

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

INTEL CORPORATION,
Petitioner,

v.

QUALCOMM INCORPORATED,
Patent Owner.

Case IPR2018-01340
Patent 9,608,675 B2

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

WORMMEESTER, *Administrative Patent Judge*.

DECISION
Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

Intel Corporation¹ (“Petitioner”) filed a Petition (Paper 3, “Pet.”) requesting *inter partes* review of claims 31 and 32 of U.S. Patent No. 9,608,675 B2 (Ex. 1501, “the ’675 patent”). Qualcomm Incorporated (“Patent Owner”) filed a Preliminary Response (Paper 7, “Prelim. Resp.”). We have jurisdiction under 35 U.S.C. § 314 and 37 C.F.R. § 42.4(a). Under 35 U.S.C. § 314(a), an *inter partes* review may not be instituted “unless . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition.” For the reasons that follow, we institute an *inter partes* review as to all the challenged claims of the ’675 patent and the sole ground presented.

II. BACKGROUND

A. *Related Proceedings*

The parties identify a district court case in the Southern District of California in which Patent Owner has asserted the ’675 patent against Apple. Pet. 2; Paper 4, 2. The parties also identify five other petitions for *inter partes* review involving the ’675 patent that Petitioner has filed. Pet. 2; Paper 4, 2. In addition, Petitioner identifies an International Trade Commission (“ITC”) investigation in which Patent Owner asserted the ’675 patent against Apple, but has since withdrawn that assertion. Pet. 1–2.

¹ Intel Corporation identifies itself and Apple Inc. (“Apple”) as real parties in interest. Paper 3, 1.

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. 1501, 1:8–10, 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.

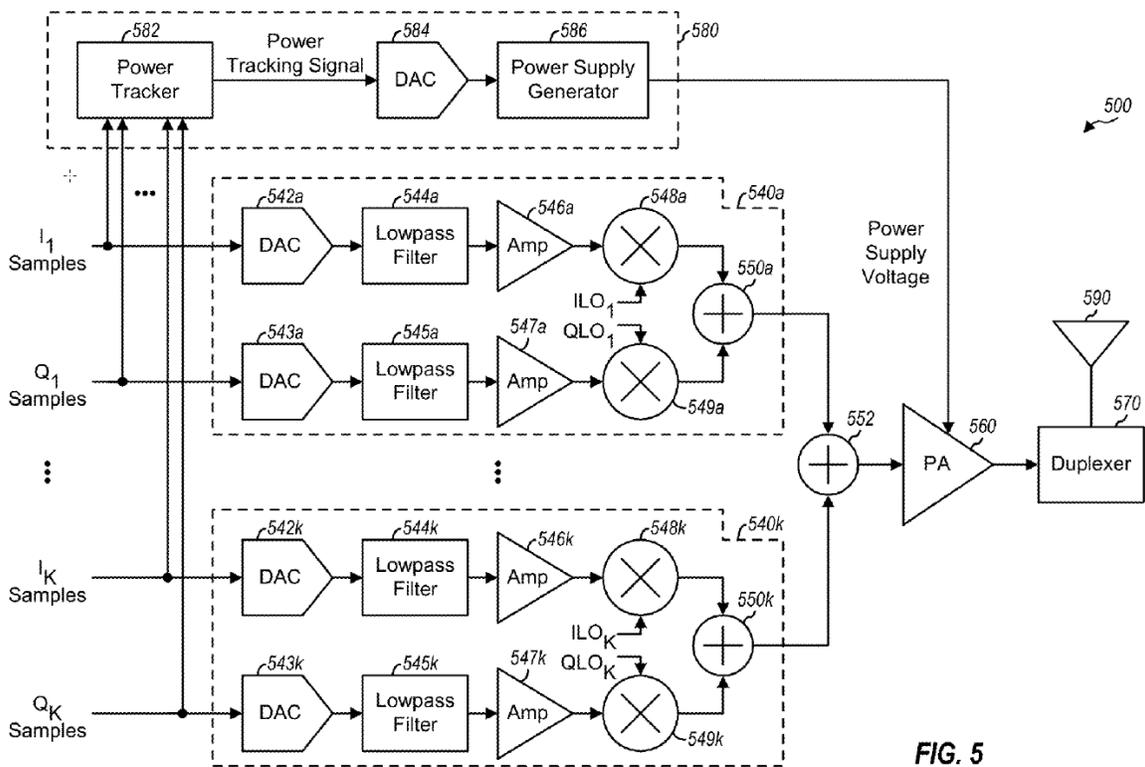


FIG. 5

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 the 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 computes the overall power of all the transmit signals based on the I and Q samples and provides a digital power tracking signal to DAC 584. *Id.* at 6:65–7:1. DAC 584 converts the digital power tracking signal to analog and provides an analog power tracking signal for all the transmit signals to power supply generator 586. *Id.* at 7:1–4, Fig. 5. Power supply generator 586 then 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 Claims

Petitioner challenges claims 31 and 32 of the '675 patent. Both claims depend from independent claim 28, which is not challenged in the Petition. Claims 28, 31, and 32 are reproduced below.

28. An apparatus comprising:

means for determining 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;

means for generating a single power supply voltage based on the single power tracking signal; and

means for receiving the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously and producing a single output radio frequency (RF) signal.

31. The apparatus of claim 28, further comprising:
means for receiving the I and Q components of the plurality of carrier aggregated transmit signals and separately upconverting the I and Q components of the plurality of carrier aggregated transmit signals to provide a plurality of upconverted RF signals, and
means for summing the plurality of upconverted RF signals and providing the plurality of carrier aggregated transmit signals to a power amplifier.
32. The apparatus of claim 28, further comprising:
means for receiving a modulated intermediate frequency (IF) signal and providing the plurality of carrier aggregated transmit signals to a power amplifier, the modulated IF signal being generated based on the I and Q components of the plurality of carrier aggregated transmit signals.

D. Asserted Ground of Unpatentability

Petitioner challenges claims 31 and 32 of the '675 patent on one ground only: obviousness under 35 U.S.C. § 103 over Yu,² Wang,³ and Choi.⁴ Pet. 22–75. In support of its arguments, Petitioner relies on a Declaration of David Choi, Ph.D. (Exhibit 1503). *See id.*

² Eur. Publ'n No. 2 442 440 A1 (published Apr. 18, 2012) (Ex. 1504, "Yu").

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. 1505, "Wang").

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. 1508, at Ex. A, "Choi").

III. DISCUSSION

A. *Multiple Petitions*

Patent Owner contends that we should exercise our discretion under 35 U.S.C. § 314(a) to deny institution of an *inter partes* review because Petitioner attempts to “sidestep” the Supreme Court’s mandate in *SAS Institute, Inc. v. Iancu*, 138 S. Ct. 1348 (2018), by filing six petitions against the same patent. Prelim. Resp. 13–16. In *SAS*, the Supreme Court held that a decision to institute under 35 U.S.C. § 314 may not institute on fewer than all claims challenged in the petition. 138 S. Ct. at 1358. Patent Owner asserts that the Board, however, has “cautioned that the presence of weak grounds in a petition could result in a complete denial of institution even if other unpatentability allegations met the threshold for institution.” Prelim. Resp. 14. As such, Patent Owner further asserts that Petitioner “has divided its challenges to the ’675 patent claims that would normally fit into one or two petitions (*i.e.*, two grounds challenging 31 claims) across *six* petitions, hoping to increase its odds of institution.” *Id.* at 14–15. Patent Owner additionally asserts that “Petitioner provides no explanation for its convoluted filing strategy and why it requires 84,000 words (6 * 14,000) to make its case that 31 claims of the ’675 patent are unpatentable based on two grounds.” *Id.* at 16 (citing *Alere Inc. v. Rembrandt Diagnostics, LP*, Case IPR2017-01130, slip op. at 10 (PTAB Sept. 28, 2017) (Paper 10)); *see also id.* at 19 (“The rules state that a petition may contain no more than 14,000 words,” and “the petition states that it contains 13,076 words.”). According to Patent Owner, “such tactics unnecessarily multiply the amount of material that the Board and patent owner must traverse to assess the patentability of the ’675 patent claims.” *Id.* at 15.

