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Paper No. 57
Entered: July 17, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SMART MICROWAVE SENSORS GMBH,
Petitioner,

v.

WAVETRONIX LLC,
Patent Owner.

Case IPR2016-00488
Patent 6,693,557 B2

Before JAMESON LEE, MICHAEL W. KIM, and DANIEL N. FISHMAN, *Administrative Patent Judges*.

FISHMAN, *Administrative Patent Judge.*

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

I. INTRODUCTION

Smart Microwave Sensors GmbH ("Petitioner"), filed a Petition (Paper 2, "Pet.") for *inter partes* review of claims 9, 10, 12, 13, 22, 23, and 25 of U.S. Patent No. 6,693,557 B2 ("the '557 patent") (Ex. 1001) pursuant to 35 U.S.C. §§ 311–319. Wavetronix LLC ("Patent Owner") filed a Patent Owner Preliminary Response (Paper 7, "Prelim. Resp."). On July 18, 2016,

based on the record before us at the time, we instituted an *inter partes* review of claims 9, 10, 12, 13, 22, 23, and 25 (Paper 11, "Dec."). We instituted that review on the following challenges to the claims:

References	Basis	Claims
Madjar[1]	§ 102(b)	9, 12, 22, 23, and 25
Boles[2]	§ 102(b)	22
Farmer[3]	§ 102(b)	22, 23, and 25
Herman[4] and Farmer	§ 103(a)	9 and 22
Boles and (either Perret[5] or Herman)	§ 103(a)	9
Boles, (either Perret or Herman), and Hohne[6]	§ 103(a)	10
Boles, (either Perret or Herman), and Analog Devices[7]	§ 103(a)	10 and 12
Farmer and Herman	§ 103(a)	9 and 12
Farmer, Herman, and Kinasewitz[8]	§ 103(a)	13

[1] Asher Madjar et al., *A novel DDS based 94 GHz high linearity FMCW RF front end*, 26th EuMC, 9-12 September 1996, Hotel Hilton Atrium, Prague, Czech Republic ("Madjar"). Ex. 1002.
[2] U.S. Pat. No. 5,506,584, Apr. 9, 1996 ("Boles"). Ex. 1003.
[3] U.S. Pat. No. 6,085,151, July 4, 2000 ("Farmer"). Ex. 1004.
[4] U.S. Pat. No. 5,008,678, Apr. 16, 1991 ("Herman"). Ex. 1005.
[5] U.S. Pat. No. 5,423,080, June 6, 1995 ("Perret"). Ex. 1006.
[6] WO 99/08128 A1 (and corresponding English language translation U.S. Pat. No. 6,373,427, Apr. 16, 2002) ("Hohne"). Ex. 1007.
[7] *A Technical Tutorial on Digital Signal Synthesis*, Analog Devices, Inc. 1999 ("Analog Devices"). Ex. 1009.
[8] U.S. Pat. No. 6,061,035, May 9, 2000 ("Kinasewitz"). Ex. 1010.

References	Basis	Claims
Russell,[9] Herman, Analog Devices, and Galani[10]	§ 103(a)	9 and 10
Russell, Analog Devices, and Galani	§ 103(a)	22
Chang[11] and Herman	§ 103(a)	9, 13, 22, and 23
Boles and (either Analog Devices or Chang)	§ 103(a)	25

Dec. 35.

Patent Owner filed a Corrected Patent Owner Response (Paper 38, "PO Resp.") and Petitioner filed a Reply (Paper 41, "Pet. Reply"). Petitioner relies on the expert Declaration of Stephen Alland (Ex. 1015) and Patent Owner relies on the expert Declarations of Christopher Wilson (Ex. 2022) and Dr. H. Gene Hawkins, Jr. (Ex. 2023).

Petitioner filed a Motion to Exclude Evidence (Paper 44) to which Patent Owner filed an Opposition (Paper 47) and Petitioner filed a Reply (Paper 49).

Patent Owner filed a Motion to Exclude Evidence (Paper 45) to which Petitioner filed an Opposition (Paper 48) and Patent Owner filed a Reply (Paper 50).

Oral Hearing was conducted on April 18, 2017. The record contains a transcript of the hearing (Paper 56, "Tr.").

[9] U.S. Pat. No. 5,929,802, July 27, 1999 ("Russell"). Ex. 1011.
[10] Zvi Galani, *An Overview of Frequency Synthesizers for Radars*, IEEE Transactions on Microwave Theory and Techniques, Vol. 39, No. 5, May 1991 ("Galani"). Ex. 1012.
[11] Kai Chang, *RF and Microwave Wireless Systems*, Copyright 2000, John Wiley & Sons, Inc., ISBN: 0-471-35199-7 (Hardback) ("Chang"). Ex. 1008.

We have jurisdiction under 35 U.S.C. § 6. The evidentiary standard is preponderance of the evidence. *See* 35 U.S.C. § 316(e); *see also* 37 C.F.R. § 42.1(d). This Final Written Decision is issued pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73.

For the reasons expressed below, we conclude that Petitioner has met its burden to show, by a preponderance of the evidence, that claims 9, 10, 12, 13, 22, 23, and 25 are unpatentable.

A. The '557 Patent

The '557 patent is directed generally to a sensor "for detecting the presence, location, speed, direction of travel, volume, and occupancy of vehicular traffic on a roadway." Ex. 1001, 1:18–20. The '557 patent discloses that prior known sensing devices utilized in-roadway devices to sense traffic, and that such older, in-roadway, devices were prone to failure and expensive to repair (requiring demolition and rebuilding of the roadway). *Id*. at 1:22–56. Further, according to the '557 patent, other prior known sensors, mounted above the roadway surface, utilized, *inter alia*, microwave radar sensing, but those sensors were large and required on-site maintenance. *Id*. at 1:57–64, 2:33–39.

According to the '557 patent,

> A vehicle sensor for detecting and monitoring vehicular targets is presented. The sensor employs a planar design resulting in a reduced profile sensor and a greatly improved sensor for manufacturing. Improvements are a result of controlled manufacturing processes for forming controlled interconnects and structures on replicable circuit boards.

Id. at 2:51–57. Figure 1 of the '557 patent reproduced below, shows an exemplary environment in which sensor 110, mounted to a light pole, emits

radio frequency ("RF") signals and senses returned signals 118 reflected off vehicles on the roadway.

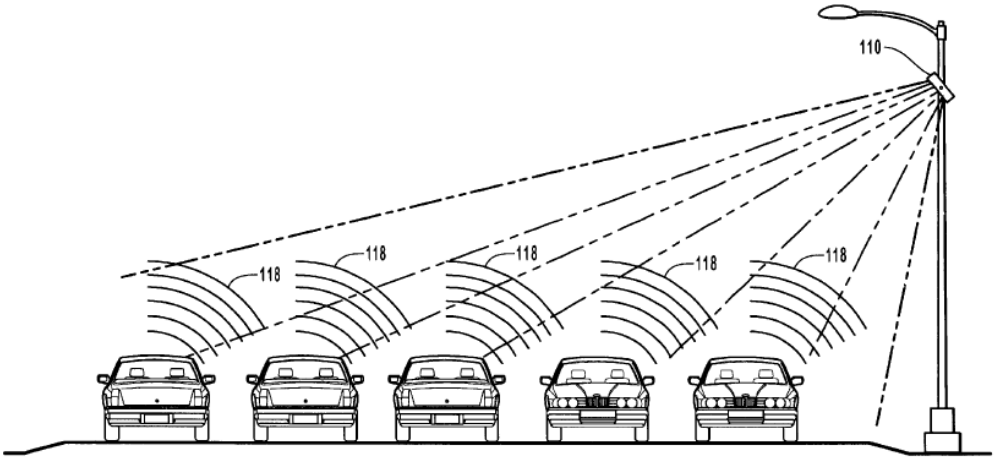


FIG. 1

Figure 8 of the '557 patent, reproduced below, discloses an exemplary controller of a sensor.

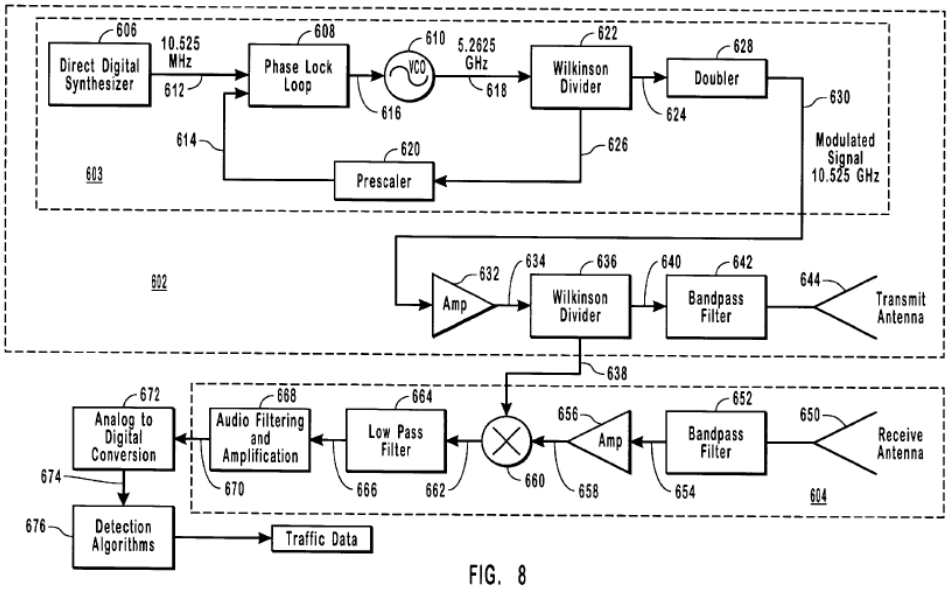


FIG. 8

The controller generally includes transmit portion 602 and receive portion 604. Ex. 1001, 7:9–12. In general, receive portion 604 receives

signals reflected off objects on the roadway from signals transmitted by transmit portion 602. *Id*. at 9:2–5. Received, reflected, radio frequency (analog) signals may be filtered and amplified and, eventually, converted to digital signals for further processing. *See id*. at 9:3–10:6. According to the '557 patent,

> The digitized output signal **674** is thereafter processed by detection algorithm **676**, which performs spectral analysis on the digitized signal **674** and generates the desired traffic statistics for use in traffic analysis, control, and forecasting. Other processing within detection algorithm **676** include automatic and continuous background estimation, automatic and continuous lane allocation and automatic and continuous detection threshold determination.

Id. at 10:11–19.

B. Related Matters

Both parties assert there are no related matters. Pet. 1; Paper 5, 1.

C. Illustrative Claims

Of the challenged claims, claims 9 and 22, reproduced below, are the only independent claims and are exemplary of the invention:

> 9. An above-ground traffic sensor for detecting vehicles traveling on a roadway, the traffic sensor comprising:
>
> a radio frequency circuit board including:
>
> a transmit portion that includes:
>
> a digitally generated modulated signal generator that digitally generates a signal that is transmitted by a transmitter towards vehicles traveling on a roadway; and
>
> a receiver portion that detects a reflected signal from the vehicles traveling on the roadway and that generates a data signal that represents traffic data from the reflected signal.

> 22. A sensor for monitoring vehicles on a roadway, the sensor comprising:
>
> a transmit portion comprising:
>
> a digital signal generator that digitally generates a modulated signal; and
>
> a transmit antenna for transmitting the modulated signal towards vehicles on a roadway;
>
> a received portion comprising:
>
> a receive antenna for receiving reflections of the modulated signal from vehicles on the roadway, wherein the reflections of the modulated signal are processed to produce traffic data representing the vehicles on the roadway.

