

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS, INC., DISH NETWORK, LLC,
COMCAST CABLE COMMUNICATIONS, LLC,
COX COMMUNICATIONS, INC.,
TIME WARNER CABLE ENTERPRISES LLC,
VERIZON SERVICES CORP., and ARRIS GROUP, INC.,
Petitioner,

v.

TQ DELTA, LLC,
Patent Owner.

Case IPR2016-01021¹
Patent 8,718,158 B2

Before SALLY C. MEDLEY, TREVOR M. JEFFERSON, and,
MATTHEW R. CLEMENTS, *Administrative Patent Judges*.

MEDLEY, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

¹ DISH Network, L.L.C., who filed a Petition in IPR2017-00255, and Comcast Cable Communications, L.L.C., Cox Communications, Inc., Time Warner Cable Enterprises L.L.C., Verizon Services Corp., and ARRIS Group, Inc., who filed a Petition in IPR2017-00417, have been joined in this proceeding.

I. INTRODUCTION

In this *inter partes* review, instituted pursuant to 35 U.S.C. § 314, Cisco Systems, Inc. (“Petitioner”) challenges claims 1–30 (“the challenged claims”) of U.S. Patent No. 8,718,158 B2 (Ex. 1001, “the ’158 patent”), owned by TQ Delta, LLC (“Patent Owner”). We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. For the reasons discussed below, Petitioner has shown by a preponderance of the evidence that the challenged claims are unpatentable. Patent Owner’s Motion to Exclude is *dismissed*.

A. Procedural History

Petitioner filed a Petition for *inter partes* review of claims 1–30 of the ’158 patent. Paper 2 (“Pet.”). Patent Owner filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). On November 4, 2016, we instituted an *inter partes* review of claims 1–30 of the ’158 patent on the following grounds (Paper 7 (“Dec.”)):

References	Basis	Claims Challenged
Shively, ² and Stopler ³	§ 103(a)	1, 2, 4, 15, 16, and 18
Shively, Stopler, and Gerszberg ⁴	§ 103(a)	3, 5, 14, 17, 19, and 28–30
Shively, Stopler, and Bremer ⁵	§ 103(a)	6, 9, 10, 12, 20, 23, 24, and 26
Shively, Stopler,	§ 103(a)	8, 11, 13, 22, 25, and 27

² U.S. Patent No. 6,144,696; issued Nov. 7, 2000 (Ex. 1011) (“Shively”).

³ U.S. Patent No. 6,625,219 B1; issued Sept. 23, 2003 (Ex. 1012) (“Stopler”).

⁴ U.S. Patent No. 6,424,646 B1; issued July 23, 2002 (Ex. 1013) (“Gerszberg”).

⁵ U.S. Patent No. 4,924,516; issued May 8, 1990 (Ex. 1017) (“Bremer”).

References	Basis	Claims Challenged
Bremer, and Gerszberg		
Shively, Stopler, Bremer, and Flammer ⁶	§ 103(a)	7 and 21

Thereafter, Patent Owner filed a Patent Owner Response (“PO Resp.”). Paper 15. Petitioner filed a Reply to the Patent Owner Response (“Pet. Reply”). Paper 20. Pursuant to an Order (Paper 24), Patent Owner filed a listing of alleged statements and evidence in connection with Petitioner’s Reply deemed to be beyond the proper scope of a reply. Paper 25. Petitioner filed a response to Patent Owner’s listing. Paper 32.

Patent Owner filed a Motion to Exclude, Paper 31 (“PO Mot. Exc.”), Petitioner filed an Opposition, Paper 36 (“Pet. Opp. Mot. Exc.”), and Patent Owner filed a Reply, Paper 40. Patent Owner filed a Motion for Observation, Paper 30 (“PO Mot. Obs.”) and Petitioner filed a Response to the Motion for Observation, Paper 37 (“Pet. Resp.”).

We held a consolidated hearing on August 3, 2017, for this case and related Case IPR2016-01020, and a transcript of the hearing is included in the record. Paper 42 (“Tr.”).

B. Related Proceedings

The parties indicate that the ’158 patent is the subject of several pending judicial matters. Pet. 1; Paper 5, 2–3.

C. The ’158 Patent (Ex. 1001)

The ’158 patent relates to multicarrier communications systems that lower the peak-to-average power ratio (PAR) of transmitted signals.

⁶ U.S. Patent No. 5,515,369; issued May 7, 1996 (Ex. 1019) (“Flammer”).

Ex. 1001, 1:28–31. A value is associated with each carrier signal, and a phase shift is computed for each carrier signal based on the value associated with that carrier signal. *Id.* at 2:38–41. The value is determined independent of the input bit value carried by the carrier signal. The computed phase shift value is combined with the phase characteristic of that carrier signal to substantially scramble the phase characteristics of the carrier signals. *Id.* at 2:38–45. Figure 1 illustrates the multicarrier communication system and is reproduced below:

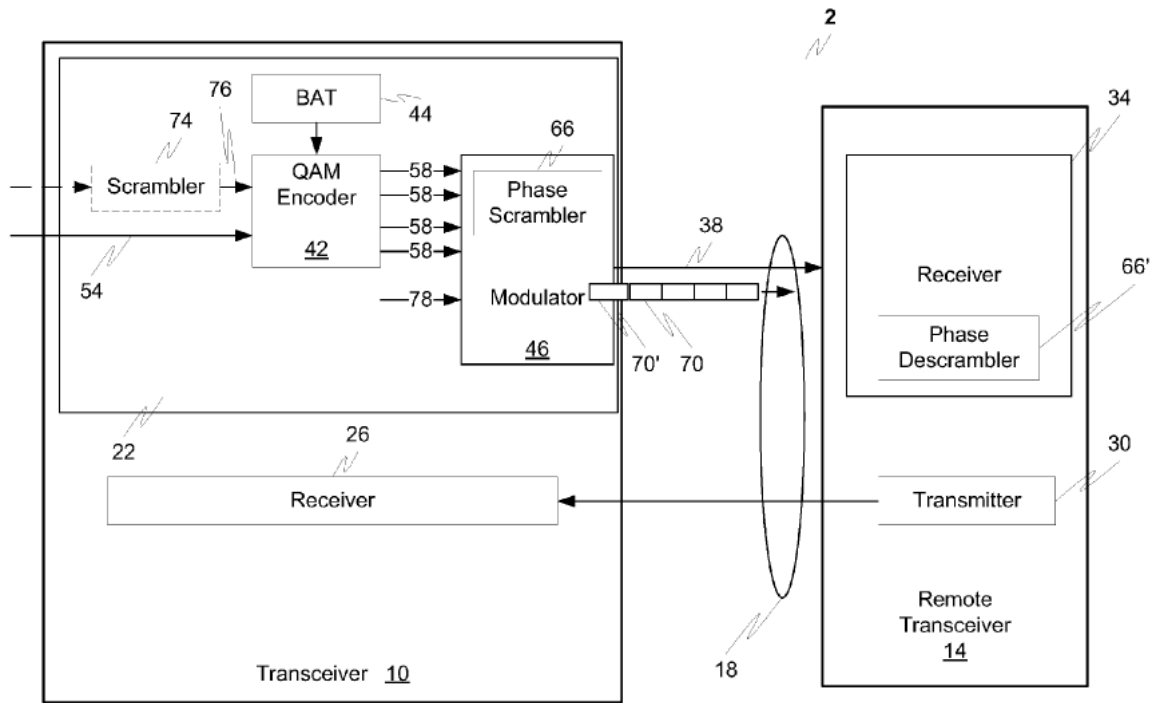


FIG. 1

Figure 1 illustrates the multicarrier communication system, digital subscriber line (DSL) communication system 2, which includes discrete multitone (DMT) transceiver 10 communicating with remote transceiver 14 over communication channel 18 using transmission signal 38 having a plurality of carrier signals. *Id.* at 3:27–31. DMT transceiver 10 includes

DMT transmitter 22 and DMT receiver 26. *Id.* at 3:31–32. Remote transceiver also includes transmitter 30 and receiver 34. *Id.* at 3:32–34. DMT transmitter 22 transmits signals over communication channel 18 to receiver 34. *Id.* at 3:40–42.

DMT transmitter 22 includes a quadrature amplitude modulation (QAM) encoder 42, modulator 46, bit allocation table (BAT) 44, and phase scrambler 66. *Id.* at 3:53–56. QAM encoder 42 has a single input for receiving serial data bit stream 54 and multiple parallel outputs to transmit QAM symbols 58 generated by QAM encoder 42 from bit stream 54. *Id.* at 3:65–4:1. Modulator 46 provides DMT modulation functionality and transforms QAM symbols 58 into DMT symbols 70. *Id.* at 4:12–14. Modulator 46 modulates each carrier signal with a different QAM symbol 58, and, therefore, this modulation results in carrier signals having phase and amplitude characteristics based on QAM symbol 58. *Id.* at 4:15–18. Modulator 46 also includes phase scrambler 66 that combines a phase shift computed for each QAM-modulated carrier signal with the phase characteristics of that carrier signal. *Id.* at 4:31–34.

D. Illustrative Claim

Petitioner challenges claims 1–30 of the '158 patent. Claims 1 and 15 are independent claims. Claims 2–14 and 29 depend, either directly or indirectly, from claim 1, and claims 16–28 and 30 depend, either directly or indirectly, from claim 15. Claim 1 is reproduced below.

