IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Innolux Corporation

Petitioner,

v.

Phenix Longhorn LLC

Patent Owner.

Case No. IPR2025-00044
U.S. Patent No. 7,557,788

PETITION FOR *INTER PARTES* REVIEW OF OF U.S. PATENT NO. 7,557,788

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#	Limitation Text
1[0]	A method of calibrating a liquid crystal display to a desired gamma curve to compensate for panel to panel manufacturing variations comprising the steps:
1[1]	a. providing said display with gamma reference control capability which is electrically reprogrammable and non-volatile;
1[2]	b. testing said display with at least one sensor with optical input, wherein said sensor is separate from said display;
1[3]	c. varying gamma reference voltage levels on columns of said display by a control circuit, wherein said control circuit is separate from said display;
1[4]	d. optimizing said gamma reference voltage levels using means for executing a predetermined algorithm according to a predetermined criteria and data sensed by said at least one sensor, wherein said means for executing said predetermined algorithm is separate from said display to achieve the desired gamma curve; and
1[5]	e. storing said gamma reference voltage levels in said gamma reference control capability.
2[0]	The method of claim 1 wherein the method is repeated more than once under different ambient display conditions to generate at least one different set of gamma reference voltage levels stored in said gamma reference control capability.
3[0]	A method of programming one or more gamma reference voltage generator integrated circuits attached to a liquid crystal display comprising the steps:
3[1]	a. selecting one or more columns on said liquid crystal display;
3[2]	b. applying one or more different gamma voltages to said liquid crystal display columns;
3[3]	c. storing said applied gamma voltages in reprogrammable, nonvolatile cells in said gamma reference voltage generator integrated circuits appropriate to said selected columns;
3[4]	d. operating means for executing one or more optimization criteria algorithms based on optical emission corresponding to said selected columns, wherein said means for executing said one or more optimization criteria algorithms is separate from said liquid crystal display;

3[5]	e. modifying said one or more different applied gamma voltages based on said one or more optimization criteria algorithms;
3[6]	f. programming said applied gamma voltages in storage cells in said gamma reference voltage generator integrated circuits appropriate to said selected columns; and
3[7]	g. repeating steps (d) through (f) until said one or more optimization criteria have been satisfied.
5[0]	A method for a liquid crystal display, comprising:
5[1]	providing said liquid crystal display with gamma reference control capability which is electrically reprogrammable and non-volatile;
5[2]	calibrating said liquid crystal display comprising:
5[3]	a. testing said liquid crystal display with at least one sensor with optical input;
5[4]	b. varying gamma reference voltage levels on columns of said liquid crystal display;
5[5]	c. optimizing said gamma reference voltage levels using means for executing a predetermined algorithm according to a predetermined criteria and data sensed by said at least one sensor; and
5[6]	d. storing said gamma reference voltage levels in said gamma reference control capability;
5[7]	retrieving said gamma reference voltage levels from said gamma reference control capability; and
5[8]	displaying an image on said liquid crystal display based on said gamma reference voltage levels.
6[0]	The method of claim 5, wherein the calibrating step is repeated more than once under different ambient display conditions to generate at least one different set of gamma reference voltage levels stored in said gamma reference control capability.

I. Introduction

The ‘788 patent claims nothing more than conventional techniques for calibrating liquid crystal displays that were well-known and widely used in the industry long before the alleged invention. The purported advances - using reprogrammable, non-volatile memory to store gamma reference voltages and optimizing those voltages with a separate control circuit - were, in fact, routine practices employed by display manufacturers for years.

This petition demonstrates that every element of the challenged claims was disclosed in the prior art, leaving no room for patentable invention. Liaw taught a comprehensive system for automatically calibrating LCD gamma curves using sensors, optimization algorithms, and programmable voltage generators. Greene disclosed using separate optical sensors and control circuitry to test and adjust display uniformity. Da Costa described smart controller chips with non-volatile, reprogrammable storage for gamma reference values. And Matsui showed calibrating displays under different ambient conditions.

A POSITA would have been motivated to combine these references, as they all aim to solve the same problem: improving display quality through precise gamma correction. The combinations represent nothing more than predictable uses of prior art elements according to their established functions. Any purported benefits of the claimed invention were already recognized and achieved in the prior art.

At best, the ‘788 patent describes an obvious variation in known calibration techniques. But patent protection is not available for such trivial advances that would have been obvious to skilled artisans. Petitioner respectfully requests that Claims 1-3 and 5-6 be held unpatentable.

II. Mandatory Notices (37 C.F.R. § 42.8)

A. Real Parties-in-Interest

Innolux Corporation (“Innolux” or “Petitioner”), located at No. 160, Kexue Road, Zhunan Science Park, Miaoli County 35053, Taiwan, is the real party in interest.

B. Related Matters

Below is a listing of related matters involving U.S. Patent 7,557,788 (the ‘788 Patent):

- *Phenix Longhorn, LLC v. Innolux Corporation*, No. 2:23-cv-00478 (E.D. Tex. Filed Oct. 10, 2023)
- *Phenix Longhorn, LLC v. AU Optronics Corp.*, No. 2:23-cv-00477 (E.D. Tex. Filed Oct. 10, 2023)

C. Designation of Lead and Back-Up Counsel

LEAD COUNSEL	BACK-UP COUNSEL
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D. Service Information

Petitioners consent to electronic service at DLInnoluxIPR@bakerbotts.com. A Power of Attorney is filed concurrently herewith under 37 C.F.R. § 42.10(b).

E. Payment of Fees – 37 C.F.R. § 42.103

Innolux authorizes the USPTO to charge Deposit Account No. 02-0384 for the fee set forth in 37 C.F.R. § 42.15(a) for this Petition and further authorizes payment for any additional fees to be charged to this deposit account.

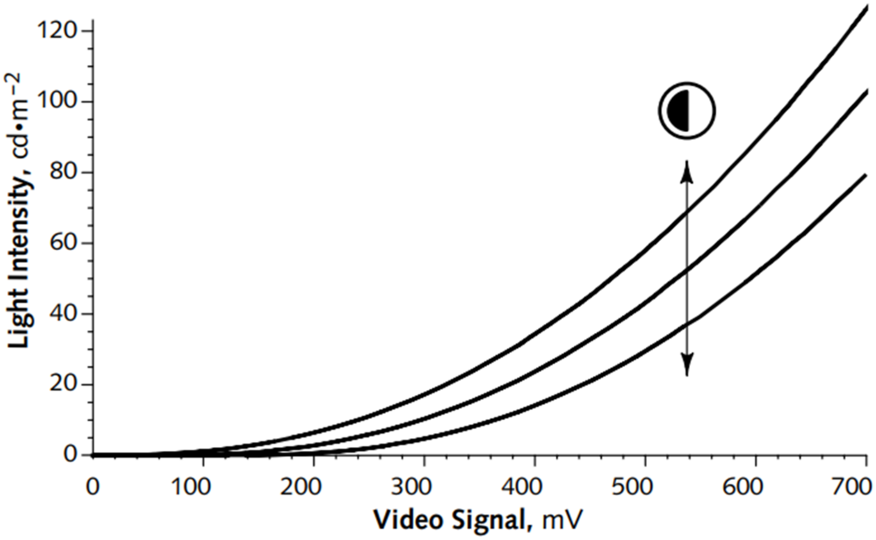
III. Petitioner Meets Standing and Eligibility Requirements for *Inter Partes* Review.

Petitioner certifies under 37 C.F.R. § 42.104(a) that the ‘788 Patent “is available for *inter partes* review and that the Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the grounds identified in the petition.” Petitioner was not served with a complaint regarding this patent until a Waiver of Service was executed on June 7, 2024.

IV. Background

A. Gamma Correction

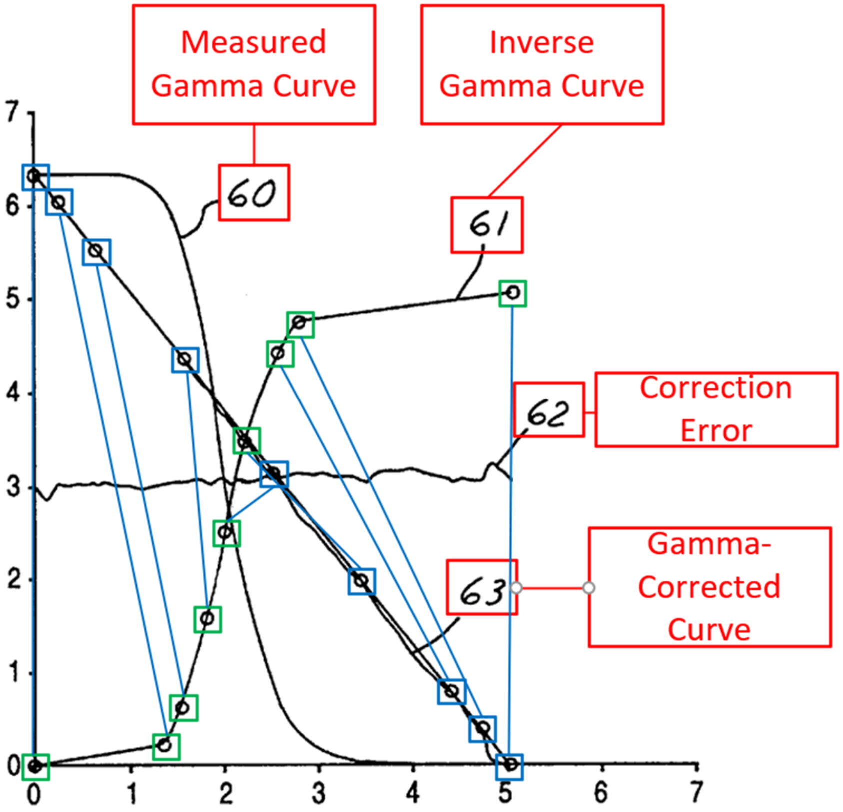
Gamma correction is an important concept in display technology that ensures that images are faithfully rendered on display devices. (EX1009, at 92-93; EX1003, at ¶ 43). Gamma correction addresses a mismatch between how electronic devices create images and how our eyes perceive them (EX1009, at 91; EX1003, at ¶ 43). Traditional cathode ray tube (CRT) displays are known to have a nonlinear relationship between the input signal and display brightness - when you increase the input signal linearly, the brightness does not increase linearly. (EX1009, at 91; EX1003, at ¶ 43). Instead, it follows a curved path (EX1009, at 913; EX1003, at ¶ 43). This curve is described by a parameter called “gamma” (EX1009, at 92-93; EX1003, at ¶ 43).



(EX1009, at 93; EX1003, at ¶ 43). Human eyes have a similar but opposite curve when perceiving brightness (EX1009, at 93; EX1003, at ¶ 43). By applying a gamma correction to adjust the signal before it reaches the display, the final image matches what our eyes expect to see (EX1009, at 101; EX1003, at ¶ 43).

Liquid Crystal Display ("LCD") screens have a similar nonlinear relationship between input voltage and transmittance – how well the LCD panel allows light to pass through it. (EX1010, at 1:10-35; EX1003, at ¶ 44). In order to correct this nonlinearity, the voltage-to-transmittance curve for a specific display must be determined, and an inverse transformation applied to accommodate for this nonlinearity (EX1010, at 1:36-60; EX1003, at ¶ 44).

This is typically done by selecting a number of points (sometimes referred to as channels) on the measured gamma curve, and providing corrections for each of those points to produce an inverse gamma curve. (EX1010, at 3:63-4:16; EX1003, at ¶ 45). When that inverse gamma curve is applied to inputs to the display, a linear relationship between input voltage and transmittance can be obtained. (EX1010, at 3:63-4:16; EX1003, at ¶ 45). This is illustrated in the figure below, which shows a measured gamma curve 60 for a display, an inverse gamma curve 61 defined by nine points (highlighted in green), and the gamma-corrected curve 63. The annotations further illustrate how the nine points (in green) in the inverse gamma curve 61 map to nine points on the gamma corrected curve 63 (in blue).



(EX1010, at 4:17-23, Fig. 6; EX1003, at ¶ 45). A common approach to gamma correction in LCD displays in 1997 was to store these nine points in high-speed digital memory, and to use a set of digital to analog converters (DAC's) to apply these gamma correction values to a display. (EX1011, at 4:43-65; EX1003, at ¶ 45).

B. Gamma Correction Circuits

Many years later, in 2003 – the time of the alleged invention - the state of the art in display technology included sophisticated systems for gamma correction to optimize image quality. (EX1003, at ¶ 46). Display devices commonly incorporated integrated circuits with dedicated gamma correction functionality, including nonvolatile memory for storing correction data, control circuitry for applying corrections, and driver circuits for outputting adjusted signals to display pixels. (EX1008, Fig. 1, 3:30-37, 6:10-28; EX1003, at ¶ 46). These integrated designs, with components formed on a single substrate, enabled high-speed operations and efficient switching between different gamma correction data sets. (EX1008, 19:56-65; EX1003, at ¶ 46)

The art recognized the importance of providing independent gamma correction for different color channels to improve overall image quality. Advanced data drivers could generate separate gamma reference voltages for red, green, and blue colors, allowing for optimized color reproduction. (EX1005, 1:61-2:3, Fig. 1; EX1003, at ¶ 47). These systems typically employed digital-to-analog converters to transform stored digital gamma data into analog reference voltages, which were then used to convert image data into appropriate driving voltages for the display. (EX1005, 3:15-32, Fig. 1; EX1003, at ¶ 47)

Flexibility in gamma correction was a key focus, with systems designed to store and apply multiple sets of correction data to accommodate varying display conditions. (EX1005, 2:25-28; EX1006, 2:29-35, 8:58-67; EX1003, at ¶ 48). This adaptability was achieved through the use of reprogrammable nonvolatile memory arrays organized in rows and columns, allowing for efficient storage and retrieval of correction values. (EX1006, 4:11-25, 5:19-28, Fig. 3; EX1003, at ¶ 48)

The art also taught sophisticated memory architectures to enable on-chip programming and flexible data management. (EX1003, at ¶ 49). Microcomputers with embedded flash memory could partition storage into separate blocks for loader programs and application data, with shared I/O circuitry and bus multiplexing to efficiently switch between execution and programming modes. (EX1007, 3:5-13, 7:49-67, Fig. 3; EX1003, at ¶ 49). This approach allowed for dynamic updating of stored data, including gamma correction values, without the need for external programming tools. (EX1007, Abstract, 2:38-43; EX1003, at ¶ 50).

