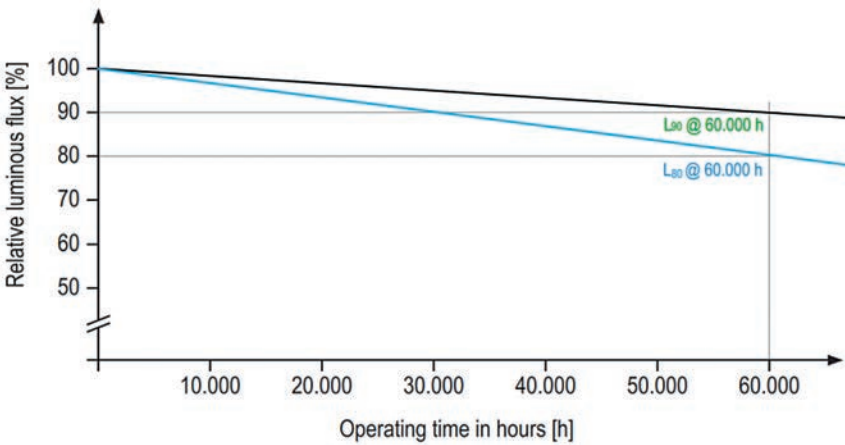
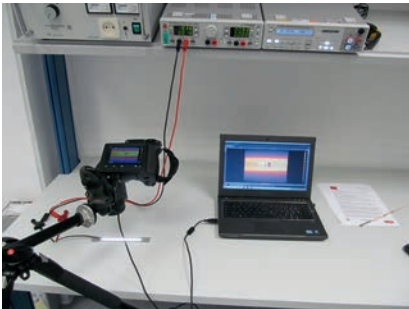
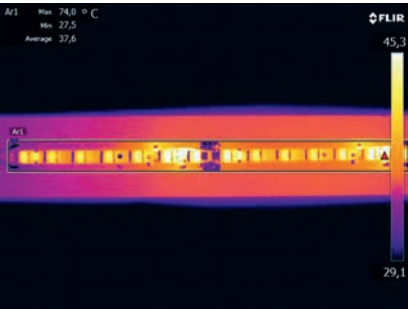
	LED Color Initial Measuring Tolerance		
	CIE (x,y) = ± 0.003 LED Linear™	CIE (x,y) = ± 0.005 Competitor A	CIE (x,y) = ± 0.010 Competitor B
CCT	Reported CCT Variation		
2,200 K	$\pm 39 \text{ K}$ 	$\pm 96 \text{ K}$ 	$\pm 192 \text{ K}$
3,000 K	$\pm 56 \text{ K}$ 	$\pm 126 \text{ K}$ 	$\pm 252 \text{ K}$
4,000 K	$\pm 78 \text{ K}$ 	$\pm 164 \text{ K}$ 	$\pm 328 \text{ K}$

VarioLED™ Flex Tapes

Superior features & benefits

Lifetime & Lifetime specifications

The luminous flux and the lifetime of LED products are exponentially proportional to the development of heat, for example the LED chip at the point where the light is generated. This place is commonly called Thermal-Junction (Tj). In the development of LED Linear™ products we pay particular attention to the fact that at an ambient temperature of Ta = 45°C, the temperature at the Junction Tj does not exceed = 95°C. This enables us to guarantee lifetimes of at least 60,000 hours with also a very low degradation of luminous flux. For this degradation there are parameters (L_r & B_r) which describe the changing luminous flux over the operating time.

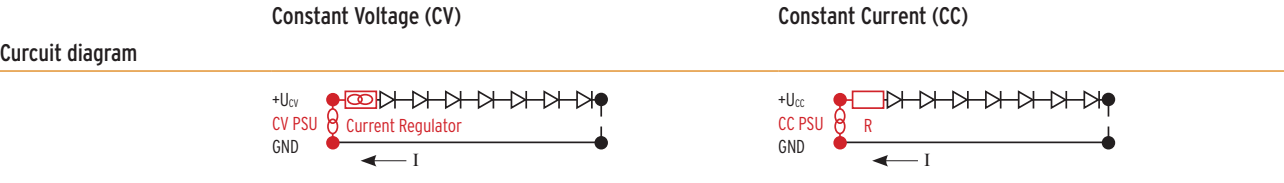


> 60.000h @ L90 B10,
for all HYDRA

The HYDRA series has a luminous flux of minimum 90% (L90) of the initial luminous flux within 60,000 h, with 10% (B10) of the LEDs can be lower and thus consequently 90% are above at specification based conditions.

