UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD., AND
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner,

v.

CELLECT, LLC,
Patent Owner.

Case IPR2020-00512
U.S. Patent No. 9,186,052

PATENT OWNER RESPONSE

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On February 17, 2020, Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc., ("Samsung" or "Petitioner") submitted a Petition to institute *inter partes* review ("IPR") of U.S. Patent No. 9,186,052 (Ex. 1001, "the '052 Patent"), challenging Claim 2. Cellect, LLC, ("Cellect" or "Patent Owner") requests that the Board find the Challenged Claims not unpatentable for the reasons set forth below.

I. INTRODUCTION

Claim 2 of the '052 Patent is directed to further miniaturizing the already-small CMOS camera on a chip. The claimed modification keeps the camera's timing and control circuitry on the same board as the image-capturing pixel array but moves the video conversion circuitry off-chip and onto a second circuit board. This modification bucked the conventional wisdom in the industry at the time, which assumed that the best way to miniaturize a camera was to integrate the pixel array with other circuitry necessary to release an image from the camera. Further, this counterintuitive modification of the camera systems known at the time of the invention provided the unexpected benefit of obviating the need for Radio Frequency Interference ("RFI") shielding.

As explained by numerous industry articles from the key time period, the proposed combination would not be made by a person skilled in the art because there was known motivation or benefit, to modify a CMOS camera on a chip to use

an off-chip circuitry architecture. Critically, the purported size and noise reduction alleged to be disclosed in the cited art does not exist and thus would not motivate a person skilled in the art to make such a combination. In addition, the proposed combination is an admittedly hindsight redesign of the asserted references that is not identified with particularity. In any case, the purported combination does not teach the recited CMOS imager with the claimed dimensions.

II. OVERVIEW OF THE STATE OF THE ART

Petitioner's analysis of the asserted references selectively focuses on isolated features but fails to consider the state of the art at the time of the invention. For example, Petitioner ignores the differences between CCD and CMOS imagers as well as the known benefits of the CMOS "camera on a chip" in the relevant timeframe. Background regarding the development and differences in various types of "solid-state imager" technology at the time of the invention follows.

A. Development History of Solid-State Imagers

The term "solid-state imagers" refers broadly to image sensors that were developed during the latter-half of the twentieth century and perform "four important functions"—"light-detection, accumulation of photo-generated signals, switching from accumulation to readout, and scanning." Ex. 2069 at 21. As shown in the figure below, several types of solid-state imagers have been developed, each with their own unique characteristics in design and performance, including metal-

oxide semiconductor (MOS), charge-coupled device (CCD), and complementary metal-oxide semiconductor (CMOS) image sensors. *Id.* at Fig. 1.1; Ex. 2053 at 5.

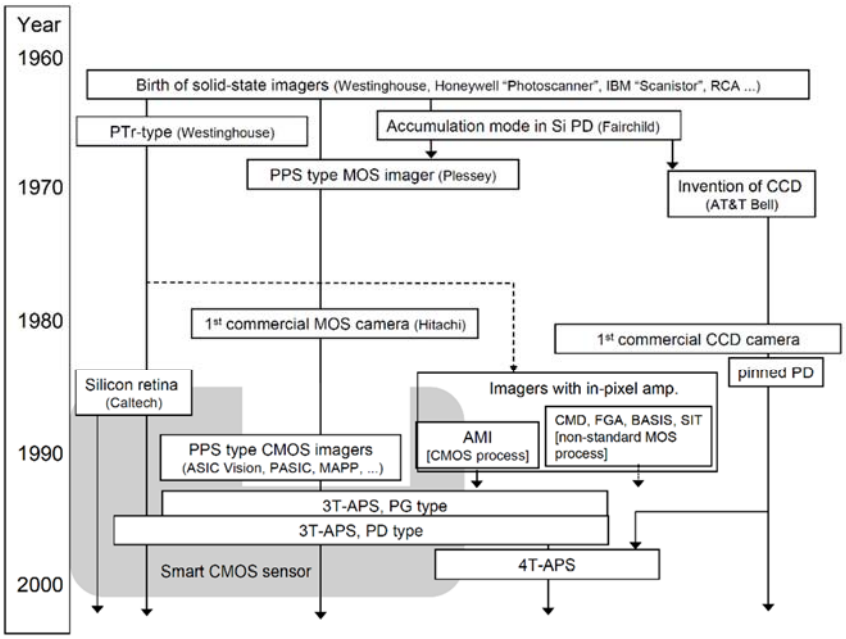


FIGURE 1.1
Evolution of MOS image sensors and related matters.

Ex. 2053 at 21, Fig. 1.1.

The origin of the CMOS imagers recited in the Challenged Claims can be traced back to the first MOS imagers using nMOS transistors. For instance, silicon-junction photosensing devices were proposed in the early 1960s by S.R. Morrison at Honeywell as the 'photoscanner' and by J.W. Horton et al. at IBM as the 'scanistor,'" while Schuster and Strull at NASA developed "phototransistors (PTrs), as photodetectors, as well as switching devices to realize X-Y addressing." Ex. 2053 at 21.

By 1968, Peter Noble at Plessey was credited for developing one of the first MOS image sensors, the passive pixel sensor (PPS), which consisted of "a photodiode and a switching MOS transistor in a pixel with X- and Y-scanners and a charge amplifier." *Id.* at 20. PPS imagers, which included only one transistor per pixel, were developed first, then active pixel sensors (APS) were developed later by Dr. Eric Fossum and included an amplifier with each pixel. By 1993, Eric Fossum and his team at Jet Propulsion Laboratory (JPL) were credited with developing the first APS CMOS imager (3T-APS). *See id.* at 23; Ex. 2053 at 1, 5.

Shortly after Noble's invention of a passive-pixel-sensor-type MOS imager, W. Boyle and G.E. Smith of AT&T Bell Labs invented the first CCD imager in 1969. Ex. 2069 at 22. As explained further below, CCD was the predominant type of image sensor in the consumer imager device market in 1997 and into the early 2000s. *Lebby Decl*., ¶¶ 11, 67, 71, 108, 120.

B. Key Differences Between Solid State Imager Technologies at the '052 Patent's Effective Filing Date

The '052 Patent's effective filing date, which is October 6, 1997, informs the knowledge and understanding of a POSITA at that time of the state of CCD and CMOS imager design.

1. CCD Imagers: Off-Chip Circuitry

In 1997, the CCD imager was the most common solid-state imaging device for consumer imaging devices, such as video cameras and point and shoot cameras,

as well as for security and surveillance applications, as shown in the figure below. Ex. 2061 (Lee) at 1:12-14; Ex. 2036 at 6, Fig. 7.5; *see also* Ex. 2053 at 2.

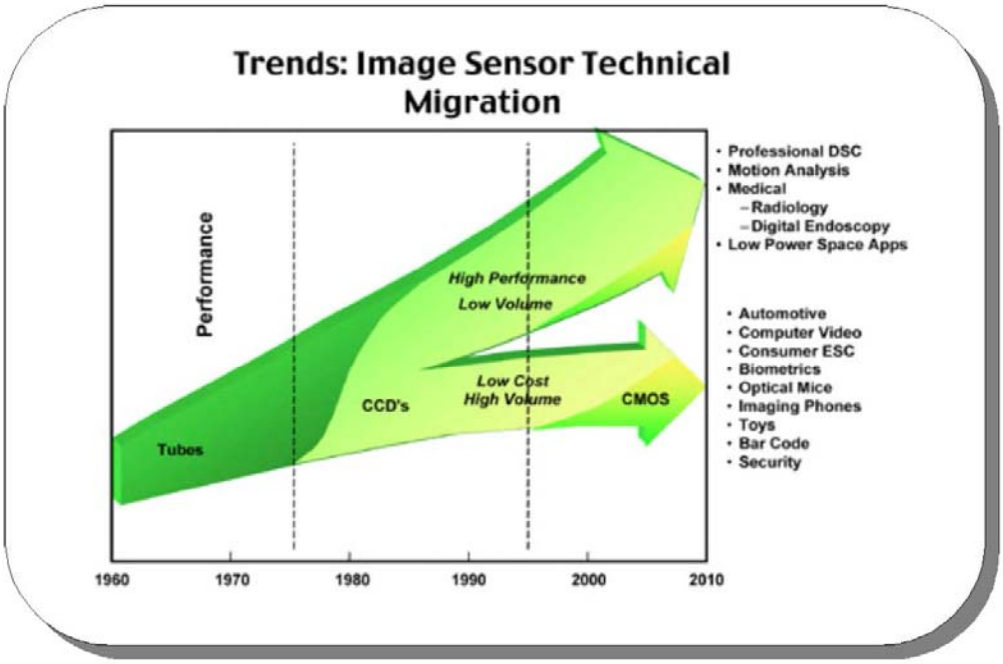


Figure 7.5: Image Sensor Migration and Materials
Source: Kodak

Ex. 2036 at 6, Fig. 7.5 (depicting market shares of imaging tubes (forest green) against CMOS imagers (neon green) and CCD imagers (green-yellow)). This figure illustrates the state of the image sensor market in the relevant timeframe and shows that in the 1990s and into the early 2000s, CCD imagers dominated the market for all of the indicated markets. CMOS imagers only started to gain market share in the late 1990s.

Due to the lack of very large scale integration (VLSI) processes for CCD devices, the manufacture of cameras employing CCD sensors required "separate integrated circuits to provide timing, control and clock driver circuitry," resulting

in "larger and more expensive" cameras. Ex. 2061 at 1:14-19. Thus, the driver circuitry driving CCD imagers was separate from the chip containing the CCD imager. Accordingly, it was a prerequisite for timing generators, clock drivers, analog readouts, and analog-digital convertors to remain off chip in CCD imagers as well, as shown in the figure below in separate circuitry labeled "Camera Electronics." Ex. 2036 at 8, Fig. 7.9. The separation of circuitry boards is due to the fact that CCDs require "a special manufacturing process in order to create components capable of transporting the charge across the chip without distortion." *Id.* at 9.