We disagree with Patent Owner. There is nothing inherently improper with filing multiple petitions at the same time to avoid issues associated with the word limit. Petitioner's practice as described by Patent Owner is expressly permitted by the Board, which previously has provided guidance that petitioners should consider filing multiple petitions if concerned with exceeding word limits. *See* Rules of Practice for Trials Before the Patent Trial and Appeal Board and Judicial Review of Patent Trial and Appeal Board Decisions, 77 Fed. Reg. 48,612, 48,635 (Aug. 14, 2012) ("Where a petitioner can demonstrate how a waiver of the page limit is in the interests of justice, a motion to waive the page limit should be considered. Alternatively, the filing of multiple petitions directed to subsets of related claims should be considered."). On this record, we find no reason to deny institution based on Petitioner's multiple filings.

B. Word Limit

Patent Owner also contends that we should deny the Petition for violating our rules on word limits and incorporation by reference. Prelim. Resp. 19–21. Noting that "a petition may contain no more than 14,000 words," Patent Owner asserts that "the [instant] petition states that it contains 13,076 words," "[b]ut that total does not count the three full sections that the petition incorporates by reference from other documents." *Id.* at 19. In particular, Patent Owner asserts that the Petition incorporates by reference 4,102 words, including "the description of the technology," "the overview of the '675 patent," and "the description of the '675 patent's prosecution history" from Dr. Choi's declaration in this case and the petition in IPR2018-01326. *Id.* at 20 (citing Pet. 6–7). Patent Owner characterizes

these instances of incorporation by reference as “improper” and “especially egregious” for “bring[ing] the petition length significantly beyond the 14,000 word limit.” *Id.* at 20 (citing 37 C.F.R. §§ 42.6(a)(3), 42.24(a)(1)(i)).

This Decision does not rely on the portions of Dr. Choi’s declaration and the petition in IPR2018-01326 that Patent Owner alleges are incorporated by reference improperly. Nevertheless, we disagree with Patent Owner. As Patent Owner acknowledges, our rules specify that “[a]rguments must not be incorporated by reference from one document into another document,” and that “combined documents are not permitted.” Prelim. Resp. 20; 37 C.F.R. § 42.6(a)(3). Patent Owner does not allege or show that the instant Petition incorporates *arguments* by reference from another document. Mere descriptions or overviews of technologies, patents, and patent prosecution histories do not constitute arguments. Nor does Patent Owner allege or show that Petitioner has combined the instant Petition with another document. Accordingly, based on the record before us, we find that Petitioner has not violated our rules regarding word limits or incorporation by reference in this case.

C. Claim Interpretation

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) (2017); *Cuozzo Speed Techs. LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016) (upholding the use of the broadest

reasonable interpretation standard).⁵ 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).

As to claim elements recited in means-plus-function format, the Federal Circuit has stated: “Section 112, ¶ 6 recites a mandatory procedure for interpreting the meaning of a means- or step-plus-function claim element. These claim limitations ‘shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.’” *Al-Site Corp. v. VSI Int’l, Inc.*, 174 F.3d 1308, 1320 (Fed. Cir. 1999); *see also In re Donaldson Co., Inc.*, 16 F.3d 1189, 1193–94 (Fed. Cir. 1994) (“[P]aragraph 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.”). Accordingly, a means-plus-function limitation is construed by determining the claimed function and identifying the structure or materials disclosed in the specification that correspond to the means for performing that function. *See Kemco Sales, Inc. v. Control Papers Co., Inc.*, 208 F.3d 1352, 1360 (Fed. Cir. 2000). “Under

⁵ 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) (to be codified at 37 C.F.R. pt. 42).

this second step, structure disclosed in the specification is corresponding structure only if the specification or prosecution history clearly links or associates that structure to the function recited in the claim.” *In re Aoyama*, 656 F.3d 1293, 1297 (Fed. Cir. 2011) (internal quotation omitted). Failure to disclose structure that performs the claimed function typically (e.g., in district court) renders the claim invalid for indefiniteness under 35 U.S.C. § 112 ¶ 2. *See Aristocrat Techs. Aus. Pty Ltd. v. Int’l Game Tech.*, 521 F.3d 1328, 1331 (Fed. Cir. 2008).

Petitioner provides proposed interpretations of various claim terms, including claim terms that it contends are means-plus-function limitations. Pet. 13–21. Patent Owner responds that “procedural defects in the petition warrant its denial,” and “[t]hose defects can be ascertained without particular construction of any terms of the ’675 patent.” Prelim. Resp. 13. In light of the parties’ arguments and evidence, we provide further discussion of the claim term “power tracker.”

1. Satisfying 37 C.F.R. § 42.104(b)(3)

Petitioner indicates that Apple (a real party in interest in this proceeding) has argued in a related ITC investigation that the recited “power tracker” is a means-plus-function limitation lacking sufficient corresponding structure. Pet. 14 n.4. Although Petitioner asserts that the challenged claims are invalid for indefiniteness under Apple’s proposed means-plus-function construction, Petitioner directs us to the construction of “power tracker” determined by the Administrative Law Judge (“ALJ”) in the ITC investigation: “component in a voltage generator that computes the power requirement.” *Id.* at 13 (citing Ex. 1518, 18–20), 14 n.4. According to

Petitioner, 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.*

In response, Patent Owner contends that we should deny the Petition because our “rules ‘require a petition to identify, not only how the challenged claim is to be construed but also how the construed claim is unpatentable’ under ‘a claim construction that it consider[s] to be correct.’” Prelim. Resp. 18 (quoting *Hologic, Inc. v. Enzo Life Sciences, Inc.*, Case IPR2018-00019, slip op. at 8–9 (PTAB Apr. 18, 2018) (Paper 17)); *see* 37 C.F.R. § 42.104(b)(3) (a petitioner must identify “[h]ow the challenged claim is to be construed”). According to Patent Owner, “[i]n this case, petitioner believes that the term ‘power tracker’ is a means-plus-function term,” but “advocates a different claim construction (*i.e.*, a non-[means-plus-function] claim construction.” Prelim. Resp. 18. Patent Owner also contends that, “[d]espite believing that ‘power tracker’ should be construed as a [means-plus-function] term, petitioner did not comply with 37 C.F.R. § 42.104(b)(3)[,] thereby providing another basis for denial of the petition.” *Id.* at 19; *see* 37 C.F.R. § 42.104(b)(3) (“Where the claim to be construed contains a means-plus-function or step-plus-function limitation . . . , the [petitioner’s] construction of the claim must identify the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function.”).

We disagree with Patent Owner. A petitioner may satisfy 37 C.F.R. § 42.104(b)(3) “by identifying 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.” *Hologic, Inc. v. Enzo Life Sciences, Inc.*, Case IPR2018-00019, slip op. at 5 (PTAB Nov. 28, 2018) (Paper 21)⁶ (quoting *Western Digital Corp. v. SPEX Techs., Inc.*, Case IPR2018-00084, slip op. at 11 (PTAB Apr. 25, 2018) (Paper 14)). In an *inter partes* review where the broadest reasonable interpretation applies, 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. *Id.* 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. *Id.* 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. *Id.* at 6.

