

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG DISPLAY CO., LTD; SAMSUNG ELECTRONICS CO., LTD.; and
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner

v.

POLARIS POWERLED TECHNOLOGIES, LLC,
Patent Owner

Case IPR2023-00771
U.S. Patent No. 7,259,521

DECLARATION OF THOMAS L. CREDELLE

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Polaris EX2001
Samsung v. Polaris
IPR2023-00771

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I, Thomas Credelle, declare under penalty of perjury as follows:

I. INTRODUCTION AND BACKGROUND

1. I have been retained as an expert witness by Polaris PowerLED Technologies, LLC (“Polaris”) and have been asked to provide my expert opinions regarding U.S. Patent No. 7,259,521 (“the ’521 patent,” EX1001).

2. In this declaration I provide my independent analysis of the ’521 patent in light of the materials cited below and my knowledge and experience in this field during the relevant time frame. I have been asked to consider what one of ordinary skill in the art at the time of the invention of the ’521 patent (a “POSITA”; refer to Section V below) would have understood from the specification, including scientific and technical knowledge related to the patent. I have also been asked to consider whether certain references disclose or render obvious the invention described by claims 1-5 and 7 of the ’521 patent.

3. My findings, as explained below, are based on my study, experience, and background in the fields discussed below, informed by my education in electrical engineering and solid state optics. I have also relied on my review and analysis of the prior art, information provided to me, and information that I have independently reviewed.

4. I am being compensated for my independent analysis as an expert with respect to this *inter partes* review proceeding at my standard hourly rate of

\$500/hour, but my compensation is not contingent in any way on the content of my analysis or the outcome of this proceeding. I have no financial interest in Petitioner (Samsung) or Patent Owner (Polaris) and I have no financial interest in the challenged patent.

II. QUALIFICATIONS

5. Details of my professional qualifications and background are set out in my *curriculum vitae* (EX2002) As shown in my *curriculum vitae*, I have devoted my career to the research and development and product engineering of flat panel displays and materials/optics/electronics for flat panel displays. I have over 20 years of involvement in flat panel display technology including active-matrix LCD R&D, starting in 1983 at RCA Labs and continuing at GE. I led the product development of active-matrix LCDs for notebook computers at Apple in the early 90's and had close collaboration with many LCD developers in Asia. Later in my career, while at Clairvoyante, I made significant contributions to the design and implementation of new pixel architectures for LCDs and OLEDs; both efforts involved TFT design modifications to achieve the desired goals of high pixel transmission and reduced circuit complexity. More recently, I have been involved in several patent litigation cases which required a detailed knowledge of TFT design and processing.

6. I am currently the President of TLC Display Consulting and have split my time between technical consulting and patent litigation support.

7. I received my M.S. degree in Electrical Engineering from the Massachusetts Institute of Technology in 1970, with an emphasis on Electro Optics and Solid-State Materials. I received my B.S. degree in Electrical Engineering in 1969 from Drexel University.

8. I was employed by RCA at Sarnoff Labs in Princeton, NJ, from 1970 through 1986 at first as a Member of the Technical Staff and later as a Group Manager in charge of all Active Matrix LCD research. During my time at RCA, I participated in research and development projects relating to optical materials and flat panel displays, including LCD devices. In 1983, I established the Thin Film Transistor (“TFT”) LCD Program at Sarnoff Labs. As a Group Manager, I led a project that resulted in the development of the first poly silicon TFT LCD at Sarnoff Labs. I received the Sarnoff Outstanding Achievement Award for Large Area Flat Panel TV Developments.

9. From 1986 to 1991, I was employed by GE as the Manager of TFT LCD Research and Development at the GE Research and Development Center in Schenectady, NY. My duties included contributing to and managing research and development efforts relating to TFT and LCD technology for avionics applications. While employed by GE, I led the team that built the world’s first 1-million-pixel

color LCD device. I also led the development of numerous other display devices utilizing LCD technology.

10. From 1991 to 1994, I was employed by Apple Computer as the Manager of Display Engineering. In my role at Apple, I supervised all TFT-LCD design (in-house and at vendors), engineering, and qualification for the first PowerBook notebook computers introduced to market in the United States. A key part of my effort was the evaluation and development of active matrix LCDs with improved performance, such as viewing angle, contrast ratio and uniformity and backlight control.

11. From 1994 to 1996, I was employed as the Director of Advanced Product Marketing by Allied Signal, where I was involved with the design and engineering of optical films and custom focusing LED backlight designs for improving the viewing angle performance of LCD devices.

12. From 1996 to 1999, I was employed as the Director of Product Marketing for Motorola's Flat Panel Display Division, where I worked in the development of new flat panel technology, and I also worked closely with Motorola groups responsible for integrating TFT-LCD technology into mobile phone products.

13. From 1999 to 2001, I served as the Vice President of Operations of Alien Technology Corporation. During my time at Alien Technology, I was

involved with the design and architecture of drive electronics packaging technology suitable for flexible LCD devices.

14. From 2001 to 2007, I served as the Vice President of Engineering for Clairvoyante, Inc. My responsibilities as the VP of Engineering included managing research, development, engineering, and marketing of technologies for improving the resolution and power consumption of color flat panel displays, which required significant changes to the TFT-LCD layout and LED backlight. During my time at Clairvoyante, I was therefore heavily involved with the design of the active-matrix array and the LCD driving circuitry. My work resulted in the issuance of multiple patents relating to TFT-LCD and TFT-OLED display technology.

15. From 2007 to 2008, I served as the Senior VP of Engineering for Puredepth, Inc. My responsibilities included the design of hardware and software to create 3D images on TFT-LCDs. Hardware included a high-brightness, high power LED backlight source that had to survive in slot machines 24/7. LED backlight controllers were an important part of this development work.

16. From 2008 to 2012, I served as VP Engineering at Display Engineering, a company founded to design and sell high-brightness LED-LCDs for outdoor use. Commercial LCD displays were converted to high brightness through a complete redesign of the LED backlight, LED driving circuits, and LED cooling.

LED controllers were selected based on the requirements of the newly engineered LED backlights, which were based on strings of LEDs.

17. From 2012 through 2015, I served as the Vice President of Application Engineering and Device Performance for Innova Dynamics, Inc., a nanotechnology company developing materials to be used in LCDs and touch sensors. In 2008, I founded TLC Display Consulting, a company that provides technical consulting in the areas of flat panel displays, liquid crystal displays, and related electronics. I currently serve as the President of TLC Display Consulting.

18. I have been an active member of the Society for Information Display (“SID”) for over 40 years, having attended every SID Annual Technical Symposium since 1972. I was a member of the Society for Information Display’s Program Committee for 15 years, and the Director of the Society for Information Display’s Symposium Committee for 10 years. In 1984, I was awarded the title of Fellow of the Society for Information Display in recognition of my achievements and contributions to flat panel display technology.

19. I am a named inventor on over 80 US patents relating to flat panel display and LCD technology. I have also authored several articles relating to LCD technology and flat panel displays that were published by industry periodicals such as Information Display and peer reviewed journals such as the Society for Information Display’s Digest of Technical Papers.

20. Because of my background, training, and experience, I am qualified as an expert in the technical areas relevant to the '887 patent.

III. MATERIALS CONSIDERED

21. In preparing this declaration, I have considered the claims, specification, and prosecution history of the '521 patent. As part of my analysis for this Declaration, I have considered my own knowledge and experience, including my work and experience with LCDs and OLEDs. Additional materials that I have reviewed in preparing this declaration include the following documents:

Paper/Exhibit No.	Description
1	<i>Samsung Elecs. Co. v. Polaris PowerLED Techs., LLC</i> , Case No. IPR2023-00771, Petition for <i>Inter Partes</i> Review (P.T.A.B. Mar. 24, 2023).
1001	U.S. Patent No. 7,259,521 (“the '521 patent”)
1002	Expert Declaration of Dr. Kattamis (“Kattamis Decl.”)
1004	Prosecution File History of the '521 Patent
1005	Complaint in <i>Polaris PowerLED Technologies, LLC v. Samsung Electronics America, Inc.</i> , Case No. 2:22-cv-00469 (E.D. Tex.)
1006	U.S. Patent Publication No. 2005/0190128 (“Hayafuji”)
1007	U.S. Patent Publication No. 2005/0140600 (“Kim”)
1008	International Publication No. WO 2004/034365 (“Steer”)
1009	James W. Nilsson, et al., <i>Electric Circuits</i> (5th ed. 1996) (“Nilsson”)
1010	Paul Horowitz, et al., <i>The Art Of Electronics</i> (2nd ed. 1989) (“Horowitz”)
1011	Willem den Boer, <i>Active Matrix Liquid Crystal Displays – Fundamentals and Applications</i> (1st ed. 2005) (“den Boer”)
1012	Min-Koo Han, <i>AM backplane for AMOLED</i> , PROC. OF ASID (2006) (“Han”)

Paper/Exhibit No.	Description
2003	R. Dawson, et al., “The impact of the transient response of organic light emitting diodes on the design of active matrix OLED displays,” IEEE ELEC. DEV. MTG. DIGEST (1998) (“Dawson”)

IV. CLAIM CONSTRUCTION

22. It is my opinion that none of the terms of the '521 patent require explicit construction by the Board in order to resolve the issues presented in the Petition. In forming the opinions provided herein, I have applied the plain meaning of each claim term as it would have been understood by a person of ordinary skill in the art (“POSITA”).

V. PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

23. I understand that the teaching of the prior art is viewed through the eyes of a POSITA. Counsel for Polaris has informed me that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. In my opinion, the relevant field of art for the patents-in-suit is that of electrical engineering and display technologies. I have also been informed by counsel for Polaris that the person of ordinary skill is generally familiar with the type of problems encountered in the field and the prior art solutions to those problems and possesses an ordinary level of creativity.

24. For the purpose of my opinions in this declaration, I applied Petitioner's and Dr. Kattamis's definition of a POSITA. I reserve the right to advance a different definition requiring different or additional qualifications..

VI. TECHNOLOGY BACKGROUND

A. Active Matrix architecture

25. Display elements can be driven directly to create illumination or driven passively with only row and column drivers to create low resolution displays, but the vast majority of displays use an "active matrix" of thin film transistors (TFTs) to adjust the current of each pixel. Active-matrix LCDs include a simple pixel circuit made up of low mobility amorphous silicon (a-Si) TFTs and some form of storage capacitance at each pixel of the display. The simple circuit, illustrated below, stores a voltage value to switch the liquid crystal molecules to adjust the pixel brightness, and the row and column drivers change the stored voltage on each pixel once per frame. An example of a simple active matrix for LCDs is shown below. The data line from data drivers supplies an analog signal when the select line is energized. A common connection to all pixels completes the circuit.

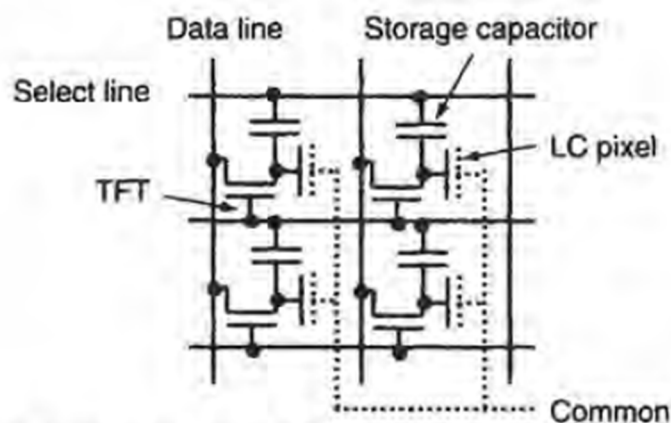


Figure 2.3: Circuit diagram for four pixels in an active matrix LCD.

EX1011, Den Boer, 26, FIG. 2.3.

26. The driving circuitry principal for AMLCDs is illustrated below for a two row by three column section of an AMLED. The row signal sequentially addressed the rows and the column drivers provide data signals simultaneously to all the pixels in a row.

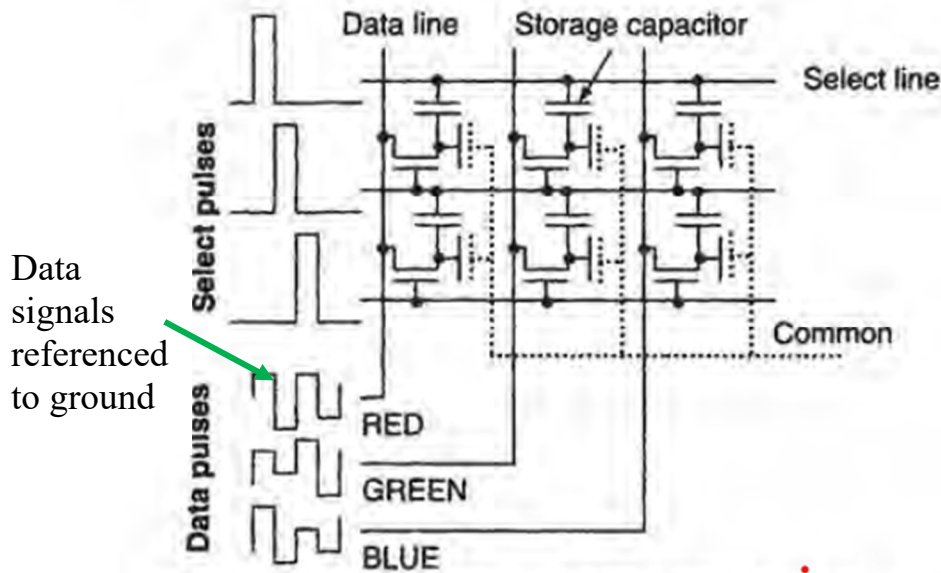


Figure 2.17: Operation of TFT LCD with drive waveforms.

EX1011, 40, FIG. 2.17 (annotated).

27. A block diagram of a typical TFT-LCD module is shown below.

EX1011, 94. Besides the source driver ICs and gate driver ICs, additional power supplies and timing controllers are shown. A digital video signal is provided to the source drivers and converted into the correct analog voltage levels for the TFT array. The data signals and gate signals are each referenced to ground to operate the display. Extensive development over the past several decades has resulted in higher levels of integration, but the basic concepts still apply.

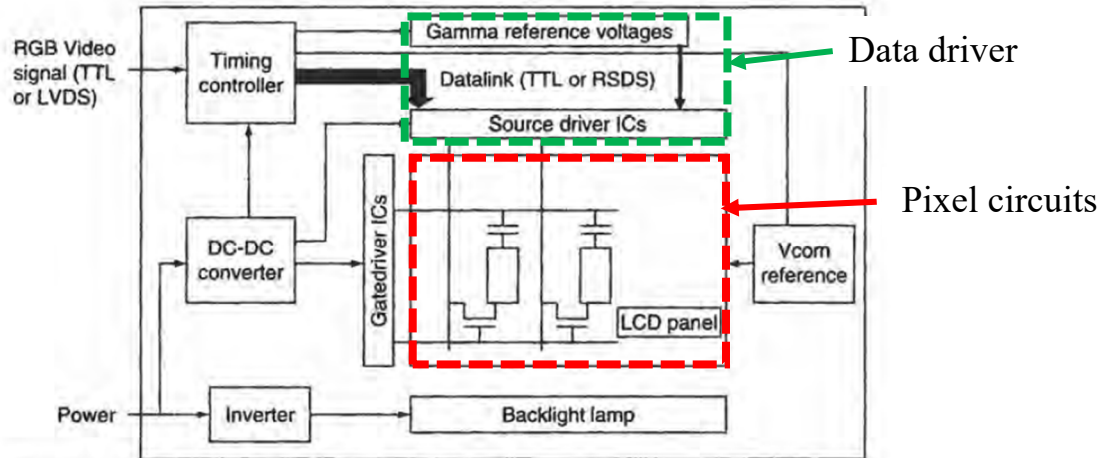


Figure 4.8: Block diagram for a TFT LCD module.

EX1011, 94, FIG. 4.8 (annotated).

28. A typical data driver circuit for AMLCDs (AMOLED data drivers are essentially the same except for the output buffer stage as higher currents are required for OLEDs) is shown below. EX1011, 97. Digital data from a source is latched into the data driver, then is converted to analog voltages with appropriate gamma correction (digital to analog converter). Analog data is then buffered through amplifiers (output buffer) to provide drive signals to the columns of the display.

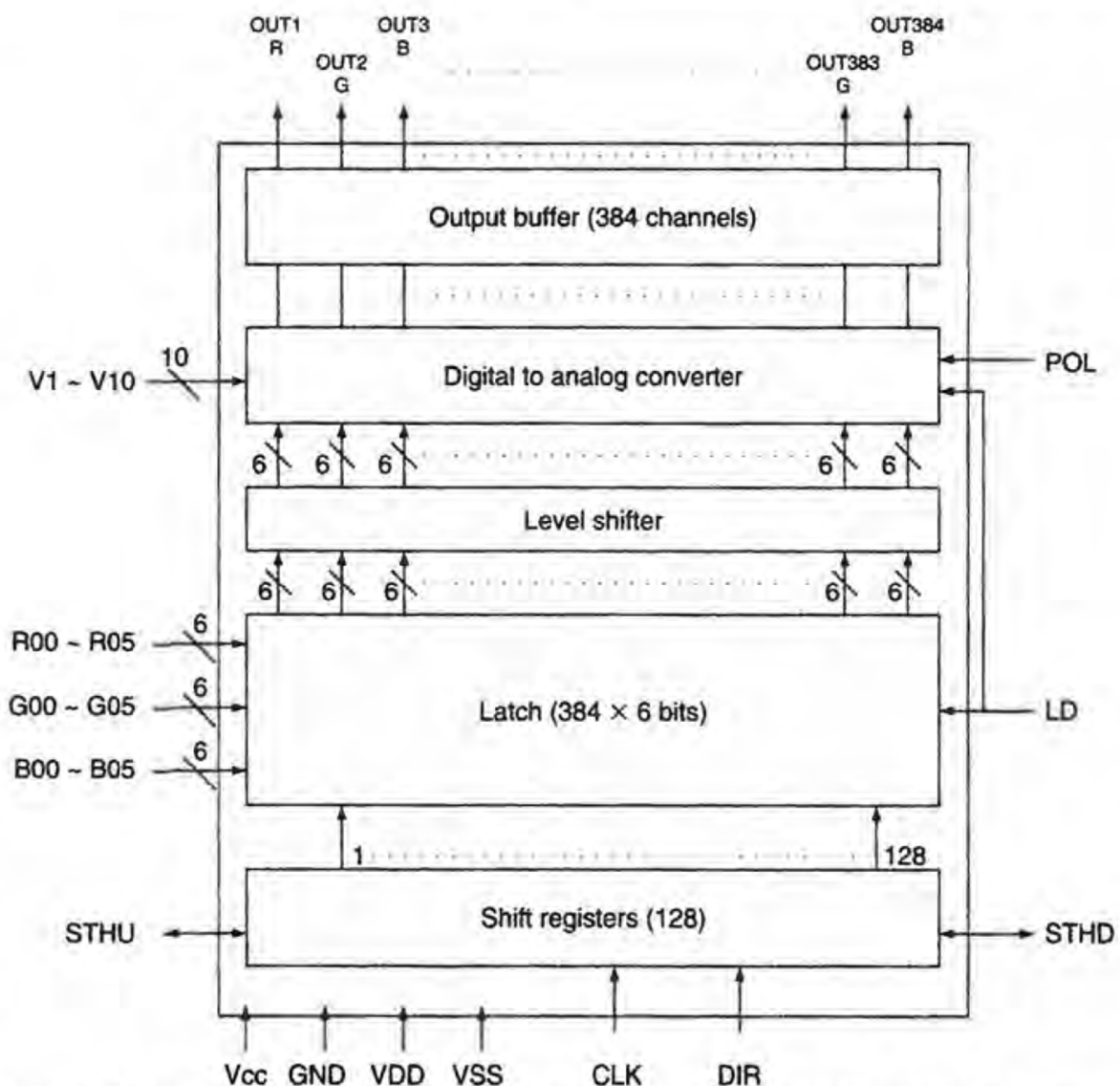


Figure 4.11: Basic architecture of a source driver IC with 384 channel outputs for use in XGA and SXGA panels (eight or ten chips per panel, respectively).

