

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GEOTAB INC. AND GEOTAB USA, INC.,
Petitioner,

v.

FRACTUS, S.A.,
Patent Owner

Case No. IPR2025-01027
Patent No. 11,349,200

REPLY DECLARATION OF DANIEL VAN DER WEIDE, PH.D.

Geotab Exhibit 1103 Geotab v. Fractus IPR2025-01027

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	MATERIALS REVIEWED AND CONSIDERED	1
III.	GROUND 2	3
IV.	GROUND 1	12
	A. Spatial Diversity	12
	B. Pattern Diversity	15
	1. Dou+Jing would have provided pattern diversity.....	16
	2. Fractus's argument that Jing's antenna cannot provide pattern diversity is wrong.	28

I, Daniel van der Weide, Ph.D., declare:

I. INTRODUCTION

1. I previously provided opinions (reflected in EX1007) on behalf of Geotab Inc. and Geotab USA, Inc. (“Petitioners” or “Geotab”), concerning the patentability of certain claims in U.S. Patent No. 11,349,200 (EX1003, “the ’200 patent”), and specifically claims 1-20 (the “Challenged Claims”). I provide this Declaration in support of Geotab’s Reply to Patent Owner’s Response. In particular, I was asked by Geotab to consider arguments made by Patent Owner Fractus, S.A. (“Fractus”) and by Patent Owner’s expert, Dr. Hossein Hashemi.

2. As I explained in my previous declaration (EX1007, ¶2), I am being compensated for my services at my standard rate, plus actual expenses. As before, my compensation is in no way contingent on my findings, my testimony, or the outcome of any proceeding, and I have no other personal or financial stake or interest in this proceeding’s outcome, or expectation or promise of additional business in exchange for my positions.

3. I make this Declaration based on my personal knowledge, including my education, training, research, and professional experience.

II. MATERIALS REVIEWED AND CONSIDERED

4. As in my previous declaration, my findings are based on my years of education, research, experience, and background in wireless hardware devices and

antenna design, 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 (“POSA”), as set forth in Section VI of EX1007.

5. In forming my opinions, I studied and considered the Petition (Paper No. 29); my previous declaration (EX1007); and the materials cited in my previous declaration, including those cited in Appendix A to EX1007. I also reviewed the Board’s Decision Granting Institution of *Inter Partes* Review (Paper No. 21, “DI”); the Patent Owner Response (Paper No. 30, “POR”); the declarations of Patent Owner’s expert, Dr. Hossein Hashemi (EX2010, EX2029); and the material Fractus cited in its POR and Dr. Hashemi cited in his declarations.

6. The below table supplements the list of documents I included with my previous declaration (EX1007, Appendix A) with additional exhibits that I studied and considered for this declaration (in addition to those recited above).

Exhibit	Description
1101	D.I. 104, Claim Construction Order, <i>Fractus, S.A. v. Verizon Connect Inc. et al.</i> , No. 2:24-cv-01009 (E.D. Tex. Mar. 18, 2026)
1102	D.I. 114, Order, <i>Fractus, S.A. v. Verizon Connect Inc. et al.</i> , No. 2:24-cv-01009 (E.D. Tex. Apr. 6, 2026)
1104	Dr. Hashemi’s declaration in support of Patent Owner’s Preliminary Response, filed by Fractus as EX2008 in IPR2025-00929
1105	Steven E. Ellingson, <i>Electromagnetics II</i> (2025) (available at https://commons.libretexts.org/book/eng-19441 (last accessed April 25, 2026)), filed by Fractus as EX2009 in IPR2025-00929

Exhibit	Description
1107	Internet Archive copy of “Capitol Broadcasting Who We Are” web page captured on April 8, 2002.
1108	Internet Archive copy of “Capitol Broadcasting Home” web page captured on March 31, 2002.
1109	SEC Form 10-Q (Quarterly Report) for Lin TV Corp. (June 30, 2002)
1110	S. Derek Turner & Mark Cooper, <i>Out of The Picture 2007: Minority & Female TV Station Ownership in the United States</i> (Free Press 2007)
1114	U.S. Patent Application No. 2009/0002248 to Zhao et al. (“Zhao”)
1115	Declaration of Dara del Rosario
1116	Amendment of Parts 2 and 73 of the Commission’s AM Broadcast Rules concerning the use of the AM carrier, FCC 84-301 (Aug. 14, 1984)
1117	614-902 MHz (National Telecommunications and Information Administration Mar. 1, 2014) <i>available at</i> http://www.ntia.gov/files/ntia/publications/compendium/0614.00-0902.00_01MAR14.pdf
1118	Rodney Vaughan et al., Channels, Propagation and Antennas for Mobile Communications, 50 IET Electromagnetic Waves Series 577-580 (2003)

III. GROUND 2

7. Fractus alleges that “the knowledge of” the POSA regarding the specification’s description of 4G communication standards supporting the 1900-2170 MHz, 810-960 MHz, 1710-1990 MHz, and 2-11 GHz frequency ranges “would indicate to the POSITA that the inventors were in possession of the 698-806 MHz spectrum.” POR, 32-34. Fractus cites EX2016, EX2020, EX2021, and EX2022 further stating that “the Upper and Lower 700 MHz Bands were well understood by the person having ordinary skill in the art (“POSA”) as being

associated with advanced cellular services no later than the Fall of 2002.”¹ This is not what a POSA would understand these documents to show.

8. Fractus did not introduce any testimony from its expert on how a POSA would have understood the ’429 Application’s written description, or how a POSA would have understood the documents that Fractus cites for its argument about the ’429 Application’s disclosure. Thus, I am unable to respond to testimony from Dr. Hashemi on this point because he did not offer any. However, I can respond to the attorney arguments that Fractus makes in its POR, and Fractus’s conclusions are unsupported and wrong.

9. EX2016 does not mention either Upper or Lower 700 MHz Band—or any frequency band within 698-806 MHz—being used for “advanced wireless services.” Nothing in EX2016 describes using the 698-806 MHz spectrum for a frequency band associated in particular with a “4G communication standard” as required by the Challenged Claims. EX2020 and EX2022 show portions of the lower 700 MHz Band being auctioned for “[f]lexible fixed, mobile, and **broadcast uses**” (EX2020, 4; EX2022, 3-4). EX2021 lists various companies including many broadcast companies who won the FCC Lower 700 MHz Band Auction #49. Some

¹ EX2027 defines 698-746 MHz as the “Lower 700 MHz Band” and 746-806 MHz as the “Upper 700 MHz Band.” EX2027, 4.

of these broadcast companies include Capital Broadcasting and Banks Broadcasting. EX2021, 2-3. Capitol Broadcasting was a TV and radio broadcast company. EX1115; EX1107; EX1108. Bank Broadcasting was a TV broadcast company that owned and operated several TV stations. EX1115; EX1109, 56; EX1110, 40-41.

10. In my opinion, a POSA would have understood from these references that by December 2006 the reallocation of the Upper and Lower 700 MHz Bands to various wireless and broadcast companies was occurring, but a POSA would not have understood that those frequency bands were reallocated for any “advanced wireless services” let alone a 4G communication standard in general or LTE wireless services in particular. Fractus itself shows that in 2002, the FCC noted possible ways in which the Lower 700 MHz Band “could” be reallocated (POR, 26) such as for “new broadcast operations” as well as wireless communications. (POR, 26; EX2018, ¶70). POSAs understood that “broadcast operations” included television broadcast.

11. Contrary to Fractus’s unsupported attorney argument, EX2018’s table (reproduced below with Fractus’s highlighting and my added red annotation) is not “the FCC order illustrating the allocation of the Lower 700 MHz Band.” POR, 27. EX2018 does not show that the lower 700 MHz frequencies were allocated to wireless communications. At best, POSAs would have understood EX2018 to

show that various uses for the lower 700 MHz Bands were being considered, including radio and TV broadcasting such as “Broadcasting NG128,”² “Broadcast Radio (TV),” and “Auxiliary Broadcasting” for relaying audio and TV signals.

