

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ELECTRONICS, INC.,
Petitioner,

v.

CONSTELLATION DESIGNS, LLC,
Patent Owner.

IPR2023-00229
Patent 11,019,509 B2

Before MIRIAM L. QUINN, BRENT M. DOUGAL, and
MICHAEL T. CYGAN, *Administrative Patent Judges*.

CYGAN, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. *Background and Summary*

LG Electronics (“Petitioner”) filed a Petition (Paper 2, “Pet.”) requesting institution of *inter partes* review of claims 1, 2, 8–12, 18–23, and 29–30 of U.S. Patent No. 11,019,509 (Ex. 1001, the “’509 patent”). Constellation Designs LLC (“Patent Owner”) filed a Preliminary Response (“Prelim. Resp.”). Paper 7. On June 5, 2023, we denied Petitioner’s request for additional briefing. Paper 8. On June 29, 2023, with authorization from the Board, Patent Owner filed a submission limited to evidence related to the *Fintiv* factors, and a single page identifying the corresponding *Fintiv* factor. Paper 9.

Pursuant to 35 U.S.C. § 314(a), an *inter partes* review may be instituted only if “the information presented in the petition . . . and any [preliminary] response . . . shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.”

For the reasons given below, on this record Petitioner has not established a reasonable likelihood that it would prevail in showing the unpatentability of any asserted claim of the ’509 patent.¹ Accordingly, we do not institute an *inter partes* review as to any asserted claim of the ’509 patent.

B. *Real Parties in Interest*

Petitioner identifies LG Electronics, Inc., LG Electronics USA, Inc., and LG Electronics Alabama, Inc. as the real parties in interest. Pet. 98.

¹ For this reason, we need not evaluate the evidence for discretionary denial under *Fintiv* submitted with paper 9.

Patent Owner identifies Constellation Designs LLC as the real party in interest. Paper 5, 1.

C. Related Matters

The parties represent that the '509 patent is involved in *Constellation Designs, LLC v. LG Electronics, Inc. et al*, C.A. No. 2:21-cv-00448 (E.D. Tex. Dec. 9, 2021); Pet. 98; Paper 5, 1. Patent Owner represents that Petitioner has filed, at the same time that this Petition was filed, petitions for *inter partes* review against the '509 patent as IPR2023-00320, and against related family members U.S. Patent No. 8,842,761 (IPR2022-01482), U.S. Patent No. 10,567,980 (IPR2022-01549), U.S. Patent No. 10,693,700 (IPR2023-00228), and U.S. Patent No. 10,693,700 (IPR2023-00319). Paper 5, 1–2.

D. The '509 Patent

The '509 patent is titled “Receivers Incorporating Non-Uniform Constellations With Overlapping Constellation Point Locations.” Ex. 1001, code (54). The '509 patent issued from Application Serial No. 16/728,384, filed on December 27, 2019, and claims priority through a series of continuation applications to Provisional Application No. 60/933,319, filed on June 5, 2007. *Id.* at codes (21), (22), (60), (63).

The '509 patent describes a communication system in which a transmitter transmits a signal over a channel to a receiver using a predetermined modulation scheme, which is decoded at the receiver. *Id.* at 5:53–54. The receiver includes a demodulator, which demodulates the signals to obtain symbol or bit likelihoods to a demapper that provides the likelihoods to a decoder, which decodes the encoded bit stream. *Id.* at Fig. 3, 5:54–60. The coding scheme may be a capacity approaching code such as a turbo code or an LDPC code. *Id.* at 5:43–44. The mapper/demapper relies

upon mapping of coded bits to a symbol within a geometrically distributed signal constellation. *Id.* at 5:46–49, 5:55–58.

The constellation, which describes the possible symbols that can be transmitted, may be designed to optimize a specified capacity through an iterative process. *Id.* at 1:42–44, 7:46–49. A procedure for such optimization is described as follows:

The following procedure could be used to determine the target capacity that includes some margin on top of the user rate. First, the code (e.g. LDPC or Turbo) can be simulated in conjunction with a conventional equally spaced constellation. Second, from the simulation results the actual SNR of operation at the required error rate can be found. Third, the capacity of the conventional constellation at that SNR can be computed. Finally, a geometrically shaped constellation can be optimized for that capacity.

