UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GEOTAB INC. AND GEOTAB USA, INC.,
Petitioners,

v.

FRACTUS, S.A.,
Patent Owner.

Case No. PGR2025-00056
Patent 12,095,149

EXPERT DECLARATION OF HOSSEIN HASHEMI, Ph.D.

I, Hossein Hashemi, Ph.D., do hereby declare as follows:

I. Introduction

1. I am a Professor of Electrical Engineering at the University of Southern California ("USC"). I am, however, currently on a leave of absence and temporarily working as a full-time employee at Astera Labs, Inc.

2. I have been retained by Edell, Shapiro and Finnan, LLC (hereinafter "the Edell Firm"), to provide various opinions regarding U.S. Patent No. 12,095,149 ("the '149 Patent"). I understand that my declaration is being submitted in connection with a Patent Owner Preliminary Response in a post grant review of the '149 Patent. Unless otherwise noted, the statements made herein are based on my personal knowledge and, if called to testify with regards to this declaration, I could and would do so competently and truthfully.

3. I have been retained in this matter by the Edell Firm as a technical expert in the field of electrical engineering, particularly within the context of antenna design and operation in multifunction wireless devices. I am being compensated for my work in this matter at my usual and customary rate of $760.00 per hour. I have no personal or financial stake or interest in the outcome of the post grant review or any related action. My compensation in no way depends upon my testimony or the outcome of the post grant review.

4. I have been advised that the Edell Firm represents Fractus, S.A. (hereinafter "Patent Owner") in this matter and that Geotab Inc. and Geotab USA, Inc. (hereinafter "Petitioners") have petitioned for post grant review of the '149 Patent. I have no personal or financial stake or interest in Patent Owner, Petitioners, or the '149 Patent.

5. I reserve the right to supplement and/or amend my opinions in this declaration based on future positions taken by Petitioners or their experts, additional documents, testimony, or other information provided by Petitioners or their witnesses, any actions from the Patent Trial and Appeal Board ("Board"), or as otherwise necessary.

II. Qualifications

6. My qualifications for forming the opinions set forth in this expert report are summarized here and explained in more detail in my curriculum vitae which is attached as Exhibit A to this Declaration. Exhibit A includes a full list of my publications and other professional contributions and achievements, and a list of the cases in which I have testified at deposition, hearing, or trial.

7. I am currently the Ming Hsieh Electro-Physics Professor of Electrical and Computer Engineering, and a Co-Director of the Ming Hsieh Institute at USC. I received my Bachelor of Science degree in Electronics Engineering from Sharif University of Technology in 1997. I received my Master's degree in Electronics

Engineering from Sharif University of Technology in 1999. I received my Master's degree and Ph.D. in Electrical Engineering from the California Institute of Technology in 2001 and 2003, respectively.

8. From 1997 to 1999 I was a radiofrequency integrated circuit design engineer at Keresem Communications Research. I became an Assistant Professor of Electrical Engineering at USC in October 2003 and remained in that position until May 2009. From November 2007 to May 2009, I also occupied the Gordon S. Marshall Early Career Chair at USC. In May 2009 I became a tenured Associate Professor of Electrical Engineering at USC and remained in that position until my promotion to Professor in December 2014, a title I have held since then.

9. I have over 25 years of industry and academic experience. In particular, I have experience with antennas and electromagnetic technologies including designing, simulating, taping out, and measuring complex electromagnetic structures spanning frequency ranges of 100 MHz – 170 GHz, as well as infrared frequencies (1550nm wavelength), and demonstrating numerous phased arrays (multi-antenna systems) spanning radiofrequency to infrared frequencies.

10. I have been privileged to receive a number of awards and honors throughout my career. These include:

- Fellow, Optica 2023
- Fellow, Institute of Electrical and Electronics Engineers (IEEE) - 2019

- Winner, Nokia Bell Labs Prize - 2016
- Outstanding Young Engineer Award of the IEEE Microwave Theory and Techniques Society (MTT-S) - 2015
- Distinguished Lecturer, IEEE Solid State Circuits Society 2013 – 2014
- Distinguished Scholar for "Outstanding Achievement in Advancement of Engineering," Association of Professors and Scholars of Iranian Heritage -2011
- Inaugural Winner, Maseeh Entrepreneurship Prize Competition, USC - 2011
- NSF CAREER Award - 2009
- USC Viterbi School of Engineering Junior Faculty Research Award - 2008
- DARPA Young Faculty Award - 2008
- Lewis Winner Award for Outstanding Paper, IEEE International Solid-State Circuits Symposium (ISSCC) - 2007
- Best Paper Award, IEEE Journal of Solid-State Circuits - 2004
- Charles Lee Powell Foundation Research Award - 2004
- Young Scholar Award, Association of Professors and Scholars of Iranian Heritage - 2003
- Graduate Fellowship Award, Intel Foundation - 2002
- Outstanding Student Designer Award, Analog Devices - 2001
- Outstanding Accomplishment Award, von Brimer foundation - 2000
- Engineering and Applied Science Division Fellowship, California Institute of Technology - 1999

- Ranked first in Ph.D. EE qualifying exam, California Institute of Technology - 2000
- Ninth place out of 300,000 in national qualifying exam for undergraduate studies – 1993

11. I have co-authored two books and over 125 peer-reviewed journal and conference papers. I have also spoken at numerous invited workshops, talks and short courses. Many of these relate directly or indirectly to antennas, antenna arrays and various modes of wireless communication and electronics design.

12. I am the named inventor on 15 United States Patents, including patents related to antenna technology, including U.S. Patent Nos. 10,615,949 (Hybrid-based cancellation in presence of antenna mismatch) and 8,203,484 (Path-sharing transceiver architecture for antenna arrays).

III. Legal Standards

13. While I am not an attorney, I have been informed by counsel of certain legal principles I should apply in reaching my opinions in this matter. Also, as an inventor, expert witness and otherwise in the course of my work, I have experience studying and analyzing patents and patent claims from the perspective of a person of ordinary skill in the art (POSITA or "skilled artisan").

A. Claim Construction

14. I understand that claim terms are to be interpreted from the point of view of a POSITA at the time of the invention. I further understand that claim terms are generally to be given their ordinary meaning, considered in light of the claim language, patent specification, and prosecution history. I further understand that a patentee may act as its own lexicographer and depart from the ordinary and customary meaning by defining a term with reasonable clarity, deliberateness, and precision, but that there is a presumption that a claim term carries its ordinary and customary meaning.

B. Person of Ordinary Skill in the Art

15. I understand that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the invention. He or she is a person of ordinary creativity who understands the scientific and engineering principles applicable to the pertinent art. I am familiar with the knowledge and capabilities of one of ordinary skill in the art in the field of the '149 Patent at the time of invention.

16. I understand that whether a patent claim would have been obvious is determined from the point of view of a person of ordinary skill in the art at the time of the invention. I have applied this standard in my analysis.

C. Validity

17. I understand that for a post grant review to be instituted, Petitioners must show that it is more likely than not that at least 1 of the claims challenged in the petition is unpatentable. I understand that Petitioners bear the burden of proving any instituted grounds of invalidity by a preponderance of the evidence. I understand that a "preponderance" means "more likely than not." I understand that general and conclusory assertions, without underlying factual evidence, may not support a conclusion that something is "more likely than not." Rather, the preponderance of the evidence standard requires that a reasonable finder of fact be convinced that the existence of a specific material fact is more probable than the non-existence of that fact. The preponderance of the evidence standard does not support speculation regarding specific facts and is instead focused on whether the evidence more likely than not demonstrates the existence or non-existence of specific material facts. Here, I understand that Petitioners have argued that the claims at issue are obvious over different grounds, a first ground applying a combination of two or more references and a second ground based on a parent application to the '149 Patent.

18. I also understand that, in performing a proper invalidity analysis, an expert must do more than simply provide quotes from the evidentiary record along

with conclusory allegations of unpatentability. To the contrary, an expert's conclusions regarding unpatentability must be supported by actual analysis and reasoning set forth in the expert declaration, such that the theoretical and factual foundation for the expert's conclusions can be properly evaluated.

19. I understand that a patent claim may be found unpatentable as obvious under 35 U.S.C. § 103 only if the Board establishes by a preponderance of the evidence that, as of the priority date, the subject matter of the claim, considered as a whole, would have been obvious to a person having ordinary skill in the field of the technology (the "art") to which the claimed subject matter belongs.

20. I understand that the analysis of whether a claim is obvious depends on a number of necessary factual inquiries, for example, (1) the scope and content of the prior art; (2) the differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of non-obviousness.

