Trials@uspto.gov
571.272.7822

Paper 30
Date: January 14, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION,
Petitioner,

v.

QUALCOMM INCORPORATED,
Patent Owner.

IPR2018-01328
Patent 9,608,675 B2

Before MICHELLE N. WORMMEESTER, AMANDA F. WIEKER, and SCOTT B. HOWARD, *Administrative Patent Judges*.

WORMMEESTER, *Administrative Patent Judge*.

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

I. INTRODUCTION

Intel Corporation[1] ("Petitioner") filed a Petition (Paper 2, "Pet.") requesting an *inter partes* review of claims 1–3, 5, 7–15, 17–21, 23–25, and 27 of U.S. Patent No. 9,608,675 B2 (Ex. 1201, "the '675 patent"). Qualcomm Incorporated ("Patent Owner") filed a Preliminary Response. Paper 7 ("Prelim. Resp."). Pursuant to 35 U.S.C. § 314, we instituted an *inter partes* review of challenged claims 1–3, 5, 7–15, 17–21, 23–25, and 27 based on all the grounds presented in the Petition. Paper 8 ("Inst. Dec."). Patent Owner filed a Response (Paper 14, "PO Resp."), and Petitioner filed a Reply (Paper 16, "Pet. Reply"). Patent Owner then filed a Sur-reply. Paper 19 ("PO Sur-reply").

On October 9, 2019, we conducted an oral hearing. A copy of the transcript (Paper 29, "Tr.") is included in the record. With our authorization, the parties subsequently filed additional briefs on the meaning of certain claim language. Paper 27 ("PO Br."); Paper 28 ("Pet. Br.").

We have jurisdiction under 35 U.S.C. § 6(b). For the reasons that follow, we determine that Petitioner has shown by a preponderance of the evidence that claims 1–3, 5, 7–15, 17–21, 23–25, and 27 of the '675 patent are unpatentable. This final written decision is issued pursuant to 35 U.S.C. § 318(a).

[1] Intel Corporation identifies itself and Apple Inc. ("Apple") as real parties in interest. Paper 2, 1.

II. BACKGROUND

A. Related Proceedings

Prior to institution, the parties identified various matters involving the ’675 patent, including a federal district court case, an International Trade Commission (“ITC”) investigation, as well as five other petitions for *inter partes* review. Pet. 2; Paper 4, 2. Since the entry of our Institution Decision, however, Patent Owner has asserted that “[t]he ’675 patent is currently not involved in any litigation beyond the PTAB.” PO Resp. 16. Petitioner has not stated otherwise.

B. The ’675 Patent

The ’675 patent describes power tracking for generating a power supply voltage for a circuit, such as an amplifier, that processes multiple transmit signals sent simultaneously. Ex. 1201, 1:8–10, 1:35–38. Figure 5, which is reproduced below, illustrates a transmit module with power tracking for all transmit signals according to the ’675 patent. *Id.* at 1:65–67.

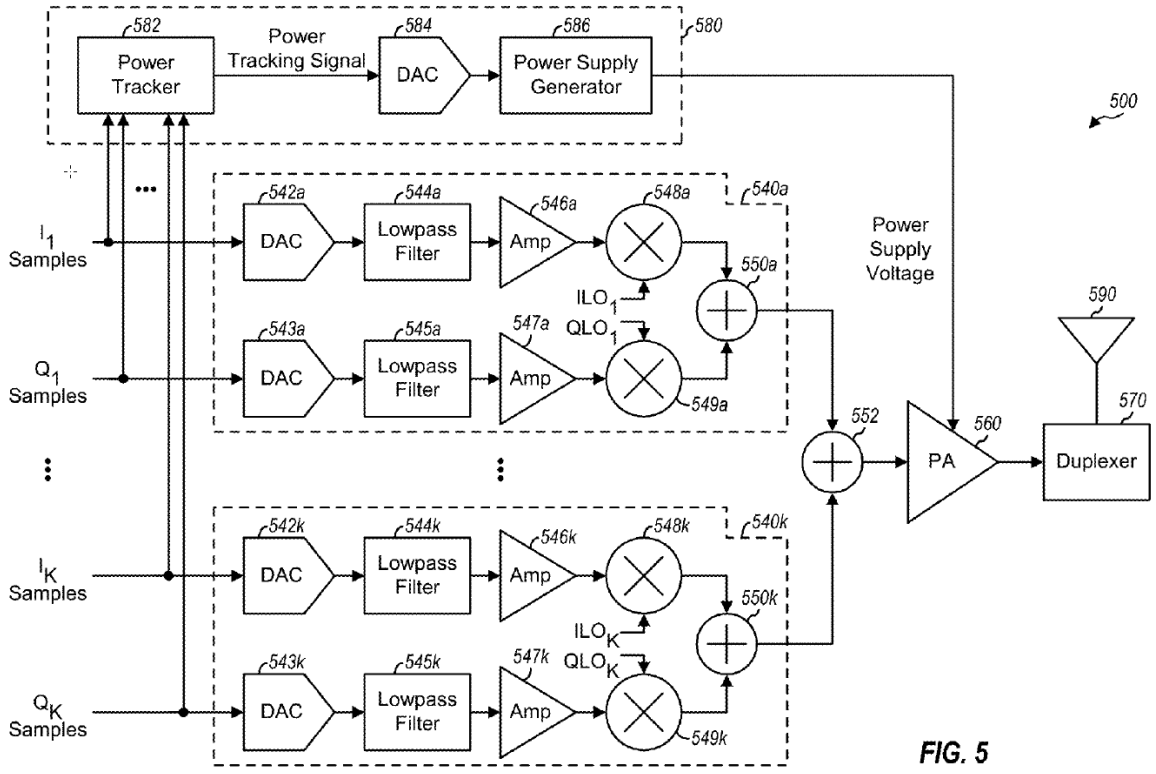

FIG. 5

In particular, Figure 5 shows transmit module 500, which includes K transmit circuits 540a to 540k that can simultaneously process K transmit signals, with each transmit circuit processing one transmit signal. *Id.* at 6:34–37. Transmit module 500 also includes summer 552, power amplifier ("PA") 560, duplexer 570, and power tracking supply generator (or voltage generator) 580. *Id.* at 6:37–39.

Inphase (I) and quadrature (Q) samples for a transmit signal are provided to both a transmit circuit and voltage generator 580. *Id.* at 6:42–44. For example, transmit circuit 540a receives I_1 and Q_1 samples for a first transmit signal and generates a first upconverted radio frequency ("RF") signal for the first transmit signal. *Id.* at 6:40–42. Within transmit circuit 540a, the I_1 and Q_1 samples are converted to I and Q analog signals by digital-to-analog converters (DACs) 542a and 543a. *Id.* at 6:44–46. The

I and Q analog signals are then filtered by lowpass filters 544a and 545a, amplified by amplifiers 546a and 547a, upconverted from baseband to RF by mixers 548a and 549a, and summed by summer 550a to generate the first upconverted RF signal. *Id.* at 6:46–50.

The other transmit circuits operate similarly. *Id.* at 6:54–57. Summer 552 receives all upconverted RF signals from the transmit circuits, sums the upconverted RF signals, and provides a modulated RF signal to PA 560. *Id.* at 6:59–62.

Within voltage generator 580, power tracker 582 receives I_1 to I_K samples and Q_1 to Q_K samples for all transmit signals being sent simultaneously. *Id.* at 6:63–65. Power tracker 582 then computes a digital power tracking signal based on the I and Q samples for these transmit signals and provides the digital power tracking signal to DAC 584. *Id.* at 6:65–7:1, 8:6–32. DAC 584 converts the digital power tracking signal to analog and provides the analog power tracking signal to power supply generator 586. *Id.* at 7:1–4, Fig. 5. Power supply generator 586 generates a power supply voltage for PA 560. *Id.* at 7:6–8.

Once PA 560 receives both the modulated RF signal from summer 552 and the power supply voltage from power supply generator 586, PA 560 amplifies the modulated RF signal using the power supply voltage. *Id.* at 7:8–11. PA 560 then provides an output RF signal for all the transmit signals being sent simultaneously. *Id.* at 7:11–12. The output RF signal is routed through duplexer 570 and transmitted via antenna 590. *Id.* at 7:12–14.

C. Illustrative Claim

Petitioner challenges claims 1–3, 5, 7–15, 17–21, 23–25, and 27 of the '675 patent. Claims 1 and 18 are independent. Claim 1 is illustrative of the claims under challenge:

> 1. An apparatus comprising:
>
> a power tracker configured to determine a single power tracking signal based on a plurality of inphase (I) and quadrature (Q) components of a plurality of carrier aggregated transmit signals being sent simultaneously, wherein the power tracker receives the plurality of I and Q components corresponding to the plurality of carrier aggregated transmit signals and generates the single power tracking signal based on a combination of the plurality of I and Q components, wherein the plurality of carrier aggregated transmit signals comprise Orthogonal Frequency Division Multiplexing (OFDM) or Single Carrier Frequency Division Multiple Access (SC-FDMA) signals;
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> a power supply generator configured to generate a single power supply voltage based on the single power tracking signal; and
>
> a power amplifier configured to receive the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously to produce a single output radio frequency (RF) signal.

D. Asserted Grounds of Unpatentability

Petitioner challenges claims 1–3, 5, 7–15, 17–21, 23–25, and 27 of the '675 patent on four grounds based on obviousness over 35 U.S.C. § 103. Pet. 15–81. We instituted *inter partes* review of that ground. Inst. Dec. 2, 35–36. The instituted grounds are as follows.

Claim(s) Challenged	35 U.S.C. §	References
1–3, 5, 7, 11, 17–21, 27	103	Chen,[2] Wang[3]
12	103	Chen, Wang, Eliezer[4]
8–10	103	Chen, Wang, Choi[5]
13–15, 23–25	103	Chen, Wang, Dahlman[6]

In support of its arguments, Petitioner relies on a declaration (Ex. 1203) as well as a reply declaration (Ex. 1231) of David Choi, Ph.D. Patent Owner submits with its Response a declaration of Tim Williams, Ph.D. (Ex. 2002). The transcripts of the depositions of Dr. Choi are entered in the record as Exhibits 2006 and 2007, and the transcript of the deposition of Dr. Williams is entered in the record as Exhibit 1230.

III. ANALYSIS

A. Claim Construction

The claim construction standard applicable to this *inter partes* review proceeding is the broadest reasonable interpretation in light of the patent specification. *See* 37 C.F.R. § 42.100(b) (2018); *Cuozzo Speed Techs. LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016) (upholding the use of the broadest

[2] W. Chen et al., *Hybrid Envelope Tracking for Efficiency Enhancement in Concurrent Dual-Band PAs*, 54 Microwave & Optical Tech. Letters 662 (2012) (Ex. 1212).
[3] Wang et al., *Design of Wide-Bandwidth Envelope-Tracking Power Amplifiers for OFDM Applications*, 53 IEEE Transactions on Microwave Theory & Techniques 1244 (2005) (Ex. 1205).
[4] Eliezer, US 2009/0004981 A1, published Jan. 1, 2009 (Ex. 1211).
[5] Jinsung Choi et al., *Envelope Tracking Power Amplifier Robust to Battery Depletion*, 2010 IEEE MTT-S Int'l Microwave Symposium Digest 1074 (2010) (Ex. 1208, at Ex. A).
[6] Erik Dahlman et al., 4G LTE / LTE-ADVANCED FOR MOBILE BROADBAND (Elsevier Ltd. 2011) (Ex. 1206).

reasonable interpretation standard).[7] Under this standard, claim terms generally are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *See In re Translogic Tech., Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007).

Petitioner provides proposed interpretations of various terms recited in the challenged claims. Pet. 12–14; Pet. Reply 2–8; Pet. Br. 1–3. Patent Owner also provides proposed interpretations of various claim terms. PO Resp. 14–18; PO Sur-reply 2–8; PO Br. 1–3. In light of the parties' arguments and evidence, we address the following claim terms: "power tracker," "plurality of carrier aggregated transmit signals," and "generates the single power tracking signal based on a combination of the plurality of I and Q components." *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (noting that "we need only construe terms 'that are in controversy, and only to the extent necessary to resolve the controversy'" (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc*., 200 F.3d 795, 803 (Fed. Cir. 1999))).

[7] The revised claim construction standard for interpreting claims in *inter partes* review proceedings as set forth in the final rule published October 11, 2018, does not apply to this proceeding because the new "rule is effective on November 13, 2018 and applies to all IPR, PGR and CBM petitions filed on or after the effective date." Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340 (Oct. 11, 2018) (codified at 37 C.F.R. § 42.100(b) (2019)). The Petition here was filed on July 3, 2018.

1. "power tracker"

This term appears in several claims, including independent claims 1 and 18. All the challenged claims in this proceeding therefore require the recited "power tracker." The administrative law judge ("ALJ") in the related ITC investigation[8] construed "power tracker" to mean "component in a voltage generator that computes the power requirement." Ex. 1218, 18–20 (ITC order) (cited by Pet. 13). In construing that term, the ALJ applied the standard used in civil actions. *Id.* at 3–5 (citing *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005)). For purposes of this proceeding, the parties do not dispute the ALJ's construction. PO Resp. 16 ("Patent Owner agrees with the ITC's non-[means-plus-function] construction of 'power tracker' as a 'component in a voltage generator that computes the power requirement.'"); Pet. Reply 5–6, 8 ("The Board . . . should adopt the construction of 'power tracker' that both parties have agreed to—'component in a voltage generator that computes the power requirement.'"). On this record, we adopt the ALJ's construction.

Even though the parties do not dispute the ALJ's construction of "power tracker," they dispute whether Petitioner's approach in offering that construction in this proceeding complies with our rules. According to Petitioner, Apple (a real party in interest in this proceeding) argued in the related ITC investigation that the recited "power tracker" is a means-plus-function limitation lacking sufficient corresponding structure; but the ALJ nevertheless determined that term to be a structural limitation. Pet. 13

[8] Prior to institution, Petitioner indicated that Patent Owner had asserted the '675 patent against Apple in the ITC investigation but then withdrew the assertion. Pet. 2.

(citing Ex. 1218, 18–20) & n.3. Although Petitioner asserts that the challenged claims are invalid for indefiniteness under Apple's proposed means-plus-function construction, Petitioner additionally asserts that its "Petition shows the invalidity of the challenged claims under the ALJ's construction," as "indefiniteness is not an issue that can be considered in an [*inter partes* review proceeding]." *Id.*

We recognize that Petitioner is offering a construction for "power tracker," namely, the ALJ's structural construction from the ITC investigation, under which it argues that the challenged claims are invalid as obvious, while at the same time expressing its belief that the challenged claims "also" are invalid for indefiniteness under a different construction, namely, Apple's proposed means-plus-function construction. *See id.* As we explained in our Institution Decision, this approach is acceptable. Inst. Dec. 11–13. In particular, we noted that a petitioner may "identify[] claim constructions it proposes as the basis for requesting review of the challenged claims," without "express[ing] its subjective agreement regarding correctness of its proffered claim constructions or . . . tak[ing] ownership of those constructions." *Id.* at 11; *Hologic, Inc. v. Enzo Life Scis., Inc.*, IPR2018-00019, Paper 21 at 5 (PTAB Nov. 28, 2018) (Decision Denying Request for Rehearing) (quoting *W. Digital Corp. v. SPEX Techs., Inc.* IPR2018-00084, Paper 14 at 11 (PTAB Apr. 25, 2018)). We also noted that in an *inter partes* review where the broadest reasonable interpretation applies, such as here, a petitioner may proffer a construction that the patent owner advocated in a different forum and may state that it disagrees that the construction is correct under the standard applied in the other forum but that it proposes the construction as the broadest reasonable interpretation of the

term in question. Inst. Dec. 12; *Hologic*, Paper 21 at 5, 8. Additionally, in a broadest reasonable interpretation case, a petitioner may argue that a claim is indefinite but still offer a construction for the claim. Inst. Dec. 12; *Hologic*, Paper 21 at 5, 7. If a petitioner is concerned that the Board may not adopt what it believes to be the proper claim construction, the petitioner may offer alternative constructions and demonstrate unpatentability under each construction. Inst. Dec. 12; *Hologic*, Paper 21 at 6.

In its Response, Patent Owner contends that "whether a claim term is means-plus-function (MPF) or not is the same regardless of the claim construction standard applied," and that the claim term "'power tracker' cannot be deemed MPF under *Phillips* but not MPF when BRI is applied." PO Resp. 16 (citing *In re Donaldson Co.*, 16 F.3d 1189, 1193 (Fed. Cir. 1994) (en banc)). Pointing to Dr. Choi's deposition testimony, Patent Owner further asserts that "Petitioner's expert continues to take the position that 'power tracker' is a [means-plus-function] term in the present PTAB matter." *Id.* at 17 (citing Ex. 2006, 127:11–13). According to Patent Owner, "Petitioner must be held to that expert position." *Id.* Thus, Patent Owner contends, "the Petition has failed [to] comply with the requirements of 37 C.F.R. §§ 42.104(b)(3)–(4)" because it "fails to present a case sufficient for the claim construction that Petitioner's expert continues to assert." *Id.* at 17–18; *see also id.* at 18 ("Because the Petition fails to make the required case for the 'power tracker' that ***Petitioner's expert asserts*** is an MPF limitation, the challenged claims are not unpatentable.").

