

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ELECTRONICS, INC.,
Petitioner,

v.

CONSTELLATION DESIGNS, LLC,
Patent Owner.

IPR2023-00319
Patent 10,693,700 B1

Before BRENT M. DOUGAL, MICHAEL T. CYGAN, and
SCOTT RAEVSKY *Administrative Patent Judges*.

DOUGAL, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining No Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

A. *Background and Summary*

Petitioner, LG Electronics Inc., filed a Petition to institute an *inter partes* review challenging the patentability of claims 5, 15, and 25¹ (the “challenged claims”) of U.S. Patent 10,693,700 B1 (Ex. 1001, “the ’700 patent”). Paper 3 (“Petition” or “Pet.”). Patent Owner, Constellation Designs, LLC, filed a Preliminary Response. Paper 7. Applying the standard set forth in 35 U.S.C. § 314(a), we instituted *inter partes* review. Paper 10.

Patent Owner filed a Response (Paper 12, “PO Resp.”), Petitioner filed a Reply (Paper 13, “Reply”), Patent Owner filed a Sur-reply (Paper 14, “PO Sur-reply”), and Petitioner filed a Sur-sur-reply (Paper 20, “Pet. Sur-reply”)². An oral hearing was held on April 17, 2024, and a copy of the transcript is in the record. Paper 24 (“Tr.”).

We have jurisdiction under 35 U.S.C. § 6. This Decision is a Final Written Decision under 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 as to the patentability of the claims on which we instituted trial. Having reviewed the arguments of the parties and the supporting evidence, we determine that Petitioner has not shown by a preponderance of the evidence that the challenged claims are unpatentable.

B. *Related Matters*

The parties identify the following related district court litigation: *Constellation Designs, LLC v. LG Electronics Inc. et al.*, No. 2:21-cv-00448 (E.D. Tex.). Pet. 81; Paper 5, 1. Patent Owner also identifies the following

¹ Claims 2, 3, 12, 13, 22, and 23, though challenged by Petitioner, were disclaimed by Patent Owner after trial was instituted. Ex. 2024.

² The Petitioner Sur-reply was authorized in view of our authorization for Patent Owner to file declarant testimony with the Patent Owner Sur-reply.

related *inter partes* reviews: IPR2022-01482, IPR2022-01549, IPR2023-00228, IPR2023-00229, and IPR2023-00320. Paper 5, 1–2.

