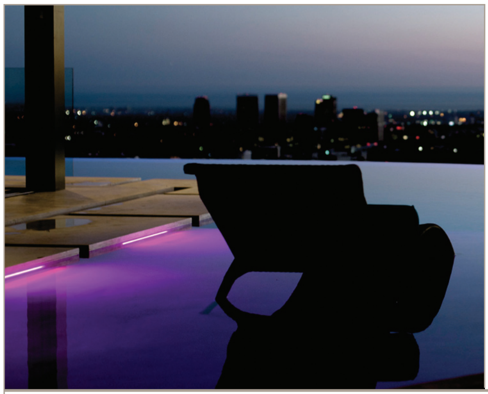
Guide to Reading LED Test Reports



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VANTAGE™

A GUIDE TO READING LED TEST REPORTS

Overview

Vantage tests LED light sources and reports on their interaction with potentially compatible Vantage dimmer models (according to manufacturer's dimming compatibility specifications, if they exist). These tests are conducted strictly to provide information to the lighting designer / specifier as to the dimming characteristics of the light source. Vantage provides no qualifications as to lumens output or any other photometric parameters, color temperature, CRI rating, glare, etc. We restrict our testing to dimming only. The suitability of the light source, so far as these and other factors are concerned, are the responsibility of the lighting designer / specifier.

Any given dimmable LED light source, whether a replacement lamp or luminaire, will either be controlled via line-voltage modified waveform dimming or via low-voltage control signal (such as 0-10VDC or PWM).

Phase-Cut Dimming

All Vantage line-voltage dimmers use phase-cut dimming, wherein during each half-cycle of the incoming voltage, that voltage is switched off for a predetermined duration, with a longer duration of the half-cycle switched off resulting in a deeper dimming level. The effect of phase-cut dimming is reducing the VRMS applied to the light source. With incandescent dimmers, for which phase-cut dimmers were designed, the waveform itself is not important, just the VRMS. This is not necessarily true of LED light sources, and the affect cannot be predicted, which is why these tests are so important. Standard (forward-phase, leading edge) – The voltage is initially switched off, and then is switched on at a predetermined time to achieve the desired dimming level. Standard dimmers use either SCR or triacs to switch the voltage. Typically standard dimmers can handle more load wattage than electronic dimmers and are lower in cost. Standard dimmers are typically specified when the light source is magnetic low-voltage or inductive in nature.

Electronic (reverse-phase, trailing edge) - The voltage is initially switched on, then off at some point for the rest of the half-cycle. Electronic dimmers use IGBTs or MOSFETs to switch voltage. Electronic dimmers are typically specified when the light source is electronic low-voltage (but not always, depending on the electronic transformer – please see manufacturer's dimming recommendation specifications) or capacitive in nature.

Typically if an LED light source is compatible with standard dimming, it will be compatible with electronic as well (unless a magnetic transformer is used). The converse is not true. However, the results of dimming with an electronic dimmer can vary from those of dimming with a standard dimmer, and often are less favorable. A careful consideration of the test sheet for a particular light source should assist with the choice of standard or electronic dimmer.

Vantage Line-Voltage Dimmers

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	SDM12-EM*	EDDIMMOD	ScenePoint	AccentPoint II	SLDS4-DIN	ELDS4-DIN	DRD4
System	InFusion	InFusion	InFusion	InFusion	InFusion	InFusion	Enspire
Format	Plug-and-Play Enclosure Module	PNP Enclosure Module	Wall-box	Receptacle	DIN	DIN	Wall-box
Dimming Method	Standard	Electronic	Standard	Standard	Standard	Electronic	Standard
High- and Low-End Trim	Yes	Yes	Yes	Yes	Yes	Yes	No*****
Curve Adjust Capable	Yes	Yes	Yes	Yes	Yes	Yes	No
Voltage	120V - 277V	120V	120V/240V	120V	120/240V	120/240V	120V
Min. Load****	5W @ 120V	N/A	15W	15W	25W	N/A	25W
Max. Load	16A	6A	5A (de-rates in multiple-gang)	2.5A	2A	2A	5A

*Samples tested prior to the 2012 release of the SDM12-EM were tested with its predecessor, the MDS8RW101, which has identical parametric performance as the SDM12-EM.

