

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION,
Petitioner,

v.

PARKERVISION, INC.,
Patent Owner.

IPR2021-00346
Patent 8,190,108 B2

Before JONI Y. CHANG, BART A. GERSTENBLITH, and
IFTIKHAR AHMED, *Administrative Patent Judges*.

AHMED, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Intel Corporation (“Petitioner”) requested an *inter partes* review of claims 1, 6–9, 12, and 17–20 (the “challenged claims”) of U.S. Patent No. 8,190,108 B2 (Ex. 1001, “the ’108 patent”). Paper 3 (“Petition” or “Pet.”). ParkerVision, Inc. (“Patent Owner”) filed a Preliminary Response. Paper 7. Applying the standard set forth in 35 U.S.C. § 314(a), we instituted an *inter partes* review of the challenged claims. Paper 12 (“Inst. Dec.”).

After institution, Patent Owner filed a Patent Owner Response (Paper 17, “PO Resp.”), Petitioner filed a Reply to Patent Owner’s Response (Paper 23, “Pet. Reply”), and Patent Owner filed a Sur-reply (Paper 28, “PO Sur-reply”). An oral hearing was held on April 26, 2022, and a copy of the transcript was entered in the record. Paper 32 (“Tr.”).

We have jurisdiction pursuant to 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. To prevail, Petitioner must prove unpatentability by a preponderance of the evidence. *See* 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2020). Having reviewed the arguments and the supporting evidence, we determine that Petitioner has shown, by a preponderance of the evidence, that claims 1, 6–9, 12, and 17–20 of the ’108 patent are unpatentable.

II. BACKGROUND

A. *Real Parties-in-Interest*

Petitioner identifies itself, Intel Corporation, as the real party-in-interest. Pet. 1, 8. Patent Owner identifies itself, ParkerVision, Inc., as the real party-in-interest. Paper 5, 1.

B. Related Matters

According to the parties, the '108 patent has been asserted in *ParkerVision, Inc. v. Intel Corp.*, No. 6:20-cv-00562-ADA (W.D. Tex.). Pet. 86; Paper 5, 1. Petitioner also identifies as related matters IPR2020-01265 and IPR2020-01302, challenging U.S. Patent Nos. 7,110,444 and 7,539,474, respectively, which are asserted in *ParkerVision, Inc. v. Intel Corp.*, No. 6:20-cv-00108-ADA (W.D. Tex.). Pet. 8.

C. The '108 Patent (Ex. 1001)

The '108 patent, titled “Method and System for Frequency Up-Conversion,” was filed on April 26, 2011, and claims priority to U.S. Patent Application No. 09/176,154, filed on October 21, 1998. Ex. 1001, codes (22), (54), (60). The '108 patent issued on May 29, 2012. *Id.* at code (45). The '108 patent describes that communication systems transmit information by modulating a carrier signal, where the carrier signal typically has a higher frequency than a baseband information signal. *See id.* at 1:44–51. The '108 patent relates to “up-convert[ing] a signal from a lower frequency to a higher frequency.” *Id.* at 1:66–67. In particular, “the invention accepts an information signal at a baseband frequency and transmits a modulated signal at a frequency higher than the baseband frequency.” *Id.* at 2:5–8.

Figure 12 of the '108 patent illustrates a structural block diagram of a transmitter according to a frequency modulation (FM) embodiment (*id.* at 3:11–13, 18:63–65), and is reproduced below.

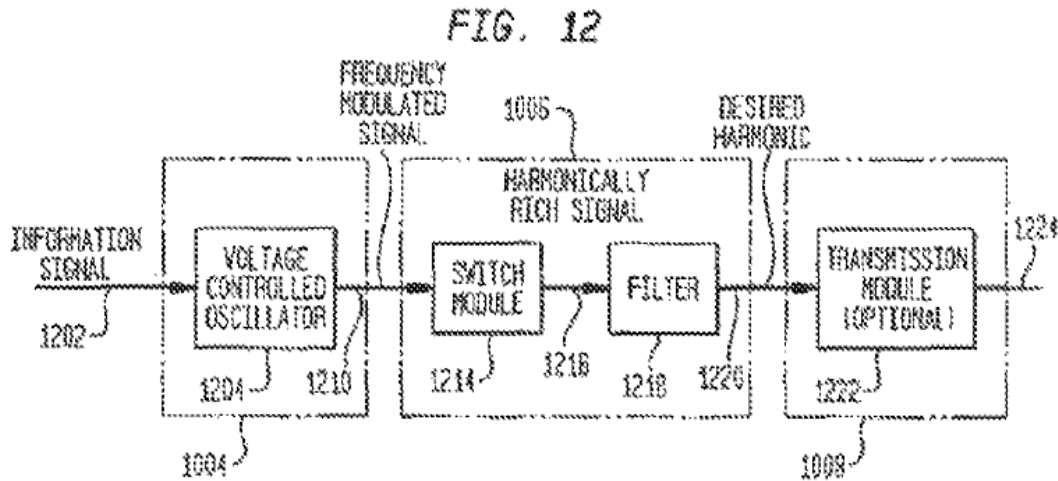


Figure 12 shows that the transmitter routes an input information signal to voltage controlled oscillator 1204, which generates and modulates oscillating frequency modulated signal 1210. *Id.* at 19:21–26. Switch module 1214 then generates “harmonically rich signal 1216 with a continuous and periodic waveform.” *Id.* at 19:26–29. Next, filter 1218 filters out unwanted harmonics and outputs a signal at a desired harmonic frequency, which transmission module 1222 prepares for transmission. *Id.* at 19:37–43.

switches 5406, 5408, and 5446 are in the Transmit (T) position, with an incoming information signal 5450 connected by switch 5446 to VCO 5444 to create a frequency modulated oscillating signal 5436. *Id.* at 55:5–9, Fig. 54B. The oscillating signal is then routed through pulse shaper 5438 to create a string of pulses 5440 which in turn cause switch 5420 to open and close, resulting in “a harmonically rich signal 5424.” *Id.* at 55:12–17, Fig. 54A. That signal is filtered, amplified, and routed to transmission module 5432, which outputs a transmission signal 5434 to antenna 5402, connected to another R/T switch 5406. *Id.* at 55:17–25, Fig. 54A.

D. Challenged Claims

Petitioner challenges claims 1, 6–9, 12, and 17–20, of which claims 1 and 12 are independent. Pet. 10. Claims 6–9 depend from claim 1 and claims 17–20 depend from claim 12. *Id.* Claim 1 is reproduced below.

1. [1Preamble] A frequency conversion module, comprising:

[1A] a first switch configured to up-convert a signal based on a control signal and a bias signal,

[1B] wherein said signal are routed to said frequency conversion module via a second switch, and

[1C] wherein said signal is transmitted by an antenna connected to a third switch.

Ex. 1001, 65:49–55 (Petitioner’s annotations added).

E. Prior Art and Instituted Grounds of Unpatentability

We instituted trial based on the following grounds of unpatentability:

Claims Challenged	35 U.S.C. § ¹	References
1, 12	103(a)	Downey, ² Sedra ³
6–9, 17–20	103(a)	Downey, Sedra, Hahnel ⁴

Inst. Dec. 37. Petitioner supports its arguments with declaration testimony of Dr. Daniel van der Weide. Exs. 1002, 1030. Patent Owner supports its arguments with a Declaration by Dr. Michael Steer. Ex. 2022.

III. ANALYSIS

A. Principles of Law

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). This burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

¹ Because the challenged claims of the ’108 patent have an effective filing date before March 16, 2013 (*see* Ex. 1001, codes (22), (60)), patentability is governed by the pre-AIA version of 35 U.S.C. § 103.

² U.S. Patent No. 5,239,686, issued Aug. 24, 1993 (Ex. 1003, “Downey”).

³ ADEL S. SEDRA ET AL., MICROELECTRONIC CIRCUITS (3rd ed. 1991) (Ex. 1004, “Sedra”).

⁴ U.S. Patent No. 2,730,624, issued Jan. 10, 1956 (Ex. 1005, “Hahnel”).

As set forth in 35 U.S.C. § 103(a),

[a] patent may not be obtained . . . 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.

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) when in evidence, objective evidence of nonobviousness.⁵ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966). 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 Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). However, Petitioner cannot satisfy its burden of proving obviousness by employing “mere conclusory statements.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Instead, Petitioner must articulate a reason why a person of ordinary skill in the art would have combined the prior art references. *In re NuVasive*, 842 F.3d 1376, 1382 (Fed. Cir. 2016).

B. Level of Ordinary Skill in the Art

We review Petitioner’s asserted obviousness grounds in view of the understanding of a person of ordinary skill in the art at the time of the invention. *Graham*, 383 U.S. at 17. Petitioner contends that a person of ordinary skill in the art “would have had at least a bachelor’s degree in

⁵ Neither party presents evidence of objective indicia of nonobviousness.

electrical engineering or a related subject and two or more years of experience in the field of radio frequency circuit design.” Pet. 40 (citing Ex. 1002 ¶ 29). Patent Owner contends that a person of ordinary skill in the art “would have: (a) a Bachelor of Science degree in electrical or computer engineering (or a related academic field), and at least two (2) additional years of experience in the design and development of radio frequency circuits and/or systems, or (b) at least five (5) years of experience and training in the design and development of radio frequency circuits and/or systems.” PO Resp. 5 (citing Ex. 2022 ¶ 20). We determine that the two proposed levels are closely aligned and are consistent with the ’108 patent and the asserted prior art.⁶ 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). We adopt the following level in determining the patentability of the challenged claims: a person of ordinary skill in the art would have had a bachelor’s degree in electrical or computer engineering, or a related subject, and two years of experience in the field of radio frequency circuit design and development.

C. Claim Construction

In this *inter partes* review, claims are construed using the same claim construction standard that would be used to construe the claims in a civil action under 35 U.S.C. § 282(b). See 37 C.F.R. § 42.100(b) (2020). The claim construction standard includes construing claims in accordance with the ordinary and customary meaning of such claims as understood by one of ordinary skill in the art at the time of the invention. See *id.*; *Phillips v. AWH*

⁶ Neither party asserts that the minor difference in the proposed levels of ordinary skill in the art makes a substantive difference in this proceeding.

Corp., 415 F.3d 1303, 1312–14 (Fed. Cir. 2005) (en banc). In construing claims in accordance with their ordinary and customary meaning, we take into account the specification and prosecution history. *Phillips*, 415 F.3d at 1315–17.

If the specification “reveal[s] a special definition given to a claim term by the patentee that differs from the meaning it would otherwise possess[,] . . . the inventor’s lexicography governs.” *Phillips*, 415 F.3d at 1316 (citing *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002)). Another exception to the general rule that claims are given their ordinary and customary meaning is “when the patentee disavows the full scope of a claim term either in the specification or during prosecution.” *Uship Intellectual Props., LLC v. United States*, 714 F.3d 1311, 1313 (Fed. Cir. 2013) (quoting *Thorner v. Sony Computer Entm’t Am., LLC*, 669 F.3d 1362, 1365 (Fed. Cir. 2012)).

Additionally, only terms that are in controversy need to be construed, and those need be construed only to the extent necessary to resolve the controversy. *See Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (holding that “only those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy”); *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (citing *Vivid Techs.* in the context of an *inter partes* review).

In the Institution Decision, we did not construe any claim terms expressly because none of the terms were in dispute. Inst. Dec. 10–11. In the briefing following institution, Patent Owner proposed a construction for the terms “switch” and “third switch,” *see, e.g.*, PO Resp. 31–34, and it

became clear that the parties dispute the meaning of the term “switch,” and construing that term is important to address the issues presented in this proceeding. Accordingly, we address the parties’ arguments and proposed constructions.

1. The Parties’ Arguments

In the Petition, Petitioner does not propose a construction for “switch,” but does assert that “[t]here is no need to construe the[] term[] for purposes of this IPR because . . . the prior art discloses the term[] under either Petitioner’s or Patent Owner’s proposed interpretations.” Pet. 29–30, n.2 (citing Ex. 1002 ¶¶ 62–63).

In the Patent Owner Response, Patent Owner notes that the U.S. District Court for the Western District of Texas (“Texas Court”) construed “switch” in the related litigation as “an electronic device for opening and closing a circuit as dictated by an independent control input.” PO Resp. 31; *see also id.* at 3–4 (citing Ex. 2011 (Document 61, Claim Construction Order), 2). Patent Owner contends that the difference between the parties’ constructions at the district court was the additional language proposed by Patent Owner, “as dictated by an independent control input,” which the district court adopted. *Id.* at 32 (citing Ex. 2011, 2). Patent Owner contends that “[a]ccording to the Specification, a control signal is transmitted to a switch from a source external to the switch, thereby making opening and closing a circuit dictated by an independent control input.” *Id.* at 32–34 (citing Ex. 1001, 41:9–14, 55:12–14, Fig. 54A). Patent Owner argues that “each disclosed embodiment in the ’108 patent depicts a switch with an independent control input (i.e., an input, an output, and a control).” *Id.* at 34 (citing Ex. 1001, 7:57–63; Figs. 28A, 29A, 30A, 31A, 32A, 33A, 54A,

57A–C). Patent Owner argues that we should adopt the Texas Court’s construction for the “switch” terms. *Id.*

Patent Owner notes that the U.S. District Court for the Middle District of Florida, Orlando Division (“Orlando Court”) also construed the term “switch” for claims of related U.S. Patent No. 6,091,940 (“the ’940 patent”), and also adopted Patent Owner’s proposed construction as a “device with an input and output that can take two states, open and closed, as dictated by an independent control input.” *Id.* (citing Ex. 2013 (Document 381, Claim Construction Order), 32).

Petitioner contests Patent Owner’s characterization of the Specification of the ’108 patent as well as Patent Owner’s construction of “switch.” *See* Pet. Reply 4–7. Petitioner contends that the term “switch” has a readily understood meaning in the art “as an electronic device for opening and closing a circuit.” *Id.* at 5 (citing Ex. 1036 (an IEEE Dictionary), 906; Ex. 1037 (a Webster Dictionary), 1354). Petitioner contends that the ’108 patent uses “switch” consistently with its widely understood meaning, referring to switches “opening and closing” and indicating that some switches might not be controlled by an electronic signal. *Id.* (citing Ex. 1001, 54:61–63, 7:60–61). In fact, Petitioner argues, nothing in the ’108 patent even refers to an “independent control input” let alone limits a switch to opening and closing as dictated by an independent control. *Id.* Petitioner points out that Patent Owner previously agreed to the same construction proposed by Petitioner here in a different prior litigation in the U.S. District Court for the Middle District of Florida, Jacksonville Division (“Jacksonville Court”) involving another related patent, U.S. Patent 9,118,528 (“the ’528 patent”). *Id.* (citing Ex. 1039 (Document 86-1, Joint-

Claim-Construction-Chart, 2 (“Agreed Upon Constructions”))). Petitioner further contends that no construction of “third switch” is necessary, but if we were to construe the term, we should reject Patent Owner’s “independent control input” language for the same reasons as argued for the term “switch.” *Id.* at 7.

