

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.

IPR2023-00771
Patent 7,259,521 B1

Before TERRENCE W. McMILLIN, JON M. JURGOVAN, and
KARA L. SZPONDOWSKI, *Administrative Patent Judges*.

SZPONDOWSKI, *Administrative Patent Judge*.

JUDGMENT

Final Written Decision

Determining Some Challenged Claims Unpatentable

35 U.S.C. § 318(a)

Denying Patent Owner's Motion to Strike

37 C.F.R. § 42.5

I. INTRODUCTION

We instituted an *inter partes* review of claims 1–5 and 7 of U.S. Patent 7,259,521 B1 (Ex. 1001, “the ’521 patent”), in response to a Petition (Paper 4, “Pet.”) filed by Samsung Display Co., Ltd., Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc. (collectively, “Petitioner”). Paper 12 (“Dec.”). During the trial, Polaris PowerLED Technologies, LLC (“Patent Owner”) filed a Response to the Petition (Paper 23, “PO Resp.”), Petitioner filed a Reply (Paper 26, “Reply”), and Patent Owner filed a Sur-reply (Paper 32, “Sur-reply”). Patent Owner also filed a Motion to Strike (Paper 33, “Motion”) and Petitioner filed an Opposition (Paper 34, “Opp.”).

An oral hearing was held on July 17, 2024, and a copy of the transcript was entered into the record. Paper 39 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6 (2018). This Decision is a Final Written Decision under 35 U.S.C. § 318(a) as to the patentability of the claims on which we instituted trial. Petitioner has the burden of proving unpatentability of a claim by a preponderance of the evidence. 35 U.S.C. § 316(e).

Based on the complete record, Petitioner has shown, by a preponderance of the evidence, that claims 1–4 and 7 of the ’521 patent are unpatentable. Petitioner has *not* shown by a preponderance of the evidence that claim 5 of the ’521 patent is unpatentable.

II. BACKGROUND

A. Real Parties-in-Interest

The parties identify themselves as the real parties-in-interest. Pet. 1; Paper 6, 1 (Mandatory Notices of Patent Owner).

B. Related Matters

The parties identify *Polaris PowerLED Technologies, LLC v. Samsung Electronics America, Inc.*, Case No. 2:22-cv-00469 (E.D. Tex.) as a related case. Pet. 1; Paper 6, 1. Patent Owner also states that Petitioner has filed petitions for *inter partes* review of U.S. Patent Nos. 8,740,456 (IPR2023-00479) and 8,217,887 (IPR2023-00484). Paper 6, 1.

C. The '521 Patent (Ex. 1001)

The '521 patent is titled “Video Driver Architecture for AMOLED Displays” and is generally directed to a video driver for an active matrix organic light emitting diode (AMOLED) display that “is capable of isolating the pixel circuit from power supply voltage variations.” Ex. 1001, code (54), 1:6–9, 1:13.

The '521 patent explains that, in conventional AMOLED displays, because “[t]he 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 . . . any variations in the power supply voltage will modulate the brightness of the AMOLED display.” Ex. 1001, 1:22–26. “Since the power supply voltage variations are likely to be nonsynchronous with the video scan rate, the net result is flickers that can be observed on the display panel and are objectionable to the viewer.” *Id.* at 1:29–32. In addition, “[t]he direct relationship between

the drive current and the power supply voltage renders AMOLED displays extremely sensitive to power supply voltage noise,” so “the brightness level of an AMOLED display will tend to drift with power supply voltage variations.” *Id.* at 1:32–39. “The power supply voltage VDD . . . will have variations due to voltage glitches, noise or drifts.” *Id.* at 2:38–41. Thus, variations in the current driver voltage “due to the power supply voltage noise and drifts result in variations of the brightness level of the display, negatively impacting the display quality of the AMOLED display panel.” *Id.* at 2:67–3:4.

Accordingly, the ’521 patent describes

a video driver for an AMOLED display system [that] generates a video drive signal that is referenced to the positive power supply voltage of the display panel. When the video drive signal is re-referenced to the positive power supply voltage, instead of to the ground voltage as in the conventional systems, the current driver in the AMOLED display panel will generate a drive current that is indicative of the video signal but independent of the power supply voltage. In this manner, the AMOLED display system is thus made to be immune to power supply voltage variations and provides display images that are free from undesired flickers and brightness variations.

Ex. 1001, 3:56–67.

Figure 1, reproduced below, is a schematic diagram of an exemplary AMOLED display system in the prior art, i.e., in a conventional system.

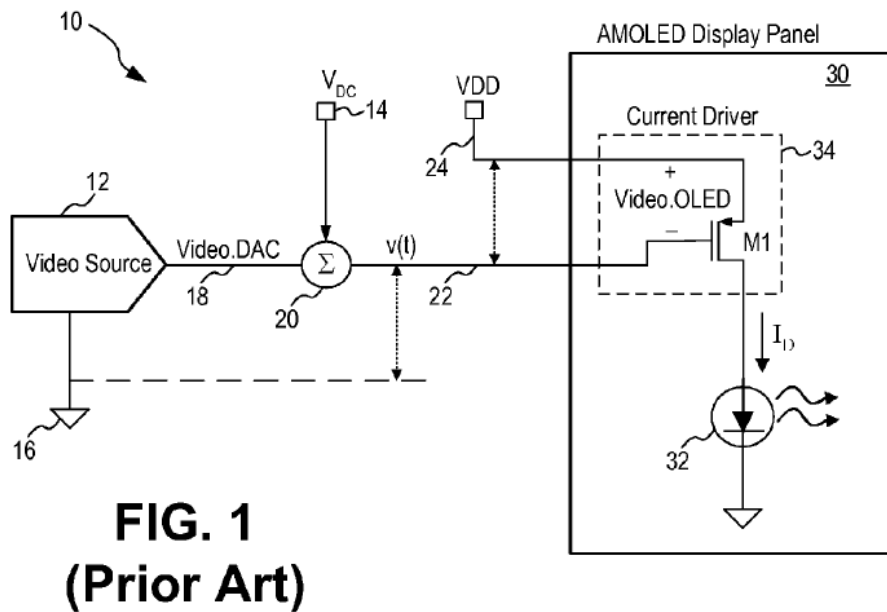


Figure 1, above, depicts video source 12 providing video signals to AMOLED display panel 30 for display. Ex. 1001, 1:57–59. Video source 12 converts digital video signals to analog signals Video.DAC on output bus 18. *Id.* at 1:64–65. “Video.DAC is summed with a DC voltage V_{DC} (node 14) at a summer 20 to generate the video drive signal $v(t)$ for driving the AMOLED display panel.” *Id.* at 1:65–2:1. In this system, “video drive signal $v(t)$ is a signal that is referenced to the ground voltage (node 16) and has a voltage value given as $v(t) = \text{Video.DAC} + V_{DC}$.” *Id.* at 2:2–6. V_{DC} “is related to the power supply voltage VDD .” *Id.* at 2:7–8. “Video.DAC is referenced to ground and the V_{DC} voltage level is added to offset the video signal to the power supply voltage VDD .” *Id.* at 2:11–14.

“At the AMOLED display panel 30, the video drive signal $v(t)$ is coupled to drive a current driver 34 for providing a drive current I_D to an OLED 32.” Ex. 1001, 2:15–17. “[T]he current driver 34 is referenced to the

positive power supply voltage VDD (node 24) of the display system 10.” *Id.* at 2:21–23. Here, “current driver 34 includes a PMOS transistor M1 having it’s [sic] drain terminal connected to the VDD power supply voltage (node 24) and it’s [sic] gate terminal connected to receive the video drive signal $v(t)$.” *Id.* at 2:23–27. “The source terminal of transistor M1 is coupled to the OLED 32 to provide the drive current I_D .” *Id.* at 2:27–28. “The drive current I_D is a function of a voltage Video.OLED across the drain-to-gate terminals of PMOS transistor M1.” *Id.* at 2:28–30. “Current driver voltage Video.OLED is the voltage applied to the current driver 34 and determines the value of drive current I_D to be applied to the OLED pixel element of the display panel.” *Id.* at 2:32–34. The ’521 patent explains that “[v]oltage Video.OLED is referenced to the power supply voltage VDD and is given as: $\text{Video.OLED} = VDD - v(t)$.” *Id.* at 2:34–37.

According to the ’521 patent, the power supply voltage VDD “will have variations due to voltage glitches, noise[,] or drifts . . . [and] can be characterized as the sum of an ideal power supply voltage VDDI and drift and noise components given as $VDD = VDDI + V_{drift} + V_{noise}$.” Ex. 1001, 2:38–45. V_{DC} “may not suffer from the same noise and drift issue as the power supply voltage and is thus assumed to have the same voltage magnitude as the ideal voltage VDDI (i.e., $V_{DC} = VDDI$).” *Id.* at 2:50–53. Substituting $v(t)$ and VDD from the equations above, the current drive voltage signal Video.OLED is given as $\text{Video.OLED} = V_{drift} + V_{noise} - \text{Video.DAC}$. *Id.* at 2:47–60. Therefore, “the noise and drift components of the power supply voltage VDD appear directly in the current driver voltage signal Video.OLED which determines the drive current I_D for the OLED

pixel element . . . result[ing] in variations of the brightness level of the display, negatively impacting the display quality of the AMOLED display panel.” *Id.* at 2:63–3:4.

Figure 2, reproduced below, is a schematic diagram of a video driver for an AMOLED display system according to a first embodiment.

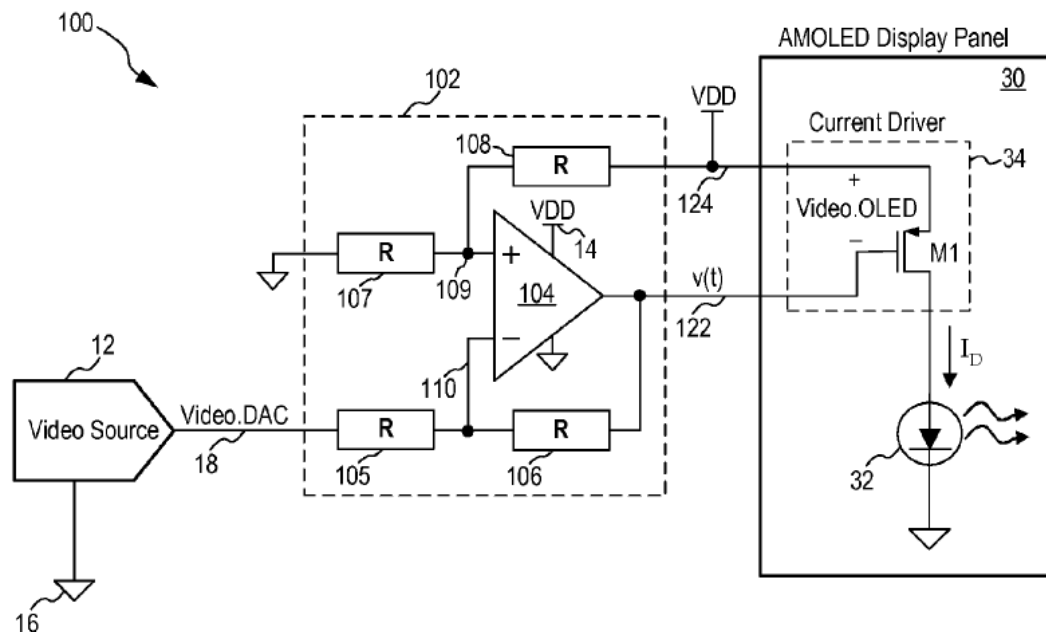


FIG. 2

In Figure 2, above, video source 12 and display panel 30 are depicted in the same manner as described in Figure 1 above, but Figure 2 further depicts “a video driver 102 [that] is incorporated in an AMOLED display system 100 for receiving input video signals Video.DAC from a video source 12 and providing a modified video drive signal $v(t)$ for driving the current driver 34 in the AMOLED display panel 30.” Ex. 1001, 4:9–16. In this embodiment, “video driver 102 is implemented using a differential instrumentation amplifier circuit to re-reference the video drive signal $v(t)$ to the positive

power supply voltage VDD.” *Id.* at 4:34–37. That is, “video driver 102 includes an operational amplifier (opamp) 104 having a positive input terminal 109, a negative input terminal 110 and an output terminal (node 122) providing the video drive signal $v(t)$.” *Id.* at 4:37–41. “The positive input terminal 109 of opamp 104 is coupled to a resistor 107 where the other terminal of resistor 107 is connected to the ground voltage.” *Id.* at 4:41–43. “A resistor 108 is coupled between the positive input terminal 109 of opamp 104 and the power supply voltage VDD (node 124) of the AMOLED display system 100.” *Id.* at 4:43–46.

Therefore, “the positive input terminal 109 of opamp 104 is connected through resistor 108 to the power supply voltage VDD instead of the ground voltage so as to realize the re-referencing function of video driver 102.” Ex. 1001, 4:56–60. “By connecting the positive input terminal 109 to the power supply voltage VDD, when the power supply voltage varies, the output signal of the instrumentation amplifier circuit, that is, the video drive signal $v(t)$ on node 122, will vary in such a way as to track the power supply voltage variations.” *Id.* at 4:60–65. “As a result, the video drive signal $v(t)$ becomes the difference between the video signal Video.DAC and the power supply voltage VDD and give as: $v(t) = VDD - Video.DAC$.” *Id.* at 4:65–5:1. Therefore, “[i]nstead of being referenced to the ground voltage, the video drive signal $v(t)$ is now made to be referenced to the power supply voltage VDD.” *Id.* at 5:3–5. Accordingly, “when the video drive signal $v(t)$ is applied to the current driver 34 for the OLED pixel element 32, the current drive voltage signal Video.OLED at the current driver 34 is given as: $Video.OLED = VDD - v(t)$,” and replacing $v(t)$ with the foregoing equation

results in *Video.OLED = Video.DAC. Id.* at 5:6–15. The ’521 patent states, “as can be observed from [this equation], 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.* at 5:18–23.

Figure 4, reproduced below, is a schematic diagram of a video driver for an AMOLED display system according to a third embodiment.

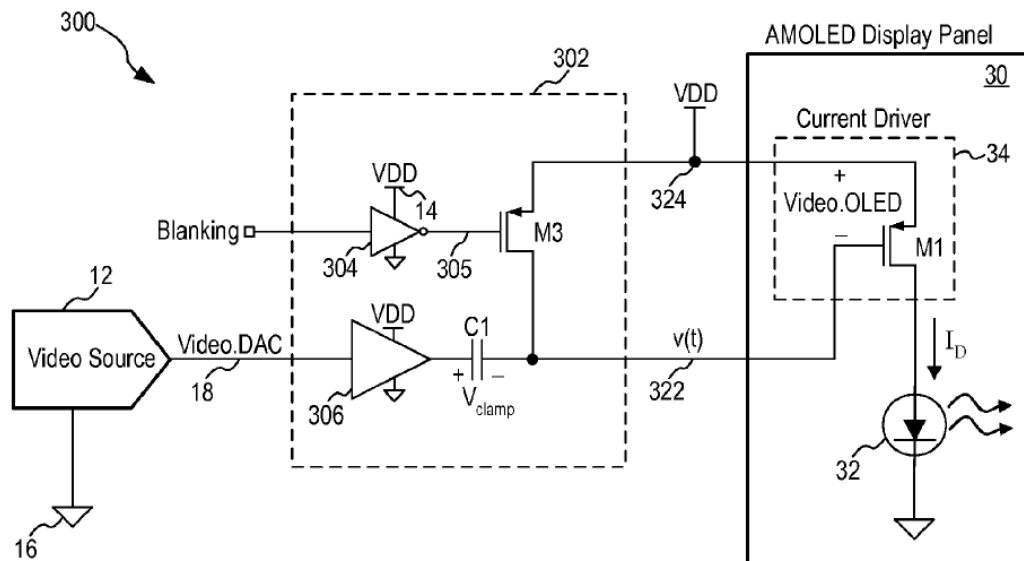


FIG. 4

In the third embodiment depicted above in Figure 4, video driver 302 “is implemented using a video clamp circuit to reference the video drive signal to the power supply voltage VDD.” Ex. 1001, 6:47–50. “[T]he video clamp circuit is implemented using an amplifier 306 coupled to receive the video signal Video.DAC and driving one plate of a capacitor C1.” *Id.* at 6:50–53. “The other plate (node 322) of capacitor C1 is the video drive signal $v(t)$.”

Id. at 6:53–54. “Video driver 302 also includes an inverter 304 receiving the video blanking signal and driving a PMOS transistor M3.” *Id.* at 6:54–56. “PMOS transistor M3 has a source terminal connected to the power supply VDD voltage (node 324) and a drain terminal connected to the left plate (node 322) of capacitor C1 providing the video drive signal $v(t)$.” *Id.* at 6:56–60. In this configuration, power supply voltage VDD, including any voltage drift, is stored on capacitor C1 as the clamping voltage V_{clamp} . *Id.* at 6:65–67. “[T]he video signal Video.DAC is applied through amplifier 306 and is added to the clamping voltage V_{clamp} ,” which results in the video drive signal $v(t)$ being referenced to the power supply voltage. *Id.* at 7:1–8. In this configuration, “voltage drifts in the power supply voltage VDD are removed from the current drive signal Video.OLED but noise in the power supply voltage may remain to impact the current drive voltage Video.OLED.” *Id.* at 7:46–51.

D. Illustrative Claim

Independent claim 1 is reproduced below, with Petitioner’s identifiers in brackets.

[1-PRE] 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:

[1-A] 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

[1-B] 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, [1-C] the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage.

