

Remote Phosphor Lumen Maintenance

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Introduction

Remote phosphor is a lighting system architecture where a separate phosphor component is powered by blue LEDs. Light fixtures and lamps use this architecture and the increased light extraction it brings to reduce LED component count and costs. Lighting uniformity and consistency are also improved and supply chains are simplified. LED light fixtures and lamps must also be designed to maintain specified luminous output over many tens of thousands of hours. This document presents results of long term lumen maintenance testing of remote phosphor LED lighting modules. By implementing lumen maintenance projection using standard methodology, this datasheet may be used as a guideline in the design of high performance remote phosphor light fixtures (luminaires) and lamps. While this report discusses reliability testing completed to date, new tests and additional results are expected in the future including additional products, temperatures, power levels and certified compliance to standards. Please consult an Intematix sales representative for more information about reliability testing and qualification of remote phosphor.

Note about LM-80: This document presents a summary of results of long-term operating life tests, some of which have been performed in accordance with IESNA LM-80 standard test methodology for LED components and modules. However, this document does not constitute a certified LM-80 report and should not be used for submission of products to qualification organizations. For more information about Intematix's certified remote phosphor LM-80 testing program and reliability qualification support, please contact Intematix sales and applications staff.

Definitions and Diagrams

Remote phosphor component:

An element or component that is mechanically separable from the LED package and contains phosphor materials. The element is used in conjunction with LED packages and arrays to construct LED lamps, LED light engines, and LED luminaires.

Conversion Efficacy (CE):

Ratio of luminous flux emitted to the radiant flux incident on the interior of the remote phosphor. CE is expressed as lumens per radiant watt ($\text{lm}/\text{W}_{\text{rad}}$) at a specified CCT and CRI and incident wavelength.

Maximum Surface Temperature (T_{max}):

Highest temperature measured on the surface of the remote phosphor component.

Irradiance:

Density of radiant flux of blue light incident on the interior of the remote phosphor expressed as watts per square centimeter (W/cm^2). Irradiance may be calculated as the sum of all the radiant watts emitted by the LEDs divided by the area of the interior of the remote phosphor.

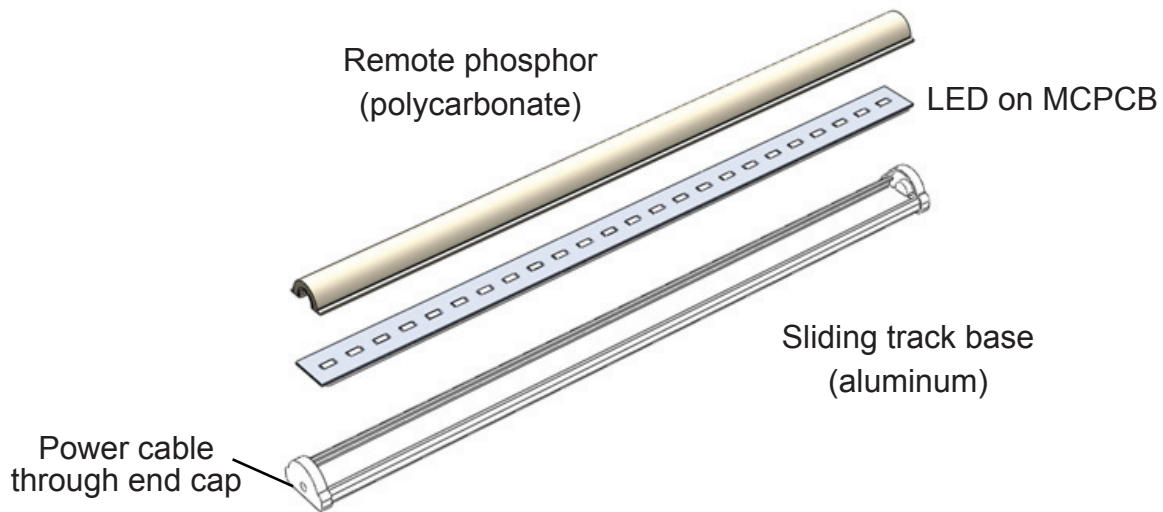
LM-80:

Standardized methodology and procedure for testing the lumen and chromaticity maintenance of LED components, arrays and modules under operating life conditions. It is defined and published by the Illuminating Engineering Society of North America (IESNA).