As discussed above, we apply the broadest reasonable interpretation in this proceeding. By contrast, the ALJ in the related ITC investigation applied the *Phillips* standard. Ex. 1518, 3–5 (ITC claim construction order); *see also* Pet. 13 (“The ALJ’s construction was based on the *Phillips* standard.”). Here, Petitioner offers a construction for the claim term “power tracker,” namely, the ALJ’s construction in the ITC investigation, and expresses its belief that the challenged claims of the ’675 patent are “also” invalid for indefiniteness under Apple’s proposed means-plus-function construction of the term. Pet. 13, 14 n.4. We find this approach to be

⁶ This decision denied the motion for rehearing of the *Hologic* decision cited by Patent Owner.

acceptable under 37 C.F.R. § 42.104(b)(3). This is not a situation like that presented in *Hologic*, where the *Phillips* standard was being applied and the petitioner offered constructions with which it expressly disagreed. *See Hologic*, slip op. at 7 (Paper 21).

2. *Request for Proposed Constructions of “power tracker”*

As discussed above, Patent Owner does not address the construction of “power tracker.” At this stage of the proceeding, we have not reached a final decision regarding whether “power tracker” is a means-plus-function limitation under section 112, sixth paragraph, which requires identification of sufficient structure, material, or acts in the specification. *See In re Donaldson Co.*, 16 F.3d 1189, 1193 (Fed. Cir. 1994) (en banc). We are able to analyze Petitioner’s asserted prior art ground for purposes of this Decision, however, without making such a determination. For purposes of this Decision, we adopt the ALJ’s construction in the ITC investigation and construe “power tracker” to mean “component in a voltage generator that computes the power requirement.” *See* Ex. 1518, 20. The preliminary evidence in favor of this construction passes the threshold sufficient to institute an *inter partes* review.

The parties are directed to address specifically in their subsequent briefing in this proceeding whether the recited “power tracker” invokes 35 U.S.C. § 112 ¶ 6. If it does invoke 35 U.S.C. § 112 ¶ 6, the parties are directed to identify the corresponding structure from the specification of the ’675 patent. *See* 37 C.F.R. 42.104(b)(3). If not, the parties are directed to explain their reasoning and address the construction of the term under the broadest reasonable interpretation standard.

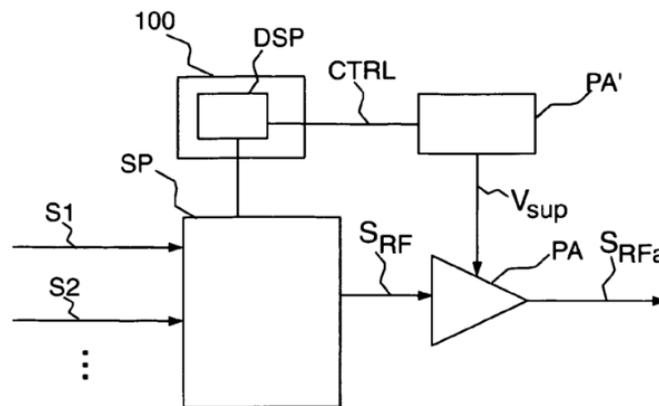
D. Obviousness over Yu, Wang, and Choi

Petitioner asserts that claims 31 and 32 of the '675 patent would have been obvious over Yu, Wang, and Choi. Pet. 22–75. For the reasons explained below, we are persuaded that Petitioner has demonstrated a reasonable likelihood of prevailing on this asserted ground.

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. 1504 ¶ 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 V_{sup} , 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. 1505, 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. Choi

Choi describes a supply modulator for envelope tracking. Ex. 1508, at Ex. A, at 1074. Figure 5 of Choi, which is reproduced below, illustrates such supply modulator.

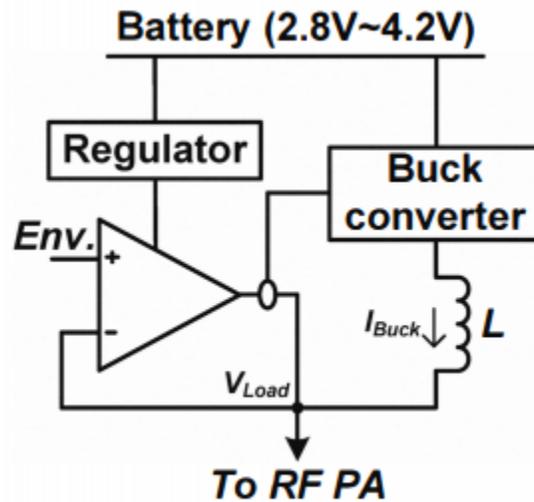


Fig. 5. Battery-to-5V boosting PA supply modulator.

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

4. Analysis

Challenged claims 31 and 32 depend from independent claim 28. Although Petitioner does not challenge claim 28 in this proceeding,

Petitioner analyzes the claim as part of its analysis for claims 31 and 32. We also address claim 28 as part of our analysis for claims 31 and 32.

a. “means for determining a single power tracking signal”

Independent claim 28 recites “means for determining 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.” As discussed above in the Claim Interpretation section, we construe “power tracker” to mean “component in a voltage generator that computes the power requirement.”

According to Petitioner, the recited “means for determining a single power tracking signal” limitation is a means-plus-function limitation. Pet. 14–16. Petitioner identifies the claimed function as “determining 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.” *Id.* at 15. Petitioner further identifies power tracker 582 as the corresponding structure disclosed in the ’675 patent. *Id.* As support, Petitioner directs us to Figure 5 of the ’675 patent, which is reproduced below. *Id.*

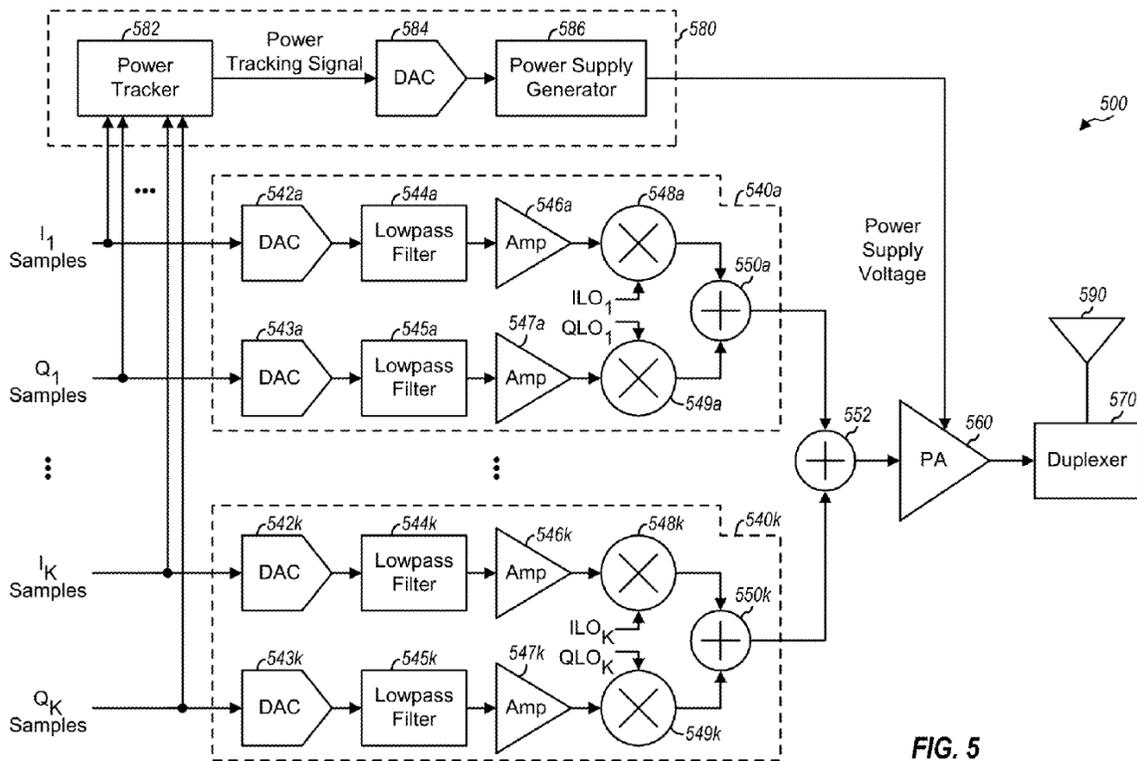


FIG. 5

Figure 5 of the ’675 patent illustrates a transmit module with power tracking for all transmit signals. Ex. 1501, 1:65–67. As Figure 5 shows, power tracker 582 receives I and Q samples for multiple transmit signals and generates a power tracking signal. *Id.* at Fig. 5; *see also* Pet. 16 (citing Ex. 1501, 6:63–7:1, 8:6–8). Petitioner also directs us to where the ’675 patent teaches that the transmit signals may comprise OFDM or SC-FDMA signals. Pet. 16 (citing Ex. 1501, 8:66–9:3).

