

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

ANDREA ELECTRONICS CORP.,
Patent Owner.

Case IPR2017-00627
Patent 6,363,345 B1

Before STEPHEN C. SIU, MICHAEL R. ZECHER, and
JEREMY M. PLENZLER, *Administrative Patent Judges*.

PLENZLER, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
Inter Partes Review
35 U.S.C. § 318 and 37 C.F.R. § 42.73

I. INTRODUCTION

We have jurisdiction to hear this *inter partes* review under 35 U.S.C. § 6 and this Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons that follow, we determine that Apple Inc. (“Petitioner”) has shown by a preponderance of the evidence that claims 1–5, 10–16, 21–23, 25, and 38–46 of U.S. Patent No. 6,363,345 B1 (Ex. 1001, “the ’345 patent”) are unpatentable, but has failed to establish that claims 6–9, 17–20, 24, and 47 of the ’345 patent are unpatentable.

A. Background

Petitioner filed a Petition to institute an *inter partes* review of claims 1–25 and 38–47 of the ’345 patent. Paper 1 (“Pet.”). Andrea Electronics Corp. (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”).

Pursuant to 35 U.S.C. § 314, we instituted trial on all challenged claims, and on all challenges raised in the Petition. See Paper 7 (“Dec. to Inst.”), 12. After institution of trial, Patent Owner filed a Patent Owner Response (Paper 11, “PO Resp.”), to which Petitioner filed a Reply (Paper 18, “Pet. Reply”).

An oral argument was held on April 25, 2018. A transcript of the oral argument is included in the record. Paper 22 (“Tr.”).

B. Related Matters

Petitioner and Patent Owner identify a number of proceedings, both in district court and before the Patent Trial and Appeal Board, involving patents related to the ’345 patent, including a district court proceeding specifically directed to the ’345 patent with Petitioner as a party and Case IPR2017-00626, which is directed to the ’345 patent and involves the same

parties as this proceeding. Pet. viii–x; Paper 4, 1. Our final decision in Case IPR2017-00626 issues concurrently herewith.

C. Asserted Grounds of Unpatentability and Evidence of Record

Petitioner contends that the challenged claims are unpatentable under 35 U.S.C. §§ 102 and 103 as set forth in the table below (Pet. 2–3, 20–67).

Reference(s)	Basis	Claims Challenged
Helf ¹	§ 102	1–7, 9–11, 13, 14, 21, 23, 38–41, and 43
Helf and the Knowledge of a Person of Ordinary Skill in the Art	§ 103	1–7, 9–11, 13, 14, 21, 23, 38–41, and 43
Helf and Martin ²	§ 103	6, 8, 9, 12, 25, 42, and 46
Helf and Boll ³	§ 103	17–20 and 47
Helf and Arslan ⁴	§ 103	15 and 16
Helf, Boll, and Arslan	§ 103	24
Helf and Uesugi ⁵	§ 103	22
Helf, Martin, and Uesugi	§ 103	44 and 45

Petitioner provides testimony from Bertrand Hochwald, Ph.D.

Ex. 1004. Patent Owner provides testimony from Scott C. Douglas, Ph.D.

Ex. 2002. Petitioner also provides deposition testimony from Dr. Douglas

¹ U.S. Patent No. 5,550,924, iss. Aug. 27, 1996 (Ex. 1010, “Helf”).

² Rainer Martin, “*An Efficient Algorithm to Estimate the Instantaneous SNR of Speech Signals*,” Eurospeech 1993 (Ex. 1006, “Martin”).

³ Steven F. Boll, “*Suppression of Acoustic Noise in Speech Using Spectral Subtraction*,” IEEE 1979 (Ex. 1009, “Boll”).

⁴ U.S. Patent No. 5,706,395, iss. Jan. 6, 1998 (Ex. 1011, “Arslan”).

⁵ U.S. Patent No. 5,459,683, iss. Oct. 17, 1995 (Ex. 1015, “Uesugi”).

(Ex. 1026) and Patent Owner provides deposition testimony from Dr. Hochwald (Ex. 2005).

D. The '345 Patent

The '345 patent “relates to noise cancellation and noise reduction and, more specifically, to noise cancellation and reduction using spectral subtraction.” Ex. 1001, 1:19–21. The '345 patent explains that its system receives a noise signal and converts that signal to the frequency domain through a Fast Fourier Transform (FFT). *Id.* at 4:50–5:14. Separate thresholds are set for each frequency bin to determine the location of noise elements for each frequency bin separately. *Id.* at 6:10–13. The '345 patent determines the thresholds by setting two minimum values, which are described as a future minimum and a current minimum. *Id.* at 6:23–41.

At predetermined time intervals (e.g., every 5 seconds), the future minimum value is initialized as the value of the current magnitude of the signal. *Id.* at 6:24–28. Over that time interval, and before the next initialization, the future minimum value of each bin is compared with the current magnitude value of the signal. *Id.* If the current magnitude is smaller than the future minimum, the value of the future minimum is replaced with that current magnitude. *Id.* at 6:28–32.

At the start of each time interval, the current minimum is set as the value of the future minimum that was determined over the previous time interval. *Id.* at 6:34–38. The current minimum then follows the minimum value of the signal for the next time interval by comparing its value with the current magnitude value. *Id.* The current minimum value is used by the spectral subtraction process to remove noise from the signal. *Id.* at 6:38–41.

E. Illustrative Claims

As noted above, Petitioner challenges claims 1–25 and 38–47 of the '345 patent. Claims 1 and 38 are independent, with claims 2–25 and 39–47 depending from either claim 1 or 38. Claim 1 is illustrative, and is reproduced below:

1. An apparatus for canceling noise, comprising:
 - an input for inputting an audio signal which includes a noise signal;
 - a frequency spectrum generator for generating the frequency spectrum of said audio signal thereby generating frequency bins of said audio signal; and
 - a threshold detector for setting a threshold for each frequency bin using a noise estimation process and for detecting for each frequency bin whether the magnitude of the frequency bin is less than the corresponding threshold, thereby detecting the position of noise elements for each frequency bin.