Petitioner counters that "both parties have agreed to" the ALJ's construction in the ITC investigation and that "Patent Owner cites no authority for the proposition that a party 'must be held to' all opinions of its

expert." Pet. Reply 6, 8. Petitioner adds that "nothing in *Donaldson* precludes [its] approach." Pet. Reply 7. In particular, Petitioner points out that "the ALJ found that 'power tracker' is ***not*** a means-plus-function term, and [Petitioner] has proposed that same (non-MPF) construction here." *Id.* at 8. Petitioner further contends that "[i]f *Donaldson* mandates consistency between proceedings in the manner Patent Owner argues, that is all the more reason for the Board to adopt the ALJ's construction." *Id.*

According to Patent Owner, however, Petitioner "conduct[s] its unpatentability analysis under a claim construction with which it expressly disagrees," which is "improper" because "[t]he Board has repeatedly made clear that a petitioner must show 'how the construed claim is unpatentable' under 'a claim construction that it *consider[s] to be correct*.'" PO Sur-reply 5–6. As support, Patent Owner cites three Board decisions: *Hologic, Inc. v. Enzo Life Sciences, Inc.*, Paper 17 at 8–9 (PTAB Apr. 18, 2018); *Toyota Motor Corp. v. Blitzsafe Texas, LLC*, IPR2016-00422, Paper 12 at 26 (PTAB July 6, 2016); and *CareFusion Corp. v. Baxter International, Inc.*, IPR2016-01456, Paper 9 at 7 (PTAB Feb. 6, 2017). PO Sur-reply 6.

We disagree with Patent Owner's arguments. Petitioner indicates that the ALJ in the related ITC investigation determined that "power tracker" is a structural term, not a means-plus-function term, and that Petitioner therefore offers in this proceeding the ALJ's construction of that term. Pet. Reply 8. Petitioner's approach is reasonable. As our reviewing court has explained, whether a claim term is a means-plus-function term is the same regardless of the claim construction standard applied. *See Donaldson*, 16 F.3d at 1193 (holding that "paragraph six applies regardless of the context in which the interpretation of means-plus-function language arises, i.e., whether as part of

a patentability determination in the PTO or as part of a validity or infringement determination in a court") (cited by PO Resp. 16–17).

Petitioner's approach also complies with 37 C.F.R. § 42.104(b)(3)–(4), which states, in pertinent part, that a petition must set forth:

> (3) How the challenged claim is to be construed. Where the claim to be construed contains a means-plus-function or step-plus-function limitation as permitted under 35 U.S.C. 112(f), the construction of the claim must identify the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function;
>
> (4) How the construed claim is unpatentable under the statutory grounds identified in paragraph (b)(2) of this section. The petition must specify where each element of the claim is found in the prior art patents or printed publications relied upon; . . . .

The plain language of 37 C.F.R. § 42.104(b)(3)–(4), as written, requires that a petition identify how the challenged claim is to be construed and how the construed claim is unpatentable, including where each element of the claim is found in the asserted prior art references. The plain language of 37 C.F.R. § 42.104(b)(3)–(4) does not prohibit a petitioner from submitting a construction adopted by a different tribunal in a related proceeding.

Our interpretation of 37 C.F.R. § 42.104(b)(3) is further supported by the rule's regulatory history. For example, in the discussion of this rule, the Patent Office states that the purpose of the petitioner's claim construction is to provide patent owners with notice as to the basis of the challenge to the claims:

> Section 42.104(b) requires that the petition identify the precise relief requested for the claims challenged. Specifically, the rule requires that the petition identify each claim being challenged, the specific grounds on which each claim is challenged, *how the*

> *claims are to be construed*, why the claims as construed are unpatentable under the identified grounds . . . .
>
> The rule provides an efficient means for identifying the legal and factual basis for satisfying the threshold for instituting *inter partes* review and *provides the patent owner with notice as to the basis for the challenge to the claims*.

Changes to Implement Inter Partes Review Proceedings, Post-Grant Review Proceedings, and Transitional Program for Covered Business Method Patents, 77 Fed. Reg. 48,679, 48,688 (Aug. 14, 2012) (codified at 37 C.F.R. pt. 42) (emphases added). The Office reiterates that purpose throughout its responses to public comment:

> *Comment 35*: Several comments recommended that the requirement for setting forth the claim construction of the challenged claims in the petition should be eliminated because, according to the comments, the requirement is burdensome and will create delays. Further, one comment suggested that claim construction should only be required to the extent necessary to establish the challenged claim is unpatentable. Other comments were in favor of the requirement.
>
> *Response*: The Office believes that the petitioner's claim construction requirement is not burdensome and will improve the efficiency of the proceeding. *In particular, the petitioner's claim construction will help to provide sufficient notice to the patent owner on the proposed grounds of unpatentability*, and assist the Board in analyzing to how a cited prior art reference meets the claim limitation(s). . . .
>
> *Comment 36*: A few comments suggested that the Office should adopt claim construction procedures similar to those in the district courts, as opposed to requiring the petitioner to submit a statement to identify how the challenged claim is to be construed.
>
> *Response*: The Office believes that the petitioner's claim construction requirement will improve the efficiency of the proceeding. As discussed previously, *the petitioner's claim construction will help to provide sufficient notice to patent owner*

> *on the proposed grounds of unpatentability*, and assist the Board in analyzing how a cited prior art meets the claim limitation.

Id. at 48,699–48,700 (emphases added). Additionally, in response to a comment from the public regarding alternative constructions, the Office states that the rule does not preclude providing alternative claim constructions in a petition:

> *Comment 40*: One comment expressed a concern as to restricting claim construction later in the proceeding and suggested that the rules should permit alternative claim construction in the petition, and revised claim construction later in the process.
>
> *Response*: *The rules do not preclude providing alternative claim constructions in a petition* or in later authorized filings.

Id. at 48,700 (emphasis added). In other words, the rule does not prohibit a petitioner from submitting a construction adopted by a different tribunal in a related proceeding, even where the petitioner argued for a different claim construction in the related proceeding. Petitioner is not required to advance a position that has been offered, and rejected, in another proceeding.

We note that Patent Owner relies on the Board decisions in *Hologic*, *Toyota*, and *CareFusion* to support its arguments. Patent Owner's reliance is misplaced, however, as the facts in those cases are distinguishable from the facts here. For example, in *Hologic*, the panel denied the petition because the petitioner stated in the petition that it was offering a construction with which it expressly disagreed. *Hologic*, Paper 17 at 8. By contrast, in this proceeding, Petitioner has not expressly disagreed with the claim construction offered in its Petition. To the contrary, Petitioner has expressly agreed with that construction by urging us to "adopt the construction of 'power tracker' that *both parties have agreed to*," namely, the ALJ's construction in the ITC investigation. *See* Pet. Reply 8 (emphasis added);

see also id. at 5–6 ("As explained in the Petition, the Board should construe 'power tracker' as 'component in a voltage generator that computes the power requirement.' . . . In its Response, Patent Owner likewise agreed that the ALJ's construction was applicable."); *id.* at 6 (asserting that "Patent Owner cites no authority for the proposition that a party 'must be held to' all opinions of its expert," where the expert has expressed a different opinion not relied on by the party). The fact that Petitioner believes the challenged claims *also* are invalid for indefiniteness under Apple's proposed means-plus-function construction does not mean that Petitioner disagrees with the ALJ's construction or that it agrees with Apple's construction (which the ALJ has rejected). *See* Pet. 13 n.3. Nor does the fact that Dr. Choi believes "power tracker" is a means-plus-function term. *See* Ex. 2006, 127:11–13. Petitioner relies on Dr. Choi's opinions regarding how to "apply the ALJ's construction to allow the Board to evaluate the claims against the cited prior art," not on his opinions as to the construction of "power tracker." Ex. 1203 ¶ 84 (cited by Pet. 13).

Similar to the petitioner in *Hologic*, the petitioner in *Toyota* stated in its petition that it was offering constructions adopted by a district court with which it expressly disagreed. *Toyota*, Paper 12 at 26–27. Moreover, the panel indicated that it denied the petition partly because the petitioner did not identify the corresponding structure for a means-plus-function claim, which is required under 37 C.F.R. § 42.104(b)(3):

> [F]or the generating means, Petitioner does not offer its construction by identifying corresponding structure, material, or acts in the Specification. Instead, for the [generating] means, Petitioner asserts that there is no corresponding structure, material, or acts in the Specification of the '786 patent, and characterizes the means-plus-function element as indefinite.

Toyota, Paper 12 at 27; *see also id.* at 28 ("In any event, with regard to alleged obviousness of claims over prior art, Petitioner has not identified structure, material, and acts in the Specification of the '786 patent that correspond to the generating means of claim 92. Therefore, Petitioner has not accounted for how such unidentified structure, material, and acts would have been met by the prior art.").

The petitioner in *CareFusion* also stated in its petition that it was offering constructions with which it expressly disagreed, and the panel likewise indicated that it denied the petition partly because the petitioner did not sufficiently identify the corresponding structure for a means-plus-function claim:

> Petitioner has failed to identify the structure, material, or acts corresponding to the claimed function of generating user interface information either on the display areas (claim 1) or on the display (claims 11 and 24). Petitioner's assertion that the claim terms are indefinite does not excuse Petitioner's failure to provide the required claim construction.
>
> Petitioner's alternative argument that the corresponding structure is a generic microprocessor is also insufficient. Except for a narrow exception, the disclosure of a general purpose microprocessor as corresponding structure for a computer-implemented means-plus-function element is not sufficient—a corresponding algorithm must be disclosed. . . . Petitioner's alternative claim construction is insufficient for failure to identify a corresponding algorithm.

CareFusion, Paper 9 at 7, 9–10 (internal citation omitted); *see also id.* at 18 ("Relying on its erroneous claim construction, Petitioner identifies where [the asserted reference] discloses one or more processors. Petitioner's erroneous claim constructions infect the anticipation and obviousness analyses of all of the challenged claims." (internal citations omitted)).

On the other hand, as discussed above, Petitioner here has offered a claim construction for "power tracker," and, in this proceeding, it has not expressly disagreed with that construction.

In view of the foregoing, we maintain our finding that Petitioner's approach in offering the ALJ's construction of "power tracker" in the related ITC investigation is acceptable under our rules. *See* Inst. Dec. 11–13 ("We find this approach to be acceptable under 37 C.F.R. § 42.104(b)(3).").

2. "plurality of carrier aggregated transmit signals"

This term also appears in several claims, including independent claims 1 and 18. All the challenged claims in this proceeding therefore require the recited "plurality of carrier aggregated transmit signals." Petitioner asserts that the ALJ in the related ITC investigation adopted Patent Owner's proposed interpretation of this claim term, construing it to mean "signals for transmission on multiple carriers at the same time to increase the bandwidth for a user." Pet. 12; Ex. 1218, 14–17 (ITC order) (cited by Pet. 12). Petitioner "believes this construction is overbroad under *Phillips*," but "applies the ALJ's construction both as the broadest reasonable interpretation for purposes of analysis under Rule 42.100, and to show that the claims are invalid even under the Patent Owner's proposed construction." Pet. 12.

Patent Owner responds that the term "carrier aggregated transmit signals" instead means "signals from a single terminal utilizing multiple component carriers which provide extended transmission bandwidth for a user transmission from the single terminal." PO Resp. 16. As support, Patent Owner directs us to where the '675 patent teaches that "carrier

aggregation . . . is operation on multiple carriers." *Id.* at 14 (citing Ex. 1201, 2:63–64).[9] Patent Owner also points out that Petitioner relies on extrinsic evidence, namely, Dahlman, for its "background discussion" of carrier aggregation. *Id.* That background discussion does not provide details on carrier aggregation, instead directing us to the declaration testimony of Dr. Choi, which, in turn, relies on Dahlman. *See* Pet. 6–7 (citing Ex. 1203 ¶¶ 45–48 (citing Ex. 1206, 104)). According to Patent Owner, Petitioner, "via its citation to Dahlman, states that 'carrier aggregation' uses 'multiple component carriers' to extend 'transmission bandwidth' from a 'single terminal.'" PO Resp. 15 (quoting Ex. 1206, 104).[10]

In its Reply, Petitioner counters that Patent Owner's "new" construction "adds several limitations to the construction that the Patent Owner previously proposed and that the ALJ adopted: that the signals be 'from a single terminal,' that they use 'multiple component carriers,' and that they provide extended transmission bandwidth 'for a user transmission from the single terminal.'" Pet. Reply 3. Petitioner contends that "[a] construction that adds limitations to a construction advanced and adopted under the narrower *Phillips* standard cannot, by definition, be the broadest reasonable interpretation." *Id.* Petitioner also contends that Dahlman describes carrier aggregation in the context of "transmission to/from a single

[9] Patent Owner cites Exhibit 1001 when referring to the '675 patent in its papers. The '675 patent is entered in the record of this proceeding as Exhibit 1201. Thus, we cite Exhibit 1201 when referring to the '675 patent in this Decision.

[10] Patent Owner cites Exhibit 1006 when referring to Dahlman in its papers. Dahlman is entered in the record of this proceeding as Exhibit 1206. Thus, we cite Exhibit 1206 when referring to Dahlman in this Decision.

terminal," not just "from a single terminal." *Id.* at 4–5 (emphases omitted) (citing PO Resp. 15); *see also* Ex. 1206, 104 (cited by PO Resp. 15). Moreover, Petitioner notes, "in the ITC, Patent Owner stated expressly that the ['675] patent is 'agnostic' with respect to coverage of uplink versus downlink transmissions." Pet. Reply 4 (citing Ex. 1229, 143 (ITC hearing transcript)).

According to Patent Owner, it proposed a narrower construction of the claim term in response to Petitioner's characterization of the ITC construction as "overbroad." PO Sur-reply 2. Patent Owner asserts that "Petitioner cannot have it both ways: If the ITC construction is wrong, as Petitioner asserts, then it should not control the scope of the claim under the BRI." *Id.* at 2–3. With respect to Patent Owner's narrower construction, Patent Owner further asserts that "the added limitations about which Petitioner complains—'from a single terminal,' 'multiple component carriers,' and 'provid[ing] extended transmission bandwidth,'—come *verbatim* from the Petitioner's own evidence, Dahlman." *Id.* at 3 (internal citation omitted). Patent Owner also contends that "the natural read of the claims is that they are reciting carrier aggregated transmit signals that are transmitted *from* the mobile terminal" because "in the '675 patent, all examples are from the perspective of the wireless device 110 (*i.e.*, mobile terminal), and the claims are directed to transmitting, rather than receiving." *Id.* at 4 (internal citations omitted).

On the record before us, we determine that Patent Owner's proposed construction (i.e., "signals from a single terminal utilizing multiple component carriers which provide extended transmission bandwidth for a user transmission from the single terminal") is overly narrow. The claims of

the ’675 patent recite “carrier aggregated transmit signals.” The ’675 patent explicitly defines “carrier aggregation” as “operation on multiple carriers,” and it explicitly defines “[a] transmit signal” as “a signal comprising a transmission on one or more carriers, a transmission on one or more frequency channels, etc.” Ex. 1201, 2:63–64, 3:60–62. Although Dahlman refers to *component* carriers in its discussion of carrier aggregation (*see* Ex. 1206, 104), we note that “a patentee can ‘choose to be his or her own lexicographer by clearly setting forth an explicit definition for a claim term that could differ in scope from that which would be afforded by its ordinary meaning,’” *Jack Guttman, Inc. v. Kopykake Enters., Inc.*, 302 F.3d 1352, 1360 (Fed. Cir. 2002) (quoting *Rexnord Corp. v. Laitram Corp.*, 274 F.3d 1336, 1342 (Fed. Cir. 2001)). Our reviewing court has explained that “[t]he specification acts as a dictionary when it expressly defines terms used in the claims,” and that such definition “[u]sually . . . is dispositive; it is the single best guide to the meaning of a disputed term.” *Vitronics Corp. v. Conceptronic, Inc.*, 90 F.3d 1576, 1582 (Fed. Cir. 1996). Here, the definitions provided in the ’675 patent refer broadly to signals comprising transmissions on carriers; they do not support limiting “carrier aggregated transmit signals” to signals comprising transmissions on *component* carriers, as Patent Owner submits.

Further, Patent Owner’s proposed construction improperly requires signals *from a single terminal*. Even if “all examples [in the ’675 patent] are from the perspective of the wireless device 110 (*i.e.*, mobile terminal),” as Patent Owner argues, the specification “is not a substitute for, nor can it be used to rewrite, the chosen claim language.” *See* PO Sur-reply 4; *SuperGuide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 875 (Fed. Cir.

