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Paper 52
Date: August 20, 2025

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

NINTENDO CO., LTD. and NINTENDO OF AMERICA INC.,
Petitioner,

v.

AMERICAN GNC CORPORATION,
Patent Owner.

IPR2024-00668
Patent 6,671,648 B2

Before JENNIFER S. BISK, SCOTT A. DANIELS, and
LISA L. TSANG, *Administrative Patent Judges*.

TSANG, *Administrative Patent Judge.*

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. §318(a)

ORDER
Denying Patent Owner's Motion to Exclude (Paper 35)
37 C.F.R. § 42.64(c)

I. INTRODUCTION

This is a Final Written Decision in an *inter partes* review challenging the patentability of claims 1 and 4 (collectively, "the challenged claims") of U.S. Patent No. 6,671,648 B2 (Ex. 1001 ("the '648 patent")). We have jurisdiction under 35 U.S.C. § 6. We issue this Final Written Decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons that follow, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 1 and 4 are unpatentable. We also, for reasons explained below, deny Patent Owner's Motion to Exclude.

A. Procedural History

Nintendo Co., Ltd. and Nintendo of America Inc. (collectively, "Petitioner") filed a Petition (Paper 3 ("Pet.")), seeking *inter partes* review of claims 1 and 4 under 35 U.S.C. § 311. *See* Pet. 1. American GNC Corporation ("Patent Owner") filed a Preliminary Response. Paper 9 ("Prelim. Resp."). On September 10, 2024, we instituted an *inter partes* review of the challenged claims. Paper 10 ("Institution Decision" or "Dec.").

Following institution, Patent Owner filed a Response (Paper 22 ("PO Resp.")), Petitioner filed a Reply (Paper 28 ("Reply")), and Patent Owner filed a Sur-reply (Paper 38 ("Sur-reply")). Patent Owner also filed a Motion to Exclude (Paper 35, "PO MTE"), Petitioner filed an Opposition (Paper 39, "Pet. MTE Opp."), and Patent Owner filed a Reply (Paper 43, "PO MTE Reply").

We heard oral argument on May 28, 2025, and the record includes a transcript of the argument. Paper 49 ("Tr.").

B. Real Parties in Interest

Petitioner identifies Nintendo Co., Ltd. and Nintendo of America Inc. as the real parties in interest. Pet. 1. Patent Owner identifies American GNC Corporation as the real party in interest. Paper 6, 2.

C. Related Matters

The parties identify that the ’648 patent is involved in *American GNC Corporation v. Nintendo Co., Ltd. and Nintendo of America Inc.*, No. 2:23-cv-00302-TL (W.D. Wash.) (“the Washington litigation”). Pet. 1; Paper 6, 2.

Petitioner also identifies that the ’648 patent was previously involved in *American GNC Corporation v. ZTE Corporation*, No. 4:17-CV-00620 (E.D. Tex.), *American GNC Corporation v. ZTE Corporation*, No. 2:17-cv-00107 (E.D. Tex.), *American GNC Corporation v. LG Electronics Inc.*, No. 2:17-cv-00119 (E.D. Tex.), *American GNC Corporation v. LG Electronics Inc.*, No. 3:17-01090 (S.D. Cal.), *American GNC Corporation v. GoPro, Inc.*, No. 3:18-cv-00968 (S.D. Cal.), *American GNC Corporation v. GoPro, Inc.*, No. 4:18-cv-06778 (N.D. Cal.), and *American GNC Corporation v. OnePlus Technology (Shenzhen) Co., Ltd.*, No. 6:20-cv-00171 (W.D. Tex.). Pet. 1–2.

Although not identified by the parties, the following proceeding before the Board involves the same parties as the instant proceeding: IPR2024-00667 (U.S. Patent No. 6,508,122 B1).

D. The ’648 Patent (Ex. 1001)

The ’648 patent is titled “Micro Inertial Measurement Unit” and discloses such a unit that uses MicroElectronicMechanicalSystem (“MEMS”) rate and acceleration sensors to obtain motion measurements.

Ex. 1001, codes (54), (57). According to the ’648 patent, conventional inertial measurement units (“IMUs”) used gyroscopes and accelerometers “hav[ing] a large size, high power consumption, and moving mass, complex feedback control loops.” *Id.* at 1:45–61. As a result, these IMUs typically had problems with “[h]igh cost, [l]arge bulk (volume, mass, large weight), [h]igh power consumption, [l]imited lifetime, and [l]ong turn-on time” that impeded their use with emerging technologies. *Id.* at 1:66–2:9.

To solve these problems, the ’648 patent’s IMU uses MEMS technology—or “micromachines”—which, the ’648 patent explains, “offer tremendous cost, size, and reliability improvements for guidance, navigation, and control systems, compared with conventional inertial sensors.” Ex. 1001, 2:10–17, 2:62–64. The ’648 patent acknowledges that MEMS angular rate sensors and accelerometers were commercially available, but discloses that “there is not yet available high performance, small size, and low power consumption IMUs.” *Id.* at 2:47–51.

Figure 1, below, shows an exemplary “block diagram illustrating the processing module for a micro inertial measurement unit.” Ex. 1001, 4:32–34.

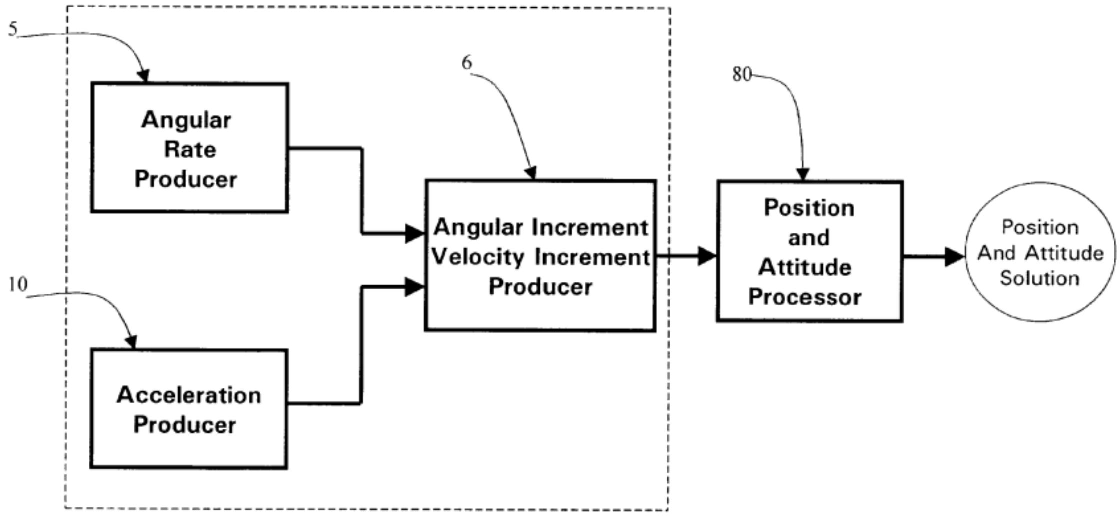

Figure 1's IMU includes angular rate producer 5, which produces X-axis, Y-axis, and Z-axis angular rate signals; acceleration producer 10, which produces X-axis, Y-axis, and Z-axis acceleration signals; and angular increment and velocity increment producer 6, which receives the angular rate signals and the acceleration signals and converts them into digital angular increments and digital velocity increments, respectively. *Id.* at 6:61–7:3.

The '648 patent discloses that, in use, the angular rate producer and acceleration producer will usually output analog voltage signals. Ex. 1001, 8:11–13. These analog voltage signals are directly proportional to angular rates and accelerations of a carrier. *Id.* at 8:13–18.

E. Challenged Claims

Petitioner challenges claims 1 and 4 of the '648 patent. Pet. 9–74. Of these, claim 1 is independent.

Independent claim 1 is reproduced with bracketing as follows:

1. [1[pre]][1] A micro inertial measurement unit, comprising:

[1[a]] an angular rate producer comprising a X axis angular rate detecting unit which produces a X axis angular rate electrical signal, a Y axis angular rate detecting unit which produces a Y axis angular rate electrical signal, and a Z axis angular rate detecting unit which produces a Z axis angular rate electrical signal;

[1[b]] an acceleration producer comprising a X axis accelerometer which produces a X axis acceleration electrical signal, a Y axis accelerometer which produces a Y axis acceleration electrical signal, and a Z axis accelerometer which produces a Z axis acceleration electrical signal; and

[1[c]] an angular increment and velocity increment producer, which is electrically connected with said X axis, Y axis and Z axis angular rate detecting units and said X axis, Y axis and Z axis accelerometers, receiving said X axis, Y axis and Z axis angular rate electrical signals and said X axis, Y axis and Z axis acceleration electrical signals from said angular rate producer and said acceleration producer respectively, wherein said X axis, Y axis and Z axis angular rate electrical signals and said X axis, Y axis and Z axis acceleration electrical signals are converted into are digital angular increments and digital velocity increments respectively.

Ex. 1001, 23:43–24:21.

Dependent claim 4 is reproduced as follows:

4. A micro inertial measurement unit, as recited in claim 1, wherein said X axis, Y axis and Z axis angular rate electrical signals produced from said angular producer are analog angular rate voltage signals directly proportional to angular rates of a carrier carrying said micro inertial measurement unit, and said X axis, Y axis and Z axis acceleration electrical signals produced from said acceleration producer are analog

[1] For consistency, we rely on Petitioner's annotations 1[pre]–1[c] referencing particular claim 1 limitations. *See* Pet. 9–74. These annotations, however, have no impact on our analysis.

> acceleration voltage signals directly proportional to accelerations of said vehicle.

Ex. 1001, 24:36–44.

F. The Asserted Challenges to Unpatentability and Evidence of Record

We instituted an *inter partes* review of the challenged claims under the following challenges to unpatentability:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1	103(a)[2]	Smith,[3] Chan,[4] Bernstein[5]
4	103(a)	Smith, Chan, Bernstein, Irwin,[6] Merhav[7]
1, 4	103(a)	Tingleff,[8] Chan, Bernstein
1, 4	103(a)	Yamawaki,[9] Chan, Bernstein, Saubolle[10]

In support of its patentability challenges, Petitioner relies on, *inter alia,* the Declaration of Darrin Young, Ph.D. ("Dr. Young") (Ex. 1002) and the Reply Declaration of Darrin Young, Ph.D. (Ex. 1045). Patent Owner

[2] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112–29, 125 Stat. 284, 287–288 (2011), amended 35 U.S.C. §§ 102 and 103. Because the '648 patent claims priority to an application filed before the effective date of the relevant amendments, we refer to the pre-AIA versions. *See* Ex. 1001, code (62).
[3] U.S. Patent No. 4,675,820, issued June 23, 1987 (Ex. 1003).
[4] U.S. Patent No. 6,058,778, issued May 9, 2000 (Ex. 1005).
[5] U.S. Patent No. 5,203,208, issued April 20, 1993 (Ex. 1006).
[6] J. David Irwin et al., *Introduction to Electrical Engineering* (1995) (Ex. 1007).
[7] Shmuel Merhav, *Aerospace Sensor Systems and Applications* (1996) (Ex. 1008).
[8] U.S. Patent No. 4,424,038, issued January 3, 1984 (Ex. 1004).
[9] Japanese Unexamined Patent Application No. Hei 7[1995]-313649, published December 5, 1995 (Ex. 1009), and certified English translation thereof (Ex. 1010).
[10] U.S. Patent No. 4,820,953, issued April 11, 1989 (Ex. 1011).

relies on, *inter alia*, the Declaration of Lawrence E. Larson ("Dr. Larson") (Ex. 2008), the Response Declaration of Lawrence E. Larson (Ex. 2019), and the Declaration of Hiram McCall ("Mr. McCall") (Ex. 2023), a named inventor of the '648 patent (*see* Ex. 1001, code (75)).

II. TIME BAR UNDER 35 U.S.C. § 315(b)

Section 315 of Title 35 of the U.S. Code states, in part, "[a]n inter partes review may not be instituted if the petition requesting the proceeding is filed more than 1 year after the date on which the petitioner, real party in interest, or privy of the petitioner *is served with a complaint alleging infringement of the patent*." 35 U.S.C. § 315(b) (emphasis added). Accordingly, a petition for *inter partes* review may be considered only if, among other things, it "identifies all real parties in interest," and no real party in interest was served with a complaint alleging infringement of the challenged patent more than one year before the petition was filed. 35 U.S.C. § 312(a)(2). "[T]he IPR petitioner bears the burden of persuasion to demonstrate that its petitions are not time-barred under § 315(b) based on a complaint served on a real party in interest more than a year earlier." *Worlds Inc. v. Bungie, Inc.*, 903 F.3d 1237, 1242 (Fed. Cir. 2018). However, "an IPR petitioner's initial identification of the real parties in interest should be accepted unless and until disputed by a patent owner," who, in turn, "must produce some evidence that tends to show that a particular third party should be named a real party in interest." *Id.* at 1242, 1244 (footnote omitted).

Patent Owner contends the Petition is time-barred under 35 U.S.C. § 315(b) because (1) STMicroelectronics N.V. and STMicroelectronics S.r.l. (collectively, "STMicro") were served in 2020 with a complaint (“the 2020 Complaint”) alleging infringement of patents including the ’648 patent; and (2) STMicro is an unnamed real party-in-interest (“RPI”) to this proceeding. PO Resp. 63–66; Sur-reply 21–22. To support its argument, Patent Owner sought additional discovery as to certain agreements and communications between Petitioner and STMicro. *See* Paper 41 (Patent Owner’s Motion for Discovery).

Concurrent with this Final Written Decision, we have entered an Order Denying Patent Owner’s Motion for Additional Discovery (Paper 50), which details reasons why Patent Owner has failed to show that STMicro was properly served the 2020 Complaint under Rule 4 of the Federal Rules of Civil Procedure. *See id.* Accordingly, we determine that STMicro was not served with a complaint alleging infringement of the ’648 patent in a manner that would have triggered the § 315(b) time bar as it relates to this proceeding.

Based on the arguments and evidence of record, we determine that Patent Owner has not produced sufficient evidence to support a finding that STMicro should be named a real party in interest to this proceeding. At best, Patent Owner’s evidence and arguments establish only that Patent Owner previously filed a complaint against STMicro, asserting that STMicro infringed patents related to the ’648 patent (*see generally* Ex. 2012); and that Patent Owner served a subpoena to compel STMicro to testify and produce documents in Patent Owner’s infringement suit against Petitioner (*see generally* Ex. 2014). The record before us does not demonstrate a relationship between Petitioner and STMicro sufficient to show that STMicro is a real party in interest. *See Worlds*, 903 F.3d at 1242, 1244 (“[A]n IPR petitioner’s initial identification of the real parties in interest should be accepted unless and until disputed by a patent owner," who, in turn, "must produce *some* evidence that tends to show that a particular third party should be named a real party in interest." (footnote omitted)).

III. UNPATENTABILITY

A. Legal Standards

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")).

The legal question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) when in evidence, objective evidence of nonobviousness. *Graham v. John Deere Co. of Kan. City*, 383 U.S. 1, 17–18 (1966). One seeking to establish obviousness based on more than one reference must articulate sufficient reasoning with rational underpinnings to combine teachings. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007).

B. Level of Ordinary Skill in the Art

Relying on the Declaration of Dr. Young for support, Petitioner contends a person of ordinary skill in the art ("POSITA")

> would have possessed a bachelor's degree in electrical engineering or similar degree, with two to three years of

> practical experience designing and/or implementing systems that include sensors for measuring movement, such as acceleration and rotational position. . . . A skilled artisan could also have had more formal education and less practical experience, or vice versa.

