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Paper 58
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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LSI CORPORATION and AVAGO TECHNOLOGIES U.S., INC.,
Petitioner,

v.

REGENTS OF THE UNIVERSITY OF MINNESOTA,
Patent Owner.

IPR2017-01068
Patent 5,859,601 B2

Before JENNIFER S. BISK, ROBERT J. WEINSCHENK, and CHARLES J. BOUDREAU, *Administrative Patent Judges*.

BISK, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

LSI Corporation and Avago Technologies U.S., Inc. ("Petitioner") filed a Petition requesting an *inter partes* review of claims 1, 2, 8, 10, 12–17, and 21 of U.S. Patent No. 5,859,601 B2 (Ex. 1001, "the '601 patent"). Paper 1 ("Pet."). Regents of the University of Minnesota ("Patent Owner"), identified as the owner of and real party in interest to the '601 patent (Paper 3, 2), did not file a Preliminary Response. Paper 34 (Patent Owner's Waiver of Preliminary Response). On February 14, 2020, Patent Owner filed a statutory disclaimer of claims 1–12, 15, 16, and 21. Ex. 2004. We instituted this review of Petitioner's challenges to claims 13, 14, and 17, the only remaining challenged claims of the '601 patent. Paper 35 ("Inst. Dec.").

Subsequent to institution, Patent Owner filed a Patent Owner Response. Paper 41 ("PO Resp."). Petitioner filed a Reply. Paper 48 ("Reply").[1] Patent Owner also filed a Sur-Reply. Paper 51 ("Sur-Reply"). A transcript of the oral hearing held on January 19, 2021, has been entered into the record as Paper 57 ("Tr.").

This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a). For the reasons that follow, Petitioner has demonstrated by a preponderance of the evidence that claim 13 of the '601 patent is unpatentable, but has not demonstrated by a preponderance of the evidence that claims 14 and 17 are unpatentable.

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[1] Petitioner filed two versions of the Reply Brief, a confidential version (Paper 48), and a redacted version available to the public (Paper 46). For purposes of this Decision, we refer to the public version of the brief.

II. BACKGROUND

A. Related Matters

The parties indicate that the '601 patent is involved in litigation, *Regents of the University of Minnesota v. LSI Corp.*, No. 0:16-cv-02891-WMW-SER (D. Minn).[2] Pet. 69; Paper 3, 2.

B. The '601 Patent

The '601 patent, titled "Method and Apparatus for Implementing Maximum Transition Run Codes," issued January 12, 1999. Ex. 1001, codes (45), (54). The '601 patent relates generally to "a channel coding technique to improve data storage devices such as magnetic computer disk drives and professional and consumer tape recorders." *Id.* at 2:40–43. In particular, the '601 patent describes using maximum transition-run ("MTR") coding to eliminate the storage of certain binary data patterns determined to be error-prone. *Id.* at 2:43–47. According to the '601 patent, using MTR coding significantly improves the final bit error rate. *Id.* at 2:47–49.

The '601 patent describes MTR coding as "impos[ing] a limit on the maximum number of consecutive transitions that can occur in the written magnetization pattern in magnetic recording." *Id.* at 2:59–61. In particular, performance is improved most significantly "when the maximum number of consecutive transitions [referred to as 'constraint length j'] is limited to two." *Id.* at 2:62–65.

In addition to MTR coding, the '601 patent describes prior art coding methods, such as Runlength limited ("RLL") codes, which "impose a (d,k)

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[2] On February 7, 2018, the identified case was transferred to the Northern District of California as No. 5:18-cv-00821-EJD (N.D. Cal.).

constraint on the recorded data sequence." *Id.* at 1:21–24. In describing RLL codes, the '601 patent describes two commonly used formats for recording binary data: (1) Non-Return-to-Zero ("NRZ"), in which "the binary '1' represents a positive level in the magnetization waveform and the binary '0' [represents a] negative level in the same waveform"; and (2) Non-Return-to-Zero-Inversion ("NRZI"), in which a 1 represents a magnetic transition and a 0 represents no transition. *Id.* at 1:24–36. For NRZ formatting, d+1 defines the minimum number of consecutive like symbols and k+1 defines the maximum number of consecutive like symbols in the sequence. *Id.* at 1:24–29. For NRZI formatting, "d and k are the minimum and maximum number of consecutive 0's between any two 1's, respectively." *Id.* at 1:29–36.

According to the '601 patent, RLL (1,k) codes, which do not allow any consecutive transitions in an NRZ format, eliminate some patterns which cause the most errors. *Id.* at 3:53–4:17. However, this coding allows for fewer patterns overall, resulting in a lower code rate and increasing inefficiency. *Id.* at 4:18–24. MTR coding, on the other hand, "eliminate[s] all sequences with three or more consecutive transitions, but allow[s] the dibit pattern to survive," which eliminates error-prone patterns with less inefficiency than a RLL (1,k) code. *Id.* at 4:24–30. MTR parameters are written as (j;k), where j is the MTR constraint described above and "k is the usual RLL constraint." *Id.* at 4:46–48.

C. Illustrative Claim

Independent claim 13 is illustrative of the subject matter at issue and reads as follows:

> 13. A method for encoding m-bit binary datawords into n-bit binary codewords in a recorded waveform, where m and n are preselected positive integers such that n is greater than m, comprising the steps of:
>
> receiving binary datawords; and
>
> producing sequences of n-bit codewords;
>
> imposing a pair of constraints (j;k) on the encoded waveform;
>
> generating no more than j consecutive transitions of said sequence in the recorded waveform such that $j \geq 2$; and
>
> generating no more than k consecutive sample periods of said sequences without a transition in the recorded waveform.

Ex. 1001, 10:46–61.

D. Proposed Grounds of Unpatentability

Petitioner asserts the following grounds of unpatentability, each based on 35 U.S.C. § 102:[3]

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
13, 14, 17	102	Okada[4]
13, 14, 17	102	Tsang[5]

Pet. 2. Petitioner also relies on the Declaration of Emina Soljanin, Ph.D. Ex. 1010 ("Soljanin Decl.").

Patent Owner disputes each of these grounds of unpatentability and relies on the Declarations of Jaekyun Moon, Ph.D. (Ex. 2016), the first named inventor of the '601 patent, and Steven W. McLaughlin, Ph.D. Ex. 2017 ("McLaughlin Decl.") as supporting its position. PO Resp. 5.

III. ANALYSIS

A. Level of Skill in the Art

The level of skill in the art is a factual determination. *See Al-Site Corp. v. VSI Int'l, Inc.*, 174 F.3d 1308, 1323 (Fed. Cir. 1999) (citing *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)). The level of skill in the art informs the claim construction analysis. *See Teva Pharm. USA, Inc. v. Sandoz, Inc.*, 135 S. Ct. 831, 841 (2015) (explaining that claim

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[3] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 285–87 (2011), amended 35 U.S.C. § 102, effective March 16, 2013. Because the application from which the '601 patent issued was filed before March 16, 2013, the pre-AIA version of § 102 applies.

[4] U.S. 5,392,270 (issued Feb. 21, 1995) (Ex. 1007).

[5] U.S. 5,731,768 (filed Jan. 31, 1996; issued March 24, 1998) (Ex. 1009).

construction seeks the meaning "a skilled artisan would ascribe" to the claim term "in the context of the specific patent claim" (emphasis omitted)).

Petitioner asserts that a person of ordinary skill in the art "would have had at least an undergraduate degree in electrical engineering or similar field, and three years of industry experience in the field of read channel technology." Pet. 12 (citing Soljanin Decl. ¶¶ 21–26).

Patent Owner does not address Petitioner's proposed level of skill but, similarly, asserts that a person of ordinary skill would have "at least a bachelor's degree in electrical engineering" and "several years (three or more) of work experience in the industry." PO Resp. 35. Patent Owner adds that a person of ordinary skill in the art would specialize "in data coding and detection techniques used in connection with reading data from various storage media such as hard drives and optical media" and "would have studied and been familiar with traditional data coding and detection techniques and devices including RLL codes, peak detectors, and sequence detectors, such as Viterbi detectors." *Id.* (citing McLaughlin Decl. ¶ 41). Patent Owner does not further address these additional specialization and knowledge requirements or explain how it differs from Petitioner's proposal of "industry experience in the field of read channel technology." *Id.* Moreover, Patent Owner does not contend that Petitioner's proposed level of skill, which we adopted in the Institution Decision, is incorrect or incomplete. *Id.*

We adopt the definition that a person of ordinary skill in the art would have had at least an undergraduate degree in electrical engineering or similar field and at least three years of relevant industry experience in the field of

read channel technology. This level is consistent with the level reflected by the references themselves.