In its Sur-reply, Patent Owner responds that “both the Orlando and Texas Courts have already considered and rejected the same arguments that [Petitioner] makes here seeking to exclude ‘as dictated by an independent control input.’” PO Sur-reply 2. Patent Owner additionally points out that more recently, the Texas Court appointed a Special Master to address claim construction in the related litigation and that the Special Master recommended construing “switch” consistent with the Texas Court’s prior constructions. *Id.* at 2 n.1 (citing *ParkerVision, Inc. v. TCL Indus. Holdings Co.*, No. 6:20-cv-00945-ADA, at Dkt. No. 49 (W.D. Tex. Oct. 29, 2021)). Patent Owner argues that *each* disclosed embodiment in the ’108 patent depicts a switch with an input, an output, and an independent control input. *Id.* at 3 (citing Ex. 1001, Figs. 28A, 29A, 30A, 31A, 32A, 33A, 54A, 57A–C). Patent Owner further contends that the passage of the ’108 patent Specification that Petitioner relies on has already been considered by the Orlando Court. *Id.* at 2–5 (citing Ex. 1001, 7:60–61; Ex. 2013, 30–32). Moreover, Patent Owner argues, reading Petitioner’s cited passage in context demonstrates that rather than suggesting that a switch is sometimes not controlled by an independent control input, that passage distinguishes the switch typically being controlled by an electronic signal as opposed to mechanical, electrical, optical or some other manner. *Id.* at 5. Patent Owner also asks us to ignore that it previously agreed, in the Jacksonville litigation,

to the same construction proposed by Petitioner here because the Orlando Court’s construction of the same term “came *after* this agreement,” and “a district court’s construction trumps any agreement the parties made in litigation.”⁷ *Id.* As for the term “third switch,” Patent Owner contends that the term “is straight-forward and does not require a construction other than ‘switch.’” *Id.* at 6.

Patent Owner also argues that it would be improper to rely on Petitioner’s extrinsic evidence in construing the “switch” terms because the extrinsic evidence is inconsistent with the disclosure of the ’108 patent. PO Sur-reply 4.

2. *Analysis*

We begin by noting that the Texas Court has construed the terms “switch” and “third switch” recited in claim 1 of the ’108 patent. *See* Ex. 1026, 5. As set forth in 37 C.F.R. § 42.100(b), we consider “[a]ny prior claim construction determination concerning a term of the claim in a civil action . . . that is timely made of record.” We have done so to the extent possible on the record before us. In particular, the district court’s claim construction is set forth in a chart format without providing the benefit of the court’s analysis as to how that construction was determined. The lack of explanation is particularly of note here because the district court did not expressly address the parties’ dispute as to whether a diode is a type of switch with an independent control input—a dispute similar to the one

⁷ The agreed construction was filed in the Jacksonville Court on January 5, 2018 and relates to the “switch” term in the ’528 patent, while the Orlando Court entered its claim construction order on April 29, 2020 and construes the “switch” and “switch module” terms in the related ’940 patent. *See* Ex. 1039, 2; Ex. 2013, 58.

before us. *See* Ex. 1040, 12 (discussing the parties' argument to the court). Moreover, the term "third switch" is used differently in claim 1 as compared to claim 12 of the '108 patent. *See* Ex. 1001, 65:54–55, 66:37–39 (claim 1 recites a third switch connected to an antenna while claim 12 recites a third switch used to up-convert the signal). The court, however, construed the terms to have their plain and ordinary meaning, and then decided that the plain and ordinary meaning of "switch" is "an electronic device for opening and closing a circuit as dictated by an independent control input." As reflected in the chart below, reproduced from the chart included in the district court's decision, the court's decision recites the two parties' proposed constructions and the court's final construction of the terms.

Term	Patent Owner's Proposed Construction	Petitioner's Proposed Construction	District Court's Final Construction
“switch” '108 patent, claim 1 ⁸	“an electronic device for opening and closing a circuit <i>as dictated by an independent control input</i> ”	“an electronic device for opening and closing a circuit”	Plain-and-ordinary meaning wherein the plain-and-ordinary meaning is “an electronic device for opening and closing a circuit <i>as dictated by an independent control input</i> ”
“third switch” '108 patent, claim 1	Plain and ordinary meaning, or “switch” as construed by the Court in Case No. 6:20-cv-108	“a switch controlling whether the antenna transmits said signal”	“Switch”: Plain-and-ordinary meaning wherein the plain-and-ordinary meaning is “an electronic device for opening and closing a circuit <i>as dictated by an independent control input</i> ”

See Ex. 1026, 5, 15 (emphases added).⁹ We are therefore deprived of the court’s reasoned analysis that resulted in the court’s construction of the term “switch” and “third switch.”¹⁰

The Orlando Court’s decision in adopting Patent Owner’s proposed construction for claims of the ’940 patent is based primarily on the fact that the defendant in that case, Qualcomm Inc. (“Qualcomm”), had previously

⁸ The court’s decision lists claims of other patents in this portion of the chart that are not at issue in this proceeding and therefore have been omitted from the chart above.

“agreed with the construction of ‘switch/switch module’ . . . advanced by [Patent Owner].” Ex. 2013, 31. The court’s analysis in arriving at its construction is provided below:

Qualcomm’s current argument is largely limited to their reference to the ’940 patent at 7:54–60, where the patent provides that “typically” a switch is controlled by an electronic or electrical input. The Court agrees with ParkerVision, however, that the embodiments and teachings of the patent as a whole support Plaintiff’s construction of “switch/switching module.”

Ex. 2013, 32.¹¹ The Orlando Court adopted Patent Owner’s proposed construction in that case as a “device with an input and output that can take two states, open and closed, as dictated by an independent control input.”

Id. Aside from the court’s statement above agreeing with Patent Owner that the teachings of the patent support Patent Owner’s construction, we do not

⁹ The Special Master’s recommendation to the Texas Court that Patent Owner relies on also includes nothing more than the claim construction set forth in a chart format similar to the district court’s decision. *See ParkerVision, Inc. v. TCL Indus. Holdings Co.*, No. 6:20-cv-00945-ADA, Dkt. No. 49 (W.D. Tex. Oct. 29, 2021)).

¹⁰ At the oral hearing, Patent Owner noted that “[t]here were several claim construction hearings,” but did not point us to any reasoning that the court may have provided at any of those hearings. *See* Tr. 35:8–16. The transcripts available on the docket in the Texas cases do not address the construction of the term “switch.” *See generally ParkerVision, Inc. v. Intel Corp.*, No. 6:20-cv-00108-ADA, Dkt. 77 (W.D. Tex. Jan. 29, 2021); *ParkerVision, Inc. v. Intel Corp.*, No. 6:20-cv-00562-ADA, Dkts. 57, 63 (W.D. Tex. June 27, 2021, Aug. 8, 2021).

¹¹ Although Patent Owner argues that “the Orlando Court provided a detailed written opinion,” most of that opinion lays out the parties’ arguments to the court, the procedural history of the claim construction dispute, the Board’s prior construction of the claim terms, and the claim construction standard employed by the Board in the *inter partes* review. *See* Ex. 2013, 24–32.

have before us the court’s reasoned analysis that may have resulted in the court’s decision to adopt that construction. We do, however, consider both courts’ construction as we analyze the meaning of “switch” based on the complete record before us. *See* 37 C.F.R. § 42.100(b).

As part of its discussion, the Orlando Court noted that the Board previously construed the terms “switch” and “switch module” in claims of the ’940 patent to mean a “device with an input and output that can take two states, open and closed.” Ex. 2013, 25 (citing *Qualcomm Inc. v. ParkerVision, Inc.*, IPR2015-01829, Paper 30 at 7 (PTAB Mar. 7, 2017)). In that *inter partes* review, Patent Owner agreed with the Board’s construction from the institution decision. *See* IPR2015-01829, Paper 30 at 7. As the Orlando Court pointed out, the Board’s construction was based on the broadest reasonable interpretation of the claims, and Patent Owner did not appeal the Board’s construction to the U.S. Court of Appeals for the Federal Circuit. Ex. 2013, 25 (citing *ParkerVision v. Qualcomm*, 903 F.3d 1354, 1358 (Fed. Cir. 2018)).

As reflected in the arguments above, Patent Owner’s proposed construction in this proceeding matches the Texas Court’s final construction in the related litigation. Petitioner too presents the same construction here that it proposed in the related litigation. The parties’ proposed constructions in this proceeding are reflected in the chart below.

Term	Patent Owner’s Proposed Construction	Petitioner’s Proposed Construction
“switch”	“an electronic device for opening and closing a circuit as dictated by an independent control input”	“an electronic device for opening and closing a circuit”

See, e.g., PO Resp. 31 (emphasis altered), 34; Pet. Reply 5. The parties make the same arguments regarding the term “third switch.” PO Resp. 31; Pet. Reply 7.

We begin with the language of claim 1, which does not expressly require an independent control input for every switch. Claim 1, as reproduced above, is directed to “[a] frequency conversion module, comprising: a first switch configured to up-convert a signal based on a control signal and a bias signal.” Ex. 1001, 65:49–51. Claim 1, therefore, recites a *control signal* that up-converts another signal by controlling the first switch that is configured to perform the up-conversion. *Id.* On the other hand, claim 1 does not recite a control signal in relation to the operation performed by the second switch and the third switch. *Id.* at 65:52–53. The same is true for claim 12, which instead recites that the third switch is used to up-convert a signal based on a *control signal*. *Id.* at 66:31–39. The claims therefore suggest that the patentees understood how to recite a control signal to the switch when the patentees intended to do so, but did not add an independent control input requirement to any of the switches.

We now turn to the Specification of the ’108 patent. The Specification includes a section titled “Terminology.” Ex. 1001, 7:22–9:46. This section provides lexicographic definitions of numerous terms used in the ’108 patent. Among the terms defined therein is the phrase “control a switch”:

Control a switch: Causing a switch to open and close. The switch may be, without limitation, mechanical, electrical, electronic, optical, etc., or any combination thereof. Typically, it is controlled by an electrical or electronic input. If the switch is

controlled by an electronic signal, it is typically a different signal than the signals connected to either terminal of the switch.

Id. at 7:57–64. We find this paragraph of critical importance to understanding the patentees’ intended meaning of the term “switch” and walk through each sentence.

The first sentence of this paragraph defines the phrase “[c]ontrol a switch” as “[c]ausing a switch to open and close.” This aspect is not in dispute.

The second sentence of this paragraph provides examples of different types of switches, expressly states that the examples are “without limitation,” and states that “[t]he switch may be” “mechanical, electrical, electronic, optical, etc. or any combination thereof.” This aspect also is not in dispute as the parties agree that, in the context of the claims, the switch is an “electronic device.”

The third sentence refers back to “the switch” just described in the second sentence using the pronoun “it” and specifically states that “[t]ypically” the type of input that may control the switch is “an electrical or electronic input.” This sentence is important at least because the patentees chose to describe these control inputs as “typically.” The use of “typically,” in this context, is non-limiting. In other words, the ’108 patent expressly leaves open the option that the described switch may be controlled with an input that is not electrical or electronic.

The fourth, and final, sentence of this paragraph is critical. It specifically states that “[i]f the switch is controlled by an electronic signal, it is typically a different signal than the signals connected to either terminal of the switch.” This sentence is significant for several reasons. First, by stating “*if* the switch is controlled by an electronic signal” (emphasis added),

the Specification reaffirms that the switch *may* be controlled by an input that is not an electronic signal. Second, reading the sentence as a whole, it states that “[i]f the switch is controlled by an electronic signal, it is *typically* a different signal than the signals connected to either terminal of the switch” (emphasis added). To clarify, a signal that is different than the signals connected to either terminal of the switch is what the parties refer to as “an independent control signal.” Thus, the fourth sentence, in the context of the parties’ dispute, means that *if* the switch is controlled by an electronic signal, it is *typically* an independent control signal. The same meaning of “typically” applies here, i.e., it is non-limiting. Thus, if the first part of the sentence that provides the conditional clause (if) is met, i.e., the switch is controlled by an electronic signal, the electronic signal is *not always* an independent control signal because typically does not require always.

Putting the discussion above into context, particularly in comparison to the construction advocated by Patent Owner, it is important to recognize that the lexicographic definition *does not require* a switch to be “dictated by an independent control input” because the definition specifically says that if the switch is controlled by an electronic control signal it is *typically* a different signal (i.e., an independent signal). Thus, Patent Owner’s proposed construction seeks to *limit* the term “switch” to what is expressly stated in the Specification as *typical*.

Patent Owner argues that the fourth sentence of the definition “merely refers to the switch typically being controlled by an electronic signal as *opposed to mechanical, electrical, optical or some other manner*.” PO Sur-reply 5. According to Patent Owner, “[t]he passage does not say that the switch is sometimes not controlled by an independent control input. The

fact remains that an independent control input is always controlling the switch.” *Id.* We agree with Patent Owner that the passage does not *expressly* say “the switch is sometimes not controlled by an independent control input.” But, that is not what Petitioner contends nor does it resolve the issue before us. As noted above, the passage states that if the switch is controlled by an electronic signal it is typically a different signal (i.e., an independent signal). That is, that the control input need not *always* be “independent,” in the manner that Patent Owner’s proposed construction mandates. *See Praxair, Inc. v. ATMI, Inc.*, 543 F.3d 1306, 1323 (Fed. Cir. 2008) (“the word ‘typically’ . . . impl[ies] that the passage describes only the most common embodiment rather than the full scope of the invention”). If the patentees wanted to limit the term “switch” to require an independent control input, the description provided in the “terminology” section of the Specification would have made that clear.¹² Ex. 1001, 7:57. For the reasons explained above, however, the description does not. Therefore, we do not agree with Patent Owner that “switch” should be *limited* to require “an independent control input.”

Patent Owner further argues that *each* disclosed embodiment in the ’108 patent depicts a switch with an input, an output, and an independent control input. PO Sur-reply 3 (citing Ex. 1001, Figs. 28A, 29A, 30A, 31A, 32A, 33A, 54A, 57A–C). But the ’108 patent Specification “does not describe the invention as limited to embodiments having” an independent

¹² Additionally, the terminology section states that “[e]ach description in this section is provided for illustrative and convenience purposes only, and is *not limiting*.” Ex. 1001, 7:24–25 (emphasis added). Yet, Patent Owner urges us to limit the “switch” even beyond the definition and description provided in the Specification. We decline to do so.

control input. *See Liebel-Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 906–08 (Fed. Cir. 2004) (rejecting the argument that when “the subject matter claimed in the patent-in-suit is the only subject matter described . . . that subject matter is the invention, and not simply a ‘preferred embodiment’ of a broader invention”); *i4i Ltd. v. Microsoft Corp.*, 598 F.3d 831, 843–44 (Fed. Cir. 2010) (“[A] claim is not limited to the embodiments described in the specification unless the patentee has demonstrated a clear intention to limit the claim’s scope with words or expressions of manifest exclusion or restriction.”). In fact, the ’108 patent Specification does not even refer to an “independent control input,” and discusses switches only as opening and closing. *See, e.g.*, Ex. 1001, 54:61–63 (“As a result of the switch opening and closing, a down converted signal 5409 is generated.”). Given the ’108 patent’s description of how a switch is controlled (*id.* at 7:57–64), we find no “clear intention to limit the claim’s scope.”¹³ *See i4i*, 598 F.3d at 843–44.

Turning to extrinsic evidence, we note that Dr. Steer agrees with Patent Owner’s proposed construction, whereas Dr. van der Weide does not offer an opinion on the meaning of the term “switch.” Specifically, Dr. Steer testifies that the Texas Court’s “construction is correct and accurately captures the meaning of ‘switch’ as understood by a [person of ordinary skill in the art (‘POSITA’)].” *See* Ex. 2022 ¶ 166. Although we have considered Dr. Steer’s testimony, we find it “less significant than the intrinsic record in determining the legally operative meaning of” the term

¹³ Patent Owner has not pointed us to any aspect of the prosecution history of the ’108 patent that supports interpreting the claim term as proposed by Patent Owner. *See* PO Resp. 31–34; PO Sur-reply 1–6.