EX1011, 97, FIG. 4.11.

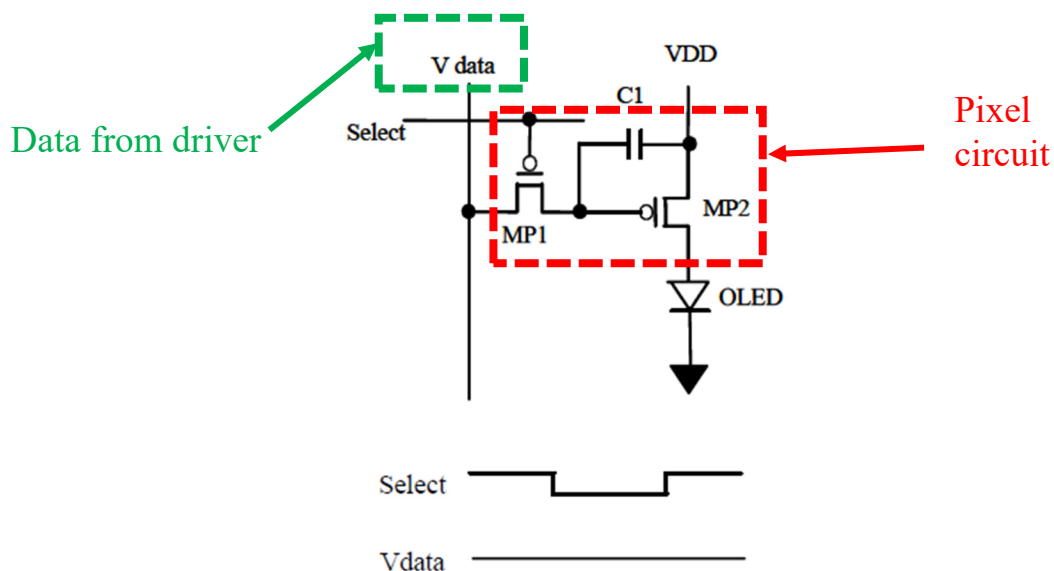
B. AMOLEDs

29. Organic Light Emitting Diode (OLED) displays have arrived on the scene over the past two decades and have several advantages over LCDs. Most importantly, the displays emit red, green, and blue light and therefore do not need

the backlight and color filters required of AMLCDs. Since they are light-emitting pixels, they can be turned off when no light is needed, e.g., a dark part of an image, and therefore can achieve higher contrast ratios and lower power for video images.

30. While OLEDs can be driven directly or passively as with LCDs, an active matrix is required to achieve the highest performance. The basic operation of an AMOLED is similar to an LCD in that rows are selected sequentially and data signals are supplied to all pixels in a row from a data driver. As with data drivers for AMLCD displays, AMOLED data drivers use amplifiers to generate the drive signals supplied to the pixels. However, since the AMOLED needs a power source to each pixel, the pixel circuit is more complicated.

31. The simplest pixel circuit used for OLEDs uses two TFTs and one capacitor; a typical pixel circuit, described by Han, is shown below. MP1 is selected to provide a data signal from a data driver, which is stored on capacitor C1. A positive voltage VDD is connected through a drive TFT MP2 to supply modulated current to the OLED. In this example, both transistors are p-type TFTs so a negative pulse turns on the TFT. Because the drive TFT must handle higher current than TFTs in AMLCDs, higher mobility devices are required; low-temperature poly silicon (LTPS) TFTs are typically used, but they suffer from non-uniform threshold voltages (denoted as V_{th}) across a substrate.



EX1012, Han, 54, FIG. 1(a) (annotated).

32. To address the issue of non-uniform transistor threshold voltages, many researchers proposed various enhancements to the simple pixel circuit even though it meant adding additional components. For example, Dawson et al. proposed in 1998 “current programming,” where current is supplied to the pixel circuit from a data driver that mirrors the desired current. EX1012, 55; EX2003, 875-878. By flowing current through the drive transistor, variations in V_{th} and mobility are cancelled out. This form of compensation worked well, but suffers from longer address times when drive current is low. EX1012, 55. The added TFTs in the pixel circuit are part of the pixel circuit and not part of the video driver which supplies the drive current. As seen by the waveforms, current I_{DATA} is reference to ground.

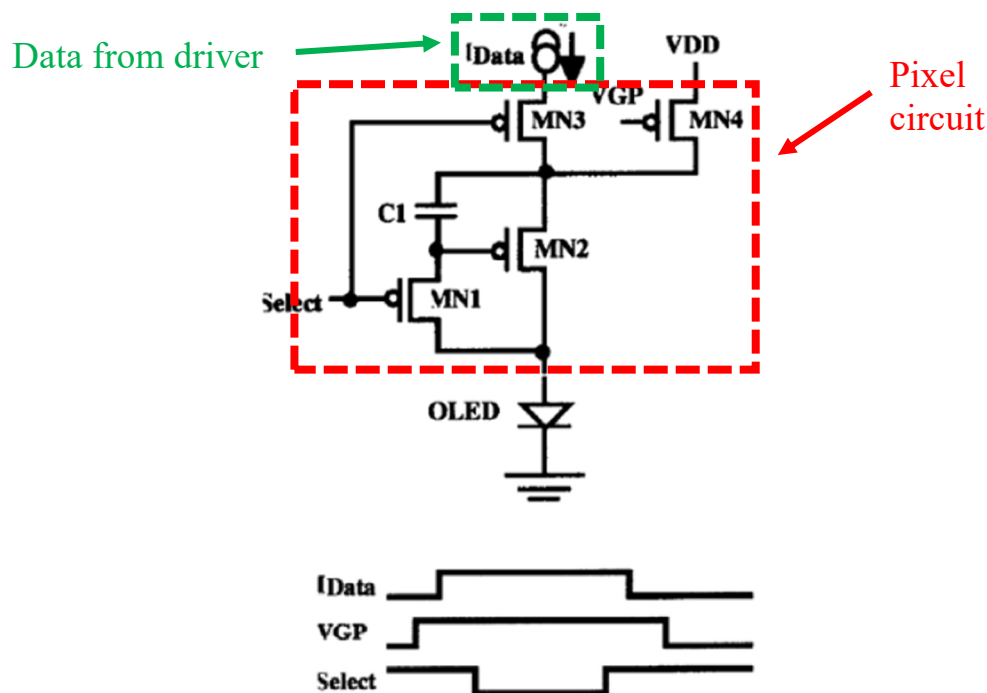


Figure 5. The reported current programming AMOLED pixel in which I_{DATA} is memorized and V_{GATE} of MN2 is determined to allow I_{DATA} [2].

EX1012, 55, FIG. 5 (annotated).

33. Another category of compensation is used with voltage programming; similar to the simple 2T-1C AMOLED circuit, an analog voltage is provided to the pixel circuit, but additional TFTs and voltages are provided to compensate for V_{th} variations in the drive TFT. As with current programming, the data is supplied along column lines from a data driver that is referenced to ground, but an additional TFT is switched to diode connect the drive TFT before programming to detect V_{th} . An additional power supply voltage, V_{sus} , is also added to provide a constant voltage to the storage capacitor. EX1012, 55.

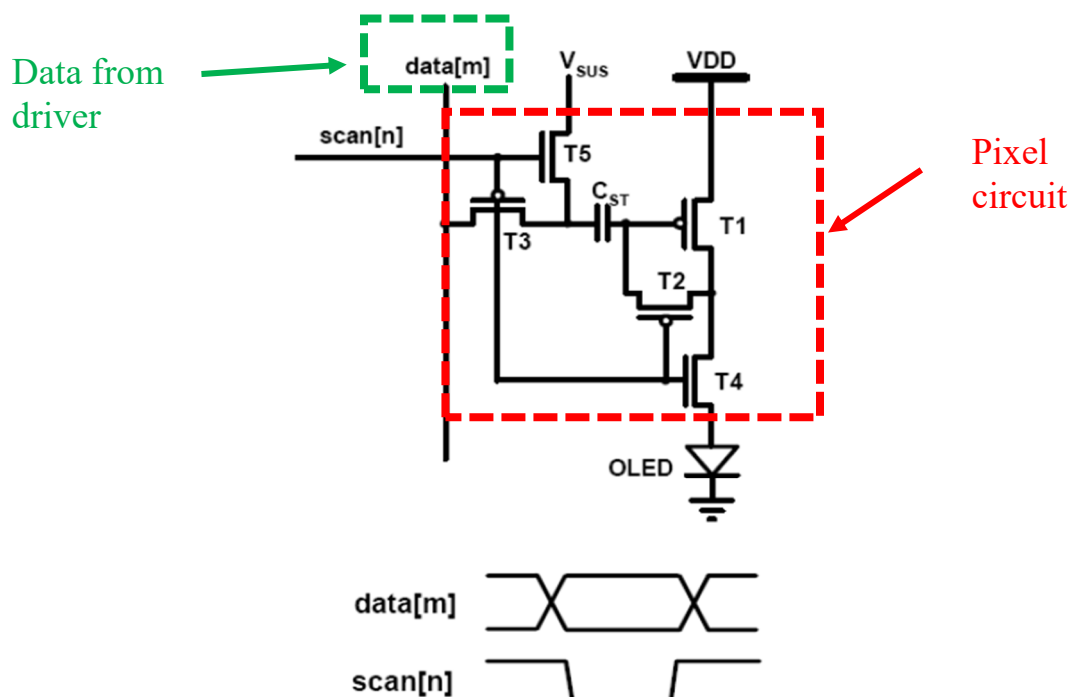


Figure 4. The reported AMOLED pixel circuit employing a reference voltage source V_{SUS} which compensates the V_{DD} supply voltage drop as well as the threshold voltage variation of poly-Si TFT [6].

EX1012, 55, FIG. 4 (annotated).

34. In summary, AMOLED displays require additional compensation to eliminate the effects of threshold variation in the drive TFT, but in all the prior art solutions, a standard video (data) driver is used to provide data to the display. A POSITA would not consider the additional TFTs in a pixel circuit used to compensate for TFT variations as ever being part of the data driver circuits just because data flows through them. In addition, all the AMOLED circuit designs use data driver and selection circuitry with a common ground reference.

VII. BACKGROUND OF THE '521 PATENT

A. Summary

35. The '521 patent, titled "Video driver architecture for AMOLED displays" issued on August 21, 2007, and was filed as application no. 11/467,738 on August 28, 2006. EX1001, '521 patent, (21), (22), (45).

B. AMOLED Displays and Power Supply Voltage Variations

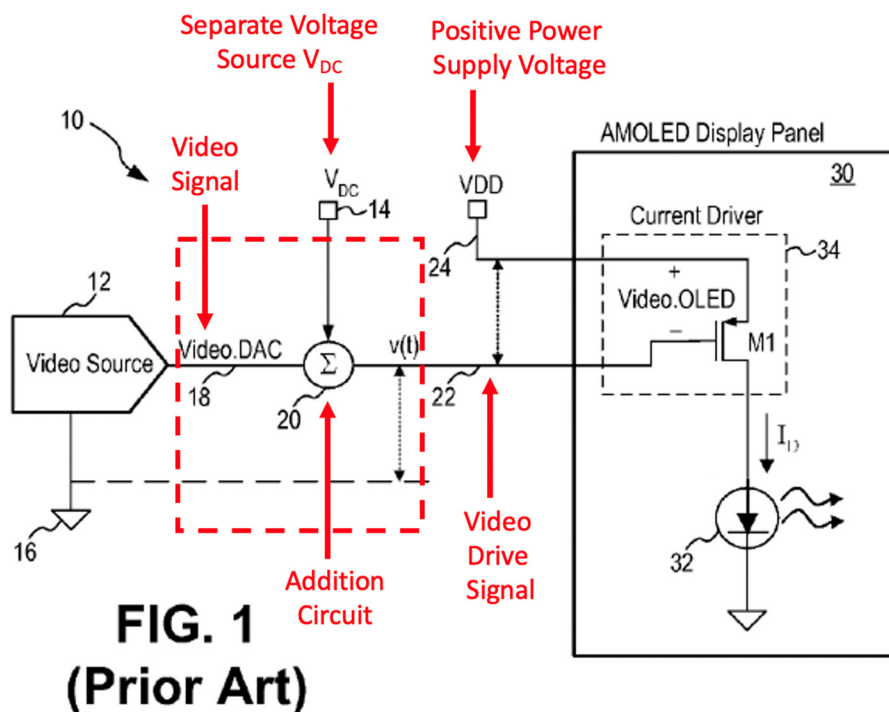
36. The '521 patent is directed to active-matrix organic light emitting diode (AMOLED) displays. EX1001, 1:13-17. AMOLED displays contain many thousands of individual OLED pixel elements, each with its own pixel driver which provides current to energize the individual pixel OLEDs. EX1001, 1:15-17. "These pixel drivers are programmed by a single current driver via a series of row and column decoders and switches such that, at any instant, only one pixel is connected to the current driver. The input to the current driver is the video drive signal." EX1001, 1:17-21. It should be noted that the pixel driver described in the '521 patent comprises a single TFT for purposes of illustration of the basic principles of the invention. The same principles apply even with additional compensation TFTs added to the circuit.

37. The current provided by the current driver is proportional to the difference between the voltage level of the video drive signal and the positive power supply voltage of the display panel." EX1001, 1:22-25. Therefore,

variations in the power supply voltage will modulate the brightness of the AMOLED display, causing the display to flicker. EX1001, 1:25-26. The direct relationship between the drive current and the power supply voltage renders AMOLED displays extremely sensitive to power supply voltage noise. EX1001, 1:32-35. In particular, when the AMOLED display is incorporated in a battery powered application, the power supply voltage will inevitably fluctuate whenever circuitry in the application device is powered up from being in a standby mode.” “For example, the AMOLED display may be incorporated in a cellular telephone where the battery voltage is coupled to a voltage regulator to provide the power supply voltage for the AMOLED display system. The power supply voltage will fluctuate when the transmitter or receiver circuit is powered up. Furthermore, battery voltage tends to drift over time.” EX1001, 1:40-51.

C. Prior Art

38. The '521 patent illustrates the problems of the prior art in its discussion of Figure 1, a schematic diagram of an exemplary prior art AMOLED display system.



EX1001, FIG. 1 (annotated).

39. In Figure 1, video source 12 provides video signals to the AMOLED display panel. EX1001, 1:56-59. The video signal, Video.DAC, is added to a DC voltage source, V_{DC} , at summing circuit 20, generating the video drive signal, $v(t)$. EX1001, 1:65-2:1. The video signal Video.DAC is referenced to ground and adding it to V_{DC} brings the analog video signal to within the range of the AMOLED display panel. EX1001, 2:1-14. The result is that video drive signal $v(t)$ is referenced to the ground voltage and its voltage value is given in the following equation:

$$\text{Eq. (1) } v(t) = \text{Video.DAC} + V_{DC}$$

EX1001, 2:6.

40. At the AMOLED display panel 30, the video drive signal $v(t)$ is coupled with Current Driver 34, which is implemented as a PMOS transistor, M1. EX1001, 2:15-17, 2:23-27. The gate of PMOS transistor M1 is connected to the video drive signal $v(t)$ and the drain is connected to power supply VDD. EX1001, 2:23-27. The drive current I_D at the OLED pixel, 32, is a function of Video.OLED, the voltage across the drain and gate terminals of transistor M1. EX1001, 2:28-30. Voltage Video.OLED is referenced to the power supply voltage VDD and is given as the following equation:

$$\text{Eq. (2) } \text{Video.OLED} = \text{VDD} - v(t)$$

EX1001, 2:37.

41. The power supply voltage VDD of the AMOLED display panel will have variations due to voltage glitches, noise, or drifts. EX1001, 2:38-41. The power supply voltage VDD can be described as the sum of an ideal power supply voltage VDDI and drift and noise components, given as the following:

$$\text{Eq. (3) } \text{VDD} = \text{V}_{\text{DDI}} + \text{V}_{\text{drift}} + \text{V}_{\text{noise}}$$

EX1001, 2:41-46.

42. The voltage Video.OLED at the display panel can be re-written by substituting $v(t)$ from Equation (1) and VDD from Equation (3) into Equation (2). EX1001, 2:47-49. The Voltage V_{DC} will not necessarily suffer from the same noise and drift issues as the power supply voltage VDD and is therefore assumed to have

the same voltage as the ideal voltage V_{DDI} (i.e., $V_{DC} = V_{DDI}$). EX1001, 2:50-53.

The current driver voltage $V_{\text{Video.OLED}}$ can be given as:

$$\begin{aligned}\text{Eq. (4)} \quad V_{\text{Video.OLED}} &= V_{DD} - v(t) \\ &= V_{DDI} + V_{\text{drift}} + V_{\text{noise}} - V_{\text{Video.DAC}} - V_{DDI} \\ &= V_{\text{drift}} + V_{\text{noise}} - V_{\text{Video.DAC}}\end{aligned}$$

EX1001, 2:53-60.

43. As can be observed in Equation (4), variations in the voltage V_{DD} (V_{drift} and V_{noise}) directly impact voltage $V_{\text{Video.OLED}}$, which determines the drive current I_D at the OLED pixel. EX1001, 2:63-67. As a result, voltage variations in the power supply cause variations in the brightness of the AMOLED display. EX1001, 2:67-3:4.

D. '521 Patent – First Embodiment

44. The '521 patent addresses the problem of power supply voltage variations by utilizing a separate video driver circuit distinct from the AMOLED display that references the video drive signal to the power supply voltage instead of to ground, as illustrated by Figure 2. EX1001, 3:8-23. The result is that any variations in the power supply voltage will cancel out at the current driver and the current I_D driving the OLED pixel will be unaffected by variations in the positive power supply voltage. EX1001, 3:58-67.

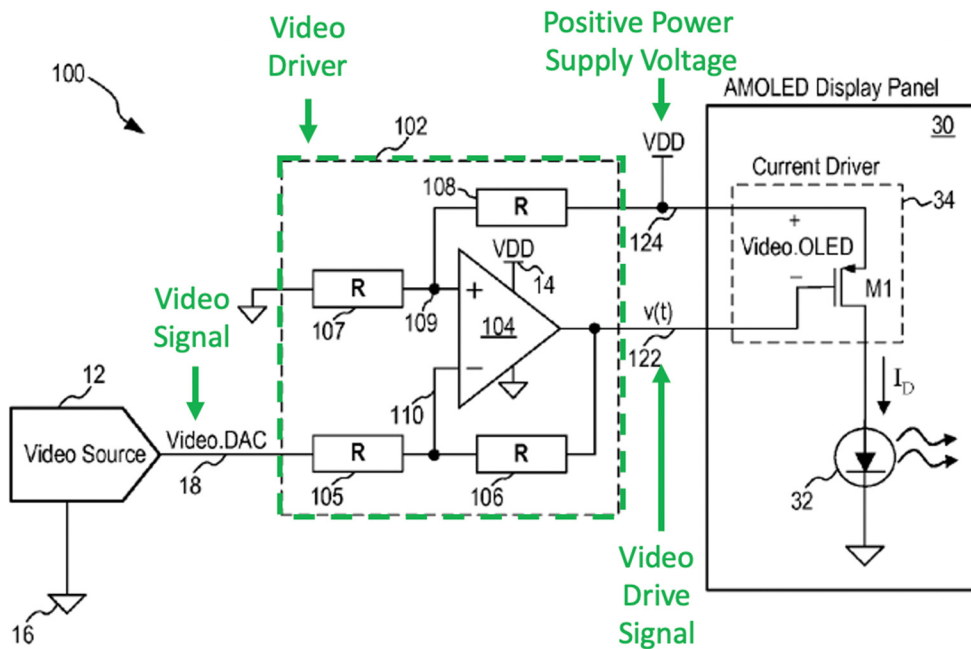


FIG. 2

EX1001, FIG. 2 (annotated).

