

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. IPR2025-00929
Patent No. 8,810,458

DECLARATION OF DAVID M. POZAR, Ph.D.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW

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I, David M. Pozar, Ph.D., declare:

1. I have been retained by Wolf, Greenfield & Sacks, P.C., counsel for Geotab Inc. and Geotab USA, Inc. (“Petitioners” or “Geotab”), to assess claims 1-10 and 12-19 (the “challenged claims”) of U.S. Patent No. 8,810,458 (“the ’458 patent”) (EX1001). I am being compensated for my time at my standard rate, plus actual expenses. My compensation is not dependent in any way upon the outcome of the *inter partes* review of the ’458 patent.

I. PERSONAL AND PROFESSIONAL BACKGROUND

2. My qualifications for forming the opinions set forth in this declaration are summarized below and explained in more detail in my current curriculum vitae, provided as EX1004. EX1004 also includes a list of my publications.

3. I am currently Professor Emeritus in the Department of Electrical and Computer Engineering at the University of Massachusetts Amherst. I received my Ph.D. in Electrical Engineering in 1980 from the Ohio State University and my M.S. and B.S. degrees from the University of Akron in 1976 and 1975, respectively, each in Electrical Engineering.

4. My work experience includes the National Security Agency (1974), the Ecole Polytechnique Fédérale de Lausanne, Switzerland (1988), the University of Massachusetts Amherst (1980–present) and numerous consulting activities throughout the U.S. and Europe.

5. My research areas include antenna engineering, microwave engineering, and wireless systems. I have published over 100 refereed journal publications in these areas, as well as four books, most of which are on the subject of wireless systems, printed antennas, phased arrays, transient radiation, and/or electromagnetics. Of particular note is my textbook, MICROWAVE ENGINEERING, first published in 1990, and currently in its fourth edition, with translations in Chinese, Greek, and Korean. *See* David M. Pozar, Microwave Engineering, 2d ed. (John Wiley: 1997). This book is presently among the most popular texts for university courses in microwave engineering throughout the world. Another one of my books is entitled, Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays (1995). In this book, which I coedited and which draws on numerous articles that I authored, I combined over 15 years of microstrip antenna research into one volume that covers the theory, design and modeling of microstrip antennas and microwave systems.

6. I have taught microwave engineering at the undergraduate and graduate level for 25 years, as well as short courses to industry and government. My awards include: IEEE Distinguished Achievement Award (2020), Life Fellow of the IEEE (2018), four IEEE best paper awards (2003, 1998, 1988, 1986), the University of Massachusetts' Chancellor's Medal (2003), Distinguished Faculty Lecturer (2003), Outstanding Teacher Award (1997), Outstanding Senior Faculty

Award (1995), Issac Koga Gold Medal (1987), IEEE Third Millennium Medal (2000), NSF Presidential Young Investigator Award (1984), and several other awards for teaching and research.

7. Several aspects of my work are directly relevant to the patents and prior art referenced in this declaration:

- In 1984, I invented the aperture coupled microstrip antenna. See D. M. Pozar, “A Microstrip Antenna Aperture Coupled to a Microstrip Line,” *Electronics Letters*, Vol. 21, pp. 49-50, January 17, 1985.
- A student of mine and I were the first to publish in the public domain the design of an aperture coupled stacked microstrip antenna. See F. Croq and D. M. Pozar, “Millimeter Wave Design of Wideband Aperture Coupled Stacked Microstrip Antennas,” *IEEE Trans. Antennas and Propagation*, Vol. 39, pp. 1770-1776, December 1991.
- My students and I also developed a variety of other aperture coupled stacked microstrip patch antenna configurations. See S. D. Targonski, R. B. Waterhouse, and D. M. Pozar, “A Wideband Aperture Coupled Stacked Patch Antenna Using Thick Substrates,” *Electronics Letters*, vol. 32, pp. 1941-1942, October 1996; D. M. Pozar and S. M. Duffy, “A Dual-Band Circularly Polarized Aperture Coupled Stacked Microstrip Antenna

for Global Positioning Satellite”, *IEEE Trans. Antennas and Propagation*, vol. 45, pp. 1618-1625, November.

8. I have also worked as a consultant in designing antennas for cellular telephone base stations.

9. Because of my knowledge and experience relevant to the technology at issue in this Declaration, I am well qualified to offer the opinions that I express in this declaration.

II. MATERIALS REVIEWED AND CONSIDERED

10. I have reviewed the ’458 patent, its prosecution history, and the prior art and other documents and materials cited herein. For ease of reference, the full list of documents that I have considered is in Appendix A: Materials Considered. I have also considered the documents cited and referenced herein, even if not included in the exhibit list below. Each of these exhibits is a type of document that experts in my field would have reasonably relied upon when forming their opinions and would have had access to either through the applicable patent office and/or well-known libraries, conferences, publications, organizations, and websites in the field as further discussed herein.

11. My opinions, as explained below, are based on my years of education, research, experience, and background in the field of “handheld device[s], which include[] an antenna for receiving and transmitting electromagnetic wave signals”

(EX1001, 1:30-32), as well as my investigation and study of relevant materials for this declaration. When developing the opinions set forth in this declaration, I assumed the perspective of a person having ordinary skill in the art, as set forth in Section VI below. In forming my opinions, I have studied and considered the materials identified in the table in Appendix A.

III. MY UNDERSTANDING OF PATENT LAW

12. In developing my opinions, I discussed various relevant legal principles with Petitioners' attorneys. I understood these principles when they were explained to me and have relied upon such legal principles, as explained to me, in the course of forming the opinions set forth in this declaration. My understanding in this respect is as follows:

13. I understand that "*inter partes* review" (IPR) is a proceeding before the United States Patent & Trademark Office for evaluating the patentability of an issued patent's claims based on prior-art patents and printed publications.

14. I understand that, in this proceeding, Petitioner has the burden of proving that the challenged claims of the '458 patent are unpatentable by a preponderance of the evidence. I understand that "preponderance of the evidence" means that a fact or conclusion is more likely true than not true.

15. I understand that, in IPR proceedings, claim terms in a patent are given their ordinary and customary meaning as understood by a person of ordinary

skill in the art (“POSA”) in the context of the entire patent and its prosecution history. If the specification or prosecution history provides a special definition for a claim term that differs from the meaning the term would otherwise possess, that special definition applies. If a claim element is expressed as a “means” for performing a specified function, I understand that it covers the corresponding structure described in the specification and equivalents of the described structure. I have applied these standards in preparing the opinions in this declaration.

16. I understand that determining whether a particular patent or printed publication constitutes prior art to a challenged patent claim can require determining the effective filing date (also known as the priority date) to which the challenged claim is entitled. I understand that for a patent claim to be entitled to the benefit of the filing date of an earlier application to which the patent claims priority, the earlier application must have described the claimed invention in sufficient detail to convey with reasonable clarity to the POSA that the inventor had possession of the claimed invention as of the earlier application’s filing date. I understand that a disclosure that merely renders the claimed invention obvious is not sufficient written description for the claim to be entitled to the benefit of the filing date of the application containing that disclosure.

17. I understand that for an invention claimed in a patent to be patentable, it must be, among other things, new (novel—or in other words not anticipated) and

not obvious from the prior art. My understanding of these two legal standards is set forth below.

A. Anticipation

18. I understand that, for a patent claim to be “anticipated” by the prior art (and therefore not novel), each and every limitation of the claim must be found, expressly or inherently, in a single prior-art reference. I understand that a claim limitation is disclosed for the purpose of anticipation if a POSA would have understood the reference to disclose the limitation based on inferences that a POSA would reasonably be expected to draw from the explicit teachings in the reference when read in light of the POSA’s knowledge and experience.

19. I understand that a claim limitation is inherent in a prior art reference if that limitation is necessarily present when practicing the teachings of the reference, regardless of whether a person of ordinary skill recognized the presence of that limitation in the prior art.

B. Obviousness

20. I understand that a patent claim may be unpatentable if it would have been obvious in view of a single prior-art reference or a combination of prior-art references.

21. I understand that a patent claim is obvious if the differences between the subject matter of the claim and the prior art are such that the subject matter as a

whole would have been obvious to a person of ordinary skill in the relevant field at the time the invention was made. Specifically, I understand that the obviousness question involves a consideration of:

- the scope and content of the prior art;
- the differences between the prior art and the claims at issue;
- the knowledge of a person of ordinary skill in the pertinent art; and
- if present, objective factors indicative of non-obviousness, sometimes referred to as “secondary considerations.” To my knowledge, the Patent Owner has not asserted any such secondary considerations with respect to the ’458 patent.

22. I understand that in order for a claimed invention to be considered obvious, a POSA must have had a reason for combining teachings from multiple prior-art references (or for altering a single prior-art reference, in the case of obviousness in view of a single reference) in the fashion proposed.

23. I further understand that in determining whether a prior-art reference would have been combined with other prior art or with other information within the knowledge of a POSA, the following are examples of approaches and rationales that may be considered:

- combining prior-art elements according to known methods to yield predictable results;

- simple substitution of one known element for another to obtain predictable results;
- use of a known technique to improve similar devices in the same way;
- applying a known technique to a known device ready for improvement to yield predictable results;
- applying a technique or approach that would have been “obvious to try,” such as choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success.
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art;
- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior-art reference or to combine prior-art reference teachings to arrive at the claimed invention. I understand that this teaching, suggestion or motivation may come from a prior-art reference or from the knowledge or common sense of one of ordinary skill in the art.

24. I understand that a universal motivation known in a particular field to improve technology can provide a motivation to combine prior art references even

without any hint or suggestion in the references themselves. I also understand that obviousness is determined in light of all the facts and that a given course of action often has simultaneous advantages and disadvantages, and that this does not necessarily obviate motivation to combine teachings from multiple references.

25. I understand that for a single reference or a combination of references to render the claimed invention obvious, a POSA must have been able to arrive at the claimed invention by modifying, implementing, or combining the teachings of the applied references.

C. Claim Interpretation

26. I understand that determining whether a claimed invention is novel and non-obvious requires comparing the prior art to the claims. In this section, I discuss the interpretations I have applied to certain claim terms in my analysis.

27. I have been informed that patent claims are construed from the viewpoint of a person of ordinary skill in the art at the time of the alleged invention. I have been informed that patent claims generally should be interpreted consistent with their plain and ordinary meaning as understood by a person of ordinary skill in the art in the relevant time period (at the time of the purported invention, or the so called “effective filing date” of the patent application), after reviewing the patent claim language, the specification, and the prosecution history (the intrinsic record).

28. I have further been informed that a person of ordinary skill in the art must read the claim terms in the context of the claim itself, as well as in the context of the entire patent specification. I understand that in the specification and prosecution history, the patentee may specifically define a claim term in a way that differs from the plain and ordinary meaning. I understand that the prosecution history of the patent is a record of the proceedings before the U.S. Patent and Trademark Office, and may contain explicit representations or definitions made during prosecution that affect the scope of the patent claims. I understand that an applicant may, during the course of prosecuting the patent application, limit the scope of the claims to overcome prior art or to overcome an examiner's rejection, by clearly and unambiguously arguing to overcome or distinguish a prior art reference, or to clearly and unambiguously disavow claim coverage.

29. In interpreting the meaning of the claim language, I understand that a person of ordinary skill in the art may also consider "extrinsic" evidence, including expert testimony, inventor testimony, dictionaries, technical treatises, other patents, and scholarly publications. I understand this evidence is considered to ensure that a claim is construed in a way that is consistent with the understanding of those of skill in the art at the time of the alleged invention. This can be useful for technical terms whose meaning may differ from its ordinary English meaning. I understand that extrinsic evidence may not be relied on if it contradicts or varies the meaning

of claim language provided by the intrinsic evidence, particularly if the applicant has explicitly defined a term in the intrinsic record.

30. I understand that determining whether a claimed invention is novel and non-obvious requires comparing the prior art to the challenged claim. In this Declaration, I apply the above standards to the terms in the challenged claims. The meanings of specific terms are discussed below in connection with evaluating the disclosure in the priority documents.

IV. DESCRIPTION OF THE RELEVANT FIELD AND THE RELEVANT TIME FRAME

31. I have reviewed the '458 patent (EX1001) and its prosecution history (EX1002).

32. I understand that the '458 patent issued from U.S. Patent Application No. 13/718,348 ("the '348 application"), filed December 18, 2012, and claims priority to Provisional Application Serial No. 60/702,205, filed July 25, 2005, and to a European application filed July 21, 2005. EX1001, codes (21), (22), (30), (60).

33. I have been informed by counsel that Fractus alleges the '458 patent's conception date is June 2005, and that it has a priority date no later than July 21, 2005, the filing date of the European application from which the '485 patent claims priority. EX1001, code (30).

34. I have been instructed by counsel for Petitioners to assume the relevant time frame for my analysis of the prior art in this Declaration is before June 2005.

35. Based on my review of this material, I believe that the relevant general field for the purposes of the '458 patent is handheld devices, like mobile phone and laptop devices, having two antennas that each support different connectivity services.

V. UNPATENTABILITY GROUNDS

36. The Grounds of unpatentability that I have considered in this declaration are based on Wong (EX1005), Lee (EX1011), Gaucher (Ex1012) and Zhao (EX1008), which I discuss further below in Sections VIII.A (Wong), VIII.B (Lee), X.A (Gaucher), and XI.A (Zhao).

37. I am asked by counsel for Petitioners to assume that Wong, Lee, Gaucher, and Zhao are each prior art to the '458 patent.

VI. PERSON OF ORDINARY SKILL IN THE ART (“POSA”)

38. I have been informed and understand that for purposes of assessing whether prior art references disclose every element of a patent claim (thus “anticipating” the claim) and/or would have rendered the claim obvious, the patent and the prior art references must be assessed from the perspective of a person

having ordinary skill in the art (“POSA”) to which the patent is related, based on the understanding of that person at the time of the patent claim’s priority date.

39. I have been informed and understand that various factors may be considered in assessing the level of a POSA, including (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. I have also been informed and understand that not all of these factors may be present in every case, and one or more of these or other factors may predominate in a particular case. I have further been informed and understand that these factors are not exhaustive but are merely a guide to determining the level of ordinary skill in the art. I have applied this standard throughout my declaration.

40. The ’458 patent involves technology in the field of handheld and portable devices having multiple antennas. I have been asked to provide my opinions as to the state of the art in this field before June 2005. I use this time frame because I have been informed by counsel that Patent Owner Fractus’s earliest-alleged conception date is June 2005. Whenever I offer an opinion in this declaration about the knowledge of a POSA, the manner in which a POSA would have understood the claims of the ’458 patent or its description, the manner in which a POSA would have understood the prior art, or what a POSA would have

been led to do based on the prior art, I am referencing the June 2005 timeframe, even if I do not say so specifically in each case.

41. In the context of the '458 patent and the prior art, it is my opinion that the POSA to whom the patent is addressed, before June 2005, would have had a bachelor's degree in electrical engineering (or similar field), and at least four years of experience in applied electromagnetics with an emphasis on antennas, or alternatively, a master's degree in electrical engineering (or similar discipline) and at least two years of similar experience. A POSA would have been capable of understanding and applying the teachings of the '458 patent and the prior-art references discussed in this declaration.

42. The basis for my familiarity with the level of ordinary skill is my own technical experience and my interaction with students and professionals in the field of mobile device antenna design who were at this level of skill as of June 2005. I am well aware of the knowledge that a POSA would have had at the time this patent was written as I have been actively consulting, teaching, and carrying out research with such students and/or professionals for approximately 25 years prior to June 2005.

43. My opinion identifying the POSA's level of ordinary skill is consistent with the problems encountered in the art, the prior art solutions to those problems, the rapidity with which innovations are made, the sophistication of the

technology, and the educational level and professional capabilities of workers in the field. This is shown, among other things, by the prior art references described in the Grounds below.

44. For example, as early as Gaucher's (EX1012) filing date in 2004, POSAs were aware of the limitations of existing mobile devices that only supported wireless connectivity within buildings that had wireless local area network (WLAN) "hot spots," but lacked connectivity when "on the road and away from hot spot locations." Gaucher, [0026]-[0027]. POSAs therefore recognized the market demand that "connectivity and mobility be maintained" and that "it would be advantageous in wireless applications to increase the mobility of the laptop computers." Gaucher, [0027]. POSAs were aware that one way to achieve this increased mobility for mobile devices that already included WLAN connectivity was to integrate the same "wireless wide area network (WWAN) connectivity often used in cell phone connections on the road." Gaucher, [0027].

45. By June 2005, POSAs were well underway to designing mobile devices having two antennas, one for WWAN connectivity and one for WLAN connectivity, as discussed in Wong (EX1005), Gaucher, and Zhao (EX1008), which I further discuss below. Further, numerous mobile devices that included WWAN and WLAN connectivity were already available for sale, such as the Dialogue Flybook (EX1028).

46. POSAs were thus aware of various problems that arise in designing and integrating multiple antennas in mobile devices (as evidenced in Wong, Gaucher, Lee, and Zhao,) and were actively designing various solutions prior to June 2005 based on evolving mobile device form-factors and cellular (WWAN) and wireless (WLAN) connectivity standards.

47. As summarized above with regards to my qualifications and experience, I possessed at least the level of skill of a POSA at the time of the alleged invention of the '458 patent.

48. I have worked with many people who fit the characteristics of the POSA, and I am familiar with their level of skill in and around June 2005. When developing the opinions set forth in this declaration, I assumed the perspective of a POSA as set forth above.

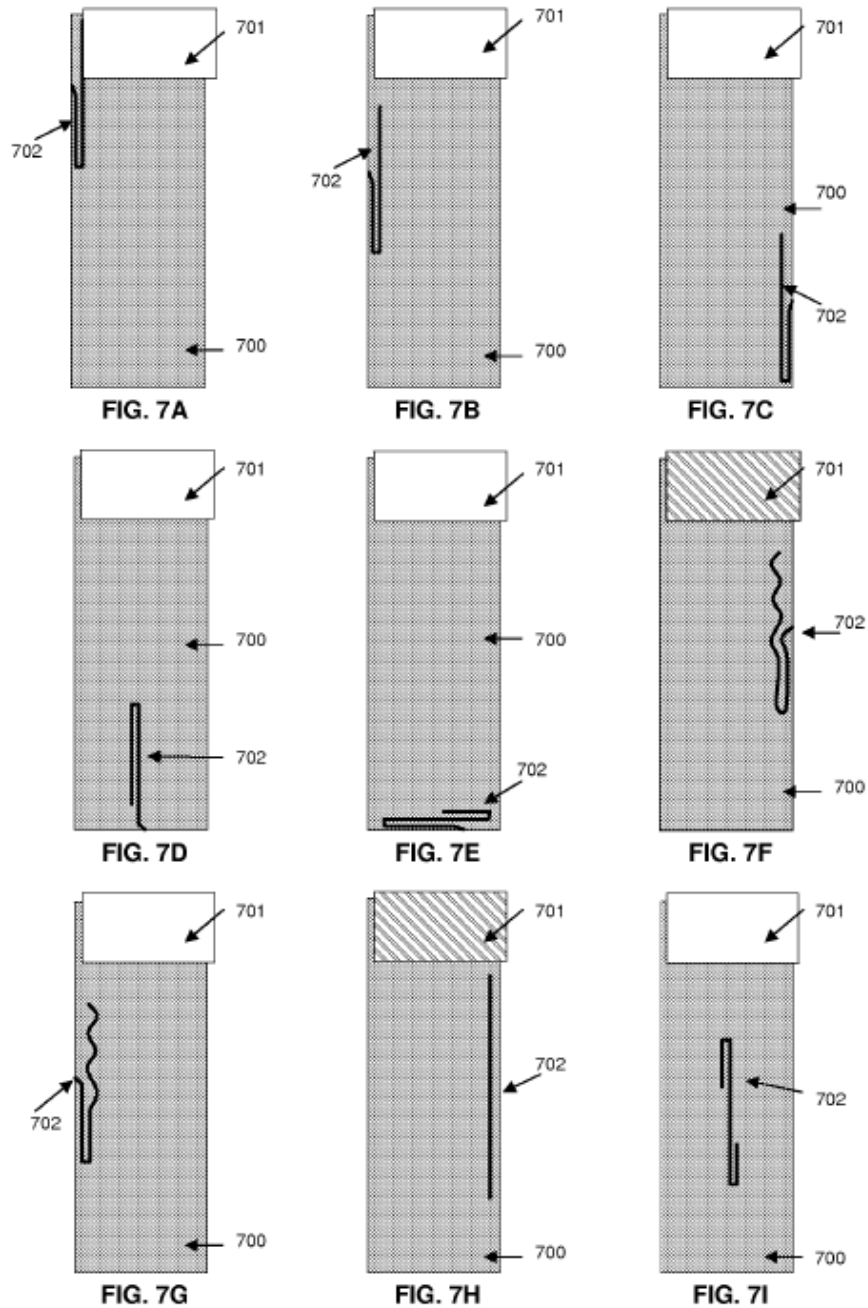
VII. THE '458 PATENT

A. Embodiments

49. The '458 patent concerns wireless portable devices (for example, mobile phones, smartphones, laptops) having multiple antennas for receiving and transmitting electromagnetic signals in different frequency bands. EX1001, 1:30-43. The device includes a first antenna (“mobile antenna”) supporting cellular communications and a second antenna (“wireless connectivity antenna”) supporting wireless connectivity services (for example, WLAN, Bluetooth).

EX1001, 1:37-40, 9:26-58. The patent purports to provide good isolation between the antennas by appropriately choosing the placement and orientation of each in relation to the device's printed circuit board (PCB). EX1001, 1:44-50.

50. Figures 7A-7I (below) illustrate "top views" of the mobile antenna (701) and wireless connectivity antenna (702) at various placements on the device's PCB. EX1001, 15:13-16, 18:29-35. In this perspective, mobile antenna 701 is at the top edge of the PCB while wireless connectivity antenna 702 is placed at different locations on the PCB. The '458 patent states it is preferable to keep the separation between the antennas as large as possible to maximize isolation between them. EX1001, 18:31-35. For example, Figure 7C's antenna arrangement purportedly yields better isolation than Figure 7A because it provides larger antenna separation than in Figure 7A. EX1001, 18:35-38.



B. Challenged Claims

51. I have been instructed by counsel for Petitioners to apply the prior art discussed here to claims 1-10 and 12-19 of the '458 patent. My application of the prior art to these claims is set forth in my analysis below. My analysis considers

the scope and content of the prior art, the differences between the prior art and the claims, the level of ordinary skill set forth above, and additional evidence listed in Appendix A showing the knowledge of a POSA prior to June 2005. My analysis including the annotated figures shows that claims 1-10 and 12-19 would have been obvious to a POSA based on Wong, Lee, Gaucher, and Zhao, as explained below.

VIII. GROUND 1: WONG-LEE

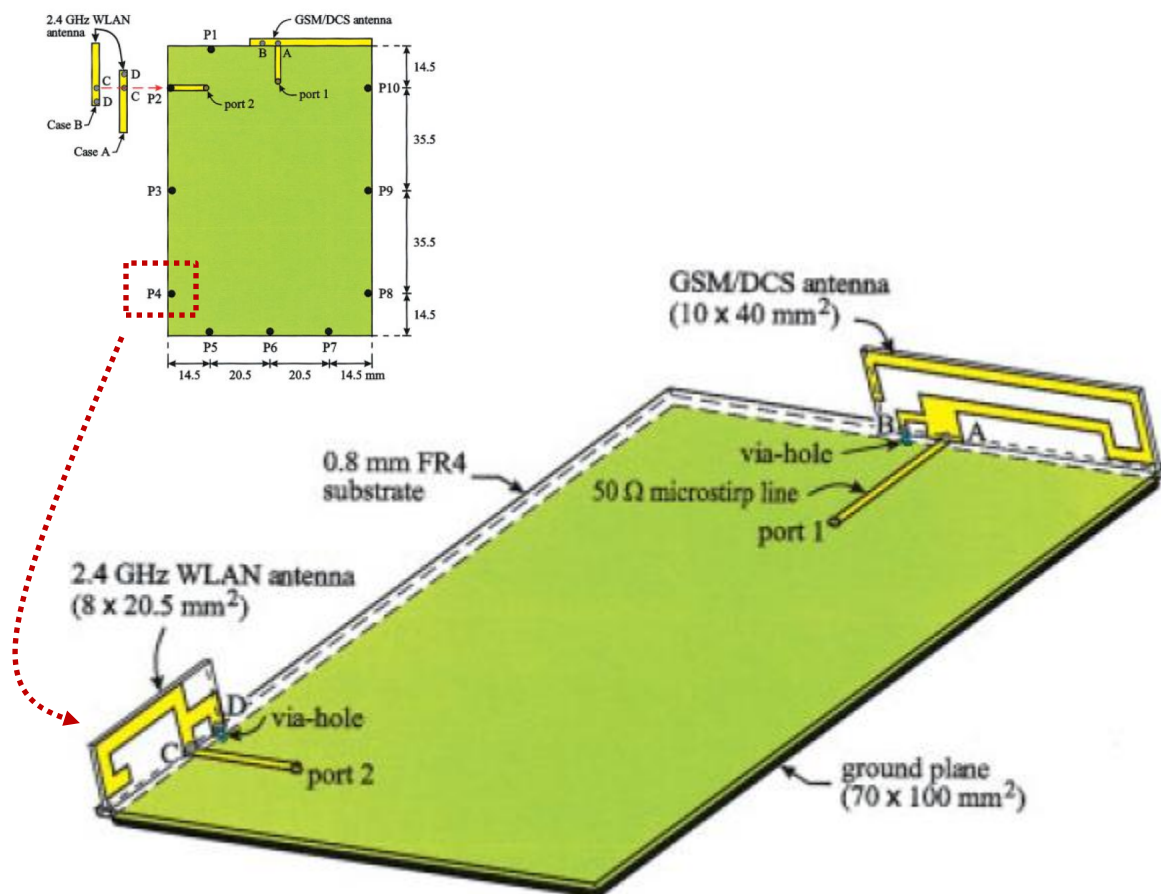
A. Wong (EX1005)¹

52. Wong studies the isolation between a Global System for Mobile Communications (GSM)/Digital Cellular System (DCS) antenna and a Wireless Local Area Network (WLAN) antenna positioned on a system circuit board (e.g., PCB) comprising a ground plane. Wong, 347-351. Both antennas are designed to be concealed inside the casing of a personal digital assistant (PDA) phone. Wong, 347-348; *e.g.*, EX1032, Fig. 5 (housing of mobile telephone 100 comprising PCB 10), [0058], [0004] (discussing “the entire apparatus housing [the antennas],” confirming that the mobile telephone 100 includes antennas within a housing);

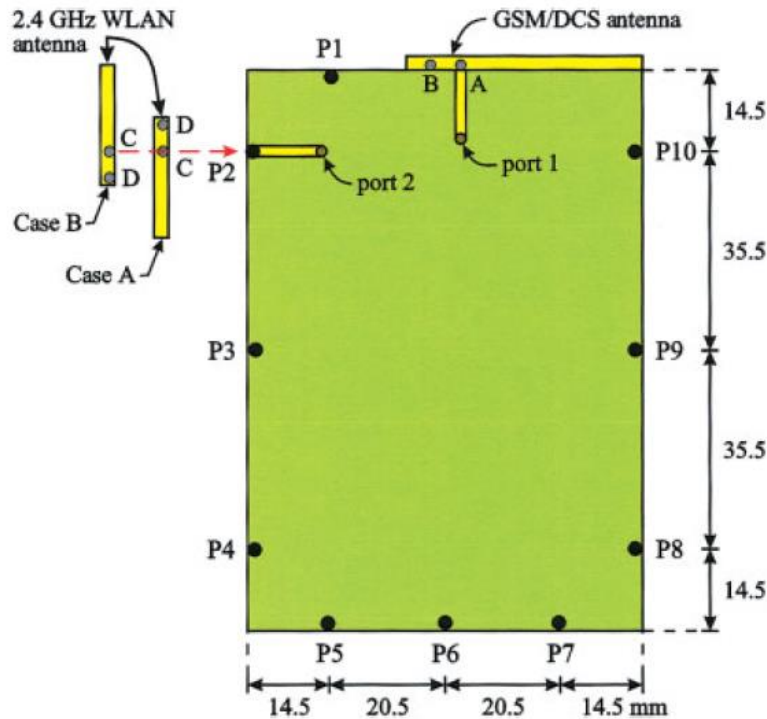
¹ The online version of Wong in EX1036 has the same disclosure as EX1005 except to add color to the figures. The figures from Wong included below use the same coloring as EX1036, which in no way changes the substance of the figures in EX1005.

EX1033, Fig. 6 (frame 602, PCB 603), 4:16-26; EX1034, Figs. 1, 3, 3:20-22, 6:13-15.

53. Wong evaluates antenna isolation by fixing a GSM/DCS antenna at a system circuit board's top edge and varying the WLAN antenna position (for example, P1-P10) along the system circuit board boundary. Wong, Figs. 1-2, 348-350.



Wong, Figure 1(a) (annotated, Fig. 2 inset)



Wong, Figure 2

B. Lee (EX1011)

54. Lee describes a quad-band monopole antenna, designed to be placed within the casing of a mobile device. Lee, 359. The quad-band antenna can transmit and receive at 824-967 MHz and 1707-2000 MHz. Lee, Fig. 2, 359.

55. I note that Lee reports the antenna's impedance bandwidth at Voltage Standing Wave Ratio of 2.5:1, which corresponds to a return loss of 7.36 dB. The frequency range at this impedance match defines the antenna's bandwidth, e.g., its operating range. The vertical axis of Lee's Figure 2 shows return loss in decibels (dB) for the quadband antenna, versus frequency on the horizontal axis.

Specifying the impedance match of interest (e.g., via the VSWR or return loss) provides the antenna impedance bandwidth. While there is no particular reason

that a POSA would have limited themselves to this particular impedance matching criteria for evaluating the antenna bandwidth—a more demanding design specification could require higher return loss, while a less demanding design specification could accept a lower return loss—the 2.5:1 VSWR (7.36 dB return loss) was a typical value used to evaluate antennas for this application, e.g., for handheld or portable wireless devices. In my opinion, a POSA would have readily agreed with Lee that this antenna would have worked well at 824-967 MHz and 1707-2000 MHz.

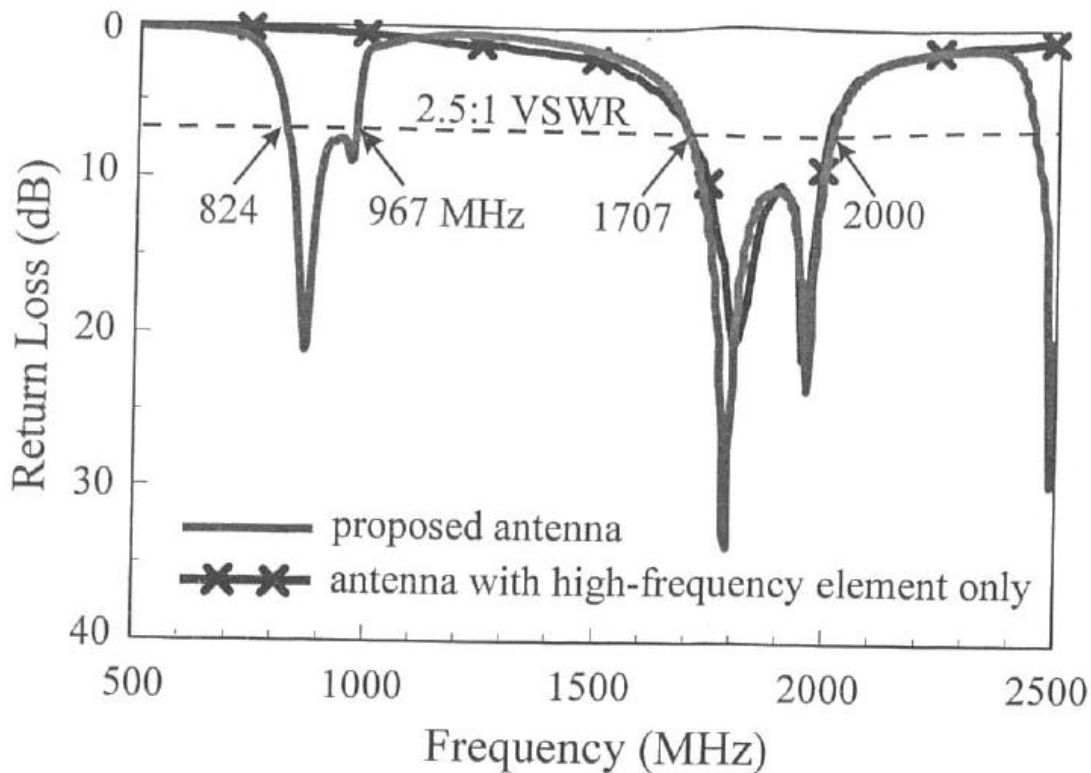
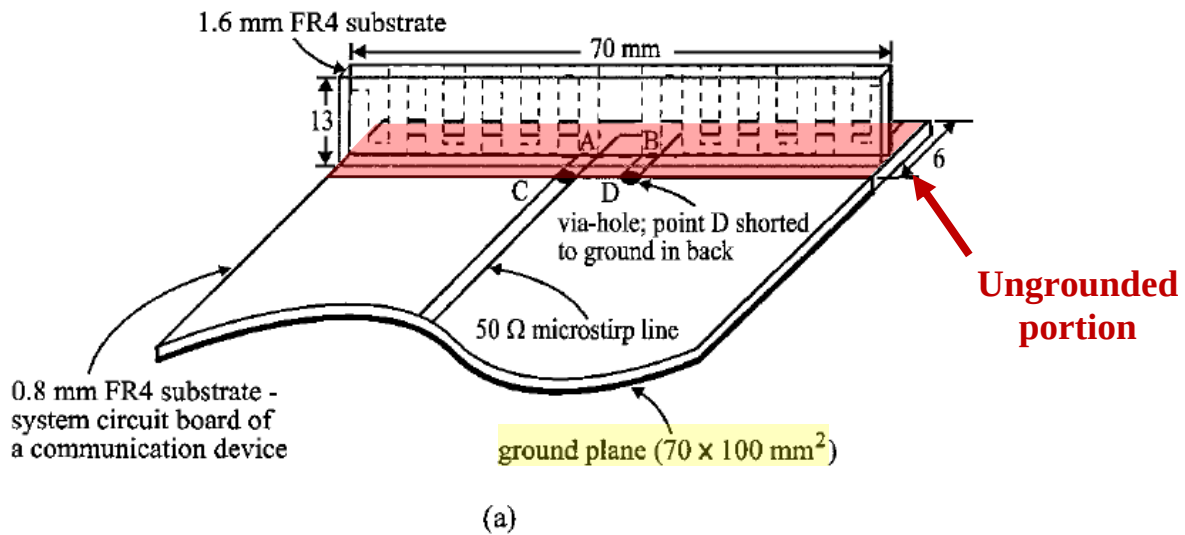


Figure 2 Measured return loss for the proposed antenna and the antenna with the high-frequency element only

56. These frequencies encompass ranges associated with several standard cellular communication bands: 824–894 MHz (AMPS or GSM850), 880–960 MHz (extended GSM), 890–960 MHz (standard GSM900), 1710–1880 MHz (GSM1800 or DCS1800), and 1850–1990 MHz (PCS1900). Lee, 359; EX1009, 9.

57. Lee mounts the quad-band antenna on an FR4 substrate—a flame-retardant (hence, “FR”) glass epoxy material with desirable permittivity for RF applications that is a popular material commonly used as a substrate for PCBs (*e.g.*, EX1014, [0038])—that provides a “system circuit board of a communication device.” Lee, Fig. 1(a), 359. Lee shows a $70 \times 106 \text{ mm}^2$ substrate: the FR4 material beneath the quad-band antenna is an ungrounded $70 \times 6 \text{ mm}^2$ region adjacent to a $70 \times 100 \text{ mm}^2$ region having a ground plane disposed on the substrate surface—opposing the antenna, *e.g.*, the “bottom” layer in Figure 1(a)’s perspective. Lee, Fig. 1(a) (annotated below), 359.



Lee, Figure 1(a) (annotated)

C. Wong-Lee Combination

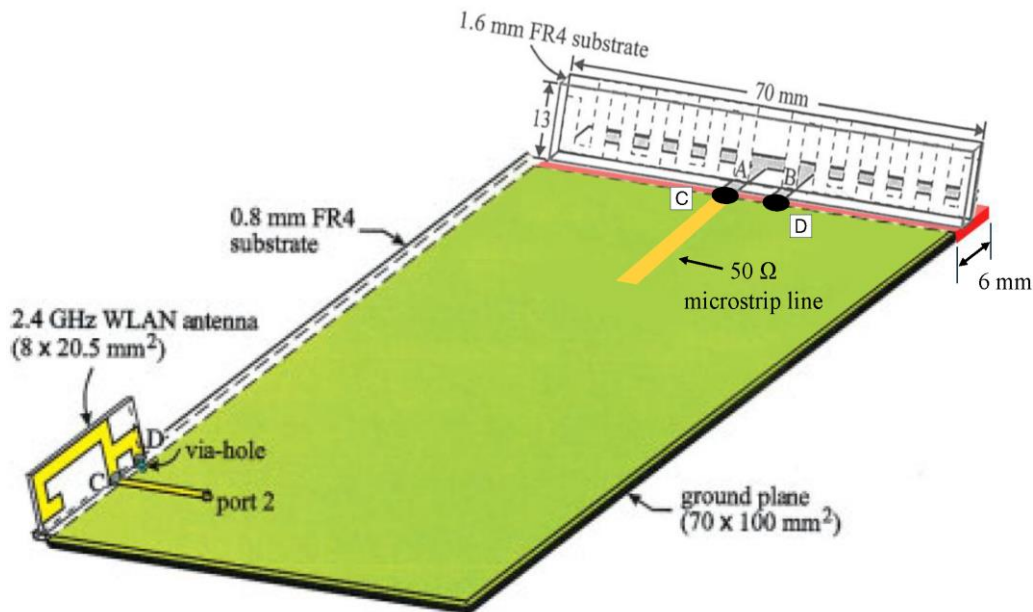
1. Combination

58. Both Wong and Lee disclose ground planes and antennas for use in a mobile device such as a PDA phone.

59. Although Wong focuses on evaluating isolation between two antennas at different locations on the PCB, rather than describing other components of a PDA phone in detail, Wong gave POSAs reasons to use the described antennas and ground plane in a PDA phone. Wong, 347 (“The isolation performances of GSM/DCS and WLAN antennas *embedded in a PDA phone*... are studied. The two (GSM/DCS and WLAN) antennas... are mounted perpendicularly along the

boundary of the system circuit board... *to perform as internal antennas for the PDA phone.*)²

60. Similarly, although Lee does not describe other mobile device components in detail, it too explains that its antennas are intended as internal components in a mobile phone. Lee, 359 (“The quad-band monopole antenna is also arranged in a compact structure... *thus making it very promising as an internal antenna, built-in within the device’s casing.*”). Thus, it is my opinion that POSAs would have had reasons to use the components described in Wong and Lee as internal antennas within a PDA phone. I further refer to this combination as Wong+Lee.