² NG128 is a footnote in FCC documentation that allows broadcast licensees or permittees to use their carrier frequencies on a secondary basis for both broadcast and nonbroadcast purposes. For example, TV broadcasters are permitted to use subcarriers within their allotted frequency range “on a secondary basis for broadcast and non-broadcast purpose.” EX1116, 14; EX1117, 3.

49 MHz (UHF)		Page 37
United States Table		FCC Rule Part(s)
Federal Government	Non-Federal Government	
470-608	470-512 BROADCASTING NG128 NG149 FIXED NG127 LAND MOBILE NG66 NG114	Public Mobile (22) Broadcast Radio (TV) (73) Auxiliary Broadcasting (74) Private Land Mobile (90)
	512-608 BROADCASTING NG128 NG149	Broadcast Radio (TV) (73) Auxiliary Broadcasting (74)
608-614 RADIO ASTRONOMY US74 LAND MOBILE US350		Personal (95)
US246		
614-890	614-698 BROADCASTING NG128 NG149	Broadcast Radio (TV) (73) Auxiliary Broadcasting (74)
	698-746 BROADCASTING NG128 FIXED MOBILE	Wireless Communications (27) Broadcast Radio (TV) (73) Auxiliary Broadcasting (74)
	NG159	

12. Fractus's Upper 700 MHz Band evidence (POR, 24) similarly shows that in addition to "wireless communications," other contemplated uses included "Broadcast Radio (TV)" and "Auxiliary Broadcasting." Fractus's assertion that POSAs knew the entire Upper 700 MHz Band "was going to be used for expanded cellular services as of 1998" (POR, 24-25) is not supported by what Fractus cites.

At best, POSAs would have been aware that some portions of the Upper 700 MHz Band *might* be used for expanded cellular services.

13. As further evidence, the auctioned-off “portions” that Fractus cites (EX2020, 2; EX2022, 2) covering the 710-716 and 740-746 MHz frequency ranges are subsets of the spectrums later used by LTE Band 12 (i.e., 698-716 and 728-746 MHz). Many auctioned frequencies were awarded to television broadcasting companies (“Capitol Broadcasting” and “Banks Broadcasting”). EX2019, 2, 4-5, 7, 9 and 13-14; EX1107; EX1108; EX1109, 56, EX1110, 40-41. None of Fractus’s evidence shows that as of December 2006 the full 36 MHz later used by LTE Band 12 was either auctioned off, or designated by spectrum auction winner(s) for advanced wireless communication, nor that POSAs expected the purchasers of the auctioned-off portions of this spectrum to later allow them to be used for LTE.

14. Fractus’s references do not show that the ’429 Application’s “inventors were in possession of the 698-806 MHz spectrum” as one of the multiple frequency bands used for advanced wireless services (POR, 34), let alone an antenna that meets the claimed complexity factors and supports:

- a frequency band
- associated with a 4G communication standard
- in this frequency range, among other advanced wireless frequency ranges.

15. A POSA would have understood the claims to recite a genus of wireless devices with a genus of antennas that meet the claimed complexity factors and collectively support communication via multiple frequency bands supported by 4G communication standards. But the '429 Application only discloses a single antenna. EX1040, [00264]-[00265], Figs. 12, 17. This antenna “operates in accordance with two mobile communication standards: GSM and UMTS” whose frequency ranges (“810 MHz-960 MHz,” “1710 MHz-1990 MHz,” and “1900 MHz-2170 MHz”) do not include the 698-806 MHz spectrum used by LTE Bands 12-14. *See* EX1040, [0325]-[0326], Fig. 19 (showing the antenna’s frequency response). The disclosed antenna does not demonstrate to a POSA that the inventors possessed a different antenna that meets the claimed complexity factors and supports communication using multiple 4G frequency bands including the 700 MHz frequency range (698-806 MHz).

16. According to the '200 patent, antenna design is not always predictable. Fractus admits this. The '200 Patent discusses numerous “difficulties” and “problems” antenna designers face involving interdependent “constraints” where changing one parameter can “counterproductive[ly]” impact others and “[i]t is usually not obvious how to control the counter-productive effects or how to compensate for them without creating still more problems.” EX1003, 4:24-5:26. And for an antenna covering multiple advanced wireless (4G) frequency bands (as

in the claims Ground 2 challenges), changing the antenna to “produce a new antenna frequency of resonance” changes the antenna’s other resonant frequencies making this unpredictable, in part, because prior optimizations are lost. EX1003, 4:9-23.

17. Producing a multi-band antenna to resonate at different advanced wireless frequency ranges than the specification’s single antenna would have required a different, unpredictable antenna. My opinion is that in 2006 the changes that a POSA would have had to make the antenna with complexity factors that the ’429 Application actually disclosed (EX1040, [00264]-[00265], Figs. 12, 17) so that it would cover frequencies in the Lower or Upper 700 MHz range were not predictable to a POSA. The changes that a POSA would have had to make to the antenna disclosed in the ’429 Application so that the antenna covered the 698-806 MHz spectrum and also met the claimed complexity factors were even less predictable.

18. Moreover, POSAs would not have understood all the members of the genus of the claimed antennas to perform similarly. The genus encompasses antennas supporting different multiple frequency ranges including frequency coverage for various standards (e.g., LTE and the GSM and UMTS standards disclosed in the specification) operating at widely different frequencies. POSAs would have recognized that the claimed genus of antennas do not have the same

design and do not all perform similarly. POSAs would not have understood the '429 Application to demonstrate possession of an antenna that meets the claimed complexity factors and supports the 700 MHz frequency range, particularly the lower 700 MHz range used by LTE Band 12.

19. Fractus states that the '429 Application describes “structural features of the genus in the form of multiple examples of *frequencies* at which the antennas operate, as well as their high speed operation.” POR, 31-32. Fractus’s cited evidence (EX1003, 25:14-26) describes *no* structural feature of any *antenna*, let alone structural features common to the claimed genus of antennas that meet the complexity factors and support every 4G communications standard that then existed or might come into existence at some future time. The '429 Application has no such explanation.

20. It is my opinion that POSAs would not have understood the claims to recite an antenna with claimed complexity factors and configured to support multiple frequency ranges of any then-existing or future 4G standard, including LTE, and particularly the 700 MHz frequency range (i.e., 698-806 MHz), which is not disclosed in the specification and is unsupported by the specification’s single antenna.

IV. GROUND 1

A. Spatial Diversity

21. For spatial diversity, Dou states that “the first internal antenna 206 and the second internal antenna 208 may be separated by a distance (D) that is no less than the quarter wavelength ($\geq \lambda/4$) of the lowest frequency.” Dou, [0024], [0035], Figs. 2A, 3A. Dou+Jing incorporates two Jing antennas and Jing’s ground plane teachings with Dou’s PCB, resulting in two Jing antennas at opposite ends of the PCB, separated by a 60 mm long ground plane. EX1007, ¶128; Petition, 35; *id.*, 36 (figure reproduced below); POR, 42 (Fractus recognizing); EX2010, ¶45 (Dr. Hashemi recognizing).

