

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

**SAMSUNG ELECTRONICS CO., LTD.,
SAMSUNG ELECTRONICS AMERICA, INC.,
FOSSIL GROUP, INC.,
FOSSIL STORES I, INC.,
FOSSIL PARTNERS, L.P., AND
OURA HEALTH OY
ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD.**

Petitioners,

v.

OMNI MEDSCI, INC.,

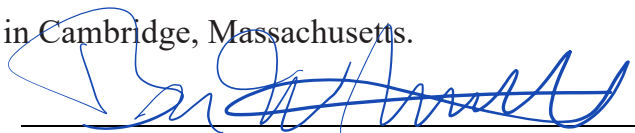
Patent Owner.

Case IPR2025-01252

Patent No. 11,160,455

**DECLARATION OF BRIAN W. ANTHONY IN SUPPORT
OF PETITIONERS' REPLY TO PATENT OWNER'S RESPONSE**

Executed this 30th day of July 2026, in Cambridge, Massachusetts.



Brian W. Anthony

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TABLE OF EXHIBITS

Exhibit No.	DESCRIPTION
1001	U.S. Patent No. 11,160,455 ("455")
1002	File History of U.S. Application No. 17/078,771 ("455FH")
1003	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 11,160,455 ("Anthony")
1004	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 9,651,533 submitted in IPR2019-00916, Ex. 1003 ("533-Anthony")
1005	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 1 (P.T.A.B. Apr. 10, 2019) ("533-Pet.")
1006	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 23 (P.T.A.B. Jan. 31, 2020) ("533-POR")
1007	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 16 (P.T.A.B. Oct. 18, 2019) ("533-Inst.")
1008	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 39 (P.T.A.B. Oct. 14, 2020) ("533-FWD")
1009	<i>Omni MedSci, Inc. v. Apple Inc.</i> , No. 21-01229, ECF 69 (Fed. Cir. June 8, 2022)
1010	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 10,517,484 submitted in IPR2021-00453, Ex. 1003 ("484-Anthony")
1011	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 1 (P.T.A.B. Jan. 22, 2021) ("484-Pet.")

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Exhibit No.	DESCRIPTION
1012	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 10 (P.T.A.B. Nov. 12, 2021) (“484-POR”)
1013	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 7 (P.T.A.B. Aug. 6, 2021) (“484-Inst.”)
1014	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 11 (P.T.A.B. Feb. 4, 2022) (“484-Pet.-Reply”)
1015	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 22 (P.T.A.B. Aug. 3, 2022) (“484-FWD”)
1016	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 26 (P.T.A.B. Feb. 14, 2025) (“484-RFWD”)
1017	<i>Apple Inc. v. Omni MedSci, Inc.</i> , No. 23-01034, ECF 44 (Fed. Cir. June 21, 2024)
1018	<i>Omni MedSci, Inc. v. Apple Inc.</i> , 2:18-cv-00134-RWS, Dkt. No. 211 (E.D. Tex. June 24, 2019)
1019	<i>Omni MedSci, Inc. v. Apple Inc.</i> , 2:18-cv-00429-RWS, Dkt. No. 152 (E.D. Tex. Aug. 14, 2019)
1020	Second Amended Docket Control Order, June 16, 2025. <i>Omni MedSci, Inc. v. Samsung Electronics Co., Ltd. et al.</i> , No. 2:24-cv-01070-JRG-RSP (E.D. Tex.)
1023	Defendants' Supplemental Invalidity and Subject Matter Eligibility Contentions, July 18, 2025. <i>Omni MedSci, Inc. v. Samsung Electronics Co., Ltd. et al.</i> , No. 2:24-cv-01070-JRG- RSP (E.D. Tex.)
1025	U.S. Patent No. 9,241,676 (“Lisogurski”)
1026	U.S. Patent Pub. No. 2010/0217102 (“LeBoeuf”)

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Exhibit No.	DESCRIPTION
1027	U.S. Patent No. 8,108,036 ("Tran")
1028	U.S. Patent Pub. No. 2005/0049468A1 ("Carlson")
1030	U.S. Patent No. 7,029,628 ("Tam")
1031	U.S. Patent No. 8,050,730 ("Zhang")
1032	U.S. Patent No. 8,821,397 ("Al-Ali")
1033	U.S. Patent Pub. No. 2011/0237911 ("Lamego")
1034	U.S. Patent No. 5,942,749 ("Takeuchi")
1035	U.S. Patent No. 5,822,473 ("Magel")
1036	US Patent 5,592,124 ("Mullins")
1037	E.F. Schubert, Light-Emitting Diodes (Cambridge Univ. Press, 2nd ed. reprinted 2014)
1038	Joseph D. Bronzino, The Biomedical Engineering Handbook (1995)
1039	U.S. Patent No. 8,079,735 ("Vakil")
1041	U.S. Patent Pub. No. 2012/0197093 ("Valencell-093")
1042	U.S. Patent No. 8,862,196 ("Lynn")
1043	U.S. Patent No. 8,412,655 ("Colman")
1044	U.S. Patent No. 5,511,553 ("Segalowitz")
1045	U.S. Patent No. 6,801,799 ("Mendelson")
1046	U.S. Patent No. 6,662,033 ("Casciani")

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Exhibit No.	DESCRIPTION
1047	U.S. Patent No. 5,028,787 ("Rosenthal")
1048	U.S. Pat. No. 9,239,951 ("Hoffberg")
1049	U.S. Pat. Pub. 2007/0194939 ("Alvarez")
1050	U.S. Patent No. 8,364,226 ("Diab")
1051	U.S. Patent No. 6,931,269 ("Terry")
1059	U.S. Patent No. 5,497,769 ("Gratton")
1060	U.S. Patent No. 5,827,182 ("Raley")
1061	U.S. Patent No. 7,764,982 ("Dalke")
1064	U.S. Patent No. 5,554,273 ("Demmin")
1065	U.S. Patent No. 5,953,713 ("Behbehani")
1077	U.S. Patent Publication No. 2006/0184040 ("Keller")
1081	US. Patent No. 9,651,533 ("533")
1082	U.S. Patent No. 10,517,484 ("484")
1127	Transcript of Igor Efimov, Ph.D. (July 16, 2026) ("Efimov-Tr.") [CONFIDENTIAL]
1128	Transcript of the Deposition of Mohammed Islam, Sc.D. (July 23, 2026) ("Islam-Tr.")

Declaration of Brian Anthony in Support of Petitioners' Reply
to Patent Owner's Response, U.S. Patent No. 11,160,455 (IPR2025-01252)

TABLE OF ABBREVIATIONS

Abbreviations	DESCRIPTION
Challenged Claims	Claims 1-20 of the '455 patent
IPR	<i>Inter Partes</i> Review
Petitioners	Petitioners Samsung Electronics Co. Ltd., Samsung Electronics America Inc., Fossil Group, Inc., Fossil Stores I, Inc., Fossil Partners, L.P., Oura Health Oy, and OnePlus Technology (Shenzhen) Co., Ltd.
Patent Owner	Omni Medsci, Inc.
POSITA	Person of Ordinary Skill in the Art
POR	<i>Samsung Electronics Co., Ltd. et al. v. Omni MedSci, Inc.</i> , No. IPR2025-01252, Paper 26 (PTAB May 7, 2026)
Anthony or Declaration	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 11,160,455 (Ex.1003)
'533-FWD	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 39 (PTAB Oct. 14, 2020) (Ex. 1008)
'484-FWD	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 22 (PTAB Aug. 3, 2022) (Ex. 1015)
'484-RFWD	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 26 (P.T.A.B. Feb. 14, 2025) (Ex.1016)
'533-Anthony	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 9,651,533 submitted in IPR2019-00916, Ex. 1003 (Ex. 1004)
'484-Anthony	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 10,517,484 submitted in IPR2021-00453, Ex. 1003 (Ex. 1010)
'533 patent	U.S. Patent No. 9,651,533 (Ex.1081)

Declaration of Brian Anthony in Support of Petitioners' Reply
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Abbreviations	DESCRIPTION
'484 patent	U.S. Patent No. 10,517,484 (Ex.1082)
'455 patent	U.S. Patent No. 11,160,455 (Ex.1001)
Lisogurski	U.S. Patent No. 9,241,676 (Ex.1025)
Carlson	U.S. Patent Pub. No. 2005/0049468 (Ex.1028)
Tran	U.S. Patent No. US 8,108,036 (Ex.1027)
LeBoeuf	U.S. Patent Pub. No. 2010/0217102 (Ex.1026)
Lamego	U.S. Patent Pub. No. 2011/0237911 (Ex.1033)
Mendelson	U.S. Patent No. 6,801,799 (Ex.1045)
Valencell-093	U.S. Patent Pub. No. 2012/0197093 (Ex.1041)
Efimov	Corrected Declaration of Prof. Igor Efimov, Ph.D. dated May 7, 2026 (CONFIDENTIAL) (Ex.2043)
Efimov-Tr.	Transcript of Igor Efimov, Ph.D. (July 16, 2026) (Ex.1127)
Islam-Tr.	Transcript of the Deposition of Mohammed Islam, Sc.D. (July 23, 2026) (Ex.1128)
SNR	Signal-to-Noise Ratio

I. INTRODUCTION

1. I am the same Brian W. Anthony who provided a declaration for this matter executed on August 5, 2025 ("Declaration") (Ex. 1003 ("Anthony")).

2. As part of my work in this proceeding, I have been asked by Petitioners to respond to certain assertions offered by Omni Medsci, Inc. ("Patent Owner") in IPR2025-01252 regarding U.S. Patent No. 11,160,455 ("the '455 patent").

3. My experience, qualifications, and compensation are provided in my August 5, 2025 Declaration and **Appendix A** thereto. Anthony, ¶¶6, 14, 16-24, Appendix A. In this Reply Declaration, I have been asked to respond to certain assertions raised by Patent Owner in its Patent Owner's Response ("POR") (Paper 26) and by Igor Efimov, Ph.D., in his supporting declaration (Ex. 2043 ("Efimov")).

4. I understand that, in this proceeding, the Board has instituted *Inter Partes* Review proceedings of claims 1-20 of the '455 patent ("Challenged Claims") as anticipated and/or obvious based on all grounds (Grounds 1-4) set forth in my prior declaration. Anthony, ¶¶12, 69-74.

5. In reaching the conclusions described in this Reply Declaration, I have relied on the documents and materials cited herein as well as those cited within and identified in my prior Declaration (*see* Anthony, ¶¶8, Appendix B). A complete listing of all materials upon which I have relied upon or considered in formulating

my opinion are included in **Appendix A** attached hereto. The materials that I have relied upon in this Reply Declaration and in my prior Declaration are the types of materials upon which experts in the relevant field of art would reasonably rely upon in forming an opinion on the subject.

6. In formulating the opinions set forth in this Reply Declaration, I have also relied upon the legal understandings set forth in my prior Declaration. *See* Anthony, ¶¶25-39, 51. My opinions are also based upon my education, training, research, knowledge, and personal and professional experience.

II. LEVEL OF ORDINARY SKILL IN THE ART

7. In my August 5, 2025 Declaration, I opined that on or before December 31, 2012, a person of ordinary skill in the art (“POSITA”) relating to the technology of the '455 patent “would have had a good working knowledge of optical sensing techniques and their applications, and some familiarity with optical system design and signal processing techniques. That knowledge would have been gained via an undergraduate education in engineering (electrical, mechanical, biomedical or optical) or a related field of study, along with relevant experience in studying or developing physiological monitoring devices (e.g., non-invasive optical biosensors) in industry or academia. This description is approximate; varying combinations of education and practical experience also would be sufficient.” Anthony ¶52. Patent Owner and Dr. Efimov applied the same definition in their analysis (POR, at 4;

Efimov, ¶¶51-53), and I continue to apply that definition here.

III. CLAIM CONSTRUCTION

8. I was instructed to apply certain constructions in providing my opinions in the Declaration, including for the “light source” and “to detect an object” limitations that the Board previously construed. Anthony, ¶¶56-57. I understand that the Board has already found the limitations met by Lisogurski applying its constructions. Anthony, ¶¶394-404, 410-411, 414-421, 443-448. Consistent with the Board's decision and as further detailed below, it is my opinion that the “light source” and “detect an object” limitations are met by Lisogurski under the Board's construction.

IV. CLAIM LIMITATIONS PREVIOUSLY ADDRESSED BY THE BOARD

9. For claim limitations that are identical or substantially identical to the limitations addressed in the prior '533 and '484 IPRs, my Declaration explains why my prior opinions remain applicable in this proceeding, why I agree with the Board's analyses, and why any differences in claim language do not alter my conclusions. *See e.g.*, Anthony, ¶¶110-113, 116-117, 120-123, 131-137, 139-140, 143-144, 146-149, 156, 158, 163-167, 171-172, 176-177, 179-180, 184, 186, 188, 190, 192-193.

10. Dr. Efimov opines that the following are “additional limitations that were not at issue and therefore not addressed in either of the prior IPR decisions”:

“driver” (claims 1, 8, and 15), “three optical wavelengths” (claims 1, 9, and 16), “the optical wavelengths comprise near infrared or visible wavelengths” (claim 1, 10), “wherein the plurality of semiconductor sources comprises six light emitting diodes” (claim 8), “the plurality of semiconductor sources and the plurality of spatially separated detectors are located on one or more arcs” (claims 2, 9, 15), “a reflective surface [positioned] to receive and redirect at least some of the output optical light” (claims 6, 13, and 17), “the output optical light comprises wavelengths between 600 nanometers and 1,000 nanometers to measure a level of oxyhemoglobin and deoxyhemoglobin” (claims 3, 11, 15), “the output signal corresponding to at least one of the optical wavelengths is used to improve measurement of the one or more physiological parameters using the output signal corresponding to the other two optical wavelengths” (claim 11), and “the system is configured to apply one or more regression signal processing methodologies to at least a part of the output signal” (claim 5). Efimov, ¶¶85-91. I disagree with Dr. Efimov's characterization of those limitations. As I opine throughout my declaration, at least certain aspects of those claim limitations were addressed by the Board in the previous '533 and '484 IPRs.

11. For example: regarding “three optical wavelengths,” the Board already found that Lisogurski met the requirement of “one or more optical wavelengths.” Anthony, ¶¶120-121, 199, 291-292, 347-349. Regarding “wherein the plurality of semiconductor sources comprises six light emitting diodes,” the Board already found

Lisogurski met “a plurality of semiconductor sources that are light emitting diodes.” Anthony, ¶¶120-121, 249, 272, 341-342. Regarding, “the plurality of semiconductor sources and the plurality of spatially separated detectors are located on one or more arcs,” the Board already found Lisogurski met “a plurality of spatially separated detectors.” Anthony, ¶¶156, 272, 287, 340.

12. And regarding Dr. Efimov's claim that “[n]one of the claims addressed in the prior IPRs recited a ‘reflective surface’” (Efimov, ¶89), that is not true. I understand that, in the prior '484 IPR, the Board found that the Petitioner had demonstrated that claim 23 of the '484 patent, which recites “a reflective surface positioned to reflect at least a portion of [the lens output] light reflected from the tissue,” was unpatentable over the combined teachings of Lisogurski, Carlson, Tran, and Valencell-093. '484-FWD, at 59-60; *see also* Anthony, ¶268.

13. Patent Owner argues that my opinions improperly “consist of quoting the prior IPR decisions and incorporating by reference [my] prior testimony,” and uses my analysis of [1.pre] as an example. POR, 17-18. Patent Owner mischaracterizes my opinions. First, I understand my declarations from the previous '533 and '484 IPRs have been resubmitted in this IPR as Exhibits 1004 and 1010, respectively. Further, my opinions here go well beyond “quoting the prior IPR decisions” and “incorporating by reference” my prior testimony. Using my analysis of [1.pre], for example, I (i) discuss the prior analysis of the Board regarding relevant

claim limitations in the prior '484 and '533 IPRs (Anthony, ¶¶110-111) (ii) compare the claim limitation at issue to the relevant claim limitations in the prior '484 and '533 IPRs (Anthony, ¶¶112-113), (iii) confirm that my opinions from my declarations from the prior '533 and '484 IPRs apply equally here (Anthony, ¶¶112-113), and (iv) set forth further support for the limitation (Anthony, ¶114). I performed similar analyses for the other limitations cited by Patent Owner. *See e.g.*, Anthony, ¶¶110-113, 116-117, 120-123, 131-137, 139-140, 143-144, 146-149, 156, 158, 163-167, 171-172, 176-177, 179-180, 184, 186, 188, 190, 192-193. Consistent with this approach, my deposition testimony explained that I was not relying on the Board's opinions themselves, but rather that the Board's findings were consistent with my previously expressed opinions regarding the same prior-art disclosures. Ex. 2045, 125:9-126:10. Further, for limitations where there is no prior Board decision (for example, the "driver" limitation in [1.a]), I provide detailed opinions regarding why those limitations are also met. *See* Anthony, ¶¶124-125.

