

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

**PATENT OWNER'S PRELIMINARY RESPONSE
UNDER 37 C.F.R. § 42.107(a)**

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TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	THE '521 PATENT	2
A.	Summary	2
B.	Person of Ordinary Skill in the Art (POSITA)	12
C.	Claim Construction	12
III.	THE PETITION FAILS TO DEMONSTRATE A REASONABLE LIKELIHOOD OF PREVAILING ON ANY CHALLENGED CLAIM.	13
A.	Summaries of the Asserted References	14
1.	Kim	14
2.	Hayafuji	17
3.	Steer	20
B.	Grounds 1 and 2: Kim Neither Anticipates Nor Renders Obvious Claims 1, 2 and 7	24
1.	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”	24
a.	Kim’s pixel circuit does not include a <i>video driver</i> and does not <i>generate a video drive signal</i>	25
b.	Kim’s pixel circuit is part of the display panel and therefore cannot be the claimed <i>video driver</i>	31
c.	The accused video drive signal is not <i>referenced to the power supply voltage</i>	36
2.	Claim [1-C]: Kim 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”	40
C.	Ground 3: Hayafuji Does Not Anticipate Claims 1 and 2	45
1.	Claim [1-A]: Hayafuji does not disclose “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”	45
2.	Claim [1-C]: Hayafuji does not disclose “the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage”	48
D.	Ground 4: Hayafuji and the Knowledge of a POSITA Do Not Render Obvious Claim 1-3 and 5	52
1.	Claim [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”	52
2.	Claim [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”	57
E.	Ground 5: Steer and the Knowledge of a POSITA Do Not Render Obvious Claims 1-4	58
1.	Claim [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”	58
2.	Claim [1-C]: Steer and the knowledge of a POSITA do not disclose or render obvious “the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage”	62
IV.	AN INSUFFICIENT NUMBER OF GROUNDS/CLAIMS MEET THE INSTITUTION THRESHOLD	65
V.	CONCLUSION.....	65

PATENT OWNER'S EXHIBIT LIST

Exhibit No.	Description
2001	Declaration of Thomas L. Credelle
2002	<i>Curriculum Vitae</i> of Thomas L. Credelle
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")

I. INTRODUCTION

The Board should deny institution of *inter partes* review of claims 1-5, and 7 of U.S. Patent No. 7,259,521 (“the ’521 patent,” EX1001) for two reasons.

First, the Petition’s cited art fails to disclose, teach, or suggest the limitation of “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,” which is required by independent claim 1 and, therefore, every claim of the ’521 patent.

Second, the Petition’s cited art fails to disclose, teach, or suggest the limitation of “the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage,” which is also required by independent claim 1 and, by extension, every claim of the ’521 patent. Nor does Petitioner provide any reason at all why either of these claim limitations would have been obvious despite the missing teachings.

The Petition therefore fails to demonstrate a reasonable likelihood of prevailing on any challenged claim. For at least these reasons, the Board should deny institution.

II. THE '521 PATENT

A. Summary

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, (21), (22), (45).

AMOLED Displays and Power Supply Voltage Variations

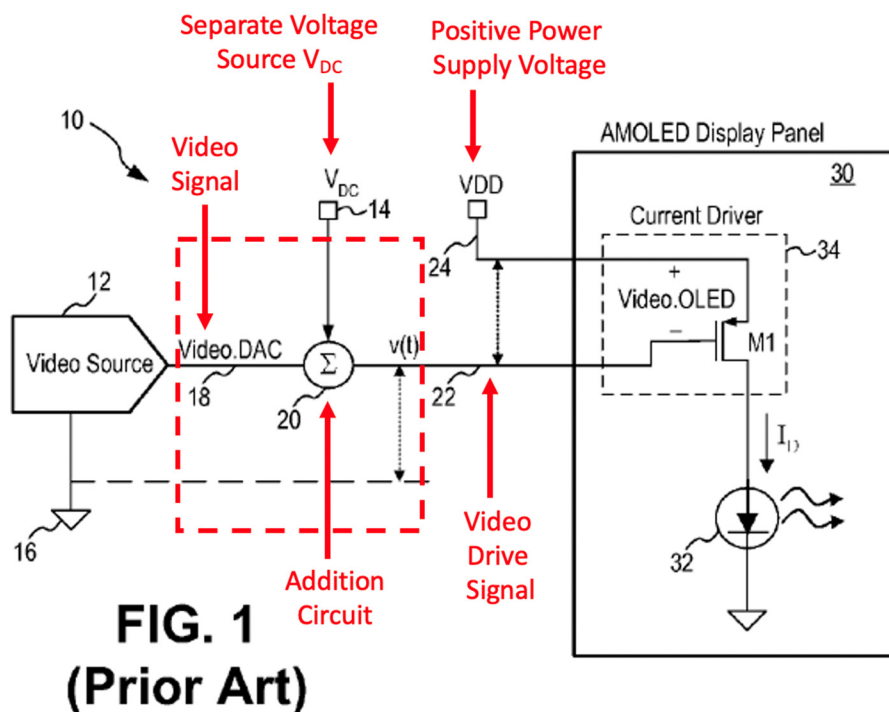
The '521 patent is directed to active matrix organic light emitting diode (AMOLED) displays. EX1001, 1:13-17. AMOLED displays contain many thousands of individual OLED pixel elements, each with its own pixel driver which provides current to energize the individual pixel OLEDs. *Id.*, 1:15-17. "These 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." *Id.*, 1:17-21.

"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." *Id.*, 1:22-25. Therefore, variations in the power supply voltage will modulate the brightness of the AMOLED display, causing the display to flicker. *Id.*, 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. *Id.*, 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.” *Id.*, 1:41-51.

Prior Art

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).

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, $v(t)$. *Id.*, 1:65-2:1. DC voltage source V_{DC} is a separate voltage source than VDD, the power supply of the AMOLED display. *Id.*, 2:1-9. 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. *Id.*, 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:

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

Id., 2:6.

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. *Id.*, 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. 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. *Id.*, 2:28-30. Voltage Video.OLED is referenced to the power supply voltage VDD and is given as the following equation:

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

Id., 2:37.

The power supply voltage VDD of the AMOLED display panel will have variations due to voltage glitches, noise, or drifts. *Id.*, 2:38-42. 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:

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

Id., 2:41-46.

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). *Id.*, 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 VDDI (i.e., $V_{DC} = V_{DDI}$). The current driver voltage Video.OLED can be given as:

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

Id., 2:53-60.

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

The '521 patent

The '521 patent addresses the problem of power supply voltage variations by utilizing a separate video driver distinct from the AMOLED display that references the video drive signal to the power supply voltage instead of to ground, as illustrated in the embodiment of Figure 2. EX1001, FIG. 2, 4:34-37. 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.

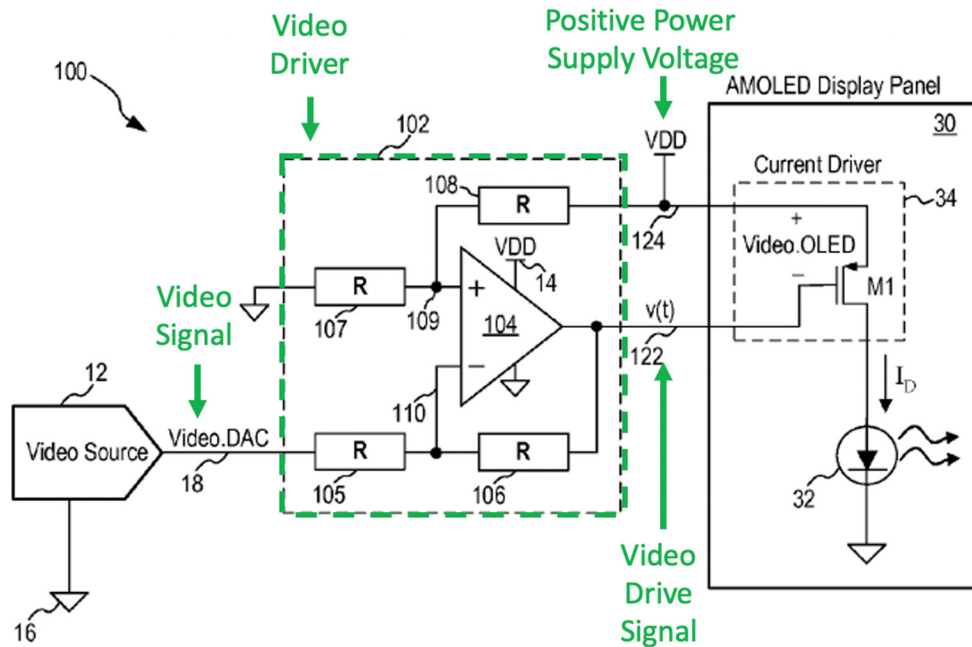


FIG. 2

EX1001, FIG. 2 (annotated).

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. *Id.*, 4:43-5:1. 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. *Id.*, FIG. 2. 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. *Id.*, 4:43-5:1. 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. The video drive signal v(t) is expressed in the following equation:

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

Id., 4:65-55:1.

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:

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

Id., 5:6-15.

“As can be observed from Equation (6), the current drive voltage signal Video.OLED is made to be independent of the power supply voltage VDD. Thus, any noise or DC drifts in the power supply voltage VDD (node 124) will not disturb the current drive signal Video.OLED and will not affect the brightness of the AMOLED display. *Id.*, 5:18-23.

Second Embodiment: Current Mode Isolator Circuit

In a second embodiment, the '521 patent discloses a video driver implemented as a current mode isolator circuit, depicted in Figure 3.

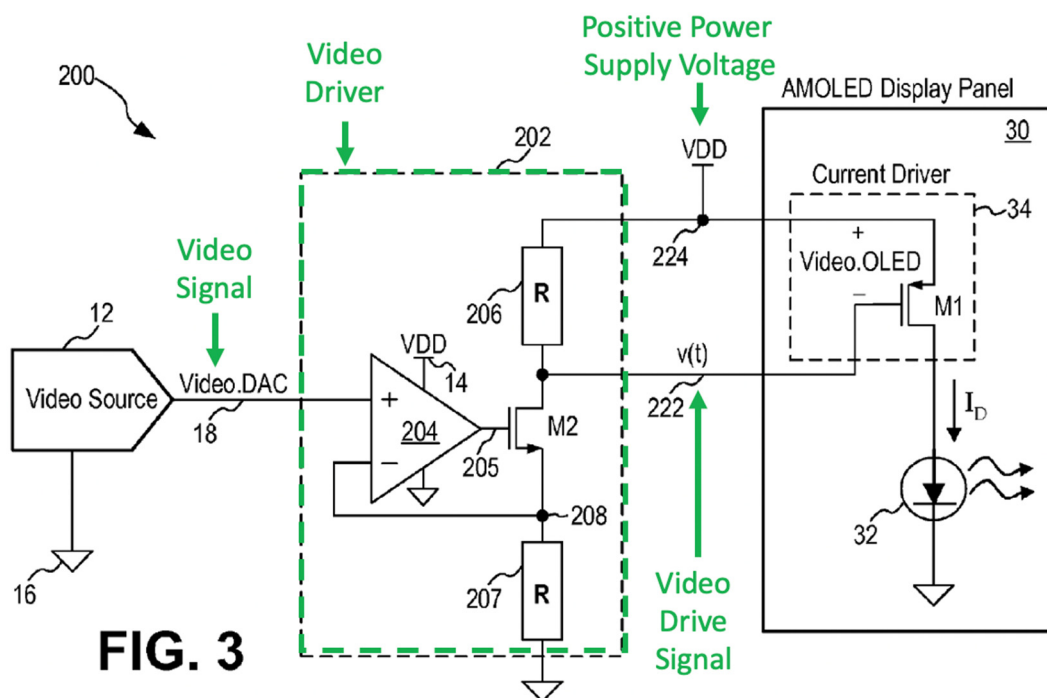


FIG. 3

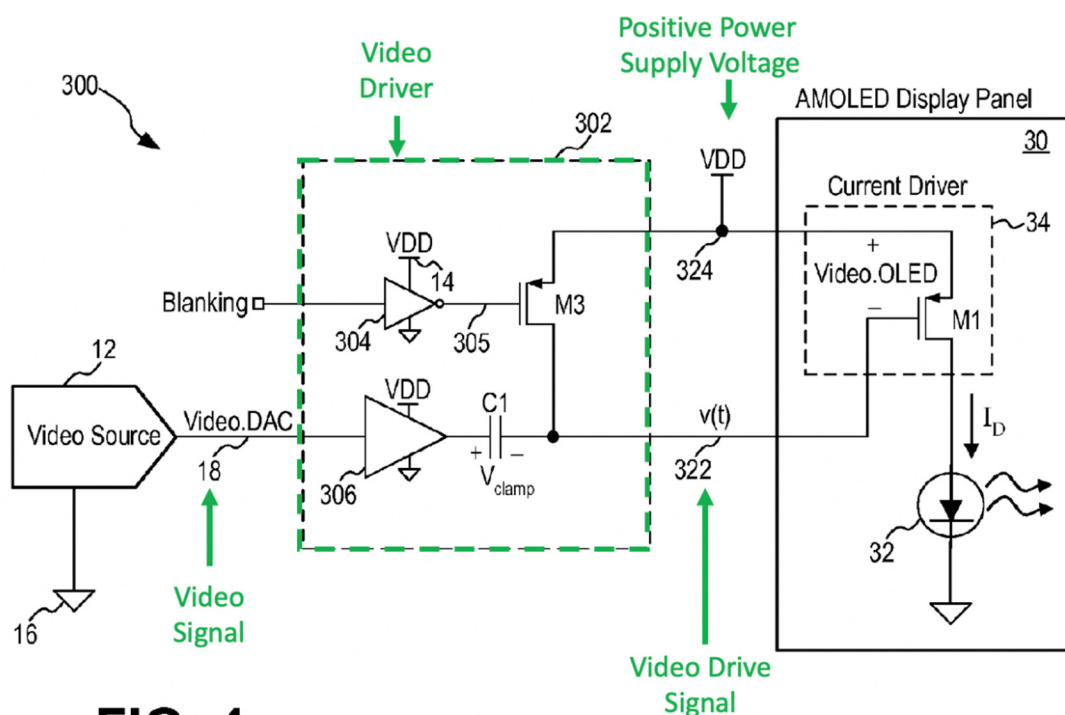
EX1001, FIG. 3 (annotated).