Id. at 7:59–67.

E. Illustrative Claim

Claim 1 is illustrative, and recites as follows:²

[1pre] A communication system comprising:

[1a] a receiver capable of receiving signals via a communication channel having a channel signal-to-noise ratio (SNR), wherein the receiver comprises:

[1b] a demodulator capable of demodulating a received signal into a demodulated signal;

[1c-1] a demapper, coupled to the demodulator, capable of determining likelihoods using the demodulated signal and a symbol constellation that includes constellation points at a plurality of unique point locations, where

[1c-2] the plurality of unique point locations are unequally spaced;

² Petitioner's bracketing indicia have been added.

[1c-3] the constellation points each have a location and a different label; and

[1c-4] the locations of at least two of the constellation points are the same; and

[1d] a decoder, coupled to the demapper, capable of using the likelihoods determined by the demapper to provide a sequence of received bits based upon a low density parity check (LDPC) code.

Ex. 1001, 13:36–57.

F. Evidence

Petitioner relies on the following patent evidence.

Name	Patent Document	Exhibit No.
Bauch	PCT Pat. Pub. No. 2006/089569 A1	1004
Eroz	U.S. Pat. Appl. Pub. No. 2004/0054960A1	1005

Petitioner further relies upon ETSI TS 102 006 V1.2.1, *Digital Video Broadcasting (DVB); Specification for System Software Update in DVB System*, Oct. 2002 (“DVB-T”), and DeGaudenzi et al., *Turbo-coded APSK modulations design for satellite broadband communications*, Int. J. Satell. Commun. Network. 2006; 24:261–281 (“DeGaudenzi”). Exs. 1009, 1014. Petitioner relies upon a declaration by Dr. Bertrand Hochwals. Ex. 1003.

G. Prior Art and Asserted Grounds

Petitioner asserts that claims 1, 2, 8–12, 18–23, and 29–30 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1, 9, 11, 19, 21, 22	103(a) ³	Eroz, Bauch
10, 20, 30	103(a)	Eroz, Bauch, DVB-T
2, 8, 12, 18, 23, 29	103(a)	Eroz, Bauch, DVB-T,

³ Petitioner asserts, and we agree for purposes of institution, that the pre-AIA patentability scheme applies to the ’509 patent. *See* Pet. 2.

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
		DeGaudenzi

II. ANALYSIS

A. *Legal Standards*

A patent claim is unpatentable under 35 U.S.C. § 103(a) 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 non-obviousness.⁴ *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. *Level of Ordinary Skill in the Art*

Petitioner asserts that a person of ordinary skill in the art at the time of the alleged invention:

would have had at least a Master’s degree in an academic area emphasizing electrical engineering or a similar discipline, and at least two years of experience in the field working with, teaching, or researching communication systems including the use of constellations in transmitting signals between devices. . . . Superior education could compensate for a deficiency in work experience, and *vice-versa*.

⁴ Neither party presents evidence or arguments regarding objective evidence of non-obviousness at this stage.

Pet. 13–14 (citing Ex. 1003 ¶¶ 21–23). Patent Owner does not address the level of ordinary skill. Prelim. Resp.

Determining the level of ordinary skill in the art involves various factors, including the “type of problems encountered in the art; prior art solutions to those problems; rapidity with which innovations are made; sophistication of the technology; and educational level of active workers in the field.” *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (citation omitted). The prior art of record also reflects the level of ordinary skill in the art. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). For purposes of this Institution Decision, we adopt the assessment offered by Petitioner, as it is consistent with the ’509 patent and the asserted prior art.

C. Claim Construction

In an *inter partes* review, we construe a patent claim “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) (2019). Under this standard, the words of a claim generally are given their “ordinary and customary meaning,” which is the meaning the term would have to a person of ordinary skill at the time of the invention, in the context of the entire patent including the specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc).

