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Paper 30
Entered: March 7, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

QUALCOMM INCORPORATED and
QUALCOMM ATHEROS, INC.,
Petitioner,

v.

PARKERVISION, INC.,
Patent Owner.

Case IPR2015-01829
Patent 6,091,940

Before BART A. GERSTENBLITH, CHRISTOPHER L. CRUMBLEY, and JASON J. CHUNG, *Administrative Patent Judges*.

CRUMBLEY, *Administrative Patent Judge*.

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

I. INTRODUCTION

In this *inter partes* review trial, instituted pursuant to 35 U.S.C. § 314, Qualcomm Incorporated and Qualcomm Atheros, Inc. (collectively, "Qualcomm") challenge the patentability of claims 1, 2, 18, 81–84, 86, 88–91, 93, 94, 251–254, 256, 258–261, 263, and 264 of U.S. Patent No. 6,091,940 (Ex. 1001, "the '940 patent"), owned by ParkerVision, Inc.

We have jurisdiction under 35 U.S.C. § 6(b). This Final Written Decision, issued pursuant to 35 U.S.C. § 318(a), addresses issues and arguments raised during trial. For the reasons discussed below, we determine that Qualcomm has proven, by a preponderance of the evidence, that claims 1, 2, 18, 81–84, 86, 88–91, 93, 94, 251–254, 256, 258–261, 263, and 264 of the '940 patent are unpatentable.

A. Procedural History

On August 28, 2015, Qualcomm requested an *inter partes* review of claims 1, 2, 18, 81–84, 86, 88–91, 93, 94, 251–254, 256, 258–261, 263, and 264 of the '940 patent. Paper 1, "Pet." ParkerVision filed a Patent Owner Preliminary Response. Paper 7, "Prelim. Resp." In a Decision on Institution of *Inter Partes* Review (Paper 8, "Dec. on Inst."), we instituted trial as to all challenged claims on the following grounds of unpatentability:

1. Whether claims 1, 2, 18, 81–84, 88–91, 94, 251–254, 258–261, and 264 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Krauss[1] and Ariie;[2] and

[1] Herbert L. Krauss et al., SOLID STATE RADIO ENGINEERING (1980) (Ex. 1003).

[2] U.S. Patent No. 5,680,078 to Ariie, issued Oct. 21, 1997 (Ex. 1004).

2. Whether claims 86, 93, 256, and 263 are unpatentable under 35 U.S.C. § 103(a), as having been obvious over the combined disclosures of Krauss, Ariie, and Sullivan.[3]

Dec. on Inst. 27.

Following institution of trial, ParkerVision filed a Patent Owner Response (Paper 16, "PO Resp."), and Qualcomm filed a Reply (Paper 19, "Pet. Reply").

Qualcomm supported its Petition with the Declaration of Dr. Lawrence E. Larson. Ex. 1002. ParkerVision took cross-examination testimony of Dr. Larson via deposition on May 16, 2016, and submitted the transcript of that deposition. Ex. 2001.

With its Response, ParkerVision submitted the Declaration of Dr. Neil Birkett. Ex. 2008. Qualcomm noticed the deposition of Dr. Birkett (Paper 17), but did not submit the transcript of any deposition.

Following Qualcomm's Reply, counsel for ParkerVision contacted the Board, alleging that the Reply exceeded the scope permitted under 37 C.F.R. § 42.23(b). We authorized ParkerVision to file an identification of the portions of the Reply that allegedly exceeded the proper scope. Paper 22. ParkerVision filed the authorized list (Paper 24), and Qualcomm filed a response (Paper 26).

Neither party filed a motion to exclude evidence.

Oral hearing was requested by both parties (Papers 21, 23), and argument before the Board was held on November 29, 2016.

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[3] Patrick J. Sullivan, et al., *Active Doubly Balanced Mixers for CMDS RFIC's*, MICROWAVE JOURNAL, 1–11 (Oct. 1, 1997) (Ex. 1005).

