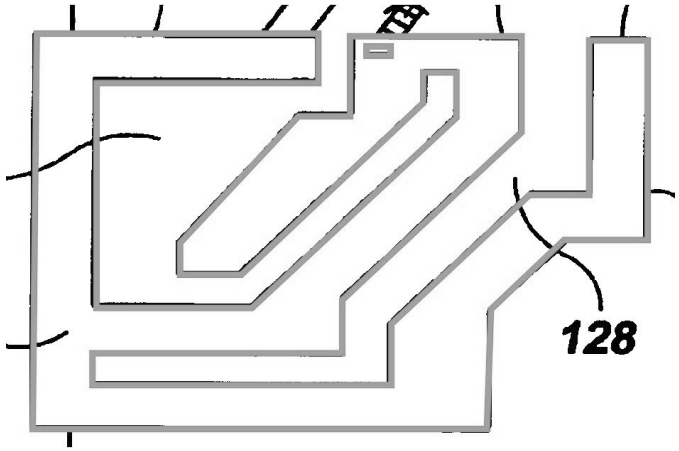
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	level of complexity defined by complexity factor F21 having a value of at least 1.2 and a complexity factor F32 having a value of at least 1.35.	 Talvitie at Figure 1 Further, it would have been obvious to a person of ordinary skill in the art that, when $N_1 = 14$; $N_2 = 40$; and $N_3 = 134$; that given $$F_{21=-}\frac{(\log_{10}(N_2)-\log_{10}(N_1)}{\log_{10} 1/2}$$ solving for F_{21} results in

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		$$F_{21=-}\frac{(\log_{10}(40)-\log_{10}(14)}{\log_{10}1/2}=\ 1.5146$$ and $$1.20\ \leq 1.5146$$ Still further, it would have been obvious to a person of ordinary skill in the art that, when $N_1\ =\ 14$; $N_2\ =\ 40$; and $N_3\ =\ 134$; that given $$F_{32=-}\frac{(\log_{10}(N_3)-\log_{10}(N_2)}{\log_{10}1/2}$$ solving for F_{32} results in $$F_{32=-}\frac{(\log_{10}(134)-\log_{10}(40)}{\log_{10}1/2}=\ 1.7442$$ and $$1.35\ \leq 1.7442$$
Claim 7		

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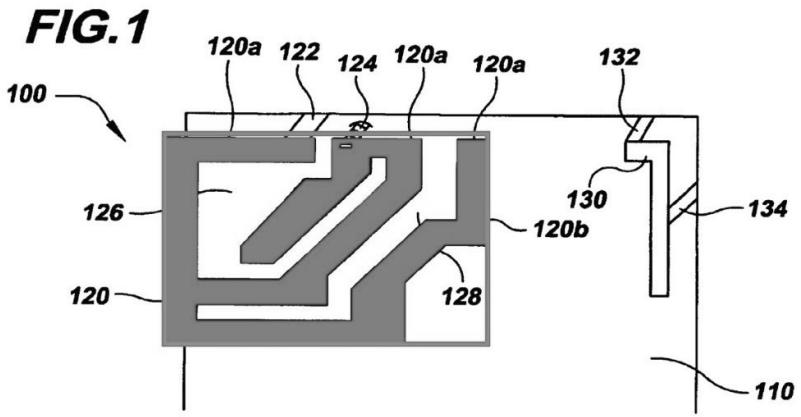
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
7[pre]	A wireless device comprising:	To the extent the preamble is limiting, Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[pre]
7[a]	a ground plane;	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[a]
7[b]	a first non-planar antenna	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[b] To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. "As shown in FIG. 2A, the wireless device 200 may have an internal diversity antenna architecture comprising a first internal antenna 206 and a second internal antenna 208 disposed on the PCB 204 for achieving diversity. In various embodiments, the first internal antenna 206 and the second internal antenna 208 may remain in a fixed position internal to the housing 202 in order to eliminate the need for an external antenna and reduce the overall size and bulkiness of the wireless device 200. In one embodiment,

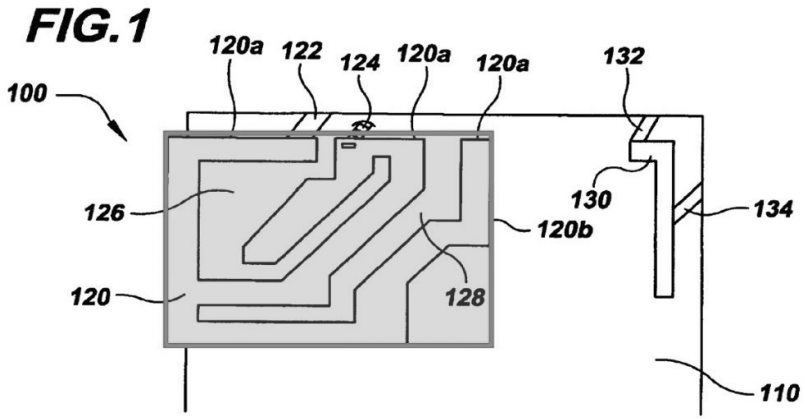
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		the internal diversity antenna architecture may comprise a first internal antenna 206 located substantially near the top of the wireless device 200. For example, the first internal antenna 206 may be located substantially near the top of the housing 202 and/or the top of the PCB 204. The internal diversity antenna architecture may comprise a second internal antenna 208 located substantially near the bottom of the wireless device 200. For example, the second internal antenna 208 may be located substantially near the bottom of the housing 202 and/or the bottom of the PCB 204." Dou at [0017] "In various embodiments, the first internal antenna 206 and/or the second internal antenna 208 may be implemented using any type of suitable internal antenna, such as a planar inverted-F antenna, a planar inverted-L antenna, an **inverted-F antenna with a helical structure, an inverted-L antenna with a helical structure**, a monopole antenna, a meandered monopole antenna, a dipole antenna, a balanced antenna, a printed helical antenna, a chip antenna, and a ceramic antenna. The embodiments are not limited in this context. Dou at [0028] "As shown in FIG. 3A, the wireless device 300 may have an internal diversity antenna architecture comprising a first internal antenna 306 and a second internal antenna 308 disposed on the PCB 304 for achieving diversity. In this embodiment, the internal diversity antenna architecture may comprise a first internal antenna 306 located substantially at the top of the wireless device 300. For example., the first internal antenna 306 may be located substantially at the top of the housing 302 and/or the top of the PCB 304. The internal diversity antenna architecture may comprise a second internal antenna 308 located substantially at the bottom of the wireless device 300. For example, the second internal antenna 308 may be located substantially at the bottom of the housing 302 and/or the bottom of the PCB 304." Dou at [0032]

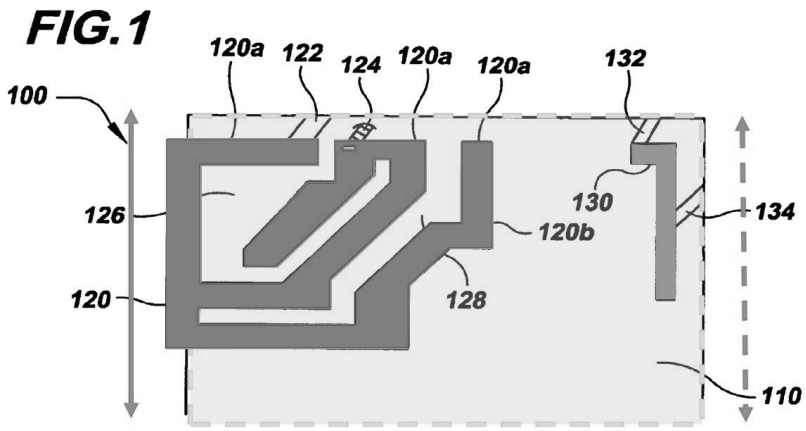
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		"FIG. 3B illustrates a side view of the wireless device 300 of FIG. 3A. As shown, the wireless device 300 may comprise a ground plane 310 to improve antenna performance in talk position and reduce SAR. As shown, the ground plane 310 does not extend underneath the second internal antenna 308. In this embodiment, the second internal antenna 208 may be separated from the ground plane 310 by a clearance distance (C) that is no less than 5 mm (>5 mm). The first internal antenna 206 may comprise, for example, a planar inverted F-antenna. The second internal antenna 208 may comprise, for example, a monopole-antenna, **an inverted-L antenna**, a meandered monopole, **a printed helical antenna**, a dipole antenna, a balanced antenna, or other suitable antenna. **The embodiments are not limited in this context**." Dou at [0034] "As shown in FIG. 4A, the wireless device 400 may have an internal diversity antenna architecture comprising a first internal antenna 406 and a second internal antenna 408 disposed on the PCB 404 for achieving diversity. In this embodiment, the first internal antenna 406 may comprise a first feed point 412 and a first ground point 414, and the second internal antenna 408 may comprise a second feed point 416 and a second ground point 418. The first internal antenna 406 may be located substantially near the top of the wireless device 400, and the second internal antenna 408 may be located substantially near the bottom of the wireless device 400. Dou at [0036] "With the development of the mobile communication industry, the requirements for a mobile terminal antenna are evolving toward multi-band operation (for example: GSM 800/900/1800/1900 Hz or WLAN 2.4 GHz/5.1 GHz/5.8 GHz), high gain, and adaptability to a plurality of usage scenarios (such as an open or closed state of a foldable phone, a handheld mode, a waist-mounted mode, or flat placement on a desktop). The existing mobile terminal antennas are categorized into two types: external antennas and internal antennas. The internal antennas are increasingly prevalent in mobile phones due to their aesthetic appearance, high portability, and improved resistance to damage from drops. The internal antennas include various planar inverted-F antennas (PIFAs) and monopole (or helical) antennas designed based on technologies similar to an external antenna technology. Since an internal antenna is required to have a

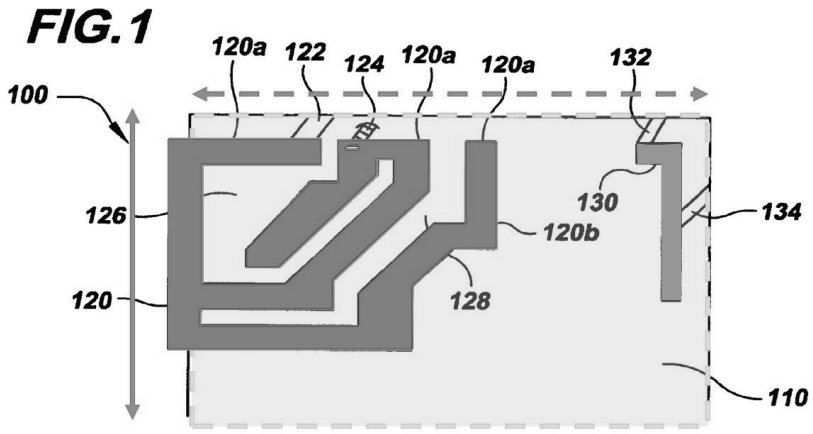
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		small volume and a compact structure, it is difficult to achieve multi-band and high-gain performance, and even more challenging to implement good matching of a plurality of frequency bands under different states. For example, many internal antennas cover only two frequency bands such as GSM 900/GSM 1800 or GSM 800/GSM 1900, while some internal antennas may cover three frequency bands such as GSM 900/GSM 1800/GSM 1900 or GSM 800/GSM 1800/GSM 1900M. A manufacturer of whole mobile phones urgently desires to produce a quad-band mobile phone which can be sold in a global market. Without ability to develop and manufacture the quad-band mobile phones, manufacturers are compelled to offer two separate tri-band models to different markets. Consequently, two different versions need to be researched and developed for one model. This complicates production and material management, and hinders cost reduction." Wei at 6:9-29 "The present invention applies to several antenna topologies, both balanced and unbalanced. In particular, monopoles, dipoles, loops, folded and loaded monopoles and dipoles and their slot or aperture equivalents (slot monopoles, slot dipoles, slot loops, folded and loaded slot monopoles and dipoles) are some of the structures that can be arranged according to the present invention. Other structures include shorted and bent monopoles (L monopoles, IFA), multibranch structures, coupled monopoles and dipole antennas and again their aperture equivalents. All of them would include the characteristic pattern built on a component of the integrated circuit package according to the present invention. Another possible antenna configuration is a microstrip or patch antenna, including their shorted versions (shorted patches and planar inverted F or PIFA structures); nevertheless for the planar cases a particular selection of the disclosed geometries should be considered to achieve the required degree of miniaturization. In particular, the characteristic pattern of the invention should include at least a curve with fifteen segments, with at least seven of the segments being shorter than one-twentieth of the longest free-space operating wavelength of the antenna. The rest of the general conditions that conform the essential geometric aspects of the invention, as described above, apply to the microstrip patch and their shorted versions as well."

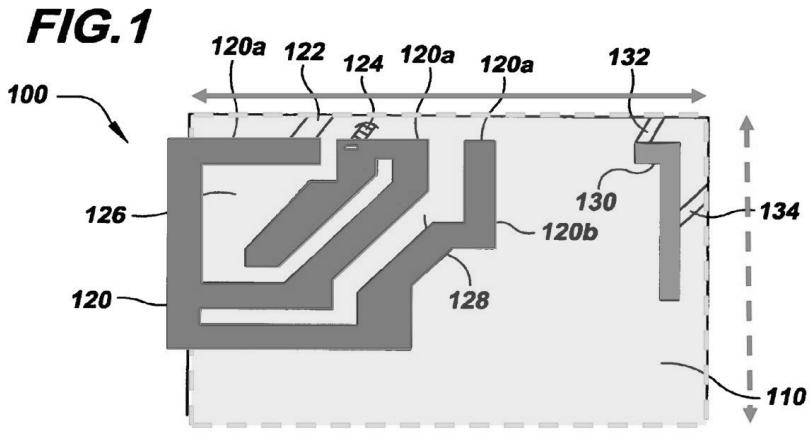
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		Castany868 at 7:5-23 "It is noted that, according to the present invention, the antenna structure is not limited to a planar structure, because the package can include several portions or parts of the antenna in multiple layers or components of the package. The layers can be optionally interconnected by means of several vias and viaholes. A preferred arrangement in several embodiments comprises repeating a similar antenna pattern on two or more layers within at least one of the package substrates, and interconnect such similar conducting patterns for the antenna at one or more points. Typically a preferred point for interconnecting such similar layers will be the feeding point. This way the current splits symmetrically on every layer so that the ohmic resistance of the overall antenna is lower and the antenna is more efficient. A simple, low-cost version of such an arrangement comprises a package including a single substrate, the substrate including an conducting antenna pattern at both sides, the patterns being connected by at least one via." Castany868 at 13:6-18
7[c]	[*the first non-planar antenna*] proximate to a first side of a ground plane rectangle enclosing the ground plane,	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[c]
7[d]	the first non-planar antenna being configured to support at least three frequency bands of the	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[d]

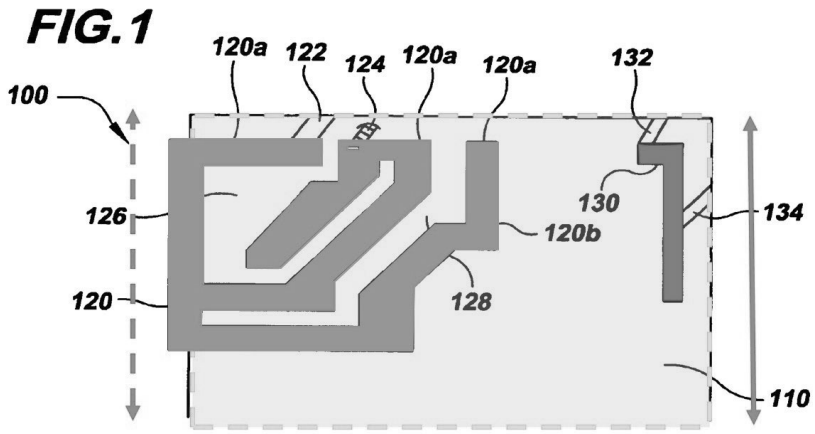
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	electromagnetic spectrum,	
7[e]	a minimum-sized parallelepiped completely enclosing a volume of the first non-planar antenna,	Talvitie expressly or inherently discloses this claim element. *See, e.g.*,  Talvitie at Figure 1

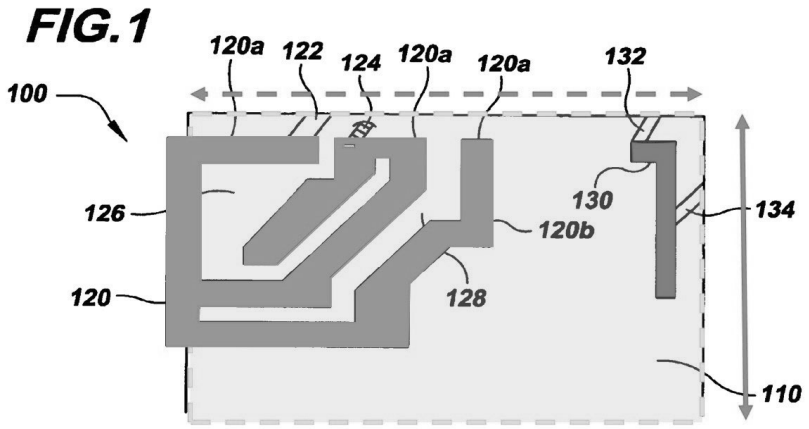
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
7[f]	the minimum-sized parallelepiped having a face with a largest area;	Talvitie expressly or inherently discloses this claim element. *See, e.g.*,  Talvitie at Figure 1
7[g]	a second antenna proximate to a second side of the ground plane rectangle, and	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[g]

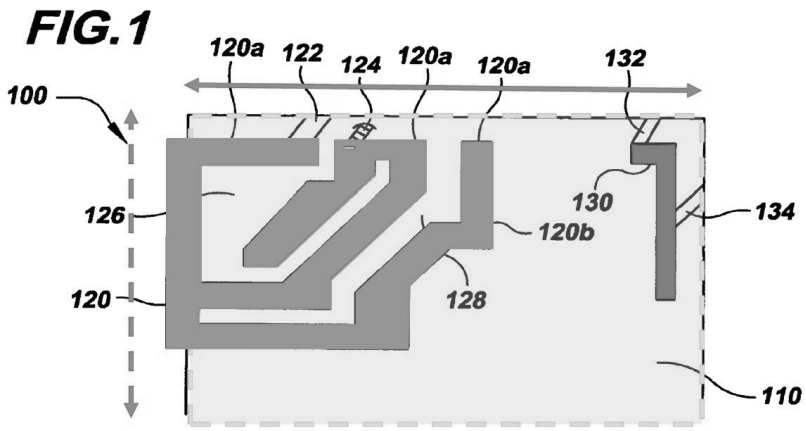
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (First Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Second Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Third Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Fourth Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Fifth Alternative)
7[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[h]
7[i]	wherein the first non-planar antenna has a first contour defined as a perimeter of any	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[e]

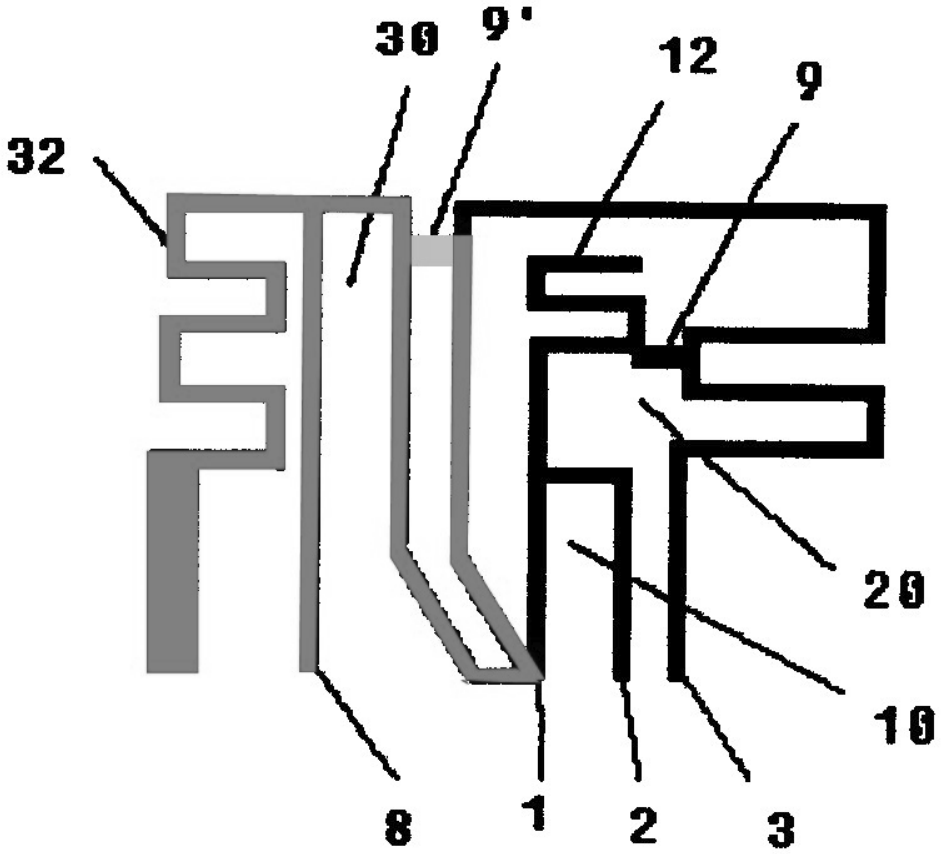
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	portions of the first non-planar antenna arranged in the face, perimeters of any closed apertures of any portions of the first non-planar antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first non-planar antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	
7[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f]

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
7[k]	complexity factor F_{32} having a value of at least 1.35;	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f]
7[l]	Wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour,	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f]

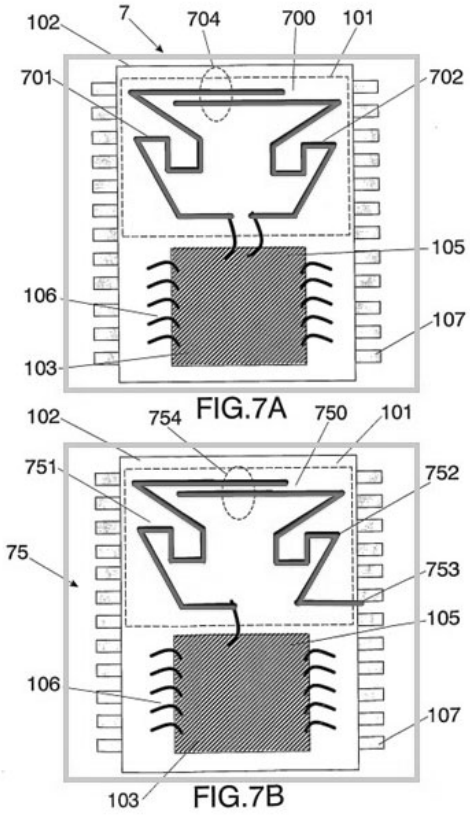
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are Double the widths and heights of the cells of the grid G2, and	
7[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[k]

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	the at least three frequency bands.	
	Claim 8	
8	The wireless device of claim 7, wherein the first non-planar antenna includes at least two antenna elements that are electromagnetically coupled.	Talvitie expressly or inherently discloses this claim element. To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. "In various embodiments, the first internal antenna 206 and/or the second internal antenna 208 may be implemented using any type of suitable internal antenna, such as a planar inverted-F antenna, a planar inverted-L antenna, an inverted-F antenna with a helical structure, an inverted-L antenna with a helical structure, a monopole antenna, a meandered monopole antenna, **a dipole antenna, a balanced antenna**, a printed helical antenna, a chip antenna, and a ceramic antenna. **The embodiments are not limited in this context**. Dou at [0028] "According to a design result, the signal loops may be further short-circuited through a conductor connection sheet, thus forming additional signal loops. In the first to third preferred embodiments, a part of the first signal loop 10 except the common conductor 5 and a part of the second signal loop 20 except the common conductor 5 may be connected through at least one conductor connection sheet 9. In the fourth

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		preferred embodiment, the first signal loop 10 and the second signal loop 20 may be connected through at least one conductor connection sheet 9." Wei at 16:9-15

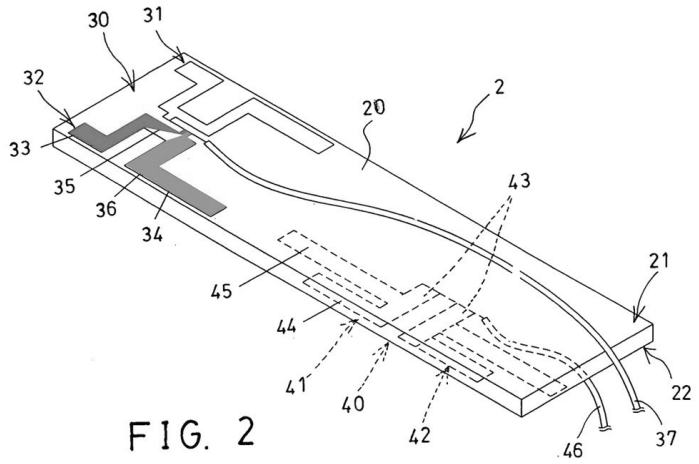
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Wei at Figure 9

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		"Package 7 in Figure 7A includes coupled dipole antenna 700 with two arms 701 and 702 which are coupled together by means of a close proximity region 704. According to the present invention, the minimum distance between conductors in 704 should be less than one-tenth of the longest free-space operating wavelength of the antenna. Figure 7B discloses another embodiment where the package 75 includes an active monopole 751 and a parasitic monopole 752, the parasitic monopole being grounded to an external ground plane or ground counterpoise by means of at least one of the terminals of the package such as for instance 753. Also, the package will include at least another terminal within the set of terminals 107 to externally ground one of the RF voltage references of die 103. Two conducting parts of the antenna such as the active monopole 751 and the parasitic one 752 are coupled by means of a close proximity region 754 such that the minimum distance between conductors in 704 should be less than one-tenth of the longest free-space operating wavelength of the antenna." Castany868 at 17:30-18:9

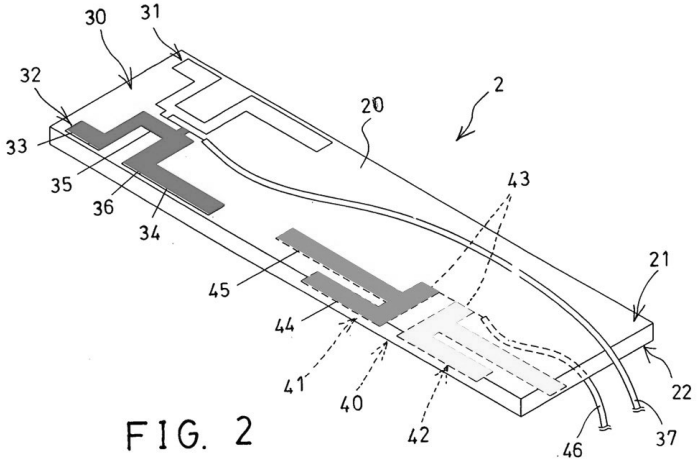
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Figures 7A and 7B
Claim 9		

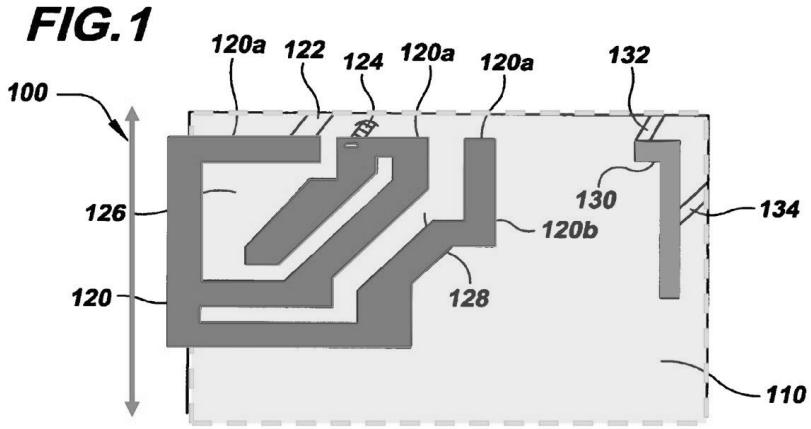
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
9	The wireless device of claim 7, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f] Further, it would have been obvious to a person of ordinary skill in the art that, when $N_1 = 14$; $N_2 = 40$; and $N_3 = 134$; that given $$F_{32=-}\frac{(\log_{10}(N_3)-\log_{10}(N_2)}{\log_{10}1/2}$$ solving for F_{32} results in $$F_{32=-}\frac{(\log_{10}(134)-\log_{10}(40)}{\log_{10}1/2} = 1.7442$$ and $$1.7442 < 1.75$$
Claim 10		
10[a]	The wireless device of claim 7, wherein a third	Talvitie expressly or inherently discloses this claim element.

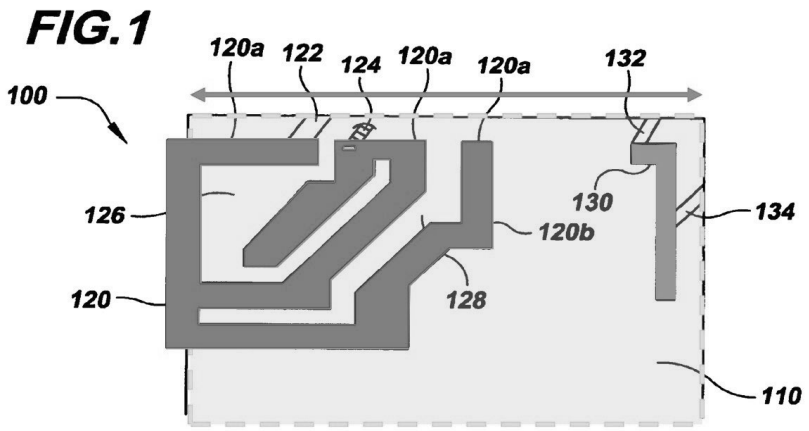
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	*See, e.g.*, claim element 1[h], 4 To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. *See, e.g.,* "It is preferable that the antenna members 31, 32 of the antenna device 30 each includes two antenna segments 33, 34 disposed up and down relative to each other, and an intermediate and/or C-shaped antenna segment 35 disposed between the antenna segments 33, 34, for receiving and transmitting signals of different frequencies, for example. It is further preferable that the antenna segments 33, 34, 35 of the two antenna members 31, 32 are disposed side by side and/or parallel to each other, or arranged in mirror symmetric relative to each other, for receiving and transmitting signals toward different lateral directions 39 relative to each other, or away from each other." Chou at [0028] "Similarly, the antenna members 41, 42 of the antenna device 40 each includes a base antenna segment 43 disposed up and down relative to each other, and two antenna segments 44, 45 extended from the base antenna segment 43 and parallel to each other, for receiving and transmitting signals of different frequencies, for example. It is further preferable that the antenna segments 43, 44, 45 of the two antenna members 41, 42 are disposed up and down relative to each other, or arranged in mirror symmetric relative

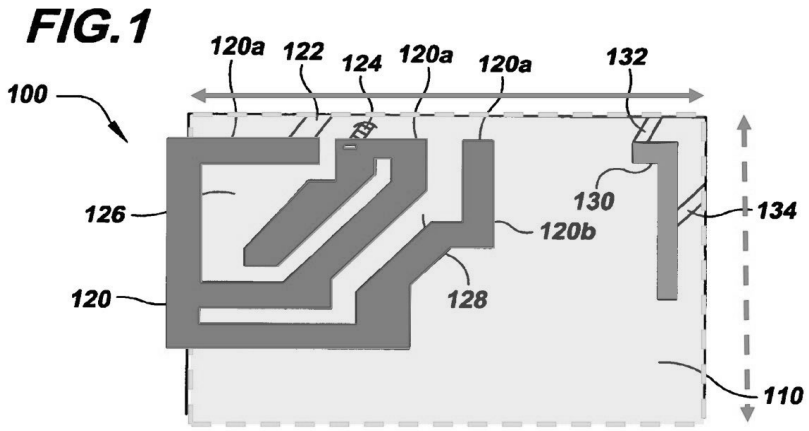
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		to each other, for receiving and transmitting signals toward different vertical directions 49 relative to each other, or away from each other." Chou at [0030]  FIG. 2 Chou at Figure 2 "It is preferable that the antenna members 31, 32 of the antenna device 30 each includes two antenna segments 33, 34 disposed up and down relative to each other, and an intermediate and/or C-shaped antenna segment 35 disposed between the antenna segments 33, 34, for receiving and transmitting signals of different frequencies, for example. It is further preferable that the antenna segments 33, 34, 35 of the two antenna members 31, 32 are disposed side by side and/or parallel to each other, or arranged in mirror

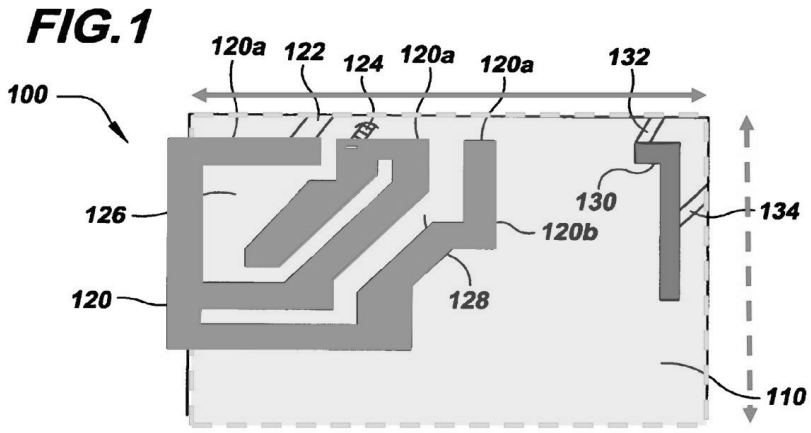
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		symmetric relative to each other, for receiving and transmitting signals toward different lateral directions 39 relative to each other, or away from each other." Chou at [0028] "Similarly, the antenna members 41, 42 of the antenna device 40 each includes a base antenna segment 43 disposed up and down relative to each other, and two antenna segments 44, 45 extended from the base antenna segment 43 and parallel to each other, for receiving and transmitting signals of different frequencies, for example. It is further preferable that the antenna segments 43, 44, 45 of the two antenna members 41, 42 are disposed up and down relative to each other, or arranged in mirror symmetric relative to each other, for receiving and transmitting signals toward different vertical directions 49 relative to each other, or away from each other." Chou at [0030] "Furthermore, each of the antenna devices 30, 40 may include two or more antenna segments 33, 34, 35; and 43, 44, 45 respectively, for receiving and transmitting signals of different frequencies, and thus for allowing the antenna devices 30, 40 to receive and transmit signals of various frequencies. There will be no dead ends or dead corners formed or generated by the antenna devices 30, 40." Chou at [0033]

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 FIG. 2 Chou at Figure 2
10[b]	the third antenna is arranged within the wireless device.	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 4, 10[a]
Claim 12		
12	The wireless device of claim 7, wherein the first side of the ground	Talvitie expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	plane rectangle is a short side of the ground plane rectangle.	*See, e.g.*,  Talvitie at Figure 1

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (First Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Second Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Third Alternative)
Claim 13		
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[pre] and 7[pre]

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
13[a]	a ground plane;	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[a], 7[a]
13[b]	a first antenna	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[b], 7[b]
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[c], 7[c]
13[d]	the first antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[d], 7[d]
13[e]	a minimum-sized parallelepiped completely enclosing a	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 7[e]

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	volume of the first antenna,	
13[f]	the minimum-sized parallelepiped having a face with a largest area;	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, 7[f]
13[g]	a second antenna proximate to a second side of the ground plane rectangle	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[g], 7[g]
13[h]	configured to receive signals from at least two frequency bands of the at least three frequency bands,	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[h], 7[h]
13[i]	wherein the first antenna has a first contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[e], 7[e]

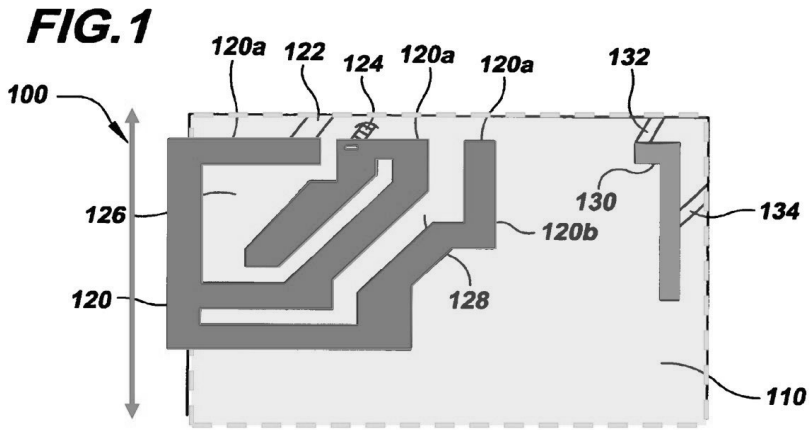
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	
13[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f], 7[j]
13[k]	complexity factor F_{32} having a value of at least 1.35; and	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f], 7[k]

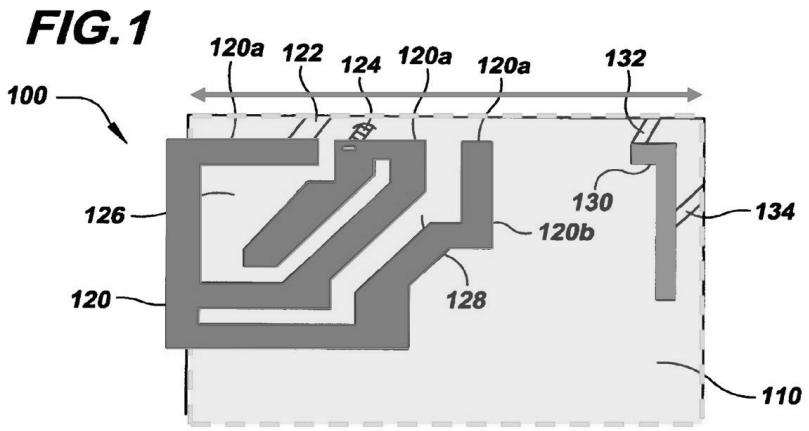
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
13[l]	wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[f], 7[l]

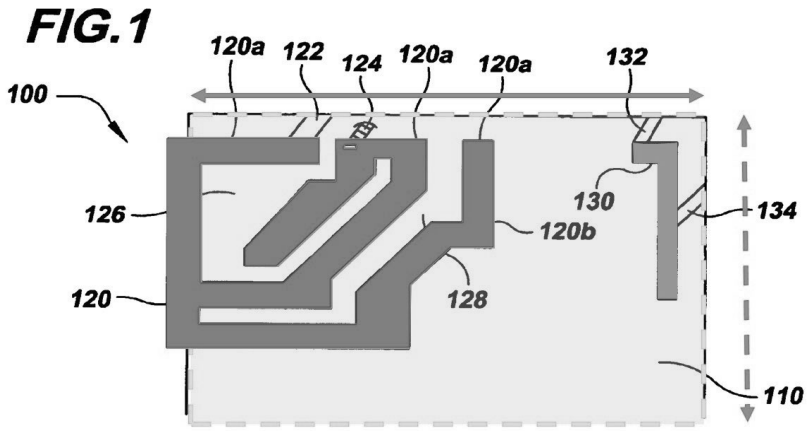
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are Double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights of the cells of the grid G2, and	
13[m]	wherein the level of complexity of the first	Talvitie expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	contour is configured to provide operation of the wireless device in the at least three frequency bands.	*See, e.g.*, claim element 1[k], 7[m]
		Claim 14
14	The wireless device of claim 13, wherein the first antenna includes at least two antenna elements that are electromagnetically coupled.	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 8
		Claim 15
15	The wireless device of claim 13, wherein the first antenna is planar.	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[b]
		Claim 17
17	The wireless device of claim 13, wherein the	Talvitie expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	complexity factor F_{32} for the first contour is smaller than 1.75.	*See, e.g.*, claim element 9
Claim 18		
18[a]	The wireless device of claim 13, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 1[h], 4, 10[a]
18[b]	the third antenna is arranged within the wireless device.	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 4, 10[a], 10[b], 18[a]
Claim 19		
19	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a	Talvitie expressly or inherently discloses this claim element. *See, e.g.*, claim element 12

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
	short side of the ground plane rectangle.	
	Claim 20	
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	Talvitie expressly or inherently discloses this claim element. *See, e.g.*,  Talvitie at Figure 1

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (First Alternative)

Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Second Alternative)

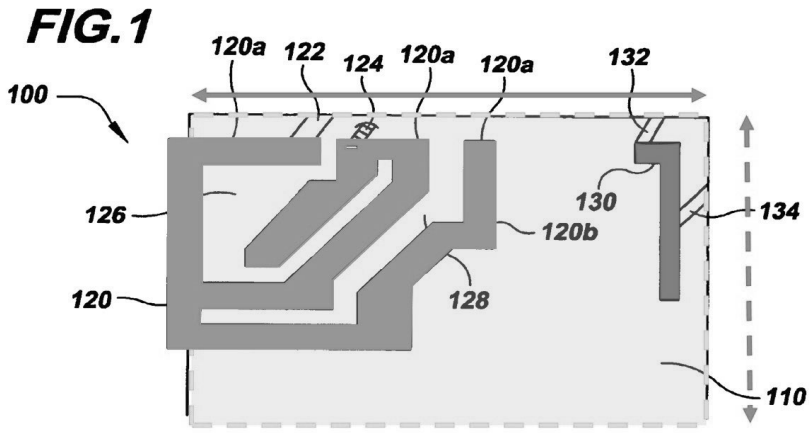
Claim No.	U.S. Patent No. 12,095,149 B2	Talvitie
		 Talvitie at Figure 1 (Third Alternative)

Exhibit – F – 05

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 12,095,149 B2
BASED ON THE HP COMPAQ nc6400 LAPTOP ("Compaq nc6400")

Based upon Plaintiff's Complaint, Infringement Contentions, and apparent claim constructions and application of the claims to Defendant's accused products, as best as they can be deciphered, the reference charted below anticipates or at least renders obvious some or all of claims 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 (the "'149 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendant that the accused products are covered by or infringe the asserted claims, particularly when these claims are properly construed and applied.

AIA law applies because the application that issued as the '149 Patent was filed on June 22, 2023, after the AIA came into force on March 16, 2013.

The Hewlett Packard Company's ("HP") HP Compaq nc6400 Laptop, as publicly demonstrated, known, offered for sale, sold, and/or used by HP and/or customers of HP or otherwise available to the public, including in this country, the ("Compaq nc6400") was available for purchase in the United States no later than May 8, 2006[2], which is prior to the critical date of the '149 patent.. Thus, the Compaq nc6400 is available as prior art at least under pre-AIA 35 U.S.C. § 102(a)-(b), or AIA 35 U.S.C. § 102(a). At least the following documents provide evidence as to the date the Compaq nc6400 was "offered for sale or publicly used or known," "the date the offer or use of the item took place or the information became known", and the "identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known" [3]:

[1] Defendants understand that, by not charting claims 6, 11, and 16 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* CNET Website, "HP Compaq nc6400 (Core Duo) review: HP Compaq nc6400 (Core Duo)" (May 8, 2006) at: https://www.cnet.com/reviews/hp-compaq-nc6400-core-duo-review/ (last accessed June 11, 2025).
[3] Defendants do not yet have complete information regarding the dates by which this product was publicly disclosed, made, used, sold, or offered for sale, the circumstances under which the research, design, and development activities were conducted, and the identities of the particular individuals involved in such activities. Defendants anticipate that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Defendants therefore reserve the right to amend and/or supplement their Invalidity Contentions and this chart if additional information becomes available during the course of discovery. The date the Compaq nc6400 was "offered for sale or publicly used or known," as well as "the date the offer or use of the item took place or the information became known" is at least as early as the dates identified in the published documents. The "identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known" includes at least those persons associated with the publication(s), press releases, and conference attendees, or other documents associated with each version on the Compaq nc6400. Defendants also reserve the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Defendants have had a fair opportunity to take discovery on these subjects.

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- CNET Website, "HP Compaq nc6400 (Core Duo) review: HP Compaq nc6400 (Core Duo)" (May 8, 2006) at: https://www.cnet.com/reviews/hp-compaq-nc6400-core-duo-review/ (last accessed June 11, 2025).
- PC Mag Website, "HP Compaq nc6400" (May 9, 2006) at: https://www.pcmag.com/archive/hp-compaq-nc6400-177617 (last accessed June 17, 2025).
- NotebookCheck Website, "HP Compaq nc6400" at: https://www.notebookcheck.net/HP-Compaq-nc6400.1437.0.html (last accessed June 17, 2025).

As described in the following claim chart, the asserted claims of U.S. Patent No. 12,095,149 (the "'149 Patent"), are invalid as anticipated by Compaq nc6400. To the extent that Compaq nc6400 is found not to anticipate one or more of the asserted claims of the '149 Patent, these claims are invalid as obvious in view of Compaq nc6400 alone or in combination with other prior art references disclosed in Defendants' Invalidity Contentions and accompanying charts, including without limitation as set forth below.

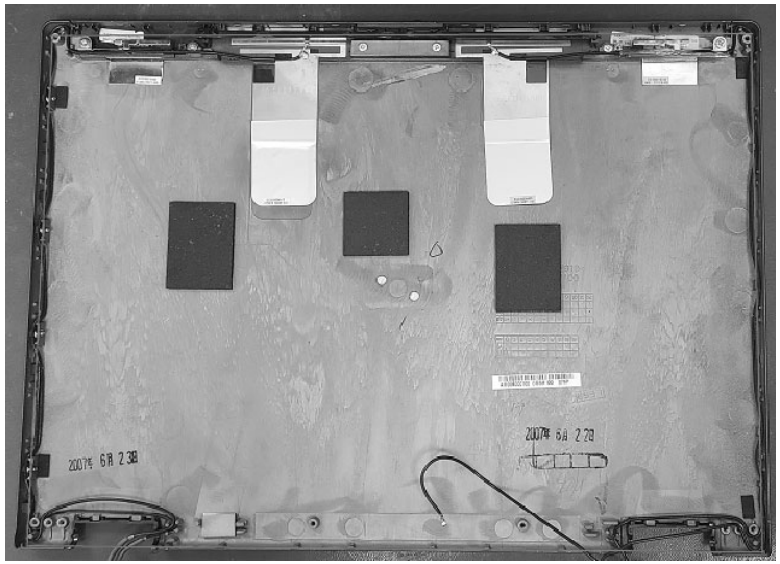
- U.S. Patent Application Publication No. 2006/0082503 to Gaucher et al. ("Gaucher")

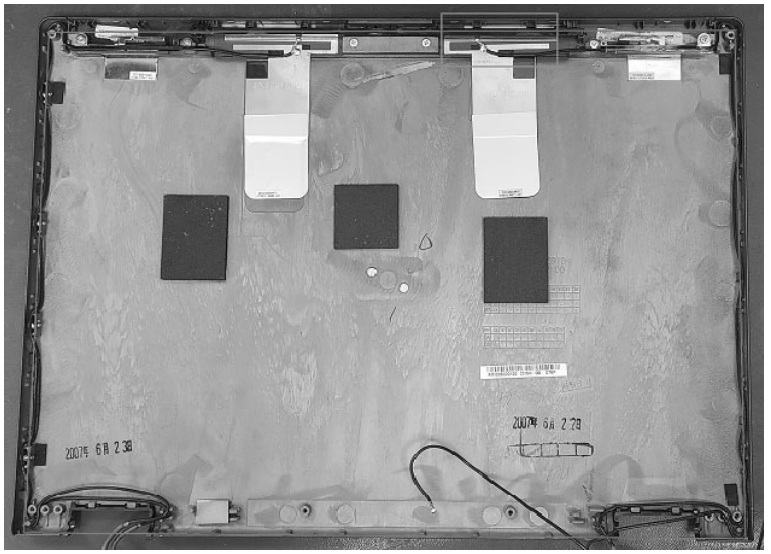
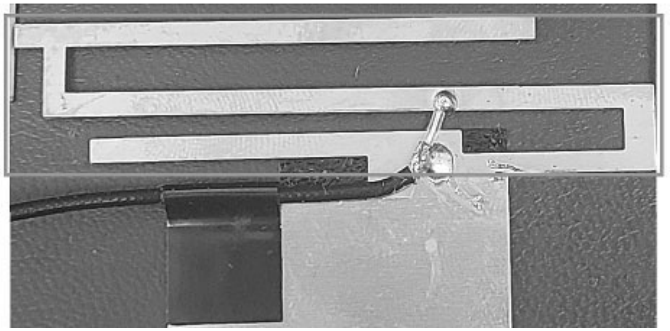
One of ordinary skill in the art, as of the priority date of the '149 Patent, would have known to combine or modify the prior art elements disclosed by the foregoing references using known methods, and to use these elements according to their established functions in order to achieve a known and predictable result.

These invalidity contentions are not an admission that the Defendants concede or acquiesce to any claim construction implied or suggested by Plaintiff's Complaint or Infringement Contentions. Nor are Defendants asserting any claim construction positions through these charts, including whether the preamble is a limitation. The portions of the prior art reference cited below are not exhaustive but are exemplary in nature. Defendants retain the right to update their constructions and contentions in view of this Court's claim construction order.[4]

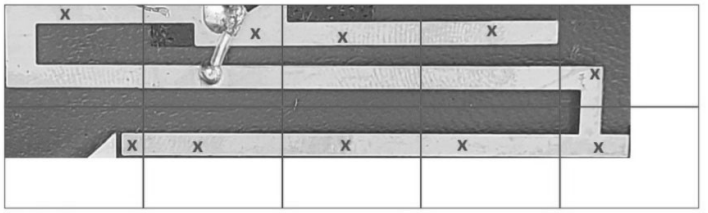
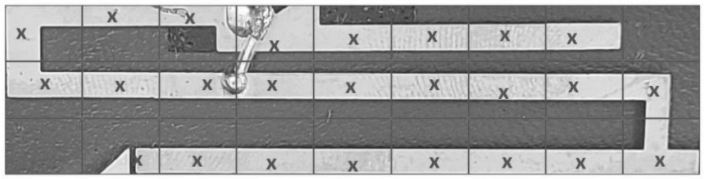
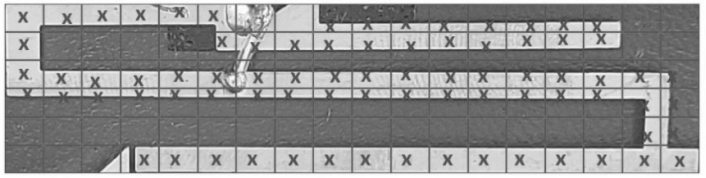
[4] Defendants reserve the right to supplement and/or alter this chart based on further investigation and ongoing discovery.

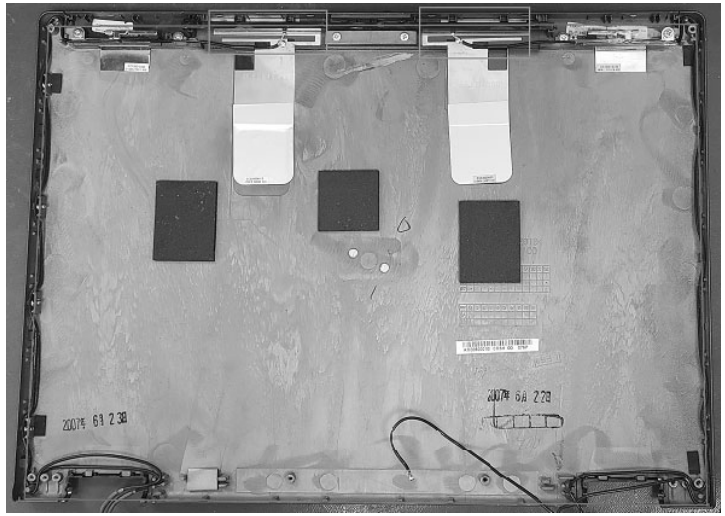
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		Claim 1
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The Compaq nc6400 is a wireless device.  *See* CNET Website, "HP Compaq nc6400 (Core Duo) review: HP Compaq nc6400 (Core Duo)" (May 8, 2006) at: https://www.cnet.com/reviews/hp-compaq-nc6400-core-duo-review/ (last accessed June 11, 2025) (photo of embedded video at 0:04-06).

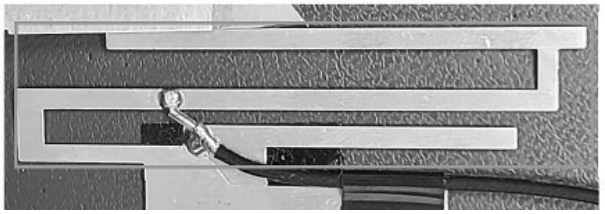
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
1[a]	a ground plane;	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The Compaq nc6400 includes a ground plane (red below). 
1[b]	a first planar antenna	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The Compaq nc6400 includes a first planar antenna (blue below) proximate to a first side of a ground plane rectangle (red below) enclosing the ground plane.

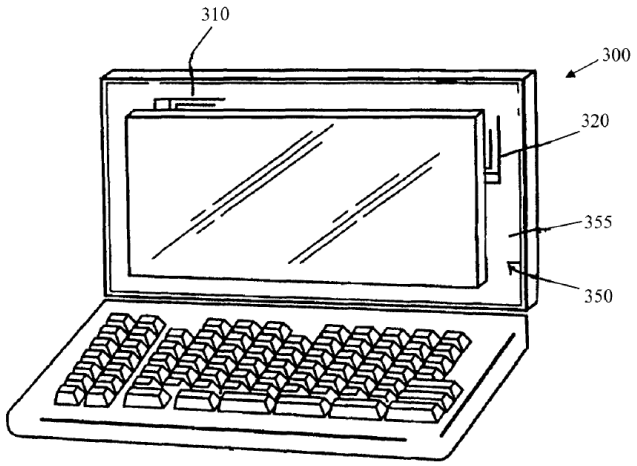
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
1[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 1[b].
1[d]	the first planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first planar antenna of the Compaq nc6400 is configured to support at least three frequency bands of the electromagnetic spectrum.
1[e]	the first planar antenna defining a first contour,	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first planar antenna of the Compaq nc6400 defines a first contour, wherein the first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35.