“switch.” *Phillips*, 415 F.3d at 1317 (internal quotations and citations omitted). In particular, we are cognizant of the Federal Circuit’s guidance that we “should discount any expert testimony that is clearly at odds with the claim construction mandated by . . . the written description.” *Id.* at 1318 (internal quotation and citation omitted). In this instance, we find that Dr. Steer’s testimony is clearly at odds with the description of switch provided in the ’108 patent because that description does not require that the operation of a switch *always* be “dictated by an independent control input.” Moreover, other extrinsic evidence, such as dictionary definitions offered by Petitioner, supports that the widely understood meaning of the term switch was a device for opening and closing a circuit. *See* Pet. Reply 5 (citing Ex. 1036 (IEEE Standard Dictionary of Electrical and Electronics Terms (3d ed. 1984)) (defining “switch” as “[a] device designed to close or open, or both, one or more electric circuits”)); Ex. 1037 (Webster’s New World Dictionary of Computing (3d ed. 1988) (defining “switch” as “a device used to open, close, or divert an electric circuit”))).

We also find it relevant that at some point during the district court litigations, Patent Owner itself agreed to Petitioner’s proposed construction. Patent Owner argues that the Orlando Court’s later construction of the term “trumps any agreement the parties made in litigation.” PO Sur-reply 5. Patent Owner’s argument, however, misses the point. Although the court’s construction is binding on the parties before the court, it does not alter the fact that Patent Owner, at one point, independently understood Petitioner’s proposed construction to be the proper construction of the term.

Based on our review of the complete record before us, including the intrinsic and extrinsic evidence, we determine that one of ordinary skill in

the art would understand “switch” to mean “an electronic device for opening and closing a circuit.” With that construction of the term “switch,” we do not find it necessary to further construe the term “third switch.”

D. Overview of the Asserted Prior Art

1. Downey (Ex. 1003)

Downey is titled “Transceiver with Rapid Mode Switching Capability” and describes a need for “a lightweight, compact and inexpensive [radio frequency (“RF”)] transceiver that can switch rapidly from the receive mode to the transmit mode.” Ex. 1003, code (54), 1:51–54. To that end, Downey’s transceiver “achieves a fast switching time between transmit and receive mode by leaving the transmit oscillator on all the time,” which “eliminates the start up time of up to about five milliseconds.” *Id.* at 1:61–65. The transmit oscillator operates “at one third the transmit frequency followed by a frequency tripler/filter/amplifier chain that can be quickly switched on and off.” *Id.* at 1:68–2:6 (explaining that “only the third harmonic of the oscillator falls into the sensitive receive frequency band”).

Figure 1 of Downey is reproduced below.

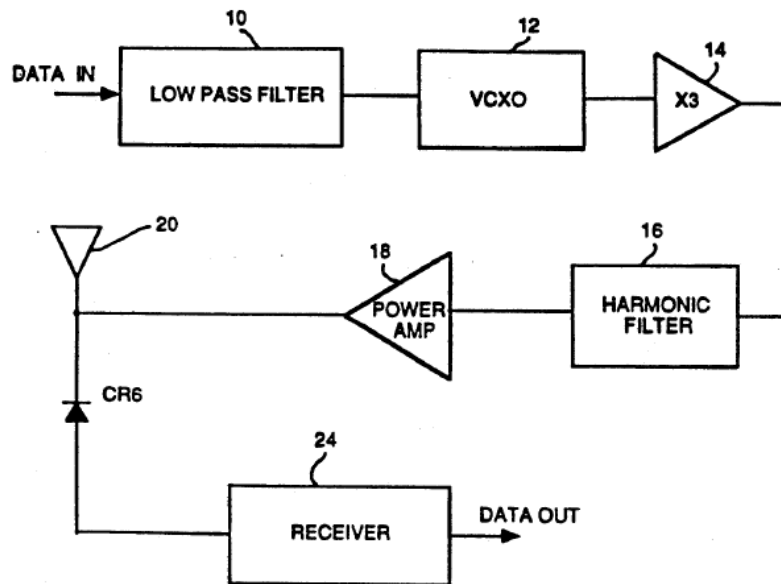


FIG. 1

Figure 1 shows a block diagram of an embodiment of Downey's transceiver. *Id.* at 2:25–26, 2:53–54. Digital data “is asserted at low pass filter 10 where high frequency components of the data bit stream are removed prior to modulation of an RF signal.” *Id.* at 2:54–60. “The output of low pass filter 10 is asserted at voltage controlled crystal oscillator (VCXO) 12, which frequency modulates the oscillator's RF signal.” *Id.* at 2:60–62. “VCXO 12 operates at a fundamental frequency that is one third of the transceiver's communication frequency.” *Id.* at 2:64–66. “The modulated RF output of VCXO 12 is asserted at frequency tripler 14 where harmonics, particularly the third harmonic, of the crystal oscillator signal are generated.” *Id.* at 2:67–3:2. “The output of frequency tripler 14 is asserted at harmonic filter 16 which selectively passes the third harmonic (at the communication frequency of the transceiver).” *Id.* at 3:2–5. “The RF signal from harmonic

filter 16 is asserted at power amplifier 18 where the signal power is boosted to a level sufficient for transmission.” *Id.* at 3:5–7. “The signal from power amplifier 18 is coupled to antenna 20 which radiates the transmit signal.” *Id.* at 3:8–10.

Figure 2c of Downey is reproduced below.

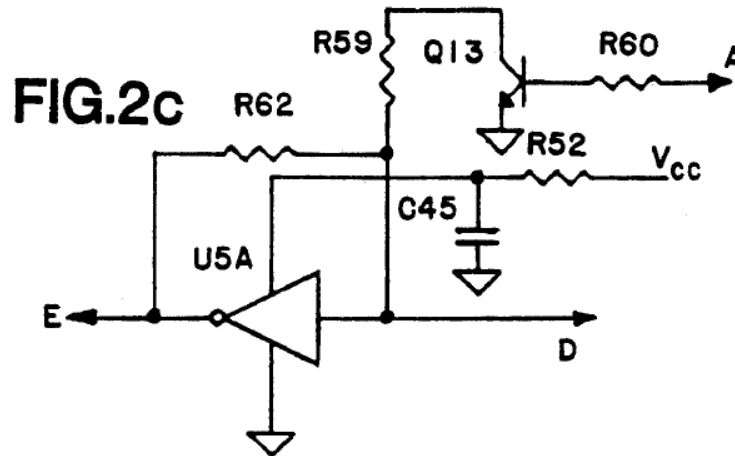


Figure 2c shows a frequency tripler circuit for Downey’s transceiver. *Id.* at 2:33–34, 4:8–9. “The output of VCXO 12 (signal D) is asserted at the input of inverter U5A.” *Id.* at 4:9–10. Inverter U5A outputs “harmonics of the input signal, particularly the third harmonic which will drive the RF power amplifier.” *Id.* at 4:10–13. “The input of inverter U5A is grounded through transistor Q13 in the receive mode . . . thereby preventing the generation of any harmonics of VCXO 12 during the receive mode.” *Id.* at 4:15–19.

2. Sedra (Ex. 1004)

Sedra is titled “Microelectronic Circuits,” and is a book “intended as a text for the core courses in electronic circuits taught to majors in electrical and computer engineering.” Ex. 1004, v (Preface). The objective of the book is “to develop in the reader the ability to analyze and design electronic circuits, both analog and digital, discrete and integrated.” *Id.* Sedra discusses

“some basic concepts that underlie the design and specification of logic gate circuits.” *Id.* at 908.

A portion of Figure 13.2 of Sedra is reproduced below.

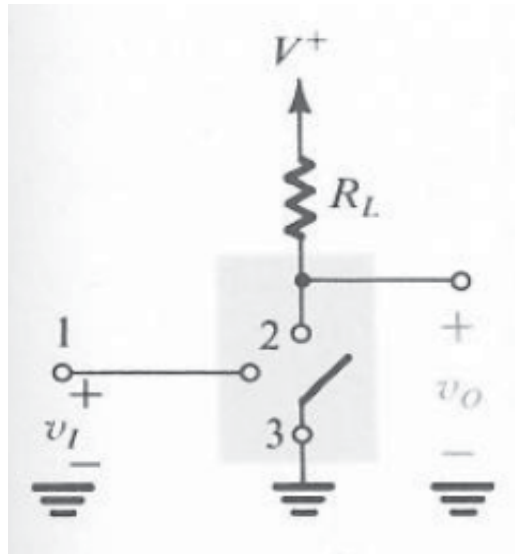


Figure 13.2 is “[a] conceptual representation of the logic inverter.” *Id.* at 909. Sedra explains that “[t]he logic inverter is basically a voltage-controlled switch such as that represented schematically in Fig[ure] 13.2.” *Id.* at 908. Sedra further explains that “[p]ractical implementations of a logic inverter utilize a transistor (a [metal–oxide–semiconductor field-effect transistor (MOSFET)] or a [bipolar junction transistor (BJT)]) as the switching element and a resistor or another transistor for the load resistor R_L .” *Id.* at 909.

3. *Hahnel (Ex. 1005)*

Hahnel is titled “Frequency Multiplier Circuit,” and relates to “a frequency multiplier where a high degree of multiplication is desired at a prescribed frequency.” Ex. 1005, 1:4, 1:18–21. Hahnel describes a circuit with “a source of fundamental frequency voltage and a pulse shaper responsive to the fundamental frequency voltage and adapted to produce

gating pulses having a repetition frequency equal to the fundamental frequency.” *Id.* at 1:59–63.

Figure 1 of Hahnel is reproduced below.

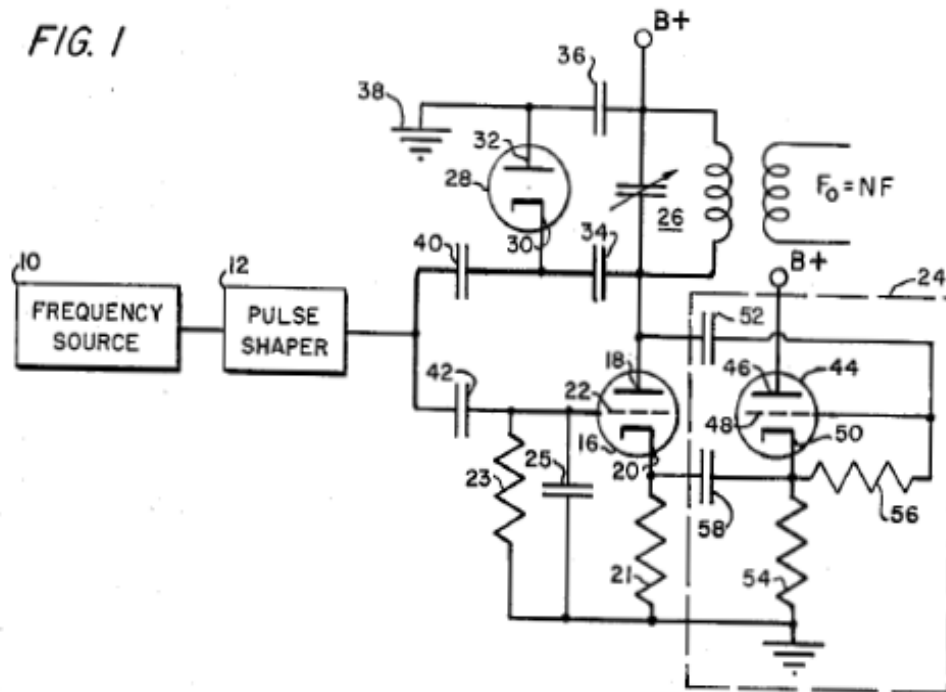


Figure 1 illustrates a schematic representation of Hahnel’s circuit. *Id.* at 2:19–20. Hahnel’s circuit includes “a source [10] of frequency voltage F which may comprise any suitable oscillator designed to produce a stable frequency output.” *Id.* at 2:24–26. “The output of frequency source 10 is applied to pulse shaper 12 for producing a substantially square-shaped voltage wave.” *Id.* at 2:26–28. “The square-wave output of pulse shaper 12 controls the duration of the period of oscillation of a harmonic frequency generator,” comprising other components of the circuit shown in Figure 1. *Id.* at 2:43–48.

E. Obviousness of Claims 1 and 12 over Downey and Sedra

Petitioner contends that claims 1 and 12 are unpatentable as obvious over the combination of Downey and Sedra. Pet. 41–67, 84–85. To support its contentions, Petitioner provides, among other things, explanations as to how the prior art teaches each claim limitation. *Id.* Petitioner also relies upon Dr. van der Weide’s testimony (Exs. 1002, 1035) to support its positions. *Id.*

Patent Owner argues that Petitioner’s proposed obviousness combination fails to teach each of the three “switch” limitations recited in claims 1 and 12. PO Resp. 46–49. On the complete record, we are persuaded by Petitioner’s explanations and evidence in support of the obviousness ground for claims 1 and 12 over Downey and Sedra. We address below the evidence, analysis, and arguments presented by the parties.

1. Independent Claim 1

a) Element [1Preamble]: “A frequency conversion module, comprising”

Petitioner contends that, to the extent the preamble is limiting, Downey teaches the preamble because Downey discloses a frequency conversion module. Pet. 41. In particular, Petitioner contends that “Downey discloses a transceiver that up-converts the frequency of the modulating oscillating control signal from the VCXO by using a ‘frequency tripler’ that triples the frequency of the signal.” *Id.* (citing Ex. 1003, 1:67–2:10, 2:60–3:5, 3:53–57, 4:9–13, 4:20–25, Figs. 1, 2a–2e; Ex. 1002 ¶¶ 77–78). Patent Owner does not present arguments as to the preamble. *See generally* PO Resp. Based on the entirety of the record and for the reasons explained by Petitioner, we determine that, to the extent the preamble is limiting,

Petitioner has proved by a preponderance of the evidence that the asserted prior art teaches the preamble.

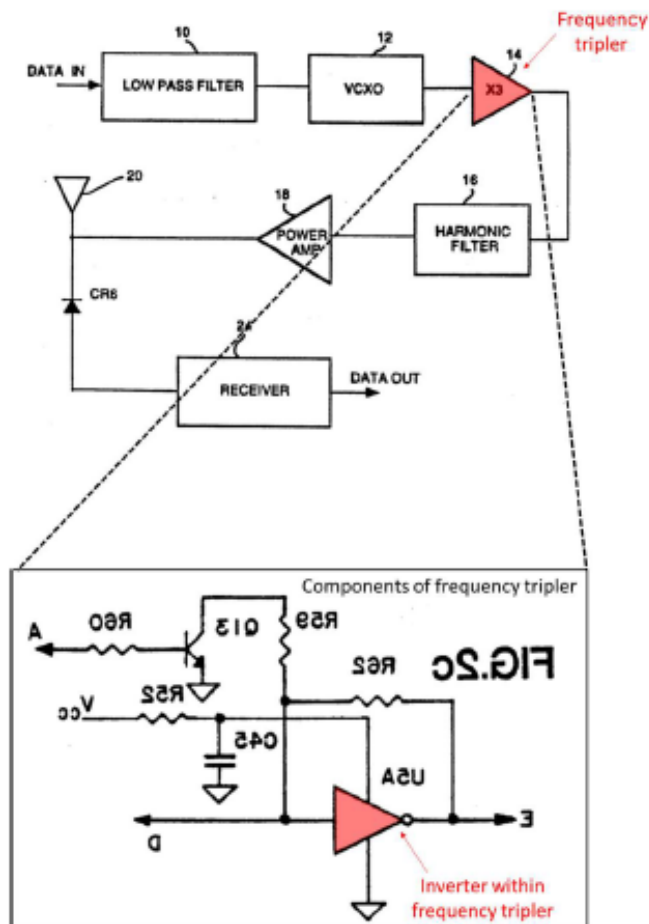
b) Element [1A]: “a first switch configured to up-convert a signal based on a control signal and a bias signal”

Petitioner contends that Downey in view of Sedra teaches this limitation. Pet. 41.