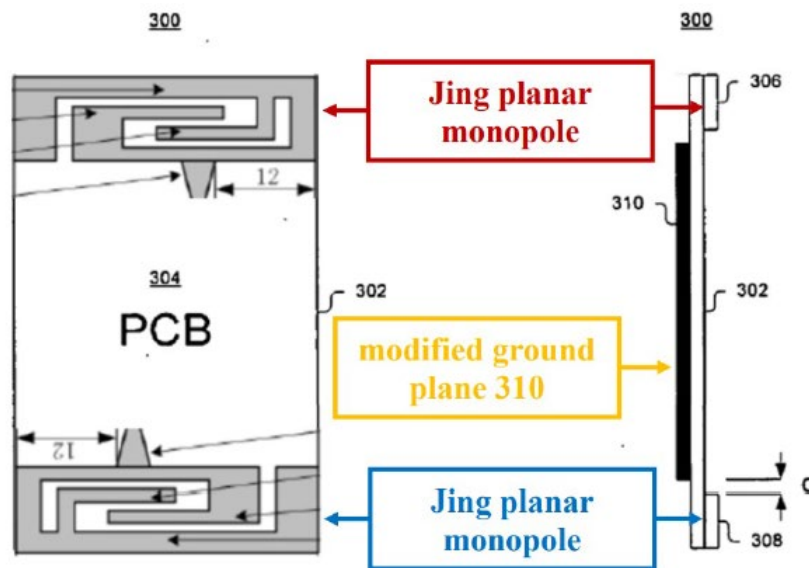


FIG. 3A

FIG. 3B

Dou implemented with Jing

22. Fractus argues that “the lowest frequency of Jing’s antenna is 900 MHz.” POR, 41. This is disingenuous because in Dou+Jing, the antenna never operates at 900 MHz.

23. Regardless, using Fractus’s 900 MHz for simplicity, the *free-space* wavelength, i.e., $\left(\frac{c_0}{f}\right) = \left[\frac{3 \times 10^{11} \left(\frac{mm}{sec}\right)}{900 \times 10^6 \left(\frac{1}{sec}\right)}\right] \approx 333.3 \text{ mm}$, so a quarter free-space wavelength at 900 MHz is 83.3 mm. This is what Fractus and Dr. Hashemi argue is “the minimum spacing” that Dou requires between the Jing antennas “to achieve spatial diversity” at 900 MHz. POR, 41-43 (citing EX2010, ¶¶44-46). This is incorrect. Fractus’s calculation fails to account for the design and materials used in Jing, which when accounted for yields a lower quarter wavelength.

24. Jing’s antenna is “printed on a FR4 substrate” having a relative permittivity $\epsilon_r = 4.4$. Jing, 2657-2658. The relative permittivity *reduces* the operating wavelength used to evaluate antenna separation. This is because the relative permittivity slows down the light passing through the dielectric, which has the effect of reducing the wavelength by an amount $1/n$ where the refractive index $n = \sqrt{\epsilon_r}$ (i.e., the square root of the relative permittivity). EX1005, 169. Because Jing’s antenna is printed on FR4, POSAs would have accounted for FR4’s relative permittivity when calculating operating wavelength to evaluate the antenna

separation in Dou+Jing. EX1105, 169 (“[T]he guided wave is different in that it exists in both the dielectric spacer and the air above the spacer.”).

25. For Dou+Jing’s antenna system, POSAs would have evaluated operating wavelength using an “effective” relative permittivity $\epsilon_{r,eff} \approx \frac{\epsilon_r + 1}{2} \approx \frac{4.4 + 1}{2} = 2.7$ that averages the relative permittivity of FR4 (i.e., 4.4) and free space (i.e., 1). EX1105, 169. With $\epsilon_{r,eff} \approx 2.7$ a quarter wavelength at 900 MHz is $\left(\frac{1}{4}\right) \left(\frac{c_0}{f}\right) \left(\frac{1}{2.7}\right)^{0.5} \approx \left(\frac{1}{4}\right) \times \left[\frac{3 \times 10^{11} \left(\frac{mm}{sec}\right)}{900 \times 10^6 \left(\frac{1}{sec}\right)}\right] \times \left(\frac{1}{1.64}\right) \approx \mathbf{50.6 \text{ mm}}$. *This 50.6 mm is less than the 60 mm antenna separation in Dou+Jing* (e.g., Petition, 41-42), meaning that *Dou+Jing meets Dou’s quarter-wavelength antenna spacing* constraint and provides spatial diversity.

26. This effective permittivity analysis to determine wavelength for an antenna printed on FR4 was conventional. EX1105, 169. Fractus *admitted* this in IPR2025-00929. *See id.*, Paper 8 at 43 (“The [POSA] would also have understood... that the permittivity of the FR-4 material used in the Zhao [PCB] should be taken into account when determining the operating wavelength of the Zhao antenna,” citing EX1104, ¶107); *id.*, paper 8 at 44-46 (applying same effective permittivity analysis discussed above, citing EX1104, ¶¶41, 108-112 and EX1105, 169).

27. Zhao's antenna at issue in IPR2025-00929 is a UWB slot antenna printed on FR4. EX1114, [0006]-[0007]; EX1004, ¶107. Because Zhao's antenna is printed on FR4, the permittivity of FR4 causes the guided wave to be "different in that it exists in both the dielectric spacer and the air above the spacer." EX1105, 169. Jing's antenna is likewise "printed on a FR4 substrate." Jing, Abstract. Consequently, a POSA calculating the quarter wavelength of Jing's lowest frequency would likewise have taken the permittivity of FR4 into account as Fractus and Dr. Hashemi did for calculating a quarter wavelength for Zhao's antenna. Despite this, Fractus and Dr. Hashemi, without explanation, calculated Jing's lowest frequency's quarter wavelength using only the permittivity of air. This is incorrect and would not have been how a POSA would have performed this calculation.

B. Pattern Diversity

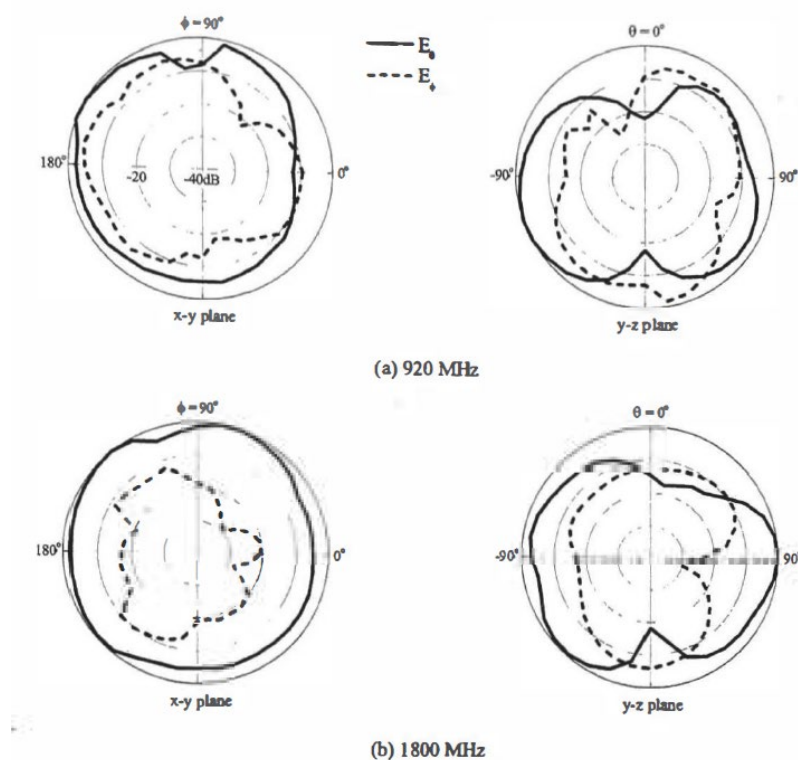
28. Pattern diversity was a well-known type of antenna diversity using multiple antennas with differently-oriented radiation patterns to improve reliability. EX1118, 577-580. I agree with Dr. Hashemi's declaration where he states: "By having two or more antennas whose radiation patterns are different or differently oriented, the nulls of the antennas lie in different directions/orientations, and the likelihood of a receiving a signal from the transmitter [] at least one of the antennas is improved." EX2029, ¶6. For example, an antenna array comprising two identical

antennas will provide pattern diversity when nulls of each antenna lie in different directions/orientations relative to each other.