Here, Petitioner contends that no term require specific construction. Pet. 14. Patent Owner does not propose any claim construction. Prelim. Resp.

At this stage, no need exists to construe any claim terms expressly to resolve the parties’ disputes. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (“[W]e need only construe 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))).

D. Obviousness over Eroz and Bauch

Petitioner asserts that claims 1, 9, 11, 19, 21, and 22 are unpatentable under § 103(a) as obvious over Eroz and Bauch. Patent Owner provides arguments and evidence against these assertions.

Upon consideration of Petitioner’s explanations and the totality of evidence in this current record, we determine that Petitioner has not demonstrated a reasonable likelihood of prevailing in showing any claim is unpatentable under § 103(a) as obvious over the combination of Eroz and Bauch.

1. Eroz (Ex. 1005)

Eroz relates to “a method of encoding structure Low Density Parity Check (LDPC) codes.” Ex. 1005, code (57). Eroz describes its invention as addressing a need for an LDPC communication system having simple coding and decoding processes and supporting high data rates without introducing greater complexity. *Id.* ¶¶ 6–7. Eroz describes a receiver that includes a demodulator, which demodulates the signals to obtain symbol or bit likelihoods to a decoder working in tandem with a bit metric generator that exchanges messages with a decoder, which decodes the encoded bit stream. *Id.* ¶ 58. The coding scheme may be an LDPC code. *Id.* The bit metric generator relies upon mapping to exchange probability information with the decoder; this process may be performed iteratively (with non-Gray mapping) or non-iteratively (with Gray mapping, such as a Gray 8-PSK scheme). *Id.* ¶¶ 58, 69.

2. *Bauch (Ex. 1004)*

Bauch relates to a method for transmitting a signal involving a forward error correction encoder, a mapper for mapping a group of code bits to a transmit symbol in accordance with a constellation diagram in which at least two different possible groups of code bits correspond to the same constellation point. Ex. 1005, code (57). Bauch describes an iterative demapping and decoding procedure using an error correcting code such as a convolutional code, with the goal to design the mapping of code bits to transmit symbols such that the iterative detector converges at a low SNR (signal to noise ratio) and shows a low error floor at high SNR, while minimizing the number of required iterations. *Id.* at 2:25–34.

3. *Analysis*

Upon review of Petitioner’s explanation and supporting evidence, and Patent Owner’s Preliminary Response, we determine that the Petition does not show a reasonable likelihood that Petitioner would prevail in showing the combination of Eroz and Bauch would have made obvious the challenged claims. In particular, we are persuaded by Patent Owner’s arguments that Eroz and Bauch cannot be combined as arranged by Petitioner, and Petitioner has provided insufficient reason to combine the teachings to do so. Prelim. Resp. 34.

a) *Petitioner’s Assertions*

Petitioner asserts that Eroz and Bauch are combinable in the following manner. Petitioner relies upon Eroz for teaching a communication system having a receiver comprising a demodulator and a demapper determining likelihoods using the demodulated signal and a symbol constellation including constellation points at a plurality of unique point locations, and a decoder based upon an LDPC code. Pet. 28–31, 42–44. Petitioner relies

upon Bauch for teaching a demapper having unequally spaced point locations, each having a location and different label, in which the locations of at least two of the constellation points are the same. *Id.* at 31–42.

Petitioner asserts that these teachings could be combined to teach the claimed invention, through reconfiguring the software in Eroz’s system to incorporate the teachings of Bauch, such that Eroz’s communication system would “perform in the same or similar manner but use constellations specified by Bauch.” *Id.* at 26–27.

Supporting this combination, Petitioner points to advantages of Bauch’s system, including “bandwidth-efficient transmission with a reduced size of the modulation alphabet due to non-unique mapping, reduced detection complexity and peak to average power ratio, and a lower error floor compared to existing protocols.” *Id.* at 24 (citing Ex. 1004, 13:36–14:30, 16:32–38, Figs. 6a–6d, 15a–15c; Ex. 1003 ¶ 73). Petitioner asserts that these advantages would serve Eroz’s objectives of the “need for using LDPC codes efficiently to support high data rates, without introducing greater complexity” and “a need to improve performance of LDPC encoders and decoders.” *Id.* (citing Ex. 1005 ¶ 6; Ex. 1003 ¶¶ 73–74).

