

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Hisense USA Corporation
Petitioner

v.

Brightplus Ventures LLC
Patent Owner

Patent No. 8,941,331

Filing Date: May 17, 2013

Issue Date: January 27, 2015

Title: SOLID-STATE LIGHTING PANELS WITH VARIABLE VOLTAGE
BOOST CURRENT SOURCES

Ex. 1022 – Second Declaration of Rafael Betancourt

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I, Rafael J. Betancourt, declare as follows:

I. Introduction

1. I am an independent consultant. I am over eighteen years of age, and I would otherwise be competent to testify as to the matters set forth herein if I am called upon to do so.

2. I have prepared this Declaration for consideration by the Patent Trial and Appeal Board in the *Inter Partes* Reviews of U.S. Patent No. 8,941,331 (“the ‘331 Patent”) and the Contingent Motion to Amend (the “Motion”) Filed by Patent Owner in the *Inter Partes* Review Proceeding.

3. I provide this Declaration at the request of and have been retained by Kilpatrick Townsend & Stockton, LLP, which represents Hisense USA Corporation (“Hisense”) in connection with the above-captioned *Inter Partes* Review. I have been informed and understand that Hisense contends that substitute claims 26-27 submitted by the Patent Owner in the Motion are invalid.

4. I am being compensated at an hourly rate of \$750 per hour. My compensation is not dependent on the outcome of or any issue in relation to the above-captioned *Inter Partes* Review, and I have no interest in either party.

5. In forming my opinions, I relied on my knowledge, education, experience, and training in the field and on documents and information referenced in this Declaration.

6. My qualifications are summarized in Ex. 1003, which is my prior declaration in this proceeding and my CV, which was submitted as Ex. 1004. *See* Ex. 1003, ¶¶6-13. I am not a lawyer, however, my understanding of the legal issues, in particular with respect to obviousness are summarized in my prior declaration. *See* Ex. 1003, ¶¶14-21. My prior declaration also provides my opinion on the appropriate level of experience for a person to be a person of ordinary skill in the art. *See* Ex. 1003, ¶¶23-25.

II. Materials Considered

7. In addition to the materials identified in my prior declaration (*see* Ex. 1003, ¶27) in forming my opinions, in addition to my knowledge and experience, I have considered the following documents and things that I have obtained, or that have been provided to me:

Exhibit	Description
1018	US 2005/0227569 to Maeda (“Maeda”)
1019	US 2005/0133800 to Park (“Park”)
1020	US 2005/0140270 to Henson (“Henson”)

8. In addition to the documents above, in forming the opinions expressed below, I have also considered my own knowledge and experience based upon my education and work in the fields of LEDs, circuitry, and display technology, as described above and in my *curriculum vitae* (Ex. 1004).

III. Patent Owner's Substitute Claims.

9. I am informed and understand that Patent Owner has proposed to substitute original claims 17 and 22 of the '331 Patent with the following substitute claims (the "Substitute Claims"):

26. (proposed substitute for Claim 17) A lighting system, comprising:

a lighting panel including a lighting bar assembly containing at least two rectangular tiles configured into a two-dimensional array;

wherein each tile comprises at least first and second strings of solid state lighting devices that are respectively configured to emit at least a first light and a second light, respectively;

at least first and second current supply circuits coupled to the at least first and second strings of solid state lighting devices, respectively, and configured to supply an on-state drive current to a respective one of the first and second strings of solid state lighting devices; and

a pulse width modulation (PWM) controller that is coupled to the first current supply circuit and the second current supply circuit and that is configured to generate, for each of the first current supply circuit and the second current supply circuit, a first PWM control signal and a second PWM control signal that are supplied to the each of the at least first and second strings.

27. (proposed substitute for Claim 22) ~~The lighting system according to claim 17,~~

~~wherein the first string of solid state lighting devices are coated with a wavelength conversion phosphor and are configured to emit the first light that includes a combined light including a dominant wavelength corresponding to a blue color and a dominant wavelength corresponding to a yellow color, and~~

~~wherein the second string of solid state lighting devices are configured to emit the second light that includes a dominant wavelength corresponding to a red color.~~

A lighting system, comprising:

at least first and second strings of solid state lighting devices that are respectively configured to emit at least a first light and a second light, respectively;

at least first and second current supply circuits coupled to the at least first and second strings of solid state lighting devices, respectively, and configured to supply an on-state drive current to a respective one of the first and second strings of solid state lighting devices;

wherein the first and second strings of solid state lighting devices are covered with a wavelength conversion phosphor containing element and are configured to emit the first light that includes a combined light including a dominant wavelength corresponding to a blue color, said blue light interacting with the wavelength conversion phosphor containing element to produce a dominant wavelength corresponding to a yellow color; and

a pulse width modulation (PWM) controller that is coupled to the first current supply circuit and the second current supply circuit and that is configured to generate, for each of the first current supply circuit and the second current supply circuit, a first PWM control signal and a second PWM control signal that are supplied to the each of the at least first and second strings.

IV. The Prior Art Addressed in My Prior Declaration Renders Every Element of Substitute Claims 26 and 27 Obvious.

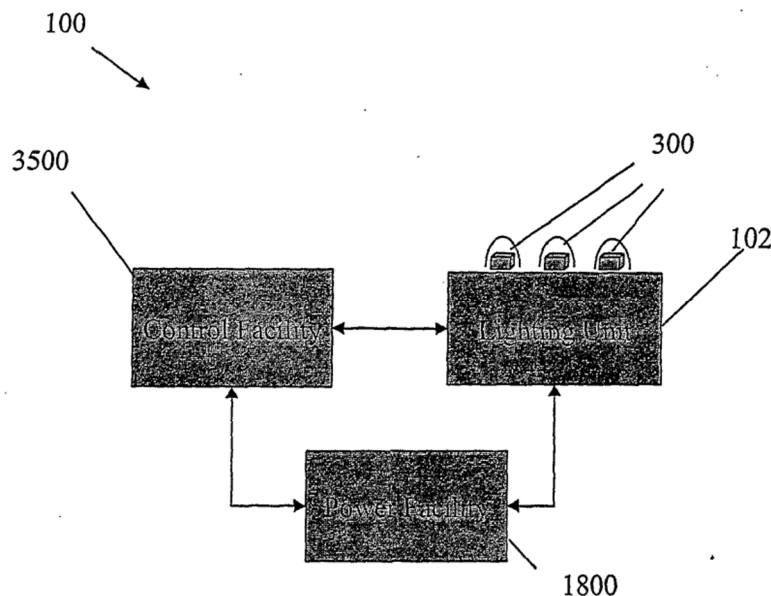
10. In my prior declaration I broke down the elements of claims 17-25 and demonstrated that each of the elements of those claims were known in the art before November 18, 2005, the priority date of the '331 Patent. *See* Ex. 1003, ¶¶49-86. In the analysis below I address the new elements of Substitute Claims 26-27 and demonstrate that each of these elements was also known in the art before November 18, 2005, the priority date of the '331 Patent.