For the recited “means for determining a single power tracking signal” limitation, Petitioner relies on both Yu and Wang. With respect to the claimed function, 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. 25, 27, 30. Petitioner asserts that control unit 100 is “[w]ithin Yu’s voltage generation circuitry.” *Id.* at 24. To illustrate, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.* at 26.

Fig. 3

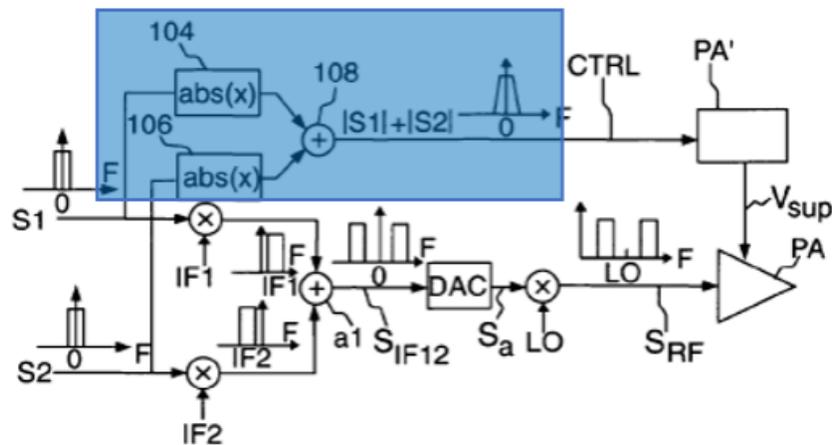
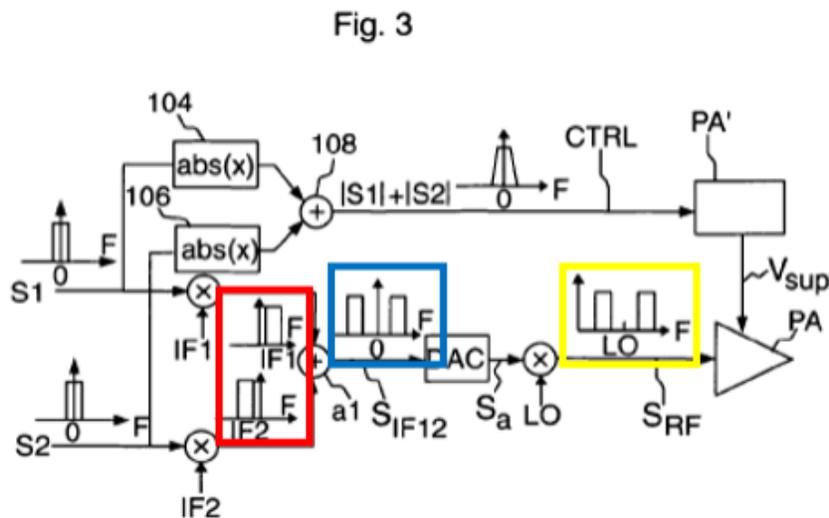


Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 32, 57. Petitioner directs us to where Yu teaches that control unit 100 may comprise function blocks 104 and 106 as well as adder 108. Pet. 25–26 (citing Ex. 1504 ¶ 66); *see also* Ex. 1504, Fig. 1 (control unit 100), Fig. 3 (blocks 104, 106 and adder 108). The annotated figure highlights Yu’s blocks and adder in blue. *See* Pet. 26. Petitioner further directs us to where Yu teaches that blocks 104 and 106 receive input signals S1 and S2, and calculate the absolute values of those signals. *Id.* (citing Ex. 1504 ¶ 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. 1504, Fig. 3; *see also id.* ¶ 57 (cited by

Pet. 26). 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.” Pet. 36–37 (citing Ex. 1503 ¶ 127). As Petitioner points out, Yu teaches using control signal CTRL for modifying supply voltage V_{sup} , which is applied to power amplifier PA. Pet. 27; Ex. 1504 ¶¶ 35, 37.

Regarding Yu’s signals S1 and S2, Petitioner additionally directs us to where Yu teaches simultaneously processing the input signals. Pet. 30 (citing Ex. 1504 ¶ 15); *see also* Ex. 1504 ¶ 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. 31.



As discussed above, Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 32, 57. Petitioner asserts that signals S1 and S2 are upconverted to different intermediate frequencies, as shown in the red box. Pet. 31 (citing Ex. 1504 ¶ 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.* 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 to increase the bandwidth for a user. *Id.* at 30–31. According to Petitioner, an ordinarily skilled artisan “would have understood Yu’s method of aggregating multiple signals on different frequencies increases the bandwidth for a user, allowing more information to be transmitted per unit of time.” *Id.* at 32. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶¶ 122–125).

Petitioner submits, however, “Yu does not expressly mention inphase (I) and quadrature (Q) components of the input signals, but [an ordinarily skilled artisan] would have understood that the input signals S1 and S2 are digital signals for wireless transmission that each would have I and Q components.” Pet. 33. 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, the standard practice for RF communication systems processing digital signals was to use I/Q components.” *Id.* (citing Ex. 1504 ¶ 20); *see also* Ex. 1503 ¶ 126.

Alternatively, Petitioner points to Wang for teaching the recited I and Q components. Pet. 37. According to Petitioner, even if Yu does not disclose I and Q signals, “it still would have been obvious to use Wang’s I/Q signal processing with Yu’s power tracker.” *Id.* at 37–38. 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 38 (citing Ex. 1505, 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.* at 38–39 (citing Ex. 1505, 1245). Petitioner contends that an ordinarily skilled artisan “would have been motivated to use Wang’s I/Q signal processing in Yu” because, “[if] 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 40. 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 40 (citing Ex. 1521, 308). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 133).

Petitioner also points to Wang for teaching Orthogonal Frequency Division Multiplexing (OFDM) signals. *Id.* at 42 (citing Ex. 1505, 1244 (title), 1253). According to Petitioner, “Yu does not explicitly disclose which modulation technique to use for transmitting signals through the power amplifier,” and an ordinarily skilled artisan “would have looked to Wang, a reference in the same field to determine a modulation technique.” *Id.* at 43. 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 44. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 139).

With respect to the corresponding structure, namely, the '675 patent's power tracker 582, Petitioner contends that "Yu's power tracker [as modified in view of Wang . . . is identical, or at a minimum, equivalent to the power tracker disclosed in the '675 patent." Pet. 46. According to Petitioner, "the power tracker in Yu . . . is a more detailed version of the power tracker disclosed in the '675 patent," but "[a]ny differences between the power tracker in the '675 patent and the power tracker in Yu would be insubstantial." *Id.* at 46–47. As support, Petitioner asserts that, "[a]s modified in view of Wang, Yu's power tracker operates in substantially the same way as the power tracker described in the '675 patent" because "it receives I/Q components for multiple transmit signals and generates a single power tracking signal based on a combination of the I/Q components." *Id.* at 47. Petitioner additionally asserts that "Yu's power tracker also achieves substantially the same result as the '675 patent structure," that is, "a single power tracking signal for multiple transmit signals that is provided to a power supply generator for a PA." *Id.* at 47–48. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 143).