B. Dr. Soljanin's Testimony

Patent Owner did not file any motions to exclude evidence. Tr. 50:10–13. However, Patent Owner makes several arguments asserting that Dr. Soljanin's testimony (Exhibit 1010) should not be given any weight. PO Resp. 2–3; 21.[6] First, according to Patent Owner, because Dr. Soljanin opined, in the related district court proceeding, that several terms in the challenged claims are indefinite, she "can hardly now find those elements of the Challenged Claims in any prior art reference." *Id.* (citing Ex. 2007 ¶¶ 37–59), 30–31.

Petitioner argues that Dr. Soljanin's testimony in the related case did not address the indefiniteness of the term "transition" and, therefore that testimony is not relevant to this proceeding. Reply 11. Moreover, indefiniteness is not an issue that can be raised in an IPR. *Id.* We agree with Petitioner that Dr. Soljanin's testimony regarding indefiniteness of claim terms not addressed in the briefing in this case is not relevant to these proceedings.

Second, Patent Owner argues that Dr. Soljanin is not properly familiar with optical recording physics, the subject of Okada. PO Resp. 3, 33; *see also* PO Resp. 21–24 (discussing Dr. Soljanin's testimony regarding optical recording systems).

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[6] Patent Owner also argues that certain of Petitioner's filed exhibits are "inadmissible." Sur-Reply 9–12 (citing Exs. 1014–1021). Because we do not rely on those exhibits, we do not address whether they are admissible or should be given any weight.

Petitioner explains that Dr. Soljanin "is an accomplished professor and author, a Bell Labs alumna, and an elected IEEE Fellow for 'contributions to coding theory and coding themes for transmission and storage systems'" and is, thus, "eminently qualified to opine" on the meaning of the claim language at issue here. Reply 10 (citing Soljanin Decl. ¶¶ 5–17). According to Petitioner, it is irrelevant that Dr. Soljanin is unfamiliar with optical recording physics because the claims, on their face, are directed to encoding m-bit datawords into n-bit codewords, and do not mention the specific recording media. *Id.* at 10–11.

We agree with Petitioner and decline to determine that all of Dr. Soljanin's testimony should be disregarded based on any lack of expertise in optical recording systems. Instead, we evaluate the persuasive value of Dr. Soljanin's testimony below in the context of analyzing the arguments and evidence regarding each limitation in turn.

Third, Patent Owner asserts that Dr. Soljanin "contradicted herself on whether Okada discloses the required j constraint of the Challenged Claims." PO Resp. 3; 33. Dr. Soljanin's testimony on the recited j-constraint limitation, and the weight it should be given, is evaluated below in the context of analyzing the arguments and evidence regarding that limitation.

C. Claim Construction

The '601 patent is expired (*see* Pet. 12; PO Resp. 35 n.8), so its claims are construed in the same manner used in a civil action under 35 U.S.C. § 282(b). Thus, the claims are construed 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. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc). Only

terms that are in controversy need to be construed, and then 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).

Petitioner does not propose explicit constructions for any terms of the challenged claims, and indicates that "[u]n[l]ess otherwise addressed herein, no express construction of any additional term is believed to be needed to resolve the challenges herein." Pet. 17. In our Institution Decision, we determined that no express construction of any terms of the challenged claims is necessary. Inst. Dec. 6–7. At this stage of the proceeding, we determine that it is necessary to address the parties' arguments regarding the term "transition."

1. *"transition"*

Claim 13 recites "generating no more than j consecutive *transitions* of said sequence in the recorded waveform such that j≥2" ("the j-constraint limitation") and "generating no more than k consecutive sample periods of said sequences without a *transition* in the record waveform" ("the k-constraint limitation"). Patent Owner asserts that the Board should construe the term "transition," as recited by claim 13, to mean "a reversal in the magnetic orientation of adjacent bit regions along a recording track of a magnetic recording medium" (Patent Owner's "magnetic construction"). PO Resp. 36. Patent Owner adds that "[e]ven if 'transitions' is not construed to mean *magnetic* transitions, at a minimum it should be construed to mean 'a change from one state or stage to another'" (Patent Owner's "alternative construction"). *Id.* at 39.

Petitioner argues that the record does not support Patent Owner's magnetic construction. Reply 2–11. Further, Petitioner asserts that Patent

Owner's alternative construction does not provide "any more clarity than the word 'transition' standing alone." *Id.* at 12.

a. Patent Owner's magnetic construction

Patent Owner asserts that the '601 patent "stress[es] that the [recited] transitions are ***magnetic*** transitions." PO Resp. 36; Sur-Reply 4–6. In particular, Patent Owner points to language in the '601 patent's summary that the invention relates to magnetic computer disk drives and that "the MTR code imposes a limit on the maximum number of consecutive ***transitions*** that can occur in the written ***magnetization*** pattern in ***magnetic*** recording." PO Resp. 36–37 (quoting Ex. 1001, 2:40–42, 2:59–61 (emphasis added by Patent Owner)). Dr. McLaughlin testifies that this language would lead a person of ordinary skill in the art to conclude that the claimed transitions are limited to "magnetic transitions in magnetic recording." *Id.* at 37; McLaughlin Decl. ¶ 49.

Patent Owner further argues that the claim language itself supports a construction limited to magnetic transitions, pointing to the fact that dependent claims 16 and 17, which indirectly depend from claim 13, recite both NRZI (claim 16) and NRZ (claim 17) recording formats, and, thus, claim 13 must cover both formats. *Id.* at 38. Dr. McLaughlin testifies that because claim 13 covers both NRZI and NRZ recording formats, the use of the term "transitions" must not be "limited to particular bit values used to record a transition in one or both of these recording formats," but instead a person skilled in the art would understand "that the important concept is the effect on the medium, i.e., whether there is a reversal in the magnetic polarities in adjacent bit regions." McLaughlin Decl. ¶ 50.

According to Patent Owner, "a skilled person in the field of digital data storage would understand the term 'transitions' to mean magnetic polarity changes on the recording medium." PO Resp. 38 (citing McLaughlin Decl. ¶¶ 43–48); Ex. 2026, 1344; Ex. 2027, 45, 199; Ex. 2028, 207–208. Patent Owner also asserts that the magnetic construction is "consistent with the non-technical, ordinary meaning of 'transition,' which is 'a passage from one state, stage, subject or place to another; change." PO Resp. 39 (citing Ex. 2029, 1254; Ex. 3031, 1287).

"[A] claim construction analysis must begin and remain centered on the claim language itself . . . ." *Innova/Pure Water, Inc. v. Safari Water Filtration Sys., Inc*., 381 F.3d 1111, 1116 (Fed. Cir. 2004). The disputed claim language does not include any reference to the type of media on which the n-bit binary codewords are recorded. The claim's focus, instead, is on how the n-bit codewords are generated. Notably, the patentee could have included language specifying that the codewords be recorded on magnetic media—but instead used the very general term "transition."

Given the broad nature of the claim language, we do not limit further the scope of the claim merely because the Specification discusses magnetic media as a type of storage device that may be used with the invention. *See SuperGuide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 875 (Fed. Cir. 2004) (citing *Electro Med. Sys. S.A. v. Cooper Life Sci., Inc.*, 34 F.3d 1048, 1054 (Fed. Cir. 1994) ("Though understanding the claim language may be aided by the explanations contained in the written description, it is important not to import into a claim limitations that are not a part of the claim. For example, a particular embodiment appearing in the written description may not be read into a claim when the claim language is broader than the

embodiment.")). The language of claims 13, 14, and 17 is broader than the embodiment Patent Owner proffers as support for its proposed construction. Moreover, Patent Owner points to nothing in the claim language, including the dependent claims, which limits the claims to magnetic media.

Moreover, the bulk of the Specification does not refer to magnetic recording. *See* Ex. 1001, code (54) ("Method and Apparatus for Implementing Maximum Transition Run Codes"), code (57) (describing "storage systems," but not referring to magnetic devices). We do not agree with Patent Owner's assertion that "the intrinsic evidence refers exclusively to magnetic recording." Sur-Reply 5. To the contrary, the Specification makes clear that the invention is *not* limited to magnetic media. *See, e.g.*, Ex. 1001, 2:40–42 ("The present invention relates to a channel coding technique to improve data storage device *such as magnetic computer disk drives*."), 3:49–52 ("The invention is advantageously used in storage and similar systems operating at high data densities."). And the Specification specifically discusses optical data storage. Ex. 1001, 1:61–66 ("In optical data storage, a special type of RLL constraint is applied to guarantee the minimum size of the written mark on the medium."). The two isolated sentences pointed to by Patent Owner referring to magnetic recording do not outweigh the rest of the Specification's focus on all types of storage devices such that the claims are limited to magnetic recording devices. PO Resp. 36–37 (citing Ex. 1001, 2:59–61); Sur-Reply 4–5 (citing Ex. 1001, 2:40–62, 2:65–3:1, 4:31–34, 4:1–4, 7:30–40).