V. GROUNDS OF UNPATENTABILITY

14. I note that Patent Owner's and Dr. Efimov's challenges to the asserted prior-art Grounds are limited to the issues addressed in the following sections. With respect to the remaining claims and Grounds, Patent Owner and Dr. Efimov rely on the same, but no additional, arguments. *See* POR, 31-32, 34, 50-51, 62-66 ; Efimov, ¶¶143-148, 160-162, 175-178, 237-272, 322-366. Accordingly, those arguments fail

as to the remaining claims and Grounds for the same reasons discussed below.

A. LISOGURSKI DISCLOSES AND RENDERS OBVIOUS “A LIGHT SOURCE COMPRISING A DRIVER” ([1.B], [8.B], [15.B])

15. As I explained in my Declaration in this proceeding, Lisogurski renders obvious “a light source comprising a driver” (claims limitations [1.b], [8.b], [15.b]). Anthony, ¶¶124-125, 212, 300. Specifically, Lisogurski, as modified, discloses “light drive circuitry 120” (i.e., a driver) and a light source—consistent with the Board’s rationale in relocating the light drive circuitry to the sensor as further discussed below, a person of ordinary skill in the art would further have been motivated to place the light drive circuitry within Lisogurski’s light source. Anthony, ¶¶124-125; Lisogurski, 10:42-46, 11:28-60. Dr. Efimov opines limitations [8.b] and [15.b] (“a light source comprising a driver”) is not met by Lisogurski for the same reasons with respect to limitation [1.b]. Efimov, ¶¶143-148, 254-256. As I opined, limitations [8.b] and [15.b] are met for the same reasons as limitation [1.b], and my responses to Dr. Efimov regarding limitation [1.b] set forth above apply equally to [8.b] and [15.b]. Anthony, ¶¶211-214, 299-302. Neither Patent Owner nor Dr. Efimov disputes that Lisogurski’s light drive circuitry 120 is a driver. Neither Patent Owner nor Dr. Efimov identifies any structure in Lisogurski, other than light drive circuitry 120, that performs the function of a driver. Rather, Patent Owner and Dr. Efimov dispute that Lisogurski discloses or renders obvious “*a light*

source comprising a driver.” Efimov, ¶96; POR, 19-20. For the reasons set forth below, I disagree.

16. Patent Owner and Dr. Efimov argue that Lisogurski does not disclose “a light source comprising a driver” as recited in limitation [1.b] because Lisogurski does not explicitly recite its light drive circuitry (i.e., driver) within light source 130 (i.e., light source). Efimov, ¶99; POR, 19-20; *see also* Efimov, ¶¶100-103. However, I did not opine that Lisogurski explicitly discloses light drive circuitry within its light source—instead, consistent with the modification of Lisogurski's sensor that the Board agreed in the prior '533 IPR, which places the light drive circuitry in the sensor along with the light source, a person of ordinary skill in the art would further have understood, and at least found obvious, that Lisogurski's light source includes light driver circuitry. Anthony, ¶¶124-125.

17. Indeed, I understand that the Board previously agreed that a person of ordinary skill in the art would have been motivated to reconfigure Lisogurski's system such that light drive circuitry 120 would be inside sensor 102 due to the “numerous industry trends” to improve wearable sensors' capabilities. '533-FWD, 22-25, 31, 47, 58; Anthony, ¶97; *see also* '533-FWD, 23 (“Petitioner articulates sufficient reasoning with rational underpinning to demonstrate why a person of ordinary skill in the art would have modified Lisogurski's sensor 102/312 and monitor 104/314 in the manner proposed.”). Applying the Board's same rationale,

a person of ordinary skill in the art would have understood, and or at least found it obvious, that Lisogurski's light source 130 within sensor 102 includes its light drive circuitry 120 to: "maintain[] precise synchronization and optimal signal integrity," (Anthony, ¶94), "enhance[] the system's efficiency by reducing noise, signal degradation, and latency[, which] aligns with standard industry practices in wearable sensor technologies, commonly used to ensure compact, energy-efficient, and responsive physiological monitoring solutions" (Anthony, ¶102), "minimize[] interference, enhances operational efficiency, improves manufacturability, and optimizes device compactness and usability" (Anthony, ¶102). Anthony, ¶¶90-107, 124-125; '533-Pet., 32. I further explained why a person of ordinary skill in the art would have understood, or at least found obvious to modify, Lisogurski in this way, including because: "light drive circuitry ... and light source 130 are operationally interdependent components," "it would have been routine design practice to integrate the two components within a common device," "[c]ombining driver ... with the optical sources reduces electrical noise and interference, enhances reliability, simplifies device architecture, and facilitates more efficient manufacturing," and that the combination would "improve the overall responsiveness of Lisogurski's system." Anthony, ¶125.

18. Consistent with my opinion, Lisogurski explicitly discloses that, regarding Figure 1: "[i]n some embodiments the functionality of some of the

components may be combined in a single component.” Lisogurski, at 15:66-16:4. Patent Owner and Dr. Efimov argue that statement does not apply to light source 130 or light drive circuitry 120 simply because those components are not explicitly identified. Efimov, ¶¶102, 113. I disagree. As the Board recognized, “Lisogurski expressly suggests the modification,” and a person of ordinary skill in the art reading that disclosure would have understood Lisogurski's flexible teaching to combine or relocate functionalities. '533-FWD, at 23; Anthony, ¶92. Indeed, the following statement includes specific *examples* of combined functionalities, thus making clear that Lisogurski's flexible teaching to combine functionalities of its components is not limited to those examples. Lisogurski, 16:4-6 (“*For example*, the functionality of front end processing circuitry 150 and back end processing circuitry 170 may be combined in a single processor system.”); Anthony, ¶84.

19. Patent Owner and Dr. Efimov further argue the Board's previous decision in the prior '533 IPR and my discussion of the motivation to modify Lisogurski show only that a person of ordinary skill in the art would have been motivated to relocate Lisogurski's light drive circuitry 120 within *sensor 102*, not further within *light source 130*. Efimov, ¶¶105-108, 110-111, 114-116, 118-119. I disagree. In Section IX.A.2 of my Declaration in this proceeding, I discussed my opinions from the prior '533 and '484 IPRs, where I opined that a person of ordinary skill in the art would have been motivated to modify Lisogurski to include its light

drive circuitry into its sensor. Anthony, §IX.A.2. I also noted that the Board in the previous '533 IPR agreed with my prior opinions to modify Lisogurski to include light drive circuitry into the sensor. '533-FWD, at 23; Anthony, ¶¶92. As further discussed, and in light of the modification, a person of ordinary skill in the art “would have understood (or at least found obvious) that a driver (i.e., light drive circuitry 120) and control circuitry 110 would be located within Lisogurski's light source 130.” Anthony, ¶125. To be clear, I do not rely on Ex. 1031 as part of my proposed grounds; I cite it only as evidence of the knowledge of a person of ordinary skill in the art. With that knowledge, this reading is further confirmed by contemporaneous art, which reflects combining the light source and a driver within a same component, e.g., a probe unit that “comprises a red light source, an infrared light source and the light driver circuit.” Ex. 1031, 14:12-26, Fig. 18; Anthony, ¶¶105-106.

20. Patent Owner and Dr. Efimov incorrectly contend that Ex. 1031 only teaches locating light driver circuit in a probe and not specifically in a light source. Efimov, ¶109; POR, 22. I disagree. As modified, Lisogurski's light source 130 includes, e.g., “a Red light emitting light source and an IR light emitting light source, e.g., Red and IR light emitting diodes (LEDs),” and light drive circuitry. Lisogurski, at 10:52-54. And as stated above, Ex. 1031 likewise discloses a light source and a driver both placed together within a same component, e.g., it's a probe unit.

21. Dr. Efimov argues that the Board's previous decision in the '533 IPR,

the Petition, and my declaration address relocating Lisogurski's light drive circuitry 120 within sensor 102 (not within light source 130 therein) only, and that it "matches the fact that those same sources also assert or find that a POSITA would have relocated Lisogurski's front end processing circuitry 150 to within sensor 102 (not within detector 140 therein)." Efimov, ¶111. I disagree. As discussed above, my opinions address relocating the light drive circuitry to within the light source. Whether the front-end processing circuitry is combined with the detector 140 in the sensor has no impact on my opinion that a person of ordinary skill in the art would have understood, and at least found obvious, to have the light source include light drive circuitry.

22. Patent Owner and Dr. Efimov also opine that the annotated version of Lisogurski Figure 1 "came from the petitioner in the '533-IPR, not from the Board," and does not support my proposed modification. Efimov, ¶112; POR, at 23-24. I disagree. I understand that the annotated Figure 1 reproduced in my Declaration was assembled by the Board in the previous '533 IPR from annotations by the previous petitioner. '533-FWD at 22. The Board further acknowledged that Petitioner's proposed combination is "illustrated in a series of Petitioner-modified versions of Lisogurski's Figure 1, which we combine into a single modified version shown below." '533-FWD, 22.

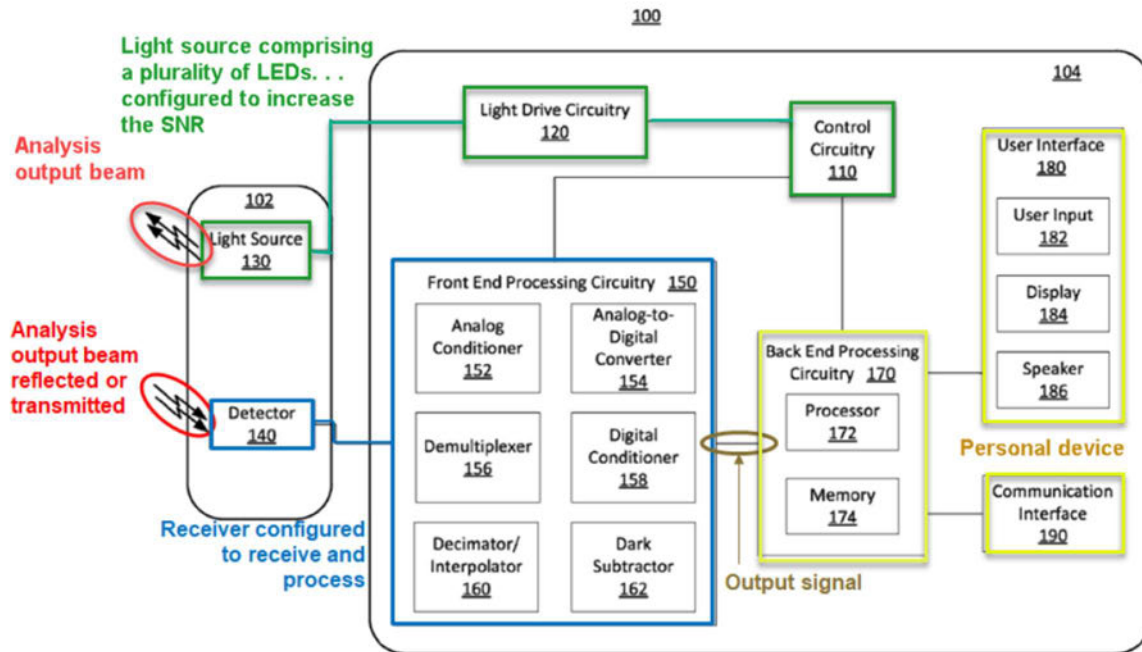


FIG. 1

'533-FWD, 22. As shown in the green annotations, the Light Drive Circuitry 120 is combined with the Light Source 130 to form a “Light source comprising a plurality of LEDs ... configured to increase the SNR.” '533-FWD, 22. Regardless, and as I have discussed above, the Board in the previous '533 IPR found that the petitioner had demonstrated why a person of ordinary skill in the art would have made the modification. Nevertheless, I rely on that version of Lisogurski Figure 1 to “highlight[] some of the components that I have described.” Anthony, ¶90.

23. Patent Owner and Dr. Efimov continue that, based on the portions of Lisogurski cited in the Petition teaching that “[l]ight drive circuitry 120 turns on/off the ‘light source 130’ by generating ‘light drive signal[s]’” (Lisogurski, at 10:42-46, 11:28-31, 11:38-41, 11:50-60), my proposed modification would result in light

source 130 sending a light drive signal to itself. Efimov, ¶¶117, 120, 122; POR, 25.

I disagree. I explain why in the following paragraph.

24. Patent Owner and Dr. Efimov ignore Lisogurski's disclosure that "**light source 130** may **include** a Red light emitting light source and an IR light emitting light source, e.g.. Red and IR light emitting diodes (**LEDs**)," and "**light source 130** may **include** any number of **light sources** with any suitable characteristics." Lisogurski, 10:49-60; Anthony, ¶77. Light drive circuitry 120 is driving the LEDs inside light source 130, not the light source 130 packaging those LEDs. Lisogurski says as much: the light drive signal is "provided to light source 130, including red 'on' period 202 IR 'on' period 204 to drive red and IR light emitters, respectively, within light source 130." Lisogurski, 12:4-6. The purpose of the light drive circuitry is to regulate the emitters, like LEDs, e.g., using current. Nothing about either the light drive circuitry or the light drive signal it produces requires it to be a separate component from the light source, which contains the emitters that the light drive circuitry drives.

25. Patent Owner and Dr. Efimov also argue that incorporating Lisogurski's light drive circuitry into light source "would give rise to undesirable heat transfer issues" negatively affecting the light drive circuitry, which Lisogurski allegedly recognizes and seeks to reduce. Efimov, ¶¶123-124 (citing Ex. 2036; Ex. 1037 at 30-31; Lisogurski, at 1:17-19 3:58-60 5:7-9); POR, at 27-28. I disagree.

First, Dr. Efimov bases his opinion on Ex. 2036 without explaining how Ex. 2036 supports his opinion. Ex. 2036 is a flyer apparently published by the U.S. Department of Energy titled "Thermal Management of White LEDs." While Ex. 2036 notes potential effects of heat on LEDs themselves rather than the surrounding circuitry, it describes "typical high-flux LED system [to be] comprised of an *emitter* [including a heat sink slug], *metal-core printed circuit board* (MCPCB), and some form of external heat sink," similar to the light source 130 in the modified sensor of Lisogurski including LEDs and light drive circuitry. Further Ex. 2036 discusses dissipating heat away from LEDs using multiple heat sinks, confirming the knowledge of a person of ordinary skill in the art to address any heat concerns. It was well known how to design an LED system including heat sinks or other known techniques to maximize the performance and longevity of the LED without damaging the surrounding circuitry. Ex. 1037 confirms such knowledge in the art by noting that LEDs are mounted in packages that include a thermal path from the LED chip, through the LED package, to a heat sink for heat dissipation. Ex. 1037, at 00026-28. Ex. 1037 further discusses the improvement in thermal resistance of heat sinks prior to 2005. Notably, Ex. 1037 does not list as a concern damaging the circuitry around LEDs with heat.

26. Further, while disclosing "varying light output during a cardiac cycle may reduce heating effects of the emitters," and "[i]t may also be desirable to reduce

the power consumption by the light drive signal to reduce heating effects caused by an emitter” without identifying what concerns may be caused by the emitters’ heating effects (Lisogurski, 1:17-19, 3:58-60), Lisogurski further provides that “parameter variation may reduce the impact of heating effects caused by a light source *on a subject*.” Lisogurski, 5:7-9. Thus, reading these passages together, the heating concern Lisogurski identifies is the effect of the light source on the subject, and that Lisogurski nowhere identifies heat from the emitters as a threat to the surrounding circuitry. *See* Lisogurski, 5:7-9; Ex. 2045, 104:4-108:7, 113:12-114:19 (“LEDs don’t generate enough heat to be a significant problem in general ... This does not teach away at all from being -- from miniaturizing the -- the emitters or combining things in a smaller space.”), 114:15-19 (“It’s a ‘may.’ It depends is what it means.”).

27. Dr. Efimov continues that the emitted heat of IR LEDs is of particular concern as IR LEDs allegedly radiate heat in the same spectrum as the measurement wavelength and would destroy or compromise light drive circuitry 120. Efimov, ¶124. I disagree. As an initial matter, Dr. Efimov cites no evidence that heat radiated by an IR LED would destroy or compromise light drive circuitry 120. Efimov, ¶124. Further, as I explain above, it was well known how to design a light source comprising LEDs and drivers such that the heat from the LEDs does not damage the driver circuitry.