Ex. 1001, 8:47–64.

E. Prior Art and Asserted Challenges to Patentability

Petitioner asserts that claims 1–5 and 7 are unpatentable on the following challenges (Pet. 6):

Claims Challenged	35 U.S.C. § ¹	Reference/Basis
1, 2, 7	102	Kim ²
1, 2, 7	103(a)	Kim ³

¹ Because the '521 patent issued from a patent application that was filed before March 16, 2013, patentability is governed by the versions of 35 U.S.C. §§ 102 and 103 preceding the Leahy-Smith America Invents Act (“AIA”), Pub L. No. 112–29, 125 Stat. 284 (2011).

² Kim et al., US 2005/0140600 A1, published June 30, 2005 (Ex. 1007). Petitioner contends that Kim is prior art under at least 35 U.S.C. § 102(b). Pet. 16. Patent Owner does not contest Petitioner’s contentions regarding the prior art status of this reference. *See generally* PO Resp.

³ In the obviousness grounds, Petitioner separately references the knowledge of a person of ordinary skill in the art. Pet. 6. When analyzing whether claims would have been obvious and whether it would have been obvious to modify prior art, it is always from the perspective of an ordinarily skilled artisan and one must consider knowledge generally available to one of ordinary skill in the art. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (one considers “the background knowledge possessed by a person having ordinary skill in the art”). The knowledge of a person of ordinary skill in the art is, therefore, always a consideration and is not a separate basis in an obviousness challenge.

Claims Challenged	35 U.S.C. § ¹	Reference/Basis
1, 2	102	Hayafuji ⁴
1–3, 5	103(a)	Hayafuji
1–4	103(a)	Steer ⁵

In support of its proposed challenges, Petitioner relies on the Declaration and Supplemental Declaration of Alex Z. Kattamis, Ph.D. *See* Exs. 1002, 1015. Patent Owner relies on the Declaration of Thomas L. Credelle. *See* Ex. 2011. Deposition transcripts for Mr. Credelle and Dr. Kattamis have also been submitted to the record. *See* Exs. 1016, 2012, 2017.

III. ANALYSIS

A. Legal Standards

Petitioner bears the burden to demonstrate unpatentability, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

To show anticipation under 35 U.S.C. § 102, each and every claim element, arranged as in the claim, must be found in a single prior art reference. *Net MoneyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359 (Fed. Cir. 2008). The anticipation inquiry takes into account the literal teachings of the

⁴ Hayafuji, US 2005/0190128 A1, published Sept. 1, 2005 (Ex. 1006). Petitioner contends that Hayafuji is prior art under at least 35 U.S.C. §§ 102(a) and (e). Pet. 15. Patent Owner does not contest Petitioner’s contentions regarding the prior art status of this reference. *See generally* PO Resp.

⁵ Steer, WO 2004/034365 A1, published Apr. 22, 2004 (Ex. 1008). Petitioner contends that Steer is prior art under at least 35 U.S.C. § 102(b). Pet. 17. Patent Owner does not contest Petitioner’s contentions regarding the prior art status of this reference. *See generally* PO Resp.

prior art reference and inferences the ordinarily skilled person would draw from it. *Eli Lilly and Co. v. Los Angeles Biomedical Res. Inst. at Harbor-UCLA Med. Ctr.*, 849 F.3d 1073, 1074–75 (Fed. Cir. 2017).

A claim is unpatentable under 35 U.S.C. § 103(a) 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.” *KSR*, 550 U.S. at 406. The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). A patent claim “is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.” *KSR*, 550 U.S. at 418. An obviousness determination requires finding “both ‘that a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.’” *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1367–68 (Fed. Cir. 2016) (citation omitted); *see KSR*, 550 U.S. at 418. Further, an assertion of obviousness “cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.” *KSR*, 550 U.S. at 418; *In re*

NuVasive, Inc., 842 F.3d 1376, 1383 (Fed. Cir. 2016) (a finding of a motivation to combine “must be supported by a ‘reasoned explanation’”).

B. Level of Ordinary Skill in the Art

Petitioner asserts a person of ordinary skill in the art “would have [had] a B.S. in Electrical Engineering or equivalent field, with 3–5 years of academic or industry experience in OLED display engineering or comparable industry.” Pet. 12 (citing Ex. 1002 ¶¶ 44–45). Petitioner further asserts that “[a]dditional education could compensate for less practical experience and vice versa.” *Id.*

Patent Owner does not dispute Petitioner’s proposed level of ordinary skill in the art, and “applies Petitioner’s definition.” PO Resp. 7 (citing Pet. 12; Ex. 1002 ¶ 44).

Because nothing in the record persuades us that our preliminary finding in the Institution Decision (Dec. 13) adopting Petitioner’s proposal was incorrect, and because the parties apply the same definition at trial, we maintain our adoption of Petitioner’s proposed level of ordinary skill in the art.

C. Claim Construction

Petitioner contends that two terms require construction, and interprets “terms not explicitly construed” in the Petition according to their plain and ordinary meaning. Pet. 12.

1. Petitioner’s Contentions

a) “referenced to”

Claim 1 recites, *inter alia*, “generating a video drive signal indicative of the video signal and *referenced to* a positive power supply voltage of the

AMOLED display panel.” Ex. 1001, 8:53–55 (emphasis added). Petitioner contends that “*referenced to*” is not defined in the ’521 patent, but the Specification describes several different relationships where a signal may be “*referenced to*” a voltage. Pet. 12. For example, Petitioner contends that, in accordance with the intrinsic record, a person of ordinary skill in the art would understand “*referenced to*” to include a direct connection between a component and a voltage signal, an indirect connection between multiple voltage signals, a voltage differential’s minuend value, and a driver functionality. *Id.* at 12–13 (citing Ex. 1001, 2:1–14, 2:20–23, 2:34–37, 3:55–58, 4:55–56, 5:63–65).

b) “*independent of the . . . power supply voltage*”

Claim 1 recites, *inter alia*, “the drive current being proportional to a current drive voltage being indicative of the video signal and *independent of the positive power supply voltage*.” Ex. 1001, 8:61–64 (emphasis added). Petitioner contends that, consistent with the Specification, a person of ordinary skill in the art would understand this to mean that “noise or DC drifts in the power supply voltage . . . will not disturb the current drive signal . . . and will not affect the brightness” of the display, and “[v]ariations in the power supply voltage VDD will no longer adversely affect the” display. Pet. 13–14 (citing Ex. 1001, 6:6–7, 5:18–23, 2:63–65, Fig. 2; Ex. 1002 ¶¶ 48, 49) (alterations in original).

2. *Patent Owner’s Contentions*

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

meaning.” PO Resp. 7. Aside from that, Patent Owner does not explicitly respond to Petitioner’s contentions.

However, in connection with limitation 1-C of the Kim grounds, Patent Owner states that “[i]n 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,” and in connection with limitation 1-A of the Hayafuji grounds, Patent Owner states that “[i]n 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.” PO Resp. 32, 40 (citing Ex. 1001, 5:6–15, 6:20–29, 7:36–43; Ex. 2011 ¶¶ 112, 124); *see also id.* at 44 (similar statement in connection with limitation 1-C of the Hayafuji grounds), 61 (similar statement in connection with limitation 1-A of the Steer ground).

3. *Analysis*

Only terms that are in controversy need to be construed, and then only to the extent necessary to resolve the controversy. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

Both parties have presented their understanding of the plain and ordinary meaning of the terms “referenced to” and “independent of.” In the Institution Decision, we requested that “[i]f there is a dispute over the plain and ordinary meaning of these terms, the parties should address those issues

during trial.” Dec. 14–15 n.6. On this record, the parties do not dispute each other’s understanding of the plain and ordinary meaning of these terms, and, based upon the parties’ arguments, we determine that no express construction of the claim terms is necessary to resolve the controversy, but address the parties’ arguments in the context of the prior art below.⁶

D. Grounds 1 and 2: Alleged Anticipation or Obviousness Over Kim

Petitioner contends claims 1, 2, and 7 are anticipated by or would have been obvious in view of Kim. Pet. 19–45. Patent Owner disputes Petitioner’s contentions. PO Resp. 8–35. After reviewing the record developed at trial, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 1, 2, and 7 are anticipated and would have been obvious over Kim.

1. Kim (Ex. 1007)

Kim is titled “Light Emitting Display, Display Panel, and Driving Method Thereof” and is generally directed to an organic EL

⁶ In the related litigation, the district court construed the limitation “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” in independent claim 1 as “a video driver receiving the video signal and receiving a positive power supply voltage of the AMOLED display panel as an input and generating a video drive signal indicative of the video signal based on the positive power supply voltage.” Ex. 1019, 8–11. Petitioner submitted the district court’s claim construction order in this proceeding, but neither party requested further briefing based on the district court’s construction, or asserted that the district court’s construction affected the arguments presented or their understanding of the plain and ordinary meaning of the limitation. *See* Tr. 19:3–20:4 (Petitioner stating that the district court’s constructions “support the Petition” and were “consistent with the arguments made in the Petition”).

(electroluminescent) element (OLED) display, where “a current that flows to the OLED of a pixel circuit in a light emitting display is substantially prevented from being influenced by a power supply voltage.” Ex. 1007, code (54), ¶¶ 7, 14.

Figure 3 of Kim, reproduced below, shows an organic EL display.

FIG.3

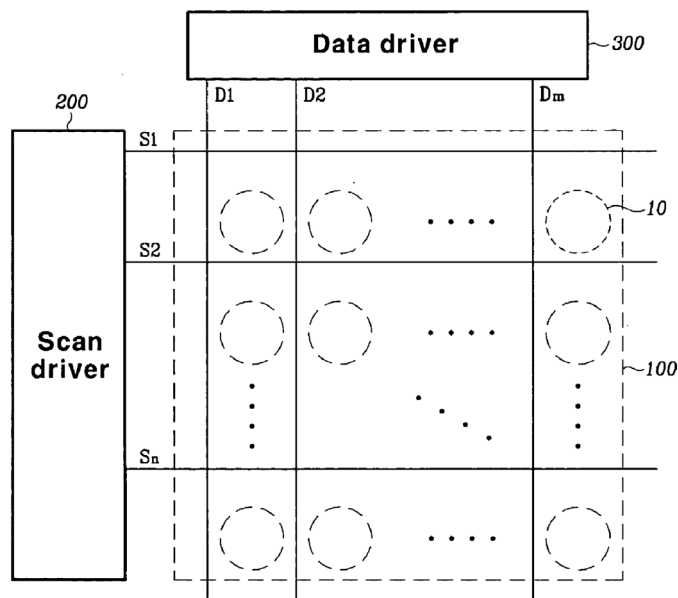


Figure 3, above, depicts an organic EL display with organic EL display panel 100, scan driver 200, and data driver 300. Ex. 1007 ¶ 45. Display panel 100 “includes a plurality of data lines D_1 through D_m each extending in a column direction, a plurality of scan lines S_1 through S_n , each extending in a row direction, and a plurality of pixel circuits 10.” *Id.* ¶ 46. The data lines transmit voltages that correspond to video signals to the pixel circuits, and the scan lines transmit select signals for selecting the pixel circuits. *Id.* Scan driver 200 sequentially applies select signals to the scan lines, and data

driver 300 applies the data voltage that corresponds to video signals to the data lines. *Id.* ¶ 47.

Figure 10, reproduced below, shows a pixel circuit according to a fourth embodiment.

FIG.10

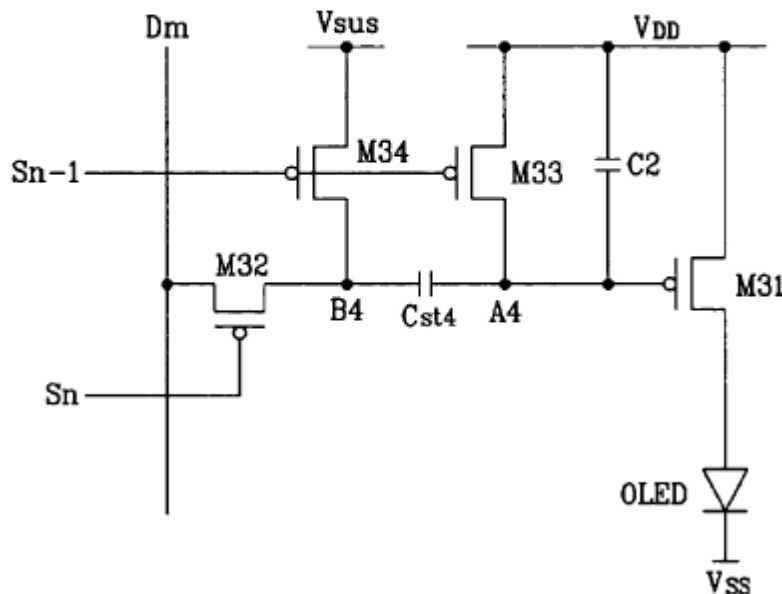


Figure 10, above, shows a pixel circuit in which “transistors M31, M32 and a capacitor C_{st4} are connected together in substantially the same relationship as the transistors M1, M2 and the capacitor C_{st1} of FIG. 6A.”⁷ Ex. 1007

⁷ In connection with Figure 6A, Kim describes a pixel circuit that includes transistors M1 and M2 that are P-type transistors, and voltage compensator 11. Ex. 1007 ¶ 51. “[T]ransistor M1 is a driving transistor for controlling the current that flows to the OLED, and it has a source coupled to the power supply voltage V_{DD} , and a drain coupled to an anode of the OLED.” *Id.*

¶ 105. Figure 10 also includes electrodes A4 and B4, where electrode A4 is coupled to the gate of transistor M31, and electrode B4 is coupled to the drain of transistor M32. *Id.* ¶¶ 57, 105. Transistor M33 is coupled between power supply voltage V_{DD} and electrode A4. *Id.* ¶¶ 58, 105. Transistor M34 is coupled between a compensation voltage V_{SUS} and electrode B4. *Id.* ¶¶ 59, 105. The pixel circuit in Figure 10 further includes capacitor C2 coupled between power supply voltage V_{DD} and a gate of the driving transistor M31. *Id.* ¶ 105.

The operation of the pixel circuit in Figure 10 is described as follows:

When the select signal from the previous scan line S_{n-1} becomes low level, the transistors M33 and M34 are turned on, the power supply voltage V_{DD} is applied to the first electrode A4 of the capacitor C_{st4} , and the compensation voltage V_{SUS} is applied to the second electrode B4 thereof.

Id. ¶ 107.

Next, the select signal from the present scan line S_n , becomes low level, and the transistor M32 is turned on. Therefore, the voltage of the second electrode B4 of the capacitor C_{st4} is changed to the data voltage, and the voltage of the first electrode A4 of the capacitor C_{st4} is changed by a voltage variation of the second electrode B4 of the capacitor C_{st4} . The voltage of the first electrode A4 of the capacitor C_{st4} is given as Equation 11.

Id. ¶ 108.

¶ 52. “A cathode of the OLED is coupled to a reference voltage V_{SS} and emits light that corresponds to the current applied from the transistor M1.” *Id.* “The reference voltage V_{SS} is a voltage lower than the power supply voltage V_{DD} .” *Id.* “By way of example, the ground voltage can be used as the reference voltage V_{SS} .” *Id.*

Equation 11 is:

$$V_{A4} = V_{DD} + \Delta V_{B4} = V_{DD} + V_{DATA} - V_{SUS}$$

Id. ¶ 109. Kim states “[t]herefore, the power supply voltage V_{DD} and the voltage of the first electrode A4 of the capacitor C_{st4} are applied to both electrodes of the capacitor C2, and the capacitor C2 is charged.” *Id.* ¶ 110.

The voltage charged in capacitor C2 is given in Equation 12:

$$V_{C2} = V_{DD} - (V_{DD} + V_{DATA} - V_{SUS}) = V_{DATA} - V_{SUS}$$

Id. ¶¶ 111–112. Kim provides the current flowing to the OLED in Equation 13:

$$\begin{aligned} I_{OLED} &= \beta/2 (V_{GS31} - V_{TH31})^2 \\ &= \beta/2 ((V_{DATA} - V_{SUS}) - V_{TH31})^2 \end{aligned}$$

Id. ¶ 113. Kim states “[a]s can be seen from Equation 13, the current flowing to the OLED is substantially not influenced by the power supply voltage V_{DD} .” *Id.* ¶ 114.

2. *Analysis of Independent Claim 1*

Petitioner contends that Kim teaches each limitation of independent claim 1. Pet. 19–45. Petitioner’s contentions and Patent Owner’s arguments in opposition are set forth below.

- a) *[1-Pre]: 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:*

Petitioner contends that Kim “discloses ‘a light emitting **display** and a driving method’ for ‘an organic EL (electroluminescent) display’ consisting of multiple pixel circuits ‘for driving an organic EL element (**OLED**)’ and

which can use an ‘**active matrix**’ method.” Pet. 19–20 (citing Ex. 1007 ¶¶ 5–7). Petitioner relies on Figure 3 of Kim and its corresponding description, including organic EL display panel **100** and pixel circuits **10**, to contend that Kim’s “data voltage from the data line D_m ” teaches the claimed “*video signal to be displayed on the AMOLED display panel.*” *Id.* at 20–21. Petitioner contends that, if the challenged claims are not anticipated by Kim, a person of ordinary skill in the art “would find it obvious that the Kim system could receive a video signal, and use that signal as the source for the ‘video signals’ explicitly discussed in Kim.” *Id.* at 21 (citing Ex. 1002 ¶¶ 93–104).