Petitioner also points to the language of claim 17, which depends indirectly from claim 13, as refuting Patent Owner's magnetic construction. Reply 3. Claim 17 recites "the binary sequences produced by combining

codewords have no more than one of j consecutive transitions from 0 to 1 and from 1 to 0 . . . when used in conjunction with the NRZ recording format." Ex. 1001, 11:1–6. According to Petitioner, Patent Owner's magnetic construction is narrower than the transitions recited in claim 17. Reply 3. We agree with Petitioner that the language of claim 17 does not make sense if the term "transition" in claim 13 is given Patent Owner's magnetic construction. Patent Owner's declarants seem to agree. *See* Ex. 1035, 104:15–22 (Dr. McLaughlin stating that the word "transition" in claim 13 cannot mean "transitions from 0 to 1 and from 1 to 0 in a binary sequence"); Ex. 1034, 87:18–88:4 (Dr. Moon stating that in claim 13 the term "transition" does not include "a change from 0 to 1 in a binary sequence").

Patent Owner argues that Petitioner reads the language of claim 17 in isolation, without regard to the Specification. Sur-Reply 6. According to Patent Owner, a transition in a waveform, as recited in claim 13, "is reflected by a reversal of the magnetic orientation of adjacent bit regions along [a] recording track, not 0s and 1s." *Id.* (citing McLaughlin Decl. ¶¶ 7–10). We do not find this argument persuasive as it relies on Dr. McLaughlin's testimony discussing the basics of hard drive technology (*see* McLaughlin Decl. ¶¶ 7–10), which Patent Owner does not tie to any particular claim language. As explained above, nothing in the claim language limits the recorded waveform to any particular type of media.

As for claim 17's recitation of "transitions from 0 to 1 and from 1 to 0," Patent Owner argues that it "limits the recording format to NRZ, where the 'binary "1" represents a positive level in the magnetization waveform and the binary "0" negative level in the same waveform,' such that a 01 or

10 corresponds to a reversal in the magnetic orientation of bit regions on the recording track." *Id.* at 7 (citing McLaughlin Decl. ¶¶ 7–12; Ex. 1001, 1:24–27. Again, we do not agree that the claim language is so limited. Patent Owner again points, as support for this assertion, to testimony by Dr. McLaughlin discussing the basics of hard drive technology (*see* McLaughlin Decl. ¶¶ 7–12). Patent Owner also points to a discussion in the background of the '601 patent describing the NRZ recording format in the context of magnetic recording. *Id.* (citing Ex. 1001, 1:24–27). Importantly, however, the '601 patent points out that "modulation codes, are mappings of data bits into symbols that are either transmitted in a communication system or recorded onto a medium in a storage device," not limiting such storage devices to those using magnetic recording. Ex. 1001, 1:16–19. The fact that the '601 patent then goes on to explain RLL codes, including NRZ and NRZI formats, in the context of magnetic recording systems does not indicate that the invention is limited to such systems. To the contrary, later in the same section, the '601 patent notes that "[i]n optical data storage, a special type of RLL constraint is applied to guarantee the minimum size of the written mark on the medium" and the section ends with a reference to an article on coding in "Proceedings of the International Society for Optical Engineering." Ex. 1001, 1:61–65, 2:33–37.

We are also not persuaded by Dr. McLaughlin's testimony that a person of ordinary skill in the art would have read the '601 patent to be limited to magnetic transitions in magnetic recording. *See* McLaughlin Decl. ¶ 49. Dr. McLaughlin bases this conclusion on the previously discussed language in the '601 patent describing magnetic media as one type

of device that may be used with the invention. *Id.* (citing Ex. 1001, 1:40–42, 2:59–61).

Patent Owner's reliance on extrinsic evidence is similarly unpersuasive. Dr. McLaughlin refers to several books and academic papers that use the term "transition" as limited to magnetic polarity changes on the recording medium. McLaughlin Decl. ¶¶ 43–48; PO Resp. 38. However, as pointed out by Petitioner (Reply 8–9), all of these publications are specifically directed to magnetic storage. *See* Ex. 2026 (titled "Recording Codes for Digital Magnetic Storage"); Ex. 2027 (titled "Magnetic Disk Drive Technology"); Ex. 2028 (titled "Theory of Magnetic Recording"). These publications, therefore, provide little, if any, evidence of how a person of ordinary skill in the art would understand the term "transition" in the context of the '601 patent, which applies to storage systems generally, and is not limited to magnetic storage systems. Instead, we agree with Dr. Soljanin that the term "transition" is very general and may have different meanings depending on context. *See* Ex. 2011, 55:21–56:11; *see also* Ex. 2029, 1254 (dictionary definition "passage from one state, stage, subject, or place to another"); Ex. 2031, 1287 (dictionary definition "[t]he process or an instance of changing from one form, state, activity, or place to another").

Accordingly, we do not adopt Patent Owner's proposed construction of transition as recited by claims 13, 14, and 17 to be a reversal in the magnetic orientation of adjacent bit regions along a recording track of a magnetic recording medium.

b. Patent Owner's alternative construction

Patent Owner asserts, as an alternative, that the term "transition" at least means "a change from one state or stage to another." PO Resp. 39.

Although this language is broad and does not explicitly refer to physical changes of a recording medium, Patent Owner apparently interprets this definition to be limited to "an actual change in state of the recording medium." *See id.* at 40 (explaining that the Board should reject Petitioner's constructions because "the mere label used (a '1' or a '0-1') does not reflect an actual change in state of the recording medium that the detector subsequently detects to read the written data"). Patent Owner relies on the non-technical dictionary definitions discussed above as supporting this construction. *Id.* at 39 (citing Ex. 2029, 1254; Ex. 2031, 1287).

Petitioner argues that Patent Owner "fails to explain how its reformulation of [the dictionary] definition provides any more clarity than the word 'transition' standing alone." Reply 12. Petitioner adds that there is no support in either the intrinsic record or the relied upon dictionary definitions for a construction requiring "an actual change in state of the recording medium." *Id.* Thus, Petitioner states that the Board should reject this construction and find that "one of ordinary skill in the art would understand 'transition' without formal construction." *Id.* Moreover, Petitioner asserts that "transition" encompasses transitions in any binary system. Tr. 5:10–14.

We agree with Petitioner that Patent Owner's articulation of this alternate construction as "a change from one state or stage to another" does not illuminate further the plain and ordinary definition of the term "transition." *See* Ex. 2029, 1254; Ex. 2031, 1287. Moreover, without any supporting intrinsic or extrinsic evidence, we do not adopt Patent Owner's implied limitation requiring that the term "transition" requires "an actual change in state of the recording medium." *See* PO Resp. 39 (citing Ex.

2029, 1254 (broad definition of the term "transition" unrelated to the recording medium); Ex. 2031, 1287 (same); Soljanin Decl. ¶¶ 63–64 (Dr. Soljanin stating that she has considered the claim terms, specification, and prosecution history, and is familiar with the relevant scientific principles and the state of the art); Ex. 2011, 57:5–6 (Dr. Soljanin stating that "a transition generally, . . . has to be some kind of a change").

c. Petitioner's construction

As mentioned above, the Petition did not propose explicit constructions for any terms of the challenged claims, including the term "transition." Pet. 17.

Patent Owner asserts that Petitioner changed its implied construction of the term "transition" between the filing of Dr. Soljanin's declaration and her deposition. PO Resp. 31–32, 40; Sur-Reply 3–4. According to Patent Owner, in the declaration, Dr. Soljanin applied a construction of "transition" as a "1," but on cross-examination changed to a "0-to-1 and 1-to-0 construction." PO Resp. 40; *see also* PO Resp. 31–32 (stating that in her declaration Dr. Soljanin asserted that "a '1' in a NRZI sequence is a transition in a recorded waveform"); 32 (stating that on cross-examination, Dr. Soljanin "testified that 'transition' as used in the Challenged Claims occurs 'whenever a 0 is followed by a 1"); Sur-Reply 3–4.

We do not agree with Patent Owner's assertion that Dr. Soljanin made such a change between her declaration and her cross-examination. According to Petitioner, at the logical level, where encoding takes place, a transition can be represented in multiple ways depending on the format used. Tr. 6:21–7:5. For example, a transition can be a change from 0 to 1 or from 1 to 0 when using NRZ format, and can also be represented by a 1 when

using NRZI format. *Id.* We understand this to be Petitioner's position throughout the proceeding.