II. ANALYSIS

A. Claim Construction

In an *inter partes* review, a claim in an unexpired patent shall be given its broadest reasonable construction in light of the specification of the patent in which it appears. 37 C.F.R. § 42.100(b); *see also Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142 (2016) (affirming that USPTO has statutory authority to construe claims according to 37 C.F.R. § 42.100(b)). Under the broadest reasonable construction standard, claim terms are generally given their ordinary and customary meaning, as would have been 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). "[A] claim construction analysis must begin and remain centered on the claim language itself." *Innova/Pure Water, Inc. v. Safari Water Filtration Sys., Inc.*, 381 F.3d 1111, 1116 (Fed. Cir. 2004). "Though understanding the claim language may be aided by the explanations contained in the written description, it is important not to import into a claim

limitations that are not a part of the claim." *SuperGuide Corp. v. DirecTV Enters., Inc.*, 358 F.3d 870, 875 (Fed. Cir. 2004). Furthermore, only those terms that are in controversy need to be construed, and only to the extent necessary to resolve the controversy. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999).

Other than the terms discussed below, we determine no other term requires express construction.

1. "Traffic Data"

Independent claim 9 recites generating a signal "that represents traffic data from the reflected signal." Independent claim 22 recites reflected signals are processed to produce "traffic data representing the vehicles on the roadway."

Petitioner argues "traffic data" means "data related to speed, range (distance), and/or vehicle (target) information, e.g., length, spacing between vehicles, vehicle type, etc." Pet. 8. Petitioner contends the '557 patent is silent regarding any definition and points to a dictionary definition of "traffic" (Ex. 1014) and another patent (Ex. 1013 ("Stammler" US 4,985,705)) as support for its interpretation of "traffic data." *Id.*; *see also* Ex. 1015 ¶ 15.

In its Preliminary Response, Patent Owner asserted Petitioner unreasonably broadens the interpretation of "traffic data" to encompass the collision-avoidance data gathered by vehicles in several of the prior art references, and argues such data is not "traffic data." Prelim. Resp. 10–11. By contrast, Patent Owner further asserted "traffic data" is "information about patterns of movement of the vehicles on a defined section of roadway, not [covering] movement of a vehicle relative to another vehicle or nearby

objects." *Id*. at 11–12 (citing Ex. 2003 (a dictionary defining "traffic" as "all the vehicles driving along a certain road or in a certain area")). Patent Owner asserts this definition is consistent with the '557 patent, which "identifies the field of the invention as 'sensors for detecting the presence, location, speed, direction of travel, volume, and occupancy of vehicular traffic on a roadway.'" *Id*. at 12–13 (quoting Ex. 1001, 1:17–20).

In our Decision on Institution, we determined the Specification of the '557 patent lacks a limiting definition, and determined the parties' arguments do not account properly for the plain meaning of "traffic data" in the context of surrounding claim language. Dec. 9 (citing *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002)). In our Decision on Institution, we determined that, in the context of claims 9 and 22, and for purposes of institution of trial, "traffic data" means "any data generated or produced from a signal reflected off vehicles on a roadway." *Id.* at 9–10.

Patent Owner's Response argues that our interpretation is in error because the claims recite *traffic* data, not *any* data and, thus, our interpretation impermissibly "eliminates the word 'traffic' from the claim language." PO Resp. 4–5. Patent Owner contends the '557 patent relates to traffic engineering and "the purposes for which the disclosed technology is used include control of signalized intersections and the collection of traffic flow data." *Id.* at 5. Patent Owner quotes a number of portions of the Specification that relate to use of the technology in traffic engineering applications, asserting, "[a]ll of the purposes, uses and features described for the relevant technology and the disclosed embodiment of the invention fall squarely within the ambit of the field of traffic engineering." *Id.* at 6. Patent Owner acknowledges that "specifics of traffic data in the context of the '557

patent vary depending on the purposes for which it is used, but certain basic attributes of the traffic data do not." *Id.* (citing Ex. 2023 ¶ 23). Specifically, Patent Owner asserts *traffic data*, as properly construed, must be at a fixed location tied to a particular section of roadway in order to generate data useful to a traffic engineer (*id.* (citing Ex. 2023 ¶¶ 25, 27)), and, thus, asserts *traffic data* must "be generated from reflections off all or substantially all of the vehicles on the section of the roadway of interest" to present a complete picture of traffic at a controlled intersection (*id.* at 7 (citing Ex. 2023 ¶¶ 26–27)).

Petitioner asserts that Patent Owner's proposed construction is unreasonably narrow. Specifically, Petitioner asserts that the Specification does not even use the phrase "traffic data," that the proposed construction improperly imports limitations from the claims, that the Patent Owner's own expert admits there is no art-recognized definition for "traffic data," and that Patent Owner's proposed construction is not supported by other prior art purportedly relevant to "traffic data." Pet. Reply 1–6 (citing Exs. 1001, 1013, 1031, 1032, 1036, 2023, 2024).

We are persuaded that Patent Owner's proposed construction of "traffic data" is unreasonably narrow. Primarily we are unpersuaded because Patent Owner's proposed restrictions in interpreting "traffic data" are not found in the claims nor in the Specification of the '557 patent. The restrictions simply are extraneous. If a feature is not necessary to give meaning to what the inventor means by a claim term, it would be "extraneous" and should not be read into the claim. *Hoganas AB v. Dresser Indus., Inc.*, 9 F.3d 948, 950 (Fed. Cir. 1993); *E.I. du Pont de Nemours & Co. v. Phillips Petroleum Co.*, 849 F.2d 1430, 1433 (Fed. Cir. 1988); *see*

also Renishaw PLC v. Marposs Societa' per Azioni, 158 F.3d 1243, 1249 (Fed. Cir. 1998).

The principal basis Patent Owner provides for such a limited interpretation is its assertion that traffic data can only be understood in the context of traffic engineering. However, we agree with Petitioner that nothing in the claims limits the invention to a particular field of use—even if such a field of use recitation were deserving of patentable weight.

Patent Owner relies heavily on its expert's testimony in support of a narrower interpretation of "traffic data" as relating to all or substantially all vehicles on a particular section of roadway. PO Resp. 6–7 (citing Ex. 2023 ¶¶ 22, 23, 25–32, 36)). However, we agree with Petitioner that the testimony of Patent Owner's expert clarifies that he found no widely accepted industry standard definition of "traffic data" that is limited to all or substantially all of the vehicles on a particular section of roadway:

> Q Is your definition of traffic data the only definition of traffic data there is?
>
> A It is the definition that I developed because I was not able to find another definition, and I think it is appropriate in the context of this application.
>
> Q I'll ask once again, is traffic data that you're providing as a definition the only definition that one of ordinary skill in the art would understand to be?
>
> A One of the challenges that traffic engineers often face is finding multiple definitions for the same term. It is conceivable that someone else could develop a different definition for traffic data.

Ex. 1036, 84:4–16. The definition provided by Patent Owner's expert is not expressed in the Specification of the '557 patent. Patent Owner's expert

does not indicate, when questioned, that any person with ordinary skill in the art would have arrived at essentially that same definition when reading the Specification of the '557 patent. Patent Owner's expert also did not testify that data, in the form of information from one vehicle from some location on a roadway, would not be of any value to a traffic engineer and, thus, would not relate to traffic engineering. To the contrary, Mr. Hawkins testified that speed of a single vehicle as "traffic data" could be useful to the traffic engineer. Ex. 1036, 62:2–6.

Regarding Patent Owner's assertion that "traffic data" *must* refer to "all or substantially all vehicles," Petitioner counters by identifying references in the field of traffic engineering that include data regarding a single vehicle within the scope of "traffic data." Pet. Reply 2–4 (citing Exs. 1013, 2024). Petitioner further identifies portions of the Specification of the '557 patent suggesting "traffic data" may include data regarding a single vehicle. *Id.* (citing Ex. 1001, 9:39–48, 9:61–65 (referring to data regarding a single "target" from a sensor)). At Oral Hearing, Patent Owner admits that data regarding a single vehicle (i.e., speed of a single vehicle) could be "traffic data":

> JUDGE LEE: I would like to say that if you have information about a single vehicle, I understand how it's not very useful, but nonetheless, why isn't it still traffic data? It tells you there's one vehicle on the road.
>
> MR. LORIMER: Well, I suppose if there were only one vehicle on the road, that might be traffic data. But if there are multiple vehicles on the road, which there usually are with these sensors, almost always, that's not traffic data because that's data about one vehicle. Not about traffic.
>
> JUDGE LEE: But we don't know whether there are multiple vehicles on the road. Let's say you get something that's

> sensing I found a car, in a broad sense that's traffic data. If you are . . . a stay-at-home mom or dad, there's a car on the road, I don't want my child on the street. So in a limited sense, it's traffic data.
>
> MR. LORIMER: Well, Your Honor, if in fact there was one car on the road and you had one of these sensors on a bridge or on a pole and you got data about that car from one of these sensors, then I suppose you could say that is traffic data because that is all or substantially all of the vehicles. But if you've got 50 cars on the road and you are only picking out one, that's not traffic data because it doesn't give you any useful information.

Tr. 44:19–45:15. Patent Owner further acknowledged during Oral Hearing that data regarding a single vehicle could be within the scope of "traffic data":

> JUDGE KIM: Let's say it got just one [(one vehicle)].
>
> MR. LORIMER: If it only got one and there was only one car on the road, yeah, it could be traffic data.
>
> JUDGE KIM: It could be. That's why I'm having these problems.
>
> MR. LORIMER: Well, if there's only one car on the road and you measured that car, then that is -- and you have some period of time, that would be volume, for example. That would be the number of cars passing that point for that particular period of time. So, yeah, it would be.
>
> JUDGE LEE: When you say it could be, that confuses us. The answer, well, it is traffic data, then it kind of follows your logic.
>
> MR. LORIMER: I think if I didn't state that clearly, Judge Kim, if there's only that one car and you get it, yeah, you have got traffic data. Okay.
>
> JUDGE KIM: I understand your point. Thank you.

Id. at 49:19–50:10. Given, at best, significant ambiguity as to whether the Specification and other evidence *requires* that "traffic data" *must* refer to "all or substantially all vehicles," we are persuaded that such a requirement would not be proper under a broadest reasonable construction.

Regarding Patent Owner's assertion that "traffic data" is limited to data about multiple vehicles on a particular section of roadway (PO Resp. 7–8), Petitioner counters by identifying references in the field of traffic engineering that use mobile sensors (i.e., not at a fixed location) for acquiring "traffic data." Pet. Reply 2 (citing Ex. 1031 ¶¶ 6, 22, 181–183). Referring to pages 7–13 of Exhibit 1031 (*Texas Highway Operations Manual* discussing "Vehicle-based Equipment"), Patent Owner's expert testified, on cross-examination, as follows:

> Q In view of the paragraph, would it be accurate to note that one of ordinary skill in the art would understand that the equipment located in a vehicle can be used to measure the speed of the traffic stream?
>
> A It says that a vehicle-mounted radar unit can be used to measure the timing speed of other vehicles in the traffic stream. It does not say it is used to measure the traffic stream.
>
> Q I said measure the speed of the traffic.
>
> A Yes. This says it is measuring the speed of vehicles in the traffic stream.
>
> Q So one of ordinary skill in the art would understand that the equipment located in a vehicle can be used to measure the speed of vehicles in a traffic stream?
>
> A That is how it's worded, the speed of other vehicles in the traffic stream.

Ex. 1036, 98:21–99:13. In light of that testimony, we determine that Patent Owner's expert testimony in support of their assertion is not credible.

We discern no reason to limit the interpretation of "traffic data" to the field of traffic engineering. Even if we were to grant such a limitation, however, we are not persuaded the proper interpretation is as limited as Patent Owner proposes. Instead, our interpretation of *traffic data* more broadly encompasses data generated from the reflected signal from even a single vehicle, regardless of whether the sensor is at a fixed location or is mobile, and that such an interpretation is correct for the reasons set forth above.