2004); *see also Liebel-Flarsheim Co. v. Medrad, Inc.*, 358 F.3d 898, 906 (Fed. Cir. 2004) (expressly rejecting "the contention that if a patent describes only a single embodiment, the claims of the patent must be construed as being limited to that embodiment"). We recognize that "understanding the claim language may be aided by the explanations contained in the written description," but "it is important not to import into a claim limitations that are not a part of the claim." *SuperGuide*, 358 F.3d at 875. Thus, "a particular embodiment appearing in the written description may not be read into a claim when the claim language is broader than the embodiment." *Id.*

In this case, the claim language itself recites nothing about signals from a single terminal. As our reviewing court has explained, "it is the *claims*, not the written description, which define the scope of the patent right." *Laitram Corp. v. NEC Corp.*, 163 F.3d 1342, 1347 (Fed. Cir. 1998). Although the '675 patent discloses examples and embodiments where the signals are from a single terminal, nowhere does the specification limit "carrier aggregated transmit signals" to those examples and embodiments. Our reviewing court has "cautioned against limiting the claimed invention to preferred embodiments or specific examples in the specification." *Williamson v. Citrix Online, LLC*, 792 F.3d 1339, 1346–47 (Fed. Cir. 2015) (quoting *Teleflex, Inc. v. Ficosa N. Am. Corp.*, 299 F.3d 1313, 1328 (Fed. Cir. 2002)). Indeed, the '675 patent states that its "disclosure is not intended to be limited to the examples and designs described." Ex. 1201, 14:21–25.

Moreover, with respect to carrier aggregation, the '675 patent further teaches that wireless device 110 "may send and/or receive transmissions" on multiple carriers according to various combinations of bands and band

groups, including three contiguous carriers in the same band, three non-contiguous carriers in the same band, three carriers in different bands in the same band group, and three carriers in different bands in different band groups. *Id.* at 3:1–35. This teaching is consistent with Dahlman's discussion of carrier aggregation, where multiple carriers "are aggregated and jointly used for transmission *to/from* a single terminal." *See* Ex. 1206, 104 (emphasis added) (cited by PO Resp. 15); Pet. Reply 4–5.

Patent Owner's proposed construction also improperly requires providing extended transmission bandwidth for a user transmission from a single terminal. The claim language recites nothing about extended transmission bandwidth, let alone extended transmission bandwidth for a user transmission from a single terminal. Although the '675 patent discloses an example where carrier aggregation provides such extended transmission bandwidth, nowhere does the specification limit "carrier aggregated transmit signals" to that example. *See* Ex. 1201, 2:65–67 ("Wireless device 110 *may* be configured with up to 5 carriers in one or two bands in LTE Release 11." (emphasis added)). As discussed above, the '675 patent states that its "disclosure is not intended to be limited to the examples and designs described." *Id.* at 14:21–25.

Turning now to Petitioner's proposed construction (i.e., "signals for transmission on multiple carriers at the same time to increase the bandwidth for a user"), we note its similar requirement of increasing the bandwidth for a user. Petitioner's proposed construction is therefore also improper for the same reasons as Patent Owner's proposed construction. In particular, the claim language recites nothing about increasing the bandwidth for a user, and nowhere does the specification limit "carrier aggregated transmit

signals" to any disclosed example where carrier aggregation increases the bandwidth for a user. Moreover, during oral argument, Petitioner's counsel conceded that Petitioner "would have no objection to eliminating that ['']bandwidth for a user['] portion" because "that language itself does not come specifically from the specification." Tr. 10:22–11:17; *see id.* at 11:8–10 (Petitioner's counsel stating that "the idea of operation on multiple carriers *in our view* implies increasing bandwidth" (emphasis added)).

Additionally, we note that claim 1 of the '675 patent recites a "plurality of carrier aggregated transmit signals being sent simultaneously." Construing "plurality of carrier aggregated transmit signals" to mean, in part, "signals for transmission . . . at the same time" would render the claim language "being sent simultaneously" redundant and superfluous. *See Dig.-Vending Servs. Int'l, LLC v. Univ. of Phx., Inc.*, 672 F.3d 1270, 1275 (Fed. Cir. 2012) (noting "the importance of construing claim terms in light of the surrounding claim language, such that words in a claim are not rendered superfluous"); *cf.* Ex. 1218, 14 (ITC judge construing "a plurality of carrier aggregated transmit signals being sent simultaneously," not just "a plurality of carrier aggregated transmit signals"); Tr. 14:5–7 (Petitioner's counsel conceding that "if [we] were to construe the broader term, it would make that ['']at the same time['] inconsistency go away").

In view of the foregoing, we construe "plurality of carrier aggregated transmit signals" to mean "signals for transmission on multiple carriers." Our construction is consistent with the '675 patent, which defines the term "carrier aggregation" as "operation on multiple carriers" and the term "[a] transmit signal" as "a signal comprising a transmission on one or more carriers, a transmission on one or more frequency channels, etc." *See*

Ex. 1201, 2:63–64, 3:60–62. Our construction also encompasses, but is not limited to, Patent Owner's proposed construction (i.e., "signals from a single terminal utilizing multiple component carriers which provide extended transmission bandwidth for a user transmission from the single terminal").

3. "generates the single power tracking signal based on a combination of the plurality of I and Q components"

This term appears in independent claims 1 and 18, which recite a power tracker that "generates the single power tracking signal based on a combination of the plurality of I and Q components." The parties' dispute as to the meaning of this claim term developed after institution as part of their respective analyses regarding whether the asserted references teach the recited power tracker. Following oral argument, we issued an order authorizing the parties to submit "further briefing on the meaning of the claim language 'generates the single power tracking signal based on a combination of the plurality of I and Q components.'" Paper 26, 2. Pursuant to our order, both parties filed briefs. *See* Pet. Br; PO Br.

In its brief, Petitioner argues that the claim term "generates the single power tracking signal based on a combination of the plurality of I and Q components" means "generates the single power tracking signal using a combination derived from the plurality of I and Q components." Pet. Br. 1. Petitioner asserts that the plain meaning of this claim term "requires only 'a' combination—not any particular combination—involving the use of the I and Q components." *Id.*

By contrast, Patent Owner argues that "based on a combination of the plurality of I and Q components" means "based on the result of an addition

operation of a plurality of inphase (I) component terms and a plurality of quadrature (Q) component terms," where "addition" refers to "the operation of combining numbers so as to obtain an equivalent simple quantity." PO Br. 1. According to Patent Owner, Petitioner's proposed construction equates "based on a combination of" with "based on," thereby "read[ing] out claim language added during prosecution." *Id.* To illustrate, Patent Owner points us to an amendment of claim 1, which is reproduced below. *Id.* at 1–2 (citing Ex. 1202, 189 (prosecution history file)).[11]

1. (Currently Amended) An apparatus comprising:

a power tracker configured to determine a single power tracking signal based on a plurality of inphase (I) and quadrature (Q) components of a plurality of different transmit signals being sent simultaneously, wherein the power tracker receives the plurality of I and Q components corresponding to the plurality of different transmit signals and generates the single power tracking signal based on a combination of the plurality of I and Q components; ~~and~~

a power supply generator configured to generate a single power supply voltage based on the single power tracking signal; and

a power amplifier to receive the single power supply voltage and the plurality of different transmit signals being sent simultaneously and to produce a single output RF signal.

The amendment to claim 1 adds, *inter alia*, the requirement that the power tracker receives a plurality of I and Q components and generates the single power tracking signal based on a combination of the plurality of I and Q components. Ex. 1202, 189 (prosecution history file). Patent Owner contends that "[t]his amendment was made to differentiate prior art, where 'Kenington discloses multiple envelope trackers,' and 'Kenington's

[11] Patent Owner cites Exhibit 1002 when referring to the prosecution history file for the '675 patent in its papers. The prosecution history file is entered in the record of this proceeding as Exhibit 1202. Thus, we cite Exhibit 1202 when referring to the prosecution history file in this Decision.

envelope tracker 162 receives only one I signal and one Q signal for envelope tracking[]. . . (*i.e.*, not a plurality of I and Q, as claimed).'" PO Br. 1–2 (citing Ex. 1202, 196, 221).

Patent Owner adds, "By amending, the applicant expressly disavowed implementations where there is no 'combination of the plurality of I and Q components.'" *Id.* at 2. Here, Patent Owner is referring specifically to Equation 2 of the '675 patent. Patent Owner asserts that the '675 patent "says that Eq. 2 can be implemented 'based on voltages of the plurality of transmit signals,' not a combination of I and Q components." *Id.* at 3. According to Patent Owner, "[b]ecause Eq. 2 can be implemented by combining voltage values, not all implementations of Eq. 2 have been shown to fall within the scope of claim 1." *Id.*

Petitioner counters that "[t]he claim language does not, as [Patent Owner] suggests, require combining I and Q components without any modification (*e.g.*, $I_1 + Q_1 + I_2 + Q_2$)." Pet. Br. 1. As support, Petitioner directs our attention to Equations 1 and 2 of the '675 patent, which are reproduced below. *Id.* (citing Ex. 1201, 8:6–27).

$$p(t)=\sqrt{K}\cdot\sqrt{I_1^2(t)+Q_1^2(t)+\ldots+I_K^2(t)+Q_K^2(t)}, \qquad \text{Eq (1)}$$

$$p(t)=\sqrt{I_1^2(t)+Q_1^2(t)}+\ldots+\sqrt{I_K^2(t)+Q_K^2(t)}. \qquad \text{Eq (2)}$$

In Equation 1, "the powers of all transmit signals are summed to obtain an overall power," and "[t]he digital power tracking signal [for period t] is then obtained by taking the square root of the overall power." Ex. 1201, 8:10–21. In Equation 2, "the voltage of each transmit signal is first computed, and the voltages of all the transmit signals are then summed to obtain the digital power tracking signal." *Id.* at 8:25–32. Petitioner contends that "[b]oth

equations satisfy the claim language, but neither combines the original, unmodified, I and Q components: rather, each equation squares the I and Q components before combining them." Pet. Br. 1–2.

Petitioner also directs our attention to claim 17 of the '675 patent, which depends from claim 1 and is reproduced below. *Id.* at 2.

> **17**. The apparatus of claim **1**, wherein the power tracker is configured to determine the single power tracking signal based on functions comprising:
>
> calculating $\sqrt{I_k^2(t)+Q_k^2(t)}$ corresponding to K inphase (I) and quadrature (Q) components to produce K voltages; and
>
> summing the K voltages.

Petitioner contends that claim 17 "requires determining the [single] power tracking signal [as recited in claim 1 by] using Equation 2," and that "the scope of the term at issue here (which is in every independent claim) must encompass Equation 2." *Id.*

As for Patent Owner's reliance on the prosecution history, Petitioner contends that "[n]othing in the amendment indicates a clear and unmistakable disavowal of Equation 2." *Id.* at 3 (citing *Core Wireless Licensing S.A.R.L. v. LG Elecs., Inc.*, 880 F.3d 1356, 1367 (Fed. Cir. 2018)). Petitioner asserts that "[t]he [disputed] term was added in an amendment that significantly altered several aspects of the claim, to overcome a rejection based on the Kenington reference," which the applicant argued "was distinguishable because it involved 'multiple envelope trackers' rather than 'a single power supply voltage derived from I and Q components of different transmit signals.'" *Id.* at 2–3 (citing Ex. 1202, 189–196). Additionally, Petitioner asserts that the "[a]pplicants described their invention ***broadly*** as

generating a power supply voltage '***derived from I and Q components***.'" *Id.* at 3 (citing Ex. 1202, 196).

On this record, we find that Patent Owner's proposed construction improperly requires a power tracker that generates a single power tracking signal based on the result of an *addition operation* on a plurality of I and Q components. For instance, the claim language recites nothing about an addition operation. As for the written description, although it may disclose Equation 1 as an example where generating a single power tracking signal is based on the result of an addition operation on a plurality of I and Q components, as Patent Owner argues, nowhere does the written description limit the meaning of "based on a combination of" to that example. Indeed, the written description does not even use that phrase. Moreover, the written description expressly states that the '675 patent's "disclosure is not intended to be limited to the examples and designs described herein." Ex. 1201, 14:21–25.

The prosecution history likewise says nothing about requiring an addition operation. *See generally* Ex. 1202. With respect to the cited amendment to claim 1 in particular, we note that the applicant argued that "Ken[]ington does not disclose a single power supply voltage derived from I and Q components of different transmit signals." *Id.* at 196. The term "derived from" by itself does not require an addition operation, and the applicant did not argue otherwise during prosecution.

Further, Patent Owner's contention that the amendment added the language "based on *a combination of*" to distinguish over Kenington is unavailing. Following the amendment, the Examiner explicitly disagreed with the applicant's arguments that "Kenington discloses multiple envelope

trackers driving different power supply for different transmit signals," and that "Kenington does not disclose a single power supply voltage derived from I and Q components of different transmit signals." *Id.* at 201. The Examiner continued to rely on Kenington, finding that it "teaches the power tracking signal *based on* I and Q." *Id.* at 203 (emphasis added); *see also id.* at 228–229 (Examiner stating in a subsequent advisory action that the applicant's request for reconsideration "does not overcome prior art of record," including Kenington). The applicant did not point to any distinctions between "based on" and "based on a combination of." *See generally id.* at 195–196 (Amendment & Response to Office Action, Nov. 12, 2014); *id.* at 221–223 (Amendment & Response to Office Action, Jan. 19, 2015). Notably, the Examiner stopped relying on Kenington only after the applicant amended claim 1 to recite "*carrier aggregated* transmit signals." *See id.* at 236–247 (Amendment & Response to Office Action under 37 C.F.R. § 1.116 and AFCP 2.0 Request, Mar. 6, 2015); *id.* at 266–280 (Office Action, July 2, 2015).

We turn now to Patent Owner's argument that the applicant expressly disavowed "implementations where there is no 'combination of the plurality of I and Q components,'" such as implementations of Equation 2 that combine voltage values. *See* PO Br. 2. Patent Owner contends in particular that "[b]ecause Eq. 2 can be implemented by combining voltage values, not all implementations of Eq. 2 have been shown to fall within the scope of claim 1." *Id.* at 3. We disagree. As Petitioner points out, claim 17, which depends from claim 1, "requires determining the power tracking signal using Equation 2." *See* Pet. Br. 2. Specifically, claim 17 recites, in part,

> the power tracker is configured to determine the single power tracking signal based on functions comprising:
>
> calculating $\sqrt{I_k{}^2(t) + Q_k{}^2(t)}$ corresponding to K inphase (I) and quadrature (Q) components to produce K voltages; and
>
> *summing the K voltages*.

(Emphasis added.) This claim language corresponds to the written description of Equation 2, which states,

> The quantity $\sqrt{I_k{}^2(t) + Q_k{}^2(t)}$ denotes the voltage of the k-th transmit signal in sample period t. In the design shown in equation (2), the voltage of each transmit signal is first computed, and the *voltages of all transmit signals are then summed* to obtain the digital power tracking signal.

Ex. 1201, 8:28–32 (emphasis added). Thus, the scope of claim 1 encompasses implementations of Equation 2 that combine *voltage* values, thereby undermining Patent Owner's disavowal argument. *See* PO Br. 3; *Poly-America, L.P. v. API Indus., Inc.*, 839 F.3d 1131, 1136 (Fed. Cir. 2016) ("[T]he standard for disavowal is exacting, requiring clear and unequivocal evidence that the claimed invention includes or does not include a particular feature.").

In view of the foregoing, we adopt Petitioner's proposed construction of the claim term "generates the single power tracking signal based on a combination of the plurality of I and Q components," namely, "generates the single power tracking signal using a combination derived from the plurality of I and Q components." *See* Pet. Br. 1. This construction encompasses implementations of both Equations 1 and 2 of the '675 patent, consistent with the written description's teaching that "*Equations (1) and (2)* are two exemplary designs of computing the digital power tracking signal based on the I and Q samples for all transmit signals being sent simultaneously."

Ex. 1201, 8:33–36 (emphasis added); *see also id.* at 8:47–50 ("In one design, the digital power tracking signal may be generated based on the I and Q samples for all transmit signals, without any filtering, e.g., as shown in *equation (1) or (2)*" (emphasis added).). This construction also is consistent with the prosecution history. For example, following its amendment to claim 1, which added the language "based on a combination of," the applicant indicated that the claim requires "a single power supply voltage *derived* from I and Q components of different transmit signals." *See* Ex. 1202, 196 (emphasis in italics added). Additionally, the applicant did not subsequently point to any distinctions between "based on" and "based on a combination of," even after the Examiner found that "Kenington teaches the power tracking signal *based on* I and Q." *Id.* at 203 (emphasis added).

B. Obviousness over Chen and Wang

Petitioner asserts that claims 1–3, 5, 7, 11, 17–21, and 27 would have been obvious over Chen and Wang. Pet. 15–59. Patent Owner traverses this ground. PO Resp. 35–51. For the reasons explained below, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 1–3, 5, 7, 11, 17–21, and 27 would have been obvious over Chen and Wang.

We start with an overview of the asserted references.

