

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

STATON TECHIYA, LLC,
Patent Owner.

IPR2022-00282
Patent 8,315,400 B2

Before GEORGE R. HOSKINS, NATHAN A. ENGELS, and
RUSSELL E. CASS, *Administrative Patent Judges*.

HOSKINS, *Administrative Patent Judge*.

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

I. INTRODUCTION

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Petitioner”) filed a Petition (Paper 4, “Pet.”) pursuant to 35 U.S.C. §§ 311–319 to institute an *inter partes* review of U.S. Patent No. 8,315,400 B2 (“the ’400 patent”), claims 1–20. We instituted the petitioned review (Paper 12, “Institution Decision” or “Inst. Dec.”).

Staton Techiya, LLC (“Patent Owner”) filed a Patent Owner Response (Paper 15, “PO Resp.”) to oppose the Petition. Petitioner filed a Reply (Paper 17, “Pet. Reply”) to the Patent Owner Response. Patent Owner filed a Sur-reply (Paper 19, “Sur-reply”) to the Reply. With prior authorization from the Board (*see* Paper 18), Petitioner filed a Sur-sur-reply to the Sur-reply (Paper 20). An oral hearing was held, for which the transcript was entered into the record (Paper 27, “Tr.”).

We have jurisdiction under 35 U.S.C. § 6(b)(4) and § 318(a). This Decision is a final written decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 as to the patentability of claims 1–20 of the ’400 patent. We determine Petitioner has shown by a preponderance of the evidence that claims 1–3, 6, 7, 9–14, and 17–20 are unpatentable, but has not shown claims 4, 5, 8, 15, and 16 are unpatentable.

II. BACKGROUND

A. *Real Parties-in-Interest and Related Proceedings*

Petitioner identifies itself (i.e., Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc.) as the sole real party-in-interest for Petitioner. *See* Pet. 1, 71; Paper 8, 1; Paper 26, 1. Patent Owner identifies

itself (i.e., Staton Techiya, LLC) and Synergy IP Corporation as the real parties-in-interest for Patent Owner. *See* Paper 7, 1.

The parties identify one district court litigation involving the '400 patent: *Staton Techiya, LLC et al. v. Samsung Elecs. Co., Ltd. et al.*, No. 2:21-cv-00413 (E.D. Tex.) (“the District Court Litigation”). *See* Pet. 71; Paper 7, 1; Paper 8, 1; Paper 26, 1.

The parties also identify several IPR and reexamination proceedings, considering patents other than the '400 patent, as related matters. *See* Pet. 71 (citing Ex. 1009); Paper 8, 1–2; Paper 26, 1–2.

B. The '400 Patent

The '400 patent concerns an earpiece that suppresses background noise in an audio signal delivered to the user's eardrum. *See* Ex. 1001, code (57), 1:15–38. Figure 1 is reproduced below:

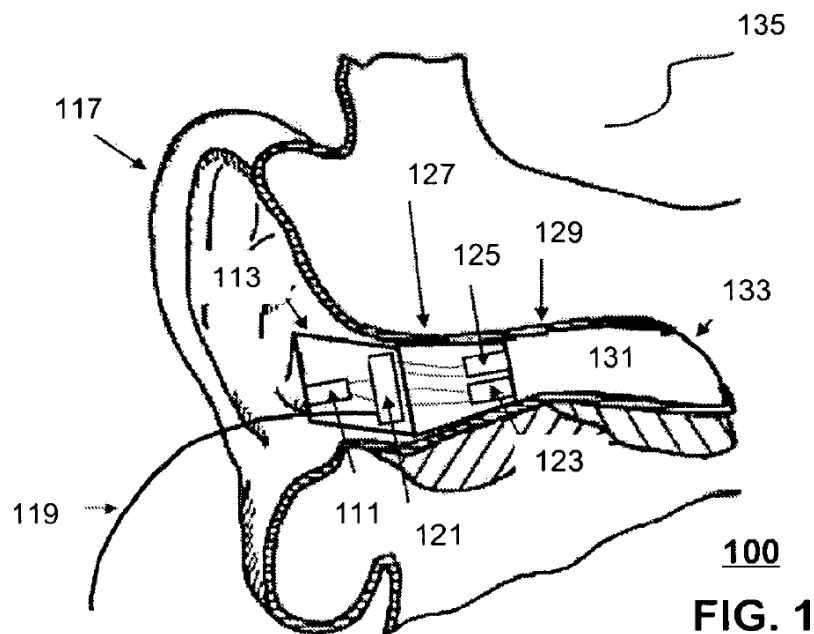


Figure 1 of the '400 Patent.

Figure 1 is a pictorial diagram of earpiece 100 inserted into ear canal 131 of user 135. *See id.* at 2:44–45, 4:13–22. The earpiece includes processor 121

connected to ambient sound microphone 111, ear canal microphone 123, and ear canal receiver (speaker) 125. *See id.* at 4:27–31, 4:40–43, 4:48–60.

Ambient sound microphone 111 captures ambient sound from the user's environment. *See id.* at 4:27–28, 5:41–48. Ear canal microphone 123 captures sound from within ear canal 131, proximate to eardrum 133, behind an acoustic seal between earpiece 100 and ear canal walls 129 at location 127. *See id.* at 4:31–40. Ear canal receiver 125 reproduces a sound signal to be delivered to eardrum 133, which reduces background noise versus the sound field at the exterior entrance to ear canal 131. *See id.* at 4:40–47, 4:61–5:3.

Figure 4 is reproduced below:

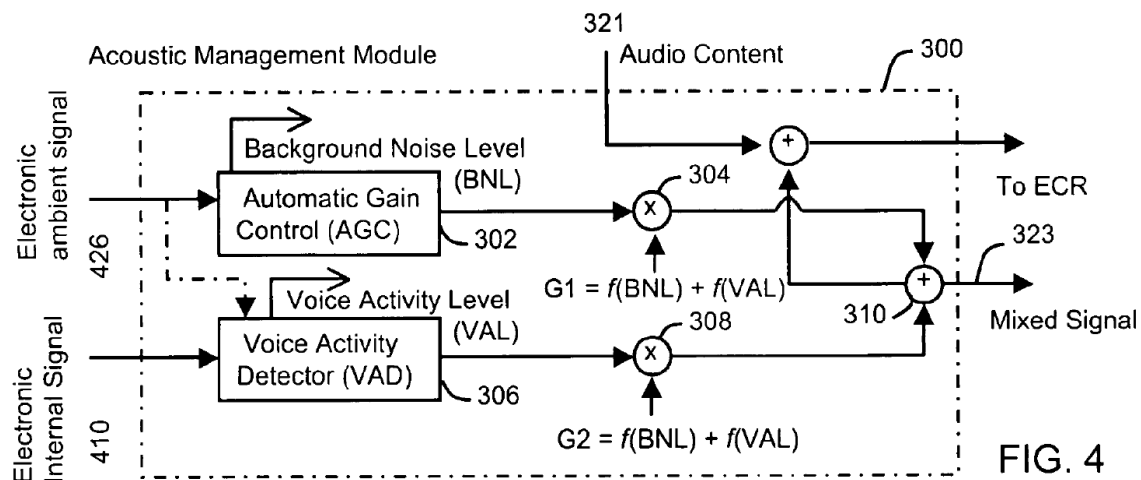


Figure 4 of the '400 Patent.

Figure 4 is a schematic 300 of an acoustic management module implemented by processor 121 of earpiece 100. *See id.* at 2:50–54, 5:29–40 (Fig. 2), 7:42–43. The inputs to the module are ambient signal 426 from ambient sound microphone 111, and internal signal 410 from ear canal microphone 123. *See id.* at 6:58–64. The output of the module is mixed

signal 323, which can be delivered to the user's eardrum by ear canal receiver 125. *See id.* at 6:49–50, 6:59–62, 8:6–11.

The acoustic management module first measures a background noise signal from ambient signal 426 or internal signal 410. *See id.* at 6:64–66. This is performed by automatic gain control 302, which outputs “Background Noise Level (BNL).” *Id.* at 7:46–49; *see also id.* at Fig. 7, 9:66–10:44 (disclosing one method of calculating background noise levels).

The acoustic management module then creates mixed signal 323 “by filtering and mixing” ambient signal 426 and internal signal 410. *Id.* at 6:49–50. The filtering and the mixing are “automatically controlled depending on the background noise level of the ambient sound field to enhance intelligibility of the new mixed signal 323.” *Id.* at 6:50–53. For example, the two input signals may be *filtered* “based on a characteristic of the background noise signal using filter coefficients,” and *mixed* “in a ratio dependent on the background noise signal . . . such as a level of the background noise level, a spectral profile, or an envelope fluctuation.” *Id.* at 6:67–7:13, 9:2–7, 10:50–11:1 (Fig. 8). The mixing may be performed at *low* background noise levels by amplifying ambient signal 426 relative to internal signal 410, at *medium* background noise levels by attenuating low frequencies in ambient signal 426 and attenuating high frequencies in internal signal 410, and at *high* background noise levels by amplifying internal signal 410 relative to ambient signal 426. *See id.* at 7:27–38; *see also id.* at Fig. 10, 11:13–33 (illustrating and describing one example of this selective mixing). The mixing is shown in Figure 4 as gains G1 and G2 applied to signals 426 and 410 respectively, which are then summed at 310. *See id.* at 7:60–8:4, 8:18–40 (Fig. 5).

C. The Claims of the '400 Patent

Claims 1, 14, and 18 are the independent claims of the '400 patent. We reproduce illustrative claim 1 here, with some line breaks added to ease readability:

1. An earpiece comprising:
at least one Ambient Sound Microphone (ASM)
configured to convert an ambient sound to an ambient
sound signal;
at least one Ear Canal Microphone (ECM) configured to
convert an internal sound from an ear canal of a user to an
internal sound signal and where the internal sound signal
includes an internal voice of the user; and
a processor operatively coupled to the at least one ASM
and the at least one ECM and which receives the ambient
sound signal and the internal sound signal, and where the
processor is configured to:
determine a background noise level from at least one
of the ambient sound signal or the internal sound
signal, and
to adjust an amplitude of one or more frequencies of
the internal sound signal and the ambient sound signal
based on the background noise level, to filter the
internal sound signal relative to the ambient sound
signal.

Ex. 1001, 12:21–38, pg. 18 (Cert. Corr.).

D. Effective Filing Date of the '400 Patent Claims

“Petitioner assumes the '400 patent’s priority date is May 4, 2007.”
Pet. 6; *see* Ex. 1001, code (60). Patent Owner does not dispute Petitioner’s
assumption. *See, e.g.*, Ex. 2009 ¶ 8 (stating Patent Owner’s witness was

“asked to assume that the date of the inventions of the claims of the ’400 patent was May 4, 2007”).

Thus, we assume (without deciding) that the ’400 patent claims are entitled to a priority date of May 4, 2007. All three of Petitioner’s principal prior art references (listed in the next section below) have filing dates that precede this priority date, so they qualify as prior art to the ’400 patent under 35 U.S.C. § 102(a). As Patent Owner does not contest the priority date, or that the references are prior art even if the challenged claims are entitled to a priority date of May 4, 2007, Petitioner has sufficiently met its burden that the three references are prior art.

Further, we conclude the first-inventor-to-file provisions of the Leahy-Smith America Invents Act¹ (“the AIA”) do not apply here, because the ’400 patent issued from an application that never contained a claim to a claimed invention having an effective filing date on or after March 16, 2013. *See* AIA § 3(n)(1); *see also* Ex. 1001, code (45) (the ’400 patent issued on Nov. 20, 2012).

E. Asserted Prior Art

Petitioner relies principally on the following three prior art references. *See* Pet. 1–2.

Name	Reference	Filing Date	Exhibit No.
Killion	US 5,524,056	Apr. 13, 1993	1006
Mejia	WO 2006/037156 A1	Sept. 30, 2005	1007
Alves	US 2008/0037801 A1	Aug. 10, 2006	1005

¹ Pub. L. No. 112-29, 125 Stat. 284 (2011).

F. Asserted Grounds

Petitioner relies on the following five grounds of unpatentability for the challenged claims. *See* Pet. 2.

Ground	Claim(s) Challenged	35 U.S.C. §	Reference(s)
1	1, 6–8, 12–15, 17	102	Alves
2	1, 6–8, 12–17	103	Alves
3	2–4, 9–11, 18–20	103	Alves, Mejia
4	16	103	Alves, Killion
5	5	103	Alves, Mejia, Killion

G. Testimonial Evidence

Petitioner relies on the testimony of Richard Stern, Ph.D., as an expert witness (Exhibits 1002, 1003, 1016, and 2010). Patent Owner relies on the testimony of David Kleinschmidt as an expert witness (Exhibits 1017 and 2009).

III. CONSIDERATION OF PETITIONER’S GROUNDS

A. Level of Ordinary Skill in the Art

Petitioner contends a person having ordinary skill in the art pertaining to the ’400 patent “would have had a bachelor’s degree in electrical engineering, computer science, or a similar field and two years of experience in the design of wireless earphones and associated signal processing.” Pet. 17; Ex. 1002 ¶¶ 17–18. “Patent Owner accepts the level of ordinary skill in the art that is proposed in the Petition.” PO Resp. 15; Ex. 2009 ¶¶ 9–10.

We conclude Petitioner’s formulation of ordinary skill is consistent with the level of skill reflected in the ’400 patent and the prior art of record,

and it is not disputed by Patent Owner. We, therefore, apply Petitioner’s formulation in our analysis below.

B. Claim Construction

We interpret the ’400 patent claims “using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” 37 C.F.R. § 42.100(b). This “includ[es] construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” *Id.*

The Petition asserts “no express constructions of the claims are necessary” in this proceeding, and “the claims should be given their plain and ordinary meaning.” Pet. 17–18; Ex. 1002 ¶ 74.

The Patent Owner Response provides several claim constructions. *See* PO Resp. 15–19 (construing “sound signal” in claims 1, 14, and 18; “noise signal” in claims 14 and 18; and “envelope” in claims 8, 17 and 20); *id.* at 19–21 (construing “a background noise level” in claim 1); *id.* at 33–35 (construing “a background noise signal” in claims 14 and 18); *id.* at 35–38 (construing “mixing” in claims 4, 15, and 19).

We discuss here Patent Owner’s claim constructions as they relate to independent claims 1, 14, and 18. We defer construction of dependent claims to later sections of this Decision.

1. “sound signal” (Claims 1, 14, and 18)

Claim 1 recites “an ambient *sound signal*” and “an internal *sound signal*.” Ex. 1001, 12:21–38 (emphases added). Claims 14 and 18 also recite ambient and internal sound signals. *See id.* at 13:20–36, 14:9–32.

In the Institution Decision, we preliminarily construed the term “sound signal” to mean “a function that carries information about sound,” as Patent Owner had proposed. Inst. Dec. 21, 29, 42.

Patent Owner continues to maintain the term “sound signal” should be construed in accordance with its ordinary and customary meaning, **“a function that carries information about sound.”** PO Resp. 16, 18–19; Ex. 2009 ¶ 52. In support, Mr. Kleinschmidt discusses several properties of a sound signal, including temporal and spectral variation, a sound level associated with amplitude at a particular frequency, and various units of measurement (e.g., pressure, amplitude, and voltage). *See* PO Resp. 18; Ex. 2009 ¶¶ 53–59. Patent Owner asserts Petitioner’s witness Dr. Stern agrees with Patent Owner’s proposed construction of “sound signal.” PO Resp. 18 (citing Ex. 2010, 105:6–22).

Petitioner replies that it “agrees to” the construction of the term “sound signal” in the Institution Decision. Pet. Reply 2; Ex. 1016 ¶¶ 7–8.

Although not discussed by either party, we note that in the District Court Litigation, the district court² disagreed with the construction Patent Owner advances here. *See* District Court Litigation, Docket No. 285 (Claim Construction Order), 29. However, in that forum, Petitioner proposed a “plain and ordinary meaning” construction in opposition to Patent Owner’s construction. *See id.* By contrast, in the present forum, Petitioner has agreed with Patent Owner’s construction. *See* Pet. Reply 2; Inst. Dec. 42.

² The cited decision, and others discussed below, were entered by a U.S. Magistrate Judge, not a U.S. District Court Judge. This distinction is immaterial here, so we will refer to the decisions as decisions of the court. *See also* Tr. 34:17–24 (indicating a District Court Judge has rejected party objections to the Magistrate Judge’s constructions).

Thus, in this Decision, we construe the term “sound signal” in claims 1, 14, and 18 to mean “a function that carries information about sound,” as we did in the Institution Decision and as both parties agree.

2. “a background noise level” (Claim 1)

Claim 1 recites “a processor configured to . . . determine a background noise level.” Ex. 1001, 12:29–33, pg. 18 (Cert. Corr.). We first consider the meaning of the term “a background noise level.” Then we discuss the impact of the District Court Litigation on this issue in this proceeding.

a) *Meaning of “a background noise level”*

Petitioner asserts Alves’s processor determines a background noise level, because Alves’s noise cancellation algorithm “*splits a noisy signal into subband signals and ‘[i]n each subband, the average power of the quasi-stationary background noise is tracked[.]’*” Pet. 22–23 (emphases added) (quoting Ex. 1005 ¶ 43, and citing Ex. 1005 ¶¶ 15, 29–32); Ex. 1002 ¶¶ 95–98. Patent Owner responds that Petitioner’s assertion “is based on an improper interpretation of ‘background noise level.’” PO Resp. 19; Ex. 2009 ¶¶ 61–65.

The Institution Decision noted in this regard that “claim 1 simply recites that the processor ‘determine[s] a background noise level,’” and preliminarily concluded the term “background noise level” “may be taken as either: (1) any one subband’s particular background noise level; or (2) the entire collection of the subband noise levels as representative of [a sound signal] as a whole.” Inst. Dec. 28–29. We stated “the ’400 patent itself contemplates that in some embodiments, an acoustic management module

may ‘apply *frequency specific* filters . . . based on the characteristics of the background noise.’” *Id.* at 29 (quoting Ex. 1001, 7:38–41 (emphasis added), citing Ex. 1001, 11:13–33 (Fig. 10)).

In response, Patent Owner maintains “[t]he term ‘background noise level,’ properly understood, refers to *a single overall background noise level*,” which Alves does not disclose because Alves tracks noise only in different frequency subbands of an overall signal. PO Resp. 19–20 (emphasis added); *see also* Ex. 2009 ¶¶ 61–63 (“The [background noise power] estimations in Alves are those *in subband signals* and thus none of the estimates reflect a background noise.”). Mr. Kleinschmidt testifies in support that “[a] person of ordinary skill in the art would understand that at any given place and time, a single ‘background noise’ exists” and “would not understand that multiple ‘background noise’ levels exist at a single place and time.” Ex. 2009 ¶ 64. Further according to Mr. Kleinschmidt, “a person of ordinary skill in the art would not understand that the portion of the background noise within one frequency subband is itself a background noise.” *Id.*

Patent Owner and Mr. Kleinschmidt conclude “[t]he ’400 patent does not reveal an intent to deviate from [the foregoing] plain and ordinary meaning of ‘background noise level.’” PO Resp. 20; Ex. 2009 ¶ 65. Instead, according to Patent Owner, the ’400 patent “consistently uses ‘background noise level’ to refer to a single value (level) calculated from a background noise signal consisting, spectrally, of the sound pressure at all frequencies.” PO Resp. 20; Ex. 2009 ¶ 65. For example, claim 5 of the ’400 patent refers to “low” or “medium” or “high” background noise levels, which Mr. Kleinschmidt testifies “makes sense only if ‘background noise’

refers to a single signal.” Ex. 2009 ¶ 65; PO Resp. 20–21. He also cites the ’400 patent disclosure at column 1, lines 56–62, “of an increasing or decreasing background noise level” which he testifies “makes sense only if ‘background noise’ is viewed as the totality of all frequencies that constitute background noise.” Ex. 2009 ¶ 65; PO Resp. 20–21.