1. In a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating a plurality of data bits, each carrier signal having a phase characteristic associated with at least one bit of the

plurality of data bits, a method for scrambling the phase characteristics of the carrier signals comprising:

transmitting the plurality of data bits from the first transceiver to the second transceiver;

associating a carrier signal with a value determined independent of any bit of the plurality of data bits carried by the carrier signal, the value associated with the carrier signal determined by a pseudo-random number generator;

determining a phase shift for the carrier signal at least based on the value associated with the carrier signal;

modulating at least one bit of the plurality of data bits on the carrier signal; and

modulating the at least one bit on a second carrier signal of the plurality of carrier signals.

Ex. 1001, 10:59–11:11.

II. ANALYSIS

A. *Principles of Law*

To prevail in its challenge to Patent Owner's claims, Petitioner must demonstrate by a preponderance of the evidence that the claims are unpatentable. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d). A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the

prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness. *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17–18 (1966).

In that regard, an obviousness analysis “need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.” *KSR*, 550 U.S. at 418; *see also Translogic Technology, Inc.*, 504 F.3d 1249, 1259, and 1262 (Fed. Cir. 2007).

B. Level of Ordinary skill in the Art

Citing its declarant, Dr. Jose Tellado, Petitioner contends that a person having ordinary skill in the art at the time of the invention would have had (1) a Master’s degree in Electrical and/or Computer Engineering, or equivalent training, and (2) approximately five years of experience working with multicarrier communications systems. Pet. 10–11; Ex. 1009 ¶ 18. Petitioner also contends that “[l]ack of work experience can be remedied by additional education, and vice versa.” Pet. 11.

Patent Owner’s expert, Dr. Robert Short indicated that for purposes of the proceeding he adopts Dr. Tellado’s definition of a person of ordinary skill in the art. Ex. 2003 ¶ 16. For purposes of this Decision, we adopt Petitioner’s proposed definition, and further find that the level of ordinary skill in the art is reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001); *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995); *In re Oelrich*, 579 F.2d 86, 91 (CCPA 1978).

C. Claim Interpretation

The Board interprets claims of an unexpired patent using the broadest reasonable construction in light of the specification of the patent in which they appear. *See* 37 C.F.R. § 42.100(b); *see also* Office Patent Trial Practice Guide, 77 Fed. Reg. at 48,766. Under the broadest reasonable construction standard, claim terms are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic*, 504 F.3d at 1257.

Petitioner proposes constructions for the following claim terms: “multicarrier” and “transceiver.” Pet. 8–9. In our Decision to Institute, we interpreted the term “transceiver” to mean “a device, such as a modem, with a transmitter and receiver,” but determined that it was not necessary to interpret the term “multicarrier.” Dec. 6–7. Neither party has indicated that our determinations were improper and we do not perceive any reason or evidence that now compels any deviation from our initial determinations. PO Resp. 13–14; Pet. Reply 7–8. Accordingly, the construction of transceiver to mean “a device, such as a modem, with a transmitter and receiver” applies to this Decision. Dec. 7. For purposes of this decision, we find it necessary to construe “scrambling the phase characteristics of the carrier signals” found in claim 1.

Scrambling the Phase Characteristics of the Carrier Signals

The preamble of claim 1 recites a transmission signal with a plurality of carrier signals where each carrier signal has a phase characteristic and “a method for *scrambling the phase characteristics of the carrier signals*, comprising.” (Emphasis added). Patent Owner argues that the italicized language should be interpreted to mean “adjusting the phases of a plurality

of carriers in a single multicarrier symbol by pseudo-randomly varying amounts.” PO Resp. 14–19. Petitioner argues that the phrase needs no interpretation, since the prior art relied upon uses the same “phase scrambling” terminology to describe pseudo-random phase changes. Pet. Reply 7 (citing Ex. 1012, 12:24–31). Additionally, Petitioner argues, without any other explanation, that “the Board should not adopt TQ Delta’s proposed construction.” *Id.* During oral argument, however, counsel for Petitioner reiterated that it is Petitioner’s position that no construction of the term is necessary, because “[r]egarding [P]atent [O]wner’s proposal of the construction, we believe that is exactly how Stopler is describing this phase scrambler as operating.” Tr. 18:23–19:5.

The phrase “scrambling the phase characteristics of the carrier signals” is recited in the preamble of claim 1. Although neither party explicitly explains why the preamble of claim 1 is limiting, both parties implicitly contend that the preamble is limiting. For purposes of this decision, we determine that the preamble is limiting. We further find it helpful to our decision and analysis to interpret the phrase in order to understand the parties’ positions with respect to how the prior art reference Stopler meets the phrase.

Patent Owner argues that “scrambling the phase characteristics of the carrier signals” should be construed to mean “adjusting the phases of a plurality of carriers in a single multicarrier symbol by pseudo-randomly varying amounts.” PO Resp. 14. Patent Owner contends that the construction is supported by the specification of the ’158 patent and clarifies that the claimed phase scrambling “must be performed amongst the individual carrier phases in a single multicarrier symbol” and is not met if

the phase adjustment only occurs over time from one symbol to the next. PO Resp. 14 (citing Ex. 2003 ¶ 37).

In support of its proposed interpretation, Patent Owner argues that the '158 patent describes that each of the plurality of carriers (of a multicarrier signal) corresponds to a different QAM symbol. PO Resp. 15 (citing Ex. 1001, 4:15–16). Patent Owner further argues that each carrier (or QAM symbol) has its own phase or phase characteristic, and that the combination of the carriers (or QAM symbols) is referred to as a DMT symbol. PO Resp. 16 (citing Ex. 1001, 4:9–11, 9:8–9; Ex. 2003 ¶ 39). Patent Owner further contends that the '158 patent describes that a “phase scrambler” scrambles phases or phase characteristics of carriers within a single DMT symbol, and that PAR in the transmission signal is reduced by adjusting the carrier phases within a single DMT symbol. PO Resp. 16 (citing Ex. 1001, 6:32–8:13; Ex. 2003 ¶ 39). PAR, Patent Owner contends, would not be reduced if carrier phases were only adjusted from one symbol to the next. PO Resp. 16 (Ex. 2003 ¶¶ 41–42).

Based on the record before us, we agree with Patent Owner's proposed construction as far as meaning “adjusting the phases of a plurality of carriers in a single multicarrier symbol.” PO Resp. 14. Patent Owner, however, provides no persuasive reasoning for also adding to that construction “by pseudo-randomly varying amounts.” *Id.* Rather, Patent Owner merely contends that (1) in a corresponding district court matter, the court construed the phrase to mean “adjusting the phase characteristics of the carrier signals by pseudo-randomly varying amounts;” (2) during prosecution of a child application to the '158 patent, the applicant explained that a “scrambler” operates by pseudo-randomly selecting bits to invert; and

(3) there was no fundamental disagreement between parties that scrambling involves adjusting the phase characteristic of a carrier signal by pseudo-randomly varying amounts. PO Resp. 16–17. Patent Owner’s explanation for why we should add “by pseudo-randomly varying amounts” to its proposed construction is conclusory. *Id.* at 17. We interpret claims using the broadest reasonable construction in light of the specification of the involved patent. That standard is not the same as the standard used in district court. Patent Owner, however, provides no explanation for why we should apply the district court construction, which is not necessarily the same as used before us, here. Moreover, Patent Owner does not explain why statements made during prosecution of a child application for the term “scrambler” is relevant to how we should interpret the disputed phrase that does not even contain the term “scrambler” in it. *Id.* at 16. In summary, Patent Owner’s arguments are conclusory.

For all of the above reasons, and for purposes of this decision, we determine that “scrambling the phase characteristics of the carrier signals” means “adjusting the phases of a plurality of carriers in a single multicarrier symbol.”

D. Asserted Obviousness over Shively and Stopler

Petitioner contends that claims 1, 2, 4, 15, 16, and 18 are unpatentable under 35 U.S.C. § 103(a) as obvious over Shively and Stopler. Pet. 11–32. We have reviewed Petitioner’s showing identifying where each limitation allegedly appears in Shively and Stopler, along with the testimony of Petitioner’s declarant, Dr. Jose Tellado. *Id.* (citing Ex. 1009). We also have reviewed Patent Owner’s assertions and evidence, including the testimony of Dr. Robert Short, as to why Petitioner’s showing is deficient. PO Resp.

Shively (Ex. 1011)

Shively discloses discrete multitone transmission (DMT) of data by digital subscriber loop (DSL) modems and the allocation of bits to the discrete multitones. Ex. 1011, 1:5–8. Bit allocation is performed to optimize throughput within aggregate power and power spectral density mask limits. *Id.* at 4:17–19. The system includes a transmitting modem and a receiving modem connected by a cable having four twisted pairs of conductors. *Id.* at 9:63–65. The modems include a source encoder, a channel decoder, and a digital modulator to take in and transmit data from a data source. *Id.* at 10:9–12. The modems also include a digital demodulator, a channel decoder, and a source decoder to receive the data and supply it to a data sink. *Id.* at 10:12–14. The source encoder compresses data, applies the compressed data to the channel decoder, which performs error correction. *Id.* at 10:15–19. The error corrected data is applied to the digital modulator, which acts as the interface with the communication channel. *Id.* at 10:15–22. The digital demodulator constructs a data stream from the modulated signal and applies it to the channel decoder, which performs error correction, and then applies the corrected data to the source decoder, which decompresses the data. *Id.* at 10:22–26.