Based on the record before us, at this stage of the proceeding, we are persuaded that Petitioner has established sufficiently for purposes of this Decision that the combination of Yu and Wang teaches the recited "means for determining a single power tracking signal" limitation. 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

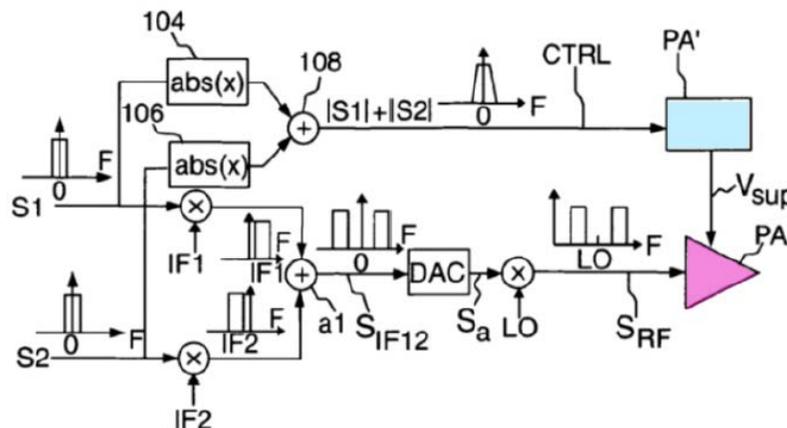
reasoning with some rational underpinning to support the legal conclusion of obviousness.”).

b. “means for generating a single power supply voltage”

Claim 28 further recites “means for generating a single power supply voltage based on the single power tracking signal.” Petitioner contends that this limitation is a means-plus-function limitation. Pet. 16–17. Petitioner identifies the claimed function as “generating a single power supply voltage based on the single power tracking signal.” *Id.* at 17. Petitioner further identifies power supply generator 586 as the corresponding structure disclosed in the ’675 patent. *Id.* As support, Petitioner directs us to where the ’675 patent teaches that “[t]he power supply generator generates a power supply voltage based on the power tracking signal.” *Id.* (citing Ex. 1501, 1:45–47, 7:6–8, 9:44–46).

For this limitation, Petitioner relies on Yu and Choi. With respect to the claimed function, Petitioner identifies Yu’s supply voltage V_{sup} as a “single power supply voltage.” Pet. 48. To illustrate, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.*

Fig. 3



As discussed above, Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 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 V_{sup} via power amplifier supply voltage module PA'. Pet. 48–49 (citing Ex. 1504 ¶ 52); *see also* Ex. 1504, Fig., 3; *id.* ¶ 57 (“[T]he supply voltage V_{sup} for the power amplifier PA is again determined depending on said control signal CTRL.”). The annotated figure shows power amplifier supply voltage module PA' (shown with light blue shading) receiving control signal CTRL and outputting supply voltage V_{sup} .

Petitioner asserts that “Yu does not disclose the internal structure of its power supply generator (PA'), but . . . it would have been obvious to implement Yu’s power supply generator using the structure disclosed in Choi.” Pet. 49. As support, Petitioner directs us to an annotated version of Figure 5 of Choi, which is reproduced below. *Id.* at 50.

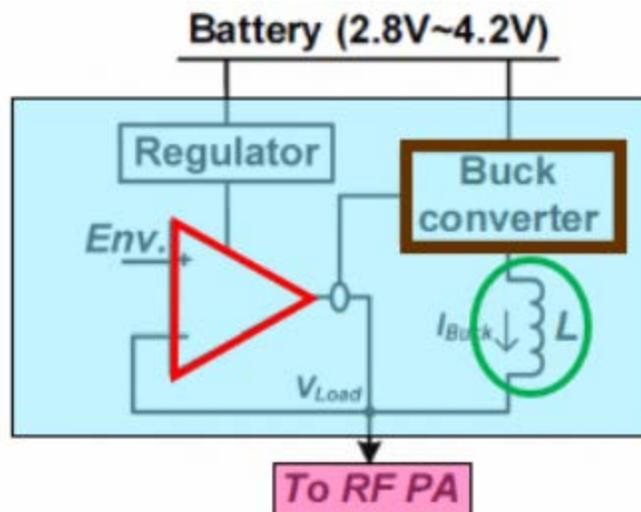


Fig. 5. Battery-to-5V boosting PA supply modulator.

Figure 5 of Choi shows the architecture of a power amplifier supply modulator, which employs a hybrid switching amplifier that dynamically regulates a power amplifier. Ex. 1508, at Ex. A, at 1074, Fig. 4. The hybrid switching amplifier includes a linear amplifier and buck converter. *Id.* at Figs. 4, 5 (cited by Pet. 50). Referring to its annotated figure, Petitioner indicates that the linear amplifier is outlined in red and the buck converter is outlined in brown. *Id.* at 50. Petitioner contends that “[t]he linear amplifier receives a power tracking signal Env , and generates the power supply voltage V_{Load} for the power amplifier,” which is highlighted in pink. *Id.* at 50–51. Petitioner further contends that “Choi discloses a specific implementation of a power supply generator that [a person of ordinary skill in the art] would have been motivated to use in a system such as Yu.” *Id.* at 53. In addition, according to Petitioner, Choi’s hybrid switching amplifier “is advantageously robust against battery depletion” and “can reduce waste of power and increase efficiency.” *Id.* at 53–54. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1502 ¶¶ 151–152).

With respect to the corresponding structure, namely, the ’675 patent’s power supply generator 586, Petitioner directs us to an annotated version of Figure 8 of the ’675 patent, which is reproduced below. *Id.* at 56.

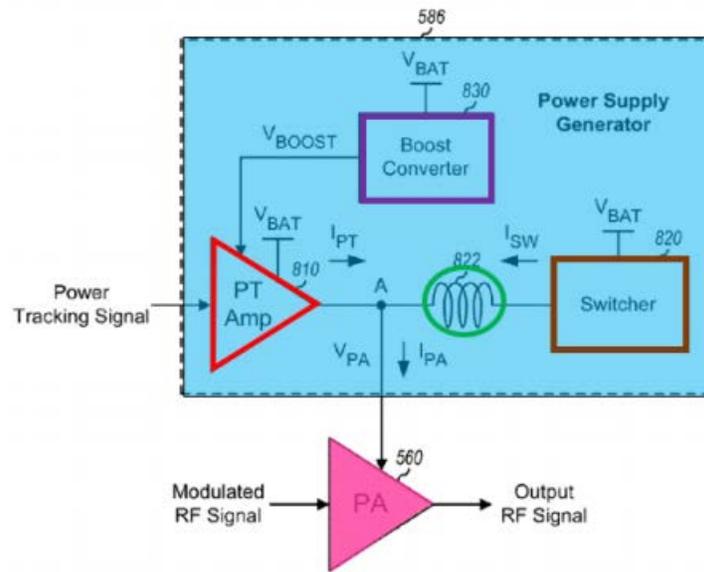
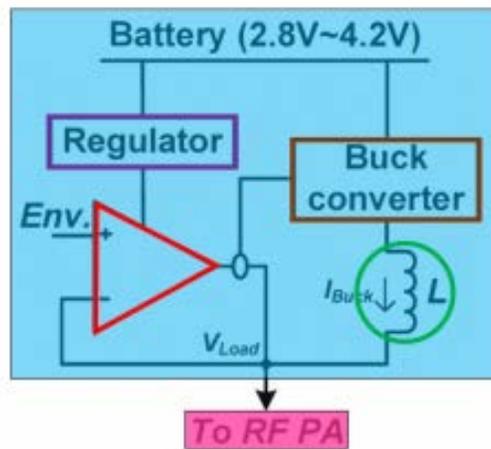


FIG. 8

Figure 8 of the '675 patent shows the design of a power supply generator with power tracking. Ex. 1501, 2:3–4. Petitioner also directs us to an annotated version of Figure 5 of Choi, which is reproduced below. Pet. 57.