- A. A lighting bar assembly containing at least two rectangular tiles configured into a two-dimensional array; wherein each tile comprises (at least first and second strings of solid state lighting devices that are respectively configured to emit at least a first light and a second light, respectively). (Substitute Claim 26).**

11. As discussed in my prior declaration, the combination of Lys (Ex. 1005) and Grootes (Ex. 1006) discloses or renders obvious each element of original claim 17, and it would be obvious to combine Lys with Grootes and the knowledge of a POSITA. Ex. 1003, ¶¶87-92. In effect, Patent Owner's proposed Substitute Claim 26 simply modifies claim 1 to include a limitation that the first and second strings of solid state lighting are included in a rectangular tile instead of a lighting panel, and a lighting bar assembly contains at least two such rectangular tiles configured into a two-dimensional (2D) array. As proved in my prior declaration, Lys describes multiple strings of LEDs that produce different colors or wavelengths of light, namely the limitations in the bracket above. Ex. 1003, ¶51.

12. Configuring multiple tiles, each containing multiple LED strings, into a two-dimensional array is well-known in the field of display technology. For instance, the '331 Patent states, in the background section, that: "For larger display and/or illumination applications, multiple solid state lighting tiles may be connected together, for example, in a two dimensional array, to form a larger lighting panel." Ex. 1001, 2:30-33.

13. Lys discusses such 2D configuration of rectangular tiles in many instances throughout the specification. For example, Lys presents, at a high level, the concept of a *lighting unit* 102, which is part of a lighting system 100 and includes multiple *light sources* (e.g., LEDs) 300. Ex. 1005, 30:6-12. The light sources 300 are disposed on a support structure and the support structure may be, for example, a board 204. Ex. 1005, 31:4-5. The board may be a circuit board or “similar facility suitable for holding light sources as well as electrical components.” Ex. 1005, 31:5-7. In other words, the board is not limited to a circuit board. Instead, the board, and therefore the support structure, can be any suitable facility that holds light sources 300 and electrical components. These descriptions lay a foundation for various more detailed designs discussed in Lys.



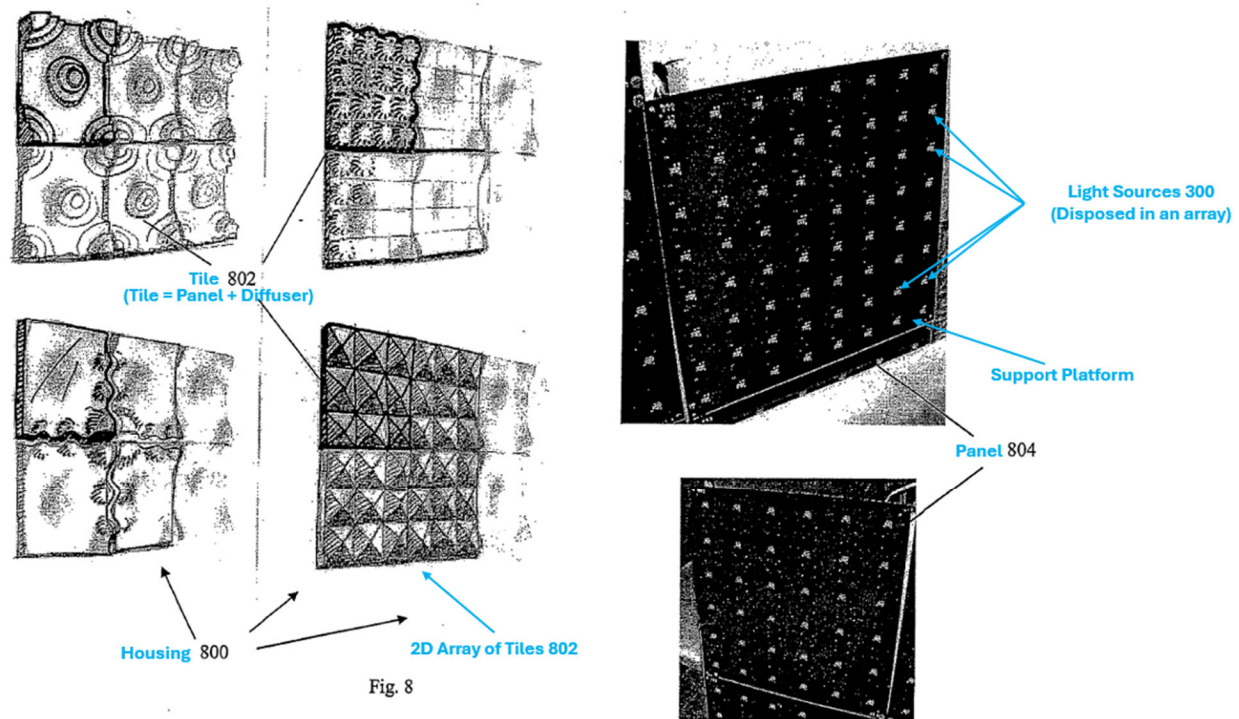
Ex. 1005, Fig. 1.

14. For instance, Lys describes a “structural element,” which is for bearing LEDs and may be designed to facilitate the tiling of these structural elements so that they can fill a portion of a 2D plane. Ex. 1005, 23:28-31; 24:2-4. As such, the construction of a 2D lighting structure or a rectangular solid lighting structure can be achieved by tiling these structural elements. Ex. 1005, 24:7-8; 24:15-16.

15. As another example of a more detailed design or configuration, Lys discusses that the term “lighting unit” is used to refer to an apparatus including one or more light sources. Ex. 1005, 49:7-8. The lighting unit 102 may have any one of a variety of possible mounting arrangements for the light sources 300 in a variety of housings 800. Ex. 1005, 49:8-10. Housing 800 is also a broad concept, as described in Lys, and may include enclosures, platforms, boards, mountings, and the like. Ex. 1005, 49:10-11. Housing 800 may be made of any material, such as metals, alloys, plastics, polymers, etc. Ex. 1005, 49:12-13.

16. Figure 8, reproduced below, shows one example where the housing 800 includes tiles 802 configured into a 2D array, and each tile 802 is comprised of a panel 804 and a diffuser 502. Ex. 1005, 49:15-17. In other words, the tile 802 and the panel 804 are similar, and the difference between them is the existence of a diffuser 502. Each panel 804, and therefore each tile 802, includes a support platform and an array of light sources 300 disposed on the support platform. Ex.

