Development and evaluation of a novel test method for digital signage displays

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Keywords

testing, Energy Labelling Directive, standardisation, television, energy efficient products, public information display, digital signage display

Abstract

Digital Signage Displays (DSDs) are a rapidly expanding energy-using product across Europe and around the world, being found in increasing numbers in public spaces like train stations and shopping malls. Global market experts project that the public display monitors used in digital signage and professional applications will grow in installation volume by nearly 20 % between 2017 and 2021, with a steady trend towards higher resolution, increasingly larger screen sizes and modular installation flexibility allowing display "walls" of any shape and size.

As DSDs have not previously been subject to energy efficiency regulations, the European Commission's draft electronic displays regulation voted by Member States in December 2018 proposes to establish an A to G energy label for these displays, helping procurement experts, retailers and specifiers to differentiate between products on the market. However, in the absence of a test method designed specifically for DSDs, the assessment may not be reliable or indicative of performance. Therefore, a novel test method for measuring and comparing the energy performance of DSDs was developed, taking into account dynamic video and static test patterns along with resolution, brightness, frame rate, cut frequency and the practicable testing of Automatic Brightness Control (ABC). The design and characteristics of the new test method are presented in this paper.

The resultant test methodology is representative of how DSDs operate in the field, offering a fair assessment and methodology for accurate and repeatable measurement and product differentiation on the basis of energy use. The new test method is applied to a limited sample of commercially available DSDs sold in Europe in 2016 to 2017, and the anonymised product test results are presented in this paper. Furthermore, the ability of the new test method to characterise ABC to a fine resolution is used to present test data in Appendix A of the report which contrasts the potential energy saving of good and poor examples of DSD ABC shown in Figures 3 and 4 in this paper.

Introduction

Over the last decade, DSDs have become increasingly common, being found in train and bus stations, shopping centres, supermarkets, and in large outdoor displays. These displays are different from televisions in that they are typically very bright, should have different ambient light sensors and algorithm profiles for ABC and operate 24 hours per day, 7 days per week. DSDs are, therefore, potentially high users of energy and represent new consumption, typically replacing posters and billboards.

DSDs were identified by the European Commission and several Member States as an important product group to regulate. In December 2018, the Member State representatives in the Regulatory Committee voted to adopt mandatory provisions for electronic displays, including televisions, computer monitors and DSDs. Included in the requirements for DSDs is the establishment of an energy label with a ranking from A to G that will be required to be displayed at the point of sale for every DSD from 2021 onwards.

By covering DSDs under the energy labelling provision, manufacturers will need to register these products in the new energy registry database and will have to report on the power consumption and label class of the DSDs they are placing on the market in Europe. These data will be vital in the next review and update of the electronic displays regulation as it provides the Commission with the analytical basis to consider establishing mandatory energy performance requirements under the Ecodesign Directive.

In order to measure energy consumption for DSDs and calculate their energy label class, a test method is required that is representative of how DSDs operate and are used in the field. However, to date there has not been a test method developed specifically for DSDs that takes into consideration both dynamic and static content, and which measures screen brightness and automatic brightness control (ABC). ABC is critical for DSDs because of the potential to save energy in any given installation and due to the extreme conditions (particularly outdoors) where some DSDs operate.

Consider the following two real-life installations of DSDs; one in a shopping mall with mixed artificial light and daylight and one in a store with mixed artificial light and restricted daylight. Table 1 presents the calculated energy savings potential at these two installations using the ABC profiles that were measured for this paper (Figures 3 and 4).

In the draft regulation for Electronic Displays (European Commission, 2018a), Article 2 Definitions sets out the definition of Digital Signage Displays as follows:

> 'Digital signage display' means an electronic display that is designed primarily to be viewed by multiple people in non-desktop based and non-domestic environments. Its specifications shall include all of the following features:
>
> a. unique identifier to enable addressing a specific display screen;
>
> b. a function disabling unauthorised access to the display settings and displayed image;
>
> c. network connection (encompassing a hard-wired or wireless interface) for controlling, monitoring or receiving the information to display from remote unicast or multicast but not broadcast sources;
>
> d. designed to be installed hanging, mounted or fixed to a physical structure for viewing by multiple people, and not placed on the market with a ground stand; and
>
> e. does not integrate a tuner to display broadcast signals.