In the QAM multitone modulation, the spectrum is broken into multiple sub-bands or QAM channels. *Id.* at 10:27–29. The digital modulator generates N QAM signal tones, one for each QAM channel. *Id.* at 10:29–30. The serial stream is segmented into N frames, each having allocated to it k_i bits of data. *Id.* at 10:30–31. The multi-carrier modulator

generates N QAM tones, one for each channel, at the same symbol rate but with a respective constellation for each channel. *Id.* at 10:35–37.

Stopler (Ex. 1012)

Stopler discloses a method and apparatus for encoding/framing a data stream of multitoned modulated signals to improve impulse burst immunity. Ex. 1012, 1:8–11. The encoding/framing scheme allows efficient operation in multipoint to point channels affected by ingress and impulsive interference. *Id.* at 5:11–14. Two dimensional interleaving is performed, with one dimension being time and the other dimension being frequency (tones or sub-channels). *Id.* at 5:18–20. Stopler further discloses a diagonalization scheme, where data packets are spread over time in a diagonal fashion, such that an impulse noise affects more than one user's packets, with the effect on each being reduced. *Id.* at 5:64–67. A code having lower redundancy can be used since the amount of corruption expected in one user's data packet will be reduced. *Id.* at 5:67–6:3.

Figure 5 of Stopler is reproduced below.

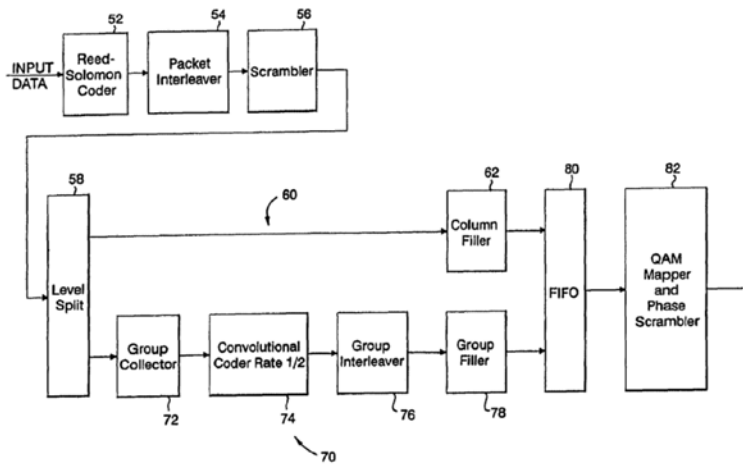


FIG. 5

As shown above, Figure 5 of Stopler, input data, in the form of data packets, is input to an RS coder 52. *Id.* at 8:55–57. Data output by RS coder 52 is input to interleaver 54. *Id.* at 9:8–10. The output of interleaver 54 is rearranged into a serial bit stream and then scrambled in scrambler 56, which is used to randomize coded and interleaved data. *Id.* at 9:34–37. Data output by scrambler 56 is divided by level splitter 58 into two levels of the TCM encoder. Splitter 58 divides serial bit stream into a group of data bits to be processed by lower level 70, and the remaining data bits to be processed by upper level 60. *Id.* at 9:48–55. In lower level 70 of TCM encode, data is collected into groups by group collector 72, which is input to coder 74, then group interleaver 76 and then group filler 78. *Id.* at 10:40–11:18. The outputs of upper stream 60 and lower stream 70 are combined into m-tuples (QAM symbols) and temporarily stored in FIFO buffer 80, which then delivers data to a QAM mapper 82. *Id.* at 11:51–57.

The input to QAM mapper 82 is data in the form of m-tuples which are mapped into QAM symbols. *Id.* at 12:21–22. To randomize the overhead channel symbols, a phase scrambling sequence is applied to the output symbols. For example, the phase scrambling sequence may be generated by a pseudo-random generator composed of a linear feedback shift register of length 21, and initialized by a user programmable seed. *Id.* at 12:24–31. Consecutive output pairs from the pseudo-random generator are converted into numbers $2a+b$ and the sum $(2a+b)$ is used to select the amount of rotation to be applied to the symbol according to the following table below:

$2a + b$		Phase Rotation
0	→	0
1	→	$+\pi/2$
2	→	π
3	→	$-\pi/2$

Id. at 12:31–45. The output from the QAM mapper 82 is provided to a modulator (not shown) which implements the particular signal modulation desired, e.g., VCMT, CDMA, etc. *Id.* at 12:55–57.

Analysis

Petitioner contends that claims 1, 2, 4, 15, 16, and 18 would have been obvious over Shively and Stopler. Pet. 11–32. Patent Owner’s arguments are directed to whether a person of ordinary skill in the art would have combined Shively and Stopler and whether Stopler describes phase scrambling. PO Resp. 45–58.

Claim 1 recites “[i]n a multicarrier modulation system including a first transceiver in communication with a second transceiver.” Petitioner contends that Shively and Stopler each describe this limitation. For example, and with respect to Shively, Petitioner argues that Shively describes a discrete multitone transmission (DMT) of data (a multicarrier modulation system) by digital subscriber loop (DSL) modems (illustrated in Figure 2 as a transmitting modem 31 and a receiving mode 32). Pet. 17 (citing Ex. 1011, 1:5–7, 9:42, 9:63–64, and Fig. 2; Ex. 1009, 31–32).⁷ We are persuaded by Petitioner’s showing and find that Shively’s modem 31 is a first transceiver in communication with a second transceiver 32 and that the

⁷ In the Petition, Petitioner references page numbers of Dr. Tellado’s Declaration, as opposed to paragraph numbers. Citations are to page numbers, unless otherwise indicated by use of the paragraph symbol (“¶”).

two transceivers communicate using discrete multitone transmission (DMT) of data, and thus are in a multicarrier modulation system.

Claim 1 further recites “using a transmission signal having a plurality of carrier signals for modulating a plurality of data bits.” Petitioner contends that Shively and Stopler each render obvious this phrase. For example, and with respect to Shively, Petitioner contends that Shively describes a transmitting modem that receives digital data from a data source and modulates separate carriers to represent the digital data, which results in a modulated signal sent to a receiving modem. Pet. 19 (citing Ex. 1011, 5:22–26). Petitioner further contends that Shively describes that the available frequency spectrum is divided into multiple QAM channels, which a person of ordinary skill in the art would have understood to be a “plurality of carrier signals” for modulating “a plurality of data bits.” Pet. 19 (citing Ex. 1011, 5:47, 5:52; Ex. 1009, 35–36). We are persuaded by Petitioner’s showing, which we adopt as our own findings and conclusions, that Shively renders obvious “using a transmission signal having a plurality of carrier signals for modulating a plurality of data bits.”

Claim 1 recites “each carrier signal having a phase characteristic associated with at least one bit of the plurality of data bits.” Petitioner contends that Shively and Stopler each render obvious this phrase. For example, and with respect to Shively, Petitioner contends that Shively describes transmitting data bits using quadrature amplitude modulation (QAM) and that QAM produces a signal whose phase and amplitude convey encoded k-bits of information. Pet. 20 (citing Ex. 1011, 1:29–30). Petitioner further contends that a person having ordinary skill in the art would have understood that the phase of a signal used in QAM to convey

bits is a phase characteristic as claimed. Pet. 20 (citing Ex. 1001, 1:43–44; Ex. 1009, 38). We are persuaded by Petitioner’s showing, which we adopt as our own findings and conclusions, that Shively describes “each carrier signal having a phase characteristic associated with at least one bit of the plurality of data bits.”

Claim 1 further recites a “method for scrambling the phase characteristics of the carrier signals.” Petitioner contends that Stopler describes a phase scrambler that applies a phase scrambling sequence to data in the form of m-tuples which are to be mapped into QAM symbols. Pet. 22 (citing Ex. 1012, 12:20–28). Petitioner contends that the QAM symbols are then provided to a modulator which implements the particular signal modulation. Pet. 22; Ex. 1012, 12:55–57, Fig. 5; Ex. 1009, 41–45).

Petitioner explains, with supporting evidence, that it would have been understood by a person having ordinary skill in the art that modulating the phase-scrambled QAM symbols results in the phases of the carrier signals being scrambled. Pet. 22 (citing Ex. 1009, 44–45). Petitioner contends that it would have been obvious to a person having ordinary skill in the art to employ Stopler’s phase scrambling techniques in Shively’s transmitter. Pet. 22–23 (citing Ex. 1009, 45). In particular, Dr. Tellado testifies that a person having ordinary skill in the art would have recognized that by transmitting redundant data symbols on multiple carriers, Shively’s transmitter would suffer from an increased peak-to-average power ratio (PAR). Ex. 1009 ¶¶ 63–64. He further testifies that a person having ordinary skill in the art would have understood the drawbacks from a high PAR and that such a person would have sought out an approach to reduce PAR of Shively’s transmitter. *Id.* ¶ 66. Dr. Tellado further testifies that it would have been

obvious to randomize the carrier phases using Stopler's techniques in order to reduce Shively's PAR. *Id.* ¶ 67. Notwithstanding Patent Owner's arguments, which we have considered and which we address below, we are persuaded by Petitioner's showing, which we adopt as our own findings and conclusions, that Stopler teaches "scrambling the phase characteristics of the carrier signals" and that it would have been obvious to combine Stopler's scrambling technique to Shively's system for the reasons provided by Petitioner. Pet. 23.