Ex. 1001, 9:35–46.

II. ANALYSIS

A. Claim Construction

“[W]e need only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy.’” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)). We construe the claims using the broadest reasonable construction in light of the '345 patent Specification. See 37 C.F.R. § 42.100(b). Applying that standard, we interpret the claim terms of the '345 patent according to their ordinary and customary meaning in the context of the patent’s written description. See *In re Translogic Tech., Inc.*,

504 F.3d 1249, 1257 (Fed. Cir. 2007). An inventor is entitled to be his or her own lexicographer of patent claim terms by providing a definition of the term in the specification with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994). In the absence of such a definition, however, limitations are not to be read from the specification into the claims. *In re Van Geuns*, 988 F.2d 1181, 1184 (Fed. Cir. 1993).

Petitioner proposes constructions for several terms. Pet. 12–18. In its Response, Patent Owner “applies [Petitioner]’s proposed constructions” set forth in the Petition, and additionally proposes a construction for “periodically.” PO Resp. 6–9. In its Reply, Petitioner contends that “[t]he Board need not adopt specific constructions for most terms because[,] under any reasonable construction, Helf either anticipates or renders the claims obvious.” Pet. Reply 2. For purposes of this decision, we determine that only the term “periodically” requires express construction, and only to the extent set forth in the discussion below, to resolve the controversies between the parties identified below.

“periodically”

Claim 6 recites that “said current minimum value is set to said future minimum value periodically,” and claim 9 recites that “said future minimum value is set to a current magnitude value periodically.”

In the portion of the Petition discussing its challenges, Petitioner provides dictionary definitions of “periodically,” which define that term as “from time to time” or “at regular intervals of time.” Pet. 35–36 (citing Ex. 1013). Patent Owner contends that “periodically,” as used in the ’345 patent, requires “occurring at regular intervals of time.” PO Resp. 7. Patent

Owner notes that its proposed construction is consistent with one of the dictionary definitions provided by Petitioner, and contends that is how one skilled in the art would have understood the term “periodically” in view of the ’345 patent Specification. *Id.* at 8–9 (citing Ex. 1001, 6:23–41, 8:36–40; Ex. 2002 ¶ 48; Ex. 2005, 99:9–100:7). In its Petition, Petitioner does not advocate for either of the two dictionary definitions over the other. In its Reply, however, Petitioner responds that, “[i]f the Board determines that it needs to construe ‘*periodically*,’ that term’s broadest reasonable construction also includes the second dictionary definition, meaning ‘from time to time.’” Pet. Reply 2 (citing Ex. 1013). Petitioner acknowledges that “[t]he ’345 specification states that the minimum values are ‘calculated continuously and updated periodically, for example, every 5 seconds,’” but contends that “[t]he specification expressly states that period is exemplary, and nothing indicates that the update period must always be the same or that it cannot change as the noise reduction process runs.” *Id.* at 3 (citing Ex. 1001, 3:32–45, 8:36–40, 8:64–67).

Although the dictionary defines “periodically” as “from time to time” or “at regular intervals of time,” based on the record before us, we agree with Patent Owner that its proposed construction is how one skilled in the art would have understood that term in the context of the ’345 patent Specification. Turning first to the intrinsic evidence, the Specification explains that “[t]he future and current minimum values are calculated continuously and initiated periodically, for example, every 5 seconds.” Ex. 1001, 8:37–39. Although the Specification later notes that “[i]t will be appreciated that, while specific values are used as in the several equations and calculations employed in the present invention, these values may be

different than those shown” (*id.* at 8:64–67), this passage does not mean that the Specification contemplates arrangements where “periodically” is simply “from time to time.” Rather, we determine that statement from the Specification indicates that the specific amount of time (i.e., every 5 seconds) may vary.

Turning now to the extrinsic evidence, the testimony of Dr. Douglas supports our conclusion, explaining that “at regular intervals of time” is the “only . . . definition . . . consistent with the understanding of a person skilled in the art in light of the specification of the ’345 Patent and its use in the particular field of audio signal processing” because

[l]ike the “period” of an audio signal itself, which is the amount of time it takes for a signal to repeat itself, “periodically” as recited in claims 6 and 9 and throughout the remainder of the specification of the ’345 Patent refers to actions that occur at regular intervals (e.g., every 5 seconds rather than merely “from time to time”).

Ex. 2002 ¶ 48. Moreover, Petitioner’s declarant, Dr. Hochwald testifies that outside of the context of the ’345 patent Specification, “periodically” means “at regular time intervals” (Ex. 2005, 99:13–15), and when asked about that term’s meaning in the context of the ’345 patent Specification, Dr. Hochwald simply noted that “all I can do is read what it says,” which is that “[i]t’s doing something periodically, for example, every five seconds” (*id.* at 100:4–6). Accordingly, the testimony from Dr. Douglas, as well as that from Dr. Hochwald, supports Patent Owner’s construction.

In summary, we adopt Patent Owner’s construction of “periodically,” requiring “at regular intervals of time,” because (1) this is consistent with how this term is used in the context of the ’345 Patent Specification; and (2) this is supported by the testimony of both experts.