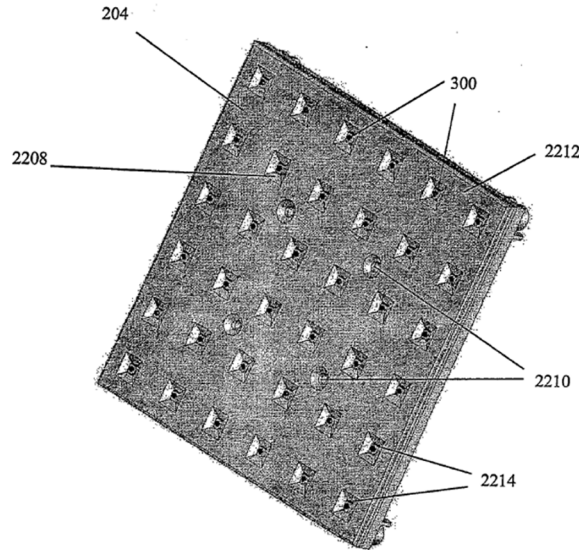
1005, 49:15-16. The tile 802 can be of any shape, including *rectangular*. Ex. 1005, 49:18-19. A POSITA would appreciate a rectangular shape as a natural and common design choice because it makes the tiling of multiple tiles easier.



Ex. 1005, Fig. 8 (annotated).

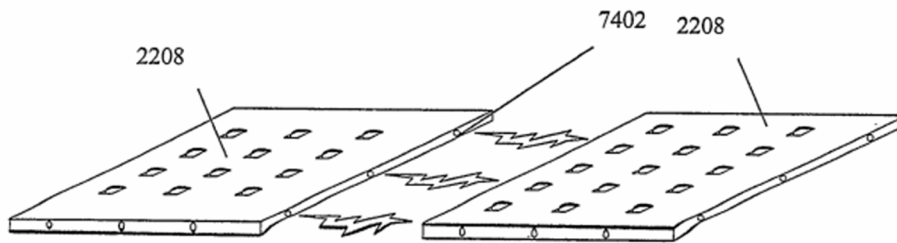
17. Figure 22b, reproduced below, shows a rectangular board 204 with an array 2208 (e.g., a six-by-six array as one of many possibilities) of light sources 300. Ex. 1005, 68:18-21. The light sources 300 may consist of miniature groups of LEDs, such as red, green, blue, white, or other colors of LEDs. Ex. 1005, 68:21-23. The benefits of the square array design lie in that it becomes convenient for the array 2208 to be placed side by side with other boards 204 containing similar

arrays 2208, and the arrays 2208 can serve as *modular* components of larger lighting systems. Ex. 1005, 68:24-28.



Ex. 1005, Fig. 22b.

18. Figure 74, reproduced below, shows that two boards 204, each of which holds the array 2208 of light sources 300, are fitted with magnetic facilities 7402 along their sides for fastening one to another. Ex. 1005, 145:18-20. The magnetic facilities 7402 provide a magnetic connection between these two boards 204. Ex. 1005, 145:20. Thus, a POSITA would appreciate that more than two boards 204 can be fastened in such a manner shown in Figure 74 to achieve a 2D array (e.g., four boards 204 in a two-by-two array, sixteen boards 204 in a four-by-four array, eighty boards 204 in a ten-by-eight array) because Lys describes (1) the tiling of structural elements like rectangular tiles, as explained above, and (2) an example of possible fastening mechanisms with reference to Figure 74.



Ex. 1005, Fig. 74.

19. In fact, Lys provides a *motivation or theory* for such designs and a combination thereof. Lys highlights that utilizing a light source 300 with a specific shape, size, and feature set that can be repeated many times throughout the lighting unit 100 allows for “*manufacturability and simplicity of design.*” Ex. 1005, 66:7-9. The lighting unit 100, which could be considered a “tile,” may touch other such lighting units 100 edge to edge to constitute a tessellation (e.g., a 2D array). Ex. 1005, 66:9-14. In my opinion, the tessellation, the lighting unit (e.g., a “tile”) 100, and the light sources 300 correspond to the “lighting bar assembly,” the “rectangular tile,” and the “solid state lighting devices” claimed in substitute claim 26, respectively.

20. Lastly, it is also worth noting that Lys expressly describes “one or more LEDs in a *string*” and multiple such strings can be used to create a light fixture that can “*vary in color*” and spectrum. Ex. 1005, 83:20-24. Lys also states that

lighting units 102 can include LEDs that produce *different colors or wavelengths* of light. Ex. 1005, 34:16-23. Thus, it is my opinion that strings (e.g., rows or columns shown in, for example, Figure 8) of light sources 300 in an array and producing different colors or wavelengths of light correspond to “at least first and second strings of solid state lighting devices” and “configured to emit at least a first light and a second light” claimed in substitute claim 26, respectively.

21. In summary, Lys starts with a general framework of a lighting unit 102 including one or more light sources 300 with reference to Figure 1 and further discusses various more detailed structures and configurations shown in, for example, figures 3, 8, 22b, and 74. Ex. 1005, 1005, 49:7-13; 23:28-31; 24:2-4; 24:7-8; 24:15-16; 34:17-23; 34:30-35:8; 66:7-14; 68:18-28; 145:18-20. Accordingly, it is my opinion that a POSITA would readily modify or combine Lys’s teachings of these more detailed implementations across Lys’s lighting systems.

B. The first and second strings of solid state lighting devices are covered with a wavelength conversion phosphor containing element and are configured to emit the first light that includes a combined light including a dominant wavelength corresponding to a blue color, said blue light interacting with the wavelength conversion phosphor containing element to produce a dominant wavelength corresponding to a yellow color. (Substitute Claim 27).

22. I note that substitute claims 27 incorporates all claim elements of original claim 17 except that the limitation “a lighting panel” has been deleted.

23. As discussed in my prior declaration, the combination of Lys and Grootes discloses or renders obvious each element of original claim 17, and it would be obvious to combine Lys with Grootes and the knowledge of a POSITA. Ex. 1003, ¶¶87-92. In effect, Patent Owner’s proposed Substitute Claim 27 adds new limitations that “the first and second strings of solid state lighting devices are covered with a wavelength conversion phosphor containing element and are configured to emit the first light that includes a combined light including a dominant wavelength corresponding to a blue color, said blue light interacting with the wavelength conversion phosphor containing element to produce a dominant wavelength corresponding to a yellow color.” However, the scope of the limitation that “the first light that includes a combined light including a dominant wavelength corresponding to a blue color” remains unclear. If this limitation means “the first light that includes the combined light *having* a dominant wavelength corresponding to a *blue* color,” it is against the common practice in the LED technical field. Because red component, green component, and blue component are normally used to achieve white light by way of combination. Combined light being blue light would be at odds with common practice.