Claim 1 also recites "transmitting the plurality of data bits from the first transceiver to the second transceiver." As discussed above, Petitioner relies on Shively's description of a transmitting modem (e.g., Figure 2 transmitting modem 31) that transmits digital data to a receiving modem (e.g., Figure 2 receiving modem 32). Pet. 23 (citing Ex. 1011, 8:56–60). We find that Shively describes transmitting digital data from a first transceiver to a second transceiver. Ex. 1011, 8:56–60. Petitioner further explains, with supporting evidence, and we agree, that a person having ordinary skill in the art would have understood that Shively's digital data are "data bits." Pet. 23 (citing Ex. 1009, 46); *see also* Ex. 1011, 5:47–58.

Claim 1 also recites "associating a carrier signal with a value determined independently of any bit of the plurality of data bits carried by the carrier signal, the value associated with the carrier signal determined by a pseudo-random number generator." Petitioner relies on Stopler to meet this limitation. In particular, Petitioner contends that Stopler teaches a pseudo-random generator that outputs consecutive output pairs that are converted into numbers $2a+b$. Pet. 24 (citing Ex. 1012, 12:28–45). The value $(2a+b)$, derived from the pseudo-random number generator, Petitioner

contends, is a “value determined independently of any bit of the plurality of data bits carried by the carrier signal.” Pet. 24 (citing Ex. 1009, 48).

Petitioner further explains, with supporting evidence, that because Stopler teaches that the value $(2a+b)$ is associated with a symbol that is transmitted on a sub-channel having a carrier frequency, the value $(2a+b)$ is associated with a carrier signal. Pet 24–25 (citing Ex. 1009, 48–49). We are persuaded by Petitioner’s showing, which we adopt, that Stopler renders obvious associating a carrier signal with a “value determined independently of any bit of the plurality of data bits carried by the carrier signal, the value associated with the carrier signal determined by a pseudo-random number generator.”

Claim 1 recites “determining a phase shift for the carrier signal at least based on the value associated with the carrier signal.” Petitioner contends that Stopler teaches that the $(2a+b)$ value is used to determine a phase shift because the sum $(2a+b)$ is used to select the amount of rotation to be applied to the symbol, where the phase rotation can be 0 , $\pi/2$, π , or $-\pi/2$. Pet. 25 (citing Ex. 1012, 12:28–45; Ex. 1009, 49). Petitioner contends that a person having ordinary skill in the art would have understood that applying a rotation to the symbol results in a phase shift in the carrier signal after the symbol is modulated onto the carrier. Pet. 25–26 (citing Ex. 1009, 49). We are persuaded by Petitioner’s showing, which we adopt, that Stopler renders obvious “determining a phase shift for the carrier signal at least based on the value associated with the carrier signal.”

Claim 1 recites “modulating at least one bit of the plurality of data bits on the carrier signal” and “modulating the at least one bit on a second carrier signal of the plurality of carrier signals.” Petitioner points to descriptions in

Shively that describes determining “a respective carrier modulated to transmit one bit in each of a plurality of multitone subchannels of the channel” and “modulating a first set of respective carriers to represent respective unique portions of the data stream.” Pet. 26 (quoting Ex. 1011, 8:3–6, 8:5–13). Petitioner further contends that Shively employs QAM multitone modulation to modulate carriers, and Shively’s multiple sub-bands or QAM channels correspond to the claimed “plurality of carrier signals.” Pet. 26 (citing Ex. 1009, 51). Petitioner submits that Stopler also teaches using QAM to convey data bits on carrier signals. Pet. 26–27. Petitioner further argues that Shively discloses modulating a portion of data on multiple carriers, and, therefore, meets the “second carrier” claim limitation. *Id.* at 27–29. We are persuaded by Petitioner’s showing, which we adopt, that the combined teachings of Shively and Stopler render obvious “modulating at least one bit of the plurality of data bits on the carrier signal” and “modulating the at least one bit on a second carrier signal of the plurality of carrier signals.”

Independent claim 15 is similar to claim 1. Petitioner has made a showing with respect to claim 15 similar to its showing with respect to claim 1. *See, e.g.*, Pet. 30–32. To the extent that claim 15 is different from claim 1, Petitioner has accounted for such differences. We also have reviewed Petitioner’s showing with respect to dependent claims 2, 4, 16, and 18. Claim 2 depends from claim 1 and recites “wherein one or more of the first transceiver and second transceiver are cable transceivers.” Claim 16, which depends from claim 15 is similar. Petitioner sufficiently accounts for this limitation by explaining that Stopler describes a cable modem attached to a cable television network and is a “cable transceiver.” Pet. 29 (citing Ex.

1012, 1:28–33, 2:9–22, and 12:55–57; Ex. 1009, 55–56). We find that Stopler describes a cable modem that meets the limitation of a cable transceiver. Petitioner contends, and we agree, that it would have been obvious to a person having ordinary skill in the art that the data transmission techniques of Shively and Stopler could be employed with a cable transceiver. Pet. 29 (citing Ex. 1009, 56).

Claim 4 depends from claim 1 and “wherein the first and second transceivers are multicarrier DSL transceivers.” Claim 18, which depends from claim 15 is similar. Petitioner sufficiently accounts for this limitation by explaining, for example, that Shively describes discrete multitone transmission (DMT) of data by digital subscriber loop (DSL) modems. Pet. 30 (citing Ex. 1011, 1:5–8). Patent Owner does not make any additional arguments regarding claims 2, 4, 15, 16, and 18 that do not pertain to claim 1. Notwithstanding Patent Owner’s arguments, which we have considered and which we address below, we are persuaded by Petitioner’s showing, which we adopt as our own findings and conclusions, that claims 1, 2, 4, 15, 16, and 18 are unpatentable as obvious over Shively and Stopler.

Patent Owner’s Contentions

Patent Owner argues that the combined teachings of Shively and Stopler do not render obvious the challenged claims. PO Resp. 44. In particular, Patent Owner argues that (1) Petitioner provides no explanation for the “use of a known technique to improve a similar device” rationale to combine Shively and Stopler (*id.* at 45–47); (2) Petitioner wrongly claims that Shively’s transmitter suffers from an increased PAR (*id.* at 47–49); (3) Petitioner’s combination of Shively and Stopler suffers from hindsight (*id.* at 49–50); (4) there is no need to solve Shively’s non-existent PAR problem

(*id.* at 50–51); (5) Stopler does not reduce PAR in a multicarrier transmitter (*id.* at 51); (6) Stopler and Shively could not be combined (*id.* at 51–55); and (7) there were no “market forces” in effect to prompt the Shively/Stopler combination (*id.* at 55–57). Patent Owner also argues that Stopler does not disclose phase scrambling. *Id.* at 57–59. We address each argument below.⁸

Scrambling the Phase Characteristics of the Carrier Signals

Patent Owner argues that Stopler does not disclose “scrambling the phase characteristics of the carrier signals” required by claim 1. PO Resp. 34–44, 57–58. We note, independent claim 15 does not recite this phrase. In essence, Patent Owner argues that claim 1 requires adjusting the phases of a plurality of carriers in a single multicarrier symbol, but that Stopler only discloses scrambling phases from one symbol to the next symbol and not with respect to multiple carriers in a single multicarrier symbol. *Id.*

⁸ Patent Owner lists several portions of Petitioner’s Reply and evidence allegedly beyond the scope of what can be considered appropriate for a reply. *See* Paper 25. We have considered Patent Owner’s listing, but disagree that the cited portions of Petitioner’s Reply and reply evidence are beyond the scope of what is appropriate for a reply. Replies are a vehicle for responding to arguments raised in a corresponding patent owner response. Petitioner’s arguments and evidence that Patent Owner objects to (Paper 25, 1–2) are not beyond the proper scope of a reply because we find that they fairly respond to Patent Owner’s arguments raised in Patent Owner’s Response. *See Idemitsu Kosan Co. v. SFC Co. Ltd.*, 870 F.3d 1376, 1381 (Fed. Cir. 2017) (“This back-and-forth shows that what Idemitsu characterizes as an argument raised ‘too late’ is simply the by-product of one party necessarily getting the last word. If anything, Idemitsu is the party that first raised this issue, by arguing—at least implicitly—that Arkane teaches away from non-energy-gap combinations. SFC simply countered, as it was entitled to do.”).

In particular, Patent Owner contends that “Stopler must be compatible with single-carrier CDMA” (PO Resp. 58) based on Stopler’s teaching that “[t]he framing scheme according to the present invention may also be performed in a CDMA system, in which case the modulator (not shown) may, for example, be a CDMA-type modulator in accordance with the TIA/EIA/IS-95 Mobile Station Compatibility Standard for Dual Mode Wideband Spread Spectrum Cellular System.” Ex. 1012, 12:58–63; *see also* PO Resp. 29–30; *id.* at 29–44 (arguing Stopler’s framing scheme must be compatible with single-carrier CDMA). According to Patent Owner, “[b]ecause Stopler must be compatible with single-carrier CDMA, it makes no sense to argue that his phase scrambling must be performed within a single multicarrier symbol.” PO Resp. 58. Thus, concludes Patent Owner, “Stopler only discloses scrambling phases from one symbol⁹ to the next symbol in time, and not with respect to multiple carriers in a single multicarrier symbol.” PO Resp. 58; *see also id.* at 37 (“It is nonsensical to scramble phases within a symbol because there is only one phase in each symbol.”).