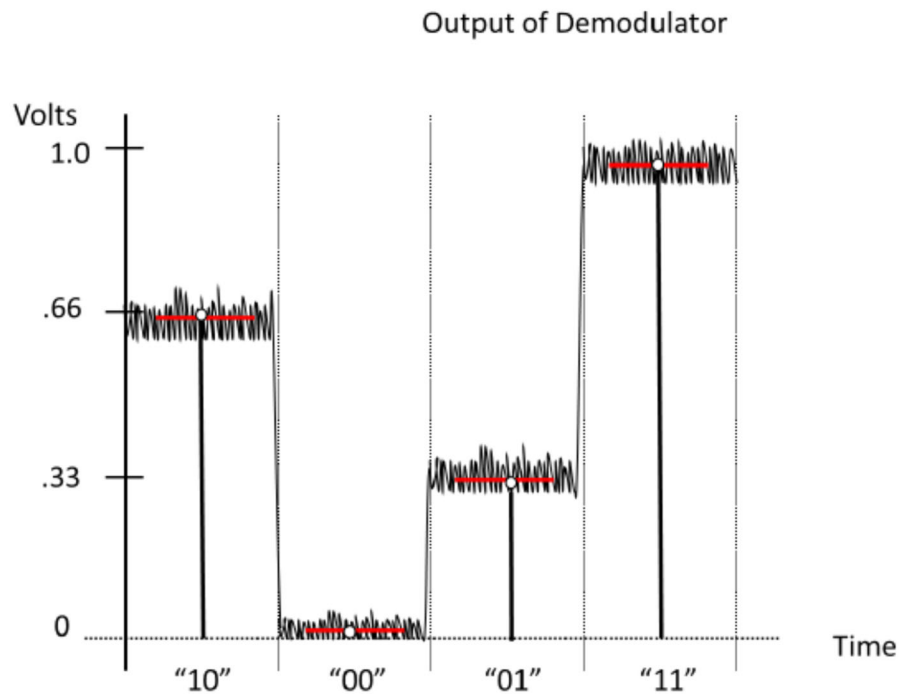
C. The '700 Patent

The '700 patent is directed to digital communication or transmission systems with “unequally spaced constellations.” Ex. 1001, 1:38–44. As background to the technology, “[a] digital communication system is used to transmit digital bits (sequences of 0s and 1s) from one device (a transmitter) to another (a receiver).” Ex. 2001 ¶ 12. Each digital communication system has a measurable “capacity,” which is the maximum amount of information that the system can reliably send over the channel. *Id.* ¶ 15. The transmitter maps each new bit sequence to constellation points. *Id.* ¶¶ 15, 18. “[A] ‘constellation’ point is a carrier signal value (such as amplitude and/or phase) that can be used to represent a longer sequence of bits.” *Id.* ¶ 12. The receiver in turn attempts to detect symbols that were received, from the transmitter, by mapping a received signal to a constellation. Ex. 1001, 1:44–46. The minimum distance ($d_{\min}$) between constellation points at high signal-to-noise ratios (SNRs) correlates to the capacity of the constellation, and accordingly, many communication systems aim to maximize this value in order to maximize capacity of the system. Ex. 2001 ¶¶ 46–54. This is to decrease the risk that the noise in the signal makes the signal unreadable, i.e., decreases the risk that the system is unable to determine which signal value was intended between two adjacent signal values.

As a simple illustration, Patent Owner’s declarant, Dr. Giuseppe Caire, provides the following example of a one-dimensional constellation, with bit values (constellation label) and signal amplitude values (constellation location):

Constellation Label	Constellation Location
“00”	0
“01”	.33
“10”	.66
“11”	1.0

Ex. 2001 ¶ 30. An output based on this constellation, and including an illustration of signal noise, is reproduced below.



Id. ¶ 33. The above figure, provided by Dr. Caire, is a graph of the signal amplitude, in volts, over time. As can be seen above, “a time-dependent continuous waveform is shown in black including noise, the average of the time-dependent continuous waveform is shown in red, the output of the demodulator is shown as discrete time values in black, and the figure is again annotated with the corresponding bit sequence.” *Id.* Thus, it can be seen how each bit value (constellation label) corresponds to the signal amplitude value (constellation location) in wave form. The receiver, with

information about the constellation, is thus able to determine the bit values communicated from the transmitter.

As mentioned, the '700 patent is directed to digital communication systems with “unequally spaced constellations.” Ex. 1001, 1:38–44. Rather than focusing on maintaining a minimum distance ($d_{\min}$) between the signal values of the constellation, the '700 patent attempts to provide “direct optimization of the constellation points of a communication system utilizing a capacity approaching channel code, [that] can yield different constellations depending on the SNR for which they are optimized” *Id.* at 5:11–16. The '700 patent explains that “capacity optimized constellation at low SNRs are geometrically shaped constellations that can achieve significantly higher performance gains (measured as reduction in minimum required SNR) than constellations that maximize $d_{\min}$.” *Id.* at 8:24–29. The '700 patent provides that “a constellation at one code rate can achieve gains that cannot be achieved at another code rate.” *Id.* at 5:20–21. Dr. Caire provides one example of “a constellation optimized for a code rate of 1/2 provides gains when with a code rate of 1/2, but may not provide the same gains at other code rates, such as 2/3 code rate.” Ex. 2001 ¶ 60. Thus, “[i]nstead, when using a code rate of 2/3, a different constellation may be used – a constellation optimized for use at 2/3 code rate.” *Id.*

“Capacity measures that can be used in the selection of the location of constellation points include . . . parallel decode (PD) capacity and joint capacity.” Ex. 1001, 5:6–8. The “PD capacity of a channel can be viewed in terms of the mutual information between the output bits of the encoder (such as an LDPC encoder) at the transmitter and the likelihoods computed by the demapper at the receiver,” and it is “influenced by both the placement of

points within the constellation and by the labelling assignments.” *Id.* at 6:64–7:3. Joint capacity describes “the achievable capacity between the input of the mapper on the transmit side of the link and the output of the channel (including for example AWGN and Fading channels).” *Id.* at 7:18–21.