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 opamp 204 having a positive input terminal receiving the video signal Video.DAC and a negative input terminal connected in a feedback configuration. *Id.*, 5:47-50. The output of opamp 204 is coupled to the gate of NMOS transistor M2. *Id.*, 5:50-52. Resistor 206 is connected between the power supply voltage VDD and the source terminal of transistor M2. Resistor 207 is connected between the drain terminal of transistor M2 and the ground voltage. 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. The current that passes through transistor M2 is put through resistor 206 which is referenced to the power supply voltage VDD. 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.

Third Embodiment: Video Clamp Circuit

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. *Id.*, 6:48-50, FIG. 4.



EX1001, FIG. 4 (annotated).

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. 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 $v(t)$. *Id.*, 6:53-54. The video driver also includes an inverter 304 receiving the video blanking signal and driving a PMOS transistor M3. *Id.*, 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. *Id.*, 6:56-60.

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. *Id.*, 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. *Id.*, 6:65-67.

When the blanking signal is de-asserted, transistor M3 is turned off and no longer drives node 322. *Id.*, 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. *Id.*, 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 referenced to the power supply voltage VDD. *Id.*, 7:2-8.

B. Person of Ordinary Skill in the Art (POSITA)

“[T]he level of skill in the art is a prism or lens through which ... the Board views the prior art and the claimed invention.” *Okajima v. Bourdeau*, 261 F.3d 1350, 1354-55 (Fed. Cir. 2001). “This reference point prevents these factfinders from using their own insight or, worse yet, hindsight, to gauge obviousness.” *Id.*

Petitioner and Dr. Kattamis allege that a POSITA “would have a B.S. in Electrical Engineering or equivalent field, with a 3-5 years of academic or industry experience in OLED display engineering or comparable industry. Additional education could compensate for less practical experience and vice versa.” Pet., 12; EX1002, ¶44. At this stage of the proceeding, Patent Owner applies Petitioner’s definition of a POSITA, including the requirement that a POSITA would have “academic or industry experience in OLED display engineering or comparable industry.” Pet., 12; EX1002, ¶44. Patent Owner, however, reserves the right to advance a definition requiring different or additional qualifications.

C. Claim Construction

Patent Owner agrees with Petitioner that the terms of the Challenged Claims should be given their plain and ordinary meaning.

**III. THE PETITION FAILS TO DEMONSTRATE A REASONABLE
LIKELIHOOD OF PREVAILING ON ANY CHALLENGED CLAIM.**

Each of Petitioner's references—Kim, Hayafuji, and Steer—fails to disclose, teach, or suggest at least two limitations in the '521 patent's sole independent claim. As described below, Kim, Hayafuji, and Steer 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. Kim's teachings do not relate to a video driver at all. Hayafuji teaches a circuit that receives a voltage offset rather than the power supply voltage, and therefore does not disclose referencing the video drive signal to the power supply voltage. Steer also fails to teach referencing the video drive signal to the power supply voltage.

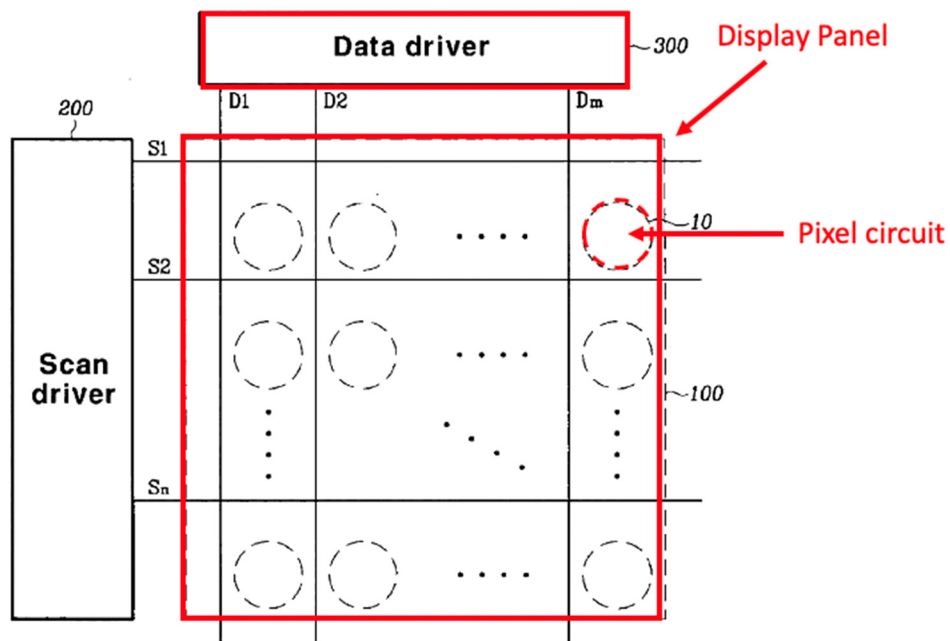
Additionally, Kim, Hayafuji and Steer do not disclose or render obvious a current driver that provides a drive current that is independent of the positive power supply voltage. Kim's drive current remains dependent on undesirable voltage variations in the positive power supply voltage. Hayafuji teaches a circuit that generates a drive current that depends on the positive power supply voltage and fails to remove either voltage noise or drift. Steer teaches a circuit that, due to amplification, generates a drive current that depends on the positive power supply voltage.

A. Summaries of the Asserted References

1. Kim

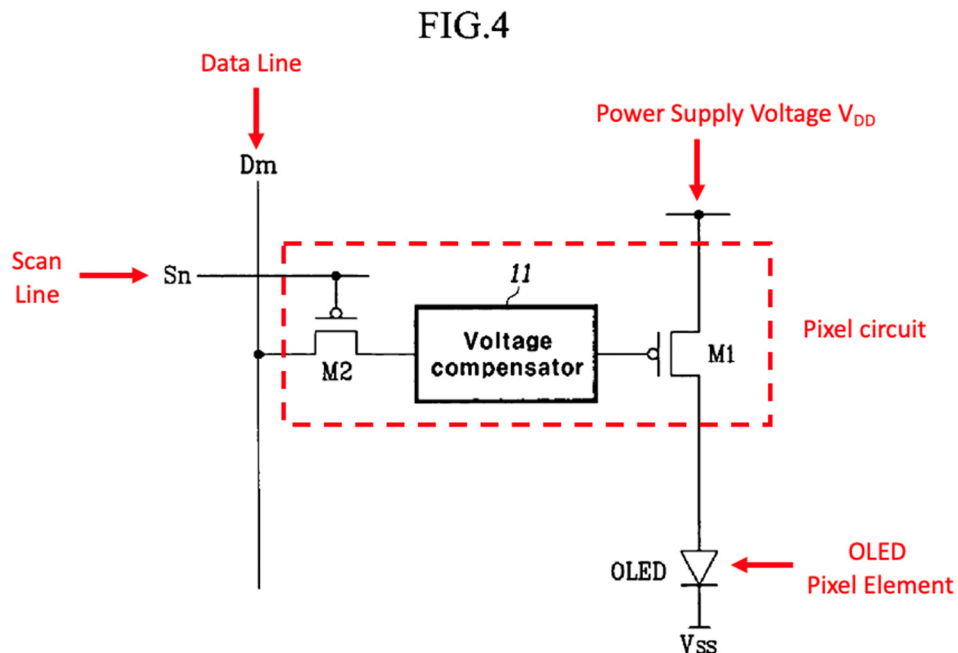
Kim relates to an organic light emitting diode (OLED) display architecture that includes a data driver, a scan driver, and a display panel with OLED pixels. EX1007, Abstract, ¶¶[0045]-[0046], FIG. 3. For each OLED pixel the display panel includes a corresponding pixel circuit. *Id.* A data driver transmits data voltages representing video signals to the pixel circuits on the data lines and a scan driver sequentially transmits select signals for selecting the pixel circuits. *Id.*, ¶[0046], FIG. 3.

FIG.3



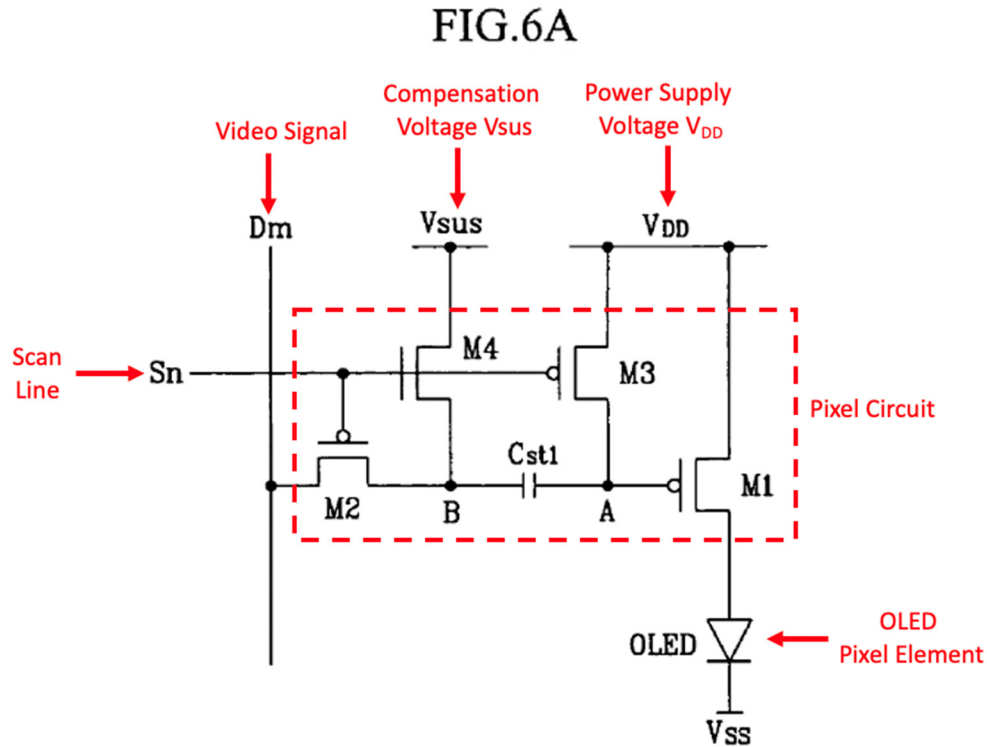
EX1007, FIG. 3 (annotated).

Each pixel circuit is connected to a data line, one or more scan lines, and the power supply voltage. *Id.*, ¶¶[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. *Id.*, ¶[0052]. The transistor M2 transmits the data voltage applied to the data line Dm to the voltage compensator 11 in response to a select signal on scan line Sn. *Id.*, ¶[0053]. The voltage compensator transmits a compensated data voltage to the gate of the transistor M1 to control how much current flows to the OLED pixel element. *Id.*, ¶[0054].



EX1007, FIG. 4 (annotated).