1. Chen

Chen is a paper that proposes a hybrid envelope tracking scheme. Ex. 1212, 662. Figure 1 of Chen, which is reproduced below, illustrates the proposed scheme. *Id.*

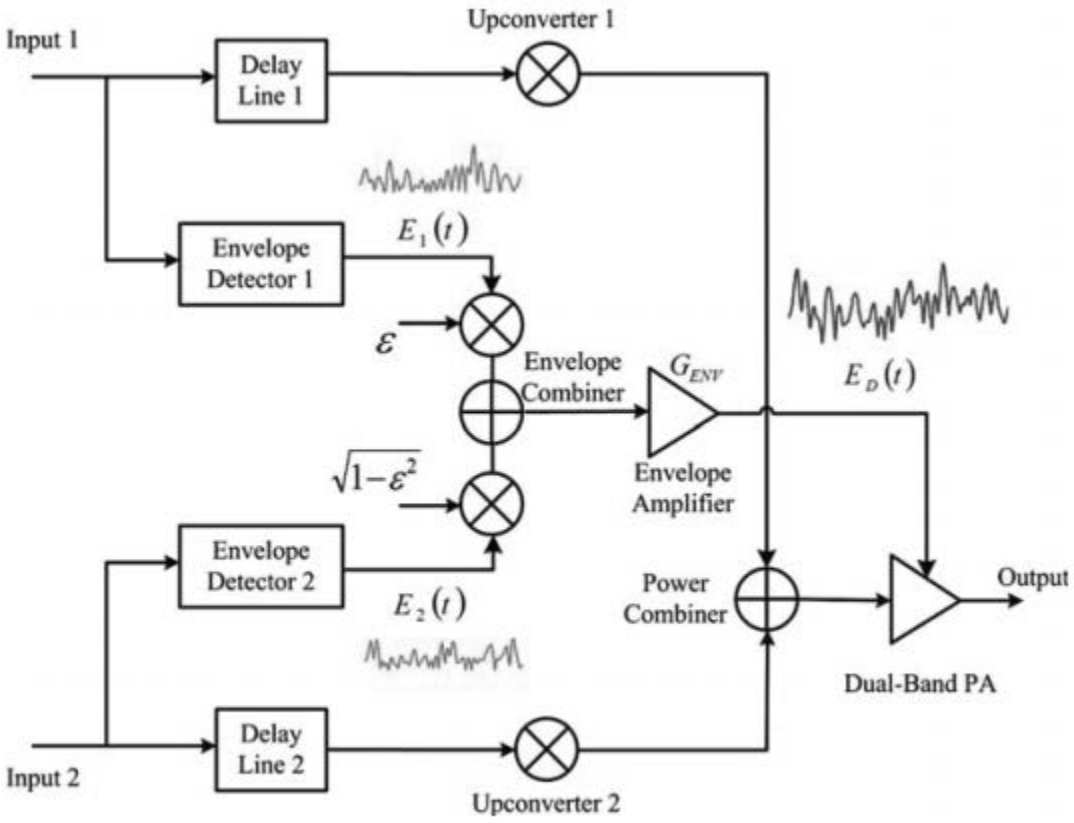


Figure 1 Proposed hybrid ET scheme for concurrent dual-band PAs.

In particular, Figure 1 of Chen shows the proposed hybrid envelope tracking architecture for concurrent dual-band power amplifiers. *Id.* Input signals 1 and 2 are provided at different frequencies (*id.* at 662), and each signal follows two paths (*see id.*, Fig. 1). Along one path, input signals 1 and 2 are fed separately to respective envelope detectors 1 and 2, where the envelopes of the signals are detected. *Id.* at 662, Fig. 1. The signals are then weighted using power weighting factor Ɛ. *Id.* Next, the signals are added together by the envelope combiner and injected into the envelope amplifier. *Id.* The output of the envelope amplifier is used to modulate the supply voltage of the target dual-band power amplifier (PA). *Id.* at 662. Chen indicates that

$E_1(t)$ and $E_2(t)$ represent the signal envelopes in dual bands, and $E_D(t)$ represents the final modulated supply of the power amplifier. *Id.*

Along the other path, Figure 1 of Chen shows input signals 1 and 2 also being fed separately to respective delay lines 1 and 2. *See id.*, Fig. 1. The signals are then upconverted by upconverters 1 and 2 and added together by the power combiner. *See id.* The power combiner outputs a signal that is provided to the dual-band PA. *See id.*

After receiving signals from both the envelope amplifier and the power combiner, the dual-band PA generates an output signal. *See id.*

2. Wang

Wang describes an envelope-tracking power amplifier system. Ex. 1205, 1244 (Title, Abstract). In Wang, the input signal is a complex baseband signal whose amplitude is $A = (I^2 + Q^2)^{1/2}$, where I and Q are the real and imaginary parts of the complex baseband signal. *Id.* at 1245, Fig. 3.

3. Independent Claims 1 and 18

Claim 1 is directed to an apparatus comprising a "power tracker," a "power supply generator," and a "power amplifier." Claim 18, which is directed to a corresponding method, recites similar limitations as claim 1. Petitioner relies on the same discussion for both claims. Pet. 16–42. Our analysis of claim 1 applies to claim 18.

a. "power tracker"

Claim 1 recites "a power tracker configured to determine a single power tracking signal based on a plurality of inphase (I) and quadrature (Q)

components of a plurality of carrier aggregated transmit signals being sent simultaneously." Claim 1 requires that "the power tracker receives the plurality of I and Q components . . . and generates the single power tracking signal based on a combination of the plurality of I and Q components." Claim 1 also requires that "the plurality of carrier aggregated transmit signals comprise Orthogonal Frequency Division Multiplexing (OFDM) or Single Carrier Frequency Division Multiple Access (SC-FDMA) signals."

As discussed above, we construe "power tracker" to mean "component in a voltage generator that computes the power requirement." *See supra* Part III.A.1. We also construe "plurality of carrier aggregated transmit signals" to mean "signals for transmission on multiple carriers." *See supra* Part III.A.2. In addition, we construe "generates the single power tracking signal based on a combination of the plurality of I and Q components" to mean "generates the single power tracking signal using a combination derived from the plurality of I and Q components." *See supra* Part III.A.3.

For claim 1, Petitioner relies on both Chen and Wang. In particular, Petitioner identifies Chen's envelope detectors 1 and 2 together with Chen's envelope combiner as comprising a "power tracker." Pet. 18–19. Petitioner also identifies the output of Chen's envelope combiner as a "power tracking signal." *Id.* at 22. Additionally, Petitioner identifies Chen's input signals 1 and 2 as "carrier aggregated transmit signals." *Id.* at 24. To illustrate, Petitioner provides an annotated version of Figure 1 of Chen, which is reproduced below. *Id.* at 18.

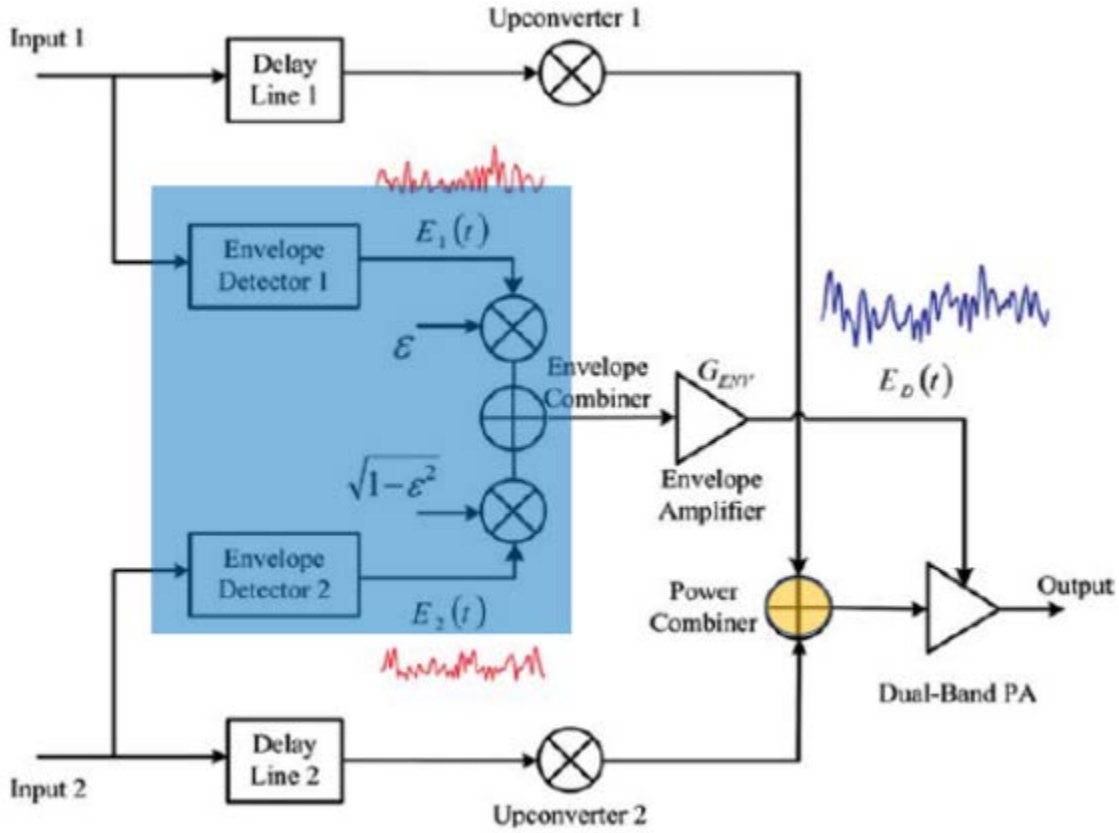


Figure 1 of Chen illustrates the architecture for a hybrid envelope tracking scheme. Ex. 1212, 662. Chen's envelope detectors 1 and 2 as well as Chen's envelope combiner are highlighted in blue. Petitioner asserts that these components are in a voltage generator for the dual-band PA, and directs us to where Chen teaches that "$E_D(t)$ is the final modulated supply of the PA." Pet. 19 (citing Ex. 1212, 662); *see also* Ex. 1212, Fig. 3 (showing envelope waveforms E(t) measured in voltages).

Petitioner further directs us to where Chen teaches that the envelopes of input signals 1 and 2 are detected by envelope detectors 1 and 2, then weighted using power weighting factor Ɛ, and then combined by the envelope combiner. Pet. 19 (citing Ex. 1212, 662). The envelope combiner outputs a signal that is fed to the envelope amplifier, which generates $E_D(t)$.

Ex. 1212, 662. Petitioner points to where Chen teaches that the detected envelope signals are represented by $E_1(t)$ and $E_2(t)$. Pet. 19 (citing Ex. 1212, 662). According to Petitioner, these envelope signals "are proxies for the power of each input signal," and the envelope combiner's output signal "is a proxy for the combined power of the two input signals." *Id.* at 20–21; *see also id.* at 22 ("[T]he use of a 'power weighting factor' to weight the envelope signals . . . confirms that the output of the Envelope Combiner represents the power requirement." (citing Ex. 1203 ¶ 100)).

With respect to Chen's input signals 1 and 2, Petitioner additionally directs us to where Chen describes the signals as "two single carrier wideband code division multiple access signals," which operate at different frequencies. *Id.* at 24 (citing Ex. 1212, 663). Petitioner contends that this teaching indicates that the signals "are from different (multiple) carriers." *Id.* Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1203 ¶ 103).

Petitioner submits, however, "Chen does not expressly mention I and Q components of the input signals, but a [person of ordinary skill in the art] would have understood that Input 1 and Input 2 are digital signals that each would have such I and Q components." *Id.* at 25. Petitioner directs us again to where Chen describes its input signals as wideband code division multiple access ("WCDMA") signals, and asserts that "WCDMA is the dominant third-generation (UMTS) cellular technology and uses Quadrature Phase Shift Keying (QPSK) modulation." *Id.* at 25–26 (citing Ex. 1212, 663; Ex. 1206, 19, 205, 389). Relying on the declaration testimony of Dr. Choi, Petitioner contends that an ordinarily skilled artisan "would have known that

QPSK modulation uses signals that have I and Q components." *Id.* at 26 (citing Ex. 1203 ¶ 105).

Alternatively, Petitioner points to Wang for teaching the recited I and Q components. *Id.* According to Petitioner, even if Chen does not disclose I and Q signals, "it would have been obvious to use Wang's I/Q signal processing in Chen." *Id.* Petitioner directs us to where Wang teaches receiving a "complex baseband signal," which Petitioner asserts "is generally understood to comprise I and Q components." *Id.* at 26–27 (citing Ex. 1205, Fig. 3; Ex. 1203 ¶ 107). Petitioner further draws our attention to Wang's teaching that "[t]he amplitude is $A = (I^2 + Q^2)^{1/2}$, where I and Q are the real and imaginary parts of the complex baseband signal." *Id.* at 27 (citing Ex. 1205, 1245). Petitioner contends that an ordinarily skilled artisan "would have been motivated to use Wang's I/Q signal processing in Chen to efficiently process and transmit the RF signals in Chen's system." *Id.* at 30. Petitioner asserts that "[c]omplex input signals (with I and Q components) allow the use of advanced modulation techniques such as quadrature phase-shift keying (QPSK), which doubles the data rate by increasing the number of bits per symbol that can be transmitted within the same bandwidth, compared with a method such as binary phase-shift keying (BPSK)." *Id.* at 31 (citing Ex. 1221, 308).

Petitioner also points to Wang for expressly teaching Orthogonal Frequency Division Multiplexing (OFDM) signals. *Id.* at 35 (citing Ex. 1205, 1244 (title), 1253). According to Petitioner, an ordinarily skilled artisan "would have looked to Wang, a reference in the same field, to determine a modulation technique for Chen." *Id.* In addition, Petitioner contends that "OFDM had many advantages, including the ability to adapt to

degraded channel conditions without complex equalization filters, and robustness against various forms of interference." *Id.* at 36 (citing Ex. 1222 ¶¶ 2–3). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1203 ¶ 117[12]).

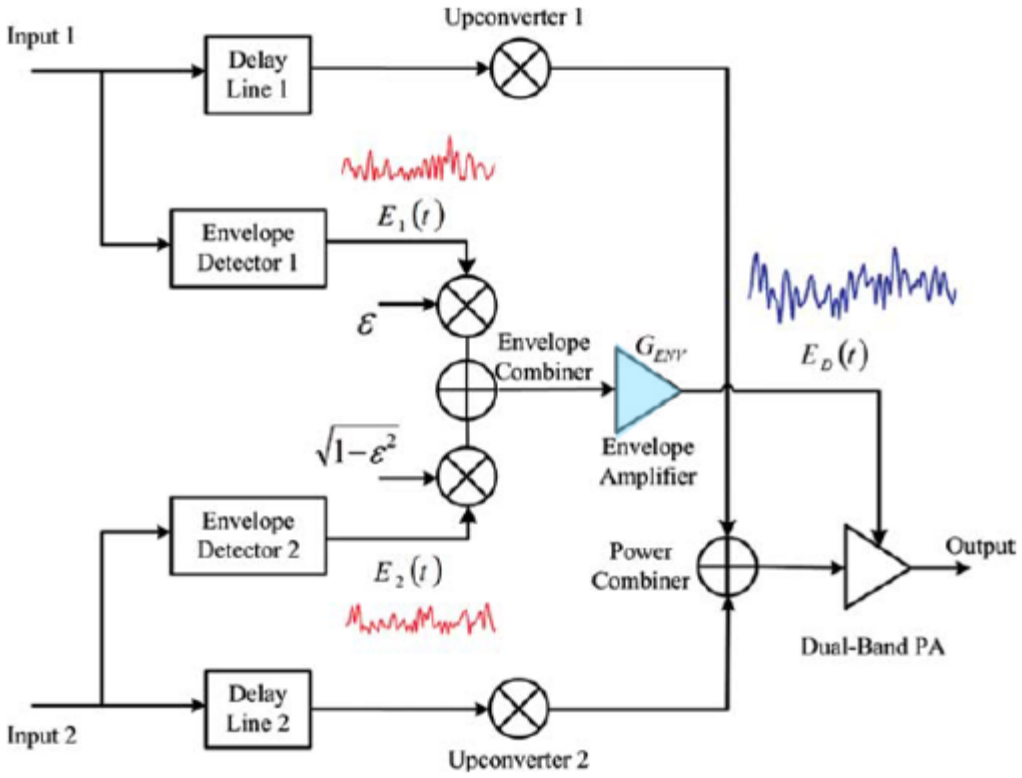
Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the recited power tracker limitations in claim 1. With respect to the recited I and Q components in particular, we are persuaded that Chen's signals 1 and 2 would have been understood to include I and Q components. *See*, *e.g.*, Ex. 1203 ¶ 105. We also are persuaded that Petitioner's proffered reasoning for modifying Chen to include Wang's baseband signal (comprising an OFDM signal with I and Q components) is sufficient to support the legal conclusion of obviousness. *See In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006) ("[T]here must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness."). Namely, we are persuaded that modifying Chen to include Wang's baseband signal would have provided a way to carry out Chen's signaling. *See* Pet. 31 ("Complex input signals (with I and Q components) allow the use of advanced modulation techniques such as quadrature phase-shift keying (QPSK)."); *id.* at 35 (asserting that an ordinarily skilled artisan "would have looked to Wang, a reference in the same field, to determine a modulation technique for Chen").

[12] Although Petitioner cites paragraph 118 of Exhibit 1203, we believe that Petitioner intended to cite paragraph 117 of Exhibit 1203, which includes the declaration testimony of Dr. Choi referred to in the Petition.

Patent Owner disputes certain aspects of Petitioner's analysis regarding the recited "power tracker." *See* PO Resp. 35–51. We address the parties' disputes in further detail below. *See infra* Part III.B.5.

b. "power supply generator"

Claim 1 further recites "a power supply generator configured to generate a single power supply voltage based on the single power tracking signal." For this limitation, Petitioner identifies Chen's envelope amplifier as a "power supply generator," and Chen's supply $E_D(t)$ as a "single power supply voltage." Pet. 38–39. To illustrate, Petitioner provides an annotated version of Figure 1 of Chen, which is reproduced below. *Id.* at 39.