Petitioner’s analysis is primarily directed to Kim’s fourth embodiment corresponding to Figure 10, and Petitioner asserts that “the concepts and discussions of Figures 1–6A are generally pertinent to the fourth embodiment.” Pet. 22. However, Petitioner asserts, “[t]o the extent these disclosures are found to be distinct embodiments, it would be obvious to combine these disclosures in view of Kim’s teachings and suggestions, which provide motivation to use the disclosures together in implementing variations of Kim’s teachings.” *Id.* at 23 (citing Ex. 1002 ¶¶ 105–106).

Patent Owner does not respond to these arguments. *See generally* PO Resp. After considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the

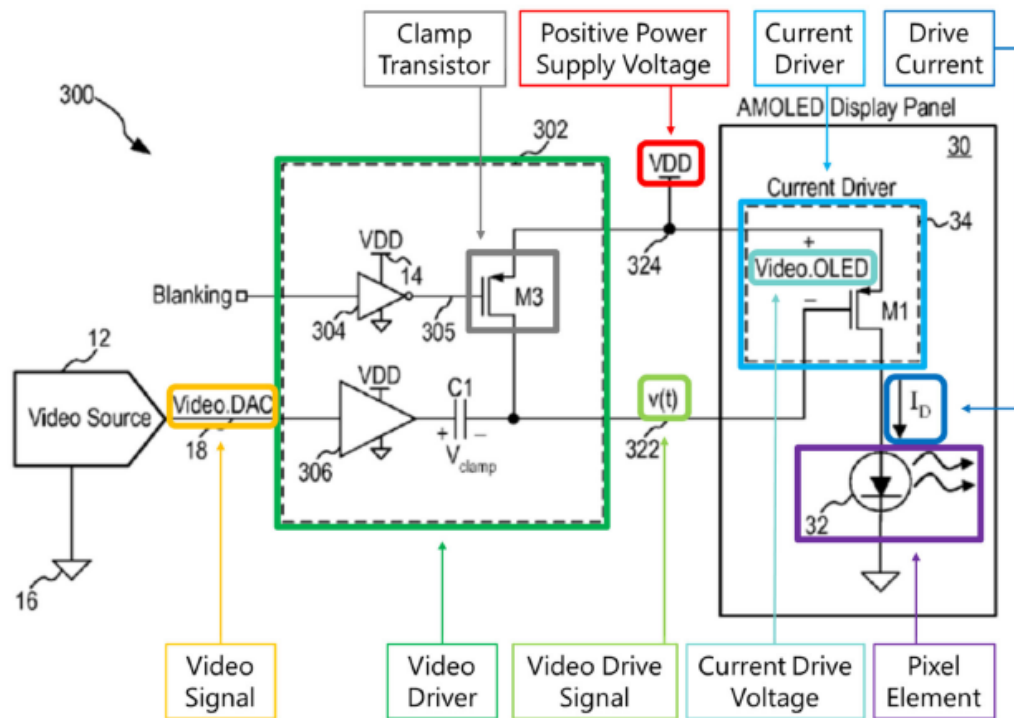
evidence, that Kim teaches the recited elements, whether under anticipation or obviousness.⁸

- b) *[1-A] 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;*

Petitioner contends that Kim’s fourth embodiment discloses the claimed **video driver** in a similar way as the ’521 patent’s third embodiment, depicted in Figure 4 of the ’521 patent.⁹ Pet. 25–28. Specifically, and referring to circuitry in Kim’s Figure 10, Petitioner contends that Kim’s capacitor C_{st4} and transistor M33 correspond to capacitor C1 and transistor M3 in the ’521 patent. *Id.* at 27. Petitioner’s annotated version of Figure 4 of the ’521 patent is reproduced below:

⁸ Petitioner does not argue that the preamble limits claim 1. Although we find that the evidence supports that the prior art teaches the preamble, we make no determination whether the preamble of claim 1 is limiting.

⁹ In the Reply Brief, Petitioner proposes an alternative mapping of the “video driver” to Figure 10 of Kim, which also includes Kim’s data driver 300. Reply 16. Because we determine that Petitioner has shown that Kim teaches this limitation based on the mapping of the “video driver” in the Petition, we need not decide whether this argument was improperly raised in the Reply, as Patent Owner argues. *See* Sur-reply 9.

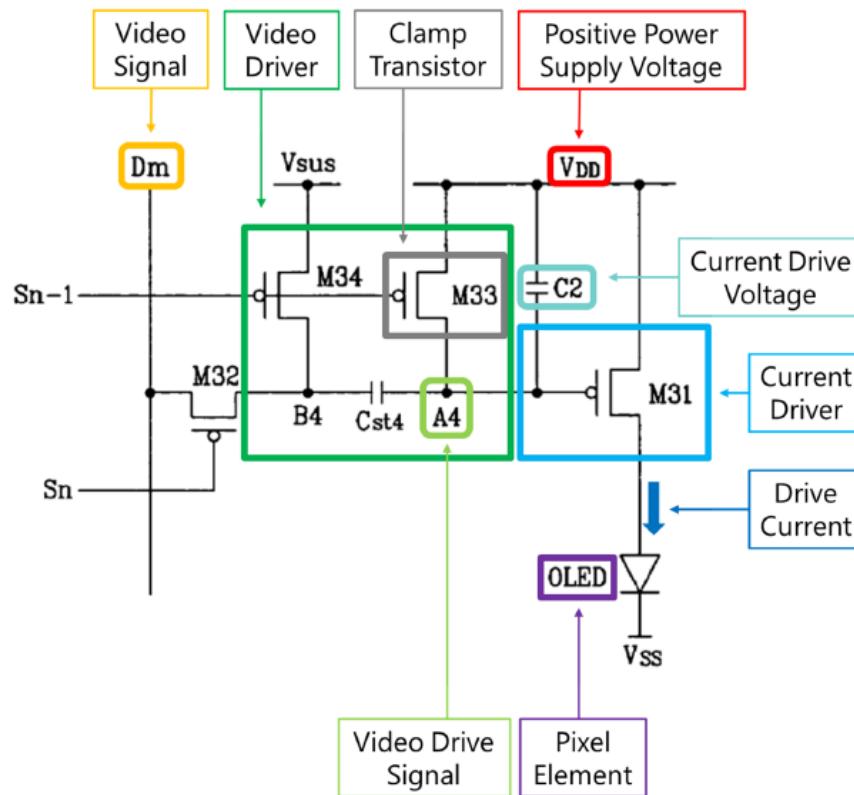


Ex.[1001], Fig. 4 (annotated)

Id. at 26. Petitioner’s annotated Figure 4 identifies video driver 302, which includes amplifiers 304 and 306 and PMOS transistor M3, as “video driver” in dark green. Petitioner also identifies Video.DAC as “video signal” in yellow; $v(t)$ as “video drive signal” in light green; VDD as “positive power supply voltage” in red; Video.OLED as “current drive voltage” in light blue; current driver 34, including transistor M1, as “current driver” in dark blue; I_D as “drive current” in dark blue; and OLED 32 as “pixel element” in purple.

Petitioner provides an annotated version of Kim’s Figure 10, reproduced below, depicting, in the same colors as in annotated Figure 4 of

the '521 patent, where Petitioner contends Kim discloses the recited claim elements.



Ex.[1007], Fig. 10 (annotated).

Pet. 28. Petitioner's annotated Figure 10 identifies circuitry including C_{st4} , $A4$, $B4$, $M33$, and $M34$ as "video driver" in dark green. Petitioner also identifies D_m as "video signal" in yellow; $A4$ as "video drive signal" in light green; V_{DD} as "positive power supply voltage" in red; $C2$ as "current drive voltage" in light blue; circuitry including " $M31$ " as "current driver" in dark blue; and OLED as "pixel element" in purple. Petitioner states that a person of ordinary skill in the art "would recognize or find obvious that 'data

voltage from the data line **D_m**’ corresponds to the relevant portion of the claimed **video signal**.” *Id.* (citing Ex. 1007 ¶¶ 9, 62; Ex. 1002 ¶ 110).¹⁰

Petitioner further contends that, similar to the ’521 patent’s third embodiment, Kim’s “fourth embodiment similarly discloses voltage at node **A4** being supplied to the gate of transistor **M31** driving the organic light emitting diode **OLED** by the video driver circuitry including Capacitor **C_{st4}** and clamp transistor **M33**.” Pet. 29. Petitioner states that a person of ordinary skill in the art “would thus recognize that *Kim*’s ‘voltage of the first electrode **A4**’ corresponds to the claimed **generated video drive signal**.” *Id.* (citing Ex. 1002 ¶¶ 111–113).

Petitioner also relies on Kim’s Equation 11:

$$V_{A4} = V_{DD} + \Delta V_{B4} = V_{DD} + V_{DATA} - V_{SUS}$$

Pet. 29. Petitioner asserts that a person of ordinary skill in the art would recognize from Equation 11 that Kim “discloses a **video drive signal** (voltage of the first electrode **V_{A4}**) indicative of the video signal (voltage **V_{DATA}**) because voltage **V_{A4}** explicitly depends on data voltage **V_{DATA}**.” *Id.* (citing Ex. 1007 ¶¶ 108, 109; Ex. 1002 ¶¶ 111–113).

Petitioner contends that **V_{A4}** is referenced to positive power supply voltage **V_{DD}** based upon Kim’s disclosure that “[w]hen . . . the transistors **M33** and **M34** are turned on, the power supply voltage **V_{DD}** is applied to the first electrode **A4** of the capacitor **C_{st4}**,” as well as Equation 11, in which

¹⁰ Petitioner contends that a person of ordinary skill in the art would understand “the ‘data voltage **V_{DATA}**’ transmitted along ‘data line **D_m**’ is the relevant portion of the claimed **video signal** destined for the addressed pixel.” Pet. 21 n.4 (citing Ex. 1002 n.1 (page 49)).

V_{A4} is a function of power supply voltage V_{DD} . Pet. 30 (citing Ex. 1007, Fig. 10, ¶¶ 107, 109; Ex. 1002 ¶¶ 114–117).

Petitioner concludes that, consistent with annotated Figure 10, a person of ordinary skill in the art would recognize that Kim “discloses *a video driver* (circuitry in green Video Driver annotation including Capacitor C_{st4} and clamp transistor **M33**) *receiving the video signal* (voltage V_{DATA}) *and generating a video drive signal* (voltage of the first electrode V_{A4}) *indicative of the video signal* (voltage V_{DATA}) *and referenced to a positive power supply voltage* (PPS voltage V_{DD}) *of the AMOLED display panel.*” Pet. 30–31 (citing Ex. 1007, Fig. 10; Ex. 1002 ¶¶ 107–117).

Patent Owner argues that Kim does not teach the claimed video driver for three reasons: (1) Kim’s alleged video driver does not generate a video drive signal; (2) Kim’s pixel circuit is not a video driver because in AMOLED displays, video drivers are distinct from pixel circuits; and (3) Kim’s alleged video drive signal is not referenced to the positive power supply voltage. PO Resp. 13–27. We address these arguments below.

(1) *Whether Kim teaches a “video driver receiving the video signal and generating a video drive signal indicative of the video signal”*

We are persuaded that Petitioner has shown that the identified portion of Kim’s Figure 10 teaches the recited “video driver” and “generat[es] a video signal.” We find particularly persuasive Petitioner’s annotated comparison of Figure 4 of the ’521 patent as compared to Kim’s Figure 10 (both reproduced above), which illustrates the similarities between the ’521 patent and Kim. See Pet. 25–28. As set forth by Petitioner, Kim’s voltage at node A4 (video drive signal generated by the video driver identified in the

dark green box) is supplied to the gate of transistor M31, driving the organic light emitting diode OLED by the video driver circuitry identified in the dark green box, similar to how voltage $v(t)$ 322 (video drive signal) is supplied to the gate of transistor M1 driving the OLED 32 by video driver 32 in Figure 4 of the '521 patent. *Id.* at 29.

The '521 patent does not explicitly define a “video driver” or explain what it means to “generat[e] a video signal.” Patent Owner argues that Kim’s Figure 10 discloses a pixel circuit which “lacks the necessary components of a video driver that are responsible for generating a video drive signal.” PO Resp. 13 (citing Ex. 2011 ¶¶ 85–91). Specifically, Patent Owner argues that Kim does not perform certain functions required to generate a video signal and does not have an amplifier. *Id.* at 16–17 (citing Ex. 2011 ¶ 89; Ex. 1007, Fig. 10).

Patent Owner contends that “[o]ne of ordinary skill in the art would have understood 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.” PO Resp. 13–14 (citing Ex. 2011 ¶ 86) (emphasis added). In support of this argument, Patent Owner cites to the den Boer¹¹ textbook, as well as the '521 patent. *Id.* at 14–15 (citing Ex. 1011, 97, Fig. 4.11; Ex. 1001, 1:56–2:12, 4:34–37, 6:1–6, 7:4–8, Fig. 2)). Similarly, Patent Owner argues that a person of ordinary skill in the art “would have understood that a video driver *would use amplifiers, among*

¹¹ Den Boer, *Active Matrix Liquid Crystal Displays* (Elsevier 2005) (Ex. 1011). Citations to den Boer are to the original page number.

other components, to generate a drive signal.” *Id.* at 15 (citing Ex. 2011 ¶ 88) (emphasis added). In support of this argument, Patent Owner again relies on the den Boer textbook, as well as the Cristaldi¹² book. *Id.* at 15–16 (citing Ex. 1011, 97–98; Ex. 2011 ¶ 88; Ex. 1006, 11, Fig. 6.16). Patent Owner also contends that each embodiment in the ’521 patent includes an amplifier. *Id.* at 16 (citing Ex. 1001, Figs. 2–4).

We agree with Petitioner that Patent Owner has introduced narrower requirements for the “video driver” than are recited in the claim. Reply 14–15 (citing Ex. 1015 ¶¶ 193–205; PO Resp. 13–15, 18; Ex. 1016, 133:10–134:4; Ex. 1001, 5:30–36, 6:38–44; Ex. 1011, 95–97). In the Sur-reply, Patent Owner states that it never proposed any construction for the “video driver” that “includes shifting, converting to analog, and amplifying” and was simply “providing background information on video drivers and video drive signals.” Sur-reply 3–4.¹³ However, these statements are difficult to reconcile with Patent Owner’s arguments that Kim does not perform the described functions to generate the video signal and does not have an amplifier, so therefore does not teach the claimed “video driver.” *See* PO Resp. 16–17 (citing Ex. 2011 ¶ 89; Ex. 1007, Fig. 10).

On this record, we are not persuaded that the claimed “video driver” “requires taking a usually digital video signal and shifting, converting to analog, and amplifying the voltage” or requires amplifiers. *See* PO Resp.

¹² Cristaldi et al., *Liquid Crystal Display Drivers Techniques and Circuits* (Springer Science+Business Media B.V. 2009) (Ex. 2006).

¹³ At the hearing, when asked, Patent Owner also stated that it was not making an inherency argument or a claim construction argument. Tr. 23:18–24:12.

13–16 (emphasis omitted). As Petitioner points out (Reply 15–16), den Boer does not refer to or define a “video driver.”¹⁴ Patent Owner states that a “video driver” is “also referred to as a source driver, column driver, and data driver” (PO Resp. 14), but, aside from a conclusory statement from Mr. Credelle (Ex. 2011 ¶ 86), does not provide additional support for this statement. *See* Reply 15–16 (citing Ex. 1015 ¶ 200). Moreover, in the Sur-reply, Patent Owner acknowledges that the citation to den Boer was “a specific example . . . where amplifiers are used to reduce impedance rather than introduce voltage gain.” Sur-reply 3. Similarly, in relying on Cristaldi, Patent Owner argues that “[o]utput buffers *typically* use amplifiers to drive current onto the data lines.” PO Resp. 16 (citing Ex. 2011 ¶ 88; Ex. 2006, 11, Fig. 6.16) (emphasis added). We decline to import requirements to the claimed “video driver” based upon examples from extrinsic documents.

Although Figure 4 of the ’521 patent includes amplifiers, while Figure 10 of Kim does not, we agree with Petitioner that the ’521 patent indicates that amplifiers are not required. *See* Reply 14–15. Moreover, Dr. Kattamis provides persuasive testimony that in the third embodiment of the ’521 patent (i.e., the Figure 4 embodiment) “‘amplifier 306’ simply uses VDD to power the op amp itself, and does not use VDD as an input to generate the video drive signal.” Ex. 1015 ¶ 205. At any rate, as argued by Petitioner (Reply 15), an amplifier is not recited in claim 1, and we decline to read into claim 1 unclaimed features of embodiments of the ’521 patent. *See SuperGuide Corp. v. DirecTV Enterprises, Inc.*, 358 F.3d 870, 875 (Fed. Cir.

¹⁴ As Patent Owner points out, Kim also does not explicitly refer to a “video driver.” *See* PO Resp. 20.

2004) (citing *Electro Med. Sys. S.A. v. Cooper Life Sci., Inc.*, 34 F.3d 1048, 1054 (Fed. Cir. 1994)) (“[A] particular embodiment appearing in the written description may not be read into a claim when the claim language is broader than the embodiment.”); *see also Thorner v. Sony Computer Ent. Am. LLC*, 669 F.3d 1362, 1366 (Fed. Cir. 2012) (“It is likewise not enough that the only embodiments, or all of the embodiments, contain a particular limitation. We do not read limitations from the specification into claims; we do not redefine words.”).