Petitioner replies that Patent Owner’s claim construction is “incorrect” because claim 1 is “not limited to a single overall background noise level/signal,” so Alves’s “subband processing” satisfies the claim as preliminarily determined by the Institution Decision. Pet. Reply 1, 3–5. Petitioner relies on “the widely accepted convention that ‘a’ usually denotes one or more” in patent claims employing the transitional phrase “comprising” as does claim 1. *Id.* at 3–4 (citing *KCJ Corp. v. Kinetic Concepts, Inc.*, 223 F.3d 1351, 1356 (Fed. Cir. 2000)). Petitioner argues claim 5 and the specification of the ’400 patent do not suggest otherwise. *See id.* at 3–4 n.2 (citing claim 5); Sur-sur-reply 5 (citing Ex. 1001, 6:30, 6:35); Ex. 1016 ¶¶ 17–20. For example, Dr. Stern testifies that “[a]t any given place and time, multiple background noises can be present in the sound field,” and subband processing can be useful to address these multiple background noises. Ex. 1016 ¶ 20; Pet. Reply 5.

We agree with Petitioner’s claim construction in this proceeding. Starting with the claim language, as we noted in the Institution Decision: “[C]laim 1 simply recites that the processor ‘determine[s] a background noise level.’” Inst. Dec. 28 (quoting Ex. 1001, 12:31–33). The Federal Circuit has “explained that the indefinite article ‘a’ means ‘one or more’ in open-ended claims containing the transitional phrase ‘comprising,’” as does claim 1 at issue here. *Salazar v. AT&T Mobility LLC*, 64 F.4th 1311, 1315

(Fed. Cir. 2023) (citing in part *KCJ*, 223 F.3d at 1356); *see also FS.com Inv. v. ITC*, 65 F.4th 1373, 1377 (Fed. Cir. 2023) (“Generally, the terms ‘a’ or ‘an’ in a patent claim mean ‘one or more,’ unless the patentee evinces a clear intent to limit ‘a’ or ‘an’ to ‘one.’”). Further: “An exception to the general rule that ‘a’ . . . means more than one only arises where the language of the claims themselves, the specification, or the prosecution history necessitate a departure from the rule.” *Salazar*, 64 F.4th at 1315 (citations omitted).

We conclude there is nothing in the plain and ordinary meaning of “a background noise level” in claim 1 to support Patent Owner’s position that the claim is limited to a *single overall* background noise level, to the exclusion of determining a background noise level in each of several frequency subbands of a single overall signal. This is supported by other language in claim 1, requiring the processor to be configured to “adjust the amplitude of *one or more frequencies* . . . based on the background noise level.” Ex. 1001, 12:31–37 (emphasis added). By referring to adjusting the amplitude of “one or more” frequencies, claim 1 supports Petitioner’s position that the claim as a whole is open to operating based on frequency subbands, and belies Patent Owner’s more limited claim construction position in the specific context of determining a background noise level. *See* Pet. Reply 5.

Patent Owner’s reliance on dependent claim 5 is not to the contrary, for at least two reasons. First, even if the language of dependent claim 5 limits claim 5 to require determining a single overall background noise level as Mr. Kleinschmidt testifies, this does nothing to limit the broader language in the parent claim 1. *See, e.g.*, 35 U.S.C. § 112 ¶ 4 (“[A] claim in dependent form shall contain a reference to a claim previously set forth *and*

then specify a further limitation of the subject matter claimed[.]” (emphasis added)).

Second, we are persuaded by Dr. Stern’s testimony on behalf of Petitioner that the low / medium / high levels referenced in claim 5 can refer to background noise levels within multiple frequency subbands of a signal, rather than the entire signal without subbands. *See* Ex. 1016 ¶¶ 17–18 (“I see no reason why claim 5 cannot be implemented with subband processing wherein a different background noise level is determined within each subband.”). This is particularly the case because claim 1 expressly contemplates adjusting the amplitude of *one or more* frequencies based on the background noise level, as discussed above. *See id.* ¶¶ 18–19. Further according to Dr. Stern, a person of ordinary skill in the art would have appreciated that subband processing provides advantages in noise suppression algorithms, such as (1) “allow[ing] filters to adapt faster,” and (2) focusing on background noise reduction “where [the noise is] present in the frequency range of interest.” *Id.* ¶¶ 19–20.

In light of this testimony from Dr. Stern, we are not persuaded by the relatively conclusory opinion of Mr. Kleinschmidt on this point. *See* Ex. 2009 ¶¶ 61–68. In particular, Mr. Kleinschmidt concludes claim 5’s reference to “low, medium, and high background noise levels . . . makes sense only if ‘background noise’ refers to a single signal,” because “[o]therwise, a background noise that had a low sound pressure level at one frequency subband and a high sound pressure level at another frequency subband could be considered to be both low and high simultaneously.” *Id.* ¶ 65. However, we agree with Dr. Stern’s opposing testimony that claim 5’s low / medium / high characterizations can apply within frequency subbands

of an overall signal, just as well as within the overall signal. *See* Ex. 1001, 12:51–59; Ex. 2016 ¶¶ 17–20.

Next turning to the '400 patent specification, we noted in the Institution Decision that “the '400 patent itself contemplates that in some embodiments, an acoustic management module may ‘apply *frequency specific* filters . . . based on the characteristics of the background noise.”” Inst. Dec. 29 (quoting Ex. 1001, 7:38–41 (emphasis added), citing Ex. 1001, 11:13–33 (Fig. 10)). Petitioner similarly contends that the '400 patent specification “contemplates subband processing.” Pet. Reply 5 (further citing Ex. 1001, 3:59–4:12). Patent Owner does not materially dispute these readings of the '400 patent disclosure, which are consistent with construing claim 1 to encompass background noise level determinations in frequency subbands.

Patent Owner instead contends “the '400 patent consistently uses ‘background noise level’ to refer to a single value (level) calculated from a background noise signal consisting, spectrally, of the sound pressure at all frequencies.” PO Resp. 20–21. In support, Patent Owner cites the '400 patent’s disclosure that a noise cancellation algorithm may vary based on whether “the background noise levels increase” or “the background noise levels decrease.” Ex. 1001, 1:56–62. Mr. Kleinschmidt testifies this disclosure “makes sense only if ‘background noise’ is viewed as the totality of all frequencies that constitute the background noise,” because “[o]therwise, a background noise could be said to be both increasing and decreasing (so long as the power of at least one subband was increasing and another was decreasing).” Ex. 2009 ¶ 65.

However, the disclosed concept of varying a noise cancellation algorithm based on whether background noise levels are increasing or decreasing is not recited in claim 1. *See* Ex. 1001, 12:29–38 (claiming processor functionality). Thus, Patent Owner’s argument relying on this disclosed concept relates to an unclaimed limitation, and therefore is not persuasive. We must be careful not to read a particular embodiment appearing in the specification into the claim, if the claim language is broader than the embodiment. *See Innova/Pure Water, Inc. v. Safari Water Filtration Sys., Inc.*, 381 F.3d 1111, 1117 (Fed. Cir. 2004) (“particular embodiments appearing in the written description will not be used to limit claim language that has broader effect”); *In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993) (“[L]imitations are not to be read into the claims from the specification.”). Moreover, as with claim 5 discussed above, we are persuaded by Dr. Stern’s testimony that a background noise level may be increasing or decreasing within frequency subbands of an overall signal, just as well as within the overall signal. *See* Ex. 1016 ¶¶ 17–20.

Neither party cites the prosecution history of the ’400 patent as bearing on the present claim construction dispute.

Finally, the *Wiley Electrical and Electronics Engineering Dictionary* defines “noise level” as “[t]he amplitude, degree, or intensity of a noise signal,” including *either* “all noise signals present” *or* “for a specified interval of frequencies.” Ex. 2004, 508. As discussed above, we discern nothing in the ’400 patent that would limit its use of the term “a background noise level” in claim 1 to the first alternative, and exclude the second alternative.

Thus, for the foregoing reasons, we maintain the Institution Decision’s construction of “a background noise level” in claim 1 as including any one frequency subband’s particular background noise level. To be clear, we also conclude this term also encompasses a single overall background noise level, but we reject Patent Owner’s position that claim 1 is limited to such an embodiment.

b) The District Court Litigation

Patent Owner points out that Petitioner has taken dramatically different claim construction positions in this proceeding and in the District Court Litigation. *See* Sur-reply 1; Sur-sur-reply *generally*. Specifically, in this proceeding Petitioner has *expressly opposed* Patent Owner’s proffered construction limiting “background noise level” to mean a single overall background noise level. *See* Section III.B.2(a) *supra*. By contrast, in the District Court Litigation, Petitioner has *expressly joined* Patent Owner in proposing that the same claim term means “a single overall background noise level, as opposed to noise levels associated with particular subband signals.” Ex. 2013, 5.

The district court has adopted the parties’ mutually proposed claim construction. *See* District Court Litigation, Docket Nos. 285 (Feb. 8, 2023, Claim Construction Order), 376 (Apr. 10, 2023, Joint Motion To Amend Claim Construction Order), and 379 (Apr. 13, 2023, Order Granting Motion No. 376). The basis for this adoption appears to be the parties’ agreement; the court provided no reasoned analysis for the adoption. *See id.* For example, based on the record presented to us, it does not appear that either party substantively addressed this claim construction to the district court or

notified the district court of Petitioner’s different claim construction position presented in this IPR proceeding. *See id.*; Tr. 18:22–19:15, 20:8–23:7, 40:11–41:15, 42:26–43:22, 65:1–13, 66:13–67:2.

Patent Owner argues we “should hold Petitioner[] to the claim constructions [Petitioner] has recognized are correct in” the District Court Litigation, which, according to Patent Owner, would distinguish Alves from the claims of the ’400 patent and doom the Petition. Sur-reply 1–3, 4–7. As legal authority for this proposition, Patent Owner cites the Board’s Consolidated Trial Practice Guide (Nov. 2019) (“CTPG”),³ which provides that “[f]or IPR[s] . . . the AIA requires that the Office consider the effect of the regulations on the economy [and] the integrity of the patent system.” CTPG 5; *see* Sur-reply 3, 5 (“The Board should apply the agreed construction [from the District Court Litigation] here to maintain consistency of claim scope and thereby protect the integrity of the patent system.”); Tr. 35:19–36:1, 38:17–40:10, 43:23–45:13.

Petitioner asserts its construction in the District Court Litigation is “appropriate based on statements of disclaimer made by the Patent Owner in” this IPR proceeding. Ex. 2013, 5 n.1; Sur-sur-reply 1–3; Tr. 10:11–24:4. Petitioner cites *Aylus Networks, Inc. v. Apple Inc.*, 856 F.3d 1353 (Fed. Cir. 2017), as holding that a patent owner’s “disavowal of claim scope in an IPR proceeding can be used against [the patent owner] in subsequent proceedings outside of the IPR.” Sur-sur-reply 1–3. Petitioner cites *CUPP Computing AS v. Trend Micro Inc.*, 53 F.4th 1376 (Fed. Cir. 2022), as holding “the Board need not, and should not, apply [a patent owner’s argument as a

³ Available at <https://www.uspto.gov/TrialPracticeGuideConsolidated>.

disavowal] within the IPR proceeding where the disavowal occurred.”

Sur-sur-reply 1, 3.

Patent Owner responds that Petitioner misunderstands the law, which is that: “Claims are to be construed in an IPR proceeding using the same claim construction standard as is applied in district court.” Sur-reply 5 (citing 37 C.F.R. § 42.100(b)). Patent Owner also argues “the Federal Circuit has made clear that ‘[t]he meaning of a claim term does not change depending on the party that argues prosecution disclaimer.’” *Id.* at 5–6 (citing *VirnetX Inc. v. Mangrove Partners Master Fund, Ltd.*, 778 F. App’x 897 (Fed. Cir. 2019)). Patent Owner asserts the *CUPP* decision does not support Petitioner’s position, because in *CUPP* the Federal Circuit “held ‘only that a disclaimer is not binding on the PTO in the very IPR proceeding in which it is made.’” *Id.* at 6 (quoting *CUPP*, 53 F.4th at 1383). Patent Owner insists Petitioner is arguing to the district court that there has been a disclaimer, and is arguing to the Board that there has not been a disclaimer, which is untenable. *See id.* at 6.

Upon considering the record presented to us, we disagree with Patent Owner’s position. The first and most important reason is our weighing of the merits of the claim construction dispute as presented in this proceeding, which favor Petitioner’s claim construction (again, as presented in this proceeding). *See* Section III.B.2(a) *supra*. We recognize that our construction is not the construction currently adopted by the district court. However, the district court’s adoption of Patent Owner’s construction appears to have been based solely on the parties’ joint proposal in the District Court Litigation. The parties’ proposal to the district court does not offer any reasoning in support of the construction that we might impute to

the district court. *See* Ex. 2013, 5. Even though the parties presented an agreed construction to the district court, here the parties present competing constructions and substantively address the merits of those constructions.

Patent Owner’s argument that we should simply adopt the district court’s claim construction to avoid inconsistent rulings is not persuasive, for the reasons provided above, and at least one additional reason rooted in the procedural history of this proceeding relative to the District Court Litigation. On September 9, 2022, Patent Owner filed its Patent Owner Response in this proceeding, arguing “a background noise level” in claim 1 means a single overall background noise level. *See* PO Resp. 19–21. On October 21, 2022, the parties jointly proposed the same construction to the court, with Petitioner’s stated reasoning being an alleged disclaimer being made *in the Patent Owner Response in this proceeding*. *See* Ex. 2013, 1, 5 & n.1; Tr. 10:11–12:1. On January 12, 2023, Patent Owner filed its Sur-reply in this proceeding, urging us to follow the parties’ jointly proposed claim construction in the District Court Litigation to avoid inconsistent results. *See* Sur-reply 1–3, 4–7. Finally, on February 8 and April 13, 2023, the district court adopted the parties’ jointly proposed claim construction, on the simple basis that it was jointly proposed. *See* District Court Litigation, Docket Nos. 285 and 379.

Thus, the only substantive reasoning in the record presented to us that might support construing “a background noise level” in claim 1 to mean a single overall background noise level is the reasoning provided in the Patent Owner Response. However, the *CUPP* decision states: “We now make precedential the straightforward conclusion we drew in an earlier nonprecedential opinion: ‘[T]he Board is not required to accept a patent

owner's arguments as disclaimer when deciding the merits of those arguments.” *CUPP*, 53 F.4th at 1383 (quoting *VirnetX*, 778 F. App'x at 910). Yet, Patent Owner is in effect asking us to do that here, given the procedural interplay of this proceeding and the District Court Litigation.

For the foregoing reasons, we conclude the District Court Litigation does not provide a persuasive basis to adopt Patent Owner's claim construction of “a background noise level” in this proceeding.

c) Conclusion

For the foregoing reasons, we construe “a background noise level” in claim 1 to include any one frequency subband's particular background noise level. We conclude this term also encompasses a single overall background noise level, but we reject Patent Owner's position that claim 1 is limited to such an embodiment.

3. “background noise signal” (Claims 14 and 18)

Claim 14 recites “determining a background noise signal,” and claim 18 similarly recites a “processor configured to . . . determine a background noise signal.” Ex. 1001, 13:30, 14:19–24. Patent Owner provides multiple constructions of the term “background noise signal,” which we discuss in turn.

a) Patent Owner's First Construction

Patent Owner implicitly argues “background noise signal” in claims 14 and 18 should be construed the same as Patent Owner construes “background noise level” in claim 1, to exclude frequency subband processing. *See* PO Resp. 33 (“Alves does not determine a background

noise signal . . . for reasons similar to those discussed above with respect to Alves’s failure to determine a background noise level,” including Alves’s “processing on a subband-by-subband basis.”), 51–52. This implicit construction is not persuasive for reasons provided in Section III.B.2 above.

b) Patent Owner’s Second Construction

Patent Owner also argues the term “noise signal” should be construed in accordance with its ordinary and customary meaning, “**a function that carries information about noise.**” PO Resp. 16, 19; Ex. 2009 ¶ 52. Patent Owner suggests this construction is “the logical extension of the construction for ‘sound signal’” discussed in Section III.B.1 above, because “[n]oise is a particular type of sound.” PO Resp. 19; Ex. 2009 ¶¶ 57–59.

Petitioner replies: “To the extent that [Patent Owner] is attempting to set up a dichotomy between the terms ‘sound signal’ and ‘noise signal,’ such a construction would be incorrect because ‘noise’ is merely a species of ‘sound’ that includes both desired sound, *e.g.*, the user’s voice, and undesired sound or noise, *e.g.*, background noise.” Pet. Reply 2–3 (citing Ex. 1017, 21:17–22:7); Ex. 1016 ¶¶ 10–12. Petitioner proposes the term “‘noise signal’ should be ‘a function that carries information about sound in which noise is present.’” Pet. Reply 3 (citing Ex. 1018, 6); Ex. 1016 ¶¶ 9, 13.

We do not need to resolve this particular dispute because, for reasons provided in Section III.C.8 below, we conclude Alves discloses determining a background noise signal even if Patent Owner’s claim construction is applied. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in

controversy, and only to the extent necessary to resolve the controversy.”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

c) Patent Owner’s Third Construction

Patent Owner contends Petitioner “err[s] in equating a background noise **level** [per claim 1] with a background noise **signal** [per claims 14 and 18].” PO Resp. 33–34 (citing Pet. 56; Ex. 1002 ¶ 206). In particular, according to Patent Owner, “a sound (e.g., noise) ‘level’ is *the magnitude* of a sound (e.g., noise) ‘signal.’” *Id.* at 34 (emphasis added) (citing Ex. 2004, 508–509); Ex. 2009 ¶¶ 52–59. Patent Owner asserts Dr. Stern agrees. *See* PO Resp. 34–35 (citing Ex. 2010, 107:18–25, 108:7–24); Sur-reply 9–10.

Petitioner replies that Patent Owner has agreed with Dr. Stern’s testimony that a “noise level [is] an attribute of a noise signal.” Ex. 2010, 111:16–18; Pet. Reply 16 (citing PO Resp. 33–34).

Patent Owner responds that “Petitioner[] do[es] not effectively rebut Patent Owner’s evidence that ‘sound level’ and ‘sound signal’” are different, and that “determining a noise level (an attribute of a noise signal) is not determining *the noise signal itself*.” Sur-reply 10 (emphasis added).

Although not discussed by either party, we note that in the District Court Litigation, the district court agreed with Patent Owner’s contention that “the plain meaning of ‘sound *signal*’ in the context of [claim 14 of the ’400 patent] is not a sound *level*.” *See* District Court Litigation, Docket No. 285 (Claim Construction Order), 29. The district court then stated it would “give each term its plain and ordinary meaning,” without describing what that meaning is for either “signal” or “level.” *Id.*

We conclude it is undisputed that a sound “level” is one attribute of a sound “signal.” *See* Pet. Reply 16; Sur-reply 10. Thus, we are not persuaded by Patent Owner’s contention that Petitioner “equat[es]” these two terms “to mean the same thing.” PO Resp. 33. Patent Owner relies on the Petition’s statement that a person of ordinary skill in the art “would have understood the term ‘noise signal’ [in claim 18] to be interchangeable with ‘noise level’ in claim 1.” Pet. 56 (citing Ex. 1002 ¶ 206). However, the cited testimony of Dr. Stern is more nuanced: “In my opinion, a person of ordinary skill in the art would have understood these terms to mean the same thing *in this context, i.e., that the amplitude of the background noise is considered* when adjusting the one or more frequencies of the internal sound signal and the ambient sound signal.” Ex. 1002 ¶ 206 (emphasis added). In any event, Petitioner’s position and Dr. Stern’s testimony on this point are clarified in the Reply. *See* Pet. Reply 16 (citing Ex. 2010, 111:16–18); Ex. 1016 ¶¶ 29–30 (stating that “in the context of the ’400 patent, no difference exists between determining a background noise level and a background noise signal,” because “[t]o determine a background noise level, a person of ordinary skill in the art would have understood that the background noise signal must first be differentiated from the desired signal”).

d) Conclusion

For the foregoing reasons, we apply Patent Owner’s construction of the term “a background noise signal” in claims 14 and 18 to mean “a function that carries information about noise.” We also recognize that a

“background noise level” as recited in claim 1 is one attribute of a
“background noise signal” as recited in claims 14 and 18.