Wong+Lee

² Emphasis is added herein unless otherwise indicated.

61. It is my opinion that in Wong in view of Lee (“Wong+Lee”), as depicted above, a POSA would have replaced Wong’s GSM/DCS antenna with Lee’s quad-band antenna near the “top” edge of the system circuit board (in Figure 1(a)’s perspective view) as Wong teaches. The Wong+Lee system circuit board thus includes Lee’s ungrounded 70 mm × 6 mm substrate extending beyond the edge of the 70 mm × 100 mm ground plane backing the rest of the FR4 substrate. The resulting combination provides the relative antenna placement described in Wong using Lee’s quad-band antenna.

2. Reasons to Combine

62. It is my opinion that POSAs would have had several reasons to substitute Lee’s quad-band antenna for Wong’s GSM/DCS antenna. Wong’s dual-band GSM/DCS antenna covers two cellular bands—GSM 900 (890–960 MHz) and DCS1800 (1710–1880 MHz)—used in Europe. Wong, 347; Gaucher, [0030].

63. POSAs knew that international variation in standard communication frequencies made deploying devices for wireless wide area networks (WWAN, e.g., cellular) problematic. Gaucher, [0028]. This made it desirable to provide devices capable of operating in the four most popular frequency bands:

AMPS/GSM850 (824–894 MHz) and ***PCS1900 (1850–1990 MHz)*** for North America, and ***GSM900 (880–960 MHz)*** and ***DCS1800 (1710–1880 MHz)*** for Europe. Gaucher, [0030].

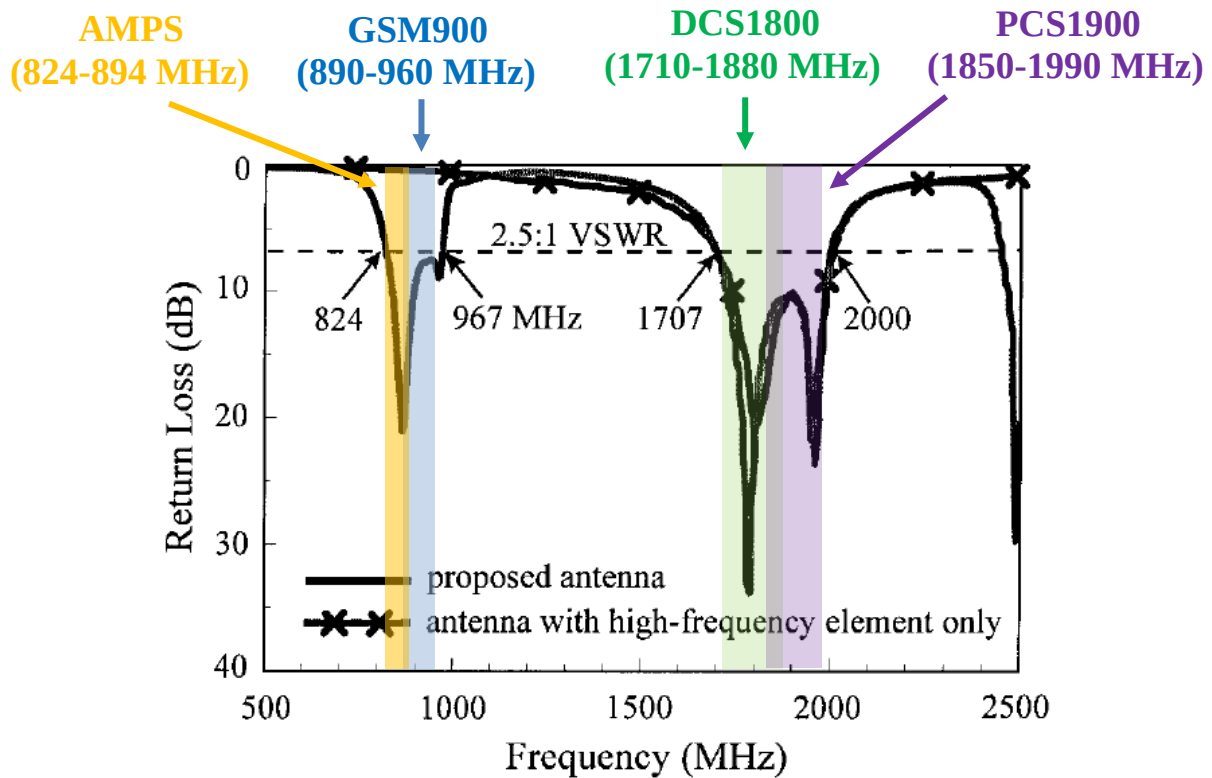
64. It is my opinion that POSAs would have had reasons to replace Wong's dual-band GSM/DCS antenna with Lee's quad-band antenna in order to add coverage for AMPS/PCS bands in North America, thereby extending the PDA phone capability and providing a device capable of operating in North America and Europe. Lee, 359; Gaucher, [0030]. POSAs would have regarded Lee's quad-band antenna as a natural extension of Wong's dual-band GSM/DCS antenna.

65. Lee's disclosure overlaps with Wong's disclosure (and the two share a common co-author, Kin-Lu Wong). For instance, Lee's quad-band antenna operates with a ground plane identical in size to Wong's $70 \times 100 \text{ mm}^2$ ground plane. Wong, 348; Lee, 359. Lee describes its $70 \times 106 \text{ mm}^2$ FR4 substrate as compatible with practical PDA phones. Lee, 359. POSAs would have sized Wong+Lee's PDA at roughly the same dimensions as its system circuit board because it was conventional for a wireless device's system circuit board (e.g., PCB) to have dimensions commensurate with the device's housing, for example, filling the available planar space within the device. *E.g.*, EX1032, Fig. 5 (mobile telephone 100, PCB 10), [0058]; EX1033, Fig. 6 (frame 602, PCB 603), 4:16-26; EX1034, Figs. 1, 3, 3:20-22 ("a circuit board assembly 302 of FIG. 3 is positioned in the front housing portion 106 [of the electronic device]"), 6:13-15 ("device 100... is suitable for portable or handheld operation").

66. It is my opinion that Wong+Lee would have used known components (Wong's system circuit board, ground plane and WLAN antenna, Lee's quad-band antenna), in a PDA phone (as motivated by both Wong and Lee) according to their conventional uses, with predictable results. It is also my opinion that Wong+Lee would have used Lee's quad-band antenna instead of Wong's dual-band GSM/DCS antenna to obtain the predictable result of a PDA phone with quad-band cellular capabilities.

3. Reasonable Expectation of Success

67. It is my opinion that POSAs would have had a reasonable expectation of success in replacing Wong's dual-band GSM/DCS antenna with Lee's quad-band antenna. Both can be used in cellular phones, and both are disposed proximate to a ground plane with an area of $70 \times 100 \text{ mm}^2$. Wong, 348; Lee, 359. Lee's quad-band antenna supports bandwidths sufficient to "***cover the required bandwidths of the AMPS/GSM and DCS/PCS bands.***" Lee, Fig. 2 ("proposed antenna" response annotated below), 360-361.



68. The annotated figure above shows how the different cellular bands occupy different regions of the spectrum between 800 and 2500 MHz. As is readily seen, the proposed antenna return loss is below 7.36 dB (e.g., at VSWR 2.5:1) for each of the four bands of interest.

69. Because Lee's quad-band antenna uses a PCB with the same ground plane area shown in Wong, and because Lee's quad-band antenna covers the desired frequency bands, it is my opinion that POSAs would have had a reasonable expectation of success in replacing Wong's dual-band GSM/DCS antenna with Lee's quad-band antenna to provide a PDA phone with Lee's quad-band coverage and Wong's WLAN coverage.

D. Mapping to Claims 1-9 and 12-13

1. Claim 1

a. Preamble

1.PRE	A wireless handheld or portable device comprising:
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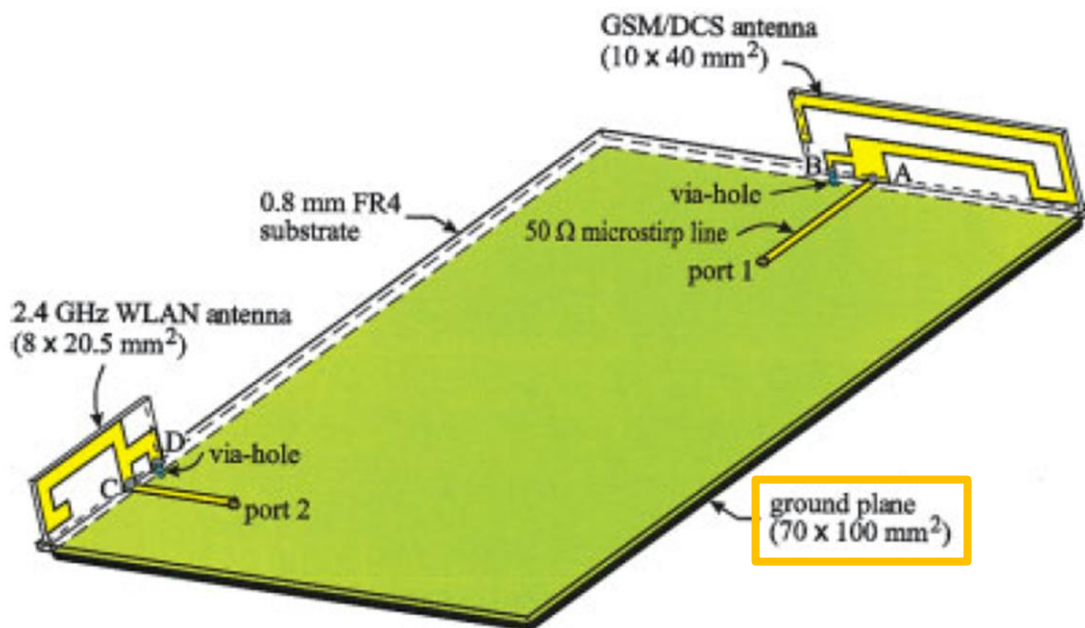
70. Wong+Lee meets [1.PRE] because its PDA phone is a “*wireless handheld or portable device*” and Wong+Lee meets the remaining limitations of claim 1 as shown below. See Section VIII.C (discussing Wong+Lee). POSAs would have found it obvious to incorporate Wong’s and Lee’s teachings in a handheld or portable device such as a PDA phone supporting cellular/WLAN dual-network operations because Wong’s antennas are designed “***to perform as internal antennas for [] PDA phone[s].***” Wong, 347. Similarly, Lee’s quad-band antenna (replacing Wong’s dual-band GSM/DCS antenna in Wong+Lee) is designed “***for application as an internal mobile-phone antenna.***” Lee, 359.

71. It is my opinion that POSAs would have recognized Wong+Lee’s PDA phone to be *wireless* because it supports cellular/WLAN dual-network operations with internal antennas. Further, Wong+Lee is *handheld* and *portable* because PDA phones were known to be sized and configured to be held and carried in a user’s hand. See Section VIII.C.2 (describing handheld devices similarly sized to the PCB in EX1032, EX1033, and EX1034).

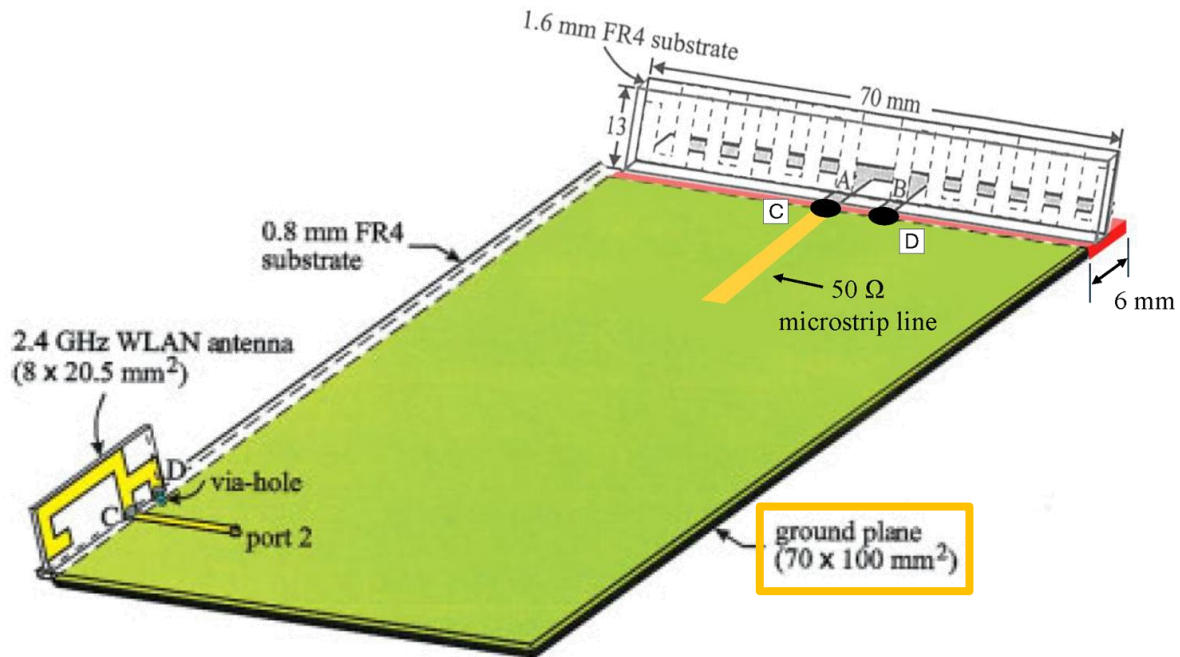
b. Limitation [1.a]

1.a	a ground plane;
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72. Wong+Lee meets [1.a] because it uses Wong's ground plane, having "a reasonable size for practical PDA phones." Wong, 348, Fig. 1(a) (annotated below).



Wong, Figure 1(a)



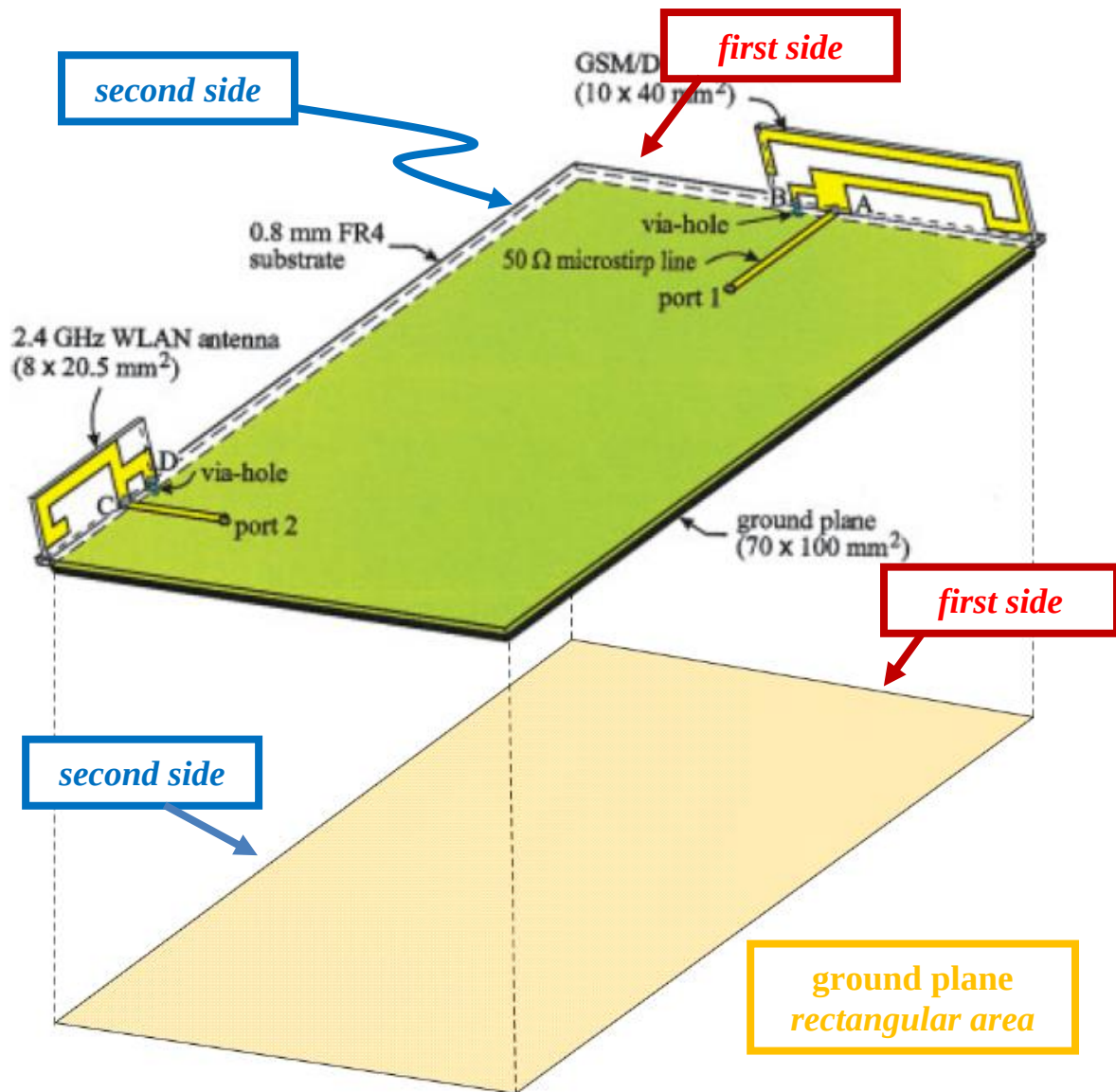
Wong+Lee

c. Limitation [1.b]

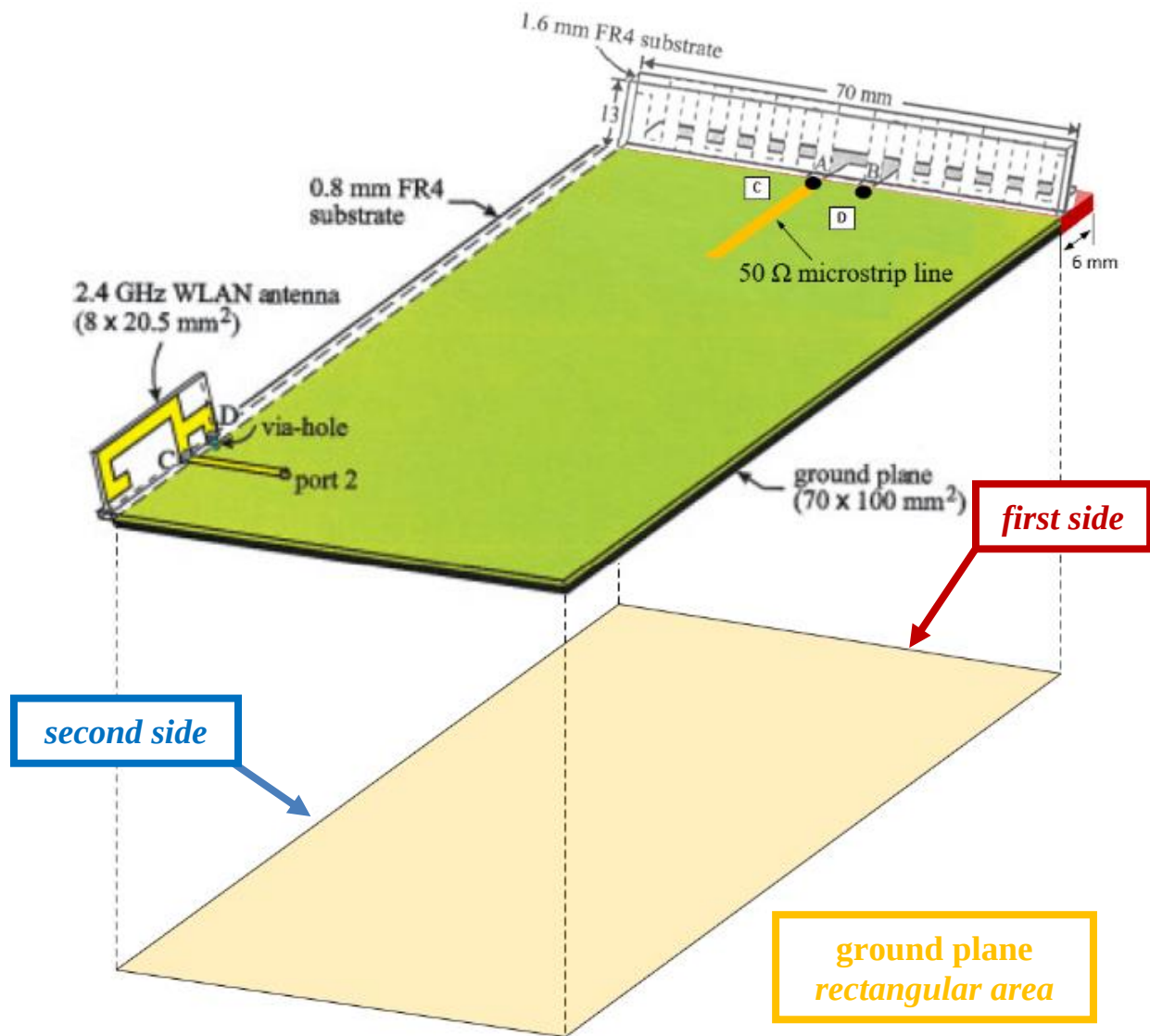
1.b	the ground plane is inscribed in a rectangular area comprising a first side and a second side, a length of the second side being greater than a length of the first side;
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73. Wong+Lee meets [1.b] because Wong’s ground plane is a layer of Wong’s rectangular PCB having a rectangular shape (“*is inscribed in a rectangular area*”) with sides of 70 mm (“*first side*”) and 100 mm (“*second side*”). Wong, 348, Fig. 1(a) (annotated below). The length of the second side (100 mm) is greater than the length of the first side (70 mm), resulting in a rectangle *inscribing the ground plane* layer of the same dimensions, as shown in the annotated Figure

below where the ground plane rectangle is represented from the back of Wong's PCB.



Wong, Figure 1(a) (annotated)



Wong+Lee

d. Limitation [1.c]

1.c	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least three frequency bands;
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74. Wong+Lee meets [1.c] because Lee's quad-band antenna (*"first antenna"*) supports **four** frequency bands (*"at least three frequency bands"*) for

cellular communication—three of which (GSM850 [AMPS]³, GSM900, PCS1900) match bands described in the '458 patent itself. Lee, 359 (“the proposed antenna has wide impedance bandwidths for both its two operating frequencies, thus making the antenna capable of **quad-band** operation in the advanced mobile phone system (APMS [sic], **824–894 MHz**), GSM (**890–960 MHz**), DCS (**1710–1880 MHz**), and PCS (**1850–1990 MHz**) bands.”); EX1001, 2:4-7 (“these handheld devices also operate in at least one frequency band used for mobile communication services, such as GSM (**GSM850**, **GSM900**, GSM1800, American GSM or **PCS1900**, GSM450)”).

75. Radio transmissions on these frequencies are “*electromagnetic waves*,” which Lee’s quad-band antenna is configured to both *transmit and receive* because GSM850, GSM900, DCS1800, and PCS1900 bands comprise frequencies for uplink and downlink communication, as indicated in the 3GPP specification:

for GSM850, the system is required to operate in the following band:
824 MHz to 849 MHz: mobile transmit, base receive; 869 MHz to 894 MHz: base transmit, mobile receive...

³ GSM850 and AMPS [Advanced Mobile Phone System] both use 824-894 MHz. EX1009, 9; EX1030, 6:22-25.

for Standard GSM900 band, the system is required to operate in the following frequency band: 890 MHz to 915 MHz: mobile transmit, base receive; 935 MHz to 960 MHz: base transmit, mobile receive...

for DCS 1800, the system is required to operate in the following band: 1710 MHz to 1785 MHz: mobile transmit, base receive; 1805 MHz to 1880 MHz: base transmit, mobile receive...

for PCS1900, the system is required to operate in the following band: 1850 MHz to 1910 MHz: mobile transmit, base receive; 1930 MHz to 1990 MHz base transmit, mobile receive.”

EX1009, 9.

76. In the 3GPP specification, “mobile transmit, base receive” indicates mobile uplink communication while “base transmit, mobile receive” indicates mobile downlink communication. The 3GPP specification segments each band (GSM850, GSM900, DCS1800, and PCS 1900) into sub-bands, one reserved for uplink communication and one for downlink communication. Each of the frequency bands supported by Lee’s quad-band antenna encompasses the respective uplink sub-band and downlink sub-band identified in the 3GPP specification. Therefore, Lee’s antenna is configured to both *transmit and receive* because it is designed to work at the frequencies that are used for transmission and reception in these cellular communication bands.

e. Limitation [1.d]

1.d	the at least three frequency bands being used for mobile communication services;
-----	--

77. Wong+Lee meets [1.d] because the frequencies utilized by Lee’s quad-band antenna are all “*for mobile communication services.*” EX1001, 9:26-37 (confirming that “GSM850, GSM900, GSM1800... [and] PCS1900” are all for “mobile communication services”).⁴

f. Limitations [1.e]-[1.f]

1.e	a second antenna configured to receive electromagnetic waves corresponding to at least one frequency band;
1.f	the at least one frequency band being used for wireless connectivity services;

i. “frequency band”

78. Claim 7 depends from claim 1 and states that “***the at least one frequency band*** used for wireless connectivity services ***corresponds to*** at least one wireless connectivity service selected from the group comprising: Bluetooth[], IEEE 802.11a, IEEE 802.11b, IEEE 802.11g, WLAN, WiFi,... ZigBee....” These “wireless connectivity service[s]” use a subset of frequencies within standard Industrial, Scientific, and Medical (“ISM”) bands. For example, IEEE Std.

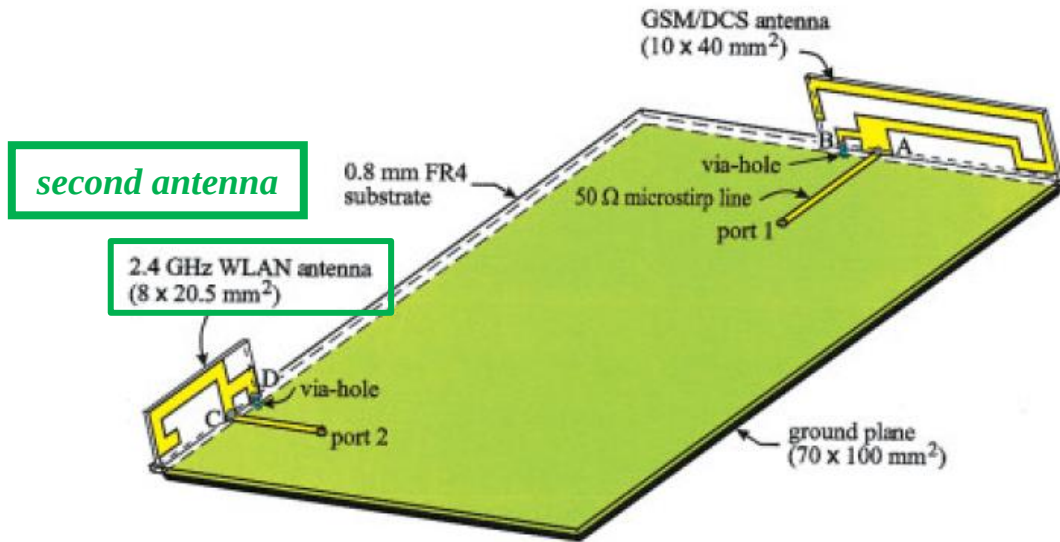
⁴ As explained in Section VIII.D.1.d ([1.c]) these bands correspond to the ranges listed in Lee.

802.11b (“802.11b”) operates in the 2.4 GHz ISM band (2400-2500 MHz). EX1015, 36069-36070; EX1018, 11 (IEEE Std. 802.11b-1999 WLAN operates in “the 2.4 GHz band designated for ISM applications”); EX1001, 9:55-57 (discussing ISM). In North America, 802.11b channels can occupy 2400-2472 MHz, while in Europe 802.11b channels can occupy 2400-2483.5 MHz. EX1018, 49-50, Figs. 142, 144. Therefore, [1.e] is met by an antenna supporting a “wireless connectivity service” that uses a subset of frequencies in (“*corresponding to*”) “*at least one frequency band.*”

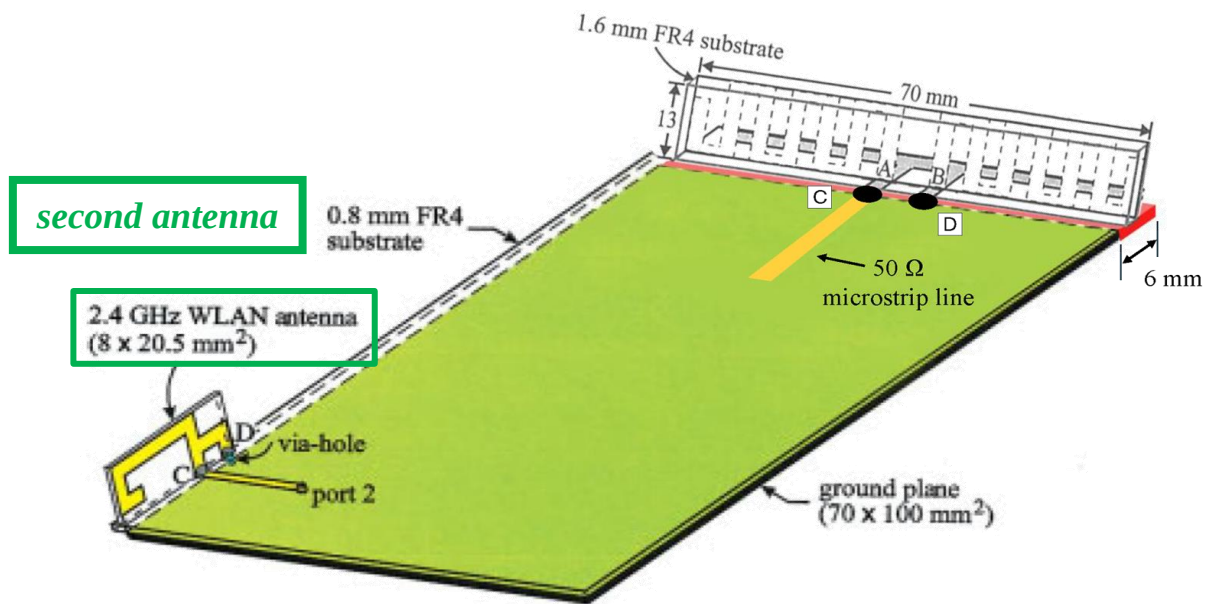
ii. Analysis

79. Wong+Lee meets [1.e] and [1.f] because Wong’s WLAN antenna (“*second antenna*”) is “one WLAN antenna for 2.4-GHz (2400–2484 MHz) WLAN operation.” Wong, 347. Wong’s WLAN antenna is thus “*configured to receive electromagnetic waves*” at these frequencies (2400-2484 MHz) because this is required for WLAN operation, which Wong’s WLAN antenna does. Wong, 347, Fig. 1(a) (annotated below). POSAs would have understood that Wong’s “2.4-GHz... WLAN operation” meant operation at 2400-2484 MHz within (“*corresponding to*”) the 2.4 GHz ISM band. Wong, 347.

80. WLAN operation is a “wireless connectivity service” meeting [1.f]. See Section VIII.D.1.f.i (above discussing “*frequency band*”); EX1001, 25:13-19, claim 7.



Wong's antennas



Wong+Lee antennas

g. Limitation [1.g]

1.g	the first antenna extends in a direction substantially parallel to the first side;
-----	--

i. “substantially parallel to the first side”

81. The '458 specification states that “[i]n this document, an antenna or the slot of a slot antenna ***is considered to extend (to be oriented) in the direction*** corresponding to the general longitudinal axis of symmetry of the smallest rectangle in which the radiating element of the antenna can be inscribed.”

EX1001, 10:38-42. I understand the “longitudinal axis of symmetry” to mean the axis extending parallel to the longer side of the rectangle. Figure 7(c) shows a first antenna extending in a direction substantially parallel to the first side of the ground plane. EX1001, Figure 7(c) (annotated below).

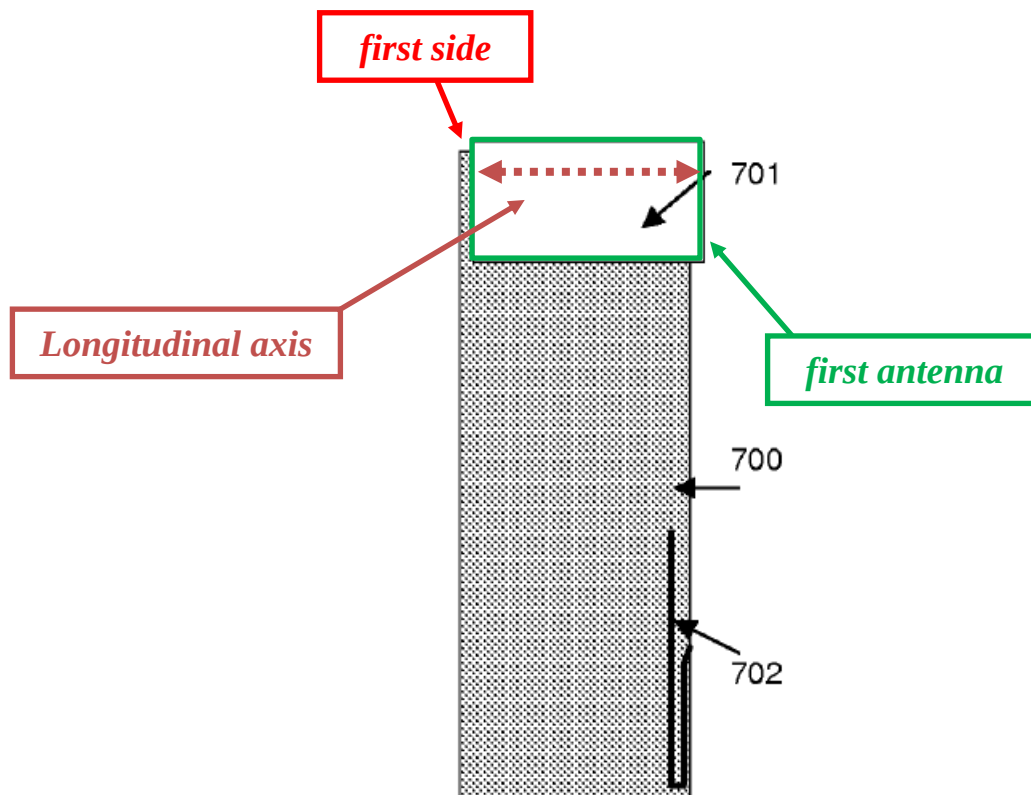
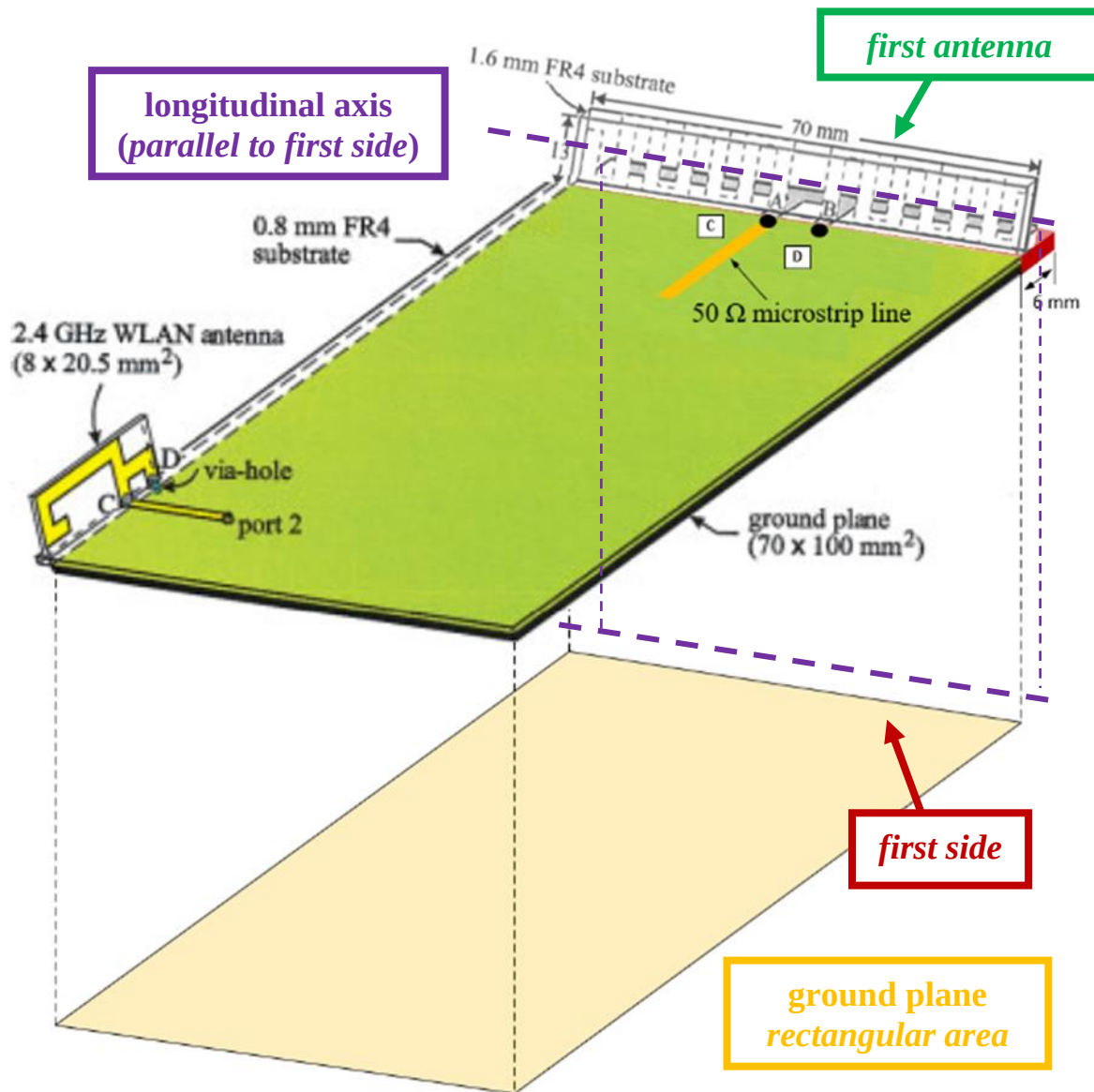


FIG. 7C

ii. Analysis

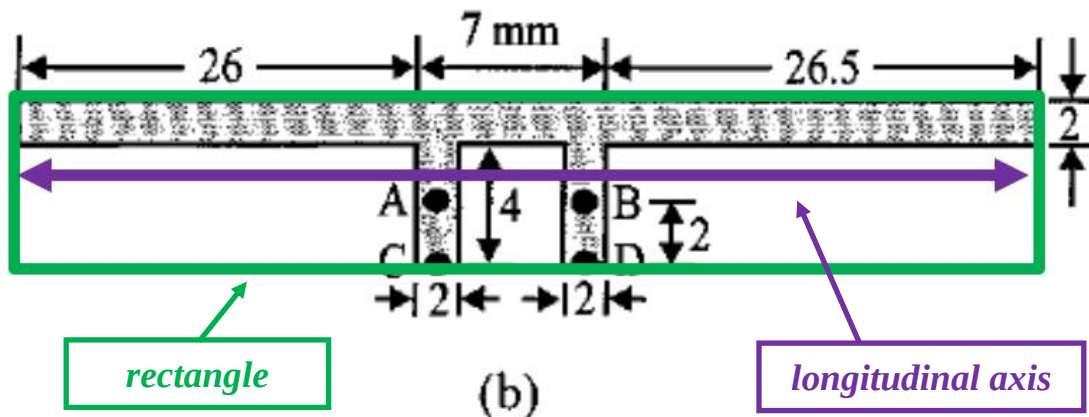
82. Wong+Lee meets [1.g] because Lee's quad-band antenna ("first antenna") extends in a direction *substantially parallel* to the *first side* of Wong's ground plane rectangle, as shown in the annotated figure below.