B. Challenges

1. Helf

Petitioner challenges claims 1–7, 9–11, 13, 14, 21, 23, 38–41, and 43 as anticipated by, or obvious over, Helf. Pet. 20–41. In its Response, Patent Owner does not dispute Petitioner’s contentions regarding claims 1–3, 13, 14, 21, 23, and 38 and, instead, only addresses specifically Petitioner’s contentions regarding claims 4–7, 9–11, 39–41, and 43. Based on our review of the record before us, we are persuaded that Petitioner has established by a preponderance of the evidence that claims 1–5, 10, 11, 13, 14, 21, 23, 38–41, and 43 are unpatentable over Helf, as Helf discloses each and every limitation of those claims. With respect to claims 6, 7, and 9, however, we determine that Petitioner failed to establish by a preponderance of the evidence that those claims are unpatentable over Helf.

a. Anticipation – Claims 1–3, 13, 14, 21, 23, and 38

Claim 1, for example, is directed to “[a]n apparatus for canceling noise.” Claim 1 requires an apparatus that receives an audio signal (“an input for inputting an audio signal”), converts that audio signal to the frequency domain to provide frequency bins (“a frequency spectrum generator for generating the frequency spectrum of said audio signal”), and determines that the various frequency bins of that signal are noise if their magnitudes are below corresponding thresholds (“a threshold detector for setting a threshold for each frequency bin . . . and for detecting . . . whether the magnitude of the frequency bin is less than the corresponding threshold, thereby detecting the position of noise elements for each frequency bin”). Claim 38 is similar to claim 1, but is directed to a “method” rather than an “apparatus,” and additionally recites “subtracting said noise elements . . .

from said audio signal.” We adopt Petitioner’s un rebutted arguments and evidence related to how Helf properly accounts for each and every element of claims 1 and 38. *See* Pet. 20–29.

Helf “relates to a device for reducing the background noise of an input audio signal.” Ex. 1010, 1:39–40. Helf determines the frequency components (i.e., frequency bins) of the audio signal using “[a] fast Fourier Transform (FFT) . . . producing a . . . frequency spectrum” of the audio signal. *Id.* at 4:13–15. Petitioner cites this disclosure from Helf as corresponding to the “inputting an audio signal” and “generating the frequency spectrum of said audio signal thereby generating frequency bins of said audio signal” recited in claims 1 and 38. Pet. 24–25, 28.

With respect to the operations of the “threshold detector” recited in claim 1 and the corresponding steps recited in the method of claim 38, Petitioner cites Helf’s discussion of its “global speech detector” and “local speech detector.” Pet. 23–29. Helf’s global speech detector and local speech detector are both used in its noise reduction scheme. Ex. 1010, 9:5–67. Petitioner cites the operations of Helf’s global speech detector alone, for example, as meeting the “setting a threshold for each frequency bin” and “detecting . . . whether the magnitude of the frequency bin is less than the corresponding threshold, thereby detecting the position of noise elements for each frequency bin” recited in claims 1 and 38. Pet. 26, 28–29 (citing Ex. 1010, 9:16–32).

There is no real dispute that the “detecting” limitation simply requires “determining[] which frequency bins contain noise elements at a given time.” *See, e.g.*, Ex. 1019, 64–65. This understanding is consistent with the ’345 patent Specification, which explains, for example, that “[e]ach bin’s

magnitude . . . is compared with . . . the adaptive threshold for that bin,” and “[i]f the magnitude is . . . below the threshold[], it is allowed as noise” (i.e., the position of noise is detected). Ex. 1001, 6:46–52. Helf explicitly states that “[t]he global speech versus noise detector . . . makes a . . . decision as to whether or not *each frequency component* is noise.” Ex. 1010, 9:30–32 (emphasis added). Helf does this by “compar[ing] the magnitude of the k th frequency component of the current frame, designated S_k , and the magnitude of the k th frequency component of the background noise estimate, designated C_k .” *Id.* at 9:16–21. “[I]f $S_k > TxC$, for more than 7 values of k (for one frame), where T is a threshold constant . . . the frame is declared a speech frame.” *Id.* at 9:21–24. We agree with Petitioner that “ TxC ” corresponds to “setting a threshold for each frequency bin” and determining whether “ $S_k > TxC$ ” corresponds to “detecting for each frequency bin whether the magnitude of the frequency bin is less than the corresponding threshold,” as required by claims 1 and 38. Based on the further statement in Helf, noted above (*id.* at 9:30–32), we also are persuaded that, when “ $S_k < TxC$,” the k th frequency component is determined to be noise, which corresponds to the “detecting the position of noise elements for each frequency bin” (i.e., determining which frequency bins contain noise elements at a given time) required by claims 1 and 38.

As for the additional requirement of claim 38 directed to “subtracting said noise elements . . . from said audio signal,” Petitioner cites Helf’s discussion of “gain multiplicative factors” for each frequency component. Pet. 26–27 (citing Ex. 1010, 1:58–63, 9:59–67, 11:25–28). Petitioner contends that “Helf attenuates (*subtract[s]*) the noise elements by multiplying the frequency components by a filter function to produce the

noise-reduced signal” (*id.* at 27 (underlining omitted) (citing Ex. 1004 ¶¶ 122–24)), and “[t]he ’345 patent uses the same technique” (*id.* (citing Ex. 1001, 7:2–9, 10:30–32, 12:46–48)). We agree that Helf discloses sufficiently the “subtracting” step because Helf uses inputs from both the global and local speech detectors for its subtraction process (see Ex. 1010, 9:59–67).

Claims 2, 3, 13, 14, 21, and 23 depend from claim 1, and Petitioner cites to relevant portions of Helf as disclosing the additional limitations of those claims. See Pet. 29–32. We are persuaded by Petitioner’s unrebutted arguments and evidence related to how Helf properly accounts for each and every element of these dependent claims, which we adopt for purposes of this decision. Specifically, we find that Helf discloses the additional limitations recited in those claims based on the citations to Helf therein and the supporting expert testimony. See *id.*

b. Anticipation – Claims 4, 5, 10, 11, 39–41, and 43

Claim 4 depends from claim 1, and claim 39 depends from claim 38. Claims 4 and 39 each further recite that “the threshold for each frequency bin [is set] in accordance with a current minimum value of the magnitude of the corresponding frequency bin” with “said current minimum value being derived in accordance with a future minimum value of the magnitude of the corresponding frequency bin.” Petitioner cites Helf’s discussion related to its “Running Minimum Estimator” as disclosing the features of claims 4 and 39. Pet. 32–34 (citing Ex. 1010, 7:39–41, 8:11–16, 8:19–31, 8:54–59, 9:19–21, 9:46–65; Ex. 1004 ¶¶ 127–131).

