

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 EX2011
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 '521 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).
12	<i>Samsung Elecs. Co. v. Polaris PowerLED Techs., LLC</i> , Case No. IPR2023-00771, Institution Decision (P.T.A.B. Oct. 16, 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”)

Paper/Exhibit No.	Description
1012	Min-Koo Han, <i>AM backplane for AMOLED</i> , PROC. OF ASID (2006) (“Han”)
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”)
2005	Kim et al., “A 10-bit Linear R-string DAC Architecture for Mobile Full HD AMOLED Driver ICs,” SID DIGEST OF TECHNICAL PAPERS (2013)
2006	Excerpts from Cristaldi, <i>Liquid Crystal Display Drivers</i> , Springer (2009)
2007	Excerpts from Tusujimura, <i>OLED Displays, Fundamentals and Applications</i> , Wiley (2012)
2008	Introduction to DDIC (Display Driver IC), Utmel Electronic, accessible at https://www.utmel.com/blog/categories/integrated%20circuit/introduction-to-ddic-display-driver-ic (last accessed January 22, 2024)
2009	AMOLED DDIC-SR6541, Square Route, accessible at https://squareroute.co.jp/square-route/amoled-ddic-sr6541/ (last accessed January 22, 2024)
2010	Onoyama, “0.5-inch XGA Micro-OLED Display on a Silicon Backplane with High-Definition Technologies,” SID Digest of Technical Papers (2012)
2011	Second Declaration of Thomas L. Credelle
2012	Transcript of January 19, 2024 Deposition of Alex Z. Kattamis, Ph.D., P.E.

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.

VI. TECHNOLOGY BACKGROUND

A. References Describing AMOLED Background Knowledge

25. An article by R. Dawson et al. published in 1998, titled “The impact of the transient response of organic light emitting diodes on the design of active matrix OLED displays” (EX2003), proposed current programming in AMOLED displays to compensate for variations in transistor characteristics across pixel

circuits in a display. This article was cited by Han's 2006 article titled "AM backplane for AMOLED" (EX1012).

26. An article by Kim et al. published in 2013, titled "A 10-bit Linear R-string DAC Architecture for Mobile Full HD AMOLED Driver ICs" (EX2005), describes AMOLED video drivers implemented as integrated circuits. The concepts discussed in the article would have been known to one of ordinary skill in the 2006 timeframe.

27. A textbook by Cristaldi et al. published in 2009, titled "Liquid Crystal Display Drivers" (EX2006), describes video driver architecture for Active Matrix LCD displays. The concepts discussed with respect to video driver output buffers would have been known to one of ordinary skill in the 2006 timeframe.

28. A textbook by Tusujimura et al. published in 2012, titled "OLED Display Fundamentals and Applications" (EX2007), includes a discussion of AMOLED basic concepts and fundamental principles that would have been known to one of ordinary skill in the 2006 timeframe.

29. A web page on Utmel Electronic's website, located at <https://www.utmel.com/blog/categories/integrated%20circuit/introduction-to-ddic-display-driver-ic> (EX2008), describes Active Matrix LCD and OLED display video drivers, including a discussion of integrated circuit packaging forms. Utmel Electronic is an electronics components distributor.

30. A web page on Square Route’s website, located at <https://squareroute.co.jp/square-route/amoled-ddic-sr6541/> (EX2009), describes the SR6541 AMOLED DDIC (display driver integrated circuit), including a figure showing the integrated circuit packaging. Square Route is a chip design and production company.

31. An article by Onoyama published in 2012, titled “0.5-inch XGA Micro-OLED Display on a Silicon Backplane with High-Definition Technologies” (EX2010), describes a virtual reality/augmented reality AMOLED display design. The design includes placing the display panel (matrix of pixels and pixel circuits), scan driver, and video driver on a single integrated circuit.

B. Active Matrix architecture

1. LCD Active Matrix

32. 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, from the den Boer textbook, of a simple active matrix for LCDs is shown below. EX1011, 26. 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.

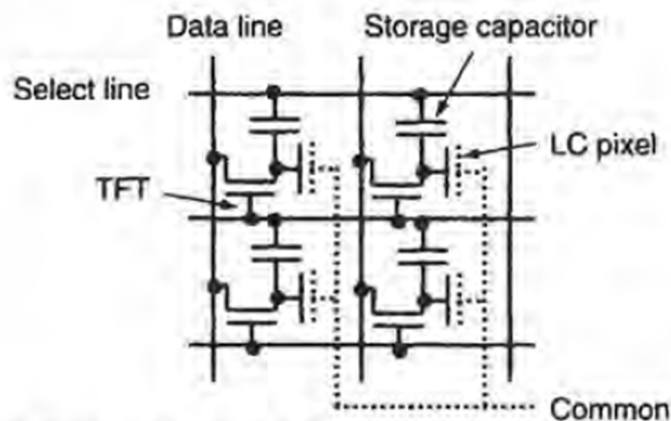


Figure 2.3: Circuit diagram for four pixels in an active matrix LCD.

EX1011, 26, FIG. 2.3.

33. 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. EX1011, 39-41.

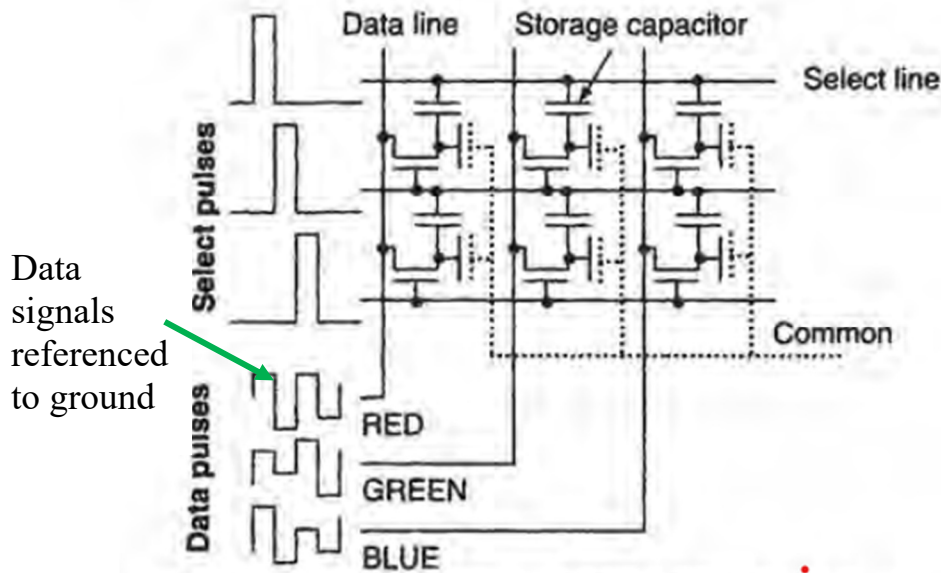


Figure 2.17: Operation of TFT LCD with drive waveforms.

EX1011, 40, FIG. 2.17 (annotated).

34. 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.

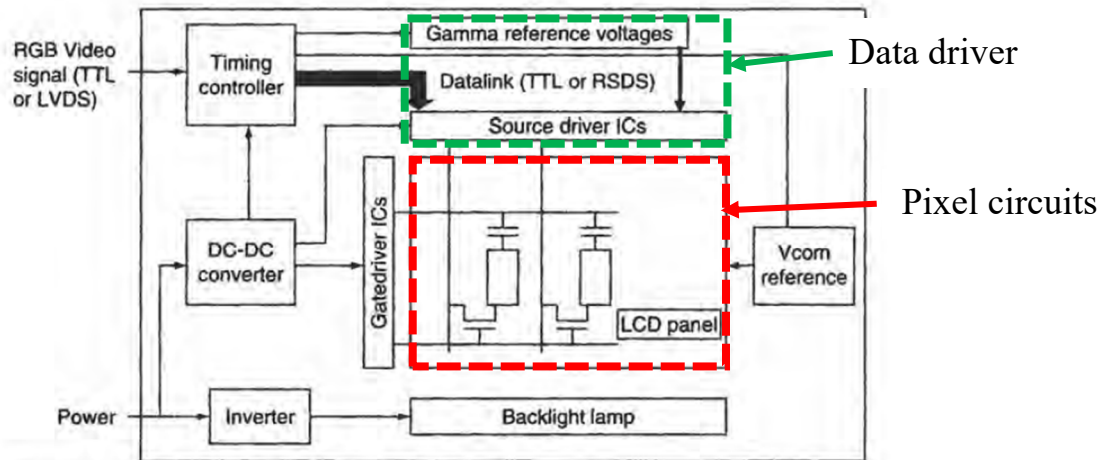


Figure 4.8: Block diagram for a TFT LCD module.

EX1011, 94, FIG. 4.8 (annotated).

35. Depending on the display size, the various components shown in the illustration above can be integrated into a single IC; this is commonly done to reduce the size of the display module and to reduce costs. This is illustrated below for a small-size AMLCD, but the same principles apply to AMOLEDs. EX2006, 191. In the last example (Figure 6.1(d)), the gate drivers are integrated onto the display substrate, while all the other circuit elements are integrated onto the display driver IC. In every case the TFT pixel circuit is separate and distinct from the row and column drivers and other “global” correction circuitry such as gamma correction circuitry.

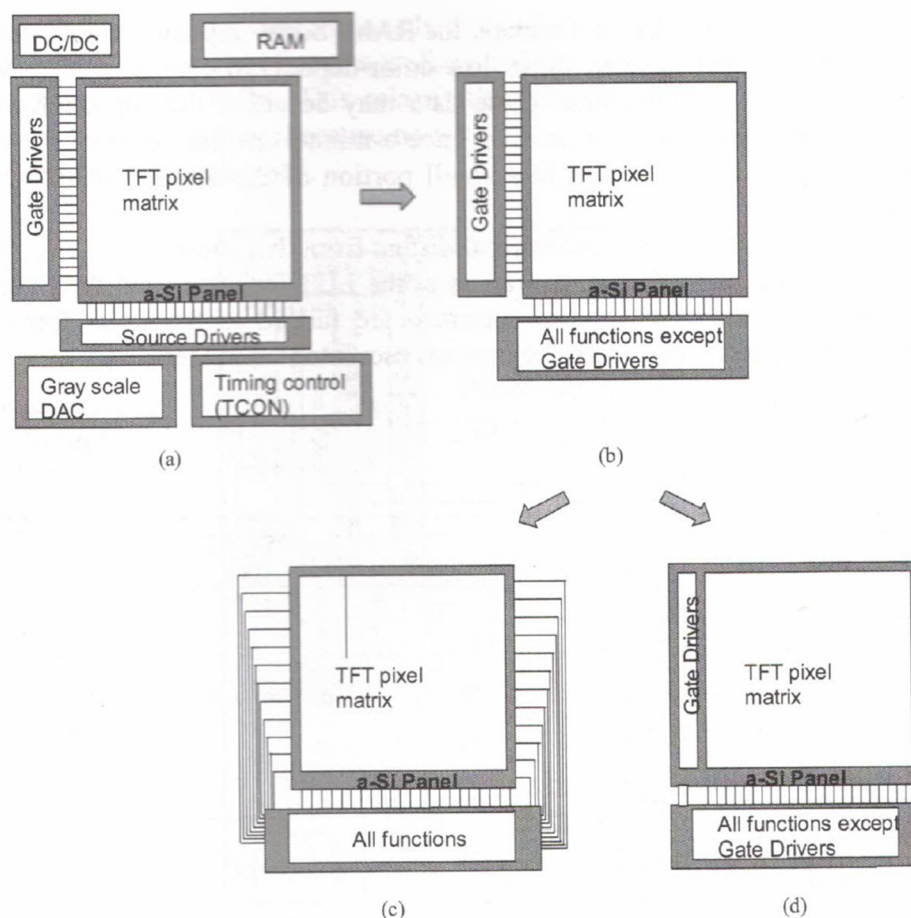


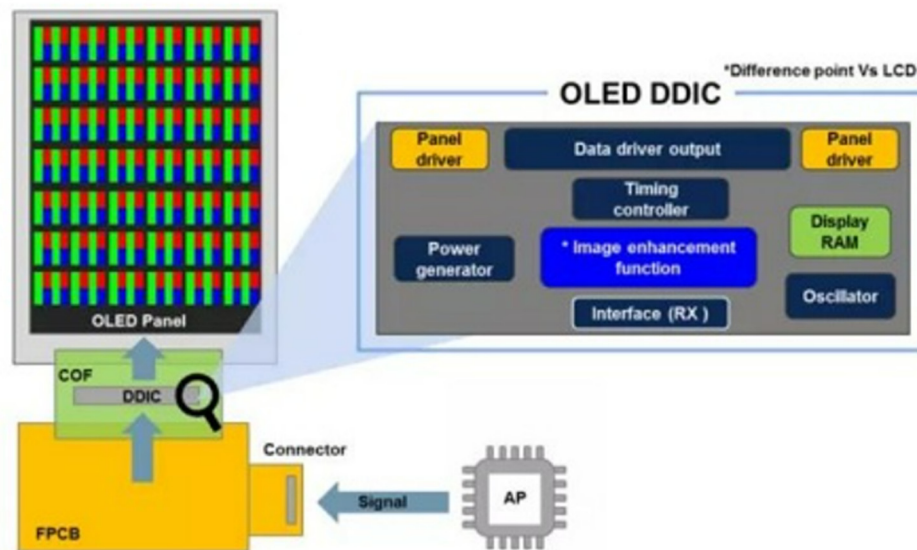
Fig. 6.1 Chipset evolution for a-Si small-size AMLCD drivers: multichip architecture (a), two-chip architecture (b), single-chip architecture (c), single-chip architecture with gate drivers integrated on the TFT backplane (d)

EX2006, 191, FIG. 6.1.

2. OLED Active Matrix

36. The same level of integration can be seen in a typical small (e.g., cell phone size) AMOLED; the gate drivers are integrated onto the display panel and one display driver IC (“DDIC”) is attached to the panel. EX2008, 2. In this example, other functional blocks are added to the DDIC, such as power generation, timing control, and display RAM. As with the LCD example above, the pixel

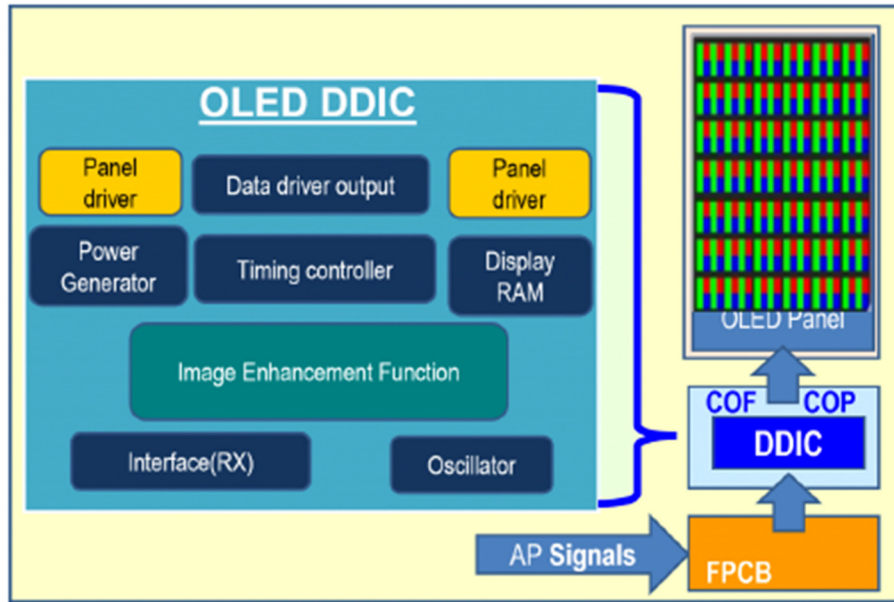
circuit for the OLED is separate and distinct functionally and physically from the video driver IC.



OLED DDIC

EX2008, 2.

37. The architecture of a typical DDIC (display drive integrated circuit) (SR6541) is shown below. EX2009, 1-2. The DDIC is mounted to a flex (COF) or mounted directly on the display panel (COP). In either case, a video signal (“AP signal”) is supplied to the DDIC and a video drive signal is created and supplied to the columns of the display.



EX2009, 2.

38. The main components of a typical data driver circuit for AMLCDs are shown below. EX1011, 97. Digital data from a source (shown as R00-R05, G00-G05, and B00-B05) is latched into the data driver, and is then converted to analog voltages with appropriate gamma correction (digital to analog converter). Analog data is then amplified (output buffer) to provide low impedance drive signals to the columns of the display.

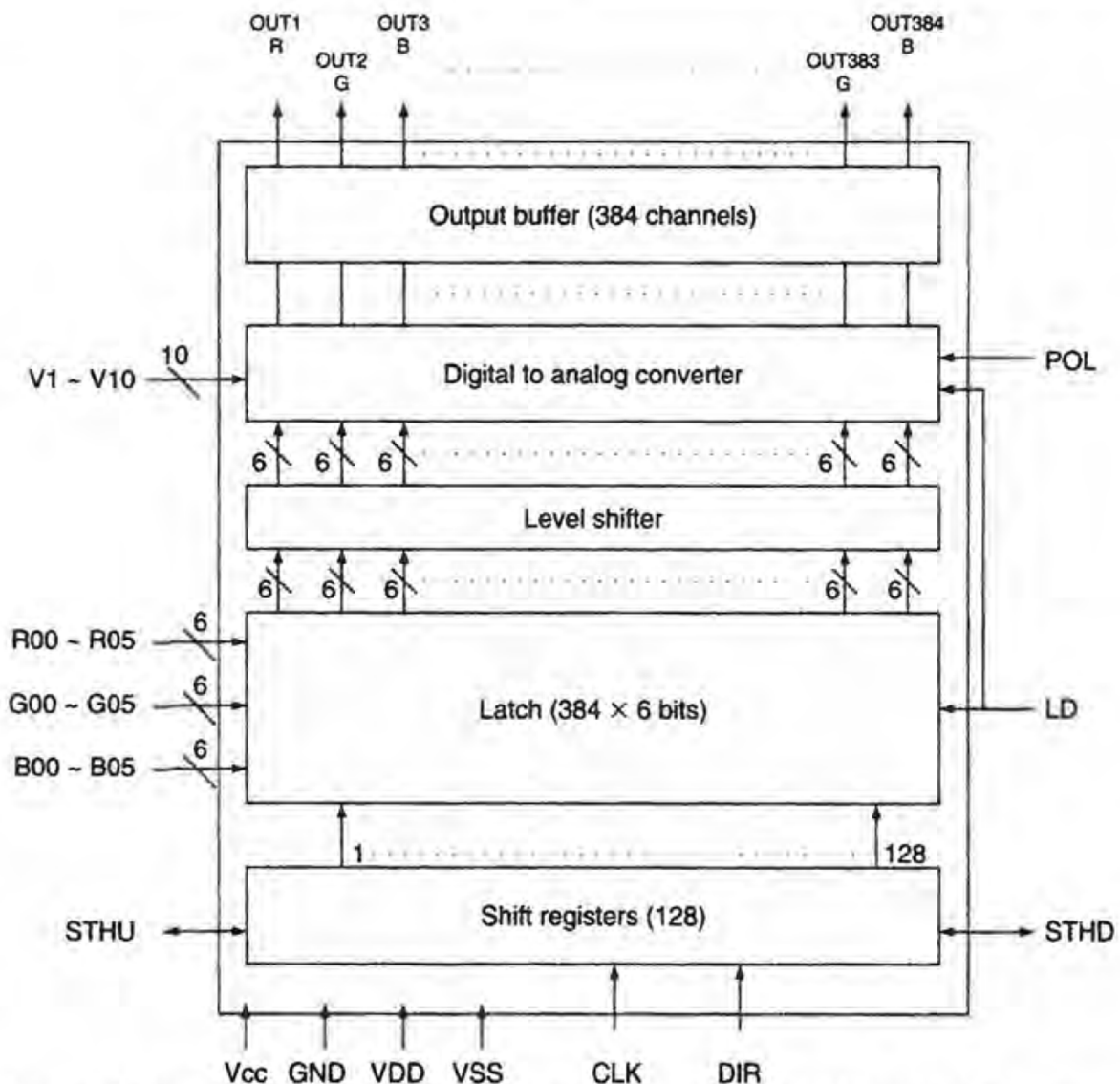


Figure 4.11: Basic architecture of a source driver IC with 384 channel outputs for use in XGA and SXGA panels (eight or ten chips per panel, respectively).

