

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DIGITAL GLOBAL SYSTEMS, INC.,
Petitioner,

v.

DEEPSIG, INC.,
Patent Owner.

IPR2024-01358
Patent 11,018,704 B1

Before WILLIAM V. SAINDON, DANIEL J. GALLIGAN, and
ANDREW L. NALVEN, *Administrative Patent Judges*.

Opinion for the Board filed by *Administrative Patent Judge*
WILLIAM V. SAINDON.

Opinion Concurring in Part and Dissenting in Part filed by
Administrative Patent Judge DANIEL J. GALLIGAN.

SAINDON, *Administrative Patent Judge*.

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

I. INTRODUCTION

A. Background and Summary

Digital Global Systems, Inc. (“Petitioner”) filed a Petition (Paper 1, “Pet.”) requesting an *inter partes* review of claims 1–24 (“the challenged claims”) of U.S. Patent No. 11,018,704 B1 (Ex. 1001, “the ’704 patent”). Inter partes review was instituted under 35 U.S.C. § 314(a). DeepSig, Inc. (“Patent Owner”) filed a Response (Paper 12, “PO Resp.”), Petitioner filed a Reply (Paper 17, “Pet. Reply”), and then Patent Owner filed a Sur-reply (Paper 19, “PO Sur-reply”). An oral hearing was held. Paper 26 (“Tr.”).

We have authority to enter this final written decision (“Decision”) under 35 U.S.C. § 318(a). The standard for review is set forth in 35 U.S.C. § 316(e), which provides that “the petitioner shall have the burden of proving a proposition of unpatentability by a preponderance of the evidence.” For the reasons provided below, we determine that Petitioner has met this burden of establishing unpatentability for claims 1–3, 7–11, 15–19, 23, and 24 but has not met this burden of establishing unpatentability for claims 4–6, 12–14, and 20–22.

B. Real Parties in Interest

The parties both assert that they are the sole real parties in interest. Pet. 88; Paper 4, 1 (Patent Owner’s Mandatory Notice).

C. Related Matters

Neither party identifies any co-pending litigation. *See* Pet. 88; Paper 4, 1.

D. Prior Art and Asserted Grounds

Petitioner's grounds rely on the following prior art references:

Name	Reference	Exhibit No.
Dzierwa	US Pat. 10,122,479 B2, iss. Nov. 6, 2018	1007
Holt	US Pat. 10,552,738 B2, iss. Feb. 4, 2020	1006
Jüschke	EP 2,538,553 A1, pub. Dec. 26, 2012	1005

Petitioner asserts that the challenged claims are unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1–3, 7–11, 15–19, 23, 24	103	Jüschke
1–24	103	Jüschke, Holt
2–6, 10–14, 18–22	103	Jüschke, Holt, Dzierwa

E. Overview of the '704 Patent

The '704 patent is directed to a method for correcting distortion of radio signals. Ex. 1001, code (57). As the '704 patent explains:

A transmit radio signal corresponding to an output of a transmitting radio signal processing system is obtained. A pre-distorted radio signal is then generated by processing the transmit radio signal using a nonlinear pre-distortion machine learning model. The nonlinear pre-distortion machine learning model includes model parameters and at least one nonlinear function to correct radio signal distortion or interference. A transmit output radio signal is obtained by processing the pre-distorted radio signal through the transmitting radio signal processing system. The transmit output radio signal is then transmitted to one or more radio receivers.

Id.

F. Challenged Claims

Claims 1–24 are challenged. Claims 1, 9 and 17 are independent. Claims 1 and 4 are reproduced below.

1. A method for correcting distortion of radio signals in a cellular communications system, the method comprising:

obtaining, at a base station in the cellular communications system, a transmit radio signal that is prepared for transmitting to one or more radio receivers associated with the cellular communications system;

accessing a nonlinear pre-distortion machine learning model associated with the base station, wherein the nonlinear pre-distortion machine learning model includes model parameters associated with values corresponding to one or more deployment scenarios in the cellular communications system, and at least one nonlinear function to correct radio signal distortion;

generating a pre-distorted radio signal by processing the transmit radio signal using the nonlinear pre-distortion machine learning model;

obtaining a transmit output radio signal by processing the pre-distorted radio signal through a transmitting radio signal processing stage of the base station; and

transmitting the transmit output radio signal to the one or more radio receivers.

4. The method of claim 2 [which depends from claim 1], further comprising:

obtaining a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers;

determining a distance metric between the transmit radio signal and the received radio signal; and

updating the values of the model parameters for the particular deployment scenario based at least on the distance metric.

II. ANALYSIS

A. Legal Standards Used in the Merits Analysis

“In an IPR, the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)); *Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (discussing the burden of proof in *inter partes* review).

A claim is unpatentable “if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.” 35 U.S.C. § 103; *see KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) when in evidence, objective indicia of non-obviousness. *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 17–18 (1966). To support this conclusion, however, it is not enough to show merely that the prior art includes separate references covering each separate limitation in a challenged claim. *Unigene Labs., Inc. v. Apotex*,

Inc., 655 F.3d 1352, 1360 (Fed. Cir. 2011). Rather, obviousness additionally requires that a person of ordinary skill at the time of the invention “would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention.” *Id.*

Moreover, in determining the differences between the prior art and the claims, the question under 35 U.S.C. § 103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. *Litton Indus. Prods., Inc. v. Solid State Sys. Corp.*, 755 F.2d 158, 164 (Fed. Cir. 1985) (“It is elementary that the claimed invention must be considered as a whole in deciding the question of obviousness.”); *see also Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1537 (Fed. Cir. 1983) (“[T]he question under 35 U.S.C. § 103 is not whether the differences themselves would have been obvious. Consideration of differences, like each of the findings set forth in *Graham*, is but an aid in reaching the ultimate determination of whether the claimed invention as a whole would have been obvious.”). As a factfinder, we also must be aware “of the distortion caused by hindsight bias and must be cautious of arguments reliant upon ex post reasoning.” *KSR*, 550 U.S. at 421.

B. Level of Ordinary Skill in the Art

The level of skill in the art is “a prism or lens” through which we view the prior art and the claimed invention. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). “This reference point prevents . . . factfinders

from using their own insight or, worse yet, hindsight, to gauge obviousness.”
Id.

“The *Graham* analysis includes a factual determination of the level of ordinary skill in the art. Without that information, a . . . court cannot properly assess obviousness because the critical question is whether a claimed invention would have been obvious at the time it was made to one with ordinary skill in the art.” *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 962 (Fed. Cir. 1986); *see also Ruiz v. A.B. Chance*, 234 F.3d 654, 666 (Fed. Cir. 2000) (“The determination of the level of skill in the art is an integral part of the *Graham* analysis.”).

Factors pertinent to a determination of the level of ordinary skill in the art include: (1) educational level of the inventor; (2) type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology; and (6) educational level of workers active in the field. *Env’t Designs, Ltd. v. Union Oil Co.*, 713 F.2d 693, 696–697 (Fed. Cir. 1983) (citing *Orthopedic Equip. Co. v. All Orthopedic Appliances, Inc.*, 707 F.2d 1376, 1381–82 (Fed. Cir. 1983)). Not all such factors may be present in every case, and one or more of these or other factors may predominate in a particular case. *Id.* Moreover, these factors are not exhaustive but are merely a guide to determining the level of ordinary skill in the art. *Daiichi Sankyo Co. v. Apotex, Inc.*, 501 F.3d 1254, 1256 (Fed. Cir. 2007). In determining a level of ordinary skill, we also may look to the prior art, which may reflect an appropriate skill level. *Okajima*, 261 F.3d at 1355.

Petitioner asserts that:

Persons of ordinary skill in the art (“POSITA”) would have a bachelor’s degree in electrical engineering, computer

engineering, or an equivalent degree and at least two years of experience working with of radio communication systems and machine learning. Additional work or research experience can substitute for less or different education, and vice-versa.