Petitioner further asserts that, because of the similarities of the systems of Eroz and Bauch, a person having ordinary skill in the art would have predictably incorporated the elements, and that such would have merely involved combining prior art elements according to known methods to yield predictable results. *Id.* at 24–26. Petitioner asserts that both Eroz and Bauch are directed to communication systems in which encoded signals are sent to a receiver over a channel, in which the receivers “demodulate a received signal, determine likelihoods using the demodulated signal, demap symbols to bits, perform decoding using the likelihoods and demapped data

in an iterative or non-iterative manner,” and using similar types of modulations. *Id.* at 25 (citing Ex 1004, Fig. 5, 2:20–34, 4:24–6:25, 12:35–13:2, 28:35–29:10, 29:18–23; Ex. 1005, Figs. 1–3, claim 7, ¶¶ 58–93). Petitioner further points to Bauch’s use of turbo codes as being similar to Eroz’s LDPC coding. *Id.* (citing Ex. 1004, 4:28–30, 9:27–35, 13:29–37; Ex. 1003 ¶ 75).

Petitioner’s declarant Dr. Hochwald states that a person having ordinary skill in the art would have the knowledge and means to replace the coding of Bauch with the LDPC codes of Eroz because LDPC encoding and decoding was “well understood and involved some of the same message passing iterations as with turbo codes.” Ex. 1003 ¶ 87.

b) Patent Owner’s Arguments

Patent Owner provides two arguments against the obviousness of Petitioner’s proposed combination. First, Patent Owner argues that Bauch’s constellations could not be effectively used with Eroz’s LDPC. Second, Patent Owner contradicts Petitioner’s asserted advantages of the combination. In view of the arguments and evidence of record, Petitioner has not persuaded us that a person having ordinary skill in the art would have combined Bauch and Eroz so as to make obvious the claimed invention.

(1) Bauch’s Constellations and Eroz’s LDPC

Patent Owner argues that Bauch’s constellations with non-unique mappings require a weak convolutional code, and “are unsuitable for use with Eroz’s LDPC codes.” Prelim. Resp. 2, 57. Patent Owner explains the distinction between convolutional and LDPC codes:

[a] coder may add additional redundant information to the input user bits that later enables the receiver’s decoder to use

error-correcting codes to help detect or recover bits lost to noise during transmission. (EX2001 at 17; EX2003 at 2-3; EX2004 at 11, 298). . . .

A convolutional code is a type of error correcting code that operates by convolving a binary information sequence through a filter, or “code generator”. (EX2001 at 17; EX2003 at 294-295; EX2004 at 312-314). Convolutional codes are important because they are deployed in many practical systems but are generally considered weaker than more powerful codes (such as turbo or LDPC codes) because they provide a higher bit error rate for a given code rate. (EX2001 at 17; EX2003 at 294-295).

Turbo codes are more powerful error correcting methods than convolutional codes and can utilize multiple convolutional decoders that exchange information in order to achieve a lower bit error rate, as compared to a convolutional code. (EX2001 at 17-18; EX2003 at 325).

LDPC codes are similar to Turbo codes in that they are both powerful error correcting codes and involve iterations within the decoder in order to perform the error correcting function. (EX2001 at 18; EX2003 at 342-343).

Prelim. Resp. 14-15.

Patent Owner points to a significant flaw in Petitioner’s analysis of the similarities between Bauch and Eroz. Petitioner asserts that Bauch teaches turbo codes, and that the similarity between turbo codes and LDPC codes supports combining their teachings. Pet. 25. Patent Owner argues that Bauch does not describe the use of turbo codes. Prelim. Resp. 42. Patent Owner argues that Bauch’s use of “turbo” is strictly limited to describing its iterative *detection*, and that Bauch does not describe iterative *decoding*. *Id.* at 43 (citing Ex. 2001, 41; Ex. 1004, 4:27–32 (“Bit interleaved coded modulation with iterative (“turbo”) detection is considered”)). Patent Owner argues that Bauch describes using convolutional codes, not iterative decoding. *Id.* at 42–43 (citing Ex. 1004, 1:25–28, 15:8–12, 24:1–3).