24. Converting blue light into yellow light using a phosphor is well known. In fact, my prior declaration explains that prior art, including Lys,

discloses wavelength conversion phosphors and the combination of light with different dominant wavelengths (e.g., blue and yellow). Ex. 1003, ¶¶82-86.

25. Moreover, the '331 Patent states, in the background section, that: “For smaller LCD screens, backlight assemblies typically employ white LED lighting devices that include a blue-emitting LED coated with a wavelength conversion phosphor that converts some of the blue light emitted by the LED into yellow light.” Ex. 1001, 1:54-59. Therefore, a POSITA would be familiar with the techniques of using a blue LED light in combination with a yellow phosphor to create light that appears white.

26. Lys describes that LED light sources may include LEDs emitting different colors (e.g., red, green, blue, etc.) and may include, in one example, “one or more *blue LEDs that include a phosphor*.” Ex. 1005, 6:13-14; 6:16-17. Such blue LEDs can produce white light using “a phosphor mechanism,” and the produced white light gives a “‘better’ white.” Ex. 1005, 36:11-13. The phosphor is considered as an integral part of the LED. Ex. 1005, 38:8-9. Lys also explains that a phosphor can shift a wavelength of light emitted from one or more of the plurality of LEDs, and the wavelength conversion nature of a phosphor is “convert[ing] luminescence having a first spectrum to a different second spectrum.” Ex. 1005, 3:15-16; 37:28-30. As an example, luminescence having a relatively *short wavelength* pumps the phosphor, which in turn radiates *longer*

wavelength radiation. Ex. 1005, 37:30-38:2. A POSITA would know that blue light is characterized by a relatively short wavelength (450-485 nm) while yellow light is characterized by a relatively long wavelength (565-590 nm). Thus, a POSITA would appreciate that the express teachings of Lys could be applied to produce yellow light (long-wavelength light) by interacting blue light (short-wavelength light) with a phosphor.

V. Additional Prior Art Renders Every Element of Substitute Claim 27 Obvious.

27. As mentioned above, converting blue light into yellow light using a phosphor is well known, and my prior declaration has explained it. Ex. 1003, ¶¶82-86. In addition, other prior art demonstrates the same.

A. Maeda: U.S. Patent Application No. 2005/0227569

28. I am informed and understand that Maeda (U.S. Patent Application No. 2005/0227569) is prior art to the '331 Patent. Maeda (Ex. 1018) is entitled "light-emitting semiconductor device, light-emitting system and method for fabricating light-emitting semiconductor device." Maeda describes its invention as: "A chip-type light-emitting semiconductor device includes: a substrate 4; a blue LED 1 mounted on the substrate 4; and a luminescent layer 3 made of a mixture of yellow/yellowish phosphor particles 2 and a base material 13 (translucent resin). The yellow/yellowish phosphor particles 2 is a silicate phosphor, which absorbs blue light emitted by the blue LED 1 to emit a fluorescence having a main

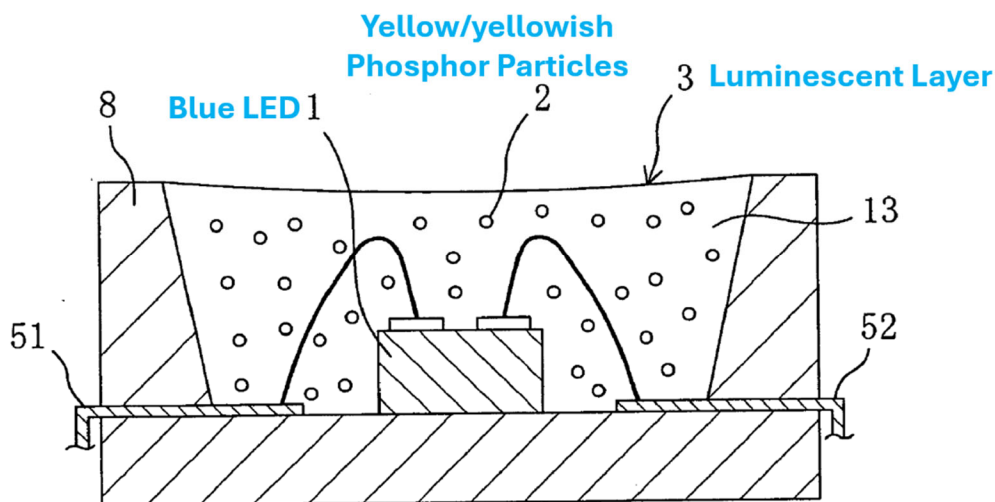
emission peak in the wavelength range from 550 nm to 600 nm, inclusive, and which contains, as a main component, a compound expressed by the chemical formula: $(\text{Sr}_{1-a1-b1-x}\text{Ba}_{a1}\text{Ca}_{b1}\text{Eu}_x)_2\text{SiO}_4$ ($0 \leq a1 \leq 0.3$, $0 \leq b1 \leq 0.8$ and $0 < x < 1$). The silicate phosphor particles disperse substantially evenly in the resin easily. As a result, excellent white light is obtained.” Ex. 1018, Abstract.

29. Maeda generally relates to “light-emitting semiconductor devices utilizing blue-light-emitting diodes (hereinafter, referred to as blue LEDs) and yellow/yellowish phosphors in combination to emit white light.” Ex. 1018, ¶1.

30. Maeda states, in the background section, that a light-emitting semiconductor device utilizing a blue LED having a main emission peak in the *blue wavelength range* from 400 nm to 530 nm and a luminescent layer containing a *phosphor* that absorbs blue light and produces a fluorescence having an emission peak within the green to *yellow wavelength range* from 530 nm to 580 nm is “known to date.” Ex. 1018, ¶2.

31. Figure 3, reproduced below, shows that a chip-type LED includes a blue LED 1 placed in the recess of the casing 8 and a luminescent layer 3 formed in the casing 8, and the luminescent layer 3 is made of a mixture of yellow/yellowish *phosphor particles* 2 and a base material (e.g., resin) 13. Ex. 1018, ¶178, 180, 181. In other words, the luminescent layer 3 includes the base material 13 and the yellow/yellowish phosphor particles 2 distributed in the base

material 13. In my opinion, the luminescent layer 3 corresponds to the “wavelength conversion phosphor containing element” claimed in substitute claim 27 because it contains the yellow/yellowish phosphor particles 2.