Pet. 5 (citing Ex. 1002 ¶¶ 12–14). Patent Owner counters that the skilled artisan would have had "at least a 'Master's Degree in Electrical or Electronics Engineering, and approximately five years of relevant experience in the development of control systems for inertial navigation, MEMS semiconductor processing, and analog circuit design.'" PO Resp. 18 (citing Ex. 2019 ¶ 57).

We adopt Petitioner's articulation of the level of ordinary skill in the art, which is consistent with our review and understanding of the technology and descriptions in the '648 patent and prior art of record, and we apply it in our obviousness evaluations below. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). We note, however, that we would reach the same conclusions applying either Petitioner's or Patent Owner's definition of the level of skill in the art.

C. Claim Construction

We apply the claim construction standard used to construe the claims in a civil action under 35 U.S.C. § 282(b), as articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). 37 C.F.R. § 42.100(b) (2019). Under the *Phillips* standard, claim terms must be given "the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention." *Phillips*, 415 F.3d at 1313.

Here, the parties dispute the meaning of three claim terms: (1) "[a] micro inertial measurement unit," recited in the preamble of claims 1 and 4;

(2) "angular rate electrical signals," recited in claims 1 and 4; and (3) "angular rate voltage signals," recited in claim 4. We address these limitations below, grouping together our analysis of "angular rate electrical signals" and "angular rate voltage signals," as the parties do in their arguments.

1. Claim Construction Principles

In construing the claims, we begin with the language of the claims themselves. *Phillips*, 415 F.3d at 1314. However, "[c]laim construction requires determining how a skilled artisan would understand a claim term 'in the context of the entire patent, including the specification.'" *Grace Instrument Indus., LLC v. Chandler Instruments Co., LLC*, 57 F.4th 1001, 1008 (Fed. Cir. 2023) (citing *Phillips*, 415 F.3d at 1313). In this regard, the specification "is the single best guide to the meaning of a disputed term." *Id.* (citing *Vitrionics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996)). Our analysis "should also consider the patent's prosecution history, if it is in evidence," because it aids in demonstrating how the Office and the patentee understood the patent. *Phillips*, 415 F.3d at 1317.

"Extrinsic evidence consists of all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises." *Markman v. Westview Instruments, Inc.*, 52 F.3d 967, 980 (Fed. Cir. 1995). Extrinsic evidence may be useful in claim construction, but is "secondary to the intrinsic evidence" and is generally of less significance than the intrinsic evidence. *Continental Circuits LLC v. Intel Corp.*, 915 F.3d 788, 799 (Fed. Cir. 2019); *see also Phillips*, 415 F.3d at 1317 (citing *C.R. Bard, Inc. v. U.S. Surgical Corp.*, 388 F.3d 858, 862 (Fed. Cir. 2004). "If the meaning of a claim term is clear from the intrinsic evidence, there is no reason to resort to extrinsic evidence." *Seabed Geosolutions (US) Inc. v. Magseis FF LLC*, 8 F.4th 1285, 1287 (Fed. Cir. 2021).

"Whether to treat a preamble as a limitation is a determination 'resolved only on review of the entire[] . . . patent to gain an understanding of what the inventors actually invented and intended to encompass by the claim.'" *Catalina Mktg. Int'l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002) (quoting *Corning Glass Works v. Sumitomo Elec. U.S.A., Inc.*, 868 F.2d 1251, 1257 (Fed. Cir. 1989)) (alterations in original). "In general, a preamble limits the invention if it recites essential structure or steps, or if it is 'necessary to give life, meaning, and vitality' to the claim." *Id.* (quoting *Pitney Bowes, Inc. v. Hewlett-Packard Co.*, 182 F.3d 1298, 1305 (Fed. Cir. 1999)). "Conversely, a preamble is not limiting 'where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention.'" *Id.* (quoting *Rowe v. Dror*, 112 F.3d 473, 478 (Fed. Cir. 1997)). "Further, when reciting additional structure or steps underscored as important by the specification, the preamble may operate as a claim limitation." *Id.* (citations omitted); *see also Gen. Elec. Co. v. Nintendo Co., Ltd.*, 179 F.3d 1350, 1361–1362 (Fed. Cir. 1999) (limiting the claim to a "raster scan display device," as recited in the preamble, where the specification emphasizes the particular problem of displaying data on a raster scan display device, rather than all display systems).

2. "A Micro Inertial Measurement Unit"

In our Institution Decision, we preliminarily construed "[a] micro inertial measurement unit," recited in the preamble, to be "a micro-sized inertial measurement unit and that the structures recited in the limitations of the claims are limited to structures implemented as MEMS devices." Dec. 24.

Petitioner argues the preamble of claim 1 is not limiting. Pet. 7. According to Petitioner, the limitations recited in the body of claim 1 themselves "define a structurally complete invention," and the preamble does not provide antecedent basis for, or otherwise impact, any limitation. *Id.* at 10; Reply 1–2 (citing *Catalina*, 289 F.3d at 808). Petitioner further contends the preamble merely recites an intended purpose or use of the invention, and notes that Patent Owner did not rely on the preamble during prosecution. Pet. 10–11.

Patent Owner contends the preamble should be construed as a limitation requiring MEMS sensors, consistent with the Specification of the '648 patent, the construction in the Washington litigation, the prosecution history, and other extrinsic evidence. PO Resp. 19–24. Patent Owner avers that "[t]he claim element 'a micro inertial measurement unit' is a fundamental characteristic of the claims and micro refers to ***micro***electromechanical systems (MEMS) devices." *Id.* at 19. According to Patent Owner, such a device is "quite literally, what [Patent Owner] built." *Id.* at 21.

We find unavailing Petitioner's reliance on *Catalina* to support its claim construction position. *See* Reply 2. In particular, although Petitioner contends the body of the claims "define[s] a structurally complete invention," Petitioner does not explain how the claims additionally "use[] the preamble only to state a purpose or intended use for the invention," as *Catalina* further requires. *See Catalina*, 289 F.3d at 808 ("a preamble is not limiting 'where a patentee defines a structurally complete invention in the claim body *and* uses the preamble only to state a purpose or intended use for the invention" (emphasis added)). In this regard, we discern no reason to interpret "[a] micro inertial measurement unit" as reciting only a purpose or intended use because the term, on its face, uses "micro inertial measurement" as an adjective that conveys further structural details of the unit.

Accordingly, on the complete record, and for the reasons set forth in our Institution Decision, we maintain our construction that "[a] micro inertial measurement unit" recited in the preamble is limiting and requires a micro-sized inertial measurement unit, and that the structures recited in the limitations of the claims are limited to structures implemented as MEMS devices. Dec. 21–24.

3. "Angular Rate Electrical Signals" and "Angular Rate Voltage Signals"

Patent Owner argues the limitations "angular rate electrical signals" and "angular rate voltage signals" require signals that "directly measure and reflect angular rate." PO Resp. 24–26. As support, Patent Owner points to the claim language and an embodiment described in the Specification of the '648 patent. *Id.* Specifically, Patent Owner contends claim 1 "requir[es] that the angular rate electrical signals be produced by an 'angular rate detecting unit' that detects (*e.g.*, measures) angular rate." *Id.* at 24 (citing Ex. 1001, 23:44–46). Patent Owner also contends "the ['648] patent describes the use of a 'vibrating' type sensor, producing Coriolis forces that are 'proportional to the applied angular rate, which then can be measured.'" *Id.* at 24–25 (citing Ex. 1001, 16:46–59, 17:19–36, 17:63–65, 18:56–61, 19:3–10). Furthermore, Patent Owner argues that "[c]laim differentiation for dependent claim 4 is separately met." *Id.* at 25.

In its Sur-reply, Patent Owner appears to change its position, arguing that the limitations require signals that "reflect angular rate." Sur-reply 7–8. We note, however, that when addressing Petitioner's grounds, Patent Owner appears to revert back to its position in the Response that the signals must "directly" reflect, though not necessarily measure, angular rate. *See, e.g., id.* at 19 (arguing, "[a]s discussed above in Section II.B., and in Response, the claimed 'angular rate electrical signals,' properly understood in light of the plain claim language and specification disclosures, are signals that directly reflect angular rate" and that Petitioner fails to show Smith "directly reflect[s] the angular rate"), 20 (contending Petitioner fails to address whether Tingleff's signals "directly reflect angular rate").

Petitioner responds that the language of claim 1 does not require any specific relationship between the claimed angular rate signals and angular rate; and Patent Owner's proffered construction "may also render the language in claim 4 superfluous." Reply 2–3 (citing Ex. 1045 ¶¶ 46–54). Petitioner further argues that the Coriolis-force-measuring angular rate producer described in the '648 patent's Specification does not "directly" measure angular rate because it instead "measure[s] *other* forces (torsional Coriolis forces on vibrating tines)" that are used to derive angular rate. *Id.* at 3 (citing Ex. 1001, 16:46–17:18; Ex. 1045 ¶ 49).

We begin with the plain language of the claims. "[A]ngular rate electrical signals," on its face, means electrical signals that reflect angular rate.[11] With respect to the limitation in the context of claim 1 as a whole, the claim recites, in relevant part,

> an angular rate producer comprising a X axis angular rate detecting unit which produces a X axis *angular rate electrical signal*, a Y axis angular rate detecting unit which produces a Y axis *angular rate electrical signal*, and a Z axis angular rate detecting unit which produces a Z axis *angular rate electrical signal*.

Ex. 1001, 23:44–24:3 (emphases added). Claim 1 further recites that these angular rate electrical signals are received by an angular increment and velocity increment producer and are converted into digital angular increments. *Id.* at 24:10–21. As such, the claim requires angular rate electrical signals produced by angular rate detecting units and converted into digital angular increments. *Id.* That the electrical signals are "produce[d]" by angular rate detecting units, i.e., units that detect angular rate, confirms our understanding that "angular rate electrical signals" encompasses electrical signals that reflect angular rate. Notably, claim 1 does not specify how the angular rate detecting units produce the electrical signals, much less require that they "directly"—or any equivalent language thereof—produce the angular rate electrical signals. *See id.* at 23:43–24:21.

Turning to the Specification, the '648 patent discloses, "[t]he micro inertial measurement unit of the present invention is preferred to employ with the angular rate producer . . . that provides three-axis angular rate measurement signals of a carrier." Ex. 1001, 6:41–45. In greater detail, the

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[11] The phrasing of the term "angular rate electrical signals" uses "angular rate" as an adjective to describe or modify "electrical signals." The electrical signals, however, cannot *be* angular rate—as a "red hat," for example, refers to a hat that *is* red—because such an interpretation would be nonsensical.

’648 patent further discloses that “*[i]n most applications,* the output of the angular rate producer 5 and the acceleration producer 10 are analog voltage signals. The three-axis analog angular rate voltage signals produced from the angular producer 5 are directly proportional to carrier angular rates.” *Id.* at 8:11–15 (emphasis added). Accordingly, contrary to Patent Owner’s proposed claim construction in its Response, the Specification discloses that it is the angular rate producer, rather than the angular rate electrical signals, that measures angular rate to thereby produce the angular rate electrical signals. *See id.* at 6:41–45, 8:11–15; *see also id.* at 7:57–65 (discussing a technique for compensating for temperature-induced “*angular rate producer* and acceleration producer *measurement errors*” (emphases added)). Indeed, Patent Owner’s argument that the claims require the signals produced by an angular rate detecting unit “that detects (*e.g.*, measures) angular rate,” appears to acknowledge the same. *See* PO Resp. 24. Moreover, the Specification’s reference to “three-axis angular rate *measurement signals* of a carrier” (*see id.* at 6:41–45 (emphasis added)) guides that the claimed “angular rate electrical signals” refer to electrical signals that more specifically reflect *a measurement* of angular rate.

The disclosure regarding the electrical output of the angular rate producer as, specifically, voltage signals, appears consistent with claim 4, which further limits the “angular rate electrical signals” of claim 1 to “analog angular rate voltage signals directly proportional to angular rates of a carrier.” *See* Ex. 1001, 8:11–15, 24:36–41. Because claim 1 is broader than claim 4, however, the disclosure of “most applications” does not limit the “angular rate electrical signals” of claim 1 beyond electrical signals that reflect a measurement of angular rate.

Patent Owner additionally points to the Specification's disclosures regarding existing MEMS technologies that use the Coriolis Effect and measure torsional forces, proportional to applied angular rate, received by tines of an oscillating inertial element; "obtain[ing] angular rate sensing signals from a vibrating type angular rate detecting unit"; and angular rate detecting units that use the Coriolis Effect to detect angular rate and motion and output "angular motion-induced signals, including rate displacement signals." *See* Ex. 1001, 16:46–59, 17:19–36, 17:63–65, 18:56–61, 19:3–10, *cited in* PO Resp. 24–25. We do not discern here, or elsewhere in the Specification, any requirement that the angular rate electrical signals "directly" measure or reflect angular rate. As Dr. Young testifies, supported by the language of the Specification, the vibrating or oscillating angular rate detecting unit example disclosed in the Specification measures torsional Coriolis forces, rather than angular rate. *See* Ex. 1045 ¶ 45 (citing Ex. 1001, 16:46–17:18).[12] Nor do we see any disclosure that undercuts or further limits our interpretation of the claimed "angular rate electrical signals" as electrical signals that reflect a measurement of angular rate.

We have also considered the prosecution history of the '648 patent, which sheds no light on the proper construction of any claim terms because it includes only an obviousness-type double patenting rejection, a terminal disclaimer, and a notice of allowability indicating the claims are allowable for their recited limitations. *See* Ex. 1015, 113–25.

[12] We disagree with Patent Owner's argument that Dr. Young's testimony regarding this issue is, in part, "improperly late." Sur-reply 7. Rather, his testimony properly responds to claim construction arguments that Patent Owner newly raises in its Response. *See Axonics, Inc. v. Medtronic, Inc.*, 75 F.4th 1374, 1379–80 (Fed. Cir. 2023).

With respect to the recited "angular rate voltage signals" in claim 4, the claim requires that "said X axis, Y axis and Z axis angular rate electrical signals produced from said angular producer are analog angular rate voltage signals," which further limits the "angular rate electrical signals" of claim 1 to being voltage signals. *See* Ex. 1001, 24:37–39. As noted above, the Specification's relevant disclosures regarding the angular rate voltage signals are similar to the plain language of the claims. *See id.* at 8:11–15. We ascertain no other disclosures in the Specification that further distinguish between the meanings of "angular rate voltage signals" and "angular rate electrical signals."

Accordingly, the claims and Specification of the '648 patent support constructions that: (1) the term "angular rate electrical signals" means electrical signals that reflect a measurement of angular rate; and (2) the term "angular rate voltage signals" means voltage signals that reflect a measurement of angular rate.

4. Remaining Claim Terms

Construction is needed only for those terms "that are in controversy, and only to the extent necessary to resolve the controversy." *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs.*, 200 F.3d at 803). After reviewing the parties' arguments and evidence, we determine that no further claim terms require express construction for this decision.

D. Summary of Asserted Art

The following subsections provide a brief description of the asserted prior art references.

1. Smith (Ex. 1003)

Smith is titled "Inertial Reference System" and discloses an inertial sensor assembly that provides positional information using three ring laser gyroscopes ("gyros") and three accelerometers. Ex. 1003, codes (54), (57).