After considering all evidence and assertions anew, we discern no persuasive reason to alter our preliminary interpretation, and conclude that the broadest reasonable interpretation of "traffic data" in light of the Specification of the '557 patent is "any data generated or produced from a signal reflected off vehicles on a roadway."

2. "Digitally Generated Modulated Signal Generator"

Claim 9 recites, in pertinent part, a "digitally generated modulated signal generator." Claim 22 similarly recites, in pertinent part, a "digital signal generator that digitally generates a modulated signal." We did not expressly construe these terms in our Decision on Institution. Patent Owner argues, based on Mr. Wilson's testimony, this term, in both claims, means a device (i.e., a circuit) "that digitally generates the entire modulated signal, *i.e.*, the digitally generated modulated signal must be generated and modulated in a single modulation process." PO Resp. 9–10 (citing Ex. 2022 ¶ 23). In particular, Patent Owner contends, "[d]igitally generating a signal and then separately modulating that signal does not fall within the scope of this limitation." *Id.* at 10. At Oral Hearing, Patent Owner presented a

grammatical argument for interpreting the digital generation and modulation recitations of the claims asserting:

> If we look at claim 9 and claim 22, claim 9 says a digitally-generated modulated signal generator that digitally generates a signal that is transmitted by a transmitter towards vehicles traveling on a roadway. And in claim 22 it says a digital signal generator that digitally generates a modulated signal.
>
> Now, if you were to take that language and read it in its plain meaning, *digitally modifies both generation and modulation, meaning that both the generation and the modulation have to be digital*.

Tr. 71:20–72:4 (emphasis added).

As an initial matter, we are unaware of, and Patent Owner has not identified, any definitive grammatical rule that requires "digitally," as used in claims 9 and 22, to be read as unequivocally modifying both generation and modulation, i.e., it is equally plausible, strictly as a grammatical matter, that "digitally" only modifies the former. Accordingly, in view of such ambiguity, we analyze the claim language and Specification to inform the context that the above claim language should be construed.

To that end, Petitioner observes that, although Mr. Wilson's Declaration refers to generating the signal using a "single process" (Ex. 2022 ¶ 23), the term "single process" does not appear in the '557 patent. Pet. Reply 7. Specifically, while Mr. Wilson points to Figures 8 and 10–12 of the '557 patent, as well as descriptive text at column 7, in support of this interpretation, none of those portions refers to a "single process." Ex. 2022 ¶ 24. Petitioner further observes that, in his deposition, Mr. Wilson was unclear as to what constitutes a "single process," and could not define what the bounds are for the scope of such a "single process." Pet. Reply 7 (citing

Ex. 1035, 33:15–22). Petitioner acknowledges, and we agree, that generating a signal by purely analog modulation techniques would not fall within the scope of a proper interpretation of the digitally generating recitations of the claims. *Id.* at 7–8.

Both parties refer to exemplary embodiments of Figures 8 and 10–12 of the '557 patent to clarify the meaning of digitally generating. Relevant portions of Figures 8 and 10–12 of the '557 patent are reproduced below:

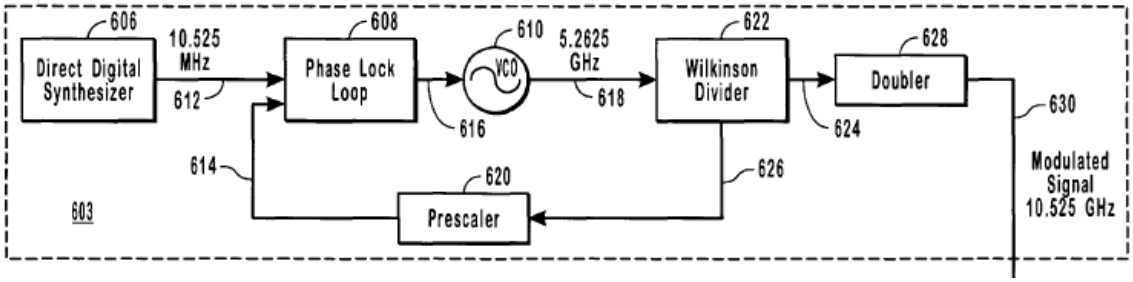


Figure 8 above depicts "digitally generated modulated signal generator **603**" including direct digital synthesizer ("DDS") 606. Ex. 1001, 7:11–15. Components 608, 610, 622, 620, and 628 provide further processing of the digitally generated signal to provide the ultimate "Modulated Signal 10.525 GHz" output signal 630. *Id.* at 8:3–55.

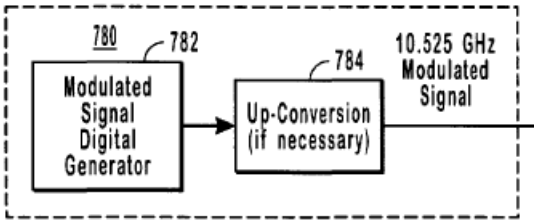


Figure 10 above depicts "digitally generated modulated signal generator **780**" including modulated signal digital generator 782. Ex. 1001, 7:27–30. "Up-Conversion" component 784 further modifies the generated signal to provide the ultimate "10.525 GHz Modulated Signal" output signal. *Id.*

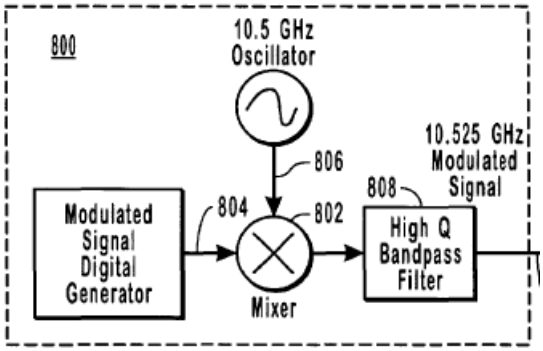


Figure 11 above depicts "digitally generated modulated signal generator **800**" including a modulated signal digital generator (no reference number). Ex. 1001, 7:36–37. Components 802, 808, and "10.5 GHz Oscillator" provide further processing of the digitally generated signal to provide the ultimate "10.525 GHz Modulated Signal" output signal. *Id.* at 8:36–53.

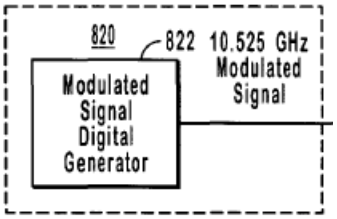


Figure 12 above depicts "digitally generated modulated signal generator **820**" including modulated signal digital generator 822 for directly generating the ultimate "10.525 GHz Modulated Signal." Ex. 1001, 7:54–62.

In each of the above Figures 8 and 10–12, the outer dashed line box is specifically disclosed in the '557 patent as the recited "digitally generated modulated signal generator." Ex. 1001, 7:6–8:55. Referring to Figure 8 of the '557 patent as an example, Patent Owner contends DDS 606 *alone* performs *all* the recited digital generation and modulation as a single process and, thus, DDS 606 *per se* is the recited "digitally generated modulated

signal generator" and "digital signal generator that digitally generates a modulated signal" of the claims:

> [MR. LORIMER:] And that's what the figures show. They show that the modulation occurs in the left-hand side of that box 602 that Judge Lee referred to. And everything to the right of that is analog. It is further conditioning, dividing and doubling, scaling of the signal. That's all analog. It's not digital.
>
> JUDGE FISHMAN: Counsel, this is Judge Fishman. Again, the same question I had for Mr. Calderon, first of all, box 603 is identified in your spec as the -- pardon me for not quoting it correctly, the digital generation and modulation generation circuit or whatever the long phrase is in claim 9. Are not the rest of those elements still doing further modulation, quote/unquote, where modulation means some alteration of a signal? You are changing a parameter of the signal? For example, phase lock loop is changing phase. A doubler is changing frequency.
>
> MR. LORIMER: The short answer to your question, Your Honor, is that we do not believe that those things to the right of 606 are further digitally modulating the signal. That's what the claim requires. Those are analog components.
>
> JUDGE FISHMAN: But your spec refers to an entire dashed line box, as Judge Lee was pointing out. The entire dash lined box 603 and the similar dashed lines in Figures 10, 11 and 12, those dashed line boxes are identified as the element that's specifically recited in claim 9.
>
> MR. LORIMER: Column 7, I believe, is what Your Honor is referring to. And it does say that the box 603 is a digitally-generated modulated signal generator. And it talks about the DDS 606 creating a signal that sweeps in frequency. And my understanding of that, Your Honor, is that the modulation occurs in the extreme left-hand side of that box. And what happens after that is an analog variation of the signal. Not digital.

Tr., 72:4–73:15.

Patent Owner's assertion that only DDS 606 of Figure 8 of the '557 patent depicts the recited digital generation element is inconsistent with the explicit disclosure of the Specification of the '557 patent. To the contrary, we find that the Specification of the '557 patent clearly discloses the dashed line box, and all of the components contained therein, including, but not limited to, DDS 606, in each of Figures 8 and 10–12 is the recited digital generation element. *See* Ex. 1001, 7:6–8:55. Furthermore, a widely accepted technical dictionary defines the verb "modulate" as "[t]o change some aspect of a signal intentionally, usually for the purpose of transmitting information." *Microsoft Computer Dictionary Fifth Edition*, p. 345 (2002). Thus, we find that the further elements to the right of DDS 606 within dashed line box 603 of Figure 8 of the'557 patent, that Patent Owner identifies as "analog variation of the signal," are still performing operations within the scope of the verb "modulate," especially under a broadest reasonable construction. Therefore, the dashed line boxes (603, 780, 800, and 820) of Figures 8 and 10–12, which are described as exemplary embodiments of the recited digital generation element, include digital components, and may also include analog components, to modulate the ultimate output signal.

Thus, we determine the "digitally generated modulated signal generator" of claim 9 and the "digital signal generator that digitally generates a modulated signal" of claim 22 must include at least some digital component, but may also include analog components, in generating the ultimate modulated signal.

3. "Radio Frequency Circuit Board"

Claim 9 recites a "radio frequency circuit board" that includes the transmit and receive portions of the sensor. Petitioner argues "radio frequency circuit board" should be construed as "any board having at least one radio frequency circuit component thereon." Pet. 6. Patent Owner contends a "circuit board" is not any board but, rather, must be construed more narrowly to be synonymous with "printed circuit board" having interconnecting foil patterned on a surface of the board. PO Resp. 10–11 (citing Mr. Wilson's Declaration (Ex. 2022), as well as an IEEE technical dictionary (Ex. 2005) in support of this interpretation). Patent Owner contends the Specification of the '557 patent uses a variety of terms interchangeably ("radio frequency circuit board," "RF circuit board," "multi-layer radio frequency circuit board," "circuit board," and "printed circuit board")—all referring to the same exemplary embodiment consisting of a printed circuit board. *Id*. at 11.

In our Decision on Institution, under the lower reasonable likelihood standard of review, we preliminarily determined that "circuit board" need not "be construed so narrowly as to be synonymous with 'printed circuit board,' primarily because the claim limitation does not include the term 'printed.'" Dec. 12. Instead, we essentially agreed with Petitioner and construed the claimed "radio frequency circuit board" to be at least broad enough to encompass "any board having at least one radio frequency circuit component thereon." *Id*.

Petitioner urges we maintain our preliminary construction of "radio frequency circuit board," and cites other references that utilize the term "circuit board" in reference to a variety of types of board—not exclusively

limited to "printed circuit boards." Pet. Reply 8–9. Petitioner also argues Patent Owner's expert Mr. Wilson acknowledges that "circuit board" could refer to other types of boards. *Id*. at 9 (citing Ex. 1035, 24:6–8, 25:2–5, 165:13–20).