As discussed above, Figure 5 of Choi shows the architecture of a power amplifier supply modulator that dynamically regulates a power amplifier. Ex. 1508, at Ex. A, at 1074. Petitioner contends that “[t]he supply voltage generator (PA’) in Yu (as modified in view of Choi) is identical, or at a minimum, equivalent to the power supply generator disclosed in the

'675 patent.” *Id.* at 56. According to Petitioner, “the power supply generators in Choi and in Figure 8 of the '675 patent are identical” because both include a power tracking amplifier (outlined in red), a boost converter (outlined in purple), a switcher (outlined in brown), an inductor (outlined in green), and a power amplifier (highlighted in pink). *Id.* at 57–58. Petitioner also contends that “[a]ny differences between the power supply generator in the '675 patent and the power supply generator in Yu (as modified by Choi) would be insubstantial,” as they operate in substantially the same way by “us[ing] a linear amplifier that receives an envelope signal and works in conjunction with a switcher/buck converter to generate a supply voltage based on the envelope signal,” and they achieve substantially the same result by “provid[ing] an envelope-tracking power supply for a PA.” *Id.* at 58–59. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 157).

Based on the record before us, at this stage of the proceeding, we are persuaded that Petitioner has established sufficiently for purposes of this Decision that the combination of Yu, Wang, and Choi teaches the recited “means for generating a single power supply voltage” limitation. 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, namely, to provide implementation details for Yu’s power amplifier supply voltage module PA', is sufficient to support the legal conclusion of obviousness. *See Kahn*, 441 F.3d at 988.

- c. “means for receiving the single power supply voltage and the plurality of carrier aggregated transmit signals . . . and producing a single output radio frequency (RF) signal”

Lastly, claim 28 recites “means for receiving the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously and producing a single output radio frequency (RF) signal.” Petitioner contends that this limitation is a means-plus-function limitation. Pet. 17–18. Petitioner identifies the claimed function as “receiving the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously and producing a single output radio frequency (RF) signal.” *Id.* at 18. Petitioner further identifies power amplifier 560 as the corresponding structure disclosed in the ’675 patent. *Id.* As support, Petitioner directs us to where the ’675 patent teaches that power amplifier 560 receives a power supply voltage from voltage generator 580, receives a modulated RF signal comprising the carrier aggregated transmit signals being sent simultaneously, and provides an output RF signal for all transmit signals being sent simultaneously. *Id.* (citing Ex. 1501, 6:59–62, 7:58–60, 7:62–64, Fig. 5).

For this limitation, Petitioner relies on Yu. With respect to the claimed function, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. *Id.* at 60.

Fig. 3

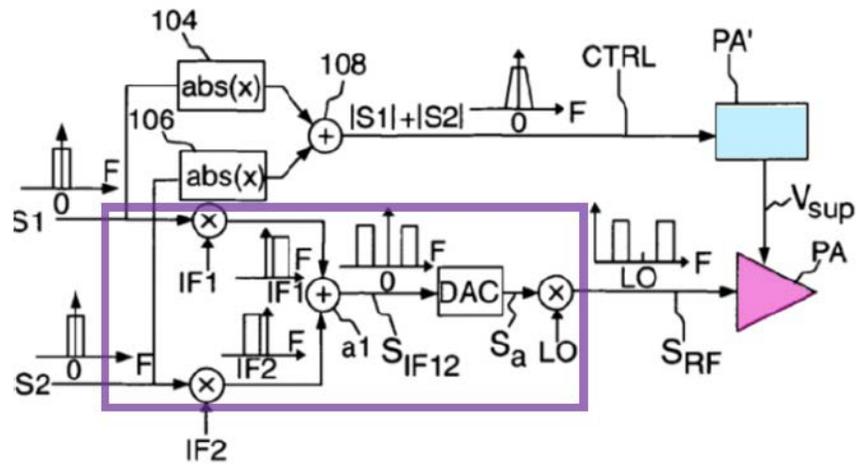


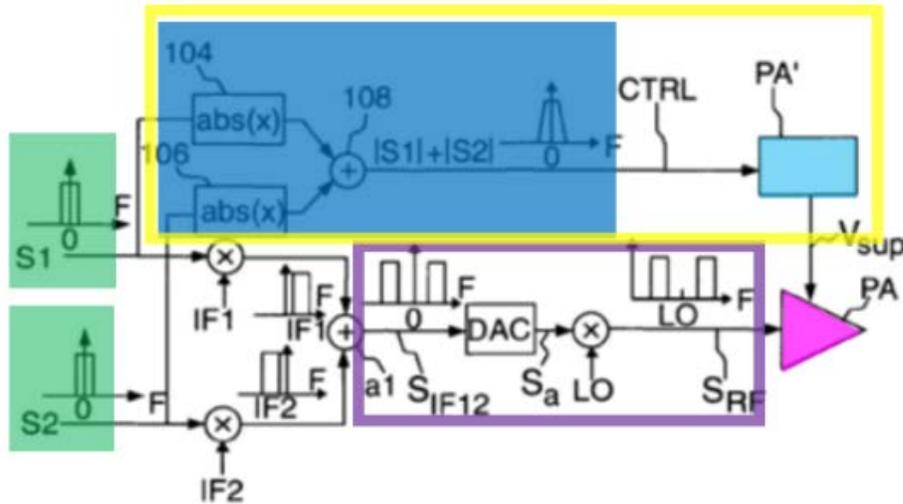
Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 32, 57. Referring to its annotated version of Figure 3, Petitioner contends that Yu teaches that power amplifier PA receives supply voltage V_{sup} (which Petitioner identifies as the “single power supply voltage”) from power amplifier supply voltage module PA' (shown with blue shading). Pet. 59. The annotated figure shows power amplifier PA (shown with pink shading) receiving supply voltage V_{sup} .

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 60. 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 61 (citing Ex. 1504 ¶ 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 61–62 (citing Ex. 1504 ¶ 33); *see also* Ex. 1504, Fig. 1.

We find that Yu’s signal S_{Rfa} corresponds to the recited “single output radio frequency (RF) signal.”

With respect to the corresponding structure, namely, the ’675 patent’s power amplifier 560, Petitioner directs us to an annotated version of Figure 3 of Yu, which is reproduced below. Pet. 62.



As discussed above, Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 32, 57. Petitioner also directs us to an annotated version of Figure 6 of the ’675 patent, which is reproduced below. Pet. 63.

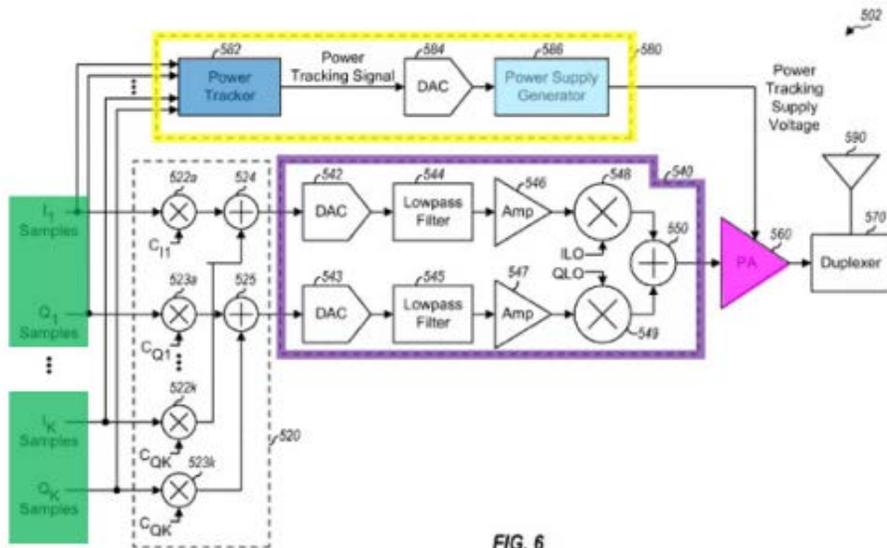


FIG. 6

Figure 6 of the '675 patent shows a design of a transmit module comprising a single power amplifier with power tracking for all transmit signals.