Overall, the state of the art demonstrated a clear trend towards integrated, flexible, and dynamically adjustable gamma correction systems in display devices, leveraging advances in memory technology and circuit design to optimize image quality across various operating conditions. (EX1003, at ¶ 50).

V. Summary of the ‘788 Patent

U.S. Patent 7,557,788 ("the ‘788 patent") discloses a method for calibrating a liquid crystal display to achieve a desired gamma curve and compensate for manufacturing variations between display panels. (EX1001, Abstract; EX1003, ¶ 51). The method involves providing the display with gamma reference control capability that is electrically reprogrammable and non-volatile. (EX1001, 2:17-28; EX1003, ¶ 51). This capability allegedly allows for automated assembly and testing of display panels, as well as reprogrammable settings to provide different gamma correction curves for various applications. (EX1001, 2:29-35; EX1003, ¶ 51).

The ‘788 patent describes testing the display using at least one optical sensor separate from the display. (EX1001, 6:38-56, Fig. 2; EX1003, ¶ 52). Gamma reference voltage levels on display columns are varied by a control circuit separate from the display. (EX1001, 3:6-12, Fig. 2; EX1003, ¶ 52). The method optimizes these gamma reference voltage levels using means for executing a predetermined algorithm based on sensor data and predetermined criteria. (EX1001, 6:48-56, Fig. 2; EX1003, ¶ 52). The optimized gamma reference voltage levels are then stored in the gamma reference control capability. (EX1001, 3:24-28; EX1003, ¶ 52).

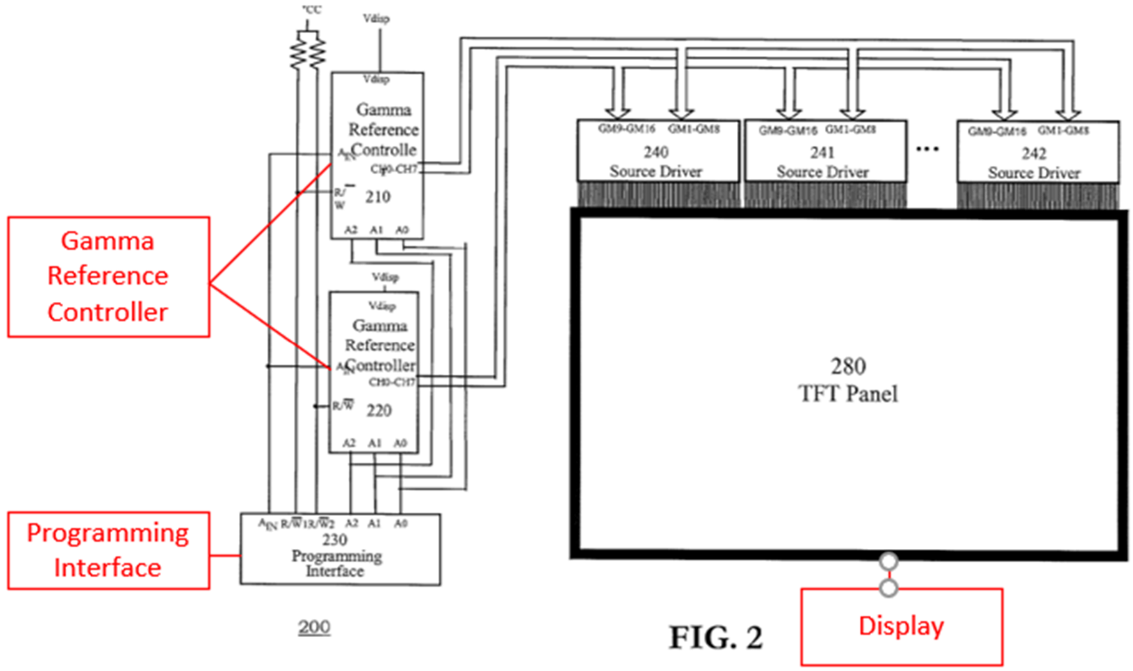


FIG. 2

The '788 patent notes that the calibration method can be repeated under different ambient display conditions to generate multiple sets of gamma reference voltage levels. (EX1001, 6:52-7:10; EX1003, ¶ 53). These stored sets allow for optimized gamma correction curves for different user or application requirements. (EX1001, 2:24-28; EX1003, ¶ 53). The patent acknowledges that gamma correction has long been a problem for TFT flat panel display manufacturers, particularly as display resolutions increase. (EX1001, 1:21-29; EX1003, ¶ 53).

A. Effective Filing Date and Date of Invention

The '788 Patent claims priority through Provisional Application No. 60/477,680, filed on June 11, 2003. EX1001, cover. Solely for the purposes of this IPR, Petitioner assumes, but does not concede, that the Provisional Application supports the issued claims of the ‘305 Patent and is, thus, entitled to an effective filing date of June 11, 2003. Pre-AIA 35 U.S.C. §§ 102 and 103 apply.

B. Prosecution History of the ‘788 Patent

U.S. Application 11/743,014 (the ‘014 Application), which issued as the ‘788 Patent, was filed on May 1, 2007, claiming priority to U.S. Application 10/746,333, which itself claimed priority to U.S. Provisional Application No. 60/477,680, which was filed on June 11, 2003. (EX1002, at 116). The original claims were rejected in a Non-Final Office Action on July 22, 2008 as obvious over Liaw (EX1005). (EX1002, at 94-95). The only limitation allegedly not found in Liaw was that Liaw did not expressly teach that the memory that stored gamma reference voltage levels was “non-volatile.” (EX1002, at 96). In a response filed October 22, 2008, Applicant presented no substantive amendments to the claims, and argued that numerous additional limitations were not present in Liaw, including an absence of (1) a “method for calibrating a liquid crystal display,”, (2) “compensating for panel-to-panel manufacturing variations,” (3) that the memory is “electrically reprogrammable and non-volatile,” (4) that the gamma reference voltage levels are applied on the columns of a display. (EX1002, at 75-76). Applicant also argued that it would not have been obvious to use non-volatile memory with Liaw. The Examiner issued a Notice of Allowance on March 5, 2009 without comment on the reasons for allowance (EX1002, at 48).

C. Level or Ordinary Skill in the Art

A POSA is a hypothetical person who is presumed to know the relevant art. *See Gnosis S.P.A. et al. v. S. Ala. Med. Sci. Foundation,* Case IPR2013-00116, Paper 68 at 9, 37 (PTAB June 20, 2014). A POSA has ordinary creativity, is not an automaton, and is capable of combining teachings of the prior art. *Id.* (citing *KSR Intl'l Co. v. Teleflex Inc.,* 550 U.S. 398, 420–21 (2007)).

With respect to the '305 Patent, a POSA as of June 11, 2003, would have had at least a bachelor of science degree in physics, electrical engineering, or the equivalent thereof and three (3) years of experience in circuit design or display technologies. (EX1003 at ¶ 24). Such a POSA would have had knowledge of integrated circuits, gamma correction, and storage of gamma correction voltage values within memory, and would have understood how to search available literature for relevant publications. (EX1003 at ¶ 24).

VI. Claim Construction

The Board construes claims under the same construction standard as civil actions in federal district court. The following terms require construction by the Board.

A. "operating means for executing one or more optimization criteria algorithms based on optical emission corresponding to said selected columns" (Claim 3)

This phrase is a means-plus-function claim under 35 U.S.C. § 112 ¶ 6 (EX1003, ¶ 56). Means-plus-function claims are construed by first identifying the claimed function and then determining the corresponding structure disclosed in the specification that performs that function. *Williamson v. Citrix Online*, LLC, 792 F.3d 1339, 1351 (Fed. Cir. 2015). The scope of the claim is limited to the structure disclosed in the specification and its equivalents, rather than covering all means for performing the claimed function. *Applied Med. Res. Corp. v. U.S. Surgical Corp.*, 448 F.3d 1324, 1332 (Fed. Cir. 2006).

When a means-plus-function claim recites an algorithm, the specification must disclose an algorithm for performing the claimed function to satisfy the definiteness requirement under 35 U.S.C. § 112. *Aristocrat Techs. Australia Pty Ltd. v. Int'l Game Tech.*, 521 F.3d 1328, 1333 (Fed. Cir. 2008). Simply disclosing a general-purpose computer as the structure for performing the claimed function is insufficient; the specification must disclose the specific algorithm that transforms the general-purpose computer into a special-purpose computer programmed to perform the claimed function. *WMS Gaming, Inc. v. Int'l Game Tech.*, 184 F.3d 1339, 1349 (Fed. Cir. 1999).

In this case, the term "operating means for executing one or more optimization criteria algorithms . . ." is indefinite because the '788 Patent does not disclose any specific algorithms as required under *Aristocrat Techs.* (EX1003, ¶ 58). Further, the term "operating" is not used within the '788 Patent specification *at all* except to refer to an “operating current” (EX1001, at 5:34; EX1003, ¶ 58). Thus, there is no corresponding structure recited in the ‘788 Patent. (EX1003, ¶ 58).

Nonetheless, and solely for the purposes of this Petition, in the event the Board does not determine that Claim 3 is indefinite, Petitioner proposes that the term be construed to refer to a “programming interface which executes an optimization algorithm”. (EX1003, ¶ 59)

Petitioner does not believe that any other terms are necessary to be construed to resolve this Petition in favor of Petitioner. (EX1003, ¶ 60).

VII. Specific Relief Requested

A. Proposed Grounds

1. Ground 1

Claims 1-3, and 5-6 are Invalid over Liaw (EX1005) in view of Greene (EX1006).

2. Ground 2

Claims 1-3 and 5-6 are Invalid over Greene (EX1006) in view of Da Costa (EX1007).

3. Ground 3

Claims 1-2 and 5-6 are Invalid over Liaw (EX1005), in view of Greene (EX1006), in further view of Matsui (EX1008)

4. Ground 4

Claims 1-2 and 5-6 are Invalid over Liaw (EX1005) in view of Da Costa (EX1007).

B. Qualifying Prior Art

The references relied upon in the grounds above qualify as prior art for the following reasons:

Prior Art Reference	Priority Date	Publication / Issue Date	Applicable Section of 35 U.S.C. § 102
U.S. Patent 6,593,934 to Liaw et al. ("Liaw")	Nov. 16, 2000	July 15, 2003	(e)
U.S. Patent 6,271,825 to Greene et al. ("Greene")	April 23, 1996	Aug. 7, 2001	(a), (e)
U.S. Patent 6,100,879 to Da Costa ("Da Costa")	Aug. 28, 1996	Aug. 8, 2000	(a), (e)
U.S. Patent 5,754,150 to Matsui ("Matsui")	Oct. 31, 1995	May 19, 1998	(a), (e)

VIII. The Board Should Not Deny Institution Under 35 U.S.C. § 325(d)

The Board should not deny institution under 35 U.S.C. § 325(d), because the arguments presented here have not been previously presented to the USPTO. In particular, the arguments presented here address newly found prior art, and directly address the limitations of the analysis of the Examiner conducted during prosecution of the issued claims under Liaw.

While Liaw (EX1005) and Matsui (EX1008) were of record during prosecution, neither Greene (EX1006) or DaCosta (EX1007) were uncovered during prosecution. Because this petition presents new argument based on newly-found prior art, the Board should not deny institution under 35 U.S.C. § 325(d).

IX. The Board Should Not Deny Institution Under 35 U.S.C. § 314(a)

The factors described in *Apple, Inc. v. Fintiv, Inc*, IPR2020-00019, Paper 11 (PTAB March 20, 2020) (Precedential) ("*Fintiv-I*") favor institution.

As of this Petition, discovery has only recently opened in the District Court Litigation and, although a stay motion has not yet been filed, Petitioner intends to promptly file a stay motion in the event of IPR institution. The Board has treated related factors as neutral after declining to speculate on the outcome of a stay motion. *See, e.g., HP Inc. v. Slingshot Printing LLC*, IPR2020-01084, Paper 13 at 9 (PTAB Jan. 14, 2021) ("HP") (instituting IPR after declining to speculate on likelihood of a stay).

Institution is strongly favored where, as here, Petitioner has been "exceptionally diligent" in filing. *Micron Tech., Inc. v. Godo Kaisha IPR Bridge 1*, IPR2020-01007, Paper 15 at 15-16 (PTAB Dec. 7, 2020). The Board has made clear that "it is often reasonable for a Petitioner to wait to file its petition until it learns which claims are being asserted against it in the parallel proceeding," and here, Petitioner filed its Petition less than eight weeks after receiving infringement contentions. *Fintiv-I* at 11. In light of Petitioner's diligence, any argument comparing the timing of respective milestones between this proceeding and the District Court Litigation would be premature.