Considering the parties' positions and the evidence of record, we now agree with Patent Owner that, consistent with the '557 patent Specification, the claimed "circuit board" is used in the claims and the Specification as a synonym for "printed circuit board." As noted by Patent Owner, all references in the Specification are to the exemplary printed circuit board, regardless of the variety of labels used to refer to that printed circuit board. PO Resp. 11. Importantly, alleged key aspects of the invention include the "planar design resulting in a reduced profile sensor" (Ex. 1001, 2:53–54) and the multi-layer board having a first side with the radio frequency components and a ground plane on the second side (*id*. at 2:58–62), which we find are aspects of a "printed circuit board," and not just any "circuit board." Ex. 2022 ¶ 28. Thus, we now narrowly construe "circuit board," as claimed, to be synonymous with "printed circuit board."

However, our revised interpretation of "radio frequency circuit board" does not impact this Decision. The only asserted ground of unpatentability in which interpretation of "circuit board" was an issue (anticipation by Madjar) has been rejected herein for other reasons unrelated to the interpretation of "circuit board," as discussed below.

4. "Above-Ground" Sensor

In our Decision on Institution, we further construed the term "above-ground" as it relates to a sensor. Dec. 10–11. We interpreted "above-ground" in the '557 patent as "not embedded into the roadway but rather

may be mounted above or about the roadway at various acceptable angles." *Id*. at 11. The parties do not dispute our interpretation in the Patent Owner's Response or Petitioner's Reply and, thus, we discern no reasons to modify our interpretation of "above-ground." *See SAS Institute, Inc. v. ComplementSoft, LLC.*, 825 F.3d 1341, 1351 (Fed. Cir. 2016) (The Board may not change a claim interpretation from the institution decision where neither party anticipated that "already-interpreted terms were actually moving targets.").

B. Printed Publications

The scope of an *inter partes* review is limited. In particular, 35 U.S.C. § 311(b) provides:

> SCOPE.—A petitioner in an inter partes review may request to cancel as unpatentable 1 or more claims of a patent only on a ground that could be raised under section 102 or 103 and only on the basis of prior art consisting of patents or printed publications.

The determination of whether a given reference qualifies as a prior art "printed publication" involves a case-by-case inquiry into the facts and circumstances surrounding the reference's disclosure to members of the public. *In re Klopfenstein*, 380 F.3d 1345, 1350 (Fed. Cir. 2004). The key inquiry is whether the reference was "sufficiently accessible to the public interested in the art" before the critical date. *In re Cronyn*, 890 F.2d 1158, 1160 (Fed. Cir. 1989); *In re Wyer*, 655 F.2d 221, 226 (CCPA 1981). "A given reference is 'publicly accessible' upon a satisfactory showing that such document has been disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence, can locate it." *Suffolk Techs., LLC v. AOL Inc.*, 752 F.3d 1358, 1364 (Fed. Cir. 2014) (quoting *SRI Int'l, Inc. v.*

Internet Sec. Sys., Inc., 511 F.3d 1186, 1194 (Fed. Cir. 2008)). The status of a reference as a printed publication is a legal question "based on underlying factual determinations." *Id.*

> [W]hether information is printed, handwritten, or on microfilm or a magnetic disc or tape, etc., the one who wishes to characterize the information, in whatever form it may be, as a "printed publication" . . . should produce sufficient proof of its dissemination or that it has otherwise been available and accessible to persons concerned with the art to which the document relates and thus most likely to avail themselves of its contents.

Wyer, 655 F.2d at 227 (citing *Philips Elec. & Pharm. Indus. Corp. v. Thermal & Elecs. Indus., Inc.*, 450 F.2d 1164, 1171 (3d Cir. 1971)).

In some asserted grounds, Petitioner relies on one or more of four non-patent literature references as printed publication prior art—Madjar (Ex. 1002), Chang (Ex. 1008), Analog Devices (Ex. 1009), and Galani (Ex. 1012). For each of these references, Petitioner relies, in part, on a date printed on each document as evidence of the public accessibility of the document. Pet. 2–4. In Chang, Analog Devices, and Galani, a copyright notice date appears on the document, and on Madjar, the date of a conference at which the document may have been presented is printed on the document. Patent Owner's Motion to Exclude requests that we exclude the dates on these exhibits as inadmissible hearsay. Paper 45, 2–3. We address the substance of each party's Motion to Exclude below. However, as such dates relate to determining printed publication status, we acknowledge that some panels of the Board have determined that the date on a copyright notice is inadmissible hearsay while other panels have relied on such a notice as probative evidence of publication. *See, e.g.*, *Int'l Bus. Machs. Corp. v. Intellectual Ventures II LLC*, Case IPR2014-00681, slip op. at 13–

14 (PTAB Oct. 30, 2014) (Paper 11) (copyright date sufficient for threshold showing that document is a printed publication); *FLIR Sys., Inc. v. Leak Surveys, Inc.*, Case IPR2014-00411, slip op. at 18–19 (PTAB Sept. 5, 2014) (Paper 9) (copyright notice establishes prima facie prior art date); *but see ServiceNow, Inc. v. Hewlett-Packard Co.*, Case IPR2015-00707, slip op. at 9–10 (PTAB Nov. 2, 2015) (Paper 14) (copyright notice entitled to no greater weight than hearsay in determining public accessibility); *Standard Innovation Corporation v. Lelo, Inc.*, Case IPR2014-00148, slip op. at 15–16 (PTAB Apr. 23, 2015) (Paper 41) (dates printed on documents are inadmissible hearsay to the extent relied on to prove publication). Regardless of whether the dates printed on Exhibits 1002, 1008, 1009 and 1012 are hearsay, even if admissible, such dates alone are accorded little weight to prove public accessibility (i.e., no greater weight than hearsay). Here, we determine *infra*, that a copyright notice date or other alleged publication data on the document is hearsay, to which no exception applies. *See* Section II.J.1. Thus, Petitioner can only show that Exhibits 1002, 1008, 1009, and 1012 are printed publications, predating the '557 patent, based on other evidence of record that establishes, by a preponderance of the evidence, the date at which the reference was publicly accessible.

Petitioner bears the burden of showing, by a preponderance of the evidence, the printed publication status of each of the non-patent references relied upon in the asserted grounds. In addition to the dates on the exhibits (e.g., copyright dates), Petitioner filed, with its Petition, Exhibit 1018 to support the printed publication status of Madjar, and Exhibit 1019 to support the printed publication status of Chang. In Petitioner's Opposition to Patent Owner's Motion to Exclude, Petitioner responds that Patent Owner's

arguments regarding printed publication status of Madjar are waived, because the argument was not presented in Patent Owner's Response. Paper 48, 1. We disagree with Petitioner. Even if Patent Owner does not raise the issue of the printed publication status of some references, Petitioner always bears the burden of demonstrating unpatentability of the originally challenged, unamended claims—including demonstrating the printed publication status of non-patent literature documents relied upon in the asserted grounds as printed publication prior art. We address the substance of Patent Owner's Motion to Exclude below. However, we observe here that Patent Owner preserved its right to move for exclusion of Madjar by timely opposing Petitioner's submission of Madjar as evidence. *See* Paper 18.[12]

Based on the reasonable likelihood standard for purposes of our Decision on Institution, and in the absence of a Motion to Exclude in the preliminary proceeding, we accepted at institution of trial all four non-patent literature references as printed publication prior art. We now review the status of each non-patent literature reference, based on the additional evidence developed through trial, and in view of the preponderance of the evidence standard.

[12] Petitioner argues that Patent Owner waived the hearsay argument with respect to Galani and Analog Devices in addition to Madjar. Paper 48, 1. For the same reasons, we determine that Patent Owner preserved its right to file its Motion to Exclude. We discuss the substance of the Motion to Exclude below, but we do not further address Petitioner's waiver argument regarding Galani or Analog Devices.

1. Madjar

Madjar is a copy of an article allegedly presented in 1996 at the 26th EuMC (European Microwave Conference). Ex 1002, 1. Exhibit 1018, filed with the Petition, is a printout of an Internet IEEE Xplore web page referring to the Madjar paper as published in 1996 at the EuMC. Following institution of this review, Petitioner filed Exhibits 1020 and 1021—other publications that reference Madjar. As discussed *infra*, we agree with Patent Owner that Exhibits 1018, 1020, and 1021 are inadmissible hearsay. *See* Section II.J.2.

Furthermore, following institution of this review, Petitioner filed Exhibit 1023—the Declaration of Mr. Grenier, the Senior Director of Publishing Technologies for IEEE. As discussed *infra*, we disagree with Patent Owner that Mr. Grenier's Declaration is inadmissible hearsay. Instead, Patent Owner's objections are more properly directed to the weight to be accorded Mr. Grenier's testimony. *See* Section II.J.4.

Mr. Grenier testifies that the Madjar paper "is currently available for public download from the IEEE digital library, IEEE Xplore." Ex. 1023 ¶ 11. Mr. Grenier further testifies that attendees at the conference "were provided copies of the publication no later than the last day of the conference [(EuMC)]." *Id.*

We accord little weight to Mr. Grenier's testimony regarding public accessibility of Madjar. Mr. Grenier does not testify that he personally attended the 1996 EuMC conference, or that he has personal knowledge of distribution of the paper on the last day of the conference. In that regard, we do not accord significant weight to his testimony that copies of the Madjar paper were distributed no later than the last day of the conference. Ex. 1023

¶ 11. Additionally, although Mr. Grenier is the Senior Director of Publishing Technologies for IEEE (*id*. ¶ 1), the record does not show that IEEE was either an organizer or sponsor of the 1996 EuMC. On this record, IEEE has no meaningful connection to the 1996 EuMC. In addition, the record does not indicate when the Madjar article was first made available for download on IEEE's digital library, IEEE Xplore. Mr. Grenier testifies that it is regular practice by IEEE to publish articles and make them available on the IEEE Xplore web site but does not indicate when such actions take place. *Id*. ¶ 7. Is it minutes after they receive the article or years afterward? Mr. Grenier further testifies that Madjar "is *currently available* for public download from the IEEE digital library, IEEE Xplore." *Id*. ¶ 11 (emphasis added). However, the date of Mr. Grenier's Declaration, when he testifies that Madjar is "presently available," is August 4, 2016—long after the critical date of the '557 patent.

For the foregoing reasons, Petitioner has failed to establish, by a preponderance of the evidence, that Madjar is a printed publication prior art.

2. Galani

Galani is a copy of a paper allegedly published in the May 1991 *IEEE Transactions on Microwave Theory and Techniques* and bears a copyright notice date of 1991 by IEEE. Ex. 1012, 1. Petitioner filed Exhibit 1022 with the Petition and, following institution of this review, Petitioner filed Exhibits 1025, 1026, and the aforementioned Exhibit 1023 (Grenier Declaration). Exhibit 1022 is a printout of an Internet web page allegedly showing the Galani paper, or at least the Abstract thereof, was published on the IEEE Xplore web site on some undisclosed date. As discussed *infra*, we determine Exhibit 1022 is inadmissible hearsay. *See* Section II.J.2. Exhibits

1025 and 1026 are printed copies of Copyright Office Catalog information allegedly evidencing a first publication date of the IEEE Transactions publication, including the Galani paper, in 1991. As discussed *infra*, we determine Exhibits 1025 and 1026 are public records and, therefore, not hearsay. *See* Section II.J.3. Mr. Grenier testifies that the Galani paper was published on the date indicated on the paper, and became publicly available for download on the IEEE Xplore web site at some unidentified date. Ex. 1023 ¶ 12.

Regarding Mr. Grenier's Declaration concerning Galani, for the same reasons discussed *supra*, we accord Mr. Grenier's testimony little weight. Mr. Grenier does not testify when Galani was made available in the normal course of business (*see* Ex. 1023 ¶ 7) and testifies, on August 4, 2014, only that Galani is "currently available" on the IEEE Xplore web site (*id*. ¶ 12). Thus, we accord little probative weight to Mr. Grenier's testimony.