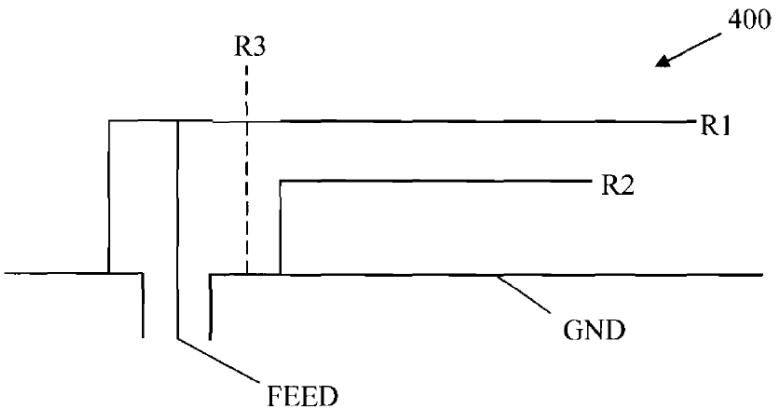
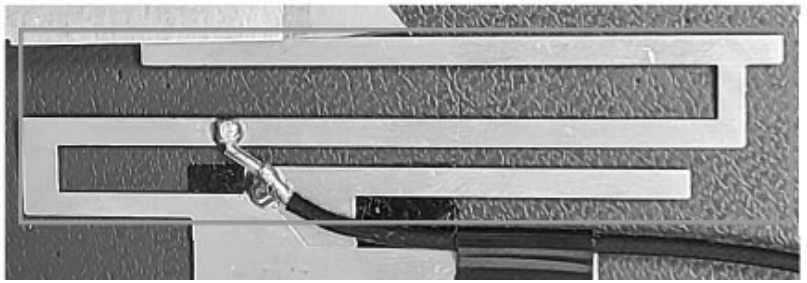
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66
1[f]	wherein the first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 1[e].

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
	complexity factor F32 having a value of at least 1.35; and	
1[g]	a second antenna proximate to a second side of the ground plane rectangle,	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The Compaq nc6400 includes a second antenna (green below) proximate to a side of the ground plane rectangle (red below). 

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 The second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands. To the extent the Compaq nc6400 does not disclose a second antenna proximate to a second side of the ground plane rectangle, it would have been obvious for the first planar antenna and the second antenna to be disposed on respective sides of the ground plane rectangle as taught in Gaucher to achieve polarization diversity.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 FIG. 3 Gaucher teaches "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the supper frame 355 of the laptop display unit 350." Like the Compaq nc6400, "As shown in FIG. 3, the pair of multiband antennas 310, 320 are mounted to the metal support frame 355, wherein the plane of each multiband antenna 310, 320 is substantially parallel to the plane, or along the plane, of the metal support frame 355." Gaucher, [0025]. Gaucher teaches that "one of the antennas [310] or [320] may be disposed on one side of the laptop display [350] while a second antenna [320] is disposed in an upper portion of the laptop display [250], [t]hereby providing antenna polarization diversity, depending on the antenna design used." Gaucher, [0004].

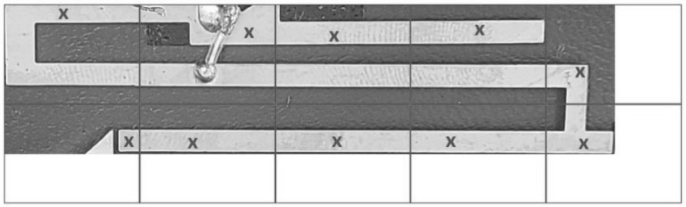
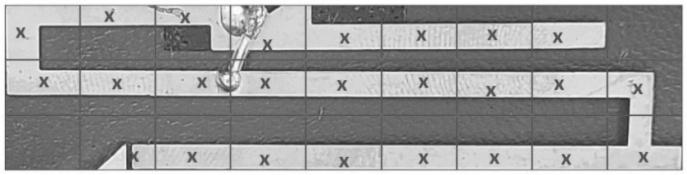
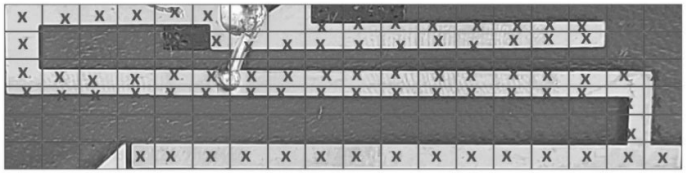
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		Like in the Compaq nc6400, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display." Gaucher, [0045].  Similar to the multiband cellular antennas of the Compaq nc6400, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower band of Europe 1710-1880 MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States." Gaucher, [0030].

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		  There would have been a reasonable expectation of success in having the first planar antenna and the second antenna of the Compaq nc6400 disposed at respective sides of the ground plane rectangle because similarly configured antennas are taught in a similarly configured laptop device in Gaucher.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		For instance, Gaucher's example antennas are based on an inverted-F antenna design like the Compaq nc6400 antennas. Gaucher and the Compaq nc6400 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the Compaq nc6400 antennas cover substantially the same frequency bands, including some bands used in the United States and some bands used in Europe. Moreover, having the antennas at respective sides of the ground plane rectangle would not have been expected to create interference problems with the WLAN and Bluetooth antennas in the Compaq because Gaucher contemplates that the laptop computer may be additionally "equipped with integrated wireless local area network (WLAN) and devices of the known Bluetooth technology." Gaucher, [0026].
1[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 1[g].
1[i]	wherein the first contour is defined as a perimeter of the first planar antenna and perimeters of any closed apertures defined within the first planar antenna;	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first contour of the first planar antenna of the Compaq nc6400 is defined as a perimeter of the first planar antenna and perimeters of any closed apertures defined within the first planar antenna. The complexity factors F21 and F32 are given by: F21=-log(N2)-log(N1)/ log(1/2)

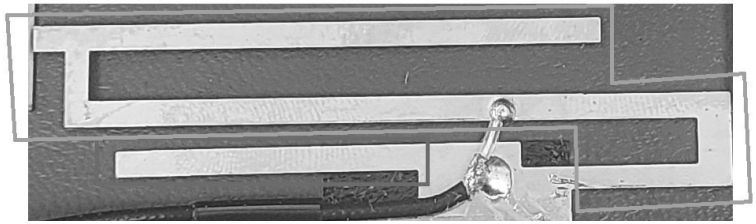
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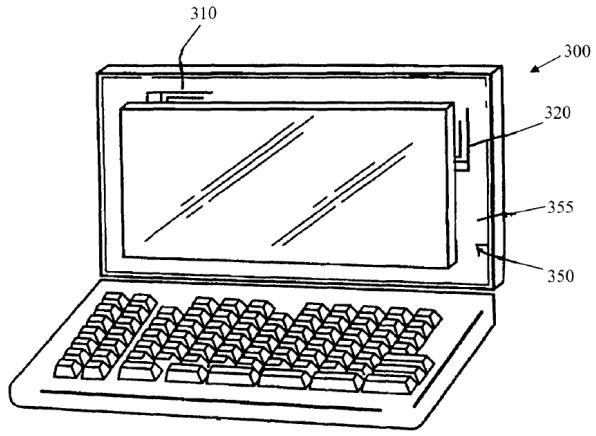
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		F32=-log(N3)-log(N2)/ log(1/2) N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour. The grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle. The number of rows results in the cells of grid G2 is as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle. The cells of the grid G1 have widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 is aligned with the grid G2. The cells of the grid G3 have widths and heights that respectively are half the widths and heights of the cells of the grid G2.

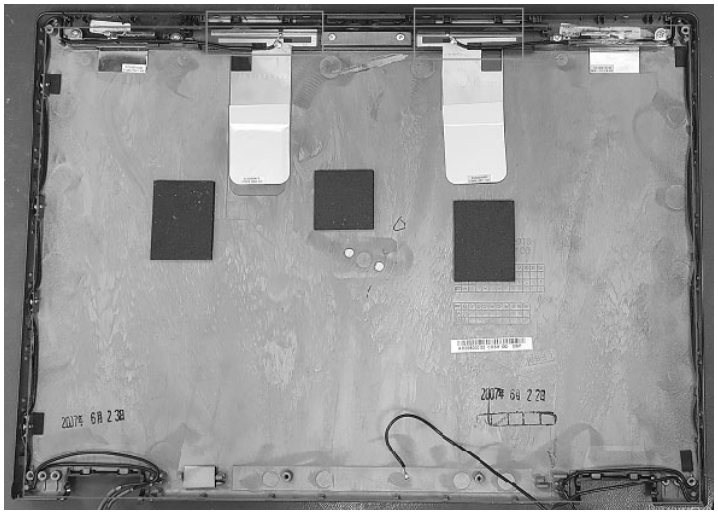
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66
1[j]	wherein the complexity factors F21 and F32 are given by:	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 1[i].

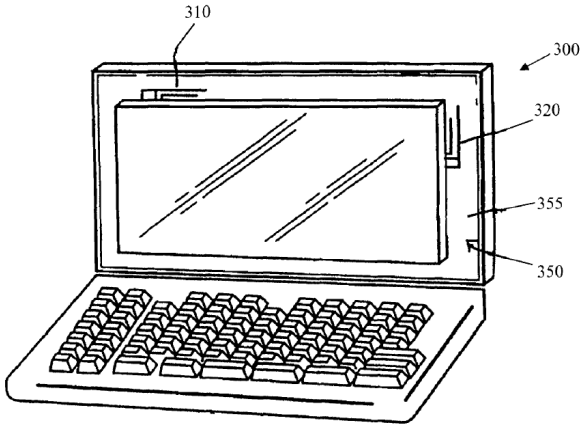
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
	$$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$$ $$F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the	

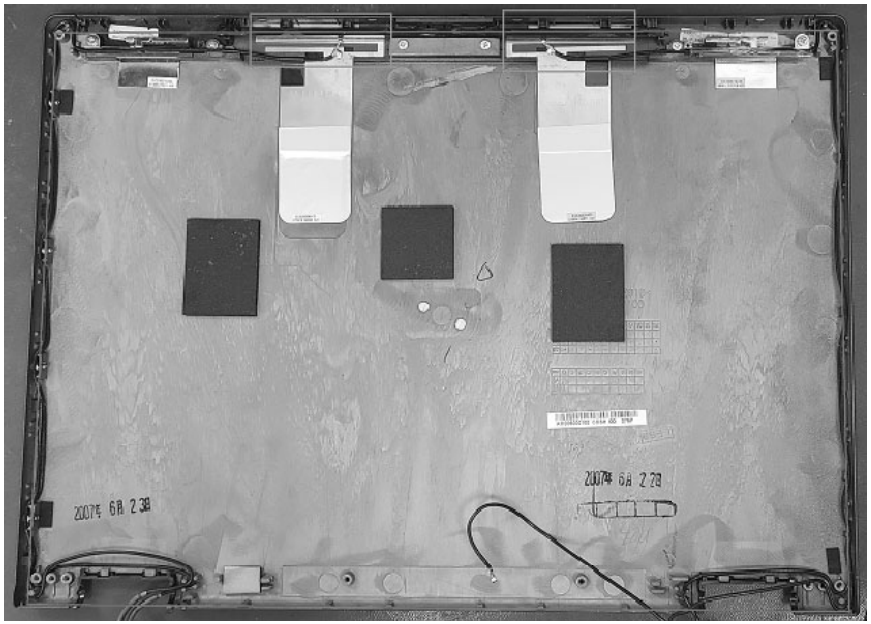
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
	grid G2 to cover the minimum-sized rectangle, the cells of the grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	
1[k]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The level of complexity of the first contour is configured to provide operation of the Compaq nc6400 in the at least three frequency bands.
Claim 2		
2	The wireless device of claim 1, wherein the first planar antenna includes at least two antenna elements that are electromagnetically coupled.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first planar antenna of the Compaq nc6400 includes at least two antenna elements (orange and purple below, respectively) that are electromagnetically coupled.

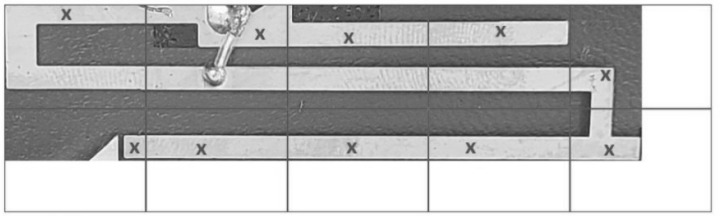
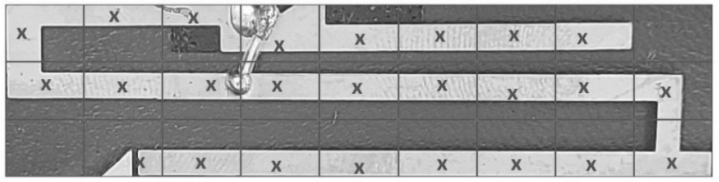
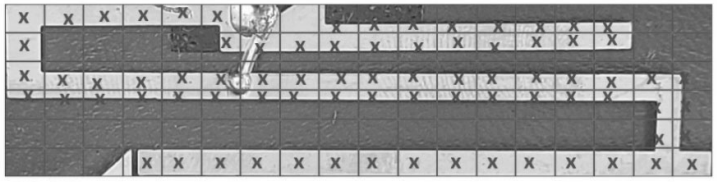
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		
Claim 3		
3	The wireless device of claim 1, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, As combined with Gaucher, the first planar antenna of the Compaq nc6400 is proximate to a first side of the ground plane rectangle, which is a short side of the ground plane rectangle.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 FIG. 3 *See also, e.g.*, Gaucher [0025].

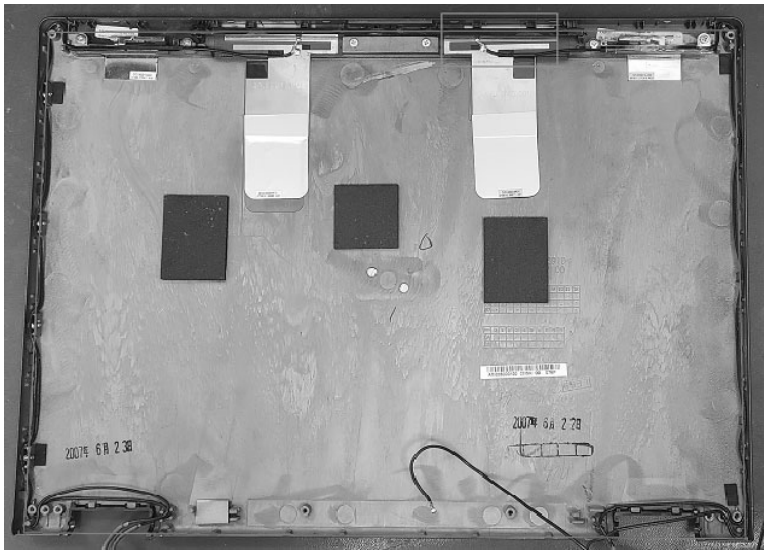
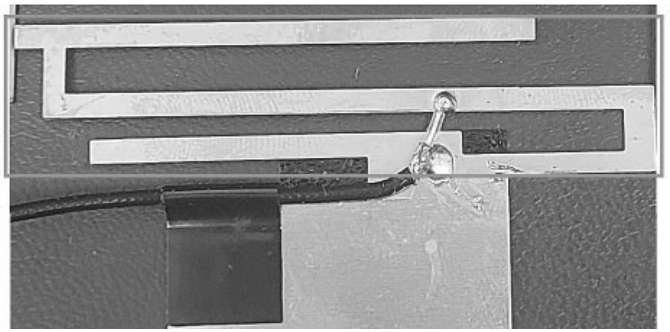
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 *See also*, *e.g.*, Gaucher [0030].
		Claim 4
4	The wireless device of claim 1, wherein the second side of the ground plane rectangle is a long side of the ground plane rectangle.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, To the extent the Compaq nc6400 does not disclose this limitation, the combination with Gaucher discloses this limitation.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		As combined with Gaucher (*see* Claim 1[g] supra), the second antenna of the Compaq nc6400 is proximate to a second side of the ground plane rectangle, which is a long side of the ground plane rectangle.  FIG. 3 *See also, e.g.*, Gaucher [0025].

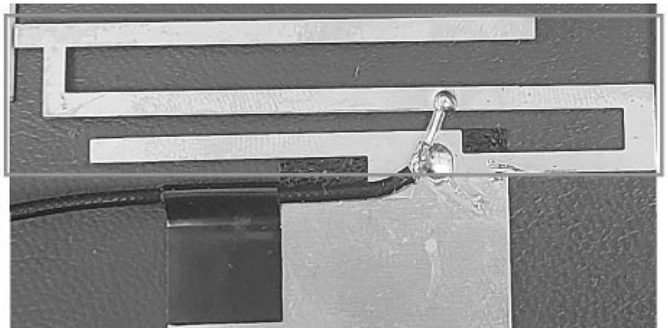
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 *See also*, *e.g.*, Gaucher [0030].
Claim 5		
5	The wireless device of claim 1, wherein the complexity factor F32 for the first contour is smaller than 1.75.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor F32 for the first contour of the first planar antenna of the Compaq nc6400 is smaller than 1.75.

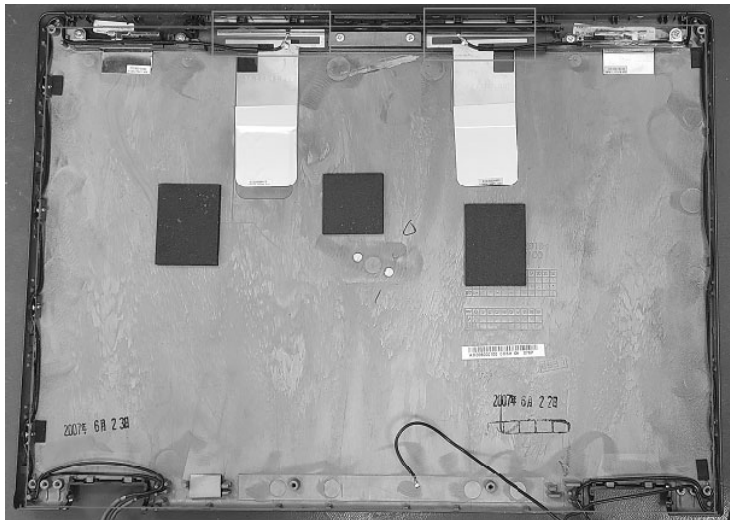
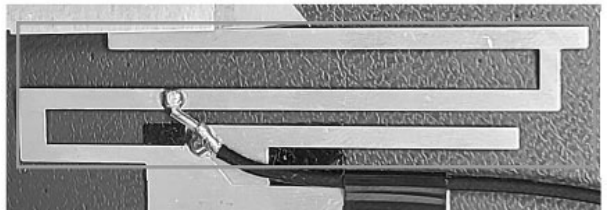
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66

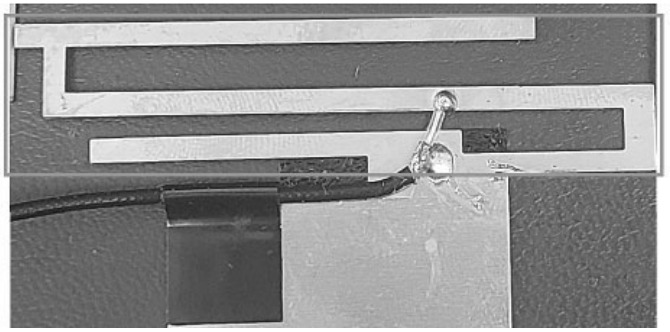
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
Claim 13		
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 1[pre].
13[a]	a ground plane;	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 1[a].
13[b]	a first antenna	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The Compaq nc6400 includes a first antenna (blue below) proximate to a first side of a ground plane rectangle (red below) enclosing the ground plane.

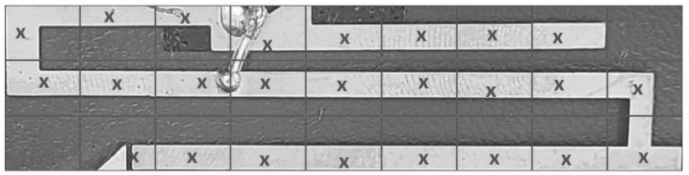
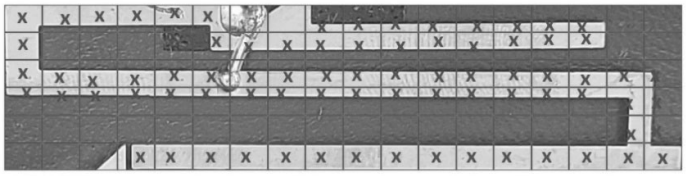
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 *See also*, *e.g.*, Gaucher [0030]. 

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 13[b].
13[d]	the first antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the HP Compaq nc6400 is configured to support at least three frequency bands of the electromagnetic spectrum.
13[e]	a minimum-sized parallelepiped completely enclosing a volume of the first antenna,	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, A minimum-sized parallelepiped completely encloses a volume of the first antenna, the minimum-sized parallelepiped having a face with a largest area (blue below).

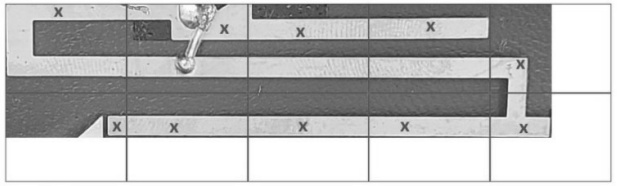
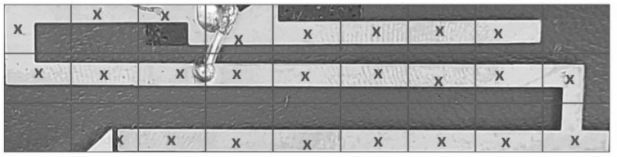
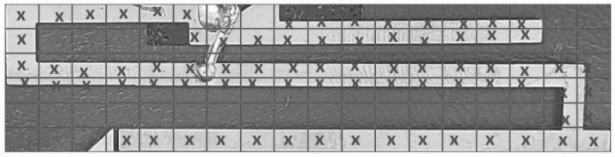
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		
13[f]	the minimum-sized parallelepiped having a face with a largest area;	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 13[e].
13[g]	a second antenna proximate to a second side of the ground plane rectangle	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The Compaq nc6400 includes a second antenna (green below) proximate to a side of the ground plane rectangle (red below) and is configured to receive signals from at least two frequency bands of the at least three frequency bands.

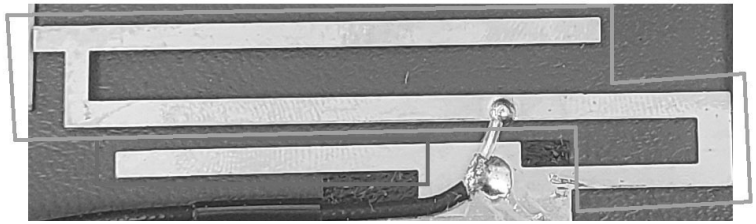
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		  To the extent the HP Compaq nc6400 does not disclose a second antenna proximate to a second side of the ground plane rectangle, it would have been obvious for the first planar antenna and the second antenna to be disposed on respective sides of the ground plane rectangle as taught in Gaucher (*see* Claim 1[g]), to achieve polarization diversity as discussed above in connection with claim 1.

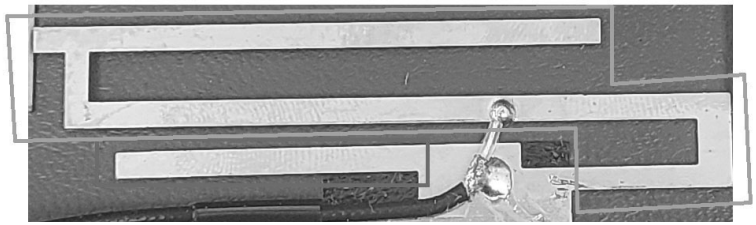
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
13[h]	configured to receive signals from at least two frequency bands of the at least three frequency bands,	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 13[g].
13[i]	wherein the first antenna has a first contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the HP Compaq nc6400 has a first contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection. 
13[j]	wherein the first contour has a level of complexity defined by	Compaq nc6400 expressly or inherently discloses this claim element.

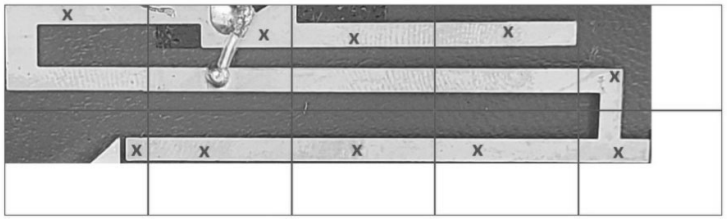
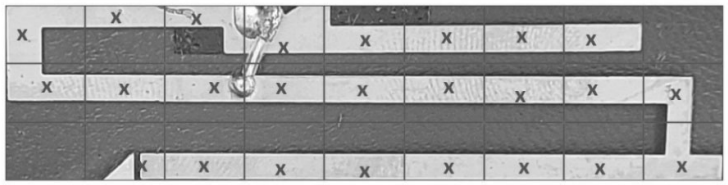
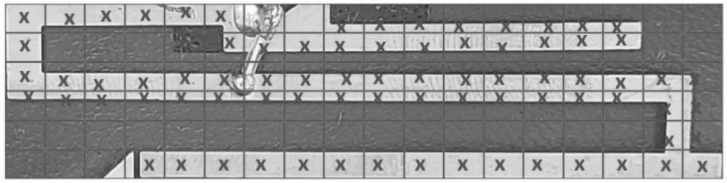
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
	complexity factor F_{21} having a value of at least 1.20 and	*See, e.g.*, The first contour of the first antenna of the HP Compaq nc6400 has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35.  N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66

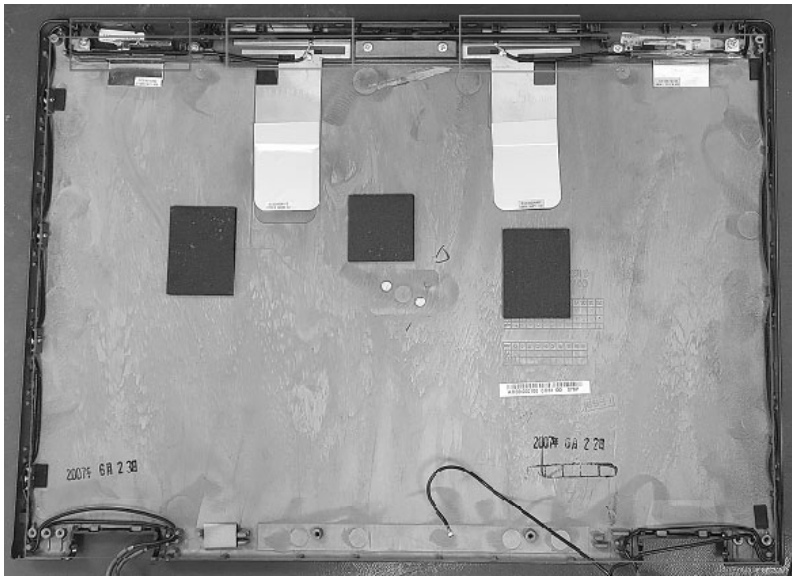
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
13[k]	complexity factor F_{32} having a value of at least 1.35; and	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 13[j].
13[l]	wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factors F21 and F32 are given by: F21=-log(N2)-log(N1) log(1/2) F32=-log(N3)-log(N2)/ log(1/2) N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour. The grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the [face]. The number of rows results in the cells of grid G2 being as square as possible. The grid G1 is aligned with a corner of the grid G2 to cover the face. The cells of G1 have widths and heights that respectively are double the widths and heights of the cells of the grid G2.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
	height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights of the cells of the grid G2, and	The grid G3 is aligned with the grid G2. The cells of the grid G3 have widths and heights that respectively are half the widths and heights of the cells of the grid G2.  N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66
13[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*,

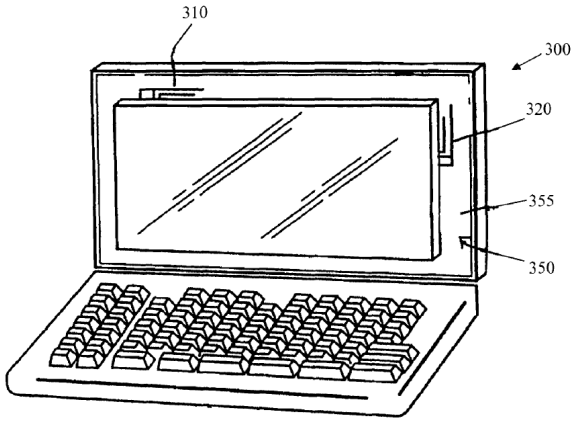
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
	device in the at least three frequency bands.	The level of complexity of the first contour of the first antenna of the HP Compaq nc6400 is configured to provide operation of the wireless device in the at least three frequency bands.
Claim 14		
14	The wireless device of claim 13, wherein the first antenna includes at least two antenna elements that are electromagnetically coupled.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the HP Compaq nc6400 includes at least two antenna elements (orange and purple below, respectively) that are electromagnetically coupled. 
Claim 15		
15	The wireless device of claim 13, wherein the first antenna is planar.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*,

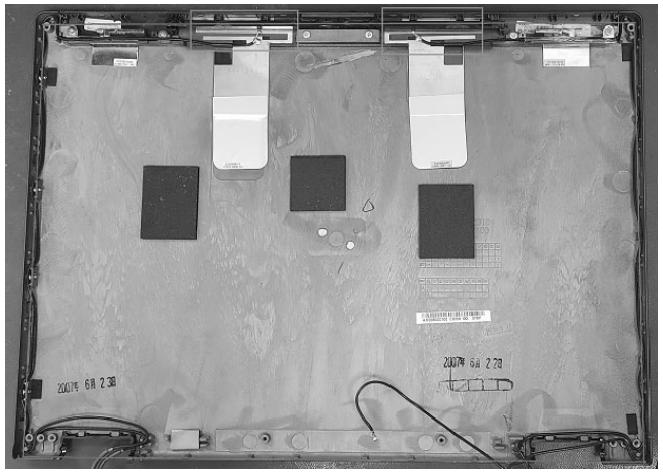
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		The first antenna of the HP Compaq nc6400 is planar. 
Claim 17		
17	The wireless device of claim 13, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The complexity factor F32 for the first contour of the first antenna of the HP Compaq nc6400 is smaller than 1.75.

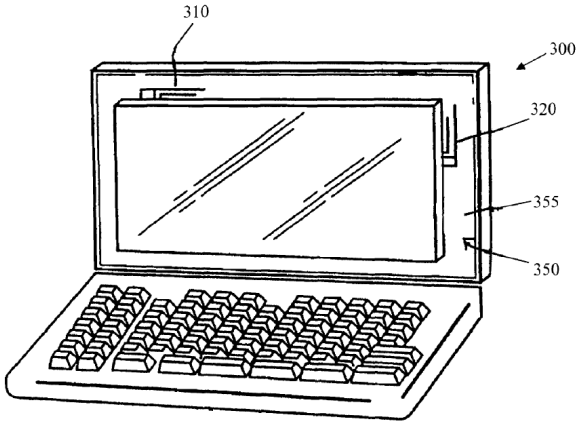
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		Claim 18
18[a]	The wireless device of claim 13, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	Compaq nc6400 expressly or inherently discloses this claim element. *See, e.g.*, The HP Compaq nc6400 includes a third antenna (purple below) arranged within the HP Compaq nc6400.  The third antenna of the HP Compaq nc6400 is configured to operate in at least two frequency bands being different from the at least three frequency bands.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
18[b]	the third antenna is arranged within the wireless device.	Compaq nc6400 expressly or inherently discloses this claim element. *See* Claim 18[a].
Claim 19		
19	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Compaq nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose this limitation, the combination with Gaucher discloses this limitation. *See, e.g.*, As combined with Gaucher (*see* Claim 1[g]), the first antenna of the HP Compaq nc6400 is proximate to a first side of the ground plane rectangle, which is a short side of the ground plane rectangle.

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 FIG. 3 *See also, e.g.*, Gaucher [0025].

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 *See also, e.g.*, Gaucher [0030].
		Claim 20
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	Compaq nc6400 expressly or inherently discloses this claim element. To the extent the HP Compaq nc6400 does not disclose this limitation, the combination with Gaucher discloses this limitation. *See, e.g.*,

Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		As combined with Gaucher, the first antenna of the HP Compaq nc6400 is proximate to a first side of the ground plane rectangle, which is a long side of the ground plane rectangle.  FIG. 3 *See also, e.g.*, Gaucher [0025].

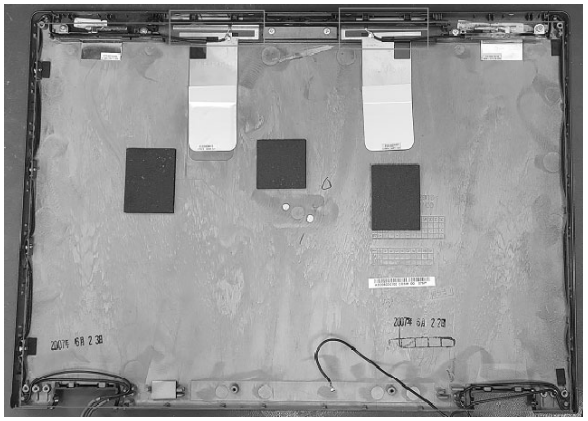
Claim No.	U.S. Patent No. 12,095,149 B2	Compaq nc6400
		 *See also, e.g.*, Gaucher [0030].

Exhibit – F – 06

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 12,095,149 B2
BASED ON U.S. PATENT APP. PUB. NO. 2007/0200773 ("DOU") AND CIAIS-MULTIBAND

Based upon Plaintiff's Complaint, Infringement Contentions, and apparent claim constructions and application of the claims to Defendants' accused products, as best as they can be deciphered, the reference charted below anticipates or at least renders obvious some or all of the asserted claims. These invalidity contentions are not an admission by the Defendants that the accused products are covered by or infringe claims 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 (the "'149 Asserted Claims")[1], particularly when these claims are properly construed and applied.

AIA law applies because the application that issued as the '149 Patent was filed on June 22, 2023, after the AIA came into force on March 16, 2013.

U.S. Patent Application Publication No. 2007/0200773 to Dou et al. ("Dou") was filed on February 24, 2006 and published on August 30, 2007. This patent is prior art under at least pre-AIA 35 U.S.C. § 102(a) or (b), (e), and (g)(2), or AIA 35 U.S.C. § 102(a). As described in the following claim chart, the asserted claims of U.S. Patent No. 12,095,149 (the "'149 Patent"), are invalid as anticipated by Dou.

To the extent that Dou is found not to anticipate one or more of the asserted claims of the '149 Patent, these claims are invalid as obvious in view of Dou alone or as modified in view of or in combination with other prior art references disclosed in Defendants' Invalidity Contentions and accompanying charts, including without limitation as set forth below.

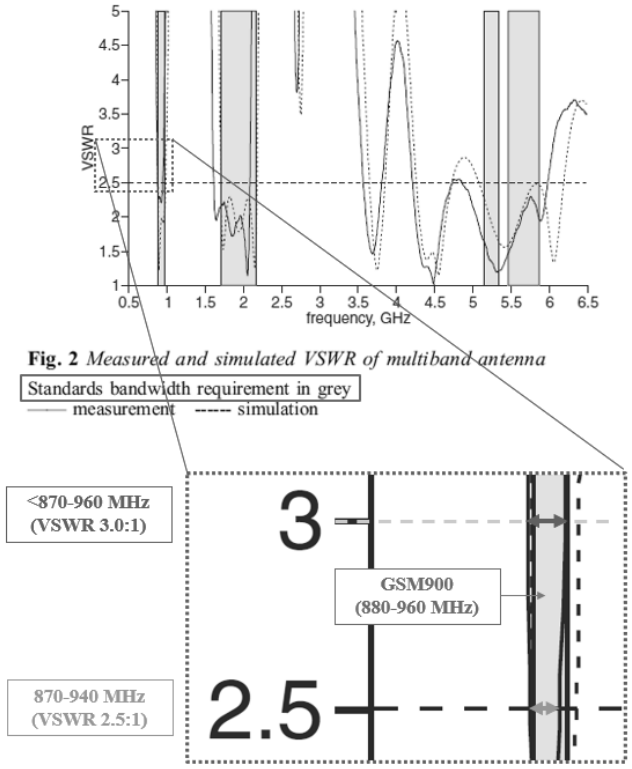
- P. Ciais, R. Staraj, G. Kossiavas, and C. Luxey. "Compact Internal Multiband Antenna for Mobile Phone and WLAN Standards," Electronics Letters, vol. 40, no. 15, pp. 920-921, July 2004 ("Ciais-Multiband")
- U.S. Patent Publication No. 2003/0025635 ("Hilgers")

These invalidity contentions are not an admission that the Defendants concede or acquiesce to any claim construction implied or suggested by Plaintiff's Complaint or Infringement Contentions. Nor are Defendants asserting any claim construction positions through these charts, including whether the preamble is a limitation. The portions of the prior art reference cited below are not exhaustive but are exemplary in nature. Defendants reserve the right to update their constructions and contentions in view of this Court's claim construction order.[2]

[1] Defendants understand that, by not charting claims 6, 11, and 16 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] Defendants incorporate herein any related work performed by or on behalf of an author or an inventor in the United States under pre-AIA 35 U.S.C. § 102(g)(2). Defendants reserve the right to supplement and/or alter this chart based on further investigation and ongoing discovery.

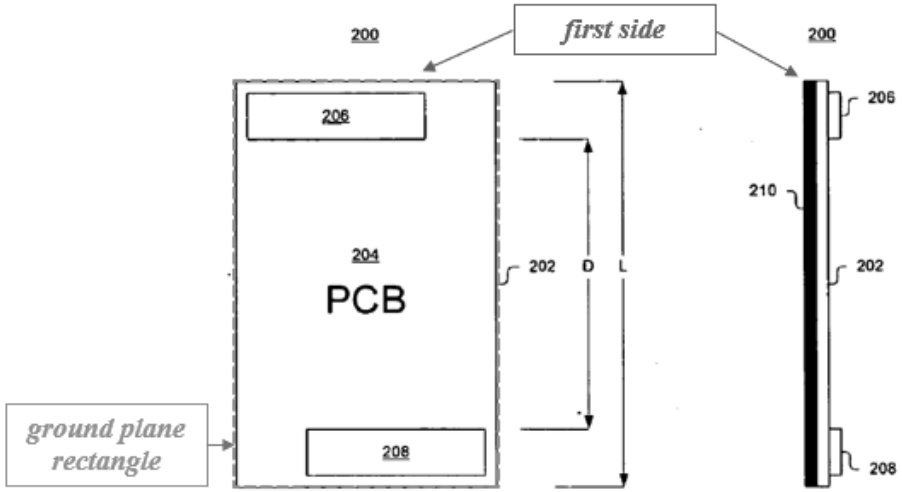
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Claim 7
7[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou expressly or inherently discloses this claim element. Dou discloses a wireless device comprising, e.g., a handheld computer, mobile telephone, or PDA. Dou, [0015]-[0016], [0031], claim 1. To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. ***See, e.g.*, Ciais-Multiband:** While Dou describes a wireless handheld device having internally-mounted antennas, it does not describe particular antennas for implementing its wireless devices and Dou leaves the antenna selection to a POSA. A POSA had reasons to implement each of Dou's first antenna 206 and second antenna 208, as shown in Dou Figures 2A-2B, as a Ciais multiband antenna. Ciais's multiband antenna was designed for use in "handset terminals"/"handset devices" (e.g., mobile phones), making it suitable for use as Dou's "internal antenna" 206 and 208 "disposed within… housing 202 of the wireless device 200." Dou, [0018]; Ciais-Multiband, 920-921. Ciais's multiband antenna is a planar inverted-F antenna (PIFA) (Ciais-Multiband, 920), which Dou describes using for the first and second antennas. Dou, [0028]. Ciais's multiband antenna provides operation at 1710-1990 MHz with VSWR 2.5:1. Ciais-Multiband, 920-921, Fig. 2. Ciais's multiband antenna covered 870 to 940 MHz at VSWR 2.5:1 and Ciais's measurements showed that the antenna covered at least 880-960 MHz (e.g., for extended (880-960 MHz) and

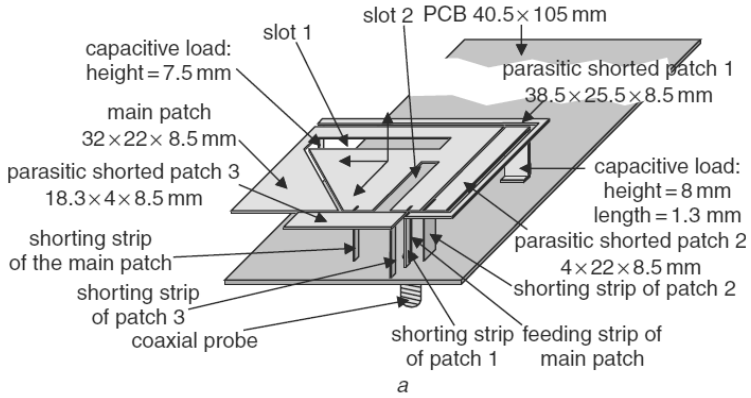
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		standard (890-960 MHz) GSM900) at VSWR 3.0:1. Ciais-Multiband, 920, Fig. 2 (annotated detail below); ETSI TS 145 005 V4.3.0 (2001-14) Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP TS 45.005 version 4.3.0 Release 4) ("ETSI TS 145 005 V4.3.0"), 8-9. Ciais's multiband antenna thus provided coverage for well-known cellular services in extended GSM900 (880-960 MHz), standard GSM (890-960 MHz), DCS1800 (1710-1880 MHz), and PCS1900 (1850-1990 MHz). ETSI TS 145 005 V4.3.0, 8-9. This coverage made Ciais's multiband antenna "suitable for mobile phone applications" like Dou's wireless device. Ciais-Multiband, 920-921; Dou, [0022] (describing exemplary coverage for GSM and PCS operations).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 **Fig. 2** *Measured and simulated VSWR of multiband antenna* Standards bandwidth requirement in grey —— measurement ----- simulation The Ciais multiband antenna also provides coverage at 4863-5991 MHz, supporting wireless networking (WLAN) at 5 GHz ISM bands (5150-5350 MHz and 5470-5725 MHz) used by IEEE Std. 802.11a and HIPERLAN/2, comporting with Duo's description of device antennas supporting wireless networking. Ciais-Multiband, 920-921, Fig. 2; Duo, [0022].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Implementing Dou's wireless device with Dou's first antenna 206 and second antenna 208 each provided by a separate Ciais multiband antenna would have been nothing more than combining familiar elements according to known methods with predictable results, and been no more than the "predictable use of prior art elements according to their established functions." KSR Int'l v. Teleflex, 550 U.S. 398, 416-417 (2007). A POSA would have had a reasonable expectation of success in using Ciais's multiband antenna in Dou's wireless device because Ciais designed the multiband antenna for internal use in cellular telephones (Ciais-Multiband, 920), and Dou expressly contemplates using a multiband PIFA antenna—like the Ciais multiband antenna—as its first and second internal antennas (e.g., Dou, [0028]-[0029]). Dou describes antenna placement within the device according to "various performance and design constraints" known to a POSA. Dou, [0030]. Ciais describes placing the multiband antenna at the end of a PCB "on the corner of a ground plane" where Dou places its antennas 206 and 208. Ciais-Multiband, Fig. 1(a), 920 (antenna is placed "on the corner of a ground plane having a size approximately equal to that of the [PCB] of a typical mobile phone, i.e. 40.5 × 105 mm."); Dou, Figs. 2A-2B, [0029]. It was well within the POSA's ordinary skill to implement Dou's wireless device with Ciais's multiband antenna, and the resulting antenna operation was predictable. Dou, [0012], [0063]. This combination of Dou in view of Ciais-Multiband (hereinafter "Dou+Ciais-Multiband") has two antennas: antennas 206 and 208 (each a Ciais multiband antenna), and meets the Challenged Claims as shown below. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. *See also e.g.*,

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Dou+Ciais-Multiband meets 7[pre] because Dou's modified device is a wireless device like a handheld computer, mobile telephone, or PDA. Dou, [0015]-[0016], claim 1.
7[a]	a ground plane;	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets 7[a] because it uses Dou's ground plane 210 to implement Ciais's ground plane teaching. Dou, Fig. 2B, [0029]; Ciais-Multiband, 920, Fig. 1(a).
7[b]	a first non-planar antenna	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets 7[b] because it implements Dou using Ciais's teaching to dispose antenna 206 (first antenna) at the top of PCB 204 "on the corner of a ground plane." Dou, Fig. 2A, [0016]-[0017]; Ciais-Multiband, Fig. 1(a), 920.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 FIG. 2A FIG. 2B PCB 204's rectangular area defines a rectangle ("ground plane rectangle") that "enclos[es]" the ground plane 210 disposed on the side of the PCB opposite from antenna 206. Dou, Figs. 2A-2B, [0016]-[0017], [0029]. PCB 204 implements Ciais's teaching of a rectangular (40.5 mm × 105 mm) PCB, also backed by a ground plane, that Ciais explains is representative of PCBs for typical mobile phones. Ciais-Multiband, Fig. 1(a) (below), 920.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 The top (40.5 mm) edge of the "ground plane rectangle" defined by PCB 204 is a "first side." Disposing antenna 206 at the top of the PCB as taught by Dou, over "the corner of a ground plane" as taught by Ciais-Multiband, places it "proximate to a first side of a ground plane rectangle" defined by the PCB area. Dou, Figs. 2A-2B (annotated above), [0016]-[0017], [0029].
7[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Dou expressly or inherently discloses this claim element. *See* Claim 7[b].
7[d]	the first non-planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Dou expressly or inherently discloses this claim element. *See, e.g.*,

<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 12,095,149 B2</th><th>Dou+Ciais-Multiband</th></tr>
<tr><td></td><td></td><td>
Dou+Ciais-Multiband meets [7.c] because Ciais's quadband antenna ("first antenna") covers—i.e., is capable of sending and receiving electromagnetic radiation ("configured to support")—in regions of the "electromagnetic spectrum" at 870-960 MHz with VSWR 3.0:1 and at 1608-2084 MHz and 4863-5991 MHz with VSWR 2.5:1. Ciais-Multiband, 920-921, Fig. 2; supra 7[a] (combination). Ciais's multiband antenna exceeds the '149 patent's VSWR performance "requirements" for these frequency ranges. '149 Patent, 37:26-59 (specifying "maximum" VSWR of 3.5:1 for "GSM900" between 800 and 960 MHz, and "maximum" VSWR of 3.0:1 for "GSM1800" (e.g., DCS1800 at 1710-1880 MHz) and "GSM1900" (e.g., PCS1900 at 1850-1990 MHz).

A POSA understood that in the context of cellular communications a "frequency band" is a frequency range specified by a regulatory or standards body for a particular use, such as a type of wireless communication. Ciais's multiband antenna is "configured to support" at least twenty-four (24) "frequency bands" that are defined in the supported frequency ranges.

The 870-960 MHz range contains at least four (4) "frequency bands" shown in Table 1.

Table 1: Frequency bands within 870-960 MHz.
<table>
<tr><th>Band</th><th>Range (MHz)</th></tr>
<tr><td>standard GSM900</td><td>890-960</td></tr>
<tr><td>extended GSM900</td><td>880-960</td></tr>
<tr><td>ISM</td><td>902-928</td></tr>
<tr><td>LTE Band 8</td><td>880-960</td></tr>
</table>

ETSI TS 145 005 V4.3.0, 8-9 ("Standard or primary" and "Extended" "GSM 900 band"); '149 Patent, 10:24-34 (discussing ISM 902-928 MHz); 3GPP TS 36.101 v8.4.0 (2008-12) Technical Specification: 3rd Generation Partnership Project; Technical Specification Group Radio Access
</td></tr>
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Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (Release 8), 2008 ("LTE-standard") ("3GPP TS 36.101 v8.4.0"), 13, Table 5.5-1 ("E-UTRA operating bands"); Ericsson white paper, "LTE—an introduction," no. 284 23-3124 Uen Rev B (June 2009), 11 (listing LTE FDD and TDD bands); pages from E. Dahlman et al., 3G Evolution: HSPA and LTE for Mobile Broadband (Academic Press 2d ed. 2008) ("Dahlman"), 497-501. The 1608-2084 MHz range ("second frequency range") contains at least fifteen (15) "frequency bands" shown in Table 2.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband

Table 2: Frequency bands within 1608-2084 MHz.

Band	Range (MHz)
DCS1800	1710-1880
PCS1900	1850-1990
UMTS Band II	1880-1990
UMTS Band III	1710-1880
UMTS Band b	1850-1910, 1930-1990
UMTS Band c	1910-1930
LTE Band 2	1850-1990
LTE Band 3	1710-1880
LTE Band 9	1749.9-1879.9
LTE Band 33	1900-1920
LTE Band 34	2010-2025
LTE Band 35	1850-1910
LTE Band 36	1930-1990
LTE Band 37	1910-1930
LTE Band 39	1880-1920

ETSI TS 145 005 V4.3.0, 8-9 (DCS1800, PCS1900); Dahlman, 139 (reference [100] identifies HSDPA specifications), 497-501, 599 (reference [100] is 3GPP TS 25.308 (ETSI TS 125 308 V6.2.0 (2004-09) Technical Specification: Universal Mobile Telecommunications System (UMTS); UTRA High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (3GPP TS 25.308 version 6.2.0 Release 6)) ("ETSI TS 125 308 V6.2.0")); ETSI TS 125 308 V6.2.0 (UMTS HSDPA description); ETSI TS 121 101 V6.0.0 (2004-12) Technical Specification: Universal Mobile Telecommunications System (UMTS); Technical Specifications and Technical Reports for a UTRAN-based 3GPP system (3GPP TS 21.101 version 6.0.0

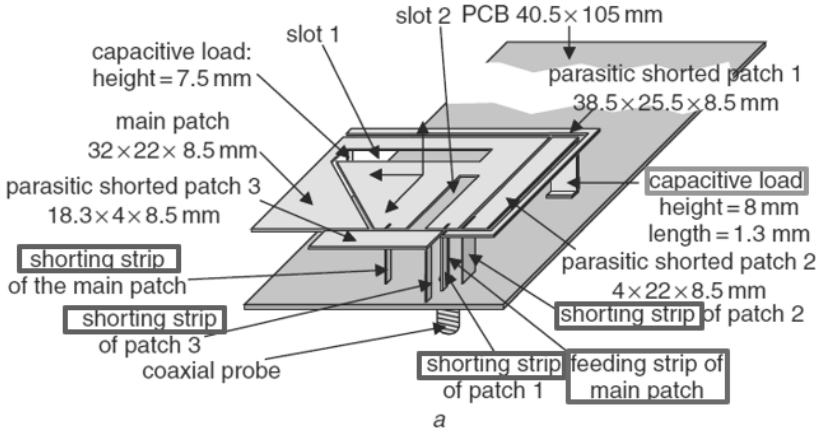
<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 12,095,149 B2</th><th>Dou+Ciais-Multiband</th></tr>
<tr><td></td><td></td><td>Release 6), 11-12 (UMTS standard comprises TS 25.101 (ETSI TS 125 101 V6.5.0 (2004-09) Technical Specification: Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD) (3GPP TS 25.101 version 6.5.0 Release 6) (“ETSI TS 125 101 V6.5.0”)), 25.102 (ETSI TS 125 102 V6.0.0 (2003-12) Technical Specification: Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (TDD) (3GPP TS 25.102 version 6.0.0 Release 6) (“ETSI TS 125 102 V6.0.0”)), TS 25.308 (ETSI TS 125 308 V6.2.0)); ETSI TS 125 101 V6.5.0, 12-13 (Table 5.0 “UTRA FDD frequency bands”); ETSI TS 125 102 V6.0.0, 11 (UTRA/TDD frequency bands); 3GPP TS 36.101 v8.4.0, 13, Table 5.5-1 (“E-UTRA operating bands” defining LTE bands); Ericsson white paper, “LTE—an introduction,” no. 284 23-3124 Uen Rev B (June 2009), 11 (listing LTE FDD and TDD bands).

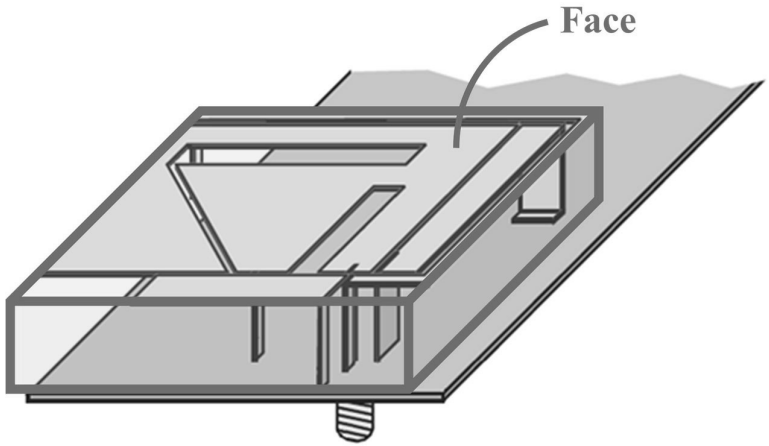
The 4863-5991 MHz range contains at least five (5) “frequency bands” shown in Table 3.

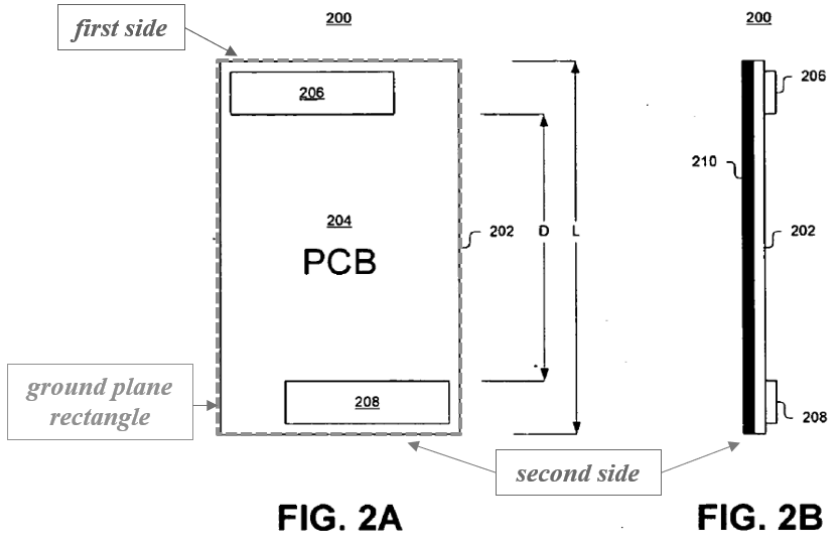
Table 3: Frequency bands within 4863-5991 MHz.