Ex. 1018, Fig. 3 (annotated).

32. The blue LED 1 emits light having a main emission peak in the wavelength range between 430 nm and 500 nm, and the yellow/yellowish phosphor particles 2 are phosphors, which absorb blue light emitted by the blue LED 1 to emit a luminescence having a main emission peak in the wavelength range from 550 nm to 600 nm. Ex. 1018, ¶181. The visible spectrum is a band of electromagnetic spectrum that is visible to human eyes, and a typical human eye responds to wavelengths from about 380 nm to 750 nm. Known to a POSITA and also consistent with the descriptions in the background section, blue light is characterized by a wavelength between about 450 nm and about 485 nm, and yellow light is characterized by a wavelength between about 565 nm and about 590

nm. Thus, a POSITA would appreciate that Figure 3 and the accompanying text disclose that blue LED 1 emits *blue light* and the yellow/yellowish phosphor particles 2 absorb the blue light and emit *yellow light*. As a result, an “excellent white light” is obtained by way of combination. Ex. 1018, Abstract and ¶42.

B. Park: U.S. Patent Application No. 2005/0133800

33. I am informed and understand that Park (U.S. Patent Application No. 2005/0133800) is prior art to the '331 Patent. Park (Ex. 1019) is entitled “solid state lighting device.” Park describes its invention as: “A light assembly for use with a low voltage power source. The light assembly semiconductor photo-emitters are electrically in series with a higher forward voltage drop than the associated low voltage power supply. To provide the necessary voltage the light assembly includes a current regulated step-up DC/DC converter. The semiconductor photo-emitters that are electrically in series are in the form of a monolithic light emitting diode array with a plurality of light emitting diode elements electrically and mechanically in series with a conductive, rigid bond region between the cathode region of the first light emitting diode element and the anode region of the second light emitting diode element. The first and second light emitting diode elements may differ in band gaps to emit different colors, that are additive to a non-primary color, such as white.” Ex. 1019, Abstract.

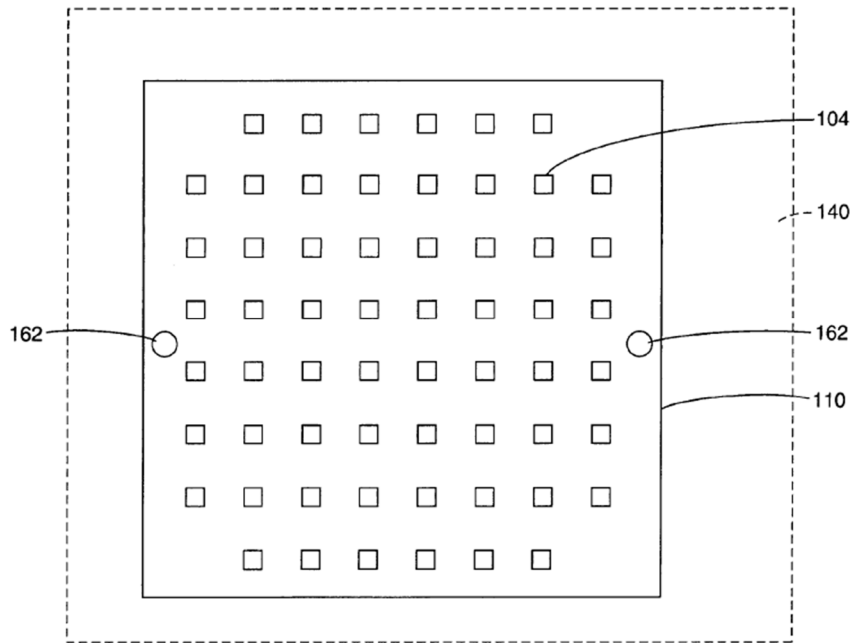
34. Park generally relates to an LED series array. Ex. 1019, ¶2. Stacked-chip semiconductor light emitting devices, like those shown in Figures 10-12, are utilized. Ex. 1019, ¶95. Park describes that: “The simplest and the most popular method of generating white light is using wavelength converting phosphors on top of a light energy LED chip.” Ex. 1019, ¶99. Typically, a blue LED chip is coated with a phosphor, and the phosphor converts *some of* the blue light into yellow, and when “yellow and blue colors mix together in the phosphor layer, (a mixture of a thermosetting polymer and a phosphor), the escaping light becomes white.” Ex. 1019, ¶99. Accordingly, Park discloses the concepts of (1) covering a blue LED chip with a phosphor and (2) converting some of the blue light into yellow light, which is further mixed with blue light to achieve white light.

C. Henson: U.S. Patent Application No. 2005/0140270

35. I am informed and understand that Henson (U.S. Patent Application No. 2005/0140270) is prior art to the '331 Patent. Henson (Ex. 1020) is entitled “solid state light device.” Henson describes its invention as: “A photon emitting device comprises a plurality of solid state radiation sources to generate radiation. The solid state radiation sources can be disposed in an array pattern. Optical concentrators, arranged in a corresponding array pattern, receive radiation from corresponding solid state radiation sources. The concentrated radiation is received by a plurality of optical waveguides, also arranged in a corresponding array

pattern. Each optical waveguide includes a first end to receive the radiation and a second end to output the radiation. A support structure is provided to stabilize the plurality of optical waveguides between the first and second ends. The photon emitting device can provide a replacement for a discharge lamp device in various applications including road illumination, spot lighting, back lighting, image projection and radiation activated curing.” Ex. 1020, Abstract.

36. Henson generally relates to a solid state light device. Ex. 1020, ¶3. The solid state light device 100 shown in Figures 1A and 1B includes an array of solid state radiation sources 104. Ex. 1020, ¶¶28-29, FIGS. 1A-1B and 2. Figure 2 further shows that multiple bare blue LED dies 104 can be utilized, and one or more of these blue LED dies 104 can be *coated*, preferably on a light-emitting surface, with *a phosphor layer*, such as YAG:Ce phosphor. Ex. 1020, ¶32. Henson further states that a portion of the *blue light* from the blue LED die is mixed with the phosphor-converted *yellow light* to effectively generate “white” light. Ex. 1020, ¶32. Accordingly, Henson discloses the concepts of (1) covering a blue LED chip with a phosphor and (2) converting a portion of the blue light into yellow light, which is further mixed with blue light to effectively generate white light.



Ex. 1020, Fig 2.