C. Ground One — Anticipation by Alves

In Ground One, Petitioner argues claims 1, 6–8, 12–15, and 17 of the
'400 patent are unpatentable as anticipated by Alves. *See* Pet. 2, 8–13,
18–34; Ex. 1002 ¶¶ 47–60, 81–126. Patent Owner opposes. *See* PO Resp.
19–39; Ex. 2009 ¶¶ 23–34, 60–85, 93–111.

A patent claim is unpatentable as anticipated under 35 U.S.C. § 102(a)
“if each and every limitation is found either expressly or inherently in a
single prior art reference.” *WhitServe, LLC v. Comput. Packages, Inc.*,
694 F.3d 10, 21 (Fed. Cir. 2012) (quoting *Celeritas Techs., Ltd. v. Rockwell
Int'l Corp.*, 150 F.3d 1354, 1361 (Fed. Cir. 1998)).

We have reviewed the record, and we conclude Petitioner's
contentions are supported by a preponderance of the evidence as to claims 1,
6, 7, 12–14, and 17, but not claims 8 and 15. We begin our analysis with a
summary of Alves, then we address Petitioner's contentions and Patent
Owner's opposition.

I. Alves

Alves discloses a dual microphone headset with noise reduction. *See*
Ex. 1005, code (54). Figure 1 is reproduced below:

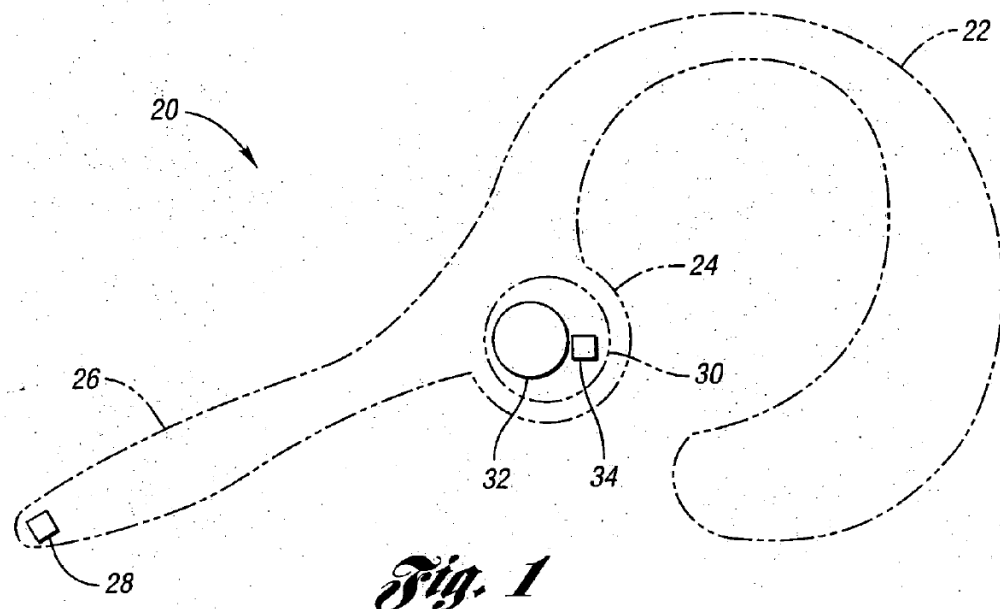


Fig. 1

Figure 1 of Alves.

Figure 1 depicts a schematic diagram of headset 20 formed of curved portion 22 that fits around a wearer's ear, earpiece portion 24 that fits within the wearer's ear, and boom portion 26 that extends toward the wearer's mouth. *See id.* ¶¶ 16, 26. The headset includes first microphone 28, speaker 32, and second microphone 34. *See id.* ¶ 27.

First microphone 28 captures ambient sound from the user's environment. *See id.* at Fig. 1, ¶¶ 8, 26–27. Second microphone 34 captures sound from within the user's ear—specifically, within a chamber formed when earpiece portion 24 fits at least partially into the ear canal to “reduce[] ambient noise from outside the chamber.” *See id.* at Fig. 2 (identifying chamber 62), Fig. 7 (showing headset 20 inserted into ear canal 134 of user 130), ¶¶ 15, 26, 28, 73. Speaker 32 is located within the same chamber, to reproduce a “reduced noise” sound signal to be delivered to the user. *See id.* at Fig. 2, ¶ 28.

Figure 3 is reproduced below:

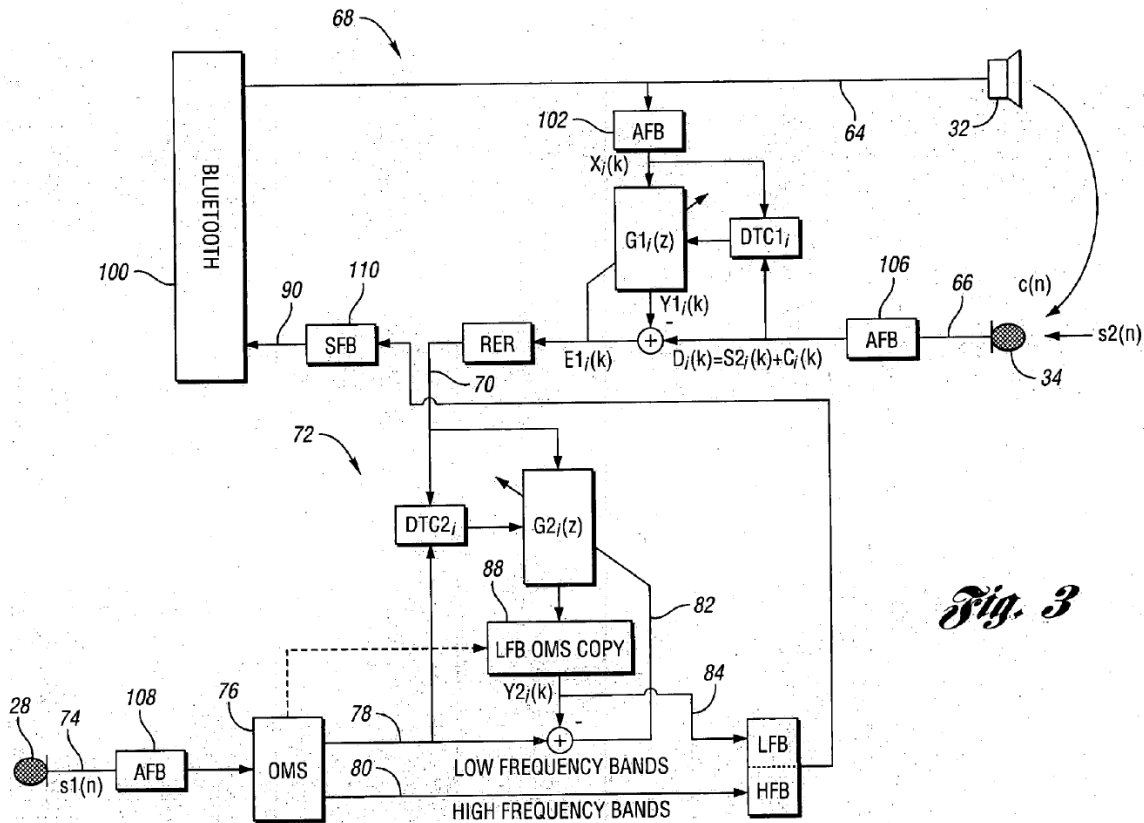


Fig. 3

Figure 3 of Alves.

Figure 3 is a block diagram showing a noise reduction process employed by headset 20. *See id.* ¶¶ 5–7, 18, 33.

First microphone 28 generates signal 74 that is fed to analysis filter bank (AFB) 108, which generates a set of frequency subbands that are outputted to noise reducer 76. *See id.* ¶¶ 31, 33, 36. Noise reducer 76 filters the subbands to eliminate some noise, and divides the result into low frequency first signal 78 and high frequency first signal 80. *See id.* ¶¶ 31, 36. Low frequency first signal 78 feeds adaptive equalizer 72. *See id.*

Second microphone 34 generates signal 66 that is fed to AFB 106, which generates a set of frequency subbands that are outputted to echo reducer 68. *See id.* ¶¶ 30, 33. Echo reducer 68, which is not directly

relevant here, decreases echo effects that result from second microphone 34 being located in the same chamber with speaker 32, and then outputs the result as signal 70 which feeds adaptive equalizer 72. *See id.* ¶ 30.

Adaptive equalizer 72 “adjusts the frequency spectrum of the second signal [70] based on the first signal [78] to produce a filtered signal.” *Id.* ¶ 8; *see also id.* ¶ 13 (“An equalized signal is generated by equalizing the second subbanded signal to the first subbanded signal.”). Specifically, the two signals 70 and 78 are inputted to “double talk detector DTC_{2i} to restrict conditions under which adaptive filters $G_{2i}(z)$ may adapt.” *Id.* ¶ 36. “Adaptive filters $G_{2i}(z)$ filter equalizes echo reducer output 70” to produce an output signal that feeds noise reducer 88, which “produce[s] noise reduced second signal 84, indicated as $Y_{2i}(k)$.” *Id.* “Difference signal 82 is generated as the difference between low frequency first signal 78 and noise reduced second signal 84,” to be “used to set filter coefficients in” adaptive filters $G_{2i}(z)$. *Id.* ¶ 31.

Signal 84 outputted by noise reducer 88, and high frequency first signal 80 outputted by noise reducer 76, are combined by synthesis filter bank (SFB) 110 to generate output signal 90, which is delivered to Bluetooth system 100 for wireless transmission. *Id.* ¶¶ 36, 43.

An exemplary noise reduction algorithm employed by noise reducers 76 and 88 is illustrated in Figure 5. *See id.* ¶¶ 20, 36, 42–43. Figure 5 shows how a speech signal $s(n)$ can be isolated from a noisy speech signal $d(n)$ by canceling background noise $v(n)$, using a frequency-domain based algorithm that operates on frequency subbands. *See id.* ¶¶ 42–43. “In each subband, the average power of quasi-stationary background noise is

tracked, and then a gain is decided accordingly and applied to the subband signals.” *Id.* ¶ 43; *see also id.* ¶¶ 44–50 (describing details of this process).

2. Claim 1

Petitioner provides arguments and evidence in support of contending claim 1 is unpatentable as anticipated by Alves. *See* Pet. 8–13, 18–24; Ex. 1002 ¶¶ 47–60, 82–102; Ex. 1016 ¶¶ 14–25. Patent Owner opposes. *See* PO Resp. 19–28; Ex. 2009 ¶¶ 23–34, 60–79. We address these arguments on a limitation-by-limitation basis.

a) “An earpiece comprising:”

Petitioner argues: “To the extent the preamble is limiting, Alves discloses an earpiece,” as headset 20 with earpiece portion 24. Pet. 18–19 (citing Ex. 1005, Fig. 1, ¶ 26; Ex. 1001, 4:22–24); Ex. 1002 ¶¶ 82–83. Patent Owner does not dispute this contention, and we find it is supported by a preponderance of evidence in the record. For example, headset 20 is formed of curved portion 22 that fits around a wearer’s ear, earpiece portion 24 that fits within the wearer’s ear, and boom portion 26 that extends toward the wearer’s mouth. *See* Ex. 1005, Fig. 1, ¶ 26; *see also* Ex. 1001, 4:22–24 (“The earpiece 100 [of the ’400 patent] can be an in the ear earpiece, behind the ear earpiece, receiver in the ear, open-fit device, or any other suitable earpiece type.”).

b) “at least one Ambient Sound Microphone (ASM) configured to convert an ambient sound to an ambient sound signal”

Petitioner argues Alves discloses an ambient sound microphone, as first microphone 28 which converts ambient sounds to ambient sound signal 74. *See* Pet. 19–20 (citing Ex. 1005 ¶¶ 26–27, 29, 31, 42; Ex. 1001,

6:41–49); Ex. 1002 ¶¶ 84–88. Patent Owner does not dispute this contention, and we find it is supported by a preponderance of evidence in the record. For example, Alves describes how first microphone 28 captures ambient sound from the user’s environment, and generates a corresponding signal 74. *See* Ex. 1005, Figs. 1 and 3, ¶¶ 8, 26–27, 31.

Accordingly, we will refer hereafter to ambient sound signal 74.

c) “at least one Ear Canal Microphone (ECM) configured to convert an internal sound from an ear canal of a user to an internal sound signal and where the internal sound signal includes an internal voice of the user”

Petitioner argues Alves discloses an ear canal microphone, as second microphone 34 which converts an internal sound from an ear canal of a user to internal sound signal 66. *See* Pet. 20–21 (citing Ex. 1005 ¶¶ 27, 29–30); Ex. 1002 ¶¶ 89–94. Petitioner also argues internal sound signal 66 includes an internal voice of the user. *See* Pet. 21 (citing Ex. 1005 ¶¶ 29–30); Ex. 1002 ¶¶ 91–92.

Patent Owner does not dispute these contentions, and we find they are supported by a preponderance of evidence in the record. For example, second microphone 34 captures sound from within the user’s ear canal, and generates a corresponding signal 66. *See* Ex. 1005, Figs. 1–3 and 7, ¶¶ 15, 26, 28, 30, 73. Internal sound signal 66 is “based on the speech spoken by the user” and, therefore, includes an internal voice of the user. *Id.* ¶ 15; *see also id.* ¶ 29 (stating second microphone 34 “will still receive adequate speech signal content from the wearer as sound propagating through structures in the head and into the ear canal of the wearer”). Alves then passes internal sound signal 66 through echo reducer 68, which decreases the echo effects of speaker 32 being located in the same ear chamber 62 as

second microphone 34, and generates output signal 70. *See id.* at Figs. 2–3, ¶¶ 28–30.

Accordingly, we will refer hereafter to internal sound signal 66 and echo-reduced internal sound signal 70.

- d) *“a processor operatively coupled to the at least one ASM and the at least one ECM and which receives the ambient sound signal and the internal sound signal”*

Petitioner argues Alves discloses the processor of claim 1 as “[a]udio processing circuitry [that] generates the reduced noise vocal signal by processing the second signal based on the first signal.” Pet. 22 (quoting Ex. 1005 ¶ 15); Ex. 1002 ¶¶ 95–96. Petitioner asserts Alves’s Figure 3 provides further detail about this audio processing circuitry, including echo reducer 68, adaptive equalizer 72, noise reducer 76, and noise reducer 88, and further establishes that the processor receives ambient sound signal 74 and internal sound signal 66. *See* Pet. 22 (citing Ex. 1005 ¶¶ 29–32); Ex. 1002 ¶¶ 95–96. Patent Owner does not dispute these contentions, and we find they are supported by a preponderance of evidence in the record. *See, e.g.*, Ex. 1005, Fig. 3; *supra* Section III.C.1 (summarizing Alves’s description of Figure 3).

- e) *“where the processor is configured to: determine a background noise level from at least one of the ambient sound signal or the internal sound signal”*

Petitioner argues Alves’s processor is configured to determine a background noise level from at least one of ambient sound signal 74 and internal sound signal 66. *See* Pet. 22–23 (citing Ex. 1005 ¶ 43); Ex. 1002 ¶¶ 97–98. In particular, according to Petitioner: “Alves discloses that its

noise cancellation algorithm splits a noisy signal into subband signals and ‘[i]n each subband, the average power of the quasi-stationary background noise is tracked.’” Pet. 22–23 (quoting Ex. 1005 ¶ 43).

Patent Owner contends Alves does not determine a background noise level. *See* PO Resp. 19–22; Ex. 2009 ¶¶ 61–68. However, this contention is premised on Patent Owner’s limiting construction of claim 1 to require determining a single overall background noise level. *See, e.g.*, PO Resp. 21 (“Petitioners do not contend that Alves determines a ‘background noise level’ under the understanding discussed above, *i.e.*, a single overall background noise level.”); Ex. 2009 ¶¶ 66–68. We have rejected that claim construction for reasons provided in Section III.B.2 above. Therefore, Patent Owner’s attempt to distinguish Alves from claim 1 on this basis is not persuasive.⁴

Moreover, it is undisputed that Alves’s processor determines background noise levels within multiple frequency subbands of ambient sound signal 74. *See, e.g.*, PO Resp. 21–22 (stating “Alves divides the signal received by first microphone 28 into numerous subbands and then . . . estimates the average power of quasi-stationary background noise within each subband” in order to “reduce[] this background noise”) (citing Ex. 1005 ¶¶ 42–43). In particular, Alves states noise reducer 76 “eliminate[s] some noise from” ambient sound signal 74. Ex. 1005, Fig. 3, ¶ 31; *see also id.* ¶ 36 (“These subbands are filtered to reduce noise in noise reducer 76[.]”).

⁴ As a result, we do not reach Petitioner’s alternative contention that Alves anticipates claim 1 even applying Patent Owner’s claim construction, by implementing Alves’s algorithm with $M = 1$ (*i.e.*, with no subbands). *See* Pet. Reply 5 n.3 (citing Ex. 1005 ¶ 43; Ex. 1016 ¶¶ 14–16); Sur-reply 7–9; Tr. 24:15–25:21, 51:16–52:20, 68:23–69:11, 75:4–76:22.

In order to accomplish this noise reduction, Alves provides: “In each subband, the *average power of quasi-stationary background noise is tracked*, and then a gain is decided accordingly and applied to the subband signals.” *Id.* ¶ 43 (emphasis added). We find these disclosures reflect determination of a background noise level from ambient sound signal 74 (that is, from at least one of ambient sound signal 74 and internal sound signal 66, as recited in claim 1).

Accordingly, we will refer hereafter to the output signals of noise reducer 76 as noise-reduced ambient sound signals 78 and 80.

f) “*where the processor is configured . . . to adjust an amplitude of one or more frequencies of the internal sound signal and the ambient sound signal based on the background noise level, to filter the internal sound signal relative to the ambient sound signal*”

Petitioner argues Alves’s processor is configured to adjust an amplitude of one or more frequencies of echo-reduced internal sound signal 70 and ambient sound signal 74 based on the determined background noise level, to filter signal 70 relative to signal 74. *See* Pet. 23–24 (citing Ex. 1005, Fig. 2, ¶¶ 8, 30–32, 36, 43); Ex. 1002 ¶¶ 99–102. Patent Owner disputes these contentions. *See* PO Resp. 22–28; Ex. 2009 ¶¶ 69–79.

We conclude Petitioner’s contentions are supported by a preponderance of the evidence. We organize our discussion according to the claim language at issue, explaining why we find Alves’s processor is configured “[i] to adjust an amplitude of one or more frequencies of the internal sound signal and the ambient sound signal based on the background noise level, [ii] to filter the internal sound signal relative to the ambient sound signal.” Ex. 1001, 12:34–38 (reference numerals [i] and [ii] added).

(i) *Adjusting an Amplitude of One or More Frequencies of the Internal Sound Signal and the Ambient Sound Signal Based on the Background Noise Level*

For the following reasons, we find a preponderance of the evidence supports Petitioner’s contention that Alves’s processor is configured to adjust an amplitude of one or more frequencies of echo-reduced internal sound signal 70 and of ambient sound signal 74, based on the background noise level.

The Internal Sound Signal

Patent Owner contends Alves does not adjust an amplitude of one or more frequencies of echo-reduced internal sound signal 70 based on the background noise level. *See* PO Resp. 22–23. Patent Owner asserts “the filters used by equalizer 72 are selected based on low frequency first signal 78, in which ‘virtually all’ noise has been eliminated by noise reducer 76.” *Id.*; *see also* Ex. 1005 ¶ 75 (“FIG. 8c provides the results of processing due to an embodiment of the present invention” and “illustrate[s] that *virtually all* noise has been eliminated.” (emphasis added)). Patent Owner similarly describes Alves’s noise reducer 76 as “removing” and “virtually eliminat[ing]” background noise from ambient sound signal 74 to generate noise-reduced ambient sound signal 78, thereby “yielding a signal [78] with speech.” PO Resp. 23–24 (annotating Ex. 1005, Fig. 2, and citing Ex. 1005 ¶¶ 31, 75).