21. I understand that the claimed invention must be considered as a whole in analyzing obviousness or non-obviousness. In determining the differences between the prior art and the claimed invention, the question under the obviousness inquiry is not whether the differences themselves would have been obvious, but

whether the claimed invention as a whole would have been obvious. Relatedly, I understand that it may be appropriate to consider whether there is evidence of a "teaching, suggestion, or motivation" to combine the prior art teachings in the prior art, the nature of the problem to be solved, or the knowledge of a person having ordinary skill in the art. I further understand arguments in support of obviousness cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

22. I understand that one indicator of non-obviousness is when prior art "teaches away" from combining certain known elements. For example, a prior art reference teaches away from the patent's particular invention if it leads in a different direction or discourages a combination with another reference, recommends steps that would not likely lead to the patent's result, or otherwise indicates that a seemingly inoperative device would be produced.

23. I understand that an obviousness determination also requires that a person of ordinary skill in the art would have had a reasonable expectation of success in making any modifications to the cited references.

24. I further understand that certain objective indicia (sometimes called "secondary considerations") can be important evidence regarding whether a patent is nonobvious, including the existence of a long-felt but unsolved need, unexpected results, commercial success, copying, and industry acceptance or praise. Evidence of such objective indicia must be considered when present. It is generally an error to reach a conclusion on obviousness before considering the evidence of such secondary considerations and then evaluating the latter solely in terms of whether it may fill any gaps in the initial conclusion on obviousness. On the other hand, such evidence is not a requirement for patentability, and the absence of such evidence is a neutral factor in the obviousness analysis.

25. I understand that the obviousness analysis cannot be based on "hindsight." The skilled artisan must view prior art at the time of the invention and without using the disclosure of the subject patent as a guide.

26. To the extent Petitioners argue a prior art reference anticipates the claimed invention of the '149 Patent, a prior art reference must be enabled to anticipate a patent. That is, I understand that the prior art reference's description must be such that a person of ordinary skill in the field of the invention can practice the subject matter based on the reference without undue experimentation.

IV. Materials Reviewed

27. In forming the opinions offered in this Declaration I reviewed and considered as appropriate the following materials: the '149 Patent and its prosecution history, the Petition, the Expert Declaration of Daniel van der Weide Ph.D. (EX1007), and the remaining exhibits to the Petition and any additional materials cited herein.

V. Background

A. Person of Ordinary Skill in the Art

28. I understand that Petitioners have relied upon the following definition of a POSITA utilized by Fractus in prior litigation involving patents related to the '149 Patent:

> [A] person with at least a bachelor's degree in electrical engineering, computer science, or a similar degree and at least four years of experience in applied electromagnetics with an emphasis on antennas. Alternatively, the person of ordinary skill in the art would have a master's degree in electrical engineering (or similar discipline) and at least two years of similar experience.

Petition at 10, *citing* EX1018, 8-9 at ¶32, EX1007 at ¶¶ 36-48. For the purpose of forming my opinions as set forth in this Declaration I have applied this definition of a POSITA.

B. Overview of the '149 Patent

29. The '149 Patent is entitled "Multiple-Body-Configuration Multimedia and Smartphone Multifunction Wireless Devices,"

30. Based on my review of the '149 Patent, it is my understanding that the '149 Patent describes a wireless device having a multiband antenna system with two or more antennas, at least one of which has a complex shape which can be characterized by a set of complexity factors that relate to different structural and functional features of the antenna. By overlaying different-sized grids on a contour of an antenna and evaluating the number of cells within the grid spanned by the contour, attributes of the antenna's complexity can be determined. For example, a complexity factor F_{21}, determined from the cell counts from grids with large-sized and medium-sized cells, characterizes the complexity and degree of convolution of features of the antenna contour that appear when the contour is viewed at relatively coarser levels of scale. EX1005 at 19:27-30. It is my understanding that the complexity factor F_{21} tends to increase with the number of antenna portions within the structure of the antenna system, typically associated with more frequency bands or radiation modes. *Id*. at 19:49-62. It is further my understanding that a complexity factor F_{32}, determined from the cell counts from grids with medium-sized and small-

sized cells, characterizes the complexity and degree of convolution of features of the antenna contour that appear when the contour is viewed at relatively finer levels of scale. *Id*. at 20:19-22. Consequently, complexity factor F_{32} tends to increase when the antenna contour includes a highly convoluted curve and reveals the degree of miniaturization achieved by the antenna system. *Id*. at 20:35-40. A POSITA would understand from the '149 Patent disclosure that evaluating an antenna using such complexity factors reveals its suitability for specific applications. *See, e.g.*, *id*. at 21:36-26:67.

31. The claims of the '149 Patent recite wireless devices including antenna systems with at least two antennas and which include antenna structures that meet specific complexity factor requirements in distinctive combinations with particular frequency bands that are supported by the antenna systems.

C. Claim Construction

32. I have reviewed and understand Petitioners' claim construction arguments (Petition at 13-17), and do not necessarily agree with them. In general, the disagreements I have with Petitioners' claim constructions, however, are not directly pertinent to any of the opinions that I am offering in this Declaration and, accordingly, are not addressed. I reserve, however, the right to disagree with

Petitioners' claim constructions and to provide different and additional opinions on claim construction if a PGR is instituted.

D. Technical Background – Antenna Spatial Diversity

33. Spatial diversity is a technique in wireless communications that uses multiple antennas to improve signal reliability and performance by mitigating the effects of multipath fading and other interference. Multipath fading occurs when a wireless signal propagates along multiple different paths of differing lengths because of interactions with obstacles, resulting in portions of the signal energy arriving at a receiver with different phases slightly offset in time. The phase-shifted versions of the signal may result in constructive or destructive interference with each other. Such interference is spatially dependent – it varies from one spot to another based on the relative phases of the phase-shifted versions of the signal at different locations. Two locations separated by a small fraction of the wavelength of the wireless signal tend to experience similar fading and interference characteristics. Consequently, two closely spaced antennas cannot provide effective spatial diversity. Conversely, by providing sufficient spacing between two antennas, the likelihood increases that at least one of the antennas will be positioned at a location where the multipath or other interference is relatively low, thereby improving overall signal quality and

reliability. As I teach my students, a commonly accepted rule of thumb is that at least a quarter-wavelength spacing between antennas is necessary to provide effective spatial diversity. In some contexts, a larger distance such as a half-wavelength spacing or more may be preferable.

E. Overview of the Cited Art

1. Dou

34. U.S. Patent Application No. 11/361,860 to Dou et al., entitled "Internal Diversity Antenna Architecture" ("Dou" or EX1013), was filed on February 24, 2006, and was published as U.S. Patent Publication No. 2007/0200773 on August 30, 2007. Dou is generally directed to an antenna architecture that includes first and second antennas located near opposite ends of a printed circuit board (PCB) such that the spacing between two antennas provides spatial diversity. Fig. 2A of Dou shows an internal diversity antenna structure comprising first and second internal antennas 206, 208 on a PCB 204 within a wireless device 200. The first internal antenna 206 is positioned near the top edge of the PCB 204, and the second internal antenna 208 is positioned near the bottom edge of the PCB 204. EX1013 at ¶ [0017]. Dou explains that:

> first internal antenna 206 and the second internal antenna 208 may be used **to implement various spatial diversity techniques** to improve

> communication of wireless signals across one or more frequency bands of wireless shared media.

EX1013 at ¶ [0022] (emphasis added). *See also* EX1013 at ¶¶ [0032], [0036].

35. It is my opinion that Dou is consistent with generally accepted spacing requirements to achieve spatial diversity, as Dou specifies the following spacing dimensions:

> In the embodiment shown in FIG. 2A, for example, the length (L) of the wireless device 200 may be greater than 0.3 wavelength (>0.3λ) of the lowest frequency, **and the first internal antenna 206 and the second internal antenna 208 may be separated by a distance (D) that is no less than the quarter wavelength (>=λ/4) of the lowest frequency**.

EX1013 at ¶ [0024] (emphasis added).

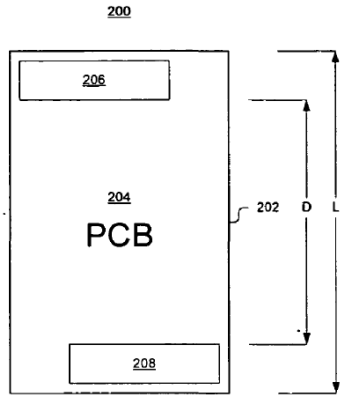


FIG. 2A

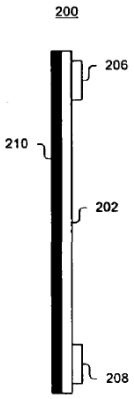


FIG. 2B

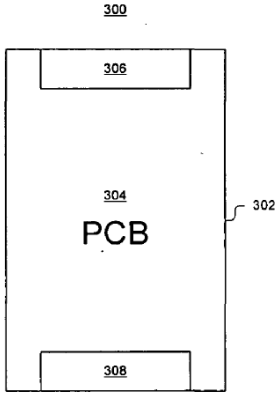


FIG. 3A

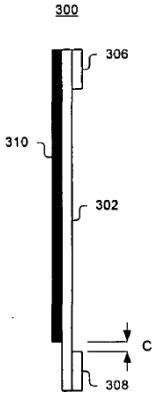


FIG. 3B

36. Dou emphasizes the importance of the quarter-wavelength spacing between the two antennas by reciting this limitation in the claims themselves:

> 8. The wireless device of claim 2, said first diversity antenna and said second diversity antenna separated by a distance greater than or equal

to a quarter wavelength of a lowest operating frequency of said wireless device.