We agree with Patent Owner. The testimony of author Gerhard Bauch states that “turbo” is limited to iterative detection; i.e., the iterative process of feeding information from the decoder back to the demapper. Ex. 2002 ¶¶ 23–26. Declarant Bauch further points to contemporaneous statements made in a separate publication, which discusses turbo codes separately from iterative demapping. Ex. 2002 ¶ 28 (citing Ex. 2017 (hereinafter “Bauch2”), 848). Declarant Dr. Caire agrees that “[t]he appropriately matched code that Bauch chose is a convolutional code, not a turbo code.” Ex. 2001 ¶ 104 (citing Ex. 1004, 1:25–28, 4:27–32, 15:7–11, 24:1–3). Dr. Caire also provides testimony distinguishing Bauch’s convolutional codes from turbo codes. Ex. 2001 ¶¶ 80–82 (citing Ex. 1004, 1:25–28, 15:8–12, 24:1–3, 26, 33–36).

We have further reviewed the sections of Bauch that Dr. Hochwald relies upon for its description of turbo codes, but found no such description. For example, Dr. Hochwald supports his statement that Bauch uses “turbo-coded data” with reference to Bauch at column 4, lines 28–30. Ex. 1003 ¶¶ 64, 75. However, that section states that “iterative (‘turbo’) detection is considered,” and is followed by the statement that the “data is encoded by the encoder 1402 of a forward error control (FEC) code, e.g., by a binary convolutional code.” Ex. 1004, 4:28–32. Dr. Hochwald’s other citations also lack description of turbo codes, instead describing “turbo iterations,” or “turbo bit-interleaved coded modulation,” neither of which describes turbo coding.⁵ Ex. 1003 ¶¶ 64, 75; Ex. 1004, 9:27–35, 12:28–37, 13:29–37.

⁵ Note that Dr. Hochwald describes “bit-interleaved coded modulation” as a concept separate from the encoding used. Ex. 1003 ¶¶ 93, 178. Bauch is further consistent with turbo referring to iterations rather than coding in this context. Ex. 1004, 1:25–29 (“the concatenation of an error correcting code,

In view of the totality of the evidence of record, we determine that Petitioner has not shown Bauch to describe use of turbo codes. Because Petitioner's rationale for combining Bauch and Eroz is partly based upon Bauch's use of turbo codes as being similar to Eroz's LDPC coding, this determination undermines the persuasiveness of Petitioner's obviousness argument.

Patent Owner further points to unaddressed considerations in combining Bauch's constellation technique with Eroz's LDPC coding. Patent Owner argues, "although each Ground relies solely on combining *Bauch*'s constellation having non-unique mappings with *Eroz*'s LDPC decoder in order to allegedly render obvious a system having a LDPC decoder and a constellation with at least two points having the same location, as required by every claim, **the author of *Bauch* has submitted a declaration confirming that his constellation cannot be effectively used with a LDPC decoder.**" Prelim. Resp. 2–3. Declarant Bauch states,

My co-authors and I did not develop and did not describe using turbo codes with the constellations described in the *Bauch* publication. In that publication, we refer only to turbo iterations or turbo detections, which are synonymous with iterative decoding and demapping, and refers to the feeding back of information from the decoder to the demapper. Instead, our disclosed approach required the use of a weak code such as a convolutional code. And that is what we disclosed. Indeed, a stronger code such as a turbo code or LDPC code would not have reasonably worked with the disclosed constellations. . . . One should not use the constellations with non-unique mappings that I disclose in my publications with a stronger code such as a turbo code or LDPC code. This is because my constellations require

e.g., a convolutional code, a bit-interleaver, and the mapper of a QAM/PSK modulation scheme. . . iterations can be performed between the demapper and the decoder."").

the code to be precisely matched with the constellation in order to achieve error free decoding. Such matching could not be achieved by a stronger turbo code or LDPC code because they do not have the characteristics necessary to allow iterative decoding and demapping to provide the appropriate amount of extrinsic information to pass between the decoder and the demapper at each iteration. As a result, and as I have published previously, use of the constellations with non-unique mappings with a powerful FEC code such as a turbo code or LDPC code will not be effective. Further, the constellations should be used with a weak code, such as a convolutional code.”