Figure 2, below, shows a block diagram of the main components of the inertial sensor assembly. Ex. 1003, 5:1–3, 7:57–58.

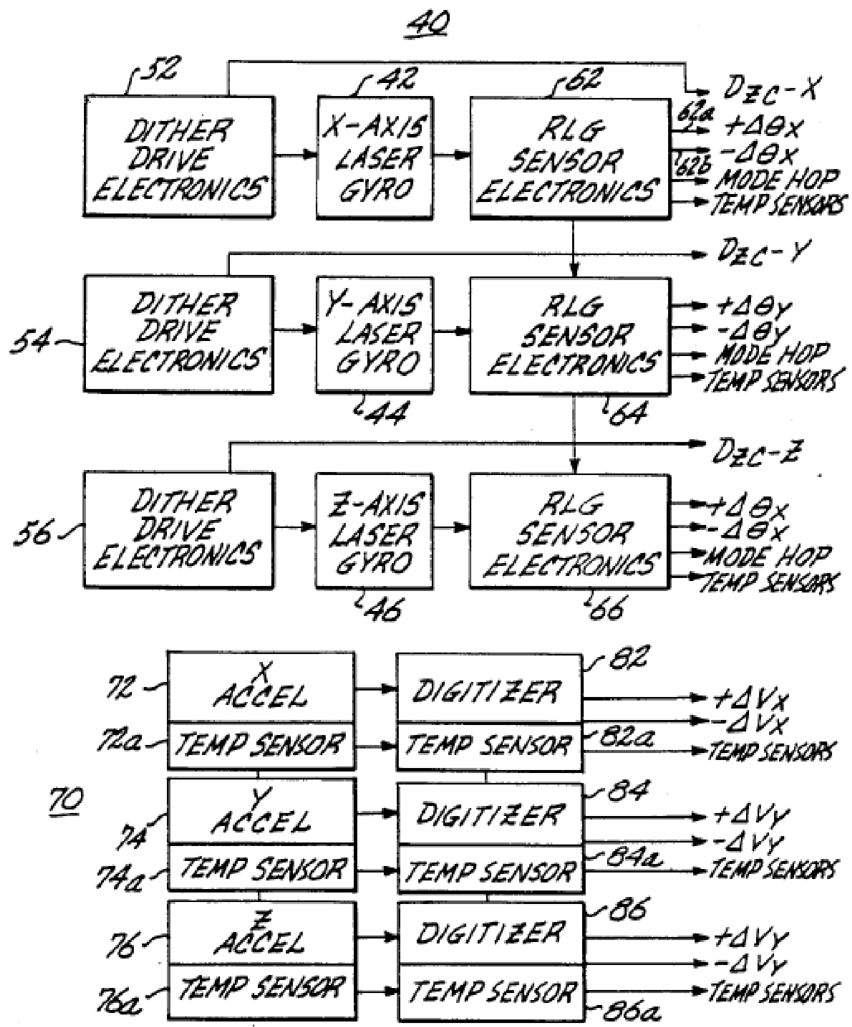

Figure 2 shows, in part, "three ring laser gyros 42, 44, 46, each having its sensitive axis aligned with one of three mutually orthogonal coordinate axes X, Y, and Z, respectively." *Id.* at Fig. 2, 7:58–62. Each of Smith's gyros "produces an output digital signal having a pulse repetition rate proportional to the rate of angular displacement of each gyro 42, 44, and 46 about its coordinate axis." *Id.* at 8:3–6. Figure 2 also shows three accelerometers 72, 74, 76, each of which, likewise, "ha[s] its sensitive axis aligned with one of the three mutually orthogonal coordinate axes X, Y, and Z, respectively." *Id.* at 8:43–48. These accelerometers output analog signals "corresponding to the rate of change of velocity of each accelerometer along its sensitive axis," and digitizers subsequently convert the analog signals to digital signals. *Id.* at 8:48–53.

2. *Tingleff (Ex. 1004)*

Tingleff is titled "Inflight Aircraft Training System." Ex. 1004, code (54). Figure 1, below, is a block diagram of Tingleff's "radar warning receiver training system." *Id.* at 5:66–68.

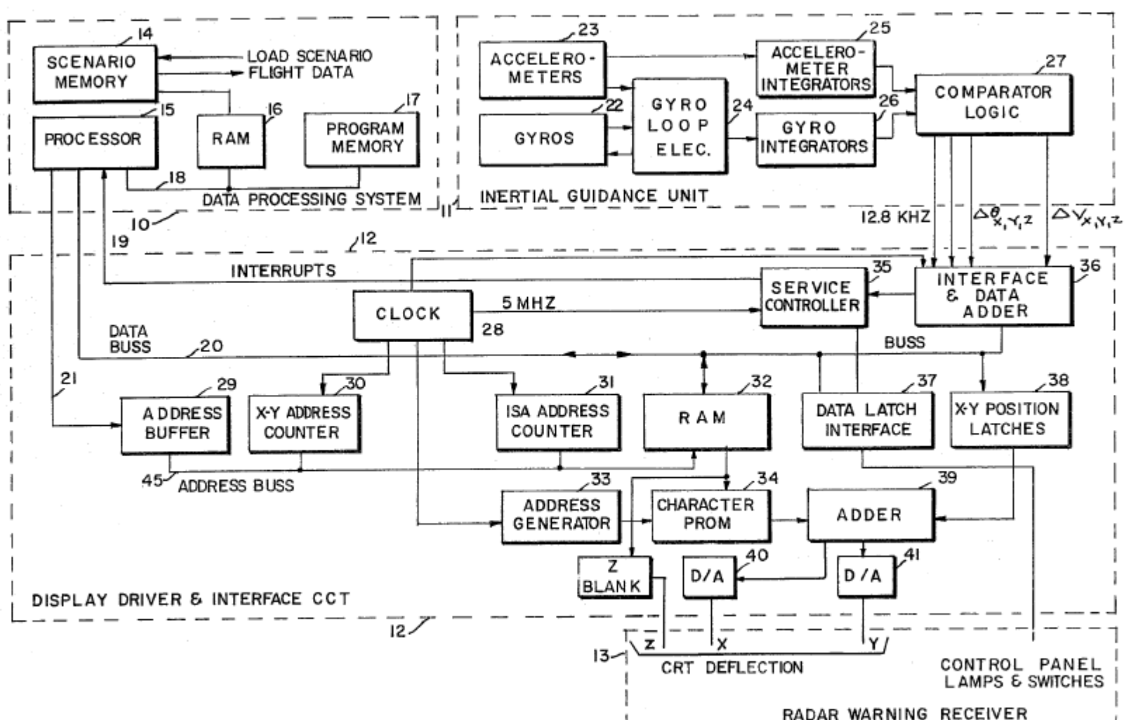

FIG. 1.

The training system of Figure 1 includes data processing system 10, inertial guidance unit 11, and driver and interface circuit 12. *Id.* at 6:2–5.

In greater detail, the inertial guidance unit senses angular rates and accelerations of an aircraft about the X, Y, and Z axes using three pairs of gyros 22 and accelerometers 23. Ex. 1004, 6:67–7:3. As the aircraft moves, analog error signals from the gyros and accelerometers "are applied to gyro-loop electronics 24[,] which attempts to hold the accelerometer pendulum and gyro gimbal nulled." *Id.* at 7:2–7:8. Accelerometer integrator 25 or gyro integrator 26, as appropriate, converts the analog signals to digital pulse trains; and comparator logic 27 modifies the pulse trains so that they represent incremental changes in attitude and velocity. *Id.* at 7:7–18.

3. Chan (Ex. 1005)

Chan is titled "Integrated Sensor Having Plurality of Released Beams for Sensing Acceleration" and provides an integrated circuit to "sens[e] activity such as acceleration in a predetermined direction of movement." Ex. 1005, codes (54), (57). By way of background, Chan explains that integrated circuits were prevalent in MEMS or electronic applications, and that known microsensors developed for MEMS applications included those that measure acceleration. *Id.* at 1:12–22. Chan further explains that acceleration microsensors were used in, for example, "air bag systems, anti-lock braking systems, and ride suspension systems for automobiles and in-flight aircraft monitoring systems for aircraft," which, according to Chan, all "require[d] small, inexpensive, and reliable acceleration devices." *Id.* at 1:33–38.

4. Bernstein (Ex. 1006)

Bernstein is titled "Symmetrical Micromechanical Gyroscope." Ex. 1006, code (54). According to Bernstein, although micromechanical gyroscopes were well-known in the art, they suffered problems with their gimbaled structure. *Id.* at 1:11–45. To solve these problems, Bernstein proposes a micromechanical gyro as illustrated in Figure 1, below.

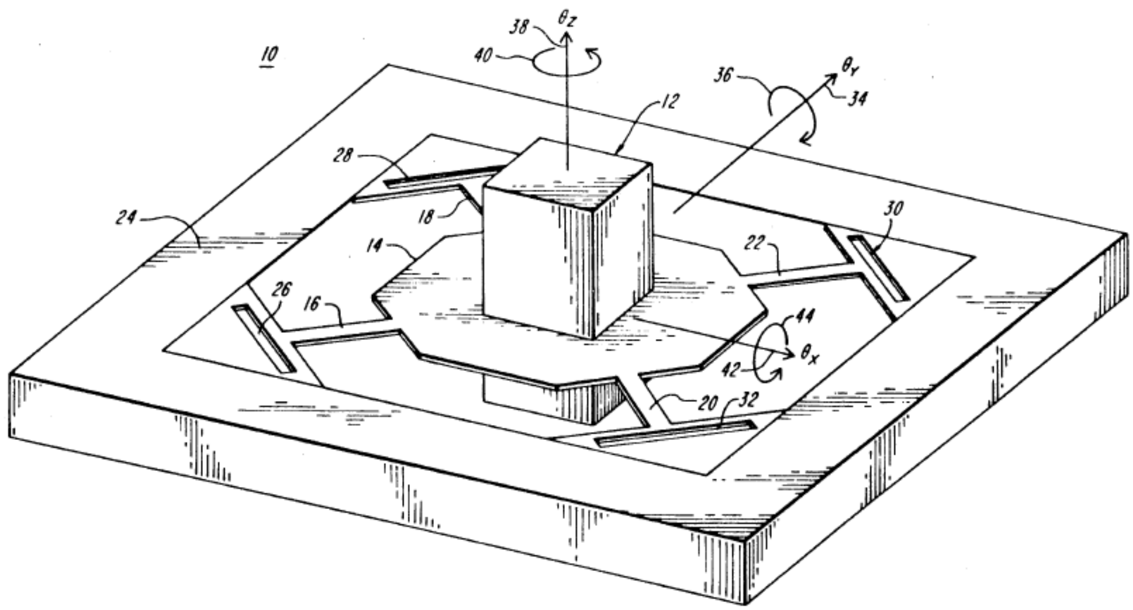

Figure 1 shows inertial mass 12 coupled to support plate 14, and support frame 24 surrounding the support plate and the inertial mass. *Id.* at Fig. 1, 2:17–26. The support plate and the inertial mass are coupled to the support frame via four flexures or flexural springs 16, 18, 20, 22. *Id.*

Bernstein additionally explains that its micromechanical gyroscope operates in a manner similar to known gyroscopes. Ex. 1006, 2:57–3:5.

5. Irwin (Ex. 1007)

Irwin includes excerpts from a textbook titled "Introduction to Electrical Engineering." Ex. 1007, 1–4. Regarding analog and digital signals, Irwin discloses that analog signals "vary continuously with time," whereas digital signals "switch between discrete levels." *Id.* at 12. Irwin notes that, therefore, electronic measurement systems often measured continuously varying parameters such as acceleration and rotation using analog signal inputs representing those parameters. *Id.* at 14. For these systems, Irwin discloses that "[t]he electronic signal generally originates from a sensor or transducer which provides an analog signal proportional to the parameter it's designed to measure." *Id.*

6. Merhav (Ex. 1008)

Merhav includes excerpts from a book titled "Aerospace Sensor Systems and Applications" and discloses, in pertinent part, the operation and properties of the ring laser gyro ("RLG"). Ex. 1008, 1, 19–23. In particular, Merhav discloses that the ring laser gyro included "a pair of colocated, closed path clockwise and counterclockwise light beams." *Id.* at 19. Interference between these two light beams "manifests itself as fringes resulting from the corresponding changes of the wavelengths and oscillating frequencies. These changes are proportional to the inertial angular rate." *Id.* Figure 8.2, below, shows an annular standing wave interpretation from a ring laser gyro. *Id.* at 22–23.

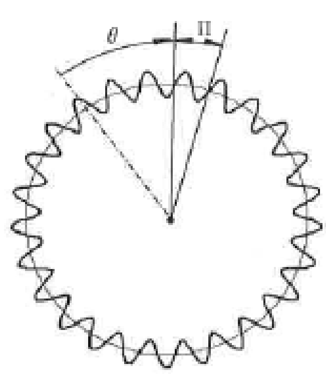

Figure 8.2 depicts "an inertially fixed ring on which a periodic light

intensity wave having the angular period Π is superimposed and that is sensed by the RLG which rotates at the angular rate Ω." Ex. 1008, 22–23. Merhav explains that "[a]s the intensity fringes cross a [photo]diode, a corresponding sinusoidal signal is generated." *Id.* at 23. Merhav further explains that "[d]igital pulse conditioning and logic convert the sinusoidal outputs into a train of pulses whose frequency is directly proportional to Ω and whose accumulated count represents the angle θ. . . . Thus, the RLG in conjunction with its output logic[] performs as a digital rate integrating gyro." *Id.*

E. Asserted Grounds of Unpatentability

1. Alleged Obviousness over Smith, Chan, and Bernstein: Claim 1

Petitioner contends that independent claim 1 of the '648 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Smith, Chan, and Bernstein. Pet. 9–37. Having considered the arguments and evidence before us, we determine Petitioner has shown by a preponderance of the evidence that claim 1 would have been obvious over the combined teachings of Smith, Chan, and Bernstein. We first address the claim limitations and Petitioner's arguments in the Petition. We then turn to the disputes raised by Patent Owner's arguments in its Response and Sur-reply and Petitioner's contentions in its Reply.

(a) Independent Claim 1

i. 1[pre]: "A micro inertial measurement unit, comprising"

As noted above, Petitioner contends the preamble is not limiting. Pet. 9–11. Alternatively, Petitioner argues that if the preamble is limiting, Smith teaches inertial sensor assembly 12 and P1 processor 14 that correspond to the recited "inertial measurement unit." *Id.* at 11–13. Petitioner further argues that Chan and Bernstein teach the recited "micro" limitation and, therefore, "confirm[] [the '648 patent's disclosures] that MEMS-based sensors for sensing acceleration and angular rotation were well-known." *Id.* at 13–16.

More specifically, Petitioner avers that Smith's inertial sensor assembly includes ring laser gyros and accelerometers that allow the assembly to "measure and output the changes in angular position and velocity along the X, Y, and Z axes"—in a manner similar to the '648 patent—of a carrier such as an aircraft. Pet. 11–13 (citing Ex. 1003, Fig. 1, 3:7–18, 5:60–65, 6:15–18; Ex. 1002 ¶¶ 90, 92; Ex. 1001, 1:18–19, 1:24–28). Petitioner further argues that the inertial sensor assembly outputs signals to the processor. *Id.* at 12 (citing Ex. 1003, 3:19–20). Additionally, Petitioner argues Smith teaches that its IMU "may be constructed in a small enclosure." *Id.* at 13–14 (citing Ex. 1003, 2:57–58).