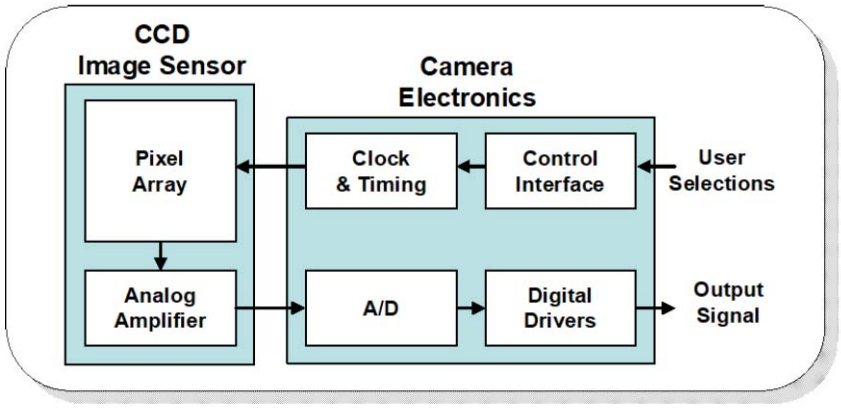


Figure 7.9: CCD Image Sensor with Off-Chip Supporting Components
Source: OIDA

Ex. 2036 at 8, Fig. 7.9.

Attempts to integrate CCD imager architecture with CMOS pixel arrays processing were made, as described in the specification of the '052 Patent, but these efforts ultimately proved unsuccessful for achieving a CMOS reduced-area

imaging device. *See, e.g.*, Ex. 1001 at 3:18-30. The imager industry also recognized the difficulty in combining CCD and CMOS technologies. For example, "while offering high performance, CCD arrays [were] difficult to integrate with CMOS processing in part due to a different processing technology and to their high capacitances, complicating the integration of on-chip drive and signal processing electronics with the CCD array." Ex. 2070 at 1:38-42; Ex. 2053 at 3 (citing the "difficulty to achieve large [CCD] array sizes" and "incompatibility of CCDs with the requirements for instrument miniaturization" as issues for future NASA space missions).

a. Bucket Brigade Design of CCD Pixel Arrays

A CCD imager "relies on the transfer of charge . . . from under one MOS electrode to the next through sequencing of voltages on the electrodes." Ex. 2053 at 2. In so doing, the electrons "are transported through the bulk silicon material macroscopic distances (*e.g.*, centimeters) before they reach the output sense node." *Id.* As a result, a typical CCD has three electrodes per pixel, such that, based on a nominally-sized one-megapixel imager, the electrons may be shifted thousands of times. *Id.* Because the drive power requirement for CCDs increases as the CCD array size increases and CCDs "are capacitive in nature," "the entire CCD array must be driven to achieve the output of a single pixel." *Id.* at 3.

CCD imagers generally used a bucket brigade design of pixel array (illustrated below) that has since been described to be its own "Achilles' heel." *Id.* at 1 ("The Achilles' heel of CCDs is fundamental to the CCD operating principle—the need for nearly perfect charge transfer."). To read out a CCD array, a single line "is scanned out from the horizontal shift register onto a capacitor which converts each charge packet to a voltage for subsequent amplification and buffering." Ex. 2050 at 2. In other words, CCD array readout is "a process of repeated lateral transfer of charge in a MOS electrode-based analog shift register," where "photo-generated signals are read after they are shifted into appropriate positions." Ex. 2056 at 1:52-56. This shifting process "requires high fidelity and low loss," further requiring "[a] specialized semiconductor fabrication process . . . to obtain these characteristics." *Id.* at 1:56-58. Higher voltages also are needed to drive the charge from each pixel through the entire array to read out the image data. Ex. 2036 at 9; Ex. 2063 at 3; Ex. 2004 at 4.

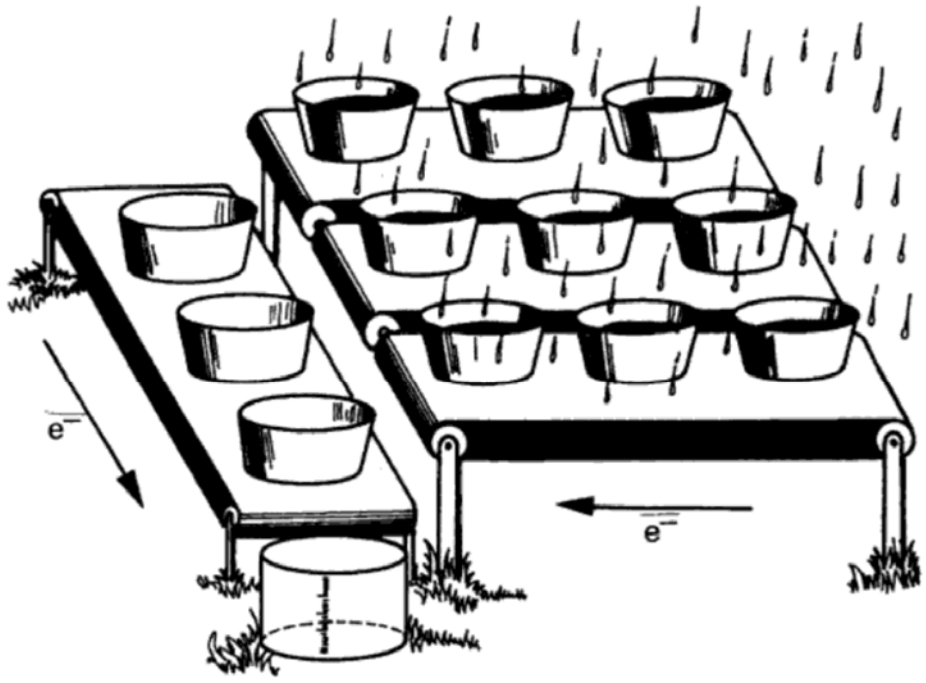


Figure 1.7(a) Bucket analogy used to describe CCD operation.

Ex. 2059 at 7, Fig. 1.7(a).

Even in 1997, CCDs had been "widely manufactured and used due to the fact that they have offered superior image quality than MOS imagers," until as recent as the writing of Exhibit 2069, circa 2007-08. *Id.* at 22. Due to its relative higher image quality over those of MOS and nascent CMOS imagers, over the span of intervening years, the CCD had been the primary technology used in scientific image sensors. Ex. 2053 at 2; *Lebby Decl*., ¶ 67.

b. Heat Generated by CCD Imagers

Known for its high-power-consumption characteristic, yet also for its ability to take images with lower noise (*e.g.*, in astronomical or in low-light imaging),

CCD imagers are detrimentally affected by the transfer of charge and usually result "in slow readout or poor readout fidelity, especially at video rates." *Id*. at 3 (*e.g.*, "The drive power requirement for CCDs . . . grows with *array* size, the entire CCD must be driven to achieve the output of a single pixel"), 11; *see also* Ex. 2069 at 76. Though CCD arrays themselves dissipate very little power, CCD control circuitry dissipate "an inordinate percentage of the power in such imaging devices" in the form of heat. Ex. 2056 at 1:60-2:7. Thus, CCD imagers in 1997 used elements to advantageously cool down the CCD sensor. *Id.* at 8-9; Ex. 2051 at 1:58-65.

2. CMOS Imagers: On-Chip Integration

The ability to have on-chip integration was a key and motivating feature for use of CMOS imagers in 1997, even though CMOS imagers at the time had more noise (*e.g.*, worse image quality) than CCD imagers. As noted by Dr. Bryan Ackland, an AT&T engineer working on CMOS retinal pixel arrays and also the named inventor on the Ackland Patent asserted by Petitioner: "[a]rguably the most important advantage of the CMOS APS approach . . . is the ability to integrate much of the camera timing, control and signal processing circuitry onto the same silicon die." Ex. 2050 at 3. This allow both a higher performance than that of CCDs and conventional CMOS image sensors and versatile functions that cannot be achieved with conventional image sensors." *Id.;* Ex. 2069 at 20. On-chip

integration also enabled cost savings because CMOS image sensors in 1997 were fabricated "based on standard CMOS large scale integration (LSI) fabrication processes, while CCD image sensors [were] based on a specially-developed fabrication process." *Id.*

In 1997, CMOS imagers had several additional advantages over CCD imagers. For example, "[o]ne advantage of APS sensors is that they can be powered from a single 3.3V (or lower) supply and do not require external multiphase clock generators," which "leads to reduced system costs and significantly reduced power dissipation" and "[s]ilicon processing costs are also reduced because of the huge volumes associated with generic digital CMOS production." Ex. 2050 at 2. Another advantage is "the flexibility that is provided by a random access sensor addressing." *Id.* CMOS imagers are "not constrained to access pixels in serial order determined by the architecture of the CCD pipeline," in that CMOS allows for "alternate forms of pixel access," like electronic pan and zoom, which are not available in CCD imagers at the time. *Id.* at 3.

Another benefit from on-chip integration and the camera on chip design is that CMOS camera-on-a-chip imagers benefit from faster readouts rates compared to CCD imagers and, aside from external hardware requirements such as a lower voltage requirement (*e.g.*, a single +5V power supply, compared to CCD imagers

that require a +10-15V power supply) and a master clock, everything else required for signal processing is on the chip. Ex. 2066 at 1, 2, Fig. 2; Ex. 2050 at 1; Ex. 2058 at 117.

III. CLAIM CONSTRUCTION

Because the Petition was filed after November 13, 2018, for this *inter partes* review proceeding, the Board applies the same claim construction standard as that applied in federal courts. *See Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board*, 83 Fed. Reg. 51340, 51343 (Oct. 11, 2018). That is, claim terms "are generally given their ordinary and customary meaning" as understood by a person of ordinary skill in the art in question at the time of the invention.

Neither party has proposed an express construction for any claim terms, and the Board has not expressly construed any claim term. Inst. Dec., 16–17. For purposes of this response, Patent Owner applies the plain and ordinary meaning of the claims, consistent with the specification.