D. Illustrative Claim(s)

The challenged claims are all dependent claims and depend, directly or indirectly, from independent claims 1, 11, and 21, respectively. Claim 5 depends from claim 1 and is illustrative:

1. A communication system, comprising:

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

a demodulator capable of demodulating a received signal into a demodulated signal;

a demapper, coupled to the demodulator, capable of determining likelihoods using the demodulated signal and a multidimensional symbol constellation selected from a plurality of multidimensional symbol constellations; and

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;

wherein the plurality of multidimensional symbol constellations comprises a plurality of different non-uniform multidimensional symbol constellations having the same number of constellation points, where the constellation points are non-uniformly spaced in each degree of freedom available to the multidimensional symbol constellations;

wherein the receiver is capable of selecting an LDPC code rate and multidimensional symbol constellation pair from a plurality of predetermined LDPC code rate and multidimensional

symbol constellation pairs, where each of the plurality of different non-uniform multidimensional symbol constellations is only included in one of the plurality of predetermined LDPC code rate and multidimensional symbol constellation pairs.

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001, 13:43–14:5, 14:65–15:3.

E. Evidence

Petitioner's ground of unpatentability relies on the following evidence:

Name	Patent Document	Exhibit
Barsoum or the '777 patent	US 7,978,777 B2 (July 12, 2011)	1015

Name	Non-Patent Literature	Author	Exhibit
ATSC327 ³	<i>ATSC Recommended Practice: Guidelines for the Physical Layer Protocol (A/327)</i> , 8 Oct. 2018	Advanced Television Systems Committee	1022

F. Asserted Grounds

Petitioner asserts the following ground of unpatentability (Pet. 2), supported by the declaration of Dr. Bertrand Hochwald (Ex. 1003):

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
5, 15, 25	103	Barsoum, ATSC327

³ Petitioner relies upon a declaration by June Mumford that expresses a public availability date of at least March 2019. Pet. 2; Ex. 2016, 6.

II. ANALYSIS

A. *Legal Standards*

Petitioner bears the burden to demonstrate unpatentability. *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

A claim is unpatentable as obvious if “the differences between the subject matter sought to be patented 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) (quoting 35 U.S.C. § 103(a)). We resolve the question of obviousness based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the prior art and the claims; (3) the level of skill in the art; and (4) when in evidence, objective indicia of nonobviousness. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

We apply these principles to the Petition’s challenges.

B. *Level of Ordinary Skill in the Art*

We review the grounds of unpatentability in view of the understanding of a person of ordinary skill in the art at the time of the invention. *Id.* at 13, 17. Petitioner asserts that a person of ordinary skill in the art

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. [Ex.]1003, ¶[93]. Superior education could compensate for a deficiency in work experience, and *vice-versa*. *Id.*

Pet. 28.

Patent Owner does not address Petitioner's level of skill. *See* PO Resp.

Patent Owner's declarant, Dr. Caire, also provides evidence that the level of skill includes: "I would say probably a person with a Ph.D. in electrical engineering, specialized with a thesis done in these topics, and possibly some years of work after Ph.D. . . . Normal students, in my experience, cannot read and understand papers like the ones that are in the exhibits." Ex. 1032, 22:20–23:19. Petitioner asserts that Dr. Caire is applying "an education level (PhD and some years of work experience) that exceeded the level specified by [Petitioner]." Pet. Sur-reply 10.

We are persuaded that Petitioner's proposal is consistent with the problems and solutions in the '700 patent and prior art of record. We also find that Dr. Caire's statement of a "Ph.D.," "and possibly some years of work after Ph.D." is consistent with Petitioner's statement that the level of skill includes "[s]uperior education" to "compensate for a deficiency in work experience." The complexity of the evidence of record emphasizes the importance of "*at least two years* of experience . . . including the use of constellations in transmitting signals between devices" or "[s]uperior education" in the same area.

We adopt Petitioner's definition of the level of skill as discussed above.

C. Claim Construction

In *inter partes* review, we construe claims using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. § 282(b), including construing the claim in

accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100(b) (2022).