The draft regulation also sets out in Article 1 Subject matter and scope those characteristics of DSDs which are outside of the scope of coverage. The regulation shall not apply to the following:

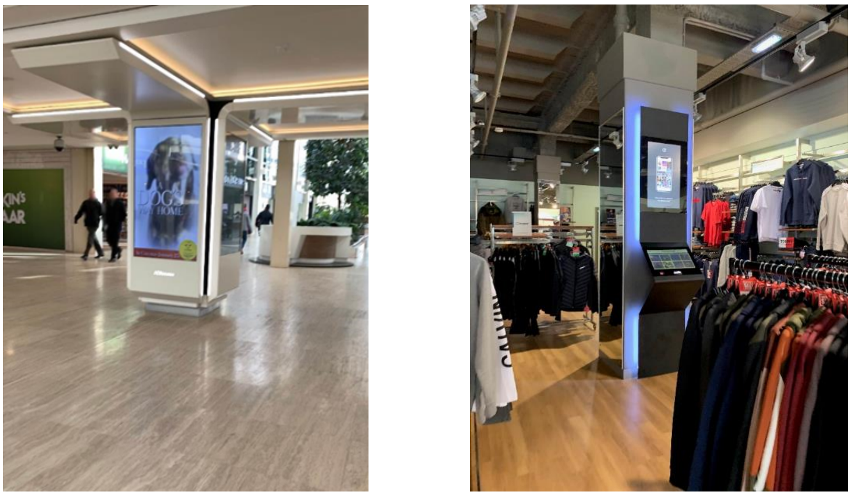

Figure 1. Photos of two real-life DSD installations: on the left, a shopping mall with mixed artificial light and daylight and on the right, an in-store DSD with mixed artificial light and restricted daylight.

Table 1. Comparison of energy savings potential from DSD ABC in two real-life situations.

Parameters	Shopping mall with mixed artificial light and daylight	In-store display with mixed artificial light and restricted daylight
Ambient light level measured at the installation	178–8,741 lux (average 1,897 lux)	114–3,704 lux
Good DSD ABC (based on Figure 3 in this paper)	26 % energy savings	28 % energy savings
Poor DSD ABC (based on Figure 4 in this paper)	0 % energy savings	0 % energy savings

Table 2. Equipment List for the Test Procedure.

Description	Capabilities	Additional capabilities
Power measuring instrument	Defined in EN 62087-1:2016	Data logging ability
Luminance measuring device (LMD)	Defined in EN 62087-1:2016	Contact probe type, data logging ability
Illuminance measuring instrument	Defined in EN 62087-1:2016	Data logging ability
Signal generation equipment	Defined in EN 62087-1:2016	
Presentation Projector – Light source for specific illuminance levels	At least 20,000 lux at minimum focusing distance	
Laptop computer for data logging	At least 3 appropriate ports of the type required for connecting the power, luminance and illumination measuring devices	
If the projector does not have a slide-show function, a Laptop for slide projection	Slide-show software	Slideshow with configurable duration preferable
Shrouding	Shroud between projector and ABC sensor if darkroom conditions are not available	

(l) digital signage displays which meet any of the following characteristics:

1. designed and constructed as a display module to be integrated as a partial image area of a larger display screen area and not intended for use as a stand-alone display device;
2. distributed self-contained in an enclosure for permanent outdoor use;
3. distributed self-contained in an enclosure with a visible display screen area less than 30 dm^2 or greater than 130 dm^2;
4. the display has a pixel density less than 230 pixels/cm^2 or more than 3,025 pixels/cm^2;
5. a peak white luminance in standard dynamic range (SDR) operating mode of greater than or equal to 1,000 cd/m^2;
6. no video signal input interface and display drive allowing the correct display of a standardised dynamic video test sequence for power measurement purposes.

This paper presents a new test method that was developed to support the policy-making process, by describing the test setup, process and methodology for conducting representative tests of DSDs for the purposes of establishing the energy label classes. This paper also presents the measurement of test results from a small sample of models that were tested.

Test method overview

This test method is designed to be aligned with EN 62087:2016, “Audio, video, and related equipment. Determination of power consumption”, which is the harmonised standard to be used for the other electronic displays covered by the new draft regulations. Some adjustments were, however, incorporated in order to allow for the practicable testing of ABC and other testing issues specific to DSDs.

The sequencing of tasks by the technician measuring a DSD is outlined below:

1. Setup DSD sample under test on a stand.
2. Run through initial setup and record default settings.
3. Continue warm-up of sample while setting up test equipment.
4. If ABC is available, determine the illumination range and the ABC latency required for the sample (see Automatic Brightness Control Test Method Overview).
5. Measure on-mode power.
6. Measure peak luminance.
7. If ABC is available, profile ABC response and measure on-mode power reduction between pre-designated ambient light conditions.