IV. LEVEL OF ORDINARY SKILL

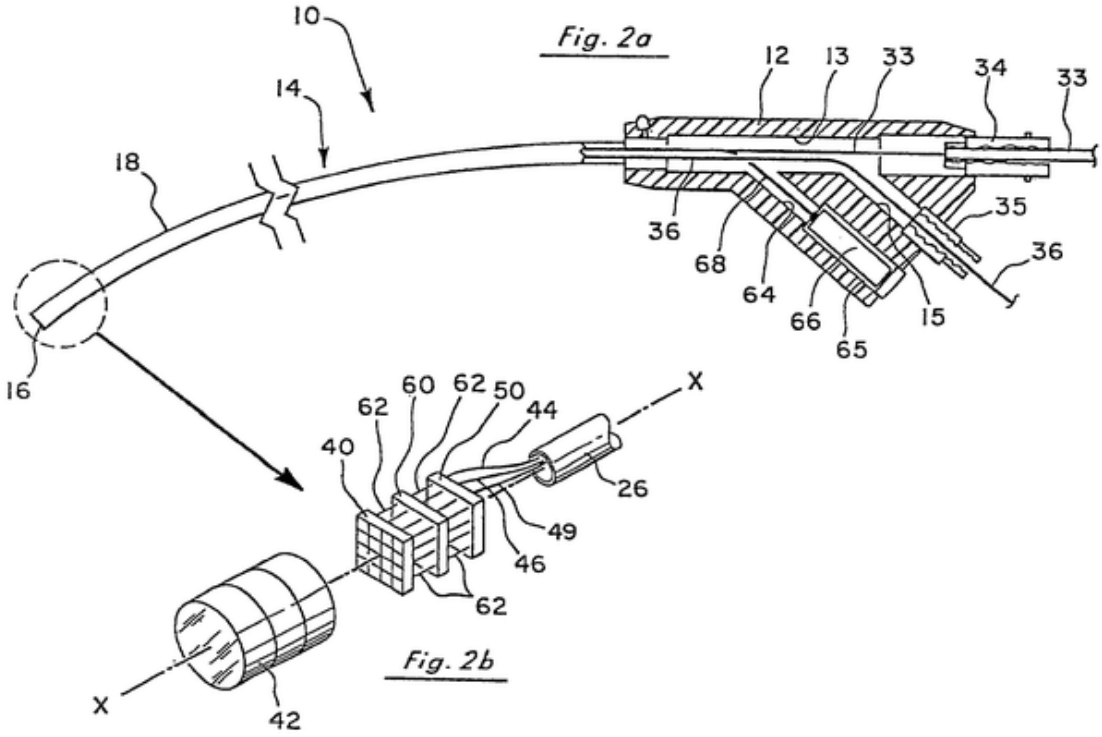
For the purposes of this trial only, a person of ordinary skill in the art in October 6, 1997, (the earliest effective date of the '052 Patent) would have had a Bachelor's degree in Electrical Engineering, Physics, or a related field, and

approximately three years of professional experience in the field of visible optical imaging devices. *Lebby Decl.*, ¶ 40.

V. OVERVIEW OF THE '052 PATENT AND ASSERTED REFERENCES

A. The '052 Patent

The '052 Patent discloses "a reduced area imaging device incorporated within endoscopic devices." '052 Patent at Title. The '052 Patent generally describes a reduced area imaging device in various configurations, and connections (either wired or wireless) between the imaging device elements and a video display. *Id.* at Abstract. An example of the reduced area imaging device is seen in Fig. 2a which is reproduced below:



The exemplary embodiment illustrated in Figure 2b reflects one aspect of Patent Owner's inventive improvement for reduced area imaging devices. In particular, while CCD image devices dominated the market for many applications in the mid-90s, CMOS imagers were being developed with certain advantages over CCD technology. These advantages include on-chip integration of circuitry and lower power requirements and consumption. Patent Owner leveraged these developments in imager technology to develop the claimed reduced area imaging device by retaining the benefits of CMOS imagers while also separating out some functionality from the standard on-chip integration design, thereby resulting in a reduced area imaging device that had a minimum profile. *Lebby*, ¶ 92.

B. Swift (Ex. 1005)

Swift is a reference fundamentally at odds with itself. Although *Swift* states that its image sensor "is **preferably** of a CMOS/Aps (Active Pixel Sensor) type," *Swift*'s description of its system architecture betrays the reality that the author merely contemplated placing a CMOS imager within the incompatible CCD system architecture. Ex. 1005 at 10 (emphasis added). Yet the author presumably gave no thought to the fact that the two systems are incompatible, let alone plug and play, in the way contemplated in *Swift*. *Lebby*, ¶¶ 97–98.

The size of *Swift*'s circuit boards also establishes that the circuitry on its circuit boards is circuitry for supporting a CCD image sensor, not a CMOS image

sensor. *See* Ex. 1001 at 2:9-12 ("This CMOS imager can incorporate a number of other different electronic controls that are usually found on **multiple circuit boards of much larger size**."). Thus, while *Swift* boasts that its "miniature camera 50 may have very small dimensions," it is many times larger than the CMOS imager disclosed in the '052 Patent. *Compare* Ex. 1005 at 5 (contemplating a maximum dimension of 100, 80, or 50 mm); *id.* 9 (contemplating a 38x38 mm housing) *with* Ex. 1001 at 9:22-26 ("Image sensor 40 can be **as small as 1 mm in its largest dimension**. However, a more preferable size for most endoscopic procedures would dictate that the image sensor 40 be **between 4 mm to 8 mm** in its largest dimension.").

The 12V power supply used in *Swift* is in the range of voltages used for CCD imagers, not CMOS imagers. *See* Lebby, ¶ 98; Ex. 1005 at 15 ("The power supply device 170 may comprise, for example, a low-voltage transformer in order to receive 30 mains power and provide, as an output, **a low (eg 12 volt) operating voltage** for the camera 152."); Ex. 1001 at 48-51 ("Additionally, this hybrid is able to run on a low power source (5 volts) which is normally not possible on standard **CCD imagers which require 10 to 30 volt power supplies**.") (emphasis added). On the other hand, CMOS imagers operate at a far lower voltage and require orders of magnitude less power than CCD imagers. Ex. 2034 at 5:28–41 (running Fossum's CMOS imager with a 5 volt power supply); Ex. 2004 at 85 (confirming

that CCD imagers are "driven with relatively high voltages); Ex. 1001 at 2:15-16 ("Furthermore, this particular CMOS imager requires 100 times less power than a CCD-type imager.").

Given these disclosures, a POSITA understands that *Swift's* multi-circuit-board system architecture is consistent with CCD imager architecture, not CMOS imagers. *Lebby*, ¶ 97. Nevertheless, *Swift* discloses an embodiment in which the camera uses Dr. Fossum's CMOS sensor, disclosed in Ex. 1048. *Swift* at 6, 10, 14. Dr. Fossum's CMOS sensor is the same "camera on a chip" discussed in the Background Section of the '052 Patent, which "incorporate[s] a number of other different electronic controls that are usually found on multiple circuit boards of much larger size." *See* '052 Patent at 2:6–15; *Lebby*, ¶ 98.

C. Ricquier (Ex. 1033)

Ricquier discloses a test setup for a dedicated imager demonstrating proof of concept for machine vision applications. Ex. 1033 (*Ricquier*) at 10. The imager includes a 256 x 256 pixel array on the sensor plane, fabricated using 1.5 um CMOS technology in order to "acquire data only from a specific region of interest and this with a variable resolution." *Id. Lebby*, ¶ 99.

Critically, having considered CCD-based cameras for this application, the authors instead chose to use CMOS technology "because it offers the selective addressability **together with the possibility of further cointegration of**

processing electronics on the same chip." *Id.*; *Lebby*, ¶ 99. Indeed, the authors explicitly stated that their work was focused on "emphasizing the development of a multi-purpose flexible sensor architecture that can be used as a module in further sensor systems **on a single chip**." *Id.* at 11. As discussed in detail above, Fossum's CMOS imager, implemented in *Swift*, realizes such an on-chip sensor system, and a POSITA would not have modified a system that realizes *Ricquier's* goals with *Ricquier's* test bench setup, particularly as Petitioner has not identified any motivation for doing so. In fact, such off-chip timing control causes well-known problems that limit the "read-out frame rate." *See Lebby*, ¶ 102 (citing Ex. 1033 at 10 (disclosing a single output amplifier); Ex. 2034 at 1:44–62 (discussing the negative impact of using a single output amplifier on an imager's frame rate)).

D. Suzuki (Ex. 1015)

Suzuki describes a solid-state image pickup device that includes a solid-state image pickup chip 221 and a circuit module 222. Ex. 1015 (*Suzuki*), 2:38-41. *Suzuki's* circuit module 222 comprises a chip-connecting board 226, a circuit board 227 including a circuit for driving the solid-state image pickup chip 221 and a circuit for amplifying the video signal from the solid-state image pickup chip 221, and a connector board 228. *Id.* at 2:50-54, Fig. 2. "Signals are fed between these boards via connection pins 229, and signals are fed between the solid-state

image pickup chip 221 and each of these boards via the outer-leads 221m and side electrodes 226e, 227e and 228e of the boards." *Id.* at 2:55-59.

A POSITA would understand Suzuki to be a CCD device, as Suzuki refers to a solid-state imager and describes a conventional CCD device design used in 1991 (when *Suzuki* was filed). The fact that *Suzuki's* circuit board 227 includes "a circuit for ***driving*** the solid-state image pickup chip 221 and a circuit for ***amplifying*** the video signal from the solid-state image pickup chip 221" separate from the image pickup chip tells a POSITA that *Suzuki* describes a CCD imaging sensor. *Lebby*, ¶ _104 (citing Ex. 1015 at 2:51-54 (emphasis added)). Petitioner cites *Suzuki* for its disclosure of a stacked arrangement of circuit boards, which are incompatible with *Swift's* CMOS sensor embodiment. *See* Petition at 15, 24–25.

E. Larson (Ex. 1029)

Larson teaches a videophone that "includes a video camera for transducing and digitizing images at a station and connected to a video processor for compressing and encoding the digitized images into video data." Ex. 1029 (*Larson*), Abstract. *Larson* reveals an embodiment of packaging a display within the same housing as the image sensor and related circuitry. *Id.* at 26:43-54. *Larson* describes a CCD camera in a "housing 131 for the CCD camera lens 44A and the LCD panel 56B." *Id.* at Fig. 8B1; *Lebby*, ¶ _105. Petitioner cites *Larson* to address deficiencies in the other cited references as to the disclosure of a

physical camera within the same physical housing as the video monitor to form the claimed device required by independent claim 2. Petition at 50.