Although the Petition does not explicitly lay out this construction, it is implied in the analysis. For example, when analyzing anticipation of claim 1 by Okada, Petitioner states that "each of the 13-bit data sequences shown in Tables 1-7 . . . has a finite number of *consecutive* transitions (*e.g.*, sequences where the data switches consecutively between '1' and '0')," and "such constraint causes the '8-to-13 converter 10 to perform data conversion before NRZI modulation in such a way that '1' will not appear three or more times in a row in a train of information data after the NRZi modulation.'" Pet. 23–24, 26 (emphasis omitted) (citing Ex. 1007, 3:54–60). In her declaration, Dr. Soljanin makes similar statements. *See, e.g.*, Soljanin Decl. ¶ 87. Thus, we do not agree with Patent Owner that in her declaration, Dr. Soljanin applied a construction of "transition" as a "1." *See* PO Resp. 40. Instead, Dr. Soljanin, in her declaration, applies a construction that a transition can be represented by a "1" *or* by a change from 0 to 1 and 1 to 0, depending on the format being used. *See, e.g.*, Soljanin Decl. ¶ 87.

This construction is consistent with Petitioner's and Dr. Soljanin's positions post-institution. *See* Reply 16 (referring to "at most four transitions from '0'-to-'1' or '1'-to-'0' are allowed per NRZ codeword" and "NRZI data where a '1' represents a transition"); Ex. 2011, 53:8–10 (Dr. Soljanin stating on cross-examination that "it can be a transition from 0 to 1" and "from 1 to 0"), 55:21–56:4 (explaining that transitions are different based on whether NRZ or NRZI is used).

We, therefore, do not agree with Patent Owner's assertion that Petitioner and Dr. Soljanin improperly shifted their construction of the term

"transition" after the Petition. Instead, we determine that Petitioner and Dr. Soljanin consistently apply a construction of "transition" such that it can be logically represented in multiple ways depending on the encoding format used—a change from 0 to 1 or from 1 to 0, when using NRZ format, for example, or a 1 when using NRZI format.

Moreover, we agree with Petitioner that nothing in the claim language, Specification, or proffered extrinsic evidence limits the construction of the term "transition" such that it excludes such logical transitions in the context of the '601 patent, which is not limited to a particular recording technology. In fact, the dictionary definitions relied upon by Patent Owner are consistent with a broad construction of the term "transition." For example, Merriam-Webster defines "transition" as "1 a : passage from one state, stage, subject, or place to another : CHANGE b : a movement, development, or evolution from one form, stage, or style to another." Ex. 2029, 1254. Similarly, The American Heritage Dictionary defines "transition" as "1. The process or an instance of changing from one form, state, activity, or place to another. 2. Passage from one subject to another, as in discourse." Ex. 2031, 1287. Both these definitions clearly include a change from 0 to 1 in a binary sequence using NRZ format and also include a 1, representing a change from 0 to 1 using NRZI format. *See also* Tr. 47:12–48:3 (Patent Owner's counsel agreeing that going from 0 to 1 or 1 to 0 is a change in state as in the general meaning of "transition" if not tied to a magnetic recording device).

d. Conclusion

As discussed above, we determine that the term "transition" as used in claims 13, 14, and 17, should receive its plain and ordinary meaning.

Moreover, as supported by evidence relied on by both parties, the plain and ordinary meaning of "transition" does not exclude Petitioner's position that a transition can be logically represented in multiple ways depending on the encoding format used—a change from 0 to 1 or from 1 to 0 when using NRZ format, for example, or a 1 when using NRZI format. *See* PO Resp. 39 (citing Ex. 2029, 1254; Ex. 2031, 1287); *see also* PO Resp. 39 (citing Ex. 2011, 57:5–6 (Dr. Soljanin stating on cross-examination that "a transition generally, it has to be some kind of a change")).

D. Anticipation by Okada

Petitioner contends that claims 13, 14, and 17 of the '601 patent are anticipated by Okada. Pet. 17–37. For the reasons that follow, we determine that Petitioner prevails in this assertion for claim 13, but not claims 14 and 17.

1. *Overview of Okada*

Okada, titled "Information Recording Reproducing Apparatus Using Data Conversion to Provide for Accurate Reproduction of High Density Recording Using an Optical Recording Medium," was filed June 6, 1994, and issued February 21, 1995. Ex. 1007, codes (54), (22), (45). Because Okada issued more than one year before the earliest priority date (April 5, 1996) of the '601 patent, this reference is prior art to the '601 patent under pre-AIA 35 U.S.C. § 102(b).

Okada describes performing data conversion for storage on an optical recording medium using NRZI recording format such that "'1' does not appear three or more times in a row in a train of information data at the time of recording information." Ex. 1007, 3:35–44, 3:54–60. Specifically, an embodiment of Okada converts 8-bit data into 13-bit data using one of two

rules. *Id.* at Figs. 6, 3:61–68. "Rule (1)" requires "at least one '0' and an even number of consecutive '1.'" *Id.* at 3:64–65. "Rule (2)" requires "a section consisting of '01010' and a section consisting of at least one '0' or an even number of consecutive '1[s].'" *Id.* at 3:66–68. Example applications of these two rules are shown in nine conversion tables. *Id.* at 4:1–8:64 (demonstrating Rule (1) in Tables 1–7 and Rule (2) in Tables 8 and 9).[7]

2. *Analysis Claim 13*

a. preamble

The preamble of claim 13 requires, "A method for encoding m-bit binary datawords into n-bit binary codewords in a recorded waveform, where m and n are preselected positive integers such that n is greater than m."[8] Ex. 1001, 10:46–49. Petitioner relies on Okada's teaching of encoding

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[7] Throughout the case, there appears to be some confusion about the recording format used by the second column of Okada Tables 1–9 and the second and third columns of Exhibit 1011. *See* Tr. 7:16–12:13. For clarity, both parties appear to ultimately agree that the second column of Exhibit 1011, which reproduces the 13-bit data from Okada Tables 1–9, includes codewords in NRZI format, and the third column of Exhibit 1011 includes codewords (after NRZI modulation) in NRZ format. *Id.*; *see also* Tr. 43:18–44:1. Thus, although the briefing is somewhat unclear on NRZ/NRZI formatting (*see, e.g.*, Sur-Reply 17, which appears to label column 3 data as written in NRZI, not NRZ, format), we treat the 13-bit data in the Okada Tables and the second column of Exhibit 1011 as written in NRZI format and the third column of Exhibit 1011 as written in NRZ format.

[8] Petitioner asserts that the preamble is not limiting, but nonetheless addresses how Okada discloses the preamble's subject matter. Pet. 17–19. Because Petitioner has shown that the recitation in the preamble is satisfied by the prior art, there is no need at this time to determine whether the

8-bit datawords into 13-bit binary codewords as teaching or suggesting such a method. Pet. 17–19, 33 (citing Soljanin Decl. ¶¶ 76–80; Ex. 1007, Figs. 6, 7, 2:48–3:3, 3:35–8:64, 9:24–10:22).

Based on the record, we are persuaded by Petitioner's showing that Okada discloses the preamble of claim 13. Patent Owner does not dispute Petitioner's contentions regarding the preamble. *See* PO Resp. 41–45. Accordingly, we determine that Petitioner has established by a preponderance of the evidence that Okada discloses the preamble of claim 13. *"receiving binary datawords"*

Claim 13 requires, "receiving binary datawords." Ex. 1001, 10:51. Petitioner identifies Okada's 8-bit input record information, which is read from a digital signal, as equivalent to the claimed dataword. Pet. 19–20, 33–34 (citing Soljanin Decl. ¶¶ 81–82; Ex. 1007, Fig. 6, 2:57–61, 3:35–4:16, 8:65–10:22, Tables 1–9).

Based on the record, we are persuaded by Petitioner's showing that Okada discloses "receiving binary datawords" as recited by claim 13. Patent Owner does not dispute Petitioner's contentions regarding this limitation. *See* PO Resp. 41–45. Accordingly, we determine that Petitioner has established by a preponderance of the evidence that Okada "receiving binary datawords."

b. "producing sequences of n-bit codewords"

Claim 1 requires, "producing sequences of n-bit codewords." Ex. 1001, 10:52. Petitioner identifies Okada's 13-bit data output, produced by

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preamble is limiting. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

8-to-13 converter 10, as equivalent to the claimed codewords. Pet. 20–21, 34 (citing Soljanin Decl. ¶¶ 85–86; Ex. 1007, Fig. 6, 3:35–4:16, 8:65–10:22, Tables 1–9).