TM-21:

Standardized computational methodology for projecting lifetime of LED components, arrays and modules using an exponential curve fit to LM-80 lumen maintenance data sets. It is defined and published by the IESNA.

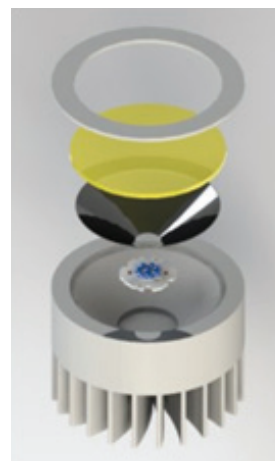
[Figure 1 - Linear remote phosphor module \(ChromaLit™ Linear\)](#)





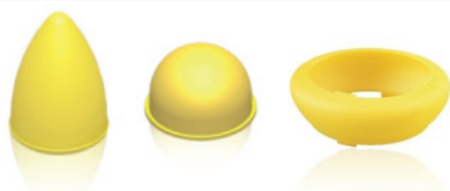


[Figure 2 - Remote phosphor dome \(ChromaLit 360XT\) with COB blue LED](#)



[Figure 3 - Remote phosphor round \(ChromaLit XT or PC\) with blue LED array](#)



Remote Phosphor Product Families

ChromaLit Platform	Product Examples	Performance Highlights	Applications
PC		<ul style="list-style-type: none"> Uniform, glare free lighting Rugged and impact resistant 	<ul style="list-style-type: none"> Down lights Light panels Tasklighting
XT/XTS		<ul style="list-style-type: none"> High lumen output Tempered glass option Off state neutral color 	<ul style="list-style-type: none"> Down lights Outdoor High bay / Industrial
360		<ul style="list-style-type: none"> 3D light emission surface Omni-directional lighting Energy Star pattern capable 	<ul style="list-style-type: none"> Retrofit lamps Decorative lamps Pendants, Sconces
360XT		<ul style="list-style-type: none"> High lumen output Omni-directional 300° beam Enables incandescent look 	<ul style="list-style-type: none"> Retrofit lamps Down lights Reflector lamps
Linear		<ul style="list-style-type: none"> High lumen output Unlimited length possibilities Uniform, glare free lighting 	<ul style="list-style-type: none"> Area lighting Troffers Under cabinet Mid and High bay

For more details about ChromaLit remote phosphor products consult Intematix technical specifications.

Lumen Maintenance Testing

Testing Process: Remote phosphor modules consist of remote phosphor components fastened to blue LED arrays with reflective surfaces. These modules are attached to heat sinks and placed into chambers with controlled air temperature. Thermocouples or infrared sensors are used to set and monitor the remote phosphor surface temperature. The electrical and photometric properties of each module are initially measured in an integrating sphere before testing begins. These measurements are recorded for the conversion efficacy of the remote phosphor in addition to the luminous radiance of the blue LEDs separately. Each 1000 hours subsequently, the modules are removed from the test chambers and measured again in an integrating sphere for each of the system components.

Results: The following charts summarize the lumen maintenance behavior of each remote phosphor system. Using IESNA TM-21 standardized methodology, lifetime for each module configuration is projected where applicable.

Product: Intematix ChromaLit Linear Remote Phosphor

Description: This lumen maintenance test report is applicable to the following order codes

CL-840-LINxx-PC0-xxxxx

CL-850-LINxx-PC0-xxxxx

Time Point Reached: 13,128 hours

Data Set	Part	Case Temp. (T _{MAX})	Amb. Temp. (T _a)	Irradiance / Drive Current (I _f)	Average CE / Radiance Maintenance	Average Chromaticity Shift (Δ u'v')	TM-21 Projected Lifetime*
H0207	Linear Remote Phosphor	65°C	45°C	0.08W/cm ² (900lm/ft)	97.0%	0.0018	L90 28,677 hrs L70 78,768 hrs expected
	Blue LED (Lumen-Max)	64°C	45°C	120mA	95.1%	0.0002	

Product: Intematix ChromaLit 360XT Remote Phosphor

Description: This lumen maintenance test report is applicable to the following order codes