Patent Owner also argues that Kim does not teach the claimed video driver because a “video driver” is distinct from a pixel circuit. PO Resp. 19–27. Therefore, Patent Owner argues, because the alleged video driver in Kim is part of the pixel circuit, it cannot disclose the claimed video driver. *Id.* at 19. Essentially, Patent Owner’s position is that “in AMOLED systems, video drivers and pixel circuits are always and indisputably distinct components.” Sur-reply 6 (citing Ex. 2011 ¶ 92). In support of this argument, Patent Owner cites to testimony from Mr. Credelle, and provides citations to other literature, such as the Tsujimura¹⁵ book, purporting to establish that video drivers and pixel circuits must be distinct. PO Resp. 19–27; Sur-reply 6–8.

We do not find this argument persuasive based upon the record before us. Independent claim 1 recites an AMOLED display system comprising, *inter alia*, a display panel comprising a plurality of OLED pixel elements, a video driver, and a current driver. Ex. 1001, 8:46–64. As set forth above,

¹⁵ Tsujimura, *OLED Display Fundamentals and Applications* (Jon Wiley & Sons, Inc. 2012) (Ex. 2007).

Petitioner identifies Kim’s organic EL display panel 100, which includes a plurality of pixel circuits 10, as the recited “display panel.” *See* Pet. 20 (citing Ex. 1007, Fig. 3); Reply 12–13. Kim’s Figure 10 “shows a pixel circuit according to a fourth exemplary embodiment,” and Petitioner identifies circuitry in this pixel circuit as the recited “video driver.” Pet. 26–28; Ex. 1007 ¶ 104; Reply 12–13.

According to Patent Owner, the ’521 patent “states that the invention is for a *video driver* that functions to isolate the pixel circuit from power supply variations.” PO Resp. 22 (citing Ex. 1001, 1:5–10); Sur-reply 6. Therefore, Patent Owner argues, “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.” PO Resp. 22 (citing Ex. 2011 ¶ 94). Patent Owner argues that “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.* (citing Ex. 2011 ¶ 94; Ex. 1001, 1:6–9) (alteration in original).

We do not find this argument persuasive. As an initial matter, the claim language does not recite any requirement that the claimed “video driver” is “isolated,” “separate,” or “distinct” from any other claimed component. *See* Reply 11–12. Nor does the Specification support such a requirement. The only cited portion of the Specification that Patent Owner relies on states that “[t]he invention relates to . . . a video driver for AMOLED displays that is capable of isolating the pixel circuit from power supply voltage variations.” Ex. 1001, 1:5–10. We do not read this description to require that the video driver must be physically separate and

distinct from the pixel circuit, or in any way limit or describe how the video driver and pixel circuit may be implemented. *See also* Reply 13.

Rather, the '521 patent broadly describes how the video driver circuit may be implemented:

The video driver circuit of the present invention described above with reference to FIGS. 2–4 can be implemented using discrete components. Alternately, the video driver circuit of the present invention can be implemented as an integrated circuit to be incorporated in the AMOLED display system. Furthermore, ***the video driver circuit of the present invention can be integrated with other circuitry of the AMOLED display panel into a single integrate[d] circuit. For instance, the video driver of the present invention can be integrated on the same integrated circuit with the current driver and the OLED pixel elements of the AMOLED display panel. In FIGS. 2–4, the video drivers are shown as being formed outside of the AMOLED display panel 30. The embodiments in FIGS. 2–4 are illustrative only and are not intended to require the video driver to be formed outside of the AMOLED display panel. The video driver of the present invention can be integrated with the AMOLED display panel when desired to reduce the component count and size of the PC board space used.***

Ex. 1001, 7:52–8:2 (emphasis added); *see* Reply 12–13. As shown above, the '521 patent discloses that the *video driver circuit may be integrated with other circuitry of the AMOLED display panel*, and the claim language includes a “plurality of . . . pixel elements” as part of the display panel. The '521 patent further discloses that the video driver circuit can be integrated on the same integrated circuit with the OLED pixel elements of the AMOLED display panel, and that the video drivers may be integrated with the AMOLED display panel. *Id.* We, therefore, disagree with Patent Owner

that that the '521 patent does not describe that the video driver can be part of (i.e., integrated with) the pixel circuit. *See* Sur-reply 7. That Patent Owner has identified examples from den Boer and the Onoyama¹⁶ paper where the alleged video driver, scan driver, and pixel circuits are distinct components integrated with the display panel or incorporated on an integrated circuit (*see* PO Resp. 25–26) is not persuasive, in light of this disclosure in the '521 patent. Patent Owner also argues that the “video driver” must be “upstream” or “downstream” from the pixel circuit (e.g., *id.* at 22; Sur-reply 6), but this is likewise not supported by the claim language or the Specification of the '521 patent for the same reasons.

The claim language is much more straightforward than would be surmised from the parties' arguments: “a video driver receiving the video signal and generating a video drive signal indicative of the video signal.” Ex. 1001, 8:53–54. We determine that Petitioner has shown, by a preponderance of the evidence, and as shown in Petitioner's annotated Figure 10 of Kim, that Kim teaches a video driver (i.e., the dark green annotation of Figure 10) receiving the video signal (Dm) and generating a video drive signal indicative of the video signal (A4).

(2) *Whether Kim teaches a “video drive signal referenced to the positive power supply voltage”*

Patent Owner argues that Kim's alleged video drive signal (i.e., A4 in Figure 10) is not referenced to the positive power supply voltage. PO Resp. 27. Specifically, Patent Owner argues that “due to variations in VDD over

¹⁶ Onoyama et al., *0.5-inch XGA Micro-OLED Display on a Silicon Backplane with High-Definition Technologies* (SID 2012 Digest) (Ex. 2010).

time, the value of VDD used to calculate VA4 is not the same value of VDD that is applied to the drive transistor,” so “VA4 is not referenced to the positive power supply voltage.” *Id.* at 28 (citing Ex. 1001, 1:32–55; Ex. 2011 ¶ 103). Patent Owner rewrites Kim’s Equations 11 and 12 to reflect this alleged variation in time:

$$VA4 = VDD(t1) + \Delta VB4 = VDD(t1) + V_{DATA} - V_{sus}$$

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

Id. at 29 (citing Ex. 2011 ¶ 107). According to Patent Owner, “[t]he 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.* at 30 (citing Ex. 2011 ¶ 108). Thus, argues Patent Owner, “VA4 is referenced to the value of VDD at earlier time t1, VDD(t1).” *Id.*

The crux of Patent Owner’s argument is that VDD (the positive power supply voltage) is not constant with time, so therefore cannot be used as a baseline to measure the voltage. We do not find these arguments persuasive for the reasons stated by Petitioner in the Reply. *See* Reply 2–11.¹⁷

Specifically, we find persuasive Petitioner’s arguments that this purported deficiency would be true of any active-matrix display, including the embodiments in the ’521 patent. *Id.* The record does not reflect why the variations in VDD over time would not similarly affect the embodiments in the ’521 patent. *See* Sur-reply 10. For example, the ’521 patent describes

¹⁷ Patent Owner makes a similar argument for limitation [1-C] for the “independent of” claim limitation, and Petitioner addresses these “temporal” arguments together in the Reply.

that Equation 7, $v(t) = V_{DD} - Video.DAC$, indicates that the video drive signal $v(t)$ is referenced to the power supply voltage V_{DD} . Ex. 1001, 6:8–19. We do not see, based on the record before us, any reason why this equation would not be similarly affected by such variations in V_{DD} over time, and would not need to be similarly rewritten as Patent Owner asserts for Kim’s Equation 11. Kim’s Equation 11 shows positive power supply signal V_{DD} as a baseline to measure the voltage V_{A4} , as Patent Owner asserts is required for this claim limitation.

Accordingly, we determine that Petitioner has shown, by a preponderance of the evidence, that Kim teaches a video drive signal that is referenced to the positive power supply voltage.

Therefore, after considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Kim teaches limitation [1-A].

- c) *[1-B] 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,*

Petitioner contends that Kim “has a current driver (e.g. **M31**) receiving the video drive signal generated at node **A4**, and the driver is coupled to a pixel element (OLED) and power supply (V_{DD}).” Pet. 32. Petitioner contends that a person of ordinary skill in the art “would recognize that *Kim* discloses **a current driver** (circuitry in blue Current Driver annotation including transistor **M31/M1**) ***coupled to at least one OLED pixel element*** (organic light emitting diode **OLED**), ***the current driver receiving the video drive signal*** (voltage of the first electrode V_{A4} or

node A) *and the positive power supply voltage (V_{DD}).*” *Id.* at 33–34 (citing Ex. 1002 ¶¶ 118–125). Petitioner identifies Kim’s transistor current I_{OLED} as the recited “drive current.” *Id.* at 34.

Patent Owner does not respond to these arguments. *See generally* PO Resp. After considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Kim teaches limitation [1-B].

d) *[1-C] the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage*

Petitioner relies on Kim’s Equations 12 and 13 in support of this limitation. Pet. 35–36. Petitioner asserts that Kim explains that “the voltage charged in the capacitor **C2** is given as Equation 12, and the corresponding current flows to the **OLED**.” *Id.* at 35 (citing Ex. 1007 ¶¶ 111–112).

Equation 12 follows:

$$V_{C2} = V_{DD} - (V_{DD} + V_{DATA} - V_{SUS}) = V_{DATA} - V_{SUS}$$

Ex. 1007 ¶ 112. “The current flowing to the OLED is given as Equation 13”:

$$\begin{aligned} I_{OLED} &= \beta/2(V_{GS31} - V_{TH31}) \\ &= \beta/2((V_{DATA} - V_{SUS}) - V_{TH31}) \end{aligned}$$

Id. ¶ 113.

Petitioner contends that “[a]s illustrated in *Kim*’s Figure 10 (annotated), the voltage across the gate and source (V_{GS}) of transistor **M31** that drives organic light emitting diode **OLED** is also the same voltage across capacitor **C2** (i.e., $V_{C2} = V_{GS31}$). Thus, the voltage across capacitor **C2** ($V_{C2} = V_{GS31}$) corresponds to the claimed *current drive voltage*.” Pet. 36

(citing Ex. 1002 ¶¶ 131–138). Therefore, asserts Petitioner, a person of ordinary skill in the art would “recognize that *Kim*’s voltage across the gate and source (V_{GS}) of the transistor **M31** corresponds to the claimed ***current drive voltage***, and that *Kim*’s current I_{OLED} corresponds to the claimed ***drive current***.” *Id.* (citing Ex. 1002 ¶¶ 131–138). Petitioner again compares *Kim*’s **M31** transistor with the M1 transistor in the ’521 patent, and asserts that both are P-channel MOSFETS, so a person of ordinary skill in the art would understand that *Kim*’s current I_{OLED} is “proportional” to the gate and source (V_{GS}) in the same manner it is “proportional” in the ’521 patent. *Id.* at 36–37 (citing Ex. 1002 ¶¶ 131–138). Petitioner further contends that *Kim* “discloses ***the video drive signal*** (voltage of the first electrode V_{A4}) being ***indicative of the video signal*** (voltage V_{DATA}),” so a person of ordinary skill in the art would understand that since V_{GS31} is calculated based on voltage V_{A4} , it must also be “indicative” of voltage V_{DATA} . *Id.* at 37 (citing Ex. 1002 ¶¶ 139–140).

Petitioner contends that *Kim*’s drive current I_{OLED} is independent of the positive power supply voltage (V_{DD}) because *Kim* states “[a]s can be seen from Equation 13, the current flowing to the OLED is substantially **not influenced** by the power supply voltage V_{DD} ,” and a person of ordinary skill in the art would understand that because *Kim*’s drive current is “not influenced” by the positive power supply voltage V_{DD} , it is therefore “independent of” the positive power supply voltage V_{DD} . Pet. 38–39 (citing Ex. 1007 ¶ 114, Fig. 10; Ex. 1002 ¶¶ 141–147).

Patent Owner argues that “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.” PO Resp. 32 (citing Ex. 1001, 5:6–15, 6:20–29, 7:36–43; Ex. 2011 ¶ 112).¹⁸ According to Patent Owner, “[d]ue 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.” *Id.* (citing Ex. 2011 ¶ 112). Patent Owner asserts that Kim’s “Equation 13 ignores the variations in VDD over time.” *Id.* at 34 (citing Ex. 2011 ¶ 117). Patent Owner argues that “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. Patent Owner rewrites Kim’s Equation 13 as follows:

$$IOLED = \beta/2 * (V_{GS31} - V_{TH31})^2$$

$$IOLED = \beta/2 * (VDD(t) + V_{DATA} - V_{sus} - VDD(t1) - V_{TH1})^2$$

$$= \beta/2 * (V_{DC} + V_{drift}(t) + V_{noise}(t) + V_{DATA} - V_{sus} - V_{DC} - V_{drift}(t1) - V_{noise}(t1) - V_{TH1})^2$$

$$= \beta/2 * (V_{drift}(t) + V_{noise}(t) + V_{DATA} - V_{sus} - V_{drift}(t1) - V_{noise}(t1) - V_{TH1})^2$$

Id. at 34 (citing Ex. 2011 ¶ 118). Patent Owner argues that “t1 is the time before new data is written and t is the time after data is written and when

¹⁸ We note that this appears consistent with Petitioner’s interpretation. *E.g.*, Pet. 38 (“none of the parameters in [Equation 13] are dependent on V_{DD}”), 92 (“Since the first V_{SUPPLY} will be eliminated in equation (4A) via subtraction of the second V_{SUPPLY}, the gate-to-source voltage V_{GS} on drive transistor 22 (i.e., the claimed **current drive voltage**) is **independent of the positive power supply voltage** as shown in equation (4B).”).

current is flowing to the OLED (the majority of time).” *Id.* at 35 (citing Ex. 2011 ¶ 119). Patent Owner argues that “the differences in undesirable voltage variations between $VDD(t_1)$ and $VDD(t)$ do not” cancel out, and the Petition “ignores these voltage fluctuations that are present during the period in which current flows to the pixel.” *Id.* Therefore, Patent Owner argues, “the drive current in Kim’s Figure 10 is not independent of the power supply voltage.” *Id.*

Similar to Patent Owner’s argument for limitation [1-A], the crux of Patent Owner’s argument is that because VDD is not constant with time, the drive current is not independent of the power supply voltage. We do not find these arguments persuasive for the reasons stated by Petitioner in the Reply. *See* Reply 2–11. Specifically, we find persuasive Petitioner’s arguments that this purported deficiency would be true of any active-matrix display, including the embodiments in the ’521 patent. *Id.* The record does not reflect why the alleged variations in VDD over time would not similarly affect the embodiments in the ’521 patent. *See* Sur-reply 10. For example, the ’521 patent describes that Equation 6, $Video.OLED = VDD - v(t)$, indicates that “the current drive voltage signal $Video.OLED$ is made to be independent of the power supply voltage VDD ” because VDD ultimately drops out of the equation, resulting in $Video.OLED = Video.DAC$. Ex. 1001, 5:10–20. We do not see, based on the record before us, any reason why this equation would not be similarly affected by such variations in VDD over time, and would not need to be similarly rewritten as Patent Owner asserts for Kim’s Equation 13. Moreover, Kim explicitly states that Equation 13 shows that “the current flowing to the OLED is substantially not influenced

by the power supply voltage V_{DD} .” Ex. 1007 ¶ 114. We agree with Petitioner that a person of ordinary skill in the art would understand that because Kim’s drive current is “not influenced” by the positive power supply voltage V_{DD} , it is therefore “independent of” the positive power supply voltage V_{DD} . Pet. 38–39 (citing Ex. 1007 ¶ 114, Fig. 10; Ex. 1002 ¶¶ 141–147).

e) Conclusion for Independent Claim 1

Based on our review and consideration of the current record, we determine that Petitioner has shown, by a preponderance of the evidence, that Kim anticipates and renders obvious claim 1 of the ’521 patent.

3. Dependent Claims 2 and 7

Petitioner contends that dependent claims 2 and 7, which depend from claim 1, are anticipated by or would have been obvious over Kim. Pet. 40–45. In support, Petitioner identifies certain passages and figures in the Kim and explains their significance with respect to the corresponding claim limitations. *Id.*

Patent Owner does not respond to these arguments. *See generally* PO Resp. After considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Kim anticipates and renders obvious dependent claims 2 and 7.

4. Summary of Grounds 1 and 2

We find that Petitioner has shown, by a preponderance of the evidence, that claims 1, 2, and 7 are unpatentable under 35 U.S.C. § 102 and § 103(a) over Kim.

E. Ground 3: Alleged Anticipation by Hayafuji

Petitioner contends that claims 1 and 2 are anticipated by Hayafuji. Pet. 45–64. Patent Owner disputes Petitioner’s contentions. PO Resp. 36–49. In particular, Patent Owner disputes that Hayafuji discloses limitation [1-A].¹⁹ *Id.* at 38–44. After reviewing the record developed at trial, we are persuaded by Patent Owner’s arguments and determine that Petitioner has not met its burden to prove by a preponderance of the evidence that claims 1 and 2 are anticipated by Hayafuji.

1. Hayafuji (Ex. 1006)

Hayafuji is titled “Drive Device and Drive Method of Light Emitting Display Panel,” and is generally directed to “a drive device and a drive method of a display panel in which display quality of an image which is caused by a ripple component superimposed onto the drive power source of the light emitting elements can be prevented from deteriorating.” Ex. 1006, code (54), ¶ 2.

Figure 6, reproduced below, shows a first embodiment of a drive device.

¹⁹ Patent Owner also argues that Hayafuji does not disclose limitation [1-C]. PO Resp. 44–48. Because we agree with Patent Owner that Petitioner has not shown that Hayafuji discloses limitation [1-A], we do not address Patent Owner’s arguments for limitation [1-C].

