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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.

IPR2018-01327
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 3, "Pet.") requesting an *inter partes* review of claims 7–15, 17, 23–25, 27, and 33 of U.S. Patent No. 9,608,675 B2 (Ex. 1101, "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 7–15, 17, 23–25, 27, and 33 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 7–15, 17, 23–25, 27, and 33 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 3, 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 5, 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. 1101, 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.

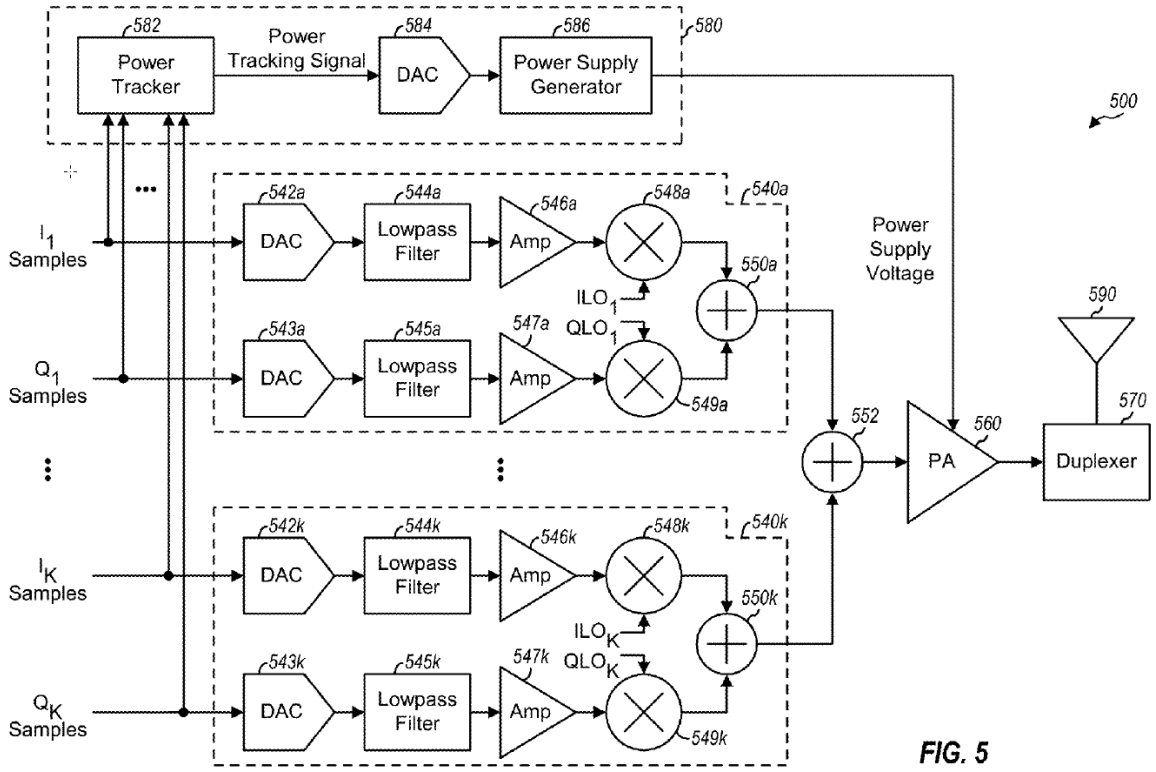


FIG. 5

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 7–15, 17, 23–25, 27, and 33 of the '675 patent. Claim 33 is independent and illustrative of the claims under challenge:

> 33. A non-transitory computer-readable medium comprising instructions, that when executed by a processor, cause the processor 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 a 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;
>
> generate a single power supply voltage based on the single power tracking signal; and
>
> receive the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously in a power amplifier to produce a single output radio frequency (RF) signal.

D. Asserted Grounds of Unpatentability

Petitioner challenges claims 7–15, 17, 23–25, 27, and 33 of the '675 patent on four grounds based on obviousness over 35 U.S.C. § 103. Pet. 12–79. We instituted *inter partes* review of those grounds. Inst. Dec. 2, 37. The instituted grounds are as follows.

Claim(s) Challenged	35 U.S.C. §	References
11, 17, 27, 33	103	Yu[2], Wang[3]
7–10	103	Yu, Wang, Choi[4]
12	103	Yu, Wang, Eliezer[5]
13–15, 23–25	103	Yu, Wang, Dahlman[6]

In support of its arguments, Petitioner relies on a declaration (Ex. 1103) as well as a reply declaration (Ex. 1131) 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 1130.

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] Yu, EP 2442440 A1, published Apr. 18, 2012 (Ex. 1104).
[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. 1105).
[4] Jinsung Choi et al., *Envelope Tracking Power Amplifier Robust to Battery Depletion*, 2010 IEEE MTT-S Int'l Microwave Symposium Digest 1074 (2010) (Ex. 1108, at Ex. A).
[5] Eliezer, US 2009/0004981 A1, published Jan. 1, 2009 (Ex. 1111).
[6] Erik Dahlman et al., 4G LTE / LTE-ADVANCED FOR MOBILE BROADBAND (Elsevier Ltd. 2011) (Ex. 1106).

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. 9–11; 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 independent claims 1, 18, and 33. Petitioner challenges claim 33, but not claims 1 and 18. Petitioner further challenges claims 7–15 and 17, however, which depend from claim 1. In addition, Petitioner challenges claims 23–25 and 27, which depend from claim 18. All the challenged claims in this proceeding therefore require the recited "power tracker."

The administrative law judge ("ALJ") in a related International Trade Commission ("ITC") investigation[8] construed "power tracker" to mean "component in a voltage generator that computes the power requirement." Ex. 1118, 18–20 (ITC order) (cited by Pet. 9). 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. 17 ("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

[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.

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. 9 (citing Ex. 1118, 18–20), 10 n.2. 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. 11–12. 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. 11–12; *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. 17 (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 17–18 (citing Ex. 2006, 127:11–13). According to Patent Owner, "Petitioner must be held to that expert position." *Id.* at 18. Thus, Patent Owner contends, "[t]he 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.*; *see also id.* ("Because the Petition fails to make the required

case for the 'power tracker' that ***Petitioner's expert asserts*** is an MPF limitation, the 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 7–8. 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.* at 8.

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 7–

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. 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. 10 n.2. 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 "appl[y] 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. 1103 ¶ 84 (cited by Pet. 10).

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. 11–12 ("We find this approach to be acceptable under 37 C.F.R. § 42.104(b)(3).").

2. "plurality of carrier aggregated transmit signals"

As discussed above, challenged claims 7–15, 17, 23–25 and 27 depend from unchallenged claims 1 or 18. Claims 1 and 18 as well as challenged claim 33 recite the term "plurality of carrier aggregated transmit signals." 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 "plurality of carrier aggregated transmit signals," construing it to mean "signals for transmission on multiple carriers at the same time to increase the bandwidth for a user." Pet. 10; Ex. 1118, 14–17 (ITC order) (cited by Pet. 10). 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. 10–11.

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 14–15 (citing Ex. 1101, 2:63–64).[9] Patent Owner also asserts that Petitioner relies on extrinsic evidence, namely, Dahlman, in its "background discussion" of carrier aggregation. *Id.* at 15. 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. 1103 ¶¶ 45–48 (citing Ex. 1106, 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. 15–16 (quoting Ex. 1106, 104).[10]

[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 1101. Thus, we cite Exhibit 1101 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 1106. Thus, we cite Exhibit 1106 when referring to Dahlman in this Decision.

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 terminal," not just "from a single terminal." *Id.* at 4–5 (emphases omitted) (citing PO Resp. 15); *see also* Ex. 1106, 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. 1129, 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. 1101, 2:63–64, 3:60–62. Although Dahlman refers to *component* carriers in its discussion of carrier aggregation (*see* Ex. 1106, 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. 1101, 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. 1106, 104 (emphasis added) (cited by PO Resp. 15); Pet. Reply 4.

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. 1101, 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 independent claims 1, 18, and 33 of the '675 patent recite 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. 1118, 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. 1101, 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 unchallenged claims 1 and 18 as well as challenged claim 33, all of which recite a power tracker that "generates the single power tracking signal based on a combination of the plurality of I and Q components." As noted above, challenged claims 7–15, 17, 23–25 and 27 depend from claims 1 or 18. All the challenged claims in this proceeding therefore require the recited power tracker.

The parties' dispute as to the meaning of "generates the single power tracking signal based on a combination of the plurality of I and Q

components" 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. 1102, 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. 1102, 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 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. 1102, 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

[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 1102. Thus, we cite Exhibit 1102 when referring to the prosecution history file in this Decision.

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. 1101, 8:6–27).

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

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

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. 1101, 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. 1102, 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. 1102, 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. 1101, 14:21–25.