Petitioner also provides printed copies of Copyright Catalog Entries in support of the alleged publication date of Galani. *See* Exs. 1025, 1026. These public records provide some support for the alleged date of publication of the Galani reference. However, we acknowledge that such a copyright entry, alone, is not sufficient to establish public accessibility. *See In re Lister*, 583 F.3d 1307, 1311–17 (Fed. Cir. 2009).

For the foregoing reasons, Petitioner has failed to establish, by a preponderance of the evidence, that Galani is a printed publication prior art.

3. Analog Devices

Analog Devices is a tutorial paper describing Digital Signal Synthesis devices and techniques published by Analog Devices, Inc., and bearing a copyright notice date of 1999. Ex. 1009, 1. Exhibits 1020 and 1021, filed

with the Petition, both allegedly published before September 27, 2001, "provide evidence of publication of the Analog Devices document prior to Sep. 27, 2001." Pet. 3. As discussed *infra*, we determine Exhibits 1020 and 1021 are inadmissible hearsay. *See* Section II.J.2. Following institution of this review, Petitioner filed Exhibit 1024—a Declaration by Mr. Gentile, an employee of Analog Devices, Inc. and co-author of the tutorial (Ex. 1009). As discussed *infra*, we disagree with Patent Owner that Mr. Gentile's Declaration is inadmissible hearsay. *See* Section II.J.4. Instead, Patent Owner's objections are more properly directed to the weight to be accorded Mr. Gentile's testimony.

Mr. Gentile testified that he co-authored Analog Devices in 1999. Ex. 1024 ¶ 7. Mr. Gentile further testified that he specifically recalls that the tutorial was published in 1999, and was available through many means, including, for example, on the Analog Devices, Inc. website. Ex. 1024 ¶ 8. Mr. Gentile's Declaration supports the copyright notice date as a date of publication and public accessibility, and, thus, is sufficient to establish public accessibility of Analog Devices in 1999.

For the foregoing reasons, Petitioner has established, by a preponderance of the evidence, that Analog Devices is a prior art printed publication.

4. Chang

Chang is a textbook entitled *RF and Microwave Wireless Systems*, authored by Mr. Chang, published by John Wiley & Sons, Inc. ("Wiley"), and bearing a copyright notice date of 2000. Ex. 1008, 3. Exhibit 1019, filed with the Petition, is a printout of a web page showing the Chang textbook available for sale on Amazon.com. As discussed *infra*, we

determine Exhibit 1019 is inadmissible hearsay. *See* Section II.J.2. Following institution of this review, Petitioner filed Exhibits 1027 and 1028—printed copies of Copyright Office Catalog entries evidencing a first publication date of Chang in 2000. As discussed *infra*, we determine Exhibits 1027 and 1028 are public records and, therefore, not hearsay. *See* Section II.J.3. However, Exhibits 1027 and 1028 (records of the Copyright Office), without more, provide insufficient probative evidence of public accessibility. *See Lister*, 583 F.3d at 1311–17.

For the foregoing reasons, Petitioner has failed to establish, by a preponderance of the evidence, that Chang is a printed publication prior art.

C. Claims 9, 12, 22, 23, and 25 Anticipated by Madjar

In view of our determination *supra* that Petitioner failed to establish that Madjar is a printed publication, Petitioner has not established, by a preponderance of the evidence, the unpatentability of each of claims 9, 12, 22, 23, and 25 as anticipated by Madjar.

D. Claims 9, 10, 12, 22, and 25 Unpatentable Based In Part On Boles

We have reviewed the parties' briefs and supporting evidence, and determine that Petitioner has shown by a preponderance of the evidence that each of claims 9, 10, 12, 22, and 25 is unpatentable over Boles either alone or in various combinations with other prior art as alleged by Petitioner.

1. Boles (Ex. 1003)

Boles discloses "a radar sensor/processor for intelligent vehicle highway systems." Ex. 1003, 1:8–9. Figure 1 of Boles, reproduced below, depicts an exemplary embodiment of a radar sensor.

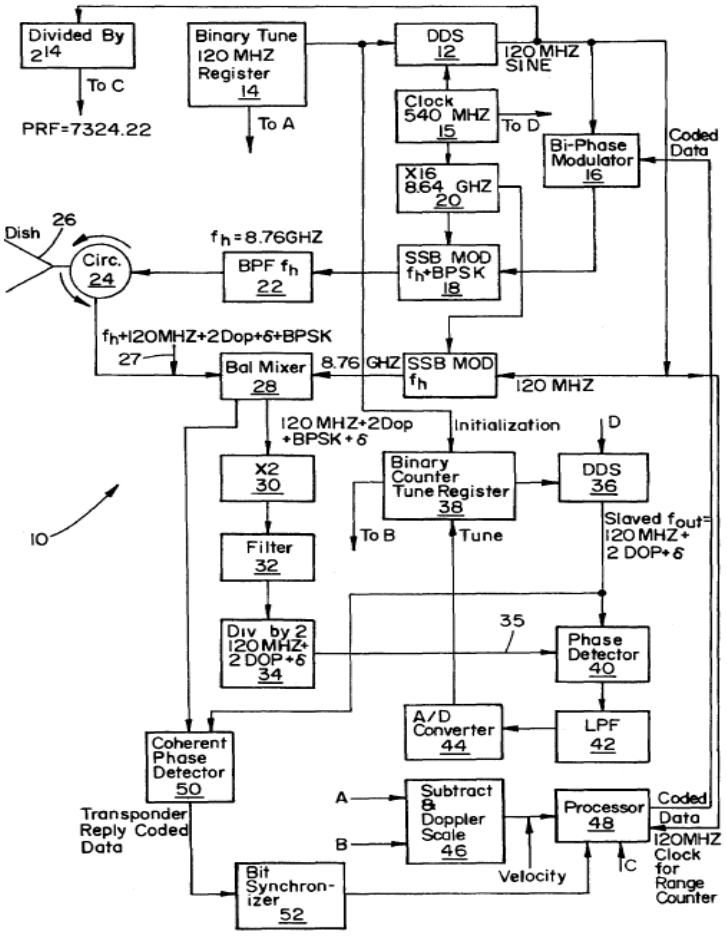


FIG. 1

Figure 1 of Boles (reproduced above) discloses an exemplary embodiment of a radar sensor in which a transmitted signal is generated by, *inter alia*, DDS 12 and processor 48 and is transmitted via dish (antenna) 26. Ex. 1003, 4:66–5:26. Reflected signals from vehicles on the road are received through dish 26 and processed by processor 48 to determine speed and range of the vehicles from which the signals are reflected. *Id.* at 5:26–6:18.

2. Claim 22 Anticipated by Boles

Petitioner argues independent claim 22 is anticipated by Boles, and provides a detailed claim chart mapping recitations of claim 22 to disclosures of Boles. Pet. 16–19.

a. Digital Generation and Modulation

Patent Owner argues Boles fails to disclose a digital signal generator that digitally generates a modulated signal as recited in claim 22. PO Resp. 15–17. Specifically, Patent Owner contends,

> Boles does not satisfy this limitation because Boles' modulated signal is not generated digitally in a single modulation process. (Ex. 2022, ¶¶23, 46.) Instead, the Boles DDS generates an unmodulated sine wave, and the bi-phase modulator then combines the signal from the processor 48 with the unmodulated sine wave to create a modulated signal. (*Id.*) This is contrary to the '557 requirement that the entire modulated signal be generated digitally. (*Id.*)

Id. at 16 (citing Ex. 2022 ¶¶ 23, 46). Patent Owner further contends Boles' bi-phase modulator 16, an analog circuit, performs the modulation function to combine data with a carrier waveform and, thus, does not generate and modulate the output signal in a single, digital process. *Id.* Instead, Patent Owner asserts the '557 patent requires the "entire modulated signal be generated digitally." *Id.*

Petitioner replies that Patent Owner is improperly attempting to import the word "entire" into the claims. Pet. Reply 12. Instead, Petitioner contends, "Boles reads on claim 22 because Boles discloses digitally generating a signal at DDS 12 and then modulating that signal using bi-phase modulator 16 that is controlled by processor 48." *Id.* (citing Ex. 1003, 5:1–26, Fig. 1).

We are persuaded by Petitioner's arguments. Patent Owner's argument is premised on its narrow interpretation of the digital generation element of claim 22. As discussed *supra*, we are not persuaded by Patent Owner's arguments that claim 22 requires that both generation and modulation of the desired signal in a single, digital process. As discussed above, even Patent Owner's expert could not define what it means to be a "single process" in the context of the '557 patent. Ex. 1035, 33:15–22. Exemplary embodiments in Figures 8, 10, and 11 clearly define each of dashed line boxes 603, 800, and 820, respectively, as a "digitally generated modulated signal generator," i.e., examples of the "digital signal generator that digitally generates a modulated signal" of claim 22. Each of these exemplary signal generators of the '557 patent includes both digital and analog components that combine to produce the ultimate modulated output signal—some processing being digital and other processing being analog.

Furthermore, the "modulated signal digital generator" in each of Figures 10, 11, and 12 is merely a box representing any of a variety of embodiments for generation of a modulated signal. Patent Owner's expert, Mr. Wilson, testified that the "modulated signal digital generator" in each of Figures 10–12 (i.e., 782 and 822 in Figs. 10 and 12, respectively) could represent a variety of structures. Ex. 1035, 30:6–38:13. Further, as noted above, even though Mr. Wilson is unclear what it means to require that the generation and modulation be performed as a "single process," he testifies that whatever is inside the boxes labeled "modulated signal digital generator" must perform the generation and modulation digitally in a single process. *Id.* at 33:4–22.

We ascribe little weight to Mr. Wilson's opinion in this regard, because his opinion is contrary to the clear disclosure of the Specification. Exemplary embodiments in Figures 8, 10, and 11, in which dashed line boxes 603, 800, and 820, respectively, are clearly designated as a "digitally generated modulated signal generator," and, in Figures 8, 10, and 11, there are clearly additional components, including analog components, involved in generation of the ultimate modulated signal to be transmitted. Thus, exemplary embodiments of the recited element disclose both digital and analog components involved in the generation of the ultimate modulated signal.

Boles specifically discloses that the 120 MHz carrier waveform is digitally generated by DDS 12, and the data to be added to the carrier is digitally generated by processor 48, a digital processor digitally generating the data to be added to the carrier. Ex. 1003, 3:47–53 ("The interrogator also includes a processor for producing coded data to be transmitted, which is directed to the modulator. The modulator comprises a bi-phase modulator wherein the coded data is bi-phase shift key modulated onto the sine wave output, and a single sideband modulator which combines the output."), 5:13–15 ("Coded data (from the interrogator processor **48**) to be transmitted is bi-phased modulated onto the 120 MHz output frequency of the DDS **12**."). An additional step in Boles' generation of the ultimate modulated signal is the operation of bi-phase modulator 16, an analog component, to further modulate the ultimate signal by combining the two digitally generated signals. This is similar to the additional analog elements, in the digitally generated modulated signal generators 603, 800, and 820 of Figures 8, 10,

and 11 of the ’557 patent, that also perform further modulation of the generated signal to generate the ultimate modulated signal for transmission.

Thus, Boles discloses the recited “digital signal generator that digitally generates a modulated signal” of claim 22 under our broader, but reasonable, construction of the recitation.

b. Traffic Data

Patent Owner argues Boles does not disclose producing “traffic data” from the signals reflected off vehicles on the roadway, as required by claim 22, because it does not generate data about “all or substantially all of the vehicles traveling on a particular portion of the roadway.” PO Resp. 17. Patent Owner argues Boles discloses detecting excessive speed of a single vehicle, rather than all vehicles on the portion of the roadway (*id.* at 17–18), and cannot detect multiple vehicles spaced apart in multiple lanes because of its coarse range resolution of 65 feet (*id.* at 18–19).