Prelim. Resp. 3–4; Ex. 2002 ¶¶ 26, 31.

Neither Petitioner nor Dr. Hochwald addresses whether the constellations used in Bauch *could effectively* be used with an LDPC code or turbo code as taught by Eroz. In addition to its flawed reliance on Bauch as describing turbo codes, Petitioner’s combination relies on Dr. Hochwald’s testimony that Eroz’s communication system would “have included unequally spaced LDPC constellations in which one or more constellation points can be placed at unique locations of the constellations,” and would “perform in the same or similar manner but use constellations specified by Bauch.” *Id.* at 26–27 (citing Ex. 1003 ¶¶ 77–78).

Dr. Hochwald’s testimony is, at best, conclusory on this point. For example, Dr. Hochwald states that both Eroz and Bauch have the capability of processing constellations with various types of modulations, and Eroz’s method for encoding and decoding the standard constellations “would require only minor modifications to use the Bauch constellations.” Ex. 1003 ¶ 77. Dr. Hochwald, in his explanation of why a person of ordinary skill in the art would have had reasonable success in making such a combination, merely points to the ability to reprogram software code in Eroz’s system to use constellations that were known in the art. Ex. 1003 ¶ 78. However, Dr.

Hochwald does not explain what those modifications would have been, or how programming ability addresses the technical ability to adapt Eroz's system to the naming and spacing of Bauch's constellations.

Indeed, Dr. Hochwald's testimony at one point refers to itself for explanation, apparently copying the exact text of the Petition. *Compare* Pet. 27 ("Reconfiguring the software LGE1003, ¶[78]") with Ex. 1003 ¶ 78 ("Reconfiguring the software LGE1003, ¶[78]"). Such testimony that merely mirrors *conclusory* statements in the Petition is entitled to little weight, if any. *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9 (August 24, 2022).

By contrast, Patent Owner argues that these modifications would amount to "substantial [and] unexplained" functional changes. Prelim. Resp. 51 (citing Ex. 2001, 47). Patent Owner highlights Bauch's use of a selector to sort streams into high and low priority bits. *Id.* at 51–52. Patent Owner points out that Eroz lacks such a selector in its point-to-point communications system, and that Petitioner has not explained whether, or how, that would be incorporated into Eroz along with Bauch's constellations and non-unique labels. *Id.* at 2, 51 (citing Ex. 2001, 48). Patent Owner argues that, absent such a selector, the unsorted streams would contain randomized bit errors. *Id.* (citing Ex. 2001, 48).

Patent Owner points to additional support for its position in declarant Bauch's statements in Bauch2. Prelim. Resp. 45 (citing Ex. 2017). Bauch2 is authored by the same Dr. Gerhard Bauch of the Bauch reference relied upon by Petitioner, and was published contemporaneously with that Bauch reference. *Id.* at 58; *see* Exs. 1004, 2017. Patent Owner argues that in Bauch2, Bauch "expressly considered and rejected the proposed combination." *Id.* Patent Owner points to Bauch2 as concluding, "the use

of powerful FEC codes such as Turbo codes or LDPC codes are wholly ineffective with *Bauch*'s constellation because LDPC codes (1) were not precisely matched to *Bauch*'s constellation and (2) lack the convergence characteristics necessary to achieve the required amount of error correction during iterative detection.” *Id.* (citing Ex. 2017, 3–4). Declarant Dr. Caire also submits testimony that *Bauch2* arrives at these conclusions. Ex. 2001 (*Caire Declaration*) ¶ 105.