45. Although the video driver is distinct from the AMOLED display panel, it receives the power supply voltage VDD as an input. EX1001, FIG. 2. The video driver includes a differential amplifier circuit that uses the power supply voltage VDD rather than a separate voltage source (e.g., V_{DC} in Figure 1) to generate the video drive signal. EX1001, 4:34-36. Video signal Video.DAC (18), which is referenced to ground, and VDD are fed into the positive and negative inputs, respectively, of operational amplifier (opamp) 104. EX1001, FIG. 2, 4:55-60. The opamp outputs video drive signal $v(t)$, which is the difference in voltage between Video.DAC and VDD, resulting in the referencing of the video drive signal to VDD rather than to ground. EX1001, 4:60-67. Because VDD is connected

to the positive input terminal of the opamp, when the voltage of VDD varies, the voltage of $v(t)$ also varies in such a way as to track the power supply voltage variations. EX1001, 4:60-65. The video drive signal $v(t)$ is expressed in the following equation:

$$\text{Eq. (5)} \quad v(t) = VDD - \text{Video.DAC}$$

EX1001, 4:65-55:1.

46. When the video drive signal $v(t)$ is applied to the drive transistor M1, the current drive voltage signal Video.OLED at the current driver is provided in the following equation:

$$\begin{aligned} \text{Eq. (6)} \quad \text{Video.OLED} &= VDD - v(t) \\ &= VDD - VDD + \text{Video.DAC} \\ &= \text{Video.DAC} \end{aligned}$$

EX1001, 5:6-15.

47. As can be observed from Equation (6), the current drive voltage signal Video.OLED is independent of the power supply voltage VDD. EX1001, 5:18-23.

Thus, any noise or drifts in the power supply voltage VDD will not disturb the current drive signal and will not affect the brightness of OLED pixel element 32.

EX1001, 5:20-23.

E. '521 Patent – Second Embodiment: Current Mode Isolator Circuit

48. In a second embodiment, the '521 patent discloses a video driver implemented as a current mode isolator circuit, depicted in Figure 3. EX1001, 5:46-47.

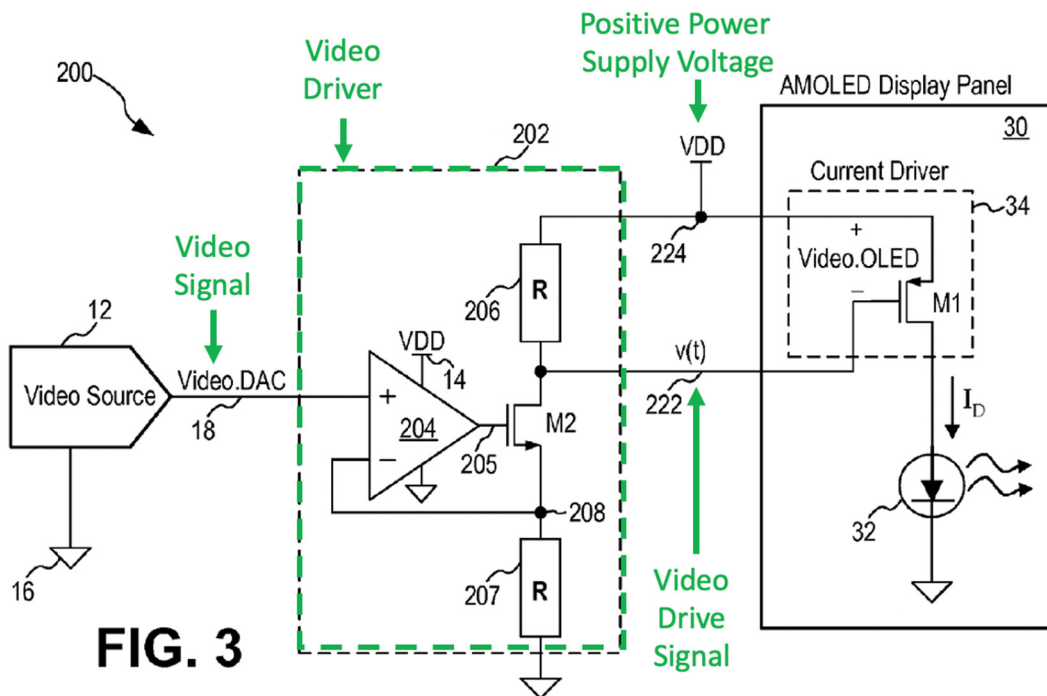


FIG. 3

EX1001, FIG. 3 (annotated).

49. As in the previous embodiment, the video driver 202 is distinct from the AMOLED display panel and receives the power supply voltage VDD as an input. EX1001, FIG. 3. “Video driver 202 includes an opamp 204 having a positive input terminal receiving the video signal Video.DAC and a negative input terminal connected in a feedback configuration.” EX1001, 5:47-50. The output of opamp 204 is coupled to the gate of NMOS transistor M2. EX1001, 5:50-52. Resistor 206

is connected between the power supply voltage VDD and the source terminal of transistor M2. EX1001, 5:52-54. Resistor 207 is connected between the drain terminal of transistor M2 and the ground voltage. EX1001, 5:55-57. The combination of opamp 204 and transistor M2 forms a transconductance amplifier where the voltage of the video signal Video.DAC is converted to a current at transistor M2 and load resistor 207. EX1001, 5:60-63. The current that passes through transistor M2 flows through resistor 206 which is referenced to the power supply voltage VDD. EX1001, 5:63-65. In this manner, the current is converted to the voltage signal $v(t)$ at node 222 which is referenced to the power supply voltage VDD through the resistive load of resistor 206. EX1001, 5:38-6:44, FIG. 3.

F. '521 Patent – Third Embodiment: Video Clamp Circuit

50. In a third embodiment, the '521 patent discloses a video driver implemented with a video clamp circuit to reference the video drive signal to the power supply voltage, depicted in Figure 4. EX1001, 6:48-50, FIG. 4.

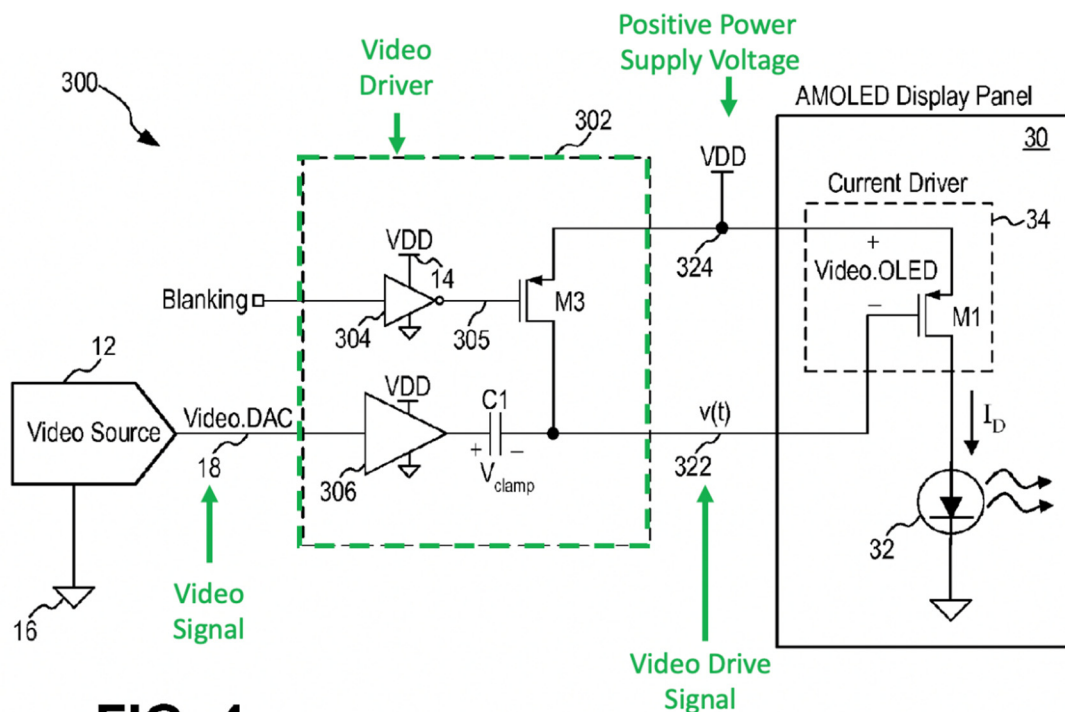


FIG. 4

EX1001, FIG. 4 (annotated).

51. As in the other embodiments, the video driver 302 is distinct from the AMOLED display panel and receives the power supply voltage VDD as an input. EX1001, FIG. 4. The video clamp circuit is implemented using an amplifier coupled to receive the video signal Video.DAC and driving the left plate of capacitor C1. EX1001, 6:50-53, FIG. 4. The right plate of capacitor C1 (node 322) is the video drive signal $v(t)$. EX1001, 6:53-54. The video driver also includes an inverter 304 receiving the video blanking signal and driving a PMOS transistor M3. EX1001, 6:54-56. The source terminal of PMOS transistor M3 is connected to the positive power supply voltage and the drain terminal is connected to capacitor C1 at node 322. EX1001, 6:56-60.

52. When the Blanking signal is asserted at the beginning of each video line to re-establish the black reference of the video display, transistor M3 is turned on and the right plate of capacitor C1 is charged up to the power supply voltage VDD. EX1001, 6:61-65. In this manner, the power supply voltage VDD, including any voltage drifts, is stored on capacitor C1 as the clamping voltage Vclamp. EX1001, 6:65-67.

53. When the blanking signal is de-asserted, transistor M3 is turned off and no longer drives node 322. EX1001, 6:67-7:2. Instead, the video signal Video.DAC is applied through amplifier 306 and is added to the clamping voltage Vclamp stored in capacitor C1. EX1001, 7:2-4. In this manner, the clamping voltage Vclamp is added to the video signal Video.DAC for the rest of the video line and the video drive signal $v(t)$ is now referenced to the power supply voltage VDD. EX1001, 7:2-8.

54. For any of the embodiments, the '521 patent teaches that the embodiments in Figures 2-4 can be implemented with discrete components, or the added driver circuit can be implemented as part of a driver integrated circuit on the AMOLED display “to reduce the component count and size of the PC board space used.” EX1001, 7:54-8:2. However, the '521 patent does not teach that the added circuit components can be incorporated into the pixel driver circuit as suggested by Dr. Kattamis. EX1002, Kattamis Decl., ¶¶92, 106-147. A POSITA in the

timeframe of the invention would clearly realize that the function of providing a video signal and the function of supplying current to the OLED pixel are completely separate. The fact that some pixel circuits add compensation circuitry (*see* Section VI.B, *supra*) does not mean that the video driver is distributed into all the pixels.

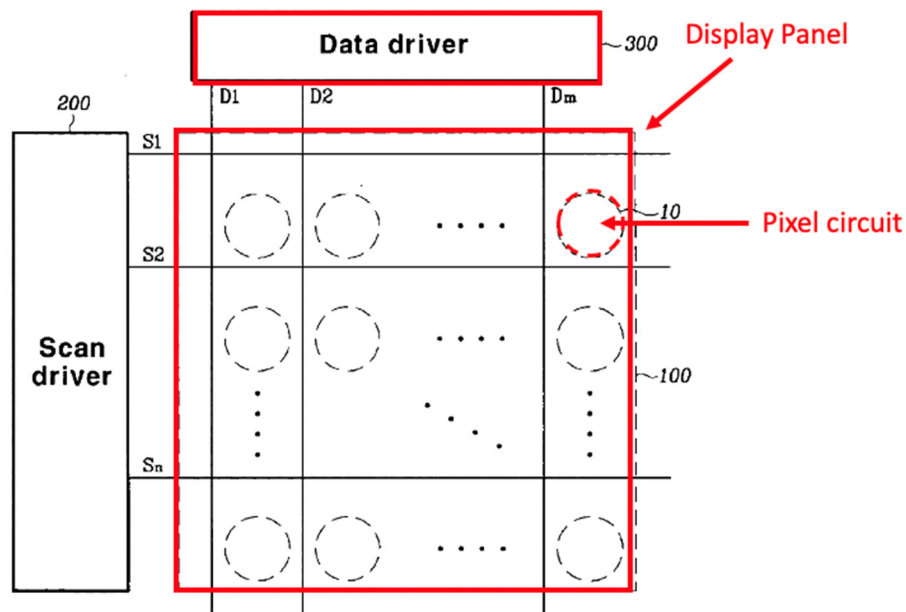
VIII. SUMMARY OF PRIOR ART

55. Each of Petitioner's references—Kim, Hayafuji, and Steer—fails to disclose, teach, or suggest at least two limitations in the '521 patent's sole independent claim (identified as elements 1-A and 1-C in the petition). As described below, neither Kim, Hayafuji, nor Steer teaches a video driver receiving the video signal and generating a video drive signal indicative of the video signal and referenced to a positive power supply voltage of the AMOLED display panel. Kim's teachings do not relate to a video driver at all, but instead disclose a compensation circuit within the pixel circuit itself to be used with standard data drivers referenced to ground. Hayafuji teaches a ripple extraction circuit that generates a voltage offset that is added to the data voltage, which is referenced to ground. Steer discloses a pixel circuit and drive circuit that uses a current compensation technique to supply a compensated data signal to the pixel circuit. The input video signal voltage is, however, referenced to ground.

A. U.S. Patent Publication No. 2005/0140600 (“Kim”)

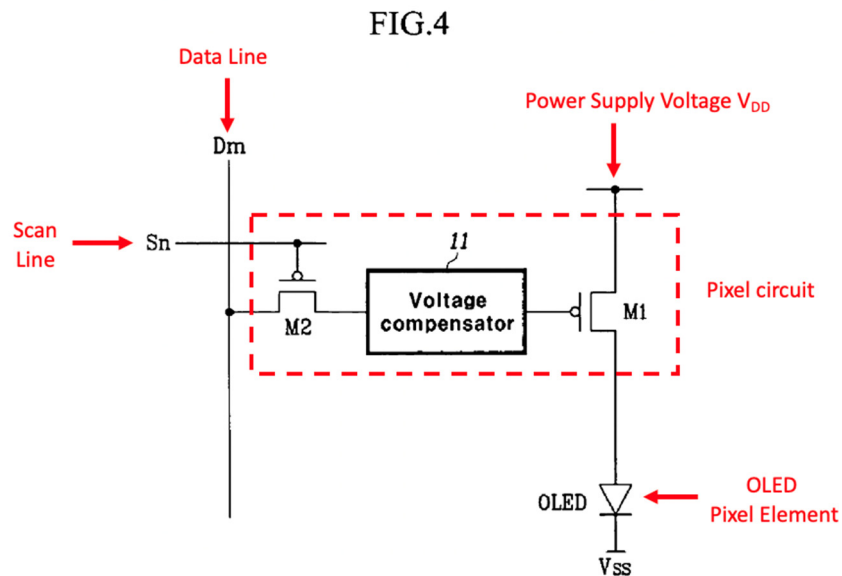
56. Kim relates to an organic light emitting diode (OLED) display architecture that includes a data driver, a scan driver, and a display panel with OLED pixels. EX1007, Kim, Abstract, ¶¶[0045]-[0046], FIG. 3. For each OLED pixel the display panel includes a corresponding pixel circuit. EX1007, Abstract; ¶¶[0045]-[0046], FIG. 3. A data driver transmits data voltages V_{data} representing video signals to the pixel circuits on the data lines and a scan driver sequentially transmits select signals for selecting the pixel circuits. EX1007, ¶[0046], FIG. 3. A POSITA would understand that the data driver 300 generates data signals V_{data} that are referenced to ground.

FIG.3



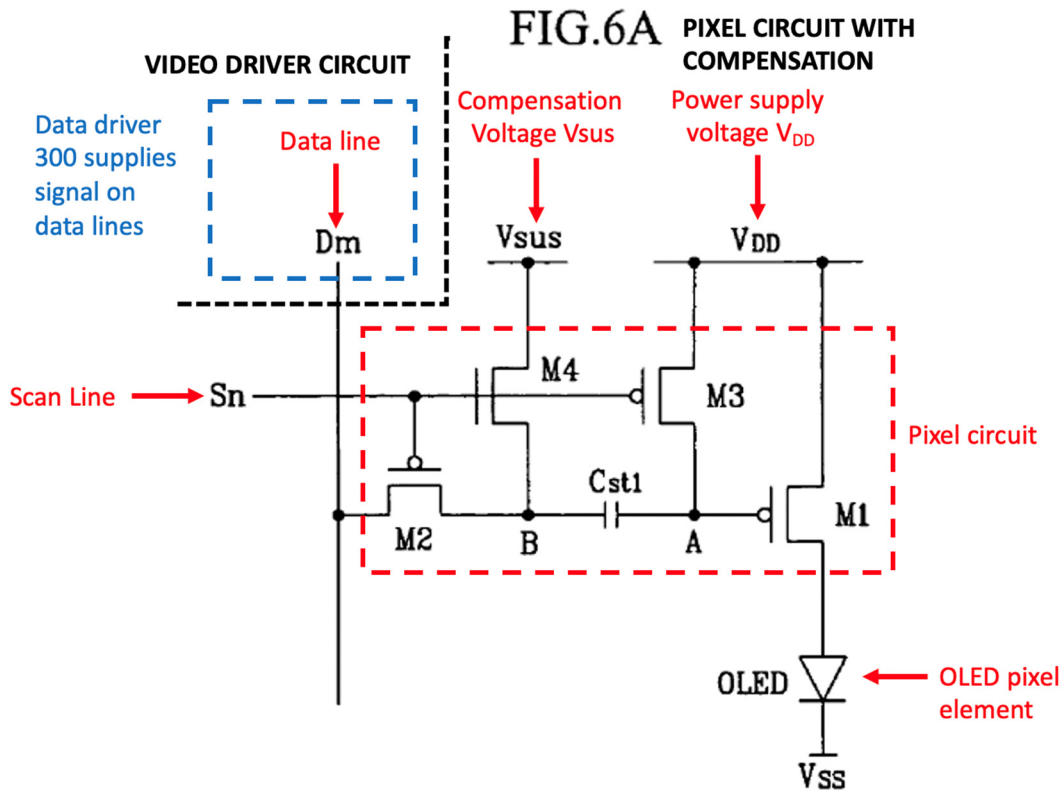
EX1007, FIG. 3 (annotated).

57. Each pixel circuit is connected to a data line, one or more scan lines, and the power supply voltage. EX1007, ¶¶[0050]-[0051]. An exemplary simplified OLED pixel circuit is disclosed in Figure 4. In this embodiment, transistor M1 is a driving transistor whose gate terminal is coupled to the power supply voltage V_{DD} and drain terminal is coupled to the OLED pixel element. EX1007, ¶[0052]. The switching transistor M2 transmits the data voltage V_{data} applied to the data lines D_m to an added circuit within the pixel circuit, referred to as a voltage compensator 11, in response to a select signal on scan line S_n . EX1007, ¶[0053]. The voltage compensator circuit consists of only switching transistors and capacitors (see EX1007, FIG. 6) and transmits a compensated data voltage to the gate of the transistor M1 to control how much current flows to the OLED pixel element. EX1007, ¶[0054].