Patent Owner submits that the Institution Decision’s annotations to Figure 3 of Alves “omit[] a critical detail, i.e., that background noise was removed at noise reducer 76,” because the Institution Decision colored ambient sound signal 74 and noise-reduced ambient sound signal 78 the

same color (blue), which “fails to reveal that first microphone signal 74 and low frequency first signal 78 differ in that the former includes noise and the latter includes virtually only speech.” PO Resp. 25–26 (citing Inst. Dec. 32–33, and providing modified annotations to Fig. 3 to illustrate the argument); Ex. 2009 ¶ 72. Patent Owner further argues “the Institution Decision incorrectly asserts that ‘if the determination of background noise level by noise reducer 76 changes, then its noise-reduced output signal 78 changes, and the affects of signal 78 on the filtering of signal 70 by adaptive equalizer 72 changes.’” PO Resp. 26 (quoting Inst. Dec. 33). Patent Owner argues that instead, “[i]f the background noise level changes, noise reducer 76 adapts accordingly so that the low frequency first signal 78 remains nearly noise free,” and, according to Patent Owner, Petitioner’s witness “Dr. Stern conceded this point during his deposition.” *Id.* at 26–27 (citing Ex. 2010, 37:6–11). Patent Owner concludes the amplitude adjustments performed by adaptive equalizer 72 on echo-reduced internal sound signal 70 cannot be “based on” the background noise level because “[t]he background noise level is not known by adaptive equalizer 72.” *Id.* at 27.

Patent Owner moreover asserts “[a] person of ordinary skill in the art would not understand that Alves’s equalization process [implemented by adaptive equalizer 72] is ‘based on’ any remnants of background noise that happen to pass through noise reducer 76.” PO Resp. 23, 27–28 (citing Ex. 2009 ¶¶ 77–78). Therefore, Patent Owner argues Dr. Stern’s testimony “that this [‘based on’] limitation would be satisfied in view of imperfections in the Alves [noise reducer 76] that would not completely remove all background noise” within noise-reduced ambient sound signal 78 is not

persuasive, because Dr. Stern’s view of the claim scope “is impermissibly broad.” *Id.* at 27 (citing Ex. 2010, 37:6–38:20⁵).

Petitioner replies that Patent Owner’s opposition “is constructed based on strawman—that ‘Petitioners rely on adaptive equalizer 72 of Alves in an effort to show’” Alves adjusts an amplitude of one or more frequencies of echo-reduced internal sound signal 70 based on a background noise level. Pet. Reply 6. Petitioner explains that its anticipation theory instead relies on the *combination* of noise reducer 76 which produces noise-reduced ambient sound signal 78 “based on” the background noise level, *with* adaptive equalizer 72 which adjusts an amplitude of one or more frequencies in echo-reduced internal sound signal 70 “based on” noise-reduced ambient sound signal 78.⁶ *See id.* at 6–7 (citing Pet. 22–24; Ex. 1005 ¶¶ 30–32, 36–41, 43; Ex. 1016 ¶¶ 21–25; Ex. 1017, 109:3–7, 113:4–17, 116:2–117:16).

Petitioner also argues Patent Owner incorrectly suggests “Alves’s noise reducer 76 alone purportedly eliminates virtually all noise from ambient signal 74.” *Id.* at 1, 6, 7 (citing Inst. Dec. 30–31; Ex. 1005 ¶ 8). Petitioner argues Alves’s description of eliminating “virtually all noise” in paragraph 75 refers to output signal 90 that results from the entirety of Alves’s noise reduction algorithm in Figure 3, not the intermediate noise-reduced ambient sound signal 78 as Patent Owner suggests. *See id.* at 7 (citing Ex. 1005, Figs. 8a–8c, ¶¶ 23, 74–75). According to Petitioner,

⁵ We believe Patent Owner’s citation to “376:–38:20” is a typographical error for “37:6–38:20.”

⁶ Thus, we disagree with Patent Owner’s assertion that Petitioner “remain[s] silent as to what component [of] Alves [Petitioner] alleges performs the amplitude adjustment and filtering.” Sur-reply 10.

Dr. Stern and Mr. Kleinschmidt agree with this understanding. *See id.* at 1, 7–8 (citing Ex. 2010, 37:6–22; Ex. 1017, 56:22–57:9, 70:17–71:7).

We find Alves adjusts the amplitude of one or more frequencies of echo-reduced internal sound signal 70 based on the background noise level. In particular, we agree with Petitioner’s contention that the combination of noise reducer 76 and adaptive equalizer 72 does this, for the following reasons.

First, noise reducer 76 reduces noise within ambient sound signal 74 *based on* the background noise level, to produce noise-reduced ambient sound signal 78. *See* Ex. 1005, Fig. 3. In particular, Alves discloses that, in an exemplary noise cancellation algorithm applied by noise reducer 76, “the average power of quasi-stationary background noise is tracked, *and then a gain is decided accordingly and applied* to the subband signals.” *Id.* ¶ 43 (emphasis added); *accord id.* ¶ 31.

Second, adaptive equalizer 72 adjusts echo-reduced internal sound signal 70 *based on* noise-reduced ambient sound signal 78. *See id.* at Fig. 3. “Adaptive equalizer 72 *adjusts the output of second microphone 34 to the spectral characteristics of the speech signal received by first microphone [28].*” *Id.* ¶ 32 (emphasis added). Alves also describes how equalizer 72 “adjusts the frequency spectrum of the second signal [i.e., echo-reduced internal sound signal 70] based on the first signal [i.e., noise-reduced ambient sound signal 78] to produce a filtered signal.” *Id.* ¶ 8. These adjustments are based on signal 78 because signal 78 is used as a control input to double talk controller DTC2_i. *See id.* at Fig. 3 (line 78 extending out of the noise reducer 76 block to the right, and then up to the DTC2_i block), ¶¶ 34, 36. These adjustments are based on signal 78 also

because signal 78 is used as a control input to adaptive filters $G2_i(z)$. *See id.* at Fig. 3 (line 78 extending out of the noise reducer 76 block to the right to the “+” circle and then to line 82 leading to the $G2_i(z)$ block), ¶¶ 31–32, 34, 36. In both of these ways, adaptive equalizer 72 uses noise-reduced ambient sound signal 78 as a control input for its adaptive equalization of echo-reduced internal sound signal 70.

The noise reduction performed by noise reducer 76 based on the background noise to generate noise-reduced ambient sound signal 78 is an important initial step, which leads to the equalization performed by adaptive equalizer 72 based on signal 78. These two steps are performed in combination, in the order specified, to adjust the output of second microphone 34 to the spectral characteristics of the speech signal received by first microphone 28. *See id.* at Fig. 3, ¶¶ 31–32, 36. We conclude the adjustments to echo-reduced internal sound signal 70 by adaptive equalizer 72 are *based on* the background noise level *because* noise is removed from signal 78 *as part of* the adjustments. This is sufficient to satisfy claim 1 in this regard.

Patent Owner’s opposition implicitly construes claim 1 to require that the background noise level determined by noise reducer 76 must be fed to adaptive equalizer 72, in order for the adjustments performed by equalizer 72 to be “based on” the background noise level as claimed. *See, e.g.,* PO Resp. 27 (“The background noise level is not known by adaptive equalizer 72.”). This implicit construction is unsupported by any claim construction analysis, particularly of the term “based on,” and is therefore not persuasive. From the present record, we conclude the combined processing of Alves’s noise reducer 76 and adaptive equalizer 72 is

sufficient for the adjustments performed by the latter to be “based on” the background noise level determined and applied by the former, as recited in claim 1.

To be clear, we do not rely here on the Institution Decision’s preliminary finding that “if the determination of background noise level by noise reducer 76 changes, then its noise-reduced output signal 78 changes, and the affects of signal 78 on the filtering of signal 70 by adaptive equalizer 72 changes.” Inst. Dec. 33. We instead recognize that the purpose of noise reducer 76 is to reduce noise within ambient sound signal 74 by producing noise-reduced ambient sound signal 78.

We need not resolve the parties’ dispute as to the amount of noise removed from signal 74 to generate signal 78. Instead, based on the record presented, we conclude Petitioner’s contentions are supported by a preponderance of the evidence *even if* noise reducer 76 in fact eliminates all noise in signal 78, for the reasons set forth above relying on the combination of noise reducer 76 and adaptive equalizer 72.

Third and finally, we find the adjustments to echo-reduced internal sound signal 70 by adaptive equalizer 72 are amplitude adjustments of one or more frequencies of signal 70, as recited by claim 1. Alves correspondingly describes how adaptive equalizer 72 “*adjusts*” signal 70 “*to the spectral characteristics* of the speech signal received by first microphone [28]” and “*adjusts the frequency spectrum* of” signal 70 “to produce a filtered signal.” Ex. 1005, Fig. 3, ¶¶ 8, 32 (emphases added).

For the foregoing reasons, we find Alves’s processor is configured to adjust an amplitude of one or more frequencies of echo-reduced internal sound signal 70 based on the background noise level.

The Ambient Sound Signal

Concerning ambient sound signal 74, Patent Owner argues only that Alves does not determine a background noise level in the first instance, so a determined background noise level cannot be used to adjust an amplitude of one or more frequencies of signal 74. *See* PO Resp. 19–28. For reasons provided in Section III.C.2(e) above, this argument is not persuasive.

Furthermore, we find a preponderance of the evidence supports Petitioner’s otherwise unopposed contention that Alves’s processor is configured to adjust an amplitude of one or more frequencies of ambient sound signal 74, based on the background noise level. Alves correspondingly discloses applying noise reducer 76 to ambient sound signal 74, to generate noise-reduced ambient sound signal 78. *See* Ex. 1005, Fig. 3, ¶¶ 31–32; Ex. 1002 ¶¶ 99–100. In noise reducer 76, “the average power of quasi-stationary background noise is tracked, and then *a gain is decided accordingly and applied* to the subband signals.” Ex. 1005 ¶ 43 (emphasis added). Petitioner’s witness Dr. Stern testifies that this gain application corresponds to the amplitude adjustment recited in claim 1. *See* Ex. 1002 ¶¶ 99–100 (“A person of ordinary skill in the art would have understood applying a gain to a signal as ‘adjusting the amplitude.’”). Patent Owner’s witness Mr. Kleinschmidt does not disagree with this testimony from Dr. Stern. *See* Ex. 2009 ¶¶ 69–79 (discussing amplitude adjustment of the internal sound signal, but not the ambient sound signal). We are persuaded by Dr. Stern’s unopposed testimony in this regard. *See, e.g.,* PO Resp. 26 (agreeing that Alves provides an “amplitude adjustment of ambient sound signal 74 by noise reducer 76 to reduce background noise in [noise-reduced] ambient sound signal 78”).

For the foregoing reasons, we find Alves's processor is configured to adjust an amplitude of one or more frequencies of ambient sound signal 74 based on the background noise level.

(ii) *Amplitude Adjustments To Filter Internal Sound Signal Relative to Ambient Sound Signal*

For the following reasons, we find a preponderance of the evidence supports Petitioner's contention that Alves's adaptive equalizer 72 performs amplitude adjustments on echo-reduced internal sound signal 70 (*see* Section III.C.2(f)(i) *supra*) to filter signal 70 relative to ambient sound signal 74.

Patent Owner suggests that the *filtering* of claim 1, like the *amplitude adjustments* of claim 1, must be "based on" the determined background noise level. *See* PO Resp. 27–28 ("A person of ordinary skill in the art would not understand the 'based on' limitation to be satisfied if background noise influenced amplitude adjustment *or filtering* to only an imperceptible extent," and "Dr. Stern overlooks the claim requirement that the amplitude adjustment *and filtering* must be based on the background noise level." (emphases added)). Petitioner replies that "claim 1 does not require filtering based on the background noise level," and "claim 1 requires only the amplitude adjustment to be based on the background noise level." Pet. Reply 10–11 n.5.

We agree with Petitioner. Claim 1 requires the "adjust an amplitude" step to be "based on the background noise level" (Ex. 1001, 12:34–37), but the succeeding "to filter" step is not required to be based on the background noise level (*id.* at 12:37–38). Therefore, Patent Owner's attempt to distinguish Alves from claim 1 on the basis that the filtering of echo-reduced

internal sound signal 70 by adaptive equalizer 72 is not based on the background noise level relies on an unclaimed limitation, and therefore is not persuasive.

Moreover, it is otherwise undisputed that Alves's amplitude adjustments to ambient sound signal 74 and echo-reduced internal sound signal 70 are performed to filter signal 70 relative to signal 74. Alves correspondingly describes how adaptive equalizer 72 has "filter coefficients" (Ex. 1005 ¶ 31), such that double talk controller DTC2_i "restrict[s] conditions under which *adaptive filters* $G2_i(z)$ may adapt" and "[a]*daptive filters* $G2_i(z)$ *filter equalizes* echo reducer output 70" (*id.* ¶ 36 (emphases added)). This filtering further is performed relative to ambient sound signal 74. *See id.* ¶ 32 ("Adaptive equalizer 72 adjusts the output of second microphone 34 to the spectral characteristics of the speech signal received by first microphone 28."); *id.* ¶ 8 (stating "equalizer [72] adjusts the frequency spectrum of the second signal [i.e., echo-reduced internal sound signal 70] based on the first signal [i.e., noise-reduced ambient sound signal 78] to produce a filtered signal"). Dr. Stern testifies that "[a] person of ordinary skill in the art would have understood that 'adjusting' to be filtering" as recited in claim 1, and this is demonstrated by Alves's own description of using "adaptive filters $G2_i(z)$ " in adaptive equalizer 72 to "filter" signal 70. Ex. 1002 ¶ 101 (citing Ex. 1005 ¶ 36); Pet. 24.

For the foregoing reasons, we find Alves's processor is configured to perform amplitude adjustments of ambient sound signal 74 and echo-reduced internal sound signal 70, to filter the latter relative to the former.

g) *Conclusion Regarding Claim 1*

We conclude Petitioner has established by a preponderance of the evidence that claim 1 is unpatentable as anticipated by Alves.

3. *Claim 6*

Claim 6 recites: “The earpiece of claim 1 where a filter characteristic for filtering the internal sound signal relative to the ambient sound signal is selected based on a level of the background noise level.” Ex. 1001, 12:60–63.

Petitioner contends this limitation is disclosed by Alves, because “the conditions under which adaptive filters $G2_i(z)$ adapt are restricted based in part on” noise-reduced ambient sound signal 78. Pet. 24–25; Ex. 1002 ¶¶ 103–104. Petitioner further asserts noise reducer 76 generates signal 78 by “reduc[ing] noise based on the ‘the average power of the quasi-stationary background noise,’” which a person of ordinary skill in the art would have understood to correspond to *a level* of the background noise level, as recited in claim 6. Pet. 25 (quoting in part Ex. 1005 ¶ 43); Ex. 1002 ¶ 104.

Patent Owner argued in the Preliminary Response that although signal 78 does “contribut[e] to the conditions under which adaptive filters $G2_i(z)$ adapt” by “relat[ing] to *whether* filters adapt (change),” claim 6 instead requires “selecting a filter characteristic” which “relates to *filter values* (characteristics) when there is an adaptation (change).” Inst. Dec. 35 (quoting Paper 9, 27–28). We preliminarily concluded “the breadth of the claim language encompasses selecting whether a filter adapts, as well as selecting filter values to be applied if there is an adaptation,” because “a filter ‘characteristic’ may be whether or not the filter modifies the

incoming signal, as well as determining how the signal is modified if there is a modification.” *Id.* We now maintain that construction, to which Patent Owner has waived objection by not raising opposing argument in the Patent Owner Response. *See* Paper 13, 10 (“Patent Owner is cautioned that any arguments for patentability not raised in the response may be deemed waived.”).

Indeed, Patent Owner now does not argue for patentability of claim 6 separately from its parent claim 1. *See, e.g.*, PO Resp. 29–32 (arguing dependent claims 7 and 8, but not dependent claim 6, separately from claim 1).

We find Alves’s processor selects a filter characteristic for filtering echo-reduced internal sound signal 70 relative to ambient sound signal 74 based on a level of the background noise level, as required by claim 6, for at least two reasons. First, as discussed in Section III.C.2(f) above, noise-reduced ambient sound signal 78 is based on a level of the background noise level, and signal 78 is used as a control input to double talk controller DTC2_i. *See* Ex. 1005, Fig. 3, ¶¶ 34, 36. Double talk controller DTC2_i then “restricts the conditions under which adaptive filters G2_i(z) adapt” in filtering signal 70 (*id.* ¶ 36), which corresponds to selecting a filter characteristic as recited in claim 6.

Second, also as discussed in Section III.C.2(f) above, Alves’s adaptive equalizer 72 uses signal 78 as a control input to adaptive filters G2_i(z) via difference signal 82. *See* Ex. 1005, Fig. 3, ¶¶ 31–32, 34, 36. Difference signal 82 is “based on” a level of the background noise level as claimed, because signal 78 is based on a background noise level, and signal 82 is the difference between output signal 84 and signal 78. *See id.*; Section III.C.2(f)

supra. In this way, a filter characteristic of adaptive filters $G2_i(z)$ for filtering echo-reduced internal sound signal 70 relative to ambient sound signal 74 is selected based on a level of the background noise level, as recited in claim 6. *See also* Ex. 1005 ¶ 31 (“Difference signal 82 is used to set the filter coefficients in dynamic/adaptive equalizer 72.”).

We conclude Petitioner has established by a preponderance of the evidence that claim 6 is unpatentable as anticipated by Alves.

4. Claim 7

Claim 7 recites: “The earpiece of claim 1 where a filter characteristic for filtering the internal sound signal relative to the ambient sound signal is selected based on a spectral profile of the background noise level.”

Ex. 1001, 12:64–67.

Petitioner contends this limitation is disclosed by Alves, because adaptive equalizer 72 uses adaptive filters $G2_i(z)$ to “*adjust[] [echo-reduced internal sound signal 70] to the spectral characteristics of*” noise-reduced ambient sound signal 78, in which some background noise has been eliminated by noise reducer 76. Ex. 1005 ¶¶ 31–32 (emphasis added) (cited at Pet. 25–26); Ex. 1002 ¶ 105. In particular, according to Petitioner, a person of ordinary skill in the art “would have recognized that ‘the average power of the quasi-stationary background noise’” determined and used by noise reducer 76 “is represented as a spectral profile of the background noise level” per claim 7.⁷ Pet. 26 (quoting in part Ex. 1005 ¶ 43; citing Ex. 1002

⁷ The Petition also refers to Alves disclosing “that a filter characteristic . . . is selected based on *a level* of the background noise level” as being pertinent to claim 7. Pet. 26 (emphasis added). We do not rely on this statement in

¶¶ 105–106). Dr. Stern testifies in support that “Alves confirms this by disclosing that the output characteristics of the second microphone [34] output are adjusted to the spectral characteristics of the speech signal received from the first microphone [28].” Ex. 1002 ¶¶ 106–107 (citing Ex. 1005 ¶ 32).

In the Institution Decision, we considered Patent Owner’s Preliminary Response argument that the Petition errs in relying on Alves’s estimation of background noise “power” (Ex. 1005 ¶ 43) as corresponding to both of a noise “level” in claim 1 and a noise “spectral profile” in claim 7. *See* Inst. Dec. 37. We concluded “Patent Owner appear[ed] to have a point” based on the preliminary record, because “the ’400 patent appears to differentiate between the level and the spectral profile of a noise signal.” *Id.* (citing Ex. 1001, 1:64–67, 7:8–13, 14:3–8 (claim 17)). We stated Dr. Stern had not explained sufficiently “why Alves’s process adapts filters $G_{2,i}(z)$ based on a *spectral profile* of background noise,” “when Alves discloses only that the ‘power’ of background noise is used to generate [noise-reduced] ambient sound signal 78.” *Id.* at 37–38 (citing Ex. 1002 ¶¶ 105–107; Ex. 1005 ¶¶ 32, 43).