**All standard ScenePoint dimmers, whether RadioLink or WireLink, use the same dimmer technology, so this test applies to all models. The one notable exception is the non-neutral RadioLink dimmer, which in general is not recommended for LED dimming. ScenePoint dimmers are not tested unless specifically requested by a customer.

***The AccentPoint relay is only tested against LED light sources that are intended for plug-in applications, such as an A19 lamp replacement, when requested by a customer.

**** Minimum Load is related to the minimum conducting current necessary to operate an SCR or triac. It is given as an RMS value, without regard to the current waveform, which depends on the characteristics of the specific light source. Typically the specified value applies to an incandescent load, whose characteristics are well-known. LEDs may react differently, and a lower minimum load than what is specified may be observed. Test results will reflect our observations.

***** DRD4 has a standard mode and a fluorescent mode. In fluorescent mode, a fixed low-end trim value of approximately 20% is applied. No high-end trim is available. A test report may represent the lowest reliable dimming set value for the DRD4 because of the lack of flexible trim.

Dimming Performance Considerations

Flicker - In some instances there will be unacceptable flicker that is observable when the minimum load requirement of the dimmer has not been met, such that the switching devices (triac or SCR) does not consistently conduct. In all tests performed at Vantage this source of flicker is eliminated by specifying the minimum number of fixtures per load.

Additionally, most LED fixtures cannot be dimmed throughout the entire dimming range, particularly at the low end. If flickering occurs at the low range, a Minimum ON adjustment is made (where possible) to re-define the dimming range so as to exclude the problematic low end of the range.

If any flickering of the light is observable by the tester, with the minimum load requirement met, and with a proper Minimum ON, the test report will attempt to characterize the flicker and the conditions in which it is observed. It must be understood that all lights have some flicker and that it may or may not be noticeable to a given individual. No flicker measurements are taken or reported on in the tests, only observations.

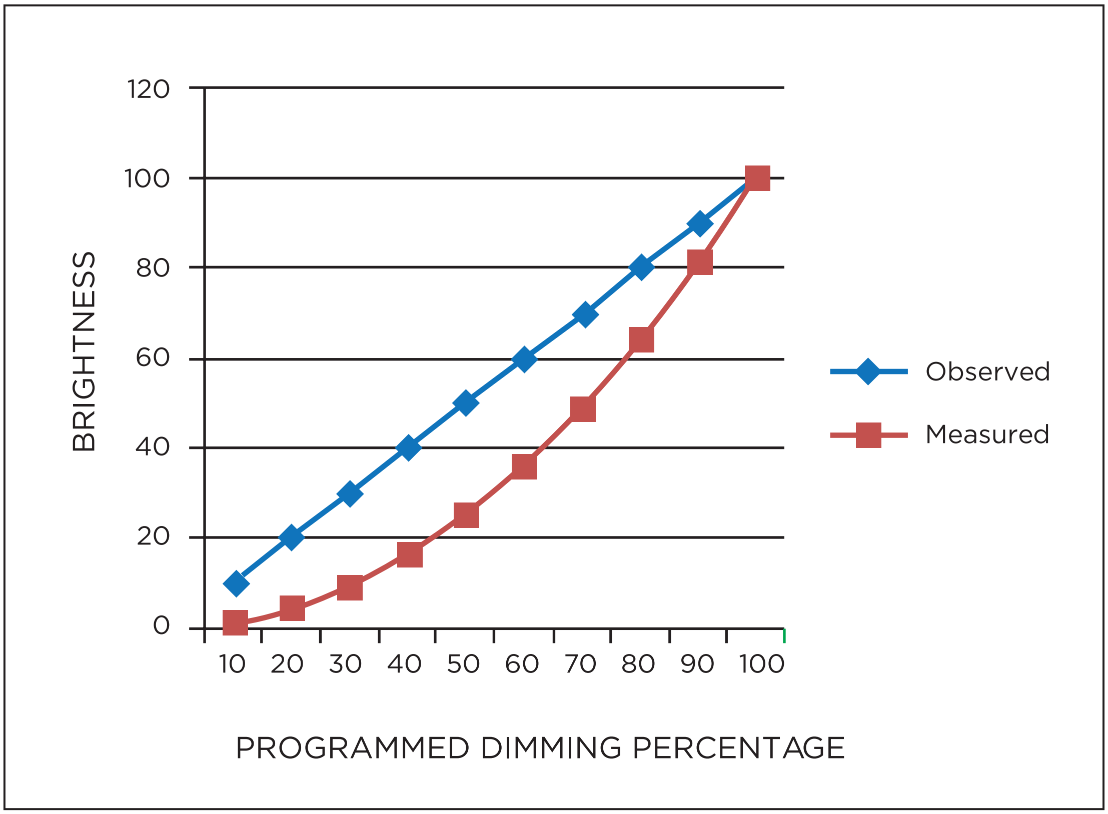
Smoothness - Smoothness is somewhat subjective, as it is a rating of the fixture's reaction to a long (20second) fade from full on to full off. Any notable jumps, flickering or flashing will reduce the smoothness rating. Any anomaly other than jumps will be characterized in the test report, whereas jumps are simply reflected in the smoothness rating.