28. Patent Owner and Dr. Efimov further argue that light source 130 and light drive circuitry 120 are separately designed and fabricated standard components such that their combination would allegedly result in, e.g., “unnecessarily increased cost, complexity, complication, and sourcing and design issues.” Efimov, ¶125; POR, 27-28. I disagree. First, Lisogurski discloses that its light source 130 includes emitters, like LEDs. Lisogurski, 10:52-56; Anthony, ¶77. While LEDs may be sold in their own packages (*see* Ex. 1037; Ex. 2036), a person of ordinary skill in the art would have understood, and at least found obvious, to incorporate an LED package into a light source along with a driver, as confirmed by the contemporaneous art discussed above. Placing an LED package and its drive circuitry on a common substrate changes where those components sit; it does not change what either component is or how it is manufactured. That is precisely the flexibility Lisogurski describes when it explains that components “shown and described as separate components are shown and described as such for illustrative purposes only.” Lisogurski, 15:66-16:2. Further, Lisogurski's Figure 1, which depicts certain components, is not meant to limit those components' arrangements as rigidly as Dr. Efimov suggests. Indeed, Lisogurski invites exactly the type of modification I propose: “[i]t will be understood that the components of physiological monitoring system 100 that are shown and described as separate components are shown and described as such for illustrative purposes only ... the functionality of some of the

components may be combined in a single component.” Lisogurski, 15:66-16:4; Anthony, ¶¶84, 91.

29. Patent Owner and Dr. Efimov further argue that my proposed modification would degrade the signal-to-noise ratio (“SNR”) of Lisogurski’s detection signal, which is “directly contrary to Lisogurski’s objective of reducing noise.” Efimov, ¶129; POR, 28-29. Dr. Efimov, however, provides no basis for such alleged SNR degradation. As I explained at my deposition, ordinary circuit-design considerations point the other way: “there’s a level of noise associated with ... a presumptive configuration where they’re separated. And so a POSITA would be very motivated to move them together in order to minimize that noise.” Ex. 2045, 80:8-19; *see also* Ex. 2045, 78:14-19, 81:2-7, 82:12-13 (“current is not the source of noise”). Instead, Dr. Efimov relies solely on Lisogurski Figures 1 and 3 to argue that the objective of Lisogurski is to “keep[] noise-generating electronic components away from the sensitive optical detector 140” and “preserves the architecture in which sensing components are located in the sensor unit, while processing and drive circuitry reside in a separate monitor.” Efimov, ¶¶130-131. I disagree.

30. Lisogurski does not disclose that the purpose of the structure in Figures 1 and 3 is to separate certain components from the detector. *See generally* Lisogurski Figures 1 and 3 and related disclosures. To the contrary, Lisogurski invites exactly the type of modification I propose: “[i]t will be understood that the components of

physiological monitoring system 100 that are shown and described as separate components are shown and described as such for illustrative purposes only ... the functionality of some of the components may be combined in a single component.” Lisogurski, 15:66-16:4; Anthony, ¶¶84, 91. Indeed, Patent Owner's and Dr. Efimov's assertion in this regard is inconsistent with the Board's prior decision in the '533 IPR agreeing to relocate front-end processing circuitry and light drive circuitry, arguably noise-generating components, to Lisogurski's sensor, as I proposed in the previous '533 and '484 IPRs and in my Declaration. '533-Anthony, ¶¶99-103; '484-Anthony, ¶¶160-164; '533-FWD, 22-24 (“Petitioner's proposed combination [] involves relocating ... light drive circuitry 120 ... of monitor 104 to sensor 102 Petitioner articulates sufficient reasoning with rational underpinning to demonstrate why a person of ordinary skill in the art would have modified Lisogurski's sensor 102/312 and monitor 104/314 in the manner proposed.... Lisogurski expressly suggests the modification by teaching embodiments in which “the functionality of some of the components may be combined in a single component” and embodiments in which “the functionality of some of the components of monitor 104 ... may be divided over multiple components.” [Lisogruski], 16:2-4, 16:7-9.... Patent Owner does not dispute this.”); Anthony, §IX.A.2, ¶¶124-125.

31. Ignoring the Board's prior decision, and again without any basis, Patent

Owner and Dr. Efimov further contend that relocating electrical components into the sensor would introduce additional electrical noise and electromagnetic interference into the detection signal that cannot be subtracted out by Lisogurski's dark subtraction technique because such noise and interference would be present when the LEDs are on and off. Efimov, ¶¶132-133. In support of this argument, Dr. Efimov claims that as modified, light drive circuitry, which generates high currents, would be in close proximity to sensitive detector 140. Efimov, ¶134. Dr. Efimov concludes that my opinions do not address his alleged concerns with the modification and that a POSITA would have avoided relocating noise-generating circuitry to the sensor. Efimov, ¶¶135-136. Again, I disagree, for the reasons set forth in the following two paragraphs.

32. As I opined in my Declaration, a person of ordinary skill in the art would have understood and at least found obvious to have the light source 130 (within sensor 102) include light drive circuitry. Anthony, §IX.A.2, ¶¶124-125. As I further opined in my Declaration, a person of ordinary skill in the art would have understood so or at least found it obvious to do so, because "integrating control and drive circuitry directly with the LEDs is advantageous to maintaining precise synchronization and optimal signal integrity," "given the limitations in transmitting accurate electrical signals without introducing noise or timing errors ... such integration [to be] technically and practically advantageous," and a person of

ordinary skill in the art would have been motivated to combine “components that perform the same functionality together in a single device to substantially minimize latency, improve signal fidelity, and simplify overall system architecture by reducing signal travel distances and potential points of interference or noise.” Anthony, ¶¶94; *cf.* Anthony, ¶¶98 (applying the same reasoning to combining front end processing circuitry 150 into sensor with detector 140). The proposed modification would thus have minimized noise and improved SNR.

33. Ignoring such benefits, Dr. Efimov focuses on potential noise generation of the components in the modified sensor the Board approved in the prior '533 IPR, assuming that dark subtraction is the only available means to filter such noise in Lisogurski. Efimov, ¶¶132-136. Again, Dr. Efimov provides no support for his alleged noise concern—likewise, Lisogurski is silent about any such alleged noise concerns brought by its explicit teaching to combine “functionality of some of the components” “in a single component.” Lisogurski, 15:66-16:4. Indeed a person of ordinary skill in the art would have understood how to design Lisogurski's sensor to address Dr. Efimov's alleged noise concerns. For example, dark subtraction is not the only means of removing noise in Lisogurski—Lisogurski discloses “[a]nalog conditioner 152 may perform any suitable analog conditioning of the detector signal,” including “any type of filtering (e.g., low pass, high pass, band pass, notch, or any other suitable filtering), amplifying, performing an operation on the received

signal (e.g., taking a derivative, averaging), performing any other suitable signal conditioning (e.g., converting a current signal to a voltage signal), or any combination thereof.” Lisogurski, 13:13-20. Lisogurski further discloses, “[d]igital conditioner 158 may perform any suitable digital conditioning of the detector signal,” including “any type of digital filtering of the signal (e.g., low pass, high pass, band pass, notch, or any other suitable filtering), amplifying, performing an operation on the signal, performing any other suitable digital conditioning, or any combination thereof.” Lisogurski, 13:46-52. I identified such alternatives at my deposition. Ex. 2045, 76:22-77:22. Thus, even to the extent noise was generated by the light drive circuitry and front-end processing circuitry, which the Board already agreed to include in the sensor, it was known to design the sensor such that the light drive circuitry does not negatively impact the received signal, e.g., using the analog and digital conditioners to compensate for this.

**B. LISOGURSKI DISCLOSES AND RENDERS OBVIOUS
“THREE OPTICAL WAVELENGTHS” ([1.M], [10], [16])**

34. As I explained in my Declaration in this proceeding, Lisogurski discloses and renders obvious “three optical wavelengths” (claim limitation [1.m] and claim [10], and [16]). Anthony, ¶¶197-204, 291, 347. Specifically, I opined that Lisogurski discloses the use of “any suitable wavelength of electromagnetic radiation” and that its light source 130/316 is configured to emit “one or more

wavelengths of light (e.g., Red and IR [infrared]),” “include any number of light sources with any suitable characteristics,” and “emit[] light at one or more wavelengths into a subject’s tissue.” Lisogurski, 10:48-11:8, 17:37-39; Anthony, ¶199. I further opined that using multiple wavelengths was common in physiological monitoring applications, such as pulse oximetry, to improve measurement accuracy and reliability and to provide additional physiological information. Anthony, ¶199. To this end, Lisogurski discloses selecting among wavelengths based on their differing sensitivity to high and low blood oxygen saturation levels. Lisogurski, 24:58-25:5; Anthony, ¶200. I further opined that it was well known in the art that using multiple, different wavelengths was a routine and effective approach to overcome the limitations of and improving measurements with fewer wavelengths of light. Anthony, ¶¶201-203 (citing LeBoeuf, [0153]; Lamego, [0035], [0033]-[0037]). To be clear, and as I explain further below, I do not rely on Lamego as part of my proposed grounds; I cite it, like the other references discussed in this declaration that are not part of an instituted ground, only as evidence of what was known to a person of ordinary skill in the art along with motivation to combine/modify and reasonable expectation of success. Dr. Efimov opines claims 10 and 16 (“three optical wavelengths for measuring at least a portion of the one or more of the physiological parameters”) is not met by Lisogurski for the same reasons with respect to limitation [1.m]. Efimov, ¶¶248-252, 263-269. As I opined, claims

10 and 16 are met for the same reasons as limitation [1.m], and my responses to Dr. Efimov regarding limitation [1.m] set forth above apply equally to claims 10 and 16. Anthony, ¶¶290-292, 346-49.

35. Patent Owner and Dr. Efimov appear to limit Lisogurski's pulse oximetry technique to a two-wavelength technique only. Efimov, ¶138 (citing Ex. 1025 at 10:52-58, 24:58-25:5); POR, 29-30. I disagree. As I discuss above, Lisogurski contains numerous disclosures providing for an open-ended number of wavelengths, and discloses red and IR light as exemplary wavelengths. Anthony, ¶199. A person of ordinary skill in the art would have understood that, even though Lisogurski discloses using red and IR light as exemplary wavelengths, that the system is not limited to those wavelengths. *See* Anthony, ¶200. For example, Lisogurski discloses that “[w]hen light source 130 is configured to emit ***two or more wavelengths of light***, the light drive signal may be configured to control the operation of each wavelength of light.” Lisogurski, 11:54-57.

36. Patent Owner and Dr. Efimov also mischaracterize that I admitted during my deposition that using three optical wavelengths is a “recent advancement” or “new advancement.” Efimov, ¶139 (citing Ex. 2046 at 391:10-392:13); POR, 29-30. That is a misinterpretation of my testimony. During the deposition, I explained about my recent projects, some of which utilize multiple wavelengths of light—counsel for Patent Owner asked if using “three or more wavelengths is more of a

recent trend,” which I misunderstood as referring to my recent work and provided more information about my projects. Ex. 2046, 391:3-392:13. My answer did not adopt counsel's premise: “We're trying to -- there was a -- I was co-author on a ... New York Times article with faculty here that was -- really came down hard on the racial disparities in the physiological in -- pulse-ox. So that has led to some internal funding being made available to try to eliminate that complication.” Ex. 2046, 392:6-13. The subject of the exchange was my own laboratory's work: “What we're trying to do now, actually, fast-forward a couple of decades is we're using multiple wavelengths ... But -- so that's been over the last six years we've been working on -- on that.” Ex. 2046, 391:15-392:2. Nowhere during my testimony, however, did I agree that using three wavelengths of light was new or a “recent trend” as of 2012—as I opined in my previous declaration, and as I do here, using multiple, e.g., three, wavelengths in a pulse oximetry system was well known in the art by the time of the alleged invention—2012.

37. Notably, Dr. Efimov argues that using three wavelengths is “deliberate design approach to improve physiological measurement performance.” Efimov, ¶139. I agree insofar as a person of ordinary skill in the art would have understood that using a third wavelength in pulse oximetry would improve the measurement, as I have opined. Anthony, ¶¶199-203. However, Patent Owner and Dr. Efimov argue that the third wavelength would need to be selected at or near an isosbestic point,

which they characterize as “a wavelength at which oxygenated hemoglobin and deoxygenated hemoglobin have approximately equal absorption coefficients.” Efimov, ¶139; POR, 30. I disagree—the claim limitation at issue simply requires “three optical wavelengths” and do not require the system to use the third optical wavelengths “at or near an isosbestic point” as Patent Owner and Dr. Efimov contend. Dr. Efimov continues that choosing a wavelength at an isosbestic point “is consistent with the dependent claim requirement that ‘output signal corresponding to at least one of the optical wavelengths is used to improve measurement of at least one of the one or more physiological parameters using the output signal corresponding to the other two optical wavelengths.’” Efimov, ¶139 (citing ’455 patent, 87:36-40; 88:51-54; 90:17-21). However, I do not see such requirement for the “three optical wavelengths” limitation—likewise, no dependent claim of the ’455 requires choosing an “isosbestic point.” Regardless, additional wavelengths, even if not at isosbestic point, would help improve the measurement accuracy as confirmed by the knowledge of a person of ordinary skill in the art. *See* Lamego, [0035]-[0037] (adding wavelengths sensitive to additional significant absorbers allows a system that would otherwise be underdetermined to resolve each absorber).

38. For example, Lamego provides two examples of using additional wavelengths to improve accuracy in a pulse oximetry that a person of ordinary skill in the art would have understood to be applicable to Lisogurski's pulse oximetry

system: adding one or more wavelengths such 760 nm and/or 805 nm to compensate for MetHb which “absorbs light at the two wavelengths used in a typical two-wavelength physiological monitor, which may cause inaccurate S_pO_2 readings.” Lamego, [0037]; Anthony, ¶¶202-203. Likewise, LeBoeuf further discloses using “multiple wavelengths, with the goal of providing specialized physiological information for each wavelength.” LeBoeuf, [0153]; Anthony, ¶201.

39. Patent Owner and Dr. Efimov also try to discredit LeBoeuf's disclosure, which confirms the knowledge of a person of ordinary skill in the art concerning the use of multiple, e.g., three or more wavelengths, for physiological measurements. Efimov, ¶141; POR, 30. For example, Dr. Efimov argues that I rely on “LeBoeuf at paragraph [0153] for the disclosure of violet, ultraviolet and green light,” that the “passage describes different wavelength ranges for different, incompatible purposes” and “does not teach combining any three specific wavelengths for measuring physiological parameters.” Efimov, ¶141. I disagree.

40. Dr. Efimov omits the first sentence of the paragraph that provides for using the listed wavelengths in combination: “optical detectors 26 and emitters 24 may be of *multiple wavelengths*, with the goal of *providing specialized physiological information* for each wavelength.” LeBoeuf, [0153]. That LeBoeuf's embodiments are disclose the use in earbuds does not make LeBoeuf's disclosure of using multiple wavelengths any less relevant to Lisogurski's system. Both

Lisogurski and LeBoeuf are directed to physiological measurement devices. *See* LeBoeuf, [0026] (“Physiological sensors that may be incorporated into headsets and/or earbuds, according to some embodiments of the present invention, may be configured to detect and/or measure one or more of the following types of physiological information: heart rate, pulse rate, breathing rate, blood flow, VO₂, VO₂max, heartbeat signatures, cardio-pulmonary health, organ health, metabolism, electrolyte type and/or concentration, physical activity, caloric intake, caloric metabolism, blood metabolite levels or ratios....”); Lisogurski, 4:6-20 (“An oximeter may include a light sensor that is placed at a site on a patient, typically a fingertip, toe, forehead or earlobe, or in the case of a neonate, across a foot. The oximeter may use a light source to pass light through blood perfused tissue and photoelectrically sense the absorption of the light in the tissue. In addition, locations which are not typically understood to be optimal for pulse oximetry serve as suitable sensor locations for the blood pressure monitoring processes described herein. including any location on the body that has a strong pulsatile arterial flow. For example, additional suitable sensor locations include, without limitation, the neck to monitor carotid artery pulsatile flow, the wrist to monitor radial artery pulsatile flow, the inside of a patient's thigh to monitor femoral artery pulsatile flow, the ankle to monitor tibial artery pulsatile flow, and around or in front of the ear.”). Further, LeBoeuf discloses that “embodiments of the present invention are not limited to

earbuds,” and that “the light-guiding structure may be molded around another part of the body, such as a digit, finger, toe, limb, around the nose or earlobe, or the like,” or “may be integrated into a patch, such as a bandage that sticks on a person’s body.” LeBoeuf, [0090].

41. Patent Owner and Dr. Efimov also try to discredit Lamego, which again confirms the knowledge of a person of ordinary skill in the art concerning the use of multiple, e.g., three or more wavelengths, for physiological measurements. Efimov, ¶142; POR, 30-31. For example, Dr. Efimov opines that Lamego is not part of the grounds and a separate reference from Lisogurski. Efimov, ¶142. Dr. Efimov further argues that Lamego’s “underdetermined system” teaching does not apply to Lisogurski’s two-wavelength system that measures two absorbers (oxy- and deoxy-hemoglobin), and that I do not explain what physiological parameter or blood constituent would be measured by the third wavelength in addition to what is measured by Lisogurski's red and IR wavelengths. Efimov, ¶142; *see also* Lamego, [0035] (“[W]hen only two wavelengths are used but there are more than two significant absorbers in the patient's tissue, the system may be underdetermined. Therefore, adding wavelengths sensitive to additional significant absorbers can help the system compensate for the additional significant absorbers and enable more accurate calculation of the concentration of each absorber and the blood oxygen saturation.”). I disagree.