B. The '940 Patent

The '940 patent, titled "Method and System for Frequency Up-Conversion," is directed to "[a] method and system . . . wherein a signal with a lower frequency is up-converted to a higher frequency." Ex. 1001, [54], [57]. According to the '940 patent, "[t]he up-conversion is accomplished by controlling a switch with an oscillating signal, the frequency of the oscillating signal being selected as a sub-harmonic of the desired output frequency." *Id.* The '940 patent explains:

> The methods and systems of transmitting vary slightly depending on the modulation scheme being used. For some embodiments using frequency modulation (FM) or phase modulation (PM), the information signal is used to module an oscillating signal to create a modulated intermediate signal. If needed, this modulated intermediate signal is "shaped" to provide a substantially optimum pulse-width-to-period ratio. This shaped signal is then used to control a switch which opens and closes as a function of the frequency and pulse width of the shaped signal. As a result of this opening and closing, a signal that is harmonically rich is produced with each harmonic of the harmonically rich signal being modulated substantially the same as the modulated intermediate signal. Through proper filtering, the desired harmonic (or harmonics) is selected and transmitted.

Id. at 1:58–2:5. The '940 patent further explains:

> For some embodiments using amplitude modulation (AM), the switch is controlled by an unmodulated oscillating signal (which may, if needed, be shaped). As the switch opens and closes, it gates a reference signal which is the information signal. In an alternate implementation, the information signal is combined with a bias signal to create the reference signal, which is then gated. The result of the gating is a harmonically rich signal having a fundamental frequency substantially proportional to the oscillating signal and an amplitude substantially proportional to the amplitude of the reference signal. Each of the

> harmonics of the harmonically rich signal also have amplitudes proportional to the reference signal, and are thus considered to be amplitude modulated. Just as with the FM/PM embodiments described above, through proper filtering, the desired harmonic (or harmonics) is selected and transmitted.

Id. at 2:6–21.

C. Illustrative Claims

Of the claims on which trial was instituted, 1 and 18 are independent. Claims 2, 81–84, 86, 88–91, 93, and 94 depend directly or indirectly from claim 1, and claims 251–254, 256, 258–261, 263, and 264 depend directly or indirectly from claim 18. Claims 1 and 18 are illustrative of the claimed subject matter and are reproduced below:

> 1. An apparatus for communicating, comprising:
>
> a first switch module that receives a first oscillating signal and a first bias signal, wherein said first oscillating signal causes said first switch module to gate said first bias signal and thereby generate a first periodic signal having a first plurality of harmonics, said first periodic signal having an amplitude that is a function of said first bias signal;
>
> a second switch module that receives a second oscillating signal and a second bias signal, wherein said second oscillating signal causes said second switch module to gate said second bias signal and thereby generate a second periodic signal having a second plurality of harmonics, said second periodic signal having an amplitude that is a function of said second bias signal;
>
> a summer coupled to said first switch module and to said second switch module, said summer to receive and combine said first periodic signal and said second periodic signal, and to output a combined periodic signal having a combined plurality of harmonics; and

a filter coupled to said summer, said filter to isolate at least one of said combined plurality of harmonics.

Ex. 1001, 66:51–67:5.

18. An apparatus for communicating, comprising:

a first switch module to receive a first oscillating signal and a first bias signal, wherein said first oscillating signal causes said first switch module to gate said first bias signal and thereby generate a first periodic signal having a first plurality of harmonics, said first periodic signal having an amplitude that is a function of said first bias signal, said first bias signal being a function of a first information signal;

a second switch module to receive a second oscillating signal and a second bias signal, wherein said second oscillating signal causes said second switch module to gate said second bias signal and thereby generate a second periodic signal having a second plurality of harmonics, said second periodic signal having an amplitude that is a function of said second bias signal, said second bias signal being a function of a second information signal;

a summer coupled to said first switch module and to said second switch module, said summer to receive and combine said first periodic signal and said second periodic signal, and to output a combined periodic signal having a combined plurality of harmonics; and

a filter coupled to said summer, said filter to isolate at least one of said combined plurality of harmonics.