Pet. 3–4 (citing Ex. 1003 ¶¶ 33–34). Patent Owner does not appear to challenge this level of skill. We use Petitioner’s definition for purposes of this Decision because it appears consistent with the level of skill reflected in the prior art and ’704 patent.

C. Claim Construction

As stated in 37 C.F.R. § 42.100(b),

a claim of a patent . . . shall be construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b), including construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. Any prior claim construction determination concerning a term of the claim in a civil action, or a proceeding before the International Trade Commission, that is timely made of record in the *inter partes* review proceeding will be considered.

37 C.F.R. § 42.100(b). Thus, under 37 C.F.R. § 42.100(b), we apply the claim construction standard set forth in *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc). That is, “the words of a claim ‘are generally given their ordinary and customary meaning’ . . . that the term would have to a person of ordinary skill in the art in question at the time of the invention.” *Id.* at 1312–13.

Petitioner and Patent Owner both assert that no terms require express construction. Pet. 15; PO. Resp. 14. However, the issues before us involve several claim construction disputes between the parties.

I. Claim 1

The parties' arguments regarding claim 1 present two claim construction issues. The first is what are "deployment scenarios" in the context of a "nonlinear pre-distortion machine learning model [that] includes model parameters associated with values corresponding to one or more deployment scenarios in the cellular communications system." The second is what it means for a "model parameter" to be "*associated with* values corresponding to one or more deployment scenarios in the cellular communications system" (emphasis added). We address these issues in turn.

a) "deployment scenarios"

Claim 1 recites a machine learning model that "includes model parameters associated with values corresponding to one or more deployment scenarios." Ex. 1001, 14:23–25. Patent Owner asserts that the prior art does not disclose "deployment scenarios," but does not offer a position on claim construction. *See* PO Resp. 16–30. Patent Owner appears to require that a "deployment scenario" involves "use-dedicated parameters or values." *Id.* at 16; *see also, e.g., id.* at 20 (arguing that the prior art "distinguishes its self-learning algorithm from 'use dedicated' algorithms").

Petitioner argues that Patent Owner's position on "deployment scenarios" is wrong for several reasons. Pet. Reply 6–7 (*see also id.* at 7–15). For example, Petitioner asserts that Patent Owner argues that the claims require a selection step, more than one deployment scenario, and also some sort of "use dependent" scenario. *Id.* It is not clear to us that Patent Owner is arguing for a separate selection step or that "one" would not satisfy "one or more." *See* PO Resp. 23–25; *cf.* Dec. on Inst. 13 (addressing arguments like these from the Preliminary Response). However, to the extent Patent

Owner is arguing that there is a selection step or that “one” cannot satisfy “one or more,” we agree with Petitioner that the claims plainly do not require a selecting step or a plurality of models be installed on each base station. As to the dispute over “use dedicated” models, that is less an issue of claim construction than an argument over the relationship (if any) between “deployment scenarios” and “use dedicated” models. We address the “use dedicated” arguments in our analysis of the prior art in a later section. We now turn to a claim construction of “deployment scenarios.”

The '704 patent provides a list of “deployment scenarios” that includes “a cellular base station . . . in an inline mode.” *Id.* at 2:39–41; *see also id.* at 2:38–65 (entire list). The “inline mode” is shown in Figures 6A and 7A, in which machine learning model 103 is placed “between an input 601 and an amplifier 603.” *Id.* at 10:38–42, 10:47–50. Figure 6A depicts the in-line mode and is reproduced below:

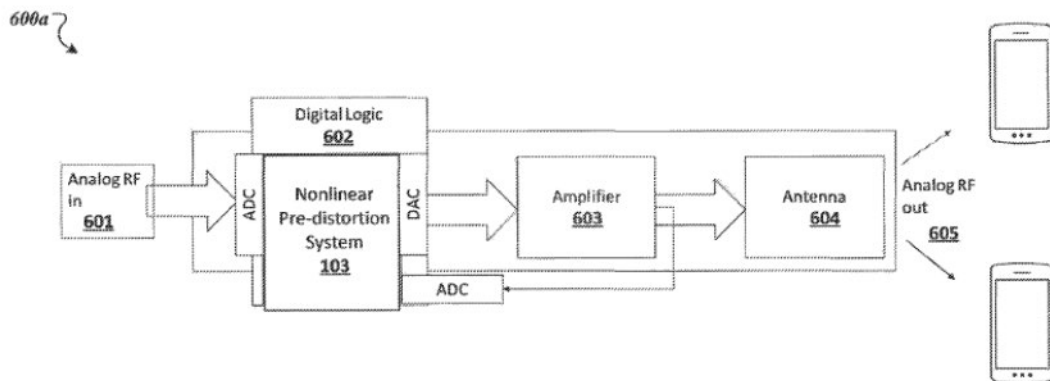
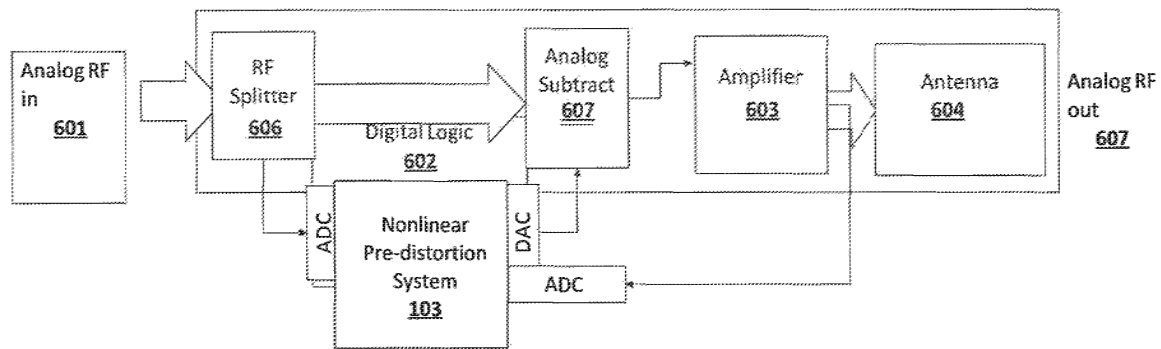


FIG. 6A

Ex. 1001, Fig. 6A. Figure 6A of the '704 patent depicts analog RF in 601 with arrows connecting nonlinear pre-distortion system 103, amplifier 603, and antenna 604. *Id.*

The “inline mode” arrangement of Figures 6A and 7A can be contrasted with Figures 6B and 7B, which depict a “fault-tolerant subtractive mode” and show nonlinear pre-distortion system 103 not in-line with analog RF in 601, amplifier 603, and antenna 604, but rather off to the side. *Id.* at 10:42–45, 10:50–54, Figs. 6B, 7B. Figure 6B of the ’704 patent is reproduced below:



Ex. 1001, Fig. 6B. In contrast to the “in-line” model 103 of Figure 6A, Figure 6B depicts a “fault-tolerant subtractive mode” for the model 103. *Id.* at 4:61–62, 10:42–45. Notably, in Figure 6B, model 103 is not directly in-line with analog RF in 601 and amplifier 603.

Other deployment scenario permutations are based on whether the signal is “inside a tower” or “inside a remote radio unit.” *Id.* at 38–65. Accordingly, we construe a “deployment scenario” according to the list of deployment scenarios provided by the ’704 patent (Ex. 1001, 2:38–65), which includes the model’s physical location (e.g., tower/base station, remote unit/receiver) and the model’s configuration relative to the input and amplifier (e.g., in-line/fault-tolerant).

b) “associated with”

Patent Owner asserts that the prior art does not disclose model parameters “associated with the base station.” PO Resp. 31–32. In particular, Patent Owner argues that a transmitter “implemented in a base station” is not “associated with the base station.” *Id.* at 31. Petitioner argues that Patent Owner offers no reason to believe that a transmitter “implemented in a base station” is not “associated with the base station.” Pet. Reply 4–5; *see also id.* at 3–6 (entire argument).