The Patent Owner Response continues to maintain that Alves does not disclose filtering echo-reduced internal sound signal 70 based on a spectral profile of the background noise level. *See* PO Resp. 29–31; Ex. 2009 ¶¶ 80–83. In support, Patent Owner contends “Alves reduces or removes background noise immediately after it is received by first microphone 28” via noise reducer 76, so “[t]he spectral profile associated with the

support of this Decision as it relates to claim 7. *See, e.g.*, PO Resp. 30–31 (arguing a “level” is different from a “spectral profile”); Ex. 2009 ¶ 83.

background noise level . . . does not serve as the basis for selecting a filter characteristic for equalizer 72.” PO Resp. 29 (citing Ex. 1005, Fig. 2, ¶ 36); Ex. 2009 ¶¶ 81–82. Further according to Patent Owner, “[a]daptive equalizer 72 adjusts the output of the second microphone 34 to the spectral characteristics of the *speech signal* received by the first microphone 28,” not the background noise received by first microphone 28 which “*is reduced or eliminated* by noise reducer 76.” PO Resp. 29–30 (quoting in part Ex. 1005 ¶ 32); Ex. 2009 ¶ 82. Patent Owner further asserts “the spectral profile associated with the background noise is never determined by Alves.” PO Resp. 29.

Petitioner replies that Alves discloses filtering echo-reduced internal sound signal 70 based on a spectral profile of the background noise, “by virtue of its subband processing.” Pet. Reply 11 (citing Ex. 1005 ¶ 43). In support, Petitioner contends a person of ordinary skill in the art “would have understood that a spectral profile of the background noise is ‘represented by the estimates of power in the individual frequency bands that [are] part of the processing in 76, the noise reduction block, and 88.’” *Id.* at 11–12 (citing Ex. 1016 ¶ 26; Ex. 1017, 27:7–17; Ex. 2009 ¶ 83; Ex. 2010, 88:18–21, 89:15–19). Petitioner therefore concludes noise reducers 76 and 88 are both “based on a spectral profile of the background noise by tracking the power or intensity of the background noise as a function of, or according to, frequency components and adjusting the gain of the signals accordingly.” *Id.* at 12. Petitioner reiterates its arguments concerning claims 1 and 6, relating to how the noise reduction performed by noise reducer 76 carries forward via signal 78 as a control input to double talk controller DTC2_i and

adaptive filters $G_{2,i}(z)$ to filter signal 70. *See id.* at 12–13 (citing Ex. 1016 ¶¶ 24–26).

Patent Owner replies that Petitioner has “failed to supplement the record since the Board [preliminarily] concluded that Alves does not disclose the limitation[]” of claim 7 in the Institution Decision.

Sur-reply 11. According to Patent Owner, Petitioner’s Reply “simply recite[s] disparate disclosures of Alves and allege[s] that the limitations are satisfied.” *Id.* at 11–12 (citing Pet. Reply 12–13). As can be seen from our summary of Petitioner’s Reply above, we disagree with this characterization. We conclude Petitioner’s Reply does supplement the record to explain more fully Petitioner’s contention that Alves discloses the limitation recited in claim 7, as contemplated by the CTPG. *See* CTPG 73 (“The Board will permit the petitioner, in its reply brief, to address issues discussed in the institution decision” and “[a] party also may submit rebuttal evidence in support of its reply.”).

Patent Owner also argues that to the extent Petitioner has attempted to change its theory, “the Board need not figure out what among the cited disclosures is meant to align with” the limitation of claim 7, because Petitioner has failed to meet its burden of proof under 35 U.S.C. § 316(e) by clearly articulating a theory of unpatentability. Sur-reply 12. For the following reasons, however, we conclude a preponderance of the evidence supports Petitioner’s contention that Alves discloses the limitation of claim 7.

We find Alves’s processor selects a filter characteristic for filtering echo-reduced internal sound signal 70 relative to ambient sound signal 74 based on a spectral profile of the background noise level, as required by

claim 7. In particular, noise-reduced ambient sound signal 78 is based on a spectral profile of the background noise level, because noise reducer 76 generates signal 78 by tracking the average power of background *in frequency subbands* of ambient sound signal 74. *See* Ex. 1005, Fig. 3, ¶ 43. This collection of frequency subbands corresponds to a spectral profile of the background noise level, as claimed. Alves further describes how adaptive equalizer 72 adjusts echo-reduced internal sound signal 70 “to the spectral characteristics of” noise-reduced ambient sound signal 78, in which some background noise has been eliminated by noise reducer 76. Ex. 1005 ¶¶ 31–32.

Thus, for substantially the same reasons discussed above in connection with claims 1 and 6, the combination of noise reducer 76 and adaptive equalizer 72 selects a filter characteristic for filtering signal 70 relative to signal 74, based on a spectral profile of the background noise level. That is, noise reducer 76 eliminates some noise from signal 74 based on the background noise spectral profile, and the resulting noise-reduced signal 78 is then used as a control input to adaptive equalizer 72.

We conclude Petitioner has established by a preponderance of the evidence that claim 7 is unpatentable as anticipated by Alves.

5. Claim 8

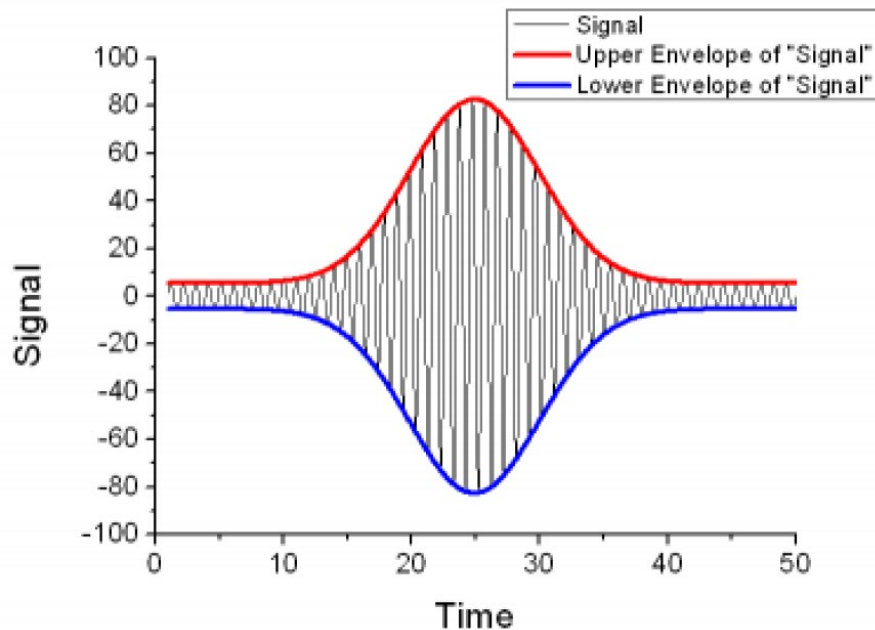
Claim 8 recites: “The earpiece of claim 1 where a filter characteristic for filtering the internal sound signal relative to the ambient sound signal is selected based on an envelope fluctuation of the background noise level.” Ex. 1001, 13:1–4.

a) *Claim Construction — “envelope fluctuation”*

Claim 8 recites selecting a filter characteristic “based on an *envelope fluctuation* of the background noise level.” Ex. 1001, 13:1–4 (emphasis added). Claims 17 and 20 similarly refer to an “envelope fluctuation” of a background noise signal. *See id.* at 14:3–8 (claim 17), 14:36–41 (claim 20).

In the Institution Decision, we construed the term “envelope fluctuation” to mean “a curved line connecting peaks . . . of an audio signal” as Patent Owner had partially proposed. Inst. Dec. 21, 39–40. However, we rejected Patent Owner’s inclusion of a “mean square” or a “root mean square” calculation as part of the claim. *Id.* at 40.

Patent Owner now accepts that “mean square” and “root mean square” calculations are not part of the term “envelope fluctuation.” *See* PO Resp. 17. However, Patent Owner submits the Institution Decision’s construction of the two-word term “envelope fluctuation” applies better to the single word “envelope” standing alone. *Id.* Thus, Patent Owner’s position is that the term “envelope fluctuation” should be construed in accordance with its ordinary and customary meaning, wherein the plain and ordinary meaning of “envelope” is “**a curved line connecting peaks of an audio signal.**” *Id.* at 16–17; Ex. 2009 ¶¶ 49–51. Mr. Kleinschmidt provides the following illustration in support of Patent Owner’s claim construction:



Mr. Kleinschmidt's Illustration of Signal Envelopes.

This illustration shows an oscillating acoustic “Signal” as a black line, plotted on a vertical scale of an unspecified unit varying between –100 and 100, over a horizontal scale showing “Time” from 0 to 50. *See* Ex. 2009 ¶ 50. The illustration identifies the “Upper Envelope” of the acoustic signal as a red line, and the “Lower Envelope” of the acoustic signal as a blue line. *See id.* Mr. Kleinschmidt testifies “a person of ordinary skill in the art would have understood that in temporal signals there may be an upper envelope associated with a curve that connects the positive peak values while a lower envelope connects the negative (i.e., lower) peak values of an oscillating acoustic signal.” *Id.*

Patent Owner argues “[t]echnical dictionaries are in accord” with Mr. Kleinschmidt’s foregoing testimony. PO Resp. 17 (citing Ex. 2005, 199). Specifically, the *Oxford Dictionary of Electronics and Electrical Engineering* defines “envelope” as “[a] smooth curved outline giving the

shape of an oscillating signal whose amplitude varies over time,” and includes an illustration similar to Mr. Kleinschmidt’s. Ex. 2005, 199.

Petitioner replies that it “agrees to” the construction of the term “envelope” in the Institution Decision. Pet. Reply 2.

Upon review of the foregoing, we construe the claim term “envelope” to mean “a curved line connecting peaks of an audio signal,” for the reasons provided in the Patent Owner Response and summarized above. This differs from the Institution Decision, which applied the same construction to the two-word term “envelope fluctuation” rather than the single term “envelope” as we do here, because we agree with Patent Owner that this makes more sense. Petitioner’s Reply does not materially disagree, despite this issue having been raised in the Patent Owner Response. *See* PO Resp. 17; Pet. Reply 2; Tr. 7:25–8:5. Thus, we construe the term “envelope fluctuation” in claims 8, 17, and 20 to mean a fluctuation of a curved line connecting peaks of an audio signal.

b) Application to Alves

Petitioner contends the limitation of claim 8 is disclosed by Alves, because noise reducer 76 tracks background noise power in frequency subbands, by applying a recursive estimator that “allows smooth transitions [in the background noise power] to be tracked but prevents any dramatic variation from affecting the noise estimate.” Pet. 26–27 (citing Ex. 1005 ¶¶ 44–45); Ex. 1002 ¶¶ 108–111. “More specifically, Alves notes that ‘the exact background noise power at any given time fluctuates around an average power even if the noise is stationary.’” Pet. 27 (quoting Ex. 1005 ¶ 48); Ex. 1002 ¶ 111. Dr. Stern concludes these disclosures reflect

“tracking fluctuations of the background noise power (‘envelope fluctuation of the background noise power’) as part of noise reduction.” Ex. 1002 ¶ 112; Pet. 27.

In the Institution Decision, we considered Patent Owner’s Preliminary Response argument that Alves does not disclose selecting a filter characteristic based on an envelope fluctuation of the background noise level. *See* Inst. Dec. 38–41. We concluded “Patent Owner appear[ed] to have a point” because Dr. Stern had not explained sufficiently “why Alves’s process adapts filters $G2_i(z)$ based on an *envelope fluctuation* of background noise.” Inst. Dec. 40–41 (citing Ex. 1002 ¶¶ 108–112).

The Patent Owner Response continues to maintain that Alves does not disclose filtering signal 70 based on an envelope fluctuation of the background noise level. *See* PO Resp. 31–32; Ex. 2009 ¶¶ 80–81, 84. In support, Patent Owner contends Petitioner improperly equates: “(1) the selection of a filter characteristic based on a *level* of the background noise level . . . and (2) the selection of a filter characteristic based on an *envelope fluctuation* of the background noise level.” PO Resp. 31 (citing Ex. 1001, 14:3–8 (claim 17)); Ex. 2009 ¶¶ 84–85.

Petitioner replies that Alves discloses filtering signal 70 based on an envelope fluctuation of the background noise level, “through the function of its noise reduction block [76 or 88],” which tracks “the average power” of background noise in each frequency subband. Pet. Reply 13 (citing Ex. 1005 ¶ 43). Petitioner contends “[t]he power of the background noise varies as a function of time,” and Dr. Stern explains Alves’s tracking of background noise power in each frequency subband “corresponds to tracking the ‘envelope’ of the noise.” *Id.* at 13–14 (citing Ex. 1005 ¶¶ 23, 43–44,

74–75, Fig. 8; Ex. 1016 ¶¶ 27–28; Ex. 2010, 100:1–7, 100:24–101:11). Petitioner contends Dr. Stern and Mr. Kleinschmidt agree that Alves’s Figure 8a discloses “tracking the envelope of the background noise of the ambient and internal sound signals.” *Id.* at 14 (citing Ex. 1016 ¶ 27; Ex. 1017, 137:3–11). Petitioner reiterates its arguments concerning claims 1 and 6, relating to how the noise reduction performed by noise reducer 76 carries forward via signal 78 as a control input to double talk controller DTC2_i and adaptive filters G2_i(z) to filter signal 70. *See id.* at 14–15 (citing Ex. 1016 ¶ 28).

Patent Owner responds that Petitioner has “failed to supplement the record since the Board [preliminarily] concluded that Alves does not disclose the limitation[]” of claim 8 in the Institution Decision. Sur-reply 11. According to Patent Owner, Petitioner’s Reply “simply recite[s] disparate disclosures of Alves and allege[s] that the limitations are satisfied.” *Id.* at 11–12 (citing Pet. Reply 13–15). As can be seen from our summary of Petitioner’s Reply above, we disagree with this characterization. We conclude Petitioner’s Reply does supplement the record to explain more fully Petitioner’s contention that Alves discloses the limitation recited in claim 8, as contemplated by the CTPG. *See* CTPG 73.

Nonetheless, we conclude a preponderance of the evidence does not support Petitioner’s contention that Alves discloses the limitations of claim 8. Dr. Stern’s original supporting declaration testimony is that Alves tracks the *power* of background noise present in frequency subbands of ambient sound signal 74 over time, which Alves states “*fluctuates* around an average power.” Ex. 1005 ¶ 48 (emphasis added); *see* Ex. 1002 ¶¶ 108–111 (citing Ex. 1005 ¶¶ 44–45, 48). Dr. Stern then concludes “a person of

ordinary skill in the art would have understood that Alves describes *tracking fluctuations* of the background noise power,” thereby satisfying claim 8 because it corresponds to tracking an “*envelope fluctuation* of the background noise power.” Ex. 1002 ¶ 112 (emphases added).

We maintain our previous conclusion that this testimony “does not sufficiently explain . . . why Alves’s process adapts filters $G_{2i}(z)$ based on an *envelope fluctuation* of background noise.” Inst. Dec. 40. In particular, although Alves tracks the fluctuating background noise power present in frequency subbands of ambient sound signal 74 over time, the Alves disclosures cited by Dr. Stern do not describe using fluctuations in *a curved line connecting peaks of an audio signal* to select a filter characteristic as required by claim 8. See Inst. Dec. 40–41 (citing Ex. 1002 ¶¶ 108–112; Ex. 1005 ¶¶ 44–45, 48). Selecting a filter characteristic based on individual fluctuations of background noise power in frequency subbands (as Alves discloses) is not the same as selecting a filter characteristic based on fluctuations in a curved line connecting the peaks of those individual power fluctuations (as claim 8 requires). Dr. Stern’s original declaration testimony is too conclusory to bridge this gap persuasively. See Ex. 1002 ¶¶ 108–112; Inst. Dec. 40–41.

Dr. Stern’s reply declaration is similarly unpersuasive. See Ex. 1016 ¶¶ 27–28. Here, Dr. Stern cites Alves’s Figure 8a as “depict[ing] the noise signal from the external microphone 28 (noise signal 140) and internal microphone 34 (noise signal 142) tracked as a function of time.” *Id.* ¶ 27 (citing Ex. 1005 ¶ 75). He then states “[a] person of ordinary skill in the art would have understood that tracking the noise level of the external sound signal as a function of time *represents an envelope*” and “as the noise level

of the external sound signal varies over time, *the envelope fluctuates.*” *Id.* ¶ 28.

We agree with Dr. Stern that the background noise power present in each frequency subband of Alves’s ambient sound signal 74 fluctuates over time, and therefore there theoretically is a corresponding fluctuation in a curved line connecting peaks of those individual power fluctuations. We part ways from Dr. Stern’s testimony, however, in his conclusion that Alves selects a filter characteristic based on fluctuations in such a curved line. Again, selecting a filter characteristic based on individual fluctuations of background noise power in frequency subbands (as Alves discloses) is not the same as selecting a filter characteristic based on fluctuations in a curved line connecting the peaks of those individual power fluctuations (as claim 8 requires).

We conclude Petitioner has not established by a preponderance of the evidence that claim 8 is unpatentable as anticipated by Alves.

6. Claim 12

Claim 12 recites: “The earpiece of claim 1 where frequency-domain multiplication is used to filter at least one of the ambient sound signal or the internal sound signal.” Ex. 1001, 13:14–16.

Petitioner contends this limitation is performed by Alves’s adaptive filters $G2_i(z)$ to filter echo-reduced internal sound signal 70. *See* Pet. 27–28; Ex. 1002 ¶¶ 113–114. In particular, Alves describes these filters as applying a “second-order data reuse normalized least mean square (DR-NLMS) algorithm in the frequency domain.” Ex. 1005 ¶ 37. Dr. Stern testifies a person of ordinary skill in the art “would have understood that an adaptive

filter using a DR-NLMS algorithm in the frequency domain employs frequency domain multiplication.” Ex. 1002 ¶ 113.

Patent Owner does not argue for patentability of claim 12 separately from its parent claim 1. *See, e.g.*, PO Resp. 29–32 (arguing dependent claims 7 and 8, but not dependent claim 12, separately from claim 1).

We conclude Petitioner has established by a preponderance of the evidence that claim 12 is unpatentable as anticipated by Alves, for the reasons provided above in connection with the parent claim 1, and based further on Petitioner’s unopposed argument directed to the limitation added by claim 12, which we adopt as our own.

7. *Claim 13*

Claim 13 recites: “The earpiece of claim 1 where an adaptive filter is used to filter at least one of the ambient sound signal or the internal sound signal.” Ex. 1001, 13:17–19.

Petitioner contends this limitation is disclosed by Alves, because “Alves discloses an adaptive filter $G2_i(z)$ to filter the internal sound signal,” as Petitioner argues in relation to the parent claim 1. Pet. 28; Ex. 1002 ¶ 115.

Patent Owner does not argue for patentability of claim 13 separately from its parent claim 1. *See, e.g.*, PO Resp. 29–32 (arguing dependent claims 7 and 8, but not dependent claim 13, separately from claim 1).

We conclude Petitioner has established by a preponderance of the evidence that claim 13 is unpatentable as anticipated by Alves, for the reasons provided above in connection with the parent claim 1, and based

further on Petitioner’s unopposed argument directed to the limitation added by claim 13, which we adopt as our own.

8. *Claim 14*

Claim 14 is an independent claim, reciting a method for acoustic management control. *See* Ex. 1001, 13:20–36.