Id. at 68:50–69:7.

II. ANALYSIS

A. Claim Construction

For purposes of our Decision on Institution, we analyzed each claim term in light of its broadest reasonable interpretation, as understood by one of ordinary skill in the art and consistent with the specification of the

'940 patent. 37 C.F.R. § 42.100(b); *Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2144–46 (2016). Under the broadest reasonable interpretation standard, and absent any special definitions, claim terms are given their ordinary and customary meaning, as would be understood by one of ordinary skill in the art in the context of the entire disclosure. *In re Translogic Tech. Inc.*, 504 F.3d 1249, 1257 (Fed. Cir. 2007). Any special definitions for claim terms or phrases must be set forth with reasonable clarity, deliberateness, and precision. *In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994).

In the Decision on Institution, we evaluated the parties' proffered constructions for the claim terms "switch module," "to gate," "harmonic," and "summer." Dec. on Inst. 8–17. We determined that, based on the record at the time, the broadest reasonable interpretations of the terms were as follows:

switch module	"device with an input and output that can take two states, open and closed"
to gate	no express construction necessary
harmonic	"a frequency or tone that, when compared to its fundamental or reference frequency or tone, is an integer multiple of it . . . [and] includes the fundamental frequency as the first harmonic"
summer	no express construction necessary

During the instituted trial, ParkerVision asserted that we should maintain our constructions of "switch module" and "harmonic." PO Resp. 22–23, 29. With respect to "summer," ParkerVision conceded that Krauss teaches a summer and, therefore, an express construction is not material to the parties' dispute. *Id.* at 25. Finally, with respect to "to gate,"

ParkerVision contends that the parties agree on the portion of the construction that is material to resolving their dispute, namely that the term means that "the switch module must change between connecting and disconnecting the bias signal from the switch module's output." *Id.* at 23.

In its Reply, Qualcomm does not contest any of ParkerVision's claim construction assertions, or take issue with its characterization that the parties agree on the salient aspects. Given the parties' positions, and upon review of the entire record, we maintain our prior constructions of "switch module" and "harmonic," and adopt ParkerVision's proffered construction of "to gate" as "to change between connecting and disconnecting." As the construction of "summer" is not material to the parties' dispute, we decline to provide an express construction here. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