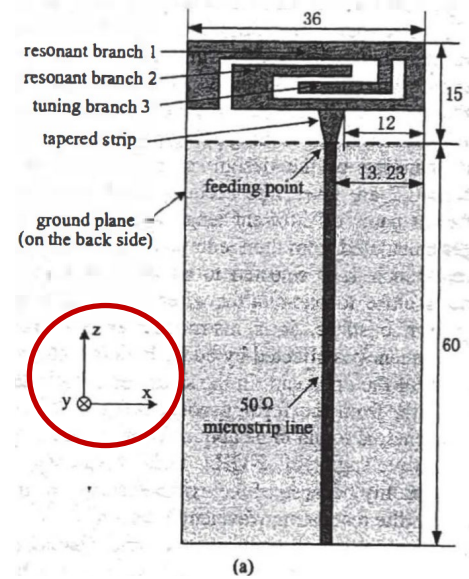
1. Dou+Jing would have provided pattern diversity.

29. Implementing Dou with two Jing antennas as described in the petition would have provided the Dou+Jing combination in Ground 1 with pattern diversity.

30. Jing (EX1011) Figure 4 shows the antenna's radiation pattern at 920, 1800, 2000, and 2400 MHz at different elevations (angle phi (ϕ) or theta (θ)) in an x-y plane (left side) and y-z plane (right side). Jing, Fig. 4, 2658-2659. The radiation patterns at 920 MHz and 1800 MHz are shown below.

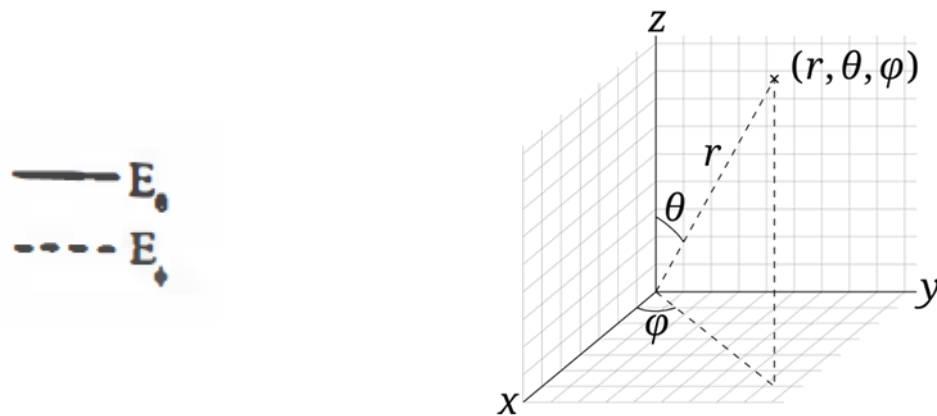


31. Jing Figure 1(a) (annotated right) defines the x, y, and z axes. Jing, 2657. In Jing's coordinate system, as shown in Fig. 1(a), the y axis increases into the planar figure, the z axis increases to the top, and the x axis increases to the right. Thus, in Jing's coordinate system, the x-z plane is parallel to the surface of the



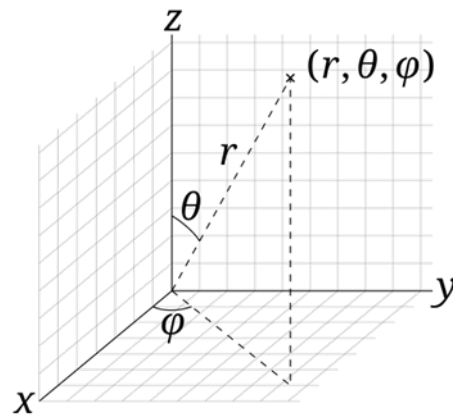
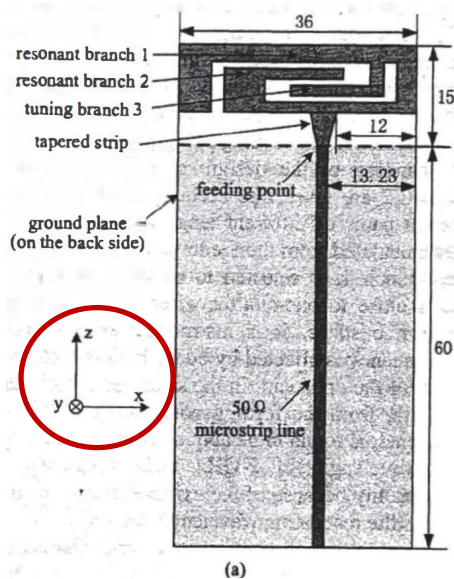
antenna's main patch, the x-y plane is a horizontal slice through the Figure 1(a) planar view parallel to the PCB's short edge (i.e., parallel to the x axis), and the y-z plane is a vertical slice through the Figure 1(a) planar view parallel to the PCB's long edge (i.e., parallel to the z axis).

32. Jing explains that the radiation pattern shows the measured electric field amplitude (E) at different elevations theta (θ) and azimuth phi (ϕ). Jing, Fig. 4 (legend detail below left).

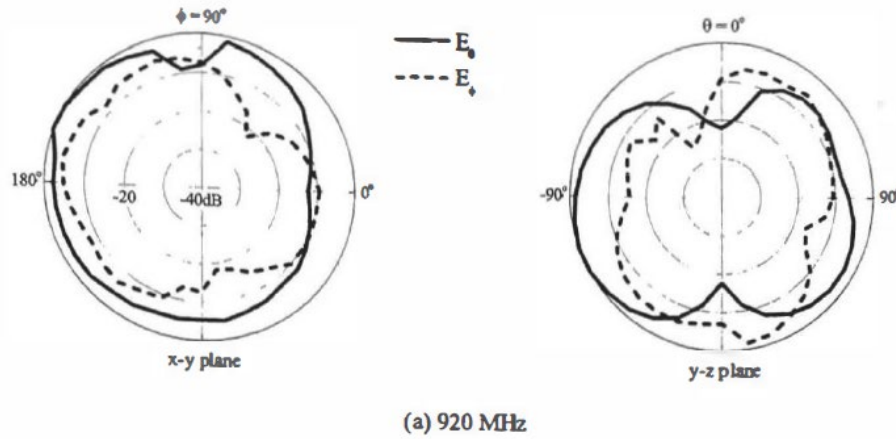


33. A POSA understood that elevation theta (θ) is the angle from the vertical axis (z) in a spherical coordinate system as shown above right. A POSA understood that azimuth phi (ϕ) is the angle increasing counterclockwise from the x axis in the x-y plane in a spherical coordinate system as shown above right.

34. As noted above, Jing defines its coordinate system so that the x-z plane is parallel to the main face of the antenna. E.g., Jing Fig. 1(a) (below left). The y axis is perpendicular to the main plane of the antenna.