Petitioner further argues Chan's description of known MEMS systems using a variety of types of microsensors, including those for sensing and measuring acceleration, "confirms that MEMS-based sensors were already well-known and had been used commercially, with applications including 'aircraft monitoring systems for aircraft' that require 'small, inexpensive, and reliable acceleration devices.'" Pet. 14 (citing Ex. 1005, 1:12–21, 1:33–44, 3:14–16). Petitioner similarly contends Bernstein teaches "a micromechanical gyroscope," well-known in the art, and that "[i]t would have been apparent and obvious that Bernstein discloses a 'micro,' e.g., MEMS-based gyroscope." *Id.* at 14–15 (emphases omitted) (citing

Ex. 1006, 1:11–13, 1:48–51; Ex. 1002 ¶ 97).

Relying on Dr. Young's testimony, Petitioner reasons that the skilled artisan would have combined the teachings of Smith, Chan, and Bernstein "to use micromechanical (MEMS-based) accelerometers and gyroscopes" in Smith's IMU, in order to achieve benefits such as reduced size, weight, power consumption, and cost. Pet. 15–18 (citing Ex. 1002 ¶¶ 98–102, 104). Petitioner also articulates benefits that would have been achieved in the aviation industry, specifically, and refers to additional prior art references to demonstrate that micromachined accelerometers and gyroscopes were known to have been used for aircraft. *Id.* at 17 (citing Ex. 1002 ¶ 102; Ex. 1013, 1:10–11, 1:36–39, 8:48–50; Ex. 1014, 1:15–36; Ex. 1001, 2:12–15). Moreover, as further support for the combination, Petitioner points to Smith's desire for a small and cheap inertial reference system. *Id.* at 16 (citing Ex. 1003, 2:56–59, 22:35–39; Ex. 1002 ¶¶ 101, 103).

Petitioner contends the '648 patent, Chan, and Bernstein all demonstrate that MEMS-based acceleration and angular rotation sensors were well-known, but Petitioner also acknowledges that some modifications to the manufacturing and electronics would have been necessary to achieve a micro-sized IMU.[13] Pet. 15–16, 18 (citing Ex. 1002 ¶ 99; Ex. 1001, 2:47–51). According to Petitioner, however, these modifications would have been straightforward and routine and used conventional techniques, such that the skilled artisan would have had a reasonable expectation of success without

[13] Petitioner's asserted ground does not rely upon applicant admitted prior art ("AAPA"). *See* Pet. 4. Consistent therewith, we interpret Petitioner's position to be that the disclosure of the '648 patent merely aids in demonstrating what the ordinarily skilled artisan would have understood and known at the time of the invention. *See id.* at 15–18.

undue experimentation. *Id.* at 15, 17–18 (citing Ex. 1002 ¶¶ 98–99, 104; Ex. 1001, 2:25–46). For example, Petitioner argues "MEMS accelerometers and gyroscopes serve the same purposes and provide the same types of velocity and angular position information as non-micromechanical counterparts," and Smith could have been modified by mounting MEMS-based gyroscopes and accelerometers "on a printed circuit board using conventional techniques." *Id.*

ii. 1[a]: "an angular rate producer comprising a X axis angular rate detecting unit which produces a X axis angular rate electrical signal, a Y axis angular rate detecting unit which produces a Y axis angular rate electrical signal, and a Z axis angular rate detecting unit which produces a Z axis angular rate electrical signal"

Regarding limitation 1[a], Petitioner contends Smith teaches ring laser gyros 42, 44, 46, each: (1) with its sensitive axis aligned with one of the X, Y, or Z axes; (2) detecting angular displacement along the X, Y, or Z axis, respectively; and (3) "produc[ing] an output digital signal having a pulse repetition rate proportional to the rate of angular displacement of each gyro 42, 44, and 46 about its coordinate axis." Pet. 18–20 (citing Ex. 1003, Fig. 2, 7:58–62, 8:3–6). Petitioner further argues, "Petitioner's mapping of this limitation to Smith is consistent with the specification of the '648 patent" because the '648 patent discloses that conventional inertial angular rate producers include ring laser gyros. *Id.* at 20 (citing Ex. 1001, 1:46–62; Ex. 1002 ¶ 108).

Additionally, Petitioner argues that to the extent "micro" in the preamble is limiting, it would have been obvious to replace Smith's laser ring gyros with micromechanical gyros for the reasons discussed with respect to obviousness of the preamble. Pet. 20 (citing Ex. 1002 ¶¶ 98–104, 109).

iii. 1[b]: "an acceleration producer comprising a X axis accelerometer which produces a X axis acceleration electrical signal, a Y axis accelerometer which produces a Y axis acceleration electrical signal, and a Z axis accelerometer which produces a Z axis acceleration electrical signal"

Petitioner asserts that Smith teaches limitation 1[b]. Pet. 21–22. For this limitation, Petitioner argues Smith teaches accelerometers 72, 74, 76, each of which detects acceleration along one of the X, Y, or Z axes and generates an analog output signal corresponding to the rate of change of velocity of the accelerometer along the X, Y, or Z axis, respectively. *Id.* (citing Ex. 1003, Fig. 2, 8:43–51).

Petitioner additionally contends that to the extent "micro" in the preamble is limiting, it would have been obvious to replace Smith's accelerometers with MEMS accelerometers for the reasons discussed with respect to obviousness of the preamble. Pet. 22 (citing Ex. 1002 ¶¶ 98–104, 113).

iv. 1[c]: "an angular increment and velocity increment producer, which is electrically connected with said X axis, Y axis and Z axis angular rate detecting units and said X axis, Y axis and Z axis accelerometers, receiving said X axis, Y axis and Z axis angular rate electrical signals and said X axis, Y axis and Z axis acceleration electrical signals from said angular rate producer and said acceleration producer respectively, wherein said X axis, Y axis and Z axis angular rate electrical signals and said X axis, Y axis and Z axis acceleration electrical signals are converted into digital angular increments and digital velocity increments respectively"

As for limitation 1[c], Petitioner argues that Smith's signal conditioning electronics 24, 32 and P1 processor 14 receive and process electrical signals from the laser ring gyros and accelerometers. Pet. 22–37. Specifically, Petitioner contends signal conditioning electronics 24 receives the signals from the gyros, and signal-conditioning circuit 108 produces, for each of the gyros, "a signal $+\Delta\theta$ having a pulse repetition rate proportional to [a] clockwise angular rotation rate of the laser gyro 10[0] . . . in its sensitive axis" and "[a] signal $-\Delta\theta$ having a pulse repetition rate proportional to [a] counterclockwise angular rotation rate of the laser gyro 100 in its sensitive axis." *Id.* at 24–25 (citing Ex. 1003, Figs. 1, 3, 6:9–11, 8:3–28, 9:7–9, 9:19–22, 9:25–33; Ex. 1002 ¶ 116).

Petitioner argues Smith's signals $+\Delta\theta$ and $-\Delta\theta$ from each of the gyros are output to the P1 processor, which includes counters that "count the number of pulses in the $+\Delta\theta$ and $-\Delta\theta$ signals that are received, over a predetermined time interval, and then store the accumulated counts." Pet. 25–29 (citing Ex. 1003, Figs. 5, 7, 8, 2:15–18, 3:46–54, 5:14–16, 6:35–38, 10:36–54, 14:7–16; Ex. 1002 ¶¶ 118, 121). According to Petitioner, these accumulated $\Delta\theta$ counts correspond to the claimed "digital angular increments" because they represent changes in angular position over a predetermined period of time and are stored in memory accessible to a CPU. *Id.* at 29–32 (citing Ex. 1018, 019–020; Ex. 1019, 026–027; Ex. 1020, 014–015; Ex. 1003, Fig. 7, 3:8–13, 6:35–38, 13:8–16 14:65–15: 13; Ex. 1002 ¶¶ 124–125).

Petitioner further asserts Smith discloses digitizers, which convert the three accelerometers' analog output signals to digital signals +ΔV and –ΔV, which represent changes in velocity. Pet. 32–34, 36 (citing Ex. 1003, Figs. 1–2, 4, 3:13–18, 6:24–26, 8:48–64, 10:5–17; Ex. 1002 ¶¶ 127, 135). Petitioner contends these signals +ΔV and –ΔV "hav[e] . . . pulse repetition rate[s] proportional to acceleration of the accelerometer . . . in a reference positive [or negative] direction along its sensitive axis." *Id.* at 33 (citing Ex. 1003, 10:10–15). Petitioner argues that Smith's P1 processor counts and accumulates the signals +ΔV and –ΔV over a period of time and stores the accumulated counts in hold registers accessible by the CPU, similar to its counting, accumulating, and storing for the signals $+\Delta\theta$ and $-\Delta\theta$ from each of the gyros. *Id.* at 34–37 (citing Ex. 1003, Figs. 7, 10, 3:13–18, 4:29–35, 5:14–16, 6:35–38, 10:36–38, 13:26–45, 14:53–59, 20:67–21:2; Ex. 1002 ¶¶ 129, 131–132, 136). Accordingly, Petitioner submits that the digital signals +ΔV and –ΔV "represent accumulated changes in velocity over a predetermined time interval expressed in digital form." *Id.* at 36.

Petitioner additionally contends that to the extent "micro" in the preamble is limiting, Smith's IMU "would have been adapted to receive and process signals from MEMS gyroscopes and accelerometers to produce the claimed digital angular and velocity increments." Pet. 37 (citing Ex. 1002 ¶ 138).

(b) Parties' Disputes

Patent Owner contends: (i) Smith, Chan, and Bernstein do not teach or suggest "[a] micro inertial measurement unit" using MEMS sensors as claimed, and an ordinarily skilled artisan would not have combined the teachings of Smith with those of Chan and Bernstein as Petitioner argues (PO Resp. 26–41; Sur-reply 8–14); (ii) Smith does not teach or suggest "angular rate electrical signals" as Patent Owner construes the term (PO Resp. 42–44; Sur-reply 18–19); and (iii) objective evidence demonstrates the claimed invention was non-obvious (PO Resp. 1–5, 33, 39; Sur-reply 14–18). We address Patent Owner's arguments below.

i. Whether an ordinarily skilled artisan would have combined the teachings of Smith, Chan, and Bernstein to achieve "[a] micro inertial measurement unit"

As an initial matter and as noted above, we agree with Patent Owner that the preamble is limiting. Patent Owner appears to acknowledge that Chan, Bernstein, and the '648 patent teach existing MEMS accelerometers and gyroscopes (*see, e.g.*, PO Resp. 29–30 (admitting that the '648 patent discloses commercially available MEMS angular rate sensors and accelerometers), 37 (acknowledging "MEMS sensors of Chan and Bernstein" (emphases omitted)), 40 (arguing against substituting Smith's laser ring gyroscopes with "a completely different (MEMS) gyroscope technology" of Bernstein)), but argues an ordinarily skilled artisan would not have combined the teachings of Smith, Chan, and Bernstein in the manner

Petitioner proposes (*id.* at 39–49).

Specifically, Patent Owner contends that "working with [the claimed] MEMS sensors was not straightforward, and required extensive experimentation and redesign." PO Resp. 30–31. Patent Owner points to various disclosures in the '648 patent that allegedly discuss the difficulty of implementing MEMS sensors in an IMU; Dr. Larson's testimony regarding the nascent field of MEMS inertial sensors and the need for complicated and non-trivial design and development beyond the capability of an ordinarily skilled artisan; Dr. Young's failure over a ten-year span to integrate MEMS sensors into navigation equipment; and inventor Hiram McCall's extensive work developing the claimed micro-IMU. *Id.* at 31, 33–36, 38–39; Sur-reply 10–13. Patent Owner further argues that implementing Chan and Bernstein's MEMS sensors into Smith's IMU—and, in particular, replacing Smith's laser ring gyros with Bernstein's MEMS gyroscopes—would not have been routine, given the challenge in building a MEMS sensor dither motion control loop. PO Resp. 38–39. Additionally, Patent Owner avers that Dr. Young's reply declaration relies on new evidence, namely the Minor (Ex. 1038) and Hulsing (Ex. 1047) references. Sur-reply 13–14 (citing Ex. 1045 ¶ 45).

Patent Owner contends that Petitioner does not cite to any of Smith, Chan, or Bernstein to support its conclusory rationale to combine, but instead relies upon a component merely being known, generalized advantages in prior art, impermissible hindsight, and the '648 patent's Specification as a roadmap. PO Resp. 29–30, 32–33, 40–41, 56–59; Sur-reply 9. Patent Owner further argues Petitioner presents attorney argument rather than evidence, and Dr. Young's testimony includes "arguments copied into his declaration" that are, moreover, "entirely too conclusory and unsupported." PO Resp. 35 (citation omitted); *see also id.* at 60–63.

Petitioner contends the Petition provides evidence, including properly-relied-upon admitted prior art in the '648 patent and comprehensive analysis by Dr. Young, that an ordinarily skilled artisan would have modified Smith to use MEMS accelerometers and gyroscopes to achieve certain benefits. Reply 6–8, 10. Petitioner argues Patent Owner "attempts to distance itself from the admissions in its own specification by citing other disclosures untethered to the claim limitations." *Id.* at 8.

With respect to Dr. Larson's adverse opinion that an ordinarily skilled artisan would not have so modified Smith, Petitioner further argues Dr. Larson's "experience rests in the unrelated field of RF MEMS"; he "never designed a MEMS device for inertial navigation applications"; and "he was unaware of relevant prior art," including Hulsing. *Id.* at 7 (citing Ex. 1046 (deposition of Dr. Larson), 23:25–24:18, 26:1–5, 34:14–35:3); Ex. 1047; Ex. 1045 ¶ 45). As for Dr. Young's alleged years-long failure to incorporate MEMS sensors into equipment, Petitioner avers that "Dr. Young testified that the duration of these projects depended on a variety of *other* factors," and the duration of a research project has no probative value regarding obviousness. *Id.* at 9. Moreover, according to Petitioner, an ordinarily skilled artisan under Patent Owner's level of skill would have had the requisite knowledge to implement the proposed combination. *Id.* at 9–10.

We credit Dr. Young's testimony as being supported by the teachings of Smith, Chan, Bernstein, and the '648 patent, as well as other contemporaneous references[14] demonstrating the known use of micromachined accelerometers and gyros for vehicles. *See, e.g.*, Ex. 1002 ¶¶ 98–105 (citing Ex. 1003, 2:56–69, 22:35–39; Ex. 1005, 1:33–38; Ex. 1013, 1:10–11, 1:36–39, 8:48–50; Ex. 1014, 1:15–36); Ex. 1045 ¶¶ 10–14, 19–24, 42–43. For example, Dr. Young testifies that MEMS devices were well-known to those of ordinary skill in the art, and that "Chan further confirms that MEMS-based accelerometers were already well-known and had been used commercially." Ex. 1002 ¶ 96; *see also* Ex. 1045 ¶¶ 10–11. Dr. Young similarly testifies that "Bernstein describes micromechanical gyroscopes for measuring angular position along a particular axis." Ex. 1002 ¶ 97; *see also* Ex. 1045 ¶¶ 10–11. Given that the evidence shows MEMS devices were well-known to those of ordinary skill in the art, Dr. Young testifies persuasively that

> [t]his combination would have been straightforward because the micromechanical accelerometers and gyroscopes are, after all, accelerometers and gyroscopes that serve the same purposes and provide the same types of velocity and angular position information as their non-micromechanical counterparts.