As discussed above, Figure 1 of Chen shows the architecture for a hybrid envelope tracking scheme. Ex. 1212, 662. Petitioner directs us to where Chen teaches that "[t]he envelopes of the input signals at different

frequencies are detected separately . . . and then added together in time domain and injected into the envelope amplifier, finally, the output of the envelope amplifier is used to modulate the supply voltage of the target dual-band PA." Pet. 39 (citing Ex. 1212, 662). The annotated figure shows Chen's envelope amplifier with light blue shading receiving the envelope combiner's output signal (which Petitioner identifies as the "single power tracking signal") and generating supply $E_D(t)$.

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the recited power supply generator limitation in claim 1. *See, e.g.*, Ex. 1212, 662, Fig. 1. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

c. "power amplifier"

Lastly, claim 1 recites "a power amplifier configured to receive the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously to produce a single output radio frequency (RF) signal." For this limitation, Petitioner identifies Chen's dual-band PA as a "power amplifier." Pet. 40–41. To illustrate, Petitioner provides an annotated version of Figure 1 of Chen, which is reproduced below. *Id.* at 41.

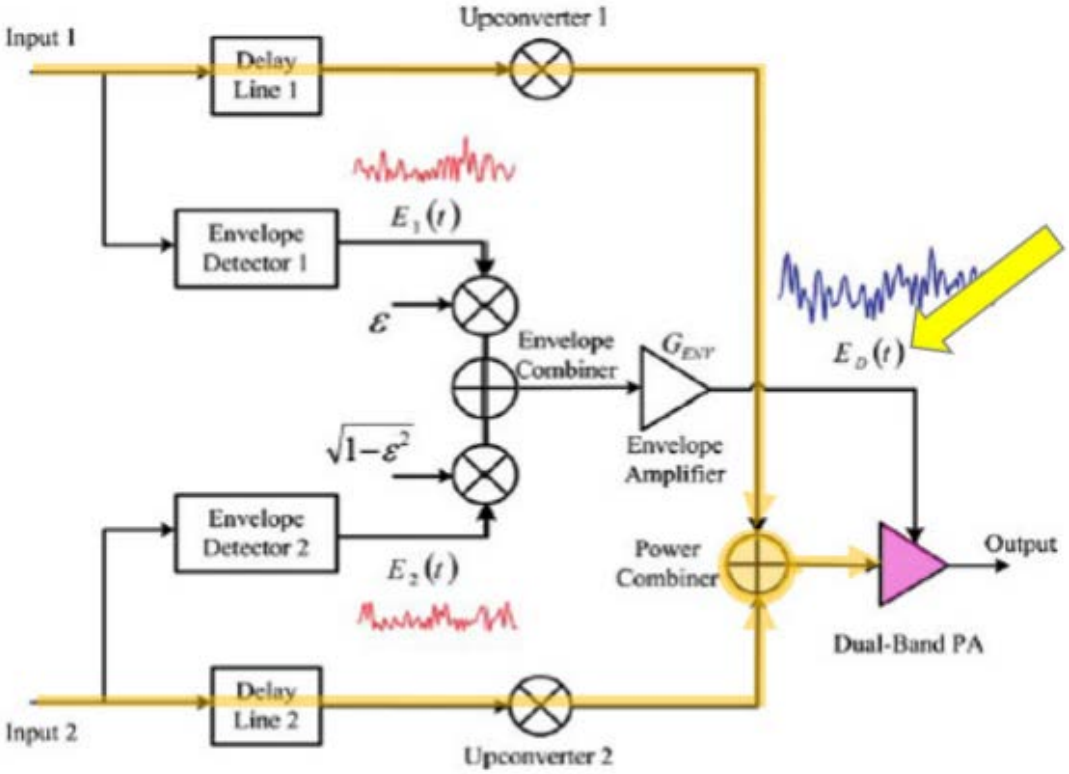


Figure 1 of Chen shows the architecture for a hybrid envelope tracking scheme. Ex. 1212, 662. Referring to its annotated Figure 1 of Chen, Petitioner contends that "the [dual-band] PA (highlighted in pink) receives the single power supply voltage $E_D(t)$ from the Envelope Amplifier, indicated at the yellow arrow." Pet. 40. Petitioner further contends that Chen's "[dual-band] PA also receives the plurality of carrier aggregated transmit signals (inputs 1 and 2) after they have been upconverted (by Upconverters 1 and 2 (mixers)) and summed (by the Power Combiner), as indicated . . . in gold, and produces a single output radio frequency signal such that the transmit signals are sent simultaneously." *Id.* We find that the signal generated by Chen's dual-band PA corresponds to the recited "single output radio frequency (RF) signal."

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the recited power

amplifier limitation in claim 1. *See, e.g.*, Ex. 1212, 662, Fig. 1. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

4. Dependent Claims 2, 3, 5, 7, 11, 17, 19–21, and 27

Claim 2 depends from claim 1 and recites that "the power tracker is configured to[] determine an overall power of the plurality of carrier aggregated transmit signals based on the I and Q components of the plurality of carrier aggregated transmit signals" and to "determine the single power tracking signal based on the overall power of the plurality of carrier aggregated transmit signals." Claim 19, which depends from claim 18, recites similar limitations. Petitioner relies on the same discussion for claims 2 and 19. Pet. 42–44.

Claim 3 also depends from claim 1 and recites that "the power tracker is configured to[] determine a power of each transmit signal in the plurality of carrier aggregated transmit signals based on the I and Q components of each transmit signal" and to "determine the single power tracking signal based on a sum of said power of each transmit signal." Claim 20, which depends from claim 18, recites similar limitations. Petitioner relies on the same discussion for claims 3 and 20. *Id.* at 45–46.

We address claims 2, 3, 19, and 20 together. As discussed above, Petitioner contends (and we agree) that Chen's envelope detectors 1, 2 and envelope combiner together correspond to the recited "power tracker," that the output of Chen's envelope combiner corresponds to the recited "single power tracking signal," and that Chen's input signals 1, 2 correspond to the recited "carrier aggregated transmit signals." *See supra* Part III.B.3.a.

Petitioner further asserts that Chen's power tracker "receives the transmit signals Input 1 and Input 2, and generates corresponding envelope signals $E_1(t)$ and $E_2(t)$, which are proxies for the powers of carrier aggregated input signals 1 and 2, respectively." Pet. 42–43; *see also id.* at 45, 46. Petitioner also asserts that Chen's envelope combiner (which comprises a part of Chen's power tracker) "sums the envelopes of the two signals and produces an output that is a proxy for the overall power of the input signals." *Id.* at 43; *see also id.* at 44, 46. Petitioner adds that "it would have been obvious, in view of Wang, to implement Chen's input signals with complex I/Q signaling, so that the Envelope Amplifier's output would be based on the I/Q components of each transmit signal. *Id.* at 43; *see also id.* at 45–46. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 43 (citing Ex. 1203 ¶¶ 126–127).

Petitioner additionally contends under an alternative theory that, to the extent Patent Owner disputes Petitioner's above analysis "because Chen discloses only voltages (measured in volts) rather than powers (measured in watts), calculating a power (measured in watts, rather than volts) would have been obvious." *Id.*; *see also id.* at 44, 46. As support, Petitioner asserts that "[b]ecause power is directly proportional to the square of the voltage . . . a [person of ordinary skill in the art] would have understood that either of these mathematical methods would yield a functional, effectively similar metric for the generation of a power tracking signal." *Id.* at 43. Petitioner further notes that "the disclosures in the '675 patent require a voltage ultimately be used as the measure for the digital power tracking signal." *Id.* at 43–44 (citing Ex. 1201, 8:19–22 ("The digital power tracking signal is then obtained by taking the square root of the overall power. The scaling

factor of $\sqrt{K}$ accounts for conversion between power and voltage.")). According to Petitioner, "[c]hoosing one mathematical form rather than the other would have been an obvious alternative among a limited number of ways to determine the power tracking signal, and would have been well within the competence and discretion of a [person of ordinary skill in the art]." *Id.* at 44. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1203 ¶ 128).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the limitations recited in claims 2, 3, 19, and 20. We also are persuaded that Petitioner's proffered reasoning for modifying the combination of Chen and Wang to determine the power of input signals 1 and 2, namely, because it would have been obvious to try, is sufficient to support the legal conclusion of obviousness. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007) ("When there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. If this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense. In that instance the fact that a combination was obvious to try might show that it was obvious under § 103."). Patent Owner does not dispute Petitioner's analysis for these limitations. *See generally* PO Resp.

Claim 5 depends from claim 1 and recites a "plurality of transmit circuits." Claim 5 requires the plurality of transmit circuits to be "configured to receive the I and Q components of the plurality of carrier aggregated transmit signals." Claim 5 also requires the plurality of transmit

circuits to be configured to "provide a plurality of upconverted RF signals, each transmit circuit configured to upconvert I and Q components of one of the plurality of carrier aggregated transmit signals and provide a corresponding upconverted RF signal." Lastly, claim 5 recites "a summer configured to sum the plurality of upconverted RF signals and provide the plurality of carrier aggregated transmit signals to the power amplifier." Claim 21, which depends from claim 18, recites similar limitations.

For claims 5 and 21, Petitioner provides an annotated version of Figure 1 of Chen, which is reproduced below. Pet. 48.

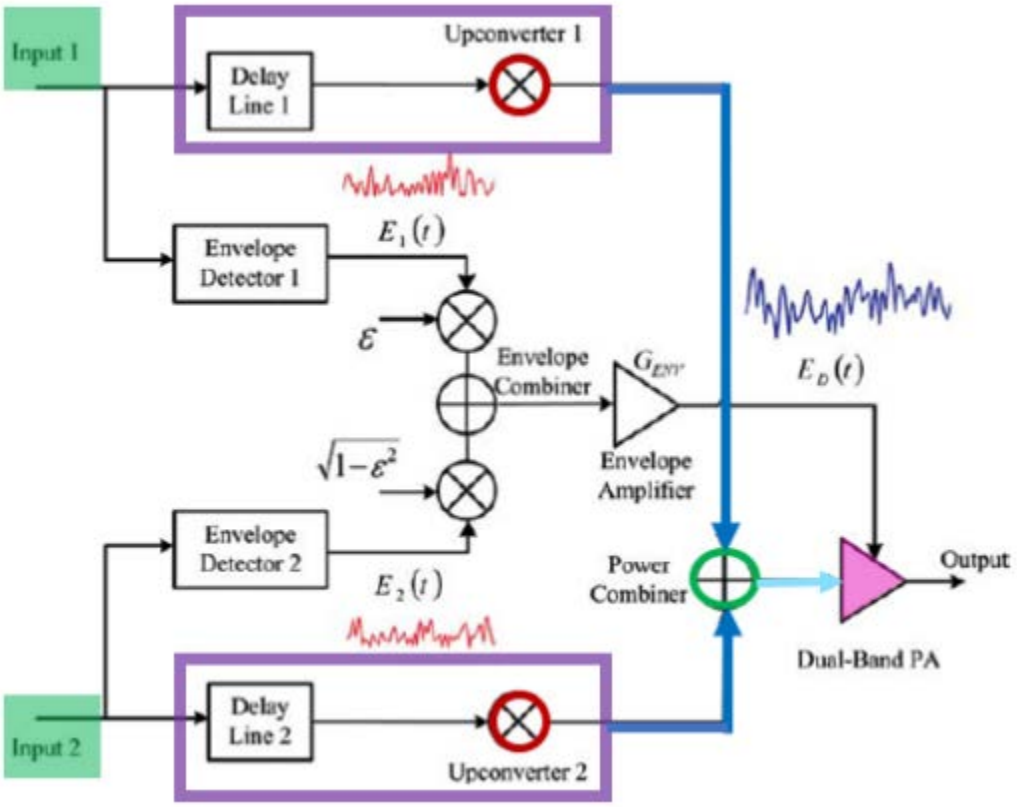


Figure 1 of Chen shows the architecture for a hybrid envelope tracking scheme. Ex. 1212, 662. Referring to its annotated figure, Petitioner contends that "Chen discloses two transmit circuits (outlined in purple), which as modified by Wang would receive the I and Q components of the

transmit signals (Input 1 and Input 2, highlighted in green)." Pet. 48. Petitioner further contends that "[e]ach transmit circuit upconverts the received I and Q components of one of the transmit signals (Input 1 or Input 2) using a multiplier (Upconverter 1 or Upconverter 2)," and then "provides an upconverted signal (highlighted in royal blue) to a Power Combiner (circled in green)," where "[t]he output of each transmit circuit is an RF signal." *Id.* at 48–49. Petitioner identifies Chen's power combiner as a "summer," and additionally contends that the power combiner (outlined in green) "receives the upconverted RF signals from the transmit circuits, sums them, and provides the signals to the power amplifier (highlighted in pink)." *Id.* at 49. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 48–49 (citing Ex. 1203 ¶¶ 139–141).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the limitations recited in claims 5 and 21. Patent Owner does not dispute Petitioner's analysis for these limitations. *See generally* PO Resp.

Claim 7 depends from claim 1 and recites "the power supply generator compris[es] a power tracking amplifier configured to receive the power tracking signal and generate the power supply voltage." For this limitation, Petitioner asserts that Chen's envelope amplifier (which Petitioner identifies as the recited "power supply generator") receives the output of the envelope combiner (which Petitioner identifies as the recited "power tracking signal") and generates supply $E_D(t)$ (which Petitioner identifies as the recited "power supply voltage"). Pet. 50–51 (citing Ex. 1212, 662, Fig. 1); *see also supra* Part III.B.3.a–b.

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the recited limitation in claim 7. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

Claim 11 depends from claim 1 and recites that "the plurality of carrier aggregated transmit signals are sent on a plurality of carriers at different frequencies." For this limitation, Petitioner contends that "Chen repeatedly discloses that the envelope tracking apparatus is for use with dual-band PAs, meaning that signals are transmitted simultaneously in two bands, i.e., at two different carrier frequencies." Pet. 51. As support, Petitioner points to Chen's abstract, for example, which states that "[a] hybrid envelope tracking scheme is proposed for concurrent dual-band power amplifiers (PAs)." *Id.* (citing Ex. 1212, Abstract); *see also id.* at 51–52 (citing Ex. 1212, 662–663). Petitioner asserts that "[t]he dual-band nature of Chen's signals is reinforced by the two upconverters shown in Figure 1 [of Chen]," where "Upconverter 1 [is] for shifting Input 1 by one carrier frequency and Upconverter 2 [is] for shifting Input 2 by a different carrier frequency." *Id.* at 52; *see also* Ex. 1212, Fig. 1. Petitioner adds that "Chen also explicitly discloses use of two different carrier frequencies, one at 900 and another at 2000 MHz," and contends that an ordinarily skilled artisan "would have known that each frequency would be a different carrier." Pet. 53 (citing Ex. 1212, 663). Petitioner relies on the declaration testimony of Dr. Choi. Pet. 52–53 (citing Ex. 1203 ¶¶ 145–147).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the recited limitation

in claim 11. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

Claim 17 depends from claim 1 and recites that "the power tracker is configured to determine the single power tracking signal based on functions" that comprise "calculating $\sqrt{I_k{}^2(t) + Q_k{}^2(t)}$ corresponding to K inphase (I) and quadrature (Q) components to produce K voltages" as well as "summing the K voltages." Claim 27, which depends from claim 18, recites similar limitations.

For claims 17 and 27, Petitioner provides another annotated version of Figure 1 of Chen, which is reproduced below. Pet. 55.

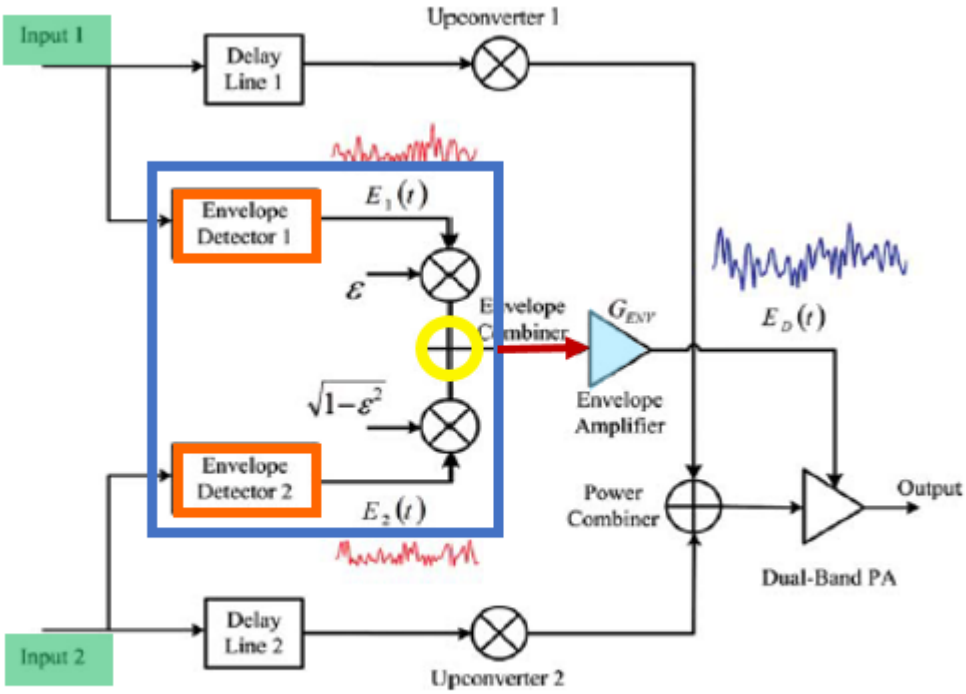


Figure 1 Proposed hybrid ET scheme for concurrent dual-band PAs.