<table><tr><th>Band</th><th>Range (MHz)</th></tr><tr><td>U-NII lower</td><td>5150-5250</td></tr><tr><td>U-NII middle</td><td>5250-5350</td></tr><tr><td>U-NII</td><td>5470-5725</td></tr><tr><td>U-NII upper</td><td>5725-5825</td></tr><tr><td>U-NII</td><td>5850-5895</td></tr></table>
IEEE Std. 802.11a-1999, 26 (IEEE Std. 802.11a defining WLAN channels in 5 GHz U-NII bands); 47 C.F.R. §§15.401, 15.403 (U-NII devices in 5.15-5.35 GHz and 5.47-5.895 GHz frequency bands); 47 C.F.R. §§15.407(a)(1) (discussing 5150-5250 MHz U-NII band), 15.407(a)(2) (discussing 5250-5350 MHz and 5470-5725 MHz U-NII bands), 15.407(a)(3)(i)</td></tr>
</table>

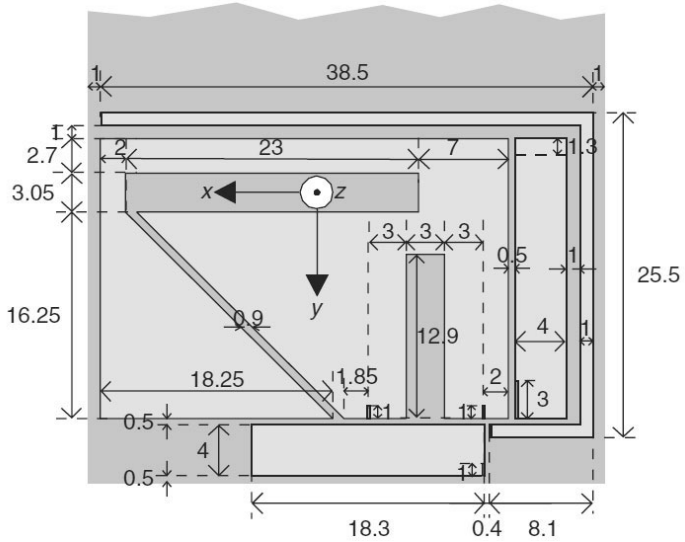
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		(discussing 5725-5850 MHz U-NII band), 15.407(a)(3)(ii)-(v) (discussing 5850-5895 MHz U-NII band); 69 Fed. Reg. 54027, 54036-54037 (Sep. 7, 2004) (codified at 47 C.F.R. §15.407). Thus, Ciais's multiband antenna is "configured to support at least three frequency bands of the electromagnetic spectrum" because it covers (e.g., is operable to send and receive radiation in) at least twenty-four frequency bands.
7[e]	a minimum-sized parallelepiped completely enclosing a volume of the first non-planar antenna,	Dou expressly or inherently discloses this claim element. *See, e.g.*, Ciais's multiband antenna is "non-planar" because it comprises antenna elements that are not contained within a single plane. For example, each "shorting strip," "feeding strip," and "capacitive load" in the "3D view of multiband antenna" in Ciais's Figure 1(a) (annotated below) are "non-planar" antenna elements because they extend out of the plane containing the "main patch."

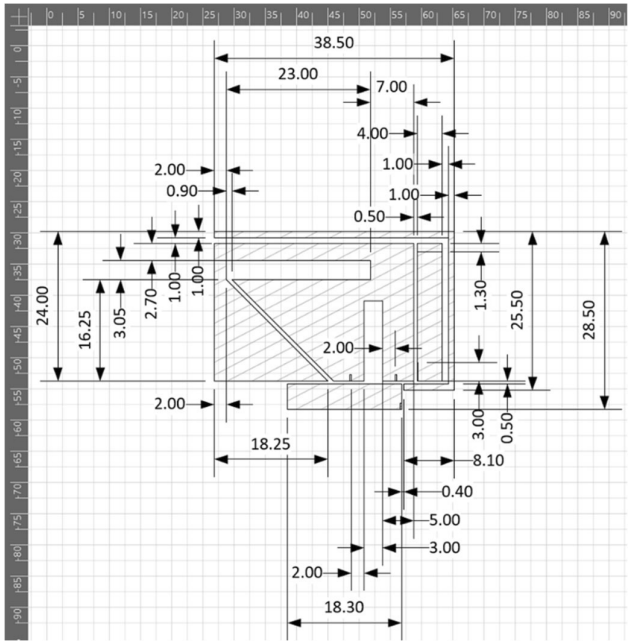
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 *a* Dou+Ciais-Multiband meets 7[e] because Ciais's multiband antenna has an "antenna box" defined by "a minimum-sized parallelepiped of rectangular faces that completely encloses a volume of the" Ciais multiband antenna ("first non-planar antenna") as shown below. Ciais-Multiband, Fig. 1(a) (annotated below). The multiband antenna's "main patch" provides the parallelepiped with a "face with a largest area."

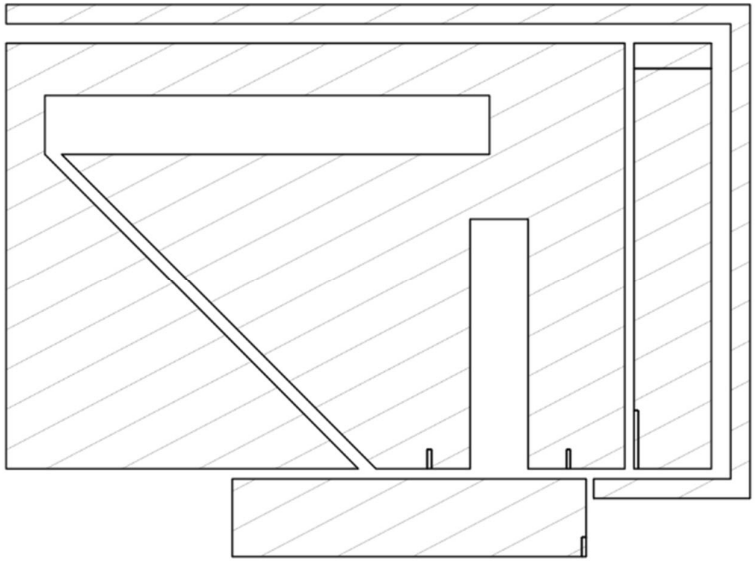
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		
7[f]	the minimum-sized parallelepiped having a face with a largest area;	Dou expressly or inherently discloses this claim element. *See* Claim 7[e].
7[g]	a second antenna proximate to a second side of the ground plane rectangle, and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets 7[g] because it implements Dou's teaching to dispose antenna 208 (second antenna) at the bottom of PCB 204. Dou, Fig. 2A, [0016]-[0017].

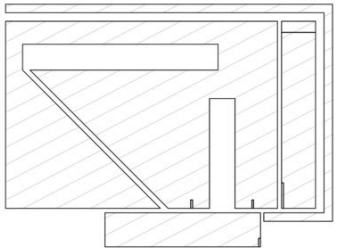
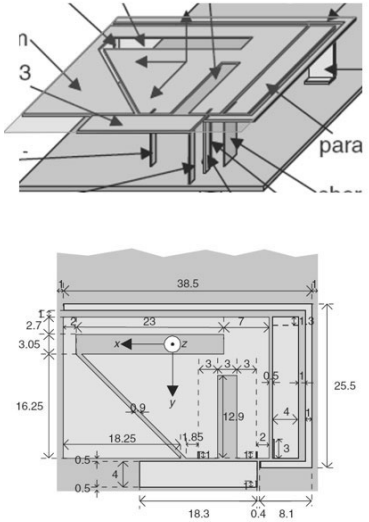
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Dou+Ciais-Quadband's antenna 208 ("second antenna") is positioned along (proximate to) "a second side" of PCB 204 that is opposite to the first side, which is also the "second side of the ground plane rectangle." Supra 7[b]; Dou, Fig. 2A, [0016]-[0017].  FIG. 2A FIG. 2B Dou+Ciais-Multiband meets the rest of 7[g] because the multiband antenna implementing Dou antenna 208 (second antenna) covers the same frequency bands as the multiband antenna implementing Dou antenna 206 (first antenna) supra 7[d].
7[h]	wherein the second antenna is configured to receive signals from at least two frequency	Dou expressly or inherently discloses this claim element. *See* Claim 7[g].

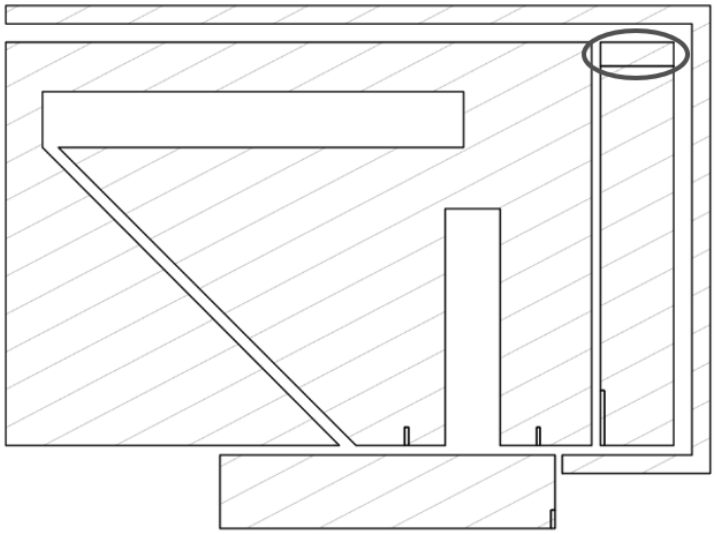
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
	bands of the at least three frequency bands;	
7[i]	wherein the first non-planar antenna has a first contour defined as a perimeter of any portions of the first non-planar antenna arranged in the face, perimeters of any closed apertures of any portions of the first non-planar antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first non-planar antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	Dou expressly or inherently discloses this claim element. *See, e.g.*, The antecedent for "the face" is the parallelepiped in 7[e]-[f] supra, corresponding to parallelepiped surface containing the "main patch" of the multiband antenna. Ciais-Multiband, Figs. 1(a), 1(b). The Ciais multiband antenna implementing Dou's antenna 206 ("first non-planar antenna) has a "first contour" meeting 7[m] as shown below. Ciais's Figure 1(b) shows the antenna element dimensions including orthogonal projections of the out-of-plane antenna elements. Ciais-Multiband, Fig. 1(a).

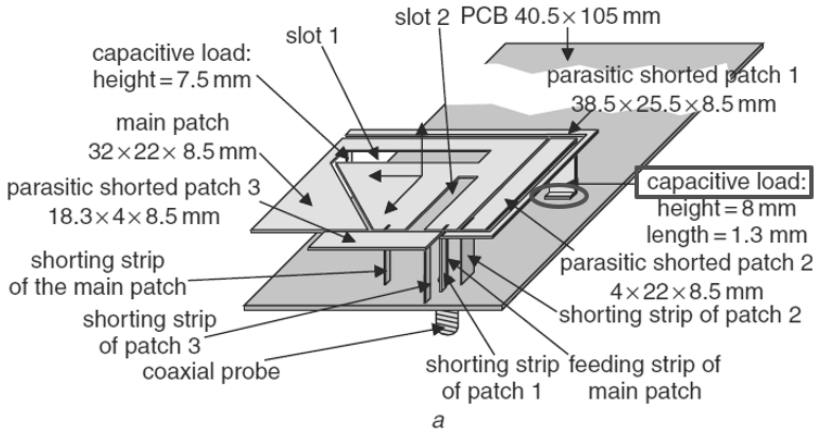
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 Using Ciais's description the antenna contour is produced to scale as follows, with dimensions in mm.

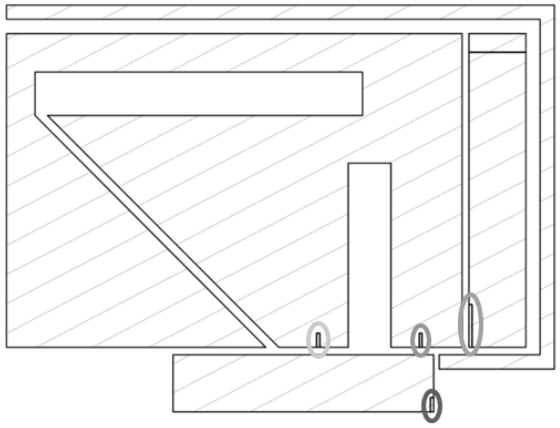
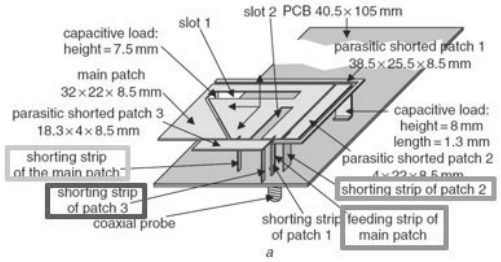
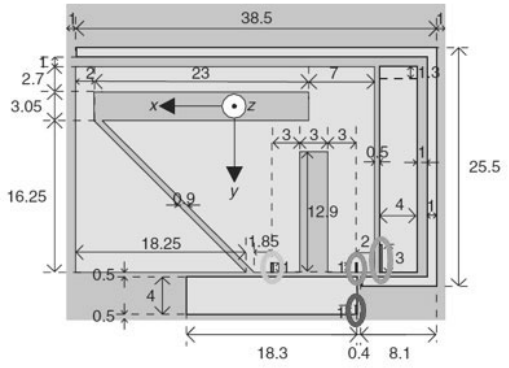
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 The multiband antenna's "first contour" is,

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 This first contour includes [1] the perimeter of all antenna elements (portions) in the plane of the multiband antenna's main patch (e.g., arranged in the face). Ciais-Multiband, Figs. 1(a) (annotated detail below top right), 1(b).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 *first contour*  Ciais-Multiband Figs. 1(a), 1(b) The first contour also includes [3] the perimeter of an orthogonal projection of the capacitive load (e.g., a portion… not arranged in the face), as highlighted below. Ciais-Multiband, 920, Figs. 1(a), 1(b).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 Regardless of whether the multiband antenna elements in the face comprise slots defining [2] perimeters of… closed apertures that receive vertical shorting and feeding strips, or orthogonal projection of each vertical strip defines [3] a perimeter on the face or [4] a closed aperture having a perimeter, the first contour includes segments defining these perimeters as shown below. Ciais-Multiband, 920, Figs. 1(a), 1(b) (annotated below).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		  

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
7[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets 7[j] because the multiband antenna's contour ("*first contour*"), *supra* 7[i], has $F_{21} = 1.41 \geq 1.20$, and $F_{32} = 1.53 \geq 1.35$, as shown for 7[l] below.
7[k]	complexity factor F_{32} having a value of at least 1.35;	Dou expressly or inherently discloses this claim element. *See* Claim 7[j].
7[l]	Wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of	Dou expressly or inherently discloses this claim element. *See, e.g.*, wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{log(N_2) - log(N_1)}{log(1/2)}$ $F_{32} = -\frac{log(N_3) - log(N_2)}{log(1/2)}$

<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 12,095,149 B2</th><th>Dou+Ciais-Multiband</th></tr>
<tr><td></td><td>cells of a grid G3 that include at least a point of the first contour,

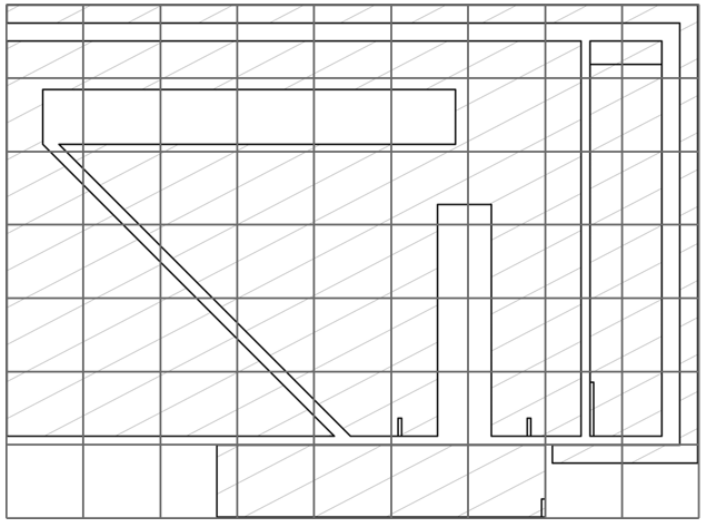
the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible,

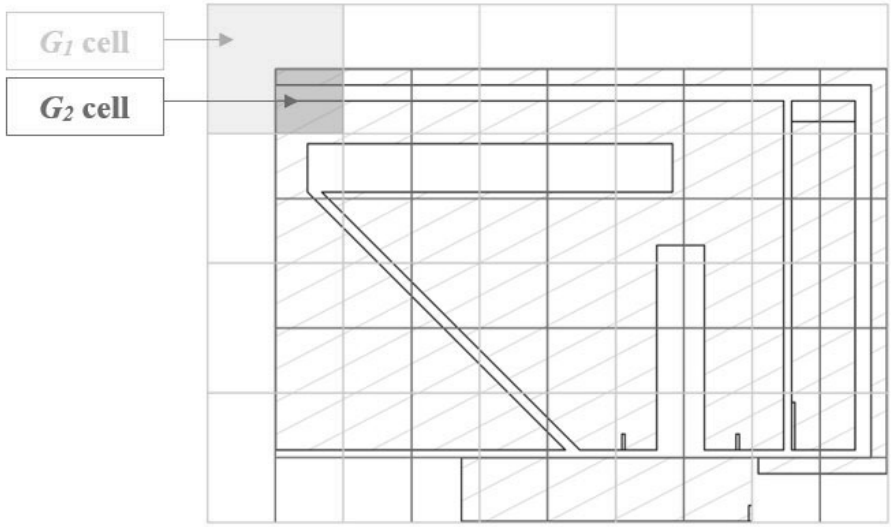
the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and</td><td>Grid G2:

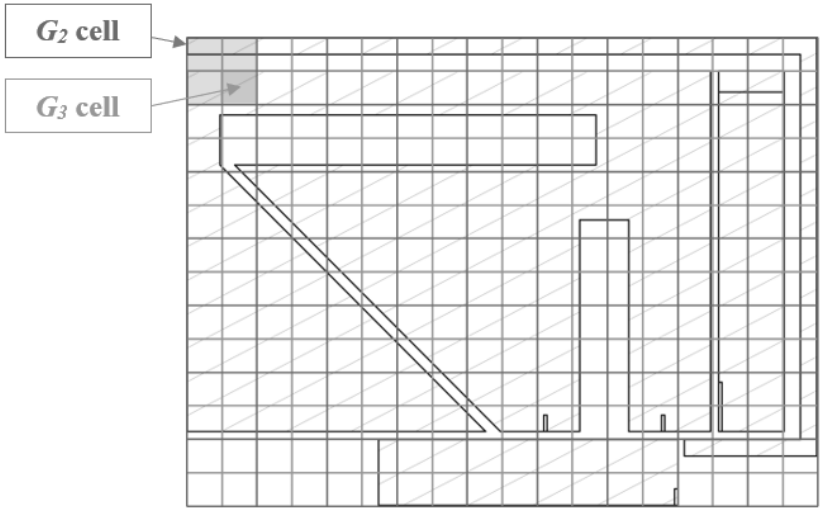
The antecedent for “the face” is “the minimum-sized parallelepiped having a face with a largest area” in 7[e]-[f]. However, 7[l] requires counting cells of a grid that include at least a point of an antenna contour, which 7[i] recites is formed by perimeters and orthogonal projections of antenna elements “onto the face.” Thus, a POSA would have understood that “the face” referred to a minimum-sized rectangle enclosing the first contour.

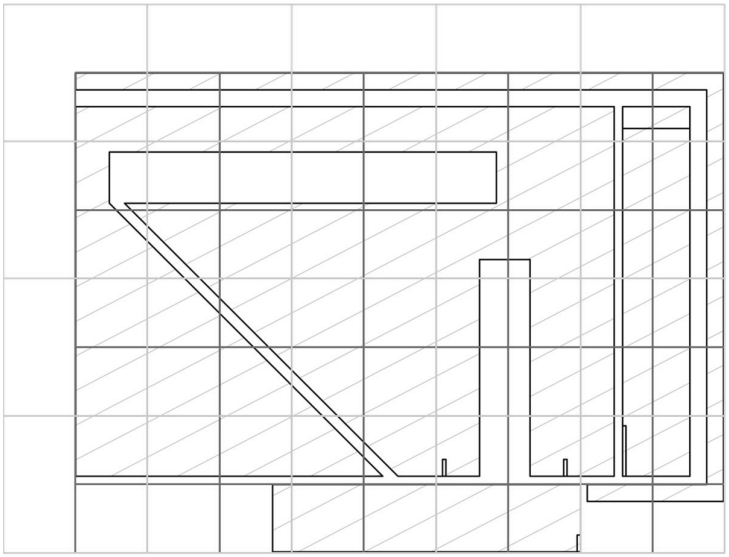
The multiband antenna contour (first contour) is 38.5 mm wide (long side of the face) and 28.5 mm in height (short side of the face). Ciais-Multiband, 920, Fig. 1(b). Grid G_2 with nine (9) columns yields cell width (columns of equal width) of $\left(\frac{38.5mm}{9}\right) = 4.28\ mm.$
With 9 columns, seven (7) rows provides an “odd number of rows of equal height arranged along a short side of the face” with “the cells… being as square as possible” because seven rows provides a cell with an aspect ratio closer to 1 (e.g., where width = height) than any other odd number of rows. ’149 Patent, 14:34-36 (defining “aspect ratio” as the ratio of width to height).

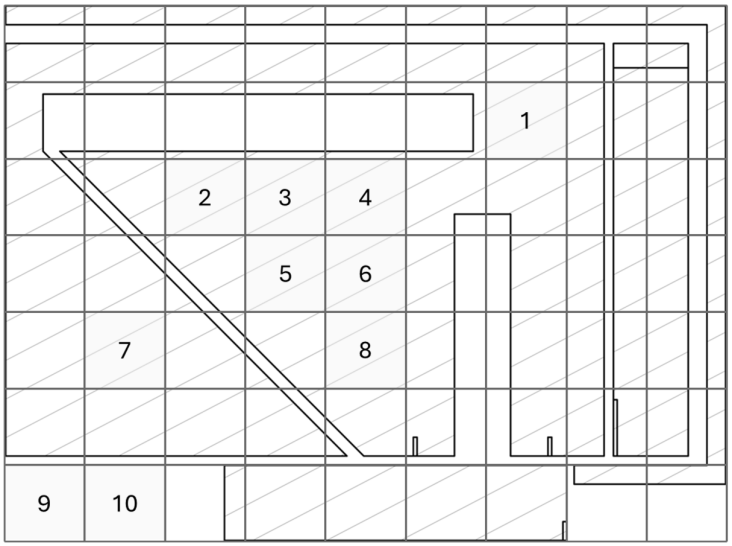
<table>
<tr><th>Rows</th><th>Cell Height (mm)</th><th>Cell Aspect Ratio $\left(\frac{width}{height}\right)$</th></tr>
<tr><td>5</td><td>$\left(\frac{28.5}{5}\right) = 5.70$</td><td>$\left(\frac{4.28}{5.70}\right) = 0.75$</td></tr>
<tr><td>7</td><td>$\left(\frac{28.5}{7}\right) = 4.07$</td><td>$\left(\frac{4.28}{4.07}\right) = 1.05$</td></tr>
<tr><td>9</td><td>$\left(\frac{28.5}{9}\right) = 3.17$</td><td>$\left(\frac{4.28}{3.17}\right) = 1.35$</td></tr>
</table>
</td></tr>
</table>

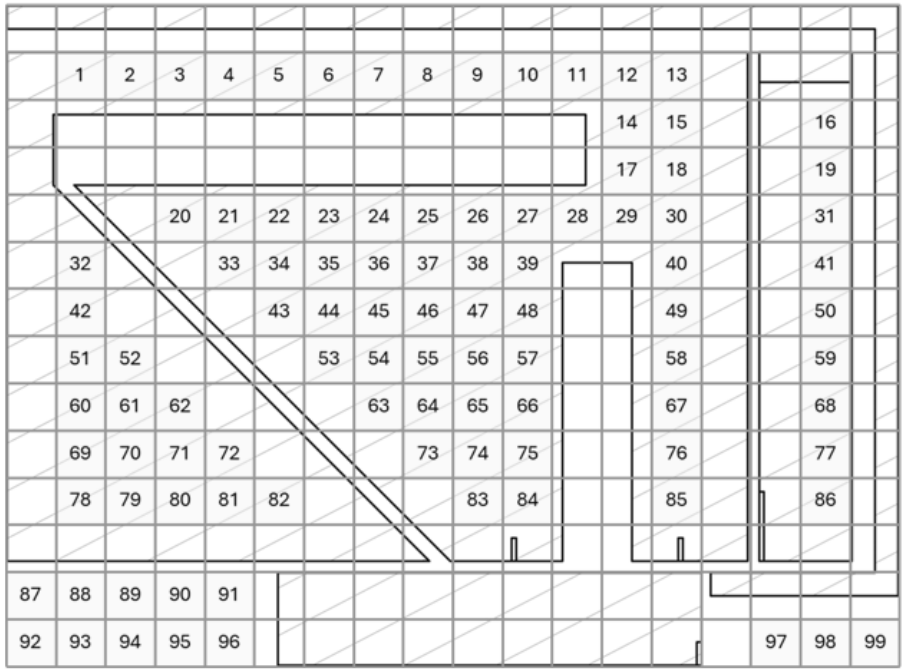
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Grid G_2  Thus, grid G2 has 7 rows by 9 columns and "tessellates" the first contour as shown above (blue outline). **Grid G1:** Grid G1 (orange outline below) is "aligned with a corner of the grid G2" and "cover[s] the face" (e.g., the first contour), wherein each G1 cell has twice the width and height of a G2 cell, e.g., "widths and heights that respectively are double the widths and heights of the cells of the grid G2."

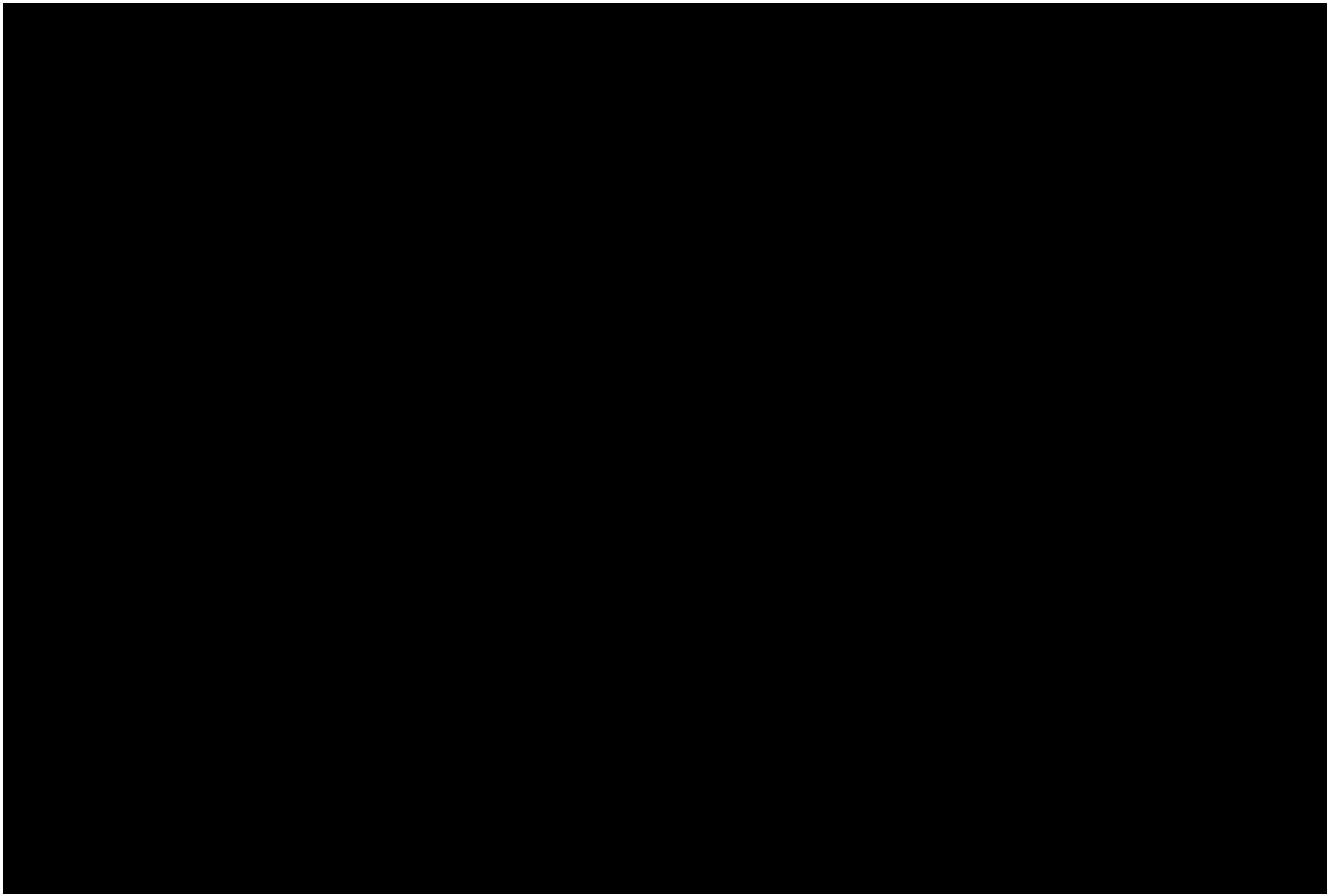
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 **Grid G3:** Grid G3 (green outline below) is "aligned with the grid G2" and each G2 cell (green) comprises four G3 cells—meaning that G3 cells have "widths and heights that respectively are half the widths and heights of the cells of the grid G2."

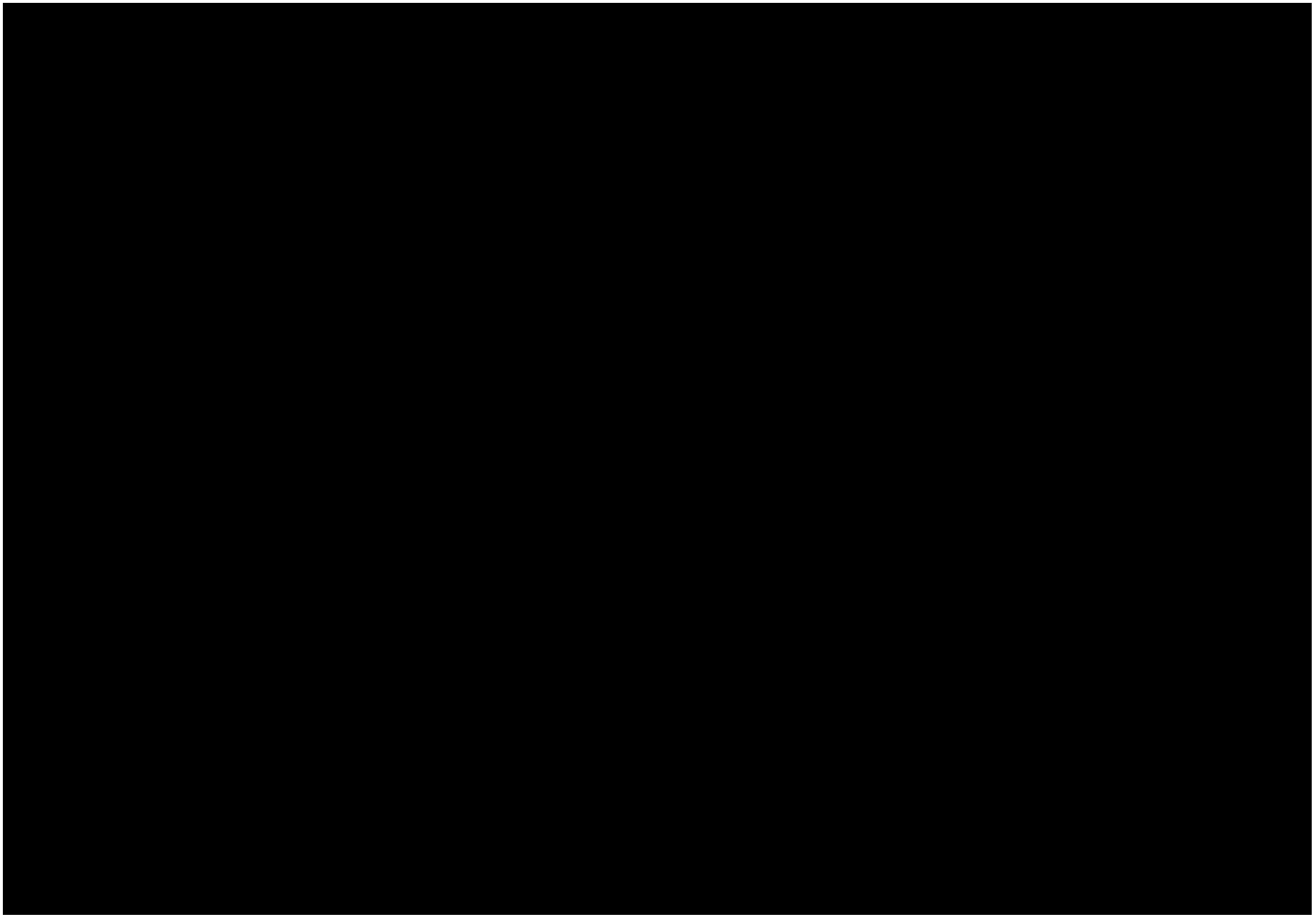
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 **<u>Cell Counts</u>:** When evaluating 7[l] a cell whose boundary coincides with a point on the "first contour" will "include at least a point of the first contour"—and is counted for N1, N2, and N3—because the '149 patent specification states that "in the present invention the boundary of the cell is also part of the cell." '149 Patent, 19:15-17. The count for each grid is shown below. **N1 = 20** All cells in 4 × 5 grid G1 "include... a point" of the first contour (black outline) so each cell is counted and N1 = 20.

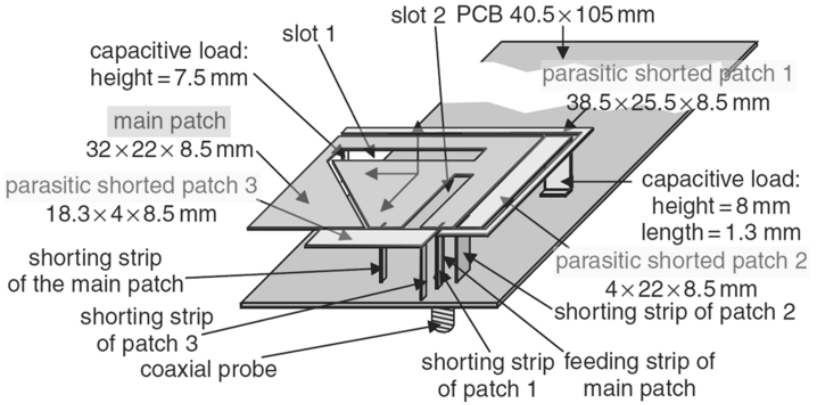
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 **N2 = 53**

		As shown below, in 7×9 grid G_2 the cells numbered 1-10 (marked below) do ***not*** "*include… a point*" of the *first contour* and are excluded from the count. Thus, $N_3 = (63 - 10) = 53$.  **N3 = 153** In the 14×18 grid G_3 the cells numbered 1-99 (marked below) do ***not*** "*include… a point*" on the *first contour*. Thus $N_3 = (252 - 99) = 153$.

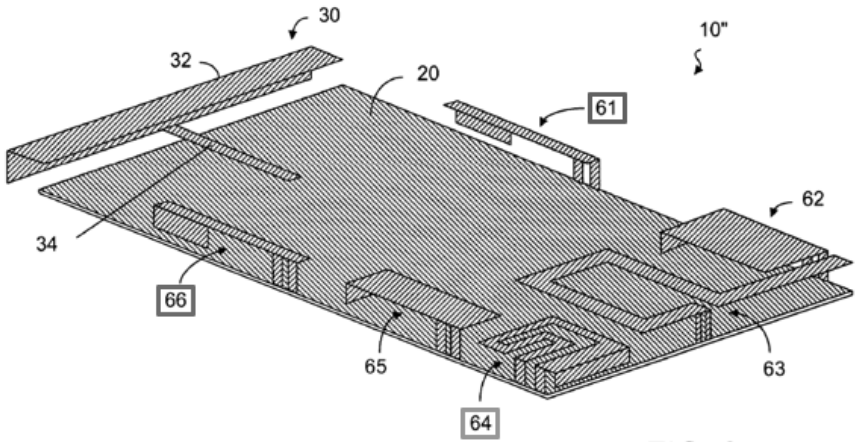
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 **<u>Calculation of F21</u>: = 1.41**





Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 Each parasitic shorted patch is physically separated from the main patch by an air gap but "located near the main patch in order to be efficiently electromagnetically coupled." Ciais-Multiband, 920. Thus, the main patch and each of parasitic shorted patches 1 to 3 are "at least two antenna elements" that are "electromagnetically coupled."
Claim 9		
9	The wireless device of claim 7, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets claim 9 because the *first contour*'s $F_{32} = 1.53 < 1.75$. *Supra* 7[j], -7[l].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		Claim 10
10[a]	The wireless device of claim 7, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	Dou expressly or inherently discloses this claim element. To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. ***See, e.g.*, Hilgers:** Dou describes its wireless device having "three or more antennas" "disposed within the housing of a wireless device," which "may comprise any suitable type of internal antenna" (Dou, [0040]), and describes the wireless device having an antenna covering frequencies for GPS (1575 MHz) as well as covering Bluetooth at the 2.4 GHz ISM band. Dou, [0022]. While Ciais's multiband antenna provided coverage in the 5 GHz ISM bands used by IEEE Std. 802.11a and HIPERLAN/2, it did not provide coverage at 1575 MHz for GPS or in the 2.4GHz ISM band used by Bluetooth. Ciais-Multiband, 920-921, Fig. 2. A POSA would have had reasons to include Hilgers's dual band antenna in order to support GPS and Bluetooth, to provide the services that Dou describes, in frequency ranges Ciais's multiband antenna did not cover. Providing GPS and Bluetooth antenna within a mobile device—as Dou describes—was conventional. E.g., Ollikainen, Fig. 9 (below), [0044] (GPS antenna 64, WLAN antenna 61, Bluetooth antenna 66).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 FIG. 9 A POSA would have mounted Hilgers's dual-band antenna within Dou's device housing because Hilgers teaches that its dual-band antenna is "mounted or soldered on to a printed circuit board," which is "within" the housing of Dou's wireless device. Hilgers, [0054]; Dou, Abstract ("housing enclosing a [PCB]"), [0016]-[0017]. Implementing Dou-Ciais-Multiband's wireless device further including Hilgers's dual-band GPS/Bluetooth antenna would have been nothing more than combining familiar elements according to known methods with predictable results, and been no more than the "predictable use of prior art elements according to their established functions." KSR, 550 U.S. at 416-417. This combination would have provided the multiband coverage that Dou describes. A POSA also would have had a reasonable expectation of success including Hilgers's GPS/Bluetooth antenna in Dou's wireless device—as Dou describes—because it was conventional (Ollikainen, [0044]), Dou explains that "the antenna architecture may comprise

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		three or more antennas" (Dou, [0040]), and Dou specifically describes the wireless device having coverage including for GPS and Bluetooth (Dou, [0022]). This combination of Dou in view of Ciais-Multiband, and further in view of Hilgers (hereinafter "Dou+Ciais-Multiband+Hilgers") has three antennas: antennas 206 and 208 (each a Ciais multiband antenna), and Hilgers's dual-band GPS/Bluetooth antenna, and meets the Challenged Claims as shown below. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. *See, e.g.*, Claim 10 depends from claim 7 and recites the additional limitation, "wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and the third antenna is arranged within the wireless device." Dou+Ciais-Multiband+Hilgers meets claim 10 because Hilgers's dual-band antenna (third antenna) covers (is configured to operate in) 1575 MHz (for GPS) and the 2.4 GHz ISM band (for Bluetooth) (at least two frequency bands being different), which Ciais's multiband antenna does not cover. Supra 7[d]; Hilgers, [0001], [0025], Fig. 4. Hilgers's dual-band antenna is "arranged within" the Dou+Ciais-Multiband+Hilgers device. Claim 7[a] (combination).
10[b]	the third antenna is arranged within the wireless device.	Dou expressly or inherently discloses this claim element. *See* Claim 10[a].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
Claim 12		
12	The wireless device of claim 7, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets claim 12 because the *ground plane rectangle*'s "*first side*" is a "*short side*" as explained *supra* 7[b]. Ciais-Multiband, 920, Fig. 1(a); Dou, Figs. 2A-2B.
Claim 13		
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[pre].
13[a]	a ground plane;	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[a].
13[b]	a first antenna	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[b]-[c].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 13[b].
13[d]	the first antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Dou expressly or inherently discloses this claim element. *See* Claim 7[d].
13[e]	a minimum-sized parallelepiped completely enclosing a volume of the first antenna,	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[d].
13[f]	the minimum-sized parallelepiped having a face with a largest area;	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[d].
13[g]	a second antenna proximate to a second side of the ground plane rectangle	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[g]-[h].
13[h]	configured to receive signals from at least two frequency	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 13[g].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
	bands of the at least three frequency bands,	
13[i]	wherein the first antenna has a first contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[f].
13[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[j]-[k].
13[k]	complexity factor F_{32} having a value of at least 1.35; and	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See also* Claim 13[j].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
13[l]	wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible,	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[l].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
	the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights of the cells of the grid G2, and	
13[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 7[m].
Claim 14		
14	The wireless device of claim 13, wherein the first antenna includes at least two antenna elements that are electromagnetically coupled.	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 8.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
Claim 17		
17	The wireless device of claim 13, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 9.
Claim 18		
18[a]	The wireless device of claim 13, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	Dou+Ciais-Multiband+Hilgers expressly or inherently discloses this claim element. *See* Claim 10. *See also, e.g.*, Claim 18 depends from claim 13. Claim 18 recites the additional limitation, "wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and the third antenna is arranged within the wireless device." Dou+Ciais-Multiband+Hilgers meets claim 18 because Hilgers's dual-band antenna (third antenna) covers (is configured to operate in) 1575 MHz (for GPS) and the 2.4 GHz ISM band (for Bluetooth) (at least two frequency bands being different), which Ciais's multiband antenna does not cover. Supra 7[c]; Hilgers, [0001], [0025], Fig. 4. Hilgers's dual-band antenna is "arranged within" the Dou+Ciais-Multiband+Hilgers device. Supra 7[a] (combination).
18[b]	the third antenna is arranged within the wireless device.	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 18[a].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
Claim 19		
19	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See* Claim 12.
Claim 20		
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	Dou+Ciais-Multiband expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Multiband meets claim 20 because Dou's modified device implements antenna 206 as a Ciais multiband antenna, and implements Ciais's teaching that the multiband antenna is placed "on the corner of a ground plane." Ciais-Multiband, Fig. 1(a), 920 (antenna is placed "on the corner of a ground plane having a size approximately equal to that of the [PCB] of a typical mobile phone, i.e. 40.5 × 105 mm."). Thus, in Dou+Ciais-Multiband, the multiband antenna (first antenna) is proximate to both a short side and a long side of the ground plane rectangle. Supra 7[b], 13[b]. While in claims 12 and 19 the "first side" is mapped to a "short side," for claim 20, the "first side" is mapped to a "long side" as shown below, without any change to the claim 13 analysis, because the Ciais multiband antenna implementing Dou antenna 206 ("first antenna") is "proximate" to the "long side" of the "ground plane rectangle" for 13[b] as shown below. Dou, Figs. 2A, 2B (annotated below); *supra* 7[b], 13[b].

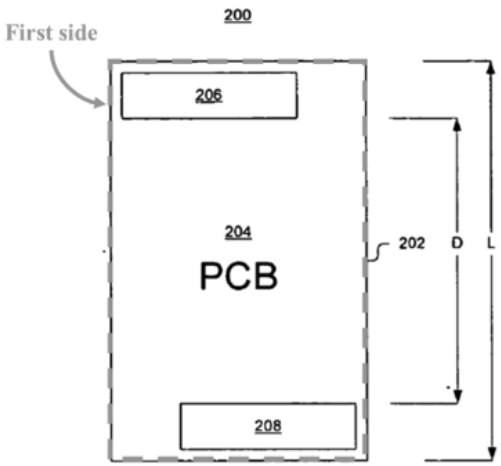
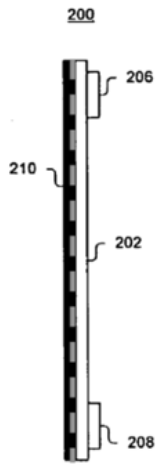
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Multiband
		 FIG. 2A  FIG. 2B Ciais's multiband antenna has a length 38.5 mm while Dou's PCB 204 is implemented with a width of 40.5mm as taught in Ciais-Multiband. Supra 7[a] (combination); Ciais-Multiband, 920, Figs. 1(a)-1(b). Thus, even if the Ciais multiband antenna were centered on the short side (rather than placed "on the corner of a ground plane"), the Ciais multiband antenna ("first antenna") would be at most 1 mm from a long edge of the PCB and ground plane (e.g., when centered on the 40.5 mm edge). This is "proximate" to a long edge (second side) of the ground plane rectangle and still meets 13[b] when the first side is mapped to the long side of PCB 204 and ground plane rectangle. Supra 7[b], 13[b]). This meets claim 20.

Exhibit – F – 07

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 12,095,149 B2
BASED ON U.S. PATENT APP. PUB. NO. 2007/0200773 ("DOU") AND CIAIS-QUADBAND AND NAKANO

Based upon Plaintiff's Complaint, Infringement Contentions, and apparent claim constructions and application of the claims to Defendants' accused products, as best as they can be deciphered, the reference charted below anticipates or at least renders obvious certain of the asserted claims. These invalidity contentions are not an admission by the Defendants that the accused products are covered by or infringe claims 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 (the "'149 Asserted Claims")[1], particularly when these claims are properly construed and applied.

AIA law applies because the application that issued as the '149 Patent was filed on June 22, 2023, after the AIA came into force on March 16, 2013.

U.S. Patent Application Publication No. 2007/0200773 to Dou et al. ("Dou") was filed on February 24, 2006 and published on August 30, 2007. This patent is prior art under at least pre-AIA 35 U.S.C. § 102(a) or (b), (e), and (g)(2), or AIA 35 U.S.C. § 102(a). As described in the following claim chart, the asserted claims of U.S. Patent No. 12,095,149 (the "'149 Patent"), are invalid as anticipated by Dou.

To the extent that Dou is found not to anticipate one or more of the asserted claims of the '149 Patent, these claims are invalid as obvious in view of Dou alone or as modified in view of or in combination with other prior art references disclosed in Defendants' Invalidity Contentions and accompanying charts, including without limitation as set forth below.

- P. Ciais, R. Staraj, G. Kossiavas, and C. Luxey. "Design of an Internal Quad-Band Antenna for Mobile Phones," IEEE Microwave and Wireless Components Letters, vol. 14, no. 4, pp. 148-150, April 2004 ("Ciais-Quadband")
- H. Nakano, Y. Sato, H. Mimaki and J. Yamauchi. "An Inverted FL Antenna for Dual-Frequency Operation," IEEE Transactions on Antennas and Propagation, vol. 53, no. 8, pp. 2417-2421, Aug. 2005 ("Nakano")

These invalidity contentions are not an admission that the Defendants concede or acquiesce to any claim construction implied or suggested by Plaintiff's Complaint or Infringement Contentions. Nor are Defendants asserting any claim construction positions through these charts, including

[1] Defendants understand that, by not charting claims 6, 11, and 16 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.

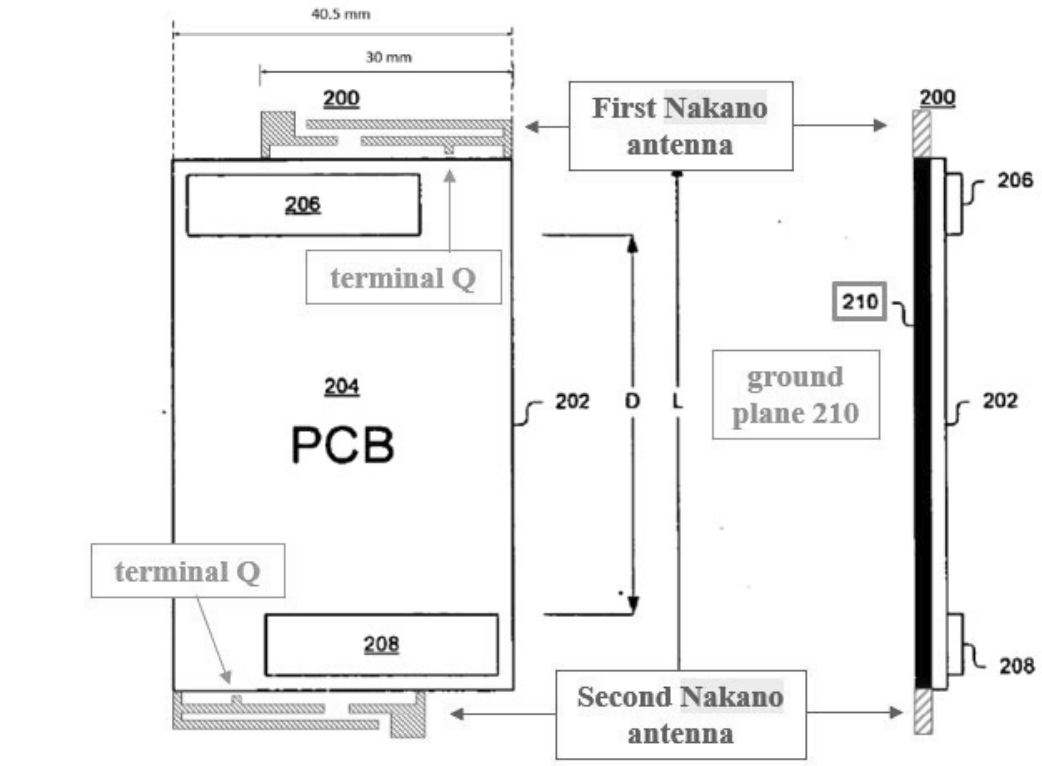
whether the preamble is a limitation. The portions of the prior art reference cited below are not exhaustive but are exemplary in nature. Defendants reserve the right to update their constructions and contentions in view of this Court's claim construction order.[2]

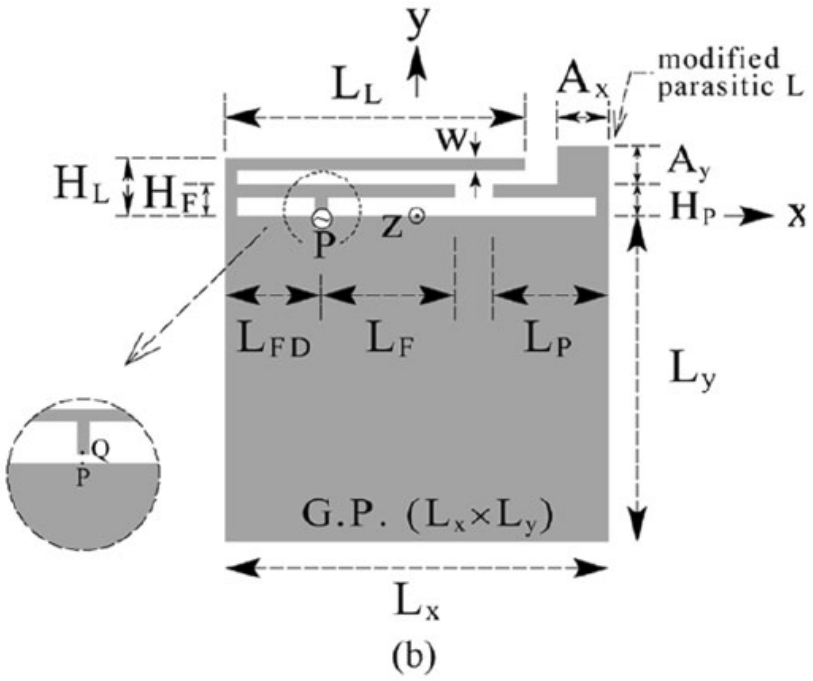
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
Claim 1		
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou expressly or inherently discloses this claim element. *See, e.g.*, The Dou wireless device is, e.g., a handheld computer, mobile telephone, or PDA. Dou, [0015]-[0016], [0031], claim 1.
1[a]	a ground plane;	Dou expressly or inherently discloses this claim element. To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. ***See, e.g.*, Nakano:** While Dou describes a wireless handheld device having "three or more" internally-mounted antennas (Dou, [0040]), it leaves the antenna selection to a POSA. Dou describes using antennas that are "compatible with multiple wireless data, multimedia and cellular telephone systems," including "WiFi and Bluetooth" (Dou, [0022]). Dou also discusses the benefits of "spatial

[2] Defendants incorporate herein any related work performed by or on behalf of an author or an inventor in the United States under Pre-AIA 35 U.S.C. § 102(g)(2). Defendants reserve the right to supplement and/or alter this chart based on further investigation and ongoing discovery.

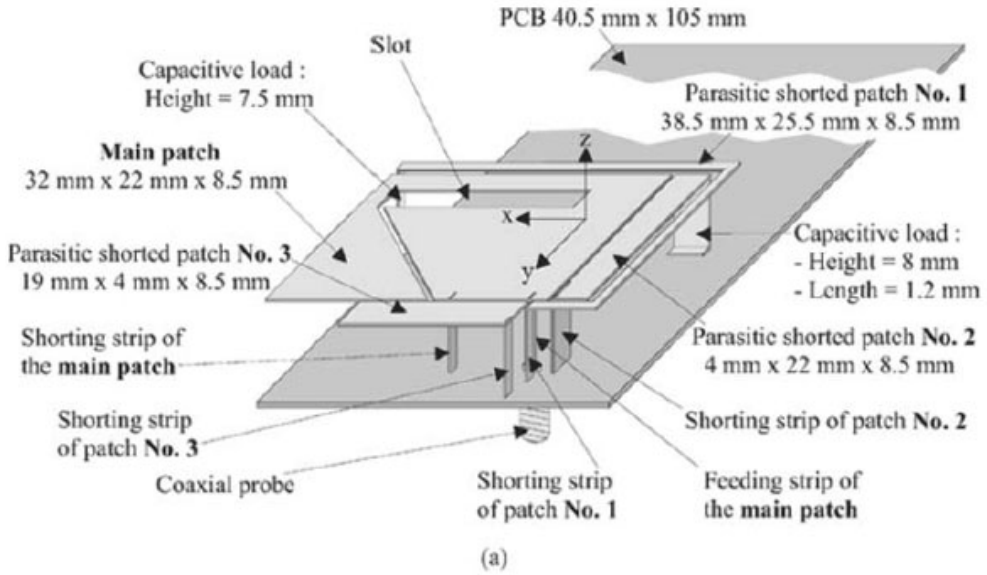
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		diversity techniques to improve communication of wireless signals across one or more frequency bands." Dou, [0022]. Dou teaches that the antennas may be of "any suitable type" (Dou, [0040]) and may be arranged in "any suitable topology… for a given implementation" (Dou, [0039]). As explained below a POSA would have had reasons to implement Dou's wireless device in a diversity architecture with Nakano's InvFL antenna providing coverage at frequencies used by WLAN, and Ciais's quadband antenna providing coverage at frequencies used for cellular communications. A POSA would have had reasons to use Nakano's InvFL antenna to implement the WLAN functionality that Dou describes its wireless device having because Nakano's antenna was designed for internal use in "mobile phone handsets" like Dou's wireless device and covered the 5.2 GHz band used by IEEE Std. 802.11a, in addition to the "2.45 GHz" (2400-2500 MHz) ISM band used by IEEE Std. 802.11b and Bluetooth. Nakano, 2417, 2419, Fig. 4; Dou, [0022]; 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) ("IEEE Std. 802.11a-1999"), 3 (802.11a uses 5.15-5.35 GHz band), 26 (Table 88 showing channels in 5 GHz bands); 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) ("IEEE Std. 802.11b-1999"), 49-50 (802.11b defines channels between 2400 and 2484 MHz); Specification of the Bluetooth System version 2.0, volume 2 (issued Nov. 4, 2004), 27 ("Bluetooth devices operate in the unlicensed 2.4 GHz ISM [] band."). Nakano's dual-frequency WLAN antenna met an "increasing demand for wireless communications" (Nakano, 2417). The market demand gave POSAs additional reasons to include Nakano's antenna in Dou's wireless device.