Ex. 1002 ¶ 99. In this regard, we note, also, that Dr. Young's Declaration includes supporting analysis and technical reasoning beyond what is presented in the Petition. *Compare* Ex. 1002 ¶¶ 98–105, *with* Pet. 15–18; *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 at 15 (PTAB Aug. 24, 2022) (precedential) (according little or no weight to declaration

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[14] Patent Owner argues Petitioner and Dr. Young rely on newly-cited references Minor and Hulsing. Sur-reply 13–14. We do not address whether these references are properly part of the record because our analysis does not rely on Minor, Hulsing, or any other evidence cited for the first time in Petitioner's Reply or Dr. Young's reply declaration.

testimony that contains a *verbatim* restatement of a petition's unsupported, conclusory arguments without additional supporting evidence or reasoning).

Patent Owner's references to Dr. Young's ten-year endeavor to incorporate MEMS sensors into inertial navigation equipment do not undermine Petitioner's persuasive showing that modifying Smith would have been routine and within the skill of an ordinary artisan. Rather, we agree with Petitioner's argument that the total duration of Dr. Young's project hinged on other factors. *See* Reply 9. Specifically, Dr. Young testifies that he lost funding for the project for about four to five years within that ten-year span. Ex. 2020, 34:24–35:11. He further testifies that his focus was on training graduate students, who sometimes worked on his projects on a part-time basis, and who also built their own MEMS sensors. *Id.* at 78:9–80:21. And although Patent Owner presumes that Dr. Young's graduate students would have met Petitioner's level of ordinary skill (Sur-reply 11), Patent Owner does not explain the basis for its presumption.

Moreover, rather than conflating obviousness with what was known at the time of the '648 patent, Petitioner, relying on Dr. Young's testimony, describes benefits that would have motivated an ordinarily skilled artisan to modify Smith—"reduced size, reduced weight, and reduced power consumption when compared to larger (non-micromechanical) components." Pet. 16; *see also* Reply 6–8, 10. To the extent there may be overlap between Petitioner and Dr. Young's articulated benefits and those described in the '648 patent, such as reduced size and weight, we do not ascribe this to impermissible hindsight because these benefits would logically flow from incorporating smaller components into Smith's inertial measurement unit. *See, e.g.*, Pet 16; Ex. 1002 ¶¶ 101, 103. Similarly, Petitioner points to portions of the ’648 patent in its arguments relating to reasons to modify Smith only to corroborate Dr. Young’s corresponding testimony as to why an ordinarily skilled artisan would have modified Smith. *See* Pet. 16–17 (explaining that Dr. Young’s specified “motivation is confirmed by the Background of the ’648 patent,” as well as Smith, Chan, Hulsing II (Ex. 1013), and Doty (Ex. 1014)), 17 (citing Dr. Young’s testimony that “[a] skilled artisan would thus have appreciated that the benefits of MEMS-based sensors would have applied to aircraft applications” and arguing, “[t]his is also consistent with the Background of the ’648 patent mentioned above”).

Notably, Patent Owner does not identify any knowledge Petitioner relies upon that was gleaned only from the ’648 patent’s disclosure, and which was not otherwise within the level of ordinary skill at the time of the invention. *See In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971) (“Any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning, but so long as it takes into account only knowledge which was within the level of ordinary skill at the time the claimed invention was made and does not include knowledge gleaned only from applicant’s disclosure, such a reconstruction is proper.”). Moreover, “‘universal’ motivations known in a particular field to improve technology provide ‘a motivation to combine prior art references *even absent any hint of suggestion* in the references themselves.’” *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380 (Fed. Cir. 2023) (quoting *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 784, 797–99 (Fed. Cir. 2021)).

As for Dr. Larson’s testimony, his testimony regarding the alleged difficulty of modifying an IMU to incorporate MEMS components largely cites as supporting evidence disclosures in the ’648 patent, self-serving allegations made in Patent Owner's complaint for infringement in the Washington litigation, and Mr. McCall's declaration. *See* Ex. 2008 ¶¶ 76–79; Ex. 2019 ¶¶ 76–84. We appreciate that Dr. Larson cites those documents as corroborating evidence for his understanding that such a modification would have been beyond the skill of an ordinary artisan, but we note that his testimony does not add substantively to what probative value those already provide.

For example, Dr. Larson does not describe any of his own experiences either relating to incorporating MEMS components in IMU devices, or otherwise as an ordinarily skilled artisan. *See* Ex. 2008 ¶¶ 76–79; Ex. 2019 ¶¶ 76–84. Dr. Larson testifies that "[his] own work with applications for similar RF MEMS devices involved many novel techniques and much experimentation, as seen in the patents and recognition [he] received," and "[t]he design challenges involved, as also . . . experienced by [himself] in [his] own work with control circuits for similar RF MEMS devices, would have been substantial for one of only ordinary skill, if possible for them at all." Ex. 2008 ¶¶ 78–79; Ex. 2019 ¶¶ 78–79. But Dr. Larson does not further explain how RF MEMS devices are "similar" to micro IMUs or explain how challenges relating to RF MEMS devices would have been germane to integrating MEMS components into inertial navigation devices. *See id.*

Additionally, Dr. Larson's testimony that the modifications would have been non-trivial, complex, and substantial, does not mean that such modifications would have been beyond the skill of an ordinary artisan. *See KSR*, 550 U.S. at 418 (stating that the obviousness analysis "can take account of the inferences and creative steps that a person of ordinary skill in the art would employ”); *see also id.* at 421 (“A person of ordinary skill is also a person of ordinary creativity, not an automaton.”). Likewise, even if the field of MEMS inertial sensors was nascent and lacking a broad or large library of knowledge, academic work, and literature, as Dr. Larson testifies, Dr. Larson does not further explain persuasively why having an established or vast field of knowledge would have been important to implement the modification without undue experimentation, especially in view of Dr. Young’s testimony that an ordinarily skilled artisan could have used conventional techniques to mount the MEMS sensors on a printed circuit board or routinely modified the manufacture and signal conditioning electronics of Smith’s IMU. *See* Ex. 1002 ¶¶ 98–99. Indeed, Chan, Hulsing II, and Doty all show that it was known at the time to use micromachined and MEMS components in inertial navigation systems. *See* Ex. 1005, 1:12–21, 1:33–44; Ex. 1013, 1:10–11, 1:36–49, 8:48–50; Ex. 1014, 1:15–36, *cited in* Pet. 14, 17.

We also find unavailing Patent Owner and Dr. Larson’s reliance on the Specification of the ’648 patent to demonstrate the difficulty of making Petitioner’s proffered combination. For example, Patent Owner argues the ’648 patent discloses that “a successful integration of MEMS angular rate sensors and MEMS accelerometers into a ‘small size’ IMU had not been accomplished, and such an IMU was ‘not yet available.’” PO Resp. 31 (citing Ex. 1001, 2:47–50). Patent Owner mischaracterizes the ’648 patent, which states that “[a]lthough the MEMS angular rate sensors and MEMS accelerometers are available commercially and have achieved micro chip-size and low power consumption, however, there is not yet available high performance, small size, and low power consumption IMUs.”

Ex. 1001, 2:47–51. Accordingly, the ’648 patent discloses that an IMU having *all three* of “high performance, small size, and low power consumption” was not yet “available *commercially*.” *Id.* (emphasis added). Similarly, Patent Owner contends the ’648 patent discloses that it would have been difficult to build a micro IMU using MEMS sensors. PO Resp. 31 (citing Ex. 1001, 6:6–43, 17:19–36). Again, Patent Owner mischaracterizes the disclosure of the ’648 patent, which refers to difficulties in building a “hallmark” micro IMU having 10 specific characteristics, as well as problems with existing MEMS angular rate producers (but unrelated to difficulty of building a micro IMU with those allegedly deficient MEMS sensors). *See* Ex. 1001, 6:6–43, 17:19–36.

We appreciate Mr. McCall’s efforts to build an improved and more accurate MEMS gyroscope and micro IMU using a dither control motion loop for digital signal processing and control. *See, e.g.*, Ex. 2023 ¶¶ 11 (“In the capacitive MEMS gyroscopes available at the time of the invention, there were significant unaddressed problems.”), 12 (“I was aware that existing MEMS gyroscope designs did not have sufficient stability and performance to meet what would have been the requirements of an IMU for an aircraft or missile system.”), 13 (“Very early in the invention and design process, I determined that accurate and reliable electronic control of the dither drive loop would require, and should utilize, digital signal processing. I was not aware of others having used DSP elements in this application.”), 20 (“My circuit designs that led to the ’122 and ’648 Patents, including the digital signal processing elements of those designs, were successfully implemented in American GNC’s coremicro IMU product.”). We also acknowledge that the ’648 patent provides extensive details of a micro IMU including dither motion control circuitry and "a feedforward open-loop signal processing scheme to obtain highly accurate motion measurements." *See, e.g.*, Ex. 1001, 3:5–13, 17:29–23:44. And we further recognize Dr. Larson's testimony regarding the difficulty of placing Mr. McCall's digital signal processing system in a MEMS sensor's control loop. *See* Ex. 2019 ¶¶ 81–84.

However, Patent Owner's arguments, Mr. McCall's testimony, Dr. Larson's testimony, and the disclosures in the '648 patent regarding the dither motion control loop and other complicated signal processing circuity are not commensurate with the scope of the claims. In particular, during oral argument, Patent Owner's counsel acknowledged that these features constituted alleged improvements to a MEMS gyroscope and were not recited in the challenged claims. Tr. 32:4–33:18. We also do not import limitations from the Specification into the claims. *See SuperGuide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 875 (Fed. Cir. 2004) ("Though understanding the claim language may be aided by the explanations contained in the written description, it is important not to import into a claim limitations that are not a part of the claim.").

Furthermore, we are not apprised of how these alleged improvements to the gyroscope itself have any bearing on the difficulty of modifying an IMU to use MEMS accelerometers and gyroscopes. Although Mr. McCall testifies that "[c]hanging one sensor technology for another is not less work than designing from scratch with a MEMS sensor" (Ex. 2023 ¶25), we do not discern from the record that designing or building a MEMS sensor would have been beyond the level of skill of an ordinary artisan. *See, e.g.*, Ex. 2020, 79:3–10 (Dr. Young testifying that his research students built their own MEMS sensors).

Accordingly, on this record, we are persuaded that Petitioner sufficiently articulates a reason with rational underpinning as to why the ordinarily skilled artisan would have combined the teachings of Smith, Chan, and Bernstein. *See* Pet. 15–18.

ii. Whether Smith teaches the claimed "angular rate electrical signals"

Relying on its claim construction position that the term "angular rate electrical signals" requires signals that directly detect and measure angular rate, Patent Owner contends Smith does not teach this feature. PO Resp. 42–44; Sur-reply 19. According to Patent Owner, laser ring gyros, as taught by Smith, output a wave signal whose frequency, rather than signal level, is angular rate. PO Resp. 43–44. In contrast, "[v]ibrating inertial mass gyroscopes output an electrical signal that is a measure of force directly proportional to the angular rate." *Id.* at 42 (citing Ex. 1001, 16:54–59). Patent Owner contends that the claimed electrical signals "must be proportional to angular rate in a Coriolis force sensor, as a person of ordinary skill would understand." *Id.* at 32 (citing Ex. 1001, 23:44–24:3, 8:11–16, 8:34–54). Therefore, Patent Owner argues, the electrical signal outputs of Smith's laser ring gyros cannot correspond to the claimed "angular rate electrical signals." *Id.* at 44.

Petitioner contends Smith's laser ring gyros' output signals "directly measure and reflect angular rate because the rate of the pulses varies based on the angular rate." Reply 4. Specifically, Petitioner argues, "the Petition mapped the pulse repetition signals output by laser gyros 42, 44, and 46 [of

Smith] as the claimed angular rate electrical signals." *Id.* at 4–5 (emphases omitted). Nevertheless, Petitioner further argues "[t]he Petition relied on Smith in combination with Bernstein, which further described MEMS-based gyroscopes that generate electrical signals proportional to the angular rate," and which meet the limitation according to Patent Owner's proffered construction. *Id.* at 5 (citing Pet. 39; Ex. 1006, 2:57–59, 3:3–5; Ex. 1045 ¶¶ 52–54).

In its Sur-reply, Patent Owner argues that Petitioner's Reply improperly raises a new theory with respect to the combination of references teaching the disputed limitation, rather than Smith alone teaching the limitation as originally set forth in the Petition. Sur-reply 18–19.

We disagree with Patent Owner's argument that the Petition relies solely on Smith for the claimed "angular rate electrical signals." In particular, in addressing limitations 1[a] and 1[c], which refer to the angular rate electrical signals, the Petition asserts, "it would also have been obvious for the ring laser gyros in Smith to have been replaced with micromechanical gyroscopes," and "under the proposed combination, . . . the IMU in Smith would have been adapted to receive and process signals from MEMS gyroscopes and accelerometers," for the reasons discussed with respect to the preamble. Pet. 20, 37. In this regard, we understand Bernstein to teach, and the '648 patent to acknowledge as prior art, the same type of MEMS gyroscope that Patent Owner attempts to distinguish from the laser ring gyroscope of Smith, and which Patent Owner argues produces signals encompassed by its proposed claim construction. *See* PO Resp. 42–44 (arguing that Smith does not teach the claimed "angular rate electrical signals" because Smith's "laser ring gyros are very different from, and work differently from, the vibrating inertial mass MEMS gyroscopes discussed in the ’648 Patent,” which produce angular rate signals proportional to angular rate in a Coriolis force sensor), 40 (arguing, “Bernstein’s gyros are made from a vibrating inertial mass” (emphasis omitted)); *see also* Ex. 1001, 16:46–49 (“Existing MEMS technologies[]. . . use vibrating inertial elements (a micromachine) to sense vehicle angular rate via the Coriolis Effect.”).

Nevertheless, as discussed in our claim construction analysis above, we construe “angular rate electrical signals” to mean electrical signals that reflect a measurement of angular rate. Our claim construction for the limitation encompasses Smith’s output signals. Smith explains, “[e]ach ring laser gyro 42, 44, and 46 produces an output digital signal having a pulse repetition rate proportional to the rate of angular displacement of each gyro 42, 44, and 46 about its coordinate axis.” Ex. 1003, 8:3–6. Therefore, Smith’s output signals reflect a measurement of angular rate because their pulse repetition rate or frequency is proportional to the angular rate of displacement. *Id.* To the extent Patent Owner argues that claim 1 requires vibrating inertial mass MEMS gyroscopes or a sensor that uses Coriolis force, we do not read limitations from the Specification into the claims. *See In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993).

iii. Objective indicia of nonobviousness

Patent Owner argues that objective evidence, including recognition, citation, use, and licensing of the ’648 patent, failure by others, and commercial success, supports a finding of nonobviousness. PO Resp. 1–4, 33, 39. In its Sur-reply, Patent Owner additionally contends its “coremicro IMU product” embodied and was coextensive with the claims of the

’648 patent. Sur-reply 14–18.

Petitioner contends that Patent Owner fails to show the requisite nexus and fails to provide any objective evidence of secondary considerations. Reply 16–17.

For the reasons below, we determine that: a) Patent Owner does not show nexus between its alleged objective indicia of nonobviousness and the claims; and b) what “evidence” of nonobviousness Patent Owner submits has little probative value.