Patent Owner also relies on Stopler’s claim 31 as corroboration for its position, contending that the phase scrambling performed by QAM Mapper and Phase Scrambler 82 “must at least be compatible with single carrier CDMA” because claim 31 is directed to a method in a “CDMA system” that includes the step of “phase scrambling.” *Id.* at 33–34 (citing Ex. 1012, 16:4–48).

⁹ Patent Owner uses “symbol” to mean “a collective multicarrier symbol in a single symbol period (*e.g.* a DMT symbol).” PO Resp. 12. Patent Owner uses “carrier” to mean “a carrier symbol (*e.g.*, a QAM symbol).” *Id.*

The “framing scheme” of Stopler is shown as a block diagram in Figure 5, reproduced below. Ex. 1012, 8:54–55 (“A block diagram of the framing scheme according to the present invention is shown in FIG. 5.”).

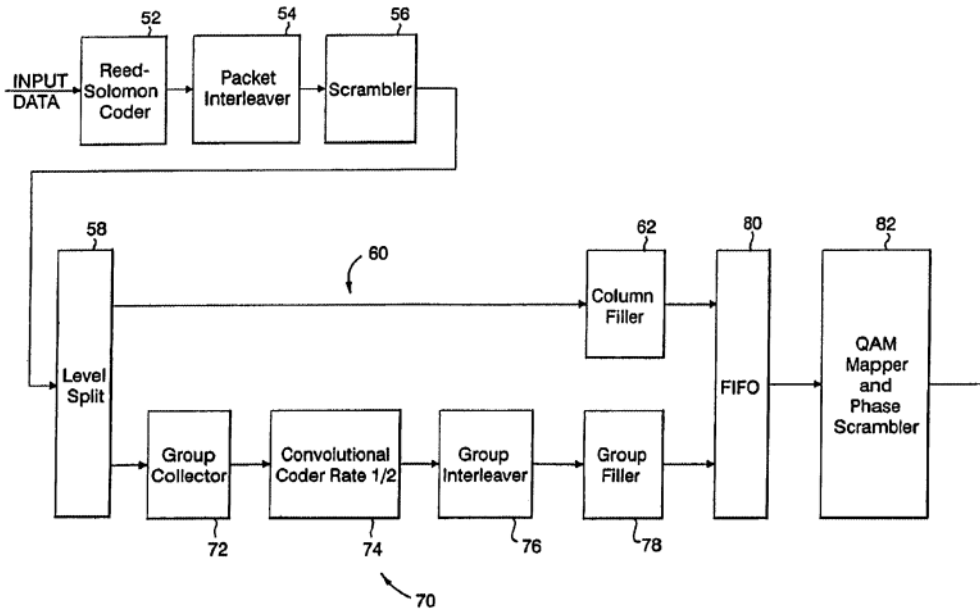
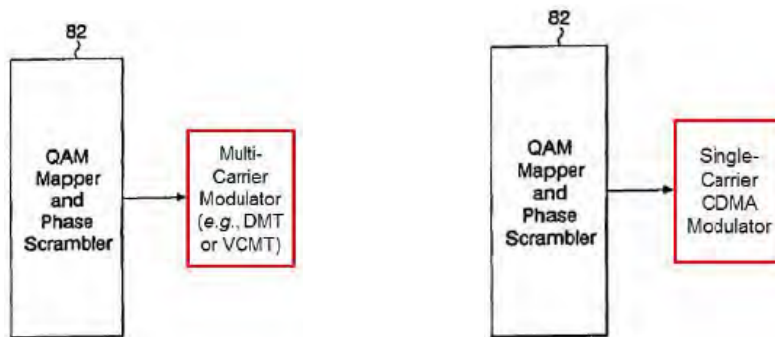


FIG. 5

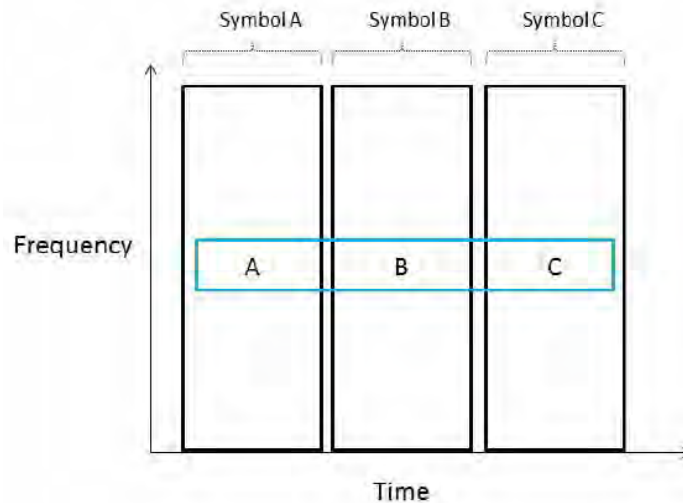
To illustrate the use of Stopler’s framing scheme with either a multicarrier modulator or a single carrier modulator, Patent Owner provides the following annotated excerpts of Figure 5:



PO Resp. 33.

We are not persuaded by Patent Owner’s argument, which is based upon its assertion that “[s]ingle-carrier systems have only one carrier with only one phase” and, therefore, “[p]hase scrambling in a single-carrier

system only makes sense when it is performed over time from symbol-to-symbol, as illustrated by the blue box,” in the figure reproduced below. PO Resp. 36–37.



Id. In this diagram, “Symbol A,” “Symbol B,” and “Symbol C” each represent a QAM symbol, not a DMT symbol, and each, according to Patent Owner, is phase scrambled relative to the other. Thus, Patent Owner’s diagram shows only that a single-carrier embodiment of Stopler would transmit one phase-scrambled QAM symbol at a time. It does *not* show that QAM Mapper and Phase Scrambler 82 phase scrambles a DMT symbol—i.e., rotates, by the same amount, the phase of a plurality of QAM symbols. This is consistent with the cross-examination testimony of Patent Owner’s expert, Dr. Short, who admitted that Stopler does not describe phase scrambling DMT symbols. Pet. Reply 17–18 (citing Ex. 1027, 60:11–14). Thus, Patent Owner’s own diagram is consistent with Petitioner’s position that Stopler phase scrambles individual QAM symbols, and Patent Owner identifies nothing in Stopler to suggest that, in an alternative embodiment with a multicarrier modulator, QAM Mapper and Phase Scrambler 82 do not

supply a plurality of phase-scrambled QAM symbols for modulation onto the plurality of carriers in the, e.g., DMT symbol.

Whereas Patent Owner's position relies upon inference, Petitioner's position is supported by express disclosure in Stopler, which unambiguously teaches "QAM symbols, for example,[] 256-QAM" whose "constellation mapping may be the same as that used in ADSL." Ex. 1012, 12:20–24. Stopler further teaches that, "a phase scrambling sequence is applied to the output symbols," including "all symbols, not just the overhead symbols." *Id.* at 12:25–28. Patent Owner's expert, Dr. Short, agreed that Stopler is referring to phase scrambling QAM symbols. Pet. Reply 16–17 (citing Ex. 1027, 54:17–55:3, 55:19–24, 58:6–8, 59:9–12, and 60:15–22). Stopler further teaches that a "scrambling sequence may be generated by a pseudo-random generator" that generates pairs whose sum "is used to select the amount of rotation to be applied to the symbol," singular; not "symbols" plural. Ex. 1012, 12:28–36. Thus, the most intuitive reading of Stopler supports Petitioner's contention that QAM Mapper and Phase Scrambler 82 determines an amount of rotation and rotates the phase of a *single* QAM symbol by that amount. Patent Owner, in contrast, identifies nothing in Stopler to suggest that QAM Mapper and Phase Scrambler 82 rotates the phase of a *plurality* of QAM symbols (e.g., every QAM symbol of a DMT symbol) by the same amount. Finally, we agree with Petitioner's argument that because "a CDMA modulator does not employ DMT symbols, there is no reason for Stopler's phase scrambler to operate on DMT symbols," whereas "both DMT and CDMA modulators employ QAM symbols," so "applying the phase scrambler to individual QAM symbols[] is the only

possible reading that is logically and technically coherent.” Pet. Reply 18 (citing Ex. 1026 ¶ 58).

Patent Owner also argues that a person of ordinary skill in the art would have understood Stopler to be scrambling phase from symbol-to-symbol over time in order to reduce narrowband noise at the frequency of an overhead pilot carrier. PO Resp. 39; *see also id.* at 38–44 (citing Ex. 2004 (U.S. Patent 6,370,156, “the ’156 patent”). According to Patent Owner, “Petitioners’ argument that Stopler discloses phase scrambling within one symbol is based on the premise that the symbol can have multiple pilot tones.” *Id.* at 40. We understand Patent Owner to be alluding to pages 13 to 14 of the Petition, which state

Stopler also explains that some of the available carriers may be reserved for the transmission of overhead signals, such as pilot tones. Ex. 1012, 10:60-62 & 12:51-54. To randomize these overhead channels, Stopler employs a phase scrambler. Ex. 1012, 12:24-26.

Pet. 13. In the claim-by-claim analysis of the Petition, however, Petitioner cites lines 20 to 28 of column 12, which include Stopler’s teaching that “the phase scrambler is applied to all symbols, not just the overhead symbols.” *See* Pet. 22 (quoting Ex. 1012, 12:27–28). Thus, Petitioner is relying not just on the scrambling of “overhead signals, such as pilot tones,” (Pet. 13) but on the scrambling of *all* QAM symbols. Because neither Petitioner’s argument nor Stopler’s teaching of phase scrambling is limited to pilot tones, Patent Owner’s argument is not persuasive.