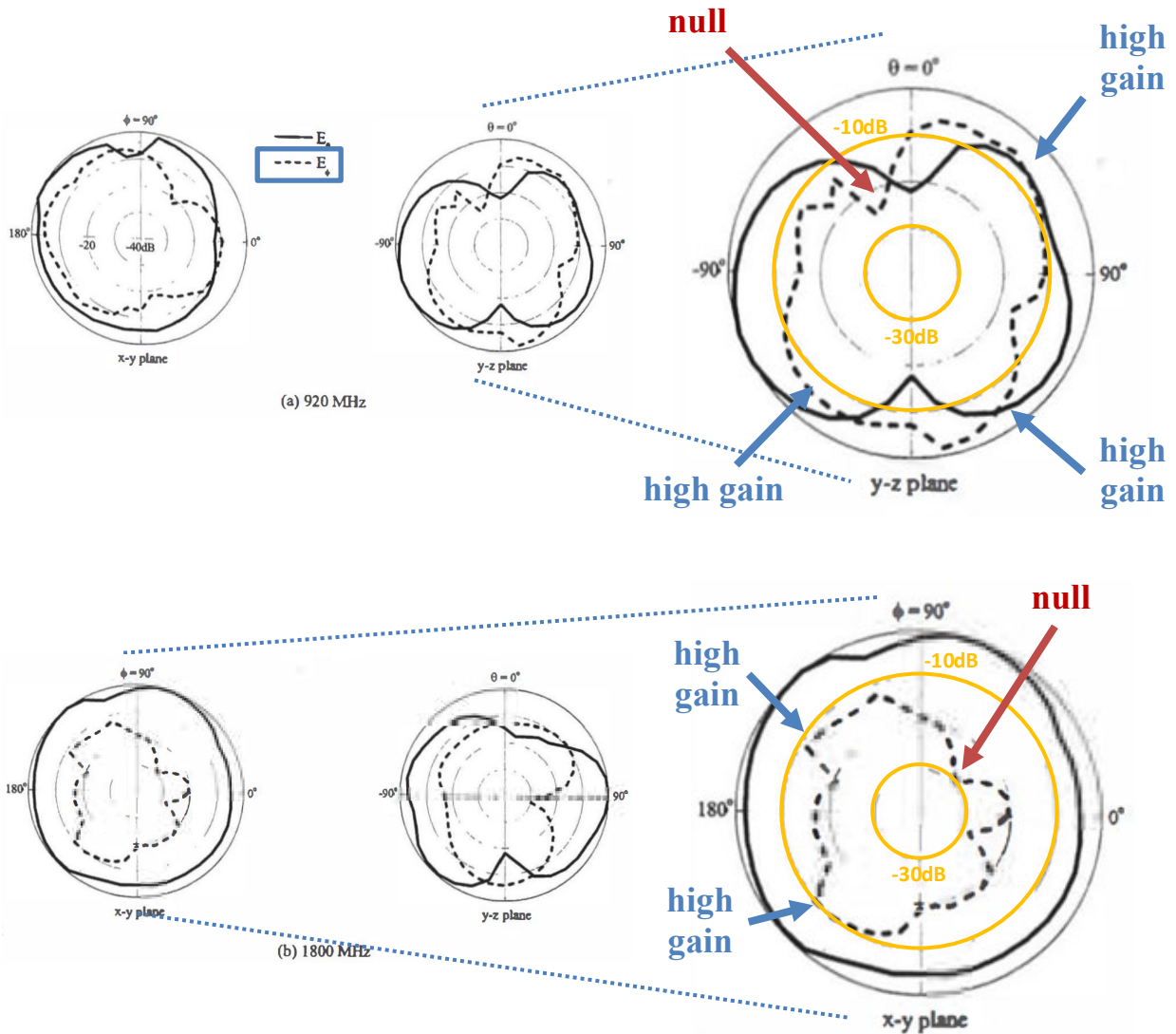
35. Thus, using the radiation pattern at 920 MHz in Fig. 4(a) (below) for discussion, the radiation pattern in x-y plane (below left) with azimuth phi (ϕ) = 0 to the right is a radiation pattern for a 360 degree azimuth sweep at elevation theta (θ) = 90 degrees. Given the way Jing defines his coordinate system, this is the radiation pattern for a horizontal slice through the planar view in Fig. 1(a) parallel to the short edge of the PCB.



36. The radiation pattern for the y-z plane at 920 MHz (above right) represents the pattern (electric field amplitude) on the y axis (pointing into the page) for a slice through the planar view in Fig. 1(a), as elevation is swept 360 degrees from the z axis (i.e., from theta (θ) = 0) that is parallel to the PCB long edge and points to the top of the PCB (i.e., its top short edge) in Fig. 1(a). In other words, theta (θ) = 180 degrees represents the electric field amplitude on that y-z plane in a direction pointing to the bottom of the planar antenna (i.e., -z) as shown in Fig. 1(a).

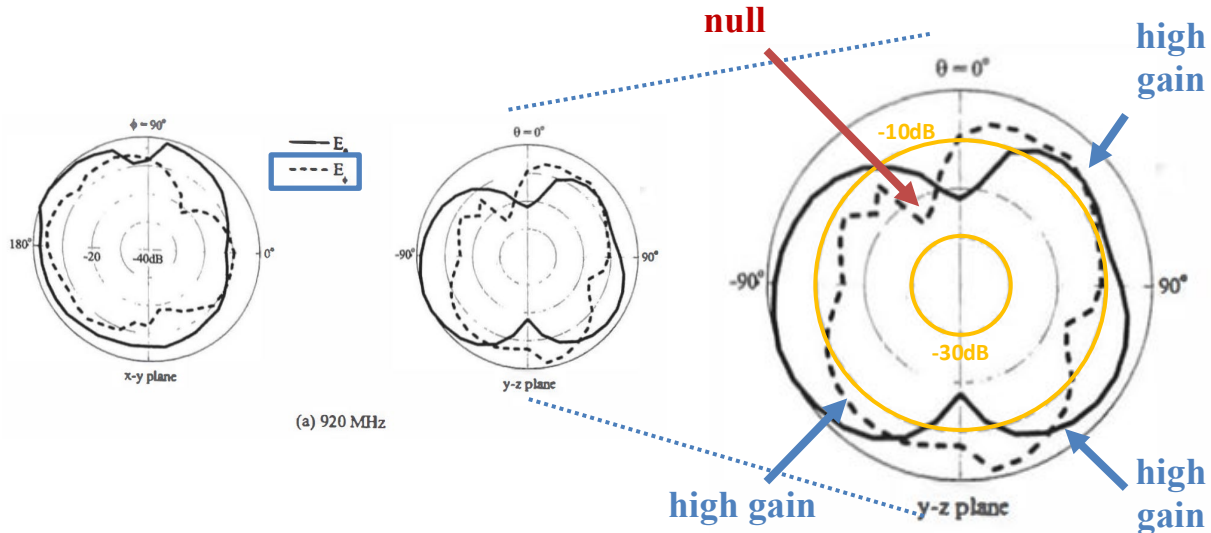
37. The Jing antenna's radiation pattern varies with frequency. Jing, 2659. Jing's non-uniform radiation pattern is shown, among other things, by the relative position and magnitude of the null and high gain region in the antenna radiation patterns identified below. Jing, Figs. 1(a) (right, defining axial orientation with y-z plane a vertical slice through planar figure), 4 (detail annotated below, showing measured radiation patterns).

38. For example, Jing's E_ϕ measurements in the y-z plane at 920 MHz and x-y plane at 1800 MHz are shown as the dashed black line that is annotated below to highlight the radiation pattern's asymmetric shape.