Id. at Claim 8 (emphasis added).

37. In Figs. 3A and 3B, Dou shows a wireless device 300 with a similar diversity antenna comprising first and second spaced-apart antennas 306 and 308 for achieving spatial diversity. *Id*. at ¶ [0032]. The primary difference between the embodiment shown in Figs. 2A-2B and that shown in Figs. 3A-3B is that the ground plane in the latter embodiment does not extend underneath the second antenna 308. *Id*. at ¶ [0034].

38. The wavelength λ corresponding to a frequency of 870 MHz, for example, is 344.8 mm. At this wavelength, the length *L* of Dou's PCB 204, which is specified to be >0.3λ, must be greater than 103.45 mm, and the spacing *D* between the first and second antennas 206, 208, which is specified to be ≥λ/4, must be at least 86.2 mm. Applying Dou's antenna spacing requirements to a frequency of 900 MHz results in at least 83.3 mm of spacing between the antennas. Specifically, the wavelength λ corresponding to a frequency of 900 MHz is 333.3 mm. At this wavelength, the spacing *D* between Dou's first and second antennas, which Dou indicates should be ≥λ/4, must be at least 83.3 mm.

2. Ciais-Multiband

39. Pascal Ciais et al., "Compact Planar Monopole Antenna for Multi-band Mobile Phones," *Electronic Letters,* vol. 40, no. 15, pp. 920-921, July 2004 ("Ciais-Multiband" or EX1010) discloses a planar inverted-F antenna (PIFA) suitable for handset terminals and combines parasitic patches, capacitive loads, and slots to achieve resonance at multiple frequencies. EX1010 at 920. In the sole embodiment described by Ciais-Multiband and shown in Fig. 1, a single antenna is located at a short end of a PCB ground plane and consists of a main patch with slots, three parasitic elements, and capacitive loads that create additional resonances at multiple frequencies. *Id*. at 920.

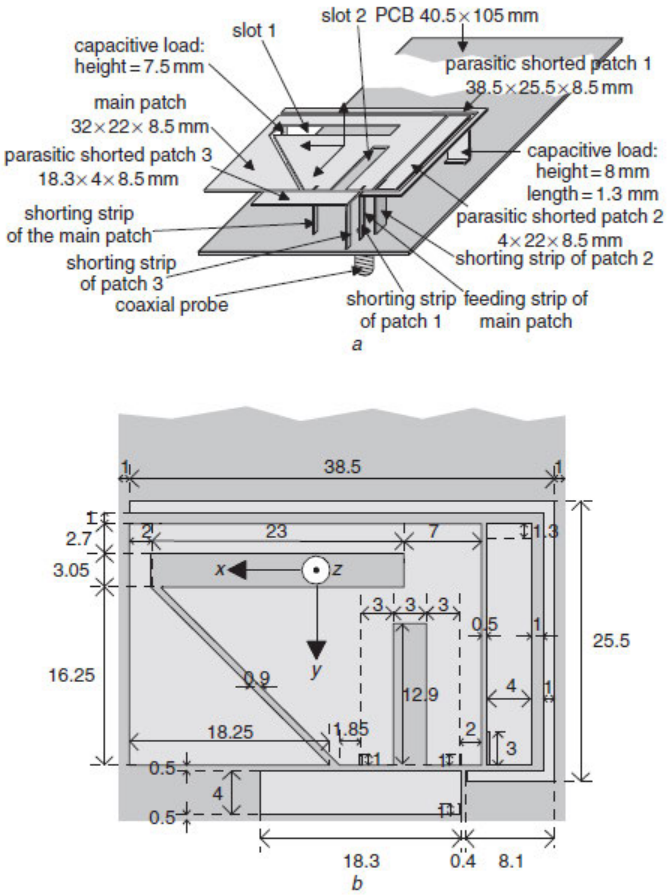


Fig. 1 *3D view of multiband antenna*
a 3D view *b* Top view (all dimensions in millimetres)

40. As shown in Fig. 1, the overall dimensions of Ciais-Multiband's antenna are 38.5 mm x 28.5 mm with a height (spacing from the PCB) of 8.5 mm. The antenna has clearances of 0.5 mm from the end (short) edge of the PCB and 1.0 mm from each of the side (long) edges of the PCB. The PCB dimensions are 40.5 mm x 105.0 mm. EX1010 at 920. Ciais-Multiband identifies the lowest band of the

antenna as 870-960 MHz, *i.e.*, 870 MHz is the lowest frequency of the Ciais-Multiband antenna. *Id*. at 920.

41. Because Ciais-Multiband does not attempt to provide antenna diversity, Ciais-Multiband includes only a single multi-band antenna located at one of the short ends of the PCB. Ciais-Multiband, consequently, does not address the issue of a suitable spacing between two such antennas to provide spatial diversity or whether the size and shape of such an antenna is practical to enable spatial diversity in a wireless device. It is my opinion that there is nothing in Ciais-Multiband that would suggest to a POSITA that the antenna spacing requirements disclosed in Dou (and understood generally in the art) could be ignored if using the Ciais-Multiband antenna.

3. Hilgers

42. U.S. Patent Application No. 10/208,680 to Hilgers *et al*., entitled "GPS Receiver Module" ("Hilgers" or EX1040), was filed on July 30, 2002, and was published as U.S. Patent Publication No. 2003/0025635 on February 6, 2003. Hilgers discloses a GPS receiver module having a dual band antenna for transmission and reception of Bluetooth signals at 2,442.8 MHz and for reception of GPS signals at 1,568.8 MHz. EX1040 at ¶¶ [0025], [0053]. Hilgers' antenna is a "printed wire

antenna" consisting of conductor paths formed on five of the six "faces" of a ceramic "rectangular block" substrate with "no metallic surface forming a reference potential on the back of the substrate" (*i.e.*, no ground plane). *Id*. at ¶¶ [0037]-[0050]. The ground-plane-less, block-shaped ceramic substrate, shown in FIG. 3 of Hilgers, has dimensions of 6x6x2.0 mm^3. *Id*. at ¶ [0052].