Finally, we are not persuaded by Patent Owner’s argument that only its interpretation—i.e., adjusting the phase of an entire DMT symbol—would “simplify implementation,” as Stopler teaches (Ex. 1012, 12:26),

whereas Petitioner’s interpretation would add complexity. PO Resp. 44 (citing Ex. 2003 ¶ 90). Patent Owner provides no explanation or analysis to support its conclusory assertions regarding simplicity and complexity, and the cited portion of Dr. Short’s declaration merely repeats what is written in the Patent Owner’s Response.

For the foregoing reasons, we are persuaded that Stopler teaches “scrambling the phase characteristics of the carrier signals” required by claim 1.

No Use of a Known Technique to Improve a Similar Device Rationale

Patent Owner argues that in making the contention that the combination of Shively and Stopler is a use of a known technique to improve a similar device, method or product in the same way, Petitioner fails to explain what is the known technique, what device/method/product is similar, and how is the alleged known technique used for improvement in the same way. PO Resp. 45–47.

In the Petition, Petitioner provides sufficient explanation regarding the reasons to combine Shively and Stopler. Pet. 14–16. The explanation provided in the Petition is not conclusory or confusing as Patent Owner asserts. The known technique is identified as phase scrambling. Pet. 15 (citing Ex. 1009, 29). The similar device is Shively’s modem. Pet. 17. And the improvement to it is the same as in Stopler—to reduce PAR. Pet. 16 (citing Ex. 1009, 29).

Shively’s transmitter does not suffer from an increased PAR and there is no reason to solve Shively’s non-existent PAR problem

Patent Owner argues that “Shively does not suffer from an increased PAR, much less one that would be recognized as a problem. Rather,

Shively's disclosed embodiment results in a substantially reduced PAR (and one that is very far below a level that is problematic)." PO Resp. 47–49. Patent Owner also argues that because Shively does not disclose a problem with PAR, one having ordinary skill in the art would have had no reason to look for a solution. PO Resp. 50–51. We are not persuaded by these arguments.

Specifically, Patent Owner argues Shively's system is unlikely to suffer from clipping,¹⁰ based on its analysis of a hypothetical 18,000 foot wire. PO Resp. 19–29. According to Patent Owner, the power of signals transmitted in Shively's proposed system would be "only 40% of maximum" in the normal mode for ADSL-1995 and "only 49% of maximum" in the power-boost mode of ADSL-1995. *Id.* Based on these figures, Patent Owner concludes that "the clipping probability for both normal and power-boost modes is virtually zero" because "[w]hile Shively's 'spreading' technique will contribute a small uptick in clipping probability, any increase would be negated by the enormous reduction in clipping probability achieved by reducing signal power by more than half." *Id.* at 28.

Petitioner argues that Dr. Short's analysis is flawed because (1) the teachings of Shively are not applicable only to 18,000 foot cables; and (2) Dr. Short "grossly underestimates the likelihood of phase alignment" in Shively because he wrongly assumes a Gaussian distribution. Pet. Reply 26–31. According to Petitioner, a proper analysis shows that Shively's

¹⁰ Patent Owner explains that, "[w]hen the maximum dynamic range of a component is exceeded, the signal will become distorted or will 'clip.'" PO Resp. 8. This is consistent with how the '158 patent uses "clipping." *See, e.g.,* Ex. 1001, 8:27–35.

techniques “significantly increases PAR and the likelihood of clipping.”
Pet. Reply 31–35.

We need not determine the exact probability of clipping in Shively’s proposed system because, even assuming Patent Owner’s analysis is accurate, it does not rebut Petitioner’s reason to combine. Petitioner does not allege that Shively’s proposed system causes clipping, or that a person of ordinary skill in the art would have been motivated to reduce PAR only if it caused clipping. Instead, Petitioner alleges that Shively’s proposed system would have an “increased” or “high” PAR:

A POSITA would have recognized that by transmitting redundant data on multiple carriers, *Shively’s transmitter would suffer from an increased peak-to-average power ratio*. [Ex. 1009, p. 27.] This increase is due to the fact that the overall transmitted signal in a multicarrier system is essentially the sum of its multiple subcarriers. *Id.* When N subcarrier signals with the same phase are added together, they have a peak power which is N times greater than their individual maximum powers. *Id.*

Since Shively’s subcarriers use quadrature amplitude modulation (QAM) . . . transmitting the same bits on two different subcarriers causes those subcarriers to have the same phase and amplitude. *Id.*, pp. 27–28. By transmitting the same bits on multiple subcarriers, Shively creates a situation where those multiple subcarriers will be phase-aligned. *Having phase-aligned subcarriers causes a high peak-to-average power ratio (PAR), since all of the subcarriers add up coherently at the same time.* *Id.*, p. 28.

Pet. 14–15 (emphases added).

Patent Owner criticizes Petitioner’s declarant for not providing “calculations or data that illustrate to what degree there is an ‘increase’ in PAR with Shively’s transmitter” (PO Resp. 48), but we are not persuaded

that such calculations and data are necessary. Petitioner's reason to combine does not depend on the PAR increase exceeding some specific numeric threshold. There is no dispute that transmitting the same data on multiple carriers increases PAR (Pet. Reply 10 (citing PO Resp. 6–7; Ex. 2003 (Short Decl.) ¶ 22)) or that Shively's technique, specifically, will increase PAR (PO Resp. 28 (“Shively's ‘spreading’ technique will contribute a small uptick in clipping probability.”)). There also is no dispute that equipment designed to handle a higher PAR can be larger, more expensive, and more power hungry than equipment designed to handle a lower PAR. Pet. Reply 36 (citing Ex. 2003 ¶ 26; Ex. 1027 45:21–46:19). Patent Owner's declarant, Dr. Short, testified that, given such issues, system designers or engineers would be interested in using techniques that could reduce PAR. Ex. 1027, 46:23–47:3. This is consistent with the reason to combine given in the Petition and supports Petitioner's position that “numerous problems” other than clipping “would have motivated a [person of ordinary skill in the art] to look for ways to reduce the PAR of Shively's technique.” Pet. Reply 36.

In light of the foregoing, we are persuaded that a person of ordinary skill in the art would have recognized that Shively's technique would increase PAR and would have been motivated to reduce PAR regardless of whether Shively's technique resulted in clipping.

Combination of Shively and Stopler suffers from hindsight

Patent Owner argues that only the inventor of the '158 patent recognized the problem of high PAR due to phase-aligned carriers. PO Resp. 49–50. Patent Owner argues that the only cited evidence that high PAR results from transmitting the same data on multiple carriers is from the '158 patent and that Petitioner “use[s] the '158 patent as a roadmap for

arriving at their theory of obviousness,” resulting in “a textbook case of impermissible hindsight bias.” *Id.* We are not persuaded by this argument.

First, the portions cited in the '158 patent in the Petition and in Dr. Tellado's declaration come from the “BACKGROUND OF THE INVENTION” section of the patent. That portion of the '158 patent uses words such as “conventional” indicating that what is described in the “BACKGROUND OF THE INVENTION” section is information that was known at the time of the invention, not just by the inventors, but persons of ordinary skill in the art. Patent Owner does not contend otherwise.

In addition, Dr. Tellado testified that a person having ordinary skill in the art would have recognized that the purpose of Stopler's phase scrambler to randomize data symbols would be to reduce PAR of transmitted signals and that the person would have been familiar with the problems created by a high PAR, including PAR due to phase-aligned carriers. Ex. 1009 ¶¶ 60, 66. Moreover, Patent Owner's own declarant recognized that PAR was a known problem at the time of the invention. Ex. 2003 ¶ 23 (“Conventional multicarrier systems, therefore, were designed to accommodate PAR.”). The ANSI T1.413-1995 standard also confirms that PAR was known at the time of the invention by describing that “[a] DMT time-domain signal has a high peak-to-average ratio (its amplitude distribution is almost Gaussian), and large values may be clipped by the digital-to-analog converter.” Ex. 1018, 36 (Section 6.5 “Tone ordering”). Based on the record evidence, we find that a person having ordinary skill in the art would have known about the problem of high PAR due to phase-aligned carriers.

Stopler does not reduce PAR in a multicarrier transmitter

Patent Owner argues that Stopler does not reduce PAR because phase scrambling is performed from symbol-to-symbol and not from carrier-to-carrier. PO Resp. 51. The argument is not persuasive for the reasons provided above.

Stopler and Shively could not be combined

Patent Owner argues that Shively and Stopler are incompatible and that it would not have been possible to incorporate Shively's bit-spreading concept into Stopler. PO Resp. 51. In particular, Patent Owner argues that Shively's bit-spreading concept is not compatible with Stopler's "diagonalization" technique. PO Resp. 51–55. This argument is misplaced as Petitioner did not rely on Stopler's "diagonalization" technique. Rather, Petitioner relies on Stopler's phase scrambler and scrambling technique. Pet. 15, 22–23. Moreover, Stopler describes its "diagonalization" technique as optional. Ex. 1012, 10:17, 13:1–3. For these reasons, we are not persuaded by Patent Owner's argument that it would not be possible to combine Shively and Stopler.