Figure 1 of Chen shows the architecture for a hybrid envelope tracking scheme. Ex. 1212, 662. As discussed above, Chen's envelope detectors 1, 2 and envelope combiner (collectively outlined in blue) correspond to the

recited "power tracker," and the output of Chen's envelope combiner (highlighted in red) corresponds to the recited "single power tracking signal." *See supra* Part III.B.3.a; Pet. 54. Chen's input signals 1 and 2 (shown with green shading), as modified by Wang, have respective I and Q components that correspond to the recited I and Q components. *See supra* Part III.B.3.a; Pet. 55.

With respect to the recited calculating limitation, Petitioner asserts that "Chen's power tracker (outlined in blue) includes Envelope Detector 1 and Envelope Detector 2 (outlined in orange), each of which calculates an envelope signal ($E_1(t)$ or $E_2(t)$) based on the signal (Input 1 or Input 2) it receives," where "envelope signals $E_1(t)$ and $E_2(t)$ are power tracking signals and are voltages." Pet. 55. Petitioner further contends that "[i]t would have been obvious, based on Wang, to determine these voltages $E_1(t)$ and $E_2(t)$ by calculating $\sqrt{I_k{}^2(t) + Q_k{}^2(t)}$, where K is the number of transmit signals (in Chen, K=2)." *Id.* at 56. As support, Petitioner directs us to where Wang teaches that "[t]he amplitude is $A = (I^2 + Q^2)^{1/2}$, where I and Q are the real and imaginary parts of the complex baseband signal." *Id.* at 57 (quoting Ex. 1205, 1245). Noting that Wang's "amplitude is a voltage," Petitioner adds that "[c]ombining Wang's method of I/Q signal processing with Chen's power tracking structure therefore creates a power tracker that produces K voltages (where K=2 in Chen) using the precise formula required by th[e] limitation" recited in claims 17 and 27. *Id.* at 56–57 (citing Ex. 1205, 1245 ("The amplitude signal is calculated from the complex baseband signal and amplified by the amplitude amplifier, providing a dynamic drain voltage to the RF transistor.")); *see also supra* Part III.B.3.a. (discussing Petitioner's proffered reasoning for combining Chen and Wang).

Petitioner relies on the declaration testimony of Dr. Choi. Pet. 55–57 (citing Ex. 1203 ¶¶ 150–154).

With respect to the recited summing limitation, Petitioner contends that "Figure 1 of Chen shows that the K voltages—signals $E_1(t)$ and $E_2(t)$—are summed by an adder (outlined in yellow) which determines the single power tracking signal (highlighted in red)." Pet. 57; *see also id.* at 58 (citing Ex. 1212, Fig. 3). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 57–59 (citing Ex. 1203 ¶¶ 155–156).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen and Wang teaches the recited limitations in claims 17 and 27. Patent Owner does not dispute Petitioner's analysis for these limitations. *See generally* PO Resp.

5. Patent Owner's Arguments

For the most part, Patent Owner does not dispute Petitioner's analysis regarding the challenged claims. Patent Owner makes several arguments, however, with respect to the recited power tracker limitations. *See supra* Part III.B.3.a. These limitations appear in independent claims 1 and 18, and are therefore required by all the challenged claims. Patent Owner argues in particular that Chen and Wang do not teach "generat[ing] the single power tracking signal *based on a combination of* the plurality of I and Q components," as recited in the claims. PO Resp. 35–44; *see, e.g.*, Ex. 1201, claim 1. Patent Owner also argues that Chen and Wang do not teach a "plurality of *carrier aggregated* transmit signals." PO Resp. 46–47. In addition, Patent Owner argues that Chen and Wang do not teach "determin[ing] a single power tracking signal based on a plurality of inphase

(I) and quadrature (Q) components." *Id.* at 47–51. Lastly, Patent Owner argues that an ordinarily skilled artisan would not have been motivated to combine the references to arrive at the claimed invention. *Id.* at 44–45. We address these arguments in turn.

a. "based on a combination of"

Patent Owner argues that Petitioner does not "identify any disclosure in Chen of a single power tracking signal being generated ***based on a combination of the plurality of I and Q components***," which, according to Patent Owner, "enables one of the primary benefits of the '675 patent: the reduction in circuit components and power consumption." *Id.* at 39, 41 (citing Ex. 1201, 6:25–27). As support, Patent Owner asserts that "[t]he proposed combination of Chen and Wang processes its input signals to calculate envelopes '***separately***' based on analog signals at different frequencies." *Id.* at 41; *see also id.* at 42 (providing annotated Figure 1 of Chen for illustration); Ex. 1212, 662 ("The envelopes of the input signals at different frequencies are detected separately, weighed, and then added together." (quoted by Pet. 42)). Patent Owner further directs us to Dr. Choi's deposition testimony that neither of Chen's envelope detectors appears to receive I and Q components, and contends that Dr. Choi's testimony means "there can be no 'combination of I and Q components.'" PO Resp. 43 (citing Ex. 2006, 104:8–10, 104:23–25; Ex. 2002 ¶ 120). According to Patent Owner, Petitioner "fails to explain how Chen's solution that requires multiple, distinct Envelope Detector signal processing components to separately process Input 1 and Input 2 does anything to achieve" the '675 patent's "solution where a 'single PA with power tracking

may be used to generate a single output RF signal for multiple transmit signals' that 'may reduce the number of circuit components, reduce power consumption, and provide other advantages.'" *Id.* at 43–44 (citing Ex. 1201, 6:20–27).

Petitioner counters that "Patent Owner's argument relies on the incorrect premise that Chen's power tracker consists of only Envelope Detectors 1 and 2." Pet. Reply 14. Petitioner asserts that "the Petition makes clear[] Chen's power tracker 'comprises the envelope detectors for the two input signals 1 and 2 ***and*** the Envelope Combiner,'" which means "the power tracker . . . receives the input signals at the Envelope Detectors, and the Envelope Combiner ***combines*** them to produce a single power tracking signal 'based on a combination of the plurality of I and Q components.'" *Id.* (citing Pet. 19, 22). According to Petitioner, "[n]othing in the claims requires that these operations be performed in any particular way (e.g., that the input signals cannot be initially processed separately), or that the power tracker have a specific structure (e.g., that the power tracker must be a monolithic physical structure rather than include two envelope detectors)." *Id.*; *see also id.* at 16 ("Patent Owner fails to identify any limitation ***in the claims*** that requires the power tracker to be implemented in a manner to reduce the number of circuits. Nor does the specification contain any such requirement; to the contrary, . . . the specification describes a method of receiving and processing signals ***separately*** before combining them into a single power tracking signal." (citing Ex. 1201, 8:23–32)).

Petitioner further contends that "Chen's 'separate' processing of input signals also matches the processing disclosed in the '675 patent specification," referring to Equation 2. *Id.* at 15. Petitioner asserts that

"Patent Owner's expert admitted that equation (2) describes the input signals being processed ***separately*** before they are summed to output the single power tracking signal—which is precisely the sequence that Chen discloses." *Id.* (citing Ex. 1230, 111:8–14 (deposition testimony of Dr. Williams)).

In response, Patent Owner contends that Petitioner's argument that Chen's envelope combiner combines the input signals, thereby satisfying the disputed claim limitation, is a new reply argument that should be rejected. PO Sur-reply 14–15. Patent Owner nevertheless also contends that "Petitioner's new reply argument is erroneous" because "the outputs of Envelope Detectors 1 and 2 *are not* I and Q components but rather envelopes of the input signals Input 1 and Input 2." *Id.* at 15; *see also id.* ("[W]hen the envelope combiner combines the processed outputs of Envelope Detectors 1 and 2, neither the petition nor the reply explains how this is combining I and Q components, as required by the claims.").

With respect to Equation 2 of the '675 patent, Patent Owner further contends that the equation "enabl[es] the computation of 'the digital power tracking signal *based on the I and Q samples*,'" but "the claims specifically require the power tracking signal to be generated '*based on a combination of . . . I and Q components*.'" *Id.* at 16–17 (citing Ex. 1201, 8:33–36). According to Patent Owner, "the 'combination' language was added during prosecution to narrow the scope of the claims," and "Petitioner's argument . . . ignores the 'combination' language." *Id.* at 17 (citing Ex. 1202, 188–196). Patent Owner asserts that "the claims were amended to explicitly recite that the power tracker is 'configured to determine a <u>single</u> power tracking signal based on a plurality of inphase (I) and quadrature (Q)

components of a plurality of different transmit signals being sent simultaneously,'" which means the claims "require the power tracker to be implemented in a manner that reduces the number of circuit components and power consumption." *Id.* at 17 (citing Ex. 1202, 189–194).

We disagree with Patent Owner's argument, which relies on Patent Owner's proposed construction of "based on a combination of" (i.e., "based on the result of an addition operation"). *See* PO Br. 1. As discussed above, that construction improperly requires the recited power tracker to generate the single power tracking signal based on the result of an *addition operation* on the plurality of I and Q components. *See supra* Part III.A.3.

The proper construction of "generates the single power tracking signal based on a combination of the plurality of I and Q components" is "generates the single power tracking signal using a combination derived from the plurality of I and Q components." *Id.* Under that construction, we find that the combination of Chen and Wang teaches a power tracker that generates the single power tracking signal based on a combination of the plurality of I and Q components, as recited in the claims. In particular, we find that Chen's envelope detectors 1, 2 and envelope combiner together correspond to the recited power tracker, as Petitioner contends. *See* Pet. 18–19; Ex. 1212, 662, Fig. 1 (cited by Pet. 18–19). To illustrate, Petitioner's annotated version of Figure 1 of Chen is reproduced below. Pet. 18.

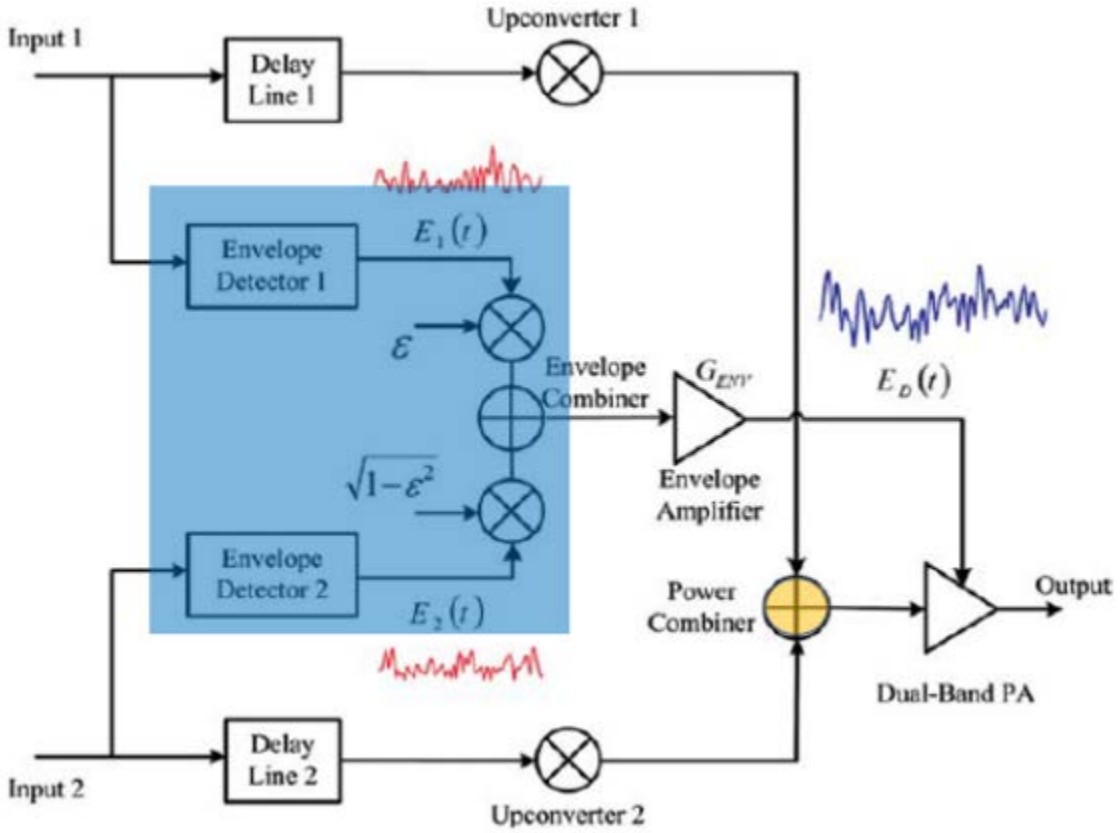


Figure 1 of Chen illustrates the architecture for a hybrid envelope tracking scheme. Ex. 1212, 662. The annotated figure highlights Chen's envelope detectors 1, 2 and envelope combiner in blue. The envelope detectors receive input signals 1 and 2. *Id.* These signals are next weighted using power weighting factor Ɛ, and then combined by the envelope combiner, which outputs a signal that is fed to the envelope amplifier. *Id.* As discussed above, we agree with Petitioner that the output of Chen's envelope combiner corresponds to the recited single power tracking signal. *See supra* Part III.B.3.a. We also agree that an ordinarily skilled artisan would have modified each of Chen's signals 1 and 2 to include Wang's baseband signal (comprising an OFDM signal with I and Q components) to provide a way to carry out Chen's signaling. *See id.* Accordingly, in view of Petitioner's proposed combination of Chen and Wang, we find that envelope detectors 1,

2 and the envelope combiner together generate the output of the envelope combiner using a combination derived from the plurality of I and Q components of the input signals, and therefore satisfy the recited power tracker limitation.

We note Patent Owner's contention that Petitioner "fails to explain how Chen's solution that requires multiple, distinct Envelope Detector signal processing components to separately process Input 1 and Input 2 does anything to achieve" the '675 patent's "solution where a 'single PA with power tracking may be used to generate a single output RF signal for multiple transmit signals' that 'may reduce the number of circuit components, reduce power consumption, and provide other advantages.'" PO Resp. 34–44 (citing Ex. 1201, 6:20–27). This contention, however, does not undermine Petitioner's showing that the combination of Chen and Wang teaches the recited power tracker. The claims themselves do not limit the structure of the power tracker, let alone exclude what Patent Owner describes as "multiple, distinct Envelope Detector signal processing components." Nor does the specification. Indeed, the specification refers specifically to "a single *PA*" (i.e., a single power amplifier), not a single power tracker, when stating that "an aspect of the present disclosure . . . . *may* reduce the number of circuit components." Ex. 1201, 6:20–27 (emphases added). Moreover, contrary to Patent Owner's position, Chen does in fact teach a single power amplifier (i.e., dual-band PA) that is used to generate a single output RF signal (i.e., signal generated by Chen's dual-band PA) for multiple transmit signals (i.e., input signals 1 and 2). *See* Ex. 1212 ¶ 662, Fig. 1; *see also supra* Part III.B.3.c.

Turning to Patent Owner's characterization of Petitioner's argument regarding Chen's envelope combiner as a "new reply argument," we note Petitioner's identification in the Petition of Chen's envelope combiner as part of the recited power tracker. *See* Pet. 18–19. Further, we note that Petitioner's argument responds directly to Patent Owner's contention that Petitioner does not address how the single power tracking signal is generated based on a *combination* of the plurality of I and Q components. *See* PO Resp. 38–44; Pet. Reply 14–15. As for Patent Owner's additional contention that the outputs of Chen's envelope detectors are envelopes of input signals 1, 2, rather than the I and Q components themselves, we are not persuaded for the reasons given above. *See* PO Sur-reply 14–15. Namely, our construction of "generat[ing] the single power tracking signal based on a combination of the plurality of I and Q components" encompasses generating the output of the envelope combiner of Petitioner's proposed combination of Chen and Wang based on the sum of the envelopes of the input signals, which have I and Q components. Patent Owner's counsel conceded during oral argument that "envelope signals" are "functions of I and Q components." Tr. 48:15–19. This is consistent with the specification of the '675 patent, which teaches generating a power tracking signal based on a sum of the *powers of the transmit signals* where the powers are functions (e.g., $\mathrm{I}_k{}^2(t) + \mathrm{Q}_k{}^2(\mathrm{t})$) of the I and Q components of the transmit signals, or, alternatively, based on a sum of the *voltages of the transmit signals* where the voltages are functions (e.g., $\sqrt{\mathrm{I}_k{}^2(t) + \mathrm{Q}_k{}^2(\mathrm{t})}$) of the I and Q components of the transmit signals. Ex. 1201, 8:6–36. The specification does not require generating the power tracking signal based on a sum of the I and Q components themselves.