EX1011, 97, FIG. 4.11.

3. OLED Active Matrix Differences

39. The architecture of the active matrix used with OLEDs is similar to that used with LCDs despite the fact that the OLED is a light *emitting* device, as opposed to LCDs which are light *modulating* devices. Because the OLED is light

emitting, power must be supplied to the OLED at each pixel and the current is controlled with an analog signal stored within the pixel circuit.

40. An exemplary active-matrix architecture for OLEDs from the Tsujimura article is shown below. EX2007, 99. As with AMLCDs, there are data drivers, which supply analog video signals (usually voltages) to columns of the display, and scan drivers, also referred to as gate drivers, which switch transistors within the pixel array. EX2007, 99. One new feature of AMOLED active matrix is the requirement for a power lead to each pixel that supplies current to the light emitting diode. As with AMLCDs, a pixel circuit is located at the intersection of rows and columns; the pixel circuit in its simplest format receives and stores data from the video driver onto a capacitor. The stored analog video voltage is applied to the gate of a driving transistor to modulate the current flowing to the OLED.

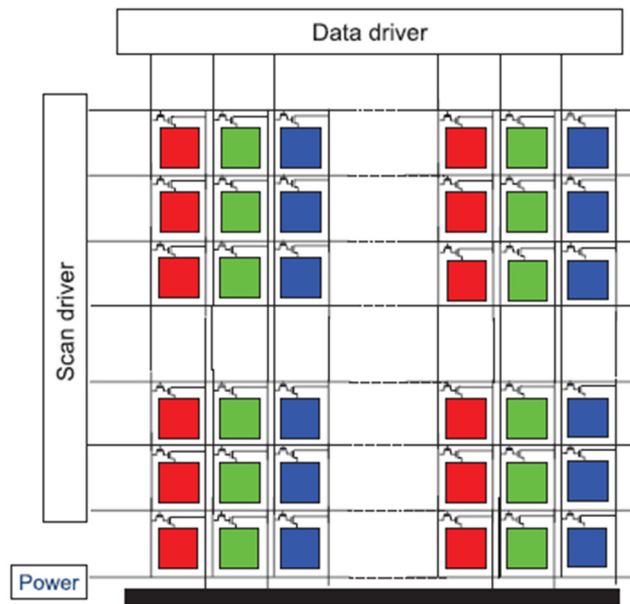


Figure 4.31 An active-matrix OLED display.

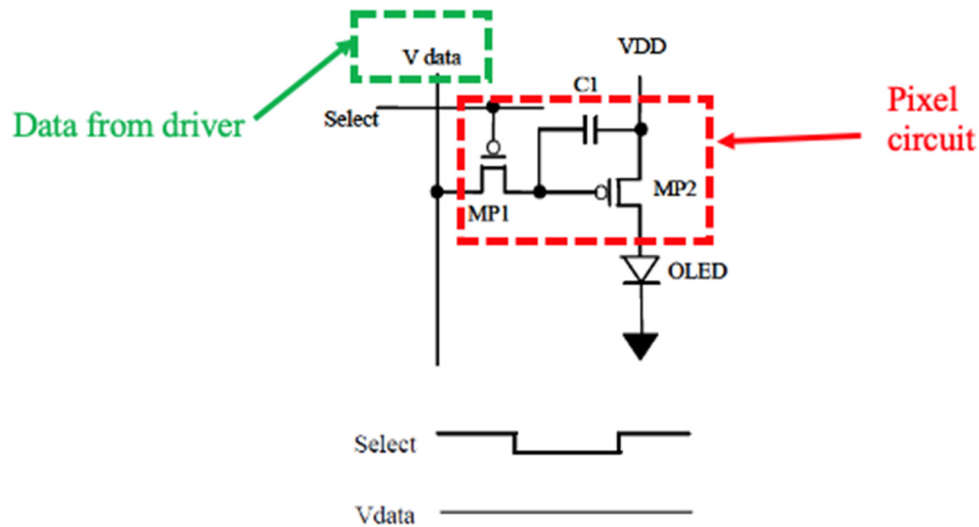
EX2007, 99, FIG. 4.31.

C. AMOLED Challenges

41. 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., dark part of an image, and therefore can achieve higher contrast ratios and lower power for video images.

42. The simplest pixel circuit used for OLEDs uses two TFTs and one capacitor; a typical pixel circuit, described by Han, is shown below. EX1012, 54. 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, 54, FIG. 1(a) (annotated).

43. 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. These added components (e.g., extra transistors or capacitors) provide *local* corrections, that is, on a pixel-by-pixel basis, to compensate for variations in transistor characteristics. 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. EX2003, 875-878. By flowing current through the drive transistor, variations in V_{th} and mobility are thus cancelled out. This form of compensation worked well but suffered 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.

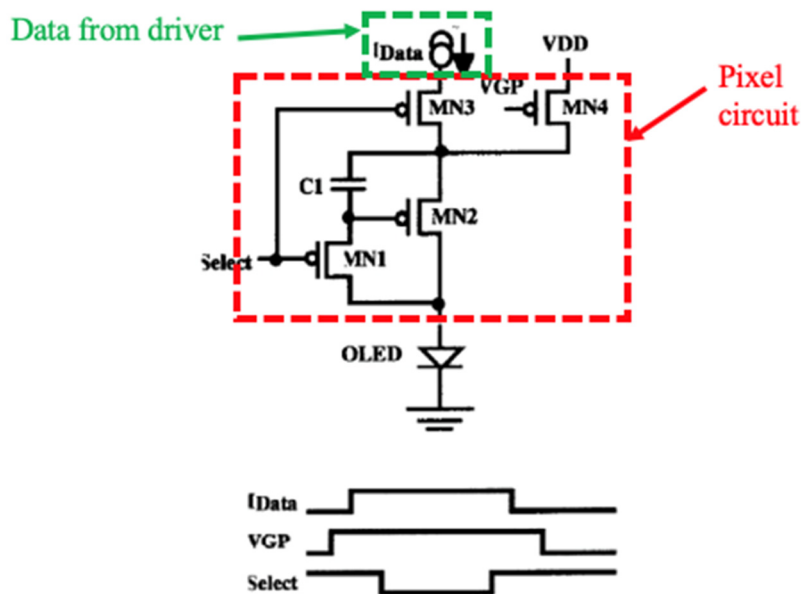


Figure 5. The reported current programming AMOLED pixel in which I_{DATA} is memorized and V_{GATE} of MN2 is determined to allow I_{DATA} [2].

EX1012, 55, FIG. 5 (annotated).

44. Another category of compensation uses voltage programming; like the simple 2T-1C (two transistors and one capacitor) 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 by measuring and shifting the video drive signal by V_{th} . 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 allow detection of V_{th} . An additional power supply voltage, V_{sus} , is also sometimes added to provide a constant voltage to the storage capacitor before new video data is written. EX1012, 55. These added components in the pixel circuit effectively level shift the data driver signal, but are not dependent on or modify the video signal supplied by the data driver in any way. That is, the action of the additional components in the pixel circuits are independent of the video signal and are therefore not part of the video drive signal generation.

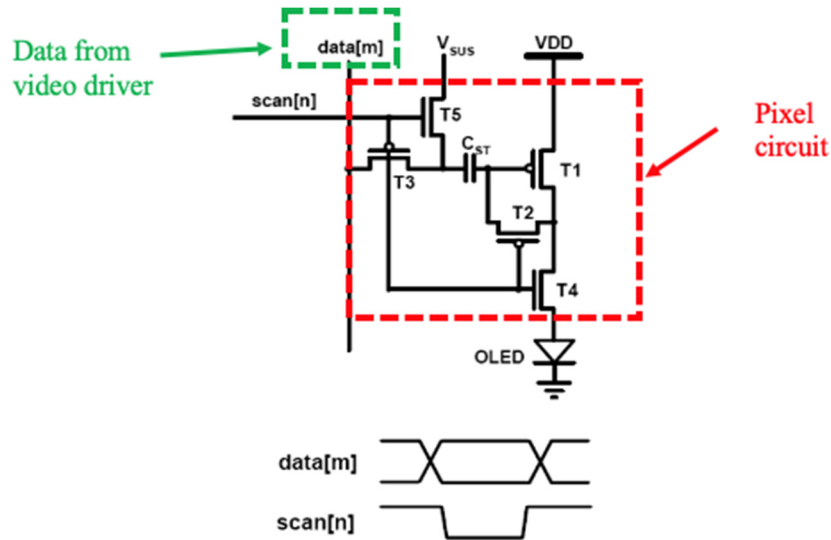


Figure 4. The reported AMOLED pixel circuit employing a reference voltage source V_{SUS} which compensates the V_{DD} supply voltage drop as well as the threshold voltage variation of poly-Si TFT [6].

EX1012, 54, FIG. 4 (annotated).

45. Another local variation, that is at the pixel level, in display performance is a change in the drive voltage V_{DD} at each pixel due to a voltage drop (“IR drop”). That is, IR drop is the decrease in voltage caused by a current, I , flowing through a line resistance, R , such that $V_{DD} = V_{DD0} - I \cdot R$. Depending on the arrangement of electrodes supplying V_{DD} to each pixel, the line resistance can cause non-uniform performance. EX1007, ¶¶[0013], [0016]-[0017]. These local variations can only be corrected by a voltage shift on a pixel-by-pixel (local) basis.

D. Video (Data) Drivers

46. As already discussed, all AMOLED displays include video data drive circuits that provide amplified signals to the columns of a display and gate select

signals to switch TFTs in the pixel circuit in a row-by-row manner. Depending on the size of the display, the functions of row selection and video signal generation may be included on the same integrated circuit, e.g., a DDIC.

47. The video data driver, often referred to as a “source driver,” “column driver,” or “display driver,” receives the digital RGB data from the CPU and converts them into analog voltages that drive the columns through analog buffers (amplifiers). A block diagram of the features of a source driver for an AMLCD is shown below. EX2006, 203-211. As already noted, the source driver for a voltage programmed AMOLED has the same functional blocks as that depicted for an AMLCD.

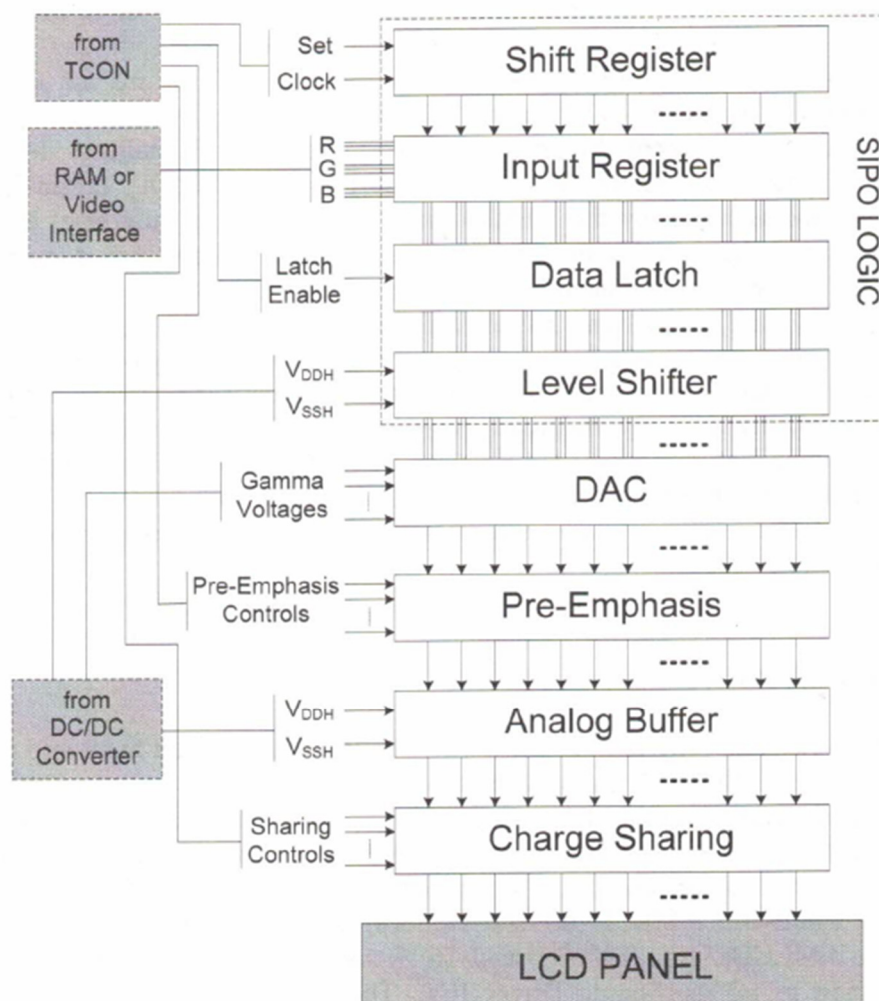


Fig. 6.15 Source Driver architecture of large size AMLCDs

EX2006, 204, FIG. 6.15.

48. In this example, digital data from RAM or video interface is input to the data driver, and the timing is controlled by the TCON circuitry. EX2006, 204-205. After a row of data is input, the data is latched and level shifted to match the voltages required for the display. Further, “gamma correction” is applied using digital to analog converters (“DACs”) to match the video signal to the display characteristics. Finally, the signal is buffered using (typically) unit gain amplifiers.

The purpose of the amplifiers is to provide a low impedance video drive signal to the high-capacitance columns of the display. EX2006, 204-205.

49. The DACs convert the digital data to amplified analog signals; a typical resistor-string DAC is shown below. EX2006, 205. Primary and secondary buffer amplifiers are used to output analog video signals to the output buffer amplifiers.

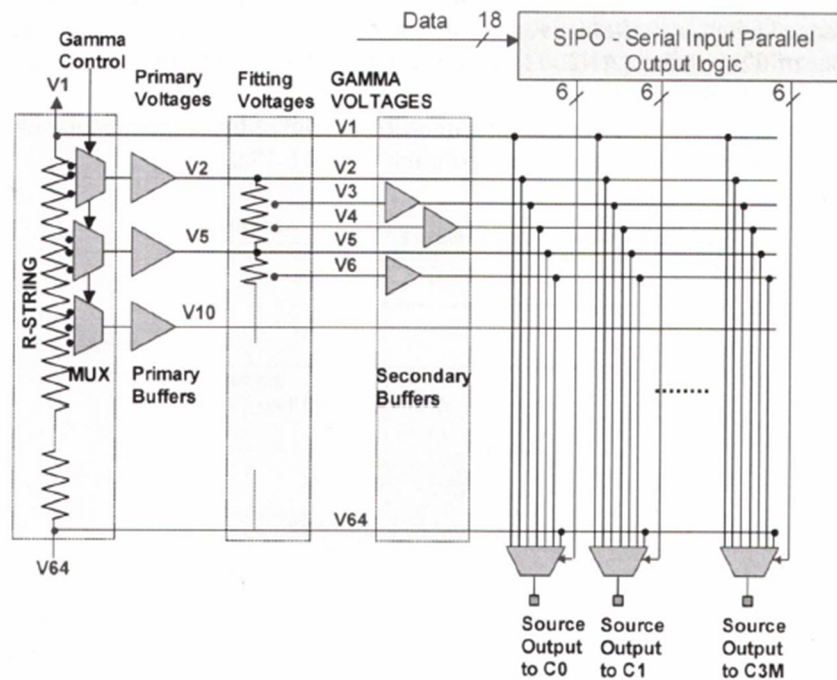


Fig. 6.16 Resistor string and MUX adopted implementing the R-DAC for positive voltages

EX2006, 205, FIG. 6.16.

Another example, applicable to displays with large number of columns, is the distributed buffered architecture. EX2006, 206-207, FIG. 6.19. In this example, the unbuffered gamma voltages are supplied to DAC circuits, and output buffers (amplifiers) are added at each column.

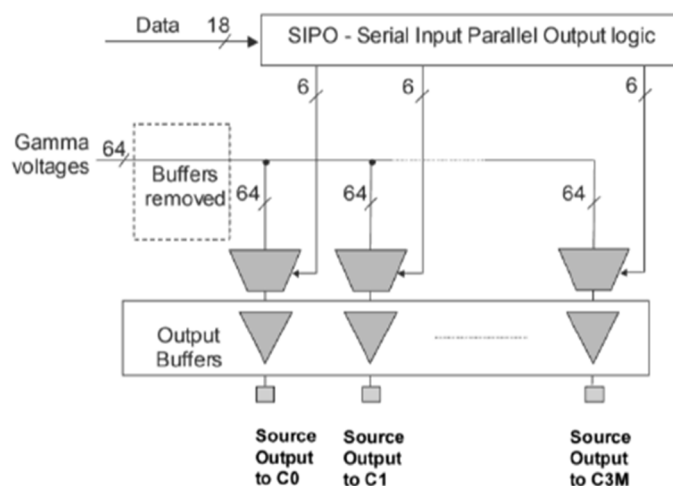


Fig. 6.19 Distributed buffer architecture

EX2006, 207, FIG. 6.19.

50. Another example of a digital driver IC, this time for AMOLEDs, is shown in the figure below from Kim et al. EX2005, 469-472. In this case “global” correction of incoming video data signals is made before sending the data to the AMOLED pixel circuits. For example, RGB gamma correction circuitry is added to the integrated circuit (in the same manner as the ’521 patent teaches that voltage reference amplifiers can be added to the source driver IC (“Furthermore, the video driver circuit of the present invention can be integrated with other circuitry of the AMOLED display panel into a single integrate circuit.” EX1001, 7:57-59).

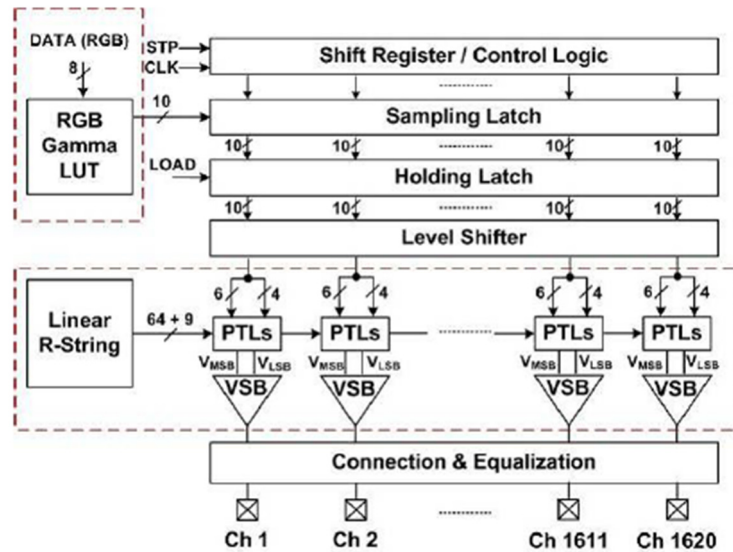


Figure.4 Proposed Column Driver Architecture

EX2005, 470, FIG. 4.

51. In summary, the video data driver in either AMLCD or AMOLED (voltage programmed) converts an incoming video signal to a video driver signal with proper drive voltages for the pixel array and with sufficiently low impedance to drive the column capacitance within the allotted row time (depends on frame rate and number of rows).