The prosecution history likewise says nothing about requiring an addition operation. *See generally* Ex. 1102. 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. 1101, 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. 1101, 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. 1102, 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 Yu and Wang

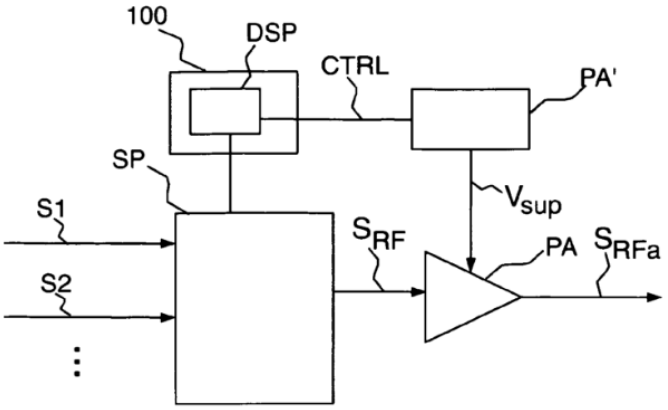
Petitioner asserts that claims 11, 17, 27, and 33 of the '675 patent would have been obvious over Yu and Wang. Pet. 12–48. Patent Owner traverses this ground. PO Resp. 30–41. For the reasons explained below, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 11, 17, 27, and 33 would have been obvious over Yu and Wang.

We start with an overview of the asserted references.

1. Yu

Yu states that its "inventive principle may be considered as an extension to the known principle of envelope-tracking amplifiers, which determine an envelope signal of the radio frequency signal to be amplified, and which control the voltage supply to the power amplifier depending on said envelope signal." Ex. 1104 ¶ 8. Figure 1, which is reproduced below, illustrates a power amplifier system according to Yu. *Id.* ¶ 33.

Fig. 1



As Figure 1 shows, Yu's power amplifier system includes signal processing unit SP, control unit 100, and power amplifier PA. *Id.* ¶¶ 33, 37–38. Input signals S1 and S2 are forwarded to signal processing unit SP, which transforms the input signals into radio frequency signal S_{RF}. *Id.* ¶ 37. Power amplifier PA is configured to amplify radio frequency signal S_{RF}, which is fed to an input of power amplifier PA. *Id.* ¶ 33. Power amplifier PA comprises power amplifier supply voltage module PA'. *Id.* ¶ 35. Power amplifier supply voltage module PA' is configured to modify supply voltage Vsup, which is applied to power amplifier PA. *Id.*

Control unit 100 is used to control the operation of power amplifier PA and its supply voltage module PA'. *Id.* ¶ 38. Control unit 100 has digital signal processing means DSP, which derive control signal CTRL based on input signals S1 and S2. *Id.* According to Yu, by deriving control signal CTRL in this way, "an improved supply voltage control for the power amplifier PA as compared to conventional envelope tracking systems may be obtained, especially in such cases, where more than one input signal S1, S2, . . . is to be processed to obtain said RF signal S_{RF}." *Id.* ¶ 39.

2. Wang

Wang describes an envelope-tracking power amplifier system. Ex. 1105, 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 Claim 33

As discussed above, challenged claim 33 is independent. Claim 1 (from which challenged claims 11 and 17 depend) and claim 18 (from which challenged claim 27 depends) also are independent. Although Petitioner does not challenge claims 1 or 18 in this proceeding, Petitioner addresses both claims as part of its analysis for dependent claims 11, 17, and 27. Pet. 13–38.

We also address unchallenged claims 1 and 18 in addition to challenged claim 33. Claim 1 is directed to an apparatus comprising a "power tracker," a "power supply generator," and a "power amplifier." Claim 18 is directed to a method and recites similar limitations. Claim 33, which is directed to "[a] non-transitory computer-readable medium comprising instructions," recites similar limitations as well. Petitioner relies on the same discussion for claims 1, 18, and 33. *See* Pet. 13–38 (discussing claims 1 and 18 together), 46–48 (referring to the discussion of claims 1 and 18 for claim 33). Our analysis of claim 1 applies to claims 18 and 33.

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 Yu and Wang. In particular, Petitioner identifies Yu's control unit 100 as a "power tracker," Yu's control signal CTRL as a "single power tracking signal," and Yu's input signals S1 and S2 as "carrier aggregated transmit signals." Pet. 15, 17, 21. Petitioner asserts that control unit 100 is "in Yu's voltage generation circuitry." *Id.* at 15. To illustrate, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.* at 16.

Fig. 3

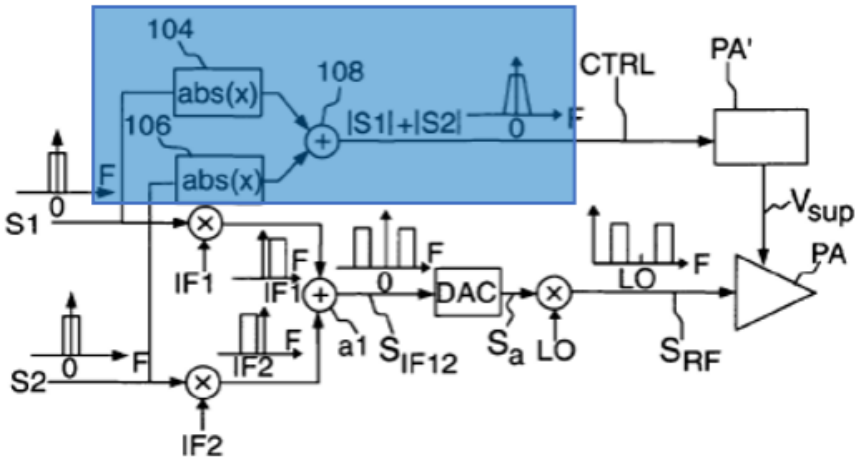


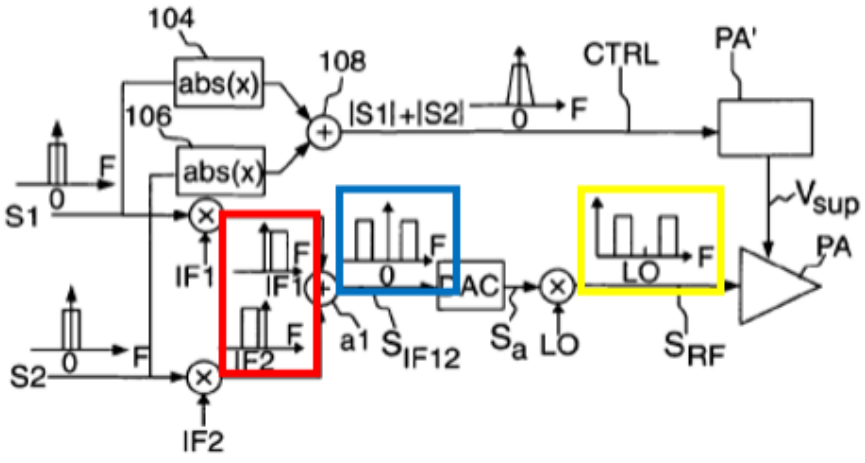
Figure 3 of Yu is a signal flow diagram. Ex. 1104 ¶¶ 32, 57. Petitioner directs us to where Yu teaches that control unit 100 may comprise function blocks 104 and 106 as well as adder 108. Pet. 15–16 (citing Ex. 1104 ¶ 66); *see also* Ex. 1104, Fig. 1 (control unit 100), Fig. 3 (blocks 104, 106 and adder 108). The annotated figure highlights Yu's blocks and adder in blue. *See* Pet. 16. Petitioner further directs us to where Yu teaches that blocks 104 and 106 receive input signals S1 and S2, respectively, and calculate the absolute values of those signals. *Id.* (citing Ex. 1104 ¶ 57).

Figure 3 of Yu shows that adder 108 combines the absolute values of input signals S1 and S2, and then outputs control signal CTRL. Ex. 1104, Fig. 3; *see also id.* ¶ 57 (cited by Pet. 16). Petitioner contends that "Yu's summing of the absolute values of the signals—(|S1| + |S2|)—is mathematically the same as the I/Q formula disclosed for determining the power tracking signal in Equation 2 of the '675 patent." Pet. 26–27 (citing Ex. 1101, 8:23–29; Ex. 1103 ¶ 106). According to Petitioner, "the absolute value of an I/Q signal is equal to the magnitude of the signal, which is a proxy for the signal's power, and the sum of the two signals' magnitudes is a

proxy for the power required to transmit the aggregated signals." *Id.* 25–26 (footnote omitted) (citing Ex. 1103 ¶ 106). As discussed below in further detail, Petitioner contends that Yu's signals S1 and S2 include I and Q components, or, alternatively, that it would have been obvious to modify Yu in view of Wang to include signals with I and Q components. Petitioner further notes that Yu teaches using control signal CTRL for modifying supply voltage Vsup, which is applied to power amplifier PA. Pet. 17; Ex. 1104 ¶¶ 35, 37.

Regarding Yu's signals S1 and S2, Petitioner additionally directs us to where Yu teaches simultaneously processing the input signals. Pet. 20 (citing Ex. 1104 ¶ 15); *see also* Ex. 1104 ¶ 16 ("[B]oth input signals may simultaneously be processed by the digital signal processing means."). Petitioner also directs us to another annotated version of Figure 3 of Yu, which is reproduced below. Pet. 21.

Fig. 3



As discussed above, Figure 3 of Yu is a signal flow diagram. Ex. 1104 ¶¶ 32, 57. Petitioner asserts that signals S1 and S2 are upconverted to different intermediate frequencies, as shown in the red box. Pet. 21 (citing

Ex. 1104 ¶ 48). Petitioner further asserts that the difference in frequencies is maintained when the signals are subsequently summed by adder a1, as shown in the blue box, and when they are upconverted again to different RF center frequencies, as shown in the yellow box. *Id.* at 22. Petitioner contends that the annotated portions of Figure 3 show that Yu's signals S1 and S2 are transmitted on multiple carriers at the same time. *Id.* at 21–22. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 102).