42. To be clear, I do not rely on Lamego as part of my proposed grounds, but it still shows what was known in the art. For example, both Lisogurski and Lamego are directed to physiological measurement devices, confirming that the knowledge of a person of ordinary skill in the art in Lamego is relevant to Lisogurski. *See* Lamego, [0041] (“A schematic of one embodiment of a multi-wavelength physiological monitor for pulse oximetry is shown in FIGS. 3-5. FIG. 3 depicts a general hardware block diagram of a multi-wavelength pulse oximeter 299”); Lisogurski, 4:6-20. Further, as discussed above, Lamego confirms that additional wavelengths allows improving accuracy in a pulse oximetry by being able to distinguish a constituent (e.g., MetHb) that absorbs both wavelengths of light being used in a pulse oximetry system. Lamego, [0037]. A person of ordinary skill in the art would thus have understood the benefits of using three optical wavelengths, been motivated and had a reasonable expectation of success in making the proposed modification, as confirmed by Lamego. Anthony, ¶¶202-203.

43. Patent Owner and Dr. Efimov further contend that Lisogurski's disclosure of “any number of light sources” does not disclose the number of wavelengths, because Lisogurski teaches that “the light source may include multiple LEDs of the same wavelength.” Efimov, ¶140 (citing Lisogurski, at 10:58-60, 19:25-31); POR, 29. I disagree.

44. Lisogurski does not limit its system to using two wavelengths of light

and Patent Owner and Dr. Efimov ignore Lisogurski's explicit disclosure of "emit[ting] photonic signals having *one or more wavelengths* of light," "include one or more light source 316 for emitting light at *one or more wavelengths*," and that "[a]s used herein, light may also include any wavelength within the radio, microwave, infrared, visible, ultraviolet, or X-ray spectra, and that *any suitable wavelength of electromagnetic radiation may be appropriate for use with the present techniques*." Lisogurski, 10:48-11:6, 17:37-39. Further, for example, Lisogurski discloses an embodiment of cardiac cycle modulation technique wherein "the first light source may be selected based on efficiency parameters and information from the first light source may be used only to control a second light source," explaining that for example, "a highly efficient *first light source that is not at a wavelength of interest* for physiological parameter determination may be used to control *one or more second light sources at wavelengths of interest*." Lisogurski, 7:61-8:3; *see also* Anthony, ¶120 (citing Lisogurski, 7:38-8:3), 198 (incorporating discussion of claim element [1.b]). A person of ordinary skill in the art would thus have understood that Lisogurski teaches not just multiple LEDs, but also multiple wavelengths, including three or more optical wavelengths as claimed.

**C. LISOGURSKI DISCLOSES AND RENDERS OBVIOUS
“...ONE OF THE OPTICAL WAVELENGTHS IS USED TO
IMPROVE MEASUREMENT...” ([4], [11], [16])**

45. As I explained in my Declaration this proceeding, Lisogurski discloses and renders obvious “at least one of the optical wavelengths is used to improve measurement of at least one of the one or more physiological parameters using the output signal corresponding to the other two optical wavelengths” (claims [4], [11], and [16]). Anthony, ¶¶253-257, 284, 347. Dr. Efimov opines claims 4 and 16 (“wherein the output signal corresponding to at least one of the optical wavelengths is used to improve measurement of at least one of the one or more physiological parameters using the output signal corresponding to the other two optical wavelengths”) is not met by Lisogurski for the same reasons with respect to claim 11. Efimov, ¶¶240-241, 263-269. As I opined, claims 4 and 16 are met for the same reasons as claim 11, and my responses to Dr. Efimov regarding claim 11 set forth above apply equally to claims 4 and 16. Anthony, ¶¶280-285, 346-49.

46. Patent Owner and Dr. Efimov contend that Lisogurski does not disclose using one wavelength to improve measurement using the other two optical wavelengths because Lisogurski's disclosure is limited to two-wavelength system only. Efimov, ¶¶165-169; POR, 32-33. I disagree for the reasons I discuss above in Section V.B regarding limitation [1.m] and in my Declaration, because Dr. Efimov's argument here depends, in part, on his contention that Lisogurski is limited to two

wavelengths. *See* Anthony, ¶256 (“See also my discussion of claim element [1.m].
Section IX.A.3.n.[1.m] (reciting, in portion, ‘three optical wavelengths’).”

47. Specifically, Lisogurski discloses using more than two wavelengths, and a person of ordinary skill in the art would have understood Lisogurski discloses and at least renders obvious using a third wavelength to improve measurement using the output signal corresponding to the other two optical wavelengths. For example, as I explain above, Lisogurski discloses “emit[ting] photonic signals having *one or more wavelengths* of light,” and “include one or more light source 316 for emitting light at *one or more wavelengths*,” and that “[a]s used herein, light may also include any wavelength within the radio, microwave, infrared, visible, ultraviolet, or X-ray spectra, and that *any suitable wavelength of electromagnetic radiation may be appropriate for use with the present techniques*.” Lisogurski, 10:48-11:6, 17:37-39. Further, Lisogurski discloses “monitor[ing] activity with [the] more sensitive available wavelength.” Lisogurski, at 24:58-25:5. A person of ordinary skill in the art would thus have understood, and at least found obvious, that Lisogurski teaches the use of multiple wavelengths of light, with each wavelength selected based on its sensitivity to the specific physiological parameters being measured, to compensate for different sensitivities to different wavelengths. Anthony, ¶256. Further, for example, Lisogurski discloses an embodiment of cardiac cycle modulation technique wherein “the first light source may be selected based on efficiency parameters and

information from the first light source may be used only to control a second light source,” explaining that for example, “a highly efficient *first light source that is not at a wavelength of interest* for physiological parameter determination may be used to control *one or more second light sources at wavelengths of interest*.” Lisogurski, 7:59-65. This teaching thus further confirms that a person of ordinary skill in the art would have understood, and at least found obvious, to use the third wavelength to improve measurement based on at least two other optical wavelengths. Anthony, ¶¶256-257.

48. Dr. Efimov opines that “Paragraph 257 of [my] report also does not address the recited operation involving output signals corresponding to three different wavelengths.” Efimov, ¶170. I disagree. Dr. Efimov cherry-picks certain sentences of my Declaration in isolation. But, reading my opinion as a whole demonstrates the flaws in Dr. Efimov’s analysis.

49. For example, as I opined in my Declaration, Lisogurski discloses using detectors 140 sensitive to the wavelengths of light of light source 130. Lisogurski, 11:6-8; Anthony, ¶257. A person of ordinary skill in the art would have understood that these separate detectors 140 sensitive to different wavelengths of light would generate separate signals, and that Lisogurski already teaches operating with multiple output signals (e.g., three or more) corresponding to those wavelengths (e.g., three or more). See Anthony, ¶257. As further explained in the next portion

of my Declaration, which Dr. Efimov ignores, a person of ordinary skill in the art would have understood, and at least found it obvious, that multiple wavelengths improve the accuracy of the measurements for the reasons discussed above (Section V.B) discussing [1.m], such as distinguishing an absorber of two wavelengths by using a third wavelength. Anthony, ¶257. Indeed, as discussed above, contemporaneous art confirms my opinion. For example, Lamego teaches adding one or more wavelengths such 760nm and/or 805nm to compensate for MetHb which “absorbs light at the two wavelengths used in a typical two-wavelength physiological monitor, which may cause inaccurate S_pO_2 readings,” which is directly relevant to Lisogurski's pulse oximetry system. Lamego, [0037].

50. Patent Owner and Dr. Efimov again try to undermine my discussion of Lamego. Efimov, ¶¶171-172; POR, 33. For example, Dr. Efimov opines that “Dr. Anthony provides no evidentiary or technical basis for asserting that Lisogurski's two-wavelength system is underdetermined or would require the type of multi-wavelength correction described in Lamego,” and “Dr. Anthony does not articulate any reason why a person of ordinary skill would have been motivated to modify Lisogurski to incorporate Lamego's multi-wavelength approach, nor does he address the technical changes such a modification would require.” Efimov, ¶¶171-172. I disagree.

51. As an initial matter, Dr. Efimov misunderstands my opinion as if Lamego's teaching is incorporated into Lisogurski. That is not my opinion. Rather, I opine, based on a person of ordinary skill in the art's knowledge as demonstrated by Lamego, that "a person of ordinary skill would have understood that Lisogurski includes an output signal corresponding to at least one of the optical wavelengths to improve measurement of the one or more physiological parameters based on the output signal corresponding to the other (multiple more) optical wavelengths." Anthony, ¶257 (citing Lamego, [0033]-[0037]). Further, Lamego discloses that a pulse oximetry system is underdetermined "when only two wavelengths are used but there are more than two significant absorbers in the patient's tissue." Lamego, [0035]. Lamego further confirms that there are more than two significant absorbers in measuring blood oxygen, e.g., when MetHb is present, confirming that it is not an issue unique to Lamego's system. Lamego, [0037]. Thus, a person of ordinary skill in the art would have understood, and least found obvious, to use a third wavelength to address such absorbers in pulse oximetry, like Lisogurski's system, to improve measurements based on two other wavelengths sensitive to such absorbers. Lisogurski, 4:6-20; Lamego, [0041]; Anthony, ¶257.

**D. LISOGURSKI DISCLOSES AND RENDERS OBVIOUS SIX
LEDS ([2], [8.M], [15.M])**

52. As I explained in my Declaration in this proceeding, Lisogurski discloses and renders obvious “six light emitting diodes” (claims [2], and claim limitations [8.m], and [15.m]). Anthony, ¶¶248-252, 272, 337. Lisogurski teaches that its light source includes “one or more” or “multiple” LEDs, and that light source 130 “may include any number of light sources with any suitable characteristics”, each of which thus disclosing the claimed “six light emitting diodes.” Lisogurski, 10:52-11:6, 17:43-45, 19:22-31, 27:36-43; Anthony, ¶250. Utilizing multiple LEDs, including multiple wavelengths and multiple LEDs per wavelength, was well-known practice at the time of the alleged invention and a person of ordinary skill in the art would have understood that using multiple LEDs would allow for improved measurement robustness, accuracy, and redundancy, and address various physiological monitoring objectives. *See* Anthony, ¶¶250-251. Using multiple LEDs, including six or more, in a physiological measurement device was in fact well known in the art, and a person of ordinary skill in the art would have understood that Lisogurski's disclosure of “one or more,” “multiple,” or “any number” of LEDs includes six LEDs. Anthony, ¶252. Dr. Efimov opines claim 2 and limitation [15.m] (“wherein the plurality of semiconductor sources comprises six light emitting diodes.”) are not met by Lisogurski for the same reasons with respect to limitation

[8.m]. Efimov, ¶¶178, 257. As I opined, claim 2 and limitation [15.m] are met for the same reasons as limitation [8.m], and my responses to Dr. Efimov regarding limitation [8.m] set forth above apply equally to claim 2 and limitation [15.m]. Anthony, ¶¶270-279, 336-338.

53. Patent Owner and Dr. Efimov argue that '455 patent Figure 18B specifically depicts an embodiment with six light-emitting diodes and that, for six LEDs, the '455 “provides the technical advantage of increasing the probability that emitted light will illuminate blood vessels within the tissue—a requirement for accurate physiological measurement.” Efimov, ¶151-152; POR, 32. I disagree to the extent Patent Owner and Dr. Efimov contend that the '455 patent specification sets forth a particular technical advantage to using six LEDs.

54. Fig. 18B depicts a mouth guard having light source input ports 1852, 1853 and detector output ports 1854, 1855. However, a person of ordinary skill in the art would have understood that the specification of the '455 patent does not provide a *particular* technical advantage to using six LEDs. In fact, the specification states that “the mouth guard may have one or more light source input ports 1852, 1853 and one or more detector output ports 1854, 1855,” and that “[a]lthough six input and output ports are illustrated, any number of ports may be used.” '455 patent, 28:24-27. Based on this, a person of ordinary skill in the art would have understood that the specification of the '455 patent provides that there is no *specific*

technical advantage to using six LEDs. Notably, Dr. Efimov does not cite this portion of the '455 patent specification when discussing Fig. 18B and therefore does not attempt to reconcile this disclosure with his opinions. Further, when asked if this passage is limited to six LEDs during his deposition, Dr. Efimov acknowledged "it does say more." Efimov-Tr., 192:21-193:17.

55. Patent Owner and Dr. Efimov further argue that when a system uses three wavelengths, six LEDs provide exactly two LEDs per wavelength, which allegedly is not an arbitrary selection, as "it provides meaningful redundancy for each wavelength channel while maintaining system efficiency." Efimov, ¶152; POR, 32. I disagree. It is true that using three wavelengths and two LEDs per wavelength results in six total LEDs. However, as I discussed above, a person of ordinary skill in the art would have understood that there is no *specific* technical advantage to using six LEDs, or two LEDs for each of three wavelengths. The '455 specification uses neither the phrase "two LEDs" nor "per wavelength," identifies no redundancy benefit, and says only that "any number of ports may be used." '455 patent, 28:26-27.

56. Patent Owner and Dr. Efimov further contend that Lisogurski's disclosure of "one or more," "multiple," and "any number" do not expressly disclose six, and that the "only specific embodiment described in Lisogurski uses two LEDs—one red and one infrared." Efimov, ¶153 (citing Lisogurski, at 10:52-60,

17:43-45, 19:22-31); POR, 31. I disagree. First, Lisogurski discloses using more than just one red LED and one IR LED. *See* Lisogurski, 7:56-59 (“[T]he first light source may be a high efficiency infrared (IR) LED ***while the one or more additional light sources may be lower efficiency red LEDs or laser diodes.***”). Further, as I previously opined, “a person of ordinary skill in the art would have understood, and at least found obvious, that Lisogurski’s disclosure of ‘one or more,’ ‘multiple,’ or ‘any number’ ... of LEDs would include six LEDs.” Anthony, ¶252. Dr. Efimov does not disagree with that opinion.

57. Patent Owner and Dr. Efimov further mischaracterize “Lisogurski’s stated objectives,” as being limited to reducing power consumption and minimizing heating effects to the exclusion of its other objectives, and assert on that basis that those objectives “counsel against using six LEDs.” Efimov, ¶154 (citing Lisogurski, at Title, 1:10-25, 3:50-60); POR, 31. I disagree. Power optimization is not Lisogurski’s sole objective. Another, and at least equally important, objective in Lisogurski is measurement accuracy and achieving high signal to noise ratios. *See e.g.*, Lisogurski, 6:3-6, 9:4-7, 9:46-60, 14:40-55, 16:33-17:10, 25:66-26:14; Anthony, ¶¶89, 176-177, 185, 188, 192, 398, 402, 426, 429. Thus, a person of ordinary skill in the art reading Lisogurski would have understood that Lisogurski’s objective of conserving power needs to be at least balanced against its objective of accurate measurement. Indeed, Lisogurski specifically notes making a tradeoff for

power consumption versus accuracy: “the system may operate in a high power mode without cardiac cycle modulation for a certain time period following, for example, high noise levels, a loss of signal, or an irregular cardiac rhythm.” Lisogurski, 9:4-7. In fact, Lisogurski does not teach compromising its accuracy for battery power—indeed, the portion of Lisogurski Dr. Efimov relies on discloses: “it may be desirable to reduce the power consumption of the light source, *while still enabling high quality physiological parameters to be determined.*” Lisogurski, 3:50-53.

58. Dr. Efimov continues that tripling the number of LEDs in Lisogurski from two to six would cut against Lisogurski's stated objectives, and would “increase heat generation,” “increase signal-processing complexity,” and “increase sensor size.” Efimov, ¶155. I disagree with each such assertion. In fact, such assertion ignores Lisogurski's explicit teaching for “one or more,” “multiple,” and “any number” of LEDs—an *unbounded* number. See Lisogurski, 10:52-11:6, 17:43-45, 19:22-31, 27:36-43; Anthony, ¶250.

59. Regarding heat generation, the cited passages of Lisogurski discuss reducing power consumption and heating effects through operational techniques such as varying light intensity, firing rate, and duty cycle. Lisogurski, 1:10-25, 3:50-60. I do not agree that those disclosures would have led a person of ordinary skill in the art to conclude that a six-LED configuration was inconsistent with Lisogurski's objectives, particularly given Lisogurski's repeated disclosure that the

system may employ multiple light sources. Lisogurski, 10:52-11:6, 17:43-45, 19:22-31, 27:36-43. Further, by the time of the alleged invention, a person of ordinary skill in the art would have understood how to implement LED-based physiological monitoring systems, including systems employing six LEDs, while managing heat generation. For example, the contemporaneous art explains that LEDs were available in packages that provided a thermal path from the LED chip through the package to an external heat sink for heat dissipation and discusses significant improvements in thermal resistance and heat-sink performance prior to the alleged invention. Ex. 1037, 00026-00028.