No "market forces" in effect to prompt Shively/Stopler combination

The Petition states that "[m]arket forces would have prompted the development of multicarrier communications devices, such as Digital Subscriber Line (DSL) modems, employing both redundant bit transmission and phase scrambling." Pet. 16 (citing Ex. 1009, 29). Patent Owner argues that neither Petitioner nor Dr. Tellado identifies a single product or standard that employs any of the ideas disclosed in Shively or Stopler. PO Resp. 55–57.

Patent Owner's arguments are misplaced. It was not incumbent on Petitioner or Dr. Tellado to identify a product or standard that employs the ideas disclosed in Shively or Stopler in order to show that the combination of Shively and Stopler would have been obvious to a person skilled in the art. That is not the standard. Rather, a claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time of the invention to a person having ordinary skill in the art. *KSR*, 550 U.S. at 406. Dr. Tellado testified that a person having ordinary skill in the art would have been familiar with problems caused by a high PAR, that equipment needed to cope with PAR would have been expensive and inefficient, and that less capable equipment would have caused distortion such as from amplitude clipping. Ex. 1009 ¶ 66. He further testified that combining Shively's redundant bit transmission with Stopler's phase scrambling technique would have allowed for faster DSL modems without requiring more complex and expensive circuitry for handling increased PAR. *Id.* ¶ 69. Patent Owner has not presented sufficient evidence to undermine Dr. Tellado's testimony. Indeed, Dr. Short testified that a way to address high PAR in a communication system would be to use transceiver components that could handle higher peak transmission values, which would be expensive and power hungry. Ex. 1027, 45:15–46:12. Based on the record before us, we find that at the time of the invention, a person having ordinary skill in the art would have recognized that an increase in PAR would have been associated with more expensive communication equipment. Accordingly, a drive to reduce equipment costs would have motivated a person having ordinary skill in the art to include

Stopler's phase scrambler into Shively's transmitter to reduce PAR. Pet. 14–16 (citing Ex. 1009 ¶¶ 66–70).

For the foregoing reasons, we are persuaded that Petitioner has established, by a preponderance of the evidence, that claims 1, 2, 4, 15, 16, and 18 of the '158 patent are unpatentable under 35 U.S.C. § 103(a) as obvious over Shively and Stopler.

E. Asserted Obviousness over Shively, Stopler, and Gerszberg

Petitioner contends that claims 3, 5, 14, 17, 19, and 28–30 are unpatentable under 35 U.S.C. § 103(a) as obvious over Shively, Stopler, and Gerszberg. Pet. 33–41. Relying on the testimony of Dr. Jose Tellado, Petitioner explains how the combination of Shively, Stopler, and Gerszberg meets all of the claim limitations. *Id.* (citing Ex. 1009).

Gerszberg discloses using a Digital Subscriber Line (DSL) modem, such as an ADSL modem, to transmit and receive modulated data. Ex. 1013, 11:66–12:7. The modem uses DMT modulation to transmit data. *Id.* at 12:7–9. Gerszberg further describes types of data services that may be provided to subscriber premises by a DSL modem that uses DMT modulation, such as high-speed internet access and video services. *Id.* at 7:44–60, 8:16–36, and 10:63–11:3. Gerszberg also describes that a DSL modem can be used in various DSL communications, such as HDSL, ADSL, SDSL, and VDSL. *Id.* at 9:66–10:3.

Based on the record before us, Petitioner has accounted sufficiently for dependent claims 3, 5, 14, 17, 19, and 28–30. Pet. 33–41. For example, claim 3 depends from claim 1 and recites “wherein one or more of the first transceiver and second transceiver are VDSL transceivers.” Claim 17, which depends from independent claim 15, is similar to claim 3. Petitioner

relies on Gerszberg’s description that its “DSL modem may be constructed using any of the techniques described in the applications incorporated by reference below” such as “High Speed Digital Subscriber Line (HDSL), Asymmetric Digital Subscriber Line (ADSL), Symmetrical Digital Subscriber Line (SDSL) and Very high data rate Digital Subscriber Line (VDSL).” Pet. 37–38 (citing Ex. 1013, 9:62–10:3) (emphasis omitted). Petitioner contends that it would have been obvious to replace Shively’s ADSL modems with VDSL modems, as taught by Gerszberg, in order to achieve higher bandwidth. Pet. 38 (citing Ex. 1009, 67). Moreover, Petitioner provides a rational reason for combining Gerszberg with the combined teachings of Shively and Stopler. Pet. 34–37. Patent Owner does not present arguments for any of those claims separate from the arguments addressed previously.

We are persuaded by Petitioner’s showing, which we adopt as our own findings and conclusions, that claims 3, 5, 14, 17, 19, and 28–30 are unpatentable as obvious over Shively, Stopler, and Gerszberg.

F. Asserted Obviousness over Shively, Stopler, and Bremer

Petitioner contends that claims 6, 9, 10, 12, 20, 23, 24, and 26 are unpatentable under 35 U.S.C. § 103(a) as obvious over Shively, Stopler, and Bremer. Pet. 41–50. Relying on the testimony of Dr. Jose Tellado, Petitioner explains how the combination of Shively, Stopler, and Bremer allegedly meets all of the claim limitations. *Id.* (citing Ex. 1009).

Bremer relates to encoding and decoding techniques for a data signal that is transmitted over a communications channel. Ex. 1017, 1:41–67. Bremer describes using a pseudorandom generator to encode the gain or phase of a signal prior to transmission, and on the receiving end, uses a

second pseudorandom generator to decode the encoded data signal. *Id.* at 1:53–64.

Based on the record before us, Petitioner has accounted sufficiently for dependent claims 6, 9, 10, 12, 20, 23, 24, and 26. Pet. 41–50. For example, claim 6 depends from claim 1 and recites “independently deriving the values associated with each carrier using a second pseudo-random number generator in the second transceiver.” Claim 20, which depends from independent claim 15, is similar to claim 6. Petitioner contends that Bremer teaches that when a transmitting device includes components causing a pseudorandom phase shift to the transmitted signal, a receiving device requires complementary components to decode the signal. Pet. 45 (citing Ex. 1017, 1:60–65, 4:33–34). Petitioner further contends that Bremer describes altering gain and phase modifiers of a data signal being transmitted from a QAM modem based on values from a pseudorandom signal generator, which generates a pseudorandom number. Pet. 45 (citing Ex. 1017, Abstract, 2:32; Ex. 1009, 77). Petitioner further contends that the values produced by a second pseudorandom number generator are independent of the values produced by a first pseudorandom number generator. Pet. 46 (citing Ex. 1017, 4:10–16, 4:35–36; Ex. 1009, 80). Petitioner provides rational reasoning for combining Bremer with the combined teachings of Shively and Stopler. Pet. 42–44.

Notwithstanding Patent Owner’s arguments, which we address immediately below, we are persuaded by Petitioner’s showing, which we adopt as our own findings and conclusions, that claims 6, 9, 10, 12, 20, 23, 24, and 26 are unpatentable as obvious over Shively, Stopler, and Bremer.

Patent Owner's Contentions

Patent Owner argues that Petitioner fails to allege a legally sufficient rationale for combining Bremer's single-carrier privacy modem system, and for modifying it such that it would have been compatible with Shively/Stopler's multicarrier systems. PO Resp. 59–60. We are not persuaded by this argument.

As explained above, Petitioner relies on Bremer for its teaching of a second pseudo-random number generator to meet the limitations of claims 6 and 20. Patent Owner quotes the reasons provided in the Petition at pages 46–47 for combining Bremer with the Shively/Stopler combination and argues that Petitioner's allegations present more questions than answers. *Id.* at 60. Patent Owner argues that Dr. Tellado provides no additional guidance. *Id.* (citing Ex. 1009, 81). We disagree with Patent Owner that Petitioner failed to provide a sufficient rationale and reasoning for modifying the combined teachings of Shively and Stopler with Bremer.

Patent Owner's focus on one passage from the Petition and one passage from Dr. Tellado's testimony overlooks other supported contentions made by Petitioner. In particular, the Petition explains that a person having ordinary skill in the art would have understood that the transceivers and receivers described in both Stopler and Shively would have been a matched pair and that the techniques used by a transmitter to encode data for transmission would have been paralleled by techniques used by a receiver to decode data. Pet. 42–43 (citing Ex. 1009, 74; Ex. 1017, 1:60–63). The Petition further explains that a person having ordinary skill in the art would have understood that a receiver must be able to reverse the phase modification applied by a transmitter. Pet. 43 (citing Ex. 1009, 75; Ex.

1017, 1:34–36). Petitioner explains that the combination of Shively, Stopler, and Bremer would have been obvious to a person of ordinary skill in the art because it is the application of a known technique (designing a receiver to match a transmitter) to improve a similar system in the same way (allowing data to be received). Pet. 44 (citing Ex. 1009, 76). Moreover, Dr. Tellado testified that “[a]lthough Bremer describes a single-carrier QAM communication system, it would have been obvious to a POSITA that Bremer’s teaching of a complementary pseudo-random number generator, and performing complementary changes of the received signal, could be applied on a carrier-by-carrier basis to the multicarrier system of Stopler.” Ex. 1009, 81. We agree with Petitioner’s reasoning and rationale provided, and determine it would have been obvious to include Bremer’s second pseudo-random number generator in the combined Shively/Stopler system receiver in order to decode and receive the phase scrambled data transmitted by the system transceiver. Ex. 1009, 73–76, 81.