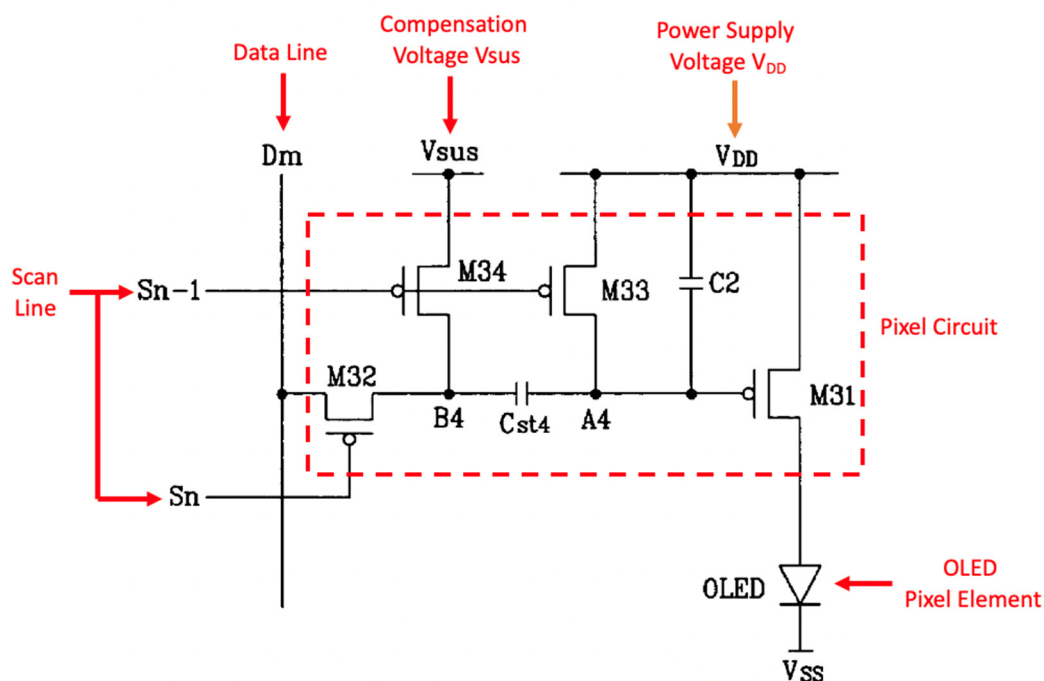
A more detailed embodiment of a pixel circuit depicting the details of the compensation circuit is disclosed in Figure 6A. In this example, a compensation voltage, V_{sus} , is connected to the compensation voltage circuit. EX1007, ¶¶[0055]-[0061].



EX1007, FIG. 6A (annotated).

An additional pixel circuit embodiment is disclosed in Figure 10. In this embodiment, two scan lines are connected to the pixel circuit. EX1007, ¶¶[0104]-[0108]. The transistors M31 and M32 correspond to transistors M1 and M2 in the pixel circuit depicted in Figure 6A. *Id.*, ¶[0105].

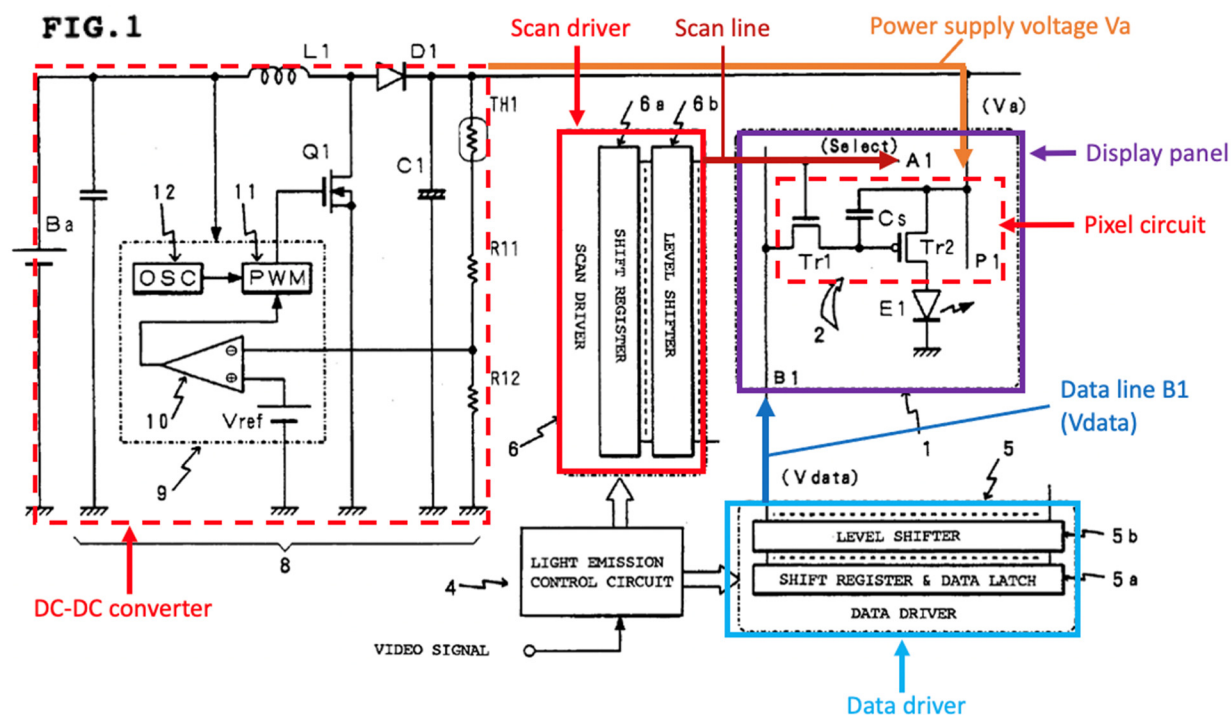
FIG.10



EX1007, FIG. 10 (annotated).

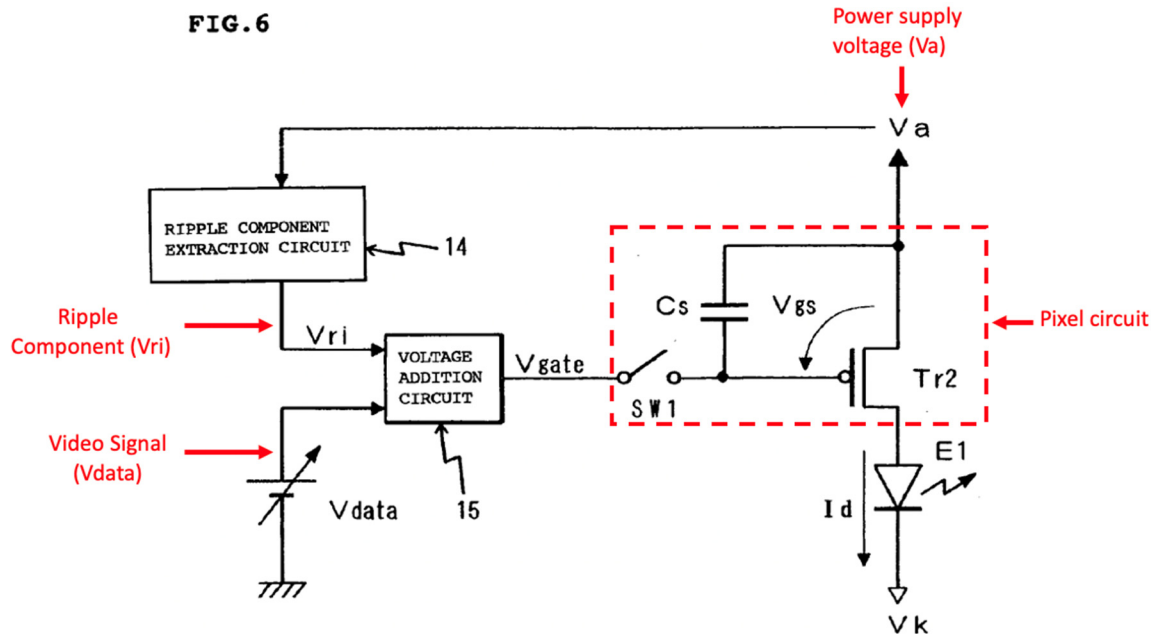
2. Hayafuji

Hayafuji discloses a system with a DC-to-DC converter providing the power supply voltage for a display panel. 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). Scan driver transmits select signals on scan lines.



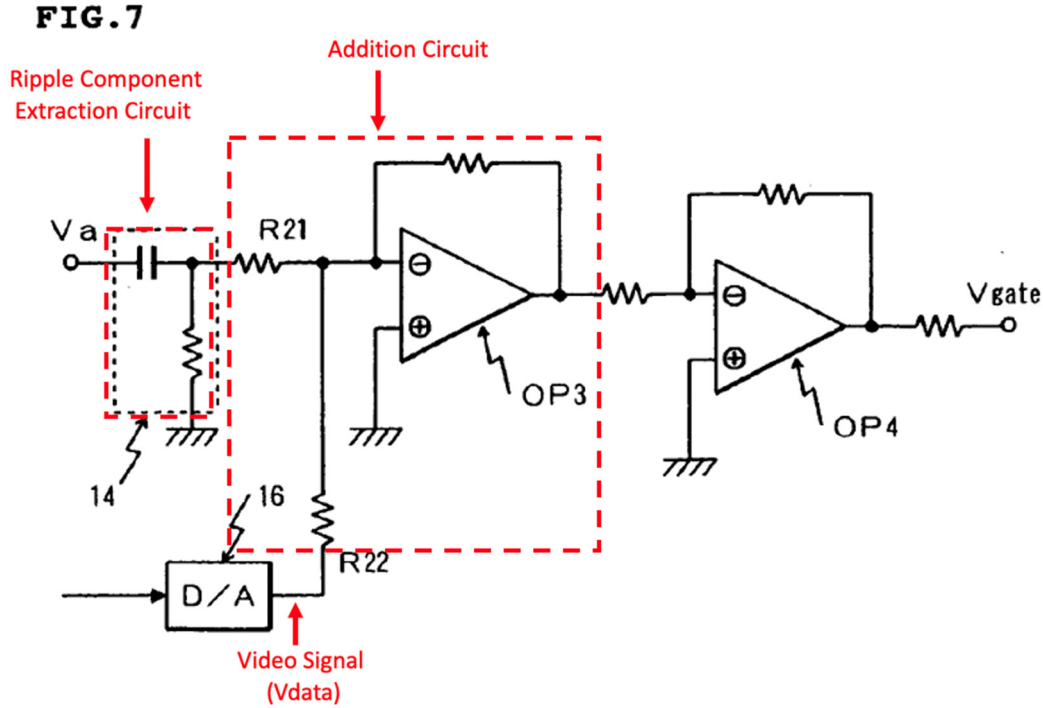
EX1006, FIG. 1 (annotated).

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. *Id.*, 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} . *Id.*, ¶[0048]. The video data from the video driver and V_{ri} are then fed into a voltage addition circuit. *Id.*, ¶¶[0048]-[0049]. The output of the voltage addition circuit, V_{gate} , feeds into the gate of the drive transistor Tr_2 in the pixel circuit of the display panel. *Id.*, ¶[0049].



EX1006, FIG. 6 (annotated)

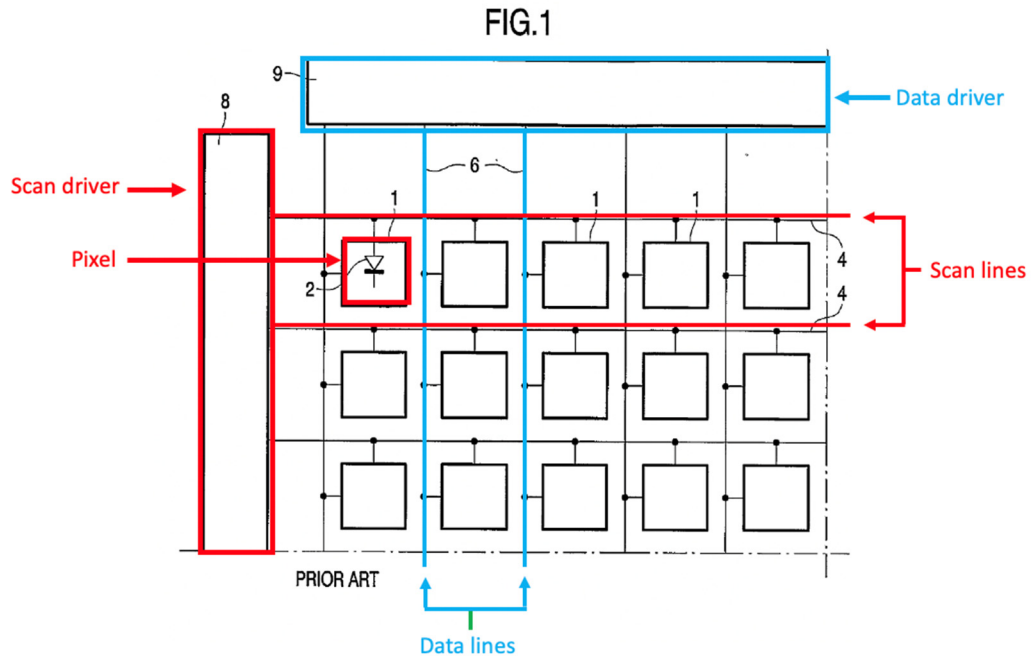
Hayafuji teaches that the ripple extraction circuit is implemented as a bypass filter, as depicted in Figure 7. EX1006, ¶[0050], FIG. 7. The bypass filter extracts the ripple component V_{ri} included in the drive voltage V_a . *Id.*, ¶[0050]. The voltage addition circuit is implemented using resistors $R21$, $R22$ and an operational amplifier $OP3$. *Id.*, ¶[0051]. The output of the addition circuit passes through a voltage buffer circuit constituted by operational amplifier $OP4$ and then to the pixel circuit. *Id.*, ¶[0051]. The positive terminals of operational amplifiers $OP3$ and $OP4$ are connected to ground. *Id.*, FIG. 7.