FIG. 6

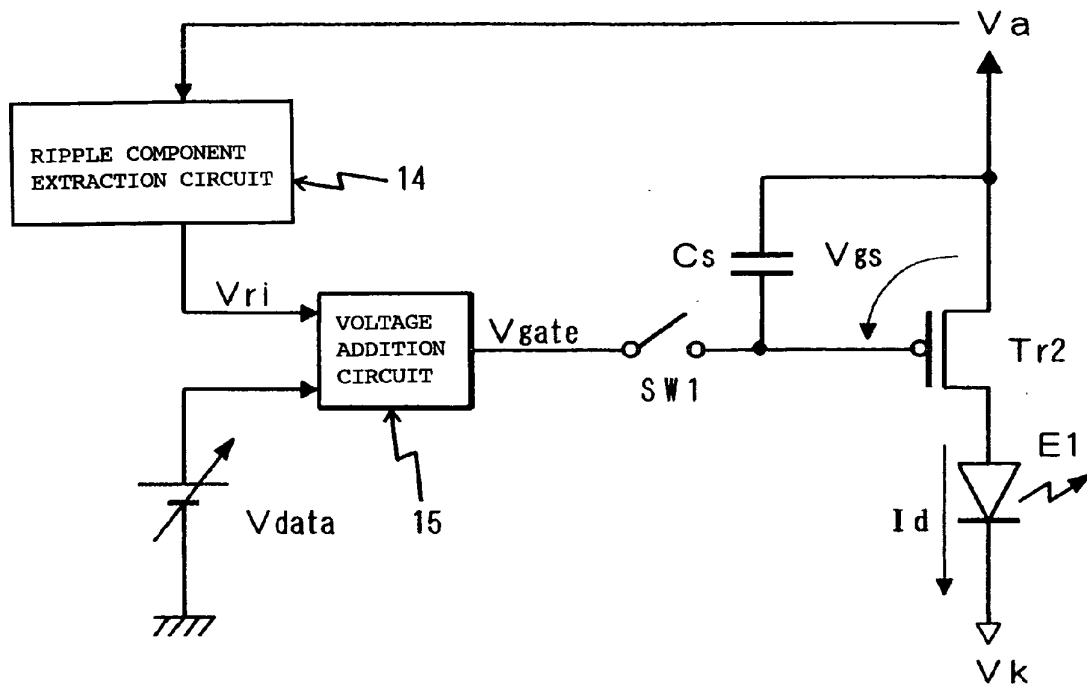
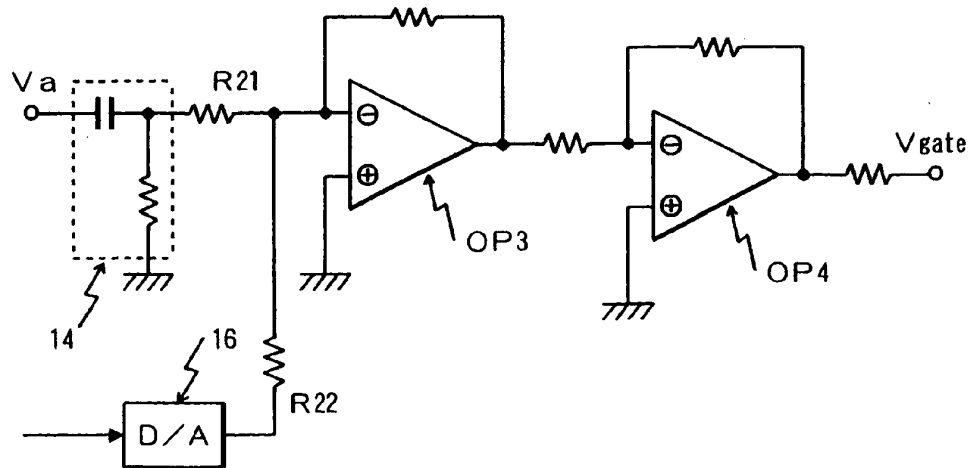


Figure 6, above, depicts ripple component extraction circuit 14 and voltage addition circuit 15. Ex. 1006 ¶¶ 47–48. “The ripple component extraction circuit 14 extracts a ripple component included in a drive voltage V_a generated by the . . . DC-DC converter, and a ripple component V_{ri} extracted by this ripple component extraction circuit 14 is supplied to one input terminal of the voltage addition circuit 15.” *Id.* ¶ 48. “The data voltage V_{data} transmitted via . . . data line B1 is input to the other input terminal of the voltage addition circuit 15.” *Id.* “[I]n the voltage addition circuit 15, treating the data voltage V_{data} as a base, the ripple component V_{ri} extracted by the ripple component extraction circuit 14 is added to the base.” *Id.* ¶ 49. “The output thereof as V_{gate} is supplied to a scan selection transistor $Tr1$ represented by reference character SW1, and the V_{gate} is

supplied to the gate of a light emission drive transistor Tr2 by the turning on of the transistor Tr1 during the addressing time and is written in a capacitor Cs.” *Id.*

Figure 7, reproduced below, is a connection diagram showing a specific example of the circuits employed in the structure shown in Figure 6.

FIG. 7

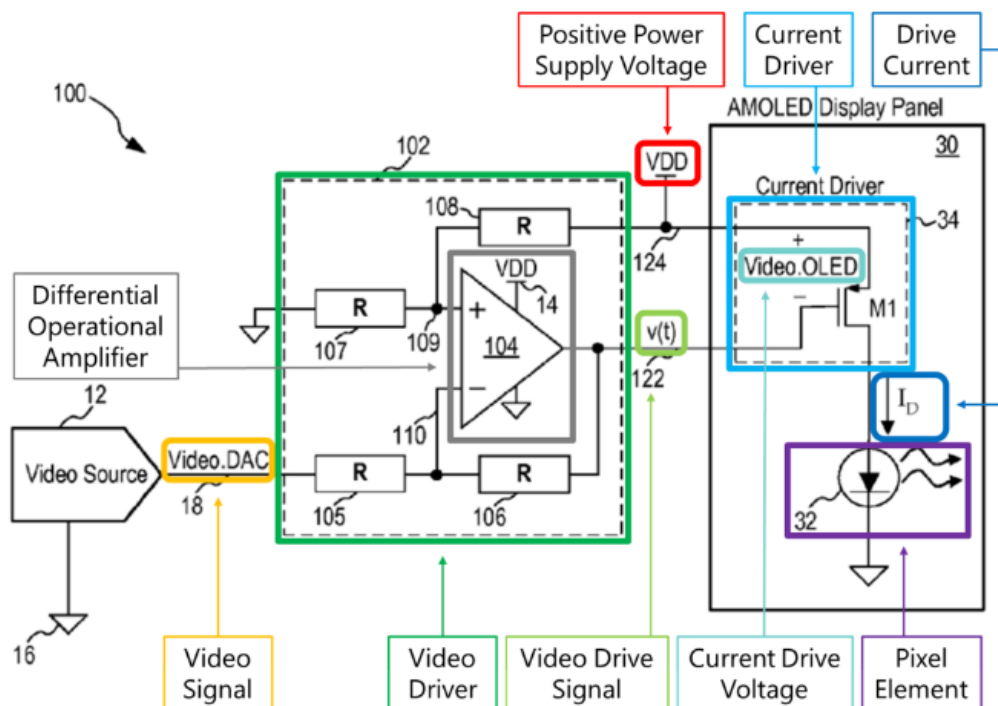


In Figure 7 above, “a capacitor and a resistor enclosed by the dashed line constitute a bypass filter, and by this filter, the ripple component extraction circuit 14 extracting the ripple component included in the drive voltage V_a is formed.” *Id.* ¶ 50. “The output thereof is supplied to a negative feedback type voltage buffer circuit constituted by an operational amplifier OP3 via a resistor R21.” *Id.*

2. *Analysis of Independent Claim 1, Limitation [1-A]*

Limitation [1-A] recites “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.” Ex. 1001, 8:53–56.

Petitioner compares Hayafuji’s disclosure to the ’521 patent’s first embodiment, depicted in Figure 2 of the ’521 patent. Pet. 45. Petitioner provides an annotated version of Figure 2 of the ’521 patent, reproduced below:

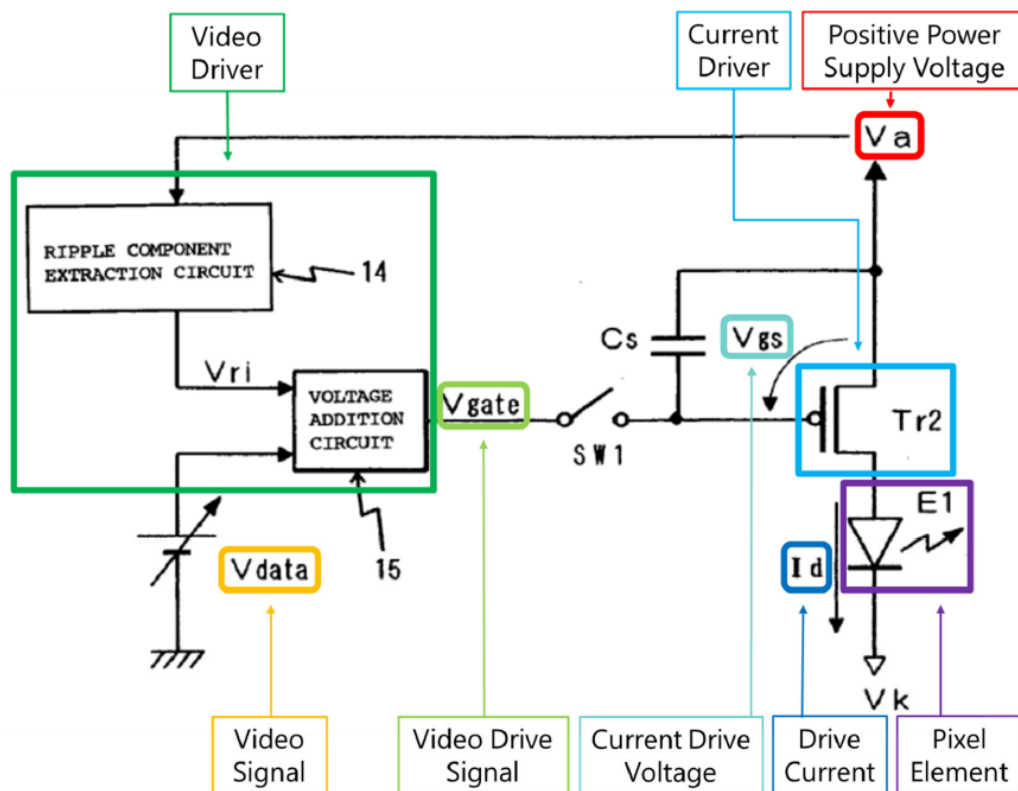


Ex.[1001], Fig. 2 (annotated).

Id. Petitioner’s annotated Figure 2 identifies video driver 102, which includes resistors 105–108 and amplifier 104, as “video driver” in dark green. Petitioner also identifies Video.DAC as the “video signal” in yellow;

$v(t)$ as the “video drive signal” in light green; VDD as the “positive power supply voltage” in red; Video.OLED as the “current drive voltage” in light blue; current driver 34, including transistor M1, as the “current driver” in medium blue; I_D as the “drive current” in dark blue; and OLED 32 as the “pixel element” in purple.

Petitioner provides an annotated version of Hayafuji’s Figure 6, reproduced below, depicting in the same colors as in Petitioner’s annotations of Figure 2 from the ’521 patent where Petitioner contends Hayafuji discloses the recited claim elements:



Ex.[1006], Fig. 6 (annotated).

Petitioner’s annotated Figure 6 of Hayafuji, above, identifies circuitry including Hayafuji’s ripple component and extraction circuit 14 and voltage

addition circuit 15 as the “video driver” in dark green; identifies V_{gate} as “video drive signal” in light green; identifies V_{data} as “video signal” in yellow; identifies V_{gs} as “current drive voltage” in light blue; identifies circuitry including light emission drive transistor $Tr2$ as “current driver” in medium blue; identifies I_d as “drive current” in dark blue; identifies V_a as “positive power supply voltage” in red; and identifies $E1$ as “pixel element” in purple. *See* Pet. 50–51.

Petitioner contends that a person of ordinary skill in the art would understand that V_a represents the “positive power supply voltage” because V_a is depicted in Figure 1 of Hayafuji as the voltage output by the power supply and present on power line P1. Pet. 52 (citing Ex. 1006 ¶¶ 17, 18, 21, Fig. 1; Ex. 1002 ¶¶ 173–182).

Petitioner contends that Hayafuji generates a video drive signal (V_{gate}). Pet. 54. According to Petitioner, “because the output of [voltage addition] circuit 15 (V_{gate}) is the sum of (1) the relevant portion of the video signal [V_{data}] and (2) the ripple component of the supply voltage [V_{ri}], V_{gate} is both indicative of the video signal and referenced to the supply voltage.” *Id.* at 54–55 (citing Ex. 1002 ¶¶ 173–182).

Patent Owner argues that V_{gate} does not disclose the claimed video drive signal because it is not referenced to the positive power supply voltage V_a . PO Resp. 38–39 (citing Ex. 2011 ¶¶ 125–133). Patent Owner argues that 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.” *Id.* at 40 (citing Ex. 1001, 4:65–5:1, 6:8–13, 7:28–33). According to Patent Owner, “[i]n

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.* at 39 (citing Ex. 1006 ¶¶ 48–49, Fig. 6). Patent Owner contends that “[t]he 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.* Patent Owner argues that because only the ripple component V_{ri} , not power supply voltage V_a , is combined with the video signal V_{data} in the addition circuit, the alleged video drive signal V_{gate} is not referenced to the positive power supply voltage. *Id.* at 40 (citing Ex. 2011 ¶ 128; Ex. 1006 ¶ 49, Fig. 6).

Patent Owner argues that “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.” PO Resp. 41 (citing Ex. 2011 ¶ 129. According to Patent Owner, V_{DC} is the main component of the power supply voltage, and is not added to the video signal V_{data} , which is illustrated in Hayafuji’s Figure 8. *Id.* at 41–42 (citing Ex. 2011 ¶ 129; Ex. 2012, 93:15–94:6; Ex. 1006 ¶¶ 52–53, Fig. 8). Therefore, Patent Owner argues, “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.” *Id.* at 42 (citing Ex. 2011 ¶ 130). Patent Owner also argues that Hayafuji’s Figure 7 further demonstrates that V_{gate} is not referenced to V_a because the positive input terminal of each operational amplifier (i.e., OP3 and OP4) is connected directly to ground (referenced to ground) rather than to the positive power supply. *Id.* at 43–44 (citing Ex. 2011 ¶ 132).

In its Reply, Petitioner argues that Patent Owner does not explain why the “main component” (i.e., V_{DC}) needs to be “referenced to” the positive power supply signal. Reply 17. According to Petitioner, because V_{ri} “is a component of the [positive power supply voltage], referencing the video drive signal to it is sufficient to be ‘referenced to’ the [positive power supply voltage].” *Id.* (citing Ex. 1015 ¶ 260). Moreover, Petitioner argues, “the entire [positive power supply] voltage (including the ‘main component’) is an input to the video driver.” *Id.* at 17–18 (citing Ex. 1015 ¶ 259; Ex. 2011 ¶ 126; Ex. 1018, 159:20–25²⁰).

In its Sur-reply, Patent Owner argues that Petitioner is incorrect that incorporating any portion of the positive power supply voltage is sufficient to teach this limitation for three reasons: (1) it is directly contrary to the claim language; (2) it “grossly mischaracterizes” the ’521 patent’s third embodiment; and (3) Petitioner’s expert admits that “the video drive signal of the third embodiment incorporates the entire positive power supply voltage VDD at the time the capacitor of the clamping circuit is charged.” Sur-reply 10–12.

We are not persuaded that Petitioner has shown, by a preponderance of the evidence, that Hayafuji discloses this limitation, for the reasons argued by Patent Owner. *See* PO Resp. 38–44; Sur-reply 10–12.²¹

²⁰ Petitioner cites to Exhibit 1018, however, the citation appears to be from Exhibit 1016, which is Mr. Credelle’s deposition transcript.

²¹ We note that Petitioner does not directly respond to Patent Owner’s arguments regarding Hayafuji’s Figure 7 and Figure 8. *See* PO Resp. 41–44.

In our Institution Decision, we stated that “neither party explains what a ‘ripple component’ is, or how (or if) it differs from ‘noise’ or ‘drift.’”

Dec. 47. Patent Owner contends that the “ripple component of the power supply voltage introduced by a DC-DC converter” as described in Hayafuji is “distinct from the voltage drift and noise addressed by the ’521 patent.”

PO Resp. 47, 42–43; Ex. 2011 ¶ 140. Petitioner states that “ripple” is “equivalent to noise,” with supporting testimony from Dr. Kattamis. Reply 19; *see* Ex. 1015 ¶ 260. Dr. Kattamis states that “[r]ipple and noise are both voltage fluctuations” and “[t]he main difference between these two phenomena is their method of generation.” Ex. 1015 ¶ 260. That is, ripple “often appears in power supplies generated by switching power converters and is the result of imperfect filtering of the switching activity within those centers,” whereas noise “is a random phenomenon and can originate from many different sources.” *Id.* However, Dr. Kattamis states that “ripple and noise are both dynamic, time-varying voltage waveforms that can exist simultaneously as voltages superposed on an otherwise constant power supply level.” *Id.* Although Hayafuji refers to “ripple noise,” it is also not clear if this is the same as the “noise” referred to in the ’521 patent. Ex. 1006 ¶ 22. Dr. Kattamis’s testimony, cited above, indicates that there may be a difference between ripple noise and noise in general, although he states that “the techniques for the suppression of each are substantially similar, if not identical.” *See* Ex. 1015 ¶ 260.