Petitioner asserts that no terms require express construction. Pet. 28. Patent Owner does not address claim construction. *See* PO Resp. We determine that no terms need to be construed. *See Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999))).

D. Analysis of the Challenged Claims

The Petition argues that dependent claims 5, 15, and 25 are obvious over the combination of Barsoum and ATSC327. Pet. 67–79.

The ’700 patent states that it is a continuation of the ’777 patent (aka Barsoum). Ex. 1001 code (63). Petitioner challenges this claim to priority, arguing that the challenged claims do not have written description support in Barsoum. Pet. 13–19. Patent Owner disagrees, providing extensive discussions of the support in Barsoum (*see* PO Resp.; PO Sur-reply) which Petitioner addresses (*see* Reply; Pet. Sur-reply).⁴ Both asserted references

⁴ Patent Owner argues that Petitioner has improperly abandoned its theories in the Petition concerning written description support. PO Sur-reply 3–4. Petitioner correctly argues that it is responding to Patent Owner’s arguments consistent with the position of the Petition. Pet. Sur-reply 7–8. Similar to *Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375, 1380 (Fed. Cir. 2015), after Petitioner argued that Barsoum was prior art to the ’700 patent, “[t]he burden of production then shifted to [the patent owner] to argue or produce evidence . . . that [Barsoum] is not prior art because the asserted claims in the [’700] patent are entitled to the benefit of [Barsoum].” Petitioner is then afforded an opportunity to combat Patent Owner’s

(Barsoum, ATSC327) are only prior art if the '700 patent cannot claim priority to Barsoum for the benefit of the challenged claims.

For the reasons expressed below, we determine that Petitioner has not shown that the challenged claims are unpatentable, as the '700 patent finds written description support in Barsoum.

1. Written Description Support

To comply with the written description requirement, the specification “must describe the inventions sufficiently to convey to a person of skill in the art that the patentee had possession of the claimed invention at the time of the application, i.e., that the patentee invented what is claimed.”

Lizardtech, Inc. v. Earth Res. Mapping Inc., 424 F.3d 1336, 1345 (Fed. Cir. 2005).

Neither party identifies any differences in the written description or figures of the '700 patent and Barsoum. Rather, Petitioner admits that “the '700 patent and [Barsoum] share the same written description and drawings.” Pet. 30. Thus, when discussing written description support both parties at times refer to the two patents interchangeably.⁵ Based on our review of the '700 patent and Barsoum, we find that they are identical in all relevant respects, except for having different claim sets and priority claims.

arguments. To hold otherwise would require Petitioner to have a crystal ball to divine the arguments Patent Owner would make as to how the claims are supported by Barsoum. This of course does not shift the ultimate burden of persuasion from Petitioner. *Dynamic Drinkware*, 800 F.3d at 1378.

⁵ Petitioner complains that for his second declaration, Patent Owner's declarant Dr. Caire, reviewed the '700 patent, but not Barsoum. Pet. Sur-reply 9. As we find, and Petitioner admits (Pet. 30), the '700 patent and Barsoum contain identical disclosures in all relevant respects, Dr. Caire's actions do not decrease the relevance or weight of his testimony as asserted by Petitioner. Pet. Sur-reply 10.

We further note that the '700 patent incorporates Barsoum by reference, and thus includes all of the disclosure of Barsoum. Ex. 1001, 1:22–27.

a) Claims 5, 15, 25

Moving now to the claims at issue⁶, claim 5 requires, in relevant part:

. . . each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001, 14:65–15:3. We use the language of claim 5 as representative as claims 15 and 25 are substantially similar. *Id.* at 16:65–17:3, 18:59–64.

Patent Owner argues that Barsoum teaches that multidimensional symbol constellations can be optimized in two ways to provide the claimed greater capacity and other claimed requirements. PO Resp. 25–26. We address these methods in reverse order. Concerning the second, we find that Petitioner agrees that Barsoum teaches what Patent Owner argues, but