CL-xxx-DOMxx-XT

Time Point Reached: 14,156 hours

Data Set	Part	Case Temp. (T _{MAX})	Amb. Temp. (T _a)	Irradiance / Drive Current (I _f)	Average CE / Radiance Maintenance	Average Chromaticity Shift (Δ u'v')	TM-21 Projected Lifetime*
H0203	360XT Remote Phosphor	155°C	90°C	0.31W/cm ²	95.1%	0.0025	L90 62,355 hrs L70 84,936 hrs expected
	Blue LED (LUXEON)	115°C	90°C	350mA	107.0%	0.0002	

* L70 > 6x Life Test Duration (719,589)

Product: Intematix ChromaLit XT Remote Phosphor

Description: This lumen maintenance test report is applicable to the following order codes

CL-xxx-Rxx-XT

CL-xxx-Sxx-XT

CL-xxx-Lxxx-XT

Time Point Reached: 10,000 hours

Data Set	Part	Case Temp. (T _{MAX})	Amb. Temp. (T _a)	Irradiance / Drive Current (I _f)	Average CE / Radiance Maintenance	Average Chromaticity Shift (Δ u'v')	TM-21 Projected Lifetime*
ji1206810	XT Remote Phosphor	78°C	25°C	0.25W/cm ²	97.9%	0.0008	L90 32,866 hrs L70 60,000 hrs expected
	Blue LED (LUXEON)	90°C	25°C	500mA	99.0%	0.0007	

* L70 > 6x Life Test Duration (97,500)

Product: Intematix ChromaLit Contour (360) Remote Phosphor

Description: This lumen maintenance test report is applicable to the following order codes