Ex. 1501, 1:65–67. Relying on the declaration testimony of Dr. Choi, Petitioner contends that “[t]he power amplifier disclosed in Yu (highlighted . . . in pink) is identical to the power amplifier disclosed in the '675 patent.” Pet. 62–63 (citing Ex. 1503 ¶ 162).

Based on the record before us, at this stage of the proceeding, we are persuaded that Petitioner has established sufficiently for purposes of this Decision that the combination of Yu, Wang, and Choi teaches the recited “means for receiving the single power supply voltage and the plurality of carrier aggregated transmit signals being sent simultaneously and producing a single output radio frequency (RF) signal.”

d. “means for receiving the I and Q components of the plurality of carrier aggregated transmit signals and separately upconverting the I and Q components . . . to provide a plurality of upconverted RF signals”

Challenged claim 31, which depends from claim 28, additionally recites “means for receiving the I and Q components of the plurality of carrier aggregated transmit signals and separately upconverting the I and Q components of the plurality of carrier aggregated transmit signals to provide a plurality of upconverted RF signals.” Petitioner contends that this limitation is a means-plus-function limitation. Pet. 19–21. Petitioner identifies the claimed function as “receiving the I and Q components of the plurality of carrier aggregated transmit signals and separately upconverting the I and Q components of the plurality of carrier aggregated transmit signals to provide a plurality of upconverted RF signals.” *Id.* at 20. Petitioner further identifies transmit circuit 540 as the corresponding

Again, Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 32, 57. Petitioner contends that “Yu discloses a transmit circuit (outlined in purple) that receives the modulated IF signal S_{IF12} and upconverts the signal to an RF signal S_{RF} by multiplying the signal with a local oscillator signal LO by means of a multiplier (outlined in orange).” Pet. 72. According to Petitioner, an ordinarily skilled artisan “would have understood that because Yu in view of Wang discloses I/Q signal processing, the transmit circuit would receive the IF signal via two signal paths—one for each of the I and Q components.” *Id.* That is, an ordinarily skilled artisan “would have understood that Yu in combination with Wang discloses a transmit circuit that receives the I/Q components of the transmit signals and separately upconverts those components to provide upconverted RF signals.” *Id.* at 73. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 72–73 (citing Ex. 1503 ¶¶ 178–179).

With respect to the corresponding structure, namely, the ’675 patent’s transmit circuit 540, Petitioner contends that Yu’s transmit circuit (outlined in purple in the annotated figure above) as modified by Wang “would be identical or, at a minimum, equivalent to the structure disclosed in the ’675 patent.” *Id.* at 73. As support, Petitioner directs us to Figure 6 of the ’675 patent and identifies components within transmit circuit 540, including two DACs (digital to analog converters) 542 and 543, two lowpass filters 544 and 545, two amplifiers 546 and 547, and two mixers 548 and 549. *Id.* (citing Ex. 1504, Fig. 6). Petitioner also directs us to its annotated version of Figure 3 of Yu, which is reproduced above, and identifies components within Yu’s transmit circuit, including a DAC (outlined in green) and a mixer (outlined in orange). *Id.* Petitioner contends that an

ordinarily skilled artisan “would have understood that Yu’s transmit circuit (in view of Wang) would involve a two-path structure for I/Q signals very similar to the configuration [] shown in Figure 6 of the ’675 patent.” *Id.* According to Petitioner, “any differences between the structures in Yu and the ’675 patent would have been insubstantial.” *Id.* at 74; *see also id.* at 71 (further discussing the same structures in Yu and the ’675 patent with respect to claim 32). Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 73–74 (citing Ex. 1503 ¶¶ 180–181).

Based on the record before us, at this stage of the proceeding, we are persuaded that Petitioner has established sufficiently for purposes of this Decision that the combination of Yu, Wang, and Choi teaches the recited “means for receiving the I and Q components of the plurality of carrier aggregated transmit signals and separately upconverting the I and Q components of the plurality of carrier aggregated transmit signals to provide a plurality of upconverted RF signals.”

- e. “means for summing the plurality of upconverted RF signals and providing the plurality of carrier aggregated transmit signals to a power amplifier”*

Claim 31 further recites “means for summing the plurality of upconverted RF signals and providing the plurality of carrier aggregated transmit signals to a power amplifier.” Petitioner contends that this limitation is a means-plus-function limitation. Pet. 21. Petitioner identifies the claimed function as “summing the plurality of upconverted RF signals and providing the plurality of carrier aggregated transmit signals to a power amplifier.” *Id.* Petitioner further identifies summer 550 as the corresponding structure disclosed in the ’675 patent. *Id.* As support,

Petitioner directs us to where the '675 patent teaches that “[t]he I and Q analog signals are . . . upconverted from IF to RF by mixers 548 and 549, and summed by a summer 550 to generate the modulated RF signal.” *Id.* (citing Ex. 1501, 7:47–51). Petitioner also directs us to Figure 6 of the '675 patent, which, according to Petitioner, “shows summer 550 providing to power amplifier 560 the modulated RF signal, which comprises the carrier aggregated transmit signals.” *Id.* (citing Ex. 1503 ¶ 105).

For this limitation, Petitioner relies on Yu and Wang. With respect to the claimed function, Petitioner contends that an ordinarily skilled artisan “would have understood that Yu’s transmit circuit (as modified by Wang) includes a summer at the end of the circuit path to sum the upconverted signals and provide an RF signal comprising the transmit signals to the PA for wireless transmission.” *Id.* at 74. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 183).

With respect to the corresponding structure, namely, the '675 patent’s summer 550, Petitioner contends that “Yu’s transmit circuit (as modified by Wang) would include a summer that would be identical or, at a minimum, equivalent to the structure disclosed in the '675 patent.” *Id.* According to Petitioner, “[t]he summer would operate in substantially the same way and achieve substantially the same result as the summer in the '675 patent,” that is, “it would sum the upconverted I and Q signals and produce an RF signal comprising the transmit signals to the PA for wireless transmission.” *Id.* at 74–75. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 184).

Based on the record before us, at this stage of the proceeding, we are persuaded that Petitioner has established sufficiently for purposes of this

Decision that the combination of Yu, Wang, and Choi teaches the recited “means for summing the plurality of upconverted RF signals and providing the plurality of carrier aggregated transmit signals to a power amplifier.”

f. “means for receiving a modulated intermediate frequency (IF) signal and providing the plurality of carrier aggregated transmit signals to a power amplifier”

Challenged claim 32 depends from claim 28 and recites “means for receiving a modulated intermediate frequency (IF) signal and providing the plurality of carrier aggregated transmit signals to a power amplifier, the modulated IF signal being generated based on the I and Q components of the plurality of carrier aggregated transmit signals.” Petitioner contends that this limitation is a means-plus-function limitation. Pet. 18–19. Petitioner identifies the claimed function as “receiving a modulated intermediate frequency (IF) signal and providing the plurality of carrier aggregated transmit signals to a power amplifier, the modulated IF signal being generated based on the I and Q components of the plurality of carrier aggregated transmit signals.” *Id.* Petitioner further identifies transmit circuit 540 as the corresponding structure disclosed in the ’675 patent. *Id.* at 19. As support, Petitioner directs us to where the ’675 patent teaches that “[t]ransmit circuit 540 receives I and Q modulated signals from digital modulator 520 and generates a modulated RF signal for all transmit signals.” *Id.* (citing Ex. 1501, 7:43–45). Petitioner also directs us to where the ’675 patent teaches that transmit circuit 540 processes the modulated I and Q signals by converting them to I and Q analog signals, filtering the analog signals, amplifying the filtered signals, upconverting the amplified signals from IF to RF signals, and summing the upconverted signals to generate a

modulated RF signal. *Id.* (citing Ex. 1501, 7:45–55). We note that Figure 6 of the '675 patent shows that summer 550 (which is included in transmit circuit 540) feeds the modulated RF signal to power amplifier 560.