To the extent the preamble (“A method for acoustic management control”) is limiting, we agree with Petitioner’s unopposed contention that it is disclosed by Alves. *See* Pet. 28–29 (citing Ex. 1005 ¶¶ 13–14); Ex. 1002 ¶¶ 116–117. In particular, Alves discloses that its process may be used to generate “a reduced noise vocal signal” delivered to the wearer of Alves’s headset 20 via speaker 32. Ex. 1005 ¶ 13; *see id.* at Figs. 1–3, ¶¶ 30, 36.

Claim 14 next recites “providing an acoustic barrier to an ear canal of a user.” Ex. 1001, 13:22. We agree with Petitioner’s unopposed contention that this is disclosed by Alves. *See* Pet. 29–30 (citing Ex. 1005, Fig. 7, ¶ 13); Ex. 1002 ¶ 118. In particular, Alves discloses that insertion portion 30 of earpiece 24 “forms a chamber with an ear when the earpiece is in contact with the ear” such that “second microphone 34 will receive less noise than first microphone 28,” because the fit “permits reception of conveyed sound while limiting interference by external noise.” Ex. 1005, Figs. 1 and 7, ¶¶ 13, 26, 73.

Claim 14 further recites capturing an ambient sound from an ASM to produce an ambient sound signal that includes an external voice of the user, and capturing an internal sound from an ECM to produce an internal sound signal that includes an internal voice of the user. *See* Ex. 1001, 13:23–29. We agree with Petitioner’s unopposed contention that Alves discloses an

ASM and an ECM, for reasons provided in Sections III.C.2(b)–(c) above concerning substantially similar limitations in claim 1. *See* Pet. 30–31; Ex. 1002 ¶¶ 119–120.

Claim 14 moreover recites “determining a background noise signal from at least one of the ambient sound signal or the internal sound signal.” Ex. 1001, 13:30–32. Petitioner contends Alves discloses this limitation, which Patent Owner disputes. *See* Pet. 31; PO Resp. 32–35.

Petitioner argues Alves’s disclosure of tracking “the average power of the quasi-stationary background noise” in frequency subbands (Ex. 1005 ¶ 43) corresponds to determining a background noise *signal* in claim 14. *See* Pet. 31. In support, Petitioner refers to its analysis for Alves disclosing determining a background noise *level* in claim 1. *See id.* (citing the Petition at section VIII.A.1.d.i).

Patent Owner firstly argues Alves does not determine a background noise signal, relying on its claim construction of “noise signal” as meaning “a function that carries information about noise.” *See* PO Resp. 32–33. However, we find that even applying this claim construction, Alves discloses determining a background noise signal. Specifically, Alves’s noise reducer 76 tracks “the average power of quasi-stationary background noise” in multiple frequency subbands of ambient sound signal 74, to apply a gain to eliminate some noise in outputted signals 78 and 80. Ex. 1005, Fig. 3, ¶¶ 31, 42–43. The tracked “average power” values carry information about the noise, which Alves uses to eliminate some noise in the signal. We preliminarily made this same determination in the Institution Decision (at page 42), and the conclusory nature of the opposing argument in the Patent Owner Response (at page 33) does not persuade us otherwise.

Patent Owner secondly argues Alves does not determine a background noise signal because of its subband processing. *See* PO Resp. 33. However, this argument is premised on Patent Owner’s limiting construction of claim 14 to require determining a single overall background noise signal. *See id.* (referring to “reasons similar to those discussed above with respect to Alves’s failure to determine a background noise level” in claim 1). We have rejected that claim construction for reasons provided in Sections III.B.2 and III.B.3 above. Therefore, Patent Owner’s attempt to distinguish Alves from claim 14 on this basis is not persuasive.

Patent Owner thirdly argues Petitioner “err[s] in equating a background noise *level* [per claim 1] with a background noise *signal* [per claim 14].” PO Resp. 33 (citing Pet. 56; Ex. 1002 ¶ 206). As discussed in Section III.B.3 above, this is not accurate, because Petitioner has agreed a sound “level” is one attribute of a sound “signal.” Further, we find a preponderance of the evidence supports Petitioner’s contention that Alves determines *both* a noise “level” per claim 1 and a noise “signal” per claim 14, as follows.

Alves determines a noise *level* per claim 1 as the *power* of background noise in each one of several frequency subbands in ambient sound signal 74. *See* Ex. 1005 ¶ 43; Section III.C.2(e) *supra*. Each one of these power determinations individually corresponds to determining a noise level. Dr. Stern testifies in support that Alves “splits a noisy signal into subband signals and *tracks the average power* of the quasi-stationary background noise (‘*determine a background noise level . . .*’)[.]” Ex. 1002 ¶ 97 (emphases added); Ex. 1016 ¶¶ 17–18, 20 (testifying that Alves discloses determining “a different background noise level . . . within each subband”).

Further, our finding that Alves's determination of a background noise power in a frequency subband is determining a noise level accords with Mr. Kleinschmidt's testimony that a sound signal "can be spectrally analyzed to obtain a sound level associated with the amplitude of a temporal sound signal at a particular frequency" and "sound level is a generic term for any sound of a particular level." Ex. 2009 ¶ 53.

Alves determines a noise *signal* per claim 14 as the *collection* of power levels of background noise in the frequency subbands of ambient sound signal 74, at different times. *See* Ex. 1005 ¶ 43; Ex. 1002 ¶ 121; Pet. Reply 16. As discussed above, Alves's tracking of this collection of power levels over time is a function that carries information about the background noise per Patent Owner's claim construction, which Alves uses to eliminate some noise in the signal.

Claim 14 finally recites "adjusting an amplitude of one or more frequencies of the internal sound signal and the ambient sound signal based on the background noise signal, to filter the internal sound signal relative to the ambient sound signal." Ex. 1001, 13:33–36. We conclude a preponderance of the evidence supports Petitioner's contention that Alves correspondingly discloses adjusting an amplitude of one or more frequencies of echo-reduced internal sound signal 70 and of ambient sound signal 74, based on the background noise signal, to filter signal 70 relative to signal 74, for the reasons provided in Section III.C.2(f)(ii) above concerning a substantially similar limitation in claim 1.

Patent Owner disagrees. *See* PO Resp. 32. However, Patent Owner's underlying reasoning is that Alves does not determine a background noise signal in the first instance, so such a signal cannot be used to adjust an

amplitude of another signal. *See id.* at 32–35. We disagree with Patent Owner’s underlying argument, for reasons provided above.

We conclude Petitioner has established by a preponderance of the evidence that claim 14 is unpatentable as anticipated by Alves.

9. *Claim 15*

Claim 15 recites: “The method of claim 14 further including a step of mixing the ambient sound signal and the internal sound signal in a ratio dependent on the background noise signal to produce a mixed signal.” Ex. 1001, 13:37–40.

a) *Claim Construction — “mixing”*

Claim 15 recites “*mixing*” two signals. Ex. 1001, 13:37–40 (emphasis added). Claims 4 and 19 contain similar terminology. *See id.* at 12:47–50 (claim 4), 14:33–35 (claim 19).

Patent Owner argues Alves does not “mix[] overlapping signals” as claimed. PO Resp. 1, 35. According to Patent Owner, Alves instead “concatenates non-overlapping signals,” which Alves describes as “frequency extending” the two signals. *Id.* at 1, 35–38 (citing Ex. 1005, Fig. 2, ¶ 32). Mr. Kleinschmidt testifies in support that Alves’s signal concatenation is not signal mixing. *See* Ex. 2009 ¶¶ 93–104 (providing illustrations demonstrating the difference). The essential difference between concatenation and mixing, according to Mr. Kleinschmidt, is that concatenation combines two signals having *non-overlapping* frequency bands, whereas mixing combines two signals having *overlapping* frequency bands. *See* Ex. 2009 ¶ 98 (referring to “concatenating, i.e., placing side-by-side” two signals), ¶ 99 (stating that in concatenation “two signals

spanning different frequencies are joined” which “is not ‘mixing’”), ¶ 102 (“[I]n the context of mixing signals, components of two or more signals must exist at the same frequency; otherwise, they cannot be mixed.”).

Petitioner replies in part that Alves’s combined signals 80 and 84 in fact have overlapping frequency bands, thereby satisfying Patent Owner’s construction of the claim term “mixing.” *See* Pet. Reply 17–18 (“[S]ignals 80 and 84 have overlapping frequency bands” so “even if signals 80 and 84 were considered to be concatenated in the frequency domain, this is . . . inconsequential because of the overlapping frequencies in signals 80 and 84.”).

For reasons discussed in the next section of this Decision, we agree with Petitioner. Therefore, we need not determine whether the claim term “mixing” is limited to combining overlapping frequency signals to the exclusion of other types of signal combinations, as Patent Owner contends. Such a determination would not help us decide whether Alves discloses the claimed mixing, which is the only patentability issue raised in this proceeding in relation to the claim term “mixing.” *See Realtime Data*, 912 F.3d at 1375.

b) Application to Alves

Petitioner contends Alves discloses the mixing required by claim 15. *See* Pet. 32–34; Ex. 1002 ¶¶ 123–125. In the Institution Decision, we “agree[d] with Patent Owner that the Petition’s analysis does not clearly articulate where the ‘mixing’ occurs within Alves.” Inst. Dec. 45 (citing Pet. 32–34). However, we further concluded Dr. Stern’s supporting testimony clearly focuses on the combination of reduced-noise high

frequency ambient sound signal 80 with signal 84 outputted by noise reducer 88, to produce output signal 90, as satisfying the mixing step of claim 15. *See id.* (citing Ex. 1002 ¶¶ 123–125). The parties’ post-institution briefing does likewise.

Patent Owner argues Alves does not mix signals 80 and 84, as required by claim 15. PO Resp. 1, 35. All the more so, according to Patent Owner, Alves does not mix signals 80 and 84 in a ratio dependent on the background noise signal, as further claimed. *See id.* at 35. We consider these two issues in turn.

(i) *Whether Alves “Mixes” Signals 80 and 84*

We find Alves mixes signals 80 and 84 to generate output signal 90, because signals 80 and 84 have overlapping frequencies. In particular, signal 84 has frequencies that fall within the “high” frequency range of signal 80.

Patent Owner argues signals 80 and 84 are “non-overlapping” in the frequency domain, so their combination into output signal 90 is different from claim 15 which “mixes overlapping signals.” PO Resp. 1, 35–36; Ex. 2009 ¶¶ 93–111. Mr. Kleinschmidt annotates Figure 2 of Alves to illustrate this argument, as reproduced below. *See* PO Resp. 36; Ex. 2009 ¶¶ 99–101.

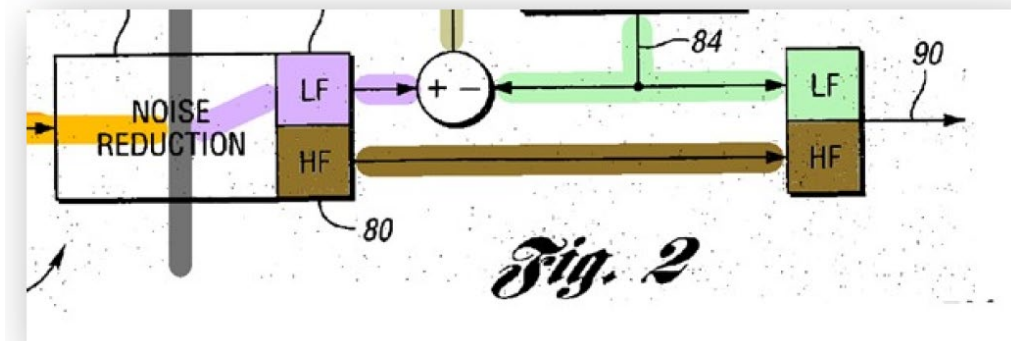


Figure 2 of Alves (Excerpt, Annotated by Mr. Kleinschmidt). Patent Owner describes Figure 2 as illustrating “the high frequency first signal 80 (brown) is always directly carried forward to constitute the high frequency component of output signal 90” and “noise reduced second signal 84 (light green) is always used as the low frequency component of output signal 90.” PO Resp. 35–36; Ex. 2009 ¶¶ 99–101. Patent Owner notes Alves refers to this combination as “frequency extending” signals 80 and 84. PO Resp. 36 (quoting Ex. 1005 ¶ 32); Ex. 2009 ¶ 101.

Mr. Kleinschmidt testifies in support that Alves’s “frequency extending” means that “the two signals always abut each other at the (unspecified) [dividing] line between low and high frequencies.” PO Resp. 36–38; Ex. 2009 ¶¶ 93–109. According to Mr. Kleinschmidt, “Alves fails to disclose that the noise reduced second signal 84 and high frequency first signal 80 may overlap” in frequency. *Id.* ¶¶ 105–106. He annotates Figure 3 of Alves to support this testimony, as reproduced below. *See id.* ¶ 105.

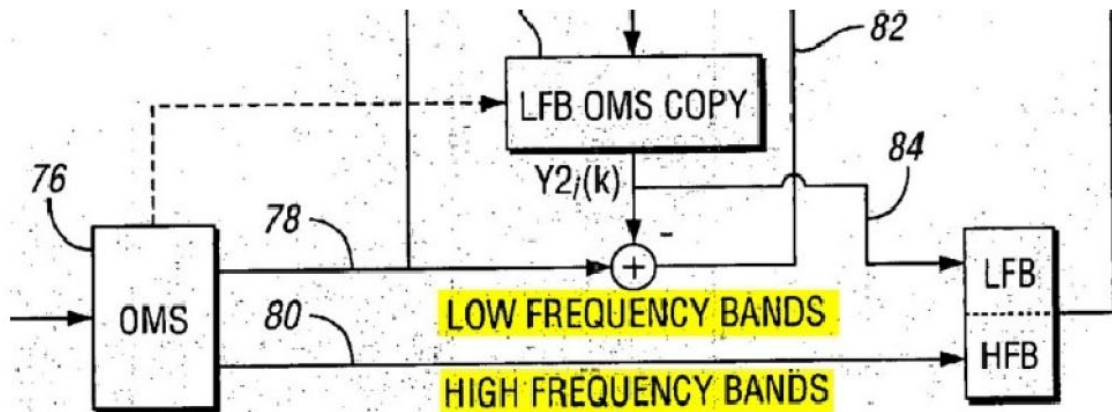
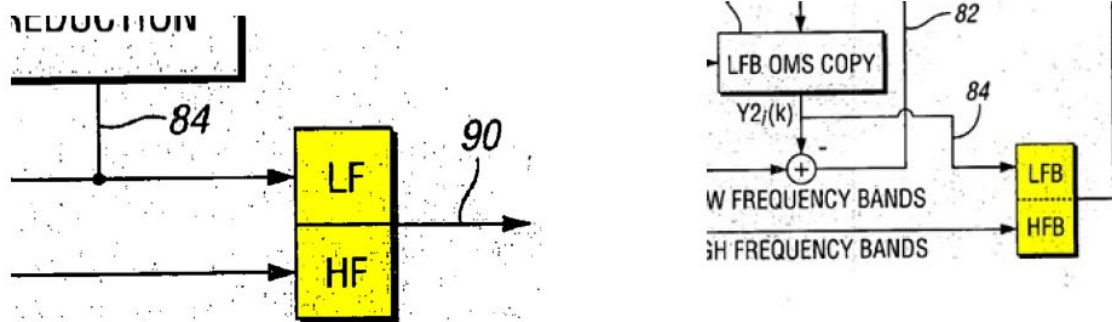


Figure 3 of Alves (Excerpt, Annotated by Mr. Kleinschmidt).

Mr. Kleinschmidt testifies Figure 3 “identifies the frequency bands for noise reduced second signal 84 as ‘Low Frequency Bands,’ and the frequency bands for high frequency first signal 80 as ‘High Frequency Bands,’” as annotated in yellow in his excerpt. *Id.* ¶¶ 105–106.

Mr. Kleinschmidt further annotates Figures 2 and 3 of Alves to provide additional support for his testimony, as reproduced below. *See id.* ¶ 107.



Figures 2 and 3 of Alves (Excerpts, Annotated by Mr. Kleinschmidt).

Mr. Kleinschmidt testifies Figure 2 “shows a [solid] line between ‘LF’ and ‘HF’ where low frequency first signal 78 and high frequency first signal 80 are joined,” and Figure 3 shows a similar dotted line between “LFB” and “HFB.” *Id.* ¶¶ 107–108. He cites Alves’s description of how ambient sound signal 74 “is divided into low frequency first signal 78 and high frequency

first signal 80” (Ex. 1005 ¶ 31) as demonstrating “that the two signals [78 and 80] that result from this division do not overlap” and, therefore, “that noise reduced second signal 84 and high frequency first signal 80 do not overlap.” *Id.* ¶ 109.

Petitioner replies that Alves mixes signals 80 and 84 to generate output signal 90, in part because signal 84 contains some frequencies in the same high frequency range as signal 80, thereby satisfying Patent Owner’s claim construction of the claim term “mixing.”⁸ *See* Pet. Reply 17–18. Petitioner contends Dr. Stern and Mr. Kleinschmidt agree that echo-reduced internal sound signal 70 “is not frequency divided with the result that signals 80 and 84 have overlapping frequency bands” in the high frequency range. *Id.* (citing Ex. 1016 ¶¶ 31, 35–37; Ex. 1017, 101:8–12, 102:11–15, 108:15–20).

Dr. Stern testifies in support that “Alves does not disclose that the internal microphone signal [66, 70, and 84] contains only low frequencies,” so a person of ordinary skill in the art would have understood “signal 84 would have contained some high frequency sounds that overlap in the frequency range of signal 80.”⁹ Ex. 1016 ¶ 36. Thus, in Dr. Stern’s opinion, Alves’s combination of signals 80 and 84 to generate output signal 90 has

⁸ Petitioner also argues that Alves, in addition to this “frequency domain” mixing, also performs “time domain” mixing of signals 80 and 84. *See* Pet. Reply 17–18. We do not rely on the alleged “time domain” mixing in support of our finding that Alves mixes signals 80 and 84.

⁹ Dr. Stern testifies there is mixing in the frequency domain additionally because “the separation between high and low frequency components of the external sound signal [i.e., bands 78 and 80] would not be perfect.” Ex. 1016 ¶ 37. We do not rely on this testimony in support of our finding that Alves mixes signals 80 and 84.

overlapping frequency bands mixed in the high frequency range of signal 80. *Id.* ¶¶ 35–36; *see also* Ex. 2010, 122:2–18 (cited at PO Resp. 38).

According to Petitioner, Mr. Kleinschmidt agrees. Pet. Reply 17 (citing Ex. 1017, 101:8–12).

In reply, Patent Owner asserts Petitioner’s “new ‘overlapping’ argument should be rejected” because “[t]he Petition does not include even a broad outline of this argument.” Sur-reply 14. We disagree. Petitioner’s Reply maintains, as in the Petition, that Alves mixes signals 80 and 84. *See* Pet. 32–34; Ex. 1002 ¶¶ 123–125; Inst. Dec. 45. The Patent Owner Response challenges that assertion, opening the door for Petitioner to defend the assertion with new argument and testimonial evidence in the Reply. *See, e.g.,* CTPG 73–75 (“A party also may submit rebuttal evidence in support of its reply.”); *Provisur Techs., Inc. v. Weber, Inc.*, 50 F.4th 117, 122–123 (Fed. Cir. 2022) (considering the proper scope of a petitioner’s reply in an IPR proceeding).

Patent Owner next argues the Institution Decision already found there is no frequency overlap between signals 80 and 84. Sur-reply 13 (citing Inst. Dec. 45). Patent Owner urges us to make the same finding here, based on the fully developed record, as supported by Mr. Kleinschmidt’s testimony summarized above. *Id.* at 14–15. Patent Owner asserts Petitioner “take[s] liberties with Mr. Kleinschmidt’s testimony” in suggesting that he agreed signals 80 and 84 have overlapping frequency bands, and in fact he “testified to the contrary: ‘I don’t believe that those two signals are overlapping.’” *Id.* at 15 (citing Pet. Reply 17; quoting Ex. 1017, 101:20–21).