Objective evidence of nonobviousness, when present, must be considered as part of an obviousness inquiry. *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Drilling USA, Inc.*, 699 F.3d 1340, 1349 (Fed. Cir. 2012). “Such evidence includes the commercial success of the patented invention, whether the invention addresses ‘long felt but unsolved needs,’ and the failure of others to produce alternatives to the patented invention.” *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir. 1995) (citing *Graham*, 383 U.S. at 17–18). Notwithstanding what the teachings of the prior art would have suggested to one of ordinary skill in the art, the totality of the evidence submitted, including objective evidence of nonobviousness, may lead to a conclusion that one or more of the challenged claims would not have been obvious to one of ordinary skill in the art. *In re Piasecki*, 745 F.2d 1468, 1471–72 (Fed. Cir. 1984).

“In order to accord substantial weight to secondary considerations in an obviousness analysis, ‘the evidence of secondary considerations must have a “nexus” to the claims, *i.e.*, there must be “a legally and factually sufficient connection” between the evidence and the patented invention.’” *Fox Factory, Inc. v. SRAM, LLC*, 944 F.3d 1366, 1373 (Fed. Cir. 2019), *cert.*

denied, 141 S. Ct. 373 (2020) (quoting *Henny Penny Corp. v. Frymaster LLC*, 938 F.3d 1324, 1332 (Fed. Cir. 2019). A patentee is entitled to a presumption of nexus if "the patentee shows that the asserted objective evidence is tied to a specific product and that the product 'embodies the claimed features, and is coextensive with them.'" *Id.* (citing *Polaris Indus., Inc. v. Arctic Cat, Inc.*, 882 F.3d 1056, 1072 (Fed. Cir. 2018). "A patent claim is not coextensive with a product that includes a 'critical' unclaimed feature that is claimed by a different patent and that materially impacts the product's functionality." *Id.* at 1375.

However, "[a] finding that a presumption of nexus is inappropriate does not end the inquiry into secondary considerations." *Fox Factory*, 944 F.3d at 1375. The patent owner may still establish nexus "by showing that the evidence of secondary considerations is the 'direct result of the unique characteristics of the claimed invention.'" *Id.* at 1373–1374 (quoting *In re Huang*, 100 F.3d 135, 140 (Fed. Cir. 1996). "'Where the offered secondary consideration actually results from something other than what is both claimed and *novel* in the claim, there is no nexus to the merits of the claimed invention,' meaning that 'there must be a nexus to some aspect of the claim not already in the prior art.'" *Lectrosonics, Inc. v. Zaxcom, Inc.*, IPR2018-01129, Paper 33 at 33 (PTAB Jan. 24, 2020) (precedential) (quoting *In re Kao*, 639 F.3d 1057, 1068–1069 (Fed. Cir. 2011). But the objective evidence need not be tied exclusively to the new feature, and a patent owner may show that "the claimed combination as a whole . . . serves as a nexus for the objective evidence." *Id.* (citing *WBIP, LLC v. Kohler Co.*, 829 F.3d 1317, 1331 (Fed. Cir. 2016)). "Ultimately, the fact finder must weigh the secondary considerations evidence presented in the context of whether the claimed invention as a whole would have been obvious to a skilled artisan.” *Id.* (citing *WBIP*, 829 F.3d at 1331–1332).

a) Nexus

Patent Owner improperly raises nexus for the first time in its Sur-reply, and again during oral argument. *See generally* PO Resp.; Sur-reply 15–17; Tr. 28:16–34:3; *see also* 37 C.F.R. § 42.23. As such, Patent Owner forfeited the argument. Nevertheless, we determine that Patent Owner’s arguments fail to show the requisite nexus between the alleged objective evidence and the claimed invention for the following reasons.

Here, Patent Owner asserts only that the objective evidence is tied to its “coremicro” IMU product, which “embodies the claimed features, and is coextensive with them”; Patent Owner does not address the other path to demonstrate nexus, namely, showing that the evidence is the “direct result of the unique characteristics of the claimed invention.” *See Fox Factory*, 944 F.3d at 1373–1374 (citations omitted); *see also* Sur-reply 14–18. Specifically, Patent Owner submits that the ’648 patent describes the coremicro IMU product, and Patent Owner provides a table comparing claim 1’s recitations to certain disclosures in the Specification of the ’648 patent. Sur-reply 15–16. But Patent Owner’s arguments conflate written description with nexus, which requires a showing with respect to the actual coremicro IMU product, rather than the written description of the ’648 patent.

As further support for its nexus argument, Patent Owner points to Mr. McCall’s testimony regarding the development of the coremicro IMU and his weekly progress reports (Ex. 2024) noting his concurrent review of a “MEMS provisional patent” and development of “MEMS Micro IMU.” *See*

Ex. 2023 ¶¶ 15–20; Ex. 2024 at 16, *cited in* Sur-reply 15. Patent Owner specifically highlights Mr. McCall's statement, "[m]y circuit designs that led to the '122 and '648 Patents, including the digital signal processing elements of those designs, were successfully implemented in American GNC's coremicro IMU product." Ex. 2023 ¶ 20. That Mr. McCall concurrently worked on an unspecified provisional patent application and the coremicro IMU, however, does not mean that the coremicro IMU embodies the claims of the '648 patent and is coextensive with them. Furthermore, as we note above, the claims of the '648 patent do not recite any particular circuit design, much less the digital signal processing that Mr. McCall refers to in his declaration, i.e., "dither sensing and drive circuitry" or "driver and phase locked loop (PLL) circuit." *See id.* at ¶ 16.

Importantly, Mr. McCall's declaration emphasizes his belief in the critical nature of the dither drive motion loop and its digital signal processing. *See* Ex. 2023 ¶¶ 10, 13–14, 16–18; PO Resp. 39 (noting "the precise, complicated feedback loop American GNC invented and patented," characterizing Mr. McCall's declaration as "describing critical design of dither motion control loop"); *see also Fox Factory*, 944 F.3d at 1375 ("In light of the patentee's own assertions about the significance of the unclaimed features, no reasonable fact finder could conclude that these features are insignificant."). However, "[a] patent claim is not coextensive with a product that includes a 'critical' unclaimed feature that is claimed by a different patent and that materially impacts the product's functionality." *Fox Factory*, 944 F.3d at 1375. In this regard, we note that Patent Owner asserts that claims 1 and 4 of the '648 patent and claims 1 and 3 of U.S. Patent No. 6,508,122 in IPR2024-00677 are all embodied in the coremicro IMU.

See Sur-reply 15–17; IPR2024-0067, Paper 37 (Patent Owner Sur-reply) at 8–11, 20–22; *see also Therasense, Inc. v. Becton, Dickinson and Co.*, 593 F.3d 1289, 1299 (Fed. Cir. 2010), *vacated on other grounds*, 374 F. App'x 35 (Fed. Cir. 2010) (determining there is no presumption of nexus where a product's success could be attributable to more than one patent embodied by the product).

b) Patent Owner's evidence

Even if we assume Patent Owner has satisfied the requisite showing of nexus, however, we would determine that the objective evidence of nonobviousness does not outweigh the evidence supporting obviousness because the "evidence" Patent Owner submits to support its contentions regarding recognition, citation, use, and license of the '648 patent, failure by others, and commercial success, is very weak.

Patent Owner supports its arguments with purported evidence in the form of Mr. McCall's declaration, Mr. McCall's notebook and weekly progress reports, Mr. McCall's deposition (Ex. 1048), Dr. Larson's response declaration, Dr. Larson's deposition (Ex. 1046), and the complaint filed in the Washington litigation (Ex. 2007). With respect to alleged commercial success (*see* PO Resp. 2–4; Sur-reply 16–17), Patent Owner relies on Mr. McCall's testimony that "[he] underst[ood] that [the coremicro IMU] product was commercially successful for American GNC" (Ex. 2023 ¶ 20) and Dr. Larson's testimony that "[he] . . . underst[ood] from reviewing American GNC's Complaint against Nintendo . . . that American GNC was successful at developing and commercializing a MEMS Inertial Measurement Unit based on the techniques claimed and patented in the '648 Patent" (Ex. 2019 ¶ 55). *See* PO Resp. 2–4; Sur-reply 16–17; Tr. 35

(Patent Owner's counsel arguing that the evidence of commercial success is Mr. McCall's testimony). Mr. McCall's testimony is entitled to little weight because he does not explain the basis for his belief, for example whether he reviewed any sales data or what "commercially successful" meant to him. Likewise, Dr. Larson's testimony is entitled to little weight because the assertions made in Patent Owner's complaint amount to self-serving allegations that are not themselves "evidence." Accordingly, Patent Owner's evidence of commercial success is very weak.

As for alleged failure by others (*see* PO Resp. 2–3; Sur-reply 16–17), Patent Owner refers to Mr. McCall's testimony that, to his knowledge, no other companies had "achieved success at designing and implementing a navigation-grade device prior to American GNC's patents and prototypes." Ex. 2023 ¶ 21; *see also id.* ¶ 8. Specifically, Mr. McCall testifies that NASA Jet Propulsion Laboratories had "attempted to develop a navigation-grade silicon MEMS device, but I understand that it was not robust enough to survive the required environmental testing"; that "[s]imilarly, Draper Labs had funding from DARPA to develop such a sensor, but I understand that it did not achieve navigation-grade performance"; and that Analog Devices had been working on silicon MEMS technology. *Id.* ¶¶ 22–23. Patent Owner also points to Dr. Larson's statement during his deposition that he knew Draper Labs was working on inertial navigation products using MEMS technology, but that he was not aware of any such commercially available products. Ex. 1046, 27:3–15.

However, these statements by Mr. McCall and Dr. Larson establish only that Patent Owner, in its own words, "beat[] MIT Draper Labs and NASA JPL to technical success" (Sur-reply 16–17) and may have been the first to commercialize its product. Moreover, the challenged claims do not require that the micro IMU be "navigation-grade." In particular, the testimony has little probative value as to whether Draper Labs, NASA JPL, and Analog Devices tried and failed to develop *the claimed invention*. *See Advanced Display Sys., Inc. v. Kent State Univ.*, 212 F.3d 1272, 1285 (Fed. Cir. 2000). Accordingly, Patent Owner's evidence of failure by others is very weak.

Regarding alleged licensing (*see* PO Resp. 4, 39; Sur-reply 17), Patent Owner avers that "[t]he '648 Patent . . . has been successfully licensed to numerous companies and industry associations," and "many companies . . . licensed that patented solution." PO Resp. 4, 39. In its Sur-reply, Patent Owner cites to a portion of Mr. McCall's deposition testimony discussing an American GNC Corporation webpage (Ex. 1039) that indicates, "[f]rom 2015 to the present [Mr. McCall] has supported the successful licensing of AGNC patents (including but not limited to those patents with him as the inventor) in the areas of silicon MEMS inertial rate sensors and critical interfacing circuits." Ex. 1048, 37:18–23. Patent Owner's arguments in its Response are unaccompanied by any citations to evidence and, therefore, constitute mere attorney argument. Moreover, the record does not include any license agreements for the '648 patent, and Mr. McCall does not testify whether any of the licensing he was involved in related to the '648 patent. *See id.* at 37:18–39:13; *see also GPAC*, 57 F.3d at 1580 (agreeing with the Board that licensing evidence should be accorded little weight where there was not nexus established between the merits of the invention and affidavits showing the licensing history of the challenged patent because GPAC "did not establish which claim(s) of the patent the licensing program incorporates," and, therefore, "has not shown that licensing of [the] invention arose out of recognition and acceptance of the subject matter claimed in the [challenged] patent"). Accordingly, Patent Owner's evidence of licensing is very weak.

As for alleged citation, use, and recognition, i.e., industry acceptance or praise (*see* PO Resp. 3, 33, 39), Patent Owner argues "the '648 Patent has been cited by Examiners and inventors over seventy times—across the industry" (*id.* at 3). Additionally, Mr. McCall testifies regarding "the recognition by the U.S. Patent Office and industry, that I understand American GNC has received for the inventions," as well as that several of Patent Owner's customers received updates during development of the coremicro IMU product. Ex. 2023 ¶¶ 3, 19. Citations of a patent during prosecution and product-development updates provided to other companies, however, cannot be said to be "praise" from industry participants. Accordingly, Patent Owner's evidence of industry praise is very weak.

Finally, to the extent Patent Owner alleges copying of the claimed invention by others (*see* PO Resp. 4, 39), Patent Owner contends Petitioner used the invention claimed in the '648 patent "without royalty or license," and that Patent Owner "demonstrat[ed] evidence of infringement" by Petitioner in its complaint filed in the Washington litigation (*id.* at 4 (citing Ex. 2007 ¶¶ 84–102)). But "[n]ot every competing product that arguably falls within the scope of a patent is evidence of copying; otherwise, 'every infringement suit would automatically confirm the nonobviousness of the patent.'" *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1246 (Fed. Cir. 2010) (quoting *Iron Grip Barbell Co. v. USA Sports, Inc.*, 392 F.3d 1317, 1325 (Fed. Cir. 2004)). We note, also, the lack of evidence in the record regarding any judgment rendered in the Washington litigation. Moreover, the record is devoid of any evidence, such as "internal documents, direct evidence such as photos of patented features or disassembly of products, or access and similarity to a patented product," that would show Petitioner endeavored to replicate the coremicro IMU. *See Liqwd, Inc. v. L'Oreal USA, Inc.*, 941 F.3d 1133, 1137 (Fed. Cir. 2019) (citing *Iron Grip Barbell Co.*, 392 F.3d at 1325)). Accordingly, Patent Owner's evidence of copying is very weak.

iv. Overall Weighing of Relevant Factors Concerning Obviousness, Including Secondary Considerations

We now weigh Patent Owner's objective evidence of nonobviousness with the other factors relevant to obviousness of claim 1. We find, for the reasons set forth above, that Smith, Chan, and Bernstein teach or suggest all of the limitations of claim 1. We further determine that Petitioner has identified sufficient evidence in the cited prior art to show that an ordinarily skilled artisan would have made the modifications Petitioner proposes for reasons known in the art at the time of the invention.

Against these determinations, we weigh Patent Owner's objective evidence of nonobviousness. Because we are not persuaded for the reasons discussed above that there is a nexus between the merits of the claimed invention and the submitted evidence relating to commercial success, failure of others, licensing, industry praise, and copying, we determine that Patent Owner's evidence does not weigh in favor of nonobviousness. Even if we had determined that Patent Owner had established the requisite nexus, however, we determine that Patent Owner submits very weak evidence of commercial success, very weak evidence of failure of others, very weak evidence of licensing, very weak evidence of industry praise, and very weak evidence of copying.

Overall, upon weighing the *Graham* factors, we determine that a lack of nexus and very weak evidence of each of commercial success, failure of others, licensing, industry praise, and copying does not outweigh our determination that Smith, Chan, and Bernstein teach or suggest every limitation in claim 1.

(c) Conclusion

In light of the foregoing, we determine that Petitioner has shown by a preponderance of the evidence that claim 1 would have been unpatentable over Smith, Chan, and Bernstein.