General guidance on DSD testing

STABILITY FOR MEASUREMENT

When a DSD sample displays a peak white pattern, the display may quickly dim within the first few seconds and gradually dim until stable. This makes it impossible to measure, in a consistent and repeatable way, power and luminance values, immediately after the image is displayed. In order to have repeatable measurements, some level of stability must be achieved. Current television testing methodology indicates that 30 seconds should be sufficient time to allow enough stability. This also allows time for any on-screen status display to disappear.

Some DSD models may have the ability to operate at even higher screen luminance levels in very bright ambient light conditions than when compared to measurements with the ABC disabled. Power consumption and screen luminance should be measured in default settings with ABC disabled. The ABC should then be enabled and the ABC sensor should be illuminated at 20,000 lux or greater to check the ability to operate at even higher screen luminance levels.

It is expected that any ABC system incorporated into a DSD should operate over a broader lighting range than for standard televisions. For making measurements under full brightness conditions, it will be necessary to illuminate the light sensor in the unit to a level similar to outdoor conditions. In order to do that, a very bright light source is required, but one that can also be adjusted so the illuminance can be decreased in a controlled way in order to test the operating range of the ABC in the wide range of ambient light conditions experienced in public spaces.

A bright lamp could be used as the source, but the positioning of the bulb is, in practice, found to be very critical and non-uniform so that an LMD close to the ABC sensor could be measuring a significantly different level than the actual sensor location. This may also cause interference with the screen luminance sensor and potentially adversely affect the repeatability of the test. It is recommended therefore that a focused video projector should be used in this case to provide a very bright collimated beam of uniform light. This luminance could then be gradually decreased while maintaining colour temperature, by displaying slides of increasing grey levels.

While video projectors can provide high brightness, the majority use incandescent light bulbs. This is not an issue in fixed installations however the filament in an incandescent bulb is very fragile when hot, so any movement of the projector may result in damage to the bulb if insufficient cooling time is allowed. It is recommended therefore that the test setup is based around a projector with an LED/Laser light source. Historically, LED projectors have not been bright enough for this task, but modern LED/Laser projectors perform much better.

Finally, in terms of the video test pattern shown on the screen, the current EN 62087 Dynamic Broadcast test pattern contains short clips with sharp scene changes. This has been known to cause a reduction in power consumption which is not typical in normal viewing. It is suggested therefore that the test pattern used should be based on the CLASP 10-minute test pattern which has longer clips and all current resolution formats up to UHD 4K (CLASP, 2016).

PEAK LUMINANCE METHOD OVERVIEW

DSDs often have built-in electronics and algorithms to protect, the display power supply from being over-driven and screen from suffering persistence (burn-in) by limiting total power to the screen. This can result in a limited luminance and limited power consumption when displaying, for example a large area of white test pattern.

In this DSD methodology, the measurement of peak luminance is made while displaying a 100 % white test pattern, but the area of white must be restricted so as not to trigger protection mechanisms as described previously. The appropriate test pattern can be determined by displaying the range of nine VESA "L" test patterns from smallest (L10) to largest (L90), while recording power and screen luminance. A graph of power and screen luminance vs L pattern should assist in determining if and when display drive limiting is occurring. For example, if power consumption is increasing from L10 to L60, while luminance is either increasing or constant (not decreasing) then those patterns are not appearing to cause limiting. If test pattern L70 indicates no increase in power consumption or luminance (where there was an increase in previous L patterns), this would indicate that limiting is occurring at L70 or between L60 and L70. It may also be that limiting has occurred between L50 and L60 and the graphed points at L60 were in fact sloping downward. Therefore, the largest patterns where we are sure no limiting occurs is L50 and this is the correct pattern to use for the peak luminance measurement. If power limiting is not occurring, then the recommended pattern is the white box with black border or VESA L80 as per ENERGY STAR Displays version 8.2.

Some DSDs will decrease luminance of the white area after it first appears. This decease may be rapid at first, then gradually decreases. This makes it difficult to repeat a measurement taken within the first few seconds (as in ENERGY STAR Displays version 8.2). A more repeatable measurement can be made 30 seconds after the image is first displayed. Also, if there is a rapid decrease in initial luminance, to aid repeatability the sample may be switched to another input for a minute and then switched back prior to displaying the image.

A peak white test pattern is displayed on the sample as the brightness of the projector light source is altered via a slide show of peak white to black slides. The power consumption, screen luminance and illuminance at the ABC sensor are measured and logged. This data must correlate with time. If possible, this data should be logged on one computer, so that the time code given to each stream of data is synchronised.