VI. GROUND 1: SWIFT IN VIEW OF RICQUIER AND SUZUKI DOES NOT RENDER CLAIM 2 OBVIOUS UNDER 35 U.S.C. § 103(A)

The invention disclosed and claimed in the '052 Patent represents a radical departure from the conventional wisdom at the time. In 1997, the industry was in the midst of transitioning from large, expensive, multi-chip, multi-board CCD imagers to smaller, cheaper CMOS imagers. Ex. 2036 at 6. These new CMOS imagers provided, on a single silicon die, the circuit components that were placed off chip in the CCD imagers, enabling the "development of a 'camera on a chip'" that could be "mass produced on standard semiconductor production lines." '052 Patent at 1:66-2:19. Efforts in the industry at the time focused on improving CMOS imager quality while driving more and more component integration onto a single silicon die. '052 Patent at 3:18-23; *see also Lebby*, ¶¶ 12–13.

Confronted with the challenge of producing a miniature camera suitable for medical and industrial imaging tasks, the inventors of the '052 Patent took a different tack. Starting from the *de riguer* CMOS "camera on a chip," the inventors recognized, contrary to the accepted industry dogma, that strategically ***de-integrating*** certain imager components would enable miniaturization theretofore unachievable:

> Although the "camera on a chip" concept is one which has great merit for application in many industrial areas, a need still exists for a reduced area imaging device which can be used in even the smallest type of endoscopic instruments in order to view areas in the body that are particularly difficult to access, and to further minimize patient trauma by an even smaller diameter invasive instrument.

'052 Patent at 3:24-30. This idea not only enabled further miniaturization of the CMOS camera on a chip but also provided the unexpected benefit of making "shielding to avoid RFI effects" unnecessary, which previously required "great efforts." Ex. 1003 at 94-95, ¶ 21. *Lebby*, ¶ 5

Petitioner has not demonstrated or attempted to demonstrate that it would have been obvious at the time of the invention to combine *Swift*, *Ricquier*, and *Suzuki* to reach Claim 2 of the '052 Patent. Petitioner's arguments ignore the state of the art at the time of the invention, rely on impermissible hindsight and a legally incorrect understanding of the Federal Circuit's "design choice" jurisprudence, and misstate the teachings of the references. Additionally, Petitioner's reliance on the *Suzuki* to reach a CMOS imaging device with the claimed dimensions fails because *Suzuki* achieved those dimensions with an entirely different camera architecture than the one claimed in the '052 Patent. Petitioner has not demonstrated that modifying *Swift* with any teachings in *Suzuki* would result in a CMOS imager with the claimed dimensions.

A. *Swift* in View of *Ricquier* and *Suzuki* Fails to Disclose an Imaging Device With the Requisite Dimensions

Claim 2 of the ’052 Patent recites an imaging device with two circuit boards. One of those circuit boards includes a CMOS pixel array and timing and control circuitry. ’052 Patent at Claim 2. The second circuit board includes “circuitry thereon to convert said pre-video signal to a post-video signal.” *Id*. Critically, the claim also requires that the “largest dimension of said image sensor along said first plane is between 2 and 12 millimeters.” *Id*. Although *Suzuki* discloses an imaging device having a diameter within that range, its imager is not arranged in the claimed manner. In particular, *Suzuki* does not disclose a first circuit board that includes a CMOS pixel array and timing and control circuitry, so Petitioner’s reference to the size of *Suzuki’s* imager to the claimed imaging device is an apples and oranges comparison. *Lebby*, ¶ 113 (citing *Suzuki* at 2:51–54).

Swift discloses a camera having far larger dimensions than either the imaging device recited in the ’052 Patent or *Suzuki*. *Lebby*, ¶ 114. Indeed, while *Swift* boasts that its “miniature camera 50 may have very small dimensions,” it is many times larger than the CMOS imager disclosed in the ’052 Patent. Compare Ex. 1005 at 5 (contemplating a maximum dimension of 100, 80, or 50 mm); *id*. 9 (contemplating a 38x38 mm housing) with Ex. 1001 at 6:58–61 (“Image sensor 40 can be as small as 1 mm in its largest dimension. However, a more preferable size

for most endoscopic procedures would dictate that the image sensor 40 be between 4 mm to 8 mm in its largest dimension.").

Petitioner does not and cannot explain what modifications to Swift would result in an imager with the dimensions of *Suzuki*. For example, Petitioner fails to explain which elements of *Swift's* circuit board 52 would be moved to a different circuit board, per *Suzuki*, in order to achieve *Suzuki's* dimensions while also satisfying the language of the claims. *See* Petition at 24-27. That is, even granting Petitioner's assertion that a POSITA would modify Swift such that "circuit board 53 is oriented parallel to circuit board 52," that modification ***would not change*** the dimensions of circuit board 52, which is far larger than 12mm. *See Swift* at 11 (disclosing a minimum dimension of 38mm); *Lebby*, ¶ 115

Petitioner's annotated version of Swift's Fig. 2 is reproduced below:

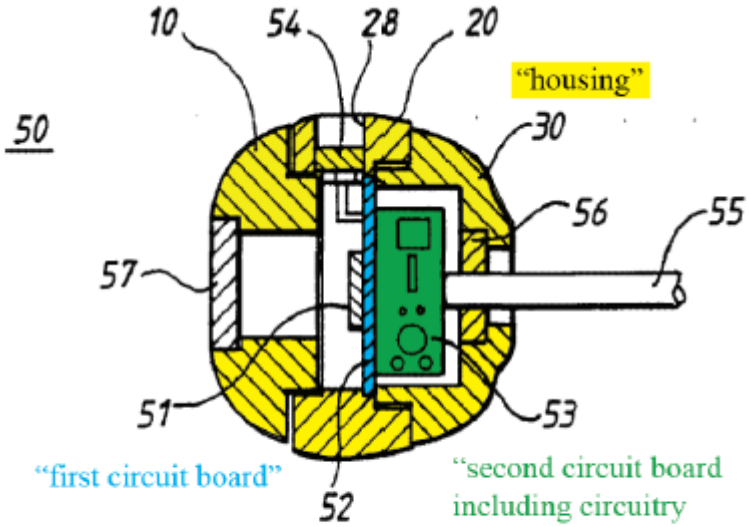


Fig.2.

Petition at 4. As should be appreciated with reference to this figure, the dimensions of *Swift's* camera along the plane of the image sensor ***would not change*** regardless of how circuit board 53 was oriented in relation to circuit board 52. *Lebby*, ¶ 115.

Even granting Petitioner's assertion that it would have been obvious to modify *Swift* and *Ricquier* with *Suzuki* in order to orient circuit board 53 parallel to circuit board 52, therefore, the size of *Swift's* camera would remain ***unchanged*** along the relevant dimension. *Id.* (citing Petition at 27). Accordingly, *Swift* modified by *Ricquier* and *Suzuki* fails to teach an imaging device having where the "largest dimension of said image sensor along said first plane is between 2 and 12 millimeters."

Additionally, Petitioner's argument for modifying *Swift* and *Ricquier* with *Suzuki* fails. *Suzuki* claims priority to an application filed in 1990, prior to the introduction of CMOS imagers:

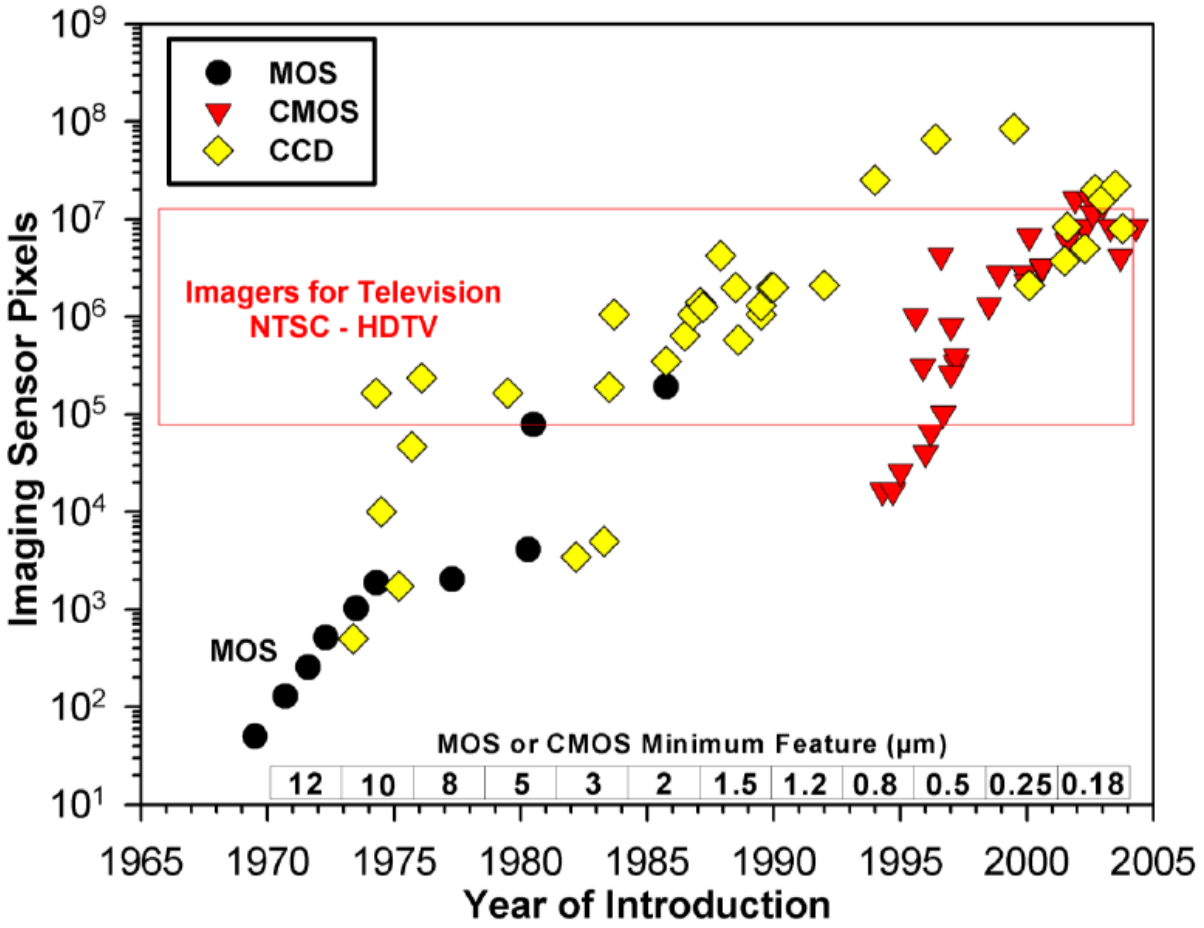


Figure 1. Chronology of visible imager development for CCD, MOS, and CMOS.