39. Jing's radiation pattern plot at 920 MHz in the y-z plane shows radiation in a vertical slice through the antenna in the y-z plane where the azimuth ϕ is fixed (it is either plus or minus y) and the value of E_ϕ on the y-z plane varies

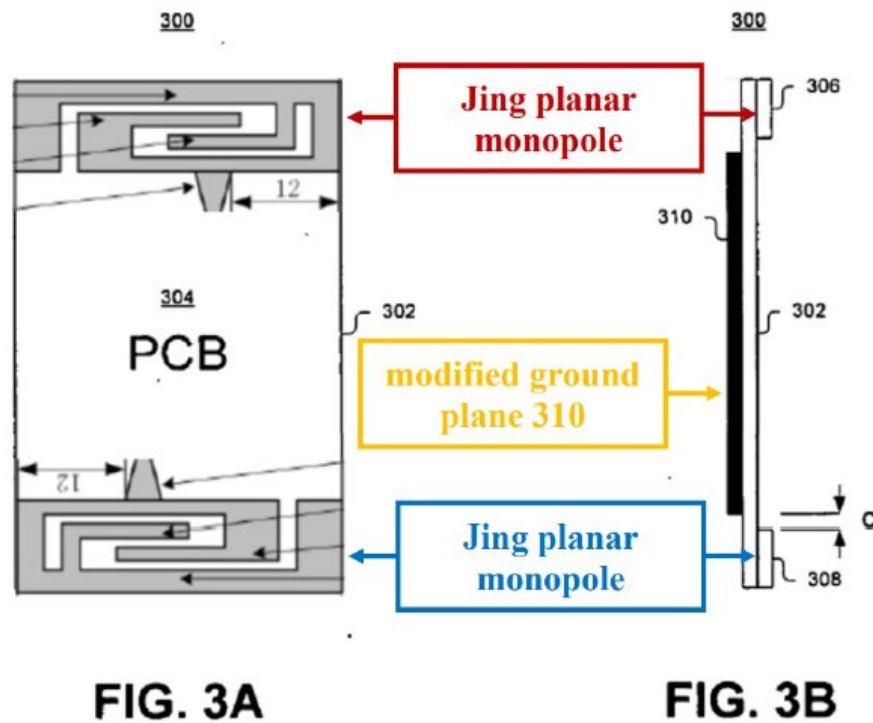
with elevation. The center represents a field amplitude of -40 dB, and each scale circle marks a 10 dB increment in magnitude.



40. By inspection, the point representing a “null” (annotated above right) has an electric field magnitude of roughly -25 dB (e.g., about the midway between the -20 and -30 dB scale). At points on the radiation pattern, e.g., 90, -90, and 180 degrees from the null (marked “high gain”), the radiation pattern shows a much larger field amplitude close to -5 dB.

41. The Jing antenna’s E_ϕ radiation pattern at 920 MHz in the y-z plane, in short, shows more than 20 dB difference in amplitude (i.e., an order of magnitude or ten-times increase in amplitude, and 100-fold increase in field power, which is proportional to the square of the electric field amplitude) between the null and these high-gain points pointing in different directions.

42. The Dou+Jing combination expressly implements two Jing antennas on opposite sides of the PCB's long-axis, with the bottom antenna rotated 180 degrees. EX1007, ¶128; Petition, 35-36; Jing, Fig. 1(a); Dou, Figs. 3A-3B; *see also* DI, 39 (citing Petition, 36); POR, 41. This is because Jing's antenna is asymmetric and oriented relative to the PCB "end" and ground plane such that the "feeding point" is positioned toward the ground plane. Jing, Fig. 1(a).

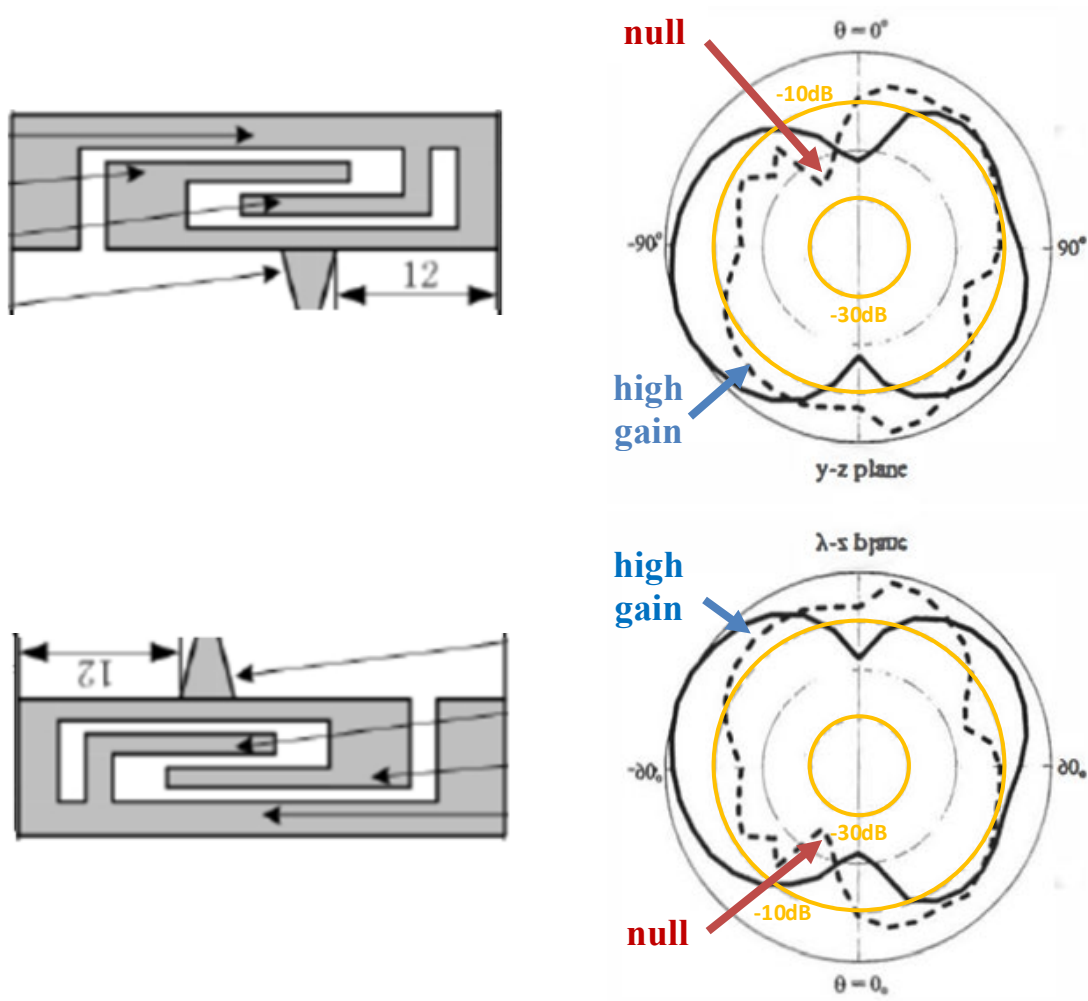


Dou implemented with Jing

Petition, 36.

43. Remember, in Jing's coordinate system the z axis points to the top of the top left antenna shown below, so that the bottom left antenna is rotated 180 degrees in the z-x plane (page plane) relative to the antenna top left (in other