We are not persuaded by Patent Owner’s arguments that are based on its unduly narrow interpretation of “traffic data.” Instead, consistent with our interpretation of “traffic data” in accordance with broadest reasonable interpretation, and consistent with the Specification of the ’557 patent, sensing the excessive speed of a single vehicle is sufficient to represent “traffic data.” A signal is generated, transmitted toward a single vehicle and reflected back from the single vehicle to determine the speed of a single vehicle—i.e., to generate a signal representing traffic data relating to a single vehicle. As discussed *supra*, Patent Owner, at Oral Hearing, acknowledged that determining the speed of a single vehicle on the roadway is an example of “traffic data,” as the term is properly construed. Tr. 44:19–45:15, 49:19–50:10.

Our interpretation of "traffic data," under the broadest reasonable interpretation, is "any data generated or produced from a signal reflected off vehicles on a roadway." Therefore, Boles meets the limitation of generating a signal representing *traffic data*.

We are persuaded, by a preponderance of the evidence, that Boles generates a modulated signal that is transmitted at vehicles on the roadway and produces the speed of a single vehicle (i.e., "traffic data") based on the reflected signal off that vehicle. Pet. 17–19.

c. Boles Anticipates Claim 22

We have reviewed Petitioner's mappings of claim 22 limitations to the teachings of Boles, appearing on pages 16–19 of the Petition. We agree with, and are persuaded by, Petitioner's stated positions with regard thereto, and specifically adopt those positions and mappings of Petitioner as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claim 22 is unpatentable as anticipated by Boles.

3. Claim 25 Obvious over Boles and (Analog Devices or Chang)

Claim 25 depends from claim 22, and narrows the claimed digital signal generator to at least one of three possible structures — one recited structure being a direct digital synthesizer (DDS) that is coupled with a phase locked loop (PLL).

Regarding claim 22, from which claim 25 depends, Petitioner contends Boles discloses use of a DDS for frequency synthesis. Pet. 16–17. Petitioner proposes combining either Analog Devices (Ex. 1009) or Chang (Ex. 1008) with Boles to disclose a DDS coupled with a PLL as one of the three recited structures of claim 25. Pet. 58–60. In view of our

determination *supra* that Petitioner has failed to establish that Chang is a printed publication prior art, we focus this analysis only on the combination of Boles and Analog Devices.

Petitioner contends Analog Devices discloses use of a DDS coupled with a PLL. Pet. 58 (citing Ex. 1009, Figs. 8–3 through 8–5, pp. 55–57). Petitioner argues a person of ordinary skill in the art ("POSITA") would have been motivated to combine Boles and Analog Devices "to increase frequency resolution while retaining high signal quality traits." Pet. 59.

Patent Owner argues Boles is not concerned with improved radar resolution but, instead, its 65-foot resolution is adequate for its intended purpose. PO Resp. 43. Thus, Patent Owner asserts there is no motivation to combine Boles with the improved range resolution of Analog Devices by the addition of a DDS coupled with a PLL. *Id.* Patent Owner further asserts the proposed combination would render Boles inoperable, because the frequency modulation of Analog Devices would not function properly with Boles' bi-phase modulation. *Id.* (citing Ex. 2022 ¶¶ 125, 126).

In an obviousness analysis, it is not necessary to find precise teachings in the prior art directed to the specific subject matter claimed, because inferences and creative steps that a person of ordinary skill in the art would employ can be taken into account. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007). A basis to combine teachings need not be stated expressly in any prior art reference. *In re Kahn*, 441 F.3d 977, 989 (Fed. Cir. 2006). However, there must be articulated reasoning with rational underpinning to support a conclusion of obviousness. *KSR*, 550 U.S. at 418 (quoting *In re Kahn*, 441 F.3d at 988).

Petitioner's arguments indicate that adding a PLL to the DDS frequency synthesizer of Boles, as suggested by Analog Devices, provides increased frequency resolution, which, in turn, results in improved range resolution of the sensor. *See* Pet. 58–60 (citing Ex. 1015 ¶ 192). The general need for improved range resolution is, therefore, the underlying reason for Petitioner's proposal to combine Boles (or other references as discussed *infra*) with Analog Devices. Petitioner also observes that Patent Owner's expert, Mr. Wilson, acknowledged that improved resolution is "advisable" depending on the goals to be met. Pet. Reply 20; *see also* Ex. 1035, 46:16–47:4. Thus, while Boles itself may disclose that its 65 foot resolution is adequate for its intended purpose, that does not negate the above finding that there exists a general need for improved range resolution, for example, were the intended purpose of Boles to change. On this record, we are persuaded, by a preponderance of the evidence, that improved range resolution would have provided clear benefits in vehicular radar applications to improve detection of objects on the roadway proximate the vehicle hosting the sensor.

Furthermore, Patent Owner's argument that the proposed combination would render Boles inoperable improperly assumes that bodily incorporation of the combined structures is required to show obviousness. The test for obviousness does not require bodily incorporation of the references but, instead, looks to what would have been suggested to the ordinarily skilled artisan by the combined references. *See In re Merck & Co.*, 800 F.2d 1091, 1097 (Fed. Cir. 1986).

Notwithstanding Patent Owner's contrary arguments, Petitioner has articulated sufficient reasoning with rational underpinning for combining the teachings of Boles with Analog Devices.

We have reviewed the parties' briefs and supporting evidence including Petitioner's mappings of claim 25 limitations to teachings of Boles and Analog Devices, and the proposed reasons for the combinations. Pet. 58–60. We agree with these mappings and reasons for the combinations, and, thus, adopt them as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claim 25 is unpatentable as obvious over Boles and Analog Devices.

4. Claim 9 Obvious over Boles and (Perret or Herman)

Petitioner provides analysis and a detailed claim chart mapping recitations of independent claim 9 to disclosures of Boles in combination with either Perret or Herman. Pet. 30–35. As discussed *supra* (*see* section II.C.1), Boles discloses a radar sensor applied to sensing range and speed of vehicles on a roadway. Petitioner argues Boles does not disclose details of the structure of the transmit and receive portions of a circuit board (Pet. 30), but contends either Perret (Ex. 1006) or Herman (Ex. 1005), in combination with Boles, discloses manufacturing such portions in a single circuit board (Pet. 31–32). Petitioner argues the ordinarily skilled artisan would have been motivated to combine either Perret or Herman with Boles, to fill a gap in Boles by applying known manufacturing techniques to produce a single circuit board, disclosed in either Perret or Herman, to yield a predictable result. *Id.*

Patent Owner argues, for the same reasons as discussed *supra*, that the proposed combination fails to disclose signals representing "traffic data"

based on its narrower interpretation of the term. PO Resp. 31. For the same reasons discussed above, we are not persuaded by Patent Owner's arguments in view of our broader, but reasonable, interpretation of "traffic data."

Patent Owner argues the Petition fails to identify a motivation to combine Boles with Perret, because Petitioner offers no evidence that Perret solves Boles' problems of leakage between transmitted and received signals, and argues further that Perret would add components, cost, and complexity to the structure of Boles, rather than simplify the structure. PO Resp. 32–33. In like manner, Patent Owner argues Petitioner provides no evidence that Herman improves on the design of Boles. *Id.* at 33–35.

We are not persuaded by Patent Owner's argument. The Petition relies on Perret or Herman in the proposed combinations only for disclosing the benefits of integrating components on a single "radio frequency circuit board," as recited in claim 9 (e.g., on a printed circuit board). Pet. 33. Perret specifically discloses the drawbacks of arranging multiple components on different circuit boards, and notes the benefit of a single circuit board design. Ex. 1006, 1:24–60; *see also* Pet. 31. In like manner, Herman discloses the benefits of a single circuit board design. *See* Pet. 32 (citing Ex. 1005, 2:6–11, 4:21–28, 4:20–28, 4:52–55). Thus, both references expressly teach the benefits of a simplified single circuit board. The proposed combination need not resolve every particular problem of Boles, as every modification has advantages and disadvantages. Instead, we are persuaded that the express benefits of a single circuit board, taught by both Perret and Herman, would have suggested to the ordinarily skilled artisan that such a benefit would have been achieved in combination with Boles.

We have reviewed the parties' briefs and supporting evidence, including Petitioner's mappings of claim 9 limitations to teachings of Boles and either Perret or Herman, and the proposed reasons for the combinations. Pet. 30–35. We agree with these mappings and reasons for the combinations and adopt them as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claim 9 is unpatentable as obvious over Boles and either Perret or Herman.

5. Claim 10 Obvious over Boles, (Perret or Herman), and Hohne; Claims 10 and 12 Obvious over Boles, (Perret or Herman), and Analog Devices.

Claims 10 and 12 both depend from claim 9, and recite specific structures for the digital signal generation. Claim 10 further recites the digitally modulated signal generator comprises the combination of a DDS, a PLL, and a Voltage Controlled Oscillator ("VCO"). Claim 12 further recites the signal generator comprises a direct digital to analog converter ("DAC").

Petitioner provides analysis and detailed claim charts for both proposed combinations. Pet. 35–39. Petitioner contends either Hohne (Ex. 1007) or Analog Devices (Ex. 1009), in combination with Boles and Perret or with Boles and Herman, discloses the DDS-PLL-VCO structure of the "digitally generated modulated signal generator," as recited in claim 10. Pet. 35–38. Petitioner further argues Analog Devices, in combination with Boles and Perret or with Boles and Herman, discloses the "direct digital to analog converter" structure of the "digitally generated modulated signal generator" as recited in claim 12. Pet. 38–39.

Petitioner argues POSITA would have been motivated to add Hohne to the proposed combinations "to achieve high range resolution when the

frequency swing of the frequency modulation of the transmit signal is limited, without any need to perform a large number of measuring cycles." Pet. 35–36 (quoting Ex. 1007, 1:36–42; citing Ex. 1015 ¶ 112). Petitioner further argues POSITA would have been motivated to add Analog Devices to the combinations "to combine the extreme frequency resolution trait of a DDS with the high frequency attribute of a PLL, which gives the PLL increased frequency resolution at the VCO output frequency while retaining the high signal quality traits of the fixed PLL reference oscillator, as taught by Analog Devices." Pet. 37 (citing Ex. 1015 ¶ 115–118; *see also* Ex. 1009, 54).

In addition to the above-discussed arguments regarding the combinations applied to claim 9, Patent Owner argues there is no motivation to add Hohne to the combination, because Boles uses a "continuous wave, bi-phase modulated signal, not a frequency modulated signal." Thus, according to Patent Owner, a combination of Boles with Hohne's frequency modulated continuous wave implementation would render Boles inoperative for its cooperative mode of operation. PO Resp. 36–37. We disagree. In his deposition, Mr. Wilson (Patent Owner's expert on radar systems) testified that technologically the two systems could probably be combined. Pet. Reply 19 (citing Ex. 1035, 162:24–163:7. Furthermore, as discussed *supra*, bodily incorporation is not the test of obviousness. *See In re Merck*, 800 F.2d at 1097. Additionally, and most importantly, Hohne expressly discloses the benefit of improved resolution by combining a DDS, a PLL, and a VCO, as recited in claim 10. Pet. 35.

Patent Owner further argues that the improved resolution of Hohne's approach is not needed in Boles. PO Resp. 36–37. In like manner, Patent

Owner argues Analog Devices' teaching of improved resolution is of no benefit to Boles. *Id.* at 42–44.

As discussed *supra*, the express teachings of Hohne or Analog Devices, describing the benefits of improved resolution, provide a suggestion to improve any radar system, including that of Boles. Thus, we are persuaded that the ordinarily skilled artisan would have recognized the benefit of improving the range resolution of a radar sensor, in the vehicular application of Boles, resulting from improved frequency resolution of the sensor derived from the structures of Hohne or Analog Devices.