E. Pixel circuit voltage shifting

52. As previously mentioned, most AMOLED displays, especially for mobile phone products, use “voltage programming” to correct for variations in the threshold voltage of the drive transistors. Since the drive transistors must set the precise current to the OLED to achieve the desired brightness, the video drive signals must be level shifted by an amount V_{th} . A basic voltage programming

pixel circuit is shown below; first proposed by Dawson et al., this circuit is designed to sample V_{th} by adding a transistor MN3 to short the gate and drain of the drive transistor MN2 during a programming step. EX2007, 132-134. The action of this programming is only to shift the video signal voltage stored on the capacitor C2 by V_{th} . The actions of this pixel circuit to level shift the voltage are independent of the video signal generation by the data driver (e.g., DDIC).

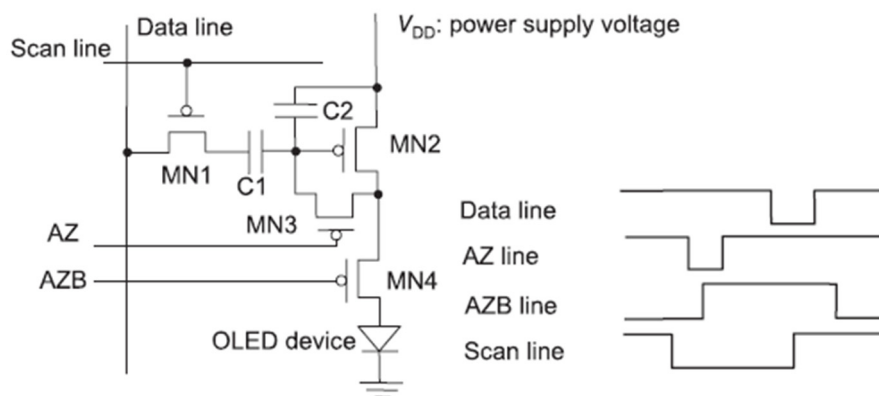
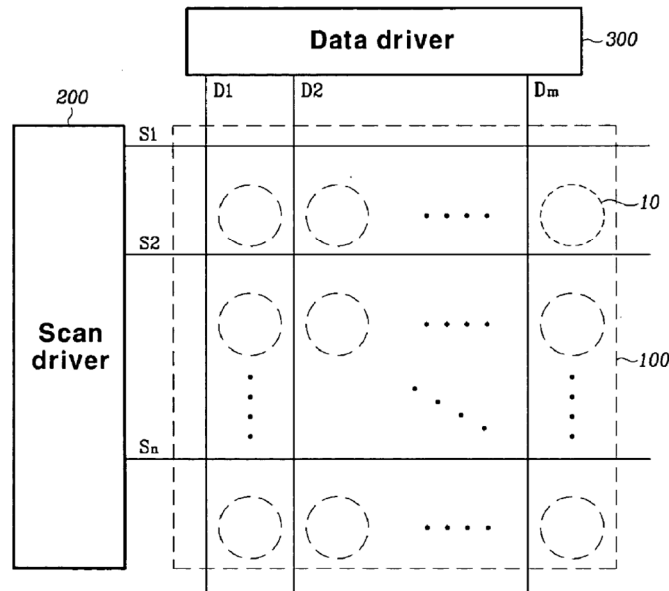


Figure 5.32 Voltage programming circuit drawn by Dawson et al. [7].

EX2007, 133.

53. Another example of voltage programming circuit used with data drivers is the Kim reference (EX1007) cited by Petitioners. Kim discloses an AMOLED display with data driver and scan driver. EX1007, FIG. 3. “The data lines D1 through Dm transmit data voltages that correspond to video signals to the pixel circuits 10.” EX1007, ¶[0046]. The signals Dm are the same as described above as video drive signals from the data driver or DDIC.

FIG.3

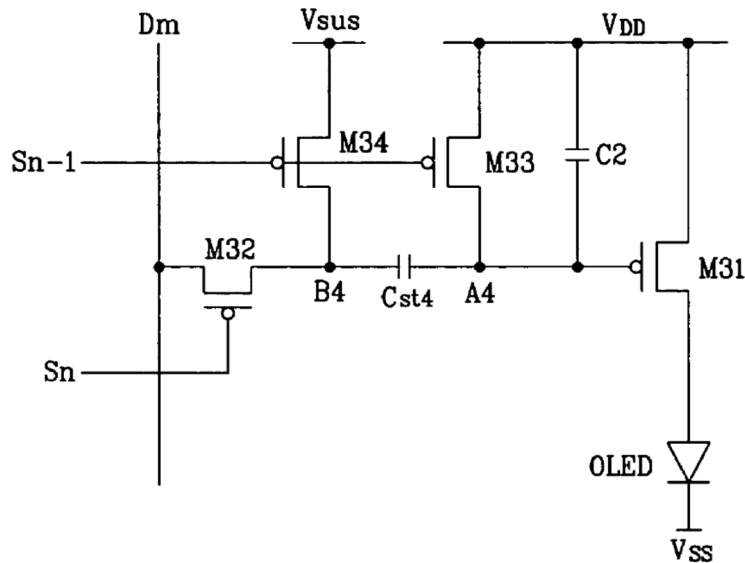


EX1007, FIG. 3.

54. All the Kim embodiments incorporate additional voltage shifting circuitry that are independent of the video drive signal, described in Figure 4 as a “voltage compensator.” EX1007, ¶[0054]. The voltage compensator simply shifts the voltage that will be applied to transistor M1; it does not change the characteristics of the analog video drive signal Dm.

55. In some cases, for example, Figure 10, reproduced below, there are two voltage adjustments. EX1007, FIG. 10. Transistor M34 adjusts the voltage of node B4 to V_{sus} and transistor M33 adjusts the voltage of node A4 to V_{DD} when Sn-1 is low. Again, the analog characteristics of the video drive signal Dm is unchanged by these actions.

FIG.10



EX1007, FIG. 10.

56. In summary, AMOLED displays may require additional compensation to eliminate the effects of threshold variation in the drive TFT or to remove voltages on a capacitor before writing new data, or to correct for IR drop in display electrodes; but in all cases, a standard video (data) driver is used to provide an amplified analog video drive signal to the display. A POSITA would not consider the additional TFTs in a pixel circuit that are used to compensate for local variations such as threshold voltage or IR drop ever to be part of the video data driver circuits.

F. AMOLED driver IC packaging

57. There are various levels of integration of the row and column drivers for AMOLED displays, depending on the size and complexity of the display. At the time of the invention (2006) it was common to attach driver ICs (both row and column ICs) to the display panel with flexible PCBs (*see supra* Section VI.B). A more common practice today, especially for small AMOLED devices, is to fabricate the row (scan) drivers directly on the display panel substrate and to mount the DDIC directly to the display panel using a flex circuit (“chip on flex”). *See supra* Section VI.B.2. Even with this level of integration, the pixel circuit is still distinct and separate from the video drivers.

58. In some cases, the level of integration is carried even further. For example, the Oyonama article describes AMOLED micro displays for AR/VR applications entirely fabricated on a silicon IC substrate. *See* EX2010, 950-953. The pixel circuit and a block diagram of the fully integrated display are shown below. Even though all the circuitry is integrated onto the same display panel, the pixel circuit functions are physically and functionally separate from the video driver and associated global correction circuitry (e.g., gamma circuit).

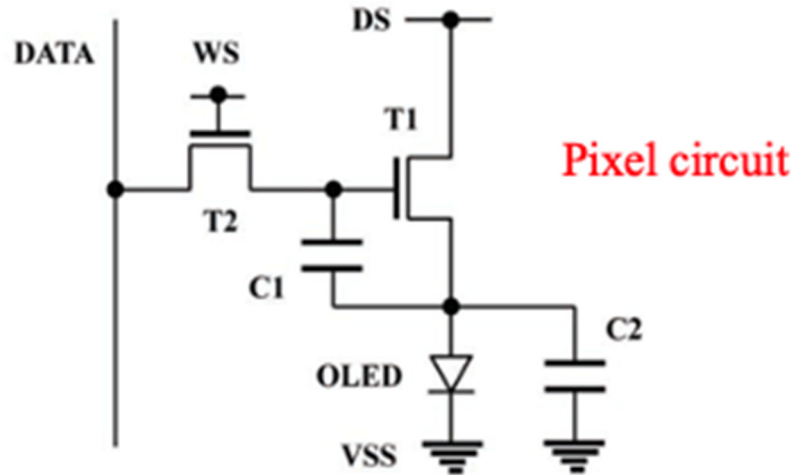


Figure 1. Schematic diagram of new pixel circuit

EX2010, 950, FIG. 1 (annotated).

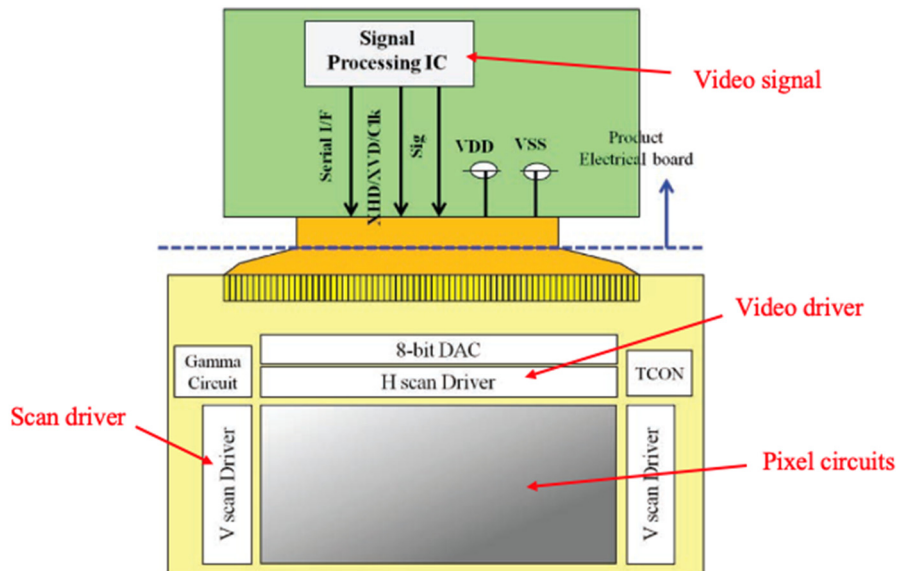


Figure 6. Block diagram of driving circuit

EX2010, 952, FIG. 6 (annotated).

VII. BACKGROUND OF THE '521 PATENT

A. Summary

59. 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

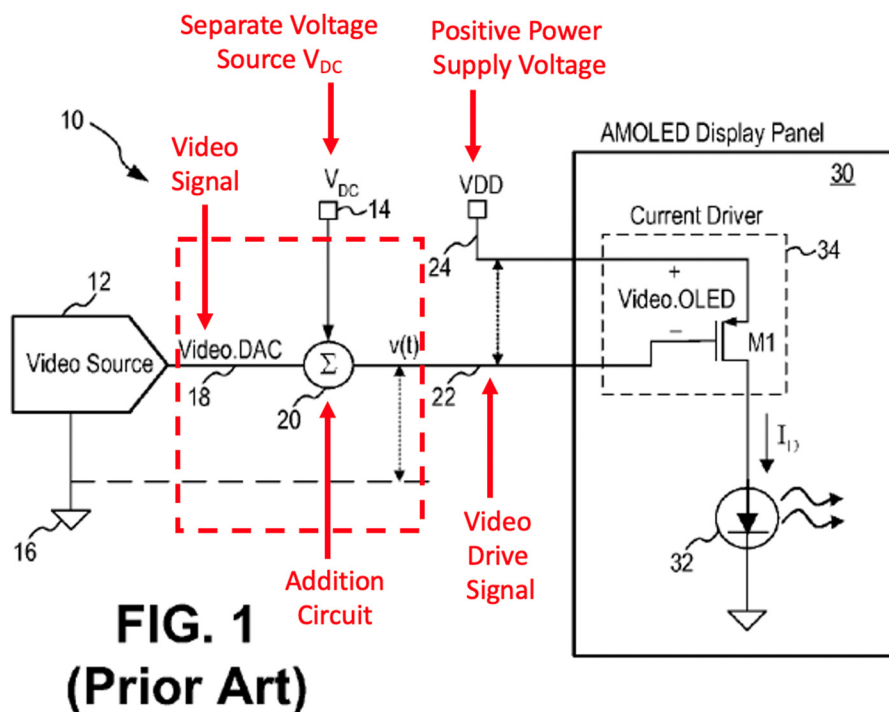
60. The '521 patent is directed to active-matrix organic light emitting diode (AMOLED) displays. EX1001, 1:13-17. AMOLED displays contain many thousands of individual OLED pixel elements, each with its own pixel driver which provides current to energize the individual pixel OLEDs. EX1001, 1:15-17. "These 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.

61. 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

62. 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).

63. 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.

64. 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.

65. 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.

66. 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.

67. 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

68. 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.

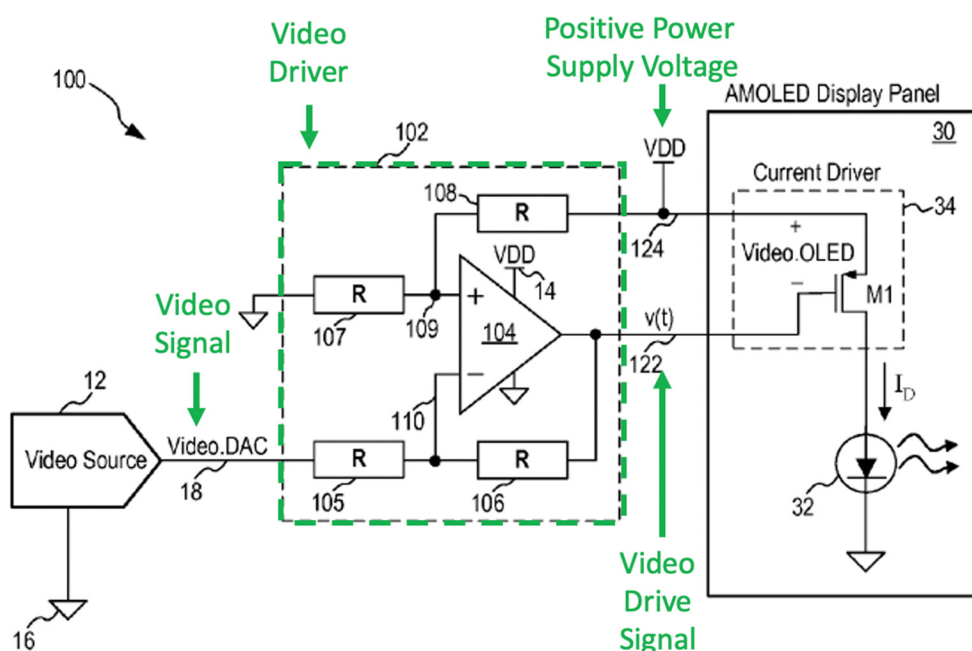


FIG. 2

EX1001, FIG. 2 (annotated).

69. 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.

70. 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.

71. 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

72. 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.

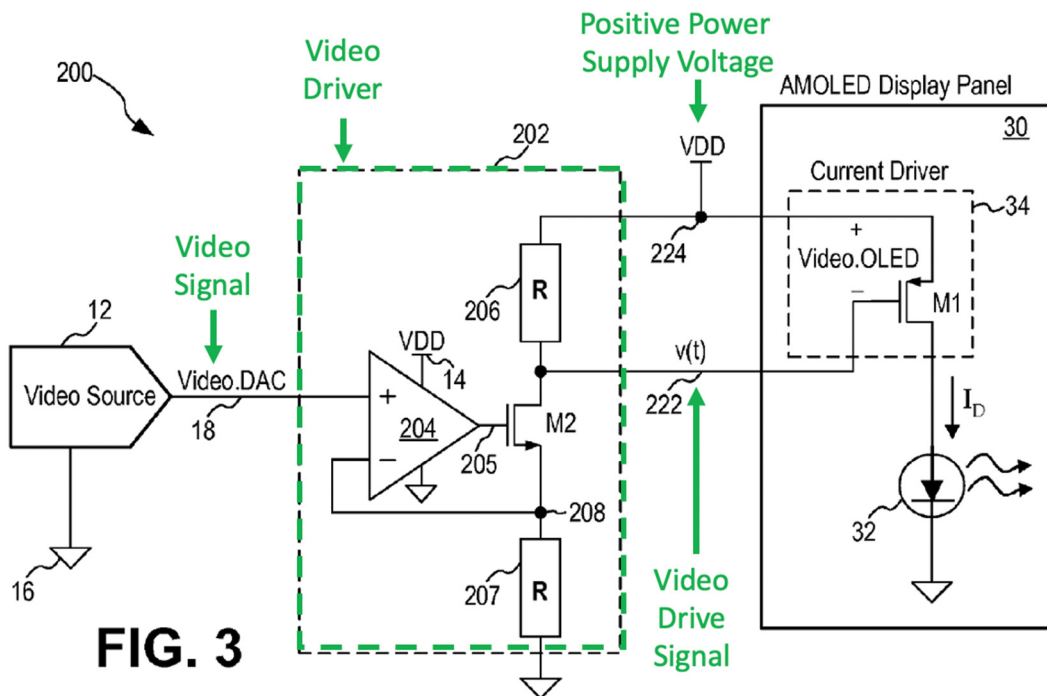


FIG. 3

EX1001, FIG. 3 (annotated).

73. 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

74. 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.

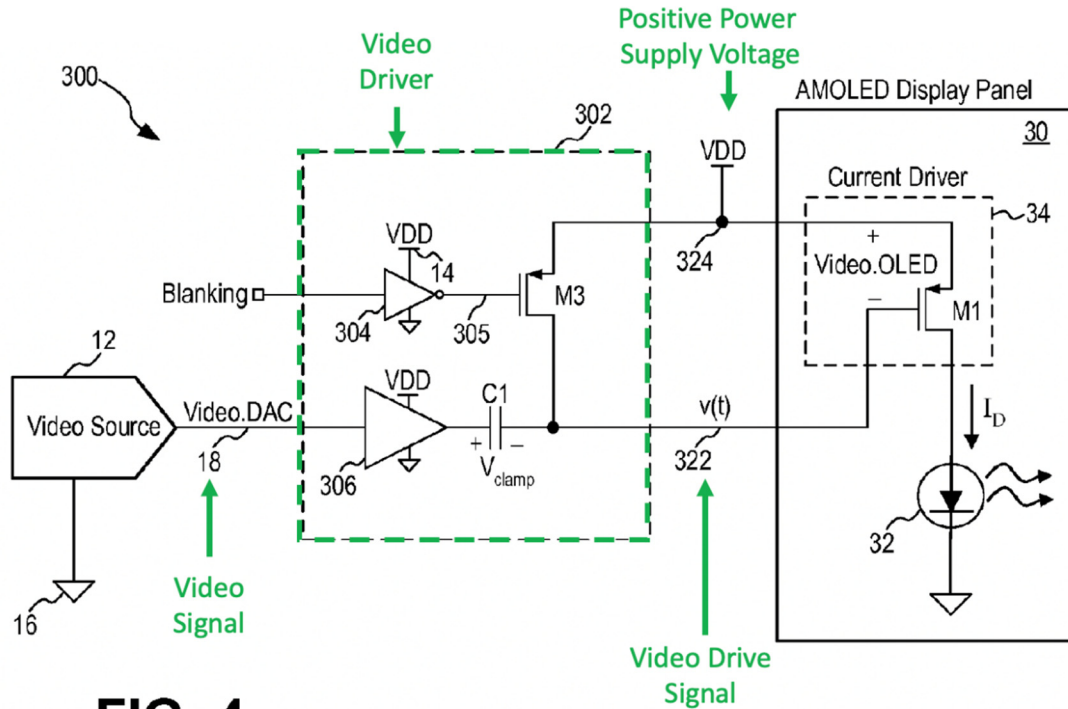


FIG. 4

EX1001, FIG. 4 (annotated).