AUTOMATIC BRIGHTNESS CONTROL TEST METHOD OVERVIEW

The light source described in EN 62087-3:2016 is not sufficiently bright, and impractical to control to a high granularity of brightness from the equivalent of sunlight to a dark room. Therefore clauses 5.6.4 and 5.6.5 are replaced with a presentation projector having a capability of producing a minimum of 20,000 lux at the minimum focal distance. During the test, a prepared set of slides is projected onto the light sensor and illumination meter. The slides start at peak white and get progressively darker until black is achieved. Overall, the slides should produce illumination on the light sensor of the DSD under test of between 12 lux and the maximum brightness at the minimum focal distance of the projector (i.e., at least 20,000 lux). In this test, 39 slides are used from peak white (RGB value 255, 255, 255) to black (RGB 0, 0, 0). These 39 slides vary from white to black as follows: 255, 250, 240, 230, 220, 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 115, 110, 105, 100, 095, 090, 085, 080, 075, 070, 065, 060, 055, 050, 045, 040, 035, 030, 025, 020, 015, 010, 005, 000.

Then each slide gets progressively lighter until peak white is achieved. Another 38 slides make the transition from 005 black to 255 white in the same incremental changes as given above. The presentations of these different sets of slides are named appropriately so they can be sorted and played in a slideshow from white to black and from black to white.

The positioning of the illuminance measuring instrument as per EN 62087-3:2016, clauses 6.3.8 only allows for a measurement during setup as the instrument obscures the ABC sensor, eliminating the possibility of continuous monitoring. The suggested projector light source produces a more uniform light beam, allowing positioning close to (but not over) the ABC sensor. Due to the high level of illumination utilised in this test method it is noted that careful positioning of the sensor to negate the effects of the instrument's depth can produce more accurate metering.

Unlike Televisions, DSD's can have more than one ambient light sensor. For testing purposes, the technician shall determine a single sensor to be utilised in the test, eliminating the other light sensors by obscuring them with black tape or another means. Unwanted sensors may also be disabled if control is provided to do so. In most instances the most suitable sensor to use would be a front-facing one. Measurement methods for DSD's with multiple light sensors may be explored further as a test method refinement at a later time.

For ABC profiling, a peak white test pattern is displayed on the sample as the brightness of the light source is altered via the grey slides to simulate ambient illumination. A subset of the slides may be used to verify correct function prior to conducting a full run. Additionally, a second set of slides running from black to white and back to black may be required for some samples if they do not respond well to decreasing ambient lighting, but this should be recorded as it is unusual behaviour. The power consumption, screen luminance and illuminance at the ABC sensor are measured and logged. This data must correlate with time. Data points for three parameters must be logged in order to relate power consumption, to screen luminance and incidental illuminance of the sensor.

The capturing of data from the three different measurement instruments must be synchronised in order match up relevant data points. To provide the synchronous timecode for the three parameters, record all the data on one computer.

Test setup

Due to the fact that DSD screen sizes can be much larger than typical consumer televisions and they are not supplied with a stand, a steady mounting structure is required for testing. It is suggested that a sturdy flat display mounting be used, such as a Video Electronics Standards Association (VESA) mounting bracket.

For units that incorporate ABC, it is necessary to test this feature. Practical restrictions may be such that the DSDs under test are in-situ outdoors or in bright ambient light conditions. A means of measuring the illuminance of controlled illumination of the ABC sensor area without interference from ambient light is required. A large triple-pass blackout cloth may be stretched over a wire frame in order to surround the sample and the light source. The light source that is used is a digital projector which will be directed onto the light sensor of the unit under test. This approach would block out all external light, however, depending on the size of the test cage under the triple-pass blackout cloth, this configuration may lead to excessive heating of the sample and test equipment.

As an alternative approach, it may be possible to use wide flexible ducting, shielded by triple-pass blackout cloth that can be extended to approximately half a meter, concertina style, shielding the light sensor and illuminance meter at one end, such that they are still in direct line-of-sight of the projector. This approach eliminates enough of the external light to be insignificant down to measurement levels of illuminance at the ABC sensor of less than 12 lux.

Next, a screen luminance measuring instrument is required. This instrument must be of a type that can measure luminance of a screen without it being influenced by bright ambient conditions, e.g. it must have a means of blocking out ambient light. Some light measuring devices (LMDs) that might be suitable include, for example, a Minolta CA-210 or CA-310. These are contact probe devices (measuring near the screen surface) with a built-in shroud in contact with the screen (to block out ambient light and position the sensor at an optimum position from the screen surface).