If Patent Owner raises §314(a) arguments in a Preliminary Response, Petitioner respectfully requests the opportunity to reply prior to institution, in order to address expected schedules at that time and whether a stipulation limiting arguments to be made in the District Court Litigation would be appropriate.

X. State of the Art

At the time of the alleged invention of the '788 Patent, the field of liquid crystal display (LCD) technology was already highly advanced, particularly in the area of gamma correction techniques. (EX1003, ¶ 61). The prior art demonstrates that key features of the target patent were well-known and widely implemented. (EX1003, ¶ 61).

Programmable gamma reference control capabilities were a standard feature in LCD systems. (EX1003, ¶ 62). For example, Da Costa (EX1007) disclosed a smart controller chip with programmable registers for storing digital gamma reference values, which could be reprogrammed via external PROM or internal flash memory. (EX1007, 7:66-8:3, Fig. 7A; EX1003, ¶ 62). This approach provided non-volatile, electrically reprogrammable gamma control, allowing for flexible adjustment of display characteristics to compensate for manufacturing variations and environmental changes. (EX1007, 11:34-46; EX1003, ¶ 62)

Automated calibration processes using optical sensors were also well-established. (EX1003, ¶ 63). Liaw taught a system with sensors to measure voltage-to-luminance characteristics, a programmable gamma voltage generating means, and a main controller with a CPU to optimize gamma voltages. (EX1005, 5:62-6:56, Fig. 7A; EX1003, ¶ 63). This enabled automatic testing, variation of gamma reference voltages, and optimization using predetermined algorithms. (EX1005, 9:6-12, Fig. 14; EX1003, ¶ 63)

The ability to store and utilize multiple sets of gamma reference voltages for different ambient conditions was known in the art. (EX1003, ¶ 64). Matsui disclosed automatically adjusting luminance based on detected external light intensity and display tilt, indicating that the gamma correction method was repeated as ambient conditions changed. (EX1008, 10:53-11:6, Figs. 4-5; EX1003, ¶ 64)

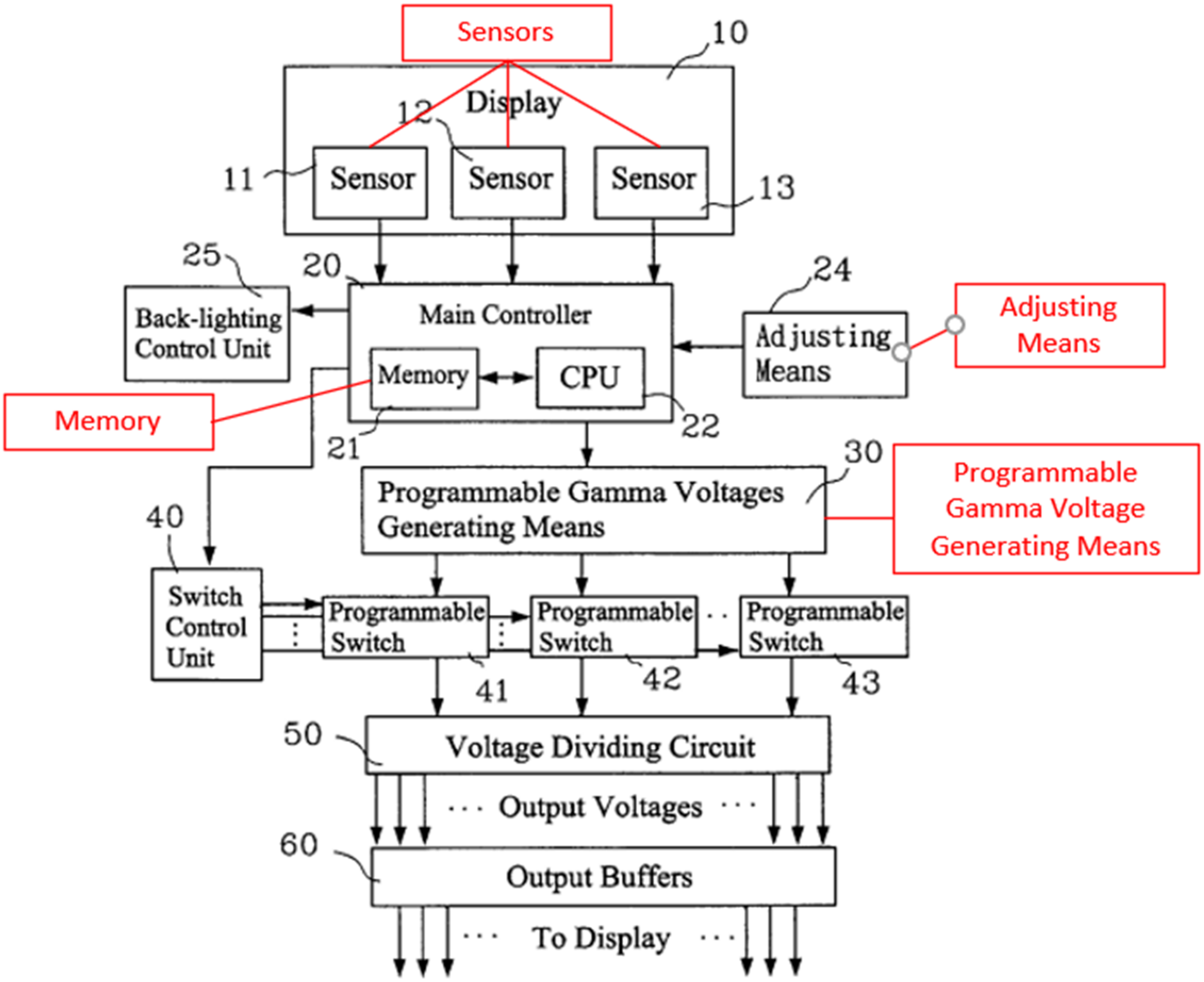
Column-specific gamma correction was also a recognized technique. Greene taught using luminance scaler/adder means to adjust drive signals for each column of pixels, effectively varying gamma reference voltage levels on a per-column basis. (EX1006, 10:59-11:11, Fig. 5; EX1003, ¶ 64)

XI. The Prior Art

A. Liaw (EX1005)

The Liaw reference discloses an automatic gamma correction system for liquid crystal displays that addresses panel-to-panel manufacturing variations. (EX1005, 1:15-34; EX1003, ¶ 66). The system includes sensors to measure voltage-to-luminance characteristics, a programmable gamma voltage generating means to output adjustable reference voltages, and a main controller with a CPU to optimize the gamma voltages. (EX1005, 5:62-6:56, Fig. 7A; EX1003, ¶ 66). Liaw's method involves testing the display with sensors, varying gamma reference voltages on display columns, optimizing those voltages using predetermined algorithms, and storing the optimized values for future use. (EX1005, 9:6-12, Fig. 14; EX1003, ¶ 66)

The system can calibrate under different ambient conditions by adjusting luminance, contrast, and color temperature. (EX1005, 3:5-8; EX1003, ¶ 67). Importantly, Liaw's gamma voltage generating means uses a digital-to-analog converter, allowing for electrical reprogramming of gamma voltages. (EX1005, 8:29-34, Fig. 11; EX1003, ¶ 67). This reference was selected because it demonstrates known techniques for calibrating LCD gamma curves to compensate for manufacturing variations, a key aspect of the challenged patent claims. (EX1003, ¶ 67).



(EX1005, at Fig. 7A).

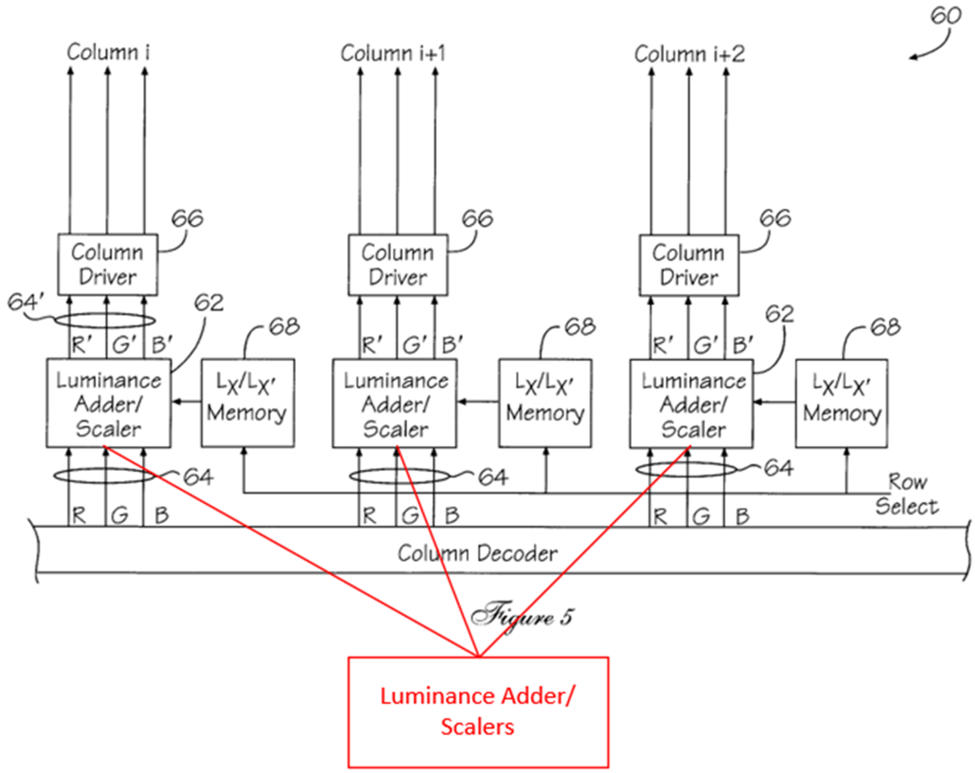
B. Greene (EX1006)

The Greene reference (EX1006) discloses methods for correcting spatial non-uniformities in brightness arising from manufacturing variations in electronic displays, including liquid crystal displays (LCDs). (EX1006, Abstract, 1:8-13, 4:8-22; EX1003, ¶ 68). Greene teaches measuring luminance variations across pixels using a photodetector, determining correction parameters, and storing these parameters in non-volatile memory. (EX1006, 10:14-36, 11:30-33, Fig. 6; EX1003,

¶ 68). The stored parameters are used to adjust drive signals in real-time, effectively providing gamma reference control for LCDs. (EX1006, 4:45-58, 10:59-11:4; EX1003, ¶ 68).

Greene describes a column-based correction approach, integrating luminance scalers/adders into column driver circuits. (EX1006, 11:5-19, Fig. 5; EX1003, ¶ 69). This allows for precise adjustment of gamma voltages on a per-column basis. The correction process can be repeated to account for display aging and changing ambient conditions. (EX1006, 11:20-24, 2:56-3:2; EX1003, ¶ 69).

Greene's methods are directly applicable to calibrating LCD gamma curves to compensate for panel-to-panel variations. (EX1003, ¶ 70). While not using the term "gamma reference voltage levels," a POSITA would have understood Greene's drive signal adjustments to be functionally equivalent for LCDs. (EX1003, ¶ 70).



(EX1006, Fig. 5).

C. Da Costa (EX1007)

The Da Costa reference discloses a system and method for controlling an active matrix liquid crystal display using a "smart" controller chip that integrates both digital and analog control capabilities. (EX1007, 2:31-34, Fig. 2; EX1003, ¶ 71). This controller allows for flexible and dynamic adjustment of display characteristics, including gamma correction, to compensate for manufacturing variations and environmental changes. (EX1007, 11:15-33, 11:34-46; EX1003, ¶ 71)

The smart controller chip contains programmable registers for storing digital values corresponding to gamma reference voltages. (EX1007, 7:51-56, Fig. 7A;

EX1003, ¶ 72). These registers can be programmed via an external PROM or internal flash memory, providing non-volatile and electrically reprogrammable gamma reference control. (EX1007, 4:57-67, 6:45-50; EX1003, ¶ 72). The stored digital values are converted to analog reference levels by integrated D/A converters and sent to the column drivers to control the display output. (EX1007, 7:22-27, 8:12-23, Fig. 2; EX1003, ¶ 72)