EX1006, FIG. 7 (annotated).

3. Steer

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. *Id.*, 2:9-13, FIG. 1.



EX1008, FIG. 1 (annotated).

Steer teaches a pixel circuit, illustrated in Figure 3, which includes, in addition to the data and scan lines, a current measurement supply line 34, power supply voltage line 26, drive transistor 22, storage capacitor 24, and switching transistors 16, 30, and 32. *Id.*, 8:3-15.

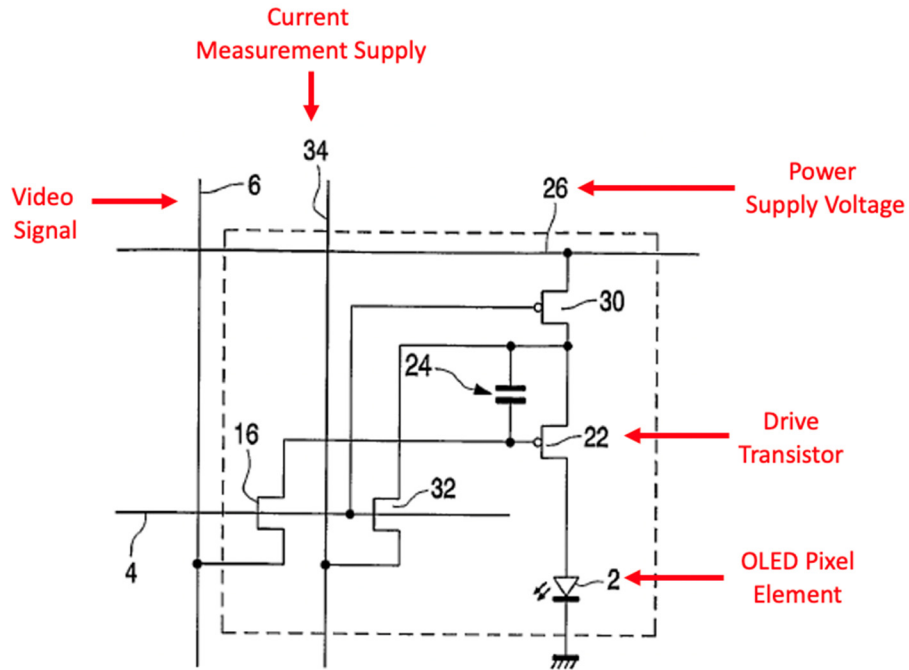


Fig.3

EX1008, FIG. 3 (annotated).

Steer additionally 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 and power supply voltage V_{SUPPLY} as inputs and provides an output voltage at node 43. A comparator 50 compares the voltage at node 43 with the data signal 52. The amplified output of the comparator 50 is provided to data line 6 of the pixel circuit. *Id.*, 9:14-19.

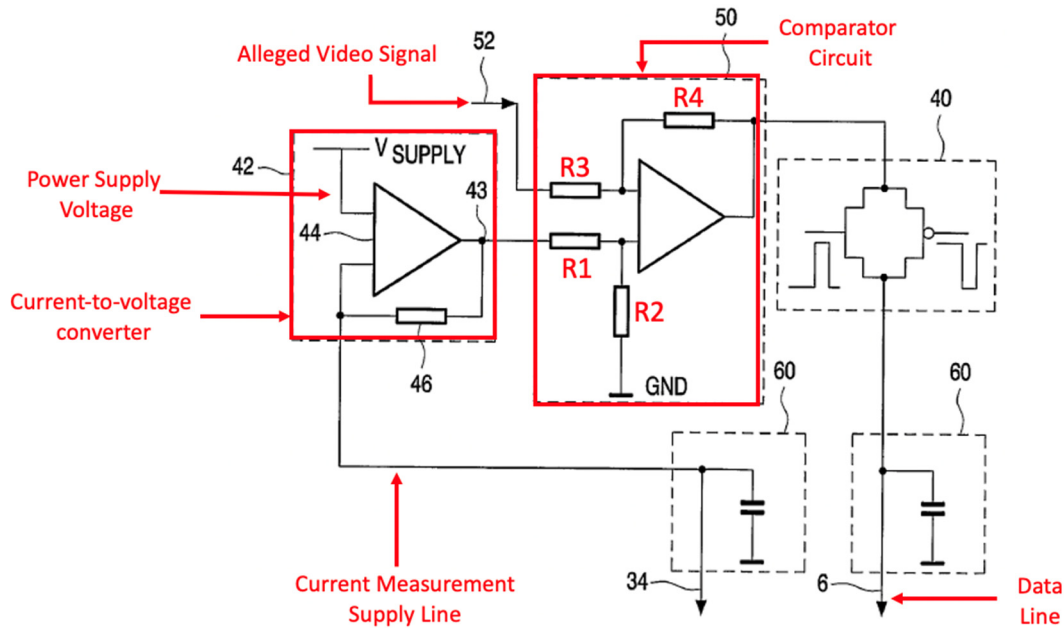


Fig.4

EX1008, FIG. 4 (annotated).

Steer teaches that the circuit of Figure 3 has two modes of operation, depending on whether there is a pulse on the scan line or not. When a pulse is provided on the scan line, the circuit enters a pixel programming mode. EX1008, 2:30-3:9, 9:30-10:4, FIG. 3. The scan line turns on transistor 16, which allows the data signal to travel from the feedback circuit to capacitor 24, where it is stored. *Id.* During this phase the scan line also turns on transistor 32, allowing the current from the current-measurement supply line 34 to drive transistor 22. *Id.* Transistor 30 is turned off during this phase, preventing the power supply voltage from driving the drive transistor. *Id.*

During a subsequent mode, after the scan line pulse has ended, transistors 16 and 32 turn off and transistor 30 is turned on. *Id.*, 3:6-9, 10:5-10, FIG. 3. During this mode, the 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. *Id.*

B. Grounds 1 and 2: Kim Neither Anticipates Nor Renders Obvious Claims 1, 2 and 7

1. 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”

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 the compensation circuit within the pixel circuit in the Figure 10 embodiment of Kim discloses the claimed “video driver” and that the voltage at node A4 discloses the generated “video drive signal.” Petitioner alleges that Kim discloses the “video driver” and “video drive signal” limitations, not that these limitations would have been obvious. Petitioner’s argument is incorrect for several reasons: *first*, the alleged video driver does not generate a video drive signal; *second*, the alleged video driver is part of the display panel even though it is required to be a distinct component; and *third*, the alleged video drive signal is not referenced to the positive power supply voltage.

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

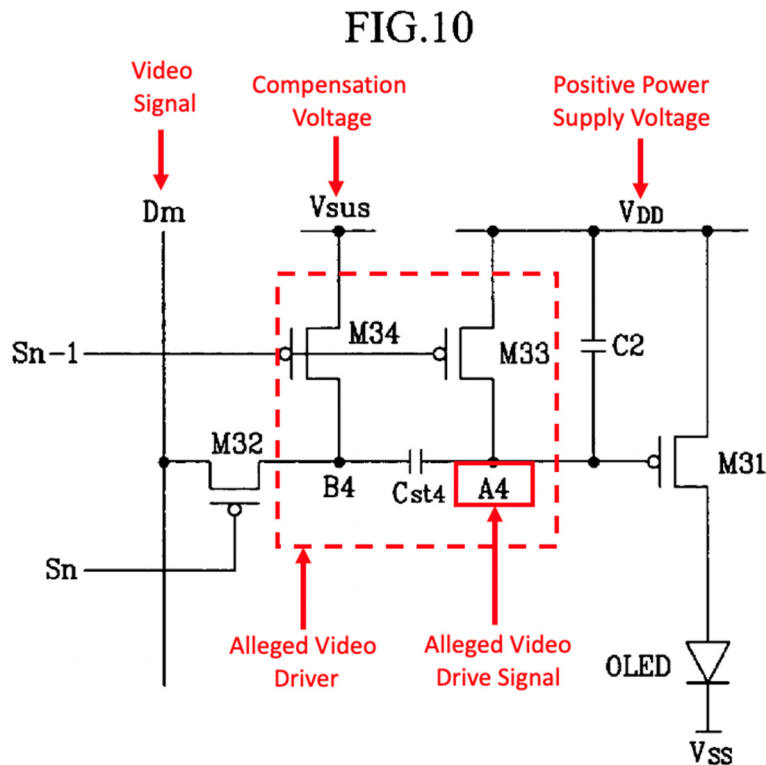
One of ordinary skill in the art would understand that a video driver and pixel circuit are different components in a system to drive OLEDs in a display. EX2001, ¶¶28-34, 70. Consistent with the understanding of one of ordinary skill in the art, the ’521 patent states that the invention is for a video 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). 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 variation. EX2001, ¶71. 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. *Id.* Otherwise, if the video driver was part of the pixel circuit, it would be impossible for the “video driver” to “isolat[e] the pixel circuit.” *Id.*; EX1001, 1:6-9.

Contrary to the disclosure of the ’521 patent and the general understanding of one of ordinary skill in the art, Petitioner identifies a portion of Figure 10 as the

“video driver.” Pet., 25. However, Kim states that “**FIG. 10 shows a pixel circuit** according to a fourth exemplary embodiment of the present invention.” EX1007, 40 (emphasis added). Because no “video driver” is disclosed in Figure 10, Petitioner is pointing to a portion of a “pixel circuit,” which is a completely different type of circuit that performs a different function. Therefore, contrary to the common usage of the terms in the art and the express disclosure of the ’521 patent, Petitioner improperly conflates “pixel circuit” and “video driver” to allege that a portion of Kim’s “pixel circuit” is a “video driver.” EX2001, ¶72. Petitioner thus fails to identify a “video driver” in Kim.



EX1007, FIG. 10 (annotated).

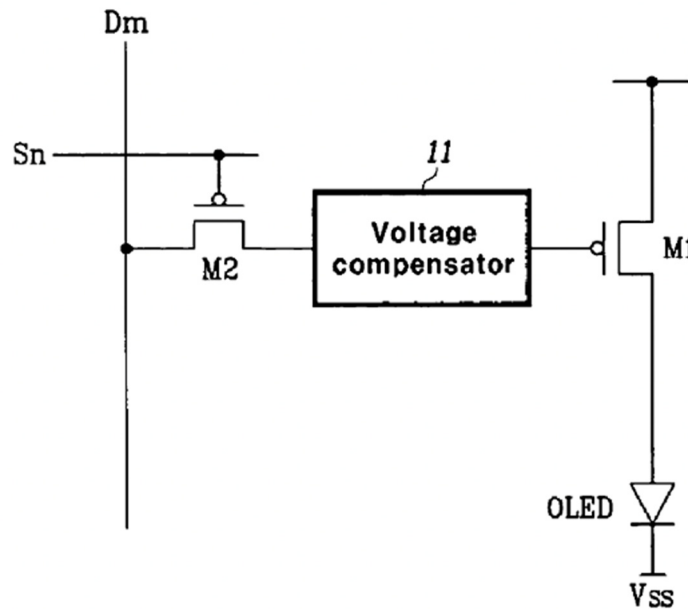
Further, because Petitioner improperly points to a portion of Kim’s “pixel circuit” in Figure 10 as the alleged “video driver,” the portion of the pixel circuit identified by Petitioner does not “generate a video drive signal.” The pixel circuit of Figure 10 lacks the necessary components of a video driver that are responsible for generating a video drive signal. EX2001, ¶73. This makes sense as a pixel circuit would not need any such circuitry as its function is *not* to “generate a video signal.” *Id.*

One of ordinary skill in the art would understand that a video driver would use amplifiers, among other components, to generate a drive signal. *Id.* Consistent with this understanding, the video driver in each embodiment of the ’521 patent includes at least one amplifier. EX1001, FIGs. 2-4. The alleged video driver of Kim includes only switching transistors M33 and M34 and capacitor Cst4, which one of ordinary skill in the art would expect in a pixel circuit. EX2001, ¶73. However, these components are not capable “generat[ing] a video signal.” Without an amplifier the alleged video driver is unable to generate the claimed video drive signal. *Id.*; EX1007, FIG. 10.