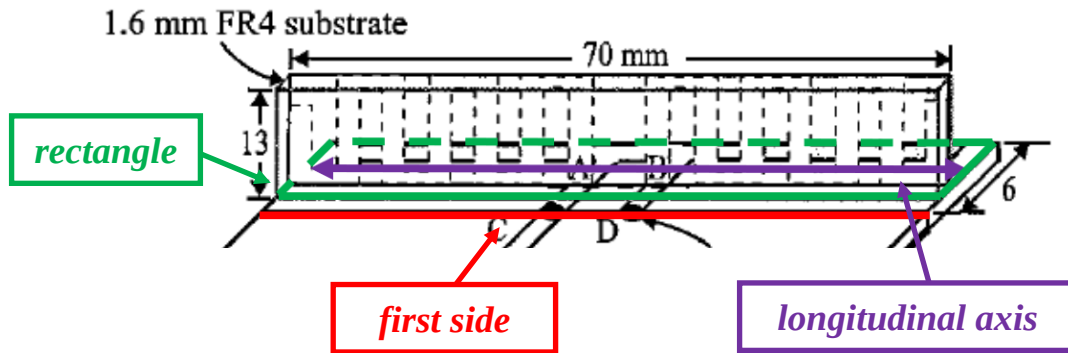
Wong+Lee

83. As observed in the figure above, Lee's antenna is mounted to Wong's PCB above the top edge of the ground plane, as Lee indicates. Lee, 359. The result yields the longitudinal axis of Lee's antenna (noted in purple) extending 70 mm relative to the PCB's ground plane (noted in orange), or in other words, the entire length of ground plane rectangle's short side. As a result, the combination of Wong+Lee shows that Lee's antenna "*extends in a direction substantially parallel*" to the 70 mm side (first side) of Wong's PCB.

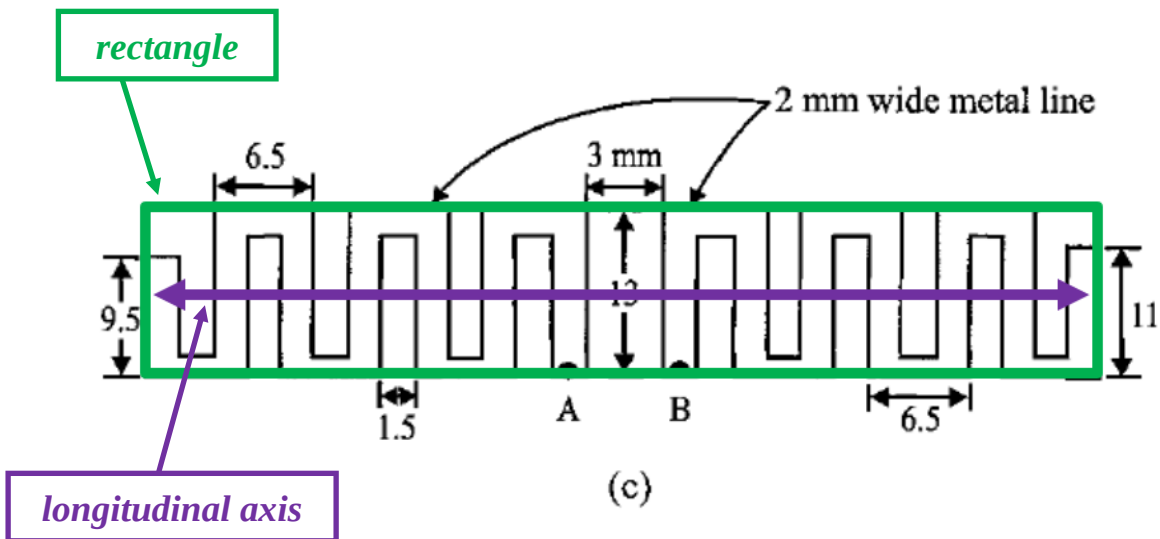
84. More specifically, Lee's quad-band antenna includes two orthogonal radiating monopole elements, separately for high and low frequencies. Lee, 359. Lee's high-frequency monopole element can be inscribed in a 6 (e.g., 4+2) mm $\times$ 59.5 (e.g., 26+26.5+7) mm rectangle parallel to the ground plane. Lee, Fig. 1(b) (annotated below).



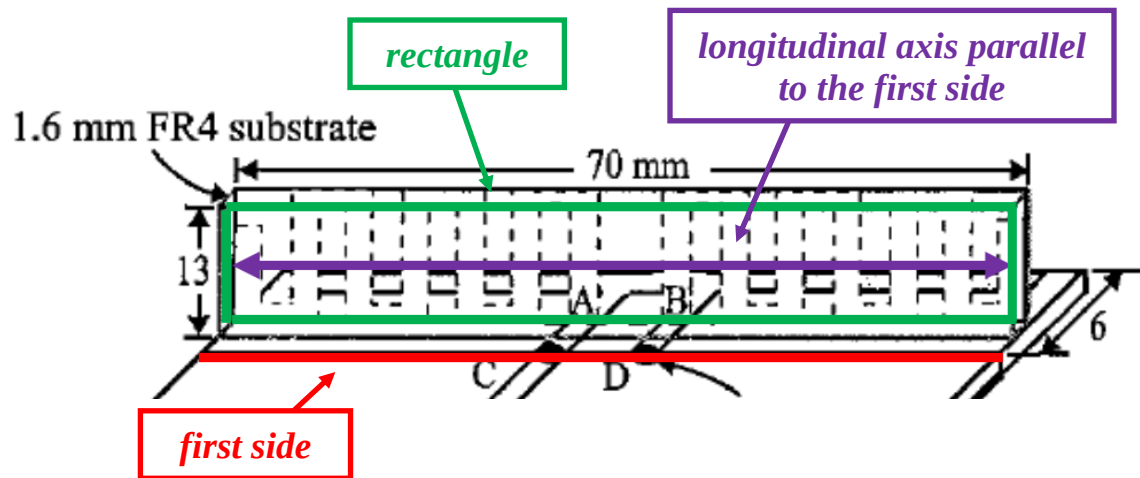
85. The rectangle's longitudinal axis is parallel to the first side of Lee's ground plane. Lee, Figure 1(a) (annotated below showing the rectangle of the monopole element from annotated Figure 1(b)).



86. Lee's low-frequency monopole element can be inscribed in a 13 mm $\times$ 55 (e.g., $(6 \times 6.5 = 39) + (6 \times 1.5 = 9) + 3 + 4$) mm rectangle perpendicular to the ground plane. Lee, Fig. 1(c) (annotated below).

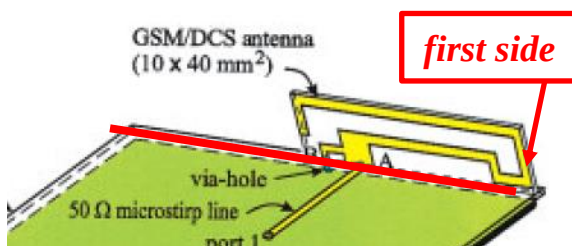


87. The rectangle's longitudinal axis is parallel to the first side of the PCB's ground plane rectangle. Lee, Fig. 1(a) (annotated below).

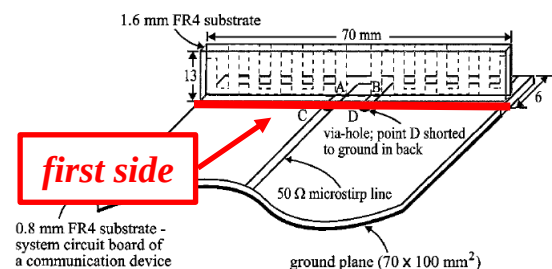


88. In short, the longitudinal axis for each rectangle inscribing a high and low frequency monopole element is parallel to the first side of the PCB's ground plane rectangle.

89. Lee's quad-band antenna and Wong's dual-band GSM/DCS antenna are each located at a top edge ("first side") of a ground plane. Wong, Fig. 1(a) (annotated detail below); Lee Fig. 1(a) (annotated detail below).

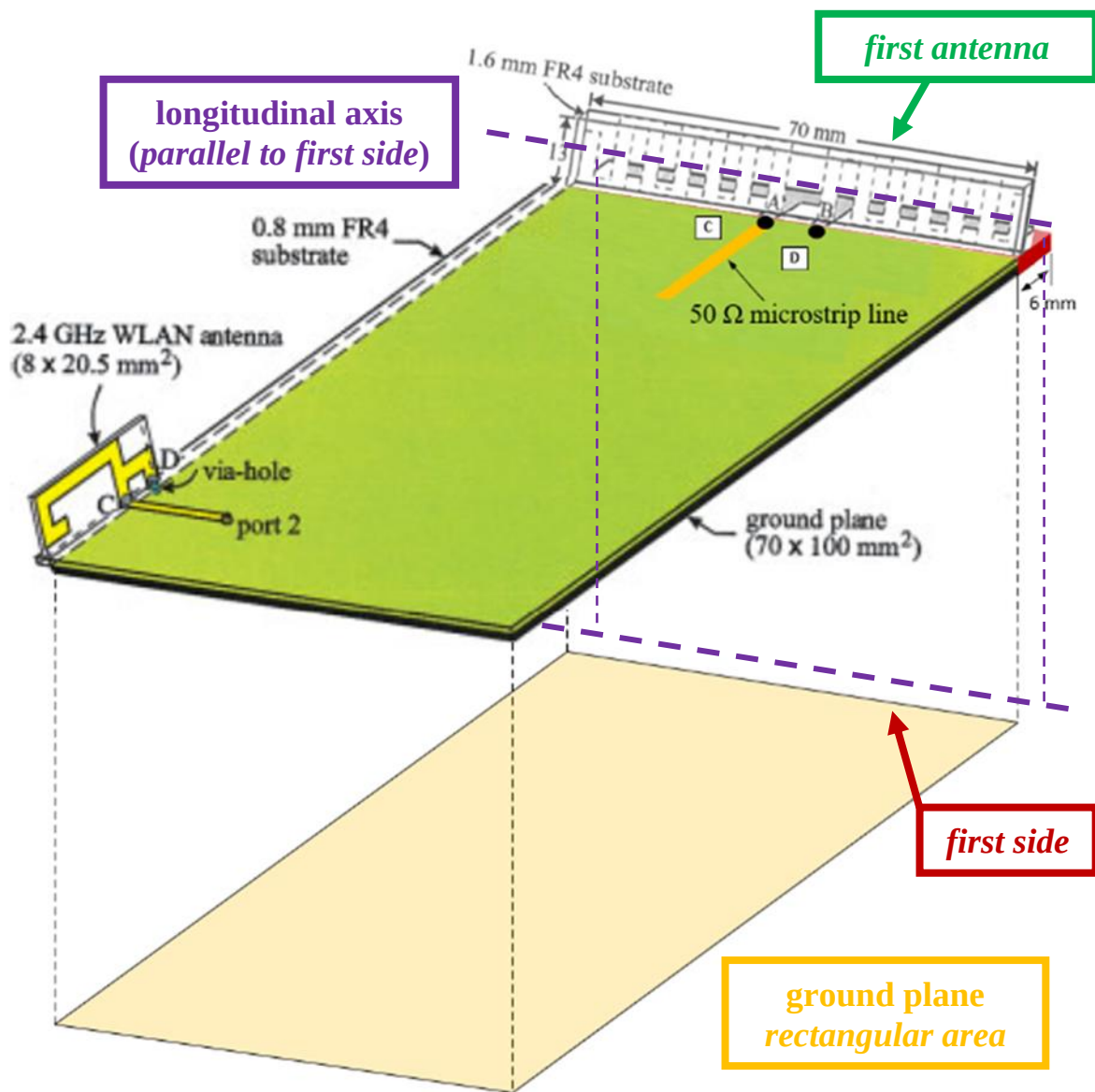


Wong, Fig. 1(a) (annotated detail)



Lee, Fig. 1(a) (annotated detail)

90. As shown below, Wong+Lee preserve the orientation of Lee's antenna relative to the ground plane so that Lee's cellular antenna extends in a direction substantially parallel to the first side of Wong's ground plane for the same reasons just explained.



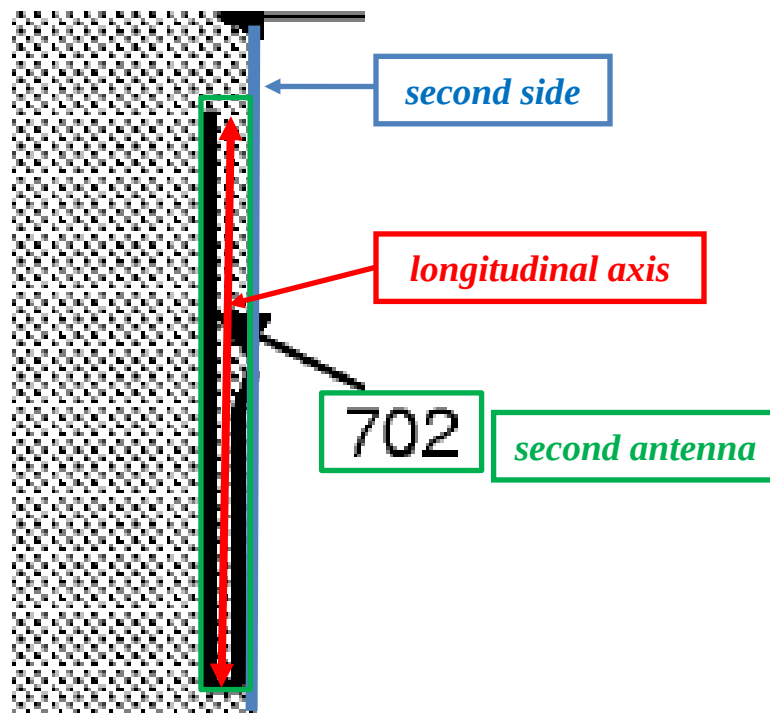
Wong+Lee

h. Limitation [1.h]

1.h	the second antenna extends in a direction substantially parallel to the second side;
-----	--

i. “*substantially parallel to the second side*”

91. Consistent with the definition at 10:38-42, the '458 patent Figure 7(c) depicts a second antenna extending in a direction substantially parallel to the second side of the ground plane. EX1001, Figure 7(c) (annotated below). The second antenna is inscribed in a rectangle having a longitudinal axis that is parallel to the second side. EX1001, Figure 7(c) (annotated below).

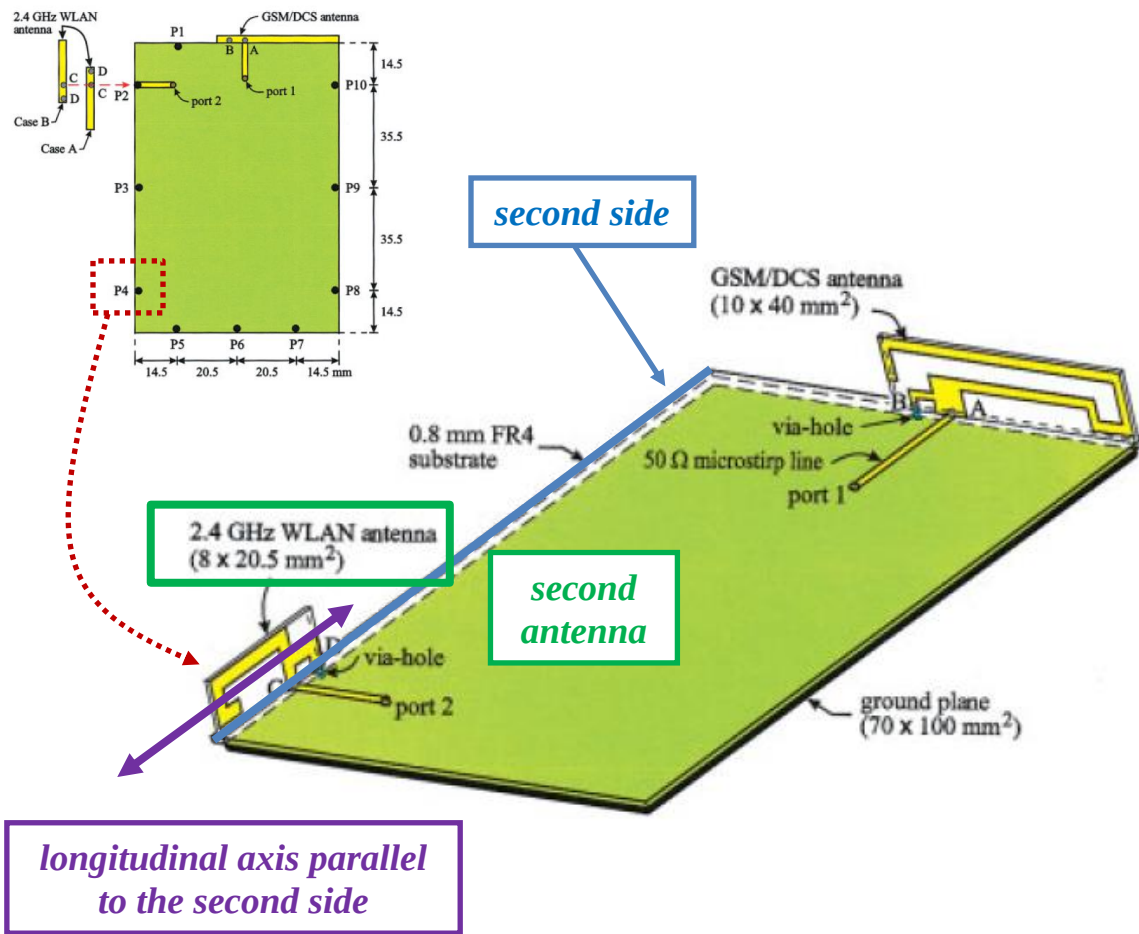


'458 patent, Figure 7(c) (annotated detail)

ii. Analysis

92. Wong+Lee meets [1.h] because Wong's WLAN antenna—when positioned at P4 in Wong's Figure 2 (below inset to Wong's Figure 1(a))—extends substantially parallel to the long axis (“second side”) of the ground plane. Wong, Fig. 2.

93. Wong's WLAN antenna is inscribed in an 8 mm × 20.5 mm rectangle perpendicular to the ground plane. The rectangle's longitudinal axis of symmetry is parallel to the longer arm of the WLAN antenna. Thus, it is parallel to the second side of the ground plane. Wong, 348, Fig. 1(a) (annotated below).



Wong, Fig. 1(a) (annotated, with Fig. 2 inset)

i. Limitation [1.i]

1.i	the first antenna is arranged substantially close to the first side; and
-----	--

i. “substantially close to the first side”

94. Figures 7(a) through 7(i) all show the first antenna arranged in the same location, close to the first side of the ground plane. Figure 7(c) (annotated below) is exemplary.

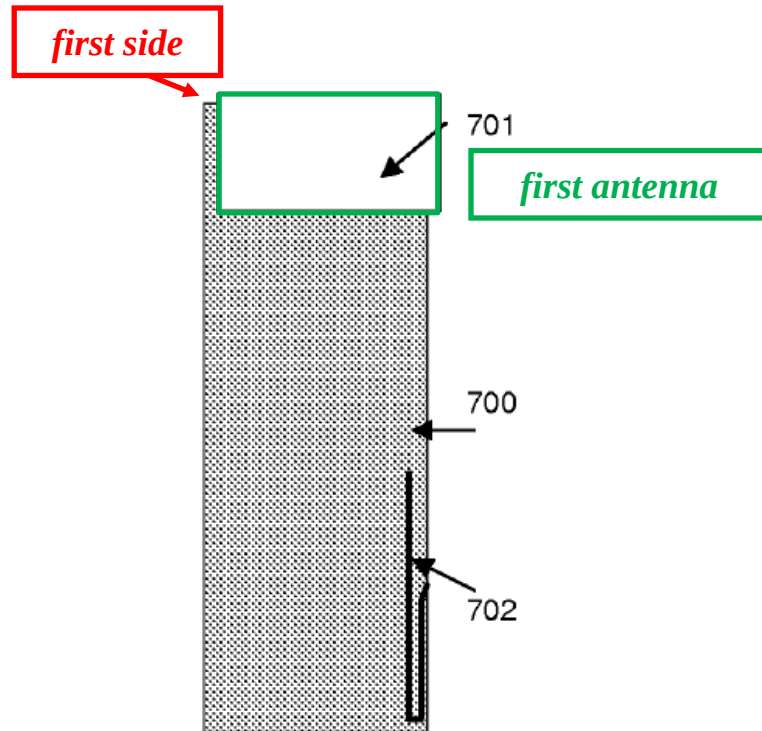
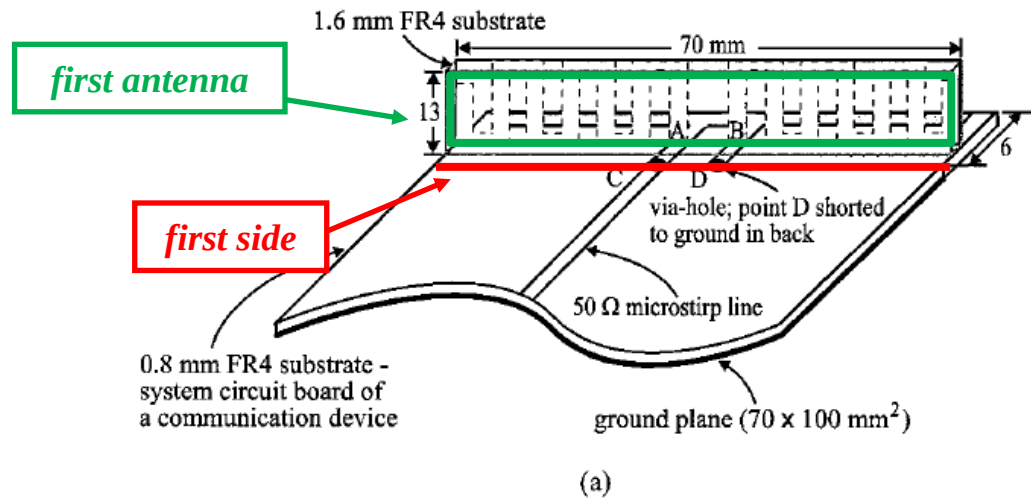


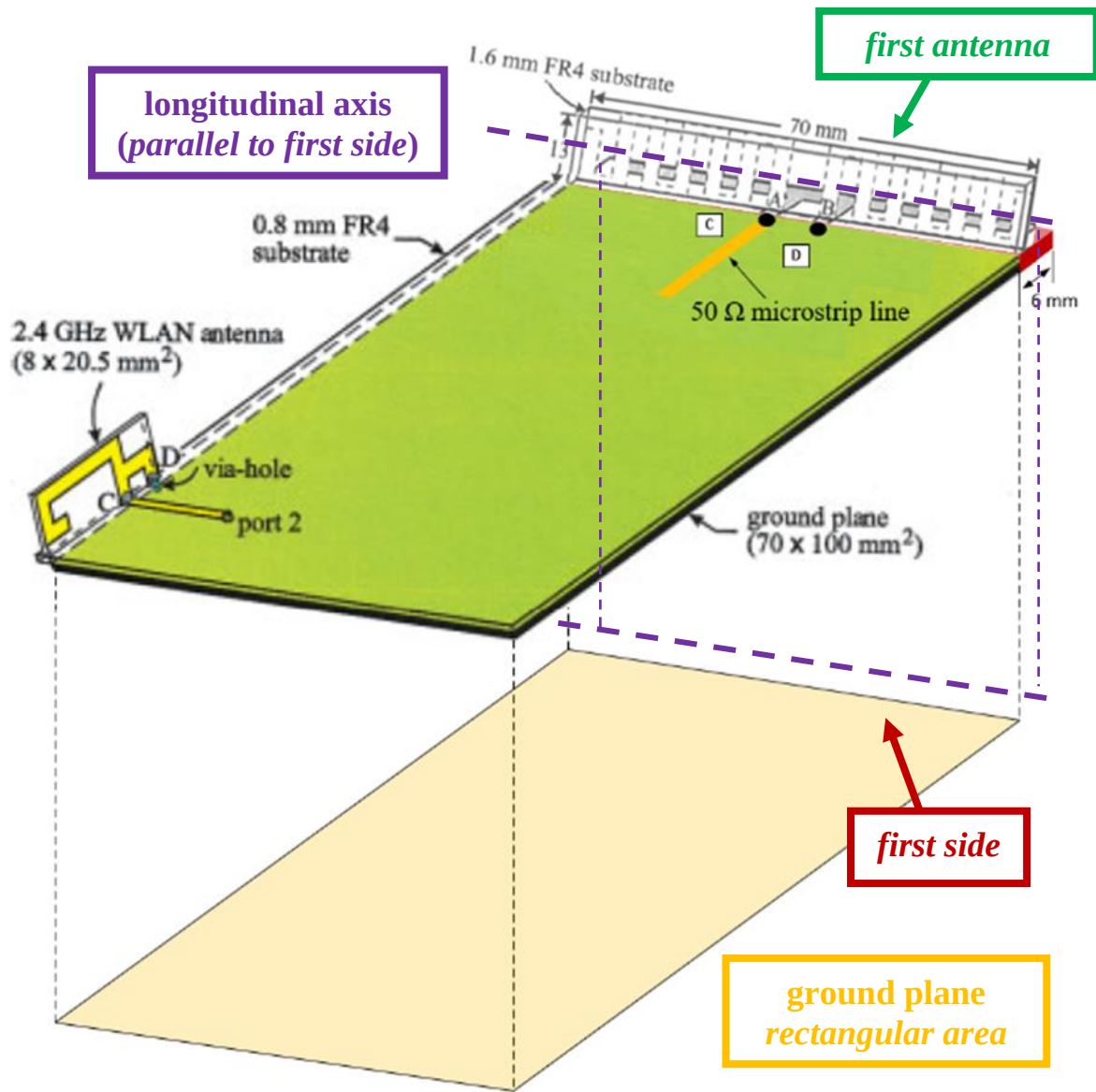
FIG. 7C

ii. Analysis

95. Wong+Lee meets [1.i] because Lee’s cellular antenna (“*first antenna*”) is disposed at and abuts the top edge of the first side of a system circuit board just like Wong’s. Lee, 359 (“The quad-band monopole antenna... ***protrudes from the top edge of the system ground plane***”), Fig. 1(a) (annotated below); Wong, 348 (“the GSM/DCS antenna is arranged to be ***fixed at the top edge of the system circuit board***”), Figs. 1(a), 2. In Wong+Lee, Lee’s quad-band antenna would thus be at least as close to the first side as is the first antenna in the patent’s Figures 7(a)-7(i).



Lee Fig. 1(a) (annotated)



Wong+Lee

96. Therefore, Wong+Lee's quad-band antenna ("first antenna") is arranged substantially close to the first side.

j. Limitation [1.j]

1.j	the first antenna and the second antenna are located internally within the wireless handheld or portable device.
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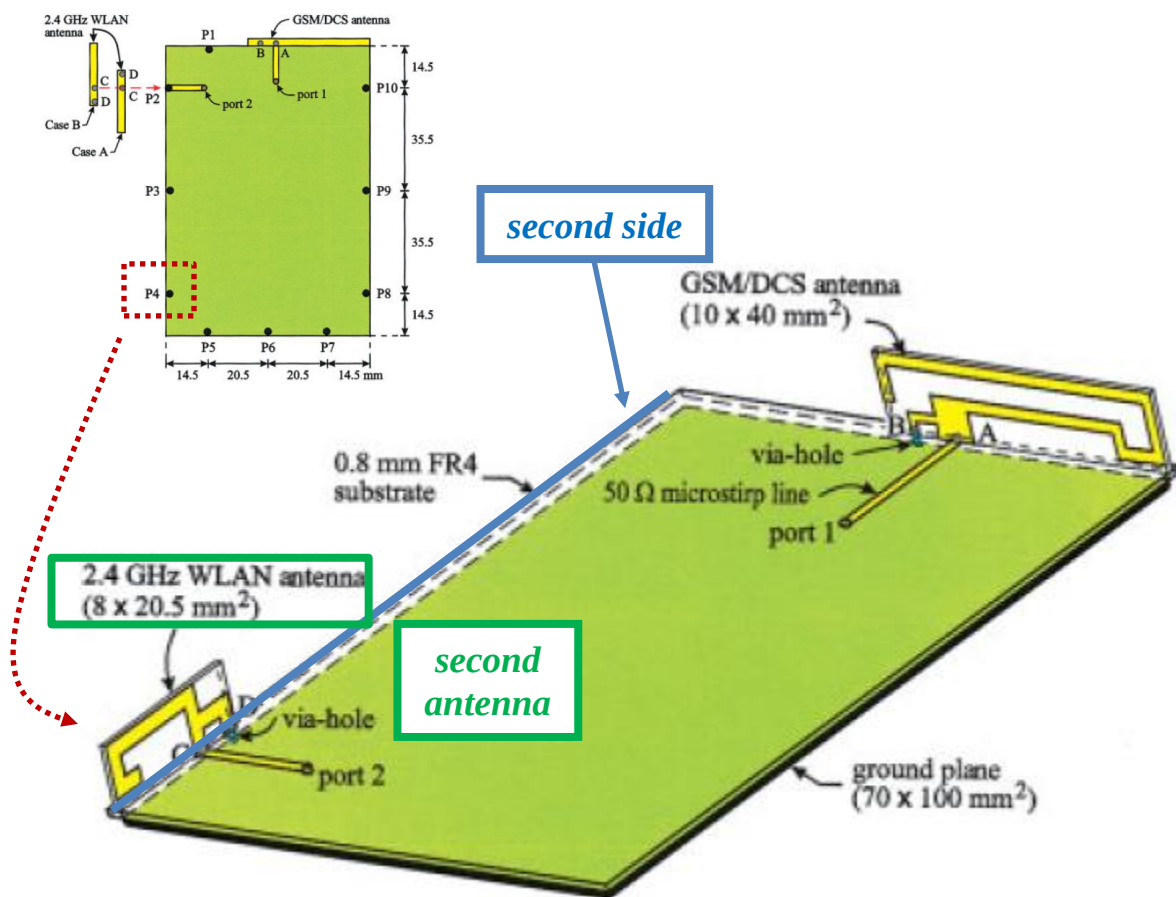
97. Wong+Lee meets [1.j] because it locates Wong’s WLAN antenna (“*second antenna*”) and Lee’s multi-band cellular antenna (“*first antenna*”) within its PDA phone (“*wireless handheld or portable device*”). See Section VIII.C.1; Wong, 347-348 (“Both the GSM/DCS and WLAN *antennas... can be concealed within the casing of a PDA phone for operation as internal antennas*”); Lee, 359 (“The quad-band monopole antenna is...very promising *as an internal antenna, built-in within the device’s casing*”).

98. POSAs would have located Wong’s WLAN antenna and Lee’s quad-band antenna inside a wireless handheld or portable device to achieve what Wong and Lee describe.

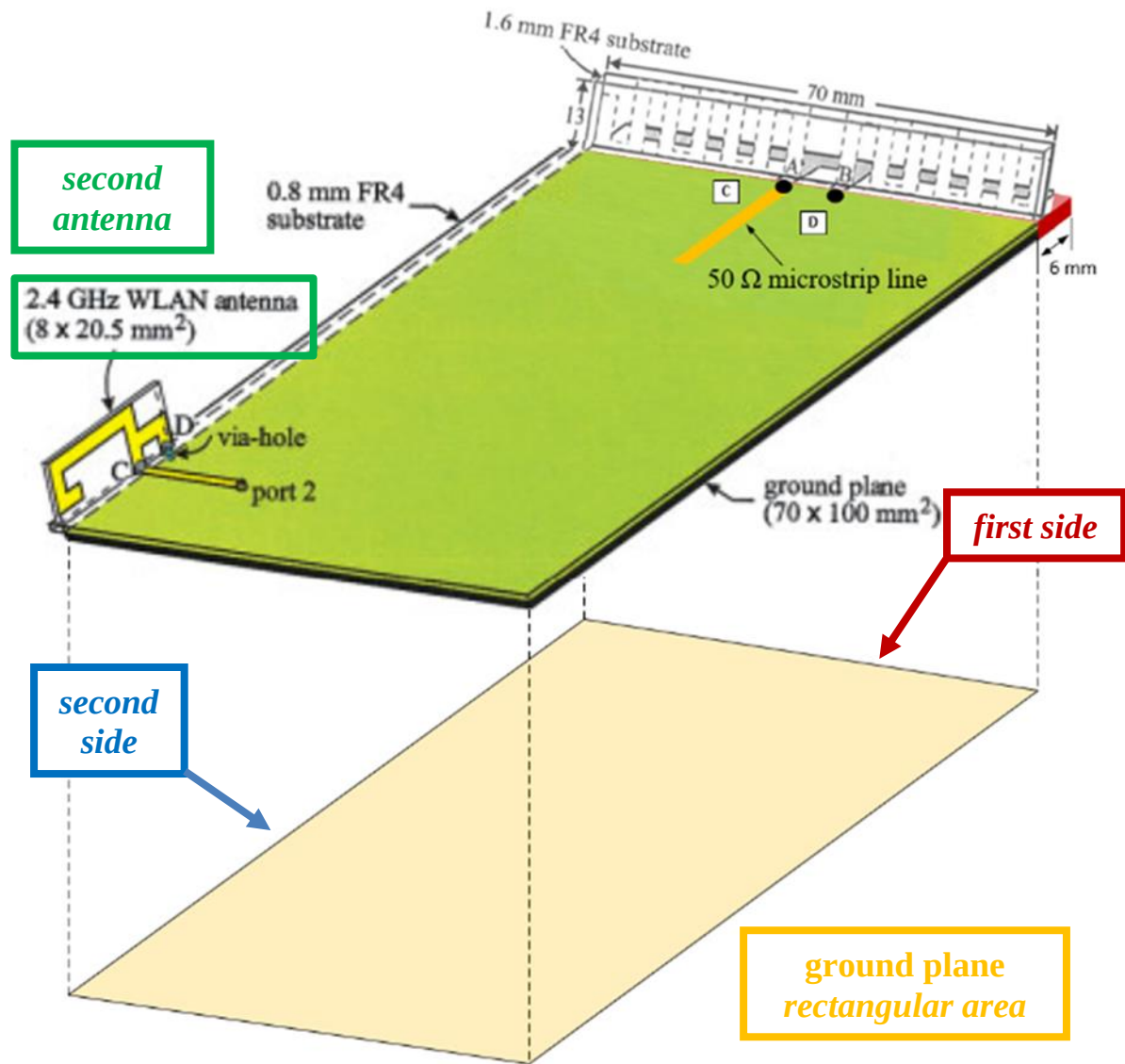
2. Claim 2

2	The wireless handheld or portable device according to claim 1, wherein the second antenna is arranged substantially close to the second side.
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99. Wong+Lee meets claim 2 because Wong’s WLAN antenna (“*second antenna*”) is positioned at the edge of the ground plane rectangle’s long side (“*second side*”). Wong, 348 (WLAN antenna positioned “along the boundary of the system ground plane”).