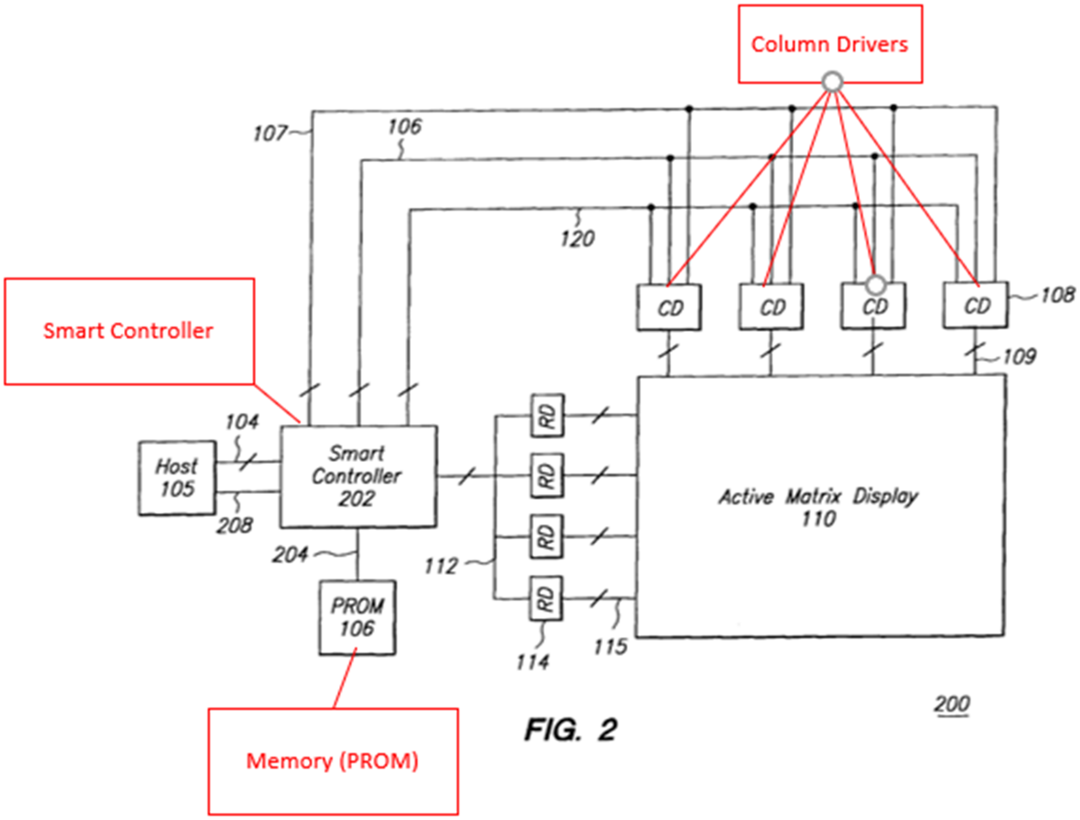


FIG. 2

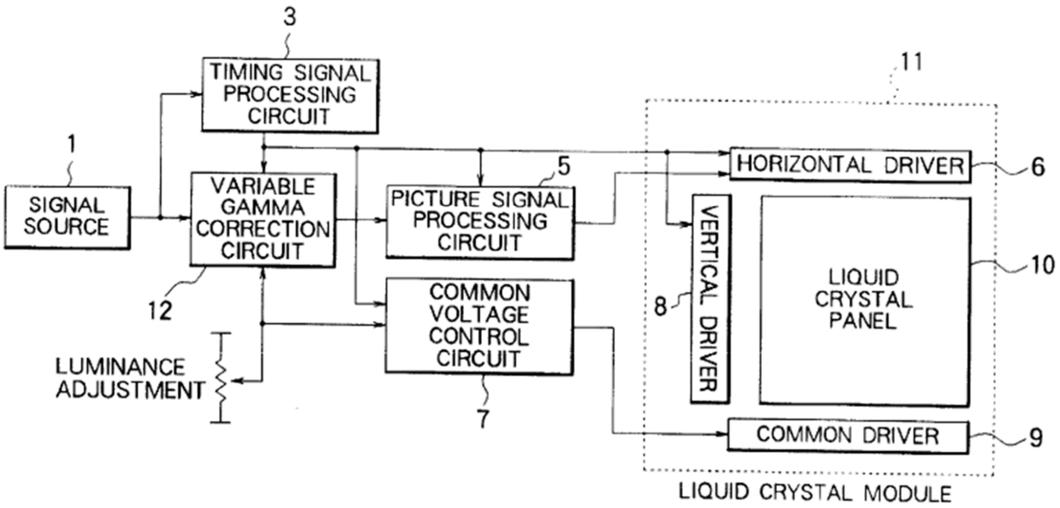
(EX1007, Fig. 2)

This integrated approach enables real-time optimization of display gamma, allowing for improved image quality across various applications and environmental conditions. (EX1007, 2:60-3:8, 11:15-33; EX1003, ¶ 73)

D. Matsui (EX1008)

The Matsui reference discloses a luminance adjusting apparatus for liquid crystal displays that addresses the need to optimize gamma correction for individual panels. (EX1008, Abstract, 1:7-10; EX1003, ¶ 74). Matsui teaches a variable gamma correction circuit that can change inflection points of a gamma correction curve by adjusting voltage levels. (EX1008, 6:6-14, Fig. 1; EX1003, ¶ 74). This circuit includes components for setting multiple reference voltages as inflection points, allowing for precise control of the display's luminance characteristics. (EX1008, 13:18-34, Fig. 1; EX1003, ¶ 74).

FIG. 3



(EX1008, Fig. 3).

Matsui's apparatus synchronously adjusts the common electrode voltage along with the gamma correction curve, enabling luminance adjustment within a narrow dynamic range. (EX1008, 9:39-45, Fig. 2; EX1003, ¶ 75). This approach reduces the required output voltage range of the picture signal processing section, potentially decreasing the cost of the horizontal driver. (EX1008, 5:64-6:3; EX1003, ¶ 75). Matsui also describes automatic adjustment based on ambient light and display tilt, suggesting the ability to store and retrieve multiple gamma correction settings. (EX1008, 10:53-11:6, Figs. 4-5; EX1003, ¶ 75).

XII. Motivations to Combine

A POSITA would have been motivated to combine each of the asserted combinations here to arrive at the challenged claims. (EX1003, ¶ 76). Each of Liaw, Greene, Da Costa, and Matsui relate to the field of integrated circuits for producing corrections to voltages used to drive a display. (EX1003, ¶ 76). Thus, all the references asserted here are analogous art, because they are in the same field of endeavor. (EX1003, ¶ 76). Even if they were not in the same field of endeavor, they are all reasonably pertinent to the problem addressed by the '788 Patent – the calibration of LCD displays. (EX1003, ¶ 76). The specific rationales to combine these references, along with more specific similarities of each, are further provided below through Section IX. (EX1003, ¶ 76).

XIII. Ground 1: Claims 1-3, 5-6 Are Invalid Over Liaw in view of Greene

As discussed above, Liaw was applied by the Examiner to reject the claims that ultimately issued as Claims 1-3, 5-6 in the '788 Patent. (EX1003, ¶ 77).

However, each and every limitation argued by Applicant that was apparently missing in Liaw is in fact present in Liaw, Greene, or both (as shown below). (EX1003, ¶ 77). A POSITA would have been motivated to combine Liaw with Greene to arrive at the claimed features. (EX1003, ¶ 77).

Liaw discloses a method for calibrating a liquid crystal display to a desired gamma curve. (EX1006, Abstract; EX1003, ¶ 78). Greene teaches using a separate, movable photodetector to test the display and optimize luminance uniformity. (EX1007, 11:30-38, Fig. 6; EX1003, ¶ 78). A POSITA would have been motivated to incorporate Greene's separate photodetector into Liaw's system as a simple substitution of one known testing method for another, yielding the predictable result of more flexible and precise display calibration. (EX1007, 11:25-29; EX1003, ¶ 78).

Furthermore, a POSITA would have been motivated to apply Greene's teaching of repeating the calibration process under different ambient conditions to Liaw's method. Greene explicitly states that ambient illumination affects image contrast and that correction methods can adjust for different lighting conditions. (EX1007, 2:56-3:2; EX1003, ¶ 79). Implementing this feature in Liaw's system would be an obvious application of a known technique to improve a similar device, allowing the display to maintain optimal performance across various usage scenarios. (EX1006, 3:5-8; EX1003, ¶ 79).

Finally, a POSITA would have been motivated to incorporate Greene's teaching of integrating correction circuitry into column driver circuits (EX1007, 11:12-15, Fig. 5) into Liaw's system. (EX1003, ¶ 81). This modification would be obvious to try, as it represents one of a finite number of identified, predictable solutions for implementing the gamma correction hardware, with the expected benefit of improved performance and reduced complexity in the overall display system. (EX1003, ¶ 81).

A. Claim 1

1. Limitation 1[0]: A method of calibrating a liquid crystal display to a desired gamma curve to compensate for panel to panel manufacturing variations comprising the steps:

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 82). Liaw describes an automatic gamma correction system and method for displays to correct for non-linearity between gray-scale values, signal voltages, and luminance. (EX1005, 1:15-34; EX1003, ¶ 82).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 83). Greene describes methods for correcting spatial non-uniformities in brightness arising from materials, manufacturing, and operational parameter variations in electronic color displays, including liquid crystal displays. (EX1011, Abstract, 1:15-17, 4:8-22; EX1003, ¶ 83). While Greene focuses on brightness/luminance correction, a POSITA would have understood this is directly related to gamma curve calibration, as gamma characterizes the display's brightness response. (EX1003, ¶ 83).

2. Limitation 1[1]: a. providing said display with gamma reference control capability which is electrically reprogrammable and non-volatile;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 84). The system includes a programmable gamma voltage generating means (30) that generates adjustable gamma reference voltages. (EX1005, 5:62-7:5, Fig. 7A; EX1003, ¶ 84). These gamma reference voltages are stored in memory (21) of the main controller (20), which is described as storing parameters for data storage. (EX1005, 6:21-36, Fig. 7A; EX1003, ¶ 84). While Liaw does not explicitly state the storage is non-volatile, a POSITA would have understood that storing calibration parameters for future use would require non-volatile storage to retain the values when power is removed from the display. (EX1003, ¶ 84)

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 85). Greene describes storing correction parameters in non-volatile random-access memory (NV-RAM). (EX1011, 10:14-36; EX1003, ¶ 85). These stored parameters are used to scale and/or interpolate drive signals in real time to correct for brightness non-uniformities. (EX1011, 4:45-58; EX1003, ¶ 85). A POSITA would have understood that the stored correction parameters effectively serve as gamma reference controls, as they adjust the brightness response of the display. The use of NV-RAM indicates this control capability is both electrically reprogrammable and non-volatile. (EX1011, 10:14-36; EX1003, ¶ 85).

3. Limitation 1[2]: b. testing said display with at least one sensor with optical input, wherein said sensor is separate from said display;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 86). Liaw's system includes sensors (11-13) that can be disposed inside or outside the display to obtain voltage-to-luminance curves. (EX1005, 5:62-6:12, Fig. 7A; EX1003, ¶ 86). These sensors can be light sensors used to measure luminance parameters of the display. (EX1005, 6:13-20; EX1003, ¶ 86). The sensors are separate components from the display itself, connected to the main controller to provide sensed data for gamma correction. (EX1005, 6:21-36, Fig. 7A; EX1003, ¶ 86).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 87). Specifically, Greene describes using "a photodetector 72 movably mounted (on an x-y arm assembly 74, for example) [that] provides the measured data when scanned over the surface of the screen 76." (EX1011, 11:30-33, Fig. 6; EX1003, ¶ 87).

4. Limitation 1[3]: c. varying gamma reference voltage levels on columns of said display by a control circuit, wherein said control circuit is separate from said display;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 88). The system includes a programmable gamma voltage generating means (30) that generates adjustable gamma reference voltages output to programmable switches (41-43) connected to columns of the display. (EX1005, 5:62-7:5, Fig. 7A; EX1003, ¶ 88). This gamma voltage generating means is controlled by the main controller (20), which is a separate control circuit from the display itself. (EX1005, 6:21-36, Fig. 7A; EX1003, ¶ 88). The system varies these gamma reference voltages during the optimization process to achieve the desired gamma curve. (EX1005, 9:22-42, Fig. 14; EX1003, ¶ 88).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 89). Greene describes using luminance scaler/adder means to adjust drive signals for each column of pixels. (EX1011, 10:59-11:11, Fig. 5; EX1003, ¶ 89). While Greene does not explicitly use the term "gamma reference voltage levels," a POSITA would have understood that adjusting the drive signals effectively varies the gamma reference voltage levels, as these drive signals control the brightness response of the display. (EX1003, ¶ 89). The luminance scaler/adder means and associated control circuitry are depicted as separate from the display itself in Figure 5. (EX1011, Fig. 5; EX1003, ¶ 89).

5. Limitation 1[4]: d. optimizing said gamma reference voltage levels using means for executing a predetermined algorithm according to a predetermined criteria and data sensed by said at least one sensor, wherein said means for executing said predetermined algorithm is separate from said display to achieve the desired gamma curve; and

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 90). The main controller (20) includes a CPU (22) that executes optimization algorithms to determine gamma reference voltages based on sensed voltage-to-luminance data from the sensors and predetermined criteria like desired luminance and contrast. (EX1005, 6:38-56, 7:46-8:4, Fig. 7A; EX1003, ¶ 90). This optimization process aims to fit the transfer curve to a desired gamma curve. (EX1005, 7:46-8:4; EX1003, ¶ 90). The main controller and CPU are separate components from the display itself, as clearly shown in Figure 7A. (EX1005, Fig. 7A; EX1003, ¶ 90).

b) Greene (EX1006)

Greene discloses this limitation. (EX1005, ¶ 91). Greene describes using stored parameters to scale and interpolate drive signals in real time to correct brightness non-uniformities. (EX1011, 4:45-58; EX1005, ¶ 91). This scaling and interpolation process constitutes a predetermined algorithm for optimizing the drive signals (effectively gamma reference voltage levels) based on previously measured brightness characteristics. (EX1011, 4:34-44; EX1005, ¶ 91). The optimization achieves a desired gamma curve by correcting manufacturing variations to produce uniform brightness across the display. (EX1011, 1:41-54; EX1005, ¶ 91).