Helf describes a “first approach [that] uses a stationary estimator 24 to look for long sequences of frames where the spectral shape in each frame is

very similar to that of the other frames” where, for example, “the room is silent and the constant background noise . . . is the primary source of the signal . . . but requires that the background noise is relatively constant and that the humans in the room are not talking for a certain period of time.” Ex. 1010, 6:44–60. The discussion of the “running minimum estimator” from Helf, cited by Petitioner, describes an alternate approach for situations where the stationary estimator cannot be used. Helf explains that its “running minimum estimator” determines a value (M_k) that is a minimum value of an average of eight consecutive frames over a 10 second interval for each frequency component (k) and, in certain circumstances, uses that value as the new background noise estimate. Ex. 1010, 8:19–59. Petitioner cites that value (M_k) as corresponding to the “future minimum value” recited in the claims, with the background noise estimate being set to that value under certain circumstances. Pet. 33–34. Based on these aforementioned disclosures, we are persuaded that Helf discloses the features of claims 4 and 39.

Patent Owner responds that, because Helf uses average values (i.e., the average of eight consecutive values), it does not disclose using a minimum value. PO Resp. 17–23. Patent Owner acknowledges that the ’345 patent, itself, uses a “smoothing process [that] produces frequency bins with multiple smoothed magnitude values, ultimately finding the minimum of all of the values,” but contends that “Helf’s averaging process produces a single output representing one average of the original samples.” *Id.* at 20–21 (underlining omitted) (citing Ex. 1001, 8:14–28; Ex. 2002 ¶¶ 52, 63–72). We disagree with Patent Owner’s characterization of the differences between Helf and the ’345 patent. While Helf may ultimately produce a

single minimum value, as discussed above, that value is based on a minimum value of the averages calculated over the given time period. At oral hearing, Patent Owner acknowledged that Helf determines many averages values (i.e., the averages of the eight consecutive frames) and determines a minimum of those values. *See, e.g.*, Tr. 22:2–6. The claim simply requires a “future minimum value,” and does not preclude that value from being a minimum value taken from a set of average values. Indeed, such an interpretation of the claim would be inconsistent with the ’345 patent’s use of smoothed values noted by Patent Owner. Ex. 1001, 8:14–28. The testimony of Dr. Douglas cited by Patent Owner does not convince us otherwise. *See* Ex. 2002 ¶¶ 52, 63–72 (effectively repeating Patent Owner’s contentions, which are unpersuasive for the reasons set forth above). Accordingly, we are persuaded that Helf’s minimum value (M_k) corresponds to the “future minimum value” recited in claims 4 and 39.

Patent Owner additionally responds that Helf does not disclose the “‘current minimum’ [value being] derived in accordance with” Helf’s minimum value (M_k). PO Resp. 23–24. Patent Owner argues that, “[i]nstead, Helf calculates a single value – ‘D’ – for the entire signal across all frequency bands” and “[b]ased on the comparison of D to 3,000, Helf updates either all the frequency bands (if $D > 3,000$) or none of the frequency bands (if $D < 3,000$).” *Id.* at 24 (underlining omitted). As Petitioner explains, however, Patent Owner’s response is not tied to the actual language of the claims. Pet. Reply 8–9. As noted above, the claims require that the “current minimum value [is] derived in accordance with a future minimum value of the magnitude of the corresponding frequency bin.” Nothing in the claim prevents that determination from being

conditioned on additional calculations or comparisons. As Patent Owner acknowledges, Helf discloses that, “[i]f D is greater than some threshold . . . and the preceding condition (a) is satisfied, then M_k is used as the new background spectral estimate.” Ex. 1010, 8:54–57. Simply put, the “current minimum value [is] derived in accordance with a future minimum value” in Helf when the conditions noted above are met.

Claims 5, 10, and 11 depend from claim 4. Claim 40 depends from claim 39, and claims 41 and 43 depend from claim 40. Petitioner cites relevant portions of Helf as disclosing the additional features recited in those claims, which we find persuasive, and adopt for purposes of this decision. See Pet. 34, 36–38. Patent Owner does not dispute Petitioner’s contentions with respect to those claims, other than addressing claims 4 and 39, from which those claims depend.

For the reasons set forth above, after reviewing all of the argument and evidence presented during trial, Petitioner has established by a preponderance of the evidence that Helf discloses the features recited in claims 4, 5, 10, 11, 39–41, and 43.

c. Anticipation – Claims 6, 7, and 9

Claims 6 and 9 each depend from claim 5, which ultimately depends from claim 1. Claim 7 depends from claim 6. Claim 6 recites that “said current minimum value is set to said future minimum value periodically,” and claim 9 recites that “said future minimum value is set to a current magnitude value periodically.”

With respect to claim 6, Petitioner contends that, under its construction of “periodically” (i.e., “from time to time”), Helf discloses that “[t]he background noise estimate (*‘current minimum’*) is set to the minimum

estimate M_k (*‘future minimum’*) whenever the difference between them exceeds a threshold, and thus, it is replaced *‘periodically.’*” Pet. 34–35. Those contentions are unpersuasive because, as explained above, we do not adopt Petitioner’s construction. Petitioner additionally contends, however, that even under Patent Owner’s construction (i.e., “at regular intervals of time”), which we adopt as explained above, Helf discloses this limitation. *Id.* at 35. Specifically, Petitioner contends that “Helf also shows that where the audio signal continuously contains speech without any pauses (Ex. 1010, 8:11–15), the current background noise estimate will be set to the minimum estimate M_k 10 seconds after the system starts, (*id.*, 8:33–43).” *Id.* (underlining omitted).