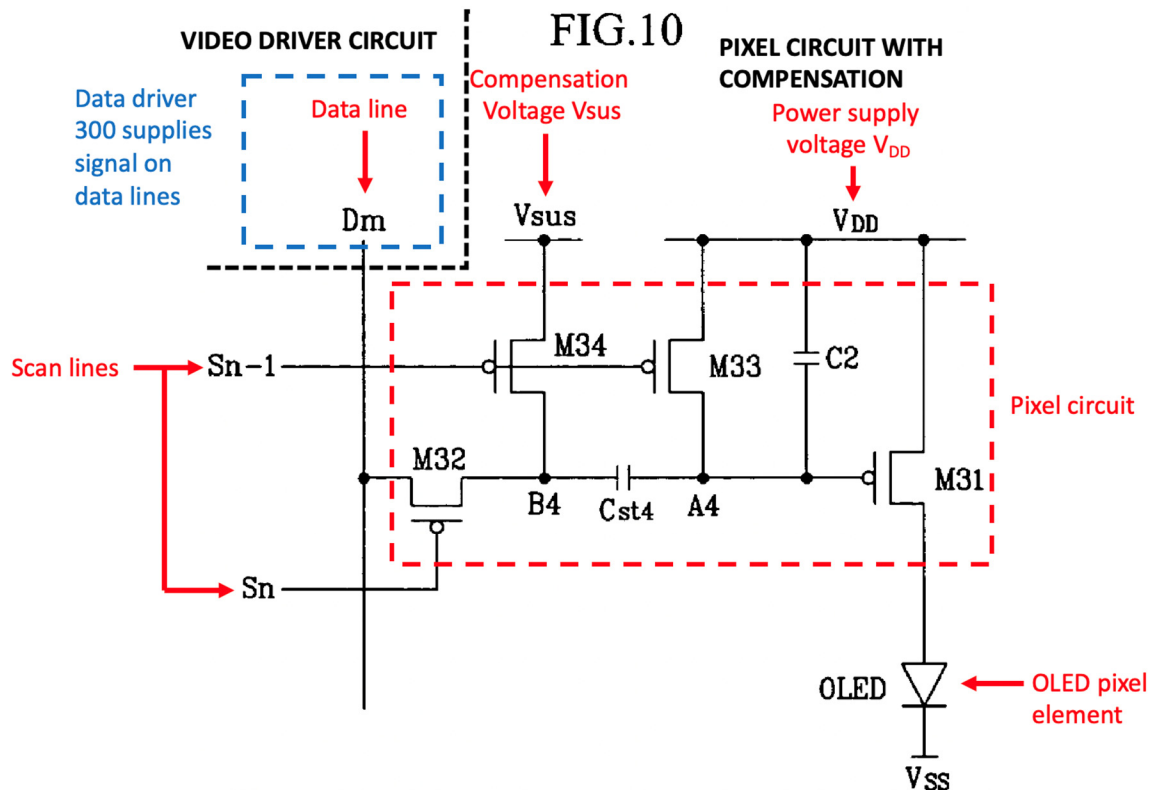
EX1007, FIG. 4 (annotated).

58. A more detailed embodiment of a pixel circuit depicting the details of the compensation circuit is disclosed in Figure 6A. In this example, a compensation voltage, V_{sus} , is connected to the compensation voltage circuit, comprising switching transistors M33 and M34 as well as coupling capacitor Cst4, within the pixel circuit. EX1007, ¶¶[0055]-[0061]. Compensated current flows to the OLED through M1, based on the compensated voltage applied between the gate and source of M1, but the compensation circuit does not *generate* any signals. EX1007, ¶[0069].



EX1007, FIG. 6A (annotated).

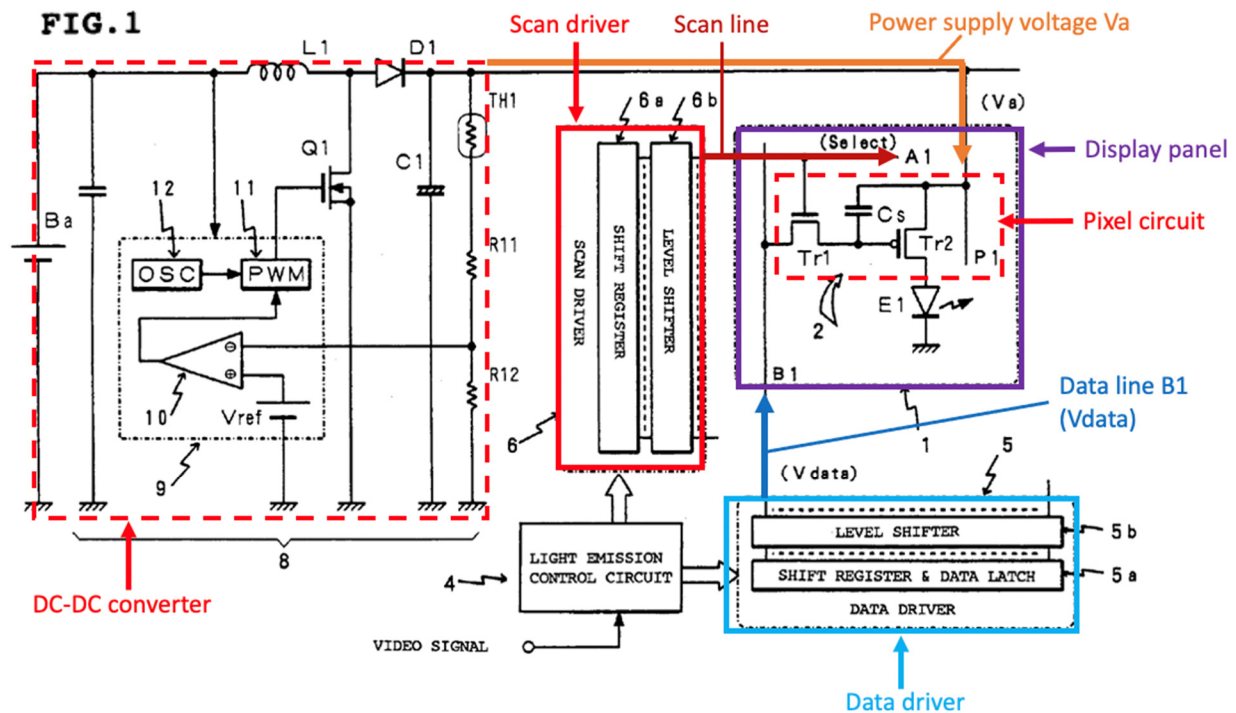
59. An additional pixel circuit embodiment is disclosed in Figure 10. In this embodiment, two scan lines are connected to each pixel circuit. EX1007, ¶¶[0104]-[0108]. The transistors M31 and M32 correspond to transistors M1 and M2 in the pixel circuit depicted in Figure 6A. EX1007, ¶[0105]. As with Figure 6A, the compensation circuit is part of the pixel circuit and does not *generate* a video signal as it is not part of the data driver 300. EX1007, FIG. 10. Compensated current flows to the OLED through M31, based on the compensated voltage applied between the gate and source of M31. EX1007, ¶¶[0105], [0113]-[0014].



EX1007, FIG. 10 (annotated).

B. U.S. Patent Publication No. 2005/0190128 (“Hayafuji”)

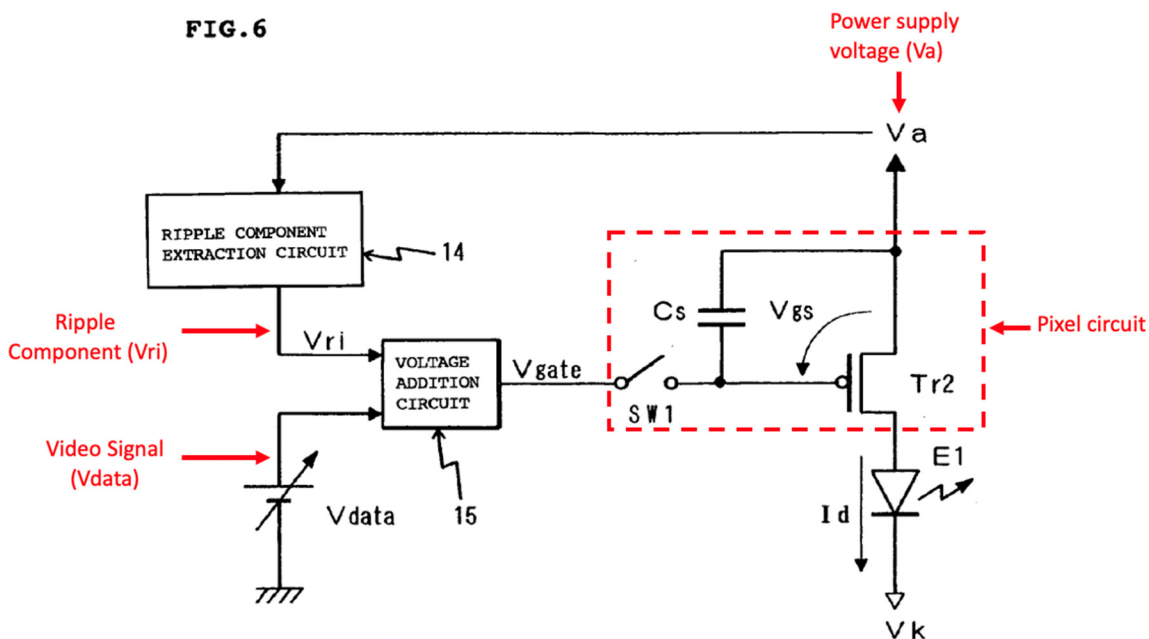
60. Hayafuji discloses a system with a DC-DC converter providing the power supply voltage for a display panel. EX1006, Hayafuji, ¶¶[0028]-[0030]. As illustrated by Figure 1, the display panel receives power supply voltage V_a from the DC-to-DC converter and display data V_{data} from the data driver (i.e., video driver). EX1006, ¶¶[0006]-[0008], FIG. 1. Scan driver transmits select signals on scan lines.



EX1006, FIG. 1 (annotated).

61. Hayafuji teaches that, in a system with a DC-DC converter that utilizes pulse width modulation (PWM), the switching operations introduce ripple noise into the power supply voltage. EX1006, ¶¶[0017], [0018], [0022]. As

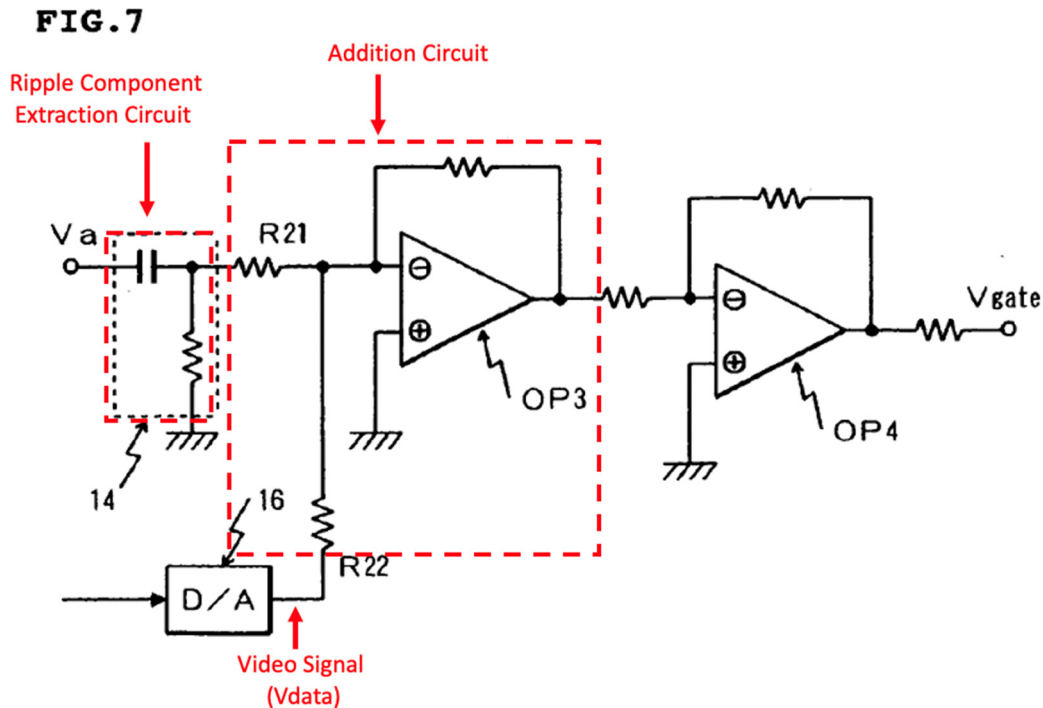
illustrated in Figure 6, Hayafuji teaches that the problem of ripple noise can be addressed by using a ripple extraction circuit and voltage addition circuit. EX1006, FIG. 6, ¶[0048]. The power supply voltage V_a is fed into the ripple extraction circuit, which outputs the ripple component of the power supply voltage, V_{ri} . EX1006, ¶[0048]. The video data from the video driver and V_{ri} are then fed into a voltage addition circuit. EX1006, ¶[0048]-[0049]. The output of the voltage addition circuit, V_{gate} , feeds into the gate of the drive transistor $Tr2$ in the pixel circuit of the display panel. EX1006, ¶[0049].



EX1006, FIG. 6 (annotated).

62. Hayafuji teaches that the ripple extraction circuit is implemented as a bypass filter, as depicted in Figure 7. EX1006, ¶[0050], FIG. 7. The bypass filter, made up of a capacitor and resistor, extracts the ripple component V_{ri} included in

the drive voltage V_a . EX1006, ¶[0050]. The voltage addition circuit is implemented using resistors R21, R22 and an operational amplifier OP3. EX1006, ¶[0051]. The output of the addition circuit passes $V_{data} + V_{ri}$ through a voltage buffer circuit constituted by operational amplifier OP4 and then to the pixel circuit. EX1006, ¶[0051]. The positive terminals of operational amplifiers OP3 and OP4 are connected to ground. EX1006, FIG. 7.

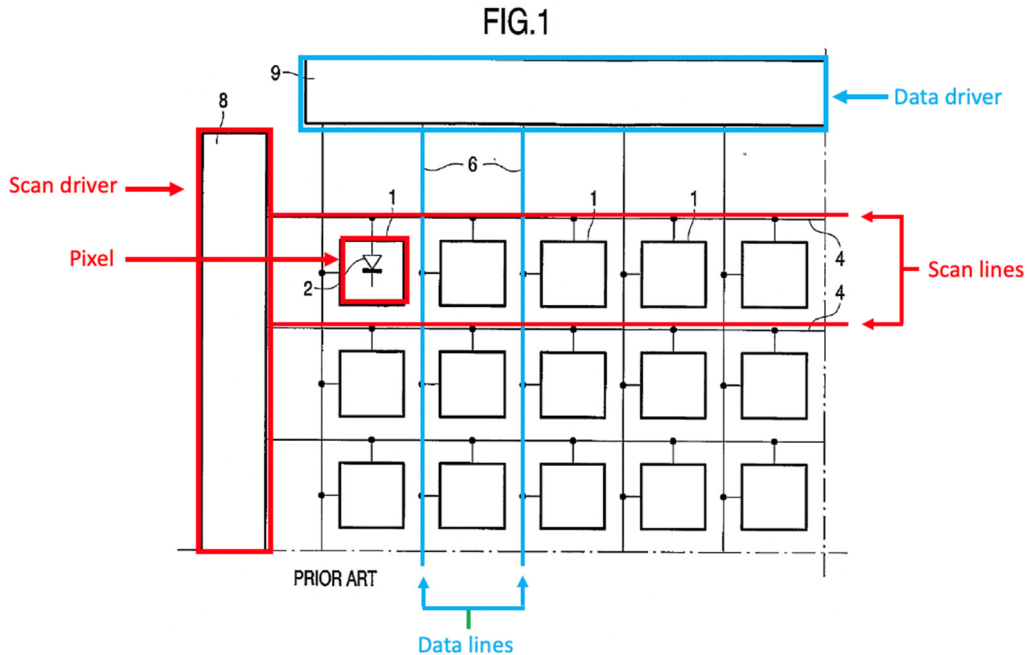


EX1006, FIG. 7 (annotated).

C. International Publication No. WO 2004/034365 (“Steer”)

63. Steer relates to an active-matrix display comprising OLED pixels, selection lines, and data lines. EX1008, 2:3-9, FIG. 1. Steer teaches a data driver

that provides image data to the pixels and a scanning driver that provides selection signals. EX1008, 2:9-13, FIG. 1.



EX1008, FIG. 1 (annotated).

64. In addition, Steer teaches a modified pixel circuit, illustrated in Figure 3, which includes, in addition to the data and scan line inputs, current compensation circuitry consisting of current measurement supply line 34, power supply voltage line 26, drive transistor 22, storage capacitor 24, a switching transistor 16, and two additional switching transistors, 30 and 32. EX1008, FIG. 3, 8:3-15. As in the conventional OLED pixel, the pixel shown in Figure 3 is voltage-programmed. However, two current paths are provided to the display element; one uses the conventional power supply line 26 and is switched by transistor 30 and

one is a current-measurement supply line 34, switched by transistor 32. EX1008, 8:3-15.

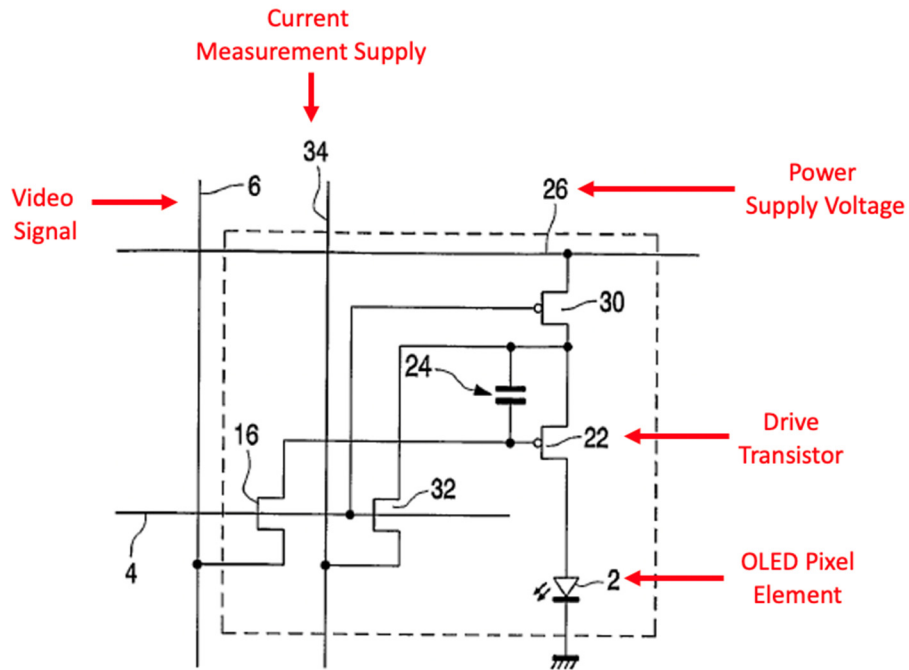


Fig.3

EX1008, FIG. 3 (annotated).

65. Steer teaches a feedback circuit, illustrated by Figure 4, that is interposed between the current-measurement supply line 34 and data line 6. EX1008, 8:21-26. The feedback circuit includes a current-to-voltage converter 42 that includes an amplifier with the current-measurement supply line 34 and power supply voltage V_{SUPPLY} as inputs and provides an output voltage at node 43. EX1008, 9:4-13. The output at node 43 is the difference between the supply voltage and current flowing in the current supply line times the resistance of the feedback resistance 46. EX1008, 9:10-13. A comparator 50 compares the voltage

at node 43 with the data signal 52. EX1008, 9:14-15. The amplified output of the comparator 50 is provided to data line 6 of the pixel circuit. EX1008, 9:17-19, FIG. 4. Hence, the comparator section 50 acts as the driver for providing data to the pixel circuit. EX1008, 9:18-19. The feedback loop is in equilibrium when the drive voltage supplied on data line 6 provides the drive that achieves the desired current. EX1008, 9:25-29.