There is no dispute that V_a (which Petitioner asserts teaches the positive power supply voltage) is composed of DC power V_{DC} + ripple

component V_{ri} . *See* Pet. 59; PO Resp. 40.²² There is also no dispute that V_{gate} (which Petitioner asserts teaches the video drive signal) is composed of $V_{data} + V_{ri}$. *See* Pet. 54–55; PO Resp. 40. Petitioner admits that V_{gate} is not referenced to V_{DC} , and is only referenced to V_{ri} , a component of V_a . *See* Reply 16–17. The issue, therefore, is only whether Hayafuji’s disclosure that a component of V_a (i.e., V_{ri}) being used to generate video drive signal V_{gate} is sufficient to teach that the positive power supply voltage V_a is referenced to video drive signal V_{gate} .

The plain language of claim 1 requires that the “video drive signal . . . [is] referenced to a positive power supply voltage of the AMOLED display panel.” Ex. 1001, 8:53–56. Because Petitioner asserts that V_a teaches the positive power supply voltage, it stands to reason that video drive signal V_{gate} must be referenced to V_a , or to $V_{DC} + V_{ri}$, which the parties agree is the equation representing V_a , as asserted by Petitioner.

As set forth above, Figure 6 of Hayafuji shows drive voltage V_a supplied to ripple component extraction circuit 14, extracting ripple component V_{ri} by the ripple component extraction circuit 14, and supplying it to one input terminal of voltage addition circuit 15. *See* Ex. 1006 ¶ 48. Then data voltage V_{data} is input to the other terminal of voltage addition circuit 15. *Id.* As further set forth, “in the voltage addition circuit 15, treating the data voltage V_{data} as a base, the ripple component V_{ri} extracted by the ripple component extraction circuit 14 is added to the base,” and

²² Patent Owner states that a “more accurate” formulation may be $V_a = V_{DC} + V_{ri} + V_{drift} + V_{noise}$. PO Resp. 47; Ex. 2011 ¶ 140; *see also* PO Resp. 41 (the “non-ripple component of V_a . . . includes noise and drift”).

“[t]he output thereof [is] Vgate.” *Id.* ¶ 49. We are not persuaded on this record that because Va is input to the ripple component extraction circuit 14, this means the video drive signal Vgate is referenced to Va (*see* Reply 17), considering that a component of Va (i.e., Vri) is extracted out prior to generation of video drive signal Vgate. Rather, we determine that the claim language requires the positive power supply voltage Va to be referenced to video drive signal Vgate, and because only a portion of it is, we are not persuaded by a preponderance of the evidence that Hayafuji discloses this claim limitation.

Accordingly, we find that Petitioner does not show, by a preponderance of the evidence, that claim 1 of the '521 patent is unpatentable as anticipated by Hayafuji.

3. Dependent Claim 2

Petitioner contends that dependent claim 2, which depends from claim 1, is anticipated by Hayafuji. Pet. 61–64. Petitioner identifies certain passages and figures in Hayafuji and explains their significance with respect to the corresponding claim limitations. *Id.* Patent Owner disputes Petitioner’s arguments for claim 2. PO Resp. 48–49.

For the same reasons as set forth above for claim 1, we find that Petitioner does not show, by a preponderance of the evidence, that claim 2, which depends from claim 1, is unpatentable as anticipated by Hayafuji.

4. Summary of Ground 3

We find that Petitioner has not shown, by a preponderance of the evidence, that claims 1 and 2 are unpatentable under 35 U.S.C. § 102 over Hayafuji.

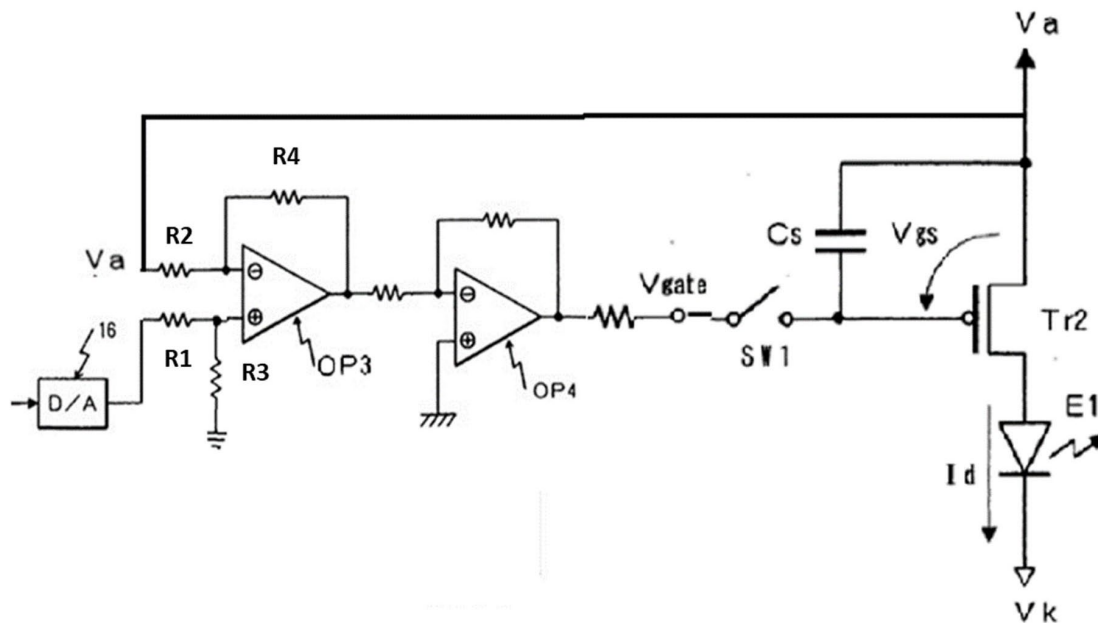
F. Ground 4: Alleged Obviousness by Hayafuji

Petitioner contends that claims 1–3 and 5 would have been obvious over Hayafuji. Pet. 64–79. Patent Owner disputes Petitioner’s contentions. Prelim. Resp. 49–57. In particular, Patent Owner disputes that Petitioner has shown sufficient reasons to modify Hayafuji as proposed. *Id.* After reviewing the record developed at trial, we are persuaded by Patent Owner’s arguments and determine that Petitioner has not met its burden to prove by a preponderance of the evidence that claims 1–3 and 5 would have been obvious over Hayafuji.

1. Analysis of Independent Claim 1

For independent claim 1, Petitioner essentially relies on its contentions for Ground 3, but asserts that it would have been obvious to modify Hayafuji “such that **video drive signal** (gate voltage V_{gate}) is configured such that **video drive signal** (gate voltage V_{gate}) is output as **the difference between the positive power supply voltage** (drive voltage V_a) **and the video signal** (data voltage V_{data}).” Pet. 68 (citing Ex. 1002 ¶¶ 213–234). In particular, Petitioner contends that a person of ordinary skill in the art would modify Hayafuji’s Figure 7 configuration “by connecting the **positive power supply voltage** (drive voltage V_a) to the inverting input of operational amplifier **OP3** rather than the non-inverting input.” *Id.* (citing Ex. 1002 ¶¶ 213–234).

Petitioner provides a combination of Hayafuji’s Figure 6 and 7 that illustrates the modification, which is reproduced below:



Pet. 69. In Petitioner’s combination of Hayafuji’s Figure 6 and Figure 7, positive power supply drive voltage V_a “(and accompanying voltage dividing resistors) are coupled to the negative terminal such that the output of the operational amplifier **OP3** would be the desired result of a control signal based on the data voltage V_{data} entering via **R1**, referenced against the drive voltage V_a .” *Id.* (citing Ex. 1002 ¶¶ 213–234).

According to Petitioner, this “would be an obvious design choice and would simplify material needs and cost because as modified, the capacitor of the high pass filter of the disclosed ripple component extraction circuit 14 would be unnecessary.” Pet. 68–69 (citing Ex. 1002 ¶¶ 213–234).

Petitioner contends that this is a “simpler design” that “eliminates the need for and the cost to include the additional ripple component extraction circuit 14 module.” *Id.* at 69–70 (citing Ex. 1002 ¶¶ 213–234). Petitioner also argues that the modification would have been obvious to a person of ordinary skill in the art because (1) 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 is compared; 2) it is merely a trivial design change that would also accomplish the purpose of Hayafuji; and 3) it would provide improved immunity to power source noises. *Id.* at 70 (citing Ex. 1002 ¶¶ 213–226; Ex. 1006 ¶ 28). Petitioner contends that a person of ordinary skill in the art would have had a reasonable expectation of success when making the modification “because implementing a differential amplifier circuit in this manner is a well-known and fundamental op amp configuration.” *Id.* (citing Ex. 1002 ¶¶ 213–234; Ex. 1010, 181).

Patent Owner argues that Petitioner’s modification “remov[es] the ripple component extraction circuit and chang[es] the configuration of the voltage addition circuit so that it would output the difference between, rather than the sum of, the inputs.” PO Resp. 49. Patent Owner argues that a person of ordinary skill in the art would not have been motivated to modify the circuits in Hayafuji’s Figures 6 and 7 in the manner proposed by Petitioner for three reasons. *Id.* at 49–57.

First, Patent Owner argues that the ripple component extraction circuit is central to the teachings of Hayafuji, so it would not have been obvious to a person of ordinary skill in the art to remove it, “as that would be contrary to the operating principles of Hayafuji and would have rendered it inoperable for its intended purpose.” PO Resp. 53 (citing Ex. 1006 ¶¶ 28, 48, Figs. 6, 7; Ex. 2011 ¶ 151).

Second, Patent Owner argues that modifying amplifier OP3 in the manner proposed by Petitioner transforms what was a summing amplifier

circuit into a differential amplifier. PO Resp. 54. Patent Owner further argues, “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.” *Id.* (citing Ex. 2011 ¶ 152; Ex. 1006 ¶¶ 28–30). Therefore, Patent Owner argues that the modification would be “contrary to the operating principles of Hayafuji and would have rendered it inoperable for its intended purpose.” *Id.* (citing Ex. 2011 ¶ 152).

Third, Patent Owner argues that the modifications are the result of impermissible hindsight bias because the teachings of Hayafuji relate to a different problem than the ’521 patent and propose a different solution. PO Resp. 55 (citing Ex. 2011 ¶ 153).

We agree with Patent Owner that Petitioner has not established, by a preponderance of the evidence, that one of ordinary skill in the art, absent hindsight, would have been motivated to modify Hayafuji in the manner proposed. *See In re Fritch*, 972 F.2d 1260, 1266 (Fed. Cir. 1992) (citing *In re Gorman*, 933 F.2d 982, 987 (Fed. Cir. 1991)) (“It is impermissible to use the claimed invention as an instruction manual or ‘template’ to piece together the teachings of the prior art so that the claimed invention is rendered obvious.”).

Petitioner’s proposed modification involves removing Hayafuji’s ripple extraction circuit and changing the configuration of the voltage addition circuit. Pet. 68–70; Reply 20–21. We agree with Patent Owner that Hayafuji’s purpose is to address ripple noise generated by a DC-DC converter. Ex. 1006 ¶ 28; Sur-reply 15. Petitioner’s proposed modification

purportedly allows for Hayafuji to *also* address and eliminate a non-ripple component by rewiring the circuit and removing the ripple extraction circuit. *See* Reply 20–21 (citing Pet. 70; Ex. 1015 ¶¶ 321–333); Pet. 68–72; Ex. 1015 ¶¶ 270–273, 321–333. As argued by Patent Owner, Hayafuji does not discuss the desirability of removing any other non-stable components of the power supply voltage. *See* Sur-reply 15–16.

Petitioner provides various reasons for the proposed modification, such as that it is a “simpler design,” would be “an obvious design choice,” “would simplify material needs and cost,” was “well-known,” was a “trivial design change,” would “provide immunity to power source noise,” and “would allow rejection of other power supply noise, such as drift.” Pet. 68–70. However, several of these reasons focus on what a person of ordinary skill in the art *would have been able to do*, rather than what a person of ordinary skill in the art *would have been motivated to do* at the time of the invention. *See Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1068–69 (Fed. Cir. 2018) (finding problematic that “the Board focused on what a skilled artisan would have been able to do, rather than what a skilled artisan would have been *motivated* to do at the time of the invention”); *InTouch Techs., Inc. v. VGO Commc’ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014). We find Petitioner’s arguments unpersuasive because they amount to little more than an assertion that the recited limitations could have been easily achieved.

We agree with Patent Owner that Petitioner’s proposed modification of Hayafuji is a redesign that appears to be the result of hindsight rather than based upon a persuasive reason for the modification. *See* Sur-reply 15–18.

Petitioner’s argument that the modification involves *adding* to the functionality of Hayafuji by using an obvious variation of the circuitry Hayafuji already discloses that eliminates both the ripple component and the non-ripple component (*see* Reply 20–21) supports the conclusion that the proposed modifications were improperly informed by the requirements of the claim. For example, Dr. Kattamis’s testimony describes the proposed modifications, which include removing the ripple component extraction circuit and rewiring the existing circuit. Ex. 1015 ¶¶ 270–273, 321–331. We find that the extent of the proposed modifications is more suggestive of hindsight than obviousness. *See Metalcraft of Mayville, Inc. v. The Toro Co.*, 848 F.3d 1358, 1367 (Fed. Cir. 2017) (“[W]e cannot allow hindsight bias to be the thread that stitches together prior art patches into something that is the claimed invention.”); *InTouch*, 751 F.3d at 1351 (Fed. Cir. 2014) (criticizing use of the challenged patent as a “roadmap” for putting what the expert referred to as “pieces of a ‘jigsaw puzzle’” together).

We also agree with Patent Owner that the proposed modifications change the basic principles upon which Hayafuji was designed to operate. *See* Sur-reply 16; *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*, 49 CCPA 976, 270 F.2d 810, 813 (1959) . . . may fail to support a conclusion of obviousness.” (first alteration in original)). In particular, we agree with Patent Owner that the “ripple component extraction circuit” is “central to the teachings of Hayafuji.” PO Resp. 53 (citing Ex. 2011 ¶ 151); *see, e.g.*, Ex. 1006 ¶¶ 2 (“The present invention relates to . . . a drive device

and a drive method of a display panel in which display quality of an image which is caused by a ripple component . . . can be prevented from deteriorating”), 28 (“[I]t is an object of the present invention to provide a drive device . . . in which deterioration of the display quality of an image caused by a ripple component . . . can be effectively reduced without increasing the circuit scale so much.”), 47 (Figure 6 “shows a first embodiment of a drive device according to the present invention and shows a structure which is allowed to have ripple component supply means that the present invention is characterized [by]”); *see id.* ¶¶ 27–30 (“SUMMARY OF THE INVENTION”). Petitioner’s proposed modifications, involving removing the ripple extraction circuit that is central to Hayafuji’s teachings, effectively change Hayafuji in a manner that Hayafuji itself does not even contemplate. *See* Sur-reply 15–16.

Moreover, even assuming a person of ordinary skill in the art understood that it would be desirable to remove other aspects of positive power supply variations aside from the ripple component (i.e., Petitioner’s reasoning that the modification would “provide immunity to power source noise,” and “would allow rejection of other power supply noise, such as drift”), this does not automatically lead to the conclusion that it would have been obvious to modify Hayafuji to accomplish this result in the manner claimed, particularly in light of Hayafuji’s purpose and teachings described above. That is, even if a person of ordinary skill in the art “could” modify Hayafuji by rewiring the circuit and removing the ripple component extraction circuit, that does not inform us that a person of ordinary skill in the art “would” make these changes to Hayafuji in light of Hayafuji’s

purpose and goals. *Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) (stating that “obviousness concerns whether a skilled artisan not only *could have made* but *would have been motivated to make* the combinations or modifications of prior art to arrive at the claimed invention”); *see also Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 993–94 (Fed. Cir. 2017) (“[T]hat reasoning seems to say no more than that a skilled artisan, once presented with the two references, would have understood that they could be combined. And that is not enough: it does not imply a motivation to pick out those two references and combine them to arrive at the claimed invention.” (emphasis omitted)).

Moreover, the issue is not whether Hayafuji “teaches away” from removing other aspects of positive power supply variations, or whether it would have been “trivial” or an “obvious design choice” to do so. *See* Reply 21; Pet. 68–70. The issue is whether a skilled artisan would have been motivated to do so based on teachings of the references; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by a person having ordinary skill in the art, all in order to determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. *KSR*, 550 U.S. at 418.

We, therefore, find that the evidence does not show that a person of ordinary skill in the art would have been motivated to modify Hayafuji in the manner proposed by Petitioner without the benefit and knowledge of the ’521 patent. *See In re NTP, Inc.*, 654 F.3d 1279, 1299 (Fed. Cir. 2011) (an obviousness analysis must “avoid hindsight reconstruction by using the

patent in suit as a guide through the maze of prior art references, combining the right references in the right way so as to achieve the result of the claims in suit”).

2. Dependent Claims 2, 3, and 5

Petitioner contends that dependent claims 2, 3, and 5, which depend from claim 1, would have been obvious over Hayafuji. Pet. 64–79. Petitioner relies on the same contentions for claim 2 as set forth above in Ground 3, and for claims 3 and 5, identifies certain passages and figures in Hayafuji and explains their significance with respect to the corresponding claim limitations. *Id.*

For the same reasons as set forth above for claim 1, we find that Petitioner does not show, by a preponderance of the evidence, that claims 2, 3, and 5, which depend from claim 1, are unpatentable as obvious over Hayafuji.