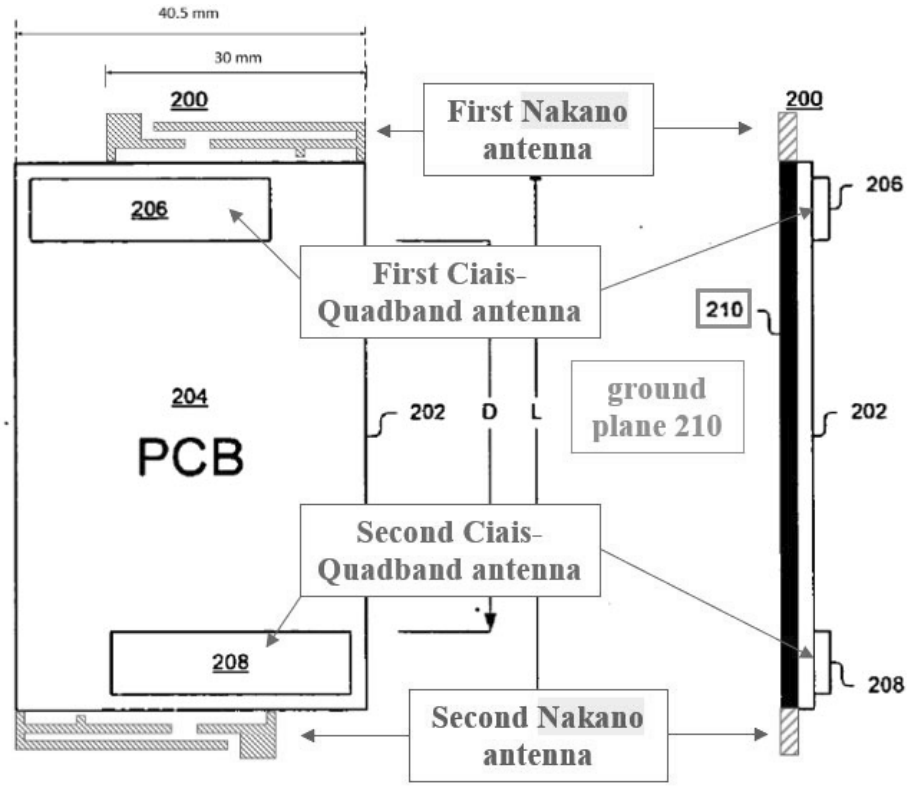
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		A POSA would have had reasons to place one of Nakano's InvFL antenna at the "top" and "bottom" of Dou's PCB 204—as shown below—to provide spatial diversity in a "diversity antenna architecture" that Dou explains improves "receiving sensitivity" and device performance. Dou, Abstract, [0001], [0014]-[0017], [0022], [0030]. Nakano's InvFL extends from a "co-planar ground plate" on the short side of a rectangular "card-type structure." Nakano, 2517, Fig. 1. A POSA would have modified Dou's wireless device to use Nakano's teaching by placing an InvFL antenna co-planar with ground plane 210 (Dou, Fig. 2B) and extending it from the ground plane both "above" and "below" PCB 204 as shown below. Dou, Figs. 2A-2B (modified below), [0016]-[0017].

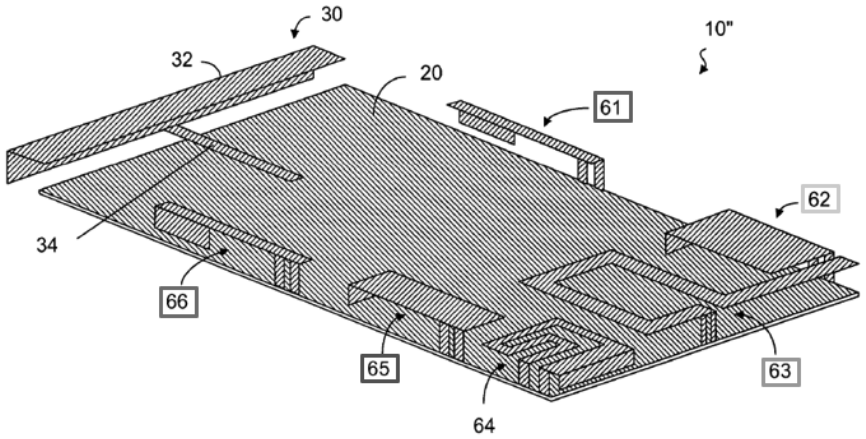
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 Nakano's antenna is excited at terminal Q. Nakano, Fig. 1(b), 2418.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 (b) A POSA would have positioned each Nakano antenna along a long edge of the PCB, as shown, to simplify offsetting the feed lines to terminal Q from Dou antennas 206 and 208, respectively. Nakano, 2417-2418, Figs. 1(a)-1(b). Implementing Dou's wireless device with two Nakano InvFL antennas as described above would have been nothing more than combining familiar elements according to known methods with predictable results, and been no more than the "predictable use of prior art elements according to their established functions." KSR, 550 U.S. at 416-417.

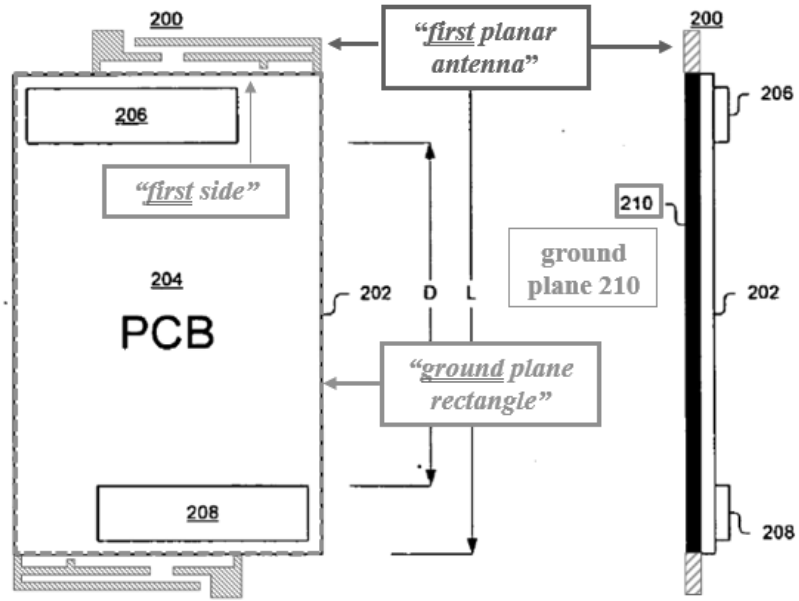
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		***See, e.g.*, Ciais-Quadband:** A POSA would have had reasons to implement each of Dou's first antenna 206 and second antenna 208 as a Ciais quadband antenna. Ciais's quadband antenna was designed for internal use in mobile phones, making it suitable for use as Dou's "internal antenna" 206 and 208 "disposed within… housing 202 of the wireless device 200." Dou, [0018]; Ciais-Quadband, 148, 150. Ciais's quadband antenna is a planar inverted-F antenna (PIFA) (Ciais-Quadband, Abstract), which Dou describes using for the first and second antennas. Dou, [0028]. Ciais's quadband antenna provided operation at 870-960 MHz and 1710-2170 MHz, used in well-known communication standards (GSM, DCS, PCS, UMTS), making the antenna "suitable for mobile phone applications" like Dou's wireless device. Ciais-Quadband, 148, 150; Dou, [0022] (describing exemplary coverage for GSM, PCS, and "WCDMA/UMTS" operations). Ciais teaches placing the quadband antenna "on the corner of a ground plane" with dimensions (40.5×105 mm) that are "representative" of a "typical mobile phone" PCB. Ciais-Quadband, 148, Fig. 1(a) (below).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 A POSA would have used Ciais's teaching to modify Dou by covering the back surface of PCB 204 with ground plane 210, and placing a Ciais quadband antenna over "the corner of" ground plane 210 to provide Dou antennas 206 and 208.

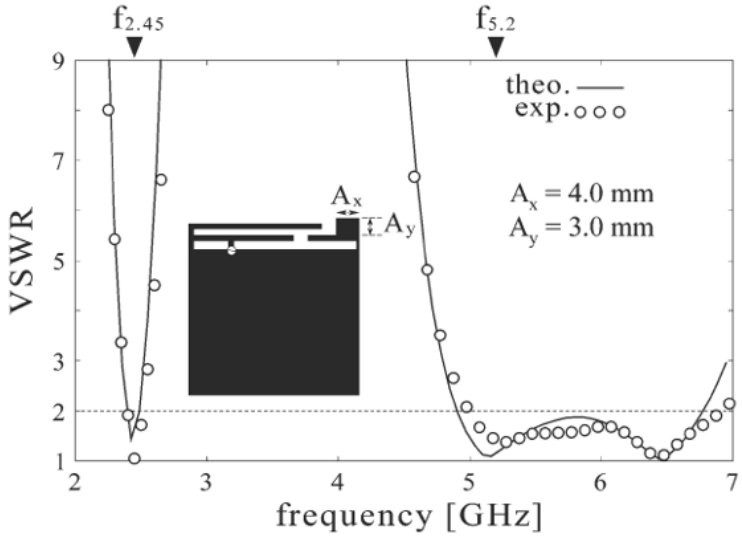
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 Implementing Dou's wireless device with Dou's first antenna 206 and second antenna 208 each provided by a separate Ciais quadband antenna would have been nothing more than combining familiar elements according to known methods with predictable results, and been no more than the "predictable use of prior art elements according to their established functions." KSR, 550 U.S. at 416-417.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		The resulting combination (hereinafter "Dou+Ciais-Quadband+Nakano") has four antennas: antennas 206 and 208 implemented as Ciais-Quadband antennas with spatial diversity supporting frequencies for cellular communications, and two "additional antenna[s]" (Dou, [0040]) implemented as Nakano antennas with spatial diversity supporting frequencies for WLAN/Bluetooth. A POSA would have had a reasonable expectation of success in combining Ciais's and Nakano's teachings with Dou for the reasons explained supra 1[a]. Dou confirms that combining multiple antennas within a single mobile wireless device was conventional and within the POSA's ordinary skill. For example, U.S. Patent Publication No. 2006/0214857 ("Ollikainen") describes "an integrated antenna system" having a WLAN antenna 61, UMTS antenna 62, "GSM 850/900 antenna 63," "GSM1800/1900 UMTS diversity antenna 65," and Bluetooth antenna 66 in a single a "hand-held electronic device" such as a mobile phone or PDA. Ollikainen, Fig. 9, [0006], [0044].  FIG. 9

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		Both Nakano's InvFL antenna and Ciais's quadband antenna were designed for internal use in "mobile phone handsets" like Dou's wireless device. Nakano, 2417; Cias-Quadband, Fig. 3, 148, 150. Dou expressly describes embodiments using planar inverted-L and planar inverted-F antennas (which Nakano combines in an inverted FL antenna) as well as a multiband PIFA antenna—like the Ciais quadband antenna. E.g., Dou, [0028]-[0029]). Dou describes antenna placement within the device according to "various performance and design constraints" known to a POSA, allowing for "any suitable topology… as desired for a given implementation. Dou, [0030], [0039]. Nakano describes an inverted FL antenna extending from a co-planar ground plate while Ciais describes placing the quadband antenna at the end of a PCB "on the corner of a ground plane" where Dou places its antennas 206 and 208. Ciais-Quadband, Fig. 1, 148; Dou, Figs. 2A-2B, [0029]. It was well within the POSA's ordinary skill to implement Dou's wireless device with Nakano's inverted FL antenna, and Ciais's quadband antenna, and the resulting antenna operation for each was predictable. Dou, [0012], [0063]. Dou+Ciais-Quadband+Nakano meets the Challenged Claims as shown below. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. *See, e.g.*, Dou+Ciais-Quadband+Nakano because it uses Dou's ground plane 210 to implement Nakano's and Ciais's ground plane teachings. Dou, Fig. 2B, [0029]; Nakano, 2417-18, Fig. 1(b); Ciais-Quadband, 148, 150, Fig. 1(a).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
1[b]	a first planar antenna	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 1[b] because Dou's modified wireless device has a first Nakano antenna ("first planar antenna") extending from ground plane 210 providing a "co-planar ground plate" as described in Nakano. Nakano, 2417, Fig. 1; Dou, Figs. 2A-2B (annotated below to show Dou+Ciais-Quadband+Nakano). Nakano's antenna is "planar" because its elements "lie in the same plane" and form "a flat structure". Nakano, Abstract, 2417, Fig. 1(b); Dou, [0017], Fig. 2B. 

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		Ground plane 210 covers the back surface of PCB 204 consistent with the ground plane teaching in Ciais-Quadband and Nakano. PCB 204's rectangular area defines a rectangle ("ground plane rectangle") that "enclos[es]" the ground plane 210 disposed on the side of the PCB opposite from antenna 206. Infra, 7[b]); Dou, Figs. 2A-2B, [0016]-[0017], [0029]. The top (e.g., 40.5 mm) edge of the "ground plane rectangle" is a "first side." The first Nakano antenna ("first planar antenna") is "proximate to a first side of a ground plane rectangle" because it extends from it. Dou, Figs. 2A-2B (annotated above), [0016]-[0017], [0029].
1[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[b].
1[d]	the first planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 1[d] because Nakano's antenna (first planar antenna) covers 2400-2500 MHz ("has a 4.1% bandwidth around 2.45 GHz") and at least 5150-5900 MHz ("a 31.8% bandwidth around 5.2 GHz") at VSWR 2.0:1. Nakano, 2417 (Abstract), 2419-20, Fig. 4.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 The 2400 MHz to 2500 MHz frequency range is the ISM 2.4 GHz band used for IEEE 802.11b and Bluetooth. '149 Patent, 25:20-22; IEEE Std. 802.11b-1999, 1 (defining the 802.11 band); Specification of the Bluetooth System version 2.0, volume 2 (issued Nov. 4, 2004), 29 (defining Bluetooth band). The Nakano InvFL antenna's 5150-5900 MHz coverage includes at least five frequency bands as shown in Table 4.

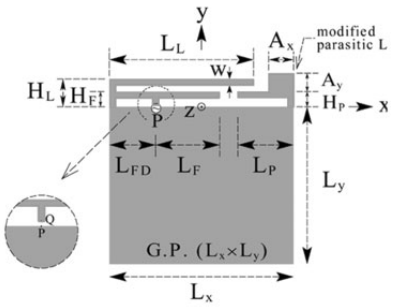
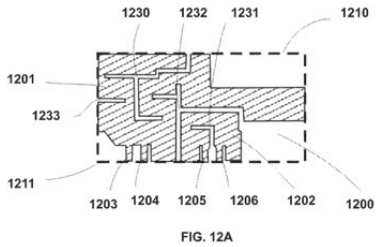
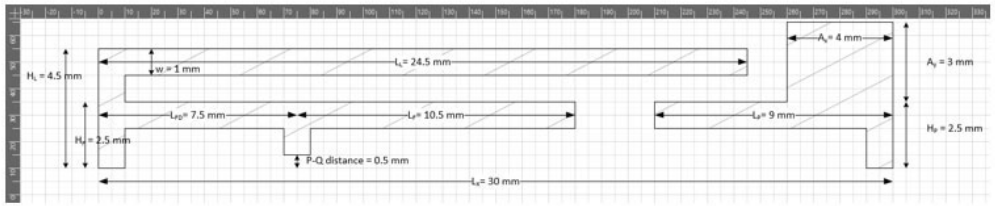
<table>
<tr><th>Claim No.</th><th>U.S. Patent No. 12,095,149 B2</th><th>Dou+Ciais-Quadband+Nakano</th></tr>
<tr><td></td><td></td><td>
Table 4: Frequency bands at 5 GHz
<table>
<tr><th>Band</th><th>Range (MHz)</th></tr>
<tr><td>U-NII lower</td><td>5150-5250</td></tr>
<tr><td>U-NII middle</td><td>5250-5350</td></tr>
<tr><td>U-NII</td><td>5470-5725</td></tr>
<tr><td>U-NII upper</td><td>5725-5825</td></tr>
<tr><td>U-NII</td><td>5850-5895</td></tr>
</table>
IEEE Std. 802.11a-1999, 26 (IEEE Std. 802.11a defining WLAN channels in 5 GHz U-NII bands); 47 C.F.R. §§15.401, 15.403 (U-NII devices in 5.15-5.35 GHz and 5.47-5.895 GHz frequency bands); 47 C.F.R. §§15.407(a)(1) (discussing 5150-5250 MHz U-NII band), 15.407(a)(2) (discussing 5250-5350 MHz and 5470-5725 MHz U-NII bands), 15.407(a)(3)(i) (discussing 5725-5850 MHz U-NII band), 15.407(a)(3)(ii)-(v) (discussing 5850-5895 MHz U-NII band); 69 Fed. Reg. 54027, 54036-54037 (Sep. 7, 2004) (codified at 47 C.F.R. §15.407).

Therefore Nakano’s InvFL antenna is operable in (“configured to support”) frequency ranges used by “at least three frequency bands of the electromagnetic spectrum,” meeting 1[d].
</td></tr>
<tr><td>1[e]</td><td>the first planar antenna defining a first contour,</td><td>
Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element.

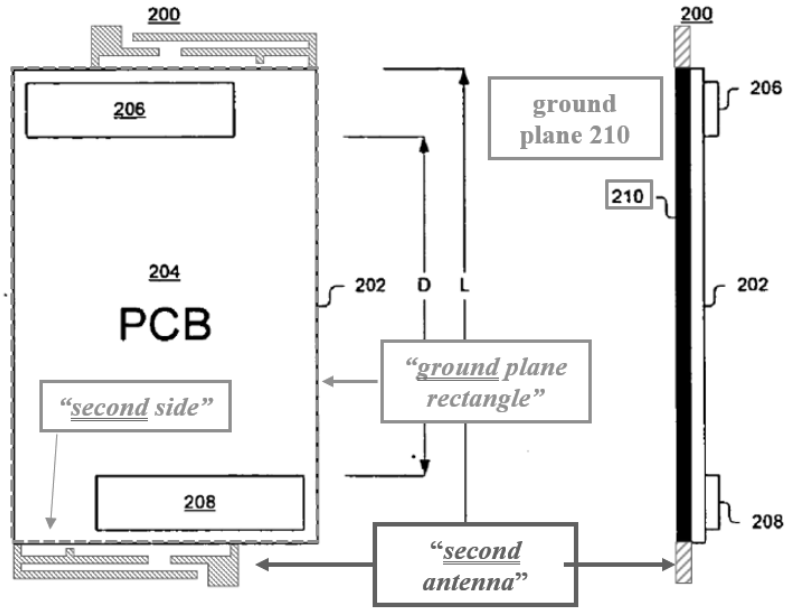
See, e.g.,

Nakano’s antenna defines a “first contour” just like the perimeter of antenna contour 350 in the ’149 patent’s embodiments in Figure 3 or antenna system 1200 in Figure 12A (below right), meeting 1[e]. ’149 Patent, 7:62-64, 33:65-34:7; Nakano, 2417, 2419, Fig. 1(b).
</td></tr>
</table>

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Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		  FIG. 12A Nakano, Fig. 1(b) (annotated) '149 patent Nakano provides antenna dimensions for "a perimeter" of the InvFL antenna defining "a first contour" meeting 1[e] as shown below. Nakano, 2417, 2419 Fig. 1(b).  

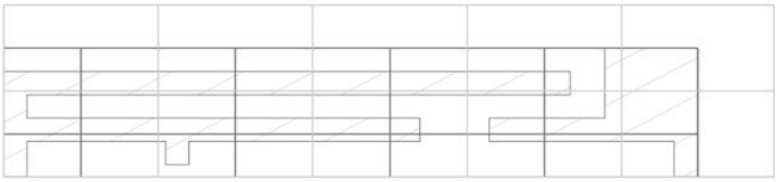
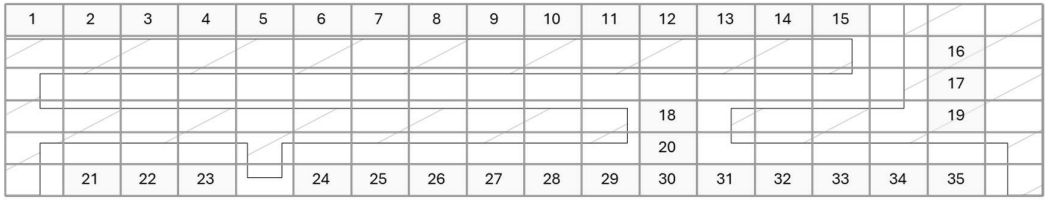
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
1[f]	wherein the first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35; and	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 1[f] because the *first contour* for Nakano's antenna has $F_{21} = 1.43 \geq 1.20$, and $F_{32} = 1.43 \geq 1.35$, as shown for 1[j] below.
1[g]	a second antenna proximate to a second side of the ground plane rectangle,	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 1[g] because as shown below Dou's modified device includes a second Nakano antenna ("second antenna") extending from "a second side of the ground plane rectangle" opposite the "first side" with the first Nakano antenna. *See also* 1[a] (combination).

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 Nakano's antenna (second antenna) meets the remaining limitations in 1[g] because it covers the same frequency bands as the first planar antenna as explained supra (1[d]).
1[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[g].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
1[i]	wherein the first contour is defined as a perimeter of the first planar antenna and perimeters of any closed apertures defined within the first planar antenna;	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[e].
1[j]	wherein the complexity factors F21 and F32 are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, **Grid G2:** Nakano's antenna contour (first contour) is 30 mm wide (long side of the face) and 5.5 mm in height (short side of the face). Nakano, 2417, 2419, Figs. 1(b), 4. Grid G2 with nine (9) columns across a "minimum-sized rectangle enclosing the first planar antenna" yields cell width for columns of equal width of (30mm/9)=3.33 mm. Setting an odd number of "2n+1" rows with integer n such that 0<n<5 yields these cells for "rows of equal height," where the aspect ratio is the ratio of cell width to cell height ('149 Patent, 18:8-10):

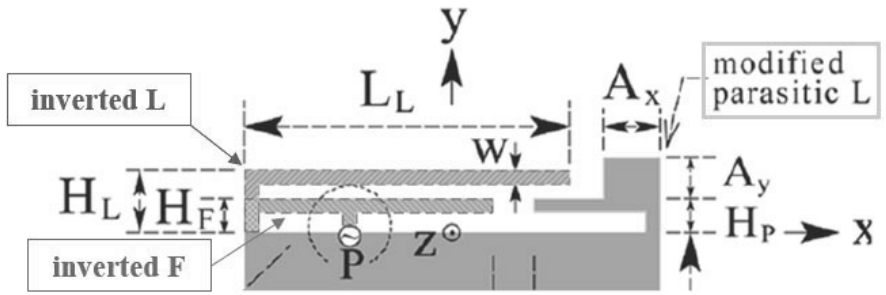
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
	long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle, the cells of the grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	<table><tr><th>Rows</th><th>Cell Height (mm)</th><th>Cell Aspect Ratio $\left(\frac{width}{height}\right)$</th></tr><tr><td>3</td><td>$\left(\frac{5.5}{3}\right) = 1.83$</td><td>$\left(\frac{3.33}{1.83}\right) = 1.82$</td></tr><tr><td>5</td><td>$\left(\frac{5.5}{5}\right) = 1.1$</td><td>$\left(\frac{3.33}{1.1}\right) = 3.03$</td></tr></table> Three (3) rows provides an “odd number of rows of equal height arranged along a short side of the minimum-sized rectangle” with “the cells… being as square as possible” because three rows provides a cell with an aspect ratio closer to 1 (e.g., where width = height) than any other odd number (“2n+1”) of rows with integer n such that 0<n<5. Thus, grid G2 has 3 rows by 9 columns as shown below (blue outline).  **Grid G1:** Grid G1 (orange outline below) is “aligned with a corner of the grid G2” and “cover[s] the face” (e.g., the first contour), wherein each G1 cell has twice the width and height of a G2 cell, e.g., “widths and heights that respectively are double the widths and heights of the cells of the grid G2.”

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 **Grid G3:** Grid G3 (green outline below) is "aligned with the grid G2" and each G2 cell (green) comprises four G3 cells—meaning that G3 cells have "widths and heights that respectively are half the widths and heights of the cells of the grid G2."  **<u>Cell Counts</u>** The count for each grid is shown below. **N1 = 10:** All cells in 2 × 5 grid G1 "include... a point" of the first contour (black outline) so each cell is counted and N1 = 10.

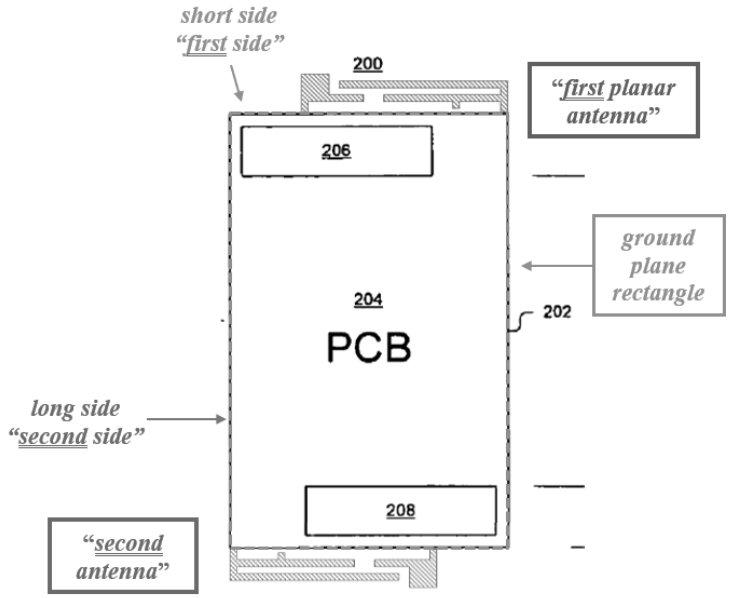
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 **N2 = 27:** As shown below, in 3 × 9 grid G_2 all 27 cells "*include… a point*" of the *first contour* and are counted. Thus, $N_3 = 27$.  **N3 = 73:** In the 6×18 grid G_3 the cells numbered 1-35 (marked below) do ***not*** "*include… a point*" on the *first contour*. Thus, $N_3 = (108 - 35) = 73$.  **<u>Calculation of F21 = 1.43</u>**

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		$$F_{21} = -\left(\frac{\log(N_2) - \log(N_1)}{\log(1/2)}\right) = -\left(\frac{\log(27) - \log(10)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(27/10)}{\log(2)}\right) = \left(\frac{0.431}{0.301}\right) = 1.43.$$ **Calculation of F32 = 1.43** The *complexity factor* F_{32} for the *first contour* is: $$F_{32} = -\left(\frac{\log(N_3) - \log(N_2)}{\log(1/2)}\right) = -\left(\frac{\log(73) - \log(27)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(73/27)}{\log(2)}\right) = \left(\frac{0.432}{0.301}\right) = 1.43.$$
1[k]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 1[k] because Nakano tuned the antenna using "five steps" described therein, "where the first three steps are rough adjustments and the fourth and fifth steps are devoted to a fine-tuning of the design" to obtain "an appropriate VSWR frequency response".



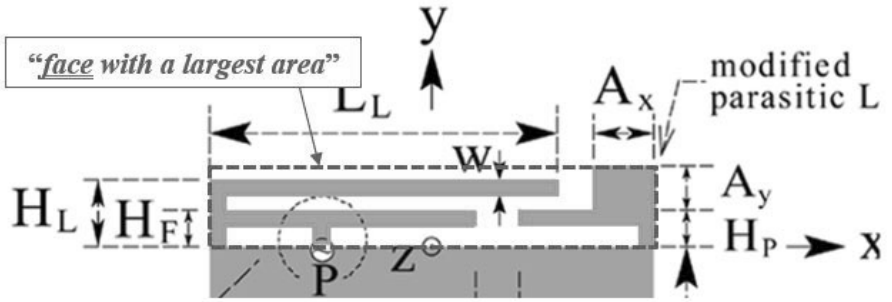
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
2	The wireless device of claim 1, wherein the first planar antenna includes at least two antenna elements that are electromagnetically coupled .	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets claim 2 because Nakano's antenna ("first planar antenna") has "inverted L and F elements" (e.g., "compounded LF") and a "parasitic L" element that have no electrical connection except through the ground plane. Nakano, 2417-2418, Fig. 1(b) (detail below).  Nakano adds the parasitic L element to mitigate the effect on VSWR of mutual coupling between the inverted L and F elements. Nakano, 2418-2419. The parasitic L element is "electromagnetically coupled" to the "compounded LF" elements (e.g., the "inverted L and F elements") because they interact through electromagnetic fields. Pages from R. Graf, Modern Dictionary of Electronics (Newnes: 7th ed. 1999), 242; Pages from S. Gilbilisco, ed., The Illustrated Dictionary of Electronics (McGraw-Hill: 8th ed. 2001), 240, 362. As explained *infra* Claim 8, parasitic antenna elements were known to modify antenna properties by electromagnetic coupling to radiating elements. *See also* U.S. Patent Publication No. 2003/0201942 ("Poilasne"), [0062]-[0063] ("Power is supplied to parasitic component 156 through magnetic coupling"), Figs. 4C-4D.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
Claim 3		
3	The wireless device of claim 1, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets claim 3 because the first side is a short side of the ground plane rectangle as explained *supra* 1[b].
Claim 4		
4	The wireless device of claim 1, wherein the second side of the ground plane rectangle is a long side of the ground plane rectangle.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets claim 4 because Dou's modified ground plane 210 is 40.5×105 mm2 as taught by Ciais-Quadband, so the ground plane rectangle has a "long side" of 105 mm. *See* Claim 1[a]); Ciais-Quadband, 148. In the modified Dou device each Nakano antenna is placed with one edge (the edge of the combined FL element) along the ground plane long edge. *See* Claim 1[a]). Mapping the second side to "a long side of the ground plane rectangle" for claim 4 thus places the second Nakano antenna ("second antenna") "proximate to a second side of the ground plane rectangle" meeting 1[g]-[h] *supra*. Dou, Fig. 2A (annotated below). This meets claim 4.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		 Moreover, the second Nakano antenna would be "proximate" to a "second side" and meet claim 4 regardless of where it is placed along the short side because even if the antenna were centered on the short length of the ground plane side the antenna could at most only be 5.25 mm from a long edge of the PCB and thus the "second side" of the ground plane rectangle.
Claim 5		
5	The wireless device of claim 1, wherein the complexity factor	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*,

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
	F32 for the first contour is smaller than 1.75..	Dou+Ciais-Quadband+Nakano meets claim 5 because the *first contour* $F_{32} = 1.43 < 1.75$, as explained *supra* 1[f], 1[j].
Claim 13		
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[pre].
13[a]	a ground plane;	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[a].
13[b]	a first antenna	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[b], [c].
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 13[b].
13[d]	the first antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[d].

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Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
13[e]	a minimum-sized parallelepiped completely enclosing a volume of the first antenna,	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets 13[e] because it uses Nakano's antenna as the first antenna. Nakano's antenna "is made of a thin conducting film." Nakano, 2417. The "volume" of "a minimum-sized parallelepiped completely enclosing a volume of" Nakano's antenna is a planar 30×5.5 mm2 area enclosing the antenna by the thickness of the thin film. Nakano, 2417, 2419, Figs. 1(b), 4. The "face with a largest area" is the top 30×5.5 mm2 surface of the parallelepiped enclosing Nakano's antenna. 
13[f]	the minimum-sized parallelepiped having a face with a largest area;	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 13[e].

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Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
13[g]	a second antenna proximate to a second side of the ground plane rectangle	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[g]-[h].
13[h]	configured to receive signals from at least two frequency bands of the at least three frequency bands,	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 13[g].
13[i]	wherein the first antenna has a first contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 13[i]. While 13[i] and 1[i] use different language to define a "first contour," as applied to Nakano's antenna ("first antenna") the two definitions yield the same result as explained supra 1[i] and shown below, because Nakano only contains antenna portions within "the face" of the parallelepiped as defined supra 13[c]. 
13[j]	wherein the first contour has a level of complexity defined by	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
	complexity factor F_{21} having a value of at least 1.20 and	*See* Claim 1[f].
13[k]	complexity factor F_{32} having a value of at least 1.35; and	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See also* Claim 13[j].
13[l]	wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[j].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
	side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights of the cells of the grid G2, and	
13[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 1[k].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
Claim 14		
14	The wireless device of claim 13, wherein the first antenna includes at least two antenna elements that are electromagnetically coupled.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 2.
Claim 15		
15	The wireless device of claim 13, wherein the first antenna is planar.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+Ciais-Quadband+Nakano meets claim 15 because Nakano's antenna (first antenna) is planar as explained *supra* 1[b]. Nakano, Abstract, 2417, Fig. 1(b).
Claim 17		
17	The wireless device of claim 13, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 5.
Claim 18		
18[a]	The wireless device of claim 13, wherein a third antenna is	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element.

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Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
	configured to operate in at least two frequency bands being different from the at least three frequency bands and	*See, e.g.*, Dou+Ciais-Quadband+Nakano meets the additional limitations in claim 18 for the reasons it meets claim 6 supra. It meets the remaining limitations in claim 18 because the Dou+Ciais-Quadband+Nakano device arranges Ciais-Quadband's antenna "within the wireless device." Supra 1[a] (combination); Ciais-Quadband, Title ("Design of an Internal Quad-Band Antenna for Mobile Phones"), 148.
18[b]	the third antenna is arranged within the wireless device.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. See Claim 18[a].
Claim 19		
19	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See* Claim 3.
Claim 20		
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	Dou+Ciais-Quadband+Nakano expressly or inherently discloses this claim element. *See, e.g.*, Dou+ Ciais-Quadband+Nakano+'s "first antenna" implemented as Nakano's antenna is adjacent to a long edge of PCB 204, ground plane 210, and the ground plane rectangle that the ground

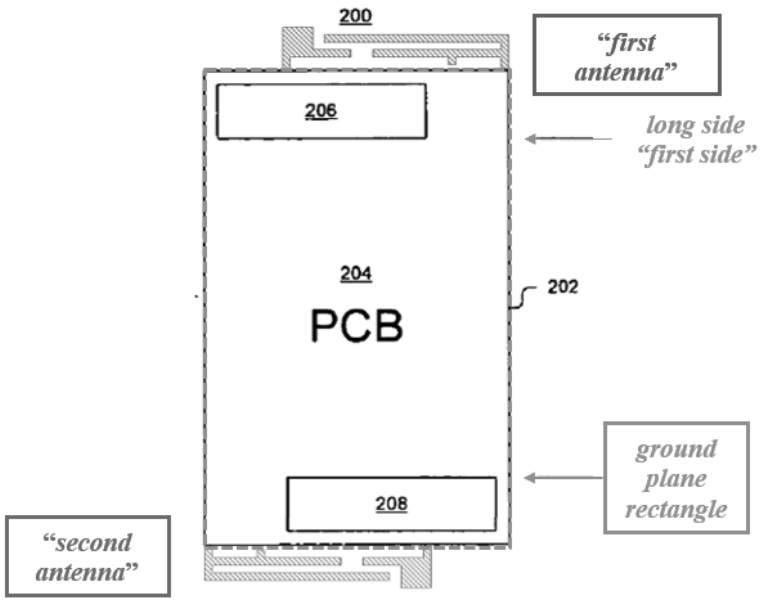
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Ciais-Quadband+Nakano
		plane defines. Supra 1[a] (combination), Claim 1[b]), Claims 3-4), Claim 13[b]); Dou, Fig. 2A (annotated below to show combination).  Thus, the first antenna is "proximate" to a "first side of the ground plane rectangle" and continues to meet 13[b] supra wherein the "first side" is mapped to a "long side" of the "ground plane rectangle," meeting claim 20.

Exhibit – F – 08

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 12,095,149 B2
BASED ON U.S. PATENT APP. PUB. NO. 2007/0200773 ("DOU") AND JING

Based upon Plaintiff's Complaint, Infringement Contentions, and apparent claim constructions and application of the claims to Defendants' accused products, as best as they can be deciphered, the reference charted below anticipates or at least renders obvious some or all of the asserted claims. These invalidity contentions are not an admission by the Defendants that the accused products are covered by or infringe claims 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 (the "'149 Asserted Claims")[1], particularly when these claims are properly construed and applied.

AIA law applies because the application that issued as the '149 Patent was filed on June 22, 2023, after the AIA came into force on March 16, 2013.

U.S. Patent Application Publication No. 2007/0200773 to Dou et al. ("Dou") was filed on February 24, 2006 and published on August 30, 2007. This patent is prior art under at least pre-AIA 35 U.S.C. § 102(a) or (b), (e), and (g)(2), or AIA 35 U.S.C. § 102(a). As described in the following claim chart, the asserted claims of U.S. Patent No. 12,095,149 (the "'149 Patent"), are invalid as anticipated by Dou.

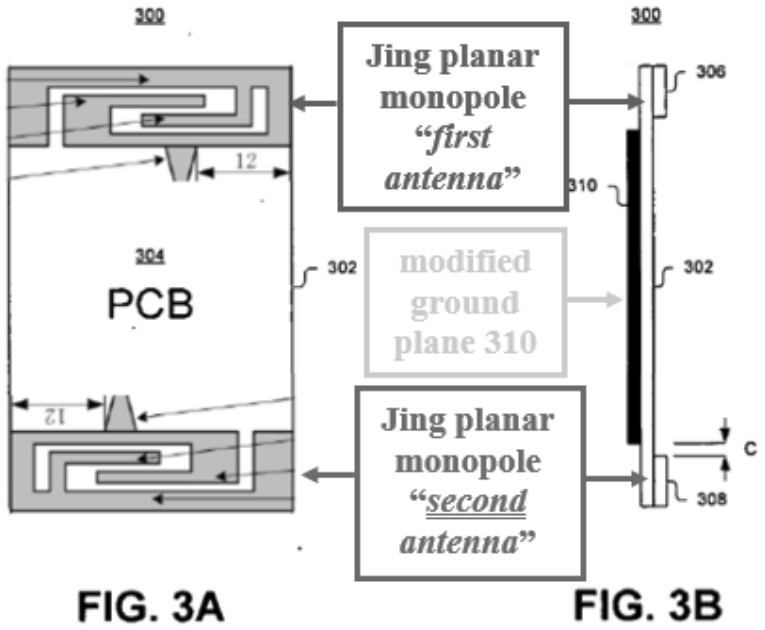
To the extent that Dou is found not to anticipate one or more of the asserted claims of the '149 Patent, these claims are invalid as obvious in view of Dou alone or as modified in view of or in combination with other prior art references disclosed in Defendants' Invalidity Contentions and accompanying charts, including without limitation as set forth below.

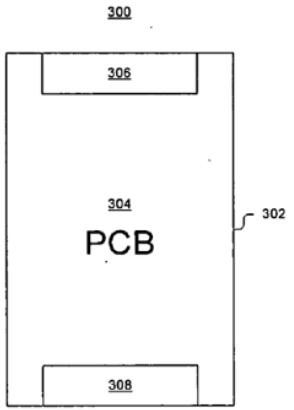
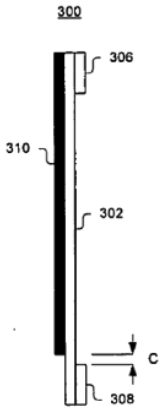
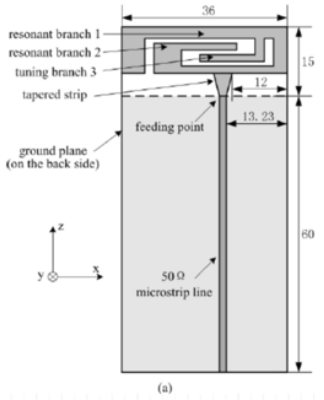
- X. Jing, Z. Du, and K. Gong. "Compact Planar Monopole Antenna for Multi-band Mobile Phones," in 2005 Asia-Pacific Microwave Conference Proceedings, vol. 4, pp. 2657-2660, IEEE, 2005 ("Jing")
- U.S. Patent No. 6,166,694 ("Ying")

These invalidity contentions are not an admission that the Defendants concede or acquiesce to any claim construction implied or suggested by Plaintiff's Complaint or Infringement Contentions. Nor are Defendants asserting any claim construction positions through these charts, including whether the preamble is a limitation. The portions of the prior art reference cited below are not exhaustive but are exemplary in nature. Defendants reserve the right to update their constructions and contentions in view of this Court's claim construction order.[2]

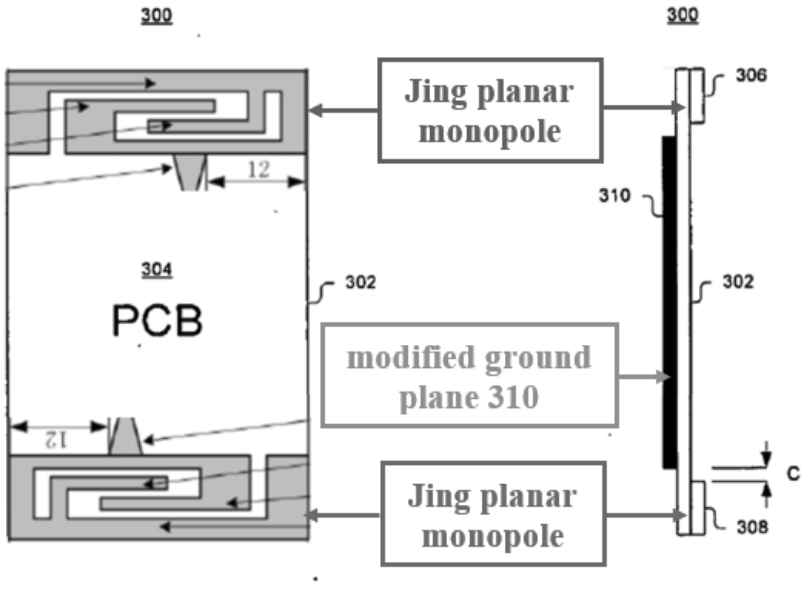
[1] Defendants understand that, by not charting claims 6, 11, and 16 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] Defendants incorporate herein any related work performed by or on behalf of an author or an inventor in the United States under pre-AIA 35 U.S.C. § 102(g). Defendants reserve the right to supplement and/or alter this chart based on further investigation and ongoing discovery.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
Claim 1		
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou describes a wireless device comprising, e.g., a handheld computer, mobile telephone, or PDA. Dou, [0015]-[0016], [0031], claim 1.
1[a]	a ground plane;	Dou expressly or inherently discloses this claim element. *See, e.g.*, Dou's ground plane 310, which serves "to improve antenna performance in talk position and reduce SAR." Dou, Figs. 3A-3B (modified below), [0034].

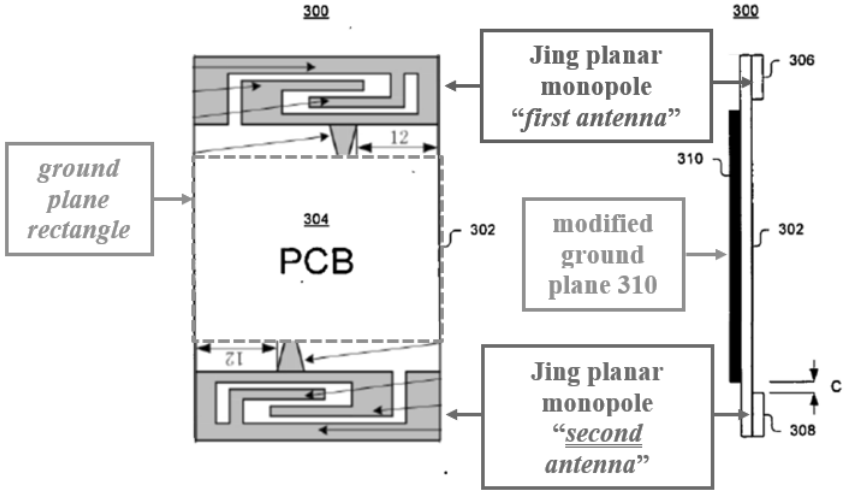
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		 FIG. 3A FIG. 3B
1[b]	a first planar antenna	Dou expressly or inherently discloses this claim element. To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. ***See, e.g.*, Jing:**

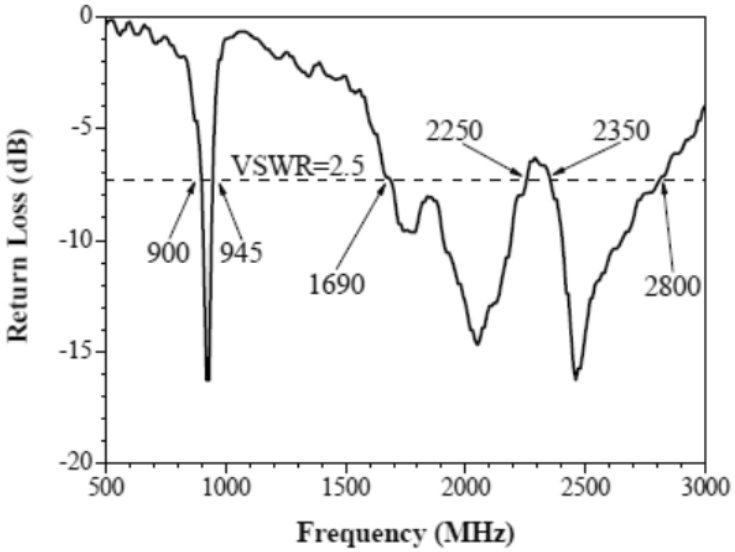
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		While Dou describes a wireless device having internally-mounted antennas, it does not describe particular antennas for achieving its wireless devices. Instead, Dou leaves antenna selection to a POSA. A POSA would have had reasons to use a Jing antenna for each of Dou's first and second antenna. Jing's antenna was designed for internal use in mobile handsets, making it suitable for use as Dou's "internal antenna[s]" 306 and 308 "integrated with the wireless device." Dou, [0033], Figs. 3A-3B (below); Jing, 2657, Fig. 1(a) (below).  FIG. 3A  FIG. 3B  Dou Jing Jing's antenna is a "planar monopole antenna" (Jing, 2657 (Abstract)), which Dou describes using for the first/second antennas. Dou, [0034]. Jing's antenna provided operation at frequencies used by

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		well-known communication standards (DCS, PCS, UMTS, Zigbee, WiFi/Bluetooth) making it "suitable for mobile phone applications" like Dou's device. Jing, 2658, Fig. 3; Dou, [0022] (describing exemplary coverage for PCS, "WCDMA/UMTS," and "ISM band in 2.4 GHz range for WiFi and Bluetooth"). POSAs would have used Jing as Dou's antennas 306 and 308. Dou's PCB 302 has ground plane 310 on the back, just like Jing has a "system ground plane" on the back surface of an FR4 substrate. Dou, Fig. 3B, [0034]; Jing, Fig. 1(a), 2658. POSAs would have recognized that whether the ground plane extends under Dou's antennas depends on the specifications required by the implemented antennas. Dou places antenna 308 at "no less than 5 mm" offset from ground plane 310 just like Jing places its antenna with a 5 mm taper offsetting it from its ground plane. Dou, Fig. 3B, [0034]; Jing, Fig. 1(a), 2657-2658. POSAs would have implemented Dou's antenna 306 and 308 using a Jing antenna for each and Jing's 36 × 60 mm ground plane as a modified ground plane 310, to achieve Dou's diversity architecture. Dou, [0034] (explaining embodiments not limited to depiction in Fig. 3). As shown in modified Dou Figs. 3A-3B (below), consistent with Jing's teachings, POSAs would have limited the extent of Dou's ground plane 310 to not extend behind Jing's antenna at 306, just like Dou does not extend it behind antenna 308.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		 FIG. 3A FIG. 3B Implementing Dou's antennas 306 and 308 using separate Jing antennas would have combined familiar elements according to known methods with predictable results, KSR, 550 U.S. at 416, and been no more than the "predictable use of prior art elements according to their established functions." *Id*., 417. POSAs would have reasonably expected success using Jing's antenna in Dou's device because Jing designed its antenna for internal use in mobile handsets (Jing, 2657), and Dou expressly contemplates

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		using multiband PIFA antennas—like Jing's—as its first/second internal antenna (e.g., Dou, [0028]-[0029], [0034]). Dou describes antenna placement within the device according to "various performance and design constraints" known to POSAs. Dou, [0030]. Jing describes placing its antenna at the end of a PCB, just like Dou. Jing, Fig. 1(a), 2657; Dou, Figs. 3A-3B, [0031]-[0032]. It was well-within the POSA's ordinary skill to implement Dou's device with Jing's antenna, and the resulting antenna operation was predictable. Dou, [0012], [0063]. The combination ("Dou+Jing") thus had at least two antennas: Dou antennas 306 and 308 each implement by a separate Jing antenna, and renders obvious the Challenged Claims as shown below. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. *See, e.g.*, Dou+Jing meets 1[b] because Dou's antenna 306 (first planar antenna) is "located substantially at the top of… the PCB 304[.]" Dou, [0032]-[0033]. Jing's antenna is "planar" because it is "printed on" a planar PCB surface. Jing, Abstract, 2657-2658, Fig. 1(a); Dou, [0034], Fig. 3B. Dou describes ground plane 310 disposed on the back of PCB 304. Dou, Fig. 3B, [0032], [0034]. In Dou+Jing, ground plane 310 conforms to the dimensions of the ground plane in Jing, which is coterminous with the FR4 substrate (e.g., with dimensions 36 mm × 60 mm) but not extending beneath Jing's antenna. Jing, 2657-2658, Fig. 1(a). Jing places its antenna on the substrate's top surface "proximate" to a 36 mm wide edge (first short side) of a rectangle enclosing the ground plane on the substrate's opposite side. Jing, 2658, Fig. 1(a) (below). In Dou+Jing, modified ground plane 310 is bounded (e.g., enclos[ed]) by a 36 mm × 60 mm rectangle (ground plane rectangle) as Jing describes. Jing's antenna implementing Dou's antenna 306 is

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		"proximate to a first side" of that ground plane rectangle because it extends from the 36 mm first short side of the rectangle enclosing the ground plane. Jing, 2657-2658, Fig. 1(a); Dou, Figs. 3A-3B (as modified below), [0032]-[0034] (antenna is "located substantially at the top of… the PCB 304," but "the ground plane 310 does not extend underneath" it).  FIG. 3A FIG. 3B Dou+Jing
1[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[c].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
1[d]	the first planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets 1[d] because Jing's antenna (first planar antenna) operates—within the "electromagnetic spectrum"—at 900-945 MHz, 1690-2250 MHz and 2350-2800 MHz with VSWR 2.5:1. Jing, 2658, Fig. 3 (below).  The 900-945 MHz range contains the ISM band at 902-928 MHz, which is used by Zigbee. ZigBee Specification (Jun. 27, 2005), 70.

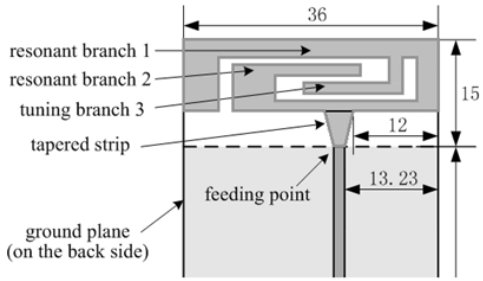
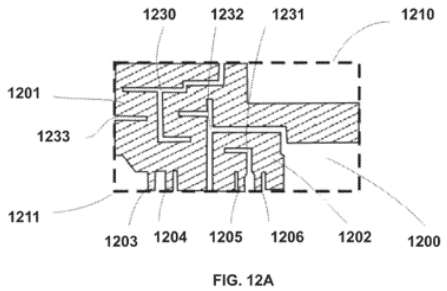
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<tr><th>Claim No.</th><th>U.S. Patent No. 12,095,149 B2</th><th>Dou+Jing</th></tr>
<tr><td></td><td></td><td>
The 1690-2250 MHz range contains at least the same twenty-one “frequency bands” within the frequency range 1710-2170 MHz as shown in Table 5 above. Jing, 2658 (DCS, PCS, UMTS).

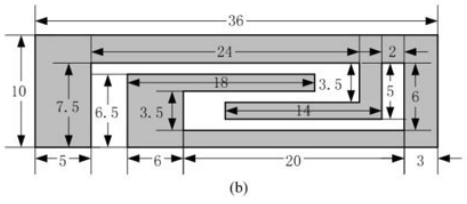
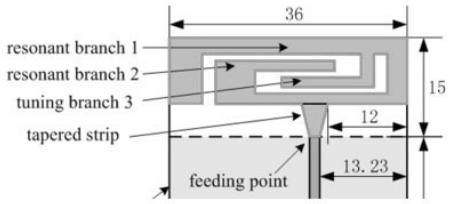
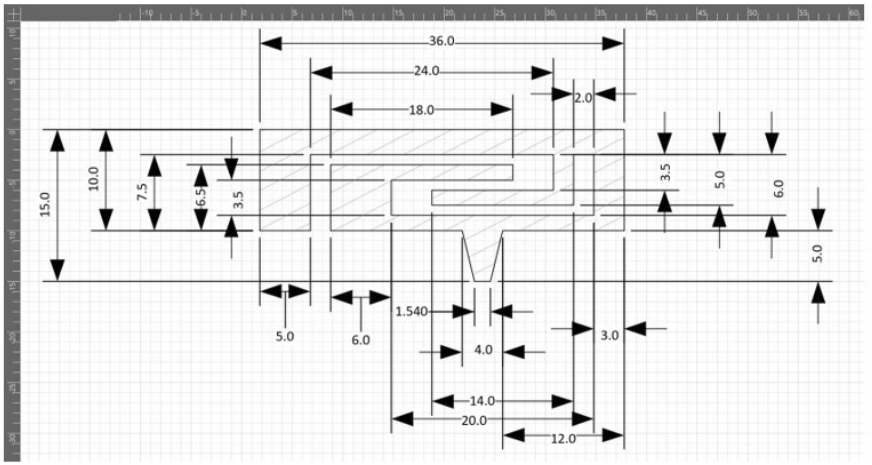
The 2350-2800 MHz range contains at least three “frequency bands” shown in Table 6.