Patent Owner responds that Helf’s background noise estimate is not set to the minimum estimate (M_k) because “ M_k will not be used to update N_k [(the background noise estimate)] unless the signal conditions prevent the computation of B_k ,” and “ M_k will not be used to update N_k unless the aforementioned parameter ‘D’ is greater than an arbitrary constant.” PO Resp. 25 (citing Ex. 1010, 8:11–17). Patent Owner, therefore, correctly concludes that “the setting of N_k to M_k . . . does not happen periodically.” *Id.* Petitioner agrees, as it does not dispute Patent Owner’s rebuttal in its Reply, noting, instead, that “if *‘periodically’* is interpreted more narrowly, claim 6 would have been obvious as explained below.”⁶ Pet. Reply 10 n.4. Indeed, Petitioner admitted as much at oral hearing. See Tr. 19:12 (counsel

⁶ Petitioner’s reference to the “more narrow[]” construction is that which we adopt, as explained above, and the reference to the obviousness challenge is to that based on the combination of Helf and Martin.

for Petitioner admitted that “Helf would not anticipate that” when asked about a construction of “periodically” requiring regular intervals).

As for claim 9, Petitioner again bases its contentions on a construction of “periodically” that we do not adopt. See Pet. 36 (contentions based on Helf disclosing a future minimum being replaced “from time to time”). Patent Owner again correctly identifies this shortcoming in the challenge. See PO Resp. 27–28. Similar to its response with respect to claim 6, Petitioner agrees with Patent Owner’s assessment of its challenge, as it does not dispute Patent Owner’s rebuttal in its Reply, noting, instead, that “[i]f ‘*periodically*’ is [interpreted more narrowly], claim 9 would have been obvious as explained below.” Pet. Reply 11 n.5.

For at least these reasons, Petitioner has failed to establish by a preponderance of the evidence that either claim 6 or 9 is anticipated by Helf. Petitioner’s challenge to claim 7, which depends from claim 6, fails for the same reasons.

d. Obviousness

Petitioner’s obviousness challenges based on Helf, alone, are predicated on potential arguments from Patent Owner where Petitioner contemplates that “Patent Owner may contend that Helf does not show comparing the ‘*magnitude*’ of each frequency bin to a threshold value as specified in claims 1 and 38, or other operations based on ‘*magnitude*’ . . . because in certain instances Helf shows operations performed on signal *power*.” Pet. 38–39 (underlining omitted). Petitioner notes that, “[o]n this basis, Patent Owner may contend Helf does not anticipate the claims.” *Id.* at 39 (underlining omitted). Petitioner addresses this potential argument proactively, reasoning that, “[t]o the extent Helf could be interpreted as

disclosing only operating on signal power, a skilled person would have found it obvious to modify Helf to perform its operations on signal magnitude.” *Id.* at 40 (underlining omitted) (citing Ex. 1004 ¶ 114). There is no dispute that “a skilled person would have found it obvious to modify Helf to perform its operations on signal magnitude,” as Petitioner contends. *See, e.g.*, PO Resp. 10 n.1 (“[Patent Owner] does not address [Ppetitioner’s] assertion with respect to the magnitude/power issue.”).

Accordingly, for the reasons set forth above, as well as those discussed in connection with the challenge based on anticipation by Helf, Petitioner has established by a preponderance of the evidence that claims 1–5, 10, 11, 13, 14, 21, 23, 38–41, and 43 would have been obvious over the teachings of Helf, but has failed to establish by a preponderance of the evidence that claims 6, 7, and 9 would have been obvious over the teachings of Helf.

2. Helf and Martin

Petitioner challenges claims 6, 8, 9, 12, 25, 42, and 46 as unpatentable over the combined teachings of Helf and Martin under 35 U.S.C. § 103. Pet. 41–52. Patent Owner responds that Petitioner “fails to demonstrate by a preponderance of the evidence that claims 6, 8, 9, 12, 25, 42, and 46 are obvious as alleged,” but only addresses claims 6, 8, and 9 with any specificity. PO Resp. 30, 39–51. We adopt Petitioner’s unrebutted arguments and evidence with respect to claims 12, 25, 42, and 46. *See* Pet. 49–52. Based on our review of the record before us, Petitioner has established by a preponderance of the evidence that claims 12, 25, 42, and 46 are unpatentable over the combined teachings of Helf and Martin. Petitioner, however, has failed to establish by a preponderance of the

evidence that claims 6, 8, and 9 are unpatentable over the combined teachings of Helf and Martin.

a. Claims 6 and 8

Claim 6 ultimately depends from claim 1, and recites that “said current minimum value is set to said future minimum value periodically.” Claim 8 depends from claim 6. Petitioner contends that “a skilled person would have found it obvious to modify Helf to update the background noise estimate [based on its “running minimum estimator”] after every 10 second interval (instead of only after the first 10 second interval) based on Martin.” Pet. 46 (underlining omitted) (citing Ex. 1004 ¶¶ 157–159). Petitioner reasons that “the skilled person would have recognized from Martin that it is beneficial to periodically update the minimum noise value to ensure it accurately reflected the current noise level,” and

[c]onfiguring Helf in this manner would have been a routine and predictable engineering task, and would yield a system in which the current background noise estimate (N_k and C_k) (“*current minimum*”) in Helf is set to the minimum estimate M_k (“*future minimum*”) whenever 10 seconds has passed since the last update (*i.e.*, it is replaced “*periodically*”).

Id. (underlining omitted) (citing Ex. 1004 ¶¶ 158, 159).