Wong, Figure 1(a) (annotated, with Fig. 2 inset)



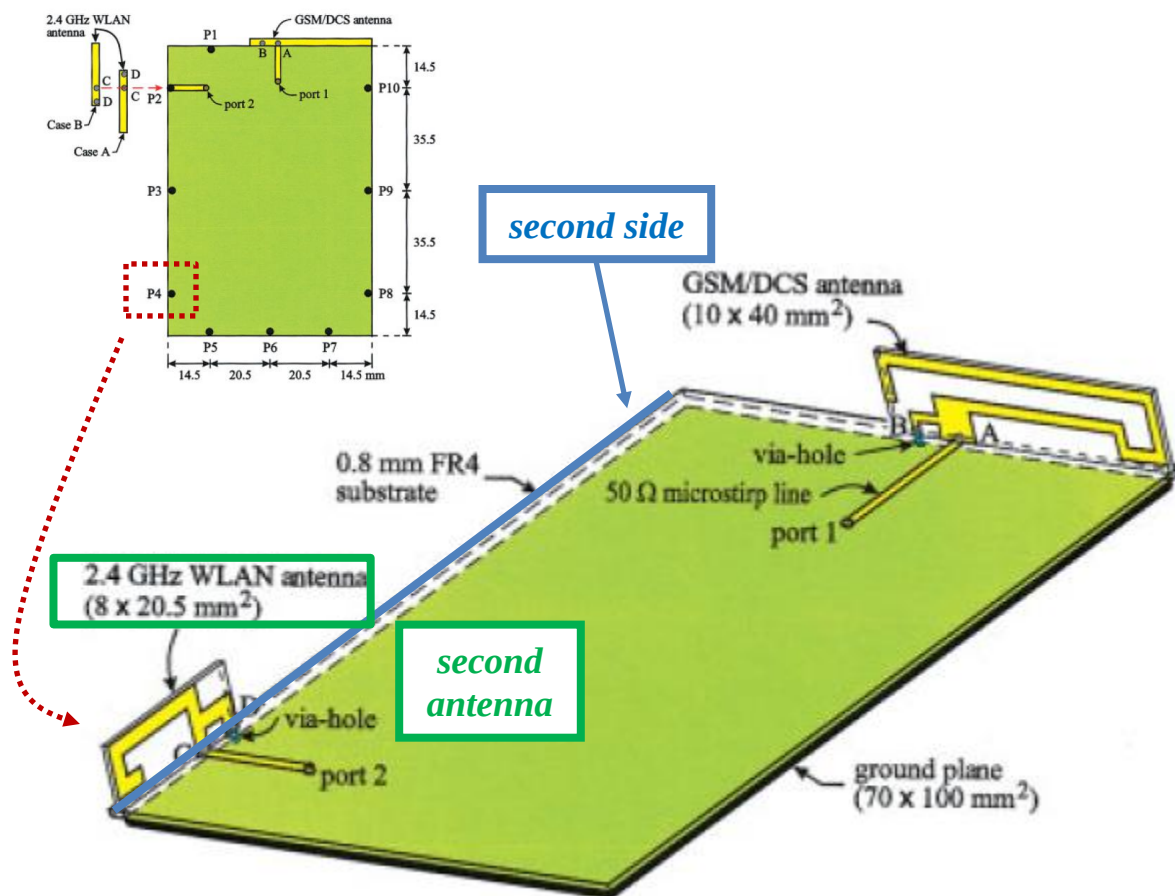
Wong+Lee PCB, antennas

100. Wong's WLAN antenna is thus at least as close to the second side as the antenna 702 depicted in Figure 7(c) of the '458 patent, which extends into the ground plane. Therefore, Wong+Lee's WLAN antenna is *arranged substantially close to the second side*.

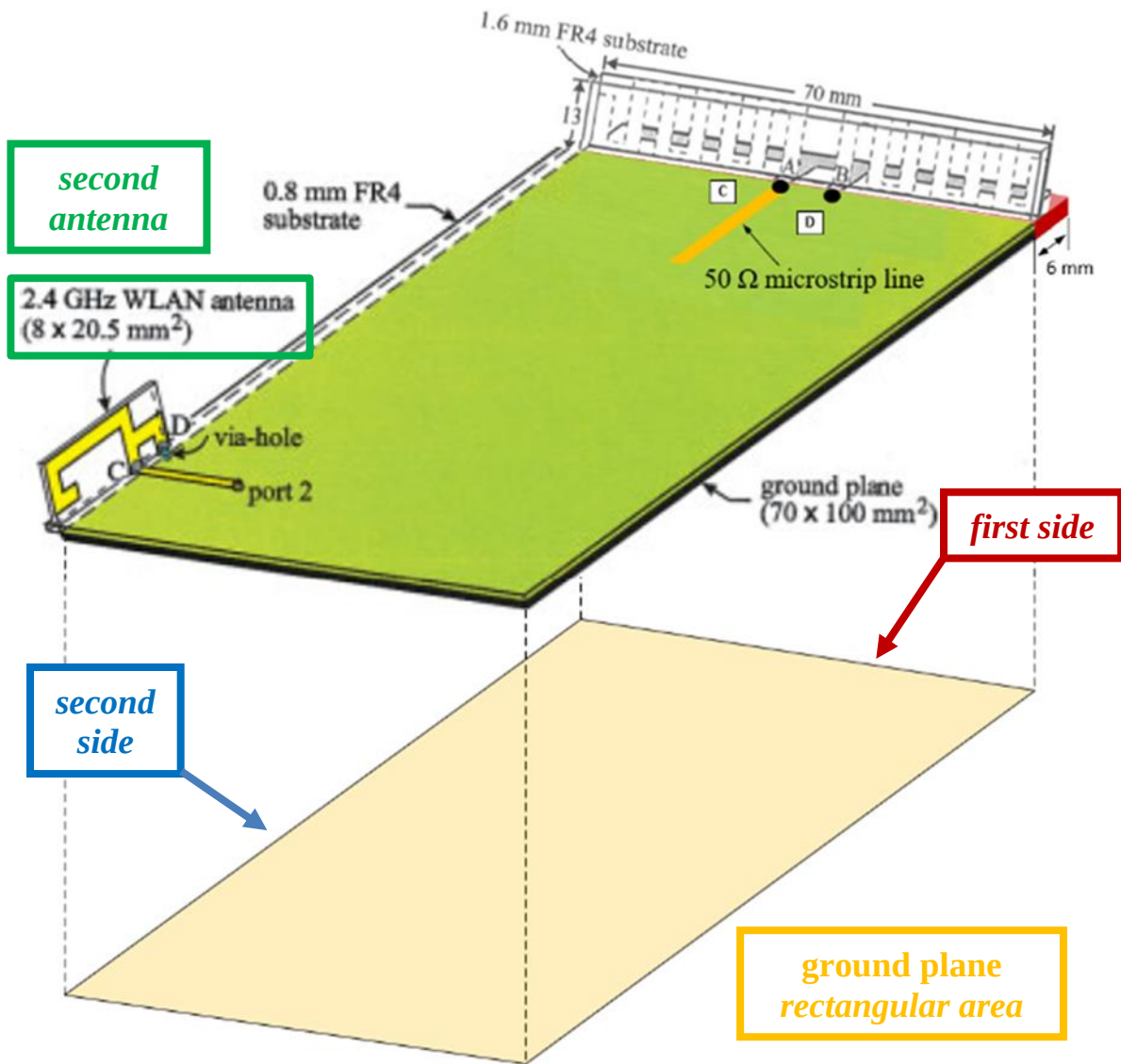
3. Claim 3

3	The wireless handheld or portable device according to claim 2, wherein the second antenna is arranged substantially close to a corner of the rectangular area.
---	--

101. Wong+Lee meets claim 3 because Wong's WLAN antenna ("second antenna") is positioned substantially close to the lower-left corner of the ground plane's rectangular area. Wong, Fig. 1(a) (annotated below, with Fig. 2 inset).



Wong, Figure 1(a) (annotated, with Fig. 2 inset)



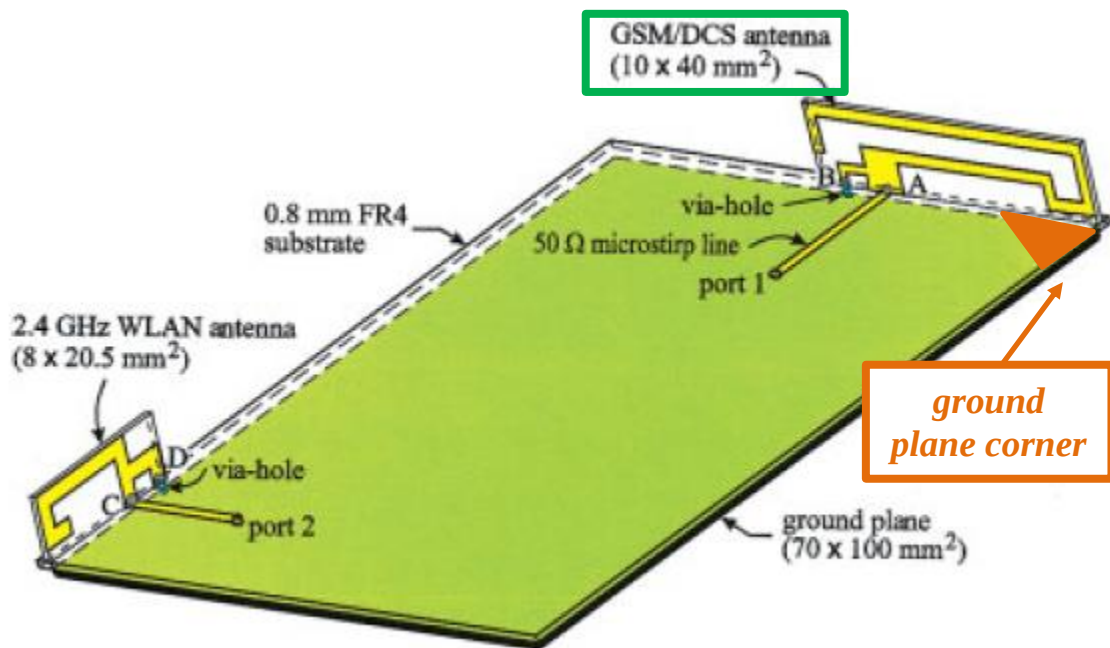
Wong+Lee PCB, antennas

102. Wong's WLAN antenna is at least as close to the lower-left corner of Wong's ground plane as the antenna 702 depicted in Figure 7(c) of the '458 patent is to the lower-right corner of the ground plane.

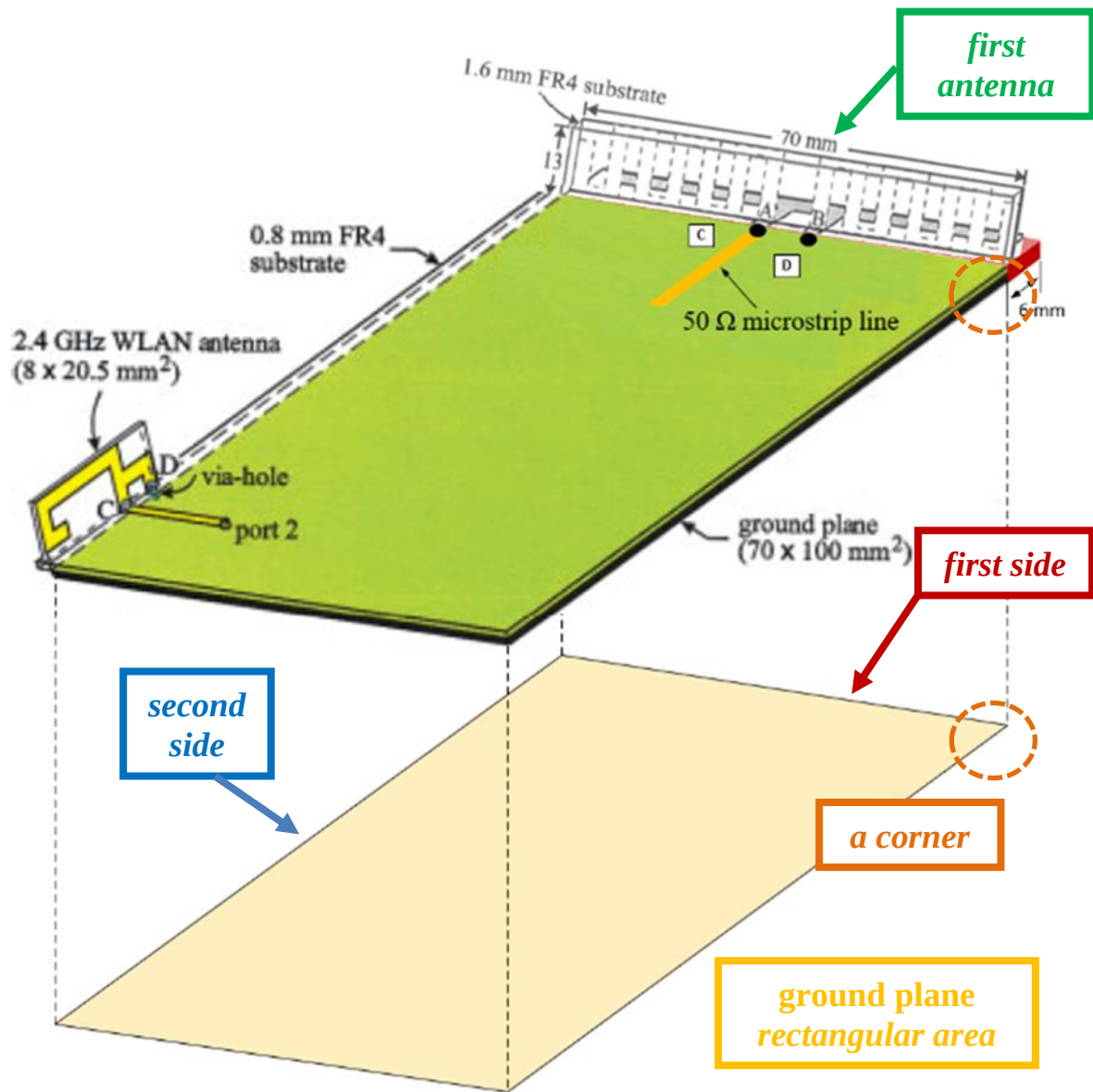
4. Claim 4

4	The wireless handheld or portable device according to claim 1, wherein the first antenna is arranged substantially close to a corner of the rectangular area.
---	---

103. Wong+Lee meets claim 4 because Lee's cellular antenna ("first antenna") is located substantially close to the top-right corner of the ground plane in Wong Figure 1(a) just like Wong's. Wong, Fig. 1(a) (annotated below); Lee, Fig. 1(a). In Wong+Lee, Lee's quad-band antenna would thus be at least as close to the top-right corner as the first antenna in the patent's Figures 7(a)-7(i) is to the top-left corner of the ground plane.



Wong, Fig. 1(a) (annotated)



Wong+Lee PCB, antennas

5. Claim 5

5	The wireless handheld or portable device according to claim 1, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
---	---

104. Wong+Lee meets claim 5 because Lee’s quad-band antenna (“*first antenna*”) is a monopole antenna. Lee, 359 (“A novel internal *monopole* antenna

suitable for applications in AMPS/GSM/DCS/PCS quad-band mobile phones is presented.”).

6. Claim 6

6	The wireless handheld or portable device according to claim 5, wherein the second antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
---	--

105. Wong+Lee meets claim 6 because Wong’s WLAN antenna (“*second antenna*”) is a planar inverted-F antenna (PIFA). Wong, 347 (“Both the GSM/DCS and ***WLAN antennas are printed PIFAs*** with compact sizes.”); EX1001, 2:43 (PIFA is a “planar inverted-F antenna”).

7. Claim 7

7	The wireless handheld or portable device according to claim 1, wherein the at least one frequency band used for wireless connectivity services corresponds to at least one wireless connectivity service selected from the group comprising: Bluetooth™, IEEE802.11a, IEEE802.11b, IEEE802.11g, WLAN, WiFi, UWB, ZigBee, GPS, Galileo, SDARs, XDARS, WiMAX, DAB, FM, DVB-H, and DMB.
---	--

106. Wong+Lee meets claim 7 because Wong’s WLAN antenna (“*second antenna*”) is a WLAN antenna that uses frequencies corresponding to the 2.4 GHz ISM band as explained in Section VIII.D.1.f (Limitations [1.e]-[1.f]). Wong, 347 (“For this application, it is required that a PDA phone be equipped with... one WLAN antenna for 2.4-GHz (2400–2484 MHz) WLAN operation.”).

8. Claim 8

a. Limitations [8.PRE]-[8.c], [8.j]

107. Wong+Lee meets Limitations [8.PRE]-[8.c] and [8.j] for the reasons it meets the corresponding limitations below. EX1016, 1.

Limitation	Corresponding Limitation	Discussion above
[8.PRE]	[1.PRE]	Section VIII.D.1.a
[8.a]	[1.a]	Section VIII.D.1.b
[8.b]	[1.c]	Section VIII.D.1.d
[8.c]	[1.d]	Section VIII.D.1.e
[8.j]	[1.j]	Section VIII.D.1.j

Wong+Lee meets the remaining limitations of claim 8 as follows.

b. Limitation [8.d]

8.d	a second antenna configured to operate in at least one frequency band;
-----	--

108. Limitation [8.d] is broader than Limitation [1.e] in that it recites “***configured to operate in*** at least one frequency band” instead of “***configured to receive electromagnetic waves corresponding to*** at least one frequency band.”

Wong+Lee thus meets [8.d], for the same reasons it meets [1.e], as discussed in Section VIII.D.1.f (Limitation [1.e]), as a PSOA would have understood Lee’s antenna to *operate* in the bands it is configured to transmit and receive electromagnetic signals.

c. Limitation [8.e]

8.e	the first antenna extends in a direction substantially parallel to a first side of the portable device;
-----	---

109. Wong+Lee meets [8.e] because Lee’s quad-band antenna (“*first antenna*”) extends in a direction parallel to the first side of the system circuit board (and hence of the portable device sized commensurate with the PCB). See Sections VIII.C (Wong+Lee combination) and VIII.D.1.g (Limitation [1.g]); Lee, Fig. 1(a).

d. Limitation [8.f]

8.f	a length of a second side of the portable device is greater than a length of the first side of the portable device;
-----	---

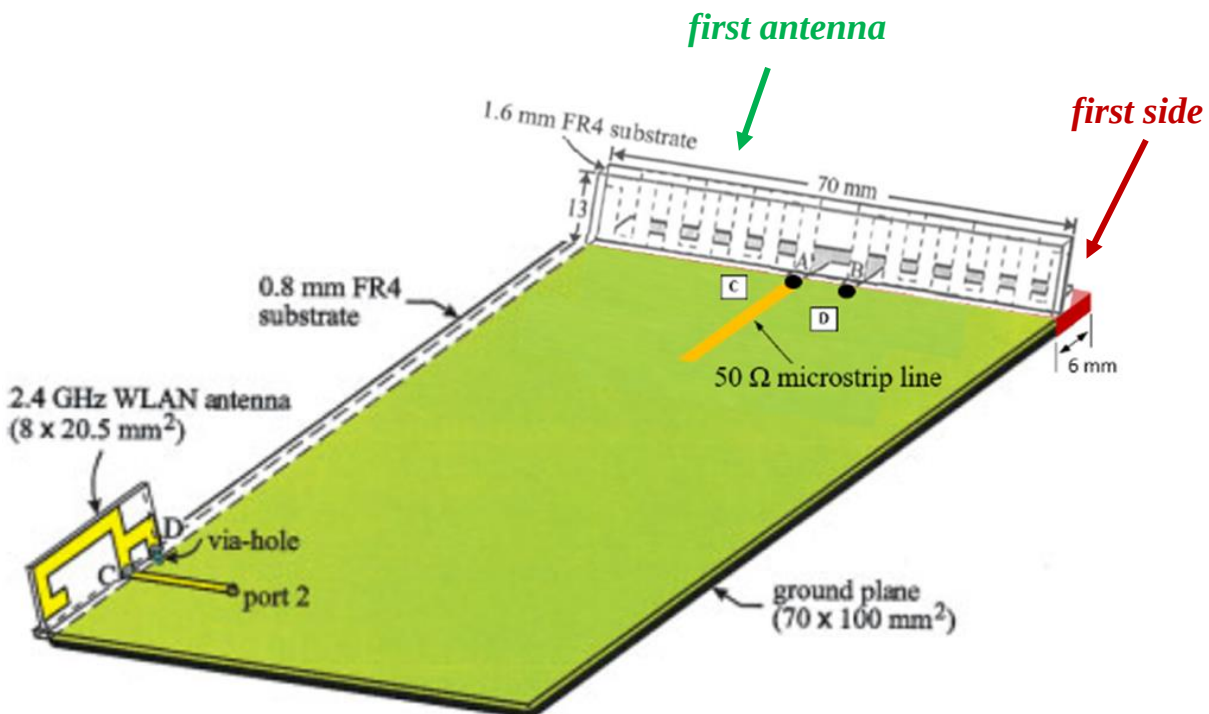
110. Wong+Lee meets [8.f] because it uses Wong’s ground plane having a second side (100 mm) and a first side (70 mm). See Section VIII.D.1.c (Limitation [1.b]); Wong, 348, Fig. 1(a).

111. Wong+Lee adds another 6 mm of substrate length to the second side, beyond Wong’s ground plane. See Section VIII.D.1.c (Limitation [1.b]). Thus, the resulting sides of the ground plane (and hence the sides of the Wong+Lee “portable device” containing and commensurate with PCB dimensions satisfy [8.f]. See Section VIII.C (Wong+Lee combination).

e. Limitation [8.g]

8.g	the first antenna is arranged substantially close to the first side of the portable device;
-----	---

112. Wong+Lee meets [8.g] because Lee’s quad-band antenna (“*first antenna*”) is disposed at the same location as Wong’s GSM/DCS antenna, and the horizontal monopole element spans the 6mm ungrounded substrate portion to the top edge of the ground plane. See Section §VIII.C (Wong+Lee combination). The “portable device” is commensurate with Wong+Lee’s PCB dimensions, and the short edge near the top of the ground plane is the *first side*. See Section VIII.D.1.i (Limitation [1.i]).



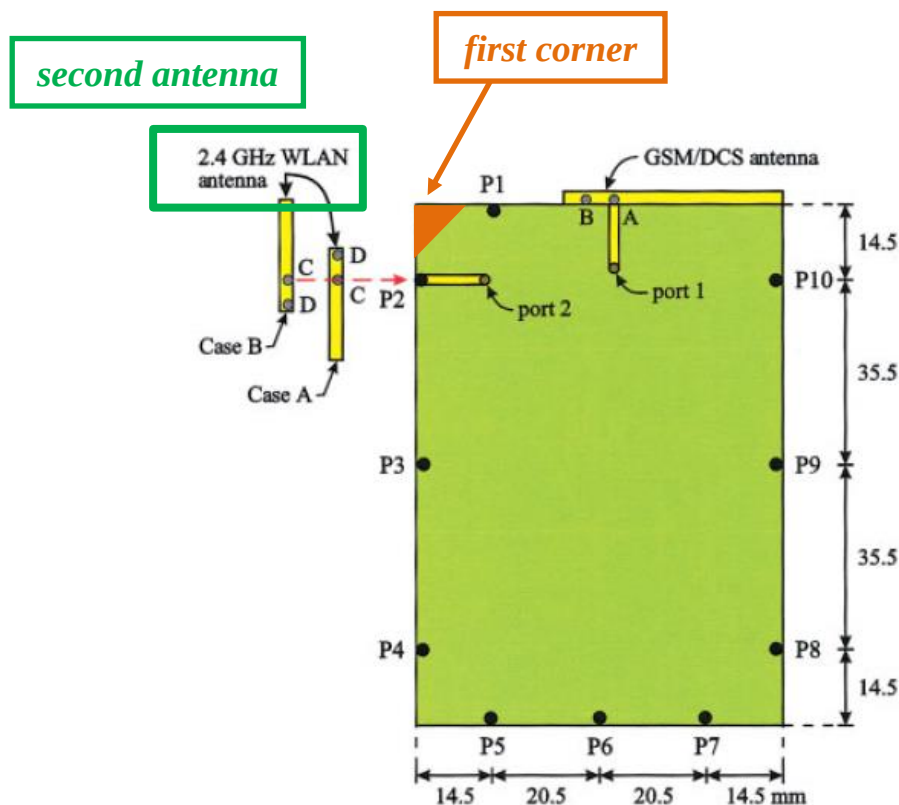
Wong+Lee

f. Limitation [8.h]

8.h	the second antenna is arranged substantially close to a first corner of the portable device;
-----	--

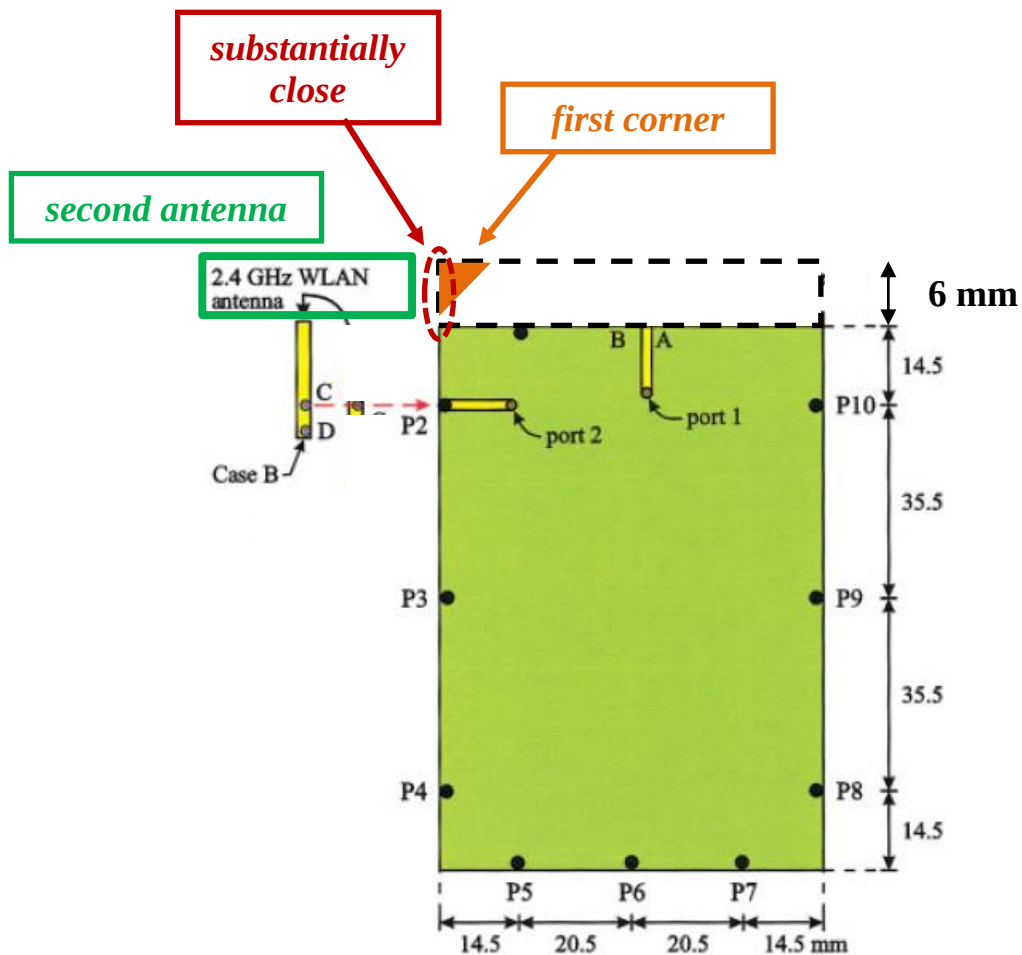
113. Wong+Lee meets [8.h] because Wong describes a WLAN antenna (“*second antenna*”) position at P2, close to the upper left corner of the ground plane. Wong, Fig. 2 (annotated below).

114. In Wong’s “Case B,” the WLAN antenna is positioned adjacent to the corner. When located at Position P2, Wong’s WLAN antenna is at least as close to the upper left corner as, for example, antenna 702 in Figure 7(a) of the ’458 patent is to the corresponding corner. Thus, it is “*substantially close to a first corner of*” Wong’s ground plane, and in turn to a first corner of the device containing the ground plane. See Section VIII.C (Wong+Lee combination).



Wong, Figure 2 (annotated)

115. The size of Wong+Lee’s portable device is commensurate with the 106mm x 70mm PCB. See Section VIII.C (Wong+Lee combination). Thus, in Wong+Lee, the “first corner” is laterally displaced 6 mm from Wong’s configuration, so that the WLAN antenna is positioned at $\left(\frac{6}{106}\right) = 5.7\%$ of the length of the long axis (second side) from the device’s corner. This is “substantially close” as claimed.



Wong+Lee

g. Limitation [8.i]

8.i	the first corner of the portable device corresponding to a first end of the first side [sic: intersecting] with an end of the second side of the portable device; and
-----	---

116. As written, this limitation contains a typographical error. Assuming it refers to a corner where the first and second sides intersect (shown in the annotated Figure 7(a) below), then Wong+Lee meets [8.i] because [8.i] is satisfied for the same reason that Wong+Lee meets [8.h].

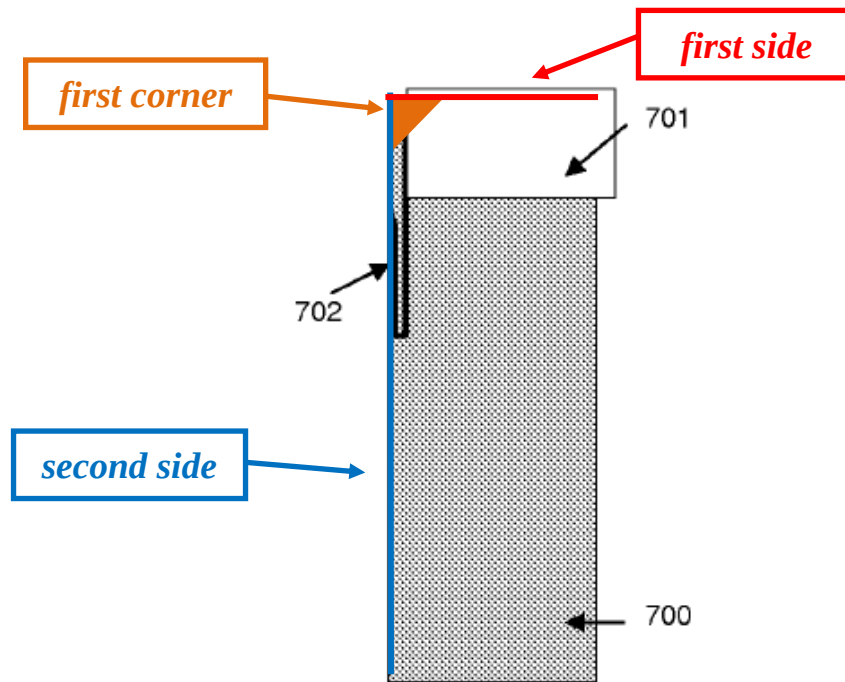


FIG. 7A

'458 patent, Figure 7(a) (annotated)

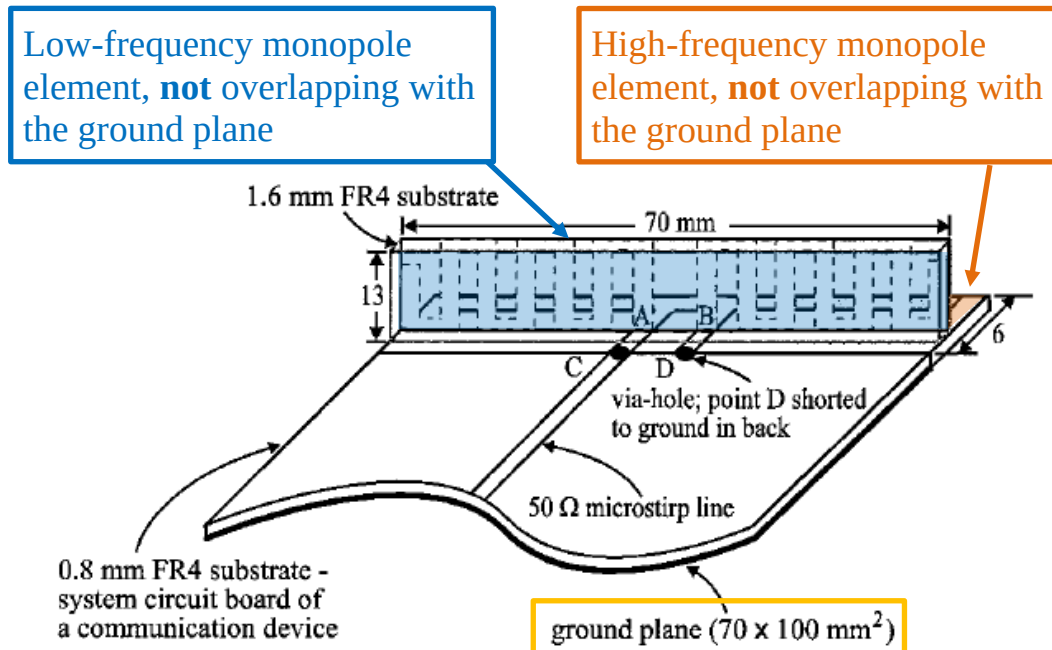
9. Claim 9

9	The portable device according to claim 8, wherein a portion of an orthogonal projection of the first antenna on a plane containing the ground plane does not overlap with the ground plane.
---	---

117. The '458 patent teaches: “In some examples, the fraction of the projection of the slot occupied by ground plane will be **less than**, or approximately equal to... 5% of the projection of the slot on the PCB.” EX1001, 11:6-9. Thus, the '458 patent contemplates an overlap of under 5%, which includes no overlap.

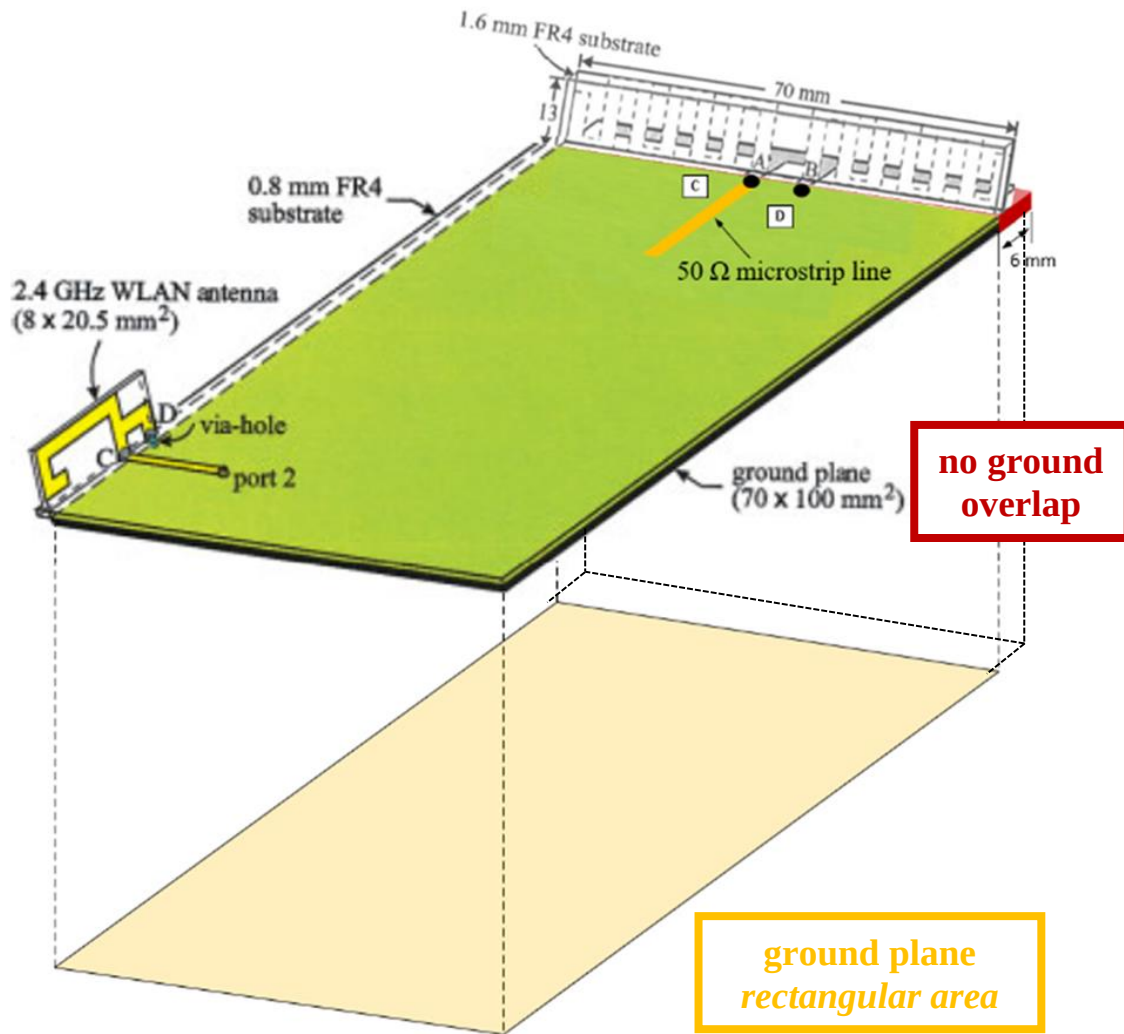
118. Lee’s quad-band antenna has an orthogonal projection, on the plane that contains the ground plane, that does not overlap with the ground plane because

the antenna is disposed on a portion of the substrate not backed by the ground plane. Lee, 359, Figure 1(a) (annotated below).



Lee, Figure 1(a), annotated

119. In Wong+Lee, Lee's quad-band antenna ("*first antenna*") has an orthogonal projection "*on a plane containing the ground plane*" that does not overlap with the ground plane, meeting claim 9.



Wong+Lee PCB

10. Claims 12-13

120. Wong+Lee meets the additional limitations in claims 12 and 13 for the reasons it meets claims 5 (see Section VIII.D.5) and 6 (see Section VIII.D.6). EX1016, 2-3; see Section VIII.C (Wong+Lee combination).

IX. GROUND 1B: WONG RENDERS OBVIOUS CLAIMS 14-15, 17-19

A. Wong

121. As discussed in Section VIII.CVIII.C.1, POSAs would have had reasons to incorporate Wong's teachings into a PDA phone. POSAs would have found it obvious to equip the PDA phone with a system circuit board and antennas designed in accordance with Wong's teachings. POSAs would have found it obvious to use Wong's GSM/DCS antenna and Wong's WLAN antenna as internal antennas within the PDA phone to achieve what Wong describes. Wong, 347.

B. Mapping to Claims 14-15 and 17-19

1. Claim 14

a. Limitations [14.PRE]-[14.a], [14.o]

122. Wong meets Limitations [14.PRE]-[14.a] and [14.o] for the reasons Wong+Lee meets the corresponding limitations below. EX1016, 5.