Ex. 1501, Fig. 6 (cited by Pet. 19).

With respect to the claimed function for this limitation, Petitioner provides an annotated version of Figure 3 of Yu, which is reproduced below. Pet. 65.

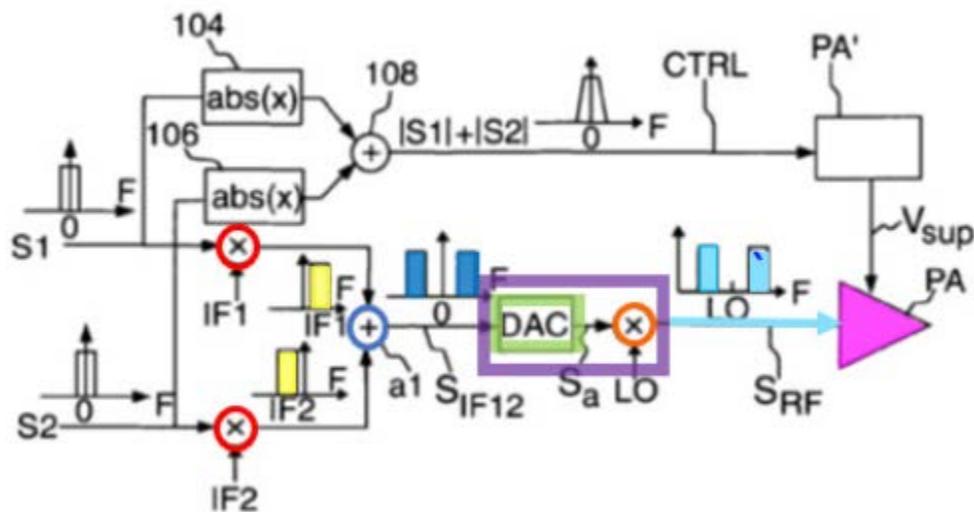


Figure 3 of Yu depicts a signal flow diagram. Ex. 1504 ¶¶ 32, 57. Petitioner contends that input signals S1 and S2 (which Petitioner identifies as the recited “plurality of carrier aggregated transmit signals”) are provided respectively to two multipliers outlined in red that multiply the input signals by intermediate frequencies IF1 and IF2. Pet. 64 (citing Ex. 1503 ¶ 166). Petitioner further contends that the multipliers upconvert the input signals to intermediate frequency (IF) signals, as indicated by what Petitioner calls “the yellow frequency rectangles.” *Id.* (citing Ex. 1503 ¶ 166); *see also*, *e.g.*, Ex. 1504 ¶ 48 (“The first input signal S1 is shifted to an intermediate frequency range IF1 by multiplying the input signal S1 with a first intermediate frequency oscillator signal IF1 by means of a first multiplier.”)

(cited by Pet. 65). Next, Petitioner contends that “[t]he two IF signals are aggregated by a summer (adder a1, outlined in blue) to create an intermediate frequency signal S_{IF12} (depicted by the dark blue frequency rectangles).” Pet. 65 (citing Ex. 1504 ¶ 49); Ex. 1504 ¶ 49 (“The intermediate frequency signals S_{IF1} , S_{IF2} are added by a first adder a1 to obtain an intermediate frequency sum signal S_{IF12} .”). According to Petitioner, “[t]his modulated IF signal S_{IF12} is derived from the original transmit signals S1 and S2, and is therefore based on the I and Q components of those signals.” Pet. 65–66. Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 167).

Petitioner further identifies a transmit circuit outlined in purple in the annotated figure that receives modulated IF signal S_{IF12} . *Id.* at 66. Petitioner explains that the transmit circuit’s DAC (outlined in green) converts the modulated IF signal to an analog signal, which is then upconverted to RF signal S_{RF} by multiplying the analog signal with a local oscillator signal LO using a multiplier (outlined in orange). *Id.* (citing Ex. 1504 ¶ 49). The annotated figure shows that the transmit circuit provides the transmit signals, as indicated by what Petitioner calls “the light blue frequency rectangles,” to the power amplifier shown with pink shading. *Id.* Petitioner relies on the declaration testimony of Dr. Choi. *Id.* (citing Ex. 1503 ¶ 168).

With respect to the corresponding structure, namely, the ’675 patent’s transmit circuit 540, Petitioner contends that Yu’s transmit circuit (outlined in purple in the annotated figure above) as modified by Wang “would be identical or, at a minimum, equivalent to the structure disclosed in the ’675 patent.” *Id.* As support, Petitioner directs us to Figure 6 of the ’675 patent and identifies components within transmit circuit 540, including

two DACs (digital to analog converters) 542 and 543, two lowpass filters 544 and 545, two amplifiers 546 and 547, two mixers 548 and 549, and a summer. *Id.* (citing Ex. 1504, Fig. 6). Petitioner also directs us to its annotated version of Figure 3 of Yu, which is reproduced above, and identifies components within Yu’s transmit circuit, including a DAC (outlined in green) and a mixer (outlined in orange). *Id.* Petitioner contends that an ordinarily skilled artisan “would have understood that Yu’s transmit circuit (in view of Wang) would involve a two-path structure for I/Q signals very similar to the configuration [] shown in Figure 6 of the ’675 patent.” *Id.* at 68. According to Petitioner, “[a]ny differences between the structures in the ’675 patent and Yu would be insubstantial.” *Id.* at 71. Petitioner explains that “Yu’s transmit circuit (as modified in view of Wang) operates in substantially the same way as the transmit circuit described in the ’675 patent,” that is, “it receives a modulated IF signal, prepares the signal for wireless transmission by performing digital-to-analog conversion and upconversion to RF frequency, and then provides the RF signal to the PA.” *Id.* Petitioner additionally explains that “Yu’s transmit circuit also achieves substantially the same result as the structure in the ’675 patent,” specifically, “an RF signal that is provided to a PA for wireless transmission.” *Id.* Petitioner relies on the declaration testimony of Dr. Choi. *Id.* at 66–71 (citing Ex. 1503 ¶¶ 169–174).

Based on the record before us, at this stage of the proceeding, we are persuaded that Petitioner has established sufficiently for purposes of this Decision that the combination of Yu, Wang, and Choi teaches the recited “means for receiving a modulated intermediate frequency (IF) signal and providing the plurality of carrier aggregated transmit signals to a power

amplifier, the modulated IF signal being generated based on the I and Q components of the plurality of carrier aggregated transmit signals.”

Patent Owner does not respond to Petitioner’s arguments regarding claims 28, 31, and 32. *See generally* Prelim. Resp. As discussed above, Petitioner does not challenge claim 28 in this proceeding. In view of the foregoing, we determine that Petitioner has demonstrated a reasonable likelihood of prevailing on its assertion that challenged claims 31 and 32 would have been obvious over Yu, Wang, and Choi.

IV. CONCLUSION

For the foregoing reasons, we are persuaded that Petitioner has demonstrated a reasonable likelihood that it will prevail in showing that claims 31 and 32 of the ’675 patent are unpatentable. We have not made a final determination, however, with respect to the patentability of these claims.

V. ORDER

For the reasons given, it is

ORDERED that *inter partes* review is instituted as to all challenged claims of the ’675 patent, namely, claims 31 and 32, based on the sole asserted ground: obviousness under 35 U.S.C. § 103 of claims 31 and 32 over Yu, Wang, and Choi;

FURTHER ORDERED that no other grounds of unpatentability are authorized for an *inter partes* review as to any claim of the ’675 patent; and

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FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4, notice is hereby given of the institution of a trial; the trial will commence on the entry date of this Decision.

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