Typical ambient lighting conditions outdoors or in shop windows are much higher (3k–10k lux) and indeed lower (<5 lux) than the levels experienced in a domestic or office setting (100–300 lux). An illuminance measuring instrument is required which must have an appropriate range and be calibrated for use in that much wider range of light levels. Some LMDs are simply not capable of measuring over that full range. An example of a suitable instrument is a Minolta CL200A. The one used in this test is calibrated from 0.0 lux to 20,000 lux so should perfectly be adequate.

Hand-held illuminance meters should be positioned carefully so that the distance between the light source and the ABC sensor is the same as the distance between the light source and the illuminance meter's sensor (see Figure 2). Given that light intensity is inversely proportional to the square of the distance from the light source, this difference in intensity may be significant at bright levels and thus should be mitigated.

If possible, the effect of the depth of the illuminance meter should be eliminated by mounting it such that the illuminance meter's sensor and ABC sensor are equidistant to the light source. Figure 2 depicts how it may be mounted onto the bottom of the DSD chassis. In our testing, hook and loop fasteners were adequate for the task.

DETERMINING PROJECTOR ILLUMINATION RANGE

In order to determine the illumination range of the projector used for the test, play the EN 62087-2, clause 4.2.2.2 Box and outline video test pattern while monitoring the input power and screen luminance with ABC disabled. After 30 seconds record the input power and screen luminance. Then, enable the ABC and project the full white test pattern labelled "255" onto the sensor. Next, select the appropriate input to display the Box and outline video test pattern while monitoring the illumination level. After 30 seconds record the input power and screen luminance. If the power consumption and screen luminance exceed the values recorded, then the display can use ABC to increase the screen brightness.

Project the test pattern labelled "000" onto the sensor while monitoring the illumination level. If the "000" test pattern produces illumination greater than 12 lux at the ABC sensor, increase the distance between the projector and the sensor until it produces 12 lux and refocus the projector. Note this distance. This will be your minimum illumination at that focal distance.

Project the full white test pattern labelled "255" onto the sensor while monitoring the illumination level. This will be your maximum illumination. Next, reduce the illumination level by displaying progressively darker slides until a reduction in power consumption and screen dimming is observed. You may have to wait up to one minute between slide-changes for the ABC to respond to the change. Once a change has been observed, switch back to the brighter slide, wait for the ABC to respond and the power consumption and screen luminance to increase and note the length of time this takes. This is your

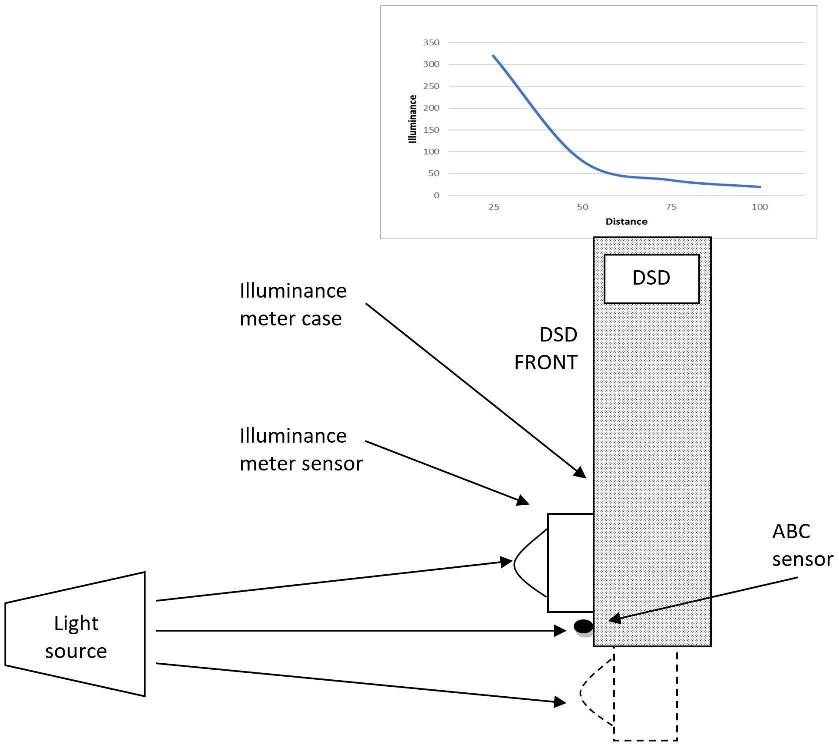

Figure 2. Illustration of the Test Setup with a Digital Signage Display (DSD).