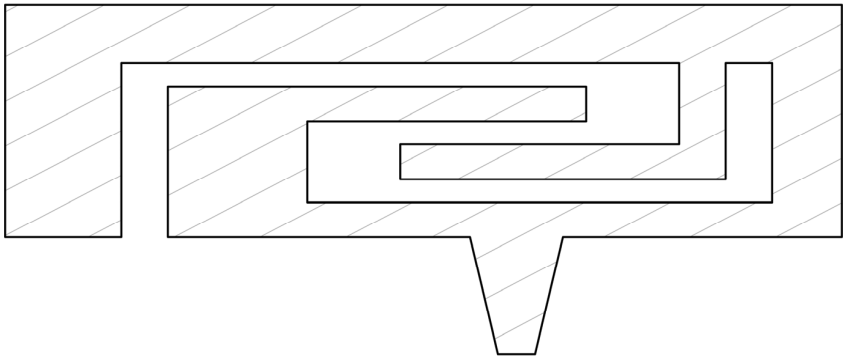
Table 6: Frequency bands within 2350-2800 MHz

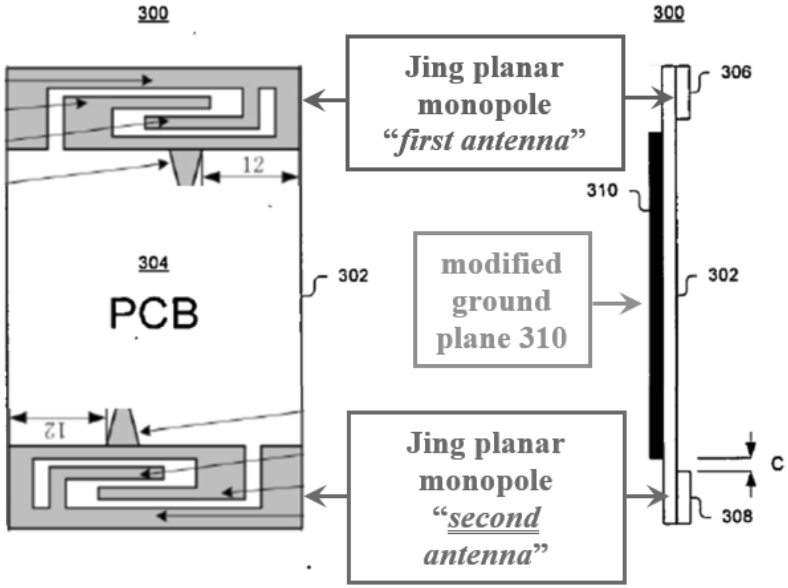
<table>
<tr><th>Band</th><th>Range (MHz)</th></tr>
<tr><td>ISM 2.4 GHz</td><td>2400-2500</td></tr>
<tr><td>LTE Band 7</td><td>2500-2690</td></tr>
<tr><td>LTE Band 38</td><td>2570-2620</td></tr>
</table>

Jing, 2658 (WLAN); D.I. 1, Complaint, Fractus, S.A., v. Geotab Inc., No. 2:24-cv-01008 (E.D. Tex. Dec. 6, 2024), 27 (Fractus citing LTE bands); 3GPP TS 36.101 v8.4.0 (2008-12) Technical Specification: 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (Release 8), 2008 (“LTE-standard”), 13, Table 5.5-1 (“E-UTRA operating bands” defining LTE bands); Ericsson white paper, “LTE—an introduction,” no. 284 23-3124 Uen Rev B (June 2009), 11 (listing LTE FDD and TDD bands); ZigBee Specification (Jun. 27, 2005), 70 (listing ZigBee bands); Pages from E. Dahlman et al., 3G Evolution: HSPA and LTE for Mobile Broadband (Academic Press 2d ed. 2008), 497-501; 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), 1 (defining the 802.11 band);
</td></tr>
</table>

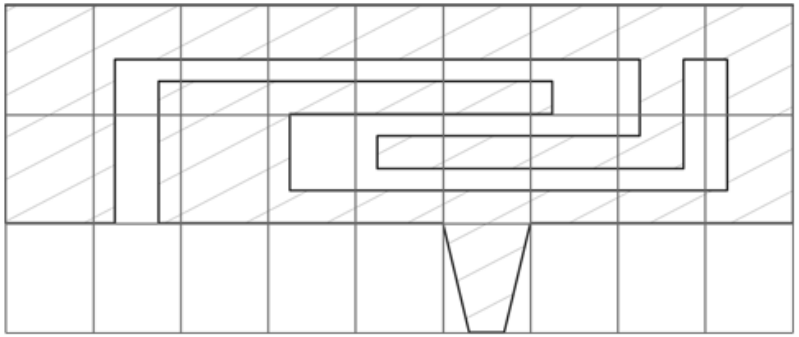
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		Specification of the Bluetooth System version 2.0, volume 2 (issued Nov. 4, 2004), 29 (defining Bluetooth band). Thus, Jing's antenna meets 1[d] because it operates in (e.g., is operable to send and receive radiation in) at least twenty-five (25) bands.
1[e]	the first planar antenna defining a first contour,	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Jing's antenna defines a "first contour" just like the perimeter of antenna contour 350 in the '149 patent's embodiments in Figure 3 or antenna system 1200 in Figure 12A (below right), meeting 1[e] and 1[i]. '149 Patent, 7:62-64, 33:65-34:7; Jing, 2658 ("The planar monopole occupies an area of 36×15 mm2.").  Jing, Fig. 1(a) (annotated detail)  FIG. 12A '200 patent A scaled rendering of Jing's "first contour" is generated from the dimensions in Jing. Jing, 2657-2658, Figs. 1(a)-1(b) (annotated detail below); Weide, ¶321.

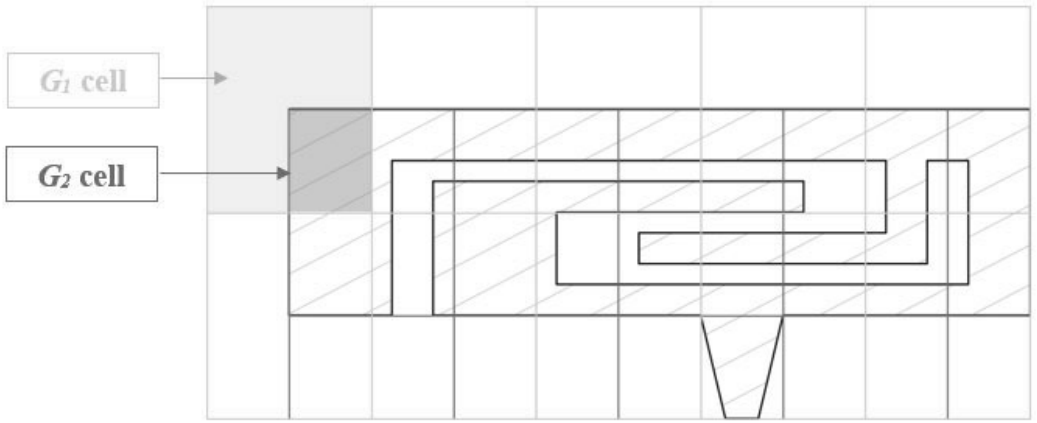
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		  

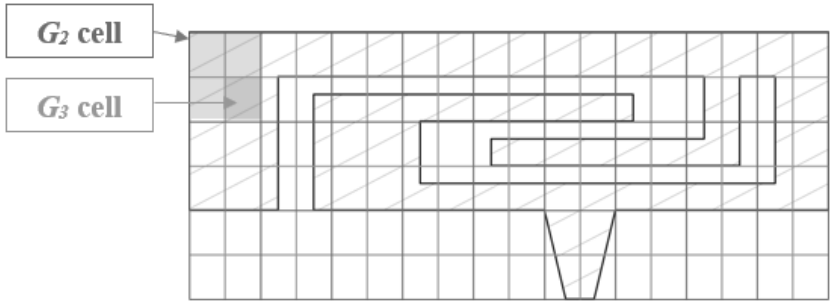
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		
1[f]	wherein the first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35; and	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets 1[f] because the first contour for Jing's antenna implementing Dou antenna 306, (see 1[e], 1[i]), has F21= 1.43≥1.20, and F32= 1.70≥1.35, as shown for 1[j] below.
1[g]	a second antenna proximate to a second side of the ground plane rectangle,	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets 1[g] because it implements Dou antenna 308 as a Jing antenna (second antenna). Jing's antenna is 36 mm wide and extends at each end to the two long edges of PCB 302, as shown below (modified Dou Figs. 3A-3B). Each long edge of PCB 302 coincides with a "long side of the ground plane rectangle" that encloses modified ground plane 310 shown below.

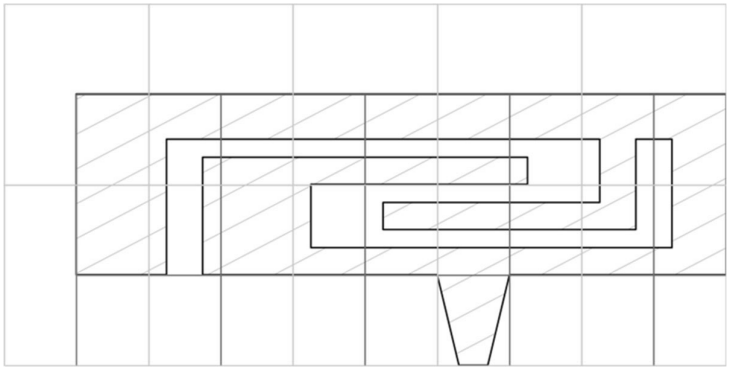
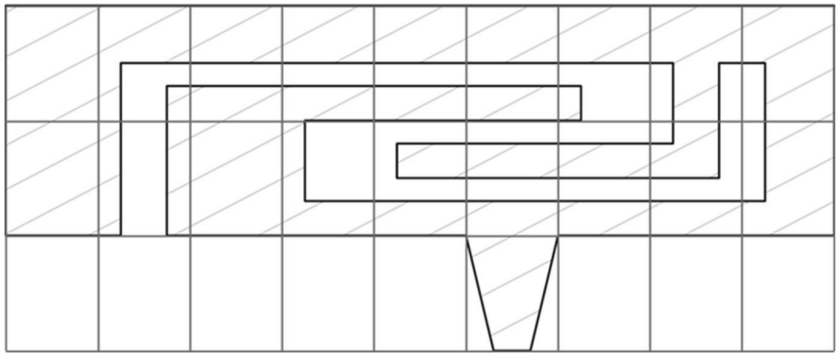
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		Since Jing's antenna and ground plane are both 36 mm wide, and positioned next to the ground plane rectangle, using two Jing antennas in Dou's device locates both antennas "proximate to" a short side (36 mm edge) and a "long side" (60 mm edge) of "the ground plane rectangle" (orange outline).  FIG. 3A FIG. 3B Jing's antenna (second antenna) meets the remaining limitations in 1[g] because it covers the same frequency bands as the first antenna as explained supra 1[d].
1[h]	wherein the second antenna is configured to receive	Dou+Jing expressly or inherently discloses this claim element.

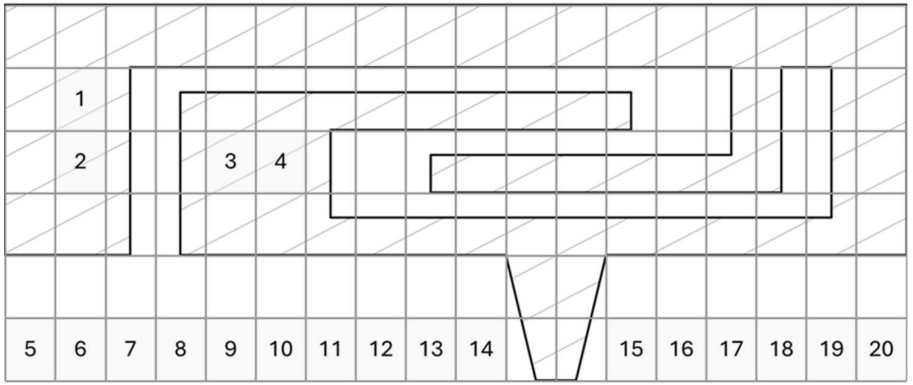
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	signals from at least two frequency bands of the at least three frequency bands;	*See* Claim 1[g].
1[i]	wherein the first contour is defined as a perimeter of the first planar antenna and perimeters of any closed apertures defined within the first planar antenna;	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[e].
1[j]	wherein the complexity factors F21 and F32 are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, The complexity factors are calculated as follows: **Grid G2:** Jing's antenna contour (*first contour*) is 36 mm wide (*long side of the face*) and 15 mm in height (*short side of the face*). Jing, 920, Fig. 1(b). Grid G_2 with nine (9) columns yields cell width (*columns of equal width*) of $\left(\frac{36mm}{9}\right) = 4.0\ mm$. Three (3) rows provides an "*odd number of rows*" with "*the cells… being as square as possible*" because it provides a cell with an aspect ratio closer to 1 (e.g., where width = height) than any other (2*n*+1) rows with integer *n*, $(0 < n < 5)$.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	least a point of the first contour, the grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle, the cells of the grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	<table><tr><th>Rows</th><th>Cell Height (mm)</th><th>Cell Aspect Ratio $\left(\frac{width}{height}\right)$</th></tr><tr><td>3</td><td>$\left(\frac{15}{3}\right) = 5.0$</td><td>$\left(\frac{4.0}{5.0}\right) = 0.80$</td></tr><tr><td>5</td><td>$\left(\frac{15}{5}\right) = 3.0$</td><td>$\left(\frac{4.0}{3.0}\right) = 1.33$</td></tr></table> Thus, grid G_2 has 3 rows by 9 columns as shown below (blue outline). Grid G_2  **Grid G1:**

		Grid G_1 (orange outline below) is "*aligned with a corner of the grid G_2*" and "*cover[s] the face*" (e.g., the *first contour*), wherein each G_1 cell has twice the width and height of a G_2 cell, e.g., "*widths and heights that respectively are double the widths and heights of the cells of the grid G_2*".  **Grid G3:** Grid G_3 (green outline below) is "*aligned with the grid G_2*" and each G_2 cell (green) comprises ***four*** G_3 cells—meaning that G_3 cells have "*widths and heights that respectively are half the widths and heights of the cells of the grid G_2.*"

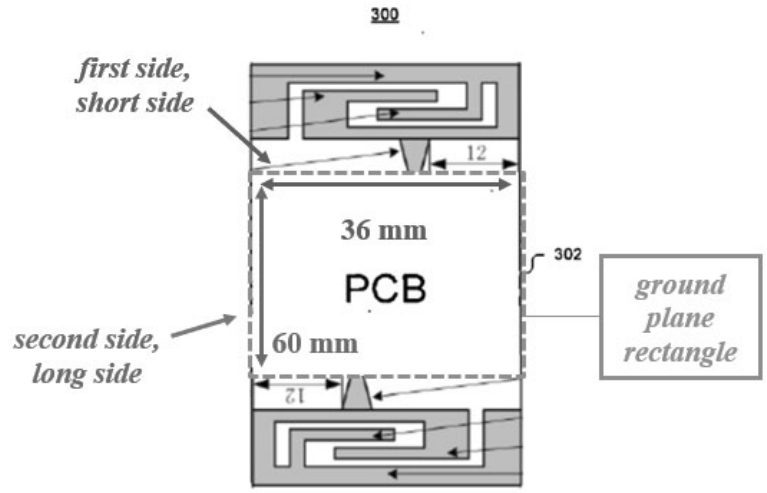
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		 **<u>Cell Counts</u>:** The count for each grid is shown below. **N1 = 10** All cells in 2 × 5 grid G_1 "*include... a point*" of the *first contour* (black outline) so each cell is counted and $N_1 = 10$.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		 **N2 = 27** As shown below, in 3×9 grid G_2 all 27 cells "*include… a point*" of the *first contour* and are counted. Thus, $N_3 = 27$.  **N3 = 88**

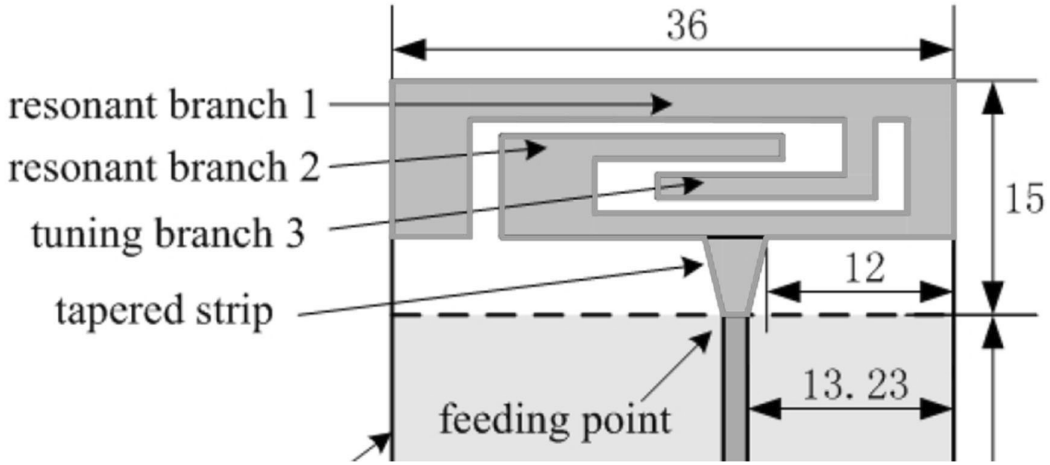
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		In the 6×18 grid G_3 the cells numbered 1-20 (marked below) do ***not*** "*include… a point*" on the *first contour*. Thus, $N_3 = (108 - 20) = 88$.  **<u>Calculation F21</u> = 1.43** The *complexity factor* F_{21} for the *first contour* is: $$\boldsymbol{F_{21}} = -\left(\frac{\log(N_2) - \log(N_1)}{\log(1/2)}\right) = -\left(\frac{\log(27) - \log(10)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(27/10)}{\log(2)}\right) = \left(\frac{0.431}{0.301}\right) = 1.43.$$

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		<u>Calculation F32</u> = 1.70 The *complexity factor* F_{32} for the *first contour* is: $$F_{32} = -\left(\frac{\log(N_3) - \log(N_2)}{\log(1/2)}\right) = -\left(\frac{\log(88) - \log(27)}{(-1)\log(2)}\right)$$ $$= \left(\frac{\log(88/27)}{\log(2)}\right) = \left(\frac{0.513}{0.301}\right) = 1.70.$$
1[k]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets 1[k] because Jing tuned the antenna "by carefully adjusting the dimensions of branch 3," based on which "the fundamental and higher modes of branch 1 can be tuned to appropriate frequencies." Jing, 2657-2658. Jing thereby "configured" the antenna's first contour's "level of complexity" to provide the frequency operation discussed supra 1[d]) because the "complexity" measures the antenna's physical features as captured by orthogonal projection in the antenna "contour". '149 Patent, 16:64-17:4, 19:27-30, 20:19-22. Jing's antenna's "first contour" also meets 1[k] under Fractus's litigation arguments because Jing's antenna is optimized to support operation in the frequency bands discussed.

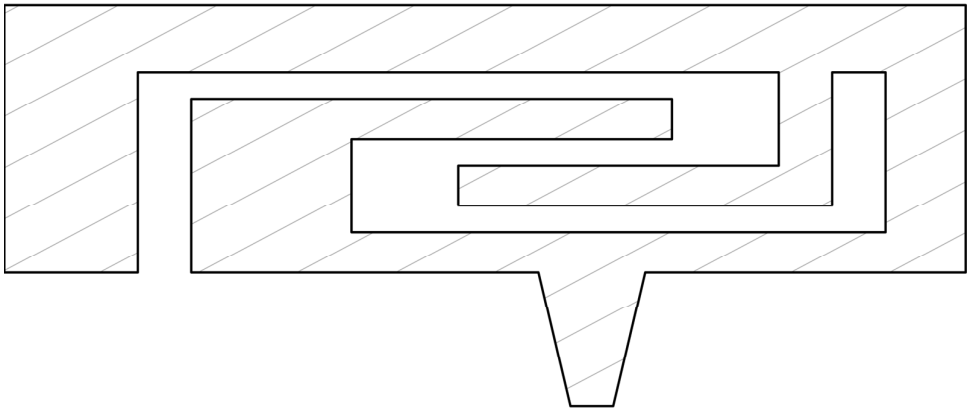
Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
Claim 3		
3	The wireless device of claim 1, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets claim 3 because the "first side of the ground plane rectangle" supra 1[b] is 36 mm long which is shorter than the 60 mm long axis of the rectangle and is thus a short side.
Claim 4		
4	The wireless device of claim 1, wherein the second side of the ground plane rectangle is a long side of the ground plane rectangle.	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets claim 4 because Jing's antenna implementing Dou antenna 308 ("second antenna") spans the ground plane rectangle, making it adjacent to "a long side of the ground plane rectangle." Dou, Figs. 3A, 3B; supra 1[g]-[h].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		 FIG. 3A
Claim 5		
5	The wireless device of claim 1, wherein the complexity factor F32 for the first contour is smaller than 1.75.	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets claim 5 because the *first contour* $F_{32} = 1.70 < 1.75$, as explained *supra* 1[f].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
Claim 13		
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[pre].
13[a]	a ground plane;	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[a].
13[b]	a first antenna	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[b].
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[b], [c].
13[d]	the first antenna being configured to support at least three frequency bands	Dou+Jing expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	of the electromagnetic spectrum,	*See* Claim 1[d].
13[e]	a minimum-sized parallelepiped completely enclosing a volume of the first antenna,	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets 13[e] because it uses Jing's antenna for Dou antenna 306 (first antenna). Jing's antenna is printed on a PCB. Supra 1[b]. The "volume" of "a minimum-sized parallelepiped completely enclosing a volume of" Jing's antenna is planar 36×15 mm2 area enclosing the antenna by the 0.8 mm thickness of the printed trace and the substrate supporting it. Jing, 2658, Fig. 1. The "face with a largest area" is the top 36×15 mm2 surface of the parallelepiped enclosing Jing's antenna trace. 

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
13[f]	the minimum-sized parallelepiped having a face with a largest area;	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 13[e].
13[g]	a second antenna proximate to a second side of the ground plane rectangle	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[g], [h].
13[h]	configured to receive signals from at least two frequency bands of the at least three frequency bands,	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 13[g].
13[i]	wherein the first antenna has a first contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, While 13[i] and 1[i] use different language to define a "first contour," as applied to Jing's antenna ("first antenna") the two definitions yield the same result as explained supra 1[i] and shown below, because Jing only contains antenna portions within "the face" of the parallelepiped as defined supra 13[e].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	
13[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[f].
13[k]	complexity factor F_{32} having a value of at least 1.35; and	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[f].
13[l]	wherein the complexity factors F_{21} and F_{32} are given by:	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[j].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible,	

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights of the cells of the grid G2, and	
13[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 1[k].

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		Claim 15
15	The wireless device of claim 13, wherein the first antenna is planar.	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing meets claim 15 because Jing's antenna implementing Dou's antenna 306 (first antenna) is planar as explained supra 1[b]. Jing, Abstract, 2657-2658, Fig. 1(a).
		Claim 17
17	The wireless device of claim 13, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 5.
		Claim 18
18[a]	The wireless device of claim 13, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	Dou+Jing expressly or inherently discloses this claim element. To the extent that this reference does not expressly disclose this claim limitation, in light of Plaintiff's apparent claim construction and infringement positions with respect to the Accused Products, a POSA would have understood it to implicitly disclose it or would have found the claim limitation obvious. ***See, e.g.*, Ying:** Dou+Jing does not provide coverage for GPS (at 1575 MHz), and Jing's antenna provided "insufficient bandwidth to cover the GSM (890-960 MHz) band." Jing, 2658, Fig. 3. A POSA would

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		have had reasons to use Ying's antenna, covering GPS and GSM900, with Dou+Jing, in order to provide Dou+Jing's wireless device with GPS and GSM900 coverage. This would have provided a wireless device with coverage for the GPS and GSM services that Dou describes its wireless device having. Dou, [0022]. As explained in Ex. F-06 (Dou+Ciais-Multiband+Hilgers), it was conventional for mobile devices to comprise multiple internal antennas, and Dou describes its device having "three or more" antennas. Dou, [0040]. Ying's antenna was designed for use within a multi-antenna device such as Dou's. Ying, 5:26 ("GSM+GPS"), 3:43-46 ("phones which need multiple antennas"). Implementing Dou+Jing's wireless device further including Ying's dual-band GPS/GSM900 antenna would have been nothing more than combining familiar elements according to known methods with predictable results, and been no more than the "predictable use of prior art elements according to their established functions." KSR, 550 U.S. at 416-417. This combination would have provided the multiband coverage that Dou describes. A POSA also would have had a reasonable expectation of success including Ying's GPS/GSM900 antenna in Dou's wireless device—as Dou describes—because it was conventional (U.S. Patent Publication No. 2006/0214857 ("Ollikainen"), [0044]), Dou explains that "the antenna architecture may comprise three or more antennas" (Dou, [0040]), and Dou specifically describes the wireless device having coverage including for GPS and GSM (Dou, [0022]). This combination of Dou in view of Jing, and further in view of Ying (hereinafter "Dou+Jing+Ying") has three antennas: antennas 306 and 308 (each a Jing antenna), and Ying's dual-band GPS/GSM900 antenna, and meets claims 6 and 18 as shown below. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Defendants' Invalidity Contentions

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
		based on knowledge of one of ordinary skill in the art and for the reasons articulated in Defendants' Invalidity Contentions Cover Pleading. *See, e.g.*, Dou+Jing+Ying meets the additional limitations in claim 18 because Ying's dual-band antenna (third antenna) covers (is configured to operate in) 880-960 MHz (for GSM900) and 1575 MHz (for GPS) (at least two frequency bands being different). Jing's antenna does not cover 1575 MHz, and Jing's antenna does not cover the full 890-960 MHz band for standard GSM900. Supra 1[d]; Ying, 5:13-28; Jing, 2658 (measured bandwidth is "insufficient to cover the GSM (890-960 MHz) band."). Thus, Ying's antenna covers "at least two frequency bands that are different" from those Jing covers. It meets the remaining limitations in claim 18 because the Dou+Jing+Ying device arranges Ying's antenna "within the wireless device." Ying, 1:12-15 (Ying provides "built-in antennas which can be incorporated into portable terminals.").
18[b]	the third antenna is arranged within the wireless device.	Dou expressly or inherently discloses this claim element. *See* Claim 18[a].
Claim 19		
19	The wireless device of claim 13, wherein the first side of the ground plane	Dou+Jing expressly or inherently discloses this claim element. *See* Claim 3.

Claim No.	U.S. Patent No. 12,095,149 B2	Dou+Jing
	rectangle is a short side of the ground plane rectangle.	
Claim 20		
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	Dou+Jing expressly or inherently discloses this claim element. *See, e.g.*, Dou+Jing's antenna 306 as Jing's antenna spans PCB 304, so that it is placed proximate both a short side and a long side of the ground plane rectangle. Supra 1[b], 13[b]. While in claims 12 and 19 the "first side" is mapped to a "short side," for claim 20, the "first side" is mapped to a "long side" as shown below, without any change to the claim 13 analysis because Jing's antenna implementing Dou antenna 306 ("first antenna") is "proximate" to the "long side" of the "ground plane rectangle" shown supra 1[b], 13[b]. Dou, Figs. 3A, 3B.

Exhibit – F – 09

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 12,095,149 B2
BASED ON THE DELL LATITUDE D820 ("D820")

Based upon Plaintiff's Complaint, Infringement Contentions, and apparent claim constructions and application of the claims to Defendants' accused products, as best as they can be deciphered, the reference charted below anticipates or at least renders obvious some or all of claims 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 (the "'149 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendant that the accused products are covered by or infringe the asserted claims, particularly when these claims are properly construed and applied.

AIA law applies because the application that issued as the '149 Patent was filed on June 22, 2023, after the AIA came into force on March 16, 2013.

The Dell Technologies Inc. ("Dell") Latitude D820, as publicly demonstrated, known, offered for sale, sold, and/or used by Dell and/or customers of Dell or otherwise available to the public, including in this country (the "D820") was available for purchase in the United States no later than March 28, 2006[2], which is prior to the critical date of the '149 patent. Thus, the D820 is available as prior art at least under at least pre-AIA 35 U.S.C. § 102(a)-(b), (g)(2) and/or AIA 35 U.S.C. § 102(a). At least the following documents provide evidence as to the date the D820 was "offered for sale or publicly used or known," "the date the offer or use of the item took place or the information became known", and the "identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known"[3]:

[1] Defendants understand that, by not charting claims 6, 11, and 16 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* https://www.cnet.com/reviews/dell-latitude-d820-review/
[3] Defendants do not yet have complete information regarding the dates by which this product was publicly disclosed, made, used, sold, or offered for sale, the circumstances under which the research, design, and development activities were conducted, and the identities of the particular individuals involved in such activities. Defendants anticipate that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Defendants therefore reserve the right to amend and/or supplement their Invalidity Contentions and this chart if additional information becomes available during the course of discovery. The date the D820 was "offered for sale or publicly used or known," as well as "the date the offer or use of the item took place or the information became known" is at least as early as the dates identified in the published documents. The "identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known" includes at least those persons associated with the publication(s), press releases, and conference attendees, or other documents associated with each version on the D820. Defendants also reserve the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Defendants have had a fair opportunity to take discovery on these subjects.

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- CNET Website, "Dell Latitude D820 review: Dell Latitude D820," https://www.cnet.com/reviews/dell-latitude-d820-review/ (March 28, 2006) (last accessed June 17, 2025)
- Archive.org, "Dell Latitude Notebooks" (April 27, 2006) at: https://web.archive.org/web/20060427211623/http:/www1.us.dell.com/content/products/category.aspx/latit?c=us&cs=04&l=en&s=bsd&~ck=mn (last accessed June 14, 2025).
- O'Grady's PowerPage Website, "Dell Latitude D820 with Intel Core Duo Processor" (March 30, 2006), at: https://www.powerpage.org/dell-latitude-d820-with-intel-core-duo-processor/ (last accessed June 17, 2025).
- NotebookCheck Website, "Dell Latitude D820" at: https://www.notebookcheck.net/Dell-Latitude-D820.1621.0.html (last accessed June 17, 2025).
- Wikipedia, "Dell Latitude" at: https://en.wikipedia.org/wiki/Dell_Latitude (last accessed June 14, 2025).

As described in the following claim chart, the asserted claims of U.S. Patent No. 12,095,149 (the "'149 Patent"), are invalid as anticipated by D820. To the extent that D820 is found not to anticipate one or more of the asserted claims of the '149 Patent, these claims are invalid as obvious in view of D820 alone or in combination with other prior art references disclosed in Defendants' Invalidity Contentions and accompanying charts, including without limitation as set forth below.

- U.S. Patent Application Publication Gaucher et al. U.S. 2006/0082503 ("Gaucher")

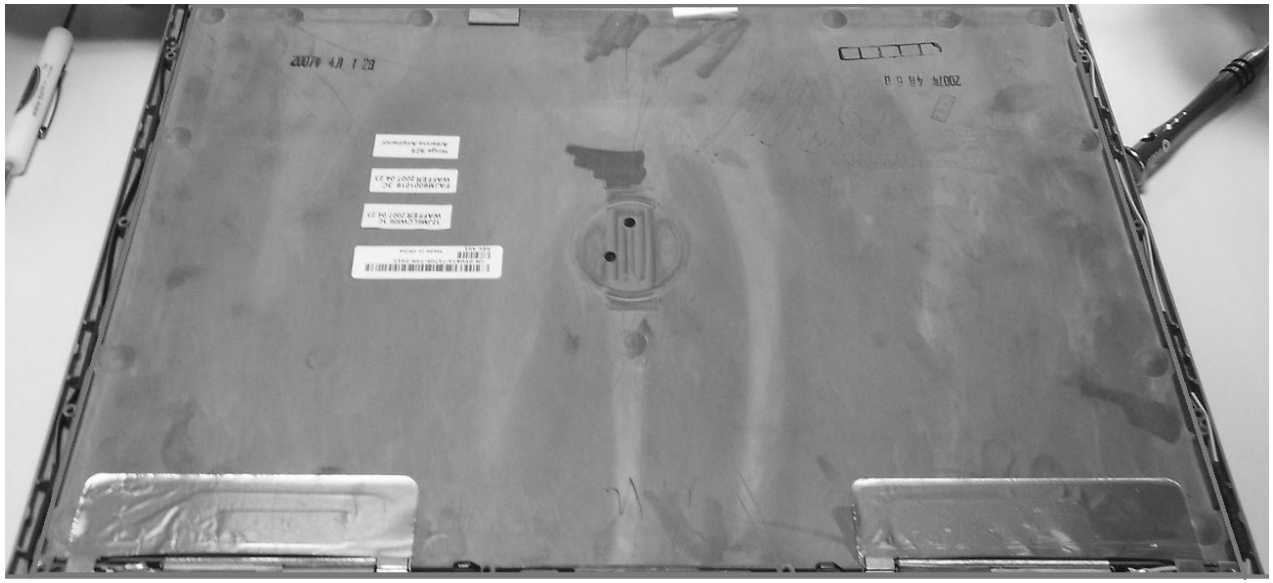
One of ordinary skill in the art, as of the priority date of the '149 Patent, would have known to combine or modify the prior art elements disclosed by the foregoing references using known methods, and to use these elements according to their established functions in order to achieve a known and predictable result.

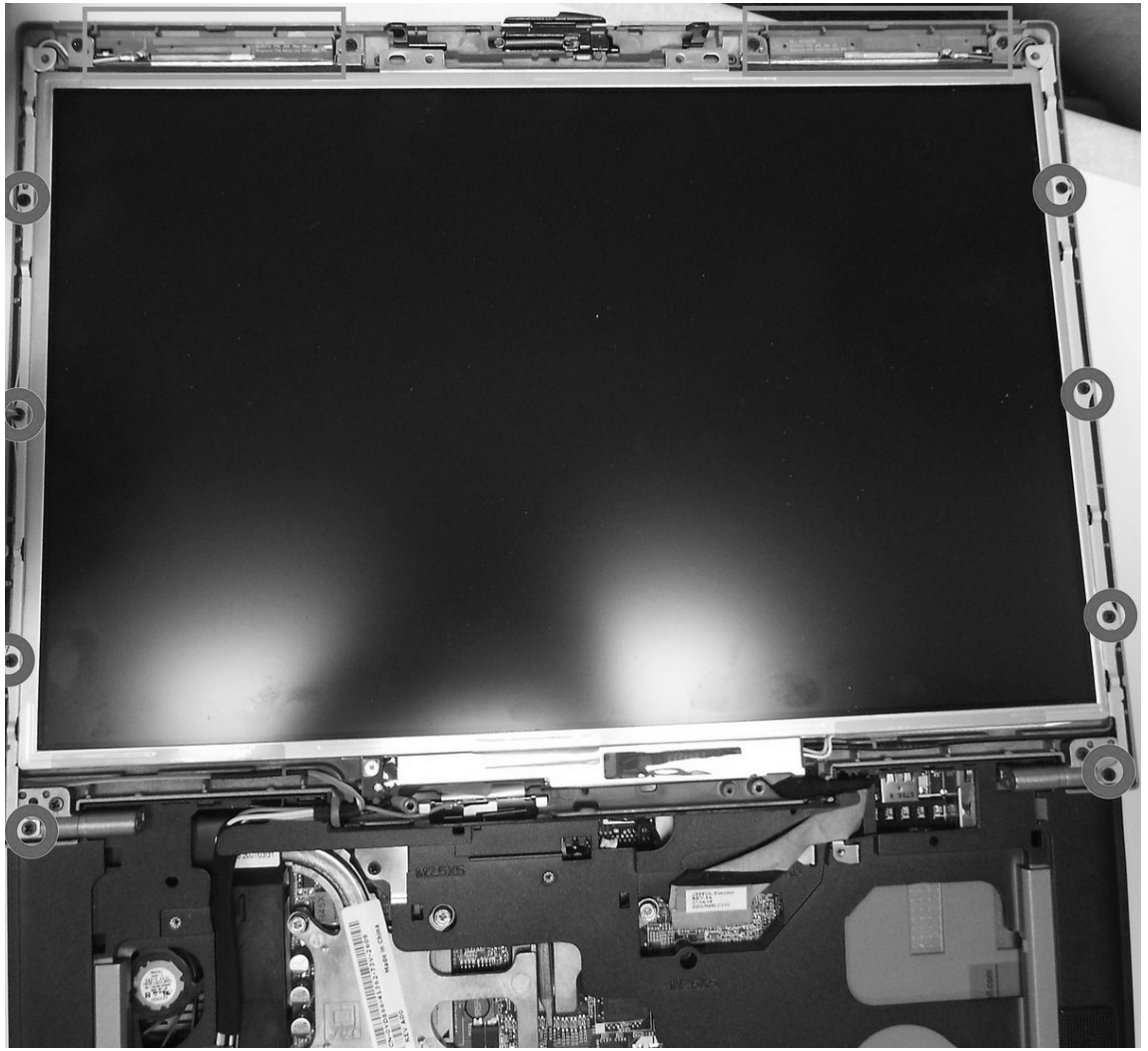
These invalidity contentions are not an admission that the Defendants concede or acquiesce to any claim construction implied or suggested by Plaintiff's Complaint or Infringement Contentions. Nor are Defendants asserting any claim construction positions through these charts, including whether the preamble is a limitation. The portions of the prior art reference cited below are not exhaustive but are exemplary in nature. Defendants retain the right to update their constructions and contentions in view of this Court's claim construction order.[4]

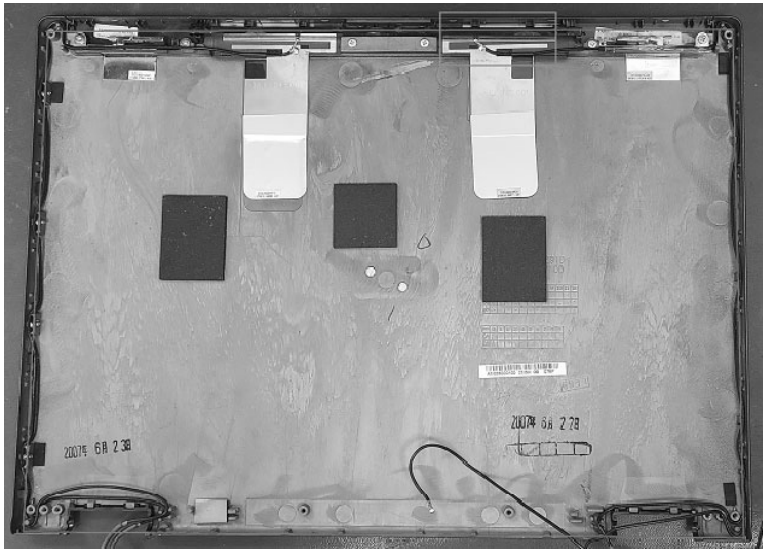
[4] Defendants reserve the right to supplement and/or alter this chart based on further investigation and ongoing discovery.

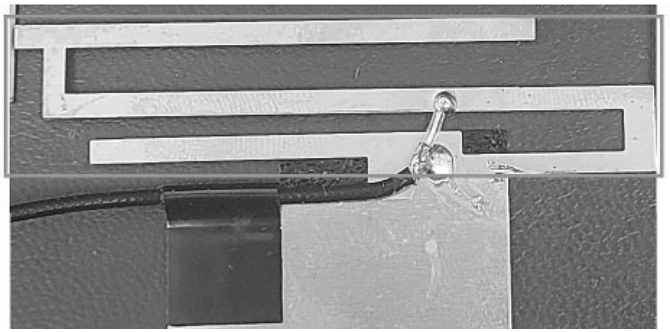
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		Claim 1
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, D820 expressly or inherently discloses this claim element. *See, e.g.*, The Dell D820 is a wireless device.  *See* Archive.org, "Dell Latitude Notebooks" (April 27, 2006) at: https://web.archive.org/web/20060427211623/http:/www1.us.dell.com/content/products/category.aspx/latit?c=us&cs=04&l=en&s=bsd&~ck=mn (last accessed June 14, 2025).
1[a]	a ground plane;	D820 expressly or inherently discloses this claim element. *See, e.g.*,

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		The Dell D820 includes a ground plane (red below).  *See* https://guide-images.cdn.ifixit.com/igi/fSfwfOnclBrPnZUF.huge (last accessed June 17, 2025).
1[b]	a first planar antenna	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See, e.g.*, The Dell D820 includes a first antenna (green below) within the wireless device.

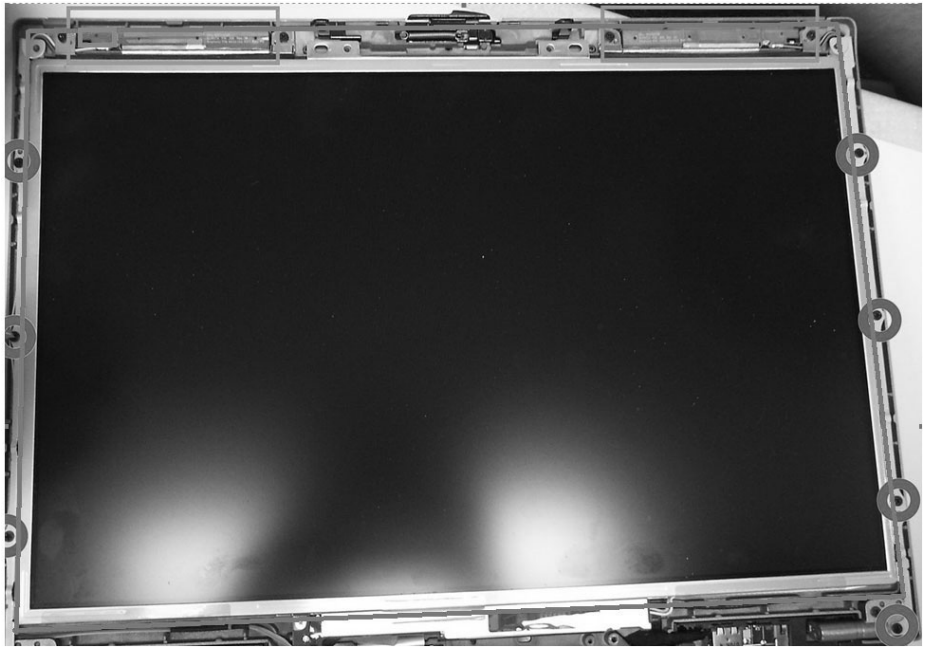
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 *See* https://guide-images.cdn.ifixit.com/igi/fSfwfOnclBrPnZUF.huge (last accessed June 17, 2025).

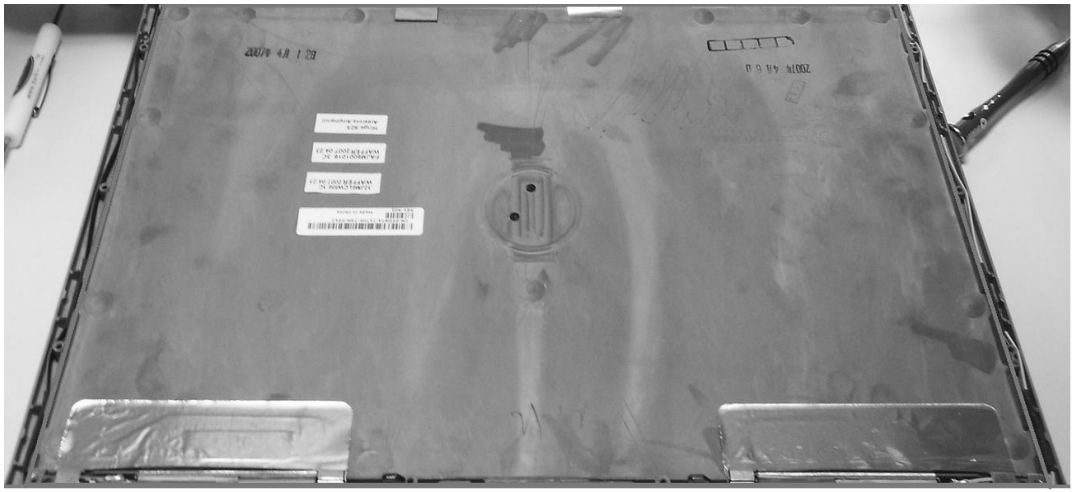
		

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		Source: https://guide-images.cdn.ifixit.com/igi/n1Tm12WPbYRVt4m6.huge The first antenna of the Dell D820 provides operation in frequency bands within 824-894 MHz and 1850-1990 MHz. The HP Compaq nc6400 includes a planar cellular antenna (blue below) that provides operation within 824-894 MHz and 1710-2170 MHz. 

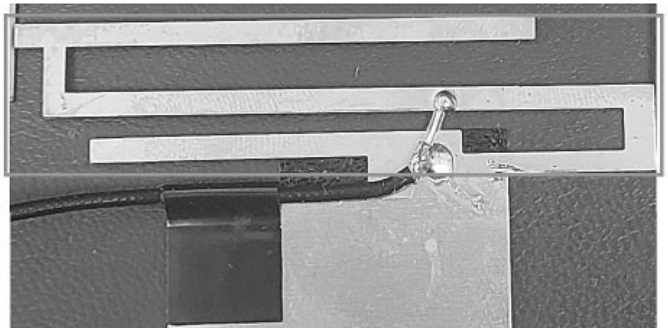
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 It would have been obvious to include the cellular antenna of the HP Compaq nc6400 in the Dell D820 in place of the first antenna of the Dell D820 in order to provide operation in more frequency bands. For instance, the cellular antenna of the HP Compaq nc6400 covers the same frequency bands as the first antenna of the Dell D820, plus additional frequency bands within 1710-1850 MHz and 1990-2170 MHz. There would have been a reasonable expectation of success because the HP Compaq nc6400 antenna is located in a similar relative position to the first antenna of the Dell D820 and cooperates with a ground plane behind the display like the Dell D820. Thus, this claim element would have been obvious in view of the HP Compaq nc6400.
1[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	D820 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the Dell D820 (green below) is proximate to a first side of a ground plane rectangle (red below) enclosing the ground plane.

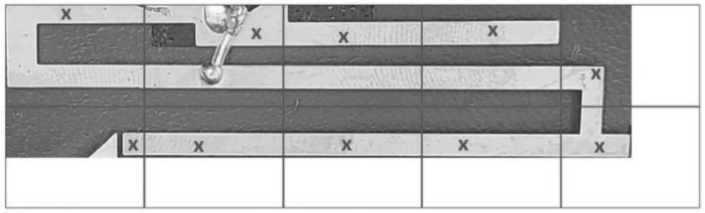
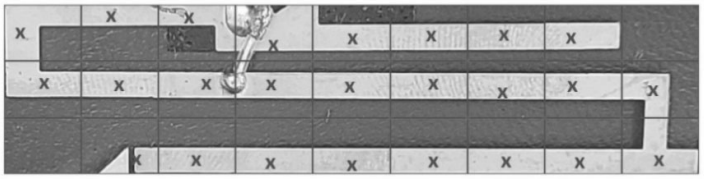
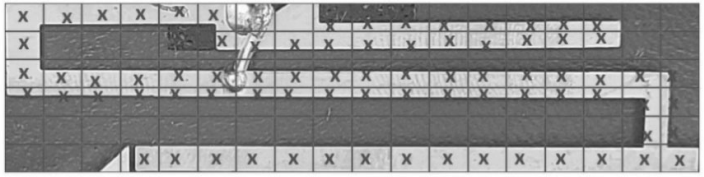
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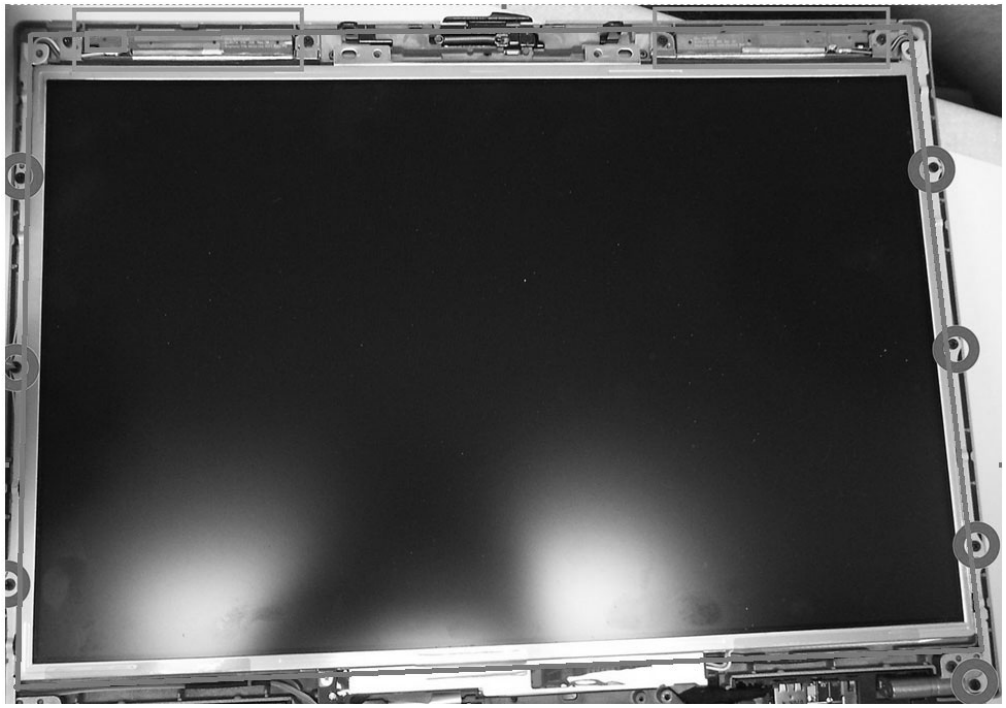
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		

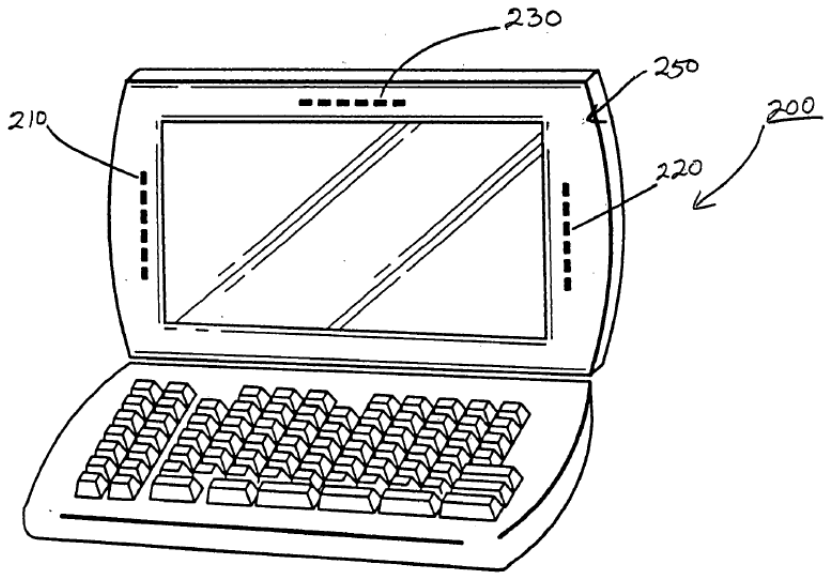
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		
1[d]	the first planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See, e.g.*, The first antenna of the Dell D820 is configured to support at least three frequency bands of the electromagnetic spectrum.

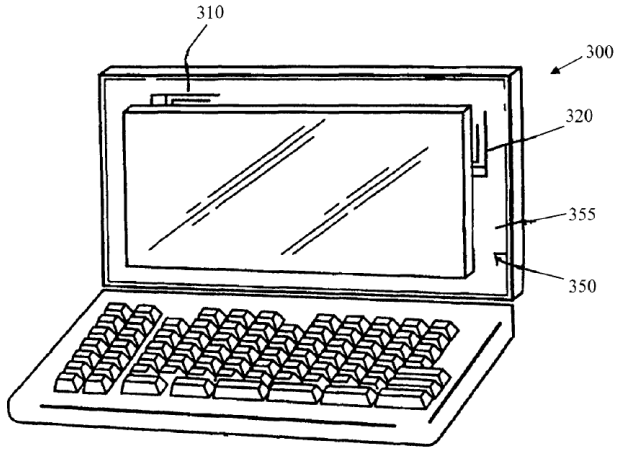
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		CONNECTIVITY: **Wired:** Wired: 56K v924 Internal Modem 10/100/1000 Gigabit[4] Ethernet network interface adaptor **Wireless:** Dell Wireless 5500 Mobile Broadband 3G HSDPA (Cingular US) Dell Wireless 5700 Mobile Broadband CDMA EVDO (Verizon Wireless US) **WLAN** Intel® 3945 WiFi 802.11a/g, Dell Wireless 1390 802.11g, Dell Wireless 1490 802.11a/g Dual-Band Mini-Cards, Internal Bluetooth (optional) For instance, the first antenna of the Dell D820 is configured to support at least three frequency bands contained between 824-894 MHz and 1850-1990 MHz. The cellular antenna of the HP Compaq nc6400 is configured to support at least three frequency bands within 824-894 MHz and 1710-2170 MHz.
1[e]	the first planar antenna defining a first contour,	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See, e.g.*, The cellular antenna of the Compaq nc6400 defines a first contour.

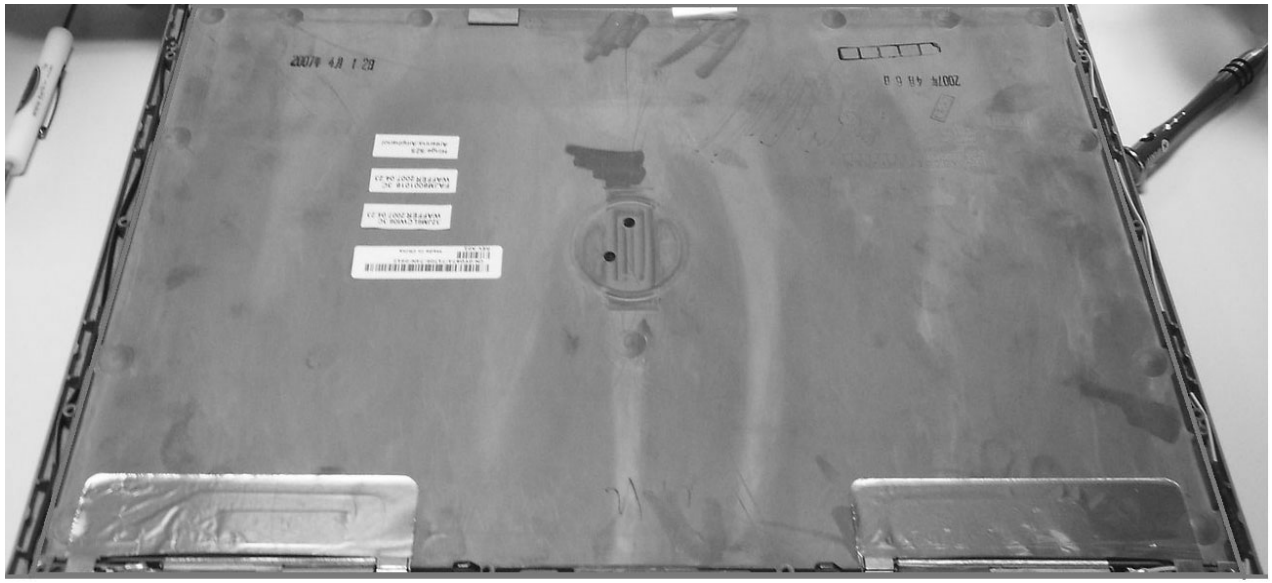
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		
1[f]	wherein the first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35; and	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See e.g.,* The first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35.