75. 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.

76. 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.

77. 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.

78. 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 or adjusting voltage references within the pixel to compensate for local variations (e.g., threshold voltage or IR drop) 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. GROUNDS 1 AND 2: KIM DOES NOT ANTICIPATE OR RENDER OBVIOUS CLAIMS 1, 2, AND 7 OF THE '521 PATENT

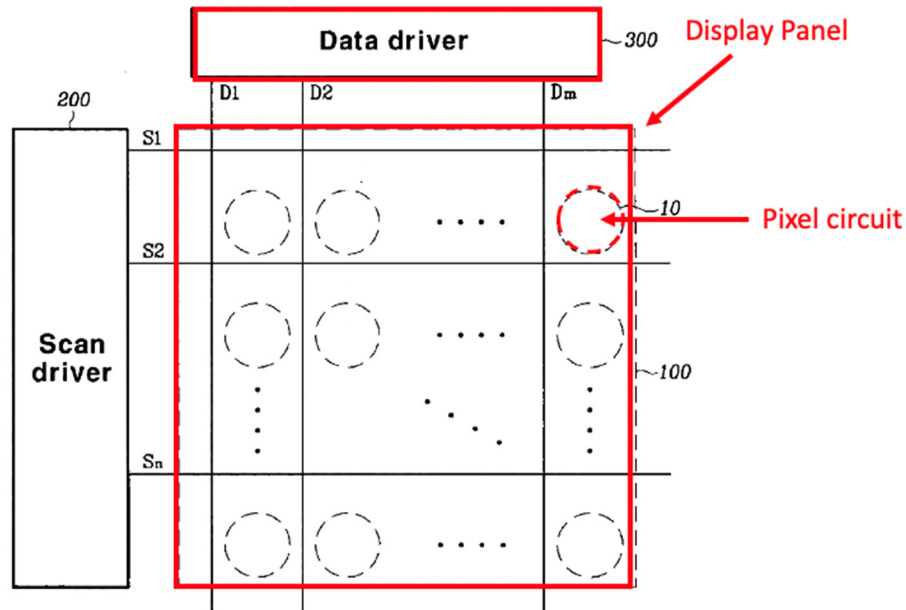
79. It is my opinion that, contrary to the claims made in the Petition and by Petitioner's expert, Dr. Kattamis, Kim does not disclose or render obvious claim elements [1-A] or [1-C] of the '521 patent. Because claims 2 and 7 depend from claim 1, those claims are also not anticipated or rendered obvious.

A. Summary of U.S. Patent Publication No. 2005/0140600 ("Kim")

80. 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

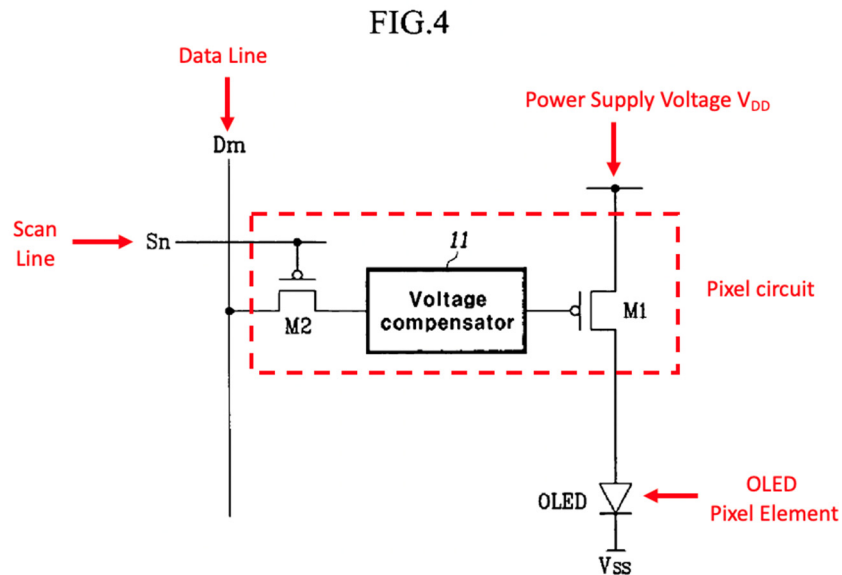


EX1007, FIG. 3 (annotated).

81. 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 Sn. 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].

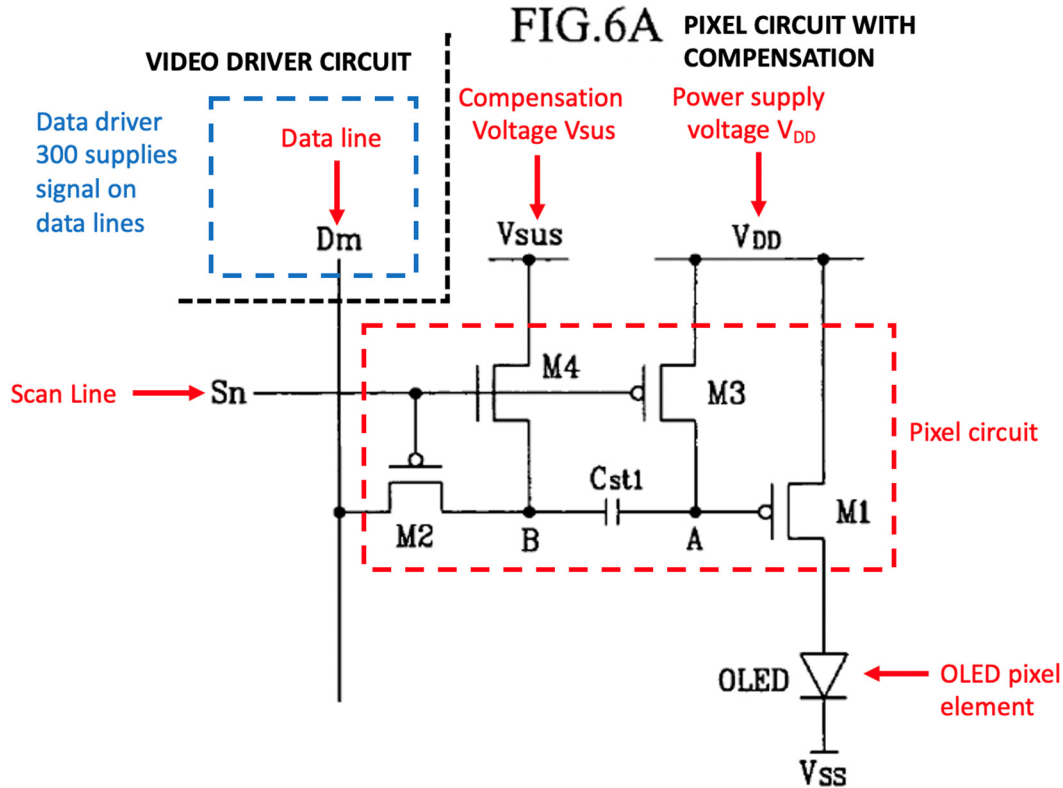


EX1007, FIG. 4 (annotated).

82. 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.

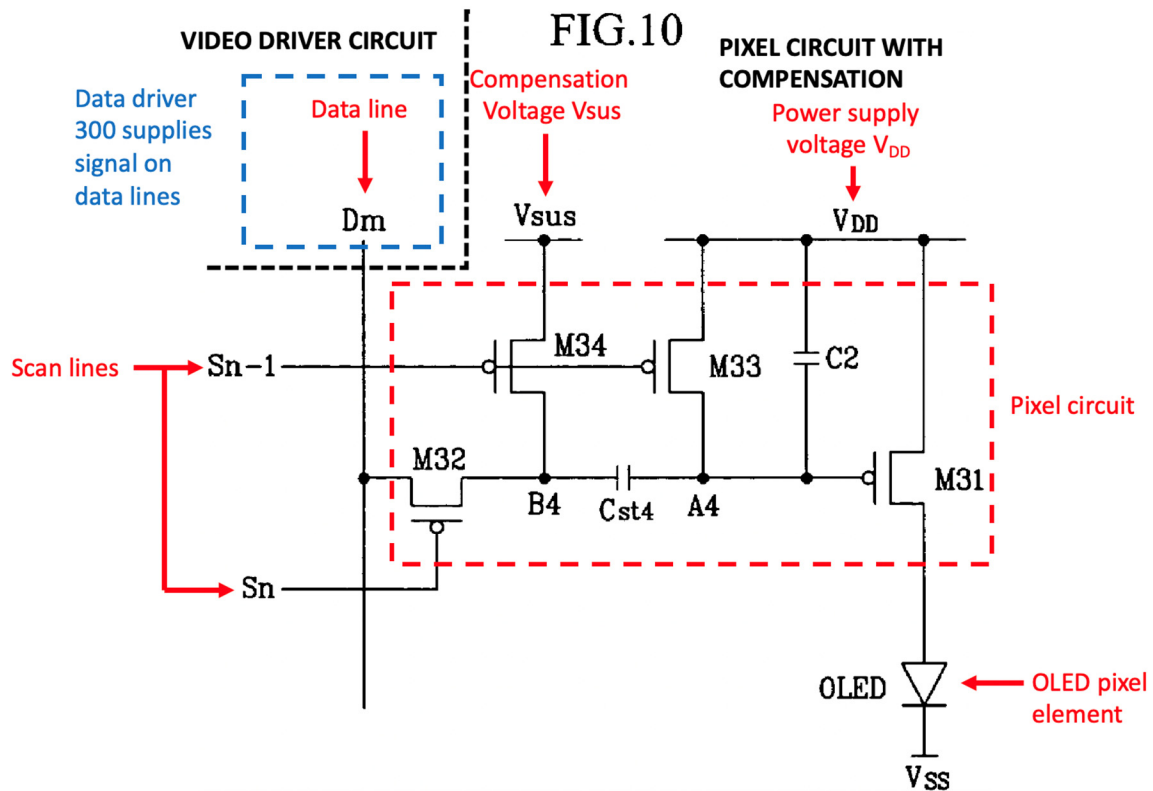
EX1007, ¶[0069].



EX1007, FIG. 6A (annotated).

83. 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. **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.”**

84. 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 does not generate a video drive signal. Second, the identified compensation circuit (alleged video driver), which is part of the pixel circuit, is not a *video driver* because, in AMOLED displays, video drivers are distinct from pixel circuits. Third, the alleged video drive signal is not referenced to the positive power supply voltage.

1. The identified portion of Kim’s pixel circuit does not generate a video drive signal.

85. Claim 1 recites that the video driver receives a “video signal” and “generat[es] a video drive signal.” The portion of the pixel circuit identified by Petitioner does not “generate a video drive signal.” The pixel circuit of Kim’s 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 to *receive*, not *generate* a video drive signal.

86. One of ordinary skill in the art would understand that generating a video drive signal requires taking a usually digital video signal and shifting, converting to analog, and amplifying the voltage so that it can properly drive the transistors in the display panel’s pixel circuits. For example, as explained in the

den Boer textbook, a video driver (also referred to as source driver, column driver, and data driver) in an Active Matrix display, illustrated in Figure 4.11, uses a level shifter to shift the voltage of the video signal from the “logical levels” to a level that can drive the pixel circuit’s transistors, a digital to analog converter, which also adjusts the gamma of the output voltage, and amplifiers (buffers) to provide sufficient current to the low impedance column electrodes. EX1011, 97.¹

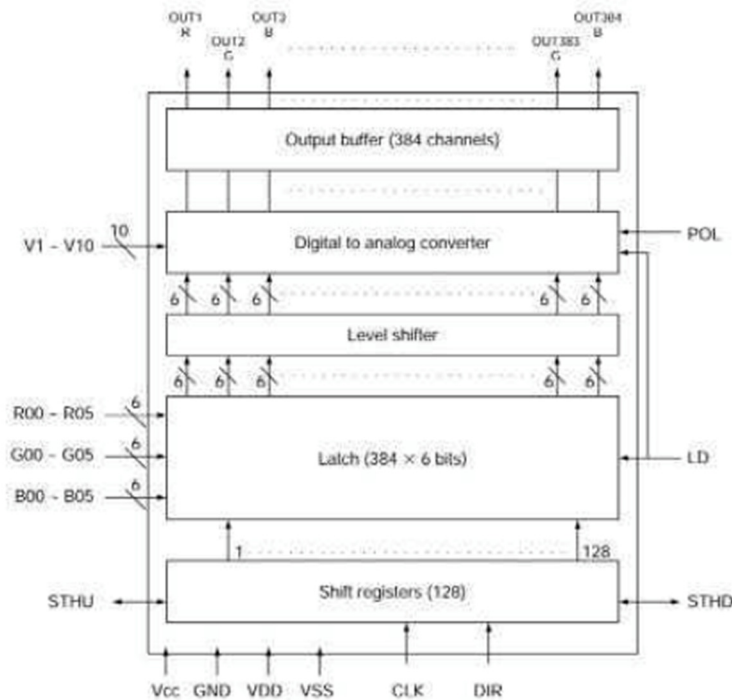


Figure 4.11: Basic architecture of a source driver IC with 384 channel outputs for use in XGA and SXGA panels (eight or ten chips per panel, respectively).

EX1011, 97, FIG. 4.11.

87. Consistent with the understanding of a POSITA, the '521 patent describes generating a video drive signal as, among other things, receiving a video

¹ Citation is to original page number.

signal from a video source, such as an image processor, and shifting it “to bring the DC range of the analog video signal to within the range of the AMOLED display panel.” EX1001, 1:56-2:12. The ’521 patent’s embodiments disclose a video driver that receives a video signal as input and uses the power supply voltage VDD as an offset to the video signal to generate a video drive signal that is within the range of the AMOLED display panel and referenced to power supply voltage VDD as illustrated in Figure 2 below. 4:34-37; 6:1-6; 7:4-8.

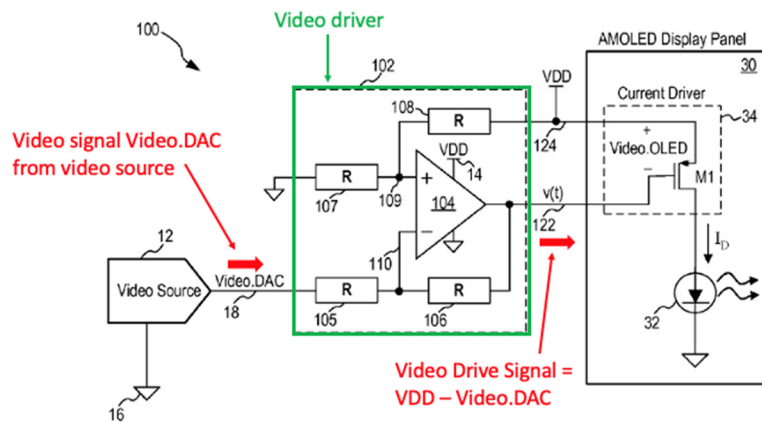


FIG. 2

EX1001, FIG. 2.

88. One of ordinary skill in the art would also understand that a video driver would use amplifiers, among other components, to generate a drive signal. For example, the video driver disclosed in den Boer uses output buffers to reduce the output impedance of the output channels in order to drive the data lines that connect to the pixel circuits. EX1011, 97-98. Output buffers typically include

amplifiers to drive current onto the data lines, as illustrated in the Figure below
from the Cristaldi textbook on LCD video drivers.

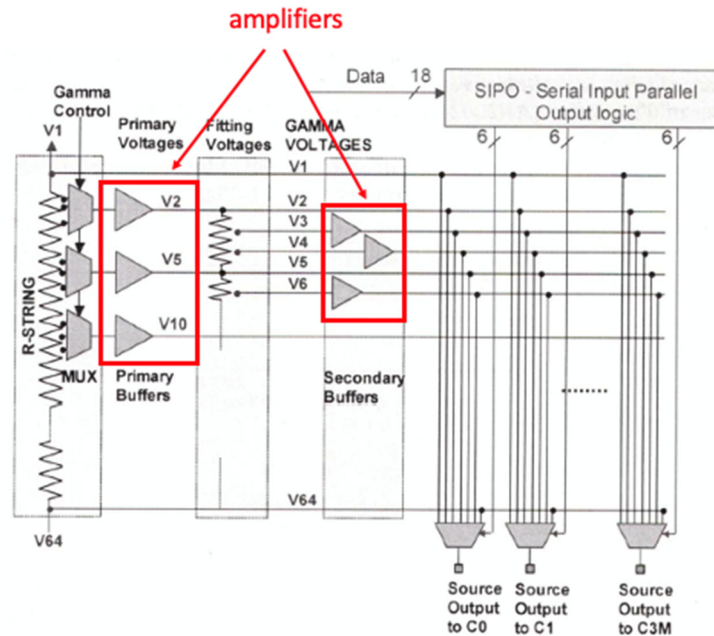


Fig. 6.16 Resistor string and MUX adopted implementing the R-DAC for positive voltages

EX2006, 205, FIG. 6.16.

Cristaldi also provides specific examples of buffer amplifier configurations, as
illustrated in the figure below.

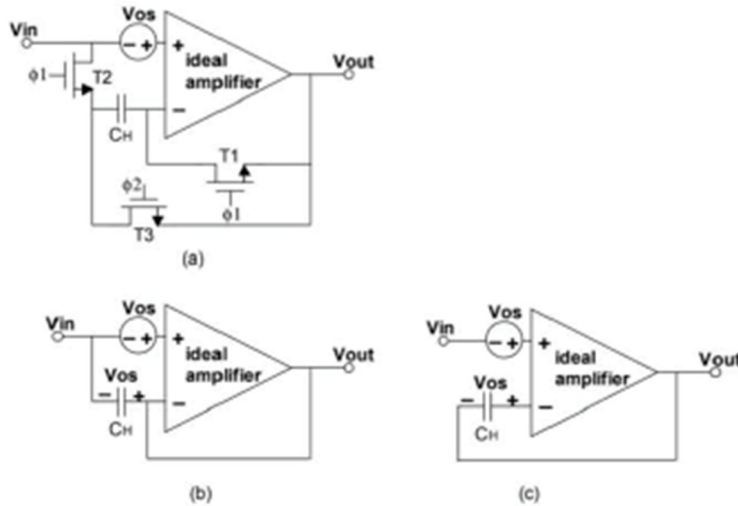


Fig. 6.4 Example of buffer amplifier with offset compensation [TSL2005]

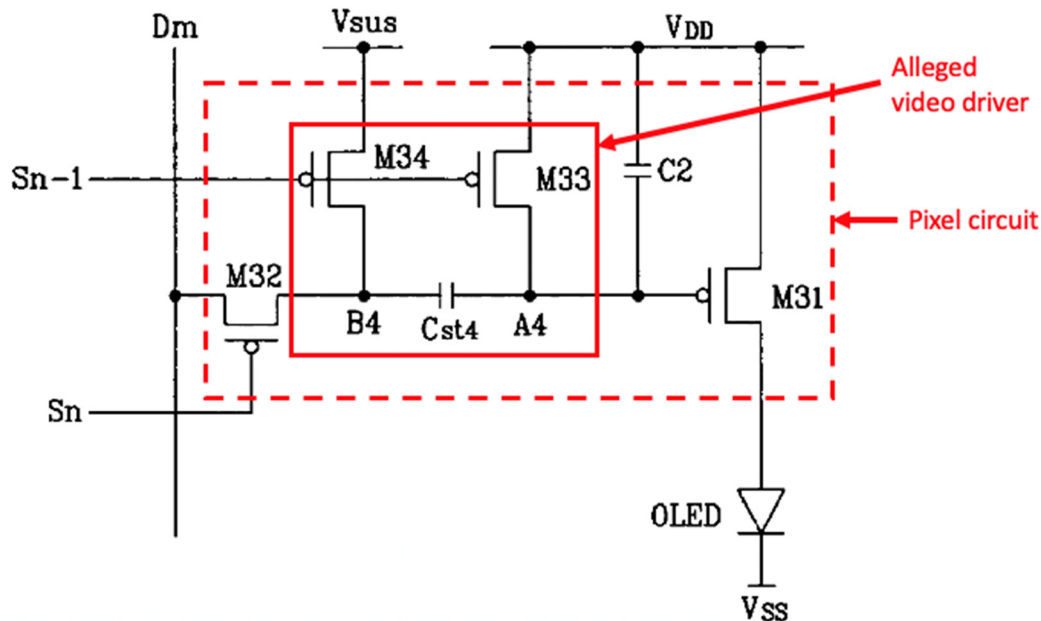
EX2006, 194, FIG. 6.4.