Ex. 2092 at 8. A POSITA therefore recognizes that *Suzuki's* "solid-state image pickup device" uses CCD technology, not CMOS. *Lebby*, ¶ 116.

As discussed in detail above, CCD imagers require off-chip circuitry for timing and control, video processing, video conversion, etc. *See* § II.B, *supra*. Petitioner has not, however, attempted to demonstrate that it would have been

obvious to de-integrate on-chip components of *Swift's* CMOS sensor in order to place them on separate circuit boards, as *required* in *Suzuki* given its CCD design. *See* Petition at 24–27. To the contrary, at the time of the invention the industry was committed to the fully integrated CMOS "camera on a chip," so a POSITA would not have looked to a CCD imager with circuitry placed on separate circuit boards for ideas on how to implement the system architecture for a CMOS imager. *Lebby*, ¶ 116.

B. A POSITA Would Not Have Combined *Swift*, *Ricquier*, and *Suzuki* to Arrive at the Claimed Invention

Swift discloses a camera that uses the CMOS APS-type sensors disclosed in the *Laser Focus World* article referenced therein. *See Swift* at 10; Ex. 1048. These APS sensors refer to the same "camera[s] on a chip" referenced in the Background of the Invention section of the '052 Patent, which differ from the prior art CCD imagers because they "incorporate a number of other different electronic controls that are usually found on multiple circuit boards of much larger size." '052 Patent at 2:9–11. Petitioner has not demonstrated any known motivation for *de-integrating* various circuit components from *Swift's* camera on a chip in order to arrive at the invention claimed in the '052 Patent.

One of the "electronic controls" found on Dr. Fossum's APS-type sensor, used in *Swift*, is the claimed "timing and control circuitry." *Lebby*, ¶ 117 (citing Ex. 1048 at 8 (comparing a CMOS sensor with "on-chip integration of clocks and

drivers" with CCD imagers); Ex. 1060 at 2 ("The amplifiers will be switched on and off by TIMING AND CONTROL CIRCUITRY that's right on the chip. In ordinary CCDs, those functions are on other chips.")). Indeed, as shown in Figure 7 (copied below), the CMOS image sensor includes a section for the CMOS pixels (red) and a portion for other circuit components, including timing and control and signal processing circuitry (blue):

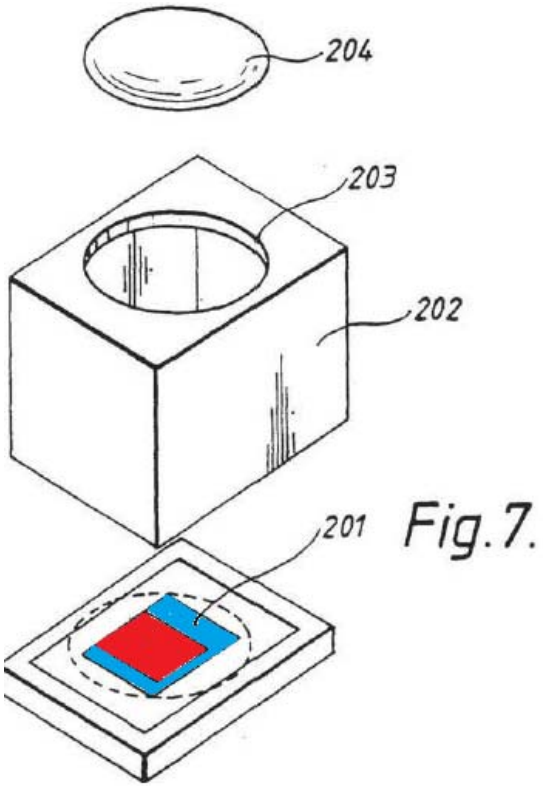
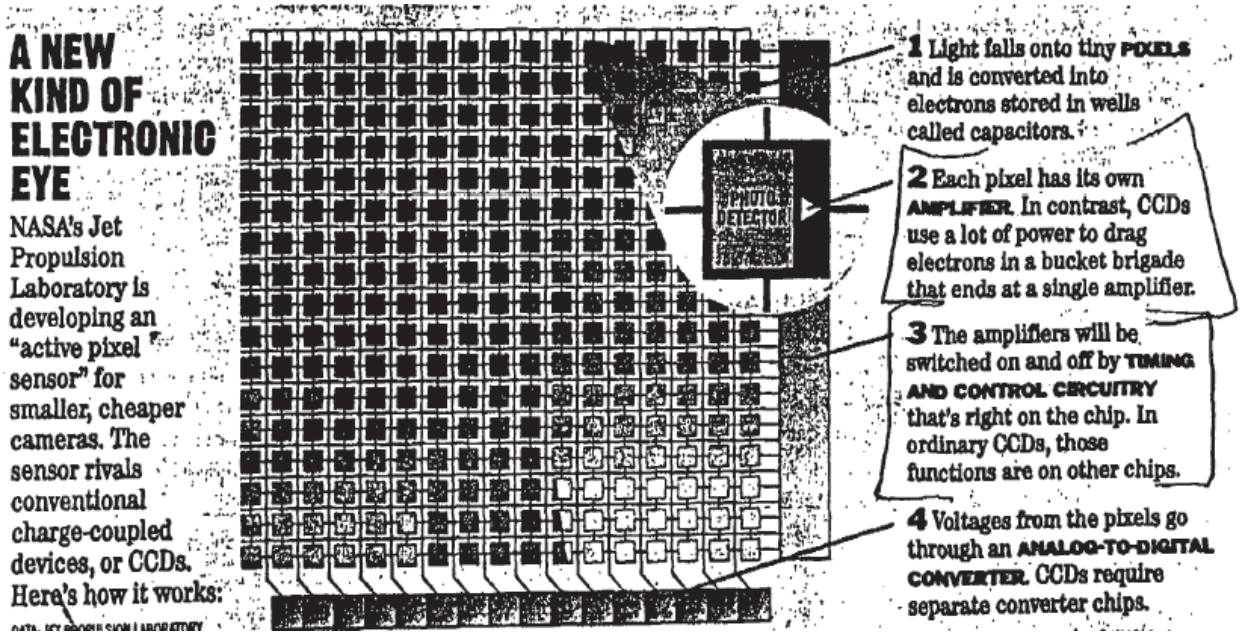


Fig. 7.

Lebby, ¶ 117 (citing Ex. 1005 at Fig. 7 (highlighting added)). In fact, *Swift's* CMOS imager, with an asymmetrically positioned "light-sensitive area," is directly analogous to Dr. Fossum's CMOS camera on a chip, which has integrated timing

and control circuitry and an analog-to-digital converter and an asymmetrically located pixel array:



Ex. 1060 at 2. As discussed below, aside from the disclosures of the '052 Patent itself, there is no evidence in the record that a POSITA would have been motivated to de-integrate these features of the *Swift*/Fossum camera on a chip or to arrange them as claimed. *Lebby*, ¶ 117.

Petitioner first argues that a POSITA would have been motivated to modify *Swift* with *Ricquier* because they are in the same "field of art." Petition at 22. However, the bare fact that two references are analogous art does not mean that a POSITA would have been motivated to combine individual teachings from those references. Rather, in order to demonstrate motivation to combine two references, Petitioner must explain "whether there is a reason, suggestion, or motivation in the

prior art that would lead one of ordinary skill in the art to combine the references, and that would also suggest a reasonable likelihood of success." *Forest Labs. v. Sigmapharm Labs.*, 918 F. 3d 928, 934 (Fed. Cir. 2019) (quoting *Smiths Indus. Med. Sys., Inc. v. Vital Signs, Inc.*, 183 F.3d 1347, 1356 (Fed. Cir. 1999)). Critically, Petitioner fails to identify **any** motivation for modifying *Swift's* imager to use an "off-chip" timing controller.

Second, Petitioner argues that "***Ricquier*** is also reasonably pertinent to the alleged problem(s) identified in the '052 of arranging the circuitry of a CMOS image sensor, including to minimize the device's size or profile area." Petition at 22. That is not true; *Ricquier* is completely silent with respect to "minimizing a device's size or profile area." *Lebby*, ¶ 118. In fact, in order to minimize device size for a CMOS imager, the well-known solution at the time was to move toward a "camera-on-a-chip." Lebby, ¶ 118 (citing Ex. 1048 at 8 ("Yet, on-chip integration is the key to achieving future camera miniaturization."); Ex. 1060 at 1 (describing the switch from "bulky" CCD imagers to "tiny" CMOS imagers "[w]ith all the smarts on one chip instead of several")).

Accordingly, not only is *Ricquier* silent with respect to minimizing device size (contrary to Petitioner's baseless claim), POSITAs at the time of the invention focused on minimizing the size of a CMOS imager by adding "all the smarts on one chip instead of several." *Id*. Thus, a POSITA at the time of the invention

would not have modified *Swift* with *Ricquier's* off-chip driving unit if the goal was to "minimize the device's size or profile area," as asserted in the Petition. Petition at 22.

Given the state of the art at the time of the invention, it is apparent that Petitioner's proposed modification of *Swift* with *Ricquier's* off-chip driving unit is a product of impermissible hindsight. In particular, Petitioner argues that there were "known… advantages of using an [sic] 'timing controller' that can be located off chip." Petition at 23. But Petitioner provides no evidence of such known advantages, and *Ricquier* discloses none. *Lebby*, ¶ 118. Indeed, *Ricquier* states that one reason the authors chose to utilize a CMOS pixel array for its imager was that "processing electronics," such as the off-chip driving unit, could be integrated into the same chip as the pixel array. *Lebby*, ¶ 118 (quoting *Ricquier* at 1 ("A CMOS technology was chosen because it offers the selective addressability ***together with the possibility of further cointegration of processing electronics on the same chip***."). The **only** record evidence that teaches or suggests any benefit associated with de-integrating some camera-on-a-chip components is the ***'052 Patent itself***. '052 Patent at 3:24–30. However, a patent's specification may not be used to supply motivation to combine one reference with another. *Graham v. John Deere Co.*, 383 U.S. 1, 36 (1966) (discussing the "importance of guarding

against hindsight... and resisting] the temptation to read into the prior art the teachings of the invention in issue" when considering the obviousness of a patent).