Petitioner submits, "Although not expressly disclosed in Yu, a [person of ordinary skill in the art] would have understood that the input signals S1 and S2 are digital signals for wireless transmission that each have I and Q components." *Id.* at 23. Petitioner directs us to where Yu describes input signals S1 and S2 as digital baseband signals, and contends that "at the time Yu was published, RF communication systems processing digital signals typically used I/Q components." *Id.* at 23–24 (citing Ex. 1104 ¶ 20). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 104).

Alternatively, Petitioner points to Wang for teaching the recited I and Q components. *Id.* at 27. According to Petitioner, even if Yu does not disclose I and Q signals, "it would have been obvious to use Wang's I/Q signal processing with Yu's power tracker." *Id.* Petitioner directs us to where Wang teaches receiving a "complex baseband signal," which Petitioner asserts "is understood to comprise I and Q components." *Id.* at 28 (citing Ex. 1105, 1245, Fig. 3). 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.* (citing

Ex. 1105, 1245). Petitioner contends that an ordinarily skilled artisan "would have been motivated to use Wang's I/Q processing in Yu" because, "[i]f a [person of ordinary skill in the art] had any doubt about what type of signaling to use, she would have looked to Wang, a reference in the same field that provides those details." *Id.* at 29–30. In addition, Petitioner contends that "[c]omplex input signals (with I and Q components) improve immunity to transmit signal noise, and allow the use of advanced (higher order) 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 30 (citing Ex. 1121, 308). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 112).

Petitioner also points to Wang for teaching Orthogonal Frequency Division Multiplexing (OFDM) signals. *Id.* at 32 (citing Ex. 1105, 1244 (title), 1253). According to Petitioner, and ordinarily skilled artisan "would have looked to Wang, a reference in the same field, to determine a modulation technique for Yu." *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 33–34 (citing Ex. 1122 ¶¶ 2–3). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 118).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu 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 Yu's signals S1 and S2 would have been understood to include I and Q components. *See, e.g.*, Ex. 1103 ¶ 104. We also are persuaded that Petitioner's proffered reasoning for modifying Yu to include Wang's baseband signal (comprising an OFDM signal with I and Q components), namely, to provide a way to carry out Yu's signaling, 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.").

Patent Owner disputes certain aspects of Petitioner's analysis regarding the recited "power tracker." *See* PO Resp. 30–41. 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 Yu's power amplifier supply voltage module PA' as a "power supply generator," and Yu's supply voltage Vsup as a "single power supply voltage." Pet. 35–36. To illustrate, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.* at 36.

Fig. 3

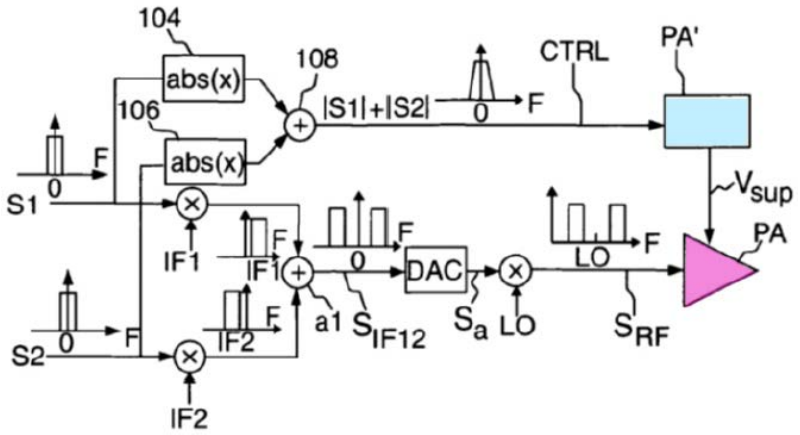


Figure 3 of Yu is a signal flow diagram. Ex. 1104 ¶¶ 32, 57. Petitioner directs us to where Yu teaches using control signal CTRL (which Petitioner identifies as the "single power tracking signal") to control the value of supply voltage Vsup via power amplifier supply voltage module PA'. Pet. 36 (citing Ex. 1104 ¶ 52); *see also* Ex. 1104, Fig. 3; *id.* ¶ 57 ("[T]he supply voltage Vsup for the power amplifier PA is again determined depending on said control signal CTRL.") (cited by Pet. 36). The annotated figure shows power amplifier supply voltage module PA' (shown with blue shading) receiving control signal CTRL and outputting supply voltage Vsup.

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu and Wang teaches the recited power supply generator limitation in claim 1. *See, e.g.*, Ex. 1104 ¶¶ 52, 57, Fig. 3. 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 Yu's power amplifier as a "power amplifier." Pet. 36. To illustrate, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.* at 37.

Fig. 3

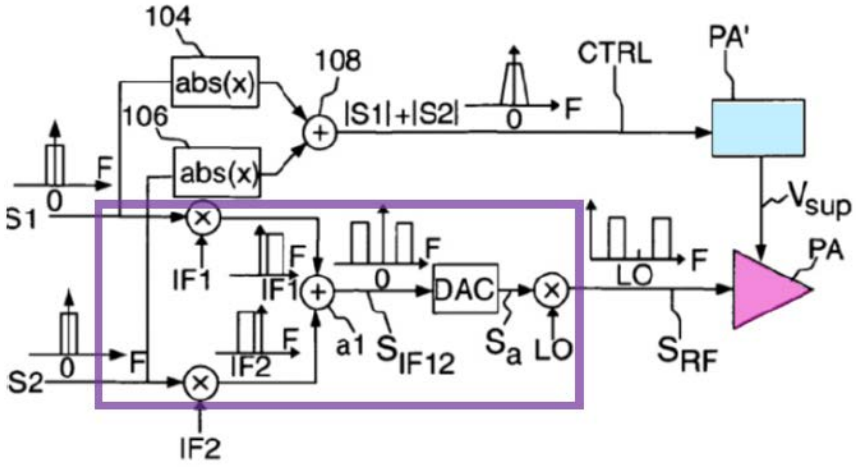


Figure 3 of Yu depicts a signal flow diagram. Ex. 1104 ¶¶ 32, 57. Referring to its annotated version of Figure 3, Petitioner contends that Yu teaches that power amplifier PA receives supply voltage Vsup (which Petitioner identifies as the "single power supply voltage") from power amplifier supply voltage module PA' (shown with blue shading). Pet. 36. The annotated figure shows power amplifier PA (shown with pink shading) receiving supply voltage Vsup.

Petitioner further contends that Yu's power amplifier PA also receives input signals S1 and S2 (which Petitioner identifies as the "plurality of carrier aggregated transmit signals"). *Id.* at 37. Referring still to its annotated version of Figure 3, Petitioner explains that Yu's input signals S1 and S2 are fed into signal processing unit SP, which is outlined in purple, and are output to power amplifier PA, which is shown with pink shading.

Id. Petitioner also explains that "the output of the SP block (S_{RF}) comprises the two input signals, at upconverted frequencies." *Id.* at 37–38 (citing Ex. 1104 ¶ 41). In addition, Petitioner directs us to where Yu teaches that, "at an output of the power amplifier PA, an amplified radio frequency signal S_{Rfa} is obtained." *Id.* at 38 (citing Ex. 1104 ¶ 33); *see also* Ex. 1104, Fig. 1. We find that Yu's signal S_{Rfa} 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 Yu and Wang teaches the recited power amplifier limitation in claim 1. *See, e.g.*, Ex. 1104 ¶¶ 33, 41. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

4. Dependent Claims 11, 17, and 27

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 Yu's "two input signals are upconverted in frequency in a manner that causes them to be sent at different frequencies as part of a radio frequency signal (S_{RF})." Pet. 39–40. To illustrate, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.* at 40.

Fig. 3

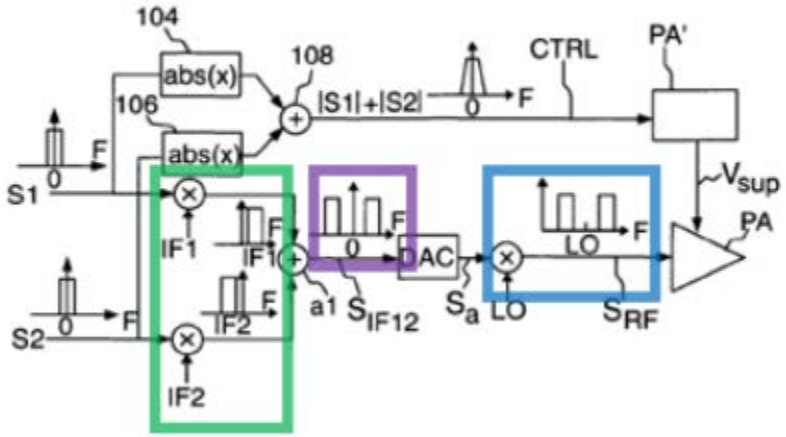


Figure 3 of Yu is a signal flow diagram. Ex. 1104 ¶¶ 32, 57. As discussed above, Yu's input signals S1 and S2, as modified by Wang, correspond to the recited "plurality of carrier aggregated transmit signals." *See supra* Part III.B.3.a. According to Petitioner, "the frequencies of input signals S1 and S2 are shifted by up-converting them twice." Pet. 40. Petitioner explains that "[i]n the first up-conversion (outlined in green), S1 is multiplied by the intermediate frequency IF1 and S2 is multiplied by the intermediate frequency IF2, which shifts the signals to intermediate frequencies S_{IF1} and S_{IF2}." *Id.* (citing Ex. 1104 ¶ 48). Yu's adder a1 adds intermediate frequency signals S_{IF1} and S_{IF2} to provide intermediate frequency sum signal S_{IF12}, as shown in the purple box. Pet. 41; Ex. 1104 ¶ 49 (cited by Pet. 41). Petitioner further explains that "[t]he second up-conversion is by multiplication by the local oscillator LO, which shifts the analog version of S_{IF12} to obtain a radio frequency signal S_{RF}, as shown in the blue box." Pet. 41 (citing Ex. 1104 ¶ 49). Additionally, Petitioner asserts that "the signals [shown in the blue box] are transmitted on carriers at different frequencies, one just below the LO frequency and another just

above the LO frequency." *Id.* Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 39–41 (citing Ex. 1103 ¶¶ 125–128).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu 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 also 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 3 of Yu, which is reproduced below. Pet. 44.