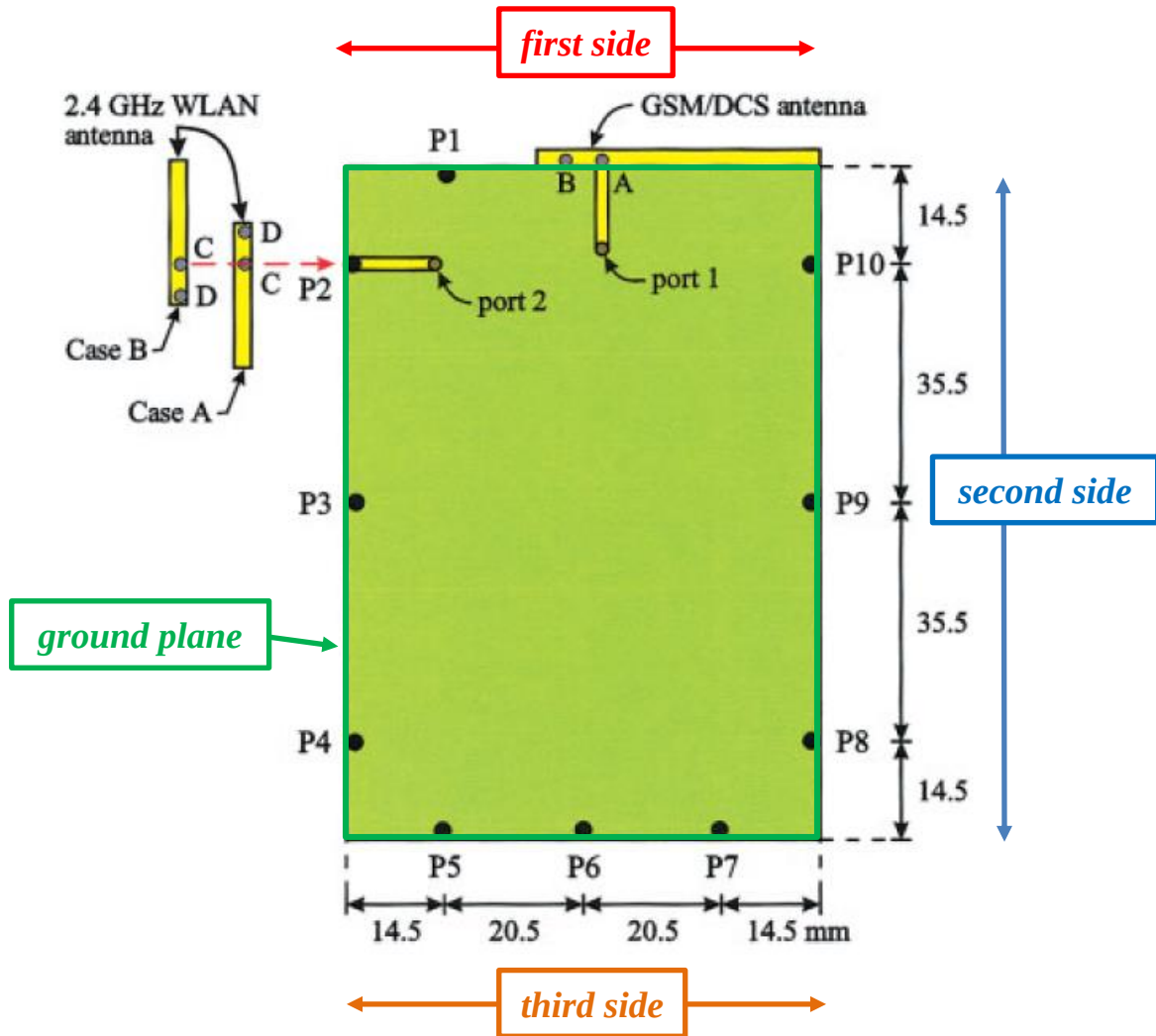
Limitation	Corresponding Limitation	Discussion above
[14.PRE]	[1.PRE]	Section VIII.D.1.a
[14.a]	[1.a]	Section VIII.D.1.b
[14.o]	[1.j]	Section VIII.D.1.j

Wong meets the remaining limitations in claim 14 as follows.

b. Limitation [14.b]

14.b	the ground plane is inscribed in a first rectangular area comprising a first side, a second side and a third side, a length of the second side being greater than a length of the first side and a length of the third side;
------	--

123. Wong's ground plane is inscribed in a 100 mm x 70 mm rectangular area. *See* Section VIII.D.1.c (Limitation [1.b]). As shown below, the second side is 100 mm, while the first and third sides are 70 mm long. Wong, 348. Thus, the second side is longer than the first and third sides. Wong, Figure (2) (annotated below).



Wong, Figure 2 (annotated)

c. Limitation [14.c]

14.c	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least two frequency bands;
------	---

124. Wong meets [14.c] because Wong's GSM/DCS antenna is operable to transmit and receive in the GSM900 (890–960 MHz) and DCS1800 (1710–1880 MHz) frequency bands, each supporting cellular communications. Wong, 347.

125. Transmissions on these bands utilize electromagnetic waves. *See* Section VIII.D.1.f (Limitation [1.e-1.f]). Wong’s GSM/DCS antenna is *configured to transmit and receive electromagnetic waves corresponding to at least two frequency bands* because, as discussed in Section VIII.D.1.d (Limitation [1.c]), GSM900 and DCS1800 are bands that encompass uplink (transmit) and downlink (receive) communication. EX1009, 9.

d. Limitation [14.d]

14.d	the at least two frequency bands being used for mobile communication services;
------	--

126. Wong meets [14.d] because as discussed in Section VIII.D.1.e (Limitation [1.d]), the GSM900 (890–960 MHz) and DCS1800 (1710–1880 MHz) bands are *used for mobile communication services* because they support cellular communications. Wong, 347.

e. Limitation [14.e]

14.e	a second antenna configured to operate in at least one frequency band;
------	--

127. As discussed in Section VIII.D.8.b (Limitation [8.d]), Wong’s WLAN antenna *is configured to operate in at least one frequency band*. Wong, 347-348.

f. Limitation [14.f]

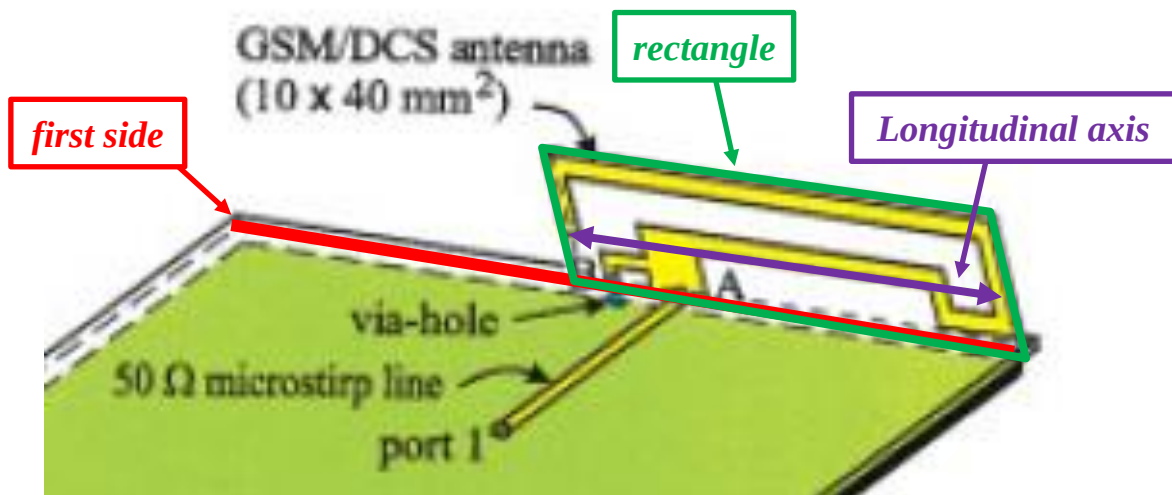
14.f	the at least one frequency band being different from the at least two frequency bands;
------	--

128. Wong meets [14.f] because Wong's WLAN antenna operates in the 2.4 GHz ISM band (2400–2500 MHz), which is different from the GSM (890–960 MHz) and DCS (1710–1880 MHz) bands. Wong, 347-348.

g. Limitation [14.g]

14.g	the first antenna extends in a direction substantially parallel to the first side;
------	--

129. Wong meets [14.g] because the GSM/DCS antenna can be inscribed in a rectangle having a longitudinal axis which is parallel to the short edge (*first side*) of Wong's ground plane rectangle. Wong, Figure 1(a) (annotated detail below); see Section VIII.D.1.g (Limitation [1.g]).



Wong, Figure 1(a) (annotated detail)

h. Limitation [14.h]

14.h	the first antenna is proximate to the first side;
------	---

130. Wong meets [14.h] because the GSM/DCS antenna (“*first antenna*”) is “arranged to be fixed at the top edge of the system circuit board” (the first side of the ground plane, as discussed in Section IX.B.1.b (Limitation [14.b])). Wong, 348. Thus, Wong’s GSM/DCS antenna is *proximate to the first side* of the ground plane. Wong, 348.

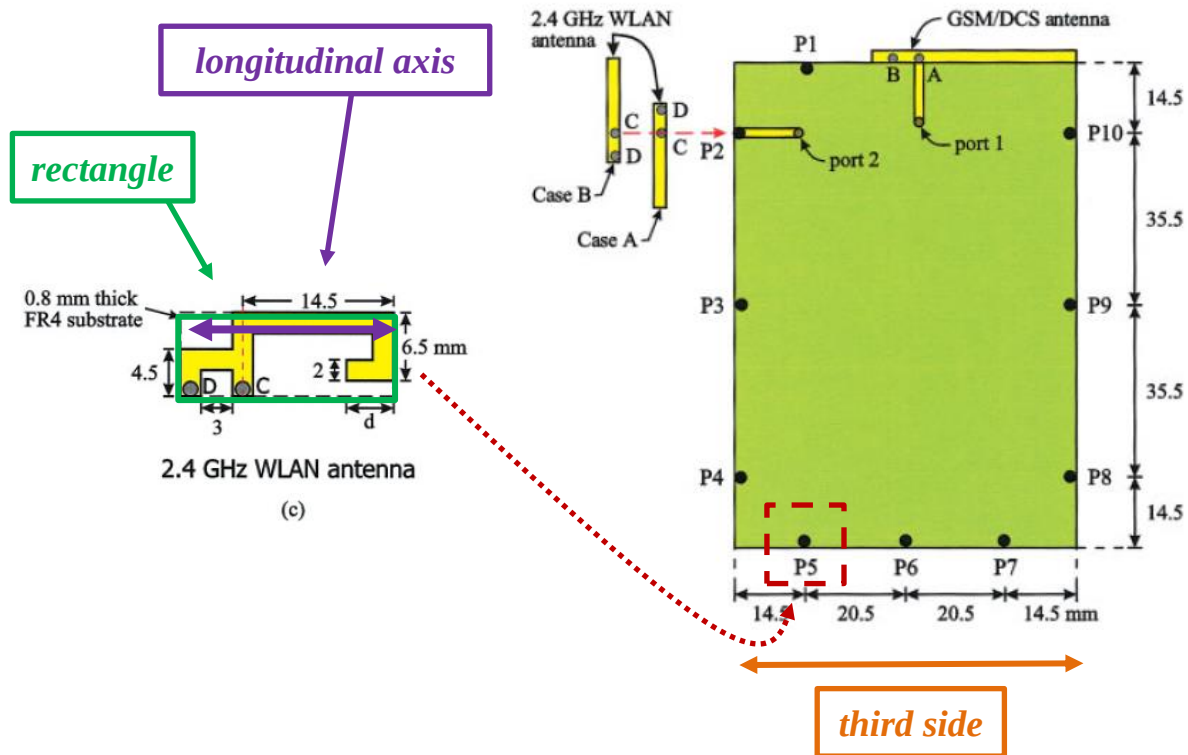
i. Limitation [14.i]

14.i	the second antenna extends in a direction substantially parallel to the third side;
------	---

131. Wong meets [14.i] because the WLAN antenna, when positioned at location P5 of Figure 2, “*extends in a direction substantially parallel to*” the ground plane rectangle’s third side. Wong, Fig. 2 (annotated below with a Fig. 1(c) inset).

132. Although Wong does not explicitly show the orientation of the WLAN antenna when positioned at location P5, POSAs would have understood that the WLAN antenna would be orientated so that both feeding point C and shorting point D were fixed at the lower edge of the system circuit board (identified as the “*third side*” in annotated Figure 2 below). With that orientation, the WLAN antenna can be inscribed in a rectangle having a longitudinal axis that

is parallel to the third side of Wong's ground plane. Wong, Figs. 1(c), 2 (annotated below).



Wong, Figure 2 (annotated, with Fig. 1(c) inset)

j. Limitation [14.j]

14.j	the second antenna is proximate to the third side;
------	--

133. Wong meets [14.j] because the WLAN antenna at location P5 of Figure 2 is fixed at the lower edge of the system circuit board, as discussed in Section IX.B.1.i (Limitation [14.i]), which is “*proximate to the third side.*” Wong, Fig. 2.

k. Limitation [14.k]

14.k	the second antenna is inscribed in a second rectangular area;
------	---

134. Wong meets [14.k] because the WLAN antenna is inscribed in a rectangular area. See Section IX.B.1.i (Limitation [14.i]).

l. Limitation [14.l]

14.l	a sum of a length and a width of the second rectangular area is smaller than a quarter of an operating wavelength of the second antenna;
------	--

135. Wong meets [14.l] because the rectangular area inscribing the WLAN antenna is 8 mm × 20.5 mm (Wong, 348), so “a sum of a length and a width of the second rectangular area” is **28.5 mm**.

136. An “operating wavelength” (λ , in mm) of an antenna depends on its operating frequency, as follows:

$$\lambda = \frac{c}{f},$$

where c = speed of light in vacuum ($\approx 3 \times 10^{11}$ mm/sec), and f = frequency (Hz).

EX1027, 15-16; EX1029, 6:27-29. Thus, 1/4 of the operating wavelengths of Wong’s WLAN antenna at 2400-2484 MHz (Wong, 347) is:

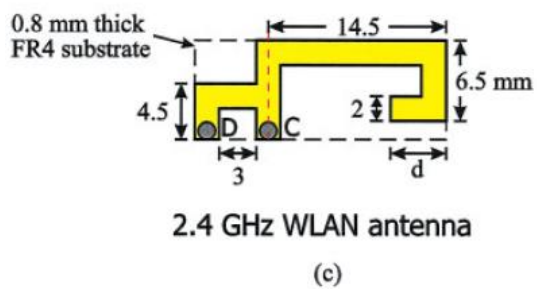
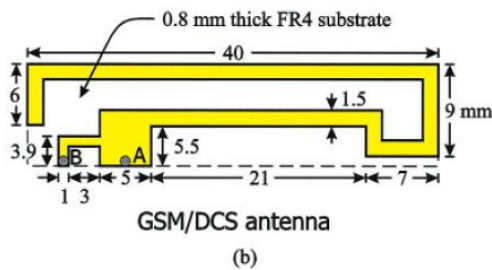
Frequency (MHz)	Wavelength (mm)	1/4 Wavelength (mm)
2400-2484	120.8-125	30.20-31.25

Wong meets [14.l] because 28.5 mm is less than 30.2 mm.

m. Limitation [14.m]

14.m	a geometry of the first antenna being different than a geometry of the second antenna;
------	--

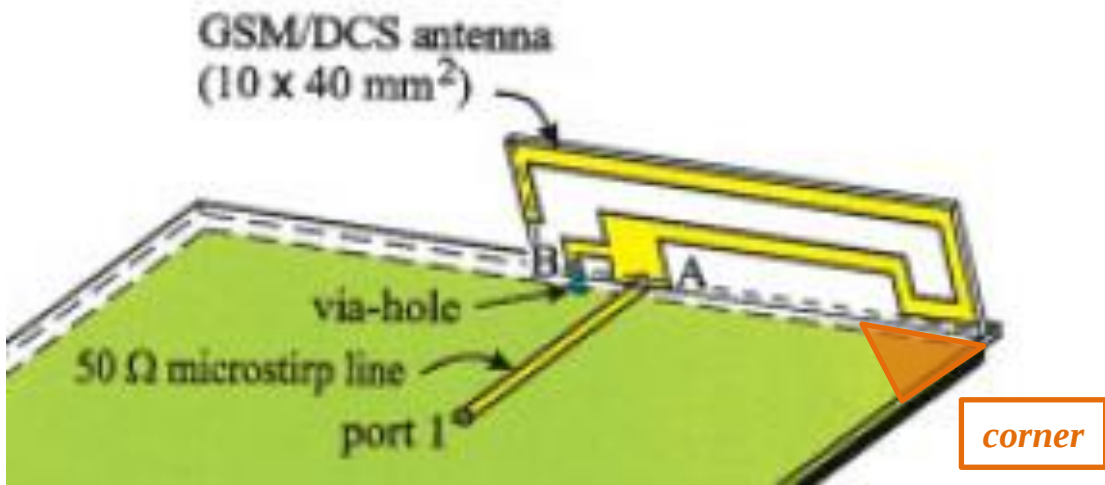
137. Wong meets [14.m] because the GSM/DCS antenna's geometry is “different” from the WLAN antenna's geometry. Wong, Figs. 1(b)-(c) (below).



n. Limitation [14.n]

14.n	at least one of the first antenna and the second antenna is proximate to a corner of the first rectangular area; and
------	--

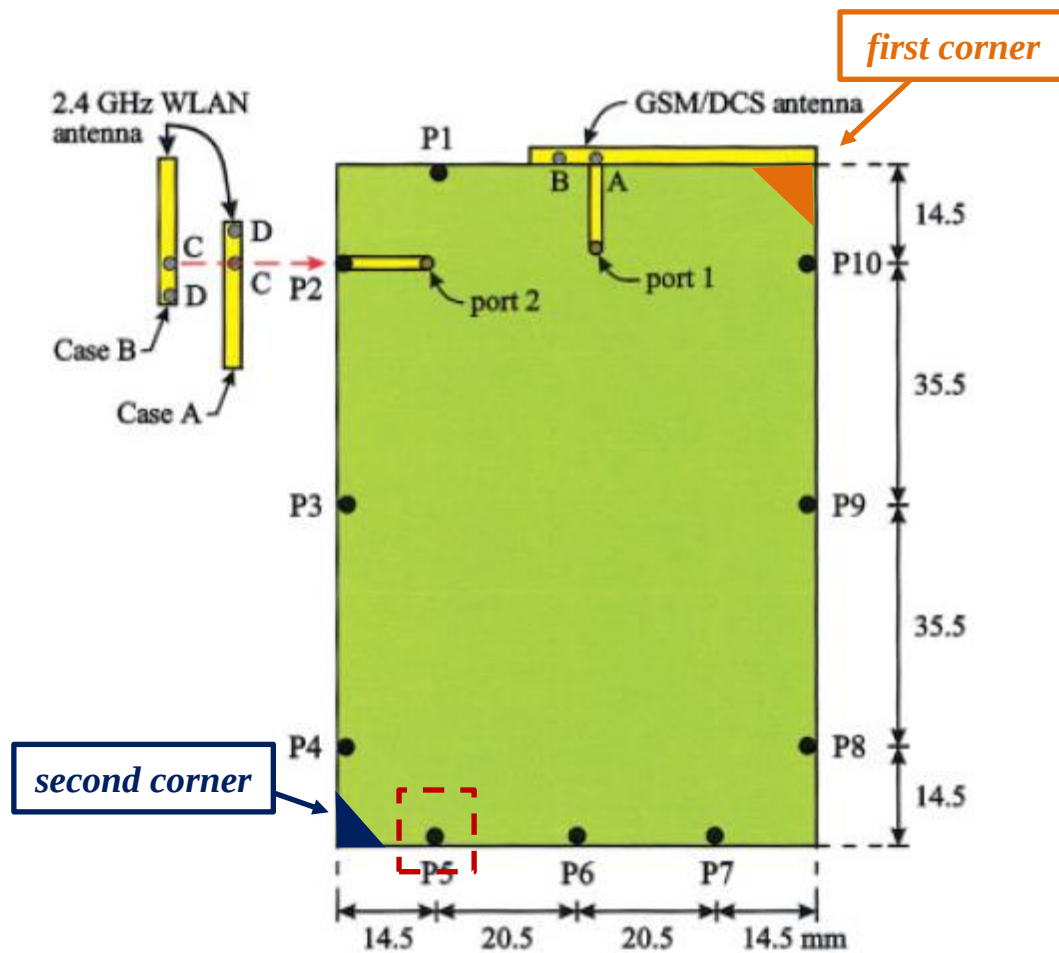
138. Wong meets [14.n] because Wong's GSM/DCS antenna is “proximate to a corner” of the rectangular area inscribing Wong's ground plane. Wong, Fig. 1(a) (annotated detail below).



2. Claim 15

15	The wireless handheld or portable device according to claim 14, wherein the first antenna is proximate to a first corner of the first rectangular area and the second antenna is proximate to a second corner of the first rectangular area.
----	--

139. Wong meets claim 15 because as discussed in Section IX.B.1.n (Limitation [14.n]), the GSM/DCS antenna is proximate to a first corner of the rectangular area inscribing Wong's ground plane. The WLAN antenna, when positioned at location P5, is proximate to a "*second corner*" of the rectangular area. Wong, Figure 2 (annotated below); see Section VIII.D.3 (claim 3).



3. Claims 17, 19

140. Wong meets claims 17 and 19 for the reasons Wong+Lee meets the corresponding claims below. EX1016, 3-4.

Claim	Corresponding Claim	Discussion above
17	7	Section VIII.D.7
19	6	Section VIII.D.6

4. Claim 18

18	The wireless handheld or portable device according to claim 14, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
----	--

141. Wong meets claim 18 because Wong’s GSM/DCS antenna is a planar inverted-F antenna (PIFA). Wong, 347 (“Both the GSM/DCS and WLAN antennas are printed PIFAs with compact sizes.”).

X. GROUND 2: GAUCHER RENDERS OBVIOUS CLAIMS 1-10 AND 12-13

A. Gaucher (EX1012)

142. Gaucher discloses “a laptop computer 300” comprising “a plurality of multiband antennas 310, 320” (*first antenna 320, second antenna 310*) “mounted to” the laptop display’s metal support frame 355. Gaucher, [0025], [0032], Fig. 3 (annotated below). The laptop’s support frame 355 “is used as a *ground plane* for the antennas.” Gaucher, [0032].

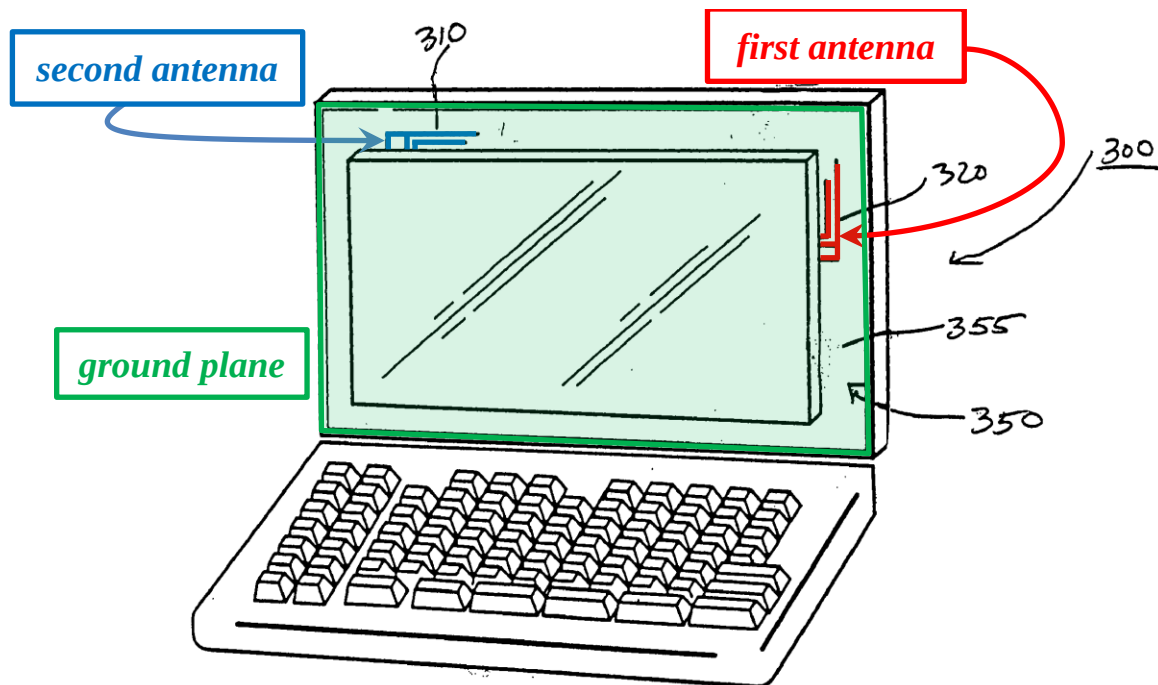


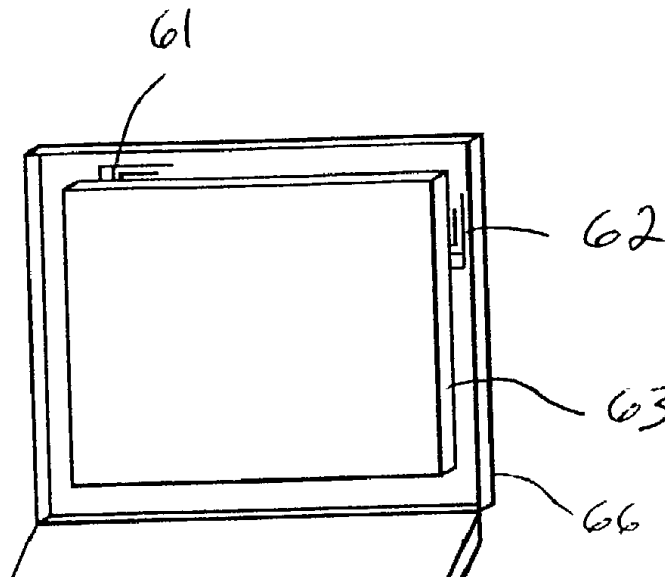
FIG. 3

Both antennas are mounted such that “the plane of each... is substantially parallel to the plane, or along the plane, of the metal support frame 355.” Gaucher, [0025].

143. Gaucher also teaches that it was beneficial to improve existing laptops with multiband “WLAN” capabilities (“working at 2.4 GHz and 5 GHz”) to include a multiband antenna that supports “WWAN” capabilities (“cell phone connections” at 800 MHz and 1800 MHz). Gaucher, [0026]-[0030] (“[I]t would be advantageous in wireless applications to increase the mobility of the laptop computers” by integrating “wireless wide area network (WWAN) connectivity often used in cell phone connections on the road.”).

144. To this end, Gaucher's laptop embodiments "include[s] extensions of the dual-band and tri-band integrated antenna designs described in" several incorporated patent applications, including Serial No. 10/318,816 (published as Gaucher848 (EX1013)). Gaucher, [0024], [0030]. POSAs would have thus been motivated to look to Gaucher's incorporated references for examples of laptops and antennas to understand the extensions of Gaucher's teachings.

145. Gaucher848 discloses a similar laptop embodiment with two multiband WLAN "antennas (61, 62) mounted to a metallic support frame (63) of the laptop display unit" where "the plane of each... antenna (61, 62) is substantially parallel to the plane of the display frame (63)." Gaucher848, [0009]-[0011], [0049], [0056]; *compare* Gaucher848, Fig. 6a (below detail) *with* Gaucher, Fig. 3.



146. Gaucher848 expands on Gaucher’s disclosure, teaching that WLAN antenna 61 (antenna 310) “can be located on the right side of the upper portion of the frame (63) (as opposed to the left side of the upper portion of the frame as shown)” and that antenna 62 (antenna 320) can be positioned on the left side, rather than the right side, of the display frame (63). Gaucher848, [0049].

1. Gaucher’s WWAN Antenna

147. Gaucher discloses a quadband WWAN (cellular) antenna “covering the four most popular [cellular] frequency bands, namely,” 824-894 MHz (AMPS/GSM850), 880-960 MHz (GSM900), 1710-1880 MHz (GSM1800), and 1850-1990 MHz (PCS1900). Gaucher, [0030], [0046], Figs. 5A-B; EX1009, 9; EX1001, 2:4-10 (defining “GSM850, GSM900, GSM1800... PCS1900” as “mobile communication services”); *see also* Section VIII.D.1.d (Ground 1, Limitation [1.c]) (discussing AMPS/GSM/DCS overlapping frequency bands); EX1009, 9.

2. Gaucher848’s WLAN Antenna

148. Gaucher848 discloses “various embedded tri-band antennas” that “operate in the 2.4-2.5 GHz, 5.15-5.35 GHz and 5.47-5.85 GHz bands” used for WLAN communication standards. Gaucher, [0024], [0026]; Gaucher848, [0008]-[0009], [0011], [0056], Figs. 8, 9, 10; EX1001, 9:46-60 (defining “wireless connectivity standards” as “allocated in one or more frequency bands,” such as the

“2.4 GHz ISM band (2400-2500 MHz), or 5.7 GHz ISM band (5650-5925 MHz)”); EX1017, 3 (defining “wireless LAN” using “the 5.15–5.25, 5.25–5.35 and 5.725–5.825 GHz unlicensed national information infrastructure (U-NII) bands, as regulated in the United States by the Code of Federal Regulations, Title 47, Section 15.407.”); EX1018, 11 (describing use of “the 2.4 GHz band designated for ISM applications.”); EX1015, 36069-36070 (defining 2.4-2.5 GHz for use by “ISM equipment”).

3. Gaucher’s WWAN+WLAN Laptop Embodiment

149. It is my opinion that, as discussed in Section X.A, POSAs would have understood that Gaucher and its incorporated references teach various embodiments of “integrated multiband antenna frameworks” mounted “on a laptop display unit.” Gaucher, [0025], [0030], Fig. 3; Gaucher848, Gaucher848, [0009]-[0011], [0049], [0056], Fig. 6a. These “antenna frameworks” include Gaucher’s quadband WWAN antenna and the WLAN antenna designs described in Gaucher848. Gaucher, [0030].

150. It is my opinion that POSAs would have found it obvious to implement the Gaucher Figure 3 laptop with Gaucher’s WWAN and WLAN antennas. Gaucher identifies a known problem: laptops “equipped with integrated wireless local area network (WLAN)” were “increasingly being used on the road and away from the hot spot locations.” Gaucher, [0026]-[0027]. According to

Gaucher, it would have been “advantageous in wireless applications to increase the mobility of the laptop computers” by including its “quadband antenna covering the four most popular” frequency bands to integrate “wireless wide area network (WWAN) connectivity often used in cell phone connections on the road.”

Gaucher, [0027], [0030].

151. It is also my opinion that POSAs would have found it obvious to implement Gaucher’s laptop with both WWAN and WLAN antennas to expand user WLAN and cellular connectivity. Gaucher recognized the user need for such laptops prior to June 2005, and laptops supporting WWAN and WLAN connectivity were already publicly advertised, for example, the Dialogue Flybook. EX1035 (press release describing public demonstration of the Dialogue Flybook in June 2004); EX1028, 13-15 (user manual describing the Flybook supporting both cellular and Bluetooth/WLAN connectivity). Thus, it is my opinion that POSAs would have understood Gaucher’s disclosure to teach a laptop embodiment including one WWAN antenna (such as antennas 320, 62) arranged on the display frame’s right or left side and one WLAN antenna (such as antennas 310, 61) arranged on the right or left side of the frame above the display. This embodiment renders claims 1-8, 10, and 12-13 obvious, as shown below.

B. Mapping to Claims 1-10 and 12-13

1. Claim 1

a. Preamble

1.PRE	A wireless handheld or portable device comprising:
-------	--

152. If [1.PRE] is limiting, Gaucher meets it because Gaucher teaches “a laptop computer 300” shown in Figure 3 (below). Gaucher, [0025]. Gaucher’s laptop computer 300 is a “*portable device*.” Gaucher, [0001] (describing “portable devices such as laptop computers and cellular phones”). Per the ’458 patent, a laptop is also a “*handheld device*.” EX1001, 1:34-41, 8:39-47.

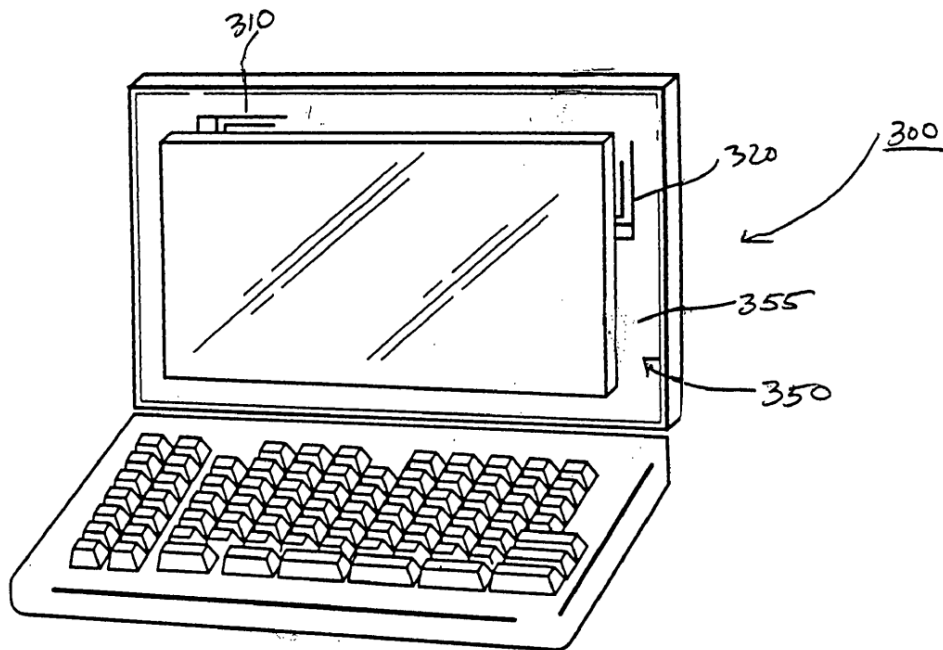


FIG. 3

153. Gaucher’s laptop is *a wireless handheld/portable device* because it includes “a plurality of multiband antennas 310, 320 mounted on the support frame 355 of the laptop display unit 350” and it was known that existing laptops like Gaucher’s (such as the Dialogue Flybook (EX1028)) were “used on the road and away from [WLAN] hot spot locations.” Gaucher, [0025]-[0027].

b. Limitation [1.a]

1.a	a ground plane;
-----	-----------------

154. Gaucher’s laptop includes *a ground plane* implemented as “support frame 355 of the laptop display unit 350.” Gaucher, [0025]. According to Gaucher, “the metal frame of the display unit is used as *a ground plane* for the antennas,” for example, “multiband antennas 310, 320 mounted on the support frame 355.” Gaucher, [0025], [0032], Fig. 3 (annotated below).

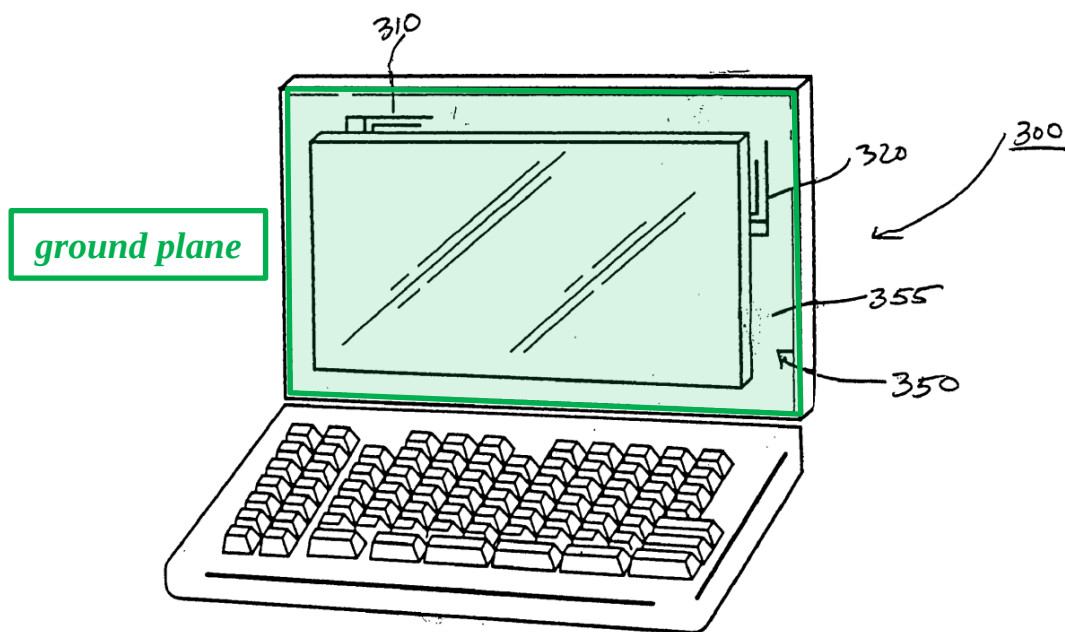


FIG. 3

c. Limitation [1.b]

1.b	the ground plane is inscribed in a rectangular area comprising a first side and a second side, a length of the second side being greater than a length of the first side;
-----	---

155. In Gaucher's Figure 3 (annotated below), **support frame 355** (*the ground plane*) *inscribes an area* supporting a *rectangular* laptop display like the display in Application No. 09/076,557 (published as Asano (EX1024)) where "display panel 13" is "a plate approximately **rectangular**." Asano, [0083]; Gaucher, [0024] (incorporating Asano by reference).

156. While Gaucher does not provide the display frame's dimensions, such rectangular laptops were conventional, for example, the IBM ThinkPad T42

(EX1019) having a *rectangular* support frame where a length of the *second side* (approximately 12.2 in) is *greater than a length of a first side* (approximately 10.0 in) for a 14.1 in display. EX1019, 7; *see also* EX1028, 22 (describing the Dialogue Flybook supporting a 1024 by 600 resolution 8.9 in. display).