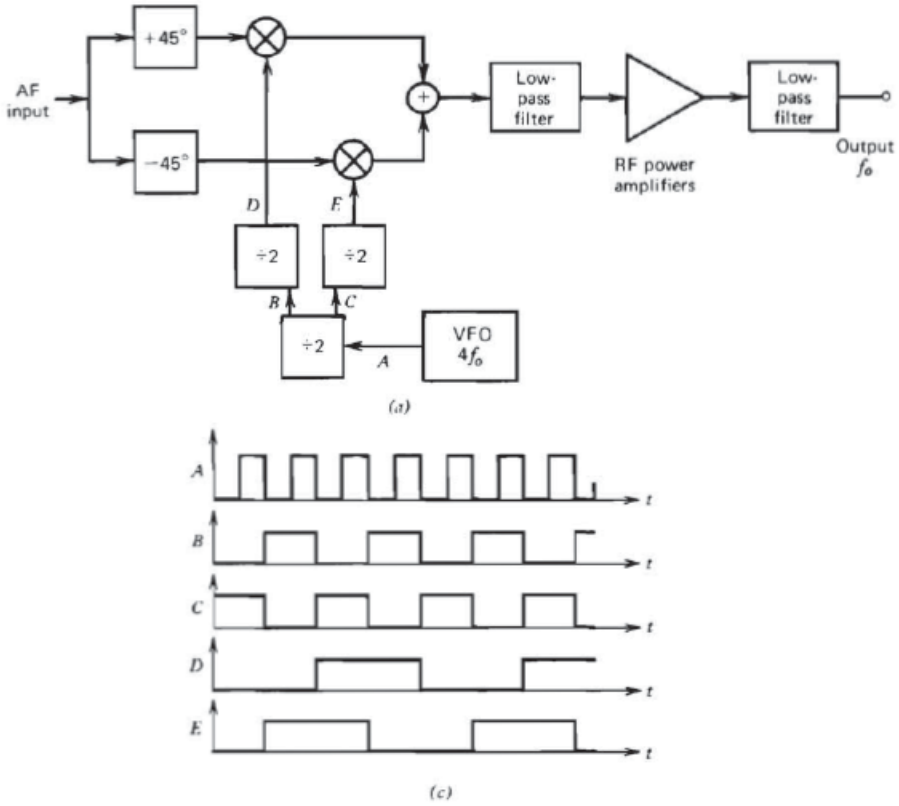
B. Obviousness over Krauss and Ariie

We instituted trial to determine whether claims 1, 2, 18, 81–84, 88–91, 94, 251–254, 258–261, and 264 are unpatentable under 35 U.S.C. § 103(a), as they would have been obvious over the combined disclosures of Krauss and Ariie. Dec. on Inst. 27. An obviousness inquiry involves four underlying determinations: the scope and content of the prior art; the differences between the prior art and the claims at issue; the level of ordinary skill; and any objective indicia of nonobviousness. *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). We begin by assessing the scope and content of the prior art, namely the disclosures of Krauss and Ariie.

1. Krauss

Krauss teaches direct-conversion single side band ("SSB") transmitters.[4] Ex. 1003, 62. Figures 16-3(a) and (c) of Krauss are reproduced below.

Fig. 16-3 Direct-conversion SSB transmitters. (*a*) Using phasing method of SSB modulation; (*b*) using third method of SSB modulation; and (*c*) frequency-division waveforms.



Figures 16-3(a) and (c) illustrate a direct-conversion SSB transmitter and the waveforms used in the transmitter. According to Krauss, "[t]he audio input signal is applied to a phase-splitting network that produces two audio signals that differ in phase by 90°." *Id.* at 65. In addition, Krauss discusses "a flip-

[4] All references to the page numbers in Krauss refer to the page numbers inserted by Petitioner in the bottom, right-hand corner of each page.

flop whose outputs, B and C . . . are at a frequency $2f_0$ and 180° out of phase." *Id.* These outputs are then divided into outputs D and E, illustrated in Figure 16-3(c), which are rectangular waves used to drive two double-balanced mixers. *Id.*

2. Ariie

Ariie teaches a low- or zero-power-consumption mixer which operates at low voltage, comprising a field-effect transistor ("FET"). Ex. 1004, 2:20–34. The FET mixes a carrier signal (input at the gate of the FET) and a data signal (input to the drain of the FET) to create a mixed signal. *Id.* An embodiment of the Ariie mixer is depicted in Figure 1:

FIG. 1

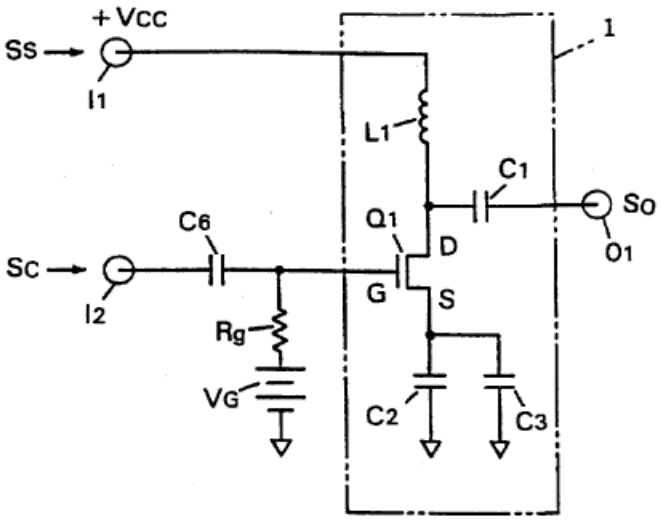


Figure 1 of Ariie depicts FET Q1 connected to carrier signal S_C at gate G, and to a composite signal that comprises data signal S_S at drain D. *Id.* at 4:16–21. The FET outputs mixed signal S_O, which includes components having frequencies of $nf_c \pm mf_s$, where n and m are positive integers. *Id.* at

4:55–61. The desired output frequency is selected from these component frequencies with the use of a filter. *Id.* at 4:61–64.