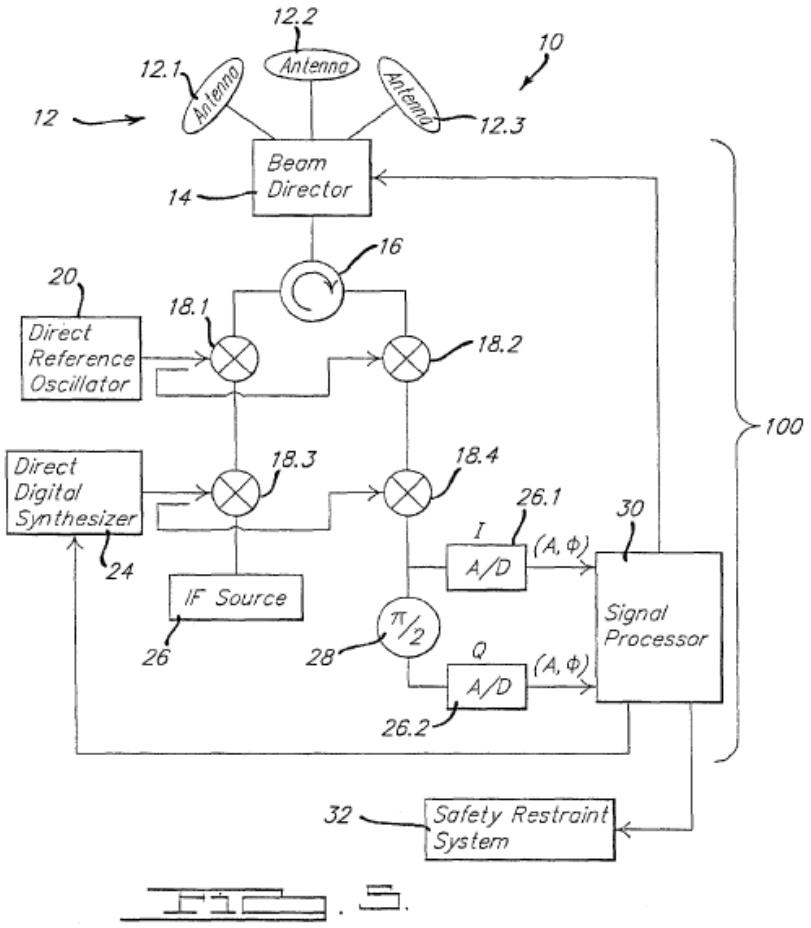
We have reviewed the parties' briefs and supporting evidence, including Petitioner's mapping of limitations of claim 10 to teachings of Boles, combined with either Perret or Herman, and Hohne, and the mapping of limitations of claims 10 and 12 to Boles, combined with either Perret or Herman, and Analog Devices, and the proposed reasons for the combinations. Pet. 35–39. We agree with these mappings and reasons for the combinations and adopt them as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claims 10 and 12 are unpatentable as obvious over Boles, either Perret or Herman, and either Hohne or Analog Devices.

E. Claims 9, 12, 13, 22, 23, and 25 (Unpatentable Based In Part On Farmer)

We have reviewed the parties' briefs and supporting evidence, and determine that Petitioner has shown, by a preponderance of the evidence, that each of claims 9, 12, 13, 22, 23, and 25 is unpatentable over Farmer, either alone or in various combinations with other prior art as alleged by Petitioner.

1. Farmer (Ex. 1004)

Farmer (Ex. 1004) is directed to a radar sensor used in vehicle collision avoidance. Ex. 1004, 1:38–41. Farmer's Figure 5 depicts a sensor used in a vehicle for sensing surrounding objects (including other vehicles on the roadway).



Farmer's Figure 5 above depicts radar system 10 comprising DDS 24, under control of processor 30, generating a signal modulated by rapidly varying the frequency generated and transmitting the signal via antenna 12 toward objects (including vehicles) on the roadway proximate the vehicle with the system. Ex. 1004, 8:13–38. The transmitted signal is reflected off objects, received by antenna 12, and provided to signal processor 30 to

detect range and velocity of sensed objects based on the reflected signals. *Id.* at 8:39–9:10.

2. Claims 22, 23, and 25 Anticipated by Farmer

Petitioner provides analysis and a detailed claim chart mapping claims 22, 23, and 25 to Farmer. Pet. 19–23.

Patent Owner presents essentially the same arguments regarding Farmer as were presented regarding Boles as discussed *supra*—arguments regarding the alleged failure to teach producing "traffic data" in accord with Patent Owner's narrow interpretation thereof. PO Resp. 19–21. For the same reasons discussed *supra*, we are not persuaded by Patent Owner's arguments.

We have reviewed Petitioner's mappings of limitations of claims 22, 23, and 25 to the teachings of Farmer appearing on pages 19–23 of the Petition. We agree with and are persuaded by Petitioner's stated positions with regard thereto, and specifically adopt those positions and mappings as our own. Thus, in view of the above discussion, we are persuaded by a preponderance of the evidence that claims 22, 23, and 25 are unpatentable as anticipated by Farmer.

3. Claims 9 and 22 Obvious over Herman and Farmer

Herman discloses "a sensor for sensing objects in proximity to a vehicle, and, more particularly, to an electronically scanning radar sensor which is especially advantageous for scanning around a corner of a vehicle." Ex. 1005, 1:7–11. Herman's sensor generates and transmits a frequency modulated continuous wave ("FMCW") radar signal (*id.* at 3:34–35), and receives reflected signals back for processing to sense the presence of an

object in the radar pattern (*id.* at 4:7–20). Herman's transmitter and receiver may be implemented as a single integrated circuit. *Id.* at 4:53–55.

Petitioner provides analysis and a detailed claim chart mapping the recitations of independent claims 9 and 22 to features of Herman. Pet. 23–30. Petitioner argues Herman discloses a radar transmitter, but fails to disclose any design details of a digitally generated modulated signal generator, as claimed. *Id.* Petitioner then asserts Farmer discloses the details of an exemplary transmitter as DDS 24. *Id.* at 24 (citing Ex. 1004, 7:32–52). Petitioner contends the ordinarily skilled artisan would have been motivated to combine Farmer with Herman, because Herman suggests any type of transmitter may be used, including an FMCW signal generator. *Id.* at 23 (citing Ex. 1005, 3:33–36). Furthermore, Petitioner contends the ordinarily skilled artisan would have turned to Farmer for details of such an FMCW transmitter. *Id.* at 25; *see also Id.* at 24 (citing Ex. 1004, 7:32–54).

Patent Owner argues Herman, like Farmer and Boles, fails to disclose generating signals representing "traffic data" in accord with its narrower interpretation of the term. Petitioner maps the recited generation of signals representing traffic data to features of Herman sensing proximity (presence or occupancy of a vehicle in the radar's view) in accord with our broader interpretation of the term. *Id.* at 27–28 (citing Ex. 1005, 5:43–54). Thus, for the same reasons discussed *supra* regarding Farmer and Boles, we are persuaded that Herman discloses producing traffic data from transmitted signals reflected off vehicles.

Patent Owner further contends there is no motivation to combine Farmer's DDS-based design with the sensor of Herman, because Farmer's solution adds cost relative to other less costly solutions that provide the

resolution and reliability sufficient for Herman's application. PO Resp. 29–31. Specifically, Patent Owner contends Mr. Alland, Petitioner's expert, testified that purely analog solutions were likely less expensive at the time of the '557 patent and, thus, there would have been no reason for the ordinarily skilled artisan to consider Farmer's DDS design to implement Herman's radar sensor for detecting vehicle proximity. *Id.* at 30.

As noted earlier, a proposed combination need not be assured of producing a less costly or simpler device. Petitioner has asserted Herman teaches any of various types of radar transmitters may be employed (including FMCW), without disclosing details of any particular design, and Petitioner relies on Farmer for disclosing one such FMCW transmitter design. Pet. 23–25; Pet. Reply 16–17. In particular, Farmer specifically discloses the cost benefits of its DDS design that would have suggested the benefits of its use in Herman to the ordinarily skilled artisan. Pet. Reply 17. Thus, we are persuaded that the ordinarily skilled artisan would have been motivated to seek Farmer as disclosing details of an exemplary FMCW transmitter — i.e., DDS 24.

We have reviewed the Petitioner's mappings of the limitations of claims 9 and 22 to the combined teachings of Herman and Farmer, and the proposed reasons for the combinations appearing on pages 23–30 of the Petition. We agree with and are persuaded by Petitioner's stated positions with regard thereto, and specifically adopt those positions and mappings as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claims 9 and 22 are unpatentable as obvious over Herman and Farmer.

4. Claims 9 and 12 Obvious over Farmer and Herman

Petitioner also contends independent claim 9 and claim 12, dependent from claim 9, are obvious over Farmer and Herman (reversing the order of the combined references set forth above). Pet. 39–44. Regarding claim 9, Petitioner maps the recitations to the disclosures of Farmer, but notes that, to the extent that Farmer does not expressly disclose a single circuit board, the ordinarily skilled artisan would have been motivated to combine the single board design of Herman with Farmer to achieve the well-known benefits of integrated manufacturing and associated lower costs. *Id.* at 40–41.

Claim 12, dependent from claim 9, recites additional details of the structure of the "digitally generated modulated signal generator" as comprising "a direct digital to analog converter." Petitioner relies on Farmer, in the proposed combination, for disclosing the structure of DDS 24 as including a digital to analog converter (DAC). *Id.* at 43–44 (citing Ex. 1004, Fig. 5 (DDS 24); Ex. 1015 ¶¶ 133, 134). Mr. Alland's testimony indicates it was well known that a DDS component includes a DAC, because a DDS component generates an analog waveform output from a digital input. Ex. 1015 ¶ 133. Petitioner further argues the ordinarily skilled artisan would have been motivated to combine Herman with Farmer for the manufacturing benefit of reduced manufacturing costs realized by employing the known technique of a single circuit board. Pet. 41.

Patent Owner presents the same arguments regarding the proposed combination failing to disclose generating "traffic data" as discussed earlier. PO Resp. 44–45. These arguments are unpersuasive for the reasons set forth *supra*.

Patent Owner further contends there is no motivation for the proposed combination, because "Petitioner does not identify anything in Herman or elsewhere that discloses a preference for one option over the other, nor does it identify any teaching that choosing one alternative over the other results in cost savings or performance enhancements." PO Resp. 46 (citing Ex. 2022 ¶ 133). We disagree. Herman clearly discloses the advantage of a design using a single circuit board. Ex. 1005, 2:6–12 ("The present sensor can be made affordable using microstrip and monolithic microwave integrated circuit (MMIC) technology to fabricate the antenna and array elements on a single printed circuit board to provide an electronic scanning radar sensor which has heretofore been prohibitively expensive for automotive use."). Thus, we find that the express teachings of Herman would have suggested to the ordinarily skilled artisan the cost benefit of a design using a single circuit board.

Patent Owner further argues Herman operates at a variety of frequencies, and "[b]ecause Petitioner does not identify exactly which combination of Herman it seeks to combine with Boles [sic], the result of the many potential combinations of the frequencies, waveforms, and components, the combination of Herman and Boles [sic] is unpredictable." PO Resp. 47 (citing Ex. 2022 ¶ 135). As discussed earlier, Patent Owner's argument incorrectly presumes a need for bodily incorporation of the references to show obviousness, rather than addressing what would have been suggested to the ordinarily skilled artisan. *See In re Merck*, 800 F.2d at 1097.

We have reviewed Petitioner's mappings of limitations of claims 9 and 12 to the combined teachings of Farmer and Herman, and the proposed

reasons for the combinations appearing on pages 39–44 of the Petition. We agree with and are persuaded by Petitioner's stated positions with regard thereto, and specifically adopt those positions and mappings as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claims 9 and 12 are unpatentable as obvious over Farmer and Herman.