"positive illumination latency". If the ABC responds to the change from the "255" slide to the "250", this would indicate that the ABC is operable in this bright range and the maximum illumination provided by the projector may be insufficient to test the upper limit of the sample's ABC, i.e. the screen luminance may increase with greater incident illumination than the projector can provide.

Switch back to the earlier darker slide and again wait for the ABC to respond and the power consumption and screen luminance to decrease and note the length of time this takes. This is your "negative illumination latency".

If the ABC is responsive at higher illuminance levels, resulting in higher screen luminance than when ABC is disabled via the menu, then the projector will need to be positioned closer to the ABC sensor, for a repeat test run of the slides in order to capture the data at higher illuminance levels. Only a subsection of the brightest slides is required for this.

Test measurement procedure

ON-MODE POWER MEASUREMENT

Preparation and measurement as per EN 62087:2016 with the following exceptions.

1. The light source described in EN 62087-3:2016 is not sufficiently bright enough to disable the ABC feature if it cannot be disabled via the menu. Therefore, the light source in clause 5.6.5 is replaced with a presentation projector having a capability of producing an illumination of at least 20,000 lux at the minimum focal distance. The projector shall be set up at the minimum focal distance from the sensor and illuminance meter. Vertical and horizontal alignment is not critical, but a white cloth should be draped over the sample to project onto, in order to check focus.
2. If the sample has an ABC sensor which cannot be disabled via the menu, project the full white 255 test pattern onto the sensor and allow the projector sufficient time to stabilise.
3. The illuminance measuring device should be positioned close to (but not obscuring) the ABC sensor such that the instrument's sensor and the ABC sensor are equidistant from the light source.
4. The 10-minute Dynamic Broadcast video pattern described in EN 62087-2:2016, 4.1.3 is replaced with the CLASP 10-minute Dynamic test pattern. The power measurement is integrated over the full 10-minute length of the test pattern with ABC disabled (either via the menu or by using the projector with the full white test pattern labelled "255"). If applicable, the on-mode power measurement is repeated using UHD/HDR and HD versions of the STEP 10-minute Dynamic test pattern.
5. In the interest of confirming consistency with historical data, a measurement may also be made using the 10-minute Dynamic Broadcast video pattern described in EN 62087-2:2016, 4.1.3.

PEAK LUMINANCE MEASUREMENT

1. Display the VESA L pattern that does not cause display drive limiting. Then, after exactly 30 seconds after the image is first displayed, record the screen luminance.

Table 3. Results for three DSDs tested according to new test method.

Sample Code	SC01	SC02	SC03
Product type	Signage Display	Signage Display	Signage Display
Claimed Screen Size:(inches)	55	55	55
Visible Screen Height (inches)	26.77	47.64	26.77
Visible Screen Width (inches)	47.60	26.77	47.64
Diagonal size (inches)	54.61	54.60	54.65
Screen Area (in2)	1,274.25	1,275.34	1,275.32
Native resolution	1920 x 1080	1920 x 1080	1920 x 1080
Resolution (MP)	2.07	2.07	2.07
EQ1: Pixel density (Dp)	1,624	1,624	1,623
Signage	y	y	y
Interface used during testing	HDMI	HDMI	HDMI
Rating Plate Voltage (V)	100–240 VAC	100–240 VAC	100–240 VAC
Rating Plate Freq (Hz)	50–60 Hz	50–60 Hz	50–60 Hz
Rating Plate Current (A)	1.8–0.8 A	n/a	3.8–1.6 A
Rating Plate Power (W or VA)	186 W	450 W	Ns
Features			
Automatic Brightness Control ABC?	y	y	N
If Automatic Brightness Control ABC, enabled by default?	n	y	n/a
Occupancy sensor present?	n	n	N
Testing Conditions			
At which voltage/frequency tested?	230 Va.c. ±1 V, 50 Hz ±0.1 Hz	230 Va.c. ±1 V, 50 Hz ±0.1 Hz	230 Va.c. ±1 V, 50 Hz ±0.1 Hz
Temperature (°C)	24.3	24.6	22.7
Humidity (%)	43.1	38.4	42.6
Air speed (m/s)	<0.1	<0.1	<0.1
Measurements			
Display has mechanism that allows the display to automatically enter Sleep or Off Mode?	y	y	y
On mode power consumption IEC 62087-3 (W)	100.9	203.9	130.9
On mode power consumption STEP (W)	100.0	204.8	130.9
Peak luminance as delivered White Box (Cd/m^2)	386	774	509
Peak luminance as delivered 3-bar B&W (Cd/m^2)	379	772	509
Peak luminance as delivered White Box (Cd/m^2) with ABC on	387	768	n/a
Peak luminance as delivered 3-bar B&W (Cd/m^2) with ABC on	385	768	n/a
Peak luminance Brightest Preset White Box (Cd/m^2)	389	Over 1,500	693
ABC Latency (s)	30	60	n/a
Active at 12 lux	y	y	n/a
ABC Upper Operating Illuminance (+/- 1000 lux)	10,500	30	n/a