Consistent with this understanding, the video driver in each embodiment of the '521 patent includes at least one amplifier. EX1001, FIGs. 2-4.

89. In contrast, the alleged video driver of Kim does not perform these functions in creating the alleged video drive signal. The signal of the alleged video driver of Kim does not increase the voltage from the logical level of the video source to the level of the display. The signal received by Kim's pixel circuit must have necessarily already undergone this voltage level shifting, otherwise the signal would not properly interact with the pixel circuit's transistors and capacitors. Additionally, the alleged video driver does not have the components needed to drive current onto the column data lines. EX1007, FIG. 10. The alleged video drive signal of Kim that actually resides within the pixel array includes only switching transistors M33 and M34 and capacitor Cst4, which one of ordinary skill in the art

would expect in a pixel circuit that corrects for local non-uniformities such as threshold voltage or IR drop. EX1007, FIG. 10. Without an amplifier the alleged video driver within the pixel array is unable to generate the claimed video drive signal. EX1007, FIG. 10; *see* ¶¶46-51, *supra*.

FIG.10

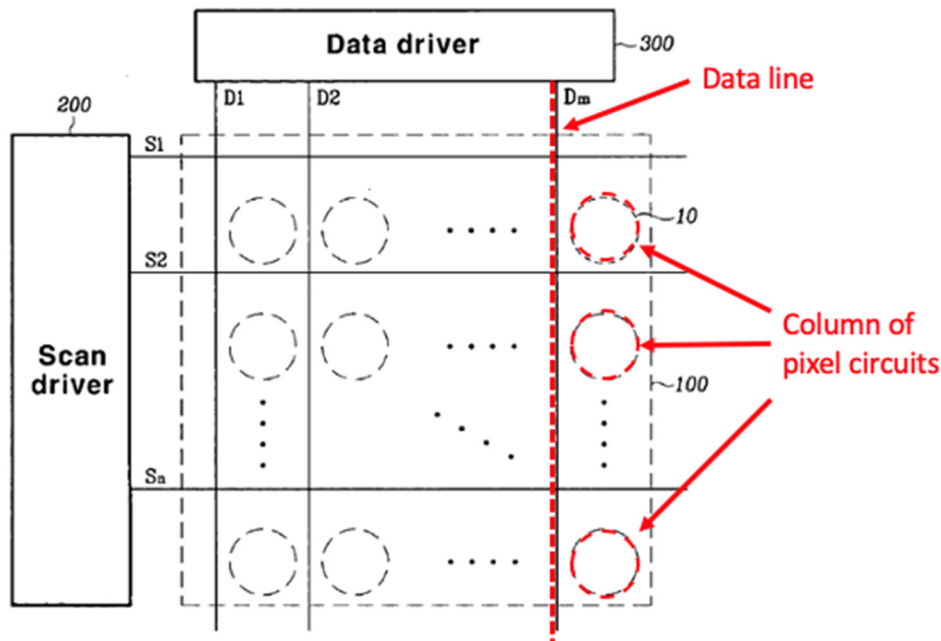


EX1007, FIG. 10 (annotated).

90. Further, because the alleged video driver in Kim is inside the pixel circuit, there is no need for it to *generate* a video drive signal, as the signal is already generated by the video data driver 300. EX1007, ¶¶[0044]-[0047], FIG. 3. In an AMOLED display system, a video driver generates a video drive signal to drive an entire column of pixels in a row by row manner. *See* ¶¶46-51, *supra*. In

contrast, the alleged video driver of Kim sends a signal only to the drive transistor within a single pixel circuit. Thus, the alleged video driver of Kim *receives* a video drive signal from the data (video) driver, as illustrated in Figure 3.

FIG.3



EX1007, FIG. 3 (annotated).

91. Additionally, the operation of the alleged “video driver” in Kim’s fourth embodiment illustrates that it does not *generate*, but rather merely makes minor adjustments to an existing video drive signal. As illustrated in Kim’s Figure 10, the alleged “video driver” is a portion of the pixel circuit that functions as a compensation circuit. EX1007, FIGs. 4, 10. Specifically, when the previous select line Sn-1 is set to low, switching transistor M34 turns on and compensation voltage

V_{sus} flows to electrode B4 of capacitor Cst4. EX1007, ¶[0105]. Switching transistor M33 also turns on and charges electrode A4 of capacitor Cst4 with the power supply voltage VDD. EX1007, ¶[0107]. When the current select line S_n becomes low, switching transistor M32 turns on and video signal D_m 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, ¶[0108]. A POSITA would understand that the operation of switching transistors M33 and M34 and capacitor Cst4 described above makes a local correction to the analog voltage supplied by the video driver to the drive transistor but does not *generate* the video drive signal.

2. The identified portion of Kim's pixel circuit is not a *video driver*.

92. Kim discloses an AMOLED display system, with data (video) driver, scan driver, and an array of pixel circuits. EX1007, ¶¶[0007]-[0009], [0044]-[0047], FIG. 3. Kim's disclosure is consistent with a POSITA's understanding of a conventional AMOLED display, where a video driver (also referred to as source drivers, column drivers, display drivers, or data drivers, *see* ¶¶32-40, *supra*) provides video data to columns of pixels and a scan driver sequentially selects rows of pixels for programming. For example, the figure below from the Tsujimura textbook shows the same relationship between the video (data) driver and pixel

circuits as Kim's Figure 3. Thus, a POSITA would understand that the *video driver* of the '521 patent, which generates an analog video drive signal with voltages and impedance levels that match the voltage and current requirements of the pixel array, is the same as the data driver in Kim's Figure 3 or Tsujimura's Figure 4.31 below. This is further supported by the fact that Kim does not refer to the voltage compensator within the pixel circuit as a "video driver." EX2012, 87:20-88:7.

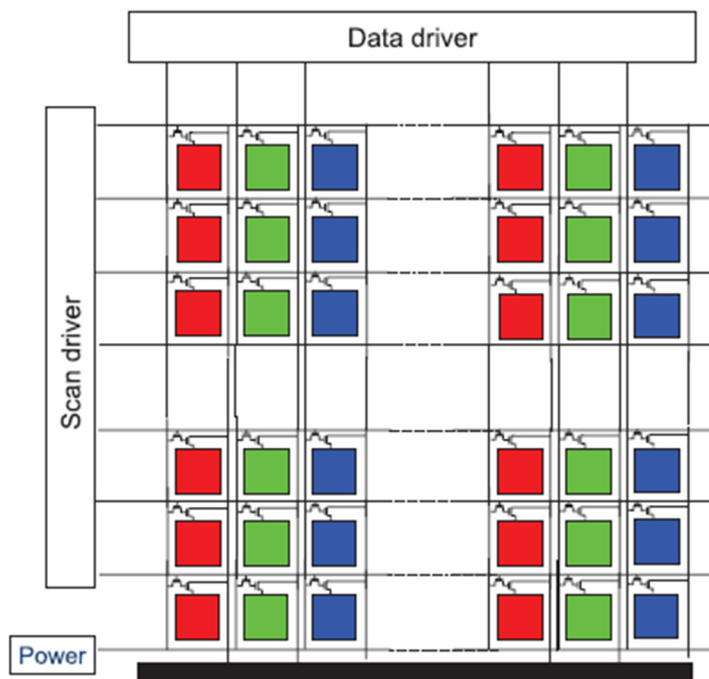


Figure 4.31 An active-matrix OLED display.

EX2007, 99 (FIG. 4.31).

93. One of ordinary skill would also understand that in AMOLED displays there is a one-to-many relationship between drivers and pixel circuits. *See* ¶¶32-40, *supra*. The data (video) driver circuitry comprises an array of drivers

where each driver in the array “drives” an entire column of pixel circuits. *See* ¶¶32-40, *supra*. The scan driver similarly is comprised of an array of drivers wherein each driver in the array “drives” a row of pixel circuits, allowing one row at a time to be programmed with the video signal in repeating cycles. *See* ¶¶32-40, *supra*. In contrast, the alleged video driver of Kim does not drive a number of pixel circuits and is therefore not a video driver. EX1007, FIGs. 4, 10.

94. Given the distinct functions of video drivers and pixel circuits in AMOLED displays, it is clear that Kim’s pixel circuit does not disclose the claimed video driver. The invention of the ’521 patent is a specific solution to the problem of power supply voltage variations that is implemented in the video driver rather than in the individual pixel circuits. Consistent with the understanding of AMOLED displays that one of ordinary skill in the art would have, the ’521 patent states that the invention is for a *video driver* that functions to isolate the pixel circuit from power supply variations:

The *invention relates to video driver* for AMOLED displays and, in particular, to a video driver for AMOLED displays *that is capable of isolating the pixel circuit from power supply voltage variations*.

EX1001, 1:5-10 (emphasis added).

95. One of ordinary skill in the art 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. Petitioner has

admitted that the specification refers to “*electrical* isolation” of the pixel circuit.

POPR Reply, 1. 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. POPR Reply, 1. Otherwise, if the video driver were part of the pixel circuit, it would be impossible for the “video driver” to “isolat[e] the pixel circuit.” POPR Reply, 1; EX1001, 1:5-10.

96. The differences in the problems addressed by the ’521 patent and Kim help explain why they propose different solutions. The problems Kim seeks to address – driving transistor threshold voltage variations and voltage drop – vary among the pixel circuits in a display. EX1007, ¶¶[0014], [0015]; EX2012, 55:17-56:11, 59:1-18. As explained in the following excerpt from a 2006 article by Han, threshold voltage non-uniformity causes undesirable variance in brightness among pixels:

[T]he ***non-uniformity*** of electrical properties of poly-Si TFT, such as the ***threshold voltage ... causes the non-uniformity of luminance in one pixel to another one.***

EX1012, 53 (emphasis added).

97. Similarly, Kim explains that due to “voltage drop”, “***the power supply voltage VDD applied to a plurality of pixel circuits is not uniform***” and “a desired amount of current may not flow to the OLED, thereby degrading image quality.”

EX1007, Kim, ¶[0013] (emphasis added). Because these voltage disturbances are not uniform across pixel circuits, the solution must provide a form of voltage compensation to each pixel circuit separately. The Han article, similar to Kim, proposed providing a compensation voltage, V_{SUS} to the pixel circuits to address similar challenges:

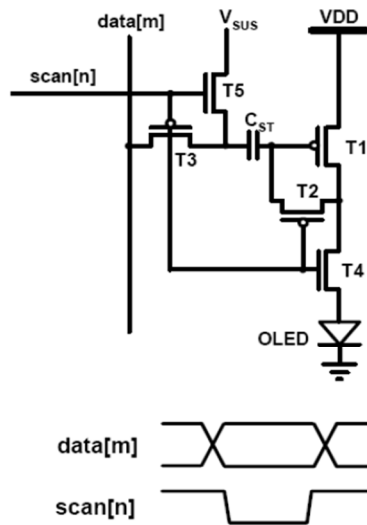


Figure 4. The reported AMOLED pixel circuit employing a reference voltage source V_{SUS} which compensates the V_{DD} supply voltage drop as well as the threshold voltage variation of poly-Si TFT [6].

EX1012, FIG. 4.

98. In contrast, the '521 patent provides examples of voltage variations that do not vary from pixel circuit to pixel circuit. The '521 patent provides the example of a component in a battery powered device turning on, causing the power supply voltage delivered to the display to fluctuate:

[W]hen 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.

EX1001, 1:40-56. In this example, the circuitry of a battery-powered device turning on would impact the power supply voltage for the entire display. Thus, the '521 claims a solution that is implemented in the video driver that is outside of the pixel circuits. That is, the '521 patent teaches a “global” correction to the generated video signal by referencing the video signal to V_{DD} before the data is supplied to the pixel circuits.

99. The '521 patent states that the video driver can be integrated with other components. For example, the “video driver of the present invention can be integrated on the same integrated circuit with ... the AMOLED display panel.” EX1001, 7:59-62. Additionally, “the video driver circuit of the present invention can be integrated with other circuitry of the AMOLED display panel into a single integrate circuit.” EX1001, 7:57-59.

100. These embodiments do not eliminate the requirement that the claimed video driver be distinct from the pixel circuits. The defining features of an *Active Matrix* OLED display are distinct pixel circuits for each OLED pixel, a video driver that sends a video drive signal to columns of pixel circuits, and a scan driver

that selects which row of pixel circuits is active. See ¶¶32-40, *supra*. Petitioner does not dispute this. EX1002, ¶¶67-70; EX2012, 79:11-16. Thus, even if the video driver and display panels are integrated, a POSITA would understand that the display would still comprise distinct pixel circuits and video drivers.

Illustrating this, Figure 4.16 in the den Boer textbook shows an AMOLED display with the video driver (referred to as data driver) and the viewing area (the matrix of OLED pixels and pixel circuits) integrated on a single piece of glass. EX1011, 102-104; EX2012, 48:2-50:11.

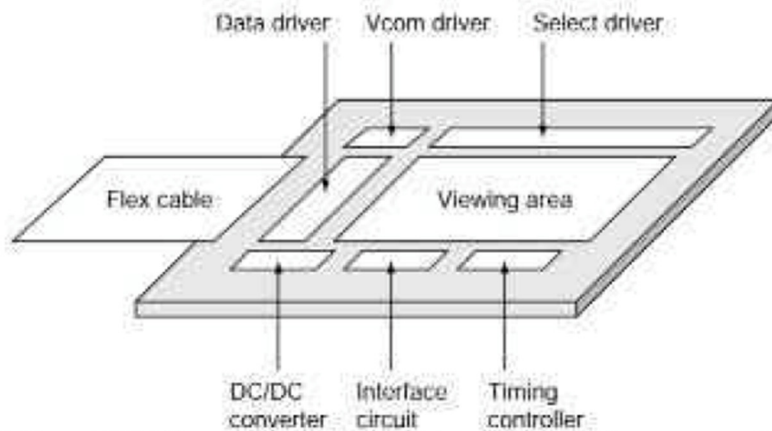


Figure 4.16: Example of configuration for a "system-on-panel."

EX1011, 104 (FIG. 4.16).

101. Similarly, AMOLED display systems where the video driver, scan driver, and pixel circuits are incorporated into an integrated circuit have been implemented. For example, Oyonama describes an AMOLED display where the video driver, scan driver, and pixel circuits are built onto a single piece of silicon:

Various driving circuits required for the Micro-OLED display have been built into the Si backplane. The vertical and horizontal scan drivers are both fabricated on the Si backplane. Additionally, 8-bit digital-to-analog (DAC) converters, a gamma voltage generation circuit, and timing controllers (TCON) were realized on the panel.

The Micro-OLED display is an all-in-one package

EX2010, 952. The figures below from Oyonama further illustrate that the video driver, scan driver, and pixel circuits are distinct components built on a single semiconductor substrate. EX2010, 950, 952.

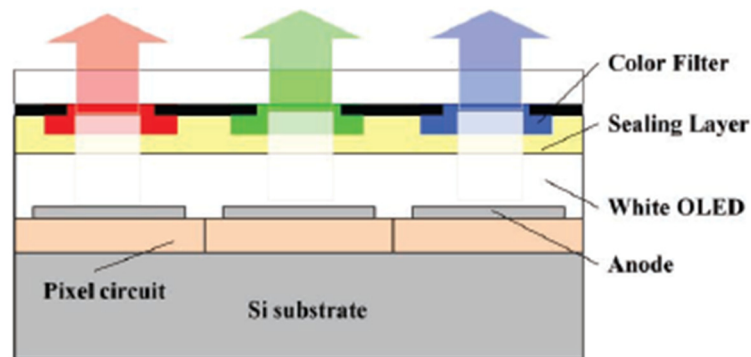


Figure 5. Cross-sectional composition

EX2010, 952, FIG. 5.

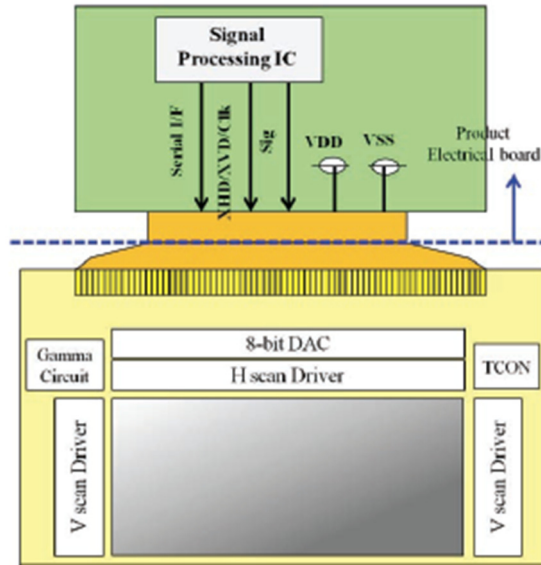


Figure 6. Block diagram of driving circuit

EX2010, 952, FIG. 6.

102. Thus, even in a design where the video driver and pixel circuits are integrated with the display panel or incorporated into a single integrated circuit, the video drivers are still distinct from the pixel circuits. Thus, the compensation circuit (alleged video driver) located in the pixel circuit of Kim does not disclose the video driver of claim 1.

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

103. Claim 1 requires the video drive signal to be “referenced to a positive power supply voltage.” The claimed positive power supply voltage is the voltage that is applied to the drive transistor to generate the current to the OLED pixel element. Petitioner argues that the voltage at electrode A4 in Kim’s Figure 10 embodiment is independent of the power supply voltage because Kim’s Equation

11 adds V_{DATA} to VDD: $V_{A4} = VDD + \Delta V_{B4} = VDD + V_{\text{DATA}} - V_{\text{sus}}$. 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. *See* EX1001, 1:32-55. Therefore, V_{A4} is not referenced to the positive power supply voltage.

104. 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. The corresponding current flows to the OLED pixel.

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

EX1007, ¶[0112].

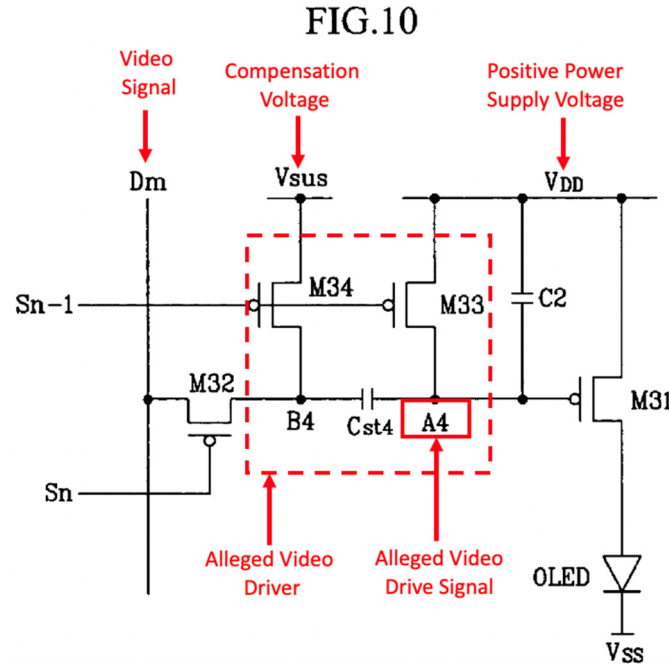
105. However, at a more granular level, the positive power supply voltage VDD is not constant with time. More accurately, VDD includes a constant ideal voltage component as well as undesirable voltage variation components such as noise and drift that vary with time:

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

EX1007, ¶[0112].