Based on the record, we are persuaded by Petitioner's showing that Okada discloses "producing sequences of n-bit codewords" as recited by claim 13. Patent Owner does not dispute Petitioner's contentions regarding this limitation. *See* PO Resp. 41–45. Accordingly, we determine that Petitioner has established by a preponderance of the evidence that Okada discloses "producing sequences of n-bit codewords."

c. "imposing a pair of constraints (j;k) on the encoded waveform"

Claim 1 requires, "imposing a pair of constraints (j;k) on the encoded waveform." Ex. 1001, 10:53–54. Petitioner identifies Okada's two rules, used to convert the 8-bit dataword to the 13-bit codeword, as equivalent to the claimed j and k restraints because they constrain the maximum number of consecutive transitions allowed on consecutive clock periods in the encoded waveform. Pet. 23–28, 34 (citing Soljanin Decl. ¶¶ 83–93; Ex. 1007, Figs. 1, 6, 7, 1:21–48, 3:35–4:16, 8:65–10:22, Tables 1–9; Ex. 1011).

Based on the record, we are persuaded by Petitioner's showing that Okada discloses "imposing a pair of constraints (j;k) on the encoded waveform" as recited by claim 13. Patent Owner does not dispute Petitioner's contentions regarding this limitation. *See* PO Resp. 41–45. Accordingly, we determine that Petitioner has established by a preponderance of the evidence that Okada discloses "imposing a pair of constraints (j;k) on the encoded waveform."

d. the j-constraint limitation

The j-constraint limitation of claim 13 requires, "generating no more than j consecutive transitions of said sequence in the recorded waveform such that j≥2." Ex. 1001, 10:55–56. Petitioner explains that both of Okada's rules for encoding result in a maximum of two consecutive transitions allowed on consecutive clock periods, and, therefore, Okada discloses the j-constraint limitation. Pet. 28–29, 35 (citing Soljanin Decl. ¶¶ 94–96; Ex. 1007, Fig. 6, 3:35–4:16, 8:65–10:22, Tables 1–9; Ex. 1011).

To show Okada's Rule 1 results in a maximum of one consecutive transition as recited by claim 13, Petitioner points to Exhibit 1011, which reproduces Tables 1–7 (created using Rule 1) and Tables 8 and 9 (created using Rule 2) of Okada and adds a column with the binary number resulting from NRZI modulation. *See* Pet 28 (citing Ex. 1011). Petitioner specifically points to entry "7a" of Table 4, which indicates that the hexadecimal value "7a" becomes "0011011000000" after application of Rule 1 in 8-to-13 encoding and "001001000000" after NRZI modulation. *Id.* According to Petitioner, this example "illustrates that there are no more than two (2) consecutive transitions in the recorded waveform following NRZI modulation." *Id.* at 28–29.

Similarly, to show Rule 2 results in a maximum of two consecutive transitions, Petitioner points to entry "e8" of Table 8 in Exhibit 1011. Pet. 29. According to Petitioner, the fact that the hexadecimal value "e8" becomes "0010100110000" after Rule 2 application in 8-to-13 encoding and "0011000100000" after NRZI modulation, "illustrates that there are no more than exactly two (2) consecutive transitions in the recorded waveform following NRZI modulation." *Id.*

Patent Owner argues that Okada does not disclose the j-constraint limitation. PO Resp. 42–44; Sur-Reply 16–18. First, Patent Owner argues that "Okada does not disclose a magnetic recording medium at all" and, therefore, cannot disclose the j-constraint limitation. PO Resp. 42. This argument, however, depends on a narrow construction of the term "transition," that, as discussed above, we do not adopt.

Second, Patent Owner argues that "Okada limits the number of consecutive times that Okada's optical head is pulsed on," which "limits the number of consecutive pits on the master copy and the number of consecutive lands on the reproduction copy" and "is a limit on the number of consecutive things that have the *same state*." PO Resp. 42–43. Patent Owner concedes that "Okada's coding scheme permits up to *twenty* consecutive transitions" if transitions include changes from 0 to 1 and 1 to 0. *Id.* at 43–44, 45–46 ("Okada permits up to twenty consecutive transitions under that construction"). We agree with Petitioner that 20 is a finite number, and, thus, Patent Owner concedes that Okada discloses the j-constraint limitation, at least where j=20. Reply 16 (citing PO Resp. 44).[9]

Based on the record, we are persuaded by Petitioner's showing that Okada discloses the j-constraint limitation as recited by claim 13. Accordingly, we determine that Petitioner has established by a preponderance of the evidence that Okada discloses "generating no more than j consecutive transitions of said sequence in the recorded waveform such that $j \geq 2$."

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[9] Patent Owner also concedes that "Rule 2 alone permits up to 12 consecutive transitions," which "limited to that one embodiment, it probably would anticipate that—there would be a constraint." Tr. 52:9–53:12.

e. *the k-constraint limitation*

The k-constraint limitation of claim 13 requires, "generating no more than k consecutive sample periods of said sequences without a transition in the recorded waveform." Ex. 1001, 10:57–59. Petitioner explains that both of Okada's rules ensure "there can never be a codeword consisting of *all* 0's or *all* 1's—thus, k is a finite number" and, therefore, Okada discloses the k-constraint limitation. Pet. 29–30, 35 (citing Soljanin Decl. ¶¶ 97–98; Ex. 1007, Fig. 6, 3:35–4:16, 8:65–10:22, Tables 1–9; Ex. 1011).

To show Okada's Rule 1 results in no more than k consecutive sample periods without a transition, as recited by claim 13, Petitioner asserts that the rule "ensures that a 13-bit codeword cannot be comprised of all 1s or all 0s following NRZI modulation" and "even in the scenario where any two 13-bit codewords are evaluated in succession, there would be no more than 22 consecutive sample periods without a transition." Pet. 29–30 (citing Ex. 1011, Tables 8 and 9).

Similarly, Petitioner asserts that "[t]here can be even fewer consecutive sample periods without a transition when Okada's Rule (2) is used, because a string of '01010' must be included in each of the 13-bit codewords." Pet. 30. According to Petitioner, "[t]he sequences generated thus have 'no more than k consecutive sample periods without a transition in the recorded waveform,'" as recited by claim 13. *Id.*

Patent Owner argues that Okada does not disclose the k-constraint limitation. PO Resp. 44–45. As with the j-constraint limitation, Patent Owner argues that Okada "does not disclose a magnetic recording medium at all" and, therefore, cannot disclose the k-constraint limitation. *Id.* at 44.

This argument, however, depends on a narrow construction of the term "transition," that, as discussed above, we do not adopt.

Patent Owner also argues that Okada's two rules "permit an unlimited number of consecutive 0s" because only one of the two rules is applicable at a time and Rule 1 is satisfied by thirteen consecutive 0s. PO Resp. 44–45. Petitioner responds by stating that none of the tables using Okada's Rule 1 (Tables 1–7) show thirteen consecutive 0s. Reply 17. Thus, even if Rule 1 theoretically could be applied such that thirteen consecutive 0s are used as the thirteen-bit codeword, this is immaterial because Okada discloses an embodiment that does *not* include such a codeword. *Id.*

We agree with Petitioner. Claim 13 covers the Okada embodiment disclosed in Tables 1–9, which discloses a method for encoding 8-bit datawords into 13-bit codewords that have a finite number of consecutive 0s or 1s. *See* Ex. 1007, Tables 1–9; Ex. 1011. Rule 2, by its terms, also satisfies the k-constraint because it requires a section of "01010," which imposes a finite limit on the number of consecutive 0s or 1s. *See* Ex. 1007, 3:66–68. Thus, Okada discloses the k-constraint limitation. *See, e.g.*, *In re Lukach*, 442 F.2d 967, 970 (CCPA 1971) ("[T]he description of a single embodiment of broadly claimed subject matter constitutes a description of the invention for anticipation purposes.").

Based on the record, we are persuaded by Petitioner's showing that Okada discloses the k-constraint limitation as recited by claim 13. Accordingly, we determine that Petitioner has established by a preponderance of the evidence that Okada discloses "generating no more than k consecutive sample periods of said sequences without a transition in the recorded waveform."

f. Conclusion

After reviewing the arguments and evidence of record, we find that Petitioner demonstrates by a preponderance of the evidence that claim 13 is anticipated by Okada.

3. *Analysis Claims 14 and 17*

Claim 14 depends from claim 13 and recites "wherein the consecutive transition limit is defined by the equation $2 \leq j < 10$" (claim 14's "j-constraint limitation"). The Petition submits that "Okada discloses a constraint length of j=2, and thus anticipates claim 14." Pet. 35–36 (citing Soljanin Decl. ¶¶ 112–113; Ex. 1007, Fig. 6, 3:35–4:16, 8:65–10:22, Tables 1–9). Patent Owner challenges this assertion, stating that Okada Rule 1 "permits up to twenty consecutive transitions" under a construction of "transition" as a change from 0 to 1 or 1 to 0 (PO Resp. 45), and Rule 2 allows for up to twelve consecutive transitions (Sur-Reply 16–17 (showing that the concatenation of "0010100111111" and "1111110010100" would have 12 consecutive transitions assuming NRZI[10] recording format)).