60. Regarding signal processing complexity, a person of ordinary skill in the art would have understood how to program Lisogurski's system to accommodate signal processing for additional wavelengths without unduly increasing signal processing complexity. Indeed, Lisogurski specifically discloses that "[w]hen light source 130 is configured to emit two or more wavelengths of light. the light drive signal may be configured to control the operation of each wavelength of light. The light drive signal may comprise a single signal or may comprise multiple signals (e.g.. one signal for each wavelength of light)." Lisogurski, 11:54-60. A person of ordinary skill in the art therefore would have understood that Lisogurski already contemplates controlling and processing multiple wavelengths and corresponding signals. A person of ordinary skill in the art would also have understood that adding

emitters does not change Lisogurski's signal-processing architecture. Lisogurski already drives its emitters in separate time slots and separates the resulting detector signal with demultiplexer 156. Lisogurski, 12:4-35; 13:11-12. Additional emitters therefore add drive slots within a cycle rather than additional processing blocks.

61. Regarding sensor size, by the time of the alleged invention, standard LEDs were small enough such that a utilizing six LEDs would not negatively impact the size of the sensor. Ex. 1038, at 765 (“In certain applications, for example in portable instrumentation, LEDs have significant advantages over other light sources because they are small and inexpensive, consume low power, produce selective wavelengths, and are easy to work with.”). Further, Dr. Efimov opines that “[c]onsistent with these objectives, Lisogurski teaches techniques intended to minimize the number and brightness of LEDs operating at any given time.” Efimov, ¶155 (citing Lisogurski, 7:38-8:3). However, that portion of Lisogurski is not limited to a system with two light sources. It describes operating a first light source at full brightness together with “one or more additional light sources”: “operat[ing] a first light source at full or regular brightness, while operating *one or more additional light sources* in a switched or otherwise modulated mode.” Lisogurski, at 7:38-43. The remainder of the cited portion provides further examples of a system with more than two LEDs, for example: “the *first light source* may be a high efficiency infrared (IR) LED while the *one or more additional light sources* may be

lower efficiency red LEDs or laser diodes.” *See* Lisogurski, at 7:38-43.

62. Patent Owner and Dr. Efimov further assert that LeBoeuf's Figure 8B shows only four LEDs. Efimov, ¶156; POR, 31-32. Such assertion is contradicted by Dr. Efimov's own admission that LeBoeuf discloses that “[v]arious configurations and arrangements of optical emitters and detectors ... may be utilized in accordance with embodiments of the present invention.” LeBoeuf, [0123]. A person of ordinary skill in the art would have understood the disclosure of “[v]arious configurations and arrangements” does not limit the number of optical emitters to the four depicted, and a person of ordinary skill in the art would have understood six to be among the arrangements contemplated, as was well known in the art.

63. For example, Lamego (Ex. 1033) explicitly discloses a sensor with six LEDs and teaches using multiple LEDs to improve accuracy. Lamego, [0041] (“In one embodiment, the n LEDs 302 include four, six, eight or sixteen LEDs of different wavelengths.”). Patent Owner and Dr. Efimov do not dispute that Lamego explicitly discloses a sensor with six LEDs. Efimov, ¶157; POR, 31-32. However, Dr. Efimov argues that “Lamego's system is designed for multi-constituent spectral analysis—a different measurement task than Lisogurski's single-parameter pulse oximetry,” and that I do not explain why a person of ordinary skill in the art would have been motivated to combine Lisogurski with LeBoeuf and/or Lamego. Efimov, ¶158. Rather than combining Lisogurski and Lamego, however, I noted Lamego for its

demonstration of the knowledge of a person of ordinary skill in the art, specifically confirming that using six LEDs was well known in the art, providing a motivation and reasonable expectation of success in using such a configuration. *See* Anthony, ¶252. I note as well that the six LEDs Lamego describes are six LEDs of six different wavelengths. Lamego, [0041]. Lamego therefore confirms that a six-emitter sensor was a known configuration independent of Dr. Efimov's premise that six can arise only from pairing two light emitting diodes with each of three wavelengths.

64. Further, I disagree that Lamego's system is designed for a different measurement task than Lisogurski's system. Both Lisogurski and Lamego disclose pulse oximetry and multiparameter physiological monitoring systems. *See e.g.*, Lisogurski, 4:6-7 ("An *oximeter* may include a light sensor that is placed at a site on a patient...."); 18:53-56 ("For example, *multi-parameter physiological monitor* 326 may be configured to display an estimate of a subject's blood oxygen saturation and hemoglobin concentration"); Lamego, [0036] ("For example, such a *multi-wavelength physiological monitor* can determine levels and/or concentrations of: methemoglobin (MetHb), carboxyhemoglobin (COHb), low hemoglobin levels, high hemoglobin levels, bilirubin, methylene blue, deoxyhemoglobin, and lipids."), [0041] ("A schematic of one embodiment of a *multi-wavelength physiological monitor for pulse oximetry* is shown in FIGS. 3-5."). Lisogurski likewise contemplates the use of "one or more wavelengths" and is not limited to single-

parameter pulse oximetry or measuring only two absorbers. Lisogurski, 4:37-45 (“The light intensity or the amount of light absorbed may then be used to calculate *any of a number of physiological parameters*, including an amount of a blood constituent (e.g., oxyhemoglobin”), 17:17-39 (“Sensor unit 312 may include *one or more light source 316 for emitting light at one or more wavelengths* into a subject's tissue.”), 17:62-66 (“For example. monitor 314 may be configured to determine pulse rate, blood pressure, *blood oxygen saturation (e.g.. arterial, venous, or both), hemoglobin concentration (e.g.. oxygenated, deoxygenated, and/or total), any other suitable physiological parameters, or any combination thereof.*”), 19:22-31.

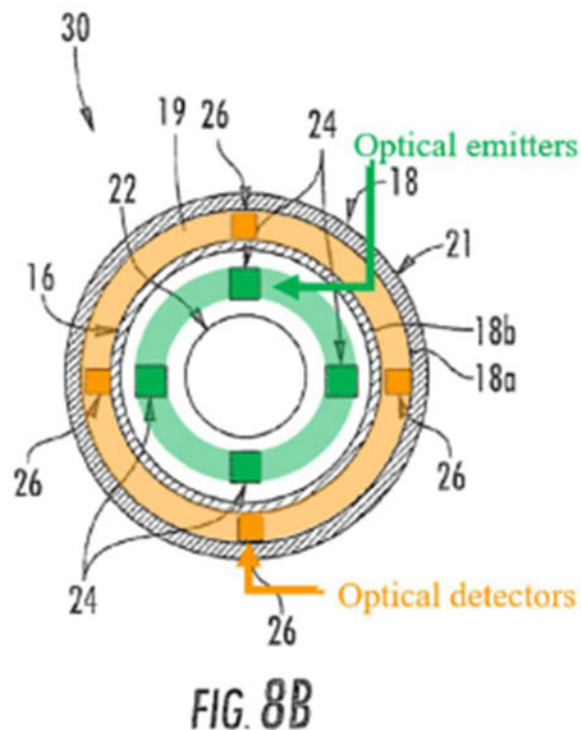
65. Regardless, a person of ordinary skill in the art would have recognized that multi-wavelength monitoring would also increase accuracy of Lisogurski's pulse oximetry measurements, by distinguishing constituents that may interfere with measurements obtained using only two wavelengths. *See e.g.*, Lamego, [0037] (“For example, many drugs cause the level of MetHb within a patient's blood to increase. MetHb also absorbs light at the two wavelengths used in a typical two-wavelength physiological monitor, which may cause inaccurate SPO2 readings. Increased levels of MetHb generally cause blood oxygen concentration level (e.g., SPO2) readings to decrease. A two-wavelength physiological monitor would provide reduced readings of blood oxygen concentration, but would not be able to identify the cause for the decreased reading, or to compensate for such readings. On the other hand, a

multi-wavelength physiological monitor, such as any of the multi-wavelength physiological monitors described below, could not only identify the cause of decreased SPO2 readings, but also (or alternatively) compensate for such cause when calculating the patient's SPO2 level and/or signal. For example, to compensate for MetHb, one or more wavelengths sensitive to MetHb can be used.”). Thus, a person of ordinary skill in the art’s knowledge of using three or more (e.g., six) to address the known issue of limited differentiation capability in dual-wavelength systems, as demonstrated by Lamego, would be relevant to Lisogurski’s pulse oximetry system. Anthony, ¶¶200-203, 250-252.

66. Patent Owner and Dr. Efimov also allege that I failed to explain “why a POSITA would have chosen six LEDs over other numbers, nor does it identify any technical reason or advantage for using specifically six LEDs in a pulse oximetry system.” Efimov, ¶158; POR, 32. Contrary to their mischaracterization, and as discussed above, I provided a detailed explanation based on the disclosures of Lisogurski and what was known in the art as to why a person of ordinary skill in the art would have understood or at least found obvious to use multiple LEDs, including six or more, to improve accuracy in Lisogurski’s pulse oximetry system. Anthony, ¶¶250-252.

E. LISOGURSKI AND LEBOEUF RENDER OBVIOUS THE ARC LIMITATIONS ([2], [9], [15])

67. As I explained in my Declaration in this proceeding, Lisogurski in view of LeBoeuf renders obvious the arc limitations, satisfying “wherein the plurality of semiconductor sources and the plurality of spatially separated detectors are located on one or more arcs” (Claims 2, 9, 15). Anthony, ¶¶258-264, 270-279, 286-289, 339-342. Indeed, LeBoeuf's Figure 8B depicts an arc arrangement of its emitters 24, which are LEDs, and its detectors 26:



LeBoeuf, Fig. 8B (showing both **detectors 26** and **emitters 24** configured in arcs). Dr. Efimov opines claims 9 and 15 (“wherein the plurality of semiconductor sources and the plurality of spatially separated detectors are located on one or more arcs”)

are not met by Lisogurski for the same reasons with respect to claim 2. Efimov, ¶¶242-247, 259-262. As I opined, claims 9 and 15 are met for the same reasons as claim 2, and my responses to Dr. Efimov regarding claim 2 set forth above apply equally to claims 9 and 15. Anthony, ¶¶ 286-289, 339-342.

68. Patent Owner and Dr. Efimov's focus on Lisogurski is misplaced—as explained in my Declaration in this proceeding, it is Lisogurski in view of LeBoeuf, in which LeBoeuf's teachings of arranging emitters and detectors in arcs is applied to Lisogurski's sensor, rendering obvious the arc limitations. Anthony, ¶¶258-259, 273-274; *see* Efimov, ¶¶179-182. I gave the same answer at my deposition when discussing this particular combination of Lisogurski in view of LeBoeuf: “my opinions are demonstrating how Lisogurski, in combination with LeBoeuf, meet the limitation. I was not relying on just Lisogurski. Lisogurski and LeBoeuf.” Ex. 2045, 162:3-6. Additionally, as I explain both in my Declaration in this proceeding and below, and contrary to Dr. Efimov's arguments, a person of ordinary skill in the art would have been motivated to implement LeBoeuf's arc arrangement teachings in Lisogurski to maximize the light signals detected and to improve the accuracy of the measurements. Anthony, ¶¶261-264.

69. Patent Owner and Dr. Efimov assert that my motivation-to-combine analysis was generic and unsupported by Lisogurski or LeBoeuf. Efimov, ¶¶190-193; POR, 49. I disagree. My motivation-to-combine analysis was based on

the disclosures of the references themselves and the knowledge of a person of ordinary skill in the art regarding the behavior of light in biological tissue. As I had explained in my Declaration, Lisogurski discloses a physiological-monitoring device that emits light into biological tissue and detects reflected light, while LeBoeuf teaches detector arrangements positioned along arcs. Anthony, ¶¶262-263; Lisogurski, 11:9-27; LeBoeuf, Fig. 8B. As discussed above, a person of ordinary skill in the art would have understood that light emitted into biological tissue undergoes significant scattering and absorption, and the reflected light exits the tissue at a wide range of angles and locations. Anthony, ¶¶262-263. Accordingly, a person of ordinary skill in the art would have understood that arranging detectors along an arc increases collection of reflected and backscattered light, while maintaining substantially uniform emitter-detector spacing to collect signals across multiple angular positions to reduce the effects of local tissue inhomogeneity, thereby improving signal quality and the accuracy and reliability of physiological measurements. Anthony, ¶¶262-264, 276. Further, arranging optical emitters in an arc increases the area of the tissue sample illuminated by the emitters, so a person of ordinary skill in the art would have understood that arranging optical emitters in an arc would increase both the area over which the measurement is performed and the amount of signals which enter and exit the tissue, thus improving the measurement accuracy by increasing the reflected signals captured and reducing the effects of

irregularities in the tissue on the resulting measurements. Anthony, ¶¶262-264, 276; Mendelson, 4:14-65 (explaining that such configurations “maximize the detection of backscattered light from the skin and minimize differences from local tissue inhomogeneity”). A person of ordinary skill in the art would also have understood that arranging detectors in arcs would increase the area over which light is detected after it exits the skin, and thus would have been motivated to apply LeBoeuf's teachings of detectors arranged along an arc to improve the detection of scattered light from biological tissue and in turn increase the signal-to-noise ratio of Lisogurski's wearable device. Anthony, ¶¶262-263; Mendelson, 4:14-65. The reason is physical rather than merely geometric. Light that enters tissue is scattered before it returns, so it emerges over a range of positions and angles about the point of entry rather than along a single line. Detector area distributed about the emitters therefore intercepts a larger fraction of the returning light than the same detector area arranged in a line, and emitter area distributed about the detectors delivers light into a correspondingly larger volume of tissue. Anthony, ¶¶262-263; Lisogurski, 11:9-27.

70. Patent Owner and Dr. Efimov also assert that both Lisogurski and LeBoeuf disclose physiological-monitoring devices that may be worn on the body does not support the motivation to combine. Efimov, ¶200 (citing Anthony, ¶¶262-263); POR, 37. I disagree. As explained in my Declaration, LeBoeuf, like

Lisogurski, is directed to physiological monitoring and is reasonably pertinent to the same problems addressed by the '455 patent, including improving optical physiological monitoring. Anthony, ¶261. Further, my motivation-to-combine analysis was not based solely on the fact that both references disclose wearable physiological-monitoring systems. Rather, as explained in my Declaration, a person of ordinary skill in the art would have been motivated to apply LeBoeuf's arc-arrangement teachings to Lisogurski because such arrangements improve the collection of reflected and backscattered light from biological tissue, thereby improving signal quality and measurement accuracy. Anthony, ¶¶262-263. The fact that both references disclose optical physiological-monitoring devices worn at a measurement site on the body further supports the applicability of LeBoeuf's teachings to Lisogurski. Lisogurski, 4:6-20; Anthony, ¶¶262-264.

71. Though Patent Owner and Dr. Efimov argue that neither Lisogurski nor LeBoeuf provides the motivation to combine because they do not recite an arc arrangement (Efimov, ¶¶194-195), my opinions are based on what a person of ordinary skill in the art would have understood based on Lisogurski's and LeBoeuf's disclosures as a whole, which include more than just the text of those references. For example, as I explained in my previous Declaration and as I testified during my deposition, Fig. 8B of LeBoeuf discloses both LEDs and photodetectors arranged in arcs and Mendelson, which reflects the knowledge of a person of ordinary skill in

the art, demonstrates that it was known that configurations such as LEDs and photodetectors arranged in arcs would increase the accuracy of a measurement. Anthony, ¶¶258-264, 273-276; Ex.2045, 191:16-192:8, 193:12-194:20, 195:5-196:6, 198:5-17; *see also* LeBoeuf Fig. 8B, [0123]. Specifically, I testified that LeBoeuf “certainly in the figures and in the -- the text highlight some -- show emitters and detectors arranged about an arc” (Ex. 2045, 193:7-9), and that “Mendelson, for example, further teaches the benefit of having things about an arc, about a center,” so that “a person of ordinary skill would have been motivated to modify Lisogurski with LeBoeuf teaching as in the figures he arranged spatially separate detectors and light sources on one or more arcs,” “[w]ith a reasonable chance of success” (Ex. 2045, 194:11-23).

72. Patent Owner and Dr. Efimov also argue that Lisogurski's disclosure “[a]ny suitable configuration of light source 316 and detector 318 may be used,” and that “sensor unit 312 may include multiple light sources and detectors, which may be spaced apart” (Lisogurski, at 17:42-45), would not have motivated a person of ordinary skill in the art to apply LeBoeuf's arc arrangements to Lisogurski, and does not teach or suggest that LeBoeuf's alleged arc arrangements would increase accuracy and reliability. Efimov, ¶201. However, as discussed above and in my Declaration, a person of ordinary skill in the art would have understood that arc arrangements for detectors and emitters taught by LeBoeuf's Fig. 8B would have

enhanced the amount of light on the area of interest and the amount of detection of such light reflected in a scattered fashion, as confirmed by Mendelson showing the knowledge of a person of ordinary skill in the art. Anthony, ¶263; Mendelson, 4:14-29, 4:59-65. Indeed, Lisogurski leaves the configuration of its light source and detectors open — “[a]ny suitable configuration ... may be used” — while LeBoeuf supplies a particular arrangement—as the knowledge of a person of ordinary skill in the art further confirms, the reason a person of ordinary skill in the art would have selected that arrangement is that backscattered light returns over a solid angle about the point of entry, so detectors distributed about the emitters in arc collect a larger fraction of the backscattered light. Lisogurski, 17:42-45; LeBoeuf, Fig. 8B; Mendelson, 4:23-28.