⁶ Petitioner does not challenge the written description support of the independent claims from which the challenged claims depend. *See* Pet. 13–19. In fact, Petitioner, and Petitioner’s declarant, argue that the limitations of the independent claims are expressly taught by Barsoum, or would be understood, based on the teachings of the same. *See e.g., id.* at 39–51; Ex. 1004 ¶¶ 122–144 (identifying both where Barsoum discloses limitations of claim 1, and what one of skill in art would understand based on the teachings of Barsoum). Petitioner says in some places that the limitations are obvious (*see e.g.,* Pet. 42, 45), but elsewhere that they are disclosed (*id.* at 75; Ex. 1003 ¶ 214 (“[Barsoum] discloses several features of claim 5 for the reasons set forth above. *See* [1pre] to [1f] [(i.e., claim 1)].”).). Patent Owner does not contest any of these arguments, and we find that Barsoum discloses, and therefore provides written description support, for all of the features of the independent claims based on the teachings of Barsoum and the understanding of one of skill in the art based on those teachings, as laid out by Petitioner (*see e.g.,* Pet. 39–51).

incorrectly argues that the claims require “optimization” which is not set forth in the claim language. Concerning the first, we find that Petitioner incorrectly argues that the identified portions of the specification should be read without considering the disclosure as a whole.

As outlined below, we agree with Patent Owner that either disclosure in Barsoum “sufficiently [] convey[s] to a person of skill in the art that the patentee had possession of the claimed invention at the time of the application.” *Lizardtech*, 424 F.3d at 1345.

(1) *Orthogonalize a PAM-8 into a QAM-64*

Patent Owner argues that Barsoum provides support for the challenged claims through its teachings of optimizing a multidimensional QAM constellation. PO Resp. 26–28, 40–45. Patent Owner argues that Barsoum teaches that “[an] approach to optimizing a multidimensional QAM constellation is to first optimize a PAM constellation, then apply that PAM constellation to both of the in-phase and quadrature components.” *Id.* at 26; *see also id.* at 26–28 (citing Ex. 1001, 3:25–34, 12:42–67, Figs. 13b, 21; Barsoum (Ex. 1015), 3:9–19, 12:11–37, Figs. 13b, 21). Patent Owner explains that “[t]his approach uses the same 8 point PAM locations, which were optimized for capacity, to produce 64 point QAM locations that have been optimized for capacity.” *Id.* at 28.

Patent Owner further argues that Barsoum “discloses that optimization of constellation points can yield different constellations depending on the signal to noise ratio (SNR) and code rate for which they are optimized,” and “that in many instances, a constellation optimized for one code rate can achieve gains that cannot be achieved at another code rate.” *Id.* (citing Ex. 1001, 5:16–25; Barsoum, 4:62–5:7). Patent Owner further explains that “a

constellation optimized for a code rate of 1/2 provides gains when used with a code rate of 1/2, but may not provide the same gains at other code rates, such as 2/3 code rate. Instead, when using a code rate of 2/3, a different constellation may be used – a constellation optimized for use at 2/3 code rate.” *Id.* at 29.

Patent Owner provides additional disclosure and discussion of specific examples, such as Figures 11b, 13b, and 21. *Id.* at 25–28, 43–45. Patent Owner argues that, for example, Figure 13b shows a PAM-8 constellation optimized for a SNR of 9.00 dB, and that “this constellation would provide greater capacity than all other PAM-8 (or QAM-64) constellations at that operating SNR of 9.00 dB, including the constellation defined by the locations indicated in the second column of figure 13b (i.e., the optimized constellation for an operating SNR of 5.27 dB).” *Id.* at 44–45. In other words, Figure 13b shows five constellations (i.e., a plurality), each optimized for a particular identified SNR that will perform better at that particular SNR than the other constellations, which have not been optimized at that particular SNR. Patent Owner argues that these constellations can then be orthogonalized into QAM-64 constellations, providing the same capacity benefits. *Id.* at 26–28, 44–45.

Petitioner does not contest that Barsoum includes any of the above disclosure. Rather, this same disclosure of orthogonalizing a PAM-8 into a QAM-64 is relied on by Petitioner for teaching many of the features of claim 1. *See e.g.*, Pet. 43–45, 47–51.