A plain reading of a “model associated with a base station” would encompass a model that operates in a base station. We do not see anything in the ’704 specification that would indicate “associated with” has any special meaning, or has a meaning contrary to our understanding of the plain meaning. We do not see the word “associated” outside the claims, whereas we see the word “implement” throughout the specification, generally in reference to an actual use of a model (consistent with our plain reading). *See, e.g.,* Ex. 1001, 5:35–39, 6:3–17, 10:55–11:3 (discussing “implementations” where the model or some other feature of the system is used in a particular way). Accordingly, we construe a model “implemented in a base station” to be “associated with the base station.”

2. Claim 4

The parties’ arguments regarding claim 4 present two claim construction issues. The first is whether the “received radio signal” can be derived from a modeled signal or whether it must be derived from a real

signal.¹ The second is whether the “model parameters” that are updated are parameters in the receiver or the transmitter. We address these issues in turn.

a) “received radio signal”

Claim 4 ultimately depends from claim 1. Claim 1 ends with a step of “transmitting the . . . signal to the one or more radio receivers.” Claim 4 begins with a step of “obtaining a received radio signal.” In particular, this received radio signal is not the transmitted signal but rather a signal that “corresponds to a representation of the . . . radio signal received at the one or more radio receivers.” Thus, the signal transmitted at the end of claim 1 is received at a radio receiver in claim 4, and the question becomes what a representation of that received signal is.

Petitioner argues that this “representation” can be a modeled signal, i.e., an artificially generated signal. Pet. Reply 16–25. Patent Owner argues that the “representation” is some kind of information about the signal that was received at the one or more radio receivers, e.g., data that characterizes

¹ The word “model” is used in two different contexts relevant to this issue. The first is found in terms like “machine learning model” (*see, e.g.*, Ex. 1001, 1:30) or “nonlinear pre-distortion model” (*see, e.g., id.* at 3:1–2). This form of “model” is used as a noun to refer to a system, such as a neural network model, embodied in software used to create something. *See, e.g., id.* at 6:8–22, 6:30–7:18. The second is found in terms like “modeled received radio signal,” in which a model (as in the first context) is used to generate some output. *See, e.g., id.* at 9:40–48. This second form of “model” is used as an adjective to refer to an artificial version of something created from a model. *See id.* Notably, not all outputs of models are modeled signals; some are actually transmitted. *See id.* at 10:3–13 (describing a model that generates a signal that is transmitted and received).

or describes the actual received signal.² PO Sur-reply 4–7. Patent Owner argues that, whatever form the representation takes, it is a representation of the radio signal received by the receiver, i.e., it represents a signal that was actually transmitted and received. *See id.*

The fact that the “received radio signal” is a representation of the “transmit output radio signal (from claim 1) that is “received at the one or more radio receivers” means that it represents a signal that was actually sent and received. Even if the “received radio signal” is not the signal itself, but a representation of that signal, we see little reason to discard or ignore the transmitted signal and instead create a model. The “received radio signal” is later used in claim 4 to determine a distance metric between it and the transmit radio signal, in order to update the model parameters. If one wants to improve the quality of the pre-distortion model after being deployed in the real world and transmitting real signals, it makes more sense to compare what was sent to what was received, rather than a model of what could have been received. *See* Ex. 1001, 5:10–19 (stating that, in order to “correct for radio signal distortions and interferences,” the system uses a “distance metric” to compare *transmit* and *received* radio signals); 6:3–22 (explaining that the model is trained using real and simulated data, and when training with real data, also described as “online tuning” or “real time online tuning,”

² During oral argument, Patent Owner’s counsel acknowledged that the ’704 patent does not provide specific examples as to what a “representation” would be. Tr. 24:2–10. Patent Owner’s counsel agreed that the representation could be “data that would provide some indication of certain metrics that can then be used, for instance, to determine the distance metric.” *Id.* at 24:3–7; *see also id.* at 23:3–25:4 (discussion of the “representation” aspect of claim 4).

the model is updated to accommodate situations that apply in a real life deployment, such as environmental conditions). Thus, we understand claim 4 to be capturing the real-world feedback loop aspect described in the specification, which we turn to next.

Figures 5A and 5B of the '704 patent show the difference between using a modeled signal versus a real signal. Figure 5A is reproduced below:

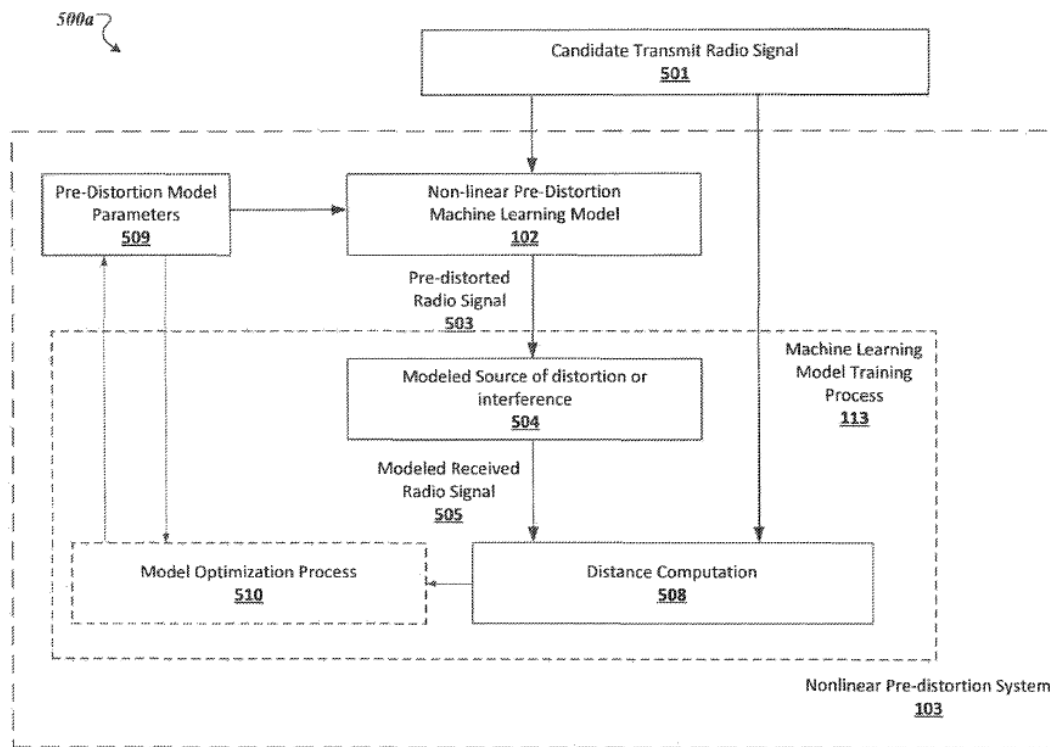


FIG. 5A

Figure 5A depicts “an example configuration of a nonlinear pre-distortion system for model training.” *Id.* at 9:37–38; *see also id.* at 9:37–65 (describing Figure 5A in full). The purpose of this arrangement is to train the pre-distortion system model (i.e., the model that forms the signal to be sent by the transmitter) using a distance computation process that compares the candidate transmit radio signal 501 with a modeled received radio signal 505. *Id.* at 9:43–54. The modeled received radio signal 505 is generated by

modeled source of distortion or interference 504. *Id.* at 9:40–48. Distance computation 508 is between modeled received radio signal 505 and candidate transmit radio signal 501. *Id.* at 9:43–49. This serves to simulate (i.e., model) what happens to a signal that is transmitted in the real world. In sum, the Figure 5A embodiment includes a modeled radio signal to initially train the pre-distortion model.