3. Level of Ordinary Skill in the Art

Qualcomm contends, citing Dr. Larson's testimony, that one of ordinary skill in the art

> as of October 1998 would possess, at a minimum, either (a) a master of science degree in electrical engineering and two or more years of experience in radio frequency circuit design, or (b) a bachelor of science degree in electrical engineering with three or more years of experience with the design and development of RF circuits.

Pet. 12 (citing Ex. 1002 ¶¶ 24–29). ParkerVision does not contest Qualcomm's designation of the level of ordinary skill in the art as of the date of the invention. Accordingly, we adopt Qualcomm's proposed level of ordinary skill in the art.

4. Proposed Combination of Krauss and Ariie

Qualcomm contends that a person of ordinary skill in the art would have had reason to combine the disclosures of Krauss and Ariie because Krauss teaches a direct-conversion SSB transmitter that would have been understood to be a type of "orthogonal modulator," and Ariie expressly teaches using its mixer in orthogonal modulators. Pet. 23 (citing Ex. 1004, 1:5–10). Alternatively, Petitioner notes that Ariie teaches that its mixer is "a low-power-consumption or zero-power consumption mixer which operates at a low voltage and can be easily integrated to make it compact"; thus, a person of ordinary skill would have had reason to use Ariie's mixers in Krauss to make Krauss more compact. *Id.* at 23–24 (quoting Ex. 1004, 2:20–23).

Given these disclosures, Qualcomm contends that the person of ordinary skill in the art would have modified the circuit in Krauss's Figure 16-3(a) to replace each double-balanced mixer with the mixer of Ariie, resulting in a device that contains every structural component recited in claim 1. *Id.* at 25–36. The references are further said to teach that such a combination will result in the mixer outputting a plurality of harmonics. *Id.* at 30 ("Krauss teaches that a mixer implemented as a non-linear device will output periodic signals that include harmonics, with the particular harmonics depending on the nature of the non-linearity." (citing Ex. 1003, 14–15)); *id.* at 31 (citing Ex. 1004, 4:59–61). Krauss and Ariie are also said to teach the use of filters to remove unwanted harmonics. *Id.* at 35–36 (citing Ex. 1003, 78; Ex. 1004, 4:59–64). As such, Qualcomm argues that the proposed combination of Krauss and Ariie teaches each limitation of the challenged claims.

ParkerVision contests only two aspects of Qualcomm's argument: first, whether incorporating Ariie's mixer into Krauss's circuit results in the claimed "switch module" (PO Resp. 32–36); and second, whether there would have been a reason to combine the references as proposed (*id.* at 36–39). We evaluate each of these arguments below.

As to the remaining limitations of claims 1 and 18, as well as the additional limitations of the challenged dependent claims, we have reviewed Qualcomm's unchallenged arguments and evidence on these points (Pet. 25–45), find them persuasive that the references disclose the limitations, and adopt Qualcomm's analysis as our findings herein.

5. Whether the References Disclose a "Switch Module" that "Gates"

ParkerVision argues that, even if a person of ordinary skill in the art were to incorporate Ariie's FET into the circuit of Krauss, the FET would not be the claimed "switch module." PO Resp. 32–36. ParkerVision highlights Qualcomm's description of the FET as a "non-linear device," but points to Dr. Larson's testimony that a non-linear device is distinguishable from a switch that operates between two possible states. *Id.* at 34 (citations omitted). As such, the FET allegedly does not operate as a switch that has two possible states, open and closed, and would not "gate" the bias signal. *Id.* at 34–35. According to ParkerVision, Qualcomm did not "identify[] any evidence showing that Ariie describes FET Q1 as changing between two possible states, alternately connecting and disconnecting the data signal S_S." *Id.* at 35.