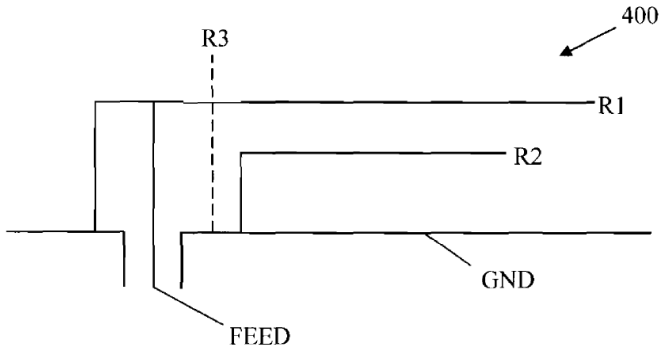
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66
1[g]	a second antenna proximate to a second side of the ground plane rectangle,	D820 expressly or inherently discloses this claim element. *See, e.g.*,

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		The antenna system of the Dell D820 includes a second antenna (blue below) proximate to a side of the ground plane rectangle (red below).  To the extent the Dell D820 does not disclose that the second antenna is proximate to a second side of the ground plane rectangle, it would have been obvious for the second antenna to be disposed proximate to the second side as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity or spatial diversity.

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		In connection with FIG. 2, Gaucher teaches that "two embedded antennas 210, 220 may be placed on the left and right edges of the laptop display 250, respectively, whereby the use of the two antennas 210 and 220 may reduce the blockage caused by the laptop display 250 in some directions that occurs in one antenna designs, and provide space diversity to the wireless communication system." Gaucher, [0004]  FIG. 2 Gaucher also teaches that "one of the antennas [310] or [320] may be disposed on one side of the laptop display [350] while a second antenna [320] is disposed in an upper portion of the laptop display [250],

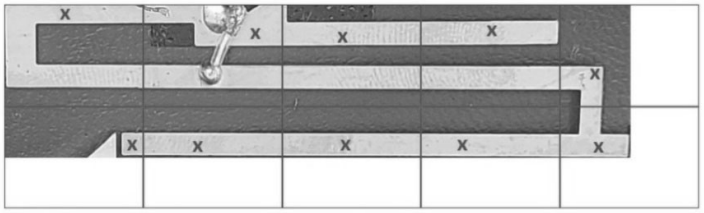
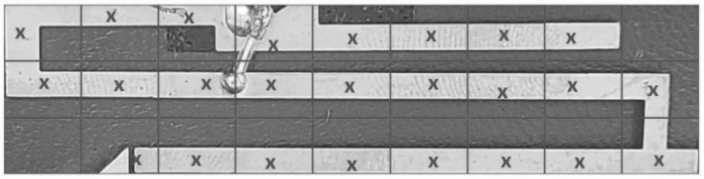
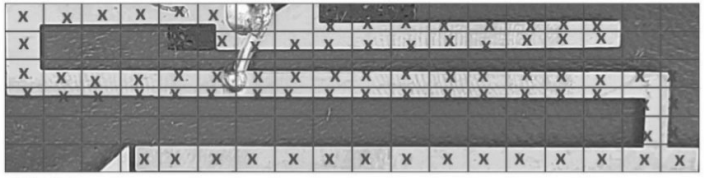
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		[t]hereby providing antenna polarization diversity, depending on the antenna design used." Gaucher, [0004].  FIG. 3 Like in the Dell D820, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display." Gaucher, [0045].

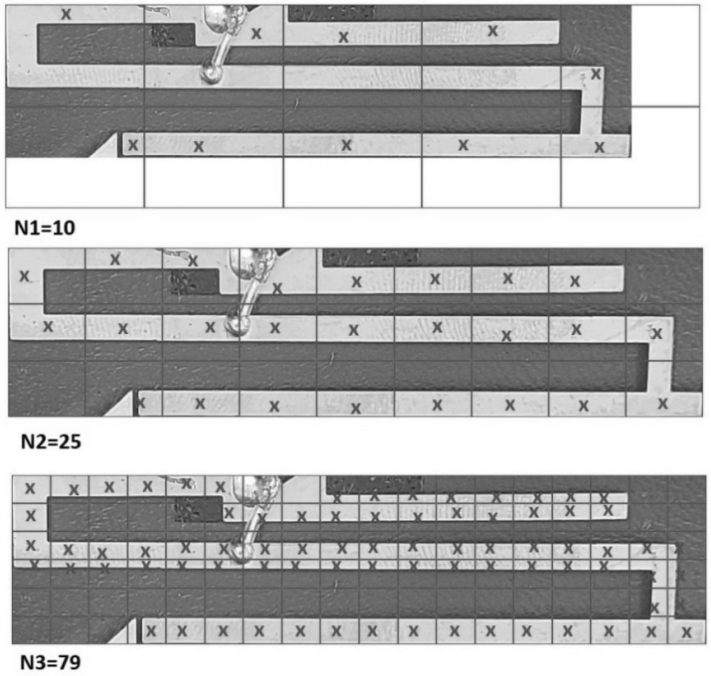
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 Similar to the multiband cellular antennas of the Dell D820, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower band of Europe 1710-1880 MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States." Gaucher, [0030].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 There would have been a reasonable expectation of success in having the first planar antenna and the second antenna of the Dell D820 disposed at respective sides of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher's example antennas are based on an inverted-F antenna design like the HP Compaq nc6400 cell antenna. Gaucher and the D820 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the D820 antennas cover substantially the same frequency bands, including some bands used in the United States and some bands used in Europe. Moreover, having the antennas at respective sides of the ground plane rectangle would not have been expected to create interference problems with the WLAN and Bluetooth antennas in the D820 because Gaucher contemplates that the laptop computer may be additionally "equipped with integrated wireless local area network (WLAN) and devices of the known Bluetooth technology." Gaucher, [0026]

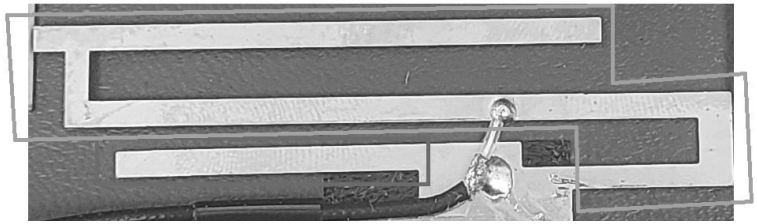
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
1[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	D820 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands. CONNECTIVITY: **Wired:** Wired: 56K v924 Internal Modem 10/100/1000 Gigabit[4] Ethernet network interface adaptor **Wireless:** Dell Wireless 5500 Mobile Broadband 3G HSDPA (Cingular US) Dell Wireless 5700 Mobile Broadband CDMA EVDO (Verizon Wireless US) **WLAN** Intel® 3945 WiFi 802.11a/g, Dell Wireless 1390 802.11g, Dell Wireless 1490 802.11a/g Dual-Band Mini-Cards, Internal Bluetooth (optional) For instance, the second antenna of the Dell D820 is configured to support at least three frequency bands within 880-960 MHz, 1710-1990 MHz, and 2010-2025 MHz.
1[i]	wherein the first contour is defined as a perimeter of the first planar antenna and perimeters of any closed apertures	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See, e.g.*,

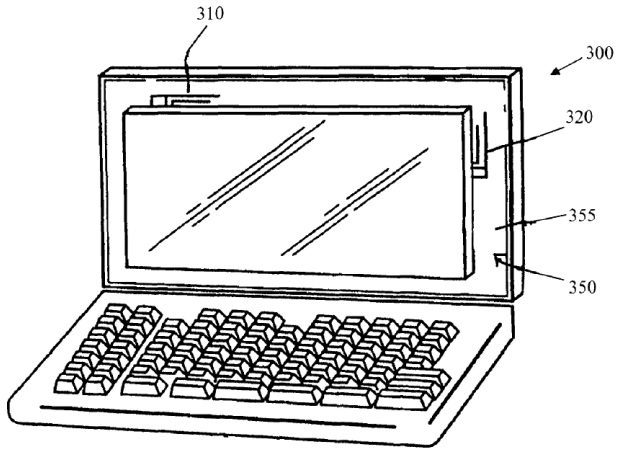
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	defined within the first planar antenna;	Claims 1[e] and 1[f] above. The first contour of the first planar antenna of the D820 is defined as a perimeter of the first planar antenna and perimeters of any closed apertures defined within the first planar antenna. The complexity factors F21 and F32 are given by: F21=-log(N2)-log(N1)/ log(1/2) F32=-log(N3)-log(N2)/ log(1/2) N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour. The grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle. The number of rows results in the cells of grid G2 is as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle. The cells of the grid G1 have widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 is aligned with the grid G2. The cells of the grid G3 have widths and heights that respectively are half the widths and heights of the cells of the grid G2.

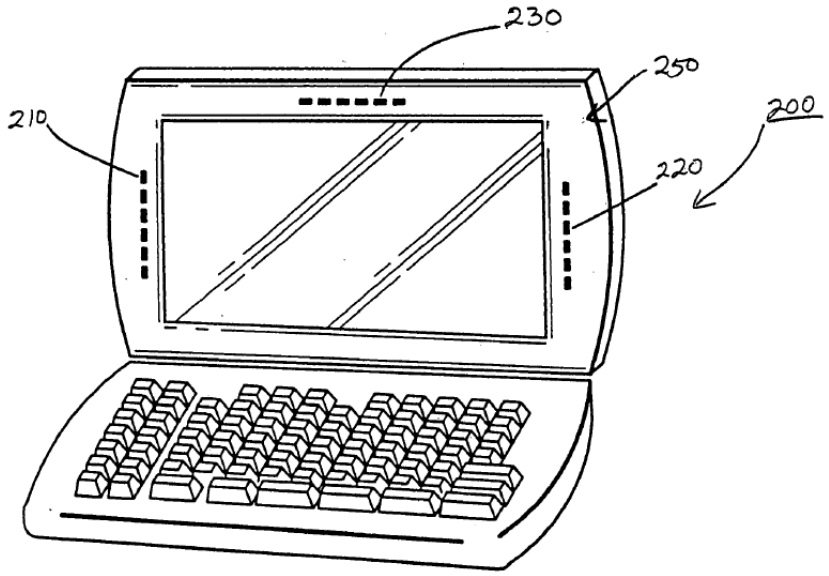
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 N1=10  N2=25  N3=79 F21=log(25/10)/log(2)=1.32 F32=log(79/25)/log(2)=1.66
1[j]	wherein the complexity factors F21 and F32 are given by:	D820 expressly or inherently discloses this claim element. *See, e.g.*,

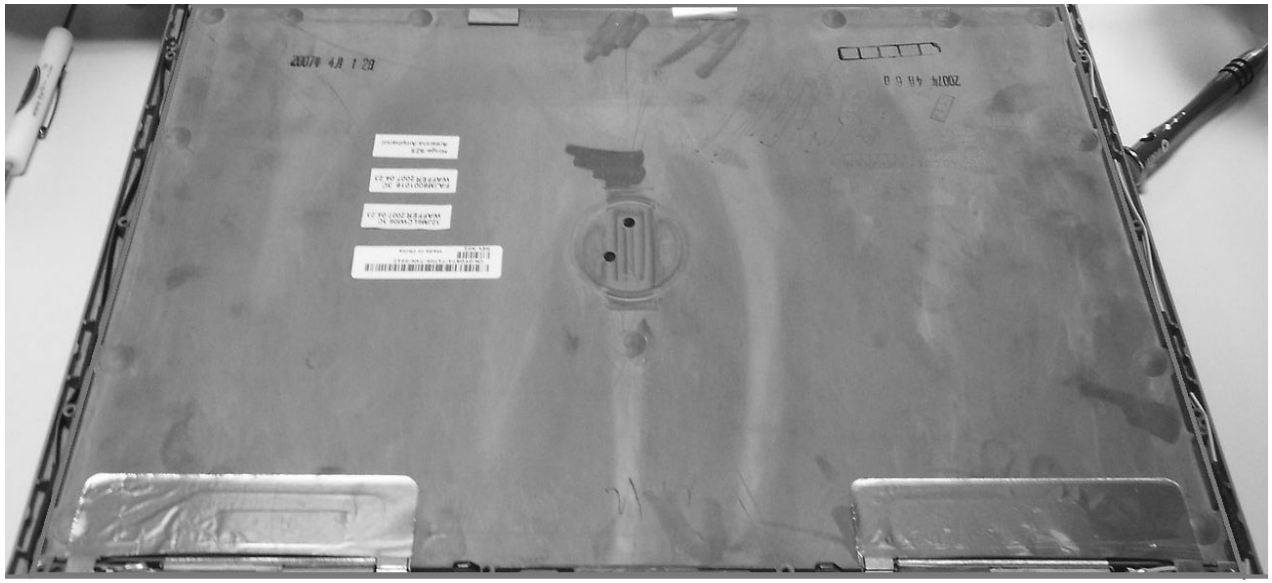
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	$F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of	*See* claims 1[f] and 1[i] above. When calculated using this mathematical formula, the first antenna contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F_{32} having a value less than 1.75.  F21=log(25/10)/log(2)=1.32

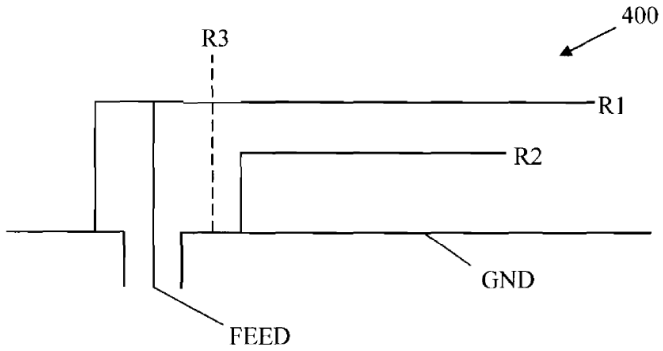
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	equal height arranged along a short side of the minimum-sized rectangle, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle, the cells of the grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	F32=log(79/25)/log(2)=1.66
1[k]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	D820 expressly or inherently discloses this claim element. *See, e.g.*, Claim 1[d] above. The level of complexity of the first contour is configured to provide operation of the Dell D820 in the at least three frequency bands.

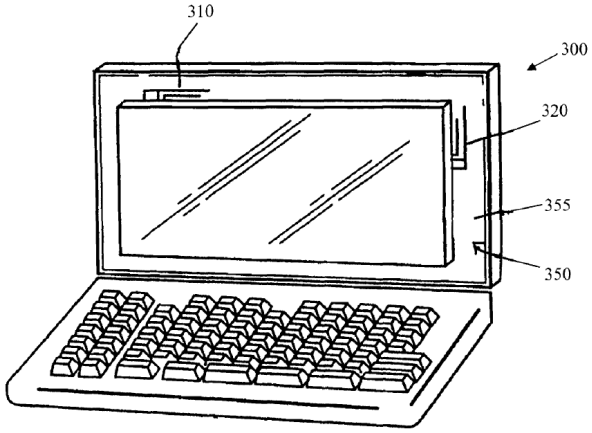
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		Claim 2
2	The wireless device of claim 1, wherein the first planar antenna includes at least two antenna elements that are electromagnetically coupled.	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See, e.g.*, The first planar antenna of the Compaq nc6400 includes at least two antenna elements (orange and purple below, respectively) that are electromagnetically coupled. 
		Claim 3
3	The wireless device of claim 1, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	D820 expressly or inherently discloses this claim element. To the extent the Dell D820 does not disclose a first planar antenna proximate to a first side of a ground plane rectangle enclosing the ground plane, where the first side of the ground plane rectangle enclosing the ground plane is a short side, it would have been obvious for the first antenna to be disposed proximate to a short side of the ground plane rectangle as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity or spatial diversity.

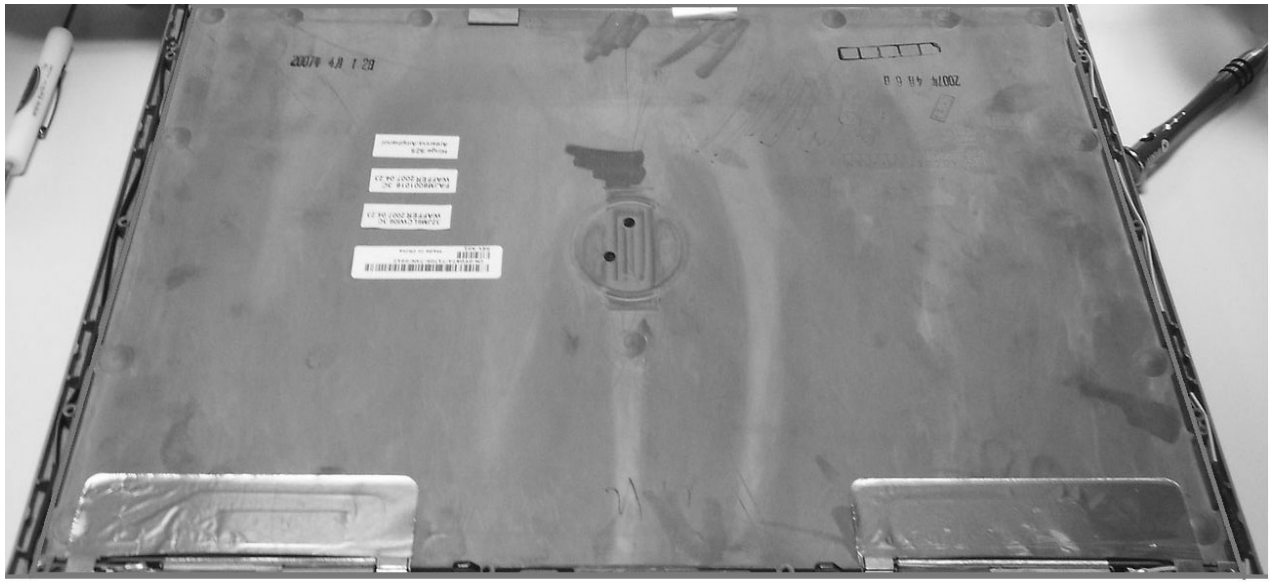
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 FIG. 3 Gaucher teaches "a laptop computer 300 including a laptop display unit 350 and a plurality of multiband antennas 310, 320 mounted on the upper frame 355 of the laptop display unit 350." Like the HP Compaq nc6400, "As shown in FIG. 3, the pair of multiband antennas 310, 320 are mounted to the metal support frame 355, wherein the plane of each multiband antenna 310, 320 is substantially parallel to the plane, or along the plane, of the metal support frame 355." Gaucher, [0025]. In connection with FIG. 2, Gaucher teaches that "two embedded antennas 210, 220 may be placed on the left and right edges of the laptop display 250, respectively, whereby the use of the two antennas 210 and 220 may reduce the blockage caused by the laptop display 250 in some directions that occurs in one antenna designs, and provide space diversity to the wireless communication system." Gaucher, [0004]

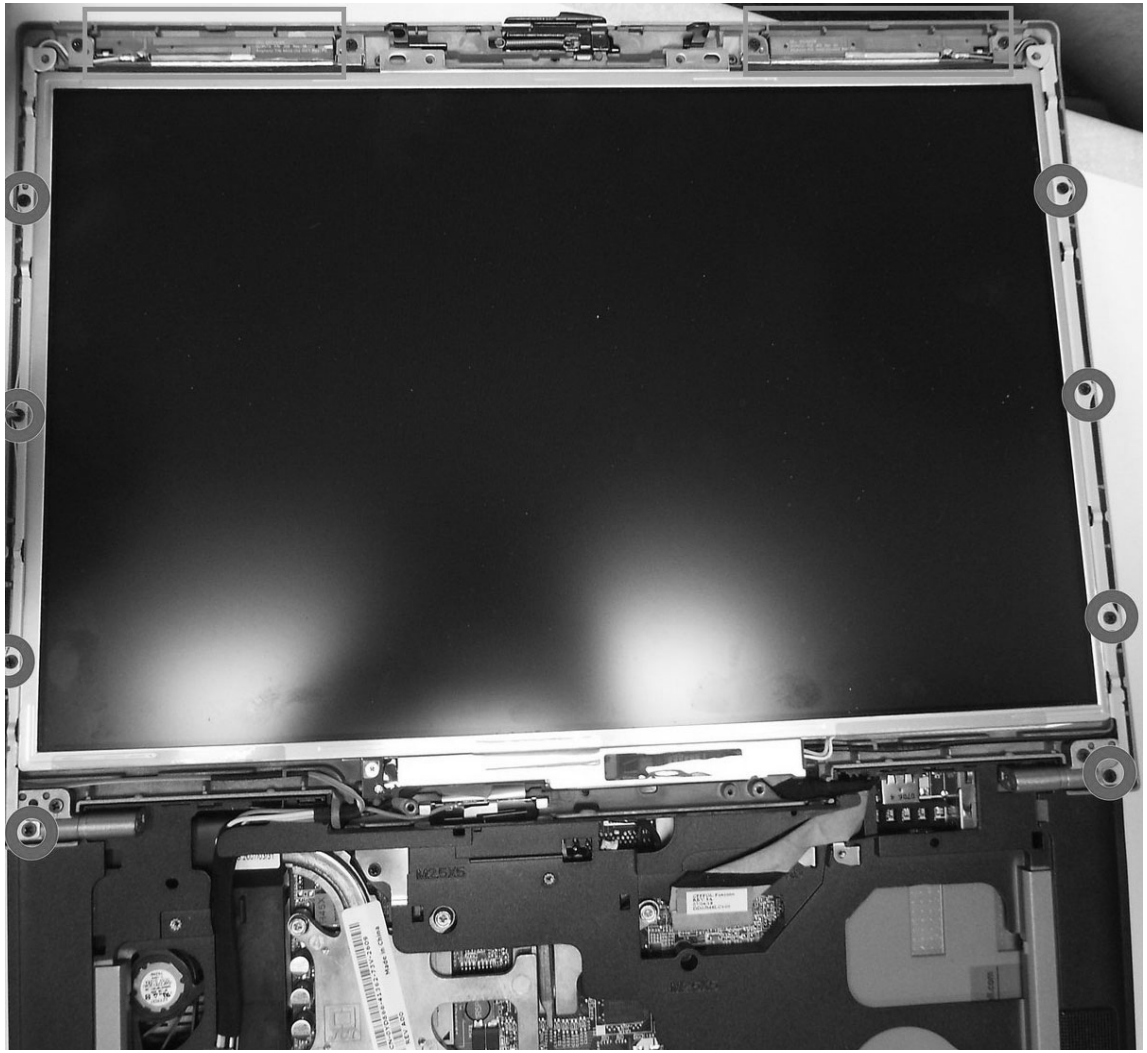
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 FIG. 2 Gaucher also teaches that "one of the antennas [310] or [320] may be disposed on one side of the laptop display [350] while a second antenna [320] is disposed in an upper portion of the laptop display [250], [t]hereby providing antenna polarization diversity, depending on the antenna design used." Gaucher, [0004]. Like in the Dell D820, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display." Gaucher, [0045].

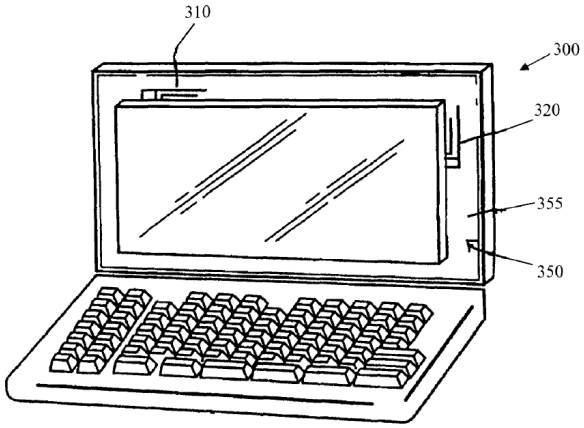
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 Similar to the multiband cellular antennas of the Dell D820, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower band of Europe 1710-1880 MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States." Gaucher, [0030].

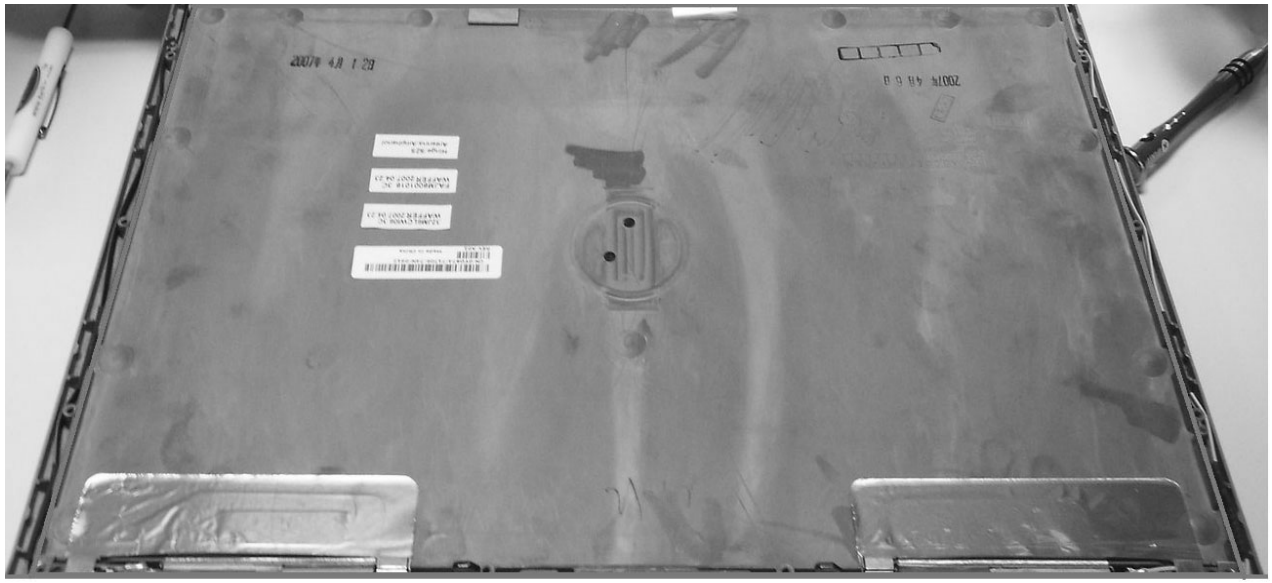
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 There would have been a reasonable expectation of success in having the first antenna of the Dell D820 disposed proximate a first short side of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher's example antennas are based on an inverted-F antenna design like the HP Compaq nc6400 cellular antenna. Gaucher and the D820 (and HP Compaq nc6400) place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the D820 (and HP Compaq nc6400) antennas cover substantially the same frequency bands, including some bands used in the United States and some bands used in Europe. Moreover, having the first antenna proximate to the first short side of the ground plane rectangle would not have been expected to create interference problems with the WLAN and Bluetooth antennas in the D820 because Gaucher contemplates that the laptop computer may be additionally "equipped with integrated wireless local area network (WLAN) and devices of the known Bluetooth technology." Gaucher, [0026]. Additionally, it would have been obvious to a person of ordinary skill in the art to modify this reference with any one or more of the references disclosed in Geotab's Invalidity Contentions based on knowledge

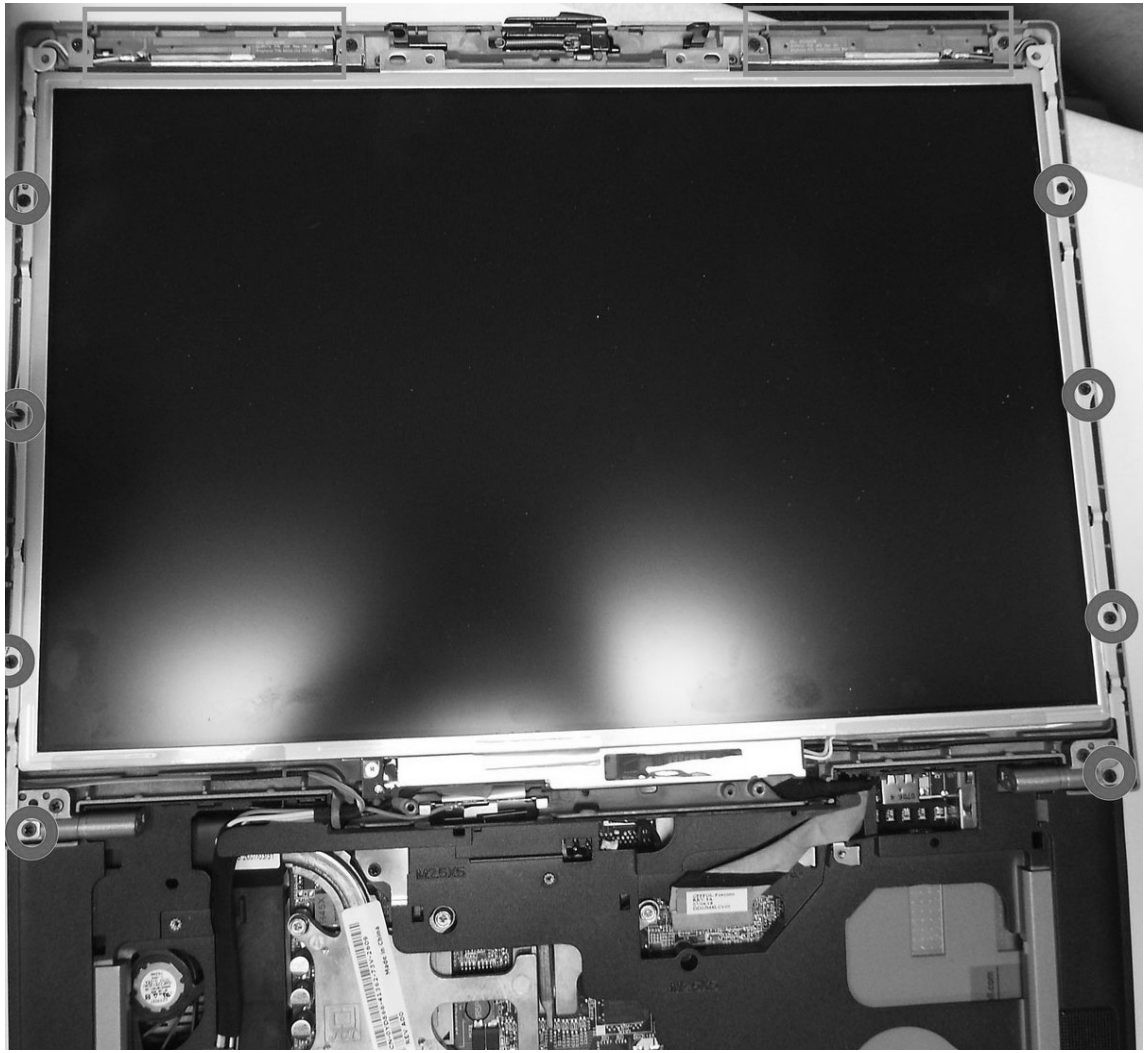
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		of one of ordinary skill in the art and for the reasons articulated in Geotab's Invalidity Contentions Cover Pleading. *See, e.g.*, As combined with Gaucher, the first planar antenna of the D820 is proximate to a first side of the ground plane rectangle, which is a short side of the ground plane rectangle.  FIG. 3

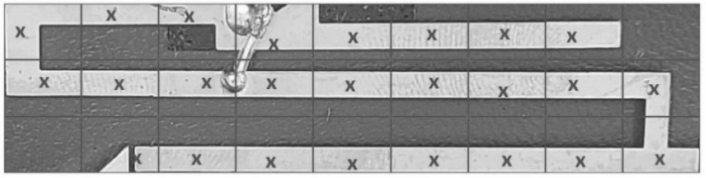
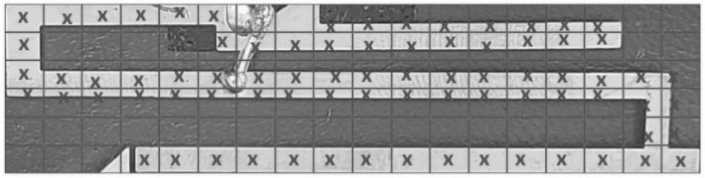
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		

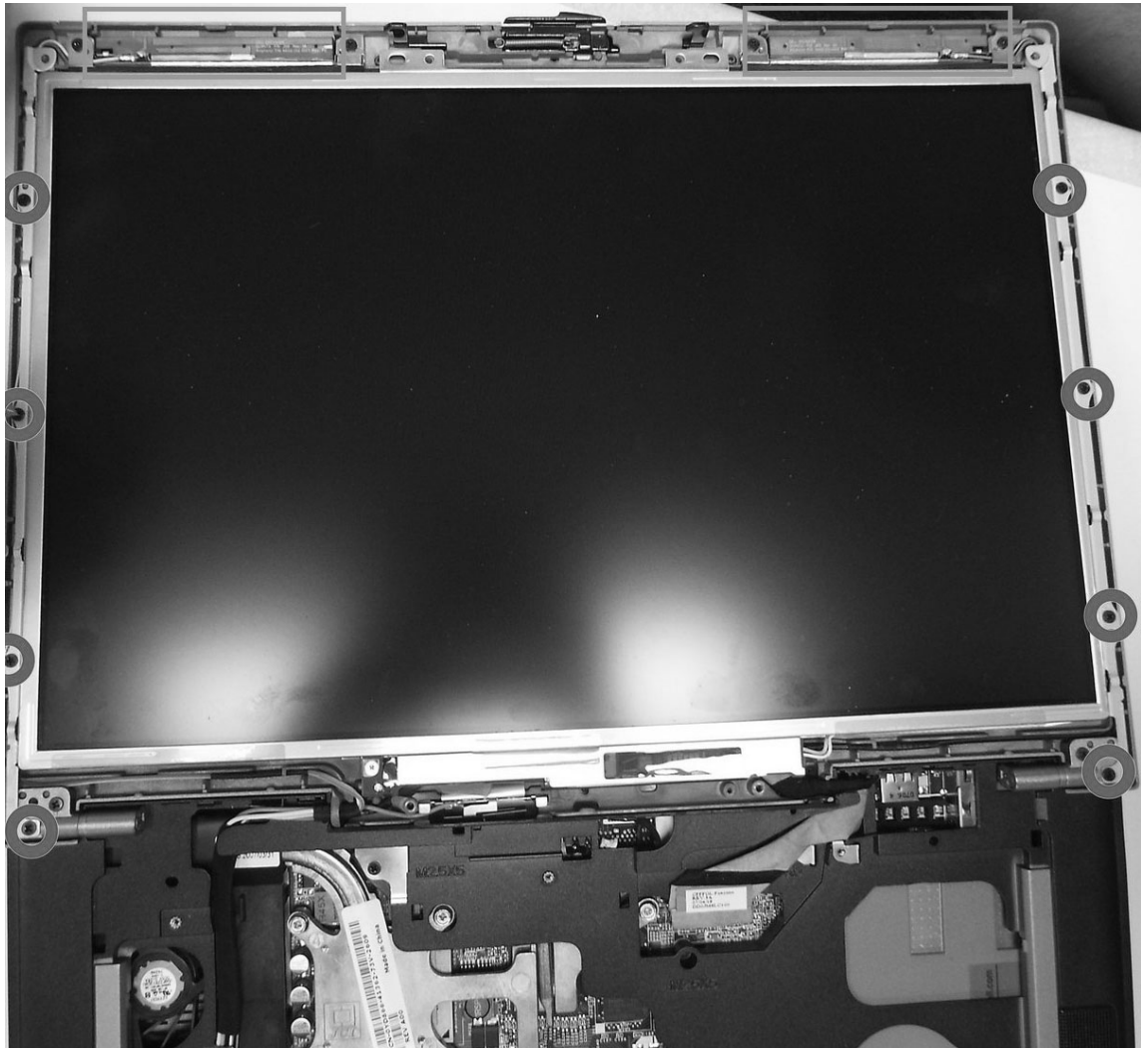
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		Claim 4
4	The wireless device of claim 1, wherein the second side of the ground plane rectangle is a long side of the ground plane rectangle.	D820 expressly or inherently discloses this claim element. *See, e.g.*, To the extent the D820 does not disclose this limitation, the combination with Gaucher discloses this limitation. As combined with Gaucher (*see* Claim 1[g] supra), the second antenna of the D820 is proximate to a second side of the ground plane rectangle, which is a long side of the ground plane rectangle.  FIG. 3

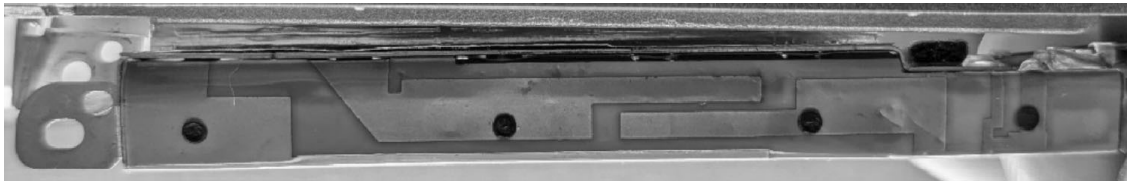
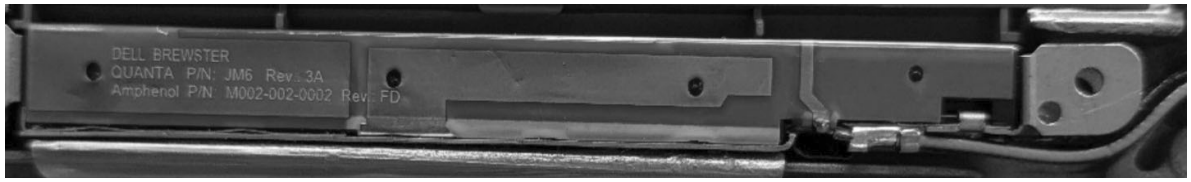
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		

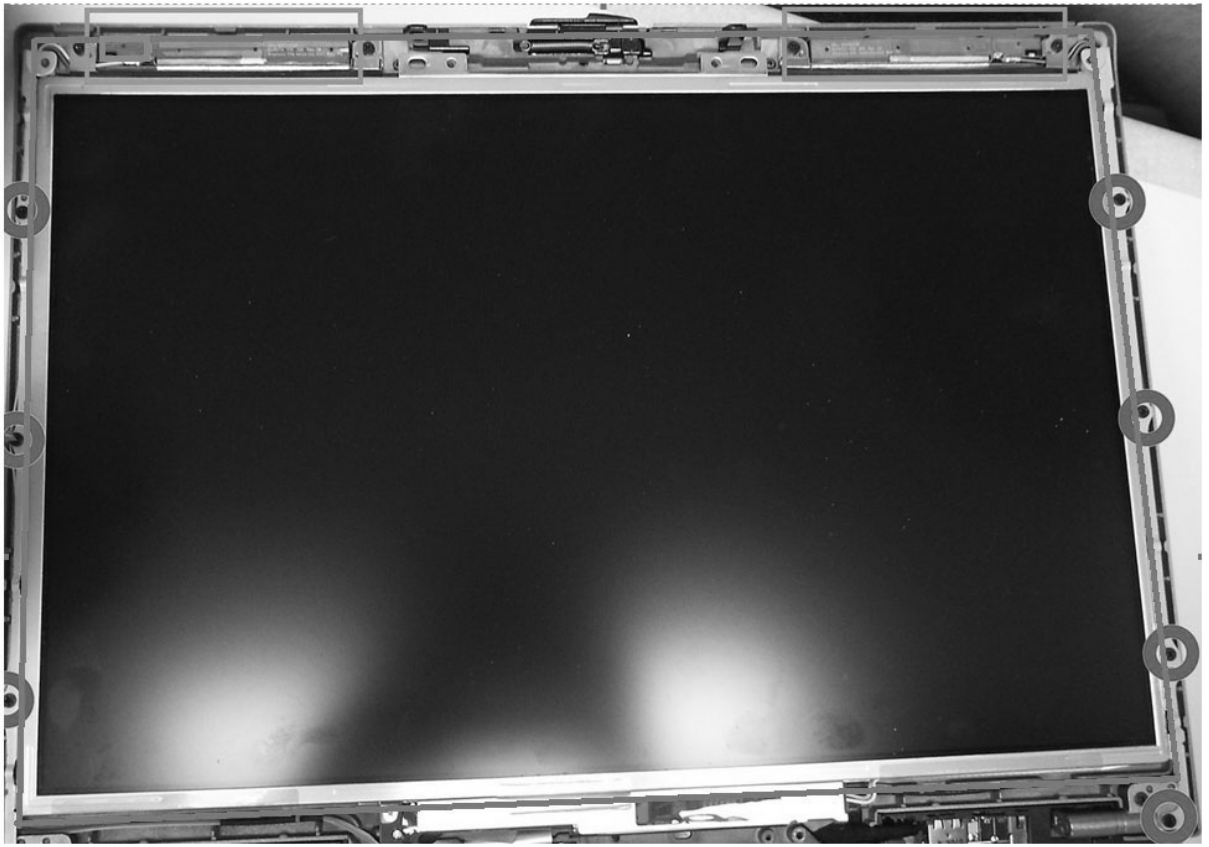
		

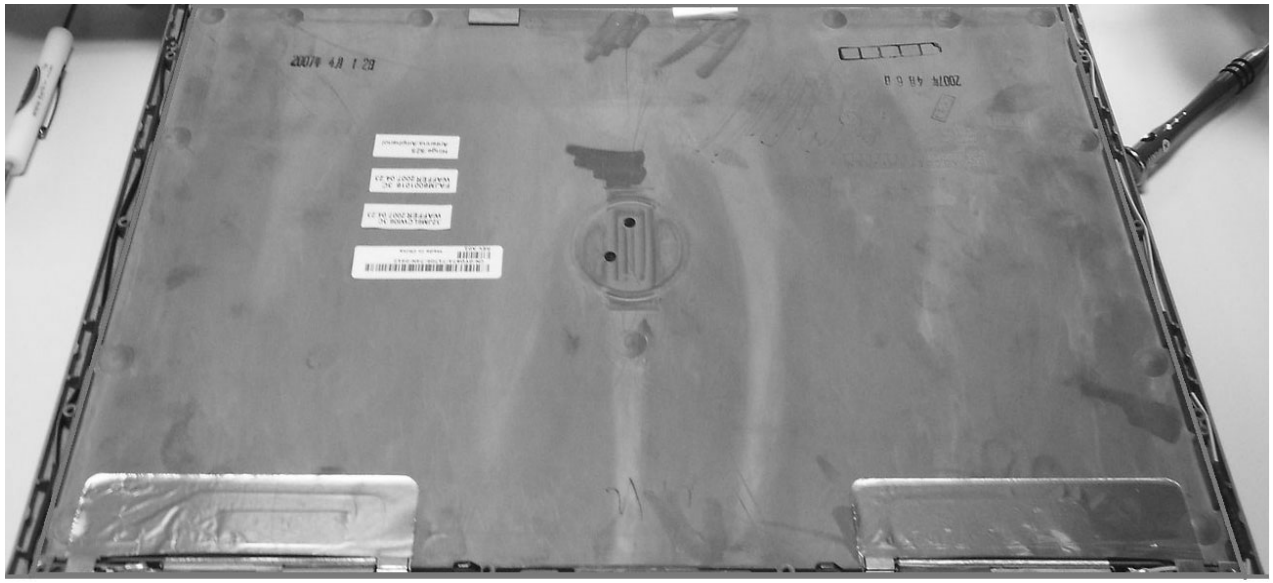
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		Claim 5
5	The wireless device of claim 1, wherein the complexity factor F32 for the first contour is smaller than 1.75.	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. *See, e.g.*, The complexity factor F32 for the first contour of the first planar antenna of the D820 is smaller than 1.75.  N2=25  N3=79 F32=log(79/25)/log(2)=1.66
		Claim 7

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
7[pre]	A wireless device comprising:	To the extent the preamble is limiting, D820 expressly or inherently discloses this claim element. *See* Claim 1[pre]
7[a]	a ground plane;	D820 expressly or inherently discloses this claim element. *See* Claim 1[a]
7[b]	a first non-planar antenna	D820 expressly or inherently discloses this claim element. *See e.g.,* The Dell D820 includes a first non-planar antenna (blue below).

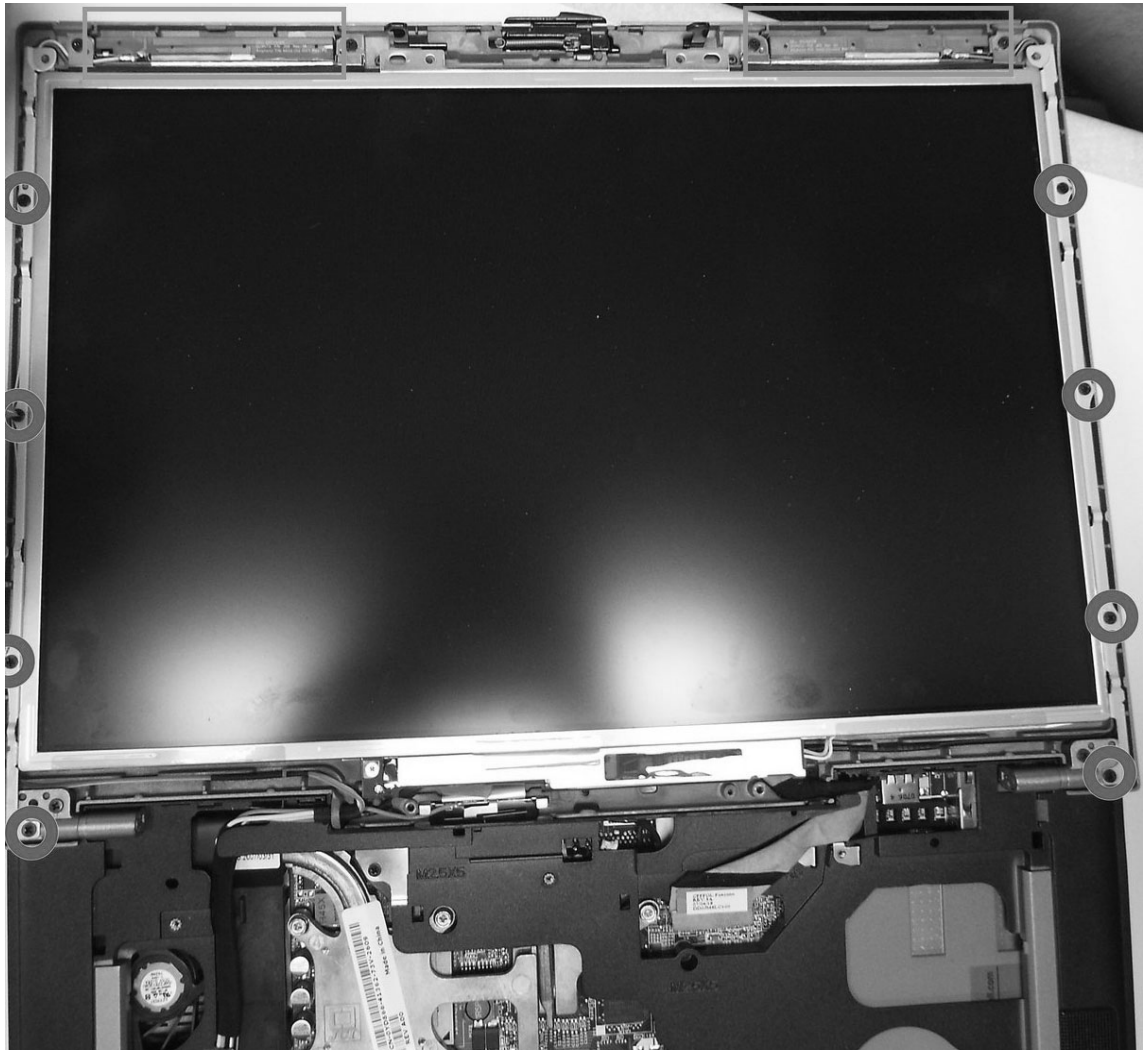
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 
7[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	D820 expressly or inherently discloses this claim element. *See e.g.,* The first antenna of the Dell D820 is proximate to a first side of a ground plane rectangle enclosing the ground plane.

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		

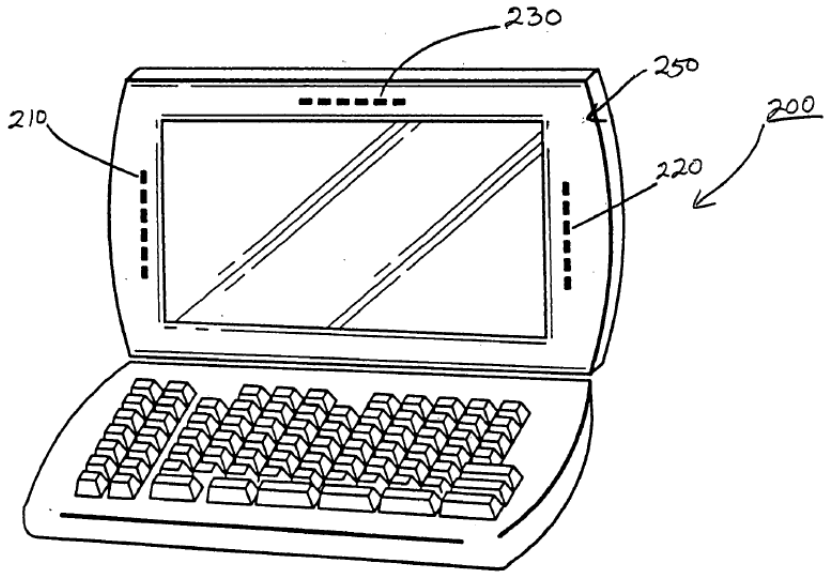
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		
7[d]	the first non-planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	D820 expressly or inherently discloses this claim element. *See e.g.,* The first non-planar antenna of the Dell D820 is configured to support at least three frequency bands of the electromagnetic spectrum. The first non-planar antenna of the Dell D820 is configured to support at least frequency bands within 880-960 MHz, 1710-1990 MHz, and 2010-2025 MHz.

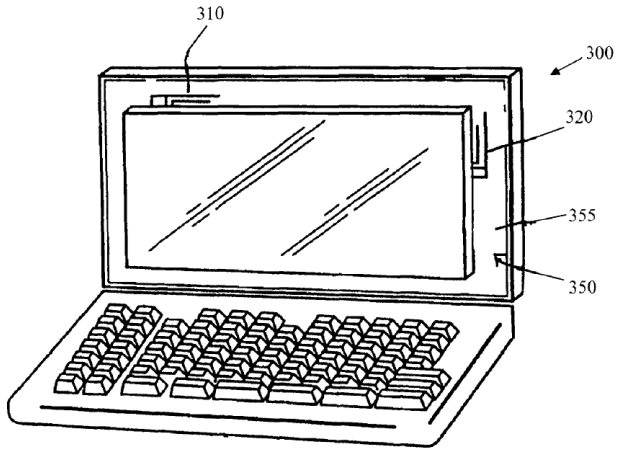
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
7[e]	a minimum-sized parallelepiped completely enclosing a volume of the first non-planar antenna,	D820 expressly or inherently discloses this claim element. *See, e.g.*, A minimum-sized parallelepiped that completely encloses a volume of the first non-planar antenna is shown below. First non-planar antenna, first side (top photo), second side (middle photo), third side (bottom photo): 
7[f]	the minimum-sized parallelepiped having a face with a largest area;	D820 expressly or inherently discloses this claim element. *See, e.g.*,

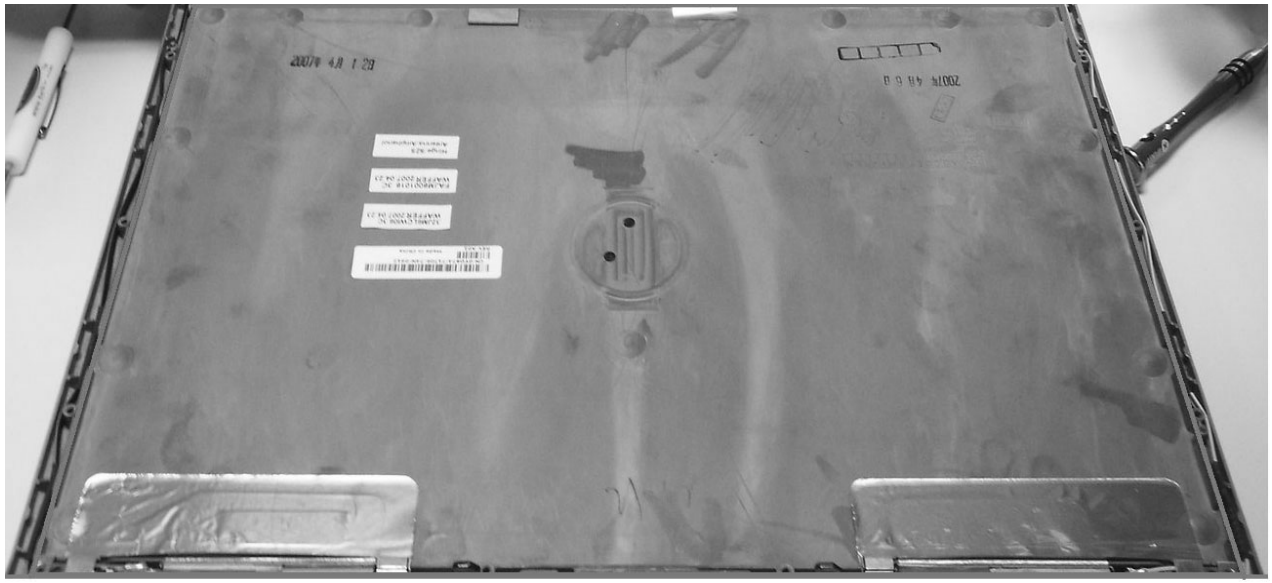
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		The minimum-sized parallelepiped has a face with a largest area shown in orange below. 
7[g]	a second antenna proximate to a second side of the ground plane rectangle, and	D820 expressly or inherently discloses this claim element. *See e.g.,* The Dell D820 includes a second antenna (green below) proximate to a side of the ground plane rectangle.