In contrast, Figure 5B depicts “an example configuration of a nonlinear pre-distortion system for online model *tuning*” and is “deployed in a real-time execution environment.” *Id.* at 9:66–10:5 (emphasis added) (noting Figure 5A was for model *training*); *see also id.* at 9:65–10:23 (discussing Figure 5B in full). Figure 5B is reproduced below:

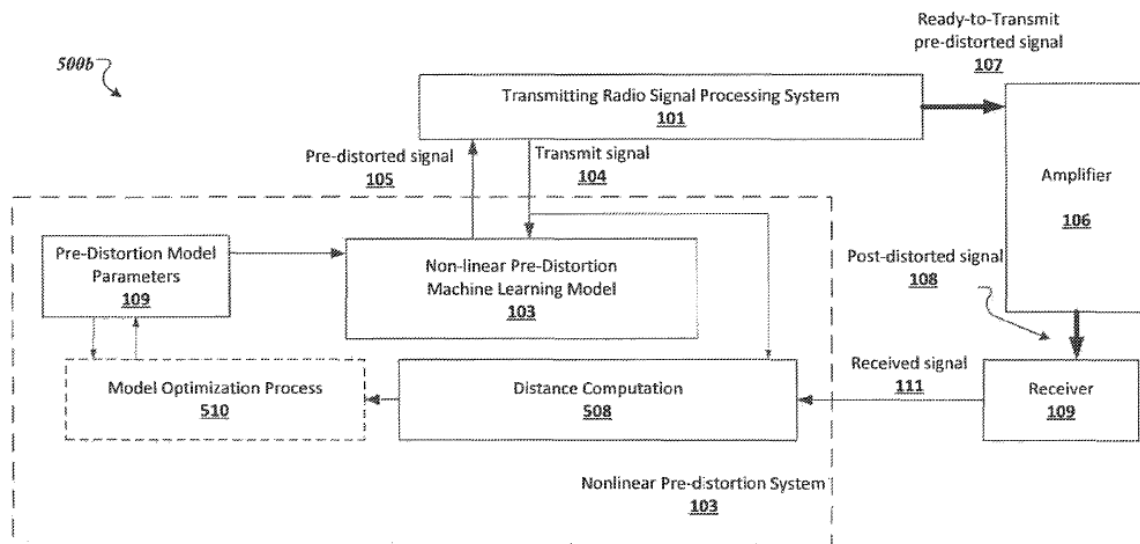


Figure 5B “provides actual transmit signals 104” to distance computation 508 and pre-distortion model optimization process 510. *Id.* at 10:5–7. In addition, in contrast to using a modeled received radio signal, distance computation 508 in the embodiment in Figure 5B uses received signal 111. *Id.* at 10:14–18. Received signal originated as ready-to-transmit

pre-distorted signal 107, passed to amplifier 106, became post-distorted signal 108 (i.e., was transmitted), which was received by receiver 109. *Id.* at 10:14–18; *see also id.* at 5:20–30 (describing a general overview of the system, including receiver 109, in Figure 1), 6:8–20 (describing how online *tuning* is done in a “real time,” i.e., real world, environment). Unlike the Figure 5A embodiment, Figure 5B does not include a modeled source of distortion or interference sending a modeled signal to the distance computation component. As the ’704 patent explains, tuning using real-world, actually transmitted signals provides feedback different from what is modeled, such as “changes in the response of a specific amplifier device over its lifetime” and “changes in environmental conditions or signal loading conditions,” which can only be gathered using real data. *See id.* at 6:8–22. In sum, the Figure 5B embodiment includes an actual transmission of a radio signal, used in order to fine tune the pre-distortion model.

Claim 4 aligns with the Figure 5B embodiment, not the Figure 5A embodiment, because the Figure 5B embodiment deals with actually transmitted signals. Claim 1 ends with an actually transmitted signal (like post-distorted signal 108 in Figure 5B), and claim 4 picks up with receiving *that signal*, generating a representation *of it*, and passing the representation on for comparison with the transmitted signal (like received signal 111 in Figure 5B is used in distance computation 508). The Figure 5B embodiment does not use a modeled signal.

Similarly, Figure 4 does not disclose or suggest subsequent or parallel modeling of an actually transmitted signal. Figure 4 of the ’704 patent illustrates a high-level flow diagram for “training a . . . machine learning model.” Ex. 1001, 8:15–17. The ’704 patent here uses the term “received

radio signal,” without the modifiers applied to Figure 5A (“modeled received radio signal”) or Figure 5B (“actual transmit signal[]” and “received signal”). *Id.* at 8:55–58 (“received radio signal”), 9:43–48 (“modeled received radio signal”), 10:14–18 (“received signal”). Thus, the “received radio signal” language used to describe Figure 4 does not specifically call out that it is a modeled received radio signal like in the description of Figure 5A. The ’704 patent also states that Figure 4 is for model “training,” like Figure 5A, whereas Figure 5B uses the phrase “tuning.” *Compare id.* at 8:15–17, *with id.* at 9:37–40 and 9:66–67. “Tuning” is used only with respect to actual signals. *Id.*; *see also id.* at 6:8–22. Regardless, we do not find the Figure 4 embodiment to disclose creating a modeled signal from an actual received signal. Claim 4 makes clear that a real signal is transmitted and received, and that the claimed received signal represents that transmitted signal; such an arrangement is not described in the discussions of Figures 4 or 5A but is described in the “tuning” of the Figure 5B embodiment.

Lastly, we do not find Figure 6A to show what is in claim 4. The ’704 patent states, “FIG. 6A illustrates an example configuration for in-line mode within a tower-mounted amplifier, placing a nonlinear pre-distortion system 103 between an input 601 and an amplifier 603.” *Id.* at 10:38–41. There is no disclosure of a modeled signal. Further, claim 1 requires “transmitting the transmit output radio signal” and claim 4 requires “obtaining a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers.” Figure 6A does not show obtaining a received radio signal and doing anything with it, let alone a received radio signal that was received by a receiver and previously transmitted.

Returning to Petitioner's arguments, Petitioner points to the "representation of" language in claim 4 as indication that it allows a modeled signal. Pet. Reply 18–25. We do not find this persuasive for several reasons. First, no embodiment describes transmitting an actual signal and then using that to create a modeled signal. The signal in the Figure 5A embodiment is modeled and the Figure 5B embodiment is not; there is no description of a mixture of the two. Petitioner's arguments cite to the Figure 5A embodiment, not the Figure 5B embodiment that has actual transmissions, as in claims 1 and 4. *See id.* 20–23 (citing and discussing Figure 5A); *see also* PO Sur-reply 5–6 (comparing the embodiments of Figures 5A and 5B and stating that, "when the '704 patent intended to disclose or describe a modeled signal, it did so expressly.").

Second, we see no persuasive argument as to why Petitioner's undisclosed scenario, where a signal is transmitted and received, but then a model of the signal is generated and used to compare rather than the actual signal, would exist in the context of the '704 patent. For example, it is not clear what it would accomplish. Comparing information about the actual signal received with the transmitted signal (i.e., Figure 5B) would facially appear more useful in achieving model tuning of transmitted signals, compared to discarding the actual signal and using a modeled signal instead. It would defeat the purpose of having real world tuning if one were to ignore the real world signal.