MEASURE ABC RESPONSE PROFILE

1. The ABC test methodology of EN62087 is impractical to characterise a UUT ABC response, with fine data granularity in terms of the power requirement and display luminance change with ambient light change. A new projector-based test methodology is employed.
2. If the sample has an ABC sensor, ensure it is enabled and cover the stand with black felt to prevent reflected light from entering the ABC sensor.
3. Connect the luminance meter and illuminance meter to enable data logging on one computer at a rate of 1 measurement every 2 seconds.
4. Set the power meter to enable data logging on the same computer at a rate of 4 measurements every second.
5. Ready the data logging software for all three instruments.
6. Project the full white test pattern labelled “255” onto the sensor while monitoring the illumination level. Begin logging data.
7. After the time period equivalent to the negative illumination latency plus 30 seconds has lapsed, change the slide to the pattern labelled “250”. Continue changing slides, decreasing in brightness until slide “000” has been projected. Alternatively, a timed slideshow can be projected using the negative or positive latency period (the greater of the two) plus 30 seconds between slides.
8. Then continue until the remaining slides have been displayed, using the positive latency period plus 30 seconds between slides.

Measurement results of samples tested

Table 3 presents some of the measurements made on the DSD samples tested using the aforementioned procedure. These results include the standard measurements of the displays followed by graphs that show the ABC responsive curves for two of the three models which had an ABC feature.

Figures 3 and 4 present the screen luminance and power measurements that were measured over a broad range of illuminance experienced by the light sensor. Figure 3 illustrates a relatively good design in ABC, whereby the screen luminance is reduced (and thus, power consumption is reduced) with a decrease in the ambient light level measured at the DSD sample's light sensor.

Figure 4 illustrates a relatively poor ABC response curve. For this model, the ambient light level measured at the sensor is varied exactly as it was for the previous model, however for this unit, screen luminance is found not to adjust the brightness of the screen except for one step at very low brightness levels (i.e., around 50–20 lux).

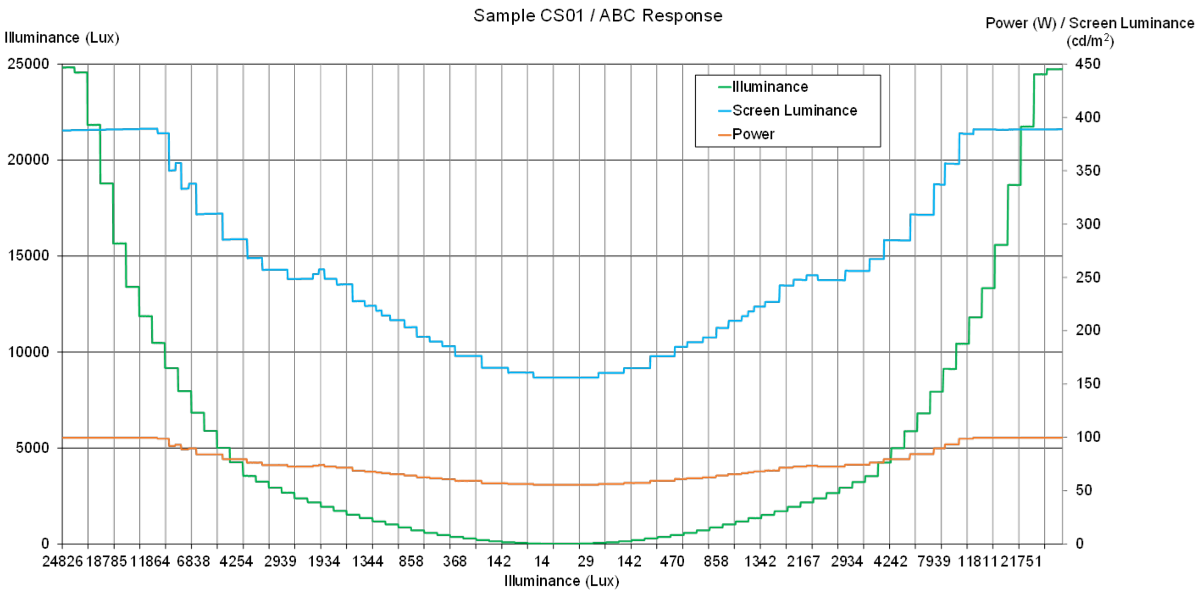

Figure 3. Power and Screen Luminance response to Ambient Lighting of an LED backlit LCD Digital Signage Display (sample CS01).