VI. Motivations to Combine

A. It Would Have Been Obvious to Combine Lys and Grootes

37. As discussed in my prior declaration, a POSITA would be motivated to combine Lys and Grootes. Ex. 1003, § VIII.

38. Additionally, Lys's teachings in connection with new features claimed in substitute claims 26 and 27 would readily be combined with the prior art in the Grounds as set forth in the Petition. Lys's disclosures in relation to rectangular tiles simply provide additional details of how the light sources are configured. Lys's disclosures in relation to wavelength conversion simply provide additional details of how the light sources function in some embodiments. Thus, a POSITA would be motivated to utilize other designs and configurations in Lys for combination.

B. It Would Have Been Obvious to Combine Lys, Grootes, and Maeda/Park/Henson.

39. In my opinion, a person of ordinary skill in the art would have been motivated to combine Lys, Grootes, and Maeda/Park/Henson, would have understood how to do so, and would have had the skillset to do so.

40. As explained above, Maeda relates to light-emitting semiconductor devices utilizing blue-light-emitting diodes and yellow/yellowish phosphors in combination to emit white light. Maeda provides additional details regarding how a blue LED that includes a phosphor creates white light.

41. To the extent that it is not readily apparent to a POSITA based on Lys's disclosure, the POSITA would readily look to the teachings of Maeda for the additional details in implementing Lys's system that uses "blue LEDs that include a phosphor" to create white light, as explicitly disclosed by Lys. Ex. 1005, 6:16-17, 36:11-13. Modifying Lys's system using Maeda's teachings (e.g., using blue-light-emitting diodes and yellow/yellowish phosphors in combination to emit white light) would have been well within a POSITA's skills and provided predictable results.

42. Actually, such a conventional implementation detail is what the '331 patent already admits as "typical", i.e., using white LED lighting devices "that include blue-emitting LED coated with a wavelength conversion phosphor that

converts some of the blue light emitted by the LED into yellow light.” Ex. 1001, 1:54-58.

43. Lastly, Maeda aims to address the unevenness in the emitted light. Ex. 1018, ¶37. A POSITA would be motivated to incorporate the teachings of Maeda to improve emitted light uniformity.

44. Likewise, a POSITA would have been motivated to combine Lys with Park. Park relates to an LED series array, and it aims to provide and employ low-cost white light LED arrays, which is the same endeavor as Lys. Ex. 1019, ¶14. A POSITA would readily look to the teachings of Park because Park is in the same endeavor as Lys.

45. Similarly, a POSITA would have been motivated to combine Lys with Henson. Henson relates to a solid state light device having an array of solid state radiation sources 104, and it attempts to achieve a higher light utilization. Ex. 1020, ¶7. A POSITA would readily look to the teachings of Henson because Henson is in the same endeavor as Lys.

46. In summary, Maeda, Park, and Henson would be highly relevant to one of skill in the art designing lighting systems and attempting to improve design flexibility and achieve better white light. A POSITA would be motivated to modify the art presented in the original grounds to include the additional disclosures of

these prior art references to provide, for example, increased modular design flexibility and better white light.

VII. Other Technical Declaration

47. I am informed and understand that Patent Owner has raised some technical questions in the Patent Owner's Response ("Response") Filed by Patent Owner in the *Inter Partes* Review Proceeding.

A. Current Supply Circuit

48. In the example shown in Figure 17 of Lys, the purpose of having the DC-DC converter is to convert the high voltage of the AC line to a low voltage suitable for light sources such as LEDs. Therefore, the voltage is no longer high (e.g., 120V, namely the standard AC voltage in the United States) after going through the DC-DC converter.

49. Patent Owner's arguments regarding using separate converters to each string or one converter to multiple strings does not make sense as it is trivial to arrange such components in an electrical lighting system as reflected by both Lys and Grootes.

50. Patent Owner asserts that none of the power supplies discussed in Lys, including the PFC/DC to DC converter 1908, supply an on-state drive current to LED strings. Indeed, Patent Owner ignores common sense of a POSITA, especially in view of a fundamental physical principle known as Ohm's law (i.e.,

the electric current through a conductive load between two points is directly proportional to the voltage across the two points). According to Ohm's law, voltage supplied against a load results in current. Ohm's law is typically expressed as $I=V/R$, where I is the current through a load/conductor, V is the voltage measured across the conductor, and R is the resistance of the load/conductor.

51. As shown in Figure 17 of Lys, the lighting unit 102 is electrically connected to its corresponding PFC/DC-DC converter 1908 as a conductive load having a certain resistance. The PFC/DC-DC converter 1908 outputs a low voltage of a current flowing through the lighting unit 102. Therefore, an on-state drive current flows through the lighting unit 102 according to Ohm's law. If the load resistance is known (e.g., calculated by multiplying the forward resistance $R_{FORWARD}$ of each LED by the number N of LEDs in a string), the desired on-state current can be readily achieved by setting the output voltage accordingly.

52. Also, I want to reiterate that Grootes explicitly discloses each of multiple current supply circuits configured to supply an on-state drive current to a respective one of the strings of solid state lighting devices, as discussed in my prior declaration. Ex. 1003, ¶60.

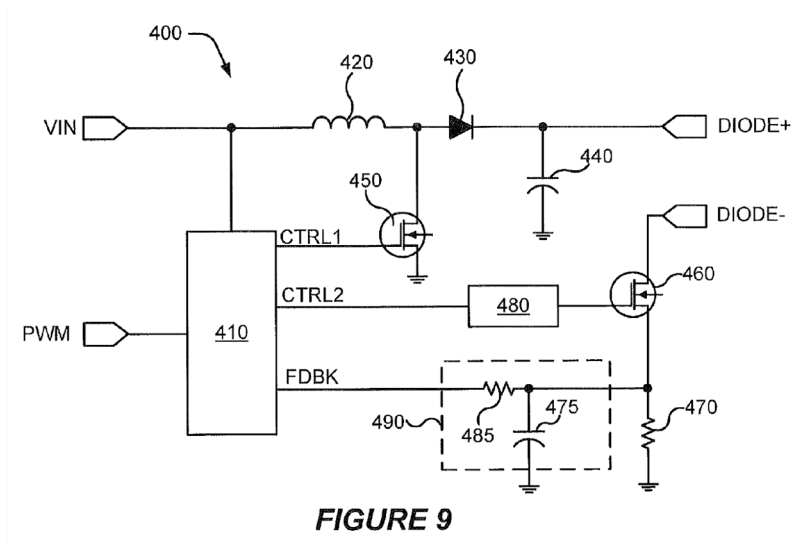
53. Lys discloses that the power facilities 1800 may "be associated with one or more power conversion devices that convert power received by an external power source to a form suitable for operation of the lighting unit 102." Ex. 1005,

58:17-19. A POSITA would know that one possible example of such suitable forms would be an on-state drive current for a string of LEDs.