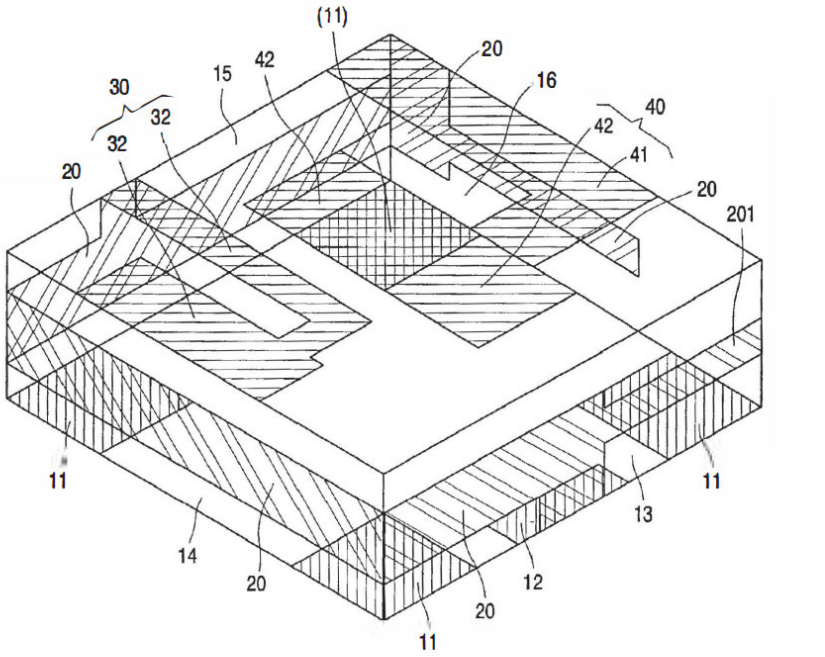
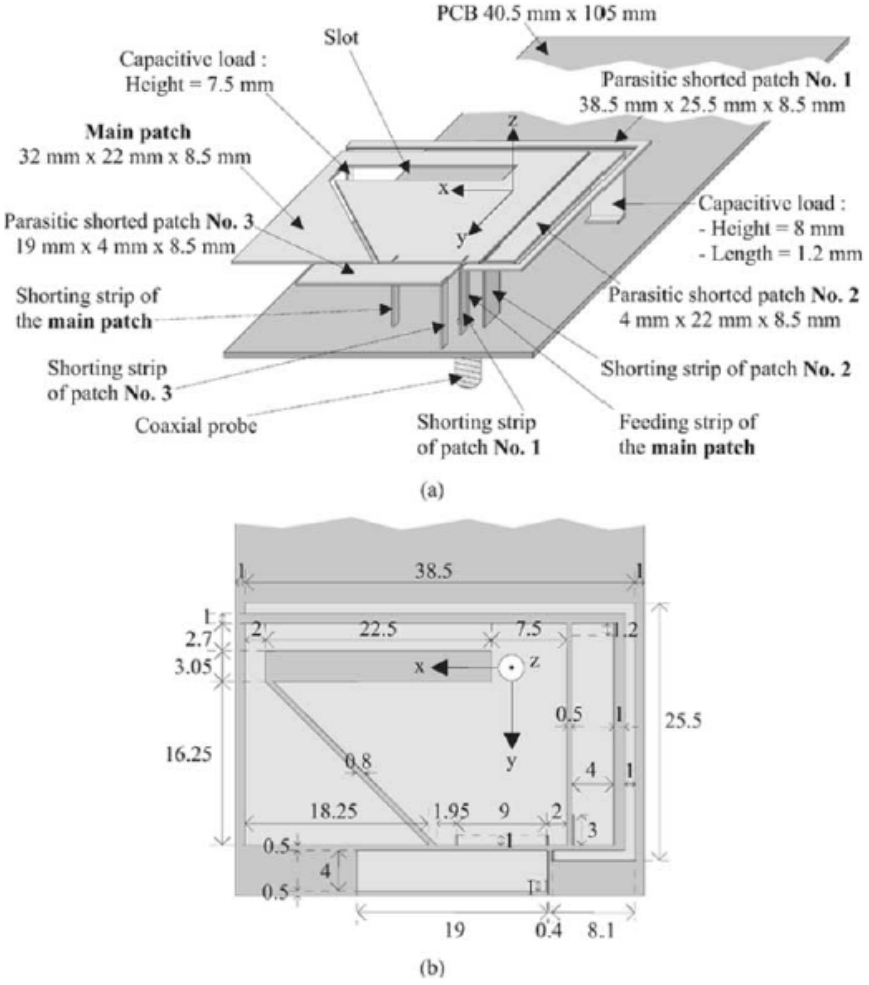


FIG. 3

4. Ciais-Quadband

43. Pascal Ciais et al., "Design of an Internal Quad-Band Antenna for Mobile Phones," *IEEE Microwave and Wireless Components Letters,* vol. 14, no. 4,

pp.148-150, April 2004 ("Ciais-Quadband" or EX1009) discloses a planar inverted-F antenna (PIFA) suitable for cellular telephone applications. In the sole embodiment described by Ciais-Quadband and shown in Figs. 1A and 1B, the antenna is located at a short end of a PCB ground plane and consists of a main patch with a slot, three quarter-wavelength parasitic elements, and capacitive loads that create additional resonances at four different frequencies. EX1009 at 148.



44. As shown in Figs. 1A and 1B, the overall dimensions of Ciais-Quadband's antenna are 38.5 mm x 28.5 mm with a height (spacing from the PCB) of 8.5 mm. The antenna has clearances of 0.5 mm from the end (short) edge of the PCB and 1.0 mm from each of the side (long) edges of the PCB. The PCB dimensions are 40.5 mm x 105.0 mm. EX1009 at 148-149. Ciais-Quadband

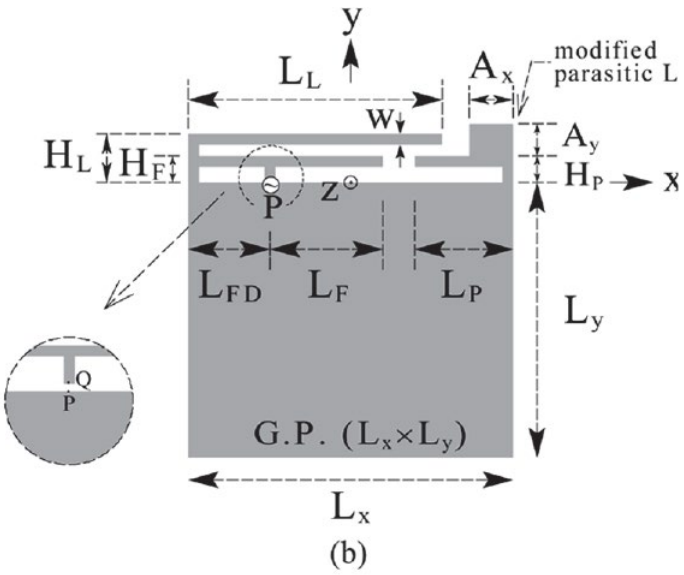
identifies the lowest band of the antenna as 870-960 MHz, i.e., 870 MHz is the lowest frequency of the Ciais-Quadband antenna. EX1009 at 149.

45. Because Ciais-Quadband does not attempt to provide antenna diversity, Ciais-Quadband includes only a single quad-band antenna located at one of the short ends of the PCB. Ciais-Quadband, consequently, does not address the issue of a suitable spacing between two such antennas to provide spatial diversity. It is my opinion that there is nothing in Ciais-Quadband that would suggest to a POSITA that the antenna spacing requirements disclosed in Dou (and understood generally in the art) could be ignored if using the Ciais-Quadband antenna.

5. Nakano

46. H. Nakano et al. "An Inverted FL Antenna for Dual-Frequency Operation," *IEEE Transactions on Antennas and Propagation*, vol. 53, no. 8, pp. 2417-2421, Aug. 2005 ("Nakano" or EX1012) describes an inverted FL antenna (InvFLA) designed to obtain dual-frequency operation for the wireless LAN frequencies of 2.45 GHz and 5.2 GHz. EX1012 at 2417. Nakano's antenna is made of a thin, flat conducting film implemented in a card-type structure in which the antenna is co-planar with a ground plane and extends from a *long* side of the ground plane. EX1012 at 2417-2418. The ground plane dimensions are 30 mm x 25.5 mm,

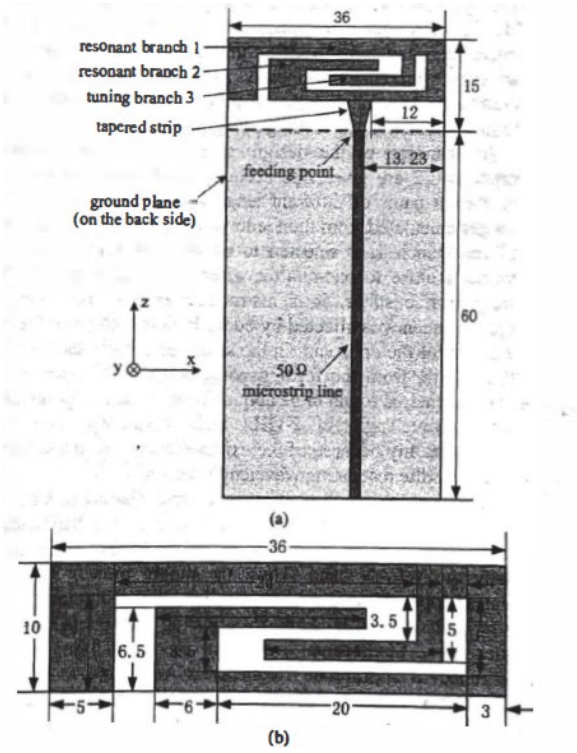
and the antenna dimensions are 30 mm x 5.5 mm. EX1012 at 2418-2420. As shown in Fig. 1(b) of Nakano, the antenna includes three sub-elements: an inverted L element, an inverted F element, and a parasitic inverted L element. EX1012 at 2418.



6. Jing

47. X. Jing *et al*. "Compact Planar Monopole Antenna for Multi-band Mobile Phones," *2005 Asia-Pacific Microwave Conference Proceedings,* vol. 4, pp. 2657-2660, IEEE, 2005 ("Jing" or EX1011) discloses a planar monopole antenna comprising a rectangular radiating patch with three branches, including two resonating branches and a tuning branch, allowing the antenna to resonate at three frequency bands. EX1011 at 2657. As shown in Fig. 1, the antenna has an area of 36 x 15 mm^2, is positioned adjacent to one end of a ground plane having a width of 36

mm and a length of 60 mm and extends from a short side of the ground plane. *Id*. at 2658. Jing identifies the lowest band of the antenna as 900-945 MHz, i.e., 900 MHz is the lowest frequency of the Jing antenna. *Id*. at 2658.