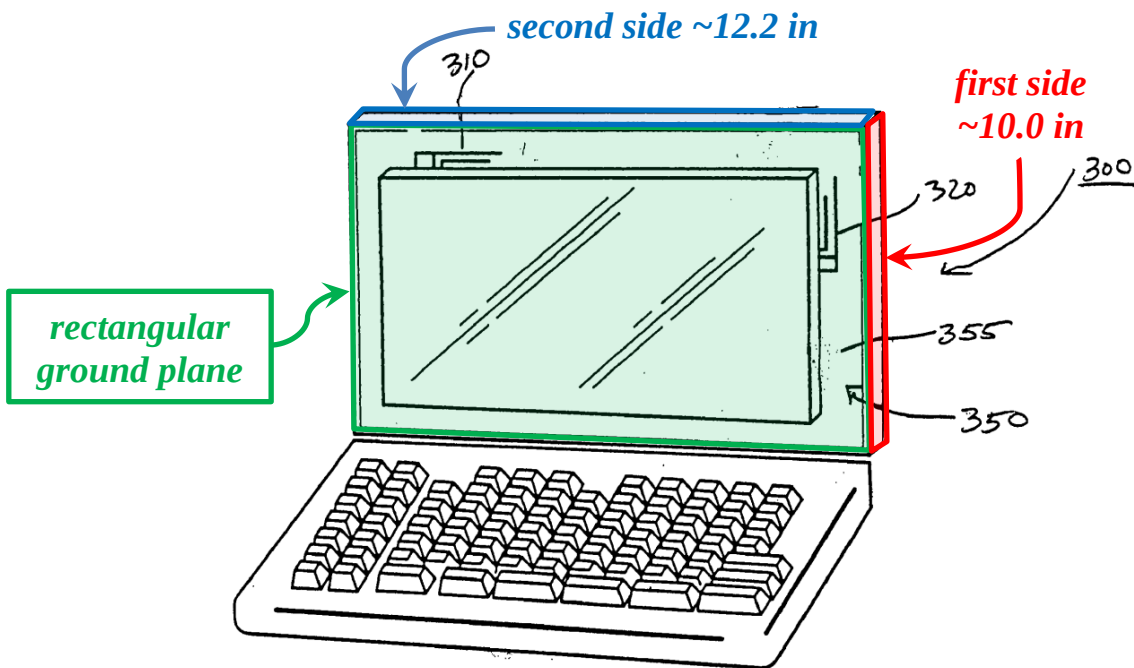


FIG. 3

d. Limitation [1.c]

1.c	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least three frequency bands;
-----	---

157. Gaucher's laptop computer 300 includes "a plurality of multiband antennas 310, 320 mounted on the *support frame* 355 of the laptop display unit

350.” Gaucher, [0025], Fig. 3 (annotated below). Multiband antenna 320 is a *first antenna*.

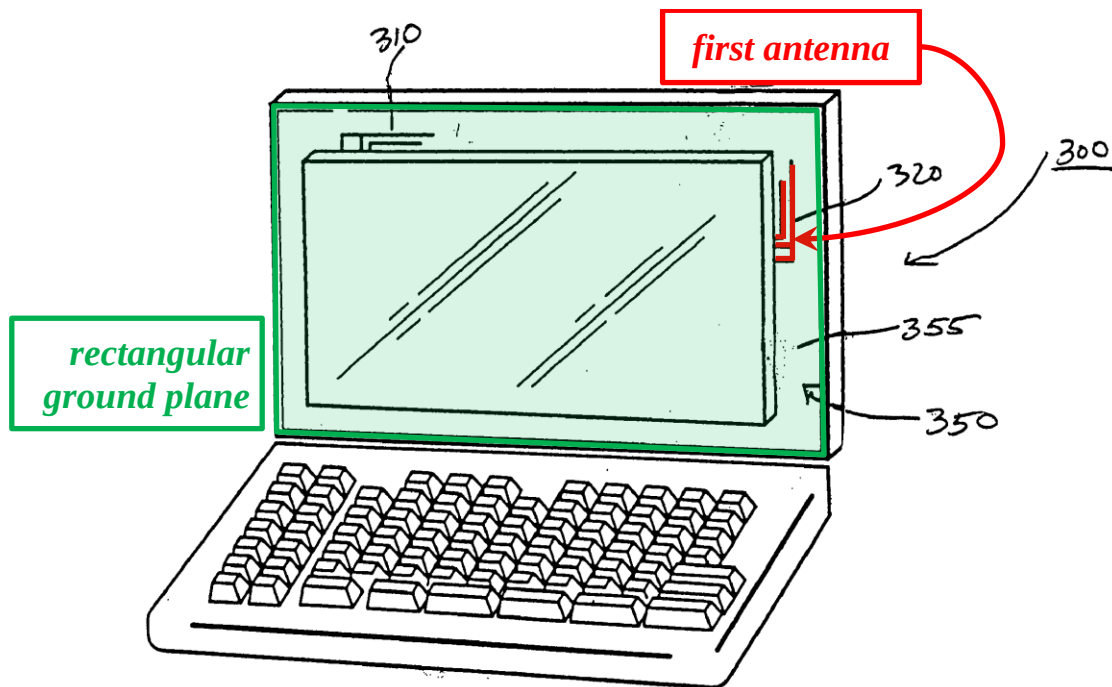


FIG. 3

158. Gaucher’s *antenna 320* can be “a compact-sized *quadband antenna* covering the four most popular frequency bands, namely, 824-894 MHz [GSM850]... 880-960 MHz [GSM900 / extended GSM900]... 1710-1880 MHz [GSM1800 or DCS1800]... and 1850-1990 MHz [PCS1900]....” Gaucher, [0030]. A POSA would have understood that “covering” these frequency bands means the antenna supports both uplink and downlink communications (*transmit and receive*), as discussed in Section VIII.D.1.d (Ground 1, [1.c]). EX1009, 9. Gaucher’s antenna 320 (*a first antenna*), implemented as a quadband antenna, is

thus “*configured to transmit and receive electromagnetic waves corresponding to at least three frequency bands.*”

e. Limitation [1.d]

1.d	the at least three frequency bands being used for mobile communication services;
-----	--

159. According to the '458 patent, a “*frequency band being used for mobile communication services*” includes GSM850, GSM900, GSM1800, and PCS1900. EX1001, 2:4-10. GSM850 operates in the 824-894 MHz frequency range, GSM900 operates in the 890-960 MHz range, GSM1800 operates in the 1710-1880 MHz range, and PCS1900 operates in the 1850-1990 MHz range. EX1009, 9; EX1001, 9:26-43 (defining “mobile or cellular communication standards” as operating in, for example, “the 810 MHz-960 MHz” or “1710 MHz-1990 MHz” regions).

160. As discussed in Section X.B.1.d (Limitation [1.c]), Gaucher’s antenna 320 implementing the quadband antenna *transmits and receives* in “the four most popular frequency bands” in 2004 for mobile communications—824-894 MHz (GSM850), 890-960 MHz (GSM900), 1710-1880 MHz (GSM1800), and 1850-1990 MHz (PCS1900). Gaucher, [0030]; EX1009, 9. Thus, implementing Gaucher’s antenna 320 as a quadband antenna is “*a first antenna configured to*

transmit and receive” in “at least three frequency bands being used for mobile communication services.”

f. Limitation [1.e]

1.e	a second antenna configured to receive electromagnetic waves corresponding to at least one frequency band;
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161. As discussed in Section X.B.1.d (Limitation [1.c]), Gaucher’s laptop computer 300 includes “a plurality of multiband antennas 310, 320 mounted on the support frame 355 of the laptop display unit 350,” where antenna 320 is a *first antenna*. Gaucher, [0025], Fig. 3 (annotated below). Multiband antenna 310 is a *second antenna*.

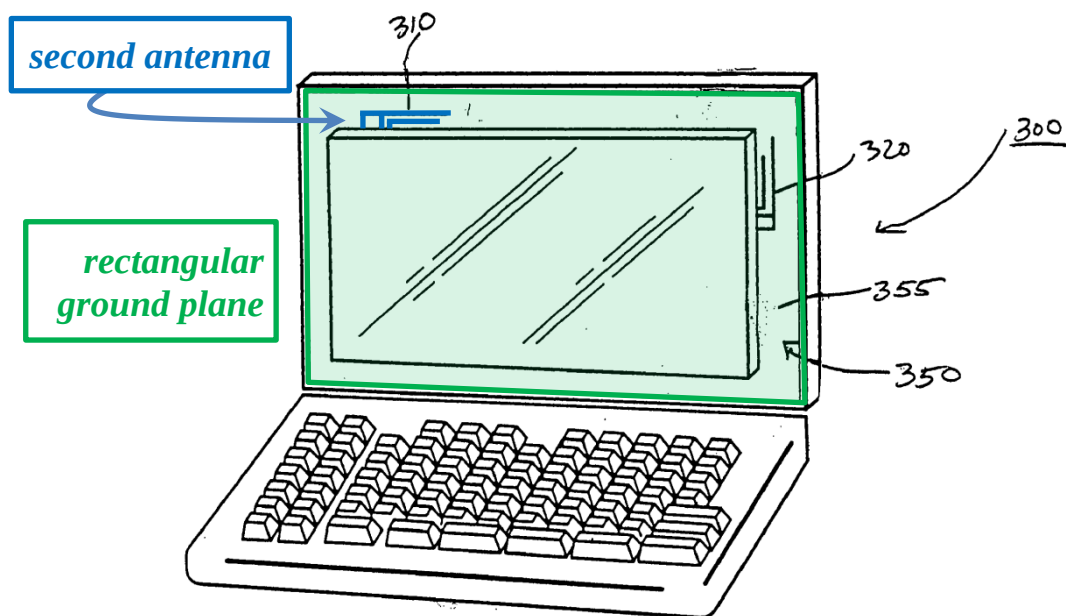


FIG. 3

162. [Antenna 310](#) can be “integrated antenna designs described in the above-incorporated patent applications and patents,” such as the tri-band antenna described in Gaucher848 that “operate[s] in the 2.4-2.5 GHz, 5.15-5.35 GHz and 5.47-5.85 GHz bands.” Gaucher, [0030], [0024] (incorporating Gaucher848 by reference); Gaucher848, [0011]; see Section X.A.2 (Gaucher848). Gaucher848’s antenna *receives electromagnetic waves*, for example, when operating an 802.11b wireless connectivity service that transmits and receives data in the 2.4–2.84 GHz range to “provide up to 11 Mbps data rate.” EX1018, 41, 51; Gaucher848, [0009], [0013]. Likewise, when operating an 802.11a service, Gaucher848’s antenna transmits and receives data in the 5.15–5.25, 5.25–5.35 and 5.725–5.825 GHz ranges. EX1017, 3-4, 24, Fig. 118 (transmitter and receiver block diagram); Gaucher848, [0009], [0013].

163. Gaucher’s antenna 310 (*second antenna*) implemented as Gaucher848’s tri-band antenna, is thus “*a second antenna configured to receive electromagnetic waves corresponding to at least one frequency band.*”

g. Limitation [1.f]

1.f	the at least one frequency band being used for wireless connectivity services;
-----	--

164. Gaucher meets [1.f] in at least four ways.

165. As discussed in Sections X.A.2 (Gaucher848) and X.B.1.f (Limitation [1.e]), Gaucher’s [antenna 310](#) implemented as Gaucher848’s tri-band wireless antenna is “*a second antenna*” included in Gaucher’s laptop 300 that “operate[s] in the 2.4-2.5 GHz, 5.15-5.35 GHz and 5.47-5.85 GHz bands.” Gaucher, [0030], [0024], [0026]; Gaucher848, [0008]-[0009], [0011], [0056], Figs. 9, 10.

i. 2.4 GHz ISM band

166. According to the ’458 patent, a “*frequency band being used for wireless connectivity services*” includes “WLAN or Bluetooth” services that operate, for example, in the “2.4 GHz ISM band (2400-2500 MHz).” EX1001, 2:16-20, 9:46-60. Thus, Gaucher’s [antenna 310](#) (*a second antenna*) implemented as Gaucher848’s tri-band antenna operating in the 2.4 GHz ISM frequency band meets Limitation [1.f].

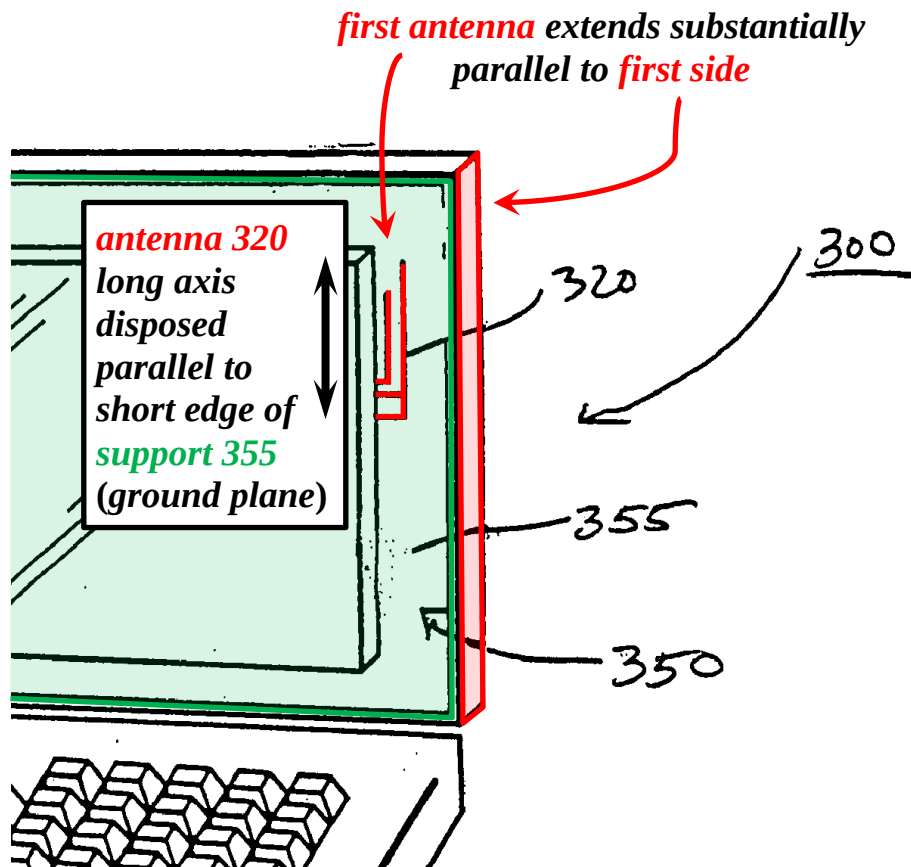
ii. 5 GHz ISM bands

167. IEEE Std. 802.11a defines the high-speed physical layer for Wireless LAN in “the 5.15–5.25, 5.25–5.35 and 5.725–5.825 GHz ***unlicensed national information infrastructure (U-NII) bands***, as regulated in the United States by the Code of Federal Regulations, Title 47, Section 15.407.” EX1017 (802.11a-1999), 3; EX1031, 63 Fed. Reg. 40831, 40836-40837 (July 31, 1998). As Gaucher848’s tri-band antenna, Gaucher’s antenna 310 works in each of these three bands and, for each, separately meets Limitation [1.f].

h. Limitation [1.g]

1.g	the first antenna extends in a direction substantially parallel to the first side;
-----	--

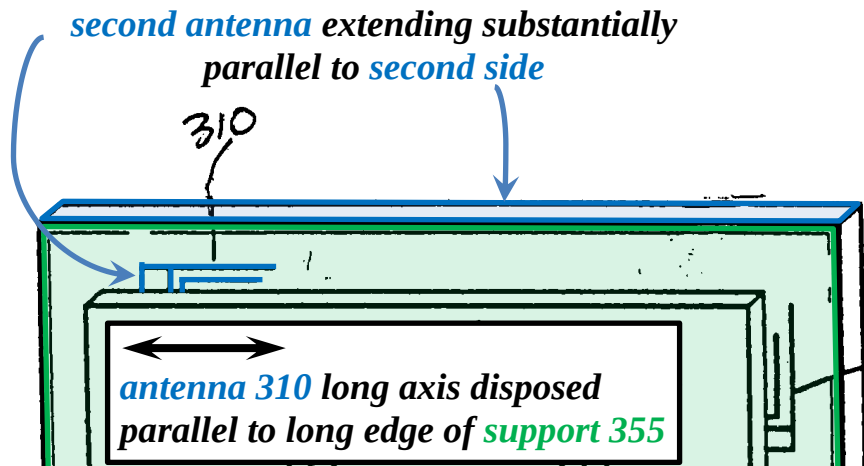
168. Gaucher meets [1.g] because antenna 320 (*first antenna*) is “mounted to the metal support frame 355... *substantially parallel to the plane*, or along the plane, *of the metal support frame 355*,” as shown in Figure 3 (annotated detail below). Gaucher, [0025], Fig. 3. Antenna 320 has a long axis that, when the antenna is so mounted, is disposed *substantially parallel* to the right-short side (*first side*) of metal support frame 355 (*ground plane*, Limitation [1.a]-[1.b]), thus meeting Limitation [1.g]. Gaucher, [0025], Fig. 3.



i. Limitation [1.h]

1.h	the second antenna extends in a direction substantially parallel to the second side;
-----	--

169. Gaucher meets [1.h] because **antenna 310** (*second antenna*) is “mounted to the metal **support frame 355**... *substantially parallel to the plane*, or along the plane, *of the metal support frame 355*,” as shown in Figure 3 (annotated detail below). Gaucher, [0025], Fig. 3. Like antenna 320, antenna 310 has a long axis that, when mounted to metal support 355 as shown in Figure 3 and described in Gaucher, is disposed *substantially parallel* to the top-long side (*second side*) of support 355 (*ground plane*, Limitation [1.a]-[1.b]), thus meeting Limitation [1.h]. Gaucher, [0025], Fig. 3.



j. Limitation [1.i]

1.i	the first antenna is arranged substantially close to the first side; and
-----	--

170. The '458 specification describes “component 2210” as “*substantially close* to a corner” of a “shorter edge[] of PCB 2300[.]” EX1001, 23:45-52. The '458 patent never identifies Figure 23C as drawn to scale or quantifies a measurement for “*substantially close.*”

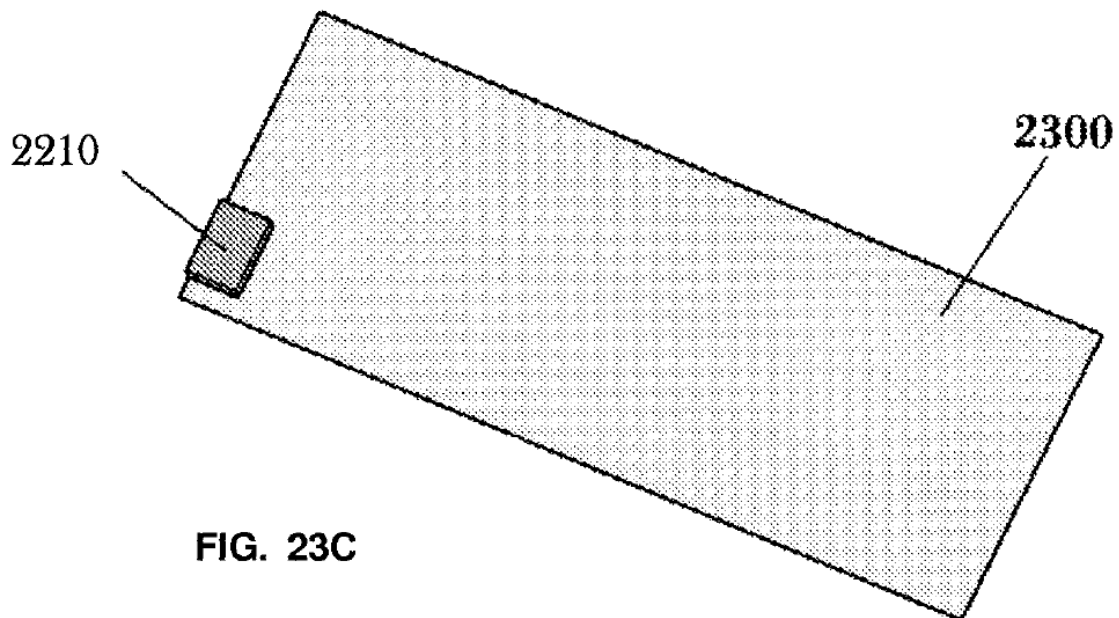
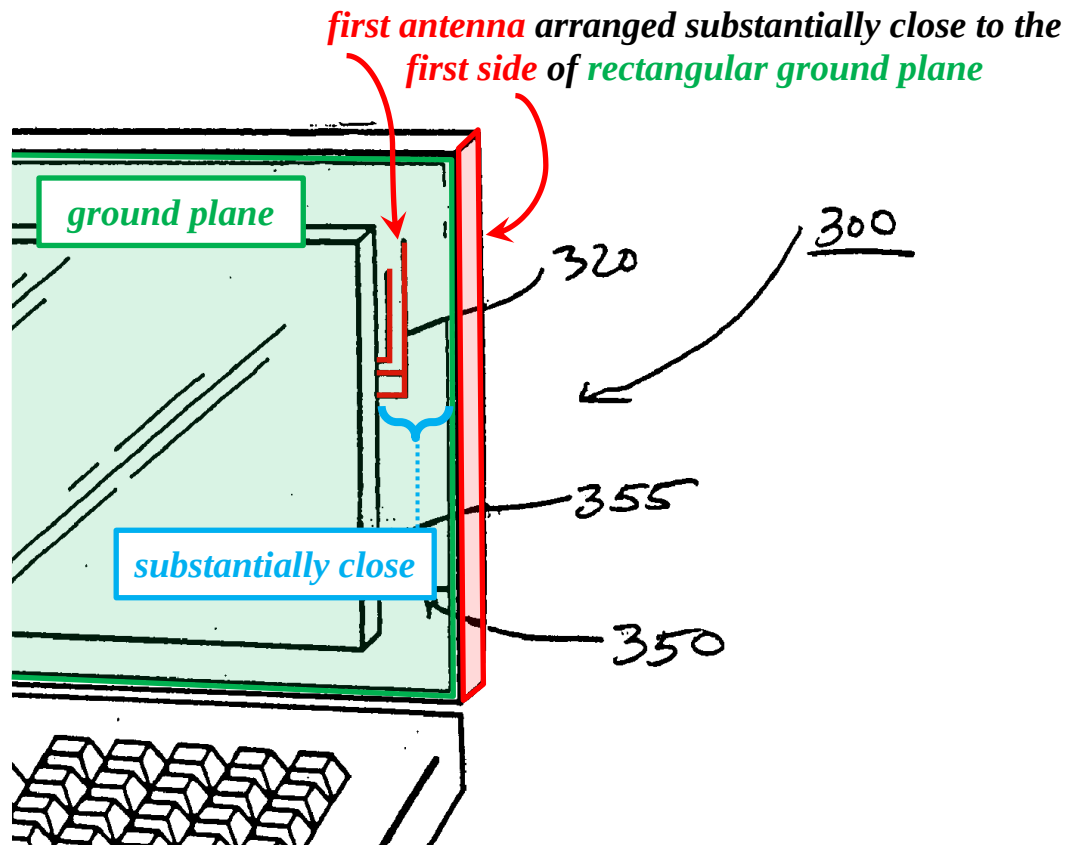


FIG. 23C

171. Gaucher meets [1.i] because **antenna 320** (*first antenna*) is “embedded... on a laptop display unit” by being “mounted to the metal **support frame 355**” between the edge of the display and the right side (*first side*) of the support frame, as shown in Figure 3 (annotated detail below). Gaucher, [0025], Fig. 3.



k. Limitation [1.j]

1.j	the first antenna and the second antenna are located internally within the wireless handheld or portable device.
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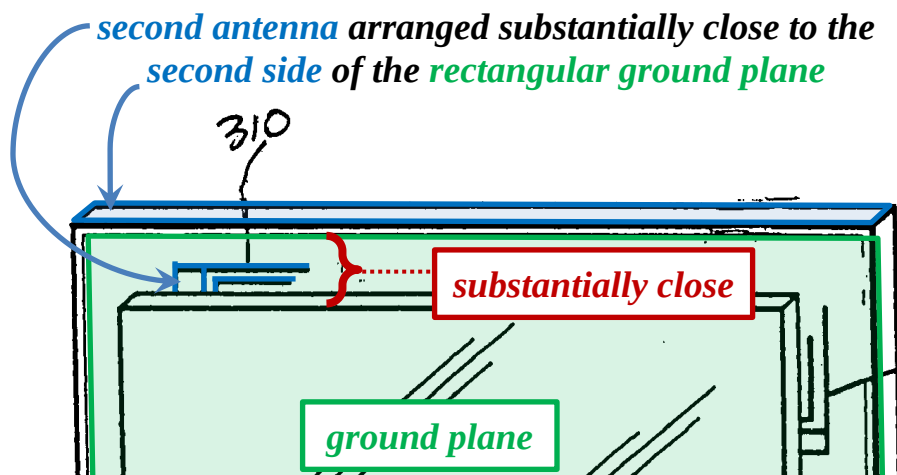
172. Gaucher teaches that its antenna 310 (*the second antenna*) and antenna 320 (*the first antenna*) are both “embedded antennas on a laptop display unit” by being “mounted on the support frame 355 of the laptop display unit 350.” Gaucher, [0025], Fig. 3. Since Gaucher’s antennas are both “embedded” on the support frame, they are both “*located internally within the wireless handheld or portable device.*”

2. Claim 2

2	The wireless handheld or portable device according to claim 1, wherein the second antenna is arranged substantially close to the second side.
---	---

173. As explained for Limitation [1.i], the '458 specification never quantifies “*substantially close*.” See Section X.B.1.j (Limitation [1.i]).

174. Gaucher meets claim 2 because, [antenna 310](#) is “embedded... on a laptop display unit” by being “mounted to the metal [support frame 355](#)” between the display’s top edge and the top-edge (*second side*) of the support frame, “[a]s shown in Figure 3” (annotated detail below). Gaucher, [0025], Fig. 3.

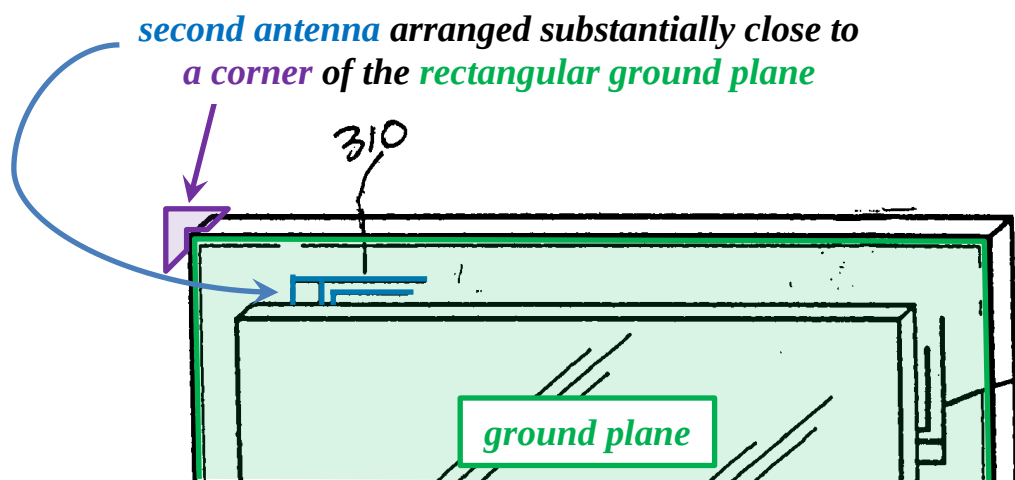


3. Claim 3

3	The wireless handheld or portable device according to claim 2, wherein the second antenna is arranged substantially close to a corner of the rectangular area.
---	--

175. As explained for limitation [1.i], the '458 patent never quantifies “*substantially close*.” See Section X.B.1.j (Limitation [1.i]).

176. Gaucher's **antenna 310** is shown in Figure 3 as mounted *substantially close to the **second side*** (such as the top side) of **support frame 355** (defining a ground plane rectangle). Gaucher, [0025], [0030], [0032], Fig. 3; see Section X.B.2 (Claim 2). Gaucher's Figure 3 (annotated detail below) depicts **antenna 310** arranged *substantially close to the **top-left corner*** of **support frame 355's** *rectangular area*.



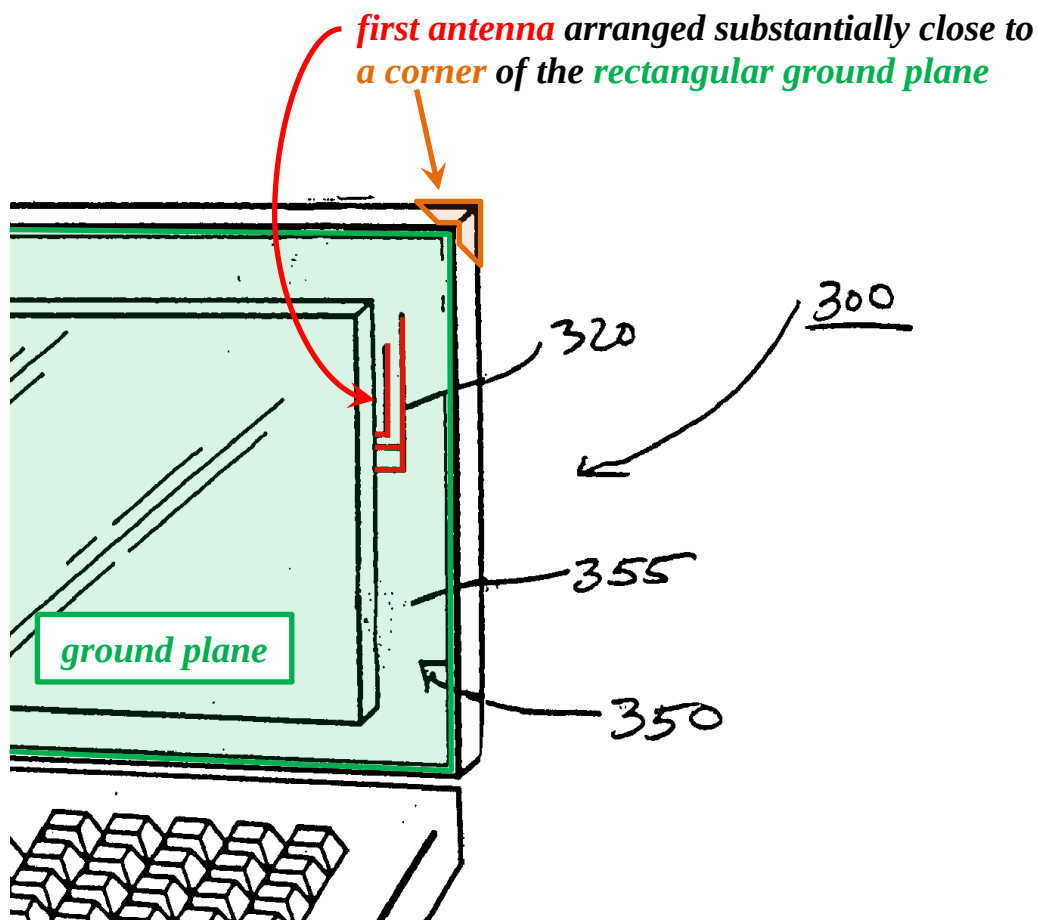
4. Claim 4

4	The wireless handheld or portable device according to claim 1, wherein the first antenna is arranged substantially close to a corner of the rectangular area.
---	---

177. As explained for limitation [1.i], the '458 patent never quantifies “*substantially close*.” See Section X.B.1.j (Limitation [1.i]).

178. Gaucher's **antenna 320** is shown in Figure 3 as mounted *substantially close to the **first side*** (such as the right side) of **support frame 355** (defining a ground plane rectangle). Gaucher, [0025], [0030], [0032], Fig. 3; see Section

X.B.1.j (Limitation [1.i]). Gaucher's Figure 3 (annotated detail below), antenna 320 is arranged substantially close to the top-right corner of support frame 355's rectangular area.



5. Claim 5

5	The wireless handheld or portable device according to claim 1, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
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179. As discussed in Section X.B.1.d (Limitation [1.c]), Gaucher's antenna 320 implemented as Gaucher's quadband antenna is *the first antenna*. Gaucher,

[0025], [0030], Fig. 3. According to Gaucher, one implementation of the quadband antenna is an “*inverted-F antenna*” which “provide[s] many advantages such as smaller antenna size, low manufacturing costs, compatibility with standard industrial laptop/display architectures, reliable performance and the like.” Gaucher, [0032].

6. Claim 6

6	The wireless handheld or portable device according to claim 5, wherein the second antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
---	--

180. Gaucher’s [antenna 310](#) implemented as Gaucher848’s tri-band antenna is *the second antenna*. See Section X.B.1.f (Limitation [1.e]); Gaucher, [0024]-[0026], [0030], Fig. 3; Gaucher848, [0008]-[0009], [0056], Figs. 9, 10. Gaucher848 explains that one implementation of the tri-band antenna is an “*inverted-F antenna*.” Gaucher848, [0049].

7. Claim 7

7	The wireless handheld or portable device according to claim 1, wherein the at least one frequency band used for wireless connectivity services corresponds to at least one wireless connectivity service selected from the group comprising: Bluetooth™, IEEE802.11a, IEEE802.11b, IEEE802.11g, WLAN, WiFi, UWB, ZigBee, GPS, Galileo, SDARs, XDARS, WiMAX, DAB, FM, DVB-H, and DMB.
---	--

181. Gaucher848's tri-band antenna "operate[s] in the 2.4-2.5 GHz, 5.15-5.35 GHz and 5.47-5.85 GHz bands." Gaucher, [0030], [0024], [0026]; Gaucher848, [0008]-[0009], [0011], [0056], Figs. 9, 10.

182. At least IEEE Std. 802.11b, IEEE Std. 802.11g, Bluetooth, and Zigbee each use the 2.4 GHz ISM band (2400-2500 MHz). EX1018 (802.11b), 41, 49-51; EX1020 (802.11g), 15; EX1021 (Zigbee), 17; EX1022 (Bluetooth), 27-29; EX1001, 2:16-20, 9:46-60. At least IEEE Std. 802.11a uses the "5.15–5.25, 5.25–5.35 and 5.725–5.825 GHz ***unlicensed national information infrastructure (UNII) bands***" (see Section X.B.1.g (Limitation [1.f])); EX1017 (802.11a), 3-4, ***each*** of which is supported by Gaucher848's tri-band antenna. Gaucher848, [0011]. WLAN networks based on IEEE Std 802.11 (including, for example, 802.11a, 802.11b, 802.11g) are known as "Wi-Fi." EX1023 (Wi-Fi Alliance), 1-2. Gaucher thus separately meets claim 7 for at least each of these "*wireless connectivity services*" (for example, 802.11a, 802.11b, 802.11g, WLAN, Wi-Fi, Bluetooth, Zigbee). EX1001, 2:16-20, 9:46-60 (describing using the 2.4 GHz ISM

band for wireless connectivity services like WLAN, IEEE 802.11b, and Bluetooth).

8. Claim 8

a. Limitations [8.PRE]-[8.c], [8.j]

183. Gaucher meets Limitations [8.PRE]-[8.c] and [8.j] for the reasons it meets the corresponding limitations below. EX1016, 1.

Limitation	Corresponding Limitation	Discussion above
[8.PRE]	[1.PRE]	Section X.B.1.a
[8.a]	[1.a]	Section X.B.1.b
[8.b]	[1.c]	Section X.B.1.d
[8.c]	[1.d]	Section X.B.1.e
[8.j]	[1.j]	Section X.B.1.k

Gaucher meets the remaining limitations in claim 8 as follows.

b. Limitation [8.d]

8.d	a second antenna configured to operate in at least one frequency band;
-----	--

184. Gaucher meets [8.d] because antenna 310 (Gaucher848's tri-band antenna) *operates in at least one frequency band*, for example, "operate[s] in the 2.4-2.5 GHz, 5.15-5.35 GHz and 5.47-5.85 GHz bands." Gaucher, [0030], [0024] (incorporating Gaucher848 by reference); Gaucher848, [0008]-[0009], [0011], [0041], [0056], Figs. 9, 10; EX1017 (802.11a-1999), 3; EX1018 (802.11b), 41, 51; see Section X.B.1.f (Limitation [1.e]).

c. Limitation [8.e]

8.e	the first antenna extends in a direction substantially parallel to a first side of the portable device;
-----	---

185. Gaucher meets [8.e] because as explained in Section X.B.1.h (Limitation [1.g]) and as “FIG. 3 shows,” antenna 320 is disposed with a long axis “*substantially parallel*” to a *first side* of laptop 300’s support frame 355. Gaucher, [0025] (“antennas 310, 320 are mounted to the metal support frame 355, wherein the plane of each... is substantially parallel to the plane, or along the plane, of the metal support frame 355.”), [0032], Fig. 3. Figure 3 further shows that the “*first side*” of support frame 355—and the long axis of antenna 320 when so mounted—is also *substantially parallel* to the *first side* of Gaucher’s laptop (*portable device*). Gaucher, Fig. 3; see Section X.B.1.h (Limitation [1.g]).

d. Limitation [8.f]

8.f	a length of a second side of the portable device is greater than a length of the first side of the portable device;
-----	---

186. Gaucher meets [8.f] because as explained in limitation [1.b] (see Section X.B.1.c), Figure 3 shows support frame 355 supporting a rectangular display where the *second side* of the frame is longer than the *first side*. Gaucher, [0025], [0032], Fig. 3; Asano, [0083]; EX1019, 7. Thus, Figure 3 shows the same relationship for the laptop lid containing the display frame, wherein the top-side (*second side*) is longer than the right-side (*first side*). See Section X.B.1.c.

e. Limitation [8.g]

8.g	the first antenna is arranged substantially close to the first side of the portable device;
-----	---

187. Gaucher meets [8.g] because as explained in Section X.B.1.j (Limitation [1.i]), Figure 3 shows that antenna 320 (*first antenna*) is disposed “*substantially close*” to a “*first side*” of frame 355. Gaucher, Fig. 3. Figure 3 further shows that the “*first side*” of frame 355 extends to the “*first side*” of the laptop lid, so that antenna 320 is also disposed *substantially close to the first side* of laptop 300 (*portable device*). Gaucher, [0025], [0032], Fig. 3.

f. Limitation [8.h]

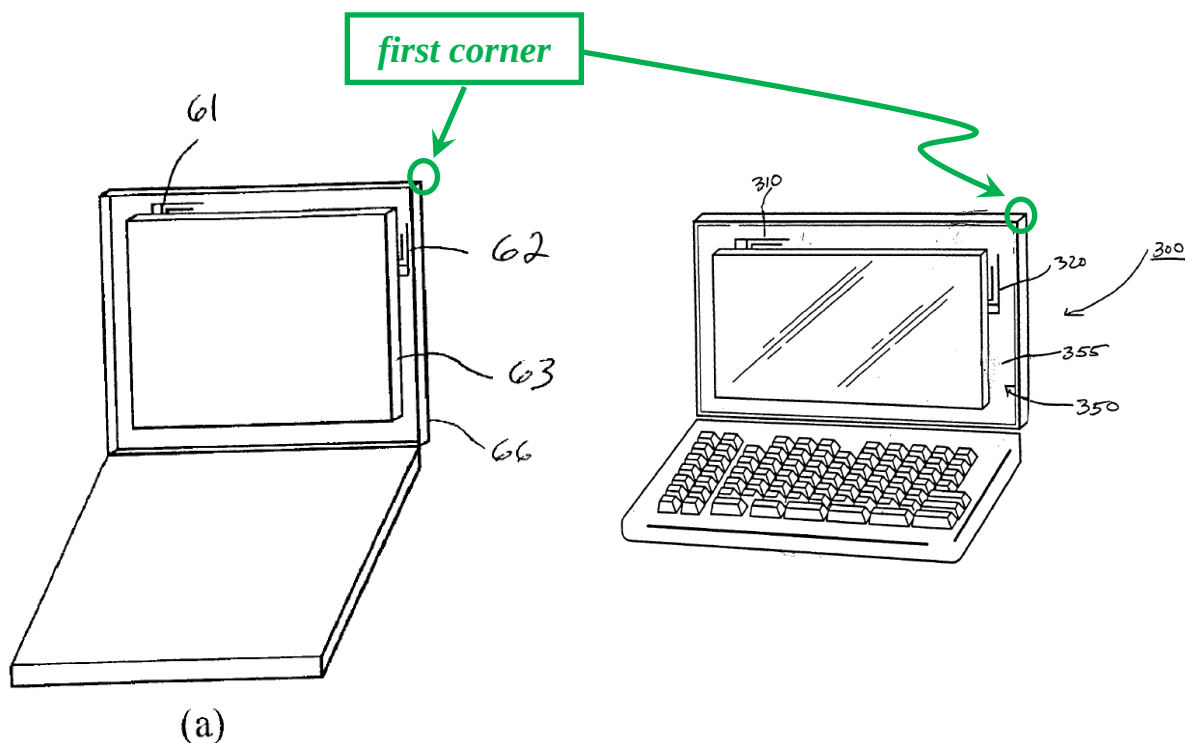
8.h	the second antenna is arranged substantially close to a first corner of the portable device;
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188. Gaucher meets [8.h] because as explained in Section X.B.3 (claim 3), Gaucher’s Figure 3 shows that antenna 310 (*the second antenna*) is arranged *substantially close to the top-left corner* of *support frame 355’s rectangular area*. Figure 3 also shows that frame 355 extends to edge—and each corner—of the laptop cover, in other words, a “*corner of the portable device*.” Gaucher, Fig. 3.