Based on our review of the record, we agree with Dr. Stern’s testimony that Alves mixes signals 80 and 84 because they have overlapping

frequencies within the high frequency range of signal 80, and we disagree with Mr. Kleinschmidt's testimony to the contrary, for the following reasons.

The written description of Alves supports Dr. Stern's testimony rather than Mr. Kleinschmidt's testimony. Alves states internal sound signal 66 "is likely to have *less* high frequency content" than ambient sound signal 74, so Alves attempts to reduce the effects of "high frequency *reduction*" in signal 66, which suggests signal 66 nonetheless has high frequency content. Ex. 1005 ¶ 29 (emphases added). Dr. Stern and Mr. Kleinschmidt agree that signal 66 has both low and high frequency content, and that echo-reduced signal 70, which is derived by reducing echoes in signal 66, also has both low and high frequency content. *See* Ex. 1016 ¶ 36; Ex. 2010, 122:2–18; Ex. 2009 ¶ 134; Ex. 1017, 101:8–12, 102:11–103:1, 107:20–108:20; Tr. 50:26–51:15.

Signal 70 is sent to adaptive equalizer 72 and then to noise reducer 88, to produce noise-reduced signal 84. *See* Ex. 1005, Figs. 2–3, ¶¶ 30, 32. Mr. Kleinschmidt does not cite, and we do not find, any written description in Alves that indicates adaptive equalizer 72 or noise reducer 88 removes high frequency content from signal 70 when producing signal 84. *See* Ex. 2009 ¶¶ 93–111 (Mr. Kleinschmidt's testimony concerning claim 15, citing Ex. 1005, Abstract, Figs. 2–3, ¶¶ 31–32).¹⁰ Alves describes how ambient sound signal 74 "is *divided* into low frequency first signal 78 and

¹⁰ During oral argument, Patent Owner's counsel argued adaptive equalizer 72 removes high frequency content from signal 70. *See* Tr. 49:17–50:25. However, that argument was unsupported by citation to the written description (*see id.*) and is not a stated opinion of Mr. Kleinschmidt (*see* Ex. 2009 ¶¶ 93–111). It is therefore merely unsupported attorney argument.

high frequency first signal 80,” but there is no corresponding description concerning a dividing of signals 70 or 84, and no similar illustration in Figures 2 and 3 of dividing signals 70 or 84 as there is of dividing signal 74. Ex. 1005, Figs. 2–3, ¶ 31 (emphasis added). Thus, we find nothing in the written description of Alves to suggest that either adaptive equalizer 72 or noise reducer 88 removes high frequency content from signal 70 when producing signal 84. Therefore, we find signal 84 has both low and high frequency content, because signal 70 does.

Signal 84 is sent to synthesis filter bank (SFB) 110, in which: “Output signal 90 is constructed by *frequency extending* noise reduced second signal 84 with high frequency first signal 80.” Ex. 1005, Figs. 2–3, ¶ 32 (emphasis added); *see also id.* ¶ 36 (“SFB 110 generates output signal 90 based on high frequency first signal 80 and noise-reduced second signal 84.”), ¶ 37 (referring to the “synthesis filter bank[]”). Mr. Kleinschmidt cites this described “frequency extending” as supporting his testimony that there is no high frequency content in signal 84 that overlaps the high frequency range of signal 80. However, most of his effort in this regard is spent differentiating between his understandings of “frequency extending” or “concatenating” on one hand, and of “mixing” on the other hand. *See* Ex. 2009 ¶¶ 93–111. He does not explain persuasively *why* he believes Alves’s mere description of “frequency extending” must be limited to mean “concatenation,” or support this alleged equivalence with citation to other objective evidence. *See id.* We are persuaded by Dr. Stern’s testimony that signal 84 has both low and high frequency content, because it is derived from signal 70 which both witnesses agree has both low and high frequency content, and there is nothing in the written description of Alves to suggest

that adaptive equalizer 72, noise reducer 88, or synthesis filter bank 110 removes high frequency content from signal 84. *See* Ex. 1016 ¶¶ 32–36; Ex. 2010, 122:2–18.

Our understanding of the written description in Alves is consistent with the claims in Alves. Independent claim 1 does not require that signal 84 comprises only low frequency content, or that the combination of signal 84 with signal 80 uses only low frequency content from signal 84. *See* Ex. 1005, claim 1 (pertinently reciting only that “a dynamic equalizer [72] adjust[s] the frequency spectrum of the second signal [66 / 70] based on the first signal [74 / 78] to produce a filtered signal [84]”). Dependent claim 3 is then further limited to require using only a *low frequency* component of signal 84 when combining it with signal 80 to generate output signal 90. *See id.* at claim 3 (“The system of claim 1 wherein an output signal [90] is produced by *combining low frequency output based on the filtered signal* [84] with high frequency output based on the first signal [74 / 80].” (emphasis added)). The interplay and terminology of claims 1 and 3 indicates signal 84 has both low and high frequency content, and in some but not all embodiments of Alves only the low frequency content of signal 84 is combined with signal 80.

The same is true of independent claim 7 and its dependent claim 8. *See id.* at claim 7 (pertinently reciting only “producing the reduced noise vocal signal based on the equalized signal [84] and on the first subbanded signal [78+80]”), claim 8 (adding “wherein the reduced noise signal is *based on low frequency components of the equalized signal* [84] and on high frequency components [80] of the first subbanded signal [78+80]” (emphasis added)).

Mr. Kleinschmidt finally relies on the illustrations in Alves's Figures 2 and 3 to support his testimony, as summarized above. We find, however, that these illustrations do not overcome our understanding of the written description of Alves. We instead find Figure 2's references to "LF" and "RF," and Figure 3's references to "LOW FREQUENCY BANDS" or "LFB" and to "HIGH FREQUENCY BANDS" or "HFB," refer only to the dividing of ambient sound signal 74 into low frequency first signal 78 and high frequency first signal 80, as provided in the written description. *See* Ex. 1005 ¶ 31. There is no corresponding written description of dividing signal 84 into low and high frequency bands, so we are not persuaded by Mr. Kleinschmidt's testimony that Figure 3 "identifies the frequency bands for noise reduced second signal 84 as 'Low Frequency Bands.'" Ex. 2009 ¶ 105.

It is true that the arrow for signal 84 in Figure 2 points to the "LF" half of the LF/HF block representing output signal 90, and the arrow for signal 84 in Figure 3 points to the "LFB" half of the LFB/HFB block representing output signal 90. This provides a modicum of support for Mr. Kleinschmidt's testimony. Nonetheless, upon reviewing the entire disclosure of Alves as a whole as discussed in detail above, we find a preponderance of the evidence indicates signal 84 has both low and high frequency content that is mixed with the high frequency content of signal 80 when generating output signal 90. The arrows in Figures 2 and 3 are explained persuasively by Dr. Stern's testimony that signal 84 "is predominantly lower frequency components" and "has more stuff at lower frequencies." Ex. 2010, 122:2–18; Ex. 2016 ¶ 36. This accords with Alves's description of signal 66 (from which signal 84 is derived) as being

“likely to have less high frequency content than” signal 74 (from which signal 80 is derived). Ex. 1005 ¶ 29.

We finally acknowledge our finding in the Institution Decision, based on the preliminary record presented at that time, that Alves “generates output signal 90 by concatenating the two signals 84 and 80, with internal sound signal 84 entirely forming a low frequency component of output signal 90, and *with ambient sound signal 80 entirely forming a high frequency component of output signal 90.*” Inst. Dec. 45 (emphasis added) (citing Ex. 1005, Figs. 2–3, ¶¶ 31, 32, 36). Nonetheless, based on the complete record now presented including Dr. Stern’s rebuttal testimony, and after re-reviewing Alves’s disclosure based on the arguments presented after institution, we now find Alves’s signal 84 contains frequencies in the high frequency range of signal 80.

In conclusion, we find Alves mixes signals 80 and 84 when combining them to form output signal 90, because signals 80 and 84 have overlapping frequencies in the high frequency range of signal 80.

(ii) *Whether Alves Mixes Signals 80 and 84 in a Ratio Dependent on the Background Noise Signal*

We next find that although Alves mixes signals 80 and 84 as Petitioner contends, a preponderance of the evidence does not support Petitioner’s further contention that this mixture is in a ratio dependent on the background noise signal, as required by claim 15.

Petitioner argues Alves mixes signals 80 and 84 “in a ratio dependent on the background noise signal” per claim 15. *See* Pet. 32–34. This argument is rooted in the combined processing of noise reducer 76 and adaptive equalizer 72, and relies on basically the same reasoning Petitioner

provides for why Alves discloses adjusting signal 70 “based on the background noise level [or signal]” per claims 1 and 14. *See id.* (discussing the combined processing of noise reducer 76 and adaptive equalizer 72); Pet. Reply 16–17 (same); Sections III.C.2(f)(i) and III.C.8 *supra*.

Petitioner particularly asserts “Alves’s noise reducers 76 and 88 determine a background noise level/signal . . . and adjust[] the gain of the internal and ambient sound signals [74 and 86] accordingly,” and “the gain-adjusted signals [78 and 84] are utilized by adaptive filter $G2_i(z)$.” Pet. Reply 16–17; *see also* Ex. 1005 ¶ 32 (adaptive equalizer 72 outputs equalized signal 86 to noise reducer 88). Petitioner then asserts: “Accordingly, the amplitude of the internal sound signal 84 is mixed in a ratio dependent on the background noise signal both because the filter characteristics of adaptive filter $G2_i(z)$ depend on the background noise level/signal and because the output of adaptive filter $G2_i(z)$ is further reduced by noise reducer 88.” Pet. Reply 17 (citing Ex. 1016 ¶ 34; Ex. 1017, 115:10–116:9). Also, “the high frequency bands 80 of the ambient sound signal are the output of noise reducer 76, and thus their amplitude also depends on the background noise level/signal.” *Id.* Petitioner concludes a person of ordinary skill in the art “would have understood that the ratio of internal sound signal to ambient sound signal in output signal 90 of Alves depends on the signal processing of noise reducers 76 and 88 and adaptive filter $G2_i(z)$.” *Id.* at 17, 18–19 (citing Ex. 1016 ¶¶ 21, 29–30, 32, 34–37).

Patent Owner argues Alves’s mixing of signals 80 and 84 to create output signal 90 is performed “regardless of” and “independent of” the background noise signal. PO Resp. 35–36, 38–39. In support, Patent Owner

cites the Institution Decision’s finding that “the dividing line between the low frequencies of internal sound signal 84 and the high frequencies of ambient sound signal 80 appears to be a constant.” Inst. Dec. 45–46; PO Resp. 38; Sur-reply 14. Mr. Kleinschmidt also testifies that “Alves does not disclose that the dividing line between the low frequency part of output signal 90 changes, much less as a function of a background noise level or a background noise signal,” so “[t]here is no varying ratio of the respective inputs from the low frequency part of output signal 90 and the high frequency part of output signal 90, much less a ratio that depends on background noise.” Ex. 2009 ¶ 110. Mr. Kleinschmidt therefore concludes signals 80 and 84 are not mixed in a ratio dependent on the background noise signal. *Id.* ¶ 111.

We conclude Petitioner’s argument and Dr. Stern’s testimony in support do not sufficiently address the claim requirement that the signals are mixed in a *ratio* that is *dependent on* the background noise signal, as specifically claimed. Petitioner asserts generally that Alves’ mixture of signals 80 and 84 is “based on” (Pet. 33–34), “dependent on” (*id.*; Pet. Reply 17, 18–19), and “utilize[s]” (Pet. Reply 17), the background noise signal. Although all that may be true, it does not explain how the mixture is in a ratio dependent on the background noise signal, as recited in claim 15. Petitioner attempts to address that claim requirement by pointing out that, before that mixture occurs: (1) noise reducer 76 eliminates some background noise from signal 74 to generate noise-reduced signals 78 and 80; (2) noise-reduced signal 78 is used as a control input to adaptive equalizer 72 to adjust echo-reduced internal sound signal 70 and output equalized signal 86; and (3) noise reducer 88 eliminates some background

noise from equalized signal 86 to generate noise-reduced signal 84. Petitioner then concludes, without much more explanation, that this means Alves's mixture of signals 80 and 84 is in a ratio dependent on the background noise determined in noise reducers 76 and 88. *See* Pet. 32–34; Pet. Reply 16–19.

Petitioner's contentions (1)–(3) might be sufficient to establish that signals 80 and 84 are mixed *based on* the background noise signal(s) determined by noise reducers 76 and 88, following the line of reasoning provided in Sections III.C.2(f)(i) and III.C.8 above in relation to claims 1 and 14. However, they are too generalized to persuade us that signals 80 and 84 are mixed *in a ratio dependent on* the background noise signal(s), as recited in claim 15. In particular, Petitioner does not explain persuasively where the claimed “ratio” is found in Alves.

In conclusion, we find a preponderance of the evidence does not support Petitioner's contention that Alves mixes signals 80 and 84 in a ratio dependent on the background noise signal. Therefore, Petitioner has not established claim 15 is unpatentable as anticipated by Alves.

10. *Claim 17*

Claim 17 recites: “The method of claim 14, where the step of adjusting further includes filtering the ambient sound signal and the internal sound signal based on a characteristic of the background noise signal where the characteristic includes at least one of a level of the background noise signal, a spectral profile, or an envelope fluctuation.” Ex. 1001, 14:3–8.

Petitioner, in addressing claim 17, refers back to its discussion of claims 1, 6, 7, and 8. *See* Pet. 34; Ex. 1002 ¶ 126. Patent Owner does not

argue for patentability of claim 17 separately from its parent claim 14. *See, e.g.*, PO Resp. 35–39 (arguing dependent claim 15, but not dependent claim 17, separately from claim 14).

We conclude Petitioner has established by a preponderance of the evidence that Alves filters ambient sound signal 74 and echo-reduced internal sound signal 70 based on a level of the background noise signal (per Section III.C.3 above concerning claim 6) and based on a spectral profile of the background noise signal (per Section III.C.4 above concerning claim 7). Thus, Petitioner has established claim 17 is unpatentable as anticipated by Alves.

D. Ground Two — Obviousness over Alves

In Ground Two, Petitioner argues claims 1, 6–8, and 12–17 of the '400 patent are unpatentable as having been obvious over Alves. *See* Pet. 2, 34–45; Ex. 1002 ¶¶ 127–164. Patent Owner opposes. *See* PO Resp. 39–49; Ex. 2009 ¶¶ 86–92.

A patent claim is unpatentable under 35 U.S.C. § 103 if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of

nonobviousness, if made available in the record, which is not the case here. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

1. Claims 1 and 14

As to claim 1, Petitioner’s Ground Two challenge relies on Alves as anticipating claim 1 per Ground One as discussed in Section III.C.2 above, except Ground Two contemplates the claim preamble “earpiece” may be found to be a claim limitation *not* disclosed by Alves’s headset 20, in which event Petitioner contends it would have been “obvious to implement the components disclosed in Alves’s ‘headset’ in an ‘earpiece.’” Pet. 34–35 (emphases added); Ex. 1002 ¶¶ 127–133.

As to claim 14, Petitioner’s Ground Two states only that: “To the extent [Patent Owner] argues that Alves does not anticipate claim 14, Alves renders it obvious for substantially the same reasons as explained in VIII.A.7.a–VIII.A.7.f,” which is Petitioner’s Ground One anticipation challenge to claim 14. Pet. 38; Ex. 1002 ¶ 143.

In opposition, Patent Owner relies solely on arguments considered above in connection with Ground One. *See* PO Resp. 39–40.

We have already concluded Alves anticipates claims 1 and 14 per Ground One. Therefore, we need not and we do not reach the alternative obviousness Ground Two against these claims.

2. Claims 6–8 and 17

Claims 6–8 recite selecting a filter characteristic for filtering the internal sound signal based on: a *level* of the background noise level (claim 6); or a *spectral profile* of the background noise level (claim 7); or an *envelope fluctuation* of the background noise level (claim 8). Ex. 1001,

12:60–13:4. Claim 17 recites filtering a sound signal based on at least one of those three characteristics. *See id.* at 14:3–8.

Petitioner asserts a person of ordinary skill in the art would have been motivated to select a filter characteristic of Alves’s adaptive filters $G2_i(z)$ based on any one of the background noise properties specified in claims 6–8 and 17, if such is not expressly disclosed by Alves, “because adaptive filters used for noise suppression traditionally adapt, at least in part, based on” background noise level, spectral profile, or envelope fluctuation. Pet. 35–37, 45; Ex. 1002 ¶¶ 134–139, 163–164 (citing Ex. 1011, at 1692). Petitioner adds that this “would have amount[ed] to no more than use of a known technique (selecting a filter characteristic of an adaptive filter based on a background noise level [or spectral profile, or envelope fluctuation]) to improve similar devices (the noise reduction system in Alves) in the same way (equalizing the internal sound signal based on the external sound signal using an equalizer).” Pet. 35–37, 45; Ex. 1002 ¶¶ 134–139, 163–164.

In opposition concerning claims 6 and 17, Patent Owner relies solely on arguments considered above in connection with their respective parent claims 1 and 14. *See, e.g.*, PO Resp. 40 (“[Petitioner’s] Ground 2 arguments against claims 6–8, 12, 13, and 15–17 fail due to the dependencies of these claims from claims 1 and 14.”). We have already concluded Alves anticipates claims 6 and 17 per Ground One. Therefore we need not and we do not reach the alternative obviousness Ground Two against claims 6 and 17.

In opposition concerning claims 7 and 8, Patent Owner argues:
(1) Petitioner and Dr. Stern do not substantiate their assertions that adaptive filters used for noise suppression traditionally adapt, at least in part, based

on a background noise spectral profile or envelope fluctuation; (2) Petitioner fails “to identify a reason that would have prompted a person of ordinary skill in the art to change [Alves’s] dynamic/adaptive equalizer 72” to select a filter characteristic based on a background noise spectral profile or envelope fluctuation instead of difference signal 82; and (3) Petitioner’s “assertion that the proposed modification would have ‘improve[d] similar devices’ in ‘the same way,’ is unsupported.” PO Resp. 40–43 (citing Pet. 36–37; Ex. 1002 ¶¶ 137, 139; Ex. 1005, Fig. 3, ¶¶ 31–32; Ex. 2009 ¶ 88; Ex. 2010, 136:23–137:2).

Petitioner’s Reply initially states “Alves discloses, *or at the very least renders obvious*,” selecting a filter characteristic based on a background noise spectral profile per claim 7 or a background noise envelope fluctuation per claim 8. Pet. Reply 11, 13 (emphasis added). However, the underlying analysis addresses only Alves’s disclosure in support of Ground One, not any sort of motivation for modifying Alves in Ground Two, as Patent Owner points out. *See id.* at 11–15; Sur-reply 12. Thus, Petitioner’s Reply does not add anything new to the record concerning Ground Two that we have not already considered above in connection with Ground One.

In the Institution Decision, concerning Ground Two as applied to claims 7 and 8, we concluded on the preliminary record “that Petitioner’s case for obviousness is weak.” Inst. Dec. 49. Now, based on a complete record, we conclude Petitioner’s case is deficient for the same reasons. *See id.* at 49–50. In particular, Dr. Stern’s testimony in support of obviousness relies heavily on Exhibit 1011, which is a journal article titled *Adaptive Noise Cancelling: Principles and Applications*, authored by Bernard Widrow and others. *See* Ex. 1011, at 1692; Ex. 1002 ¶¶ 135, 137, 164.

However, Dr. Stern does not explain how Exhibit 1011 supports his testimony. He simply cites page 1692, which is the first page of the article. We have read that page, which discusses adaptive noise canceling generally, but does not refer to a background noise “spectral profile” or “envelope fluctuation,” or anything similar thereto. Without support in Exhibit 1011, we conclude Dr. Stern’s testimony as to obviousness rests upon what could have been done, rather than what would have been done, and therefore suffers from hindsight bias. *See, e.g., InTouch Techs., Inc. v. VGo Commc’ns, Inc.*, 751 F.3d 1327, 1352 (Fed. Cir. 2014)). We conclude Petitioner has not established claims 7 and 8 are unpatentable as having been obvious over Alves.