Dimming Linearity - An important consideration of dimming performance is linearity. Perfect linearity could be defined as equal (observed) dimming steps throughout the range. If the jump from 10% to 20% is observed as a larger dimming step than the jump from 90% to 100%, this would be one example of non-linearity. Each 10% interval in the range should produce an equal dimming step (one-tenth of the brightness at full on). The percentage dim level is designed to correspond to the observed dimming level percentage. Measurements are taken at 10% intervals.

Observed brightness and measured light energy do not correspond in a directly linear fashion. The ideal curve of measured light energy to achieve perfect linearity would be such that the measurement at each percentage is proportional to the fraction squared, as such:

Observed	100	90	80	70	60	50	40	30	20	10
Measured	100	81	64	49	36	25	16	9	4	1

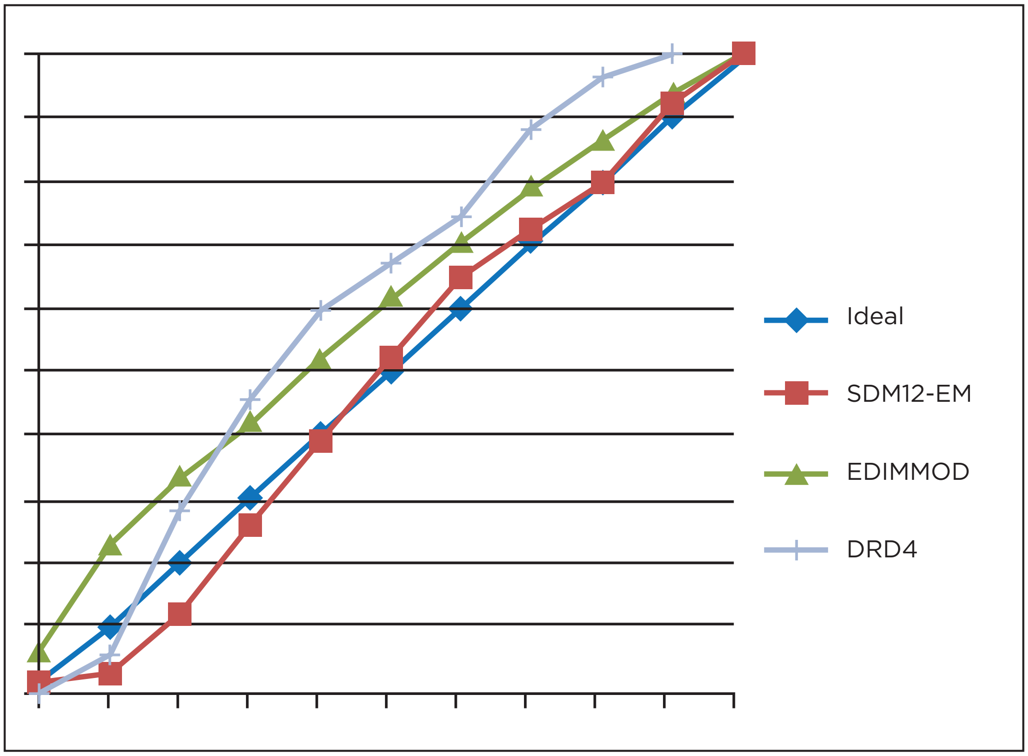
The following diagram shows the relationship between observed and measured brightness. The red line represents the ideal linear curve of actual light meter readings normalized to 100% of the maximum (undimmed) light output reading. The blue line represents the corresponding human response to the ideal linear measurement curve. The test report graphs are based on the human response, not the measured light output, so a straight line represents the ideal dimming curve.