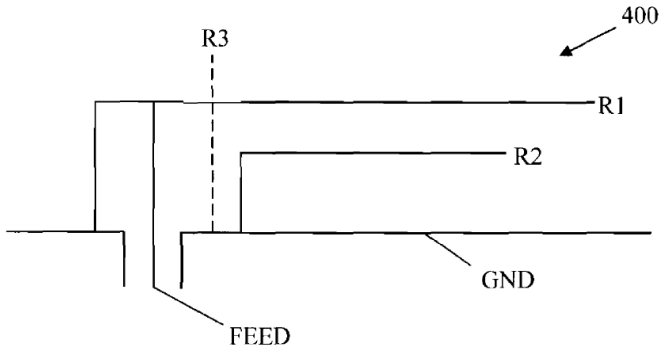
		

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		To the extent the Dell D820 does not disclose that the second antenna is proximate to a second side of the ground plane rectangle, it would have been obvious for the second antenna to be disposed proximate to the second side as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity or spatial diversity. In connection with FIG. 2, Gaucher teaches that "two embedded antennas 210, 220 may be placed on the left and right edges of the laptop display 250, respectively, whereby the use of the two antennas 210 and 220 may reduce the blockage caused by the laptop display 250 in some directions that occurs in one antenna designs, and provide space diversity to the wireless communication system." Gaucher, [0004]

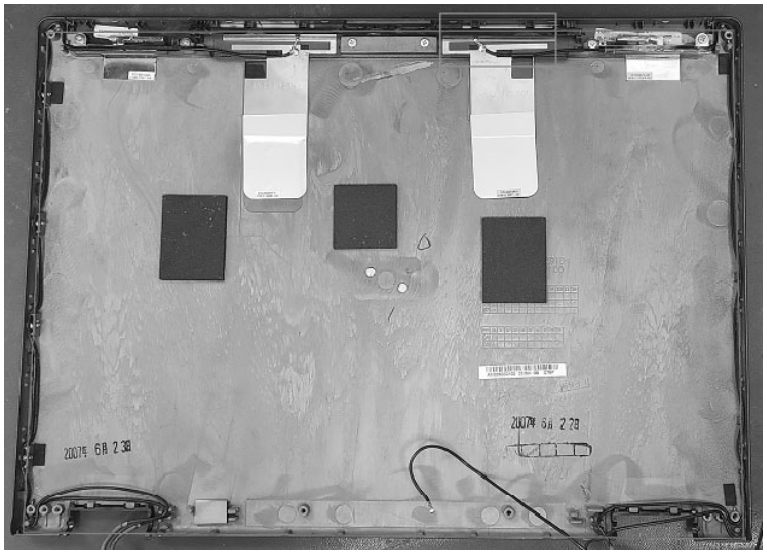
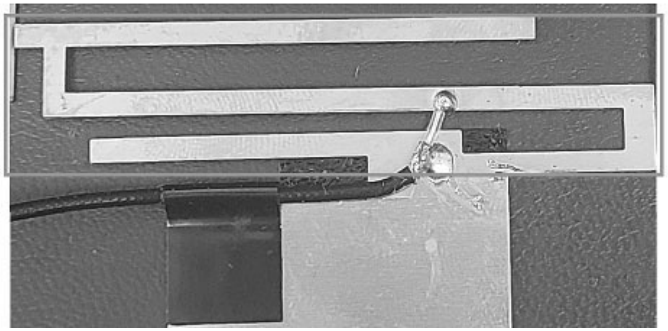
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 FIG. 2 Gaucher also teaches that "one of the antennas [310] or [320] may be disposed on one side of the laptop display [350] while a second antenna [320] is disposed in an upper portion of the laptop display [250], [t]hereby providing antenna polarization diversity, depending on the antenna design used." Gaucher, [0004].

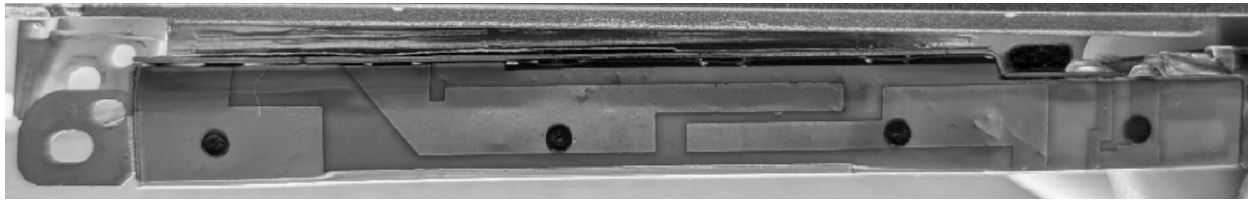
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 FIG. 3 Like in the Dell D820, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display." Gaucher, [0045].

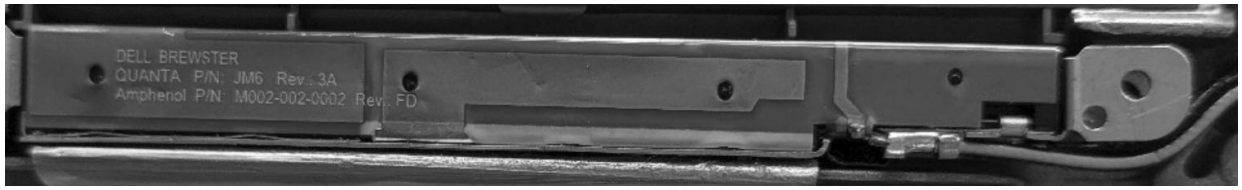
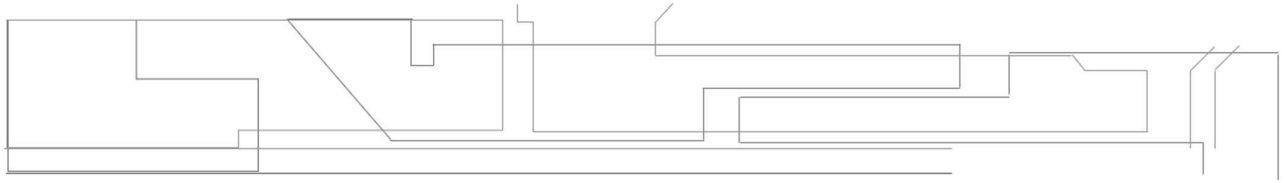
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 Similar to the multiband cellular antennas of the Dell D820, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower band of Europe 1710-1880 MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States." Gaucher, [0030].

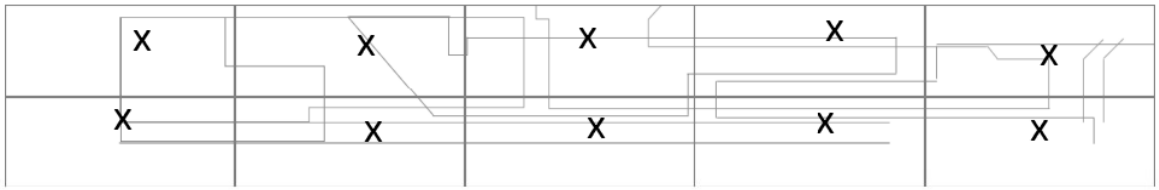
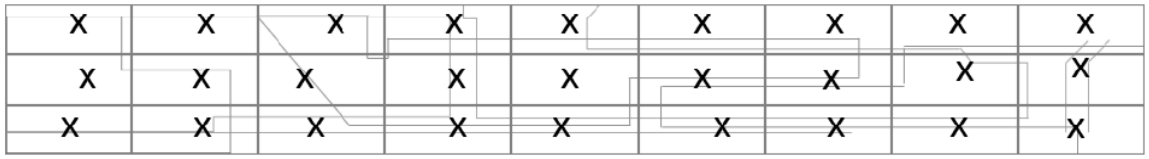
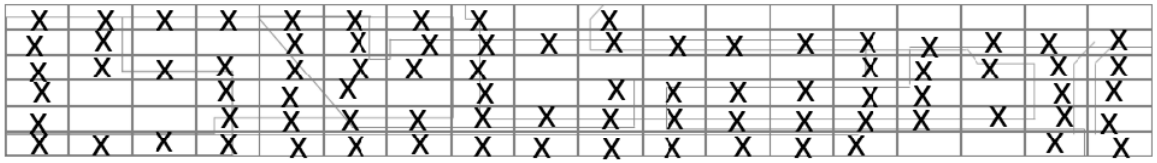
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 There would have been a reasonable expectation of success in having the first planar antenna and the second antenna of the Dell D820 disposed at respective sides of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher and the D820 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the D820 antennas cover substantially the same frequency bands, including some bands used in the United States and some bands used in Europe. Moreover, having the antennas at respective sides of the ground plane rectangle would not have been expected to create interference problems with the WLAN and Bluetooth antennas in the D820 because Gaucher contemplates that the laptop computer may be additionally "equipped with integrated wireless local area network (WLAN) and devices of the known Bluetooth technology." Gaucher, [0026]

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
7[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	D820 expressly or inherently discloses this claim element. *See e.g.,* The second antenna of the Dell D820 is configured to receive signals from at least two frequency bands of the at least three frequency bands. For instance, the Dell D820 is configured to receive signals from at least two frequency bands within 824-894 MHz and 1850-1990 MHz. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400. The HP Compaq nc6400 includes a cellular antenna (blue below) that is configured to receive signals from at least two frequency bands within 824-894 MHz and 1710-2170 MHz.

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		  It would have been obvious to include the cellular antenna of the HP Compaq nc6400 in the Dell D820 as the second antenna of the Dell D820 in order to provide operation in more frequency bands. For instance,

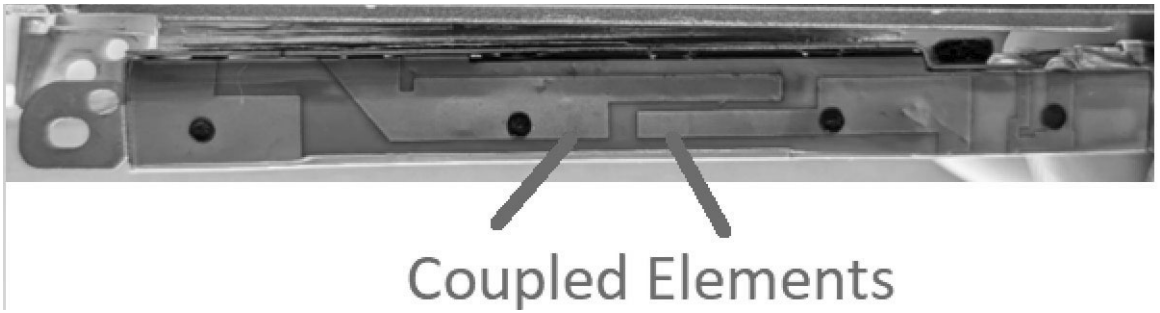
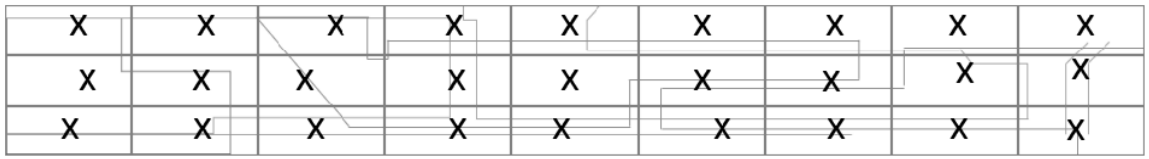
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		the cellular antenna of the HP Compaq nc6400 covers the same frequency bands as the second antenna of the Dell D820, plus additional frequency bands within 1710-1850 MHz and 1990-2170 MHz. There would have been a reasonable expectation of success because the HP Compaq nc6400 antenna is located in a similar relative position to the second antenna of the Dell D820 and cooperates with a ground plane behind the display like the Dell D820. Thus, this claim element would have been obvious in view of the HP Compaq nc6400.
7[i]	wherein the first non-planar antenna has a first contour defined as a perimeter of any portions of the first non-planar antenna arranged in the face, perimeters of any closed apertures of any portions of the first non-planar antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first non-planar antenna that are not arranged in the face,	D820 expressly or inherently discloses this claim element. *See e.g.,* The first non-planar antenna of the Dell D820 has a first contour defined as a perimeter of any portions of the first non-planar antenna arranged in the face, perimeters of any closed apertures of any portions of the first non-planar antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first non-planar antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection. First antenna, first side: 

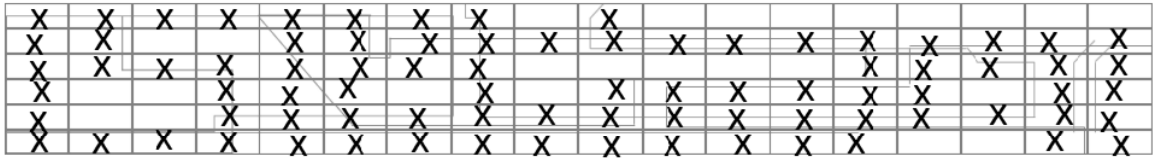
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	and perimeters of any closed apertures of the orthogonal projection;	First antenna, second side:  First contour: 
7[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	D820 expressly or inherently discloses this claim element. *See e.g.,* The first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and complexity factor F_{32} having a value of at least 1.35. *See also* Claim 7[l] below, which provides the formula used for this calculation. N1=10

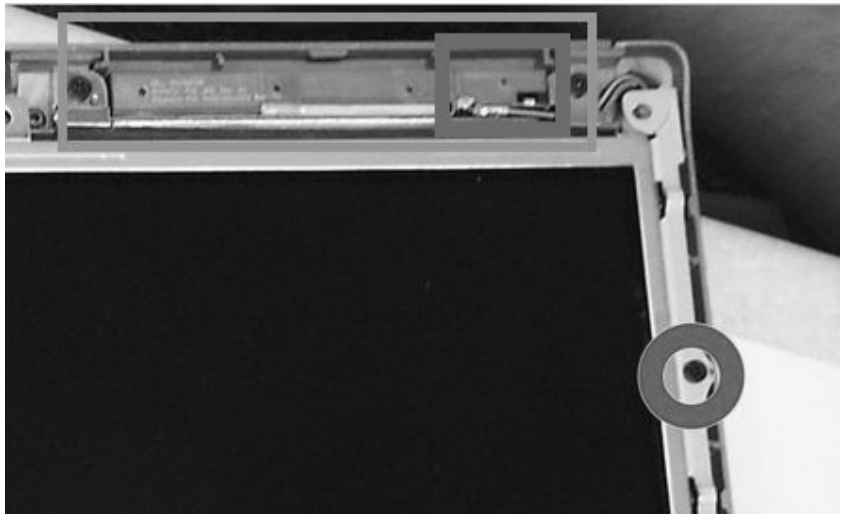
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 N2=27  N3=86  F21=log(27/10)/log(2)=1.43 F32=log(83/27)/log(2)=1.62
7[k]	complexity factor F_{32} having a value of at least 1.35;	D820 expressly or inherently discloses this claim element. *See* Claim 7[j].

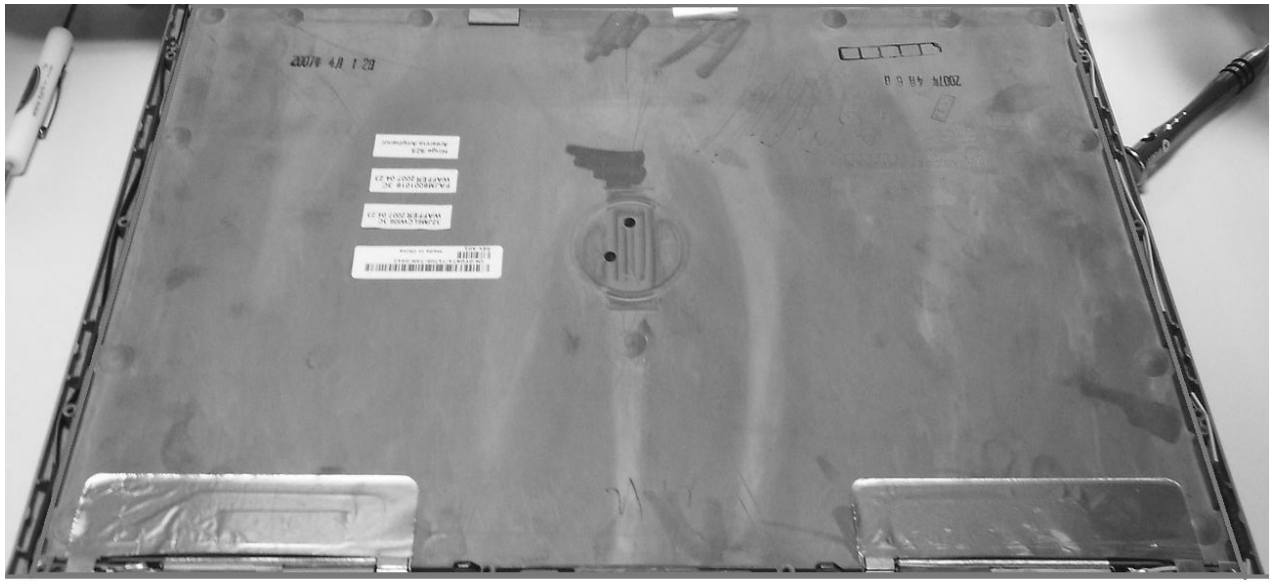
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
7[l]	Wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height	D820 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	
7[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	D820 expressly or inherently discloses this claim element. *See* Claims 1[d], 1[k].
Claim 8		

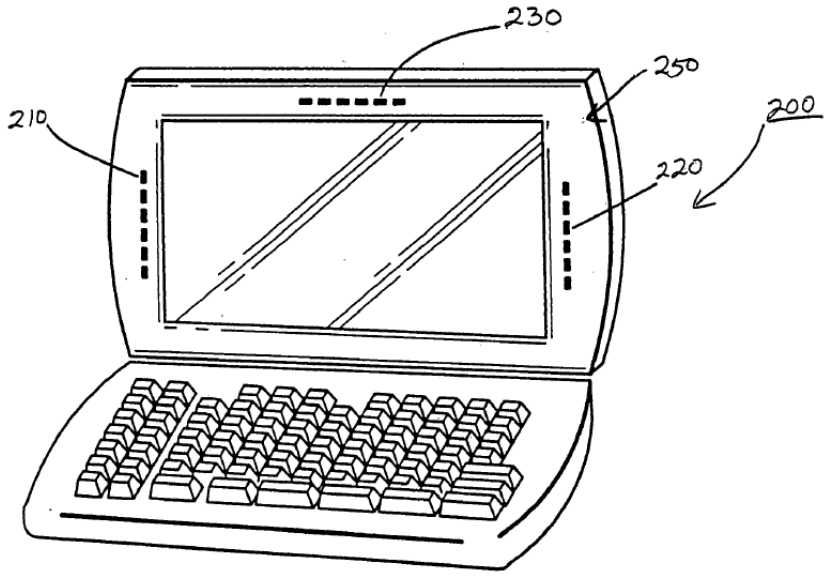
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
8	The wireless device of claim 7, wherein the first non-planar antenna includes at least two antenna elements that are electromagnetically coupled.	D820 expressly or inherently discloses this claim element. *See e.g.,* 
Claim 9		
9	The wireless device of claim 7, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	D820 expressly or inherently discloses this claim element. *See e.g.,* N2=27 

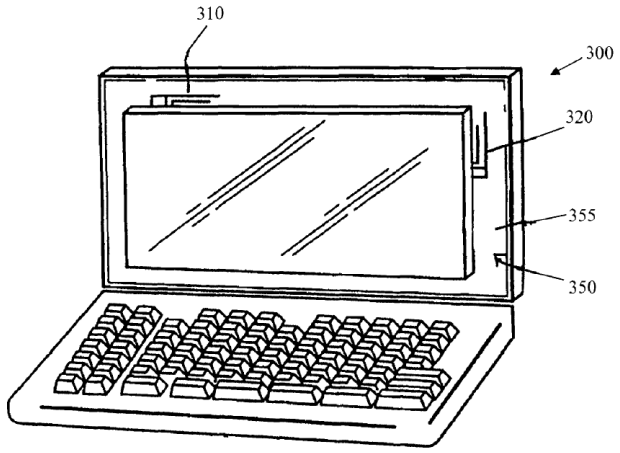
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		N3=86  F32=log(83/27)/log(2)=1.62
		Claim 10
10[a]	The wireless device of claim 7, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	D820 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Dell D820 includes a second antenna (purple below) proximate to a side of a ground plane rectangle enclosing the ground plane.

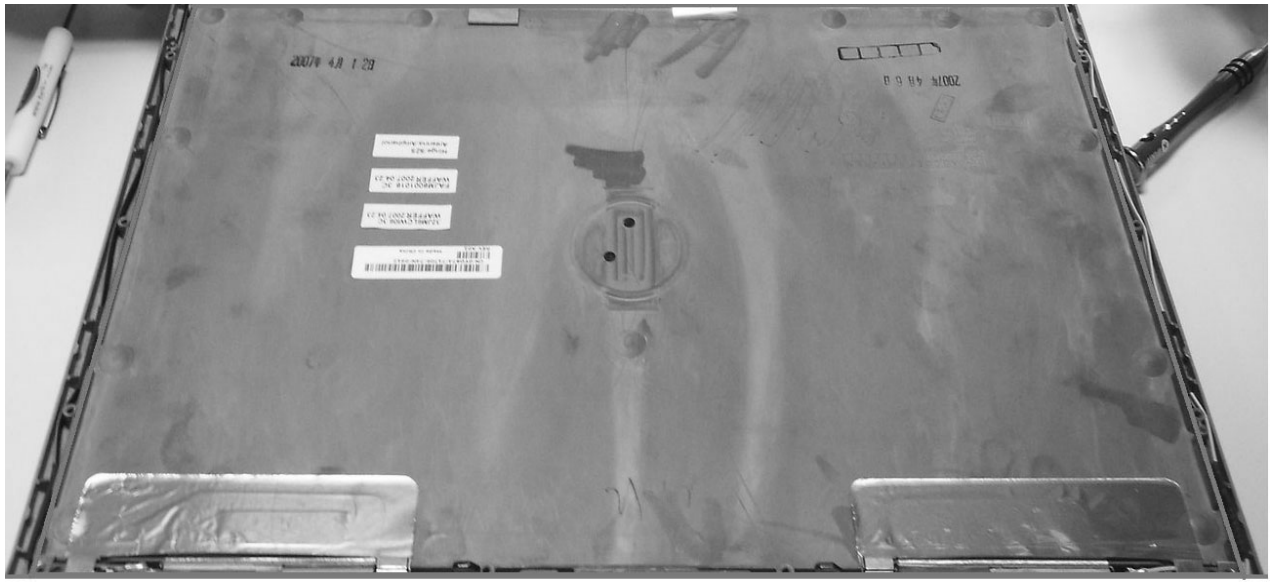
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		

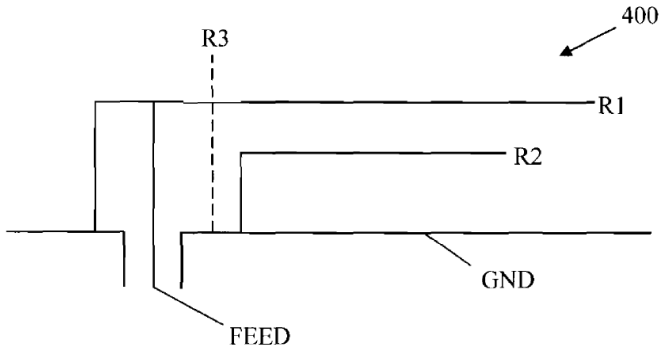
Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		
10[b]	the third antenna is arranged within the wireless device.	D820 expressly or inherently discloses this claim element. *See* Claim 10[a].
Claim 12		
12	The wireless device of claim 7, wherein the first side of the ground	D820 expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	plane rectangle is a short side of the ground plane rectangle.	*See e.g.,* To the extent the Dell D820 does not disclose this limitation, this limitation would have been obvious as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity or spatial diversity. In connection with FIG. 2, Gaucher teaches that "two embedded antennas 210, 220 may be placed on the left and right edges of the laptop display 250, respectively, whereby the use of the two antennas 210 and 220 may reduce the blockage caused by the laptop display 250 in some directions that occurs in one antenna designs, and provide space diversity to the wireless communication system." Gaucher, [0004]

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 FIG. 2 Gaucher also teaches that "one of the antennas [310] or [320] may be disposed on one side of the laptop display [350] while a second antenna [320] is disposed in an upper portion of the laptop display [250], [t]hereby providing antenna polarization diversity, depending on the antenna design used." Gaucher, [0004].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 FIG. 3 Like in the Dell D820, Gaucher's "display frame or the metal display supporters provide the ground element to the antenna design. For example, the ground element may be provided by the display frame, or metal supports, or the shielding foil on the back of the display." Gaucher, [0045].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 Similar to the multiband cellular antennas of the Dell D820, Gaucher's antennas are "quadband antenna[s] covering the four most popular frequency bands, namely, 824-894 MHz for the lower band of the United States, 880-960 MHz for the lower band of Europe 1710-1880 MHz for the upper band of Europe, and 1850-1990 MHz for the upper band of the United States." Gaucher, [0030].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		 There would have been a reasonable expectation of success in having the first planar antenna and the second antenna of the Dell D820 disposed at respective sides of the ground plane rectangle because a similarly configured antenna is taught in a similarly configured laptop device in Gaucher. For instance, Gaucher and the D820 place the antennas on a grounded display frame for use as a ground plane. The Gaucher antennas and the D820 antennas cover substantially the same frequency bands, including some bands used in the United States and some bands used in Europe. Moreover, having the first antenna at the short side of the ground plane rectangle would not have been expected to create interference problems with the WLAN and Bluetooth antennas in the D820 because Gaucher contemplates that the laptop computer may be additionally "equipped with integrated wireless local area network (WLAN) and devices of the known Bluetooth technology." Gaucher, [0026]

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
Claim 13		
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, D820 expressly or inherently discloses this claim element. *See* Claim 1[pre], 7[pre].
13[a]	a ground plane;	D820 expressly or inherently discloses this claim element. *See* Claim 1[a], 7[a].
13[b]	a first antenna	D820 expressly or inherently discloses this claim element. *See* Claim 1[b], 7[b].
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	D820 expressly or inherently discloses this claim element. *See* Claim 1[c], 7[c].
13[d]	the first antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	D820 expressly or inherently discloses this claim element. *See* Claim 1[d], 7[d].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
13[e]	a minimum-sized parallelepiped completely enclosing a volume of the first antenna,	D820 expressly or inherently discloses this claim element. *See* Claim 7[e].
13[f]	the minimum-sized parallelepiped having a face with a largest area;	D820 expressly or inherently discloses this claim element. *See* Claim 7[f].
13[g]	a second antenna proximate to a second side of the ground plane rectangle	D820 expressly or inherently discloses this claim element. *See* Claim 1[g], 7[g].
13[h]	configured to receive signals from at least two frequency bands of the at least three frequency bands,	D820 expressly or inherently discloses this claim element. *See* Claim 1[h], 7[h].
13[i]	wherein the first antenna has a first contour defined as a perimeter of any	D820 expressly or inherently discloses this claim element. *See* Claim 1[i], 7[i].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	
13[j]	wherein the first contour has a level of complexity defined by complexity factor F_{21} having a value of at least 1.20 and	D820 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j], 7[j].
13[k]	complexity factor F_{32} having a value of at least 1.35; and	D820 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j], 7[k].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
13[l]	wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long	D820 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j], 7[l].

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights	

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
	of the cells of the grid G2, and	
13[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	D820 expressly or inherently discloses this claim element. *See* Claims 1[d], 1[k], 7[m].
Claim 14		
14	The wireless device of claim 13, wherein the first antenna includes at least two antenna elements that are electromagnetically coupled.	D820 expressly or inherently discloses this claim element. *See* Claims 2, 8.
Claim 15		
15	The wireless device of claim 13, wherein the first antenna is planar.	D820 expressly or inherently discloses this claim element. To the extent the D820 does not expressly or inherently discloses this claim element, this claim element would have been obvious in view of the HP Compaq nc6400.

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		See Claim 1[b].
Claim 17		
17	The wireless device of claim 13, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	D820 expressly or inherently discloses this claim element. *See* Claims 5, 9.
Claim 18		
18[a]	The wireless device of claim 13, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	D820 expressly or inherently discloses this claim element. *See* Claim 10.
18[b]	the third antenna is arranged within the wireless device.	D820 expressly or inherently discloses this claim element. *See* Claim 10.

Claim No.	U.S. Patent No. 12,095,149 B2	Dell Latitude D820
		Claim 19
19	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	D820 expressly or inherently discloses this claim element. To the extent the Dell D820 does not disclose this limitation, this limitation would have been obvious as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity or spatial diversity. *See* Claims 3, 12.
		Claim 20
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	D820 expressly or inherently discloses this claim element. To the extent the Dell D820 does not disclose this limitation, this limitation would have been obvious as taught in Gaucher et al. (U.S. 2006/0082503) to achieve polarization diversity or spatial diversity. *See* Claims 1[g], 4, 7[g]. For instance, it would have been obvious for either the first antenna or the second antenna to be disposed proximate to a short side of the ground plane rectangle and for the other of the first antenna and the second antenna to be proximate to a long side of the ground plane rectangle, as taught in Gaucher, as a matter of design choice, and as one of a small number of positions taught by Gaucher from which to select.

Exhibit – F – 10

INVALIDITY CONTENTIONS FOR U.S. PATENT NO. 12,095,149 B2
BASED ON THE LENOVO T60 ("T60")

Based upon Plaintiff's Complaint, Infringement Contentions, and apparent claim constructions and application of the claims to Defendants' accused products, as best as they can be deciphered, the reference charted below anticipates or at least renders obvious some or all of claims 1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 19, and 20 (the "'149 Asserted Claims")[1]. These invalidity contentions are not an admission by the Defendant that the accused products are covered by or infringe the asserted claims, particularly when these claims are properly construed and applied.

AIA law applies because the application that issued as the '149 Patent was filed on June 22, 2023, after the AIA came into force on March 16, 2013.

Lenovo Group Limited's ("Lenovo") T60/T60p (performance), as publicly demonstrated, known, offered for sale, sold, and/or used by Lenovo and/or customers of Lenovo, or otherwise available to the public, including in this country, ("T60") was released by at least February 2006[2]. Thus, the T60 is available as prior art at least under pre-AIA 35 U.S.C. § 102(a)-(b), or (g)(2) and/or AIA 35 U.S.C. § 102(a)(1). At least the following documents provide evidence as to the date the T60 was "offered for sale or publicly used or known," "the date the offer or use of the item took place or the information became known", and the "identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known" [3]:

[1] Defendants understand that, by not charting claims 6, 11, and 16 in its Infringement Contentions, Plaintiff does not assert these claims against Defendants.
[2] *See* Your Gadgets Website, "The Thinkpad T Series – the Development and History of a Renowned Technology Branding," Archived on Feb. 5, 2012, available at: https://web.archive.org/web/20120205012630/http://www.your-gadgets.com/apple/5747-the-thinkpad-t-series-the-development-and-history-of-an-renowned-technology-branding.php (last accessed June 18, 2025); Wikipedia.com, "Thinkpad T60" https://en.wikipedia.org/wiki/ThinkPad_T60 (last accessed June 18, 2025).
[3] Defendants do not yet have complete information regarding the dates by which this product was publicly disclosed, made, used, sold, or offered for sale, the circumstances under which the research, design, and development activities were conducted, and the identities of the particular individuals involved in such activities. Defendants anticipate that the actual dates, circumstances, and identities of individuals will be the subject of third party discovery during this lawsuit. Defendants therefore reserve the right to amend and/or supplement their Invalidity Contentions and this chart if additional information becomes available during the course of discovery. The date the T60 was "offered for sale or publicly used or known," as well as "the date the offer or use of the item took place or the information became known" is at least as early as the dates identified in the published documents. The "identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known" includes at least those persons associated with the publication(s), press releases, and conference attendees, or other documents associated with each version on the T60. Defendants also reserve the right to rely on the public use, offer for sale, sale, or installation of the devices described in the publications identified herein once Defendants have had a fair opportunity to take discovery on these subjects.

- Your Gadgets Website, "The Thinkpad T Series – the Development and History of a Renowned Technology Branding," Archived on Feb. 5, 2012, available at: https://web.archive.org/web/20120205012630/http://www.your-gadgets.com/apple/5747-the-thinkpad-t-series-the-development-and-history-of-an-renowned-technology-branding.php (last accessed June 18, 2025).
- Wikipedia.com, "*Thinkpad T60*" at: https://en.wikipedia.org/wiki/ThinkPad_T60 (last accessed June 18, 2025)
- NotebookCheck Website, "*Thinkpad T60*" at: https://www.notebookcheck.net/Review-IBM-Lenovo-Thinkpad-T60.1294.0.html (last accessed June 18, 2025)
- NotebookCheck Website, "*Thinkpad T60p*" at: https://www.notebookcheck.net/Lenovo-Thinkpad-T60p.1401.0.html (last accessed June 18, 2025)
- NotebookReview Website, "Lenovo ThinkPad T60p Review (pics, specs)" (Apr. 5, 2006) at: https://web.archive.org/web/20060407172813/http://www.notebookreview.com/default.asp?newsID=2864&Review=Lenovo+ThinkPad+T60p (last accessed June 18, 2025)
- CNET Website, "Lenovo ThinkPad T60" (Mar. 10, 2006) at: https://web.archive.org/web/20080519075517/http:/reviews.cnet.com/laptops/lenovo-thinkpad-t60-1951/4505-3121_7-31641904-2.html (last accessed June 18, 2025)
- PCMag Website, "Lenovo ThinkPad T60" (Mar. 6, 2006) at: https://web.archive.org/web/20060409125520/http:/www.pcmag.com/article2/0,1895,1933669,00.asp (last accessed June 18, 2025)
- LaptopMag Website, "Lenovo ThinkPad T60" (May 6, 2006) at: https://web.archive.org/web/20060615095136/http://laptopmag.com/Review/Lenovo-ThinkPad-T60.htm (last accessed June 18, 2025)

As described in the following claim chart, the asserted claims of U.S. Patent No. 12,095,149 (the "'149 Patent"), are invalid as anticipated by T60. To the extent that T60 is found not to anticipate one or more of the asserted claims of the '149 Patent, these claims are invalid as obvious in view of T60 alone or in combination with other prior art references disclosed in Defendants' Invalidity Contentions and accompanying charts, including without limitation as set forth below.

One of ordinary skill in the art, as of the priority date of the '149 Patent, would have known to combine or modify the prior art elements disclosed by the foregoing references using known methods, and to use these elements according to their established functions in order to achieve a known and predictable result.

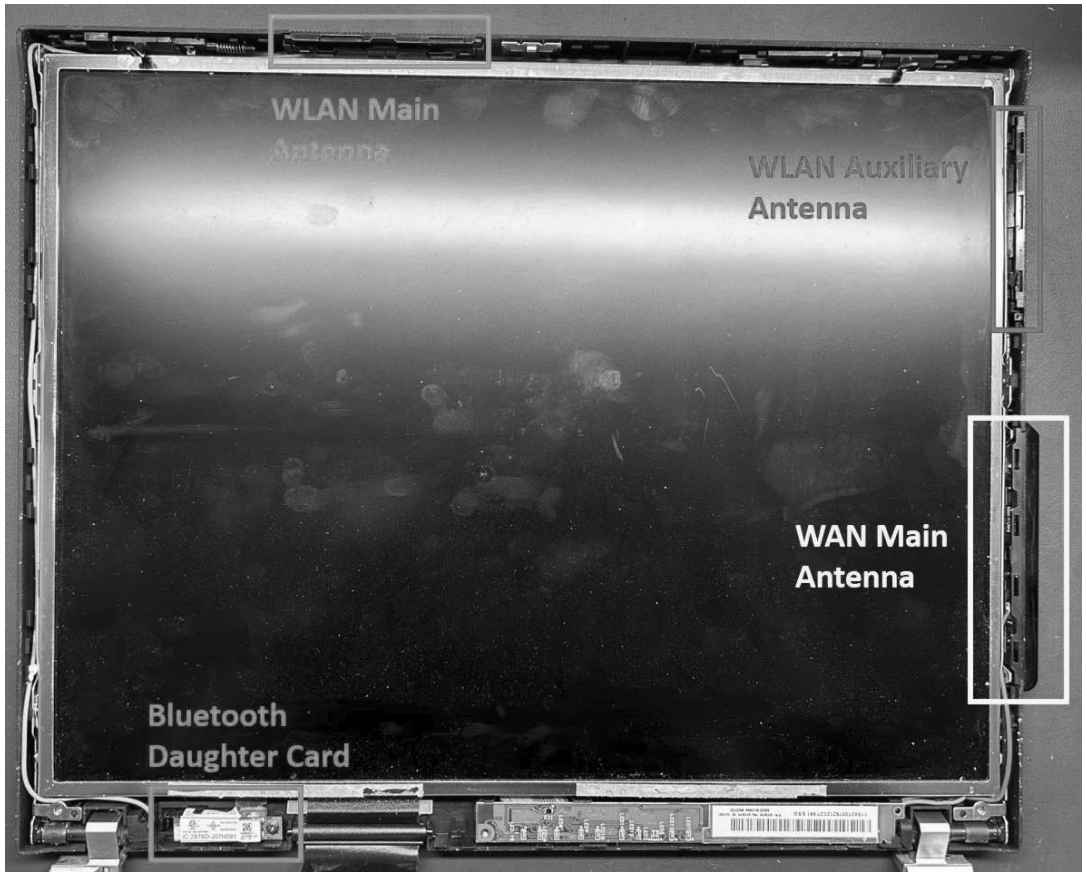
These invalidity contentions are not an admission that the Defendants concede or acquiesce to any claim construction implied or suggested by Plaintiff's Complaint or Infringement Contentions. Nor are Defendants asserting any claim construction positions through these charts, including

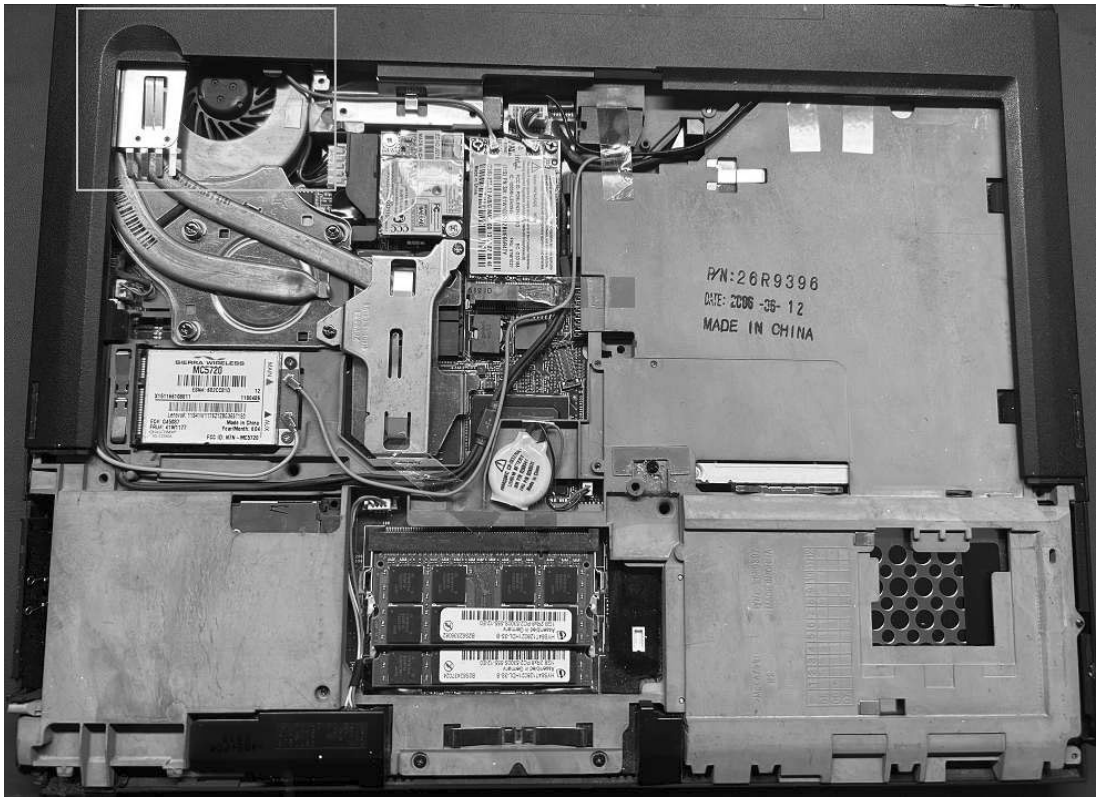
whether the preamble is a limitation. The portions of the prior art reference cited below are not exhaustive but are exemplary in nature. Defendants retain the right to update their constructions and contentions in view of this Court's claim construction order.[4]

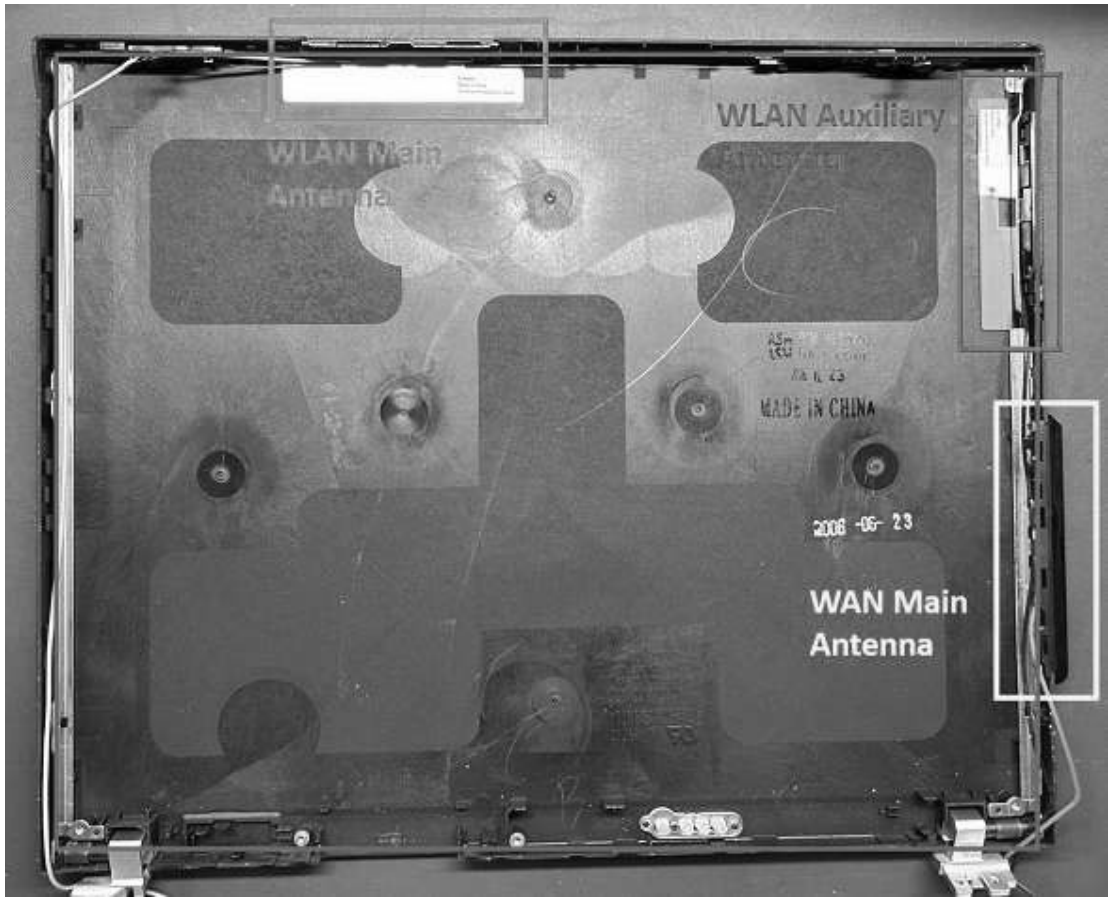
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	Claim 1	
1[pre]	A wireless device comprising:	To the extent the preamble is limiting, T60 expressly or inherently discloses this claim element. *See, e.g.*, 

[4] Defendants reserve the right to supplement and/or alter this chart based on further investigation and ongoing discovery.

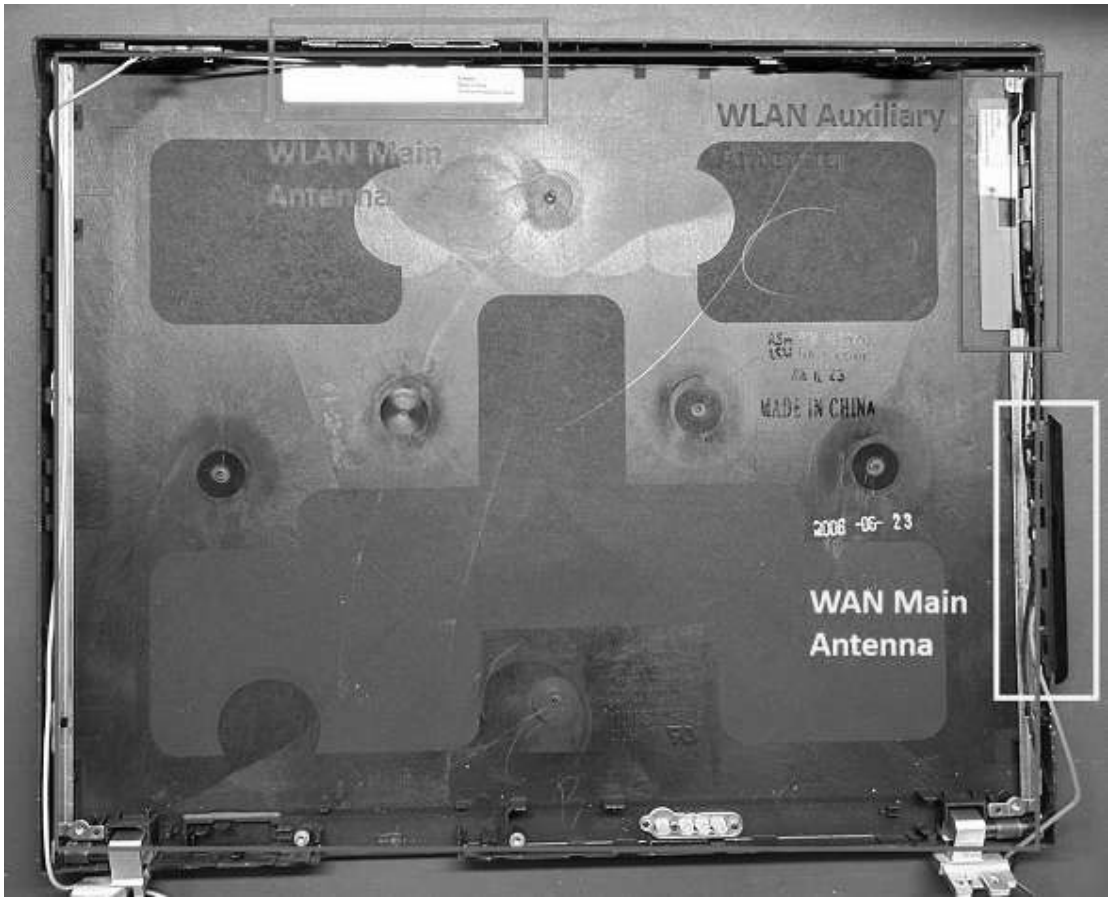
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		See Notebook Review, Archived on April 7, 2006 at: https://web.archive.org/web/20060407172813/http://www.notebookreview.com/default.asp?newsID=2864&Review=Lenovo+ThinkPad+T60p (last accessed June 18, 2025).
1[a]	a ground plane;	T60 expressly or inherently discloses this claim element. *See, e.g.*, The Lenovo T60 includes a ground plane (purple below) and at least two antennas within the wireless device.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

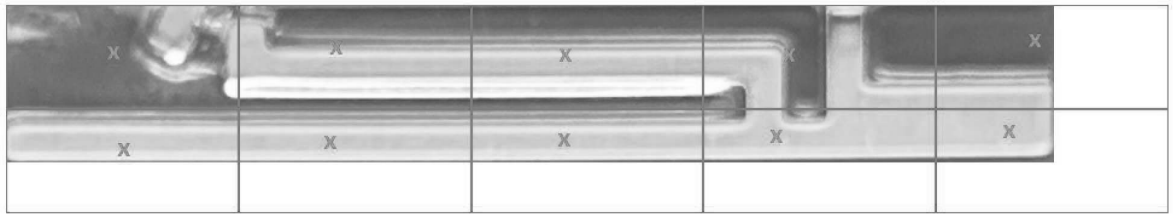
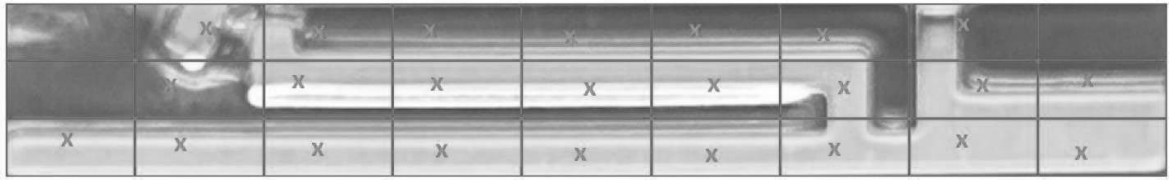
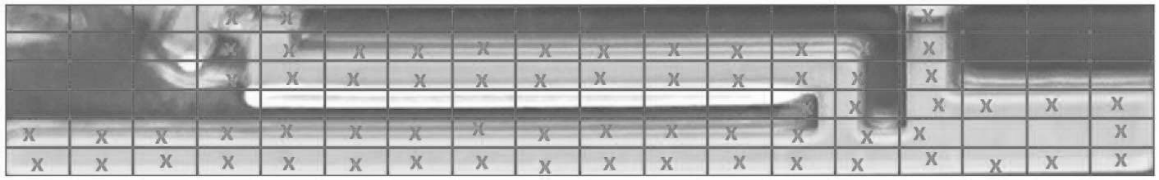
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		
1[b]	a first planar antenna	T60 expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		See Claim 1[a].
1[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	T60 expressly or inherently discloses this claim element. *See, e.g.*, The antenna system of the Lenovo T60 includes a first planar antenna (red below) proximate to a first short side of a ground plane rectangle (purple below) enclosing the ground plane.

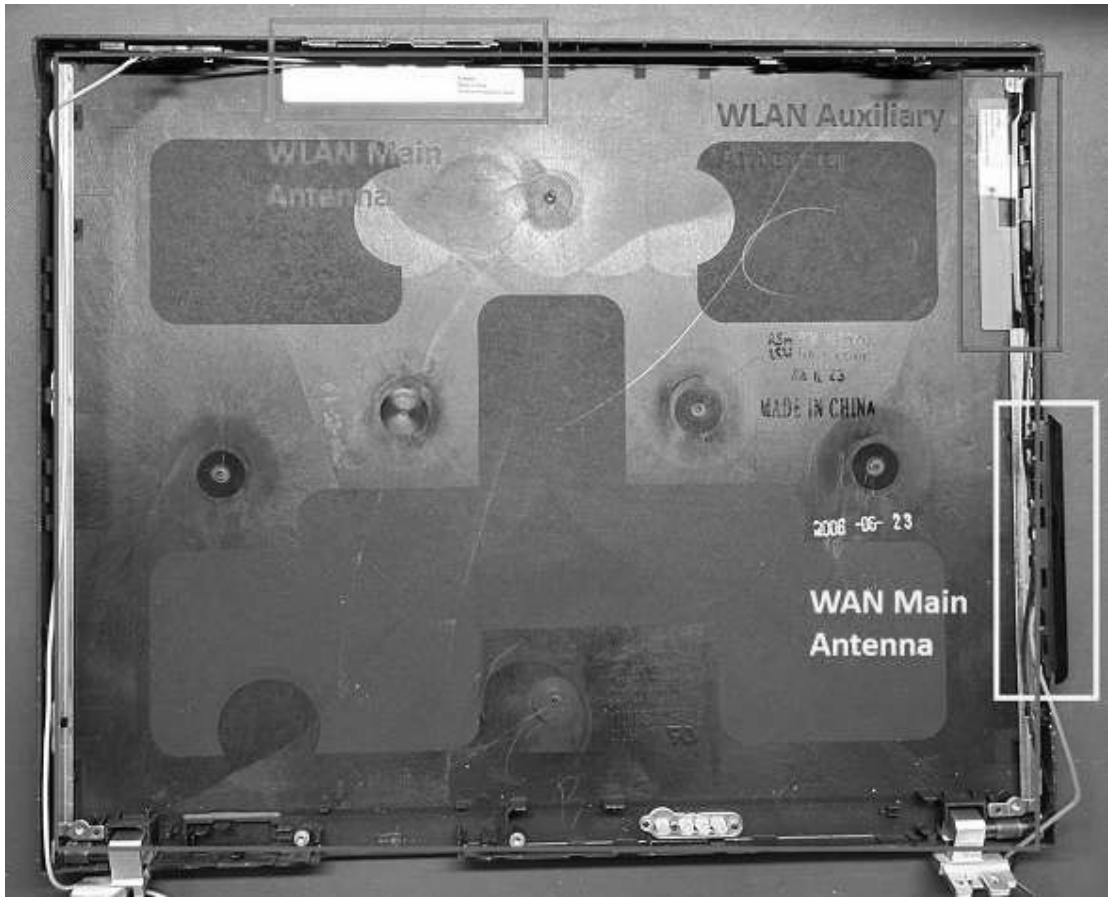
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		 **First antenna – side view**
1[d]	the first planar antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	T60 expressly or inherently discloses this claim element. *See, e.g.*, The first planar antenna of the Lenovo T60 is configured to support at least three frequency bands contained within first and second frequency ranges of the electromagnetic spectrum. The second frequency range is higher in frequency than the first frequency range. **Network** • 1Gb Ethernet installed on systems via the system board. • Intel 802.11abg Mini PCI Express wireless adapter on selected models. • ThinkPad 802.11abg(3945) Mini PCI Express wireless adapter on selected models. • Bluetooth/Modem combo card on selected models. • Integrated Sierra Wireless CDMA2000 Network Adapter for Verizon Wireless Broadband Access on selected models. *See* Lenovo Website, https://support.lenovo.com/us/en/solutions/pd008795-detailed-specifications-thinkpad-t60-t60p (last accessed June 18, 2025).