Fig. 3

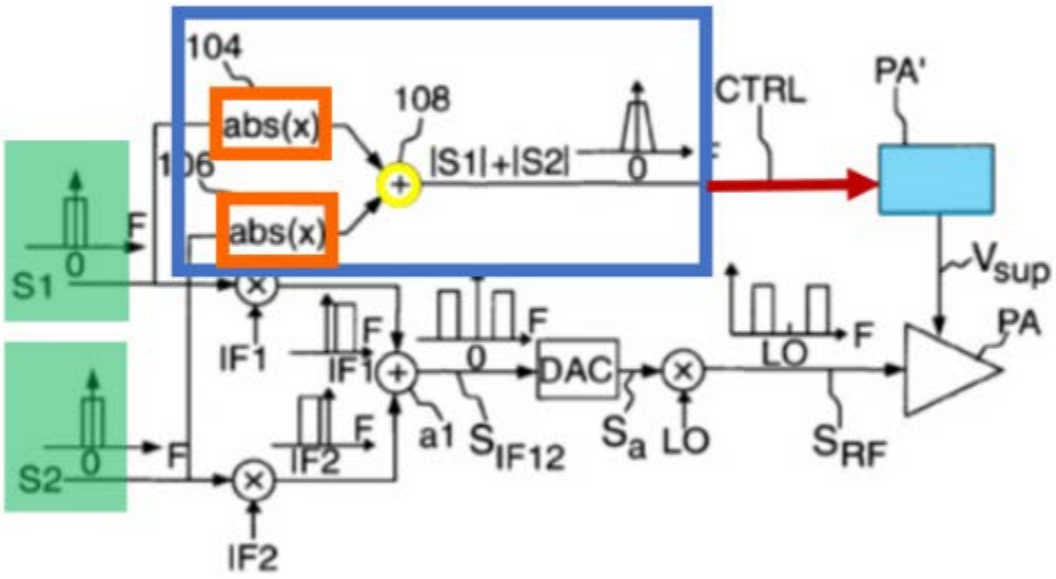


Figure 3 of Yu is a signal flow diagram. Ex. 1104 ¶¶ 32, 57. As discussed above, Yu's blocks 104, 106 and adder 108 (collectively outlined in blue) correspond to the recited "power tracker," and Yu's control signal CTRL (highlighted in red) corresponds to the recited "single power tracking signal." *See supra* Part III.B.3.a; Pet. 44. Yu's input signals S1 and S2 (shown with green shading), as modified by Wang, have respective I and Q components that correspond to the recited I and Q components. *See id.*

With respect to the recited calculating limitation, Petitioner contends that "Yu's power tracker (outlined in [] blue) calculates the absolute value of each signal (abs(x)) in blocks 104 and 106 (outlined in orange)," where "[t]he absolute value of each signal is calculated using the formula $\sqrt{\mathrm{I}_k{}^2(\mathrm{t}) + \mathrm{Q}_k{}^2(\mathrm{t})}$ and the I and Q components of each of the K signals (where in Yu, K=2)." Pet. 44. 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 45 (quoting Ex. 1105, 1245). Relying on its analysis for claims 1 and 18, Petitioner further reiterates that "[f]or a complex I/Q signal, the terms absolute value and amplitude (or magnitude) are equivalent and used interchangeably." *Id.* at 44–45; *see also id.* at 25–26 (with respect to claims 1 and 18, asserting that "the absolute value of an I/Q signal is equal to the magnitude of the signal"). According to Petitioner, Wang's "mathematical expression for amplitude or absolute value—$(I^2 + Q^2)^{1/2}$—is identical to the expression required by this claim limitation—$\sqrt{\mathrm{I}_k{}^2(\mathrm{t}) + \mathrm{Q}_k{}^2(\mathrm{t})}$." *Id.* at 45. Noting that "[t]he amplitude/absolute value of a complex signal is well-known to be a voltage," Petitioner adds that "the resultant outputs of blocks 104 and 106 in Yu are the required 'K voltages,' where K=2 in Yu." *Id.* (citing Ex. 1104,

1245). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 44–45 (citing Ex. 1103 ¶¶ 132–134).

With respect to the recited summing limitation, Petitioner contends that "Yu shows that the K voltages—the outputs of blocks 104 and 106—are summed by adder 108 (outlined in yellow) which determines the single power tracking signal (CTRL)." *Id.* As support, Petitioner directs us to where Yu teaches that "[t]he absolute values of the input signals S1, S2 are added by means of adder 108 to obtain said control signal CTRL." *Id.* (quoting Ex. 1104 ¶ 57). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 135).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu 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. These limitations appear in independent claims 1, 18, and 33, and are therefore required by all the challenged claims. Patent Owner argues in particular that Yu 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. 30–37; *e.g.*, Ex. 1101, claim 1. Patent Owner also argues that Yu and Wang do not teach a "plurality of *carrier aggregated* transmit signals." PO Resp. 40–41. Additionally, 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 37–40. We address these arguments in turn.

a. "based on a combination of"

Patent Owner argues that Petitioner does not "identify any disclosure in Yu of a single power tracking signal being generated ***based on a combination of the plurality of I and Q components***." *Id.* at 33. Specifically, Patent Owner argues that Petitioner "wholly ignores the 'combination' portion of the claim language," which Patent Owner asserts "enables one of the primary benefits of the '675 patent: the reduction in circuit components and power consumption." *Id.* at 34–35 (citing Ex. 1101, 6:25–27). As support, Patent Owner states that "the alleged I and Q components of S1 are never in the same signal processing component as the purported I and Q components of S2." *Id.* at 36 (citing Ex. 2006, 78:11–14, 79:14–16 (deposition testimony of Dr. Choi)). Patent Owner also responds to Petitioner's comparison between Yu's summing of absolute values and Equation 2 of the '675 patent, stating further that "mathematical equivalence is insufficient." *Id.* According to Patent Owner, Petitioner "fails to explain how Yu's solution that requires disparate signal processing components 104, 106 does anything to achieve" the '675 patent's "hardware 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 36–37 (citing Ex. 1101, 6:20–27).

Petitioner counters that "Patent Owner's argument relies on the incorrect premise that Yu's power tracker consists of only signal processing components 104 and 106." Pet. Reply 14. Petitioner asserts that "the Petition makes clear[] Yu's power tracker also includes adder 108," which means "the power tracker . . . receives the input signals at blocks 104 and 106, and adder 108 then ***combines*** them to produce a single power tracking signal 'based on a combination of the plurality of I and Q components.'" *Id.* at 14–15 (citing Pet. 16–18). 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.* at 15; *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. 1101, 8:23–32).

Petitioner further reiterates that "Yu's 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 Yu discloses." *Id.* at 15–16 (citing Ex. 1130, 111:8–14 (deposition testimony of Dr. Williams)).

In response, Patent Owner contends that Petitioner's argument that Yu's adder 108 combines the input signals, thereby satisfying the disputed claim limitation, was not made in the Petition and should be rejected. PO Sur-reply 14. Patent Owner nevertheless also contends that "Petitioner's new reply argument is erroneous" because "the outputs of blocks 104 and 106 *are not* I and Q components but rather absolute values of the input signals S1 and S2." *Id.*; *see also id.* at 15 ("Petitioner has not explained how [Yu]'s combining of the absolute values of the input signals S1 and S2—and *not* the I and Q components themselves—allegedly meets this claim language.").[12]

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 (citing Ex. 1101, 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.* (citing Ex. 1102, 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 <u>different</u> transmit signals being sent simultaneously,'" which means the claims "require the power tracker to be implemented in a manner that

[12] Patent Owner specifies "Chen," but we believe Patent Owner intended to specify "Yu," the asserted reference at issue.

reduces the number of circuit components and power consumption." *Id.* at 17 (citing Ex. 1102, 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 Yu 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 Yu's control unit 100, which comprises blocks 104 and 106 as well as adder 108, corresponds to the recited power tracker, as Petitioner contends. *See* Pet. 36–38; citing Ex. 1104 ¶ 66 (cited by Pet. 37–38). To illustrate, Petitioner's annotated version of Figure 3 of Yu is reproduced below. Pet. 38.