Third, what Petitioner hinges its argument on here is the "representation of" language, which indicates that the signals compared for the distance metric do not include the actually received signal. In our view, this merely reflects the practical reality that it is not literally two signals

being compared, but some relevant information about those signals that is compared.³ The brief discussion of Figure 5B does not get into these technical details. The '704 patent uses the words “representation of” elsewhere in the specification in another context to describe “an intermediate representation of the signal (e.g. a smaller or otherwise constrained latent version of the signal, which can be used to retain key structural components of the signal).” *Id.* at 7:2–8. This use of “representation of” is consistent with a plain reading of the words and our position that a “representation of the . . . signal received” is some sort of useful characterization of the signal to support the distance metric calculation. *See also* Tr. 23:3–25:4 (discussion of the “representation” aspect of claim 4). We do not find support in the specification for Petitioner’s interpretation, where there is a signal received and then a model of that signal is made (for unspecified reasons). A “modeled” signal in the context of the '704 patent is different from a “representation of [a] signal” because a modeled signal is a signal created from a model, whereas a representation of a signal is information describing a signal (which, in the context of claim 4, is an actual signal that was transmitted and received).

In sum, we determine that claim 4 requires that the transmitted signal (from claim 1) is received at one or more radio receivers, and then a representation of *that signal* (which was actually transmitted) is used to calculate the distance metric later recited in claim 4.

³ A radio signal is an electromagnetic phenomenon; only measurements of such phenomena can be processed by a computing system.

b) “model parameters”

The next claim construction issue in claim 4 is whether the step of “updating the values of the model parameters . . . based at least on the distance metric” is updating parameters in the transmitter or receiver model. Petitioner asserts that limitation 4[c] (“updating the values . . .”) includes no requirement that the model parameters are for the transmitter model. Pet. Reply 29 n.8. Petitioner argues that “[l]imiting the claimed model and updated parameters as being *solely* for a transmitter model would read out embodiments with models trained for devices with both transmitter and receiver components (e.g., a transceiver).” *Id.* (citing Ex. 1001, 8:5–6). Patent Owner’s position is that the transmitter’s parameters are being tuned in claim 4, not the receiver’s. PO Resp. 41; Tr. 29:2–4.

Based on the claim language and the antecedent basis of the various claim terms, we determine that “the model parameters” being updated in claim 4 refer back to the “model parameters” in claim 1 of the “nonlinear pre-distortion machine learning model associated with the base station.” We see no reason that “the model parameters” is referring to the parameters of an unclaimed receiver model, when transmitter model parameters have already been claimed. Although Petitioner cites to transceivers in the ’704 patent, this passage is merely discussing the features of the hardware, not a method for training a receiver model, nor a method in claim 4. Ex. 1001, 8:5–6 (describing an “OFDM or SC-FDMA modulator which might be used in a cellular transceiver”). Thus, we determine that the model parameters in claim 4 refer back to the model parameters associated with the base station recited in claim 1.

3. *Remaining Terms*

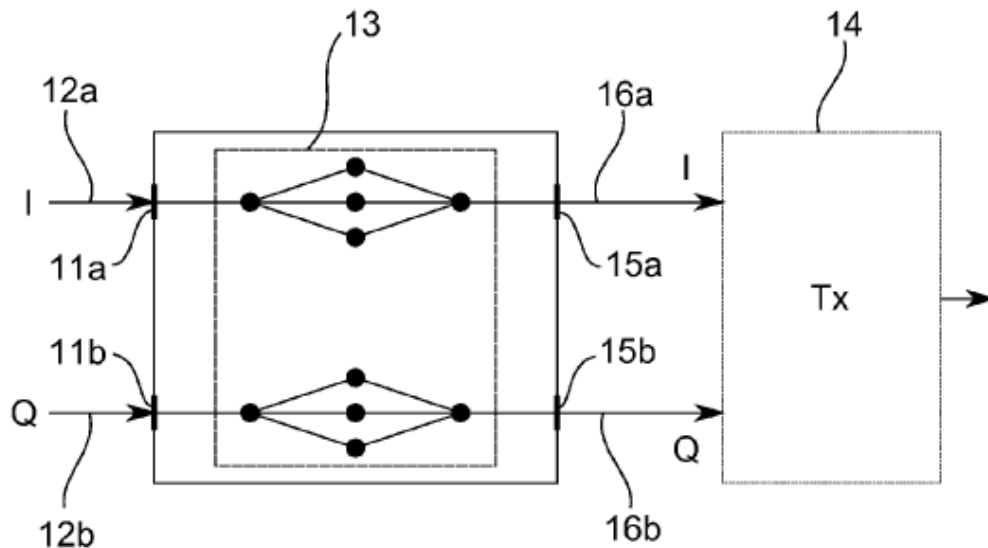
Independent claims 9 and 17 include the terms “deployment scenarios” and “associated with” similar to claim 1. Dependent claims 12 and 20 include the terms “received radio signal” and “model parameters” similar to claim 4. We construe these terms in the same way we construed them for claims 1 and 4.

We do not construe any other terms. *Realtime, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’”) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

D. Asserted Obviousness Over Jüschke (Claims 1–3, 7–11, 15–19, 23, and 24)

Petitioner asserts that claims 1–3, 7–11, 15–19, 23, and 24 would have been obvious over Jüschke. Patent Owner’s arguments are focused on limitations in claim 1. *See* PO Resp. 14–33. Thus, we will focus our analysis on claim 1. At a high level, claim 1 is directed to a method of correcting distortion in radio signals of a cellular communication system, using pre-distortion. A base station first obtains a radio signal to transmit, then a pre-distorted radio signal is generated using a nonlinear pre-distortion machine learning model, and then the signal is transmitted.

Petitioner largely relies on Figure 1 of Jüschke, reproduced below.



Ex. 1005, Fig. 1. Figure 1 of Jüschke depicts a block diagram of an apparatus “for mitigating impairments of a transmit signal.” *Id.* ¶ 38. Inputs 11a, 11b receive input signals 12a, 12b, which are fed into “a pre-distortion neural network processor 13 for pre-distorting the input digital baseband transmit signal 12 in order to obtain a pre-distorted digital baseband signal 16.” *Id.* ¶ 39. Signal 16 is sent to outputs 15a, 15b, which are coupled to transmitter device 14. *Id.*

Petitioner asserts that Jüschke discloses “obtaining a transmit radio signal” as required by claim 1 given that it obtains signal 12, processes it, and then sends it to transmitter 14. Pet. 21–22. As to the requirement in claim 1 that the device be a “base station” and “in the cellular communication system,” Petitioner asserts that Jüschke teaches that the transmitter can be “‘flexibly’ implemented in scenarios and structures, including base stations such as ‘macro-cell base stations’ and ‘small-cell

base stations”” (*id.* at 22–23 (citing Ex. 1005 ¶ 6)) and also that the system is applicable to “cellular systems” (Pet. 23 (citing Ex. 1005 ¶ 2)).

Petitioner then asserts that Jüschke discloses “a non-linear pre-distortion machine learning model associated with the base station” as required by claim 1. Pet. 23–25. In particular, Petitioner points to “pre-distortion neural network processor 13” in Jüschke. *Id.* (citing Ex. 1005 ¶¶ 8, 9, 13, 39, 72, Fig. 1; Ex. 1003 ¶ 136–140). As explained with the prior limitation, Petitioner asserts that Jüschke is intended to be used in “mobile communication systems,” and in particular, “base stations.” *Id.* at 22–23 (citing Ex. 1005 ¶¶ 2, 6).

Petitioner next asserts that Jüschke discloses that “the nonlinear pre-distortion machine learning model includes model parameters associated with values corresponding to one or more deployment scenarios.” Pet. 26–29. Petitioner asserts that the claimed “model parameters” are taught by Jüschke’s “weight and/or bias parameters (w_{kj} , b_k) of neurons.” *Id.* at 26 (quoting Ex. 1005 ¶ 17). Petitioner asserts that the values correspond to one or more deployment scenarios because the values are used in a model deployed in an in-line mode, like the deployment scenario of the ’704 patent. *Id.* at 26–28. In particular, Petitioner compares Figure 6a of the ’704 patent with Figure 1 of Jüschke, noting that both show an in-line mode because the input signal goes directly into the model and then directly to the amplifier. *Id.* at 27–28.