All Vantage InFusion-compatible line-voltage dimmers feature an ‘Adjust’ parameter designed to allow best fit to the ideal dimming curve. In the LED testing performed at Vantage, experimentation with the Adjust is performed to bring the curve as close as possible to the ideal.

A characteristic of a large percentage of LED light sources is a fairly flat upper end of the dimming curve. For these light sources it becomes very difficult to match the ideal dimming curve unless a new point less than full on is re-defined as the new 100%. This is known as applying a “high-end trim” to the dimmer output. In eliminating this “flat” upper end, the obvious effect may be to reduce the full light output. A restriction artificially placed on this high-end adjustment is that the new high end must be at least 95% (observed) of the full (undimmed) light output the source is capable of. (Studies have shown that less than 5% of the population can detect a 5% dimming change, even when they know to look for it and are shown both levels.)

To illustrate the benefit of this high-end trim, please examine the following graph of a real LED sample. The light blue line, representing the DRD4 dimmer (which has no high-end trim), is seen to have a flat high end. The light does not appear to dim as we start applying slight dimming. In fact, by the time we dim to 70%, the light output still appears to be almost 90% of the undimmed value. When compared to the other dimmers, all of which have high-end trim capabilities, the improvement in linearity is obvious.



The Power Profile - Through InFusion Design Center software, custom power profiles can be defined and assigned to individual lighting loads. By applying a power profile that matches the best-fit power profile as determined through testing, we eliminate low-end anomalies and maximize dimming linearity. The adjustable parameters of the power profile are:

Minimum On - This is a hard-stop on the low end of the dimming range. Valid range: 0 to (Maximum On less one).

Maximum On – This is a hard-stop on the high end of the dimming range. Valid range: (Minimum On plus one) to 100.

Adjust – This is the parameter discussed in the previous section that allows for matching the dimming characteristics of a particular light source to the ideal dimming curve.

The programmed dimming level will adjust to the Minimum On and Maximum On values set in the Power Profile, so that 0.4% dimming is defined by the Minimum On value and the 100.0% dimming level is defined by the Maximum On value.

Light Output Range - Once the best-fit power profile is defined and applied, the minimum light level, as a percentage of the maximum light level measured (with no dimming applied), is measured, typically at 1.0% programmed dimming level, and recorded on the test record. The maximum light level, at 100.0% programmed dimming level, is also measured and recorded. The measurements taken are translated to the square-law curve that characterizes observed light levels. The maximum will be 95% or higher (if not, the Maximum On will be adjusted so that this standard is achieved). The lower the minimum, the better, for full dimming range. Ideal is 1%, but this is very rarely achieved with LEDs.

Sample Size Issues - Typically the sample size tested is small – one or two for each model. In general if there are multiple samples they are supplied from the same batch and their characteristics are observed as identical – or close to it. Extrapolating the results of our tests assumes any given sample of a specific product model will test identically. Product revisions or variations in manufacturing challenge that assumption.

In a few cases we have tested larger groups of LED light sources together on a single dimmer output to see how they interact and have found that a model that tests fine with one or two together may exhibit flashing or flickering under specific conditions in larger groups. For example, with one manufacturer who claimed their product was compatible with both standard and electronic dimmers, if we tested a single fixture it worked fine with both. But in combination of 4 or 5, standard dimming no longer worked reliably, but they worked fine with an electronic dimmer. This led to further research, resulting in our listing that product as only compatible with electronic dimmers, despite the manufacturer's specification. Laboratory testing with limited sample size cannot discover all such issues.