3. Summary of Ground 4

We find that Petitioner has not shown, by a preponderance of the evidence, that claims 1, 2, 3, and 5 are unpatentable under 35 U.S.C. § 103(a) over Hayafuji.

G. Ground 5: Alleged Obviousness Over Steer

Petitioner contends that claims 1–4 would have been obvious over Steer. Pet. 79–108. Patent Owner disputes Petitioner’s contentions. PO Resp. 57–72. After reviewing the record developed at trial, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 1–4 would have been obvious over Steer.

1. *Steer (Ex. 1008)*

Steer is titled “Electroluminescent Display Devices” and is generally directed to “an active matrix electroluminescent display device in which current feedback is used during pixel programming so that any effects of differences between characteristics of the drive transistor of different pixels are avoided.” Ex. 1008, code (54), 7:29–32. Figure 1, reproduced below, “shows a known pixel circuit for an active matrix addressed electroluminescent display device.” *Id.* at 2:3–4.

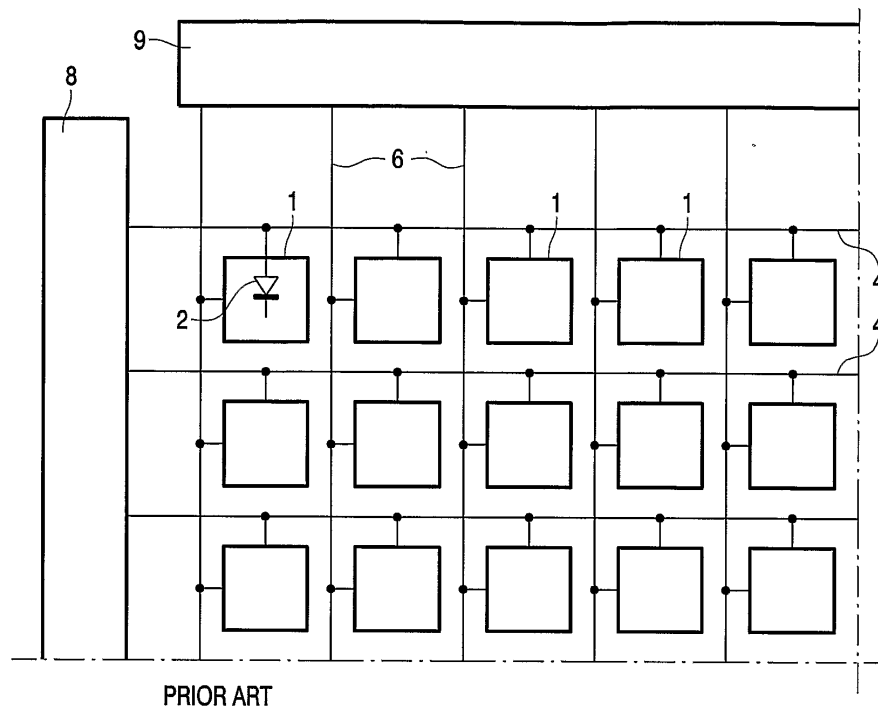


FIG.1

Figure 1, above, depicts “a panel having a row and column matrix array of regularly-spaced pixels, denoted by the blocks 1 and comprising electroluminescent display elements 2 together with associated switching means.” Ex. 1008, 2:4–9. “The pixels 1 are addressed via the sets of row

voltage V_{SUPPLY} on the other input of the amplifier 44.” *Id.* at 9:6–9. “This is the same supply voltage as for the power supply line 26.” *Id.* at 9:9–10. “The voltage at node 43 differs from this supply voltage by a value $R \times I$, where R is the resistance of the feedback resistor 46 and I is the current flowing.” *Id.* at 9:10–12. “Thus, the output voltage is a function of the current drawn from the current-measurement supply line.” *Id.* at 9:12–13.

“[C]omparator section 50 compares the voltage at node 43 with an input voltage at input 52 representing the desired current.” Ex. 1008, 9:14–15. “The amplified output of the comparator section 50 is provided to the column conductor through the gate 40.” *Id.* at 9:17–18. “The comparator section 50 thus also acts as the driver for providing the column conductor voltage.” *Id.* at 9:18–19.

2. *Analysis of Independent Claim 1*

Petitioner contends that Steer teaches each limitation of independent claim 1. Pet. 79–94. Petitioner’s contentions and Patent Owner’s arguments in opposition are set forth below.

- a) *[1-Pre]: 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:*

Petitioner contends that Steer discloses a substantially similar structure to the first embodiment of the ’521 patent, depicted in Figure 2. Pet. 79. Petitioner contends that Steer’s active matrix electroluminescent display device with organic thin film electroluminescent elements, for example, light emitting diodes, teaches the preamble. *Id.* at 80–81 (citing

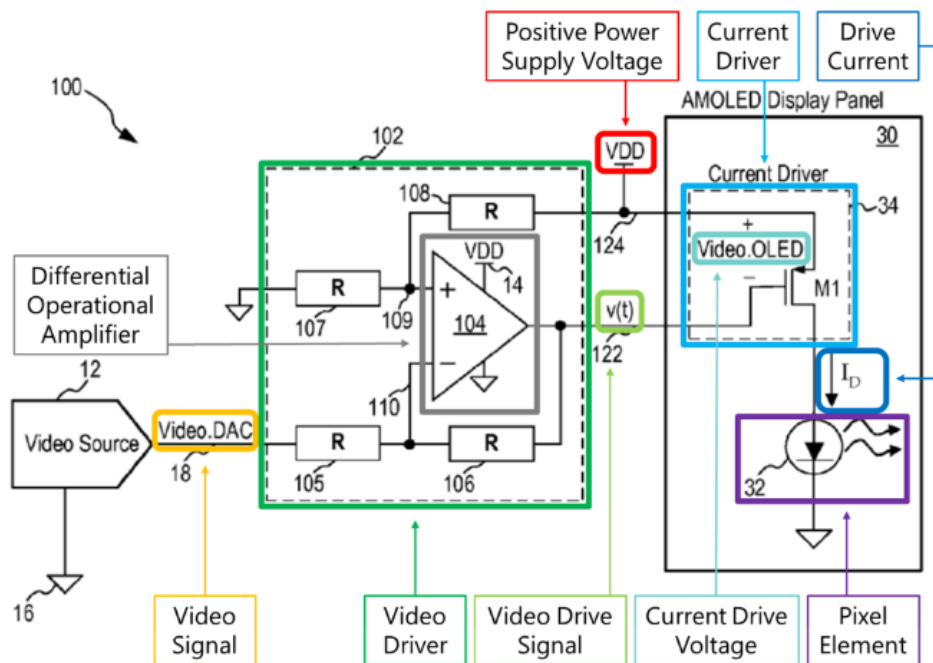
Ex. 1008, code (57), 1:11–12, 2:4–14, Fig. 1; Ex. 1002 ¶ 263). Petitioner further contends that Steer’s “input voltage at input 52 representing the desired current” corresponds to the recited video signal. *Id.* at 81–82 (citing Ex. 1008, 9:14–15).

Patent Owner does not respond to these arguments. *See generally* PO Resp. After considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Steer teaches the recited elements.²³

- b) [1-A] 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;*

As discussed above, Petitioner contends that Steer discloses a substantially similar structure as the ’521 patent’s first embodiment, depicted in Figure 2. Pet. 79. Petitioner provides an annotated version of Figure 2 of the ’521 patent, reproduced below:

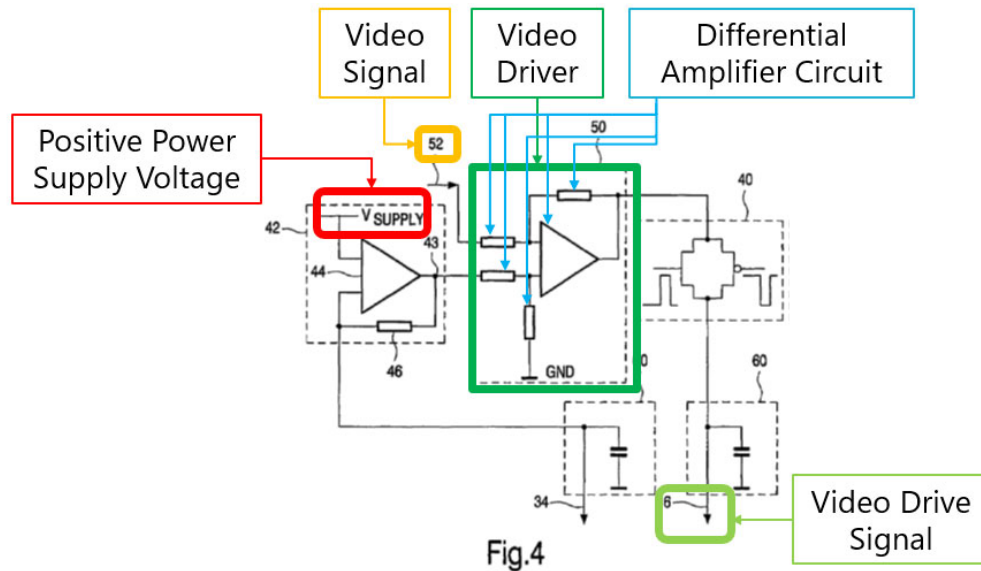
²³ Petitioner does not argue that the preamble limits claim 1. Although we find that the evidence supports that the prior art teaches the preamble, we make no determination whether the preamble of claim 1 is limiting.



Ex.[1001], Fig. 2 (annotated).

Id. at 80. Petitioner’s annotated Figure 2, above, identifies video driver 102, which includes resistors 105–108 and amplifier 104, as “video driver” in dark green. Petitioner also identifies Video.DAC as the “video signal” in yellow; $v(t)$ as the “video drive signal” in light green; VDD as the “positive power supply voltage” in red; Video.OLED as the “current drive voltage” in light blue; current driver 34, including transistor M1, as the “current driver” in medium blue; I_D as the “drive current” in dark blue; and OLED 32 as the “pixel element” in purple.

Petitioner also provides an annotated version of Steer’s Figure 4, reproduced below, depicting in the same colors where Petitioner contends Steer discloses the recited claim elements:



Pet. 83. Petitioner’s annotated Figure 4 identifies comparator section 50, which includes an amplifier and four resistors, as “video driver” in dark green; input video signal 52 as “video signal” in yellow; V_{SUPPLY} as “positive power supply voltage” in red; and the output of comparator 50 (node 6) as “video drive signal” in light green. *Id.* at 84–86.

Petitioner contends that Steer’s “video driver also receives an input from ‘high open loop gain amplifier 44’ which itself is connected to ‘ V_{SUPPLY} ’ which is ‘the same supply voltage as for the power supply line 26.’” Pet. 84 (citing Ex. 1008, 9:4–12). According to Petitioner, “amplifier 44 outputs at node 43 a value that differs from V_{SUPPLY} ‘by a value $R \times I$, where R is the resistance of the feedback resistor 46 and I is the current flowing.” *Id.* at 84–85 (citing Ex. 1008, 9:4–12). Thus, Petitioner asserts the voltage at node 43 is represented as:

$$V_{43} = V_{SUPPLY} + R \times I$$

Thus, Petitioner contends, a person of ordinary skill in the art would “recognize that voltage at node **43** is V_{SUPPLY} with an offset, and a comparison between voltage at node **43** (V_{43}) and input voltage at input **52** would result in an output signal indicative of voltage at input **52** (V_{52} or $input(t)$) (*i.e.*, the claimed **video signal**) and referenced to V_{SUPPLY} (*i.e.*, the claimed **positive power supply voltage of the AMOLED display panel**).” *Id.* at 85–86. Petitioner contends that the output of comparator **50** on node **6** (V_6 , the recited **video drive signal**) is represented by the following equation, which shows the output of the comparison between V_{43} and V_{52} :

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

Id. at 86 (citing Ex. 1008, 9:1–2; Ex. 1002 ¶ 281). Petitioner contends that this equation is “substantially identical” to the operation of the embodiments of the ’521 patent. *Id.* (citing Ex. 1001, 6:10–31 (Equation 5)).

Patent Owner argues that Steer does not disclose the claimed video signal because output V_6 is not referenced to the power supply voltage. PO Resp. 61–67. First, Patent Owner argues that V_6 “is not referenced to the positive power supply voltage because it depends on the current in the feedback circuit.” *Id.* at 62. Patent Owner provides annotated Figure 4 from Steer, reproduced below:

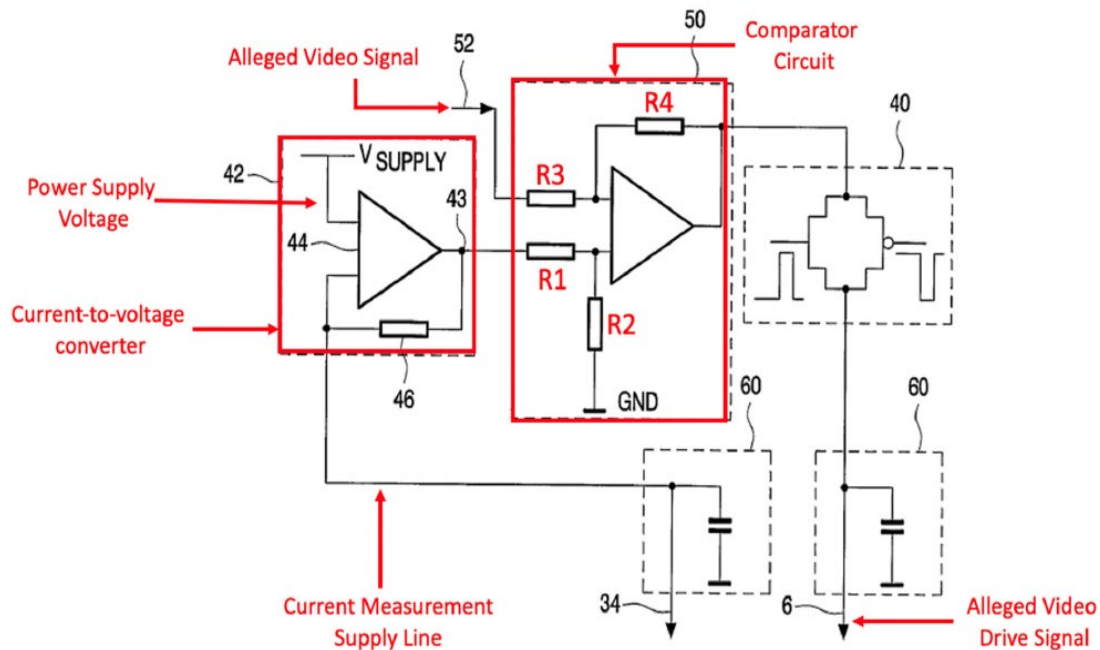


Fig.4

Id. at 63. Patent Owner’s annotated Figure 4, above, annotates Petitioner’s mapping of the claim elements, and adds notations R1, R2, R3, and R4 for the four resistors located in comparator section 50. *Id.*

Patent Owner argues that Figure 4 shows that “the alleged video driver [comparator circuit 50] does not compare the video signal [V₅₂] with the power supply voltage; instead, it compares the video signal with V₄₃, which is the sum of V_{SUPPLY} and R₄₆*I.” PO Resp. 63 (citing Ex. 1008, 9:14–19). Therefore, Patent Owner argues, the video drive signal calculation includes the value of the reference current in the feedback system: $V_6 = V_{\text{SUPPLY}} + R_{46} * I - \text{input}(t)$. *Id.* at 63–64 (citing Ex. 2011 ¶ 167). Patent Owner also argues that Steer expressly describes that comparator 50 compares the value V₅₂ with the measured feedback current, not with V_{SUPPLY}. *Id.* (citing Ex. 1008, 9:14–17). According to Patent Owner, it is irrelevant that at certain times the value of V₄₃ is momentarily

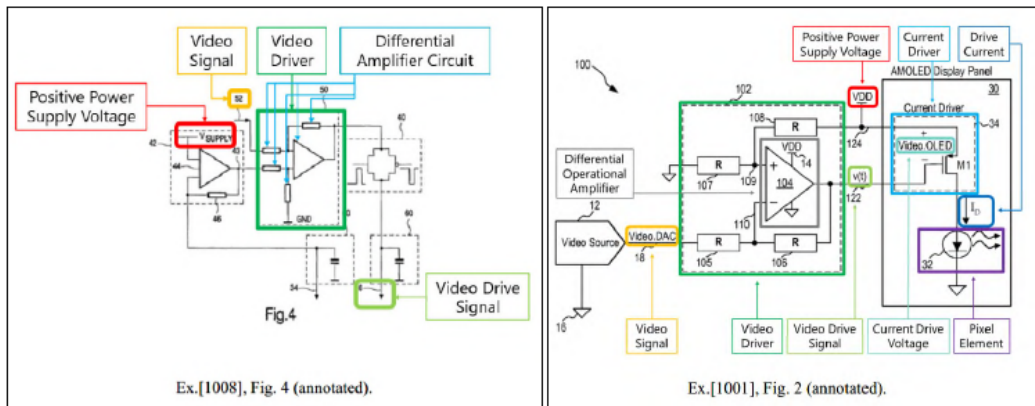
equal to V_{SUPPLY} because the current does flow to the feedback circuit. *Id.* at 64 (citing Pet. 100; Ex. 1002 ¶¶ 315–317; Ex. 2011 ¶ 168). Patent Owner argues “the inclusion of the reference current in the alleged video drive signal is significant because the value of current I is not constant,” and “[t]he use of current rather than the power supply voltage is central to the operation of Steer’s feedback system.” *Id.* at 65 (citing Ex. 2011 ¶¶ 169, 170).