73. Specifically, Mendelson discusses “backscattered light,” and a person of ordinary skill in the art would have understood that “backscattered” means that the light scatters when exiting the skin at a various angles such that an arc arrangement increases the area covered by the detectors, maximizing the fraction of backscattered light collected. Anthony, ¶¶258-264; *see also* Mendelson, 4:14-65. Although Mendelson does not use the term “angle” (Efimov, ¶¶205, 207; POR, 36-37, 39-40), a person of ordinary skill in the art would have understood that “backscattered” indicates that the light is exiting the skin at various angles. Anthony, ¶¶258-264; *see also* Mendelson, 4:14-65. Mendelson connects this directly to a

radially symmetric arrangement of detectors about the light sources, explaining that “[a]nother approach is based on the use of a sensor having six photodiodes arranged symmetrically around the LEDs ... in order to maximize the fraction of backscattered light collected by the sensor.” Mendelson, 4:14-29.

74. Dr. Efimov not only improperly argues that I misquoted certain disclosures in Mendelson (Efimov, ¶210) (I did not), but also goes on to mischaracterize this discussion himself by citing a configuration discussed in a later section to argue that the arc configuration is unrelated to the backscattered light discussion. Efimov, ¶210. Dr. Efimov is wrong and omitted relevant discussions in Mendelson. For example, my Declaration cited to 4:14-29 of Mendelson—4:14-16 that Dr. Efimov omitted teaches “a sensor having six photodiodes arranged symmetrically around the LEDs.” Anthony, ¶263 (citing Mendelson 4:14-65). In discussing the same approach, Mendelson confirms that such “configuration “creates a large area photodetector” “to maximize the fraction of backscattered light collected by the sensor.” Mendelson, 4:23-27; Anthony, ¶263 (citing Mendelson 4:14-65).

75. Notably, neither Patent Owner nor Dr. Efimov disagrees that Mendelson provides the motivation to arrange detectors in arc. Patent Owner and Dr. Efimov, however, assert that Mendelson does not show an arc arrangement of LEDs—based on that incorrect assumption, Patent Owner and Dr. Efimov contend that any motivation Mendelson may provide is restricted to detectors and thus not

applicable to LeBoeuf disclosing arc arrangements for both LEDs and detectors. Efimov, ¶¶198-199, 204-208, 235. I disagree—Mendelson describes both LEDs and detectors arranged symmetrically about a center in arcs, and a person of ordinary skill in the art would have understood that arrangement to provide the benefits I describe. Mendelson, 4:14-65; Anthony, ¶¶260-264.

76. For example, Dr. Efimov ignores Mendelson's teaching where "four R and four IR LEDs are spaced at 90-degree intervals around the substrate and at an equal radial distance from the photodiode," which expressly discloses LEDs in an arc and which is similar to in LeBoeuf's Fig. 8B. Mendelson, 4:36-44. Further, Mendelson teaches that "four R and four IR LEDs are spaced at 90-degree intervals around the substrate and at an equal radial distance from the photodiode," thereby disclosing a radially arranged emitter configuration similar to that shown in LeBoeuf's Figure 8B. Mendelson, 4:36-44. Thus, Mendelson describes both radially arranged (i.e., in arc) emitter configurations and photodetector arrays arranged symmetrically around the light sources, forming arcs. Mendelson, 4:14-65, 4:36-44. Further, consistent with my opinion as detailed above, Mendelson also teaches that this "radially-symmetric photodetector array can help to maximize the detection of backscattered light from the skin and minimize differences from local tissue inhomogeneity," which thus also teaches that LeBoeuf's Fig. 8B configuration allows improving the accuracy of measurements through the improved detection of

backscattered light and increased area of measurement to increase signals detected and decrease errors resulting from irregularities in the tissue. Mendelson, 4:14-65. Accordingly, and as I discussed above, a person of ordinary skill in the art would have been motivated to arrange Lisogurski's LEDs and detectors in arcs as taught by LeBoeuf's Fig. 8B configuration to increase both the amount of light directed to an area of interest and to increase the signals detected from the scattered reflected light from the areas of interest, which in turn increases the accuracy of the resulting measurements. Anthony, ¶¶263-264; *see also* Lisogurski, 11:16-20 ("The light intensity may be directly related to the absorbance and/or reflectance of light in the tissue. That is, when more light at a certain wavelength is absorbed or reflected, less light of that wavelength is received from the tissue by detector 140").

77. In this regard, I note that Patent Owner mischaracterizes (POR, 36-37) my testimony as if I had not reviewed documents cited in Mendelson. Instead, I testified: "I believe I've reviewed that document in the past. I don't recall the last time I reviewed it." Ex. 2045, 199:6-7. Regardless, Mendelson itself discloses and confirms the knowledge of a person of ordinary skill in the art as discussed above, and whether or not I reviewed the documents cited in Mendelson does not impact my opinion.

78. Additionally, Patent Owner and Dr. Efimov argue that the cited portions of Mendelson do not support that a "closely grouped detector arrangement

would fail to capture much of the angularly scattered light.” Efimov, ¶¶207-209; POR, 36-37, 39-40. I disagree. Mendelson explains that the described arc configuration “essentially creates a large area photodetector made of six discrete photodiodes” which “maximize[s] the fraction of backscattered light collected by the sensor,” and that increasing the area of measurement “minimize[s] differences from local tissue inhomogeneity.” Mendelson at 4:14-65. A person of ordinary skill in the art would have understood from these disclosures that increasing the spatial coverage of the photodetectors allows the sensor to collect reflected and backscattered light over a wider range of locations and angles, increases the amount of useful light detected, reduces sensitivity to localized variations in the tissue, and improves the detection of scattered light exiting the tissue at different angles and locations. Anthony, ¶¶262-263 (explaining that an arc arrangement “enhances the amount of scattered light from biological tissue detected, thereby improving the signal relative to background noise and resulting in an increased signal-to-noise ratio”); *see also* Mendelson 4:14-65 (explaining that an arc configuration “essentially creates a large area photodetector made of six discrete photodiodes” which “maximize[s] the fraction of backscattered light collected by the sensor” and that increasing the area of measurement “minimize(s) differences from local tissue inhomogeneity”); Lisogurski, 9:50-52 (explaining that its system “increase[s] the brightness of the light sources in response to the noise to improve the signal-to-noise

ratio"). In view of Lisogurski's teaching that "[t]he light intensity may be directly related to the absorbance and/or reflectance of light in the tissue," a person of ordinary skill in the art would thus have been motivated to arrange the LEDs and detectors in arcs to increase the amount of light on an area of interest and to improve detection of such light scattered from the area of interest, as disclosed in LeBoeuf. Anthony, ¶¶262-263; Lisogurski, 11:16-20.

79. Patent Owner and Dr. Efimov rely on other LED and detector arrangements, including those disclosed in LeBoeuf, to attempt to downplay the importance of the arc configurations applied to Lisogurski. Efimov ¶¶196-197; 202, 207; POR, 38-39. Again, Patent Owner and Dr. Efimov fail to consider the knowledge of a person of ordinary skill in the art confirmed by Mendelson. As I discussed above, Mendelson discloses the benefits of distributing emitters and detectors about an arc center in increasing the signals directed at a tissue sample and subsequently detecting the reflected light signals. Mendelson, 4:14-65. A person of ordinary skill in the art would have known of these benefits and thus would have been motivated to look to LeBoeuf's arc arrangement teachings and applied these teachings to Lisogurski's sensor in order to produce more accurate measurements. Thus, a person of ordinary skill in the art would have had reason to select the arc arrangement that increases the fraction of backscattered light collected, for the reasons discussed above.

80. Patent Owner and Dr. Efimov further argue that a person of ordinary skill in the art would not have been motivated to combine Lisogurski and LeBoeuf due to LeBoeuf's additional earbud components. Efimov, ¶¶203, 212-226. However, I did not propose *directly* or *physically* inserting LeBoeuf's earbud into Lisogurski's sensor—instead, my opinion was that a person of ordinary skill in the art would have been motivated to implement LeBoeuf's *teaching* of arc arrangements of the LEDs and detectors to Lisogurski to improve measurement accuracy. Anthony, ¶¶262-264. Similarly, Dr. Efimov argues that light guide 18 (also referred to as cover 18 (LeBoeuf, [0103])) and light-guiding region 19 are what enables detection of scattered light by optical detector 26 (Efimov, ¶197), but he ignores LeBoeuf's disclosure that the cover 18 on which he relies is optional. LeBoeuf, [0103] ("it should be noted that, in other embodiments, the earbud housing 16 may also serve as a light guide without the need for cover 18"). Importantly, as discussed above, a person of ordinary skill in the art would have recognized that the arc arrangements of LEDs and detectors, without other components that Dr. Efimov alleges as required (Efimov, ¶¶212-213), improves detection of light signal, and thus improves measurement accuracy. The benefit I identify follows from the placement of the emitters and detectors themselves—the area of skin over which light enters and returns—and not from any light-guiding structure. Further, LeBoeuf discloses that "embodiments of the present invention are not limited to earbuds," and that "the

light-guiding structure may be molded around another part of the body, such as a digit, finger, toe, limb, around the nose or earlobe, or the like,” or “may be integrated into a patch, such as a bandage that sticks on a person’s body.” LeBoeuf, [0090].

81. Further contrary to Patent Owner’s and Dr. Efimov’s arguments (Efimov, ¶¶219-221, 227, 236; POR, 41-46), the geometry of LeBoeuf, or the disclosure of different configurations in LeBoeuf’s other embodiments, does not negate a person of ordinary skill in the art’s motivation to apply LeBoeuf’s teaching of arc arrangements of the LEDs and detectors to Lisogurski. Anthony, ¶¶262-264; Lisogurski, 17:42-45 (“[a]ny suitable configuration” of light sources and detectors may be used). Nor does LeBoeuf tie the benefit of the arrangement depicted in Figure 8B to the earbud context; the reasons that arrangement improves the collection of returning light apply to any system that uses emitters and detectors to perform reflectance physiological measurements. Importantly, as discussed above, I do not propose inserting LeBoeuf’s earbud embodiment physically into Lisogurski—again, my opinion instead is that a person of ordinary skill in the art would have applied LeBoeuf’s arc arrangement teachings to Lisogurski’s sensor to achieve their corresponding benefits of improved measurements. Ex. 2045, 205:6-25, 336:1-338:4. As I put it at my deposition, “I’m not wholesale copying one embodiment or the other. But I’m highlighting the teachings of Lisogurski in view of LeBoeuf. And the teachings of a concentric arc, the teachings of the -- the

cladding material, the reflective surface.” Ex. 2045, 182:20-24. In that regard, and contrary to Patent Owner's mischaracterization, I did not agree that the arc arrangements cannot be realized without LeBoeuf's other components—at best, I acknowledged that LeBoeuf discloses those components. Ex. 2045, 168:18-169:18; POR, 33-34.

**F. LISOGURSKI IN VIEW OF LEBOEUF RENDERS OBVIOUS
THE REFLECTIVE SURFACE LIMITATIONS ([6], [13], [17])**

82. As I explained in my Declaration in this proceeding, Lisogurski in view of LeBoeuf renders obvious the reflective surface limitations, satisfying “wherein the wearable device further comprises a reflective surface to receive and redirect at least some of the output optical light from the plurality of semiconductor sources” (Claims 2, 9, 15). Anthony, ¶¶258-262, 265-268, 350-355, 392-393, 408-409. Dr. Efimov opines claims 6 and 13 (“wherein the wearable device further comprises a reflective surface [positioned] to receive and redirect at least some of the output optical light from the plurality of semiconductor sources”) are not met by Lisogurski for the same reasons with respect to claim 17. Efimov, ¶¶334-339, 343-348. As I opined, claims 6 and 13 are met for the same reasons as claim 17, and my responses to Dr. Efimov regarding claim 17 set forth above apply equally to claims 6 and 13. Anthony, ¶¶392-393, 408-409. Specifically, LeBoeuf's “light guiding earbud 30” includes “earbud housing 16,” such that light “can be focused on a particular region

of the ear where a particular physiological activity may be located.” LeBoeuf, [0123], [0125], [0017], [0133]; FIG. 8C. As I previously opined, a person of ordinary skill in the art would have been motivated to apply LeBoeuf's reflective surface teaching to Lisogurski's system to advantageously improve efficiency and signal measurement quality, by focusing the optical output light on a particular region of interest and reducing signals from regions that are not of interest. Anthony, ¶¶265-266.

83. Such motivation is further confirmed by Exhibit 1041 (“Valencell-093”). Anthony, ¶265 (citing Ex. 1041, [0152]). For example, Valencell-093 discloses a “light guiding region 2306” that “may surround or partially surround the sensor module 700, 800” and “may be a reflector” made of “a metal, metallic alloy, mylar, mica, reflective plastic, reflective textile, or the like” to “help direct light to and/or from the sensor module 700, 800 and a blood flow region [, which is the specific region intended to be measured.]” Ex. 1041, [0152]. Contrary to Patent Owner's and Dr. Efimov's assertion, Valencell-093's teaching discussed in this paragraph is not limited to any particular “configuration shown in ‘FIGS. 24-27.’” POR, 55-56; Efimov, ¶¶289-290. Indeed, as the Board already found in the previous '484 IPR that a person of ordinary skill in the art “would have had reason to combine [reflective surface] teachings of Lisogurski and Valencell-093” because Lisogurski and Valencell-093 “both concern analogous miniaturized pulse oximetry devices

having the same applications”—the Board's rationale and finding were not limited to any particular geometry of Valencell-093's device, and is equally applicable here. '484-FWD, 55-60 (addressing substantially identical “a reflective surface positioned to reflect at least a portion of [the lens output] light reflected from the tissue” limitation in the '484). Indeed, Dr. Efimov does not dispute that Valencell-093's reflector material or LeBoeuf's reflective surface would help direct light from a light source to a user, and that the Board's prior finding was not limited to any particular configuration disclosed in Valencell-093. *See* Anthony, ¶268.

84. Patent Owner and Dr. Efimov contend that Petitioners and I have not shown that a person of ordinary skill in the art would have been motivated to implement the reflective surface of LeBoeuf's Figure 8C in Lisogurski. Efimov, ¶¶275, 279; POR, 52-61. For the reasons discussed below, I disagree.

85. First, I note that although Dr. Efimov refers to LeBoeuf's disclosure of this limitation an “*alleged* reflective surface teaching[.]” he does not challenge that LeBoeuf discloses this limitation. *See* Efimov, ¶¶274, 277; *see also* Efimov, ¶¶283, 293. His objection is directed to the motivation to apply that teaching and to how it would be implemented, not to whether LeBoeuf discloses a reflective surface at all.

86. Patent Owner and Dr. Efimov focus on components of LeBoeuf's Figure 8C embodiment other than the reflective surface, and contend that those components prevent a person of ordinary skill in the art from implementing

LeBoeuf's reflective surface teaching to Lisogurski. Efimov, ¶¶278-284. As an initial matter, I agree with Dr. Efimov to the extent that my opinion is to apply LeBoeuf's reflective surface *teaching* to Lisogurski, and not the related components of LeBoeuf's Figure 8C embodiment. I gave the same testimony: "I'm not proposing a wholesale copying of a particular embodiment ... So it's not presupposing a particular amalgamation of an embodiment." Ex. 2046, 336:5-13. Otherwise I disagree with Patent Owner's and Dr. Efimov's contention for the reasons discussed below.

87. For example, to support his position, Dr. Efimov relies on [0125] of LeBoeuf, opining that the explicitly disclosed benefit relates to the configuration of Fig. 8C as a whole, which "does not refer to LeBoeuf's teaching of a reflective surface in isolation," and that such benefits are achieved by the reflective surfaces in combination with "the related components in the Figure 8C embodiment." Efimov, ¶¶285-288. I disagree. Figure 8A (and thus its cross-sectional view in Figure 8B), Figure 8C, and Figure 8D of LeBoeuf are only slightly different. The chief difference among these Figures are the material properties of earbud housing 16 (in addition to the cover 18). For Figure 8A, earbud housing 16 is light transmissive. LeBoeuf, [0123]-[0124], Fig. 8A. For Figure 8C, the earbud housing 16 is light reflective. LeBoeuf, [0125], Fig. 8C. For Figure 8D, the earbud housing 16 is reflective for one or more wavelengths of light and transmissive for

one or more wavelengths of light. LeBoeuf, [0126], Fig. 8D. A person of ordinary skill in the art reading LeBoeuf would thus have understood that the listed benefits of Figure 8C relate to its reflective surfaces, not its other components or general configuration. LeBoeuf, [0125]. A person of ordinary skill in the art would have understood that, if the listed benefits related to the other components, LeBoeuf would have applied the statement to all of Figure 8A through Figure 8D as a whole, rather than emphasizing the benefit of the particular “configuration” in Figure 8C. The only structural difference [0125] recites relative to Figure 8A is that “the earbud housing 16 may be at least partially reflective to scatter light within the cavity,” together with the apertures 34a, 34b through which the light then exits. LeBoeuf, [0125]. The “configuration” to which the stated advantages attach is therefore the reflective surface — not base 50, speaker 22, or the other components the Figure 8C embodiment shares with Figure 8A.