Petitioner asserts that Jüschke renders obvious “generating a pre-distorted radio signal by processing the transmit radio signal using the nonlinear pre-distortion machine learning model” as well as “obtaining a transmit output radio signal” and transmitting that signal. Pet. 30–37. In

particular, Petitioner points to Jüschke's teaching of a "pre-distortion neural network processor 13" that uses "nonlinear transfer or activation functions" in its model to send signals to transmitter 14. *See id.*

Patent Owner disputes whether Jüschke discloses that the model is associated with the base station as claimed. PO Resp. 31–32. Patent Owner also disputes whether Jüschke discloses both parameters and values corresponding to deployment scenarios as claimed. PO Resp. 16–31. Patent Owner does not appear to dispute the other limitations; we agree with and adopt Petitioner's position as to those limitations. We now turn to the two disputed limitations of claim 1.

1. "nonlinear pre-distortion machine learning model associated with the base station"

Petitioner asserts that Jüschke discloses a system "for mobile communications" that uses "base stations." Pet. 22–23 (citing Ex. 1005 ¶¶ 2, 6). Patent Owner disputes whether Jüschke discloses the model associated with the base station as claimed, focusing on the words "associated with." PO Resp. 31–32. Patent Owner argues that Petitioner's position is that the model is "implemented within" the base station but that the claim requires the model to be "associated with" the base station. *Id.* at 27. As we explained in the claim construction section, we fail to see how a model "implemented within," i.e., used in, a base station is not also "associated with" the base station. The model deployed in the base station would need to be configured appropriately in order to perform that function in that context. Petitioner has established by a preponderance of the evidence that Jüschke teaches a nonlinear pre-distortion machine learning

model associated with the base station. *See* Pet. 23–25 (citing, e.g., Ex. 1005 ¶¶ 8, 9, 13, 39), 22–23 (citing, e.g., Ex. 1005 ¶¶ 2, 6, 59).

2. “*model parameters associated with values corresponding to one or more deployment scenarios*”

Petitioner asserts that the “model parameters associated with values” are the “weight and/or bias parameters” of the model. Pet. 26–27. Regarding “deployment scenarios,” Petitioner asserts that the various parameters in Jüschke are for “mobile communication systems” and are “optimized” for these systems. *Id.* at 26 (citing Ex. 1005 ¶ 59). Petitioner further asserts that the configuration of the model in Jüschke is the same configuration as the “in-line” deployment scenario described in the ’704 patent. *Id.* at 26–29. Patent Owner’s arguments are split between the “deployment scenarios” (PO Resp. 16–21) and “parameters” (*id.* at 21–31) aspects of the limitation. We address these in turn.

a) “*deployment scenarios*”

In arguing that Jüschke does not disclose the claimed “deployment scenarios” (*see* PO Resp. 16–21), Patent Owner argues that “Jüschke does not disclose any association of the weight or bias parameters, . . . to any deployment scenario, and . . . base station” (*id.* at 19). For the reasons explained in our claim construction section above, we construe “deployment scenarios” to include “inline mode” models located within a base station, according to the list of deployment scenarios set out in the ’704 patent. *See* Ex. 1001, 2:38–65. The in-line deployment scenario depicted in Figure 6A of the ’704 patent bears a striking resemblance to the arrangement depicted in Figure 1 of Jüschke. In both figures, the analog radio signal is fed directly into the model and then the model directly outputs the signal to the

amplifier. *Compare* Ex. 1001, Fig. 6A, *with* Ex. 1005, Fig. 1. As construed, the “deployment scenarios” represent the physical configurations of the device in which the model is found, such as “in-line.” Petitioner shows by a preponderance of the evidence that Jüschke’s similar in-line configuration is a “deployment scenario” as claimed because it teaches an inline model for a cellular system transmitter (i.e., base station). Pet. 26–29 (citing, e.g., Ex. 1005, Fig. 1, ¶¶ 6, 59; Ex. 1003 ¶¶ 146–147); *see also* Ex. 1001, 2:37–41 (stating that “[t]he particular deployment scenario[] may be . . . sending a radio transmission from a cellular base station that includes the . . . model . . . in an inline mode”).

b) “parameters”

Patent Owner argues that “Petitioner treats the claimed recitation . . . as a single inquiry: whether Jüschke has a learning model with ‘model parameters’ that are used in the cellular communications system,” “but without showing that the parameters themselves are selected for the model to correspond to one or more deployment scenarios.” PO Resp. 25. As we explained in our analysis of the “deployment scenarios” limitation, however, Petitioner has established that the model in Jüschke is in a deployment scenario using an in-line mode for a base station. To the extent Patent Owner is arguing for a separate “selecting” step, none is claimed, as we pointed out in our claim construction analysis above.

Patent Owner makes similar arguments, stating that “Jüschke’s algorithms are not ‘use dedicated,’” “not trained,” and that its weights “do[] not disclose any correspondence of the weight . . . to any deployment scenario.” PO Resp. 26–30. However, given that the weights in Jüschke’s model are used in the particular deployment scenario of an in-line model in a

base station, we fail to see how those weights are not appropriately trained or corresponding to that scenario.

Additionally, Patent Owner’s characterization of Jüschke as “not ‘use dedicated’” or “not trained” mischaracterizes Jüschke’s teachings. *See id.* at 26 (citing Ex. 1005 ¶¶ 28, 59). In paragraph 28, Jüschke considers its self-learning and self-optimizing neural network to be superior “compared to use dedicated, non-self-learning algorithms.” Ex. 1005 ¶ 28. Paragraph 59 of Jüschke is similar. It is clear from these paragraphs that Jüschke is comparing learning algorithms to non-learning algorithms, and Jüschke uses “use dedicated” to describe the non-learning algorithms. Contrary to Jüschke’s usage of the term, Patent Owner appears to be arguing that “use dedicated” algorithms are ones intended for various deployment scenarios. *See, e.g.,* PO Resp. 26. That reading is incorrect because the claimed models are learning models, meaning that the claimed models are not “use dedicated” in the vernacular of Jüschke.

3. Conclusion for Claim 1

Having reviewed the briefing and evidence cited therein, we determine that Petitioner has established by a preponderance of the evidence that claim 1 would have been obvious in view of Jüschke.

4. Remaining Claims in the Jüschke-Alone Ground

Patent Owner argues that Petitioner’s grounds for claims 9 and 17 are deficient for the same reasons as claim 1. PO Resp. 33. We determine that Petitioner has established by a preponderance of the evidence that claims 9 and 17 would have been obvious in view of Jüschke for similar reasons as claim 1. *See* Pet. 53–54, 56. Patent Owner does not separately address

dependent claims 2, 3, 7, 8, 10, 11, 15, 16, 18, 19, 23, or 24 in its Response. *See* Pet. Reply 16. We adopt Petitioner’s unchallenged assertions regarding the unpatentability of claims 2, 3, 7, 8, 10, 11, 15, 16, 18, 19, 23, or 24 as our own factual findings and determine that they establish, by a preponderance of the evidence, that these claims would have been obvious in view of Jüschke. *See* Pet. 37–53, 55, 56.

*E. Asserted Obviousness Over Jüschke and Holt
(Claims 1–24)*

Petitioner asserts that claims 1–24 would have been obvious in view of Jüschke and Holt. Pet. 57–80. Patent Owner relies on its arguments for Jüschke alone for claims 1–3, 7–11, 15–19, 23, and 24. *See* PO Resp. 33–34. Given that Petitioner has established these claims as unpatentable in view of Jüschke alone, we determine they are also unpatentable in view of Jüschke and Holt. Patent Owner separately argues dependent claims 4–6, 12–14, and 20–22, with claim 4 serving as representative. *Id.* at 34–42.