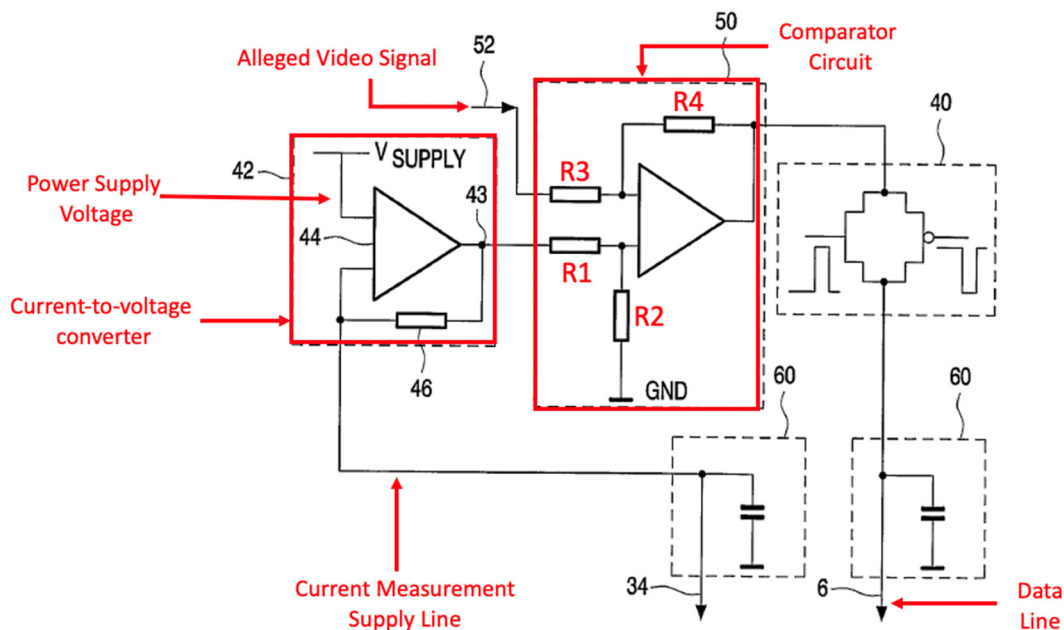


Fig.4

EX1008, FIG. 4 (annotated).

66. Steer teaches that the circuit has two modes of operation, depending on whether there is a pulse on the scan line or not. When an ON pulse is provided on the scan line, the circuit enters a pixel programming mode. EX1008, 2:30-3:9, 9:30-10:4, FIG. 3. The scan line turns on transistor 16, which allows the data signal

to travel from the feedback circuit to capacitor 24, where it is stored. EX1008, 2:30-3:9, 9:30-10:4, FIG. 3. During this phase the scan line also turns on transistor 32, allowing the current from the current-measurement supply line 34 to drive transistor 22. EX1008, 2:30-3:9, 9:30-10:4, FIG. 3. Transistor 30 is turned off during this phase, preventing the power supply voltage from driving the drive transistor. EX1008, 2:30-3:9, 9:30-10:4, FIG. 3.

67. During a subsequent mode, after the scan line pulse has ended, transistors 16 and 32 turn off and transistor 30 is turned on. EX1008, 3:6-9, 10:5-10, FIG. 3. During this mode, the compensated voltage stored in capacitor 24 is applied to the gate of drive transistor 22 and the drive transistor draws current from power supply line 26 to illuminate the OLED display element. EX1008, 3:6-9, 10:5-10, FIG. 3.

IX. GROUNDS 1 AND 2: KIM DOES NOT ANTICIPATE OR RENDER OBVIOUS CLAIMS 1, 2, AND 7 OF THE '521 PATENT

68. It is my opinion that, contrary to the claims made in the Petition and by Petitioner's expert, Dr. Kattamis, Kim does not disclose or render obvious claim elements [1-A] or [1-C] of the '521 patent. Because claims 2 and 7 depend from claim 1, those claims are also not anticipated or rendered obvious.

A. Claim [1-A]: Kim does not disclose or render obvious “a video driver receiving the video signal and generating a video drive

signal indicative of the video signal and referenced to a positive power supply voltage of the AMOLED display panel”

69. Claim 1 requires a “video driver receiving the video signal and generating a video drive signal ... referenced to a positive power supply voltage of the AMOLED display panel.” The Petition argues that the compensation circuit within the pixel circuit in the fourth embodiment of Kim, depicted in Figure 10, discloses the claimed “video driver” and that the voltage at node A4 discloses the generated “video drive signal.” Pet., 25-26, 29. With respect to the “video driver” and “video drive signal” limitations, Petitioner alleges only anticipation and not obviousness. Pet., 25-26, 29. Petitioner’s argument is incorrect for at least the following reasons. First, the alleged video driver is not a video driver at all and does not generate a video drive signal. Second, the alleged video driver is part of the display panel even though it is required to be a distinct component. Third, the alleged video drive signal is not referenced to the positive power supply voltage.

1. Kim’s pixel circuit does not include a *video driver* and does not *generate a video drive signal*.

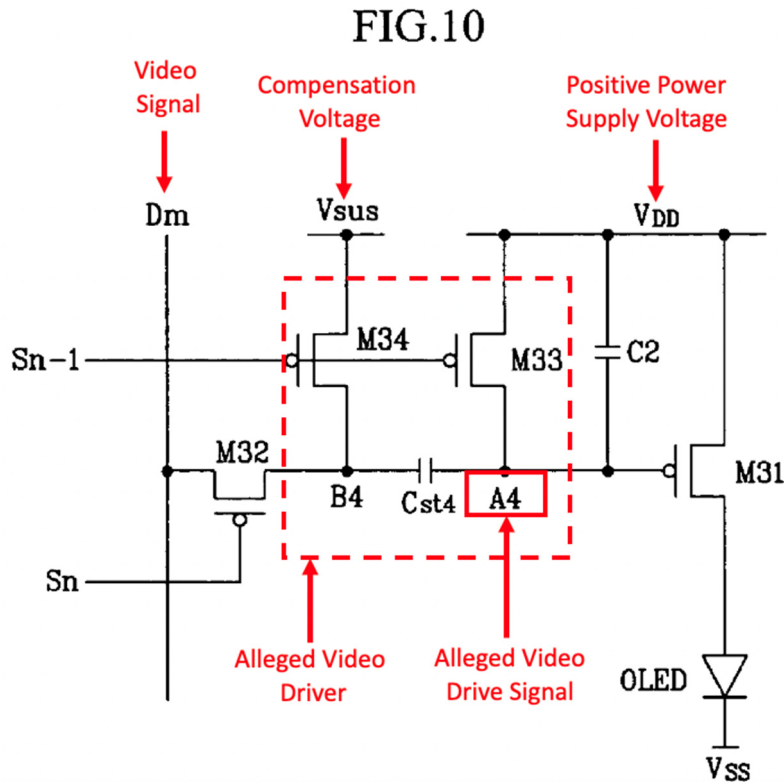
70. One of ordinary skill in the art would understand that a video driver and pixel circuit are different components in a system to drive OLEDs in a display. A POSITA would consider a video driver to be a type of data driver. Video is a type of data associated with moving pictures, but video is made up of modulated data signals generated in the data/video driver. Data drivers can also handle static

images like static computer text; the data/video driver still has to generate signals that the AMOLED can display, whether moving or not. A POSITA would understand that the claimed “video driver” is a data driver with circuitry to generate the claimed video drive signal. *See* ¶¶28-34, *supra*. Video drivers typically contain circuitry to generate or amplify digital or analog signals. *See* ¶¶28-34, *supra*. A POSITA would expect a video driver to convert video signals from a source, e.g., computer or television, to a format compatible with the pixel array. *See* ¶¶28-34, *supra*.

71. The ’521 patent states that the invention is for a video driver that functions to isolate the pixel circuit from power supply variations. EX1001, 1:5-10. A POSITA would thus understand that the invention relates to the functionality of an upstream video driver that isolates the downstream pixel circuit from the power supply voltage variations. Therefore, in the understanding of one of ordinary skill in the art, the claimed video driver of the ’521 patent is necessarily separate and distinct from the pixel circuit, which is consistent with the general usage of these terms in the field.

72. Petitioner identifies a portion of Figure 10 as the “video driver.” Pet., 25. Kim’s fourth embodiment, depicted in Figure 10, is a pixel circuit, not a video driver. EX1007, ¶¶[0104]-[0113]. Therefore, because no “video driver” is disclosed in Figure 10, Petitioner is pointing to a portion of a “pixel circuit,” which

is a completely different type of circuit that performs a different function. Because Petitioner and Dr. Kattamis improperly allege that a portion of Kim's "pixel circuit" is a "video driver," the Petition fails to identify the claimed "video driver" in Kim.



EX1007, FIG. 10 (annotated).

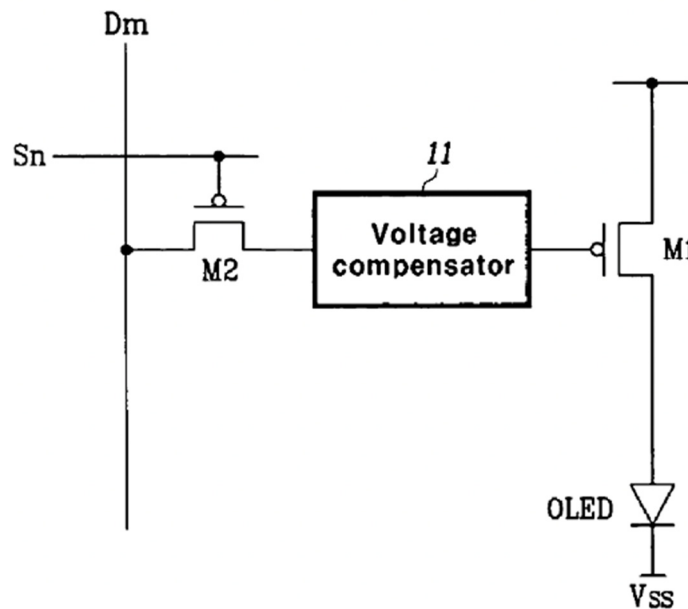
73. The pixel circuit alleged to be a "video driver" in the Petition does not "generate a video drive signal." The pixel circuit of Figure 10 lacks the necessary components of a video driver that are responsible for generating a video drive signal. This makes sense as a pixel circuit would not need any such circuitry, as its function is not to generate a video signal. One of ordinary skill in the art would

understand that a video driver would use amplifiers, among other components, to generate a drive signal. Consistent with this understanding, the video driver in each embodiment of the '521 patent includes at least one amplifier. EX1001, FIGs. 2-4. The alleged video driver of Kim includes only switching transistors M33 and M34 and capacitor Cst4, which one of ordinary skill in the art would expect in a pixel circuit. EX1007, FIG. 10. Without an amplifier, the alleged video driver is unable to generate the claimed video drive signal. EX1007, FIG. 10. Conversely, there is no need for a pixel circuit to include amplifiers, as a pixel circuit does not *generate* a drive signal.

74. Additionally, the operation of the alleged “video driver” in Kim’s fourth embodiment illustrates that it does not *generate*, but rather merely *modifies* an existing video signal. As illustrated in Kim’s Figure 4, the alleged “video driver” is a portion of the pixel circuit that functions as a compensation circuit. EX1007, FIG. 4. Specifically, when the previous select line Sn-1 is set to low, switching transistor M34 turns on and compensation voltage Vsus flows to electrode B4 of capacitor Cst4. EX1007, ¶[0107]. Switching transistor M33 also turns on and charges electrode A4 of capacitor Cst4 with the power supply voltage VDD. EX1007, ¶[0108]. When the current select line Sn becomes low, switching transistor M32 turns on and video signal Dm is applied to electrode B4 of capacitor Cst4. EX1007, ¶[0108]. The change in voltage applied to B4 causes the voltage of

electrode A4 of capacitor Cst4 to vary by the same amount as the difference between V_{sus} and D_m . EX1007, ¶[0109]. One of ordinary skill in the art would understand that the operation of switching transistors M33 and M34 and capacitor Cst4 described above *adjusts* but does not *generate* a video drive signal.

FIG.4

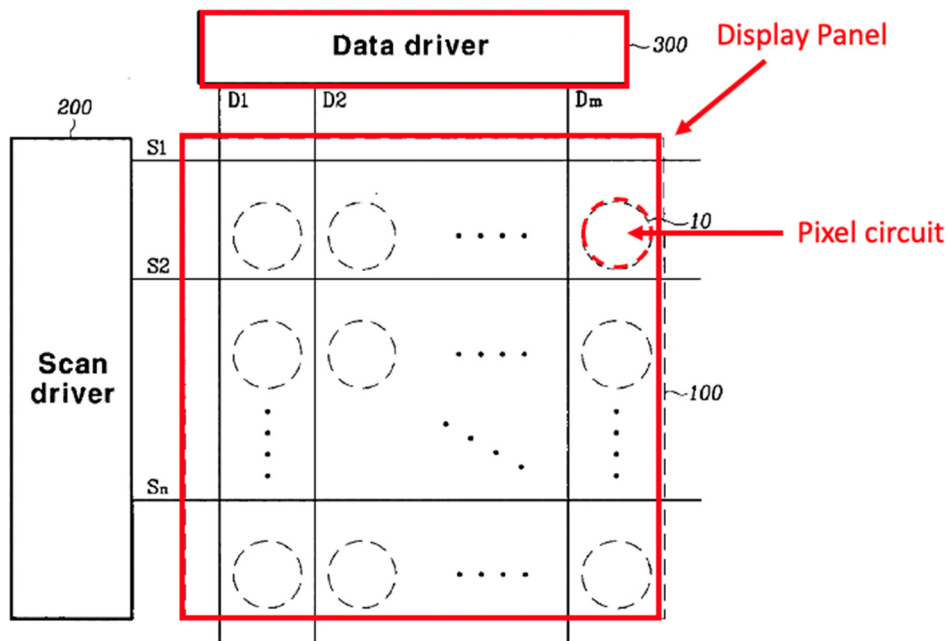


EX1007, FIG. 4.

75. The Petition's identification of the compensation circuit of Kim's Figure 10 embodiment as a video driver does not make sense in the context of Kim's disclosure as a whole. A POSITA would understand that the only component in Kim that generates a drive signal with video data is data driver 300, as illustrated in Kim's Figure 3. EX1007, FIG. 3, ¶¶[0044]-[0046]. However, there

is no disclosure that Kim's data driver 300 generates a signal that is referenced to the power supply voltage. This is not surprising because data drivers are typically referenced to ground. ¶¶28-34, *supra*.

FIG.3



EX1007, FIG. 3 (annotated).

76. The '521 patent and Kim address different problems, which explains why they teach different designs. The problems addressed by the '521 patent include undesirable voltage drift and noise, such as that caused by components in a battery-powered system turning on. EX1001, 1:40-55. These are system-wide problems and do not require pixel-level solutions. Thus, it would make sense for a POSITA to implement a solution in a video driver external to the individual pixel

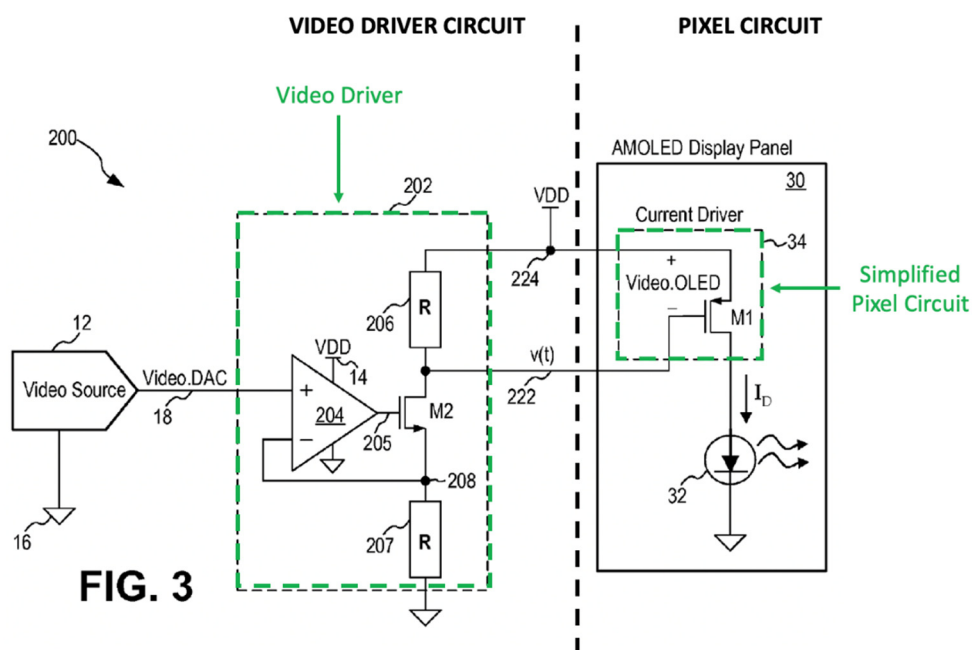
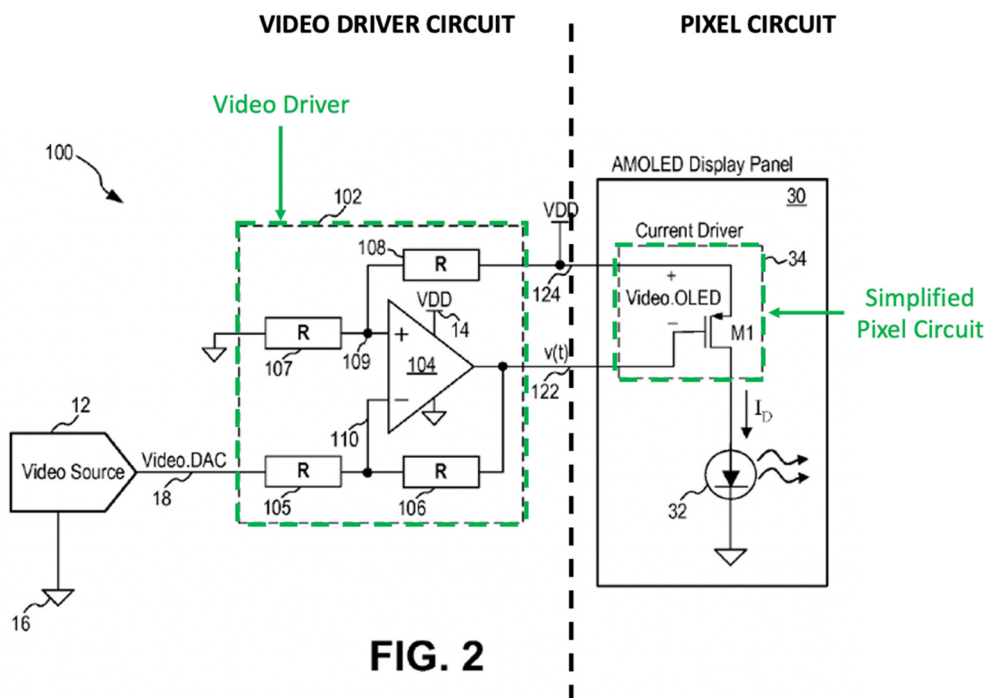
circuits. In contrast, the problems Kim attempts to solve include variations in voltage drop at different pixels and variations in transistor threshold voltages at different pixels. EX1007, ¶¶[0013], [0015], [0016]. These problems vary from pixel to pixel and therefore require a solution within each pixel circuit, which is how conventional compensation circuits are implemented. ¶¶29-34, *supra*.