G. Asserted Obviousness over Shively, Stopler, Bremer, and Gerszberg

Petitioner contends that claims 8, 11, 13, 22, 25, and 27 are unpatentable under 35 U.S.C. § 103(a) as obvious over Shively, Stopler, Bremer, and Gerszberg. Pet. 50–53. Relying on the testimony of Dr. Jose Tellado, Petitioner explains how the combination of Shively, Stopler, Bremer, and Gerszberg allegedly meets all of the claim limitations. *Id.* (citing Ex. 1009).

Based on the record before us, Petitioner has accounted sufficiently for dependent claims 8, 11, 13, 22, 25, and 27. Pet. 50–53. For example, claim 11 depends from claim 6, and recites “wherein the first and second transceivers are VDSL transceivers.” Claim 25, which depends from claim

20, is similar to claim 11. Petitioner relies on Gerszberg's description that its "DSL modem may be constructed using any of the techniques described in the applications incorporated by reference below" such as "High Speed Digital Subscriber Line (HDSL), Asymmetric Digital Subscriber Line (ADSL), Symmetrical Digital Subscriber Line (SDSL) and Very high data rate Digital Subscriber Line (VDSL)." Pet. 37–38 (emphasis omitted) (citing Ex. 1013, 9:62–10:3). Petitioner contends that it would have been obvious to replace Shively's ADSL modems with VDSL modems, as taught by Gerszberg, in order to achieve higher bandwidth. Pet. 38, 52 (citing Ex. 1009, 67, 89). Moreover, Petitioner provides a rational reason for combining Gerszberg with the combined teachings of Shively and Stopler. Pet. 50–51. Patent Owner does not present arguments for any of those claims separate from the arguments addressed previously.

We are persuaded by Petitioner's showing, which we adopt as our own findings and conclusions, that claims 8, 11, 13, 22, 25, and 27 are unpatentable as obvious over Shively, Stopler, Bremer, and Gerszberg.

H. Asserted Obviousness over Shively, Stopler, Bremer, and Flammer

Petitioner contends that claims 7 and 21 are unpatentable under 35 U.S.C. § 103(a) as obvious over Shively, Stopler, Bremer, and Flammer. Pet. 53–60. Relying on the testimony of Dr. Jose Tellado, Petitioner explains how the combination of Shively, Stopler, Bremer, and Flammer allegedly meets all of the claim limitations. *Id.* (citing Ex. 1009).

Flammer relates to data transmission between a source node and a target node, where each node has a transmitter and a receiver. Ex. 1019, Abstract. Flammer uses pseudo-random number generators in its communication system. Flammer describes synchronization between

pseudo-random number generators at different ends of a communication channel. *Id.* at 3:49–4:10. As part of the synchronization, an acquisition/synchronization packet is transmitted that includes a seed value from the source node to the target node. *Id.* at 3:52–58. The transmitted seed value is used to initialize the pseudo-random number generators executing at the respective source and target nodes. *Id.* at 3:52–4:9. Once the pseudo-random number generators at both the source node and the target node have the same seed value, they can generate identical pseudo-random number sequences for selecting frequency bands. *Id.* at 4:42–53.

Based on the record before us, Petitioner has accounted sufficiently for dependent claims 7 and 21. Pet. 50–53. Claim 7 depends from claim 6 and recites “using in the first and second transceivers a same seed for the first and second pseudo-random number generators and the value of the seed is transmitted from the first transceiver to the second transceiver.” Claim 21, which depends from claim 20, is similar to claim 7. Petitioner contends that Flammer teaches a transceiver as a node having a transmitter and a receiver. Pet. 57 (citing Ex. 1019, Abstract). Petitioner further contends that in Flammer, the source node is the first transceiver and the target node is the second transceiver. Ex. 1009, 92. Petitioner argues that Flammer teaches that it was known for the pseudo-random number generators in the source node and the target node to use the same seed value. Pet. 57 (citing Ex. 1019, 3:52–67; Ex. 1009, 92–93). Petitioner further explains, with supporting evidence, that Flammer teaches transmitting a value of a seed from a source node (a first transceiver) to a target node (a second transceiver) when the target node receives an acquisition/synchronization packet which contains information about the node, including a seed value.

Moreover, Petitioner provides a rational reason for combining Flammer with the combined teachings of Shively, Stopler, and Bremer. Pet. 54–57. Patent Owner does not present arguments for either of claims 7 and 21 separate from the arguments addressed previously.

We are persuaded by Petitioner’s showing, which we adopt as our own findings and conclusions, that claims 7 and 21 are unpatentable as obvious over Shively, Stopler, Bremer, and Flammer.

I. Patent Owner’s Motion to Exclude

Patent Owner moves to exclude Exhibits 1022–1025, 1028, and portions of 1026 and 2013. PO Mot. Exc. Exhibit 1022 is styled “Robert T. Short, ‘Physical Layer,’ *in* WIMEDIA UWB (2008).” Pet. Reply 5. Patent Owner argues that we should exclude Exhibit 1022 as irrelevant. PO Mot. Exc. 2–4. Exhibit 1022 was not cited or discussed in any way in Petitioner’s Reply. Moreover, we did not rely on Exhibits 1022 in rendering our decision. We did not and need not consider Exhibit 1022. We have determined that Petitioner has demonstrated, by a preponderance of the evidence, that the challenged claims are unpatentable, without considering the specific objected to evidence.

Exhibit 1023 is styled “Denis J. G. Mestdagh and Paul M. P. Spruyt, ‘A Method to Reduce the Probability of Clipping in DMT-Based Transceivers,’ *IEEE Transactions on Communications*, Vol. 44, No. 10, (October 1996).” Pet. Reply 5. Exhibit 1024 is styled “Stefan H. Muller and Johannes B. Huber, ‘A Comparison of Peak Power Reduction Schemes for OFDM,’ *IEEE Global Telecommunications Conference* (1997).” *Id.* Exhibit 1028 is styled “T. Starr, J. M. Cioffi, P. J. Silverman, UNDERSTANDING DIGITAL SUBSCRIBER LINE TECHNOLOGY (1999) (selected

pages).” *Id.* Exhibit 2013 is a copy of the cross examination transcript of Dr. Tellado.

Patent Owner argues that we should exclude Exhibits 1023, 1024, and 1028 in their entirety as irrelevant. PO Mot. Exc. 9–12. Patent Owner also argues that we should exclude certain portions of Exhibit 2013 allegedly discussing Exhibits 1023, 124, or 1028. *Id.* Although Exhibits 1023, 1024, and 1028 are mentioned briefly in Petitioner’s Reply, we did not rely on Exhibits 1023, 1024, 1028, or the objected to portions of Exhibit 2013 in rendering our decision. We did not and need not consider Exhibits 1023, 1024, 1028, or the objected to portions of Exhibit 2013. We have determined that Petitioner has demonstrated, by a preponderance of the evidence, that the challenged claims are unpatentable, without considering the specific objected to evidence.

Exhibit 1025 is a copy of Dr. Tellado’s thesis. Pet. Reply 5. Patent Owner argues that we should exclude Exhibit 1025 as irrelevant. PO Mot. Exc. 4–6. Exhibit 1025 was not cited or discussed in any way in Petitioner’s Reply. Moreover, we did not rely on Exhibits 1025 in rendering our decision. We did not and need not consider Exhibit 1025. We have determined that Petitioner has demonstrated, by a preponderance of the evidence, that the challenged claims are unpatentable, without considering the specific objected to evidence.

Lastly, Patent Owner seeks to exclude paragraphs 16 (last two sentences), 29, 42, 43 (first sentence), and 52 of Exhibit 1026 (Second Tellado Declaration), and certain portions of Dr. Tellado’s cross examination transcript (Exhibit 2013). PO Mot. Exc. 6–9. We did not rely on the objected to portions of Exhibits 1026 or 2013 in rendering our

decision. We did not and need not consider the objected to portions of Exhibits 1026 or 2013. We have determined that Petitioner has demonstrated, by a preponderance of the evidence, that the challenged claims are unpatentable, without considering the specific objected to evidence.

For all of the above reasons, we *dismiss* Patent Owner's Motion to Exclude.

J. Motion for Observations

Patent Owner also filed a Motion for Observations (Paper 30, "PO Mot. Obs."), to which Petitioner filed a Response (Paper 37, "Pet. Resp."). To the extent Patent Owner's Motion for Observations pertains to testimony purportedly impacting Dr. Tellado's credibility, we have considered Patent Owner's observations and Petitioner's responses in rendering this Final Written Decision, and accorded Dr. Tellado's testimony appropriate weight in view of Patent Owner's observations and Petitioner's response to those observations. *See* Obs. 1–13; Obs. Resp. 2–11.

III. CONCLUSION

Based on the evidence and arguments, Petitioner has demonstrated by a preponderance of the evidence that claims 1, 2, 4, 15, 16, and 18 are unpatentable over Shively and Stopler; claims 3, 5, 14, 17, 19, and 28–30 are unpatentable over Shively, Stopler, and Gerszberg; claims 6, 9, 10, 12, 20, 23, 24, and 26 are unpatentable over Shively, Stopler, and Bremer; claims 8, 11, 13, 22, 25, and 27 are unpatentable over Shively, Stopler, Bremer, and Gerszberg; and claims 7 and 21 are unpatentable over Shively, Stopler, Bremer, and Flammer.

IV. ORDER

Accordingly, it is:

ORDERED that claims 1–30 of the '158 patent have been shown to be unpatentable;

FURTHER ORDERED that Patent Owner's Motion to Exclude is *dismissed*; and

FURTHER 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.

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