In response, Qualcomm argues that even though Ariie does not state expressly that its FET may be a switch, this is the natural result of incorporating the FET into the circuit described in Krauss. Pet. Reply 9–10. Qualcomm observes that "Krauss discloses a rectangular signal having two states, on and off, which would necessarily operate Ariie's FET as a gate or switch."[5] *Id.* at 10. Rectangular wave D, disclosed in Figure 16-3(c) of

[5] ParkerVision contends that Qualcomm's argument—regarding operating Ariie's mixer with a rectangular wave—is a new argument that goes beyond the scope of a proper reply. *See* Paper 24, 1 (identifying pages 9–12 and 16–18). We have evaluated ParkerVision's position and disagree that Qualcomm raised the argument for the first time in its Reply. In particular, we note that the Petition specifically highlighted the "First Oscillating Signal D" of Figure 16-3(c)—the rectangular wave—and states that gate G of Ariie's FET Q1 would receive that signal. Pet. 26, 28.

Krauss, is shown as an input into one of the mixers of Figure 16-3(a). Ex. 1003, 64. Qualcomm contends that when wave D is high, it would cause the FET to close; whereas, when D is low, the FET would open. Pet. Reply 11. The same reasoning holds for rectangular wave E, which drives the second mixer of Krauss. Qualcomm argues that it is irrelevant whether the FET of Ariie could be run in another manner, which does not operate as a switch, because the rectangular control signal of Krauss has only two states, off and on. *Id.* at 12.

We have reviewed the parties' arguments and the testimony of the experts. We agree with Qualcomm that, in the combination of references as proposed, the rectangular wave of Krauss would drive the Ariie FET as a switch. That switch, in turn, would cause the FET to gate the input signals of Krauss, satisfying the disputed limitations of the claims. We note that Dr. Birkett does not testify to the contrary, stating only that Ariie does not teach the FET as alternating between connecting and disconnecting the data signal. Ex. 2008 ¶ 37. While this is correct, Dr. Birkett's testimony is directed to the disclosure of Ariie individually, rather than looking to the proposed combination. *In re Keller*, 642 F.2d 413, 426 (CCPA 1981) ("[O]ne cannot show non-obviousness by attacking references individually where, as here, the rejections are based on combinations of references." (citing *In re Young*, 409 F.2d 754 (CCPA 1968))). Dr. Birkett does not address—and ParkerVision does not dispute—that when operated with the rectangular waves of Krauss, Ariie's FET acts as a switch.

It is of no moment that, as ParkerVision argues, Ariie's FET may be run in a manner that does not act as a switch, with many possible states between open and closed. PO Resp. 35; *see also* Ex. 2008 ¶ 38 (Dr. Birkett:

"The Ariie FET *could* be used to combine carrier signal S_C and the data signal S_S as described in the Ariie patent without acting as a switch.") (emphasis added). According to ParkerVision, this means that a "switch module" is not *necessarily* present in the combination and, therefore, cannot be disclosed inherentlytaught inherently. PO Resp. 36. As discussed above, however, Krauss shows that its oscillating signal is a rectangular wave, and ParkerVision does not dispute that the rectangular wave necessarily would operate the FET as a switch. The fact that an FET could be driven with other waveforms—not taught in Figure 16-3 of Krauss—in a manner that is not a switch does not detract from our finding that the proposed combination of Krauss and Ariie discloses waveforms that drive the FET such that it acts as a switch.

Finally, even if Krauss did not teach using a rectangular wave to drive its mixer—or if we were to disregard that as a new argument—we would still conclude that the limitations of the claims are taught by the combination of Krauss and Ariie. The "gating" performed by the "switch module" is functional in nature, describing the effect the apparatus has on transitory electrical signals. Thus, the "switch module" limitation is met when the claimed apparatus is capable of performing that gating function. The record is clear, and ParkerVision does not deny, that Ariie's FET is capable of being used as a "switch module" that "gates," if it is driven with the proper input. This is sufficient to satisfy the limitations. In other words, ParkerVision cannot use functional language to distinguish the challenged apparatus claims over the structure disclosed by the proposed combination of Krauss and Ariie. *See Hewlett-Packard Co. v. Bausch & Lomb Inc.*, 909

F.2d 1464, 1469 (Fed. Cir. 1990) ("[A]pparatus claims cover what a device *is*, not what a device *does*.").