2. Alleged Obviousness Over Smith, Chan, Bernstein, Irwin, and Merhav: Claim 4

Petitioner contends that dependent claim 4 of the '648 patent is unpatentable under 35 U.S.C. § 103(a) as obvious over Smith, Chan, Bernstein, Irwin, and Merhav. Pet. 37–43. Petitioner relies on Irwin to teach that sensors may measure parameters such as acceleration and rotation and "provide[] an analog signal proportional to the parameter" (*see* Ex. 1007, 13–14, *cited in* Pet. 38), thereby "confirm[ing] that it would have been obvious for an acceleration or rotation sensor to have provided an analog voltage signal proportional to the measured acceleration or rotation" (Pet. 38). Supported by Dr. Young's testimony and teachings in other portions of the Irwin textbook, Petitioner further argues that "it was well-known that the amplitude of an analog signal is typically measured in volts." *Id.* at 38 (citing Ex. 1002 ¶ 140; Ex. 1007, 14–15; Ex. 1022, 12–13).

Thus, Petitioner contends, it would have been obvious for Smith's electrical signals produced by the angular producer and the acceleration producer to have included analog voltage signals directly proportional to the angular rotation and acceleration, respectively, of the aircraft carrying the gyros and accelerometers. Pet. 38–39 (citing Ex. 1002 ¶¶ 141, 149–150), 42–43 (citing Ex. 1002 ¶¶ 147–148); *see also id.* at 43 (arguing Smith discloses its IMU "is mounted to the aircraft with which it is used"). According to Petitioner, this conclusion is consistent with Smith, which teaches that its accelerometers produce analog signals that "are directly used to generate" digital +ΔV and –ΔV signals each having a pulse repetition rate proportional to acceleration of a respective accelerometer. *Id.* at 39–40. Therefore, it would have been obvious that Smith's analog signals would have been proportional to measured acceleration. *Id.* (citing Ex. 1002 ¶ 142). Petitioner further argues that "Chan and Bernstein further confirm that the claimed proportionality also applies to MEMS-based sensors." *Id.* at 39 (citing Ex. 1005, 1:40–43; Ex. 1006, 2:57–59, 3:3–5).

Similar to Smith's accelerometer output signals, Petitioner argues Smith's laser ring gyros output signals $+\Delta\theta_x$, $+\Delta\theta_y$, $+\Delta\theta_z$ and $-\Delta\theta_x$, $-\Delta\theta_y$, $-\Delta\theta_z$ each having a pulse repetition rate proportional to angular displacement of a respective laser ring gyro. Pet. 40. Although Petitioner acknowledges "Smith suggests that the signals output by the ring laser gyroscopes are digital," Petitioner turns to Merhav to teach that a ring laser gyro would have generated an analog signal proportional to detected angular rates before generating pulse signals. *See* Ex. 1008, 19, 23, *cited in* Pet. 40–41. In particular, Merhav teaches that laser ring gyros would have generated a sinusoidal signal that would have been converted by "[d]igital pulse conditioning and logic . . . into a train of pulses whose frequency is directly proportional to Ω and whose accumulated count represents the angle θ.” Ex. 1008, 23. Supported by Dr. Young’s testimony and teachings in Smith, Petitioner argues, “[a] skilled artisan would have understood that the sinusoidal signal generated by the ring laser circuitry constitutes an analog signal.” Pet. 41 (citing Ex. 1002 ¶ 145). Petitioner further argues, supported by Dr. Young’s testimony and teachings in the Irwin textbook and Tingleff, that selecting a gyroscope that outputs a digital signal or an analog signal would have been routine for an ordinarily skilled artisan. *Id.* at 42 (citing Ex. 1002 ¶ 146).

Furthermore, as discussed above, we construe “angular rate voltage signals” to mean voltage signals that reflect a measurement of angular rate. Because, for the reasons provided above, Petitioner has established that Smith, Chan, Bernstein, Irwin, and Merhav would have taught or suggested electrical signals measured in volts, i.e., voltage signals, that reflect a measurement of angular rate, we determine that Petitioner has shown sufficiently that they teach or suggest the claimed “angular rate voltage signals.”

Beyond its claim construction arguments relating to claim 4’s “angular rate voltage signals” limitation, Patent Owner contends only that Smith does not teach the claimed “angular rate voltage signals.” *See* PO Resp. 42–44. Patent Owner’s argument, however, relies on the same reasoning with respect to Smith’s teachings and claim 1’s “angular rate electrical signals.” *See id.* We have discussed above why we are unpersuaded by Patent Owner’s arguments with respect to claim 1, and we are, likewise, unpersuaded by Patent Owner’s arguments with respect to claim 4 for those same reasons. *See* § E.1.(b).ii., *supra*; *see also* Pet. 39 ("Chan and Bernstein further confirm that the claimed proportionality also applies to MEMS-based sensors.").

In light of the foregoing, we determine that Petitioner has shown by a preponderance of the evidence that claim 4 would have been unpatentable over Smith, Chan, Bernstein, Irwin, and Merhav.

3. *Alleged Obviousness Over Tingleff, Chan, and Bernstein: Claims 1 and 4*

Petitioner argues that claims 1 and 4 of the '648 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Tingleff, Chan, and Bernstein. Pet. 43–56.

Having considered the arguments and evidence before us, we determine that Petitioner has shown by a preponderance of the evidence that claims 1 and 4 would have been obvious over the combined teachings of Tingleff, Chan, and Bernstein. For each claim, we first address the claim limitations and Petitioner's arguments in the Petition directed thereto. We then turn to the disputes raised by Patent Owner's arguments in its Response and Sur-reply and Petitioner's contentions in its Reply.

(a) Independent Claim 1

i. 1[pre]: "A micro inertial measurement unit, comprising"

As noted above, Petitioner contends the preamble is not limiting. Pet. 9–11, 43–44. Alternatively, Petitioner argues that if the preamble is limiting, Tingleff teaches inertial guidance unit 11, corresponding to the recited "inertial measurement unit," that contains gyros 22 and accelerometers 23 that measure angular rates and acceleration about the X, Y, and Z coordinates for an aircraft. *Id.* at 44–45 (citing Ex. 1004, Fig. 1, 6:67–7:2, 4:24–26; Ex. 1002 ¶ 155).

For this ground, Petitioner explains that, "for substantially the same reasons fully explained for [alleged obviousness of claim 1 over Smith, Chan, and Bernstein], it would have been obvious based on Tingleff in light of Chan and Bernstein to use a 'micro' inertial measurement unit." Pet. 45 (citing Ex. 1002 ¶¶ 93–105, 156–157). In particular, Petitioner argues Tingleff's aircraft "simulation system is 'relatively small and self-contained,'" and the skilled artisan would have sought to use components: (1) "that are as small as possible" for the benefits of "reduced size, reduced weight, reduced power consumption, and reduced cost"; and (2) known for aircraft applications. *Id.* at 45–46 (citing Ex. 1004, 3:11–13; Ex. 1002 ¶¶ 101–102, 156).

ii. 1[a]: "an angular rate producer comprising a X axis angular rate detecting unit which produces a X axis angular rate electrical signal, a Y axis angular rate detecting unit which produces a Y axis angular rate electrical signal, and a Z axis angular rate detecting unit which produces a Z axis angular rate electrical signal"

Regarding limitation 1[a], Petitioner contends Tingleff's gyros 22 are three sets of gyros that measure or sense angular rates about the X, Y, and Z coordinates, respectively. Pet. 46–47 (citing Ex. 1004, Fig. 1). These gyros output analog error signals to gyro loop electronics 24, which use the signals to attempt to hold the gyro gimbal nulled, and which also output the signals to gyro integrators 26 that convert the signals to digital pulse trains. *Id.* at 47 (citing Ex. 1004, 7:2–11). In this manner, the signals "are also used as the analog rate signals within [inertial guidance] unit 11." Ex. 1004, 7:3–8.

Supported by Dr. Young's testimony, Petitioner avers that an ordinarily skilled artisan would have understood that Tingleff's angular rate error signals are "signal[s] output due to angular rotation," and which "represent[] the difference between the current position of a gyro gimbal and its original (null) position." Pet. 48 (citing Ex. 1002 ¶ 159).

Petitioner further argues that "to the extent the word 'micro' in the preamble is limiting, . . . it would have been obvious for the gyros in Tingleff to have been replaced with micromechanical gyroscopes which were well-known, each of which would have produced an angular rate electrical signal," for the same reasons discussed with respect to obviousness of claim 1 over Smith, Chan, and Bernstein. Pet. 48 (emphasis omitted).

iii. 1[b]: "an acceleration producer comprising a X axis accelerometer which produces a X axis acceleration electrical signal, a Y axis accelerometer which produces a Y axis acceleration electrical signal, and a Z axis accelerometer which produces a Z axis acceleration electrical signal"

With respect to limitation 1[b], Petitioner argues Tingleff's accelerometers 23 include three sets of accelerometers that measure or sense acceleration about the X, Y, and Z coordinates, respectively. Pet. 49–50 (citing Ex. 1004, Fig. 1, 6:67–7:2). Like Tingleff's gyros, the accelerometers output analog error signals to the gyro loop electronics, which attempt to hold the accelerometer pendulum nulled. *Id.* at 50 (citing Ex. 1004, 7:2–7). The signals "are also used as the analog rate signals within [inertial guidance] unit 11," and accelerometer integrator 25 converts the acceleration analog signals to digital pulse trains. *Id.* (citing Ex. 1004, 7:3–11). Supported by Dr. Young's testimony, Petitioner contends an ordinarily skilled artisan would have understood Tingleff's "'error signal' . . . result[s] from an acceleration that causes a displacement in the accelerometer pendulum, which is processed by the gyro loop electronics 24 to hold the pendulum to its original (null) position," and "each accelerometer produces an analog electrical signal indicating X, Y, and Z-axis acceleration, respectively." *Id.* at 50–51 (citing Ex. 1002 ¶¶ 163, 158–159).

Petitioner further argues that "to the extent the word 'micro' in the preamble is limiting, . . . it would also have been obvious for the accelerometers in Tingleff to have been replaced with micromechanical accelerometers which were well-known, each of which would have produced an acceleration electrical signal," for the same reasons discussed with respect to obviousness of claim 1 over Smith, Chan, and Bernstein. Pet. 51 (emphasis omitted).

iv. 1[c]: "an angular increment and velocity increment producer, which is electrically connected with said X axis, Y axis and Z axis angular rate detecting units and said X axis, Y axis and Z axis accelerometers, receiving said X axis, Y axis and Z axis angular rate electrical signals and said X axis, Y axis and Z axis acceleration electrical signals from said angular rate producer and said acceleration producer respectively, wherein said X axis, Y axis and Z axis angular rate electrical signals and said X axis, Y axis and Z axis acceleration electrical signals are converted into digital angular increments and digital velocity increments respectively"

As for limitation 1[c], Petitioner argues Tingleff teaches the claimed "angular increment and velocity increment producer" in the form of accelerometer integrators 25, gyro integrators 26, and comparator logic 27, which are electrically connected to the gyros, accelerometers, and gyro loop electronics and receive the analog signals therefrom. Pet. 52–53 (emphasis omitted) (citing Ex. 1004, Fig. 1, 7:8–11; Ex. 1002 ¶ 167). Petitioner reiterates that Tingleff's accelerometer and gyro integrators convert the respective analog signals into digital pulse trains, which are input to the comparator logic. *Id.* at 53 (citing Ex. 1004, 7:8–11). Tingleff teaches that its comparator logic adds a reference signal to the pulse trains, such that the pulse trains "represent the incremental changes in attitude $\delta\theta_{X,\ Y,\ Z}$ and incremental changes in velocity $\delta V_{X,\ Y,\ Z}$ experienced by the inertial guidance platform." Ex. 1004, 7:11–18. According to Petitioner, these incremental changes in attitude $\delta\theta_{X,\ Y,\ Z}$ and incremental changes in velocity $\delta V_{X,\ Y,\ Z}$ are expressed digitally and correspond to the recited "digital angular increments and digital velocity increments." Pet. 54–55 (citing Ex. 1002 ¶¶ 169–171). Petitioner further argues it would have been obvious that the incremental changes "represent accumulated changes in angle over a predetermined time interval expressed in digital form, because determining the incremental change in rotation and velocity would have required a sampling of signals from the accelerometers and gyroscopes over a period of time." *Id.* at 55 (citing Ex. 1002 ¶ 171).

Petitioner further argues that "to the extent the word 'micro' in the preamble is limiting, . . . it would also have been obvious for the gyroscopes and accelerometers in Tingleff to have been substituted with micromechanical gyroscopes and accelerometers as explained for limitation 1[a]–1[b]." Pet. 55 (emphases omitted).

(b) Parties' Disputes for Claim 1

Patent Owner contends: (i) Tingleff, Chan, and Bernstein do not teach or suggest "[a] micro inertial measurement unit" using MEMS sensors as claimed, and an ordinarily skilled artisan would not have combined the teachings of Tingleff with those of Chan and Bernstein as Petitioner proposes (PO Resp. 45–48; Sur-reply 8–14); (ii) Tingleff does not teach or suggest "angular rate electrical signals" as Patent Owner construes the term (PO Resp. 48; Sur-reply 19–20); and (iii) objective evidence demonstrates the claimed invention was non-obvious (PO Resp. 1–5, 33, 39; Sur-reply 14–18). We address Patent Owner's arguments below.

i. Whether an ordinarily skilled artisan would have combined the teachings of Tingleff, Chan, and Bernstein to achieve "[a] micro inertial measurement unit"

Patent Owner argues Petitioner fails to properly show that Tingleff, Chan, and Bernstein teach or suggest the claimed "micro inertial measurement unit," for the same reasons it advances with respect to obviousness over Smith, Chan, and Bernstein. *See* PO Resp. 34, 45–48. Patent Owner additionally contends that a general advantage, such as "size," does not provide a sufficient motivation, especially where Tingleff "prais[es] features of their own invention, rather than expressing any need to further improve." *Id.* at 47 (citing *In re Beasley*, 117 F. App'x 739, 744 (Fed. Cir. 2004); Ex. 1004, 3:11–13). Furthermore, Patent Owner avers, existing MEMS gyroscopes would have had "insufficient accuracy, sensitivity, and stability" that would not have led one to insert them into aircraft. *Id.* (citing Ex. 1001, 17:19–36; Ex. 2023 ¶¶ 8, 12).

We have addressed above and find unpersuasive Patent Owner's arguments against modifying Smith to include MEMS gyroscopes and accelerometers; for the same reasons as those provided above, we are similarly unpersuaded by Patent Owner's overlapping arguments directed to modifying Tingleff. With respect to Petitioner's articulated benefit of reduced size by using sensors that are as small as possible, Petitioner's reference to Tingleff's "relatively small" IMU size merely shows that Tingleff is consistent with Petitioner's proposed modifications and articulated benefits. Patent Owner's reliance on *In re Beasley* to support its argument that a general advantage cannot serve as a reason to modify is unavailing at least because that case stands for a proposition that has been modified by *KSR* and *Intel*. Rather, as we note above, *Intel* holds that "'universal' motivations known in a particular field to improve technology provide 'a motivation to combine prior art references *even absent any hint of suggestion* in the references themselves.'" *Intel*, 61 F.4th at 1380. Furthermore, Patent Owner does not dispute the additional reasons proffered by Petitioner to modify Tingleff beyond achieving reduced size.