Additionally, the operation of the alleged “video driver” in Kim’s fourth embodiment illustrates that it does not *generate*, but rather merely *modifies* an existing video signal. EX2001, ¶74. As illustrated in Kim’s Figure 4, the alleged “video driver” is a portion of the pixel circuit that functions as a compensation

circuit. EX1007, FIG. 4. Specifically, when the previous select line Sn-1 is set to low, switching transistor M34 turns on and compensation voltage Vsus flows to electrode B4 of capacitor Cst4. *Id.*, ¶[0107]. Switching transistor M33 also turns on and charges electrode A4 of capacitor Cst4 with the power supply voltage VDD. *Id.* When the current select line Sn becomes low, switching transistor M32 turns on and video signal Dm is applied to electrode B4 of capacitor Cst4. *Id.*, ¶[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 Vsus and Dm. *Id.* One of ordinary skill in the art would understand that the operation of switching transistors M33 and M34 and capacitor Cst4 described above *adjusts* but does not *generate* the video drive signal. EX2001, ¶74.

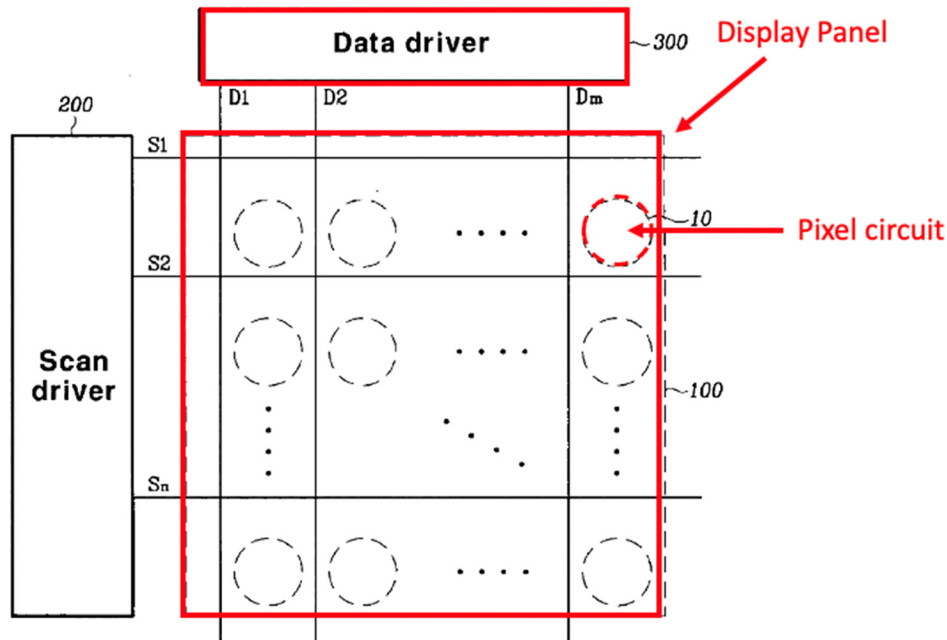
FIG.4



EX1007, FIG. 4.

The Petition’s identification of the compensation circuit of Kim’s Figure 10 embodiment as a video driver is also incorrect in the context of Kim’s disclosure as a whole. EX2001, ¶75. A POSITA would understand that the only component in Kim that generates a drive signal with video data is data driver 300, as illustrated in Kim’s Figure 3. *Id.* However, because Kim’s data driver 300 does not reference the video signal to the power supply voltage, the Petition incorrectly alleges the compensation circuit portion of the pixel circuit is a “video driver.” *Id.*

FIG.3



EX1007, FIG. 3 (annotated).

Finally, the different problems addressed by the '521 patent and Kim explain their different designs. The problems addressed by the '521 patent—undesirable voltage drift and noise, such as that caused by components in a battery-powered system turning on—are system-wide and do not require pixel-level solutions. EX1001, 1:40-55; EX2001, ¶76. Thus, it would make sense for one of ordinary skill in the art to implement a solution in a video driver external to the individual pixel circuits. EX2001, ¶76. In contrast, the problems Kim attempts to solve—variations in voltage drop at different pixels and variations in transistor threshold voltages at different pixels—vary from pixel to pixel and therefore require a

solution within each pixel circuit. EX1007, ¶¶[0013], [0015], [0016]; EX2001, ¶76.

For the above reasons, Kim does not disclose or render obvious a video driver that generates a video drive signal.

b. Kim’s pixel circuit is part of the display panel and therefore cannot be the claimed *video driver*.

Because Kim’s “pixel circuit” in Figure 10 is part of the display panel, no portion of the “pixel circuit” can be the “video driver” limitation under the plain language of the claims. As noted above, Petitioner identifies a portion of the “pixel circuit” of Figure 10 in Kim as the alleged “video driver.” Pet., 25. However, Kim consistently and repeatedly discloses that the “pixel circuits” like the one showed in Figure 10 are *part of the display panel*.

In another exemplary embodiment of the present invention, *a light emitting display includes* a plurality of data lines for transmitting data Voltages corresponding to Video Signals, a plurality of Scan lines for Selecting Select Signals, and *a plurality of pixel circuits*.

In still another exemplary embodiment of the present invention, a method for driving *a display panel including a matrix of pixel circuits* is provided.

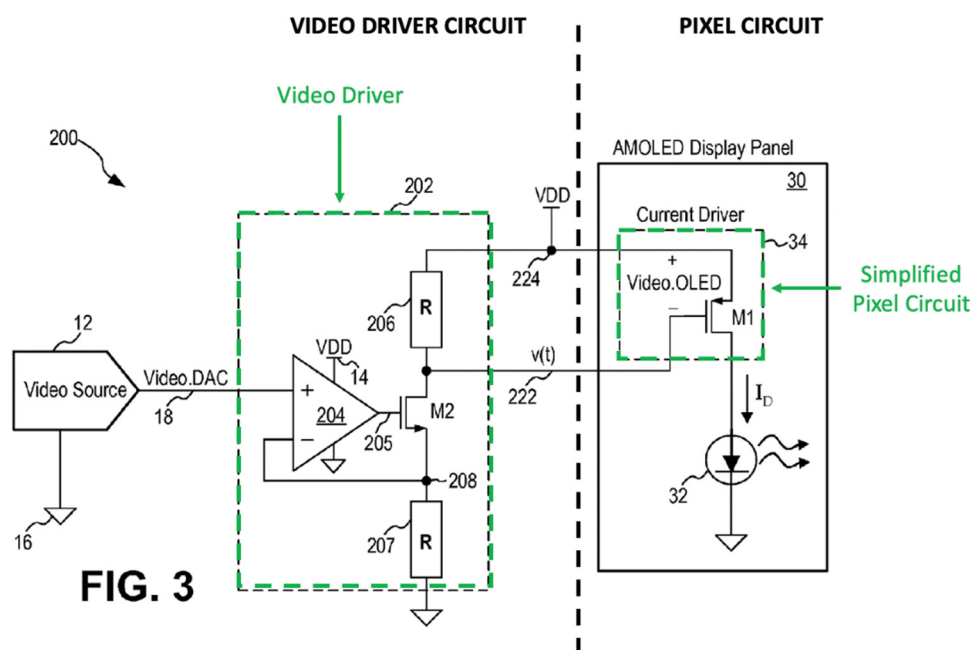
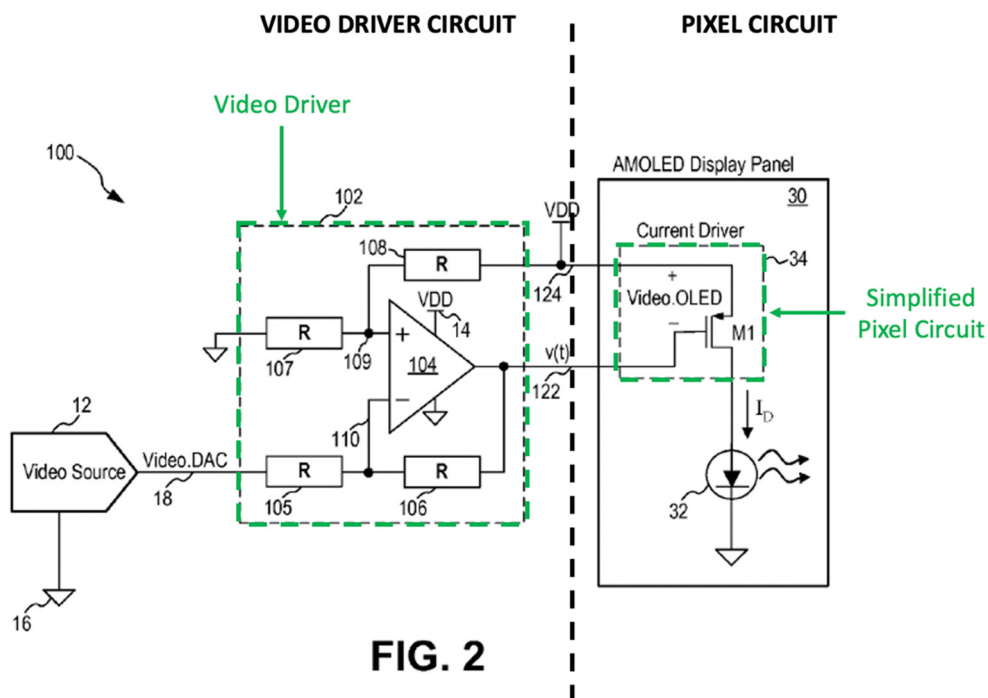
In still yet another exemplary embodiment of the present invention, a method for driving *a display panel including a matrix of pixel circuits is provided*.

In still yet another exemplary embodiment of the present invention, a method for driving *a display panel including a matrix of pixel circuits is provided.*

The *organic EL display panel 100 includes* a plurality of data lines D through D, each extending in a column direction, a plurality of Scan lines S through S, each extending in a row direction, and *a plurality of pixel circuits 10.*

EX1007, ¶¶18-21, 46 (emphasis added); *see also id.*, FIG. 3. This is consistent with the common understanding in the art that pixel circuits are part of AMOLED displays. EX2001, ¶78.

The '521 patent similarly describes pixel circuits as being part of the display panel. EX1001, 1:6-9, 1:14-21. For example, each of the '521 patent's embodiments disclose a system with a video driver distinct from the AMOLED display panel and its pixel circuits, as illustrated in Figures 2-4.



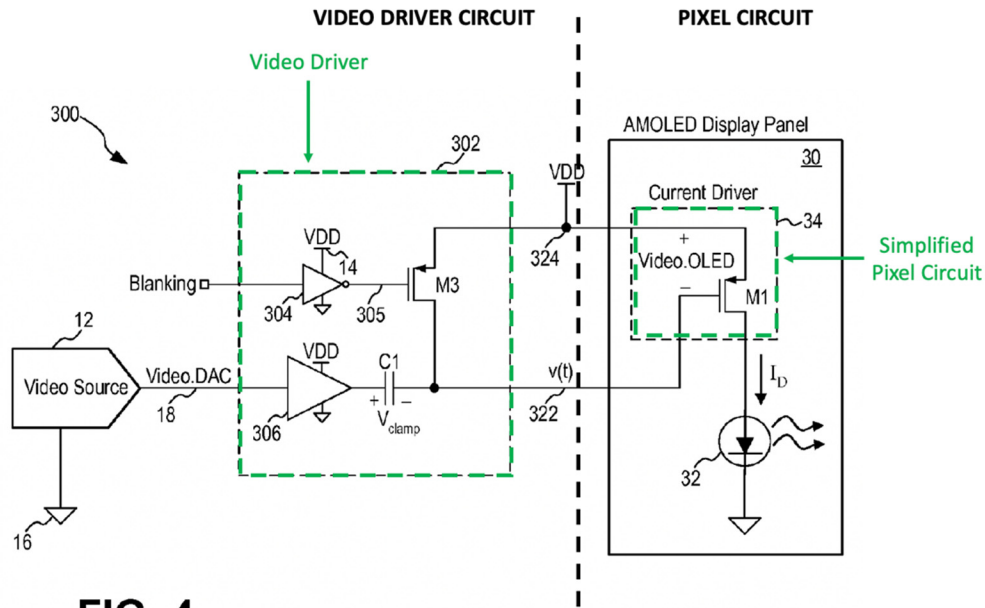


FIG. 4

EX1001, FIGs. 2-4 (annotated).

Additionally, in the context of the Figure 4 embodiment, the '521 patent explicitly states that the video driver generates a signal for an entire line of the display panel at a time, which necessarily requires it to be separate from the pixel circuits. EX1001, 7:4-6 (“In this manner, the clamping voltage V_{clamp} is added to the video signal Video.DAC for the rest of the video line[.]”); EX2001, ¶80.

Petitioner’s allegation that a portion of a “pixel circuit,” which Kim unambiguously discloses as part of the display panel, is the “video driver” in the challenged claims is contrary to the plain language of the claims and to Federal Circuit precedent on interpreting separate and distinct claim elements. *See, e.g.*, EX1007, ¶¶18-21, 46. The '521 patent claims the “video driver” and “display panel” as separate and distinct elements.