Lastly, Patent Owner's reliance on the prosecution history to support its contention that "the 'combination' language was added during prosecution to narrow the scope of the claims" also is unpersuasive. *See* PO Sur-reply 17. As discussed above in the Claim Construction section, following the addition of the "combination" language, the Examiner still found that the cited prior art reference "teaches the power tracking signal *based on* I and Q." *See* Ex. 1202, 203 (emphasis added). We note that the applicant did not point to any distinctions between "based on" and "based on a combination of" in response to the Examiner's finding. The prosecution history therefore does not support Patent Owner's contention.

b. "carrier aggregated"

Patent Owner argues that "neither Chen nor Wang discloses carrier aggregation under either party's construction of that term," both of which "require the extension (*i.e.*, increase) of the bandwidth of a single user based on transmission across multiple carriers." PO Resp. 46. As support, Patent Owner asserts that "Chen describes base station technology that is processing signals provided by different users." *Id.* According to Patent Owner, "[p]rocessing of signals from different users . . . fails to account for at least two aspects of carrier aggregated transmit signals as properly construed: [1] 'signals from a single terminal;' and [2] signals 'which provide extended transmission bandwidth for a user transmission.'" *Id.* Patent Owner adds that "Wang does nothing to cure these deficiencies." *Id.*

We disagree with Patent Owner's argument, which relies on Patent Owner's proposed construction of "carrier aggregated transmit signals" (i.e., "signals from a single terminal utilizing multiple component carriers which

provide extended transmission bandwidth for a user transmission from the single terminal"). *See* PO Resp. 16. As discussed above, that construction is overly narrow and improperly requires signals from a single terminal as well as providing extended transmission bandwidth for a user transmission from a single terminal. *See supra* Part III.A.2.

The proper construction of "plurality of carrier aggregated transmit signals" is "signals for transmission on multiple carriers." *Id.* Under that construction, we find that the combination of Chen and Wang teaches the recited "plurality of carrier aggregated transmit signals." In particular, as discussed above, we find that Chen's input signals 1 and 2, as modified by Wang, correspond to the recited "plurality of carrier aggregated transmit signals." *See supra* Part III.B.3.a. Chen describes the signals as "two single carrier wideband code division multiple access signals," which operate at different frequencies. Ex. 1212, 663 (cited by Pet. 24). Petitioner contends that this teaching indicates that the signals "are from different (multiple) carriers." Pet. 24 (citing Ex. 1203 ¶ 103).

Patent Owner's argument focuses on features that the claims do not require, namely, signals from a single terminal and providing extended transmission bandwidth for a user transmission from the single terminal. *See* PO Resp. 46. Accordingly, Patent Owner's argument does not undermine Petitioner's showing that the combination of Chen and Wang teaches the recited carrier aggregated transmit signals.

c. "generat[ing] a single power tracking signal based on a plurality of inphase (I) and quadrature (Q) components"

With respect to this limitation, Patent Owner points to Petitioner's argument that "[u]sing Wang's I/Q processing in Chen would result in each of Chen's input signals having I and Q components," and contends that Petitioner's argument "fails to account for how any signal in Wang could be combined as taught by Chen to provide an acceptable control input to Chen's dual-band amplifier" because "Input 1 and Input 2 of Chen are analog inputs" and "[t]here are no digital-to-analog converters between Input 1 and Input 2 and the dual-band power amplifier." PO Resp. 48. To illustrate, Patent Owner considers various scenarios. For example, Patent Owner contends that "if the Petition's argument is literal, the combination is nothing more than Chen with I and Q components at its inputs," where "[r]eceipt of digital I, Q inputs would result in garbage outputs at $E_1(t)$ and $E_2(t)$" because "Chen's Envelope Detector 1 and Envelope Detector 2 process analog signals." *Id.* at 48–49. Patent Owner also contends that if "the Petition is positing that a [person of ordinary skill in the art] would perform Wang's DSP's processing of its I and Q components, with Chen providing downstream processing of Wang's DSP's outputs," then "[i]nputting Wang's digital outputs to [Chen's processing] components would again result in garbage output for control of Chen's dual-band power amplifier" because "Wang's digital signal processor's outputs are digital and incompatible with Chen's analog processing components." *Id.* at 50. Patent Owner further contemplates that "the Petition might be implying that the output from Wang's . . . 'Amplitude Amplifier' is the signal for being combined," but contends that such "signal in Wang is analogous to Chen's

input to its power amplifier, $E_D(t)$, which is after all of Chen's analog combining has occurred." *Id.* at 51. Patent Owner relies on the declaration testimony of Dr. Williams. *Id.* at 48–51 (citing Ex. 2002 ¶¶ 133–138).

In response, Petitioner argues that "[a]lthough Figure 1 of Chen does not show a digital-to-analog converter, Chen expressly discloses that the envelope-tracking power amplifier was validated using baseband signals—which are digital." Pet. Reply 24 (citing Ex. 1212, 662 ("The feasibility of this scheme is validated using baseband and analog co-simulation with real large signal circuit models.")). Petitioner contends that "[i]t would have been readily apparent to a [person of ordinary skill in the art] that this validation with baseband signals would not have been possible without a digital-to-analog converter." *Id.* (citing Ex. 2006, 93:17–95:15 (Dr. Choi's deposition testimony)). Petitioner also argues that "[e]nvelope detectors can accept digital inputs" and that the outputs of Chen's envelope detectors are not necessarily analog, as an ordinarily skilled artisan "cannot readily tell from the signal waveform whether the signal is an analog signal or a high-resolution digital signal." *Id.* at 25 (citing Ex. 1231 ¶¶ 17–23). Petitioner adds that "[t]he law does not require Wang's I/Q signaling to be inserted into Chen without any modifications to Chen." *Id.* at 26. According to Petitioner, "the fundamental structure disclosed in Chen—a structure that combines multiple signals to determine a single power tracking signal for generating a single supply voltage for a power amplifier—could be readily modified to use digital I/Q signaling such as in Wang." *Id.*

Patent Owner counters that "Chen's few isolated mentions of 'LTE-Advanced' and 'baseband and analog co-simulation' indicate, at most, that digital I and Q components may have existed *somewhere* (*e.g.*, upstream of

the architecture shown in Chen Figure 1) and provide no disclosure that Inputs 1 and 2, specifically, are digital." PO Sur-reply 23–24 (internal citation omitted). Patent Owner further contends that "being unable to tell whether a signal is depicted as being analog or digital is *not* a disclosure that the signal is digital." *Id.* at 26. Additionally, Patent Owner contends that "in the architecture of Chen's Figure 1, *at least* six components cannot process digital signals at the frequencies described in Chen," namely, the two envelope detectors, the envelope combiner, the envelope amplifier, the power combiner, and the dual-band PA. *Id.* at 24–25. According to Patent Owner, "to implement[] Chen's architecture with Inputs 1 and 2 as digital signals, *at least four DACs* would need to be added, if not more." *Id.* at 26. Patent Owner notes that "Petitioner neither argued nor made the required showing that these DACs are inherently disclosed by Chen or would be obvious based on Chen." *Id.*

Based on the record before us, we disagree with Patent Owner. Patent Owner's focus on whether Chen's input signals are analog signals and whether Chen's system components can process digital signals disregards Wang's broader teaching of providing an OFDM signal with I and Q components as a way to carry out signaling. Ultimately, "[t]he 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 413, 425 (CCPA 1981). Instead, "the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art." *Id.* Petitioner relies on Wang's teaching of a complex baseband signal comprising an OFDM signal with I and Q components. Pet. 26–27 (citing Ex. 1205, 1245, Fig. 3); *id.* at 35 (citing

Ex. 1205, 1244 (title), 1253). Petitioner explains that "[c]omplex input signals (with I and Q components) allow the use of advanced modulation techniques such as quadrature phase-shift keying (QPSK), which doubles the data rate by increasing the number of bits per symbol that can be transmitted within the same bandwidth, compared with a method such as binary phase-shift keying (BPSK)." *Id.* at 31 (citing Ex. 1221, 308). Petitioner also explains that "OFDM had many advantages, including the ability to adapt to degraded channel conditions without complex equalization filters, and robustness against various forms of interference." *Id.* at 36 (citing Ex. 1222 ¶¶ 2–3). According to Petitioner, it is for these reasons an ordinarily skilled artisan would have considered using Wang's baseband signal in Chen's system.

We further note that "[a] person of ordinary skill is also a person of ordinary creativity, not an automaton." *KSR*, 550 U.S. at 421. Thus, in modifying Chen's system to include Wang's baseband signal, a person of ordinary skill would have made any necessary additional modifications, such as adding digital-to-analog converters, so that Chen's system could process appropriately Wang's signal.

Accordingly, we find that Patent Owner's contentions do not undermine Petitioner's obviousness showing.

d. Motivation to Combine

Patent Owner argues that "[t]here would be no motivation to combine the base station application of Chen with 802.11g WiFi standard of Wang, where Petitioner's declarant testified that he is 'not aware of any cellular base stations in 2013 that use the IEEE 802.11g wireless LAN standards.'"

PO Resp. 44–45 (quoting Ex. 2006, 113:23–25). As support, Patent Owner asserts that "the OFDM disclosed in Wang is for a particular WLAN standard, namely IEEE 802.11g WiFi," and that "[t]he OFDMA used on the downlink in cellular base stations is far more challenging for envelope tracking than the OFDM used in 802.11g." *Id.* at 45. Patent Owner further notes that "[c]ellular OFDMA has both a larger bandwidth and a higher peak to average power ratio." *Id.* According to Patent Owner, "the Petition's motivation to combine is deficient" because "the Petition fails to provide any argument regarding why and how a [person of ordinary skill in the art] would combine teachings of a WiFi system into a cellular base station reference." *Id.* at 45.

In response, Petitioner counters that "Patent Owner ignores the actual combination that the Petition proposes, i.e., the use of Wang's I/Q signal processing and OFDM modulation in Chen." Pet. Reply 17 (citing Pet. 26–27, 37). Petitioner asserts that "[t]he Petition does not, as Patent Owner suggests, propose incorporating the WiFi standard from Wang into Chen." *Id.* According to Petitioner, the "Petition argues only that a [person of ordinary skill in the art] looking to implement and improve Chen would have been motivated to look to Wang and use its disclosure of very basic RF concepts (I/Q signal processing and OFDM modulation)." *Id.*

Patent Owner counters that "[i]t was Petitioner's burden to articulate why and how the [person of ordinary skill in the art] would allegedly combine teachings of Wang's WiFi system with the cellular base station of Chen," and that "[t]he Petition and supporting declaration fail to do this and do not address the disparity across operating environments of Chen and Wang at all." PO Sur-reply 18.

Based on the record before us, we disagree with Patent Owner. Patent Owner's focus on "the disparity across operating environments of Chen and Wang" disregards Wang's broader teaching of providing an OFDM signal with I and Q components as a way to carry out signaling. We explained above that "[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference." *Keller*, 642 F.2d at 425. Instead, "the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art." *Id.* As Petitioner points out, Wang teaches a complex baseband signal comprising an OFDM signal with I and Q components. Pet. 26–27 (citing Ex. 1205, 1245, Fig. 3); *id.* at 35 (citing Ex. 1205, 1244 (title), 1253). Petitioner contends that "[c]omplex input signals (with I and Q components) allow the use of advanced modulation techniques such as quadrature phase-shift keying (QPSK), which doubles the data rate by increasing the number of bits per symbol that can be transmitted within the same bandwidth, compared with a method such as binary phase-shift keying (BPSK)." *Id.* at 31 (citing Ex. 1221, 308). Petitioner also contends that "OFDM had many advantages, including the ability to adapt to degraded channel conditions without complex equalization filters, and robustness against various forms of interference." *Id.* at 36 (citing Ex. 1222 ¶¶ 2–3). According to Petitioner, it is for these reasons an ordinarily skilled artisan would have considered using Wang's baseband signal in Chen's system. Contrary to what Patent Owner argues, we find that these reasons provide sufficient rationale for why an ordinarily skilled artisan would have considered using Wang's baseband signal in Chen's system. Accordingly,

we find that Patent Owner's argument does not undermine Petitioner's obviousness showing.

That "the OFDM disclosed in Wang is for a particular WLAN standard, namely IEEE 802.11g WiFi," as Patent Owner asserts, does not change our finding in this regard. As we noted above, "[a] person of ordinary skill is also a person of ordinary creativity, not an automaton," and, in modifying Chen's system to include Wang's signal, would have made any necessary additional modifications so that Chen's system could process appropriately Wang's signal. *See KSR*, 550 U.S. at 421.

Patent Owner does not dispute other aspects of Petitioner's analysis regarding the challenged claims. *See generally* PO Resp.

In view of the foregoing, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 1–3, 5, 7, 11, 17–21, and 27 would have been obvious over Chen and Wang.

C. Obviousness over Chen, Wang, and Eliezer

Petitioner asserts that claim 12 of the '675 patent would have been obvious over Chen, Wang, and Eliezer. Pet. 59–65. Patent Owner does not respond specifically to this ground. *See generally* PO Resp. For the reasons explained below, we determine that Petitioner has demonstrated by a preponderance of the evidence that claim 12 would have been obvious over Chen, Wang, and Eliezer.

Having already discussed Chen and Wang above, we start with an overview of Eliezer. *See supra* Part III.B.1 & 2.

1. Eliezer

Eliezer describes a power efficient digital transmitter, which incorporates a linear amplifier and a switched mode power supply (SMPS). Ex. 1211 ¶ 2. Figure 11 of Eliezer is reproduced below.

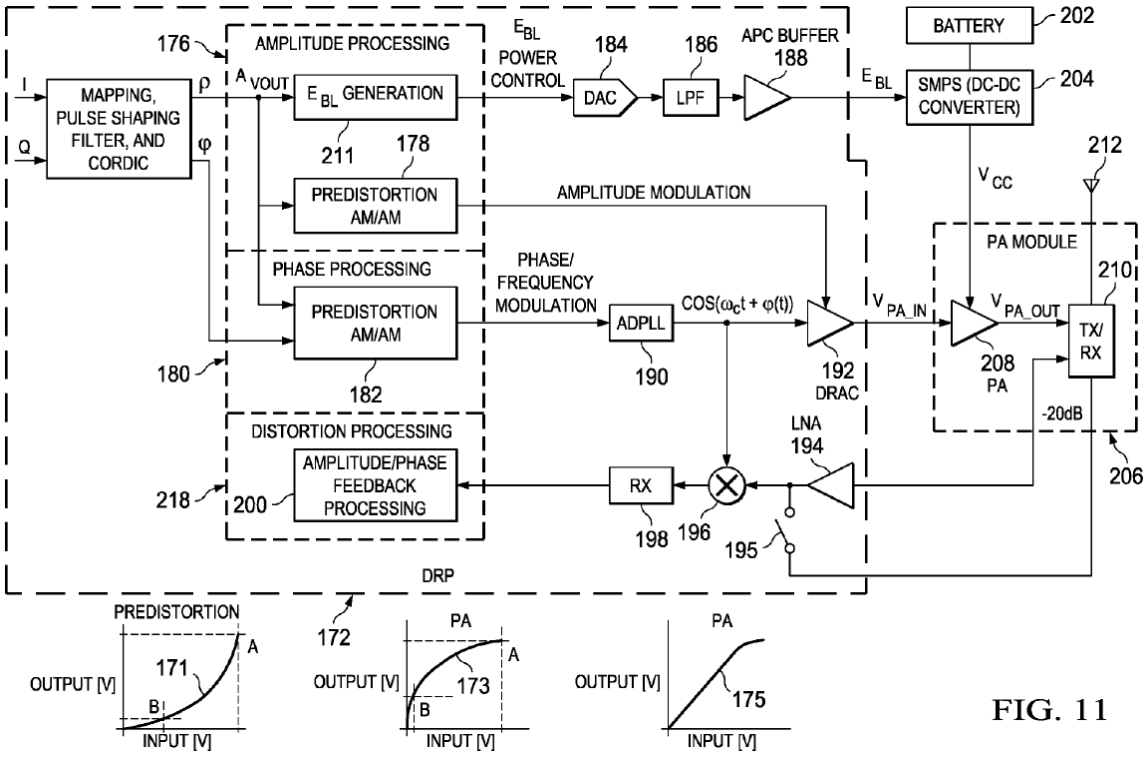


FIG. 11

Figure 11 is a block diagram of a power efficient digital transmitter. *Id.* ¶ 108. The transmitter includes power amplifier (PA) module 206 and SMPS 204. *Id.* PA module 206 includes power amplifier 208. *Id.*

Eliezer explains that one problem with using an SMPS is the degraded efficiency at high rates of switching, which is needed to accommodate wide bandwidth input signals. *Id.* ¶ 109. To address this problem, Eliezer's SMPS 204 is operative to follow a reduced-bandwidth form of the desired envelope signal A_{VOUT}. *Id.* ¶ 111. In particular, SMPS 204 is used to provide a slow form (i.e., reduced bandwidth) of envelope tracking based on

a narrower bandwidth distorted version of the envelope waveform such that SMPS 204 can use a lower switching rate corresponding to the lower bandwidth, thereby obtaining high efficiency in the regulation. *Id.* ¶ 122. The reduced bandwidth form of signal A_{VOUT} is represented by E_{BL}. *Id.* ¶¶ 107, 110.