Fig. 3

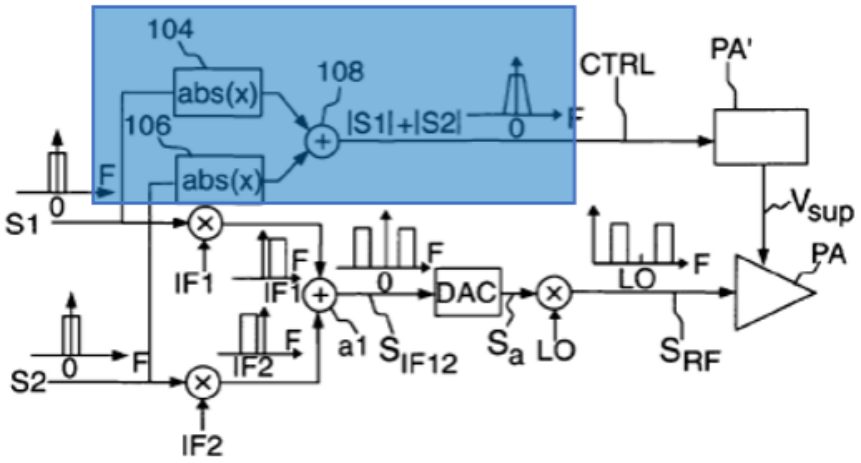


Figure 3 is a signal flow diagram. Ex. 1104 ¶¶ 32, 57. The annotated figure highlights Yu's blocks 104, 106 and adder 108 in blue. The blocks receive input signals S1 and S2, and then they calculate the absolute values of those signals. *Id.* ¶ 57. The adder sums the absolute values of the input signals to obtain control signal CTRL, which the adder subsequently outputs. *Id.* As discussed above, we agree with Petitioner that Yu's control signal 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 Yu's signals S1 and S2 to include Wang's baseband signal (comprising an OFDM signal with I and Q components) to provide a way to carry out Yu's signaling. *See id.* Accordingly, in view of Petitioner's proposed combination of Yu and Wang, we find that blocks 104, 106 and adder 108 together generate control signal CTRL 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 Yu's solution that requires disparate signal processing components 104,

106 does anything to achieve" the '675 patent's "hardware 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. 36–37 (citing Ex. 1101, 6:20–27). This contention, however, does not undermine Petitioner's showing that the combination of Yu 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 "disparate 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. 1101, 6:20–27 (emphases added). Moreover, contrary to Patent Owner's position, Yu does in fact teach a single power amplifier (i.e., power amplifier PA) that is used to generate a single output RF signal (i.e., amplified radio frequency signal S_{Rfa}) for multiple transmit signals (i.e., input signals S1 and S2). *See* Ex. 1104 ¶ 33, Figs. 1, 3; *see also supra* Part III.B.3.c.

Turning to Patent Owner's characterization of Petitioner's argument regarding Yu's adder 108 as a "new reply argument," we note Petitioner's identification in the Petition of Yu's adder 108 as part of the recited power tracker. *See* Pet. 14–15. 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. 34–36; Pet. Reply 14–15. As for Patent Owner's additional contention that the

outputs of Yu's blocks 104, 106 are absolute values of input signals S1, S2, 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 control signal of Petitioner's proposed combination of Yu and Wang based on the sum of the absolute values of the input signals, which have I and Q components. Patent Owner's counsel conceded during oral argument that "what's coming out of blocks 104 and 106" are "envelope signals," which "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. 1101, 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 16. 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. 1102, 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 Yu nor Wang discloses carrier aggregation under either party's construction of that term," both of which "require the increase [extension] of the bandwidth of a single user based on transmission across multiple carriers." PO Resp. 40. As support, Patent Owner asserts that "Yu's Figure 3 and Figure 4 embodiments describe base station technology that is processing signals provided by different users." *Id.* According to Patent Owner, "[p]rocessing signals from different users fails to disclose '*signals from a single terminal* utilizing multiple component carriers *which provide extended transmission bandwidth for a user transmission* from the single terminal.'" *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 Yu and Wang teaches the

recited "plurality of carrier aggregated transmit signals." In particular, as discussed above, we find that Yu's input signals S1 and S2, as modified by Wang, correspond to the recited "plurality of carrier aggregated transmit signals." *See supra* Part III.B.3.a. To illustrate, Petitioner's annotated version of Figure 3 of Yu is reproduced below. *See* Pet. 21.

Fig. 3

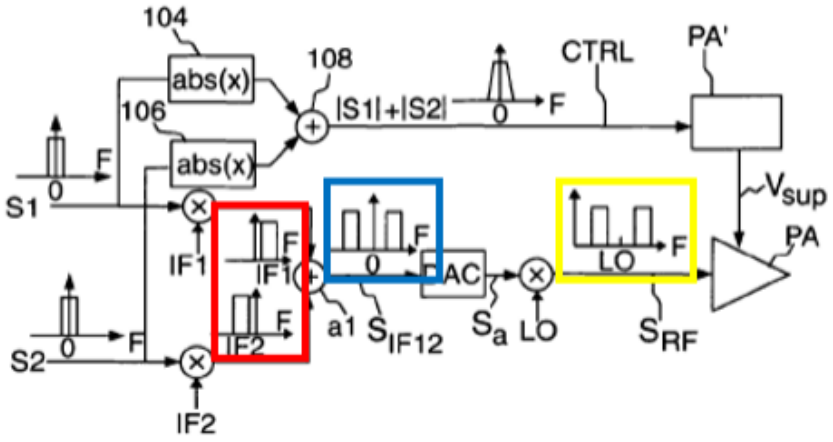


Figure 3 depicts a signal flow diagram. Ex. 1104 ¶¶ 32, 57. Petitioner asserts that signals S1 and S2 are upconverted to different intermediate frequencies, as shown in the red box. Pet. 21 (citing Ex. 1104 ¶ 48). Petitioner further asserts that the difference in frequencies is maintained when the signals are subsequently summed by adder a1, as shown in the blue box, and when they are upconverted again to different RF center frequencies, as shown in the yellow box. *Id.* at 22. Petitioner contends that the annotated portions of Figure 3 show that Yu's signals S1 and S2 are transmitted on multiple carriers at the same time. *Id.* at 21–22. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 102).

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. 40. Accordingly, Patent Owner's argument does not undermine Petitioner's showing that the combination of Yu and Wang teaches the recited carrier aggregated transmit signals.

c. Motivation to Combine

Patent Owner argues that an ordinarily skilled artisan "would not be motivated to combine the Figure 3 and Figure 4 base station implementations of Yu with the single channel 802.11g WLAN technology described in 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. 38–39. 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 39. 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 39–40.

In response, Petitioner contends that "Figures 3 and 4 from Yu are not 'base station implementations' that are inappropriate for mobile terminals." Pet. Reply 17. Petitioner asserts that "nothing in Yu suggests that Figures 3 and 4 cannot be applied to narrower frequency spacings typical in mobile terminals," and "[a]lthough Figures 3 and 4 are preferred embodiments for

larger frequency spacings, they still would perform the invention of the '675 patent—the transmission of multiple signals simultaneously using a single power amplifier (PA) that receives a single power supply voltage from a single power tracking supply generator—even when the frequency spacing is narrow." *Id.* at 17–18. Petitioner further asserts that "Yu's general description of its subject matter points to a broad scope of application that specifically includes mobile devices." *Id.* at 18 (citing Ex. 1104 ¶ 34).

Citing its discussion in the Petition regarding reasons for combining Yu and Wang, Petitioner also contends that "even if Figures 3 and 4 from Yu were 'base station implementations,' a [person of ordinary skill in the art] still would have been motivated to incorporate concepts from Wang (such as OFDM) into the systems disclosed by Yu." *Id.* at 18–19 (citing Pet. 27–35). Petitioner asserts that Patent Owner's argument is based on "the false premise that the Petition proposes incorporating the 802.11g WiFi standard into Yu." *Id.* at 18. According to Petitioner, the "Petition argues only that a [person of ordinary skill in the art] looking to implement and improve Yu would have been motivated to look to Wang and use basic RF concepts (e.g., OFDM modulation) that Wang discloses." *Id.* at 19. Petitioner states that its "Petition never suggested, and its argument does not depend upon, incorporating the IEEE 802.11g WiFi standard into Yu." *Id.*

Patent Owner counters that Petitioner's argument that Yu's Figures 3 and 4 can be applied to narrower frequency spacings typical in mobile terminals "is an improper new reply argument." PO Sur-reply 18. Patent Owner nevertheless contends that Petitioner's argument "is not an affirmative reason why the [person of ordinary skill in the art] would

allegedly be motivated to modify the embodiments of these figures." *Id.* As support, Patent Owner asserts that "the only embodiments described with respect to these figures are for the wide frequency spacings expressly described in the reference." *Id.* at 19. Patent Owner further asserts that an ordinarily skilled artisan "would recognize that the embodiment of Figure 2 is for narrower frequency spacings, whereas the embodiments of Figures 3 and 4 are not," and "Yu thus teaches that Figure 2 should be used for narrow frequency spacings and teaches away from using Figures 3 and 4 in such scenarios." *Id.* Patent Owner adds, "It 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 Yu," and "[t]he Petition and supporting declaration fail to do this and do not address the disparity across operating environments of Yu and Wang at all." *Id.* at 20.