6. Limitation 1[5]: e. storing said gamma reference voltage levels in said gamma reference control capability.

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1005, ¶ 92). The main controller (20) includes a memory (21) for parameter calculation and data storage. (EX1005, 6:21-24, Fig. 7A; EX1005, ¶ 92). The memory can store at least one gray-scale-to-luminance destination curve and the Gamma reference voltages evaluated by the central process unit. (EX1005, 6:24-27; EX1005, ¶ 92). While Liaw does not explicitly state the storage is non-volatile, a POSITA would have understood that storing calibration parameters for future use would require non-volatile storage to retain the values when power is removed from the display. (EX1005, ¶ 92).

b) Greene (EX1006)

Greene discloses this limitation. (EX1005, ¶ 93). Greene describes storing correction parameters in non-volatile random-access memory (NV-RAM). (EX1011, 10:14-36; EX1005, ¶ 93). These stored parameters are used to scale and interpolate drive signals in real time, which a POSITA would have understood effectively serve as gamma reference voltage levels. (EX1011, 4:45-58; EX1005, ¶ 93). The use of NV-RAM ensures the storage is both electrically reprogrammable and non-volatile, as required by the gamma reference control capability described in limitation 1[1]. (EX1011, 10:14-36; EX1005, ¶ 93).

B. Claim 2: The method of claim 1 wherein the method is repeated more than once under different ambient display conditions to generate at least one different set of gamma reference voltage levels stored in said gamma reference control capability.

1. Liaw (EX1005)

Liaw renders obvious repeating the method more than once under different ambient display conditions to generate multiple sets of gamma reference voltage levels stored in the gamma reference control capability. (EX1003, ¶ 94). Liaw discloses the system can be used with adjusting means for luminance, contrast, and color temperature and a back-lighting control unit. (EX1005, 3:5-8; EX1003, ¶ 94). This indicates the ability to calibrate under different ambient conditions. The memory can store "at least one gray-scale-to-luminance destination curve", suggesting multiple curves for different conditions. (EX1005, 2:65-67; EX1003, ¶ 94). A POSITA would have understood the calibration process could be repeated for different ambient settings (e.g. luminance, color temperature) to generate and store multiple optimized gamma reference voltage sets, allowing optimal display performance across various usage scenarios. (EX1003, ¶ 94).

2. Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 95). Greene teaches that the measurement of primary luminance variations can be repeated after a period of usage to compensate for display aging. (EX1006, 8:16-24; EX1003, ¶ 95). This implies repeating the method under different conditions, as the display characteristics change over time. Greene further discloses that the correction methods can address non-uniformities from uneven aging (EX1006, 4:45-58; EX1003, ¶ 95), and describes a self-calibrating function that can be initiated periodically (EX1006, 4:59-63; EX1003, ¶ 95). A POSITA would have understood these teachings to disclose repeating the calibration process multiple times as the display ages to generate updated correction parameters stored in the non-volatile memory. (EX1006, 7:41-8:4; EX1003, ¶ 95).

C. Claim 3

1. Limitation 3[0]: A method of programming one or more gamma reference voltage generator integrated circuits attached to a liquid crystal display comprising the steps:

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 96). The system includes a programmable gamma voltage generating means (30) composed of a digital-to-analog converter (DAC) and buffers that generates adjustable gamma reference voltages for a liquid crystal display. (EX1005, 1:7-13, 1:62-2:8, 6:57-7:5, Fig. 7A; EX1003, ¶ 96). While not explicitly stated as "attached," a POSITA would have understood the gamma voltage generating means must be connected to the display to provide the reference voltages, which is equivalent to being attached. (EX1003, ¶ 96). The method comprises steps for optimizing and programming these gamma reference voltages, as detailed in the subsequent limitations. (EX1005, 9:6-12, Fig. 14; EX1003, ¶ 96).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 97). While Greene does not explicitly use the term “gamma reference voltage generator integrated circuits,” it describes luminance scaler/adder circuitry that performs an equivalent function of adjusting pixel drive signals to correct for non-uniformities in liquid crystal displays. (EX1011, 1:8-13, 2:43-55, 10:59-11:4, Fig. 4; EX1003, ¶ 97). This circuitry is attached to the display and programmed with correction values stored in memory, analogous to programming gamma reference voltage generators. (EX1011, 4:14-24, 10:14-36; EX1003, ¶ 97). A POSITA would have understood the luminance correction circuitry of Greene to be functionally equivalent to gamma reference voltage generators for LCDs, as both serve to adjust the brightness response of the display to achieve desired uniformity. (EX1003, ¶ 97).

2. Limitation 3[1]: a. selecting one or more columns on said liquid crystal display;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 98). The system includes programmable switches (41-43) connected to a switch control unit (40) that interconnects the switches and voltage dividing circuit with corresponding gray-scale values. (EX1005, 6:57-7:5, Fig. 7A; EX1003, ¶ 98). The switch control unit applies gamma reference voltages to specific divided voltage points according to gray-scale signals from the CPU. (EX1005, 7:6-12; EX1003, ¶ 98). While Liaw does not explicitly use the term “columns”, a POSITA would have understood that applying voltages to specific points in the voltage dividing circuit is equivalent to selecting columns, as these voltage points correspond to columns in the display. (EX1003, ¶ 98).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 99). Greene explicitly describes applying luminance scaling/correction to columns of pixels, stating “luminance scalers/adders 62 are placed into a pixel stream 64 associated with each column driver 66.” (EX1006, 11:5-7, Fig. 5; EX1003, ¶ 99). This indicates that columns of the display are selected for correction. The column-based correction is further evidenced by Greene’s description of parallel implementation where “scalers/adders 62 and memories 68 can be integrated into the column driver circuit 66.” (EX1006, 11:12-15, Fig. 5; EX1003, ¶ 99).

3. Limitation 3[2]: b. applying one or more different gamma voltages to said liquid crystal display columns;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 100). The programmable gamma voltage generating means (30) generates a set of gamma reference voltages that are output to the programmable switches (41-43). (EX1005, 5:39-6:5, Fig. 7A; EX1003, ¶ 100). These gamma reference voltages are then applied to corresponding divided voltage points in the voltage dividing circuit (50) by the switch control unit (40) according to gray-scale signals. (EX1005, 7:6-16, Fig. 7A; EX1003, ¶ 100). A

POSITA would have understood that applying different voltages to different points in the voltage dividing circuit is equivalent to applying different gamma voltages to different columns of the display, as the voltage dividing circuit outputs correspond to display columns. (EX1005, 8:5-16, Fig. 13; EX1003, ¶ 100).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 101). While Greene does not explicitly use the term "gamma voltages", it describes adjusting drive signals applied to pixels in columns to correct for luminance non-uniformities. (EX1006, 1:41-54, 10:59-11:4, Fig. 5; EX1003, ¶ 101). A POSITA would have understood these drive signals in an LCD to be gamma voltages that control pixel brightness. Greene states "the drive voltage administered to each color element may be adjusted" (EX1006, 9:59-10:3), which directly corresponds to applying different gamma voltages to display columns. (EX1003, ¶ 101). The column-based nature of the correction is evident from Greene's description of "luminance scalers/adders 62 are placed into a pixel stream 64 associated with each column driver 66." (EX1006, 11:5-7, Fig. 5; EX1003, ¶ 101).

4. Limitation 3[3]: c. storing said applied gamma voltages in reprogrammable, nonvolatile cells in said gamma reference voltage generator integrated circuits appropriate to said selected columns;

a) Liaw (EX1005)

Liaw does not expressly disclose storing the applied gamma voltages in reprogrammable, nonvolatile cells in the gamma reference voltage generator integrated circuits. (EX1003, ¶ 102). However, a POSITA would have found it obvious to modify Liaw's system to store the gamma voltages in such memory within the gamma voltage generating means (30). Liaw discloses storing gamma reference voltages in memory (21) (EX1005, 5:39-46, Fig. 7A), and a POSITA would have recognized the benefits of using reprogrammable, nonvolatile memory in the gamma voltage generator itself to retain calibrated voltages when powered off and allow easy updates. (EX1003, ¶ 102). This modification would predictably improve Liaw's system by enabling persistent storage of optimized gamma voltages directly in the voltage generation circuitry. (EX1003, ¶ 102).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 103). Greene describes storing correction values for each pixel in non-volatile random-access memory (NV-RAM) after measuring luminance. (EX1006, 10:14-36; EX1003, ¶ 103). While not explicitly called "gamma reference voltage generator integrated circuits," a POSITA would have understood the stored correction values to be equivalent to gamma voltages, and the NV-RAM storing these values for each pixel to function as reprogrammable, nonvolatile cells. (EX1003, ¶ 103). The column-specific nature is evident from Greene's description of integrating memories into column driver circuits. (EX1006, 11:5-19, Fig. 5; EX1003, ¶ 103).

5. Limitation 3[4]: d. operating means for executing one or more optimization criteria algorithms based on optical emission corresponding to said selected columns, wherein said means for executing said one or more optimization criteria algorithms is separate from said liquid crystal display;

a) Liaw (EX1005)

Liaw discloses this limitation (EX1003, ¶ 104). The main controller (20) includes a CPU (22) that executes optimization algorithms to determine gamma reference voltages based on voltage-to-luminance data from optical sensors (11-13). (EX1006, 6:38-56, 5:62-6:12, Fig. 7A; EX1003, ¶ 104). This optimization process aims to fit the transfer curve to a desired gamma curve for the selected display columns. (EX1006, 7:46-8:4; EX1003, ¶ 104). The main controller and CPU are clearly separate components from the display itself, as shown in Figure 7A. (EX1006, Fig. 7A; EX1003, ¶ 104).

b) Greene (EX1006)

Greene discloses this limitation (EX1003, ¶ 105). Greene describes using photo-sensing means to measure luminance variations across pixels (EX1006, 8:7-9; EX1003, ¶ 105). These measurements are used in algorithms to determine correction values, as Greene states: "The correction methods incorporate the measurement of the brightness characteristics of the display" (EX1006, 4:34-36;

EX1003, ¶ 105). The algorithms are executed by control circuitry separate from the display, as evidenced by the luminance scaler/adder means depicted apart from the LCD array in Figure 4 (EX1006, Fig. 4, 7:41-8:4; EX1003, ¶ 105).

6. Limitation 3[5]: e. modifying said one or more different applied gamma voltages based on said one or more optimization criteria algorithms;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 106). The CPU (22) optimizes and evaluates gamma reference voltages using predetermined algorithms, then delivers signals representing these optimized gamma voltages to the programmable gamma voltage generating means (30). (EX1005, 6:48-56, Fig. 7A; EX1003, ¶ 106). This process of optimizing and then delivering new gamma voltages to the voltage generating means modifies the applied gamma voltages based on the optimization algorithms. (EX1003, ¶ 106). The voltage generating means (30) then outputs these modified gamma voltages to the programmable switches (41-43) for application to the display columns. (EX1005, 6:57-7:5, Fig. 7A; EX1003, ¶ 106).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 107). Specifically, Greene describes adjusting drive signals (equivalent to gamma voltages in LCDs) based on measured luminance variations and calculated correction values. (EX1006, 1:41-54, 10:59-11:4; EX1003, ¶ 107). This adjustment process utilizes optimization criteria to reduce luminance non-uniformities below a detection threshold. (EX1006, 4:45-

58; EX1003, ¶ 107). A POSITA would have understood that the luminance scaler/adder means (56) in Greene's system performs this modification by applying the stored correction parameters to the input video signal in real-time, effectively modifying the gamma voltages applied to the display columns. (EX1006, Fig. 4, 10:59-11:4; EX1003, ¶ 107).

7. Limitation 3[6]: f. programming said applied gamma voltages in storage cells in said gamma reference voltage generator integrated circuits appropriate to said selected columns; and

a) Liaw (EX1005)

A POSITA would have found it obvious to modify Liaw's system to program the applied gamma voltages in storage cells in the gamma reference voltage generator integrated circuits appropriate to the selected columns. (EX1003, ¶ 108). While Liaw discloses delivering optimized gamma voltages to the programmable gamma voltage generating means (30), it does not explicitly state these voltages are programmed into storage cells within the means itself. (EX1005, 6:48-56, Fig. 7A; EX1003, ¶ 108). However, a POSITA would recognize the benefits of storing the optimized voltages locally in the gamma voltage generator, such as retaining calibrated values when powered off and allowing quick access during display operation. (EX1003, ¶ 108).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 109). While not using those exact terms, Greene describes storing correction values (equivalent to gamma voltages) in non-volatile random-access memory (NV-RAM) for each pixel/column. (EX1011, 10:14-18; EX1003, ¶ 109). A POSITA would have understood this process of storing correction values in NV-RAM to be functionally equivalent to programming gamma reference voltage generators for the selected columns, as these stored values are used to adjust drive signals (gamma voltages) in real-time. (EX1011, 4:45-58, 10:59-11:4, Fig. 5; EX1003, ¶ 109). The column-specific nature is evident from Greene's description of integrating memories into column driver circuits. (EX1011, 11:12-15, Fig. 5; EX1003, ¶ 109).

8. Limitation 3[7]: g. repeating steps (d) through (f) until said one or more optimization criteria have been satisfied.

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 110). Liaw describes that the process of optimizing gamma voltages, modifying the voltages, and applying the new voltages can be repeated until reaching "the determined value". (EX1005, 5:5-7, Fig. 15A; EX1003, ¶ 110). While Liaw does not use the exact phrase "optimization criteria," a POSITA would have understood that reaching "the determined value" is equivalent to satisfying optimization criteria. (EX1003, ¶ 110). The iterative process shown in Figure 15A, where steps are repeated until reaching determined values, further illustrates this concept of repeating optimization steps until criteria are met. (EX1005, Fig. 15A; EX1003, ¶ 110).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 111). Greene describes an iterative process of measuring, calculating corrections, and adjusting drive signals until luminance non-uniformities are reduced below a detection threshold. (EX1006, 4:45-58; EX1003, ¶ 111). This corresponds to repeating the optimization, modification, and programming steps. Greene also explicitly describes repeating the measurement and correction process to compensate for aging of the display over time (EX1006, 11:20-24; EX1003, ¶ 111), further evidencing the iterative nature of the calibration method.