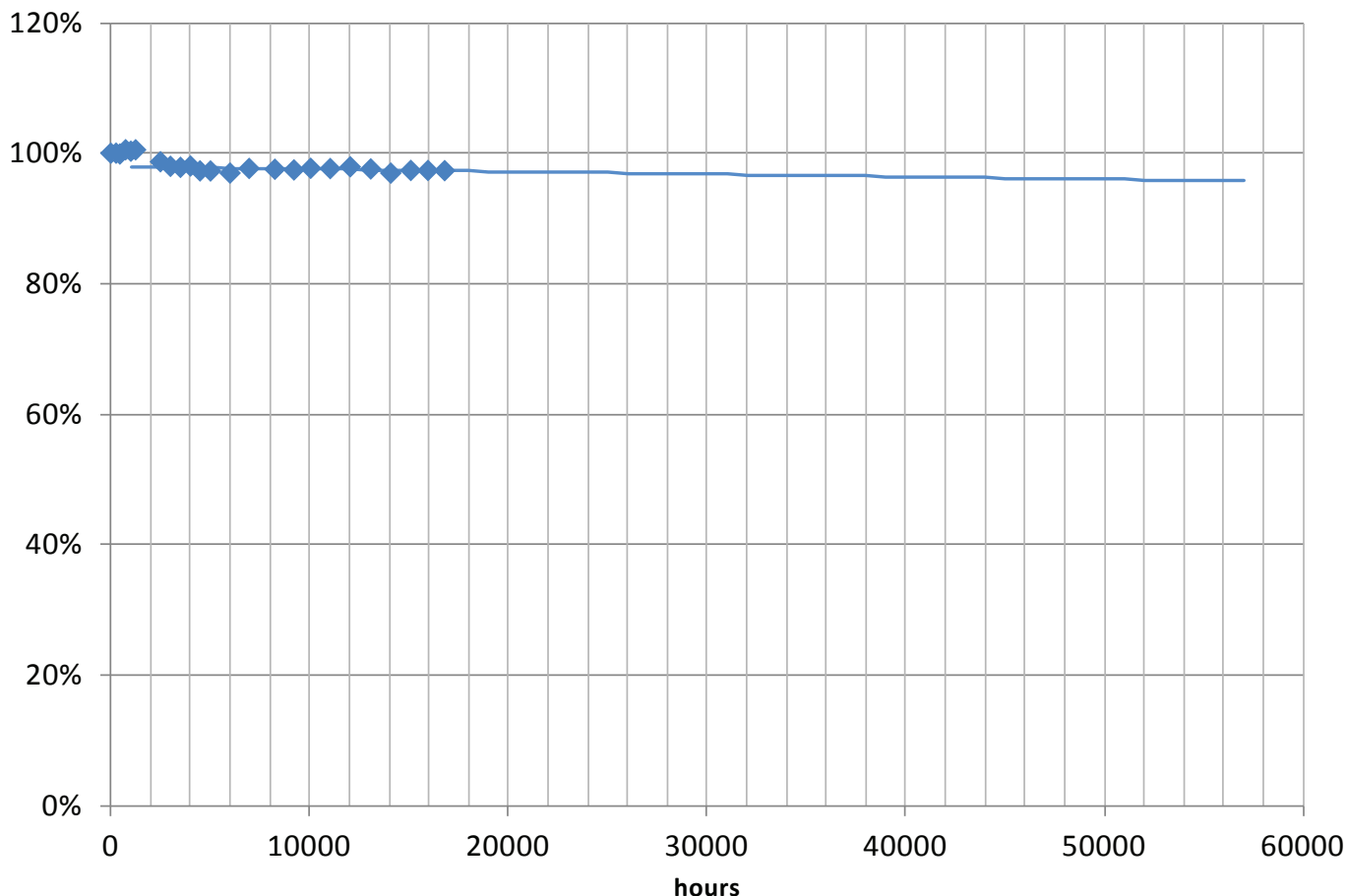
CL-xxx-CTRxx-PC

Time Point Reached: 15,000 hours

Data Set	Part	Case Temp. (T _{MAX})	Amb. Temp. (T _a)	Irradiance / Drive Current (I _r)	Average CE / Radiance Maintenance	Average Chromaticity Shift (Δ u'v')	TM-21 Projected Lifetime*
H0178	PC 360 Contour Remote Phosphor	72°C	25°C	0.25W/cm ²	94.0%	0.0004	L90(9K) = 24,000hrs L70 100,800 hrs expected
	Blue LED (LUXEON)	72°C	25°C	750mA	97.4%	0.0011	

* L70 > 6x Life Test Duration

TM-21 Lifetime Projection



Product: Intematix ChromaLit CAN40 Remote Phosphor

Description: These lumen maintenance test reports are applicable to the following order codes