Based on the record before us, we disagree with Patent Owner. Patent Owner's focus on "the disparity across operating environments of Yu and Wang" 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." *See 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.* As Petitioner points out, Wang teaches a complex baseband signal comprising an OFDM signal with I and Q components. Pet. 28 (citing Ex. 1105, 1245, Fig. 3); *id.* at 32 (citing Ex. 1105, 1244 (title), 1253). Petitioner explains that "[c]omplex input

signals (with I and Q components) improve immunity to transmit signal noise, and allow the use of advanced (higher order) 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 30 (citing Ex. 1121, 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 33–34 (citing Ex. 1122 ¶¶ 2–3). According to Petitioner, it is for these reasons an ordinarily skilled artisan would have used Wang's baseband signal in Yu's system. Contrary to what Patent Owner argues, we find that these reasons provide sufficient rationale for why an ordinarily skilled artisan would have used Wang's baseband signal in Yu'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. *See* PO Resp. 39. We note that "[a] person of ordinary skill is also a person of ordinary creativity, not an automaton," and, in modifying Yu's system to include Wang's signal, would have made any necessary additional modifications such that Yu'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 challenged claims 11, 17, 27, and 33. *See generally* PO Resp.

In view of the foregoing, we determine that Petitioner has demonstrated by a preponderance of the evidence that claims 11, 17, 27, and 33 would have been obvious over Yu and Wang.

C. Obviousness over Yu, Wang, and Choi

Petitioner asserts that claims 7–10 of the '675 patent would have been obvious over Yu, Wang, and Choi. Pet. 48–62. 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 7–10 would have been obvious over Yu, Wang, and Choi.

Having already discussed Yu 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. 1108, at Ex. A, at 1074. To illustrate, Figure 5 of Choi is reproduced below.

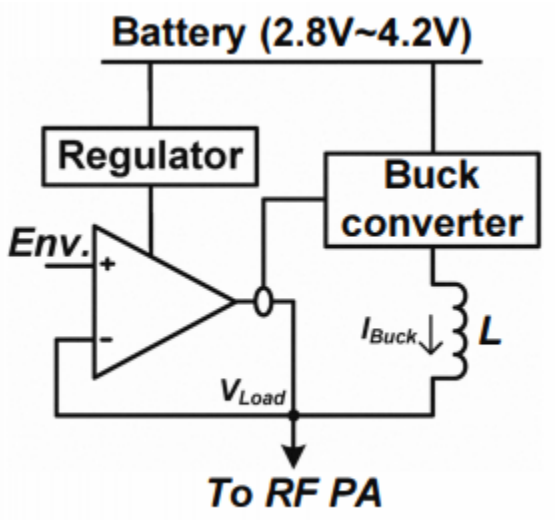


Fig. 5. Battery-to-5V boosting PA supply modulator.

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 7–10

Claims 7–10 depend directly or indirectly from claim 1. As discussed above, we find that Petitioner has established sufficiently for purposes of this Decision that the combination of Yu and Wang teaches the limitations recited in claim 1. *See supra* Section III.B.3.

Claim 7 depends directly 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 Yu's power amplifier supply voltage module PA' (which Petitioner identifies as the recited "power supply generator") receives control signal CTRL (which Petitioner identifies as the recited "power tracking signal") and generates supply voltage Vsup (which

Petitioner identifies as the recited "power supply voltage"). Pet. 48–49 (citing Ex. 1104, Fig. 3). Petitioner also asserts, however, that "Yu does not disclose a power tracking amplifier in its power supply generator (PA')." *Id.* at 49. For this aspect of the limitation, Petitioner relies on Choi. *Id.*

In particular, Petitioner identifies Choi's hybrid switching amplifier as a "power supply generator" and Choi's linear amplifier as a "power tracking amplifier." Pet. 49–50; *see* Ex. 1108, at Ex. A, at Fig. 5. As discussed above, Choi's hybrid switching amplifier comprises the linear amplifier. Ex. 1108, at Ex. A, at 1074, Fig. 4. Petitioner contends that Choi's "linear amplifier receives the power tracking signal ENV and generates the power supply voltage V_{LOAD} for the power amplifier." Pet. 51. Petitioner further contends that "[i]t would have been obvious to use Choi's HSA to implement Yu's PA' module." *Id.* at 53. According to Petitioner, "Yu and Wang each disclose envelope-tracking architectures at a fairly high (functional block) level, while Choi discloses a specific implementation of a power supply generator to achieve high bandwidth and high efficiency." *Id.* (citing Ex. 1103 ¶ 151); *see also id.* at 55 (citing Ex. 1108, at Ex. A, at 1074; Ex. 1103 ¶ 153). In addition, Petitioner asserts that "Choi's HSA is advantageously robust against battery depletion." *Id.* at 56 (citing Ex. 1108, Ex. A, at 1074–1075).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu, Wang, and Choi teaches the recited limitation in claim 7. We also are persuaded that Petitioner's proffered reasoning for further modifying the combination of Yu 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 8 depends from claim 7 and recites "the power supply generator further compris[es] 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." For this limitation, Petitioner relies on Choi. As discussed above, Petitioner identifies Choi's hybrid switching amplifier as a "power supply generator" and Choi's linear amplifier as a "power tracking amplifier." Petitioner additionally identifies Choi's buck converter as a "switcher." Pet. 57. We note that Choi's hybrid switching amplifier comprises the buck converter in addition to the linear amplifier. Ex. 1108, at Ex. A, at Fig. 5. Petitioner directs us to where Choi teaches that "the switching buck converter roles as a dependent current source . . . and supplies most of the current needed at the output. . . . The current sensing unit detects the current flowing from the linear amplifier to the output and it changes the state of the switching amplifier according to the magnitude and polarity of the sensed current." Pet. 58 (citing Ex. 1108, at Ex. A, at 1075).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu, Wang, and Choi teaches the recited limitation in claim 8. Patent Owner does not dispute Petitioner's analysis for this limitation. *See generally* PO Resp.

Claim 9 depends from claim 7 and recites "the power supply generator further compris[es] 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 "the power tracking

amplifier operates based on the boosted voltage or the battery voltage." For these limitations, Petitioner identifies Choi's regulator as a "boost converter." Pet. 59–60. We note that the regulator is part of Choi's hybrid switching amplifier. Ex. 1108, at Ex. A, at Fig. 5. Petitioner contends that "Figure 5 [of Choi] shows that [the regulator] 'receive[s] a battery voltage' and provides a boosted voltage 'for the power tracking amplifier [Choi's linear amplifier]' as claimed." Pet. 59 (citing Ex. 1108, at Ex. A, at 1075, Fig. 5). Petitioner also directs us to where Choi teaches that "the additional 5V boost converter, whose input range is from 2.8V to 4.2V, is coupled to the supply of the linear amplifier," which "results in a stable supply voltage to the RF PA regardless of the battery depletion." *Id.* at 59–60 (citing Ex. 1108, at Ex. A, at 1075).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu, Wang, and Choi teaches the recited limitations in claims 9 and 10. 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 7–10 would have been obvious over Yu, Wang, and Choi.

D. Obviousness over Yu, Wang, and Eliezer

Petitioner asserts that claim 12 of the '675 patent would have been obvious over Yu, Wang, and Eliezer. Pet. 62–72. 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 Yu, Wang, and Eliezer.

Having already discussed Yu 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. 1111 ¶ 2. Figure 11 of Eliezer is reproduced below.

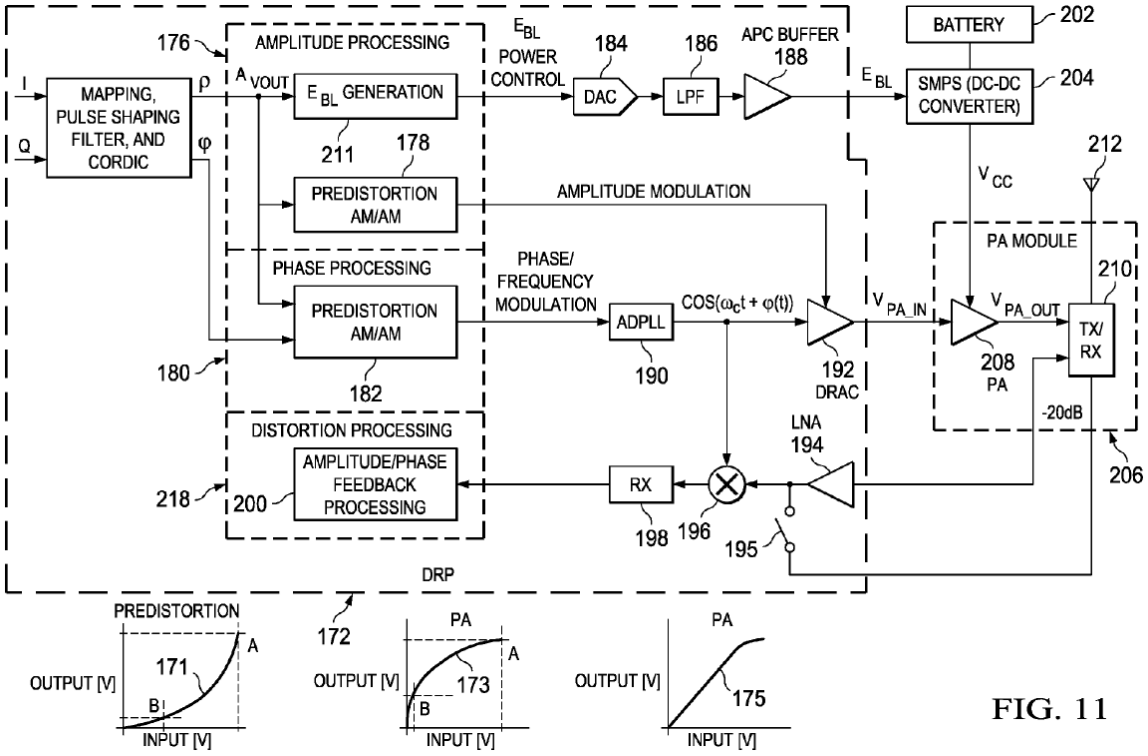


FIG. 11

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 Yu and Wang teaches the limitations recited in claim 1. *See supra* Part III.B.3. Claim 11 recites "the plurality of carrier aggregated transmit signals are sent on a plurality of carriers at different frequencies." Yu teaches "process[ing] multiple different input signals which may have target bandpass frequency ranges in the radio frequency signal that may differ by