With respect to Patent Owner's allegation that MEMS gyroscopes had drawbacks that would have guided against incorporating them into an aircraft, the '648 patent refers to their "insufficient accuracy, sensitivity, and stability" for "high performance electronics and control," but does not specify the types of "high performance" devices and/or systems to which it refers. *See* Ex. 1001, 17:19–36. Moreover, Petitioner provides references that show MEMS or micromachined gyroscopes were used in aircraft at the time. *See* Ex. 1013, 1:10–15, 1:35–39, 8:48–50; Ex. 1014, 1:15–36; *see also* Pet. 17. That others found MEMS or micromachined gyroscopes to be sufficient for use in aircraft and aviation applications despite the weaknesses identified by the '648 patent and Mr. McCall shows that these weaknesses were perceived by some as acceptable drawbacks. *See Medichem, S.A. v.*

Rolabo, S.L., 437 F.3d 1157, 1165 (Fed. Cir. 2006) ("[A] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine.").

ii. Whether Tingleff teaches the claimed "angular rate electrical signals"

Relying on its claim construction position that "angular rate electrical signals" requires signals that directly detect and measure angular rate, Patent Owner contends Tingleff does not teach this feature. PO Resp. 48. Patent Owner further argues Petitioner provides only a token explanation of Tingleff's "black box" gyros 22 that is insufficient to show Tingleff teaches the limitation. *Id.*; Sur-reply 19.

Petitioner contends Bernstein "further describes MEMS-based gyroscopes that generate electrical signals proportional to the angular rate," and "it would have been basic knowledge of a skilled artisan that an electrical signal generated by a sensor 'provides an analog signal proportional to the parameter.'" Reply 11 (citations omitted).

In its Sur-reply Patent Owner argues that Petitioner's Reply improperly raises a new theory with respect to the combination of references teaching the disputed limitation, rather than Tingleff alone teaching the limitation as originally set forth in the Petition. Sur-reply 19–20.

We disagree with Patent Owner's argument that the Petition relies solely on Tingleff for the claimed "angular rate electrical signals." In particular, in addressing limitations 1[a] and 1[c], which refer to the angular rate electrical signals, the Petition argues, "it would have been obvious for the gyros in Tingleff to have been replaced with micromechanical gyroscopes which were well-known, each of which would have produced an angular rate electrical signal," and "[u]nder the proposed combination, . . . the IMU in Tingleff would have been adapted to receive and process signals from MEMS gyroscopes and accelerometers." Pet. 48, 55.

Nevertheless, as discussed in our claim construction analysis above, we construe "angular rate electrical signals" to mean electrical signals that reflect a measurement of angular rate. Under our claim construction, Tingleff's error signals meet the limitation. Tingleff teaches that as its IMU senses aircraft motion, the gyros' error signals are: (1) used to hold the gyro gimbal nulled; and (2) input as analog rate signals to the gyro integrator. Ex. 1004, 7:2–11. Further, Dr. Young testifies persuasively that an ordinarily skilled artisan would have understood that, in Tingleff, these error rate signals are analog rate "signal[s] output due to the angular rotation of the moving object" and which "represent[] the difference between the current position of a gyro gimbal and its original (null) position." *See* Ex. 1002 ¶¶ 158–160. Therefore, Tingleff's error rate signals are electrical signals that reflect a measurement of angular rate.

iii. Objective indicia of nonobviousness

We have addressed above Patent Owner's allegations and objective evidence of nonobviousness. *See* § E.1.(b).iii., *supra*. As previously discussed: (1) Patent Owner has not established a nexus between the merits of the claimed invention and the offered evidence; and (2) even if we were to assume a nexus exists, the evidence of commercial success, failure of others, licensing, industry praise, and copying are all very weak. *See id.*

iv. Overall Weighing of Relevant Factors Concerning Obviousness, Including Secondary Considerations

We now weigh Patent Owner's objective evidence of nonobviousness with the other factors relevant to obviousness of claim 1. We find, for the reasons set forth above, that Tingleff, Chan, and Bernstein teach or suggest all of the limitations of claim 1. We further determine that Petitioner has identified sufficient evidence in the cited prior art to show that an ordinarily skilled artisan would have made the modifications Petitioner proposes for reasons known in the art at the time of the invention.

Against these determinations, we weigh Patent Owner's objective evidence of nonobviousness. Because we are not persuaded for the reasons discussed above that there is a nexus between the merits of the claimed invention and the submitted evidence relating to commercial success, failure of others, licensing, industry praise, and copying, we determine that Patent Owner's evidence does not weigh in favor of nonobviousness. Even if we had determined that Patent Owner had established the requisite nexus, however, we determine that Patent Owner submits very weak evidence of commercial success, very weak evidence of failure of others, very weak evidence of licensing, very weak evidence of industry praise, and very weak evidence of copying.

Overall, upon weighing the *Graham* factors, we determine that a lack of nexus and very weak evidence of each of commercial success, failure of others, licensing, industry praise, and copying does not outweigh our determination that Tingleff, Chan, and Bernstein teach or suggest every limitation in claim 1.

v. Conclusion

In light of the foregoing, we determine that Petitioner has shown by a preponderance of the evidence that claim 1 would have been unpatentable over Tingleff, Chan, and Bernstein.

(c) Dependent Claim 4

For claim 4, Petitioner points to Tingleff's teaching that the angular rate electrical signals and acceleration electrical signals are analog. Pet. 55 (citing Ex. 1004, 7:7–11). Petitioner further argues that, for the same reasons as discussed with respect to obviousness over Smith, Chan, Bernstein, Irwin, and Merhav, an ordinarily skilled artisan would have understood that Tingleff's analog signals are additionally "'voltage signals' that are 'directly proportional' to the angular rate or acceleration" of the device carrying the gyroscopes and accelerometers of Tingleff. *Id.* at 55–56 (citing Ex. 1002 ¶¶ 176–178, 140–141, 148; Ex. 1007, 14). According to Petitioner, these would have been basic concepts well-known and also obvious to an ordinarily skilled artisan in order "to obtain more accurate and thus more useful measurements." *Id.* at 56. Additionally, Petitioner avers that Tingleff's "IMU is mounted to the device, vehicle or carrier (*e.g.* aircraft) with which it is used." *Id.* (citing Ex. 1004, 7:2–5; Ex. 1002 ¶¶ 179–180).

As discussed above, we construe "angular rate voltage signals" to mean voltage signals that reflect a measurement of angular rate. Because, for the reasons provided above, Petitioner has established sufficiently that Tingleff, Chan, and Bernstein would have taught or suggested voltage signals that reflect a measurement of angular rate, we determine that Petitioner has shown sufficiently that the combination teaches or suggest the claimed "angular rate voltage signals."

Patent Owner's Response does not advance arguments directed to claim 4 as allegedly obvious under this ground. *See generally* PO Resp. Accordingly, Patent Owner has forfeited any argument regarding Petitioner's contentions for these claims. *See In re Nuvasive, Inc.*, 842 F.3d 1376, 1381 (Fed. Cir. 2016) (explaining that a patent owner forfeits an issue presented in its preliminary response if it fails to renew the issue in its response after trial is instituted). We have reviewed Petitioner's arguments regarding claim 4, which Patent Owner does not contest, and find them persuasive. Accordingly, we adopt Petitioner's contentions as our own. Based on Petitioner's arguments and accompanying evidence, we determine that Petitioner has shown by a preponderance of the evidence that claim 4 would have been unpatentable over Tingleff, Chan, and Bernstein.

(d) Conclusion

In light of the foregoing, we determine that Petitioner has shown by a preponderance of the evidence that claims 1 and 4 would have been unpatentable over Tingleff, Chan, and Bernstein.

4. Alleged Obviousness Over Yamawaki, Chan, Bernstein, and Saubolle: Claims 1 and 4

Petitioner argues that claims 1 and 4 of the '648 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Yamawaki, Chan, Bernstein, and Saubolle. Pet. 57–74. We do not reach this remaining ground in this Decision because we have already determined that all challenged claims would have been unpatentable as obvious over Smith, Chan, and Bernstein (claim 1); Smith, Chan, Bernstein, Irwin, and Merhav (claim 4); or Tingleff, Chan, and Bernstein (claims 1 and 4), as discussed above. *See* 35 U.S.C. § 318(a); *Boston Sci. Scimed, Inc. v. Cook Grp. Inc.*, 809 F. App'x 984, 990 (Fed. Cir. 2020) (nonprecedential) ("We agree that the Board need not address [alternative grounds] that are not necessary to the resolution of the proceeding.").

IV. PATENT OWNER'S MOTION TO EXCLUDE EVIDENCE

Patent Owner filed a Motion to Exclude the Reply Declaration of Dr. Young (Ex. 1045) and alleged newly cited Exhibits 1037, 1038, 1040, 1043, 1047, 1053, 1057, 1063, 1064, and 1065 in Petitioner's Reply. *See* PO MTE 1; PO MTE Reply 4. Petitioner opposes Patent Owner's Motion. Pet. MTE Opp. Patent Owner, as the moving party, bears the burden to establish that it is entitled to the requested relief. 37 C.F.R. §§ 42.20(c), 42.62(a). For the reasons discussed below, we deny Patent Owner's Motion.

A. Reply Declaration of Dr. Young (Ex. 1045)

Patent Owner moves to exclude the Reply Declaration of Dr. Young as allegedly being "full of new testimony and references to new Exhibits, as well as supplementation and recharacterizations of his prior testimony," to which Patent Owner had no opportunity to respond. PO MTE 1–2, 4–7; PO MTE Reply 1–4. Patent Owner explains that paragraphs 33, 36, 40, and 45 of Dr. Young's reply declaration, for example, cite new exhibits that could and should have been cited in his declaration. PO MTE 2–3. Patent Owner further argues that the reply declaration provides supplemental testimony beyond that provided in the Declaration of Dr. Young. *Id.* at 3–4, 6–7.

Petitioner responds that Patent Owner's Motion identifies no evidentiary objections within the proper scope of a motion to exclude. Pet. MTE Opp. 1–3. Petitioner additionally avers that Dr. Young's reply permissively responds to arguments and evidence submitted with the Patent

Owner Response, for example new claim construction arguments and Dr. Larson and Mr. McCall's declarations, and "consistently refers back to his opening declaration," thereby "confirm[ing] that Dr. Young's reply opinions are consistent with the opinions provided in his opening declaration. *Id.* at 3–8. As for Patent Owner's opportunity to respond, Petitioner argues it could have done so via additional deposition of Dr. Young regarding his reply declaration, or in its Sur-reply. *Id.* at 5–6.

We agree with Petitioner that a motion to exclude should be directed to the admissibility of evidence. *See* 37 C.F.R. § 42.64; CTPG 79 ("A motion to exclude must explain why the evidence is not admissible (e.g., relevance or hearsay) but may not be used to challenge the sufficiency of the evidence to provide a particular fact. . . . Nor should a motion to exclude address arguments or evidence that a party believes exceeds the proper scope of reply or sur-reply."). On the other hand, "[i]f a party believes that a brief filed by the opposing party raises new issues, is accompanied by belatedly presented evidence, or otherwise exceeds the proper scope of reply or sur-reply, it may request authorization to file a motion to strike." CTPG 80.

Here, Patent Owner did not request authorization to file a motion to strike. Although Patent Owner argues that its "concerns—including about particularity requirements and about the prejudice of being improperly restricted in its rebuttal—are broader" than a concern that Petitioner has exceeded the proper scope of reply evidence (PO MTE Reply 2), our guidance is clear as to the proper scope of motions to exclude and strike. *See* CTPG 79–80. Moreover, as Petitioner notes, Patent Owner had sufficient opportunity to respond to Dr. Young's reply declaration via additional deposition of Dr. Young, and in its Sur-reply. As for particularity concerns, Patent Owner's Motion does not identify any portions of the Petition that allegedly lack particularity. *See* 35 U.S.C. § 312(a)(3); 37 C.F.R. § 42.104(b).

Patent Owner's Motion to Exclude does not address the admissibility of the Reply Declaration of Dr. Young. Rather, it argues that the declaration violates the proper scope of a reply under 37 C.F.R. § 42.23. PO MTE 1–6. Accordingly, we find that Patent Owner's Motion does not state a proper basis for excluding the Reply Declaration and, therefore, we deny the Motion to Exclude the Reply Declaration of Dr. Young (Ex. 1045). We note, however, that our analysis above does not rely on any portions of Dr. Young's reply declaration that cite to new evidence or provide testimony either dissimilar in scope to his prior testimony or that does not solely respond to arguments raised in Patent Owner's Response. *See* CTPG 73; 37 C.F.R. § 42.23.

B. Exhibits 1037, 1038, 1040, 1043, 1047, 1053, 1057, 1063, 1064, and 1065

Patent Owner moves to additionally exclude Exhibits 1037 (Juneau), 1038 (Minor), 1040 and 1057 (Clark), 1043 and 1047 (Hulsing),[15] 1053 (Crossbow), 1063 (Accelerometer ACH-04-08-05), 1064 (Analog Devices I), and 1065 (Analog Devices II). PO MTE 1–2, 7. According to Patent Owner, these exhibits were newly filed with Petitioner's Reply rather

[15] Exhibits 1043 and 1047 are a paper authored by Rand Hulsing and titled, "MEMS Inertial Rate and Acceleration Sensor." *See* Exs. 1043, 1047. These exhibits are different evidence than Exhibit 1013, a U.S. patent granted to Rand H. Hulsing, II and titled "Triaxial Angular Rate and Acceleration Sensor." *See* Ex. 1013, codes (54), (75). Petitioner filed Exhibit 1013 with the Petition.

than being properly filed with the Petition. *Id.* at 2. Patent Owner argues that Petitioner improperly relied on Exhibits 1037, 1040, and 1043 during depositions of Mr. McCall and Dr. Larson without affording an opportunity to respond. *Id.* at 3; PO MTE Reply 3–4.

Petitioner contends, "Petitioner and its expert properly used these exhibits to respond to arguments in the Patent Owner Response" and specific testimony of Mr. McCall and Dr. Larson. Pet. MTE Opp. 8–11.

As with Patent Owner's arguments above relating to Dr. Young's reply declaration, Patent Owner's Motion to Exclude does not address the admissibility of these exhibits, for example with respect to their relevance or hearsay. Rather, it argues that the exhibits violate the proper scope of a reply under 37 C.F.R. § 42.23. PO MTE 1–6. Accordingly, we find that Patent Owner's Motion does not state a proper basis for excluding Exhibits 1037, 1038, 1040, 1043, 1047, 1053, 1057, 1063, 1064, and 1065 and, therefore, we deny the Motion to Exclude Exhibits 1037, 1038, 1040, 1043, 1047, 1053, 1057, 1063, 1064, and 1065. We note, however, that our analysis above does not rely on any of these exhibits. *See* CTPG 73; 37 C.F.R. § 42.23. Nor do we view Petitioner's questioning of Mr. McCall and Dr. Larson regarding Exhibits 1037, 1038, 1040, and 1043 as discrediting either witness's testimony in any way.

V. CONCLUSION

After reviewing the complete record developed during the course of the trial, we conclude that Petitioner has demonstrated by a preponderance of the evidence that claims 1 and 4 of the '648 patent are unpatentable.

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not shown Unpatentable
1	103(a)	Smith, Chan, Bernstein	1	
4	103(a)	Smith, Chan, Bernstein, Irwin, Merhav	4	
1, 4	103(a)	Tingleff, Chan, Bernstein	1, 4	
1, 4	103(a)[16]	Yamawaki, Chan, Bernstein, Saubolle		
Overall Outcome			1, 4	

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has demonstrated by a preponderance of the evidence that claims 1 and 4 of the ’648 patent are unpatentable;

FURTHER ORDERED that Patent Owner’s Motion to Exclude (Paper 35) is denied; and

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

[16] As explained above, because we determine that the challenged claims are unpatentable under other grounds, we decline to address the remaining ground.

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