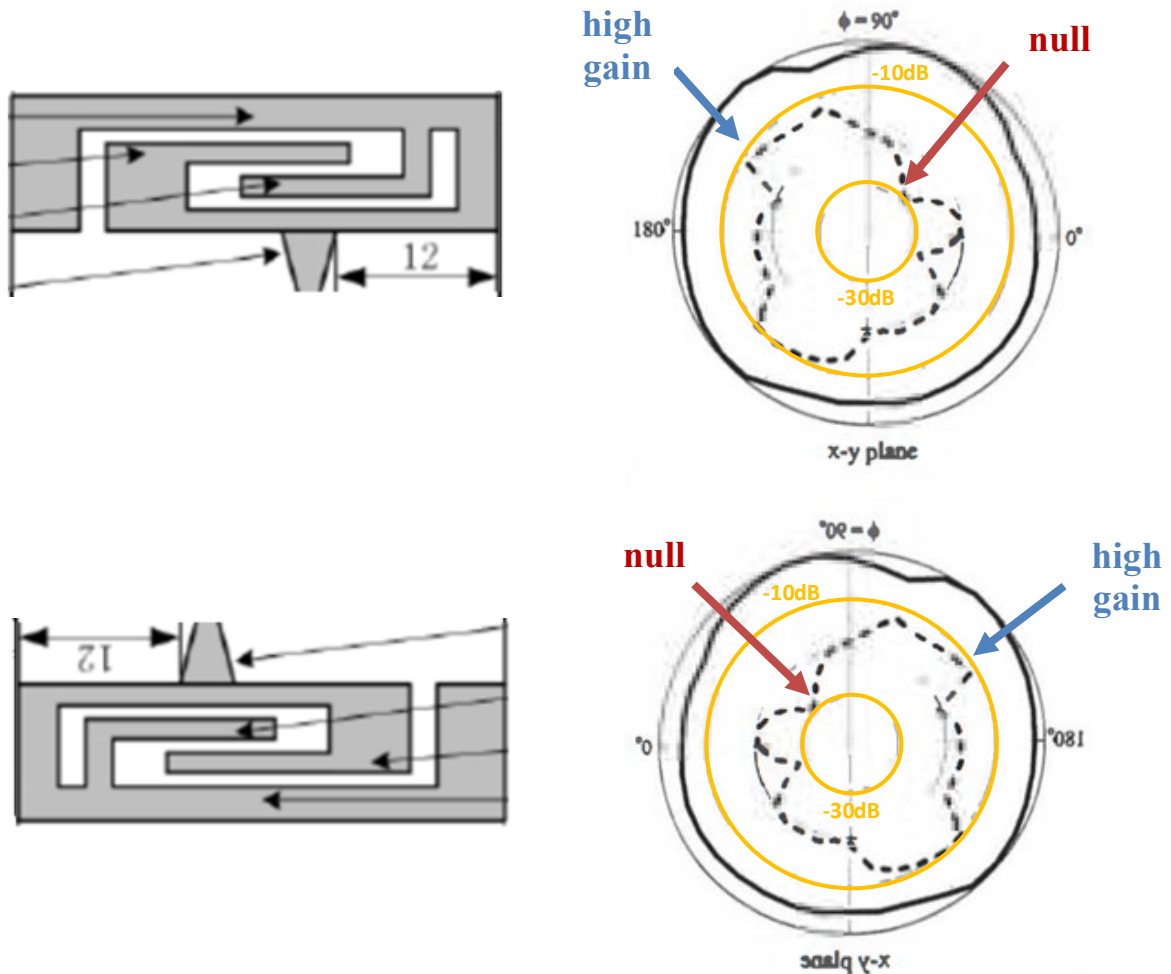
words, rotating 180 degrees about the y axis normal to the page). The Dou+Jing combination has pattern diversity because, as shown below, for the y-z plane at 920 MHz, a null in the radiation pattern of one antenna corresponds to a direction with a high gain region for the other antenna, and vice versa.



44. As I show above (top right), a 180-degree rotation of the antenna about the y-axis results in its radiation pattern flipping top-to-bottom in y-z plane. A 180-degree rotation about the y-axis maps each point (x, y, z) on the upper antenna to $(-x, y, -z)$ on the lower antenna. That is, the y-coordinate is preserved,

while x and z flip sign. In Jing's y-z plane radiation pattern figure (Fig. 4 at 920 MHz, with θ measured from +z so the top of the plot is $\theta = 0^\circ$ and the horizontal centerline corresponds to the y-axis at $\theta = 90^\circ/-90^\circ$), this antenna rotation manifests as a top-to-bottom flip of the radiation pattern about that horizontal y-axis line. For example, as the annotated radiation patterns above (right side) show, a null at angle θ on the upper antenna's pattern corresponds to a high gain of the lower antenna's pattern at angle $(180^\circ - \theta)$.

45. The Jing antenna's x-y radiation patterns at 1800 MHz (annotated below) likewise demonstrates pattern diversity because each antenna provides higher sensitivity in a direction that the other antenna has lower (null) sensitivity. Remember, in Jing's coordinate system x increases to the right for the top left antenna below, so that the bottom left antenna below is rotated 180 degrees in the z-x plane (page plane) relative to the top left antenna below (in other words, rotating 180 degrees about the y axis normal to the page).



46. As I show above (top right), a 180-degree rotation of the antenna about the y-axis results in its radiation pattern flipping left-to-right in x-y plane. A 180-degree rotation about the y-axis maps each point (x, y, z) on the upper antenna to $(-x, y, -z)$ on the lower antenna. That is, the y-coordinate is preserved, while x and z flip sign. In Jing's x-y plane radiation pattern figure (Fig. 4 at 1800 MHz, with ϕ measured from +x so the right side of the plot is $\phi = 0^\circ$ and the vertical centerline corresponds to the y-axis at $\phi = 90^\circ/-90^\circ$), this antenna rotation manifests as a left-to-right flip of the radiation pattern about that vertical y-axis

line. For example, as the annotated radiation patterns above (right side) show, a null at angle ϕ on the upper antenna's pattern corresponds to a high gain of the lower antenna's pattern at angle $(180^\circ - \phi)$.

47. This Dou+Jing antenna configuration provides pattern diversity because one antenna has relatively high gain in the same direction where the other antenna has a null. That is the purpose of pattern diversity. And, regardless, POSAs would have had reasons to implement Dou+Jing this way in order to achieve pattern diversity with the Jing antennas because that would have implemented a well-known “design constraint” to achieve pattern diversity and thus a form of antenna diversity as described in Dou.

48. Dr. Hashemi agrees that this type of configuration provides pattern diversity. EX2029, ¶6 (“By having two or more antennas whose radiation patterns are different or differently oriented, the nulls of the antennas lie in different directions/orientations, and the likelihood of a receiving a signal from the transmitter at [] least one of the antennas is improved.”).

49. Dr. Hashemi's assertion that “two identical similarly oriented antennas will exhibit the same radiation pattern, and therefore, will not provide pattern diversity” does not contradict any of the pattern diversity analysis above. To the contrary, that assertion is based on a false premise—a strawman—that misrepresents the Dou+Jing combination, which as shown above places the two

Jing antennas with one rotated 180 degrees relative to the other. It is my opinion that POSAs would have implemented the Dou+Jing combination as described (Petition, 35-36; EX1007, ¶¶122-128) with a reasonable expectation of success, consistent with the Petition's reasons to combine Dou and Jing in a manner meeting Dou's "design constraints." Petition, 33-36; EX1007, ¶133. The benefits of antenna diversity were well-known and POSAs would have understood that implementing Dou+Jing in this way would have provided pattern diversity.

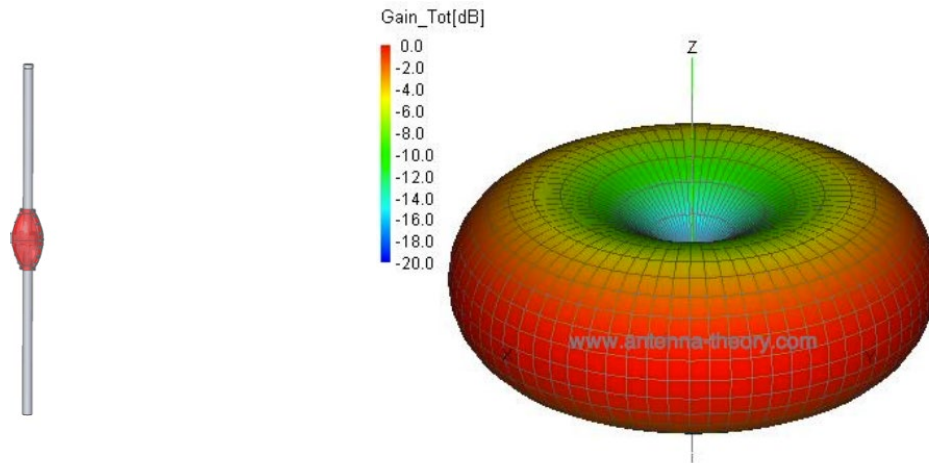
2. Fractus's argument that Jing's antenna cannot provide pattern diversity is wrong.

50. Fractus cites to Jing's radiation pattern and states that the Dou+Jing combination cannot provide pattern diversity because Jing's antenna has an "omnidirectional radiation pattern[]." POR, 45. This argument fails on many levels.