6. Reason to Combine Krauss and Ariie

ParkerVision argues, in the alternative, that, even if Krauss and Ariie teach all limitations of the claims, a person of ordinary skill in the art would have had no reason to combine their disclosures in the manner Qualcomm suggests. PO Resp. 36–39. ParkerVision notes that the Krauss circuit is a suppressed carrier transmitter, meaning that its output does not contain the input frequency or the applied oscillating signal that drives the mixer. *See* Ex. 2008 ¶ 31. This is because Krauss uses double-balanced mixers, which suppress the carrier signal in their output. PO Resp. 38 (citing Ex. 2001).

By contrast, ParkerVision argues, the FET mixer of Ariie is unbalanced, meaning that its output will contain not only the desired frequency, but also the input and oscillating frequencies as leakage. Ex. 2008 ¶ 31. Including the FET of Ariie in the circuit of Krauss, therefore, would result in a transmitter that no longer suppresses the carrier. ParkerVision argues that this changes the principle of operation of Krauss, and results in a transmitter that is "unsatisfactory and inoperable for its intended purpose." PO Resp. 39.

It is correct that a person of ordinary skill in the art has little reason to make a modification that renders the prior art unsatisfactory or inoperable for its intended purpose. *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984). But it is not sufficient that the result of the modification is merely somewhat inferior to the prior art. *In re Gurley*, 27 F.3d 551, 554 (Fed. Cir. 1994).

ParkerVision appears to define the "intended purpose" of Krauss's circuit as providing a suppressed carrier transmitter. *See* PO Resp. 38 ("replacing Krauss's double-balanced mixers with unbalanced mixers would result in an output signal that no longer had a suppressed carrier"). We disagree that Krauss's purpose is so limited. Krauss is a general textbook on solid-state radio engineering, "about the analysis and design of the radio-frequency electronic circuits that are the building blocks of radio transmitters and receivers." Ex. 1003, 3. Given this broad focus, it is more accurate to describe Krauss as directed to transmitters generally, as opposed to a particular kind of suppressed-carrier transmitter. While a suppressed carrier transmitter may have some advantages over unsuppressed carriers, it does not follow that unsuppressed carriers have no use, or are inoperable. Indeed, as Qualcomm observes, Krauss acknowledges that transmitters can use either suppressed or unsuppressed carrier approaches. Pet. Reply 5 (citing Ex. 1030, 500).

Ariie discloses that its FET mixers have certain advantages, such as low or zero power consumption and easy, compact integration. Ex. 1004, 2:20–23. It is reasonable that a person of ordinary skill in the art would have been willing to trade-off the benefit of a suppressed-carrier transmitter for the benefits taught by Ariie. In other words, any disadvantage[6] of a transmitter with an unsuppressed carrier would have been weighed against the advantages of Ariie's mixer. We cannot conclude that incorporating an

[6] We note that Dr. Larson testified that, in certain circumstances, transmitting the carrier may be beneficial. Ex. 2001, 188:17–22, 189:4–11. From this testimony, we conclude that unsuppressed carrier transmitters are not always disadvantageous.

unbalanced mixer into Krauss' transmitter would so frustrate its operation that a person of ordinary skill in the art would not contemplate the modification. In other words, on balance, we find that the advantages of combining the teachings of the references as proposed by Qualcomm outweigh the alleged disadvantages. Accordingly, Qualcomm has provided sufficient evidence of a reason with rational underpinnings as to why one of ordinary skill in the art would have been prompted to combine the teachings of Ariie with those of Krauss.