D. Claim 5

1. Limitation 5[0]: A method for a liquid crystal display, comprising:

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 112). Liaw describes an automatic gamma correction system and method specifically for liquid crystal displays (LCDs). (EX1005, 1:7-13, 1:15-34; EX1003, ¶ 112).

b) Greene (EX1006)

Greene discloses this limitation (EX1003, ¶ 113). While Greene does not explicitly state the display is a liquid crystal display, Greene indicates the methods apply to all electronic gray-tone and color displays, irrespective of their construction, including liquid crystal displays (LCDs). (EX1011, 1:8-13, 1:55-2:15; EX1003, ¶ 113). A POSITA would have understood Greene's methods to be directly applicable to and usable with liquid crystal displays, as LCDs are a common type of electronic color display that suffers from brightness non-uniformities due to manufacturing variations, which Greene's methods aim to correct. (EX1011, 1:41-54, 4:8-22; EX1003, ¶ 113).

2. Limitation 5[1]: providing said liquid crystal display with gamma reference control capability which is electrically reprogrammable and non-volatile;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 114). Liaw's system includes a programmable gamma voltage generating means (30) that generates adjustable gamma reference voltages based on values from the main controller. (EX1005, 5:62-6:12, Fig. 7A; EX1003, ¶ 114). This gamma voltage generating means is implemented using a digital-to-analog converter (DAC) connected to buffers, allowing it to be electrically reprogrammed. (EX1005, 8:29-34, Fig. 11; EX1003, ¶ 114). While Liaw does not explicitly state the storage is non-volatile, the system includes memory (21) for storing gamma reference voltages (EX1005, 6:21-36, Fig. 7A; EX1003, ¶ 114). A POSITA would have understood that storing calibration parameters for future use would require non-volatile storage to retain the values when power is removed from the display. (EX1003, ¶ 114).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 115). Greene describes storing correction parameters in non-volatile random-access memory (NV-RAM) to adjust pixel luminances. (EX1006, 4:3-6; EX1003, ¶ 115). These stored parameters are used to scale and interpolate drive signals in real-time, effectively providing gamma reference control for an LCD. (EX1006, 4:34-44; EX1003, ¶ 115). The storage is reprogrammable, as Greene indicates measurements and adjustments can be repeated to compensate for display aging. (EX1006, 11:20-24; EX1003, ¶ 115). While Greene does not use the term "gamma reference control," a POSITA would have understood the luminance adjustment based on stored values to be functionally equivalent for an LCD. (EX1003, ¶ 115).

3. Limitation 5[2]: calibrating said liquid crystal display comprising:

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 116). The entire system and method described by Liaw focuses on automatic gamma parameter correction for LCDs. (EX1005, 1:7-13, 8:29-34; EX1003, ¶ 116). This gamma correction process involves testing the display with sensors (11-13), varying gamma reference voltages using the programmable gamma voltage generating means (30), optimizing those voltages using the CPU (22), and storing the optimized values. (EX1005, 5:62-6:12, Fig. 7A); EX1003, ¶ 116.

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 117). The entire method described by Greene is a calibration process for correcting spatial non-uniformities in luminance across the display. (EX1011, 1:41-54; EX1003, ¶ 117). This process involves measuring luminance variations, determining and storing associated correction values, and using those values to adjust pixel luminances in real-time. (EX1011, 1:55-3:2, 4:45-58; EX1003, ¶ 117). A POSITA would have understood this luminance correction process to be equivalent to calibrating the gamma response of an LCD, as it adjusts the brightness characteristics to achieve a desired uniform output across the display. (EX1003, ¶ 117).

4. Limitation 5[3]: a. testing said liquid crystal display with at least one sensor with optical input;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 118). Liaw's system includes sensors (11-13) that can be disposed inside or outside the display to obtain voltage-to-luminance curves. (EX1005, 5:62-6:12, Fig. 7A; EX1003, ¶ 118). These sensors can be light sensors used to measure luminance parameters of the display. (EX1005, 6:13-20; EX1003, ¶ 118). A POSITA would have understood that light sensors have optical input to detect light emitted by the display. (EX1003, ¶ 118). The sensors are used to test the display by measuring its optical output characteristics during the gamma correction process. (EX1005, 9:47-10:3, Fig. 14; EX1003, ¶ 118).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 119). Greene describes using "photo-sensing means" to measure luminance variations across pixels of the display.

(EX1011, 7:55-8:4, 11:20-24; EX1003, ¶ 119). A POSITA would have understood this photo-sensing means to be an optical sensor used to test the display's output. Greene further elaborates on this sensor, describing "a photodetector 72 movably mounted (on an x-y arm assembly 74, for example) [that] provides the measured data when scanned over the surface of the screen 76." (EX1011, 11:30-33, Fig. 6; EX1003, ¶ 119). This photodetector clearly constitutes a sensor with optical input used for testing the display. (EX1003, ¶ 119).

5. Limitation 5[4]: b. varying gamma reference voltage levels on columns of said liquid crystal display;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 120). The system uses programmable switches (41-43) connected to a voltage dividing circuit (50) to apply gamma reference voltages to divided voltage points corresponding to display columns. (EX1005, 7:6-31, Fig. 7A; EX1003, ¶ 120). The programmable gamma voltage generating means (30) outputs adjustable gamma reference voltages to the switches, which are then applied to specific points in the voltage dividing circuit under control of the switch control unit (40). (EX1005, 6:57-7:23, Fig. 7A; EX1003, ¶ 120). A POSITA would have understood that applying different voltages to different points in the voltage dividing circuit is equivalent to varying gamma voltages on display columns, as the voltage dividing circuit outputs correspond to display columns. (EX1005, 7:24-28, Fig. 13; EX1003, ¶ 120).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 121). While Greene does not explicitly use the term "gamma reference voltage levels," it describes adjusting drive signals, including voltages, for pixels to correct luminance non-uniformities. (EX1011, 2:1-3, 9:41-48; EX1003, ¶ 121). For an LCD, these drive voltages correspond to gamma reference voltage levels. Greene indicates the corrections can be applied to columns of pixels, stating "luminance scalers/adders 62 are placed into a pixel stream 64 associated with each column driver 66." (EX1011, 11:5-7, Fig. 5; EX1003, ¶ 121). This column-based correction is further evidenced by Greene's description of integrating correction circuitry into column driver circuits. (EX1011, 11:12-15, Fig. 5; EX1003, ¶ 120).

6. Limitation 5[5]: c. optimizing said gamma reference voltage levels using means for executing a predetermined algorithm according to a predetermined criteria and data sensed by said at least one sensor; and

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 122). The main controller (20) includes a CPU (22) that executes optimization algorithms to determine gamma reference voltages based on the voltage-to-luminance data from the sensors (11-13) and predetermined criteria like desired luminance and contrast. (EX1005, 5:62-6:12, 8:17-28, Fig. 7A; EX1003, ¶ 122). This optimization process aims to fit the transfer curve to a desired gamma curve for the display. (EX1005, 5:39-61; EX1003, ¶ 122). While Liaw does not use the exact phrase "predetermined algorithm", a POSITA would have understood the described optimization process to be equivalent to executing such an algorithm to achieve the desired gamma characteristics. (EX1003, ¶ 122).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 123). Greene describes using luminance scaler/adder means to modify input signals based on stored correction parameters derived from sensor measurements. (EX1011, 2:33-55, 10:59-11:4, Fig. 4; EX1003, ¶ 123). This process optimizes the drive signals (corresponding to gamma reference voltage levels) according to predetermined criteria to correct luminance non-uniformities below a detection threshold. (EX1011, 4:45-58; EX1003, ¶ 123). The luminance scaler/adder 56 in Figure 4 executes this predetermined optimization algorithm using the stored parameters and input video signal to generate normalized output signals. (EX1011, Fig. 4, 10:59-11:4; EX1003, ¶ 123).

7. Limitation 5[6]: d. storing said gamma reference voltage levels in said gamma reference control capability;

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 124). The main controller (20) includes a memory (21) for parameter calculation and data storage. (EX1005, 5:57-59, Fig. 7A; EX1003, ¶ 124). The memory (21) can store the Gamma reference voltages evaluated by the central process unit. (EX1005, 6:2-4; EX1003, ¶ 124).

While Liaw does not explicitly state the storage is non-volatile, a POSITA would have understood that storing calibration parameters for future use would require non-volatile storage to retain the values when power is removed from the display. (EX1003, ¶ 124).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 125). Greene describes storing correction parameters in non-volatile random-access memory (NV-RAM) for each pixel/column. (EX1011, 10:14-36; EX1003, ¶ 125). For a liquid crystal display, these stored correction parameters correspond to gamma reference voltage levels, as they are used to adjust drive signals (gamma voltages) in real-time to correct luminance non-uniformities. (EX1011, 4:45-58, 10:59-11:4; EX1003, ¶ 125). The use of NV-RAM ensures the storage is both electrically reprogrammable and non-volatile, as required by the gamma reference control capability. (EX1011, 10:14-36; EX1003, ¶ 125).

8. Limitation 5[7]: retrieving said gamma reference voltage levels from said gamma reference control capability; and

a) Liaw (EX1005)

A POSITA would have understood that Liaw implicitly discloses this limitation. (EX1003, ¶ 126). While Liaw does not explicitly state that stored gamma values are retrieved, a POSITA would recognize this step is necessary to utilize the optimized values. Liaw discloses storing optimized gamma reference voltages in memory (21) for subsequent use in driving the display. (EX1006, 2:61-3:8, Fig. 7A; EX1003, ¶ 126). For these stored values to be applied to the display columns via the programmable gamma voltage generating means (30) and voltage dividing circuit (50), they must first be retrieved from memory. (EX1006, 3:9-23, Fig. 7A; EX1003, ¶ 126). Without retrieval, the stored optimized values could not be utilized to achieve the desired gamma correction, rendering the calibration process futile. (EX1003, ¶ 126).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 127). While Greene does not explicitly describe a retrieval step, it discloses that the stored correction parameters are used by the luminance scaler/adder means to modify input signals in real-time. (EX1006, 4:34-44, 4:59-63, 10:59-11:4, Fig. 4; EX1003, ¶ 127). A POSITA would have understood that this real-time use of stored parameters necessarily involves retrieving them from the non-volatile memory where they are stored. (EX1003, ¶ 127). The luminance scaler/adder (56) in Figure 4 could not apply the stored correction factors to modify the input video signal without first retrieving those values from memory. (EX1003, ¶ 127).

9. Limitation 5[8]: displaying an image on said liquid crystal display based on said gamma reference voltage levels.

a) Liaw (EX1005)

Liaw discloses this limitation. (EX1003, ¶ 128). The entire purpose of Liaw's gamma correction system is to improve image quality on liquid crystal displays. (EX1005, 1:7-13; EX1003, ¶ 128). After optimizing and storing the gamma reference voltages, the voltage dividing circuit (50) outputs voltages to output buffers (60) according to input gray-scale values of the image, using the optimized gamma reference voltages. (EX1005, 10:32-34, Fig. 7A; EX1003, ¶ 128). These output buffers then drive the display columns to produce the image with corrected gamma characteristics. (EX1005, 7:24-31, Fig. 7A; EX1003, ¶ 128). While not explicitly stated, a POSITA would have understood that applying these optimized voltages to the display columns results in displaying an image based on the calibrated gamma reference voltage levels. (EX1003, ¶ 128).

b) Greene (EX1006)

Greene discloses this limitation. (EX1003, ¶ 129). Greene describes applying corrected drive signals to adjust primary luminances of color spaces associated with pixels in the display to match luminances and correct spatial non-uniformities (EX1006, 7:54-63; EX1003, ¶ 129). A POSITA would have understood that this process of applying corrected drive signals to ensure uniform brightness necessarily involves displaying an image on the LCD using those corrected signals. (EX1003, ¶

129). Greene further explains that the correction methods are used to display moving images at a predetermined refresh rate (EX1006, 6:65-7:3; EX1003, ¶ 129).

E. Claim 6: The method of claim 5, wherein the calibrating step is repeated more than once under different ambient display conditions to generate at least one different set of gamma reference voltage levels stored in said gamma reference control capability.

Claim 6 is substantially identical to Claim 2, and the analysis provided above regarding Liaw and Greene at *supra,* § IX.B applies equally to Claim 6.

XIV. Ground 2: Claims 1-3 and 5-6 Are Invalid Over Greene in view of Da Costa

A POSITA would have been motivated to combine Greene with Da Costa to arrive at the claimed features. (EX1003, ¶ 131). Greene discloses a method for correcting spatial non-uniformities in brightness for electronic displays, including LCDs,. (EX1011, Abstract, 1:15-17; EX1003, ¶ 131). Da Costa teaches a smart controller chip with integrated analog and digital circuitry for flexible gamma control in active matrix displays. (EX1005, 2:35-46; EX1003, ¶ 131). A POSITA would be motivated to incorporate Da Costa's programmable gamma reference control capability into Greene's system to achieve more precise and dynamic brightness correction. (EX1003, ¶ 131).