48. Because Jing does not attempt to provide antenna diversity, Jing includes only a single antenna located at one of the short ends of the ground plane. Jing, consequently, does not address the issue of a suitable spacing between two such antennas to provide spatial diversity or whether the size and shape of such an antenna is practical to enable spatial diversity in a wireless device. It is my opinion that there is nothing in Jing that would suggest to a POSITA that the antenna spacing

requirements disclosed in Dou (and understood generally in the art) could be ignored if using the Jing antenna.

7. Ying

49. U.S. Patent No. 6,166,694 to Ying, entitled "Printed Twin Spiral Dual Band Antenna" ("Ying" or EX1040), was filed on July 9, 1998 as U.S. Patent Application No. 09/112,152, and issued on December 26, 2000. Ying discloses a dual band antenna which includes two spiral conductor arms of different lengths and mounted on a substrate on a PCB of a mobile terminal. EX1040 at Abstract, 3:46-51. For better radiation efficiency, the antenna is mounted at the edge of the PCB. *Id*. at 5:49-52. The two spiral radiating arms are commonly fed via an antenna feed pin, which is connected to a grounded post via a matching bridge used to tune the antenna by matching the input impedance at the input terminal. *Id*. at 4:29-67. The different lengths of the two spiral antennas allow the antenna to be tuned to two different resonant frequencies. *Id*. at 5:1-28.

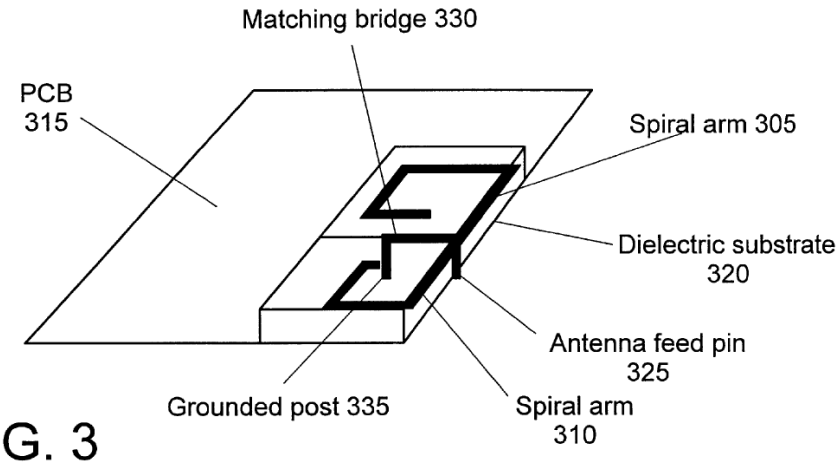


FIG. 3

VI. Ground 1A – Claims 7-9, 11-14, 16-17, and 19-20 are patentable over Dou in view of Ciais-Multiband

50. The Petition alleges that claims 7-9, 11-14, 16-17, and 19-20 would have been obvious to a POSITA at the time of invention based on the combined teachings Dou and Ciais-Multiband. Petition at 17-55. Because the proposed combination of Dou with Ciais-Multiband provided in the Petition directly contradicts the teachings of Dou, it is my opinion that the combination would not have been obvious and a POSITA would not have had a reasonable expectation of success in implementing the combination. Therefore, post-grant review should not be instituted based upon Ground 1A.

51. An objective of Dou's antenna design is to achieve spatial diversity between two antennas. EX1013 at ¶¶ [0017], [0022], [0023]. The combination of

Dou and Ciais-Multiband proposed in the Petition would construct an antenna that violates the explicit design constraints specified by Dou – design constraints that are well known in the art as being necessary to achieve the spatial diversity Dou's antenna design seeks. Because the Petition modifies Dou's antenna in a way that is contrary to Dou's design constraints, it is my opinion that the proposed combination would not have been obvious.

52. Dou's diversity antenna includes two antennas 206 and 208 located at opposite ends of a PCB 204 for the purpose of achieving spatial diversity. *See* Section V.E.1, *supra*; EX1013 at ¶ [0017]. The Petition proposes to implement Patent Owner's claimed antenna system by replacing Dou's first antenna 206 with a first copy of Ciais-Multiband's antenna and by replacing Dou's second antenna 208 with a second copy of Ciais-Multiband's antenna. Petition at 19-23. Despite the Petition showing many annotated diagrams throughout and carefully identifying the dimensions of the proposed combination, the Petition tellingly provides no diagram showing the structure resulting from the proposed combination of Dou and Ciais-Multiband. Nor does the Petition include any discussion of whether Dou's antenna arrangement – modified by substituting two copies of Ciais-Multiband's single antenna – satisfies Dou's specification of having at least a quarter-wavelength

spacing between the two antennas to provide spatial diversity, an objective of Dou's antenna design.

53. The Petition relies on the embodiment shown in Figs. 2A and 2B of Dou, replacing each of antennas 206 and 208 with a copy of Ciais-Multiband's single antenna. Petition at 24-25. As explained in Section V.E.1, *supra*, Dou specifies that the first and second antennas 206 and 208 be "separated by a distance (D) that is no less than the quarter wavelength (>=λ/4) of the lowest frequency." EX1013 at ¶ [0024]. The lowest frequency of Ciais-Multiband's antenna is 870 MHz. EX1010 at 920. The wavelength λ corresponding to a frequency of 870 MHz is 344.8 mm, and a quarter of this wavelength – the minimum spacing specified by Dou to achieve spatial diversity at this wavelength – is 86.2 mm. *See* Section V.E.1, *supra*.

54. In the proposed combination of Dou and Ciais-Multiband, the Petition "uses Dou's ground plane 210" (Petition at 23) but implements it using the 40.5 mm x 105 mm dimensions from Ciais-Multiband because it is "representative of the Printed Circuit Board (PCB) of a typical mobile phone." EX1010 at 920; Petition at 24-25. The Petition further asserts that the antenna of the Ciais-Multiband antenna is 38.5 x 28.5 mm. EX1010 at 920; Petition at 39. Factoring in the Ciais-Multiband antenna's clearances of 0.5 mm from the end edge of the PCB (EX1010 at 920), the

recipe for combining Dou and Ciais-Multiband prescribed by the Petition yields the following structure:

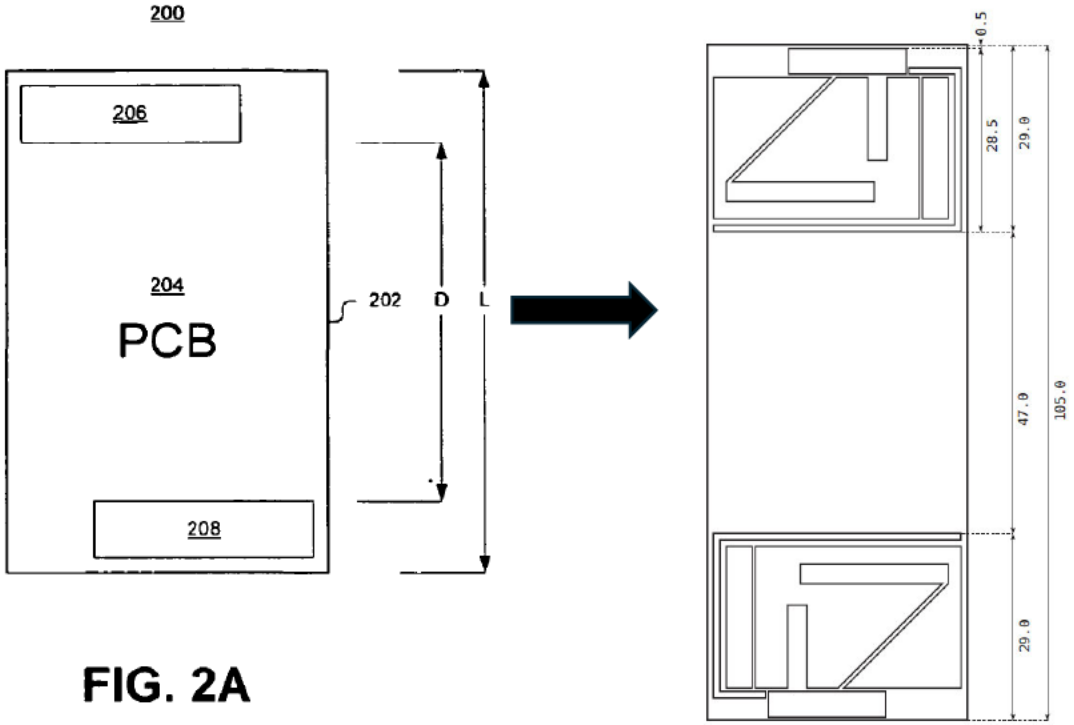


FIG. 2A

55. Subtracting the 29 mm required for the antennas at each end of the PCB from the 105 mm overall length of the PCB results in a spacing between the two antennas of 47.0 mm. This distance is **barely more than half** of the quarter-wavelength lower bound (86.2 mm) of the spacing specified by Dou to achieve spatial diversity at the antennas' lowest frequency (870 MHz). Such a spacing between antennas is contrary to the express teachings of Dou and would eliminate

effective spatial diversity, the core feature Dou's antenna architecture seeks to provide. It is, therefore, my opinion that the proposed modification would not have been obvious to a POSITA at the time of invention of the '149 Patent.