some ten MHz up to various hundred MHz." Ex. 1104 ¶ 15 (cited by Pet. 39).

Claim 12 recites "the single power tracking signal has a bandwidth that is smaller than an overall bandwidth of the plurality of carriers." For this limitation, Petitioner relies on Eliezer. In particular, Petitioner identifies Eliezer's reduced-bandwidth envelope signal E_{BL} as a "single power tracking signal." Pet. 68. 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 69.

FIG. 12

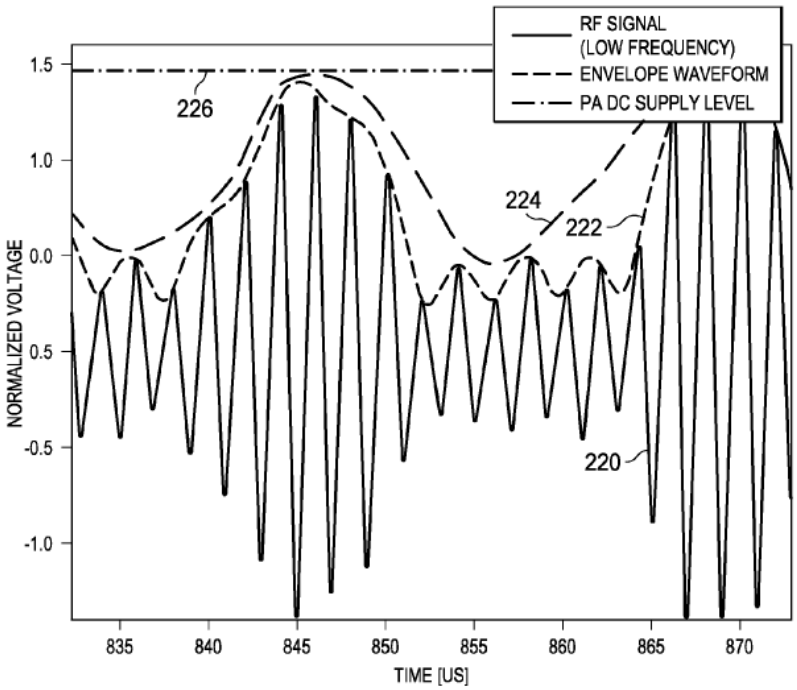


Figure 12 of Eliezer is a graph comparing an RF envelope generated by Eliezer's system and a "prior art" envelope. Ex. 1111 ¶ 128. Eliezer describes the graph as follows:

> 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. 69). 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. 69. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 69–70 (citing Ex. 1103 ¶ 175). 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. 1111 ¶ 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 Yu in order to increase efficiency. *Id.* at 70. 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. 1111 ¶ 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 tracking signal (as disclosed in Eliezer) would reduce the difficulty in accomplishing this task." Pet. 71 (citing Ex. 1105, 1245; Ex. 1103 ¶ 179).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu, 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 Yu 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 Yu, Wang, and Eliezer.

E. Obviousness over Yu, Wang, and Dahlman

Petitioner asserts that claims 13–15 and 23–25 of the '675 patent would have been obvious over Yu, Wang, and Dahlman. Pet. 72–79. Patent Owner traverses this ground. PO Resp. 41–45. 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 Yu, Wang, and Dahlman.

Having already discussed Yu 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. 1106, 104. Figure 7.4 of Dahlman is reproduced below.

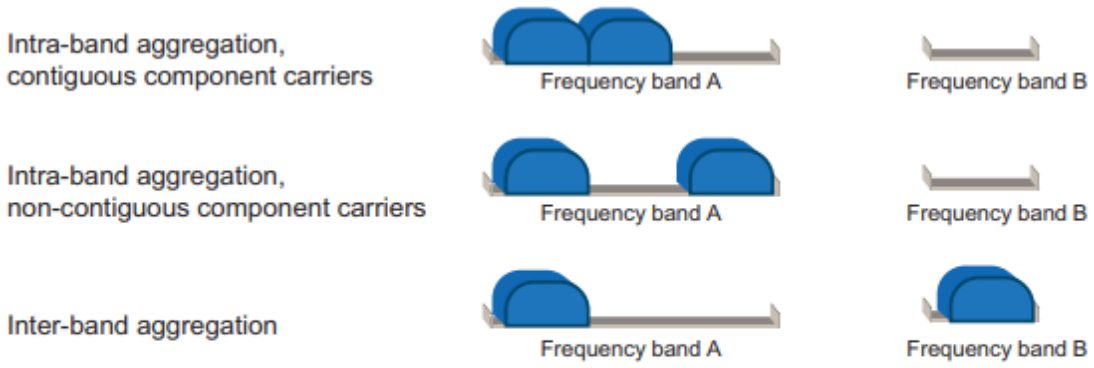


FIGURE 7.4

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 "the carrier aggregated transmit signals are intra-band carrier aggregated transmit signals." As discussed above, we find that Petitioner's proposed combination of Yu and Wang teaches the limitations recited in claim 1. *See supra* Section III.B.3. Claim 14, which depends from claim 13, recites the "intra-band carrier aggregated transmit signals are contiguous." Claim 15, which also depends from claim 13, recites 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. 73–79.

In particular, Petitioner relies on Dahlman, directing us to Figure 7.4 of Dahlman, which is reproduced above. Pet. 74, 77–79. As discussed above, the figure shows intra-band aggregation with contiguous component carriers and intra-band aggregation with non-contiguous component carriers. Ex. 1106, Fig. 7.4. Petitioner contends:

> A [person of ordinary skill in the art] . . . would have been motivated to combine Yu'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 Yu architecture and so that it would comply with the LTE standard, which requires intra-band carrier aggregation.

Pet. 75–76. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1103 ¶ 187).

Based on Petitioner's argument and evidence, we are persuaded that the proposed combination of Yu, 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 Yu and Wang to include Dahlman's aggregation schemes, namely, to provide a way to carry out Yu's signaling, is sufficient to support the legal conclusion of obviousness. *See Kahn*, 441 F.3d at 988.

Patent Owner disputes Petitioner's analysis regarding these claims. *See* PO Resp. 41–45. We address the parties' dispute in further detail below.

3. Patent Owner's Arguments

Patent Owner makes two arguments. The first argument addresses claim 14, and the second argument addresses claims 13 and 15. We address these arguments in turn.

With respect to claim 14, Patent Owner argues that "Yu teaches away from using the Figure 3/Figure 4 embodiments as proposed by the Petition." PO Resp. 43. Patent Owner directs our attention to claim 14 of the '675 patent, which recites contiguous intra-band carrier aggregated transmit signals. *Id.* Patent Owner asserts that "[t]he frequency spacing in intra-band carrier aggregation is negligible," pointing to Figure 2A of the '675 patent as support. *Id.* (citing Ex. 1101, Fig. 2A). Patent Owner further asserts, "Yu states that in such instances, its Figure 2 embodiment should be used." *Id.* As support, Patent Owner points to Yu's teaching that "[t]he embodiment according to Figure 2 is particularly preferred for such signal processing scenarios, in which a desired frequency spacing Δf . . . of the different input signals S1, S2, . . . within the radio frequency signal S_{RF} is in the range of the bandwidth of the signals S1, S2, . . . said desired frequency spacing Δf being much smaller than the frequency of the local oscillator LO." *Id.* at 41 (quoting Ex. 1104 ¶ 56);[13] *see also* Ex. 1104 ¶ 68 ("[T]he embodiment explained . . . with reference to Figure 2 may advantageously be employed if a desired frequency spacing Δf satisfies the following relation: (fs1+fs2) < 2*Δf << flo," where fs1, fs2 represent the bandwidth of input signals S1, S2, and flo represents the frequency of local oscillator LO.). Patent Owner

[13] Patent Owner cites Exhibit 1004 when referring to Yu in its papers. Yu is entered in the record of this proceeding as Exhibit 1104. Thus, we cite Exhibit 1104 when referring to Yu in this Decision.

additionally points to Yu's teaching that "the embodiment explained . . . with reference to Figure 4 is advantageously employed if the following relation is satisfied: (fs1, fs2) << Δf << flo, . . . wherein fs1 = 20 MHz, fs2 = 10 MHz, Δf = 500 MHz." *Id.* at 42 (citing Ex. 1104 ¶ 70). According to Patent Owner, claim 14 is not unpatentable because "Yu teaches away from using the Figure 3 and Figure 4 embodiments for instances where Δf is small, like intra-band contiguous carrier aggregation," and "[t]he Petition does not explain why a [person of ordinary skill in the art] would implement a Yu Figure 3/4 system when Yu expressly states that Figure 2 should be used." *Id.* at 43–44. Patent Owner relies on the declaration testimony of Dr. Williams. *Id.* at 41–44 (citing Ex. 2002 ¶¶ 139–143).