Specifically, a POSITA could have modified Greene's luminance scaler/adder circuitry to include Da Costa's programmable registers and D/A converters for storing and generating gamma reference voltages. (EX1005, 7:51-56, Fig. 7A;

EX1003, ¶ 131). This modification would be a simple substitution of one known element (Greene's generic luminance scaling) for another (Da Costa's specific gamma voltage generation) to obtain predictable results of improved display uniformity. (EX1011, 10:59-11:4; EX1005, 8:12-23; EX1003, ¶ 131)

The combination would benefit from Da Costa's ability to store multiple gamma curves and dynamically switch between them, allowing for compensation of both manufacturing variations and environmental changes. (EX1005, 11:15-33; EX1003, ¶ 132). This aligns with Greene's goal of correcting both gradual and abrupt non-uniformities in displays. (EX1011, 4:8-22; EX1003, ¶ 132)

Furthermore, integrating Da Costa's host system interface into Greene's setup would enable software-controlled optimization of gamma reference levels. (EX1005, 5:1-12; EX1003, ¶ 133). This would enhance Greene's ability to perform iterative corrections and adapt to changing display conditions over time. (EX1011, 11:20-24; EX1003, ¶ 133)

The combined system would maintain Greene's optical sensing capabilities for measuring display output (EX1011, 11:30-33), but leverage Da Costa's programmable architecture to more efficiently implement the correction algorithms. (EX1003, ¶ 134). This integration represents an application of a known technique (Da Costa's programmable gamma control) to improve a similar device (Greene's display correction system) in the same way, yielding predictable improvements in display uniformity and adaptability. (EX1003, ¶ 134).

A limitation-by-limitation analysis of Greene is provided *supra*, at § IX, and is not repeated here. Below is a limitation-by-limitation analysis of DaCosta.

A. Claim 1

1. Limitation 1[0]

Da Costa discloses this limitation. (EX1003, ¶ 137). The reference teaches a system and method for controlling an active matrix display that allows for flexible and dynamic adjustment of display characteristics such as gamma. (EX1007, 2:31-34, 11:15-33; EX1003, ¶ 137).

2. Limitation 1[1]

Da Costa discloses this limitation. (EX1003, ¶ 138). The smart controller chip contains programmable registers for storing digital values corresponding to gamma reference voltages. (EX1007, 7:66-8:3, Fig. 7A) These registers can be programmed via an external PROM or internal flash memory, both of which are non-volatile storage. (EX1007, 4:57-67, 6:45-50)

3. Limitation 1[2]

Da Costa mentions compensating for environmental changes (EX1007, 11:34-46), which suggests using an external optical sensor to test the display. (EX1003, ¶ 139). A POSITA would have understood that some form of external testing or sensing capability could be used to detect environmental changes and optimize display parameters. (EX1003, ¶ 139).

4. Limitation 1[3]

Da Costa discloses this limitation. The smart controller chip (202 or 302) adjusts analog reference levels provided to the column drivers (108 or 354) of the display (110). (EX1007, Fig. 2, Fig. 3A, Fig. 3B; EX1003, ¶ 140). This adjustment is performed by multiplexer circuitry (413) and digital-to-analog converter circuitry (416 or 450) within the controller, which selects digital values from registers (410) and converts them to the necessary analog voltages for the display columns. (EX1007, 7:22-27, 8:12-23, Figs. 7A-B; EX1003, ¶ 140). The smart controller chip is clearly shown as a separate component from the display in the system diagrams. (EX1007, Fig. 2, Fig. 3A, Fig. 3B; EX1003, ¶ 140)

B. Claim 3

1. Limitation 3[0]

Da Costa discloses this limitation. (EX1003, ¶ 141). The smart controller chip (202 or 302) contains programmable registers (410) for storing digital values corresponding to gamma reference voltages. (EX1007, 7:51-56, Fig. 7A; EX1003, ¶ 141). These registers can be programmed via an external PROM (206) or internal flash memory (303), allowing the gamma reference values to be set for the display. (EX1007, 5:30-39, 6:56-61; EX1003, ¶ 141). The stored digital values are used to generate analog reference levels that drive the column drivers (108 or 354) of the attached liquid crystal display (110). (EX1007, 2:47-59, 8:12-23, Figs. 2, 3A, 3B; EX1003, ¶ 141)

2. Limitation 3[1]

Da Costa discloses this limitation. (EX1003, ¶ 142). The smart controller chip (202 or 302) generates column control signals and display data that are sent to the column drivers (108 or 354). (EX1007, Figs. 2, 3A, 3B; EX1003, ¶ 142). These column drivers are connected to and drive the column electrodes of the display (110). (EX1007, 4:38-49, Fig. 2; EX1003, ¶ 142). A POSITA would have understood that the process of sending specific control signals and data to particular column drivers inherently involves selecting which columns of the display to activate and program with certain voltage levels. (EX1003, ¶ 142). This column selection is a fundamental aspect of how active matrix displays operate to create images by addressing individual pixels. (EX1003, ¶ 142)

3. Limitation 3[2]

Da Costa discloses this limitation. (EX1003, ¶ 143). The smart controller chip (202 or 302) generates analog reference levels using integrated digital-to-analog converters (416 or 450). (EX1007, 8:55-66, Figs. 4A, 4B; EX1003, ¶ 143). These reference levels are sent to the column drivers (108 or 354), which apply the corresponding voltages to the display columns. (EX1007, 4:38-56, 6:35-41, Figs. 2, 3A, 3B; EX1003, ¶ 143).

4. Limitation 3[3]

Da Costa discloses this limitation. (EX1007, 7:66-8:3, Fig. 7A; EX1003, ¶ 144). While it does not use the words "nonvolatile storage cells for gamma voltages," it does disclose that the registers can be programmed via an external PROM or internal flash memory, which a POSITA would recognize as "nonvolatile storage cells." (EX1007, 4:57-67, 6:45-50; EX1003, ¶ 144).

C. Claim 5

1. Limitation 5[0]

Da Costa discloses this limitation. (EX1003, ¶ 145). The reference describes a system and method for controlling an active matrix display, which includes liquid crystal displays, using a smart controller chip that integrates both digital and analog control capabilities. (EX1007, 1:10-28, 2:35-3:2; EX1003, ¶ 145).

2. Limitation 5[1]

Da Costa discloses this limitation. (EX1003, ¶ 146). The smart controller chip contains programmable registers for storing digital values corresponding to gamma reference voltages. (EX1007, 4:50-56, Fig. 7A; EX1003, ¶ 146). These registers can be programmed via an external PROM or internal flash memory, both of which are non-volatile storage. (EX1007, 2:47-56, 4:45-50; EX1003, ¶ 146). The gamma reference values can be dynamically modified by software in the host system, enabling electrical reprogramming. (EX1007, 5:1-12, 11:15-33; EX1003, ¶ 146).

3. Limitation 5[2]

Da Costa discloses this limitation. (EX1003, ¶ 147). The smart controller chip allows for dynamic modification of analog reference levels through programmable registers, which can be updated by software in the host system. (EX1007, 6:26-33, 11:15-33; EX1003, ¶ 147). This process enables calibration to compensate for manufacturing variations and environmental changes, allowing the display characteristics to be optimized for particular applications or conditions. (EX1007, 2:19-27, 5:1-12; EX1003, ¶ 147).

4. Limitation 5[4]

Da Costa discloses this limitation. (EX1003, ¶ 148). The smart controller chip (202 or 302) contains programmable registers (410) that store digital values corresponding to gamma reference voltages. (EX1007, 7:51-56, Fig. 7A; EX1003, ¶ 148). These digital values are converted to analog reference levels by D/A converters (416 or 450) and sent to the column drivers (108 or 354) to drive the display columns. (EX1007, 7:22-27, 8:12-23, Figs. 2, 3A, 3B; EX1003, ¶ 148). The system allows for dynamic modification of these levels by the host system software, enabling real-time adjustment of gamma reference voltages applied to the display columns. (EX1007, 5:1-12, 11:15-33; EX1003, ¶ 148)

5. Limitation 5[5]

Da Costa discloses this limitation. (EX1003, ¶ 149). The smart controller chip allows dynamic adjustment of gamma reference voltages through software in the host system. (EX1007, 5:1-12, 11:15-33; EX1003, ¶ 149). This capability enables optimizing display characteristics for specific applications or environmental conditions according to predetermined criteria. (EX1007, 5:1-12; EX1003, ¶ 149). While Da Costa does not expressly mention using sensor data, a POSITA would have understood that environmental data could be input to the optimization process to achieve desired display performance. (EX1003, ¶ 149).

6. Limitation 5[6]

Da Costa discloses this limitation. (EX1003, ¶ 150). The smart controller chip contains programmable registers for storing digital values corresponding to gamma reference voltages. (EX1007, 7:51-56, Fig. 7A; EX1003, ¶ 150). These registers can be programmed via an external PROM or internal flash memory, both of which are non-volatile storage. (EX1007, 4:57-67, 6:45-50; EX1003, ¶ 150). The stored digital values are then used to generate the analog reference levels that drive the column drivers, allowing the calibrated gamma settings to be retained and utilized by the display system. (EX1007, 2:47-59, 7:66-8:11; EX1003, ¶ 150).

7. Limitation 5[7]

Da Costa discloses this limitation. (EX1003, ¶ 151). The smart controller chip uses programmable registers to store digital values corresponding to gamma reference voltages. (EX1007, 6:62-7:9, Fig. 7A; EX1003, ¶ 151). These stored values are necessarily retrieved and converted to analog reference levels by the D/A converters (416 or 450) to drive the column drivers (108 or 354). (EX1007, 7:22-27, 8:12-23, Figs. 2, 3A, 3B; EX1003, ¶ 151). A POSITA would have understood that the controller must retrieve the stored digital values to generate the appropriate analog voltages for display operation, as this retrieval is fundamental to the controller's ability to dynamically adjust and utilize the stored gamma levels. (EX1007, 2:60-3:8, 11:15-33; EX1003, ¶ 151)

8. Limitation 5[8]

Da Costa discloses this limitation. (EX1003, ¶ 152). The smart controller chip (202 or 302) uses the stored gamma reference values to generate analog reference levels that are provided to the column drivers (108 or 354). (EX1007, 7:66-8:11, Figs. 2, 3A, 3B; EX1003, ¶ 152). These column drivers then apply the corresponding voltages to the display columns to produce the desired image. (EX1007, 1:19-28, 8:25-38; EX1003, ¶ 152).

XV. Ground 3: Claims 1-2, 5-6 Are Invalid Over Liaw, in in view of Greene, in further view of Matsui

A POSITA would have been motivated to combine Liaw with Greene and Matsui to arrive at the claimed features. (EX1003, ¶ 153). Specifically, a POSITA would have been motivated to incorporate Greene's separate optical sensor and optimization algorithm into Liaw's system to improve calibration accuracy. (EX1003, ¶ 153). Greene teaches using "a photodetector 72 movably mounted (on an x-y arm assembly 74, for example) [that] provides the measured data when scanned over the surface of the screen 76" (EX1007, 11:30-33; EX1003, ¶ 153). This separate sensor allows for precise measurement of display output, which a POSITA would have recognized as beneficial for Liaw's goal of correcting "spatial non-uniformities in brightness that arise from materials, manufacturing, operational and lighting parameter variations" (EX1006, Abstrac; EX1003, ¶ 153t). Incorporating Greene's separate sensor and optimization means would have been a simple substitution of one known element for another to obtain predictable improvements in calibration precision. (EX1003, ¶ 153).

Furthermore, a POSITA would have been motivated to incorporate Matsui's teaching of repeating calibration under different ambient conditions into Liaw's system. (EX1003, ¶ 154). Matsui discloses automatically adjusting luminance based on detected external light intensity (EX1008, 3:1-6) and display tilt (EX1008, 3:7-14; EX1003, ¶ 154). A POSITA would have recognized that combining this feature with Liaw's system would allow for dynamic optimization of display performance across various usage scenarios, addressing Liaw's concern with "ambient illumination affect[ing] the contrast of the displayed image" (EX1006, 2:56-3:2; EX1003, ¶ 154). This combination would have been obvious to try, as it would involve choosing from a finite number of identified, predictable solutions (i.e., static vs. dynamic calibration) to yield the predictable result of improved display performance under varying conditions. (EX1003, ¶ 154).

The combination would yield a system that uses a separate optical sensor to measure display output, executes optimization algorithms based on that data, and repeats the calibration process under different ambient conditions - all features of the claimed invention. (EX1003, ¶ 155). This combination would have been within the technical grasp of a POSITA and would have yielded predictable results, supporting a conclusion of obviousness. (EX1003, ¶ 155).

A limitation-by-limitation analysis for Liaw and Greene is already provided *supra*, at § IX. Below is a limitation-by-limitation analysis of Matsui.

A. Claim 1

1. Limitation 1[0]

Matsui discloses this limitation. (EX1003, ¶ 157). Specifically, Matsui teaches a luminance adjusting apparatus for adjusting the gamma correction curve of a liquid crystal display to achieve a desired luminance output. (EX1008, Abstract, 1:7-10, 6:6-14; EX1003, ¶ 157). While Matsui does not explicitly state this is to compensate for manufacturing variations, a POSITA would have understood that adjusting the gamma curve for each individual display panel compensates for panel-to-panel variations that occur during manufacturing. (EX1003, ¶ 157).