Dr. Caire further explains that the combination of *Bauch*'s constellations with *Eroz*'s LDPC codes would lack “an appropriate amount of extrinsic information to pass between the decoder and the demapper at each iteration. *Id.* ¶ 104 (citing Ex. 1004, 9:31–35). Dr. Caire further states, “[b]ecause *Bauch* went to great care to precisely match the convolutional code to the proposed constellation, the system can resolve the common bits with a single pass of the decoder, and then rely on the error correcting capabilities of the convolutional code during *iterative detection* to resolve the ambiguous bits;” and consequently, “*Bauch* explains that if the error correction code is not carefully chosen, error free communication may not be possible.” *Id.* ¶ 74.

In view of the totality of the evidence of record, we determine that Petitioner has not shown that *Bauch*'s constellation could be effectively used with *Eroz*'s LDPC codes. Because Petitioner's rationale for combining *Bauch* and *Eroz* is partly based upon Petitioner's allegation that *Bauch*'s constellation would be advantageously used with *Eroz*'s LDPC codes, this determination to the contrary undermines the persuasiveness of Petitioner's obviousness arguments. In particular, the record does not support Petitioner's arguments that the combination would provide an advantage through improving LDPC performance or efficiency, or that such a

combination “merely involved combining prior art elements according to known methods to yield predictable results.” Pet. 24–27.

(2) *Reasons to Modify Eroz with Bauch’s Constellation*

Patent Owner provides additional argument and evidence against Petitioner’s stated reasons to combine Bauch and Eroz; i.e., “support[ing] higher data rates, without introducing greater complexity,” “to improve performance,” “bandwidth-efficient transmission with a reduced size of the modulation alphabet due to non-unique mapping, reduced detection complexity and peak to average power ratio, and a lower error floor compared to existing protocols.” Prelim. Resp. 49; Pet. 24.

First, with regard to system performance and system complexity, Patent Owner states that Eroz and Bauch have opposing objectives. Prelim. Resp. 49. Patent Owner states, “Eroz attempts *to improve system performance* using specific LDPC arrangements that increase data transmission rates *and lower system complexity* while Bauch designs constellations that, while achieving a hierarchical system, *lowers performance and increases complexity* when compared to a system that does not utilize iterative detection.” Prelim. Resp. 49 (citing Ex. 1005 ¶¶ 6, 7, 127; Ex. 1004, 13:30–38, 14:19–25, 15:14–23; Ex. 2001, 45–46; Ex. 2002, 17).

Petitioner and Dr. Hochwald acknowledge Eroz’s goal of “support[ing] high data rates without introducing greater complexity,” but characterize Bauch as having “reduced detection complexity.” Pet. 23 (citing Ex. 1004, 13:36–14:30, 16:32–38). Patent Owner admits that “a single pass of a convolutional code decoder has lower complexity than a single pass of a LDPC decoder.” Prelim. Resp. 54. However, Patent Owner argues that “iterative decoding and demapping using a LDPC code, when

compared to a LDPC decoder that does not require iterative decoding and demapping, represents a substantially higher detection complexity.” *Id.* at 54–55 (citing Ex. 1004, 1:25–34, 11:6–10, 14:30–15:23; Ex. 2001, 50; Ex. 2002, 19).

In part, the disagreement between the parties reflects Patent Owner’s view that iterative detection is required in *Bauch*, contrasted with Petitioner’s view that iterative detection is optional. Petitioner asserts that even without iterations, “ambiguities occur only in certain bit positions for the least important code bits, which enable reasonable performance even without iterations. If no iterations are performed, the receiver sees an effective higher code rate.” Pet. 23. Patent Owner argues that “the use of iterative detection to achieve additional gain at each iteration is central to the error correction approach described in *Bauch*.” Prelim. Resp. 64 (citing Ex. 1004, 7:33–8:16, 8:35–9:3, 11:6–10; Ex. 2001, 56).