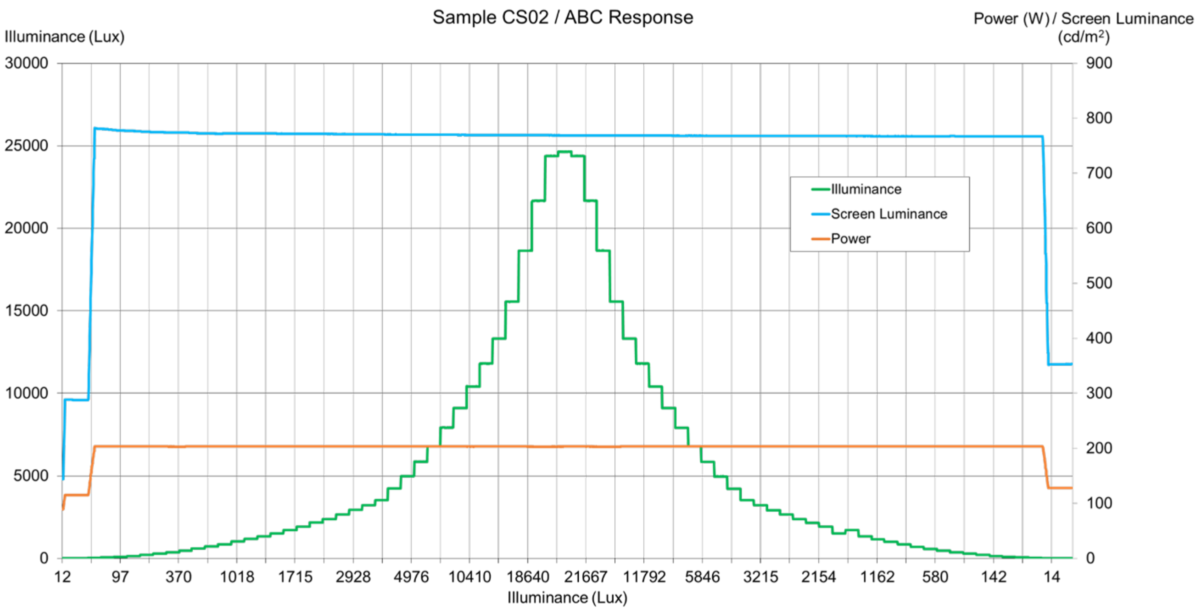

Figure 4. Power and Screen Luminance response to Ambient Lighting of an LED backlit LCD Digital Signage Display (sample CS02).

Table 4. Energy Label Class Distribution for Proposed DSD Equation.

New Energy Label Classes (April 2021)	EEI Values	EU Television models (Nov 2018)	Digital Signage Displays (Scaled to match)
*A (most efficient)	EEI < 0.30	0 %	
B	0.30 ≤ EEI < 0.40	0 %	
C	0.40 ≤ EEI < 0.50	0.1 %	
D	0.50 ≤ EEI < 0.60	0.5 %	
E	0.60 ≤ EEI < 0.75	3.0 %	
F	0.75 ≤ EEI < 0.90	21.4 %	
G (least efficient)	0.90 ≤ EEI	74.9 %	

Conclusions and recommended equation

In order to best harmonise the labelling of DSDs with that of other displays, we recommend the following equation be adopted by the standardisation body for determining the energy classes:

$$EEI = \frac{(P_{measured} + 1)}{(3 \times [90 \times \tanh(0.025 + 0.00354 \times (A - 11)) + 4] + 3) + corr_{lum}}$$

Where $corr_{lum}$ would be set appropriately (for example, as (0.00062 × (lum-500) × A) for Digital Signage Displays where lum is the peak white luminance in cd/m^2 of the brightest preset mode of the display and A is the display area in dm^2) to ensure that the distribution of DSDs approximated the same distribution as that of televisions. Table 4 presents a distribution of energy label classes of the DSDs tested which approximates the same distribution of re-scaled televisions from a CLASP database of over 700 models of televisions for sale in the EU that was gathered in November 2018.

Testing of DSDs will be conducted in 2019 following the test method set out in this paper and the appropriate $corr_{lum}$ will be determined and published for the Commission and DSD stakeholders to review. This work needs to be completed by 2021, when the regulation takes effect and the label classes for DSDs would be applicable.

References

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