Starting from the incorrect premise that *Ricquier* teaches an advantage to using an off-chip driving unit, Petitioner then states that its proposed modification "adds flexibility in selecting from the several design choices for 'fitting … the components into the available space' and 'plac[ing]' circuitry on 'various layers' arranged 'stackwise' to 'allow[] for a more compact camera head.'" Petition at 23. However, because a POSITA never would have moved *Swift's* timing and control circuitry off chip in the first place (absent the teachings of the '052 Patent), Petitioner's arguments directed to the alleged "flexibility" afforded by the proposed modification are the product of hindsight. *Metalcraft of Mayville, Inc. v. The Toro Co.*, 848 F. 3d 1358, 1367 (Fed. Cir. 2017) ("Without any explanation as to how or why the references would be combined to arrive at the claimed invention, we are left with only hindsight bias that *KSR* warns against." (citing *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 421 (2007)).

During the deposition of Petitioner's expert, Dr. Neikirk, it became apparent that his analysis relied on hindsight reconstruction of the claimed invention based on the theory that the location of the timing and control circuitry is simply a "design choice." *See* Neikirk Tr. at 38:4–39:13; 44:15–23. However, Dr. Neikirk

acknowledged that when he used the term "design choice" he was not drawing any legal conclusions. *Id*. at 74:12–75:12.

In fact, the choice of where to locate the timing and control circuitry is not a matter of "design choice" as a matter of law because the claimed arrangement solved a particular problem and gave rise to unexpected results. *See In re Chu*, 66 F.3d 292, 298–99 (Fed. Cir. 1995) (holding that a specific arrangement is not a matter of "design choice" where it solves a stated problem or provides unexpected results (citing *In re Rice*, 341 F.2d 309 (CCPA 1965); *In re Kuhle*, 526 F.2d 553, 555 (CCPA 1975)). The claimed imaging device of the '052 Patent both solves the particular problem of further miniaturizing the CMOS "camera on a chip" and produced the unexpected result of obviating the need for RFI shielding, which previously required "great efforts." *Lebby*, ¶ 110 (citing Ex. 1003 at 85–86, 94-95; Ex. 1048 at 8).

Second, Petitioner argues that *Ricquier* is also relevant to the problem of "reduc[ing] image noise in a CMOS sensor." Petition at 22. This also is not true, as Ricquier is silent with respect to noise reduction. *Lebby*, ¶ 119. In fact, Petitioner's expert admitted that Ricquier discloses no noise reduction associated with locating timing a control circuitry off-chip. Neikirk Tr. at 100:19-101:14 ("He doesn't say that putting the off-chip driver made the noise better, but what I believe he's teaching is that it did not make it worse.").

To the contrary, a POSITA understands that if the goal was to reduce noise, it would be beneficial to "place[] the timing and control ***circuits on the same planar structure with the pixel array***." '052 Patent at 9:45–47 (emphasis added). Accordingly, Petitioner's proposed combination of *Swift* and *Ricquier*, which involves placing *Ricquier's* off-chip timing unit on the opposite side of the circuit board supporting the pixel array would be ***counterproductive*** to the goal of noise reduction. *Lebby,* ¶ 119 (citing Petition at 23). Accordingly, in order to reduce noise a POSITA would maintain *Swift's* timing and control circuity on-chip rather than placing it on the opposite side of the circuit board, as asserted in the Petition.

Third, while Petitioner asserts that *Ricquier* teaches "express advantages" in the form of "'selective addressability' and "multiple resolutions…[and] data rates up to 10 MHz,'" none of those alleged advantages are associated with *Ricquier's* timing controller being realized "off chip." *Lebby*, ¶ 120 (citing Petition at 24).

Ricquier provides a proof-of-concept for using a CMOS imager for machine vision applications. Ex. 1033 at Abstract. The goal of the project was "to acquire data only from a specific region of interest and this with a variable resolution." *Ricquier* at 10. In order to achieve these goals, the authors chose to use CMOS technology "because "it offers the selective addressability" and the ability to program "multiple resolutions" required to meet the design goals. *Id.*; *see also id*. at 11 ("To realise the acquisition of image data only in specific regions of interest,

an X-Y addressable architecture was selected."). Critically for purposes of Petitioner's motivation to combine argument, however, the X-Y addressability and multiple resolution capability disclosed in *Ricquier* is a feature of **all** CMOS imagers and is the reason CMOS was chosen over CCD in the first instance. *Lebby*, ¶ 120 (citing *Ricquier* at 10; Ex. 1060 at 2 ("They put an amplifier in each [pixel], along with circuits that allowed each pixel to be read out individually for features such as panning and zooming.").

Petitioner's argument that "a POSITA would have been further motivated to apply *Ricquier's* known teachings in implementing *Swift's* CMOS solid-state imager because of *Ricquier's* express advantages of 'selective addressability' and 'multiple resolutions … [and] data rates up to 10 MHz'" is also meritless. Petition at 24. Because *Swift* discloses a camera based on Dr. Fossum's CMOS imager, its pixel array **already enjoys** that advantage. *Lebby*, ¶ 120. Accordingly, *Ricquier's* disclosure of selective addressability and capability to program multiple resolutions is a product of utilizing CMOS technology rather than placing the timing controller being "off chip."

Further, Petitioner fails to assert (let alone explain how or whether) the "data rates up to 10 MHz" result from implementing the timing controller "off chip." Petition at 24. To the contrary, a POSITA understands that *Ricquier's* off-chip driver placement **limits** the imager's data rate because, like a traditional CCD

imager, such an architecture requires that "signals are coupled to a single output amplifier" (*Ricquier* at 10):

> Typically, each column of CCD pixels is transferred to a corresponding cell of a serial output register, **whose output is amplified by a single on-chip amplifier** (e.g., a source follower transistor) before being processed in off-chip signal processing electronics. **As a result, the read-out frame rate is limited by the rate at which the on-chip amplifier can handle charge packets** divided by the number of pixels in the imager.

Ex. 2034 at 1:45–52 (emphasis added). Thus, a POSITA would not have modified Swift with Ricquier's off-chip driver because it would limit "the rate at which the on-chip amplifier can handle charge packets." *Lebby*, ¶ 121.

Fourth, and perhaps most importantly, *Ricquier* explicitly teaches away from the off-chip driver utilized in its tests. First, *Ricquier* explains that CMOS technology was chosen not only for the "selective accessibility" of its pixels array, but for "possibility of further cointegration of processing electronics on the same chip." *Ricquier* at 10. Indeed, the authors stated that their work is focused on "emphasizing the development of a multi-purpose flexible sensor architecture that can be **used as a module in further sensor systems on a single chip**." *Id.* at 11. Given that *Ricquier* itself described cointegration of processing electronics as the goal of the authors' work, it clearly discourages a POSITA "from following the

path set out in the reference." *Arctic Cat v. Bombardier Recreational Prods.*, 876 F.3d 1350, 1360 (Fed. Cir. 2017).

For at least the foregoing reasons, a POSITA would not have modified *Monroe's* imager to place any alleged "timing and control" circuitry "off chip" as disclosed in *Ricquier*. Accordingly, Petitioner has not demonstrated a reasonable likelihood that Claim 2 of the '052 Patent is unpatentable.

C. *Swift* in view of *Ricquier* and *Suzuki* Does Not Disclose a Circuitry on a Second Circuit Board to Convert Pre-video Signal to a Post-Video Signal

Swift does not disclose the claimed "said second circuit board including circuitry thereon to convert said pre-video signal to a post-video signal." '052 Patent, claim 2. Petitioner asserts that "*Swift* discloses configuring circuit boards 52 and 53 and their associated circuitry in multiple different ways, at least one which meets the limitations." Petition at 38.

As a preliminary matter, because *Suzuki* teaches a CCD camera, a POSITA would not have looked to *Suzuki* for ideas of how to implement the system architecture for a CMOS imager. *See* § VI.A, *supra*; *Lebby*, ¶ 122. Contrary to *Suzuki*, *Swift* discloses utilizing the APS-type sensors disclosed in the *Laser Focus World* article referenced therein. *See* Ex. 1005 at 10; Ex. 1048. Petitioner acknowledges this connection between *Swift* and the *Laser Focus World* article. Petition at 14, 16. These APS sensors refer to the same "camera[s] on a chip"

referenced in the Background of the Invention section of the '052 Patent, which differ from the prior art CCD imagers because they "incorporate a number of other different electronic controls that are usually found on multiple circuit boards of much larger size." '052 Patent at 2:9-19.

One of the "electronic controls" found on Fossum's APS-type sensor is the claimed "circuitry… to convert said pre-video signal to a post-video signal":

> By consolidating many functions and reading images in a more efficient way, it requires one-hundredth the power of a CCD-based system. **And the chip does its own conversion from analog to digital for output on computer monitors or disk storage**. About all it needs is a power source and a lens to focus light on it.

Ex. 1060 at 1; *see also* Ex. 1048 (*Laser Focus World*) (disclosing that CMOS is the "preferred choice for implementation of on-chip signal processing"); *see also* '052 Patent at 2:6-19 (discussing Fossum's "camera on a chip"). Because Fossum's (and therefore *Swift's*) "camera on a chip" includes the "circuitry thereon to convert said pre-video signal to a post-video signal," *Swift* does not disclose the claimed "circuitry" located on a second circuit board, and a POSITA would not have modified *Swift* with *Suzuki's* teachings. *Lebby*, ¶ 123.

Petitioner asserts that the circuitry component mounted on circuit board 53 that is used to "process image signals received" from the image sensor is the claimed "circuitry… to convert said pre-video signal to a post-video signal."

Petition at 39 (citing Swift 9:7-13). But *Swift* never states that circuit board 53 includes "circuitry… to convert said pre-video signal to a post-video signal." *Lebby,* ¶ 124. The evidence cited in the Petition only states that Swift's **camera** outputs a signal that may be viewed on a monitor, not that the circuitry component mounted on circuit board 53 is responsible for converting a pre-video signal to a post-video signal. *See* Petition at 15-16 (citing Swift 8:31-9-13, 3:31-4:4); *see also id*. at 40 (citing Ex. 1005 at 15:7-8, 15:13-14, 17:34-18:3, 18:8-11).