56. A POSITA, understanding that at least a quarter-wavelength spacing between antennas is necessary to achieve spatial diversity, and following Dou's express specification of this spacing, would not have expected the combination proposed in Ground 1A of the Petition to successfully provide the spatial diversity Dou's antenna arrangement is intended to provide. Thus, it is my opinion that the Petition fails to meet its burden of establishing that a POSITA would have been motivated to make such a combination, let alone yield predictable results doing so. It is further my opinion that the combination of Dou and Ciais-Multiband proposed in Ground 1A of the Petition, consequently, would not have been obvious to a POSITA at the time of invention. Accordingly, it is also my opinion that it is not more likely than not that Petitioners would prevail with respect to invalidating claims 7 and 13 or their dependent claims under Ground 1A.

VII. Ground 1B – Claims 10 and 18 are patentable over Dou in view of Ciais-Multiband and Hilgers

57. The Petition alleges in Ground 1B that dependent claims 10 and 18 would have been obvious to a POSITA at the time of invention based on the

combined teachings of Dou, Ciais-Multiband, and Hilgers. Petition at 56-59. Because Hilgers does nothing to remedy the deficiencies of the combination of Dou and Ciais-Multiband proposed in Ground 1A of the Petition, a POSITA would not have combined Dou, Ciais-Multiband, and Hilgers for substantially the same reasons explained in Section VI, *supra*.

58. Regarding independent claims 7 and 13, the respective parent claims of claims 10 and 18, the Petition does not further rely on Hilgers in Ground 1B, merely relying on the arguments from Ground 1A. That is, Ground 1B relies on Hilgers solely for limitations in dependent claims 10 and 18 and still proposes to replace Dou's two antennas 206 and 208 with duplicate copies of the Ciais-Multiband antenna to meet the requirements of their independent claims 1 and 13. Consequently, the proposed addition of Hilgers' antenna does nothing to address the non-obviousness of replacing Dou's antennas with two copies of Ciais-Multiband's antenna, as explained in Section VI, *supra*. The proposed combination of Dou+Ciais-Multiband+Hilgers still destroys the spatial diversity Dou sought to achieve between antennas 206 and 208, because the spacing between the swapped-in Ciais-Multiband antennas is barely half that specified by Dou.

59. For this reason alone, it is my opinion that it is not more likely than not that Petitioners would prevail with respect to invalidating claims 10 and 18 under Ground 1B as explained for Ground 1A in Section VI, *supra*.

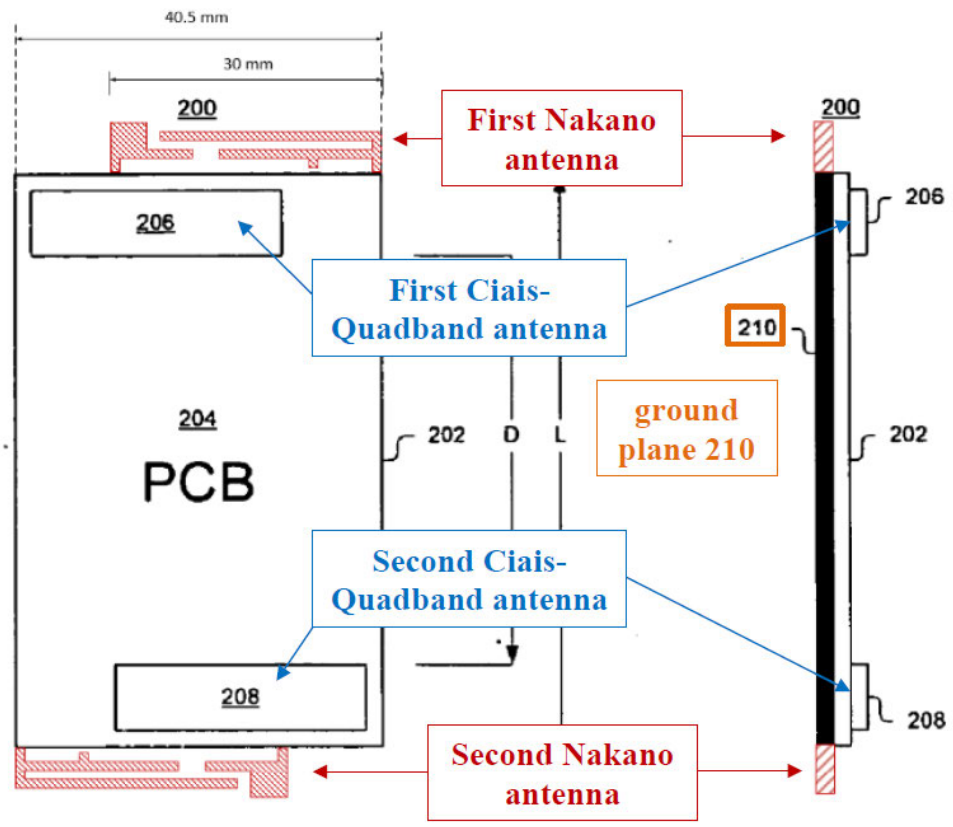
VIII. Ground 2 – Claims 1-20 are patentable over Dou in view of Ciais-Quadband and Nakano.

60. The Petition alleges that claims 1-20 would have been obvious to a POSITA at the time of invention based on the combined teachings Dou, Ciais-Quadband, and Nakano. Petition at 59-116. Because the proposed combination of Dou with Ciais-Quadband and Nakano provided in the Petition directly contradicts the teachings of Dou, it is my opinion that the combination would not have been obvious and a POSITA would not have had a reasonable expectation of success in implementing the combination. Therefore, it is my opinion that post-grant review should not be instituted based upon Ground 2.

61. An objective of Dou's antenna design is to achieve spatial diversity between two antennas. EX1013 at ¶¶ [0017], [0022], [0023]. The combination of Dou, Ciais-Quadband, and Nakano proposed in the Petition would construct an antenna that violates the explicit design constraints specified by Dou – design constraints that are well known in the art as being necessary to achieve the spatial diversity Dou's antenna design seeks. Because the Petition modifies Dou's antenna

in a way that is contrary to Dou's design constraints, it is my opinion that the proposed combination would not have been obvious.

62. Dou's diversity antenna includes two antennas 206 and 208 located at opposite ends of a PCB 204 for the purpose of achieving spatial diversity. *See* Section V.E.1, *supra*; EX1013 at ¶ [0017]. The Petition relies on the embodiment shown in Figs. 2A and 2B of Dou and proposes to implement Patent Owner's claimed antenna system by replacing Dou's first antenna 206 with a first copy of Ciais-Quadband's quad-band antenna and by replacing Dou's second antenna 208 with a second copy of Ciais-Quadband's quad-band antenna. Petition at 64-67. The Petition provides a diagram of the proposed Dou+Ciais-Quadband+Nakano antenna system:



Petition at 66.[1]

[1] For completeness, I note that, within Ground 2, the Petition maps the end-mounted copies of the Nakano antenna to the first and second antennas of independent claims 1 and 13 but maps the copies of the Ciais-Quadband antenna to the first and second antennas of independent claim 7. This inconsistency, however, is immaterial to the opinions presented here, because in all cases, Ground 2 proposes to replace Dou's antennas 206 and 208 with copies of the Ciais-Quadband antenna.

63. The Petition does not address whether Dou's antenna arrangement – modified by substituting two copies of Ciais-Quadband's single antenna for antennas 206 and 208 – satisfies Dou's specification of having at least a quarter-wavelength spacing between the two antennas to provide spatial diversity, an important objective of Dou's antenna design. As explained in Section V.E.1, *supra*, Dou specifies that the first and second antennas 206 and 208 be "separated by a distance (D) that is no less than the quarter wavelength (>=λ/4) of the lowest frequency." EX1013 at ¶ [0024]. The lowest frequency of Ciais-Quadband's antenna is 870 MHz. EX1009 at 149. The wavelength λ corresponding to a frequency of 870 MHz is 344.8 mm, and a quarter of this wavelength – the minimum spacing specified by Dou to achieve spatial diversity at this wavelength – is 86.2 mm. *See* Section V.E.1, *supra*.