(1) “a first switch configured to up-convert a signal”

Petitioner contends that Downey’s frequency tripler 14 includes an inverter U5A that up-converts a modulated signal from voltage controlled crystal oscillator (VCXO) 12. Pet. 41–45 (citing Ex. 1002 ¶¶ 79–86). Petitioner contends that in Downey’s system, an information signal is routed through a low pass filter 10 and output to VCXO 12. *Id.* at 42 (citing Ex. 1003, 2:54–61, Fig. 1). Petitioner further contends that the VCXO operates at a frequency that is one-third of the frequency of the signal ultimately transmitted. *Id.* at 42–43 (citing Ex. 1003, 2:64–66, 3:54–56; Ex. 1002 ¶ 81). The modulated oscillating signal supplied to frequency tripler 14 from the VCXO thus has a frequency of 16.628 MHz. *Id.* at 43–44 (citing Ex. 1002 ¶ 83). Petitioner contends frequency tripler 14 “creates a harmonically rich signal that includes the third harmonic (with a frequency of 49.885 MHz (3 x 16.628 MHz)) of the modulated oscillating signal.” *Id.* at 44 (citing Ex. 1003, 2:66–3:2; Ex. 1002 ¶ 84). Petitioner contends this tripling of the modulated oscillating signal amounts to an up-conversion of the modulated oscillating signal to the desired output communications frequency. *Id.* at 44–45 (citing Ex. 1003, 2:64–66, 3:54–56; Ex. 1002 ¶ 85).

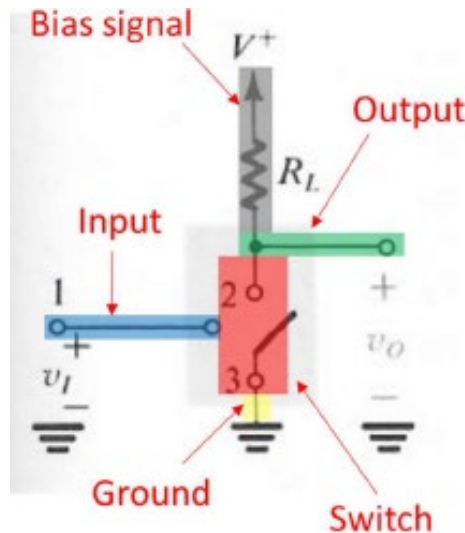
Petitioner further contends Downey in view of Sedra teaches up-converting a signal with a switch. *Id.* at 45. Petitioner's annotated version of Figures 1 and 2c of Downey are reproduced below.



Id. Figure 2c is a schematic diagram of Downey's frequency tripler circuit (Ex. 1003, 2:32–34), which Petitioner has rotated and combined with Figure 1 of Downey, providing annotations (in red) to show that Downey's frequency tripler 14 includes inverter U5A. Pet. 45–46 (citing Ex. 1003, 4:8–13). Petitioner contends that the inverter “is the component that up-converts the modulated oscillating signal to the third harmonic.” *Id.* Petitioner further contends that “[i]t was well-known in the art that an

inverter is a switch,” and that “Sedra expressly discloses that an inverter is ‘basically a . . . switch.’” *Id.* at 46 (citing Ex. 1004, 908–09; Ex. 1002 ¶ 87).

Petitioner’s annotated version of Figure 13.2 of Sedra is reproduced below.



Id. at 48. Figure 13.2 of Sedra (above) includes Petitioner’s annotations showing Sedra’s inverter switch (red) with one terminal connected to a bias signal (grey) and another to ground (yellow). *Id.* at 48–49 (citing Ex. 1004, 908–10; Ex. 1002 ¶ 91). Petitioner contends that “Sedra explains that an inverter includes a switch, such as a transistor, that opens and closes to either allow signals to pass or prevent them from doing so—just like the switch of the ’108 patent.” *Id.* at 49–50 (citing Ex. 1001, 33:33–55, 55:12–20; Ex. 1004, 908–10; Ex. 1002 ¶ 92).

(2) Rationale to Combine Downey and Sedra

Petitioner contends that “a POSITA would have been motivated to combine Sedra with Downey. Specifically, a POSITA would have been motivated to use Sedra to design the inverter of Downey and would have had a reasonable expectation of success of doing so.” Pet. 50 (citing Ex. 1002 ¶ 93). Petitioner contends that “both Sedra and Downey describe the use of

inverters in signal processing” (*id.* (citing Ex. 1003, 4:10–13; Ex. 1004, 1, 911, 930; Ex. 1002 ¶ 94)), and “Sedra provides the additional details of the structure of Downey’s inverter,” i.e., it “shows the components and structure to use in such an inverter” (*id.* (citing Ex. 1004, 908–09; Ex. 1002 ¶ 95)), and also “discloses benefits of using a switch within the inverter in a system like Downey” (*id.* at 51). In particular, with respect to Sedra’s alleged benefits, Petitioner contends that one of Downey’s goals “is to provide a compact transceiver” and Sedra “accomplishes this goal because switching elements—such as [metal–oxide–semiconductor (MOS)] transistors—are small and energy efficient.” *Id.* (citing Ex. 1003, 1:51–52; Ex. 1004, 906). Petitioner further contends that using Sedra’s switch to design Downey’s inverter would thus yield predictable benefits and result in an improved inverter that can be used to process signals for transmission. *Id.* at 51–52 (citing Ex. 1002 ¶ 96).

Petitioner argues that a person of ordinary skill in the art would have had a reasonable expectation of success combining Downey with Sedra because the “combination is simply the application of known techniques to a known device,” and given Sedra’s disclosure, “a POSITA would have had a roadmap of how to construct the inverter of Downey—specifically, by using the switch disclosed in Sedra within the inverter of Downey.” *Id.* at 52 (citing Ex. 1002 ¶ 97).

(3) Patent Owner’s Response

Patent Owner argues that “[i]nverter U5A in the frequency tripler circuit of Downey is not configured as a switch, nor can it be without rendering the circuit unsuitable for its intended purpose.” PO Resp. 48. Patent Owner argues that “inverter U5A is not toggled between an open and

closed state, but instead is configured to operate as a ‘non-linear amplifier.’” *Id.* at 48–49 (citing Ex. 1003, 4:10–13; Ex. 2022 ¶ 197). According to Patent Owner, a person of ordinary skill in the art would have understood that “a [complementary metal-oxide semiconductor (‘CMOS’)] inverter with appropriate feedback ensures that the transistor operates [in] its active region (i.e., it is always ON/conducting current).”¹⁴ *Id.* at 49 (citing Ex. 1003, Fig. 2c; Ex. 2021; Ex. 2022 ¶ 198). Patent Owner contends such a configuration “is essential to the operation of Downey’s ‘frequency tripler’ circuit that uses the nonlinear function to ‘develop harmonics of the input signal, particularly the third harmonic.’” *Id.* (citing Ex. 1003, 4:10–13). Patent Owner argues that there is no teaching, suggestion, or motivation in Downey to use an inverter as a switch for up-conversion nor would it have been obvious or inherent to a person of ordinary skill in the art to modify the inverter in Downey (which operates as a non-linear amplifier) to operate as a completely different device—a switch. *Id.* at 50 (citing Ex. 2022 ¶ 199).

As to Petitioner’s proposed combination of Downey and Sedra, Patent Owner contends that “[i]mplementing the transistor of Sedra with the inverter of Downey would not change the operation of Downey’s frequency tripler circuit,” and “one would have to ignore all of the disclosure in Downey, and abandon all of the teachings and suggestions of Downey,” using hindsight to modify Downey to arrive at the claimed invention. PO Resp. 49–50 (citing Ex. 2022 ¶ 200).

¹⁴ Downey’s disclosed circuit component for U5A inverter is “74HC04” (*see* Ex. 1001, 5:21), and Patent Owner relies on an Application Note from Fairchild Semiconductors titled “CMOS Linear Applications,” which discusses a MM74C04 inverter. *See* Ex. 2021; Ex. 2022 ¶ 198.

(4) Petitioner's Reply

Petitioner responds that although Downey discloses an inverter for performing up-conversion, the Petition also relies on the combination of Downey and Sedra, “which specifically describes an inverter like Downey’s . . . and states that an ‘inverter is basically a voltage-controlled switch.’” Pet. Reply 8–9 (citing Ex. 1004, 908; Ex. 1030 ¶¶ 5–6). Petitioner asserts that Patent Owner’s arguments ignore Sedra’s disclosure. *Id.* at 9. Petitioner contends that “Sedra’s inverter has the same configuration as the ‘first switch’ disclosed in the ’108 patent—a fact that PO does not dispute.” *Id.* Petitioner asserts that “Downey in combination with Sedra thus plainly disclose the claimed ‘first switch.’” *Id.* at 10 (citing Ex. 1001, Fig. 28A; Ex. 1004, 908).

Petitioner further contends that Patent Owner is also wrong that Downey alone does not disclose the required switch because Patent Owner’s argument that a non-linear amplifier is different from a switch is based on “two demonstrably incorrect propositions: (1) an inverter cannot function as both a ‘switch’ and ‘amplifier’ at the same time; and (2) a ‘non-linear’ amplifier cannot be a switch.” Pet. Reply 10–11 (citing Ex. 1030 ¶ 9). Petitioner contends that basic engineering textbooks, including one authored by Dr. Steer, show that amplifiers and switches are not mutually exclusive components. Pet. Reply 11–12 (citing Ex. 1031, 116–22; Ex. 1035, 174; Ex. 1030 ¶¶ 11–12). Petitioner argues that “it is precisely the operation of Downey’s inverter as a non-linear amplifier—and the resulting square-wave waveform—that allows Downey to upconvert a signal as described in Downey (and in the ’108 patent).” *Id.* at 14–15 (citing Ex. 1003, 2:67–3:5, 4:10–13; Ex. 1030 ¶¶ 18–23); *see also id.* at 15–20 (explaining the

difference between linear and non-linear amplifiers) (citing Ex. 1004, 13, Fig. 1.11; Ex. 1030 ¶¶ 21–25).

(5) Patent Owner’s Sur-reply

In its Sur-reply, Patent Owner argues that Petitioner “ignores that there are *other* types of amplifiers that are a compromise between these two types of amplifiers,” such as those “that operate in an active region (linear/non-linear modes) without causing the amplifier to saturate.” PO Sur-reply 11 (citing Ex. 1031, 136; Ex. 1038, 146). Patent Owner further argues that “amplifiers, such as inverter U5A (part no. 74HC04) as configured in Downey, are never ‘purely linear’ and will always ‘exhibit harmonic content or other distortions.’” *Id.* (citing Ex. 2023, 107:18–110:22; Ex. 1032, 14–17). Patent Owner points to the voltage transfer characteristic of the MM74C045 inverter to argue that Downey’s inverter operates in both linear and non-linear modes. *Id.* at 12–13 (citing Ex. 2021, Fig. 1; Ex. 2023, 131:16–132:10, 132:11–24). Patent Owner asserts, without support, that “[b]ecause the amplifier operates in both linear and non-linear modes, it is sometimes referred to as a non-linear amplifier.” *Id.* at 13. Patent Owner further argues that a “pure non-linear amplifier can use transistors that operate in two discrete regions — saturation region and cut-off/pinch-off region.” *Id.* (citing Ex. 2022 ¶¶ 133–143). Patent Owner asserts that “a continuously-ON non-linear amplifier can use transistors that operate in the saturation region and triode/linear region.” *Id.* (citing Ex. 2022 ¶¶ 137–138). According to Patent Owner, “[i]nverter U5A in Downey is a continuously-ON non-linear amplifier,” and “does not operate as a pure non-linear amplifier.” *Id.* at 14.

As to Petitioner’s proposed combination of Downey and Sedra, Patent Owner argues that “implementing Downey’s inverter U5A with the transistor of Sedra would not change this operation.” PO Sur-reply 8 (citing PO Resp. 49). Patent Owner argues that “[u]nlike a switch, inverter U5A of Downey (implemented with the transistor of Sedra) is not opening a circuit.” *Id.* (citing PO Resp 48–49; Ex. 2022 ¶¶ 195–198).

(6) *Our Analysis*

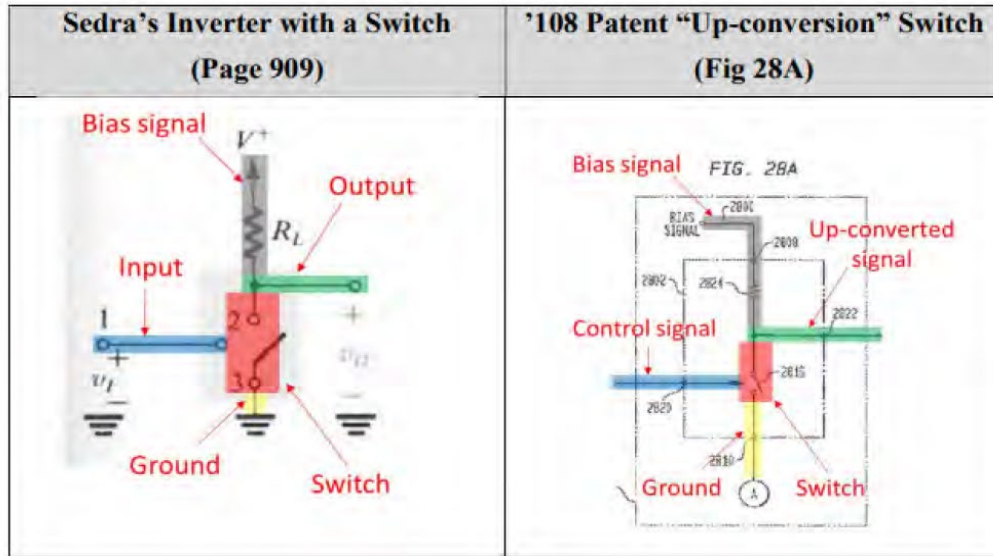
Having fully considered the parties’ arguments and evidence, we conclude that Petitioner has shown by a preponderance of the evidence that the combination of Downey and Sedra discloses this limitation.

Patent Owner’s arguments focus on Petitioner’s contention that Downey alone discloses this limitation. As discussed above, Patent Owner argues at length about why inverter U5A in Downey’s frequency tripler circuit is not configured as a switch and does not operate as a switch. Patent Owner’s arguments are based on the specific circuit components shown in Downey’s frequency tripler circuit and characteristics of the MM74C04 inverter. Patent Owner does not address Petitioner’s contention that the combination of Downey and Sedra also teaches this limitation, except to argue that Sedra’s inverter when combined with Downey “would not change the operation of Downey’s frequency tripler circuit,” and that a person of ordinary skill in the art “would have to ignore all of the disclosure in Downey, and abandon all of the teachings and suggestions of Downey” to combine the two references. PO Resp. 49–50. Patent Owner therefore does not meaningfully address Petitioner’s proposed combination. *See In re Mouttet*, 686 F.3d 1322, 1333 (Fed. Cir. 2012) (“the test for obviousness is what the combined teachings of the references would have suggested to

those having ordinary skill in the art”) (citing *In re Keller*, 642 F.2d 413, 425 (CCPA 1981)).