1. An active matrix organic light emitting diode (AMOLED) display system comprising an AMOLED *display panel* receiving a video signal to be displayed on the AMOLED *display panel*, the AMOLED *display panel* comprising a plurality of organic light emitting diode (OLED) pixel elements, the AMOLED display system comprising:

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*; and

a current driver coupled to at least one OLED pixel element, the current driver receiving the video drive signal and the positive power supply voltage and providing a drive current to the 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.

EX1001, claim 1 (emphasis added).

Therefore, Petitioner’s allegation that part of the “display panel” (i.e., a portion of a “pixel circuit”) is the “video driver” in the challenged claims is contrary to the plain language of the claims and Federal Circuit precedent, which both require the “video driver” and “display panel” to be separate and distinct structures. *Becton, Dickinson & Co. v. Tyco Healthcare Grp., LP*, 616 F.3d 1249, 1254 (Fed. Cir. 2010) (“Where a claim lists elements separately, ‘the clear implication of the claim language’ is that those elements are ‘distinct

component[s]’ of the patented invention.”) (quoting *Gaus v. Conair Corp.*, 363 F.3d 1284, 1288 (Fed. Cir. 2004); *HTC Corp. v. Cellular Commc’n Equip. LLC*, 701 F. App’x. 978, 982 (Fed. Cir. 2017) (“The separate naming of two structures in the claim strongly implies that the named entities are not one and the same structure.”); *Engel Indus., Inc. v. Lockformer Co.*, 96 F.3d 1398, 1404–05 (Fed. Cir. 1996)). Petitioner has thus failed to identify a “video driver” that is separate from the “display panel” as expressly required by the claim language.

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

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: $V_{A4} = VDD + \Delta V_{B4} = VDD + V_{DATA} - V_{sus}$. Pet., 29-30. However, due to variations in VDD over time, the value of VDD used to calculate V_{A4} is not the same value of VDD that is applied to the drive transistor. See EX1001, 1:32-55; EX2001, ¶82. Therefore, V_{A4} is not referenced to the positive power supply voltage. EX2001, ¶82.

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.

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

EX1007, ¶[0112].

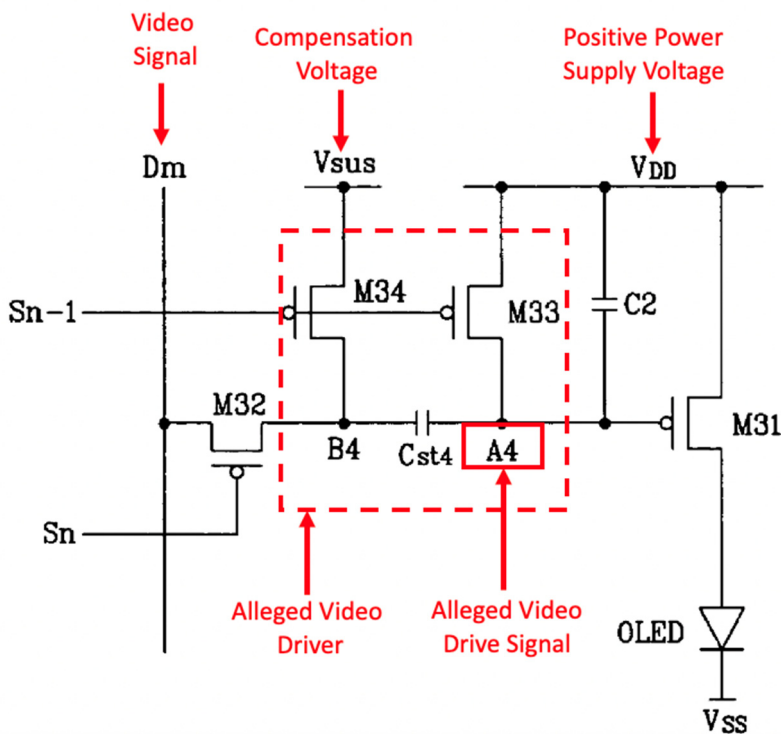
However, at a more granular level, the positive power supply voltage VDD is not constant with time. EX2001, ¶84. More accurately, VDD includes a constant ideal voltage component as well as undesirable voltage variation components such as noise and drift that vary with time:

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

Id.

The value of VDD that is used to determine VA4 in Equation 11 is not necessarily the same value of VDD that is applied to the source of drive transistor M31. *Id.*, ¶85. When Sn goes low, Sn-1 goes high, the transistor M33 is turned off and VDD is no longer applied to electrode A4 of capacitor Cst4. *Id.* Therefore, the value of VDD at A4 no longer varies with the power supply voltage connected to drive transistor M31. *Id.*

FIG.10



EX1007, FIG. 10 (annotated).

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:

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

$$VC2 = VDD(t) - (VDD(t1) + V_{DATA} - V_{sus})$$

EX2001, ¶86.

The modified equations above illustrate that $VDD(t_1)$ is a constant representing the value of VDD stored on the A4 electrode of capacitor Cst4 after

transistor M33 turns off and VDD no longer is connected to the capacitor. *Id.*, ¶87.

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. *Id.* 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). *Id.* Instead, VA4 is referenced to the value of VDD at earlier time t1, VDD(t1). *Id.*

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). *Id.*, ¶88; 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. EX2001, ¶88. Therefore, the output of amplifier 306 would continue to be impacted by variations in VDD even after the clamping voltage is set on capacitor C1. *Id.*

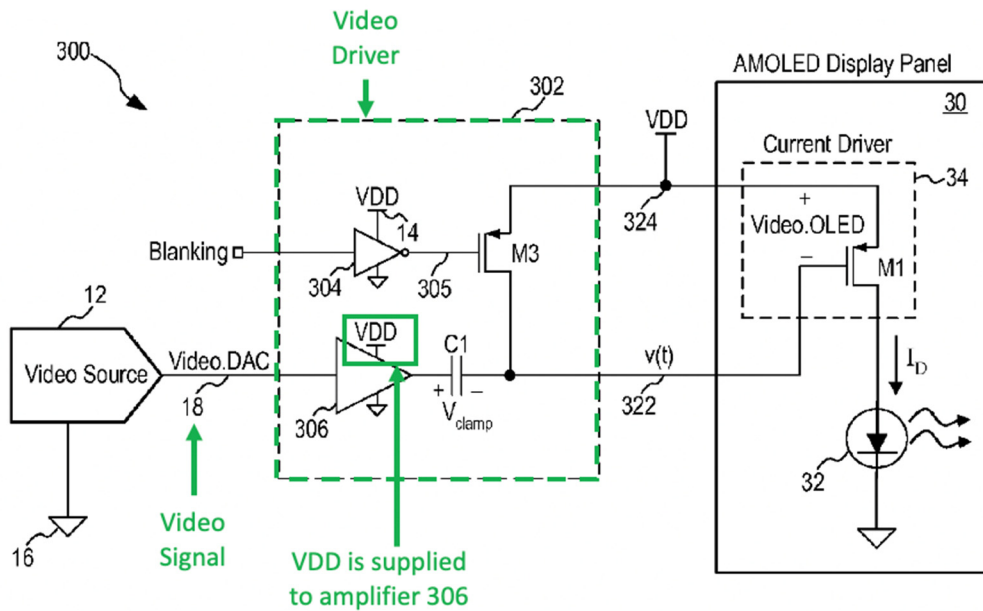


FIG. 4

EX1001, FIG. 4 (annotated).

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

2. Claim [1-C]: Kim 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”

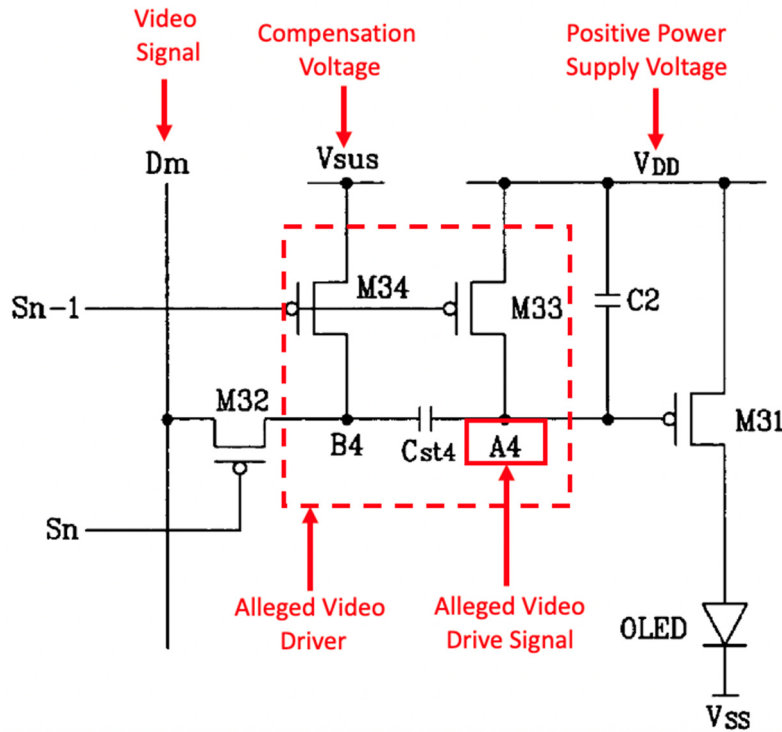
Claim 1 requires a “drive current being ... independent of the positive power supply voltage.” Alleging anticipation and not obviousness, the Petition argues that the drive current in Kim’s Figure 10 embodiment is independent of the power supply voltage because the equation 13 describing the current flowing to the OLED does not include the power supply voltage VDD: $I_{OLED} = \beta/2 * (V_{GS31} -$

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

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. EX2001, ¶91.

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]; EX2001, ¶92. As illustrated in Kim's Figure 10, data line D_m carries the video signal and V_{sus} is a compensation voltage separate from the power supply voltage V_{DD} .

FIG.10



EX1007, FIG. 10 (annotated).

When the previous select line S_{n-1} is low level, transistor M34 is turned on and compensation voltage V_{sus} 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. *Id.* 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. *Id.*, ¶[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:

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

Id., ¶¶[0108]-[0109].

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

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

Id., ¶[0112].

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:

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

Id., ¶[0113].

However, Equation 13 ignores the variations in V_{DD} over time. EX2001, ¶96. 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:

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

Id.

To solve for the OLED pixel drive current, I_{OLED} , Kim's equation 13 (*id.*, ¶[0113]) can be re-written as follows:

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

$$\begin{aligned} I_{OLED} &= \beta/2*(VDD(t) + V_{DATA} - V_{sus} - VDD(t1) - V_{TH1})^2 \\ &= \beta/2*(V_{DC} + V_{drift}(t) + V_{noise}(t) + V_{DATA} - V_{sus} - V_{DC} - \\ &\quad V_{drift}(t1) - V_{noise}(t1) - V_{TH1})^2 \\ &= \beta/2*(V_{drift}(t) + V_{noise}(t) + V_{DATA} - V_{sus} - V_{drift}(t1) - \\ &\quad V_{noise}(t1) - V_{TH1})^2 \end{aligned}$$

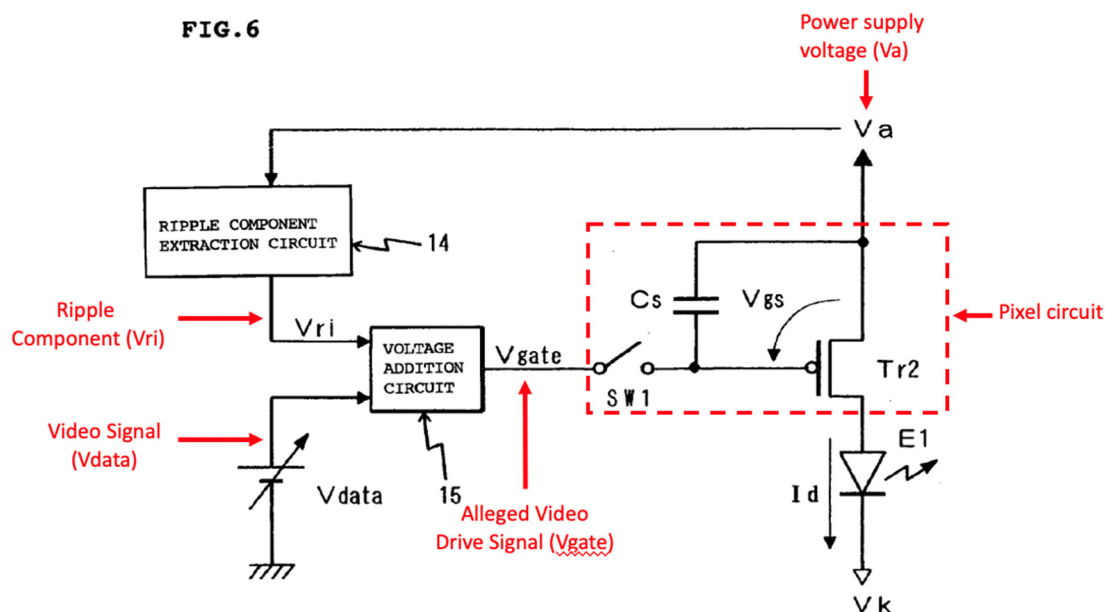
Id., ¶97.