Claim 1 introduces the “plurality of different non-uniform multidimensional symbol constellations.” Petitioner’s declarant explains that Barsoum “discloses that the selected geometrically shaped (i.e., unequally

spaced or non-uniform) constellations may be selected from a plurality of geometric constellations. Ex. 1003 ¶ 132 (citing Barsoum (Ex. 1015), 2:56–58, 5:54–6:4, 7:8–10, 8:7–15, 8:47–54, 12:12–16; 3:61–64, 4:5–21, FIGs. 11a, 11b, 13a, 13b, 15a, 15b, 17a, 17b). Petitioner’s declarant continues, “the constellations of FIG. 11b, 13b, 15b, 17b are one dimensional PAM constellations. However, [Barsoum] explains that one dimensional geometric PAM constellations can be optimized into multidimensional QAM constellations.” *Id.* ¶ 135 (citing Barsoum, 3:11–19; 4:29–31; 12:12–16; 12:38–49). Petitioner’s declarant states: “a POSITA would have understood that the geometric (i.e., non-uniform) one dimensional constellations of FIG. 11b having the same number of constellation points (i.e., 4) would have been capable of being optimized into four respective geometric (i.e., non-uniform) multidimensional constellations and then one selected therefrom for use by the receiver 16.” *Id.* ¶ 138 (citing Barsoum, 2:56–58, 5:54–6:4, 7:8–10, 8:7–15, 8:47–54, 12:12–16; 3:61–64, 4:5–21, FIGs. 11a, 11b, 13a, 13b, 15a, 15b, 17a, 17b).

The Petition advances these positions by its declarant, essentially word for word. Pet. 43–45, 47–48. We determine that each of these statements by Petitioner’s declarant and Petitioner, supported by the teachings of Barsoum, are admissions as to the teachings of Barsoum and what one of skill in the art would understand Barsoum to either expressly or implicitly teach.

Consistent with the above findings, Petitioner also admits that Barsoum “discloses optimized 1D symbol constellations used to create a 2D constellation” and that “the created QAM-64 is optimized on a ‘per dimension basis’ only.” Pet. Reply 10; *see also* Pet. Sur-reply 2–3. In fact,

the Petition, and Petitioner's declarant, admit that Barsoum teaches that "though some non-uniform constellations do not have a greater capacity than other constellations maximized for $d_{\min}$, the written description of the '777 patent *explains how to optimize a nonuniform constellation so that it can be capable* of having a greater capacity such as a greater parallel decoding capacity." Pet. 16 (citing Barsoum, 6:13–22); Ex. 1003 ¶ 77. Patent Owner highlights this statement (PO Sur-reply 2–3), to which Petitioner does not respond (*see* Pet. Sur-reply).

Petitioner does not directly address or contest Patent Owner's position that one of skill in the art would understand that Barsoum provides written description support for: a plurality of different non-uniform multidimensional symbol constellations orthogonalized from an optimized PAM-8 (such as the PAM-8 constellations from one of Figures 11b, 13b, 15b, 17b) into QAM-64 constellations provides a constellation "capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR" as required by claim 5 and discussed above. *See also* PO Sur-reply 20–21 (citing Ex. 2025 ¶ 19) (Discussing the testimony of Patent Owner's declarant that the increased capacity of the PAM-8 constellations continues in the QAM constellations on the per dimension basis); Pet. Sur-reply 3 (Petitioner agreeing that the constellations are optimized on a per dimension basis).

Rather, Petitioner argues that QAMs can be further optimized, and thus, there exist constellations with potentially greater parallel decoding

capacity.^{7,8} Pet. Reply 2–19; Pet. Sur-reply 2–4, 6–7. Petitioner argues that in order to have written description support, Barsoum must include disclosure of “further optimizing multidimensional constellations after forming them from orthogonalized 1D constellations.” Pet. Sur-reply 6. In other words, “a POSITA would have understood that SNR and parallel decoding optimizations of PAM constellations would involve amplitude and/or 1D spacing optimizations, whereas optimizations of QAM constellations [(as a whole)] would also involve phase considerations.” Pet. Reply 13 (citing Ex. 1029 ¶¶ 10, 33).

Petitioner does not sufficiently explain why claim 5 requires this type of optimization, or why this would be required in order for Barsoum to provide written description support for the claim. Claim 5 does not expressly require optimization of phase considerations and Petitioner does not argue for a claim construction that would include such a requirement.

When claim 5 specifies that “each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality,” it does not require the *greatest* parallel

⁷ Barsoum’s disclosure of optimizing QAMs in multidimensions is discussed in the following section.