The claims require “a first *switch* configured to up-convert.” Sedra specifically discloses a *switch* used to implement an inverter, and also states that an “inverter is basically a voltage-controlled switch”—disclosure that Patent Owner does not dispute. See Ex. 1004, 908–09, Fig. 13.2. Patent Owner also does not dispute that Downey’s frequency tripler circuit includes an inverter that upconverts the input signal. Ex. 1003, 4:8–13. Patent Owner’s arguments are directed to the inverter U5A that operates as a non-linear amplifier, as disclosed in Downey. PO Resp. 46–50. Patent Owner specifically argues “[i]nverter U5A in the frequency tripler circuit of Downey is *not configured as a switch*, nor can it be without rendering the circuit unsuitable for its intended purpose.” PO Resp. 48. But Sedra’s inverter *is a switch*. Patent Owner does not explain why a switch-based inverter would not work in Downey to accomplish the up-conversion.

Petitioner offers persuasive evidence that Petitioner’s combined circuit not only meets the claim limitation, but also looks and functions similar to the one disclosed in the ’108 patent Specification. Petitioner’s comparison of Sedra’s inverter with the ’108 patent’s up-conversion switch is reproduced below.



Pet. Reply 10 (citing Ex. 1001, Fig. 28A; Ex. 1004, 908). Petitioner's comparison above shows Sedra's inverter alongside Figure 28A of the '108 patent, with annotations showing the various input and output signals to each of the switches. As shown in Petitioner's comparison of the two figures, Sedra's inverter has the same configuration as the switch corresponding to the claimed "first switch" in the '108 patent. Dr. van der Weide testifies that "[b]oth switch configurations include a transistor symbolized as an ideal switch (red), which opens and closes a circuit between the bias signal (gray) and ground (yellow)." Ex. 1030 ¶ 8 (citing Ex. 1002 ¶¶ 91–92). Dr. van der Weide further testifies that Sedra describes that "an inverter includes a switch, such as a MOSFET or BJT transistor, that closes to allow a signal to pass through it and opens to prevent signals from passing through it." Ex. 1002 ¶ 92 (citing Ex. 1004, 908–10). Dr. van der Weide testifies that "when the switch opens and closes, the output signal (green) fluctuates between 1V and 0V," and therefore, the output signal is a square wave. *Id.* Dr. van der Weide testifies that this is the same function as the switch of the '108 patent. *Id.* (citing Ex. 1001, 32:43–45, 33:33–55,

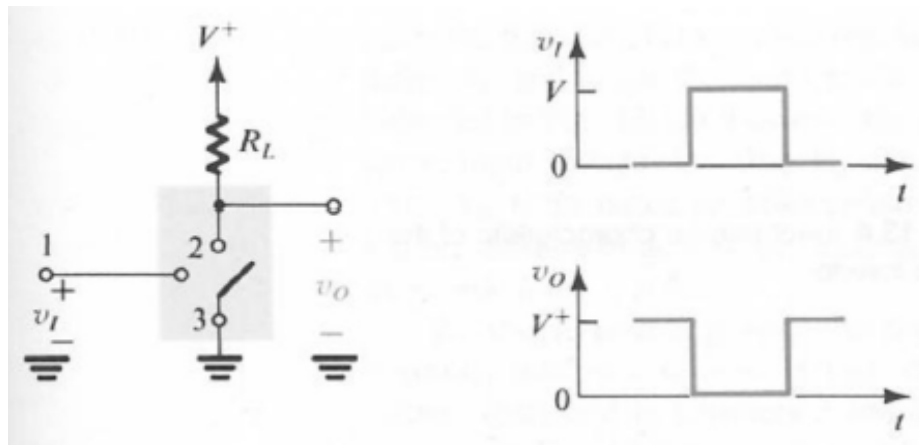
42:65–43:16, 55:12–20). We find Dr. van der Weide’s testimony persuasive because it is based on the disclosure of the ’108 patent and Sedra.

Petitioner also provides adequate reasons with rational underpinning as to why a person of ordinary skill in the art would have been motivated to combine the teachings of Downey and Sedra, including because Sedra accomplishes Downey’s goal of providing a compact transceiver by using small and energy efficient MOS transistors. Pet. 51–52 (citing Ex. 1003, 1:51–52; Ex. 1004, 906; Ex. 1002 ¶ 96). Sedra provides a roadmap of how to construct an inverter to be used in the circuit of Downey, and a person of ordinary skill in the art would thus have had a reasonable expectation of success in Petitioner’s proposed combination. *Id.* at 52 (citing Ex. 1002 ¶ 97). Dr. van der Weide testifies that an ordinarily skilled artisan would have understood from Sedra that a switch connected to a voltage supply through a resistor is an inverter and that “this circuit realizes the logic inversion operation,” allowing it to be used as an inverter in Downey’s circuit. *See* Ex. 1002 ¶ 97 (citing Ex. 1004, 908–09, Fig. 13.2). We credit Dr. van der Weide’s testimony because it is based on Sedra’s disclosure.

Patent Owner and Dr. Steer fail to address Petitioner’s arguments or Dr. van der Weide’s testimony on motivation to combine. *See* PO Resp. 49–50 (citing Ex. 2022 ¶ 200); PO Sur-reply 8–9 (citing PO Resp. 49). Instead, Patent Owner’s arguments focus on Downey’s disclosed inverter functioning as a non-linear amplifier and the related circuitry in Downey’s frequency tripler circuit. For example, Patent Owner argues that the inverter in Downey is a special type of non-linear amplifier that is always ON and is

therefore not a switch.¹⁵ See PO Resp. 48–50; PO Sur-reply 11–14. Patent Owner points to the existence of resistor R62 in Downey’s circuit to argue that a person of ordinary skill in the art would have considered inverter U5A “operates [in] its active region (i.e., it is always ON/conducting current).” PO Resp. 49 (citing Ex. 2022 ¶ 198; Ex. 2021).

Patent Owner does not however address why a person of ordinary skill in the art looking to use Sedra’s inverter to design Downey’s inverter would alter Sedra’s *switch* circuit to something else, or why the combined circuit would also have the same non-switch characteristics that Patent Owner contends render Downey’s inverter deficient in teaching this limitation. See Ex. 1004, 908–09. Figure 13.2 of Sedra is reproduced below.



Id. at 909. Figure 13.2 is “[a] conceptual representation of the logic inverter.” *Id.* Sedra discloses its inverter circuit operates as a switch that

¹⁵ Petitioner contends that a person of ordinary skill in the art would have understood that a non-linear amplifier is one that toggles between open and closed states. Pet. Reply 12–13 (citing Ex. 1033, 8 (“Non-linear amplifiers operate such that the transistor is saturated (‘fully-ON’) o[r] cut-off (‘fully-OFF’), no intermediate state”). Patent Owner contends that Downey’s inverter is a special non-linear amplifier that is continuously-ON. PO Sur-reply 13.

fluctuates between open and close positions depending on the input signal, and produces a square wave output signal that is the inverted form of the input signal. *Id.* at 908–09. Sedra explains that the inverter transfer characteristic of its inverter indicates that it is “a grossly nonlinear device,” which is consistent with the mode that Downey states its inverter should operate in. *Id.* at 911; Ex. 1003, 4:10–13. Downey states that it is the non-linear operation that allows Downey’s circuit to up-convert a signal and act as a frequency tripler. Ex. 1003, 4:10–13. It is therefore unclear why a person of ordinary skill in the art considering combining Sedra’s inverter with Downey’s circuit would alter the configuration of Sedra’s inverter from a mode that Downey states enables up-conversion to a different mode that Patent Owner alleges does not meet the claim limitation.¹⁶ *See* Ex. 1030 ¶¶ 13–16. Rather, we find it more likely, as argued by Petitioner and supported by Dr. van der Weide’s testimony, that an ordinarily skilled artisan would have understood from Sedra that a switch connected to a voltage supply through a resistor realizes the logic inversion operation, allowing it to be used as an inverter in Downey’s circuit just as it is disclosed in Sedra. Pet. 52 (citing Ex. 1002 ¶ 97).

Nor do we agree with Patent Owner’s argument that a person of ordinary skill in the art would have understood that the use of resistor R62 suggests that the U5A inverter is in continuously on mode. Petitioner cites an example of at least one other reference that discloses the use of a similar resistor configuration with an inverter where the output waveform represents

¹⁶ Notably, Patent Owner does not argue that the combined circuit would not accomplish the up-conversion. *See* PO Resp. 49 (arguing that “implementing the transistor of Sedra with the inverter of Downey would not change the operation of Downey’s frequency tripler circuit”).

the ON and OFF values indicating that the inverter turns on and off. *See* Ex. 1030 ¶ 27 (citing Ex. 1034, Fig. 4a.); Pet. Reply 18–20 n.6. To the extent Patent Owner argues that the presence of resistor R62 would have resulted in a continuously on state in the combined circuit with Sedra’s inverter, “the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference.” *In re Keller*, 642 F.2d at 425. “Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art.” *Id.* The presence of a feedback resistor in Downey’s circuit therefore does not undermine the combined teachings of Downey’s circuit with Sedra’s inverter.

Lastly, we reject Patent Owner’s argument that a sinusoidal input to Downey’s U5A inverter suggests that the inverter always stays on. *See* PO Sur-reply 14 n.6 (“unlike a switch, inverter U5A of Downey receives a sinusoidal input signal”); Tr. 54:7–20. We see no support in the record to find that a sinusoidal input signal prevents a switch from operating between on and off states; as Petitioner points out, Patent Owner’s position is at odds with the very disclosure of the ’108 patent. *See, e.g.*, Ex. 1001, 33:1–11 (explaining that the modulating input signal can be a sinusoidal wave, causing the switch to open and close); Tr. 64:7–65:3.

Fundamentally, Patent Owner does not explain how its arguments relating to Downey’s circuit would be applicable to Petitioner’s proposed combined circuit which in fact does utilize a “switch.” Patent Owner argues that “one would have to ignore all of the disclosure in Downey, and abandon all of the teachings and suggestions of Downey” to arrive at the combination

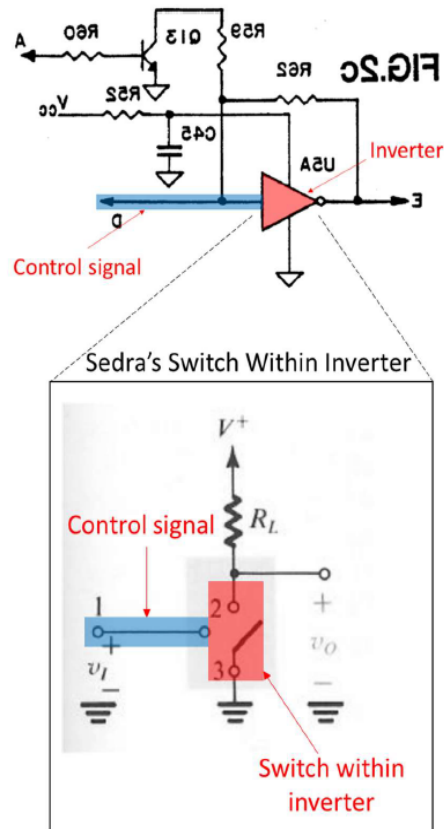
(PO Resp. 50), but we find no teachings in Downey that dissuade Petitioner's proposed combination.

We are therefore persuaded that a person of ordinary skill in the art would have been motivated to combine Downey and Sedra in the manner proposed by Petitioner and would have had a reasonable expectation of success for the combination. We are therefore persuaded that the combination of Downey and Sedra teaches this limitation.

(7) *“based on a control signal and a bias signal”*

Petitioner contends that Downey teaches using a control signal and a bias signal to up-convert a signal with a switch. Pet. 52 (citing Ex. 1002 ¶ 98). In particular, Petitioner contends that “the modulated oscillating signal from [Downey's] VCXO 12 controls the switch within the inverter of Downey and Sedra—just like the control signal from the '108 patent's VCO controls the switch.” *Id.* at 54 (citing Ex. 1003, 3:53–54, 4:8–10, 4:16–19, Fig. 2c; Ex. 1004, 908).

Petitioner's annotated versions of Figure 2c of Downey and Figure 13.2 of Sedra are reproduced below.



Id. at 55. Figure 2c is a schematic diagram of Downey's frequency tripler circuit (Ex. 1002, 2:12–14), which Petitioner has rotated and combined with Figure 13.2 of Sedra to show a control signal (blue) applied to Sedra's switch (red) shown as being within Downey's frequency tripler's inverter. *Id.* (citing Ex. 1002 ¶ 101).

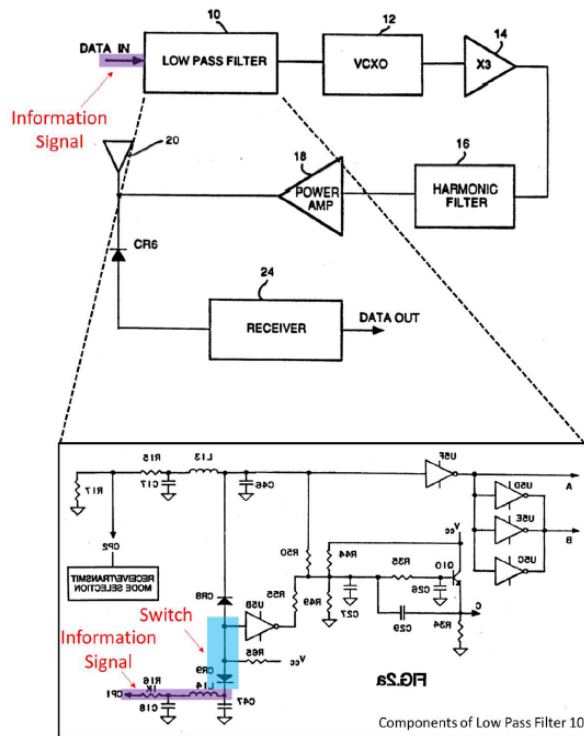
Petitioner contends that Downey's signal V_{CC} teaches a bias signal. *Id.* at 56 (citing Ex. 1003, 3:30–31). Petitioner contends that "the control and bias signals of Downey in view of Sedra operate the same way as the signals of the '108 patent," that is, "[t]he control signal causes Downey's inverter (implemented with Sedra's switch) to open and close," and "[w]hen

the switch is open, the switch outputs the bias signal voltage V_{CC} .” *Id.* at 58–59 (citing Ex. 1001, 55:12–20; Ex. 1003, 4:8–19; Ex. 1002 ¶ 104).

Patent Owner does not present arguments as to this limitation. *See generally* PO Resp. Based on the entirety of the record and for the reasons explained by Petitioner, we determine that Petitioner has proved by a preponderance of the evidence that the asserted prior art teaches this claim limitation.

c) *Element [1B]: “wherein said signal are routed to said frequency conversion module via a second switch, and”*

Petitioner contends that Downey teaches this limitation. Pet. 59–61. Petitioner’s annotated version of Figures 1 and 2a of Downey are reproduced below.