Reduced-bandwidth envelope signal E_{BL}, which is derived from signal A_{VOUT}, is generated by E_{BL} generation circuit 211. *Id.* ¶¶ 107, 124. Signal E_{BL} is converted to analog by DAC 184, passed through low pass filter 186, and input to buffer 188 before being fed to SMPS 204. *Id.* ¶ 124. SMPS 204 generates supply voltage V_{CC}, which is provided to linear power amplifier 208. *Id.*

2. Dependent Claim 12

Claim 12 depends from claim 11, which depends from claim 1. For the reasons given above, we find that Petitioner's proposed combination of Chen and Wang teaches the limitations recited in claims 1 and 11. *See supra* Part III.B.

Claim 12 recites "the single power tracking signal has a bandwidth that is smaller than an overall bandwidth of the plurality of carriers." Petitioner relies on Eliezer. In particular, Petitioner identifies Eliezer's reduced-bandwidth envelope signal E_{BL} as a "single power tracking signal." Pet. 61. Petitioner contends that Eliezer teaches that the bandwidth of signal E_{BL} is narrower than the bandwidth of signal A_{VOUT}, which Petitioner asserts is the amplitude portion of the RF signal. *Id.* As support, Petitioner directs us to Figure 12 of Eliezer, which is reproduced below. *Id.* at 62.

FIG. 12

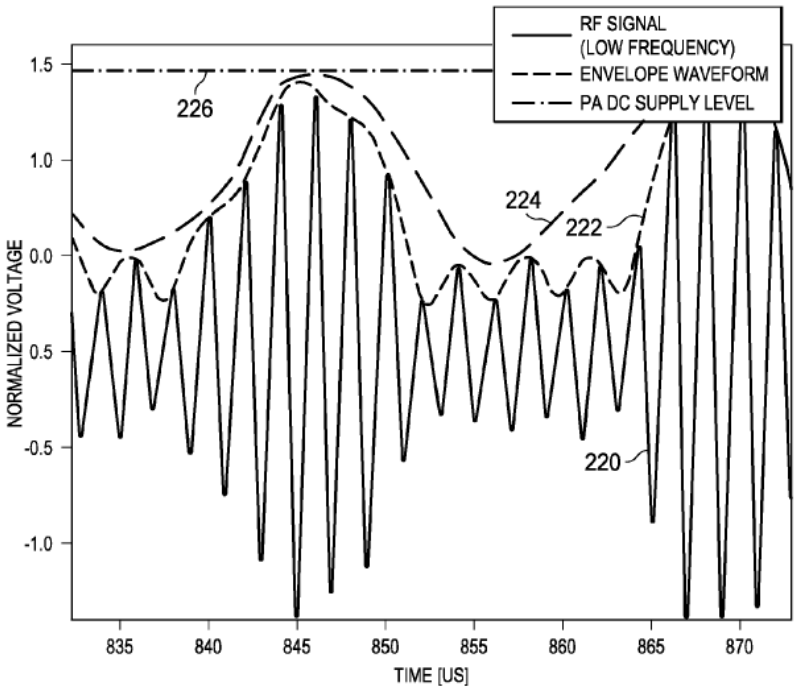


Figure 12 of Eliezer is a graph comparing an RF envelope generated by Eliezer's system and a "prior art" envelope. Ex. 1211 ¶ 128. Eliezer describes the graph as follows:

> The graph shows the normal DC supply voltage 226 to the power amplifier 208, the RF signal 220 (a low frequency version is shown for clarity sake), a high bandwidth envelope signal 222 that tightly hugs the RF signal and is suitable for regulating the voltage for a saturated PA and a reduced bandwidth envelope signal 224 (dashed trace) that maintains headroom for operation with a linear PA in accordance with the present invention. The reduced-bandwidth envelope signal is generated by the E_{BL} generation circuit 211 and in accordance with the present invention, is fed to the V_{CC} supply voltage input of the power amplifier 208. This band limited envelope signal 224 is significantly less demanding than signal 222, thus enabling the switching regulator [(SMPS)] to follow it much more easily.

Id. (cited by Pet. 62–63). According to Petitioner, "trace 224 is smoother (e.g., has less variation as a function of time) than trace 220," which "means

that the power tracking signal 224 has a lower bandwidth than the RF signal 220." Pet. 63. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1203 ¶ 162). Petitioner additionally directs us to where Eliezer teaches that its system maintains the condition $f_C < f_A$, where f_C represents the bandwidth of signal E_{BL} and f_A represents the bandwidth of A_{VOUT}. *Id.* (citing Ex. 1211 ¶ 120).

Petitioner further contends that an ordinarily skilled artisan would have been motivated to use Eliezer's signal processing to generate a band-limited envelope signal for a power supply generator in Chen in order to increase efficiency. *Id.* at 64. We note that Eliezer's signal processing addresses degraded power supply efficiency at high rates of switching, which is needed to accommodate wide bandwidth input signals. Ex. 1211 ¶ 109. Petitioner also asserts that "Wang specifically focuses on the importance of 'the time alignment between the envelope and RF paths in order to minimize the distortion and EVM [error vector magnitude],'" and contends that an ordinarily skilled artisan "would have understood that a reduced bandwidth envelope signal (such as that disclosed in Eliezer) would reduce the difficulty in accomplishing this task." Pet. 64 (citing Ex. 1205, 1245; Ex. 1203 ¶ 166).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen, Wang, and Eliezer teaches the recited limitation in claim 12. We also are persuaded that Petitioner's proffered reasoning for further modifying the combination of Chen and Wang to include Eliezer's signal processing, namely, to increase system efficiency, is sufficient to support the legal conclusion of obviousness. *See Kahn*, 441

F.3d at 988. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

In view of the foregoing, we determine that Petitioner has demonstrated by a preponderance of the evidence that claim 12 would have been obvious over Chen, Wang, and Eliezer.

D. Obviousness over Chen, Wang, and Choi

Petitioner asserts that claims 8–10 of the '675 patent would have been obvious over Chen, Wang, and Choi. Pet. 65–73. Patent Owner does not respond specifically to this ground. *See generally* PO Resp. For the reasons explained below, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 8–10 would have been obvious over Chen, Wang, and Choi.

Having already discussed Chen and Wang above, we start with an overview of Choi. *See supra* Part III.B.1 & 2.

1. Choi

Choi describes a supply modulator for envelope tracking. Ex. 1208, at Ex. A, at 1074. Figure 5 of Choi, which is reproduced below, illustrates such supply modulator.

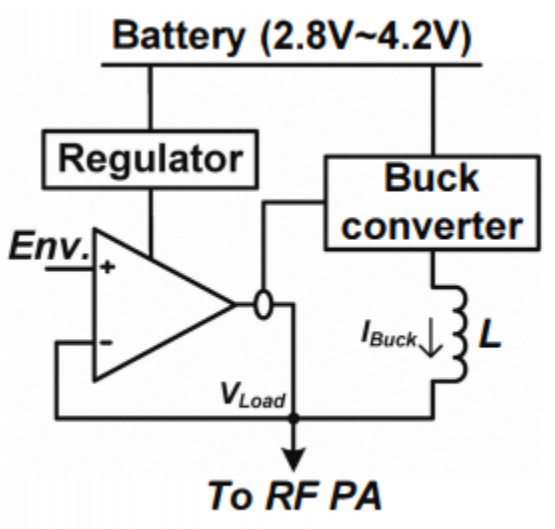


Fig. 5. Battery-to-5V boosting PA supply modulator.

In particular, Figure 5 of Choi shows the architecture of a power amplifier supply modulator that dynamically regulates a power amplifier. *Id.* The supply modulator employs a hybrid switching amplifier (HSA), which comprises the linear amplifier, regulator, and switching buck converter. *Id.* at 1074, Fig. 4. The linear amplifier receives an envelope signal designated as "Env." *See id.* at Fig. 5. The regulator operates as an independent voltage source, and the buck converter operates as a dependent current source, supplying most of the current needed at the output. *Id.* at 1075. A current sensing unit detects the current flowing from the linear amplifier to the output and changes the state of the switching amplifier according to the sensed current. *Id.* An additional boost converter, whose input range is from 2.8 V to 4.2 V, is coupled to the supply of the linear amplifier, which regulates the load voltage. *Id.*

2. Dependent Claims 8–10

Claim 8 depends from claim 7, which depends from claim 1. For the reasons given above, we find that Petitioner's proposed combination of Chen

and Wang teaches the limitations recited in claims 1 and 7. *See supra* Section III.B.

Claim 8 recites the "power supply generator" further comprises "a switcher configured to sense a first current from the power tracking amplifier and provide a second current for the power supply voltage based on the sensed first current." Petitioner relies on Choi. In particular, Petitioner identifies Choi's hybrid switching amplifier as a "power supply generator," Choi's linear amplifier as a "power tracking amplifier," and Choi's buck converter as a "switcher." Pet. 65–67. Referring to Figure 5 of Choi, Petitioner contends that "[t]he buck converter is shown as sensing the current from the linear amplifier . . . and providing a supply current (I_{Buck}) for the power supply voltage ('To RF PA') based on the sensed current, in order to assist the linear amplifier." *Id.* at 67 (citing Ex. 1208, at Ex. A, at 1075). Petitioner further contends that an ordinarily skilled artisan would have been motivated to further modify the combination of Chen and Wang discussed above to include Choi's hybrid switching amplifier in order to "reduce waste of power and increase efficiency" as well as to "obtain robustness against battery depletion." *Id.* at 69–70 (citing Ex. 1208, at Ex. A, at 1074–1075). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1203 ¶¶ 176, 178).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen, Wang, and Choi teaches the recited limitation in claim 8. We also are persuaded that Petitioner's proffered reasoning for further modifying the combination of Chen and Wang to include Choi's hybrid switching amplifier is sufficient to support the legal

conclusion of obviousness. *See Kahn*, 441 F.3d at 988. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

Claim 9 depends from claim 7, which depends from claim 1, and recites that the "power supply generator" further comprises "a boost converter configured to receive a battery voltage and provide a boosted voltage for the power tracking amplifier." Claim 10 depends from claim 9 and recites that "the power tracking amplifier operates based on the boosted voltage or the battery voltage." For these limitations, Petitioner relies on Choi. In particular, Petitioner identifies Choi's hybrid switching amplifier as a "power supply generator," Choi's linear amplifier as a "power tracking amplifier," and Choi's additional boost converter as a "boost converter." Pet. 71 (referring to discussion of claim 8); *see also id.* at 65–67 (discussing claim 8). As discussed above, Choi's additional boost converter, whose input range is from 2.8 V to 4.2 V, is coupled to the supply of the linear amplifier. Ex. 1208, at Ex. A, at 1075, Fig. 5. Petitioner further contends that an ordinarily skilled artisan would have been motivated to further modify the combination of Chen and Wang discussed above to include Choi's hybrid switching amplifier in order to "reduce waste of power and increase efficiency" as well as to "obtain robustness against battery depletion." Pet. 69–70 (discussing claim 8) (citing Ex. 1208, at Ex. A, at 1074–1075). Additionally, Petitioner contends that an ordinarily skilled artisan "would have been motivated to use . . . Choi's boost converter in Chen's architecture to prevent distortion as the battery becomes depleted and the voltage provided by the batter falls, such that the battery voltage is lower than the peak voltage magnitude of the amplified signal." *Id.* at 71–72 (citing Ex. 1208, at Ex. A, at 1074–1075). Petitioner relies on the

declaration testimony of Dr. Choi. *Id.* at 69–72 (citing Ex. 1203 ¶¶ 176, 178, 182).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen, Wang, and Choi teaches the recited limitations in claims 9 and 10. We also are persuaded that Petitioner's proffered reasoning for further modifying the combination of Chen and Wang to include Choi's hybrid switching amplifier is sufficient to support the legal conclusion of obviousness. *See Kahn*, 441 F.3d at 988. Patent Owner does not dispute Petitioner's analysis for these limitations. *See generally* PO Resp.

In view of the foregoing, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 8–10 would have been obvious over Chen, Wang, and Choi.

E. Obviousness over Chen, Wang, and Dahlman

Petitioner asserts that claims 13–15 and 23–25 of the '675 patent would have been obvious over Chen, Wang, and Dahlman. Pet. 73–81. Patent Owner does not respond specifically to this ground. For the reasons explained below, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 13–15 and 23–25 would have been obvious over Chen, Wang, and Dahlman.

Having already discussed Chen and Wang above, we start with an overview of Dahlman. *See supra* Part III.B.1 & 2.

1. Dahlman

Dahlman is a book entitled "4G LTE / LTE-Advanced for Mobile Broadband." One of Dahlman's chapters describes carrier aggregation. Ex. 1206, 104. Figure 7.4 of Dahlman is reproduced below.

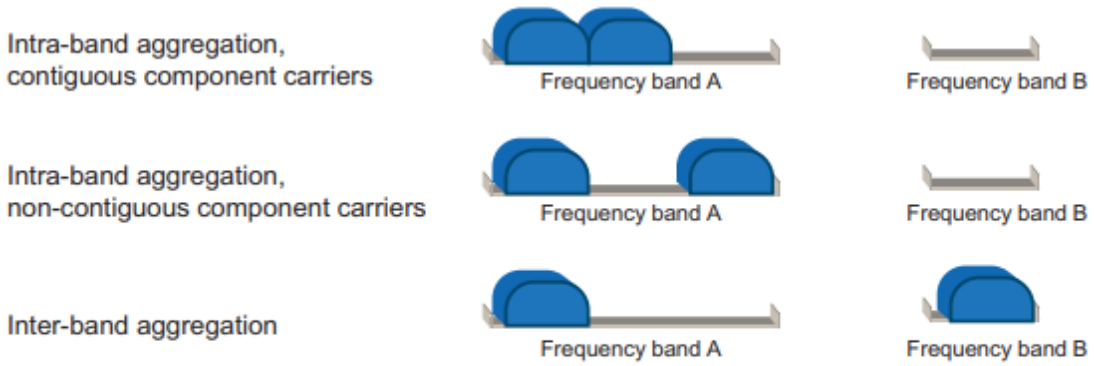


FIGURE 7.4

Carrier aggregation.

Figure 7.4 of Dahlman illustrates various types of carrier aggregation. *Id.* at Fig. 7.4. For example, the figure shows intra-band aggregation with contiguous component carriers, intra-band aggregation with non-contiguous component carriers, and inter-band aggregation. *Id.*

2. Dependent Claims 13–15 and 23–25

Claim 13 depends from claim 1 and recites that "the carrier aggregated transmit signals are intra-band carrier aggregated transmit signals." Claim 14, which depends from claim 13, recites that the "intra-band carrier aggregated transmit signals are contiguous." Claim 15, which also depends from claim 13, recites that the "intra-band carrier aggregated transmit signals are non-contiguous." Claims 23–25 recite similar

limitations as claims 13–15, respectively. Petitioner addresses all these claims together. *See* Pet. 74–81.

In particular, Petitioner relies on Dahlman, directing us to Figure 7.4 of Dahlman, which is reproduced above. Pet. 75, 79–80. As discussed above, the figure shows intra-band aggregation with contiguous component carriers and intra-band aggregation with non-contiguous component carriers. Ex. 1206, Fig. 7.4. Petitioner contends:

> A [person of ordinary skill in the art] . . . would have been motivated to combine Chen's architecture (as modified in view of Wang) with Dahlman's disclosure of the LTE and/or LTE-Advanced wireless communications standard in order to implement different and potentially better ways of aggregating carrier signals for transmission in the Chen architecture and so that it would comply with the LTE standard, which requires intra-band carrier aggregation.

Pet. 77. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1203 ¶ 194).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Chen, Wang, and Dahlman teaches the recited limitations in claims 13–15 and 23–25. We also are persuaded that Petitioner's proffered reasoning for further modifying the combination of Chen and Wang to include Dahlman's aggregation schemes, namely, to provide a way to carry out Chen's signaling, is sufficient to support the legal conclusion of obviousness. *See Kahn*, 441 F.3d at 988. Patent Owner does not dispute Petitioner's analysis for these limitations. *See generally* Prelim. Resp.

In view of the foregoing, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 13–15 and 23–25 would have been obvious over Chen, Wang, and Dahlman.

IV. CONCLUSION[13]

In summary:

Claim(s)	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–3, 5, 7, 11, 17–21, 27	103	Chen, Wang	1–3, 5, 7, 11, 17–21, 27	
12	103	Chen, Wang, Eliezer	12	
8–10	103	Chen, Wang, Choi	8–10	
13–15, 23–25	103	Chen, Wang, Dahlman	13–15, 23–25	
Overall Outcome			1–3, 5, 7–15, 17–21, 23–25, 27	

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

V. ORDER

In consideration of the foregoing, it is hereby

ORDERED that claims 1–3, 5, 7–15, 17–21, 23–25, and 27 of the ’675 patent are held *unpatentable*; and

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

IPR2018-01328
Patent 9,608,675 B2

PETITIONER:

David Cavanaugh
Richard Goldenberg
Theodoros Konstantakopoulos
Louis Tompros
WILMER CUTLER PICKERING HALE AND DORR LLP
david.cavanaugh@wilmerhale.com
richard.goldenberg@wilmerhale.com
theodoros.konstantakopoulos@wilmerhale.com
louis.tompros@wilmerhale.com

PATENT OWNER:
Matthew Johnson
Joseph Sauer
David Cochran
David Maiorana
Richard Graham
Joshua Nightingale
JONES DAY
mwjohnson@jonesday.com
jmsauer@jonesday.com
dcochran@jonesday.com
dmaiorana@jonesday.com
ragraham@jonesday.com
jrnightingale@jonesday.com