88. Dr. Efimov opines that Petitioners and I do not provide “an explanation, or supporting evidence, of specifically *how* LeBoeuf’s teaching of a reflective surface would have been implemented in Lisogurski’s sensor by a POSITA.” Efimov, ¶291. Specifically, Dr. Efimov opines that a person of ordinary skill in the art would have understood that LeBoeuf Figure 8C’s reflective surface embodiment is premised on and involves related components, but that Petitioners and I do not explain how those components will be implemented in Lisogurski. Efimov,

¶¶292-296, 299-310. To this end, Dr. Efimov opines that the components of LeBoeuf's Figure 8C are incompatible with Lisogurski because LeBoeuf's Figure 8C is meant to be placed in the ear while Lisogurski does not teach that its sensor can be an earbud to be placed within an ear. Efimov, ¶¶297-298. Each of Patent Owner's and Dr. Efimov's contentions misses the point.

89. To be clear, and as discussed above, my opinion is not to *physically insert* LeBoeuf's earbud housing 16 with reflective surface of Figure 8C into Lisogurski—instead, my opinion is that a person of ordinary skill in the art would have been motivated to apply LeBoeuf's reflective surface *teaching* to Lisogurski. I gave that same testimony at my deposition in this proceeding: when asked whether I was “proposing to modify Lisogurski to include the earbud housing 16 shown in Figure 8C of LeBoeuf, yes or no,” I answered, “As I answered, I’m not proposing the earbud housing. I’m proposing the teachings of the reflective surface.” Ex. 2046, 339:10-24; *see also* Ex. 2046, 340:6-10 (“I’m proposing the combination, which is using the reflective surface, not arbitrarily stamping of an earbud housing into something. It is the teachings of the both of them.”). Indeed, as discussed above, a person of ordinary skill in the art would have recognized that the reflective surface, without other components that Dr. Efimov alleges as required, improves detection of light signal, and thus improves measurement accuracy. Anthony, ¶¶265-266; LeBoeuf, [0125] (reflective surface helps “focus [the light generated by

optical emitters 24] on a particular region of the ear where a particular physiological activity may be located” and (2) “reduce[s] unwanted optical signals from regions that may not be relevant to the physiological activity of interest.”); Valencell-093, [0152] (a sensor surrounded by a “reflective” material may “help[] direct light to and/or from the sensor module [] and a blood flow region [i.e., measurement site] within the body part”). And as I opined, adding reflective surface to a physiological measurement system like Lisogurski’s “would involve only routine changes that were already well-known in the art” and that a person of ordinary skill in the art would have had a reasonable expectation of success. Anthony, ¶267. These facts are further supported by Valencell-093, the Board’s decision in the previous ’484 IPR, and U.S. Pat. No. 8,821,397 (Ex. 1032; which Dr. Efimov ignores). *See* Anthony, ¶268. Regarding the alleged incompatibility of Lisogurski and LeBoeuf, Dr. Efimov ignores that LeBoeuf discloses that “the light-guiding structure may be molded around another part of the body, such as a digit, finger, toe, limb, around the nose or earlobe, or the like.” LeBoeuf, [0090]. Thus, a person of ordinary skill in the art would have understood that LeBoeuf’s teachings are not limited to any particular structure or configuration, but rather would be flexibly applied, compatible with Lisogurski’s system, regardless of which part of the body it is attached to.

90. Dr. Efimov further contends that I “agreed that Figure 8C is a different embodiment.” Efimov, ¶317 (citing Ex. 2045 at 178:9-179:17). That is misleading. As I testified during my deposition, and as I further opine here, Figure 8C is “slightly different” from Figures 8A-B, with the main difference being the material of earbud housing 16—my testimony was directed to the differences among the figures, not to any contention that Figures 8A-8C depict mutually exclusive, different embodiments. When asked whether my reference to LeBoeuf’s “light-guiding ear bud 30” referred to the embodiment shown in Figures 8A and 8B, I answered “8A, 8B, 8C, yep.” Ex. 2045, 166:3-4. I also explained that “8C is a cross-section of an arc arrangement, as well, of 8A and 8B,” and that “[t]he presumptive difference between 8A and 8C in isolation is the additional reflective scattering material 16.” Ex. 2045, 189:8-15; *see also* Ex. 2045, 178:9-179:17. Indeed, as I further discuss below, a person of ordinary skill in the art would have found it evident from LeBoeuf’s disclosures that Figure 8C has the same arc arrangements of Figures 8A and 8B.

91. Patent Owner and Dr. Efimov further argue that Figures 8A-8D and Figure 8C embodiments are improperly combined in my arc limitation (illustrating Figure 8B) and reflective surface limitation (illustrating Figure 8C) discussions. Efimov, ¶¶311, 314-316, 318-319; POR, 61-62. I disagree. As detailed above, LeBoeuf Figures 8A to 8D include slight differences, e.g., materials for the earbud

housing 16 and cover 18, but are not separate embodiments. Indeed, these Figures use the same numbered elements, and LeBoeuf discloses that “[l]ike numbers refer to like elements throughout,” indicating that they are of the same embodiment. LeBoeuf, [0073]. Notably, Figure 8B is a “a cross-sectional view of the earbud of FIG. 8A.” LeBoeuf, [0048]-[0049]. Given that both Figures 8C and 8D are side section views like Figure 8A, and given the similarities among the Figures, a person of ordinary skill in the art would have understood that the arc arrangements in cross-section view of Fig. 8B would also be present, but not shown, in the side section view of Figure 8C and 8D. LeBoeuf, [0050]-[0051]. I gave that testimony at my deposition as well: “8C is a cross-section of an arc arrangement, as well, of 8A and 8B ... The presumptive difference between 8A and 8C in isolation is the additional reflective scattering material 16.” Ex. 2045, 189:8-15. Regardless, LeBoeuf further discloses that “[f]eatures described with respect to one figure or embodiment can be associated with another embodiment or figure although not specifically described or shown as such.” LeBoeuf, [0073]. That answers Dr. Efimov’s objection that LeBoeuf provides no cross-sectional view of the Figure 8C embodiment. *See* Efimov, ¶¶315, 318. LeBoeuf tells the reader that features shown in one figure carry over to another even where they are not shown, so the absence of a cross-sectional view of Figure 8C is not a disclosure that its emitters and detectors are arranged differently from those in Figure 8B. Further, LeBoeuf teaches that “[v]arious

configurations and arrangements of optical emitters and detectors may be utilized in accordance with embodiments of the present invention.” LeBoeuf, [0123]. Thus a person of ordinary skill in the art would have understood that the features of Figure 8B, namely the arc configurations, would have at least applied to Figure 8C, rather than needing to combine different embodiments as Patent Owner and Dr. Efimov contend.

92. Patent Owner and Dr. Efimov also opine that my opinion for the arc limitation and the reflective surface limitation are internally contradictory because the purpose of the arc arrangement is to spread the emitted light across a broader area of tissue and the purpose of the reflective surface is to concentrate the emitted light onto a smaller, targeted area of tissue. Efimov, ¶¶229-234, 320-321; POR, 61-62. I disagree. Dr. Efimov misunderstands the respective purposes of the arcs and reflective surfaces. As I opined, the benefit of the LED arc arrangement is that it beneficially increases the surface area of the user's skin exposed to light. Anthony, ¶¶262-263, 276. On the other hand, the benefit of the reflective surfaces is that it ensures that sufficient light is delivered to skin, instead of emitting, for example, completely away from the user's skin. Anthony, ¶¶265-266, 355. In this way, a person of ordinary skill in the art would have recognized that the LED arcs and reflective surfaces are complementary and work together to ensure the same goal of maximizing the amount of light delivered to and reflected from the areas of interest

on the skin in furtherance of measurement accuracy. For example, the arc arrangement ensures that increased amount of light reaches the area of interest, and the reflective surface ensures that sufficient light reaches the area of interest, as opposed to unintended area of the skin due to scattering. The two act on different variables. The arc distributes the emitters and detectors across the surface of the skin, increasing the area over which light enters and returns. The reflective surface acts on light that would otherwise leave the device in directions away from the skin, redirecting it toward the tissue. Increasing the fraction of emitted light that reaches the skin at all does not narrow the area of skin the arc arrangement illuminates, so the two objectives are not in tension. With their complementary benefits, and consistent with the Board's prior findings, a person of ordinary skill in the art would have understood how to apply LeBoeuf's arc and reflective surface teachings to Lisogurski.

VI. SECONDARY CONSIDERATIONS

93. As I set forth under My Understanding of Obviousness in the Legal Understanding Section of my Declaration, I understand that certain objective factors called "secondary considerations" or "objective indicia" of nonobviousness, if they are present, may be considered in determining whether the claimed invention would have been obvious to a person of ordinary skill in the art. Anthony, ¶39. I also understand, however, that for such secondary considerations to be relevant to the

obviousness of a claim, there must be a causal relationship, or a “nexus,” between the claim and the evidence, and that this nexus must be based on a novel element of the claim rather than something in the prior art.

94. Here, I have considered Patent Owner's and Dr. Efimov's assertion of secondary considerations, in addition to Dr. Islam's supporting declarations, and it is my opinion that there is no evidence of secondary considerations or any nexus between any alleged evidence that Patent Owner, Dr. Efimov, and Dr. Islam identify and the '455 claims. Patent Owner's, Dr. Efimov's, and Dr. Islam's assertion of copying and long-felt need in the industry are without sufficient basis in my opinion, and I disagree with their assertions. POR, 66-71; Efimov, ¶¶367-401; Ex. 2100, ¶¶6-34.

95. First, regarding copying, Patent Owner asserts and Dr. Efimov opines that Samsung was directly exposed to and implemented technology disclosed by Dr. Islam and that this alleged implementation supports the non-obviousness of the challenged claims. Efimov, ¶¶370-387; Ex. 2100, ¶¶7-21. In support of that opinion, Dr. Efimov and Dr. Islam together identify several alleged techniques that they contend were disclosed to Samsung, which Dr. Efimov contends were later implemented in Samsung products, [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED] Efimov, ¶¶372, 375, 382 (collectively referring to them as “SNR-improvement techniques”); Ex. 2100, ¶13.

96. As an initial matter, Dr. Efimov appears to assume that those techniques were proprietary to Patent Owner because Dr. Islam characterized them as such and because they are purportedly “covered by” the ’455. Efimov Tr. 58:6-10; 60:3-11, 117:18-118:3; Efimov, ¶¶377, 381-386; Ex. 2100, ¶¶8-13. I disagree that either basis supports the allegations that Samsung copied the SNR-improvement techniques, or that any such techniques were in fact proprietary. As a preliminary matter, when asked about these techniques, Dr. Islam testified that he did not know if they were used in prior art wearable devices (Islam-Tr., 48:8-49:3, 74:1-14, 85:7-17, 99:9-101:4, 104:22-105:26, 139:8-15), but conceded that they were generally known in the field (Islam-Tr. 1128, 30:1-15, 87:6-22, 104:4-20, 132:10-133:16). Indeed, each of Dr. Islam’s alleged “proprietary” “SNR-improvement techniques” was already disclosed in the prior art, as the Board found previously and as shown in the table below. Dr. Efimov’s analysis does not address these prior-art teachings or the Board’s findings.

Declaration of Brian Anthony in Support of Petitioners' Reply
to Patent Owner's Response, U.S. Patent No. 11,160,455 (IPR2025-01252)

Feature identified by Dr. Efimov	The Board's relevant prior finding
[REDACTED]	[REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED]
[REDACTED] [REDACTED]	[REDACTED] [REDACTED] [REDACTED]

¹ While alleging [REDACTED] technique, Patent Owner, Dr. Islam, and Dr. Efimov tie it to [REDACTED] [REDACTED] only. POR, 67; Efimov, ¶¶382, 385, 390; Ex. 2100, ¶13.

Declaration of Brian Anthony in Support of Petitioners' Reply
to Patent Owner's Response, U.S. Patent No. 11,160,455 (IPR2025-01252)

[illegible]

97. Furthermore, Dr. Islam provides no allegation as to which of his SNR-Improvement techniques, if any, was implemented in Samsung's products, and Dr. Efimov likewise does not provide his independent analysis as to Samsung's alleged practice of the SNR-improvement techniques—rather, Dr. Efimov appears to rely primarily on Patent Owner's infringement contentions as evidence that Samsung products allegedly implement the functionalities identified above. Efimov, ¶¶382-387; *see generally* Ex. 2100. Dr. Efimov's deposition testimony also confirms the lack of his independent analysis. During his deposition, Dr. Efimov admitted that he did not examine the Samsung Accused Products, did not review Samsung source code, and did not review Samsung internal technical documents concerning the operation of those products. Efimov-Tr., 81:11-20, 87:7-20, 97:22-98:3, 98:20-99:7, 114:19-20.

98. Contrary to his cursory opinion on copying based solely on the Patent Owner's infringement contentions, Dr. Efimov, along with Dr. Islam, further agreed that assessing the features and operation of a product ordinarily requires review of the product itself or technical information describing its operation. Efimov-Tr., 169:16-170:5; Islam-Tr. 34:6-50:19, 74:17-76:12, 78:9-79:12, 82:12-83:3, 88:2-89:3, 118:12-119:18. I agree that one cannot confirm what features a product has without at least testing the product or confirming technical descriptions of the product, and cannot confirm how the features are implemented without reviewing

the source code or detailed technical descriptions of such features specific to the product at issue.

99. Despite such requirements, and based on my review of the infringement contentions available at Exhibit 2116, the infringement contentions claim charts upon which Dr. Efimov exclusively bases his copying opinion primarily cite datasheets describing capabilities of third-party components rather than evidence demonstrating which Samsung products use those components or how those components actually operate within Samsung products. *See, e.g.*, Ex. 2116, 86-92, 201-207, 315-321. These allegations simply do not show that any of the SNR-improvement limitations are met. For example, to support the allegation that Samsung's products [REDACTED] the infringement contentions cite documents for multiple processing circuitries, some of which indicates that LED current is programmable. Ex. 2116, 86-92. In my opinion, that disclosure establishes only that certain processing circuitry is capable of driving LEDs at different current levels; it does not establish whether or how those circuitries are implemented in Samsung's products, or that Samsung's products actually [REDACTED] as alleged. Indeed, the infringement contentions in Exhibit 2116 do not identify whether those processing circuitries, each identified as having different features purportedly satisfying limited parts of the claim limitations, are all implemented in an accused product, let alone

how the circuitry or which available feature of the circuitry is implemented. The remaining citations identified in connection with that functionality are either not specific to the Samsung products or consist of marketing materials that do not provide technical details regarding product operation. Ex. 2116, 86-92.

100. Dr. Efimov further asserts that “Samsung took the information it learned from Dr. Islam regarding the technologies disclosed and claimed in the ’455 Patent and implemented those teachings into its own Accused Products.” Efimov, ¶384. However, neither Dr. Efimov nor Dr. Islam identifies technical evidence demonstrating that Samsung implemented specific features from the materials provided by Patent Owner or that Samsung was not already using any accused functionalities. Based on my review of [REDACTED] and presentation materials identified by Dr. Islam (Ex. 2100, ¶8 (citing Exs. 2101-2107)) and cited by Dr. Efimov (Efimov, ¶¶371-380), those materials describe the identified functionalities at a high level and do not provide detailed technical guidance regarding their implementation beyond what the Board already found was known in the art.

101. I also note that the presentation materials themselves acknowledge that several of the identified signal-to-noise-ratio improvement techniques were already known and being used in commercial wearable devices before the alleged disclosures to Samsung. *See, e.g.*, Ex. 2106, OMS_SAM0031852 [REDACTED]

[REDACTED]. I agree that the SNR-improvement techniques identify well-known generic concepts only, as the Board already found.