Claim 4 ultimately depends from independent claim 1. Claim 4 includes a step of “obtaining a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers.” The method then uses the received radio signal to “update[e] the values of the model parameters,” the model being associated with the base station that transmitted the radio signal in claim 1.

Petitioner asserts that Jüschke transmits a radio signal and that signal is the same as the signal received by a radio receiver. Pet. 68. Petitioner asserts that Holt teaches receiving a signal at a receiver. *Id.* at 69–70. According to Petitioner, a “[person of ordinary skill in the art] would have understood that Holt’s disclosure of transmitted and received

communication data received by a decoder model implemented in a receiver device teaches a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers.” *Id.* at 70 (emphasis removed) (citing Ex. 1003 ¶ 245). With respect to the claimed “updating the values of the model parameters,” Petitioner asserts that a “[person of ordinary skill in the art] would have understood that Holt’s loss function teaches determining a distance metric between the transmit radio signal and the received radio signal.” *Id.* at 72–73 (emphasis removed) (citing Ex. 1003 ¶ 250).

Patent Owner argues that Petitioner is incorrect and that the signal transmitted and the signal received are not the same. PO Resp. 35. Patent Owner points out that Holt’s communication channel is a modeled channel, not an actual channel, and further argues that the sections relied on by Petitioner are for training a decoder (receiver), not the encoder (transmitter) as claimed. *Id.* at 37–38; *see also id.* at 34–42 (entire argument).

Petitioner responds that the received signal in claim 4 can be a modeled signal from a modeled channel. Pet. Reply 17–23. Petitioner also responds that even if claim 4 required an actual signal, a person of ordinary skill in the art would have understood that Holt could use “an actual communication channel.” *Id.* at 27–28 (citing Pet. 59, Ex. 1003 ¶ 224); *see also id.* at 25–30 (entire argument).

Patent Owner responds that “there is no disclosure or suggestion in Petitioner’s asserted art to compute a distance metric between a transmit radio signal and a received radio signal that is then used to update model parameters for the pre-distortion machine learning model used for processing a transmit radio signal, and generating a pre-distorted radio

signal.” PO Sur-reply 2–4. Patent Owner argues that claim 4 requires a received radio signal, not a modeled signal. *Id.* at 4–7.

Based on our claim construction analysis of claim 4, above, we agree with Patent Owner that claim 4 requires an *actually transmitted* signal and an update of the *transmitter’s* model. This claim construction eliminates Petitioner’s position regarding Holt teaching a modeled signal. *See, e.g.,* Pet. Reply 17–23. We then turn to Petitioner’s argument that Holt teaches updating a model using an actually transmitted signal. *See* Pet. 59–60. There, Petitioner relies on a disclosure in Holt of an “actual communication channel 302 used to train the channel model 208.” Ex. 1006, 18:1–2. This is depicted in Figure 6 of Holt, in connection with a “fourth loss function” which is used to “train the decoder model.” *Id.* at 18:42–48; *see generally id.* at 17:58–18:51 (describing Figure 6). Whether training the channel model or the decoder model, Holt here does not disclose using the actual communication channel to train the encoder, i.e., transmitter.

In sum, we find that Petitioner has not shown by a preponderance of the evidence that the prior art describes the claimed step of “obtaining a received radio signal,” and even if it did, Petitioner has not shown by a preponderance of the evidence that the prior art describes the claimed step of “updating the value of the model parameters” in the manner required by claim 4. Claims 12 and 20 are nearly identical to claim 4, and Petitioner’s ground fails for similar reasons. *See* Pet. 76. Claims 5, 6, 13, 14, 21 and 22 depend from claims 4, 12, and 20, and Petitioner’s ground fails for similar reasons as those claims. *See id.* at 77–80.

*F. Asserted Obviousness Over Jüschke, Holt, and Dzierwa
(Claims 2–6, 10–14, 18–22)*

Petitioner asserts that claims 2–6, 10–14, 18–22 would have been obvious in view of Jüschke, Holt, and Dzierwa. Pet. 81–86. This ground is not meaningfully discussed in the briefs. *See* PO Resp. 34; Pet. Reply 15–16; PO Sur-reply 1. Because Petitioner has already established the unpatentability of claims 2, 3, 10, 11, 18, and 19 in view of Jüschke alone, and the parties raise no other issues unique to the addition of Holt or Dzierwa, we determine that Petitioner has established the unpatentability of these claims in view of Jüschke, Holt, and Dzierwa. Likewise, because Petitioner has not established the unpatentability of claims 4–6, 12–14, and 20–22 in view of Jüschke and Holt, and the parties raise no other issues unique to the addition of Dzierwa, we determine that Petitioner has not established the unpatentability of these claims in view of Jüschke, Holt, and Dzierwa.

III. CONCLUSION

For the reasons given above, we determine that Petitioner has established by a preponderance of the evidence that claims 1–3, 7–11, 15–19, 23, and 24 of the '704 patent would have been obvious in view of the prior art cited. We also determine that Petitioner has not established by a preponderance of the evidence that claims 4–6, 12–14, and 20–22 of the '704 patent would have been obvious in view of the prior art cited.

In summary:

Claim(s)	35 U.S.C. §	Reference(s)/Basis	Claim(s) Shown Unpatentable	Claim(s) Not Shown Unpatentable
1–3, 7–11, 15–19, 23, 24	103	Jüschke	1–3, 7–11, 15–19, 23, 24	
1–24	103	Jüschke, Holt	1–3, 7–11, 15–19, 23, 24	4–6, 12–14, 20–22
2–6, 10– 14, 18–22	103	Jüschke, Holt, Dzierwa	2, 3, 10, 11, 18, 19	4–6, 12–14, 20–22
Overall Outcome			1–3, 7–11, 15–19, 23, 24	4–6, 12–14, 20–22

IV. ORDER

In consideration of the foregoing, it is hereby

ORDERED that the record show that Petitioner has established the unpatentability of claims 1–3, 7–11, 15–19, 23, and 24 of the '704 patent;

FURTHER ORDERED that the record show that Petitioner has not established the unpatentability of claims 4–6, 12–14, and 20–22 of the '704 patent; 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.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

DIGITAL GLOBAL SYSTEMS, INC.,
Petitioner,

v.

DEEPSIG, INC.,
Patent Owner.

IPR2024-01358
Patent 11,018,704 B1

Before WILLIAM V. SAINDON, DANIEL J. GALLIGAN, and
ANDREW L. NALVEN, *Administrative Patent Judges*.

GALLIGAN, *Administrative Patent Judge*, Concurring in Part and
Dissenting in Part.

I concur that claims 1–3, 7–11, 15–19, 23, and 24 are unpatentable and join all of the majority’s decision in that regard. I respectfully dissent, however, with the majority’s claim construction in § II.C.2.a regarding “received radio signal” and its analysis of claims 4–6, 12–14, and 20–22, which depends on that construction.

Claim 4 depends from claim 1 via claim 2 and recites “obtaining a received radio signal that corresponds to a representation of the transmit

output radio signal received at the one or more radio receivers.” The majority concludes that the recited “received radio signal” cannot be a modeled signal. Majority Dec. § II.C.2.a. I disagree with this conclusion.

Starting with the claim language, the term “received radio signal” on its own suggests a radio signal that is received. But the patentee decided not to simply say “obtaining a received radio signal” or “obtaining a received radio signal that is received at the one or more radio receivers.” Rather, the patentee chose the recited language, which is close to language in the written description used to describe a modeled signal.