In this analysis, t1 is the time before new data is written and t is the time after data is written and when current is flowing to the OLED (the majority of time). *Id.*, ¶98. The V_{DC} components in $VDD(t1)$ and $VDD(t)$ cancel out but the differences in undesirable voltage variations between $VDD(t1)$ and $VDD(t)$ do not. *Id.* 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. *Id.* Therefore, the drive current in Kim's Figure 10 is not independent of the power supply voltage.

C. Ground 3: Hayafuji Does Not Anticipate Claims 1 and 2

- 1. Claim [1-A]: Hayafuji does not disclose “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”**

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.” Alleging disclosure (not obviousness), Petitioner argues that Hayafuji’s ripple extraction circuit and addition circuit, depicted in Figure 6 (below), 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. EX2001, ¶¶101-107.



EX1006, FIG. 6 (annotated).

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 . *Id.*, 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} . *Id.* 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.

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. EX2001, ¶104. This is analogous to having a voltage that is referenced to the ground. *Id.* As illustrated by the following equations, each embodiment of the '521 patent uses power supply voltage V_{DD} as a baseline to measure the voltage of the video drive signal:

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

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

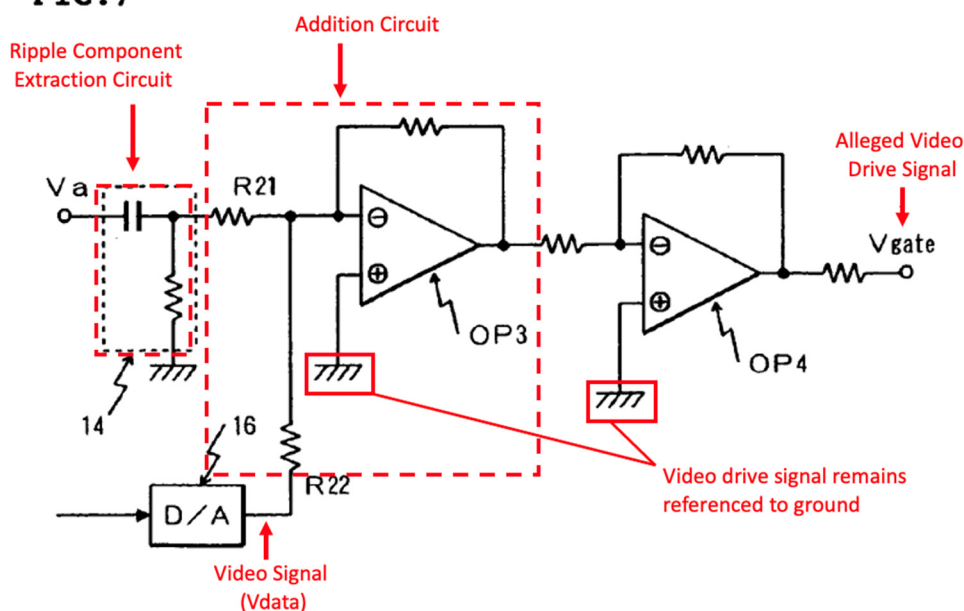
Third embodiment: $v(t) = V_{DD} + \text{Video.DAC}$

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

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.” EX2001, ¶105. 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} : $V_{gate} = V_{ri} + V_{data}$. *Id.* 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.

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). *Id.*, ¶¶[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. EX2001, ¶106.

FIG. 7



EX1006, FIG. 7 (annotated).

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.

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

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. EX2001, ¶108. 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: $\text{Video.OLED} = V_{\text{noise}} - \text{Video.DAC}$

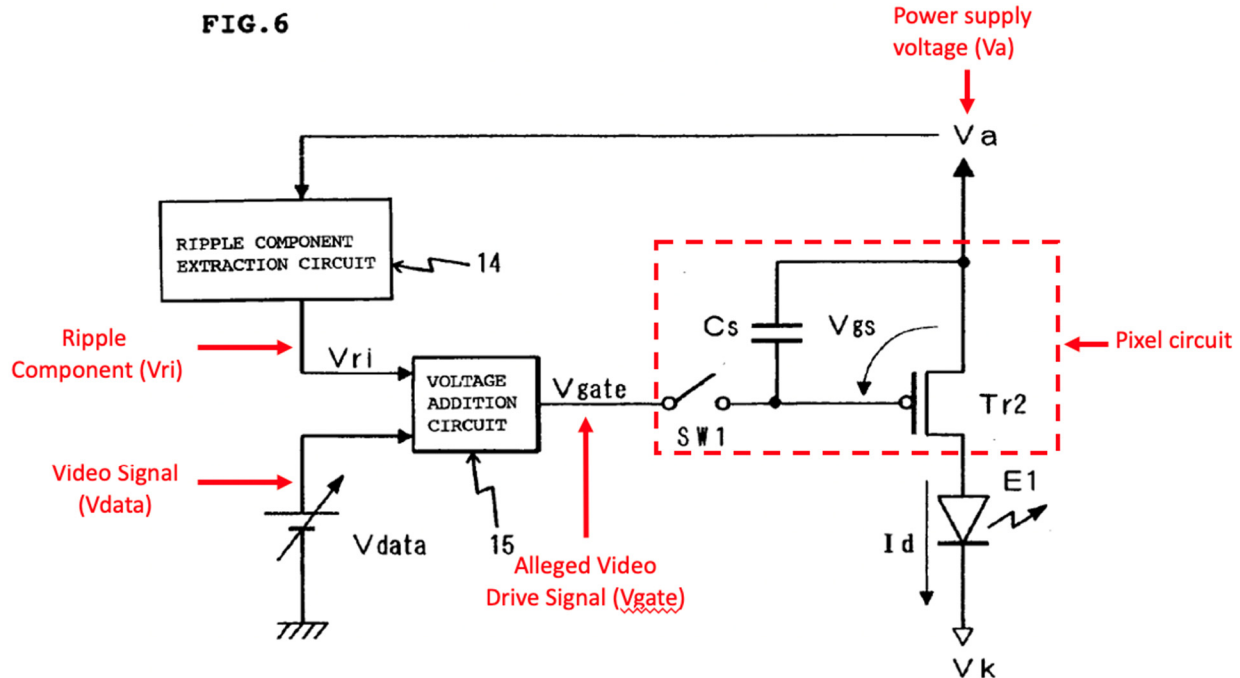
EX1001, 5:5-15, 6:20-29, 7:36-43.

Additionally, as illustrated in the equations above, each embodiment of the '521 patent removes undesirable voltage drift from the current drive voltage. *Id.*

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., 58-60. 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. EX1006, ¶¶[0048]-[0049]; EX2001, ¶¶109, 111.

Hayafuji generates an alleged video drive signal V_{gate} that is the sum of the video signal V_{data} and the ripple component voltage V_{ri} : $V_{\text{gate}} = V_{\text{data}} + V_{\text{ri}}$. EX1006, ¶[0049]; Pet., 59. V_{gate} is applied to the gate terminal of drive transistor Tr2 and the power supply voltage V_a is applied to the source terminal. EX1006, ¶[0049], FIG. 6. The current flowing through drive transistor Tr2 to the pixel element is determined by the gate-source voltage (i.e., current drive voltage), described by the following equation: $V_{\text{gs}} = V_a - (V_{\text{data}} + V_{\text{ri}})$. EX2001, ¶111.

Because V_a is part of the equation for the current drive voltage, the drive current is not independent of the power supply voltage. *Id.*



EX1006, FIG. 6 (annotated).

The Petition argues that, because the ripple component voltage V_{ri} is not included in the current drive voltage equation, that the drive current is independent of the power supply voltage. Pet., 58-60. The Petition alleges that V_a can be expressed as the sum of DC power and the ripple component V_{ri} : $V_a = V_{dc} + V_{ri}$. *Id.*, 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: $V_{gs} = V_{dc} - V_{data}$, which does not include the ripple component V_{ri} . *Id.* Petitioner's argument is incorrect for two reasons.

First, Petitioner's own admissions confirm 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: $V_{gs} = V_{dc} - V_{data}$. *Id.*; EX2001, ¶113.

Second, Petitioner's 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, 2:38-46, 2:67-3:4, 5:18-23, 6:33-37, 7:46-51; EX2001, ¶114. Thus, a more accurate formulation of Hayafuji's power supply voltage than provided in the Petition is: $V_a = V_{dc} + V_{ri} + V_{drift} + V_{noise}$. EX2001, ¶114. 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:

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

EX2001, ¶114.

This result is similar to the prior art described in the '521 patent that the claimed invention sought to overcome, which also includes Vnoise and Vdrift in the current drive voltage:

$$\begin{aligned} \text{(Eq 4) Video.OLED} &= \text{VDD} - v(t) \\ &= \text{VDDI} + \text{Vdrift} + \text{Vnoise} - \text{Video.DAC} - \text{VDDI} \\ &= \text{Vdrift} + \text{Vnoise} - \text{Video.DAC} \end{aligned}$$

EX1001, 2:53-60; EX2001, ¶115.

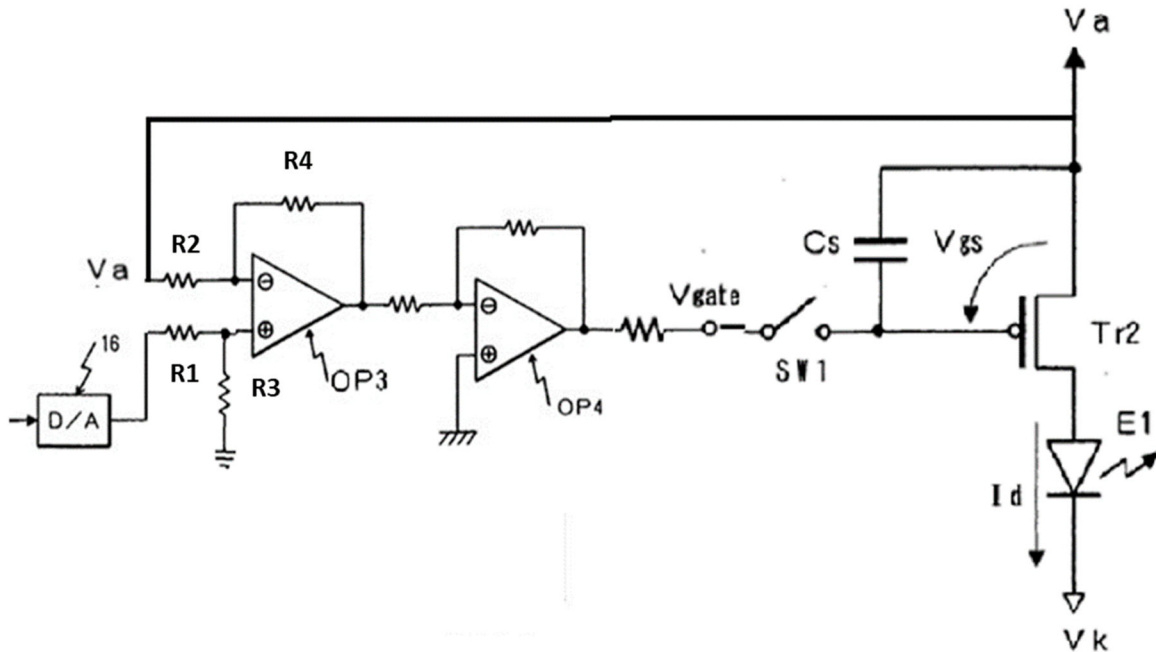
Thus, because the current drive voltage in Hayafuji includes the power supply voltage, Va, including the undesirable variable voltage components Vnoise and Vdrift, the drive current of Hayafuji is not independent of the positive power supply voltage and this claim limitation is not disclosed.