189. As discussed in Sections X.B.1.f (Limitation [1.e]) and X.B.8.b (Limitation [8.d]), antenna 310 is implemented using Gaucher848’s tri-band antenna. POSAs would have known that antenna 310 could be disposed

“substantially close” to the **top-right** corner of the laptop display, which is also a corner of “the portable device.”

190. Gaucher848 explains that the tri-band antenna mounted on the top-side of the support frame is not limited to a left-side-placement, but can also “be located on the right side of the upper portion of the frame (63) (as opposed to the left side of the upper portion of the frame as shown).” Gaucher848, [0049], *cf.* Fig. 6(a) (showing a similar laptop/antenna configuration as Gaucher’s Figure 3 with antenna 61 on “left side”).

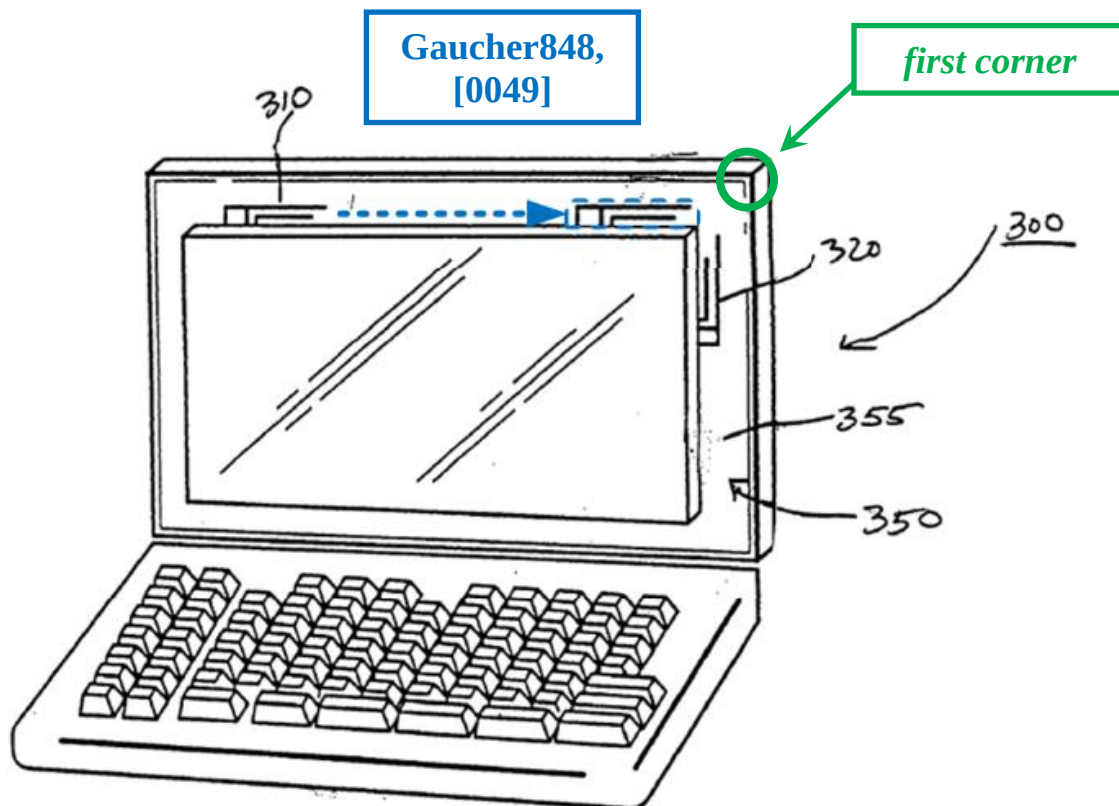


Gaucher848, Fig. 6(a)

Gaucher, Fig. 3

191. Thus, rearranging **antenna 310** (*second antenna*) in Gaucher’s Figure 3 from the upper-left portion to the upper-right portion of **support frame 355**, as

Gaucher848 specifically teaches as an option for its tri-band antenna, is *the second antenna... arranged substantially close to the top-right corner of the portable device*.

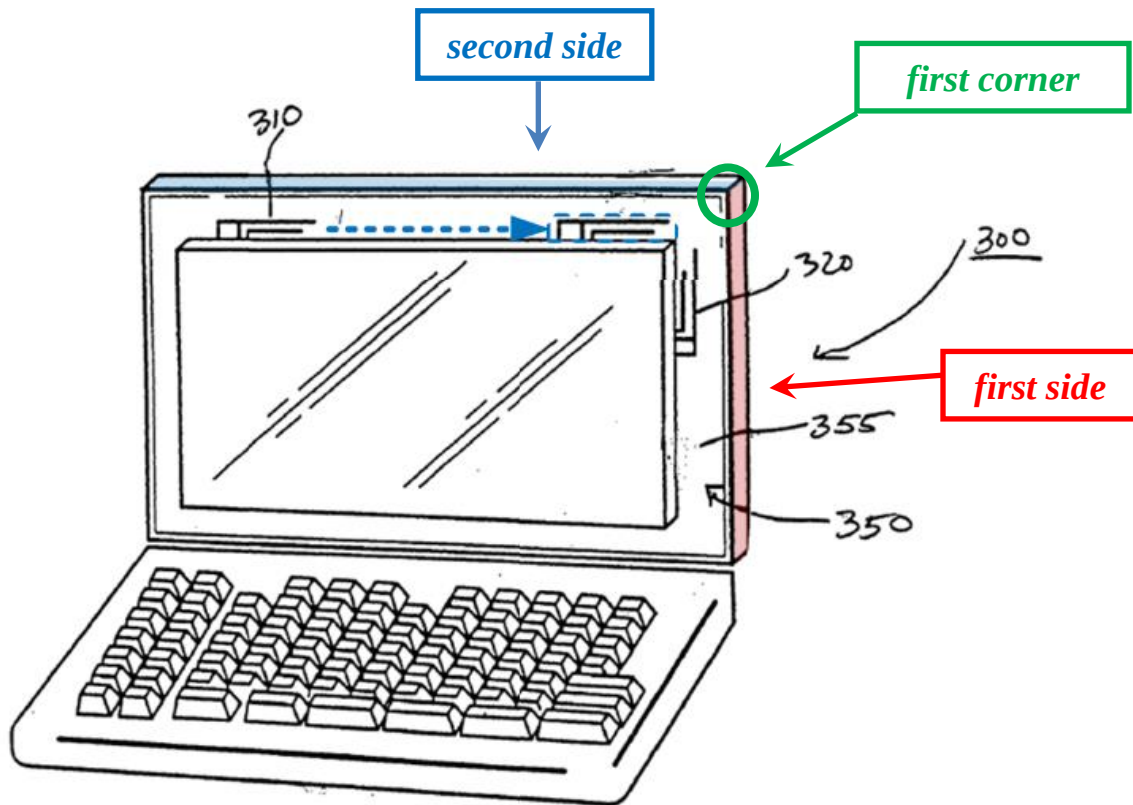


g. Limitation [8.i]

8.i	the first corner of the portable device corresponding to a first end of the first side with an end of the second side of the portable device; and
-----	---

192. Gaucher meets [8.i] because as shown in Figure 3, laptop 300 (*portable device*) has a *first side*—the lid’s right side—and a *second side*—the lid’s top side. This conforms to the *first/second side* of frame 355 as discussed in Sections X.B.1.h (Limitation [1.g]) and X.B.8.c (Limitation [8.e]): *the first side* is

the right side where Gaucher's antenna 320 is located, while the *second side* is the upper-side, as Figure 3 shows that frame 355 has sides coterminous with the laptop (*portable device*) sides. Gaucher, Fig. 3; Gaucher848, [0049]; see Section X.B.8.f (Limitation [8.h]).



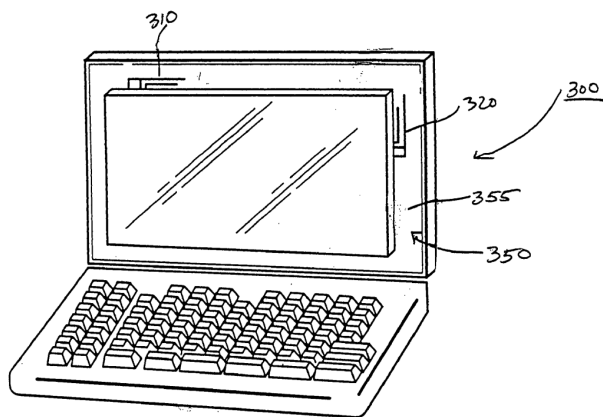
193. The laptop's "*first corner*" is the top right corner as shown in Figure 3, which coincides with the right corner of upper-side (*the second side*) of support frame 355 when Gaucher's antenna 310 is implemented as Gaucher848's tri-band antenna and located on the upper-right portion of the support frame, as taught in Gaucher848. Gaucher848, [0049]; see Section X.B.8.f (Limitation [8.h]). This meets [8.i].

9. Claim 9

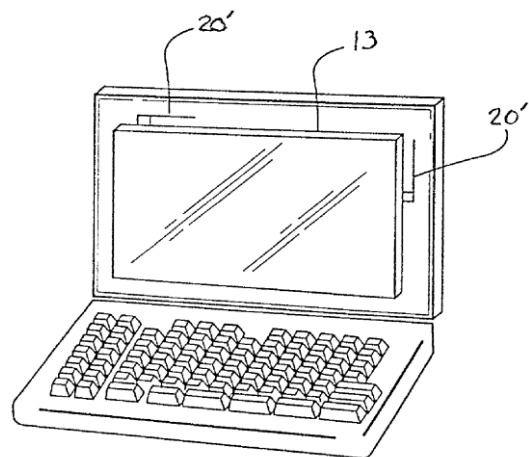
9	The portable device according to claim 8, wherein a portion of an orthogonal projection of the first antenna on a plane containing the ground plane does not overlap with the ground plane.
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194. As explained for limitations [1.g] and [8.g], Gaucher teaches that *first antenna 320* is “mounted to the metal support frame 355... substantially parallel to the plane, or along the plane, of the metal support frame 355.” Gaucher, [0025], Fig. 3; see Sections X.B.1.h (Limitation [1.g]) and X.B.8.e (Limitation [8.g]).

195. Gaucher also incorporates-by-reference Application No. 09/876,557 (published as Asano (EX1024)) describing a laptop embodiment with two inverted-F antennas “disposed in the plane of the display” like Gaucher’s laptop. Gaucher, [0024]-[0025], Fig. 3; Asano, [0058], Fig. 3E.



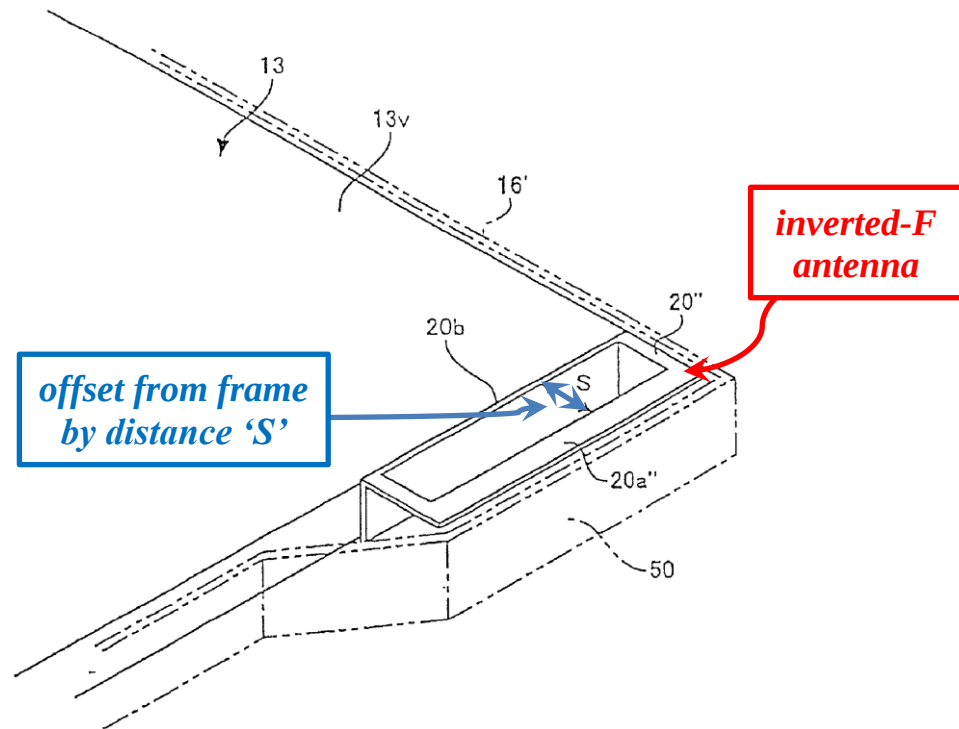
Gaucher, Fig. 3



Asano, Fig. 3E

196. Asano teaches in Figure 16 that when using an inverted-F antenna (such as antennas 320, 20”) “located in a plane approximately parallel to the...

display panel,” as in the laptops above, the antenna’s “radiator portion... may be located... ***at a distance more than a predetermined dimension S from the*** portion made of conductive material such as the ***frame 13A***” (such as Gaucher’s support frame 355). Asano, [0131]-[0132], Fig. 16.



Asano, Fig. 16

197. In applying this teaching to Gaucher’s laptop, POSAs would have understood that Figure 16 represents an angled-view of an “*orthogonal projection*” of the inverted-F antenna (such as Gaucher’s antenna 320 discussed in limitations [1.c], [1.g], [8.b], [8.g]) “*on a plane containing the ground plane*” (such as Gaucher’s support frame 355 discussed in limitations [1.a]-[1.b] and [8.a]). Gaucher, [0025], [0032]. Gaucher’s antenna 320 (*first antenna*) moved a predetermined distance ‘S’ (as shown in Figure 16 above) therefore yields “a

portion of an orthogonal projection of the first antenna... not overlap[ping]”

Gaucher’s support frame 355 (*ground plane*).

10. Claim 10

10	The portable device according to claim 8, wherein the second antenna is substantially close to the first side of the portable device and extends in a direction substantially parallel to the first side of the portable device.
----	--

198. As discussed in Section X.B.8.f (Limitation [8.h]), Gaucher’s antenna 310 (*the second antenna*) can be arranged in the upper-right portion of support frame 355 (Gaucher848, [0049]) in the same way that antenna 310 is “*substantially close to the*” left side support frame 355, as shown in Gaucher’s Figure 3 and discussed in Section X.B.3 (Claim 3). When antenna 310 is located on the upper-right portion of support frame 355 as taught by Gaucher848, it “*is substantially close to the first side*” (right side) “*of the portable device.*”

11. Claims 12-13

199. Gaucher meets the additional limitations in claims 12 and 13 for the same reasons it meets claims 5 (*see* Section X.B.5) and 6 (*see* Section X.B.6), respectively. EX1016, 2-3.

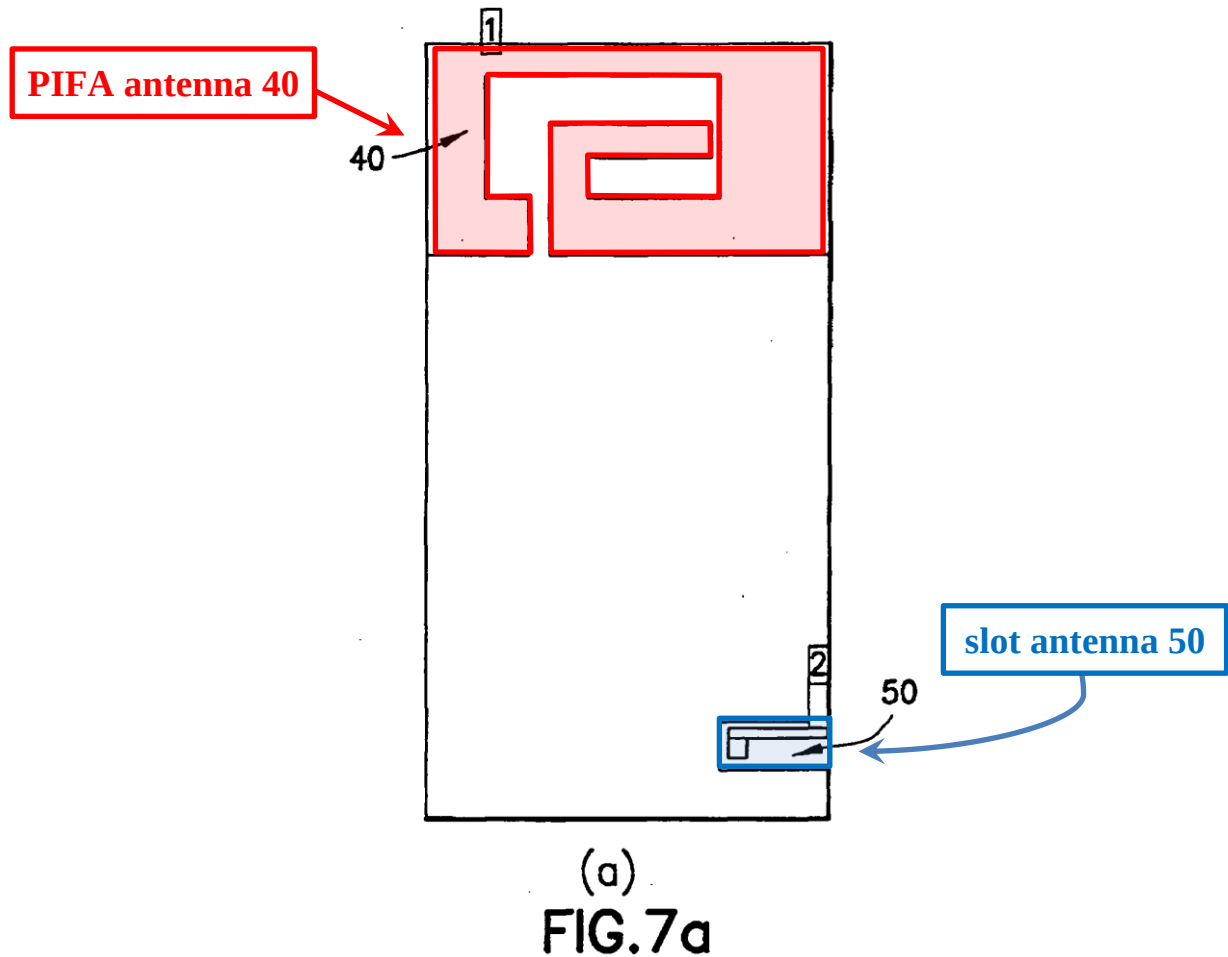
XI. GROUND 3: ZHAO RENDERS OBVIOUS CLAIMS 14-18

A. Zhao (EX1008)

200. Zhao discloses wireless ultra-wideband (“UWB”) communication systems comprising a quarter-wavelength slot UWB antenna integrated on a 40

mm by 80 mm PCB conventional for “mobile handsets.” Zhao, [0002] (describing “UWB-equipped mobile devices”), [0004] (describing UWB designs for mobile terminals comprising mobile handsets), [0007], [0031] (describing UWB antenna “integrated on a PCB of a mobile terminal”), [0038]. Zhao thus motivates the use of its described antennas and ground plane on a conventional mobile device. Zhao, [0002], [0004].

201. Zhao also discloses placing a “dual-band PIFA antenna 40” along with the “quarter-wavelength slot UWB antenna 50” on the PCB as in, for example, Figure 7a (annotated detail below). Zhao, [0035], [0038], [0042], [0044], [0046] (“The locations of the dual-band PIFA antenna 40 and the quarter-wavelength slot UWB antenna 50 are shown in FIG. 7a...”), Fig. 7a.



202. **Antenna 40** is “a conventional dual band PIFA GSM antenna (working at frequencies of 0.9 GHz and 1.8 GHz).” Zhao, [0044], [0046], Fig. 7b (showing antenna 40’s return loss (denoted S11)). **Antenna 50** is a 12.75 mm by 4 mm (maximum) L-shaped slot antenna “preferably operat[ing] in the... 3.1 GHz to 4.9 GHz” ultra-wide band (“UWB”) frequency range used for “short-range,” “higher-data-rate communication[s]” (such as data, audio, and video between consumer electronics). Zhao, [0002], [0038], [0042], [0046], [0052], Fig. 7b (showing antenna 50’s return loss (denoted S22)).

203. The Figure 7a antenna positions “present[] the best isolation” with antenna 40 aligned along the top-side and “8 mm above the PCB,” and antenna 50 positioned toward the PCB’s lower-right corner. Zhao, [0044], [0049]. According to Zhao, Figure 7a’s antenna positioning “presents the best isolation” because “the two antennas are separated by the greatest distance.” Zhao, [0046], [0049], [0055].

B. Mapping to Claims 14-18

1. Claim 14

a. Preamble

14.PRE	A wireless handheld or portable device comprising:
--------	--

204. Zhao meets [14.PRE] because it describes wireless ultra-wideband (“UWB”) communication systems comprising a UWB antenna “for mobile terminals” integrated on a PCB with dimensions consistent with conventional wireless handheld devices. Zhao, code (54), [0002] (describing “UWB-equipped mobile devices”), [0004] (describing UWB designs for mobile terminals comprising mobile handsets), [0007], [0031]-[0032] (describing “a quarter-wavelength slot UWB antenna integrated on a PCB of a mobile terminal”), [0038] (describing UWB slot antenna integrated on 80 mm x 40 mm PCB); EX1025, 87 (describing UWB antenna “for mobile UWB devices”) (*cited in* Zhao, [0004]). It is my opinion that POSAs would have had reasons to use Zhao’s UWB antenna and PCB in a wireless handheld or portable device because Zhao describes such

technology as “provid[ing] a clear added-value benefit to the mobile phone industry by developing UWB-equipped mobile devices.” Zhao, [0002].

b. Limitation [14.a]

14.a	a ground plane;
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205. Zhao describes integrating a UWB antenna “on a PCB of a mobile terminal.” Zhao, [0031], [0032], [0038]. Zhao simultaneously describes integrating slot UWB antennas “on a ground plane” with 80 mm by 40 mm by 1mm dimensions, “which is the size of a typical PCB for a mobile terminal.” Zhao, [0038]. In short, Zhao integrated its antennas on a PCB comprising a dielectric material 21 (such as FR4 in [0038]) and an “electrically conducting layer” 23. Zhao, [0042].

206. Figure 3 (annotated below) shows a planar view of the PCB surface comprising the “electrically conducting layer[] 23” (*ground plane*). Zhao, Fig. 3, [0042]. Hash marks in annotated Figure 3 below show where the ground plane extends over the region where the slot antenna feed line 30 (with proximal end 31) is positioned on dielectric 21 on the opposing PCB side. Zhao, Fig. 3, [0042]. Figure 4 shows a profile view of PCB 20 comprising “electrically conducting layer[] 23,” having rectangular slot 27 (for the slot antenna). Zhao, Figs. 3-4 (annotated below), [0042].

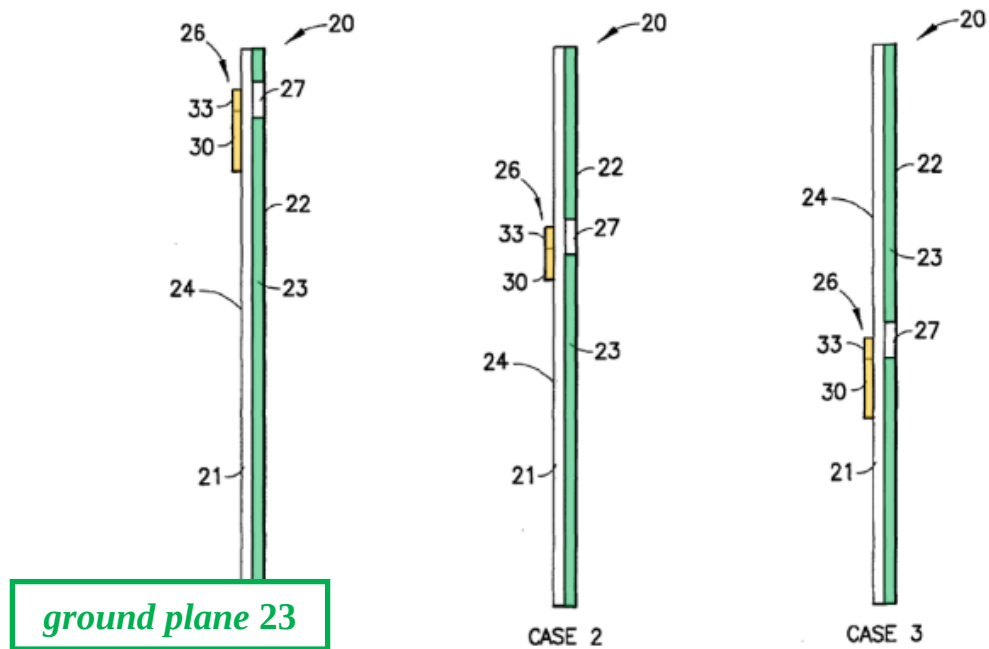


FIG.4

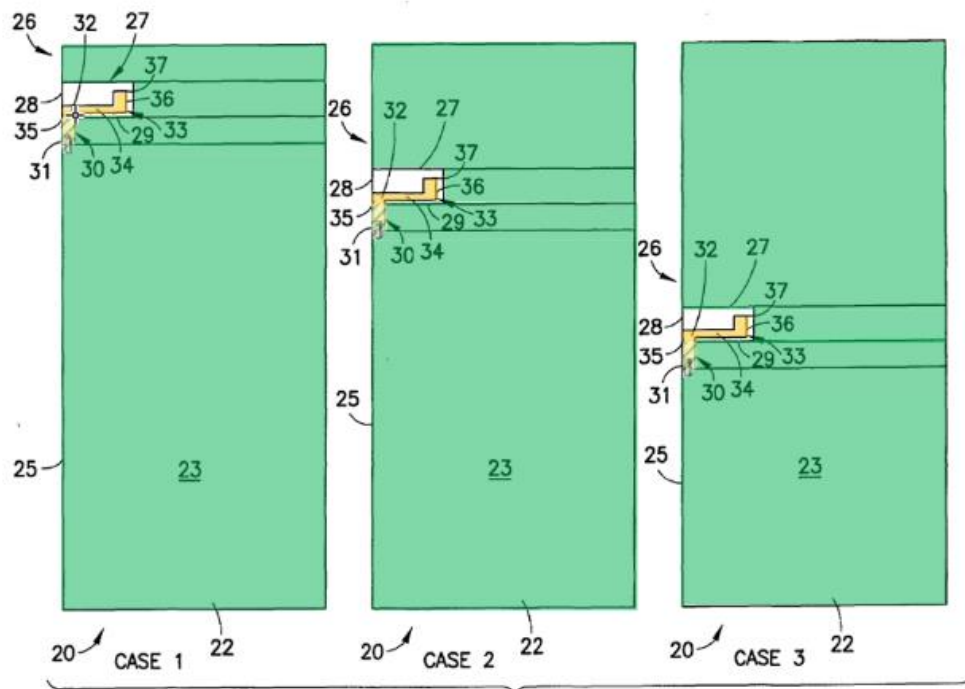


FIG.3

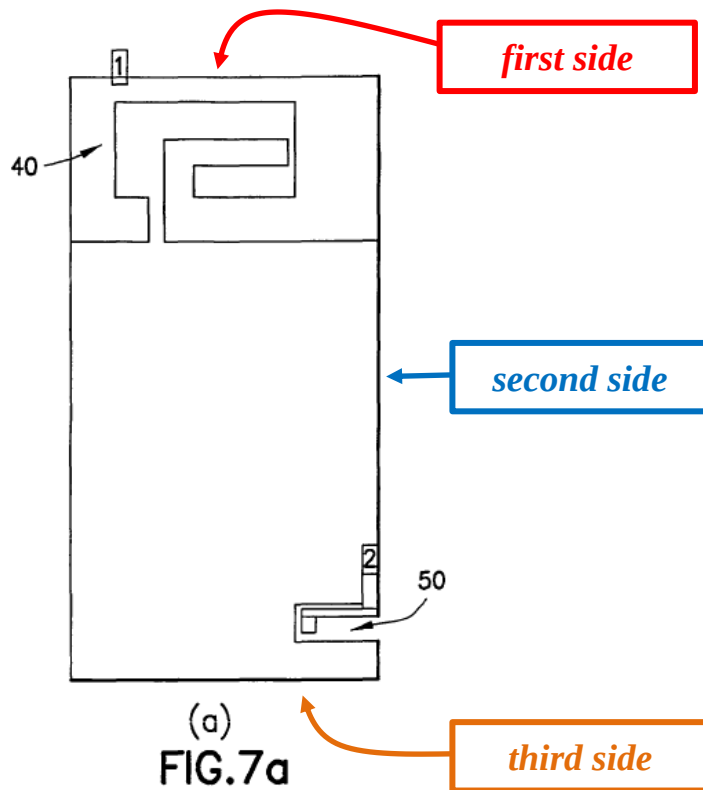
207. A POSA would have understood that Zhao's electrically conducting layer is a *ground plane* because it is the only conductive layer that Zhao identifies

on the PCB; it has the rectangular dimensions of the PCB as Zhao describes ([0038]); and it was conventional to use a ground plane on a surface of a PCB as shown in Figures 3-4.

c. Limitation [14.b]

14.b	the ground plane is inscribed in a first rectangular area comprising a first side, a second side and a third side, a length of the second side being greater than a length of the first side and a length of the third side;
------	--

208. Zhao meets [14.b] because—as discussed in Section XI.B.1.b (Limitation [14.a])—the electrically conducting layer (*ground plane*) has a rectangular area with length 80 mm (*second side*) and width 40 mm (*first* and *third side*). Zhao, [0038]. Herein the “sides” are defined by reference to the planar view of PCB 20 in Figure 7a. The 80 mm length is greater than the 40 mm width. A POSA would have understood that the ground plane “*is inscribed in a first rectangular area*” because the ground plane is bounded/enclosed by a rectangle having the PCB’s dimensions. Zhao, [0038]; EX1001, 10:38-42 (describing “the smallest rectangle in which the radiating element of the antenna can be inscribed”); EX1026, 220 (defining “inscribed”).

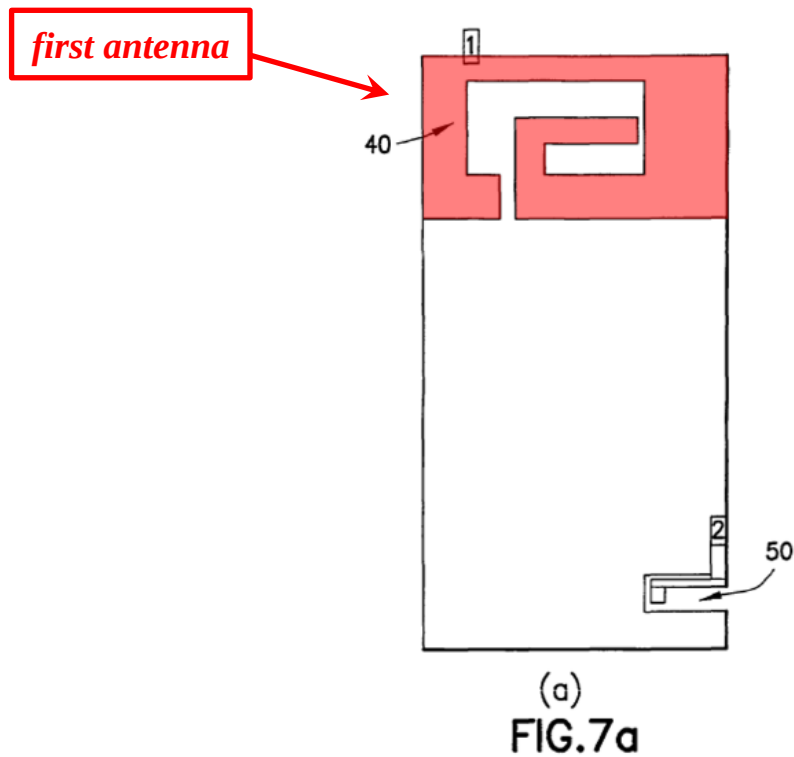


d. Limitations [14.c]-[14.d]

14.c	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least two frequency bands;
14.d	the at least two frequency bands being used for mobile communication services;

209. Zhao meets [14.c]-[14.d] because it describes a mobile terminal using a dual-band PIFA [planar inverted-F antenna] **antenna 40** (a *first antenna*) that operates in the GSM900 and GSM1800 frequency bands. Zhao, Fig. 7a (annotated below); [0044] (antenna 40 is “a conventional dual band PIFA GSM antenna (working at frequencies of 0.9 GHz and 1.8 GHz)”); [0046] (“The location[] of the dual-band PIFA antenna 40... [is] shown in FIG. 7a....”). A POSA would have understood that the PIFA GSM antenna works (is “*configured to transmit and*

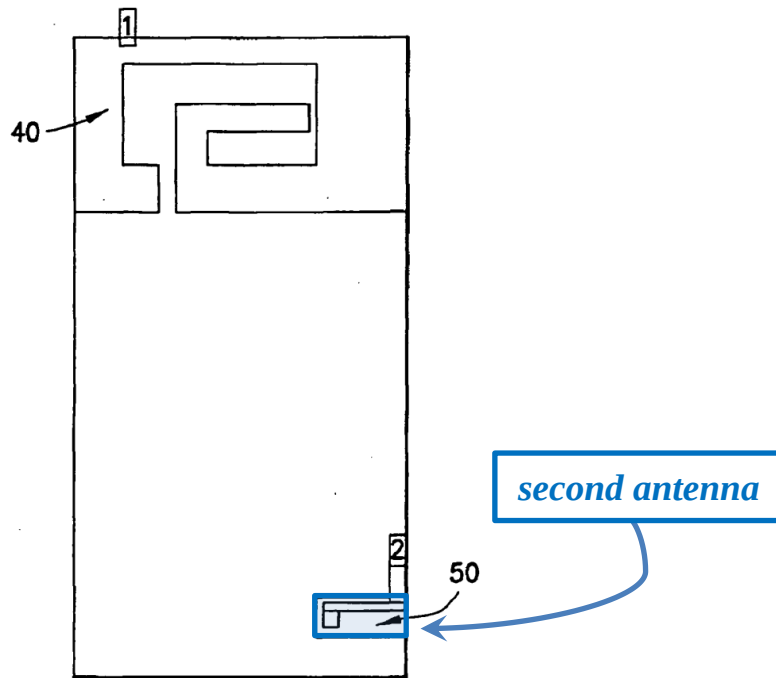
receive”) in the GSM900 and GSM1800 *frequency bands*. Zhao, Fig. 7b, [0044]; EX1009, 9; *see* Section VIII.D.1.e (Limitation [1.d]); *see also* EX1001, 2:4-10 (describing exemplary bands for mobile communication services), 9:26-43 (similar).



e. Limitation [14.e]

14.e	a second antenna configured to operate in at least one frequency band;
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210. Zhao meets [14.e] because its mobile terminal includes a “quarter-wavelength slot UWB [antenna 50](#)” (*a second antenna*). Zhao, [0046] (“The location[] of... the quarter-wavelength slot UWB antenna 50 [is] shown in FIG. 7a....”), Fig. 7a (annotated detail below).



(a)
FIG. 7a

211. Antenna 50 “operate[s] in the frequency range of 3.1 GHz to 4.9 GHz,” which covers ultra-wideband (UWB) frequencies for “higher-data-rate communication links” like video and audio data transmissions. Zhao, Fig. 5, [0002], [0038], [0043]; *see also* Zhao, Fig. 7b (showing antenna 50 return loss S22).