Martin is directed to “estimat[ing] the instantaneous signal-to-noise ratio of speech signals.” Ex. 1006, 1093. Petitioner explains that “Martin’s algorithm tracks the noise floor of an audio signal, and estimates the noise level as a function of the noise floor over a predetermined period,” and “[d]uring each period, Martin’s algorithm tracks two minimum noise values.” Pet. 42 (citing Ex. 1006, 1094). Petitioner notes that “[a]t the beginning of each period of M samples, Martin uses P_{Mmin} to track the minimum value observed during that period,” “[a]t the end of each period,

Martin stores the final minimum value as P_n ,” and “[t]hen, Martin resets the value of P_{Mmin} , by setting it equal to P_{max} , and at the beginning of the next period, P_{Mmin} is set to the current magnitude . . . starting the process all over again.” *Id.*

Petitioner does not rely on Martin to teach the “current minimum value” or the “future minimum value” recited in claim 6. Pet. Reply 14. Rather, Petitioner explains that “the skilled person would have adjusted some of the timing aspects of Helf’s algorithm based on features of Martin as this was part of the ordinary development process that would have been undertaken by a [person of ordinary skill in the art].” *Id.* (underlining omitted). Petitioner contends that “a skilled person would have found it obvious to modify Helf to update the background noise estimate after *every* 10 second interval (instead of only after the first 10 second interval)” because “the skilled person would have recognized from Martin that it is beneficial to periodically update the minimum noise value to ensure it accurately reflected the current noise level.” Pet. 46 (underlining omitted) (citing Ex. 1004 ¶¶ 157–159).

Patent Owner responds that Helf’s “running minimum estimator” is a less accurate estimation of background noise that requires two preconditions before it is used to set the background noise estimate. PO Resp. 40–41 (citing Ex. 1010, 8:11–17, 33–59; Ex. 2002 ¶¶ 115–120). Patent Owner contends that Petitioner fails to establish why one skilled in the art would abandon these preconditions and automatically update its background noise estimate using the “running minimum estimator” every ten seconds. *Id.* We agree.

With respect to its “running minimum estimator,” Helf explains that the “running minimum estimator” is used “when either the speech signal is never absent for more than a second or the background noise itself is never constant in spectral shape.” Ex. 1010, 8:11–15. Helf acknowledges that its “running minimum estimator” is “much less accurate” than its “stationary estimator,” which is typically used for background noise estimates. *Id.* at 8:15–17. As a result, Helf only uses its “running minimum estimator” if “[i]t has been more than 10 seconds since the last update of the background noise spectral estimate due to the Stationary Estimator,” and “[t]he difference, D , between the past background noise estimate, which may have resulted from the Stationary Estimator or the Running Minimum Estimator, and the current Running Minimum Estimator is great.” *Id.* at 8:32–42.

We see no persuasive reason to set Helf’s current background noise estimate (N_k and C_k , considered the “current minimum” by Petitioner) to the minimum estimate (M_k) from the “running minimum estimator” (considered the “future minimum” by Petitioner). The testimony of Dr. Douglas supports this conclusion. *See, e.g.,* Ex. 2002 ¶¶ 119, 120. Addressing the portions of Helf noted above, Dr. Douglas testifies that “Helf only relies on M_k in a ‘worst case’ scenario” and “disfavors the use of M_k , even where B_k is unavailable,” and concludes that “one of ordinary skill would not be motivated to force the use of the disfavored M_k every ten seconds even where the much more accurate B_k estimate is available.” *Id.* ¶ 119. Dr. Douglas further testifies that “one of ordinary skill would not have been motivated to abandon[] the comparison of D to a threshold” because “one of ordinary skill in the art would recognize that Helf is a signal-dependent system, and it would not abandon its ability to adapt to varying signal

conditions in favor of a blind periodic update using a disfavored estimate.”
Id. ¶ 120.

We credit the testimony of Dr. Douglas over that of Dr. Hochwald in this regard. See Ex. 1004 ¶¶ 157–159; Ex. 2002 ¶¶ 115–120. The testimony from Dr. Douglas is consistent with the disclosure of Helf, while that of Dr. Hochwald is based on conclusory statements. For example, the only portions of Dr. Hochwald’s testimony cited in the Petition in connection with the rationale provided in this challenge are conclusory statements that “[a] person of ordinary skill would have found it obvious to modify Helf to update the background noise estimate after every 10 second period based on the teachings of Martin,” and “[t]he skilled person would have recognized it was beneficial to periodically update the minimum noise value to ensure it accurately reflected the current noise level,” which are contrary to the disclosure of Helf noted above. Ex. 1004 ¶¶ 158, 159.

Claim 8 depends from claim 6, and Petitioner’s contentions in connection with claim 8 do not cure the deficiencies in the challenge to claim 6 noted above. Accordingly, Petitioner has failed to establish by a preponderance of the evidence that claims 6 and 8 would have been obvious over the combined teachings of Helf and Martin.

b. Claim 9

Claim 9 ultimately depends from claim 1, and recites that “said future minimum value is set to a current magnitude value periodically” and “said current-magnitude value being the value of the magnitude of the corresponding frequency bin.” Petitioner contends that one skilled in the art “would have found it obvious to reset [Helf’s] running minimum estimate M_k at the start of every 10 second interval.” Pet. 48–49 (citing Ex. 1004

¶¶ 155, 164). Petitioner explains that “Martin teaches a process where a future minimum P_{Mmin} and a current minimum P_n are updated at the end of every window of L or M samples to ensure that the minimum estimates reflect the current noise level,” and “[c]onfiguring Helf in this manner would result in a system that, at the beginning of each 10 second interval, would set the minimum estimate M_k (*‘future minimum’*) to the smoothed magnitude value of the current frame (*‘current magnitude’*).” *Id.* (citing Ex. 1006, 1094; Ex. 1010, 8:19–32; Ex. 1004 ¶¶ 154–155, 164). We are not persuaded by Petitioner’s contentions that one skilled in the art would have used Helf’s “running minimum estimator” at regular ten second intervals for the same reasons discussed above relative to the challenge to claim 6.

Accordingly, Petitioner has failed to establish by a preponderance of the evidence that claim 9 would have been obvious over the combined teachings of Helf and Martin.