102. Notably, despite asserting Samsung's copying, Patent Owner, Dr. Islam, and Dr. Efimov do not explain how the alleged presence of known techniques in Samsung products constitutes evidence that Samsung copied those techniques from Patent Owner rather than independently implemented concepts already known in the art. *See generally* Efimov, ¶¶371-380; POR, 67-68; Ex.2100, ¶¶7-21. Likewise, and as discussed above, other than high-level communications concerning the generic, well-known techniques that the Board already found to be met by the prior art, Dr. Islam fails to identify any proprietary technique that he shared with Samsung or that Samsung could have copied. *See* Ex. 2100. In fact, I note that Dr. Efimov and Dr. Islam fail to identify evidence showing what proprietary information was actually received by Samsung Electronics Co., Ltd. or Samsung Electronics America, Inc., how any such entities or individuals were involved in Samsung's wearable-device development efforts, or whether any information presented by Patent Owner was ever incorporated into Samsung products. Efimov Tr., 107:15-111:4, 126:2-137:14; *see generally* Ex. 2100; POR, 67-68. I have not seen any evidence tying the development or operation of Samsung's products to Dr.

Islam's alleged disclosure of the '455 patent or known SNR improvement techniques.

103. Dr. Efimov and Dr. Islam further assert that the '455 patent addressed a long-felt but unresolved need relating to motion artifacts, ambient-light interference, and signal-to-noise ratio in wearable physiological monitoring systems. Efimov, ¶¶388-402; Ex. 2100, ¶¶22-34. In particular, Dr. Efimov and Dr. Islam together identify (1) increasing signal-to-noise ratio by increasing light intensity; (2) the detection system configured to be synchronized to the light source; (3) change detection, and; (4) spatially separated detectors,. Efimov, ¶¶390, 402; Ex. 2100, ¶¶24-31; POR, 69-71. I disagree that any such generic, well-known techniques would have resolved any alleged industry need relating to motion artifacts, ambient-light interference, or signal-to-noise ratio in wearable physiological monitoring systems that were not resolved before—indeed, as noted above and consistent with my opinion, the Board already found (as shown in the table above) each of these functionalities was known in the prior art. *See also*, Section VI above.

104. Notably, none of Dr. Efimov's, Dr. Islam's, or Patent Owner's analyses explains why these known techniques, either individually or in the combinations recited by the Challenged Claims, would have solved a long-felt need in a manner not already known by a person of ordinary skill in the art. Efimov, ¶¶388-402;

Ex. 2100, ¶¶22-33; POR, 69-71. Notably, Dr. Islam admitted that, while some of these techniques were generally known in the field of optical sensing (Islam-Tr. 30:1-15, 87:6-22, 104:4-20, 112:18-113:20, 114:14-115:1, 132:10-133:16), he did not know whether or to what degree these techniques were already being used in wearable devices as of the priority date (Islam-Tr. 48:8-49:3, 74:1-14, 85:7-17, 99:9-101:4, 104:22-105:26, 139:8-15), and thereby failing to show that his alleged inventions provided any solution, let alone a novel one, to the industry's alleged long felt needs. Further, Dr. Islam's own evidence states that some of these techniques were being used in commercial wearable devices by 2017 (Ex. 2103, OMS_SAM0031785 ("Some of these techniques are already being used in premium wearable devices.")) and yet the "SNR ... problem" was still not "solved" in those devices (Ex.2100, ¶¶31-33). Such techniques, therefore, in fact did not result in any resolution of the purported industry needs per Dr. Islam's own allegation, and could not have newly resolved any such needs because they were all known techniques in the industry. POR, 69-71; Efimov, ¶389; Ex. 2100, ¶31-33.

105. Patent Owner, Dr. Efimov and Dr. Islam further characterize some of these functionalities as "coordinated" and as "a suite of integrated hardware and signal processing techniques." Efimov, ¶¶386 ("a suite of integrated hardware and signal processing techniques, including ambient light cancellation through change detection schemes, synchronization of LED transmitters and receivers, and dynamic

adjustment of LED light intensity”), 401 (“integrated suite of techniques that collectively addressed this long felt need, enabling, for the first time, the sufficiently accurate measurement of heart rate, SpO2, and other physiological parameters during the daytime and during exercise”), 402; Ex. 2100, ¶30; POR, 69-71. Again, I disagree that any such generic, well-known concepts would have resolved any industry needs. Further, I note that neither Dr. Efimov nor Dr. Islam provides any technical evidence demonstrating that the alleged benefits he identifies are attributable to the claimed combinations themselves, rather than to the known benefits associated with the individual techniques that comprise those combinations.

106. Even to the extent any alleged industry needs were resolved, I see no technical evidence in Patent Owner's Dr. Efimov's, or Dr. Islam's analysis and allegations showing that any alleged resolution of the need is attributable to features unique to the Challenged Claims. For example, Patent Owner, Dr. Efimov and Dr. Islam assert that the Challenged Claims enabled sufficiently accurate physiological measurements during daytime use and exercise. Efimov, ¶¶390, 399, 401; Ex. 2100, ¶30; POR, 69-71. However, I do not see any technical analysis comparing the performance of the Challenged Claims against prior systems, quantifying any alleged improvement, or demonstrating that the claimed combinations uniquely achieved the results described in the declarations. Rather, Dr. Efimov and Dr. Islam appear to infer that the claimed combinations produced the alleged benefits because

they include techniques directed to improving signal-to-noise ratio. Again, these techniques were well-known in the art as of the priority date, yet none of the Patent Owner, Dr. Efimov, or Dr. Islam explains why the alleged industry need persisted, especially in light of Dr. Islam's own evidence allegedly indicating that such industry need still existed in 2017. POR, 69-71, Efimov, ¶¶388-402; Ex. 2100, ¶¶31-33; Ex. 2103, OMS_SAM0031785.

107. Accordingly, while Patent Owner, Dr. Efimov and Dr. Islam cite references discussing motion artifacts, ambient-light interference, and signal-to-noise ratio (POR, 69-71, Efimov, ¶¶391-402; Ex. 2100, ¶¶22-30), their analyses do not establish that the Challenged Claims uniquely solved those issues, that any alleged benefits are attributable to features unique to the Challenged Claims, or that the claimed combinations achieved results not already expected from their constituent techniques. To the contrary, the techniques identified by Patent Owner, Dr. Efimov and Dr. Islam were not only individually known in the art, as discussed above, but were also known, or at least obvious, to be used in combinations, as the Board previously found. For example, the Board previously found that the prior art disclosed combinations including increasing signal-to-noise ratio by increasing light intensity, and the detection system configured to be synchronized to the light source. *See* '533-FWD, 26-39. Similarly, the Board separately found that the prior art disclosed combinations including increasing signal-to-noise ratio by increasing light

intensity, the detection system configured to be synchronized to the light source, change detection based on light-on/light-off measurements, and spatially separated detectors. *See* '484-FWD, 23-48. Further, as discussed in my Declaration and in this Reply Declaration, combining these same techniques further with the wavelength comparison technique were also taught and at least rendered obvious by the prior art. *See* Section VI above.

108. As such, the techniques identified by Patent Owner, Dr. Efimov and Dr. Islam, whether used individually or in the combinations identified above, were already known in the art and were understood to provide their corresponding benefits, including improvements in signal quality and the accuracy and reliability of physiological measurements, as of the priority date. To the extent any such benefits were achieved, they would have been attributable to the known operation of those techniques and combinations, rather than to any feature unique to the Challenged Claims. Further, the fact that some of these techniques were reportedly being used in commercial wearable devices years later while the alleged signal-to-noise-ratio problems purportedly persisted confirms that the use of such known techniques, whether individually or in combination, did not uniquely solve the alleged industry problems. Accordingly, in my opinion, the evidence does not establish that the Challenged Claims uniquely solved the alleged industry problems, that any alleged benefits are attributable to features unique to the Challenged Claims,

or that the claimed combinations achieved results beyond the known and expected benefits of their constituent techniques.

109. In sum, Patent Owner's, Dr. Efimov's, and Dr. Islam's opinions regarding copying and long-felt need do not alter my conclusion that the Challenged Claims would have been obvious to a person of ordinary skill in the art.

VII. CONCLUSION

110. In summary, and as outlined in my Declaration and set forth above, I have concluded that claims 1-20 of the '455 patent are anticipated and/or rendered obvious over the prior art references discussed in my Declaration and herein. As discussed above, I disagree with Patent Owner's and Dr. Efimov's arguments, and none of their arguments alters my opinions expressed in my previous Declaration.

111. I reserve the right to supplement my opinions in the future to respond to any arguments that Patent Owner or its expert(s) may raise and to consider new information as it becomes available to me.

112. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office.

113. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful

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false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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APPENDIX A (LIST OF MATERIALS CONSIDERED)

Exhibit No.	DESCRIPTION
1001	U.S. Patent No. 11,160,455 ("455")
1002	File History of U.S. Application No. 17/078,771 ("455FH")
1003	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 11,160,455 ("Anthony")
1004	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 9,651,533 submitted in IPR2019-00916, Ex. 1003 ("533-Anthony")
1005	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 1 (P.T.A.B. Apr. 10, 2019) ("533-Pet.")
1006	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 23 (P.T.A.B. Jan. 31, 2020) ("533-POR")
1007	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 16 (P.T.A.B. Oct. 18, 2019) ("533-Inst.")
1008	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2019-00916, Paper 39 (P.T.A.B. Oct. 14, 2020) ("533-FWD")
1009	<i>Omni MedSci, Inc. v. Apple Inc.</i> , No. 21-01229, ECF 69 (Fed. Cir. June 8, 2022)
1010	Declaration of Brian Anthony in Support of Petition for Inter Partes Review of U.S. Patent No. 10,517,484 submitted in IPR2021-00453, Ex. 1003 ("484-Anthony")
1011	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 1 (P.T.A.B. Jan. 22, 2021) ("484-Pet.")

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Exhibit No.	DESCRIPTION
1012	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 10 (P.T.A.B. Nov. 12, 2021) (“484-POR”)
1013	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 7 (P.T.A.B. Aug. 6, 2021) (“484-Inst.”)
1014	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 11 (P.T.A.B. Feb. 4, 2022) (“484-Pet.-Reply”)
1015	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 22 (P.T.A.B. Aug. 3, 2022) (“484-FWD”)
1016	<i>Apple Inc. v. Omni Medsci, Inc.</i> , No. IPR2021-00453, Paper 26 (P.T.A.B. Feb. 14, 2025) (“484-RFWD”)
1017	<i>Apple Inc. v. Omni MedSci, Inc.</i> , No. 23-01034, ECF 44 (Fed. Cir. June 21, 2024)
1018	<i>Omni MedSci, Inc. v. Apple Inc.</i> , 2:18-cv-00134-RWS, Dkt. No. 211 (E.D. Tex. June 24, 2019)
1019	<i>Omni MedSci, Inc. v. Apple Inc.</i> , 2:18-cv-00429-RWS, Dkt. No. 152 (E.D. Tex. Aug. 14, 2019)
1020	Second Amended Docket Control Order, June 16, 2025. <i>Omni MedSci, Inc. v. Samsung Electronics Co., Ltd. et al.</i> , No. 2:24-cv-01070-JRG-RSP (E.D. Tex.)
1023	Defendants' Supplemental Invalidity and Subject Matter Eligibility Contentions, July 18, 2025. <i>Omni MedSci, Inc. v. Samsung Electronics Co., Ltd. et al.</i> , No. 2:24-cv-01070-JRG-RSP (E.D. Tex.)
1025	U.S. Patent No. 9,241,676 (“Lisogurski”)
1026	U.S. Patent Pub. No. 2010/0217102 (“LeBoeuf”)

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Exhibit No.	DESCRIPTION
1027	U.S. Patent No. 8,108,036 ("Tran")
1028	U.S. Patent Pub. No. 2005/0049468A1 ("Carlson")
1030	U.S. Patent No. 7,029,628 ("Tam")
1031	U.S. Patent No. 8,050,730 ("Zhang")
1032	U.S. Patent No. 8,821,397 ("Al-Ali")
1033	U.S. Patent Pub. No. 2011/0237911 ("Lamego")
1034	U.S. Patent No. 5,942,749 ("Takeuchi")
1035	U.S. Patent No. 5,822,473 ("Magel")
1036	US Patent 5,592,124 ("Mullins")
1037	E.F. Schubert, Light-Emitting Diodes (Cambridge Univ. Press, 2nd ed. reprinted 2014)
1038	Joseph D. Bronzino, The Biomedical Engineering Handbook (1995)
1039	U.S. Patent No. 8,079,735 ("Vakil")
1041	U.S. Patent Pub. No. 2012/0197093 ("Valencell-093")
1042	U.S. Patent No. 8,862,196 ("Lynn")
1043	U.S. Patent No. 8,412,655 ("Colman")
1044	U.S. Patent No. 5,511,553 ("Segalowitz")
1045	U.S. Patent No. 6,801,799 ("Mendelson")
1046	U.S. Patent No. 6,662,033 ("Casciani")

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Exhibit No.	DESCRIPTION
1047	U.S. Patent No. 5,028,787 ("Rosenthal")
1048	U.S. Pat. No. 9,239,951 ("Hoffberg")
1049	U.S. Pat. Pub. 2007/0194939 ("Alvarez")
1050	U.S. Patent No. 8,364,226 ("Diab")
1051	U.S. Patent No. 6,931,269 ("Terry")
1059	U.S. Patent No. 5,497,769 ("Gratton")
1060	U.S. Patent No. 5,827,182 ("Raley")
1061	U.S. Patent No. 7,764,982 ("Dalke")
1064	U.S. Patent No. 5,554,273 ("Demmin")
1065	U.S. Patent No. 5,953,713 ("Behbehani")
1077	U.S. Patent Publication No. 2006/0184040 ("Keller")
1081	US. Patent No. 9,651,533 ("533")
1082	U.S. Patent No. 10,517,484 ("484")
1127	Transcript of Igor Efimov, Ph.D. (July 16, 2026) ("Efimov-Tr.") [CONFIDENTIAL]
1128	Transcript of the Deposition of Mohammed Islam, Sc.D. (July 23, 2026) ("Islam-Tr.")
2035	König, V., et al., "Reflectance Pulse Oximetry – Principles and Obstetric Application in the Zurich System," Journal of Clinical Monitoring, Vol. 14, pp. 403-412 (1998)
2036	"Thermal Management of White LEDs," U.S. DOE Building Technologies Program (Feb. 2007)

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Exhibit No.	DESCRIPTION
2043	Corrected Declaration of Prof. Igor Efimov, Ph.D. dated May 7, 2026 (CONFIDENTIAL)
2044	Updated <i>curriculum vitae</i> of Prof. Igor Efimov, Ph.D.
2045	Transcript of Apr. 17, 2026 Deposition of Dr. Brian W. Anthony
2046	Transcript of Apr. 18, 2026 Deposition of Dr. Brian W. Anthony
2100	Declaration of Dr. Mohammed Islam (CONFIDENTIAL)
2101	OMS_SAM0031768 (CONFIDENTIAL)
2102	OMS_SAM0031776 (CONFIDENTIAL)
2103	OMS_SAM0031782 (CONFIDENTIAL)
2104	OMS_SAM0031797 (CONFIDENTIAL)
2105	OMS_SAM0031867 (CONFIDENTIAL)
2106	OMS_SAM0031851 (CONFIDENTIAL)
2107	OMS_SAM0031961 (CONFIDENTIAL)
2108	U.S. Patent No. 5,632,272 to Diab et al. ("Masimo '272 Patent")
2109	U.S. Patent No. 7,738,935 to Turcott ("Pacesetter '935 Patent")
2110	U.S. Patent No. 6,126,595 to Amano et al.
2111	Fitbit '854 Publication

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Exhibit No.	DESCRIPTION
2112	GE Dash 2000 Patient Monitor Operating Manual
2113	Accuracy in wrist-worn, sensor-based measurements of heart rate and energy expenditure in a diverse cohort, Scherbina et. al, (Stanford 2016)
2114	Are Currently Available Wearable Devices for Activity Tracking and Heart Rate Monitoring Accurate, Precise, and Medically Beneficial" El-Amrawy et al., Healthcare Informatics Research (2015)
2115	A review of wearable sensors and systems with application in rehabilitation, Patel et. al, Journal of Neuroengineering and Rehabilitation, 2012
2116	Samsung Watch Infringement Claim Chart
2117	Declaration of Dr. Mohammed Islam (REDACTED)
2118	Corrected Declaration of Prof. Igor Efimov, Ph.D. dated May 7, 2026 (REDACTED)
	<i>Samsung Electronics Co., Ltd. et al. v. Omni MedSci, Inc.</i> , No. IPR2025-01252, Paper 1 (PTAB Aug. 5, 2025) (Petition for Inter Partes Review)
	<i>Samsung Electronics Co., Ltd. et al. v. Omni MedSci, Inc.</i> , No. IPR2025-01252, Paper 13 (PTAB Nov. 12, 2025) (Patent Owner's Preliminary Response)
	<i>Samsung Electronics Co., Ltd. et al. v. Omni MedSci, Inc.</i> , No. IPR2025-01250, Paper 20 (PTAB Apr. 10, 2026) (Patent Owner's Notice of Deposition of Brian W. Anthony)
	<i>Samsung Electronics Co., Ltd. et al. v. Omni MedSci, Inc.</i> , No. IPR2025-01250, Paper 26 (PTAB May 7, 2026) (Patent Owner's Response)