In reply, Petitioner does not dispute Patent Owner's assertion that Rule 1 allows for up to 20 consecutive transition, but argues that Okada's Rule 2 "independently qualifies as an anticipating method." Reply 14. According to Petitioner, "Okada's Rule (2) method (as seen in the data in the third column of Tables 8 and 9 of Exhibit 1011) shows a 'j-constraint' that is even lower—at most four transitions from '0'-to-'1' or '1'-to-'0' are allowed per NRZ codeword (*e.g.*, 'fc' in Table 9) and at most eight

[10] The Sur-reply appears to incorrectly interchange the NRZI and NRZ recording format labels here.

transitions when multiple NRZ codewords are combined in a recorded waveform (*e.g.*, 'fc' followed by 'f8' in Table 9)." *Id.* at 16.

Patent Owner argues that this argument—"Rule (2) 'standing alone' anticipates" is improper and should not be considered as it was not articulated in the Petition. Sur-Reply 12–16. We do not agree that this argument is newly articulated in the Reply Brief. The Petition clearly states that Rules 1 and 2 of Okada "*each impose[]*" the j-constraint. Pet. 23–24. And the Petition separately sets out how Rule 1 and Rule 2 disclose both the j-constraint (*id.* at 28–29 (Rule 1), 29 (Rule 2)) and the k-constraint (*id.* at 29–30 (Rule 1), 30 (Rule 2)).

We agree, however, with Patent Owner that Petitioner has not sufficiently shown that Okada's Rule 2 anticipates claim 14. For the j-constraint, the Petition states that "imposition of Rule (2) results in a maximum of two consecutive transitions (as seen in Tables 8 and 9)." Pet. 29. Petitioner bases its allegation of anticipation on this assertion—"Okada discloses a constraint length of j = 2, and thus anticipates claim[] 14." *Id.* at 36. In the Reply Brief, Petitioner changes this assertion, without explanation, to a j-constraint that is at most *four* per codeword and at most *eight* when multiple codewords are combined, again relying for support on the codewords set forth in Okada's Tables 8 and 9. Reply 16. Although Petitioner consistently points to Tables 8 and 9 as evidence that Okada's Rule 2 anticipates the j-constraint limitation of claim 14, we understand Petitioner's position from the briefing to be that Okada's Rule 2 anticipates claim 14. *See, e.g.*, Pet. 29 ("[I]mposition of Rule (2) results in a maximum of two consecutive transitions allowed on consecutive clock periods."); Reply 14 ("Each of Okada's rules . . . independently qualifies as an

anticipating method."), *id.* at 15 ("Okada's 'Rule (2)' clearly discloses every limitation of the three challenged claims of the '601 patent.").

We understand Petitioner to agree with Patent Owner's assertion that Rule 2 allows for up to twelve consecutive transitions. Sur-Reply 16–17 (showing that the concatenation of "0010100111111" and "1111110010100" would have 12 consecutive transitions assuming NRZI[11] recording format). In fact, we see no reason that the two examples given by Patent Owner would not be legitimate codewords using Okada's Rule 2. Thus, there does not appear to be a dispute that Okada's Rule 2, by its terms, does not anticipate claim 14's j-constraint limitation requiring a value of j that is less than ten.

At the hearing, however, Petitioner explained that it is relying *solely* on Tables 8 and 9 for anticipation of claim 14. Tr. 21:1–22. In other words, Petitioner argues that each of Tables 8 and 9 is an independent example of using Okada's Rule 2 and thus, each of these two tables independently anticipates claim 14. *See* Tr. 21:1–7 ("For Rule 2, Okada provides two examples in tables 8 and 9. Each table reflects the creation of a given set of arbitrary 13-bit encoded sequences that comply with either Rule 1 or Rule 2, and then, assigning those code words back to the inputs."). We see no language in any of Petitioner's briefs, however, that sets forth this position. Thus, we consider this argument to be improper as untimely.

Even if Petitioner's argument were timely, Petitioner has not explained how each of Tables 8 and 9, independently, comprises a complete

[11] The Sur-reply appears to incorrectly interchange the NRZI and NRZ recording format labels here.

embodiment such that Tables 8 and 9, by themselves, and without any rearrangement, anticipate claim 14. *In re Gleave*, 560 F.3d 1331, 1334 (Fed. Cir. 2009) (stating that to establish anticipation "the reference must disclose each and every element in a claimed invention," "arranged or combined in the same way as in the claim"). For example, Okada discloses that its 8-to-13 converter "performs data conversion to expand 8-bit input record information to 13-bit data." Ex. 1007, 3:61–62. Okada's Tables 1–9 provide conversions for the 8-bit hexadecimal inputs, i.e., 00 to ff. *Id.* at 4:17–8:64. Petitioner does not explain specifically why a person of ordinary skill in the art would understand Okada as disclosing an 8-to-13 converter that operates solely on the 8-bit hexadecimal inputs (d8 to ff) in Tables 8 and 9.

After reviewing the arguments and evidence of record, we find that Petitioner does not demonstrate by a preponderance of the evidence that claim 14 is anticipated by Okada. Claim 17 depends directly from claim 14, and Petitioner's case against it suffers from the same problems as its case against claim 14. *See* Pet. 37 (relying on the analysis for claim 14 for anticipation of the overlapping limitations in claim 17).

E. Anticipation by Tsang

Petitioner asserts that claims 13, 14, and 17 of the '601 patent are anticipated by Tsang. Pet. 37–56. Patent Owner opposes Petitioner's assertion. PO Resp. 46–66. Having considered the arguments and evidence presented during trial, we determine that Petitioner has not established by a preponderance of the evidence that the challenged claims are anticipated by Tsang. In particular, Petitioner has not shown that Tsang qualifies as prior art under pre-AIA 35 U.S.C. § 102(e) because it does not disclose an

invention "by another," as required by § 102(e). Integral to this Decision is the Seagate Annual Report (Ex. 2025), authored by Moon and Brickner, and provided to Tsang prior to the filing of Tsang.

1. *Overview of Tsang*

Tsang, titled "Method and Apparatus for Implementing Codes with Maximum Transition Run Length," was filed January 31, 1996, and issued March 24, 1998. Ex. 1009, codes (54), (22), (45). Tsang identifies Kinhing P. Tsang as the sole inventor and identifies Seagate Technology, Inc., as assignee. *Id.*, codes (73), (75).

Tsang acknowledges the existence of "[a] class of block codes that limits the number of consecutive symbol transition, typically representing binary '1's', are known as maximum transition run (MTR) codes. Ex. 1009, 2:22–25. Further, Tsang states that "[a]t densities considerably greater than those in currently commercially available products, the most likely error sequence has been demonstrated to consist of write patterns that contain three or more unspaced consecutive transitions." *Id.* at 2:18–22. To avoid such patterns, Tsang discloses that "codes with MTR values (no more than two successive binary '1's' in the coding result) equal to two are desirable." *Id.* at 2:25–28.

Tsang also explains that "[t]o design a MTR code with MTR=2 having a rate of m/n . . . an exhaustive search of the possible n bit blocks is used to find 2^m different n-bit words which satisfy the MTR=2 constraint," but there is "a desire to provide an encoding algorithm which satisfies the MTR=2 constraint that is each to implement using Boolean logic and is not limited by invalid patterns beginning or ending with '11'." *Id.* at 2:45–3:8. To address this desire, Tsang uses "a finite state machine represented by a

two-state trellis diagram" to choose a set of codewords from the list of all possible n-bit codewords that satisfy the MTR constraints. *Id.* at 4:3–16.

2. *The Seagate Annual Report*

The Seagate Annual Report, authored by Drs. Moon and Brickner, the inventors of the '601 patent, is dated September 26, 1995. Ex. 2025. It describes research focused on "the use of fixed-delay tree search with decision feedback (FDTS/DF) with (0,*k*) run length limited (RLL) codes." *Id.* at 2. Section 4.2 describes "a new class of codes, designated *maximum transition run* (MTR) codes," which "limit the number of consecutive transitions that can occur in a recorded sequence." *Id.* at 5. The Report proposes "the use of MTR=2;*k* codes . . . for use in magnetic recording." *Id.* The Report also describes "an example of a MTR block code, the rate 4/5, MTR=2;*k*=8 block code" is shown in Table IV. *Id.* at 8–9.