3. Helf and Boll

Petitioner challenges claims 17–20 and 47 as unpatentable over the combined teachings of Helf and Boll under 35 U.S.C. § 103. Pet. 52–57. Claims 17–20 each ultimately depend from claim 13, which depends from claim 1. Claim 47 depends from claim 38. Petitioner acknowledges that “Helf does not expressly teach residual noise reduction in its scheme,” but notes that “Boll . . . explains that ‘residual noise reduction’ can be performed after spectral subtraction remove residual noise – a problem Helf itself identifies.” Pet. 55 (underlining omitted) (citing Ex. 1009, 117, Fig. 3). Petitioner cites Boll as teaching the additional features recited in claims 17–20 and 47, and contends that one skilled in the art would have found it obvious to apply those teachings in Helf’s system. Pet. 52–57.

There is no dispute that Boll teaches the additional features recited in claims 17–20 and 47. Rather, Patent Owner responds that Petitioner has failed to provide a reason why one skilled in the art would have included those particular features in Helf’s system. PO Resp. 51–54.

Petitioner notes disclosure from Helf and Boll in support of the proposed combination. Pet. 54 (citing Ex. 1009, 115, 117; Ex. 1010, 9:12–15). The cited portion of Helf explains that, “if the frame truly is noise only, slight errors in deciding whether or not frequency components are due to noise or signal will give rise to so-called ‘twinkling’ sounds.” Ex. 1010, 9:12–15. Petitioner contends that “Boll also notes this problem” and “explains unwanted sounds can be eliminated by applying a residual noise reduction process after the noise has been subtracted from the signal to remove those artifacts.” Pet. 54 (citing Ex. 1004 ¶¶ 173–174; Ex. 1009, 115, 117). Based on these teachings of Helf and Boll, Petitioner reasons that “[a] skilled person would have found it obvious to add Boll’s conventional residual noise reduction technique to Helf’s process, as it would reduce unwanted sounds caused by not all of the noise being subtracted out of a bin.” *Id.* at 55 (underlining omitted) (citing Ex. 1010, 9:12–15; Ex. 1009, 115; Ex. 1004 ¶¶ 174–176).

Patent Owner responds that Petitioner has failed to provide sufficient explanation as to why one skilled in the art would have made the particular modifications to Helf that it proposes. PO Resp. 51–54. Patent Owner contends that “Helf provides only a generic description of these twinkling sounds and the reasons they may arise” and “does not expressly indicate that his system will suffer from ‘twinkling’ sounds.” *Id.* at 53 (underlining omitted). We are left with competing conclusory testimony from Dr.

Hochwald and Dr. Douglas in this regard, which is essentially a disagreement without any meaningful explanation as to why the proposed modifications would or would not have been made. *See* Ex. 1004 ¶¶ 173–179; Ex. 2002 ¶¶ 140–145.

Patent Owner further contends that “Helf is a complex system” and Petitioner “provides no meaningful explanation as to how Boll’s residual noise processor could be routinely incorporated into Helf’s complex system,” nor has Petitioner “established that Boll’s residual noise processor would resolve any such twinkling sounds that allegedly might occur in Helf.” PO Resp. 53 (underlining omitted). Patent Owner is correct, as Petitioner simply states that the proposed modification “would involve simply using the Boll process at the analogous point in the Helf scheme.” Pet. 55 (underlining omitted) (citing Ex. 1004 ¶¶ 175, 176). The cited testimony of Dr. Hochwald does not elaborate on that statement. *See* Ex. 1004 ¶¶ 175, 176. Nor does Petitioner address Patent Owner’s response in its Reply in any meaningful way. *See* Pet. Reply 20–22 (pointing to the conclusory testimony of Dr. Hochwald). In our view, what is lacking from Petitioner’s arguments and supporting testimony is a cogent explanation as to *why* one of ordinary skill in the art would have used Boll’s residual noise reduction process in Helf’s system, especially because it is not readily apparent from Helf’s disclosure that its system suffers from the “twinkling” sounds alleged by Petitioner. Absent such an explanation, we are not persuaded that Petitioner presents a sufficient rationale for combining the teachings of Helf and Boll that supports a conclusion of obviousness.

Based on the record before us, Petitioner has failed to establish by a preponderance of the evidence that claims 17–20 and 47 are unpatentable over Helf and Boll.

4. Helf and Arslan

Claim 15 depends from claim 13, and claim 16 depends from claim 15. Those claims define additional features of the particular spectral subtraction techniques recited in the claims from which they depend, including the type of filter function for the spectral subtraction. Petitioner cites Arslan as teaching the additional features in those claims, which we find persuasive, and adopt for purposes of this decision. Pet. 57–61.

Patent Owner does not dispute those contentions. Rather, Patent Owner responds, generally, that Petitioner fails to establish why one skilled in the art would have used Arslan’s Wiener filter in Helf’s system. PO Resp. 55–56.

Petitioner notes that “Helf discloses subtracting noise using a filter function to attenuate any noise in the signal, [but] does not disclose using a Wiener filter for this purpose.” Pet. 59. Petitioner further explains that Arslan describes using filter multiplication in conventional spectral subtraction and “shows that noise suppression systems can be adapted to use Wiener filters to remove the noise from an audio signal.” *Id.* at 59–60 (citing Ex. 1011, 11:34–37). Petitioner reasons that “[a] skilled person would have recognized that Helf could be similarly adapted to use a Wiener filter function,” and such a person “would have known that Wiener filters were commonly used to remove noise from audio signals, and that Helf’s system could be easily adapted to implement this standard type of filter.” *Id.* at 60 (citing Ex. 1004 ¶¶ 191, 192). Petitioner explains how the Wiener

filter would be applied to Helf's system. *Id.* at 61. We are persuaded that selecting a specific filter technique, such as the Wiener filters taught by Arslan, from a finite number of known techniques for implementing spectral subtraction would have been obvious based on the unrebutted evidence before us.