⁸ Petitioner’s Reply and Sur-reply discuss Exhibit 1030 (Fuentes) to highlight the additional optimization possible for a QAM. Reply 7–8; Pet. Sur-reply 2–4. We note that Fuentes, which appears to be a university thesis, includes a date of June 2017 (Ex. 1030, 1) and therefore is not helpful to us in determining what one of skill in the art would understand at the time of invention of Barsoum which was filed on June 5, 2008 (Barsoum, code (22)). We also note that there does not appear to be any evidence of record to establish whether Fuentes was publicly available at the time of filing of the ’700 patent.

decoding capacity, or that the plurality be of all known multidimensional symbol constellations optimized to achieve the greatest capacity.

It appears as though because Patent Owner is arguing that certain optimizations meet the claimed requirements, Petitioner is now arguing that all dimensions must be optimized because this results in the greatest capacity. However, Petitioner does not address why the greatest capacity possible is required by the claim and we see no reason to read this additional requirement into the claim.

We find that the specific examples and teachings in Barsoum, as discussed above and identified by *both* parties, “sufficiently [] convey to a person of skill in the art that the patentee had possession of the claimed invention at the time of the application.” *Lizardtech*, 424 F.3d at 1345.

In particular, we find that one of skill in the art would understand that Barsoum provides written description support for: a plurality of different non-uniform multidimensional symbol constellations orthogonalized from an optimized PAM-8 (such as the PAM-8 constellations from one of Figures 11b, 13b, 15b, 17b) into QAM-64 constellations provides a constellation “capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR” as required by claim 5 and discussed above.

(2) *Optimizing Over Each Degree of Freedom*

Patent Owner also argues that Barsoum teaches that “a multidimensional QAM constellation” can be “directly optimize[d] over each degree of freedom.” PO Resp. 25–26 (citing Ex. 1001, 13:2–11; Barsoum, 12:39–48).

Under the heading “N-Dimensional Constellation Optimization,” Barsoum states:

Rather than designing constellations in 1-D (PAM for instance) and then extending to 2-D (QAM), it is possible to take direct advantage in the optimization step of the additional degree of freedom presented by an extra spatial dimension. In general it is possible to design N-dimensional constellations and associated labelings. The complexity of the optimization step grows exponentially in the number of dimensions as does the complexity of the resulting receiver de-mapper. Such constructions constitute embodiments of the invention and simply require more run-time to produce.

Barsoum, 12:39–48.

Petitioner argues that this disclosure “is devoid of any details for directly optimizing each degree of freedom” and admits to the complexity of the optimization. Reply 3 (citing Ex. 1001, 13:1–11). Petitioner further argues that the disclosure:

fails to describe or explain whether the optimization is for uniform or non-uniform multi-dimensional constellations, and whether there is any difference in optimizing the two types of constellations. Thus, such disclosure cannot be relied upon as written description support for feature [5], which is directed to “non-uniform multidimensional symbol constellations.”

Id. (citing Ex. 1029 ¶¶ 6–7).

Patent Owner responds, supported by its declarant, that Petitioner’s argument ignores the rest of Barsoum’s disclosure. PO Sur-reply 15–17; Ex. 2025 ¶¶ 8–9. Patent Owner’s declarant explains that Barsoum

describes how to optimize constellations including the use of unconstrained or constrained non-linear optimization. (EX1015 8:34-37). Barsoum provides possible objective functions for the optimization. (EX1015 8:37-40, 49-56). Barsoum discloses that point locations are varied. (EX1015 8:41-42, 49-56). Barsoum describes running the optimization process iteratively. (EX1015

8:49-56). Barsoum identifies various optimization constraints. (EX1015 2:37-41, 2:55-66, 8:23-24, 8:57-9:2). Barsoum even includes a detailed flow diagram (FIG. 5) of an example optimization process. (EX1015 7:10-8:23).

Ex. 2025 ¶ 9

Patent Owner further argues that the point of Barsoum is to “improve[] upon ***uniform*** constellations (that have equally spaced locations) by instead optimizing constellations by changing the distances between locations.” PO Sur-reply 16 (citing Barsoum, 2:37–48, 2:56–3:9, 4:47–59, 7:15–17). And that “as described in Barsoum, the ***optimized constellations are non-uniform constellations.***” *Id.*

Petitioner’s response is to say that those specific details are not included at Barsoum, 12:39–48. Pet. Sur-reply 5.