64. In the proposed combination of Dou, Ciais-Quadband, and Nakano, the Petition implements the ground plane using the 40.5 mm x 105 mm dimensions from Ciais-Quadband because it is "representative of the Printed Circuit Board (PCB) of a typical mobile phone." EX1009 at 148; Petition at 64, 87. The Petition further asserts that the antenna of the Ciais-Quadband antenna is 38.5 x 28.5 mm. EX1009 at 149; Petition at 100. Factoring in the Ciais-Quadband antenna's clearances of 0.5 mm from the end edge of the PCB (EX1009 at 148), the recipe for combining Dou,

Ciais-Quadband, and Nakano prescribed by the Petition yields the following structure[2]:

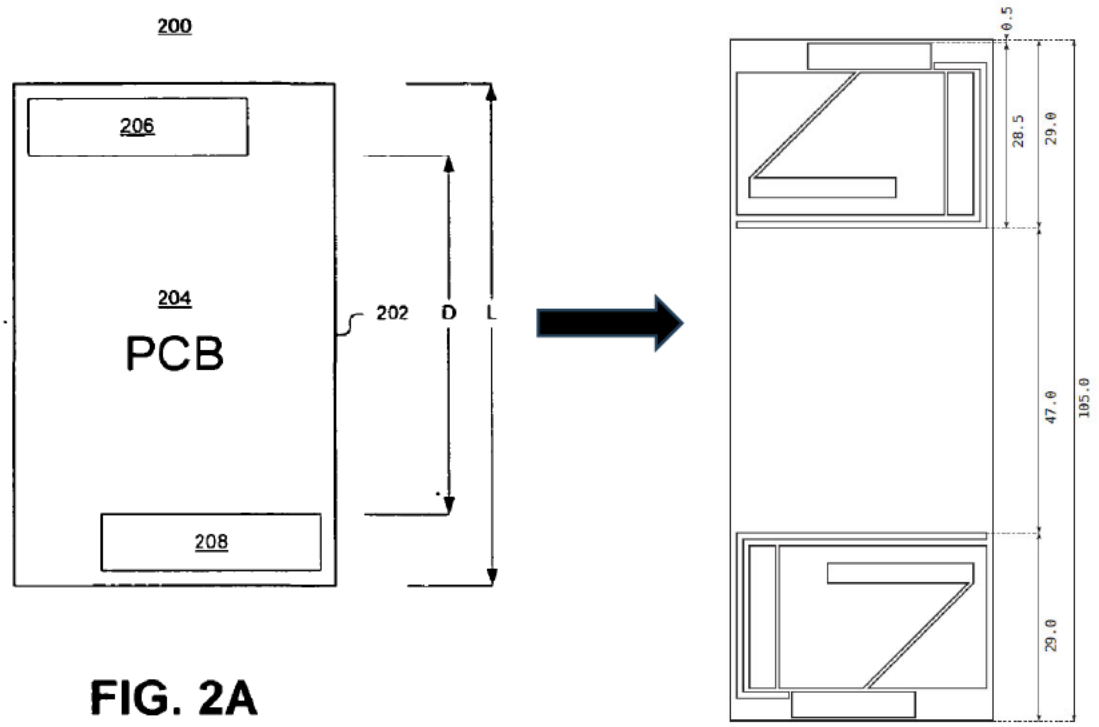


FIG. 2A

65. Subtracting the 29 mm required for the antennas at each end of the PCB from the 105 mm overall length of the PCB results in a spacing between the two antennas of 47.0 mm. This distance is **barely more than half** of the quarter-

[2] The proposed end-mounted Nakano antennas have been omitted from this figure for simplicity because they are not pertinent to the specified minimum spacing between Dou's antennas 206 and 208.

wavelength lower bound (86.2 mm) of the spacing specified by Dou to achieve spatial diversity at the antennas' lowest frequency (870 MHz). Such a spacing between antennas is contrary to the express teachings of Dou and would eliminate effective spatial diversity, an important feature Dou's antenna architecture seeks to provide. The proposed modification, therefore, would not have been obvious to a POSITA at the time of invention of the '149 Patent.

66. It is my opinion that a POSITA, understanding that at least a quarter-wavelength spacing between antennas is necessary to achieve spatial diversity, and following Dou's express specification of this spacing, would not have expected the combination proposed in Ground 2 of the Petition to successfully provide the spatial diversity Dou's antenna arrangement is intended to provide. Thus, it is my opinion that the Petition fails to meet its burden of establishing that a POSITA would have been motivated to make such a combination, let alone yield predictable results doing so. The combination of Dou, Ciais-Quadband, and Nakano proposed in Ground 2 of the Petition, consequently, would not, in my opinion, have been obvious to a POSITA at the time of invention. Accordingly, it is my opinion that it is not more likely than not that Petitioners would prevail with respect to invalidating independent claims 1, 7, and 13 or their dependent claims under Ground 2.

67. It is further my opinion that the proposed addition of Nakano's antenna does nothing to address the non-obviousness of replacing Dou's antennas with two copies of Ciais-Quadband's antenna. The proposed combination of Dou+Ciais-Quadband+Nakano still destroys the spatial diversity Dou sought to achieve between antennas 206 and 208, because the spacing between the swapped-in Ciais-Quadband antennas is barely half that specified by Dou.

68. Moreover, the Petition's proposed placement of the two copies of the Nakano antenna extending off of the respective short ends of Dou's PCB is predicated on a false characterization of Nakano's disclosure. The Petition incorrectly states that "Nakano's InvFL antenna extends from a 'co-planar ground plate' on the **short side** of a rectangular 'card-type structure.' " Petition at 61. The opposite is true. As shown in Fig. 1 of Nakano and explained in Section V.E.5, *supra*, Nakano's antenna extends from the **long side** of the ground plane having a length L_X of 30 mm and not the short side having a length L_Y of 25.5 mm. EX1012 at 2417-2418; Fig. 1. Ground 2, which requires extending Nakano's antenna from the top and bottom **short sides** of Dou's ground plane, is premised on this false characterization of Nakano's disclosure. In fact, consistent with the length of the **long side** of Nakano's ground plane, Nakano's antenna dimensions are 30 mm x 5.5 mm. *Id*. at

2418-2420. **That is, the length of Nakano's antenna is the same as the length of a long side of Nakano's ground plane**. *See* Section V.E.5, *supra*. The Petition's justification for extending the Nakano antennas from the short ends of Dou's ground plane is supported by nothing more than the false statement that Nakano's antenna extends from the short side when, in fact, Nakano teaches the opposite. Thus, for this additional reason, it is my opinion that the combination of Dou, Ciais-Quadband, and Nakano proposed in Ground 2 of the Petition would not have been obvious to a POSITA at the time of invention and it is not more likely than not that Petitioners would prevail with respect to invalidating independent claims 1, 7, and 13 or their dependent claims under Ground 2.

IX. Ground 3A – Claims 1, 3-5, 13, 15, 17, and 19-20 are patentable over Dou in view of Jing

69. The Petition alleges that claims 1, 3-5, 13, 15, 17, and 19-20 would have been obvious to a POSITA at the time of invention based on the combined teachings of Dou and Jing. Petition at 120-145. Because the proposed combination of Dou and Jing provided in the Petition directly contradicts the teachings of Dou, it is my opinion that the combination would not have been obvious. Therefore, post-grant review should not be instituted based upon Ground 3A.

70. An objective of Dou's antenna design is to achieve spatial diversity between two antennas. EX1013 at ¶¶ [0017], [0022], [0023]. The combination of Dou and Jing proposed in the Petition would construct an antenna that violates the explicit design constraints specified by Dou – design constraints that are well known in the art as being necessary to achieve the spatial diversity Dou's antenna design seeks. Because the Petition modifies Dou's antenna in a way that is contrary to Dou's design constraints, it is my opinion that the proposed combination would not have been obvious and a POSITA would not have had a reasonable expectation of success in implementing the combination. Therefore, it is my opinion that post-grant review should not be instituted based upon Ground 3A.

71. Dou's diversity antenna includes two antennas 306 and 308 located at opposite ends of a PCB 304 for the purpose of achieving spatial diversity. *See* Section V.E.1 *supra*; EX1013 at ¶ [0017]. Relying on the embodiment shown in Figs. 3A and 3B of Dou, the Petition proposes to implement Patent Owner's claimed antenna system by replacing Dou's first antenna 306 with a first copy of Jing's single antenna and by replacing Dou's second antenna 308 with a second copy of Jing's single antenna. Petition at 123-126. This implementation is illustrated in the annotated figure provided on page 125 of the Petition, reproduced below.