2. Limitation 1[1]

Matsui discloses this limitation. (EX1003, ¶ 158). Specifically, Matsui teaches a variable gamma correction circuit 12 that can change inflection points of a gamma correction curve. (EX1008, 10:7-11, Fig. 3; EX1003, ¶ 158). This gamma correction circuit includes transistors and other components that allow the gamma correction to be electrically adjusted. (EX1008, 11:10-26, Fig. 6; EX1003, ¶ 158). While Matsui does not explicitly state the gamma correction settings are non-volatile, a POSITA would have understood that the adjusted settings would need to be retained when power is removed for the adjustments to be useful, implying some form of non-volatile storage. (EX1003, ¶ 158). This understanding is supported by Matsui's teaching that the gamma correction can be optimized for individual displays. (EX1008, 13:58-63; EX1003, ¶ 158).

3. Limitation 1[3]

Matsui discloses varying gamma reference voltage levels on columns of the display by a control circuit separate from the display. (EX1003, ¶ 159). Specifically, the variable gamma correction circuit 12 changes inflection points of the gamma correction curve, which involves adjusting voltage levels applied to the display columns. (EX1008, 10:21-26, 9:39-45; EX1003, ¶ 159). Figure 3 shows the gamma correction circuit 12 as a separate component from the liquid crystal panel 10, and horizontal drivers, which (in this orientation), a POSITA would have understood are column drivers. (EX1008, Fig. 3; EX1003, ¶ 159).

B. Claim 2

Matsui discloses this limitation. (EX1003, ¶ 160). Specifically, Matsui teaches automatically adjusting luminance based on detected external light intensity

(EX1008, 3:1-6, Fig. 4) and display tilt (EX1008, 3:7-14, Fig. 5). (EX1003, ¶ 160). This indicates the gamma correction and voltage adjustment method is repeated as ambient conditions change, generating different gamma reference voltage sets. (EX1003, ¶ 160). While not explicitly stated, a POSITA would have understood these different sets must be stored in the variable gamma correction circuit to enable automatic adjustment based on changing conditions. (EX1003, ¶ 160). The adjustable power sources and reference voltages in Matsui's circuit allow for storing multiple voltage sets (EX1008, 11:35-13:63, Fig. 6; EX1003, ¶ 160).

C. Claim 3

1. Limitation 3[0]

Matsui discloses this limitation. (EX1003, ¶ 161). Specifically, Matsui describes a variable gamma correction circuit 12 that is part of a luminance adjusting apparatus for a liquid crystal display. (EX1008, 10:21-26, Fig. 3; EX1003, ¶ 161). This circuit includes multiple transistors, current sources, and resistances that implement programmable gamma correction functionality. (EX1008, 11:10-13:36, Fig. 6; EX1003, ¶ 161). While not explicitly called an "integrated circuit", a POSITA would have understood that this complex circuit would be implemented as an integrated circuit attached to the display. (EX1003, ¶ 161). Matsui further describes methods of adjusting and programming this gamma correction circuit to achieve desired gamma characteristics for individual displays. (EX1008, 5:55-63, 9:17-26; EX1003, ¶ 161).

2. Limitation 3[1]

Matsui does not expressly disclose selecting one or more columns on the liquid crystal display. (EX1003, ¶ 162). While Matsui describes adjusting gamma correction for the entire display (EX1008, 2:55-3:11), it does not specifically mention selecting individual columns for adjustment. (EX1003, ¶ 162). However, a POSITA would have understood that the gamma correction could be applied selectively to columns if desired, as liquid crystal displays are typically driven on a column-by-column basis using source drivers. (EX1008, Fig. 3, showing horizontal driver 6 connected to liquid crystal panel 10). (EX1003, ¶ 162). The ability to select and adjust individual columns would have been obvious to a POSITA as a way to fine-tune the gamma correction for different areas of the display. (EX1003, ¶ 162).

3. Limitation 3[2]

Matsui discloses this limitation (EX1003, ¶ 163). Specifically, Matsui teaches changing inflection points of a gamma correction curve by adjusting voltages in the variable gamma correction circuit. (EX1008, 6:6-14, Fig. 1; EX1003, ¶ 163). This process involves applying different gamma voltages to achieve the desired gamma correction characteristic. (EX1008, 9:17-13:63, Fig. 6; EX1003, ¶ 163). While Matsui does not explicitly mention applying these voltages to specific columns, a POSITA would have understood that the gamma voltages are applied to drive the display columns via the horizontal driver 6 connected to the liquid crystal panel 10. (EX1008, Fig. 3; EX1003, ¶ 163). Applying different gamma voltages to the columns is necessary to implement the variable gamma correction described by Matsui. (EX1003, ¶ 163).

4. Limitation 3[5]

Matsui discloses this limitation. (EX1003, ¶ 164). Specifically, Matsui teaches automatically adjusting gamma correction parameters based on detected ambient light conditions or display tilt. (EX1008, 10:27-11:6, Figs. 4-5; EX1003, ¶ 164). This adjustment process involves modifying the voltages applied in the variable gamma correction circuit 12 to achieve the desired gamma characteristics. (EX1008, 9:21-13:63, Fig. 6; EX1003, ¶ 164). A POSITA would have understood that implementing such automatic adjustments based on sensor inputs requires executing optimization algorithms to determine appropriate voltage modifications for the display columns. (EX1003, ¶ 164).

D. Limitation 3[6]

Matsui discloses this limitation. (EX1003, ¶ 165). While not explicitly mentioning "storage cells," Matsui teaches a variable gamma correction circuit for adjusting gamma correction parameters. (EX1008, 3:32-42, Fig. 6; EX1003, ¶ 165). A POSITA would have understood that implementing variable gamma correction requires programming voltage values into some form of memory within the gamma correction circuitry. (EX1003, ¶ 165). Though Matsui does not explicitly discuss selected columns, a POSITA would have recognized that gamma voltages would be programmed for appropriate columns to implement the variable gamma correction described. (EX1003, ¶ 165).

E. Claim 5

1. Limitation 5[0]

Matsui discloses this limitation. (EX1003, ¶ 166). Specifically, Matsui teaches a luminance adjusting apparatus and method for adjusting the luminance of a liquid crystal display by changing gamma correction and common voltage. (EX1008, Abstract, 1:7-10; EX1003, ¶ 166).

2. Limitation 5[1]

Matsui discloses this limitation. (EX1003, ¶ 167). Specifically, Matsui teaches a variable gamma correction circuit 12 that can change inflection points of a gamma correction curve. (EX1008, 10:7-11, Fig. 3; EX1003, ¶ 167). This circuit includes components for setting multiple reference voltages as inflection points. (EX1008, 13:18-34, Fig. 1; EX1003, ¶ 167). While not explicitly stated, a POSITA would have understood that the ability to adjust the gamma correction via a manual dial or automatic sensors implies the gamma reference control is electrically reprogrammable. (EX1008, 10:21-26, 9:31-10:6; EX1003, ¶ 167). Though non-volatility is not expressly disclosed, a POSITA would have found it obvious to implement non-volatile storage to maintain optimized settings when power is removed, as this would be necessary for the individual display optimization taught by Matsui. (EX1008, 13:58-63; EX1003, ¶ 167).

3. Limitation 5[2]

Matsui discloses this limitation. (EX1003, ¶ 168). Specifically, Matsui teaches adjusting the gamma correction curve and common voltage to optimize the luminance characteristics of the display. (EX1008, 9:39-45, 10:21-26; EX1003, ¶ 168). This adjustment process involves changing inflection points of the gamma correction curve using the variable gamma correction circuit 12 and synchronously adjusting the common electrode voltage. (EX1008, 10:21-26, 10:43-47, Fig. 3; EX1003, ¶ 168). A POSITA would have understood this process of optimizing the gamma curve and voltage levels for individual displays to be equivalent to calibrating the liquid crystal display. (EX1008, 5:64-6:3; EX1003, ¶ 168).

4. Limitation 5[4]

Matsui discloses this limitation. (EX1003, ¶ 169). Specifically, Matsui teaches changing inflection points of the gamma correction curve by adjusting voltages in the variable gamma correction circuit 12. (EX1008, 6:6-14, Fig. 1; EX1003, ¶ 169). This process involves varying gamma reference voltage levels applied to the display columns, as the gamma correction curve directly determines the voltage-luminance relationship for each column. (EX1008, 1:15-33, Fig. 8; EX1003, ¶ 169). While Matsui does not explicitly mention columns, a POSITA would have understood that the adjusted gamma voltages are applied to drive the display columns via the horizontal driver 6 connected to the liquid crystal panel 10. (EX1008, Fig. 3; EX1003, ¶ 169).

5. Limitation 5[6]

A POSITA would have understood that Matsui discloses storing the gamma reference voltage levels in the gamma reference control capability. (EX1003, ¶ 170). While not explicitly stated, Matsui teaches adjusting gamma correction parameters for individual displays (EX1008, p. 5, lines 29-34), which a POSITA would have recognized requires storing the optimized values to maintain calibration. (EX1003, ¶ 170). The variable gamma correction circuit 12 changes inflection points by adjusting voltages (EX1008, p. 9, lines 21-26, Fig. 2), and these adjusted values must be retained to drive the display with the optimized gamma curve. (EX1003, ¶ 170). Without storage, the carefully tuned gamma correction would be lost after each adjustment, defeating the purpose of Matsui's individualized display optimization. (EX1003, ¶ 170).

6. Limitation 5[8]

Matsui discloses this limitation. (EX1003, ¶ 171). Specifically, Matsui teaches that the variable gamma correction circuit 12 processes input picture signals using the adjusted gamma correction curve to display images on the liquid crystal panel 10 with optimized luminance characteristics. (EX1008, 10:21-26, Fig. 3; EX1003, ¶ 171). The horizontal driver 6 applies the gamma-corrected voltages to the display columns to produce the image with the desired luminance response. (EX1008, 10:27-42, Fig. 3; EX1003, ¶ 171). While not explicitly stated, a POSITA would have understood that displaying images is the fundamental purpose of

Matsui's liquid crystal display apparatus, and that the carefully optimized gamma reference voltages are used to achieve this purpose. (EX1003, ¶ 171).

F. Claim 6

Claim 6 is substantially identical to Claim 2, and the analysis provided *supra*, at § XI.B shows where in Matsui these limitations are found.

XVI. Ground 4: Claims 1-3, and 5-6 Are Invalid Over Liaw in view of DaCosta

A POSITA would have been motivated to combine Liaw with Da Costa to arrive at the claimed features. (EX1003, ¶ 173). Specifically, a POSITA would have been motivated to incorporate Da Costa's programmable registers and digital-to-analog conversion circuitry into Liaw's gamma correction system to provide more flexible and dynamic control over gamma reference voltages. (EX1003, ¶ 173). Liaw discloses a gamma correction system with sensors and optimization algorithms, but lacks the detailed programmable architecture described in Da Costa. (EX1006, 5:62-7:5; EX1003, ¶ 173). Da Costa teaches storing digital gamma values in programmable registers and using D/A converters to generate analog reference voltages. (EX1005, 7:51-56, 8:55-66; EX1003, ¶ 173). This arrangement allows for easy reprogramming and dynamic adjustment of gamma curves. (EX1005, 11:15-33; EX1003, ¶ 173)

Combining Da Costa's programmable architecture with Liaw's optimization system would have been an obvious application of a known technique to improve a similar device, yielding predictable results. (EX1005, 2:35-46; EX1006, 1:55-65; EX1003, ¶ 174). The combination would enhance Liaw's ability to compensate for manufacturing variations and environmental changes by providing greater flexibility in adjusting gamma reference voltages. (EX1005, 11:34-46; EX1006, 1:28-34; EX1003, ¶ 174)

Furthermore, a POSITA would have been motivated to implement Da Costa's non-volatile storage capability in Liaw's system to retain optimized gamma values when power is removed. (EX1005, 4:57-67; EX1003, ¶ 175). This modification would be a simple substitution of one known element (Liaw's unspecified memory) for another (Da Costa's non-volatile storage), providing the predictable benefit of preserving calibrated settings between power cycles. (EX1006, 6:21-27; EX1005, 2:47-56; EX1003, ¶ 175)

The combination would have been obvious to try, as it would involve choosing from a finite number of identified, predictable solutions (i.e., various programmable architectures for gamma correction) to address the known problem of display calibration and gamma adjustment. (EX1006, 1:21-39; EX1005, 2:19-27; EX1003, ¶ 176). A POSITA would have had a reasonable expectation of success in combining these elements, as both references relate to gamma correction in liquid crystal displays and aim to improve display quality through dynamic adjustment of gamma characteristics. (EX1003, ¶ 176).

A limitation-by-limitation of Liaw is provided *supra*, at § IX and a limitation-by-limitation analysis of Da Costa is provided *supra*, at § X, and are not repeated here.

XVII. Conclusion

For the foregoing reasons, Petitioner respectfully submits that the Board invalidate each of Claims 1-3, and 5-6.

Dated: October 15, 2024

Respectfully submitted,

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CERTIFICATION OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 7,557,788 contains, as measured by the word-processing system used to prepare this paper, 13,816 words. This word count does not include the items excluded by 37 C.F.R. § 42.24 as not counting towards the word limit.

Dated: October 15, 2024

Respectfully submitted,

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CERTIFICATE OF SERVICE UNDER 37 C.F.R. § 42.105

I hereby certify that on October 11, 2024, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 7,557,788 and supporting exhibits to be served via FedEx Express® or Express Mail on the Patent Owner at the following correspondence address of record as listed on the USPTO Patent Center:

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