In particular, with reference to the flowchart of Figure 4, which “illustrates a flow diagram of an example process 400 for training a nonlinear pre-distortion machine learning model to correct distortion and interference” (Ex. 1001, 8:15–17), the ’704 patent states that “[t]he system obtains a received radio signal corresponding to input of a radio receiver by processing the pre-distorted candidate transmit radio signal using one or more sources of distortion or interference 406” (Ex. 1001, 8:55–58). This step of the process is describing a modeled signal in that the “received radio signal” is obtained by processing a signal with sources of distortion or interference. *See* Tr. 25:10–26:2 (Patent Owner’s counsel’s description of Figures 4 and 5A as describing modeled signals). This disclosure is significant because it means that the Specification uses the term “received radio signal” to describe a modeled signal. Thus, the term “received radio signal” itself does not mean that the signal must actually be received.

Having said that, I realize that claim 1 requires a transmission in the transmitting step, and, therefore, a signal presumably would be received somewhere, assuming there is a radio receiver in range. But the fact that a

signal is received at a radio receiver does not mean that the step of “obtaining a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers” requires obtaining the radio signal that is received.

I believe that the claim was drafted to cover certain deployment scenarios in which the received signal cannot be fed into the pre-distortion system, as illustrated in certain embodiments. Figure 6A of the '704 patent is below.

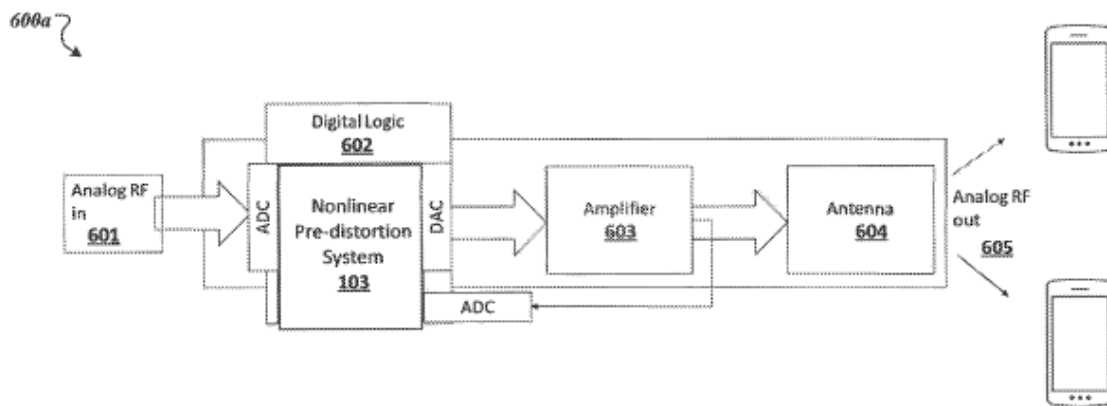


Figure 6A above “illustrates an example configuration for in-line mode within a tower-mounted amplifier, placing a nonlinear pre-distortion system 103 between an input 601 and an amplifier 603.” Ex. 1001, 10:38–41. As shown in the figure, the output from amplifier 603 goes to antenna 604 to be transmitted to radio devices depicted at the right. Importantly, Figure 6A shows that the output from amplifier 603 also goes to nonlinear pre-distortion system 103 via an analog to digital converter. In this deployment scenario, it makes sense to take the transmitted signal and process it to “obtain[] a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers,” as recited in claim 4, because the nonlinear pre-distortion

system is in the transmitting tower, which is not the receiver of the transmitted signals.

Claim 1 appears to cover the embodiment of Figure 6A because claim 3, which ultimately depends from claim 1, recites “wherein the particular deployment scenario comprises one of” five scenarios, one of which is “sending a radio transmission from the base station that includes the nonlinear pre-distortion machine learning model inside a tower mounted amplifier in an inline mode.” This is the inline tower configuration of Figure 6A. *See* Ex. 1001, 10:38–41 (“FIG. 6A illustrates an example configuration for in-line mode within a tower-mounted amplifier, placing a nonlinear pre-distortion system 103 between an input 601 and an amplifier 603.”). Claim 1, therefore, should cover this embodiment of its dependent claim. *See Littelfuse, Inc. v. Mersen USA EP Corp.*, 29 F.4th 1376, 1380 (Fed. Cir. 2022) (“By definition, an independent claim is broader than a claim that depends from it, so if a dependent claim reads on a particular embodiment of the claimed invention, the corresponding independent claim must cover that embodiment as well.”); *Intamin Ltd. v. Magnetar Techs., Corp.*, 483 F.3d 1328, 1335 (Fed. Cir. 2007) (“An independent claim impliedly embraces more subject matter than its narrower dependent claim.”).

Claim 4, of course, does not depend from claim 3, so claim 4 could have been drafted to exclude claim 1’s coverage of the inline tower configuration and its modeled signals. But the language of claim 4, which largely tracks a modeled signal disclosure in the ’704 patent (Ex. 1001, 8:55–58), does not appear to convey such an exclusion of subject matter.

Patent Owner argues that “the ’704 patent delineates when a ‘modeled received radio signal’ is used and when it is not.” PO Sur-reply 5.

According to Patent Owner, Figure 5A deals with modeled signals and does not disclose a radio receiver, whereas Figure 5B “plainly illustrates a Received signal 111 received at Receiver 109, and Received signal 111 is fed back to the Nonlinear Pre-distortion System 103.” PO Sur-reply 5–6 (citing Ex. 1001, 4:55–56, 9:46–47, 10:14–18). I agree that Figure 5A deals with modeled signals and that Figure 5B shows a receiver sending the received signal to nonlinear pre-distortion system 103. It does not follow, however, that Figures 5A and 5B are mutually exclusive in all respects. Indeed, in introducing Figure 5B, the ’704 patent states the following: “FIG. 5B illustrates an example configuration of a nonlinear pre-distortion system for online model tuning. In some implementations, the nonlinear pre-distortion system 500a is the same as the nonlinear pre-distortion system 103.” Ex. 1001, 9:66–10:2. Nonlinear pre-distortion system 500a is depicted in Figure 5A, which means that the nonlinear pre-distortion system of Figure 5B can use the nonlinear pre-distortion system of Figure 5A, which uses modeled signals. This would make sense in the deployment scenario of Figure 6A, discussed above, in which the nonlinear pre-distortion system is in the tower that transmits the signals that are received at remote radio devices.

Patent Owner also argues that, “when the ’704 patent intended to disclose or describe a modeled signal, it did so expressly, using the words ‘model’ or ‘modeled.’” PO Sur-reply 6. This assertion, however, is belied by the ’704 patent’s disclosure of obtaining a received radio signal with reference to Figure 4, which is a modeled signal but is not called a “modeled

received radio signal.” *See* Ex. 1001, 8:55–58 (“The system obtains a received radio signal corresponding to input of a radio receiver by processing the pre-distorted candidate transmit radio signal using one or more sources of distortion or interference 406.”).

Finally, I disagree with Patent Owner’s suggestion that claim 4 tracks the Figure 5B embodiment to the exclusion of a modeled signal embodiment, such as in Figure 5A (*see* PO Sur-reply 5–6), for the simple reason that claim 4 uses conspicuously different language from Figure 5B. In describing Figure 5B, the ’704 patent states that, “[i]n the online tuning configuration, the receiver 109 sends the received signal 111 to the nonlinear pre-distortion system in order for the system to compute the distance metric between the transmit signal 104 and the received signal 111.” Ex. 1001, 10:14–18. As discussed above, however, claim 4 recites “obtaining a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers.” To track Figure 5B, one would simply say “obtaining the signal received at the one or more radio receivers.” The fact that the drafter chose language that more closely aligns with a modeled signal disclosure (Ex. 1001, 8:55–58) persuades me that claim 4 at least encompasses a modeled signal as the “received radio signal.”

For the foregoing reasons, I would conclude that “obtaining a received radio signal that corresponds to a representation of the transmit output radio signal received at the one or more radio receivers” encompasses a modeled signal as described in the ’704 patent.

IPR2024-01358
Patent 11,018,704 B1

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