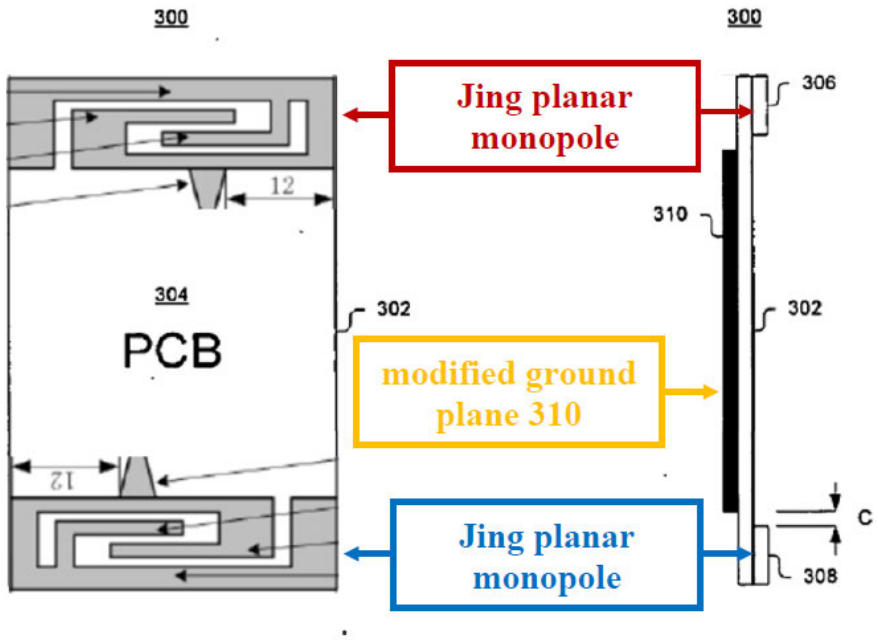
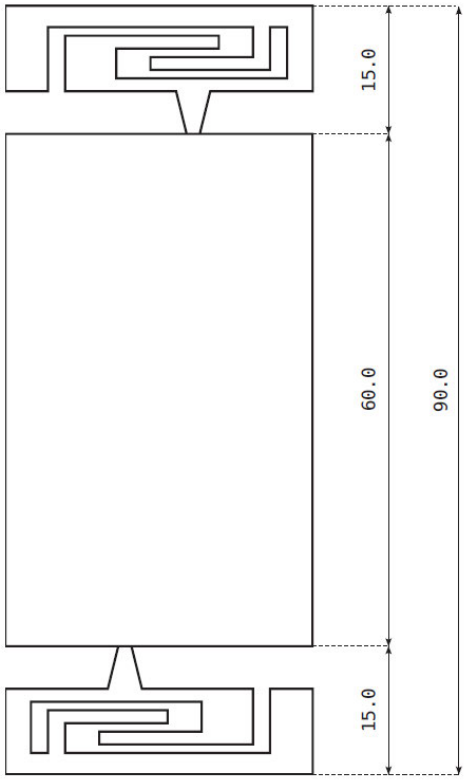


FIG. 3A FIG. 3B

72. Absent from the Petition is any discussion of whether Dou's antenna arrangement – modified by substituting two copies of Jing's antenna – complies with Dou's specification of having at least a quarter-wavelength spacing between the two antennas to provide spatial diversity, an important objective of Dou's antenna design. It does not. As explained in Section V.E.1, *supra*, Dou specifies that the first and second antennas be "separated by a distance (D) that is no less than the quarter wavelength (>=λ/4) of the lowest frequency." EX1013 at ¶ [0024]. The lowest frequency of Jing's antenna is 900 MHz. EX1011 at 2658. The wavelength λ corresponding to a frequency of 900 MHz is 333.3 mm, and a quarter of this

wavelength – the minimum spacing specified by Dou to achieve spatial diversity at this wavelength – is 83.3 mm. S*ee* Section V.E.1, *supra*.

73. In the proposed combination of Dou and Jing, the Petition further explains, "POSAs would have implemented Dou's antenna 306 and 308 using a Jing antenna for each and Jing's 36 × 60 mm ground plane as a modified ground plane 310, to achieve Dou's diversity architecture. … As shown in modified Dou Figs. 3A-3B (below), consistent with Jing's teachings, POSAs would have limited the extent of Dou's ground plane 310 to not extend behind Jing's antenna at 306, just like Dou does not extend it behind antenna 308." Petition at 125. Thus, the recipe for combining Dou and Jing prescribed by the Petition results in the following structure:



74. The 60 mm spacing between the two antennas in the Petition's modified antenna is well short of the lower bound (83.3 mm) of the spacing specified by Dou to achieve spatial diversity at the antennas' lowest frequency (900 MHz).

75. For completeness, I note that the separation constraints discussed above are described in Dou with reference to Figs. 2A and 2B, while Petitioners' invalidity ground is based upon Figs. 3A and 3B. As explained in Dou, however, "the wireless device 300 may be similar in some structural and operational aspects as wireless device 200, as described above." EX1013 at ¶ [0031]. Accordingly, a POSITA

would understand that the design constraints described with respect to Figs. 2A and 2B apply with equal force to Figs. 3A and 3B. *See also id*. at ¶ [0035] ("FIG. 4A illustrates one embodiment of a wireless device 400 having an internal diversity antenna architecture. In various embodiments, the wireless device 400 may be similar in some structural and operational aspects as wireless device 200 and/or wireless device 300, as described above."). Further, an antenna separation of no less than the quarter wavelength (>=λ/4) of the lowest frequency is a generally accepted requirement for an antenna diversity system. Therefore, even absent the specific requirement for such separation in Dou, it is my opinion that a POSITA would have nevertheless understood that such separation was required to implement the spatial diversity sought in Dou.

76. Because the antenna spacing proposed in Ground 3A of the Petition is contrary to the express teachings of Dou (as well as the general understanding in the art at the time of invention), it is my opinion that the combination proposed in the Petition would eliminate effective spatial diversity, a feature Dou's antenna architecture seeks to provide. It is, therefore, my opinion that the proposed modification would not have been obvious to a POSITA at the time of invention of the '149 Patent.

77. It is also my opinion that a POSITA, understanding that at least a quarter-wavelength spacing between antennas is implemented to achieve spatial diversity, and following Dou's express teaching of this spacing, would not have expected the combination proposed in Ground 3A of the Petition to successfully provide the spatial diversity Dou's antenna arrangement intended to provide. Thus, it is my opinion that the Petition fails to meet its burden of establishing that a POSITA would have been motivated to make such a combination, let alone yield predictable results doing so. The combination of Dou and Jing proposed in Ground 3A of the Petition, consequently, would not, in my opinion, have been obvious to a POSITA at the time of invention. Accordingly, it is my opinion that it is not more likely than not that Petitioners would prevail with respect to invalidating claims 1 and 13 or their dependent claims under Ground 3A.

X. Ground 3B – Claims 6 and 18 are patentable over Dou in view of Jing and Ying

78. The Petition alleges in Ground 3B that dependent claims 6 and 18 would have been obvious to a POSITA at the time of invention based on the combined teachings of Dou, Jing, and Ying. Petition at 146-149. Because Ying does nothing to remedy the deficiencies of the combination of Dou and Jing proposed in Ground 3A of the Petition, it is my opinion that a POSITA would not have combined

Dou, Jing, and Ying for substantially the same reasons explained in Section XI, *supra*. Moreover, the Petition provides no guidance whatsoever as to how a POSITA could have combined or integrated Ying's antenna with the proposed Dou+Jing antenna system.

79. Regarding independent claims 1 and 13, the respective parent claims of claims 6 and 18, the Petition does not further rely on Ying in Ground 3B, merely relying on the arguments from Ground 3A. That is, Ground 3B still proposes to replace Dou's two antennas 306 and 308 with duplicate copies of the Jing antenna. Consequently, the proposed addition of Ying's antenna does nothing to address the non-obviousness of replacing Dou's antennas with two copies of Jing's antenna, as explained in Section IX, *supra*. The proposed combination of Dou+Jing+Ying still destroys the spatial diversity Dou sought to achieve between antennas 306 and 308, because the spacing between the swapped-in Jing antennas is only a fraction of that specified by Dou. For this reason alone, it is my opinion that it is not more likely than not that Petitioners would prevail with respect to invalidating claims 6 and 18 under Ground 3B, as explained for Ground 3A in Section IX, *supra*.

I declare under penalty of perjury that the foregoing is true and correct.

Date: 10/8/2025 By: _____
Hossein Hashemi, Ph.D.