Petitioner’s argument would have us ignore the entirety of the disclosure of Barsoum, minus one paragraph. Not only is the noted paragraph the 4th to last paragraph in the disclosure, it also expressly refers to the prior discussion of optimization. Barsoum, 12:39–43 (“tak[ing] direct advantage in the optimization step . . .”). We find that one of skill in the art would understand Barsoum, 12:39–48 within the context of the entire disclosure. Thus, we disagree with Petitioner that Barsoum is lacking detail as argued or that one of skill would not know whether the noted paragraph relates to “non-uniform multidimensional symbol constellations.”

Petitioner also continues to argue that optimizing over an additional degree of freedom is complex. Pet. Sur-reply 5–6. Petitioner states the Patent Owner’s declarant Dr. Caire “provid[ed] several pages of explanation” not found in Barsoum in his deposition explaining the complexity of the resulting demapper. *Id.* at 5 (citing Ex. 1032, 143:8–145:11).

Reviewing this testimony, Dr. Caire explains that as the number of constellation points increases, the complexity of the mapper grows exponentially because each constellation point can be a 1 or a zero and the mapper must be able to read each of these scenarios for each point. Ex. 1032, 143:8–145:11. This is consistent with Dr. Caire’s prior testimony and Barsoum that “the ‘complexity’ is the increased time spent performing the disclosed optimization for each added dimension. (EX1015 12:39-48 (‘The complexity of the optimization step grows exponentially in the number of dimensions as does the complexity of the resulting receiver de-mapper. ***Such constructions constitute embodiments of the invention and simply require more ‘run-time’ to produce.***’) (emphasis added)).” Ex. 2025 ¶ 10.

Having determined that one of skill in the art would understand Barsoum as disclosing optimizing a multidimensional QAM constellation over each degree of freedom, Petitioner does not contest that such a disclosure provides the benefits required by claim 5 that “each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.” In view of the above, and consistent with the prior discussion of orthogonalizing an optimized PAM-8, we agree with Patent Owner that one of skill in the art would understand the disclosure of optimizing a multidimensional QAM constellation over each degree of freedom to provide similar benefits, including the requirements of claim 5 outlined above. Thus, we find that one of skill in the art would understand that Barsoum provides written description support for claim 5.

(3) *Conclusion – Written Description*

In view of the above, we find that either disclosure in Barsoum identified by Patent Owner satisfies the written description requirement.

2. *35 U.S.C. § 103*

As noted previously, Petitioner argues that dependent claims 5, 15, and 25 are obvious over the combination of Barsoum and ATSC327. Pet. 67–79. Having determined the Barsoum provides written description support for claims 5, 15, and 25, Barsoum cannot be prior art under 35 U.S.C. § 102(a)(1) as asserted by Petitioner. Pet. 2; 35 U.S.C. § 102(a)(1) (requiring that “the claimed invention was patented . . . before the effective filing date of the claimed invention). Furthermore, having determined that the ’700 patent is entitled to an effective filing date of Barsoum ’777, which is June 5, 2008, the asserted March 2019 date of ATSC327 does not qualify it as prior art to the ’700 patent. Thus, the Petition does not establish by a preponderance of the evidence that claims 5, 15, and 25 are obvious over the combination of Barsoum and ATSC327.

III. CONCLUSION

For the reasons discussed above, we determine Petitioner has *not* proven, by a preponderance of the evidence, that the challenged claims are unpatentable, as summarized in the following table:

Claims	35 U.S.C. §	Reference(s) /Basis	Claims Shown Unpatentable	Claims Not shown Unpatentable
5, 15, 25	103	Barsoum, ATSC327		5, 15, 25
2, 3, 12, 13, 22, 23 ⁹	103	Barsoum, Exhibit 1023		
Overall Outcome				5, 15, 25

IV. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 5, 15, and 25 have not been shown to be unpatentable; and

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

⁹ As noted above, these claims were disclaimed and thus, we do not address this ground.

IPR2023-00319
Patent 10,693,700 B1

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