CL-xxx-CANxx-PC

CL-xxx-ELPxx-PC

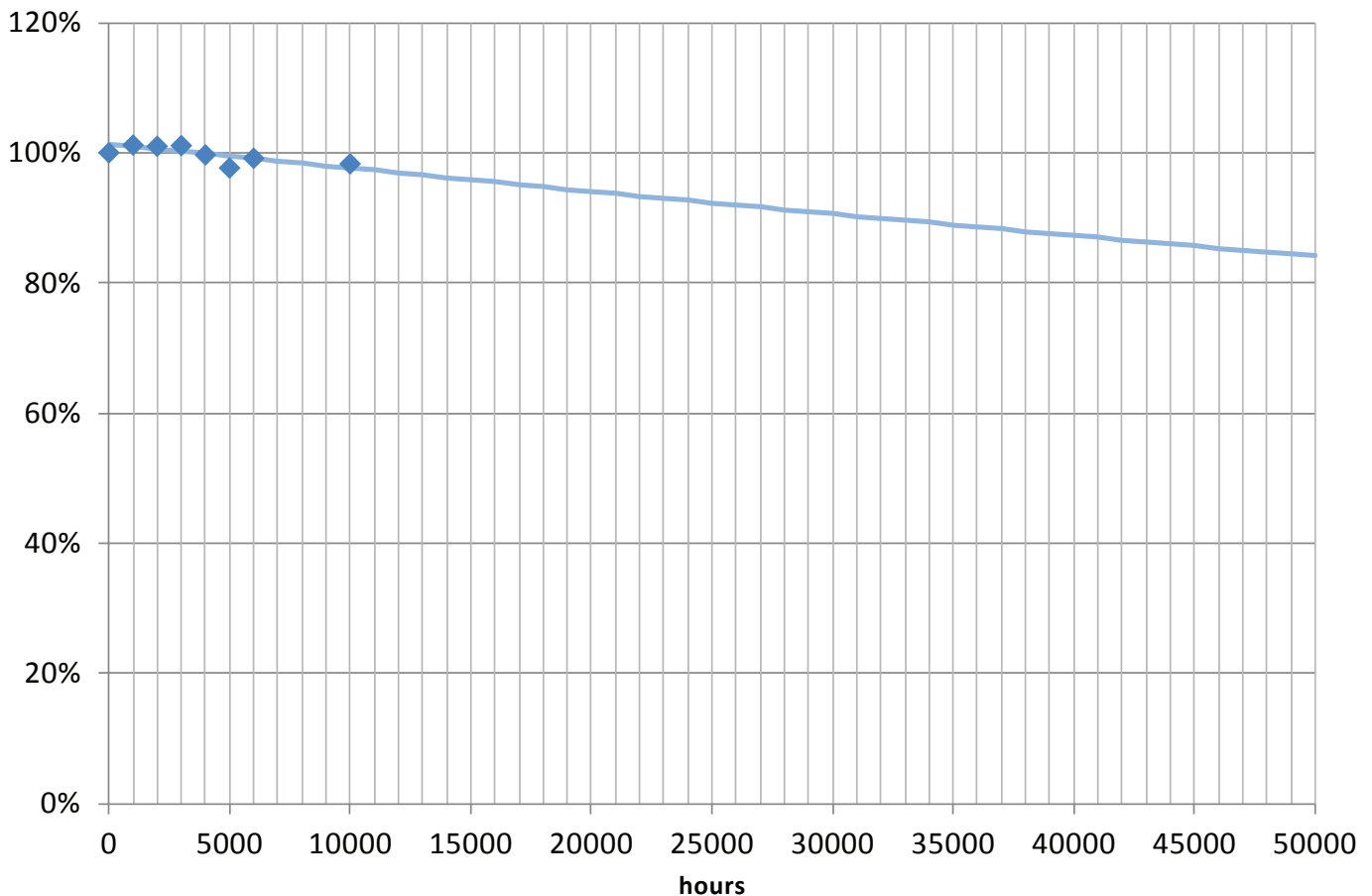
CL-xxx-DOMxxx-PC

Time Point Reached: 10,000 hours

Data Set	Part	Case Temp. (T _{MAX})	Amb. Temp. (T _a)	Irradiance / Drive Current (I _f)	Average CE / Radiance Maintenance	Average Chromaticity Shift (Δ u'v')	TM-21 Projected Lifetime*
ji1206810	PC 360 Remote Phosphor	79°C	25°C	0.24W/cm ²	99.2%	0.0047	L90(10K) = 31,800 hrs L70 = 60,000 hrs
	Blue LED (LUXEON)	54°C	25°C	500mA	98.8%	0.0009	

* L70 > 6x Life Test Duration (98,970)

TM-21 Lifetime Projection



Product: Intematix ChromaLit PC Remote Phosphor

Description: This lumen maintenance test report is applicable to the following order codes

CL-xxx-Rxx-PC

CL-xxx-Sxx-PC

CL-xxx-Lxxx-PC

Time Point Reached: 16,000 hours

Data Set	Part	Case Temp. (T _{MAX})	Amb. Temp. (T _a)	Irradiance / Drive Current (I _p)	Average CE / Radiance Maintenance	Average Chromaticity Shift ($\Delta u'v'$)	TM-21 Projected Lifetime*
H0194	PC Remote Phosphor	80°C	25°C	0.07W/cm ²	97.4%	0.0062	L90 30,000hrs L70 100,000hrs expected
	Blue LED (LUXEON)	46°C	25°C	500mA	98.6%	0.0003	

* TM-21 methodology permits data projections of 6 times data hours maximum. Lifetime performance is an estimate.

Discussion of Results

Remote phosphor LED lighting systems have been tested in various configurations to up to tens of thousands of hours. The resulting trends and projections indicate L70 lifetimes of more than 50,000 hours for remote phosphor when operated within specifications. As general guidelines, 50,000 hour or greater lifetimes may be obtained when operating polycarbonate remote phosphor components at lower than 100°C sustained temperatures. At 80°C or below, L70 lifetime is expected to extend to 100,000 hours or more. For XT platforms using glass or silicone materials, temperatures of up to 150°C may be reached for similarly long lifetimes. Additional tests and qualified certification of remote phosphor systems are ongoing. Please consult your Intematix sales representative for more information.

About Intematix

Intematix develops essential phosphor materials to drive the LED lighting revolution. The company's comprehensive range of products and solutions can be used to build foundations for the world's LED lighting products and systems including general lighting, displays, automotive and many others. A broad selection of products and innovative delivery systems accelerate time-to-market, improve light quality and efficacy and reduce costs. For more information, please visit www.intematix.com.

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