B. PWM Controller and Two PWM Control Signals Per LED String

54. Patent Owner's understanding of the PWM controller and the two PWM control signals is profoundly incorrect. In order to fully understand the "first PWM control signal" for current control and the "second PWM control signal" for on-off control, we must understand element 17C in view of the specification of the '331 Patent, especially the discussion associated with Figure 9.

55. As shown in Figure 9 of the '331 Patent, reproduced below, a current supply circuit 400 has a variable voltage boost converter configuration and includes a PWM controller 410, a charging inductor 420, a diode 430, an output capacitor 440, a first control transistor 450, a second control transistor 460, and a sense resistor 470. Ex. 1001, 12:47-51. The current supply circuit 400 receives an input voltage VIN and a PWM signal (labeled as "PWM" in Figure 9). *Id.* at 12:51-54. The current supply circuit 400 is configured to provide a substantially constant current to a corresponding LED string connected between a positive output terminal (labeled as "DIODE+") and a negative output terminal (labeled as "DIODE-"). *Id.* at 12:55-59. The current supply circuit 400 may act as a voltage boost converter to provide the high voltage that may be required to drive the LED string. *Id.* at 12:59-61.



Ex. 1001, Fig. 9.

56. The PWM controller 410 is configured to control the operation of the first control transistor 450 and the second control transistor 460 to provide a constant current to the LED string connected between the positive output terminal and the negative output terminal. *Id.* at 14:19-24. When the first PWM control signal (labeled as “CTRL1” in Figure 9) generated by the PWM controller 410 turns on the first control transistor 450, the charging inductor 420 is energized by the input voltage VIN. *Id.* at 14:24-26. When the first PWM control signal turns off the first control transistor 450, the magnetic energy stored in the charging inductor 420 is discharged as a current through the rectifier diode 430 and is stored in the output capacitor 440. *Id.* at 14:31-34. Under the control of the first PWM control signal, a high voltage can be built up in the output capacitor 440 by repeatedly

charging and discharging the magnetic field of the charging inductor 420. *Id.* at 14:34-36. This basically explains how the first PWM control signal functions.

57. On the other hand, when the second control transistor 460 is activated (i.e., turned on) by the second PWM control signal generated by the PWM controller 410, the charge stored in the output capacitor 440 flows through the LED string via the positive output terminal. *Id.* at 14:36-39. The higher the duty cycle of the second PWM control signal (i.e., the longer the on-time within each cycle), the larger the intensity of the light emitted by the LED string. This basically explains how the second PWM control signal functions.

58. In addition, the current through the LED string is monitored by the PWM controller 410 as a feedback signal (labeled as “FDBK” in Figure 9), which corresponds to a voltage on the sense resistor 470 when transistor 460 is turned on. Ex. 1001, 14:43-45. The feedback signal is filtered by a low pass filter 490 to suppress transient currents that may arise when the LED string is turned on. *Id.* at 14:45-50. The voltage stored on the output capacitor 440 is thus also adjusted by the PWM controller 410 in response to the feedback signal to provide a constant current through the LED string. *Id.* at 14:51-54. Therefore, the first PWM control signal determines the voltage stored on the output capacitor 440, which in turn determines the current flowing through the LED string, while the feedback signal tells the PWM controller 410 how to adjust the voltage stored on the output

capacitor 440. In other words, the feedback signal tells what the adjustment should be, whereas the first PWM control signal facilitates the implementation of the desired adjustment.

59. As a result of the design of current supply circuit 400 and especially the functioning of the first PWM control signal and the second PWM control signal, “the average current passing through the LED string 23 may be altered even while maintaining the on-state current at a substantially constant value.” Ex. 1001, 13:20-25. Since the dominant wavelength of the light emitted by the LED string varies with the current flowing through it, the dominant wavelength remains substantially stable even when the intensity varies. Id. at 13:25-28.

60. Accordingly, the specification of the '331 Patent unequivocally introduces a first PWM control signal and a second PWM control signal per LED string, within which the first PWM control signal is for dominant wavelength control (i.e., color hue control) and the second PWM control signal is for intensity control.

61. As shown below, Figure 25 of Lys and accompanying text teaches the same concept as Figure 9 of the '331 Patent. Lys expressly states that Figure 25 shows a schematic diagram with one possible embodiment for “creating the two control signals from a controller” to control one or more LEDs in a string. Ex. 1005, 83:20-22. Although the embodiment of one LED string is mentioned, Lys

immediately extrapolates the concept to “*multiple such strings*” used to create a light fixture that can vary in color and spectrum. *Id.* at 83:23-24. In other words, although only one LED string is described or shown, the techniques disclosed in relation to Figure 25a can be readily applied to multiple LED strings.

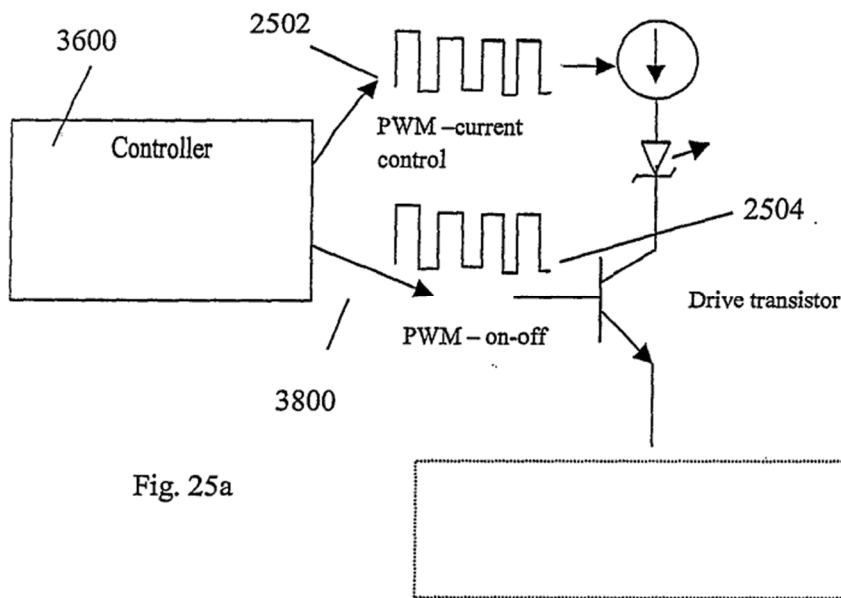


Fig. 25a

Ex. 1005, Fig. 25a.