Petitioner has not challenged the status or contents of the Seagate Annual Report. In fact, the Petition itself refers to the Report as setting forth a "key finding from Seagate's research." Pet. 6 (citing Ex. 1009),[12] 44–45. Tsang, itself, refers to the Seagate Annual Report, as does the '601 patent. Ex. 1009, 2:36–38 ("The upper bound of the MTR=2 code rate in which k=∞ has been found to be 0.8791 as indicated in the Seagate Annual Report."); Ex. 1001, 2:47–58 ("This improvement in the bit error rate can be traded for an increase in storage density if the error rate performance is already satisfactory." (citing an additional related Seagate document and presentation by Brickner and Moon).

[12] Although the Petition refers to the Seagate Annual Report, the Report itself was not entered into the record until Patent Owner filed it with its Patent Owner Response. *See* Ex. 2025.

3. *Whether Tsang is Prior Art Under 35 U.S.C. § 102(e)*

Because Tsang was filed prior to the earliest priority date of the '601 patent, Petitioner asserts that this reference is prior art to the '601 patent under pre-AIA 35 U.S.C. § 102(e). Pet. 3. Patent Owner argues that Tsang does not qualify as prior art because it does not disclose an invention "by another," as required by § 102(e). PO Resp. 29, 46, 61–65. Patent Owner also argues that Drs. Moon and Brickner completed their invention prior to the January 1996 filing date of Tsang. *See id.* at 29, 46, 56–61.

For the reasons that follow, we agree with Patent Owner that Tsang is not prior art to the '601 patent under § 102(e).

a. Legal Background

Under § 102(e), a claim is anticipated if "the invention was described in . . . an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent." Thus, "there are two conditions expressed in section 102(e): (1) the application for the reference patent must have been by one who is legally 'another' and (2) the filing date must be 'before the invention . . . by the applicant.'" *In re Land*, 368 F.2d 866, 879 (CCPA 1966). To overcome a prior art reference under §102(e), the applicant or patentee may antedate the invention by establishing prior conception and reduction to practice relative to the filing date of the prior application. *In re Costello*, 717 F.2d 1346, 1351 (Fed. Cir. 1983). Alternatively, the applicant or patentee may "establish that the relevant disclosure [in the prior application] describes their own invention." *Id.*

As an initial matter, as mentioned above, Tsang lists Kinhing P. Tsang as its sole inventor. Ex. 1009, code [75]. The '601 patent lists Jaekyun

Moon and Barrett J. Brickner as the inventors. Ex. 1001, code [75]. Thus, we agree with Petitioner that, on its face, Tsang has a different inventive entity than the '601 patent. *See* Reply 23. Nonetheless, determining whether the prior application has a different inventive entity on its face than the challenged patent does not end the inquiry. We must also determine "whether the portions of the reference relied on as prior art, and the subject matter of the claims in question, represent the work of a common inventive entity." *EmeraChem Holdings, LLC v. Volkswagen Grp. of Am., Inc.*, 859 F.3d 1341, 1345 (Fed. Cir. 2017) (quoting *Riverwood Int'l Corp. v. R.A. Jones & Co.*, 324 F.3d 1346, 1356 (Fed. Cir. 2003)).

> [T]o decide whether a reference patent is 'by another' for the purposes of 35 U.S.C. § 102(e), the Board must (1) determine what portions of the reference patent were relied on as prior art to anticipate the claim limitations at issue, (2) evaluate the degree to which those portions were conceived 'by another,' and (3) decide whether that other person's contribution is significant enough, when measured against the full anticipating disclosure, to render him a joint inventor of the applied portions of the reference patent.

Duncan Parking Techs. v. IPR Grp., 914 F.3d 1347, 1358 (Fed. Cir. 2019).

In *Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375 (Fed. Cir. 2015), the Federal Circuit explained the shifting burden of production in an *inter partes* review with respect to showing whether a reference is prior art. *Id*. at 1379–80. Here, although the burden of persuasion never shifts to Patent Owner, Petitioner satisfied its initial burden of production by arguing that Tsang anticipates the challenged claims under § 102(e). *See id*. at 1379 (stating the petitioner satisfied its initial burden of production by arguing that the prior art anticipated the claims under § 102(e)(2)). The burden of production then shifted to Patent Owner to

argue or produce evidence that Tsang does not anticipate the challenged claims or that Tsang is not prior art. As we explain below, we conclude that Patent Owner sufficiently argued and produced evidence that Tsang is not prior art because it is not work "by another," thereby shifting the burden of production back to Petitioner to prove that Tsang constitutes prior art under § 102(e). *See id*. at 1380.

b. The Scope of the Petition

Patent Owner contends that Petitioner relies solely "on general descriptions in the Tsang Patent about values for *m, n, j,* and *k* for MTR codes to allege anticipation." PO Resp. 63; Sur-Reply 21; Tr. 54:4–7 ("the portions that [the Petition relies] on of [Tsang] are drawn from the Seagate Annual Report and disclosed in the Seagate Annual Report."). According to Patent Owner, "the Petition does not rely on the Tsang Patent's particular trellis-based, codeword block concatenation strategy for an MTR code to allege anticipation of the Challenged Claims." PO Resp. 63 (citing Pet. 44–45, 52–54); *see also* Sur-Reply 22 (listing citations to the Seagate Annual Report relied upon in the Petition). Petitioner argues that "Tsang invented and claimed specific MTR codes not disclosed to him by either Moon or Brickner" and, therefore, "[t]he inventions in Tsang are 'by another' under Section 102(e)." Reply 25; *see also* Reply 23 (stating that "[t]he '601 patent and Seagate Annual Report disclose a single MTR code type, namely a rate 4/5 MTR code," but "Tsang invented different rate 5/6 and rate 6/7 MTR codes").

Although we recognize the Petition relies on various portions of Tsang for background and context, when considering the Petition as a whole, we agree with Patent Owner that the Petition relies solely on material

disclosed in the Seagate Annual Report for anticipation of the challenged claims. Throughout the Petition, Petitioner focuses on Tsang's disclosure of two embodiments "for encoding 'data words . . . having "m" successive bits' into 'code words . . . having "n" bits where "n" is greater than "m"'" as anticipating. Pet. 38 (citing Ex. 1009, 2:28–44, 4:1–6, 10:17–19, 19:34–38), Pet. 39–43 (citing Ex. 1009, Figs. 4A, 9A), Pet. 44–46 (citing Ex. 1009, 2:14–28, 2:36–38, 5:25–6:24, 11:27–56). Petitioner also emphasizes that "Dr. Tsang set forth a key finding from Seagate's research—a finding previously presented in the Seagate Annual Report," that "[t]he upper bound of the MTR=2 code rate in which k=∞ has been found to be 0.8791." Pet. 6 (quoting Ex. 1009, 2:36–38); 45.

To the extent the Petition refers to specific MTR rates, such as Tsang's 5/6 and 6/7 MTR rates, these examples do not refer to the values of constraints j and k, but instead refer to the values of m and n, the number of bits in the claimed dataword and codeword—values which are not limited by the challenged claims. Pet. 38 (noting that Tsang discloses examples with "m=5 and n=6" and "m=6 and n=7"), 44 ("Encoder (65) converts 6-bit input data to 7-bit codewords, and is a state-dependent encoder."), 45 (discussing the values of j and k used with Tsang's two embodiments); Ex. 1009, 4:1–6, 10:17–19. In other words, the challenged claims cover any positive integer value of m and n that satisfy the recited MTR constraints. *See* Ex. 1001, 10:46–49 ("A method for encoding m-bit binary datawords into n-bit binary codewords in a recorded waveform, where m and n are preselected positive integers such that n is greater than m"). Because the challenged claims are not limited to the specific m/n MTR rates disclosed by Tsang, we are not persuaded that the Petition relies on these rates for its assertion that Tsang

anticipates the claims. *Cf. Duncan Parking*, 914 F.3d at 1358–59 (determining that because the claims of the challenged patent "clearly include elements previously disclosed" by the putative prior art, "the question is whether [the same inventive entity] conceived those elements as they were disclosed in the [putative prior art]").

Thus, when considering whether the "relied-upon portions" of Tsang are the work of another, we focus—as Petitioner has—on the disclosure of MTR constraints j and k.

c. Work of Another

To satisfy its burden of production to show Tsang's disclosure of MTA constraints j and k is not the work of another, Patent Owner submits declarations from one of the '601 patent inventors, Dr. Moon (Ex. 2016), a report authored by Brickner and Moon and dated May 1995 (Ex. 2033 ("the May 1995 Report")), and the Seagate Annual Report (Ex. 2025). See PO Resp. 61–62. Relying on this evidence, Patent Owner asserts that the portions of Tsang disclosing MTR constraints j and k are solely the work of the '601 patent inventors. *Id.* at 61–65.