106. The value of VDD that is used to determine V_{A4} in Equation 11 is not necessarily the same value of VDD that is applied to the source of drive transistor M31. When S_n goes low, 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).

107. 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:

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

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

108. The modified equations above illustrate that $V_{DD}(t_1)$ 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 $t1$, $VDD(t1)$.

109. Petitioner argues that the operation of 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. However, the Petition ignores that 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. Therefore, the output of amplifier 306 would continue to be impacted by variations in V_{DD} even after the clamping voltage is set on capacitor C1.

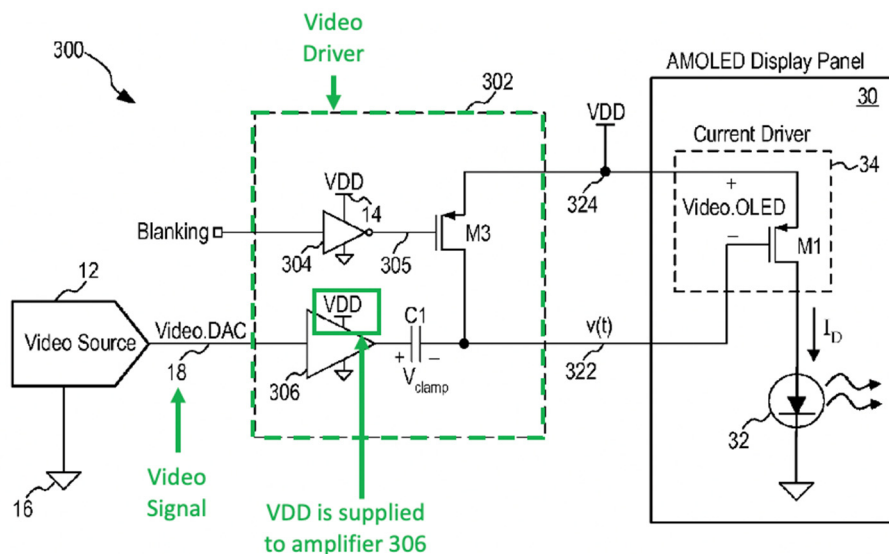


FIG. 4

EX1001, FIG. 4 (annotated).

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

C. 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.”

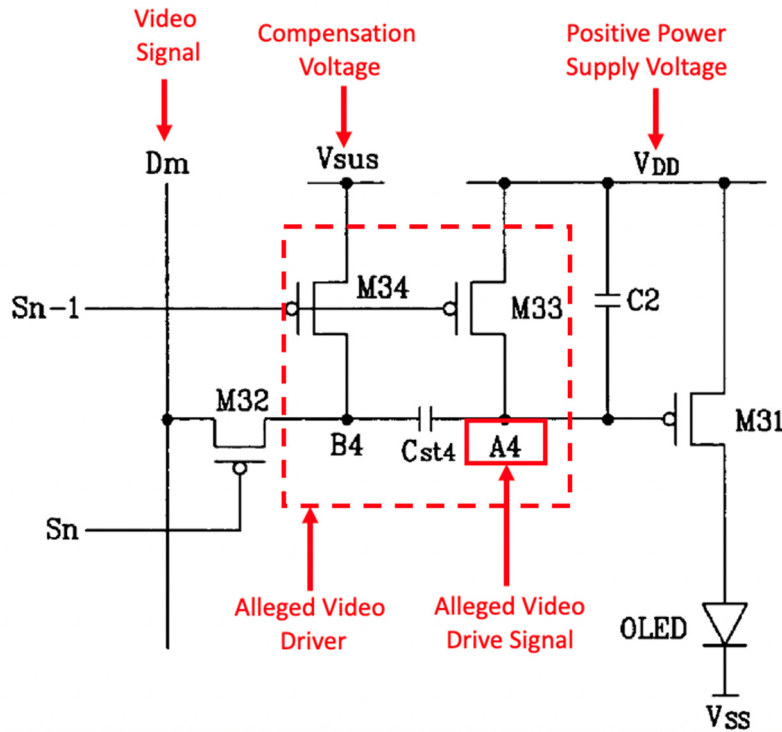
111. Claim 1 requires a “drive current being ... independent of the positive power supply voltage.” Alleging disclosure and not obviousness, the Petition argues that the drive current in Kim’s Figure 10 embodiment is independent of the power supply voltage because the equation 13 describing the current flowing to the OLED does not include the power supply voltage VDD: $I_{\text{OLED}} = \beta/2 * (V_{\text{GS1}} -$

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

112. 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.

113. 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).

114. 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].

115. 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].

116. 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].

117. 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:

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

118. 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].

119. 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.

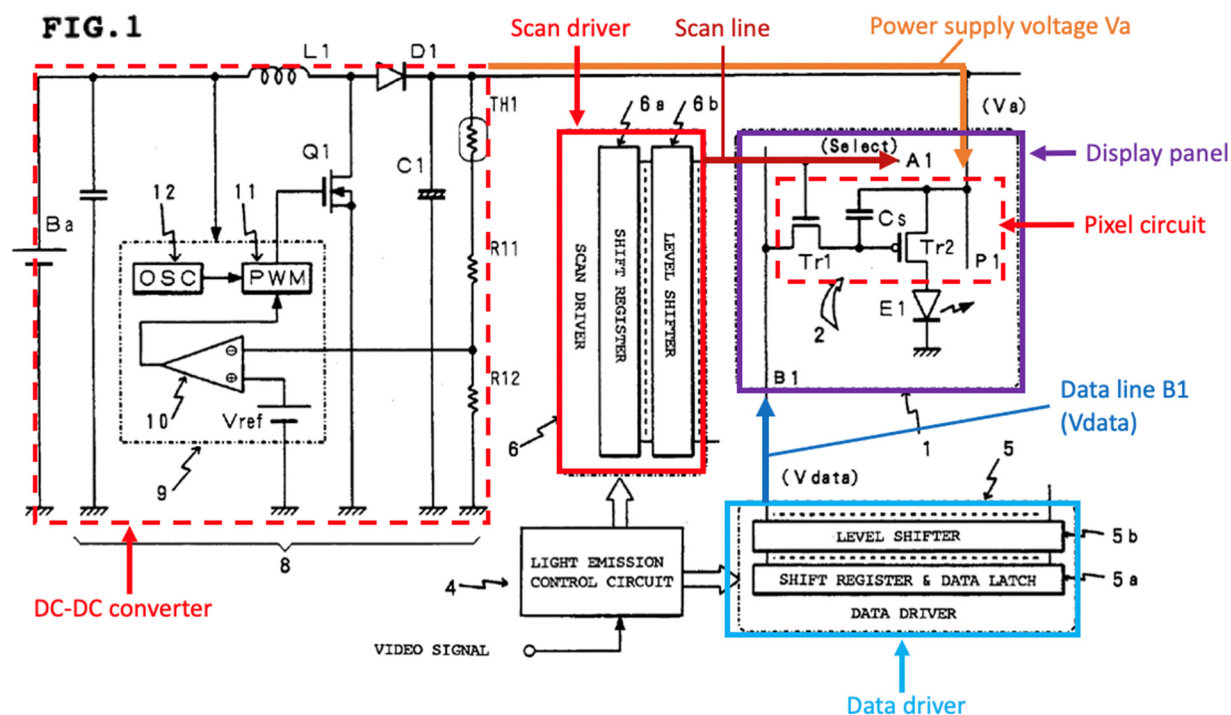
120. For the reasons enumerated above, it is my opinion that Kim does not disclose or render obvious independent claim 1 of the '521 patent, and as such also does not disclose or render obvious any dependent claim of the '521 patent.

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

121. 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. Summary of U.S. Patent Publication No. 2005/0190128 ("Hayafuji")

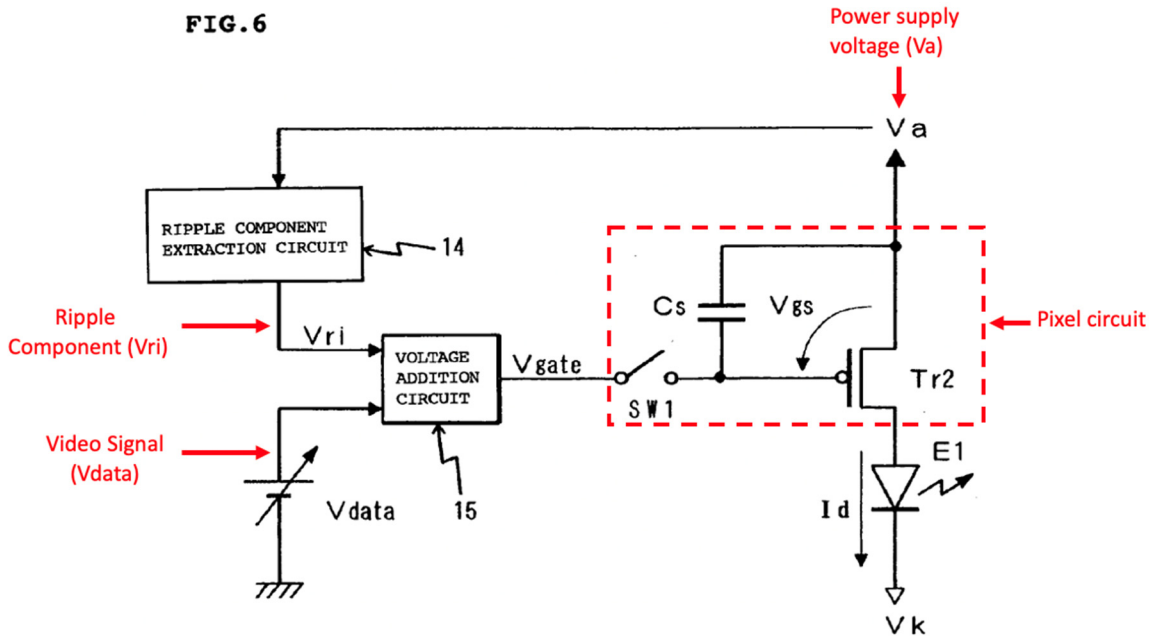
122. Hayafuji discloses a system with a DC-DC converter providing the power supply voltage for a display panel. EX1006, ¶¶[0028]-[0030]. As illustrated by Figure 1, the display panel receives power supply voltage V_a from the DC-to-DC converter and display data V_{data} from the data driver (i.e., video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



EX1006, FIG. 1 (annotated).

123. 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].

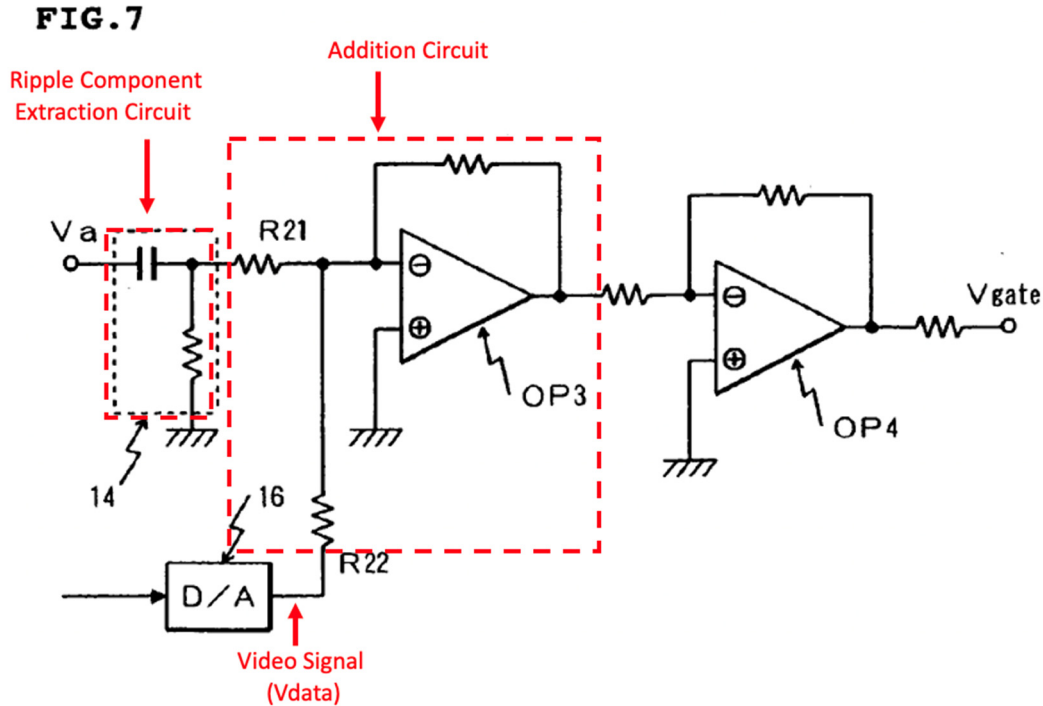


EX1006, FIG. 6 (annotated).

124. 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]. A POSITA would understand that this is a high-pass filter. 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.

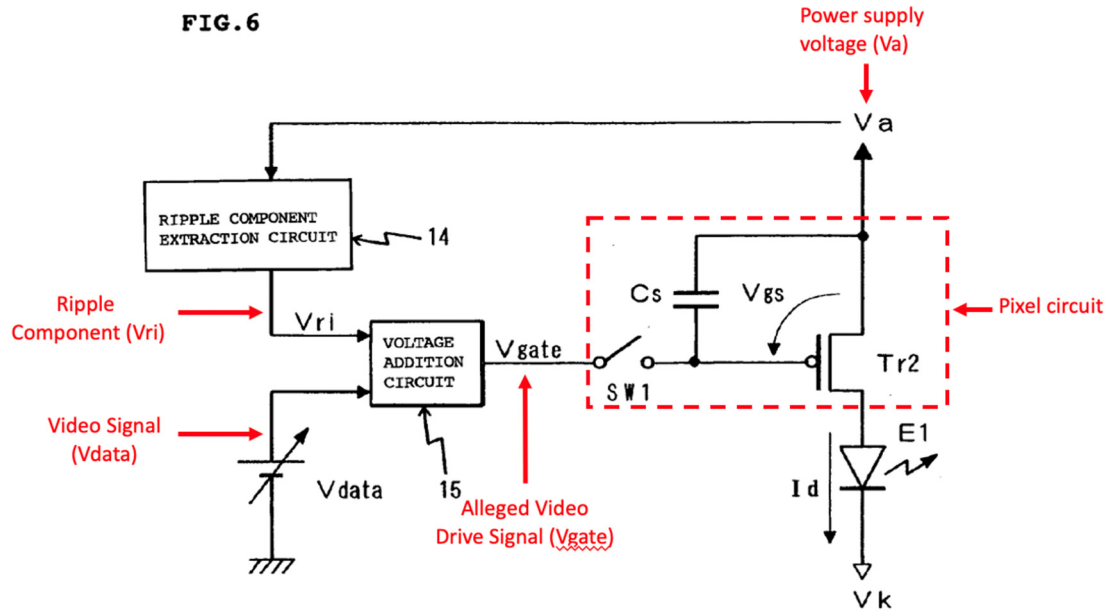


EX1006, FIG. 7 (annotated).

- B. 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.”**

125. 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 and that V_{gate} discloses the claimed video drive signal. Pet., 53-55. However,

because the voltage of signal V_{gate} is not referenced to the positive power supply voltage V_a in Hayafuji, V_{gate} does not disclose the claimed video drive signal.



EX1006, FIG. 6 (annotated).

126. Hayafuji discloses a circuit that purports to compensate for undesirable ripple variations in the power supply voltage that are introduced by the use of a DC-DC converter in the system. 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.

127. 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 the ground. As illustrated by the following equations, each embodiment of the '521 patent uses either the entire power supply voltage, V_{DD} , or the main component of the power supply voltage, V_{DC} , as a baseline to measure the voltage of the video drive signal:

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

Second embodiment: $v(t) = V_{DD} - \text{Video.DAC}$

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

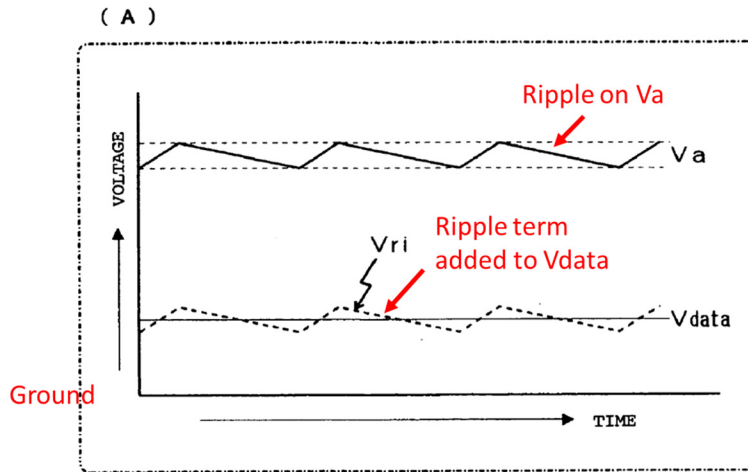
EX1001, 4:65-5:1, 6:8-13, 7:28-33.

128. 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.

129. The Institution Decision states that “Patent Owner does not explain why combining the ripple component V_{ri} , which is included in power supply voltage V_a with the relevant portion of the video signal V_{data} , is not sufficient to show that the video drive signal V_{gate} is referenced to the power supply voltage V_a .” DI, 44. However, the non-ripple component of V_a , which includes noise and drift, is completely filtered out in Hayafuji’s ripple extraction circuit before it is added to the video signal. Petitioner admits that V_a can be expressed as $V_{DC} + V_{ri}$, where V_{DC} is the non-ripple power supply voltage. Pet., 59. V_{DC} is the main component of the power supply voltage and is not added to the video signal V_{data} . EX2012, 93:15-94:6. This is illustrated clearly in Hayafuji’s 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



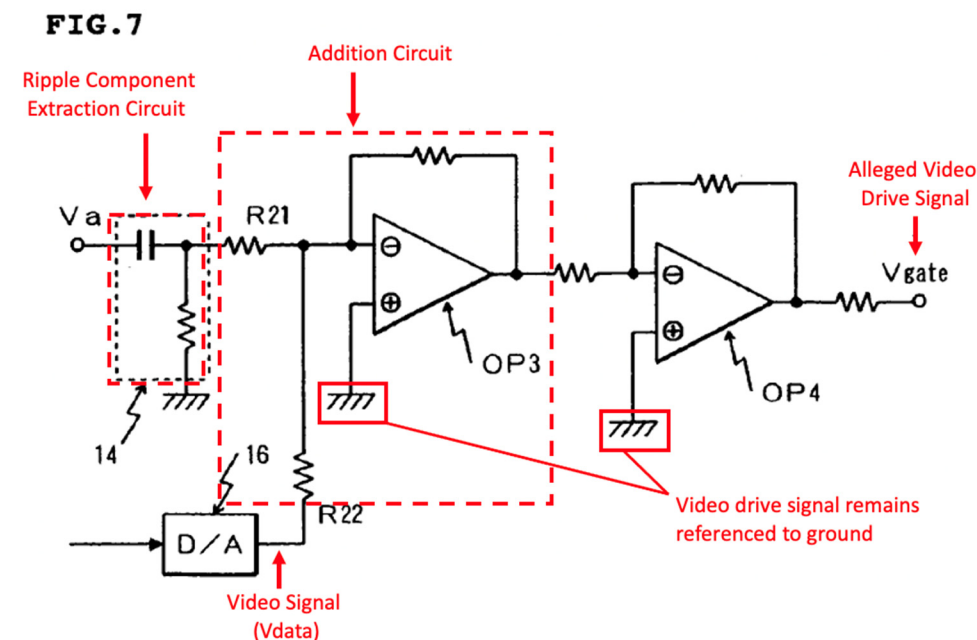
EX1006, FIG. 8 (annotated).