Id. at 60. Figure 2a is a schematic diagram of Downey’s low pass filter circuit (Ex. 1003, 2:27–27), which Petitioner has rotated and combined with Figure 1 of Downey to argue that “Downey discloses diode CR9 (second

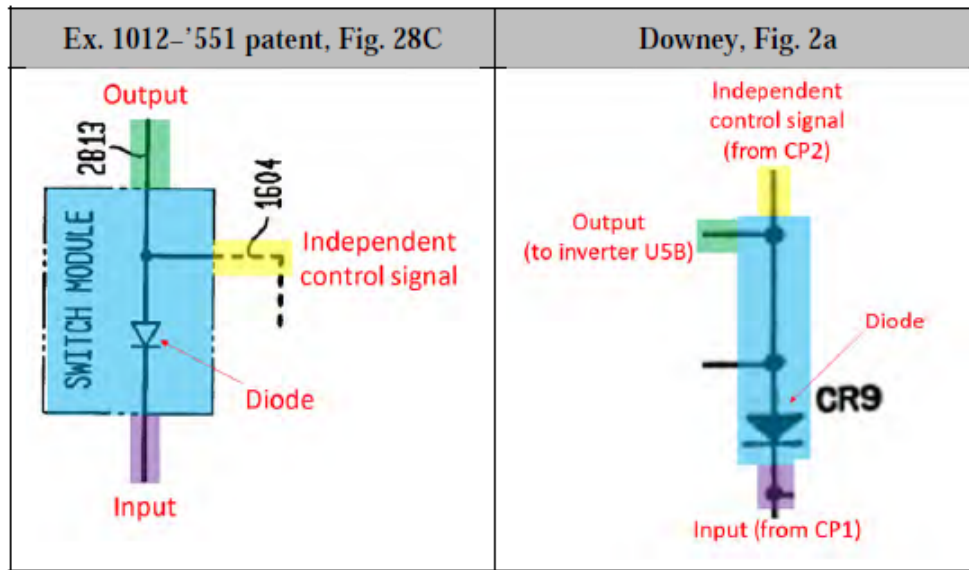
switch (light blue)) that routes the input data to be up-converted to the VCXO via a low pass filter.” *Id.* at 59–60 (citing Ex. 1003, 3:19–52, Figs. 1, 2a; Ex. 1002 ¶ 105). Petitioner further contends “[t]he ’108 patent specifically refers to diodes as switches.” *Id.* at 61 (citing Ex. 1001, 33:60–61; Ex. 1012, Figs. 28C–28D, 56:26–33; Ex. 1002 ¶ 106).

Patent Owner responds that Downey’s diode CR9 is not a switch because it is not “an electronic device for opening and closing a circuit *as dictated by an independent control input.*” PO Resp. 51 (citing Ex. 2022 ¶ 202). Patent Owner asserts that the ’108 patent does not refer to a diode as switch, but instead refers to a “diode ring” as a switch, and person of ordinary skill in the art would have understood the two to be different. *Id.* (citing Ex. 2022 ¶ 203).

In its Reply, Petitioner argues that Patent Owner’s argument that CR9 is not a switch is based on Patent Owner’s improper construction of “switch,” requiring an “independent control input.” Pet. Reply 21. Petitioner argues that Downey discloses, with reference to Figure 2a (reproduced above), that when the receive/transmit signal CP2 is high, the transceiver is in transmit mode, and diode CR9 allows the information signal CP1 to pass through to inverter U5B, and when CP2 is low, diode CR9 prevents information signal CP1 from passing through. *Id.* at 22–21 (citing Ex. 1003, 3:27–30, Fig. 2a; Ex. 1030 ¶¶ 30–36).

Moreover, Petitioner asserts that, in the parallel litigation, Patent Owner has argued that various diodes with similar configuration as Downey’s, disclosed in U.S. Patent No. 6,061,551 (“the ’551 patent”), which is incorporated by reference in the ’108 patent, meet the “switch” limitation. Pet. Reply 24–27 (citing Ex. 1040, 12–13; Ex. 1012, 56:60–62,

Figs. 28A–C; Ex. 1030 ¶¶ 39–40). Petitioner’s comparison of Figure 28C from the ’551 patent and Figure 2a from Downey is reproduced below.



Pet. Reply 26. Petitioner’s annotations show the various inputs and outputs to the diode shown in each of the two figures in support of Petitioner’s argument that Downey’s diode CR9 has the same structure in all relevant respects as the “diode switch” in Figure 28C of the ’551 patent. *Id.* at 25–26. Petitioner contends that Patent Owner’s argument that Downey’s diode CR9 is not a “switch,” thus directly contradicts both the ’108 patent’s disclosure and Patent Owner’s representations in district court. *Id.* at 27.

In its Sur-reply, Patent Owner argues that Downey’s diode CR9 does not receive an independent control input because diode CR8 prevents signal CP2 from reaching CR9. PO Sur-reply 19–22. According to Patent Owner, diode CR8 in Downey’s circuit makes the configuration different than the one shown in Figure 28C of the ’551 patent. *Id.* at 22–23. Patent Owner also seeks to distinguish arguments that it made to the district court by arguing that Patent Owner never stated to the court that a diode by itself is a “switch,” but instead represented to the court that the module containing the

diode is the switch. *Id.* at 23–25. Patent Owner argues, for the first time, that diode CR9 is not a switch because “a diode (similar to a one-way valve) only allows current to flow in one direction,” and is therefore not closing a circuit. *Id.* at 18; Tr. 60:6–13.

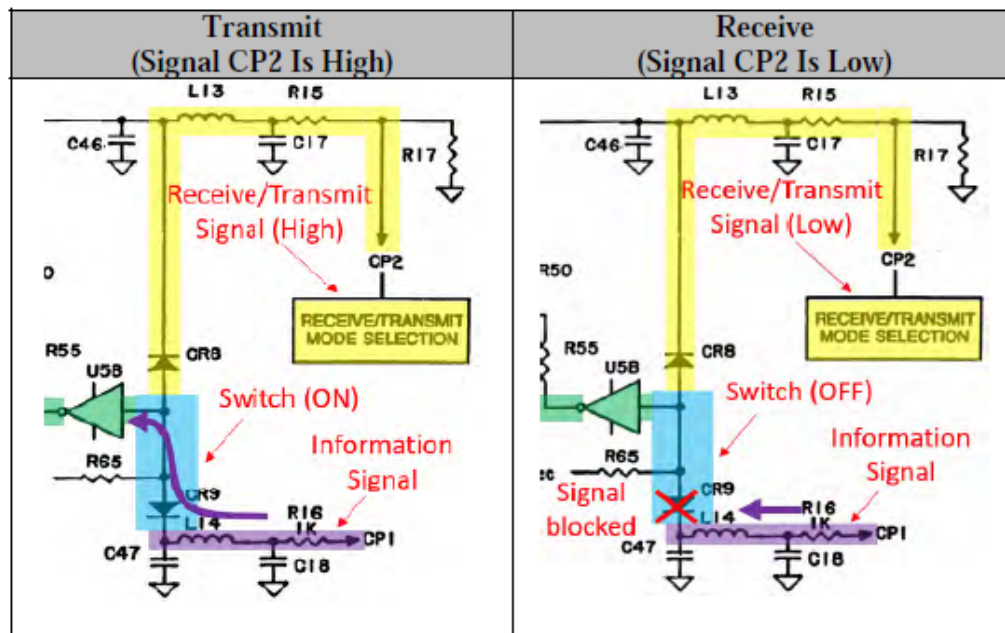
To begin, we agree with Petitioner that the arguments asserted in Patent Owner’s Response, and Dr. Steer’s testimony in support thereof, are entirely dependent upon Patent Owner’s proposed construction of “switch,” which we do not adopt.

We consider Patent Owner’s new argument raised in Patent Owner’s Sur-reply (PO Sur-reply 18) to be untimely. *See NuVasive*, 842 F.3d at 1380–81 (holding that the patent owner waived arguments that were not raised in its response after institution); Paper 13, 8 (“Patent Owner is cautioned that any arguments not raised in the response may be deemed waived.”). Even if not waived, we find no evidentiary support for Patent Owner’s requirement that a switch has to permit *bidirectional current* flow in order to be in a closed state. PO Sur-reply 18 (citing PO Resp. 21). As a threshold matter, Patent Owner’s proposed construction for the term “switch” does not require such bidirectional current flow. Further, Patent Owner fails to offer any support for such a requirement. Patent Owner’s citation to its own Patent Owner Response refers to a discussion of FETs used in a switching system, not to the claimed “second switch.” *See* PO Resp. 21 (citing Ex. 2022 ¶ 146). Even in that context, Dr. Steer’s cited testimony is merely that “a FET used as a switch has two states – either ON (closed) or OFF (opened); allowing all current through or preventing current from flowing.” Ex. 2022 ¶ 146. Patent Owner’s argument that the claimed “switch” requires permitting *bidirectional* current flow in a closed state is

therefore entirely unsupported. On the contrary, Dr. Steer himself testifies that “[i]n circuits, information can be conveyed either as charge, voltage, or current,” and that “a voltage signal refers to information that is almost entirely conveyed as a voltage.” Ex. 2022 ¶¶ 14–15 n.3, 42. Dr. Steer’s testimony supports that a switch may open and close a circuit for a voltage signal, not just a current signal or for bidirectional flow.

Patent Owner’s argument also lacks support because, as Petitioner points out, Patent Owner has previously argued and Dr. Steer has explained in his textbook, that diodes, at least in certain configurations, operate as switches. *See* Pet. Reply 24–27 (citing Ex. 1040, 12–13; Ex. 1038, 174–75). Patent Owner’s arguments distinguishing these prior statements as relating to different circuit configurations are based on differences that are immaterial to Petitioner’s contentions. *See* PO Sur-reply 18 n.9 (seeking to distinguish diodes from PIN diodes) (citing Ex. 1038, 178), 22–25 (referring to diodes disclosed in the ’551 patent as “rectifiers” in order to distinguish them from diodes).

Petitioner's annotated versions of Figure 2a of Downey are reproduced below.



Pet. Reply 22. Petitioner's annotations of Figure 2a show Petitioner's argument that Downey's diode CR9 (highlighted in blue) opens and closes a circuit between inverter U5B (highlighted in green) and CP1 (highlighted in purple). *Id.* at 21–24. Downey discloses that the “input data stream is conditioned . . . and is applied to the input of inverter USB through diode CR9. Diode CR9 is forward biased by V_{cc} applied through resistor R65.” Ex. 1003, 3:27–31 (emphasis added). In view of Downey's disclosure, Dr. van der Weide testifies that “based on whether receive/transmit signal CP2 is high or low, diode CR9 either closes the circuit from CP1 to the inverter (allowing information signal CP1 to be applied to the inverter (green) through the diode CR9) or opens that circuit (preventing information signal CP1 from being applied to the inverter (green) through the diode CR9).” Ex. 1030 ¶ 37 (citing Ex. 1003, 3:27–30). He further testifies as to how CR9 allows information signal CP1 to be applied to the input of

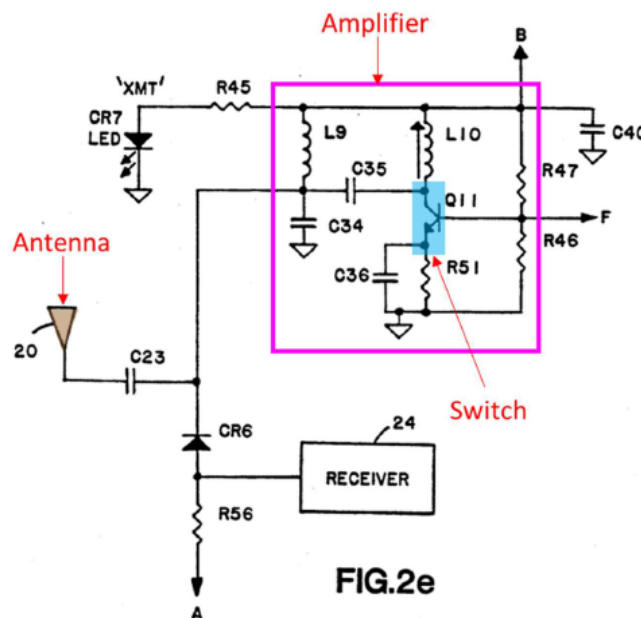
inverter U5B in the transmit mode. *See id.* ¶¶ 32–36. We credit Dr. van der Weide’s testimony because it is consistent with Downey’s disclosure of how its circuit operates.

Based on the full record before us, we find Petitioner’s argument and evidence persuasive to show that Downey’s diode CR9 teaches the recited “second switch” because Petitioner establishes sufficiently that Downey’s diode CR9 is “an electronic device for opening and closing a circuit.”

Accordingly, we find that Downey teaches or suggests this limitation.

d) Element [1C]: “wherein said signal is transmitted by an antenna connected to a third switch”

Petitioner contends that Downey teaches this limitation. Pet. 61 (citing Ex. 1002 ¶ 102). Petitioner’s annotated version of Figure 2e of Downey is reproduced below.

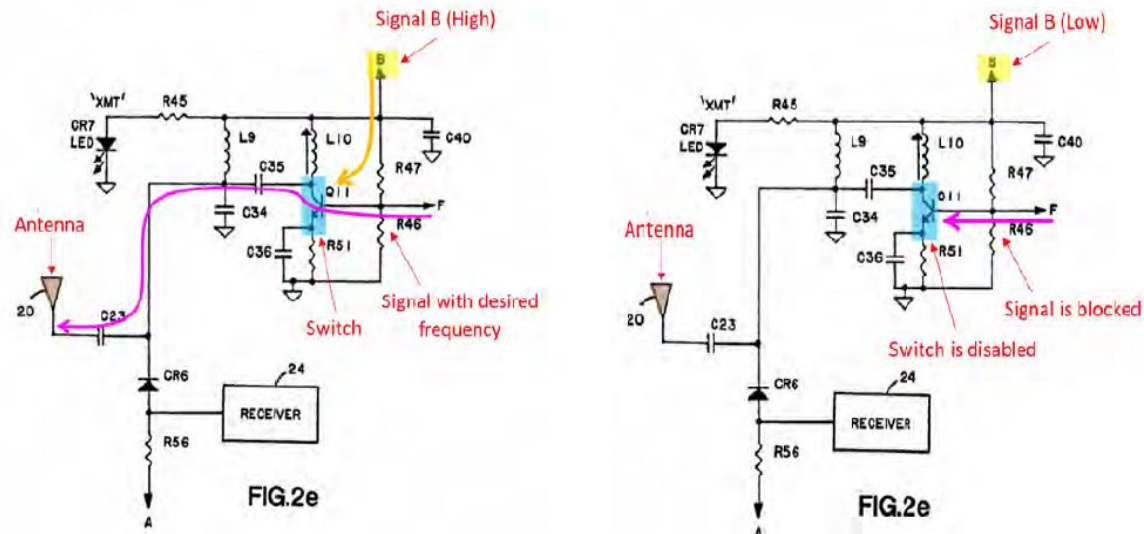


Id. at 64. Figure 2e is a schematic diagram of Downey’s power amplifier circuit (Ex. 1003, 2:37–38), which Petitioner has annotated to identify an amplifier, a switch (Q11), and an antenna (numeral 20). *Id.* (citing Ex. 1002 ¶ 112). Petitioner contends that Downey’s “amplifier includes a third

switch—transistor Q11 (light blue . . .)—that controls whether the antenna (brown) transmits the signal.” *Id.* at 63 (citing Ex. 1003, 4:33–35, Fig. 2e; Ex. 1002 ¶ 112). Petitioner contends that “[w]hen the Downey transceiver is in the ‘transmit mode,’ current is supplied to the switch (transistor Q11), which permits the desired harmonic to be amplified and supplied to antenna 20.” *Id.* at 64–65 (citing Ex. 1003, 3:46–52, 4:35–37; Ex. 1002 ¶ 113).