Dr. Moon testifies that he and Dr. Brickner performed research at the University of Minnesota under two grants, one from Seagate. Ex. 2016 ¶¶ 40–43. During the research, Dr. Moon's main contact at Seagate was Mr. Robert Kost, "who was then the boss of Kinhing ('Paul') Tsang, the listed inventor for Tsang." *Id.* ¶ 45. The purpose of the research was "to develop coding schemes to improve sequence detection performance for HDDs." *Id.* ¶ 44. Dr. Moon testifies that "[i]n the course of our research and by the spring of 1995, we developed, invented, conceived, and reduced to practice the MTR codes claimed in the '601 patent." *Id.* According to Dr. Moon,

between 1995 and 1997, he attended many in-person and telephonic calls with both Mr. Kost and Mr. Tsang in which "we discussed the subject of my research, including the MTR codes, in significant detail." *Id.* at 46. In addition, Dr. Moon testifies that "Brickner and I disclosed our inventive MTR codes to Seagate in around May 1995" in the May 1995 Report. *Id.* at 47 (citing Ex. 2033).

To corroborate the Dr. Moon's testimony, Patent Owner submits contemporaneous notes of Mr. Kost (Ex. 2034), an invention disclosure form dated September 8, 1995 (Ex. 2035), the May 1995 Report (Ex. 2033), the Seagate Annual Report (Ex. 2025), a 1998 paper co-authored by Mr. Kost (Ex. 2018), table of contents for a 1996 Intermag conference (Ex. 2020), and a paper authored by Drs. Moon and Brickner published in IEEE in 1996 (Ex. 1012). Ex. 1009 ¶¶ 46–67. In particular, Patent Owner points to the Seagate Annual Report as disclosing, in May of 1995, MTR codes with constraints j and k consistent with the subject matter recited by the challenged claims and emphasizes that Tsang, itself, refers to the Seagate Annual Report. PO Resp. 57–58 (citing Ex. 2025, 5–6), 49 (citing Ex. 1009, 2:36–38), 60. Patent Owner also points to the May 1995 Report as corroborating that date as well as 1995 notes of Mr. Kost, which according to Patent Owner, "corroborates that Moon and Brickner were working on a 'new coding concept . . . [b]y examining the distance properties,' which is the essence of their MTR codes." *Id.* at 60 (citing Ex. 2033, Fig. 2; Ex. 2034; Ex. 2016 ¶ 52).

Having considered the evidence presented by Patent Owner, we find Patent Owner has satisfied its burden of production to show Tsang is not § 102(e) prior art. We find the testimony of Dr. Moon—as corroborated by

the Seagate Annual Report, which is explicitly relied upon by both Tsang and the Petition—to be persuasive evidence that the relied-upon portions of Tsang represent the work of the '601 patent inventors.

The burden, therefore, shifts back to Petitioner to rebut Patent Owner's evidence and show Tsang qualifies as § 102(e) prior art. In response, Petitioner challenges the sufficiency of Patent Owner's evidence and asserts that Dr. Tsang was a necessary contributor of the invention disclosed in Tsang, thereby making Tsang's disclosure "by another." Reply 19–20, 23–25. We are not persuaded by Petitioner's arguments.

d. Dr. Moon's Credibility

Regarding the sufficiency of the evidence, Petitioner argues the testimony of Dr. Moon is not reliable. Reply 19–20. First, Petitioner argues Dr. Moon lacks credibility because he "has a substantial financial stake in the outcome of the litigation between UMN and LSI." Reply 19 (citing Ex. 2016 ¶ 76; Ex. 1034, 10:15–11:13). Second, Petitioner asserts that "Dr. Moon advocated for many years that the challenged claims are not limited to magnetic systems," but has changed his opinion in this proceeding. *Id.* at 20 (citing Ex. 2016 ¶ 33).

In response, Patent Owner argues that Petitioner "does not come close to undercutting Moon's detailed testimony, especially as corroborated by numerous contemporaneous documents that LSI does not challenge." Sur-Reply 19 (citing Exs. 2012–2015, 2025, 2030, 2032–2035).

We are not persuaded that Dr. Moon's testimony lacks credibility. Even taking into consideration Dr. Moon's interest in the outcome of this case, the pertinent parts of his testimony, detailing the dates when he and Dr. Brickner conceived of the invention, are not actually challenged by

Petitioner. Moreover, Petitioner has not challenged any of Patent Owner's corroborating evidence or even asserted that it is insufficient. *See* Reply 19–20, 23–25. In fact, Petitioner admits that at least portions of Dr. Moon's testimony are correct. *See* Pet. 6 (stating that the work of Drs. Moon and Brickner "was admittedly 'supported' by Seagate Technology" and that a "key finding from Seagate's research" is set forth in the Seagate Annual Report).

Moreover, the purpose of corroboration is to negate any self-interest that may taint an inventor's testimony. *See Price v. Symsek*, 988 F.2d 1187, 1195 (Fed. Cir. 1993) (describing an inventor's testimony as "attempting to remember specifically what was conceived and when it was conceived, a situation where, over time, honest witnesses can convince themselves that they conceived the invention of a valuable patent"). The sufficiency of corroborative evidence is determined by a rule of reason analysis where "[a]n evaluation of *all* pertinent evidence must be made so that a sound determination of the credibility of the inventor's story may be reached." *Id.* at 1195. Applying the rule of reason, we find Patent Owner's proffered evidence sufficient for corroboration purposes, particularly in light of the Seagate Annual Report and the reliance on that document by both the Petition and Tsang itself.

e. Dr. Tsang's Contribution

Regarding whether Dr. Tsang was a necessary contributor to the subject matter of Tsang relied upon by the Petition, Petitioner argues that "as to Tsang's rate 5/6 and rate 6/7 MTR codes, there is no evidence that Tsang derived his inventions from anyone," and "[a]t a minimum, Tsang's 'contribution is significant enough' to at least 'render him a joint inventor on

the applied portions of the [Tsang] patent.'" Reply 24–25. Petitioner notes that Dr. Moon testified at his deposition that he should not have been included as an inventor on the Tsang patent because "[t]his is about specific embodiment, specific implementation of MTR code." *Id.* at 24 (quoting Ex. 1034, 75:16–76:2). Petitioner, thus, concludes that "Tsang invented and claimed specific MTR codes not disclosed to him by either Moon or Brickner" and "[t]he inventions in Tsang are thus 'by another' under Section 102(e)." *Id.*

However, as discussed above, the relevant question is not whether Dr. Moon contributed to the inventions claimed in Tsang (for example, Tsang's algorithm for choosing codewords using a finite state machine represented by a two-state trellis diagram) such that he should be a named inventor on that patent. The question is whether the *portions of Tsang relied upon by the Petition* to anticipate the claims of the '601 patent represent the work of someone other than the inventors of the '601 patent. As discussed above, we are persuaded that the Petition relies on the portions of Tsang describing MTR constraints j and k, which are also described in the Seagate Annual Report. Tsang's exemplary choice of m equal to 6 or 7 and n equal to 7 or 8 does "no more than merely explain . . . the current state of the art" as set forth by Drs. Moon and Brickner. *Duncan Parking*, 914 F.3d at 1358; *See* Ex. 1009, 2:42–44 (explaining that in the context of the Seagate Annual Report, "[f]or practical implementation, m and n are usually chosen to be small integers and the ration m/n is as close to the code capacity as possible"). Thus, Dr. Tsang's contribution to the subject matter relied upon for anticipation by the Petition is not "significant enough, when measured

against the full anticipating disclosure, to render him a joint inventor of the applied portions" of Tsang. *Duncan Parking*, 914 F.3d at 1358.

Based on the arguments and evidence presented during trial, we determine that Petitioner has not satisfied its burden to prove the portions of Tsang relied upon for anticipation represent the work of another to qualify as prior art under § 102(e). Accordingly, we find that Petitioner has not established by a preponderance of the evidence that any challenged claim of the '601 patent is unpatentable as anticipated by Tsang.

IV. CONCLUSION[13]

Based on the full record, we determine that Petitioner shows by a preponderance of the evidence that claim 13 of the '601 patent is unpatentable under 35 U.S.C. § 102 as anticipated by Okada, but Petitioner has not shown that claims 14 and 17 are unpatentable.

Claim(s)	35 U.S.C. §	Reference(s) /Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
13, 14, 17	102	Okada	13	14, 17
13, 14, 17	102	Tsang		13, 14, 17
Overall Outcome			13	14, 17

[13] 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).

V. ORDER

For the reasons given, it is:

ORDERED that, pursuant to 35 U.S.C. § 314(a), Petitioner has shown by a preponderance of the evidence that claim 13 of the '601 patent is unpatentable;

ORDERED that, pursuant to 35 U.S.C. § 314(a), Petitioner has not shown by a preponderance of the evidence that claims 14 and 17 of the '601 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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