D. Ground 4: Hayafuji and the Knowledge of a POSITA Do Not Render Obvious Claim 1-3 and 5

- 1. Claim [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”**

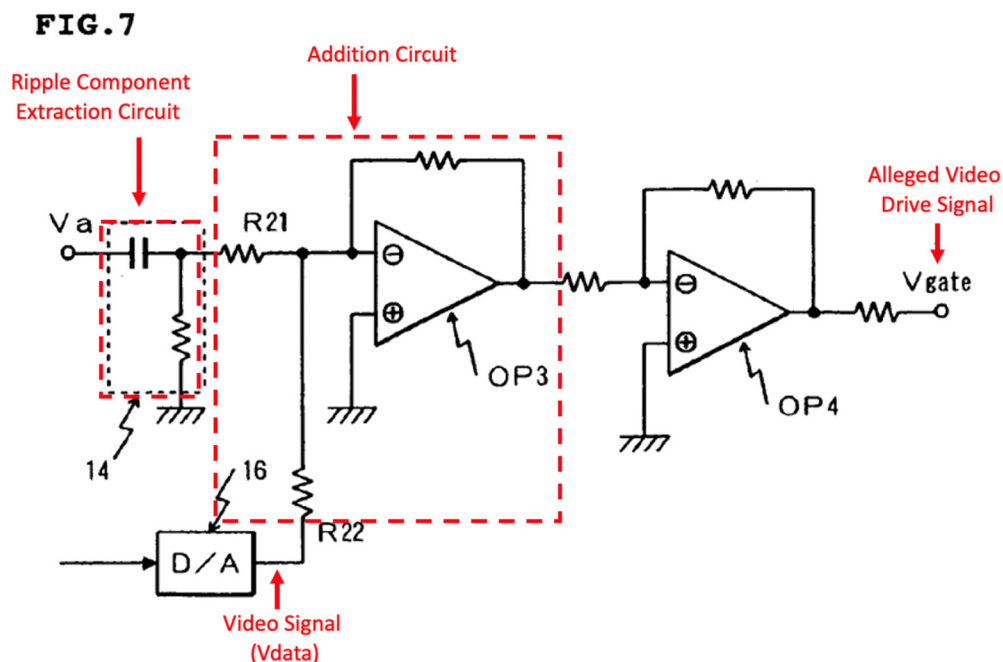
Claim 1 requires “a video driver ... generating a video drive signal ... referenced to a positive power supply voltage of the AMOLED display panel.” In alleging obviousness, Petitioner argues that a POSITA would have been motivated to modify the circuit taught by Figures 6 and 7 of Hayafuji such that the alleged video drive signal Vgate would be the sum of power supply voltage Va 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. EX2001, ¶119.



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

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



EX1006, FIG. 7 (annotated).

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. 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. *Id.*, 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. EX2001, ¶122. 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. *Id.*, ¶122; *Plas-Pak Indus., Inc. v Sulzer Mixpac AG*, 600 F. App’x. 755, 758 (Fed. Cir. 2015) (“However, combinations that change the ‘basic principles under which the [prior art] was designed to operate,’ *In re Ratti*, 270 F.2d 810, 813 (C.C.P.A. 1959), or

that render the prior art ‘inoperable for its intended purpose,’ *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984), may fail to support a conclusion of obviousness.”).

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. EX2001, ¶123. The proposed modifications transform what was a summing amplifier circuit into a differential amplifier. Pet., 71; EX2001, ¶123. 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. EX2001, ¶123; 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. EX2001, ¶123; *Plas-Pak*, 600 F. App’x. at 758 (“However, combinations that change the ‘basic principles under which the [prior art] was designed to operate,’ *In re Ratti*, 270 F.2d 810, 813 (C.C.P.A. 1959), or that render the prior art ‘inoperable for its intended purpose,’ *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984), may fail to support a conclusion of obviousness.”).

Third, the modifications proposed in the Petition are the result of impermissible hindsight bias. *InTouch Techs., Inc. v. VGO Commc'ns, Inc.*, 751 F.3d 1327, 1348 (Fed. Cir. 2014). The teachings of Hayafuji relate to a different problem than the '521 patent and propose a different solution. EX2001, ¶124. 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. *Id.*

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 Hayafuji does not anticipate this limitation as set forth in Section C.1, *supra*.

2. Claim [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”

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. Pet., 72. Because a POSITA would not have been motivated to modify the circuit as proposed in the Petition, this

claim limitation is not rendered obvious for the same reasons presented in Section C.2, *supra*.

E. Ground 5: Steer and the Knowledge of a POSITA Do Not Render Obvious Claims 1-4

- 1. Claim [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”**

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 power supply voltage VDD as a baseline to measure the voltage of the video drive signal:

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

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

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

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

Because the output V_6 of the feedback system is not referenced to the power supply voltage, Steer does not disclose the claimed video drive signal.

Steer teaches a pixel circuit, depicted in Figure 3, in which data line 6 delivers a video signal to the gate terminal and line 26 delivers the positive power supply voltage to the source terminal of drive transistor 22 to drive current to OLED pixel 2. EX1008, 2:3-9, 2:30-3:9, 8:3-20, FIG. 3.

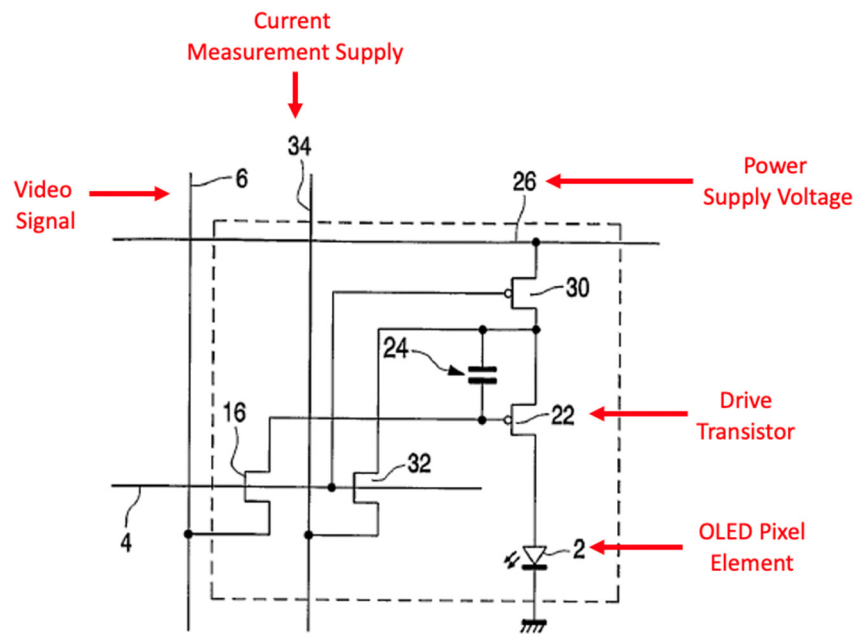


Fig.3

EX1008, FIG. 3 (annotated).

Steer further teaches a feedback system, depicted in Figure 4, that generates the voltage, V_6 , that is output to line 6. EX1008, 8:21-29, Figure 4. The feedback system of Fig. 4 includes amplifier circuit 44, which takes as inputs the positive power supply voltage V_{SUPPLY} and a reference current 34. *Id.*, FIG. 4, 8:30-9:13.

The amplifier circuit 44 outputs voltage V_{43} . *Id.* The feedback system includes an amplifier configured as a comparator circuit 50, which Petitioner alleges is the claimed “video driver.” Comparator 50 takes as inputs V_{43} and alleged video signal V_{52} . *Id.*, 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. *Id.*

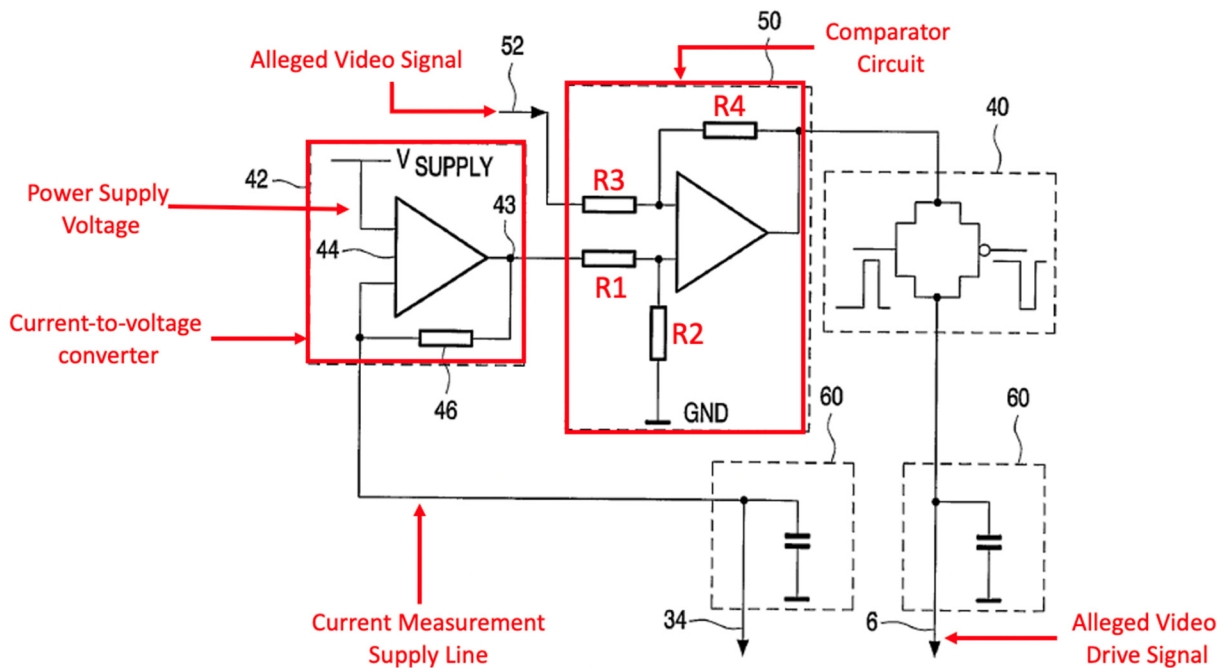


Fig.4

EX1008, FIG. 4 (annotated).

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

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

Pet., 86.

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, which Petitioner ignored. EX2001, ¶133. According to Steer, comparator 50 amplifies the signal, which requires resistors R_3 and R_4 to have different values. EX2001, ¶ 133; 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 :

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

EX2001, ¶133.

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} . *Id.*, ¶134. Therefore, the video drive signal V_6 is **not** “referenced to a positive power supply voltage” because V_{SUPPLY} does not serve as a baseline to measure the alleged video drive signal. *Id.*

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

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.

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. EX2001, ¶136. 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, 5:5-15, 6:20-29, 7:36-43.

Additionally, as illustrated in the equations above, each embodiment of the '521 patent removes undesirable voltage drift from the current drive voltage. *Id.*

As discussed in Section III.E.1, *supra*, Petitioner argues that the voltage of the alleged video drive signal V6 is represented by the following equation, where *input(t)* is the alleged video signal V52:

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

Pet., 92.

According to Petitioner, because signal V6 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:

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

Id.

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

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

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

Id.

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

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. EX2001, ¶142. As discussed in Section III.E.1, *supra*, the equation describing the voltage of the signal generated by the video driver is multiplied by R_4/R_3 :

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

Id.

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

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

EX2001, ¶143.

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. *Id.*, ¶144. Therefore, Steer does not disclose a drive current independent of the positive power supply voltage. *Id.*

IV. AN INSUFFICIENT NUMBER OF GROUNDS/CLAIMS MEET THE INSTITUTION THRESHOLD

None of Petitioner's grounds meet the institution standard. But even if the Board determined otherwise, the vast majority of grounds fail, and thus instituting a trial on all claims and all grounds would not be an efficient use of the Board's resources. *See Chevron Oronite Co. v. Infineum USA L.P.*, IPR2018-00923, Paper 9, 10–11 (P.T.A.B. Nov. 7, 2018) (informative) (explaining that “the Board may consider the number of claims and grounds that meet the reasonable likelihood standard when deciding whether to institute *inter partes* review under 35 U.S.C. § 314(a)"); *Deeper, UAB v. Vexilar, Inc.*, IPR2018-01310, Paper 7, 41–43 (P.T.A.B. Jan. 24, 2019) (informative) (explaining the same); *see also BJ's Wholesale Club Holdings, Inc. v. Walmart Apollo, LLC*, IPR2022-01561, Paper 11, 28-29 (P.T.A.B. Apr. 12, 2023) (exercising discretion to deny institution where Petitioner showed a reasonable likelihood of success only for 1 of 14 challenged claims on 2 of 4 asserted grounds). Accordingly, the Board should deny institution.

V. CONCLUSION

Petitioner failed to meet its burden under 35 U.S.C. § 314(a) and 37 C.F.R. § 42.108(c) to show a reasonable likelihood that the any of the challenged claims is unpatentable. As such, Patent Owner respectfully requests that the Board deny institution of an *inter partes* review.

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CERTIFICATE OF WORD COUNT (37 C.F.R. § 42.24(d))

1. This Patent Owner Preliminary Response complies with the type-volume limitation of 14,000 words, comprising 10,864 words, excluding the parts exempted by 37 C.F.R. § 42.24(a)(1).

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I certify that the above-captioned **PATENT OWNER PRELIMINARY RESPONSE UNDER 37 C.F.R. § 42.107(a)** and associated Exhibits 2001-2003 were served in their entireties on July 17, 2023, upon the following parties via electronic mail:

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