Patent Owner responds that “the proper construction of ‘switch’ is [‘]an electronic device for opening and closing a circuit as dictated by an independent control input,”” and transistor Q11 in Downey is not toggled between an open and closed state, but instead is configured to operate as a “power amplifier,” providing gain. PO Resp. 52–54 (citing Ex. 1003, 3:5–8; Ex. 2022 ¶¶ 207–209).

In its Reply, Petitioner asserts that Patent Owner’s argument that Q11 is not a switch is based on Patent Owner’s characterization of Signal B as a fixed supply voltage. Pet. Reply 27–29 (citing PO Resp. 43, 53). Petitioner contends that “Signal B is a version of the receive/transmit signal CP2 transmitted from low pass filter 10 (shown in Figure 2a),” and selectively supplies power to Q11 based on whether CP2 is high or low. *Id.* at 29 (citing Ex. 1003, 3:38–52, 4:33–42; Ex. 1030 ¶¶ 47–54). Petitioner’s annotated versions of Figure 2e of Downey are reproduced below.



Pet. Reply 30–31. Petitioner annotates Figure 2e of Downey separately to show how Downey’s circuit operates when Signal B is high and when Signal B is low. *Id.* (citing Ex. 1003, Fig. 2e; Ex. 1030 ¶¶ 47–54). Petitioner contends that depending on the state of Signal B, transistor Q11 either passes or blocks Signal F, which is the up-converted signal to be transmitted. *Id.* at 30. Petitioner contends that when Signal B is high, transistor Q11 closes the circuit between Signal F and the antenna, allowing Signal F to be amplified by transistor Q11 and transmitted by the antenna, and when Signal B is low, transistor Q11 opens the circuit between signal F and the antenna, preventing Signal F from passing through the circuit to the antenna. *Id.* Moreover, Petitioner further contends that a person of ordinary skill in the art would have understood that when Signal B is high, transistor Q11 would act as a switching amplifier by opening and closing a circuit (the circuit between inductor L10 and resistor R51) based on the value of Signal F. *Id.* at 31–32 (citing Ex. 1031, 116, 153; Ex. 1030 ¶¶ 55–58).

Patent Owner responds that transistor Q11 is only operational when the Downey transceiver is in the transmit mode, and “[i]n this mode, transistor Q11 provides gain (i.e., amplifies a signal) . . . and, thus, is

configured to operate as a ‘power amplifier.’” PO Sur-reply 25–26 (citing Ex. 1003, 3:5–8; Ex. 2022 ¶ 207). Patent Owner contends that when the circuit is non-operational, i.e., when Signal B is low, transistor Q11 is still a power amplifier but is not working. *Id.* at 26. According to Patent Owner, “[w]hether the circuit is operational or non-operational does not change the fundamental nature of transistor Q11 as being configured as a power amplifier (i.e., it does not turn an amplifier into a switch).” *Id.*

We agree with Petitioner that Patent Owner confuses Petitioner’s contentions. Pet. Reply 31 (citing PO Resp. 53). By considering the operation of transistor Q11 in the transmit mode *only*, i.e., when Signal B is high, Patent Owner ignores Petitioner’s contention that in receive mode (when Signal B is low), transistor Q11 is off, and those two states, Petitioner contends, demonstrate that Q11 functions as a switch. *Id.*; *see also* Tr. 29:18–30:5 (providing a light switch analogy).

Dr. van der Weide testifies that Signal B corresponds to the receive/transmit signal CP2, which is generated within the low pass filter 10 portion of the transceiver. Ex. 1030 ¶¶ 49–51 (citing Ex. 1003, Fig. 2a).

Dr. van der Weide further testifies that

Since Signal B selectively supplies power to the power amplifier, it dictates whether transistor Q11 opens or closes a circuit to pass Signal F, which is the up-converted signal to be transmitted via the antenna. That is, in transmit mode, Signal B is high and transistor Q11 closes a circuit, allowing signal F to pass to the antenna. In receive mode, Signal B is low and transistor Q11 is opens a circuit and prevents signal F from passing to the antenna.

Id. ¶ 52 (citing Ex. 1003, 3:38–52, 4:33–42); *see also id.* ¶¶ 53, 54 (annotating Downey’s Fig. 2e showing signal F when Signal B is high and when Signal B is low). Dr. van der Weide’s testimony is consistent with Downey’s disclosure.

We are also persuaded by Petitioner’s argument that transistor Q11 functions as a “switching amplifier.” Pet. Reply 28. Patent Owner asserts transistor Q11 is configured as an amplifier, and therefore, cannot also be configured as a switch. PO Resp. 52–53. Dr. Steer testifies in support of Patent Owner’s argument that “unlike a transistor used as a switch, transistor Q11 provides gain.” See Ex. 2022 ¶¶ 205–207. As Petitioner points out, Dr. Steer’s textbook, on the other hand, makes clear that amplifiers and switches are not mutually exclusive. See Pet. Reply 11–12 (citing Ex. 1031, 116–22; Ex. 1035, 174). For example, Dr. Steer explains in his textbook that “a switching amplifier is ideally either fully on or fully off,” i.e., functions as a switch. See Ex. 1031, 119. Dr. Steer further explains that “[t]he main concept of the Class D [switching] amplifier is using the transistor as a switch.”¹⁷ *Id.*

Dr. van der Weide persuasively testifies that a person of ordinary skill in the art would have understood “that a given device (such as the transistor in an inverter) can and typically does act as both a switch and an amplifier,” and a person of ordinary skill in the art “would have been aware of specific, well-known examples of transistors used for both functions.” Ex. 1030 ¶ 11 (citing Ex. 1031, 116–22; Ex. 1035, 174).

In light of the discussion above, including Dr. van der Weide’s testimony, we agree with Petitioner that transistor Q11 functions as a switch

¹⁷ Patent Owner contends that Petitioner’s reliance on Dr. Steer’s textbook is improper as it was published well after the priority date of the ’108 patent. PO Sur-reply 16. We consider Dr. Steer’s textbook not as prior art, but instead as impeachment evidence for Dr. Steer’s testimony, which testimony is the only evidentiary support for Patent Owner’s argument that an amplifier cannot also function as a switch. See Pet. Reply 11 (refuting Dr. Steer’s testimony with Dr. Steer’s textbook).

in Downey’s power amplifier circuit, and based on the full record before us, we find Petitioner’s argument and evidence persuasive to show that Downey’s transistor Q11 teaches the recited “third switch.”¹⁸ Accordingly, we find that Downey teaches or suggests this limitation.

2. *Independent Claim 12*

Petitioner contends that “claim 12 has substantially the same scope as claim 1 but is the ‘method version’ of claim 1,” and relies on its arguments directed to claim 1.¹⁹ Pet. 84–85 (citing 1002 ¶ 145). Patent Owner does not present separate arguments as to claim 12. *See* PO Resp. 46 n.8 (“[Patent Owner’s] analysis of claim 1 of the ’108 patent similarly applies to claim 12.”). Based on the entirety of the record and for the reasons explained by Petitioner, we determine that Petitioner has proved by a preponderance of the evidence that the asserted prior art teaches the claim limitations recited in claim 12.

3. *Weighing the Graham Factors*

“Once all relevant facts are found, the ultimate legal determination [of obviousness] involves the weighing of the fact findings to conclude whether the claimed combination would have been obvious to an ordinary artisan.”

Arctic Cat Inc. v. Bombardier Recreational Prods. Inc., 876 F.3d 1350, 1361

¹⁸ To the extent Patent Owner’s arguments are based on its proposed construction of the term “switch” (PO Resp. 52; Tr. 41:4–9), we do not adopt that construction and, thus, for this additional reason, we do not agree with those arguments.

¹⁹ Petitioner notes that “claim 12 has essentially the same limitations as claim 1, except that the ‘first switch’ routes the signal to the antenna,” and is “a switch controlling whether the antenna transmits said signal.” Pet. 61 n.6; *see also* PO Resp. 46 n.8 (agreeing that “claim 12 also recites a first and third switch, but their roles are reversed from claim 1”).

(Fed. Cir. 2017). On balance, considering the record before us, Petitioner has shown, by a preponderance of the evidence, that the combination of Downey and Sedra would have rendered the subject matter of claims 1 and 12 obvious to one of ordinary skill in the art at the time of the invention.

F. Obviousness of Dependent Claims 6–9 and 17–20 over Downey, Sedra, and Hahnel

Petitioner contends that claims 6–9 and 17–20 are unpatentable as obvious over Downey, Sedra, and Hahnel. Pet. 67–85. Patent Owner argues that Petitioner’s proposed obviousness combination fails to provide an adequate rationale to combine Downey and Hahnel given the differences between Downey’s circuit and that of Hahnel. PO Resp. 45–49. On the complete record, we are persuaded by Petitioner’s explanations and evidence in support of the obviousness ground for claims 6–9 and 17–20 over the combination of Downey, Sedra, and Hahnel. We address below the evidence, analysis, and arguments presented by the parties.

1. Claim 6

Claim 6 depends from claim 1 and additionally recites “a pulse shaper; and an oscillating signal generator.” Ex. 1001, 66:13–14. Petitioner contends that Downey in view of Sedra and Hahnel renders claim 6 obvious. Pet. 67.

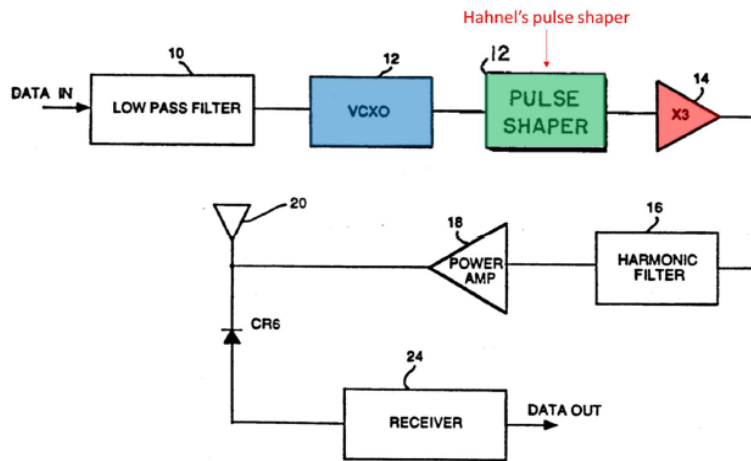
a) “a pulse shaper”

Petitioner contends that Hahnel discloses the claimed “pulse shaper.” *Id.* at 70 (citing Ex. 1002 ¶¶ 124–125). Petitioner contends that the pulse shaper in Hahnel receives an oscillating signal and shapes that signal into a string of pulses. *Id.* at 72–73 (citing Ex. 1005, 2:23–29, Figs. 2C, 2D; Ex. 1002 ¶¶ 126–128).

b) Rationale to Combine Downey and Hahnel

Petitioner contends that a person of ordinary skill in the art would have been motivated to combine Hahnel's pulse shaper with Downey's system. *Id.* at 76 (citing Ex. 1002 ¶ 133). Specifically, Petitioner contends that both Downey and Hahnel "describe techniques to increase, or multiply, the frequency of a signal" and "Hahnel describes the benefit of using a pulse shaper in systems such as Downey," which require additional time or steps to produce an up-converted signal with sufficient amplitude without a pulse shaper. *Id.* at 76–77 (citing Ex. 1003, 2:9–11; Ex. 1005, 1:18–39; Ex. 1002 ¶ 134). Petitioner argues that combining Downey with Hahnel to use a pulse shaper in Downey's system would solve these problems yielding predictable benefits. *Id.* at 77 (citing Ex. 1002 ¶ 135). Petitioner contends that a person of ordinary skill in the art would have had a reasonable expectation of success combining Downey with Hahnel because Hahnel shows how to combine the references by "instruct[ing] that the pulse shaper should be positioned between the oscillator and frequency multiplier." *Id.* at 77–78 (citing Ex. 1005, Fig. 1; Ex. 1002 ¶ 136).

Figure 1 of Downey, as modified and annotated by Petitioner, is reproduced below.



Id. at 79. Petitioner’s modified Figure 1 shows Petitioner’s proposal to add Hahnel’s pulse shaper (green) to Downey between oscillator 12 (blue) and frequency multiplier 14 (red). *Id.* at 78–79 (citing Ex. 1002 ¶ 137).

(1) Patent Owner’s Arguments on Motivation to Combine Downey and Hahnel

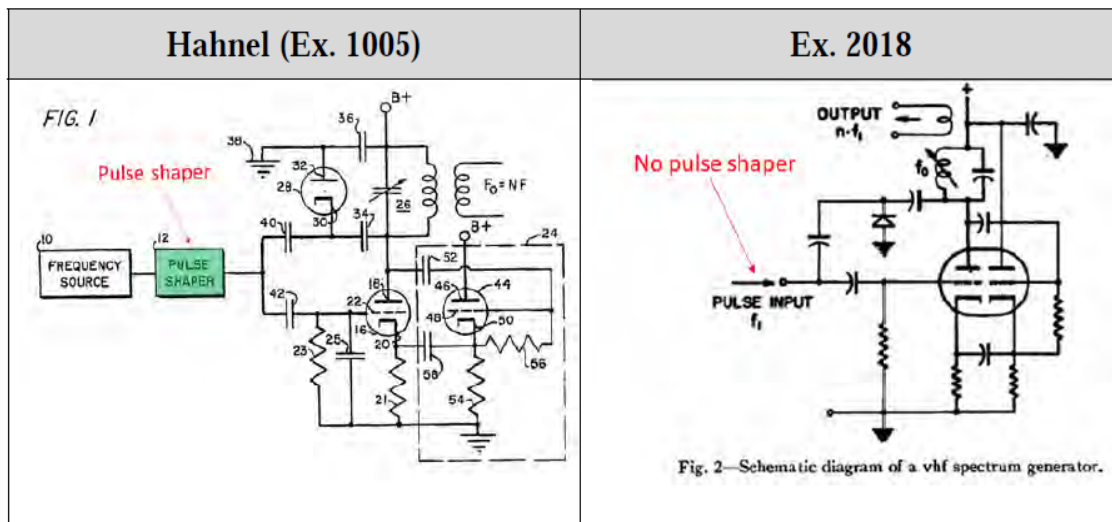
Patent Owner responds that communications systems disclosed in Downey and Hahnel are incompatible because Hahnel discloses an apparatus which produces a discontinuous radio frequency signal while Downey teaches outputting a continuous radio signal, and a person of ordinary skill in the art would not have been motivated to combine the two. PO Resp. 54 (citing Ex. 2022 ¶ 210). Patent Owner, quoting from a different Hahnel reference, argues that “[t]he circuit of Hahnel is an oscillator that is turned on and off, that is keyed, by pulses . . . [derived from a] crystal-controlled fundamental frequency.” *Id.* (citing Ex. 2018, 78).²⁰ Patent Owner argues

²⁰ Exhibit 2018 is an article titled “Multichannel Crystal Control of VHF and UHF Oscillators” by Alwin Hahnel, from the Proceedings of the Institute of Radio Engineers.

that “Downey, on the other hand, uses a crystal to control the oscillating frequency of the RF signal,” and that “Downey specifically teaches that the benefit of its system is ‘leaving the transmit oscillator on all the time.’” *Id.* at 55 (citing Ex. 1003, 1:63). Patent Owner contends that it would not have been obvious to a person of ordinary skill in the art “to insert the pulse shaper of Hahnel into the transceiver circuit of Downey,” and that “to get to the invention of the ’474 [sic] patent using Downey and Hahnel, one would have to ignore all of the disclosure in Downey, and abandon all of the teachings and suggestions of Downey.” *Id.* (citing Ex. 2022 ¶ 212).