Product Range - If multiple models from a manufacturer have the same light engine, but may have different color temperature, form factor, etc., they will be combined into one test report. The model tested will be indicated, and the range of products to which the test results apply are called out in the Product Range information. Typically not much rigor is applied to this data beyond what is supplied by the provider of the test sample.

Low Voltage Dimming Control

Currently there are two Vantage products capable of 0-10VDC dimming control:

	LVOS-0-10-PWM*	EL-LEDKIT
System	InFusion	Enspire
Format	Station designed for mounting in J-Box	Wall-box switch
Control Voltage Range	0-14VDC Source 1.5-14VDC Sink	0.5-9.5VDC
High and Low-End Trim	Yes	No
Maximum Current	10mA Source or Sink	50mA Sink

*Tests performed against the predecessor to the LVOS-0-10-PWM, the Q-LVOS, were conducted without an adjust factor, as that device was not capable of it.

Dimming Performance Considerations

Flicker - Many low-voltage control LED light sources cannot be dimmed throughout the entire dimming range, particularly at the low end. If flickering occurs at the low range, a Minimum ON adjustment is made (where possible) to re-define the dimming range so as to exclude the problematic low end of the range.

Smoothness - Smoothness is somewhat subjective, as it is a rating of the fixture's reaction to a long (20second) fade from full on to full off. Any notable jumps, flickering or flashing will reduce the smoothness rating. Any anomaly other than jumps will be characterized in the test report, whereas jumps are simply reflected in the smoothness rating.

Best-Fit Power Profile - The only adjustment typically made for the sake of improved linearity is if the upper end of the curve is observed to be flat, the Maximum On value can be reduced to correct the curve. Otherwise the control is linear across the voltage range defined between Minimum On and Maximum On, with no Adjust feature as is possible with line-voltage dimmers.

Making Value Judgments From the Test Reports

Currently there are no standards for judging dimmability. A particular LED light sample may have very poor dimmability, but because there is no flicker or unacceptable behavior other than a high minimum threshold and high level of non-linearity, because there is no standard, no failure is reported for such a sample. The sample is reported to fail only if there are adverse affects or no dimming whatsoever. The cause of failure will be spelled out in the observations portion at the bottom of each test report.

While the purpose of the test reports offered by Vantage is not necessarily to provide comparative evaluations between multiple products, questions often arise concerning this end. When judging the comparative dimming performance of two or more products, in addition to considering the test report observations it is appropriate to ask two fundamental questions:

1) How important is linearity in the application? By viewing the curves of the compared products, one can obtain a sense of linearity throughout the range.

2) How important is the low-end light output threshold in the application? In addition to the curve, two figures are shown per dimmer relative to the minimum light output threshold (as a percentage of the non-dimmed value). These are the measured value (corresponding to manufacturer's specification) and the perceived value (relating to the square-law human perception of light level). A 9% measured minimum light level corresponds to an observed 30%. These values are provided in order to compare to specifications while still providing a realistic expectation of minimum observed light output.

Applying the Results of the Test Report

Once an LED light product is selected for an application, the next question is which dimmer is most appropriate. It is likely that either forward-phase or reverse-phase response is superior to the other, as the test report will demonstrate. If cost is an issue and the LED product is compatible with forward-phase dimming, consider the DRD4. If cost is not an issue, typically the native Vantage InFusion dimmers will be a better choice.

Once a dimmer is selected, create a power profile within InFusion Design Center for the LED light product, modifying Minimum On, Maximum On, and Adjust as per the test report, and apply this power profile to each dimmer output comprised of that product. Do not mix multiple products on a single dimmer output. If it is desired that a mixture of light products act as a single zone, create a load group, group the individual loads together in that zone, and apply all related tasks to the group as opposed to the individual lighting loads. This application in particular drives a demand for a high level of linearity in the products.

If a ScenePoint or DIN Dimmer is used instead of the dimmer modules shown in the test, some tweaking of the minimum level may be required in order to achieve reliable results at the low end. Start with the values shown in the test report and then adjust as necessary. Even when using a dimmer module, depending on the particular sample of the product, some minor tweaks might also be required.
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