In its Reply, Petitioner counters that "Yu identifies particular embodiments that are preferred for various frequency spacings," but "nothing in Yu suggests that Figures 3 and 4 cannot be applied to narrower frequency spacings." Pet. Reply 25 (citing Ex. 1104 ¶¶ 56, 59, 62, 68, 70). Petitioner adds that "even if the teachings of Figures 3 and 4 are not the preferred embodiments for narrow frequency spacings, they are fully applicable to narrow frequency spacings and could be used for intra-band carrier aggregated transmit signals." *Id.*

Based on the record before us, we agree with Petitioner. Yu describes its various embodiments in terms of preference. For example, Yu teaches that its Figure 2 embodiment is "particularly preferred" where the desired frequency spacing is in the range of the bandwidth of signals S1, S2. Ex. 1104 ¶ 57. Yu further teaches that its Figure 3 embodiment is "particularly preferred" where the desired frequency spacing is relatively larger. *Id.* ¶ 59. According to Yu, its Figure 3 embodiment "may

advantageously be employed" where the frequency spacing exceeds the bandwidth of input signals S1, S2 by a factor of ten or more. *Id.* That a specific embodiment in Yu may be *preferred* or *advantageous* given certain conditions does not mean that those conditions *require* using the specific embodiment. Indeed, Yu states that "all examples recited herein are principally intended expressly to be only for pedagogical purposes . . . , and are to be construed as being *without limitation to such specifically recited examples and conditions*." *Id.* ¶ 75 (emphasis added).

Moreover, we note Yu's additional teaching that "the differentiation between applying the algorithm for determining the control signal CTRL according to Figure 2 or Figure 3 may be made depending on whether the desired Δf frequency spacing exceeds a predetermined threshold value." *Id.* ¶ 71 (cited by PO Resp. 42). Yu explains that "the method according to Figure 2 may be applied, if the desired frequency spacing Δf does not exceed a predetermined threshold value, whereas the method according to Figure 3 may be applied, if the desired frequency spacing Δf equals or exceeds a predetermined threshold value." *Id.* The option of having a predetermined threshold value indicates that in some instances the method according to Figure 2 may be applied for a particular frequency spacing, whereas in other instances the method according to Figure 3 may be applied for the same frequency spacing, depending on the predetermined threshold value. Yu does not define or fix the predetermined threshold value.

For these reasons, we find that Patent Owner's teaching away argument does not undermine Petitioner's obviousness showing for claim 14.

With respect to claims 13 and 15, Patent Owner argues that "[a]pplying Yu's teachings to the '675 patent's claim 13 and 15 embodiments similarly dictates use of Yu's Figure 2 embodiment." PO Resp. 44. As support, Patent Owner asserts that "[i]ntra-band carrier aggregation, as recited in claims 13 and 15[,] requires all component carriers to be within the same band," and that "each band may be up to 200 MHz wide." *Id.* Patent Owner further asserts, "Yu states that its Figure 3 embodiment should be used when the 'frequency spacing Δf between the input signals S1, S2 in their upconverted state within the radio frequency signal S_{RF} exceeds the bandwidth of the input signals S1, S2 . . . by a factor of ten or more.'" *Id.* at 44 (quoting Ex. 1104 ¶ 59). According to Patent Owner, "Yu teaches away from using the Figure 3 and 4 embodiments for intra-band carrier aggregation." *Id.* at 45. To illustrate, Patent Owner considers an example in which "individual carriers have a bandwidth of 20 MHz." *Id.* at 44 (citing Ex. 1101, 2:59–60). Patent Owner points to Dr. Choi's deposition testimony as "confirm[ing] that for 20 MHz carriers, a cutoff frequency for the Figure 3 [embodiment] of ten times the carrier bandwidth of 20 MHz is 200 MHz." *Id.* at 44 (citing Ex. 2006, 58:24–25, 58:14–59:16). Patent Owner further asserts that, by contrast, "[w]hen spaced at their maximum distances within a 200 MHz band, the center frequencies of two component carriers is 180 MHz." *Id.* Patent Owner states that "[b]ecause 180 MHz does not 'exceed[] the bandwidth of the input signals S1, S2 by a factor of ten or more,' Yu teaches that the Figure 2 embodiment should be used, and teaches away from utilizing its Figure 3 or Figure 4 embodiments for intra-band carrier aggregation." *Id.* at 44–45.

Patent Owner relies on the declaration testimony of Dr. Williams. *Id.* (citing Ex. 2002 ¶¶ 144–145).

In response, Petitioner counters that Patent Owner's argument is "mathematically wrong." Pet. Reply 25. Petitioner contends that "Patent Owner's example arbitrarily assumes the largest possible carriers—20 MHz carriers," as "the '675 patent states that '[e]ach carrier may cover ***up to 20 MHz***,' and both the patent and Yu expressly contemplate carriers of 5 MHz and 10 MHz." *Id.* at 26 (internal citations omitted) (citing Ex. 1101, 2:59–60, 9:11–12, 9:24–25; Ex. 1104 ¶¶ 69–70). Petitioner considers a further example:

> If 10 MHz carriers are used, then even if those carriers are spaced at the maximum distance apart within a 200 MHz band (i.e., at the edges of the band), the center frequencies of those carriers (5 MHz from the lower edge of the band, and 5 MHz from the higher edge of the band) will differ by 190 MHz—which is ***19 times*** the bandwidth of a carrier.

Id. According to Petitioner, "even under Patent Owner's erroneous assumption that Figure 3 of Yu applies only to large frequency spacings (i.e., when the desired frequency spacing is at least 10 times the bandwidth of a carrier), Figure 3 would be fully applicable for use with noncontiguous intra-band carrier aggregated signals." *Id.*

Patent Owner responds that "Petitioner's fabricated example arbitrarily selects a band having a width of 200 MHz in order to make the math work, but there is no basis for this selection." PO Sur-reply 25 (internal citation omitted).

Based on the record before us, we agree with Petitioner. Yu teaches that its Figure 3 embodiment "may advantageously be employed if the frequency spacing Δf between the input signals S1, S2 . . . exceeds the

bandwidth of the input signals S1, S2 . . . by a factor of ten or more." Ex. 1104 ¶ 59. Petitioner's example shows that the frequency spacing between two 10 MHz wide carriers within a 200 MHz wide band is 19 times the bandwidth of the carriers. Accordingly, Yu's Figure 3 embodiment may be used in Petitioner's example. We therefore find that Patent Owner's teaching away argument does not undermine Petitioner's obviousness showing for claims 13 and 15.

That Petitioner does not explain why it uses a 200 MHz wide band in its example does not change our finding. In describing non-contiguous intra-band carrier aggregation, the '675 patent teaches that "wireless device 110 is configured with three non-contiguous carriers in one band in low-band." Ex. 1101, 3:12–15, Fig. 2B (cited by PO Resp. 44). The '675 patent further teaches that "[l]ow-band, mid-band, and high-band refer to three groups of bands (or band groups), with each band group including a number of frequency bands (or simply, 'bands')." *Id.* at 2:55–58. Both parties acknowledge that the '675 patent specifies that "[e]ach band may cover up to 200 MHz and may include one or more carriers," where "[e]ach carrier may cover up to 20 MHz." *See id.* at 2:58–60 (cited by PO Resp. 44; Pet. Reply 26; PO Sur-reply 25). Petitioner's example falls squarely within the parameters set forth in the '675 patent. In particular, Petitioner's example uses a 200 MHz wide band and two 10 MHz wide carriers. Petitioner need not explain why its example uses a 200 MHz wide band other than for the fact that each band may cover up to 200 MHz. Indeed, Petitioner's example uses a band having the same width as the band that Patent Owner's example uses, and Patent Owner's reasoning for using a

200 MHz wide band is that "[t]he '675 patent states that each band may be up to 200 MHz wide." *See* PO Resp. 44.

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

IV. CONCLUSION[14]

In summary:

Claim(s)	35 U.S.C. §	References	Claims Shown Unpatentable	Claims Not Shown Unpatentable
11, 17, 27, 33	103	Yu, Wang	11, 17, 27, 33	
7–10	103	Yu, Wang, Choi	7–10	
12	103	Yu, Wang, Eliezer	12	
13–15, 23–25	103	Yu, Wang, Dahlman	13–15, 23–25	
Overall Outcome			7–15, 17, 23–25, 27, 33	

[14] 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 7–15, 17, 23–25, 27, and 33 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.

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