In *Swift*, the pre- to post-video conversion is done *on-chip*, and any further processing carried out by the circuitry on circuit board 53 is performed on a signal already suitable "for output on computer monitors or disk storage." Ex. 1060 at 1; Ex. 1005 at 10. For example, as shown in Fig. 4b of the '052 Patent, the term video processing does not mean or even imply converting a "pre-video signal to a post-video signal." *Lebby*, ¶ 124–125. Rather, video processing involves many other video conditioning procedures, including white balancing, for example. *Id*. Indeed, because the APS-type image sensor discussed in *Swift* already "does its own conversion from analog to digital for output on computer monitors or disk storage" (Ex. 1060 at 1), the "image signal" received by *Swift's* circuitry component used to "process image signals" received from the image sensor cannot be a pre-video signal, as recited in independent claim 2 (i.e., "said second circuit

board including circuitry thereon to convert ***said pre-video signal*** to a post-video signal").

For the foregoing reasons, the *Swift* in view of *Ricquier* and *Suzuki* fails to disclose "circuitry… to convert said pre-video signal to a post-video signal" as recited in Claim 2 of the '052 Patent.

VII. GROUND 2: LARSON IN VIEW OF SWIFT, RICQUIER, AND SUZUKI DOES NOT RENDER CLAIM 1 OBVIOUS UNDER 35 U.S.C. § 103(A)

Petitioner cites *Larson* for "implementation details for such an imaging device … with a physical camera and a display screen contained in a single housing." Petition at 50. *Larson* does not cure any deficiencies noted with respect to Ground 1 above.

Additionally, a POSITA would have not modified *Swift*, *Ricquier*, and *Suzuki* with *Larson*. *Larson* discloses a CCD camera. Thus, to the extent a POSITA modified *Larson* in view of *Swift*, a POSITA would have used *Larson's* CCD image sensor, which provided superior performance and was a mature technology especially for security and surveillance applications such as in *Swift*. A POSITA would not have replaced the CCD image sensor in Larson with a CMOS image sensor, especially not a passive pixel sensor (in Ricquier) used for machine vision applications. Lebby, ¶ 126–127.

Accordingly, the Board should find that Petitioner has not demonstrated that Claim 2 of the '052 Patent is unpatentable.

VIII. SECONDARY CONSIDERATIONS DEMONSTRATE NON-OBVIOUSNESS OF THE CHALLENGED CLAIM

The non-obviousness of the claims are also supported by strong secondary considerations of non-obviousness, including long felt, need, unexpected results, industry praise, and commercial success of the patented invention. These considerations confirm that Petitioner's conclusory obviousness arguments are untethered from the real world, and instead the product of the type of hindsight bias that is routinely criticized by the Supreme Court and Federal Circuit.

Under *Graham*, secondary considerations, which are also referred to as objective indicia or objective evidence, may serve as evidence of non-obviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17-18 (1966). Secondary considerations are "part of the whole obviousness analysis, not just an afterthought." *Leo Pharm. Prods. v. Rea*, 726 F.3d 1346, 1357 (Fed. Cir. 2013). Indeed, secondary considerations are a "check against hindsight bias" and "'may often be the most probative and cogent evidence in the record.'" *In re Cyclobenzaprine Hydrochloride*, 676 F.3d 1063, 1075-76, 1079 (Fed. Cir. 2012) (quoting *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538-39 (Fed. Cir. 1983)). Thus, evidence of secondary considerations of "must always when present be considered en route to a determination of obviousness." Id.

Secondary considerations of nonobviousness may include, among other things, commercial success, industry skepticism, long-felt but unresolved need, failure of others, copying, unexpected results, industry praise, proceeding contrary to accepted wisdom. *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Drilling USA, Inc.*, 699 F.3d 1340, 1349 (Fed. Cir. 2012); *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 662-63 (Fed. Cir. 2000). Nonobviousness, however, may be established based on only one, or a few, of the secondary considerations. *See, e.g.*, *Intri-Plex Techs., Inc. v. Saint-Gobain Performance Plastics Rencol Ltd.*, IPR2014-00309, Paper 83, at 45- 46 (PTAB Mar. 23, 2015) (reasoning that "commercial success alone sufficiently outweighs the other three [Graham] factors…").

While there must be a nexus between the merits of the claimed invention and any secondary considerations of nonobviousness, there is no requirement that the claimed invention be "solely responsible" for such secondary considerations. *Continental Can Co. USA, Inc. v. Monsanto Co.*, 948 F.2d 1264, 1273 (Fed. Cir. 1991). A patentee is entitled to a rebuttable presumption of nexus between the asserted evidence of secondary considerations and a patent claim if the patentee shows that the asserted evidence is tied to a specific product and that the product is the invention disclosed and claimed. *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019). Here, there are at least four secondary considerations

that strongly support nonobviousness of the ’052 Patent: long felt but unresolved need, industry skepticism, unexpected results, industry praise, and commercial success.

A. Commercial Success and Licensing

The fact that companies have taken a license to the ’052 Patent is powerful evidence of non-obviousness. *See Minnesota Mining & Mfg. Co. v. Johnson & Johnson Orthopaedics, Inc.*, 976 F.2d 1559, 1575 (Fed. Cir. 1992) (stating that taking a license “provide[s] a colorful picture of the state of the art, what was known by those in the art, and a solid evidentiary foundation on which to rest a nonobviousness determination.”). Patent Owner and its parent, Micro-Imaging Solutions has licensed its patented reduced are imaging device to several companies including: Gyrus Group PLC, Cook Inc., Cook Medical Technologies LLC, Coopersurgical, Inc., Ethicon Endo-Surgery, Inc., Fujikura Ltd., Microtek Medical, Inc., Endosee Corp., Karl Storz Imaging, Inc., and Voyage Medical Inc. *See* Ex. 2074. As such, this significant objective evidence confirms the non-obviousness of the Challenged Claims of the ’052 Patent.

B. Recognition of a Problem and Long Felt but Unresolved Need

Although there existed endoscopic devices, there was a pressing need for smaller, more cost effective and reliable endoscope. “Evidence of a long-felt but unresolved need can weigh in favor of the non-obviousness of an invention

because it is reasonable to infer the need would not have persisted had the solution been obvious." *Personal Web Techs., LLC v. Apple, Inc.*, 848 F.3d 987, 1056 (Fed. Cir. 2017). Patent Owner's reduced-area imaging device, the core inventive feature in the challenged claims and as incorporated in an endoscope described in the specification of the '052 Patent, provides an imaging device with a "largest dimension of said image sensor along said first plane is between 2 and 12 millimeters."

Industry publications such as Orthopaedic Product News in July 2007 recognized the contribution to the art by Patent Owner's reduced-area imaging device as incorporated in an endoscope that addressed a long felt need for a smaller imaging device in endoscopes. In particular, Orthopaedic Product News recognized Patent Owner's incorporating a reduced-area CMOS imaging device, as recited in the Challenged Claims, stating:

> A Denver-based company has developed and patented high resolution, sturdy and inexpensive CMOS sensors (Complimentary Metal Oxide Semiconductors) that are actually built into the distal tip of arthroscopes, as well as other commonly used endoscopes.
>
> . . .
>
> It is evident that we have needed an appropriate and thoughtful improvement to the scope and video system as we currently know it. The development of the CMOS sensor has addressed the needs of the surgeon, surgical facility and the patient while addressing the important

> issues of video image, thoughtful design and cost-effectiveness. This disposable scope system represents a significant advancement for arthroscopists, cost-conscious hospitals and surgery centers and I believe it will be embraced by the endoscopy companies. The justification that my peers and I always recall is that if we can't see…we can't do the procedure.

Ex. 2089 at 2-3.

C. Industry Skepticism

"If industry participants or skilled artisans are skeptical about whether or how a problem could be solved or the workability of the claimed solution, it favors nonobviousness." *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1335 (Fed. Cir. 2016). As noted in the prosecution history, at the time of the invention the industry was skeptical regarding the use of CMOS imagers in the medical imaging application on it was recognized at the time that CMOS imager quality, as compared to CCD imagers that were widely used in devices at the time, was meaningfully lower than available with CCD imager devices:

> "There has been great skepticism in the industry as to the capability to use CMOS technology in medical imaging applications. CMOS imagers have been characterized as not being able of producing high quality images. Despite this skepticism, we were able to locate companies developing CMOS technology that might be useable within an imaging device . . . [that] utilize[] a CMOS pixel array with timing and control placed together on one plane or circuit board, and remaining

> processing circuitry either placed in a remote control box, or on other circuit boards placed closely adjacent the CMOS pixel array."

Ex. 1003 at 85 (Adair Declaration). Accordingly, the industry skepticism for the patented invention of the Challenged Claims, which is based on a claimed element of the Challenged Claim, is yet further evidence of nonobviousness.

D. Unexpected Results

In considering unexpected results, courts consider whether the claimed invention exhibits some superior property or advantage that a person of ordinary skill in the relevant art would have found surprising or unexpected. *Forest Labs., LLC v. Sigmapharm Labs., LLC*, 918 F.3d 928 (Fed. Cir. 2019) (citing *In re Soni* , 54 F.3d 746, 750 (Fed. Cir. 1995)). The results must be unexpected by one of ordinary skill in the art at the time of the application. *In re Geisler* , 116 F.3d 1465, 1470 (Fed. Cir. 1997). During prosecution of a related reduced-area imaging device application, the inventor Jeffrey Adair submitted a declaration noting the unexpected results achieved by his claimed reduced-area imaging device. In particular, Adair noted:

> During our testing of the devices claimed in this invention, we discovered an unknown, but very important advantage that our device has over CCD imagers. This advantage is the capability of our device to reject radio frequency interference (RFI) which is emitted by electrosurgical generators used during surgery. . . . CCD devices cannot be used near an electrical surgical generator without requiring significant shielding for the CCD device. . . . Even when such shielding is incorporated, RFI levels are only brought to a reasonable

> level which may still result in an obstructed view of the surgical area. After testing several types of CMOS configurations, we concluded **that remoting processing circuitry from the CMOS imager and timing and control circuits** eliminated the need for shielding. In other words, we found that this configuration was not susceptible to RFI.

Ex. 1003 at 85-86 (Adair Declaration) (emphasis added).