VarioLED™ Flex Tapes

Constant Voltage vs. Constant Current LED Drive



Characteristics		
LED Drive	Constant Voltage (12, 24, 48 VDC)	Constant Current (mA)
Luminous Flux Stability	Homogeneous brightness levels by constant current regulators on each module	Brightness stability depends on the used PSU and binning U _r
Modul length	Variable, long module lengths possible	Fix, short module lengths in SELV
SELV < 60 VDC	Simply to ensure by CV LED Drive	U _r cumulative, SELV area only within boundaries
Binning U _r LED	Not critical due to CC driver architecture	Very important, since the voltage in the system is variable
Power Supply Unit - PSU	Operation with CV PSUs. Changes in the module length have no influence	Operation with CC PSUs. Change of the module length needs to be adjusted in the driver
Costs	Operation with CV PSUs. Changes in the module length have no influence	Lower costs, CC-drive are cheaper than CV drive through less components on the LED-module
Installation & Cabling	Low wiring requirements due to larger module lengths	Higher wiring effort due to fixed module lengths

Features		
Supply voltage U _{in}	Constant U _{in}	Variable U _{in}
Supply current	Constant I _{in} (CC-Regulator)	Constant I _{in} (PSU)
Lamp lengths	Free scaleable	Limited by U _r
System stability	Stable	Unstable, if U _r Binning is not homogeneous

Benefits		
	Very stable lamp system	Cheaper to produce, more costs efficient
	Easy installation, length scalability	Higher lamp efficiency
	Egalisation of small changings in Binning U _r	

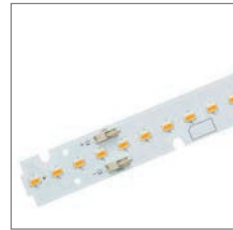
VarioLED™ Flex Tapes

Flexible PCB versus rigid PCB LED light engines

The choice of the printed circuit board technology, whether rigid or flexible, is a fundamental choice in developing an LED lamp with respect to lifetime, light intensity, form factors, flexibility and function in the application.



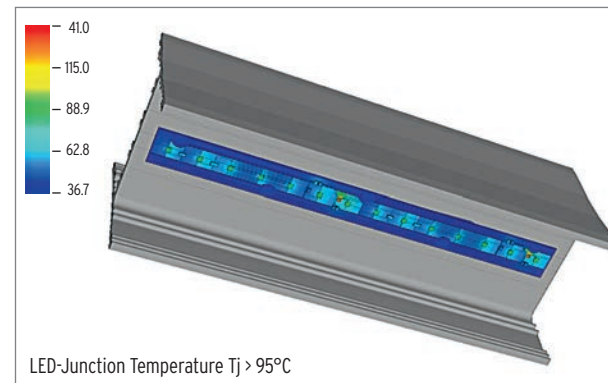
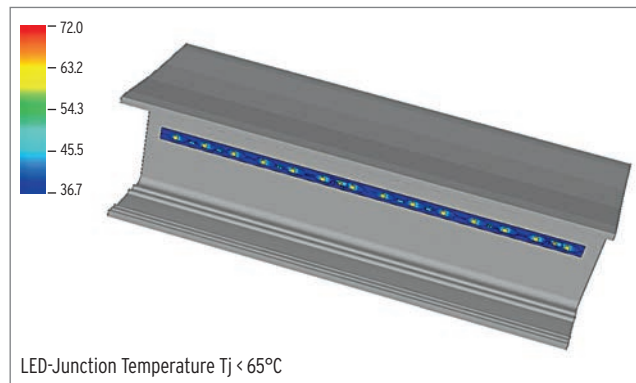
VarioLED™ Flex(ible)



Generic Rigid LED-Module (Zhaga)

Reliability, durability and thermals of the Flexible PCB technology

- Outperforming reliability and less interface connections (solder joints, connectors, contact crimps, etc.)
- Exceptional thermal stability due to direct contact of the flexible printed circuit board with the heat sink. This allows the use of powerful LEDs and ensures high lifetime and reliability of the system.
- Optimum heat dissipation due to the direct connection to the heat sink.
- Lower LED Junction Temperature (T_j) ensures a long lifetime with minimal degradation effects (lumen degradation and color location shift)
- LED modules based on flexible printed circuit board technology achieve thermal advantage of 30% compared to rigid systems, such as FR4 based on Zhaga boards



Cost savings

- Easy wiring of the LED tape in the luminaire
- Miniaturization of luminaires, smaller cross sections possible
- Easy mounting, no screws needed
- Can be cut at predefined points, making it field attachable and suitable for customer assembly
- Requires little space and reduces storage costs

VarioLED™ Flex Tapes

IES TM-30-15 reports for white LED-strips

In May 2015 the Illuminating Engineering Society proposed a new calculation method for the color rendering of LEDs. This new method is described in detail in the technical memorandum IES TM-30-15. This new method assesses the spectral power distribution (SPD) of white light sources near the Planck locus regarding the color fidelity, color discrimination and color preference. The TM-30-15 method utilizes 99 color evaluation samples (CES) - each represented by a spectral reflectance factor function - to quantify the difference in color rendition between the test source and reference source. This allows a much more differentiated assessment of the color rendering of a light source compared to the CRI method utilizing only 8 reference colors. The introduced Fidelity Index R_f and the Gamut Index R_g characterizing the light source will help our customers to specify our luminaires more easily for certain applications or for projects with given design rules.

The measurements of the spectral power distribution are conducted at 25 °C ambient temperature in the photometric laboratory of LED Linear™ using an absolute calibrated spectrometer BTS256-LED in the integrating Ulbricht sphere ISD-100HF-V01 (both Gigahertz Optik, Germany). The tested CRI 95+ and CRI 85+ LED types used for the HYDRA White products are tested with the following photometric codes: W927, W930, W935, W940, W820, W822, W825, W827, W830, W835, W830, W850. This report is based on calculations processed with the IES TM-30-15 Advanced Calculation Tool (version 1.01 as of 2015-10-02), provided by the Illuminating Engineering Society (IES).

Example W930/3,000 K