Second, Patent Owner argues that the video drive signal (V_6) is not referenced to the positive power supply voltage because the alleged video driver (comparator circuit 50) amplifies the signal based on the values of the resistors (annotated as R1–R4) in the comparator circuit. PO Resp. 66. Patent Owner argues that “the value of V_6 also depends on the values of resistors R3 and R4 . . . which Petitioner ignored.” *Id.* (citing Ex. 2011 ¶ 173). Patent Owner, therefore, argues the equation for V_6 is as follows:

$$\begin{aligned} V_6 &= (V_{43} - V_{52}) * R4/R3 \\ &= [V_{\text{SUPPLY}} + R46 * I - V_{52}] * R4/R3 \end{aligned}$$

Id. According to Patent Owner, V_6 is not “referenced to the positive power supply voltage” because “the entire equation is multiplied by $R4/R3$. . . , resulting in a value for V_6 that is not an offset from V_{SUPPLY} .” *Id.* at 67 (citing Ex. 2011 ¶ 174).

We are persuaded that Petitioner has shown that Steer teaches limitation [1-A]. We find particularly persuasive Petitioner’s annotated comparison of Figure 2 of the ’521 patent to Steer’s Figure 4 (both also reproduced in larger scale above), which illustrates the similarities between the ’521 patent and Steer:



Reply 24. We agree with Petitioner that Steer’s Figure 4 discloses a substantially similar configuration as Figure 2 of the ’521 patent. *See id.* at 23–24 (citing Ex. 1001, Fig. 2; Ex. 1008, Fig. 4; Ex. 1015 ¶¶ 426–432); Pet. 79, 84–86.

There is no dispute that $V_6 = V_{\text{SUPPLY}} + R_{46} \cdot I - \text{input}(t)$. Pet. 86; PO Resp. 63–64. As is evident, V_{SUPPLY} (positive power supply voltage) is the first value in the equation calculating V_6 (video drive signal). We are not persuaded that because the reference current is included in this calculation, the video drive signal does not, nonetheless, reference the positive power supply voltage. The plain language of the claim does not require that the video drive signal be exclusively referenced to the positive power supply voltage. *See* Reply 25; Ex. 1015 ¶ 421. “In the patent claim context the term ‘comprising’ is well understood to mean ‘including but not limited to.’” *CIAS, Inc. v. Alliance Gaming Corp.*, 504 F.3d 1356, 1360 (Fed. Cir. 2007). We also find persuasive Petitioner’s arguments, which are supported by testimony from Dr. Kattamis, that, in certain circumstances, node 43 is exactly V_{SUPPLY} (i.e., the feedback current will be equal to zero),

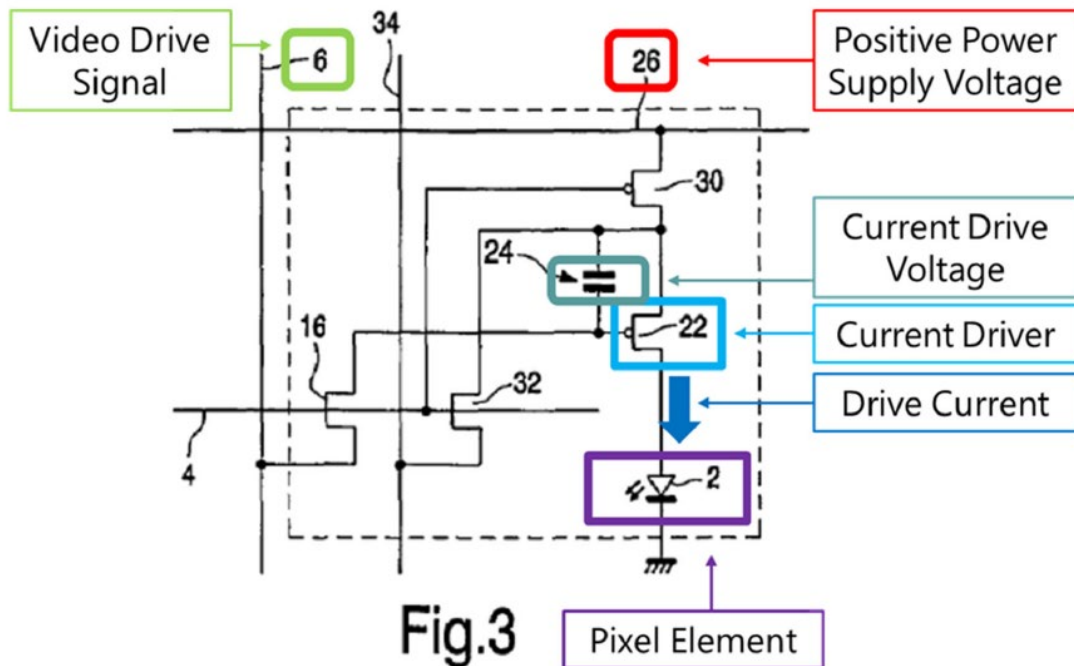
so V_{43} will be equal to the positive power supply voltage (V_{SUPPLY}) during those times. *See* Ex. 1015 ¶¶ 392–394, 416, 423–425.

We are also not persuaded by Patent Owner’s arguments regarding the effect of resistors R3 and R4 on comparator circuit 50. First, we again note the similarities between comparator circuit 50 in Steer (shown in Figure 4) and video driver 102 of the ’521 patent (shown in Figure 2). *See* Reply 23–24; Ex. 1015 ¶¶ 417, 426–430). For example, it is unclear from Patent Owner’s arguments why the resistors in video driver 102 would not have the same alleged effect as those in Steer. Moreover, the ’521 patent also discloses using matched resistors. *See* Ex. 1015 ¶ 432 (citing Ex. 1001, 5:31–37). Dr. Kattamis persuasively testifies that Steer is silent as to the value of the resistors in the differential circuit of comparator 50, and that it would have been obvious to a person of ordinary skill in the art to make the obvious design choice of using the same value of resistors, which would result in unity-gain. *See* Ex. 1015 ¶¶ 390, 431; *see also* Reply 24–25.

Therefore, after considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Steer teaches limitation [1-A].

- c) *[1-B] 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,*

Petitioner provides an annotated version of Steer’s Figure 3 in connection with limitation [1-B], reproduced below:



Ex.[1008], Fig. 3 (annotated).

Petitioner’s annotated Figure 3, depicted above, identifies in light green node 6 as the “video drive signal”; identifies in red V_{SUPPLY} as the “positive power supply voltage”; identifies in blue drive transistor 22 as the “current driver”; identifies in teal circuitry including storage capacitor 24 as “current drive voltage”; and identifies in purple EL display element 2 as the “pixel element.” Pet. 87.

Petitioner contends that drive transistor 22 (current driver) is coupled to EL display element 2 (OLED pixel element) and receives drive signal 6 at its gate via address transistor 16 and power supply voltage from power supply line 26 via transistor 30. Pet. 87 (citing Ex. 1008, 2:30–3:9, 8:32–9:3, 9:25–26, 10:5–10). According to Petitioner, “[d]uring the pixel drive phase, line 26 corresponds to V_{SUPPLY} .” *Id.* (citing Ex. 1008, 10:5–10).

Patent Owner does not respond to these arguments. *See generally* PO Resp. After considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Steer teaches limitation [1-B].

- d) *[1-C] the drive current being proportional to a current drive voltage being indicative of the video signal and independent of the positive power supply voltage*

Petitioner contends that drive transistor 22 (current driver) receives a “current drive voltage” comprising the gate-source voltage (the difference between the voltage at the source of drive transistor 22 and the voltage provided from the driver on line 6 on the gate of drive transistor 22).

Pet. 88. According to Petitioner, the voltage on line 6 “is *indicative of the video signal* because voltage [that] is generated on line 6 varies directly with the video signal input on line 52.” *Id.* (citing Ex. 1002 ¶¶ 293–297; Ex. 1008, Fig. 4). Petitioner, therefore, contends that a person of ordinary skill in the art “would understand that the gate-source voltage for drive transistor 22 is the claimed *current drive voltage*, and would further understand that the current flowing through drive transistor 22 and into EL element 2 is the claimed *drive current*.” *Id.* at 89 (citing Ex. 1002 ¶¶ 289–290, 292; Ex. 1008, Fig. 3).

Petitioner also compares Steer’s drive transistor 22 with the M1 transistor in the ’521 patent, and asserts that both are P-channel MOSFETS, so a person of ordinary skill in the art would understand that Steer’s current flowing through drive transistor 22 and into the EL element 2 is “*proportional*” to the gate-source voltage in the same manner it is

“proportional” in the ’521 patent. Pet. 90 (citing Ex. 1002 ¶¶ 291–292; Ex. 1008, Fig. 3).

Petitioner contends that the current drive voltage is independent of the positive power supply voltage because a change in voltage of V_{SUPPLY} will be recognized both at node 43 and at line 26. Pet. 91. According to Petitioner, “[a] mathematical representation of the voltages at each node shows that V_{SUPPLY} does not appear in the gate-to-source voltage over drive transistor **22**, and therefore, is independent of V_{SUPPLY} .” *Id.* Petitioner contends that the following equation represents the gate-to-source voltage:

$$V_{\text{GS}} = R * I - \text{input}(t)$$

Id. at 92 (citing Ex. 1002 ¶¶ 295–297).

Patent Owner argues that “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.” PO Resp. 67–68. Using the equation for V_6 set forth above for limitation [1-A], Patent Owner contends that the correct equation for V_{gs} is as follows:

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

Id. at 70 (citing Ex. 2011 ¶ 184). Patent Owner, therefore, contends that multiplier R_4 / R_3 prevents V_{SUPPLY} from dropping out of the equation, and therefore, Steer does not disclose a drive current independent of the positive power supply voltage. *Id.*

Similar to limitation [1-A] above, Patent Owner's contentions argue the influence of resistors R1–R4 in comparator section 50. For the same reasons set forth for limitation [1-A], we are not persuaded by these arguments.

Therefore, after considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Steer teaches limitation [1-C].

e) Conclusion for Independent Claim 1

Based on our review and consideration of the current record, we determine that Petitioner has shown, by a preponderance of the evidence, that Steer renders obvious claim 1 of the '521 patent.

3. Dependent Claims 2–4

Petitioner contends that dependent claims 2–4, which depend from claim 1, would have been obvious over Steer. Pet. 94–108. Petitioner identifies certain passages and figures in Steer and explains their significance with respect to the corresponding claim limitations. *Id.*

Patent Owner does not separately respond to Petitioner's contentions as to claims 2 and 4, but does present arguments for claim 3. PO Resp. 70–72. Claim 3 depends from claim 2 and recites in part “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.” Ex. 1001, 9:4–7.

For claim 3, Petitioner essentially relies on the same contentions as for limitations [1-A] and [1-C], as shown in Figure 4 of Steer. Pet. 96–101. According to Petitioner, a person of ordinary skill in the art:

would understand that the amplifier and resistors of comparator 50 are in a differential arrangement and that input line 52 is coupled to the negative terminal of the operational amplifier via a resistor and that node 43 (a function of V_{SUPPLY}) is coupled to a positive terminal of the operational amplifier, and therefore, the output on line 6 (V_6) is the difference between V_{SUPPLY} and the voltage on input line 52 (*input (t)*).

Id. at 98 (citing Ex. 1002 ¶¶ 307–309). Petitioner argues that “Steer does not disclose the value of the resistors in the differential circuit of the video driver” and a person of ordinary skill in the art “would be motivated to make the obvious design choice of using the same resistance values in the differential circuit.” *Id.* at 99 (citing Ex. 1002 ¶¶ 313–314).

Patent Owner presents essentially the same arguments as set forth above for limitation [1-A]. PO Resp. 70–72. For the same reasons as set forth for limitation [1-A], we are not persuaded by Patent Owner’s arguments.

Therefore, after considering the evidence and arguments of the complete record, we determine that Petitioner has shown, by a preponderance of the evidence, that Steer renders obvious dependent claims 2–4.

4. *Summary of Ground 5*

We find that Petitioner has shown, by a preponderance of the evidence, that claims 1–4 are unpatentable under 35 U.S.C. § 103(a) over Steer.

IV. MOTION TO STRIKE

Our Consolidated Trial Practice Guide²⁴ (“CTPG”) states that “striking the entirety or a portion of a party’s brief is an exceptional remedy that the Board expects will be granted rarely.” CTPG 80. However, “where a reply clearly relies on a new theory not included in prior briefing . . . striking the portion of the brief containing the theory may be appropriate.” *Id.* at 81.

Patent Owner seeks to strike (1) paragraphs 328–330 of Dr. Kattamis’s Supplemental Declaration (Exhibit 1015) and (2) the arguments on pages 20–21 of Petitioner’s Reply citing these paragraphs (hereafter “the challenged arguments”). Motion 1. Patent Owner asserts that the foregoing introduces new arguments that are improperly raised in the Reply that do not rebut Patent Owner’s arguments in the Patent Owner Response. *Id.* at 2–3.

In its Opposition, Petitioner argues that the challenged arguments “merely elaborate on the invalidity theories set forth in Dr. Kattamis’s original declaration, and are directly responsive to arguments raised by [Patent Owner] and its expert in its Response.” Opp. 1.

We agree with Petitioner for the reasons stated in the Opposition. *See* Opp. 1–3. There are two restrictions on what a petitioner may include in its reply. “First, the arguments and evidence in the reply must not be part of a new theory of unpatentability. Second, the arguments and evidence in the reply must be responsive to the patent owner’s contentions or the Board’s institution decision.” *Corephotonics, Ltd. v. Apple, Inc.*, 84 F.4th 990, 1008 (Fed. Cir. 2023) (emphasis omitted).

²⁴ Available at <https://www.uspto.gov/TrialPracticeGuideConsolidated>.

We are not persuaded that the challenged arguments violate either of the foregoing restrictions. The challenged arguments relate to Ground 4 of the Petition, i.e., the obviousness challenge over Hayafuji. As described above in Section III.F.1., in the Patent Owner Response, Patent Owner disputed Petitioner's proposed modification of Hayafuji that replaced Hayafuji's addition circuit with a differential amplifier circuit.

The challenged arguments are directly responsive to Mr. Credelle's contentions that Petitioner's proposed modification "transform[s] what was a summing amplifier circuit into a differential amplifier," which "was necessary for eliminating the undesirable ripple component of the power supply voltage," which was "the entire purpose of Hayafuji," and the modification "would be contrary to the operating principles of Hayafuji and would have rendered it inoperable for its intended purpose." *See* Ex. 2011 ¶ 152 (cited at PO Resp. 54); *see* Ex. 1015 ¶¶ 325 (summarizing Mr. Credelle's testimony), 326 (stating "I disagree with Mr. Credelle").

Dr. Kattamis testifies that "Mr. Credelle fails to observe, however, that [a voltage addition circuit] is only one of several substantially interchangeable options for performing mathematical operations on signals to achieve cancellations." Ex. 1015 ¶ 326. Paragraph 327 describes Hayafuji's method, while paragraphs 328 and 329 describe "potential algebraic manipulations of Hayafuji's equations" and paragraph 330 reiterates that the summing op amp OP3 is exchanged for a differencing op amp. *Id.* ¶¶ 327–329. The same schematic for the modification (i.e., the modified Figures 6 and 7 of Hayafuji) is relied upon as in the Petition. *Id.* ¶ 330 (referring to Ex. 1015 ¶ 273, which shows the modification of Figures

6 and 7 of Hayafuji); *see* Ex. 1002 ¶ 215. Therefore, Petitioner’s reply arguments rely on the same prior art, embodiments, and legal arguments previously identified in the Petition, and merely elaborate on the reasoning for the modification in response to Patent Owner’s arguments. *See Rembrandt Diagnostics, LP v. Alere, Inc.*, 76 F.4th 1376, 1384 (Fed. Cir. 2023) (stating that “a reply may be proper if it is responsive and simply expands on previously raised arguments”); *see also Chamberlain Grp. Inc. v. One World Techs. Inc.*, 944 F.3d 919, 925 (Fed. Cir. 2019) (“Parties are not barred from elaborating on their arguments on issues previously raised.”).

Accordingly, we are not persuaded that Petitioner has provided a new theory of patentability related to these arguments, nor are we persuaded that any new arguments have been introduced. Therefore, Patent Owner’s Motion to Strike is *denied*.

V. CONCLUSION²⁵

For the foregoing reasons, we are persuaded that Petitioner has established by a preponderance of the evidence that claims 1–4 and 7 of the

²⁵ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this Decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

'521 patent are unpatentable. We are *not* persuaded that Petitioner has established by a preponderance of the evidence that claim 5 of the '521 patent is unpatentable.

Claims	35 U.S.C. §	Reference/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 2, 7	102	Kim	1, 2, 7	
1, 2, 7	103(a)	Kim	1, 2, 7	
1, 2	102	Hayafuji		1, 2
1–3, 5	103(a)	Hayafuji		1–3, 5
1–4	103(a)	Steer	1–4	
Overall Outcome			1–4, 7	5

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–4 and 7 of the '521 patent have been shown to be unpatentable;

ORDERED that claim 5 of the '521 patent has *not* been shown to be unpatentable;

ORDERED that Patent Owner's Motion to Strike (Paper 33) is *denied*; and

FURTHER ORDERED that, because this is a final written decision, parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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