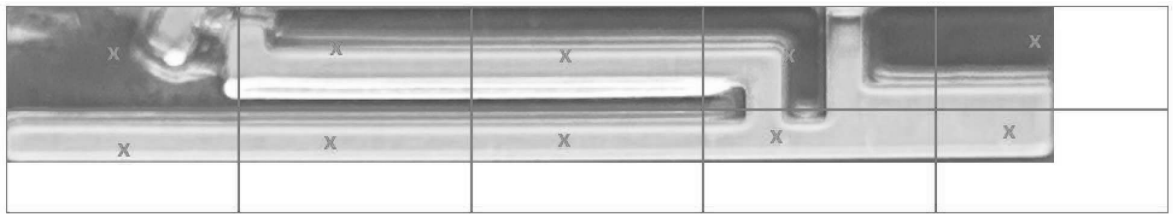
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		The first antenna is configured to support at least three frequency bands contained within at least 2.4-2.484 GHz, 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.725-5.875 GHz.
1[e]	the first planar antenna defining a first contour,	T60 expressly or inherently discloses this claim element. *See, e.g.*, 
1[f]	wherein the first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35; and	T60 expressly or inherently discloses this claim element. *See, e.g.*, The first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.35. N1=10

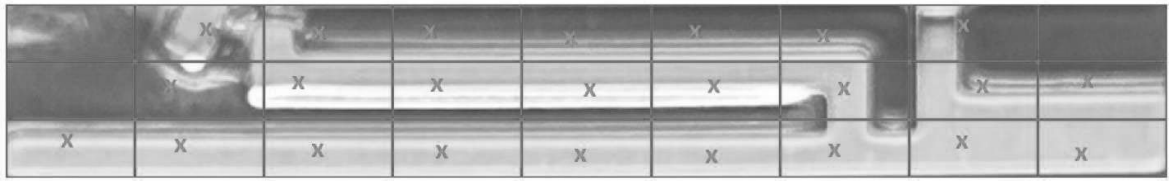
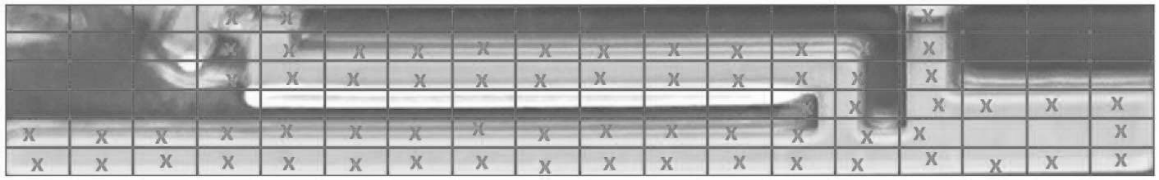
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		 N2=24  N3=67  F21=log(24/10)/log(2)=1.26 F32=log(67/24)/log(2)=1.48 The complexity factor calculation is performed according to the method in the patent.
1[g]	a second antenna proximate to a second side of the	T60 expressly or inherently discloses this claim element. *See, e.g.*,

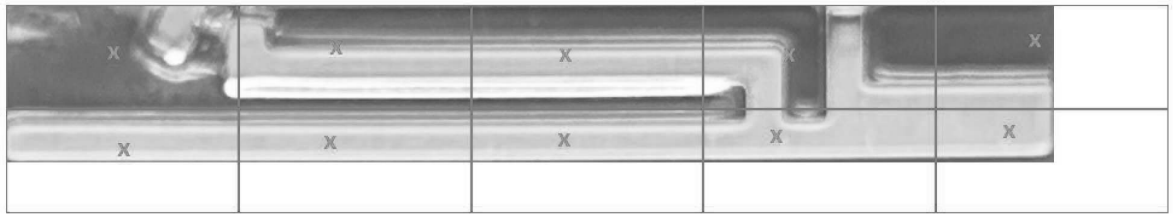
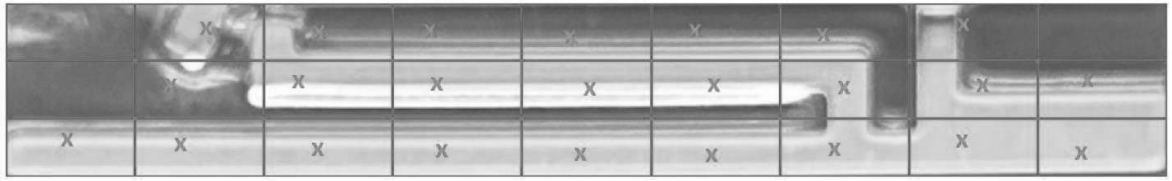
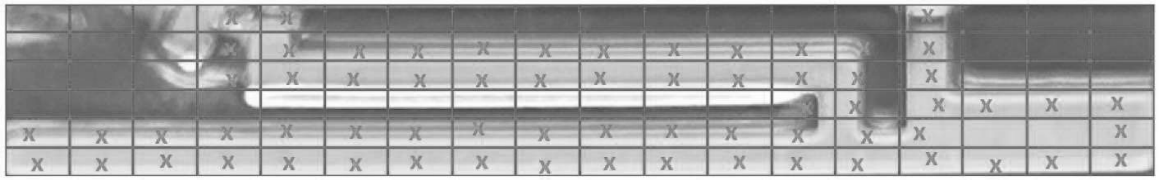
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	ground plane rectangle,	The antenna system of the Lenovo T60 includes a second antenna (blue below) proximate to a second side of the ground plane rectangle (purple below).

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

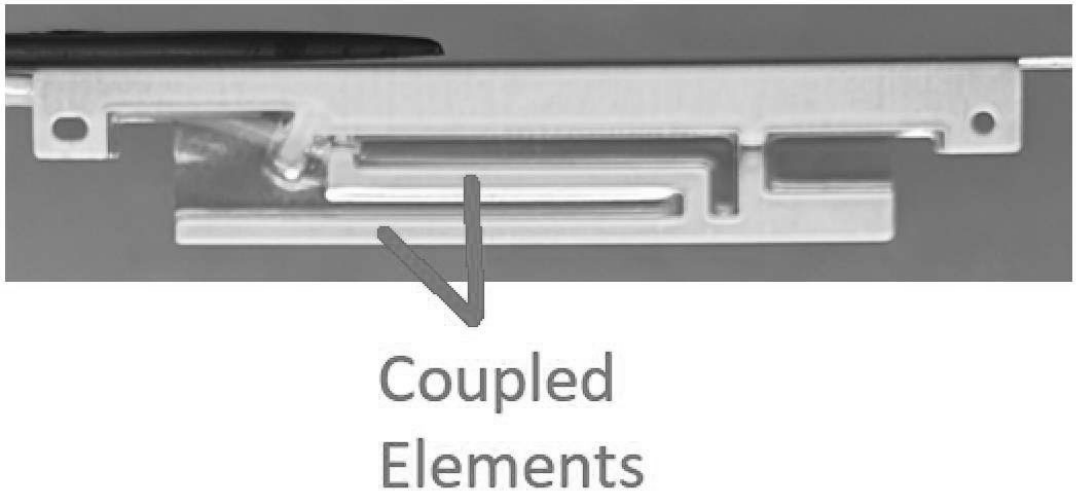
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		
1[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	T60 expressly or inherently discloses this claim element. *See, e.g.*, The second antenna of the Lenovo T60 is configured to receive signals from at least two frequency bands of the at least three frequency bands. The second antenna of the Lenovo T60 is configured to receive signals within at least at least 2.4-2.484 GHz, 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.725-5.875 GHz.
1[i]	wherein the first contour is defined as a perimeter of the first planar antenna and perimeters of any closed apertures	T60 expressly or inherently discloses this claim element. *See* Claims 1[e] and [f] above. The first contour of the first planar antenna of the T60 is defined as a perimeter of the first planar antenna and perimeters of any closed apertures defined within the first planar antenna. The complexity factors F21 and F32 are given by:

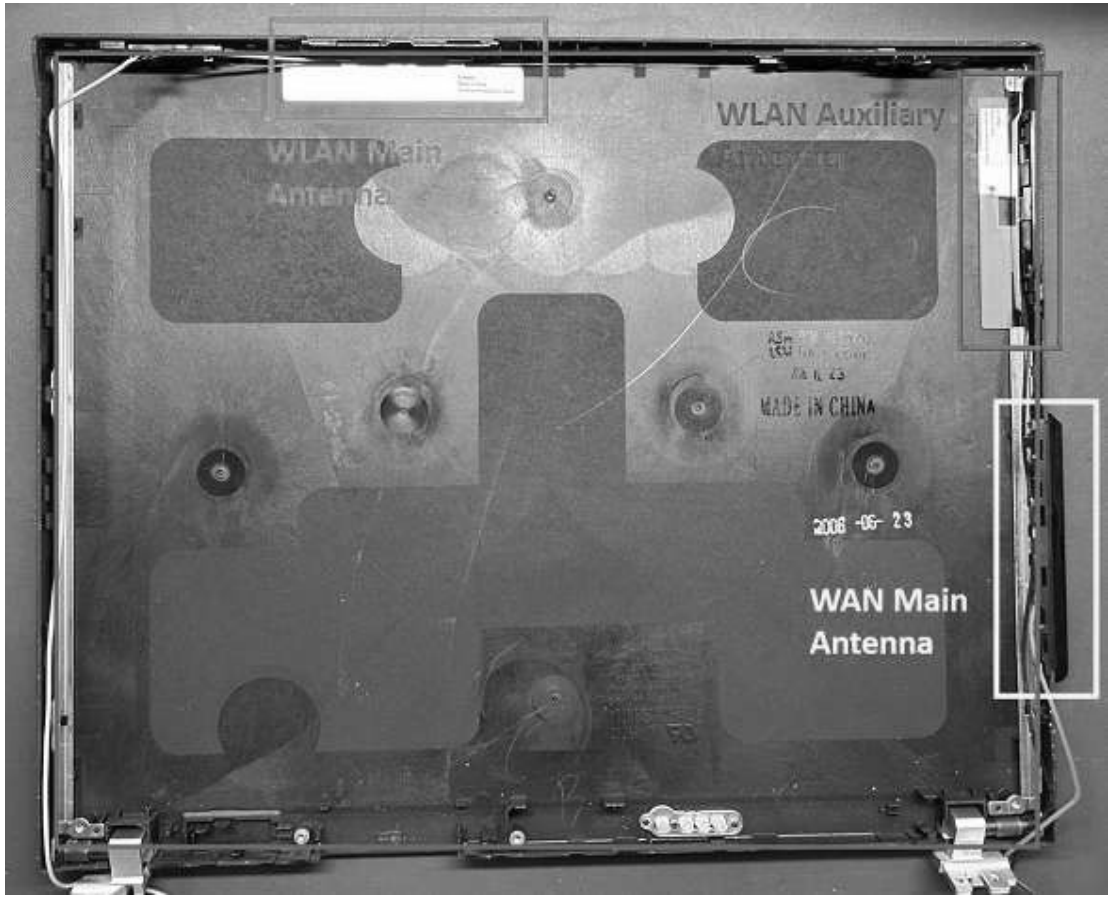
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	defined within the first planar antenna;	F21=-log(N2)-log(N1)/ log(1/2) F32=-log(N3)-log(N2)/ log(1/2) N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour. The grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle. The number of rows results in the cells of grid G2 is as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle. The cells of the grid G1 have widths and heights that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 is aligned with the grid G2. The cells of the grid G3 have widths and heights that respectively are half the widths and heights of the cells of the grid G2. N1=10  N2=24

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		 N3=67  F21=log(24/10)/log(2)=1.26 F32=log(67/24)/log(2)=1.48
1[j]	wherein the complexity factors F21 and F32 are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include	T60 expressly or inherently discloses this claim element. *See* claims 1[f] and 1[i] above. When calculated using this mathematical formula, the first antenna contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value less than 1.35. N1=10

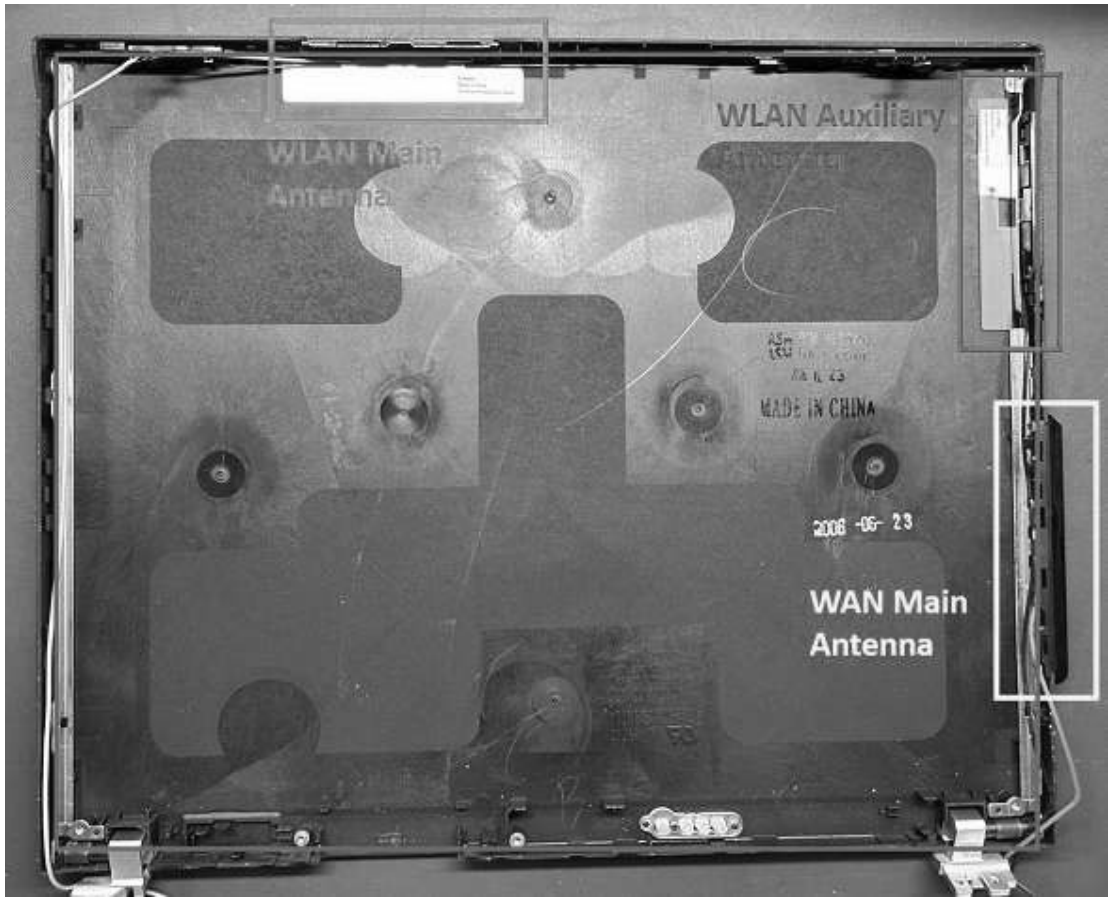
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides a minimum-sized rectangle enclosing the first planar antenna into nine columns of equal width arranged along a long side of the minimum-sized rectangle and into an odd number of rows of equal height arranged along a short side of the minimum-sized rectangle, wherein the number	 N2=24  N3=67  F21=log(24/10)/log(2)=1.26 F32=log(67/24)/log(2)=1.48

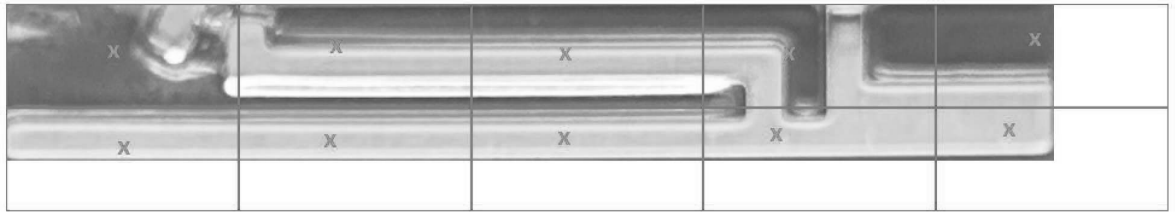
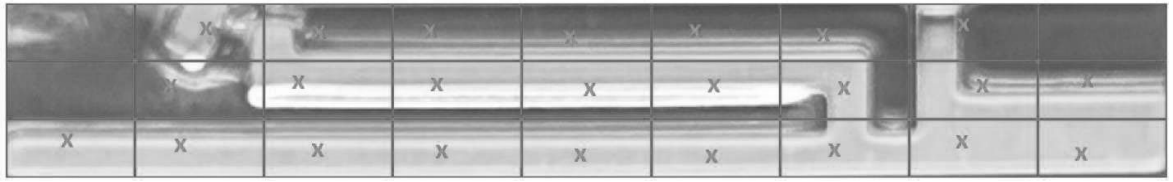
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the minimum-sized rectangle, the cells of the grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	
1[k]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	T60 expressly or inherently discloses this claim element. *See e.g.*, The level of complexity of the first contour is configured to provide operation of the T60 in the at least three frequency bands.

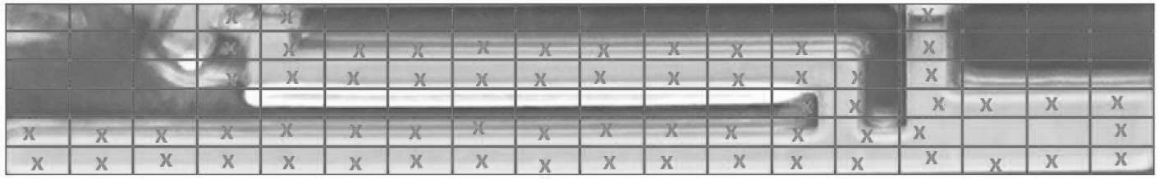
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		Claim 2
2	The wireless device of claim 1, wherein the first planar antenna includes at least two antenna elements that are electromagnetically coupled.	T60 expressly or inherently discloses this claim element. *See, e.g.*, The first planar antenna includes at least two antenna elements that are electromagnetically coupled. 
		Claim 3
3	The wireless device of claim 1, wherein the first side of the	T60 expressly or inherently discloses this claim element. *See* Claim 1[d].

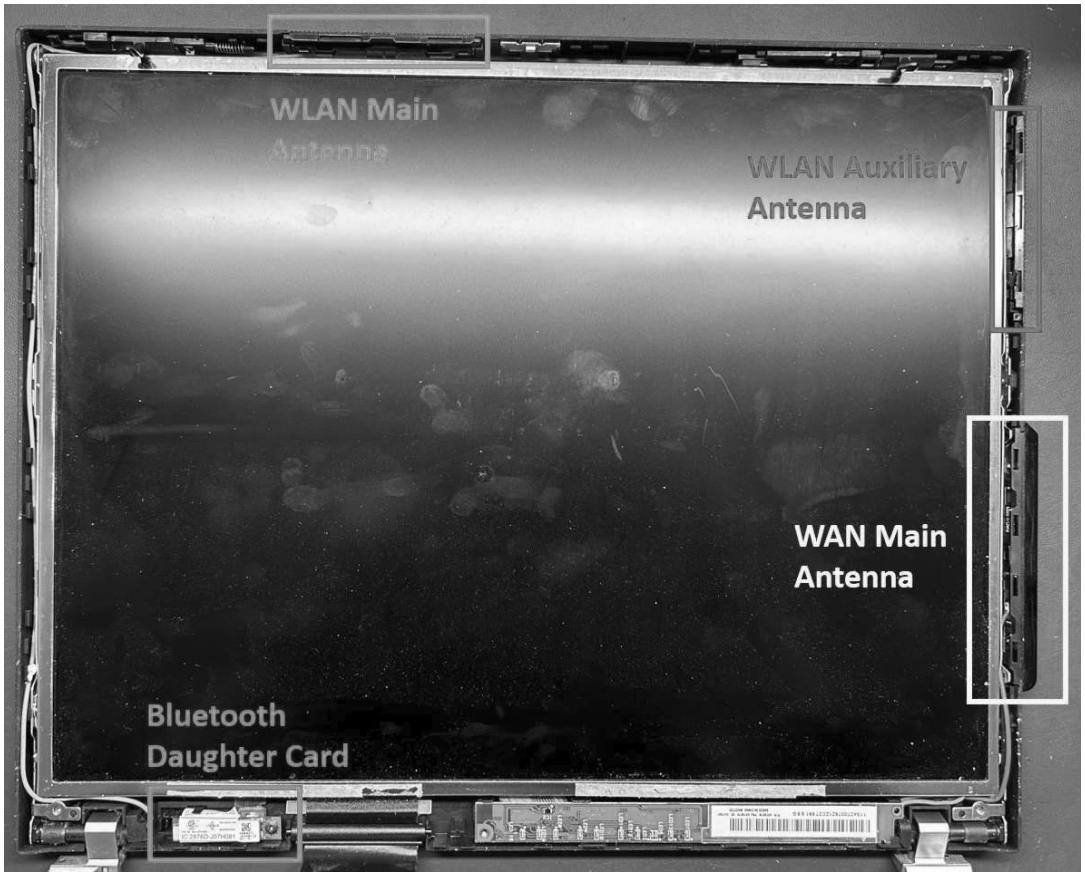
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	ground plane rectangle is a short side of the ground plane rectangle.	The antenna system of the Lenovo T60 includes a first antenna (red below) proximate to a first side of a ground plane rectangle (purple below) which is a short side of the ground plane rectangle. 

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	Claim 4	
4	The wireless device of claim 1, wherein the second side of the ground plane rectangle is a long side of the ground plane rectangle.	T60 expressly or inherently discloses this claim element. *See* Claim 1[d]. The antenna system of the Lenovo T60 includes a second antenna (blue below) proximate to a second side of the ground plane rectangle (purple below), which is a long side of the ground plane rectangle.

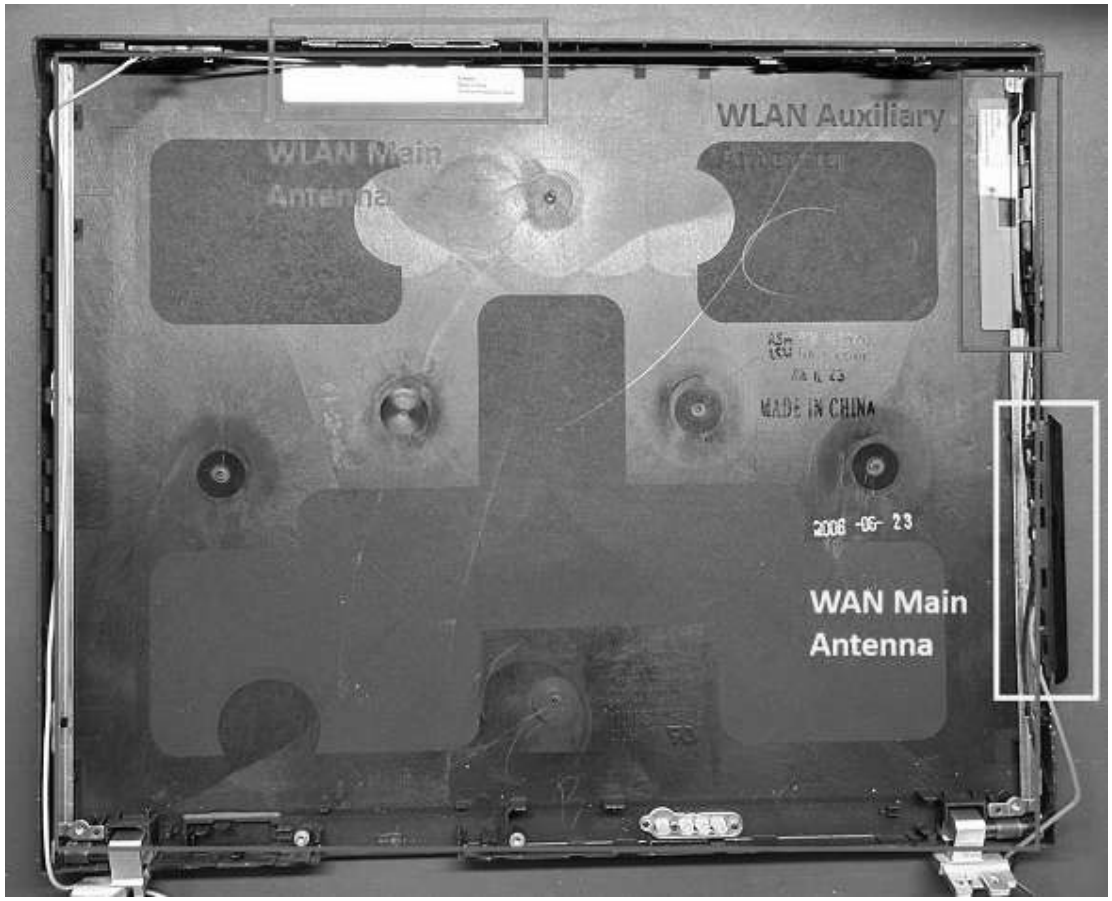
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	Claim 5	
5	The wireless device of claim 1, wherein the complexity factor F32 for the first contour is smaller than 1.75.	T60 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j]. The complexity factor F32 for the first contour is smaller than 1.75. N1=10  N2=24  N3=67

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		 F21=log(24/10)/log(2)=1.26 F32=log(67/24)/log(2)=1.48 The complexity factor calculation is performed according to the method in the patent.
Claim 7		
7[pre]	A wireless device comprising:	To the extent the preamble is limiting, T60 expressly or inherently discloses this claim element. *See* Claim 1[pre].
7[a]	a ground plane;	T60 expressly or inherently discloses this claim element. *See* Claim 1[a].
7[b]	a first non-planar antenna	T60 expressly or inherently discloses this claim element. *See, e.g.*, T60 includes a first non-planar antenna (yellow below).

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		 **First antenna – side view**
7[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	T60 expressly or inherently discloses this claim element. *See, e.g.*, The first antenna of the T60 is proximate to a first side of a ground plane rectangle enclosing the ground plane.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		
7[d]	the first non-planar antenna being	T60 expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	configured to support at least three frequency bands of the electromagnetic spectrum,	*See e.g.,* The first non-planar antenna of the Lenovo T60 is configured to support at least three frequency bands of the electromagnetic spectrum. The first non-planar antenna of the Lenovo T60 is configured to support at least three frequency bands at least within 824-894 MHz and 1710-2170 MHz.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		Table 1: Frequency bands within 1690-2250 MHz.

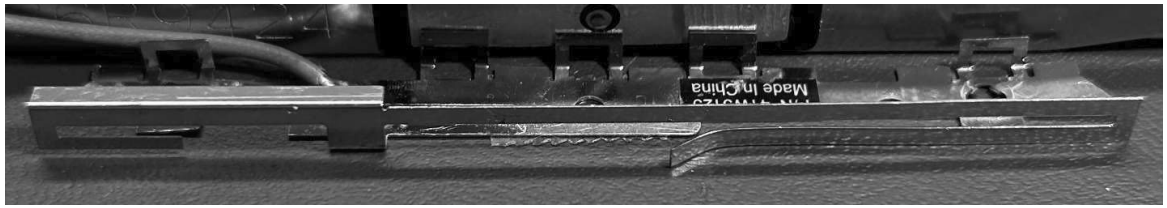
Band	Range (MHz)
DCS1800	1710-1880
PCS1900	1850-1990
UMTS Band I	1920-2170
UMTS Band II	1850-1990
UMTS Band III	1710-1880
UMTS Band IV	1710-2155
UMTS Band a	1900-1920, 2010-2025
UMTS Band b	1850-1910, 1930-1990
UMTS Band c	1910-1930
LTE Band 1	1920-2170
LTE Band 2	1850-1990
LTE Band 3	1710-1880
LTE Band 4	1710-2155
LTE Band 9	1749.9-1879.9
LTE Band 10	1710-2170
LTE Band 33	1900-1920
LTE Band 34	2010-2025
LTE Band 35	1850-1910
LTE Band 36	1930-1990
LTE Band 37	1910-1930
LTE Band 39	1880-1920

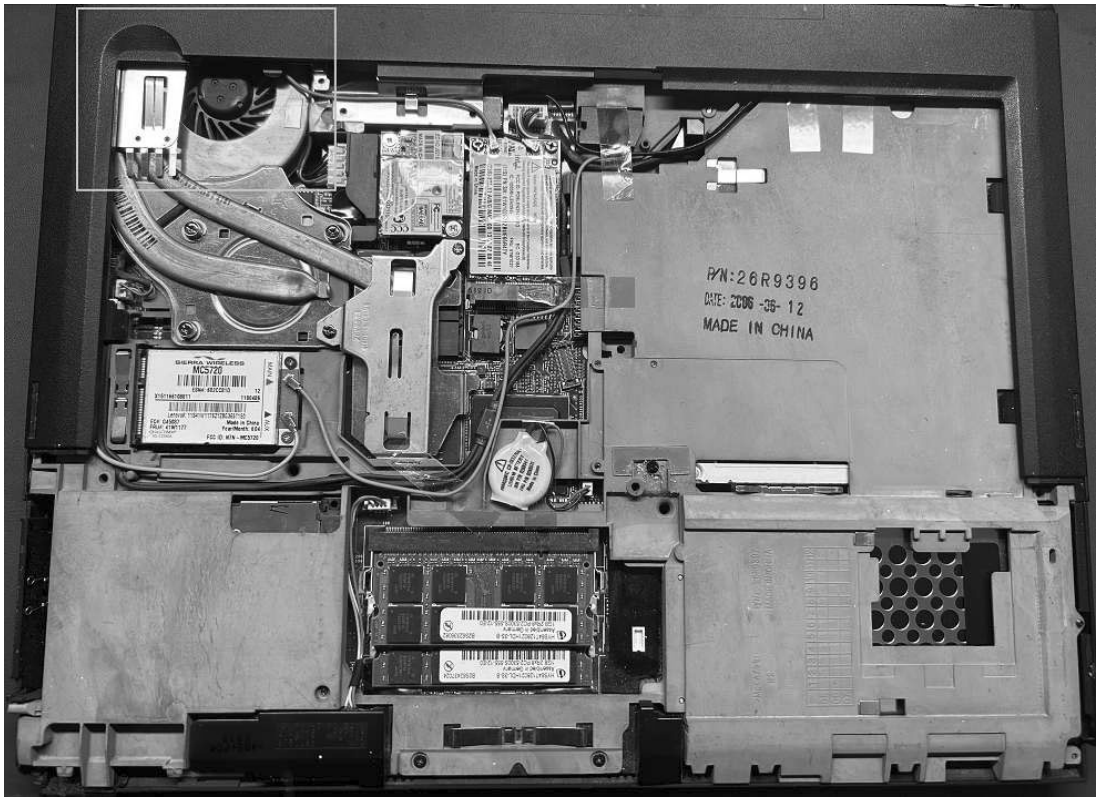
X. Jing et al., "Compact Planar Monopole Antenna for Multi-band Mobile Phones," 2005 Asia-Pacific Microwave Conference Proceedings, vol. 4, pp. 2657-2660, IEEE, 2005, at 2658 (DCS, PCS, UMTS); ETSI

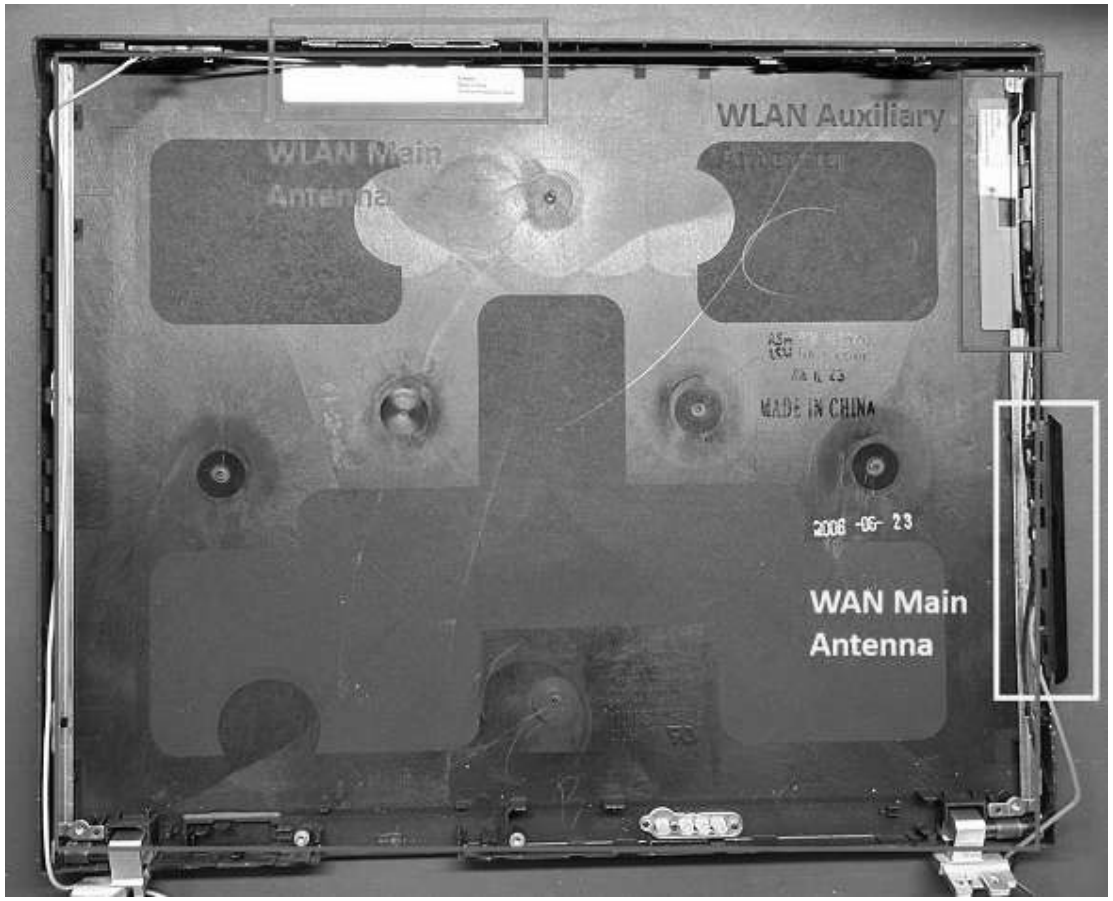
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		TS 145 005 V4.3.0 (2001-14) Technical Specification: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception (3GPP TS 45.005 version 4.3.0 Release 4), 8-9 (DCS1800, PCS1900); Pages from E. Dahlman et al., 3G Evolution: HSPA and LTE for Mobile Broadband (Academic Press 2d ed. 2008) ("Dahlman"), 139 (reference [100] identifies HSDPA specifications), 497-501, 599 (reference [100] is 3GPP TS 25.308 (Dahlman)); ETSI TS 125 308 V6.2.0 (2004-09) Technical Specification: Universal Mobile Telecommunications System (UMTS); UTRA High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (3GPP TS 25.308 version 6.2.0 Release 6) (UMTS HSDPA description); ETSI TS 121 101 V6.0.0 (2004-12) Technical Specification: Universal Mobile Telecommunications System (UMTS); Technical Specifications and Technical Reports for a UTRAN-based 3GPP system (3GPP TS 21.101 version 6.0.0 Release 6), 11-12 (UMTS standard comprises TS 25.101 (ETSI TS 125 101 V6.5.0 (2004-09) Technical Specification: Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD) (3GPP TS 25.101 version 6.5.0 Release 6)), 25.102 (ETSI TS 125 102 V6.0.0 (2003-12) Technical Specification: Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (TDD) (3GPP TS 25.102 version 6.0.0 Release 6)), 25.308 (Dahlman)); ETSI TS 125 101 V6.5.0 (2004-09) Technical Specification: Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD) (3GPP TS 25.101 version 6.5.0 Release 6), 12-13 (Table 5.0 "UTRA FDD frequency bands"); ETSI TS 125 102 V6.0.0 (2003-12) Technical Specification: Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (TDD) (3GPP TS 25.102 version 6.0.0 Release 6), 11 (UTRA/TDD frequency bands)[5]; 3GPP TS 36.101 v8.4.0 (2008-12) Technical Specification: 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (Release 8), 2008, 13, Table 5.5-1 ("E-UTRA operating bands" defining LTE bands); Ericsson white paper, "LTE—an introduction," no. 284 23-3124 Uen Rev B (June 2009), 11 (listing LTE FDD and TDD bands).

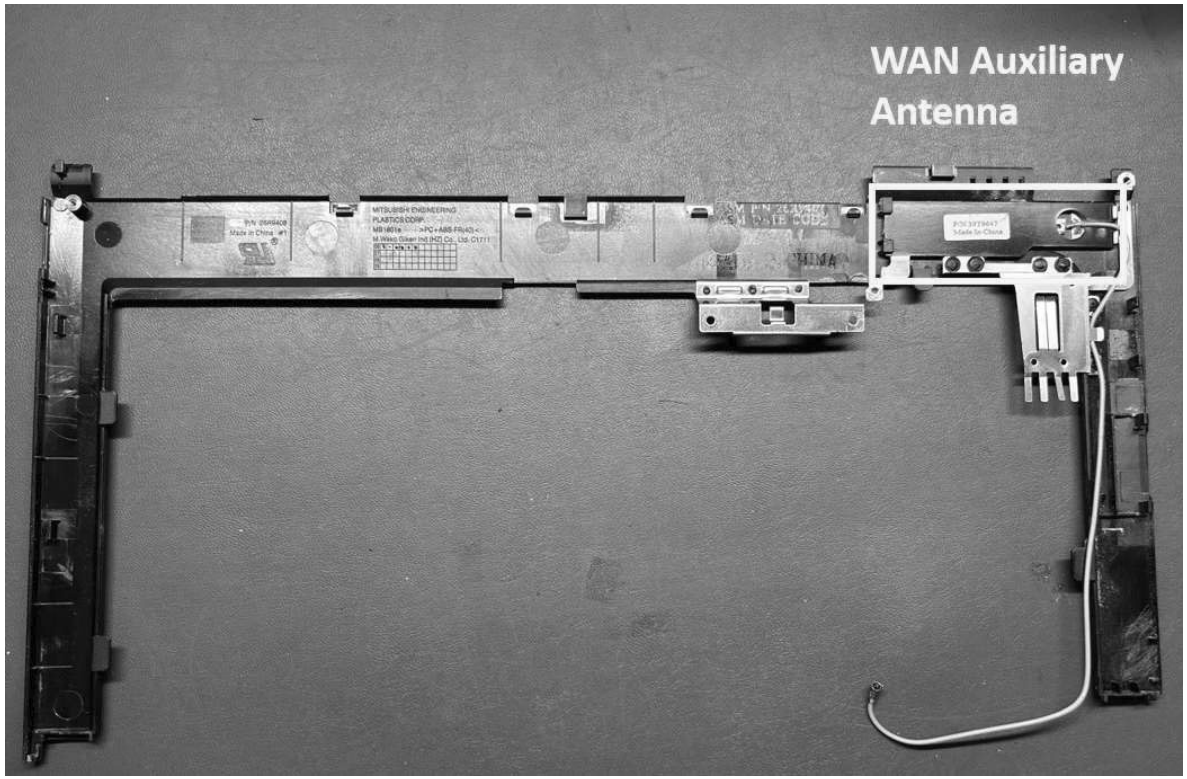
[5] While Dou refers to "WCDMA/UMTS" in 1710-2170 MHz (Dou, [0022]), as shown in Table 1 the standard defines at least seven distinct "bands" within the 1710-2170 MHz frequency range.

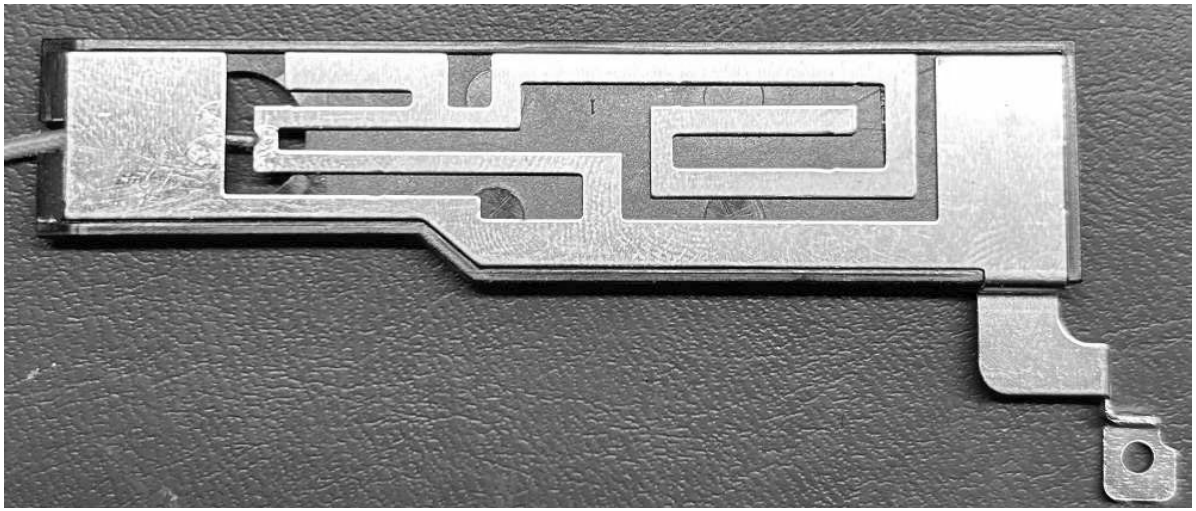
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Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
7[e]	a minimum-sized parallelepiped completely enclosing a volume of the first non-planar antenna,	T60 expressly or inherently discloses this claim element. *See, e.g.*,  
7[f]	the minimum-sized parallelepiped having a face with a largest area;	T60 expressly or inherently discloses this claim element. *See e.g.,* 
7[g]	a second antenna proximate to a second side of the ground plane rectangle, and	T60 expressly or inherently discloses this claim element. *See, e.g.*, The T60 includes a second antenna (purple below) proximate to a second side of the ground plane rectangle.

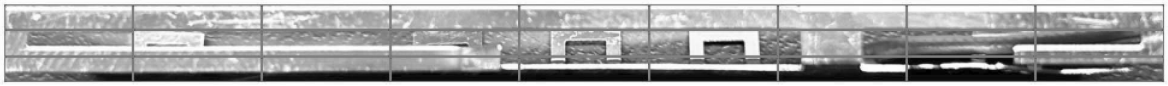
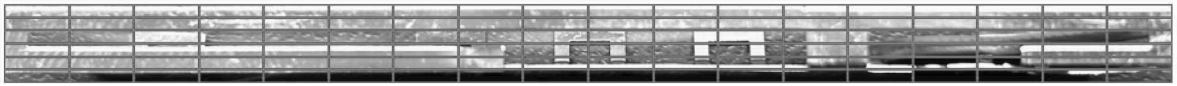
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		

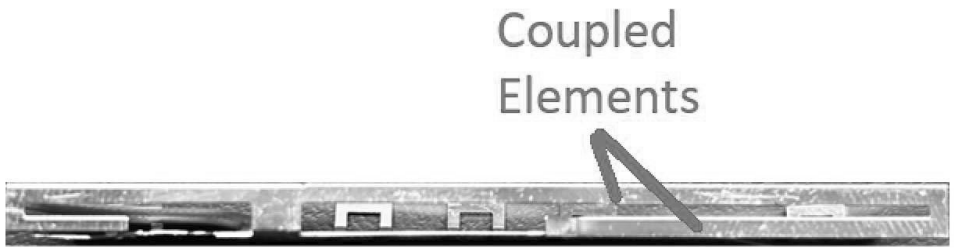
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		
7[h]	wherein the second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands;	T60 expressly or inherently discloses this claim element. *See e.g.,* The second antenna is configured to receive signals from at least two frequency bands of the at least three frequency bands. The second antenna is configured to receive signals from at least two frequency bands at least within 880-960 MHz and 1850-1990 MHz.
7[i]	wherein the first non-planar antenna	T60 expressly or inherently discloses this claim element.

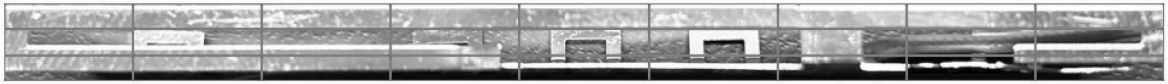
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	has a first contour defined as a perimeter of any portions of the first non-planar antenna arranged in the face, perimeters of any closed apertures of any portions of the first non-planar antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first non-planar antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	*See e.g.,* The first non-planar antenna has a first contour defined as a perimeter of any portions of the first non-planar antenna arranged in the face, perimeters of any closed apertures of any portions of the first non-planar antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first non-planar antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection. 
7[j]	wherein the first contour has a level of complexity defined by	T60 expressly or inherently discloses this claim element. *See, e.g.*,

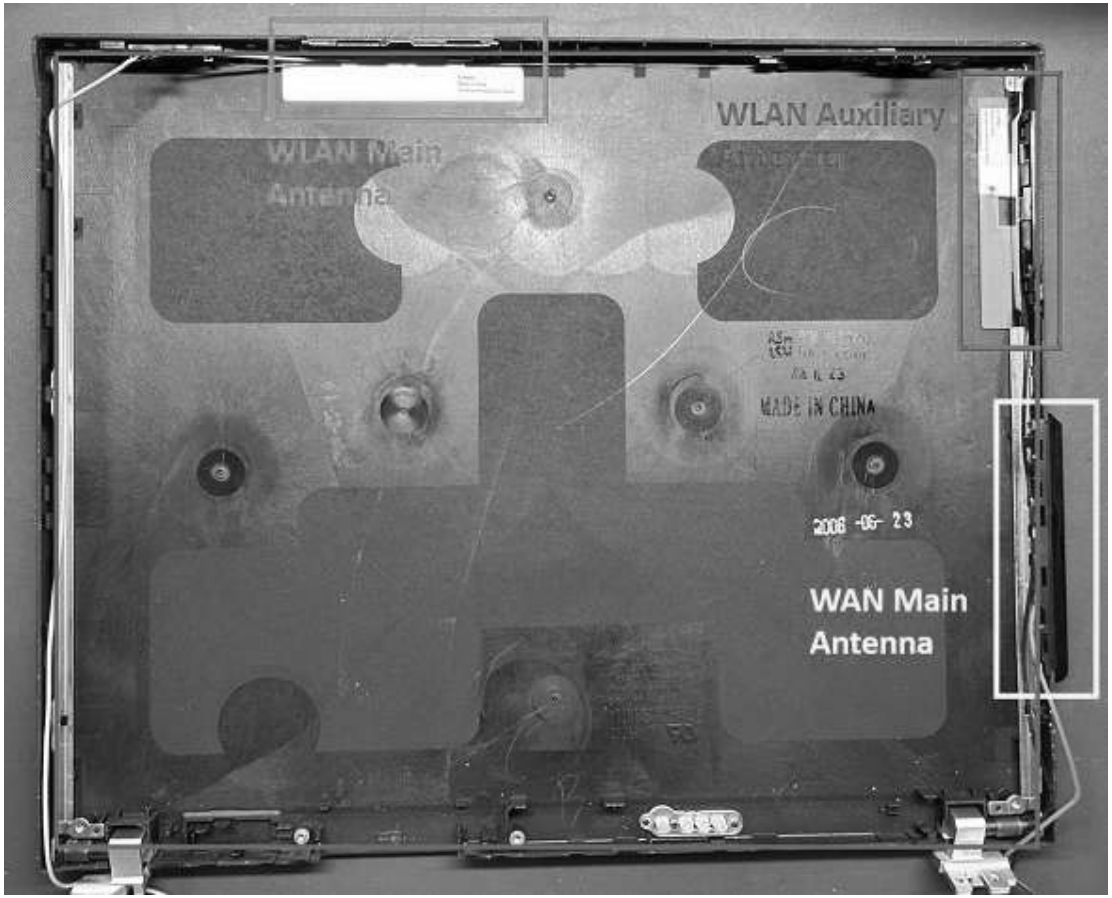
Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	complexity factor F_{21} having a value of at least 1.20 and	The first contour has a level of complexity defined by complexity factor F21 having a value of at least 1.20 and complexity factor F32 having a value of at least 1.75. See also Claim 7[l] below, which provides the formula used for this calculation. N1=10  N2=23  N3=67  F21=log(23/10)/log(2)=1.2 F32=log(67/23)/log(2)=1.54 The complexity factor calculation is performed according to the method in the patent.
7[k]	complexity factor F_{32} having a value of at least 1.35;	T60 expressly or inherently discloses this claim element. *See* Claim 7[j].

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
7[l]	Wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal	T60 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j].

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights that respectively are double the widths and heights of the cells of the grid G2, and	
7[m]	wherein the level of complexity of the first contour is	T60 expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	configured to provide operation of the wireless device in the at least three frequency bands.	*See* Claims 1[d], 1[k].
		Claim 8
8	The wireless device of claim 7, wherein the first non-planar antenna includes at least two antenna elements that are electromagnetically coupled.	T60 expressly or inherently discloses this claim element. *See e.g.,* The first non-planar antenna includes at least two antenna elements that are electromagnetically coupled. 
		Claim 9
9	The wireless device of claim 7, wherein the complexity	T60 expressly or inherently discloses this claim element.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	factor F_{32} for the first contour is smaller than 1.75.	*See e.g.,* the complexity factor F_{32} for the first contour is smaller than 1.75. N1=10  N2=23  N3=67  F21=log(23/10)/log(2)=1.2 F32=log(67/23)/log(2)=1.54 The complexity factor calculation is performed according to the method in the patent.
		Claim 10
10[a]	The wireless device of claim 7, wherein a third antenna is configured to	T60 expressly or inherently discloses this claim element. *See, e.g.*,

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	operate in at least two frequency bands being different from the at least three frequency bands and	A third antenna (red below) arranged within the T60 is configured to operate in at least two frequency bands being different from the at least three frequency bands. 

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		 The third antenna of the Lenovo T60 is configured to operate in at least two frequency bands within at least at least 2.4-2.484 GHz, 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.725-5.875 GHz.
10[b]	the third antenna is arranged within the wireless device.	T60 expressly or inherently discloses this claim element. *See* Claim 10[a].
Claim 12		
12	The wireless device of claim 7, wherein the first side of the ground plane rectangle is a short side of the ground plane rectangle.	T60 expressly or inherently discloses this claim element. *See* Claim 7[c].
Claim 13		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
13[pre]	A wireless device comprising:	To the extent the preamble is limiting, T60 expressly or inherently discloses this claim element. *See* Claim 1[pre], 7[pre].
13[a]	a ground plane;	T60 expressly or inherently discloses this claim element. *See* Claim 1[a], 7[a].
13[b]	a first antenna	T60 expressly or inherently discloses this claim element. *See* Claim 1[b], 7[b].
13[c]	proximate to a first side of a ground plane rectangle enclosing the ground plane,	T60 expressly or inherently discloses this claim element. *See* Claim 1[c], 7[c].
13[d]	the first antenna being configured to support at least three frequency bands of the electromagnetic spectrum,	T60 expressly or inherently discloses this claim element. *See* Claim 1[d], 7[d].

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13[e]	a minimum-sized parallelepiped completely enclosing a volume of the first antenna,	T60 expressly or inherently discloses this claim element. *See* Claim 7[e].
13[f]	the minimum-sized parallelepiped having a face with a largest area;	T60 expressly or inherently discloses this claim element. *See* Claim 7[f].
13[g]	a second antenna proximate to a second side of the ground plane rectangle	T60 expressly or inherently discloses this claim element. *See* Claim 1[g], 7[g].
13[h]	configured to receive signals from at least two frequency bands of the at least three frequency bands,	T60 expressly or inherently discloses this claim element. *See* Claim 1[h], 7[h].
13[i]	wherein the first antenna has a first	T60 expressly or inherently discloses this claim element.

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	contour defined as a perimeter of any portions of the first antenna arranged in the face, perimeters of any closed apertures of any portions of the first antenna arranged in the face, a perimeter of an orthogonal projection onto the face of any portions of the first antenna that are not arranged in the face, and perimeters of any closed apertures of the orthogonal projection;	*See* Claim 1[i], 7[i].
13[j]	wherein the first contour has a level of complexity defined by complexity factor	T60 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j], 7[j].

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	F_{21} having a value of at least 1.20 and	
13[k]	complexity factor F_{32} having a value of at least 1.35; and	T60 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j], 7[k].
13[l]	wherein the complexity factors F_{21} and F_{32} are given by: $F_{21} = -\frac{\log(N_2) - \log(N_1)}{\log(1/2)}$ $F_{32} = -\frac{\log(N_3) - \log(N_2)}{\log(1/2)}$ where N1 is a number of cells of a grid G1 that include at least a point of the first contour, N2 is a number of cells of a grid G2 that include at least a point of the first	T60 expressly or inherently discloses this claim element. *See* Claims 1[f], 1[i]-[j], 7[l].

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	contour, and N3 is a number of cells of a grid G3 that include at least a point of the first contour, the grid G2 divides the face into nine columns of equal width arranged along a long side of the face and an odd number of rows of equal height arranged along a short side of the face, wherein the number of rows results in the cells of grid G2 being as square as possible, the grid G1 being aligned with a corner of the grid G2 to cover the face, the cells of grid G1 having widths and heights	

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	that respectively are double the widths and heights of the cells of the grid G2, and the grid G3 being aligned with the grid G2, the cells of the grid G3 having widths and heights that respectively are half the widths and heights of the cells of the grid G2, and	
13[m]	wherein the level of complexity of the first contour is configured to provide operation of the wireless device in the at least three frequency bands.	T60 expressly or inherently discloses this claim element. *See* Claims 1[d], 1[k], 7[m].
Claim 14		

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
14	The wireless device of claim 13, wherein the first antenna includes at least two antenna elements that are electromagnetically coupled.	T60 expressly or inherently discloses this claim element. *See* Claim 2.
Claim 15		
15	The wireless device of claim 13, wherein the first antenna is planar.	T60 expressly or inherently discloses this claim element. *See* Claim 1[b].
Claim 17		
17	The wireless device of claim 13, wherein the complexity factor F_{32} for the first contour is smaller than 1.75.	T60 expressly or inherently discloses this claim element. *See* Claim 5.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
		Claim 18
18[a]	The wireless device of claim 13, wherein a third antenna is configured to operate in at least two frequency bands being different from the at least three frequency bands and	T60 expressly or inherently discloses this claim element. *See* Claim 10.
18[b]	the third antenna is arranged within the wireless device.	T60 expressly or inherently discloses this claim element. *See* Claim 10.
		Claim 19
19	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a short side of the	T60 expressly or inherently discloses this claim element. *See* Claim 3.

Claim No.	U.S. Patent No. 12,095,149 B2	Lenovo T60
	ground plane rectangle.	
	Claim 20	
20	The wireless device of claim 13, wherein the first side of the ground plane rectangle is a long side of the ground plane rectangle.	T60 expressly or inherently discloses this claim element. *See* Claim 4. Moreover, two of the antennas in the Lenovo T60 (red and blue below) have substantially the same complexity factor and frequency band coverage, such that one of the antennas may be the first antenna disposed proximate to the short side of the ground plane rectangle or the other of the antennas may be the first antenna disposed proximate to the long side of the ground plane rectangle.

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