(2) Petitioner’s Reply Arguments

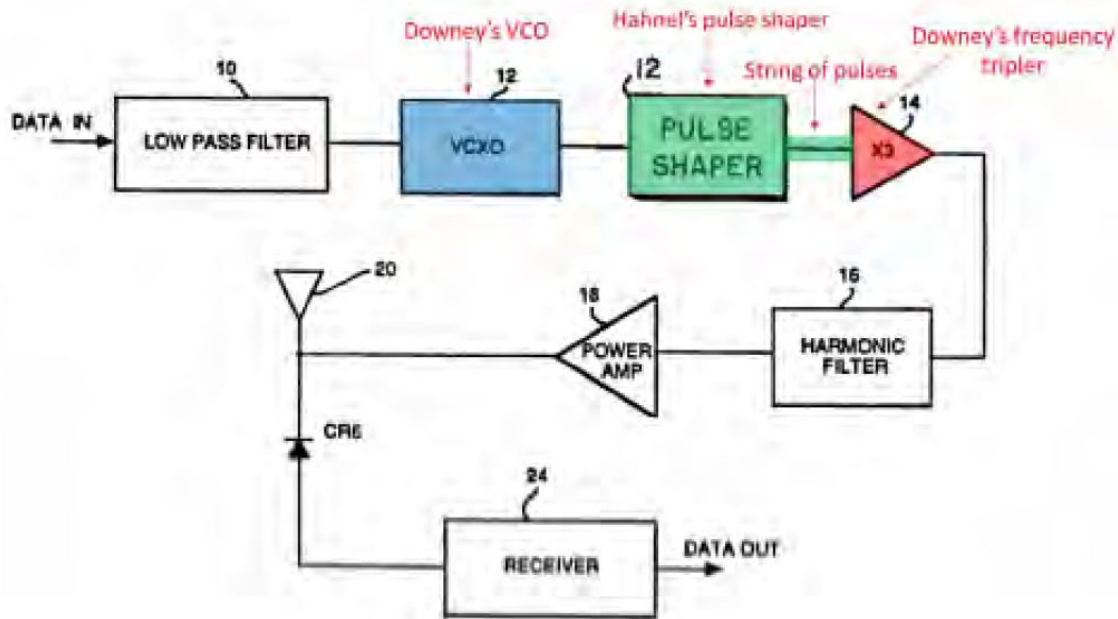
In its Reply, Petitioner contends that Patent Owner’s argument focuses on the wrong Hahnel reference, and that Hahnel and Exhibit 2018 are different publications that disclose different circuits, including “different components—most importantly, Exhibit 2018 does not even include the ‘pulse shaper’ for which the Petition relied on Hahnel in the first place.” Pet. Reply 33–34 (citing Ex. 1005, Fig. 1; Ex. 2018, Fig. 2; Ex. 2022 ¶¶ 188–189; Ex. 1030 ¶ 60). Petitioner’s comparison of the two circuits is reproduced below.



Id. at 34. Petitioner annotates Figure 1 from Hahnel to highlight the pulse shaper component (green) that Petitioner relies on for the proposed combination and annotates Figure 2 of Exhibit 2018 to show that there is no pulse shaper component disclosed.

Petitioner further contends that Patent Owner's substantive arguments concerning motivation to combine are also wrong. Pet. Reply 34.

Petitioner's annotated circuit combining the pulse shaper of Hahnel with Downey's circuit is reproduced below.



Id. at 35. Petitioner’s annotated figure of its proposed combined circuit illustrates Petitioner’s argument that a person of ordinary skill in the art “would have been motivated to incorporate Hahnel’s pulse shaper (green) into Downey’s circuit between the voltage-controlled oscillator (VCXO 12 (blue)) and frequency tripler 14 (red).” *Id.* at 34–35 (citing Ex. 1030 ¶ 61). Petitioner contends that “the motivation to do so would be to open and close the inverter in the frequency tripler crisply, and thereby generating an up-converted signal that has a harmonic at the desired output frequency with a much larger and more constant amplitude as compared to the other undesired harmonics.” *Id.* at 34. Contrary to Patent Owner’s argument, Petitioner contends, “the proposed combination does not involve putting the pulse shaper *in front of Downey’s voltage-controlled oscillator (VCXO, blue)* to turn the oscillator on and off,” but instead, “the pulse shaper is provided *after the oscillator* and in front of Downey’s frequency tripler (red).” *Id.* at 36. Because the pulse train is not fed into the oscillator in the proposed

circuit, “it is entirely irrelevant that Hahnel’s oscillator turns on and off while Downey states that its oscillator stays ‘on all the time.’” *Id.*

(3) Patent Owner’s Sur-reply Arguments

Patent Owner responds that the circuits disclosed in Hahnel and in Exhibit 2018 “are functionally identical.” PO Sur-reply 27 (citing Ex. 2022 ¶¶ 188–190). According to Patent Owner, Exhibit 2018 shows a “pulse input” and combined with its express teachings, “e.g., ‘uhf oscillator . . . is keyed by pulses,’ ‘the pulse repetition interval (T) is divided into a regenerative and a degenerative period,’” a person of ordinary skill in the art would have understood Figure 2 of Exhibit 2018 to indicate the use of a pulse shaper. *Id.* Patent Owner further contends that “Hahnel’s pulse shaper comes *before* (or is provided in front of) the oscillator, not *after* as [Petitioner] suggests.” *Id.* at 28. Patent Owner asserts that “to get to the invention of the ’108 patent using Downey and Hahnel, one would have to ignore all of the disclosure in Hahnel, and abandon all of the teachings and suggestions of Hahnel.” *Id.* (citing Ex. 2022 ¶ 213).

(4) Analysis

We are persuaded that Petitioner sufficiently shows that an ordinarily skilled artisan would have had reason with rational underpinning to combine the teachings of Hahnel with Downey. Patent Owner’s reliance on Exhibit 2018 to argue that Hahnel discloses an apparatus incompatible with Downey is misplaced. As evident from Petitioner’s comparison of the figures from Hahnel and Exhibit 2018 (reproduced above), Hahnel and Exhibit 2018 disclose entirely different circuits. *Compare* Ex. 1005, Fig. 1 *with* Ex. 2018, Fig. 2; Pet. Reply 34. Dr. Steer testifies that “Hahnel was preceded by a 1953 publication (Ex. 2018) which describes the circuit in

further detail.” Ex. 2022 ¶ 188. Dr. Steer further testifies that the circuits are identical and the functionality is identical. *Id.* ¶ 189. Dr. Steer, however, offers no support either in Hahnel or Exhibit 2018 for his conclusion. Neither of the references incorporates the other and there is no indication in either of the references that they are related. *See* Ex. 1003; Ex. 2018. Not only are the two circuits relied upon by Dr. Steer facially different in various respects (*see* comparison above), the circuit disclosed in Exhibit 2018 does not include the very pulse shaper component of Hahnel that Petitioner relies on for the proposed combination. Ex. 2018, Fig. 2. Because Dr. Steer and Patent Owner rely on Exhibit 2018 to argue that Hahnel’s circuit is incompatible with Downey’s circuit for the purposes of Petitioner’s proposed combination, we find Patent Owner’s arguments do not undermine Petitioner’s rationale to combine Downey with Hahnel. *Id.* ¶¶ 210–213; PO Resp. 54–55.

Contrary to Patent Owner’s assertions, Petitioner does rely on Hahnel’s teachings to argue why a person of ordinary skill in the art would have been motivated to combine Hahnel’s pulse shaper with Downey’s circuit. *See* Pet. 76–79. Hahnel explains the drawbacks of systems that do not have a pulse shaper, including “a large number of stages,” the difficulty in obtaining “a high degree of frequency accuracy,” and the difficulty in isolating “the desired harmonic frequencies from the many spurious oscillations and unwanted harmonics.” Ex. 1005, 1:18–39. Hahnel further explains its goals of providing a system, using a pulse shaper, that “permits better control of the amplitude of the desired output harmonic frequency,” and “wherein the amplitude of the desired harmonic frequency is at a maximum.” *Id.* at 1:50–2:14. Relying on that disclosure, Dr. van der Weide

testifies that adding Hahnel’s pulse shaper to Downey’s system would yield predictable benefits, such as providing an improved up-conversion circuit that generates a signal with a sufficient amplitude and can generate such a signal with fewer steps in less time. Ex. 1003 ¶ 135 (quoting Ex. 1005, 1:18–39, 1:50–2:14). Dr. van der Weide further testifies that Hahnel expressly discloses how to combine the references because it notes that the pulse shaper should be located between an oscillator and a frequency multiplier. *Id.* ¶ 136 (citing Ex. 1005, Fig. 1). We credit Dr. van der Weide’s testimony because it is based on the express teachings of Hahnel and Downey. And because Petitioner’s proposed combination adds Hahnel’s pulse shaper *after* oscillator 12 in Downey’s circuit (*see* Petitioner’s annotated figure above), Patent Owner’s argued difference between the oscillators in Downey and Hahnel does not apply to Petitioner’s proposed use of Hahnel’s pulse shaper in Downey’s circuit. *See* Pet. Reply 36.

Based on the entirety of the record, we determine that Petitioner has proved by a preponderance of the evidence that the asserted prior art teaches the “pulse shaper” limitation.

c) “an oscillating signal generator”

Claim 6 also recites “an oscillating signal generator.” Ex. 1001, 66:13–14. Petitioner contends that Downey discloses a voltage controlled oscillator, i.e., VCXO 12 that generates a modulated oscillating signal. Pet. 79 (citing Ex. 1003, 2:60–63, Fig. 1; Ex. 1002 ¶ 138). Patent Owner does not present arguments as to this limitation. *See generally* PO Resp. Based on the entirety of the record and for the reasons explained by Petitioner, we

determine that Petitioner has proved by a preponderance of the evidence that the asserted prior art teaches this claim limitation.

2. *Claim 7–9 and 17–20*

Claim 7 depends from claim 6 and additionally recites “wherein the oscillating signal generator comprises a voltage controlled oscillator configured to generate an oscillating signal.” Ex. 1001, 66:15–17. For the additional limitations in claim 7, Petitioner relies on its arguments directed to claim 6. Pet. 80 (citing Ex. 1003, 2:60–63, 3:61–66; Ex. 1002 ¶ 139).

Claim 8 depends from claim 7 and additionally recites “wherein the pulse shaper is configured to generate a string of pulses based on the oscillating signal.” Ex. 1001, 66:18–20. Petitioner contends that Hahnel teaches the additional limitations of claim 8 because it “discloses a pulse shaper” that “receives an oscillating signal from the frequency source and outputs a string of pulses.” Pet. 80–81 (citing Ex. 1005, 1:60–66, 2:23–30, 2:32–39, Figs. 2C, 2D; Ex. 1003, 2:60–3:2, 3:53–4:19; Ex. 1002 ¶ 140).

Claim 9 depends from claim 8 and additionally recites “wherein the first switch opens and closes based on the string of pulses.” Ex. 1001, 66:22–23. For the additional limitations of claim 9, Petitioner relies on its arguments directed to claim 1 with respect to the “first switch,” and further contends Hahnel teaches a “pulsed-signal from the pulse shaper . . . is input to the control input 22 of the switch 16.” See Pet. 82–83 (citing Ex. 1005, 1:70–2:5, 2:43–3:44, Figs. 1, 2; Ex. 1003, 4:8–13, Fig. 1; Ex. 1002 ¶ 143). Petitioner contends that in the combination of Downey, Sedra, and Hahnel, “[w]hen Downey’s inverter is implemented with Sedra’s switch, the string of pulses from Hahnel’s pulse shaper will open and close Sedra’s switch.” *Id.* at 83–84 (citing Ex. 1004, 908; Ex. 1002 ¶ 144).

Petitioner contends that “claims 17–20 have essentially the same scope as claims 6–9, respectively,” and relies on its arguments directed to claims 6–9. Pet. 85 (citing Ex. 1002 ¶ 146).

Patent Owner does not present arguments as to claims 7–9 and 17–20. *See generally* PO Resp. Based on the entirety of the record and for the reasons explained by Petitioner, we determine that Petitioner has proved by a preponderance of the evidence that the asserted prior art teaches the claim limitations recited in those dependent claims.

3. *Weighing the Graham Factors*

“Once all relevant facts are found, the ultimate legal determination [of obviousness] involves the weighing of the fact findings to conclude whether the claimed combination would have been obvious to an ordinary artisan.” *Arctic Cat Inc.*, 876 F.3d at 1361. On balance, considering the record before us, Petitioner has shown, by a preponderance of the evidence, that the combination of Downey, Sedra and Hahnel would have rendered the subject matter of claims 6–9 and 17–20 obvious to one of ordinary skill in the art at the time of the invention.

IV. PETITIONER’S OBJECTION TO PATENT OWNER’S DEMONSTRATIVES

At the oral hearing, Petitioner objected to Patent Owner’s demonstratives 81 and 82 (*see* Paper 30) as containing new arguments that were not previously presented by Patent Owner. Tr. 6:17–7:1. Petitioner argued that those demonstratives contain testimony from Dr. van der Weide that Patent Owner did not cite in its Sur-reply and address an issue that was not presented in Patent Owner’s Response. *Id.* Patent Owner did not rely on those demonstratives during the oral hearing. *Id.* at 8:10–15 (Patent

Owner’s counsel stating that he may not refer to those demonstratives during the hearing). We therefore dismiss Petitioner’s objection as moot.²¹

V. CONCLUSION

For the reasons discussed above, Petitioner has demonstrated, by a preponderance of the evidence, that claims 1, 6–9, 12, and 17–20 of the ’108 patent are unpatentable.²² Our conclusions regarding the challenged claims are summarized below:

Claims Challenged	35 U.S.C. §	Reference(s)/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 12	103(a)	Downey, Sedra	1, 12	
6–9, 17–20	103(a)	Downey, Sedra, Hahnel	6–9, 17–20	
Overall Outcome			1, 6–9, 12, 17–20	

²¹ We also note that demonstratives are not evidence, and in making our decision, we consider the arguments presented in the papers and the evidence presented in the exhibits filed in this case. *See* Paper 29, 5 (“Demonstrative exhibits used at the hearing are not evidence, nor will they be relied upon as evidence.”); Consolidated Trial Practice Guide 84, *available at* <https://www.uspto.gov/TrialPracticeGuideConsolidated> (“Demonstrative exhibits used at the final hearing are aids to oral argument and not evidence.”).

²² Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1, 6–9, 12, and 17–20 of U.S. Patent No. 8,190,108 B2 are determined to be unpatentable;

FURTHER ORDERED that Petitioner's objection to Patent Owner's demonstratives 81 and 82 is *dismissed* as moot; and

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

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