212. Claim 17 depends from claim 14 and recites that the “*at least one frequency band*” includes “UWB” frequency bands. EX1001, 26:41-46. Thus, Zhao’s antenna 50 is “*a second antenna configured to operate in at least one frequency band*” as claimed.

f. Limitation [14.f]

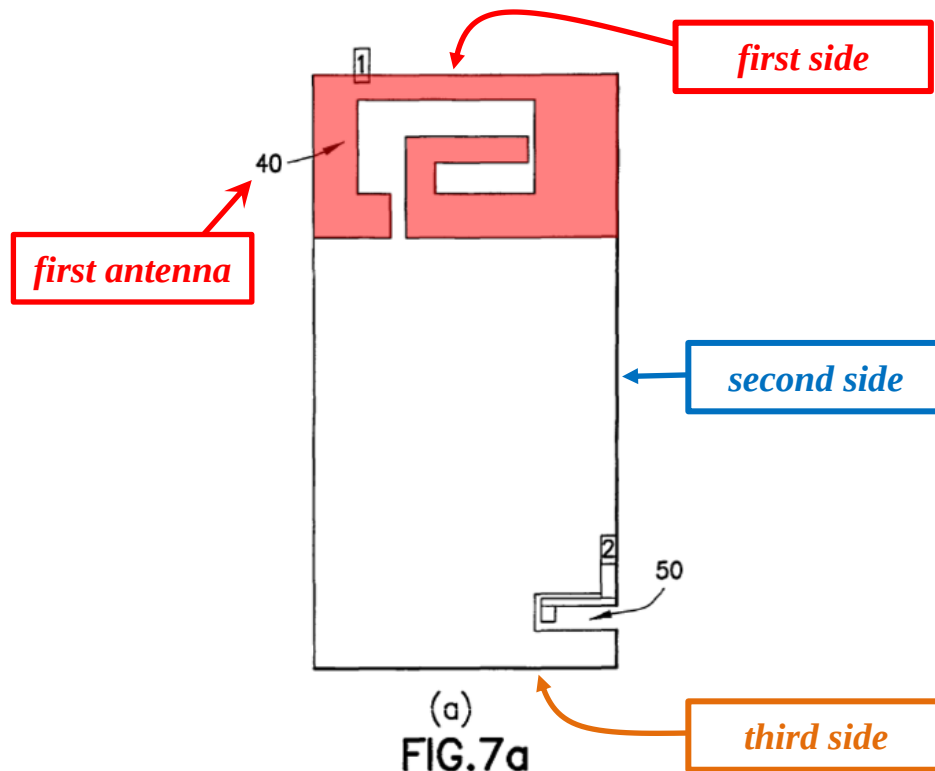
14.f	the at least one frequency band being different from the at least two frequency bands;
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213. Zhao meets [14.f] because the UWB band (3.1 GHz to 4.9 GHz), discussed in Section XI.B.1.e (Limitation [14.e]), is different from the GSM900 (890-960 MHz) and GSM1800 (1710-1880 MHz) bands, as discussed in Section XI.B.1.d (Limitations [14.c]-[14.d]).

g. Limitations [14.g]-[14.h]

14.g	the first antenna extends in a direction substantially parallel to the first side;
14.h	the first antenna is proximate to the first side;

214. Zhao meets [14.g] and [14.h] because *first antenna 40* has a long axis that is disposed substantially parallel—and proximate—to the top edge (“*first side*”) of the mobile terminal PCB and its ground plane as depicted in the planar view in Figure 7a. Zhao, Fig. 7a (annotated detail below), [0044], [0046] (“The location[] of the dual-band PIFA antenna 40... [is] shown in FIG. 7a....”); *see* Section XI.B.1.c (Limitation [14.b]).



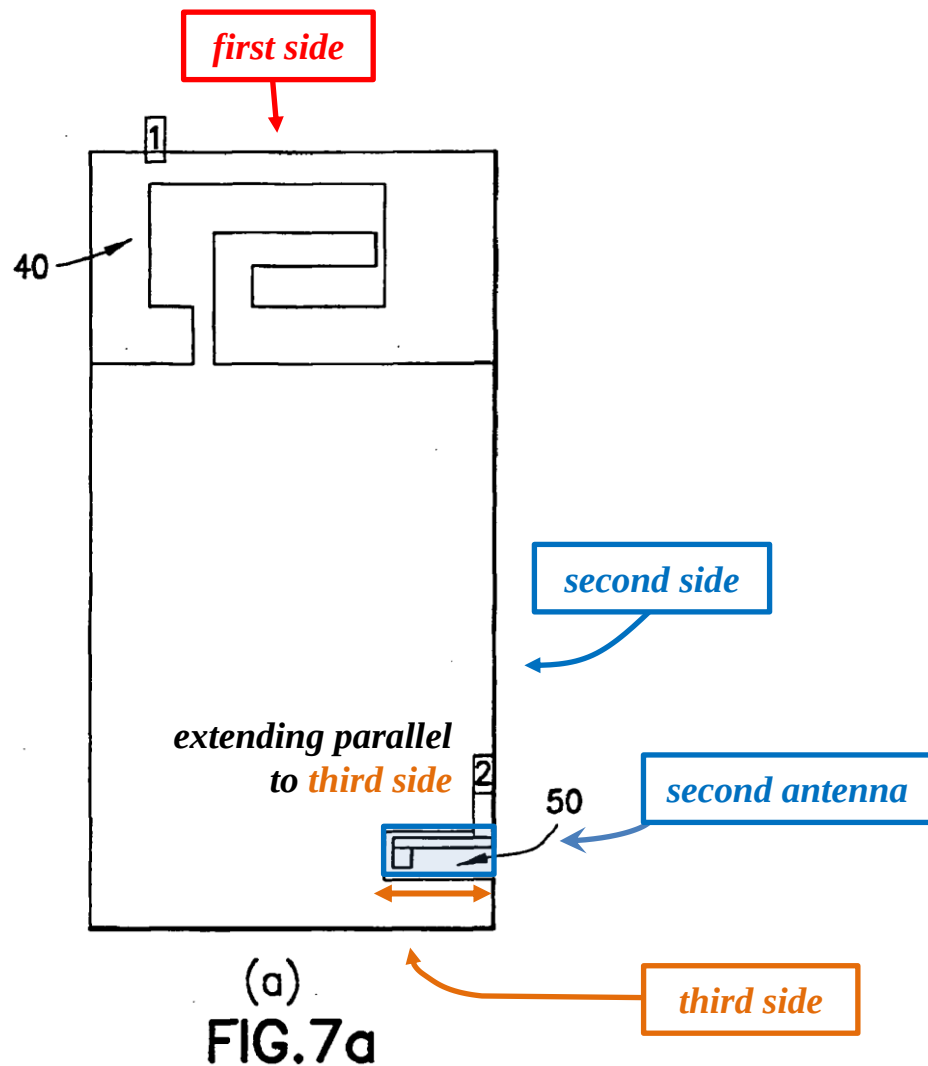
h. Limitation [14.i]-[14.j]

14.i	the second antenna extends in a direction substantially parallel to the third side;
14.j	the second antenna is proximate to the third side;

215. Zhao meets [14.i] and [14.j] because antenna 50 (*second antenna*) is located proximate to the lower-right corner of the mobile terminal's PCB and its *ground plane*—and thus proximate to the PCB/ground plane's lower edge (*third side*) as shown in the planar view of Figure 7a (annotated below) depicting PCB 20 and dielectric 21. Zhao, Figs. 3-4, 7a, [0042] (describing quarter-wavelength UWB slot antenna), [0046] (“The location[] of... the quarter-wavelength slot UWB antenna 50 [is] shown in FIG. 7a....”); see Section XI.B.1.e (Limitation

[14.e]). In Figure 7a's planar view depicting the PCB surface with dielectric 21, the PCB's lower side is the *third side* of the *ground plane*'s rectangular area. See Section XI.B.1.c (Limitation [14.b]).

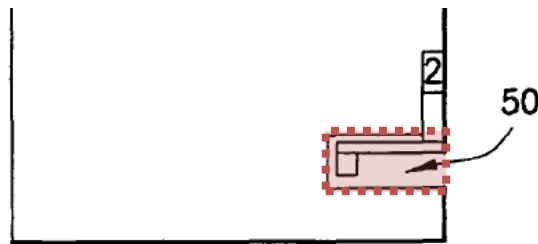
216. Antenna 50 has a long axis because its largest size is “12.75 mm×4 mm” (Zhao, [0052]), and planar view Figure 7a (showing a planar view of PCB 20 with dielectric 21) shows antenna 50 *extending a maximum of 12.75 mm parallel to the third side*. Zhao, Fig. 7a; see also Zhao, Fig. 3, [0042].



i. Limitation [14.k]

14.k	the second antenna is inscribed in a second rectangular area;
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217. Zhao meets [14.k] because Zhao’s slot antenna 50 (*second antenna*) is bounded by (*inscribed in*) a *rectangular area* of at most “12.75 mm×4 mm,” shown as “rectangular slot 27” in planar view Figure 4. Zhao, Fig. 4, [0042], [0052]; *see also* Zhao, Fig. 7a (annotated detail below), [0046] (“The location[] of... antenna 50 [is] shown in FIG. 7a....”); Section XI.B.1.g (Limitation [14.h]).



j. Limitation [14.l]

14.l	a sum of a length and a width of the second rectangular area is smaller than a quarter of an operating wavelength of the second antenna;
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218. Zhao meets [14.l] because *second antenna 50* (a “quarter-wavelength” slot antenna) measures **at most** “12.75 mm×4 mm” (Zhao, [0052]), thereby making “a sum of a length and a width of the *second rectangular area*” **at most 16.75 mm**. See Section XI.B.1.i (Limitation [14.k]).

219. Zhao’s antenna 50 operates from “3.1 GHz to 4.9 GHz.” Zhao, [0038]; *see* Section XI.B.1.f (Limitation [14.f]). Frequency and wavelength are inversely related to each other via the equation $\lambda = \frac{v}{f}$, where ‘ λ ’ is wavelength, ‘ v ’

is velocity (speed of light), and ‘ f ’ is frequency. EX1027, 15-16; EX1029, 6:27-29. Based on this equation, antenna 50’s free-space “*operating wavelength*” for 3.1-4.9 GHz, using the speed of light $3.0 \times 10^8 \text{ (m/s)} \times 10^3 \text{ (mm/m)} = 3.0 \times 10^{11} \text{ (mm/s)}$, is between 61 and 97 mm. EX1001, 4:18-26 (antenna segments sized relative to “free-space” operating wavelength), 5:11-16 (“rectangle... longest side... does not exceed [1/20] the longest free-space operating wavelength of the antenna”), 23:3-12 (sizing slots by reference to “free-space operating wavelength”).

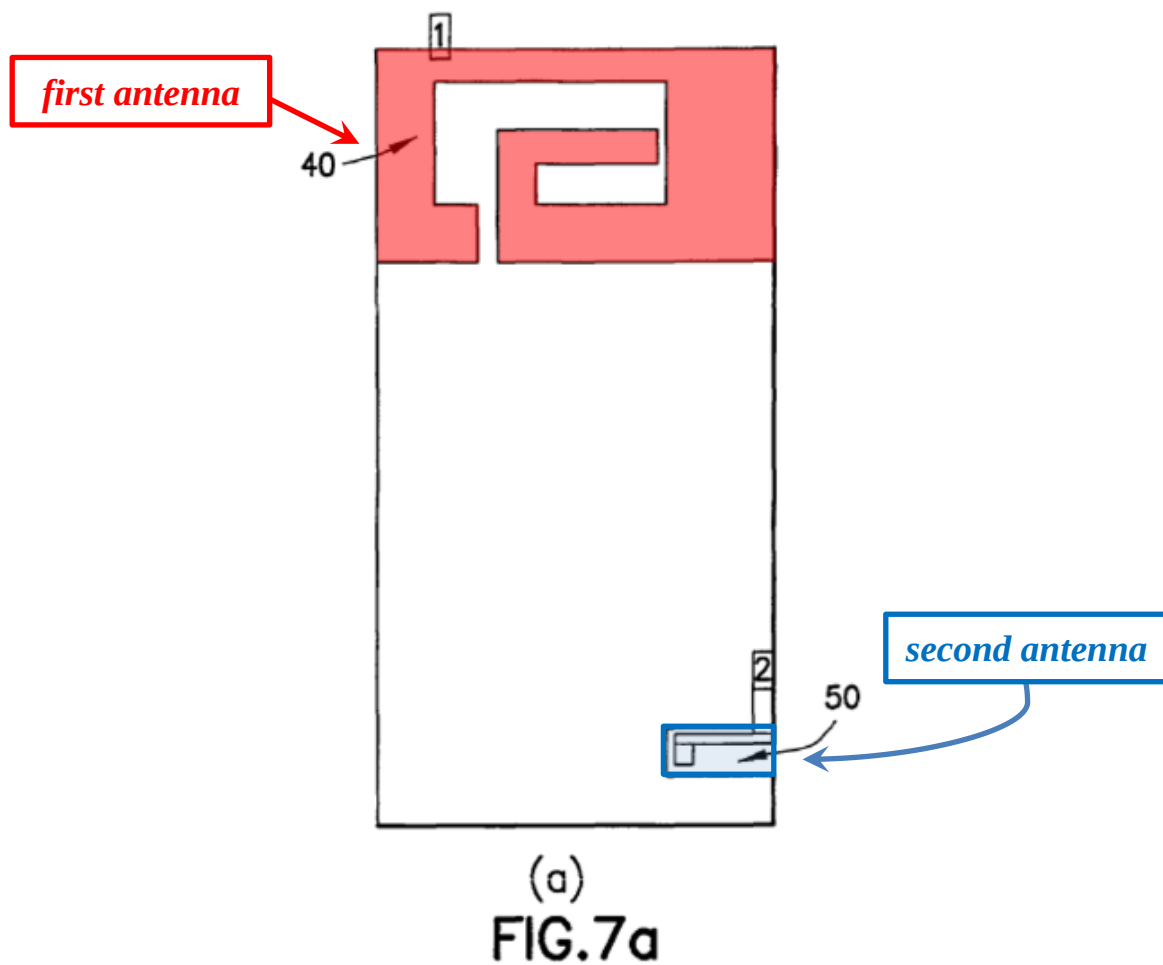
f (Hz)	wavelength (mm)	$\frac{1}{4}$ wavelength (mm)
3.1×10^9	$\left(\frac{3.0 \times 10^{11}}{3.1 \times 10^9} \right) = 0.97 \times 10^2 = 97$	$97/4 = 24.25$
4.9×10^9	$\left(\frac{3.0 \times 10^{11}}{4.9 \times 10^9} \right) = 0.61 \times 10^2 = 61$	$61/4 = 15.25$

220. At 3.1 GHz a quarter of the 97 mm operating wavelength is 24.25 mm. Since 16.75 mm is ***smaller*** than “a quarter of an operating wavelength” of *second antenna 50* at 3.1 GHz—for example, 24.25 mm—Zhao’s UWB antenna meets [14.1].

k. Limitation [14.m]

14.m	a geometry of the first antenna being different than a geometry of the second antenna;
------	--

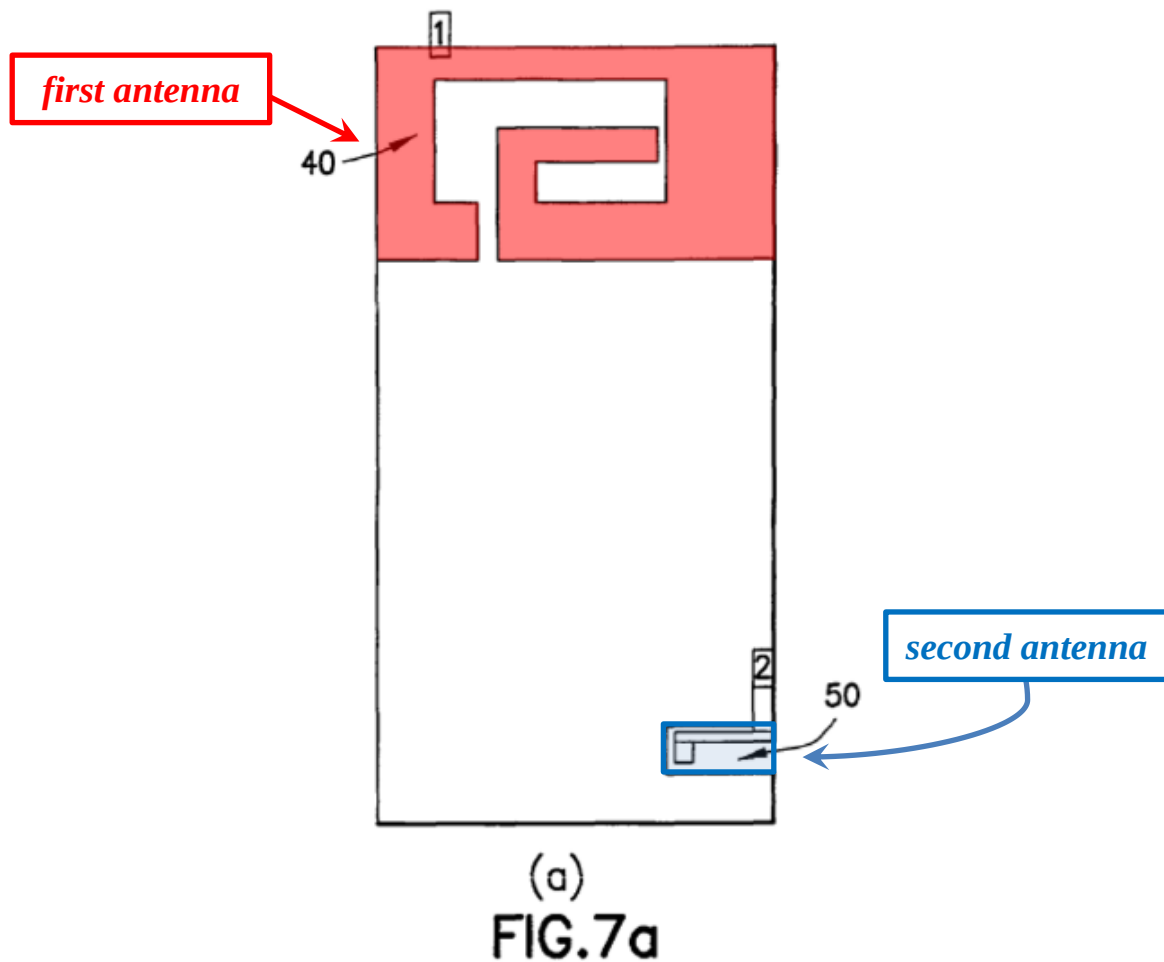
221. Zhao meets [14.m] because the quarter-wave “L-shaped stub” slot antenna 50 (*second antenna*) has a different geometry than the PIFA antenna 40 (*first antenna*). Zhao, [0046], [0042], Fig. 7(a) (annotated detail below).



I. Limitation [14.n]

14.n	at least one of the first antenna and the second antenna is proximate to a corner of the first rectangular area; and
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222. Zhao meets [14.n] in at least two ways because **antenna 40** (*first antenna*) and **antenna 50** (*second antenna*) are each disposed proximate to a corner of the “rectangular area” that circumscribes the ground plane (and PCB). Zhao, Fig. 7a (annotated detail below); [0046], see Sections XI.B.1.b (Limitation [14.a]) and XI.B.1.c (Limitation [14.b]).



223. As can be observed in Zhao’s Figure 7a, *first antenna 40* is located above and spans the length of the upper-side of the PCB, while *second antenna 50* is in the lower-right corner. Zhao, [0044], [0046]. The PCB comprises a ground plane (electrically conductive layer 23) that covers the PCB excepting the aperture formed by slot 27, as shown in Figs. 3-4. See Section XI.B.1.b (Limitation [14.a]); Zhao, Figs. 3-4, [0038], [0042].

224. Thus, *antenna 40* is “*proximate to*” both upper corners and *antenna 50* is “*proximate to*” the lower-right corner of the *ground plane’s rectangular area*. POSAs would have recognized that Zhao’s antennas are both “*proximate*” to their respective upper and lower corners because Zhao teaches separating the antennas as far as possible across the PCB for better performance. Zhao, [0055] (“[T]he best isolation performance... is obtained when the PIFA antenna 40 and the quarter-wavelength slot UWB antenna 50 have the greatest separation distance.”).

225. Regardless, POSAs would have found it obvious to position each antenna in this manner because Zhao describes maximizing the distance between antennas.

m. Limitation [14.o]

14.o	the first antenna and the second antenna are located internally within the wireless handheld or portable device.
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226. Zhao meets [14.o] because **antenna 40** (*first antenna*) is a PIFA [planar inverted F antenna] antenna “located 8 mm above the PCB” of the mobile terminal and **antenna 50** (*second antenna*) is slot antenna disposed in rectangular slot 27 in conductive layer 23 (*the ground plane*) on the mobile terminal PCB. Zhao, [0042], [0044], [0046]. A POSA would have disposed the PCB, and the two antennas, “*internally within*” the wireless mobile terminal (“*wireless handheld or portable device*”) because a mobile device PCB and its electronics were conventionally located internal to the mobile device. See Section VIII.C (discussing PCBs housed in mobile devices, for example, EX1032-EX1034).

227. A POSA would have had additional reason to place both antennas (and PCB) internally because a mobile device conventionally comprised a housing that would have protected the PCB, its electronics, and the two antennas from external exposure and physical damage. *E.g.*, Gaucher⁸⁴⁸, [0003]-[0004]; Asano, [0006]. Moreover, a POSA would have understood that Zhao’s planar (PIFA) and slot antenna form factors were ideally suited to placement within a mobile device housing because they had a profile that conformed to the PCB profile, for example,

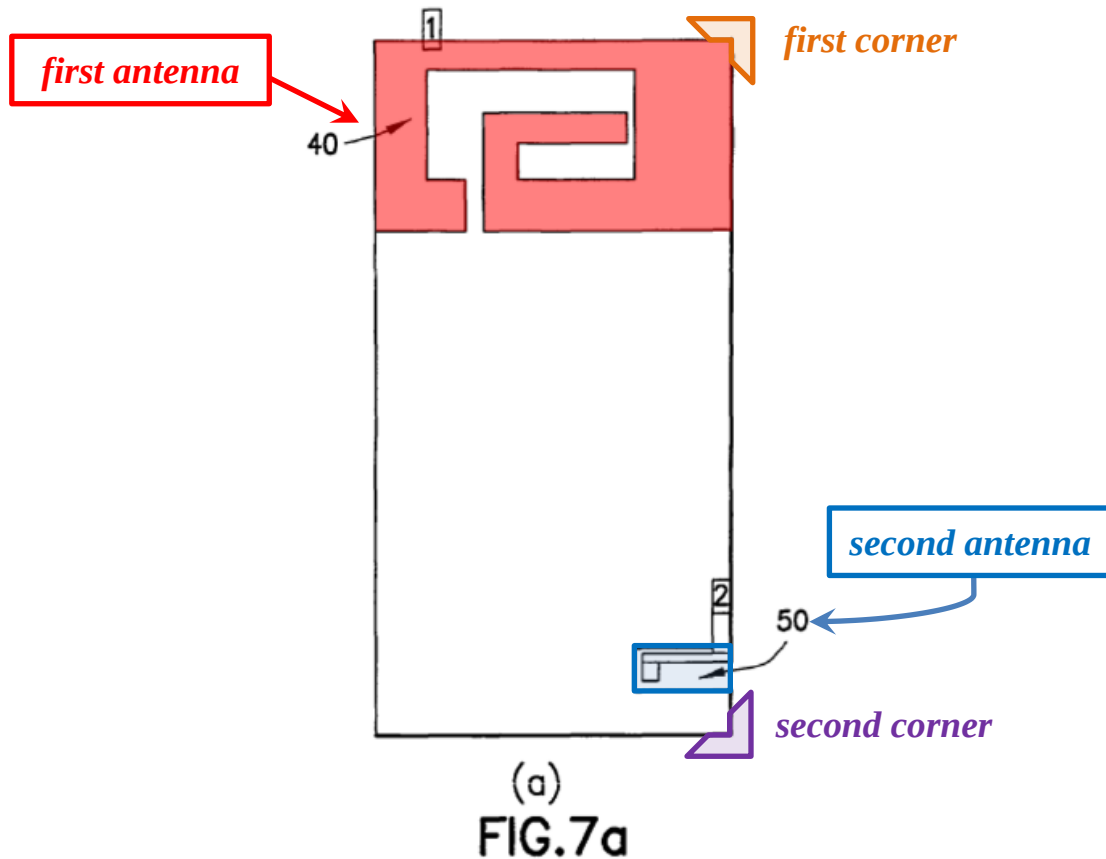
planar and rectangular, which would have been located internal to the mobile device for the reasons noted above.

2. Claim 15

15	The wireless handheld or portable device according to claim 14, wherein the first antenna is proximate to a first corner of the first rectangular area and the second antenna is proximate to a second corner of the first rectangular area.
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228. As discussed in Sections XI.B.1.b (Limitation [14.a]) and XI.B.1.l (Limitation [14.n]), Zhao’s PCB forms a *ground plane* defining “*the first rectangular area*.” Zhao, [0038], [0046], Fig. 7a (annotated detail below).

229. Zhao’s Figure 7a (annotated detail below) teaches that the *first antenna 40* is located above and spans across the upper corners of the PCB and the *second antenna 50* is in the bottom-right corner of the PCB, making either of the upper corners “a *first corner*” and the bottom-right corner “a *second corner*,” as claimed.

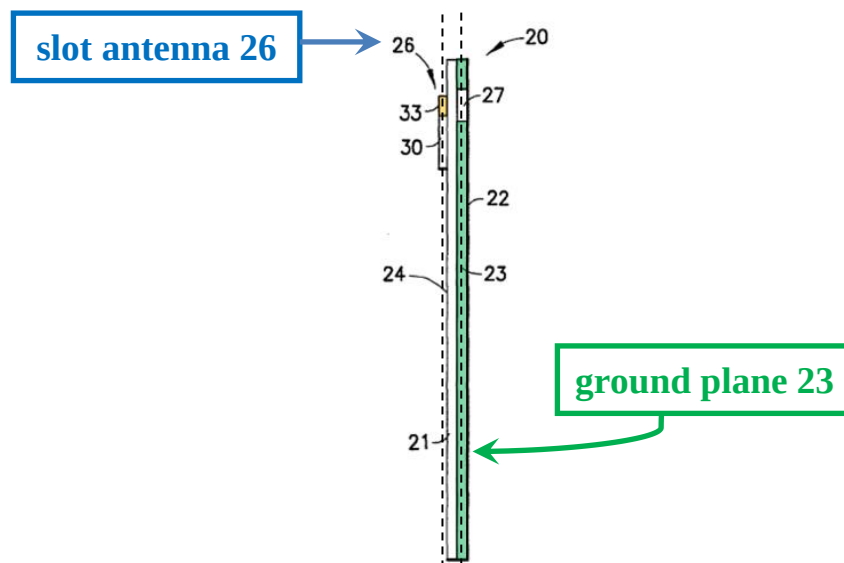


230. As also discussed in Sections XI.B.1.b (Limitation [14.a]) and XI.B.1.l (Limitation [14.n]), Zhao teaches that both antennas are “*proximate*” to their respective upper and lower corners because when placing the antennas on the PCB as Zhao describes “the greatest separation distance” between the antennas provides “the best isolation performance.” Zhao, [0049], [0055].

3. Claim 16

16	The wireless handheld or portable device according to claim 14, wherein the second antenna is contained in a plane substantially parallel to a plane containing the ground plane.
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231. Zhao meets claim 16 because “quarter-wavelength slot antenna 26” (antenna 50 in Fig. 7a) comprises L-shaped stud 33 “printed on second side[] 24 of the PCB[] 20” opposite the “first side[] 22” comprising electrically conductive layer 23 (*ground plane*). Zhao, Fig. 4 (annotated detail below), [0042], [0046]; see Sections XI.B.1.b (Limitation [14.a]) and XI.B.1.i (Limitation [14.k]). As shown in Figure 4 (annotated detail below), slot antenna 26 is contained within a plane that is “*substantially parallel*” to the plane containing layer 23.



232. Zhao’s slot antenna 26 is “printed on... the PCB,” which is similar to the slot antennas described in the ’458 patent that are “printed on or etched in the ground plane of the PCB.” Zhao, [0014], [0042]; EX1001, 10:53-54. To the

extent that the slot antennas in the '458 patent are “contained in a plane substantially parallel to a plane containing the ground plane,” Zhao’s slot antennas are similarly contained in a plane parallel to the PCB’s ground plane.

4. Claim 17

17	The wireless handheld or portable device according to claim 14, wherein the at least one frequency band is used for a wireless connectivity service selected from the group comprising: Bluetooth™, IEEE802.11a, IEEE802.11b, IEEE802.11g, WLAN, WiFi, UWB, ZigBee, GPS, Galileo, SDARs, XDARS, WiMAX, DAB, FM, DVB-H, and DMB.
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233. Zhao meets claim 17 because “quarter-wavelength slot UWB antenna 50” / slot antenna 26 (*second antenna*) is a UWB antenna that “operat[es] in the frequency range of 3.1 GHz to 4.9 GHz[.]” Zhao, [0002], [0007], [0038], [0042], [0046]; see Section XI.B.1.e (Limitation [14.e]).

5. Claim 18

18	The wireless handheld or portable device according to claim 14, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
----	--

234. Zhao meets claim 18 because antenna 40 (*first antenna*) is a “dual-band **planar inverted F-antenna.**” Zhao, Fig. 7a, [0015], [0021], [0023], [0035], [0044], [0046]-[0047], claim 6.

XII. DECLARATION

I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

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

Date: 4/29/2025 By: DM Pozar
David M. Pozar, Ph.D.

APPENDIX A: MATERIALS CONSIDERED

Exhibit	Description
1001	U.S. Patent No. 8,810,458 (“the ’458 patent”)
1002	Prosecution History of U.S. Patent No. 8,810,458
1005	K-L Wong, J-H Chou, S-W Su, and C-M Su. “Isolation between GSM/DCS and WLAN Antennas in a PDA Phone,” <i>Microwave and Optical Technology Letters</i> , volume 45, no. 4, 2005, pp. 347-352 (“Wong”)
1008	U.S. Patent App. Pub. No. 2009/0002248 to Zhao et al. (“Zhao”)
1009	ETSI TS 145 005 V4.3.0 Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP TS 45.005 version 4.3.0 Release 4), 2001
1010	Plaintiff’s Disclosure of Asserted Claims and Infringement Contentions Against Geotab Pursuant to Local Patent Rules 3-1 and 3-2, <i>Fractus, S.A. v. Geotab Inc.</i> , No. 2-24-cv-01008 (E.D. Tex.), served Mar. 12, 2025.
1011	G-Y Lee and K-L Wong. “Quad-Band Internal Monopole Mobile-Phone Antenna,” <i>Microwave and Optical Technology Letters</i> , volume 40, no. 5, 2004, pp. 359-361 (“Lee”)
1012	U.S. Patent App. Pub. No. 2006/0082503 to Gaucher et al. (“Gaucher”)
1013	U.S. Patent App. Pub. No. 2004/0113848 to Gaucher et al. (“Gaucher848”)
1014	WIPO Publication No. WO 2006/040609 to Zhao et al.
1015	Overall Revision of the Rules Regarding Industrial Scientific and Medical (ISM) Equipment, 50 Fed. Reg. 36061, 36069 (Sep. 5, 1985) (codified at 47 C.F.R. §18.301)
1016	’458 patent Claim Limitation Comparison Chart
1017	IEEE Std. 802.11a-1999, Supplement to the IEEE Standard for Information Technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements— Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: High-speed Physical Layer in the 5 GHz Band (Dec. 30, 1999)

Exhibit	Description
1018	IEEE Std. 802.11b-1999, Supplement to the IEEE Standard for Information Technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements— Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher-Speed Physical Layer Extension in the 2.4 GHz Band (Jan. 20, 2000)
1019	IBM Hardware Announcement: New IBM ThinkPad T42 notebooks feature new fingerprint and Intel PRO/Wireless technologies (Jan. 11, 2005)
1020	IEEE Std. 802.11g-2003, 802.11g IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications, Amendment 4: Further Higher Data Rate Extension in the 2.4 GHz Band (June 27, 2003)
1021	ZigBee Specification (Jun. 27, 2005)
1022	Specification of the Bluetooth System version 2.0, volume 2 (issued Nov. 4, 2004)
1023	Wi-Fi Alliance Press Release, “Wi-Fi Celebrates Its Third Birthday” (Apr. 7, 2003) (Wayback Machine copy dated Sep. 28, 2003)
1024	U.S. Patent App. Pub. No. 2002/0021250 to Asano et al. (“Asano”)
1025	Y.J. Wang et al., “Novel Microstrip-Monopole-Integrated Ultra-Wideband Antenna for Mobile UWB Devices,” in <i>Radio and Wireless Conference, 2003. RAWCON’03. Proceedings</i> , IEEE, 2003, pp. 87-90.
1026	Excerpts from James et al., <i>Mathematics Dictionary</i> (Chapman & Hall, 5th ed. 1992)
1027	Excerpts from Pozar, <i>Microwave Engineering</i> (John Wiley & Sons, Inc., 3rd ed. 2005)
1028	Dialogue Flybook User’s Manual rev. 1.02 (2003)
1029	U.S. Patent No. 5,596,401 to Kusuzawa
1030	U.S. Patent No. 6,624,789 to Kangasvieri et al.
1031	Unlicensed NII Devices in the 5 GHz Frequency Range, 63 Fed. Reg. 40831, 40836-40837 (July 31, 1998) (codified at 47 C.F.R. §15.407)

Exhibit	Description
1032	U.S. Patent App. Pub. No. 2004/0121828 to Wang et al. (“Wang”)
1033	U.S. Patent No. 6,728,555 to Pirilä et al.
1034	U.K. Patent App. Pub. No. GB 2336019 to Berg et al. (“Berg”)
1035	Smith, “Dialogue demos ‘total wireless’ sub-notebook” (The Register, Jun. 2, 2004)
1036	K-L Wong, J-H Chou, S-W Su, and C-M Su. “Isolation between GSM/DCS and WLAN Antennas in a PDA Phone,” <i>Microwave and Optical Technology Letters</i> , volume 45, no. 4, 2005, pp. 347-352 (color version)

APPENDIX B: U.S. PATENT NO. 8,810,458 CLAIM LIST

REF	Limitation
[1.PRE]	A wireless handheld or portable device comprising:
[1.a]	a ground plane;
[1.b]	the ground plane is inscribed in a rectangular area comprising a first side and a second side, a length of the second side being greater than a length of the first side;
[1.c]	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least three frequency bands;
[1.d]	the at least three frequency bands being used for mobile communication services;
[1.e]	a second antenna configured to receive electromagnetic waves corresponding to at least one frequency band;
[1.f]	the at least one frequency band being used for wireless connectivity services;
[1.g]	the first antenna extends in a direction substantially parallel to the first side;
[1.h]	the second antenna extends in a direction substantially parallel to the second side;
[1.i]	the first antenna is arranged substantially close to the first side; and
[1.j]	the first antenna and the second antenna are located internally within the wireless handheld or portable device.
2	The wireless handheld or portable device according to claim 1, wherein the second antenna is arranged substantially close to the second side.
3	The wireless handheld or portable device according to claim 2, wherein the second antenna is arranged substantially close to a corner of the rectangular area.
4	The wireless handheld or portable device according to claim 1, wherein the first antenna is arranged substantially close to a corner of the rectangular area.

REF	Limitation
5	The wireless handheld or portable device according to claim 1, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
6	The wireless handheld or portable device according to claim 5, wherein the second antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
7	The wireless handheld or portable device according to claim 1, wherein the at least one frequency band used for wireless connectivity services corresponds to at least one wireless connectivity service selected from the group comprising: Bluetooth™, IEEE802.11a, IEEE802.11b, IEEE802.11g, WLAN, WiFi, UWB, ZigBee, GPS, Galileo, SDARs, XDARS, WiMAX, DAB, FM, DVB-H, and DMB.
[8.PRE]	A portable device comprising:
[8.a]	a ground plane;
[8.b]	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least three frequency bands;
[8.c]	the at least three frequency bands being used for mobile communication services;
[8.d]	a second antenna configured to operate in at least one frequency band;
[8.e]	the first antenna extends in a direction substantially parallel to a first side of the portable device;
[8.f]	a length of a second side of the portable device is greater than a length of the first side of the portable device;
[8.g]	the first antenna is arranged substantially close to the first side of the portable device;
[8.h]	the second antenna is arranged substantially close to a first corner of the portable device;
[8.i]	the first corner of the portable device corresponding to a first end of the first side with an end of the second side of the portable device; and

REF	Limitation
[8.j]	the first antenna and the second antenna are located internally within the portable device.
9	The portable device according to claim 8, wherein a portion of an orthogonal projection of the first antenna on a plane containing the ground plane does not overlap with the ground plane.
10	The portable device according to claim 8, wherein the second antenna is substantially close to the first side of the portable device and extends in a direction substantially parallel to the first side of the portable device.
11	The portable device according to claim 8, wherein the at least one frequency band is used for a mobile communication service, and said at least one frequency band being different from the at least three frequency bands.
12	The portable device according to claim 8, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
13	The portable device according to claim 12, wherein the second antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
[14.PRE]	A wireless handheld or portable device comprising:
[14.a]	a ground plane;
[14.b]	the ground plane is inscribed in a first rectangular area comprising a first side, a second side and a third side, a length of the second side being greater than a length of the first side and a length of the third side;
[14.c]	a first antenna configured to transmit and receive electromagnetic waves corresponding to at least two frequency bands;
[14.d]	the at least two frequency bands being used for mobile communication services;
[14.e]	a second antenna configured to operate in at least one frequency band;

REF	Limitation
[14.f]	the at least one frequency band being different from the at least two frequency bands;
[14.g]	the first antenna extends in a direction substantially parallel to the first side;
[14.h]	the first antenna is proximate to the first side;
[14.i]	the second antenna extends in a direction substantially parallel to the third side;
[14.j]	the second antenna is proximate to the third side;
[14.k]	the second antenna is inscribed in a second rectangular area;
[14.l]	a sum of a length and a width of the second rectangular area is smaller than a quarter of an operating wavelength of the second antenna;
[14.m]	a geometry of the first antenna being different than a geometry of the second antenna;
[14.n]	at least one of the first antenna and the second antenna is proximate to a corner of the first rectangular area; and
[14.o]	the first antenna and the second antenna are located internally within the wireless handheld or portable device.
15	The wireless handheld or portable device according to claim 14, wherein the first antenna is proximate to a first corner of the first rectangular area and the second antenna is proximate to a second corner of the first rectangular area.
16	The wireless handheld or portable device according to claim 14, wherein the second antenna is contained in a plane substantially parallel to a plane containing the ground plane.
17	The wireless handheld or portable device according to claim 14, wherein the at least one frequency band is used for a wireless connectivity service selected from the group comprising: Bluetooth™, IEEE802.11a, IEEE802.11b, IEEE802.11g, WLAN, WiFi, UWB, ZigBee, GPS, Galileo, SDARs, XDARS, WiMAX, DAB, FM, DVB-H, and DMB.

REF	Limitation
18	The wireless handheld or portable device according to claim 14, wherein the first antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
19	The wireless handheld or portable device according to claim 18, wherein the second antenna is an antenna selected from the group comprising: a monopole antenna, an inverted-F antenna, a patch antenna, and a planar inverted-F antenna.
20	The wireless handheld or portable device according to claim 14, wherein the second antenna is fitted over a curved surface.