77. Thus, Kim does not teach this claim element because the pixel circuit of Figure 10 does not include an actual *video driver* and does not *generate* a video drive signal.

2. Kim’s pixel circuit is part of the display panel and therefore not the claimed video driver.

78. Because Kim’s “pixel circuit” in Figure 10 is part of the display panel, no portion of the “pixel circuit” can be the “video driver” limitation under the plain language of claim 1, which identifies them as separate elements. Kim discloses that the “pixel circuits” like the one shown in Figure 10 are part of the display panel. EX1007, ¶¶[0018]-[0021], [0046], FIG. 3. This is consistent with the common understanding in the art that pixel circuits are part of AMOLED displays. ¶¶29-34, *supra*.

79. The ’521 patent similarly describes pixel circuits as being part of the display panel. EX1001, 1:6-9, 1:14-21. In contrast, the ’521 patent describes video drivers as being distinct from the display panel. EX1001, FIGs. 2-4.



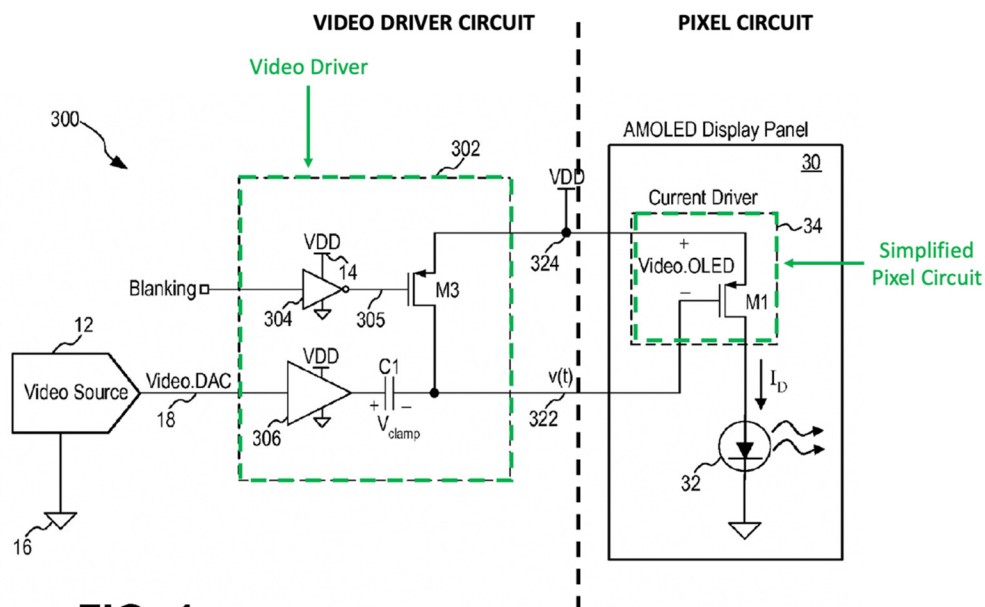


FIG. 4

EX1001, FIGs. 2-4 (annotated).

80. Additionally, in the context of the third embodiment, the '521 patent explicitly states that the video driver generates a signal for an entire line of the display panel at a time, which necessarily requires it to be separate from the pixel circuits. EX1001, 7:4-6 (“In this manner, the clamping voltage V_{clamp} is added to the video signal Video.DAC for the rest of the video line[.]”).

81. Petitioner has therefore failed to identify a “video driver” that is separate from the “display panel” as required by the claims.

3. The accused video drive signal is not *referenced to the power supply voltage*.

82. Claim 1 requires the video drive signal to be “referenced to a positive power supply voltage.” Petitioner argues that the voltage at electrode A4 in Kim’s fourth embodiment discloses the claimed “video drive signal.” The Petition alleges

that is referenced to the power supply voltage because Kim's Equation 11 adds V_{DATA} to VDD: $V_{A4} = VDD + \Delta V_{B4} = VDD + V_{DATA} - V_{sus}$. Pet., 29-30. However, due to variations in VDD over time, the value of VDD used to calculate V_{A4} is not the same value of VDD that is applied to the drive transistor during the emission period. Therefore, V_{A4} is not referenced to the positive power supply voltage.

83. To determine the drive current to the OLED pixel in Kim's Figure 10 embodiment, the power supply voltage VDD and the voltage of A4 are applied to the electrodes of capacitor C2, represented by Equation 12. EX1007, ¶[0112]. The corresponding current flows to the OLED pixel.

$$(Eq\ 12): VC2 = VDD - (VDD + V_{DATA} - V_{sus}) = V_{DATA} - V_{sus}$$

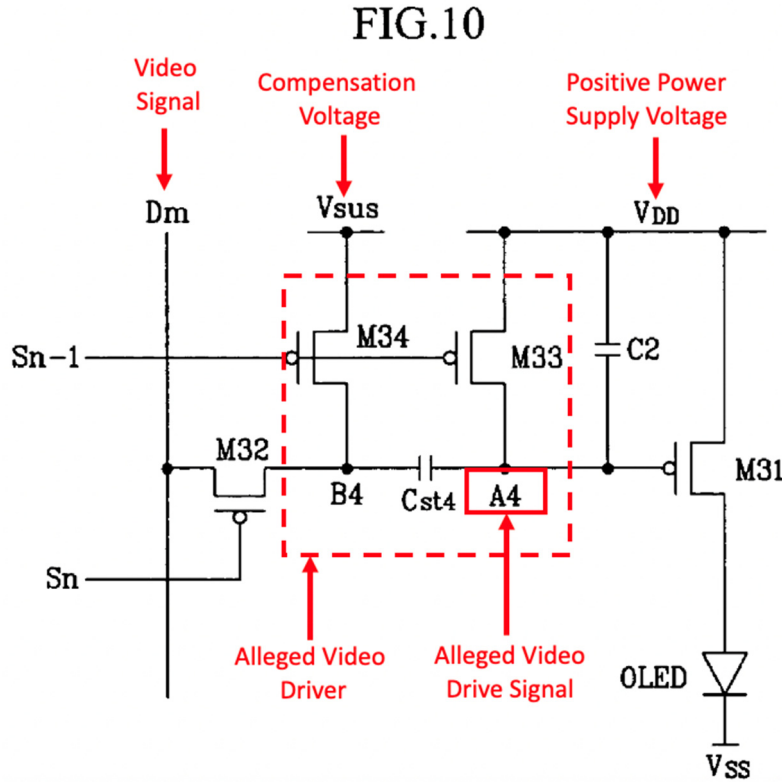
EX1007, ¶[0112].

84. However, the positive power supply voltage VDD is not constant with time. More accurately, VDD includes a constant ideal voltage component as well as undesirable voltage variation components such as noise and drift that vary with time:

$$VDD = VDD(t) = V_{DC} + V_{drift}(t) + V_{noise}(t)$$

85. The value of VDD that is used to determine V_{A4} in Equation 11 is not the same value of VDD that is applied to the source of drive transistor M31 during the emission period (when current is driving the pixel). When S_n goes low and S_{n-1} goes high, the transistor M33 is turned off and VDD is no longer applied to

electrode A4 of capacitor Cst4. Therefore, the value of VDD at A4 no longer varies with the power supply voltage connected to drive transistor M31.



EX1007, FIG. 10 (annotated).

86. Using t_1 to indicate the short period of time during which VDD is applied to electrode A4 of capacitor Cst4 and t to indicate the longer time period during which VDD is applied to the source terminal of drive transistor M31 and current is flowing to the OLED, Equations 11 and 12 can be re-written as follows:

$$V_{A4} = V_{DD}(t_1) + \Delta V_{B4} = V_{DD}(t_1) + V_{DATA} - V_{sus}$$

$$V_{C2} = V_{DD}(t) - (V_{DD}(t_1) + V_{DATA} - V_{sus}).$$

87. In the modified equations above, $VDD(t_1)$ is a constant representing the value of VDD stored on the A4 electrode of capacitor Cst4 after transistor M33 turns off and VDD no longer is connected to the capacitor. This is different than $VDD(t)$, which is the value of VDD over time and that is connected to the source terminal of drive transistor M31 when current is flowing to the pixel. The value of VA4 is therefore not referenced to the relevant power supply voltage that is applied to the source terminal of drive transistor M31 while current is supplied to the pixel, which is $VDD(t)$. Instead, VA4 is referenced to the value of VDD at earlier time t_1 , $VDD(t_1)$.

88. The Petition alleges that Kim's fourth embodiment is similar to the third embodiment of the '521 patent, which discloses a clamping voltage stored on capacitor C1, depicted in Figure 4 below. Pet., 30. I disagree. In Figure 4 of the '521 patent, amplifier 306 receives the power supply voltage VDD, which is different than typical video driver amplifier circuits, which use a separate voltage supply (e.g., similar to V_{DC} described in the '521 patent). EX1001, FIG. 4. This voltage VDD varies over time just like the voltage VDD that is applied to the drive transistor in the pixel circuit during the emission phase. Therefore, the output of amplifier 306 would continue to be impacted by variations in VDD even after the clamping voltage is set on capacitor C1.

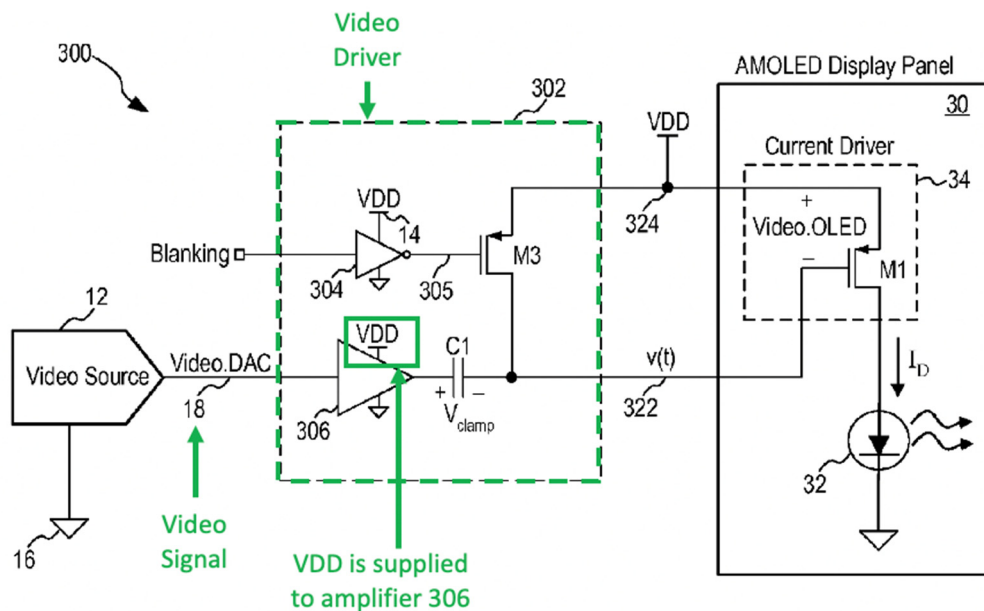


FIG. 4

EX1001, FIG. 4 (annotated).

89. Therefore, Kim does not disclose or render obvious a video drive signal referenced to the positive power supply voltage of the AMOLED display panel.

B. Claim Element [1-C]: Kim does not disclose or render obvious “...a current driver coupled to at least one OLED pixel element ... the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage”

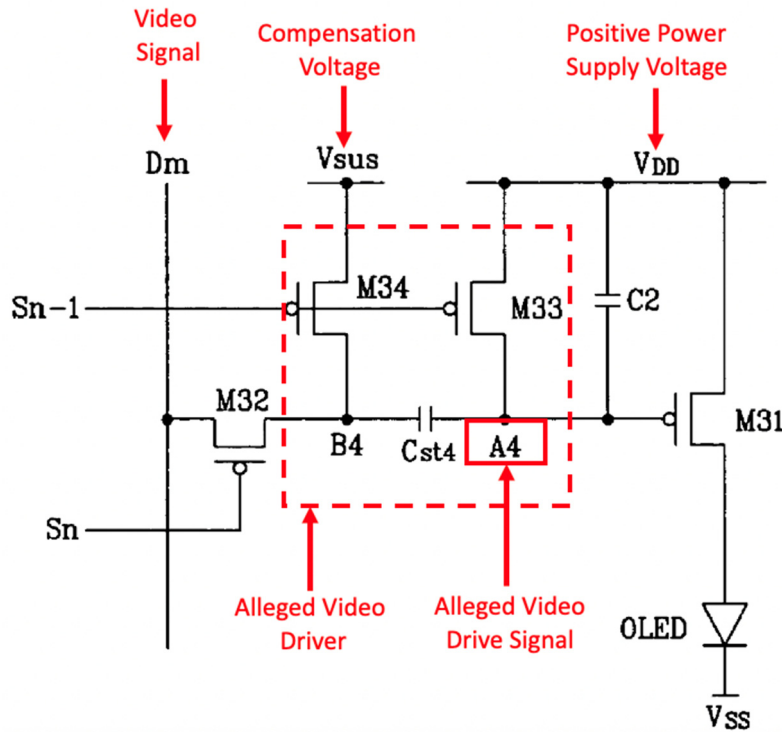
90. Claim 1 requires a “drive current being ... independent of the positive power supply voltage.” Alleging disclosure and not obviousness, the Petition argues that the drive current in Kim’s Figure 10 embodiment is independent of the power supply voltage because the equation 13 describing the current flowing to the OLED does not include the power supply voltage VDD: $I_{\text{OLED}} = \beta/2 * (V_{\text{GS}31} -$

$V_{TH31})^2$. Pet., 38-39. Equation 13, however, presents an overly simplistic view of the drive current.

91. In the context of the '521 patent, the drive current is independent of the positive power supply voltage if the power supply voltage is not a factor in calculating the drive current and at least unwanted voltage drift is removed from the current drive voltage. EX1001, 5:6-15, 6:20-29, 7:36-43. Due to changes over time of unwanted voltage variations such as noise and drift, these voltage variations are not removed from the current drive voltage in Kim.

92. The Petition alleges that the drive current to the OLED pixel in Kim's Figure 10 embodiment is independent of the positive power supply voltage. Pet., 38-39. Similar to the prior art disclosed in the '521 patent specification, Kim's fourth embodiment teaches introducing a separate supply voltage, V_{sus} , into the pixel circuit to generate a compensated signal that drives the transistor coupled to the OLED. EX1007, ¶¶[0106]-[0108]; EX1001, 1:65-2:14, FIG. 1. As illustrated in Kim's Figure 10, data line Dm carries the video signal and V_{sus} is a compensation voltage separate from the power supply voltage V_{DD} . EX1007, ¶[0117].

FIG.10



EX1007, FIG. 10 (annotated).

93. When the previous select line S_{n-1} is low level, transistor M34 is turned on and compensation voltage V_{sus} (also a positive power supply voltage) is applied to electrode B4 of capacitor Cst4. EX1007, ¶[0107]. Transistor M33 is also turned on and power supply voltage V_{DD} is applied to terminal A4 of capacitor Cst4. EX1007, ¶[0107]. When the current select line S_n becomes low level, transistor M32 turns on and video signal D_m is applied to terminal B4 of capacitor Cst4. EX1007, ¶[0108]. When this occurs, the voltage of electrode A4 of capacitor Cst4 correspondingly changes by the value of the voltage change in electrode B4

which is the difference between V_{sus} and D_m . The voltage at A4 is described in

Equation 11:

$$(Eq\ 11): V_{A4} = V_{DD} + \Delta V_{B4} = V_{DD} + V_{DATA} - V_{sus}$$

EX1007, ¶¶[0108]-[0109].

94. The power supply voltage V_{DD} and the voltage of A4 are applied to the electrodes of capacitor C2, represented by Equation 12. EX1007, ¶¶[0110]-[0112]. The corresponding current flows to the OLED pixel. EX1007, ¶¶[0110]-[0112].

$$(Eq\ 12): V_{C2} = V_{DD} - (V_{DD} + V_{DATA} - V_{sus}) = V_{DATA} - V_{sus}$$

EX1007, ¶[0112].

95. The current that flows through transistor M31 to the OLED pixel is given as Equation 13, where V_{GS} is the gate-source voltage of M31 and V_{TH31} is the threshold voltage of drive transistor M31:

$$(Eq\ 13): I_{OLED} = \beta/2 * (V_{GS31} - V_{TH31})^2$$

EX1007, ¶[0113].

96. However, Equation 13 ignores the variations in V_{DD} over time. More accurately, V_{DD} includes a constant ideal voltage component as well as undesirable voltage variation components such as noise and drift that vary with time:

$$V_{DD} = V_{DD}(t) = V_{DC} + V_{drift}(t) + V_{noise}(t)$$

97. To solve for the OLED pixel drive current, I_{OLED} , Kim's Equation 13 can be re-written as follows:

$$\text{(Eq 13): } I_{\text{OLED}} = \beta/2 * (V_{\text{GS}31} - V_{\text{TH}31})^2$$

$$I_{\text{OLED}} = \beta/2 * (V_{\text{DD}}(t) + V_{\text{DATA}} - V_{\text{sus}} - V_{\text{DD}}(t1) - V_{\text{TH}1})^2$$

$$= \beta/2 * (V_{\text{DC}} + V_{\text{drift}}(t) + V_{\text{noise}}(t) + V_{\text{DATA}} - V_{\text{sus}} - V_{\text{DC}} - V_{\text{drift}}(t1) - V_{\text{noise}}(t1) - V_{\text{TH}1})^2$$

$$= \beta/2 * (V_{\text{drift}}(t) + V_{\text{noise}}(t) + V_{\text{DATA}} - V_{\text{sus}} - V_{\text{drift}}(t1) - V_{\text{noise}}(t1) - V_{\text{TH}1})^2$$

EX1007, ¶[0113].

98. In this analysis, $t1$ is the time before new data is written (when S_{n-1} is low) and t is the time after data is written and when current is flowing to the OLED (the majority of time). The V_{DC} components in $V_{\text{DD}}(t1)$ and $V_{\text{DD}}(t)$ cancel out but the differences in undesirable voltage variations between $V_{\text{DD}}(t1)$ and $V_{\text{DD}}(t)$ do not. The Petition completely ignores these voltage fluctuations that are present during the period in which current flows to the pixel. These voltage variations in the current drive voltage in Kim's fourth embodiment would be greater than any potential voltage variations taught in any of the '521 patent's embodiments. Therefore, the drive current in Kim's Figure 10 is not independent of the power supply voltage.

99. For the reasons enumerated above, it is my opinion that Kim does not disclose or render obvious independent claim 1 of the '521 patent, and as such also does not disclose or render obvious any dependent claim of the '521 patent.