5. Claim 13 Obvious over Herman, Farmer, and Kinasewitz

Claim 13 depends from claim 9, and further recites that the circuit board comprises a "planar antenna." Petitioner asserts claim 13 is obvious over Herman and Farmer, as discussed above with respect to claim 9, and further adding Kinasewitz to the combination for disclosing such an antenna arrangement, and provides a detailed claim chart for all recitations. Pet. 44–46 (citing *inter alia* Ex. 1010, 1:61–65, 2:66–3:5, 3:25–31). Petitioner contends the ordinarily skilled artisan would have been motivated to add Kinasewitz to the Herman-Farmer combination, because Farmer discloses that its antenna may be a phased-array antenna, and Kinasewitz discloses a phased-array antenna that is a planar board and, thus, the combination obtains the benefits of Kinasewitz for reduced size and cost. *Id.* at 44–45 (citing Ex. 1010, 2:4–10; Ex. 1015 ¶¶ 137, 138).

Patent Owner presents the same arguments regarding the proposed combination failing to disclose generating "traffic data" (PO Resp. 47–48) and, for the same reasons as above, we are not persuaded because the arguments are based on Patent Owner's erroneously narrow interpretation of "traffic data."

Patent Owner further argues there is no motivation to add Kinasewitz to the combination of Herman and Farmer, because the FMCW modulation

of Herman-Farmer is not compatible with the "frequency-scanned end-fire phased-array" antenna design of Kinasewitz. PO Resp. 48–49. Again, Patent Owner's argument is not persuasive because it presumes the need for bodily incorporation of Kinasewitz's antenna to operate with the single circuit board design suggested by the combined teachings of Herman and Farmer. As noted above, bodily incorporation is not the test of obviousness but instead the test is what would have been suggested to the ordinarily skilled artisan. *See In re Merck*, 800 F.2d at 1097. Instead, here, we find that the planar physical structure of Kinasewitz's antenna would have suggested use of a similar physical design for a suitable antenna for the FMCW modulation techniques of the combined Herman-Farmer disclosures.

We have reviewed Petitioner's mappings of limitations of claim 13 to the combined teachings of Farmer, Herman, and Kinasewitz, and the proposed reasons for the combinations appearing on pages 44–46 of the Petition. We agree with and are persuaded by Petitioner's stated positions with regard thereto, and specifically adopt those positions and mappings as our own. Thus, in view of the above discussion, we are persuaded, by a preponderance of the evidence, that claim 13 is unpatentable as obvious over Farmer, Herman, and Kinasewitz.

F. Claims 9, 10, and 22 (Unpatentable Based In Part On Russell)

All grounds based on Russell include Galani in the proposed combination. Pet. 46–54. In view of our determination *supra* that Petitioner failed to establish that Galani is a printed publication, Petitioner has not established, by a preponderance of the evidence, the unpatentability of each of claims 9, 10, and 22 as obvious over Russell in combination with Galani and other references.

G. Claims 9, 13, 22, and 23 Obvious over Chang and Herman

In view of our determination *supra* that Petitioner failed to establish that Chang is a printed publication, Petitioner has not established, by a preponderance of the evidence, the unpatentability of each of claims 9, 13, 22, and 23 as obvious over Chang and Herman.

H. Conclusion Regarding Unpatentability

For the above reasons, we are persuaded by a preponderance of the evidence that claims 9, 10, 12, 13, 22, 23, and 25 of the ’557 patent are unpatentable.

I. Petitioner’s Motion to Exclude

Petitioner filed a Motion to Exclude, as irrelevant under FRE 401 and 402, Exhibits 2017, 2025, and 2026 and paragraphs 26, 30, 38, and 118 of Exhibit 2022 that make reference to the above-identified Exhibits. Paper 44. Exhibit 2017 is an excerpt from title 47 of the Code of Federal Regulations pertaining to telecommunications. Exhibit 2025 is an excerpt from an IEEE publication relating to safety of radio frequency transmissions. Exhibit 2026 is an excerpt from an IEEE publication setting standards for boundary scan testing of electronic circuits. According to Petitioner, each of these Exhibits appears to have a date that post-dates the critical date of the ’557 patent. *Id*. at 2–3. Furthermore, according to Petitioner, Mr. Wilson, Patent Owner’s expert, refers to these exhibits in his Declaration (Ex. 2022) at paragraphs 26, 30, 38, and 118. *Id*. at 1.

In this Decision, we do not rely on Exhibits 2017, 2025, and 2026 or Mr. Wilson’s arguments in the identified paragraphs relating to these Exhibits. Accordingly, Petitioner’s Motion to Exclude is *dismissed* as moot.

J. Patent Owner's Motion to Exclude

Patent Owner filed a Motion to Exclude requesting that we exclude the entirety of various exhibits and identified portions of Petitioner's expert Mr. Alland's Declaration (Ex. 1015). Paper 45. Petitioner filed an Opposition to Patent Owner's Motion to Exclude (Paper 48) and Patent Owner replies to that Opposition (Paper 50).

Patent Owner's Motion asserts, *inter alia*, that the identified exhibits are inadmissible as not authenticated in accordance with FRE 901 and 902. Paper 45, 1–4, 8–11, 15. At Oral Hearing, Patent Owner agreed to withdraw the arguments regarding authentication in its Motion and, thus, we need not address Patent Owner's assertion that these Exhibits are not authenticated. Tr., 63:13–65:1.

1. Exhibits 1002, 1008, 1009, and 1012

Patent Owner argues the date printed on each of Exhibits 1002, 1008, 1009, and 1012, is inadmissible hearsay under FRE 801 and 802 as out of court statement offered to prove that truth of the matter asserted—that each document was a printed publication as of the date printed on that document (i.e., that it was sufficiently publicly accessible). Paper 45, 2–3 (citing *Standard Innovation Corp. v. Lelo, Inc.*, Case IPR2014-00148, Paper 41 (PTAB April 23, 2015)). As discussed *supra*, we agree with Patent Owner that the dates printed on these Exhibits are hearsay with no applicable exception. Thus, we *grant* Patent Owner's motion requesting that we exclude the copyright notice date from each of Exhibits 1008, 1009, and 1012, and exclude the date of the EuMC conference on Exhibit 1002.

However, we note that the documents *per se* are not excluded from the record as hearsay—only the date imprinted on each as proof of the

printed publication status of each document. The underlying documents of these Exhibits are offered not to prove the publication dates thereof but, instead, are statements offered to demonstrate the knowledge of persons of ordinary skill in the art. Petitioner may rely on other evidence to establish the date of public accessibility of each of these documents, the analysis of which we have set forth *supra*. *See* Section II.B.1–4.

2. Exhibits 1018–1022

Regarding Exhibit 1018, we agree with Patent Owner that the statement in Exhibit 1018 that Madjar was published in 1996 is hearsay—an out of court statement offered to prove the truth of what it asserts, namely that Madjar was sufficiently publicly accessible in 1996. Paper 45, 4–5. Exhibit 1018 is a printout of an IEEE Xplore web page, and merely restates the date of the EuMC conference printed on the face of Madjar. Petitioner argues this date establishes the date of publication by IEEE. Paper 48, 2. However, we find no indication in the record that the document was published *by IEEE*. The IEEE Xplore web site catalogs numerous documents that are published by persons or organizations other than IEEE. We are persuaded that Petitioner has shown insufficiently that the purported publication dates for non-IEEE documents listed in the IEEE Xplore web site catalogs are accurate, and are also persuaded that no exception to the hearsay rules would apply. For the above reasons, we determine Exhibit 1018 is hearsay and no exception applies. Accordingly, Patent Owner's Motion to Exclude Exhibit 1018 is *granted*.

Regarding Exhibit 1019, we agree with Patent Owner that the statement in Exhibit 1019 that Chang was published in 2000 is hearsay—an out of court statement offered to prove the truth of what it asserts, namely

that Chang was sufficiently publicly accessible in 2000. Paper 45, 5–6. Exhibit 1019 is a printout of an amazon.com web page offering the Chang textbook for sale. Initially, we note Exhibit 1019 does not indicate a date of *publication* but, instead, merely recites "Hardcover – June 16, 2000." Furthermore, amazon.com is not the publisher of Chang, and the record is devoid of any evidence that amazon.com would know the date of publication other than by repeating the copyright notice date imprinted in the book. For the above reasons, we determine Exhibit 1019 is hearsay and no exception applies. Accordingly, Patent Owner's Motion to Exclude Exhibit 1019 is *granted*.

Exhibits 1020 and 1021 are publications that refer to Analog Devices and, by virtue of their respective, alleged, dates of publication, Petitioner relies on these Exhibits to support its alleged date of public accessibility of Analog Devices prior to the '557 patent critical date. We agree with Patent Owner's assertion that both of these Exhibits are hearsay—out of court statements offered to prove the truth of what they each assert, namely that Analog Devices was published in 1999. Paper 45, 6–7. For the above reasons, we determine Exhibits 1020 and 1021 are hearsay and no exception applies. Accordingly, Patent Owner's Motion to Exclude Exhibits 1020 and 1021 is *granted*.

Regarding Exhibit 1022, we agree with Patent Owner that the statement in Exhibit 1022 that Galani was published in 1991 is hearsay—an out of court statement offered to prove the truth of what it asserts, namely that Galani was sufficiently publicly accessible in 1991. Paper 45, 7–8. Exhibit 1022 is a printout of an IEEE Xplore web page but merely restates the alleged publication date printed on the face of Galani. Although Galani

appears to be an IEEE publication that was apparently, at some date, catalogued on the IEEE Xplore web site, we find no exception to the hearsay rule applicable to this web page printout. For the above reasons, on this record, we determine Exhibit 1022 is hearsay and no exception applies. Accordingly, Patent Owner's Motion to Exclude Exhibit 1022 is *granted*.

3. Exhibits 1025–1028

Exhibits 1025 and 1026 are printouts of records from the Copyright Office allegedly establishing the date of publication of Galani. Exhibits 1027 and 1028 are printouts of records from the Copyright Office allegedly establishing the date of publication of Chang. We agree with Petitioner that these Exhibits fall within the "public records" exception to the hearsay rules under FRE 803(8) "because they are public records that set out the office's activities under FRE 803(8)(A)(i) and because PO has not shown that the source of information or other circumstances indicate a lack of trustworthiness under FRE 803(8)(B)." Paper 48, 15. For the above reasons, on this record, we determine Exhibits 1025–1028 fall within the public records exception to the hearsay rules. Accordingly, Patent Owner's Motion to Exclude Exhibits 1025–1028 is *denied*.

4. Exhibits 1015, 1023, and 1024

We disagree with Patent Owner's assertion that the Declarations of Mr. Alland (Ex. 1015), Mr. Grenier (Ex. 1023) and Mr. Gentile (Ex. 1024) are inadmissible hearsay. Paper 45, 9–14. Instead, the Declarations by each of Mr. Alland, Mr. Grenier, and Mr. Gentile was made for this proceeding under penalty of perjury, and there is no evidence that any of these declarants was unavailable for cross-examination. To the extent Patent Owner argues these Declarations should be excluded for other reasons (FRE

401, 402, 602, 702, and 703), we determine such arguments are properly directed to the weight to be accorded the Declarations, rather than their admissibility. Thus, Patent Owner's request to exclude Exhibits 1023, 1024, and portions of Exhibit 1015 is *denied*.

III. ORDERS

After due consideration of the record before us, and for the foregoing reasons, it is:

ORDERED that claims 9, 10, 12, 13, 22, 23, and 25 of the '557 patent are held *unpatentable*;

FURTHER ORDERED that Petitioner's Motion to Exclude is *dismissed* as moot;

FURTHER ORDERED that Patent Owner's Motion to Exclude is *granted* with respect to the date imprinted on Exhibits 1002, 1008, 1009, and 1012;

FURTHER ORDERED that Patent Owner's Motion to Exclude is *granted* with respect to Exhibit 1018–1022;

FURTHER ORDERED that Patent Owner's Motion to Exclude is *denied* with respect Exhibits 1023–1028 and portions of Exhibit 1015; 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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