62. The control facility 3500 (e.g., the controller 3600 shown in Figure 25a) can switch between a current control mode 2502 and a *separate* PWM mode 2504. Ex. 1005, 83:17-18. Such a system can include *simultaneous* current control (via PWM) for wavelength and PWM control (for intensity), and as a result the desired output color and intensity can be achieved. *Id.* at 83:18-20. First, the current control mode 2502 and the PWM mode 2504 are separate. They are not the same. Second, they can be achieved simultaneously. They are not mutually

exclusive. Because of these characteristics, the desired output color (by current control mode 2502) and intensity (by PWM mode 2504) can be achieved simultaneously in a balanced manner.

63. Moreover, the current control mode 2502 itself could be controlled by a PWM stream. Ex. 1005, 83:17-18. In other words, the current control mode 2502 is also implemented by a PWM control signal (i.e., a “PWM stream”). This is consistent with the illustration shown in Figure 25a of Lys, where the current control mode 2502 is labeled as “PWM – current control” and the PWM mode 2504 is labeled as “PWM – on-off.”

64. After unpacking Figure 9 of the '331 Patent and Figure 25a of Lys, a POSITA would recognize that the teachings of Lys echo the '331 Patent in essence. As shown in the annotated figures, Figure 25a of Lys and its associated text disclose the concepts packed in Figure 9 of the '331 Patent.

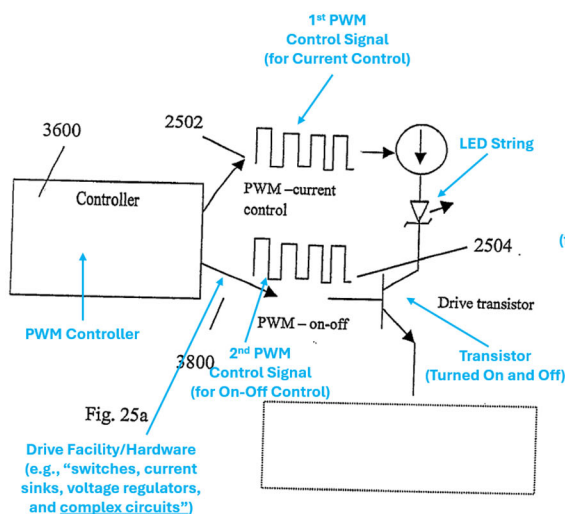


FIG. 25a of Lys

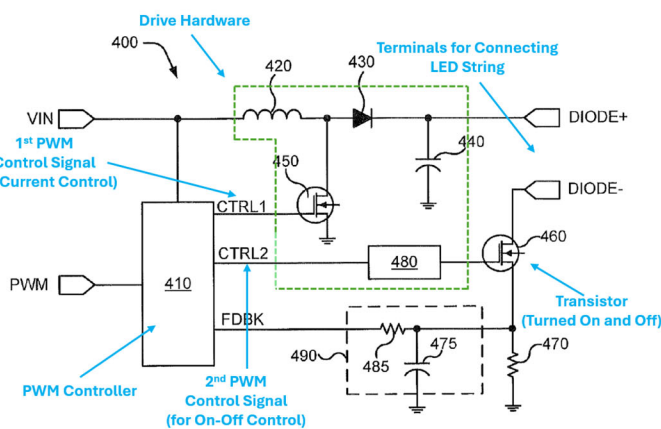


FIG. 9 of '331 Patent

Ex. 1005, Fig. 25a (annotated); Ex. 1001, Fig. 9 (annotated).

65. Notably, the PWM control signal for current control discussed in Lys corresponds to the first PWM control signal CTRL1, and both are for current control and therefore color control. Also, the PWM control signal for on-off control discussed in Lys corresponds to the second PWM control signal CTRL2, and both are for intensity control by way of adjusting the duty cycle. In other words, the fundamental operation principles embodied in Figure 25a of Lys and Figure 9 of the '331 Patent are identical in essence.

66. Since Patent Owner's understanding of the PWM controller and the two PWM control signals is profoundly incorrect, their arguments are unsurprisingly meritless. For example, Patent Owner argues that the control facility 3500 (e.g., the controller 3600 shown in Figure 25a) is not controlled by a PWM stream and therefore is not a PWM controller. Response at 19. In other words, Patent Owner assumes that what determines whether a controller is a PWM controller or not is the input side of the controller (i.e., whether it is controlled by a PWM signal). Patent Owner's argument focuses on the wrong side (the input side) of the controller. Since Lys's controller 3600 generates two PWM control signals (one for current control, the other for on-off control), the controller 3600 is a PWM controller because claim 17 requires the PWM controller "configured to generate ... a first PWM control signal and a second PWM control signal."

67. Patent Owner also argues that Lys discloses one PWM controller generating a signal for *one string*, not one PWM controller for *multiple strings*, reasoning that “each string would have its own PWM controller.” Response at 20. Patent Owner is wrong. Figure 25a is just one simplified example used to explain the PWM control mechanisms for separate and simultaneous current control (for color) and on-off control (for intensity). A POSITA would readily appreciate that multiple LED strings can *share* one PWM controller because a PWM controller normally is capable of providing multiple channels for multiple LED strings. For example, a sixteen-channel PWM controller is capable of providing individualized control for up to sixteen LED strings.

68. Patent Owner asserts that each string receives “just one signal” and not two distinct PWM control signals arguing that “the signal is passed between the drive circuitry 3800 to control one LED string.” Response at 21. This is fundamentally incorrect. Simply because the PWM control signals are passing through the same drive circuitry 3800 doesn’t mean both PWM control signals are identical. What ultimately determines whether these two signals are “just one signal” or not should be the waveforms of the two signals, not their paths. There is no evidence in Lys that prove these two PWM control signals are “just one signal.”

C. Other Claim Elements

69. Patent Owner asserts that the temperature sensor and the sense resistor in Lys must be implemented in the DC-DC converter shown in Figure. 17 of Lys and that a POSITA would not do so because of purported interference issues. Response at 38-39. I disagree because a POSITA would appreciate that the temperature sensor and the sense resistor in the current supply circuit could be implemented in conjunction with the DC-DC converter and that there are no technical obstacles to doing so.

70. Patent Owner also argues that Xu does not teach two current supply circuits coupled to the feedback input. Response at 41. This argument once again ignores common sense of a POSITA. Xu does not have to teach the feedback loop of each current supply circuit, just as Lys does not have to show a PWM controller for each LED string as discussed above. Disclosing the feedback loop for one representative current supply circuit would enable a POSITA to duplicate the feedback loop for each current supply circuit.

I hereby declare that statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. Should further information become available to me as this matter proceeds, I may

revise my opinions accordingly as necessary. I declare under penalty of perjury
that the foregoing Declaration is true and correct.

9/23/2024
Date

Rafael Betancourt
Rafael J. Betancourt