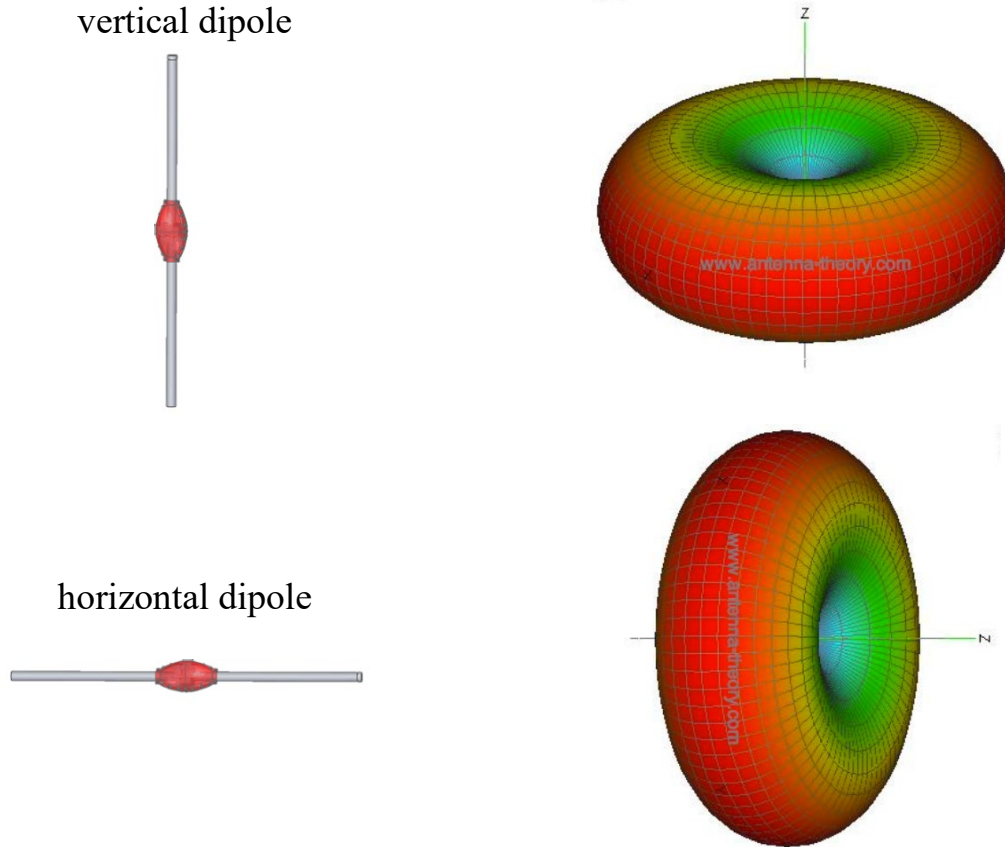
51. *First*, Fractus's argument relies on a false premise (i.e., that an antenna with an omnidirectional radiation pattern cannot provide an antenna architecture with pattern diversity). Contrary to Fractus's argument, a POSA knew that an antenna architecture using omnidirectional antennas could easily provide pattern diversity.

52. Fractus never explains what an omnidirectional antenna is. However, a POSA knew that an ideal dipole was a canonical example of an omnidirectional antenna, with a well-known radiation pattern as shown below in three dimensions:

the pattern is independent of azimuth but sensitive to elevation and has a null response directly overhead and below the antenna. A dipole antenna is one of the most common and simple types of antennas, consisting of two identical conductive elements (like metal wires or rods) that feed into a central point.



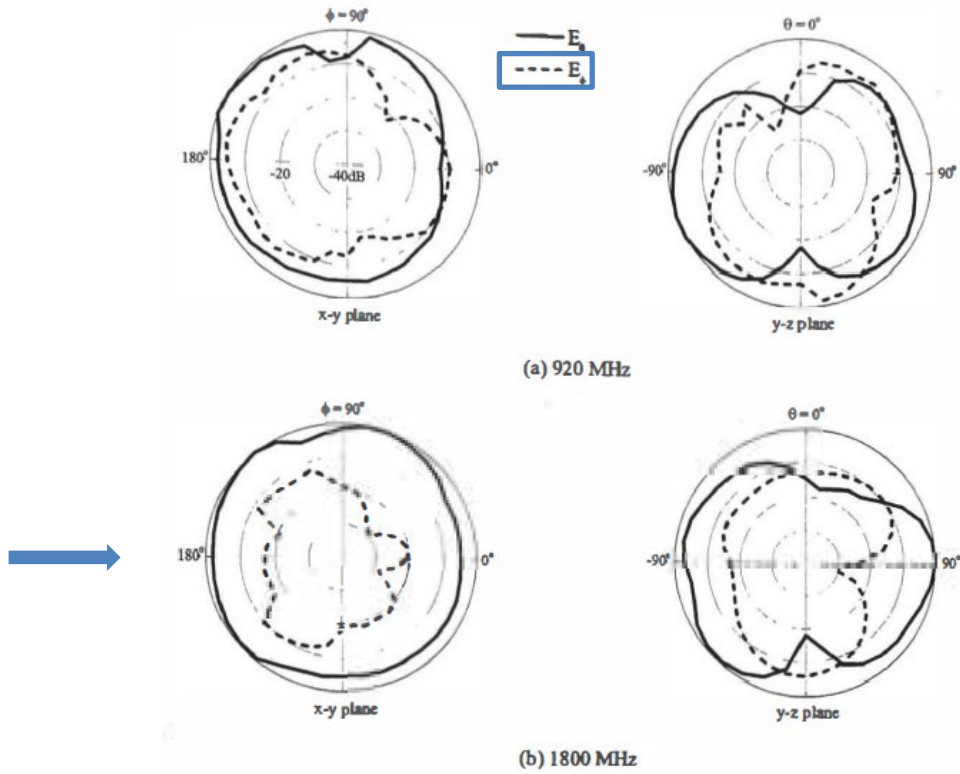
53. A POSA knew that two dipoles (e.g., each an omnidirectional antenna) could provide an antenna array with pattern diversity by, for example, simply disposing one dipole vertically and another horizontally. In this way, as shown below, one antenna would provide high gain in the direction of the other antenna's null. The POSA knew that this would have provided an antenna array with pattern diversity.



54. Thus, Fractus's suggestion that an omnidirectional antenna cannot provide an antenna array with pattern diversity is simply wrong. And a POSA would have known this.

55. **Second**, regardless, Fractus's argument also fails because Jing's antenna does not have an omnidirectional radiation pattern.

56. Figure 4 further confirms that the Jing antenna is not omnidirectional in its plot of measured E_ϕ at 1800 MHz in the x-y plane (i.e., the bottom left plot below).



57. As explained above, the x-y plane is a horizontal slice through the antenna in the planar view in Fig. 1(a), parallel to the short edge of Jing's PCB (i.e., parallel to the x axis defined in Jing Figure 1(a)). The measured value of E_ϕ at azimuth $\phi = 0$ degrees (i.e., the direction facing the right side of the antenna in Figure 1 parallel to the antenna surface) is *less* than -20 dB, while at 180 degrees (i.e., the direction facing the left side of the antenna in Fig. 1 parallel to the antenna surface) the measured value is *more* than -20 dB. At roughly 225 degrees azimuth, E_ϕ increases to roughly -10 dB. This confirms that the antenna's radiation pattern is not omnidirectional.

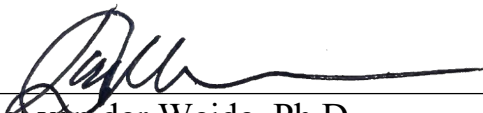
58. Thus, Fractus's arguments fail at every level. It is simply not true that an omnidirectional antenna cannot be used to provide an antenna array with pattern diversity, and regardless Jing's antenna is not omnidirectional. A POSA would have known this.

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.

Dated: May 18, 2026

By:



Daniel van der Weide, Ph.D.