130. Therefore, because V_{DC} is not part of the alleged video drive signal, the alleged video drive signal is not referenced to the positive power supply voltage.

131. The differences in the designs of Hayafuji's circuit and the '521 patent's video driver impact the operation of the AMOLED display. Hayafuji's ripple component extraction circuit is designed to compensate for voltage ripple, which is a voltage disturbance that results in undesirable AC voltage signals being superimposed onto the DC power supply voltage signal. Ripple is consistently introduced by the normal operation of the DC-DC converter in the power supply system. Hayafuji uses a high-pass filter to extract only the ripple component that is on the power supply voltage. If the power supply voltage experiences fluctuations other than the ripple, the solution of Hayafuji will not work. For example, voltage

drift refers to a gradual decrease in the voltage provided by the power supply system over time due to factors such as temperature or the gradual degradation of a battery over time. If the value of V_a in Hayafuji drifts downwards over time, adding V_{ri} to V_{data} will not provide any compensation for this drift, causing a change in pixel brightness over time. The high-pass filter of Hayafuji compensates *only* for the ripple that is consistently and predictably superimposed onto the power supply voltage by the DC-DC converter.

132. Additionally, the implementation of Hayafuji's ripple component extraction and addition circuits, illustrated in Figure 7, further demonstrates that the alleged video signal is not referenced to the positive power supply. 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.



EX1006, FIG. 7 (annotated).

133. 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.

C. 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.”

134. 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.

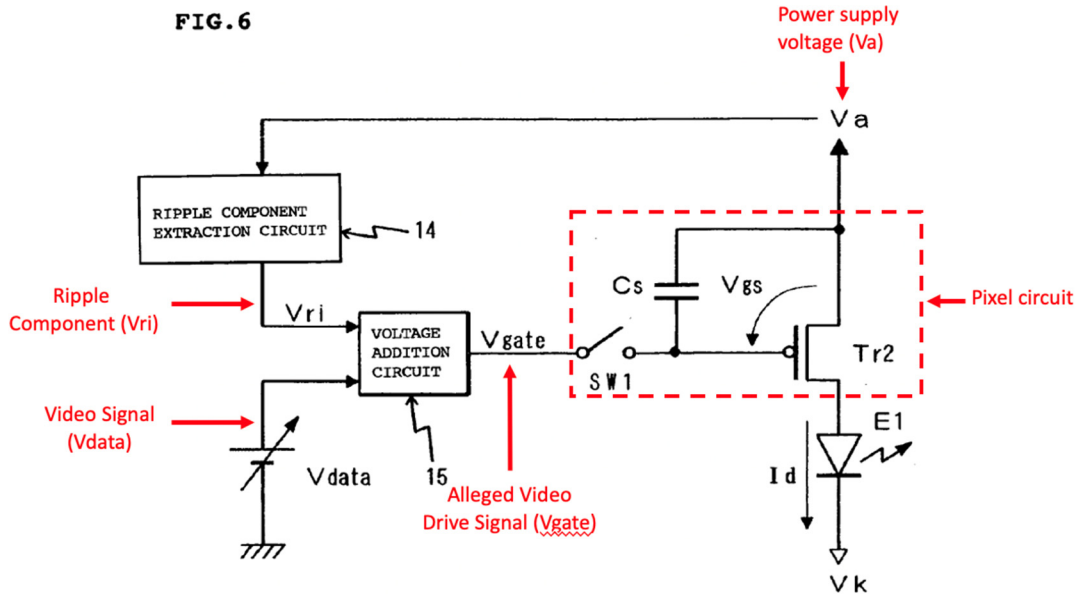
135. The Petition argues that Hayafuji discloses this limitation because the drive current that drives the OLED pixel does not include the ripple component voltage portion of the power supply voltage. Pet., 53-54. Petitioner's argument is incorrect because, in Hayafuji's circuit, the positive power supply 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].

136. 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

137. 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).

138. 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.

139. **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.

140. **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:

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

141. 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:

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

$$\begin{aligned} &= VDDI + V_{drift} + V_{noise} - Video.DAC - VDDI \\ &= V_{drift} + V_{noise} - Video.DAC \end{aligned}$$

EX1001, 2:53-60.

142. 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.

143. 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.

D. Claim 2: Hayafuji does not disclose “wherein the video drive signal is indicative of the sum of or the difference between the positive power supply voltage and the video signal.”

144. Claim 2 depends from claim 1 and recites “wherein the video drive signal is indicative of the sum of or the difference between the positive power supply voltage and the video signal[.]” Because Hayafuji’s voltage addition circuit does not add the positive power supply voltage to the video signal, it does not disclose a video drive signal that is “indicative of the sum of or the difference between the positive power supply voltage and the video signal.”

145. As set forth above, the Petition admits that the power supply voltage V_a can be expressed as a DC voltage component V_{DC} and a ripple component V_{ri} .

Pet., 59. In Hayafuji, the alleged video drive signal V_{gate} is the output of the addition circuit, which calculates the sum of the video signal and the ripple component V_{ri} : $V_{gate} = V_{data} + V_{ri}$. EX1006, FIG. 6, ¶[0049]. The DC voltage component V_{DC} is filtered out of the signal that is provided to Hayafuji's addition circuit. EX1006, FIG. 6, ¶[0049]. Thus, the power supply voltage V_a is not summed with the video signal, and the video drive signal is *not* indicative of either the sum of or the difference between the positive power supply voltage (V_a) and the video signal.

146. For the *reasons* enumerated above, it is my opinion that Hayafuji does not disclose dependent claim 2 of the '521 patent, and as such also does not disclose any claims that depend from claim 2.

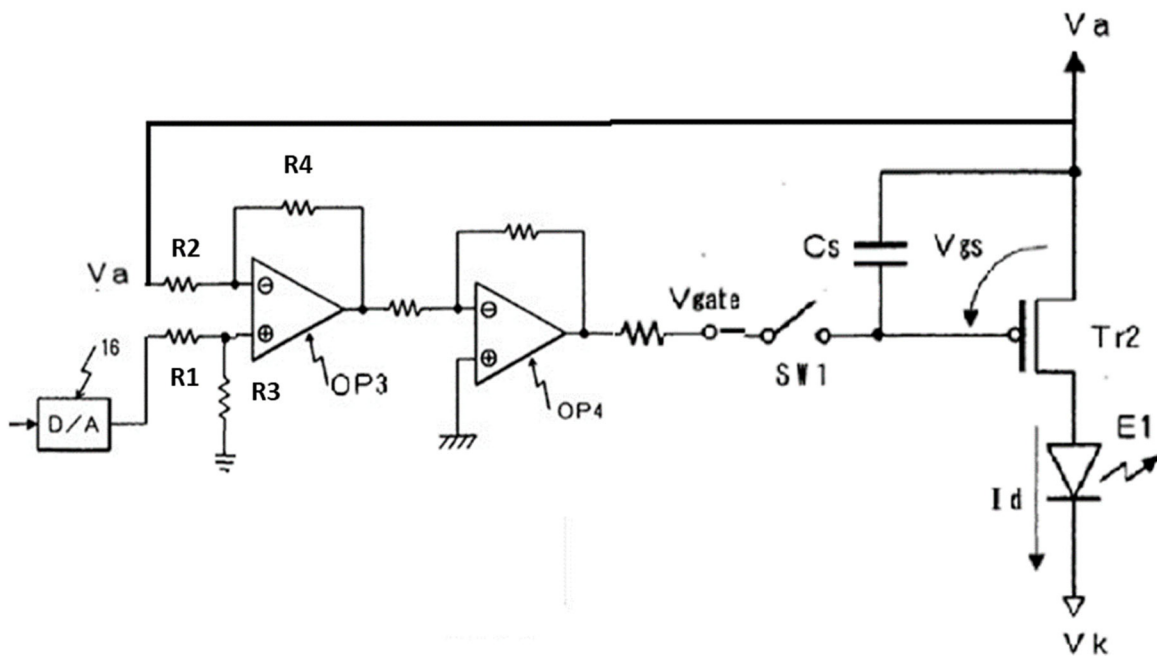
X. GROUND 4: HAYAFUJI AND THE KNOWLEDGE OF A POSITA DO NOT RENDER OBVIOUS CLAIMS 1, 3, AND 5 OF THE '521 PATENT

147. 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

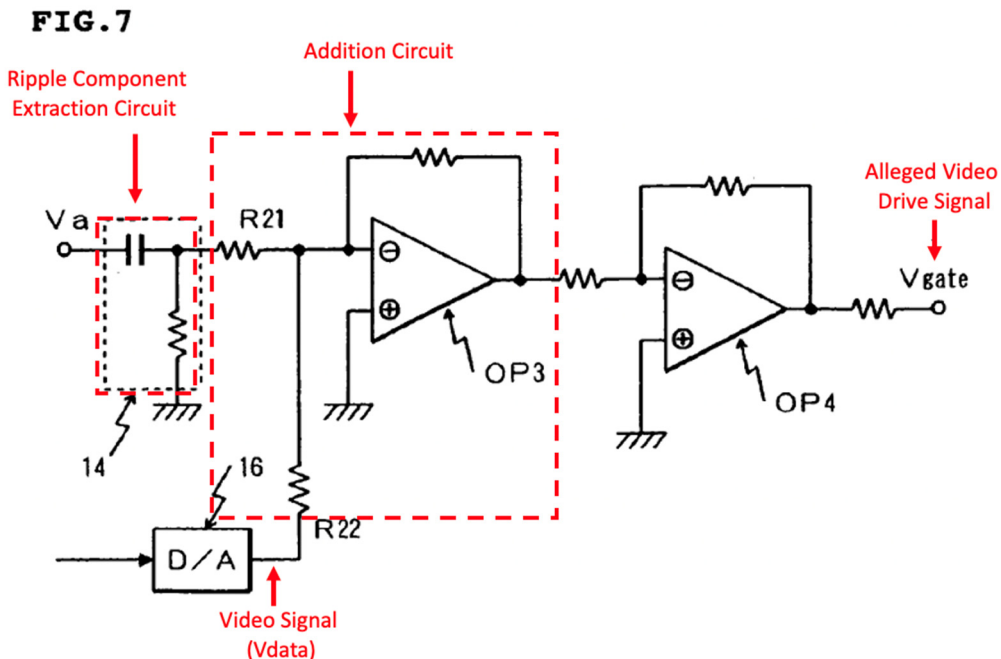
and referenced to a positive power supply voltage of the AMOLED display panel.”

148. 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 difference between 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).

149. 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 difference between 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 negative 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. The result of the proposed modifications is a circuit that outputs the difference between power supply voltage V_a and video signal V_{data} .



EX1006, FIG. 7 (annotated).

150. 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.

151. 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.

152. 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.

153. 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.

154. Finally, Petitioner's own expert indicated that it would not have been obvious to use the power supply voltage as an offset to the video signal as required by claim 1. The Petition's proposed modifications to Hayafuji result in an alleged video drive signal V_{gate} that is the difference between power supply voltage V_a and video signal V_{data} : $V_{gate} = V_a - V_{data}$. Pet., 72. However, when asked about the '521 patent's first embodiment, which generates a video drive signal that is the

difference between the positive power supply voltage VDD and the video signal Video.DAC, Dr. Kattamis stated that he would not expect to use the power supply voltage as an offset to the video signal and instead would expect to use voltage with a value less than VDD:

Q If you turn to the -- if you continue down from the bottom of column 4 to the top of column 5 [of the '521 patent], there's a formula for the signal $v(t)$ going to the pixel VDD minus Video.DAC. Would you consider that to be an offset from VDD?

...

A Usually, I mean, I wouldn't -- usually an offset is not power rail. So that's the only reason I would say no.

Q What does "power rail" mean in this context?

A So "power rail" meaning the highest voltage I can achieve. So for example, if the highest voltage I have is VDD, if I put an offset of VDD to my signal, then I can't use it against VDD. So I would expect it to be less in the traditional sense of offset.

EX2012, 73:5-22 (emphasis added).

155. 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 IX.B, *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.”

156. 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 X.A, *supra*, this claim limitation is not rendered obvious for the same reasons presented in Section IX.C, *supra*.

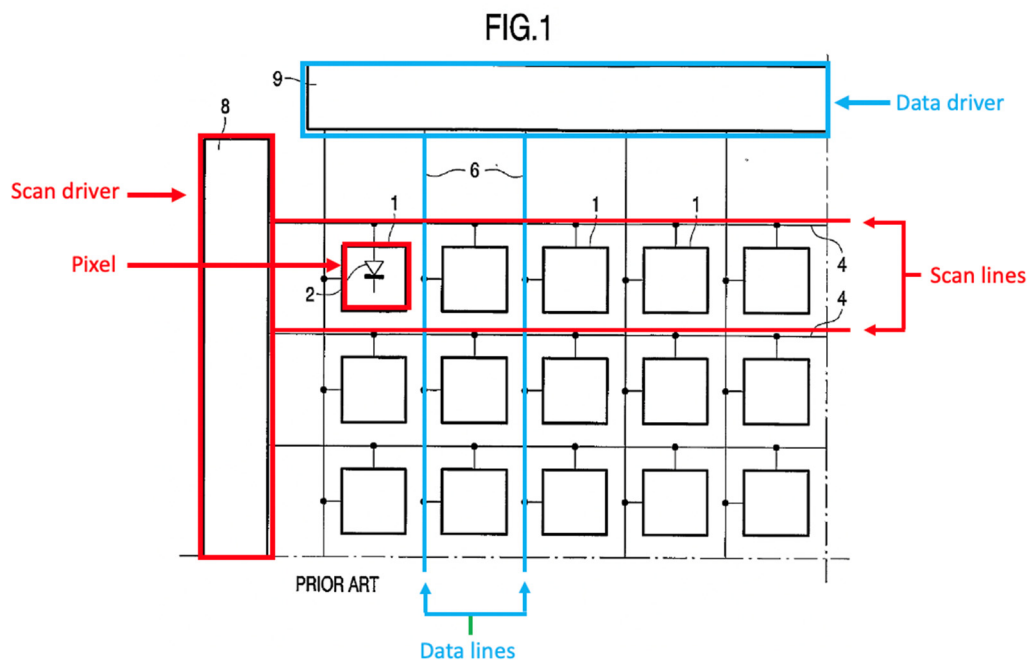
157. For the *reasons* enumerated above, it is my opinion that Hayafuji and the knowledge of a POSITA do not render obvious independent claim 1 of the ’521 patent, and as such also do not render obvious any dependent claim of the ’521 patent.

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

158. 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] or dependent claim 3 of the ’521 patent. Because claims 2-4 depend from claim 1, those claims are also not rendered obvious.

A. Summary of International Publication No. WO 2004/034365 (“Steer”)

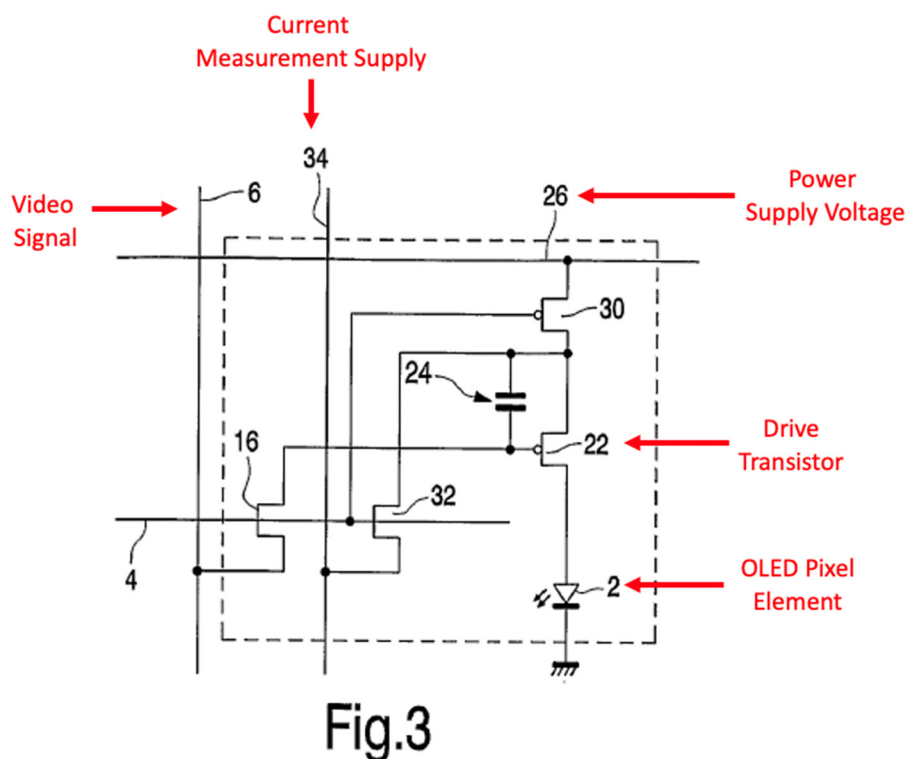
159. Steer relates to an active-matrix display comprising OLED pixels, selection lines, and data lines. EX1008, 2:3-9, FIG. 1. Steer teaches a data driver that provides image data to the pixels and a scanning driver that provides selection signals. EX1008, 2:9-13, FIG. 1.



EX1008, FIG. 1 (annotated).

160. 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.



EX1008, FIG. 3 (annotated).

161. 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.

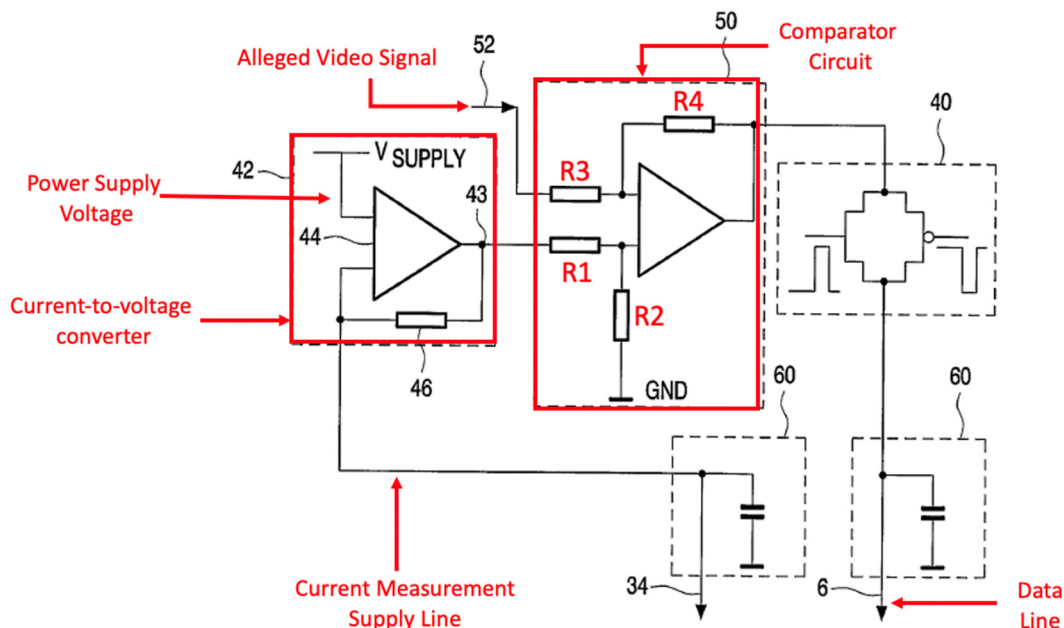


Fig.4

EX1008, FIG. 4 (annotated).