E. Industry Praise

Products embodying the invention claimed reduced-area imaging device have received industry praise. "Evidence that the industry praised a claimed invention or a product that embodies the patent claims weighs against an assertion that the same claim would have been obvious." *Lextrosonics, Inc. v. Zaxcom, Inc.*, IPR2018–01129, Paper 33 at 68 (PTAB. Jan. 24, 2020) (citing WBIP, 829 F.3d at 1331). Patent Owner has received such praise. For example, Micro-Imaging Systems won the Orthopedics This Week's 2016 Sports Medicine Technology Award for its "Distally mounted CMOS Sensor for disposable/reusable and rigid/flexible scopes" which features the claimed reduced-area imaging device, Orthopedics This Week noted the benefits of Patent Owner's CMOS sensors that could be place in the tip of an endoscope:

> Current cameras and endoscopes (all types) have remained unchanged for decades and degrade from "Day 1" of utilization thus causing undesirably compromise of visual clarity at an extremely inconvenient time! This technology allows for flexible or rigid applications as a reusable or a disposable with significant value. Utilization of this

> technology can eliminate the five things that degrade current and problematic technology. It has the real benefit of reducing repair costs as well as OR "down time" and the need to acquire costly surplus inventory to avoid catastrophes."

Ex. 2090 at 14-15. Accordingly, Patent Owner's endoscopes, which embodied the claimed features of the reduced-area imaging device, including a CMOS pixel array and separated image processing circuitry, was thus praised by others for the innovative and non-obvious features claimed in the Challenged Claims.

F. Proceeding Contrary To Accepted Wisdom

Prior to the '052 Patent, the accepted wisdom in the art was that CMOS imagers should be implemented in an on-chip integration manner. Dr. Eric Fossum spearheaded the development of the CMOS camera on a chip design efforts. Fossum's design would enable full realization of the benefits of a CMOS imager boasting numerous benefits over the dominant CCD image sensor. For example, the CMOS camera on a chip would enable designers to "make a camera small and cheap enough to open vast new markets for everything from dolls that "see" to rear-bumper cameras that would help drivers back up." Ex. 1060. However, Patent Owner recognized that a need still existed for a reduced-area imaging device which could be used in even smaller devices, such as endoscopic instruments, in order to view areas that are particularly difficult to access, and to further minimize patient trauma by an even smaller diameter invasive instrument.

As a result, the ’052 Patent describes and claims a reduced-area imaging device which took advantage of Fossum’s revolutionary “camera on a chip” technology, but rearranged the circuitry to separate out circuitry so that a further minimum profile could be achieved.

IX. CONCLUSION

Petitioner has not established by a preponderance of the evidence that challenged claim 2 of the ’052 Patent is invalid. Patent Owner accordingly requests that the Board find claim 2 patentable.

Respectfully submitted,

Dated: November 9, 2020

Jonathan S. Caplan /

Jonathan S. Caplan (Reg. No. 38,094)
Jeffrey H. Price (Reg. No. 69,141)
Kramer Levin Naftalis & Frankel LLP
1177 Avenue of the Americas
New York, NY 10036
Tel: 212.715.9000 Fax: 212.715.8000

James Hannah (Reg. No. 56,369)
Kramer Levin Naftalis & Frankel LLP
990 Marsh Road
Menlo Park, CA 94025
Tel: 650.752.1700 Fax: 212.715.8000

(Case No. IPR2020-00512)

Attorneys for Patent Owner

PATENT OWNER'S EXHIBIT LIST

EXHIBIT NO.	DESCRIPTION
Exhibit-2001	Complaint for Patent Infringement in *Cellect, LLC v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.*, 1:19-cv-00438, dated February 14, 2019.
Exhibit-2002	Proof of Service for Summons and Complaint, dated February 19, 2019.
Exhibit-2003	Scheduling Order in a Patent Case in *Cellect, LLC v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.*, 1:19-cv-00438, dated June 10, 2019.
Exhibit-2004	E. Fossum, *Active-pixel sensors challenge CCD,* Laser Focus World, pp. 83-87, June 1993 ("Fossum").
Exhibit-2005	Parties' Joint Claim Construction Chart in *Cellect, LLC v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.,* 1:19-cv-00438, dated May 8, 2020.
Exhibit-2006	U.S. Patent No. 5,754,313 ("Pelchy").
Exhibit-2007	Zarnowski and Pace, *Imaging options expand with CMOS technology*, Laser Focus World, June 1997 ("Zarnowski")
Exhibit-2008	U.S. Patent No. 4,491,865 ("Danna").
Exhibit-2009	U.S. Patent No. 5,453,785 ("Lenhardt").
Exhibit-2010	Hearing Transcript before Judge Hegarty, dated July 10, 2019.
Exhibit-2011	*Cellect, LLC v. Samsung Electronics Co., LTD and Samsung Electronics America, Inc.,* 1:19-cv-00438 Docket Sheet.
Exhibit-2012	Declaration of Jonathan S. Caplan, dated March 17, 2020.
Exhibit-2026	U.S. Patent No. 6,073,034 ("Jacobson").
Exhibit-2027	U.S. Patent No. 6,141,037 ("Upton").

EXHIBIT NO.	DESCRIPTION
Exhibit-2028	U.S. Patent No. 6,147,366 ("Drottar").
Exhibit-2029	U.S. Patent No. 5,929,901 ("Adair").
Exhibit-2030	PCT WO 90/10361 ("Ullman").
Exhibit-2031	PCT WO 95/15044
Exhibit-2032	U.S. Patent No. 5,896,375 ("Dent").
Exhibit-2033	U.S. Patent No. 6,590,928 ("Haartsen").
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Exhibit-2037	Samsung's Invalidity Contentions, dated January 21, 2020.
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Exhibit-2040	U.S. Patent No. 5,879,289 ("Yarush").
Exhibit-2041	U.S. Patent No. 7,369,176 ("Sonnenschein").
Exhibit-2042	File History of U.S. Patent No. 6,752,255
Exhibit-2043	U.S. Patent No. 5,986,693 ("Adair '693").
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Exhibit-2051	U.S. Patent No. 5,596,228 A, to Richard L. Anderton *et al.* ("Anderton").

Exhibit-2052	*1997 Product Timeline*, DIGIT. PHOTOGRAPHY REV., https://www.dpreview.com/products/timeline?year=1997&brand=&category (last visited Oct. 20, 2020).
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Exhibit-2054	Eric R. Fossum, *CMOS Image Sensors: Electronic Camera On A Chip*, 1995 IEEE INT'L ELECTRON DEVICES PROC. 17, 17-25 (1995).
Exhibit-2055	Eric R. Fossum *et al.*, *CMOS Active-Pixel Image Sensor Containing Pinned Photodiodes*, NASA TECH BRIEFS 40-42 (Oct. 1996).
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Exhibit-2059	JAMES R. JANESICK, *History, Operation, Performance, Design, Fabrication and Theory, in* SCIENTIFIC CHARGE-COUPLED DEVICES 3, 22-37 (2001) ("Janesick").
Exhibit-2060	Laura Johannes, *Advances in CMOS Chips Help Sales of Digital Cameras*, WALL ST. J., Aug. 21, 1998, https://www.wsj.com/articles/SB903661392760427500.

Exhibit-2061	U.S. Patent No. 6,721,008 B2, to Paul P. Lee *et al*. ("Lee").
Exhibit-2062	Dawn Levy, *News Release: Speedy Camera-On-A-Chip Unites Image Capture and Processing*, STANFORD NEWS SERV., Apr. 2001, https://news.stanford.edu/pr/01/digicam3425.html.
Exhibit-2063	Elizabeth M. Lockyer, *Applications Hold the Key to Imager Choice*, PHOTONICS SPECTRA 80-90 (Mar. 1997).
Exhibit-2064	Sunetra Mendis *et al.*, *CMOS Active Pixel Image Sensor*, 41 IEEE TRANSACTIONS ON ELECTRON DEVICES 452, 452-53 (1994).
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Exhibit-2069	JUN OHTA, SMART CMOS IMAGE SENSORS & APPLICATIONS (CRC Press, Taylor & Francis Group 2008).
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Exhibit-2075	Deposition Transcript of Dean Neikirk, Ph.D. (Oct. 8, 2020).
Exhibit-2076	Deposition Transcript of Dean Neikirk, Ph.D. (Sept. 30, 2020).
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Exhibit-2078	*Charged-Coupled Device*, WIKIPEDIA, Aug. 15, 2020, https://en.wikipedia.org/w/index.php?title=Charge-coupled_device&oldid=973099011.
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Exhibit-2084	Southwest Museum of Engineering, Communications & Computation, *Hitachi*, SMECC (2007), https://www.smecc.org/hitachi.htm (last visited Oct. 20, 2020).
Exhibit-2085	Albert Theuwissen, *CMOS Image Sensors: State-Of-The-Art and Future Perspectives*, 2007 EUR. SOLID-STATE CIRCUITS PROC. 21, 21-27 (2007).
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Exhibit-2087	Brian Dunbar, NASA, *NASA Technology is All Around You*, NASA, Dec. 12, 2016 (last updated Aug. 6, 2017), https://www.nasa.gov/specials/apollo50th/index.html.
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Exhibit 2092	L. Kozlowski, *Development Status of CMOS 1920 x 1080 Imaging system-on-Chip for 60p and 72p HDTV*, SMPTEMotion Imaging (Oct./Nov. 2004)
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Exhibit 2095	Deposition Transcript of Dean Neikirk, Ph.D., IPR2020-00512 (dated Oct. 9, 2020).
Exhibit-2096	Authenticated version of Exhibit 2052, *1997 Product Timeline*, DIGIT. PHOTOGRAPHY REV., https://www.dpreview.com/products/timeline?year=1997&brand=&category (last visited Oct. 20, 2020), ("Authenticated Ex. 2052").
Exhibit-2097	Authenticated version of Exhibit 2062, Dawn Levy, *News Release: Speedy Camera-On-A-Chip Unites Image Capture and Processing*, STANFORD NEWS SERV., Apr. 2001, https://news.stanford.edu/pr/01/digicam3425.html, ("Authenticated Ex. 2062").
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/Jonathan S. Caplan /

Jonathan S. Caplan (Reg. No. 38,094)
Kramer Levin Naftalis & Frankel LLP
1177 Avenue of the Americas
New York, NY 10036
Tel: (212) 715-9000

CERTIFICATE OF SERVICE

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Persons Served	Scott A. McKeown James L. Davis, Jr. Carolyn Redding

/Jonathan S. Caplan /
Jonathan S. Caplan
Registration No. 38,094
Counsel for Patent Owner