Accordingly, Petitioner has established by a preponderance of the evidence that claims 15 and 16 are unpatentable over the combined teachings of Helf and Arslan.

5. Helf, Boll, and Arslan

Claim 24 depends from claim 23, which ultimately depends from claim 1, and defines additional features of the smoothing process. Petitioner notes that "Helf teaches techniques for smoothing the attenuation filter coefficients across time and frequency" and "techniques for smoothing the signal in each frequency component over time when estimating the noise level," but "does not teach smoothing the estimated magnitude of each frequency component over time and frequency." Pet. 62 (citing Ex. 1010, 8:19–30; 10:1–2, 10:43–46, 10:51–53). Petitioner cites Boll as teaching smoothing over time and Arslan as teaching smoothing over neighboring frequencies. *Id.* at 62–63. Petitioner reasons that "[a] person of ordinary skill in the art would have found it obvious to combine Arslan's frequency smoothing technique with Boll's time smoothing technique." *Id.* at 63.

Patent Owner responds, correctly, that Petitioner "provides no additional substantive explanation why a skilled artisan, starting with Helf, would first be motivated to combine Helf with Boll, and then further combine those references with Arslan." PO Resp. 57. Petitioner contends that it "explained that a [person of ordinary skill in the art] would have been

motivated to modify Helf to apply the same smoothing technique to bin magnitude by adding both Arslan's frequency smoothing and Boll's smoothing over time." Pet. Reply 23–24 (citing Pet. 61–63). Noticeably missing from the cited portion of the Petition, as well as the Reply, is any explanation as to *why* one skilled in the art would have made these proposed modifications to Helf's system. Absent such an explanation, we are not persuaded that Petitioner presents a sufficient rationale for combining the teachings of Helf, Boll, and Arslan that supports a conclusion of obviousness.

Accordingly, Petitioner has failed to establish by a preponderance of the evidence that claim 24 is unpatentable over the combined teachings of Helf, Boll, and Arslan.

6. Helf and Uesugi

Claim 22 depends from claim 21, which depends from claim 1, and additionally recites "an estimator for estimating a magnitude of each frequency bin." Petitioner cites Uesugi's approximation method as teaching this additional feature. Pet. 64–65 (citing Ex. 1015, 1:14–22, 1:28–29, 4:26–42, 5:18–24). Petitioner provides evidence and persuasive explanation, which is largely un rebutted, in support of its contentions. Specifically, Petitioner explains that Uesugi discloses a method to approximate magnitude to eliminate the need for a square root operation. *Id.* at 64. Petitioner reasons that the skilled person would have understood that performance of Helf's system, which requires two square operations and a square root operation, would be improved by approximating the magnitude of each frequency bin to eliminate the square root operation. *Id.* at 64–65 (citing Ex. 1004 ¶¶ 190, 193; Ex. 1010, 9:16–21). Petitioner explains that "[t]o

implement this feature, the skilled person would have looked to standard digital signal processing techniques, including those taught by Uesugi.” *Id.* at 65 (underlining omitted) (citing Ex. 1004 ¶ 200).

Patent Owner responds that Petitioner’s “expert fails to provide any basis for his conclusion that the use of Uesugi’s approximation method will ‘significantly reduce’ the computational requirements of the stated square root calculation.” PO Resp. 58. Notably, Patent Owner does not dispute Dr. Hochwald’s testimony, which is supported by the disclosure of Uesugi. *See, e.g.*, Ex. 1015, 1:14–22, 1:28–29, 4:26–42, 5:18–24 (discussing approximations as a way to reduce complications of the calculation). Although Dr. Hochwald does not cite to additional evidence to reach the conclusion that approximating a square root operation using addition and multiplication significantly reduces computational requirements, we nevertheless are persuaded by his testimony. Consistent with the disclosure of Uesugi, as noted above, the whole point of an approximation is to reduce computational requirements. It is a trade-off between computational resources and accuracy. Thus, we also are unpersuaded by Patent Owner’s contentions regarding the reduction in accuracy that would result from using such an approximation method in Helf’s system.

Accordingly, Petitioner has established by a preponderance of the evidence that claim 22 is unpatentable over the combined teachings of Helf and Uesugi.

7. Helf, Martin, and Uesugi

Claim 44 depends from claim 40, which depends from claim 39, and claim 45 depends from claim 44. Claim 44 recites “estimating a magnitude of each frequency bin as a function of a maximum and a minimum of said

frequency bins for a number n of frequency bins,” similar to claim 22, and claim 45 recites “smoothing the estimate of each frequency bin.” We are persuaded by Petitioner’s contentions regarding claim 44 for the reasons set forth above regarding claim 22, as Petitioner’s contentions and Patent Owner’s response are virtually identical for those two claims. *See* Pet. 66; PO Resp. 59.

With respect to claim 45, Petitioner additionally contends that “Helf shows the minimum noise estimate M_k for a frequency component is calculated as a rolling average of that component’s magnitude over eight consecutive frames” and, “[t]hus[,] . . . the estimated magnitude would be averaged over eight frames, and . . . the running minimum estimator ‘smooth[es] the estimate.’” Pet. 66–67 (citing Ex. 1010, 8:19-32). We are persuaded by that additional contention, which is unrebutted by Patent Owner. *See generally* PO Resp. 58–59.

Accordingly, Petitioner has established by a preponderance of the evidence that claims 44 and 45 are unpatentable over the combined teachings of Helf, Martin, and Uesugi.

C. ORDER

For the reasons given, it is

ORDERED that Petitioner has demonstrated that claims 1–5, 10–16, 21–23, 25, and 38–46 of the ’345 patent are unpatentable;

FURTHER ORDERED that Petitioner has not demonstrated that claims 6–9, 17–20, 24, and 47 of the ’345 patent are unpatentable; and

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

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