7. Conclusion

We have reviewed the evidence and arguments presented by the parties and find that a person of ordinary skill in the art would have had reason to combine the disclosures of Krauss and Ariie and would have had a reasonable expectation of success in doing so, and the combination would have taught all elements of the challenged claims. Furthermore, ParkerVision has not presented any evidence pertaining to objective indicia of nonobviousness. For these reasons, we conclude that Qualcomm has met its burden to prove, by a preponderance of the evidence, that claims 1, 2, 18, 81–84, 88–91, 94, 251–254, 258–261, and 264 would have been obvious to one of ordinary skill in the art at the time of the invention over the combined disclosures of Krauss and Ariie.

C. Obviousness over Krauss, Ariie, and Sullivan

We also instituted trial to determine whether claims 86, 93, 256, and 263 are unpatentable under 35 U.S.C. § 103(a), as they would have been obvious over the combined disclosures of Krauss, Ariie, and Sullivan. Dec. on Inst. 27. These dependent claims further require that the FET is a

complementary metal oxide semiconductor FET. *See, e.g.*, Ex. 1001, 74:50–52 (claim 86). Qualcomm relies on Sullivan, in combination with Krauss and Ariie, to disclose this limitation. Pet. 45–47.

Sullivan is directed to mixers for complementary metal-oxide semiconductor ("CMOS") radio frequency integrated circuits ("ICs"). Ex. 1005, 1. Sullivan discloses that "[t]he similarities between [metal-oxide-semiconductor field-effect transistor (MOSFET)] and MESFET devices allow the designer to apply the extensive knowledge of MESFET mixers[] to the design of MOSFET mixers." *Id.* Sullivan further states that "[u]sing CMOS technology, RF designers can utilize the large infrastructure in place that supports and develops low cost, mass-produced ICs. The drive to increase transceiver integration and reduce transceiver cost makes CMOS an attractive technology for low cost, highly integrated transceivers." *Id.* at 9.

Qualcomm acknowledges that Ariie does not recognize CMOS as the specific fabrication technology for its FET. Pet. 46. Rather, relying on the testimony of Dr. Larson, Qualcomm contends that a person of ordinary skill in the art would have had reason to implement Ariie's FET using a CMOS process. *Id.* (citing Ex. 1002 ¶¶ 289, 294).

ParkerVision does not challenge Qualcomm's characterization of the disclosure of Sullivan or Dr. Larson's testimony on this point, or contend that a person of ordinary skill in the art would not have combined Sullivan's disclosure with that of Ariie and Krauss. Nor does ParkerVision raise any other argument for the patentability of claims 86, 93, 256, and 263 separate from those made for the independent claims, which we have found unpersuasive. *See* Paper 9, 3 ("Patent Owner is cautioned that any arguments for patentability not raised in the response will be deemed

waived."). We find persuasive Qualcomm's unchallenged evidence, analysis, and reasons as to why one of ordinary skill in the art, at the time of the invention, would have been prompted to combine the teachings of the references, we find them persuasive and adopt them as our own.

For the foregoing reasons, we conclude that Qualcomm has established, by a preponderance of the evidence, that claims 86, 93, 256, and 263 would have been obvious to one of ordinary skill in the art at the time of the invention over the combined disclosures of Krauss, Ariie, and Sullivan.

III. CONCLUSION

For the foregoing reasons, based on a review of the complete record developed during trial, we conclude that Qualcomm has proven, by a preponderance of the evidence, that claims 1, 2, 18, 81–84, 86, 88–91, 93, 94, 251–254, 256, 258–261, 263, and 264 are unpatentable.

IV. ORDER

Accordingly, it is:

ORDERED that claims 1, 2, 18, 81–84, 86, 88–91, 93, 94, 251–254, 256, 258–261, 263, and 264 of U.S. Patent No. 6,091,940 are *unpatentable*;

FURTHER ORDERED that, pursuant to 35 U.S.C. § 318(b), upon expiration of the time for appeal of this decision, or the termination of any such appeal, a certificate shall issue canceling claims 1, 2, 18, 81–84, 86, 88–91, 93, 94, 251–254, 256, 258–261, 263, and 264 of U.S. Patent No. 6,091,940; 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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