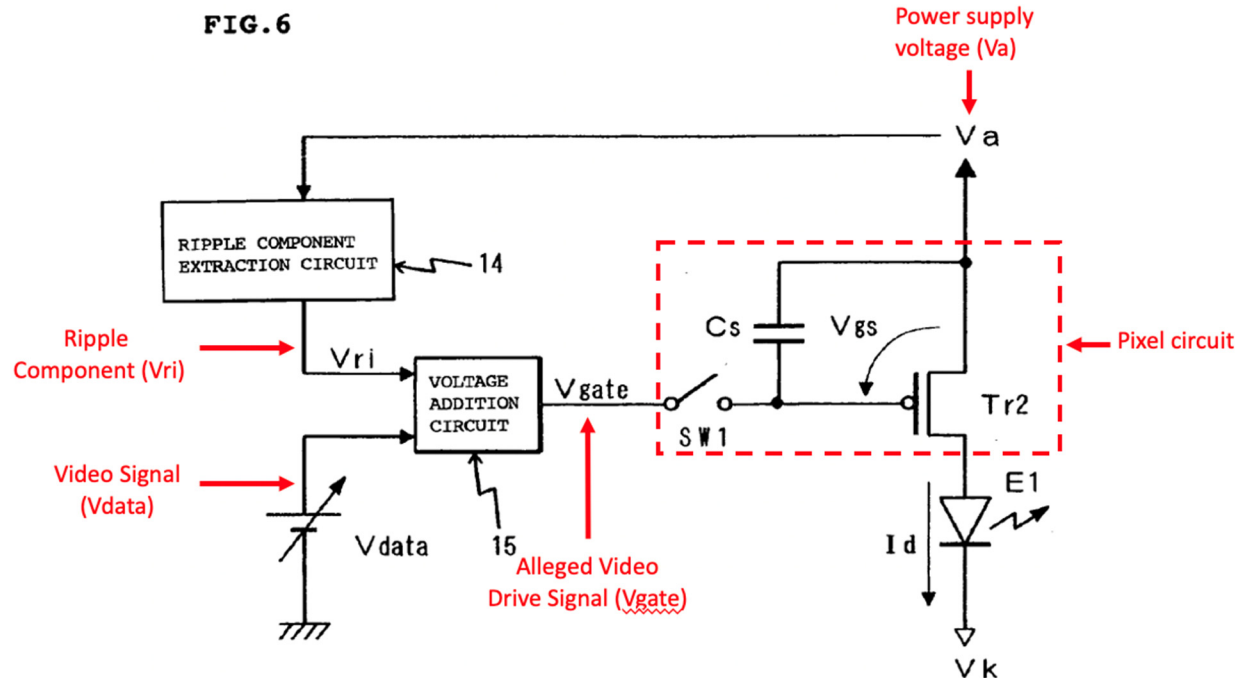
X. GROUND 3: HAYAFUJI DOES NOT ANTICIPATE CLAIMS 1 AND 2 OF THE '521 PATENT

100. It is my opinion that, contrary to the claims made in the Petition and by Petitioner's expert, Dr. Kattamis, Hayafuji does not disclose claim elements [1-A] or [1-C] of the '521 patent. Because claim 2 depends from claim 1, it is also anticipated for the same reasons.

A. Claim Element 1-A]: Hayafuji does not anticipate “a video driver receiving the video signal and generating a video drive signal indicative of the video signal and referenced to a positive power supply voltage of the AMOLED display panel”

101. Hayafuji Claim 1 requires “a video driver receiving the video signal and generating a video drive signal ... referenced to a positive power supply voltage of the AMOLED display panel.” Petitioner argues that Hayafuji's ripple extraction circuit and addition circuit, depicted in Figure 6, disclose the claimed “video driver” limitation and that signal Vgate discloses the claimed “video drive signal.” Pet., 53-55. However, because the voltage of signal Vgate is not referenced to the positive power supply voltage Va, Vgate does not disclose the claimed video drive signal.

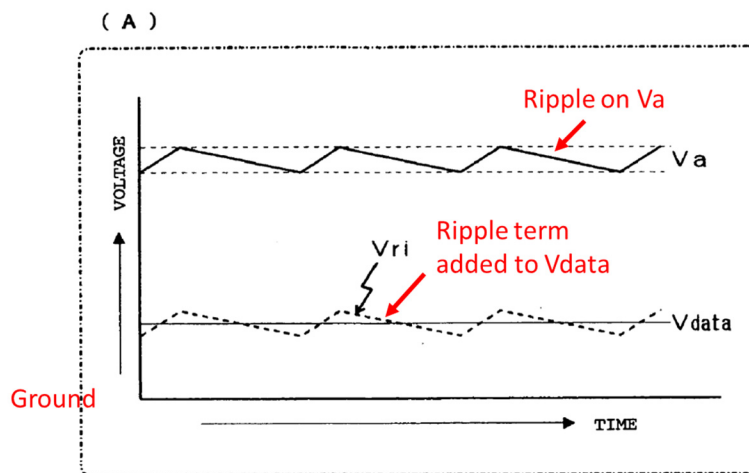
102. Hayafuji discloses the use of a ripple extraction circuit to isolate high-frequency ripple noise in the positive power supply related to the user of a DC-DC converter. EX1006, ¶¶[0017], [0018], [0022], [0028], [0030]. In Hayafuji, the power supply voltage V_a is delivered to a ripple component extraction circuit that extracts *only* the ripple component, V_{ri} , of power supply voltage V_a . EX1006, FIG. 6, ¶¶[0048]-[0049]. The ripple component V_{ri} is then supplied to an addition circuit where it is added to the video signal V_{data} to produce V_{gate} . EX1006, FIG. 6, ¶¶[0048]-[0049]. The Petition argues that adding the ripple component V_{ri} to the data signal V_{data} generates a video drive signal, V_{gate} , that is referenced to the positive power supply V_a . Pet., 54-55.



EX1006, FIG. 6 (annotated).

103. The ripple extraction circuit of Hayafuji is implemented as a bypass filter. EX1006, ¶[0050]. Thus, the dc voltage V_a is blocked and only the voltage noise (e.g., ripple) above the cutoff frequency passes to the voltage addition circuit where it is combined with the data signal, V_{data} . EX1006, FIG. 7, ¶[0050]-[0051]. This is illustrated clearly in Figure 8, annotated below, where V_{ri} is added to V_{data} and V_{data} is referenced to ground and not V_a . EX1006, FIG. 8, ¶[0052]-[0053].

FIG. 8



EX1006, FIG. 8 (annotated).

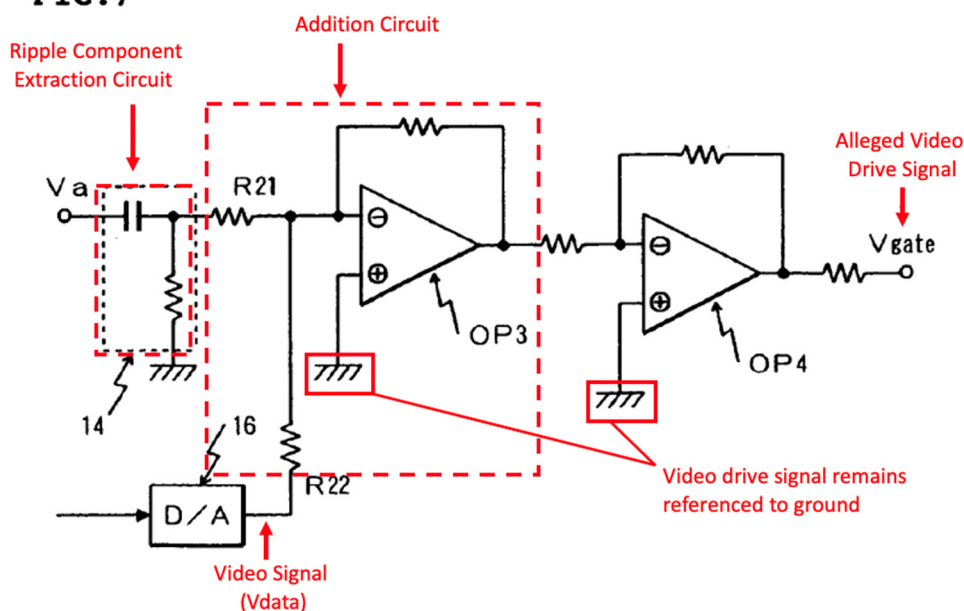
104. In the context of the '521 patent, a video drive signal is referenced to the positive power supply when the positive power supply is used as a baseline to measure the voltage. This is analogous to having a voltage that is referenced to ground. Each embodiment of the '521 patent uses power supply voltage V_{DD} as a

baseline to measure the voltage of the video drive signal. EX1001, 4:65-5:1, 6:8-13, 7:27-33.

105. In contrast to the '521 patent, the alleged video drive signal V_{gate} of Hayafuji is not calculated using the positive power supply as a baseline and is thus not “referenced to a positive power supply voltage.” As illustrated in Hayafuji’s Figure 6, only the ripple component V_{ri} , not power supply voltage V_a , is combined with the video signal V_{data} in the addition circuit. EX1006, FIG. 6, ¶[0049]. V_{gate} is therefore the sum of ripple component V_{ri} and video signal V_{data} : $V_{gate} = V_{ri} + V_{data}$. EX1006, FIG. 6, ¶[0049]. Because the positive power supply voltage V_a of Hayafuji does not even appear in the calculation for V_{gate} , it is not referenced to the positive power supply voltage.

106. Additionally, Hayafuji’s circuit includes two operational amplifiers, one in the voltage addition circuit (OP3) and another in a voltage buffer circuit (OP4). EX1006, ¶¶[0050]-[0051], FIG. 7. In each operational amplifier in Hayafuji, the positive input terminal is connected directly to ground (i.e., *referenced to ground*) rather than to the positive power supply.

FIG. 7



EX1006, FIG. 7 (annotated).

107. For these reasons, Hayafuji does not disclose a video driver that generates a video drive signal referenced to a positive power supply of the AMOLED display panel.

B. Claim Element [1-C]: Hayafuji does not anticipate “the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage”

108. Claim 1 requires “the drive current being ... independent of the positive power supply voltage.” In the context of the ’521 patent, the drive current flowing to the OLED pixel is independent of the power supply voltage if the power supply voltage VDD is not a factor in calculating the current drive voltage. The equations for current drive voltage Video.OLED in the ’521 patent’s three embodiments illustrate this concept:

First embodiment: $\text{Video.OLED} = \text{Video.DAC}$

Second embodiment: $\text{Video.OLED} = \text{Video.DAC}$

Third embodiment: $\text{Video.OLED} = V_{\text{noise}} - \text{Video.DAC}$

EX1001, 5:6-15, 6:20-29, 7:36-43. Additionally, each embodiment of the '521 patent removes undesirable voltage drift from the current drive voltage. EX1001, 5:6-15, 6:20-29, 7:36-43.

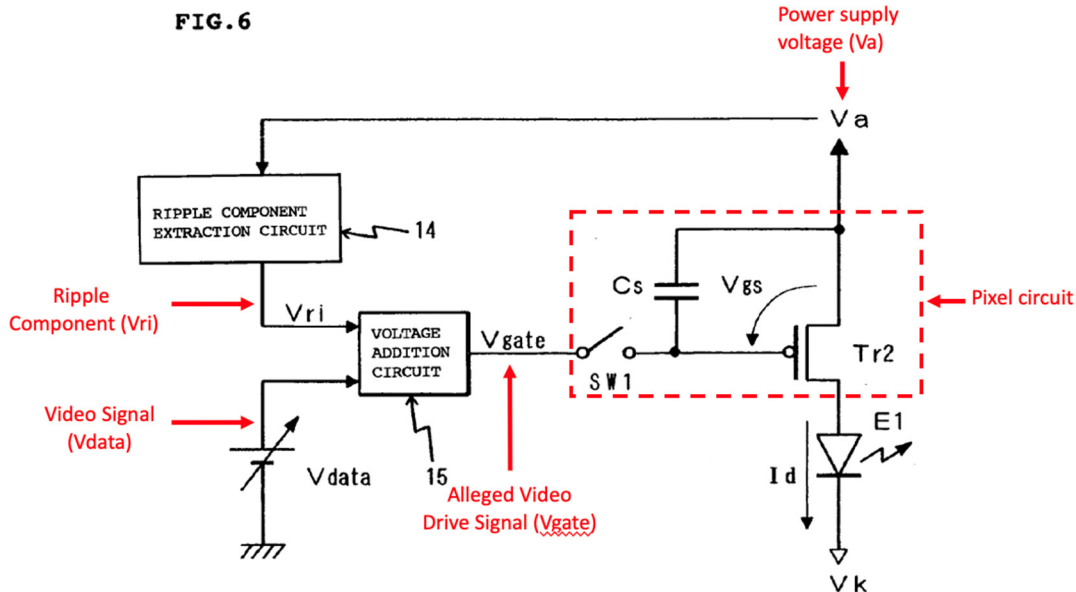
109. The Petition argues that Hayafuji discloses this limitation because the drive current that drives the OLED pixel does not include the ripple component voltage portion of the power supply voltage. Pet., 53-54. Petitioner's argument is incorrect because, in Hayafuji's circuit, the positive power supply voltage V_a does not drop out of the equation for the current drive voltage signal that determines the drive current for the OLED pixel. Pet. 53-54, 5; EX1006, ¶¶[0054]-[0055].

110. Additionally, Hayafuji's circuit does not remove either the voltage noise or voltage drift described in the '521 patent. EX1001, 2:63-3:4, 5:18-23, 6:33-37, 7:46-51

111. Hayafuji generates an alleged video drive signal V_{gate} that is the sum of the video signal V_{data} and the ripple component voltage V_{ri} : $V_{\text{gate}} = V_{\text{data}} + V_{\text{ri}}$. EX1006, ¶[0049]; Pet., 59. V_{gate} is applied to the gate terminal of drive transistor Tr_2 and the power supply voltage V_a is applied to the source terminal. EX1006, ¶[0049], FIG. 6. The current flowing through transistor Tr_2 is determined

by the gate-source voltage (current drive voltage): $V_{gs} = V_a - (V_{data} + V_{ri})$.

EX1006, ¶[0049], FIG. 6. Because V_a is part of the equation for the current drive voltage, the drive current is not independent of the power supply voltage.



EX1006, FIG. 6 (annotated).

112. The Petition presents an alternative equation for the gate-source voltage to argue that the drive current is independent of the power supply voltage. The Petition alleges that V_a can be expressed as the sum of DC power V_{dc} and the ripple component V_{ri} : $V_a = V_{dc} + V_{ri}$. Pet., 59. The Petition substitutes this expression of V_a into the equation for V_{gs} : $V_{gs} = V_{dc} + V_{ri} - V_{data} - V_{ri}$, which simplifies to $V_{gs} = V_{dc} - V_{data}$. Pet., 59. Petitioner argues that, because V_{ri} is not included in the current drive voltage equation, that the drive current is independent of the power supply voltage. Petitioner's argument is incorrect for two reasons.

113. **First**, Petitioner's own admission confirms that the drive current is not independent of the power supply voltage because the main component of the positive power supply voltage (i.e., V_{dc}) is part of Petitioner's admitted equation for the current drive voltage. Pet., 59.

114. **Second**, this argument ignores the undesirable voltage drift that each embodiment of the '521 patent removes from the current drive voltage. Pet., 59; EX1001, 5:18-23, 6:33-37, 7:46-51. The limited teachings of Hayafuji relate to removing only the ripple component of the power supply voltage introduced by a DC-DC converter, which is distinct from voltage drift and noise addressed by the '521 patent's teachings. EX1006, ¶[0022]; EX1001, 1:40-55, 2:38-42, 2:67-3:4, 5:18-23, 6:33-37, 7:46-51. Thus, a more accurate formulation of Hayafuji's power supply voltage than provided in the Petition is: $V_a = V_{DC} + V_{ri} + V_{drift} + V_{noise}$. Using this formulation of V_a , we can see that the Hayafuji's current drive voltage includes both V_{drift} and V_{noise} , as well as the DC power component:

$$\begin{aligned} V_{gs} &= V_{dc} + V_{ri} + V_{drift} + V_{noise} - V_{data} - V_{ri} \\ &= V_{dc} + V_{drift} + V_{noise} - V_{data}. \end{aligned}$$

115. This result is similar to the prior art described in the '521 patent that the claimed invention sought to overcome, which also includes V_{noise} and V_{drift} in the current drive voltage:

$$(Eq\ 4)\ V_{video.OLED} = V_{DD} - v(t)$$

$$\begin{aligned} &= VDDI + Vdrift + Vnoise - Video.DAC - VDDI \\ &= Vdrift + Vnoise - Video.DAC \end{aligned}$$

EX1001, 2:53-60.

116. Thus, because the current drive voltage in Hayafuji includes the power supply voltage, V_a , including the undesirable variable voltage components V_{noise} and V_{drift} , the drive current of Hayafuji is not independent of the positive power supply voltage.

117. For the *reasons* enumerated above, it is my opinion that Hayafuji does not disclose independent claim 1 of the '521 patent, and as such also does not disclose any dependent claim of the '521 patent.

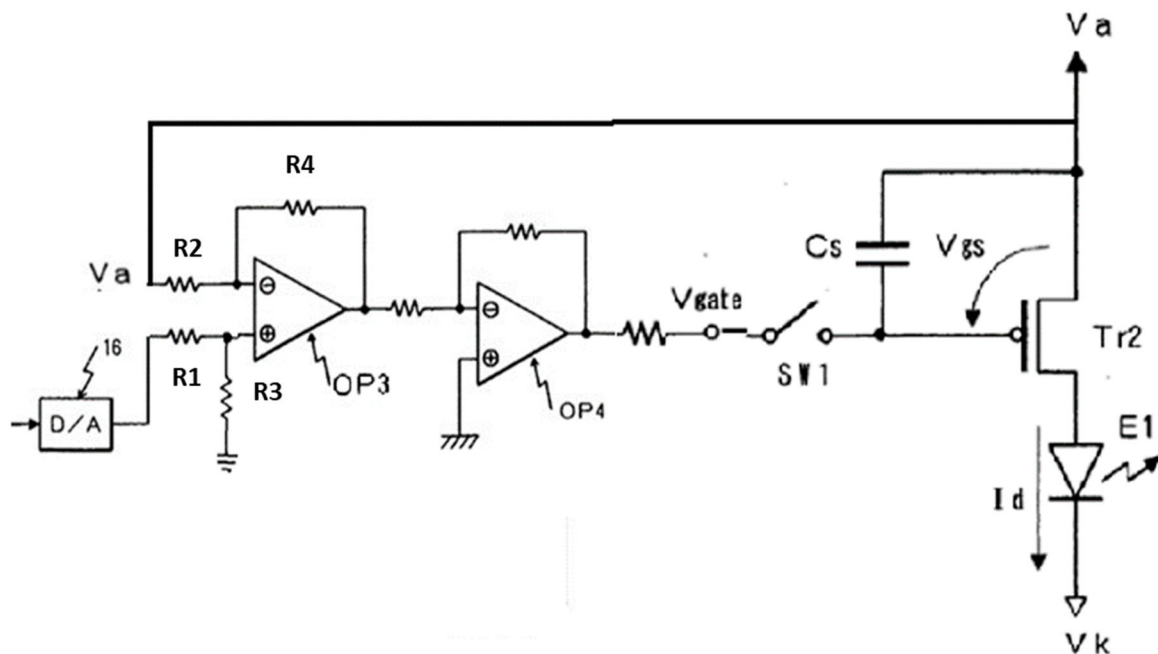
XI. GROUND 4: HAYAFUJI AND THE KNOWLEDGE OF A POSITA DO NOT RENDER OBVIOUS CLAIMS 1, 3, AND 5 OF THE '521 PATENT

118. It is my opinion that, contrary to the claims made in the Petition and by Petitioner's expert, Dr. Kattamis, Hayafuji and the knowledge of a POSITA do not render obvious claim elements [1-A] or [1-C] of the '521 patent. Because claims 2, 3, and 5 depend from claim 1, those claims are also not rendered obvious.