162. Steer teaches that the circuit has two phases of operation, depending on whether there is a pulse on the scan line or not. The feedback system is used during the pixel circuit programming phase, when an ON pulse is provided on the scan line and the pixel does not emit light. EX1008, 8:29-32; 9:30-10:1. A current representing the desired pixel drive current is drawn from the current-measurement supply line 34 and the feedback system generates the corresponding gate voltage for the drive transistor. EX1008, 9:30-10:1. The data voltage for the drive transistor is stored on capacitor 24 of the pixel circuit.

163. During a subsequent light emission phase, 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 phase, 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.

B. 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.”

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

Petitioner argues that the feedback system of Steer, depicted in Figure 4, discloses

the claimed video driver and that signal V_6 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 either the entire power supply voltage, VDD, or the main component of the power supply voltage, VDC, as a baseline to measure the voltage of the video drive signal. The video drive signal is not referenced to any other significant voltage component.

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

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

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

EX1001, 4:65-5:1, 6:8-13, 7:28-33. The alleged video drive signal V_6 is not referenced to the power supply voltage.

165. **First**, the alleged video drive signal is not referenced to the positive power supply voltage because the alleged video drive signal depends on the current in the feedback circuit.

166. Steer teaches a current feedback system, depicted in Figure 4, that is used to modify the voltage, V_6 , supplied to the columns of the display (line 6) to adjust for non-uniform transistor characteristics. EX1008, 8:21-29, FIG. 4. The current 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 operates to convert the reference current into output voltage V_{43} , which equals the sum of V_{SUPPLY} and $R_{46} * I$, where I is the reference current 34 and R_{46} is the resistance of resistor 46:
 $V_{43} = V_{\text{SUPPLY}} + R_{46} * I$. EX1008, FIG. 4, 8:30-9:13.

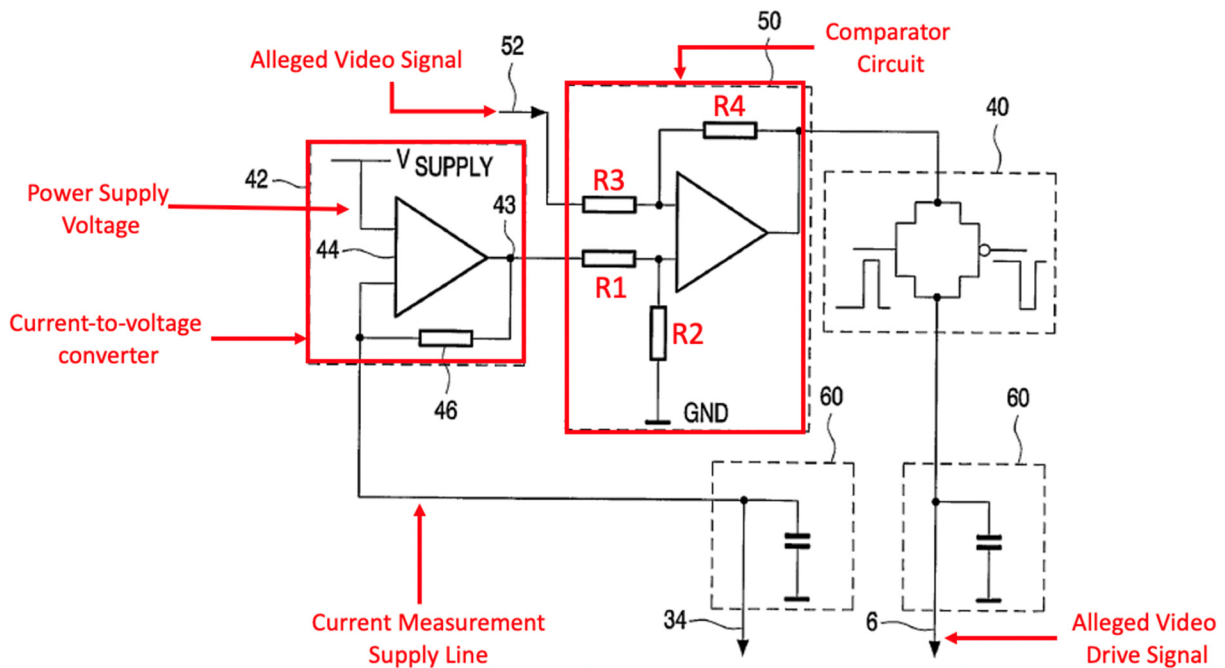


Fig.4

EX1008, FIG. 4 (annotated).

167. The feedback system also includes an amplifier configured as a comparator circuit 50, which Petitioner alleges is the claimed “video driver.” Comparator 50 takes as inputs V_{43} ($V_{\text{SUPPLY}} + R_{46} * I$) and the alleged video signal V_{52} , (referred to as *input(t)* by Petitioner). 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. The alleged video driver does not compare the video signal with the power supply voltage; instead, it compares the video signal with V_{43} , which is the sum of V_{SUPPLY} and $R_{46} \cdot I$. Therefore, unlike in the '521 patent, where the video drive signal is calculated as an offset of the positive power supply voltage, in Steer the alleged video drive signal calculation includes the value of the reference current in the feedback system: $V_6 = V_{\text{SUPPLY}} + R_{46} \cdot I - \text{input}(t)$. Furthermore, Steer expressly describes comparator 50 as comparing the value of the alleged video signal V_{52} with the measured feedback current, not with V_{SUPPLY} :

A Comparator section 50 compares the voltage at node 43 with an input voltage at input 52 representing the desired current. These sections 42, 50 effectively *provide measurement of the current drawn and comparison with the desired current [52]*.

EX1008, 9:14-17 (emphasis added). Thus, “the output voltage is a function of the current drawn from the current-measurement supply line,” EX1008, 9:12-13, and the alleged video drive signal is not referenced to the power supply voltage.

168. The Petition argues that, during certain instances of the programming phase, no current flows to the feedback circuit and, therefore, the value of V_{43} is momentarily equal to V_{SUPPLY} . Pet., 100; EX1002, ¶¶315-317. This is irrelevant, however, because there can be no dispute that the current does flow to the feedback

circuit when the alleged video drive signal is programming the pixel circuit. The entire purpose of Steer's teaching is to "use[] current feedback during pixel programming" in order to provide "per-pixel compensation of the drive transistor characteristics." EX1008, 7:6-9. If no current is flowing into the feedback circuit during the programming phase, then the feedback circuit provides no compensation to alleged video drive signal V_6 and serves no purpose.

169. The inclusion of the reference current in the alleged video drive signal is significant because the value of current I is not constant. The reference current is based on the current flowing to the OLED pixel which varies based on the data voltage for any given cycle. EX1008, 9:16-20. The current also varies based on the drive transistor characteristics, such as threshold voltage, that vary between pixel circuits. EX1008, 7:29-32.

170. The use of the current rather than the power supply voltage is central to the operation of Steer's feedback system. Steer's feedback system uses the current feedback during pixel programming "so that any effects of differences between characteristics of the drive transistor of different pixels are avoided." EX1008, 7:29-32. It is the current feedback that allows Steer to compensate for per-pixel non-uniformities:

Thus, the desired pixel current is used as the input signal, and the actual current flowing is used as a feedback signal during the addressing phase. This enables differences in drive transistor

characteristics to be tolerated. The pixel is then driven using the programmed voltage level during the remainder of the frame period. EX1008, 5:16-20. Thus, Steer does not seek to mitigate power supply voltage variations by referencing the alleged video drive signal to the positive power supply voltage. Instead, Steer's feedback system is designed to measure a feedback current to compensate for differences in transistor characteristics between the various pixel circuits. EX1008, 7:6-9, 7:29-32.

171. Therefore, because Steer's alleged video drive signal is a function of the current being fed into the feedback system, the video drive signal is not referenced to the positive power supply voltage.

172. ***Second***, the alleged video drive signal is not referenced to the positive power supply voltage for the additional reason that the alleged video driver amplifies the signal based on the values of the resistors in the comparator circuit. 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} :

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

Pet., 86.

173. 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 R_3 and R_4 , labeled in the figure above (as well as depending on R_{46} and

the feedback current as discussed above), which Petitioner ignored. 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.”). Thus, V_6 is multiplied by R_4/R_3 where R_3 is not equal to R_4 :

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

174. 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, resulting in a value for V_6 that is not an offset from V_{SUPPLY} .

175. In sum, the alleged video drive signal V_6 is **not** “referenced to a positive power supply voltage.” The voltage at V_{43} that is compared with the video signal at comparator circuit 50 depends not only on V_{SUPPLY} but also the value of R_{46} multiplied by the current flowing to the feedback circuit ($R_{46} * I$). Additionally, the equation for the video drive signal is multiplied by R_4/R_3 . Therefore, V_{SUPPLY} does not serve as a baseline to measure the alleged video drive signal.

C. Claim Element [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.”

176. Claim 1 requires “the drive current being ... independent of the positive power supply voltage.” 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.

177. 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 V_{DD} 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: Video.OLED = Video.DAC

Second embodiment: Video.OLED = Video.DAC

Third embodiment: Video.OLED = V_{noise} – Video.DAC

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

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

179. As discussed in Section XI.B, *supra*, Petitioner argues that the voltage of the alleged video drive signal V_6 is represented by the following equation, where $input(t)$ is the alleged video signal V_{52} :

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

Pet., 92.

180. 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:

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

Pet., 92.

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

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

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

Pet., 92.

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

183. 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 XI.B, *supra*, the equation describing the voltage of the signal generated by the video driver is multiplied by R_4/R_3 :

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

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

$$\begin{aligned} V_{\text{gs}} &= V_6 - V_{26} \\ &= [V_{\text{SUPPLY}} + R_{46} * I - \text{input}(t)] * R_4/R_3 - V_{\text{SUPPLY}} \\ &= V_{\text{SUPPLY}} * R_4/R_3 + R_{46} * I * R_4/R_3 - \text{input}(t) * R_4/R_3 - V_{\text{SUPPLY}} \\ &= V_{\text{SUPPLY}}(R_4/R_3 - 1) + R_{46} * I * R_4/R_3 - \text{input}(t) * R_4/R_3 \end{aligned}$$

185. 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.

D. Claim 3: Steer and the knowledge of a POSITA do not disclose or render obvious "the video driver comprises a differential

instrumentation amplifier circuit for providing the video drive signal being the difference between the positive power supply voltage and the video signal.”

186. Claim 3 recites that the video drive signal is “the difference between the positive power supply voltage and the video signal.” The Petition argues that the output of Steer’s comparator circuit 50 is the difference between alleged video signal V_{52} and V_{SUPPLY} .

187. As explained above in Section XI.B, in addition to the values of the alleged video signal V_{52} and power supply voltage V_{SUPPLY} , the alleged video drive signal V_6 is also influenced by the values of the feedback current I , resistor R_{46} , and the amplification dictated by the values of resistors R_3 and R_4 :

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

188. Therefore, for Petitioner’s argument to be true, there would have to be (i) no current flowing to the feedback circuit when the alleged video drive signal is generated (thus I would equal zero), ***and*** (ii) resistors R_3 and R_4 would have to have equal resistance values, resulting in comparator 50 providing no amplification (unity gain). Both of these conditions are contrary to the teachings of Steer.

189. The Petition argues that, during certain instances of the programming phase, no current flows to the feedback circuit and, therefore, the value of V_{43} is momentarily equal to V_{SUPPLY} . Pet., 100; EX1002, ¶¶315-317. This is irrelevant,

however, because there can be no dispute that the current does flow to the feedback circuit when the alleged video drive signal is programming the pixel circuit. The entire purpose of Steer's teaching is to "use[] current feedback during pixel programming" in order to provide "per-pixel compensation of the drive transistor characteristics." EX1008, 7:6-9. If no current is flowing into the feedback circuit during the programming phase, then the feedback circuit provides no compensation to alleged video drive signal V_6 and serves no purpose.

190. Additionally, Steer teaches that comparator 50 amplifies the signal V_6 , which requires resistors R_3 and R_4 to have different values. EX1008, 9:14-24. According to Steer, "[t]he *amplified output* of the comparator section 50 is provided to the column conductor through the gate 40." EX1008, 9:17-19 (emphasis added). Steer also explains that comparator 50 could employ a lower gain if an "integrating amplifier" that is "not shown in Figure 4" is added to the circuit. EX1008, 9:20-24. This discussion implies that comparator 50 employs some gain, otherwise it could not be lowered. EX1008, 9:20-24. Additionally, the Petition relies on the circuit as shown in Steer's Figure 4 and does not mention using additional components to lower the gain of comparator 50. Pet., 96-101. Furthermore, there is no mention in Steer of employing unity gain in comparator 50. EX1008.

191. For these reasons, it is contrary to the teachings of Steer for either (i) the feedback circuit to have no current flowing when comparator 50 generates the alleged video drive signal, or (ii) comparator 50 to provide no amplification. Therefore, Steer fails to disclose or render obvious that the video drive signal is the difference between the positive power supply voltage and the video signal.

XII. LEGAL PRINCIPLES

192. I am not an attorney and have not been asked to offer my opinion on the law. However, I understand that I am obliged to follow existing law. I have therefore been asked to apply the following legal principles in my analysis.

193. I understand that in an *inter partes* review proceeding the party challenging the patent's validity must prove by a preponderance of the evidence that the patent claims are invalid.

194. I understand that validity based on novelty, *i.e.*, anticipation and obviousness is governed by 35 U.S.C. §§ 102–103 (Pre-AIA) which read as follows:

35 U.S.C. 102 (PRE-AIA) CONDITIONS FOR PATENTABILITY;

NOVELTY AND LOSS OF RIGHT TO PATENT

A person shall be entitled to a patent unless —

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign

country, before the invention thereof by the applicant for patent, or

(b) the invention was patented or described in a printed publication in

this or a foreign country or in public use or on sale in this country,
more than one year prior to the date of the application for patent in the
United States, or

(c) he has abandoned the invention, or

(d) the invention was first patented or caused to be patented, or was
the subject of an inventor's certificate, by the applicant or his legal
representatives or assigns in a foreign country prior to the date of the
application for patent in this country on an application for patent or
inventor's certificate filed more than twelve months before the filing
of the application in the United States, or

(e) the invention was described in — (1) an application for patent,
published under section 122(b), by another filed in the United States
before the invention by the applicant for patent or (2) a patent granted
on an application for patent by another filed in the United States
before the invention by the applicant for patent, except that an
international application filed under the treaty defined in section
351(a) shall have the effects for the purposes of this subsection of an
application filed in the United States only if the international
application designated the United States and was published under
Article 21(2) of such treaty in the English language; or

(f) he did not himself invent the subject matter sought to be patented,
or

(g) (1) during the course of an interference conducted under section
135 or section 291, another inventor involved therein establishes, to
the extent permitted in section 104, that before such person's
invention thereof the invention was made by such other inventor and
not abandoned, suppressed, or concealed, or (2) before such person's

invention thereof, the invention was made in this country by another inventor who had not abandoned, suppressed, or concealed it. In determining priority of invention under this subsection, there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other.

[35 U.S.C. § 102.]

35 U.S.C. 103 Conditions for patentability; non-obvious subject matter.

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

(b)

(1) Notwithstanding subsection (a), and upon timely election by the applicant for patent to proceed under this subsection, a biotechnological process using or resulting in a composition of matter that is novel under section 102 and nonobvious under subsection (a) of this section shall be considered nonobvious if-

(A) claims to the process and the composition of matter are contained in either the same application for patent or

in separate applications having the same effective filing date; and

(B) the composition of matter, and the process at the time it was invented, were owned by the same person or subject to an obligation of assignment to the same person.

(2) A patent issued on a process under paragraph (1)-

(A) shall also contain the claims to the composition of matter used in or made by that process, or

(B) shall, if such composition of matter is claimed in another patent, be set to expire on the same date as such other patent, notwithstanding section 154.

(3) For purposes of paragraph (1), the term "biotechnological process" means-

(A) a process of genetically altering or otherwise inducing a single- or multi-celled organism to- (i) express an exogenous nucleotide sequence, (ii) inhibit, eliminate, augment, or alter expression of an endogenous nucleotide sequence, or (iii) express a specific physiological characteristic not naturally associated with said organism; (B) cell fusion procedures yielding a cell line that expresses a specific protein, such as a monoclonal antibody; and (C) a method of using a product produced by a process defined by subparagraph (A) or (B), or a combination of subparagraphs (A) and (B).

(c)

(1) Subject matter developed by another person, which qualifies

as prior art only under one or more of subsections (e), (f), and (g) of section 102, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the claimed invention was made, owned by the same person or subject to an obligation of assignment to the same person.

(2) For purposes of this subsection, subject matter developed by another person and a claimed invention shall be deemed to have been owned by the same person or subject to an obligation of assignment to the same person if —

(A) the claimed invention was made by or on behalf of parties to a joint research agreement that was in effect on or before the date the claimed invention was made;

(B) the claimed invention was made as a result of activities undertaken within the scope of the joint research agreement; and

(C) the application for patent for the claimed invention discloses or is amended to disclose the names of the parties to the joint research agreement.

(3) For purposes of paragraph (2), the term "joint research agreement" means a written contract, grant, or cooperative agreement entered into by two or more persons or entities for the performance of experimental, developmental, or research work in the field of the claimed invention.

35 U.S.C. § 103.

195. I understand that a claim is unpatentable for being anticipated (sometimes called lack of novelty) if a prior art reference disclosed, at the time of the invention, each claim element as arranged in the claim. I also understand that if a prior art reference fails to expressly disclose one or more claim elements, the claim may be anticipated if the missing element(s) are inherently disclosed. I understand that to establish inherency, the evidence must make clear that the missing claim element is necessarily present in the prior art reference. I understand that anticipation requires a high threshold because each and every claim element must be unambiguously taught by a single reference, either explicitly or inherently.

196. I understand that to be patentable, an invention must also not have been obvious to a person of ordinary skill in the pertinent art at the time the invention was made. A claim is invalid for obviousness if the differences between the subject matter sought to be patented and the prior art are such that that the claimed subject matter as a whole would have been obvious, at the time the invention was made, to a person having ordinary skill in the art to which that subject matter pertains.

197. In determining whether a claimed invention is invalid for obviousness, one should consider the scope and content of the prior art, the level of ordinary skill in the relevant art, the differences between the claimed invention and the prior art, and whether the claimed invention would have been obvious to one of ordinary

skill in the art in light of those differences. I understand that hindsight must not be used when comparing the prior art to the invention for obviousness. I understand that it is improper to stitch together an obviousness finding from discrete portions of prior art references without considering the references as a whole.

198. Obviousness may be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. In addition, obviousness may be shown by showing that it would have been obvious to combine the teachings of more than one item of prior art. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of one of ordinary skill in the art, multiple approaches and rationales may be considered, including:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of a known technique to improve similar devices, methods, or products in the same way;
- Applying a known technique to a known device, method, or product ready for improvement to yield predictable results;

- Applying a technique or approach that would have been “obvious to try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; or
- Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

199. I understand that in order for a prior art combination to render a claim obvious, the cited references must disclose each element of the challenged claim, alone or in combination. Additionally, there must have been some motivation to combine the asserted prior art, and the proposed combination would have rendered the patented claims obvious. I also understand that hindsight is inappropriate, as obviousness must be evaluated at the time of the invention. As part of my obviousness analysis, I have considered the scope and content of the prior art. I also considered whether any differences between the alleged invention and the

prior art are such that the subject matter, as a whole, would have been obvious to a POSITA.

200. It is my understanding that to demonstrate unpatentability, the burden is on the Petitioner to demonstrate that their prior art references must disclose, teach, or suggest all limitations of a given claim. To the extent that the cited references do not disclose, teach, or suggest the limitations of an independent claim, then those references also do not disclose, teach, or suggest all the limitations of any dependent claims depending therefrom.

XIII. CONCLUSION

201. 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.

202. 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 January 29, 2024 in Powell Butte, OR.



Thomas L. Credelle