We determine that Petitioner’s assertions are not supported by *Bauch*. Petitioner relies upon *Bauch*’s non-unique mapping of labels to locations. Pet. 17–22. For example, Petitioner points to *Bauch*’s Figure 15a as illustrating mapping eight symbol constellation points to six unique point locations, and argues that “[s]uch mappings ‘are the basis for’ *Bauch*’s teachings.” *Id.* at 20 (citing Ex. 1004, Fig. 15A, 4:8–12, 4:21–22). However, *Bauch* states that for “non-unique mappings as given in Figs. 15a–c . . . the performance will be poor if no iterations are performed; i.e., iterations are mandatory.” Ex. 1004, 8:35–9:2. Dr. Hochwald similarly indicates that absent iterations, bit positions with non-unique mappings will be zero, reflecting unresolvable ambiguities. *Id.* ¶¶ 69–70. Petitioner’s reliance upon *Bauch*’s non-unique mappings thus also requires *Bauch*’s iterative detection. Consequently, Petitioner may not reasonably rely upon

purported performance and reduced complexity advantages flowing from non-iterative detection.

Nor has Petitioner clearly explained which of the other asserted advantages; i.e., “lower error floor compared to existing protocols,” “bandwidth-efficient transmission with a reduced size of the modulation alphabet due to non-unique mapping,” and peak to average power ratio, would persist in the absence of iterations. At best, Petitioner appears to tie these advantages to the purported performance gains. *See* Ex. 1003 ¶¶ 51 (characterizing performance gains as reduction in minimum required signal-to-noise ratio), 54 (listing as performance requirements a specified bit rate and a maximum transmit power); Ex. 2001 ¶ 92. However, as explained above, Petitioner has not shown such performance gains occur absent Bauch’s iterative detection.

Moreover, Dr. Bauch’s testimony directly and persuasively rebuts the effect of Petitioner’s proposed substitution on system performance. Dr. Bauch testifies that, “[t]he constellations I proposed were not designed for capacity performance when compared with a traditional equally spaced constellation,” and that they would “sacrifice[] performance” when compared to a traditional equally spaced constellation with unique mappings. Ex. 2002 ¶ 34. Dr. Caire echoes this testimony, stating that Erož’s “traditional equally spaced constellation . . . was widely believed to be the best performing constellation.” Ex. 2001 ¶ 97.

With respect to improved bandwidth efficient transmission, Patent Owner’s declarants testify that Bauch’s constellations would not be recognized as an improvement over Erož’s uniform constellations. Prelim. Resp. 54. Dr. Caire testifies that “it was known that a uniform constellation would provide better bandwidth-efficient transmission” when compared to

the constellations of Bauch. Ex. 2001 ¶ [49]. Dr. Bauch states that his proposed constellations “were not designed to provide more bandwidth efficient transmission when compared to a non-hierarchical and traditional equally spaced constellation.” Ex 2002 ¶ [19].

Thus, in contrast to Petitioner’s and Dr. Hochwald’s conclusory arrangement of the teachings of Eroz and Bauch, Dr. Bauch provides a detailed and persuasive explanation of why Eroz’s codes would not have reasonably provided an advantage when combined with Bauch’s constellations. Ex. 2002 ¶¶ 17–19, 22, 27, 30–31.

Consequently, we do not find Petitioner’s stated reasons to combine Bauch and Eroz to be persuasive. Upon consideration of the entirety of the record, we are not persuaded that the evidence shows that introducing Bauch’s constellations into Eroz would support higher data rates without introducing greater complexity, improve performance, or provide an improved bandwidth-efficient transmission.

c) Determination

For the foregoing reasons, we determine that Petitioner has not met its burden to show a rationale for a person of ordinary skill in the art to combine the teachings of Eroz and Bauch. Thus, Petitioner has not shown a reasonable likelihood that Petitioner would prevail on its obviousness contentions for claim 1. Because its obviousness contentions for each other challenged claim under any of the grounds presented also rely on the same combination of Eroz and Bauch, Petitioner has not shown a reasonable likelihood of prevailing on the obviousness of any other challenged claim.

III. CONCLUSION

For the reasons discussed above, the Petition does not show a reasonable likelihood that Petitioner would prevail on its obviousness contentions for any claim being challenged.

IV. ORDER

For the foregoing reasons, it is:

ORDERED that pursuant to 35 U.S.C. § 314(a), the Petition is denied and no *inter partes* review is instituted.

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