A. Claim Element [1-A]: Hayafuji and the knowledge of a POSITA do not render obvious "a video driver receiving the video signal and generating a video drive signal indicative of the video signal

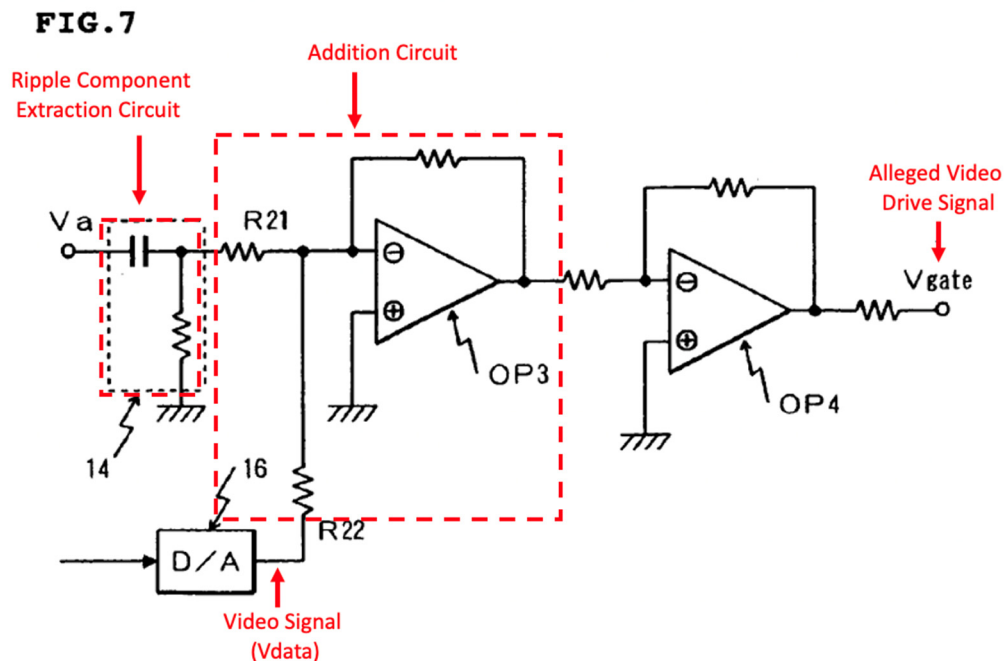
and referenced to a positive power supply voltage of the AMOLED display panel”

119. Claim 1 requires “a video driver ... generating a video drive signal ... referenced to a positive power supply voltage of the AMOLED display panel.” In alleging obviousness, Petitioner argues that a POSITA would have been motivated to modify the circuit taught by Figures 6 and 7 of Hayafuji such that the alleged video drive signal V_{gate} would be the sum of power supply voltage V_a and video signal V_{data} and thus referenced to V_a . Pet., 68-72. Because a POSITA would not have been motivated to modify the circuits of FIGs. 6 and 7 in this manner, this claim element is not rendered obvious.



Pet., 69 (EX1006, FIGs. 6 and 7, combined and modified).

120. According to the Petition, a POSITA would have been motivated to modify the circuit described in Figures 6 and 7 of Hayafuji such that the alleged video drive signal V_{gate} would equal the sum of the video signal (V_{data}) and power supply voltage V_a . Pet., 68-69. According to the Petition, a POSITA would have been motivated to remove the ripple component extraction circuit and connect V_a to the positive terminal of amplifier OP3. Pet., 68-69. The Petition argues that a POSITA would further modify Hayafuji by connecting the video signal to the positive input terminal of amplifier OP3. Pet., 68-69.



EX1006, FIG. 7 (annotated).

121. The Petition argues that the proposed modifications would be an obvious design choice and would simplify material needs and cost because the capacitor of the high-pass filter of the ripple component extraction circuit would be

unnecessary. Pet., 69-70. The Petition further argues that a POSITA would have been motivated to make these modifications because it was well known that in conventional differential instrumentation amplifier circuits, the positive input terminal is the reference voltage (often ground) to which the negative terminal voltage is compared. Pet., 70. The Petition further argues that a POSITA would have been motivated to make the proposed modifications because the resulting circuit would be improved in that it would eliminate power supply noise and drift in addition to removing the ripple component as taught by Hayafuji. Pet., 70. The Petition also alleges that a POSITA would have had a reasonable expectation of success when making these modifications because implementing a differential amplifier circuit is a well-known configuration. Pet., 70. Contrary to Petitioner's allegations, a POSITA would not have modified the circuit taught in Figures 6 and 7 of Hayafuji as proposed by the Petition for at least the reasons below.

122. First, a POSITA would not have removed Hayafuji's ripple component extraction circuit. Hayafuji attempted to address a very specific problem in OLED displays, namely the deterioration of image display quality "caused by a *ripple component* generated in a power supply circuit represented by a DC-DC converter." EX1006, ¶[0028] (emphasis added). Hayafuji purportedly addressed this problem by teaching a circuit employing a *ripple component extraction circuit* that provides the ripple component of the power supply voltage.

EX1006, FIGs. 6, 7, ¶[0048]. There is no discussion in Hayafuji of voltage drift and noise as those terms are used in the '521 patent. The ripple component extraction circuit is, therefore, central to the teachings of Hayafuji. It would not have been obvious to a POSITA to remove it as that would be contrary to the operating principles of Hayafuji and would have rendered it inoperable for its intended purpose.

123. Second, a POSITA would not have been motivated to modify amplifier OP3 such that the power supply voltage and video signal are connected to the negative and positive input terminals, respectively. The proposed modifications transform what was a summing amplifier circuit into a differential amplifier. Pet., 71. But summing the ripple component V_{ri} extracted by the ripple component extraction circuit with the video signal V_{data} was necessary for eliminating the undesirable ripple component of the power supply voltage, which is the entire purpose of Hayafuji. EX1006, ¶¶[0028]-[0030]. Thus, the ripple component extraction circuit and summing amplifier circuit go hand-in-hand in Hayafuji's proposed solution for eliminating undesirable ripple from the power supply voltage. Thus, a POSITA would not have been motivated to modify amplifier OP3 as that would be contrary to the operating principles of Hayafuji and would have rendered it inoperable for its intended purpose.

124. Third, the teachings of Hayafuji relate to a different problem than the '521 patent and propose a different solution. Hayafuji relates to a specific type of voltage ripple introduced by a DC-DC converter whereas the '521 patent is concerned with voltage drift and noise, such as in battery powered devices. EX1006, ¶[0028]; EX1001, 1:40-55, 2:38-67. As a purported solution, Hayafuji teaches a ripple extraction circuit that isolates a specific type of ripple which is anticipated to occur. EX1006, ¶¶[0048]-[0051]. In contrast, the '521 patent teaches referencing the video drive signal to the positive power supply, which will more generally cancel out noise and drift. EX1001, 3:8-23. A POSITA would only end up modifying Hayafuji in the manner proposed in the Petition if the POSITA already had the inventions of the '521 patent in mind as the proposed modification would defeat the entire purpose of Hayafuji's system.

125. For the above reasons, a POSITA would not have made the modifications to Hayafuji proposed in the Petition. Therefore, this claim limitation is not rendered obvious for the same reasons that Hayafuji does not disclose this limitation as set forth in Section X.A, *supra*.

B. Claim Element [1-C]: Hayafuji does not disclose or render obvious “the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage”

126. Claim 1 requires “the drive current being ... independent of the positive power supply voltage.” The Petition argues that, with the proposed

modifications a POSITA would have been motivated to make to Hayafuji, the current voltage signal would not include the power supply voltage and the current would therefore be independent of the power supply voltage. Because a POSITA would not have been motivated to modify the circuit as proposed in the Petition for the reasons set forth in Section XI.A, *supra*, this claim limitation is not rendered obvious for the same reasons presented in Section X.B, *supra*.

127. For the *reasons* enumerated above, it is my opinion that Hayafuji and the knowledge of a POSITA do not render obvious independent claim 1 of the '521 patent, and as such also do not render obvious any dependent claim of the '521 patent.

XII. GROUND 5: STEER AND THE KNOWLEDGE OF A POSITA DO NOT RENDER OBVIOUS CLAIMS 1-4 OF THE '521 PATENT

128. It is my opinion that, contrary to the claims made in the Petition and by Petitioner's expert, Dr. Kattamis, Steer and the knowledge of a POSITA do not render obvious claim elements [1-A] or [1-C] of the '521 patent. Because claims 2-4 depend from claim 1, those claims are also not rendered obvious.

A. Claim Element [1-A]: Steer and the knowledge of a POSITA do not disclose or render obvious “a video driver receiving the video signal and generating a video drive signal indicative of the video signal and referenced to a positive power supply voltage of the AMOLED display panel”

129. Claim 1 requires “a video driver ... generating a video drive signal ... referenced to a positive power supply voltage of the AMOLED display panel.”

Alleging disclosure, Petitioner argues that signal V_6 , which is output from comparator 50 in the feedback circuit depicted in Figure 4, discloses the claimed video drive signal. Pet., 85-86. In the context of the '521 patent, a video drive signal is "referenced to the positive power supply voltage" if the positive power supply is used as a baseline to measure the voltage against. As illustrated by the following equations, each embodiment of the '521 patent uses power supply voltage VDD as a baseline to measure the voltage of the video drive signal:

First embodiment: $v(t) = VDD - \text{Video.DAC}$

Second embodiment: $v(t) = VDD - (\text{Video.DAC}/R)*R$

Third embodiment: $v(t) = VDD + \text{Video.DAC}$

EX1001, 4:65-5:1, 6:8-13, 7:27-33.

130. Because the output V_6 of the feedback system depicted in Figure 4 is not referenced to the power supply voltage, Steer does not disclose the claimed video drive signal. Steer teaches a pixel circuit, depicted in Figure 3, in which data line 6 delivers a video signal to the gate terminal and line 26 delivers the positive power supply voltage to the source terminal of drive transistor 22 to drive current to OLED pixel 2. EX1008, 2:3-9, 2:30-3:9, 8:3-20, FIG. 3.

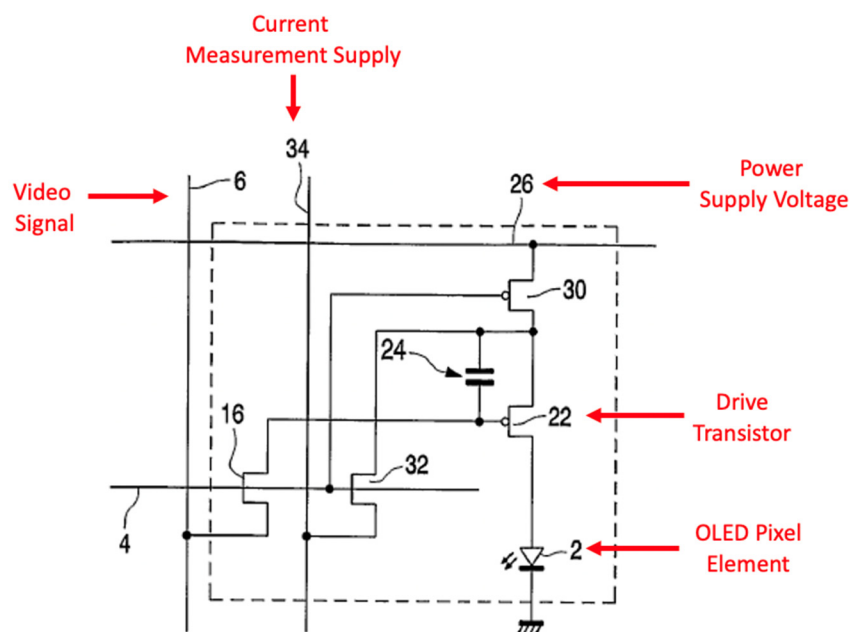


Fig.3

EX1008, FIG. 3 (annotated).

131. Steer further teaches a feedback system, depicted in Figure 4, that generates the voltage V_6 , that is output to line 6. EX1008, 8:21-29, FIG. 4. The feedback system of Figure 4 includes amplifier circuit 44, which takes as inputs the positive power supply voltage V_{SUPPLY} and a reference current 34. EX1008, FIG. 4, 8:30-9:13. The amplifier circuit 44 outputs voltage V_{43} . EX1008, FIG. 4, 8:30-9:13. The feedback system includes an amplifier configured as a comparator circuit 50, which Petitioner alleges is the claimed “video driver.” Comparator 50 takes as inputs V_{43} and alleged video signal V_{52} . EX1008, 9:14-19. Comparator 50 provides amplification and outputs the difference between V_{43} and V_{52} as V_6 , which Petitioner alleges is the claimed video drive signal. EX1008, 9:14-19.

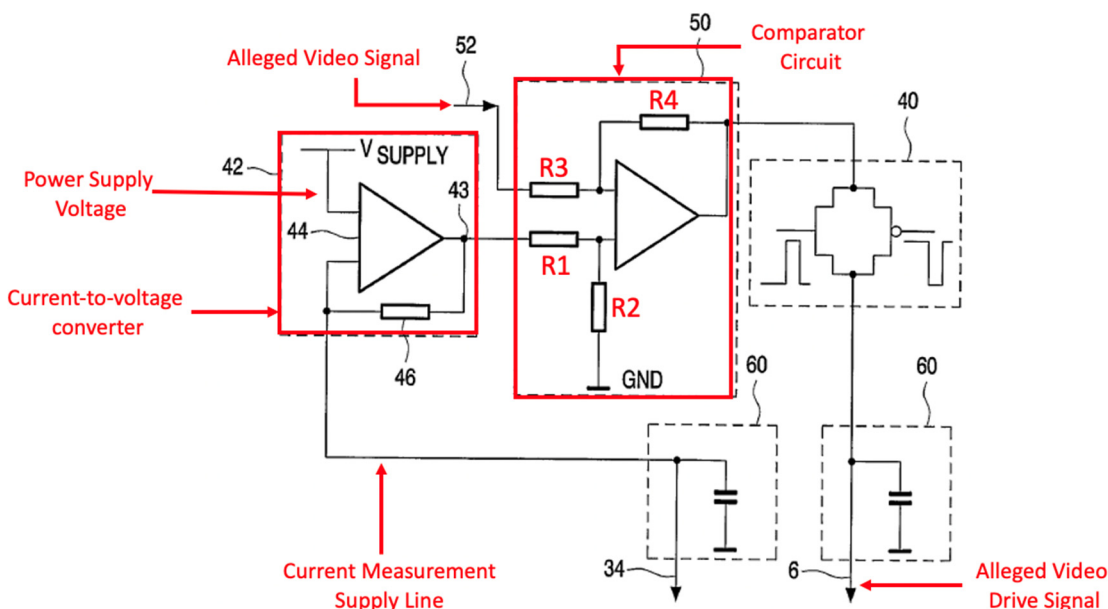


Fig.4

EX1008, FIG. 4 (annotated).

132. Petitioner argues that V_6 is referenced to the positive power supply voltage because its voltage is determined by the following equation, in which the data signal V_{52} (referred to as $input(t)$ by the Petitioner) is subtracted from V_{SUPPLY} :

$$\text{Steer (2): } V_6 = V_{SUPPLY} + R \cdot I - input(t).$$

Pet., 86.

133. Petitioner's argument that V_6 is referenced to the power supply voltage V_{SUPPLY} is incorrect because the value of V_6 also depends on the values of resistors R3 and R4, labeled in the Figure above, which the Petition ignores. Pet., 85-86. According to Steer, comparator 50 amplifies the signal, which requires resistors R3 and R4 to have different values. EX1008, 9:17-18 ("The amplified output of the comparator section 50 is provided to the column conductor through

the gate 40.”). The configuration of the circuit of comparator 50 is such that the amplification causes the entire expression describing V_6 to be multiplied by R_4/R_3 :

$$\begin{aligned} V_6 &= (V_{43} - input(t)) * R_4/R_3 \\ &= [V_{SUPPLY} + R_{46} * I - input(t)] * R_4/R_3 \end{aligned}$$

134. The alleged video drive signal V_6 of Steer is not “referenced to the positive power supply voltage” because the entire equation is multiplied by R_4/R_3 as shown above. This multiplication operation results in a value for V_6 that is not an offset from V_{SUPPLY} and cannot be measured using V_{SUPPLY} as a baseline. Therefore, the video drive signal V_6 is not “referenced to a positive power supply voltage.”

B. Claim [1-C]: Steer and the knowledge of a POSITA do not disclose or render obvious “the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage”

135. Claim 1 requires “the drive current being ... independent of the positive power supply voltage.” Alleging anticipation, Petitioner argues that the drive current in Steer meets the “independent of the positive power supply voltage” limitation because the positive power supply voltage V_{SUPPLY} does not appear in the equation for the current drive voltage of drive transistor 22. Pet., 91-92. Petitioner’s argument is incorrect because the amplification introduced by the feedback system onto alleged video drive signal V_6 prevents V_{SUPPLY} from dropping out of the current drive voltage equation.

136. In the context of the '521 patent, the drive current flowing to the OLED pixel is independent of the power supply voltage if the power supply voltage VDD is not a factor in calculating the current drive voltage. The equations for current drive voltage Video.OLED in the '521 patent's three embodiments illustrate this concept:

First embodiment: $\text{Video.OLED} = \text{Video.DAC}$

Second embodiment: $\text{Video.OLED} = \text{Video.DAC}$

Third embodiment: $\text{Video.OLED} = V_{\text{noise}} - \text{Video.DAC}$

EX1001, 5:6-15, 6:20-29, 7:36-43.

137. Additionally, as illustrated in the equations above, each embodiment of the '521 patent removes undesirable voltage drift from the current drive voltage. EX1001, 5:6-15, 6:20-29, 7:36-43.

138. As discussed in Section XII.A, *supra*, Petitioner argues that the voltage of the alleged video drive signal V_6 is represented by the following equation, where $\text{input}(t)$ is the alleged video signal V52:

$$\text{Steer (2): } V_6 = V_{\text{SUPPLY}} + R \cdot I - \text{input}(t).$$

Pet., 86.

139. According to Petitioner, because signal V_6 is applied to the gate of drive transistor 22 and V_{SUPPLY} is applied to the source of drive transistor 22, the current drive voltage V_{gs} is represented by the following:

$$\text{Steer (4): } V_{gs} = V_6 - V_{\text{SUPPLY}}.$$

Pet., 92.

140. Petitioner alleges that substituting equation (2) into equation (4) yields the following equation for the current drive voltage, where V_{SUPPLY} cancels out entirely.

$$\text{Steer (4A): } V_{gs} = V_{\text{SUPPLY}} + R \cdot I - \text{input}(t) - V_{\text{SUPPLY}}$$

$$\text{Steer (4B): } V_{gs} = R \cdot I - \text{input}(t)$$

Pet., 92.

141. Petitioner further alleges that the drive current is, therefore, independent of the power supply voltage V_{SUPPLY} . Pet., 92.

142. However, Petitioner's argument is incorrect because the amplification introduced onto alleged video drive signal V_6 prevents V_{SUPPLY} from cancelling out of the current drive voltage equation. As discussed in Section XII.A, *supra*, the equation describing the voltage of the signal generated by the video driver is multiplied by R_4/R_3 :

$$\begin{aligned} V_6 &= (V_{43} - V_{52}) \cdot R_4/R_3 \\ &= [V_{\text{SUPPLY}} + R_{46} \cdot I - V_{52}] \cdot R_4/R_3 \end{aligned}$$

143. Using the correct equation for V_6 results in the following equation for the gate-source voltage V_{gs} on drive transistor 22:

$$V_{gs} = V_6 - V_{26}$$

$$\begin{aligned} &= [V_{\text{SUPPLY}} + R_{46} * I - \text{input}(t)] * R_4 / R_3 - V_{\text{SUPPLY}} \\ &= V_{\text{SUPPLY}} * R_4 / R_3 + R_{46} * I * R_4 / R_3 - \text{input}(t) * R_4 / R_3 - V_{\text{SUPPLY}} \\ &= V_{\text{SUPPLY}}(R_4 / R_3 - 1) + R_{46} * I * R_4 / R_3 - \text{input}(t) * R_4 / R_3 \end{aligned}$$

144. Using the correct equation for the current drive voltage rather than the Petition's equation (4B), it is apparent that the multiplier R_4/R_3 prevents V_{SUPPLY} from dropping out. Therefore, Steer does not disclose a drive current independent of the positive power supply voltage.

XIII. CONCLUSION

This declaration reflects my opinions as currently held. However, my analysis may continue such that I may consider additional information that may result in additional observations.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the U.S. Code.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on July 17, 2023 in Powell Butte,
OR.



Thomas L. Credelle