3. Claims 12 and 13

As to claim 12, Petitioner’s Ground Two challenge relies on Alves as anticipating claim 12 per Ground One as discussed in Section III.C.6 above, except Ground Two contemplates that Alves may not explicitly disclose using frequency-domain multiplication to filter signal 70, in which event Petitioner contends it would have been obvious “to use frequency domain multiplication in adaptive filters $G2_i(z)$.” Pet. 38; Ex. 1002 ¶¶ 140–141.

As to claim 13, Petitioner’s Ground Two states only that: “To the extent [Patent Owner] argues that Alves does not anticipate claim 13, Alves renders it obvious for substantially the same reasons as explained in VIII.A.6,” which is Petitioner’s Ground One anticipation challenge to claim 13. Pet. 38; Ex. 1002 ¶ 142.

In opposition, Patent Owner relies solely on arguments considered above in connection with Ground One. *See* PO Resp. 39–40.

We have already concluded Alves anticipates claims 12 and 13 per Ground One. Therefore we need not and we do not reach the alternative obviousness Ground Two against these claims.

4. *Claims 15 and 16*

As to claim 15, Petitioner's Ground Two states only that: "To the extent [Patent Owner] argues that Alves does not anticipate claim 15, Alves renders it obvious for substantially the same reasons as explained in VIII.A.8.a," which is Petitioner's Ground One anticipation challenge to claim 15. Pet. 39; Ex. 1002 ¶ 144. Thus, Ground Two does not add anything to Ground One concerning claim 15. For the reasons provided in Section III.C.9 above concerning Ground One, we conclude Petitioner has not established claim 15 is unpatentable as having been obvious over Alves.

Claim 16 depends from claim 15. See Ex. 1001, 13:41. Petitioner's case for the obviousness of claim 16 relies on Alves as disclosing the "ratio" limitation of parent claim 15, then states "Alves is silent regarding the details of deciding the gain" applied to the respective ambient and internal sound signals per Alves's ratio. Pet. 39; Ex. 1002 ¶¶ 145–148. Petitioner contends it would have been obvious to a person of ordinary skill in the art to decrease the gain of the internal signal as the background noise levels decrease, and to increase the gain of the ambient sound signal as background noise levels decrease, per claim 16. See Pet. 39–44; Ex. 1002 ¶¶ 148–162. Thus, Petitioner's case for claim 16 does not address Alves's deficiency as to the "ratio" limitation claim 15, discussed in Section III.C.9 above. Therefore, for reasons provided in Section III.C.9 above concerning

Ground One, we conclude Petitioner has not established claim 16 is unpatentable as having been obvious over Alves.

E. Ground Three — Obviousness over Alves and Mejia

In Ground Three, Petitioner argues claims 2–4, 9–11, and 18–20 of the '400 patent are unpatentable as having been obvious over Alves and Mejia. *See* Pet. 2, 13–14, 46–59; Ex. 1002 ¶¶ 61–68, 165–218. Patent Owner opposes. *See* PO Resp. 10–13, 49–52.

1. Claims 2–4

Claim 2 recites: “The earpiece of claim 1 further including an Ear Canal Receiver (ECR) for delivering audio content to the ear canal of the user where user speech delivered by the ECR is filtered to provide a natural sounding voice to the user.” Ex. 1001, 12:39–42.

Claim 3 recites: “The earpiece of claim 2 where the ambient sound signal includes an external voice signal, where the ambient sound signal and the internal sound signal are mixed to form a mixed signal, and where the mixed signal is provided to the ECR.” *Id.* at 12:43–46.

Claim 4 recites: “The earpiece of claim 3 where the ambient sound signal and the internal sound signal are mixed in a ratio dependent on characteristics of the background noise level of the ambient sound signal.” *Id.* at 12:47–50.

Petitioner argues Alves discloses an ear canal receiver (i.e., speaker 32) for delivering audio content to the ear canal of the user per claim 2; Alves’s ambient sound signal includes an external voice signal and Alves mixes its ambient and internal sound signals to form a mixed signal provided to the ECR per claim 3; and Alves’s signals are mixed in a ratio

dependent on characteristics of the background noise level of the ambient sound signal per claim 4. *See* Pet. 46–51; Ex. 1002 ¶¶ 165–187. Thus, in Petitioner’s view, Alves’s only shortfall versus claims 2–4 is that Alves “does not explicitly disclose that speaker 32 delivers ‘user speech . . . filtered to provide a natural sounding voice to the user’” per claim 2. Pet. 46; Ex. 1002 ¶ 167.

Petitioner then cites Mejia as disclosing “a receiver in the ear canal of a user delivering filtered user speech to provide a natural sounding voice of the user.” Pet. 46–47 (citing Ex. 1007, code (57), Fig. 1, 3:5–19; Ex. 1002 ¶¶ 168–169). Petitioner contends a person of ordinary skill in the art “would have been motivated to modify the system disclosed by Alves in view of Mejia to deliver output signal 90 to speaker 32, as well as to Bluetooth system 100, to mitigate the unnatural sounding voice experienced by the wearer as a result of the occlusion effect” that both Alves and Mejia recognize as a problem that needs to be addressed. Pet. 47–49 (citing Ex. 1002 ¶¶ 170–177; Ex. 1005 ¶ 29; Ex. 1007, 1:21–2:2).

In opposition concerning claims 2 and 3, Patent Owner relies solely on arguments considered above in the context of parent claim 1. *See, e.g.*, PO Resp. 49–50. For reasons provided above, that opposition is not persuasive. Further, we adopt Petitioner’s additional analysis and evidence addressing claims 2 and 3 here as our own in this Decision, and we accordingly conclude Petitioner has established by a preponderance of the evidence that claims 2 and 3 are unpatentable as having been obvious over Alves and Mejia.

In opposition concerning claim 4, Patent Owner additionally argues the combination of Alves and Mejia set forth in the Petition “would not *mix*

an ambient sound signal and an internal sound signal *in a ratio that depends on characteristics of a background noise level*,” as required by claim 4. PO Resp. 50 (emphasis added). In particular, Patent Owner argues Petitioner does not rely on Mejia to address the deficiencies of Alves in this regard, as discussed above in connection with a similar limitation in claim 15. *See id.* Petitioner replies that there are no deficiencies in Alves for the addition of Mejia to address in regard to claim 4, citing Section III.G of Petitioner’s Reply which concerns anticipation by Alves of claim 15. *See* Pet. Reply 20–21. For reasons provided in Section III.C.9 above comparing Alves with claim 15, we find Petitioner has not established Alves mixes signals 80 and 84 in a ratio dependent on characteristics of the background noise level as recited in claim 4. Further, Petitioner does not rely on Mejia in relation to this limitation in claim 4. Thus, Petitioner has not established claim 4 is unpatentable as having been obvious over Alves and Mejia.

2. Claims 9–11

Claim 9 recites: “The earpiece of claim 1 where an analog circuit is used to filter at least one of the ambient sound signal or the internal sound signal.” Ex. 1001, 13:5–7.

Claim 10 recites: “The earpiece of claim 1 where a time domain transversal filter is used to filter at least one of the ambient sound signal or the internal sound signal.” *Id.* at 13:8–10.

Claim 11 recites: “The earpiece of claim 1 where an IIR-type filter is used to filter at least one of the ambient sound signal or the internal sound signal.” *Id.* at 13:11–13.

Concerning claims 9 and 10, Petitioner argues Alves applies adaptive filters $G2_i(z)$ to signals, which “may be implemented in using any of a wide variety of architectures and algorithms” such as a DR-NLMS algorithm, but Alves “does not provide further examples of adaptive filter algorithms or architectures that could be used.” Pet. 51, 52 (quoting in part Ex. 1005 ¶ 37); Ex. 1002 ¶¶ 188–189, 193. Petitioner cites Mejia as disclosing an analog circuit filter per claim 9, and a time domain transversal filter per claim 10. *See* Pet. 51, 53 (citing Ex. 1007, 9:14–15, 10:19–14:9; Ex. 1001, 11:2–3); Ex. 1002 ¶¶ 190, 194–195. Petitioner asserts a person of ordinary skill in the art would have been motivated to apply these kinds of filters within Alves’s noise cancellation process, “because both Alves and Mejia disclose similar goals of processing signals from an internal and external microphone to provide more natural sounding voice.” Pet. 51 (claim 9), 53 (claim 10); Ex. 1002 ¶¶ 191, 196. Petitioner adds this would have amounted to no more than combining prior art elements (the system in Alves with the analog filtering architecture of Mejia) according to known methods to yield predictable results (filtering internal and external signals to produce more natural sounding speech), and “a simple substitution of one known element (the DR-NLMS filtering scheme in Alves) for another (the analog filtering scheme in Mejia).” Pet. 51–52, 53; Ex. 1002 ¶¶ 191–192, 196.

Concerning claim 11, Petitioner argues Alves applies adaptive filters $G2_i(z)$ to signals, which “may be implemented in using any of a wide variety of architectures and algorithms” such as a DR-NLMS algorithm, but Alves “does not provide further examples of adaptive filter algorithms or architectures that could be used.” Pet. 53–54 (quoting in part Ex. 1005 ¶ 37); Ex. 1002 ¶¶ 197–198. Petitioner cites Mejia as disclosing an IIR-type

filter per claim 11. *See* Pet. 54 (citing Ex. 1007, 9:14–15, 14:17–16:3); Ex. 1002 ¶¶ 199. Petitioner asserts a person of ordinary skill in the art would have been motivated to apply an IIR-type filter within Alves’s noise cancellation process, “because both Alves and Mejia disclose similar goals of processing signals from an internal and external microphone to provide more natural sounding voice.” Pet. 54; Ex. 1002 ¶ 200. Petitioner adds this would have amounted to no more than combining prior art elements (the system in Alves with the IIR-type filtering algorithm of Mejia) according to known methods to yield predictable results (filtering internal and external signals to produce more natural sounding speech), and “a simple substitution of one known element (the DR-NLMS filtering scheme in Alves) for another (the IIR filtering scheme in Mejia).” Pet. 54; Ex. 1002 ¶¶ 201–203.

In opposition, Patent Owner relies solely on arguments we have considered above in the context of parent claim 1. *See, e.g.*, PO Resp. 49–50. For reasons provided above, that opposition is not persuasive.

Further, we adopt Petitioner’s additional analysis and evidence addressing claims 9–11 here as our own in this Decision, and we accordingly conclude Petitioner has established by a preponderance of the evidence that claims 9–11 are unpatentable as having been obvious over Alves and Mejia.

3. *Claim 18*

Claim 18 is an independent claim reciting an earpiece, and includes many limitations that are also recited in independent claim 1 or independent claim 14. *See* Ex. 1001, 14:9–32. Petitioner’s argument comparing claim 18 with Alves, and Patent Owner’s opposition thereto, refer back to positions taken for claims 1 and 14. *See* Pet. 55–57; Ex. 1002 ¶¶ 204–210;

PO Resp. 51–52. For reasons provided above, we are persuaded by Petitioner’s arguments in these regards.

Petitioner additionally argues “it would have been obvious to modify Alves in view of Mejia so that speaker 32 receives output signal 90 and plays it into the ear canal of the user,” for substantially the same reasons discussed in Section III.E.1 above in relation to claim 2. Pet. 56–57; Ex. 1002 ¶¶ 207–210. For reasons provided in Section III.E.1 above, we are persuaded by Petitioner’s arguments in these regards.

We conclude Petitioner has established by a preponderance of the evidence that claim 18 is unpatentable as having been obvious over Alves and Mejia.

4. *Claim 19*

Claim 19 recites: “The earpiece of claim 18 where the output signal comprises the ambient sound signal and the internal sound signal mixed as a function of the background noise signal.” Ex. 1001, 14:33–35.

Petitioner relies on Alves as disclosing this subject matter, incorporating its arguments from Ground One in relation to the “mixing” limitation of claim 15. *See* Pet. 58–59; Pet. Reply 21; Ex. 1002 ¶¶ 211–213. Patent Owner’s opposition likewise is the same here. *See* PO Resp. 52; Ex. 2009 ¶ 111.

We conclude a preponderance of the evidence supports Petitioner’s contention that Alves generates output signal 90 by mixing ambient sound signal 80 and internal sound signal 84, for reasons provided in Sections III.C.9(a) and III.C.9(b)(1) above concerning the limitation of

claim 15 reciting “mixing the ambient sound signal and the internal sound signal.”

We also conclude a preponderance of the evidence supports Petitioner’s contention that this mixing is performed as a function of a background noise signal, for basically the same reasons provided in Section III.C.2(f) above concerning the limitation of claim 1 reciting signal amplitude adjustments “based on the background noise level.” Specifically, noise reducer 76 reduces noise within ambient sound signal 74 *as a function of* the background noise signal, to produce noise-reduced ambient sound signals 78 and 80. *See* Ex. 1005, Fig. 3, ¶¶ 31, 36. Then, adaptive equalizer 72 adjusts echo-reduced internal sound signal 70 to produce equalized signal 86 *as a function of* noise-reduced ambient sound signal 78, because signal 78 is a control input to double talk controller $DTC2_i$ and to adaptive filters $G2_i(z)$. *See id.* at Fig. 3, ¶¶ 32, 36. Next, noise reducer 88 reduces noise within equalized signal 86 *as a function of* the background noise signal, to produce signal 84. *See id.* In all of these ways, signals 80 and 84 are produced as a function of the background signal, so their ultimate mixing into output signal 90 is performed as a function of a background noise signal.

We conclude Petitioner has established by a preponderance of the evidence that claim 19 is unpatentable as having been obvious over Alves and Mejia.

5. Claim 20

Claim 20 recites: “The earpiece of claim 19 where the processor is configured to filter the ambient sound signal and the internal sound signal

based on a characteristic of the background noise signal where the characteristic includes at least one of a level of the background noise signal, a spectral profile, or an envelope fluctuation.” Ex. 1001, 14:36–41.

Petitioner relies on Alves as disclosing this subject matter, incorporating its arguments from Ground One in relation to a similar limitation in claim 17. *See* Pet. 59; Ex. 1002 ¶¶ 215–218. Patent Owner’s opposition likewise is the same here. *See, e.g.*, PO Resp. 49–52.

We conclude, for reasons provided in Section III.C.10 above in relation to claim 17, that Petitioner has established by a preponderance of the evidence that Alves filters ambient sound signal 74 and echo-reduced internal sound signal 70 based on a level of the background noise signal and based on a spectral profile of the background noise signal. Thus, Petitioner has established by a preponderance of the evidence that claim 20 is unpatentable as having been obvious over Alves and Mejia.

F. Ground Four — Obviousness over Alves and Killion

In Ground Four, Petitioner argues claim 16 of the ’400 patent is unpatentable as having been obvious over Alves and Killion. *See* Pet. 2, 14–17, 59–64.

Claim 16 depends from claim 15. *See* Ex. 1001, 13:41. The parent claim 15 is not challenged as part of Ground Four. *See* Pet. 2, 59–64. Therefore, we understand Petitioner’s case for obviousness in Ground Four relies on Alves as either disclosing the subject matter of parent claim 15 per Ground One, or rendering obvious that subject matter alone (without Killion) per Ground Two. For example, Petitioner contends: “Alves generally discloses using input from a first microphone (in Alves, located

outside the ear canal of the wearer) to correct a signal from a second microphone (in Alves, located inside the ear canal of the wearer),” which “[a]s explained in VIII.A.8 [Ground One against claim 15] Alves accomplishes . . . by combining noise reduced and equalized signals from the two microphones.” Pet. 59–60; Ex. 1002 ¶¶ 219–222.

Petitioner relies on Killion as disclosing a hearing aid system that mixes signals from a directional ambient sound microphone and an omnidirectional ambient sound microphone, to provide improved speech intelligibility. *See* Pet. 60 (citing Ex. 1006, 3:14–16, 5:17–21); Ex. 1002 ¶¶ 223–224. Petitioner suggests Alves uses its two microphones (ambient and ear canal) and Killion uses its two microphones (directional and omnidirectional) because the respective pairs of microphones both have complimentary characteristics with respect to reducing background noise to improve generation of a voice signal. *See* Pet. 59–61 (citing Ex. 1005, code (57), ¶¶ 7, 29; Ex. 1006, 5:22–28, 5:41–44, 5:52–56, 6:7–11); Pet. Reply 21–22; Ex. 1002 ¶¶ 219–226. Petitioner asserts it would have been obvious to a person of ordinary skill in the art to modify Alves’s ambient-internal sound ratio to mix in the specific fashion recited in claim 16, based on Killion’s direction-omnidirectional sound ratio processing. *See* Pet. 61–62 (citing Ex. 1006, 7:19–27, 7:60–8:7, 8:22–36, 9:12–17); Pet. Reply 22–25; Ex. 1002 ¶¶ 227–234; Ex. 1016 ¶¶ 43–49.

In short, a foundational premise of Petitioner’s Ground Four against claim 16 is that Alves discloses mixing ambient and internal sound signals “in a ratio dependent on the background noise signal,” per parent claim 15. For reasons provided in Section III.C.9 above, that premise is not supported by a preponderance of the evidence, so we conclude Petitioner has not

established claim 16 is unpatentable as having been obvious over Alves and Killion.

G. Ground Five — Obviousness over Alves, Mejia, and Killion

In Ground Five, Petitioner argues claim 5 of the '400 patent is unpatentable as having been obvious over Alves, Mejia, and Killion. *See* Pet. 2, 64–70; Ex. 1002 ¶¶ 241–259.

Claim 5 depends from claim 4. *See* Ex. 1001, 12:51. The parent claim 4 is not challenged as part of Ground Five. *See* Pet. 2, 64–70. Therefore, we understand Petitioner's case for obviousness in Ground Five relies on Alves and Mejia rendering obvious the subject matter of parent claim 4 per Ground Three. Ground Five then adds Killion against claim 5 in a similar fashion to Ground Four against claim 16. *See, e.g.,* Pet. 64–65 (“As discussed above in VIII.D.1 [Ground Four against claim 16], a POSITA would have been motivated to implement Killion's fader circuit with Alves's first and second microphones[.]”); Ex. 1002 ¶¶ 241–244.

Thus, a foundational premise of Petitioner's Ground Five against claim 5 is that Alves discloses mixing ambient and internal sound signals “in a ratio dependent on characteristics of the background noise level,” per parent claim 4. For reasons provided in Section III.C.9 above as to claim 15, and Section III.E.1 above as to claim 4, that premise is not supported by a preponderance of the evidence, so we conclude Petitioner has not established claim 5 is unpatentable as having been obvious over Alves, Mejia, and Killion.

IV. SUMMARY OF CONCLUSIONS

In summary, we determine a preponderance of the evidence establishes claims 1–3, 6, 7, 9–14, and 17–20 of the '400 patent are unpatentable, but not that claims 4, 5, 8, 15, and 16 of the '400 patent are unpatentable, as shown in the following table:¹¹

Claim(s)	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 6–8, 12–15, 17	102	Alves	1, 6, 7, 12–14, 17	8, 15
1, 6–8, 12–17	103	Alves ¹²		7, 8, 15, 16
2–4, 9–11, 18–20	103	Alves, Mejia	2, 3, 9–11, 18–20	4
16	103	Alves, Killion		16
5	103	Alves, Mejia, Killion		5
Overall Outcome			1–3, 6, 7, 9–14, 17–20	4, 5, 8, 15, 16

¹¹ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. § 42.8(a)(3), (b)(2).

¹² We do not reach this ground as to claim 1, 6, 12–14, and 17 to conserve the Board's resources, because we have determined these claims are unpatentable based on Ground One. See Section III.D *supra*.

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–3, 6, 7, 9–14, and 17–20 of the '400 patent have been proven by a preponderance of the evidence to be unpatentable;

FURTHER ORDERED that claims 4, 5, 8, 15, and 16 of the '400 patent have not been proven by a preponderance of the evidence to be unpatentable; and

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

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